Track Projection and Fitting Using Kalman and SVX Hits

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Goal of this Project

- Project Cgl tracks from Central Arm
- Build Kalman tracks and associate SVX hits
- Refine tracks by Kalman Fitting and Smoothing
- Calculate DCA
- Use Single-track and Au-Au event(Exodus) to check Deterioration due to occupancy
- Help to optimize design, such as radius

Data Source:

60K pi+ & 60K D^0

$1<Pt<7GeV$ $-0.4<y<0.4$ $0<\varphi<2\pi$ collision vertex(0,0,0)

Simulation Process:

1) Generate single particle event (pi+ or D^0) as PISA input

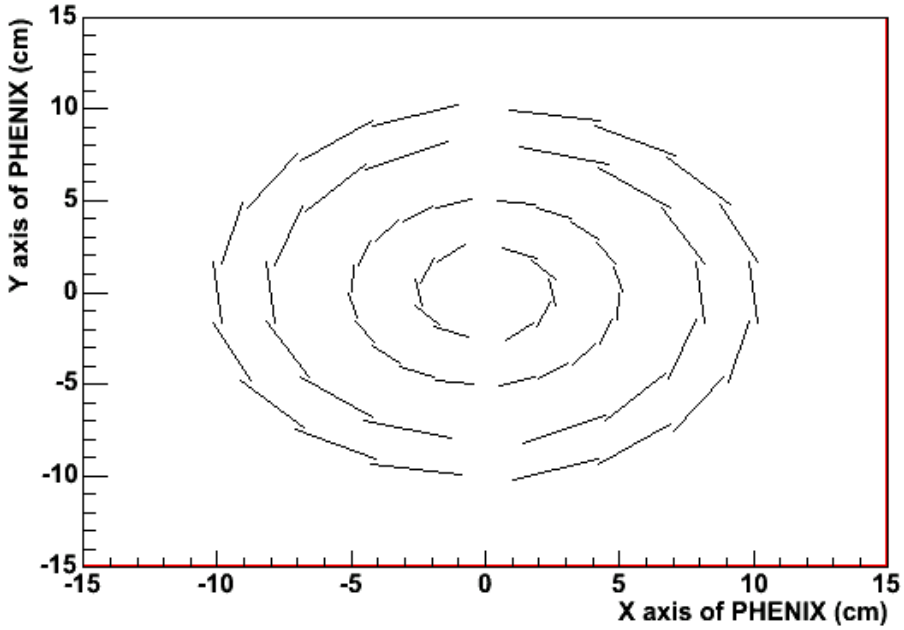
2) Take PISA output (PISAEvent.root) as the input of reconstruction

3) Run in pisaToDST.C each detector reconstruction package (DC, SVX, etc), then run Cgl to use DC&PC1 hits to fit the initial p, phi0 and theta0 of each DC track, and associate detector hits to build a Cgl track.

4) Select those Cgl tracks with quality = 31 or 63, use their p, phi0 and theta0 as the initial input of Kalman Fitting, so as to construct Kalman Tracks, and let it associate SVX hits on each layer.

5) The Kalman Track will be fitting to each DC and SVX hits by looking at the azimuthal and z residuals, takeing into account of the hits' resolution.

