Test of ATLAS Inner Detector Reconstruction Software Using Combined Test Beam Data

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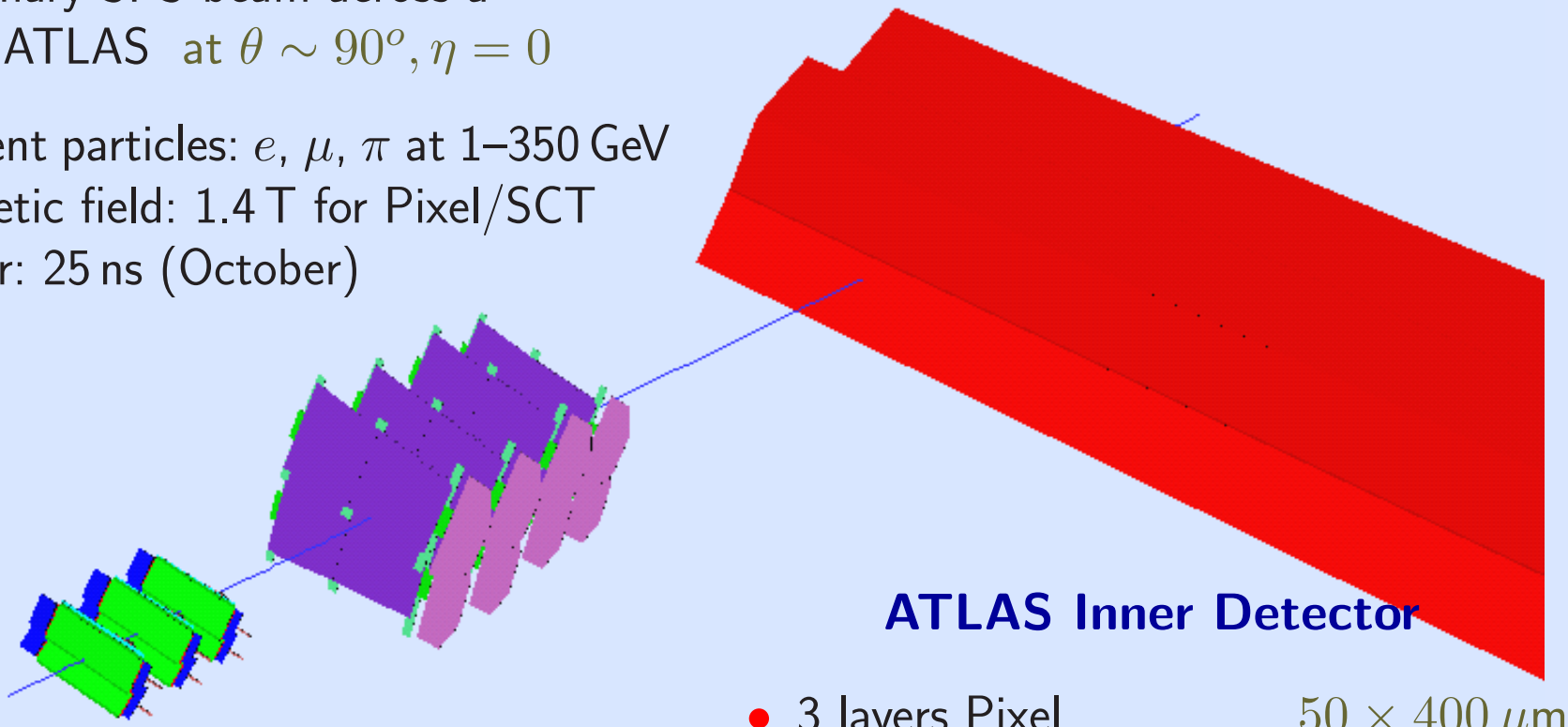
on behalf of the ATLAS Inner Detector Software Group

