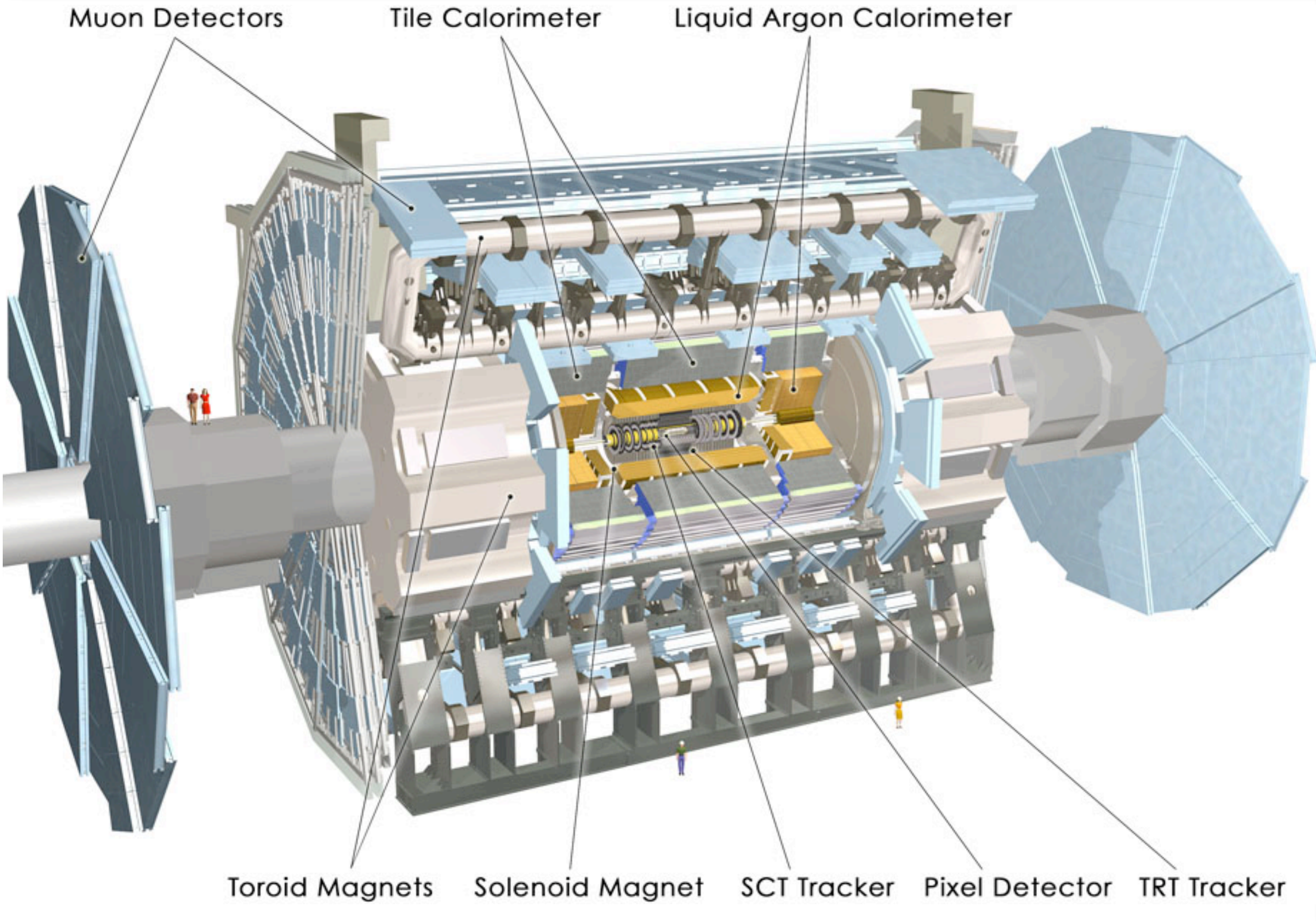
# ATLAS Inner Detector: Commissioning with Cosmics Data

