ATLAS Inner Detector Monitoring
(purpose, implementation and usage)

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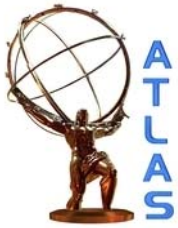
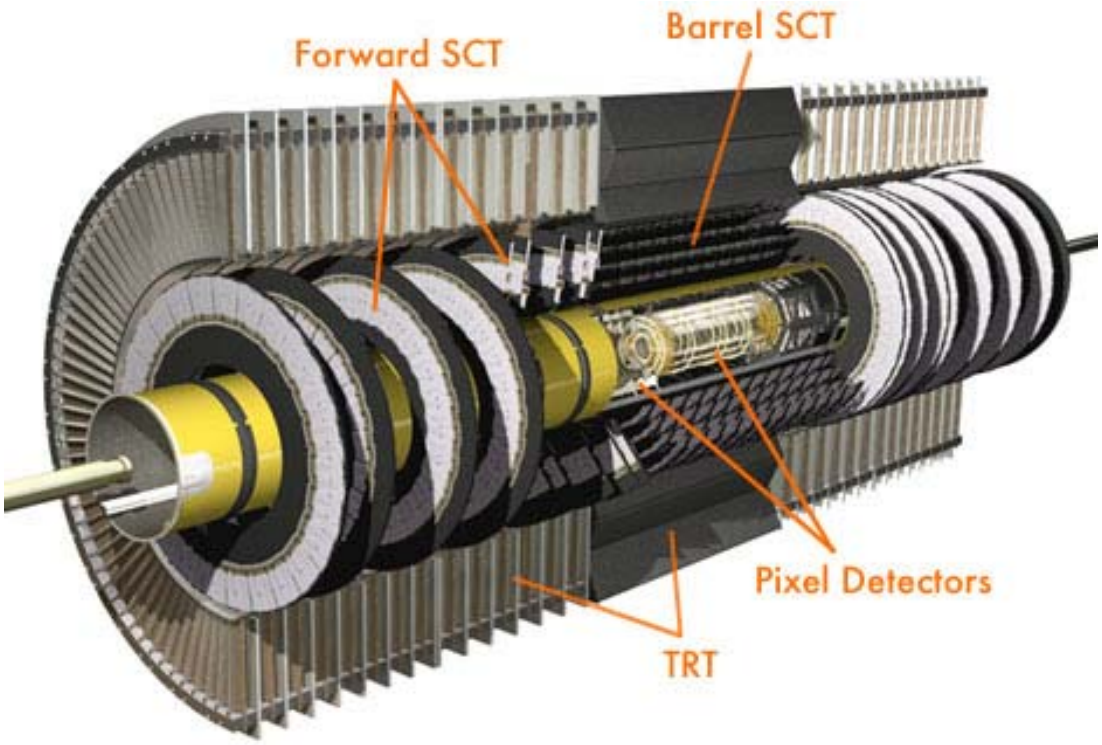


Outline

- Quick introduction into ATLAS Inner Detector
- Individual sub-detectors monitoring
  - Pixel
  - SCT
  - TRT
- Global monitoring of Inner Detector
- Conclusion

ATLAS Inner Detector

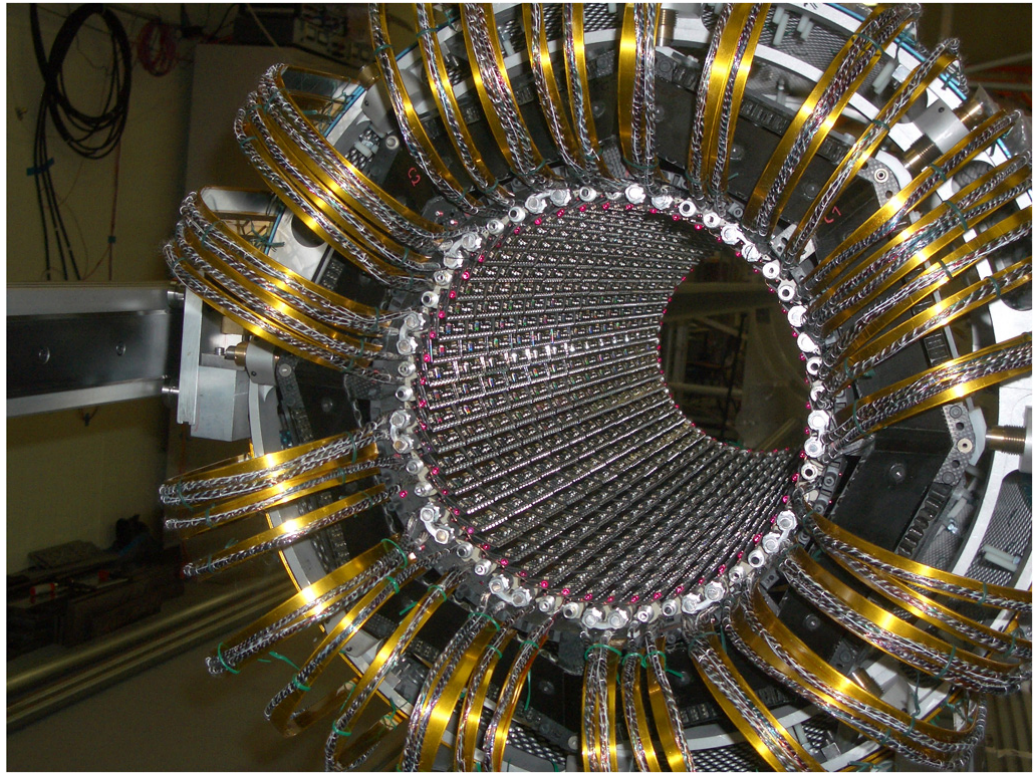


- Purpose is to provide
  - high precision efficient tracking
  - Vertex reconstruction
    - Primry
    - Secondary
  - Electron/pion separation
- Consists of 3 sub-detectors
  - Pixel detector
  - SemiConductor Tracker
  - Transition Radiation Tracker

