

Studies of Track Selection for the Alignment of the ATLAS Inner Detector

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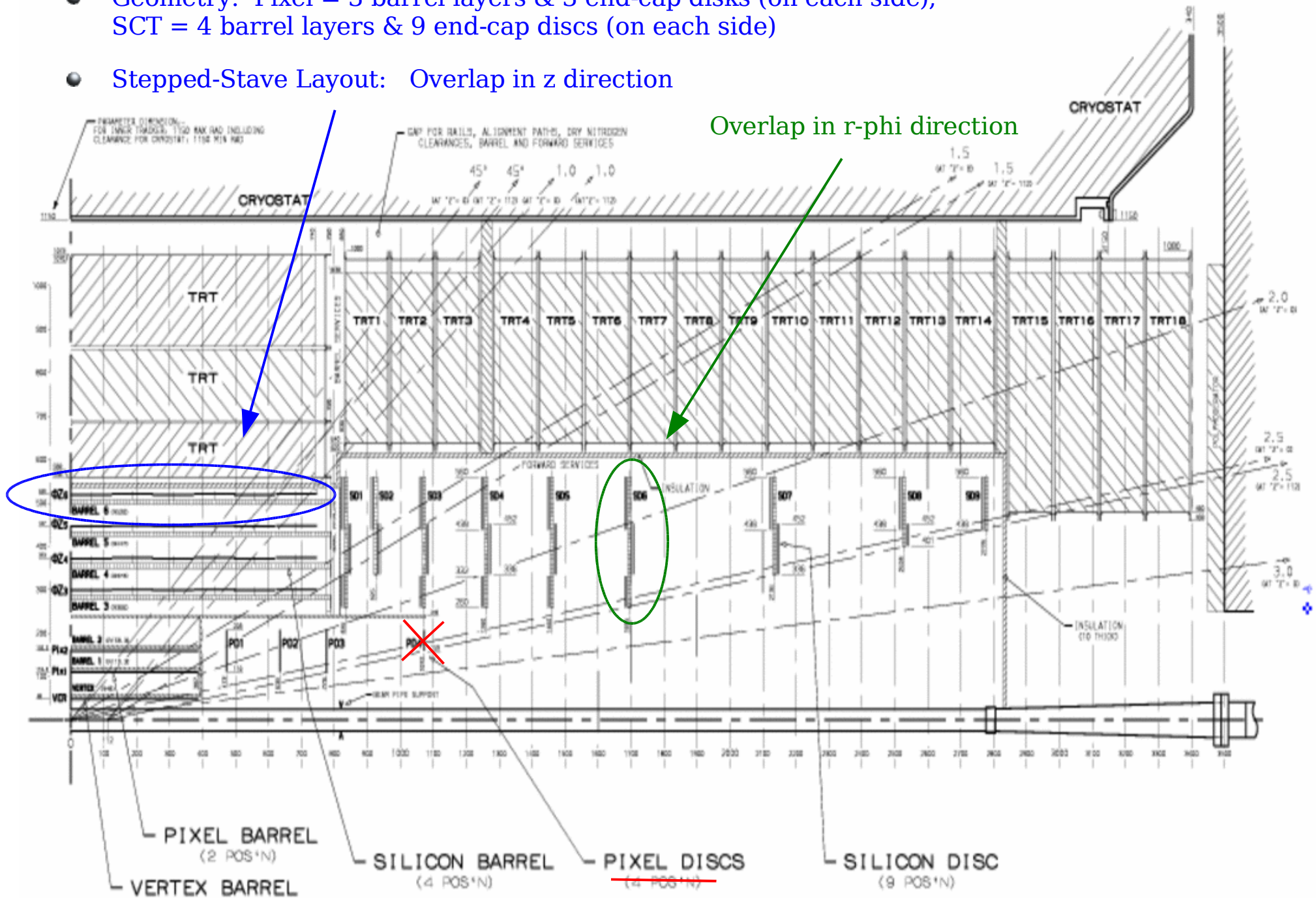
- ATLAS is one of the 5 experiments at the LHC at CERN
- Within ATLAS particle trajectories will be reconstructed using Inner & Muon detectors
- Alignment of the Inner Detector is crucial for:
 - Secondary vertex reconstruction
 - Momentum resolution
- Large rates of high p_T muons enable the use of track-based alignment procedures to:
 - Provide the ultimate precision alignment constants
- Quality studies of reconstructed tracks and their impact on track-based alignment procedures are needed

- For the moment only studies of:
 - Coverage of the inner detector: Pixel & SemiConductor Tracker (SCT)
 - Single track performance, that is, perigee parameters of single tracks
- No track selection yet
- Single-particle sample used:
 - Muons with $p_T = 50 \text{ GeV}$
 - Generated with Athena framework software
 - No pile up

