Pasqal Analyst Day | June 30, 2026

Wasiq Bokhari, Pasqal CEO:

Okay, welcome everyone. It's great to have everybody here. We are very excited to have this opportunity to introduce Pasqal and talk a bit about all the work that we've been doing.

Before we get started, I want to make some introductions. I want to start with an acknowledgement. We have our partners from Bleichroeder here, and I would like to acknowledge Marcello here, and then we have other members of the Bleichroeder team here as well. These are our partners.

And with that, before I do a personal introduction, before we go into introduction to Pasqal, I would like to ask my colleagues to provide a brief introduction to themselves. So starting with Loïc, our CTO.

Loïc Henriet, Pasqal CTO:

Hello everyone. Very happy to meet you. I am Loïc Henriet. I'm an engineer and a physicist by training. I've been spending the last 12 years working on quantum computing, first in the academia, and then at Pasqal for the last seven years as a founding member. And I'm the CTO of the company. Happy to meet you.

Stéphane Rougeot, Pasqal CFO:

Good morning everyone. So I'm Stéphane Rougeot. I'm the CFO of the company. You may have seen the announcement that came out yesterday, so it's pretty recent. And I've been CFO of listed companies for the last 25 or more years. Always at the crossroads of corporate finance, business, and how to scale and transform company and grow the business, and then technology.

And I was CFO of a listed company out of Europe. I did the IPO of Thomson back in the days, not Thomson Reuters, but Thomson Multimedia in Paris and New York at the end of the '90s. So a long career.

I'm very excited to join Pasqal and scale the company and exploit all the leadership that you're going to hear about today. So great to be with you today.

Wasiq Bokhari, Pasqal CEO:

Thank you. And I would like to also introduce Mark Armstrong, our chief commercial officer. He brings a long, distinguished career from HPE.

Mark Armstrong, Pasqal CCO:

Yeah. Good morning everyone. And yeah, as Wasiq says, it's about day two for me. So the announcement's not yet here, but very excited to join Pasqal. I had a long career at Hewlett Packard Enterprise. For the last five years, I ran their AI and HPC business across Europe, Middle East, Africa, which I think has got some interesting similarities to this industry. And I'm looking forward to having success and working with the team. So nice to meet you. Thank you.

Wasiq Bokhari, Pasqal:

Thank you very much. So this slide shows, that's a photograph of our quantum processor. We have multiple of these commercially deployed across the world. This beautiful machine is 10 feet by seven feet by six feet, and it requires less than four kilowatts of power, and it goes into standard data centers. For us, quantum computing is a reality today. It is not something in the future.

I'm going to start with the three most important things that we are going to talk about in this presentation. These are the key takeaways. So I'm going to tell you what we are about to tell you in the whole presentation, and then we will go into more details. The first thing: we are focused exclusively on quantum computing. We believe this is the most important sector, the most demanding sector, the sector with the greatest opportunities out of all the possibilities of quantum technologies. And we believe it requires relentless focus on this to build the right systems that result in world-class computing systems. That's the first message I want to get across.

Now, building on that. We are a global leader in industrialized and operational, high-complexity quantum computers. So I have a couple of words in there that I just want to talk about: industrialized, high-complexity, operational quantum computers.

So let's start with high complexity. We can make quantum computers which have one qubit, two qubits, 10 qubits. These are not high-complexity quantum computers because we can simulate them on existing classical computers. So they're interesting from maybe some R&D or educational point of view, but they cannot do useful workloads. Only when you start to get beyond 100 qubits, and our commercial systems are 100 to 200-plus qubits, only then can you do work that you cannot do on any other form of compute. So that's the high-complexity part.

Industrialized, that's another very important vector. Many universities with brilliant people will create lab systems. These are one-off systems, and these systems are meant to showcase something, but they are not meant to be deployed in a useful environment. Industrialization means that you have to think about the key attributes of compute at scale. These attributes are reliability, scalability, the supply chain, unit economics, redundancy. You have to think from an engineering's systems principle, and that is a very hard road to take.

We took this decision years ago, in the infancy of our history, that we will not ship lab equipment. It was a deliberate decision. We said we will engineer our systems properly, even if it means that we go a little bit slower, but if this results in us delivering actual compute systems that can stand alongside traditional HPC and now GPU-based compute, then we have achieved our mission, and that's exactly what we did. We are one of the very few companies in quantum computing world who have actually crossed this threshold of properly engineered systems. So that's the second item in that headline.

The third one is operational, which is a very important point. If you build well-engineered systems and these are high-complexity quantum computers, they have to be able to be deployed in standard data centers and work reliably, and we have a track record of that. So with that clarification, here's where we are. We believe, after IBM, we have the second- highest number of high-complexity quantum computers deployed in the world. We are a much younger, much smaller company, and we are very proud of this fact. We have seven of such units, all between 100 to 200-plus qubits, operating across three continents, and we have an established track record in terms of their operational capabilities.

And all of our QPUs operate without deep cryogenic systems, which is a really big advantage. They can go into standard data centers. The room that they stay in is identical to the rooms that the standard CPU and GPU racks are installed in. This is a major advantage that we have. So that's point number one that I want to talk about.

Point number two: we deliver useful quantum computing today. There is an inherent advantage in the way we build quantum computers based on neutral atoms, and the advantage is this: it gives us the best of both worlds. What do I mean by that? It means we can deliver full analog quantum computing today, with which we are solving business problems today, and the same hardware, literally the same hardware platform, gives you cutting-edge, industry-leading, fault-tolerant quantum computing with the same specs and the same timelines as any other company. This is a very powerful advantage that we have.

But here are some specifics on this. We are one of few companies that have actually delivered more than 1,000 physical qubits. These are the highest quality, fully connected quantum qubits, one of the very few. We expect to deliver at least 10,000 physical qubits per single machine by 2029 and on the same machines, the same hardware platform, we will deliver at least 200 logical qubits with six nines of fidelity. So the same hardware approach gives you the best of both worlds. Really important point.

I talked about analog and I talked about FTQC, and I'll talk a little bit more about that. But one of the big things that we have shown recently is that we showed rigorous quantum advantage in the simulation of real-world materials. This is a really important result that just came out a couple of months ago, and we can share the arXiv paper on this. So that's the second point I wanted to share. We deliver the best of both worlds today and tomorrow on the same hardware platform.

Number three: as a business, we do not boil the ocean when it comes to solving problems. We are not just a tool looking for a problem. We made a deliberate analysis multiple years ago, and we identified specific mathematical problems that we have an unfair advantage in solving over any other form of compute, and we map those problems to important industry problems in specific verticals, and that's what we focus on.

In the end, we all agree quantum computing is computing. It has to solve a problem. Customers don't care whether it's a quantum computer, or a GPU, or what kind of quantum computer. They just want the problem solved. So our focus has been laser-focused on finding the problems where we can solve it today, deliver a business value proposition, and this allows us to go deep and solve those problems today.

So our approach is very different. Instead of boiling the ocean, we hyper-focus, and we have picked three sectors. First sector is energy, or oil and gas. Our reference customer there is Saudi Aramco, and I'll talk about the use cases there. Second is financial services, and our reference customer there is Crédit Agricole. You might have seen the beautiful press release that came out today, just prior to our meeting here today. And the third is specialty materials, which is in line with what we demonstrated for quantum advantage. This focus, this readiness, and this inherent advantage of our technology approach allows us to build a business and a backlog today. These are the three key messages I wanted to share with you before the start of the presentation.

If you just focus on the left-hand side of this presentation, I just want to highlight a couple of things. We are one of the few companies in the whole world, in any sector, that have been founded by a Nobel Laureate, and it’s just not any Nobel Laureate. It is Professor Alain Aspect. He’s the Nobel Laureate in quantum physics. He’s the person who experimentally proved quantum entanglement and, therefore, started the whole field of quantum information sciences. We are a deeply technical team with 70-plus, actually much more, PhDs throughout the company.

On the right-hand side, we are headquartered in France, but we are a global company. We have operations in Canada, in US, in Saudi Arabia, in South Korea, because we have deep customer engagements in those areas. And of course, we are backed by high-quality clients, partners, and investors.

So I talked about this. Let me just summarize differentiators. Number one: commercially ready today. Really important point. Number two: the same approach, same hardware platform, solves problems today and gives a future to our customers. Now, why is that important? Two reasons. Number one: we need to earn trust with customers to show them that we deliver value and that is a process we are able to start right now based on the maturity for our systems and our focus on areas where we can deliver value. Second, this reduces risks for our customers because once they commit to our hardware platform, our software platform, they know that they will not risk obsolescence because the same system will meet and deliver the best FTQC requirements as well.

Loïc will talk about this slide in much more detail, but what I wanted to share with you here is something which we are very proud of. We published this roadmap more than two years ago, I think almost three years ago now, and we have delivered each and every element either on time or ahead of time. When we make a promise, we deliver, we execute, and we don't make idle promises. We believe this is a unique strength of our culture and our approach. And when we talk about what we will deliver by the end of the decade, we bring the same level of earnestness and seriousness to those promises, and we'll talk more about in terms of what the technology roadmap looks like.

Professor Alain Aspect, Nobel Laureate; Professor Antoine Browaeys, the co-inventor of the neutral atom space itself; and Georges-Olivier Reymond, the first person to trap a neutral atom. What I'm trying to say is that the history of the neutral atom space is the history of Pasqal and its co-founders. The modality that is now considered to be perhaps the most promising modality to create quantum computers is the history of Pasqal. The most important thing, if you look about it, trapping of neutral atoms, the basic principle of creating quantum entanglement in neutral atom systems, is the Rydberg blockade discovered by Professor Antoine Browaeys. Quantum simulation, his work.

You go to the right. After our founding, we deployed our first commercial quantum computer in 2022, four years ago. So we have a lot of operating history. And recently, we announced this result in quantum advantage on TNCO, and we also did a formal inauguration of our QPU at Aramco, which is installed in their Tier 1 data center in the Dhahran, operating autonomously and reliably. Let me talk about quantum advantage for a second. People talk about this term a lot, and I'll just make some high-level remarks and then we'll talk in more detail about this. Last year, we wrote what we believe was the first paper with IBM on a scientifically rigorous definition of quantum advantage for material simulations, and that was intentional because we wanted to set a scientifically rigorous bar and a standard that everybody would adhere to.

When we look at all the results and news that comes out around how quantum computers outperform non-quantum computers, we look at those problems in three different buckets. The first one is math for the sake of doing math. It's basically a problem which is, in some sense, an artificial problem. It may be interesting academically, but it's not something that you would actually use in the real world, and for that you can run different tests and benchmarks and can show that, yes, quantum computers will do it really well, but they have no practical use. But we are very pragmatic people. We want to create a new form of compute.

The second class problems is what I call toy simulation problem. So you take a real material and you hyper-simplify it, come up with a toy model for that, and then you run it and you see whether you can outperform the classical compute, and you can see various results there, but none of them have crossed the threshold of getting into the quantum realm.

Starting this year, there's two important results that came out. The first one was by IBM, and this paper was about potassium copper fluoride, and in the paper, they acknowledge that this result can be replicated using classical computing, so it's actually not demonstrative of quantum advantage. Our paper, which we co-wrote for Los Alamos National Lab, clearly demonstrates that we are in the area of, in the realm of, quantum advantage. I'm going to talk more about this. And that really signifies our approach always is practical, usable, demonstrable quantum computing and its benefits. Everybody in this room knows this, which is quantum computers are not going to replace existing computers. They are going to work seamlessly with CPUs and GPU-based compute. But at the heart of it, and Loïc says it really well, which is what distinguishes quantum computers versus other forms of compute is that, for quantum computers, you give them problems where the problem complexity is high, but the data I/O is relatively low. So where you have many, many different kinds of solutions, and if you find the right solution, that's high problem complexity. Where you have to really simulate material from a quantum mechanical point of view and you cannot use approximations, that's high problem complexity, but the amount of data going back and forth is not very high, which makes them perfect complements to other forms of compute.

