

Inner Detector Commissioning Overview

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On behalf of the ATLAS Inner Detector Group

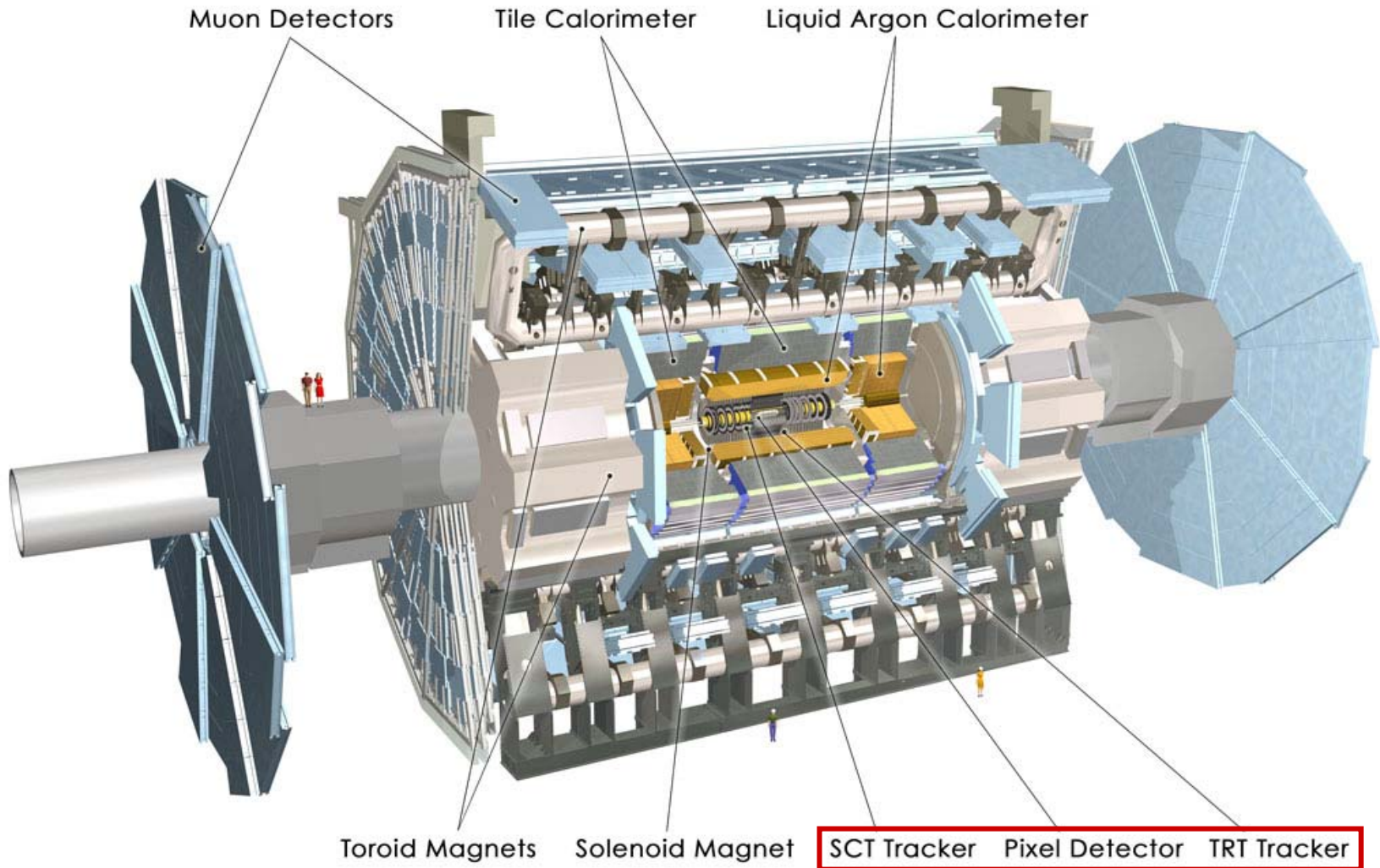
April 15, 2009

ATLAS Tau Workshop



The ATLAS Detector

At the very heart of ATLAS; ~90% of all channels are in the ID

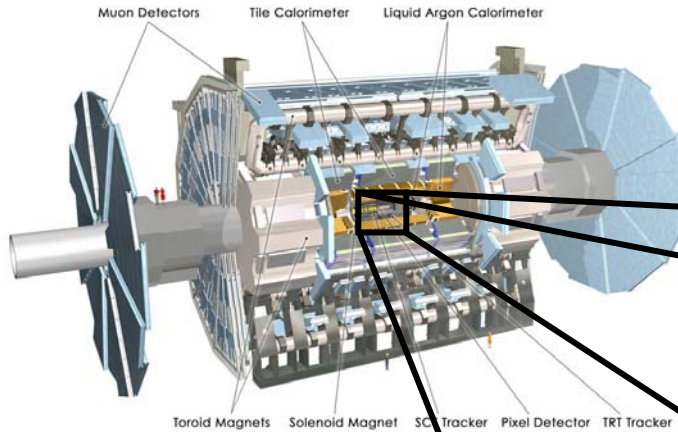


Operated inside 2 Tesla solenoidal field, coverage $\eta < 2.5$ (Transition Radiation Tracker $\eta < 2.0$)

$$\sigma/p_T = 0.05\% p_T \oplus 1\%$$

The ATLAS Inner Detector

Barrels (Pixel, SCT and TRT)

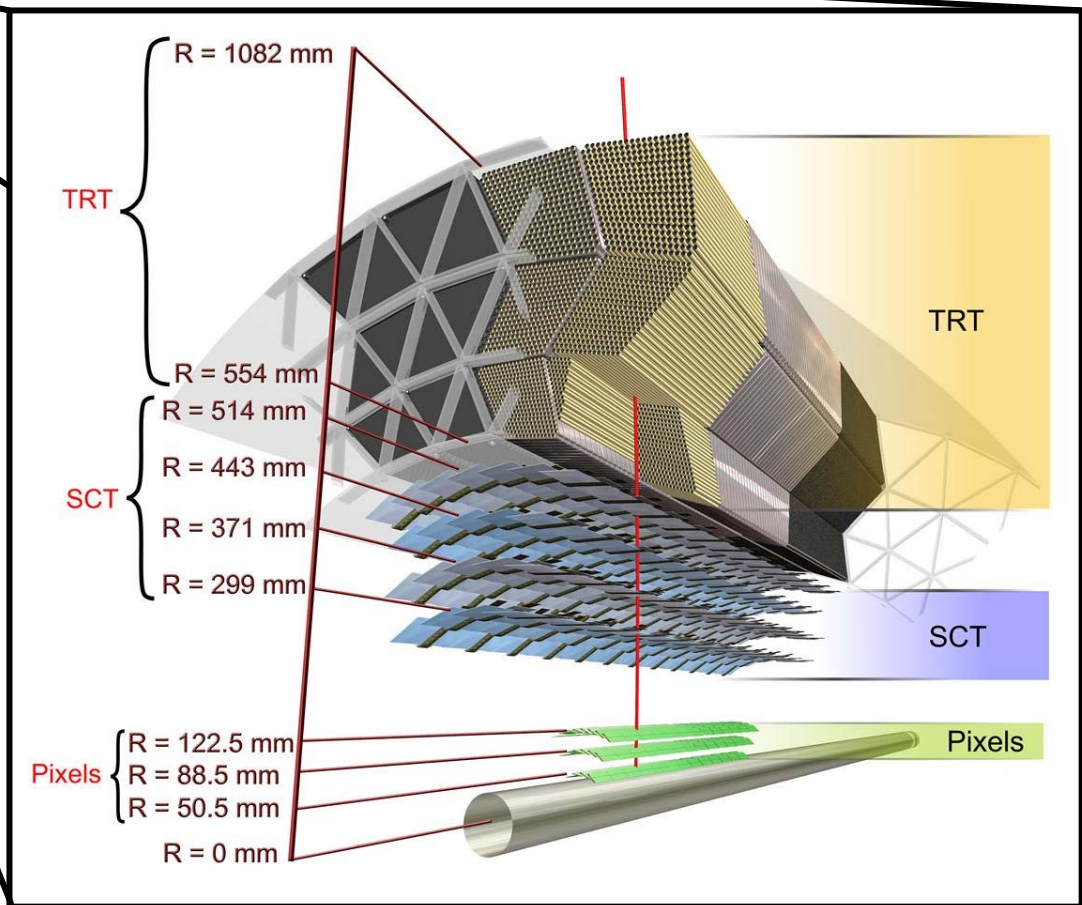


Pixel Detector

- 3 cylindrical layers with 5, 9, 12 cm radius in barrel region
- 2×3 disks in forward regions
- 1744 modules, each with 46860 pixel of $50 \mu\text{m} \times 400 \mu\text{m}$
- 80 M channel
- Resolution: $10 \mu\text{m} \times 110 \mu\text{m}$