ATLAS Combined Test Beam 2004

Combined Test Beam

Send primary SPS beam across a "slice" of ATLAS at $\theta \sim 90^o, \eta = 0$

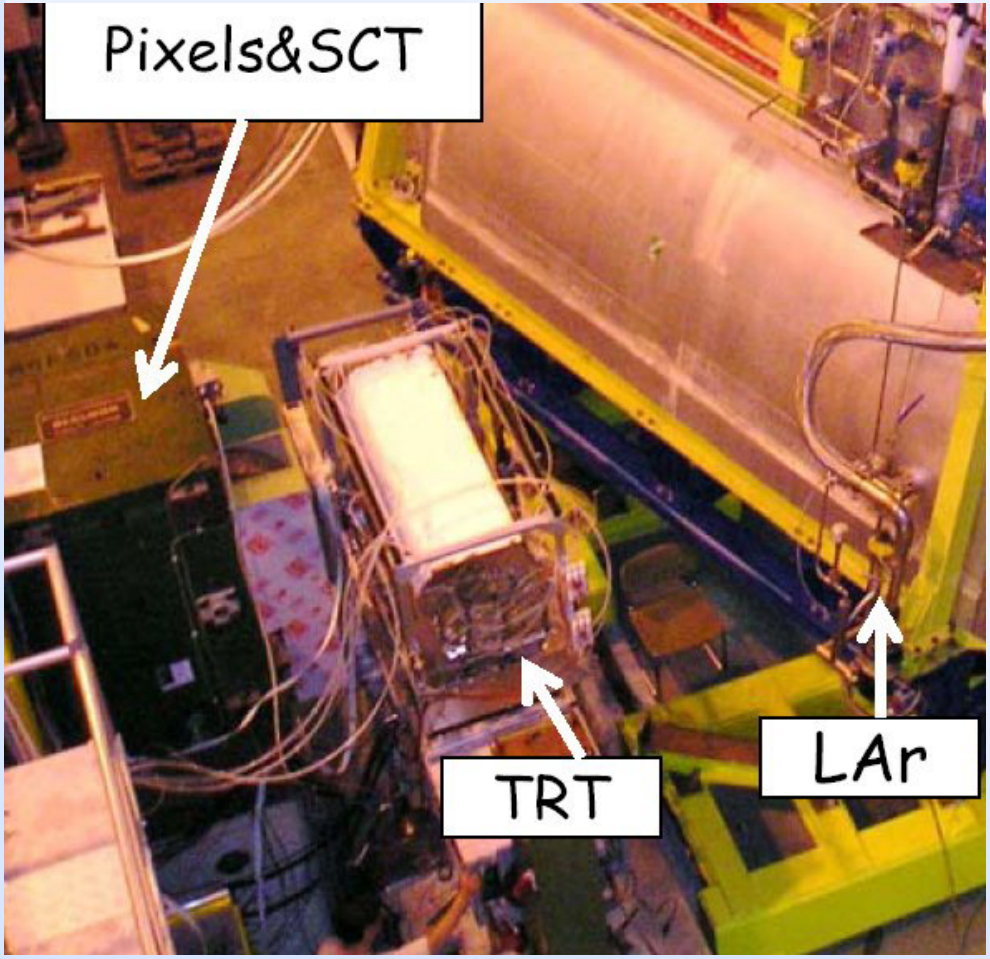
- different particles: e, μ, π at 1–350 GeV
- magnetic field: 1.4 T for Pixel/SCT
- trigger: 25 ns (October)



ATLAS Inner Detector

- 3 layers Pixel $50 \times 400\,\mu$m
- 4×2 layers Si strip (SCT) $70 - 90\,\mu$m
- ∼36 layers TR tubes $\oslash\, 4$mm
- barrel plus similar forward set-up

Combined Test Beam Set-up and Current Programme



A full integration test of

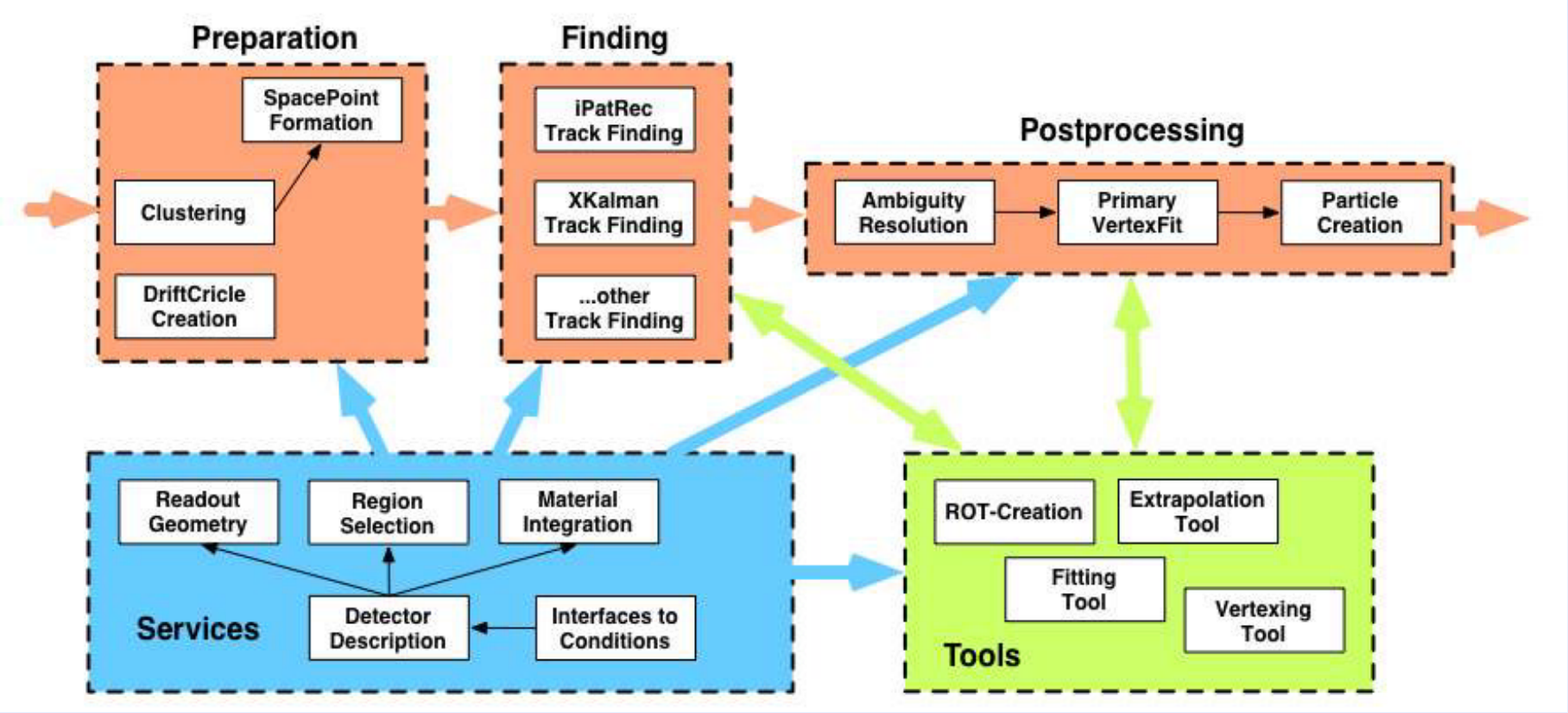
- read-out and trigger
- data acquisition
- detector control system
- data quality monitoring
- offline reconstruction chain
- calibration and alignment
- track reconstruction

▶ spot obstacles now, not in 2007 !