But in our case, we can clearly demonstrate which part is being done by the QPU and which part is being done by the CPU or the GPU, and that is precisely how we work. So our systems, they have a native capability of working with other forms of compute. We build the hardware and all the low-level software. So that's your OS, electronics, everything related to the QPU runtime. That's part of our core that we built.

On top of that, we have built this resource coordination layer that allows for that seamless working between CPU and GPU clusters. And on top of that, that you have the application layer with the SDKs, with the mathematical libraries, with the application libraries, and so on. So basically, we provide the whole stack, which makes a turnkey for our customers to start to use this in a useful way, whether we deploy it on-prem or whether they access this through the cloud. Again, this is part of a deliberate thinking of how do you enable compute, not just make quantum computers. And also, if you look at the other side of it, I talked a lot about our hardware, but if you look at our overall patent portfolio, it is almost at parity in terms of the software patents and the hardware patents. So we continue to focus on both areas.

Everybody in the room is also aware of this, which is from the current phase, from utility to advantage, to the fault-tolerant data. So I want to talk about two things here before I get into some details. There are two ways in which you can do quantum computing. One is called analog and the other is fault-tolerant. Analog is not a primitive form of fault-tolerant. It is a completely different way of doing computing.

Here's the analogy. The brain is an analog computer. CPU-based digital computers are the equivalent of fault-tolerant quantum computers. They both solve problems. In fact, the brain solves some problems really, really well, really, really efficiently compared to other computers that we use. So analog and FTQC are completely different ways of computing, and they have their strengths and their challenges, but they are completely complementary.

Quantum annealing is a small subset of analog quantum computing. Here's the analogy. If I look at a landscape and imagine this landscape is your energy landscape, you have flat, or you have hills, or you have valleys and stuff. Quantum annealing is like a train that runs on a track. It is a fixed route. It goes from point A to point B, doesn't go anywhere else. But full analog quantum computing means you have a 4x4 all-terrain vehicle that can just go wherever you want to go, which means you can explore the entire domain of the problem, and you can explore it in a dynamical fashion. This is a really important thing, just like the brain just doesn't do one thing linearly, analog quantum computing solves problems in a general, dynamical way. It is a different paradigm of doing computing, but the beauty for us is the same hardware approach, the same machines give you the best of both. You get this today, and you get that tomorrow at the same spec, same timelines. That's what's unique about Pasqal.

And why can we do that? Because we spent a lot of time industrializing and making our systems commercially ready so they are actually usable as quantum computers, and then it is a switch between analog-to-digital mode or analog-to-FTQC mode. There's a very important implication of that. Everybody has this conception that if you're not doing FTQC, you can only solve certain kinds of optimization problems, but when you do full analog quantum computing, you can solve a much broader class of problems, which means you can do all kinds of material simulations, which currently we think we cannot do, and we can solve really complex optimization problems on top of it. And that is why we are able to go and monetize these applications for these really important customers today.

The market opportunity is very big. Everybody in the room knows these figures. These figures are looking at 2040 time screen, but if you look at, again, the mapping of this to the industries that we look at, very large opportunities for us: financial services, energy, specialty materials, very large end markets, very large opportunities for us. And for us as a business, it's all about getting focus, getting traction, showing commercial value, earning customer trust, and building that flywheel.

With that, I'm going to stop and I'm going to hand it over to Loïc to go into more details about our technology.

Video:

For centuries, we believed the world was predictable. That nature followed simple rules, linear rules, classical rules. But nature was never classical. Nature is quantum. The way plants harvest sunlight to the way molecules form, to the invisible forces shaping our universe. Quantum physics has always been there.

But until now, we've been trying to understand a quantum world with classical machines. And today, we are reaching their limits. Designing medicines, building sustainable energy, optimizing global logistics, discovering new materials. Problems classical computers were never designed to solve. To truly understand nature, we must compute like nature.

Quantum computers built from neutral atoms. Identical qubits. Controlled by light. Designed for real environments. Built to scale. Not just research machines, but industrial quantum computers. Built with software and cloud access. Enabling quantum applications today. Designed to work alongside AI and high-performance computing. Bringing quantum computing into the real world.

Behind every quantum breakthrough are people: Scientists, engineers, developers. Turning decades of physics into technology the world can use. Nature was never classical. The future won't be either. Pasqal. Advancing quantum towards reality.

Loïc Henriet, Pasqal CTO:

So now I will take you under the hood of our quantum computing platform and talk about the technology itself. So our qubits are single atoms of rubidium, and this translates into five key advantages when it comes to compute.

First one is about scalability. We see no fundamental roadblock to reach 10,000 physical qubits and even more. Because we're working with optics and lasers rather than fabricated chips, so we don't have to manufacture our qubits. Nature does that for us. It keeps costs and manufacturing complexity down.

Second, Wasiq talked about that already, is the key strength that we can have dual analog and digital modes on our same hardware platform. So we can run in analog mode to deliver value today while we build for full fault-tolerant quantum computers later down the road. So customers aren't asked to wait for our roadmap to be delivered. They can get something useful right now. Third one: coherence, uniformity, quality. There is no fabrication spread, no defective qubit in the corner of the chip.

Fourth is hybrid classical-quantum. So we are using QPUs alongside CPUs and GPUs.

Fifth one is room temperature, low power. So we don't need a specific infrastructure to make our quantum computing infrastructure work. So no deep cryogenics, only four kilowatts of electricity.

So if you read across to the right, you'll see that each of these translates in practice to lower cost, clean upgrade path to FTQC, best performance, modularity, and very light infrastructure footprint.

So back to our technology and product roadmap, so this is really the single most important chart if we want to understand how we translate our scientific groundings into products and commercial activities.

So I will walk you from the left to the right and, as Wasiq said, what we said we would achieve, we did deliver on time.

So the top band is about the hardware engine, so physical qubits per machine. We went from 200 to 1,000 today, and we're on the path to between 10,000 and 50,000

Loïc Henriet, Pasqal CTO:

... 50,000 qubits before the end of the decade. But I want to be precise here. Raw physical qubits is not the only thing that matters. What will matter in the long run is the number of logical qubits, error collected qubits. On that line, we go from 20 in the relatively short term to 200 by 2029. And very importantly, so this number always needs to come with the number on fidelity. So you have to understand that logical qubits always comes with a fidelity associated with it, otherwise it doesn't mean anything.

And what we are targeting is to reach the MegaQuOp regime, so 10 to the minus six error rates with 200 logical qubits by 2029. In terms of what our customers actually buy, this is the middle band. So those products, they map directly onto the hardware engine. So Orion is shipping today up to 200 quits, very good analog performances. We have Vela, which bring the first quantum advantage use cases to our clients and then Centaurus with early FTQC and Lyra in 2029 with impactful FTQC.

The bottom band is about the software and the upper layers, the libraries that make all of this usable in a computing environment. So hybrid classical quantum programming, Slum integration that we developed alongside IBM and NVIDIA and open source application libraries for simulation, optimization, graph machine learning. We need to have an entire stack to support our users and to have the minimal amount of effort from users so that we integrate into the existing classical stack from standard HPC and AI. So the message I want to leave you with is that this is a roadmap with products that are attached to every stage and with the release cadence that we are following.

Now if you ask what is the best platform positioned for FTQC at scale, what I would say that there are broadly speaking two main categories, two metrics that you want to have a look at. The first one is scale. So the circuits on the left and how scalable the system is. So neutral atoms can reach up to 50,000, as I said, qubits in a single machine, a single vacuum chamber. So this is quite powerful compared to some other technologies and leading technologies around there.

So here we don't need interconnect to reach those numbers. It's really within the single core that we are able to reach that. We think that we'll be able to reach that by 2029. So that's not a marginal lead. It's really an order of magnitude that in the end translates into computing power. The second metrics that you want to have a look at is fidelity. So look at the green curve. Neutral atom error rates are falling fast and have already converged right onto the others.

So historically speaking, when you look back, it's a technology that is relatively younger. So when you compare it to ions and super connecting qubits, of course it took a bit more time to develop and to reach the levels of fidelities that are necessary for quantum error correction to work. But right now we have quota and we are at the levels that is at a level that is required for FTQC. So we combine the scale advantage with quality and this combination that puts neutral atoms in the category of players that are the most likely to win at scale.

So if you want a direct comparison, this is a table that lays us against all the serious alternatives. We can start with scalability. Of course, number of qubits today that have been demonstrated, it's not a roadmap. It's not a plan. It's results that we have demonstrated and published. Connectivity, I think it's one of the most underappreciated metrics on this page. So we have native all-to-all connectivity, meaning that any qubit can communicate with any other one within our vacuum chamber. This is made possible by qubit movement. So you can move a qubit around during the computation while preserving coherence. And actually this feature was also developed by Antoine Browaeys in his lab at Institut d'Optique in Paris and now it's used by most neutral atom labs around the world. So keep going down.

Operating temperature, so room temperature versus deep cryogenics. So it's simpler. The fact that we can move the qubits around, it leads us to a relatively interesting logical overhead. So 100:1 compared to some other typical architectures which are more like 1000:1. And the bottom two rows are ours alone. So dual analog mode of operation and demonstrated quantum advantage on material simulation. I will talk to you about that in a moment.

But one message that I want to emphasize is that when you read that table across, no single row tells you with the story. It's the way each row combines and compound with the other ones that really matter in the end.

So how do we build physically a machine with 1,000 qubits? So everything happens in the greenish cylinder that you can see on the bottom. This is a vacuum chamber and we have a very strong vacuum, so it's 10 to the minus 11 millibar. So it's the pressure that you would find at the surface of the moon and we trap single atoms inside that ultra-high vacuum chamber. To do that, we proceed with three steps. So first we load atoms in an array of troughs that are generated by lasers. The loading is probabilistic. So you begin with the partially filled array as you can see on the top left picture, but then we move individually the atoms around to end up with an array with perfect filling after rearrangement.

So making it work rests on several key ingredients. So first is the optical architecture. So high power lasers, high aperture optics and you want also to have a strategy to rearrange the atoms that works well. So these are deep engineering capabilities that we've developed and that are quite hard to replicate. And the next slide is a result of all of three coming together.

So this is a proof that this works. Those are real images from our machine, not simulations. So each bright dot that you see here is a single rubidium atom and you can count them and more than 1024 qubits on the right image. No defect. So now that we have built large qubit registers, what do we do with them? So there are a variety of use cases and applications in several verticals. We talked about oil and gas, we talked about finance, but I want to deep dive on one very important result, which is related to material science field.

So this is the slide that I would like you to remember. It's quite technical, but I really love it, so I need to talk about it. So it's our single most important scientific results. So it's the first quantum advantage that Pasqal has delivered on a problem that actually matters. And I want to talk about that because it has been 12 years that I've been working towards this result, so I'm quite excited about it.

So let me define quantum advantage carefully. So it means producing a result that a classical computer cannot practically reproduce and these problems needs to be something of interest, something that existed before actually the quantum computer was designed. So the famous early demonstrations, for example, random circuit sampling from Google, they cleared the bar on performance but not on usefulness as was discussed. So what's different here is that we've done it on a material with a real interest.

So you have a picture of this TmMgGa04 magnet on the top left. So this is a real material and this is a frustrated magnet. So what does that mean? It means that you have tiny magnets on the triangular lattice and it is frustrated, meaning that all the constraints cannot be satisfied at once. And this makes it hard for classical computers to describe how this magnet behaves. So the behavior of this whole class of material is actually very difficult even on the most powerful CPUs and GPU clusters to understand. So that's what happened with this particular magnet. The team at Los Alamos National Laboratory was not clear on understanding why this magnet would behave the way it behaved.

