Commissioning of the ATLAS detector and combined beam test results

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Xth Pisa Meeting, May 21-27 2006, Isola d’Elba
ATLAS road map

2005 2006 2007 2008

Detector installation

Combined test beam (1% of ATLAS)

Integration, from detector to off-line cosmic runs

Global cosmic run

First beams

X Pisa Meeting, 22 May 06
ATLAS commissioning, P. Perrodo
Installed today

- **Liquid argon and TILES calorimeters:**
  - All in the cavern, Barrel LARG cryostat is cold,
  - Barrel Front end electronics all here, expect the power supplies
  - A small fraction of the readout is possible yet
  - Will grow in size with more power supplies

- **Muon spectrometer (barrel and forward)**
  - Chambers under installation.
  - Very small fraction of the readout available
  - Forward wheels coming next

- **Inner detector (SCT+TRT, pixel later)**
  - SCT+TRT barrel integrated, tested on surface
  - Good fraction of the readout present already used.
  - Then long installation in the cavern

- **Magnets:**
  - Solenoid: ~cold
  - Barrel toroid: pumping
  - Endcap toroid: end Sept. 06
ATLAS combined test beam
Test beam results with muons

- **Tracking Muon Spec.- Inner Detector**
  - Back extrapolation of a muon track to the inner detector (Pixel + SCT)
  - Validation of the reconstruction software
  - Alignment procedure
  - Measure of the tracking performances

- **Performances Calo.-Muon Spec.**
  - Muons (~300 GeV) with a Bremsstrahlung in the Calorimeters
  - Validation of the reconstruction software
  - Evaluate inter-calibration Calo – Muon spectrometer
  - Quality of the simulation (Geant 4)

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### Fitted value of \( \text{par}[1]=\text{Mean} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>1.02 ± 0.04</td>
</tr>
<tr>
<td>Offset</td>
<td>-7.95 ± 0.42</td>
</tr>
</tbody>
</table>

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### Comparison Data - Simulation

- **Data**
- **Simulation**

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X Pisa Meeting, 22 May 06

ATLAS commissioning, P. Perrodo
Detector integration

- **Exercise various combinations of ATLAS sub-systems:**
  - *Detectors, DAQ and online databases.* Idem with DCS (Slow ctrl.)
  - *Calorimeters and the calorimeter trigger.* Calibration, integration of the trigger.
  - *Magnets:*
    - *Solenoid mapping.* Exercise the calorimeters electronics.

- **Functional tests:** test the performances: operational, new errors, recovery procedures, stability of the data taking, calibration procedures

- **Run with cosmics:**
  - Data taking, on line monitoring, full analysis chain exercised. Detector study: bad channels.

- Repeat the exercise when the readout system grows in size.
Detector schematics

- Detector 1
  - Front-end elec,
  - TTCVi
  - LTP 1
  - L1 receivers
  - Trigger logic
  - Possibly cosmosics L1A

- Detector 2
  - Front-end elec,
  - TTCVi
  - LTP 2

- Local DAQ 1

- Local DAQ 2

- DAQ
  - Slow Control (DCS)
  - Possibly chaining LTP (Local Trigger Processors)
  - Online monitoring

- Data Storage

- Configuration
  - Condition
  - Data bases

- Load parameters

- Store parameters

- Offline Software

- Data analysis

- On-line databases:
  - COOL as condition DB
  - Interfaces between COOL and PVSS
  - Configuration from ORACLE to PVSS
  - Various choices for configuration/conditions according to the features of the detectors.
Commissioning of the 150 ROS (Read-Out System) completed this year: LARG, TILES, L1Muons

Pre-series test with ~10 % of the full system, all functionalities present.

3Q06: 32 SFIs, 12 DFMs, 2 L2SV, switch

Modular system: more and more PCs and switch cards will arrive between this end 06 and May 2007
**DAQ pre series results**

- Event Builder only. Comparison pre-series with model in various configurations.

- Event Builder + Level2. Dummy L2 algorithm. 8 ROS, 8 SFI. Comparison pre-series with model in various configurations.
Long runs (→24hrs). 8 ROS, 8 SFI, 20 L2, dummy algorithms. Stability observed.

Test with Event Filter. Real algorithms (Online 10.0.06) with ROS emulation sending Geant events.
Grouping of Sub-System Partitions

- Partitioning of the detector. Used for:
- Commissioning
- Calibration of the detectors during the LHC inter-fills

- Run independent groups of partitions thanks to a special interface board

- This provides a large flexibility for commissioning
- The CTP can receive cosmic trigger signals

- Cosmic Trigger
- Clouds of Sub-System Partitions

= LTP (Local Trigger Processor)
= LTP Interface

CTP (Central Trigger Proc.)