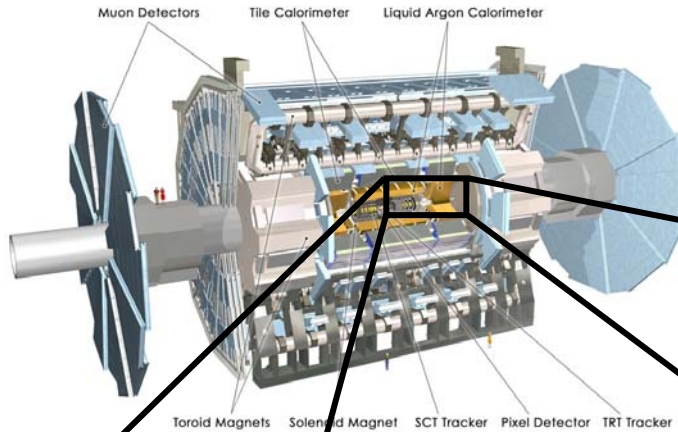
Semiconductor Tracker (SCT)

- 4 cylindrical double layers with radius 30, 37, 44, 51 cm in barrel region
- 2×9 disks in forward regions
- 4088 modules with $80 \mu\text{m}$ strips
- 6 M channel
- Resolution: $17 \mu\text{m} \times 580 \mu\text{m}$



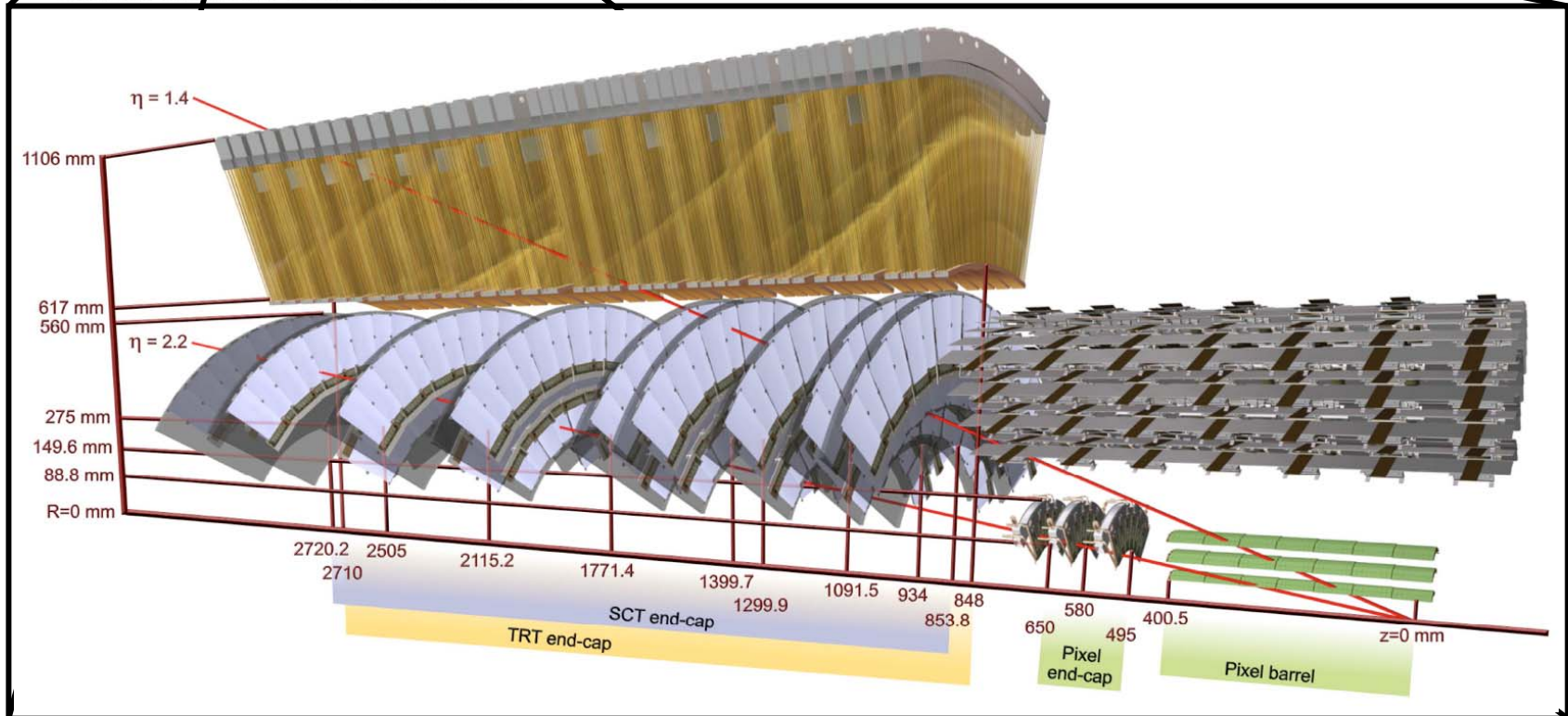
The ATLAS Inner Detector

Endcaps (Pixel, SCT and TRT)



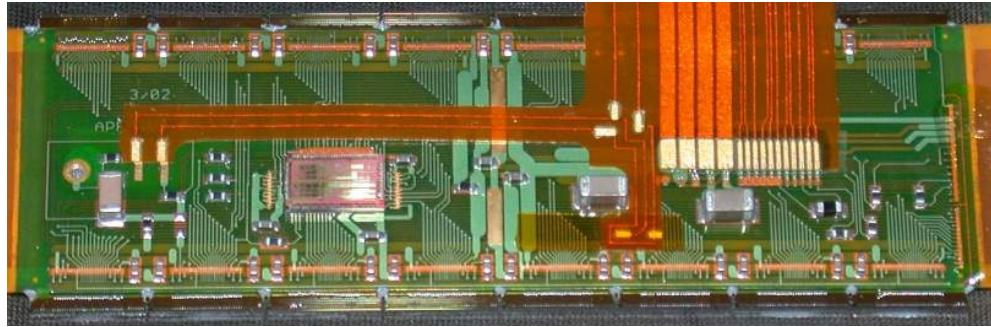
Transition Radiation Tracker (TRT)

- Polypropylen-polyethylene fibers (barrel) polypropylene foils (endcap) as radiator
- 4 mm diameter straw tubes with 35 μm anode wires
- 73 layers in barrel region with axial straws
- 2×160 (20 disks each) with radial straws in forward region
- 351 K channel
- $e\text{-}\pi$ identification: $0.5 \text{ GeV} < E < 150 \text{ GeV}$

