Inner detector software experience from the combined test beam and cosmic rays data

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Trigger & Physics week
Tracking performance
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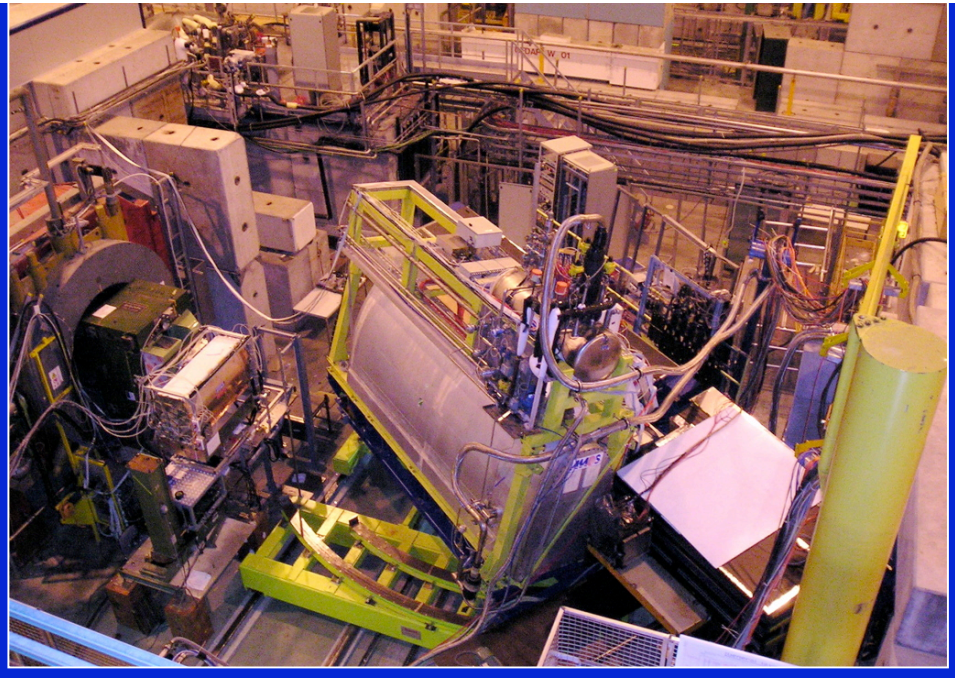
Contents

- Test beam and cosmic rays data available.
- Impact on the software:
  - Simulation
  - Reconstruction
  - Monitoring and analysis
  - Alignment & Calibrations
- Detector and software performance studies
- Conclusions

Data available

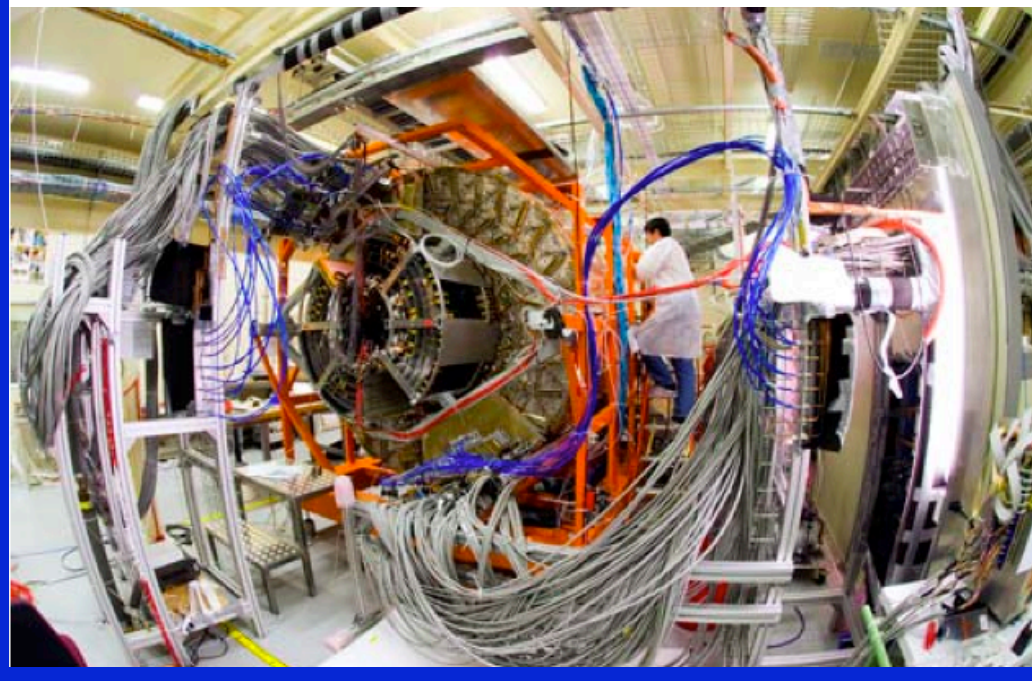
ATLAS Combined test beam 2004

- ATLAS barrel slice
- ID not final positions (d(SCT,TRT) ~1.1m)
- Particles: e^{+-},π^{+-},μ^{+-},γ
- Energies: 1 - 350 GeV (~ known)
- B field: 0 - 1.4T (for Silicon)
- Additional material in some runs (η=1.6)
- Combined data with calorimeters and muon system
- Random triggers



