Commissioning of the Transition Radiation Tracker

Second ATLAS Physics Workshop of the Americas
Simon Fraser University
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on behalf of

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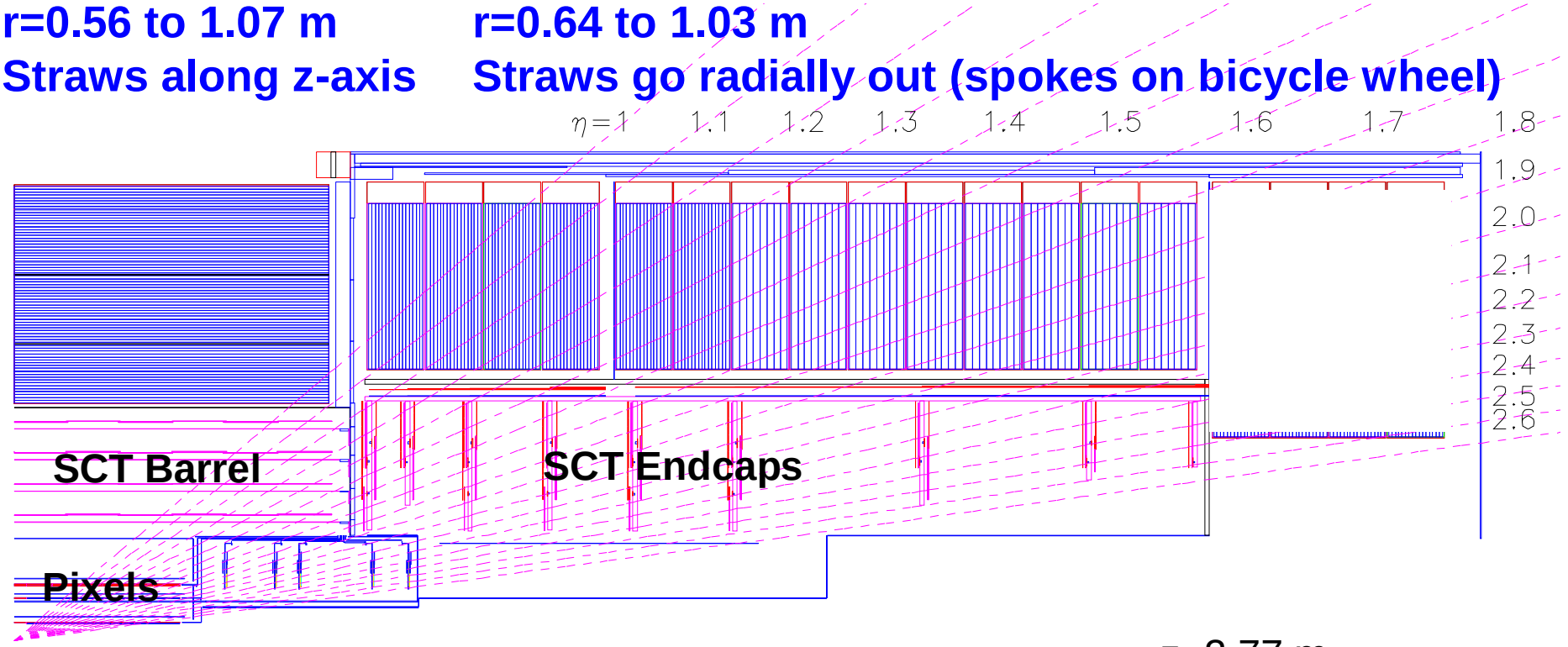
TRT Geometry (1 quadrant of inner detector)

TRT has 350,000 straws with 4 mm diameter
Charged particle can hit 36 straws for |eta|<1.7
Position resolution per straw is about 200 microns

TRT Barrel
z=0.00 to 0.74 m
r=0.56 to 1.07 m
Straws along z-axis

TRT Endcap
z=0.83 to 2.77 m
r=0.64 to 1.03 m
Straws go radially out (spokes on bicycle wheel)