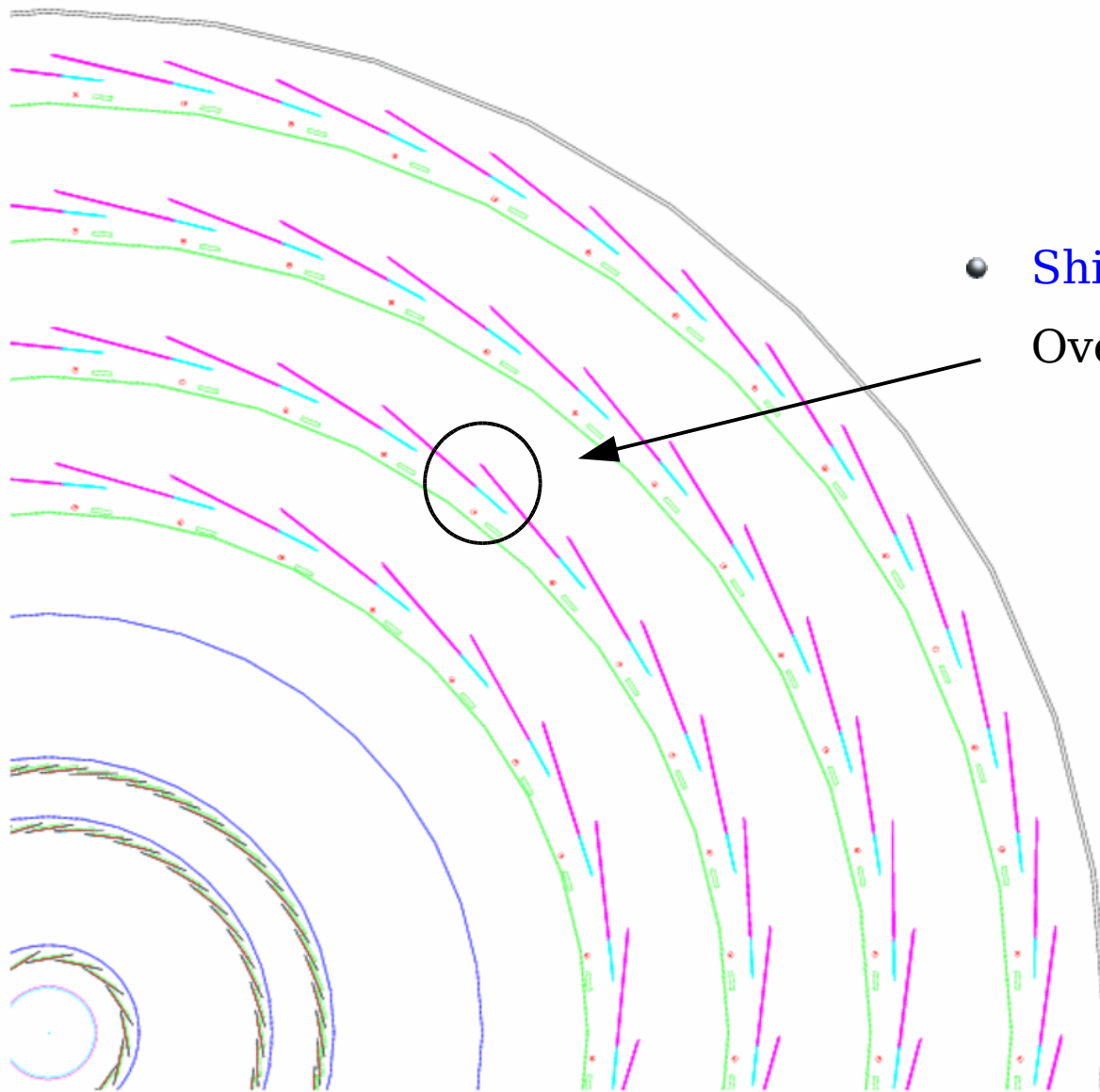
COVER AGE OF THE INNER DETECTOR

Inner Detector Layout – Longitudinal View

- Geometry: Pixel = 3 barrel layers & 3 end-cap disks (on each side), SCT = 4 barrel layers & 9 end-cap disks (on each side)
- Stepped-Stave Layout: Overlap in z direction



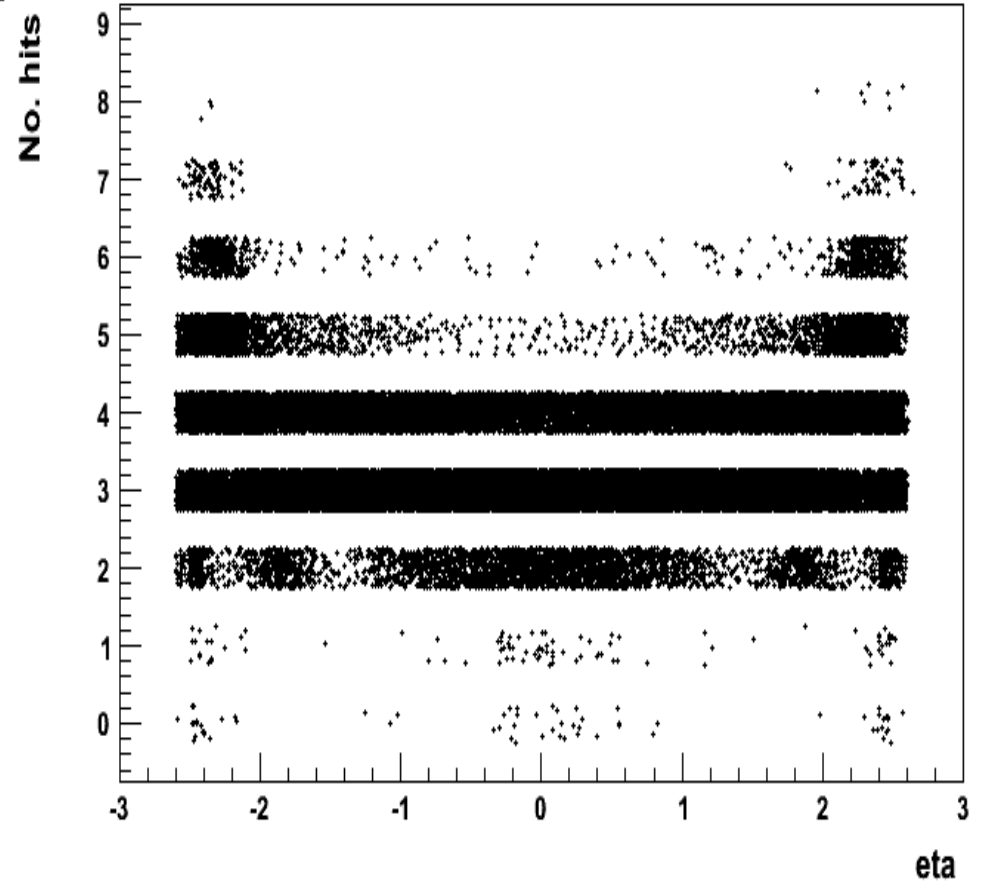
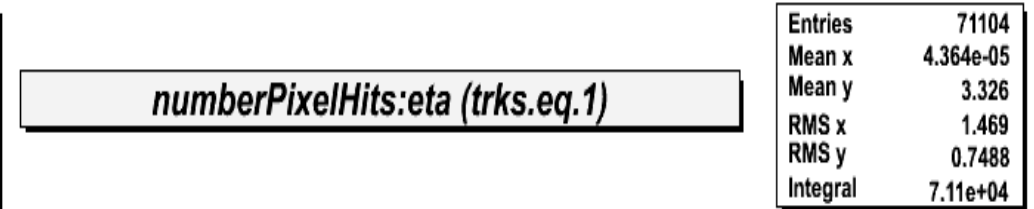
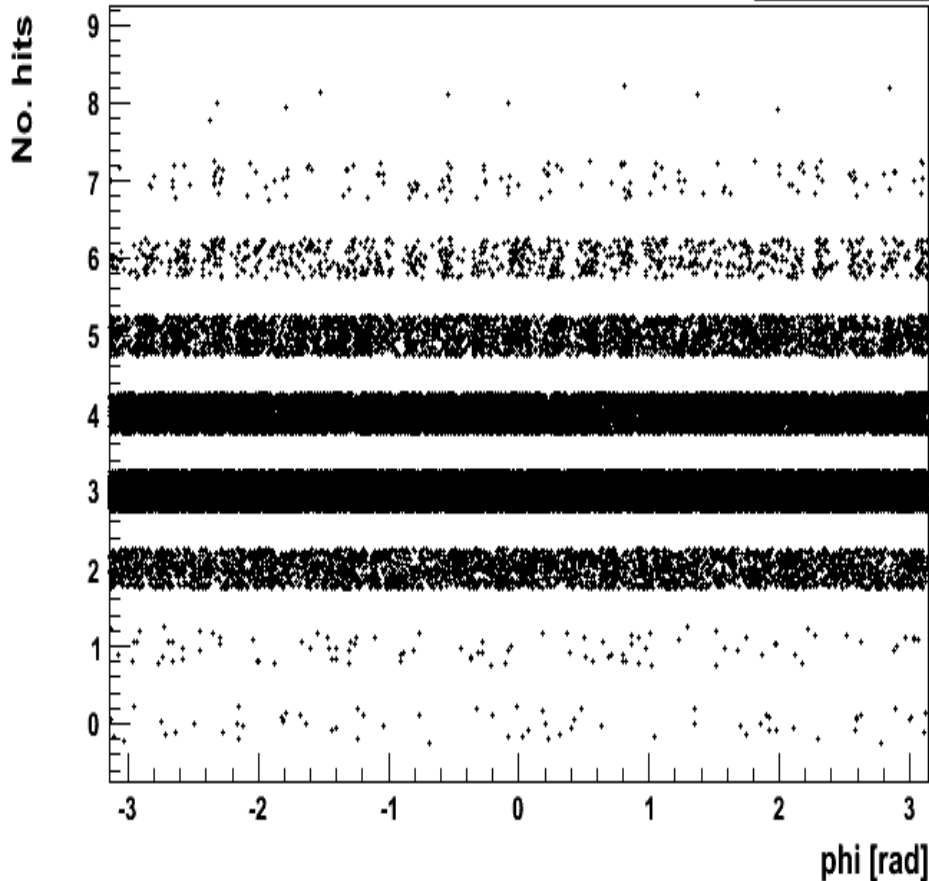
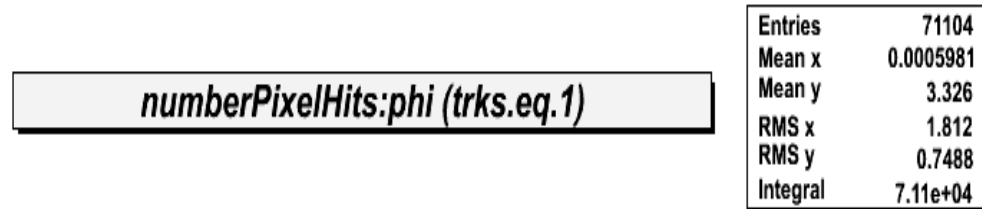
Inner Detector Layout – Transverse View