Lucia Masetti - University of Bonn
On behalf of the ATLAS Collaboration

EPS 2009
Cracow, 16/07/2009


SPONSORED BY THE
Federal Ministry of Education and Research
universitätbonn

# The ATLAS detector



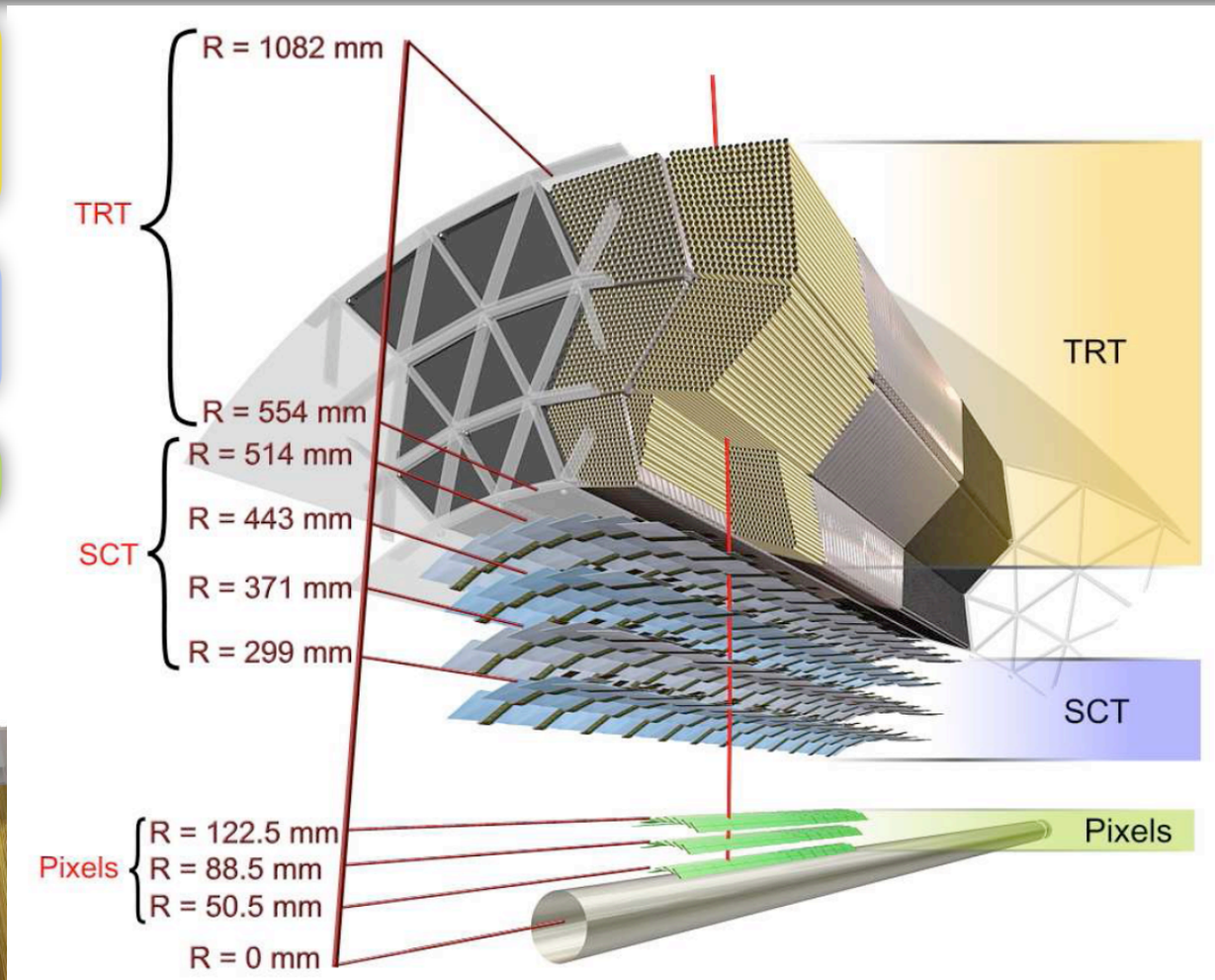
# The Inner Detector

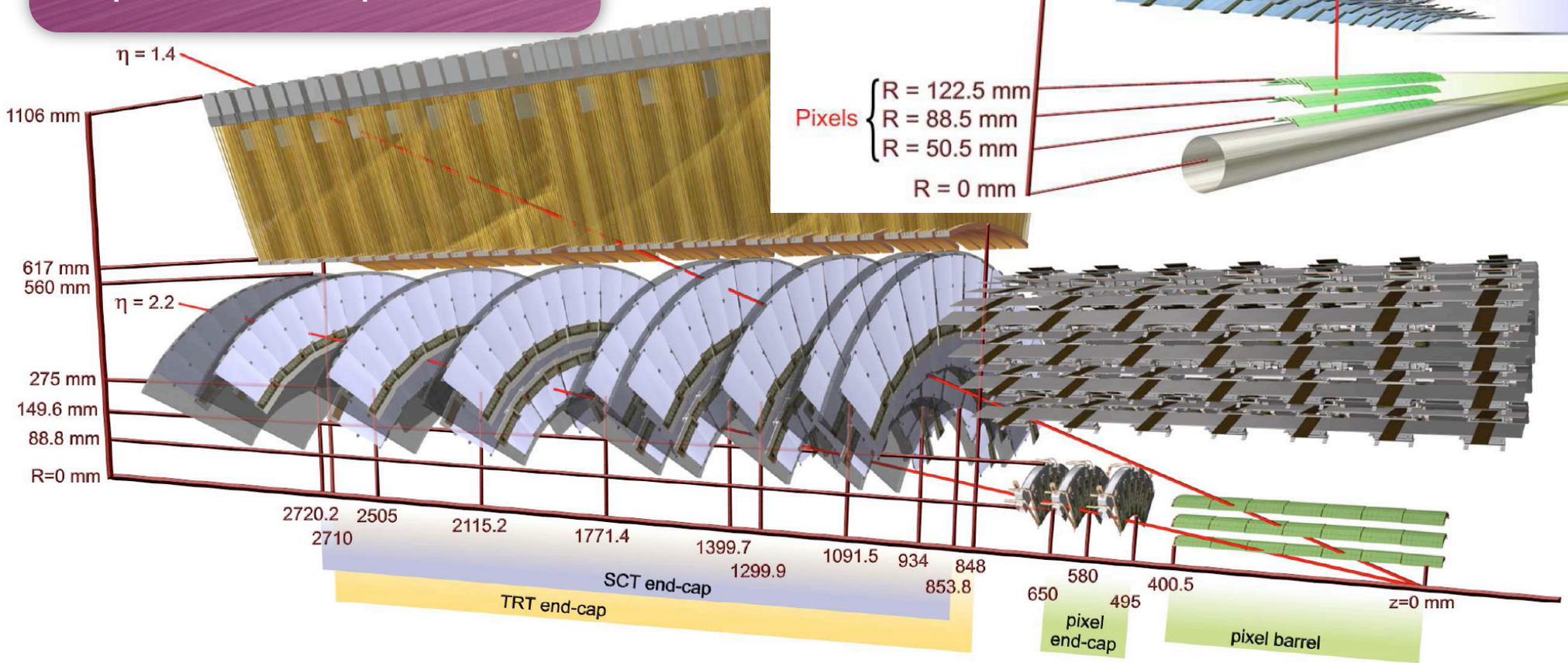
Transition Radiation Tracker (TRT)
(350k channels) with e/π separation

SemiConductor Tracker (SCT)
~6M silicon strips

Pixels: 80M channels

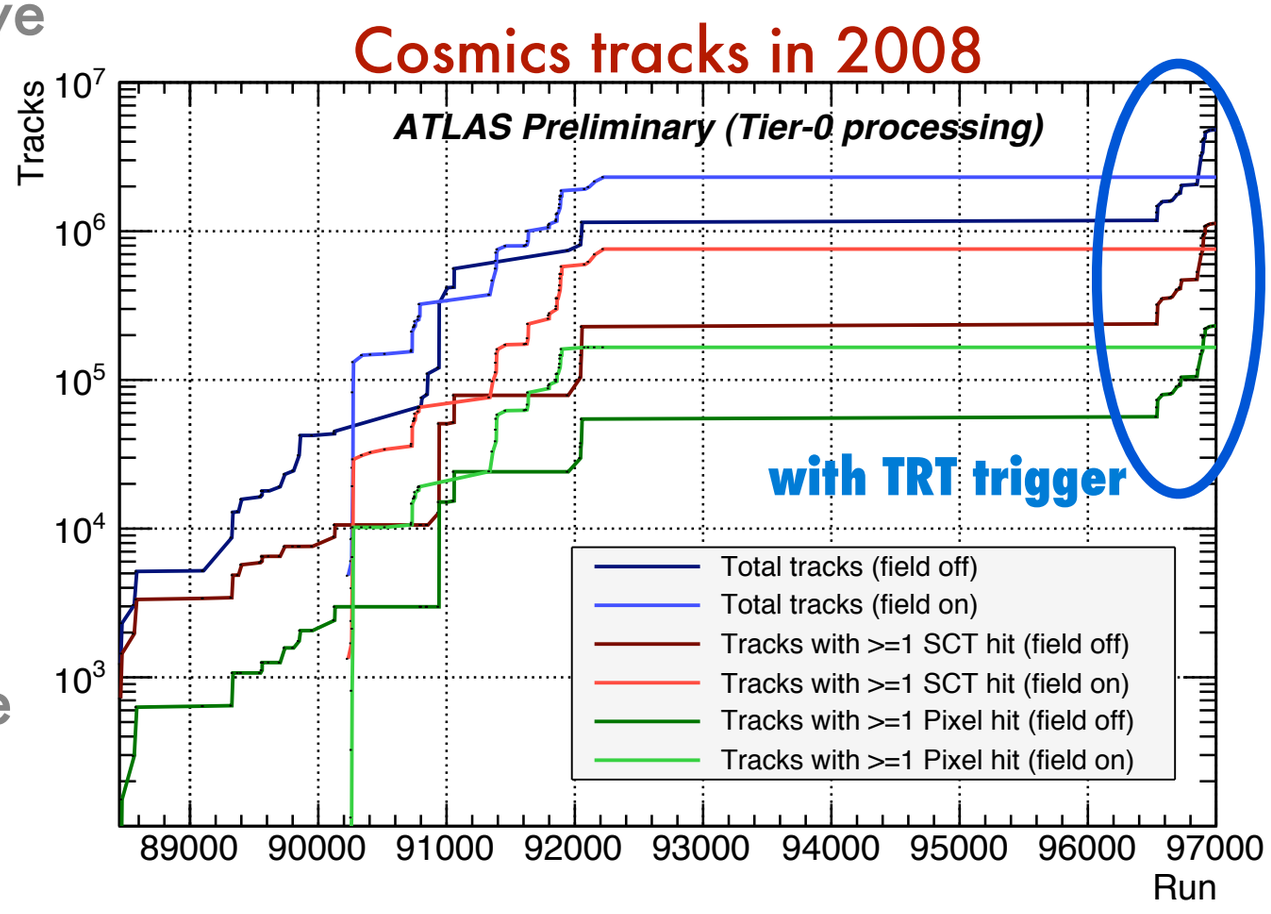
2 Tesla Solenoid
$\sigma/pT \sim 5 \times 10^{-4}\ pT \oplus 0.01$



# ID commissioning

- 2007: Pixel, SCT and TRT installed in the cavern, not yet completely connected
- Jan-Aug 2008: Last connections, evaporative cooling commissioning for Pixel and SCT
- Sep-Oct 2008: Combined cosmics run, ready for first beam on Sep 10th
- Nov-Dec 2008: Standalone calibration and combined cosmics data taking with TRT trigger
- Jan-May 2009: Evaporative cooling consolidation, "slice weeks" for groups of sub-systems (Pixel and SCT with hits simulator)
- Jun 2009: Slice week with cooled silicon detectors, ATLAS-wide cosmics run
- Jul-Aug 2009: Evaporative cooling and detector consolidation



