Topical Workshop on Electronics for Particle Physics, TWEPP, Paris, 21 - 25 September 2009

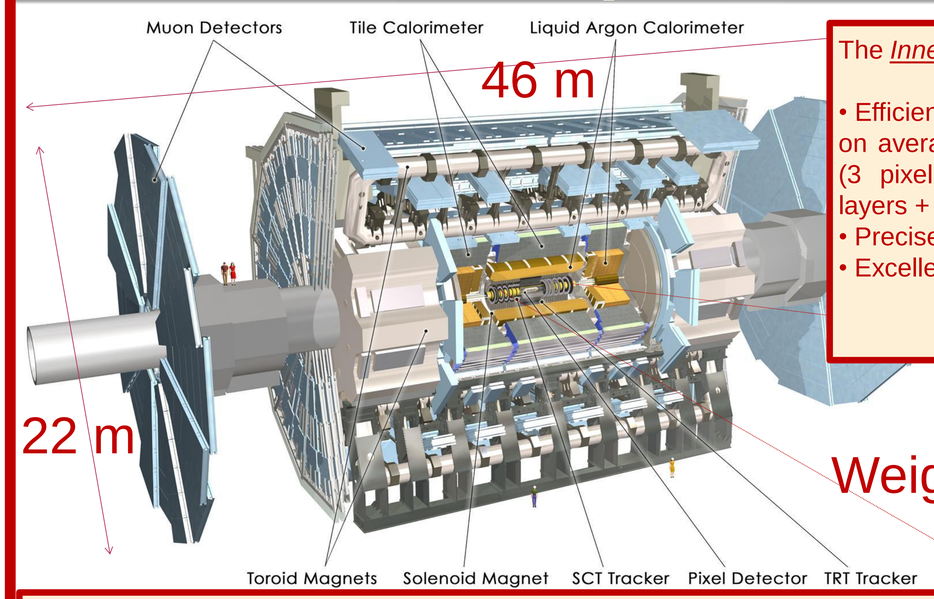
ATLAS Silicon Microstrip Tracker Operation

Peter Vankov

UNIVERSITY OF LIVERPOOL

On behalf of the ATLAS Collaboration

ATLAS Experiment



The *Inner Detector* (ID) provides:

- Efficient particle tracking, based on average of 37 measurements (3 pixel layers + 4 SCT strip layers + ~30 TRT straws)
- Precise vertex determination
- Excellent momentum resolution

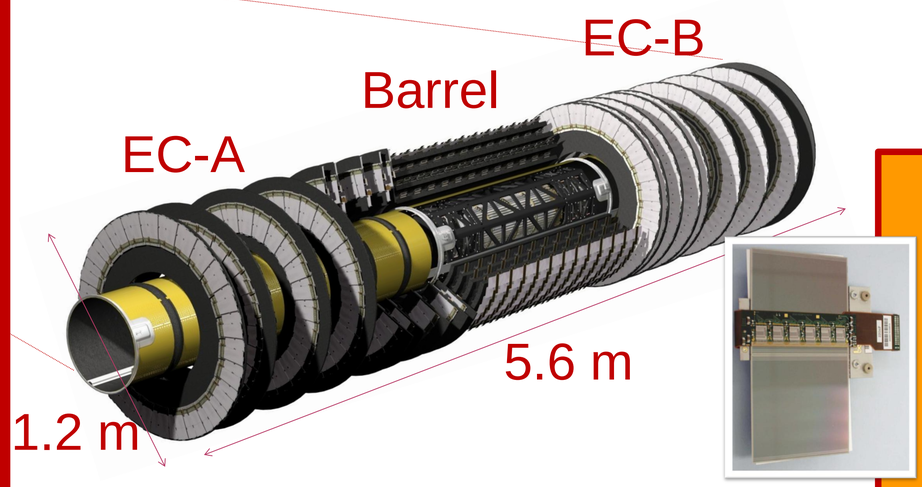
- The largest ever built HEP experiment, operating at LHC, CERN
- Designed to explore the $\sqrt{s}$=14 TeV p-p collisions at L= 10^{34} cm^{-2} s^{-1}
- Basic subsystems:
  - * *Inner Detector* (Pixel Detector, **SCT**, TRT) within solenoid of B=2T
  - * *Calorimeters* (Electromagnetic and Hadronic)
  - * *Muon Spectrometer*, using toroidal magnetic field of B=0.5T