That was when put in a very, very complex scientific instrumentation with the low temperature, strong magnetic fields. So what we did is a one-to-one quantum simulation of that material. So that's a strip on the right. We take the real material at the end strong scale. We write down its microscopic magnetic model and then we map this model onto our quantum processor, our quantum simulator. So we're not approximating the physics in a simplified model. What we are doing is that we are reproducing the actual material on the quantum computer and describing really the real model of this magnet.

Now the two charts at the center of the slide. So the top one overlays our quantum simulation results, the green dots against the solid line, which are independent measurements that were taken at MagLab and they match quantitatively, as you can see. You can even see that the system passes through this well-known one third plateau for the magnetization and our machine is able to capture it.

The bottom chart to me is quite amazing. So we have five separate machines, Fresnel Massy one, Fresnel Massy two, Fresnel Canada, Ruby and Jade. Those are five Pasqal machines, three in France, one in Germany, one in Canada, all able to solve that problem. What you have is that they all give the same answer. So raw producibility across independent QPUs is a very hard thing to achieve. It's the difference between the true computing equipment and the lab approaches and the lab experiment that you do once.

So for our users, it makes no difference to understand, to know if they have run their workload on FC1 or FM1. They just launch on their cloud portal. It runs independently somewhere in the world and they can trust the results. So finally, if we were to run the same procedure on classical GPUs, it would take several weeks to get to the same results that we were able to reach in a few hours on our quantum processing units. And even after waiting several weeks on GPUs, there would be no guarantee that the result that you would find would be a converge result. So you would not be able to trust the result that would come out after several weeks compared to something which takes a few hours for us and matches reality.

So when we say that Pasqal has delivered quantum advantage, this is something that is with verifiable evidence behind the claim and it's directly relevant to the field of advanced materials on which we're working. So this is one of the examples of the things that we can do with our analog qubit machines. We can do it right now and the beauty of neutral atom is that actually using the exact same hardware platform, we can also implement logical qubits. So let me turn to that.

So when you scale the system, because physical qubits, however many you have still make errors, you want to be able to correct for the errors. So to run the longest, most valuable computations at scale, you need logical qubits. You need error corrective qubits, you need FTQC. So how do you do that? Well, you put several physical qubits at work together to protect one robust unit of information. So that's the graph on the left. Out of several physical qubits with redundancy, you build one logical qubit.

In order to be able to do that, you need a few ingredients that are listed on the right, robust physical qubits, of course, reliable atomic operations with the very low infidelities, high fidelities, all-to-all connectivity is best. You can manage if you don't have that, but the overhead to pay is quite large in that case. You need fast qubit readout to be able to measure errors and feedback on the system to correct for the errors in real time and then you need a code, so procedure to read out and correct the errors.

So this is what is called the code, the error-connecting code or error-detecting code and there is a lot of work ongoing as to how you build your code with your hardware in mind with the strength of your hardware in mind.

So this is our correction working on our hardware today. So it's not a theory, not a roadmap. It's really something that we did implement. It's what we call the 4.2.2 codes. So four physical qubits plus one flight qubit equals one logical qubit. So you get this ratio. Equal two logical qubit, sorry. So you get this ratio of one to two. So you don't need to follow the circuit at the top. What you want to look at is that the story that is displayed by the histograms at the bottom of the slide.

So on the left, you don't have any procedure, you don't have your detection implemented. And so you see that we land on the correct state about 40% of the time. So what you would like to have ideally is to have the green histogram bars as high as 0.5 on the two left and right sides of this plot, but you see that you get only 40% probability of achieving that. So you have noise, which is spread everywhere. You have wrong outcomes that pop up.

On the right, we have implemented this error detection procedure and you can see that we've enhanced the results because using the parity checks in the 4.2.2 code enabled us to actually detect errors and correct for them. So the probability to reach the correct results is enhanced to 90% in that case. So real results on the hardware. And the nice thing is that we did that, that particular demonstration on the hardware that was used primarily before as an analog machine, the exact same machine which was used to run use cases for our clients was turned into an R&D device for us to develop logical quits and we were able to turn that demonstration relatively quickly.

And after that demonstration, we said, "Okay, so why does it matter commercially?" Well, we did apply it to a real computational task. So we did that to solving differential equations. So differential equations, as you know, they end up in an enormous part of engineering, finance, physics. So we decided to benchmark our logical processor on this particular task, solving differential equation.

So the top chart shows the error distribution. So the frequency at which you get a given error, either on the physical qubit implementation of solving this differential equation or using the logical qubit implementation. As you can see with the green bars, the logical qubits are clearly shifted towards lower errors so it gets beneficial to solve the differential equation using this logical encoding compared to physical encoding alone.

And so the bottom chart, it shows both approaches tracking the true solution because we're not in the regime of quantum advantage. You can do that using a standard classical computer with the logical run is far closer to the actual solution compared to physical qubits. So to our knowledge, this is the first time anywhere in the world that differential equations can be solved using a logical quantum algorithm and we did that with performances that are better than with physical qubits alone.

So let me close this technology session on the system engineering side of things. What I showed you earlier is the versatility of our platform, right? We can actually do analog and digital quantum advantage in material science, logical qubit demonstrations. This is very versatile, but what we're doing is that we are actually transferring this technology advantage into a commercial and engineering advance by defining modular architecture. So the QPU sits at the center and the capabilities that are related to this QPU are shown on the side and you can see that they can be upgraded independently. So that's the thing that counts.

So why do we want to do that? Because on the R&D side, it enables us to decouple the various modules and to accelerate R&D by keeping a fixed set of interfaces so we can accelerate on the technology side. And on the commercial side, customer can increase qubit counts, reduce noise, add addressability, layer digital gates. So that's something that is quite interesting because it doesn't have to replace the entire system. So our existing customers can iterate upgrades as well as our system is very modular. And now we will turn to the demonstration of our product.

Jaap Kautz, Pasqal VP, Products:

Hello, my name is Jaap Kautz, and in this video I will demonstrate how you can use Pasqal's QPU for real life use cases. The two use cases we will discuss in this video are portfolio optimization and material simulation.

Let's start with portfolio automation. This is a problem which often occurs in finance where people want to optimize their portfolio of stocks or bonds to either maximize return or to minimize risk or a combination of both. To show how this problem can be tackled with a quantum computer, we developed a quantum portfolio optimizer, which in background uses a QPU to solve this problem.

When we use this application, we first have to choose which stocks we're interested in. So we can select a number of stocks, we can remove some, we can add some, we can manually add more and then we can choose to either minimize the risk or to find a portfolio which maximizes the return. We'll go somewhere midway. We can run this experiment on a real quantum computer or on an emulator. For the demo, we will first show how the emulator works and then continue with the quantum computer. There's all kinds of advanced settings if you're interested, but if you are not, you can just choose optimize portfolio.

So the first thing the application needs to do is to translate this finance problem into a problem which can be handled by the QPU. The first step is to analyze the stock results of the past two years. From this data, it will calculate an expected return and a standard deviation, so the volatility of the stock. And in addition, it will analyze whether these stocks all move simultaneously or independently and that is depicted in this covariance matrix.

Finally, this covariance matrix is used to build a QUBO matrix and this QUBO matrix is the formulation that our quantum computer understands. So in the background, this job was already submitted to the QPU. If you are a finance person and not interested in how a QPU works, you can just wait and then after a while you get an advice on which stocks to buy. However, for this demo, we will show what happens behind the scenes.

So we'll go to our cloud dashboard. And here you can see that indeed a job was submitted to an emulator and we can see what that job looks like. So in a quantum neutral atom quantum computer, the qubits consists of atoms. So the QUBO formulation which we submitted needs to be translated into some atomic configuration. And what you see here is the positions of the atoms in the QPU. So they're arranged in a plane like this. Then we manipulate these atoms with lasers and what you can see here at the bottom is the intensity of this laser over time.

At the end of this laser pulse, we do a measurement and that's the measurement which is then sent back to the portfolio optimization application. Good. While we wait for this result to complete, we will create a new job and submit it to the QPU. So we create a new job. This time we will select more stocks and as the number of stocks increases and we want to add some weights to the stocks, the number of possible configurations of our portfolio increases dramatically. And with this number of stocks and three bits per stock, we end up with a number of configurations in the order of 10 to the 18th. So that's a billion times a billion different configurations and this is very difficult to analyze classically already. So we'll run it on the QPU because our emulator has a hard time running this as well. We again can choose what the return is we favored. We want to, this time will be a bit more risk averse. We choose to run it on the QPU. We can choose our settings. We want to run it rather fast, so we reduce the number of shots and then we submit it to the QPU. We can look in our dashboard again and there it is.

In the meantime, our previous job has finished, so this is our earlier job with only a few stocks and this is what the results look like. So to understand these results, I'll explain what this graph means. So each item in this graph is a potential configuration of our portfolio. So a set of stocks you could buy and the height of each bar indicates how optimal this configuration is according to our QPU.

So here we see that according to the QPU, this is the code for the most optimal configuration. If we now go back to our portfolio optimization application and we look at our earlier results, then we can see that the stocks we should buy out of these four stocks are Apple and Nvidia. And this will give a return of roughly 18% with a risk of 30% and this is better than what you would've gotten if you would have just randomly selected these stocks.

So this is a great example of how you can use a quantum computer for portfolio optimization. We can see what's happening to the QPU job. We see that it's still running, but secretly I ran this job also before. So here you can see if we have a job with many solutions, many stocks, it also gives an advice of which stocks you should buy and it gives you a distribution for your portfolio which optimizes for either profit or minimized risk.

So this shows you how a finance problem is turned into a QUBO formulation, which is then executed on a QPU. This is already very interesting for finance, but the good thing is that this QUBO formulation is not only used in finance, but is a very generic way to define optimization problems. So it's used in telecommunications, in oil and gas, in logistics, anywhere where you have discrete optimization problems, this QUBO formulation can be used.

The second use case we will discuss today is material simulation. Material simulation is a method to discover the properties of a material without doing measurements in an actual physical lab. This is interesting because this way you can learn the properties of a material which you would like to use for new electronics or for other applications without actually having to measure them in the lab or without even having the material at all. It may not even exist yet.

Material simulation is already actively done on classical computers, but it's computationally very expensive. So it needs a lot of compute power to be able to do this. And what makes it difficult is that the electrons in the material behave according to the laws of quantum mechanics, and this is difficult to simulate classically. However, our quantum computer already has these quantum mechanical laws built in inherently and it's therefore a natural fit to do these simulations on a quantum computer.

And this year we have shown that we did the first simulations of a real material, which were later confirmed in laboratory experiments. The material we investigated is called TMGO and what we were interested in is the magnetic properties of this material. So how strongly magnetic is this material and what happens if you apply an external magnetic field to this material, what happens then to the magnetization?

Material internally consists of atoms and these atoms are arranged in the lattice and on the left here, you see the lattice structure of TMGO. So you see that these atoms are arranged in a hexagonal pattern. And when we do quantum simulation on the neutral atom QPU, we position the atoms in our QPU in such a way that the behavior of the electrons around the atoms in the QPU simulates the behavior of the electrons in the material. So then if we do measurements on the atoms in our QPU, we can predict properties of the real material. And in this case, we're interested in the magnetic properties of this material and we will look at the excitations of the atoms in our QPU, which will give us information about the magnetization of the real material.