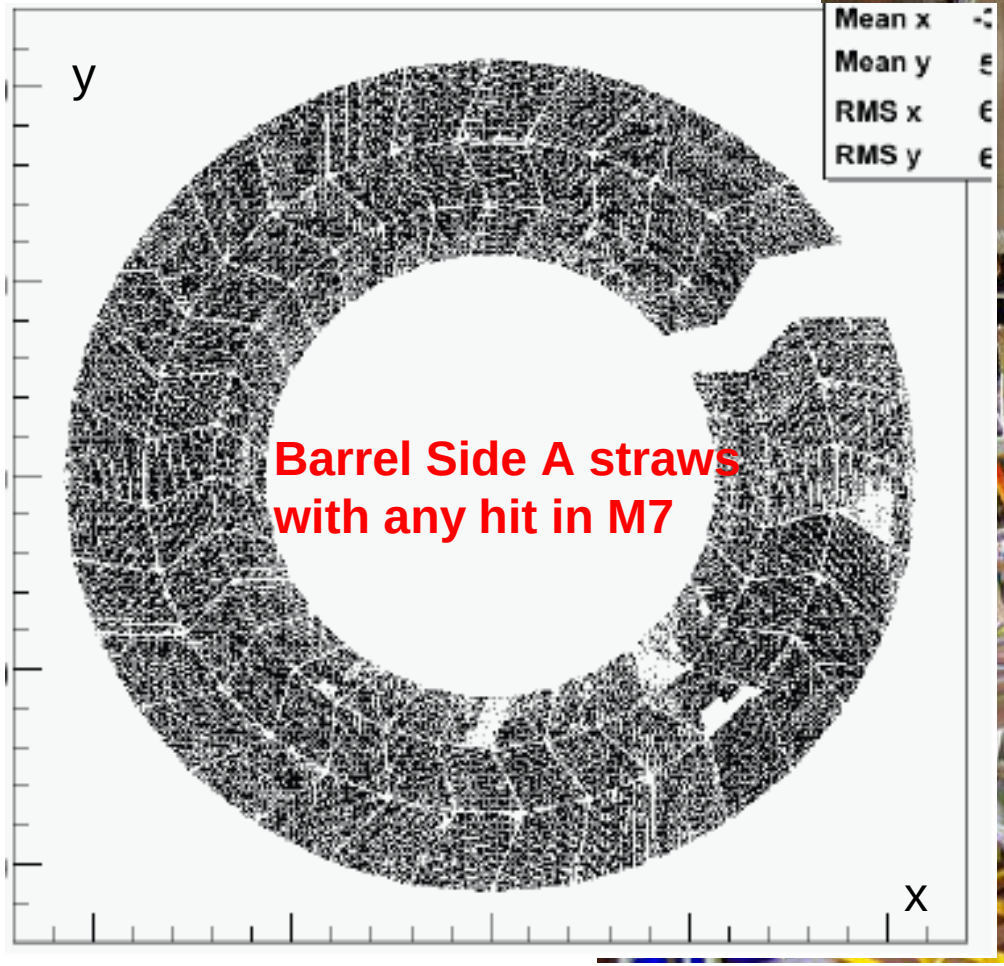


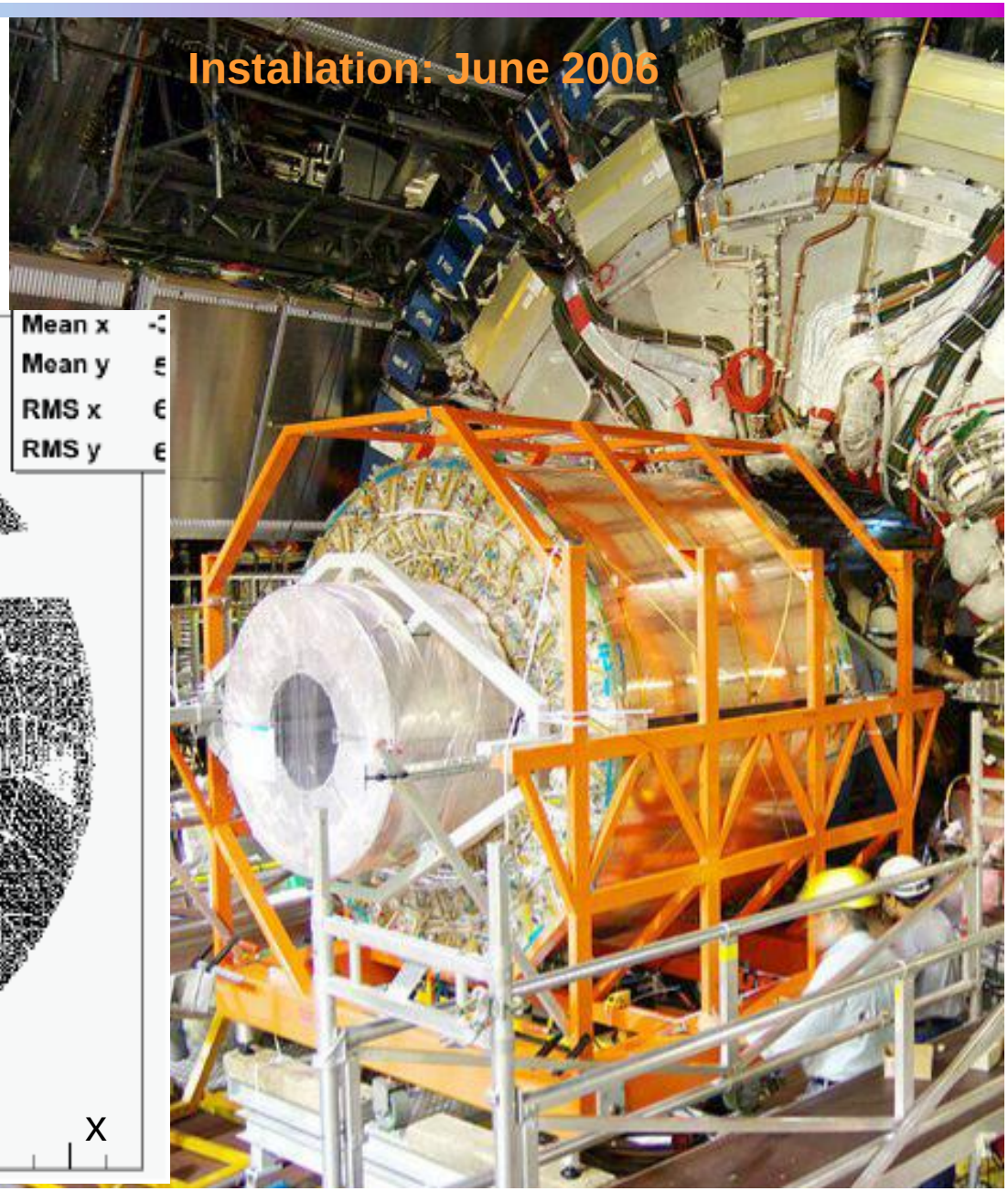
z=0.00 m

z=2.77 m

TRT M7 run: June 2008

M7 cosmic ray run: almost all 50,000 straws on side A barrel read out at trigger rate of 83 kHz





TRT Electronics System

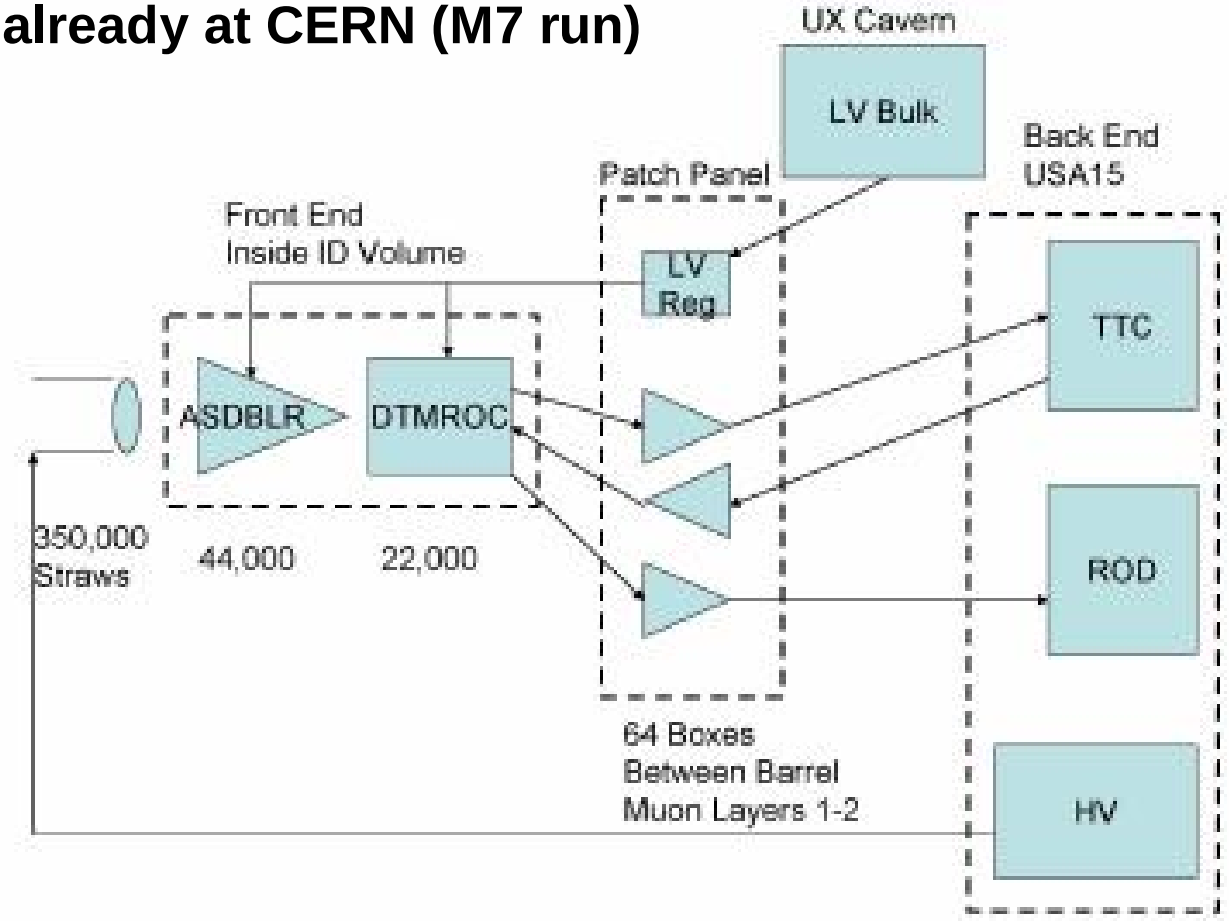
Front-end electronics checked before and after installation

