IONQ (NYSE: IONQ)

The "World's Most Powerful Quantum Computer" Is A Hoax With Staged Nikola-Style Photos – An Absurd VC Pump With A Recent Lock-Up Expiration Takes SPAC Abuses To New Extremes

- **A part-time side-hustle run by two academics who barely show up, dressed up as a "company"**
- **A useless toy that can't even add 1+1, as revealed by experiments we hired experts to run**
- **Fictitious "revenue" via sham transactions and related-party round-tripping**
- **A scam built on phony statements about nearly all key aspects of the technology and business**
- **CEO appears to be making up his MIT educational credentials**

$1.6B market cap | $8/share | ADV 6.4MM shares | Short interest 7mm shares **5/2/22 per Capital IQ*

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Part I: IonQ claims to have the "World's Most Powerful Quantum Computer," launched with great fanfare in 2020 as "the culmination of two decades of academic research." We believe the machine doesn't exist and that the announcement was part of an ongoing pattern of fraud that its CEO and co-founders are now trying to cover up.

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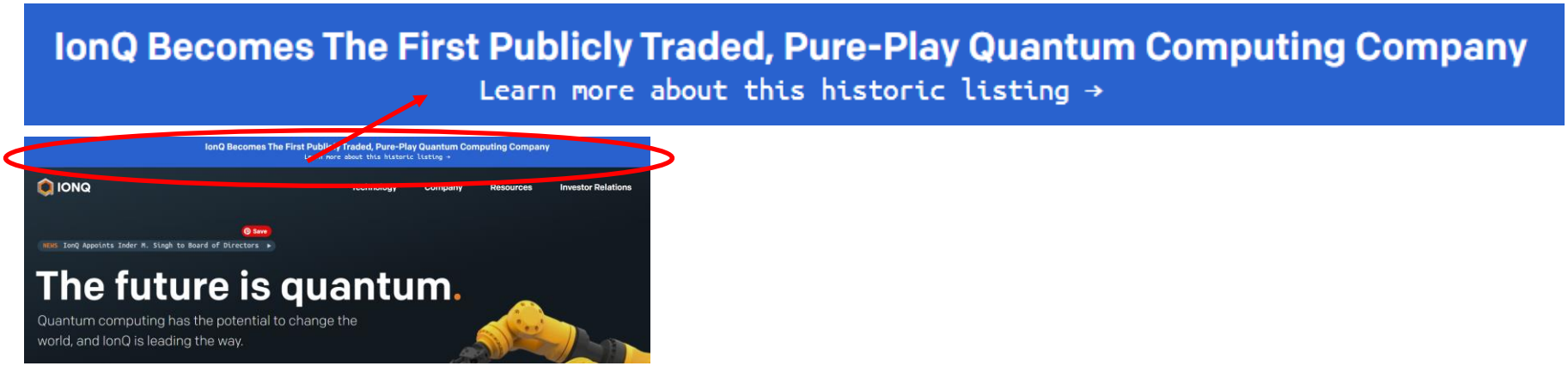
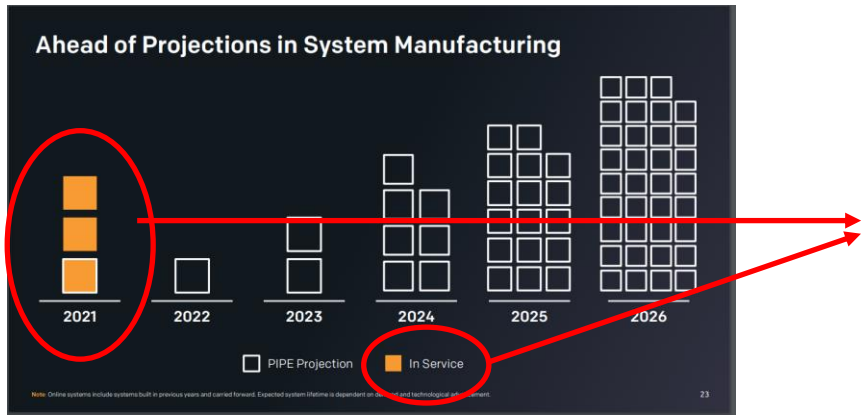
IonQ listed via a SPAC in October 2021 as "The First Publicly Traded, Pure-Play Quantum Computing Company," a "historic listing" as the company reminds every sucker with a banner on its homepage. The market loves a pure play, fueling a short-lived run to $36/share. Despite an 80% fall to $8, it still sports a preposterous market cap of $1.6B. The investor presentation indicates they only have three quantum computers in service, implying >$500 million of market cap per machine.

IonQ homepage



IonQ investor presentation indicates only 3 quantum computers "In Service"



Each orange box appears to represent a quantum computer in service

Source: IonQ website Jan 2022, cached copy https://web.archive.org/web/20220122164236/https://ionq.com/; IonQ Sept 2021 investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/09/IonQ_Investor_Presentation_-_Sept_2021_Updates_v092121.pdf

We're surprised it took until 2021 for the world's first quantum computing IPO, given that – like sightings of Bigfoot, Loch Ness, and the Yeti – researchers like IonQ's founders have been providing "scientific proof" for decades. We note proclamations going back 30 years that quantum computers are on the verge of transforming the world. A 1994 article in Science stated that "Quantum Computing Creeps Closer to Reality." A 2011 article: "Practical Quantum Computers Creep Closer to Reality."

1994 article in Scientific American

Quantum Computing Creeps Closer to Reality

2011 article in IEEE Spectrum

Practical Quantum Computers Creep Closer to Reality ›Physicists find quantum

2016 article in Science

Scientists are close to building a quantum computer that can beat a conventional one

2017 article in industry journal

Toward Mass-Producible Quantum Computers

2017 article in Bloomberg

Quantum Computing Might Be Here Sooner Than You Think

2018 article in industry journal

The Era of Quantum Computing Is Here.

Source: https://www.scientificamerican.com/article/quantum-computing-creeps-closer-to/; https://spectrum.ieee.org/practical-quantum-computers-creep-closer-to-reality; https://www.science.org/content/article/scientists-are-close-building-quantum-computer-can-beat-conventional-one; https://zephyrnet.com/toward-mass-producible-quantum-computers/; : https://www.bloomberg.com/news/features/2017-06-14/the-machine-of-tomorrow-today-quantum-computing-on-the-verge; https://www.quantamagazine.org/the-era-of-quantum-computing-is-here-outlook-cloudy-20180124/

IonQ's top holders are the some of the usual purveyors of SPAC trash. The largest holder is Silicon Valley venture capital firm NEA, which was one of the largest holders in Allakos (ALLK) when we exposed it in a report. They remain on the board. The stock is down 97%, erasing $7B of market cap after one of the largest one day blowups in biotech history. Of course no charade is complete without Softbank popping up as a top holder, and it appears that Silver Lake, Google, and Michael Dell's family office have been bamboozled as well. We further note the Quantumscape (QS) CEO's appearance on IonQ's advisory board. We published a report on that SPAC last year, which is down 61% since.

Top holders per Capital IQ

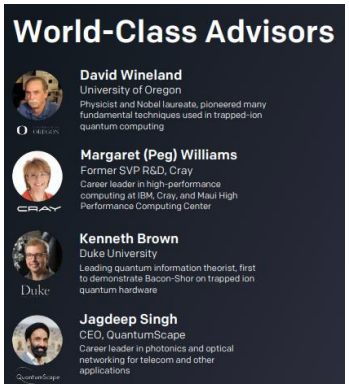
Latest Holders

Holder	Common Stock Equivalent Held	% Of CSO	Market Value (USD in mm)
New Enterprise Associates, Inc.	29,326,045	14.835	230.8
You, Harry L. Independent Director	7,425,000	3.756	58.4
Kim, Jungsang Chief Strategy Officer & Director	7,232,043	3.659	56.9
Monroe Ph.D., Christopher Chief Scientist	6,534,138	3.305	51.4
SoftBank Investment Advisers (UK) Limited	6,138,729	3.105	48.3
Alphabet Inc. (NasdaqGS:GOOGL)	4,556,532	2.305	35.9
Osage University Partners	4,147,081	2.098	32.6
Silver Lake Management, L.L.C.	4,000,000	2.024	31.5

Softbank announcement; IonQ's advisory board members

SoftBank and IonQ in Strategic Pact on Quantum Computing

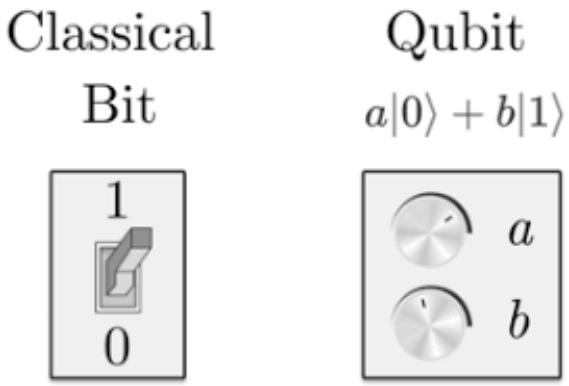
The giant Japanese tech investor has taken a large stake in the Maryland start-up to eventually bring quantum-computing power to other SoftBank portfolio companies



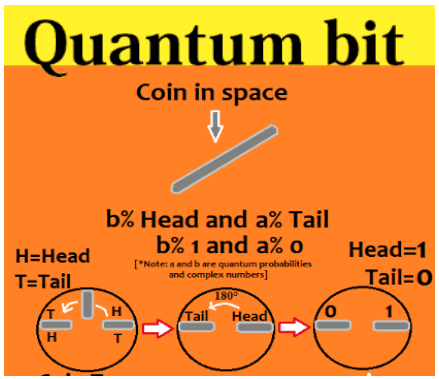
Source: Capital IQ data; https://www.wsj.com/articles/softbank-and-ionq-in-strategic-pact-on-quantum-computing-11623192815

Quantum computers have remained a science fiction fantasy since they were dreamed up in 1980, with the exception of primitive lab contraptions for R&D tinkering. Periodically scams like IonQ come along and claim to have one on the verge of solving the world's problems. Regular computers use binary digits called "bits" to represent information as 0's and 1's. Their CPU chips manipulate vast numbers of 0's and 1's using millions of tiny transistors. Quantum computers are based on the idea of a quantum bit called a "qubit." While regular bits can be either 0 or 1, a qubit can be in a continuum of states such 0 or 1 or both simultaneously. Therefore, a qubit can hold more values than a bit and pack more information: one qubit is as powerful as two regular bits; two qubits are as powerful as four bits; etc. A simple analogy and a harder one:

A BIT is like a toggle switch that can only be on or off, while a QUBIT is like a dial that can be on, off, or any combination in between



A BIT is like a coin on a table (a two dimensional surface) that can be heads or tails, while a QUBIT is like a coin flipped in the air (a three dimensional space) and can be X% heads and Y% tails simultaneously depending on its spin and angle



Source: https://brilliant.org/practice/quantum-bits/; https://byte-man.com/quantum-of-computer/

Quantum computers are measured by two key metrics: the number of qubits, and the quality or error rates ("fidelity") of these qubits. IonQ has a legacy 11-qubit computer that researchers can tinker with via Amazon Web Services, Microsoft Azure, and Google Cloud. It also claims to have "deployed" its mysterious 32-qubit system in 2020. Leading quantum experts indicate that a minimum of 1,000 to 100,000 qubits are needed for a useful machine. To date, all quantum computers ever made - whether by IonQ, Google, IBM, Honeywell, or countless competitors – barely have any qubits and remain similar to vacuum tube devices circa 1940. Illustrating the delusion of a useful quantum device, Los Alamos Lab claimed to have a 7-qubit system in 2000 with 10 qubits around the corner. Twenty-two years later, IonQ has barely added any more qubits.

Article in the year 2000 in MIT Technology Review indicates a 7-qubit quantum computer

In the meantime, however, Chuang and his fellow experimenters are far less concerned with their machines' physical size than with their qubit count. "The first year we had lots of wonderful one-qubit machines popping up all over the place," he says. "Now at IBM we have a three-qubit computer, and we're planning even larger computers." In March, Los Alamos National Laboratory announced a seven-qubit NMR computer, and Chuang is confident that one lab or another will soon be demonstrating molecules with as many as 10 qubits. He concedes that this

Yet a truly useful quantum computer will need hundreds or even thousands of qubits. Presumably, says Chuang, that means some kind of

"…announced a seven-qubit NMR computer…"

"…will soon be demonstrating molecules with as many as 10 qubits…"

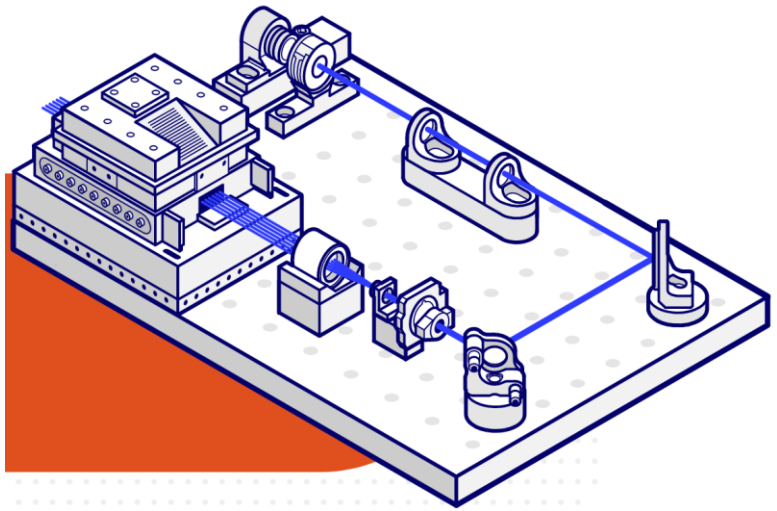
Source: https://www.technologyreview.com/2000/05/01/236302/quantum-computing/

Qubits can be made in at least two dozen different ways, using various properties like an electron's spin, an atom's state, or a molecule's vibration to simulate the bits inside regular computer chips. Countless large players, startups, and academic labs each have their own flavor of qubit using this particle or that along with the requisite bickering and bluster. IonQ's "trapped ion" approach uses charged particles suspended in an electromagnetic field and manipulated with lasers. Ion traps are one of the oldest technologies, invented in the 1950's, per Wikipedia. A cache of IonQ's site from 2019 shows a tabletop resembling a Willy Wonka or steampunk factory, with lasers and Nikon-like lenses: "In 2019, leading companies will start investigating real-world problems in chemistry, medicine, finance, logistics, and more using our systems."

IonQ website Dec 12, 2019, as cached by Internet Archive

The World's Most Advanced Quantum Computer

Our quantum cores use lasers pointed at individual atoms to perform longer, more sophisticated calculations with fewer errors than any quantum computer yet built. In 2019, leading companies will start investigating real-world problems in chemistry, medicine, finance, logistics, and more using our systems.



Source:;https://web.archive.org/web/20191212082755/https://ionq.com/; https://en.wikipedia.org/wiki/Trapped_ion_quantum_computer

As we researched the space, we noticed a recent flood of articles by leading scientists in the field, who blasted the current hype and IonQ specifically: "It is clear to me that the IonQ SPAC has gone too far in what is…morally acceptable." Some of the op-eds and papers further explain why a usable, error-corrected quantum computer is a mathematical fallacy and actually impossible. We often short fraudulent "science projects" in biotech or technology, but it's highly unusual to see prominent academics calling out the ethics of some of their own peers.

Revolt! Scientists Say They're Sick of Quantum Computing's Hype

Source: https://www.wired.com/story/revolt-scientists-say-theyre-sick-of-quantum-computings-hype/

Mitigating the quantum hype

https://arxiv.org/ftp/arxiv/papers/2202/2202.01925.pdf

QC ethics and hype: the call is coming from inside the house

Source: https://scottaaronson.blog/?p=5387

Is Quantum Tech All Hype?

Source: https://builtin.com/software-engineering-perspectives/quantum-tech-hype

Quantum Computing: More Hype Than Reality?

Source: https://medium.com/one-pale-blue-dot/quantum-computing-more-hype-than-reality-771812c5054f

Will Quantum Computing Ever Live Up to Its Hype?

Source: https://www.scientificamerican.com/article/will-quantum-computing-ever-live-up-to-its-hype/

As examples of the backlash in the quantum community toward IonQ's claims, we noted blistering articles by two professors and colleagues of IonQ founder Chris Monroe at the University of Maryland. Monroe remains a UMD professor as well at Duke, a full time academic role along with his C-level role at IonQ. The authors are prominent with one having authored over 100 technical papers. They state they are "disturbed" by the "hype"; label it a "quantum Ponzi scheme" to "lure unsuspecting investors" with "fake science"; "a bubble" which may "crash" and take "legitimate" research "down with it"; "crazy headlines" and "false expectations" that are "not based on any research or reality"; and provide myriad technical reasons for why such computers may be impossible or at least decades or centuries away.

July 2021 article by UMD Professor Victor Galitski, Joint Quantum Institute

Quantum Computing Hype is Bad for Science

Source: https://www.linkedin.com/pulse/quantum-computing-hype-bad-science-victor-galitski-1c/

March 2022 article by UMD Chair in Physics and Distinguished University Professor Sankar Das Sharma, Joint Quantum Institute

Quantum computing has a hype problem

Quantum computing startups are all the rage, but it's unclear if they'll be able to produce anything of use in the near future.

Source: https://www.technologyreview.com/2022/03/28/1048355/quantum-computing-has-a-hype-problem/

Many of these papers lay out the elephant in the room, the key scientific falsehood at the core of the "quantum Ponzi scheme": decoherence and the mathematical impossibility of ever being able to correct for it. Decoherence is the process by which quantum states – that is, the qubits - rapidly collapse because of noise, causing errors to spin out of control. Some theorists have envisioned a way out of this plight called "quantum error correction" that uses large numbers of qubits for error correction and others for computation. A famous physicist explains below that the scheme requires processing 10^{300} variables: "to repeat, a useful quantum computer needs to process a set of continuous parameters that is larger than the number of subatomic particles in the observable universe."

IEEE Spectrum article by Mikhail Dyaknov, a professor of physics

"I'm skeptical that these efforts will ever result in a practical quantum computer*…Could we ever learn to control the more than 10^{300} continuously variable parameters defining the quantum state of such a system?* ***My answer is simple. No, never****. I believe that, appearances to the contrary, the quantum computing fervor is nearing its end… All these problems, as well as a few others I've not mentioned here, raise serious doubts about the future of quantum computing"*

Source: https://cslab.pepperdine.edu/warford/cosc425/The-Case-Against-Quantum-Computing.pdf; https://spectrum.ieee.org/the-case-against-quantum-computing

One prominent scientist in the field after another – including ex-employees of IonQ we interviewed – echoes this view, forcefully stating that quantum computers can't even work in principle, given that quantum decoherence undermines the entire theory. Anyone searching with the keywords "quantum computing" and "decoherence" or "hype" quickly encounters a barrage of papers by quantum computing insiders – researchers who have dedicated their careers only to arrive at the bitter truth. As an example, we note an interview with a mathematics professor at Yale and in Israel, who has studied decoherence for a decade. He states he was initially "quite enthusiastic, like everybody else" and then expounds on decoherence and "the mirage" of quantum computing.

Interview with Yale mathematician who has studied quantum coherence for a decade - excerpts

The Argument Against Quantum Computers

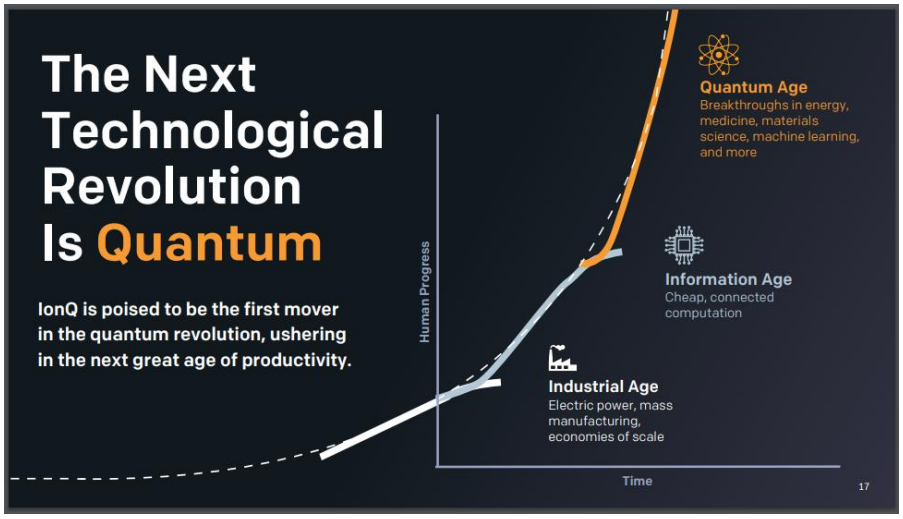
The mathematician Gil Kalai believes that quantum computers can't possibly work, even in principle.

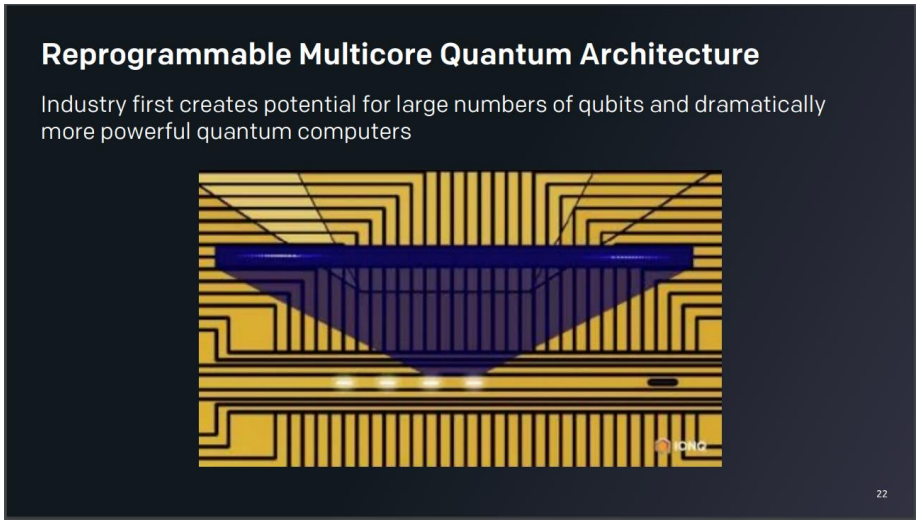
"…Kalai, a mathematician at Hebrew University in Jerusalem, is one of the most prominent of a loose ***group of mathematicians, physicists and computer scientists arguing that quantum computing, for all its theoretical promise, is something of a mirage****. Some argue that there exist good theoretical reasons why the innards of a quantum computer — the "qubits" — will never be able to consistently perform the complex choreography asked of them. Others say that the machines* ***will never work*** *in practice, or that if they are built, their advantages won't be great enough to make up for the expense."*

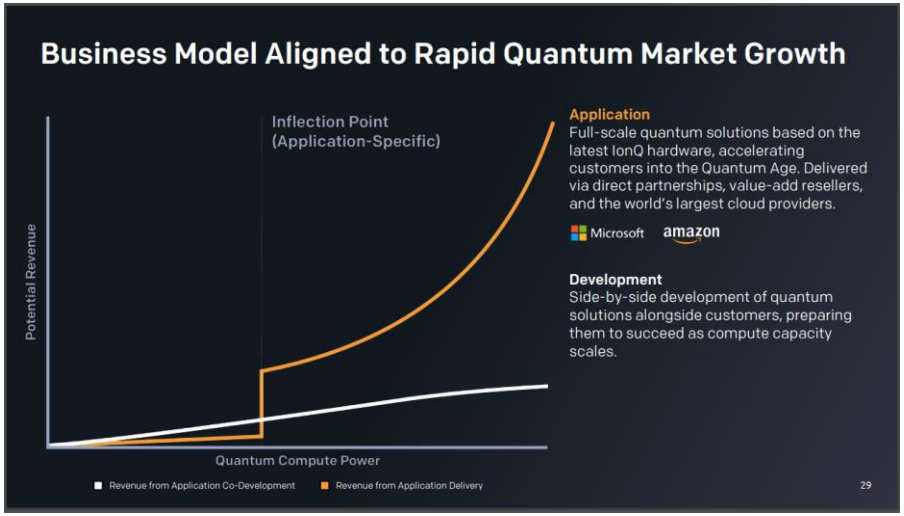
Source: https://www.quantamagazine.org/gil-kalais-argument-against-quantum-computers-20180207/#comments

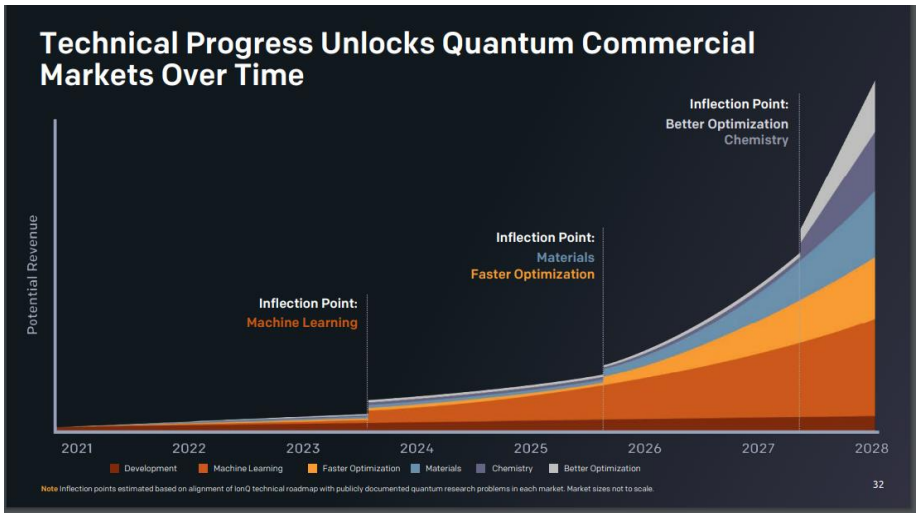
As we read IonQ's presentations, we noticed that the claims are stunning and in large font, yet the slides look like the SPAC version of an illustrated children's book – stuffed with make-believe hockey sticks on seemingly every other page and futuristic conceptual renderings.

Example slides from IonQ's investor presentations









Source: IonQ investor presentations https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/09/IonQ_Investor_Presentation_-_Sept_2021_Updates_v092121.pdf

We further noticed that slide after slide makes over-the-top claims, only to have tiny footnotes at the bottom that flatly contradict them. For example, the company boasts that its "Technical Roadmap Paves the Way for Its Leadership in Quantum Computing." Comically, the adjoining paragraph strongly disavows the roadmap, saying that "for the avoidance of doubt" it is "not incorporated into, and does not form part of, this registration statement." We think the reason is clear: the roadmap makes phony claims about the number of qubits, and IonQ is attempting a dubious legal out.

Roadmap slide from SPAC deck

Prospectus promotes the roadmap while at the same time disavowing it - excerpts

IonQ's Technical Roadmap Paves the Way for Its Leadership in Quantum Computing

IonQ's technical roadmap was designed to provide **transparent guidance** to its quantum computer users regarding when IonQ expects certain quantum computing capabilities to become available. The #AQ metric provides a simple and effective measure to estimate the computational power of each generation of quantum computers.

IonQ's Forward-Looking Roadmap

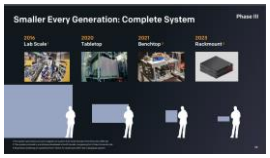
In December 2020, IonQ publicly released a forward-looking technical roadmap for the next eight years. **For the avoidance of doubt, the IonQ roadmap is not incorporated into, and does not form part of, this registration statement.**

Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf; roadmap announcement https://ionq.com/posts/december-09-2020-scaling-quantum-computer-roadmap; prospectus https://www.sec.gov/Archives/edgar/data/1824920/000119312521098621/d70340ds4.htm

The number of footnotes that backtrack on the roadmap slide is telling. Another slide represents their 2021 computer as the size of an adult's torso, but a footnote says it's merely a prototype – and not at IonQ. The same slide says their machine will be down to a slim rack-size machine next year, but the footnote says it's just an "illustrative rendering" and "not a designed system." A comparative slide shows that IonQ's "quantum volume" is off the scale higher than any competitor's, but the footnote says their "data is not comparable with other vendors." A particularly absurd slide shows a dime-sized quantum chip by next year – yet the footnote says it's "a project of MIT Lincoln Labs, not IonQ. Used for illustrative purposes only."

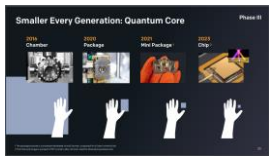
Excerpts from IonQ investor presentations showing footnotes that backtrack on each slide

Note Prepared on the basis of certain technical, market, competitive and other assumptions to be subsequently described in further detail, and which may not be satisfied. As a result, these projections are subject to a high degree of uncertainty and may not be achieved within the time-frames described or at all.
Note Market inflection points are estimated based on alignment of IonQ technical roadmap with publicly documented quantum research problems in each market
1 Algorithmic qubit number defined as the effective number of qubits for typical algorithms, limited by the 2Q fidelity
2 Employs 16:1 error-correction encoding
3 Employs 32:1 error-correction encoding



1 The system pictured is an early trapped ion system from IonQ founder Chris Monroe's UMD lab.
2 The system pictured is a prototype developed at IonQ founder Jungsang Kim's Duke University lab.
3 Illustrative rendering of a potential form-factor for rackmount QPU. Not a designed system.

1 Estimated quantum volume of IonQ's 5th generation system — assumes 32 qubits with 99.9% fidelity two-qubit gates based on internal preliminary results
2 Publicly announced quantum volume based on experimental results: Honeywell announcement, IBM announcement
3 Estimation based on published qubit counts and fidelity
4 Not possible to calculate — either not a universal gate set quantum computer (D-Wave), years from first working prototype, or unproven hardware approach
Note Table reflects different inputs and sources and thus company data is not comparable with other vendors



1 The package pictured is a prototype developed at IonQ founder Jungsang Kim's Duke University lab.
2 This chip and image is a project of MIT Lincoln Labs, not IonQ. Used for illustrative purposes only.

Source: IonQ investor presentations; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/09/IonQ_Investor_Presentation_-_Sept_2021_Updates_v092121.pdf; https://s28.q4cdn.com/828571518/files/doc_presentation/2022/March-2022-Investor-Updates_v09.pdf

IonQ is based in Maryland and was founded by two professors, Chris Monroe and Jungsang Kim, who are Chief Scientist and CTO, respectively. Ex-employees indicate they still run the show despite rarely showing up, along with an absentee, figurehead CEO based in Seattle with no grasp of quantum computing. Tellingly, neither Monroe or Kim has left his full-time university role or the teaching load, grad students, and research labs involved. Although IonQ was only founded in 2016, it already seems to be on its third CEO. The first appears to be a physics PhD who only lasted two years. An ex-employee opined that he was fired because he "avoided the quantum hype"; "I guess he wasn't hype enough. And then this guy came in and just set up a SPAC."

Current IonQ CEO, Peter Chapman

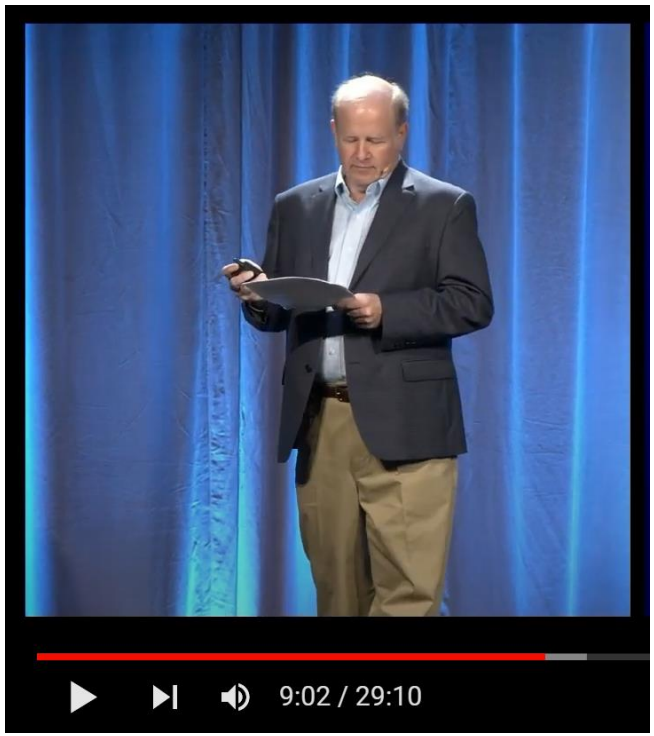
Ex-employee opines that previous CEO was fired because he wasn't promotional enough

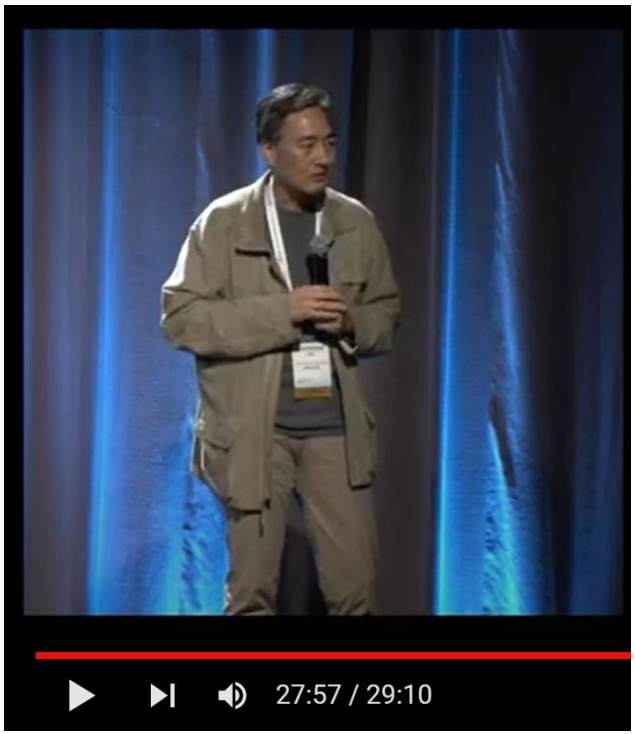
"I thought Dave Moehring ran things very well. I was shocked to hear that he was fired. I thought he was a great CEO when I was there. He was one of the main people who avoided the quantum hype. He was very grounded in what we can do and what they should pitch that they're doing. I guess ***he wasn't hype enough. And then this guy came in and just set up a SPAC, just to go public****. I can imagine people would be concerned about that." – Ex-IonQ employee, member of technical staff*

Source: screenshot from https://www.youtube.com/watch?v=FiaACOJ74s8; Scorpion Capital consultation calls with experts

The "guy who came in and just set up a SPAC" is CEO Peter Chapman. As we began to investigate IonQ, we noticed that he appeared befuddled during public appearances and on TV when trying to "talk quantum." He gave a talk where he appeared to be reading a script, and then was confronted by an audience member who suggested IonQ's performance benchmarks were contrived garbage. After trying to evade the question with vague statements only to be challenged again, he looked like a deer stuck in the headlights and punted to IONQ co-founder Kim, who looked equally nervous.

Clips from a YouTube video of IonQ presentation at a quantum computing conference. Chapman is challenged at 25:50.

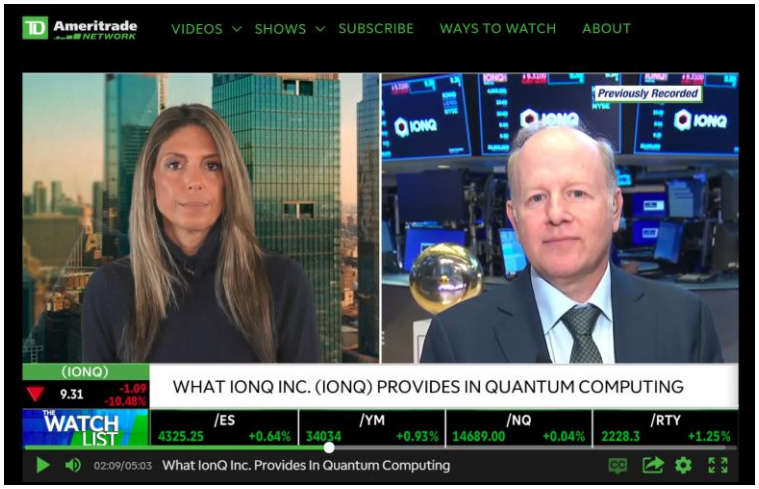




Source: https://www.youtube.com/watch?v=XhYgRu2J0aE

Chapman's only role seems to be to pump the stock on as many TV promos as he can get. We noticed striking discrepancies and red flags each time he spoke, suggestive of a company lying wildly to investors. In a recent interview, he stated that "Um so we have um thousands of customers that run jobs on our hardware every week," yet IonQ reports trivial revenue. He indicated in another interview that they charge "several thousand dollars per hour for compute hours." With thousands of customers running jobs "every week" at a price of "several thousand" per hour, we would expect $100MM+ revenue. Yet, IONQ reported only $451K of YTD revenue around the time the claims were made in late 2021.

Chapman claims IonQ has thousands of customers, 2:04 into the interview



Source: https://tdameritradenetwork.com/video/rB4A-Hw7FV2BfD0raQYAJA

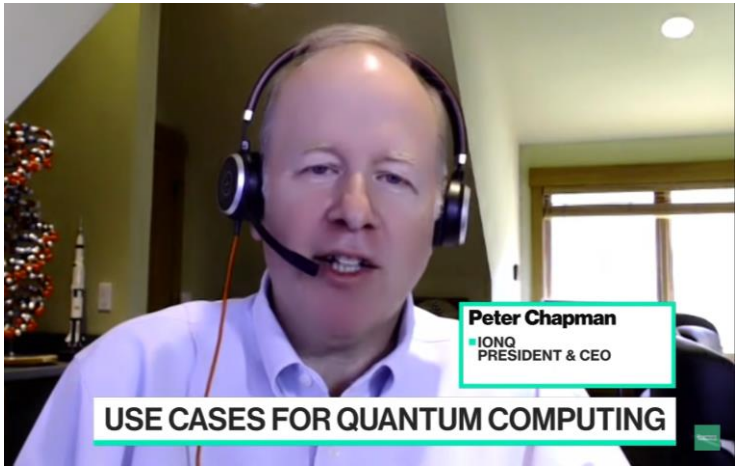
…and that they charge "several thousand dollars per hours" for compute time

Michael Kesslering: *So then when you kind of talked about some of the use cases and who the customer set would be, what sort of pricing model are you using for those customers?*
Peter Chapman: *Today, the pricing model is competitive with kind of supercomputing pricing, meaning* ***basically several thousand dollars per hour*** *for compute hours.*

Source: https://acceleratesshares.com/podcasts/absolute-return-podcast-168-leadership-chat-ionq-ceo-peter-chapman/

As short-sellers we traffic in CEO's who lie, but we rarely encounter ones who make bogus claims as recklessly and compulsively as Chapman, or ones as oblivious to the legal jeopardy. We further observed a troubling level of hubris, a related trait prevalent in the leadership of frauds that we short. In one interview, he states that "You know, people have said that IonQ is like, buying into Intel in the early days. I think it's actually closer to Nvidia, you know." In another, he indicated a lack of competitors and that IonQ has "the field to ourselves" – a bizarre claim given competition from Google, IBM, Honeywell, and countless others – and stated that "many people expect that quantum computers will be able to solve many of mankind's kind of grand challenges." Since he suggests there are no other players, we presume that IonQ is this presumptive savior.

Chapman claims quantum computing will solve man's greatest challenges, 1:29 in



Source: https://www.youtube.com/watch?v=par38CPdyMU

*"Well you know, quantum computing many people expect that quantum computers **will be able to solve many of mankind's kind of grand challenges**, everything from direct carbon capture, to new drug discovery, new batteries, solving strong AI, improving machine learning. Since we're talking about just a much bigger computer, it's kind of **hard to say where it won't be used."***

Source: https://www.youtube.com/watch?v=par38CPdyMU

*"You know, people have said that IonQ is, **like buying into Intel** in the early days. I think it's actually closer to Nvidia, you know."*

Source: https://accelerateshares.com/podcasts/absolute-return-podcast-168-leadership-chat-ionq-ceo-peter-chapman/

Ex-employees confirmed our impression, painting Chapman as a habitual dissembler: "he says anything"; "it's just complete crap"; "Peter just lies"; "very little that he says that's the truth." Another indicated "worry in the company about hype and what Peter was saying," adding that his statements were "weird," not "grounded in reality," required damage control, that it "upsets the scientists at the company," and that his statements make "the scientists very uncomfortable."

Ex-executive stated the CEO "says anything" and that "it's just complete crap"

*"**He says anything**. I just read an interview with him in World Biz Magazine and he talked about it like he's excited by working with product managers. There are no product managers at IonQ. **It's just complete crap […] And they just continue to lie. Peter just lies. There's very little that he says that's the truth**." " - Former executive*

"Worry in the company" about the CEO's statements

*"At that point in time, obviously, it wasn't public yet, but there was **worry in the company about hype and what Peter was saying**. Like the "Wall Street Journal" and things like that. And there were a couple of times where Chris and Jungsang had to do a little bit of damage control because the CEO basically came in, and the company shifted pretty drastically from a very science-focused CEO to a very outward, wanting the company to be much more publicly known CEO. He made some comments in the "Wall Street Journal" about quantum theory and Siri Apple assistants and then made some comments about quantum computers solving rubric's cubes and things like that. Just kind of **weird things to make it more publicly hyped up that wasn't really grounded in reality.**" - Former employee, physicist*

CEO's statements make IonQ's scientists "upset" and "very uncomfortable"

*"One of the big things is **Peter sows all this hype in the community and in the public, and it upsets the scientists at the company. The scientists are kind of upset about the hype**. A lot of people, the fact that IonQ ever hit a $6 billion market cap was just really weird. And I think that made people in the company unsettled. Scientists are very about the data and saying it as it is. Peter is sometimes with these - that **makes the scientists very uncomfortable**. The time scales for something like that are just so much longer off. He had a talk a couple of years ago or a year ago where he talked about these rack-mounted computers at server farms, rack-mounted quantum computers at server farms. **And that really made people pretty uncomfortable**." - Former employee, physicist*

Source: Scorpion Capital consultation calls with experts

A leading researcher who has co-authored papers with IonQ's founders described Chapman as a "very dangerous combination" of a "salesman" and someone who "doesn't know" quantum computing, adding that "outside IonQ, people laugh at the kinds of things Peter Chapman says." He then listed specific claims Chapman has made which he stated were "obvious" to "everybody" as "not true" yet he doubled down by repeating them.

