Groovy Project Solving Cloudy Problem

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Mauro Pivi holds a section of beam pipe with built-in grooves. (Image courtesy of Brad Plummer)

Experiments in the PEP-II accelerator have shown that beam pipes with grooves can snare unwelcome electrons, greatly reducing the formation of electron clouds that can disturb the beam.

While electron clouds presently pose little threat to the PEP-II beam, they are a major concern for the International Linear Collider (ILC) or a future B-factory project. In high energy storage rings, synchrotron radiation liberates electrons from the beam pipe walls. A positron or proton beam will accelerate the free electrons, and these electrons can then strike the chamber walls, releasing more electrons in a cascade effect until a cloud forms. Ultimately, scientists think the grooved chambers will be a good solution for certain sections of the ILC positron

damping ring.

While PEP-II continued to provide beams for the BaBar experiment this summer, the ILC Group monitored the performance of four segments of beam pipe installed in a straight section of the accelerator where there are no magnets. Two sections have smooth interior walls, like normal beam pipes. Two sections have grooves cut into the interior walls that look like metal teeth on a comb. Data show that the beam pipes with grooves had 20 to 30 times less current from electron clouds than the two smooth segments. The grooves, or teeth, act as traps.

"The geometry of the grooves is important. We ran plenty of simulations to figure out the most effective grooves, and we tested two different designs in PEP-II," said Mauro Pivi of SLAC's ILC Accelerator Design group. Robert Kirby, Lanfa Wang, Tor Raubenheimer, Morrison Munro, Gennady Stupakov, Bobby McKee and Tom Markiewicz have also contributed to the project.

The teeth are far enough apart so that radiation strikes the interior wall rather than the top of the teeth. The incoming radiation frees electrons from the beam pipe walls, but the teeth are tall enough to trap electrons, which bounce between the teeth until they run out of energy.

The next step is to test a beam pipe in sections of the accelerator with magnetic fields. Under these conditions, researchers think triangular grooves, like shark teeth, will make the best trap. "Simulations say that it will also work very well to suppress electron clouds, but it's a lot trickier to design," Pivi said.

Both grooved and smooth pipe segments were coated with titanium nitride to suppress the number of electrons generated from synchrotron radiation. The grooved pipes have 100 times less current from electron clouds than PEP-II's regular stainless steel smooth chambers.

Source: Heather Rock Woods, SLAC