Opinions Libres

le blog d'Olivier Ezratty

Decode Quantum with Nick Farina and Johannes Pollanen from EeroQ

Welcome to the 79th episode of “Decode Quantum”. We continue our “international episodes”, this times with the cofounders of the US startup EeroQ, **Nick Farina** and **Johannes Pollanen**, which aims to create qubits with electron spins, electrons being shielded from controlling electronic circuits by a layer of superfluid helium. This is the only company doing this.

Nick Farina is the CEO and co-founder of EeroQ in 2017. Beforehand, he worked as an business angel investor, and an entrepreneur, launching multiple tech startups (GiftedHire for online job search, Voltage Digital a digital agency, JetZet providing itinerary management tools to business travelers). He’s the one bringing business acumen to the company. He is also a Quantum Computing Governance Member at the World Economic Forum since 2021. In 2000-2003, he was a caddie at a golf club (Biltmore Country Club) where he spent summers watching people cheat at golf and lament their losses in tech stocks.

Johannes Pollanen is a co-founder and the Chief Science Officer of EeroQ. He is a researcher from Michigan State University (MSU) where he holds the Cowen chair of Distinguished Chair in Experimental Physics. He is also Associate Director of the MSU Center for Quantum Computing Science and Engineering. He runs the Laboratory for Hybrid Quantum Systems, which is focused on hybrid quantum technologies involving superconducting qubits, superfluids, trapped electrons, and other condensed matter systems. He developed the EeroQ electrons on superfluid helium architecture. He did his PhD at Northwestern University with Bill Halperin and contributed to the discovery of new quantum phases in superfluid helium-3, which influenced his later work in designing quantum computing platforms. He then was a post-doc at Caltech, with Jim Eisenstein, working on exotic many-body states in ultra-clean semiconductor systems.

Here is the edited transcript of the podcast:

Fanny Bouton: I start with the first question that we ask to all our guests. How did you learn quantum science and technology?

Nick Farina: I learned a lot from Johannes Pollanen, actually. My interest in physics started out in undergraduate studies. I was a major in history. I did not get my degree in physics, but I was fascinated by the natural world around me and things that we could see and feel. So things that not very abstract, but that is powering what is around us, but that we can't see with the naked eye. I had always found that interesting, even before I met Johannes, the study of atoms and smaller particles. And so then, in 2010 when I was on the board of a theater company and I met Johannes. He was doing his PhD at Northwestern University in condensed matter physics under Bill Halpern. We became fast friends talking about science. At that time, I was running my first software startup.

So a quick story about my background, which I always like to say is less interesting than the background of EeroQ. I was running a company called JetZet. What we did was allowing people to take their travel information. So if someone was traveling from, let's say, Paris to New York, they would take their travel, information to San Francisco. would connect them with their LinkedIn connections so they could see who they knew in San Francisco, and connect with those people and make meaningful social connections. The product was initially a success. I will never forget when I was on an airplane and I saw someone in front of me using the product and to me as an entrepreneur, that was validated our idea. I enjoy being an entrepreneur so much because you got to create something that would never have existed before and then here you are one year later and you're watching something becoming a reality. What then happened was that LinkedIn turned off their API for using travel. So we no longer were able to offer that feature. I learned a very valuable lesson that if you're in business, you should never rely only on one vendor for your company. That company essentially went out of business, even though it had been picking up traction and was successful.

So this is when I met Johannes. And then my second business started out being called Gifted Hire. We connected high achieving university students with jobs and careers. So we we gave away in combination with our nonprofit partners, over a million dollars a year in scholarships. We sent out about 26 million email opportunities.

Later on, when Johannes Pollanen became a professor in 2016. I was about to sell out my company and I asked Johannes "*what are you going to do with your research funding*?" and this is where our stories converge and we had remained friends for that five-year period.

He said, well you know there's about seven different ways to build a quantum computer but you know there is a paper that was proposed in 1999 in Science that was a theory paper and I believe it hasn't gotten enough attention and I believe it needs to have more exploration and this is called electrons and helium. So I had done some other investigation of my own. I asked him the typical investor questions like are you going to compete with large companies like IBM? And Johannes said, well it's simply a better system so if we can get this system to work even though it's earlier, then we can have a shot at creating this system to really become one of the best systems.