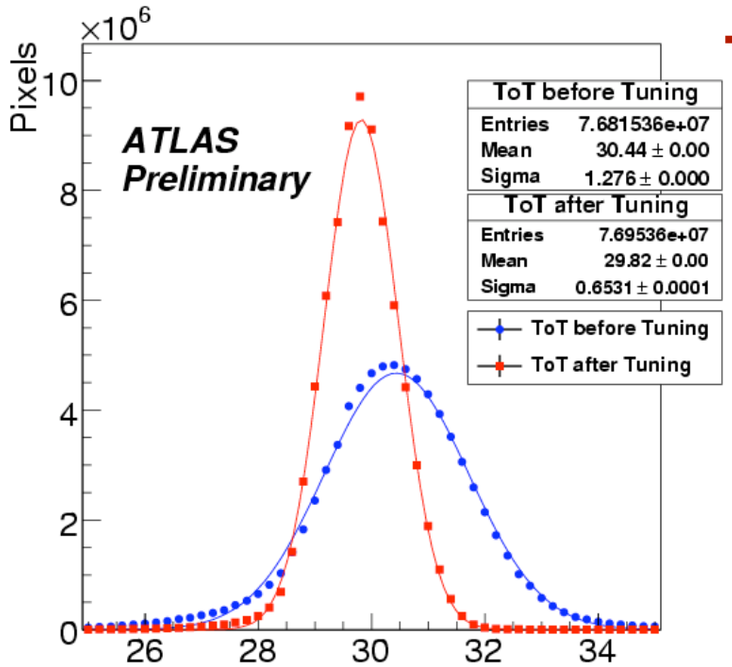
# Pixel detector status

- The latest on-detector leak-down measurement indicated a fluid loss of 14 kg/ year
  - All cooling loops will be operated unless a significant degradation is observed

- Off-detector failures:
  - All optical transmitter plug-ins (laser arrays) in the ROD crates are being exchanged
    - New production with improved ESD protection
    - Old plug-ins had a failure rate of few channels per week of operation

- 2% of the detector cannot be operated due to on-detector failures
  - Mostly due to problems in the optical links or open HV connections
  - 1.4% of B-layer is affected

