Decode Quantum with Mathieu Munsch from Qnami

Welcome to this 81st episode of the Decode Quantum podcast series, traveling around the world on quantum science and technologies, Fanny Bouton and myself were with Mathieu Munsch, the CEO from QNAMI.

Mathieu Munsch is the CEO and co-founder of QNAMI, a Swiss startup located in Basel, specializing in NV-center quantum sensors. Born in France, he was first trained in optics semiconductors and spintronics before turning to research in quantum physics. After obtaining his PhD at the Institut Néel in Grenoble, he continued his postdoctoral work on the manipulation and detection of quantum dot single spins. At the University of Basel, he launched Qnami in 2017 to commercialize sensors that perform very high-resolution magnetic imaging.

Fanny Bouton: First usual question, how did you fall in love with quantum? When? What happened?

Mathieu Munsch: this actually dates back to when I was in high school, I think. At the time, I was already very interested in all sorts of science, and in particular astronomy, astrophysics, and soon after, quantum. Basically, everything which was a bit complicated, I kind of liked at the time. So, yeah, I guess that’s how I was a big fan of all these science magazines that we have, like Science et Vie, like Life Science for our English audience. Kind of one that I was like eating every time it would get out. I would just buy it and read it all.

Fanny Bouton: I discovered quantum in 96 about teleportation in science.

Olivier Ezratty: most engineers have the same story. At least those who really like science. I mean, scientists and engineers. But still, you didn't study quantum physics right away. You probably went through a more classical curriculum before.

Mathieu Munsch: early on, I wanted to become a scientist. I wanted to become the next Einstein, as all of us once, I guess. And I met a physics professor in high school who advised me to go through this very specific French program, which is the "classe préparatoire" (prep school). And he basically told me, you should do that, and it will just create more options. And if you want to do research, you can still do it. So, I did that, which gave me a bit of a broader perspective. But still, I wanted to do science. And I chose one engineering school with a big major on physics. It was still very broad. But I could take one or two lectures on quantum. I had a bit of an interaction with quantum here again, I guess, in that period.

Fanny Bouton: Do you remember the title of your thesis?

Mathieu Munsch: It was a non-linearity for quantum dots in a semiconductor microcavity. And what that meant, what we were working with semiconductor stacks. We were building small microcavities out of them, like small pillars, really like very small, micrometer size, so smarter than a hair. And we would shine light on this. They would trap the light. And within that semiconductor sandwich, we had one quantum dot. And the idea was that this quantum dot could only absorb one photon at a time. You had this kind of one photon switch. And today we use this type of technology for basically making a spin photon interface. This is what it's called today. Some people have. are trying to bring this technology to the market.

Étude du régime de Purcell pour une boîte quantique unique dans une microcavité semiconductrice : vers une non-linéarité optique géante under the supervision of Jean-Philippe Poizat and Alexia Auffèves, in 2009.

Olivier Ezratty: how did you pick the theme? Because you had a generic training when you were doing your engineering school. So how did you find it? Maybe there's some lessons learned for young students who want to find a PhD location.

Mathieu Munsch: there is some randomness to all of that. I did a first training in Bose-Einstein condensation. That was in Australia. Really interesting. And then my second master training was with a team from the Institute Néel that was working on this. I found it really interesting. And I stick there for my thesis. And I guess the big shift that happened to me was during the studies.

Maybe I started with the idea of going in astrophysics. But I then realized that my interest was with experiments, and an experiment on stars involves a lot of people, and you're contributing not so much. It can be really interesting, but it's often more about data analysis and very collective work, whereas in quantum, you are basically building a system, controlling a complete system, and it was a little more fun for me. So that's how I got to do it for real.

Olivier Ezratty: after this PhD, you did a postdoc at CEA Leti, so again in Grenoble. What was the work you did there? It was the continuation of what you did in these quantum dots or something else.

Mathieu Munsch: There was a bit of a continuation. We changed a bit the platform. There was also, this was the beginning of… me starting to explore different research topics. I was very lucky during my postdoc time, here in the CEA and later at the University of Basel to have the chance and the trust of my, advisors to open different research fields with different PhD students. We were working on these spin photon interfaces and we were also working at the CEA specifically on terahertz lasers, how you could use a novel approach to generate lasers with certain power output in that.

Olivier Ezratty: then you go to the university of Basel for a second postdoc, and then you really land in the world where you're right now, the NV center's world.