Semi-Conductor Tracker(SCT)

- 4088 silicon modules arranged in Barrel and EndCap sections
- 6.3 million readout channels (~ 61 m² of silicon)
- Spacial resolution: rφ~17μm / Z ~ 580 μm (23 μm strip resolution)

EndCaps (EC)

- 1976 modules
- 4 module types
- 9 disks/endcap
- 2 endcaps (A&C)
- 1.1 to 1.4<|η |<2.5



Barrel

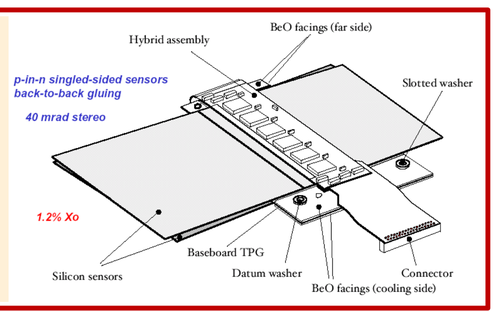
- 2112 modules
- 1 module type
- 4 barrel layers
- |η|<1.1 to 1.4

Detector technology & operation

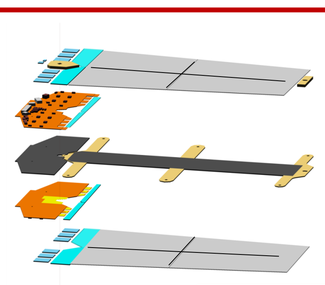
Design

- Each module consists of 2 pairs of silicon (p-on-n) strip sensors, back-to-back
- 40 mrad stereo angle between the two module planes
- 768 readout silicon strips per side (1536 strips/module)
- strip pitch: 80 μm (barrel), 57-94 μm (endcap)

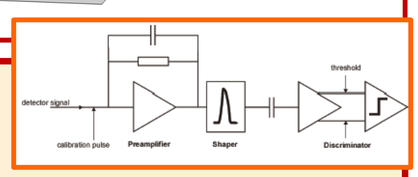
Barrel module



Endcap module



- ✓ 4 wedge shape silicon sensors
- ✓ 768 p-in-n strips, single sided
- ✓ Sensor alignment < 5μm
- ✓ 40mrad stereo angle



Operation

- Optical communication
- 5.6 W/module
- Up to 500V sensor bias

Front-end electronics

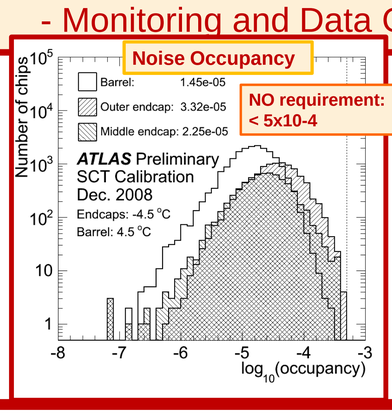
- Binary readout
- 6 readout chips(ABCD3TA)/side, on the hybrid
- Radiation-hard DMILL technology
- 25 ns clock

Comissioning

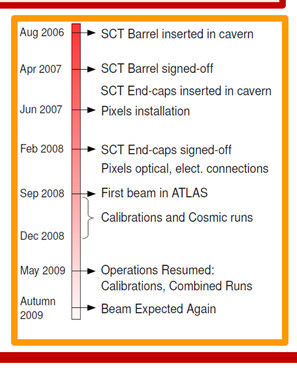
Comissioning tests

Operational modules
- Barrel: 99.6 % modules
- EndCaps : 97.8 % modules (2% out - cooling issues)