# Pixel detector calibration



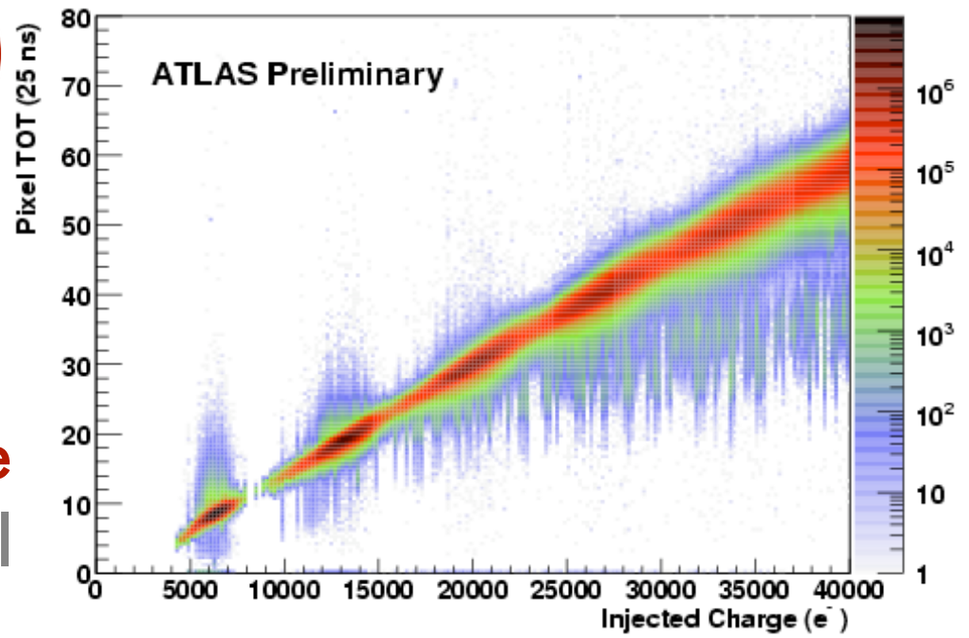

## Time-over-Threshold (ToT)

**Tuning:** 1 mip = 30 BC

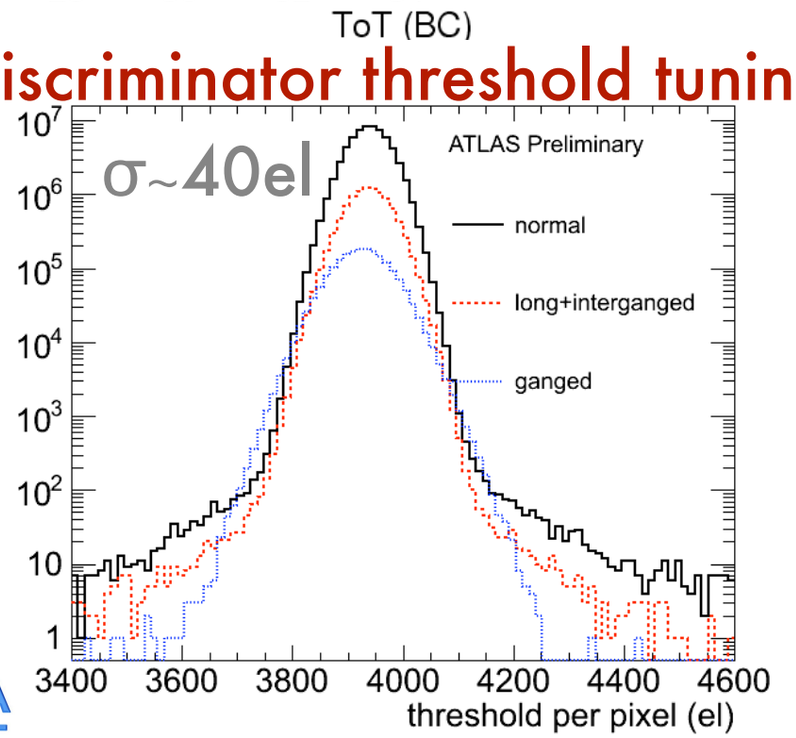
σ: 1.3 BC → 0.7 BC

## Calibration curve

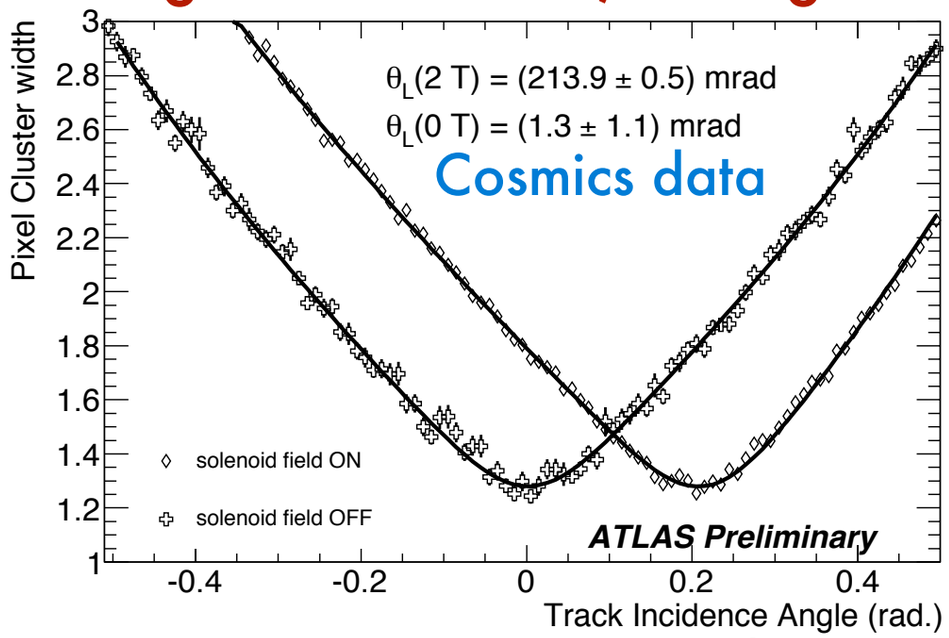
Linear, tails at $10^{-4}$ level



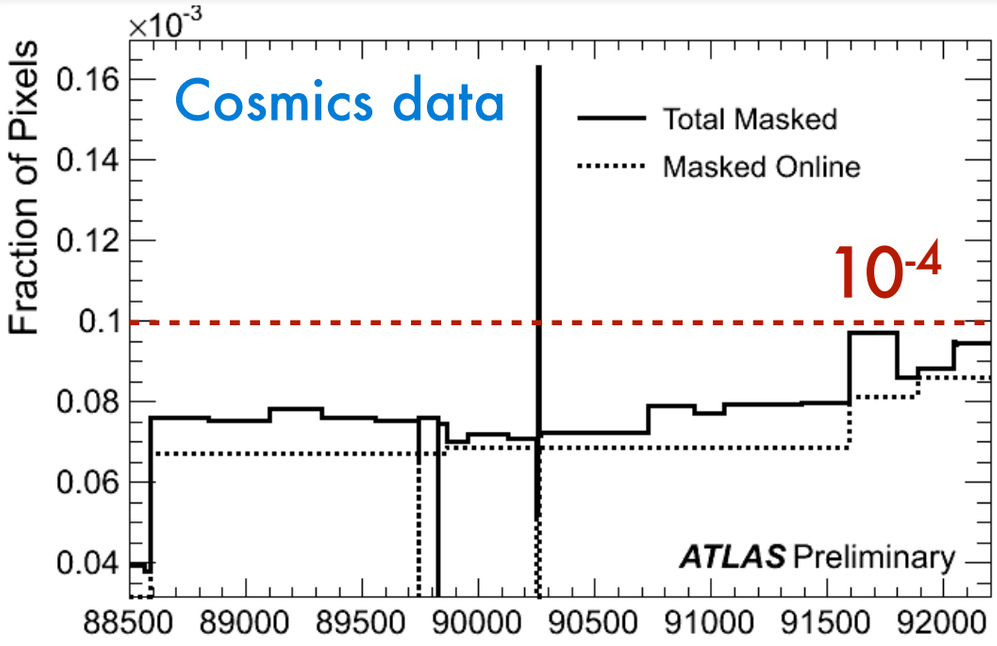

## Discriminator threshold tuning



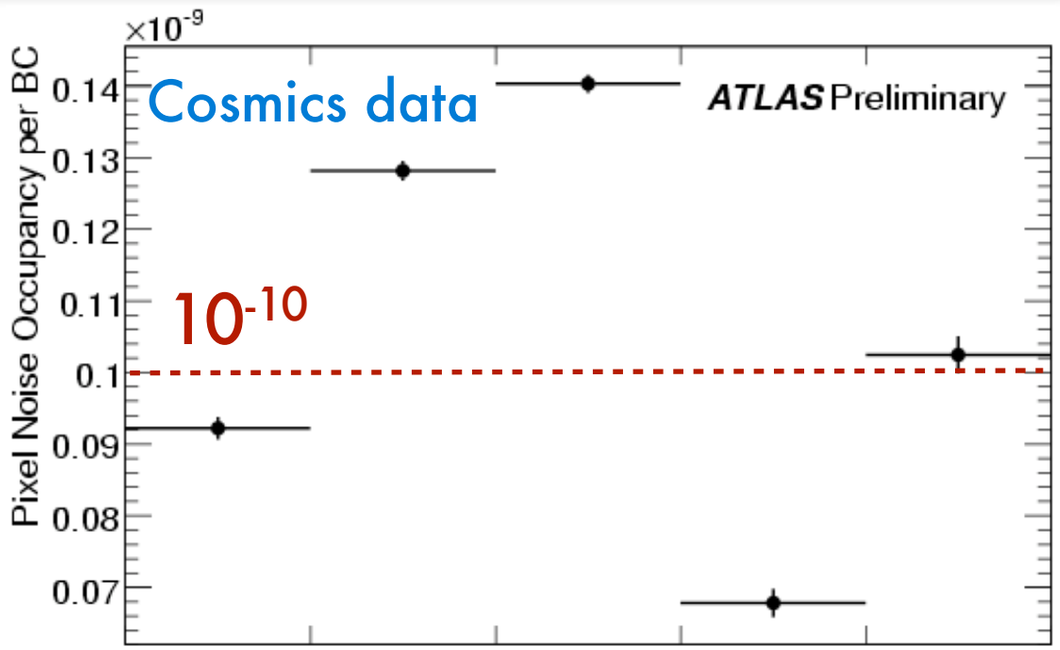

## Lorentz angle with and w/o magnetic field



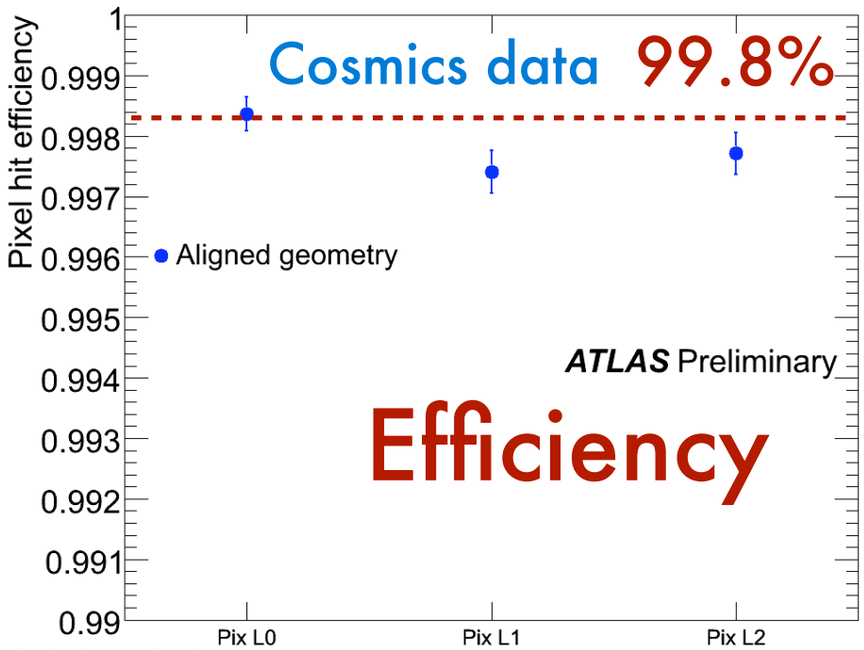