Mathieu Munsch: my research there is still a bit with spin photon interfaces, a lot more with, I start to do NMR measurements and optomechanics as well. I really expand my field of interest, and I get to know Patrick Maletinsky, who is a young professor at the University of Basel, same floor, and he's the one starting a group on NV center in, particular and magnetic imaging using these NV centers. This is when we meet and start and discuss and soon after comes the idea.

Olivier Ezratty: you spent a couple of years there, I presume, as a postdoc and then finally you created the company. You went really fast from the postdoc to company creation, at least, if we benchmark with other researchers co-founding a company.

Mathieu Munsch: I always had an interest in business and creating a business. And I tried a few things. I was exploring my own research as well as ideas on the side. And I remember this, we had in Switzerland, our annual meetings are in the mountains. This is where it happens, obviously. And in one of these meetings, we take back the train and, I just happened to be with Patrick, and then he talks about what he's doing, his technology, but also the fact that there's a lot of requests for collaborations, more than he can handle, and basically the beginning of an idea on his side that, should we do something about it?

To me, it's like, yo, this sounds really cool, and we have here a technology that is operational at room temperature, which is simplifying a great deal the adoption and the dissemination of the technology, so I think we should look into it. So, I don't know if it was fast, to answer your question, but it just happened progressively.

Olivier Ezratty: when you did create a company? You were the only founder or you had co-founders back then?

Mathieu Munsch: we were a team. So this moment, this conference was in 2016. From there, in a week, I decide I should do this. I find an arrangement with my advisor at the time to ramp down my activities, pass them on to other people in the group. And with Patrick, we find a tech transfer grant. We find a bit of money to cover my salary so that I can do a market study.

And for about a year, this is what I do. I do a market study. I define what will be the first business goals. We try and expand the vision as well, understand where it can go. And I start to look for what will be the core team. And we decided. It was very… It was very clear that I would want to… Focused on the business side of things. We needed one person in the material science. We needed one person in the software. So I started to look for them. And in 2017, with the full team, we created the company.

Fanny Bouton: and how did you fund the company at the beginning.

Mathieu Munsch: We do a lot with not a lot at the time. We are quite successful with the grants, which are available. Also, we start to participate in startup competition. We win some. And that brings, you know, 100K plus 50K plus 100K. So we're really starting with not a lot. We bring a bit of capital of our own. But at that time, it's our first company. So there is no… No millions that we can pour in the company.

Olivier Ezratty: when you started the company, did you get some kind of entrepreneurial training? Because I presume you didn't have any initial training on that. The quantum ecosystem was not that rich back then. But maybe in the regular startup scene, you had some training.

Mathieu Munsch: that is true. And that was essential. Definitely not in quantum. At the time, we could count the number of quantum startups with our two hands, right? It was really a very different picture. But there was training available. And this is one of the good things, which I suppose you get in Europe, in France, for sure. But in Switzerland, it's really available in high quality, for sure. So I follow Like Entrepreneurship 101, get the basics, read a lot, buy tons of books, **Lean Startup** from Eric Ries, for example, which I suppose everyone has read. But I try and get as much inspiration as I can from people around me. And I follow, I really follow, you know, the one-on-one lecture. I try to follow a set of rules here to define what the business, what makes sense from a business perspective. And as I was curious in science, I find myself being very curious in business as well, how the mechanics work, what makes sense. I really immediately enjoyed what I'm doing.

Olivier Ezratty: What did you learn about the creation of a startup? It's interesting because I've got currently some discussions with people on LinkedIn on should startups who are in the quantum space do a product market fit study or address these questions. Differently, so. Do you have ideas on that?

Mathieu Munsch: I did, and I haven't changed. I've learned that it's very hard. It really is very hard, right? From day one, it's not easy to establish a solid product market fit, and very likely it's going to change, right? You go with an idea, and what you're going to sell is probably going to be different. If not the product, at least the solution or what you are actually selling, the value proposition will very likely change. And in some cases, your technology is early, and this value proposition will make, in the case of quantum computer, take a long time to really materialize. I still think that one should do it, because what it does is that it forces you to lay down on paper, a certain number of assumptions, and then, Then start to test them. It may take some time, but it really works as a roadmap. You need to check these assumptions. You need to understand that you're making assumptions, and you need to understand that it's okay to say they're bad and move to another set of assumptions. But if you're doing none of that, only working on the technology, I don't think your chance of taking the right path is good, because you can develop a product for a long time that nobody wants. It really happens.

