Performance and operation experience of the Atlas Semiconductor Tracker

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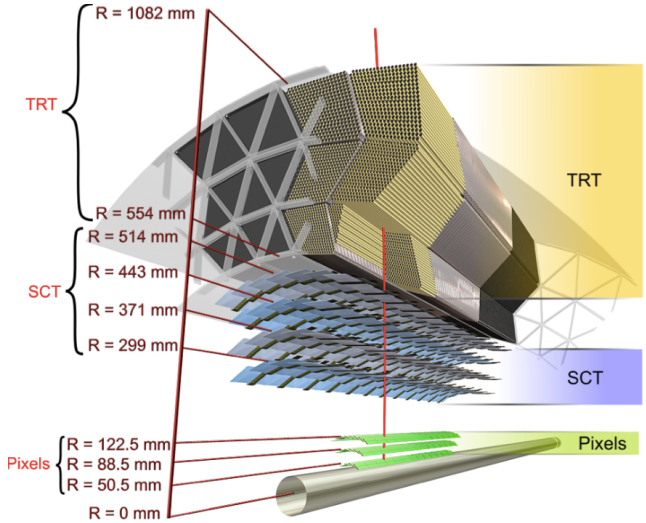
Physics in Collision 2013

The ATLAS Inner Detector

- ATLAS is a multi-purpose detector in LHC.
- The ATLAS inner detector (ID) is composed of three Sub-detectors.
  - Pixel detector
  - SemiConductor Tracker (SCT)
  - Transition Radiation Tracker (TRT)