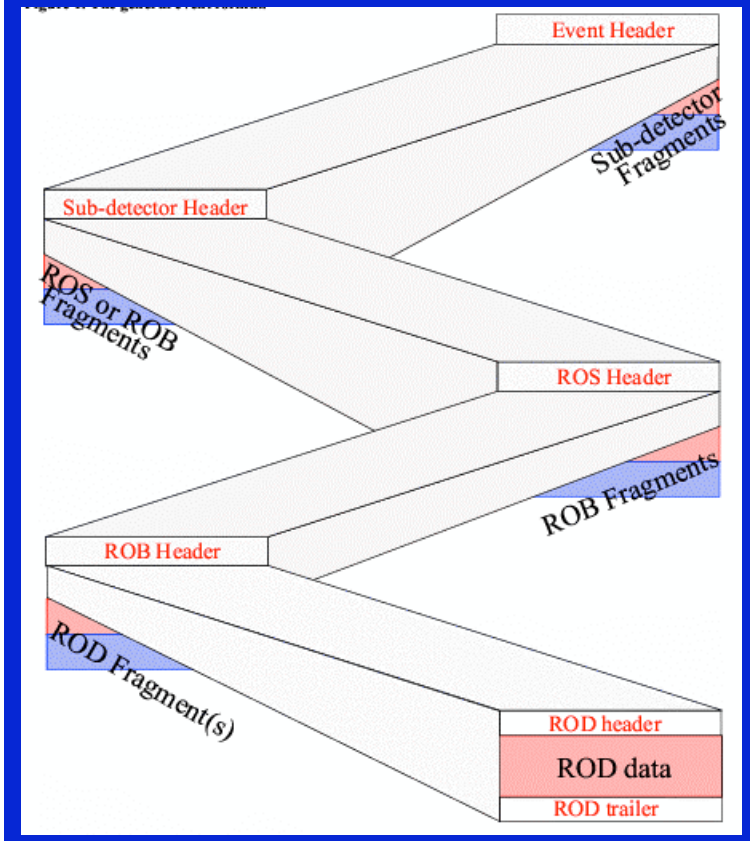
SR1 cosmic rays 2006

- As built detectors:
  - ID barrel
  - ID endcap C
  - Pixel endcap A
- Particles: mainly μ^{+-}
- Energy cosmic spectra with a cutoff (unknown)
- B field: 0
- Standalone ID
- Random triggers



Impact on the software

- Real data as opposed to simulated LHC data!!!!
  - Realistic detectors & electronics (imperfections, not aligned, not calibrated)



ByteSream converters

- **Realistic decoders and cabling maps had to be developed (fake BS was used before to test full reconstruction)**
- **RawData objects including errors**
- **Encoders are now also available and will be used for the next BS production.**

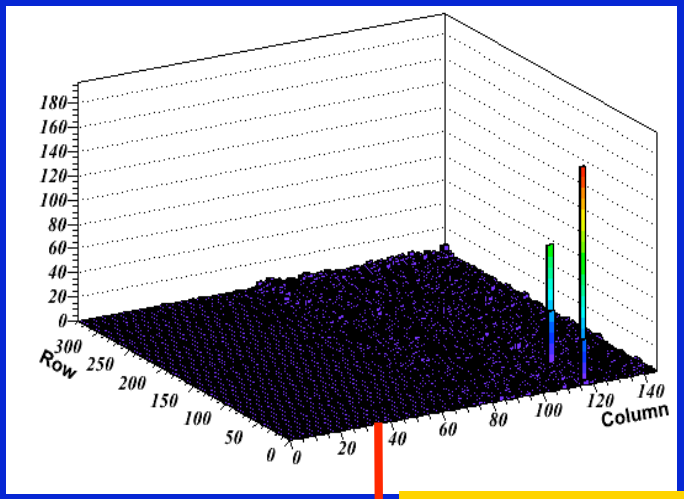
Detector description

- Fixes in TRT and SCT implementations thanks to cosmics data

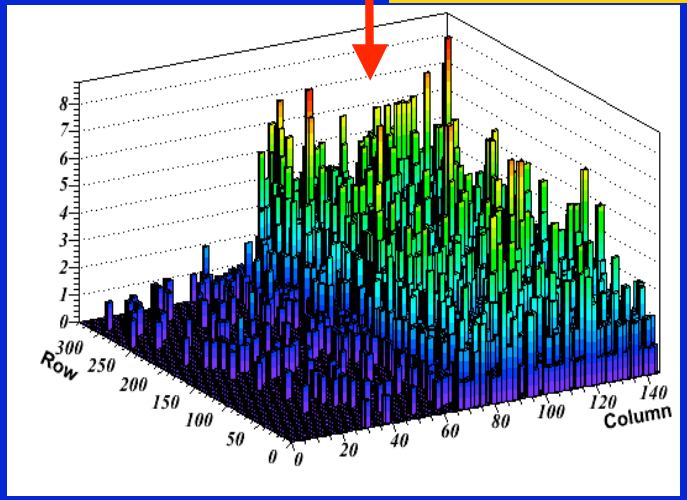
Impact on the software

Conditions data infrastructure

- CTB first user of ConDB and further developments done with cosmics data.
- Tools to access conditions data from online systems in place:
  - DAQ configuration file (Cabling, Thr, masked channels, …)
  - DCS measurements (T, I, …)
  - Calibration (noisy)
- Tools to load results to ConDB developed:
  - Output of monitoring tools (noise, inefficient channels, …)
  - Alignment and calibration constants
- Reconstruction & simulation making use of conditions data.
- Detector description including alignment corrections.