Olivier Ezratty: what was the initial goal of the company? I presume it's more or less stable, because you were starting in the NV center space. What's the technology? It's still a product and business. This is the technology behind that. And then how things change over time.

Mathieu Munsch: the QNAMI's mission is fundamentally to advance human knowledge and basically support scientific and technological developments. We are providing support tools to scientists and R&D engineers. And those two solutions should help them understand the world when they're scientists or accelerate their technological developments if they are, say, a semiconductor company or an industrial partner. So this is really fundamentally what we're doing or aspiring to do. And on a practical level, the solutions we develop are imaging solutions or analytical tools that provide information on the nanoscale about electromagnetic properties. So. The idea is we're going to be able to measure extremely small currents, extremely. small magnetic signatures, extremely small temperature variation in a sample, and that information is useful to understand a certain new type of material or to understand how a certain chip works or does not work.

Olivier Ezratty: and you're using the so-called NV centers. I'm not sure we had many folks about that. We had Jean-Francois Roch a long time ago, you probably know. So can you explain the physics parts of NV centers and why they are so good magnetic sensors, at least on top of that, at the nanoscale level.

Mathieu Munsch: NV centers are absolutely marvelous, fascinating for a number of different reasons. So what is an NV center? It's a molecule in diamond. So we're starting. The starting place is extremely high quality diamond, extremely pure diamond. only carbon atoms in each location of the lattice. And then we're going to bond it with nitrogen. And this is going to create some vacancies as well. And what we're looking for is there is a process so that these nitrogen and vacancy will combine, forming that very molecule. And when that happens, it's going to store electrons. And these electrons are going to behave like a quantum system. So we basically have a spin system in diamond. Why is this interesting? First, because we're talking about one single, let's say one single spin. It is a very small object. And when you do sensing or imaging, the resolution, the spatial resolution, so your ability to see small details is directly linked to the size of your sensor. If you're using optical light, it's going to be. The wavelength of that light, if you're using. a certain size sensor, it's going to be the size of that sensor. So here we're talking about an atomic sensor, so it doesn't get smarter than that. So it's basically ultimate resolution that you can achieve. That's one.

Second is that this quantum system has, the ability to work at room temperature. In, most quantum technologies, not all of them, you need to cool them down, either, with, cryogen, installation or with optical means, but you always kind of need a strong infrastructure just to cool them down. In Diamond, you get that for free, and that basically opens up the opportunity to do quantum sensing on just a standard environment.

Olivier Ezratty: you use only the two free electron spins in the vacancy. You don't use the nuclear spin. That's our own. I mean, the ^{13}C and nitrogen nuclear spin like we do in quantum computing.

Mathieu Munsch: there is indeed nuclear spins that can couple to this electron spin and we do not use it. Some people do. In sensing. maybe less. Right now, more for computing applications.

Olivier Ezratty: It's only for computing. Okay. Companies like Quantum Brilliance and others, who use the spins for the nuclear spin for storing quantum data as far as I know and they use the electron spin for exchange. So, you use only the electron spins for your sensing.

Mathieu Munsch: In our case, we're not using nuclear spins in sensing.

Olivier Ezratty: when you describe this quantum sensing mechanism, could you compare it to classical ways to do the same stuff? What are the classical means? Because usually when you talk about quantum sensing, there's sometimes, a lack of comparisons. So I like to compare before and after. So classical sensing at the atomic scale, and maybe you can use a… And the meaning of classical may be fuzzy because an electron microscope is still quantum.

Mathieu Munsch: The classical way of doing something similar to what we do, would be to use. We're measuring magnetic fields. This spin system is going to react to magnetic field. And one other way, classical way to measure magnetic signatures is simply to walk a magnet around, like just walk a magnet across your sample and see how this magnet is affected by the underlying magnetism. It's kind of a compass experiment. And the challenge in classical… Oh, sorry. solutions is to design a very small magnet, right? So the competing classical solutions are exactly that, extremely small magnet that you bring close to the sample, scan over your sample so that you can detect fluctuation in the underlying magnetic fields. The challenge with that is that these magnets are small. It's hard to do them twice the same. So you start to have reproducibility questions and the measurement is not very direct. So you have also a lot of data analytics to do after, you know, from the data that you collect to get the actual sample information.

Olivier Ezratty: what's the improvement, from this classical magnet solution and the Inviscentos solution in terms of, I don't know, accuracy, precision, and what are the orders of magnitude of gains you get with such a solution.