Set-up and Programme

Aug 09	TRT (with Calo+Muons)
Aug 12	Pixel(2) + TRT
Sep 07	Pixel(6) + TRT
∼now	Pixel + SCT + TRT, magnet

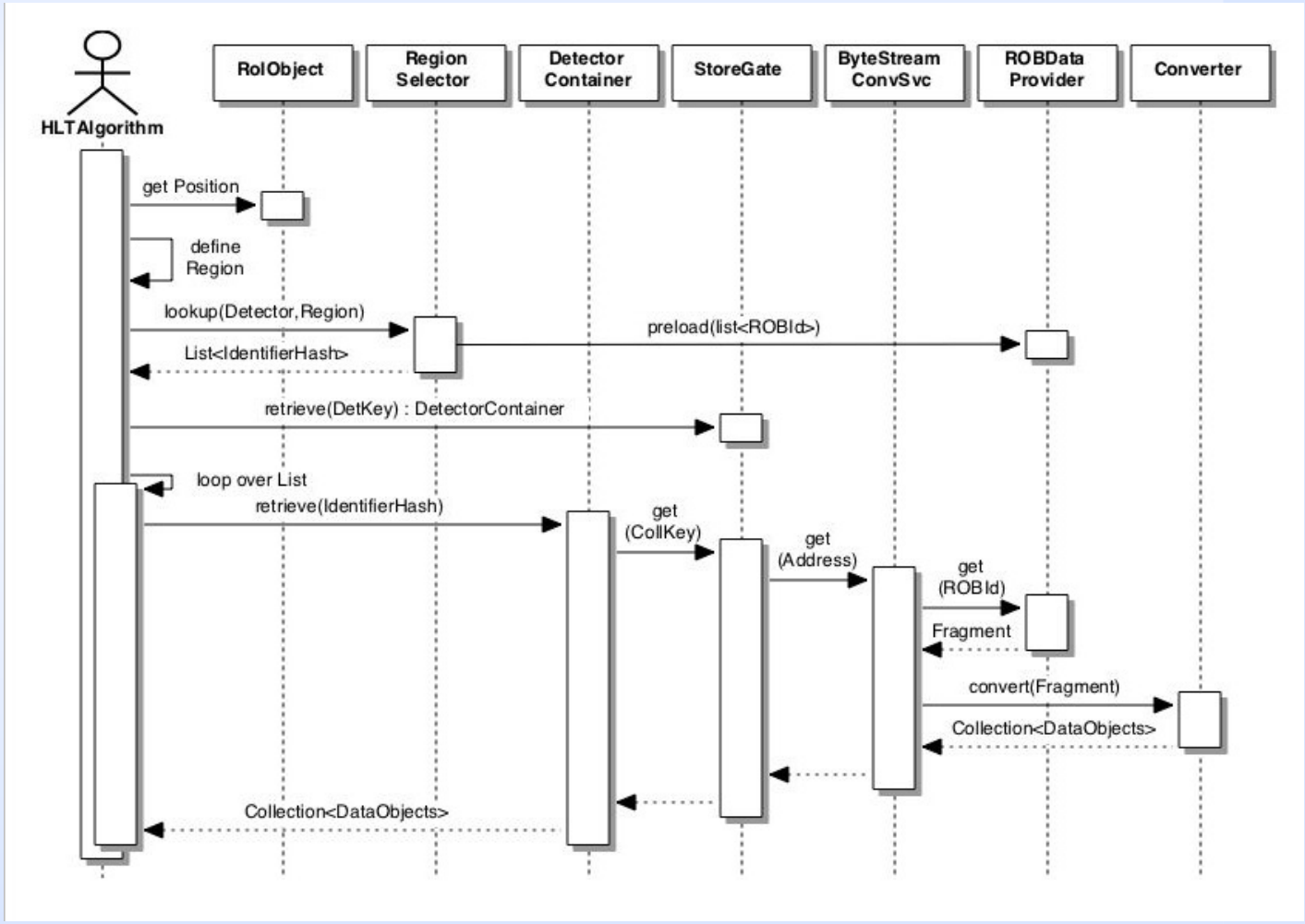
Offline Reconstruction Chain



- result of the re-design in mid-2003
- fully modularised, following the paradigms of the ATLAS athena framework
- the **combined test beam** offline software is using it

ByteStream Converters

- used in HLT **and** offline to decode raw data
  (HLT = high level trigger)
- HLT-oriented design
  (region of interest, decoding on demand)
- CTB2004: **first test** with data from readout prototype hardware
- new converters written