So the tool we use for this is Pulser Studio and in this tool we can position atoms in our QPU as we want. So we can increase the number of atoms. We can change the configuration of the lattice from square to triangular. Also, here we can play with the number of atoms, we can change the distances and then we say

that we want to create this pattern in our QPU. We can even manually still move atoms to a different place if we want that.

And now we have the atoms in our QPU, which represent the real world material. Now we were interested in the magnetic properties of our real world material. However, in our QPU, we will not apply a real magnetic field, but instead we will apply a laser pulse and this laser pulse acts as our magnetic field. So it's a fake magnetic field, but the atoms will behave the same way under this laser pulse as the real material would behave under a magnetic field.

We can change the shape of this pulse so we can make it a ramp. And so what we do in this experiment is that we see what happens if we increase the magnetic field over material over time. In reality, we are increasing the laser amplitude over time.

We can emulate this. And the emulation is running and what it will show here is the magnetization of each of the atoms. So all of the atoms are in the zero state at the beginning of the experiment. Then we run the experiment and then you will see that the magnetization changes. And at the end of the experiment there is various states the material could be in. So there could be in this state, there are several atoms excited as you see on the left. And in this state, there's a pair of other atoms excited as you can see on the left. And from these results, we can calculate what the magnetization of the original material would be under this magnetic field. We do this repeatedly for various magnetic fields, and then we can really analyze the complex behavior of this material in a magnetic field.

So we did that and you see the results here. You can see the result here is if we suddenly turn the magnetic field off, how the material behaves, and you can see all kinds of oscillations in the material. And the great thing is that this simulation only took one day while if you would run it on a classical QPU, this simulation would take weeks.

We ran this simulation on several of our deployed QPUs, one in Canada, three in France, one in Germany, and they all show the same results.

Wasiq Bokhari, Pasqal CEO:

So we'll take a Q&A session now. So let me just open up the floor for any questions for Loïc and myself based on what we have shared.

Gary Mobley, StoneX:

Thanks. Thanks for letting me be first. Sure. Gary Mobley with StoneX. You mentioned a number of partnerships in your full stack in the idea of heterogeneous compute, I think you had Nvidia's logo up there. Maybe you can expand as to where you think the puck is going next from hardware perspective for partnerships and related IBM is listed as a partner, but how do you manage that co-opetitious relationship?

Wasiq Bokhari, Pasqal CEO:

I'm going to start with the-

Loïc Henriet, Pasqal CTO:

I can take with the first part on the technical side just to... So as we said, really believe that you want to have an entire compute workflow that uses CPUs, GPUs, and QPUs in the best way possible so that you get the best results in the end. So what we do want to do as an industry and as an ecosystem is to have a unified way of doing that. So that's why I think most of the actors, the big actors in the field want to work together on that when we can think of the QRMI representation, the Slurm plugin that we developed with IBM. So this is joint open source effort that has been done by people from Pasqal, people from IBM, from Nvidia, from people in the academia, because we do believe that there is actually an added benefit for everyone to simplify the life of the user and it will benefit everyone to be able to do that.

So at the technical level, it's really how we think things going.

Wasiq Bokhari, Pasqal CEO:

In general, in this field, we feel that the most important thing to focus on is the customer. If you deliver value to the customer, then you build a business. What we find in the field is that all the leading companies are quite aware of this and we have a very healthy cooperative way of working together. There are many more points of intersection for us to cooperate than not and that is the spirit we bring to this field. And that's why we are able to work with all leading companies.

Gary Mobley, StoneX:

So I noticed on your chart for 2040, optimization was the largest opportunity and I was just wondering if you plan on still delivering analog computers in 2040 or if you're going to be only focusing on fault-tolerant computers.

Loïc Henriet, Pasqal CTO:

That's a good point. It's a good point. It's very hard to predict the state of the field in 2040. So Pasqal is only seven years old. You're asking for rather bold prediction here, but our current understanding is that those machines are very good for doing specific things. Like you have several kinds of classical processors as well, CPUs, GPUs, TPUs, you name it. And you might have several forms of quantum computers also coexisting, several modalities, but also within the same modality, several types. So digital FTQC analog solving each particular problem most efficiently. So yeah, that's our current understanding of the value that analog has and will continue to have in the future alongside FTQC.

John McPeake, Rosenblatt Securities:

Okay. 2040, I don't know if I'm going to be still around. John McPeake from Rosenblatt Securities. You use stocks in the demo on the optimizer for the number, and what I'm curious about is how many variables can be handled by the system and is there a roadmap to add more on the analog compute side?

Loïc Henriet, Pasqal CTO:

That's a very good question. So depending on the optimization problem at hand, the mapping that you have is not the same. So it really depends on the problem itself. The overhead that you have. For the simplest optimization problem, you can have one qubit per one viable, but typically when you have like some constraints, additional things, the number of qubits necessary are larger than that.

But all in all, what we find is that by increasing the number of physical qubits, you will be able to embed more complex instances as time goes by. So that's really our roadmap to try to be able to have many more physical qubits and as well like local control so that you can more easily accommodate for the constraints in the optimization problems and you can solve it in a more native manner on hardware. So that's really the target.

Wasiq Bokhari, Pasqal CEO:

And if I can just add to just that, that is the nature of how we work with our partners because we work very closely with them. As Loïc said, it is very problem specific nd we keep on pushing to a point where we deliver value for them today. And that is the somehow a proprietary nature of the specifics of the problem that we are solving as well for our customers.

John McPeake, Rosenblatt Securities:

I do have a followup on the gate-based side. Some of the people in the room I think listened to QuEra's presentation couple weeks ago, a week ago and they were talking about 1,000 logicals at 9-nines and they're using a similar approach. And I'd love to hear or just contrast/compare your approach and neutral atom to theirs and that's it. Thanks.

Loïc Henriet, Pasqal CTO:

Sure. We've known the QuEra people for a while now. Of course, we are longtime friends. In the academia, I think we have built this field also together so it's very nice to see their progress and what they've done and also what they plan on doing. So first, let me tell you that.

A few differentiators between Pasqal and QuEra though. So we are really building products that we are shipping and that we are operating with all those machines that are operating up there. We are not a research lab, that is quite clear. We don't want to be doing the job of a research lab. So I think when you compare the technology, both companies are working on with rubidium atoms relative with quite a few commonalities between the hardware things. So all the things that you can do with the hardware from QuEra, you'd be able to do that from hardware from Pasqal as well.

And we are working very deep right now and accelerating on FTQC as the commercialization phase of FTQC becomes closer. So that was really our target to decide on when to actually work very strongly on FTQC depending on the advance of the field and right now we are accelerating. So our current roadmap is 200 logical qubits with tend to remain at six error rates by 2029 and we'll make significant efforts to reach that results or actually be earlier than that.

Wasiq Bokhari, Pasqal CEO:

I think again, going back to from our very first slide, we don't focus on one off results. Whatever we commit to, whatever we have delivered is what we can deliver consistently as a compute platform. That's what we focus on. That's a big difference.

Troy Jensen, Cantor Fitzgerald:

Hey, this is Troy from Cantor Fitzgerald. So a couple questions following up on John too, on optimization. So I guess from my perspective, I guess I know of two, right? There's differential equations or there optimization equations. I thought you guys talked about both during your presentations. Can you just help me out with what do you guys best equip to? I would assume it was more optimization and are there others outside of those two?

Wasiq Bokhari, Pasqal CEO:

Let me give you a high level just again, we have to break out of the... We are not quantum annealing, right? Quantum annealing is small, small subset of analog. So we can do optimization and material simulation and many of the problems. So that's why we can talk about all of those. So with that, I'll just hand it off to you if you want to talk more about this.

Loïc Henriet, Pasqal CTO:

Sure. Yeah. Using our analog approaches solving QUBO optimization, so discrete optimization problems is something that we can do relatively broadly right now as of today. The showcase that I displayed here with solving differential equations is not done with the same kind of algorithm. It's done with a quantum kernel, so kind of machine learning like algorithm under the hood. So it's not a discrete optimization problem that we are solving.

So typically the things that we are solving right now, they fall into three main categories. First is like quantum simulation. So when you simulate a quantum mechanical behavior, materials, chemistry. Second is discrete optimization and third is machine learning related in particular when the data is structured under the form of graphs. So you have those three algorithmic primitives that are implementable on our analog hardware right now. So all the algorithms, all the use cases that you can see, they all fall within these three categories and that's what we're working on.

Troy Jensen, Cantor Fitzgerald:

Okay. Thank you. And then also if you just look at the logical, physical to logical ratio, it looks like you guys are at about 500 to 1 right now, right? A thousand physical and two logical. Can you just talk about, can you guys get that number, that ratio better for you? What's the ultimate goal that you guys think you can reach?

Loïc Henriet, Pasqal CTO:

Sure, of course. So the thousand physical qubits has been demonstrated on one particular quantum processing unit on which we have not implemented our detection or correction procedures. If we would have done so we'd have like a 2 to 1 ratio, so 500 logical qubits. But it would not make sense. We would not be able to do anything with that because the number of logical qubits, as I said, is not the only thing that matters. The thing that matters that you combine those number of logical qubits with fidelities and operations like magistrate distillations, so on, everything, all the machinery that has to come. So we could have made a demonstration that would not have been very useful of 500 relatively low quality logical qubits, but that's not what we decided to do.

On the other side, we used a smaller scale processor with better fidelity operations to actually demonstrate these two logical qubits and outperform on our benchmark, which was solving differential equation, logical compared to physical.

So to your question, I think there are many moving pieces. You always need to have number of logical qubits with the fidelity. This is really key as well as what is the code, what are the things that you are using for that. And right now what we're targeting is a ratio of 1 to 100 on our roadmap in terms of overhead. We might be some improvements there. There is a lot of work going on, including from ourselves, but our target for the moment is 1 to 100 in relatively short term.

Troy Jensen, Cantor Fitzgerald:

Just last one for me. How important is error correction when you guys get to 6-nines reliability?

Loïc Henriet, Pasqal CTO:

Yeah. Yeah. Well, the 6-nines is when you're measuring logical fidelity. So it's that at the logical level, the 6-nines, right? So what you have to understand with the quantum correction is that there is a threshold effect, right? So what does it mean? It means that there is a fidelity that depends on the code that you're using. If you are below this fidelity, correcting error will not help you. The overhead that you have to pay is too large, it's not worth it. You should rather do it with, compute with physical qubits, right?

If you are on the other side, then the benefits start to kick in and it's exponential the way you gain from error correction if you are further and further away from that threshold. That's really the idea. And so this 10 to the minus six error rates is when we'll be able to reach levels of physical fidelities that are on the good side of the threshold, to be able to lower the fidelity to 10 to the minus six error rates.

So why is that number of 200 logical qubits ten to the minus six error rates interesting? Because it's what we call the MegaQuOps regime where you can pile up like a million or few million operations at the logical level, and with that we believe that we'll be able to have the first real meaningful quantum advantage applications of logical qubits. It's at that moment. I guess there is a relative consensus in the field about that at the moment. Of course, there are advances in algorithms, in hardware development, so we'll see in the future.

Jesse Sobelson, BTIG:

Hey guys, Jesse Sobelson with the BTIG. So what's the current two qubit gate fidelity on your machine today? And then what is the threshold that's needed for the Vela and Centaurus code to break even?

Loïc Henriet, Pasqal CTO:

Right. So 99.4% peak fidelity on our machine, it's currently under review. It's an archive paper, but you have measurements that you can find on the supplementary material of the paper about this 99.4% two qubit gate fidelity. So I'm talking about the most difficult one, the single qubit gates are better than that. And typically what we want to be able to do is like 10,000 physical qubits, 99.9% two qubit gate fidelities to be able to be below threshold and reach this level that I was talking about, the MegaQuOps regime.