Mathieu Munsch: we get an order of magnitude improvement. So with, With this modern magnet, you will get images with lateral resolution in the 100-nanometer range, and we do 20-nanometer working to get 10-nanometer in spatial resolution, electromagnetic imaging. So that's one big improvement. The other big improvement is it's completely non-invasive, because when you're walking a magnet over something that is itself a very small magnet, there is a chance that you actually, you know, write it instead of read it. So that's a big, big advantage. Something we'll learn on the way. We thought resolution would be the most important thing, but actually there are other stuff in our value proposition that are really important. So that's another one.

Olivier Ezratty: that's interesting, because indeed the NV centers itself, the electrons don't impact the material you want to inspect.

Mathieu Munsch: it's basically a board magnet. It cannot be a smarter magnet. And even when you consider the role of the, I presume, the laser that reads out the state of the vacancy using fluorescence, so it doesn't impact as well the stuff you are looking at. The readout mechanism uses two ingredients. One is an optical beam that you mentioned, and the other one is a radio frequency. So we're bringing light and we're bringing microwave close to the sample. Those are two potential sources of heating or noise. In 99% of the case, this is absolutely non-interfering. We are launching this year a new solution so that we are able to do the same measurements in a cryogenic environment. Why not? Not to support quantum computing, like quantum for quantum. how I like to call it. In this case, sometimes you need to be a little more careful whether you can heat up things because your environment is a little more sensitive as well.

Olivier Ezratty: Do you mean that your technique could be used in a so-called cryoprober that are used to inspect some silicon qubits or other such components?

Mathieu Munsch: our sensor works from -270°C to 300°C so it's a broad range.

Olivier Ezratty: I'm asking the question because there's one cryoprober at CEA Leti where you worked and there's one that's going to be soon installed at Quobly which , is going to have its own one to inspect its silicon qubit chips.

Mathieu Munsch: That's definitely something we're, looking after. What exists, what is needed in that environment. There's not much actually that is existing. So it's a very interesting, market.

Fanny Bouton: Can you talk about your customers and use cases?

Mathieu Munsch: The bulk of our customers today are scientists from top tier universities. And we have we have some in France and in Germany, in Switzerland, in the UK, now in the US as well. Most of them work on a specific type of electronics, which we call spintronics. And for this, they grow new types of materials. They want to understand them with with high precision. And the reason is because ultimately, this type of research leads to. Devices and the devices are, for example, magnetic sensors or magnetic memories like. Like M-RAM, which is maybe one of those memory that you have heard of, which is now becoming commercial, has huge potential for AGI applications. This type of technology is very thin layers, very small nodes. So you need to have this nanoscale understanding. So this brings me to the second class of users that we start and have and would like to develop, which are a semiconductor industry or R&D centers like IMEC, like the Fraunhofer Institute, or eventually like TSMC or Samsung.

We're not yet offering anything for production, but we are very interested in supporting their development. Product design, their R&D phase, basically. And we can accelerate. their learnings. You were talking about a cryoprober. The probers are really interesting, but you need a complete sample with electrical connects. We do not need that. We can test a number of properties very early in the manufacturing process.

Olivier Ezratty: When you say not yet in production, do you mean that the usage of your product in a so-called characterization, within semiconductor fabs would bring a larger volume and you may be interested to do that.

Mathieu Munsch: yes, semiconductor production, it's a very different environment. So let me start there. The requirements are completely different. Speed is of utmost importance. Reliability is equally important. And we are not there yet. The technology is still new and needs validation. But it is a very interesting market. Semiconductor has all the attention today for very good reasons, it is the backbone of all our society, right? And we see a lot of interest in designing the next generation chips, right? Yesterday, there was this news that AI, or like last week, that AI could be done differently with different hardware. It is the case, right? It opens avenues. So people are really exploring how can we do something.

Olivier Ezratty: There's no different hardware, by the way. It was NVIDIA GPUs, but it's a cheaper solution, as far as I know.

Mathieu Munsch: You have to have more insight. I think we recognize today, as we are now ending with this Moore's Law, that there is a tight interaction between how we design the chip, like the hardware, and the use that we want to do of it, right? So there's… There's continuous work on… on all sides to develop the right chip for the right application. And that is very stimulating for us because there is lots of activity in R&D and later in production for new chips, new designs, new architectures, new materials. I find the moment really, really quite exciting.