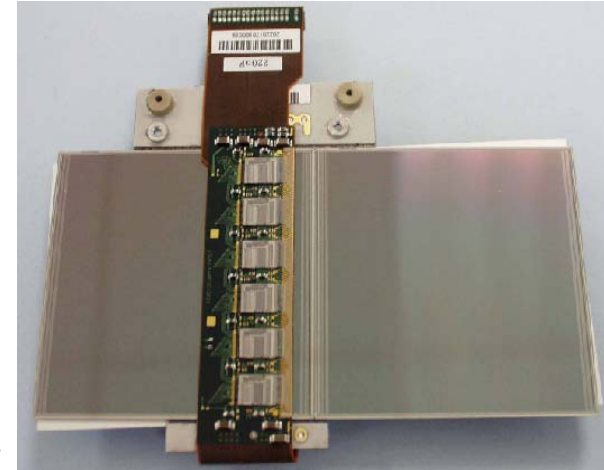


Critical for the ATLAS Physics Program

Pixel Module



SCT Barrel Module



TRT Straws

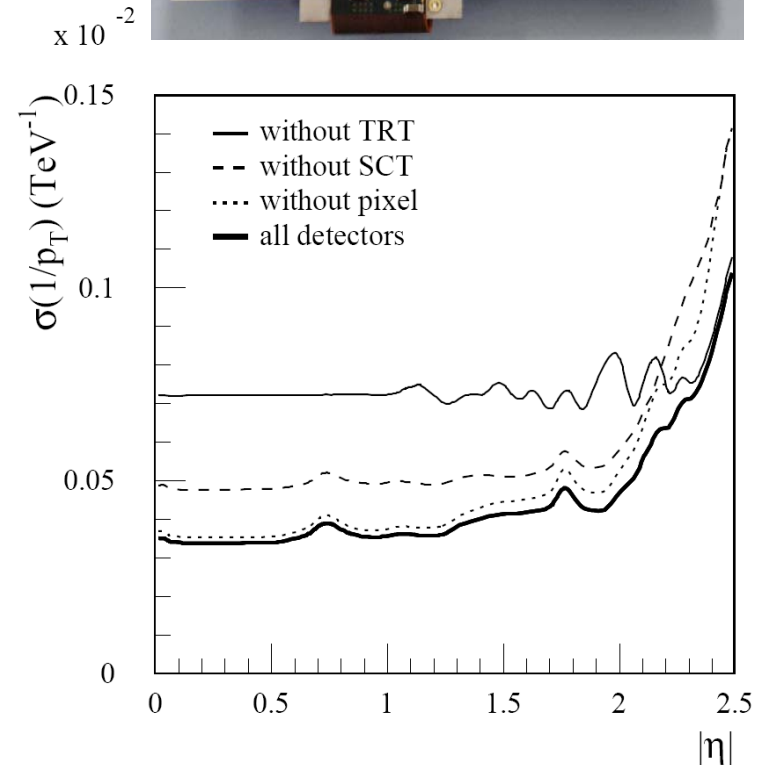
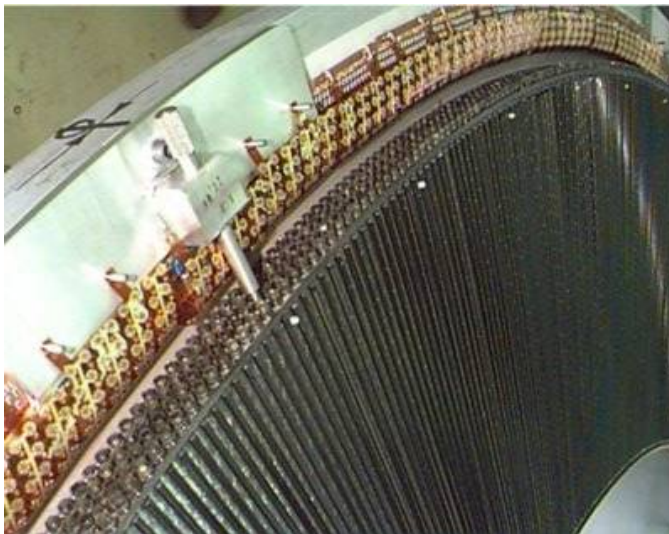
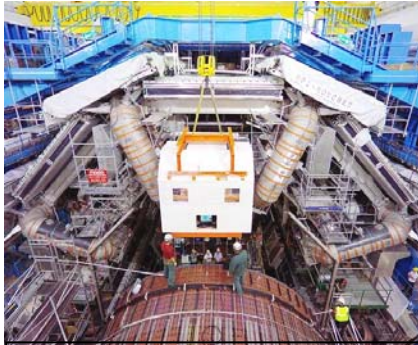


Figure: ATLAS Inner Detector TDR

Inner Detector Installation Timeline



ID Barrel Installed

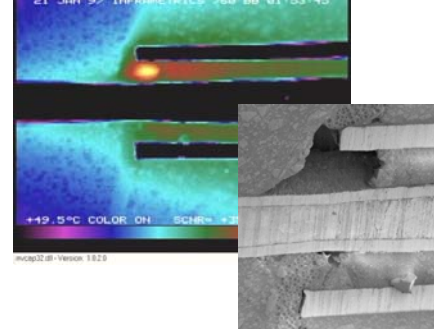
Aug. 25, 2006



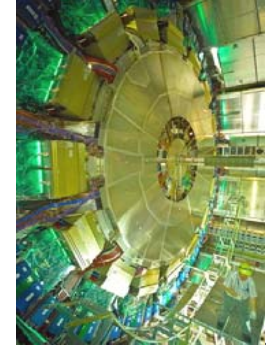
ID endcaps installed

May 29, 2007

Jun. 19, 2007



Ev. heater saga



ID sealed

Apr. 24, 2008

2006

2007

2008

Jun. 28, 2007

Apr. 18, 2008

May 1, 2008

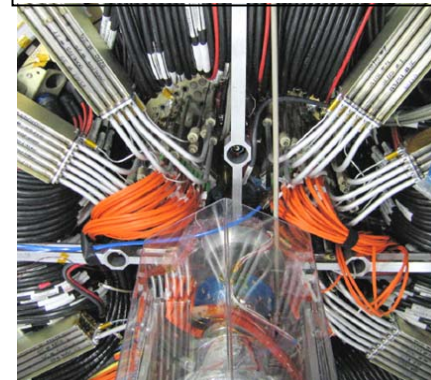
Preparatory work



Pixel installed



Connection complete



Cooling failure



Inner Detector Status (2008)

Pixel Detector

- 98.4% of all modules are operational
- Noise occupancy of 5×10^{-9}
- Hit efficiency 99.8%
- 4 leaking cooling loops in the endcaps (3 on the C-Side, 1 on the A-Side)
- High mortality rate of off-detector optical link transmitters (being replaced)

SCT

- >99% of barrel and >97% of endcap modules are operational
- Noise occupancy of 4.4×10^{-5} (barrel) and 5×10^{-5} (endcap)
- Hit efficiency >99%
- 2 cooling loops in the endcaps were not operated during the 2008 cosmics running; one of these was repaired during the recent shutdown
- High mortality rate of off-detector optical link transmitters (being replaced)

TRT

- 98% of all channels are operational (~2% dead from assembly and installation)
- All RODs have arrived at CERN and have been functioning well since Oct. 2008

Status for 2009 is expected to be even better for all sub-systems

TX Plug-in Deaths

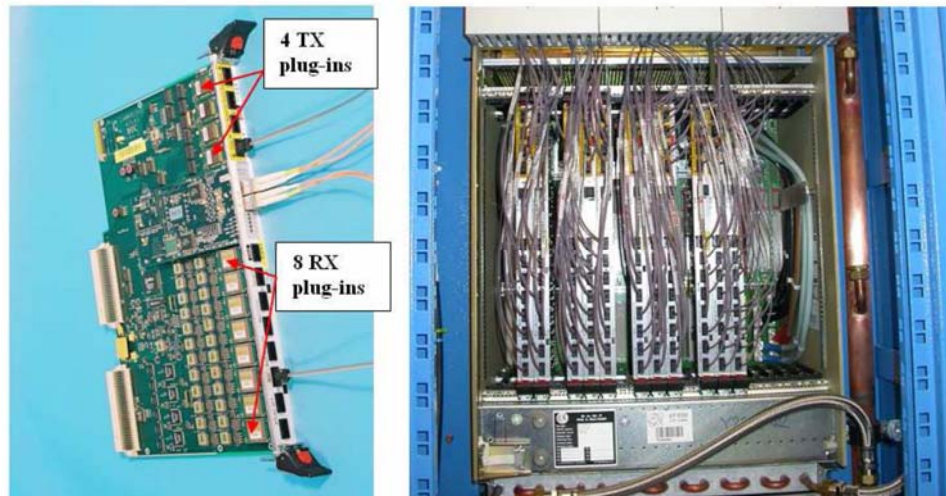
TX VCSEL array sends optical clock and control signals to the modules

Problem common between Pixel and SCT

- Plug-in failure; VCSEL channels stopping spontaneously
- Failure rate of ~1 - 2 channels per day
- Suspected ESD damage during production (23 / 24 dead devices have shown a shift in the diode IV curve characteristic of ESD)
- We have been able to simulate these delayed deaths using an ESD gun
- It is well known that ESD is the primary cause of early field deaths of VCSELs; so we have very strong reasons for suspecting ESD.