# Pixel detector performance



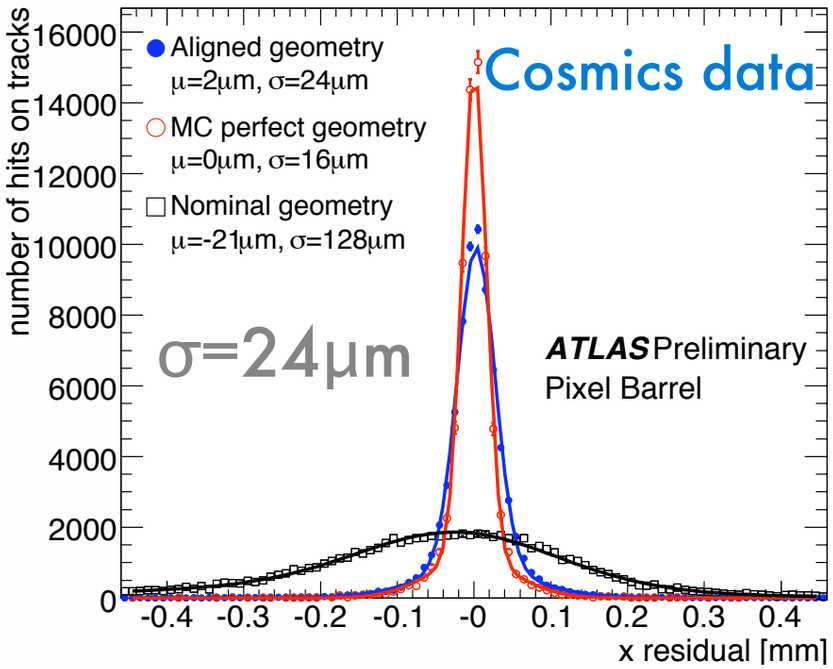

## Noise

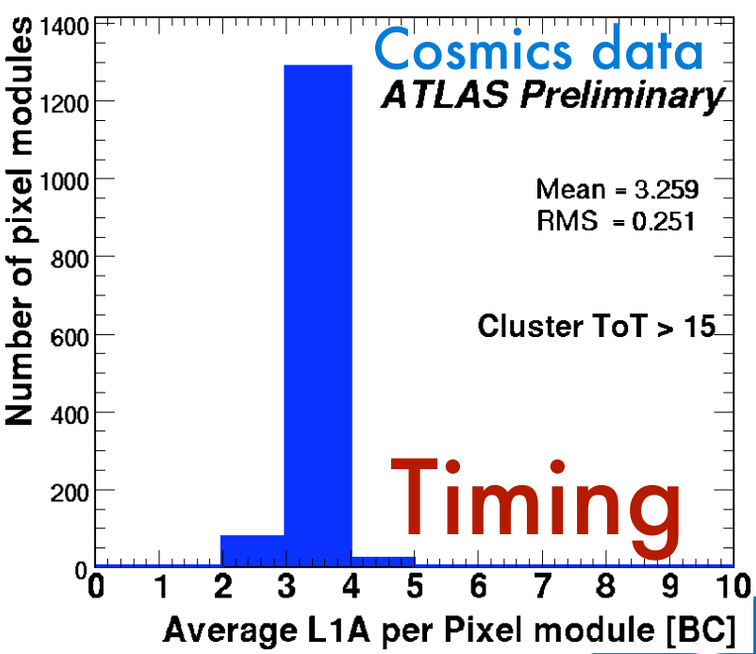



## Alignment




## Efficiency




## Timing

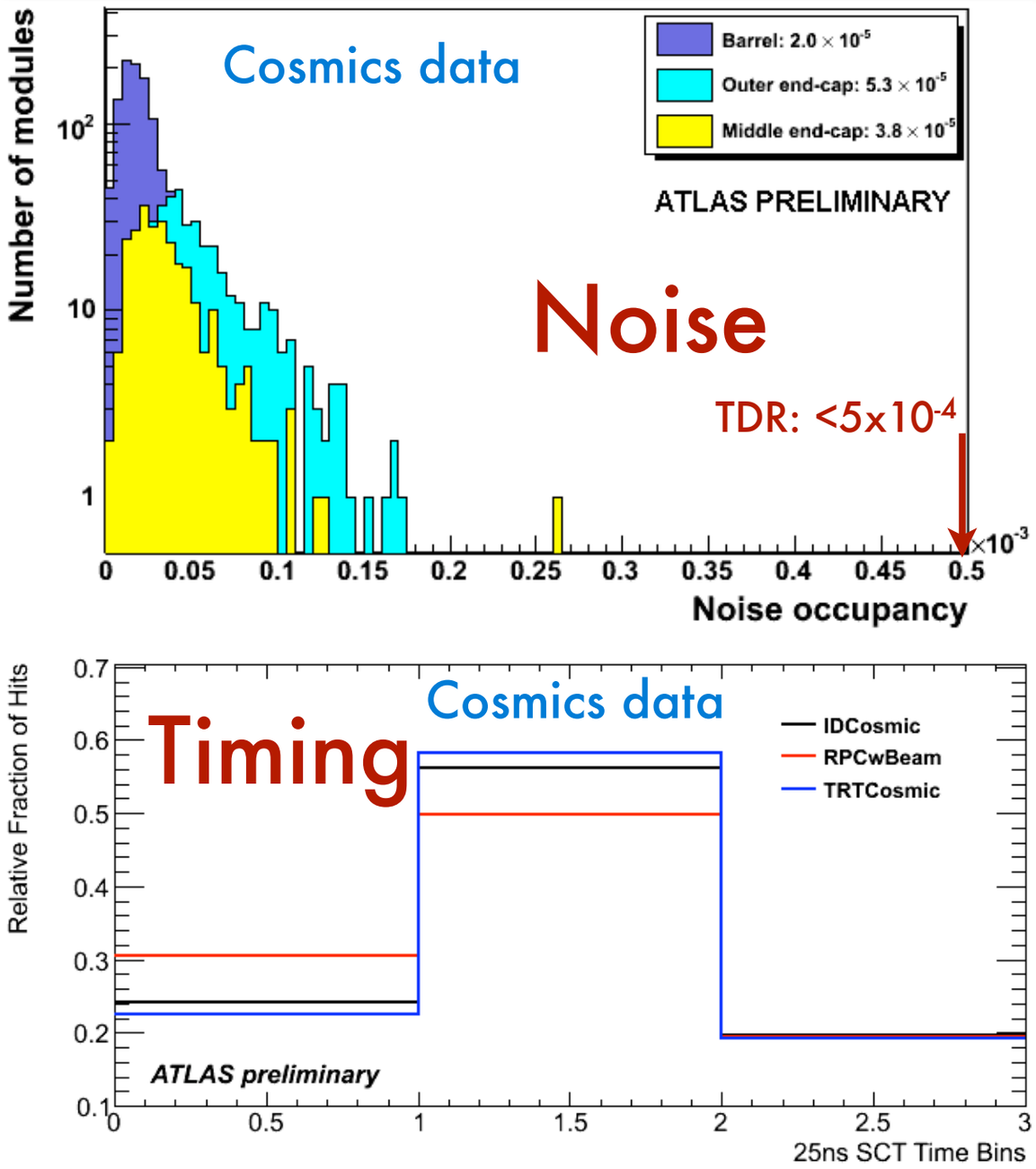
# SCT detector status

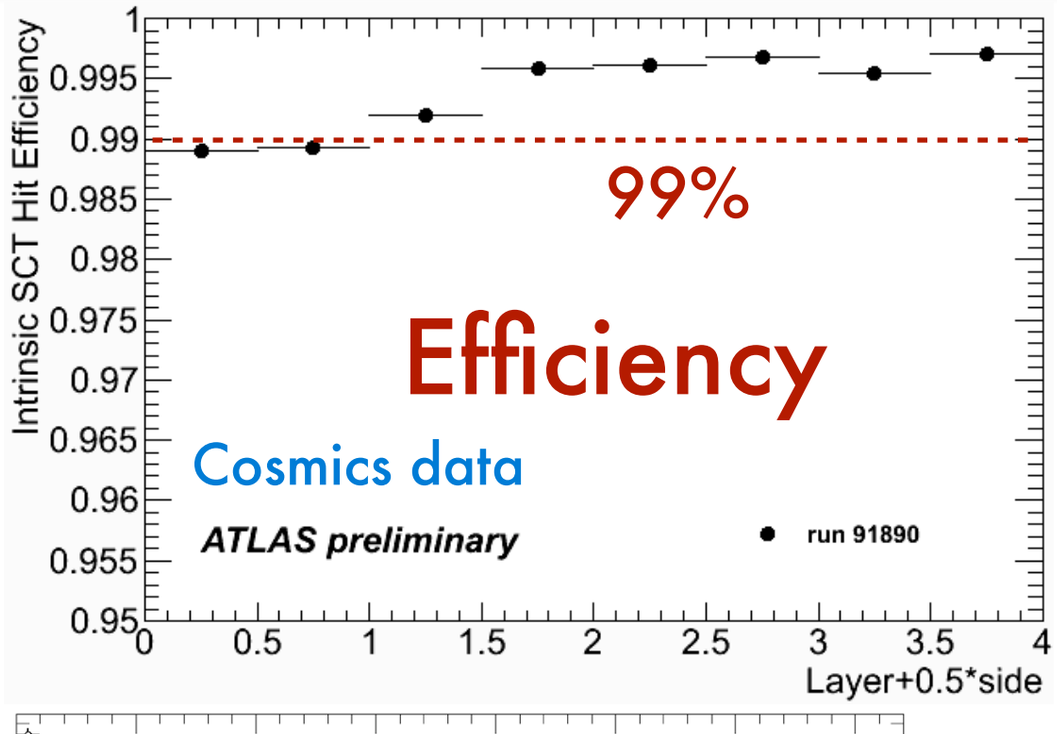
- One cooling loop in one end-cap cannot be operated
  - 1.3% of the end-cap, 0.35% of the detector

- Same problem as Pixel detector with transmitter plug-ins
  - Already exchanged plug-ins in 2 out of 8 crates
  - No failures in the new ones during the June run