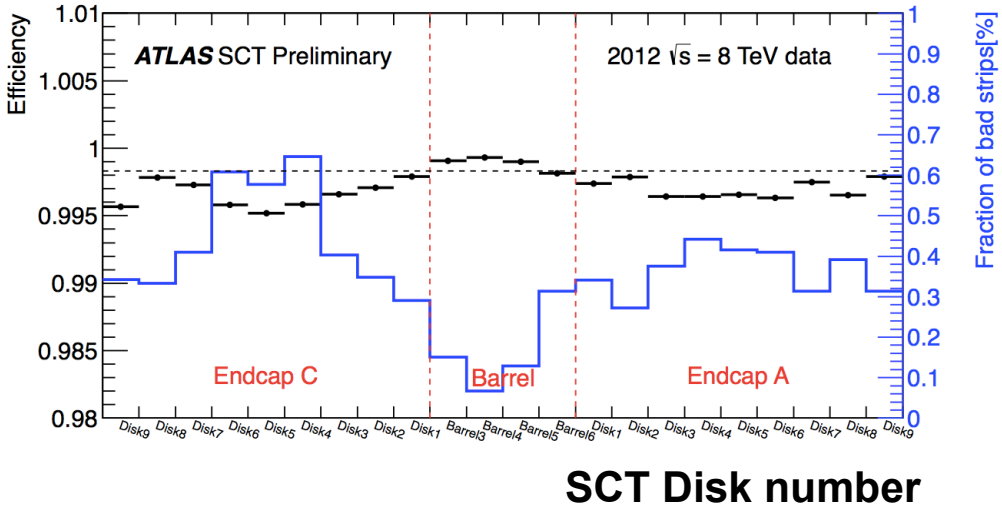


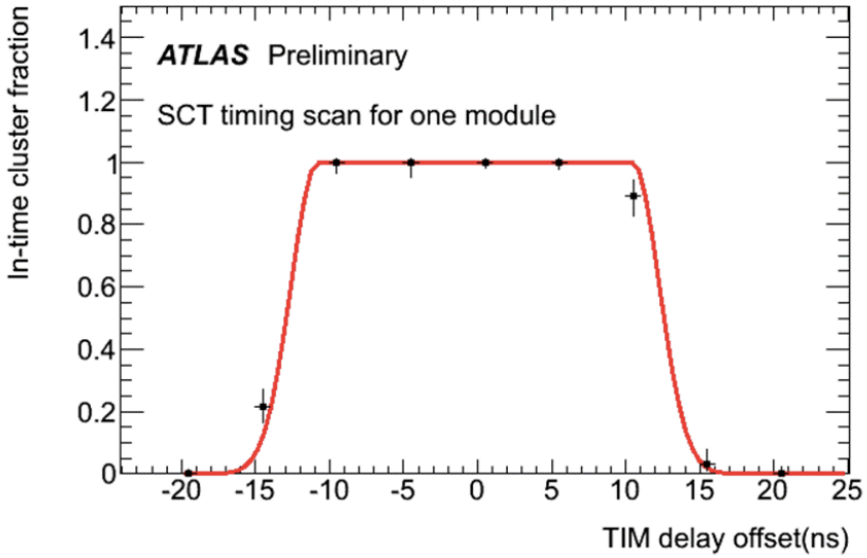
- Inner detector provides
  - Precision tracking at LHC luminosity
  - primary/secondary vertex reconstruction
  - Excellent b-tagging in jets
  - Electron, muon, tau, b- and c- hadron reconstruction

Hit Efficiency

- **Hit efficiency: (number of hits) / (number of possible hits on tracks)**
  - Hit efficiency > 99.5% over all layers,

- **By studying In time hit efficiency as a function of readout delay time**
- **Synchronize the readout timing of 4088 modules to 2ns precision**