New TX plug-ins

- New production is on-going in Taiwan (with much stricter ESD protection during fabrication); all will be installed prior to physics running later this year
- Will have several installation sessions prior to August



Operations

DAQ, DCS, DQ and Offline

Pixel Detector

- Improved stability and performance of the ROD DSP Code
- Software development / improvements for DAQ, DCS, DQ and Offline

SCT

- Stable and improving throughout the DAQ, DCS, DQ and Offline
- Improvements to operation and performance along the way
- ROD firmware fix resolves problem of decreasing efficiency

TRT

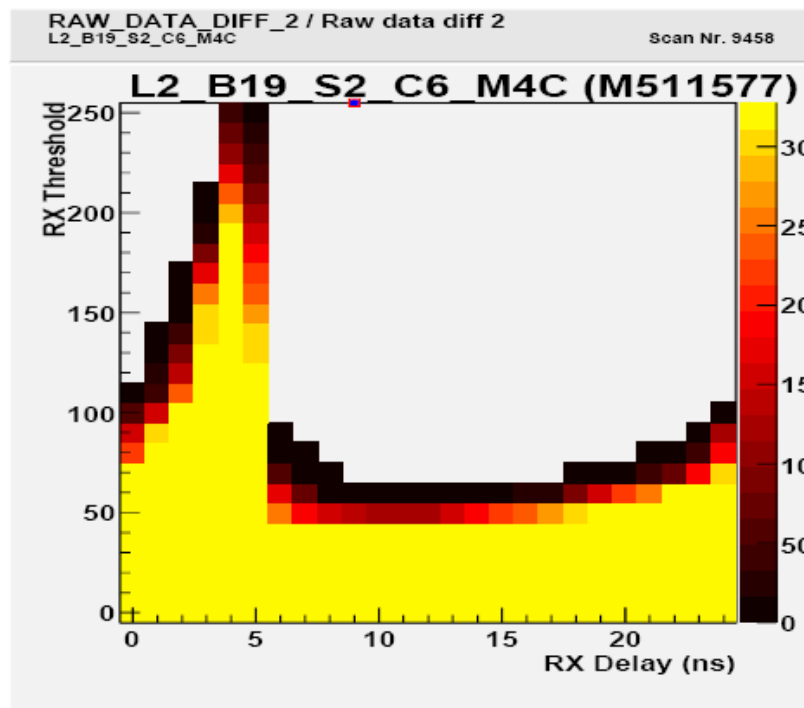
- Offline software effort directed at code clean-up; preparations for Release 15
- TRT DAQ code improved for better stability in Run State transitions
- Online monitoring working in the latest ATHENA releases at Point 1



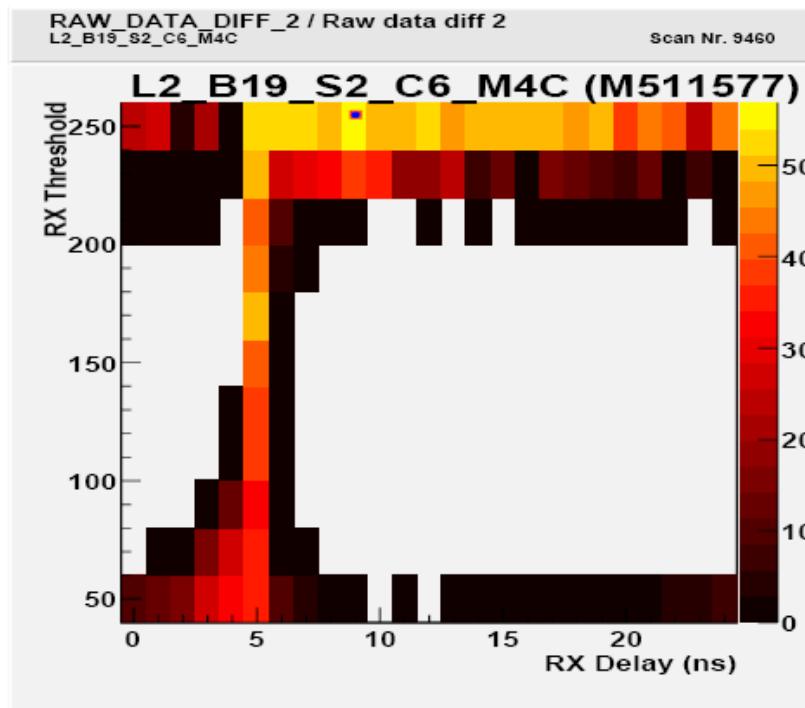
Calibrations (Pixel)

As one example: Optical tuning

- Cannot operate a module without good optical tuning
- Adjust: on-detector laser power, PIN current threshold of the off-detector PIN diode, the off-detector sampling clock delay



**Error Rate with a 20 MHz
Clock Pattern**

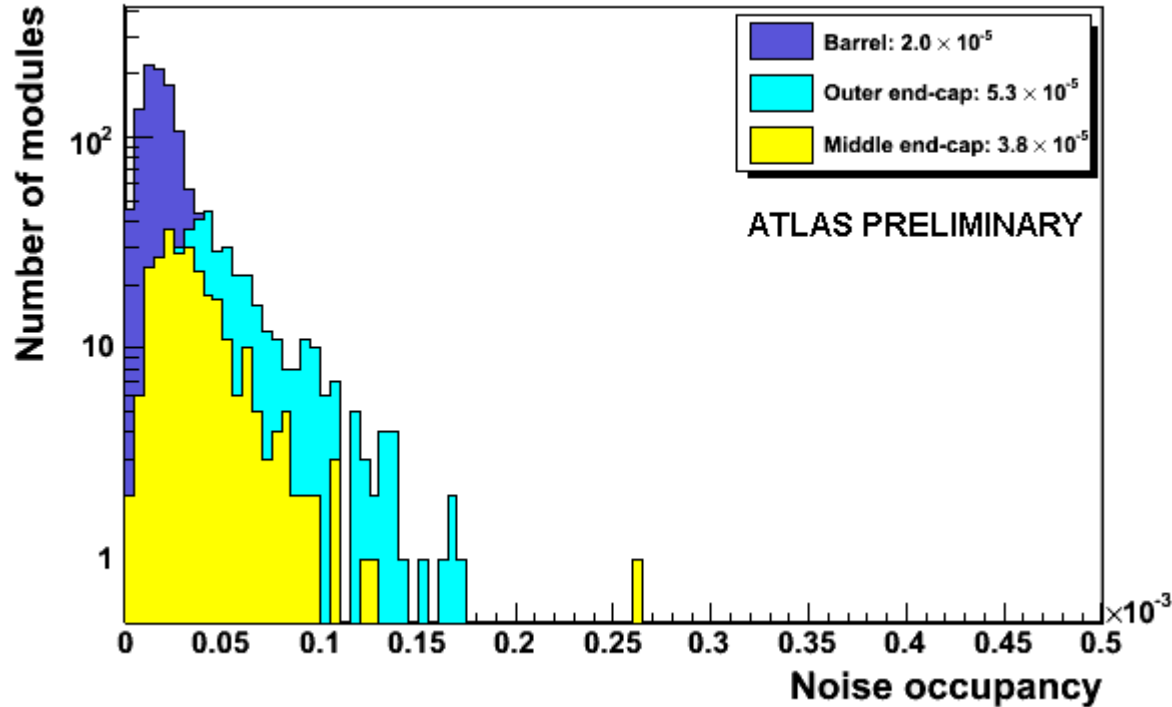


**Error Rate with
Pseudo-Random Data**

Calibrations (SCT)

As one example: Noise occupancy

- Low noise occupancy means that if you have a hit on a strip, it is most likely from a real particle



September 10, 2008

First Beam

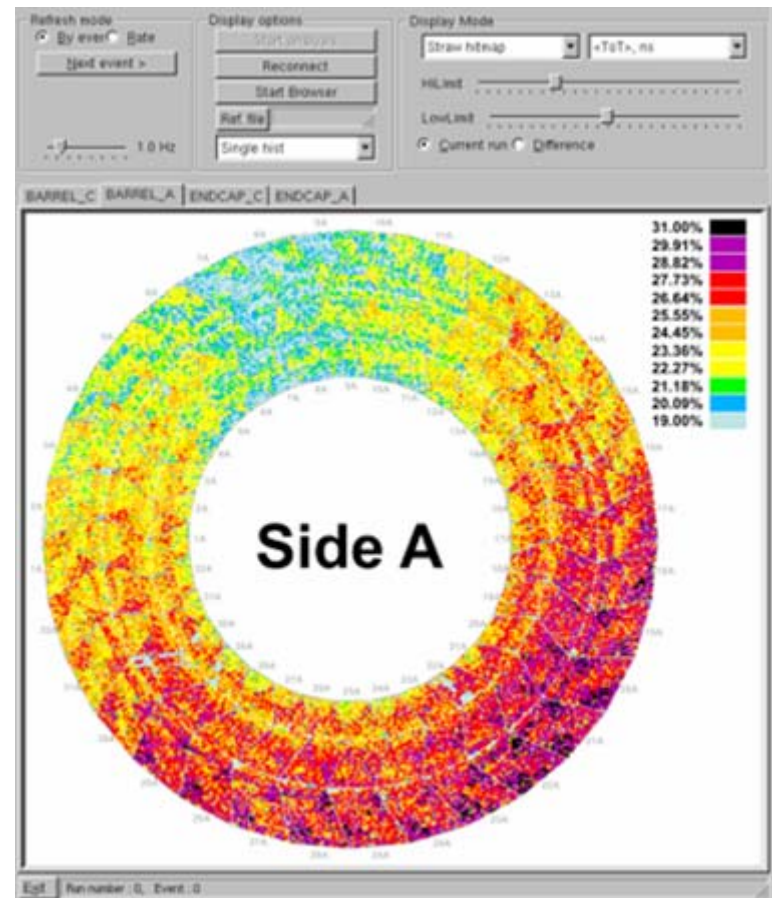
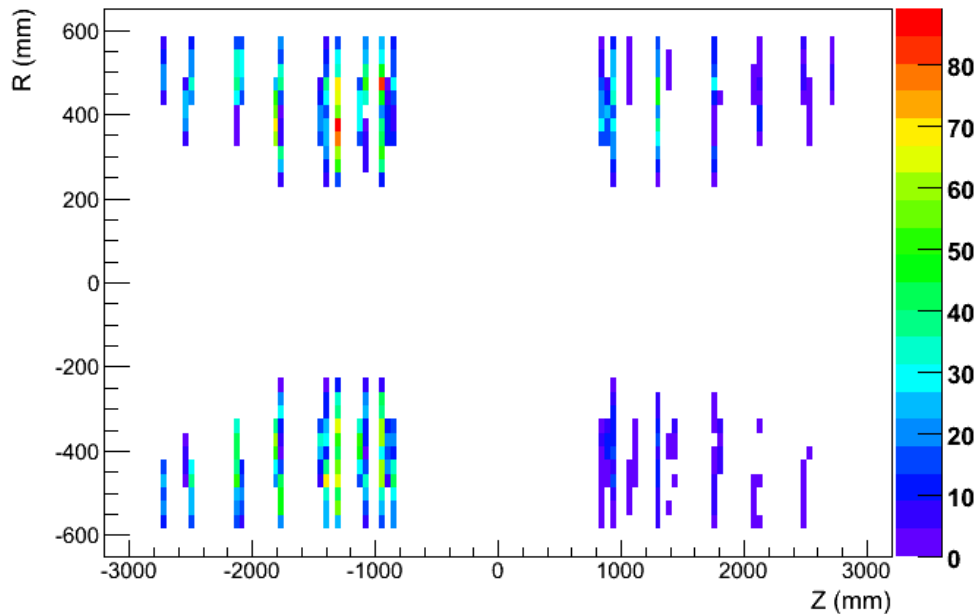
- Pixels OFF, SCT Barrel OFF, SCT Endcaps at reduced voltage, TRT ON
- Despite the reduced SCT Endcap voltage, can see a large number of hits in beam splash event