We then realized that, at least in the United States, when you take money from a VC within about five years, they want to see that you have built a multi-billion dollar company. If you have not done that, then they start to get a little bit impatient and they start to to want their money back. In 2016, Johannes and I thought that there was no way we knew enough about what we were doing, and we didn't have a roadmap, we didn't have the team, we didn't have the investment. Another important element is the quantum computing ecosystem was not very mature. You didn't have cloud services, for example. You didn't have off-the-rack tools like the one from Quantum Machines. So the ecosystem really didn't support it.

So we said that there could be a new type of quantum computer that was better than these larger competitors. So, let's make a business out of this. And so for the first five years, we worked on de-risking the science and making it more acceptable. I used some of my own money and some money from very brave friends, especially one of our investors named Dave Ferguson was another major investor, and we decided to de-risk the science of the system by doing sponsored research at Michigan State.

To finish that story, in 2021, we brought on Steve Lyon from Princeton University to be our CTO, and then in 2022, we made a few changes. We moved, and this is where Johannes can get into the more technical parts, but we moved from using the motional state of the electron qubit to the spin state of the electron, and we moved for longer coherence times.

We also focused on using CMOS as the foundational structural layer for the computer. And then we raised about $15M from B Capital Group. They are the venture strategic associate of the Boston Consulting Group in 2022.

Fanny Bouton: we think to deep dive a bit maybe after on the funding and other things about the company. So, Johannes, can you tell us a bit more about EeroQ? Can you tell us how you started to learn quantum science? Where is the passion coming from?

Johannes Pollanen: I am in some sense a career physicist. I really got hooked on physics at the end of high school and then during my undergraduate education, which was at the University of North Carolina in Chapel Hill, I just fell in love with quantum physics. You know, it just struck me as like one of the most amazing things about nature. It was so counterintuitive. And I realized that this is something that if I spent my entire life thinking about, I would never get bored. And that has proved to be true. I still think that that probably will continue until I die someday. After my undergrad, I realized at some point I worked actually in quantum physics. I worked on experimental nuclear astrophysics as an undergraduate and I realized that I loved being in the lab. My advisor at the time, when I was applying to graduate school, said, if you like this kind of work, probably what you should look at is condensed matter or quantum physics, because the labs are usually very integrated.

You have a few graduate students, and everybody is working together to solve some problem. And you get to kind of experience the entire landscape of doing experimental science. I took that to heart. I went to Northwestern University, working with Bill Halperin, and worked on superfluid helium-3 at extremely low temperatures, much colder than we get our systems at EeroQ. And we worked on some esoteric questions associated with the many body condensed phases of matter that form in that system at very low temperatures. Quantum physics plays the key role. That was the thing that I really got stuck on.

When I was at Caltech, I kind of started to see that there was this quantum revolution. So after I finished my PhD, I went to Caltech, to the Institute for Quantum Information and Matter there, which is one of the preeminent quantum computing and quantum information centers in the US and the world and started working on semiconductor systems, with a connection to topological quantum computation. I started realizing that there’s a ton of people working on quantum in a variety of different contexts.

I realized for the first time that the things that we were doing in the lab, like these things that are just questions about nature, now we’re getting to the point where we can manipulate nature. We can take individual quantum particles or design circuits that behave as individual synthetic atoms, and we can control their quantum properties. Once you get to that level of understanding, you start thinking about technologies, right? Before you’re trying to figure out how something works.

But once you get to that understanding that you can actually manipulate the fundamental constituents of nature, now you can try to build something. And so this was where I really, being a part of that cohort made me realize that we have the possibility to do something that has some impact, way outside of academic journals. and universities. We’re going to be able to create a technology that can revolutionize computation, and usher in a new era of computation. I knew that that’s what I wanted to work on when I became a professor at MSU and we started working on various quantum information things in my lab, and then as Nick alluded to.

Olivier Ezratty: you need to be curious in quantum if you're not, you're dead, you're lost. By the way I've got a memory test for you: do you remember the title of your thesis?

Johannes Pollanen: it was something like "Transverse pulsed NMR of superfluid helium in the presence of quench disorder" or something like that.

Olivier Ezratty: Yeah, more or less, yes. In aerogel, unconventional pairing in the presence of quench disorder.

Transverse Pulsed NMR of Superuid Helium-3 in Aerogel: Unconventional Pairing in the Presence of Quenched Disorder, 2012.

Johannes Pollanen: the aerogel was the quench disorder that we would introduce. It really started from a deep love of understanding quantum mechanics and quantum physics. These connections are funny. They happen in these bizarre ways. Like, if Nick, you know, Nick hadn't been on the board of the theater company that my wife ran, you know, it's just amazing how these, how serendipity plays such an important role in all of this.

