



Contribution ID: 185

Type: **Talk**

## Test Results of 3D Silicon Pixel Sensors for Future ATLAS Upgrades

*Tuesday, 12 February 2013 14:25 (20 minutes)*

3D Silicon pixel detectors, selected to make-up 25% of the ATLAS Insertable B-Layer (IBL) and 100% of the ATLAS Forward Physics (AFP) tracking system, were studied in an intense laboratory and beam test qualification program in 2011 and 2012. The IBL is a new pixel layer which will be installed between the current ATLAS pixel detector and a new, thinner beam pipe of radius 3.2 cm during the phase 0 long shut-down in 2013-14. Beam tests of sensors before and after irradiation were performed using 4 GeV positrons at DESY, Germany and 180 GeV pions from the SPS at CERN, Switzerland. Sensors were bump-bonded to ATLAS FE-I3 front-end readout cards and also to the new FE-I4 cards, which have a smaller pixel size of  $50\ \mu\text{m} \times 250\ \mu\text{m}$  and faster readout compared to FE-I3. Tracks were reconstructed using data from the EUDET and ACONITE beam telescopes delivering a resolution of  $3\ \mu\text{m}$ . At a variety of angles, thresholds and bias voltages, studies into radiation hardness, charge collection efficiency, charge sharing and edge efficiency were performed to both qualify the 3D Silicon sensors to IBL requirements and to analyse improved manufacturing techniques for future ATLAS upgrades.

### **quote your primary experiment**

ATLAS

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**Session Classification:** Semiconductor Detectors 1