Olivier Ezratty: Can we come back to the product itself? Because we didn't describe the product. So I would say it's audio, but you can put a picture in a transcript of the podcast. But could you describe the product, the shape and form, the size? I don't know if you can talk about the price, and also the cantilever mechanism that you use to move around the NV center on top of the object. So describe a little bit the fun of it, the mechanics, whatever.

Mathieu Munsch: Let me step back for a second. We have two main products in the company. One is what we call the Quantum Foundry. This is in reference to semiconductor foundry. This is where we produce the quantum sensors. And the mission of that quantum foundry is to develop sensors for QNAMI, the quantilevers that you mentioned, but also support the development of the ecosystem.

There are many more applications we could talk about later for ND sensors, which require engineering of these quantum sensors. So in our case, the sensor that we produce is maybe a centimeter square so that you can hold it. But really what it is, it is a it has a handle and it gets smaller and smaller and smaller. So at the end, it's a very it's a microscopic needle made of diamond with one and only one of these ND centers very precisely located.

So that's that's the sensor. And that sensor goes into a microscope. And that's the sensor. So the microscope is the full solution that we develop. And that is. It's a desktop solution, so you should think of, you know, something half a cubic meter size with a bit of electronics, a computer for the user interface. What you can put there are samples which are a few centimeters square maximum. We're not with the semiconductor wafer dimensions. We're really with something smarter. What researchers use day to day.

Olivier Ezratty: Do you need to have special mechanical engineering to craft a product on top of the physics side with the Envy Center.

Mathieu Munsch: that is a very interesting point, which we get asked by students a lot. When we go to quantum conferences and what is it that I should do when I want to work for a quantum company? Yes, there is a lot of quantum science and you need to know. some of it, if you really want to work in this field. But the more we progress, the more we have, other complementary engineering needs. So we have people focusing entirely on mechanical engineering, people focusing entirely on electrical engineering, people that are pure optics experts. And they learn quantum by, you know, like a diffusive effect by being with us, but they really bring these other orthogonal engineering knowledge that we need. So, yes, there's a lot of other stuff. These three are in particular important for us.

Olivier Ezratty: It's the case for many of the startups we know. They need to learn a lot of engineering disciplines on top of scientific and R&D and pure research. It's funny because there's some belief that, Quantum startups are mostly about engineering, but some of them still do fundamental, some fundamental research or applied research. How do you grade that scale in your case, generally speaking, in your case.

Mathieu Munsch: It varies over time. So right now, like in the past years, we have worked to develop this new cryogenic system. Here, the main challenge was how do we have the whole technology fit in that space? So it was a big engineering problem. So we spend most of our time on that. A bit before, we were focusing a lot on what are the type of quantum sensing sequence we can propose that allow our users to do this type of application? This type of measurement or this type of measurement. So it goes in waves, I would say. sometimes more focused on really quantum stuff, sometimes more focused on engineering. But there is a baseline engineering, which is always there, right.

Olivier Ezratty: I believe in your case, you probably have more engineering than the guys doing quantum computing hardware, where there's still a lot of physics involved.

Mathieu Munsch: We don't have fundamental software challenges to crack, right? In a way, our basic operation is semi-classical, and our advanced operations start to be really quantum.

Olivier Ezratty: I presume you develop a lot of software to drive your system. The user experience is important. Is that important in your case?

Mathieu Munsch: it is very important, because in our case, our users will not know about NV centers. They will not know about quantum physics. So they will not be able to, you don't want them to have to go into understanding how an NV center works before they have an image of their electromagnetic properties. So the software is designed so that they just do not need to understand that. They can, there's always the advanced mode where you can do your own stuff. But in our case, it's very important that there is a layer in which they just need to know nothing about quantum. And basically just enter the parameters of their experiment, how large they want to image, what precision.

Olivier Ezratty: since we are in software, can you give us some details? What is the operating system you use? What kind of tools your developers are using.

Mathieu Munsch: this is something actually which I think is a big part of the value that we have developed in the company. One of our co-founders is Alexander Stock. During his PhD, he built together with others in the University of Ulm an open-source platform basically for MD-Center operation. And the platform is really beautiful because it deconvolves three layers, a hardware layer, a logic layer, and a user interface layer, like all the user experience. It seems simple. I learned that it's hard to implement, but basically now every time we come with new hardware, we can just… code a new module, and all the other layers are going to work. We don't need to, you know, go back to the code, make sure that this input here does not trigger something unwanted there. He has led the development of this program in his PhD, and we decided to just embrace that open source platform. Our LabQ software is a baby from that open source. I generally believe in open source.