Milestone and special runs to exercise data-taking with ATLAS DAQ

- **Essential to commission detector for physics collisions**

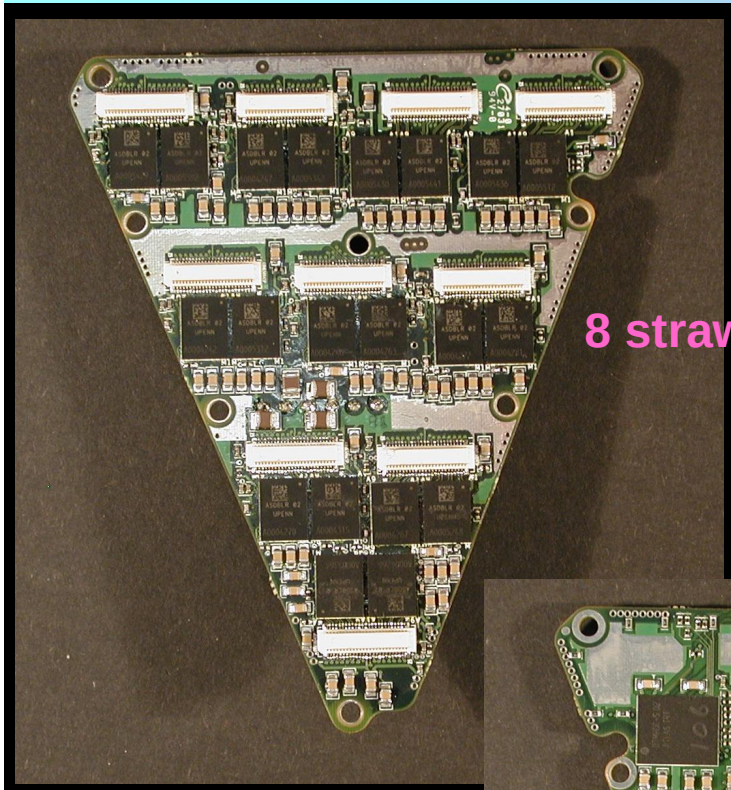
RODs sommes prets!

- **97 passed tests at UBC (96 needed)**
- **56 already at CERN (M7 run)**



All RODs expected at CERN mid-July

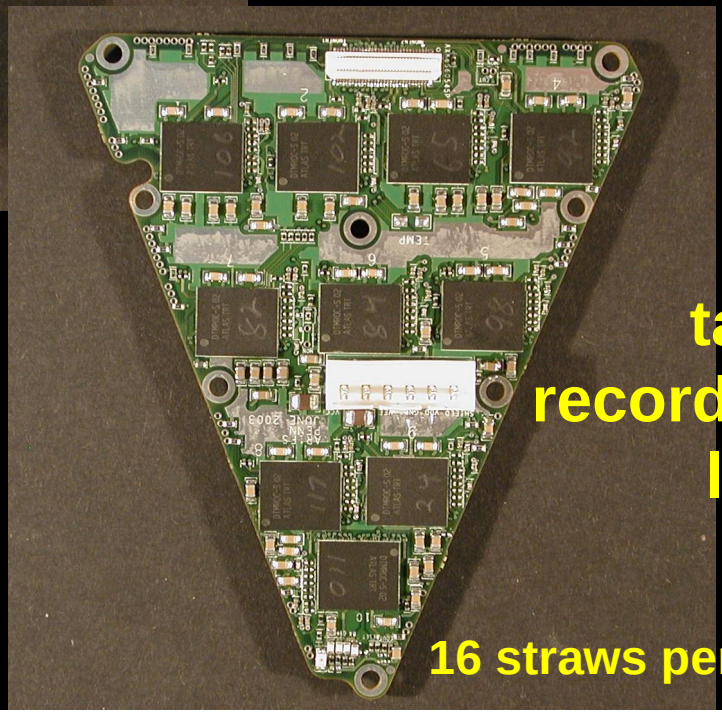
Barrel Front-end Fast Electronics



8 straws per chip

Double-sided Electronic board

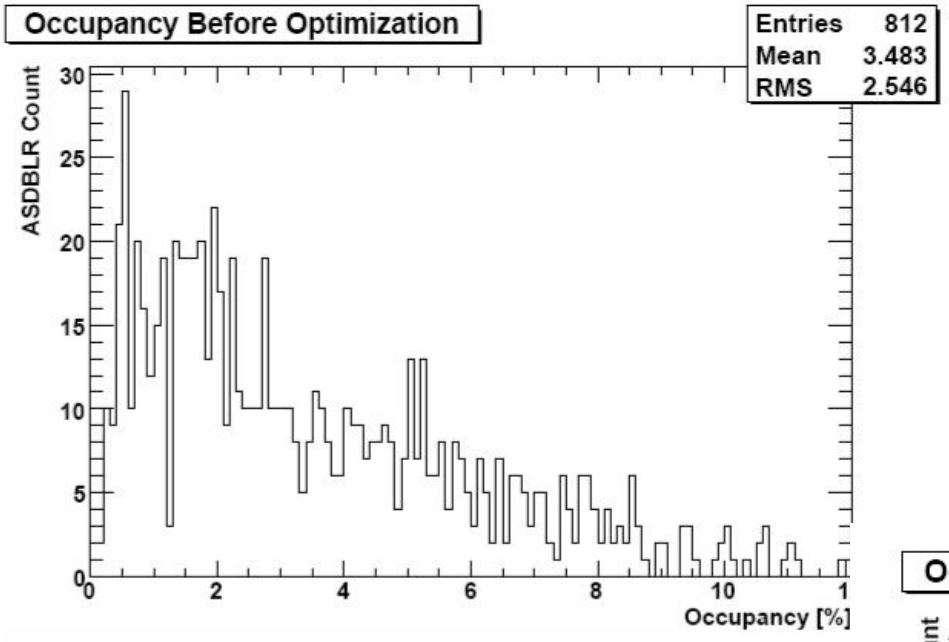
Analogue:
amplifier
shaper
discriminator
baseline restoration

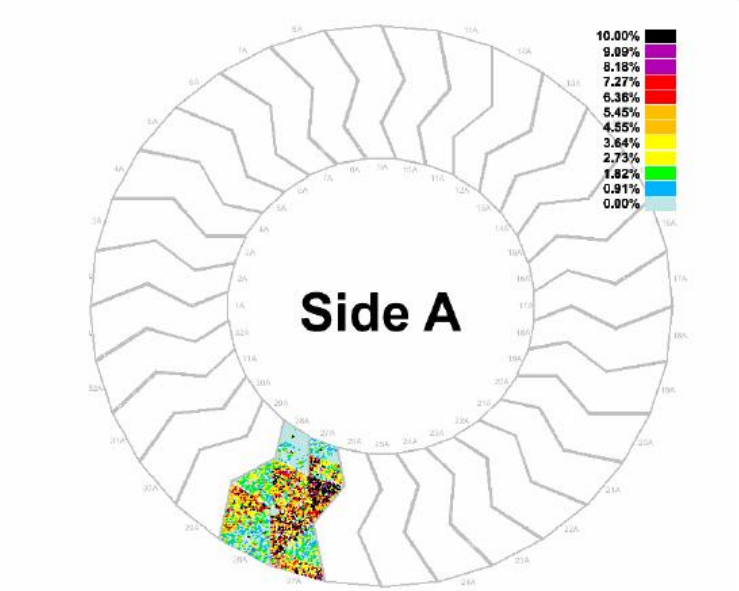


16 straws per chip

Digital:
take 75 ns snapshot
record above/below threshold
low every 3.125 ns,
high every 25 ns