Pixel Detector Monitoring

Pixel - Purpose

- **Aim of tools**
  - The PixelMonitoring is used both online and offline
  - Will monitor all relevant data which concerns the Pixel detector only
  - The online monitoring is optimised to look at:
    - Calibration of the detector
    - Identify modules that are noisy or turned off
    - Monitor the errors on the pixel bytestream
  - The offline tools are the same but with different histogram configurations
  - The pixel shifter should be notified about any problems of the order of minutes and be able to correct them

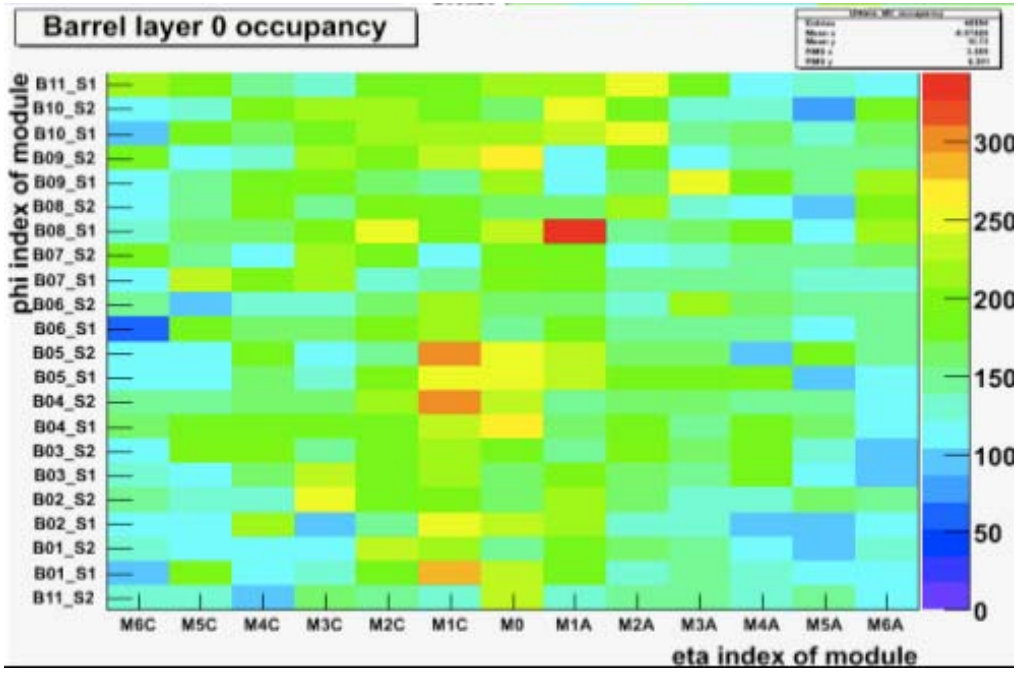


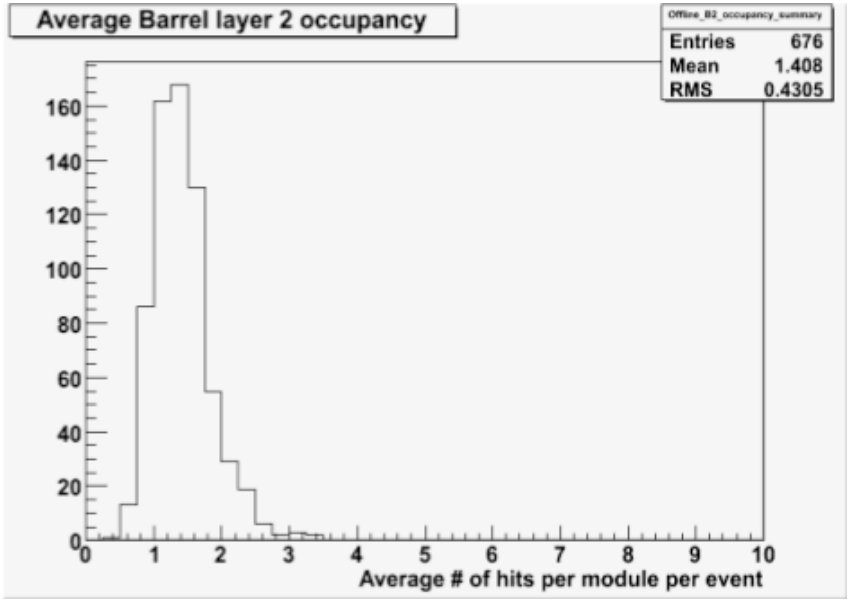
The Pixel Detector

Pixel – Example plots

Occupancy plots

- Easy and quick identification of dead and noise modules





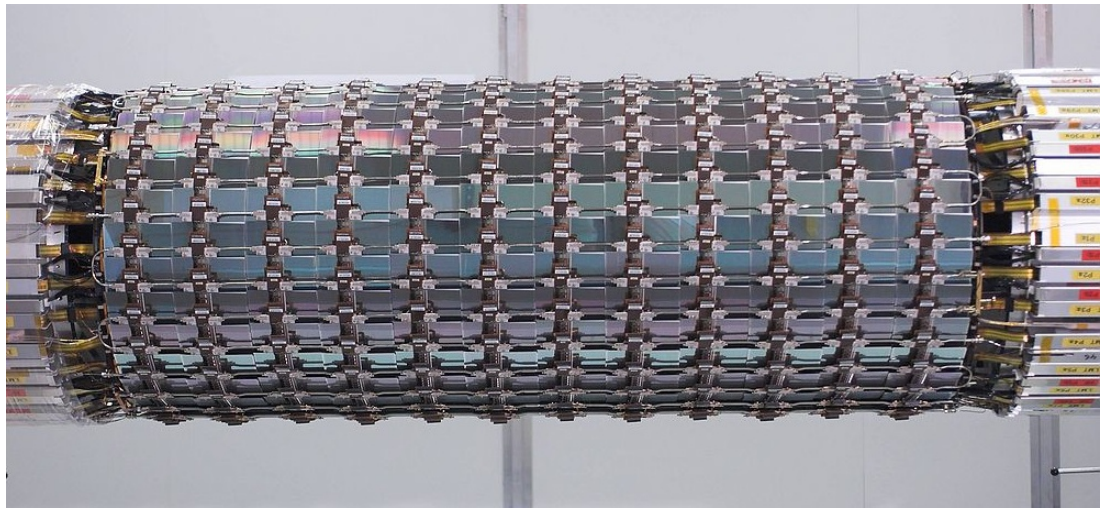
Occupancy summary plots

- One entry per all modules

SCT Detector Monitoring

SCT – Purpose

- **Aim of tools**
  - The SCT Monitoring should provide quick identification of any problems which may affect the data quality of this particular sub-detector
  - This includes all sub-detector specific information as well as SCT hits and track information
  - The monitoring can be divided into the following parts:
    - Offline
    - Online
    - ROS
    - DCS
    - Calibration