Fanny Bouton: how many people you have now in the team how you grow your staff it's not too hard to to hire people and to to have all the best talent to have a startup in that field.

Mathieu Munsch: we're 16 right now um, I wouldn't say that hiring was difficult also because you know we don't have like we're not a hundred so i suppose that if we would be looking to to grow very fast we could run in different types of problems i'm sure um i think Switzerland is very attractive which is also helping us i i am very proud of the team that we have assembled um really strong and all very interested in working in startup uh so, I would say hiring was never too much of a challenge, in fact, in our very case.

Fanny Bouton: what do you think about the market of the quantum sensors? We talk less than quantum computing or cybersecurity and encryption.

Mathieu Munsch: I think it's a very interesting market and it will be big. The sensor market is $300 billion in total. And if you look at the number of use cases where you need to improve sensitivity, where you want to do. better measurements, we're talking about a two-digit number, right? We're talking about 15% of applications where people would really be okay to pay more if they could have better sensitivity. So it gives you an idea of how big the market could be for quantum sensors. Now, the reason why we, it's also a market that is a little more difficult to talk about because it's fragmented, right? In sensor, there are so many different applications. There's so many different sensor modalities and so many different sensor applications that it makes it a little harder to talk about it as one thing, right? And also for a company developing in that sector, it's always a question, will you go and develop a technology, for example, to replace MEMS? But the investments are huge, right? We're talking about how do you scale up technology? Volume. How do you scale down cost? And we're talking about huge numbers, millions of units that you want to ship in a year. That's one approach. But then you're asking, where am I going to sell?

And in the absence of product market fit, this investment is not always easy to make. I think Bosch is giving a fair go at it. They're really exploring how they can develop quantum sensor to, I suppose, take over some part of their own technology, like to replace some part of their own technology and address specific needs. Another approach is to focus on one vertical, which is what we see from the existing startups. Some are exploring mining applications.

So how could we use quantum sensor to locate or deposit with higher precision faster? Some are in microscopy. like QNAMI, some others are looking at, can we improve the way navigation is done? Can we build systems that do not rely on GPS so that we have a safe redundancy in case, you know, hacking or even just accident. That's another way to think about it, but then you have to look at an hour view of the market. So I think all in all that makes the sensor market extremely attractive, but a little more difficult to talk about as one thing.

Olivier Ezratty: There are two potential volume markets that I see. One is medical imaging, which can be based on also many centers in some cases, we have a couple of companies even in France on that. And the other one is the automotive market, where it's more about the PNTs or position navigation and timing, replacing your GPS and stuff like that. Which probably may not use any centers. So do you think there are other potential volume markets that would be interesting in that space.

Mathieu Munsch: You have two here that are indeed the big volume markets. No, I don't think of anything else.

Olivier Ezratty: You can have higher value and smaller market. It depends, but the sensing market, I don't mean it's got no value, but it's not very expensive systems like a large quantum computer with thousands of logical qubits may become in the future. So we have average pricing and small to mid-sized volume. At some point, if somebody finds a way to get a huge volume, that's going to be interesting. Another one is NV centers can be used also for materials inspection.

Olivier Ezratty: I mean, non-destructive inspection for steel, or whatever in nuclear plants, it's not. your business, as far as I know. It's not exactly what you want to do. You're more in the semiconductor space.

Mathieu Munsch: semiconductor space, interested in batteries, interested in material analysis or system analysis. Yeah, so not directly in this, you mentioned application of non-destructive testing to metallic infrastructure. Maybe a little less, but there is a company in France, looking at this application, for example.

And coming back to your question of volume market, I think medical is interesting in the sense that it is a volume market. The price, the sensitivity to price is maybe lower than in automotive, where it really needs to be low cost. So I think medical… market is it makes for an interesting um shot do you think by the way that this market although.

Olivier Ezratty: it's very fragmented could consolidate at some point are there room for consolidation.

Mathieu Munsch: geographically in a given modality or whatever i want to think so yes um if we just take the example that you mentioned uh on on industrial testing the technology that you develop is not orthogonal to for example what kilami does right um so it is more a question of bandwidth why we're doing this and not that and indeed at some point as as a company grow the question of growing externally uh makes complete sense right uh so i think yes the the market um, is is i think in fact it's soon ready, for some first consolidation. I'm curious where it's going to go. But I think it's a, yes, you have a good point.