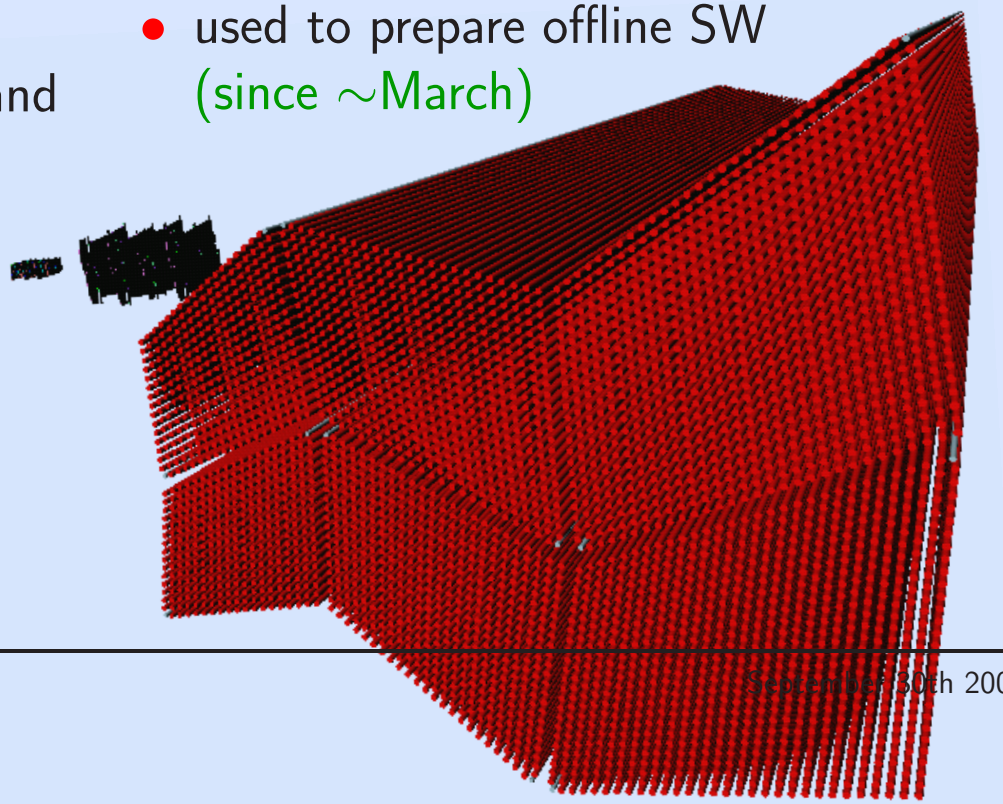
Detector Description and Simulation

Detector Description

- GeoModel - a common description used by simulation, digitisation, reconstruction and visualisation
- based on NOVA (a MySQL DB) but migration to oracle ongoing
- implementation for ATLAS and Combined TB 2004 set-up
- possibility to include Alignment adjustments from a Conditions DB