- Shingled-Stave layout :
Overlap in phi direction

Pixel Hits

- Coverage of the 3 barrel layers together: $|\eta| < 1.9$ and of the innermost layer: $|\eta| < 2.6$
- Coverage of the 3 end-cap discs together: $2.2 < |\eta| < 2.4$ and of the outermost disc: $2 < |\eta| < 2.6$

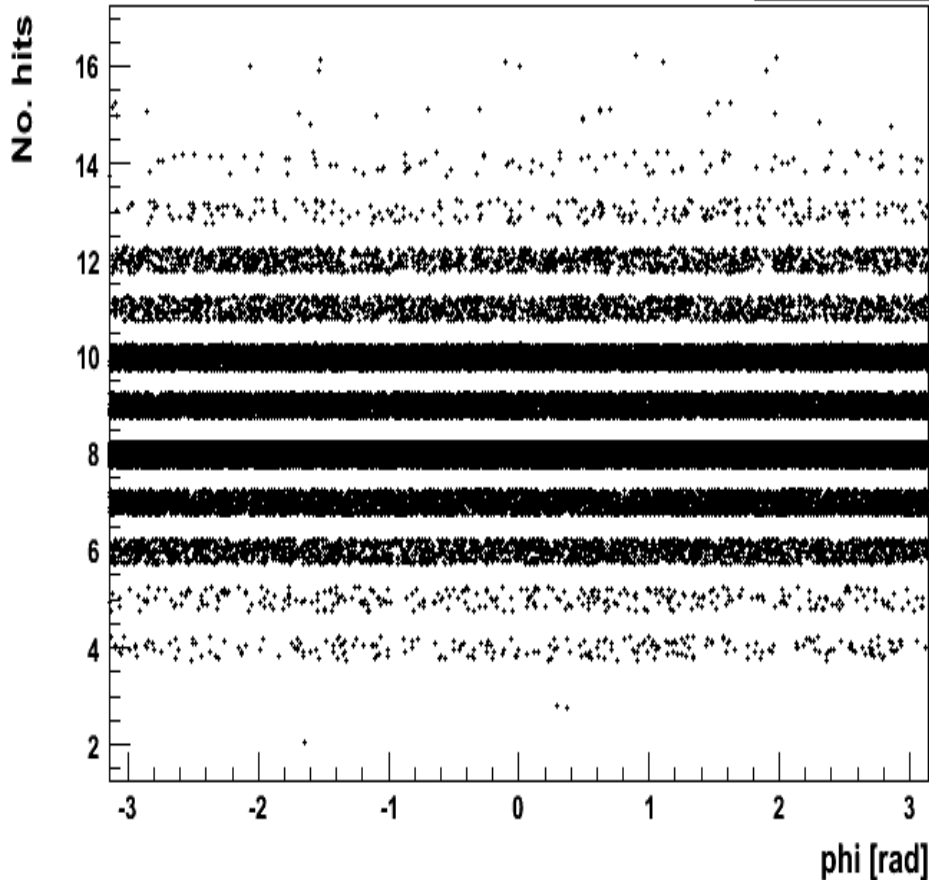


SCT Hits

- Coverage of the 4 barrel layers together: $|\eta| < 1.1$ and of the innermost layer: $|\eta| < 1.6$
- Coverage of at least one of the 9 end-cap discs: $1.1 < |\eta| < 2.6$
 - A track crosses 4 end-cap discs at most (8 rings)

