The ATLAS Pixel Detector

September 3 2008, by Kelen Tuttle

The ATLAS pixel detector is lowered into the LHC. (Photo courtesy of CERN)

With the Large Hadron Collider start-up only weeks away, SLAC researchers working on the LHC are feeling the excitement. SLAC has been involved in designing and building the ATLAS (A Toroidal LHC ApparatuS) detector since mid-2006, when the lab officially joined the collaboration.

Since then, SLAC has become an ATLAS Tier 2 computing center and begun contributing to efforts on the ATLAS pixel detector and high-level trigger system. In addition, many SLAC researchers currently work on the LHC accelerator and theoretical studies. Overall, eight SLAC researchers are based at CERN, with another 10 to 15 working there part-time and about 50 others working on LHC projects from SLAC.

"SLAC's skills are a good match to several ATLAS efforts, and although we didn't join the collaboration until just a few years ago, we are sharing our expertise wherever we can help," said Charlie Young, who co-leads the SLAC ATLAS team with physicist Su Dong. Young serves as the run coordinator for the large crew that operates, tests and commissions the ATLAS pixel detector. He is currently at the LHC preparing for the start-up.

The ATLAS detector has an onion-like structure; it comprises several different detectors layered upon one another. At the center is the pixel detector, which nestles closest to the beam pipe and the interaction point. As dense bunches of protons collide 40 million times per second, the pixel detector records the aftermath like a big digital camera. But instead of the average digital camera's 4 million pixels, this mega-digital camera has 80 million.

As a charged particle travels through one of these pixels, that pixel records the amount of energy the particle deposits, much as a digital camera records color. The detector also tracks the directions in which particles travel using its three-layer structure: as a particle travels away from the collision point, the detector senses its location in each layer, allowing analysts to later reconstruct the particle's trajectory.

SLAC researchers, including Assistant Professor Ariel Schwartzman and postdoctoral researcher Claus Horn, are writing software with which to calibrate all 80 million of the detector's pixels to ensure that no pixel is artificially bright or dim. This project also compiles calibration data taken by many different research teams.

"This software helps to understand the performance of the pixel detector over time and to test new calibration techniques," said Schwartzman. "We can help many groups with this one project."

Although the beam has yet to circulate in the Large Hadron Collider, plans for future enhancements are already in the works. The planned upgrade to the proton beams will boost the number of interactions by a factor of ten. This will require a significant modification to the pixel detector. The detector sits close enough to the beam that the increase in interactions would cause enough radiation damage to require replacement of the current model every one to two years. It took far more than two years to build the pixel detector, so it will need to be redesigned to be more radiation tolerant. SLAC researchers are helping to develop a new type of sensor that can handle the radiation.

"As we transition from the research part of R&D to the development part, there is a lot more work to be done," said Young. "We're trying to figure out how we can take our current ideas and develop them into something that could actually be built."

Provided by SLAC

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