Chapman is a "dangerous combination" of a "salesman" and someone who "doesn't know" quantum computing

*"The current CEO is Peter Chapman. **He doesn't know quantum computation at all. And he's a salesman at the same time. This, in my opinion, is a very dangerous combination** because I have heard him say things that are just completely wrong. Outside IonQ, and I'm sure probably even inside IonQ because I know technical people at IonQ, and I understand that **they're worried. Outside IonQ, people laugh at the kinds of things that Peter Chapman says**." - Leading quantum computing researcher who has published papers with IonQ's founders*

Chapman's statements about IonQ's computer were "obvious" to "everybody" as "not true" yet he doubled down

*"Let me give an explicit example…and Peter Chapman came into the discussion and said that the quantum volume of their machine is 4 million. And the gap between a few hundred and 4 million is so huge that you just don't say such things if you have any basic understanding whatsoever of the meaning of what you're saying. Because if you're saying that the quantum volume of your machine is 4 million, then it is far, far more advanced than that of the competitors. **And it was obvious that it is not true to everybody**. For a period of time, people, including myself, thought that maybe he made a mistake and maybe he didn't mean it. But he **repeated this statement multiple times** because he doesn't seem to understand the basics of what he's saying." - Leading quantum computing researcher who has published papers with IonQ's founders*

Source: Scorpion Capital consultation calls with experts

In addition to a revolving door of CEO's, we noted abrupt and mysterious departures of key employees. Frauds tend to be fixated on high profile hires to add credibility, and it's common to see them quickly flee upon realizing they were fooled. In late 2020, IonQ trumpeted two critical hires, presumably as preparation for the SPAC: a VP of Software who was the head of Google's quantum computing software team, and a VP of Business Development. Both are widely-respected in the field, and IonQ's CEO announced them as "undeniable leaders in the quantum computing industry." Both departed rapidly and quietly with no announcement, the first we believe within a few months despite officially being there a year for optics purposes; and the second immediately after the SPAC.

IonQ press release Oct 29, 2020 announcing a new VP Software and VP Business Development

IonQ Hires Dave Bacon and Denise Ruffner

10/29/2020

IonQ announces Dave Bacon as new VP of Software and Denise Ruffner as new VP of Business Development

Dave Bacon LinkedIn bio excerpt indicates he left in a year, although an ex-employee stated he actually left within months

Vice President Software
IonQ · Full-time
Oct 2020 - Sep 2021 · 1 yr
Seattle, Washington, United States

Denise Ruffner LinkedIn bio excerpt indicates she left in a year, immediately after the SPAC

Vice President Of Business Development
IonQ Inc. · Full-time
Oct 2020 - Nov 2021 · 1 yr 2 mos
Pasadena, California, United States

Source: https://quantumzeitgeist.com/ionq-hires-vp-of-software-dave-bacon-and-vp-of-business-development-denise-ruffner/; https://www.linked; n.com/in/denise-ruffner-116246/; https://www.linkedin.com/in/dabacon/

Two ex-employees, both in senior roles and who we believe to be privy to the circumstances of the departures, alleged that the new VP of Software "had to lie more publicly" and "didn't like" that he was "asked to go on investor calls and tell stories." One detailed a third recent exit involving a scientist in a key role, who "challenged" the co-founders about what "what was there and what wasn't and they didn't want to hear it" – they "don't want to be challenged in any way."

Ex-employee in a senior role opined that Dave Bacon was asked "to lie more publicly" and "didn't like it"

*A: "Dave [redacted], "What the fuck?" [Redacted] sold a bill of goods. He's brilliant. And **he was asked to go on investor calls and tell stories. He didn't like it. I think Dave had to lie more publicly than [redacted] and didn't like it."***

*Q: "**Was Dave Bacon asked to say things that he felt would not be kosher or ethical?"***

*A: **"Yeah. Yeah**. In fact, Dave basically stopped working maybe six months in. He stopped working, and they wouldn't let him leave because it would be embarrassing to the company. So, Dave stopped working…he was very much of a team player who didn't want to embarrass the company but **wasn't really there even though his name was used."***

Q: "What was the scuttlebutt on the other staff there, like the technical staff?"

A: "Everybody's unhappy. There was never a real explanation given for Dave…there was never a lot of explanation or anything. It was just like, shut up and keep working and let's not talk about this."

Q: "Were there other notable departures?"

*A: "[Redacted] probably contributed over 50% of the IP at IonQ and is in most of the publications. He was very blunt about what was there and what wasn't there, and they didn't want to hear it. He would express things like our photonic interconnect, is it really going to work? He's very theoretical physics and **he would just challenge things and Chris and Jungsang don't want to be challenged in any way…He expressed skepticism** of obstacles and the projected time to achieve the obstacles…That was his skepticism." – Ex-senior employee*

Another ex-senior employee speculates that Dave Bacon may have left because of product misrepresentations

Q: "Why did Dave Bacon leave? What was your interpretation of why he left?"

*A: "He probably was promised a lot of different things when some of the leaders talked to him. I can totally imagine. I mean, I don't know whether that's actually the case. **And then he probably came in and opened the lid to see that there really aren't many things that they promised. Because at the end day, Dave Bacon is also a scientist at heart."***

Q: "When you say promises, what kinds of promises are you referring to?"

*A: **"I would think that they would have said something like 32 qubits is a 4 million quantum volume."** –Ex employee*

Source: Scorpion Capital consultation calls with experts

Our research suggests that IonQ's scientific co-founders - the ones "who don't want to be challenged in any way" and appear to be sitting on >$100MM of stock - are engaging in conduct as egregious as the CEO's, just more shrewdly. We spoke with a number of Monroe and Kim's longtime friends and fellow academics, some they have co-authored papers with. Monroe – the real heavy – appears to want his cake and eat it too: trying to preserve his scientific reputation by allegedly privately blaming the CEO and "financial types," while publicly playing along as the scientific promoter-in-chief. Peers related conversations where Monroe allegedly admitted the unsavoriness of the SPAC but chalked it up to the nature of the game. An ex-IonQ executive provided similar color – that Monroe seemed to be "embarrassed by the whole thing"; that he's now stuck with a CEO "who's completely lying"; and that "that's why he's staying away" and allegedly rarely shows up to the offices.

Monroe is allegedly "embarrassed" by the IonQ SPAC and staying away from the offices

*"Chris Monroe kind of **seemed to me to be embarrassed by the whole thing** and kind of went in and out of seemingly paying attention and seemingly leading his team. I heard a lot from his team: "Chris is never around. Chris has no time." So, Chris just wasn't all there." – Former executive of IonQ*

Ex-executive opined that Monroe is keeping his distance

*"I think **Chris is caught in a place where he's handed over his company to someone who's completely lying**. I think he doesn't know how to handle it, and **I think that's why he's staying away**. This is my impression. Jungsang thinks he's the world's best businessman." - Former executive of IonQ*

Source: Scorpion Capital consultation calls with experts

We spoke with one of the seminal figures in quantum computing, a name that all in the field would recognize and who has a long friendship with Monroe. His comments were scathing and echoed those of other leading academics we consulted: that he's "appalled by this prospectus that IonQ put out" and that the hype "just disturbs me." Another widely-respected scientist indicated "big concern" in the field about IonQ's claims; that they appear more focused on the stock than being "scientifically accurate"; and that they're giving "the field a bad name." A third researcher suggested universal skepticism among other scientists.

Seminal figure in the field is disturbed and "appalled"

"I also don't like the hype, even though I know the people at IonQ and it ***just disturbs me*** *when I see that…if you said something like [IonQ has] in a physics research paper, man, you'd get attacked…I must say I was kind of* ***appalled by this prospectus that IonQ put out****…the kind of stuff they're putting out there is just a no-no for a research paper, you would get killed if you said that… I mean, so far they haven't done anything that can't be done on a classical computer. And also, they show all the signs that it's just not large enough scale yet to be doing something really interesting" – Leading scientist in the quantum computing field*

Another leading figure indicated concern in the field about IonQ's claims

"There's a ***lot of concern about what IonQ is saying and that IonQ seems to have worried more about their stock price and hyping what they're doing than being scientifically accurate****….people don't like it because many other people and I feel like you have to be honest about what you're doing in order to make progress. For me, I dislike it because I think it's going to* ***give the field a bad name****, and there are going to be people like myself who want to actually make progress and build something, and it's not going to look good for us. So, there's a big concern." – Leading expert in quantum computing*

Researchers and scientists are "very skeptical of all the marketing hype"; "getting out of control"

*"…don't listen to the hype, don't listen to everything that they put out in the articles. ..****People that are in the industry, the researchers, the scientists, the PhDs that are working on this, are very skeptical of all the marketing hype because it's kind of almost getting out of control****." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

Source: Scorpion Capital consultation calls with experts

A ex-IonQ employee in a key scientific role stated that the founders have now "damaged" their reputations, with well-known names in the field characterizing IonQ as "lies and fraud." He further described the company as a pariah in the quantum computing community for "making all of these claims that are dubious" – that "everybody knows its fake essentially"; that it's a "gigantic house of cards" where "the leadership has been blinded by money" and is "in it for the money rather than making robust progress toward actually delivering quantum computers."

Ex-employee stated that some in the field use the words "lies and fraud" to describe IonQ

*A: **"I think their reputation has already been damaged**. Some people still respect them, myself included, especially for maybe Chris in the sense that he's done a lot of good science, at least historically. So, I will not tarnish that. But the recent gig with IonQ and what they're claiming out there and the statements they make, many in the field in private believe that this is overblown at best…**some people use stronger words**."*

Q: "Like what?"

*A: **"Lies and fraud. In a sense, I understand why they choose such strong words."***

Q: "Are these names in the quantum community that would be well-known?"

A: "Yes."

Q: "What were they saying was fraudulent?"

*A: "Nothing specifically. It's just a general attitude towards IonQ at this point in the sense that they're **making all of these claims that are dubious**, like the miniaturization aspect or the fidelity aspect or the number of qubits. It's like a widespread symptom. It's just the general aura that the company essentially gives out through PR and presentations. **They are not necessarily scientific**. It pushes people away." –Former senior scientific employee of IonQ*

Ex-employee suggested that IonQ is "gigantic house of cards" where "the leadership has been blinded by money"

*"What I think people feel, is that **the leadership has been blinded by money**, maybe. This is the speculation between some of us. And what they're basically building is just **a gigantic house of cards**…who knows, maybe they're going for acquisition in a couple of ears, and what they're thinking is, we don't necessarily want to deliver all of these things that we've promised because it's irrelevant because **everybody knows it's fake essentially**. Which company's roadmap isn't?...Surely, it feels as though they are just going for some gigantic house of cards and are **in it for money rather than making robust progress towards actually delivering quantum computers.**" – Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

Other ex-employees provided similar color. A former executive eviscerated one key claim after another as "not true" and "all over the place." Echoing a recurring theme, another implied that that the leadership has no interest in product or scientific progress. One stated that "pretty much everybody" in the field is skeptical: "it's a lot of bullshit and in sort of a bubble." Others called it "hype" and "bluster," and that the "excitement is basically unfounded" and "just a lot of salesmanship."

Ex-executive alleges IonQ's claims are not true and marked by "so many inaccuracies"

*"If you look at the roadmap, they're not hitting the roadmap. Look at slide 19, they say the most usable qubits, **it's not true**. "Highest quantum volume," **not true**. "Best error correction overhead," can't tell. "Systems getting smaller and smaller each generation," haven't proven that and no scientific publications […} There are **just so many inaccuracies** in what they talk about and what I really have problems with is that they showed in 2021, they'll have 22 logical qubits...no. So, it's just off **all over the place**...and nobody has called them out on where they are today." - Former executive*

Leadership is allegedly not interesting "actually getting things done"

*"If I had to boil it down, it's really the leadership failure, and that's my personal view, that is essentially shared by some of us…it became clear to me that the **leadership at IonQ is not necessarily interested in actually getting things done** as promised and there is always an issue of non-transparency…and it's just a buildup of uninformed decisions made again and again that can potentially even be viewed as sort of intended." –Former senior employee of IonQ*

"Hype" and "bluster" is "unfounded" with "a lot of salesmanship"

*"This applies to every single quantum computing company - there's **a lot of hype and a lot of bluster and a lot of big claims** made, and the majority of **the excitement is basically unfounded, and there's just a lot of salesmanship** […] I would say that it sounds like you have a pretty good notion of Peter Chapman…yeah, a lot of salesmanship […] I don't think it's impossible, but **I'm just skeptical**. It's a very hard thing to gauge…I think that sort of **application space is going to be pretty small**. There's a lot of hype about drug discovery, logistics optimization." – Former IonQ employee, physicist*

"Pretty much everybody" in the field is skeptical of IonQ; " a lot of bullshit and in sort of a bubble"

Q: "Who are the scientists out there that have been most critical or skeptical of IonQ?"

*A: "**I would say pretty much, everybody**. One of the big names that comes to mind is John Preskill at Caltech. He's basically saying that pretty much **it's a lot of bullshit** and in sort of a bubble." – Ex-IonQ employee, senior member of technical staff*

Source: Scorpion Capital consultation calls with experts

Although Monroe is a prominent academic, we noticed a long history of hype and specious claims, consistent with ex-employee characterizations of his and Kim's conduct. A 2005 interview led one to believe he had a postage-sized "quantum chip" that's "scalable and mass producible." Various articles hyped it as using "the same semiconductor manufacturing process" as regular chips. In 2016, he boasted of already knowing how to build a 50-100 qubit trapped ion computer - "right now" - yet IonQ appears stuck at 11 qubits for years.

2005 article on Chris Monroe's purported "quantum chip"

U-M develops scalable and mass- producible quantum computer chip

*"The chip produced at U-M is about as big as a postage stamp…**the quantum chip developed at U-M could be scaled up to include hundreds of thousands of electrodes, Monroe said**. "There is a worldwide race to build these (chips) right now, as such an integrated chip structure shows a way to scale the quantum computer to bigger systems—just like the microfabrication of conventional chips have given us the impressive gains in conventional computing speed and power," Monroe said.*

2016 article quotes Monroe claiming to be able to a 50-100 qubit ion trapped computer "right now"

*"**We know how to build a quantum computer with 50-100 qubits** with trapped ions right now," said Monroe. "This is a big enough system that we cannot simulate what happens, even with all the conventional computers in the world."*

Source: http://ns.umich.edu/index.html?Releases/2005/Dec05/r121205b; https://quantum.duke.edu/2016/01/06/extensible-universal-reconfigurable-ion-trap-quantum-archtype-euriqa/; https://geeknewscentral.com/2005/12/17/first-marketable-quantum-computer-chip/

The pre-SPAC Chris Monroe appears to be a different figure than the one with tens of millions in stock. Leading researchers wryly noted that he was one of the leading voices wagging a finger at D-Wave, a quantum computing company with wild claims that some called a "scam." Monroe called it "salesmanship" and "not exactly science." We further note his comments in 2019 warning of "breathless announcements of records broken" and "too much hype" that "risks disillusionment that may slow" progress. In a 2012 talk, he admitted that having "only about 15 qubits" isn't useful – yet IonQ's only machine appears to be an 11-qubit toy.

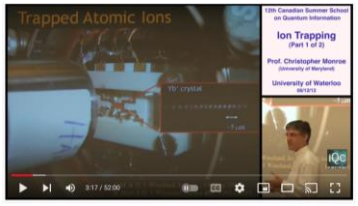
In 2013, Chris Monroe criticized an alleged quantum computing scam

"…critics say that the company's claims are not supported by scientific evidence. ***"It's not exactly science, what they're doing," says Christopher Monroe****, a physicist with the Joint Quantum Institute at the University of Maryland. "It's high-level engineering, and I think it's high-level* ***salesmanship, too****"…Monroe remains skeptical…"There's no evidence that what they're doing has anything to do with quantum mechanics," he says."*

In 2019 prior to the SPAC, Monroe warned of quantum hype

'The ***big quantum computing discoveries that will most impact society are still years away. In the meantime, we will see breathless announcements*** *of records broken as the technology rapidly develops. These incremental advances are important for government, which has a role in encouraging this research, as well as for industries that need to start developing ways to use quantum computers as they become more powerful. But* ***too much hype risks disillusionment*** *that may slow the progress.'*

In 2012 lecture on ion trapping, Monroe admitted that 15 qubits isn't useful. 3:05 in.



"*The field is still waiting for something that's useful and* ***having only about 15 qubits is maybe not so useful."***

Source: Scorpion Capital consultation calls with experts; https://www.npr.org/2013/05/22/185532608/quantum-or-not-new-supercomputer-is-certainly-something-else; https://thequantuminsider.com/2019/10/27/quantum-godfathers-3-christopher-monroe-the-michigan-magician/; https://www.youtube.com/watch?v=aOm50nPd5kQ

SPAC's have breathed new life into failed, stale VC-backed science experiments like IonQ, which have stampeded to exploit the structure with fake projections and other loopholes for investor abuse. We spoke with two leading researchers who have published papers with IonQ's founders and have long personal histories with them. Both indicated that IonQ's data is ancient; that their technology and metrics haven't progressed in 5 or more years; that they're "quite surprised" at the lack of progress; and that the founders had hoped to make progress vs. hitting a wall years ago: "they were not able to accomplish that."

Gate fidelities have stalled at levels that make IonQ's computer unusable

*"The point is with .97 to .98 fidelity of the gate that is available right now in the cloud, **they are at the same level in terms of the gate fidelity as they were almost five years ago**. And five years ago, Chris Monroe and co-authors published a paper in Nature about the five-qubit universal, programmable trapped ion quantum computer. This was before IonQ was created. And if you look at the specifications of that quantum computer and the gate fidelities of that quantum computer are .97 to .98. So, throughout those five years or about five years, during the technology transfer from the University of Maryland to IonQ, the gate fidelities did not improve." – Leading quantum computing researcher who has published papers with IonQ's founders*

IonQ founder expected error rates to have advanced; "I am surprised that the gate fidelity stayed so low"

*"**I fully expected that by now, they would have three or more nines of gate fidelity. In my discussions with Chris Monroe three years ago, it followed that that would be the case.** And, in fact, they started preparing for it…I am quite surprised, to be honest, that this didn't happen. **I am surprised that the gate fidelity stayed so low** […] I say no advancement because realistically, by the time that I left the University of Maryland group had.99 fidelity, and I worked with that device, and what they have available right now through Amazon, Google, and Microsoft is a worse quality computational device than the one that I used in the lab while I was at University of Maryland and while I was there collaborating with those people." – Leading quantum computing researcher who has published papers with IonQ's founders*

Another researcher states the founders expected more progress but failed; "I'm surprised by the lack of progress"

*"**I'm surprised by the lack of progress because of my conversations with Chris Monroe and Jungsang Kim**…they were seriously planning on running more complex quantum computations back in the day…They believed it themselves. It's just that…they were not able to accomplish that," – Another leading researcher who has published papers with IonQ founders*

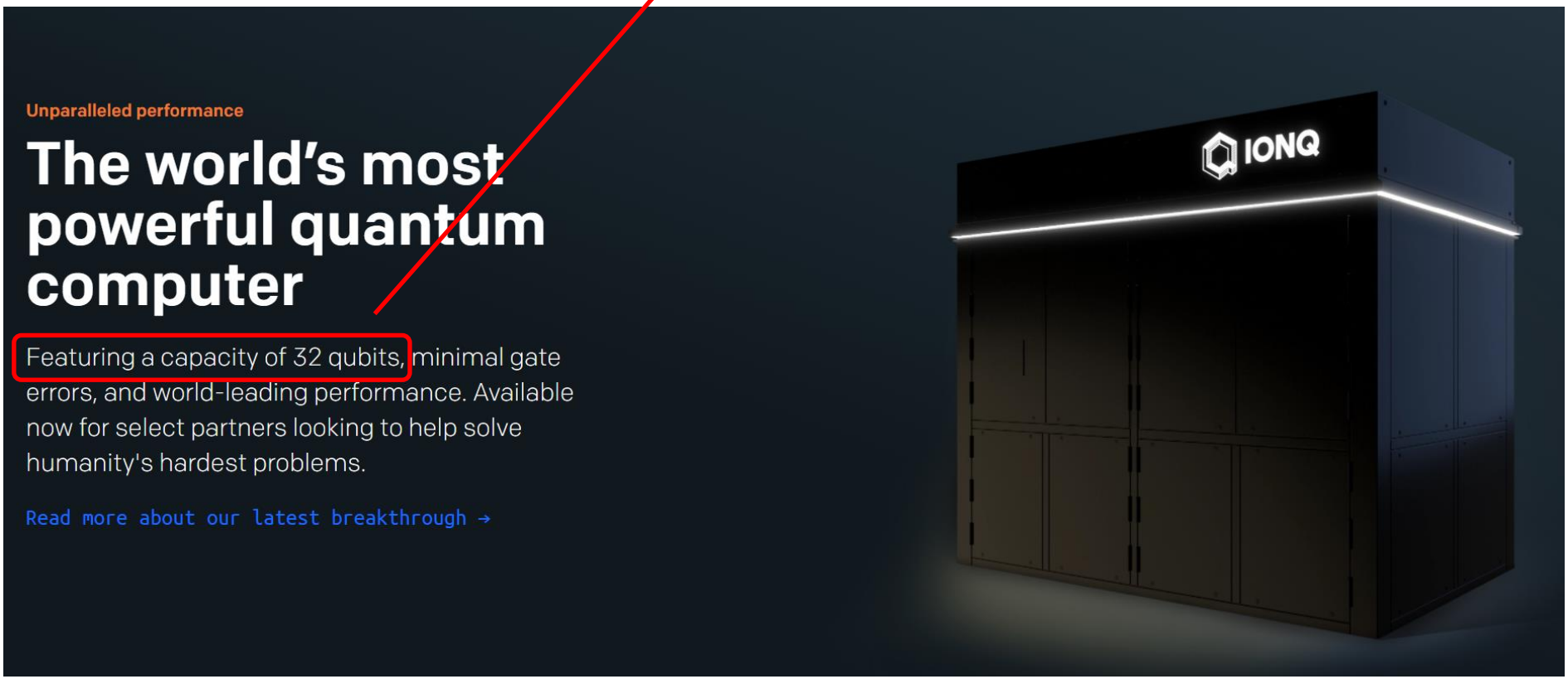
Source: Scorpion Capital consultation calls with experts

2. **Reminiscent of Nikola's shenanigans, our research indicates that <u>IonQ's purported 32-qubit "world's most powerful quantum computer" is a brazen hoax</u>. The machine is featured near the top of its homepage and is its claim to fame as well as the basis of its SPAC. We believe that IonQ's only actual machine is a useless, experimental, error-ridden toy with far fewer qubits, similar to science projects one can use for free from its competitors.**

Source: https://ionq.com/

The basis of IonQ's claim to fame and its SPAC transaction is its claim of having "The world's most powerful computer" purportedly "featuring a capacity of 32 qubits." The claim is displayed prominently near the top of the landing page for its website, with a slick photo of what appears to be the mysterious device.

"Featuring a capacity of 32 qubits"; "Available now for select partners"



Source: https://ionq.com/

The image links to an October 2020 post by the CEO Pater Chapman on "our latest breakthrough." In strong, unambiguous language declaring "the magnitude of this new quantum computer's debut," he states that he is "incredibly excited to unveil" the computer; a "very proud moment" that "signals a big cornerstone in the journey"; "the culmination of two decades of academic research"; and "a vital stepping stone."

Oct 1, 2020 post by IonQ CEO

Introducing the World's Most Powerful Quantum Computer

*"I am **incredibly excited to unveil IonQ's new quantum computer**, the most powerful on the market."*

*"This is **a very proud moment**, one that validates our trapped-ion approach…"*

*"…our **new 32 qubit system signals a big cornerstone in the journey** of quantum computing."*

*"To appreciate **the magnitude of this new quantum computer's debut**, it's important to reflect on how we got here. Our new system is the **culmination of two decades** of academic research…"*

*"…our 32 qubit system is a **vital stepping stone** in the process…"*

Source: https://ionq.com/posts/october-01-2020-introducing-most-powerful-quantum-computer

IonQ issued a press release the same day announcing the 32-qubit computer, with a number of specific and dramatic claims – in particular, that it "features 32 perfect qubits with low gate errors" and an "expected quantum volume greater than 4,000,000." The press release quotes the CEO Chapman, co-founders Monroe and Kim, and a number of purported "customers." Perhaps the most brazen statement in the release comes from Chris Monroe himself, who goes so far as to boast that the system has already been deployed: "The new system we're deploying today is able to do things no other quantum computer has been able to achieve…the holy grail…."

Oct 1, 2020 press release

IonQ Unveils World's Most Powerful Quantum Computer

*"The new hardware **features 32 perfect qubits with low gate errors**, giving it an expected **quantum volume greater than 4,000,000**."*

*"In a single generation of hardware, we went from 11 to 32 qubits, and more importantly, improved the fidelity required to **use all 32 qubits**," said IonQ CEO & President Peter Chapman.*

*"**The new system we're deploying today** is able to do things no other quantum computer has been able to achieve…" […] Monroe says "with our new IonQ system…the holy grail for scaling quantum computers in the long haul."*

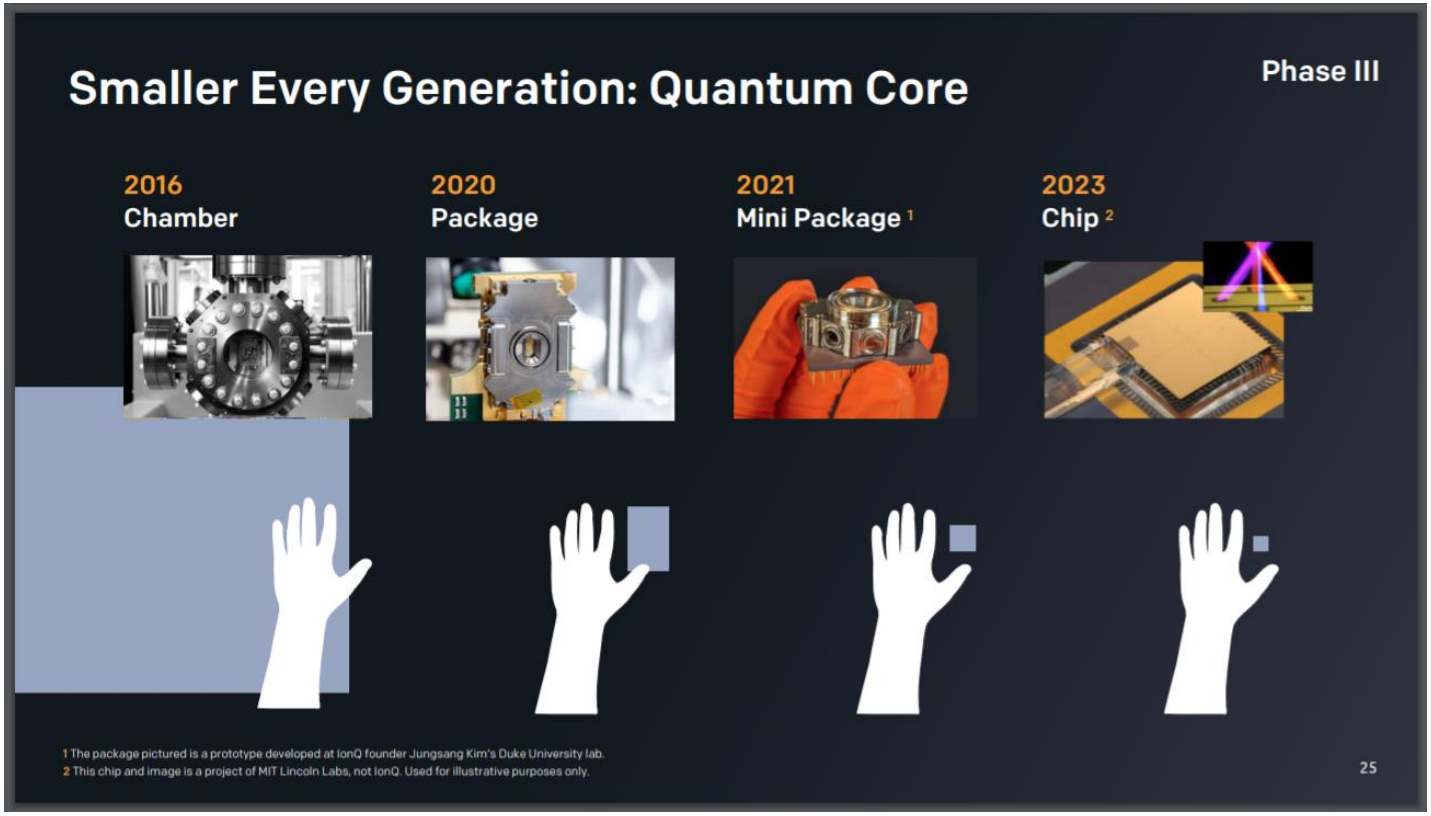
Source: https://investors.ionq.com/news/news-details/2020/IonQ-Unveils-Worlds-Most-Powerful-Quantum-Computer/default.aspx

During the SPAC roadshow in March 2021, IonQ's CEO further talked up "the 2020 device" – "our new 32 qubit system, and about the size of a deck of cards"

Chapman comments Mar 2021 during roadshow

"On Slide 25, you can see the evolution of our ion trap and the vacuum chamber. In 2016, this is a vacuum chamber found today in many academic settings. ***The 2020 device is our new 32 qubit system, and about the size of a deck of cards****…But by 2023, we expect that much of the optics, the ion trap, and the vacuum can all be blown onto a single chip, and then we network them together with an optical cable; another area where IonQ's founders have already shown in working in their labs." – IonQ CEO Peter Chapman*

IonQ investor presentation, Mar 2021



Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf; roadshow comments https://www.sec.gov/Archives/edgar/data/1824920/000119312521072373/d142872dex993.htm

During another SPAC promotion event in July 2021, both the IonQ CEO and the CEO of dMY Technology – the acquisition vehicle – made numerous comments doubling down on the existence of the 32-qubit device. Of particular note and importance, IonQ's CEO stated that they already "put our first customers onto the 32 in June…"

Comments by IonQ CEO Chapman and dMY CEO De Masi, July 2021

*"So if you look at, for instance, **our new 32 qubit system**…" – IonQ CEO Chapman*

*"In our system, what we're doing is we're addressing the qubits directly. So, we're not moving the qubits during computation. What there is, is **there's 32 laser beams, which come down and address each one of the qubits**. And you can do that without actually moving the qubits themselves. In our next generation system,..What you'll see is more qubits. And then there will be a qubit address selector technology that **allows you to take the 32 qubits and address any one of the qubits** that are sitting in the ion trap chip. Again, not moving them." – IonQ CEO Chapman*

*"And so, you could kind of think of it as the Honeywell system is... Maybe a good analogy would be they have a two qubit bus and **we have a 32 qubit bus**. And maybe trying to take a bit of a classical analogy, as well." – IonQ CEO Chapman*

***"We put our first customers onto the 32 in June**, which was on private. So, we'll continue to do that with private customers through the beta period." – IonQ CEO Chapman*

*"I mean, it's that stark **when you go from 32 to 64 qubits and you have two to the power of 32 more power in a year**. I mean, imagine the pricing power that IonQ is going to have, right? These are the things that really get investors out of bed, get customers out of bed and, of course, are why we're so excited about the space." – dMY CEO De Masi*

Source: https://www.sec.gov/Archives/edgar/data/1824920/000119312521217476/d196587d425.htm

IonQ's 32-qubit announcement did the trick, as the media immediately ran with the story and parroted the company's "breakthrough." Google searches now default to telling investors that IonQ's qubit number is 32.

Oct 2020 articles in Forbes, Techcrunch, and industry news sites

IonQ Releases A New 32-Qubit Trapped-Ion Quantum Computer With Massive Quantum Volume Claims

IonQ claims it has built the most powerful quantum computer yet

IonQ Announces a 32 Qubit Ion Trap Computer with Low Qubit Gate Errors

IonQ Releases A New 32-Qubit Trapped-Ion Quantum Computer With Massive Quantum Volume Claims

Google searches now lead with IonQ having 32 qubits

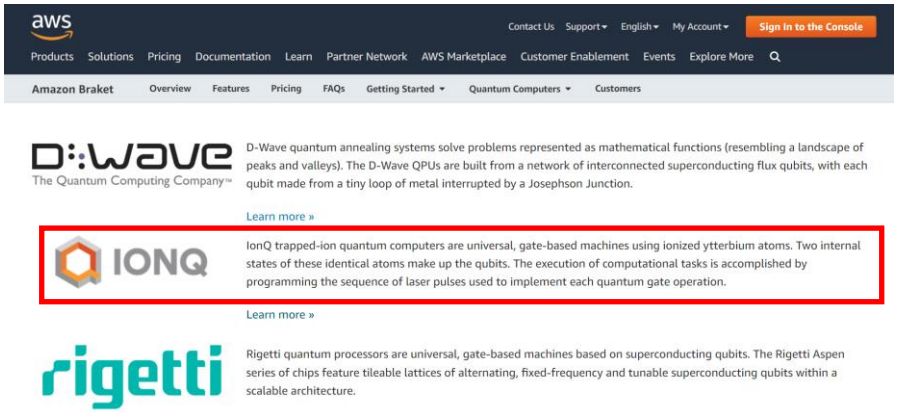
Source: https://www.forbes.com/sites/moorinsights/2020/10/07/ionq-releases-a-new-32-qubit-trapped-ion-quantum-computer-with-massive-quantum-volume-claims/?sh=5dec36033b39; http://quantumhermit.com/ionq-announces-a-32-qubit-ion-trap-computer-with-low-qubit-gate-errors; https://techcrunch.com/2020/10/01/ionq-claims-it-has-built-the-most-powerful-quantum-computer-yet/; https://moorinsightsstrategy.com/ionq-releases-a-new-32-qubit-trapped-ion-quantum-computer-with-massive-quantum-volume-claims/; various Google search results

As we tried to learn more about IonQ's purported 32-qubit computer, we encountered a series of stunning red flags. First, despite the company stating that the computer was being deployed that day, we could locate no sign of its existence on Amazon Web Services or Microsoft Azure, where the IonQ announcement said it would be "commercially available." Even now, over a year and a half after the 32-qubit announcement, both AWS and Azure only reference 11 qubits.

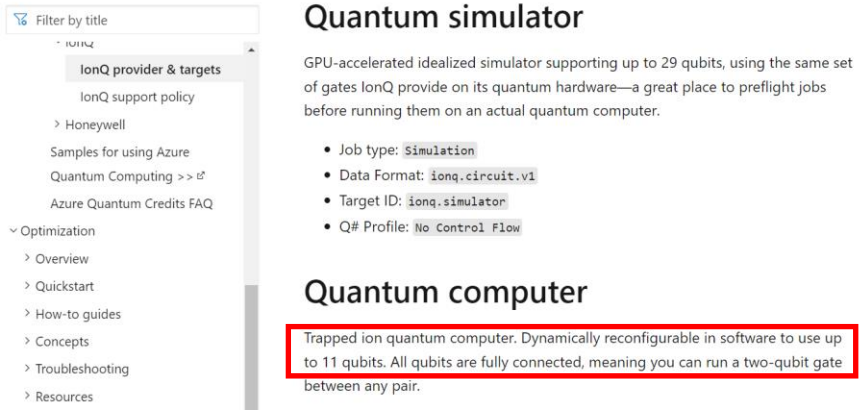
Microsoft Azure page for IonQ: *"Trapped ion quantum computer. Dynamically reconfigurable in software to use up to **11 qubits**."* Source: https://docs.microsoft.com/en-us/azure/quantum/provider-ionq

Amazon Web Services page for IonQ: *"To date, we've run single-qubit gates on a 79-ion chain, and complex algorithms consisting of multiple **two-qubit gates on chains of up to 11 ions.**"* Source: https://aws.amazon.com/braket/quantum-computers/ionq/

AWS Braket quantum computers page



Microsoft Azure page for IonQ



Source: https://aws.amazon.com/braket/quantum-computers/; https://docs.microsoft.com/en-us/azure/quantum/provider-ionq

Given that IonQ's homepage – where most retail investors would look - leads with its 32-qubit computer and its press releases announced the launch with unambiguous language, we found it unusual that the recent prospectus only mentions an 11-qubit computer: "We sell access to a quantum computer with 11 qubits…"; "We are still in the early stages of generating revenue with our 11-qubit quantum computer."

IonQ prospectus Oct 22, 2021

PROSPECTUS SUMMARY

This summary highlights information contained elsewhere in this prospectus and does not contain all of the information that you should consider in making your investment decision. Before investing in our securities, you should carefully read this entire prospectus, including our consolidated financial statements and the related notes thereto and the information set forth in the sections titled "Risk Factors" and "Management's Discussion and Analysis of Financial Condition and Results of Operations." Unless the context otherwise requires, we use the terms "IonQ," "company," "we," "us" and "our" in this prospectus to refer to IonQ, Inc. and our wholly owned subsidiaries.

Overview

We are developing quantum computers designed to solve the world's most complex problems, and transform business, society and the planet for the better. We believe that our proprietary technology, our architecture and the technology exclusively available to us through license agreements will offer us advantages both in terms of research and development, as well as the commercial value of our intended product offerings.

We sell access to a quantum computer with 11 qubits and we are in the process of researching and developing technologies for quantum computers with increasing computational capabilities. We currently make access to our quantum computers available via three major cloud platforms, Amazon Web Services' (AWS) Amazon Braket, Microsoft's Azure Quantum, Google's Cloud Marketplace, and to select customers via our own cloud service.

We are still in the early stages of generating revenue with our 11-qubit quantum computer. Since our inception, we have incurred significant operating losses. Our net losses were $15.4 million and $17.3 million for the year ended December 31, 2020 and the six months ended June 30, 2021, respectively, and we expect to continue to incur significant losses for the foreseeable future. As of June 30, 2021, we had an accumulated deficit of $56.9 million.

Source: https://www.sec.gov/Archives/edgar/data/1824920/000119312521305372/d206735ds1a.htm

One could give IonQ the benefit of the doubt and assume that while they don't "sell access" to their 32-qubit computer - as their prospectus says they do for their 11-qubit system - it nonetheless exists. Yet when we did a word search in their prospectus for "32 qubit," we found only two hits – both buried in the fine print in a troubling disclosure that says the system "is not yet available for customers and may never be made available." The disclosure makes it clear that not only is the 32-qubit system not being sold, it isn't even available "for customer use or independent verification by a third party" – which may "even never occur."

IonQ prospectus Oct 22, 2021. Updated prospectus filed on Nov 15, 2021 repeats the same disclosure.

"Our 32-qubit system, which is an important milestone for our technical roadmap and commercialization, is not yet available for customers and may never be available.

We are developing our next-generation 32-qubit quantum computer system, which has **not yet been made available to customers**. We expect this system to have 22 algorithmic qubits, i.e., qubits that are usable to run quantum algorithms, but **the number of algorithmic qubits available in this system has not been finalized and may be fewer than planned**. The availability of this generation of quantum computer system for customer use or independent verification by a third party may be materially delayed, or even never occur."

Source: https://www.sec.gov/Archives/edgar/data/1824920/000119312521305372/d206735ds1a.htm; Nov 15 prospectus - https://www.sec.gov/Archives/edgar/data/1824920/000119312521330111/d262236d424b3.htm

This buried disclosure occurred well after the machine was announced, making it obvious – we believe – that IonQ is now trying to create a legal out. Yet the effort is as inept as it is corrupt, as CEO Peter Chapman then quickly contradicted the disclosure on the Q3 2021 earnings call, claiming that the 32-qubit system is in fact available to customers and is being used by Goldman Sachs and Fidelity, echoing his statement in July 2021 that they "put our first customers onto the 32 in June…" We note that an updated prospectus was filed the same day as the Q3 earnings call, once again stating that "Our 32-qubit system…is not yet available to customers and may never be available" – emphasizing further that "independent verification by a third party" may "even never occur."

Excerpt of IonQ Q3 2021 earnings call transcript, Nov 15, 2021

Peter Chapman

Hi, Ruben, happy to answer. So at the current time, we have two systems, which are servicing jobs out on the cloud for all three cloud partners and internal for our private cloud. And then there is an additional system which is the what we call the 32 qubit systems, which right now is in private beta. And we have customers and in fact, actually, Goldman Sachs and Fidelity, have been running jobs on that system as well as other customers.

Source: https://seekingalpha.com/article/4469760-ionq-inc-class-ionq-ceo-peter-chapman-on-q3-2021-results-earnings-call-transcript; https://www.sec.gov/Archives/edgar/data/1824920/000119312521330111/d262236d424b3.htm

Aside from the ludicrous inconsistences between IonQ's website, press releases, prospectus filings, and comments by CEO Chapman and co-founder Monroe, we were amazed to find that while their corporate presentation manages to fill 29 pages with fluff, the word "qubit" is only used 4 times. We could locate no mention of 32-qubit much less 11-qubit. Oddly, despite the 32-qubit announcement in 2020 – referred to then as a "cornerstone in the journey," a "vital stepping stone," and "culmination of two decades" of research – the landmark milestone is now missing from IonQ's timeline which bizarrely starts only in 2021.

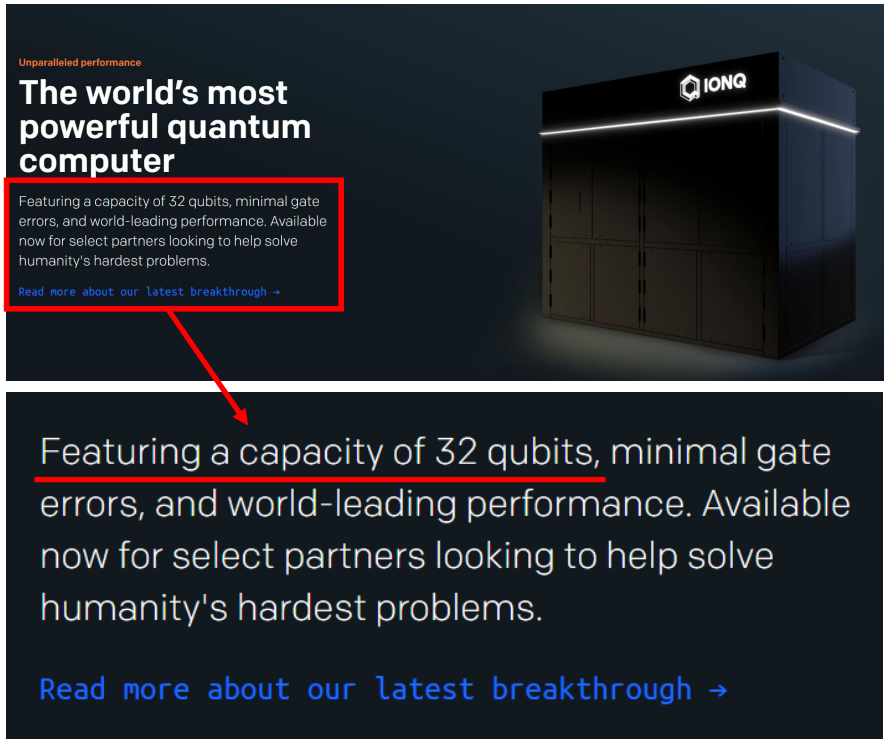
Timeline in recent Sept presentation excludes the 2020 32-qubit milestone, starting in 2021

Roadmap in the initial investor presentation in March 2021 also excludes the 2020 milestone

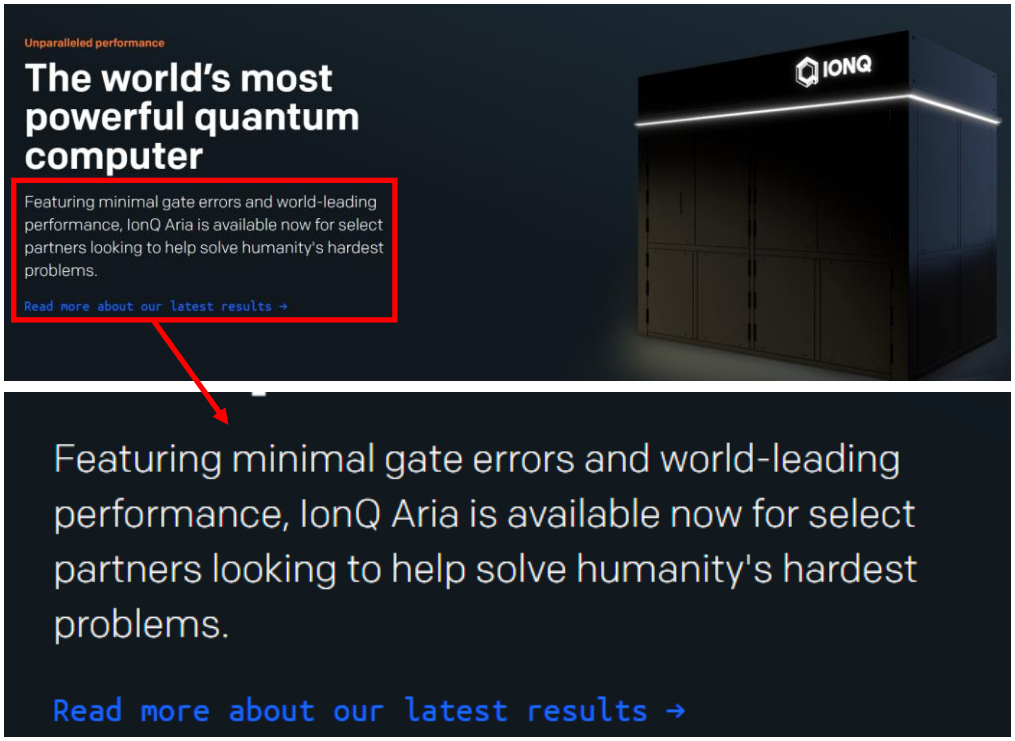
Sourcehttps://s28.q4cdn.com/828571518/files/doc_presentation/2021/11/IonQ-Investor-Presentation-Sept-2021-Updates-v091721.4.pdf; ; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

We note another unusual discrepancy. In mid-February 2022, based on cached images at the Internet Archive's Wayback Machine, IonQ appears to have quietly removed any mention of 32-qubit in reference to their "world's most powerful quantum computer," which they now seem to have re-branded as Aria. We note that while the pics remains the same, the phrase "Featuring a capacity of 32-qubits" has been expunged. We then did a word-search in the new white paper it links to, and didn't find a single mention of "32-qubits."