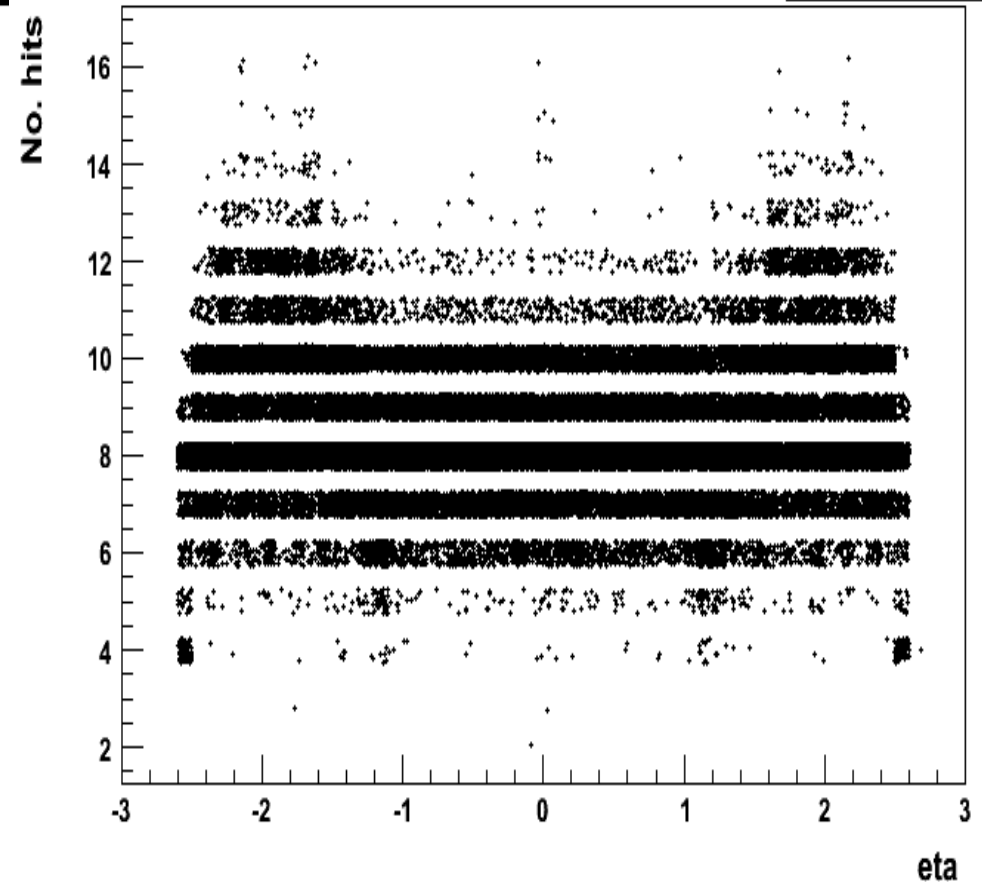
numberSCTHits:phi (trks.eq.1)

Entries	71104
Mean x	0.0005981
Mean y	8.456
RMS x	1.812
RMS y	1.262
Integral	7.11e+04



numberSCTHits:eta (trks.eq.1)

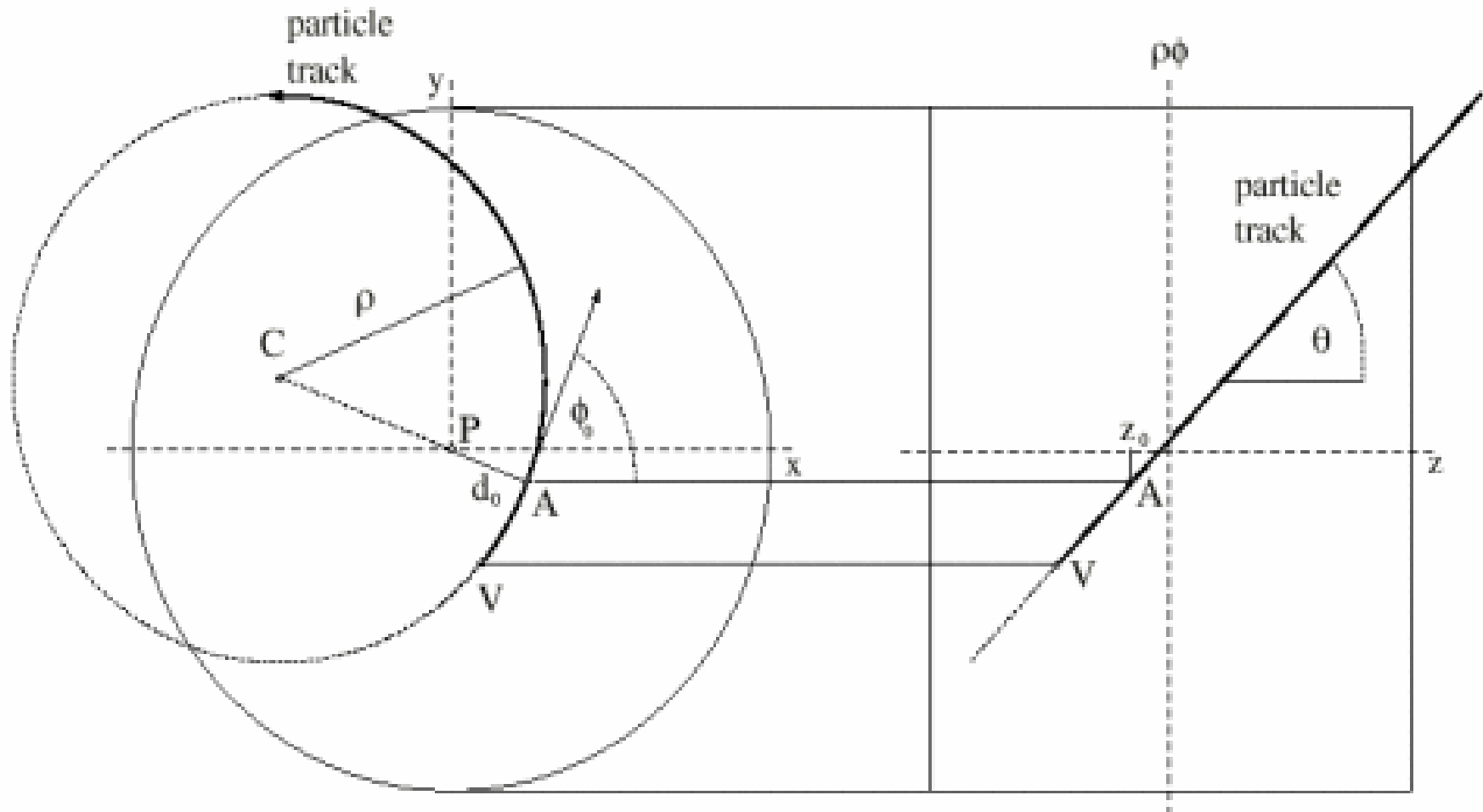
Entries	71104
Mean x	4.364e-05
Mean y	8.456
RMS x	1.469
RMS y	1.262
Integral	7.11e+04



S I N G L E T R A C K P E R F O R M A N C E

Definition of Perigee Parameters

- d_0 = distance from the point of closest approach A to the nominal interaction point P ($x=0, y=0$)
- z_0 = the z value at the point A
- $-\pi < \phi < \pi$, $0 < \theta < \pi$, $\eta = -\ln(\tan(\theta/2))$