- On-detector failures:
  - HV and LV problems in 0.1 - 0.6% of the detector

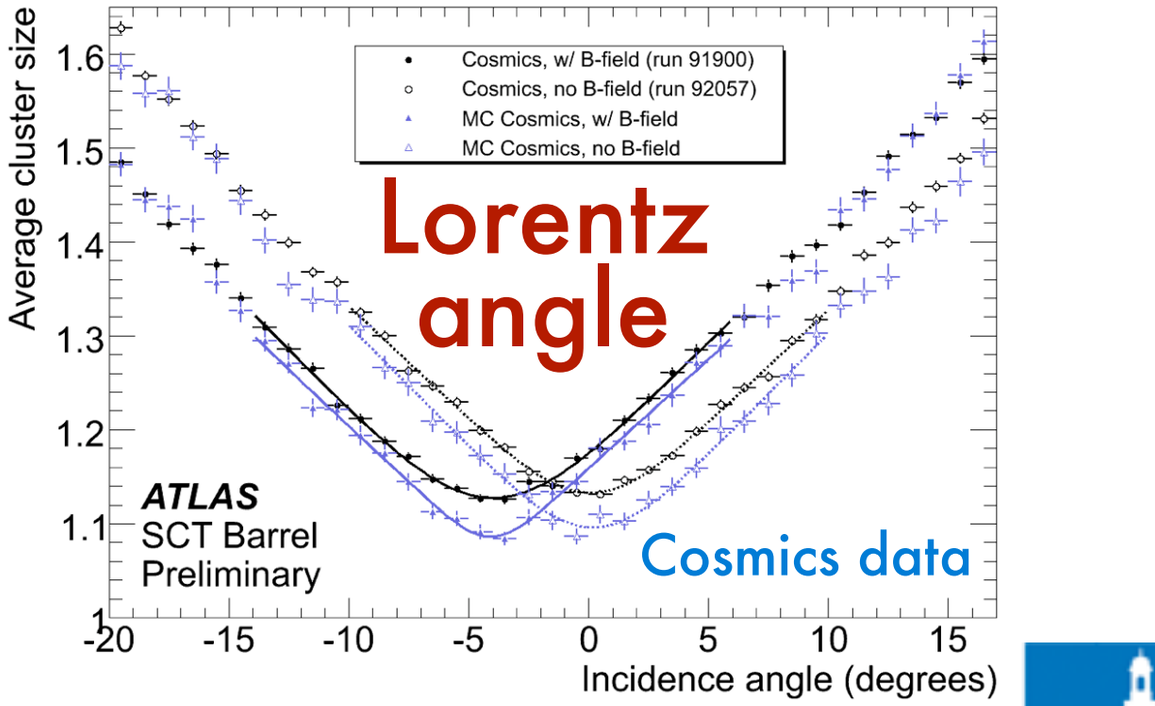
# SCT performance









# TRT detector status

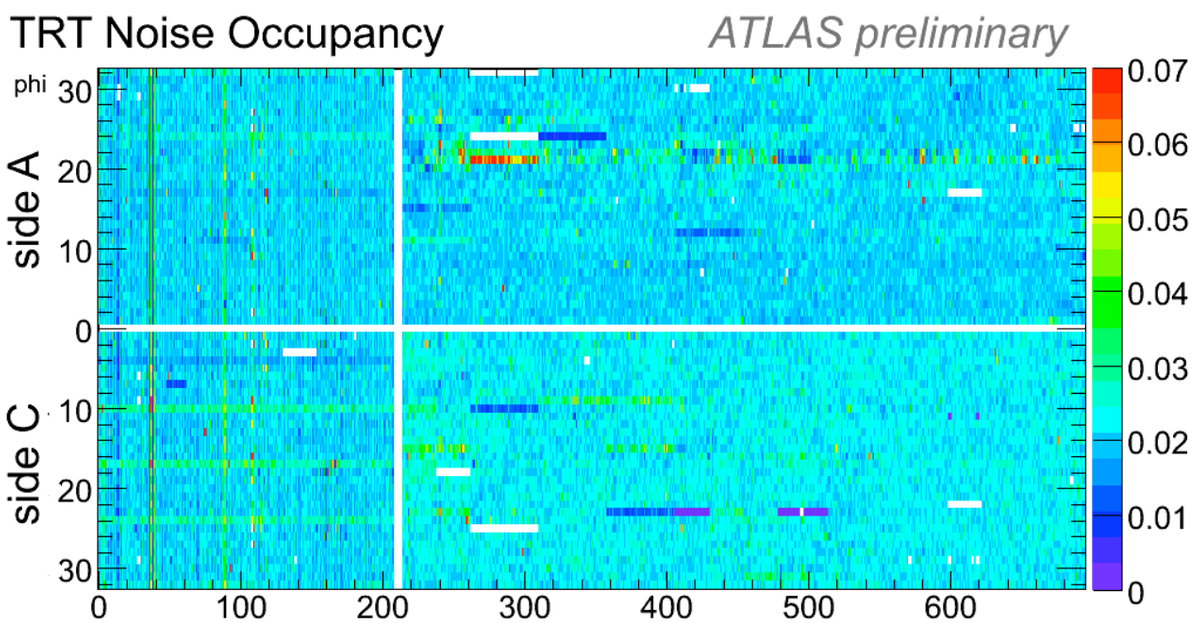
- Entire TRT running smoothly
  - No interruption in operation due to cooling
  - Regular milestone runs since March

- Improved leak rate of active gas system to 0.15 l/h (smallest leak rate of a large volume detector in the LHC)

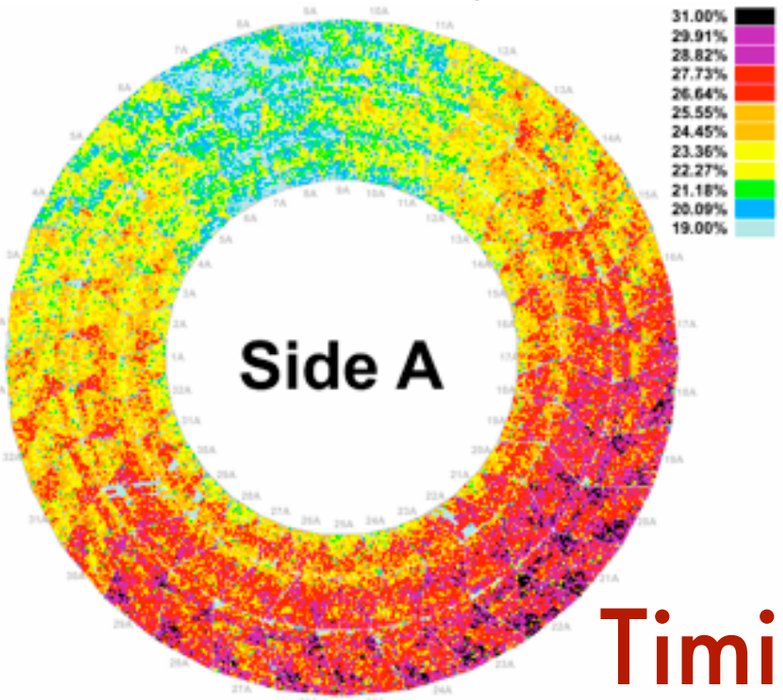
- Non-recoverable failures:
  - 2.2% dead straws

- Fast-OR trigger very useful for cosmics, but will not be used for collisions
  - 95% purity, used as reference timing trigger