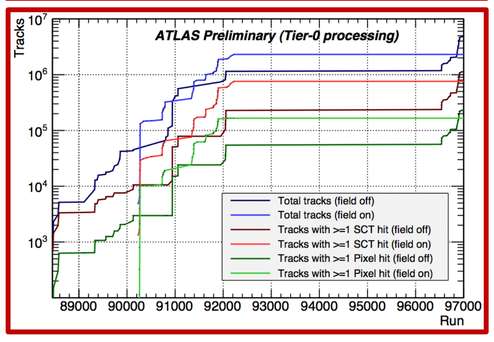
- ✓ Electrical connections
  - LV check
  - HV current voltage scan
  - Temperature readings
- ✓ Optical connections
  - P-i-n current
  - Light from fiber measured at the Readout Driver
  - Fiber connection & module mapping
- ✓ Calibration tests
  - Digital and Analogue functionality
  - Noisy/Dead channel mapping, Gain curve
  - Noise occupancy
- ✓ Cosmic tests (ATLAS combined runs)
  - Readout chain
  - Monitoring and Data Quality

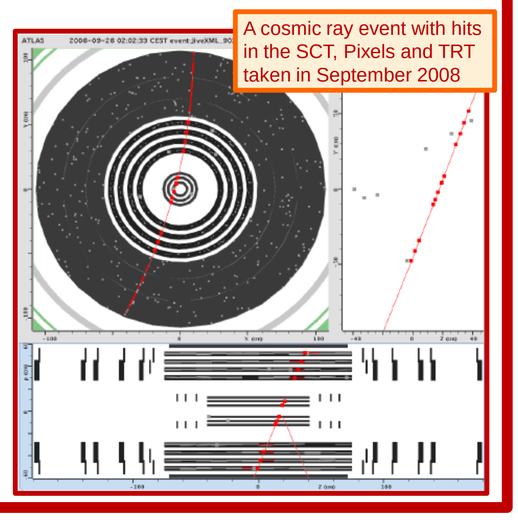


NO requirement: < 5x10-4



Oct–Nov'2008 cosmic data taking

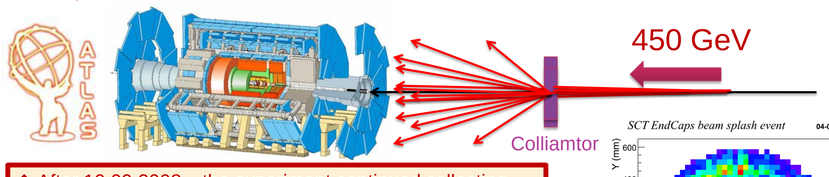




A cosmic ray event with hits in the SCT, Pixels and TRT taken in September 2008

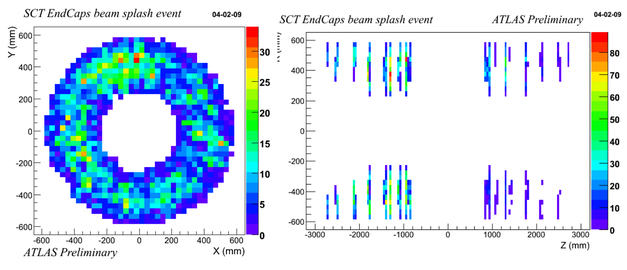
Performance (I)

10 september 2008 – First Beam in ATLAS

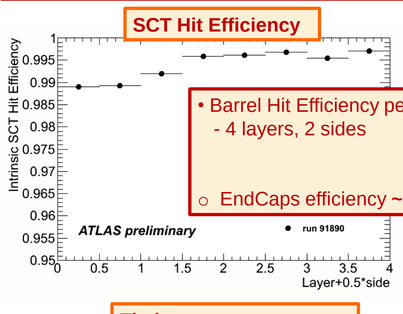


- ❖ Pixel Detector: OFF (for safety)
- ❖ SCT Barrel: OFF
- ❖ SCT EndCaps: ON, with (for safety):
  - low voltage (20 V)
  - raised threshold (1.2 fC)