P ... nominal interaction point

A ... point of closest approach to P

V ... vertex

C ... center of helix in (x-y) plane

ρ ... radius of the helix in (x-y) plane

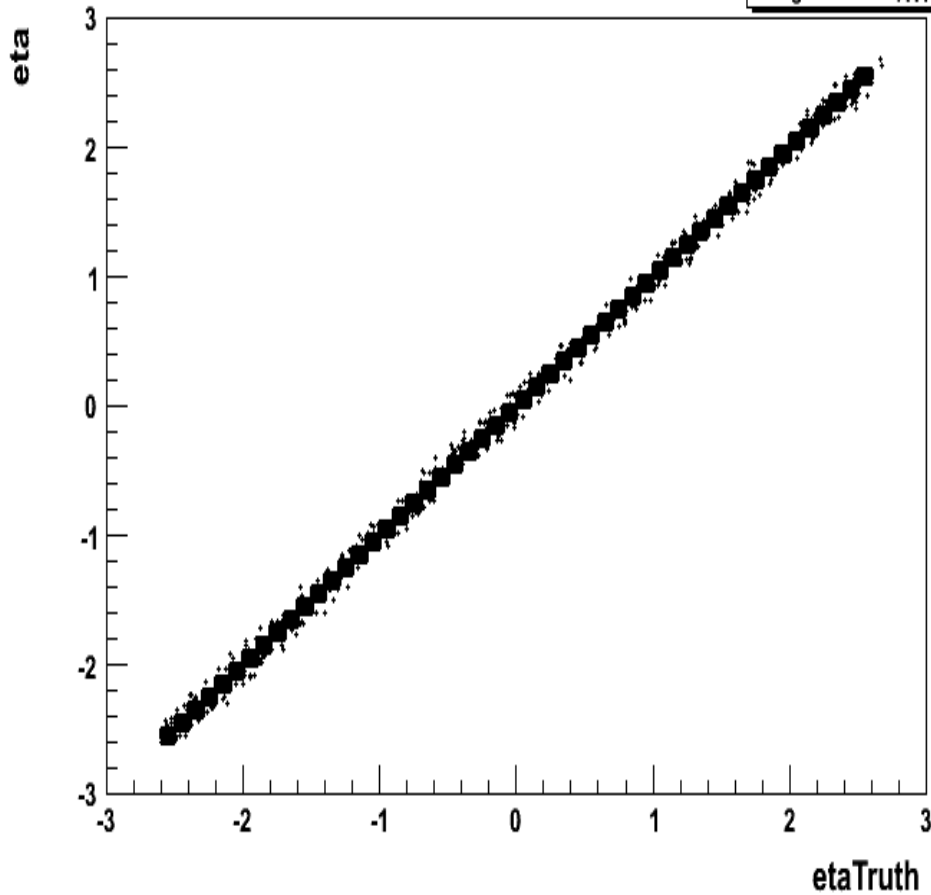
Pseudorapidity

- eta of tracks is well measured

- Residual = reconstructed - truth
- eta resolution = 0.0006

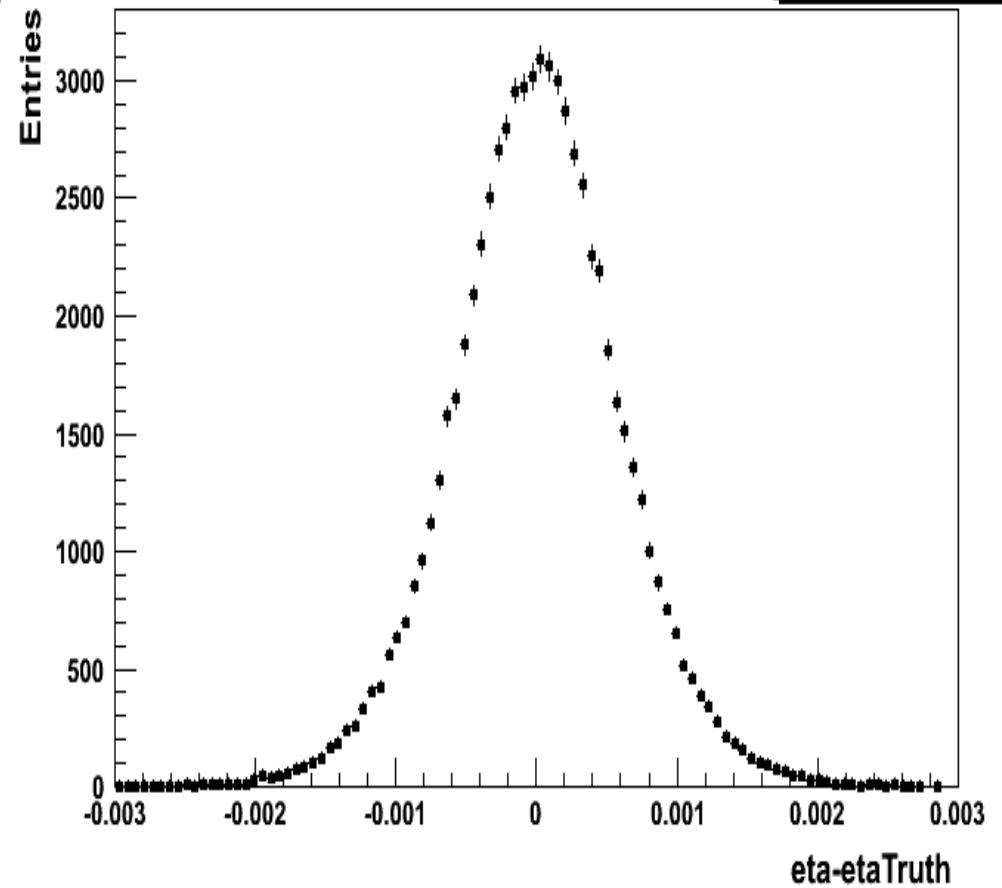
eta:etaTruth (trks.eq.1)

Entries	71104
Mean x	3.975e-05
Mean y	4.364e-05
RMS x	1.469
RMS y	1.469
Integral	7.11e+04



etaRes (trks.eq.1)