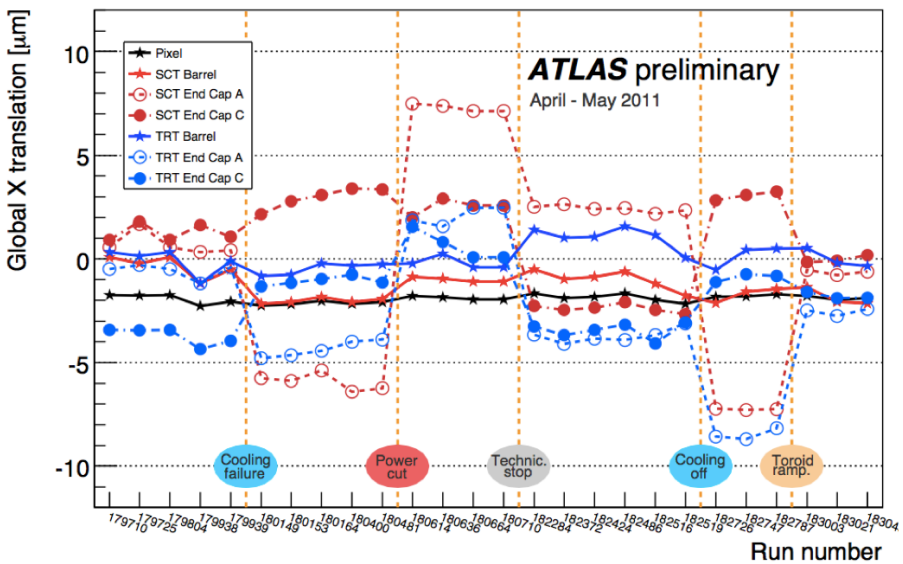


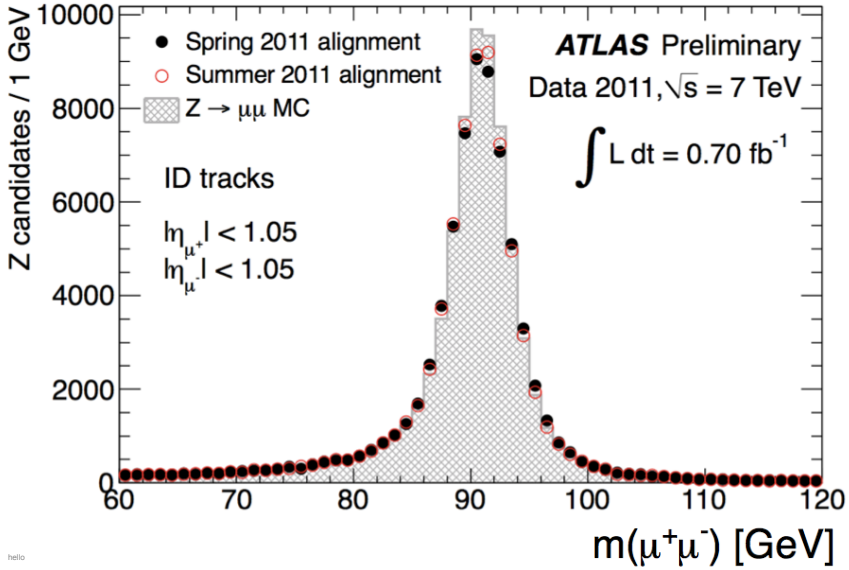


Track Based Alignment

- track-based alignment is performed to minimise χ^2 from hit residuals
  - measured hit position minus expected position from track extrapolation.
- The momentum resolution is very close to ideal limits from Monte Carlo predictions.
  - Ideal resolution in Z->μμ peak
- Alignment can be done run by run to improve the momentum resolution
  - detector is stable up to 1~2 micrometers during normal data taking runs
  - Found 5~10 micrometers detector movement in during technical stop during 2012 data taking

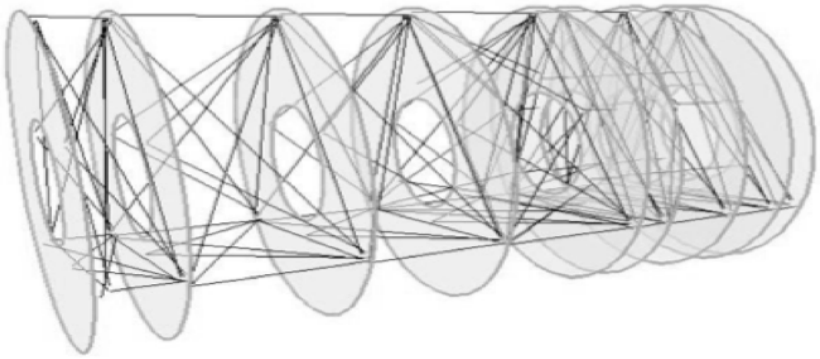
    --due to switch on/off of the cooling or of the solenoid