- ❖ After 10.09.2008 – the experiment continued collecting cosmic data until Nov'2008.
- ❖ Combined ATLAS Cosmic runs Oct-Nov'2008 used for:
- ● Timing in
- ● Performance studies
- ● Alignment

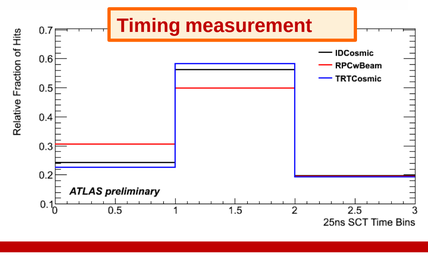


SCT Hit Efficiency

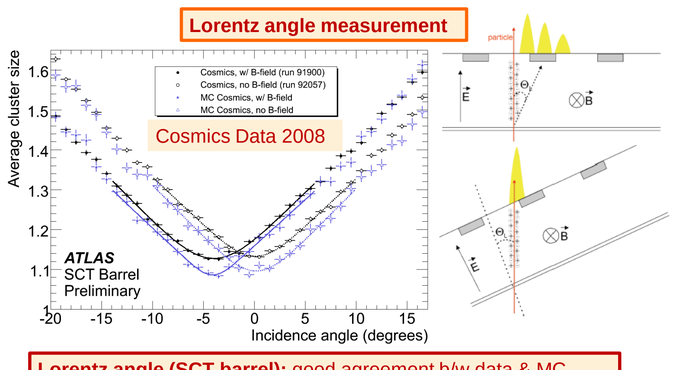


- Barrel Hit Efficiency per layer ≥ 99%
  - 4 layers, 2 sides
- EndCaps efficiency ~ 99%

Timing measurement



Lorentz angle measurement

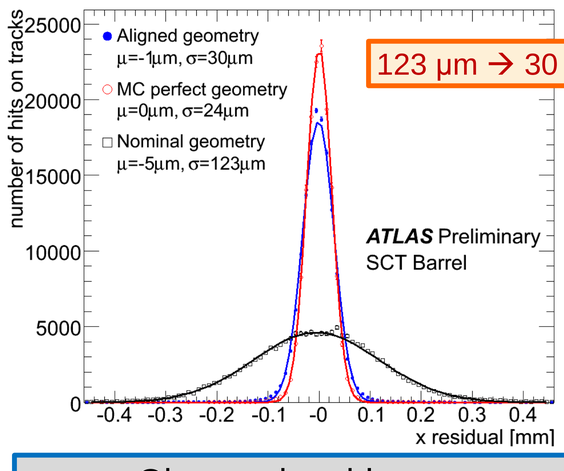


Lorentz angle (SCT barrel): good agreement b/w data & MC

Data: Θ_L = 3.93±0.03 (stat.)±0.10 (syst.)
Monte Carlo: Θ_L = 3.69±0.19 (syst.)

Performance (II)

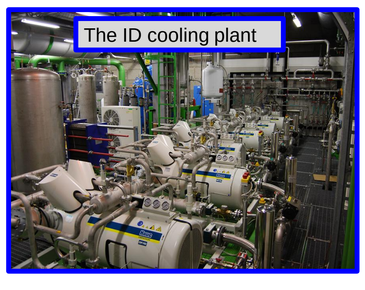
Alignment



123 μm → 30 μm

Residual distribution for x-coordinate

- Barrel is aligned down to module level (with resolution very close to a fully aligned geometry (MC))
- EndCaps - only the large structures are aligned (module-to-module alignment is not possible because of low statistics)



Observed problems

Cooling
- failure of 3 ID compressors (incident on May 1st 2008)
- kg of C3F8 lost and 900 kg contaminated

Optical readout
- failure of some SCT Vcsel channels (TX)

Both problems are currently solved (The ID compressors were repaired; cooling is operational since August'2008. All failed TX plugins were replaced.)

SCT is fully functional and shows excellent performance !

Ready for the LHC restart in Nov'2009.