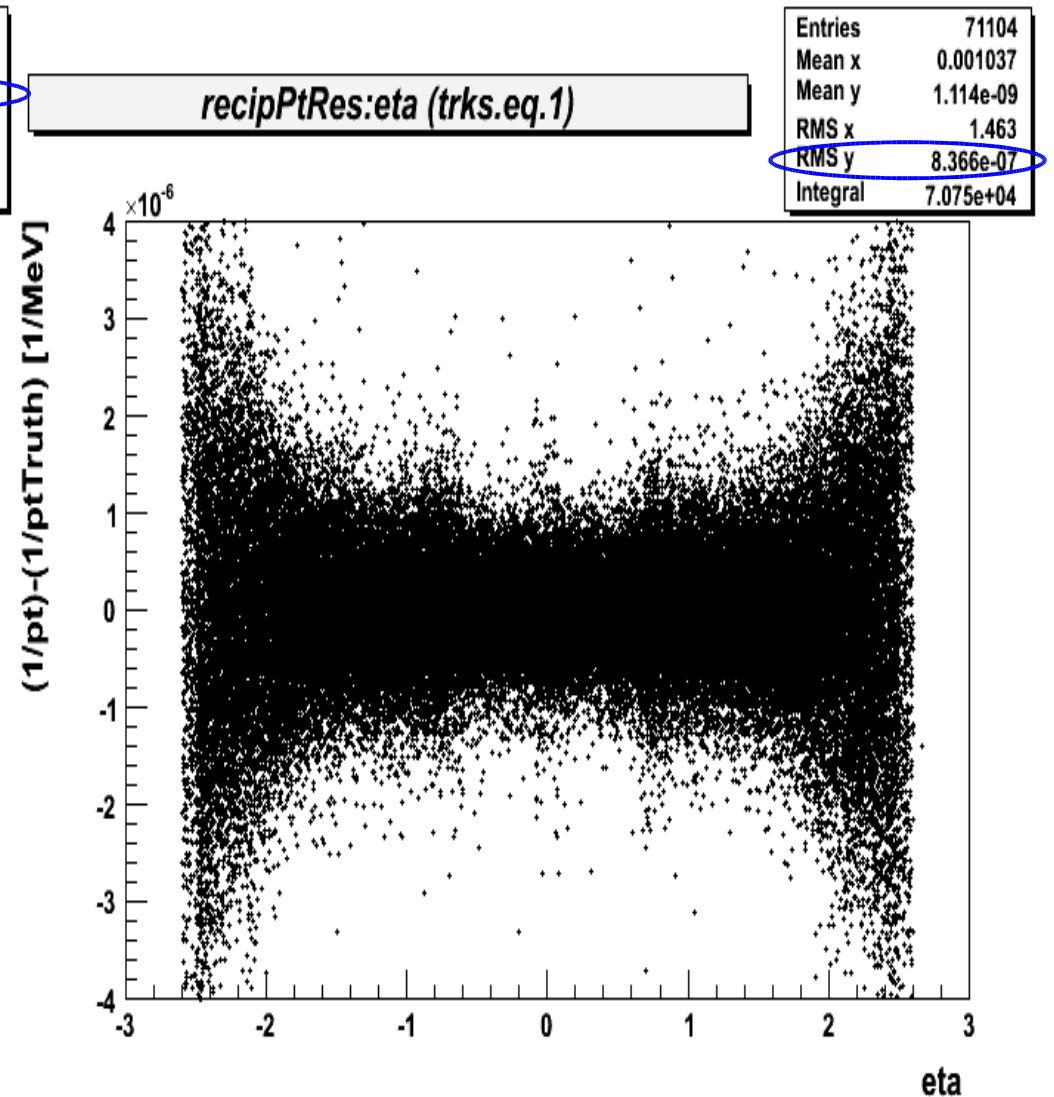
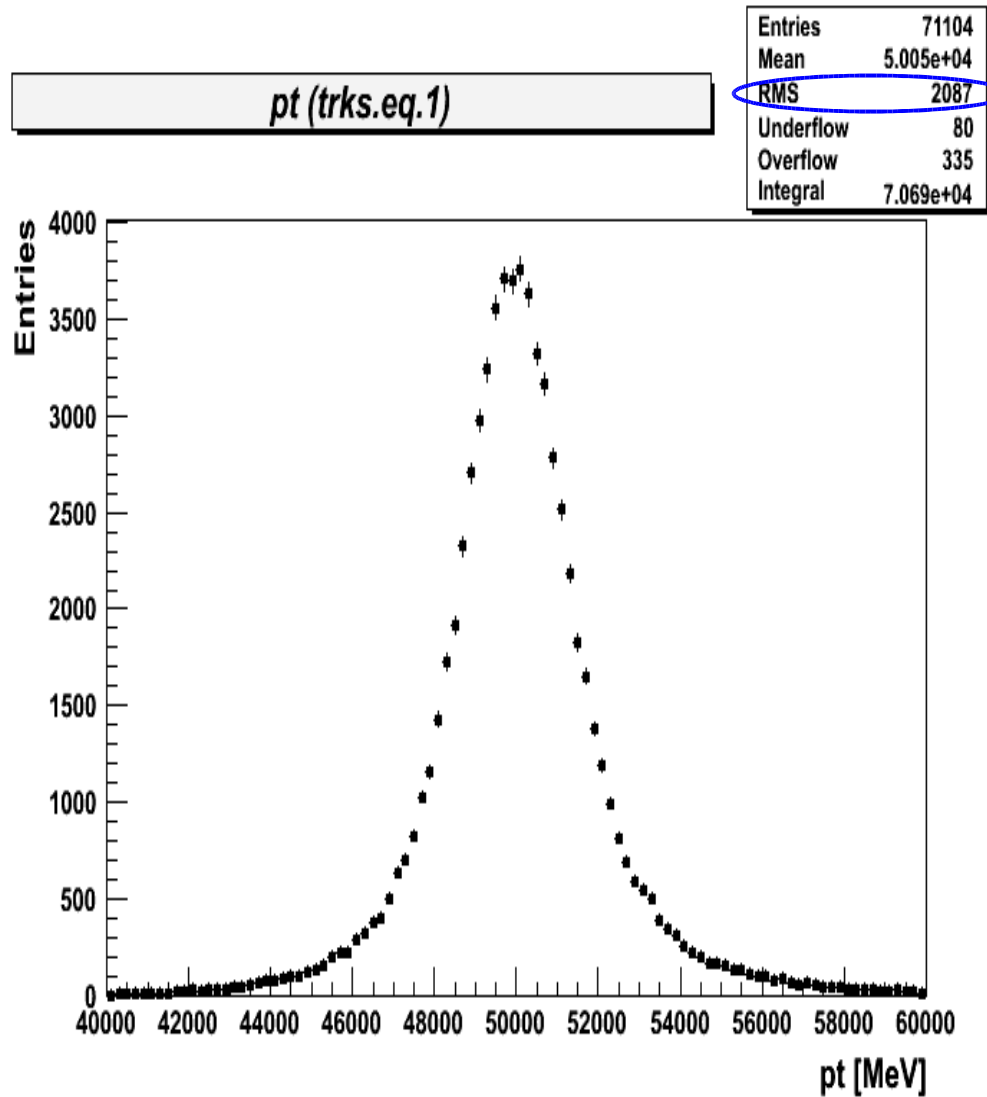
Entries	71104
Mean	2.984e-06
RMS	0.0006023
Underflow	18
Overflow	24
Integral	7.106e+04



Transverse Momentum

- p_T resolution = 2.1 GeV

- $1/p_T$ resolution = 0.84 1/TeV
- expected resol ($\eta=2.5$) = 0.75 1/TeV



We lose p_T resolution at high η !