SCT able to check endcap timing at the level of ~ 25 ns with beam splash
TRT barrel timed in to the level of ~ 1 ns; endcap to the level of \sim few ns

SCT EndCaps beam splash event

ATLAS Preliminary

04-02-09



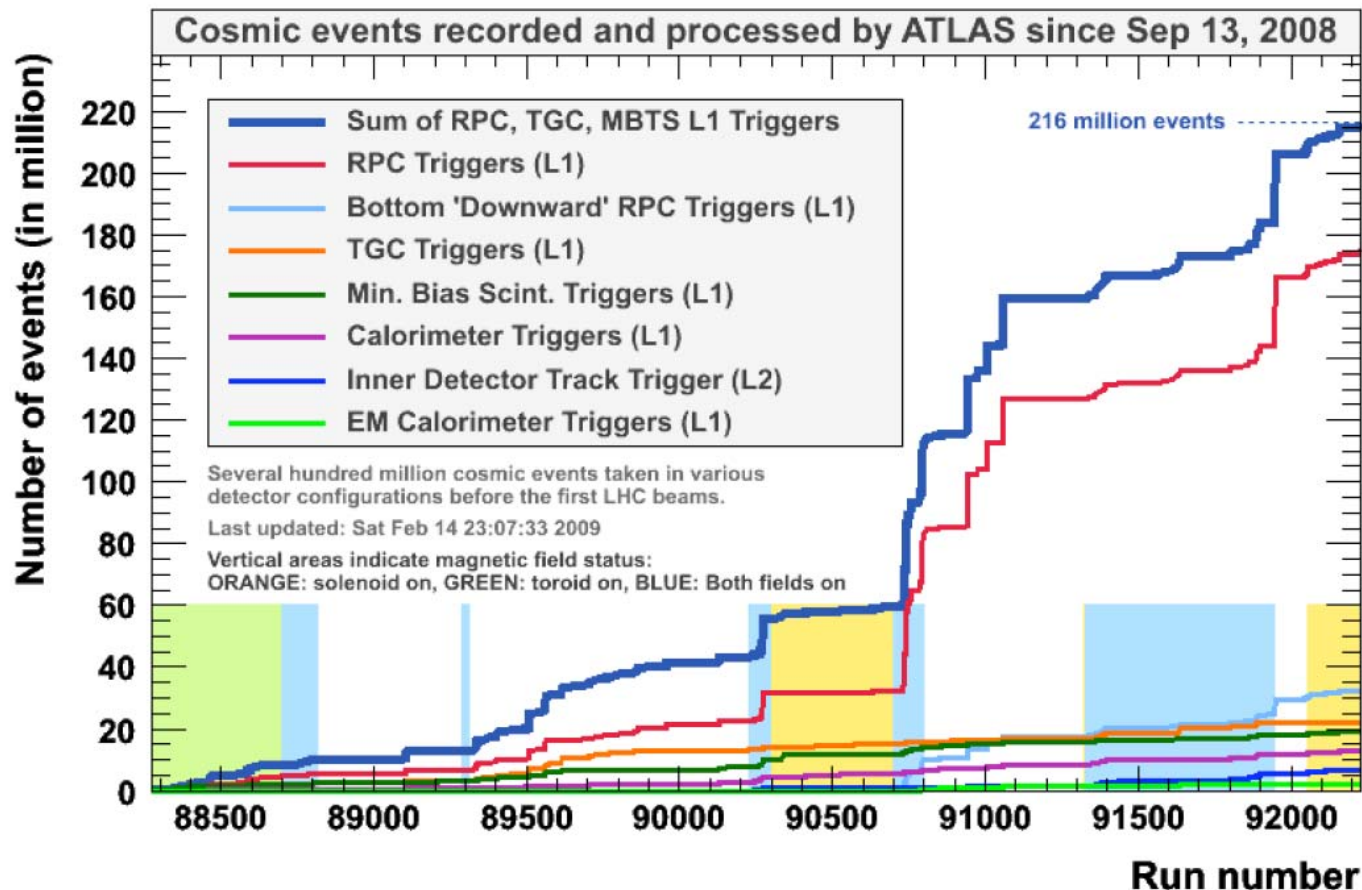
Cosmics Data-Taking

First Pixel cosmics on Sept. 14, 2008

- ATLAS Combined Run Sept. 14 – Oct. 22; B-field ON and OFF
- Main triggers: RPC and TGC at L1; TRT or Silicon at L2

ID Combined Run Nov. 26 – Dec. 1, 2008

- 150 k B-Field OFF cosmics events
- Main triggers: TRT FastOR at L1; TRT or Silicon at L2



Data-taking Overview

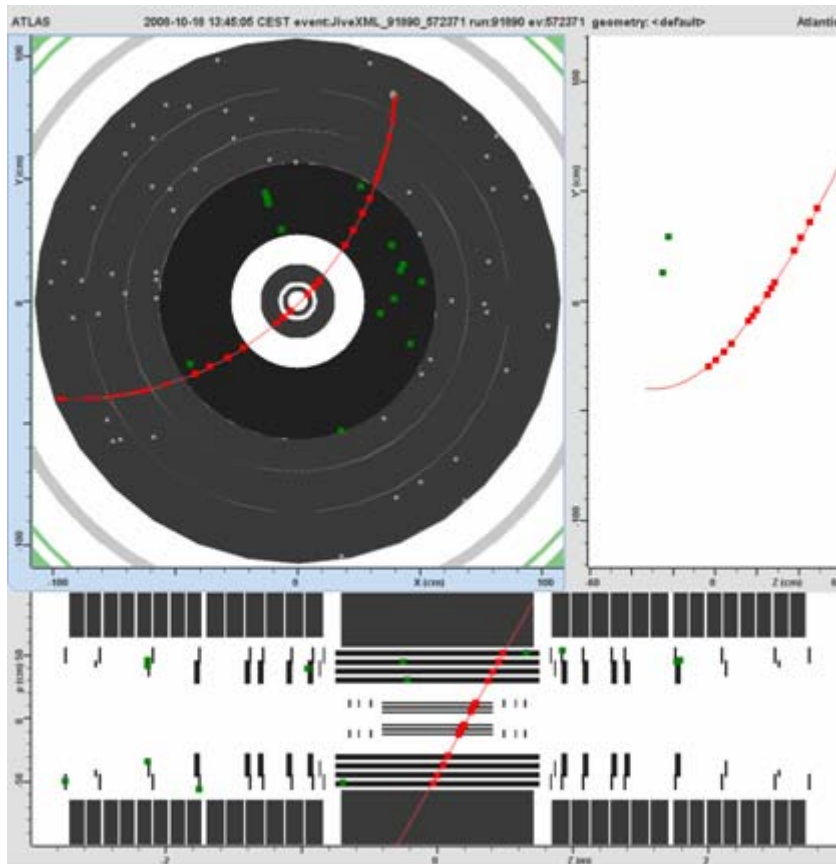
Cosmic events recorded with B-field ON:

- 2.6 M ID tracks; 880 k with SCT hits; 190 k with Pixel hits

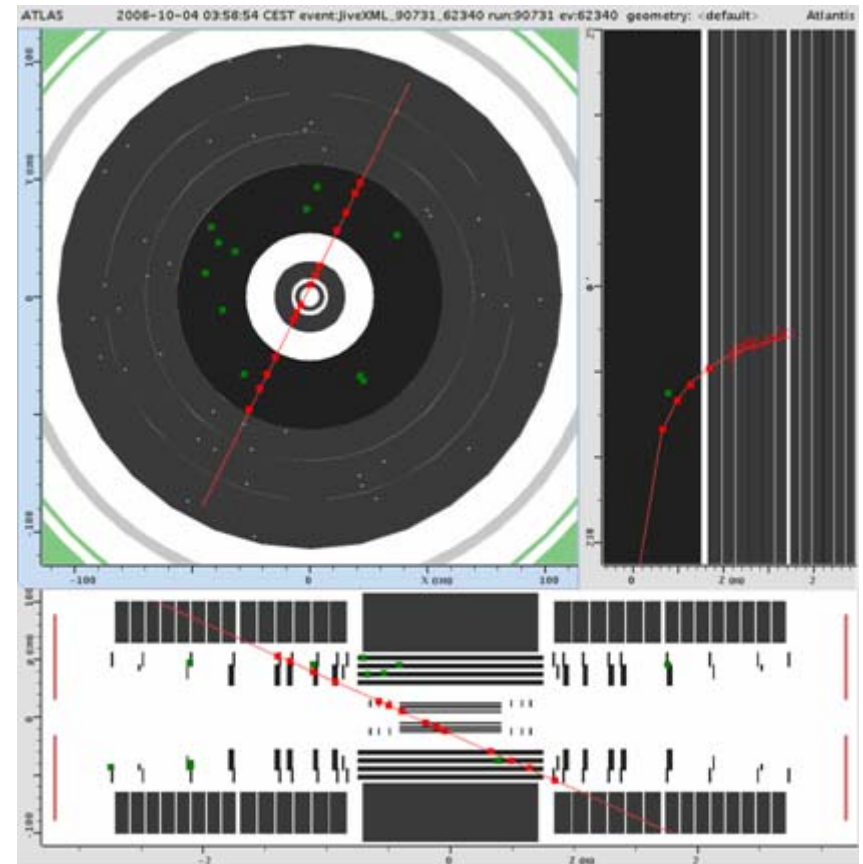
Cosmic events recorded with B-field OFF:

- 5 M ID tracks; 2 M with SCT hits; 230 k with Pixel hits

Extremely useful for alignment studies (See Oleg Brandt's talk)



B-field ON

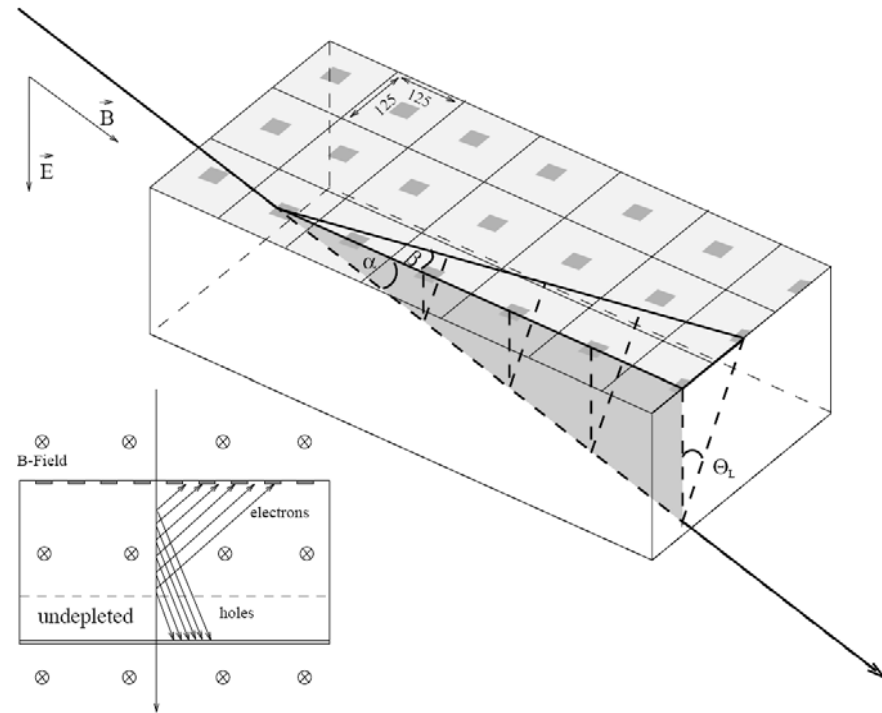
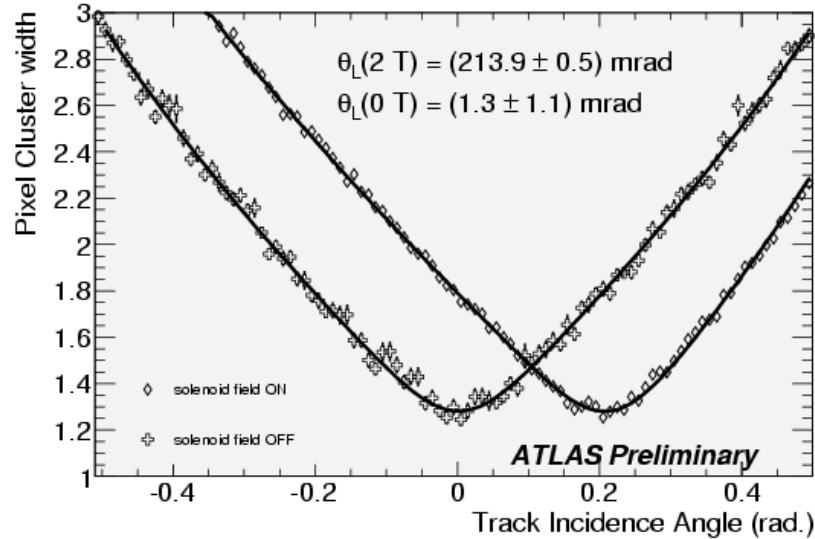


B-field OFF

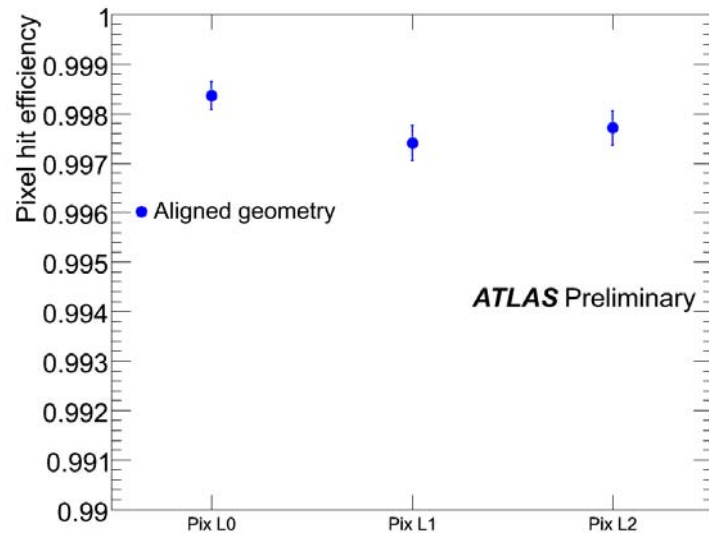
Commissioning Results (Pixel)

Lorentz Angle measurement (understanding is crucial for alignment)