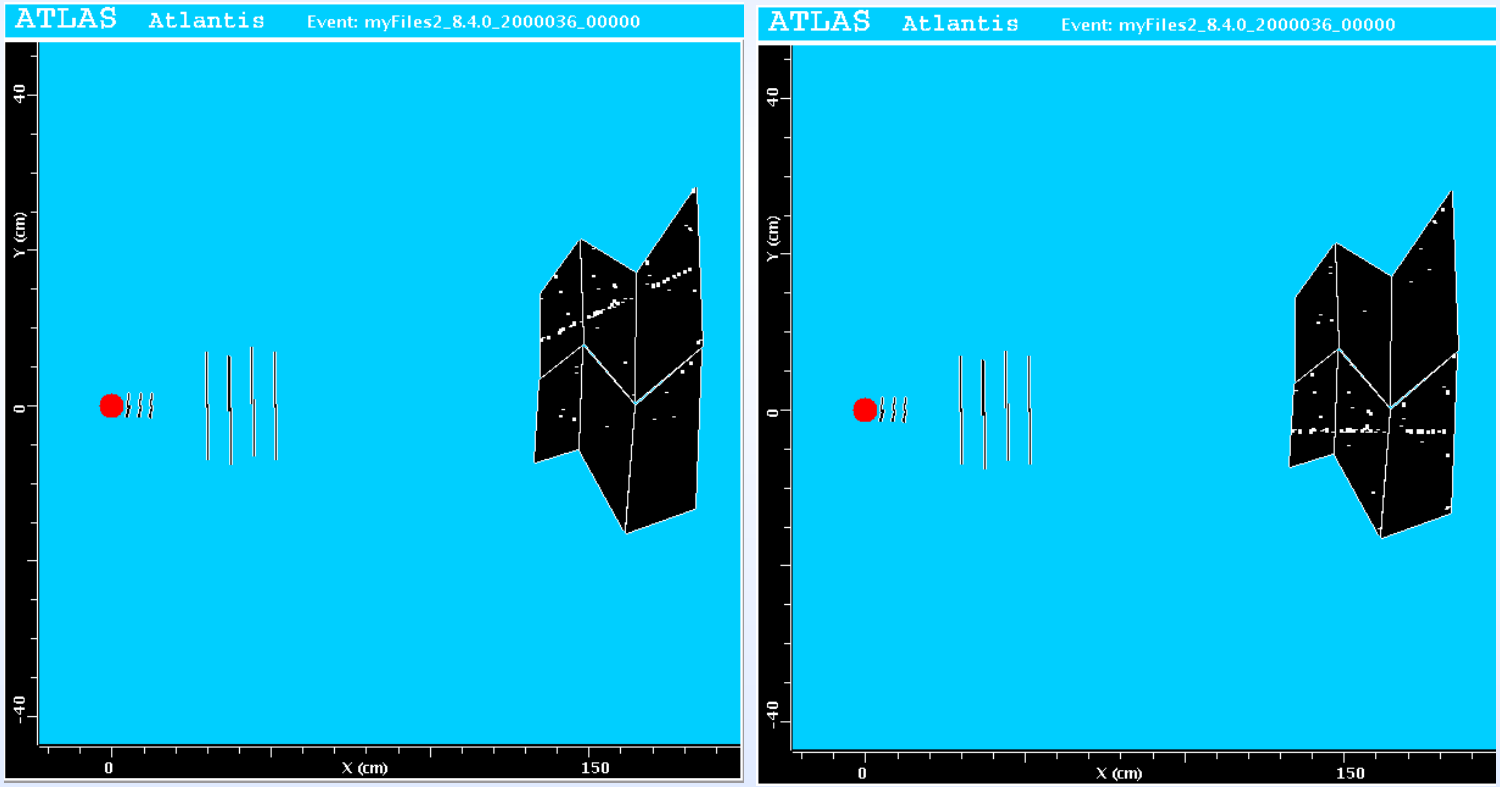
Simulation

- Geant4 with CTB GeoModel
- Full CTB or **InnerDetector only**
- different particles, energies simulated with an evolving CTB configuration
- used to prepare offline SW (since ∼March)



Decoding the First TRT Events

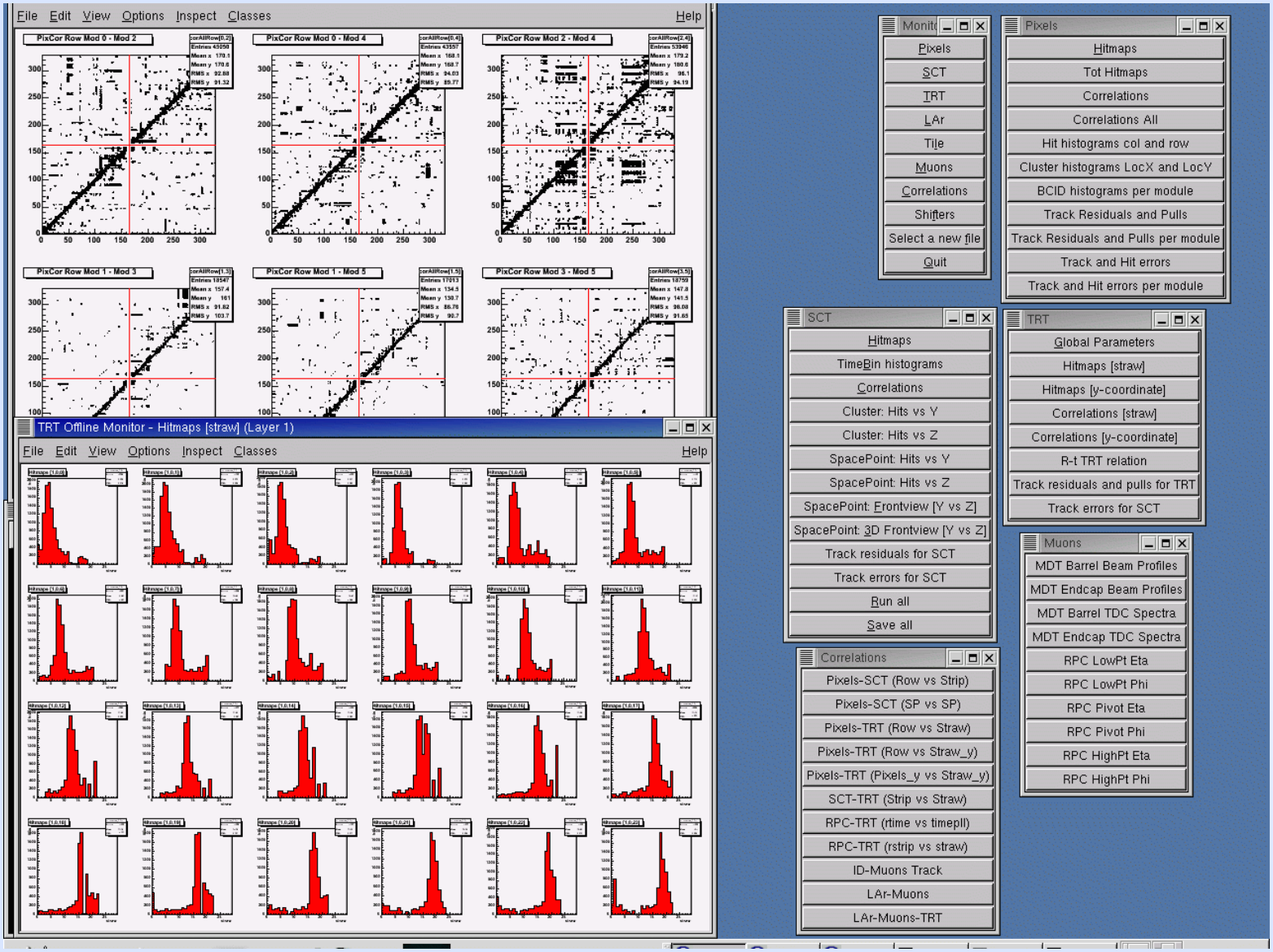
Altas offline event display (Atlantis) with test beam set-up