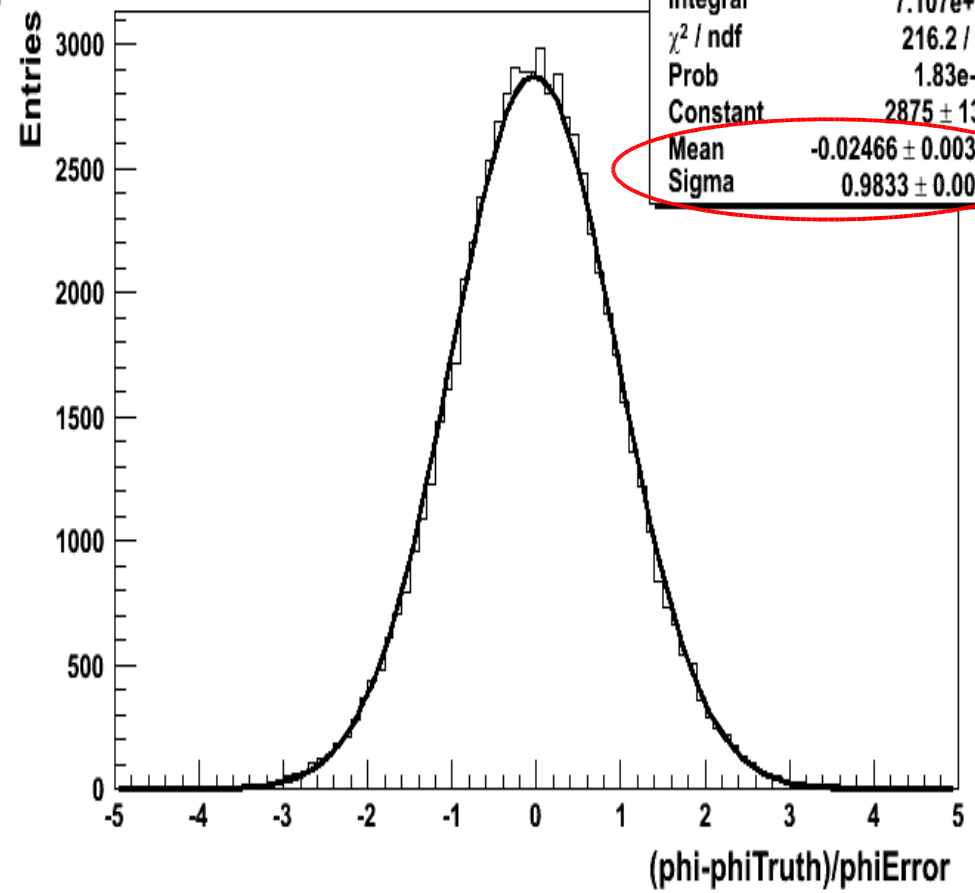
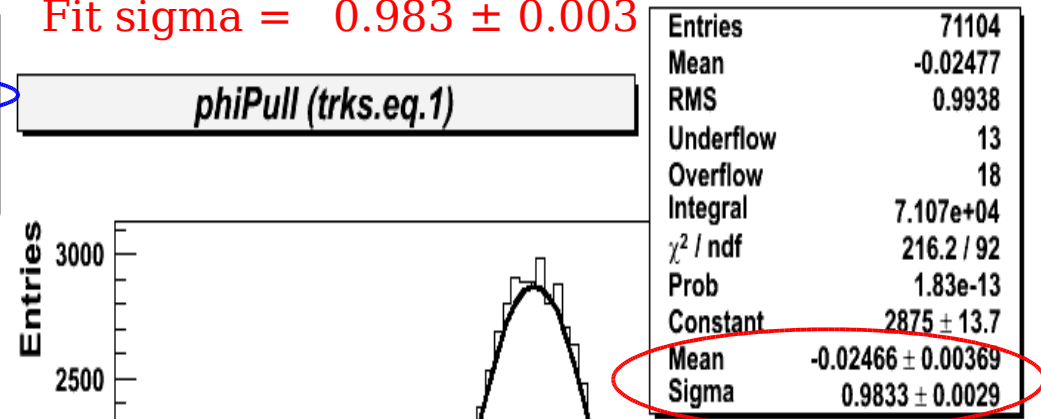
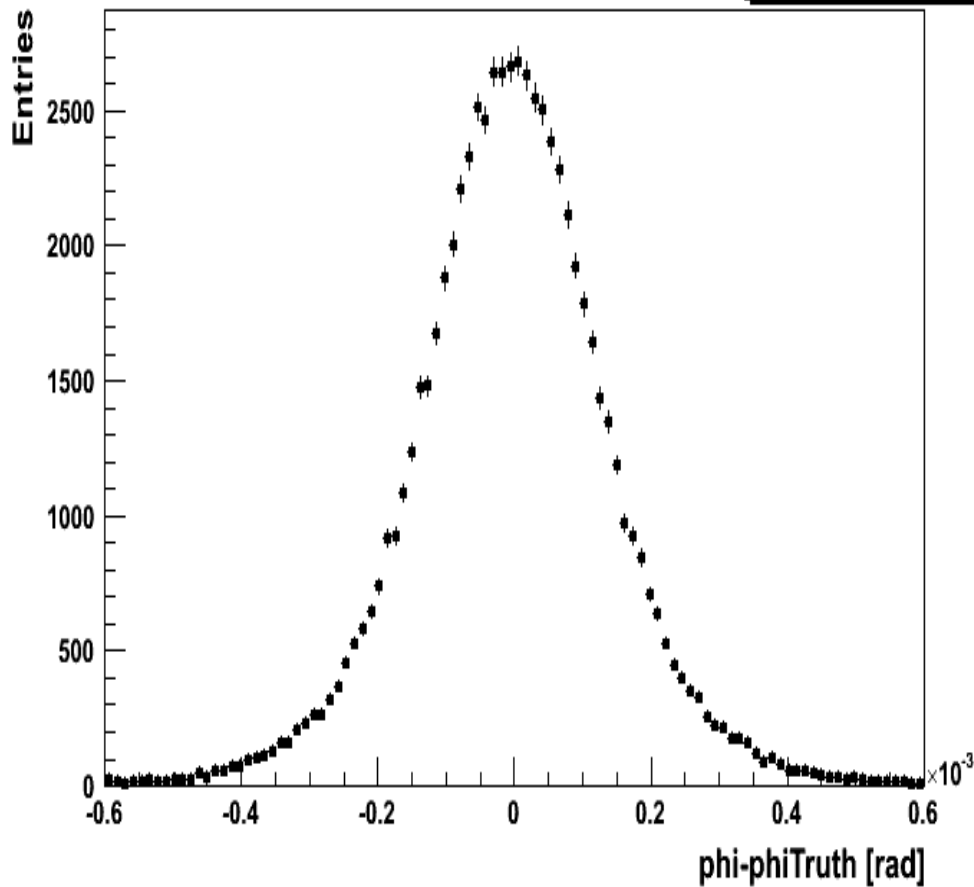
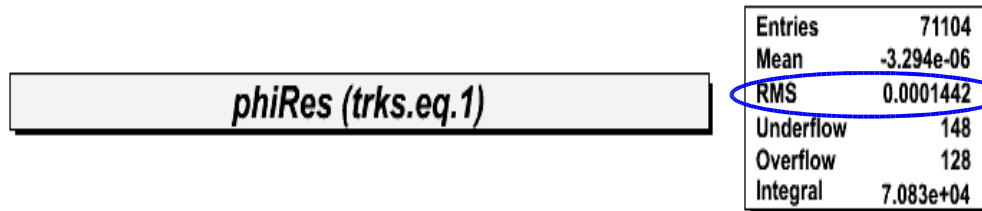
Phi