Olivier Ezratty: let's come back to the story of the company, but mostly about spin on helium. I mean, it's one of the most exotic technology I know about in the commercial world. There are what call exotic qubits in labs, but you are a company. Explain to us, what is it about? Why do you put electrons on helium? And by the way, which helium isotope?

Johannes Pollanen: it's actually not helium-3, it's helium-4, although I studied helium-3.

Olivier Ezratty: you studied helium-3, but you are using helium-4, because you want to avoid helium spin to generate trouble on the spin of electron you try to control above the helium?

Johannes Pollanen: You allude to a very subtle point that often gets lost. We work with helium-4, which is a spinless version of helium. If you it was on helium-3, it would be problematic for a number of reasons, partly because the nuclear spins of the helium can decohere the spin of the electron.

Olivier Ezratty: What's interesting with the spin of helium is you've got a kind of schizophrenia in quantum space, because you need to have isolated qubits, so the spin is isolated, but then you need to control it. So how do you manage this schizophrenia?

Johannes Pollanen: what you should really imagine is individual electrons, which are trapped in high vacuum, above the surface of superfluid helium. This is a system that's been experimentally realized for the first time back in the late 1960s and early 70s. It forms the first low-dimensional electron system that was ever realized. So the electrons float there in vacuum above the helium surface. They do this naturally because the helium is mildly dielectric. It polarizes underneath the electron, creates a little positive image charge, and the electron is bound to its own image beneath the helium surface. So it naturally traps in the vertical direction. What has happened over the years is that people have developed more and more sophisticated devices for manipulating and controlling individual electrons down to the single elementary particle level.

We do this all the time. We trap a single electron in one of our dots, manipulate it with microwave fields, and if we don't want to get rid of it, it'll just sit there for an indefinite amount of time. A colleague of mine here at MSU years ago, Mark Dickman, he's a theorist, predicted that the motion of the electron could potentially be used as a qubit. This is now the motion normal to the helium surface. It turns out that's actually quite difficult to control.

There are some academic groups that are working on trying to realize qubits based on that motion perpendicular to the helium surface. In that configuration, the electron is a charge qubit. The charge qubits are usually much easier to control because they couple more strongly to their control electronics. But they're also more susceptible to noise and decoherence.

And so my colleague, Steve Lyon, our CTO, predicted, and developed a plan years ago now to utilize the spin of the electron. That spin is just hanging out. It's closer to trapped ions than to electrons in quantum dots in potential well in silicon qubits.

With electrodes beneath the helium surface, we create a quantum dot in vacuum that holds the electron. It's the spin degree of freedom there. Now one of the big issues is how to do high-fidelity spin readout of the electron spin. The reason we love this system so much is mainly because of the scaling provided by the CMOS underlayer.

Underneath superfluid helium, control electronics is all a CMOS architecture that we engineer and design and build with a commercial foundry and lends itself naturally to scaling to large numbers. Relative to silicon spin qubits is that instead of the electron being buried in the silicon, You can make a spin qubit in silicon. You really can't make its coherence worse if you take it out of the silicon and place it in vacuum. You're essentially just removing all of the decoherence mechanisms. But you hold on to the beauty of the scalability that the CMOS provides. And that's a big reason for why we're doing it.

Sensing and Control of Single Trapped Electrons Above 1 Kelvin by K. E. Castoria, N. R. Beysengulov, G. Koolstra, H. Byeon, E. O. Glen, M. Sammon, S. A. Lyon, J. Pollanen, and D. G. Rees, arXiv, December 2024 (12 pages).

Olivier Ezratty: you mentioned that the tough part is to read out the spin. But how about the gates themselves, particularly the qubit gates, which really are difficult for the spin qubits.

Johannes Pollanen: we're working to build those at the moment. In our current version, the electron gets its motion quantized in a trap. And then, with the application of a magnetic field and a small local magnetic field gradient, you couple its spin to its motion. And by reading out the motional state of the qubit, you can determine its spin. Those are the devices that we're currently building.

Olivier Ezratty: and is that non-destructive? It's non-demolition measurement (QND)?