before bug fix

after bug fix in ByteStream converter

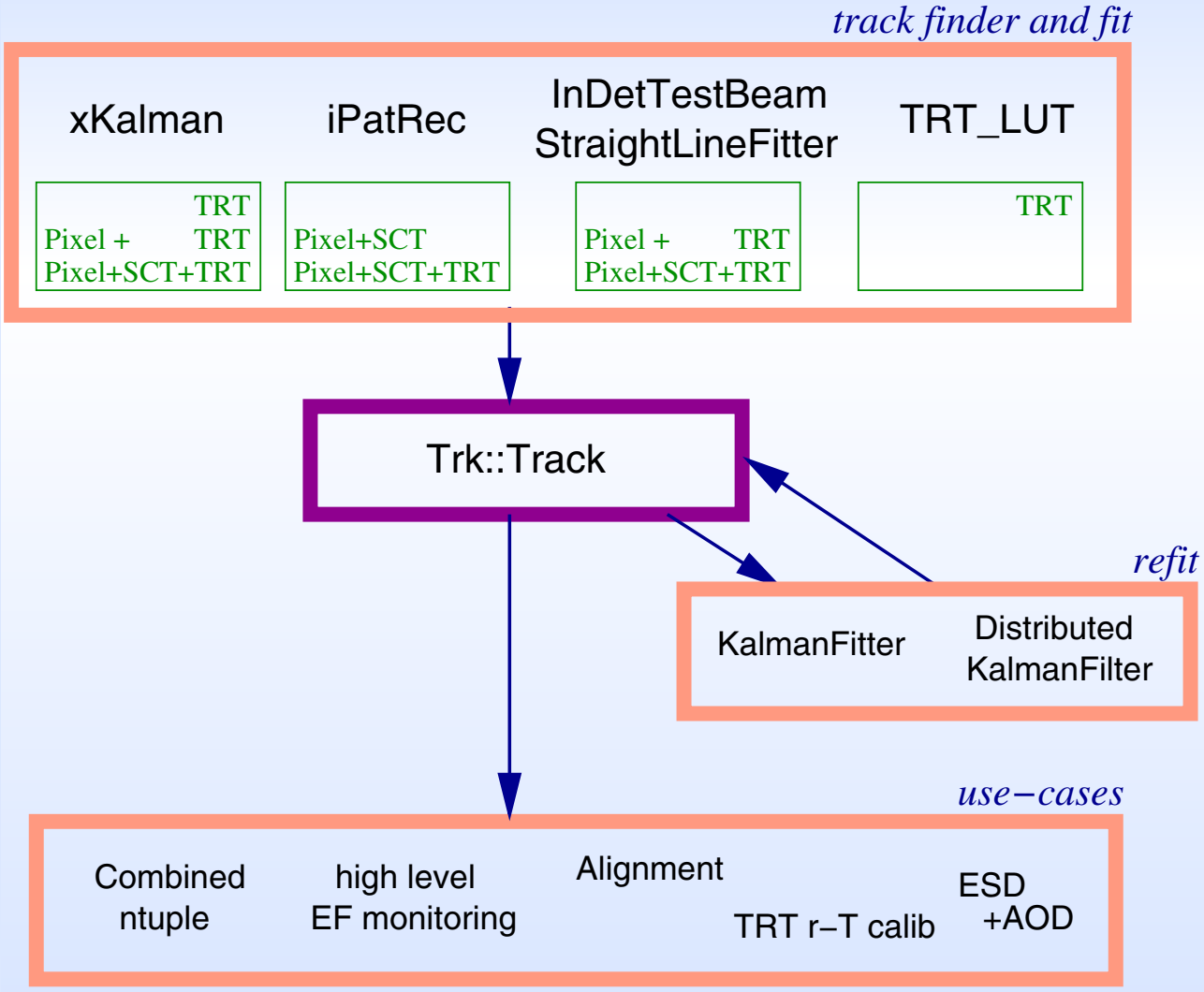
Data Quality Monitoring: Ntuple and online



now manual checks **(flexible)**

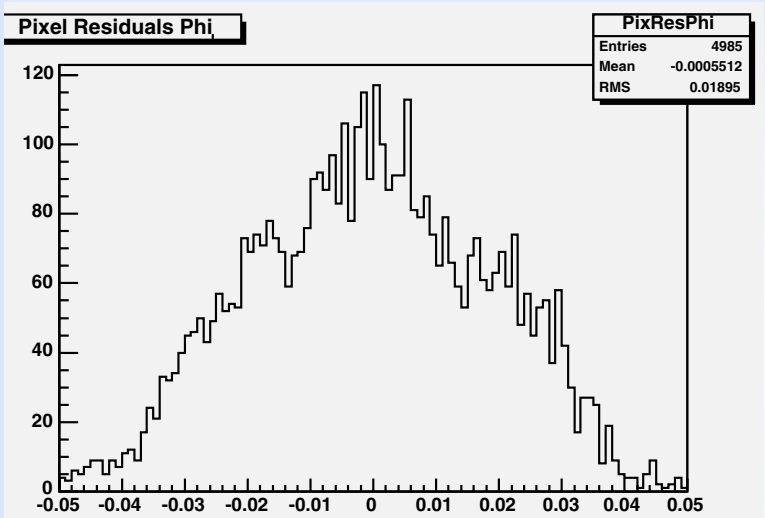
experience transfered to online-monitoring **(automated)**