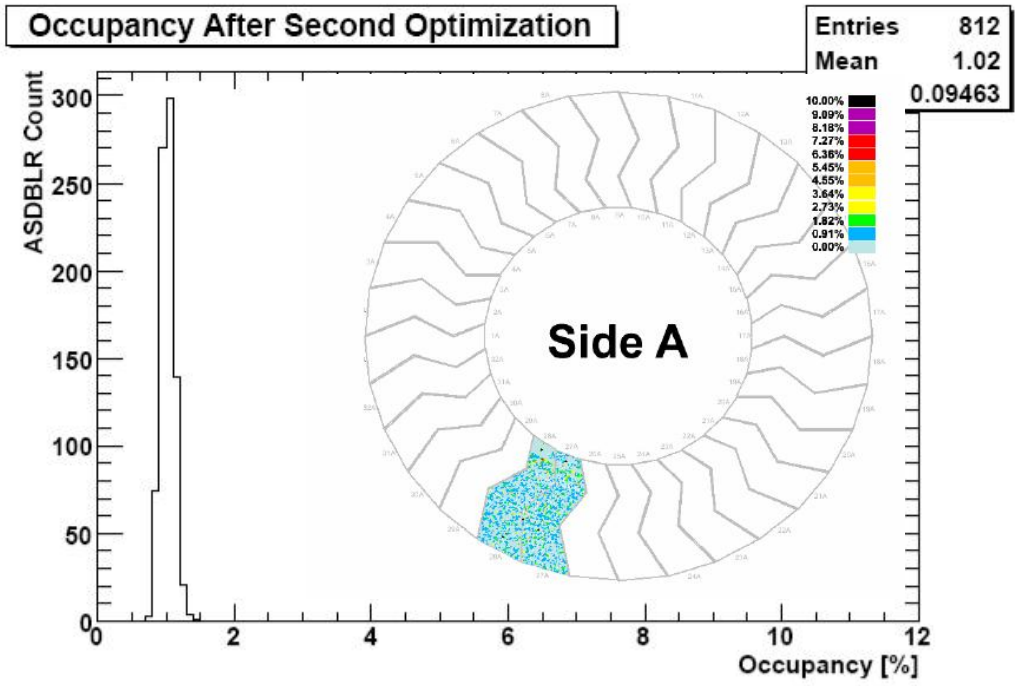
Threshold equalization *(Ryan Reece)*





Adjust level of low threshold to obtain equal occupancy over detector (quiet time calibration)

- **Throws away hottest and coldest straws on ASDBLR chip**
- **Occoccupancy for 6 out of 8 channels on ASDBLR chip**



Timing in the detector readout

(Mike Hance, Ben LeGeyt, Săsa Fratina)

Leading edge when electrons ionized closest to wire at straw center arrive

- position information for tracking

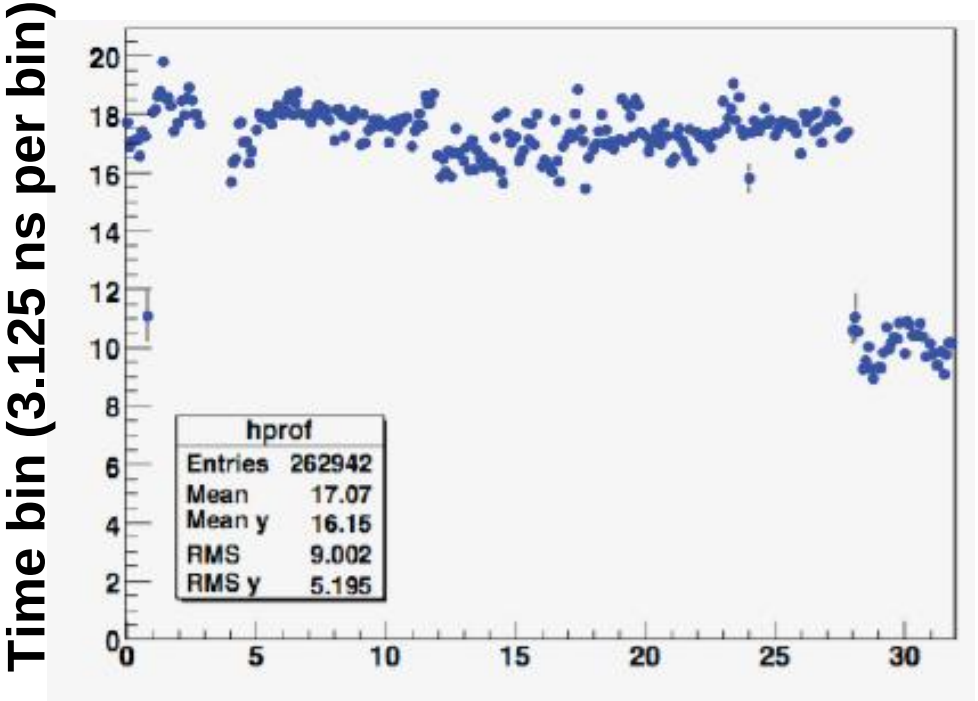
Trailing edge when electrons ionized furthest (2 mm) from wire at straw center arrive

- these take 40-50 ns to drift in
- should arrive at the same time for all straws crossed by the particle

M7 run data

- Shows that hardware calibration provides good alignment
- Found offset of one bunch crossing (8 bins) for 4 stacks, easily fixed

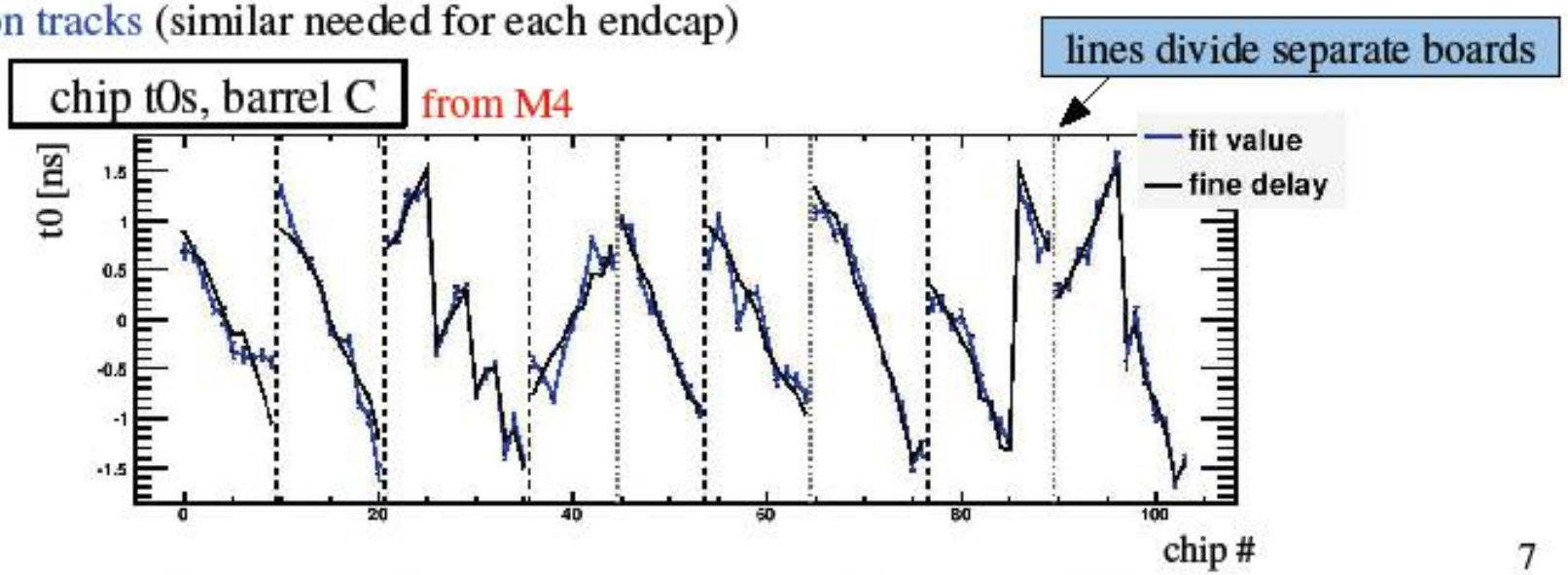
Average trailing edge
for 1600 straws in each stack
(corrected for time of passage of cosmic ray muon and chip-to-chip offsets)