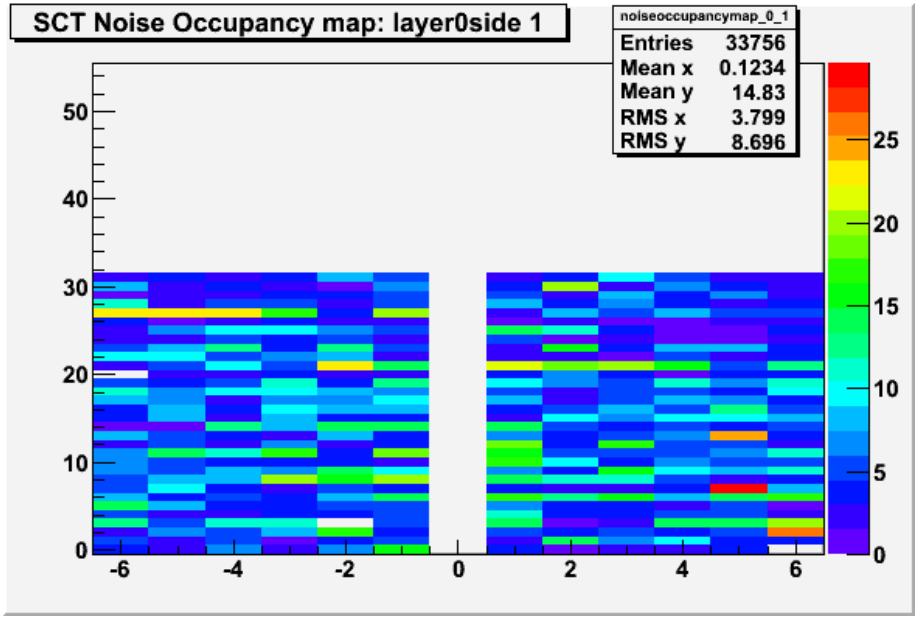


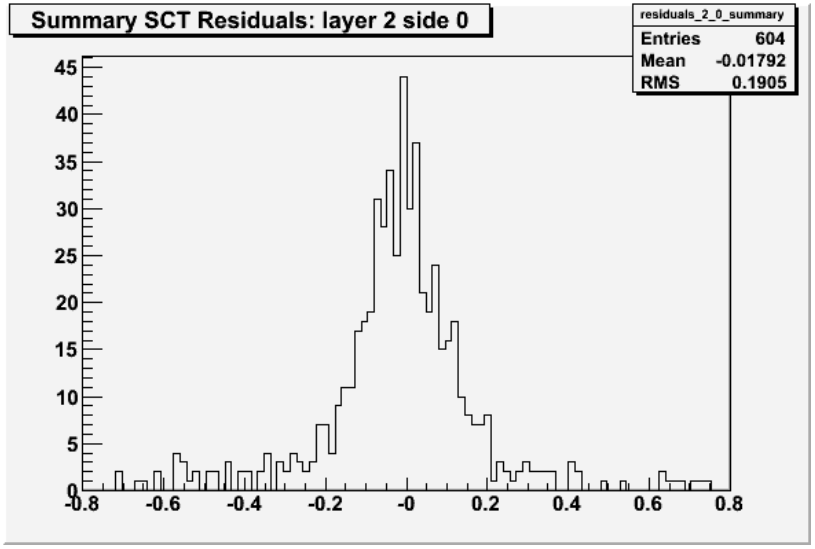
The SCT Barrel

SCT – Example plots

Noise occupancy plots

- Easy and quick identification of dead and noise modules/sides





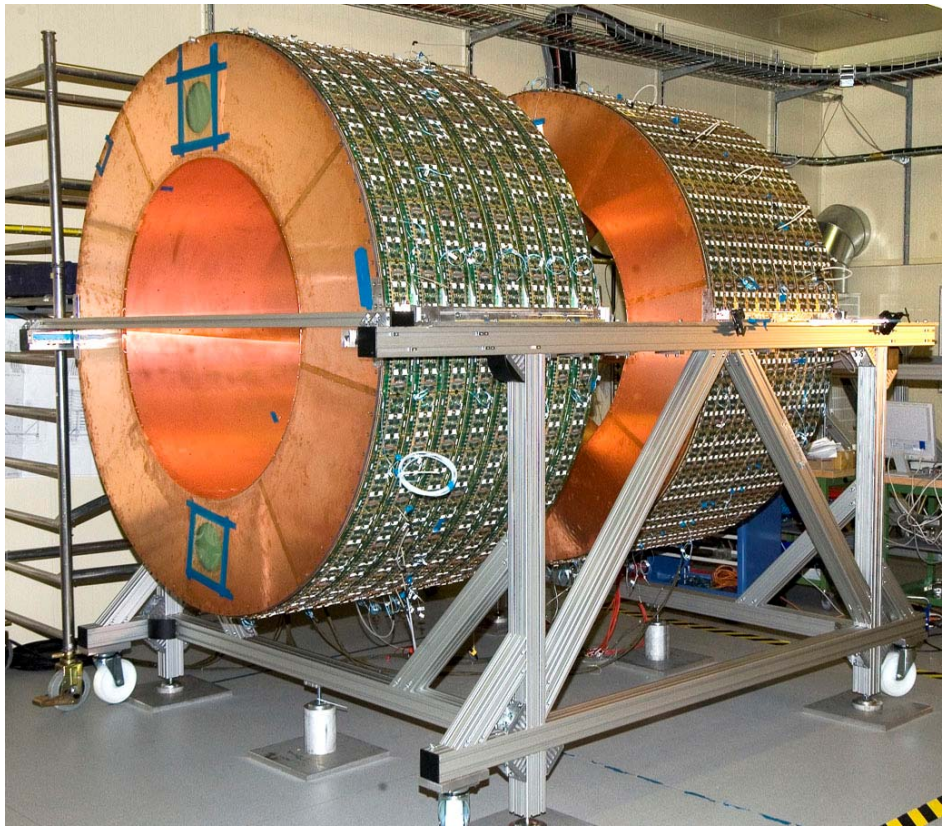
Residual plots

- Monitoring of tracking and alignment of modules

TRT Detector Monitoring

TRT – purpose

- **Aim of tools**
  - The monitoring should include timing, efficiency, noise, low level and high level hit response
  - It will look at three levels of read out chain (ROD, EF and offline)
  - The TRT monitoring consists of two tools;
    - the TRT Viewer
    - the Athena based monitorings