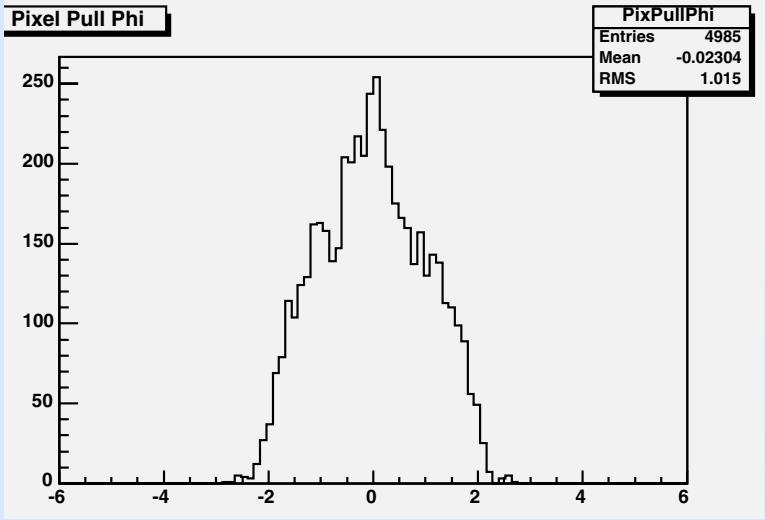
Track Reconstruction for the Test Beam

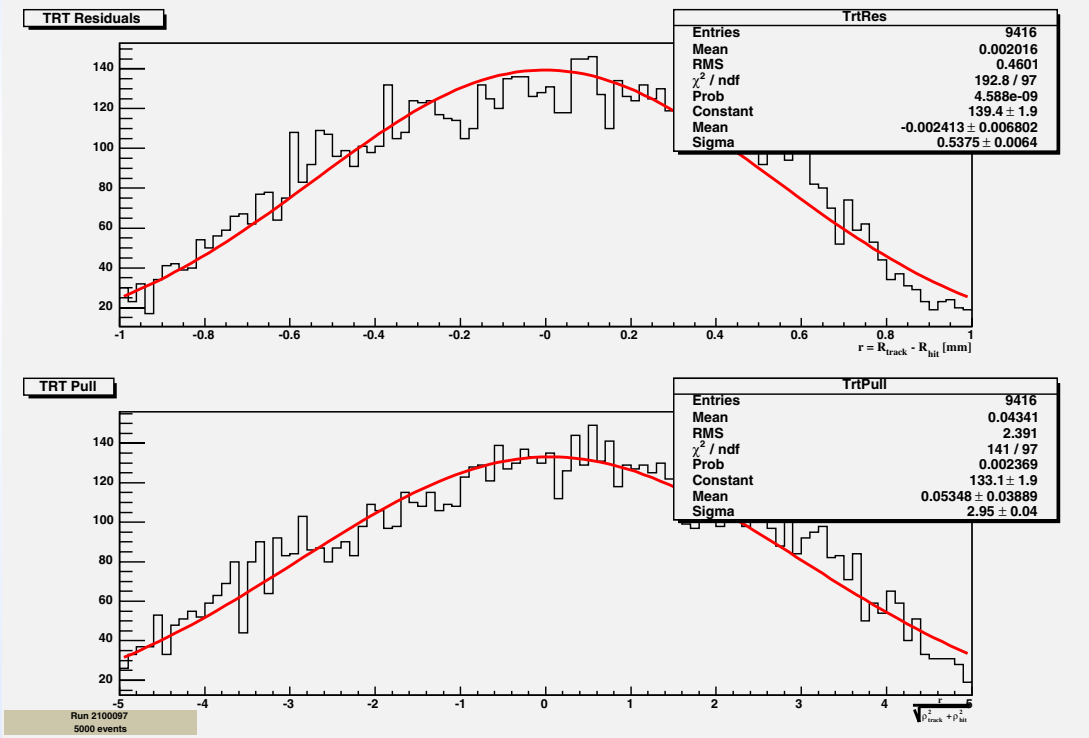


- track finding needed adaptations to reconstruct CTB data
- profit from common Track class
- lots of feed-back to implementation of new offline chain

Test Beam Reconstruction Using Pixel and TRT Data







Tracks passing Pixel (3 layers) and TRT

(run 2100097, 180 GeV pions, StraightLineFitter)

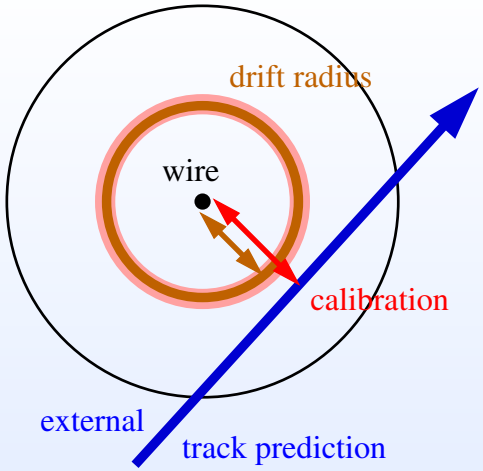
Alignment and Calibration on Real Data

Alignment

- track fitting with loose constraints
- use residual minimisation strategies
- tested on events simulated with misalignment
- working interface to Conditions DB and Geomodel
- effort ongoing, e.g. on making SCT/Pixel alignment independent of SCT presence
- preliminary: Pixel module shifts up to $20\,\mu$m in ϕ ($50\,\mu$m in η)