Stack number
(11.25 degrees per stack)

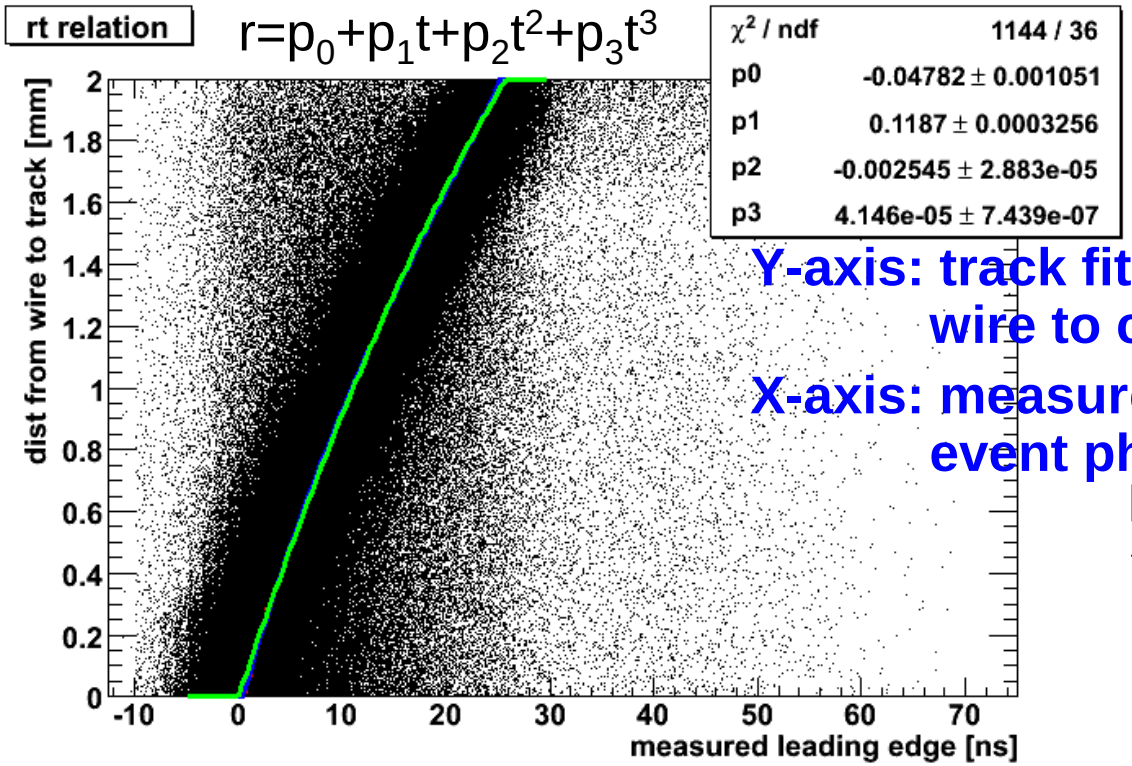
Calibration: t0 per TTC line

- We expect straw to straw t0 variations to contribute at order ~0.1ns
- Chip to chip variations have been shown to be the same across all phi sectors for each side of the barrel by both hardware fine delay scans and my calibration (see plot)
- Can reach ~0.1ns accuracy in t0 with ~1000 hits on a detector element
- So it seems reasonable to calibrate on board level, taking chip to chip delays into account, until we get ~1000 hits/straw, then consider switching to straw level
- board level calib for barrel: 1000 hits * 9 boards/phi * 2 sides * 32 phi / 30 hits per track = 18,000 tracks (similar needed for each endcap)
- straw level calib for barrel: 1000 hits * 1642 straws/phi * 2 sides * 32 phi / 30 hits per track = 1.5 million tracks (similar needed for each endcap)



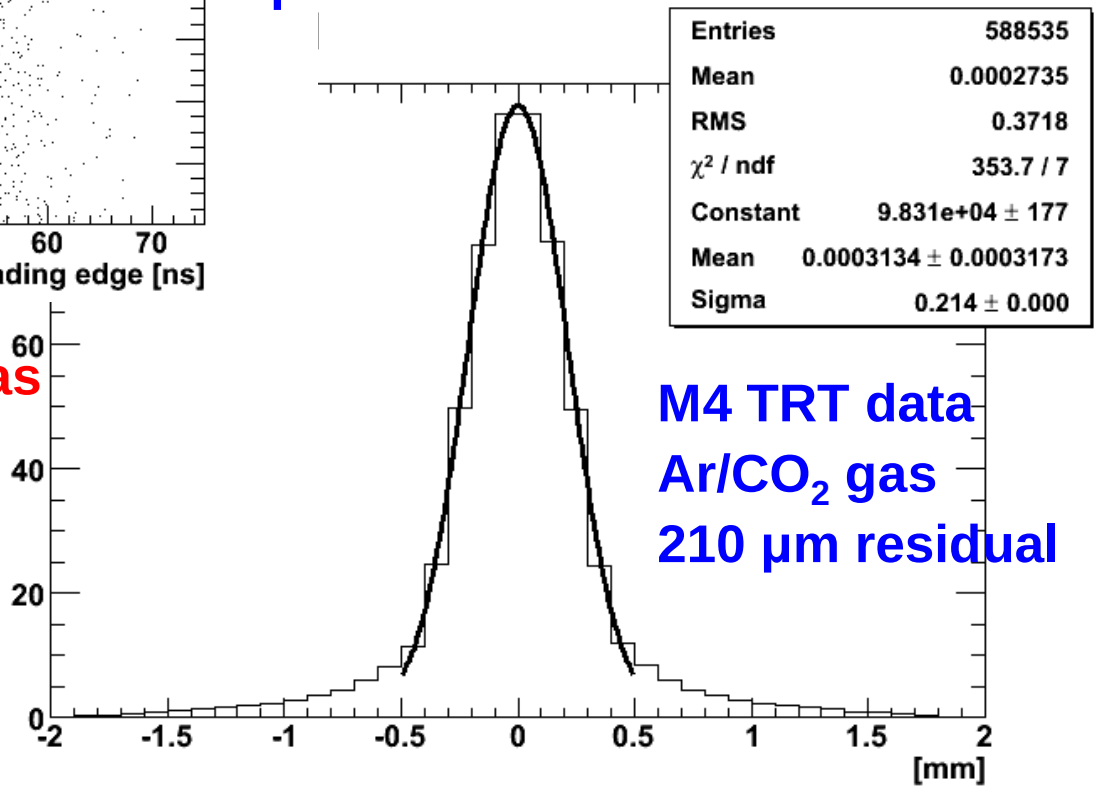
Calibration: position(time)

(Dominick Olivito, Chafik Driouchi, NBI)



