Agilent case study: Research—Accelerated

Collaboration Between Agilent and DESY Created a New Kind of Ion Getter Pump

When researchers come to Hamburg to see the particle accelerators at DESY, they have a lot of questions. Questions about the interactions of tiny elementary particles. Questions about the behavior of new types of nanomaterials. Questions that will take time and testing to answer.

But one of the most common questions they ask is simply, "What is this?"

The object of their curiosity is actually a series of objects attached, every 6 m, on the accelerator of the European XFEL, the world's largest X-ray laser, that stretches out before them for more than 3 km.

"They always ask because it looks very peculiar," says Winfried Decking, scientist and coordinator for accelerator construction at DESY, a leading research center with 50 years of experience building and operating accelerators.

The Pump and the System

Decking, a physicist, is referring to the unique design of the in-line ion getter pumps that he and his colleague, Torsten Wohlenberg, an engineer, helped to develop in collaboration with Agilent. (The cross-functional team from Agilent included R&D, marketing, and order-fulfilment personnel.)

"Our idea was to design a pump directly around the beam pipe," Wohlenberg says.

Compared to traditional designs, which use T-pieces to connect pumps to the pipe, the in-line pump is far easier to install. Indeed, the core of the in-line pump—manufactured to precise dimensions and strict tolerances—becomes part of the pipe through which the beam passes.

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"It has other benefits from more of a physics point of view," Wohlenberg explains, "because it has a very low magnetic field where the beam passes through, which is very beneficial for the high-quality beams we are using."

"We are very happy with the results," Decking adds. "Of course, it's not one pump. We are talking about a system, a huge-scale vacuum system based on these pumps—and they work very, very nicely."

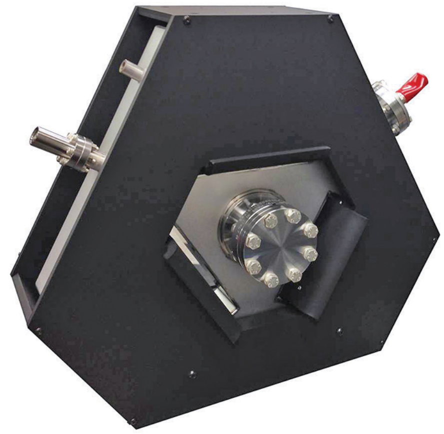
Designing Away Drawbacks

In a particle accelerator, a beam of charged particles travels in an environment that is maintained under high vacuum conditions. To achieve the desired degree of vacuum, scientists use ion getter pumps, which are highly reliable and do not generate vibrations that could disturb the trajectory of the beam.

Traditional configurations, however, are affected by two drawbacks:

- Accelerated particles are sensitive to stray magnetic fields, specifically to the influence of components transverse to the direction of the beam. In a typical configuration, the magnets are asymmetrically related to the beam tube, thus preventing a self-compensating effect of the components.
- The beam of charged particles must be protected from the titanium sputtered by the ion pump cathodes and also from titanium debris from possible peeling phenomena. This issue is typically overcome with the addition of complex optical shields, which reduce the effective pumping speed.

The in-line design offers a number of advantages. The arrangement of the magnets and the geometry of the pole piece used to guide the magnetic field lines were conceived to minimize any disturbance to the beam's trajectory. Moreover, the element location inside the pump has been optimized to be optically self-shielded toward the beam, without requiring additional expensive and complex optical shields. Finally, thanks to the in-line solution, a simple RF shield (a copper coated tube with pumping slits) can easily be installed directly inside the pump at the accelerator site.



In-line ion getter pump developed for the particle accelerator at DESY

Other Advantages

"One requirement we had for this 3 km vacuum system was that it should be aligned very precisely, locally to 0.1 mm in some parts. To do that, you need fixed points, and these points are the vacuum pumps. They are positioned very precisely, and are aligned as any other accelerator component, such as magnets and so on," Wohlenberg says.

"When you have an accelerator and you shoot an electron beam through it, you want to know where the beam is in this vacuum pipe. For this, we need beam-position monitors, which also should be very, very precise, again, to 0.1 or 0.2 mm. Because it is so easy and so nice to set these vacuum pumps, we just attach the beam-position monitors rigidly to the pumps as a real unit, and align them together. This was something that was not foreseen at the beginning, but turned out to be a very efficient solution when you need to install a couple of hundred of these beam-position monitors together with the vacuum pumps. That is something we found unique, so our standard modular unit is a pump and beam-position monitor as a fixed point for the vacuum system. The main point is that the installation is much easier. If you have to install this huge number of pumps, then installing them easy or not easy makes a huge difference."

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