The geometry of SVX Detector



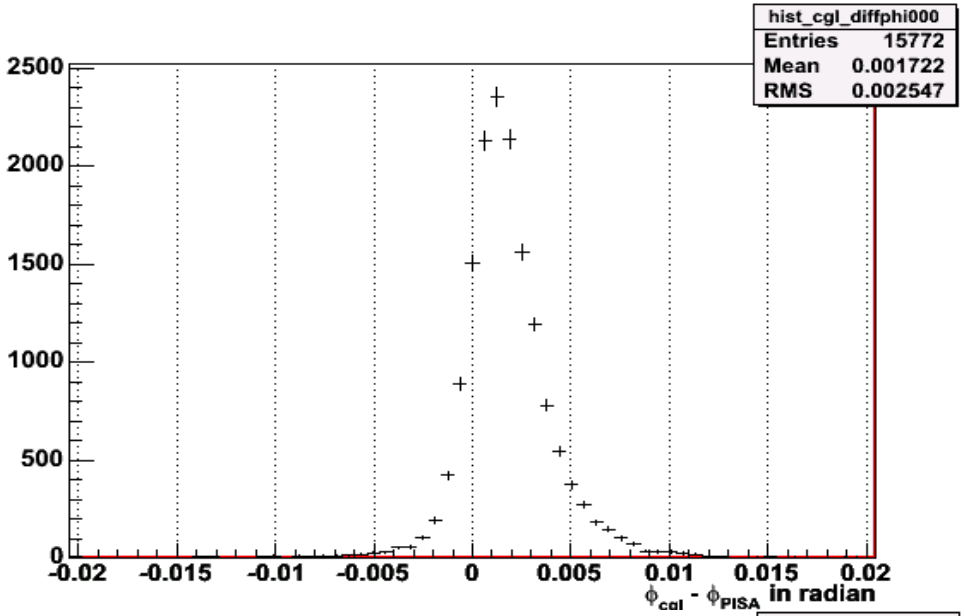
What we changed from default PISA:

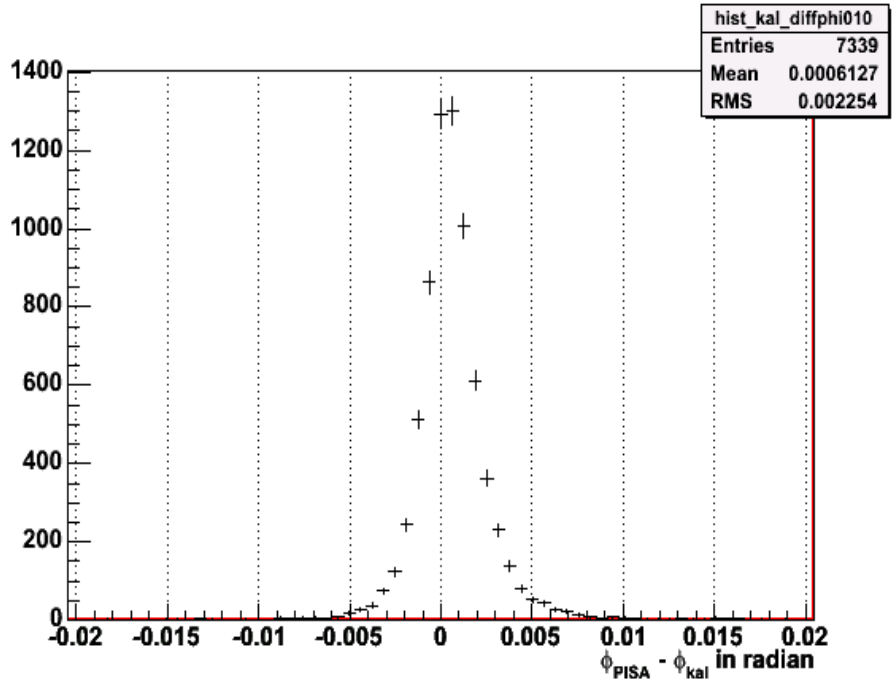
The 2nd layer (r=6.0cm) is now moved to r=5.0cm, and the strip sensors on it are replaced with pixels. This is to check the 2-pixel-layer design.