Johannes Pollanen: initially, it's destructive, but we have plans to make it, ultimately QND. Now to do the gates, that's a more straightforward approach, which is the electrons, in addition to being trapped in vacuum above the CMOS layer, we can move them around. We can position them wherever we'd like on the surface of the chip. And in particular, if you want to generate a gate, we have a patent pending on this approach, you can bring the electrons close to one another for a specified amount of time. During that time, entanglement will ensue based on their mutual magnetic interaction via the dipole, the two magnetic dipoles. So for a specified amount of time, you can generate essentially a universal gate set. You need one other thing, which is you need local single-qubit rotations, which we achieve with on-chip current-carrying wires.

Olivier Ezratty: so how do you control the local single-qubit gate.

Johannes Pollanen: you can bring an electron near a magnetic field that you can turn on and off.

Olivier Ezratty: so it's just a magnetic field?

Johannes Pollanen: It's a straight field.

Olivier Ezratty: you can do an X and Z gates with that?

Johannes Pollanen: That’s right. And then the two-qubit gates are done via this dipole interaction. In a way, it’s similar to silicon qubits, but with more protection for the electrons.

Olivier Ezratty: oOne of the big questions is, of course, how do you scale and which kind of fidelities you have. It’s maybe too early to tell. Yeah, well with the scaling, I think.

Johannes Pollanen: the gate fidelities will be, once we get to the point where we’re measuring those, we’ll be able to tell you what those look like. We have good confidence that at least in this dipole-dipole regime, that likely limiting factor, in the two-qubit gate fidelities is going to be timing. But time is something that essentially is how long do you have the two electrons near one another and then move them apart. And that timing can be done quite precisely. And so we anticipate that those, our estimates are that the gate fidelities there will be at the level of, if I’m conservative, 0.1 percent error. So 99.9%.

Olivier Ezratty: you mean, a three-nines?

Johannes Pollanen: that’s right, for the two qubit gate. You can make qubits out of almost anything in these days. In my group, we make superconducting qubits. We make qubits out of, you know, atomic defects in diamond. I think the bigger issue is the scaling side of things. And as a species, we’ve only ever scaled one thing to the level of 10 to the 10. And that’s transistors and CMOS. It took a long time to develop scaling architecture. It took 60, 70 years to develop CMOS to the level we’re at now. If we don’t utilize CMOS to build the scaling that we need for quantum computing, we’re facing a challenge of inventing a new scaling architecture for all of quantum, or individually for all of these different platforms. Maybe that’s possible, but that seems really hard. And so there are a few technologies, silicon spins, spins in silicon, electron spins in silicon, electrons floating above the surface of superfluid helium and some photonic platforms that can leverage CMOS.

And that I think is a big, important factor and has been really critical to our approach. We want to make sure that we start with something that is more than just a physics experiment. We want to have some sense that we can actually build some large scale system out of this. We’ve developed a large scale CMOS based scaling architecture already at EeroQ that we designed. In principle, it can run, it’s not maybe the most efficient at all quantum error correcting algorithms, but we architected it in such a way that once we have the single, the two qubit gates and all this stuff ready, we can essentially just move the electrons around in that architecture to do error correction in a non-local way.

Olivier Ezratty: my question on scaling is probably multifold because one thing is, of course, to have it work at small scale first. That’s the beginning of any endeavor of this kind. And then you’ve got scaling with regard to fidelities and you can keep good two qubit gates fidelities at scale. What temperature are you using? I presume less than 1K, but how low? And the cryo-CMOS is a technology known for heating. So there’s probably some energy constraints at that level. So there’s a matter of scaling there as well, because if it’s heating, you’ve got to have a large dilution fridge and stuff like that. There are many aspects with scaling, not just the size of the CMOS circuit and how many electrons you control.

Johannes Pollanen: with the cryo-CMOS, we’ve already started with the scaling architecture that we developed over the past year, which is called the Wonder Lake chip. We’ve done on-chip heating tests to see how quickly we can run the gates and the transistors that we have buried underneath in order to do electron motion. And so there’s a trade-off at the moment, because we are running this thing in a dilution refrigerator at 10 millikelvin. Give or take, there’s, there’s trade-offs in terms of how fast the clock, speed you can run, essentially, on that kind of chip and deal with the on-chip heating. But we can see that, essentially, from the properties of the electrons. We can see how much they're being affected by this. But we do have, in principle, these devices can be run as high as one Kelvin, and we have plans to develop. So we have also, we're doing tests of a similar kind in terms of on-chip power dissipation at 1K, where you can, instead of the tens of microwatts of cooling power that you have in the dilution refrigerator, you have something more than that, hundreds of milliwatts, yeah. But no, these are all important factors that our engineers work on to try to sort out.