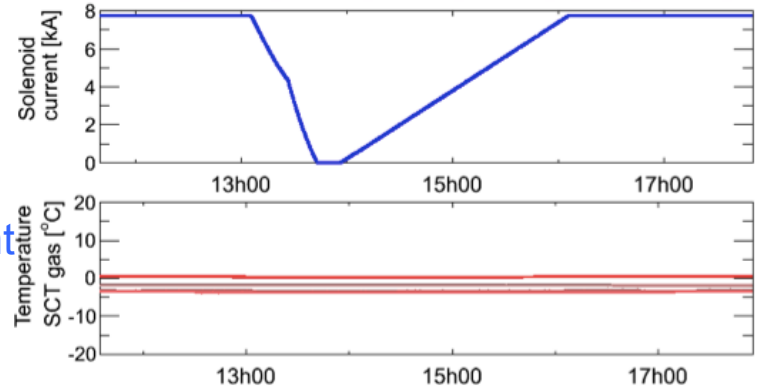


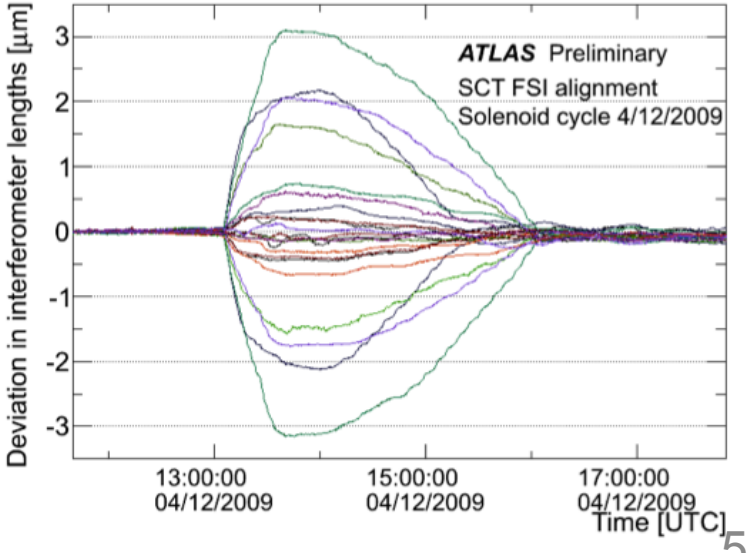


Laser Alignment

- Frequency Scanning Interferometry (FSI) technique is developed for SCT detector
  - A geodetic grid attached to the SCT support structures.
  - Monitor the relative position of detector components
  - all 842 grid lengths are measured to a precision of < 1μm.
- FSI laser alignment provide
  - Good time resolution (a few second)
  - Continuous measurements (running during ATLAS stop)
  - Cross check of Level 1 track based alignment results
- Example : FSI monitor SCT Barrel movement during Solenoid cycle event