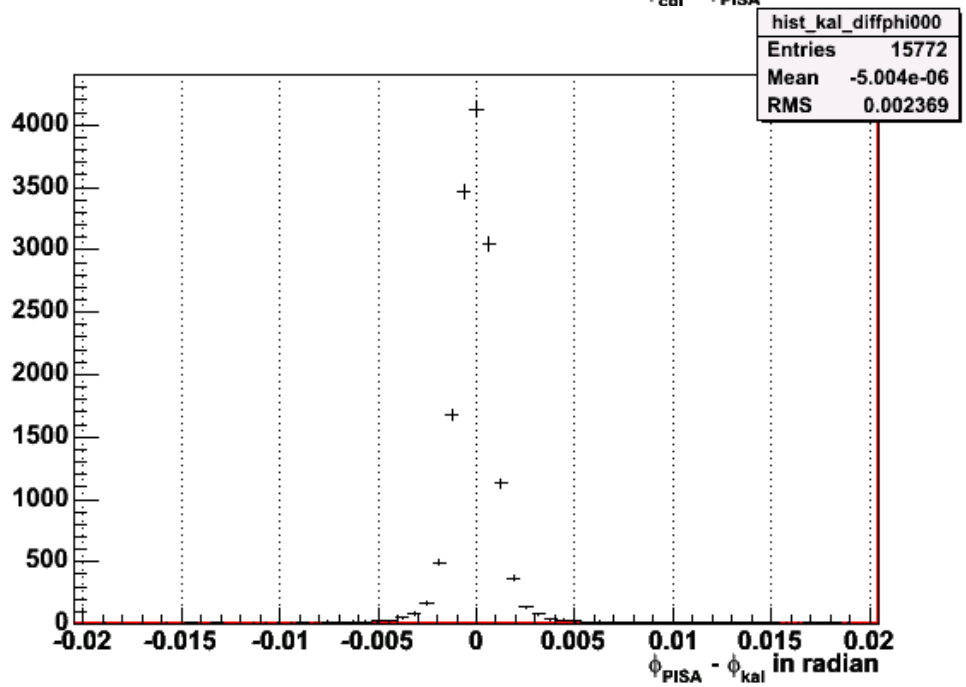
To confide with this change, the z-length of 2nd layer is from 25.8cm to 21.8cm, and all cages are removed. We also increase the number of ladders from 10 to 20 so as to have roughly the same φ coverage.

Single pi+: φ residual of Layer 0 (pixel)

Top-right: Cgl tracks, residual is obviously bigger than resolution (50um/2.5cm=0.002radian)
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting, big improvement