Jesse Sobelson, BTIG:

Thanks. And then just back on the analog piece of things, can you give me an example of what near term analog simulation problems we might be able to solve that would be commercially useful? And then how far analog simulation is expected to scale before we need to start incorporating error detection or correction, or if we even need to get to a point where we're solving molecules as complex as say FeMoco?

Loïc Henriet, Pasqal CTO:

Right. I think FeMoco now is maybe not the right benchmark because of the classical advances that occurred a few weeks back. But leaving aside that problem in material simulation, I would say that right now is actually already good enough to use our machines as a scientific and industrial quantum material discovery engine alongside CPUs and GPUs. So several hundreds of physical qubits is enough to be able to have something that is quite interesting and can be used commercially.

We will expand materials. So that's the broad area and we have demonstrated magnetism, like 2D magnetism. So that's the baseline and we want to expand, continue working on that particular field and we believe that with Vela and the next generations of machine, we'll be able to expand the span of problems that we can tackle using analog machines. So this is on material science.

Of course, you can add error mitigation strategies, error detection, like combination of analog and digital without needing to have like full FTQCs and that's clearly on our roadmap. And that's what I meant when I answered the previous question that actually we believe that analog will continue to coexist and we are investing a lot on that because of those particular tools that make it richer in the kinds of problem that we can solve.

David Williams, Needham:

David Williams from Needham. Just wanted to see if you could talk maybe a little bit more about your modular architecture. You talked about being upgradable and giving both platforms of analog and the digital, but maybe just talk a little bit about that modular platform, what it looks like, and how do you see that progressing over time?

Loïc Henriet, Pasqal CTO:

Yeah. So that's a very good question. So typically what we have is that we have a modularity at the physical level as well as at the functional level here, it's the displays that we are at the functional level where you have some functions that can be addressed by given modules and you can add those functions to the quantum posting unit. In real life, it's more at the physical level that you have the modularity, meaning that being able to have modules that have a set of interfaces that are well-defined between and one another so that you can decouple the R&D timelines as well as like the upgrade path for all of them.

So that's typically the idea that we have started to develop and that we are continuing to invest on. That's really something and yeah we believe it has both value from ourselves at the R&D level and also for our customers.

Wasiq Bokhari, Pasqal CEO:

There's a question back there.

Suji Desilva, Roth Capital Partners:

Hi, Suji Desilva, Roth. The follow-up on Dave's question. Is that capability to have these modules distinct like that? Is that relatively unique to Pasqal? Is that something other quantum companies can implement? If you could help us understand maybe what you did differently there that's an advantage for you guys, that'd be helpful.

Loïc Henriet, Pasqal CTO:

Right. Well, I don't know all the roadmaps and all the plans on the systems of all our competitors, but what I can say is that of course we have actually worked a lot on that problem to actually make sure that we can make it a reality. And that's something that might be also doable relatively easily with the neutral atoms, where you have this particular architecture where you don't have a chip that is engraved and if it doesn't answer to your specific ask, you have to build a new one. For us, we build the register depending on the computation that you want to do.

So for example, when I take the example of the demonstration that was done on a logical qubit, solving differential equations, for that we needed several zones, like an entangling zone, a zone that was storage. So the register was split in several kinds of zones, right? And so for that, it's a specific requirement for digital FTQC related development. And so we were able to do that because actually the architecture is not fixed, the qubit layout is not fixed. So you are able to do that to upgrade or to change your machine because there is a lot of versatility. And we did that on the exact same hardware platform on which we did implement a QUBO optimization problem for which you don't need those zones. You don't need actually all the same sets of lasers. So that's one key thing with the technology itself that enables us to do that.

Ryan Choi, Bank of America:

Hey guys, thanks for taking my question. Ryan Choi from Bank of America. So you guys laid out a roadmap three years ago, hit every goal on time or if not earlier, very impressive. But when you think about 2029 and delivering your fault-tolerant computer, how should we think about that timeline potentially getting compressed, whether it be with using AI in your research process or whatnot. And broadly speaking, like industry wise, is that also something that your team is potentially anticipating? Have a follow-up.

Loïc Henriet, Pasqal CTO:

Yeah, that's a very good question. I've been working in this particular field for quite some time now and I have been impressed actually by the pace of development of the entire industry towards FTQC, which is really, really fascinating to see, both on the academia and also in the industries with many players that are really delivering great results every day. So that being said, I think our estimates are being challenged in the good way now and there might be some way to actually accelerate. So we are working on that on our roadmap to try and see if we can do that.

Ryan Choi, Bank of America:

That's very helpful.

Wasiq Bokhari, Pasqal CEO:

And just on that, because there's overall development in the field, we benefit from that as well. So if everybody's accelerating, then we benefit from that as well.

Ryan Choi, Bank of America:

Got it. And I guess on the flip side, when you think about risks and challenges that also lie in your path and that timeline of 2029 being elongated, what are the key risks for your team at Pasqal? And it would be helpful to hear specific technical challenges that you've identified and have a plan to mitigate and address.

Loïc Henriet, Pasqal CTO:

So I could name many technical challenges of course. So for us, I would say one thing that has been top of mind for us, and I guess for most neutral atom providers out there, is the fact that this technology could be seen as slow compared to some other technologies. Why? Because you need to count photons when you measure the qubits, right? And so you have a camera, you just count the number of photons that you collect and this tells you if it's a zero or if it's a one. And this is a slow process. So that's actually what makes quantum computing as of today relatively slow with neutral atoms compared to some other competitors.

This has been top of mind for many people in the field and there are ways to actually accelerate that. Because when you think about it, the thing that actually matters is the gate speed or the time it takes to actually compute and this is really the final bottleneck as to what speed I can reach. And when you think about the time it takes for to qubit gate and neutral atoms, it's actually quite competitive compared to some other changes. The fact that we were slow is related to the fact that measurement itself was taking like the entire time budget available.

So actually measurement speed, clock rate is one thing that was one of the main challenges, still is. There are good results from the scale from other teams actually are working on that and this is one important thing to actually overcome. I'm confident that we'll see results in the next years. And related to that is, well, being able to actually do quantum error correction in a fast way because you need to acquire results on cameras and feedback on the system very rapidly. This is kind of related issue.

Wasiq Bokhari, Pasqal CEO:

It's more of an engineering-

Loïc Henriet, Pasqal CTO:

It is.

Wasiq Bokhari, Pasqal CEO:

... versus any side effect.

Loïc Henriet, Pasqal CTO:

On the scientific side-

Wasiq Bokhari, Pasqal CEO:

There's no-

Loïc Henriet, Pasqal CTO:

… we don't see any roadblock. There are obstacles at the engineering perspective, of course. It's not an easy thing, but we're getting there.

Kevin Garrigan, Jefferies:

Yeah. Hey guys, Kevin Gary from Jefferies. So you talked about being a full stack company and we've heard a few other quantum computing companies use that phrase. So just looking at the software side of things, can you just talk a little bit more about how you differentiate there? And is your plan to kind of put a ton of R&D dollars towards developing software and be the best at a certain application?

Wasiq Bokhari, Pasqal CEO:

We can talk about the low level then talk about the high level?

Loïc Henriet, Pasqal CTO:

Yeah.

So we do have our own operating system, of course, for like embedded software and so on, which is something that is proprietary that we built to assemble and to orchestrate all the magnificent equipment that we have on the hardware level. And then on top of that, you have like software layers and middleware to talk to that hardware. So on that we have a specific modality in the way that there is this analog control that is not like widespread. So we had to develop on our own the way to communicate with our hardware. This is a Python library, which is called Pulser, open-source. Many people are working on it, researchers from all around the globe. We are the primary developers of that, but it is open-source. And so this is like the gateway to our hardware, relatively low level, pulse level control, but not calibration dependent.

On top of that, we've built libraries that abstract away the complexity of the hardware layer by layer. So you have Pulser, which is the API, you have algorithmic primitives, optimization, material, machine learning. On top of that we are building application layer so that people who are using our hardware don't have to care about the hardware itself, the way to program it, but can input like the domain problem specific data.

So that's the target that we are developing right now in collaboration with our partners. And large part of our stack above Pulser is open-source.

Nehal Chokshi, Northland Capital Markets:

Nehal Chokshi, Northland Capital Markets. Loïc, you mentioned that there's a certain threshold at which you start to see benefits of error correction in terms of the physical two-qubit gate fidelity. What is that threshold? And let's use 10 to the negative six logical error rate as the target for that.

Loïc Henriet, Pasqal CTO:

Yeah. It's a very interesting question, but I'm afraid there is no definite answer to that question because it depends on the code that you're using. So a threshold is attached to a code. So the surface code, which is the most well-known code, typically the threshold is like if you reach fidelities that are above 99% fidelities for all operations, including two-qubit gates. Surface code is like that. But then there are other types of codes for which the threshold is not the same. And so the field, what we are trying to do is to develop the codes that are interesting and good from this threshold perspective, so that it's relatively easy to be above the threshold, but at the same time can be implemented on the hardware architecture that we have. So it's the code design approach, between the code and the hardware, to try to find the best match so that we can have operations that are above this threshold.

So on our roadmap, there is no specific code that is attached to this result. So we are still working on finding the best match between the hardware architecture itself and the code that we'll use. There are many candidates for that and it's still open.

Nehal Chokshi, Northland Capital Markets:

So as you explore these different codes though, would you expect that threshold to be even lower or higher than the 99% on the surface code that you talked about just now?

Loïc Henriet, Pasqal CTO:

We'll see. We'll see.

Nehal Chokshi, Northland Capital Markets:

We'll see. Okay. And so at the 99.4% fidelity that you're at with the two-qubit gate fidelity, do you see a need to further improve that at this point in time?

Loïc Henriet, Pasqal CTO:

Yes. Our target, as I said earlier, is to have this 10 to domestics error rate that we can achieve with 10,000 physical qubits, 99.9% two-qubit gate.

Nehal Chokshi, Northland Capital Markets:

But that 10 to the negative six is on a logical error rate basis, on a physical-

Loïc Henriet, Pasqal CTO:

99.9.

Nehal Chokshi, Northland Capital Markets:

Got it. Okay.

Loïc Henriet, Pasqal CTO:

Three 9's.

Nehal Chokshi, Northland Capital Markets:

Thanks.

Jeff Grossman, Solebury:

I think we're going to take one last question for this section then Wasiq and Stephane are going to do another section afterwards, but we're going to do a quick break after this question here?

Julian Frost, Wedbush Securities:

Thanks. Julian Frost with Wedbush Securities. So earlier we were comparing modalities a bit. You talked about how currently with fidelities, trapped ion is the best, then super conducting then neutral atom, but you're closing the gap and you believe that neutral is on track to pass them both for fidelity. So I'm wondering if you could just expand on what do you think the key difference maker milestone is that will cause that leapfrog? And if you believe trapped ion and superconducting won't have an answer to it or just what's going to cause that jump if there's something specific you can point to? And if this is for your existing analog architecture or the fundamentally new, more error corrected architecture on the roadmap? Thank you.

Loïc Henriet, Pasqal CTO:

That's a good question. So actually I think going back in time, I can explain the fact that we had relatively lower fidelities compared to trapped ions, which is easier to compare with because it's atomic species, laser control and so on. No manufacturing defect. I would say there are two factors. First one is understanding the system itself. Error model, understanding where the error was coming from actually. So there was something that was not so clear in the community 10 years ago to understand was it laser phase noise? Was it intensity? What was the thing that was causing this error to be relatively high compared to our competitors? That was 10 years ago. The second thing is that maybe in terms of the maturity of our equipment to drive those qubits, including lasers, was not as high because it was a more recent field. So the supply chain was also less robust and there were things to discover.