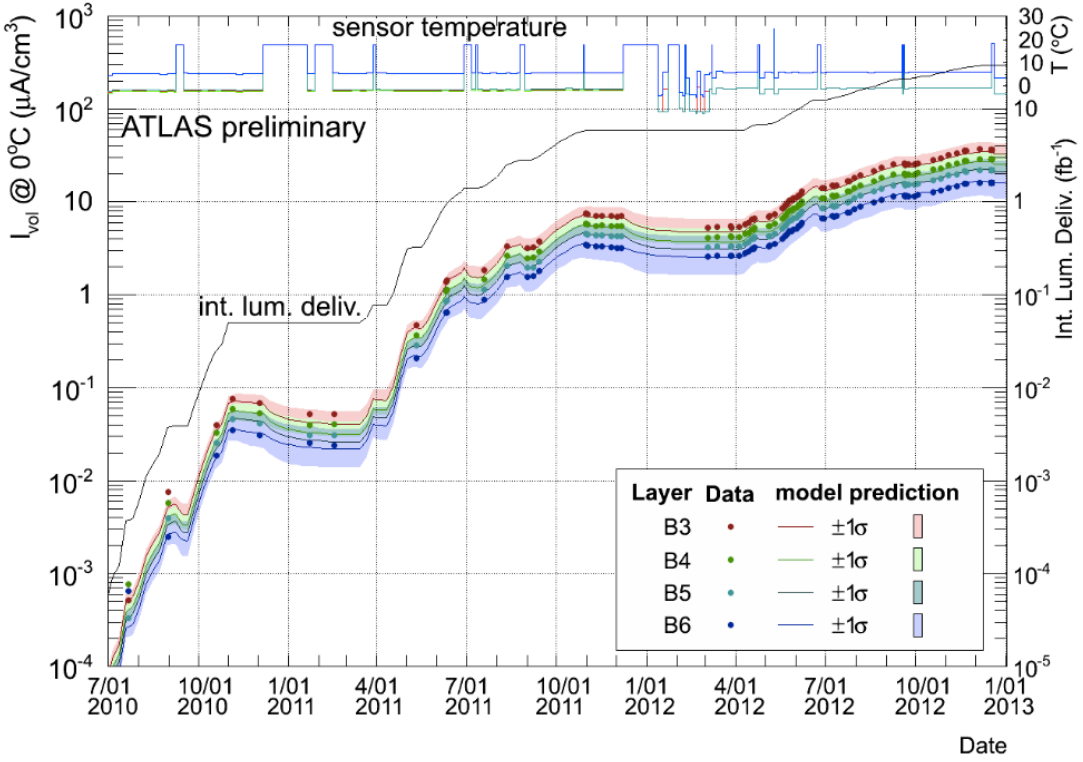






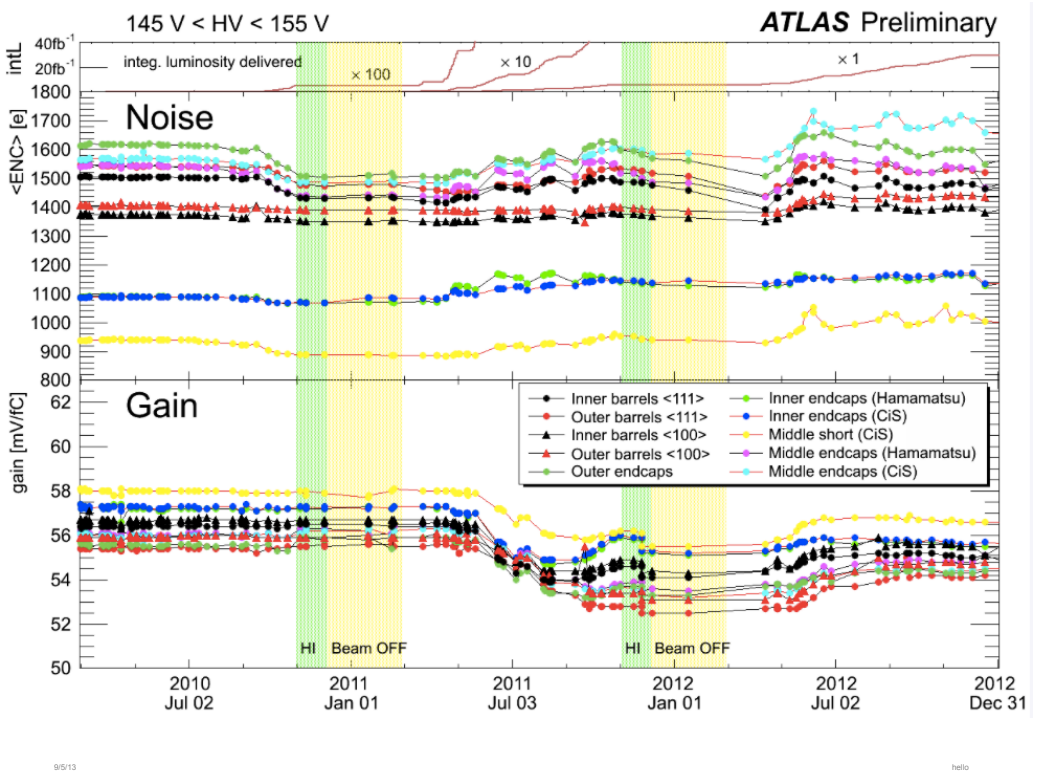
Radiation Damage

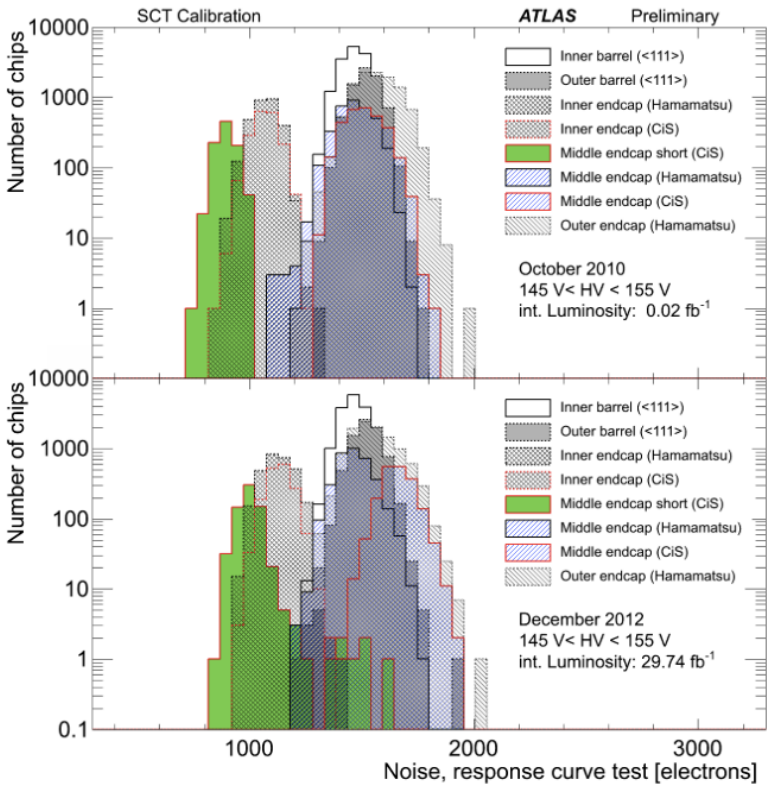
- The radiation effect is also monitored via the module leakage currents.
- The predictions of radiation damage are based on
  - the Hamburg/Dortmund model
  - simulations of minimum bias events using FLUKA†
- Excellent agreement for the barrel was found between data and model