- Quantifies the electron drift in the sensor due to the magnetic field



Hit efficiency

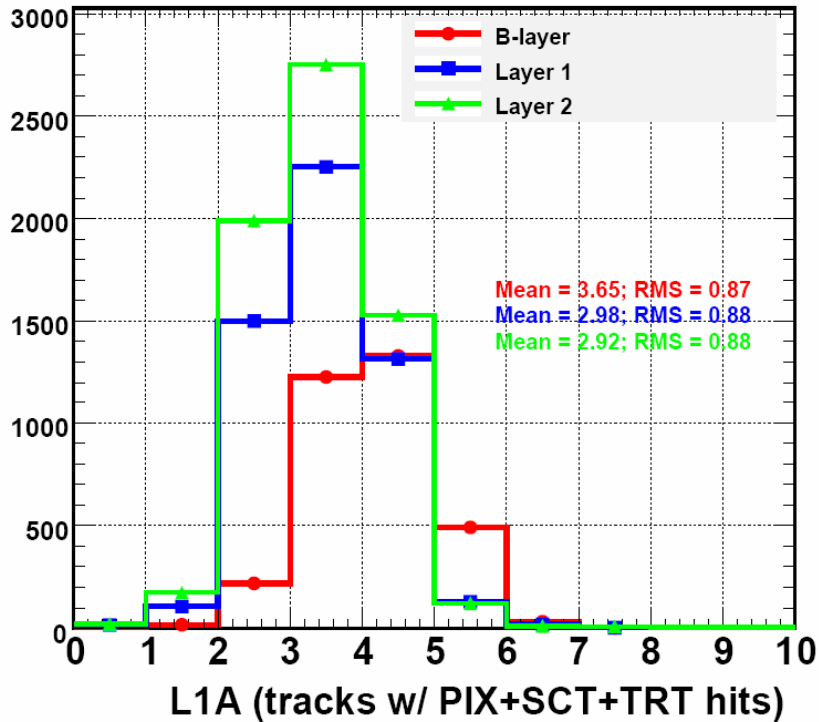


Commissioning Results (Pixel)

Pixel Timing Studies

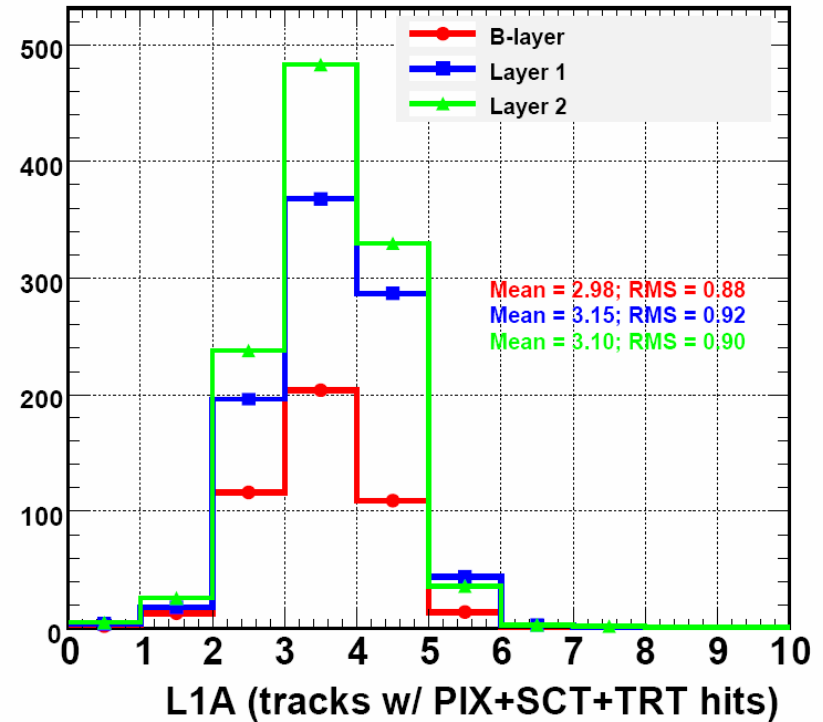
- Proper calibration → Proper ToT measurement
- Leads to higher precision in clustering and better vertexing

Run: 91338, IDCosmic



Before adjustment: Run 91338

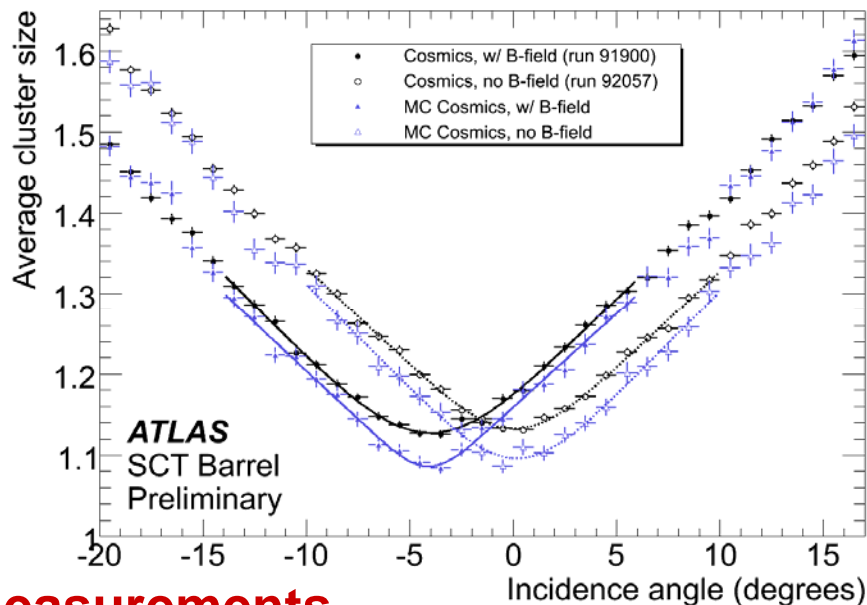
Run: 91808, IDCosmic



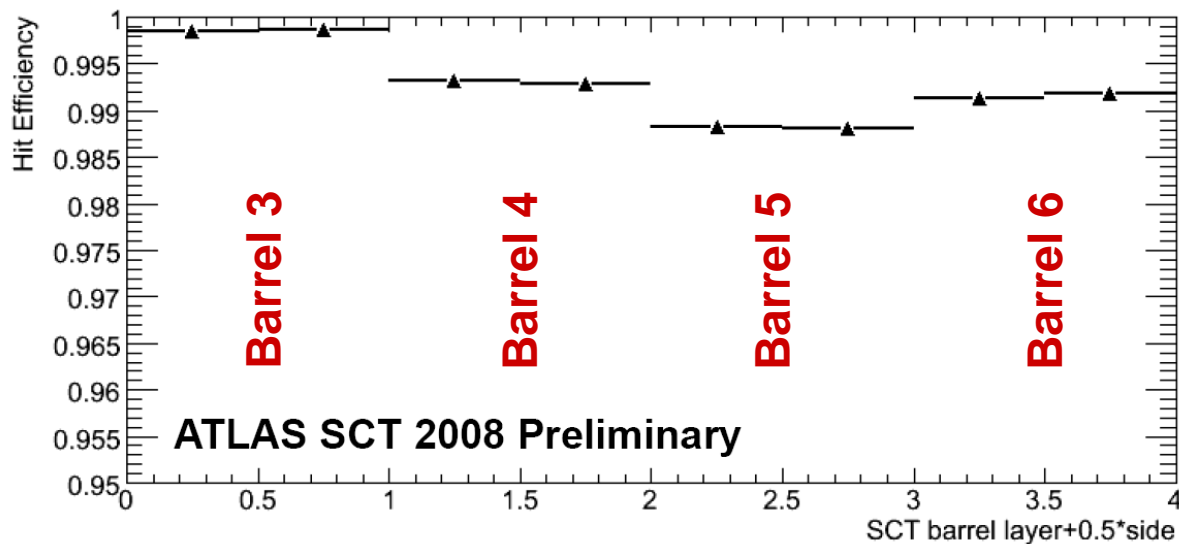
After adjustment: Run 91808

Commissioning Results (SCT)