So going forward, I think now we understand completely our system. I've not talked about that, but we have extremely good understanding at Pasqal, but as a field of the major error sources that are there and the rest will come from enhancing our laser systems, optical systems to be able to have homogenous fields, strong intensity, low phase noise, so all of this. I don't see any obstacle to 99.9% as I said earlier.

Ankit Hira, Solebury:

That concludes our first Q&A session. We now have a 15-minute break. Please return back here by 10:20am. Thank you

Loïc Henriet, Pasqal CTO:

Thank you.

Wasiq Bokhari, Pasqal CEO:

Okay, thank you very much. I think we are reconvening. So just to recap what we've discussed so far, actually we were having this informal discussion just prior to this session and maybe I'll just say it explicitly, there's a prevalent mental model that quantum computing can only be done in one way, which is FTQC. So what we've communicated is that there's two completely different ways of doing quantum computing, which is full analog, which is a super, super set of quantum annealing and FTQC. So that's the first key point. Just like the brain is an analog system, it's not your computer and it doesn't work... I mean, it does pretty well. So there's complete different ways of doing computing, that's the first.

And the second is Pasqal, same hardware gives you best of both worlds. It's a really unique feature that we have. We believe we are the company that has most properly explored the potential of neutral atoms by paying attention to both of these modalities of doing computing and by building well engineered, commercially ready, commercially deployed systems. I just want to recap that part of it. So that's where I'm going to start.

So this leads us to the next thing in terms of what we sell, how we sell, and why does it work for the customers? So what we sell are three things. We sell our quantum computers, our QPUs, people buy it directly, or our systems are available through the cloud and whenever I say I sell, we sell our QPUs, I mean it's the hardware and the software stack, the libraries that we talked about earlier. Same thing with cloud access, you get access to the underlying compute to the entire software stack on top of it. And the third thing is built on top of the hardware, the software layer, we build solutions and that's what we work on in conjunction with our end customers, because remember our focus is not to boil the ocean, it's to solve specific problems that are high value problems today, which we can monetize today and this gives us a ramp and a bridge to the future as well.

How we sell this, two ways. Mostly direct sales. So when we sell our systems, we sell them directly to our end customers who could be sovereign customers, large enterprises, and public sector customers, so they buy directly from us. Same thing applies to cloud. Cloud access is sold directly primarily to enterprises and that is the lowest barrier to entry for them, easiest way for them to get in and to ramp up their utilization. We also have deep relationships with Microsoft and Google where our quantum compute and the software stack is available through GCP and Azure. It's available today. We have OVHcloud, Scaleway, and multiple other venues also available in which you can get cloud access to our quantum compute. In fact, you can go to our website and sign up for your cloud account and it'll take you 15 minutes or less and you'll be playing with our quantum computers.

So we have literally taken all the mystery and the barrier out of this. What we showed in the previous example for the portfolio optimization, if we did not tell you that it was a quantum computer doing the compute in the backend, you would not know, you would actually not care, but you're just solving the problem and that's the level of reduction of barrier of entry that we aim for because in the end, it's all about the customer experience. And then once we have sold our systems, when we have to deploy at scale or integrate into various enterprises, or we have to integrate then into existing workflows, then we utilize our partners like Capgemini, TCS, and so on, the traditional enterprise integrators.

This is an example, pictures of some of our deployments and as Loïc mentioned earlier, these are all our Orion class machines, all in different operating environments, all functioning, meeting the SLAs for our customers and we have extensive operating history here. One thing I would like to mention here is our ability of doing in situ upgrades. Because we do not have to build chips, it means we can do in situ upgrades in the number of qubits our machines have. We just inject more atoms into the vacuum chamber and voila, you have more qubits. That is again, a unique capability that we have.

I want to spend most of the time actually on this slide, which are the specifics of what we're working on. And remember, this is all on full analog quantum computing that is available today. On Saudi Aramco, which is a key reference customer for us in the area of oil and gas, there are some use cases that already are in public domain. There's a much longer list that we continue to work on and these use cases are around reservoir simulations, well placement optimization, rig scheduling optimization, and demurrage prediction. Demurrage is the amount of time a ship has to wait before it gets into port and if you have a constant back and forth of ships. But you look at these four different problems, there is an optimization angle to it, but it's not a simple optimization, it's a very complex optimization angle. And on the reservoir simulation, it's inherently a mathematical problem of finding underlying correlations in whatever data you have and reducing the error rates on that.

All of this is possible and at the business value scale today using our analog quantum computing, that's what we work on. Our system is deployed in the Dhahran and we work hand in hand with specific teams in Aramco to build up applications and solutions in those areas and many other areas and that's the way we operate with all of our customers. This again goes back to the concept of focus versus boiling the ocean and we believe for us, this is the way to deliver value today to earn the customer trust today, build the ramp to the future. So that's what we're doing with Aramco. A lot of this is on the upstream side. Upstream side, as you know, for all oil and gas companies is a very critical part of the business.

On financial services, there was a press release that came out earlier today with Credit Agricole. Let me read the headline of the press release in case you haven't seen it. "Credit Agricole and Pasqal advance their strategic partnership to deploy quantum computing applied to finance." This is based on the work we've done over the last three years where we have shown value in credit default risk modeling portfolio optimization and what we're working on right now is on the capital reserve consumption, especially risk weighted assets. This is something that we are progressing to the next stage to production deployment. We believe this is a result of the hard work, the consistent methodical work we have done to identify where we can add value again, based on the full analog computing capability we have today and now we are looking at how we start to integrate that into the workflows and scale it up.

We believe this strategy for us of focused reference customer validation is an important strategy for us as a business and we believe this also brings benefit to the quantum industry itself to be able to show real world use cases. We talk quite a bit about the high value materials in terms of magnetic materials. So whatever we have shown over there is extensible to similar class of materials and other class of materials. It's a very powerful native capability we have and we'll be talking more about that in the near future as well.

I want to show you this slide. This goes back to our mindset of not just doing R&D but delivering actual useful systems. The bars here show the number of quantum computers delivered or in production. And this is for various companies. At the bottom, you see the amount of funding that has been publicly disclosed that has been raised by multiple players in the field. Within pure-play quantum computing companies we are a leader in terms of the number of quantum computers either operating, deployed, or in production that are going out there. In terms of the capital raised, this number is actually an overestimate of the amount of funds it took us to actually deliver that number of 10. We did it with less than half of that amount. The heart of that is it shows the incredible... I would say the distinguishing capital efficiency of our business. We believe that's a differentiator for us.

We have two manufacturing facilities, one in France, one in Canada to serve the Americas. They're up and running. With appropriate staffing levels without any extension. These facilities can produce up to 13 machines per year. If you need to add extra line, it's very capital efficient for us. We can add extra line and we can increase our capacity. So commercially, if you look at it, the ingredients for us to build and scale this business based on the commercial traction we have, we have already put those foundations in place.

So let me summarize and then I'm going to hand it over to Stephane. If you look at it from a business point of view, let's look at this series of steps. The foundation of that is to make sure you have commercial grade, enterprise grade ready QPUs and the associated manufacturing capability. Remember, we don't do lab equipment. Whatever we talk about is commercial grade, which can be deployed and operates autonomously. On top of it is the focus on specific high value use cases again, with a sector focus and delivering value and building that track record. On top of that is now our increased commercial presence across various geographies and that is something that we'll be leaning much more into. On top of that, we have already established our cloud computing as a service as a very important access point for all enterprises. So these are the four basic elements that form the foundation of our business and this is also what we currently look at in terms of our business model and business plan.

But with this new addition of our proof point on quantum advantage, which opens up the entire material sector, there is more drivers to our business growth that get activated. And one very interesting one that I want to mention in passing is because of our capability to do this kind of accurate quantum level material simulation, we can use our computers to generate quantum data, which then coupled with specialized AI models, is a further accelerator to our business and enables new ways of doing material simulation in other related areas. The heart of this, again, you cannot get to this point if you only have lab systems that do not perform reliably repeatedly and you must have enough of an operating fleet of systems so you can actually build a business out of this. And that is at the heart of it, a core differentiator that we believe puts Pasqal aside from many other quantum companies. So with that, I'm going to hand it over to Stephane to talk about some more details about our business.

Stéphane Rougeot, Pasqal CFO:

Thank you. Can you hear me? Yes. Perfect. So you understand we are not a lab shop. We are not an R&D lab. This is a real company. We have first class clients and you saw that. We are delivering real products and we are generating actual revenue, so not just grants and subsidies, but actual commercial revenues. If you look on this graph on the left side, you can see that the overall revenues almost double year on year between 24 and 25 to reach 24 million euros. Actually and more importantly, the commercial revenues, they now account for more than 60% of the revenues of the company and they've been multiplied by five compared to 2024. And so this is something that's really important and when you look at our bookings where we have as of the end of March, more than 66 million euros of orders, we're really talking here about essentially commercial bookings.

What's important is that these are revenues coming from multiple clients. It's not based on a single customer and also these are revenues attached only to quantum computers. There is nothing else. This is what we focus on as you understood from the presentation from Wasiq and from Loïc. Now we are about to accelerate with the hardware, we have the technology, we have everything in the engineering in order to deploy. We have the manufacturing capabilities as you understood from the previous page and we are now investing in terms of commercial deployment.

And we have amassed a pretty significant amount of money in order to fund for this acceleration. On the right side, you can see that as of today, we have $140 million of cash on our bank accounts. On top of that, we have secured a $250 million convertible note a couple of months ago and then as part of this transaction, we have the money in the trust account and so we could end up with at least 400 and up to north of $600 million of cash in order to fund that acceleration. I will speak in a minute about the use of proceeds.

If you go to the next page, it works, these resources that we have now, these financial resources on top of technology, the people, all the capabilities that we have, they are ample enough in order to fund our development because you understood we have a very capital efficient model. It's very capital efficient when you think in terms of OpEx and it's very capital efficient when you think in terms of CapEx. So you can see here the numbers when you look at '24 and '25, anywhere between 50 to 70 million euro of OpEx spent, which covers for both the cost of goods sold of what we have produced, but also the R&D and all the step that we have for research and development and also engineering. Some cost also for commercial, but that will of course increase in the coming years and finally D&A. So these are all the OpEx that we are incurring.

From a CapEx standpoint, you can see that it's quite limited. We are talking about 20 million per year and that caters for the spent in order to put in place all the manufacturing equipment both in Canada and in France. And you can see that that would allow to produce 13 quantum computers per year. So that has been largely done in '24 and to some extent, in '25. And finally, when you look at the cash burn of the company, anywhere between 30 to 50 million euro of cash burn per year. Of course, as we will scale, as we will accelerate, that number will probably increase a little bit, but we are not talking about spending a lot of money and also we will start generating revenues and so we don't expect a very significant increase in our cash burn and what is sure is that we have ample resources with everything that we have on our bank accounts and that the transaction will provide us in order to fund the expansion of the company.

When you look at the transaction, what you have on the left here is the valuation of the company that has been agreed as part of the transaction. We're talking about a two billion euro valuation. Of course, when you look at the competition and other players that are listed in the space, generally have a pretty healthy valuation. So that means this is a pretty attractive entry point when you think about the valuation for anyone who would like to participate and be exposed to the quantum space and we're very happy to provide that, especially as we see a pretty drastic growth in our business in the coming years with the commercial scale and the footprint that we have today.

And also when you have in mind the balance sheet that we have, especially the cash on hands, which gives us security and solidity, which is important for the company, especially from a business standpoint, because of course when you have clients like Aramco or these type of enterprise clients, they want to make sure the company is going to be around in the coming years and the resources that we have on hand that you can see here allow us to make them comfortable about that in addition to, of course, funding our development. Transaction overview, on that one, I'll go relatively quickly. You essentially got already most of those numbers. On the top left, you can see the cash on hand that we have today and the cash that we expect from the transaction that will end up potentially north to $600 million. So again, something that puts us on the right foot in order to fund the rapid expansion that we expect for the business and for the company as a whole and then the valuation elements.