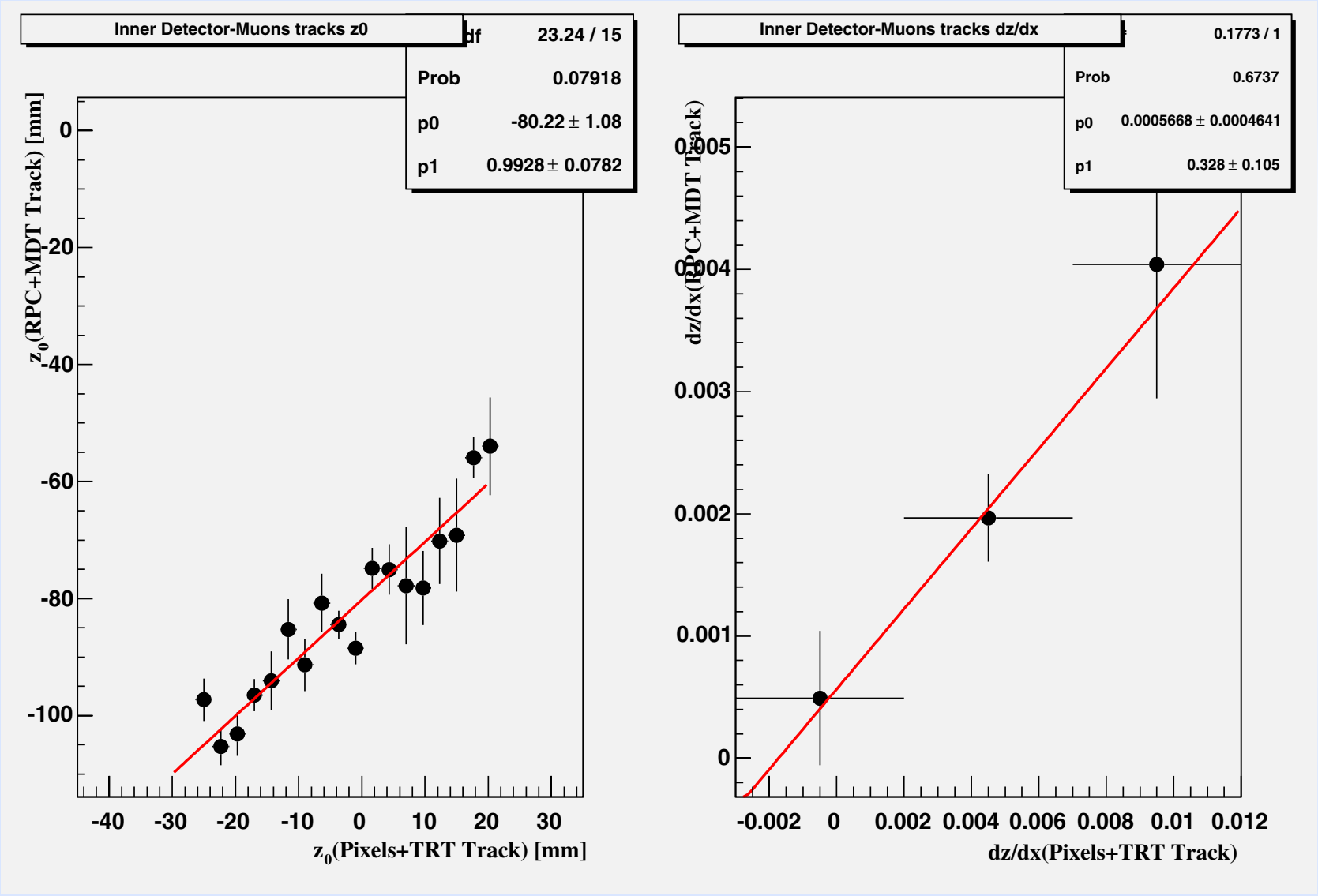
TRT Calibration

- obtain radius from calibrated drift time
- use track prediction to probe calibration



- A proper and individual drift time correction was found neccessary for efficient **track finding**!

Inner Detector and Muons



What We Have Already Learnt from the Combined TB

- The CTB setup changes often (detectors, position, cabling, soon B field), and tracking is most sensitive to that.

  Much of it is currently toggled by hand, but interfaces to DB are worked on.

- High flexibility demanded from reconstruction packages to adapt to a **real setup**: no field, parallel tracks, TRT only, TRT+2Pixel, ...

- The modular reconstruction chain has been very useful to make software more **uniform** and **independent** of the different algorithms and detector technologies. (Example: refitting and monitoring on the basis of Trk::Track)

- The **flexible choice** of reconstruction algorithm has allowed fast debugging.

- Frequent communication between detector and software experts necessary

Conclusions

- The Inner Detector integration has been **successful**:
  Read-out, data decoding, conditions DB, off-line reconstruction, tracking

- The combined test beam programme will continue for another month – it will stay interesting !