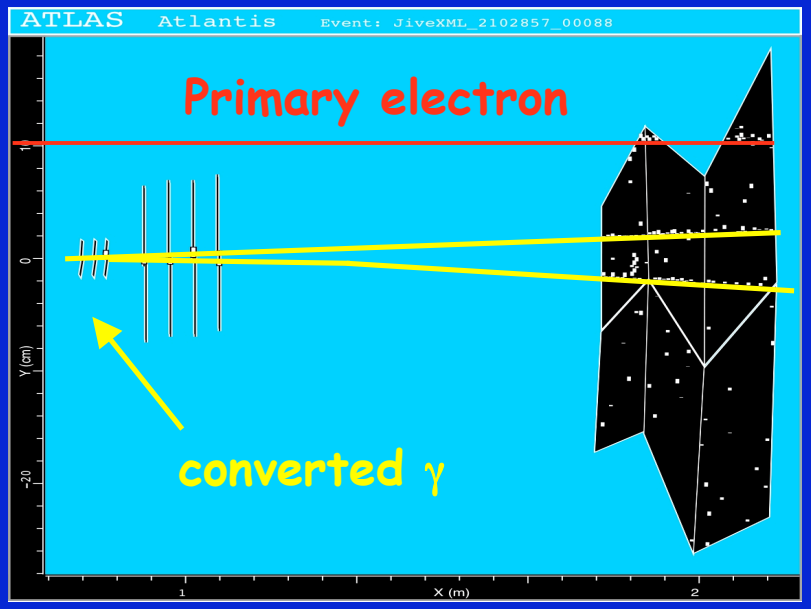
Masking Pixels noisy channels

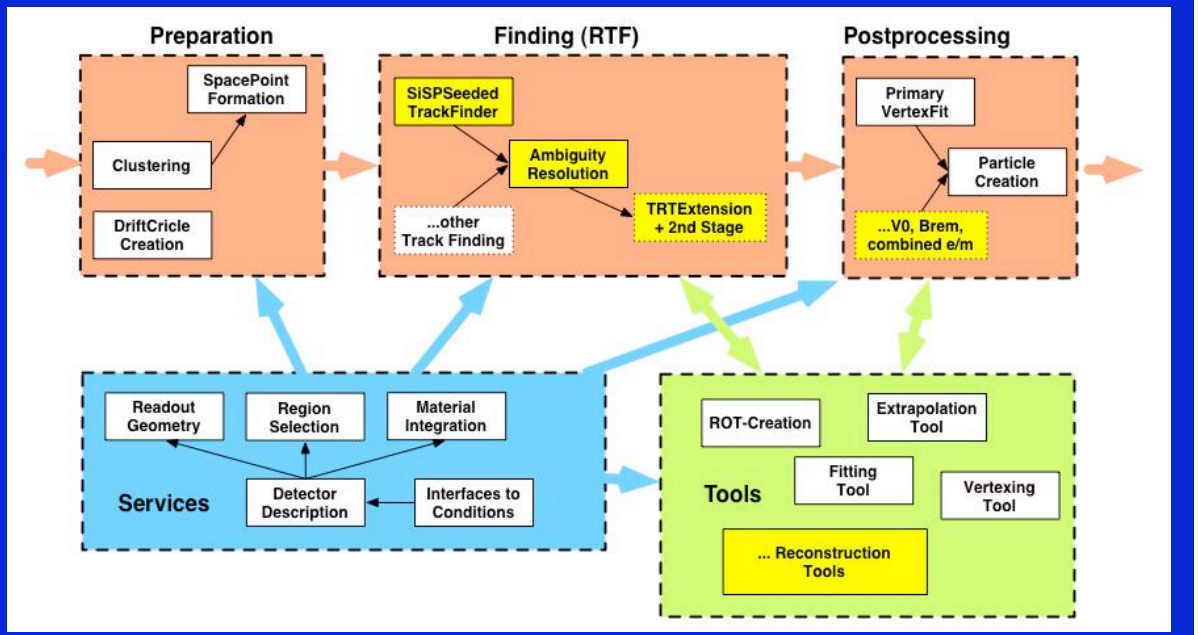


Impact on the software

Tracking developments

- The CTB was used as a testbed to develop the new tracking model
  - CTBTracking was the first algorithm using new tracking EDM
  - Kalman Filter
  - Gaussian Sum Filter
  - Back tracking