Feb 17, 2022 screenshot says "Featuring a capacity of 32-qubits"



April 14, 2020 screenshot shows "32-qubits" has now been expunged



Source: https://web.archive.org/web/20220217145539/https://ionq.com/; IonQ website https://ionq.com/.

The sudden scrubbing of IonQ's site to remove mention of 32-qubits in relation to "the world's most powerful computer" strikes us *mens rea* – a legal concept that means "guilty mind." We note another example: a telling change in IonQ's recent 10K filing vs. its last 10Q. The 10Q referenced its 11-qubit computer, while the 10K appears to bend over backwards to avoid any mention of qubit counts at all, whether 11 or 32. The 10K now merely refers to "quantum computers of various qubit capacities," which we again find misleading as IonQ appears to only have one capacity – 11 qubits.

Nov 2021 10Q filing opens with mention of an 11-qubit computer

Overview

We are developing quantum computers designed to solve the world's most complex problems, and transform business, society, and the planet for the better. We believe that our proprietary technology, our architecture, and the technology exclusively available to us through license agreements will offer us advantages both in terms of research and development, as well as the commercial value of our intended product offerings. We sell access to a quantum computer with 11 qubits, and we are in the process of researching and developing technologies for quantum computers with increasing computational capabilities. We currently make access to our quantum computers available via three major cloud platforms, Amazon Web Services' (AWS) Amazon Bracket, Microsoft's Azure Quantum, and Google's Cloud Marketplace, and to select customers via our own cloud service.

We are still in the early stages of generating revenue with our 11-qubit quantum computer. We have incurred significant operating losses since our

Mar 2022 10K filing has changed the wording to "various qubit capacities"

Overview

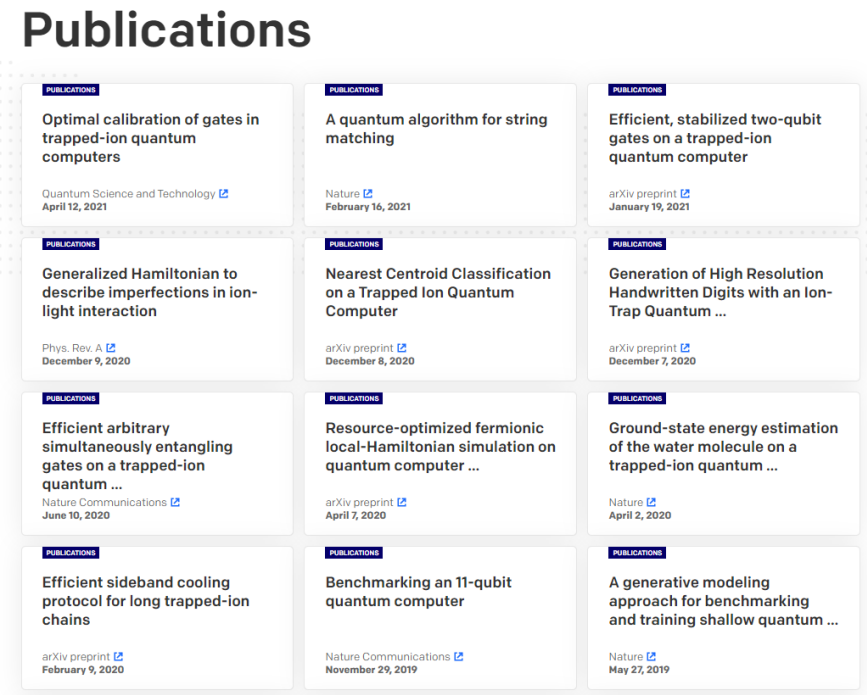
We are developing quantum computers designed to solve the world's most complex problems, and transform business, society and the planet for the better. We believe that our proprietary technology, its architecture and the technology exclusively available to us through license agreements will offer us advantages both in terms of research and development, as well as the commercial value of our intended product offerings.

Today, we sell access to several quantum computers of various qubit capacities and are in the process of researching and developing technologies for quantum computers with increasing computational capabilities. We currently make access to our quantum computers available via three major cloud platforms, Amazon Web Services' ("AWS") Amazon Braket, Microsoft's Azure Quantum and Google's Cloud Marketplace, and also to select customers via our own cloud service. This cloud-based approach enables the broad availability of quantum computing as a service ("QCaaS").

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/0001824920/000119312521329877/d235265d10q.htm; https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312522086738/d257705d10k.htm

We further noted the striking absence of publications and key data for the mysterious 32-qubit machine. Co-founders Monroe and Kim are prolific authors, and the publications page on IonQ's site shows 33 papers from 2016 to 2021. The seminal data paper for their 11-qubit machine is from 2019, sharing basic information such as gate fidelities and error rates without which any technical announcement is meaningless. Yet their site is a barren desert when it comes to any such metrics on their 32-qubit one – a remarkable fact in light of the precise technical data IonQ has promoted around its purported performance.

IonQ publications page



2019 paper provides key data on 11-qubit machine – we could find no such data for the 32-qubit system

Benchmarking an 11-qubit quantum computer

K. Wright, K. M. Beck, S. Debnath, J. M. Amini, Y. Nam, N. Grzesiak, J.-S. Chen, N. C. Pisenti, M. Chmielewski, C. Collins, K. M. Hudek, J. Mizrahi, J. D. Wong-Campos, S. Allen, J. Apisdorf, P. Solomon, M. Williams, A. M. Ducore, A. Blinov, S. M. Kreikemeier, V. Chaplin, M. Keesan, C. Monroe & J. Kim

Nature Communications **10**, Article number: 5464 (2019) | Cite this article

25k Accesses | **117** Citations | **165** Altmetric | Metrics

Abstract

The field of quantum computing has grown from concept to demonstration devices over the past 20 years. Universal quantum computing offers efficiency in approaching problems of scientific and commercial interest, such as factoring large numbers, searching databases, simulating intractable models from quantum physics, and optimizing complex cost functions. Here, we present an 11-qubit fully-connected, programmable quantum computer in a trapped ion system composed of 13 $^{171}Yb^{+}$ ions. We demonstrate average single-qubit gate fidelities of 99.5%, average two-qubit-gate fidelities of 97.5%, and SPAM errors of 0.7%. To illustrate the capabilities of this universal platform and provide a basis for comparison with similarly-sized devices, we compile the Bernstein-Vazirani and Hidden Shift algorithms into our native gates and execute them on the hardware with average success rates of 78% and 35%, respectively. These algorithms serve as excellent benchmarks for any type of quantum hardware, and show that our system outperforms all other currently available

Source: https://ionq.com/resources/publications; https://www.nature.com/articles/s41467-019-13534-2

A former employee of IonQ alerted us to a recent paper from Sept 2021, authored by IonQ and its "customer" Goldman Sachs, who the CEO listed as one of the firms already using its 32-qubit computer. IonQ doesn't list the paper on its publications page and appears to have buried it – because, we believe, it reveals the 32-qubit system as a hoax. The paper states that experiments were run on "the newest generation IonQ quantum processing unit (QPU)," yet the second to last paragraph - buried near the end of a dense 12 page paper - makes an amusing admission: "Note that we restricted the experiments to four qubits…."

IonQ paper from Sep 21, 2021, using their "newest generation" system – excerpts below

Low depth amplitude estimation on a trapped ion quantum computer

Tudor Giurgica-Tiron,[1,2] Sonika Johri,[3] Iordanis Kerenidis,[4,5] Jason Nguyen,[3] Neal Pisenti,[3] Anupam Prakash,[4] Ksenia Sosnova,[3] Ken Wright,[3] and William Zeng[1]

[1]*Goldman, Sachs & Co.*
[2]*Stanford University, Palo Alto, CA.*
[3]*IonQ Inc, 4505 Campus Dr, College Park, MD 20740*
[4]*QC Ware, Palo Alto, USA and Paris, France*
[5]*IRIF, CNRS - University of Paris, France*

(Dated: September 21, 2021)

III. EXPERIMENTAL APPARATUS

The experimental demonstration was performed on the newest generation IonQ quantum processing unit (QPU).

The end of the paper reveals that experiments were restricted to a mere "four qubits"

Note that we restricted the experiments to four qubits, because our main goal was to probe the regime where the evaluation oracle is invoked a large number of times in a noisy setting, achieving up to fifteen sequential oracle invocations with still excellent results. A next step would be to establish tradeoffs between circuit depth and number of oracle calls in an experimental setting, as theoretically proved in [9], and this may soon become feasible with further improvements in hardware.

Source: https://arxiv.org/pdf/2109.09685.pdf

We then spoke with an executive of QC Ware, a key IonQ partner that's listed as a co-author of the same paper based on the purported 32-qubit system – yet they don't appear to have laid eyes on the mystery device, either. The executive skeptically noted that IonQ "kept referring" to the machine used in the paper "as the 32-qubit machine, blah-blah-blah," but highlighted the same red flag as the ex-employee: that only 4 qubits were used. He added that "they keep talking" about this machine, but that "it's behind closed doors."

IonQ kept referring to its "32-qubit machine" although only 4 qubits were used in the paper

"Throughout the experiment, IonQ did call it the 32-qubit machine. ***As we were doing the experiment, they did call it the 32-qubit machine. However, the Goldman experiment never really used 32 qubits****. Throughout the experiment, they kept referring, okay, this is going to be* ***the 32-qubit machine, blah-blah-blah****. Let me pull this up here. I think they just used 4 qubits based on what it says here in the paper. Yeah, it uses 4 qubits and 4 RBS gates.* ***They basically just used 4 qubits. But they kept referring to this as the 32-qubit machine.****" – QC Ware executive*

IonQ "keep talking about it" but the machine is "behind closed doors"

"They keep talking about it, this machine but that's in the lab. ***It's behind closed doors****." – QC Ware executive*

Source: Scorpion Capital consultation calls with experts

3. **Extensive interviews with ex-executives and employees confirm our findings and lead us to conclude that the company's claims of a 32-qubit machine are fraudulent. We received color stating that "it was totally made up"; "doesn't exist"; and that the company is "trying to cover up that it's not there." Our research indicates extreme discomfort among IonQ's staff and an "unprecedented amount of pushback" as its leadership allegedly pushed for a fake product announcement with "outlandish claims" that "are so far removed from reality," with "essentially every scientist" at the company opposed and "flipping out."**

An ex-executive confirmed our finding, and alleged being told at joining that the 32-qubit machine "was in the next room and it was working," but that "it never happened"; that is was "bullshit" and "totally made up." The executive re-read the IonQ release announcing the 32-qubit machine and stated "that is a sham because that doesn't exist." An ex- IonQ physicist explained the "misleading" technical trick behind the hoax.

Former executive alleges the 32-qubit machine "was in the next room" but "that's bullshit" and "totally made up"

*A: "**When I joined, I was told that the 32-qubit device was in the next room, and it was working. It never happened**. They recently did a study, an archived paper where they showed decent performance on a device, but I don't even think they named how many qubits, but there has **never been a publication or a demonstration of that 32-qubit device, 4.2 million quantum volume and frankly, I'm shocked that none of the analysts have never called them on it**."*

Q: "When they say they have a 32-qubit machine in the room next door, did you ever see it?"

*A: "**They don't. That's bullshit**."*

Q: "Did you ever try to ask and see it? Let me in the room? Was it totally made up?"

*A: "**Totally made up**." - Former executive*

The executive re-read the IonQ press release and stated it's a sham

*"I went back, and I looked at their announcement from October 1, 2020, where they said, "IonQ unveiled the most powerful quantum computer." **That is a sham because that doesn't exist. I reread through it to see if they had used language that was saying we think it could grow there or we think it can do this, and they didn't; they said it's here**."- Former executive*

The technical trick behind the hoax involved loading useless ions into an ion trap

*"With the ion-trap quantum computers, you load the ion into the trap, and it's really **a misleading headline to say we have a 32-qubit quantum computer because you can load as many ions as you want into the trap. You could load 1000 or 10,000. That doesn't mean that you can do anything useful with it** because your hardware needs to be able to manipulate those ions accurately to do the quantum computations. If you look at the IonQ headlines back in 2019 or late 2018, they were announcing that they had 79-qubit computer, I think, and what that meant technically was that they were able to load 79 ions in a trap and do some gates that were probably not very good. So, 32 qubits to the company at that time I don't think was very impressive. If it's not accessible online, it means the errors are high, and it means that it **would spit out garbage**, and it's not worth making it accessible to academics who do experiments on it."- Former employee, physicist*

Source: Scorpion Capital consultation calls with experts

The ex-executive indicated that it is "totally" well-known inside IonQ that the 32-qubit machine doesn't exist, replying affirmatively when we asked if staff were uncomfortable with the company's conduct – "to me, that's fraudulent." The executive further alleged that IonQ is trying "to cover up that it's not there" - despite featuring it prominently on its homepage – and mentioned conversations with the CEO that suggest his complicity.

Allegedly "totally" known inside IonQ that the 32-qubit machine doesn't exist; staff were uncomfortable with it

Q: "When you say the 32-qubit computer doesn't exist, when you're there in meetings, you're talking to people, what would they say? Was that truly just a flagrant lie, or did they have a machine on a table that has 32 qubits, and it had errors, so they couldn't release it, they couldn't publish it, just had bad data? Or they just literally didn't have it?"

A: "There's a machine in development, and they hope that it will be able to do it, but it hasn't done it yet."

*Q: **"Was it well-known inside the company that there's no 32-qubit machine right now?"***

*A: **"Totally."***

*Q: **"And were people uncomfortable with the fact that they had pitched it?"***

*A: **"Totally**. And that was one of the problems in sales, Salespeople did say it [exists]. **To me, that's fraudulent."***

Q: "So, they would represent to customers that they have a 32-qubit machine when they didn't?"

A: "They would." - Former executive

Ex-executive stated the company is trying to "cover up that it's not there" and suggested the CEO was in the know

Q: "This issue of the 32-qubit machine, was it swept under the rug? Would you be at meetings and like, we've got a press release about it, now what do we do? Or was it like, if you want to keep your job, you just don't bring it up?"

*A: "[Redacted] brought it up and said, "How are we going to do this?" In light of the earlier press release, it's a problem. "What are you going to do?" And [the answer] was always "We're going to have to think about it." And then, "We're not publishing anything on quantum volume. If customers want to know that, they have to do it themselves." So, **they're trying to cover up that it's not there, and it's really a tough place to be."***

*Q: "**Did you ever have a direct conversation with Chapman**?"*

*A: "**Oh yeah**."*

*Q: "**And what would Chapman say**?"*

*A: "**We'll have it one day. We're working on it**."*

Q: "And did he ever acknowledge that announcing something they don't have was a mistake?"

A: "He never would admit that it was a mistake, because in his own mind he's too brilliant and powerful." - Former executive

Source: Scorpion Capital consultation calls with experts

The ex-executive stated that "a lot of people in the industry that think it's fraudulent," and mentioned a conversation with a key IonQ partner – we redact the name to protect confidentiality - who "said your company is fraudulent," with regard to the representation of the 32-qubit quantum computer. The executive added that potential customers would call and ask about it, with IonQ having to then "tap-dance" and give them "the runaround" – "so, nobody's ever seen it."

Ex-executive suggested concern in the industry that IonQ's claim of a 32-qubit computer is "fraudulent"

*A: "**[Key IonQ partner, name redacted] took [redacted] aside and said your company is fraudulent. There are a lot of people in the industry that think it's fraudulent**, that the representation of the 32 [qubit machine] is fraudulent. This is science. So, when you make a scientific claim, you back it with a scientific paper. And there are no scientific papers really coming out backing their claim. So, people don't like that, and then **people would call and say I want to use the 32-qubit machine and they get the runaround. Oh, it's in a test, or it's this. So, nobody's ever seen it."***

*Q: "Oh, got. So, there were some customers that believed they had a 32-qubit machine, they approached them, and then the company basically **tap-danced around it**."*

*A: "**Oh, totally, all the time**." - Former executive*

Source: Scorpion Capital consultation calls with experts

The former executive elaborated on IonQ's alleged attempts to now cover up their announcement of a 32-qubit machine: "caught in this corner"; "they continue to lie. Peter [CEO] just lies." The executive mocked IonQ's notion of "algorithmic qubits," a bespoke measure to continue the charade that they have 32-qubits, calling it "bullshit." We emphasize that IonQ continues to feature the "World's Most Powerful Quantum Computer" prominently on its homepage.

IonQ "put themselves in a corner" by claiming they have a 32-qubit computer

*"They made this claim on 32-qubit 4.2 quantum volume. And **they realized they put themselves in a corner because no matter what they come out with, it's not 32-qubits and 4.2 quantum volume**. So, they've been very careful, and they will tell you they will no longer publish quantum volume, and if you want to know it, you've got to figure it out for yourself. And there are two things: One is **dancing around the fact that they shot their mouth off. Secondly, they can't recover from shooting their mouth off**, so now they're saying we don't publish quantum volume." - Former executive*

Ex-executive alleged that the company and the CEO "continue to lie"

*"What's happening is there's only one scientific publication, and it's a non-peer-reviewed paper. There's only one scientific publication on the latest device. And **they're caught in this corner because it's not 32 qubit 4.2 quantum volume. And so, they're really stuck. The question is whether someone's going to call them out** and say you announced it two years ago. Nobody's called them out. And **they just continue to lie. Peter just lies. There's very little that he says that's the truth**." - Former executive*

Ex-executive called algorithmic qubits "bullshit"

*"Q: "They defined this **bespoke measure called algorithmic qubits**, and then they say we actually have 32 algorithmic qubits."*
*A: "**That's bullshit**." - Former executive*

Source: Scorpion Capital consultation calls with experts

As further evidence that the 32-qubit machine is allegedly non-existent and a "fraudulent" claim, the ex-executive pointed to the utter absence of data "that shows they have a 32-qubit 4.2 quantum volume device": "simply haven't published it because it doesn't exist." The executive further pointed to a paper submitted on Oct 7, 2021, which purports to show IonQ's best device – yet 32-qubit data is curiously lacking. We note that this paper was updated on Jan 3, 2022 – the date shown on the latest version of the paper. The executive stated that it's "remarkable that that paper isn't on the website," which we find telling given the laundry list of other papers IonQ features on their publications page.

Lack of IonQ publications showing data for a 32-qubit machine

"They just don't present data that doesn't tell their story. It's not that they're faking data. ***There's no data anywhere in this presentation, right? There's no data that shows they have a 32 qubit 4.2 quantum volume device****. There's no data. Show me a paper that has—they're not lying per se, or there's no scientific fraud, i.e., a publication where they lie on the charts or something.* ***They just simply haven't published it because it doesn't exist****. " - Former executive*

October 2021 paper shows IonQ's purportedly best machine yet 32-qubit data is curiously lacking

"The paper is actually not on the website. It's called 'Application-Oriented Performance Benchmark for Quantum Computing.' And it was submitted on October 7, 2021*. And that is the best publication of IonQ performance. Page 12 shows the best performance of IonQ, but it only* ***shows 21 qubits****…and they don't even address quantum volume. And so, it's kind of* ***remarkable that that paper isn't on the website****." - Former executive*

October 2021 paper was updated to Jan 3, 2022

Application-Oriented Performance Benchmarks for Quantum Computing

Thomas Lubinski,[1,2] Sonika Johri,[3] Paul Varosy,[4] Jeremiah Coleman,[5] Luning Zhao,[3] Jason Necaise,[6] Charles H. Baldwin,[7] Karl Mayer,[7] and Timothy Proctor[8]
(Quantum Economic Development Consortium (QED-C) collaboration)*

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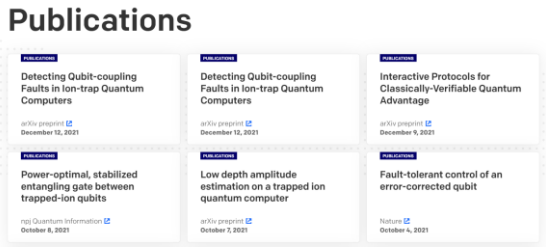
[8]Quantum Performance Laboratory, Sandia National Laboratories, Albuquerque, NM [illegible] USA and [illegible], CA 94550, USA

(Dated: January 3, 2022)

Paper is missing on IonQ's publications page



Publications

Detecting Qubit-coupling Faults in Ion-trap Quantum Computers
December 12, 2021

Detecting Qubit-coupling Faults in Ion-trap Quantum Computers
December 12, 2021

Interactive Protocols for Classically-Verifiable Quantum Advantage
December 9, 2021

Power-optimal, stabilized entangling gate between trapped-ion qubits
October 8, 2021

Low depth amplitude estimation on a trapped ion quantum computer
October 7, 2021

Fault-tolerant control of an error-corrected qubit
October 4, 2021

Source: Scorpion Capital consultation calls with experts; https://arxiv.org/pdf/2110.03137.pdf; https://ionq.com/resources/publications

The ex-executive's allegations that IonQ's claim of a 32-qubit machine are "fraudulent" were corroborated by a former senior technical employee in a key role. The ex-employee was careful to use legalistic language, but the implication was clear and the internal color was devastating: not only was the announcement allegedly false, but there was "an unprecedented amount of pushback" by the "scientists who are building the systems." The ex-employee suggested that "essentially every scientist" at IonQ opposed the announcement, and that "essentially all" of the scientists "felt extremely uncomfortable with the statement."

Ex-employee indicated the 32-qubit computer announcement was false and met with strong internal resistance

Q: "What are some of the areas or some of the claims where you think they're being particularly aggressive, where you don't agree with how they're positioning it publicly?"

A: "For instance, and we can probably talk about other things as well, but just to take one particular example, there was a forward-looking ***statement from about a year and a half ago, maybe, a year ago about the expected quantum volume of 4 million."***

*Q: "****The 32 qubit computer announcement in October 2020?****"*

A: "Yes, but that is one example out of many. So, announcements are made. I understand that legally speaking, this is a forward-looking statement, but in a sense, the statements were crafted in my opinion in such a way that people were supposed to expect such a machine to come online with certain specifications by certain dates or quarters. To date, however, if you go and take a look at what is available to the clients that are using IonQ's machines, ***I do not believe you will find a client that has access to the machine that actually has 32 qubits with 4 million quantum volume as was stated in the statement****."*

Q: "Was there disagreement or pushback in the company before this took place?"

A: "There was. ***Certainly, I would say, an unprecedented amount of pushback, especially by the scientists who are building the systems****, who have built the systems, unlike some of these founders who've been professors long enough to not know what actually goes in the lab, as you can imagine.* ***I can tell you that essentially every scientist has expressed strong opinions*** *as to how difficult and a monumental challenge this is going to be…****you could bet essentially all of the scientists who've seen the PR have felt extremely uncomfortable with the statement****." – Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

The ex-senior technical employee strongly suggested the 32-qubit announcement was untrue, and implied that technical staff were already upset prior to the announcement because they "knew that that's the kind of statement that leadership wanted to make." The ex-employee described the machinations behind the announcement, which we redact, and summarized the resistance from IonQ scientists: "you can imagine a lot of the scientists would actually kind of flip out."

Ex-employee elaborated on why the 32-qubit announcement was untrue and indicated that staff were upset

*Q: "**So, that 32-qubits machine that they announced with 4 million quantum volume, was that essentially a false statement for all practical purposes?"***

*A: "**I don't know what counts as false."***

*Q: **"Okay, did they have 4 million quantum volume?"***

*A: **"To the best of my knowledge, no."***

Q: "And did they know that they didn't have 4 million quantum volume when they made the statement?"

A: "When they made the statement, 4 million quantum volume was not there. I think that was pretty clear from the statement in the sense that they said that they're not going to deliver by a certain date in the first place."

Q: "I'm going to read you the first sentence of that press release of October 2020. IonQ unveils the world's most powerful computer. IonQ, the leader in quantum computing today, unveiled its next-generation quantum computer system. The new hardware system features 32 perfect qubits with low gate errors, giving it an expected quantum volume greater than 4 million."

*A: "…**I would say that is false**. Again, I'm not a lawyer, but if somebody gave me that statement and you tell me it either has to be true or false, then I'll say that's really false…to me, when you say you unveil something, it implies you have it, but by the time the PR released, **I do not believe we had it**."*

Q: "Were people upset when the release was made? What was their reaction?"

*A: "**I think people were upset even before that because people knew that that's the kind of statement that leadership wanted to make**. I mean, I can actually tell you where the 4 million quantum volume comes from […] So, that's where the number comes from, and the leadership took that as, okay; well, that must be achievable, which, in my opinion, scientifically speaking, falls down in two aspects…If you ask me is 4 million ever achievable, the honest answer is I don't know…**Yeah, you can imagine a lot of scientists would actually kind of flip out**." –Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

The ex-senior employee alleged that IonQ's CEO and founders pushed for the announcement, and described the statement of a 32-qubit machine as "outlandish claims" that are "so far removed from reality" and "what can reasonably be expected," even questioning whether the purported 32-qubit machine's 4 million quantum volume, as indicated in the press release, is "ever achievable."

Ex-employee suggested that the announcement was pushed by the CEO and co-founders of IonQ

Q: "Who pushed this? Was this Peter Chapman?"

*A: "**I would say the founders and Peter Chapman** knowing what I know." –Former senior scientific employee of IonQ*

Ex-employee described the statements of a 32-qubit machine as "outlandish claims" that are "so far removed from what can actually be done"

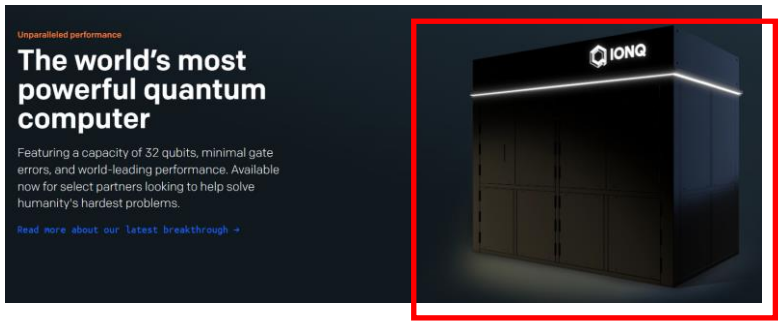
*"…**the statements that are being made, I do not believe, are consistent with the capabilities that they have** and what they can potentially deliver is the concern. I understand, sometimes you have to make the leap of faith. This is what happens when you're, for instance, writing academic grants and a little bit of hype to encourage people to get excited about it; I don't think there's much harm in those. But if you're making **outlandish claims that are in a sense so far removed from what can actually be done with what is available today and what can realistically be expected** based on know-how and technical understanding of how our system currently behaves, then this can actually be very discouraging. So, there's that element that I'm concerned about…I do not believe the level of investment into making technical progress, especially from a fundamental research side, is sufficient to actually support the claims for deliverables to come later." –Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

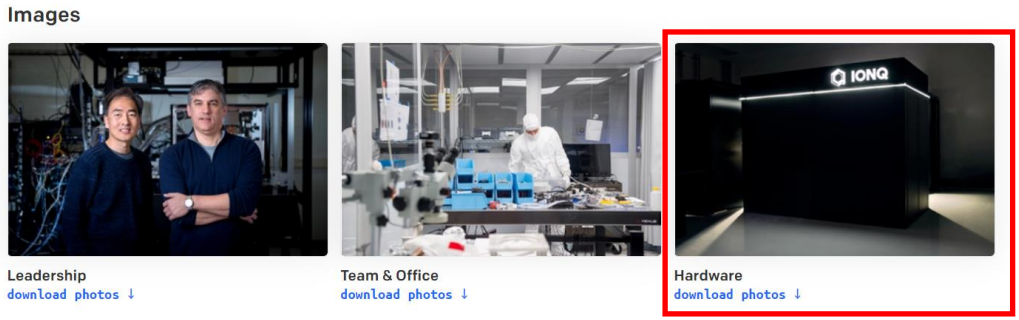
4. **Ex-employees suggested that photos of IonQ's computer in a sleek, commercially-viable package are staged and misleading. Two even stated that they "never saw" the standalone form factor featured prominently on IonQ's site and promotional materials. Pictures we located indicate the device is actually a primitive skunkworks contraption that one can't take "out of the lab for real use," resembling an explosion of "spaghetti" with electromechanical parts, lasers, cables, HVAC equipment, racks of screwdrivers, and multiple chassis that ex-employees indicated are "garage size" or the size of a "small adult elephant." At best, we suspect IonQ concocted a shell for SPAC photo ops to conceal the device's crudeness, as it suddenly appeared on their site right before the deal was announced in March 2021.**

IonQ's homepage leads with a picture of what its quantum computers actually look like – a sleek, standalone box. The site's "Media Resources" link allows one to download gleaming pics of the device, shown below.

IonQ homepage



"Media Resources" section makes pics available



"The outer enclosure for IonQ's next-generation system, which creates a highly stable environment (acoustics, temperature, humidity) for the system." –
Industry article, Oct 2, 2020

Source: Scorpion Capital consultation calls with experts; Cambium Biomaterials SEC filings; https://www.sec.gov/Archives/edgar/data/1883516/000188351621000001/0001883516-21-000001-index.htm; https://www.sec.gov/Archives/edgar/data/1883516/000188351621000001/xslFormDX01/primary_doc.xml; https://thequantuminsider.com/2020/10/02/ionq-unveils-new-32-qubit-quantum-computer/

Multiple ex-IonQ employees suggested that the photos of the slick black box quantum computer are staged or misleading. A former executive suggested the picture is "imaginary"; "not really real"; couldn't even tell if the photo is just a mock-up; and called the actual computer a "skunkworks" contraption. An ex-member of the technical staff laughed and called it just "a promo thing," stating the actual computer is "big optics table" with "a million pieces everywhere." He said the machine is twice his height and that he's 5'10', and called the company's claims of a small size "completely outrageous" and "totally absurd."

Former executive suggested the picture is "imaginary" and "not really real"

*A: **"It's like an imaginary…if I was to ship this to your lab, I would put this shell around it. But inside it's just skunkworks**. It's just a bunch of wires, a bunch of stuff, very much handmade, very inelegant. They're on very stable tables. It's a two-story table, and then they don't even show the racks of controllers that are with it. It's just a huge box, and it's probably, I would say, 10 feet by 6 or 8 feet wide and double high."*

Q: "Do they just have a bunch of plastic shells lying there? Or are they just only used for the photo-op? Do these plastic boxes actually house the machines today, or are they just on the side when they need a pic?"

*A: "**I don't even know if that's real or if it's a mockup**. I've been inside the lab. I'm just trying to think if that's really real. I think it's just an outer shell that they may have one of, but **it's not really real**." - Former executive*

Machine is "big optics table" with a "million pieces everywhere"; pic is a promo

*"I don't know if you've been to a trapped ion lab before, but they're always just **a big optics table, and there are a million pieces everywhere. I've seen the picture of the box. I think we actually just put a box around it [laughs], probably as a promo thing. I wouldn't look into that too much. It's kind of just like a promo**…that's not an innovation of any kind. If you include every piece of equipment that they're using to monitor it, then it's **a small room. It's a big box. The box is a promo**; it's probably twice the height of me, I imagine or maybe one-and-a-half. I'm 5'10. I cannot imagine a scenario in the next 10 years where you are shipping a box in any way like a PC terminal. There's just no way. Not only do you need technicians, but you need a Ph.D., post-doc quantum physicist as your technician, and you would need them there all the time. Yeah, like 24/7. I think some companies, maybe IonQ, they talk about boxing it up and shipping it and selling it places. But to me, that's **completely outrageous**, at least in the current state. That [the CEO's comments on a rack-sized box by 2023] to me, that seems **totally absurd; just hearing it, it seems absurd to me**." – Ex-employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

Two ex-employees stated they saw the older, legacy IonQ quantum computer, but "never saw" the black box on IonQ's homepage and investor materials, calling it "probably a staged photo op." One of them, a physicist, indicated the photo is unrealistic, as the computer is "very fragile" and not portable with a lot of large components "that can break." At best, we suspect that IonQ concocted an exterior shell for photo ops, to conceal the delicate and crude interior, after these employees left, as the photo first appeared on their site right before the SPAC.

Ex-IonQ physicist states he "never saw" a box that looks like the IonQ photo

*Q: "**So, you actually never saw that box. You never saw it look like that?"***

*A: "**Yeah, the back one with the backlit IonQ logo, yeah, I never saw that**."*

Q: "Is that the kind of thing you just put on a pickup and transport, or is very fragile—all the components, optics, cabling?"

*A: "They're **very fragile**. Ideally, you build the box. You put everything in it. You put it together, and you never open the box; you never do anything. You just let it sit there. [Without tuning] it goes down. You have to go in and fix some motor that's broken because these beams are directed by various motors and stuff like that. **It's very fragile**. There are a ton of electrical, mechanical components. **A lot of things that can break. There's the pulse generator, there's the vacuum chamber, there are these precise motors that direct the fiber optic cables that shine on the ions**. There are a lot of things that can break. The kind of complications associated with having so many things that can break in an ion-trap quantum computer is a shortcoming."*

*Q: "Is it **even realistic they put that black housing around it, except for a staged photo-op**? It seems like they would need to delicately remove that black housing 20 times a day."*

*A: "**Yeah, I don't think** - ideally, the end game would be something that you never have to open, like your laptop. You never have to go inside. I'm pretty sure that that photo is either a **photo op**, or else there's some very easy way to get inside it. There's no way that it would work to build a quantum computer that you can't get into." – Ex-IonQ employee, physicist*

Ex-employee called the pic "probably a staged photo op" and can't recall seeing on at IonQ like the pic

*"I'm pretty sure that's probably a **staged photo op**. It's not as pretty. Maybe they made it prettier. When I was there, it was kind of like a steel case, unfinished, and it was very much a prototype. I never saw the picture on their website, that black box with IonQ on it. **I've never seen that in person, but I had seen the computers in person when I was there, and they were just in unfinished steel boxes**." – Ex-IonQ employee, physicist*

Source: Scorpion Capital consultation calls with experts

Ex-employees, as well as other quantum computing experts who have previously worked closely with IonQ's co-founder, stated the actual IonQ computer is "room-size, like garage size"; that its size is "like a car" and requires a separate table with a regular computer; and said it requires a "medium-sized room to operate" one machine.

IonQ's computer is "room-sized, like garage size"

"How big a machine is comes down to what you consider to be the computer. This is all ion trapping and the basis for trapped ion quantum computers; it's an old theory at this point, so you can find all this stuff in old scientific papers. There's the actual trap itself, which is where the ions sit, which is really the register. People talk about the CPU. Some people might say that's the computer. And if you mean ***the thing that's doing the computation, you're talking about something that's maybe a few square feet****. My perspective is the computer is everything that goes into making the computations run. And on that scale, you're talking about something that is definitely much larger when you have to consider all of the control electronics, all of that stuff; you're talking about* ***room-sized, like garage size basically, maybe a one-car garage****." – Ex-IonQ employee, physicist*

The size of the machine is "like a car"

"I haven't been at IonQ recently, but I don't believe many things have changed. The ions themselves used to be suspended in a vacuum chamber, which measured about a foot by a foot. The gates are induced with lasers. So, to induce a gate with lasers, you have to have a stabilized optic table. And the optic table is about the size of a pool table. And there needs to be some controllers and classical computer that stand in a different room. It's the size of a car plus a table with a desktop where it's like a classical computer that is plugged in to control all of the quantum hardware. So, ***it's like a car plus a separate chair and a computer desk with a classical computer on it****."- Leading quantum computing researcher who has published papers with IonQ's founders*

IonQ's computer requires "a medium-sized room to operate"

"They definitely need ***a medium-sized room to operate*** *because it has to host the system. It has to host the electronics; it has to host the computers that are connecting to that; it has to have a lot of moving parts, like a laptop. It has a keyboard; it has a monitor." – Physicist at Google working on their quantum computing effort*

Source: Scorpion Capital consultation calls with experts

One ex-employee, a senior member of the technical staff, indicated that IonQ's machine is "about a small adult elephant in size," and described the myriad components that scale its footprint: lasers and optical systems, electronic systems, a vacuum chamber, etc. A leading quantum computing scientist and friend of the co-founders called it "the optical equivalent of spaghetti."

IonQ's quantum computer is the size of a "small adult elephant"

Q: "How large are IonQ's machines? Peter Chapman has said 2023, so that's two years from now, we're going to have a rack-mounted machine."

*A: "Many of these systems are **about a small adult elephant in size and that's not surprising because you have a lot of equipment. You have lasers; you have optical systems; you have a vacuum chamber; you have an electronic system**, everything has to be well isolated, routed, all of that considered, and you also have to make room for physicists to go in and tinker, so human intervention from time to time is necessary. I understand the stock photos that IonQ uses often showing it is a small thing…that's a vacuum chamber, it's a fraction of the actual size of a quantum computer because to me; a computer is not necessarily just the ions and where the ions directly fit. To me, a computer is sort of a holistic thing. Because when we talk about the size of a computer, we're talking about CPU, RAM, and all of the electronics that connect them and all of the things considered. If I have to use the conventional definition of a computer, the **actual computer size is pretty large**." - Former senior technical IonQ employee*

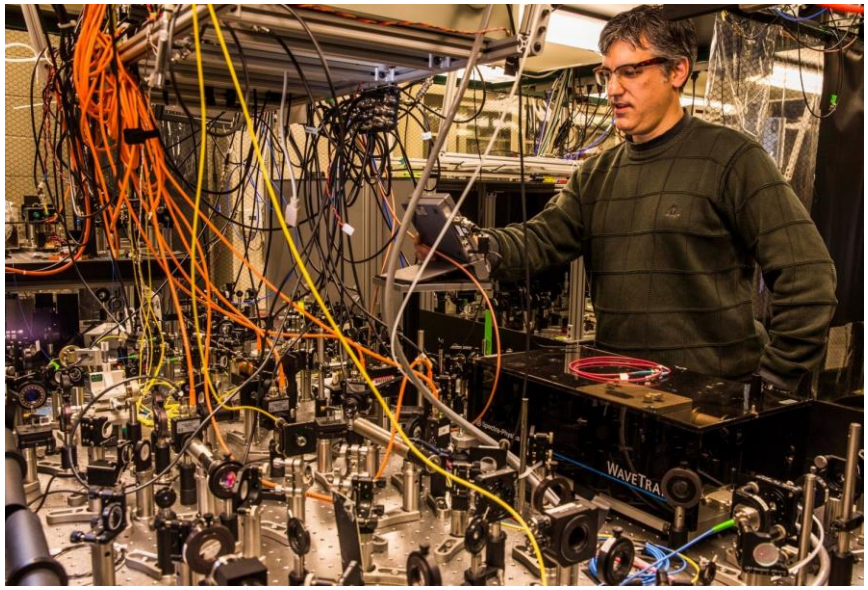
Ex-IonQ physicist states he "never saw" a box that looks like the IonQ photo

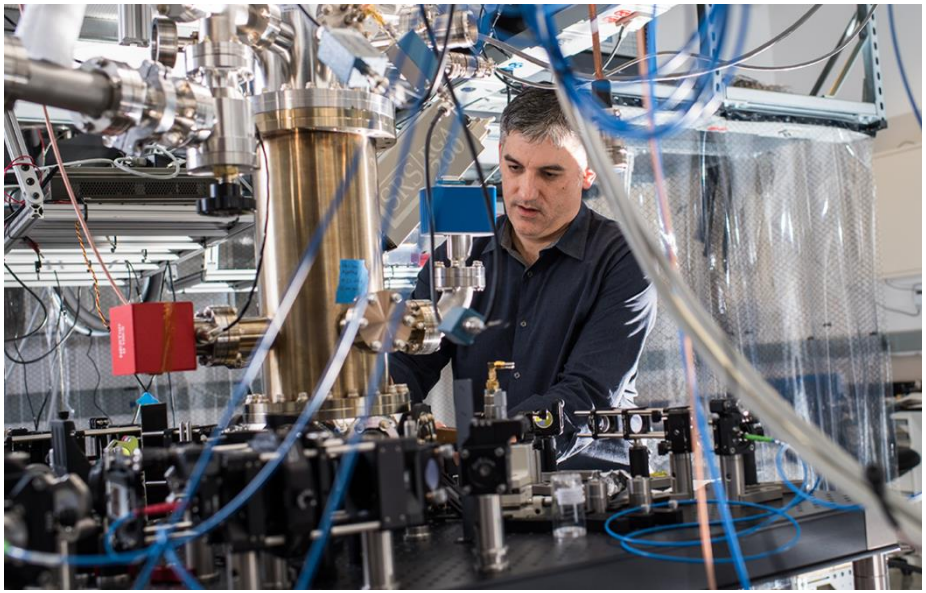
*"If you look inside, you might see what looks like **the optical equivalent for this spaghetti** that you see on a superconducting dilution refrigerator with all of these wires coming down and things like that. The optical equivalent of that would be an optical table with mirrors and lenses and things like that" – Leading quantum computing scientist and longtime friend of both co-founders*

Source: Scorpion Capital consultation calls with experts

We located various pictures which we believe confirm the information provided by ex-employees. Far from looking like the box on IonQ's site, the system is a primitive skunkworks contraption that appears to take up the size of a garage. The Washington Post once quoted co-founder Monroe discussing an older version of the device "the size of a small room": "There are so many pieces of equipment that we hold together, not literally with duct tape and glue, but sort of with that mentality."

*"The quantum device in Monroe's lab is **the size of a small room**. It uses lasers of various colors to activate the quantum particles. "There are **so many pieces of equipment that we hold together, not literally with duct tape and glue**, but sort of with that mentality," Monroe said. The system is particularly sensitive to temperature and humidity fluctuations — if they get two degrees warmer, the lasers expand beyond use."* – *Washington Post article in 2014*





Source: https://www.washingtonpost.com/business/on-it/lockheed-martins-bet-on-quantum-computing/2014/03/15/9db067f8-a61b-11e3-84d4-e59b1709222c_story.html; https://www.science.org/content/article/scientists-are-close-building-quantum-computer-can-beat-conventional-one

A 2020 profile of the IonQ co-founder on a Duke website shows that the size of the device remains ridiculous. The byline for the photo says "Chis Monroe sits behind an optics table filled with experimental pieces of his ion trapping quantum computing technology."