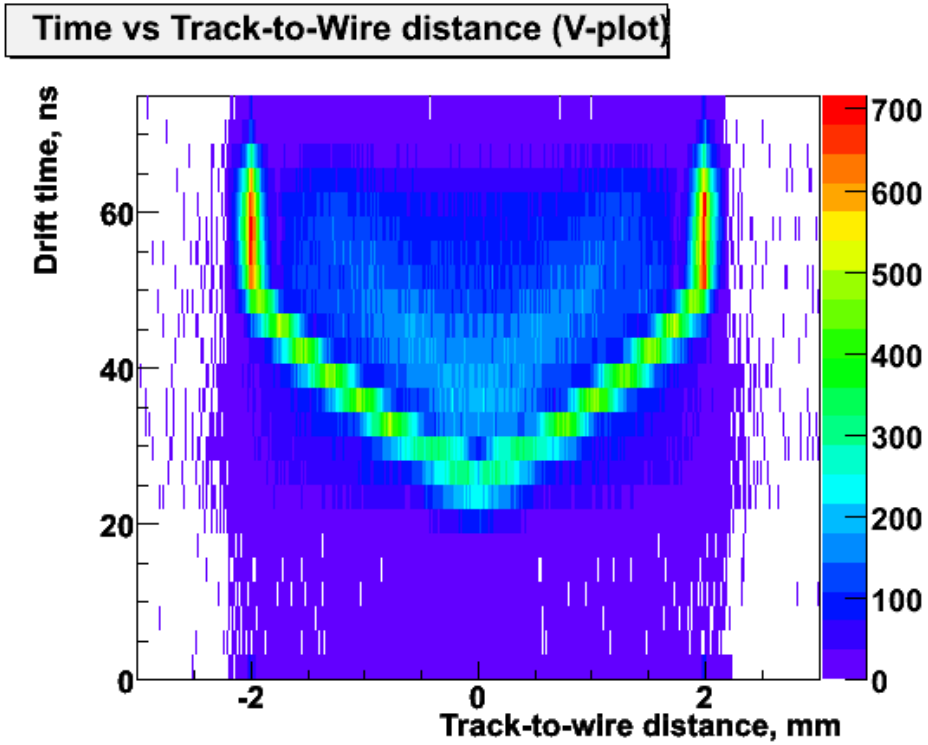


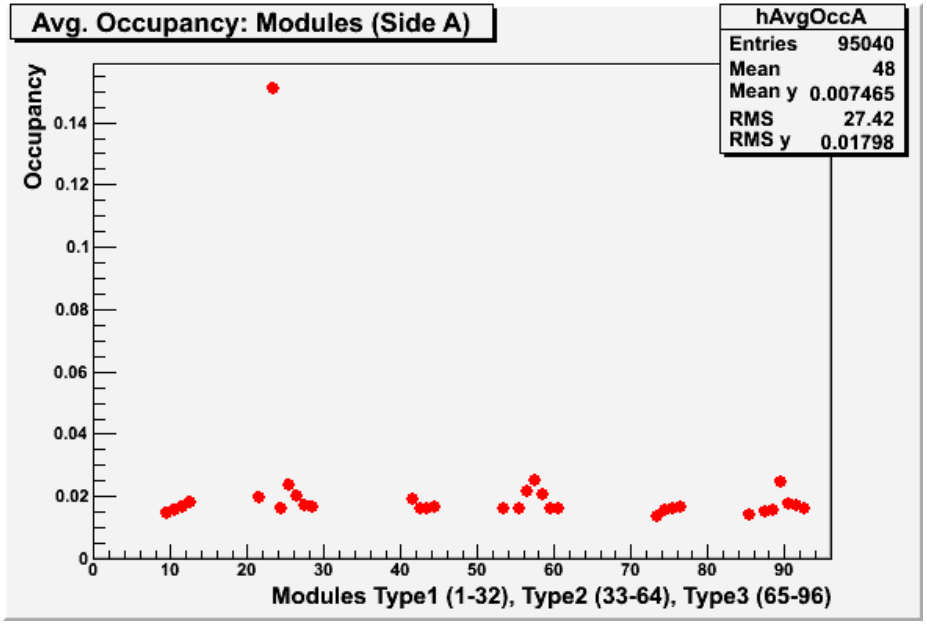
The TRT Barrel

TRT – Example plots

Drift time vs Track to wire distance plot

- Monitor R-T relation and compare with calibration





Occupancy plots

- Easy and quick identification of dead and noise modules

ID Global Monitoring

ID – purpose

- **Aim of tools**
  - Monitoring of synchronisation differences between 3 subdetectors: LVL1, BCID, matching of segments at the boundary surface of the 3 subdetectors.
  - Monitoring of noise occupancy correlation between the 3 subdetectors
  - Provide monitoring of hits, combined track information and residuals of combined tracks, looking for deviations in any ID part or phi sector
- **Particular aspects**
  - The ID Global Monitoring is a standalone tool which can work with any number of the subdetectors on. At least 2 subdetectors are needed for ID information to be produced, but one detector will be used for debugging purposes