Y-axis: track fit estimate of distance from wire to closest approach of particle

X-axis: measured leading edge, corrected for event phase and t0



M4 TRT data

Ar/CO_2 gas

210 µm residual

Note: calibration depends on gas

Ar/CO_2 drift velocity 70 µm/ns

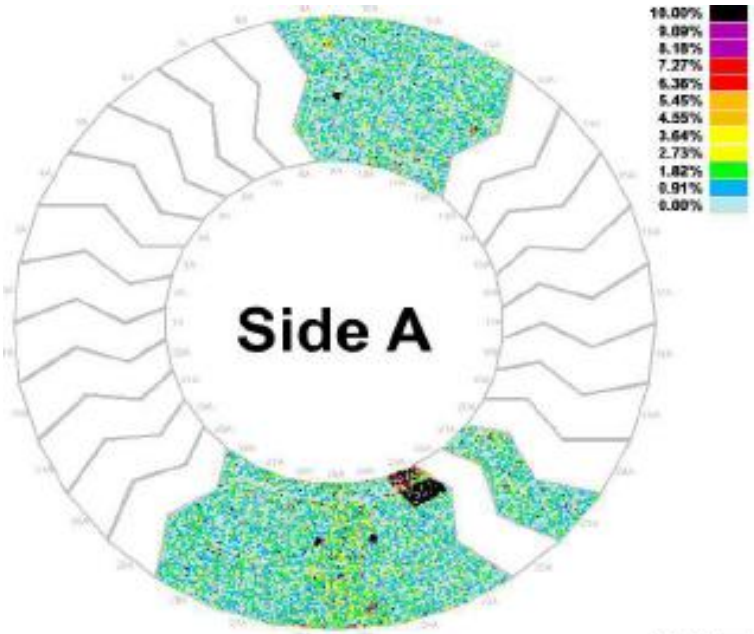
Xe/CO_2 drift velocity 50 µm/ns

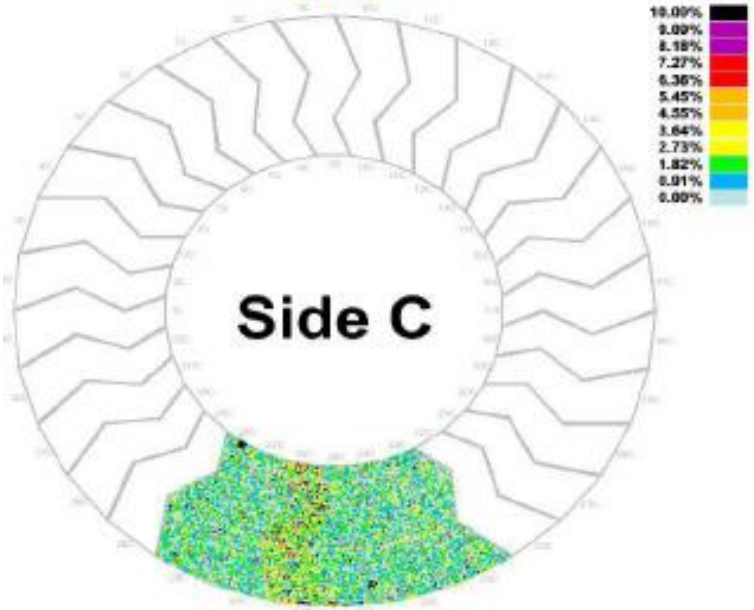
and magnetic field

Expect better resolution with Xe/CO_2

Alignment

(John Alison, Andrea Bocci, Duke)