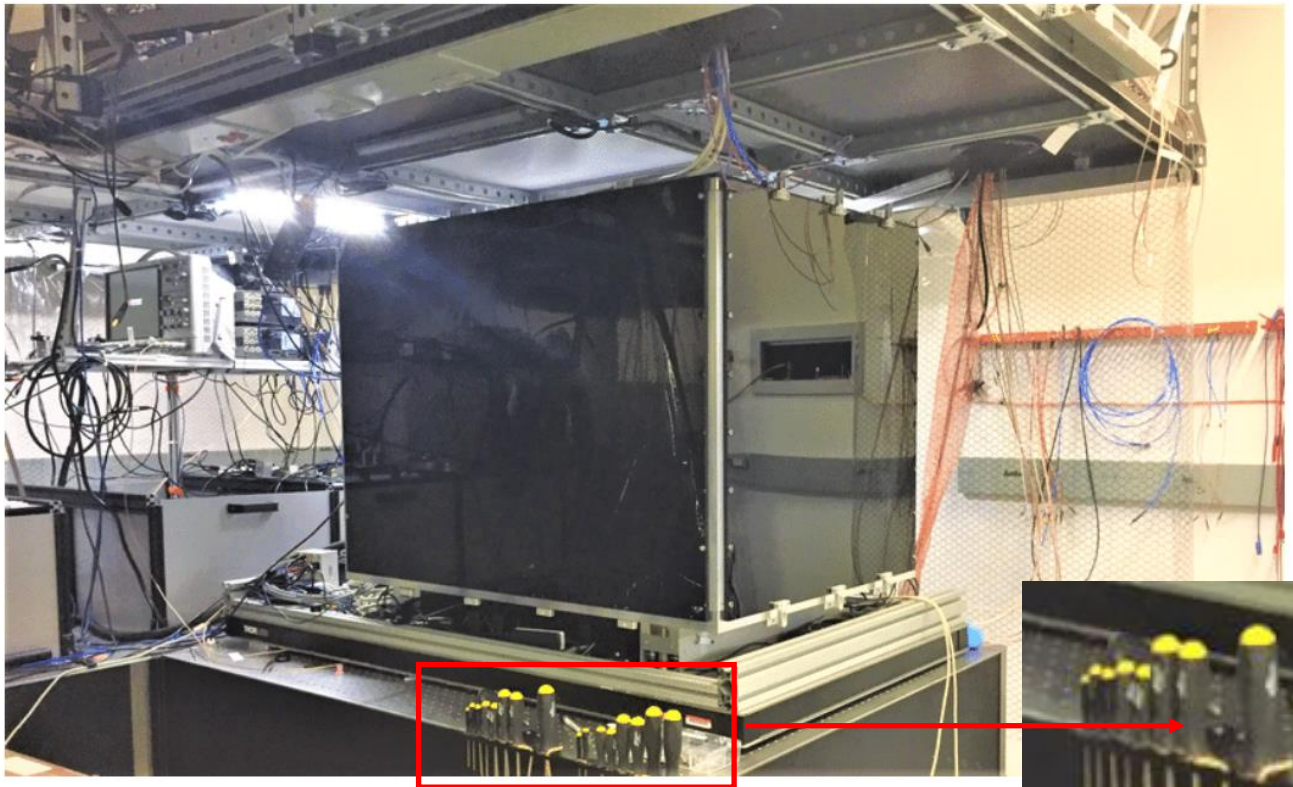
Chris Monroe profile, Aug 2020

Chris Monroe: Realizing Ion-Trap Quantum Computers to Solve Unsolvable Problems

Source: https://pratt.duke.edu/about/news/chris-monroe-profile

Another paper, also from 2020, shows crude infrastructure missing from the sleek pics of IonQ's purported box: wires and cabling that look like an explosion of spaghetti; large structures around the ceiling and floor, which we believe to be for thermal/electromagnetic stability, HVAC, and other environmental parameters; and a large collection of components that look like bulky lasers and measurement devices, not to mention what looks like a rack for 15 screwdrivers.

June 2020 research paper. Photo caption says "Trapped-ion quantum computer; Source: IonQ"



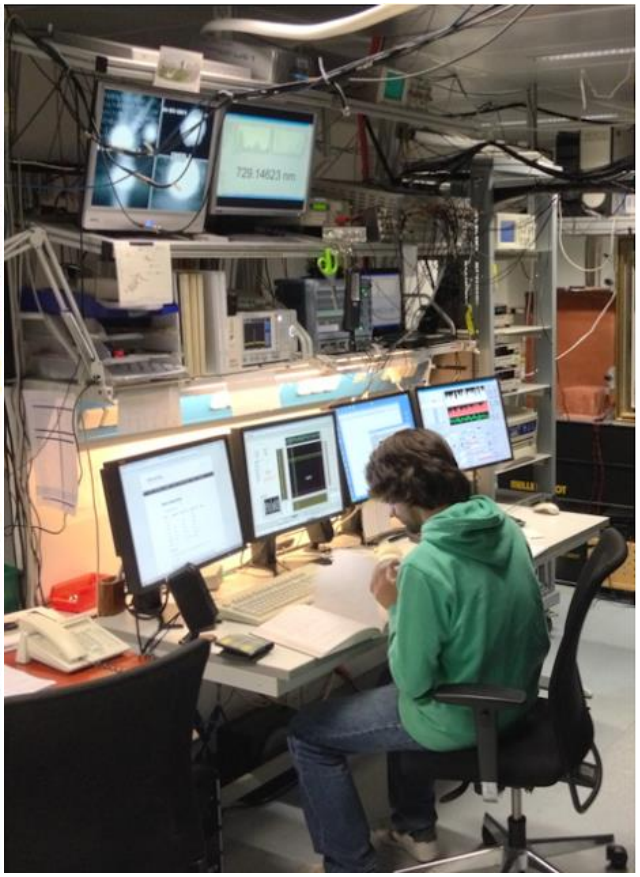
Trapped-ion quantum computer; Source: IonQ

How many screwdrivers does one IonQ computer need to keep running?

Source: https://www.researchgate.net/figure/Trapped-ion-quantum-computer-Source-IonQ_fig4_341926965

IonQ's quantum computer is based on an ion-trap technology. Photos of an ion-trap quantum computer from the laboratory of one the leading ion-trap researchers in the world once again convey that the "state of the art" is still primitive and skunkworks in nature.

"Here's How Ion Trap Computers Work" – March 2021 article by a researcher

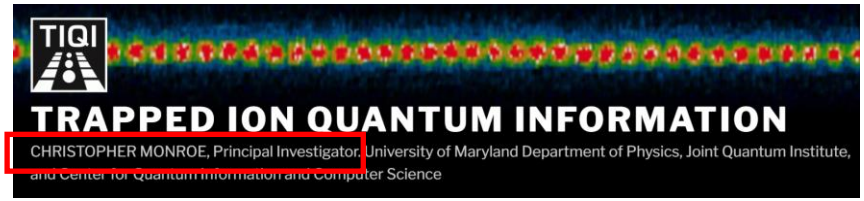


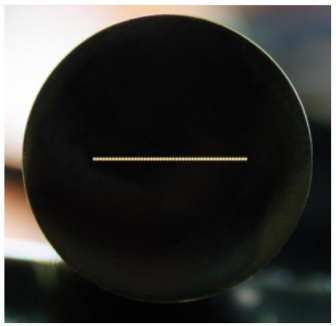
Source: https://thequantumaviary.blogspot.com/2021/03/heres-how-ion-trap-quantum-computers.html

Each of the lasers – just one of numerous key components - used in an ion-trap system are massive. A UMD site on trapped ion systems, with Monroe's name on the headline, says that "We create evenly spaced laser beams that are focused on the ions using a 32-channel AOM designed by L3-Harris." L3's site lists the dimensions for such a laser: 27 x 7.5 x 4 inches. Monroe's disclosed in a UMD interview that the "central processing unit" of his computer has "32 laser beams."

"***We have 32 laser beams," says Monroe***. *"And the atoms are like ducks in a row; each with its own fully controllable laser beam. I think of it like the atoms form a linear string and we're plucking it like a guitar string. We're plucking it with lasers that we turn on and off in a programmable way.* ***And that's the computer; that's our central processing unit."*** ***– Article on UMD website, https://www.umdphysics.umd.edu/about-us/news/research-news/1741-nature-2021.html***

UMD site on trapped ion systems lists Chis Monroe as principal and specifies the L3-Harris laser used





Fiber array for qubit readout

With this system, we can manipulate ions either individually or collectively with full control over Raman drive frequency, amplitude, and phase. We create evenly spaced laser beams that are focused on the ions using a 32-channel AOM designed by L3-Harris. The detection light from each qubit is collected on an array of 32 fibers for fast individual readout. Entanglement is performed by applying two high power laser beams to the target ions for a specific amount of time. Optimizing the shape of these pulses results in the creation of a pure two-qubit entangled state useful for quantum computation with minimal error.

L3-Harris website shows technical specs for such a laser

MULTI-CHANNEL ACOUSTO-OPTIC MODULATOR (AOM) ILLUMINATION MODULE

Precision control of optical beams for quantum state manipulation

Sourcehttps://iontrap.umd.edu/research/quantum-computation-with-ion-chains/; https://www.l3harris.com/sites/default/files/2020-12/l3harris-multi-channel-acousto-optic-modulator-illumination-module-spec-sheet-sas.pdf

Lasers are one of many daunting obstacles in reducing the size of ion-trap quantum computers from passenger vehicles to something usable. Numerous industry articles on ion-traps describe the cornucopia of optical components as a key reason one can't "take these systems out of the lab for real use." We note the "benchtops full of mirrors and lenses" in the photos of Monroe's computer shown a few slides earlier.

MIT article on ion traps, Nov 2020

"Walk into a quantum lab where scientists trap ions, and you'll find ***benchtops full of mirrors and lenses, all focusing lasers to hit an ion "trapped" in place*** *above a chip. By using lasers to control ions, scientists have learned to harness ions as quantum bits, or qubits, the basic unit of data in a quantum computer. But this* ***laser setup is holding research back*** *— making it difficult to experiment with more than a few ions and to take these systems out of the lab for real use."* **– *MIT article*, https://news.mit.edu/2020/lighting-ion-trap-1104**

2020 Nature paper by MIT scientists describes optics-related constraints in ion trap systems like IonQ's

Integrated multi-wavelength control of an ion qubit

"However, current implementations ***rely on free-space optics for ion control, which limits their portability and scalability****."* ***- Source: https://www.nature.com/articles/s41586-020-2811-x***

5. **Given that the absurdly large size of its system dooms any commercial viability, IonQ has promoted a fake story around rapid miniaturization, claiming to have a small data center device by next year and one that's desktop-size within 3 years. One ex-employee after another ridiculed the CEO's comments as "complete bullshit"; "completely outrageous,"; "bottom line ridiculous"; and stated they may be relevant "in 50 years."**

Given the absurdly large size of its system, IonQ has promoted a story around rapid miniaturization. Its computers today are larger than some cars, which makes their commercial relevance a fantasy. We believe that IonQ has therefore engaged in a campaign to dupe investors into thinking the device's size will soon make it practical. The CEO has indicated they'll be the size of a desktop computer by 2025 – 3 years from now. He further indicated that IonQ would launch a rack-mounted version in 2023 – next year. We note that typical server racks are 19 inches wide.

Techcrunch article, Sep 2020

Quantum startup CEO suggests we are only five years away from a quantum desktop computer

Follow-up Techcrunch article, Dec 2020

IonQ plans to launch a rack-mounted quantum computer for data centers in 2023

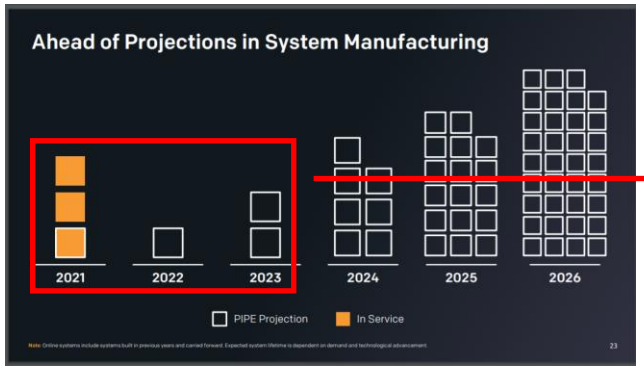
Source: https://techcrunch.com/2020/09/14/quantum-startup-ceo-suggests-we-are-only-five-years-away-from-a-quantum-desktop-computer/; https://techcrunch.com/2020/12/09/ionq-plans-to-launch-a-rack-mounted-quantum-computer-for-data-centers-in-2023/?guccounter=1

The CEO's comments suggest outright fabrication. Photos of a trapped-ion system show large tables of lenses, lasers, and optical components, yet Chapman implied that by 2023, it would all be on a single chip and that "I just tell somebody in Taiwan to start and give me 10,000 of those things." He added that "we don't have a manufacturing problem" and that a million qubits – versus the 11 they have on their AWS research toy today – is "No problem. That's easy." We contrast his claim of manufacturing scalability by 2023 with a preposterous slide buried in IonQ's investor presentation, which states that they currently only have three quantum computers – and suggests they will manufacture 3 more by 2023.

IonQ CEO comments in Dec 2020 interview

*That's the goal," he said about the chip. "**As soon as you get to 2023, then you get to go to scale in a different way, which is, I just tell somebody in Taiwan to start and give me 10,000 of those things**. And you get to scale through manufacturing, as well." […] "**We don't have a manufacturing problem. You want a million qubits? No problem. That's easy,**" Chapman quipped.*

Follow-up Techcrunch article, Dec 2020



Investor presentation shows a mere 3 quantum computers currently "in service"

Source: https://techcrunch.com/2020/12/09/ionq-plans-to-launch-a-rack-mounted-quantum-computer-for-data-centers-in-2023/?guccounter=1; IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/11/IonQ-Investor-Presentation-Sept-2021-Updates-v091721.4.pdf

An article in a data center publication illustrates IonQ's success in pushing a phony narrative about the size of its device. The piece indicates that IonQ already has already "revealed" a server rack-sized device; that they've already miniaturized "much of the technology onto a single chip"; and that "the single Quantum chip is 'the size of half a dollar'".

Trade article Dec 2020 - excerpts

Quantum computing data centre racks now a reality

The revolutionary technology will be ready for mainstream use by 2023...

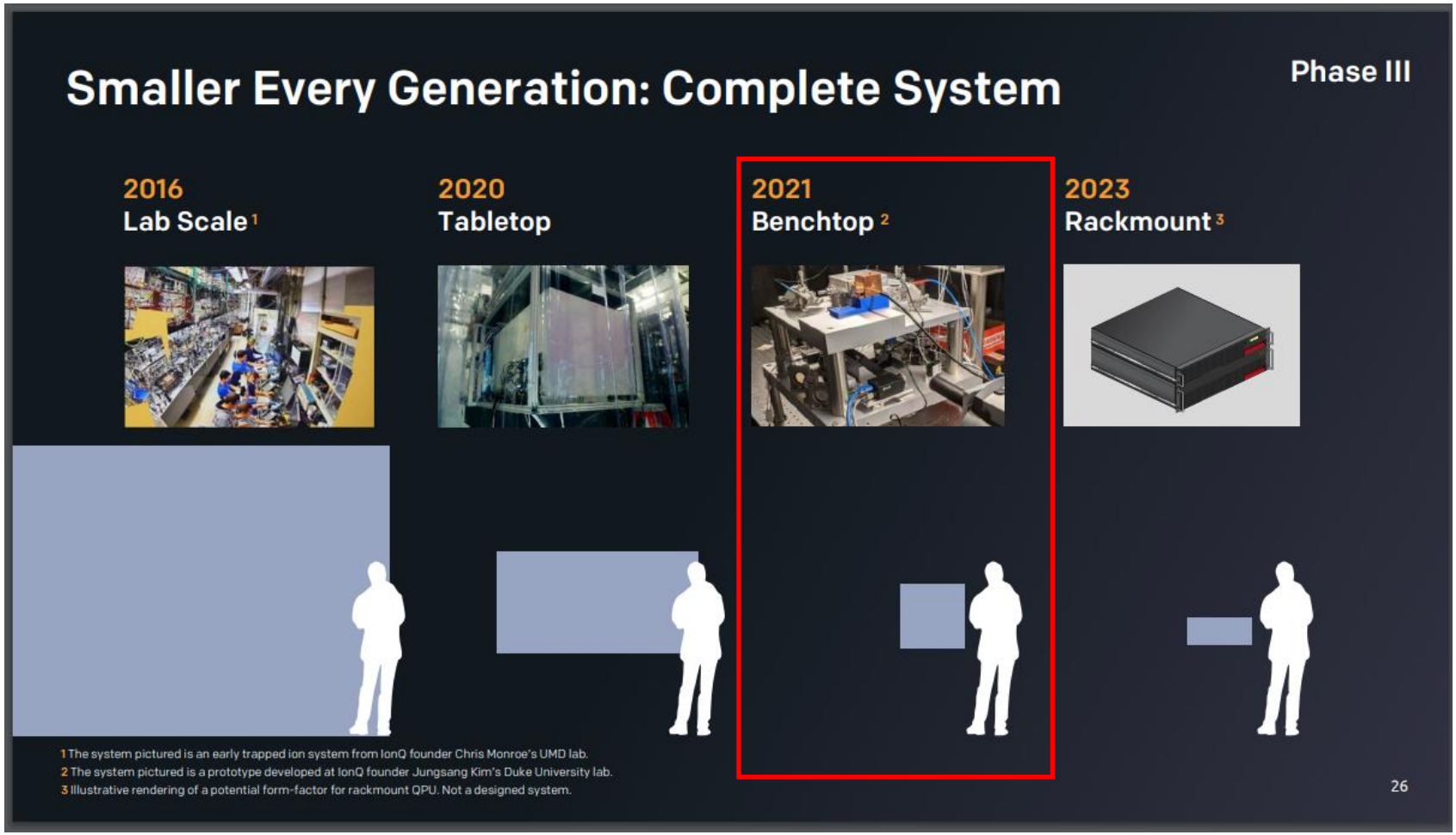
As IonQ, the world's leading quantum computing hardware and software company, reveals a new rack-mounted quantum computer for data centres, the race is on to go commercial with the technology.

The state-of-the-art system, which according to recent press reports is still at the prototype stage, is the size of a workstation, and uses a single Quantum chip 'the size of a half dollar'.

Source https://datacentremagazine.com/technology-and-ai/quantum-computing-data-centre-racks-now-reality

IonQ's investor presentation represents its current 2021 computer – the "complete system" – as already being at "benchtop" size, depicted graphically as the height of an adult's torso and slightly wider. Given ex-employee color about the actual size of the "complete system," we believe the slide is fraudulent.

IonQ investor presentation

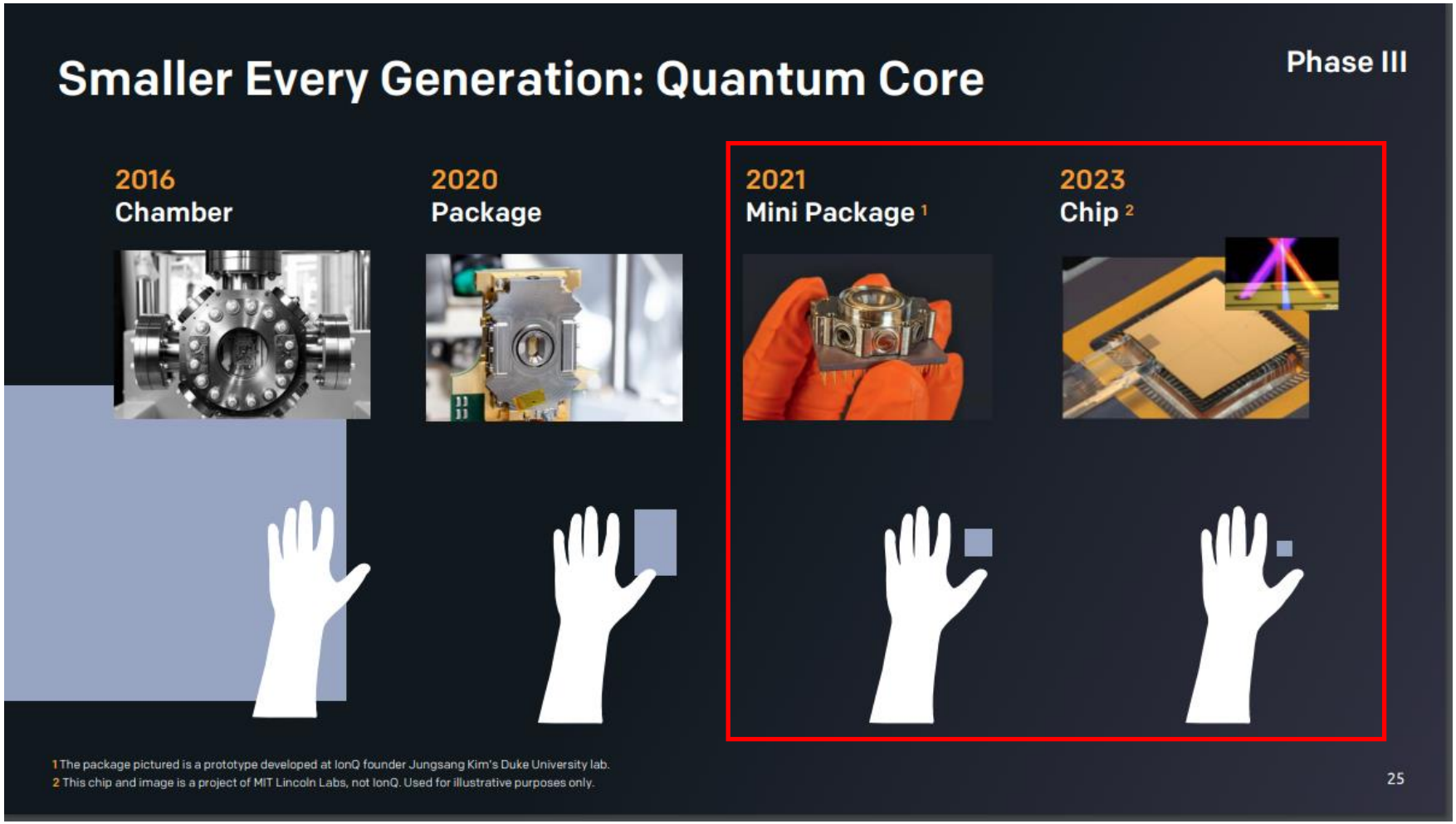


***Red ours for emphasis**

Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

IonQ represents key components such as its 2021 "Quantum Core" - comprised of the vacuum chamber and trap – as even smaller, roughly the width of three fingertips or a large postal stamp. The company indicates that by next year the vacuum chamber and ion trap will be the size of what appears to be a dime-sized chip.

IonQ investor presentation

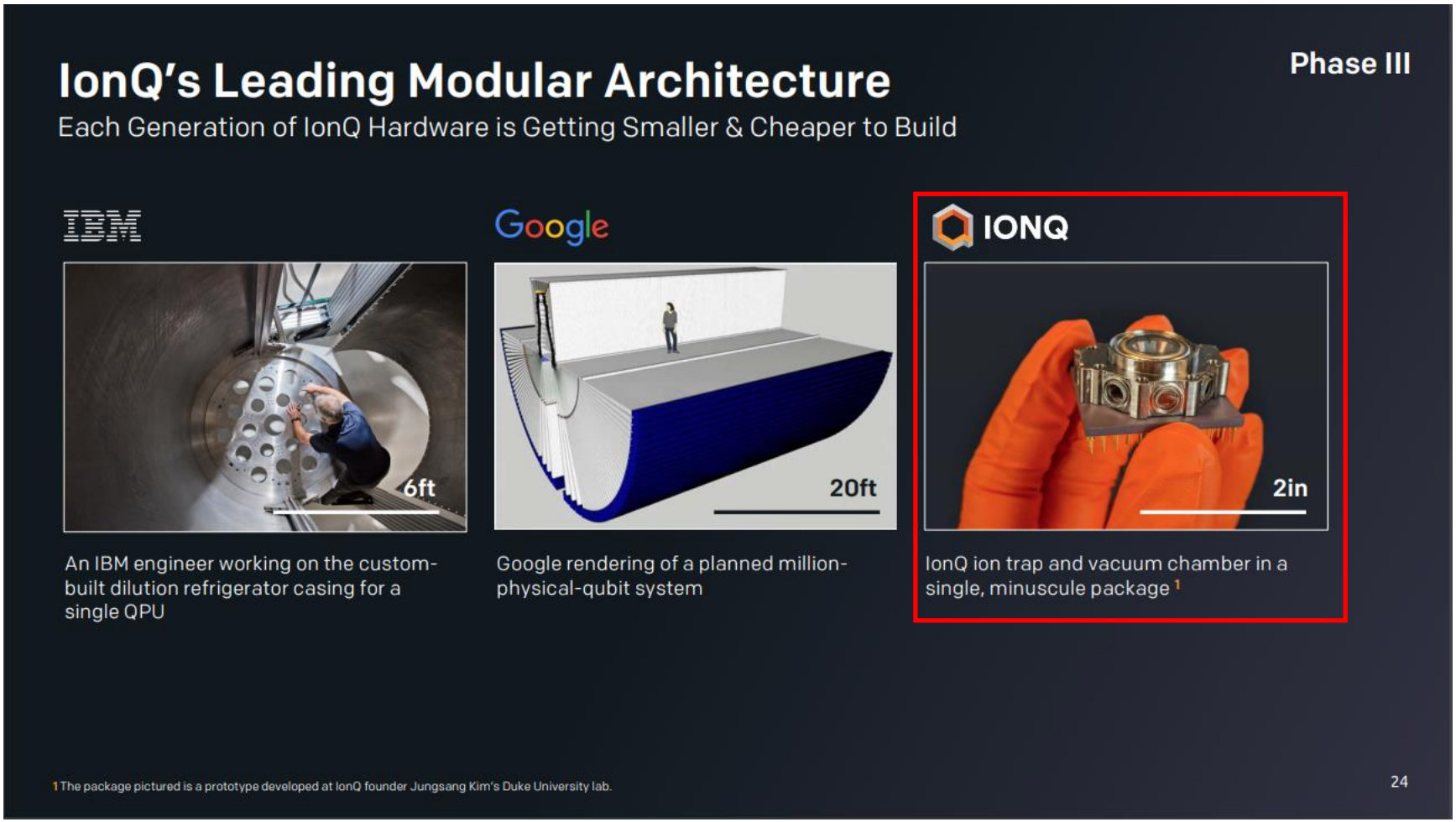


***Red ours for emphasis**

Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

To further emphasize its size advantage versus competitors, IonQ adds other pictures for the avoidance of doubt. Its presentation indicates that its ion trap and vacuum chamber package is only 2 inches wide, versus IBM and Google's hardware at 6 feet and 20 feet, respectively.

IonQ investor presentation



***Red ours for emphasis**

Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

One ex-employee and executive after another slammed and ridiculed the CEO's promotion of server-sized IonQ machines by next year. We quote four below. One stated that the CEO's comments are "complete bullshit" and may be relevant "in 50 years." A second called them "completely outrageous," "totally absurd," and stated that "there's just no way" they're plausible in the next 10 years, stating that the computers require a Ph.D. technician 24/7. A third simply laughed and called the CEO's claim "bottom line ridiculous." A fourth dismissed it as "just baloney."

"Completely outrageous"; "totally absurd"; "just no way"

***"I cannot imagine a scenario in the next 10 years where you are shipping a box in any way like a PC terminal. There's just no way**. Not only do you need technicians, but you need a Ph.D., post-doc quantum physicist as your technician, and you would need them there all the time. Yeah, like 24/7. I think some companies, maybe IonQ, they talk about boxing it up and shipping it and selling it places. But to me, that's **completely outrageous**, at least in the current state. That [the CEO's comments on a rack-sized box by 2023] to me, that seems **totally absurd**; just hearing it, it seems absurd to me."*
– Ex-IonQ employee, member of technical staff

"Complete bullshit" and "a very silly idea"; maybe relevant "in 50 years"

Q: "The CEO, Peter Chapman, said that they are two years away now, 2023, from having these in rack-mounted size"
*A: "**Yeah, that's complete bullshit**. To be honest, I can't even think of a use for a rack-mounted quantum computer at a server farm or a demand for something that doesn't work well there. I don't think the demand would be big enough that you would want to put one in a server farm. **It's a very silly idea to me at the moment. Maybe in 50 years**, if quantum computers work really well and everyone has an application for it that they can use, then it would make sense." – Ex-IonQ employee, physicist*

Ex-employee laughed and called the rack-mounted computers "bottom line ridiculous"

Q: "What do you think about rack-mounted computers by 2023?"
*A: **"[Chuckles] This is bottom-line ridiculous."** - Ex-IonQ senior technical employee*

"Just baloney"

*"They talked about is in two years that they're going to have a data center-sized device. They're nowhere near that. **It's just baloney. You don't go from the big behemoth to a rack in the data center in two years; you just don't.**" – Ex-executive*

Source: Scorpion Capital consultation calls with experts

Ex-employees further suggested that the photos of the "2021 Mini Package" – 2 inches wide and comprised of the vacuum chamber and ion trap – are phony. While IonQ represents it as its current system, a former physicist indicated they don't have any machines "developed with that in it" and that "the ones now are about probably like a cubic foot of volume. So, they're much, much bigger."

Ex-employee indicates that the current vacuum chamber and ion trap package is a cubic foot of volume

Q: "Go to page 24 of the presentation. See the picture on the right, the miniature vacuum package?"

A: "Page 24 of the March 2021 one?"

Q: "Yes. The picture on the right says, "IonQ's ion trap in a vacuum chamber in a single minuscule package." Is that what that is? That just looked like some engineered metal. I don't see an ion trap in there or anything."

A: "Those mini vacuum chambers are what I was telling you Jungsang works on. And that is the vacuum chamber, and inside of that vacuum chamber, that chip would be placed, and then you would trap the ions on the chip. That chip, the picture of it is very blown up. It's very, very small."

Q: "Is this the vacuum chamber that they use in their machines, this two-inch thing?"

A: "That is the micro one. ***I don't think they have any machines currently developed with that in it."***

Q: "How big is their vacuum pressure chamber now—it's not that one?"

A: ***"The ones now are about probably like a cubic foot of volume. So, they're much, much bigger."*** *– Ex-IonQ employee, physicist*

Source: Scorpion Capital consultation calls with experts

6. In contrast to the fake commercialization narrative pushed by IonQ, ex-employees and leading quantum experts indicate that its current 11-qubit computer is a useless demonstration "toy" for R&D tinkering, with no commercial relevance or practical use cases: the calculations it can do are so trivial you can do them in your head; a cellphone is a "million, billion times more powerful"; "can't do anything useful"; relevant in the way that "an 11-bit vacuum tube computer in 1920 might have been relevant."

A leading quantum computing scientist who has known IonQ's founders for 20 years described the hype as massively divorced from reality and laundry-listed he problems with IonQ's hardware, such as its immaturity and issues with decoherence and high error rates. He described the calculations their computer could do as so trivial that you don't even need a pocket calculator – that you could almost do them in your head. He stated that their SPAC raised "everybody's eyebrows" in the field, and described co-founder Monroe's hypocrisy as jarring, given his previous criticism of quantum hype from sketchy companies like D-Wave.

Quantum computing hype doesn't match reality and IonQ's hardware is immature; prone to errors and decoherence

"I've known Monroe and Kim for probably about 20 years. I followed their trajectories, which were purely academic for a long time. We travel in the same community, publish in the same journals, attend the same conferences, and so on. I'm also quite familiar with some of the other members of their team. Quantum computing currently is absolutely going through ***a major hype phase. There's no question about that. There are a lot of promises regarding what it can deliver, and there's a big gap with respect to the reality*** *of what's actually out there and how long it's going to take to see these deliverables. There are a number of key factors here. One is the* ***maturity of the hardware****. Another one is the scope and breadth of the algorithms that quantum computing provides. In both cases, both the hardware and the quantum algorithms, there is a lot of hype. The third factor is the issue of* ***decoherence and the need for quantum error correction*** *and how that's going to impact everything down the line." – Leading quantum computing scientist*

IonQ's machine can only run calculations so "trivial" that "you can almost do them in your head"

"When IonQ went public with the SPAC, that ***raised everybody's eyebrows*** *and beyond. The element of surprise was huge, but also it generated a lot of skepticism among experts regarding the credibility of that valuation of two billion. In a way, it's* ***especially jarring given that Monroe himself has been very critical of D-Wave****. D-Wave has received a lot of critique over the years from people like Chris Monroe and many other academic luminaries and for very good reasons because there were issues with their technology.* ***The critique was something like, how can you guys be selling devices you're calling quantum computers when the only problems you can solve with these devices are essentially trivial****? In the beginning, it was certainly true that you could just solve them on—you didn't even need a laptop—you could do it on a pocket calculator. Nowadays, you do need fairly heavy-duty classical computers to compete with what D-Wave can do. And that's not true for IonQ.* ***With IonQ, the calculations that they can run right now are essentially trivial. You can almost do them in your head. That kind of hypocrisy was really quite jarring****."– Leading quantum computing scientist*

Source: Scorpion Capital consultation calls with experts

The scientist described trying to use IonQ's 11-qubit computer on AWS as a disappointment and stated that "we were surprised" at its inferiority. More ominously, he described IonQ's machine as a "black box" where you couldn't audit what was the computer was doing, leading him to speculate "more nefariously, that they were hiding something": "we had a hard time getting behind-the-scenes look"; "we couldn't really ask a lot of questions…"

IonQ's machine was a surprising disappointment

"I can tell you a little bit anecdotally about ***my experience accessing IonQ hardware through Amazon Braket****. It's not me directly; it's a grad student in my group who I work very closely with who has tried it. That has not been the greatest experience. In terms of the user interface, ease of use and so on.* ***The experience was definitely inferior*** *to what happens if you try to access say, Rigetti through the Braket interface. It was inferior in terms of the low-level operations you could perform, the amount of insight you could get into what's actually going on when you send a command, how are the qubits responding. What's happening behind the scenes was not nearly as good with IonQ as with Rigetti.* ***We were surprised*** *by that mostly because we had gotten used to the standards that were set by Rigetti." – Leading quantum computing scientist*

"Lack of transparency" and inability to audit calculations

"It was the user interface, ***the lack of transparency. When you try to program a quantum computer nowadays, you don't want to do it as a black box****. You really want to be able to peek inside and understand at a very low-level what operation is being performed, what waveforms are being sent, sequencing of operations, which qubit is doing what, and what's the quality of that qubit and so on. You want to ask very low level down to the hardware level questions, and* ***that was just not possible with IonQ****." – Leading quantum computing scientist*

The scientist speculated that perhaps something "nefarious" was occurring behind the scenes

"It just gave us the impression that either they hadn't bothered to enable such features to their users, which would be somewhat disturbing or, ***more nefariously, that they were hiding something […] We had a hard time getting a behind-the-scenes look at what was going on. It was more like a black box****. We programmed it, and we got the output, and* ***we couldn't really ask a lot of questions about what happened in between****, unlike what you can do with Rigetti and IBM, where you do get a lot of insight on what happens in between. For a really early-stage type machine like all of them are, it's important to have that insight." – Leading quantum computing scientist*

Source: Scorpion Capital consultation calls with experts

The scientist continued that "thousands and probably millions of qubits" are required for a useful computer, and that IonQ's trapped ion technology can't even scale to 50 qubits. He described how the ions in their system quickly "buckle," and threw cold water on the theoretical solutions IonQ has promoted, such as an optical interconnect.

"Thousands and probably millions of qubits" required to make quantum computing useful

*"In order to realize the power of quantum computing, **you have to be able to scale up to essentially an arbitrary number of qubits, certainly thousands and probably millions of qubits**. That just has to be on the path somehow. When I say what hasn't been shown convincingly in terms of scaling, what I mean by that is I would like to see two traps containing whatever the upper limit is, let's say, on the order of 50s, 79, maybe you can even go as far as 79. I'm not sure whether that was a linear trap or not. But okay. Let's say you have a 100 ion linear trap. **I would want to see that they can actually successfully optically interconnect two of those and perform operations between the ions** in the two separate traps. That would be a landmark type of result that would give us hope that you can actually scale up the technology as realized in terms of linear traps. **And that hasn't been done yet"**. – Leading quantum computing scientist*

IonQ's trapped ion approach doesn't scale and the technology quickly "buckles" as you try to add qubits

*"There are **difficulties with scaling up the trapped ion systems, which are often brushed under the rug**. That has to do with how you're going to address and control a large number of trapped ion qubits in a way that maintains the ability to perform a coherent quantum computation, and there are basically two different schemes there, and we can get into more detail. There's a linear arrangement of ions, a linear trap, which is primarily what IonQ has been focusing on so far. And there's a strict **upper limit on the number of ions you can put in a linear trap; it's 50 or so; before the linear arrangement starts to buckles, you start to get these zigzag patterns in the ions, and that's not good**." – Leading quantum computing scientist*

Optical interconnect proposed by IonQ is an unsolved and "major difficulty"

*"In order to scale up beyond 50 or so, you need to start to connect different traps, and that is done optically, at least in theory; that's the idea. So, then there's a whole fairly **unsolved technical issue of how you generate entanglement between ions** and photons because the medium connecting the different traps will be photonic, optical. So, there's this transducer problem, conversion of quantum information or entanglement between ions and light. That is a fairly major difficulty about which quite a bit has been written but not too much has been done experimentally convincingly demonstrating that that works." – Leading quantum computing scientist`*

Source: Scorpion Capital consultation calls with experts

He continued that comments by IonQ's CEO do "not reflect the scientific, technological reality" and that even if they had a 30-ish qubit computer compared to the 11-qubit system they make available "in the cloud," that it would still be a toy: "a laptop is more powerful than a 30-qubit quantum computer." He explained that he has personally worked on quantum error correction for 20 years, and that it is the "elephant in the room" that necessitates millions of qubits for a computer to be useful. He slammed IonQ's promotion of double-digit qubit systems as "very, very premature in terms of a scalable technology."

Even 30-ish qubit computer is a toy that's less powerful than a laptop

"What you can calculate currently with a 30-ish qubit device is something that you could easily always calculate on a laptop, no problem. ***A laptop is more powerful than a 30-qubit quantum computer****." – Leading quantum computing scientist*

CEO's statements do "not reflect the scientific, technological reality"

Q: "The CEO is making statements out there saying as soon as we get to 50-170 qubits, we're there, we can do something useful. What is your perspective on his statements?"

A: "That's where I'm very critical. I think that's where there's hype. ***It does not reflect the scientific, technological reality****." – Leading quantum computing scientist*

Error correction is "the elephant in the room" and requires millions of qubits

*"****Error correction is on everybody's mind. I've personally worked on it for 20 years. It is undoubtedly the most important enabler of scalable quantum computing****. It goes well beyond the specific issue of how you hook up different ion traps or whether you use linear arrays or CCDs and so on. This is the big one, quantum error correction […]* ***The elephant in the room is that you need a very large number of physical qubits per error-corrected logical qubit*** *in order to actually start to reap the benefits of quantum computing. Estimates vary wildly as to how many physical qubits or launchable qubit. The consensus is probably, well, it depends on what you want to do exactly, but it could be in the hundreds, it could be in the thousands of physical qubits or logical qubits. And that's why* ***these current numbers of 30 or 11, hundreds, they're all very, very premature in terms of a scalable technology. That's why earlier I was saying millions is probably where we need to go because we're going to have to devote a lot of our physical qubits to do error correction****, a large fraction thereof." – Leading quantum computing scientist*

Source: Scorpion Capital consultation calls with experts

A former scientific employee of IonQ in a senior role slammed IonQ's computer as a toy and stated that his cell phone is a "million, a billion times more powerful." He described users of IonQ's machine as "people just kind of tinkering around because you can't really do any meaningful work" on it. He further slammed the "quantum advantage" experiments that IonQ promotes as "a contrived problem that has no physical meaning or commercial value." Another ex-employee dismissed the "fledgling" computers as having no use case "in the next five years."

IonQ's computers are trivial compared to a cell phone and can't be used for any meaningful work

*"Look, the 11-qubit quantum computer performance they provide; **I can do this much faster on my cell phone**. So, it is not surprising to me that **people are just kind of tinkering around because you can't really do any meaningful work** in any of these machines other than for demonstration purposes. Strictly speaking, **my cell phone is million, a billion times more powerful** than the quantum computers offer today on any of the platforms, to be honest, with the exception of some of these **contrived experiments** made to demonstrate quantum advantage. But that is not what people normally consider computation. I mean, it is a **contrived problem that has no physical meaning or commercial value**." –Former senior scientific employee of IonQ*

IonQ's hardware is "very fledgling" with numerous unsolved challenges in the company's trapped-ion approach; surprised to see them go public; no use case in next five years

*"I was **surprised to see them go public, personally** because in my experience with working with quantum hardware…**the state of the hardware right now is very fledgling. I would be surprised if there were really clear and profitable use cases for quantum any time in the next five years. The main challenges of the trapped ion are well known**, and we were working on those challenges, like trying to scale the qubits trying to maintain proper error rates for two-qubit gates. You need a lot of qubits, but you also need good quality qubits, and the quality of the qubit is very important. Most of the quantum algorithms that are kind of like the top of the field right now are the QAOA and VQE; these things are still not even really besting classical simulations of quantum computers" – Former IonQ employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

The same feedback – that IonQ's machine is a useless "toy" - was shared by every single ex-employee that we interviewed. An ex-IonQ physicist implied that any hype to the contrary was dishonest; that it can't "run a calculation that's worth anything" or "do anything useful," even if it had far more qubits than the current version. Another ex-member of the technical staff derided the hype: the computers are "mainly toys" – "the fact of the matter" – useful only for testing scripts in "toy examples." He added that it's still 10 years away before they're not a toy – but cautioned that people were saying that 10 years ago as well.

IonQ's computer can't do anything useful

"Investors want to hear one thing. People who are looking for this next big emerging technology, they hear Google or IonQ or Honeywell, they've got this new 50-qubit device, 64-qubit device, 128-qubit device and that sells, frankly. It's exciting. But the reality is the number of qubits in your quantum computers isn't the only important metric. There's a big gap between how many qubits we can fit in a computer vs. how accurate we can make the gates in a circuit. To run a program, you're performing millions of primitive operations. And if you can't do that really repeatedly and with really, really high accuracy, it doesn't matter how many qubits you have; it doesn't matter how fast your machine is. You're ***not going to be able to run a calculation that's worth anything. I think something that's not talked about with honesty*** *is how big of a challenge that is and how much room needs to be covered to get to a point where* ***even if we have dozens of qubits, they're not actually able to do anything useful****. And that's just a really hard technical challenge." – Former IonQ employee, physicist*

IonQ's computer is just a "toy"

*"****There is definitely quantum hype right now, definitely, without a doubt****. People want to invest in quantum companies because it's very hot. I've spent a good amount of time developing algorithms, and the hardware really is just not there yet, and it's unclear how long it would take to get to where these things would be helpful […] I think it is very clear, and I don't think they would disagree, that the small 10-qubit devices are* ***mainly toys right now. That's the fact of the matter****. It doesn't become anything more than that until you are past the number of qubits that can be classically simulated, and those qubits are of very high quality, which is not really the case […] Everything that's available right now is only useful for researchers who want to test that the* ***scripts that they are writing can run in the toy examples****. When I tell people, I always say about 10 years when it's not a toy. But they were saying 10 years 10 years ago." – Ex-IonQ employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

A former employee compared IonQ's machine to a primitive vacuum tube computer. He called it as "practically relevant" as "an 11-bit vacuum tube computer in 1920 might have been relevant," adding that it was irrelevant for "solving real problems" in the foreseeable future. Another agreed that a vacuum tube computer was "a fair analogy" and that you could do "nothing" even with 79 single-qubit gates – more than 7X the current 11 qubits.