ID - Implementation

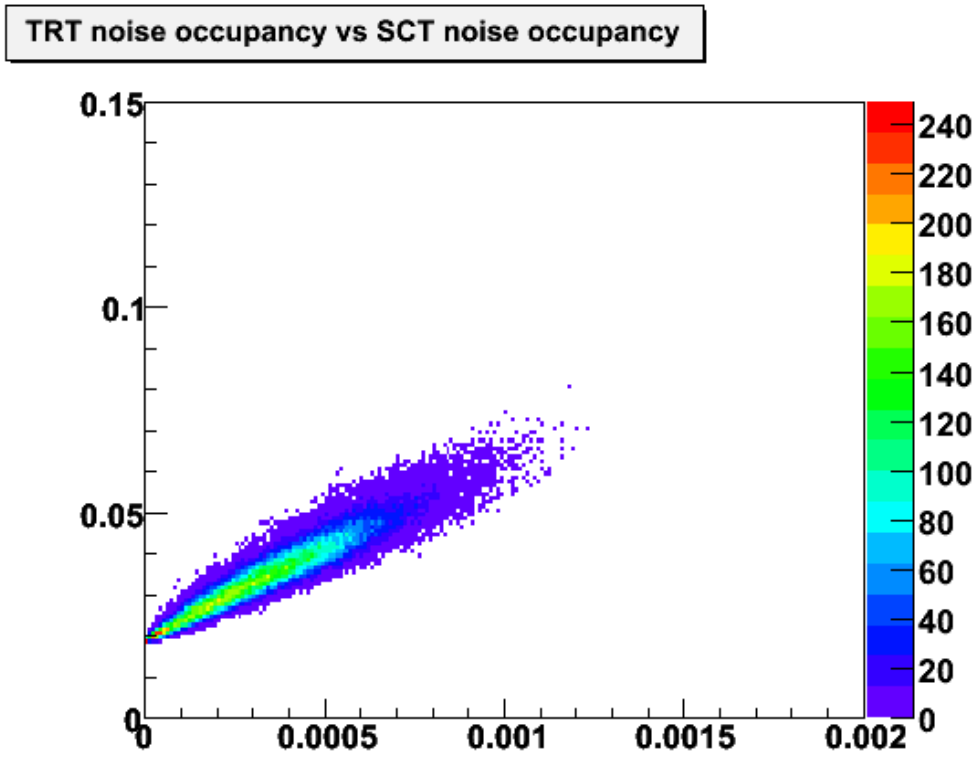
- **Current implementation**
  - **(cosmics)**
    - **InDetGlobalMonitorig package was developed for SCT+TRT tested on surface during summer 2006**
    - **Fully tested with cosmic muons**
    - **Since mid-2007 when Pixel detector was in place new functionalities were added to monitor it as well**
    - **Now Pixel is monitored on the same level as SCT and TRT**
  - **Full Dress Rehearsal – 2 (FDR2)**
    - **FDR2 is simulated events passing through the chain of Atlas Data Acquisition, triggers etc. as they are events from real detector.**
    - **Most of the monitoring tools were tuned for cosmics (histogram ranges, memory usage etc)**
    - **One have to retune for collision data and even drop some tools like TopBottom Monitoring**
    - **Due to memory consumption and algorithms migration issues lite version of InDetGlobalMonitoring was used during FDR2**