Noise and Gain

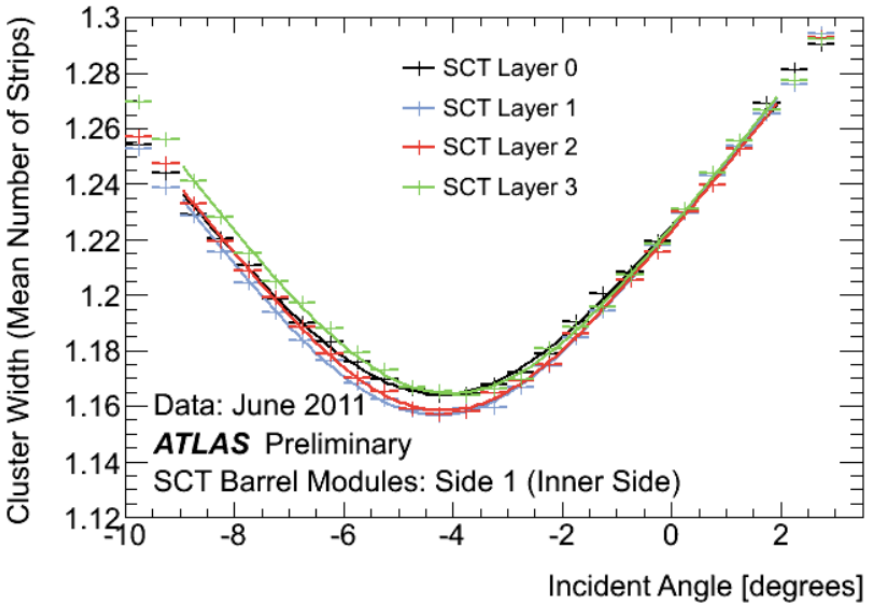
- After receiving 30 fb^{-1} of delivered luminosity
  - small variations in noise and gain, of the order of a few percent, during 2011 and 2012 for all modules.
  - higher noise increase for some modules equipped with CiS sensors
  - Gains: gradual and universal changes of a few % in mid 2011 and early 2012