IonQ's technical achievements are just "funny" – as relevant as an 11-bit vacuum tube computer from 1920; no relevance for "solving real problems" or perhaps even in 10 years.

"It's just—it's funny, for the quantum information community, having an 11-qubit quantum computer that can do the things that this paper espouses that IonQ's computers can do is a big deal. That doesn't mean that it's a big deal from the perspective of being able to perform valuable computations. ***It's practically relevant in the same sense like demonstrating an 11-bit vacuum tube computer in 1920 might have been relevant****…I would not say it's relevant in terms of solving real problems now or solving real problems next year or probably in five years or probably in 10 years." – Former IonQ employee, physicist*

Similar to a vacuum tube computer from 1950; can't do "nothing" with a 79-qubit computer

*Q: "****Is that kind of like having a 79 vacuum tube computer from 1950?"***

*A: "****Yeah, I think that is pretty much a fair analogy*** *because you basically have control independently of 79 bits of information. The reason that's important for quantum computing is that because of the power of those non-classical interactions like that entanglement; it's actually really hard to isolate qubits from each other."*

*Q: "****What can you do with 79 single-qubit gates, anything?"***

A: ***"No [chuckles], nothing****. I mean, you can demonstrate in principle that you technically have a quantum computer, which is to say you have a system where you can provide inputs and get an output, but you can't do anything useful with it."*

Q: "Is that like a 79-bit computer, basically, 79 single-qubit gates. Is that the right way to think about it?"

A: "Yes, it is essentially. You can do certain things that a classical computer still couldn't do, but none of them are useful."

Q: "It's roughly the equivalent to 79 bits?"

A: "Yeah, exactly. It's the quantum equivalent." – Ex-IonQ employee,

Source: Scorpion Capital consultation calls with experts

Another ex-employee was more generous, likening IonQ's system to "big chunks of silicon" from the 1960's instead of a contraption from 1920. He expressed skepticism that IonQ has any path to get to the thousands of qubits needed to "scale things up to the point that it's going to be practical." A leading quantum computing researcher who has published papers with IonQ's founders called it "a scientific toy" that's "worse than your cell phone" in terms of its "computational capacity" – clarifying that he meant versus a 20 year-old cell phone, similar to a "computer from 1950 to 1960."

IonQ's quantum computer is like a regular computer from the 1960's; no path to the thousands of qubits needed to "make anything practical"

"The real problem for me, to make anything practical, to make quantum computing practical, you need 500 qubits; you need thousands of qubits with really high fidelities. ***How do you get there - any quantum computing company will get to the 500 or thousands of [qubits with] decent fidelities? I didn't find any solid answer****. If we went back to how classical computers were in the '60s, big chunks of silicon. I believe that's what's truly lacking in the quantum computing world. Someone needs to come up with a way to scale things up to the point that it's going to be practical.* ***The way I see it right now, I don't see a really good way to do so.****" – Former IonQ employee, senior member of technical staff*

"Scientific toy" worse than a 15 to 20 year old cell phone; similar to a computer from the 1950's

"It is a scientific toy. In terms of its computational capacity, it's worse than your cell phone*. When I say worse than your cell phone, a cell phone is at least 15 to 20 years old because you just don't compare it with modern cell phones that are very powerful computational machines. If you compare the computational capacity of IonQ's best available trapped ion quantum computer to a classical machine, then yes, it would be worse than a 20-year-old phone.* ***It would probably be equivalent to a computer from 1950 to 1960****." - Leading quantum computing researcher who has published papers with IonQ's founders*

Source: Scorpion Capital consultation calls with experts

The researcher who has published papers with IonQ's founders described their machine as a demonstration of "elementary functionality" for "educational purposes" only, stating it was "too small and too noisy" to outperform any regular computer. He added that even for grad students and such, IonQ's system is "certainly nothing that you could do anything seriously useful on."

IonQ's computer is only "for educational purposes: to demonstrate "elementary functionality"; "too small and noisy" to outperform regular computers

Q: "What can I do with it? What is the purpose of this being on a cloud? Just for grad students who run experiments? What can you do with an IonQ quantum computer?"

*A: "You can **demonstrate the elementary functionality that a quantum computer enables**. It allows you to run lab demonstrations of the kinds of computations that you would want to run eventually on scalable quantum computers. And it does not outperform any classical computer whatsoever. It's **too small and too noisy** in order to be able to accomplish that. So, if you want to demonstrate a single quantum algorithm such as Bernstein-Vazirani or Grover's Search over a small case, maybe 16 elements or some simple computation like that, then you would use the trapped ion device or the IonQ device. **It's for educational purposes; I would say, only**." - Leading quantum computing researcher who has published papers with IonQ's founders*

Even for university researchers, IonQ's machine is "certainly nothing" you can do anything "seriously useful on"

*"11 qubits is basically R&D. A university researcher would probably pay to use something like that and test out small quantum circuits. **It's certainly nothing that you could do anything seriously useful on, no**. " - Leading quantum computing researcher who has published papers with IonQ's founders*

Source: Scorpion Capital consultation calls with experts

A physicist at Google working on their quantum computing effort provided identical color to ex-IonQ employees and other leading researchers: "very, very infant" technology that's as primitive as computers from half a century ago; one can only "play with them as toy model"; "cannot do anything useful on them"; no real world applications.

"Very, very infant" technology that's as primitive and cumbersome as regular computers from half a century ago

*"**As a researcher, I can tell you that currently, the state of the technology is very, very infant**. If I want to draw some parallel for you, essentially, the state of the technology looks the same way that normal computers looked 50 years ago. They were inside these huge warehouses. They had a **large number of people operating them, big chunks of equipment and things like that, and very, very limited computational power. That's how normal computers looked 50-60 years ago**. Quantum computing is essentially in that stage." – Physicist at Google working on their quantum computing effort*

One can only "play with them as a toy model"; "cannot do anything useful on them"

*"The thing is, always remember, the actual devices that you have available right now, they are only capable of performing very limited computation. Again, think of computers 50 years ago. Of course, **you could play with them as a toy model of some larger computation, but you cannot do anything useful on them**. You cannot do anything useful that a classical computer wouldn't be able to do." – Physicist at Google working on their quantum computing effort*

The researcher emphasized you can't do anything "useful" on IonQ's computer; no real world applications

*"On an IonQ quantum computer, you can do almost anything that you could do with a real quantum computer, but the thing is that because the system is very small, the number of qubits is very small, most of the things that you can do is research. **You cannot do anything—let me repeat—"useful" on it.** For example, let's say you have a client that wants to lower some transportation logistic overhead and optimize some problems like that. You cannot take such a problem to a quantum computer and tell it to, oh, okay, optimize it for me. It cannot do that because it's not big enough. It doesn't have enough computation power." – Physicist at Google working on their quantum computing effort*

Source: Scorpion Capital consultation calls with experts

An ex-technical employee explained that IonQ's quantum computer can't do anything one can't easily do with simple quantum simulator software on a regular laptop. He added that even if IonQ doubled their number of qubits from the 11 available via AWS, he could write a 20-qubit simulator "on my laptop in a couple of hours." He further expressed his surprise that IonQ was able to go public without being able to show any superiority over a typical personal computer.

IonQ can't do anything one can't do with wimple quantum simulator software on a laptop

*"**You can do a lot of simulations of quantum computers on regular computers. That's what most people are doing right now because we don't have good actual quantum computers to run things on**, and most of the time, you're comparing the simulation to the real ones that test how well the hardware is working. I guess technically supremacy was reached by Google or whatever. But really, what that was a bunch of random gates that don't actually have any meaning for a real, tangible problem. So, I was surprised to see a company go public that's just quantum before that barrier was reached. **IonQ hasn't reached quantum supremacy where they have a problem that they've demonstrated that cannot be solved on a classical computer**, and they solve it with a quantum computer. That has not happened. To my knowledge, there's no company or research lab that has shown this example." – Ex-IonQ employee, member of technical staff*

Would only take a couple of hours to program a laptop to do everything a next generation IonQ computer could do

*"I could go and write a 20-qubit simulator probably **on my laptop in a couple of hours, and it would do everything that that 20-qubit computer could do**." – Ex-IonQ employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

7. **A key trick that IonQ has used to entice investors is the use of algorithms and tests to demonstrate "quantum superiority," a term indicating that its system is better than "any other quantum computer." Every ex-employee and leading expert we interviewed slammed the benchmarks as rubbish and "hype" - "contrived" self-serving exercises based on "mock problems" or "a toy problem" that "has no real application."**

A key trick that IonQ has used to entice investors is the use of algorithms to demonstrate quantum superiority. As an example, we note a press release announcing "two rigorous real-world tests that show that its quantum computer" produces better results than "any other quantum computer." Remarkably in the release, Monroe even wags his finger at other quantum computing companies for fueling "hype" by releasing "highly selective descriptions and statistics," and cautions investors that "the real test" is what your computer can do in a "real-world setting." His co-founder Kim concluded the release with assurances that their test was solving "meaningful problems" – "our qubits are perfect, allowing them to "map onto any future problem."

IonQ press release declaring quantum supremacy

IonQ publishes new benchmarks for quantum computation

03/21/2019

IonQ, the leader in trapped-ion quantum computing, released today the results of two rigorous real-world tests that show that its quantum computer can solve significantly more complex problems with greater accuracy than results published for any other quantum computer. The results, released on arXiv.org, are further validation of IonQ's trapped-ion technology. In December, IonQ announced the most powerful system built to date. And in February, it published the world's first quantum computer simulation of the water molecule.

"There is a lot of hype in the market now as many players release highly selective descriptions and statistics for their quantum computers," said Christopher Monroe, IonQ's co-founder and Chief Executive Officer.

"The real test of any computer is what can it do in a real-world setting. We challenged our machine with tough versions of two well-known algorithms that demonstrate the advantages of quantum computing over conventional devices. The IonQ quantum computer proved it could handle them. Practical benchmarks like these are what we need to see throughout the industry."

Source: IonQ press release https://investors.ionq.com/news/news-details/2019/IonQ-publishes-new-benchmarks-for-quantum-computation/default.aspx

The press release then reveals the tests that IonQ used – the Bernstein-Vazirani and Hidden Shift algorithms. In contrast to Monroe and Kim's doth-protest-too-much shtick about the "real-world" nature of these benchmarks, every ex-employee who we asked to comment slammed them as exactly the rubbish the founders decried as "hype." One described them as cynical self-serving exercises that are "contrived" and where you've "just constructed a problem that has no real application" except to show your system is "the best." A leading researcher who has published with IonQ's founders called the algorithms "artificial" and focused on a "very constrained type of problem."

Quantum supremacy experiments are cynical self-serving exercises solving "a problem that no real application"

*"**It's contrived**. Everyone wants to say they have a device that has quantum supremacy that can perform a calculation 10 million times faster than a classical computer. But if you're very specifically tailoring the problem you're solving to be something that is easy to do on a quantum computer but almost impossible to do on a classical computer, then it's very easy to show you have supremacy, but you've just **constructed a problem that has no real application**, other than to demonstrate the fact that your computer can do something a classical computer couldn't do." – Former IonQ employee, physicist*

IonQ's system can only be used for "artificial," useless computations; can't do anything a prehistoric computer can't

*"**You can do some computations, but you would have to constrain your computational model to something artificial…a very constrained type of problem**. Or you can demonstrate the Bernstein-Vazirani algorithm, which is a kind of an algorithm that tells you something about a black box and, again, a black box is a construct taken from theoretical computer science, and it's not necessarily the most practical type of construct, which is to say that within the black box computational model, **there is nothing that IonQ's device can do that a computer from the past, a classical computer from the past would not be able to do**. Let's say IBM 3000; I think it's sufficiently prehistoric." - Leading quantum computing researcher who has published papers with IonQ's founders*

Source: Scorpion Capital consultation calls with experts

A quantum computing faculty member who has used IonQ's computer via AWS described the company's showcase algorithms as merely solving "mock problems" - "a toy problem"; "not going to solve any real-world problems." A physicist at Google working on their quantum computing effort echoed the same sentiment, describing IonQ as an "infant" technology doing demo's on "artificial problems" that are specifically designed for "showcase" purposes, while having done nothing on problems that are "real world."

Quantum computers like IonQ's can't "solve any real-world problem"; can only solve "mock problems" or "a toy problem"

"Most quantum computers, if you talk with IBM, Rigetti, they can do very simple quantum algorithms. ***They are mock problems****; for example, Quantum Fourier Transform is an algorithm similar to for Fourier Transform, where you go from frequencies into numbers, the value of the frequency. Here you can go from one phase, the phase information into a number information.* ***It's a toy problem****. The number of qubits is your limiting factor on the kind of problems you can solve, and I'm only talking from a quantum type of algorithm because* ***these are not going to solve any real-world problems with 11 qubits****." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

"Infant technology" that can only solve "artificial problems" designed to make them look good; no application for any "real world problems"

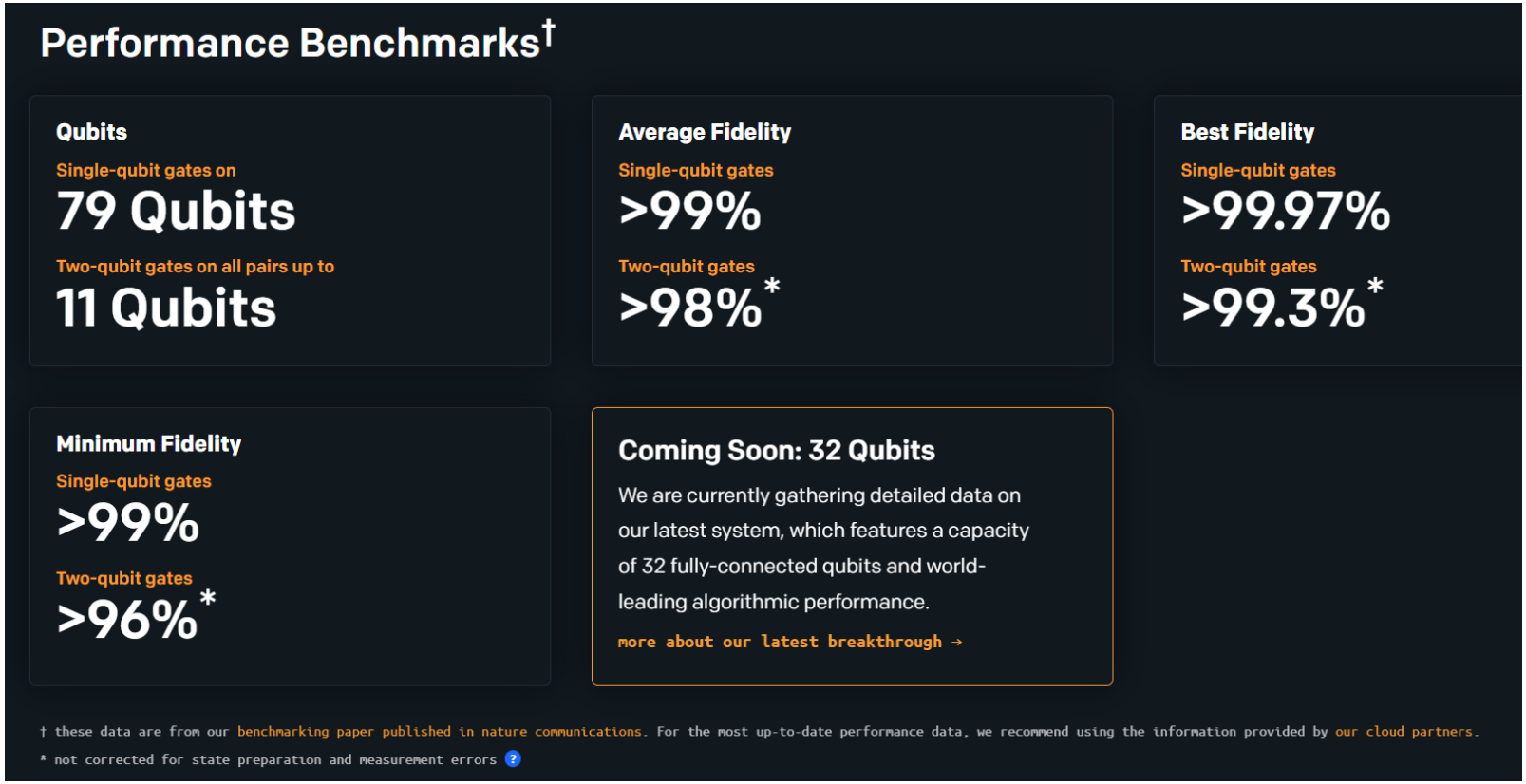
"The ones that have been demonstrative so far are ***artificial problems that are specifically designed to showcase the capabilities of quantum computers. Real-world problems, no one has still done anything*** *that cannot already be done faster on the classical computer or supercomputer for that case. Always remember that technology is an infant." – Physicist at Google working on their quantum computing effort*

Source: Scorpion Capital consultation calls with experts

8. IonQ's trapped-ion technology is doomed by "pernicious" error rates, a key performance metric and fatal flaw in contrast to misleading benchmarks that portray errors as low. Virtually every ex-employee and expert we interviewed slammed its error rates as a joke, describing a catastrophic "chain process" where errors compound like a game of telephone: "your answer is totally garbled": "your entire computation breaks down after a few steps"; "your chances of getting the right answer diminish very, very quickly" given the tendency for "very small errors to accumulate." A leading expert and friend of the founders stated that their error rates need to be 100 times lower; alleged that Monroe's error rates have stagnated at the same level "for 10 years, 15 years, 20 years"; and that "I just don't see how it's going to work."

IonQ appears to be well aware that error rates are its Achilles Heel. As a result, its website prominently features performance benchmarks that convey the misleading impression that error rates are low. Error rates are typically expressed as "gate fidelities" that demonstrate the quality of two-qubit gates. Investors looking at the site are led to believe that the gate fidelities are nearly perfect – with average fidelities of >98% and best fidelity of 99.97%, i.e., error rates of <2% and .03%, respectively.

IonQ website shows fidelities and error rates that convey a misleading impression



Source: https://ionq.com/technology

Despite IonQ's press releases about its alleged technical progress and accomplishments, it appears to have made zero progress on error rates in over three years – its most critical performance benchmark. We located an archived version of IonQ's site from Jan 2020, which shows an older version of their performance benchmarks graphic. The error rates are 100% identical to those shown on IonQ's current site. Shockingly, the 2020 graphic features a footnote that states the data is as of Dec 2018.

Performance benchmarks from 2018 are identical to those on IonQ's current website

Source: https://ionq.com/technology

Virtually every ex-IonQ employee and expert we interviewed slammed the error rates shown as a joke. One former employee indicated that a 98% fidelity level renders the computer error prone and useless, adding that a minimum of 99.99% fidelity is required before any useful applications are possible. He emphasized that going from 99% to 99.99% is infinitely more difficult than from 50% to 99%. A second ex-employee stated that a 2% error rate is catastrophic, creating "a chain process" where errors compound like a game of telephone - "even a small toy" computation requires 99.9% fidelity, i.e., a 0.1% error vs. IonQ's 20X higher error of 2%.

98% fidelity is irrelevant and >99.99% is required; going from 98% to 99.99% is "way harder" than "50% to 99.3%"

"In the research community, you hear people talk about the number of nines you have, which is to say 99% fidelity is two nines. The number that gets thrown around a lot is that ***we don't really see useful applications start coming about and reliable computers until we have four nines, 99.99% fidelity****. Then you can do maybe on the low end, a few hundred qubits and on the high end, for more intensive applications thousands, tens of thousands, hundreds of thousands. You might think 96%, 98%, 99% is not that far from 99.9%; you're 96% of the way there.* ***But getting that last few percent or that last few tenths of a percent or hundreds of a percent is really where the outstanding challenge lies. It's way harder to get from 99.3% to 99.99% than to get from 50% to 99.3%.****" – Former IonQ employee, physicist*

2% error rate creates "a chain process" where errors rapidly compound like a game of telephone

"When they talk about the best fidelity, that means they tried them all and that's the best they could possibly do after many runs probably. The average 2-qubit fidelity is what you need, and that's going to directly impact the depth of the circuit that you could submit without getting a garbage nonsense answer. ***Really, what you want for even a small toy example is probably 99.9%. What 98% means is that means is anytime that you try to perform an operation on the quantum space between the two qubits, the probability that that will be what you expect is 98%****. So, 2% of the time, the rotation of—the way you would think about this is on the Bloch sphere, performing the operation as a rotation in this kind of abstract space. Performing these rotations, you will either over-rotate or under-rotate by about 2%. And so, that actually affects the next rotation as well.* ***It's a chain process where each previous error will compound…it's like a game of telephone. If you are transferring between 10 people and there's a 2% error rate, it'd be like a whole sentence, maybe one letter is off and by the time you get to the end****…" – Ex-IonQ employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

An ex-IonQ physicist provided a more technical explanation for why the company's 2% error rate is "actually a lot more pernicious" than it appears. He stated that it prevents the computer from running a long program, as each step introduces a 2% error which by the 20th step means that "your answer is totally garbled": "your entire computation breaks down after a few steps" - "your chances of getting the right answer diminish very, very quickly" given the tendency for "very small errors to accumulate."

IonQ's 98% average fidelity level introduces vast computational errors that render the machine useless

*A: "**Everyone cares about how many qubits you have in your machine, at least the public does, but what's really important - it doesn't matter until you have gate fidelities that are really, really good**. Because the gate fidelity that you have controls what's called the "circuit depth," which is the complexity or the length of the algorithm that you can run."*

Q: "Does gate fidelity control the circuit depth?"

*A: "Yes, that's essentially correct, which is to say **you can't run a very long program if you only have a 98% fidelity on a two-qubit gate because what that means is you're basically constantly introducing error into your computation**, and by the 20th gate that you run, your answer is totally garbled because this stuff compound multiplicatively at each step. You can think about the fact that if you have a 10% chance of getting something wrong, on the 10th step, you have a .9 to the 10 accuracy, which degrades very quickly." – Former IonQ employee, physicist*

98% fidelity means that errors spin out of control and "your entire computation breaks down after a few steps"

*"A gate is, is the most primitive operation. And if your error scales such that every repeated step accumulates the error from the previous step, **then you have 98% error. That means that if you performed 50 operations, your chances of getting "the right answer" diminish very, very quickly**...It's a little less straightforward than that when you talk about quantum computing because…things aren't binary because they operate in a continuous variable space. So, **it's actually a lot more pernicious, and it's one of the reasons that scaling quantum computing is so hard is because there's room for very small errors to accumulate**. It would be like if you had 98% gate accuracy; after the 11th operation, your chance of being in the correct state approximately goes to .98 to the 11…the error grows as the complexity of the circuit grows, so very quickly those errors basically diverge, and you can't really do any smart way of summing them to get anything that makes sense. **You basically lose any kind of coherence to your operations…your entire computation breaks down after a few steps."** - Former IonQ employee, physicist*

Source: Scorpion Capital consultation calls with experts

A professor who is one of the most famous and distinguished names in quantum computing – a decades-long friend of IonQ's co-founder Monroe – was scathing about the "hype coming out of their company" and wondered aloud whether he could "trust any data" they provide. He stated "there's no evidence at all" that IonQ could ever build an error-correcting, usable quantum computer. He observed that progress in IonQ's error rates – and those of Monroe's previous machines – hit the wall years ago – "hovering around a few percent for years and years, for 10 years, 15 years, 20 years."

Error rates of IonQ and Monroe's quantum machines are far too high to build an error-correcting quantum computer

*"There is some **hype coming out of their company, and I'm a little bit worried about that**…some of the things that they say they're going to do in the future, that **seems a big stretch**. In one of their slides, they claim that with the IonQ system, they can build an error-correcting quantum computer with 20 or 50 qubits, some small number of qubits, which theoretically is true, but it requires their 2-qubit error rate to be something like 10^{-5}. And **there's no evidence at all that they can ever get to 10^{-5}. In fact, they've been hovering around a few percent for years and years, for 10 years, 15 years, 20 years**. It's getting a little bit better from, let's say, a few percent to 1% and may a fraction of a percent in some cases. But to get to 10^{-5} is not at all obvious." – Leading expert in quantum computing*

Error rates even at a pitiful 11 qubits "are not that good"; expert wonders if he can trust anything IonQ says

*"This is what people do all the time. They announce that they built a system, but that doesn't mean that they actually ran it. Once a company does that, then **do I trust any data at all that they say?** I think the latest one is maybe 11 qubits…and then, **even at 11, the numbers I get on the performance side are not that good**. If you read the press releases—and it's not just IonQ, it's many, many companies—it sounds all great, and then you find out, well, they didn't quite do it right." – Leading expert in quantum computing*

Source: Scorpion Capital consultation calls with experts

He echoed the color from IonQ ex-employees that error rates become an essentially insurmountable problem after about 10 qubits, causing computations to break down quickly and "start losing coherence." He hypothesized a maximum gate limit of 40-50 gates for IonQ – well below the thousands or millions of gates needed for real-world use – and noted that a regular computer "might have a million gates or more." The Wikipedia entry for "Logic Gate" states that a modern CPU may actually have over 100 million gates.

Error rates creating daunting difficulties starting at about 20 qubits; unlikely IonQ can get to many beyond 10

"But 11 qubits, you can run that on your laptop easily. It's nice that they got it to work, and it's a good milestone, but ***come on, this is not that hard****. The other thing to realize is in ion traps, the more ions you have in a trap, then some vibration frequencies get closer and closer, and it's harder and harder to make good gates. And people generally think around 20 qubits is where these frequencies are getting so close that it's going to be hard to make good gates out of it. If you have one trap, the number of ions you can have in that trap is 20—****I mean, I think Chris Monroe says he can do 50 or more—but the fact that they're doing 11 right now and 2% error means it's really hard to go beyond ten. Twenty will be hard.****" – Leading expert in quantum computing*

Error rates are so high that computations break down completely after about 40 gates, rendering the computer useless; regular computers have millions of gates

"In the latest results, I think it's 11 qubits; they have a 2.5% average error on the two-qubit gates, which are the hard gates. And so, ***with 2.5% error per gate means you can do about 40 gates before you start losing coherence and the quantum computer stops working right. Let's just say 2%. That means every 50 gates you make an error****. That's what 2% means because 2% is 50. Now, if you have 11 qubits and you can have 50 total gates before you have an error and you have 11 qubits, that's roughly it can do 5 gates per qubit before you have a problem. Because 5 x 11 is about 50. Five gates is not a very sophisticated algorithm.* ***Now, if you think about classical programs, you might have a million gates or more****. And if you think about an optimized quantum program, you might have 40, 50 qubits, two-qubit gates per qubit, maybe 10, maybe 50 in that range. And they have 4. Imagine if they had 32 qubits. That means you could have 1.5 two-qubit gates per qubit before the error started swamping you.* ***That's nothing. You can't do an algorithm****. So, even if they had 32 qubits at 2%, that's not good enough." – Leading expert in quantum computing*

Source: Scorpion Capital consultation calls with experts

As a leading figure in the field and a friend of IonQ's co-founder Chris Monroe, we find his criticism to be withering. He noted that IonQ's progress on error rates has stalled - "that concerns me" and is "a real issue" – and mocked Monroe's claims to the contrary. He laid out an unsolvable technical dilemma: that IonQ needs vastly more qubits to be useful, but that each new qubit escalates the error rate. He added that IonQ's error rates need to be 100 times lower than they are now, and cast it as a physics problem with no way out: "don't see how they're going to get there"; "I just don't see how it's going to work."

Red flag that IonQ's progress on error rates has stalled and that error rates are "not that good"

"The fact that they got 2% errors with 11 qubits in a trap might be an improvement because it might have been five years ago; it was that kind of performance out of 2 or 3 qubits. And to get it at 11, that's harder, and that's good. But ***you can kind of see it's not this amazingly rapid improvement. It's slow; it's difficult, it's not quite sure exactly what's happening there****. That concerns me. You want to be making your qubits better over time. And this is especially weird for IonQ because I know that Chris has gone out and given scientific talks, talking about how ions are perfect, they're atomic clocks, blah-blah-blah, and they make it sound like they potentially have tiny tiny error rates. But* ***one can argue that if you look at the actual progress, especially on two-qubit gates, not that good. This is a real issue****." – Leading expert in quantum computing*

Error rates need to be 100 times lower than what they are now; implies it's an unsolvable physics problem

"I think you need to have between 50 and 100 qubits with errors that are between .01% and .03%. It's more than that, but let's just take those two numbers. Now, 50 to 100 qubits is beyond what they can do. ***I don't see how they're going to get there with their current system. That two-qubit error is maybe 100 times lower than what they're seeing now****, and I know that the errors are going to get worse when they scale it up to more qubits. The progress on errors has been really slow.* ***I just don't see how it's going to work****. I don't think it's five years. Is it 10 years? Maybe. Maybe they have a bunch of ideas, but no, I don't see that.* ***Those are two fundamentally hard problems that tend to push on each other. If you have more qubits, your gate errors get worse****. I just don't even see how they're going to get beyond 20, 30, 40 qubits in their trap. Now, they have ideas of this optical communication between traps, but that looks really problematic in its own mind. That looks really hard." – Leading expert in quantum computing*

Source: Scorpion Capital consultation calls with experts

Ex-employees elaborated on the fatal technical dilemma in which IonQ is trapped, pun intended: its machine can't do anything useful without orders of magnitude more qubits, but every qubit added introduces massive errors given the nature of the technology. Two former employees echoed the color on the preceding pages that the problem is basically unsolvable. One stated that it's "a real hurdle to imagine scaling these things up right now" and that the "jury's really still out." A second elaborated that the difficulty scales exponentially, not linearly – that is, getting to 1000 is not simply twice as hard as getting to 500 – and offered a sobering anecdote about it taking 3 years just to go from 5 to 11 qubits.

IonQ's machine is prone to errors that are currently an unsolvable problem that prevents them from scaling to the number of qubits required to be useful

"Basically, every ion is talking to every other ion, so if one ion is doing something that it's not quite supposed to be doing, that induces basically ***an error in every other ion****. And there are theoretical ways that potentially you can get around that, but no one has really demonstrated that that theory has been actualized in any meaningful way, so it's* ***a real hurdle to imagine scaling these things up right now****. People have ideas of how to do it, but I think the jury's really still out on whether any of these ideas will really be a breakthrough that actually allows the technology to develop to where it can be useful." – Former IonQ employee, physicist*

Difficulty in scaling qubits is exponential, not linear; took three years to go from 5 to 11 qubits, and thousands are needed

"The difficulty of going to 100 or 500 or thousands of qubits, ***it doesn't scale linearly. It's not just twice as hard to do 1000 qubits compared to 500. I can tell you my experience going from 5 to 11 and from 5 to 11, took about three years of work****. Five qubits were basically demonstrated in an academic lab, which is state of the art at that point in 2018. And they do have to invest a bunch of money, hire a lot of people and do a bunch of things to get to the point of 11. And then you would say, how about you push it to 22? IonQ hasn't really released data for 32. They have sort of hinted that that's where they are going. But having a paper or something where I can see the data and I see all of the numbers, they don't have that yet." – Former IonQ employee, senior member of technical staff*

Source: Scorpion Capital consultation calls with experts

Former employees indicated that IonQ has no way out of its technical predicament, and that without being able to massively scale the number of qubits, it remains "this little toy computer" that can only "perform some contrived application." A former IonQ physicist stated that thousands or millions of qubits are necessary to run any useful computations – compared to a mere 11 qubits in IonQ's currently available machine. However, he explained that the difficulty of maintaining viable error rates with each new qubit spikes as well, re-iterating that it "scales exponentially."

"Little toy computer" that can "perform some contrived application"; can't scale to a useful number of qubits; difficulty is exponential

"For quantum computing generally and especially trapped ion quantum computing, the one thing that is always talked about in academia and never talked about in industry really or at least isn't given the scrutiny that it should be is scalability. ***You've got this little toy computer that works; it's got 11 qubits that can perform some contrived application****. So, the idea is okay, now instead of 11 qubits, we just need hundreds or thousands or millions, but the reality is, yeah,* ***these systems are hard to develop, and they're complicated to build****, but it's not like you can just build a lot of them and then connect and then boom, you have a machine with 100,000 qubits. Every new qubit that you add to a machine, the difficulty of maintaining those fidelities, the* ***difficulty of performing operations really scales exponentially****. There are interesting theoretical and physical reasons for that." – Former IonQ employee, physicist*

Need thousands of qubits to do anything useful

"We're talking about machines that have thousands of qubits, maybe hundreds. You would ***need machines that, at the minimum, close to a thousand, probably more, and that would be to start doing the simplest useful problems****." – Former IonQ employee, physicist*

Source: Scorpion Capital consultation calls with experts

Aside from the practical impossibility of adding qubits without errors spinning out of control, ex-employees threw cold water on the only theoretical solution as well, which IonQ has spun as a way out of its technical quandary. The concept is to dedicate vast numbers of physical qubits for error correction to create "error-corrected qubits" called "logical qubits." A former employee explained that the number of physical qubits needed for logical qubits is so vast that it's an unsolved problem – "very hard and will likely take a long time."

IonQ talks up number of qubits, but good qubits – logical, error-corrected qubits – is what matters and is a major unsolved problem

*"**You can't run large and complicated algorithms without a lot of qubits but having a lot of qubits isn't useful if you don't have really good gate fidelity**. One of the things that I found frustrating about working in industry is there's such a push to say more qubits, more qubits, more qubits when really we should be talking about better qubits. You need more qubits, but first, you need better qubits. I think **getting better qubits not just more qubits is really one of the outstanding challenges that's going on right now**, and this goes back to what we were talking about with logical qubits and al that sort of fidelity conversation." – Former IonQ employee, physicist*

Only theoretical way around errors is to build error-corrected qubits called "logical qubits, which requires vast numbers of qubits dedicated to error correction; daunting and unsolved problem

*"I can tell you **the general consensus is that to start building these devices in a manner that's useful, you have to have a total logical qubit rather than just a physical qubit**. A logical qubit is a qubit that doesn't actually have an error. Basically, you can error-correct faster than errors are induced…**Even if you have those logical qubits, now you still have to build a lot of them** and connect a lot of time. So, I don't necessarily think it's something that is technically unfeasible ever; it's just **very hard and will likely take a long time**." – Former IonQ employee, physicist*

Source: Scorpion Capital consultation calls with experts

A leading physicist goes even further and slams the entire idea of logical qubits as hype and doomed by the impossibility of solving for errors – rendering all of quantum computing a fiction. To be useful, he explains that a quantum computer must process a set of continuous parameters - 10^{300} - that is larger than the number of subatomic particles in the universe. He states that keeping errors under control for this many parameters is "absolutely unimaginable," and that the theoretical solution – logical qubits – is basically fooling "the general public."

Source: https://spectrum.ieee.org/the-case-against-quantum-computing

A useful quantum computer must process a set of continuous parameters - 10^{300} - larger than the number of subatomic particles in the universe

"Experts estimate that the number of qubits needed for a useful quantum computer, one that could compete with your laptop…is between 1,000 and 100,000. So the number of continuous parameters describing the state of such a useful quantum computer at any given moment must be at least $2^{1,000}$, which is to say about 10^{300}. That's a very big number indeed. How big? It is much, much greater than the number of subatomic particles in the observable universe. ***To repeat: A useful quantum computer needs to process a set of continuous parameters that is larger than the number of subatomic particles in the observable universe****." – Leading physicist*

It's impossible to correct for errors with 10^{300} parameters

"In contrast, ***it's absolutely unimaginable how to keep errors under control for the 10^{300} continuous parameters that must be processed by a useful quantum computer****. Yet quantum-computing theorists have succeeded in convincing the general public that this is feasible…With those extra qubits, they argue, you can handle errors by forming logical qubits using multiple physical qubits. How many physical qubits would be required for each logical qubit? No one really knows, but estimates typically range from about 1,000 to 100,000. So the upshot is that a useful quantum computer now needs a million or more qubits. And the number of continuous parameters defining the state of this hypothetical quantum computing machine—which was already more than astronomical with 1,000 qubits —now becomes even more ludicrous…****it's sobering that no one has yet figured out how to combine many physical qubits into a smaller number of logical qubits that can compute something useful****." – Leading physicist*

9. We independently verified that IonQ's 11-qubit quantum computer, accessible through Amazon Web Services, is a farce that can't even properly add 1 + 1. We hired a quantum computing expert to run a script to see how often it returned "2" as the answer. The error rates were shocking. We hired a second expert to repeat the exercise by writing a script to add 2 + 3. The results were even more erroneous and a sharp contrast to IonQ's claims that it is "poised to" usher in "the next great age of productivity."

The first quantum computing expert we hired is a faculty member who we asked to run a simple program on IonQ's computer via Amazon Web Services, given his background in testing algorithms on different systems. He wrote a script for it to add 1 + 1 a thousand times, and repeated the experiment five times for 5,000 individual calculations. He stated that such a simple calculation should yield a perfect answer…

Expert tests various quantum algorithms on different quantum computers

*"I personally have done what I would call as **testing quantum algorithms**. I know a few algorithms, and I can run those algorithms on various devices. One is a Quantum Fourier Transform, Bernstein-Vazirani, there's Deutsch-Jorsa, so there are different algorithms. **I like to test those algorithms and look at their performance on each of these devices**, it really depends on the number of qubits, and it depends on the errors and connectivity. On the other hand, I've also just done a very simple what you would call a real-world problem which is adding numbers. If you think of an adder, like a classical circuit of an adder where you've got two binary numbers, and you want to add those two binary numbers and get an answer, you can simulate that on a quantum computer as well, though you're kind of wasting the potential of a qubit when you do that. So, **I've done that experiment on the IonQ and from that, I get a general idea of how well it performs because one plus one should give me a two and two plus three should give me a five."** – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

A simple calculation should yield a perfect answer, but errors in quantum computers quickly garble the answer and make it unrecognizable

*"**When you sample the quantum computer, you might not see all 0's or all 1's because a lot of errors have been introduced**, and now, you're seeing all kinds of values like 10111 and 11100, and all of that stuff. Current quantum computers, because of the errors, lose information over time. **That was a very simple calculation. All I'm doing is converting 1's to 0's; I should get a perfect answer at the end of it**. In a classical computer, you would get a perfect answer. In a quantum computer right now, if you go past, let's say, 20 or 100 of these switching numbers, you might not be able to recognize the answer anymore. So, it is important that when we talk about quantum computers, to look at how much error is in that quantum computer, and the errors are introduced every time you do a gate operation." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

Source: Scorpion Capital consultation calls with experts

Although adding two binary answers like 2 + 3 should produce the exact answer of 5 each time, he stated the actual output is "an eye opener." He further added that problems submitted to IonQ's system on AWS may sit in the queue for 30-60 minutes, and that "sometimes you have to wait until the next day for the job to come back."

Should see an exact answer each time when adding two binary numbers, but results were "an eye opener"

"I could send you a link to the IonQ experiment I did where ***all I'm doing is adding up a binary number with another binary number, 2+3, and I should see the answer 5 every time, but I don't see the number 5 every time****. I see 4 or 6 or different numbers, and I think* ***it's an eye-opener when you see that****." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

Expert sometimes has to wait 30-60 minutes for IonQ's computer to run, or even wait until the next day

"Your problem sometimes will sit in the queue for 30 minutes or one hour, depending on how busy their quantum computer is. So, 30 minutes to do the setup, and then submit the job and then you have to wait for the job to come back, and sometimes you have to wait until the next day for the job to come back." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member

Source: Scorpion Capital consultation calls with experts

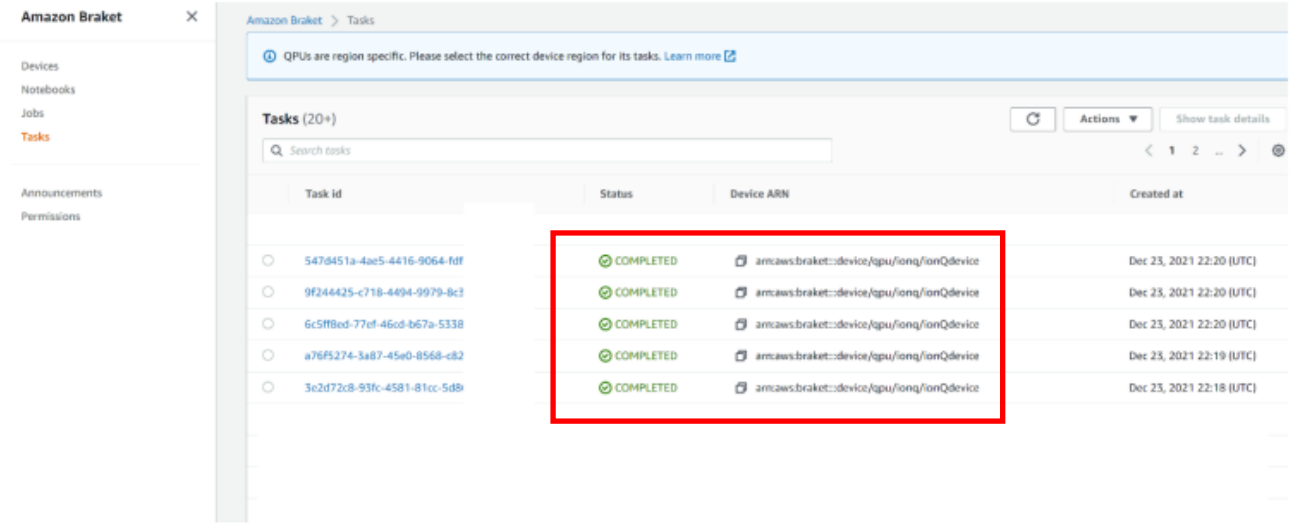
A screenshot from the AWS panel shows that the expert ran 5 different runs on IonQ's quantum computer.

Screenshot from AWS Braket interface

Experiment:

We add 1 + 1 using a 2 bit classical adder circuit mapped on to the quantum circuit. Each experiment is 1000 shots (measurements). The results from each experiment are plotted below to show the resulting answer from probabilistic measurements. 5 separate experiments were conducted. Three resulting qubits are measured, thus the answers can take values between 0 and 7.

The list of experiments run on IonQ are in the screenshot below:



Source: Scorpion Capital consultation calls with experts; AWS

The runs indicated that IonQ's "World's Most Powerful Quantum Computer" can't even properly add 1+ 1 and is utterly unusable. The answers were all over the place, ranging from 0 to 7. In each of the 5 runs, the computer returned the value 2 only 59% to 70% of the time – indicating surprisingly high error rates far greater than the >98% average fidelity IonQ claims on their website. We begin by summarizing the 5 runs in table format – note that each run asked the computer to add 1+1 a thousand times, for five thousand total tries.