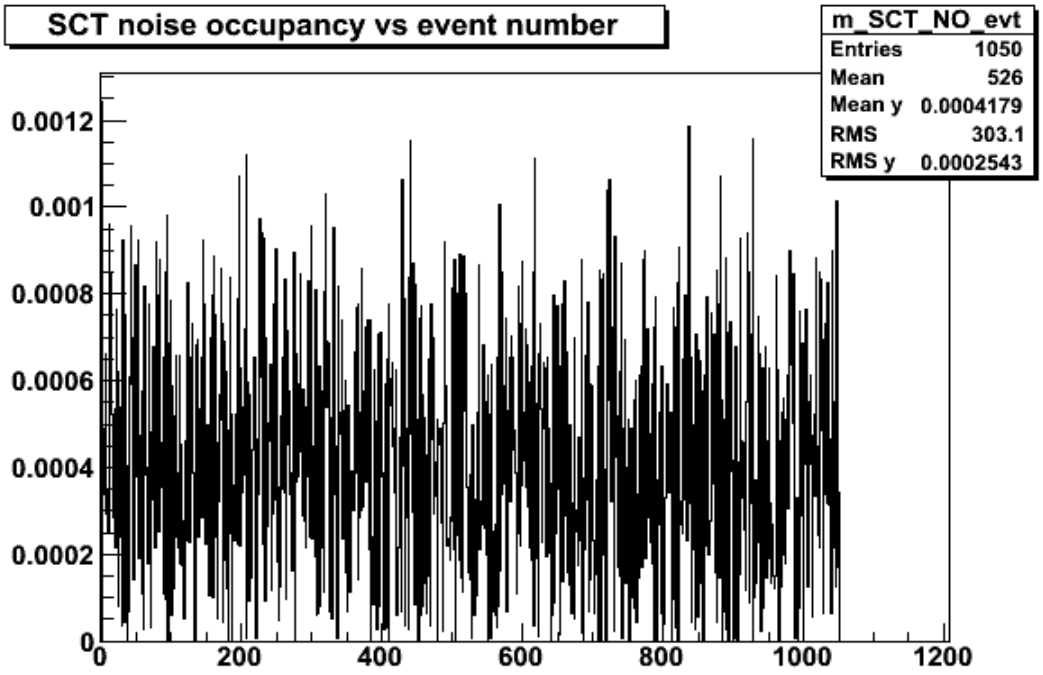
Existing tools

- **InDetGlobalSynchMonTool (monitoring of LVL1, BCIDs)**
- **InDetGlobalHitsMonTool (monitoring of number of hits, residuals on combined tracks)**
- **InDetGlobalSegmentsMonTool (matching of TRT, SCT & Pixel segments)**
- **InDetGlobalTopBottomMonTool (matching parameters of top and bottom tracks)**
- **InDetGlobalNoiseOccupancyMonTool (Pixel, SCT & TRT noise occupancies)**

NoiseOccupancy MonTool

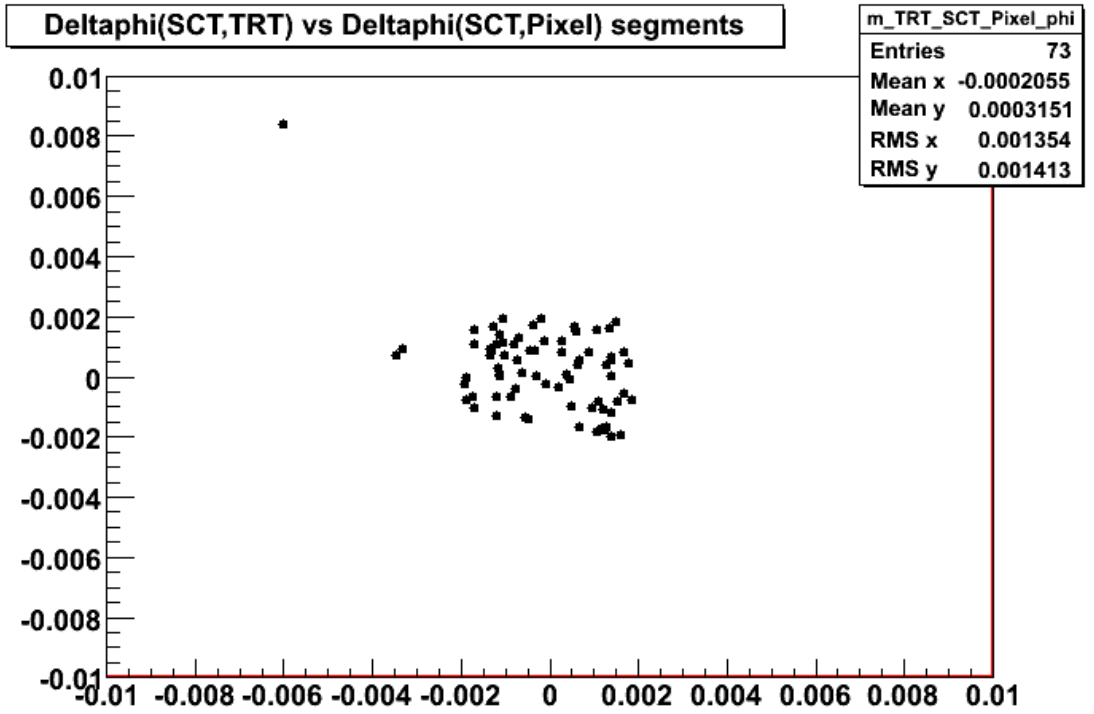
- Plots from FDR2 data
- Show clear correlation between SCT and TRT noise
- For debug purposes one can look at noise level of each detector as well