Finally, use of proceeds. So of course we're going to continue to invest in core R&D, especially the strengthening of the analog technology that we have, but also the quick ramp up of the FTQC technology and hardware and everything related that we have. That covers for R&D, that covers also for engineering and everything that allows to have equipment including software and middleware and applications that are relevant for the business needs of our clients today and of course, tomorrow. We'll invest also very much into our commercial expansion. So we'll do that in a disciplined way. We'll invest in terms of geographies where we know the clients and the industries have business needs and where the quantum solution can bring them solutions that are fitted to resolve their needs. So we'll do that from a geo standpoint and then you understood also from an industry standpoint, we've been extremely focused on four industries and we'll continue to do that for the coming years.

As we expand more and we get closer to full FTQC, by talking to our clients today, next year and in the coming years, we'll have exposure to many other problems and issues that they have and therefore we'll be very well placed to design, especially using FTQC, what are the quantum solution that can help these people resolve their future issues, issues that sometimes they don't even know today. Finally, we'll also continue to invest in what we call the deployment of the technology. So we're talking here about the engineering, we're talking about the manufacturing. We're talking about bringing down the unit economics of quantum compute and quantum compute that is being sold to clients either through hardware or through equipment or through cloud-based usage. So this is something that we want to continue to spend money on. So this is what the proceeds will be used for when you think of '26, '27, '28. And again, we have plenty of runway in order to fund the development of the company.

Yeah, maybe a couple of words on this last page, which is the combination of the SPACs. So Bleichroeder is a great partner. They bring us a lot of benefits and network and capabilities that we need. It's the right fit with Pasqal, and we think that is going to position us extremely well for of course business success, but also stock success, which we all expect. So thank you for your attention and we are ready now for Q&A. Can always go back to some technology questions, but we're going to try to be more on the commercial and financial side. Thank you.

Wasiq Bokhari, Pasqal CEO:

Any further questions?

Kingsley Crane, Canaccord:

Sure. So this is Kingsley Crane over at Canaccord. I noticed on the production capacity slide that there's some variance between the on prem, the cloud and the R&D systems. I'm just curious what may cause that variance and then to the extent that that's impacted by the modular architecture, I'm curious, does it create more engineering effort to implement the system, to upgrade the system? Is that all monetizable and then just color on initial ASPs, upgrade ASPs, and just thoughts on that upgrade cadence. Thank you.

Wasiq Bokhari, Pasqal CEO:

Okay. Do you want to talk about just the difference between different kinds of manufacturing? I can talk about the upgrades and stuff.

Loïc Henriet, Pasqal CTO:

Yeah, sure. So maybe

Loïc Henriet, Pasqal CTO:

... maybe we can find back the slide and it will come back up. So the idea is that we do have several manufacturing sites, and they have all their own throughput possible.

Now, what we have shown here on the slide, maybe it's a bit earlier. This one, right? It's about the expected production capacity based on QPU type. So you can see that there is an on-prem line cloud and R&D. So R&D is for our own internal usage to be able to have our R&D team as a client of the manufacturing body so that we can take those machines and continue to tune them up and boost their capabilities. On-prem is when we deliver our machine on site, and the cloud is when there is usage from the cloud but the machine is ours and stay in our premises or data center. This is the split that we envisage.

As you can see, a key point here is that we do believe that cloud will take more and more of the actual percentage of machines, and we'll see a market shifting towards cloud from on-prem at the commercial level before the end of the decade, so that's our expected movement of the market. Of course, we can always decide to invest more on R&D and reserve some of those machines for ourselves if we want to accelerate more on the R&D side and be opportunistic about client deliveries as well. So that's why there is some error bars on those numbers if you wish.

Wasiq Bokhari, Pasqal CEO:

I mean, this is basically summarizing our view in terms of how we want to engage effectively with the enterprise customers, and cloud access is the most effective way to do that, so that's why we put the split this way. But it's exactly the same machines that are being built. There's nothing different in the machines themselves.

Troy Jensen, Cantor Fitzgerald:

Okay, so if we all went and used your financial optimization tool, would you guarantee our returns? What's your conviction?

Wasiq Bokhari, Pasqal CEO:

Well, clearly, risk and reward are not the only two parameters, right? So the example that we showed you, it only takes those two parameters in terms of-

Troy Jensen, Cantor Fitzgerald:

I was just teasing, anyway, but I would just want to follow up on ASPs per quantum computer and then your thoughts on how Quantinuum's pricing there is, trying to capture X percent of the economic value that they're creating.

Wasiq Bokhari, Pasqal CEO:

We have not talked about our pricing at this point, so we have not shared that, so I will not be able to comment on that. And similarly, I don't want to comment about somebody else's value or how they price. But in general, what you've heard from us today is a couple of things. Number one, we have clarity and certainty in terms of what we provide, both in terms of the investment part of the ROI and also the return part of the ROI. So the opportunity is obviously there for us to find, to monetize that. Let me just leave it at that. The most important point is to demonstrate that ROI, and that's what I've been focused on.

Brian Kinstlinger, Alliance Global Partners:

Great, thanks. Brian Kinstlinger at Alliance Global Partners. As it relates to the $66 million of backlog, is that all on-prem? How many QPUs does that represent? And now that you have seven successful installations, what's the average sales cycle look like for that $66 million of backlog?

Wasiq Bokhari, Pasqal CEO:

Do you want to talk about a little bit of the breakdown and then I can talk about?

Stéphane Rougeot, Pasqal CFO:

Yeah. So the backlog is a mix between some on-prem machines and of course in terms of recognition, revenues will come when those machines are commissioned. So it takes a little bit of time because generally, and it's not exactly the sales cycle, but the procurement and commissioning cycle for an on-prem machine is over 12 months. We are talking between 12 to 18 months. Of course, as we work on the engineering, our ambition is to bring that down, not just in terms of revenue recognition, but for our clients. And then we also have a pretty significant number of bookings that is cloud-based, so that's what we have right now in the order books.

The sales cycle, obviously much quicker when it's cloud-based. What matters with clients is make sure that we can spend time with them about their use case, about their issues, and that we can see how that can be solved and addressed best with quantum solution that exists today, what we call the analog one. That always takes a little bit of time, and as you do it in a given industry, then it's quicker to do with other clients in that industry. So what we've done already in the oil and gas industry and what we're doing right now in the financial services, they will help reduce the sales cycle. You're talking about, let's call it a few month when it comes to cloud-based. Of course, when it's meshed in, it's a longer time because it's a bigger commitment.

Gary Mobley, StoneX:

Thanks. I had another question about revenue scalability. So for the on-prem sale, is that a one-and-done type sale, or is there a residual revenue element to it like maintenance and support? And then for the cloud-based compute, how should we think about the linear-y or logarithmic scale of the revenue per QPU? I'm certain that a newer QPU is capable of generating more revenue, so maybe you can just talk about that.

Wasiq Bokhari, Pasqal CEO:

Okay. Maybe I'll take a crack. So whenever you have a system sale, there's an O&M component to it, which typically has a lifetime. So there is a recurring component to that. There was a question earlier, which is if you have deployed a QPU, is there additional revenue possibility and upgrades? The answer is yes. So for the same asset, you have these two additional parts to that. On the cloud side, could you repeat your question again?

Stéphane Rougeot, Pasqal CFO:

New generations. Are the new generations of machine allowing higher revenues?

Wasiq Bokhari, Pasqal CEO:

High revenue. The answer is yes. I mean, obviously as the compute capability becomes better, or it becomes more potent and there's more of the application stack that's available as well, then we have that flexibility to be able to price it in a different way.

John McPeake, Rosenblatt Securities:

Could you put the slide 33 online? I don't know if it's the one before this.

Wasiq Bokhari, Pasqal CEO:

The one before this, yes.

John McPeake, Rosenblatt Securities:

So these are high qubit quantum processing units. So D-Wave has annealers, right, and then IQM ships gate-based machines, and you guys have 10 machines in production. Could you talk a little bit about the comparison?

Wasiq Bokhari, Pasqal CEO:

Seven operating.

John McPeake, Rosenblatt Securities:

Right.

Wasiq Bokhari, Pasqal CEO:

Three in production.

John McPeake, Rosenblatt Securities:

And those are analog machines? Are they analog gate? Because it feels like this slide is apples to oranges a little bit.

Wasiq Bokhari, Pasqal CEO:

It indeed, there's a little bit of that. It's all 100 qubit plus, 100 to 200 qubits, all high complexity, commercially available machines.

John McPeake, Rosenblatt Securities:

I got you. So those are seven D-Wave annealers with over 100 equivalent.

Wasiq Bokhari, Pasqal CEO:

So remember, annealers are not the same as anneal, as you said, it's an apples to oranges comparison. The way we look at this is as pure quantum computers, which is a super set of an annealing machine. So we would compare ourselves to companies that ship pure quantum computers, but of course, we are just counting the number of machines that are shipped.

John McPeake, Rosenblatt Securities:

I gotcha. And then I have the most boring question that will be asked today, I promise you for-

Stéphane Rougeot, Pasqal CFO:

Why do you look at me?

John McPeake, Rosenblatt Securities:

For SPACs, what is the fully diluted share count if you include all of the warrants and options and any dilutive instruments?

Stéphane Rougeot, Pasqal CFO:

I think we have that on the last, on the cap table page.

Wasiq Bokhari, Pasqal CEO:

It's in the F4.

Stéphane Rougeot, Pasqal CFO:

Yeah, let me check.

Marcello Padula, Bleichroeder:

I'll take that question. This here doesn't, this slide that you see that's on the screen does not include the dilutive effect of the warrants and the other components. But if you go to the F4, all that is baked into that. The number right now as you see up there on the top right is 264. It's probably closer to 300.

John McPeake, Rosenblatt Securities:

300.

Marcello Padula, Bleichroeder:

Yeah.

John McPeake, Rosenblatt Securities:

Okay. Thank you. It's just for comp tables and stuff like that.

Marcello Padula, Bleichroeder:

Yeah, no, of course.

John McPeake, Rosenblatt Securities:

Yeah, help me with the math. Appreciate that.

Marcello Padula, Bleichroeder:

Reach out anytime, we can help you.

Julian Frost, Wedbush Securities:

Thanks. This is Julian Frost with Wedbush Securities. So I have a two part question. So when we think about pricing, given these are early products and early projects, how do you approach these sales conversations with customers? Do you meet them where they are in terms of pricing project scope and budget, or do you have more of a set price for machines, cloud time solutions?

Wasiq Bokhari, Pasqal CEO:

We have a set price schedule. Remember, our first commercial machine was deployed more than 40 years ago. So we have had time to build that track record and this is, again, a differentiator for us is we are not putting lab equipment out there, right? So these commercial machines based on an actual comparison between what the pricing landscape looks like, and what value we deliver, we have a set price schedule both on the cloud side and on the machine side.

Julian Frost, Wedbush Securities:

Got it. That makes modeling easier for all of us.

Wasiq Bokhari, Pasqal CEO:

Exactly.

Julian Frost, Wedbush Securities:

I guess on that note, how do you view, I guess the on-prem and cloud economics evolving over time, like the pricing, the margin profile, at what point do you think there'll be a, I guess we might already be there, but mature levels of unit economics?

