



Jamil Abo-Shaeer, CEO



Pleasanton-based startup Vector Atomic is a prime example of entrepreneurs benefiting from the Tri-Valley assets we've been discussing.

CEO Jamil Abo-Shaeer spent eight years of his career working for DARPA, essentially the venture capital arm of the Department of Defense, and 10 years before that worked as a researcher. This perspective provided Jamil with unique insight into the future of quantum technology and how it might be commercialized.

When he and his co-founders decided to start Vector Atomic, they came to LLNL's Advanced Manufacturing Lab at the Livermore Valley Open Campus (LVOC). Jamil sat down with us to talk about their early days growing at LLNL, winning multiple \$5 million+ contracts, and moving to their own space in Pleasanton.

Q&A

First of all, what does commercializing quantum technology mean?

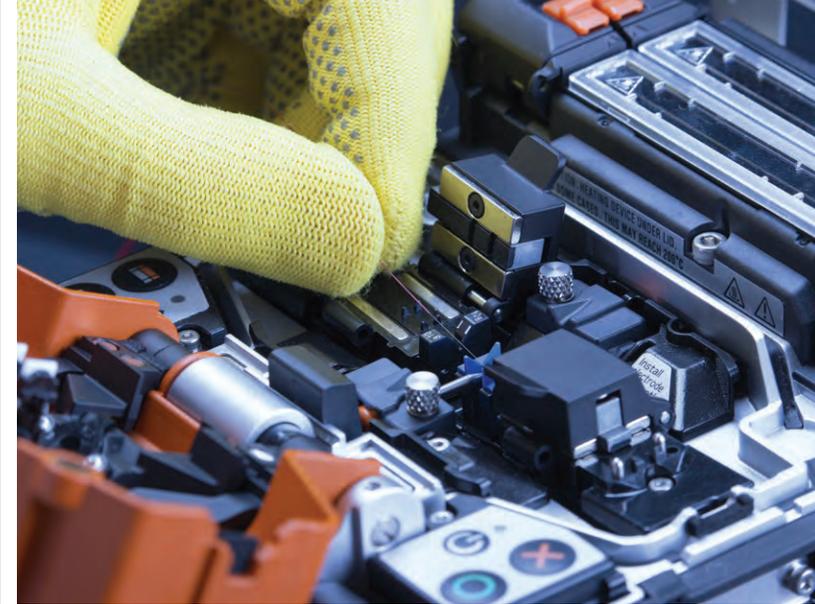
Essentially, we're building atomic sensors based on quantum technology which could be used in GPS

satellites, submarine navigation, and a number of other applications.

The basis for GPS technology is precision timing; radio signals are broadcast to you from multiple satellites at known locations. The time the signals require to make the journey can be used to triangulate your location because they travel at the known speed of light. It's accurate within a couple meters and is cooked into most infrastructure - cell towers, the energy grid, the financial sector, etc. The problem is that even when working perfectly, these satellites still have to be resynchronized twice a day. Additionally, GPS is not always available. Someone who knows what they're doing could knock out GPS for a square mile with \$100 in parts from Radio Shack. A more sophisticated adversary could jam or even spoof GPS over a much larger area. It's definitely a problem when billion dollar planes and ships don't know where they are.

What is the end goal of this technology?

To make GPS and navigation, in general, more resilient. To know our position within a meter, we need very accurate timing — clocks that are good to billionths of a second. Quartz clocks, like in your wristwatch, aren't very stable. After only a day, even the best quartz oscillators can be off by 10's of microseconds (1 millionth of a second),



corresponding to a position error of a couple miles. The current atomic clocks used on GPS satellites that orbit the earth drift by nanoseconds (1 billionth of a second) each day, so they must be sent daily updates to correct for this. Our goal is to build shoe-box sized clocks that drift by 10's of picoseconds (1 trillionth of a second) per day.

How did connecting with LLNL help you get started?

The specialized equipment we need to build and test our product exists at the Labs. We initially looked at Berkeley Labs but found that LLNL had the right technology. When we found out about the entrepreneurship program and available space at the AML it seemed like a perfect solution. It turned out to be a symbiotic relationship for the Labs as the contracts we won also provide them with funding to pursue research in this space.

How has the Tri-Valley location worked for you?

It's been great. All of the founders previously worked and lived in Silicon Valley and it's cheaper to live here. Now we have a lifestyle where our employees are buying houses and are close to the Labs.

The affordability of flexible commercial space is essential to us because we're building real hardware which requires both lab space and office space.

Silicon Valley has gotten rid of a lot its lab space so they can pack in more software engineers. The proximity to LLNL is also a huge advantage as we maintain access to incredible equipment there.

What comes next?

We compete with big defense contractors and established companies for government contracts and so far we've been successful. One project will result in an at-sea navigation demo on a Navy Ship in 2022. We've grown from seven to twenty employees in less than a year, and project we'll be at 30 by the end of 2020, so we're preparing to move into larger lab space in Pleasanton previously occupied by AEye.