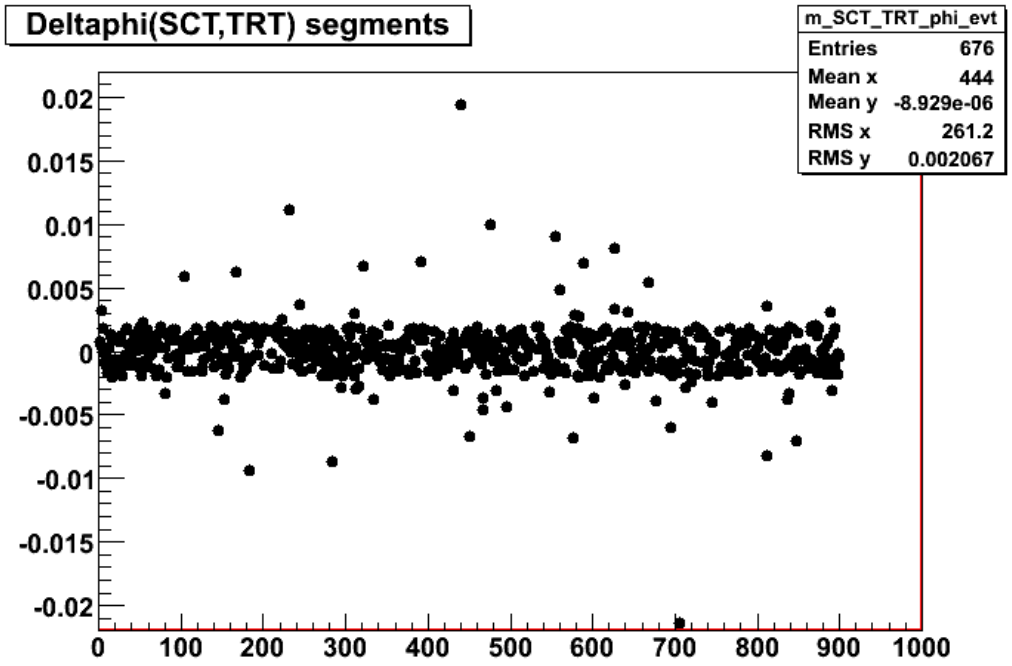




Segments MonTool

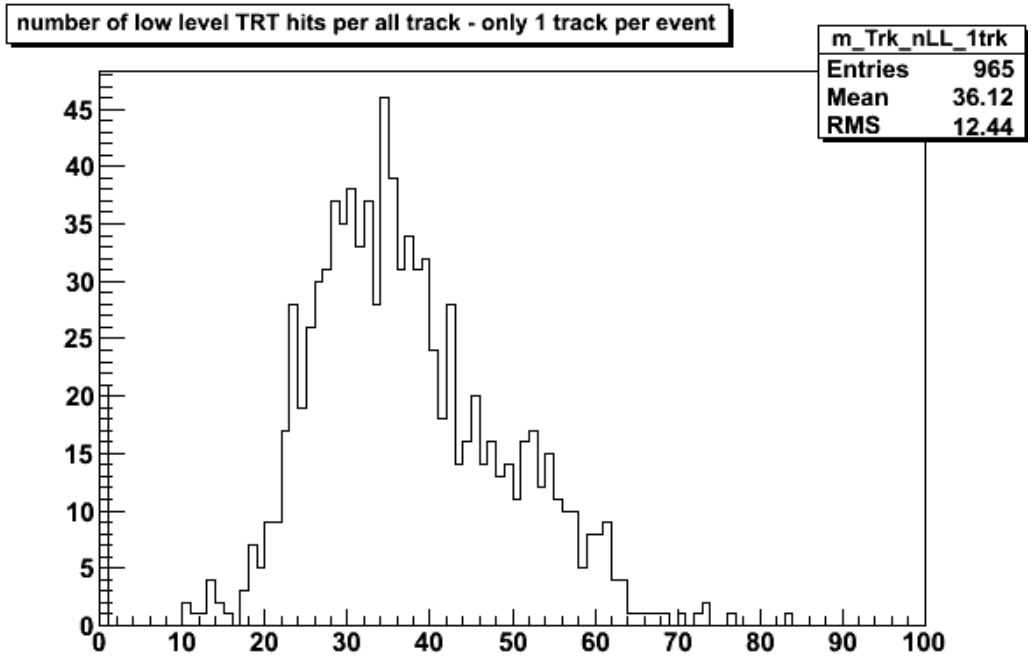
- Plots from simulated cosmic events
- Check delta_phi of track segments reconstructed independently in Pixel, SCT & TRT
- Mean should be ~0 unless detectors are misaligned or not synchronised