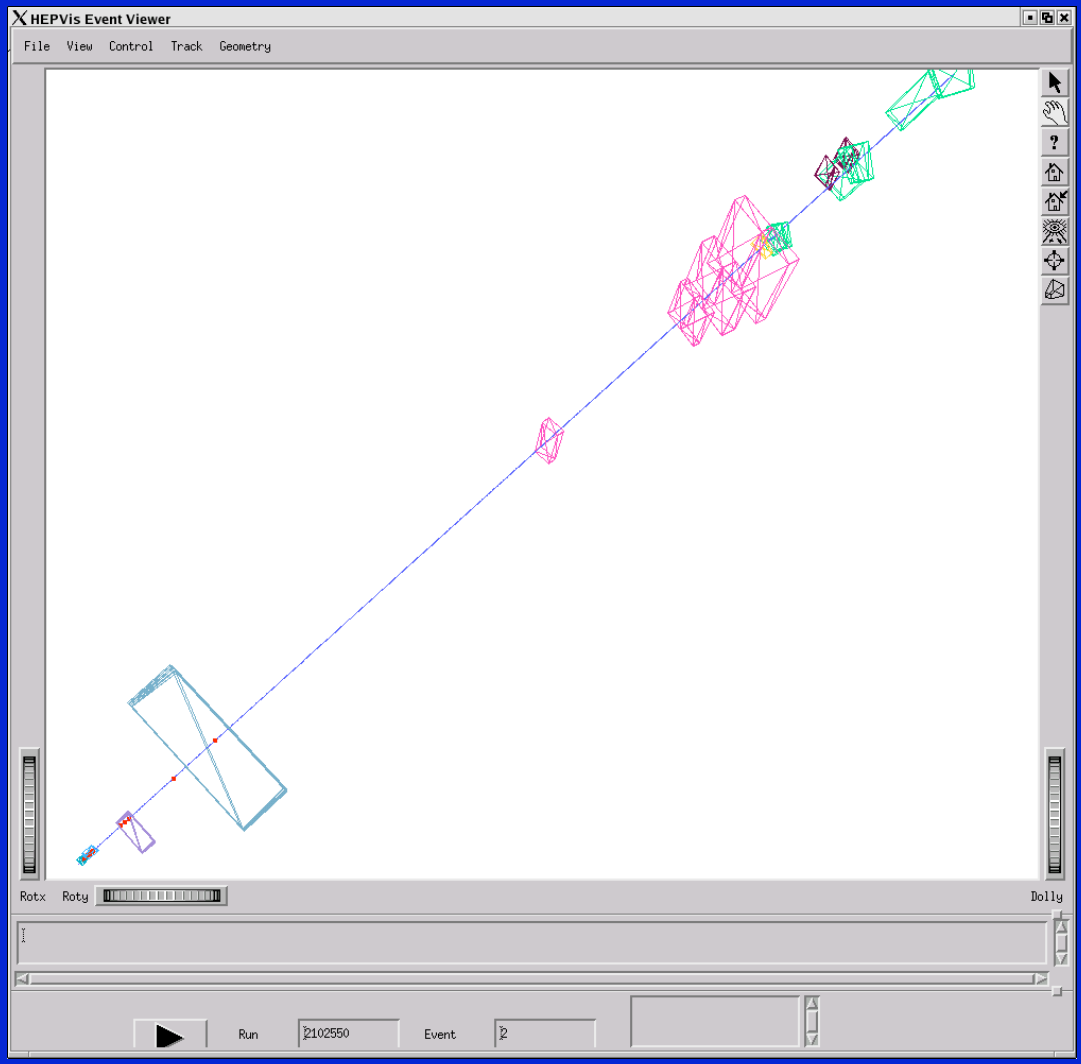




Impact on the software

Combined tracking reconstruction

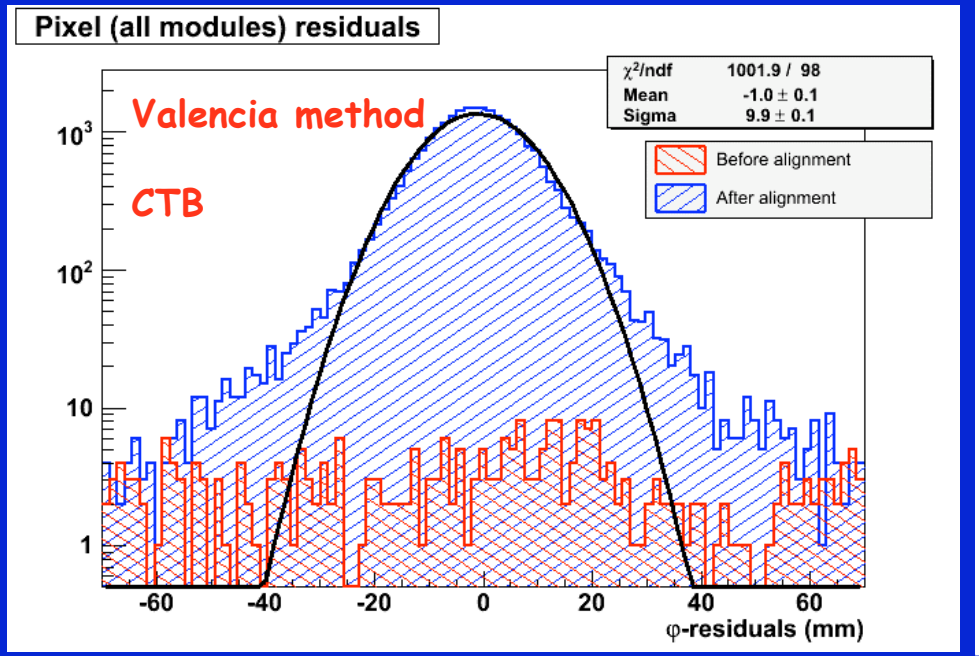
- First test of combined fit making use of new tracking EDM was done with the CTB real data.



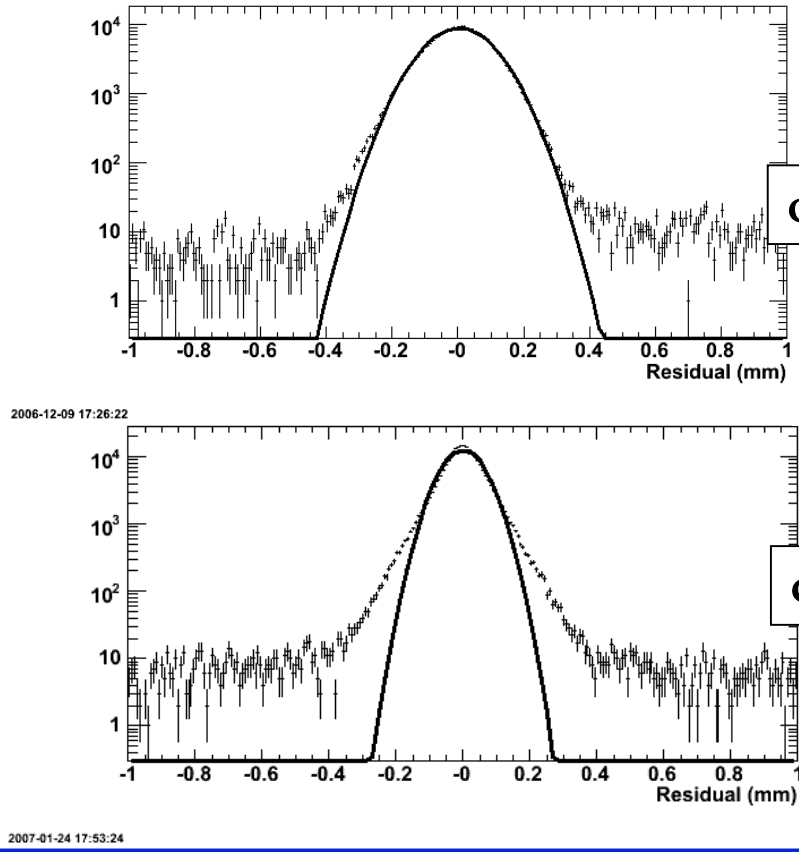
Impact on the software

Alignment and calibrations

- Chance to test alignment and calibration methods with real data (CTB, cosmics) and as built detectors (SR1 cosmics).



SCT barrel residuals (cosmics, B = 0!!!)