Olivier Ezratty: two other questions related to that. Do you plan to skip the NISQ route and go directly to an FTQC architecture or you want to first start with a NISQy system? Do you think you're going to reach the limits of the size of the QPU and it will require some interconnect? That's something I'm studying right now, looking at how do you differentiate the various technologies around with regards to the need for interconnect which is bulky and complicated.

Nick Farina: I can answer the first question because that's a sort of a business side question. With regards to the NISQ era, we do plan on our first proof of scale being a NISQ era computer. We're going to start with a small demonstrator on the cloud. We currently have a simulator where you can simulate around 20 electrons on helium qubits. We're very excited about this because it allows people to explore and navigate all of those really unique properties that Johannes was just talking about. We did this in partnership with Superstaq and their software team (now part of Infleqtion). The next step is to have a small demonstrator using actual hardware running on a large cloud platform within the next year. The next step is to have a small demonstrator using actual hardware running on a large cloud. We're cautious about giving out dates because we never want to disappoint people. We want to under promise and over deliver. We're working very hard with our team of around 15 people, including here in Chicago, at Princeton in New Jersey and Lansing Michigan. After having this small demonstrator chip in the cloud, we'll move on to a tape out of a chip that we're going to be using in the cloud and we're going to be using it in, to get to around 10,000 physical cubits with a foundry partner.

This will be in the 2027 range for a tape out. This is not having it on the cloud or anything. This is a tape out of physical cubits. But that's where that would be in the NISQ range. And then by the year 2027, we will be able to get that going, get up, iron out all the flaws. And so 2027, really, for us is the year. And I know it's this, it's similar for a lot of other quantum computing companies, where 2027 is the big year, where people make the big breakthrough.

So I know you hear that a lot. I hear that a lot, too. But I think it's actually true. I think that one thing I always just talk about is you have these three snowballs coming downhill, all converging towards one another. And one of these snowballs is error correction, and one of them is better quality chips, and then the other one are more efficient algorithms. And so what might have taken you a million physical qubits 10 years ago, now this has all changed because you can't simply say, oh, you need X qubits to run. You know, a certain algorithm, because you have to account, as you know, for, you know, what the overhead is, error correction, and you have to account for how efficient. the algorithm is uh in running these qubits so what's happening is we're seeing rapid advancement both in industry and also in academia with error correction so qLDPC codes are among my favorites and we're seeing great advances there.

We have proven out the scaling element with this Wonder Lake chip and then we're using our seed round to prove out, scaling and then now we're using our series a round of financing to prove out our two qubit gates so.

Olivier Ezratty: you mentioned qLDPC error correction. So before we talk about interconnect, Johannes can you explain a little bit what what's going to happen with the connectivity between the qubits. Is it local or non-local and nearest neighbor given you shuttle all the electrons?

Johannes Pollanen: in principle you get all-to-all connectivity but that particular circuit might not actually be particularly useful for something so you want to you have to take into account both the readout where you're going to put readouts regions where you’re going to put operation zones all this stuff but because based on a given architecture the qubits can be shuttled around with really high efficiency this way in fact it’s actually that should we have.

The interconnect question comes back to one of your point about there are many things associated with scaling interconnection being one of them. Our goal is to avoid having to do any kind connecting, certainly at the NISQ era level.

Without some crazy number of wires going into the fridge actually this is one of those things that I learned one of the fun things about quantum computing is I learned a ton about classical computing as we’ve worked on quantum computing but one of the amazing things is that you know in your laptop you have somewhere between you know 10 to the 8 and 10^10 transistors on the processor but there’s only something like a hundred thousand wire bonds that go to that thing and it’s that distinct that ratio of wires that go onto the chip.

Olivier Ezratty: There are two thresholds to consider, business-wise and application-wise. Most of the roadmaps from all the vendors is trying to reach a 100 logical qubit with, I don’t know, 10^-6 to 10^-8 error rates. Then, there’s another one which I believe is very important, probably, further down the road, is a couple of thousand, because that’s where you have the need for quantum chemistry very valuable applications. I always refer to the benchmarks that were commissioned by DARPA recently, and you can have this QBI center in Chicago next door to you. So, at which point do you need interconnect to reach those levels? The latter being the better.