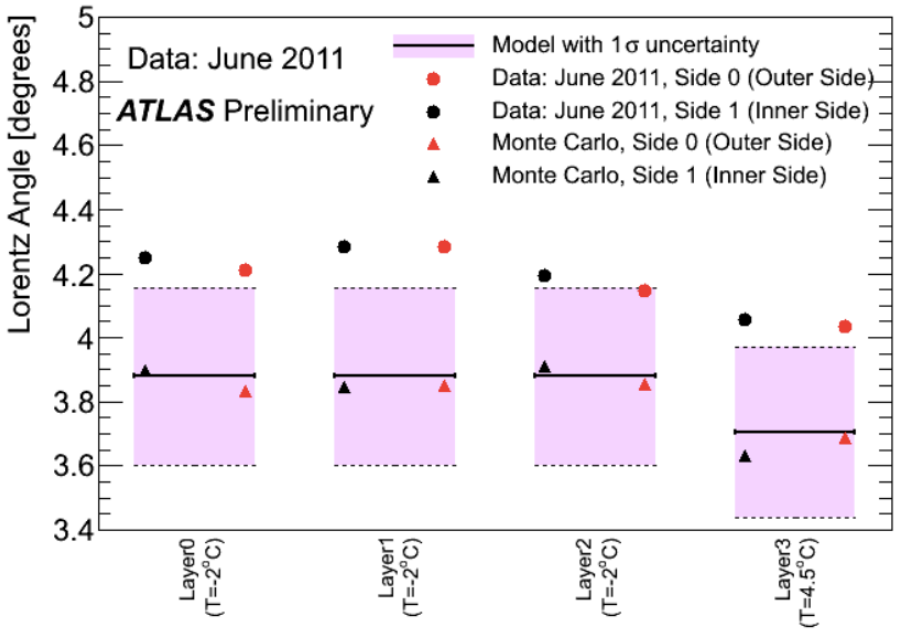




Lorentz Angle

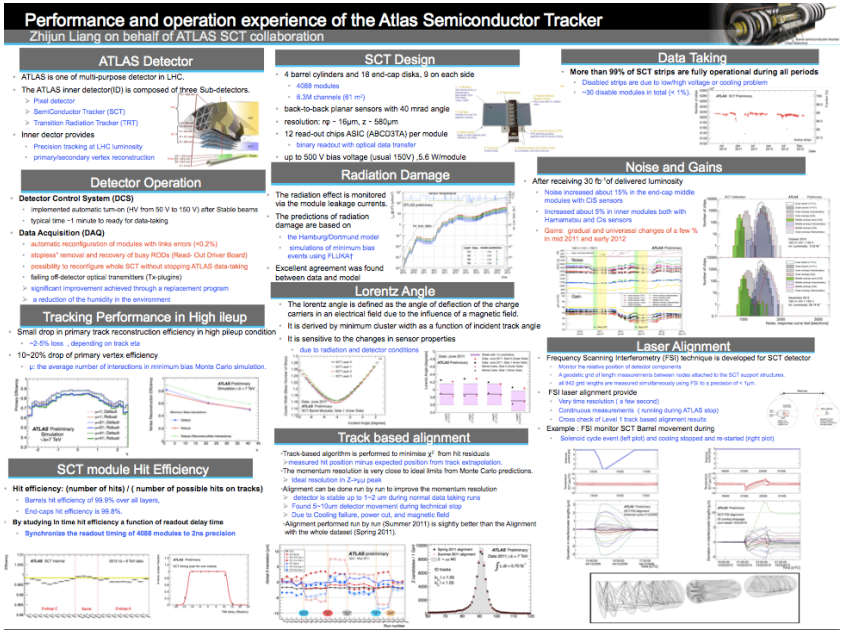
- The Lorentz angle is defined as the angle of deflection of the charge carriers in an electrical field due to the influence of a magnetic field.
- It is derived by minimum cluster width as a function of incident track angle
- It is sensitive to the changes in sensor properties
  - due to radiation and detector conditions





Summary

- Excellent data taking efficiency and SCT hit efficiency
- Advanced track based alignment was performed
  - Together with laser based alignment to understand detector movement
- Obtain excellent track momentum resolution
- Radiation damage in SCT was measured and monitor.
  - Agreed with predictions, under control
- Tracking and vertexing is robust in high pileup condition



Find more details in poster