σ = 96 μm

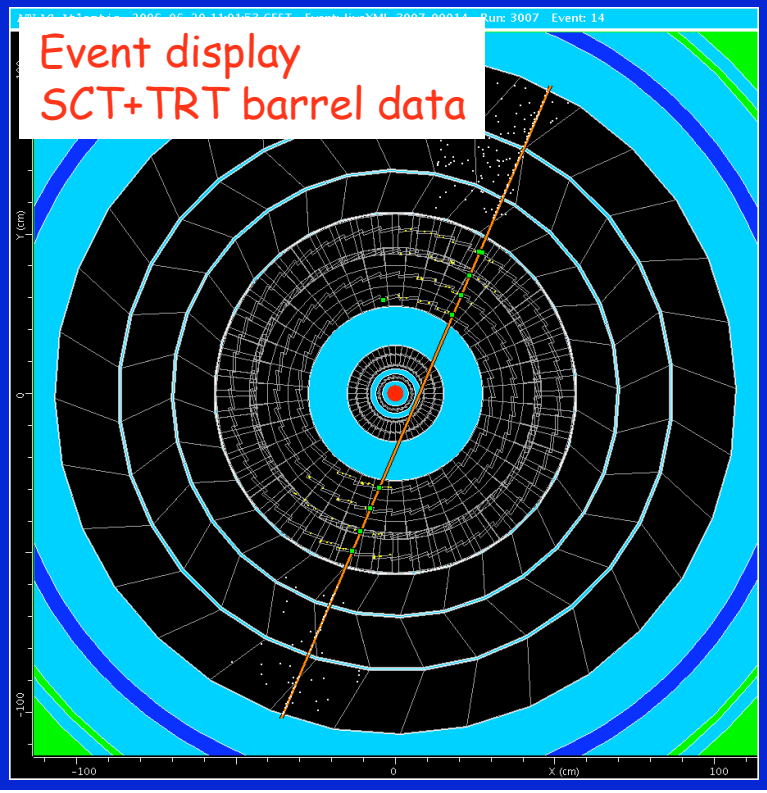
Alignment

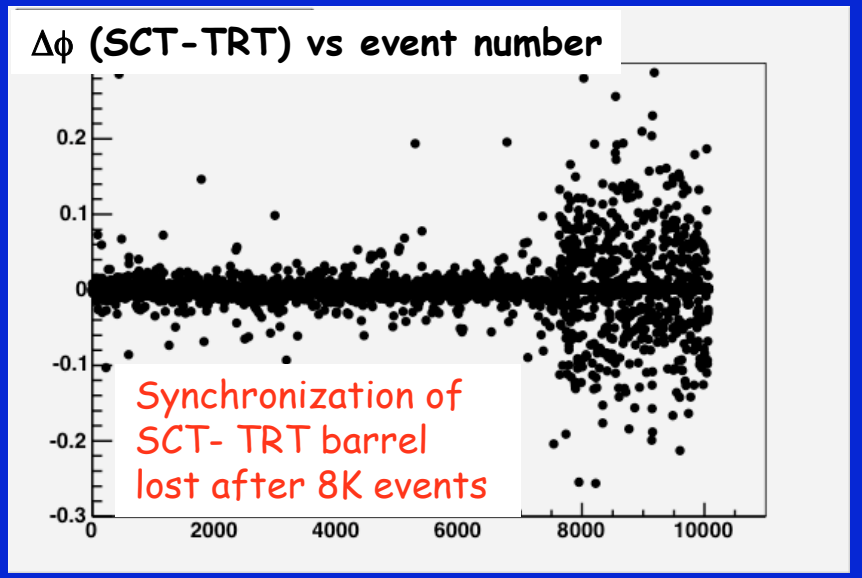
σ = 59 μm

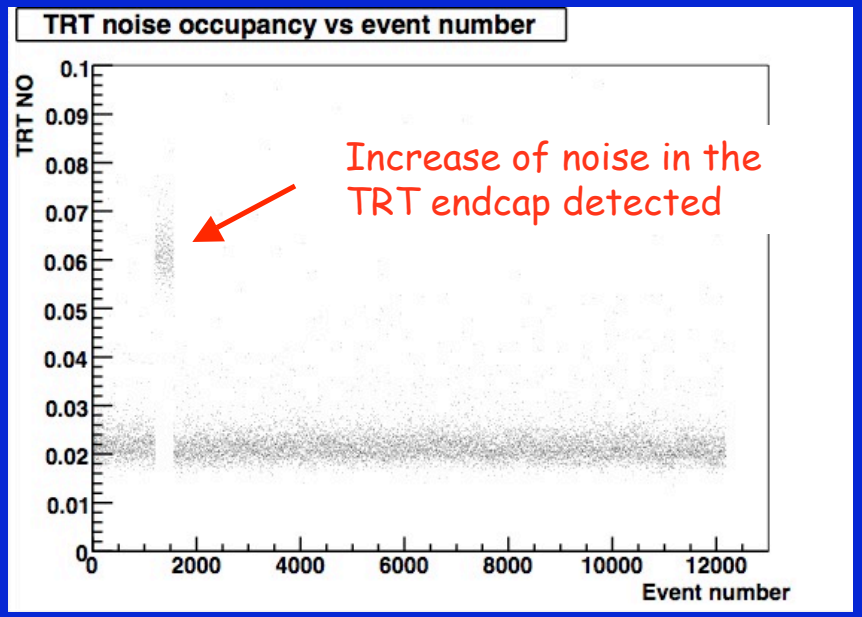
Impact on the software

Monitoring in Athena

- Tools to monitor the detector performance have been developed.
- Improvements in Atlantis ED
- Monitoring tools and event displays tested online.