# TRT performance

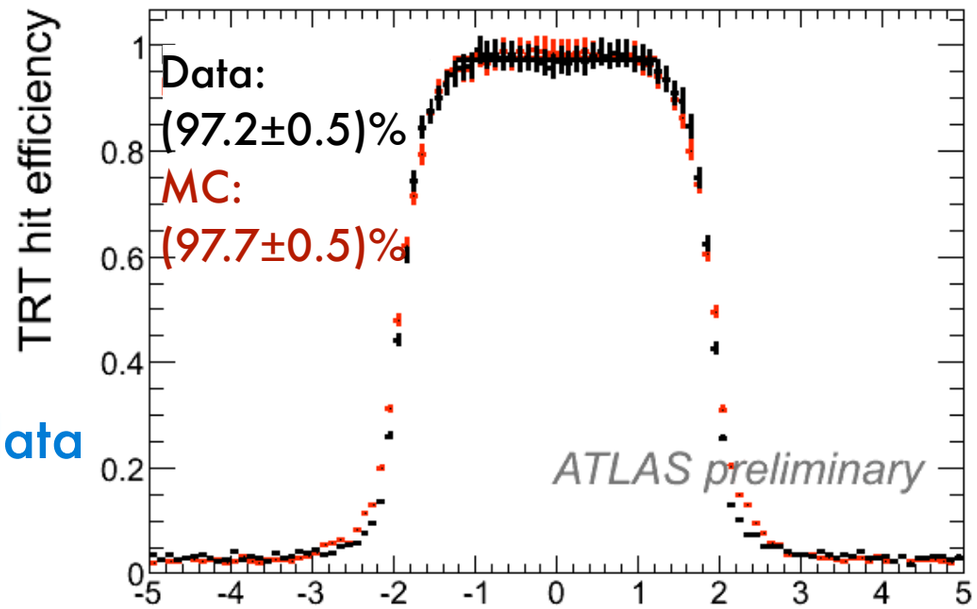



Beam splash event with timing tuned for cosmics

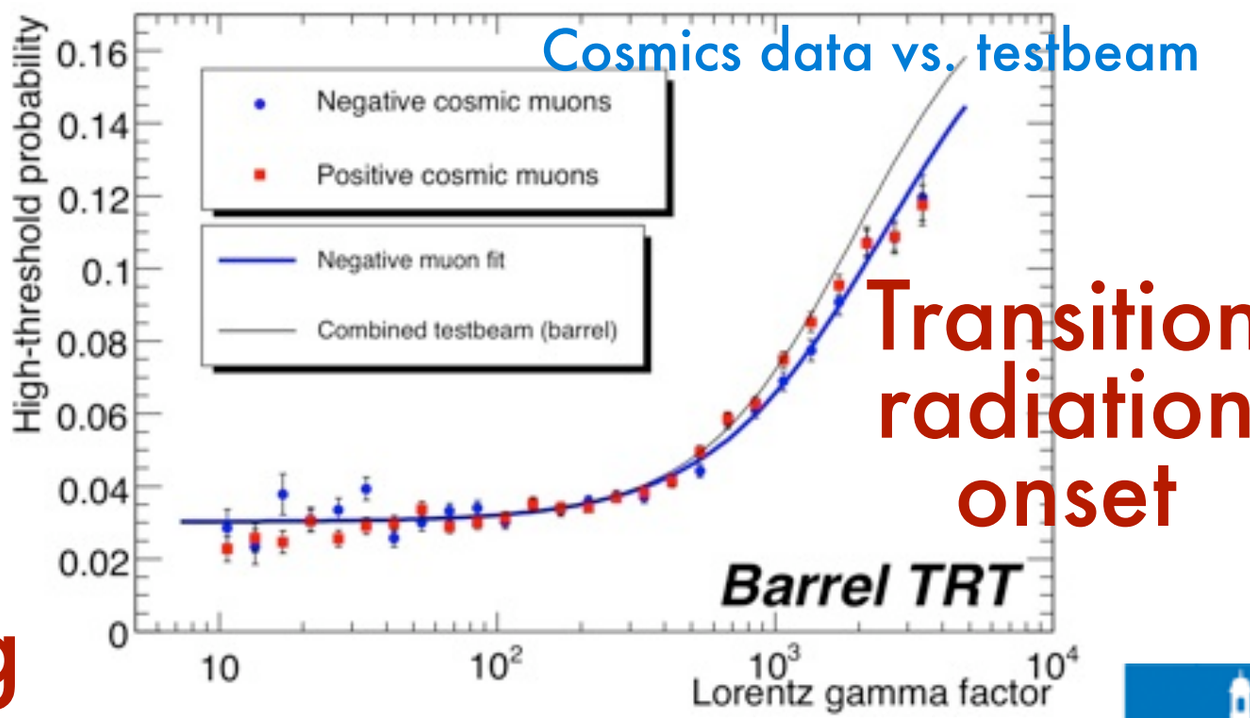



Timing

Cosmics data



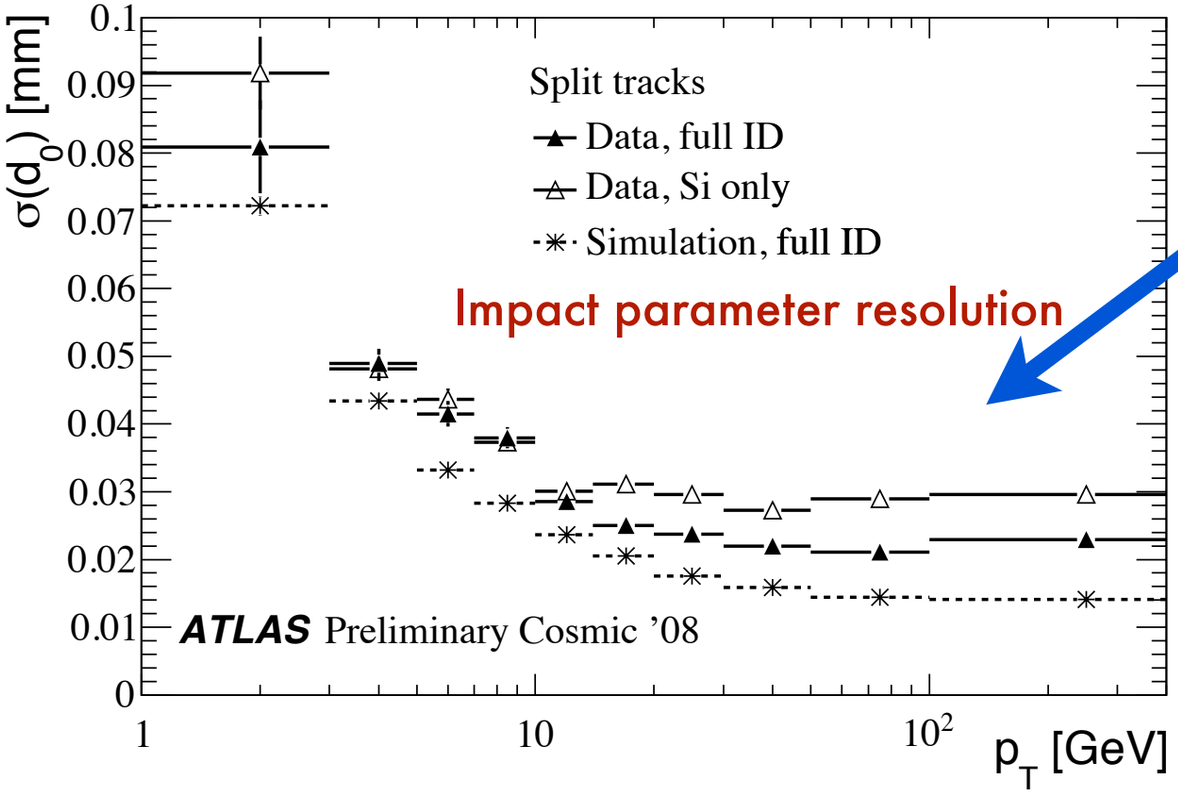

Cosmics data vs. testbeam



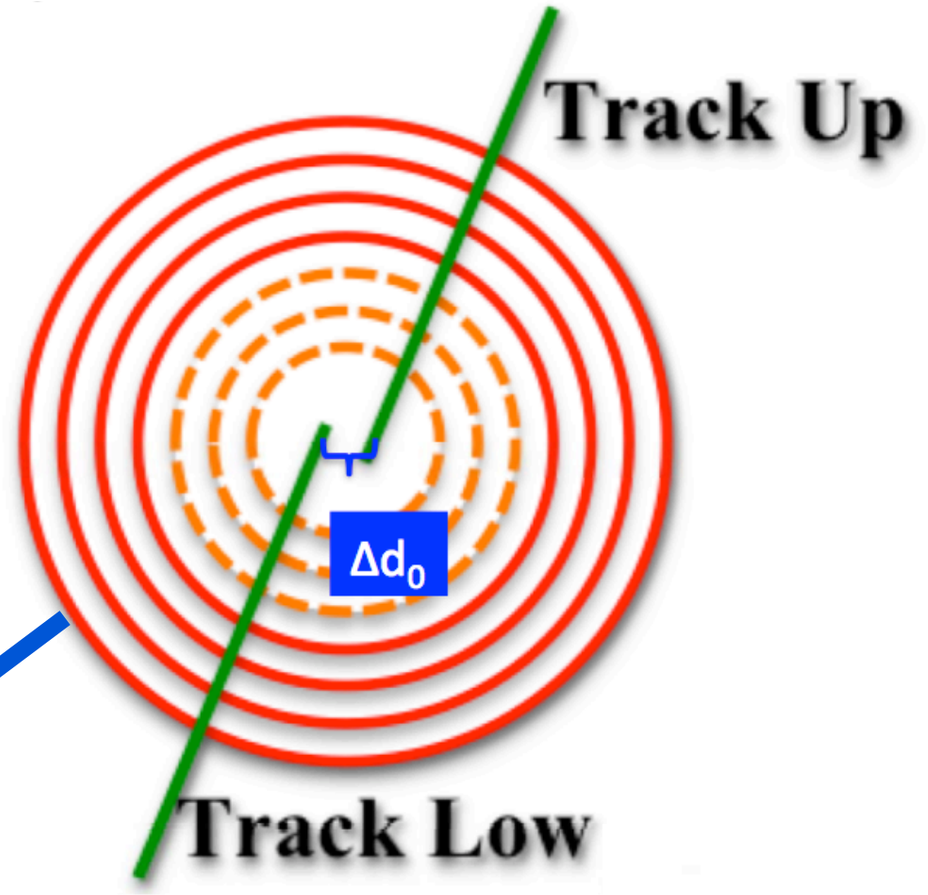

Transition radiation onset

# Combined tracking

- Cosmic tracks cross both the upper and the lower hemisphere of the ID
  - Tracks split in the center and refitted separately allow to measure the track parameter resolution and bias directly in data