Distribution of answers to 1 + 1 in each of the five runs

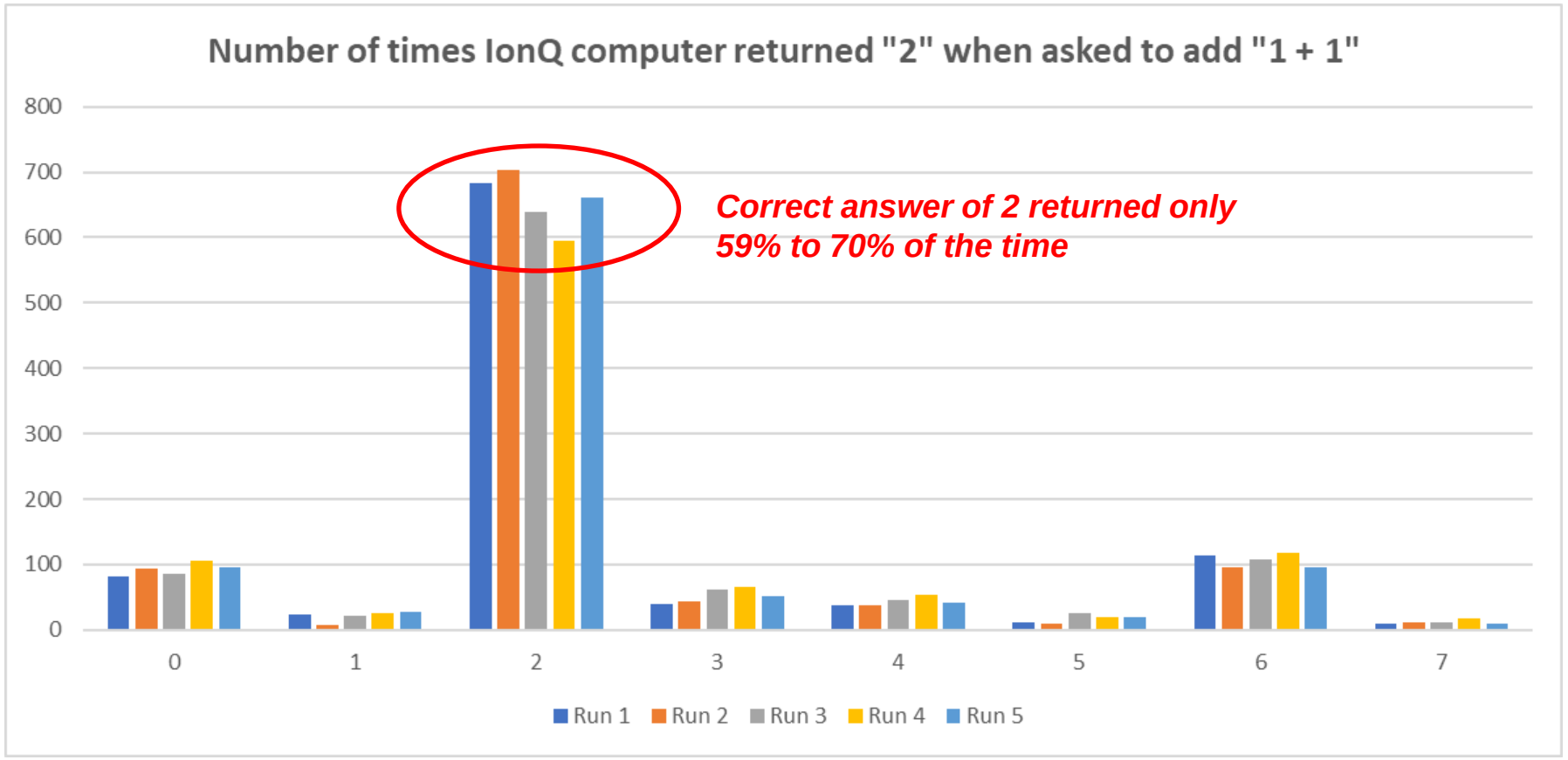
Sum of 1+ 1	Run 1	Run 2	Run 3	Run 4	Run 5
0	82	93	86	106	95
1	23	8	21	26	27
2	**683**	**703**	**639**	**594**	**661**
3	39	44	62	66	52
4	38	37	46	53	42
5	11	9	26	20	19
6	114	95	108	117	95
7	10	11	12	18	9
	1000	1000	1000	1000	1000

Correct answer is 2

Source: Scorpion Capital consultation calls with experts; Scorpion Capital analysis

We also show the distribution of answers graphically for each run. The horizontal axis shows each of the actual sums returned for 1 + 1, which ranged from 0 to 7 although the correct answer is 2. The vertical axis shows the number of times each of those discrete answers was returned for each run of 1,000 calculations. We encourage others to independently repeat our experiment.

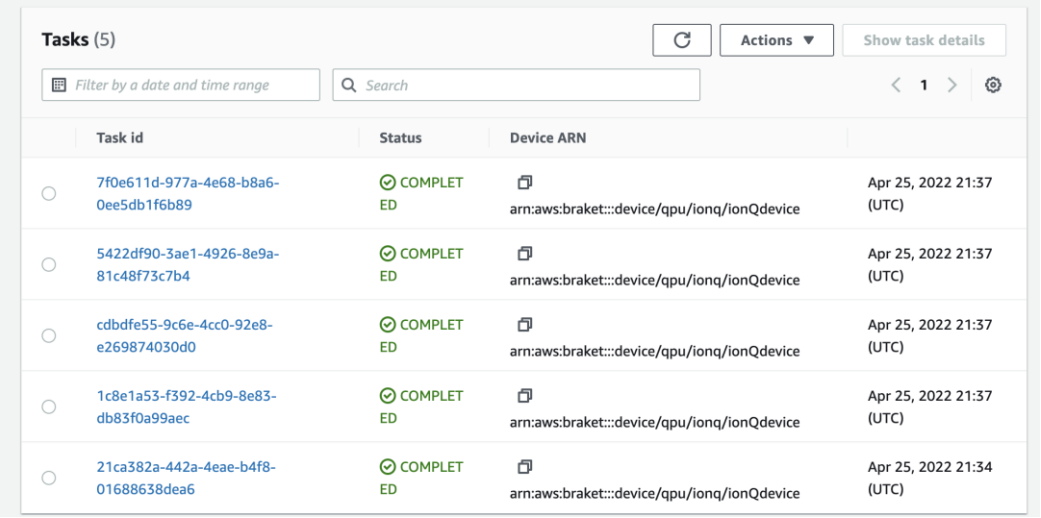
Graphical distribution of answers to 1 + 1 in each of the five runs



Source: Scorpion Capital consultation calls with experts; Scorpion Capital analysis

We asked a second quantum computing expert to repeat the experiment, asking him to add 2 + 3 to see how often IonQ's computer returned 5 as the answer. A screenshot from the AWS panel shows that the expert ran 5 different runs on IonQ's quantum computer. We also include excerpts from the software script he wrote, which was shared with us.

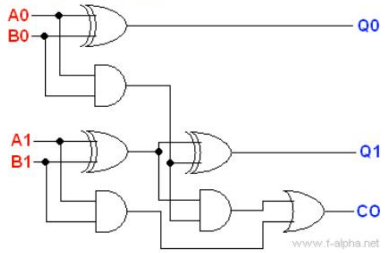
Screenshot from AWS Braket interface and excerpt of software script run on the system




```
# Import Braket libraries
from braket.circuits import circuit, Circuit, Gate, Moments
from braket.circuits.instruction import Instruction
from braket.aws import AwsQuantumTask, AwsDevice
from braket.devices import LocalSimulator
import matplotlib.pyplot as plt
# magic word for producing visualizations in notebook
%matplotlib inline
import numpy as np
```

Two-Bit Adders

I have tried to remain faithful to the 2-bit adder




```
# Need to build a native version of the CCNOT (Toffoli) gate for

@circuit.subroutine(register=True)
def CCNot(controls=[0, 1], target=2):
    """
    build CCNOT from H, CNOT, T, Ti
    """
    cOb1, cOb2 = controls
```

Source: Scorpion Capital consultation calls with experts; AWS

The results were even worse. The computer returned 5 as the answer to 2 + 3 only about 50% of the time across each of the five runs. The answers ranged from 0 to 7. We again summarize the 5 runs in table format.

Distribution of answers to 2 + 3 in each of the five runs

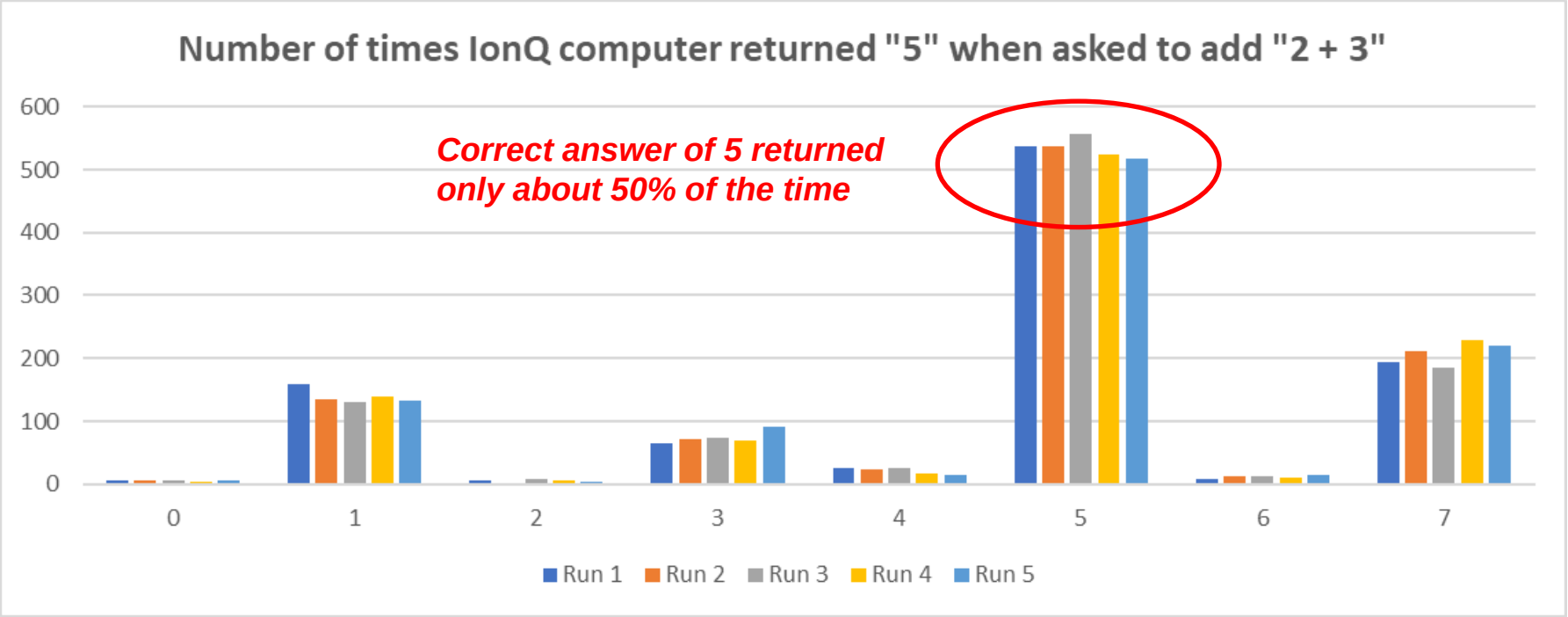
Sum of 2+3	Run 1	Run 2	Run 3	Run 4	Run 5
0	5	7	7	3	7
1	160	135	130	140	132
2	5	2	8	7	3
3	65	72	74	69	91
4	26	24	26	17	14
5	536	537	557	524	518
6	8	12	13	11	14
7	195	211	185	229	221
	1000	1000	1000	1000	1000

Correct answer is 5

Source: Scorpion Capital consultation calls with experts; Scorpion Capital analysis

We also show the distribution of answers graphically, indicating that the answers were all over the place and only landed on 5 some of the time. The frequency with which the computer produced erroneous answers is readily apparent.

Graphical distribution of answers to 2 + 3 in each of the five runs



Source: Scorpion Capital consultation calls with experts; Scorpion Capital analysis

10. **Aside from being plagued by errors and lacking any useful computational ability, IonQ's only system is crippled by reliability and uptime problems, as well as "reproducibility" challenges from one machine to another, which explains why it only appears to have 3 computers "in service." An expert who we asked to test the machine via AWS had to wait for a day it was actually "available," while another described jobs sitting in the queue for 30-60 minutes, and sometimes having to "wait until the next day for the job to come back." A ex-employee pointed us to a recent paper by IonQ staff that quantified the shockingly poor reliability – only 53% uptime. IonQ appears to have buried the paper. Given the lags, we speculate whether manual processing may be occurring in the background by human beings, similar to Theranos allegedly using third-party blood testing machines.**

Source: https://arxiv.org/pdf/2108.03708.pdf

When we asked a quantum computing expert to run sample calculations on IonQ's computer via AWS, we were surprised and amused when he indicated that that he had to wait for a day that it was "available," as we presumed it was available on demand 24/7. This led us to query former employees and researchers about the computer's reliability. A former employee described the many problems that occur as IonQ's computer attempts to operate, stating they had to re-load ions into the computer every 30 minutes as ion chains "break up" and "shatter" because of "collisions" and "residual particles."

IonQ's computer encounters serious problems as it attempts to operate

A: "For instance, and it's just one of many examples, these ***ion chains break up because of some collisions with a particle that's in the vacuum chamber, there are some residual particles*** *in there, so those particles can sometimes collide with these ion chains, and it will shatter the chain, in which case,* ***you have to reload the chain and then settle the chain down and make sure all of the calibrations that are done*** *routinely and rather fast to ensure that the computer in a sense comes back to the operational mode. And then, once it's back to the operational mode, we resume our jobs."*

Q: "So, are you saying every 30 minutes, they have to reload the ions into the computer?"

A: "In a sense, yes." –Former senior scientific employee of IonQ`

Source: https://arxiv.org/pdf/2108.03708.pdf

A former senior technical employee pointed us to a recent paper authored by IonQ staff that quantified the computer's shockingly poor reliability – only 53% uptime, perhaps a world record for unusability. IonQ appears to have covered up the paper, as it's missing from their publication page as of the date of this report. The paper describes an onerous and manual cycle of constantly fixing and calibrating the machine, due to qubit coupling and other problems that prevent scaling.

Excerpts from Aug 2021 paper by IonQ staff indicating 53% uptime

Detecting Qubit-coupling Faults in Ion-trap Quantum Computers

Andrii Maksymov, Jason Nguyen, Vandiver Chaplin, Yunseong Nam, Igor L. Markov
{maksymov,nguenj,chaplin,nam,markov}.ionq.co

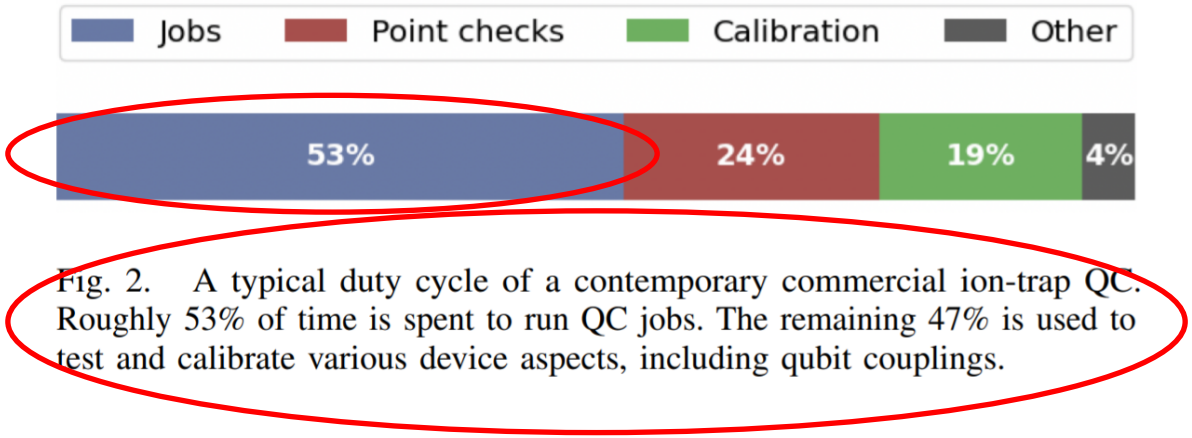


Fig. 2. A typical duty cycle of a contemporary commercial ion-trap QC. Roughly 53% of time is spent to run QC jobs. The remaining 47% is used to test and calibrate various device aspects, including qubit couplings.

"With the power to couple arbitrary pairs of qubits, comes the responsibility to ensure that qubit couplings are properly calibrated and can perform accurate gate operations. Therefore, the duty cycle of an ion-trap QC interchanges operational periods and rounds of recalibration…In more mature QC systems with improved coupling quality, ***more subtle faults will complicate fault detection****…Testing (N2) qubit couplings, now already at a quarter of the ion-trap QC duty cycle, is* ***going to consume a larger fraction of time as QC systems scale up….Brute-force diagnosis that checks qubit couplings one at a time scales poorly****…"*

Source: https://arxiv.org/pdf/2108.03708.pdf

Given the computer's low level of uptime, we speculate (with only circumstantial red flags) whether manual processing may be occurring in the background by human beings, similar to Theranos employees allegedly using third-party blood testing machines. One researcher who used IonQ's machine via AWS described jobs sitting in the queue for 30-60 minutes, and sometimes having to "wait until the next day for the job to come back." A leading quantum computing expert who has worked with IonQ and its founders suggested a high degree of manual involvement in the background in running calculations. He stated that this has now been automated but may not work as well as when humans did it. We wonder whether there still may be elves in the background.

Jobs sit in the queue for long periods and may not be ready until the following day

*"Your problem sometimes **will sit in the queue for 30 minutes or one hour**, depending on how busy their quantum computer is. So, 30 minutes to do the setup, and then submit the job and then **you have to wait for the job to come back, and sometimes you have to wait until the next day for the job to come back**." – Quantum computing expert; user of IonQ's machine; quantum computing faculty member*

Manual processes have now been automated but may not work as well as when human beings were doing them

*"The device that they used back then, it was a 5-qubit device, and I believe IonQ right now has an 11-qubit device, and that's the one that is publicly available via Google, Microsoft, and so forth. There's another benefit of the device that they have available right now, the one that I worked in the lab with required me to collaborate very closely with all of our engineers because **for every computational experiment that we ran, we needed to calibrate the gate from scratch, and it was a manual process. Now, this process has been fully automated, and I guess a fully automated process may not be doing as good of a job as the human was back in the day**, which was only three years ago, not too long ago, but when I worked with a trapped ion device at the University of Maryland." – Leading quantum computing expert who has worked closely with IonQ and its founders*

Source: Scorpion Capital consultation calls with experts

Ex-physicists and other former IonQ employees described each IonQ machine as a hand-made, arts-and-crafts project that's impossible to scale with "tens of thousands of components." One directly involved in building them bemoaned the "replicability" and "reproducibility" problems from one machine to another. They indicated it could take "close to a year" to build a single machine with a cost of one to one and half million.

IonQ's computers are difficult to replicate

*"**One of the frustrations we had is the replicability of devices. A trapped-ion quantum computer is made up of literally tens of thousands of components, and they're all assembled by hand basically**. Every single step in that process makes the machine a little bit different. I was sort of a process engineer. Creating a master plan for how to build a system in a way that the next person who comes along and builds it, it's going to be the exact same is hugely challenging, and it's also really important. You have to have a standard deviation. So, that's a big one that I can speak to personally. Going back to what we've talked about with the reproducibility, even just looking at the design that someone has laid out and trying to recreate that, that's a challenge. That's probably what I experienced most directly in terms of my own work." – Former IonQ employee, physicist*

Could take "close to a year" to build a device

*"When I was there, the iteration time between generations of devices was on the order of six to nine months. **Building a device from design to completion to construction was close to a year**. If you think something's going to take you a month, it will take you four months, and that makes projecting plans in the future really challenging. It's like this black swan problem. You know that there are going to be all of these hidden variables that are going to make your life a lot harder than you think it should be when you're sitting down and planning a new project. **It's quite a long process to build one of these devices**" – Former IonQ employee, physicist*

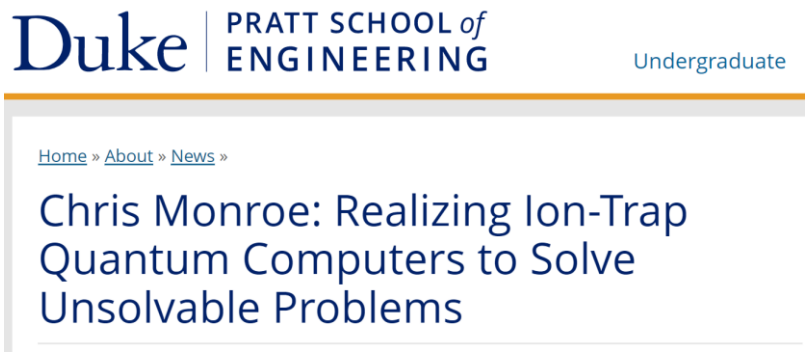
It may take 6-12 months to build a device, with one to one and half million in cost

***"In usual academia, these machines are built in about a year**, and at an industry level, I believe that they take six months. Of course, that depends on many things, the amount of R&D that gets put into each one of these machines…once you have the blueprints—to get there, it's more like six months, and **the cost is about a million or a million and a half**." – Former IonQ employee, senior member of technical staff*

Source: Scorpion Capital consultation calls with experts

IonQ's co-founder Chris Monroe appeared to be much more honest about the company's challenges prior to the SPAC. We note an interview published by Duke's School of Engineering, where he basically admits the machines are impossible to scale – indicating it takes "18 months" from a researcher expressing interest in their machine to being able to carry out the experiment. He adds that "we'd like to get that down to weeks or months…"

Chris Monroe profile Aug 2020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Chris Monroe: Realizing Ion-Trap Quantum Computers to Solve Unsolvable Problems

"Right now it takes an average of 18 months between a researcher inquiring about using our systems to us designing a circuit that can carry out their idea to publishing a paper on the experiment," said Monroe. "We'd like to get that down to weeks or months and build multiple systems and qubit technologies that are tailored for specific applications."

Source: https://pratt.duke.edu/about/news/chris-monroe-profile

11. **IonQ's machine is preposterously slow. One ex-employee stated that it could take days or years to run useful computations given its piddling clock speed. A leading physicist and longtime friend of IonQ's founders stated the technology is 1,000 times slower than competing approaches, indicating it could take 3 years for a sample use case like simulating a protein, versus other approaches that could do it in a day. In response to their speed and scalability predicament, IonQ has floated the notion of a photonic interconnect, an essential enabling technology in their roadmap. Ex-employees ridiculed the idea as vapor – a "choke point" and "weak link" - and criticized the co-founder for continuing to promote the idea: "…and the claims are being made. I don't know what he's thinking."**

Every ex-employee of IonQ we spoke with, as well as every quantum computing expert, indicated that the company's machine is too slow to be usable. We begin with a former senior employee in a technical role, who stated the clock speed of IonQ's ion trap was so slow that it doomed the entire approach, and that it could days or years to run computations required to make the computer relevant.

Clock speed of ion trap computers is too slow to be useful

"Another thing that worries me is speed. It's not a secret that many in the field do not think ion traps are going to work because the clock speed of an ion-trap quantum computer is just very slow*. So, there is a need to improve the clock speed, and these technologies, in a sense, exist at a proof-of-concept level, but it's nowhere near mature enough to be incorporated in a commercial device. Is IonQ actually going to spend significant effort to resolve that issue? Probably not, is my guess. [Redacted] did bring up this issue, and it was not really well received." – Former senior scientific employee of IonQ*

Error-correction computations required to make the computer useful could take days or years

A: "Ion-trap machines at IonQ, the two-qubit gates, which is the fundamental building block of your quantum computer at the execution level; it runs at around 100 microseconds. That's really slow because at the end of the day, you're going to have sufficiently many gates and so, if your program is sufficiently large, then one execution is going to take a long time and then, as I said, you have to run this many times. ***In a sense, when is the computation actually going to finish?*** *In the roadmap, IonQ says we'll do quantum error correction—that's the big part that also does sit very well with me. Once you go to this thing called "quantum error-corrected quantum computer," you need to do many of these two-qubit gate operations in order to do one operation on a quantum computer at a logical level, that is an error-protected level. Once you turn on error correction and have to spend multiple two-qubit gates of the order of tens to hundreds to perform one real, like an error-protected gate, at this level, it would take more than a millisecond. So, if you're saying each gate consumes 10 milliseconds and then you have a million gates to perform, one cannot reasonably expect this computation to finish."*

*Q: "****So, you're saying that the clock speed is so slow that it actually can't even finish a calculation. Like you could be sitting there for days or years?"***

*A: "****Yeah, that's right. So, I am very concerned about the ion-trap approach. The speed issue has to be resolved, and it's not like you can just flip the switch and move to a faster gate****. One needs to do research, engineering research, systems engineering, prototyping and all of that. But whether IonQ would swallow and actually execute this, even when many in the community raised this concern,* ***I don't think it's going to happen. So, I do not believe IonQ is doing enough to mitigate the foreseen challenges****." – Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

A leading quantum computing physicist and longtime friend of IonQ's founders told us that the company's ion trap approach is 1,000 times slower than other quantum computing approaches. He indicated it could take 3 years to do a calculation like simulating a protein, versus competing approaches that could do it in a day. Speaking of the company, he added that "they know this."

Ion traps are 1,000 times slower than other quantum computer approaches and could take three years to simulate a protein vs one day on another type of quantum computer

"I think all ion traps are about 1000 times slower than superconducting quantum computers*. Whether that matters or not right now is a moot point. But in the future, it probably will matter. The trapped ions typically run at about 1 to 10 kHz rate, and superconducting processors it's probably like a microsecond. So, 100 to 1000 times slower…and the reason it matters is in the future when we have algorithms at scale, it's going to take hours for a quantum computer to do a calculation…If it takes a day on a superconducting quantum computer* ***to simulate some protein, if all else being equal, which is the caveat, if you did that on a trapped ion computer running 1000 times slower, that's 1000 days, that's three years****. And so, great, it's not the age of the universe, quantum computing works, but it's not very practical from a human time scale to wait three years for an answer.* ***They know this****, so they're trying to make their processors faster." – Leading quantum computing scientist and longtime friend of both co-founders*

Source: Scorpion Capital consultation calls with experts

In response to the speed and scalability predicament of IonQ's ion trap system, the company has floated the idea of a photonic interconnect to couple smaller traps into a larger system. We emphasize that interconnects are an essential enabling technology in IonQ's dream of useful ion trap computers. However, a former senior employee slammed the idea as vapor and hype, stating that optical interconnects are unreliable and even slower than traps. He alleged that IonQ is well-aware that interconnects are not a solution and criticized the company's co-founder for continuing to promote the idea: "…and the claims are being made. I don't know what he's thinking."

Optical interconnects are even slower and are unreliable, remaining a pipe dream

"I don't believe [they've done anything with optical interconnects]. Chris did some research things back in 2000 about optical interconnects, the photonic interconnect technology, and this is yet another challenge in the sense that—we were talking in regards to Honeywell, a multi-core approach where you're shuttling the chains. So, this is more like a multi-node approach. If you think about it as a regular computer. You have a CPU that hosts multiple cores, but then a computer processor has multiple computers that are also hooked up. So, you have multiple compute nodes. At that level is what I usually consider as to where photonic interconnect is going to come in. ***The problem with photonic interconnect is it's even slower, and it's very unreliable. If you ask me, this is still at a fundamental research level****, and how they actually plan to bring such an underdeveloped technology that mainly sits in the area of doing fundamental research to a commercial product within the timeframe that they promised,* ***it's questionable to me****." – Former senior scientific employee of IonQ*

Former employee claims IonQ's founder is aware that photonic interconnects are not a solution, and questioned the company's claims to the contrary

"The confusing part is that ***Chris Monroe himself has done this line of research before to know that the fidelity of photonic interconnects is not good****, the speed of photonic interconnect is very slow, and this is going to be an obvious bottleneck,* ***given that nothing substantially is being done about it, and the claims are being made. I don't know what he's thinking****." – Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

One former employee and quantum computing expert after another ridiculed or mocked IonQ's notion of photonic interconnects, indicating that IonQ hasn't even proven that the concept works in principle much less via an engineering solution – a "choke point" and "weak link."

Ex-executive threw cold water on the idea of interconnecting chambers with qubits in them

"This whole story where they're going to photonically interconnect chambers to grow the device, I have real problems with. Think about I need to get to 1000 qubits. So, ***I'm going to interconnect what? Fifty or 100 of these 40-qubit chambers? And what's going to happen to errors****, and what's going to happen to connectivity? I just don't think it's a good solution. Their ability to scale,* ***I just don't believe****." - Former executive*

Connecting modules with interconnects is a "choke point" and "weak link"

"The question is, ***how do I connect qubits in module A to qubits in module B?*** *Because you have to do it with as high fidelity or else your module to module connection is your choke point.* ***That's the weak link****. So, that is the major challenge that I see with the IonQ approach […] But how do you connect modules together so that you have an extensible or scalable quantum system. They have talked publicly about some ideas to do that […] But the fidelities with which they can do that today, at least what I've seen in the public domain, have not been that high." – Leading quantum computing scientist and longtime friend of both co-founders*

IonQ hasn't even shown the interconnect approach works "in principle"

"The approach IonQ does is they want to build multiple individual smaller traps and then connect them by fiber optics. They haven't shown in principle that it works *and that now it's an engineering problem. The second problem is just adding more ions or qubits is not enough. You also have to make them work properly. Usually, the more large the systems are, the harder it gets to control it. That's one of the biggest obstacles that we have in quantum computation. Adding more qubits is not the hardest part. The hardest part is really making them behave in a quantum way and that they keep all of their properties as we try to scale up and going to bigger and bigger systems […]* ***Their roadmap is with these multiple traps to interconnect them. I personally am not super-convinced about that approach. I think that's their biggest drawback****."– IBM quantum computing researcher with expertise in ion-traps*

Source: Scorpion Capital consultation calls with experts

An ex-employee explained in detail why coupling traps is essentially impossible. A leading scientist and longtime friend of IonQ's founders corroborated that their entire approach simply breaks down, with an ion trap expert in IBM's quantum computing group stating bluntly that ion traps are not "going to solve any real-world problem."

Coupling traps together is essentially impossible with acceptable error rates and fidelities

"The number one thing is that these traps don't actually scale infinitely with the number of ions you can trap. They're trying to address them with laser beams, so there's only so much space for that. How you actually scale - Chris's lab works on this, so it's all publicly available - is that ***you couple traps together. And so, doing that is already very hard because coupling them is a process that is low fidelity, and so any time you would want to do an interaction between two qubits on different traps, there's going to be loss there, and even a little bit of loss in these experiments really propagates through the whole thing, and it's pretty detrimental****. The reason classical computers work so well is because the fidelity of a given logic gate is like 10^{-17} or something. Whereas with these, it's 99.9 something, even the best case. So, I think scaling the number of qubits is hard regardless. That's going to be challenging, an engineering feat. This fidelity that I just mentioned and improving that fidelity to be what you'd need to be as close to zero as possible is a fundamental limit in my mind.* ***The limitation is that you want to get the fidelity of that two-qubit interaction as close to zero as possible, and it's not even very close to zero right now. And it hasn't been for many years****." – Ex-IonQ employee, member of technical staff*

Linear ion trap systems quickly break down and can't scale

Q: "So you're saying their entire technology is based on linear chains, whether ingle-qubit gates or these two-qubit gates?"
A: "Yes."
Q: "And you're saying there's a fundamental flaw – they say, "We use a specialized chip called the linear ion trap," and ***you're saying a linear ion trap intrinsically has certain problems/limitations, and it breaks down after 100 qubits****."*
*A: "****100-ish qubits, that's right."*** *– Leading quantum computing scientist*

Scaling is the "biggest drawback" of ion trap systems

"Their biggest drawback is scaling, meaning going up to bigger and larger systems, like thousands of qubits*. This is where a lot of engineering has to be done. In the past 20 years, ions haven't fully been used in academic research and systems, and my research group back then had a system size of maybe up to 10-20 qubits. These are moderate sizes that you can use for fun stuff, but* ***they're not going to solve any real-world problem."*****– IBM quantum computing researcher with expertise in ion-traps*

Source: Scorpion Capital consultation calls with experts

12. Despite purportedly having the world's most powerful quantum computer, IonQ has disclosed a pitifully small list of "customers" and partners in its press releases and materials. We spoke with a significant percentage of those mentioned, and they each laughed at, mocked, or trashed IonQ's capabilities – contradicting their quotes in IonQ's releases: the machine "isn't really real"; "way too much instability"; "not really useful"; "run times are really slow"; and users are "definitely" unhappy. "Customers" were evasive or laughed when we asked if they pay for access to the computer.

Despite purportedly having the world's most powerful quantum computer, IonQ has disclosed a pitifully small list of "customers" and partners in its press releases and investor materials. We spoke with a significant percentage of those mentioned, and they each laughed at, mocked, or trashed IonQ's capabilities – contradicting their quotes in IonQ's releases. For example, when IonQ announced "the world's most powerful computer," the release quoted two quantum software and services firms: 1QBit and QCWare. In Nov 2021, IonQ then talked up a partnership with Multiverse Computing which would "dramatically increase the accessibility of quantum computing" for financial services. The following pages detail the devastating color that 1QBit, QCWare, and Multiverse provided regarding their experience with IonQ's system.

IonQ press release quotes a handful of customers/partners

IonQ Unveils World's Most Powerful Quantum Computer.

IonQ talks up partnership with Multiverse Computing

Bringing Quantum to the Market With Multiverse Computing

*"IonQ and **1QBit** are working together on applying quantum computers to solve previously intractable problems in a variety of industries and are excited to explore new possibilities resulting from the release of IonQ's newest generation of devices," said Arman Zaribafiyan, Head of Quantum Simulation, 1QBit.*

*"We design quantum machine learning algorithms to drive performance on near-term hardware," said Iordanis Kerenidis, Head of Algorithms International, **QC Ware**. "We collaborated with IonQ in implementing QC Ware's quantum classification algorithm on their system, and **the excellent results attest to their unique approach and demonstrated performance**."*

*"We are excited to announce IonQ as a preferred quantum compute partner for our Singularity platform," said Enrique Lizaso, CEO of **Multiverse Computing**. "Together, our two platforms will allow us to develop joint solutions to interesting, real-life problems in finance."*

Source: https://ionq.com/news/october-01-2020-most-powerful-quantum-computer; https://www.businesswire.com/news/home/20211111005590/en/Multiverse-Computing-Partners-with-IonQ-to-Unlock-the-Power-of-Quantum-Computing-for-Global-Financial-Companies

We spoke with a senior executive of 1QBit, who stated that while they have worked with IonQ "since inception" - for 2 ½ to 3 years – they almost never use the "world's most powerful quantum computer": maybe "twice a year" for "minutes" at a time. He indicated that the machine "isn't really real" for any type of production setting and has "way too much instability" and errors to be used on "mission critical tasks," emphasizing that there is "no instance" where you would use it for anything important.

1Qbit has worked with IonQ for years but barely uses their machine – perhaps twice a year for a few minutes; "isn't really real" for any type of production setting

*"**We've been working with IonQ since inception or since they made the first device available. At least two-and-a-half, three years now** […] We've done experiments—apologies if this is well understood—but **using quantum computers in any type of production setting isn't really real**, so nobody's using quantum computers beyond just experimenting with quantum devices. **We use IonQ's computer I would say twice a year maybe**, maybe once a quarter at the highest volume. I don't know the specific numbers, but **it's definitely in the minutes**; it's not in the hours or days." – Senior employee of 1Qbit, an IonQ partner/customer*

"Way too much instability" and errors to ever use on "mission-critical tasks"; "no instance" where you would use it for anything important

*"It's not useful in a production setting is what I was trying to reference earlier is that **there are no mission-critical tasks you would ever ask a quantum computer to do because it's just too early days for it, and there's way too much instability in terms of errors that get introduced**, so you have to run these things on multiple occasions, and then you have to do strong error correction—sorry, lots of checks on it to make sure that the outcomes are accurate. So, there's almost no instance where you'd be like, yeah, my quantum computer runs my risk processing application for my company or whatever." – Senior employee of 1Qbit, an IonQ partner/customer*

Source: https://arxiv.org/pdf/2108.03708.pdf

He stated that anybody "tinkering" with IonQ's device "isn't really doing anything"; that the type of computation one can do with it is "trivial"; and that the machine is "not really useful." He added that the computer's "run times are really slow" and that decoherence problems cause the physics to "break down" and produce errors. Adding insult to injury, he indicated that while 1QBit has worked with IonQ since inception, they have not generated revenue for IonQ.

"Tinkering" IonQ's device "isn't really doing anything"; "it's trivial" and "not really useful"

*"The way to think about this stuff is **anybody who's tinkering with the IonQ device in AWS or Azure Quantum isn't really doing anything**. That type of access or that type of computation in the cloud is, I mean, **it's trivial** or just the nature of the work that you've done. So, there's no feedback necessarily. **It's not really useful**." – Senior employee of 1Qbit, an IonQ partner/customer*

Partner states they have not generated any revenue for IonQ

*"**Have we generated revenue for IonQ? No**. Either we worked directly with them as we did the first time and then the research collaboration between the companies and it is not a paid thing or the time when we brought the customer, which was Goldman, then we brought the customer between the customer and us, there was a different contact, and with IonQ, it was a research collaboration where they agreed to demonstrate what we proposed to them as a demonstration of their hardware." – Senior employee of QCware, an IonQ partner/customer*

IonQ's "run times are really slow" and decoherence problems cause the physics to "break down" and cause errors

*"The challenge with the IonQ device is that its **run times are really slow by computational standards**, and the problem you run into when you have really slow computation is you have something called decoherence, so your system over time, if it takes too long for you to process that system in the device, **it starts to decohere, or the relationships between the qubits or the assets in the use case start to break down because the physics break down** and, therefore, the relationships that you're measuring start to break down. As a result of that, you have errors." – Senior employee of 1Qbit, an IonQ partner/customer*

Source: https://arxiv.org/pdf/2108.03708.pdf

In addition, we spoke with two executives of IonQ partner QCWare, given that IonQ published a paper with QCWare and talks up Goldman Sachs as a collaborator. One QCWare executive indicated that IonQ's error rates are around 30% - radically higher than the 2% or so IonQ claims on its website. A second stated that QCWare and customers are "definitely" unhappy with their results from the machine and that it's not "what they were expecting." We note that these comments flatly contradict the QCWare quotes used in a recent IonQ press release, which one of the execs actually pointed out.

IonQ press release Sep 2021

Goldman Sachs, QC Ware and IonQ Demonstrate Quantum Algorithms Proof-of-Concept That Could Revolutionize Financial Services, Other Industries

"While QC Ware has designed novel practical quantum algorithms and software for enterprise implementation, ***IonQ has built unique hardware with quantum gates of high enough quality to run these algorithms."*** *– QCWare quote in IonQ press release*

In our interviews however, QCWare stated that IonQ's error rates are far higher than those reported on its website

Q: "When you run an actual algorithm, you're saying the error rate is 78%, or it's accurate 70% to 80% of the time?"
A: ***"No, the accuracy is around 70% or so for the ones that we are observing."***
Q: "How is it useful to do an algorithm on something that's 70% accurate? How do you know that the result is correct?"
A: "That's exactly what we are quantifying now. I know that the people in IonQ are working on reducing the error a lot, but that's a problem that is common to all quantum hardware providers." – Executive of a key IonQ partner

QCWare added that IonQ's customers are unhappy with their experience using the machine

"I know that the team and a lot of people have publicly said we're not entirely happy with the IonQ results that we get when we run through Amazon Braket…I don't know if that was originally in the press release, but that was the sentiment definitely from—I don't know if I can quote anyone on that—but ***that was the sentiment from different customers, let me just say different financial customers that I talked to, that maybe the machine that's on Braket is not getting what they were expecting****. We just had our big conference, and it's just like, this is the sentiment I got from a couple of these hallway conversations. I don't think you can find this in a press release." - Executive of a key IonQ partner, QCWare*

Source: Scorpion Capital consultation calls with experts; https://investors.ionq.com/news/news-details/2021/Goldman-Sachs-QC-Ware-and-IonQ-Demonstrate-Quantum-Algorithms-Proof-of-Concept-That-Could-Revolutionize-Financial-Services-Other-Industries/default.aspx

One QCWare executive described customer dissatisfaction with IonQ's error rates and gate fidelities – "not great"; "qubit fidelity was not on par." The executive didn't state the customer's identity, but we believe it to be Goldman Sachs, perhaps the highest profile "customer" that IonQ has hyped. The exec continued that IonQ's trapped ion technology is inferior to Honeywell's, which we find damning as it's one of three key players in trapped ion quantum computing besides IonQ. He noted that Honeywell's gate fidelities are a "significantly big jump" above IonQ's.

Customers indicate dissatisfaction and that IonQ's error rates and gate fidelities are below Honeywell's

*"**The one issue that people bring up is the fact that the fidelities on the machine that's on Braket are not great** or not exceptional; I mean, they could be better. It was one of these companies that we work with, it's a finance company, but I don't feel comfortable sharing their name. Very large company. **They said the qubit fidelity was not on par, was essentially not what they expected, and I think they were referring to the fact that it is below the Honeywell machine**. So, that comment was done in direct comparison with the Honeywell machine and basically said we've done experiments on Honeywell, we've done experiments on IonQ, and the Honeywell experiments went well; the IonQ ones didn't because the fidelities are not good." – Executive of a key IonQ partner, QCWare*

IonQ's trapped ion technology is inferior to Honeywell's

*"If you look at the press release, even their own press release about the machine that's currently on Braket, and you look at things like **the fidelity, the error rates, and the fidelities and all those, and then compare those with their direct competitor, which is Honeywell**. They're just under the Honeywell numbers. So, the way to recreate what I just did from their own press release is to just look at their own numbers, the numbers they've published, and those numbers are below the Honeywell numbers. I think that **their current commercially-available machine is just under par from where Honeywell is**." - Executive of a key IonQ partner, QCWare*

Honeywell's gate fidelities are a "significantly big jump" above IonQ's, which is "below par"

*"The two-qubit gate fidelity that they have published is 97.5, and this is the two-qubit gate fidelity that's on the Braket machine. So, that's 97.5. That's the number for IonQ. This number is really critical. The same number for Honeywell is 99.5. So, it's a significantly big jump. All of quantum computing is trying to get to a point where this fidelity gets to 99.999 and a few nines. **That makes the case of how the current machine is below par with the Honeywell machine."** - Executive of a key IonQ partner, QCWare*

Source: Scorpion Capital consultation calls with experts

Given QCWare's troubling feedback, we were not surprised when one of their executives stated that "there's no money involved in the current partnership" and "no money changing hands," which suggests that despite the hype, IonQ can't get anyone to even pay to use their "world's leading" quantum computer. Furthermore, he indicated that prospective customers "are hard to come by" and that QCWare hasn't even proposed IonQ's hardware to more than three or four customers in about a year and a half.

QCWare has only found 4 customers to introduce to IonQ's technology

*Q: **"How many customers have you proposed them to?"***

*A: "I don't have an exact count. **Less than a handful, maybe three or four, not more than that. Over a year, year-and-a-half**."*

Q: "Why didn't you introduce them to a lot more people?"