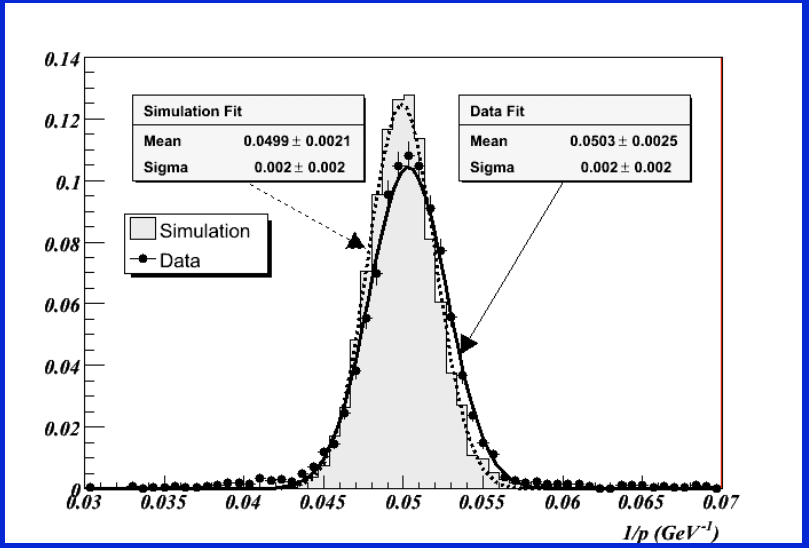


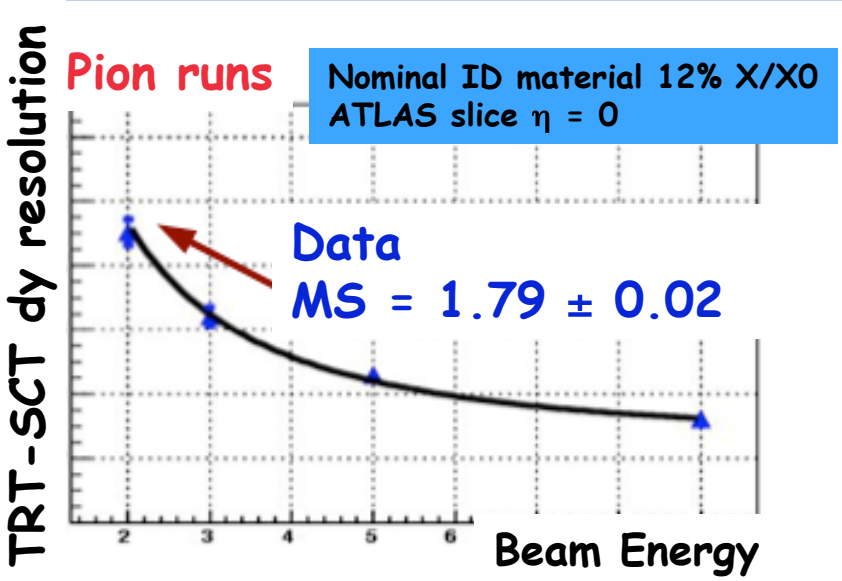


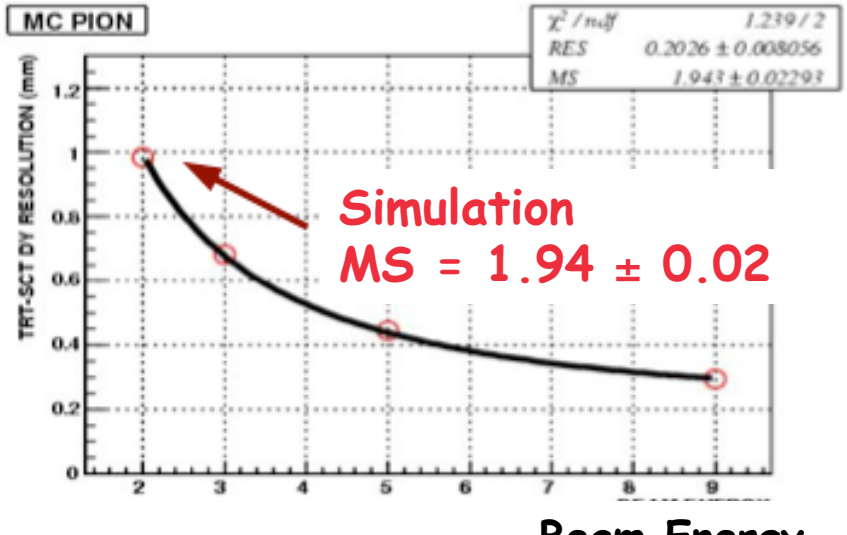
Impact on the software

Simulation

- Data/MC comparisons have been performed to evaluate and improve goodness of the simulation and digitization processes.