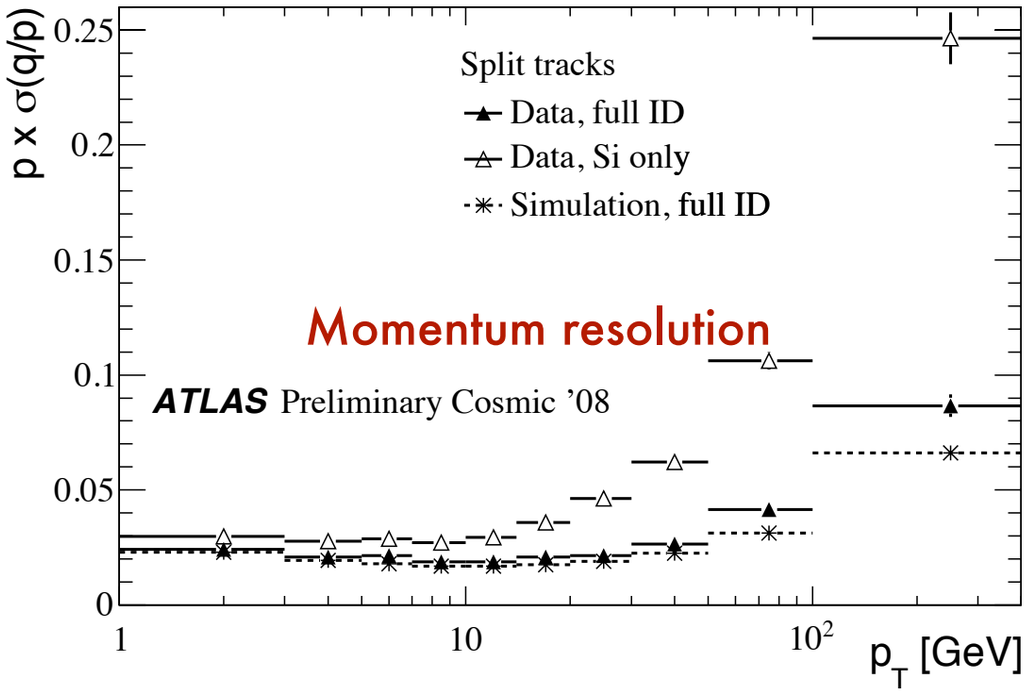


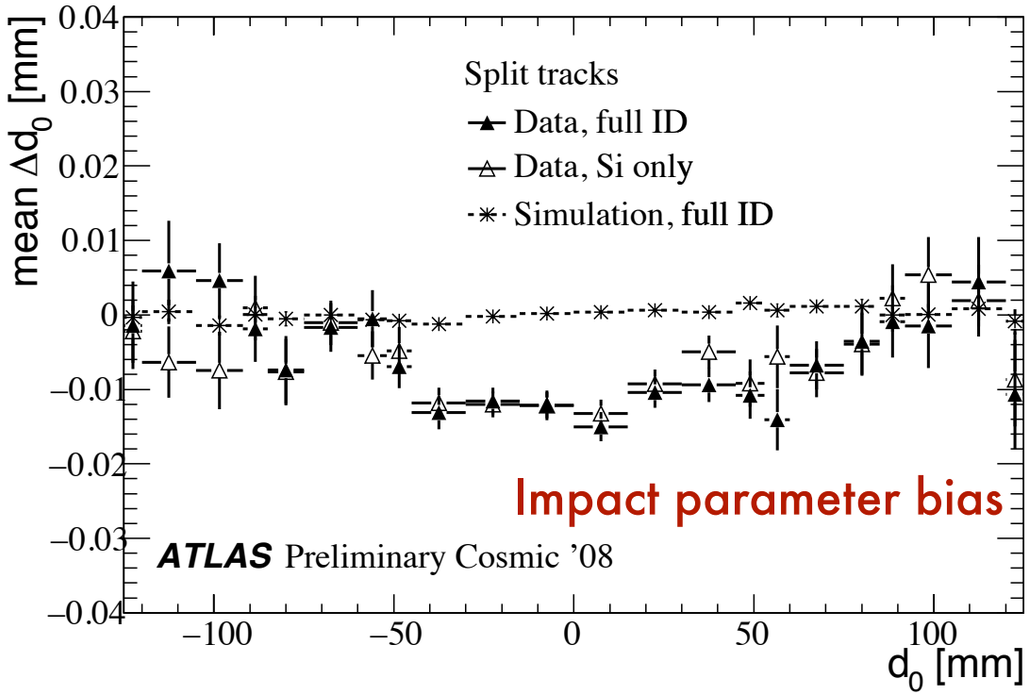

Impact parameter resolution

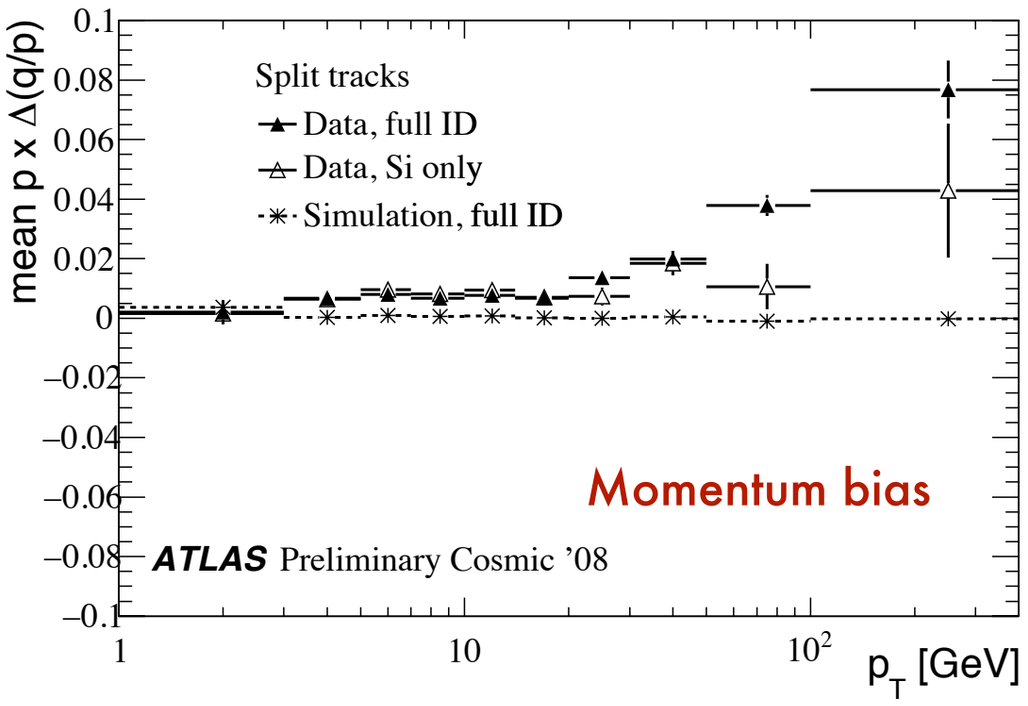



Direct measurement of the track parameter resolution possible!

# Tracking performance




- With the current alignment already very close to ideal detector performance
- Some (small) biases are seen and are under study in the alignment group

# Summary and outlook

- Noise and hit efficiencies in silicon detectors better than specifications
- TRT in long stable operation and used as reference timing for cosmics
- Track parameter resolution already close to expectation from perfect detector
- Cosmics data being analysed, very useful to understand the detector performances
- Further combined runs foreseen from September/October with cosmics and beam
- The ATLAS Inner Detector is well prepared for first collisions!
  - 98% of the pixel detector, 99.5% of SCT and 98% of TRT are operational