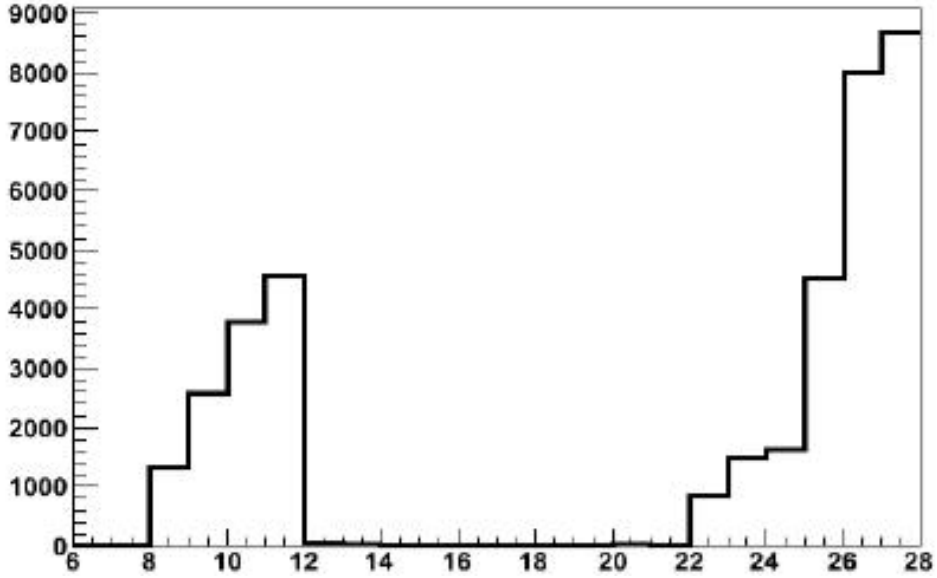


M6 first combined SCT+TRT run since surface commissioning

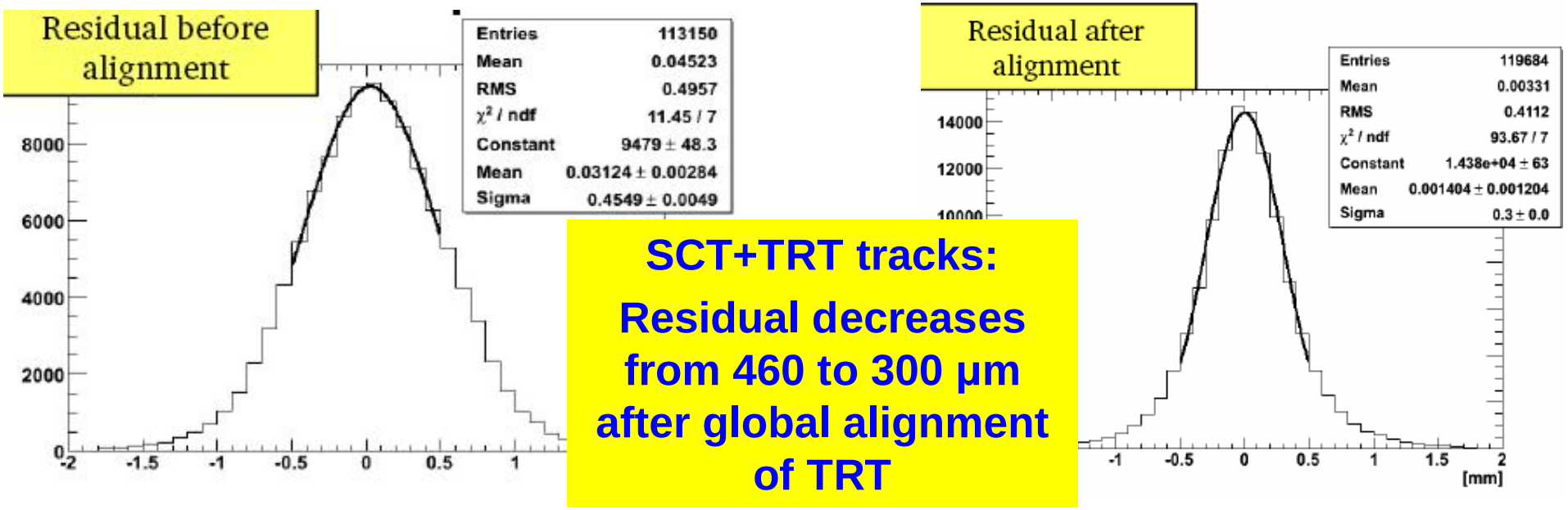
Ran global TRT alignment on tracks

- At least 5 SCT hits
- At least 20 TRT hits

Number of hits on tracks versus phi stack

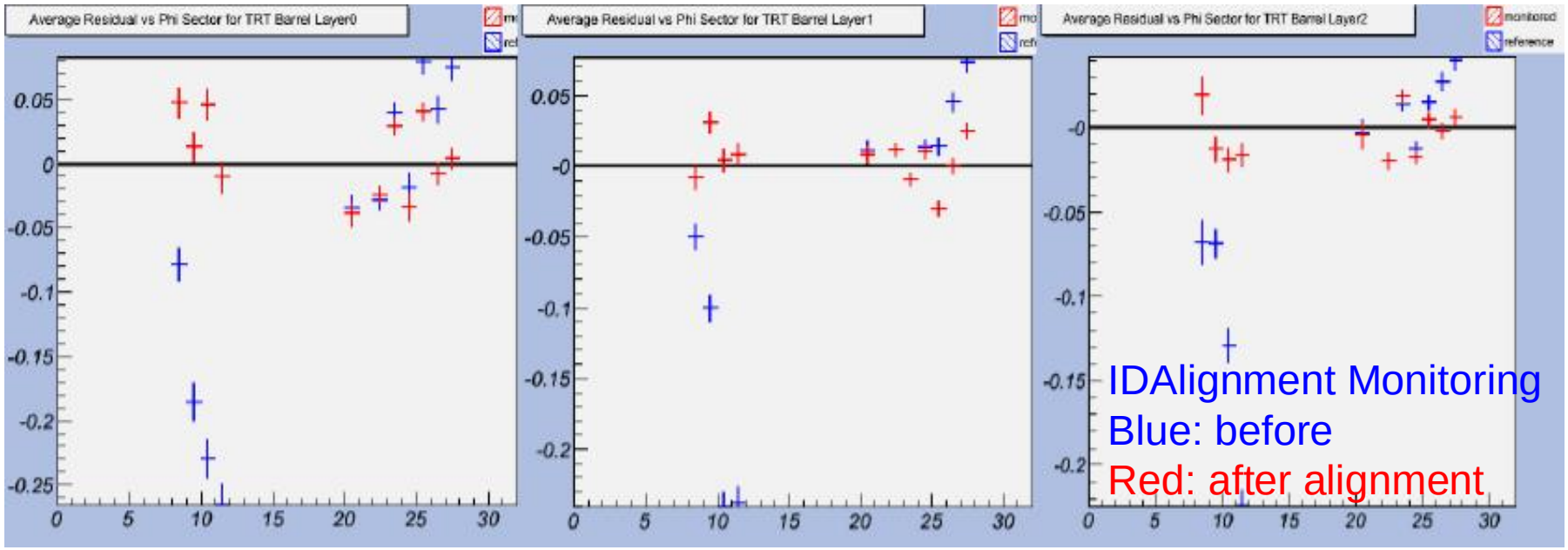


Alignment: residuals *(John Alison, Andrea Bocci, Duke)*



SCT+TRT tracks:

Residual decreases from 460 to 300 μm after global alignment of TRT



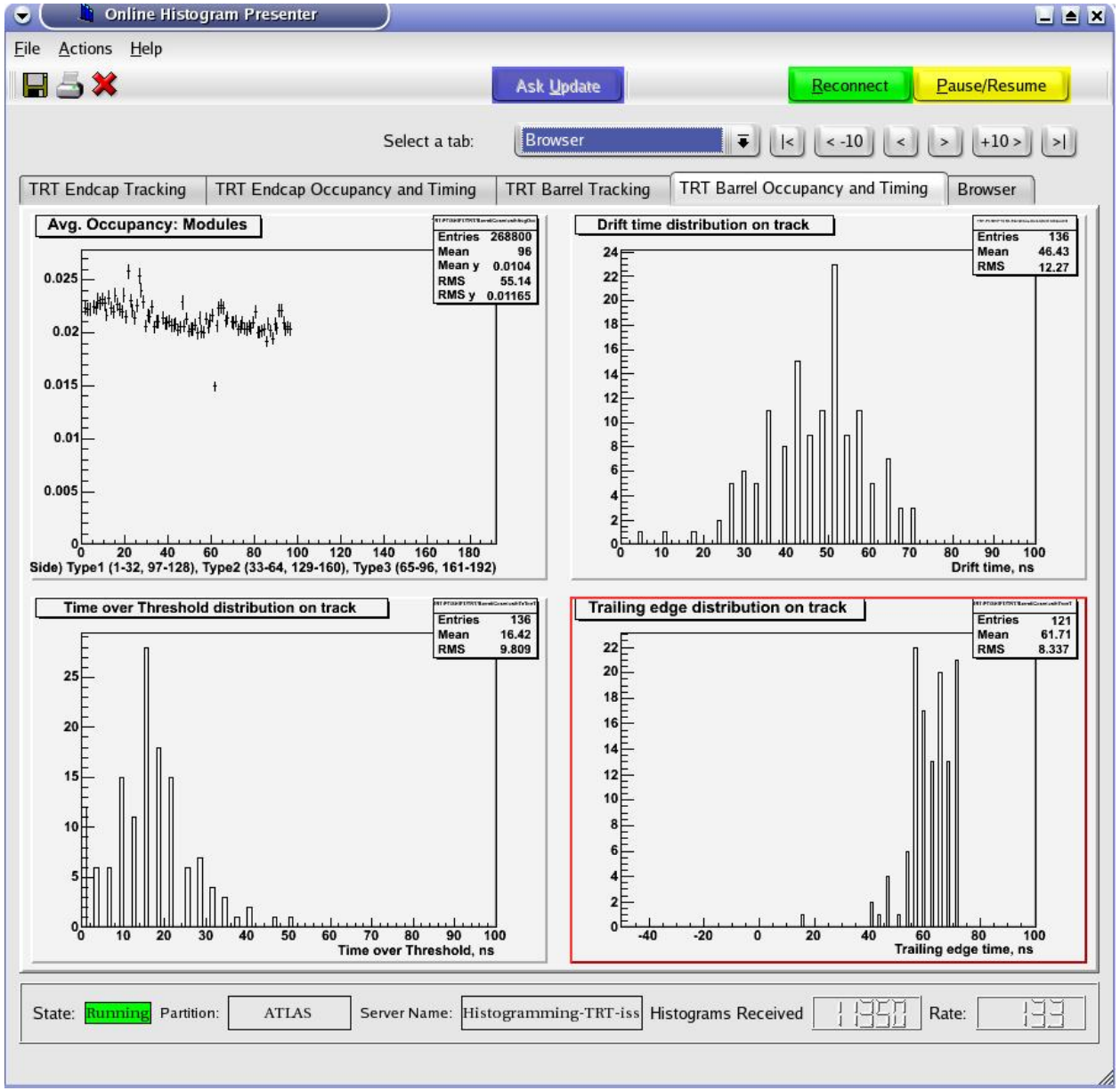
TRT Data Quality Monitoring

(Jim Degenhardt
Peter Cwetanski, IU)

Athena code to analyse TRT data and present results to shifters in real time and offline