Wasiq Bokhari, Pasqal CEO:

Right. So you have a couple of points in there. I'll just take a crack at that. As we discussed earlier, as we have later and later generational machines, then obviously we reserve the option to set the pricing both for the on-prem as well as through cloud access. In addition, because of the large fleet we have in the manufacturing capacity we have, we also have the additional lever of further optimizing our total cost per unit so we can control the cost basis of that as we ramp up as our learning curve continues to progress.

So on that side, we have this openness on that point of view, but what we want to... We believe that we will maintain a competitive edge in terms of pricing and performance in the market. I think that's the key statement I want to make, and that derives some our approach itself and this is a structural advantage that we have. We have seen some indications of that in terms of the financials, the OpEx, the CapEx, the free cash flow. So you've seen some indications of that, but a lot of this derives from the structural advantage of the approach itself, and that will continue to accrue.

David Williams, Needham:

Thanks. David Williams again from Needham. I wanted to ask maybe on the M&A front as you think about the opportunities to scale, are there areas of the business today that you could maybe accelerate the business? Is there any assets in the market you see, whether it's IP or even other companies, other technologies, maybe supply chain things that could help you?

Wasiq Bokhari, Pasqal CEO:

At a high level, obviously I mean, that's a toolkit that's available for us for inorganic growth and acceleration. At a high level, again, anything that's accretive to our roadmap, technology roadmap, which is complimentary and accretive, obviously that's a target. And we pride ourselves to be able to try to look around corners. We have done some acquisitions in the past, we try to look around corners so obviously that will never go away for us. The second is on the commercial side because we have focus in terms of the problems we are solving for specific industries that gives us another avenue in terms of accelerating that market entry, the customer acquisition in a sense. So that's another thing because of our commercial maturity as well. So those are at a high level, two areas we can look at.

David Williams, Needham:

And then maybe lastly, just do you think your customers understand the real differentiation between the analog component that you bring as well as the digital? Do you think they understand the power of that and how it does differentiate you in the market?

Wasiq Bokhari, Pasqal CEO:

In the end, they don't care. In the end, they just want their problem solved. In the end, I think a lot of the discussion around analog, FTQC, which modality versus not. It is a topic of today because of the general state of the industry. But in the end, the customers, they just want their problem solved and that's what we are focused on. Just like today, we don't argue about the specifics of the GPU or the CPU construction of which kind of memory is being used and so on. So we feel that's the way quantum industry will evolve. So we stay focused on the customer and delivering value.

Tyler Anderson, Craig Hallum:

Hi, Tyler Anderson from Craig Hallum. I have a boring question as well. Is the revenues and just financial statement, are those going to be in dollars or euros when you file?

Wasiq Bokhari, Pasqal CEO:

Okay.

Stéphane Rougeot, Pasqal CFO:

They're going to be in dollars, right?

Wasiq Bokhari, Pasqal CEO:

Yeah.

Stéphane Rougeot, Pasqal CFO:

Well, we do euros, and so you will have euros financial statement. That's what you have right now in the F4.

Marcello Padula, Bleichroeder:

It'll be euro-based financials, IFRS, PCAOB, IFRS. Part of the transaction is they're going to remain FPI for our private issuer. It'll be French based as part of that.

Tyler Anderson, Craig Hallum:

And then for your 99.4, is this post-selected fidelity?

Loïc Henriet, Pasqal CTO:

So we're talking about the fidelities of the physical qubit gates. So there is some amount of post-processing indeed in terms of our measurement errors particular. You can see all of the details in the paper if you wish we describe all the procedure there.

Tyler Anderson, Craig Hallum:

Yeah, I have to go back and look at that. Thank you. And then for your analog, I was wondering, you say that annealing is a subset and annealing can do quantum tunneling within optimization problems. I'm just wondering what other features your QPU enables users to have to give better advantage using analog.

Loïc Henriet, Pasqal CTO:

Sure. Yeah. Well, when you think about annealing, the idea is really that you want to follow the path in the energy landscape and follow the ground state all the way to where you want it to be at the end. So that's the assumption and that's the idea behind quantum annealing.

The thing with analog is that you can be out of, so this implies that you are always following the ground state so you are going slowly, and there is only one path that you can follow. Using analog computing in general, you can be really abruptly out of equilibrium. There is nothing that prevents you from exploring the phase space really with all the different paths that you can take.

So you have various knobs available to you on the hardware. You can tune all of them arbitrarily, if you wish, in a continuous manner. So really, it's about the way you program the machine. It's continuous compared to discrete gates, but the things that you can do is you can do annealing, you can do out of equilibrium, crunches, you can do whatever you like. You're not constrained by one kind of computing, you just have a different way to control your dynamics compared to gates.

Tyler Anderson:

Right. That makes sense. Thank you. And then I just have one more for your gate-based system. I just want to ask, you have qubit rearrangement and you have pole shaping that is helping you with this material simulation whatnot. How much of an advantage do you think that is? Is this less steps as compared to somebody with a planer architecture, namely like a super conducting and just want to talk about all the different ways that you can do that a little bit differently.

Loïc Henriet, Pasqal CTO:

Yeah, that's a very good question. So actually, it boils down to describing the power of analog and register reconfigurability compared to fixed digital architectures. So the register, you can tune it so that you have the geometry or the topology of your problem itself can be mapped down onto the hardware. So that you don't have to pay the overhead of having swap gates or things like that to actually compile down your problem topology to the hardware that you have, which is fixed. So this is something that is actually quite native on our platform. And then when you compare to when you have like analog and digital, if you were to actually simulate the dynamics of a spin Hamiltonian using digital gates, what you would have to do is to rotarize your Hamiltonian to break it down into sequences of gates and what you find is huge overhead in the end.

So if you wanted to do what we did like simulation of out of equilibrium housing model with gate based, the overhead that you would pay in terms of swap gates plus protonation is huge. You would need something like 10 to the minus five error rates and 10,000 gates to be able to achieve the same level of performances. It's really a great change compared to... So if you wanted to do what we did on the material science use case with digital, you would not be able to do that with the current hardware. You would need a lot of progress on the digital side.

Tyler Anderson, Craig Hallum:

If you don't mind, can I have one more?

Loïc Henriet, Pasqal CTO:

Okay.

Tyler Anderson, Craig Hallum:

So are you able to take logical qubits, let's say the data qubit within the logical qubit and then place it in the arrangement of what the problem is, but then fix the placement of those and then perform nearest neighbors? Are you performing nearest neighbor gates at all within your architecture or is this always movement to perform those two-

Loïc Henriet, Pasqal CTO:

So typically, in the current architecture that we have for digital error detecting code, when we perform gates, we just move the qubits close and shine the laser so that there is a gate between those two and then we move them back in the general position. So that's the way it's done. So you have an entangling zone where you shine very strongly a laser in an homogenous fashion and when you have pairs of qubits that are very close by, they feel a CZ gate, so an intending gate, but that's the way it's done right now. There are ways to do also other kinds of gates if you want without moving the atoms. This is something that's open to us, so this you can do. Really what it comes down to the end is like you have an algorithm that you want to implement. How do you compile it down in terms of instructions on your how do I set? And this is an interesting, but yeah, this is an interesting problem. Thank you.

David Liu, Mizuho:

Hi. Yeah. David Liu, I was wondering if you can talk about your manufacturing and supply chain partnerships, how that'll evolve as you guys start to ship more and better systems, and maybe especially regarding your most critical components like the vacuum chambers and the laser tweezers and anything else.

Wasiq Bokhari, Pasqal CEO:

Do you want to take it?

Loïc Henriet, Pasqal CTO:

Sure. Maybe you can, you want to take the first crack?

Wasiq Bokhari, Pasqal CEO:

I'll take the first part. I mean, in terms of the key components, there's some key components we actually acquired those. So we actually did the vertical integration on those, like the vacuum chambers and so on. On key systems like lasers we have very close partnerships with those companies and these are multi-range, multi-year partnerships. So in fact, we are also driving the state of the art in a sense because of our leading edge requirements. In terms of supplier dependency, because of the inherent design of the system outside the vertical integration, we have made sure we don't have a single supplier dependency, and when we have few supply dependency, we have very deep relationships, plus we have forward inventory that we have for long lead items. So our supply chain from that point of view is lower risk and not single source dependent. So that's part of the construction of the supply chain.

What Loïc had mentioned earlier is if you look at the overall system design, this goes back to our engineering focus for the last many years is there's some aspects to it that are truly key and proprietary that are either in house or with key closed partners which we control and other stuff is effectively it's off the shelf as much as we can and that removes that part of the risk as well. Do you want to add something more to it? So I think this is how we're able to address this and this then enables us for scale up because we have control over the key points of that. We can ramp up our vacuum chamber, we have access to the laser systems, the optics and so on and so forth, everything else is rampable. In fact, we can, if you wanted, we can outsource a couple of these mechanical assemblies as we do to contract manufacturers and so on. So there's no suppliers from that point of view.

Troy Jensen, Cantor Fitzgerald:

Hey, just an easy question. Can you help us out with timing of the transaction? When does the deal expected to close and we find out the redemptions and then the de-SPAC date are roughly?

Wasiq Bokhari, Pasqal CEO:

Correct. Marcello, do you want to take a crack at this, please? There you go.

Marcello Padula, Bleichroeder:

Thank you. So in terms of where we are in the deal on June 26th or last Thursday, we filed the F4 publicly. That was our second public amendment was our first public amendment and ideally we should get effectiveness in early July, which puts us at a close date of around end of July, beginning of August. In terms of the dates for the EGM, right now, we have it tentatively scheduled for July 28th, but more to come just because we can't set the date until we have the effectiveness from the SEC.

Suji Desilva, Roth Capital Partners:

Thanks. Hi guys. Suji from Roth again. So the chart you have with systems, I'd be curious, I'm assuming it's cloud based and on-prem, commercial, non-commercial. If we did just commercial on-prem, that chart would look starkly, I think, toward you guys or something. First of all, is that correct? And second of all, the comment about it being cloud longer term, more units than commercial, is commercial the use of these by guys like Aramco, is that more be a more near term phenomenon because the cloud isn't available or does your ability to translate these systems to what they need, is that only uniquely deliverable on-prem versus cloud?

Wasiq Bokhari, Pasqal CEO:

I mean, the way we look at it is whether we deploy on-prem or cloud, there's a special class of customers that let's call them public sector or sovereign customers. Outside of that, everything is commercial. Even those are effectively commercial for us because they buy under normal commercial terms for us. The difference between cloud access versus on-prem is more about what is easier for the end customer. We believe for enterprises to use them for use cases, in general, it's easier for them to start to access it through the cloud. The barrier to entry is very low, just like with any cloud access, you can ramp it up as your demand goes up. So that is why we emphasize a lot on the cloud access. I don't know if I answered your question.

Suji Desilva, Roth Capital Partners:

No, mostly with the on-prem sales then, would you expect that to diminish over time as customers are doing it now because that's the only way to access it?

Wasiq Bokhari, Pasqal CEO:

The proportion would diminish the raw numbers would we believe will go up, but the fraction of sales that are cloud versus on-prem, that will shift because we feel that that fraction will shift more and more towards cloud.

Suji Desilva, Roth Capital Partners:

Fair enough.

Wasiq Bokhari, Pasqal CEO:

Thanks.

Wasiq Bokhari, Pasqal CEO:

I think we are coming to a close at this point.

Stéphane Rougeot, Pasqal CFO:

Yep.

Wasiq Bokhari, Pasqal CEO:

So first of all, we just wanted to say a big thank you to you for being here for listening about Pasqal, and to learn a bit more about this remarkable company that we have been building and we are happy to entertain more questions and so on you have, but really thank you very much for being here and for all of your great questions today.

Stéphane Rougeot, Pasqal CFO:

Thank you.

Wasiq Bokhari, Pasqal CEO:

Thank you.