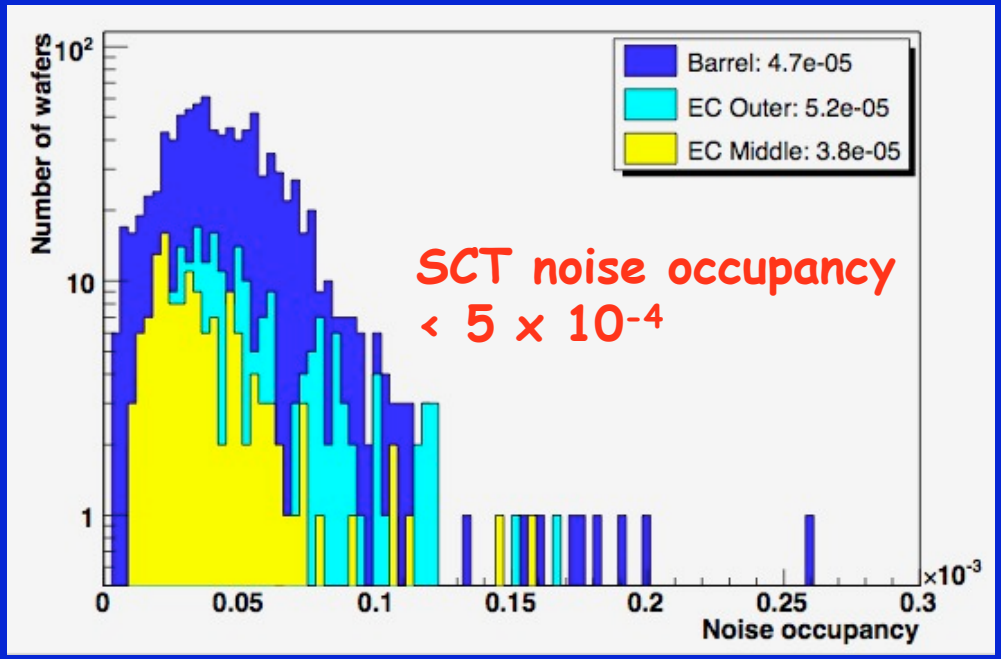


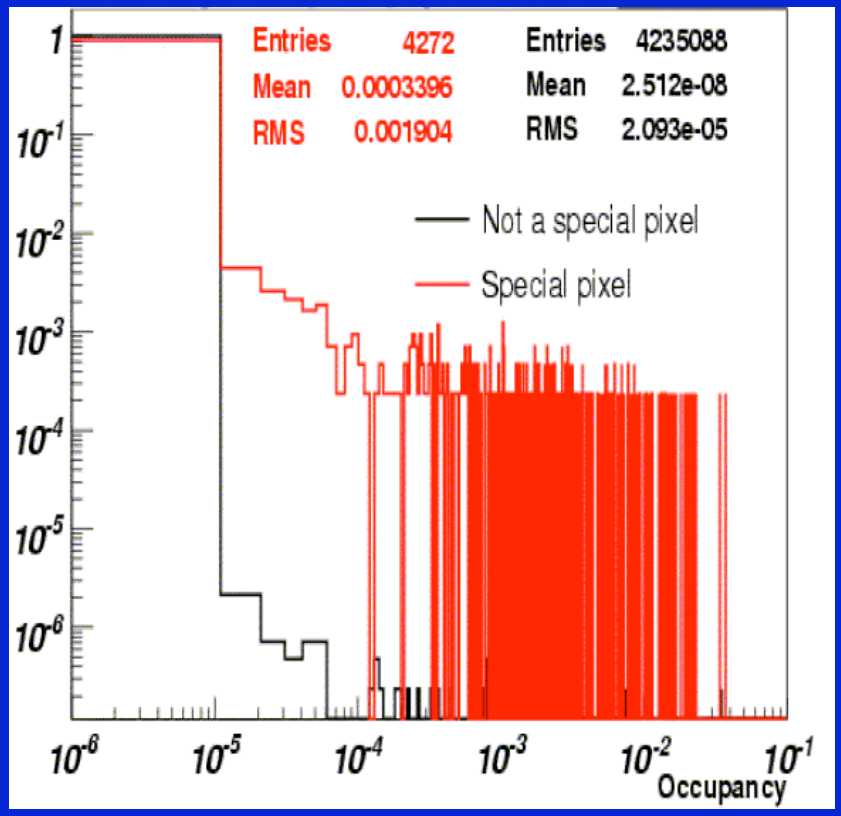


$\sigma^2 = \sigma(\text{int})^2 + \sigma^2(MS)/p^2$

Detector performance studies

- SR1 data used to do the first studies of the as built detector performance

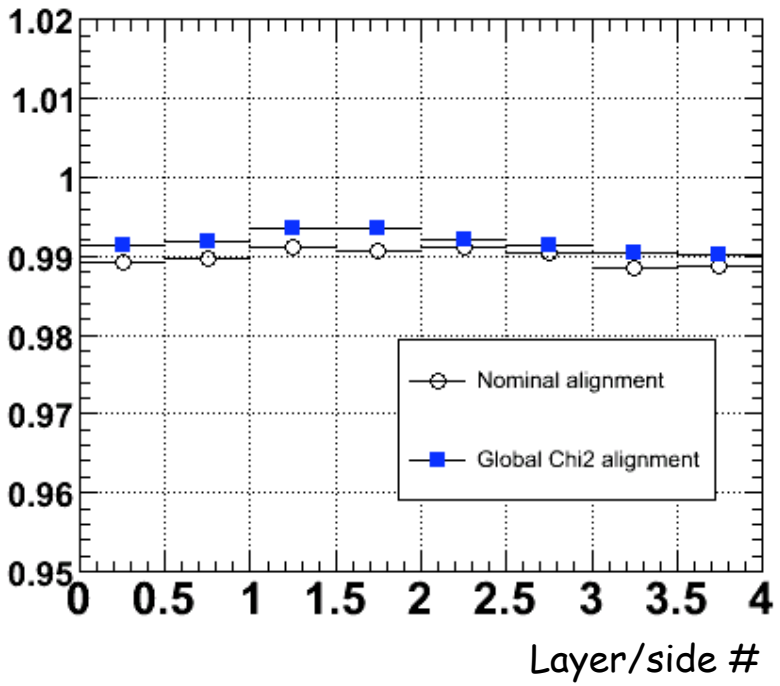


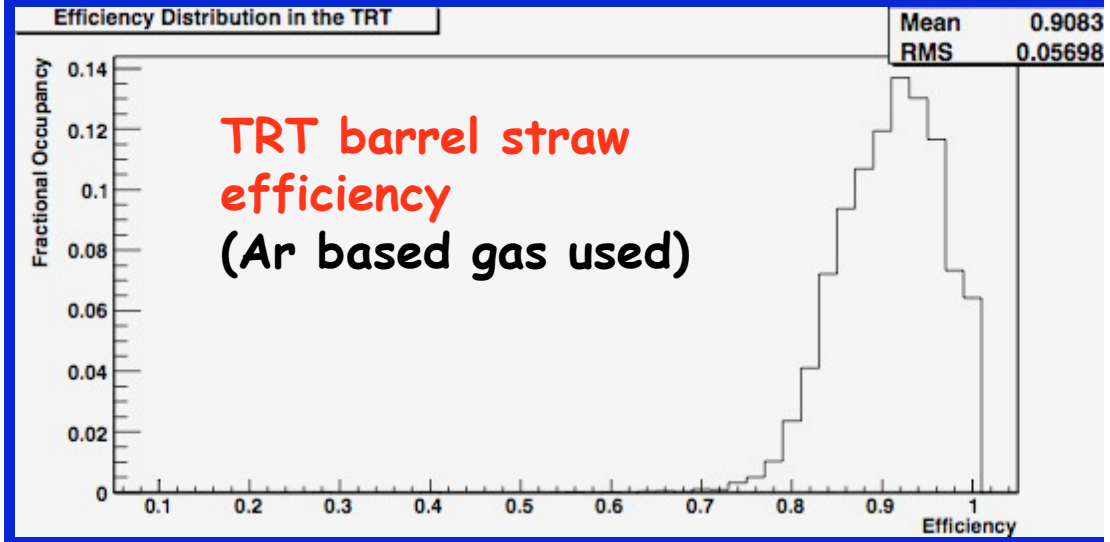


Noise well within specififacions (and in agreement with production tests)
No increase of noise observed in any tested configuration

Detector performance studies

SCT barrel efficiencies

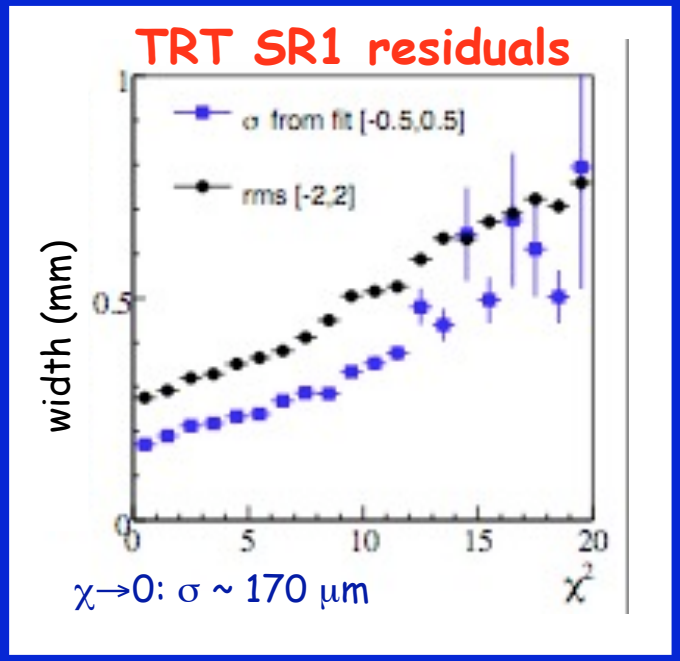


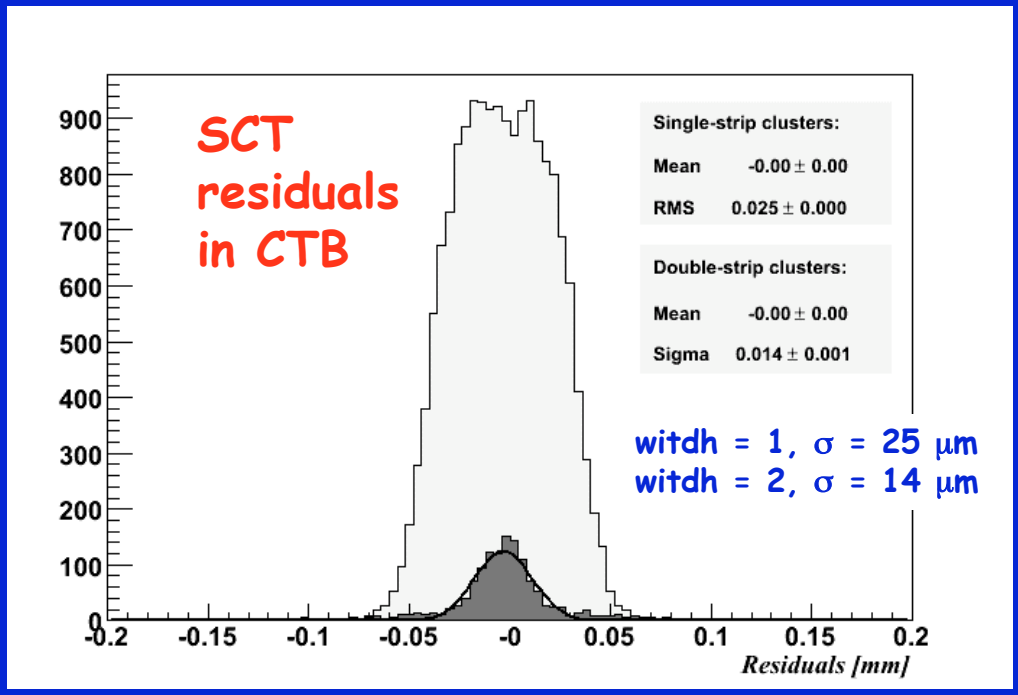


TRT barrel straw efficiency
(Ar based gas used)

Efficiencies are well within specifications

Detector performance studies





- TRT resolutions obtained at SR1 are well within specifications (in progress for SCT to get rid of the wrong track uncertainty estimate)
- SCT residuals at the CTB well within specifications

Conclusions

- A clear improvement in the inner detector software has been done thanks to the combined test beam and cosmics real data:
  - BS converters
  - Conditions data
  - Tracking
  - Alignment and calibrations
  - Monitoring
  - Detector description
  - Simulation
- Improvement includes fixes and new developments.
- First collaboration between hardware and software communities and more hardware and detector experts becoming software developers
- First chance to meet part of the as built detector which seems to be well within specifications.
- Next chance will be with cosmics taken at the pit together with calorimeters and muon system (already next week for the TRT barrel!!!)

Impact on the software