Pixels
SCT
TRT

LAr Barrel
LAr EMEC
LAr HEC/FCAL
Tile Barrel
Tile Extended

L1 Calorimeter trigger

MDT Barrel
MDT End-Cap
RPC
TGC-A
TGC-C
CSC

Run independent groups of partitions thanks to a special interface board
Level 1 trigger

Calorimeter trigger

- June 06: final RODs
- July 06: ROiBuilder, HLT
- Sept 06: CTP integration

Muon Barrel trigger

- June 06: run with lower sector, CTP, HLT cosmics

Muon Endcap trigger

- July 06: electronics for the TGC trigger (M1-C)
- Sept 06: first final sector logic

June 06: CTP in place

- July 06: Conf databases, combined with RPCs, combined with HLT
- Aug 06: Add the calorimeters

June 06: ROS integration, ROiBuilder and RPC

MuCTPI
Cosmic runs

- **Exercise the full functionalities:**
  - Conf DB, Trigger, DAQ, Slow control, HLT, on-line monitoring, event display, control room, shifts
  - Full calibration procedures. Treatment of the bad channels

- **Detectors available:**
  - LARG barrel, TILES barrel (limited readout). L1CALO trigger
  - Muon spectrometer lower sector

- **Physics goals**
  - Amplitude inter calibration
  - Timing studies
  - Bad channels characterization
Cosmic trigger with Tiles calo.

Goal for June:
8 SD top *2
8 SD bottom * 2

Four Coinc. Boards

(A ∪ B) ∩ (C ∪ D)

Estimate Rate < Hz

(coinc. ~400 Hz * 100 ns ~ 1E-5)
Cosmic runs

**Internal LARG inter-calibration**
- Amplitude vs $\eta$
- Needs 40,000 muons/cell for 0.5% precision
- Rate 0.04 (0.15 non-projective) Hz
- 100 muons/cell $\rightarrow$ ~100 days of DAQ
- But can understand timing at 0.6 ns

**TILES response to MIP**
- At the combined test beam

In the Cavern (LV power supplies different $\rightarrow$ noise)
Cosmic runs

- **LARG-TILES inter-calibration**
  - Response to MIP at the combined test beam, compared to simulation, for layers and total
  - 3% agreement

- **TILES timing**
  - From comparison of various cells
  - Time resolution found of 1.7 ns

- **TILES time difference (top-bottom)**
  - After correction fits with the geometrical estimate
  - Precision of 1.8 ns
Some rates

- **TILES**
  - 1/16 of the barrel: 1GB/day

- **LARG**
  - Electronic calibration ramps (100,000 channels in the barrel): 5.2TB (transparent), 42GB (averaged locally in the LARG DAQ)
  - Calibration signals recording: 650 GB

- **Cosmics** at 10Hz
  - TILES: 1.4MB/s
  - LARG 15MB/s. Maximum recording 20 MB/s

- **Muons** (lower sector)
  - 20 Hz and 2kB/event

- **Autumn 06**: end cap calorimeter. Need the Event Builder to take the data flow.
Test the BT as a separate object

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<th>run</th>
<th>Goal</th>
<th>Current [kA]</th>
<th>ramp time [hours]</th>
<th>total [hours]</th>
<th>recovery [days]</th>
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<td>0.3</td>
<td>3.9</td>
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<tr>
<td>2</td>
<td>test at 1/4 of full energy</td>
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<td>0.7</td>
<td>2.9</td>
<td>--</td>
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<td>test at 1/2 of full energy</td>
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<td>1.0</td>
<td>3.6</td>
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<tr>
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<td>test at 3/4 of full energy</td>
<td>18</td>
<td>1.3</td>
<td>3.5</td>
<td>--</td>
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<tr>
<td>5</td>
<td>test at full energy</td>
<td>20.5</td>
<td>1.4</td>
<td>3.8</td>
<td>--</td>
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<tr>
<td>6</td>
<td>fast dump low current</td>
<td>5</td>
<td>0.3</td>
<td>0.9</td>
<td>??</td>
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<tr>
<td>7</td>
<td>fast dump (quench)</td>
<td>15</td>
<td>1.0</td>
<td>1.3</td>
<td>??</td>
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<td>8</td>
<td>steady state test</td>
<td>20.5</td>
<td>1.4</td>
<td>11.8</td>
<td>--</td>
</tr>
</tbody>
</table>

Exercise everything already installed in presence of magnetic field

- Infrastructure (LV, gas, cooling) already installed around the detector
- Operate the Front-End electronics: LARG, TILES calorimeter, Barrel Muons (MDT, RPC) chambers
- Muon spectrometer: Alignment system, precise measurement of the field (B at 1-2mT for Bl at 4 \times 10^{-3}), effect of the surrounding structures
- Take cosmics with muon spec., TILES and LARG

Similar issues for the solenoid mapping
Global cosmic run to first beams

- Toward a global cosmic run (spring 2007)
  - Integrate the detectors and systems as they come, when they grow in size, debug the full chain from shifts to data analysis.
  - Cosmics can be used for the barrel part. Use of cosmics for the end-caps is under investigation.

- Beam gas
  - can be used for the end-caps: alignment, timing, inter-calibration.
  - Run at high L1 trigger rate with real events. DAQ challenge.

- Very first collisions: detector debugging and performances
  - With ~10-100 pb-1, ~ $10^4$ Z->ee, Z-> $\mu\mu$, also tt->bl$\nu$ bjj,
  - Trackers, Calorimeters, muon alignment, jet energy scale and b-tag

- A lot of work and fun is coming!

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