*A: "Because clients are hard to come by. We're talking about R&D projects. All of these clients are R&D departments of Fortune 200 companies. And then we sign up the client, QC Ware does that, and then **if the client has enough interest and things are going well, we might propose that we go and do an experiment on actual hardware**.." – Executive of a key IonQ partner, QCWare*

Partner states that "there's no money involved in the current partnership"

*"Right now, **there's no money involved in the current partnership we have**. We just tell them we want access to the latest and greatest machine, a machine that might not be available on Amazon Braket. Therefore, we bring the customer to you, IonQ, to run this, and so, you, IonQ, benefit by running this experiment and getting your name associated with the customer like a Goldman Sachs. That's the kind of customers we would bring to them. And therefore, **there's no money changing hands between QC Ware or IonQ in this partnership**. That's how we are set up to work for the time being." – Executive of a key IonQ partner, QCWare*

Source: Scorpion Capital consultation calls with experts

Multiverse Computing, another of the key partners that IonQ has promoted, laughed when we asked if they pay for access to IonQ's technology, saying it's "still at a very early stage" – "it's not that they are useless." He initially evaded our question and then stated "it's a free partnership," adding that none of the four "customers" they have introduced to IonQ are paying either. He further implied they barely use it.

IonQ partner laughed when we asked if they or other customers are willing to pay for IonQ's technology

Q: "If I'm reading between the lines, it seems like you're being diplomatic, but you're not willing to pay for it."

A: "[Laughing] Quantum technology is still at a very early stage. The quantum computers still do not have the same level of maturity as classical computers. ***It's not that they are useless****…" - Executive of a key IonQ partner*

The exec laughed again when asked if they have to pay for access to IonQ's technology

Q: "How much does it cost to use the machine? How many hours are you running it every month or every year?"

A: "That's a good question. ***Cost in terms of money [laughs out loud]. I couldn't provide you these details****. I'd have to look at that. I don't know them by heart. I know we have an agreement with them."*

Q: "Are you a paying customer, or do they let you use it for free?"

A: "No, they let us use the technology because we are also testing the platforms."

Q: "Like $5000 or $10,000 a year or something?"

A: "Yeah, something like that, not a million."

Q: ***"Is this a paid partnership or just a free partnership?***

A: ***"No, it's a free partnership****." – Executive of a key IonQ partner*

The partner indicated that none of the four customers it's introduced to IonQ are paying for access

Q: "How many customers are using it through you?"

A: "At least four. One right now, and with our three contracts, at least they are going to be using IonQ."

Q: "How much are these customers willing to pay IonQ, or they're not paying anything?"

A: "They are getting the access through us, but once we finish the project; if they want to continue using IonQ, they have to pay for it, either directly or through AWS."

Q: ***"And are any of these customers currently paying IonQ, or they're not?"***

A: ***"No, I don't think so, not yet****."*

*Q: "****So, they're all basically getting it for free?"***

*A: "****Right now, yes****,."– Executive of a key IonQ partner*

Source: Scorpion Capital consultation calls with experts

13. IonQ's revenue and bookings are driven by phony related-party deals and round-tripping, creating the illusion of commercial momentum prior to listing via a SPAC.

IonQ has aggressively promoted its commercial progress by talking up sales growth and bookings. It claims to have "bookings" of $17MM, having magically tripled in September 2021 right before it began trading.

Press release Sep 9, 2021

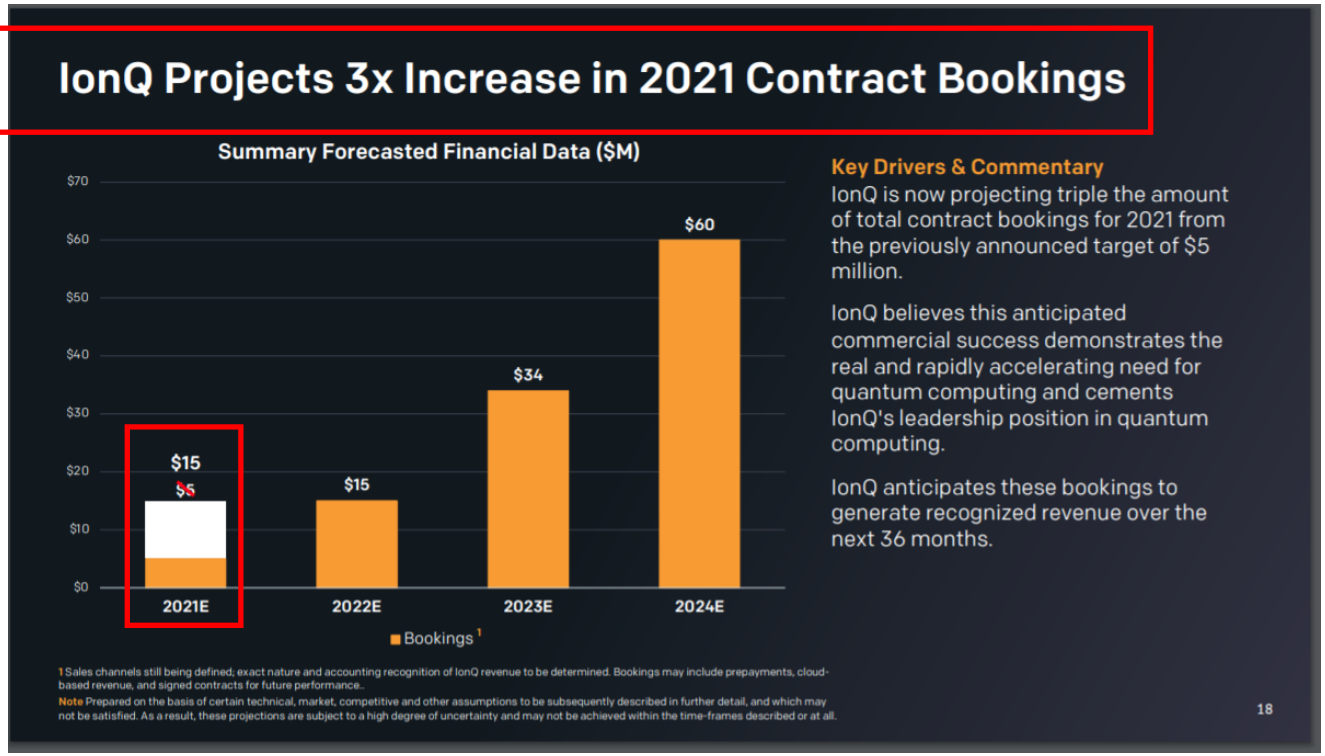
IonQ Triples Expectation for 2021 Contract Bookings

Press release Dec 7, 2021

IonQ Leads Charge for Quantum Commercialization at Q2B 2021

Investor presentation Sep 2021

IonQ Projects 3x Increase in 2021 Contract Bookings



Source: https://investors.ionq.com/news/news-details/2021/IonQ-Triples-Expectation-for-2021-Contract-Bookings/default.aspx; https://investors.ionq.com/news/news-details/2021/IonQ-Leads-Charge-for-Quantum-Commercialization-at-Q2B-2021/default.aspx; IonQ Sep 2021 investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/11/IonQ-Investor-Presentation-Sept-2021-Updates-v091721.4.pdf

The company has promoted a roster of marquee customers and partners such as Goldman Sachs, Fidelity, Accenture, GE, Google, Amazon, and Softbank. On the Q3 call, CEO Chapman talked up their commercial momentum: "IonQ is the only provider of quantum computing hardware available on all three major public clouds" and has "integrated IonQ's hardware" with "platforms like IBM's Qiskit and Google Search."

Excerpts from IonQ investor presentation, Sep 2021

IonQ press releases

Accenture and IonQ Collaborate to Accelerate Quantum Computing Into the Enterprise

09/14/2021

IonQ and GE Research Partner to Explore How Quantum Computing Could Impact Risk Management

09/23/2021

Goldman Sachs, QC Ware and IonQ Demonstrate Quantum Algorithms Proof-of-Concept That Could Revolutionize Financial Services, Other Industries

09/21/2021

IonQ's Leading Trapped-Ion Quantum Hardware Now Available on Google Cloud Marketplace

06/17/2021

IonQ Partners with Microsoft to Power Azure Quantum

11/04/2019

Source: IonQ investor presentation https://s28.q4cdn.com/828571518/files/doc_presentation/2021/11/IonQ-Investor-Presentation-Sept-2021-Updates-v091721.4.pdf; IonQ press releases https://investors.ionq.com/news/default.aspx; IonQ Q3 earnings calls transcript https://seekingalpha.com/article/4469760-ionq-inc-class-ionq-ceo-peter-chapman-on-q3-2021-results-earnings-call-transcript

Given the long list of top-tier customers and the availability of IonQ's quantum hardware "through every major US cloud provider" per the CEO's comments on the Q3 call, we were surprised to discover that the company only reported an immaterial $233,000 of revenue in Q3 2021 and $451,000 for the nine months ended Sep 30 2021, and zero revenue for the same periods in 2020. This leads us to conclude that IonQ's total cumulative revenue since inception to 9/30/21 was only $451K. The company's total 2021 revenue of $2.1MM was driven almost entirely by Q4, which comprised ~80% of the total for the year.

IonQ Q3 2021 10Q filing

	Three Months Ended September 30,		Nine Months Ended September 30,	
	2021	2020	2021	2020
	(in thousands)			
Revenue	$ 233	$ —	$ 451	$ —
Costs and expenses:				
Cost of revenue (excluding depreciation and amortization) (1)	234	57	742	57
Research and development (1)	6,180	2,339	15,311	7,643
Sales and marketing (1)	1,286	81	2,384	263
General and administrative (1)	2,461	727	8,321	1,840
Depreciation and amortization	596	372	1,543	995
Total operating costs and expenses	10,757	3,576	28,301	10,798
Loss from operations	(10,524)	(3,576)	(27,850)	(10,798)
Offering costs associated with warrants	(4,259)	—	(4,259)	—
Other income	2	11	7	305
Loss before benefit for income taxes	(14,781)	(3,565)	(32,102)	(10,493)
Benefit for income taxes	—	—	—	—
Net loss	$(14,781)	$(3,565)	$(32,102)	$(10,493)

Source: Capital IQ screen

The first question the CEO received on the company first ever earnings call – on Nov 15, 2021 - was from a Morgan Stanley analyst asking for basic detail about the YTD "total contract value bookings" of $15.1MM. The CEO evaded and refused to answer the question, which asked for the number of customers that comprise the bookings and their mix. The CEO stated that they have "thousands of customers" but that he wouldn't "break out the individual customer names because many of these [sic] actually covered by confidentiality process."

Excerpt of IonQ Q3 2021 earnings call transcript, Nov 15, 2021

Katy Huberty

"Thank you. Good afternoon and congratulations on the public listing and many product announcements and milestones in the quarter. I have a couple of questions. The first is about the bookings and mix of bookings year-to-date, what can you tell us about the number of customers or deals within that 50 [sic] million of bookings, and about the mix of customers and use cases that you've seen this year?"

Peter Chapman

"Hi, Katy, thanks for calling in, and excellent questions. What we have seen to date is that we've seen thousands of customers running projects on our machines with billions of shots in terms of running their quantum computations. We continue to see a mix of customers coming in through our public cloud where we actually don't know who all the customers are, because that fits with the public cloud provider, and we have customers on a private cloud as well. We are to date not going to break out the individual customer names because many of these actually covered by confidentiality process."

Source: IonQ Q3 earnings calls transcript https://seekingalpha.com/article/4469760-ionq-inc-class-ionq-ceo-peter-chapman-on-q3-2021-results-earnings-call-transcript

The reason for the CEO's evasiveness was buried in the Q3 10Q filing, where the language was similarly less than candid. It suggested that most or all of the company's revenue in Q3 and for 2021 came from only 2 and 3 customers respectively – a troubling contrast to the CEO's claim of "thousands of customers."

Excerpts from IonQ 10Q filing for Q3 2021

"Significant customers are those which represent more than 10% of the Company's total revenue. **The Company's revenue was from 2 significant customers for the three months ended September 30, 2021 and from 3 significant customers for the nine months ended September 30, 2021**. The Company did not have any revenue for the three and nine month periods ended September 30, 2020."

Comparison of Q3 2021 vs. same period in 2020

"Revenue increased by $0.2 million, or 100%, to $0.2 million for the three months ended September 30, 2021 from zero for the three months ended September 30, 2020. **The increase was primarily driven by three new revenue contracts** under which we provided services during the three months ended September 30, 2021."

Comparison of first 9 months of 2021 vs. same period in 2020

"Revenue increased by $0.5 million, or 100%, to $0.5 million for the nine months ended September 30, 2021 from zero for the nine months ended September 30, 2020. **The increase was primarily driven by four new revenue contracts** under which we provided services during the nine months ended September 30, 2021."

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312521329877/d235265d10q.htm#

The Related Party section of the filing then explained why IonQ's revenue is a farce: the two customers that drove 70% of its revenue in Q3 are the University of Maryland (UMD) and Duke - which spun off IonQ. The entities are so intertwined it is difficult to discern where they end and IonQ begins. Monroe and Kim, the two co-founders and Chief Scientist and CTO, respectively, oddly remain professors at UMD and Duke; IonQ licensed its core technology from the two universities in exchange for stock. IonQ even leases its office space from UMD. When IonQ says that UMD and Duke are its key "customers" of compute resources, it's admitting that its largest customer is itself – i.e., its co-founders and their own academic organizations.

Excerpts from IonQ 10Q filing for Q3 2021

Licensing of intellectual property is of critical importance to our business. For example, we license patents (some of which are foundational patents) and other intellectual property from the University of Maryland and Duke University on an exclusive basis. If the license agreement with these universities terminates, or if any of the other agreements under which we acquired or licensed, or will acquire or license, material intellectual property rights is terminated, we could lose the ability to develop and operate our business.

We are heavily reliant upon licenses to certain patent rights and other intellectual property from third parties that are important or necessary to the development of our products. In particular, **our quantum computing technology is dependent on our license agreement with University of Maryland and Duke University** (the "Universities"). Significant intellectual property developed by our co-founders, Jungsang Kim, our Chief Technology Officer, and Christopher Monroe, our Chief Scientist, has been and **is required to be assigned to the Universities as a result of Dr. Kim and Dr. Monroe's employment by the Universities**, and certain such intellectual property is licensed pursuant to the license agreement with the Universities.

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312521329877/d235265d10q.htm#

In other words, IonQ's revenue is not only negligible but whatever little scraps they've scrounged up are related-party round-tripping. Of the whopping $233K of total Q3 2021 revenue, $164K or 70% was from UMD and Duke. The related party disclosure then exposes the circular nature of the flows – in Q3, IonQ expensed $313K of R&D as transactions with UMD and Duke as well as $101K in other items. In other words, IonQ spent $414K with its two largest customers, who then turned around and "purchased" $164K of quantum computing access and services.

Excerpts from Related Party footnotes from IonQ's 10Q filing for Q3 2021

12. RELATED PARTY TRANSACTIONS

Transactions with UMD and Duke

As described in Note 5 – *Agreements with UMD and Duke*, the Company entered into a License Agreement and Option Agreement with UMD and Duke whereby the Company, in the normal course of business, has licensed certain intellectual property and, in the case of the Amendments to the Duke and UMD Option Agreements, has purchased research and development services. The Company considers these agreements to be related party transactions because during 2021 and 2020, the Company's Co-Founder and Chief Technology Officer served as a professor at Duke and the Company's Co-Founder and Chief Scientist served as a professor at UMD. During the nine months ended September 30, 2021, the Company's Chief Scientist moved to Duke and each, in their role as professors at Duke, are leading the research subject to the License Agreement and Option Agreement with Duke as of September 30, 2021.

In addition, the Company entered into an amendment to its operating lease for office space with UMD. The lease was amended with UMD in March 2020 to extend the terms of the agreement for the existing premise and lease additional expansion premise and was amended in December 2020 to provide additional rent adjustments. Refer to Note 12 of the audited financial statements for the year ended December 31, 2020 for additional information regarding the Company's leases.

In September 2021, the Company entered into a multiyear deal with UMD to provide certain quantum computing services and facility access related to the National Quantum Lab at UMD in exchange for payments totaling $14 million.

The Company's results from transactions with UMD and Duke, as reflected in the Condensed Consolidated Statements of Operations and Comprehensive Loss are detailed below (in thousands):

	Three Months Ended September 30,		Nine Months Ended September 30,	
	2021	2020	2021	2020
Revenue	164	—	164	—
Cost of revenue	34	—	34	—
Research and development	313	7	1,649	117
Sales and marketing	8	—	8	—
General and administrative	59	55	189	71

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312521329877/d235265d10q.htm#

The related party games and round-tripping continued in Q4 2021. IonQ's filings disclose its revenue from UMD/Duke for 2021 as well as for the first nine months of the year, as well as its R&D transactions with them. This allowed us to calculate the related party contribution for Q4. UMD/Duke accounted for an astounding 62% of IonQ's "revenue" in Q4, and 56% for all of 2021. The data also makes the round-tripping clear: for all of 2021, IonQ expensed $1.9MM of R&D with Duke/UMB, who turned around and drove $1.2MM of sales. Most importantly, the data shows IonQ's suddenly increased dependence on UMD/Duke starting in Q3 and into Q4 vs. Q1/Q2– just in time for the SPAC. In other words, the only way that IonQ showed "growth" around the time of its listing is by manufacturing it via the related parties that spun it out as a company.

Q4 estimates based on IonQ 2021 10K and Q3 2021 10Q

000's	2021	Q3	Q1-Q3 total	Implied Q4
Total IonQ revenue	2,099	233	451	1,648
Revenue from UMD/Duke	1,179	164	164	1,015
R&D transactions with UMD/Duke	1,949	313	1,649	300
% of revenue from UMD/Duke	56%	70%	36%	62%

36% of Q1-Q3 revenue came from Duke/UMD, but quickly doubled to 70% in Q3 – just as IonQ needed to show growth for the SPAC listing

Source: IonQ SEC filings https://www.sec.gov/ix?doc=/Archives/edgar/data/0001824920/000119312521329877/d235265d10q.htm; https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312522086738/d257705d10k.htm#fin257705_3; Scorpion Capital estimates and analysis

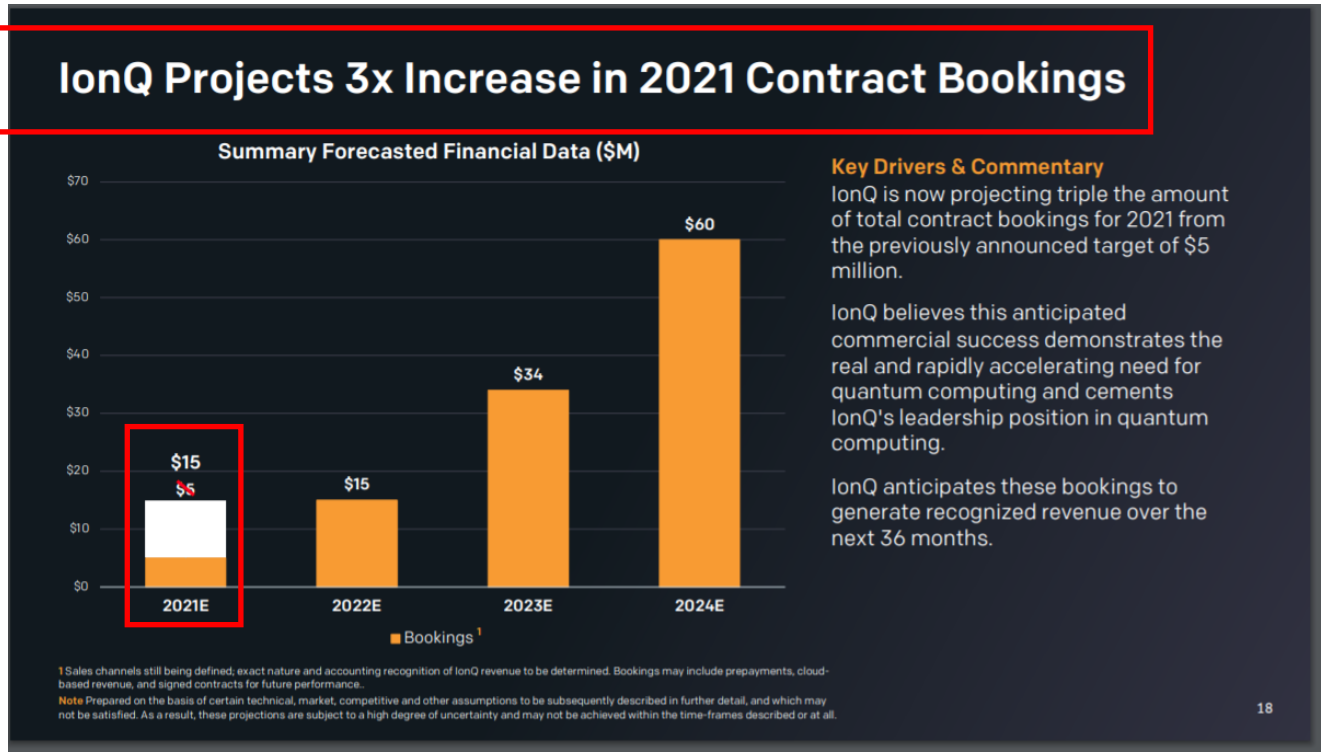
Given the immaterial level of IonQ's revenue, the company has tried to re-frame the narrative around bookings and bookings growth. A critical part of their SPAC pitch is the purported $15MM of bookings through Q3 2021 and $17MM as of Q4.

Press release excerpt for Q3 2021 earnings, Nov 15, 2021

Third Quarter Financial Highlights

- Revenue of $223 thousand, for a total of $451 thousand year to date.
- Year-to-date total contract value (TCV) bookings of $15.1 million.

Investor presentation Sep 2021



Source: https://investors.ionq.com/news/news-details/2021/IonQ-Announces-Third-Quarter-2021-Financial-Results/default.aspx; ; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/11/IonQ-Investor-Presentation-Sept-2021-Updates-v091721.4.pdf

The bookings were $5MM until Sep 9, 2021, when IonQ issued a press release announcing that they had tripled to $15MM. We note the fortuitous timing of the 300% increase – a mere 3 weeks before the SPAC transaction closed and IonQ began trading. We further note the curious timing of another press release the day before this one, where IonQ announced that the University of Maryland and IonQ agreed to jointly establish the "First-of-its-Kind National Quantum Lab," with a "new $20MM investment from UMD" to provide the "university and its partners with unprecedented access to quantum computing." The purported "Q-Lab," per the release, "will be located…next to IonQ's headquarters…."

IonQ press release Sep 9, 2021

IonQ Triples Expectation for 2021 Contract Bookings

09/09/2021

COLLEGE PARK, Md.--(BUSINESS WIRE)-- IonQ, the leader in quantum computing, today announced that it is tripling its expectation for 2021 total contract bookings from its previously announced target of $5 million to $15 million. For IonQ, this commercial success demonstrates the real and rapidly accelerating need for quantum computing among enterprise customers and cements its leadership position in quantum computing. IonQ anticipates these bookings to generate recognized revenue over the next 36 months.

IonQ press release Sep 9, 2021

IonQ and University of Maryland Establish First-of-Its-Kind National Quantum Lab

09/08/2021

New $20M Investment From UMD Will Provide University and Its Partners with Unprecedented Access to Quantum Computing

Source: https://investors.ionq.com/news/news-details/2021/IonQ-Triples-Expectation-for-2021-Contract-Bookings/default.aspx; https://investors.ionq.com/news/news-details/2021/IonQ-and-University-of-Maryland-Establish-First-of-Its-Kind-National-Quantum-Lab/default.aspx

The tripling of "bookings" a few weeks before IonQ began trading was simply a hoax, using a related-party deal to create the illusion of growth. The Sep 9, 2021, press release that announced the bookings spike failed to explain that it was driven by the University of Maryland Q-Lab announcement the day before and their $20MM "investment." In fact, the press release went to great lengths to mislead investors, by separately breaking out the Q-Lab deal as an example of "operating momentum" de-linked from the 3X bookings growth. It wasn't until the 10Q filing on Nov 15, 2021 that a key sentence appeared in the footnotes – that UMD would pay IonQ $14MM for "certain quantum computing services and facility access related to the National Quantum Lab at UMD." We find the words "at UMD" to be misleading as well, as the press release stated that the purported lab "will be located…next to IonQ's headquarters…."

Excerpts from Related Party footnotes from IonQ's 10Q filing for Q3 2021

12. RELATED PARTY TRANSACTIONS

Transactions with UMD and Duke

As described in Note 5 – *Agreements with UMD and Duke*, the Company entered into a License Agreement and Option Agreement with UMD and Duke whereby the Company, in the normal course of business, has licensed certain intellectual property and, in the case of the Amendments to the Duke and UMD Option Agreements, has purchased research and development services. The Company considers these agreements to be related party transactions because during 2021 and 2020, the Company's Co-Founder and Chief Technology Officer served as a professor at Duke and the Company's Co-Founder and Chief Scientist served as a professor at UMD. During the nine months ended September 30, 2021, the Company's Chief Scientist moved to Duke and each, in their role as professors at Duke, are leading the research subject to the License Agreement and Option Agreement with Duke as of September 30, 2021.

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In September 2021, the Company entered into a multiyear deal with UMD to provide certain quantum computing services and facility access related to the National Quantum Lab at UMD in exchange for payments totaling $14 million.

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312521329877/d235265d10q.htm

We find it amazing that not only did the CEO refuse to answer a simple question on the earnings call regarding the number of customers who comprise the $15MM of "bookings," but that the CFO engaged in a similar game. He trumpeted the tripling of bookings, and then talked up the Q-Lab deal with Maryland – but failed to disclose the critical fact that the tripling was due to this one particular deal, even representing the increase as due to "customers" versus one related party.

CFO comments during IonQ Q3 2021 earnings call on Nov 15, 2021

"Thank you, Peter, and good afternoon, everyone. I would like to start off by quickly going through some of our financial results in more detail. Earlier in Q3, we raised our full year 2021 forecasted bookings expectations from $5 million to $15 million. Today, I am happy to announce that as of the end of Q3, ***our total bookings for the year have already exceeded our increased expectations for the full year ending up at $15.1 million. We believe this is a recognition of the promise our customers see in our platform, and resulted from customers buying more*** *and also earlier than we had expected."*

"As Peter touched upon earlier, in Q3, we announced a partnership with the University of Maryland to create the national quantum lab at Maryland, or Q-Lab […] Access to the facility will be open to UMD affiliated students, faculty, researchers, staff and partners across the country allow in collaboration with our own scientists and engineers. ***We will be the exclusive provider of quantum computers to the Q-Lab. And as such, the University of Maryland is an important customer."***

Source: IonQ Q3 earnings calls transcript https://seekingalpha.com/article/4469760-ionq-inc-class-ionq-ceo-peter-chapman-on-q3-2021-results-earnings-call-transcript

As we shall detail, we believe that the UMD Q-Lab deal is a sham to manufacture bookings growth out of thin air. UMD is a related-party with a significant financial interest in IonQ, with the same incentives as IonQ's founders and investors to pump the story. UMD has attempted to build a quantum computing franchise and a fundraising machine around its initiatives in the space. An article in the local Baltimore Sun stated that UMD "officials have worked for years to cultivate the institution's reputation as a leader in quantum technology research" and "hatched" IonQ. It quoted the university's president, who boasted of becoming "the Quantum Capital of the world."

Baltimore Sun article, Sep 8, 2021

*"University of Maryland **officials have worked for years to cultivate the institution's reputation as a leader in quantum technology research**, having housed one of the laboratories from which IonQ was hatched. The university is currently home to seven quantum-focused centers and more than 200 researchers."*

*"No other university in the United States is able to provide students and researchers this level of hands-on contact with commercial-grade quantum computing technology and insights from experts working in this emerging field," said University of Maryland President Darryll J. Pines in a statement. "We could not be more proud of IonQ's success and we are excited to establish this strategic partnership, **further solidifying UMD and the surrounding region as the Quantum Capital of the world."***

UMD site quotes President Darryll Pines: "Quantum can be for us what silicon was for Silicon Valley"

Source: https://www.baltimoresun.com/education/bs-md-university-maryland-quantum-computing-20210907-20210908-xeed5azaardotbr577lzslm4re-story.html; https://quantum.umd.edu/

Our research leads us to conclude that the Q-Lab doesn't even exist, yet IonQ already appears to be using it conjure revenue out of thin air. The related party disclosure in the 10Q filed on Nov 15, 2021, suggests that IonQ had already booked $4MM of accounts receivable and $3.8MM of unearned revenue with UMD and Duke as of Sep 30, 2021. The filing doesn't state how much of the $4MM is with UMD vs. Duke, but it appears patently obvious to us that IonQ announced the $14MM deal on Sep 9 and then instantly billed UMD for $4MM by Sep 30.

Excerpts from Related Party footnotes from IonQ's 10Q filing for Q3 2021

In September 2021, the Company entered into a multiyear deal with UMD to provide certain quantum computing services and facility access related to the National Quantum Lab at UMD in exchange for payments totaling $14 million.

The Company has the following balances related to transactions with UMD and Duke, as reflected in the Consolidated Balance Sheets (in thousands):

	September 30, 2021	December 31, 2020
Assets		
Accounts receivable	4,000	—
Prepaid expenses and other current assets	520	1,013
Operating lease right-of-use asset	4,098	4,296
Other noncurrent assets	1,975	2,365
Liabilities		
Accounts payable	15	5
Current operating lease liabilities	564	495
Unearned revenue	3,836	—
Non-current operating lease liabilities	3,681	3,776

Source: https://www.sec.gov/ix?doc=/Archives/edgar/data/1824920/000119312521329877/d235265d10q.htm

The purported Q-Lab exhibits no signs of an operational or active entity, yet IonQ reported $1MM of Q4 2021 revenue from UMD/Duke, based on our calculations – presumably by converting the $4MM of accounts receivable booked commensurate with the deal. Without this Q4 contribution, IonQ's illusion of "growth" would instantly evaporate. We could locate no website for the Q-Lab, nor any staff, job postings, or even an address, in contrast to a number of other quantum computing labs at UMD which have extensive websites, such as the Quantum Technology Center, Joint Quantum Institute, and many others. This is consistent with the press release announcing the deal, which states that the Q-Lab "will" – laughably – "be located...next to IonQ's headquarters."

Excerpt from IonQ Q3 2021 earnings release, Nov 15, 2021

Financial Outlook

- Expected bookings of $600 thousand to $800 thousand for fourth quarter 2021, to end the year between $15.7 million and $15.9 million.
- Expected revenue of $1.0 million to $1.2 million for fourth quarter 2021, to end the year between $1.5 million and $1.7 million.

CFO comments during IonQ Q3 2021 earnings call on Nov 15, 2021

"The closing of bookings in Q3 will have a direct impact on recognized revenue and accordingly, we anticipate our top line for Q4 to end up between $1 million and $1.2 million *for the full year revenue of $1.5 million to $1.7 million for 2021."*

Source: https://ionq.com/news/november-15-2021-ionq-announces-third-quarter-2021-financial-results; IonQ Q3 earnings call transcript https://seekingalpha.com/article/4469760-ionq-inc-class-ionq-ceo-peter-chapman-on-q3-2021-results-earnings-call-transcript

14. The signature commercial deal driving this "growth" was characterized by an ex-executive as a "sham transaction" driven by IonQ's "desperation" at having "very little pipeline." Our interviews indicate a "suspicious," "weird," and secretive process in the run-up to the deal, with further evidence leading us to conclude that the entity is either non-operational or simply phony, despite IonQ recognizing revenue and bookings from it. The pattern is consistent with ex-employee allegations of customers being paid to do deals with IonQ and other quid pro quo's.

A former executive bluntly called the purported National Quantum Lab and instantaneous tripling of bookings that it drove a "sham transaction," calling it "bullshit" and "backscratching" by UMD. The executive indicated that IonQ was already giving away access to its machine, and that "when the deal happened, there was desperation" at IonQ due to "very little pipeline": "Frankly, they were looking at ways they could meet their revenue numbers, and this was one way to do it."

Ex-executive described the transaction as a sham "that bordered on bullshit"

*"It is kind of a **sham transaction, and that announcement was—for me, that bordered on bullshit—when they tripled revenue expectations because it was like, look, you just signed this deal yesterday. So, now you're tripling your revenue**. I didn't feel that it was strategically the message they really wanted to send for the company because it puts them under pressure to have increasing amounts of revenue in a market that's still very nascent. I felt that it was a stupid move because they're setting expectations that the revenue is going to really grow and ramp, and it's not." – Former executive of IonQ*

Q-Lab deal was allegedly "backscratching" as there was "desperation" at IonQ given "very little pipeline"

*"But **we were giving access away anyway**. I view it as positioning and the university using money from their profits off the stock; it really didn't cost them anything. I viewed it as **a little bit of backscratching** […] **when the UMD deal happened, there was desperation because there was very little pipeline**." – Former executive of IonQ*

Q-Lab deal was allegedly due to the company looking for a way to "meet their revenue numbers"

***"Frankly, they were looking at ways that they could meet their revenue numbers, and this was one way to do it**. So, it took the monkey off the back as far as revenue, except then they made the stupid announcement that we've tripled our bookings, we've tripled, and we're going to exceed expectations which to me just sent the wrong message to the market…So, they're struggling to come up with what the revenue is going to be, and they knew that the university had expressed that there was some interest in positioning the University of Maryland as a quantum leader and with Dr. Pines." – Former executive of IonQ*

Source: Scorpion Capital consultation calls with experts

The ex-executive detailed a "suspicious," "weird," and secretive process internally at IonQ by which the National Quantum Lab allegedly came about. The executive indicated that IonQ's VP of Sales and other key staff were shut out of the process, that information was "so closed and restricted," and that staff were surprised and cynical when the deal was announced: "it was weird"; "a very strange situation"; "never clear to me why we were shut out"; "we were all cynical"; "whatever they did, so that was clever."

Ex-executive detailed a "suspicious,' "weird," and secretive process by which the deal allegedly came about

"[Redacted, a key UMD employee] was not involved at any of these sessions and really took it hard that this was done without [redacted's] inclusion…And then this deal took place and ***what was suspicious about this deal to me is, look, the VP of Sales wasn't involved in the deal, and none of the sales team was involved in the deal. I'll tell you; it was weird from our part that you're doing this deal, but you don't trust anybody that you have in sales to do it…The whole thing was a little weird****…And then, all of a sudden, that took a life of its own…it was weird because part of my complaint about IonQ was that there was never any information. And so, here they are negotiating a large deal with the university, but the sales team is not involved, and it was just weird….And then [the key person on the UMD side] didn't know anything about it…****It was just a very strange situation****." – Former executive of IonQ*

Information was allegedly "closed and restricted" with confusion about why key employees "were shut out" of the process

"It was never clear to me why we were shut out*. I was told that Chris Monroe was involved in it, but I know the CFO, Thomas, was really the point man, and* ***I couldn't understand why information was so closed and restricted****, but that was the story of IonQ is that information was never readily apparent, and I could never understand why you name someone [redacted], and then you don't give them any information.* ***It was just part of the normal weirdness****." – Former executive of IonQ*

Allegedly surprise and cynicism internally at IonQ after the Q-Lab deal was announced

*"****Yeah, we were all cynical****. Nobody ever said, clever, well done. I mean, it was clever that they got the university to commit to* ***whatever they did, so that was clever. But it was a surprise*** *because there really isn't a lot of quantum expertise at the university, but I understand that the university's trying to create this big impression." – Former executive of IonQ*

Source: Scorpion Capital consultation calls with experts

When we asked how staff and students at UMD would ever use the $14-20MM of compute time they appear to have "purchased" from IonQ, the ex-executive bluntly stated that they couldn't – essentially describing the essence of a sham transaction: "I mean, it just doesn't add up"; "there's no way they can use it"; "I don't know what they're doing to do with it"; "there's no way in hell they can use $15 million worth of compute time."

Ex-executive indicated "there's no way" that UMD faculty and staff would be able to use the "purchased" compute time

Q: "Who are these contemplated Maryland faculty and students that would be using the IonQ computer? Basically, Monroe's grad students and buddies?"

A: "I think there are some professors. So, there are a couple of people there, but I don't view University of Maryland as a quantum powerhouse."

Q: "So, how would they conceivably purchase $14 million of compute time?

A: "I don't know what they're going to do with it."

Q: "Is there even enough—that just sounds like years and years and years worth of quantum computing time

A: "No, there's not enough. That is true. ***There's no way they can use it****. [Redacted] gave some time to a faculty member at the University of Maryland and literally spent hours on the phone with their IT department, who couldn't understand how to interface with Amazon, and it was like this huge cluster-f."*

Q: "So, there aren't even enough people there that understand how to use the compute time for this to be relevant?"

A: ***"I would tell you that there's no way in hell they can use $15 million worth of compute time. Yeah, there's no way that can use millions worth of time****. I can tell you one user last year, we let him have full access to the computer and gave him priority, and he was doing machine learning, which is very compute-intensive. And he used $200,000 worth of time in probably six months. So, let's say 10 people at the University of Maryland were doing machine learning, and they were using $200,000 in six months;* ***I mean, it just doesn't add up****." – Former executive of IonQ*

Source: Scorpion Capital consultation calls with experts

To corroborate these allegations, we also spoke with a professor at the University of Maryland – a peer and colleague of IonQ co-founder Chris Monroe who is closely involved with UMD's quantum computing initiatives. Although the purported UMD Q-Lab already appears to be IonQ's key source of revenue and bookings, he indicated the lab remains in the planning stages and is not operational; that it was premature for UMD staff to purchase IonQ compute time; that it had no structure; and appeared unaware of the most basic details of the $20MM venture – despite his leadership role in UMD's quantum computing initiatives.

UMD professor indicated that the National Quantum Lab is still in the planning stages and not operational

Q: "What's the status of the National Quantum Lab? Is it up and running?"

A: "No, it's being planned out now*. We haven't yet had the first oversight committee meeting. That'll be happening in the spring…I think, so we're in this buildup phase.* ***So, no, it's not yet a thing where people can show up and do work****"*

Q: "Is there a website for it that I can look at?"

A: "I don't know. Things are under development; maybe, I could look that up…"

Q: "Who's the head of it? Who's running it? Are professors running it? Is IonQ going to run it? How is it structured?"

A: "There's going to be a working group that will run it across the two. I don't recall who's the chariot. ***We haven't met yet****, I think these next six months will be the period when the buildup will happen."*

Q: "Do you even know how it's going to work? It says this is all designed to give access to UMD faculty and students access to IonQ's machines. Are you guys almost like a grant-making body where you allocate that compute time?"

A: "Right, ***what I believe we're going to do once we start meeting is figuring those things out. My guess - because we haven't met*** *- so, we'll probably be creating some protocols and methods…"*

Q: "Does it have a pretty sizable advisory board or board of directors? Is that structure still in discussion?"

A: "What I know is I've been asked to serve, and when we first meet, I will get to know the other people. I expect I will know many of them because I know the community. But I don't know that yet."

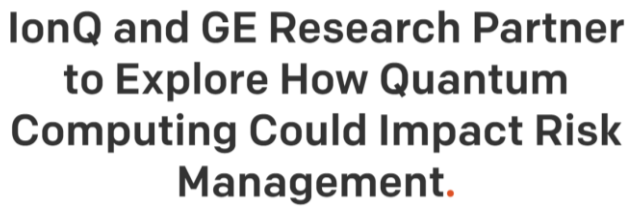
Q: "Would it surprise you, given the early stages that the Q-Lab is in, that IonQ has already booked $4 million in revenue from this lab? That's what's in their filings."

A: "Yeah. I don't know the inside details of that.*" – Professor at UMD involved in quantum computing*

Source: Scorpion Capital consultation calls with experts

An ex-senior employee alleged that IonQ's CEO pushed to get "customers" by essentially paying them to do a deal, alleging GE as one example - "GE is not biting" - and describing a "whatever it takes" mentality. The ex-employee called it "reprehensible" and "a new low": "in my years in quantum, I have never ever seen anybody pay to a deal, never." Contrary to IonQ's announcement of a "partnership" with GE, the ex-employee alleged that IonQ funded headcount at GE.

IonQ announcement Sep 2021



Ex-employee alleged that IonQ's CEO pushed to pay customers to do deals with IonQ

*A: "**They actually paid someone to do a deal with them, and Peter Chapman was saying that if you have to spend a lot of money to get a deal, that's fine with me, I just want the signing. I found that reprehensible**, and that was Peter Chapman and his buddy at GE, [name redacted]. It was GE. They paid GE so that they could do a research project with them and make an announcement. So, they didn't pay for revenue; they paid for an announcement or a collaboration. I would say it was $100k or less. It wasn't that much money, but in my years in quantum, **I have never ever seen anybody pay to do a deal, never. I view that as a new low."***

Q: "And what did IonQ pay them for? What was the exchange?"

A: "I think the exchange was they were supporting the headcount within GE to do the collaboration."

Q: "So, they were basically funding the people at GE to do the collaboration?"

A: "Yes."

Q: "Prior to that, was GE not willing to do anything with IonQ?"

*A: "This was the Peter and the [GE individual, name redacted] brain trust. Like **GE is not biting, so what do we have to do to make them bite? Oh, how about if we pay for the people**, and that way, they'll get interested in quantum. Oh, okay. We're paying for it; we're so clever." - Former senior employee of IonQ*

Source: https://ionq.com/news/september-23-2021-ionq-ge-research-risk-management; Scorpion Capital consultation calls with experts

The ex-employee further alleged quid pro quo's where IonQ selected investors for its SPAC based on their "willingness to do research engagements with IonQ," implying that Hyundai was another example of a marquee deal like GE where the "rank and file said 'Hell no'" to spending money with IonQ. We note IonQ's recent promotion of a collaboration with Hyundai. The ex-employee cautioned us to expect a similar dynamic in upcoming customer announcements.

IonQ announcement Jan 2022

IonQ and Hyundai Motor Partner to Use Quantum Computing to Advance Effectiveness of Next-gen Batteries

Ex-employee alleged that IonQ chose SPAC investors based on a quid pro quo to "commit" money to IonQ

*A: **"As part of the SPAC, they chose investors based on investors' willingness to do research engagements with IonQ, and if those investors would commit a certain amount of money**, they'd be doing research deals with IonQ; then they would take them as investors…There are other deals that people invested in, and they said, for example, I've made so much on IonQ, I'm willing to give you a $2 million engagement to work with our company because I've made so much profit. So, there was that. **And then there were also deals where we said; we'll take you as an investor if you agree to spend x-dollars a year with us doing joint research projects**."*

Q: "Who were those customers?"

*A: "What happened is Hyundai promised to do a joint research project, but it was with the CEO and when you finally went down to the rank and file and you said, you promised to spend x-dollars, **the rank and file said, "Hell no." And I also expect there to be others [like Hyundai]."***

Q: "Are Hyundai and these others investors in the company?"

A: "Yes." - Former senior employee of IonQ

Source: https://arxiv.org/pdf/2108.03708.pdf

15. **IonQ has no meaningful intellectual property. It promotes a "QPU chip" as its secret sauce and "the heart of our quantum computer." However, our research indicates that IonQ procured the chips from a third-party vendor operated by Honeywell, its key competitor – as absurd as if AMD purchased CPU's from Intel and claimed it was "AMD Inside." Ex-employees indicated the "chip" was a standard model made widely available by the vendor, dismissing it as "not special" and easy to replicate with typical microfabrication technology.**

IonQ heavily promotes their gold-colored "QPU chip" – the so-called "quantum processing unit" – as their secret sauce and the heart of their intellectual property, portraying it as a special version of CPU's in regular computers: "Empowered by Unique Technological Advantages."