- $\text{phi resolution} = 0.14 \text{ mrad}$

- $\text{Pull} = (\text{reconstructed} - \text{truth}) / \text{error}$

Fit mean = -0.025 ± 0.004

Fit sigma = 0.983 ± 0.003

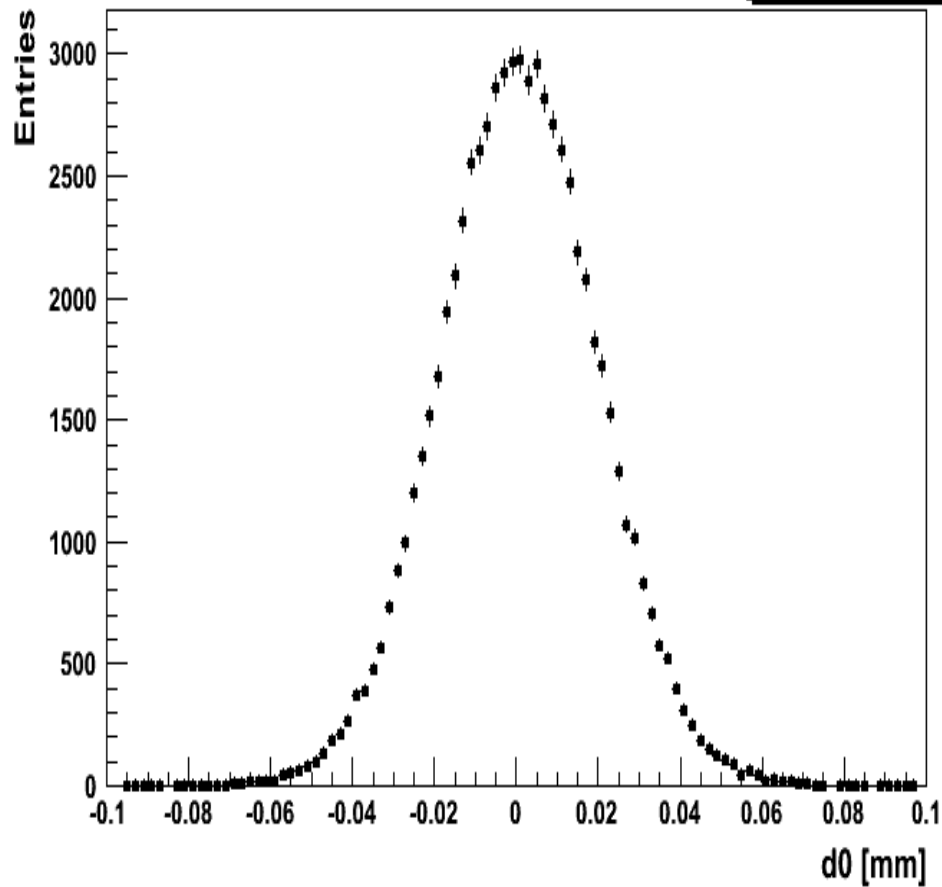


error of phi is correct !

Impact parameters

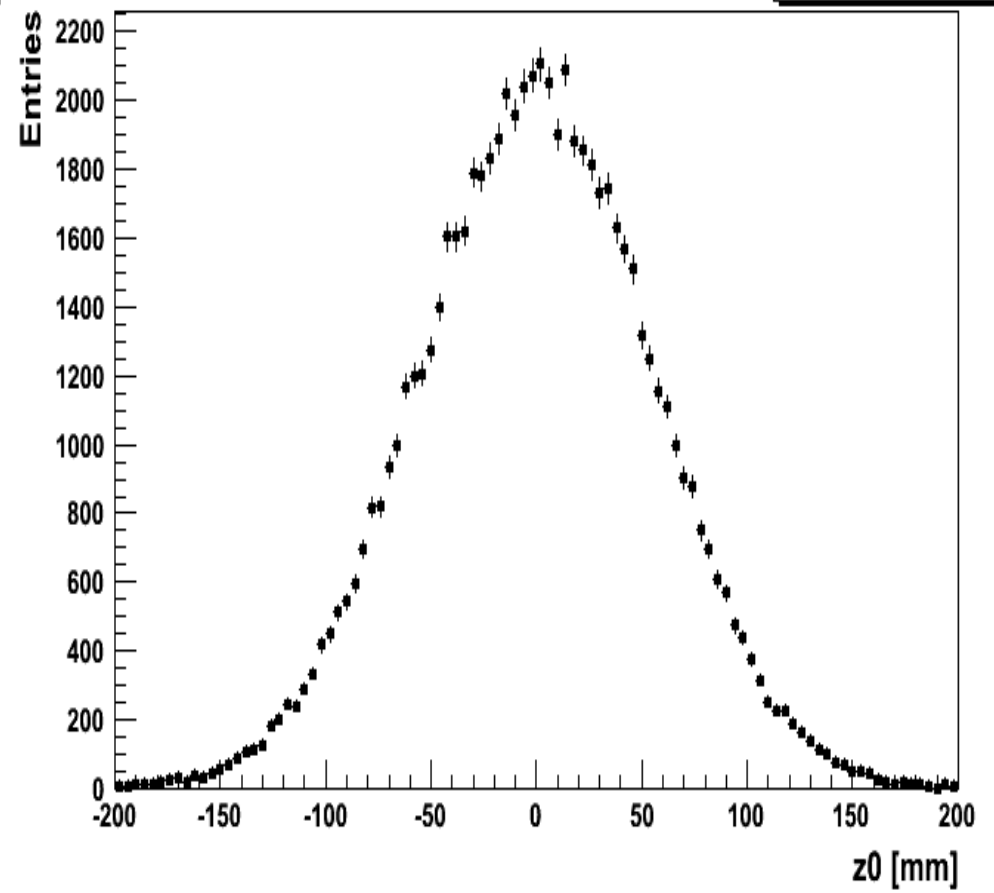
d0 (trks.eq.1)

Entries	71104
Mean	0.0007946
RMS	0.01928
Underflow	31
Overflow	29
Integral	7.104e+04



z0 (trks.eq.1)

Entries	71104
Mean	-0.3102
RMS	55.92
Underflow	8
Overflow	10
Integral	7.109e+04



CONCLUSION & OUTLOOK

- Quality studies of reconstructed tracks so far are promising
- Studies for the near future: Impact parameter resolutions, track chi square, etc
- Use of other samples, e.g. pions
- Studies of efficiencies for track finding
- Studies of primary vertex reconstruction
- Finally provide a robust track selection TOOL for alignment algorithms

- Senior Scientists: Prof. S. Bethke, Dr. R. Nisius, Dr. S. Kluth, Dr. S. Menke
- IMPRS Coordinator: Dr. J. Schieck
- Postdocs: Dr. N. Ghodbane
- Doctoral students: R. Haertel, A. Bangert
- Diploma students: T. Goettfert, M. Kayl