Olivier Ezratty: Fanny asked you about your initial funding, but I presume you're interested as well in the other funding source, as the company was growing, or did you get funding through your customers in a classical way?

Mathieu Munsch: We did that too. But so going back to history with this founder team and the first hires, we developed the first product. And in 2019, we're about to ship the first product and we raise our first round by Venture Capsule. In particular, I want to mention Quanto Nation, who you know very well. They are everywhere. Yes, it's a VC fund completely dedicated to quantification. They were absolutely instrumental. in our ability to raise funds in this world because they have this interesting mix of scientists and financial backgrounds. So in our case, they gave the yes on, is this technologically legit? And with that yes from AVC, we could convince the others that we're all kind of interesting, but not sure what's the trick here. How can it be so nice? So yeah, we had a round with them. We had another round two years later. We raised the third round last year. So venture capital was definitely important and a part of our growth strategy.

Olivier Ezratty: What's your total funding, if it's public?

Mathieu Munsch: It's not public, but I can say that we have probably been able to raise some venture capital amount and generated our own sales for almost an equal amount.

Olivier Ezratty: one last question about the Basel ecosystem. It's developing QAI ventures, and the procurement of the IonQ quantum computer.

Mathieu Munsch: I think in Switzerland there's both a lot of great things that are happening and also some more annoying things. On the annoying side, Switzerland, was not part of Europe. We're going to be back this year, hopefully, touching wood, crossing my fingers. But we were not part of the EU anymore in terms of all the research that is going on. And that really impacted the research here and the collaborations, like the continental collaborations that we could set up. So that was really bad. And another thing, which is, a specificity of Switzerland, we don't make, big industrial investments. There is in Switzerland an important, role, which is that there is no unfair competition. We're not going to privilege this company or this industry over another one. Quantum has grown really big in Switzerland. It's really having research, but the transfer to the industry is a little more complicated. There is no big program here. Here, fortunately, there are people. There is a Swiss quantum commission now. headed by Nicolas Gisan, who you may know from Geneva, one of the pioneers in quantum communication and cryptography. They're doing their best effort to develop a quantum program in Switzerland, but this has lagged behind France or Germany, to only give these two examples. That's not, ideal. On the other hand, there are a growing number of quantum companies, in particular over the last years. In Basel specifically, there is the ecosystem that you mentioned, Quantum Basel, QAI, and this is really interesting because those people are taking the problem from the other side. They are bringing money. They are thinking, okay, how do we use this money to go fast? And they have been extremely successful at creating collaborations all around the world, bringing American companies here, bringing physical quantum computers here. So I think this is a great development, and I'm looking forward to how this continues.

Olivier Ezratty: I was there at an event, a QAI venture, back in October in 2023. I saw many European companies and German companies were establishing an office there, like Kipu Quantum, in Basel. So usually when you go in a given location, you either are attracted by the local market, by the local talent, the local money, or whatever. What's the mix you think which makes Basel interesting here?

Mathieu Munsch: I think it's this vision from Quantum Basel to create a very specific ecosystem with a lot of quantum companies, a direct access to quantum computing infrastructure so that you can run calculation, do tests for all the peripherals. Like, you know, quantum is a very complex ecosystem. So not everybody's building a quantum computer. Many people would like to access a quantum computer. So I think one of their key approach is that they're trying to make this easy. And they're also trying to figure out how they can be. Support it in the best possible way. I think there is still a lot to do and they are still improving their offer and their value proposition. over time. So, yeah, Switzerland is not an end market, like a huge end market, right? So this is not the reason. I think it really is for the ecosystem that they're trying to create here.

Fanny Bouton: Thank you, Mathieu. It was our 81st episode of Decode Quantum with Olivier Ezratty and Mathieu Munch from Qnami and myself, Fanny Bouton.

*PS: Fanny Bouton and I have been hosting the **Decode Quantum podcast series** since 2020. We do this pro-bono, without an economic model. This is not our main activity. Fanny Bouton and I are active in the ecosystem in several ways: she is the "quantum lead" at OVHcloud and I am an author, teacher (EPITA, CentraleSupelec, ENS Paris Saclay, etc.), trainer, independent researcher, technical expert with various organizations (Bpifrance, the ANR, the French Academy of Technologies, etc.) and also a cofounder of the Quantum Energy Initiative.*

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