Lorentz angle measurement



Barrel efficiency measurements



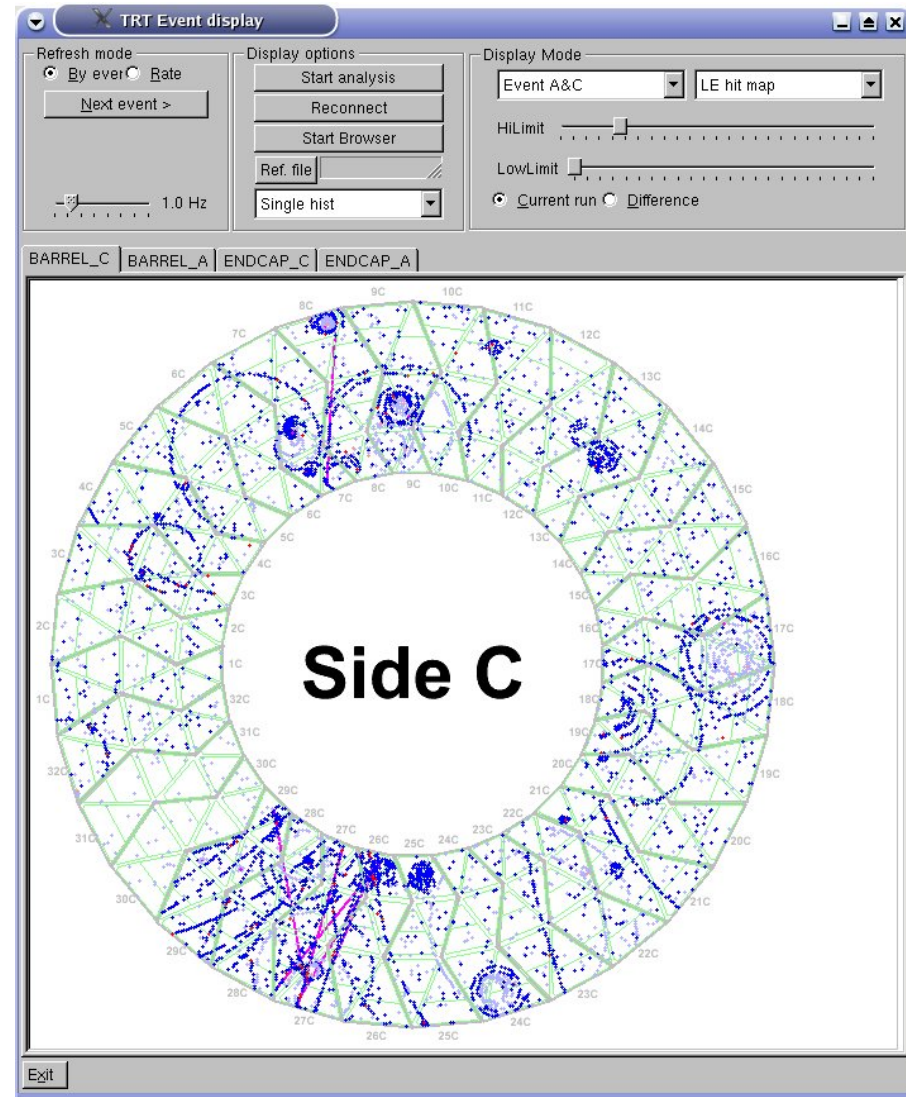
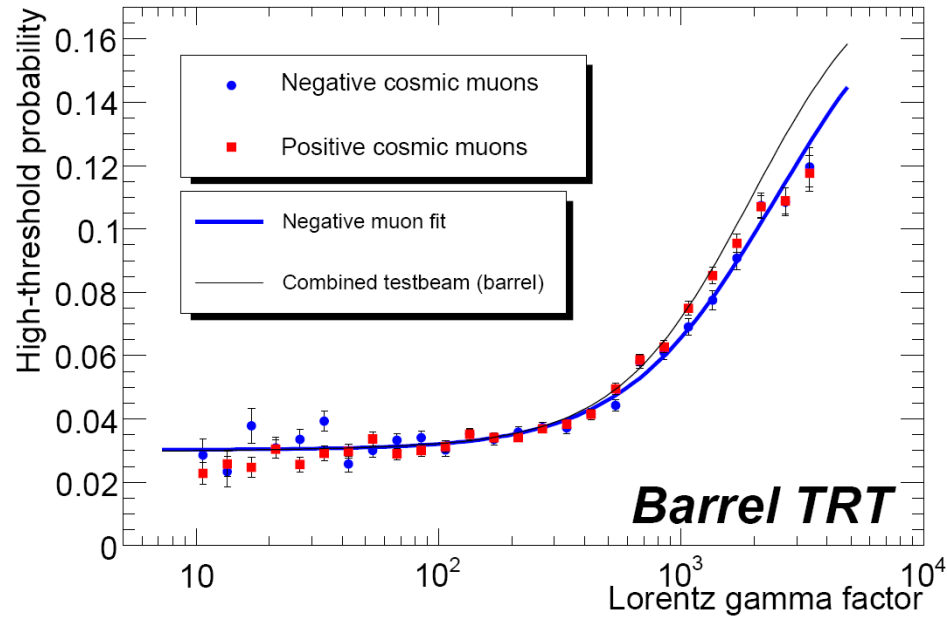
Commissioning Results (TRT)

Cosmics data-taking with B-field on

- Produced bubble-chamber like event displays as low-momentum particles curl within the detector volume

Turn-on of transition radiation

- Measured using cosmic muons



If You're Interested in Real Data...

There are a few ways to find the exact runs that you need

ATLAS Run Queries

Run Search - Insert Your Query:

Examples (query format inspired by SPHINX):

Run and event ranges	Time ranges and duration	Detectors	Streams	Magnets	Data quality
find run 90270-90350 and events 10000+ / show run and events					Isolated runs in given run number range and min. number of events.
f 90270-90350 and ev 100k+ / sh r and ev					Isolated runs and number of events for selected runs and show runs and number of events for selected runs (unless alternative - same query as above, note that the show part could be dropped since same as default)
f 90270-90350 and ev 100k+ / sh r and ev and flag and part / model					Same query as above, but without default requirements (default is "flag status and part ATLAS")
f 90270+ and ev 100k+					Isolated all runs with run number greater or equal than 90270 and less than 100k events
f 90270-90350,90500+					Isolated runs number in given range or greater or equal

Contact and support: Andreas.Hoecker_jorg.steier

ATLAS Run Summary Information

Introduction

This page gives pointers to the run summaries extracted from COOL for each data-taking period (starting from M4) and the Full Dress Referrals. Links to other tools are provided at the base of the page. Data taking schedule dates are taken from the [running schedule TWiki](#) and the [FDH TWiki](#). If you do not see the run numbers you want in this list, you may still use the [searchable runlist](#) to find them.

Period	Dates	Runs	Links
M4	2008-1-11 - 2008-2-26	78781 - 78713	-5488.18
M7	2008-5-13 - 2008-6-03	48524 - 71504	18524,88872,69872,71504
CaloSW	2008-3-21 - 2008-4-07	52769 - 54987	AB
M8	2008-3-07 - 2008-3-11	44533 - 45640	41533, 43043,43841, 45640
1 Feb 2008	2008-2-01 - 2008-2-29	36527 - 40952	36527,39000,39001,39500,39502,40952
Jan 2008	2008-1-01 - 2008-1-31	35430 - 36526	Atlas
Dec 2007	2007-12-01 - 2007-12-31	32199 - 35429	32199,35000,35001,35429
Nov 2007 psetM5	2007-11-05 - 2007-11-30	29580 - 32637	29580,32100,30791,32637
M5	2007-10-22 - 2007-11-04	27778 - 29580	Atlas
Oct 2007 psetM4	2007-10-01 - 2007-10-21	26900 - 27777	Atlas
Sept 2007 psetM4	2007-09-02 - 2007-09-30	25920 - 26929	25920,26183,23359,24358,24359,25929
M4	2007-08-22 - 2007-09-02	19079 - 25919	AB
SDR1	2008-02-01 - 2008-02-03	3650 - 3679	AB
VDH2	2008-06-02 - 2008-06-05	52280 - 52385	AB

For more details on how these data are derived, see [CoolOnlineData](#). The tables were generated using the [searchable runlist](#) interface developed by Shaun Roe, which allows one to query arbitrary run number ranges or single dates and also gives links to more detailed information.

Manually maintained lists

Several people are indicating interesting runs on TWiki, here is a selection:

- [Single beam and after \(commissioning\)](#)
- [Trigger operation](#)
- [Data Trigger](#)
- [Data LHC Trigger slice](#)
- [Cosmic commissioning](#)

Latest updates

Experiment Data News

You may subscribe to this information by clicking on the icon above [what does this do?](#) these are updated every ten minutes

ATLAS Run Summary Information webpage

- Contains links to DQ plots, Trigger Table, B-Field status, etc.
- <http://atlas-service-runinformation.web.cern.ch/atlas-service-runinformation>

ATLAS Run Queries webpage

- Search for runs with specific numbers of events
- <http://atlas-runquery.cern.ch>

Conclusions

Extremely successful commissioning with first beam and cosmics

- Many performance notes for each sub-system are now being drafted
- Commissioning will continue into the collision era (e.g., endcap alignment)

Pixels

- Improvements on-going for many software aspects
- Should have all replacement TX plug-ins installed prior to 2009 physics running
- Will operate the 4 affected cooling loops in May – June and evaluate them

SCT

- Continue DAQ, DCS and Firmware developments, improvements and upgrades
- For 2009, 115 / 116 cooling loops will be operated
- Should have all replacement TX plug-ins installed prior to 2009 physics running

TRT

- Plan to improve Active Gas by fixing small leaks and studying the system
- Continue to refine DAQ, DCS and Offline software

Outlook for 2009 / 2010

- All sub-systems are in good shape and looking forward to first collisions!
- Streamline the 24 h calibration loop using express stream data, running on the CAF (CERN Analysis Facility)

Backup Slides