IonQ page on Amazon Web Services

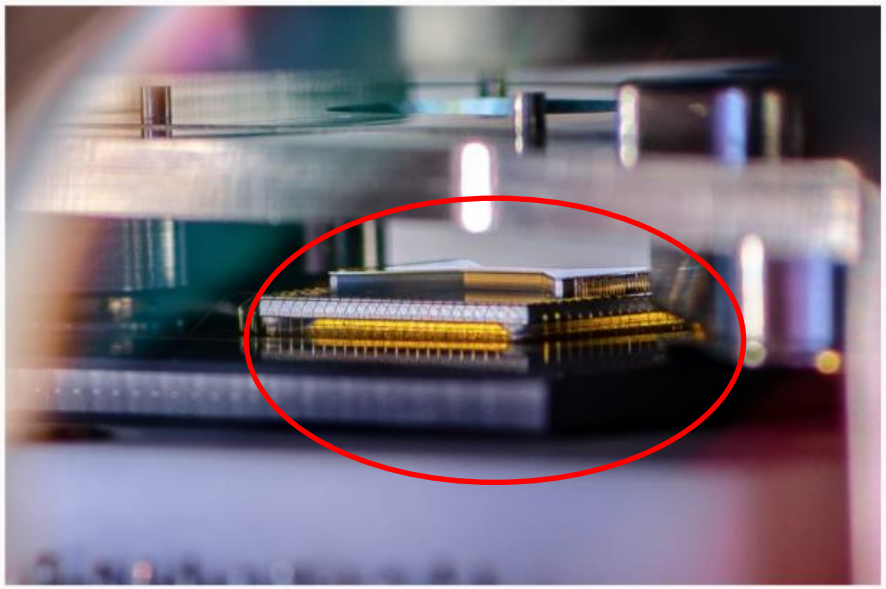
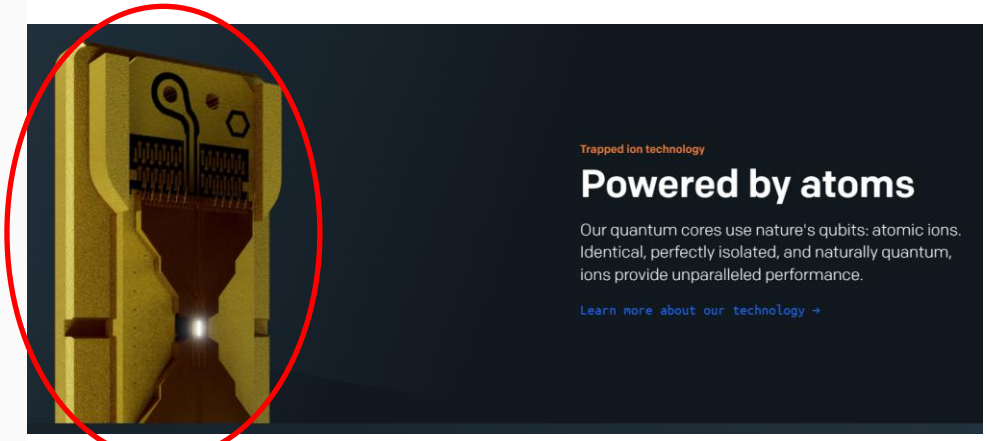
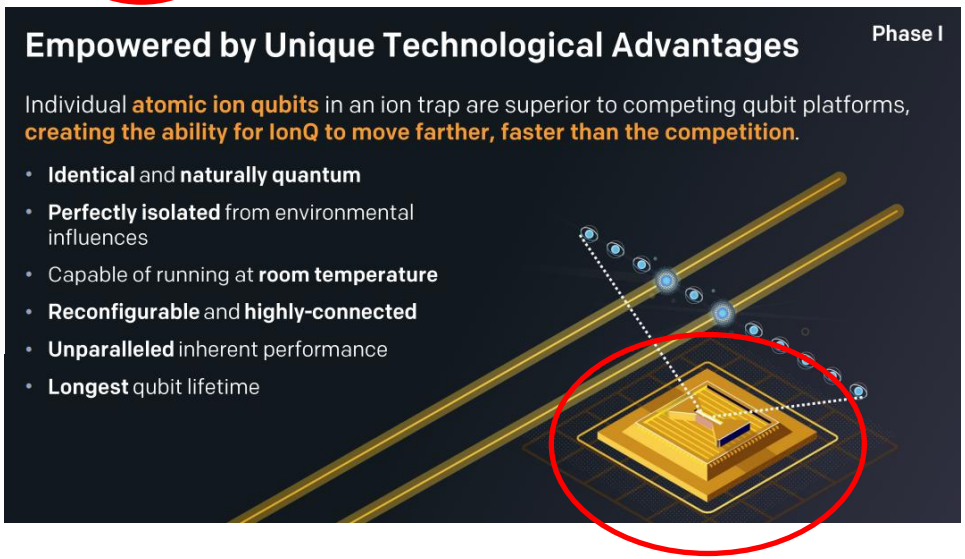


Figure 2. The ion trap, mouting hardware, and vaccum chamber of an IonQ QPU

IonQ website and investor presentations

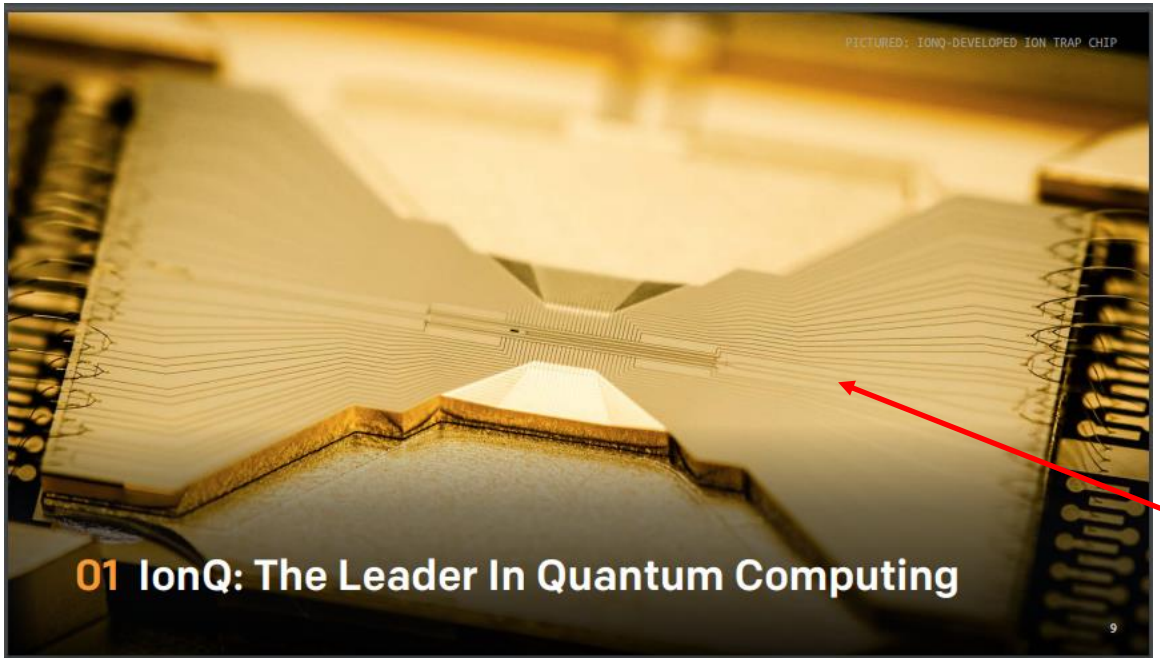




Source: IonQ website and investor presentations; https://s28.q4cdn.com/828571518/files/doc_presentation/2022/March-2022-Investor-Updates_v09.pdf; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf; https://aws.amazon.com/braket/quantum-computers/ionq/

IonQ's CEO promotes "this gold plated chip" as "the heart of our quantum computer" and states it's "easily manufactured and with high yields." Their website and presentations lead with slick photos of the "chip," which is basically the chamber where ions are manipulated. The CEO claims "we've got the best QPU today…"

IonQ recent investor presentations



CEO comments

***"We've got the best QPU today**, is now built a chip, which has got multiple zones of computation." – Peter Chapman, IonQ CEO*

Source: https://www.sec.gov/Archives/edgar/data/1824920/000119312521217476/d196587d425.htm

*"On Slide 9, we start to paint a picture of what IonQ quantum computers look like. **This gold plated chip is the heart of our quantum computer. This is a picture of an ion trap chip. It's the size of many other chips, easily manufactured, and with high yields."***

Source: IonQ website and investor presentations; https://s28.q4cdn.com/828571518/files/doc_presentation/2022/March-2022-Investor-Updates_v09.pdf; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

Contrary to IonQ's promotion of unique intellectual property, ex-employees told us that IonQ was actually sourcing its "chip" from a third-party vendor called Sandia – a laboratory owned by the US government and managed by Honeywell. We note Honeywell is IonQ's primary competitor in ion trap-based quantum computers. As an analogy, imagine if AMD claimed to have the world's best CPU, while actually purchasing it from Intel. Ex-employees indicated the ion trap was a standard model made widely available by Sandia.

Ex-employee indicates that Sandia, run by Honeywell, was making the ion trap

*"Honeywell runs Sandia. What happened was when I was there, **they were getting traps from Sandia** and then when Honeywell announced that they were going to join the quantum computing game, they started fabricating their own traps, IonQ did. In the new machines, I think they fabricate their own traps. They made the switch in about the summer of 2020." – Ex-IonQ employee, physicist*

Ex-employee stated that the picture of ion trap on IonQ's IR page is Sandia's. not IonQ's

*Q: "You go to ionq.com and then click investor relations on the top right. You see the investor relations page where it says, "investor relations," they have the stock price on the right? They have that big, blown-up picture of the background of an ion trap. It's gold-colored. **Is that theirs or Sandia's?"***

*A: **"Yeah, that is Sandia's. Yes. That was the one that they were using when I was there."** – Ex-IonQ employee, physicist*

Another ex-employee stated it's well-known that IonQ's trap came from Sandia

Q: "The 11-qubit machines were using Sandia ion traps?"

*A: "To the best of my knowledge, yes. They may have swapped it; I don't know, but that would be my guess because those machines sort of come from years ago. **It's not a secret. It's an HOA 2 trap from Sandia**. I'm sure you can find the references in the publication." – Ex senior technical employee of IonQ*

Source: Scorpion Capital consultation calls with experts

Three former employees corroborated that IonQ wasn't making its own traps but sourcing them from Sandia. A former employee of Sandia and an expert in ion traps provided further verification. IonQ now claims to be making its own traps. However, the ex-Sandia employee as well as former employees of IonQ indicated that IonQ's design remains a clone of Sandia's and dismissed the "chip" as "not special" and easy to replicate with standard microfabrication technology.

A third former employee corroborated that IonQ's wasn't making its own traps and sourced them from Sandia

"It was dependent on the National Foundry, the number of machines in quantum computers is the same as the number of traps. Back then, when I was working there, ***it was a huge bottleneck with the number of traps because we were not making them****." – Ex-IonQ employee, senior member of technical staff*

An ex-Sandia employee and ion trap expert indicated that some IonQ traps look identical to Sandia's or are "very similar" and implied that IonQ simply copies Sandia's design

"I'm pretty confident; yeah, all the pictures, it's identical*. I'm pretty sure they started off using Sandia's ion traps […] This, to me, looks like a trap that was modeled after a Sandia […] It's kind of funny because at the end, when you look at this, basically, you just have a bunch of electrodes on the sides, and then you have a couple of RF electrodes, a couple of DC electrodes in the middle going at 90-degrees to that, perpendicular to those.* ***I mean, that's such a standard thing to do****, and then once we figured out how big our beams have to be, then the next logical conclusion is to make this trap very skinny in the middle with an hourglass shape. Have I ever seen this trap before? No. But is it from Sandia? I don't know.* ***It's definitely very similar to one of their traps; it was called an HOA, a high optical access trap. Everything since then is kind of similar because that was a great design****." – Ion-trap expert, ex-Sandia employee*

Ion traps are trivial to fabricate

Q: "So, anybody with a trapped ion computer can make the trap that they need. It's not that big a deal?"

A: "Yes. It's a well enough—it's microfabricated. Microfabrication is a well-established technology. So yes, and it's just math to design it, and then you have to go through testing, and you might have to iterate. ***But in the end, it's math to design and experience, but all of these guys have experience, they can all do the math, and they all have access to excellent microfabrication technologies. Because of that, no, it's not special****, not any more special than the next quantum computing company unless you found out someone's doing it in their garage and then you need to bail." – Ion-trap expert, ex-Sandia employee*

Source: Scorpion Capital consultation calls with experts

We note that before the SPAC transaction, IonQ's founders appeared to be more honest about the origin of their "unique" intellectual property. A University of Maryland website with Chris Monroe's name on the header bluntly stated that "we use a chip trap developed by Sandia…."

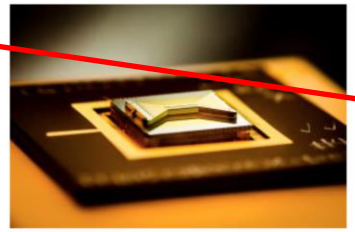
Excerpts from University of Maryland site state the chip is from Sandia

TRAPPED ION QUANTUM INFORMATION

CHRISTOPHER MONROE, Principal Investigator. University of Maryland Department of Physics, Joint Quantum Institute, and Center for Quantum Information and Computer Science

Methods

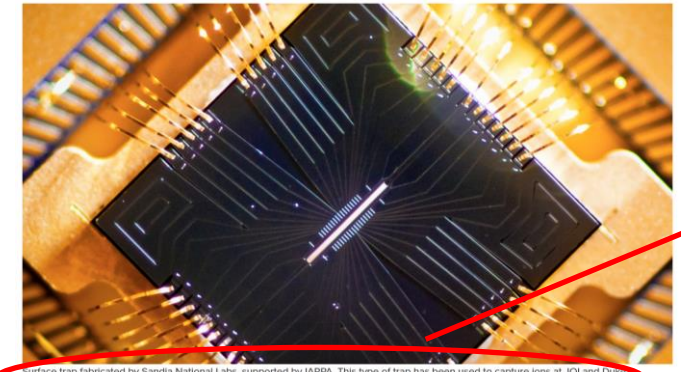
We use a chip trap developed by Sandia National Laboratories that enables precise control over our ion chains. With 100 electrodes on the surface, the electric potential above the trap surface is engineered precisely to achieve shuttling and merging of ions to deterministically build up long chains or to provide individual qubit readout in the middle of a quantum algorithm. The high optical access design allows small laser beam widths at each individual ion for individual addressing of our qubits with minimal cross-talk.



HOA-2 ion trap for trapping long chains

***"We use a chip trap developed by Sandia** National Laboratories…"*

Excerpts from a second University of Maryland site, for the Joint Quantum Institute, state the same



Surface trap fabricated by Sandia National Labs, supported by IARPA. This type of trap has been used to capture ions at JQI and Duke University, as well as other institutions. The image shown here appears on the cover of this week's issue of Science Magazine. Credit and permissions, contact

*"Surface trap **fabricated by Sandia** National Labs, supported by IARPA. **This type of trap has been used to capture ions at JQI and Duke University, as well as other institutions**."*

Source: https://iontrap.umd.edu/research/quantum-computation-with-ion-chains/; https://jqi.umd.edu/news/future-ion-traps

16. **IonQ's two co-founders, who still run the show as its key C-level officers, are full-time professors for whom the company is a side-hustle where they occasionally show up and "bark orders." Investors should wonder what they know that makes them reluctant to leave their day jobs. IonQ is simply a stagnant academic research project masquerading as a company, dressing up old technical data, puff presentations, and a glossy site into a cynical SPAC promotion.**

Source: https://investors.ionq.com/governance/executive-management/default.aspx#Chris-Monroe

IonQ was co-founded by two professors, Chris Monroe and Jungsang Kim, upon whose research the company is based. They remain the Chief Scientist and CTO, respectively. They are front and center in the company's commentary and materials as its vision and driving force. Besides the CEO Peter Chapman and CFO, no other C-level officers are even listed, underscoring the small size of the executive team and the pivotal role that Monroe and Kim play.

The only leadership listed on IonQ's site and other materials

Peter Chapman
President & CEO

Jungsang Kim
Co-Founder & CTO

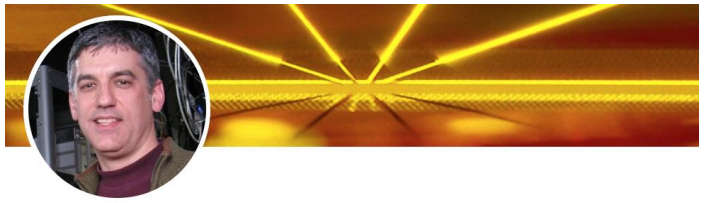
Thomas Kramer
Chief Financial Officer &
Corporate Secretary

Chris Monroe
Co-Founder & Chief Scientist

Source: https://investors.ionq.com/governance/executive-management/default.aspx#Chris-Monroe

Given their C-level roles, we find it unusual that both Kim and Monroe have other full time jobs – that is, IonQ is a side-hustle among a long list of other gigs. Monroe's LinkedIn bio says he is currently a full-time professor at Duke as well as a professor at the University of Maryland, consistent with his bio on IonQ's site. Kim's bio says he's a professor at Duke. Color from ex-executives and employees leads us to conclude that IonQ is not an actual company but simply one of their countless academic projects masquerading as one – an illusion created via fluff presentations and a slick website for the purposes of a SPAC promotion.

Monroe and Kim's LinkedIn bios - excerpts



Christopher Monroe · 3rd
Chief Scientist, IonQ; Gilhuly Family Presidential Distinguished Professor of ECE and Physics at Duke University
Durham, North Carolina, United States · Contact info

Duke University
Massachusetts Institute of Technology

Experience

Gilhuly Family Distinguished Professor of Physics and Electrical and Computer Engineering
Duke University · Full-time
Jan 2021 - Present · 1 yr 4 mos
Durham, North Carolina, United States

University of Maryland
14 yrs 9 mos
College Park, MD

College Park Professor
Feb 2021 - Present · 1 yr 3 mos

Jungsang Kim · 3rd
Innovator in Systems Research and Quantum Computing
Raleigh-Durham-Chapel Hill Area · Contact info
500+ connections

IonQ Inc.
Stanford University

Experience

Co-Founder and Chief Technology Officer
IonQ Inc.
Sep 2015 - Present · 6 yrs 8 mos
College Park, MD, USA

Duke University
17 yrs 11 mos

Professor
Jul 2013 - Present · 8 yrs 10 mos
Durham, NC

Source: https://www.linkedin.com/in/christopher-monroe-a8760326/; https://www.linkedin.com/in/jungsang-kim-706a953/

When Monroe recently added a professorship at Duke on top of the one at UMD, Duke stated that he will be "tasked with classroom teaching duties" in "areas ranging from Quantum Physics 101 to The Physics of Music." His CV states he is on 10 other boards, and his UMD site suggests that he oversees ~30 post-docs, grad students, and researchers. The site for Kim's lab at Duke indicates 12 such staff, as well as a long list of other research areas, projects, and grants, similar to Monroe.

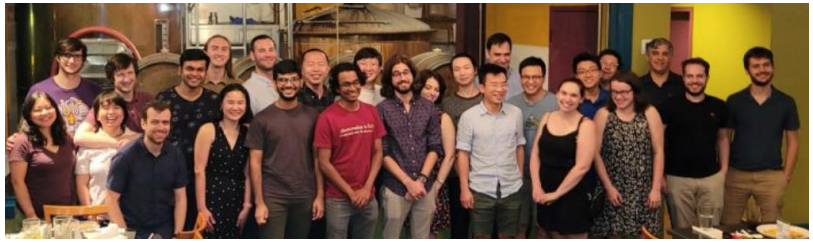
Duke announcing Monroe's appointment

"Besides realizing these ambitious goals, Monroe will also be tasked with classroom teaching duties that he sees as critical…and also ***teaching undergraduates in areas ranging from Quantum Physics 101 to The Physics of Music.****" – Duke announcement, Aug 2020*

Excerpt from Monroe CV detailing various board positions

Boards
Max Planck Institute for Quantum Optics, Scientific Advisory Board (2018–)
CalTech Institute for Quantum Information and Matter, Advisory Board (2018–)
Center for Quantum Technology, National University of Singapore: Technical Advisory Board (2018–).
National Academies of Sciences Intelligence Science and Technology Experts Group (ISTEG) (2015–)
DoD Advisory Board for Quantum Sciences and Engineering at ARL, AFRL, and NRL (2015–).
JILA and Univ. of Colorado NSF Physics Frontier Center External Advisory Board (2014–).
Center for Quantum Information, Tsinghua University, Beijing, China: International Advisory Board (2012–).
Institute for Quantum Computing, University of Waterloo, Canada: Scientific Advisory Committee (2010–).
Networked Quantum Information Technology Hub, Oxford University, UK: Scientific Advisory Committee (2013–).
Physics and Engineering Physics Department, Stevens Institute of Technology: External Advisory Board (2009–).

Kim and Monroe's sites at Duke and UMD show members of their personal research groups/labs



Source: https://pratt.duke.edu/about/news/chris-monroe-profile; Monroe CV at UMD website https://www.umdphysics.umd.edu/images/CV/Monroe_CV_.pdf; https://iontrap.umd.edu/group-members/; https://mist.pratt.duke.edu/people/current-members

An ex-IonQ executive emphasized that Monroe and Kim run the show – "make every decision" and the rest of the staff is "just a pawn" – yet it's "weird" that Monroe is barely at the company and is at "arms length." The executive added that the co-founders simply parachute in occasionally and "shout orders," with Kim allegedly there a day or two a week and Monroe even less.

Monroe and Kim "make every decision"; rest of staff is "just a pawn"

Q: "Is there any technical leadership beyond Chris and Jungsang Kim, or are they it, the guys that who are parachuting in and who are the dominant personalities?

*A: "Yes, absolutely. **They make every decision […] You're just a pawn**. If you're a scientist, you just do what you're instructed to do, and there's **no pushback or flexibility** or innovation […] The fact of the matter is **nobody is empowered to make a decision except for Peter and Jungsang.**" - Former executive*

"Weird" that Monroe is barely at the company and "arms length"; co-founders parachute in and "shout orders"

*"There are a couple of **weird things**. First of all, Jungsang spends more time with the company than Chris. **Chris was kind of at an arm's length. The dynamic is the famous professor comes in and shouts orders**. It's like being first year of grad school where they go, "You will do this today," and you go, "What about that?" "Nope. I want it this way." There's absolutely no collaboration or idea exchange. **It's just you will do what I tell you to do now**. Jungsang is the dominant one, and it's really Jungsang, but Chris isn't much better; Chris just is there less." - Former executive*

Kim allegedly only at IonQ "a day or two" a week; Monroe "maybe a day"

*"It depends on their academic schedule. I would say **Jungsang is there weekly, a day or two. I don't think Chris is**. I would say maybe a day a week." - Former executive*

Source: Scorpion Capital consultation calls with experts

Two other ex-employees confirmed the color, suggesting widespread concern among employees about the unusual situation and indicated that Monroe and Kim – the CTO and CSO – are barely at the company. Monroe is basically missing in action and Kim allegedly disappears for weeks at a time because he's at Duke.

Senior member of technical staff confirmed that Monroe and Kim are barely at the company

A: "Yeah, that's a good question. At least I know with Jungsang, it's about half of his time...Chris, he does so many things, and he's not really a hands-on type of person. If I say half of the time, that's kind of hard to estimate ***since you don't see him****."*

Q: "And how often was Chris Monroe there?"

A: "Not that often. I would say once a week or so."

Q: "For like a couple of hours or something like that?"

A: "Yeah, just taking calls and talking to management, not necessarily doing work. Jungsang was definitely the guy actually sitting down and doing calculations."

Q: "How many times did you see Chris Monroe come to the company when you were there?"

A: "That's kind of hard to estimate. I'd say ***once a week****."*

Q: "Jungsang Kim is based at Duke, or he's based at IonQ?"

A: "I think he's based at Duke."– Ex-IonQ employee, senior member of technical staff

Employees are concerned that the CEO doesn't understand quantum and the co-founders are "not even in the same location as the company"

"If you listen to the kinds of comments that I had, then I'm pretty sure ***many employees who I think are reasonable people would agree with my comments. In other words, I would imagine that they have some concerns****. I can speak about myself. One of the main concerns is that the CEO of the company doesn't understand quantum, and he is driving the company in some strange direction, and he says strange things, and he overpromises. Simultaneously with that, the technical leaders who are Jungsang Kim and Chris Monroe, they have their professor tenures at Duke University that is located in Durham, North Carolina, whereas IonQ is located in Maryland. So, it's an hour's flight away.* ***The intellectual leadership is not even in the same location as the company****." – Former employee, senior member of technical staff*

Kim was allegedly missing for weeks at a time "because he was at Duke"

"Jungsang Kim would fly back and forth, so there would be weeks where he was there and then ***weeks when he wasn't because he was at Duke****." – Ex-IonQ employee, member of technical staff*

Source: Scorpion Capital consultation calls with experts

Our interviews indicate that Monroe is "the visionary" and "main guy" behind the entire company, but only comes in "once in a while" and is "probably the least involved" among C-level executives. A leading researcher who has published papers with Kim and Monroe stated they're "the thought leadership," and that he turned down a job at IonQ because their failure to give up their full-time professor roles indicates they're not "100% committed," adding that he didn't want to wager his career on IonQ if the co-founders refuse to.

Leading quantum researcher who has published papers with Monroe and Kim says they provide "the thought leadership" at IonQ; turned down job because they're not "100% committed"

"I was offered a job at IonQ and I declined it. I'd thought very carefully about whether I should invest my career into IonQ, which for me is a major deal. One of the reasons you may be interested in learning is, the technical leaders of the company are Chris Monroe and Jungsang Kim. And the majority of the technical employees are either graduate students or post-docs coming from Chris Monroe's or Jungsang Kim's group. What I'm trying to say is that ***the thought leadership belongs to Chris and Jungsang. Both Chris and Jungsang, they're full-time university professors. To me, it was very unsatisfactory that the technical leaders kept their university tenures. It felt to me that they weren't 100% committed*** *to IonQ. I didn't want to wager my entire career on IonQ, when the two founders of the company, they* ***did not wager their careers on the company****." – Leading quantum computing researcher who has published papers with IonQ's founders*

Monroe is the "visionary" and "main guy" but has another full-time job ; comes in "once in a while" to IonQ

"I ***would really like to stress that Chris Monroe is the visionary behind the company*** *and the technology, so he is the main guy.* ***They have full-time professor jobs, so they do come to IonQ once in a while, but it's difficult to say how often****. But now, Chris joined Duke, so he's in Raleigh, North Carolina. He lives in a different city." - Leading quantum computing researcher who has published papers with IonQ's founders*

Monroe is "probably the least involved" among the C-level executives

"I would say Junsang's here pretty much every week, at least a few days at a time. Chris, it's hard to say. That man has many, many roles at different countries and universities and panels that ***it's random. He tries to come in, and he's probably the least involved among all these other C-executives that we're talking about****.." – Ex-senior technical employee of IonQ*

Source: Scorpion Capital consultation calls with experts

An ex-employee in a senior and key technical role slammed the odd state of affairs: if the founders believe IonQ is going "to be a successful thing," they would "actually commit, but they don't"; that they must know something everyone else doesn't; and that recruits ask the same question and no one has a good answer.

Red flag that co-founders haven't committed 100% to the company; skeptical how "they can actually just hold both positions"; potential recruits are skeptical for the same reason

"I don't understand either. ***I mean, if they really believe down to earth that this was going to be a successful thing, you would think that they would actually commit, but they don't. So, there must be something that they know they don't say****; who knows? It's* ***unclear to me how they can actually just hold both positions and then somehow make others believe that this is going to be a successful enterprise without a doubt****. It's confusing. When you talk to some of the candidates that are interviewing at IonQ, some of them actually ask the same questions, and I don't hear a good answer."– Former senior member of IonQ technical staff in a critical role*

Source: Scorpion Capital consultation calls with experts

Three ex-senior employees stated the CEO Peter Chapman is as absent as the co-founders. One stated that he lives in Seattle, while IonQ is based on the other coast in Maryland, and shows up "at the office maybe once a month." A second corroborated the information, indicating that Chapman "spent most of his time in Seattle" and that he'd see him "once or twice a month, like a day or two." A third ex-employee in a key scientific role echoed that Chapman is rarely at the offices; that he doesn't do "anything in terms of technical stuff" and that "Peter doesn't do quantum"; and that "I don't really know about his background…"

CEO is based in Seattle and shows up "maybe once a month"

*"**Peter is in Seattle. He also has a house somewhere like in; I don't know, New Hampshire or something like that**. But generally, the management is virtual. Thomas Kramer, the CFO, goes in every day. But Peter not, Jungsang not, Chris not, and they are supposedly opening a Seattle office and a New York office and a Boston office because people don't want to move. **Peter would show up at the office maybe once a month**." - Former executive*

Spent most of his time in Seattle and "saw him about once or twice a month"

*"The CEO commutes. At that point in time, at least, he was commuting and **spent most of the time in Seattle** but some of the time in College Park. **I saw him about once or twice a month, like a day or two**." – Ex-IonQ employee, physicist*

Ex-senior employee expressed ignorance about Chapmans' role and background

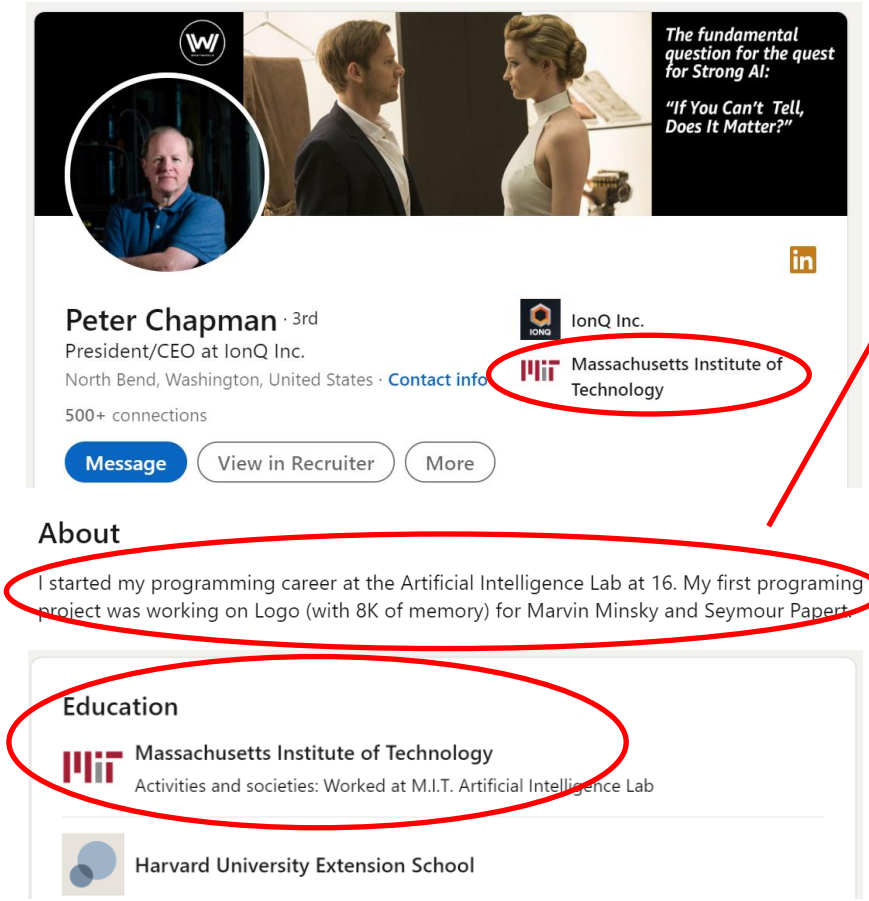
Q: "Would Chapman show up at the offices once a month? Once a week?"
*A: **"Hard to say."***
Q: "What's his role?"
*A: "I don't think he does anything in terms of technical stuff. **Peter doesn't do any quantum."***
Q: "Where did he go to college? I can't find anything on his background."
*A: "**That I don't know."***
Q: "Did he even go to college? You don't know?"
*A: "I would assume so**. I don't really know about his background** all that much." –Ex-senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts

17. **IonQ's CEO appears to be misrepresenting his MIT educational credentials, while promoting a narrative that he's a child prodigy who began programming at the MIT Artificial Laboratory at age 16. We are left to wonder if he attended or graduated from any college at all.**

In one IonQ promotional piece and interview after another, CEO Peter Chapman portrays himself as a child prodigy who began programming at age 16 at MIT at the Artificial Intelligence Lab – "a super smart genius type character" according to a recent interview. His LinkedIn profile leads with MIT at the top, and then lists it again under the educational credentials section of his profile.

Screenshot excerpts of Chapman's LinkedIn profile, taken 4/16/22



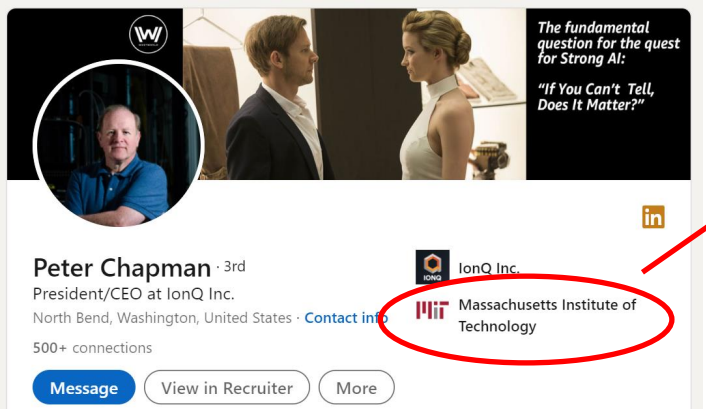
*"**I started my programming career at the Artificial Intelligence Lab at 16**. My first programing project was working on Logo (with 8K of memory) for Marvin Minsky and Seymour Papert."*

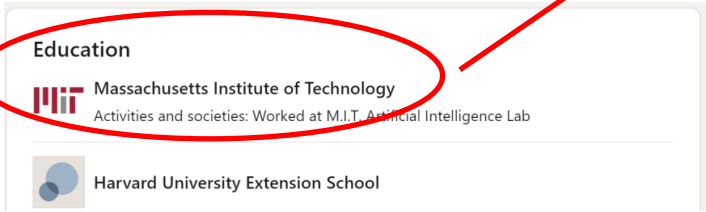
*"I'm super duper excited to have Peter Chapman CEO of IonQ on the show today…Peter, going into your background, you're programming computers 16 years of age at the Artificial Intelligence Lab at MIT, **a super smart genius type character."** – Aug 2021 interview with Peter Chapman*

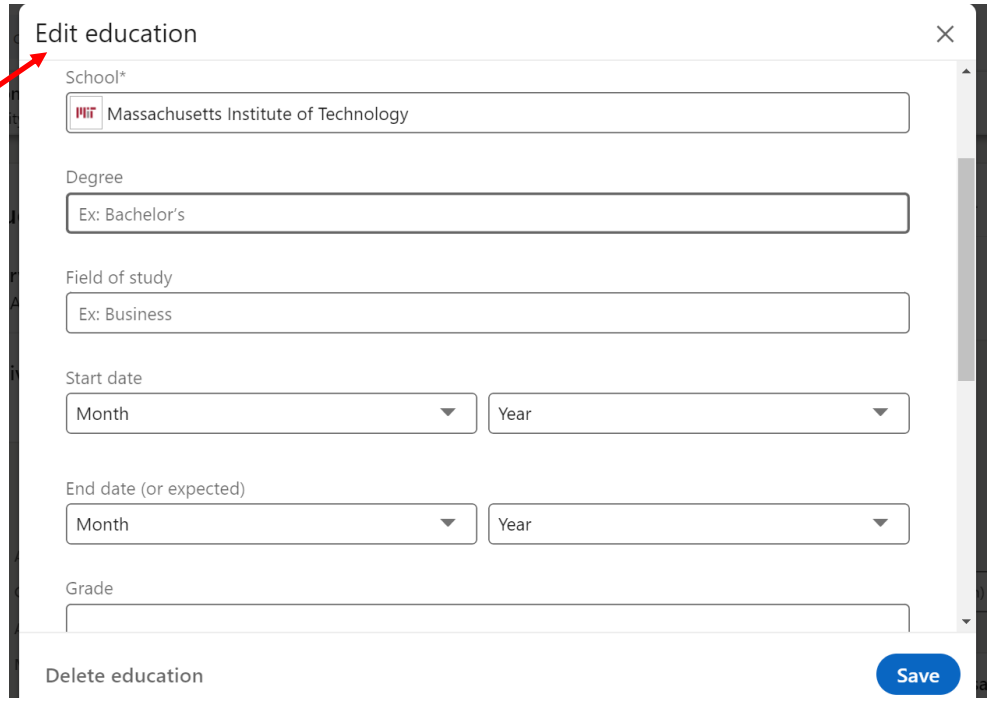
Source: Peter Chapman LinkedIn profile https://www.linkedin.com/in/peterhchapman/; interview Aug 2021 https://www.sec.gov/Archives/edgar/data/1824920/000119312521254201/d216170d425.htm

We note that there is no way to "accidentally" enter MIT in the education credentials section of LinkedIn. The edit boxes for both the intro/header section and the education section – Chapman lists MIT under both – make it clear what you're representing.

Screenshot excerpts of Chapman's LinkedIn profile, taken 4/16/22







Source: Peter Chapman LinkedIn profile https://www.linkedin.com/in/peterhchapman/; LinkedIn profile edit feature screenshots

His executive profile at the Potomac Officers Club states that "Chapman obtained his various degrees from the Massachusetts Institute of Technology and the Harvard University Extension School." His bio in the SPAC pitch deck states that his "career began at 16 in MIT AI Lab…"

Chapman's profile at Potomac Officers Club

EXECUTIVE PROFILES

Peter Chapman,
President and CEO,
IonQ

Peter Chapman, President and CEO of IonQ

Peter Chapman is the president and chief executive officer of IonQ, working out of North Bend, Washington. He recalls beginning his programming career at the Artificial Intelligence Lab when he was just 16 years old.

Chapman said that his first programming project was working on Logo for Marvin Minsky and Seymour Papert. Now, some 40 years later, he said he finally has enough computing resources to tackle the problem.

Chapman's list of interests includes solutions that allow the computer to understand the answers that it provides. He finds the time to engage like-minded people, especially former co-workers, in professional discussions, his LinkedIn account revealed.

Chapman has been leading IonQ, a quantum computing hardware and software company, for over two years. He takes pride in having been part of the company's transformation from a theoretical concept into a tangible computing option for innovative enterprises.

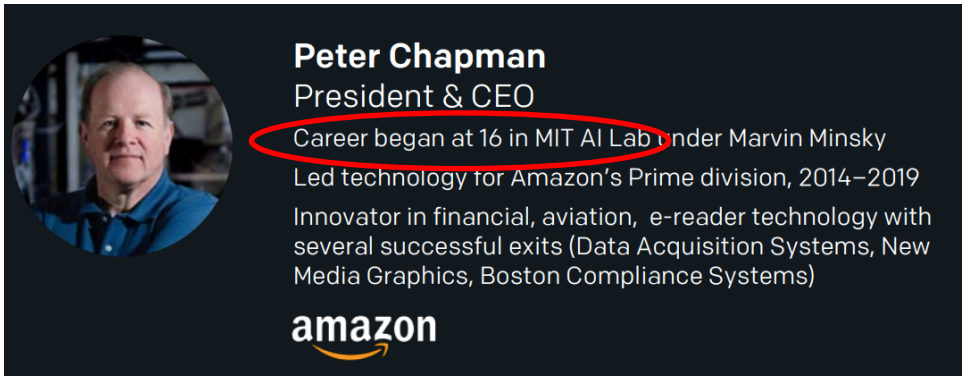
Before taking on his current role, Chapman was director for engineering at Amazon Prime. He said that he was one of two technical directors who ran the technology behind the company.

Prior to working for Amazon, Chapman was president and CEO at Media Arc. He recounted that the company was born out of a merger between eMusic .com and K-NFB Reading Technologies.

Chapman is no stranger to building companies from the ground up. In 1989, he founded a video game company called Level Systems. In 1997, he founded Boston Compliance Systems.

Chapman obtained his various degrees from the Massachusetts Institute of Technology and the Harvard University Extension School.

SPAC pitch deck



*"He recalls **beginning his programming career at the Artificial Intelligence Lab when he was just 16 years old."***

*"Chapman **obtained his various degrees from the Massachusetts Institute of Technology and the Harvard University Extension School."***

Source: https://potomacofficersclub.com/peter-chapman-president-and-ceo-of-ionq/#; https://s28.q4cdn.com/828571518/files/doc_presentation/2021/03/IonQ-Investor-Presentation-030721-vFF.pdf

Far from being a child prodigy, we suspect his purported gig at MIT at age 16 was simply nepotism. Chapman has stated his father was an astronaut, who we believe to be Philip Chapman, whose Wikipedia profile states did his doctorate at MIT in the 1960's and then appears to have remained in the Cambridge/Boston research scene. We note that Peter Chapman's profile on the IonQ site and in SEC filings not only fails to list MIT, but lists no educational credentials at all. We are left to ponder his mysterious background - did Chapman even attend college, does the child prodigy have a computer science degree; if so, from where? We further question which other claims in his bio are true – "inventing the original sound card for computers"; "writing the software" the FAA "uses to prevent mid-air collisions"; and so forth.

Bio on IonQ website fails to mention education, in contrast to other named executive officers

Peter Chapman

President & CEO

Peter Chapman is President and CEO of IonQ and a Member of the Board. Prior to joining IonQ, Mr. Chapman was Director of Engineering for Amazon Prime, where he led the team responsible for Prime's 2-Day delivery. He has over 40 years of leadership in software engineering, including alongside luminaries like Marvin Minsky and Ray Kurzweil. Mr. Chapman is credited with inventing the original sound card for computers, writing the software the Federal Aviation Administration uses to prevent mid-air collisions, and developing systems that protect the integrity of financial markets. Mr. Chapman has founded and led several companies to successful exits. He has served as IonQ's president and chief executive officer and a member of its board of directors since May 2019.

Bio in SEC S-1 filing lists no education, either

Executive Officers

Peter Chapman. Mr. Chapman has served as our president and chief executive officer and a member of our board of directors since May 2019. From September 2014 to May 2019, Mr. Chapman served as a director of engineering for Amazon Prime at Amazon.com, Inc. prior to joining IonQ. Before that, Mr. Chapman was the president at Media Arc, Inc. We believe Mr. Chapman is well qualified to serve on our board of directors because of his prior leadership and officer positions at technology and software companies.

Source: https://investors.ionq.com/governance/executive-management/default.aspx; https://www.sec.gov/Archives/edgar/data/1824920/000119312521305372/d206735ds1a.htm

Our befuddlement at Chapman's background and exact day to day role at IonQ appears to be shared by ex-employees. A former employee in a key scientific role, who interacted with Chapman, echoed comments by others that Chapman is rarely at the offices; that "Peter doesn't do quantum"; and that "I don't really know about his background all that much."

Ex-senior employee expressed ignorance about Chapmans' role and background

Q: "Would Chapman show up at the offices once a month? Once a week?"

*A: **"Hard to say."***

Q: "What's his role?"

*A: "I don't think he does anything in terms of technical stuff. **Peter doesn't do any quantum."***

Q: "Where did he go to college? I can't find anything on his background."

*A: "**That I don't know."***

Q: "Did he even go to college? You don't know?"

*A: "I would assume so**. I don't really know about his background** all that much." –Former senior scientific employee of IonQ*

Source: Scorpion Capital consultation calls with experts