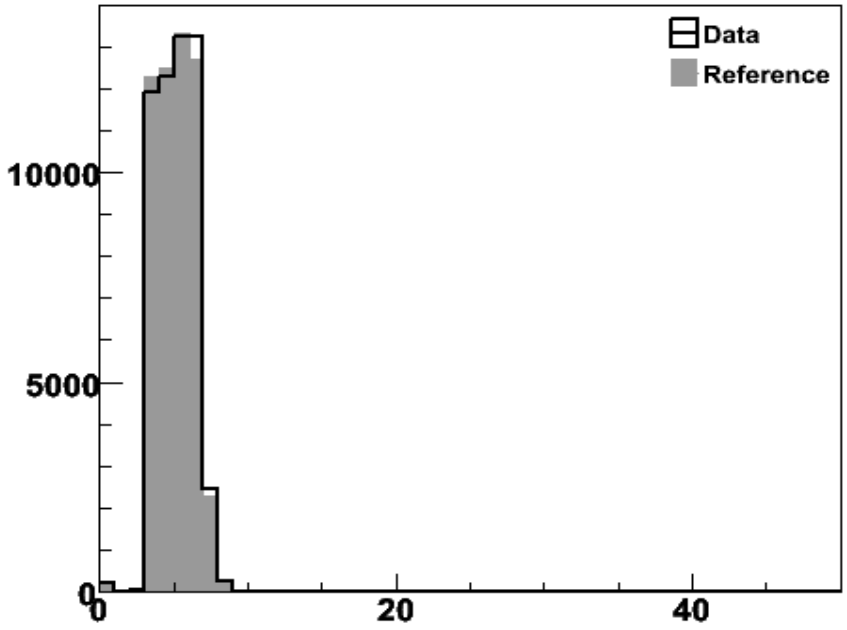




Hits MonTool

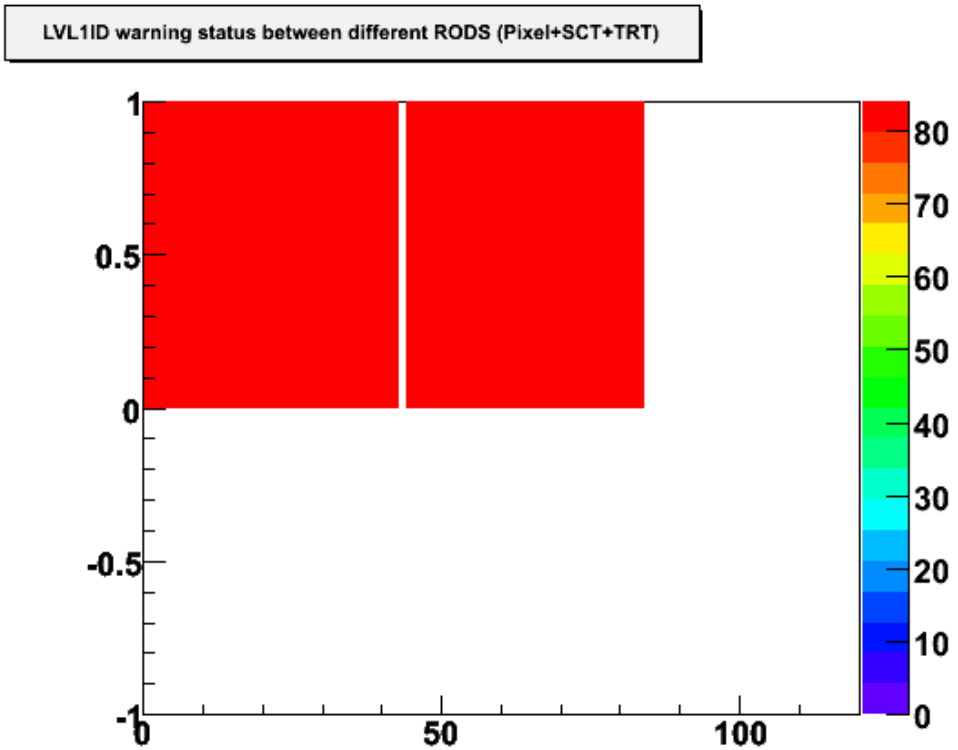
- Plots from cosmic muons and FDR2
- Tool is mostly needed to control if tracking works as it is supposed
- This quantity is monitored by particular sub-detectors as well
- Another purpose is to cross check these histograms and histograms from Pixel, SCT and TRT monitoring packages





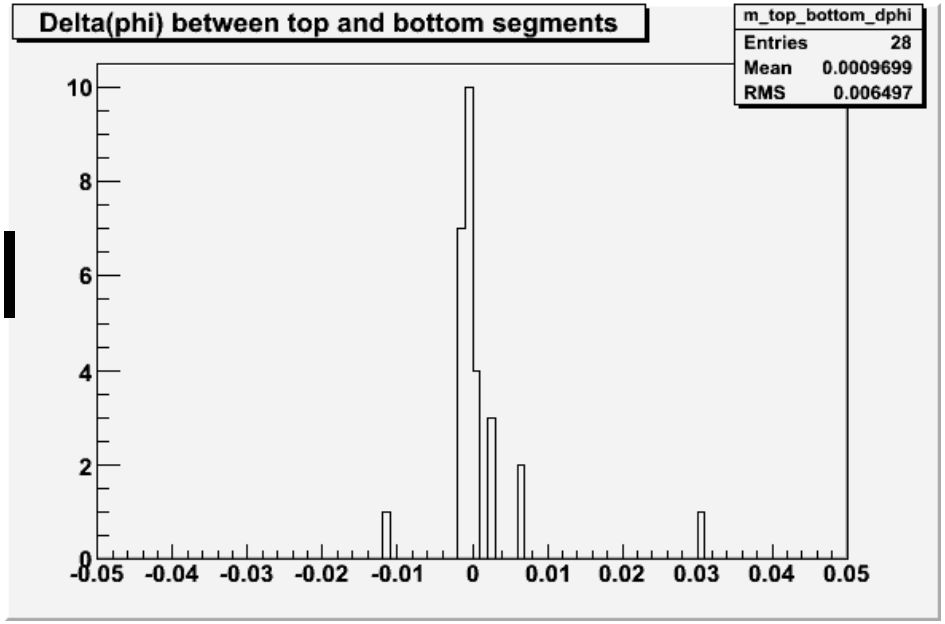
Synchronisation MonTool

- Checks LVL1ID and BCID between subdetectors and even between different parts of a particular subdetector
- If synchronised 0 is filled but is any mismatches -1 will be flashed
  - The gap in plot is introduced to separate RODs from different sub-detectors



TopBottomMonTool

- Compares track parameters between tracks reconstructed in top and bottom sectors of the detector
- Not useful for collision data in current shape



Conclusion

- Monitoring (both online and offline) is the first step of understanding the detector
- Monitored quantities allow quickly observe possible problems and solve them
- Monitoring is in a good shape both at individual sub-detector level and at Global level
- But still many issues exist
  - Code is not always written in an optimal way
    - Recently all monitoring code has been reviewed and changes are being implemented now
  - Memory and CPU consumption is rather high
  - Not all the histograms are optimized