Johannes Pollanen: when we started the company, one of the things that kept us operating in stealth for a while was that we were like, we have the idea for the technology, like the hardware. We weren’t experts in quantum error correction or algorithms or any of these other things. I remember Nick saying to me at one point, he was like, look, if this is really gonna turn into an industry and an ecosystem, all of those things are sufficiently hard problems. Companies will appear that will attack algorithms and error correction and all these other things. And we’ll partner with them. And without having to try to build all of these things ourselves. And that’s in fact what’s happened. And this moving target of error correction and how many, you know, what NISQ machines can do is one that we try to stay on top of, you know, while we stay focused on our roadmap. But I do believe that, you know, people are going to find interesting and meaningful things to do with, as you say, systems that have thousands of physical qubits and that have interesting connectivity for problems like quantum chemistry and things.

Olivier Ezratty: We may switch to the business side of any of our partners in Chicago and stuff like that.

Fanny Bouton: It would be interesting to understand what is your integration in the Chicago quantum ecosystem? What drove you there?

Nick Farina: Chicago was a nationwide search for us. It just so happened that I grew up here and that Johannes did his PhD there. So that was almost by accident. Our potential hires preferred to work out of Chicago than elsewhere. What makes Chicago unique is that we have, all of these national DoE labs. So we have Argonne and Fermilab in addition to all of these world-class universities like Northwestern, University of Illinois, Urbana-Champaign, University of Chicago, and also resources like world-class clean room Pritzker Nanofab from the University of Chicago, that we are able to leverage in doing fabrication testing. Chicago also offers a really appealing balance of an exciting place for young people to live and start families, but still affordable enough where they can see themselves buying a house one day and settling down with their families. Chicago also brings everything together really nicely, the Chicago Quantum Exchange, and the governor of Illinois who just put in that $500M into the state. So many organizations out there are working collectively to help Chicago quantum companies grow.

When we talked about my first company, I was in Chicago. I was having a very hard time finding funding because it was 2010. Chicago was very risk averse to funding and venture capital. We didn't have things like Zoom. You were expected if someone gave you venture capital money, you were expected to be in that location so that your investor could look over you. So we moved to New York and raised a little bit of money there and then other people's did that. People did the same for San Francisco. But then when COVID happened, many people lost their lives, but deals were able to be done from anywhere. We now have about 50 shareholders and at least 45 of them are outside of Chicago. So Chicago is great because people are willing to put money into Chicago, even if they're not already in Chicago. Plus, Chicago is putting in more and more capital with accelerators like Duality and more local angel investors. So Chicago is getting its own capital.

Fanny Bouton: the company seems focused on building the technology and not being distracted by building so-called use cases with the end-user customer. It's nice. Is that an explicit choice, a way to avoid over-promising stuff?

Nick Farina: that's an explicit choice. Building a quantum computer is difficult enough that you really need to focus only on that. So you can see our fridge in the background and our team. And we're working 100% very long hours just trying to engineer this quantum computing chip. So if you could imagine taking that. Plus also trying to build a large sales force, build a marketing force, develop applications, we believe one thing I've learned in my business career from both my failed companies and my successful companies, and I've learned more at failure than success, is that focus, really, focus wins. And the company that is going to be the most focused on the end goal at the end of the day is going to have the highest likelihood of success because they will have been spending all of their time focusing on a singular goal as opposed to getting distracted. My mantra is that especially as a startup and even as a big company, focus wins. I mean, look at NVIDIA, they're a very focused company. Even though they are now, I believe, the largest market cap in the world, they are still very focused. So focus is what wins and that is why we do what we do.

Johannes Pollanen: it was a deliberate choice and continues to be part of our philosophy exactly the way it is. We are working now with local software partners to help develop the code that future customers could use to interface with our machine. We have advisors and and partners who know a ton about applications and these kinds of things and that really has made I think that kind of thing is going to be what makes quantum computing successful overall is that different people are focusing on the things that they know how to do and then we put these pieces together in a meaningful way that creates the…

Fanny Bouton: the benefit for society, and it's not too difficult to hire and staff?

Johannes Pollanen: to get the right talent has been great. We've gotten very lucky with our first round of hiring. We essentially knew who the experts are and the people whom we really wanted. We reached out and got them on board pretty quickly. The beauty of it is that the community of people that work on this system is quite small. It's actually really expanding now, partly due to the success that we've had and the success that some academic groups have had. And so we really wanted to get a core team. We were able to do that hiring very quickly, thankfully. We'll see how, as we expand, this problem just gets you know, it scales, hopefully not exponentially.

Fanny Bouton: we're arriving at the end of this Decode Quantum with the start-up EeroQ, with Nick Farina (CEO) and Johannes Pollanen (CSO). Thank you to both of you to discuss with us.

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