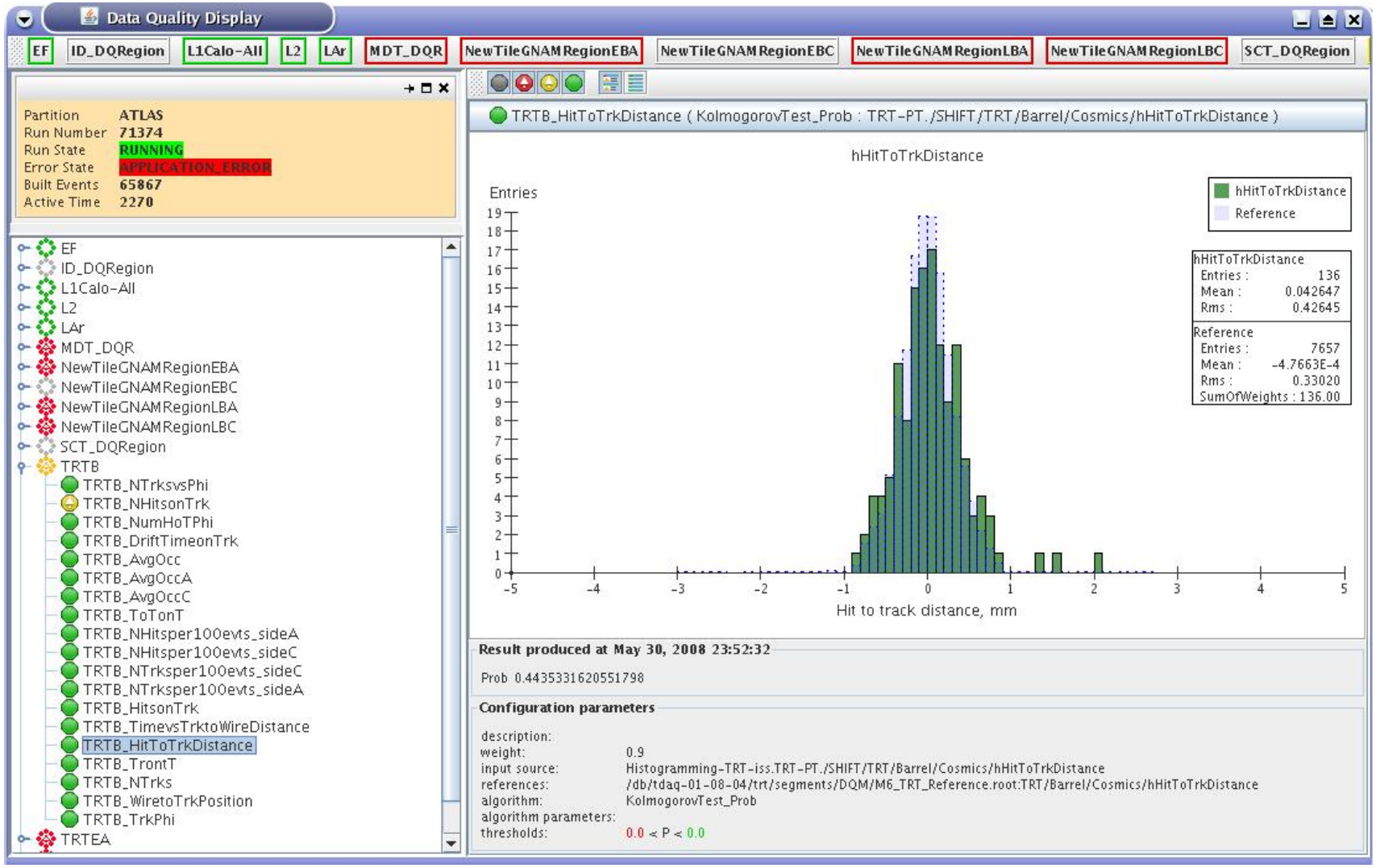
- **Tested in M runs**
- **Tested in FDR**

Output histograms also compatible with powerful visualization of TRTViewer



TRT monitoring in DQMF *(Jim Degenhardt Peter Cwetanski, IU)*

Set up automatic checks of monitoring histograms via ATLAS Data Quality Monitoring Framework for online (event filter) and offline (Tier-0)

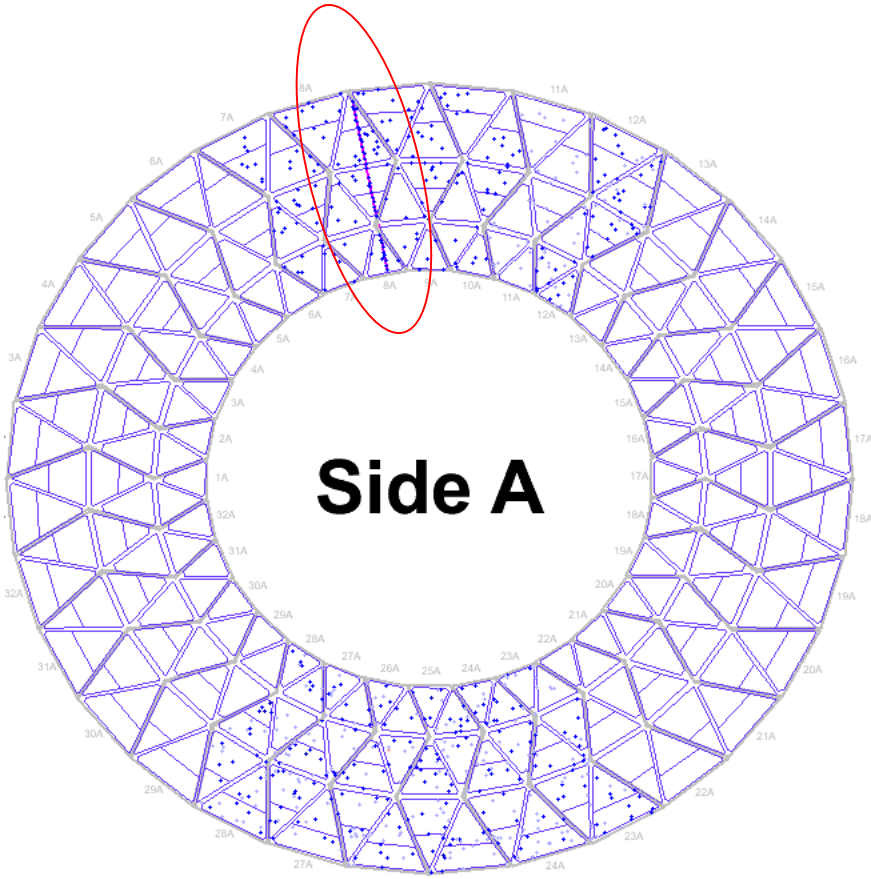


Trigger: TRT only tracking at L2

(Săsa Fratina, Dominick Olivito, Jim Degenhardt

Cosmic ray muons

- Improved algorithm to work over entire volume of TRT, and also with magnetic field on
- Integrated in Atlas online framework and runs in auto-accept mode in M runs since December 2007
- Collect data to constrain weak modes in alignment



Physics Collisions

- Comparing performance of “new tracking” version with old version
- Overall efficiency similar, more hits attached with new algorithm
- Optimizing algorithm to improve efficiency and CPU time

Summary & Plans

TRT commissioning is well advanced

- Hardware operation
- Threshold equalization
- t0 calibration
- r(t) calibration
- Alignment
- Data Quality Monitoring
- Trigger for cosmic ray muons

Plans as physics collisions approach

- Trigger reconstruction for TRT-only tracks in physics collisions
- Tracking performance
- Threshold & hit efficiency
- Transition radiation for electron identification (with Xenon)
- Photon conversions to map detector material