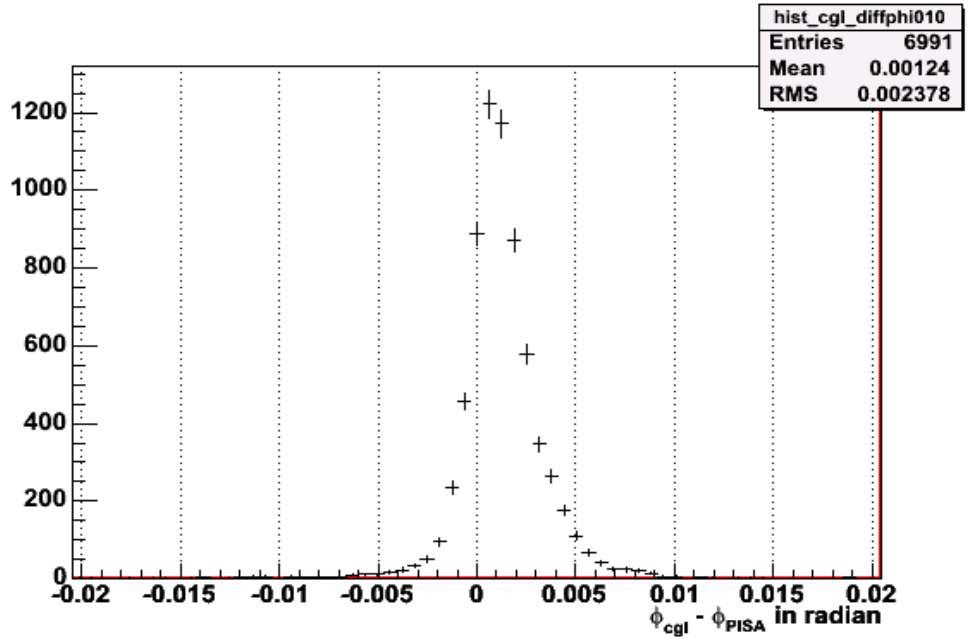


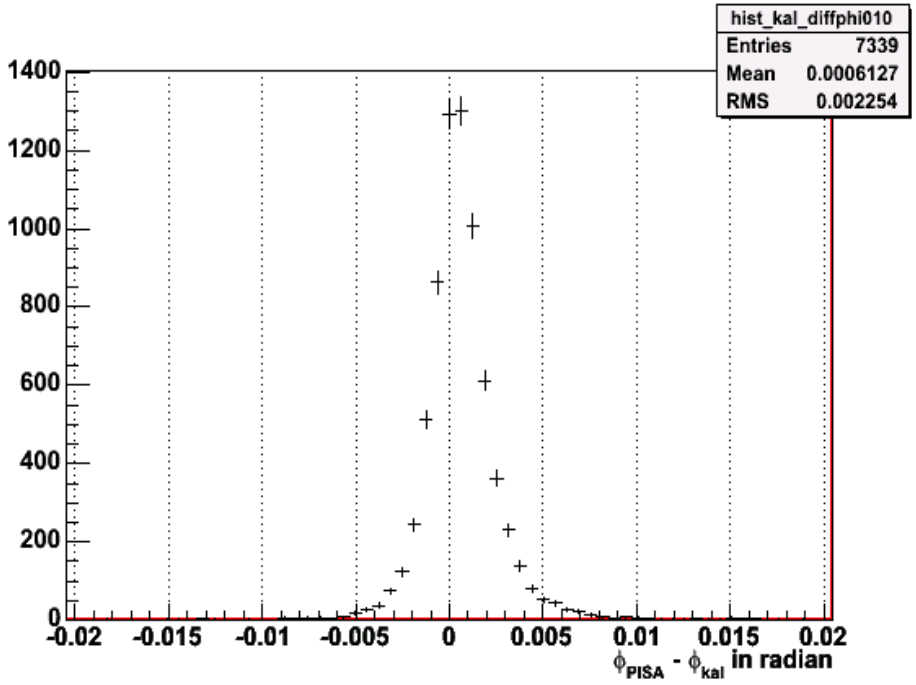


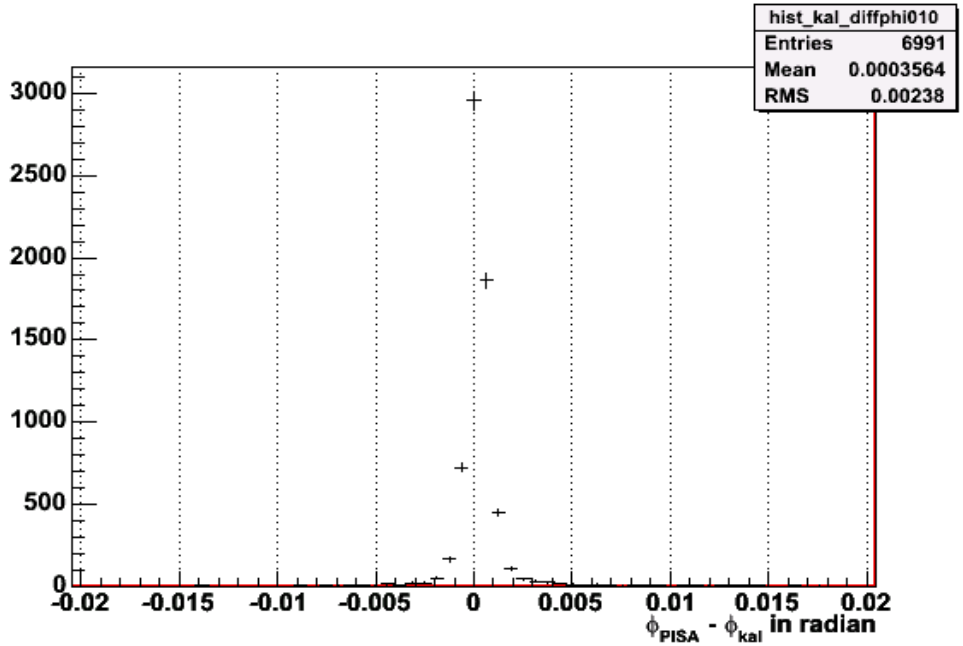


Single pi+: φ residual of Layer 1 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

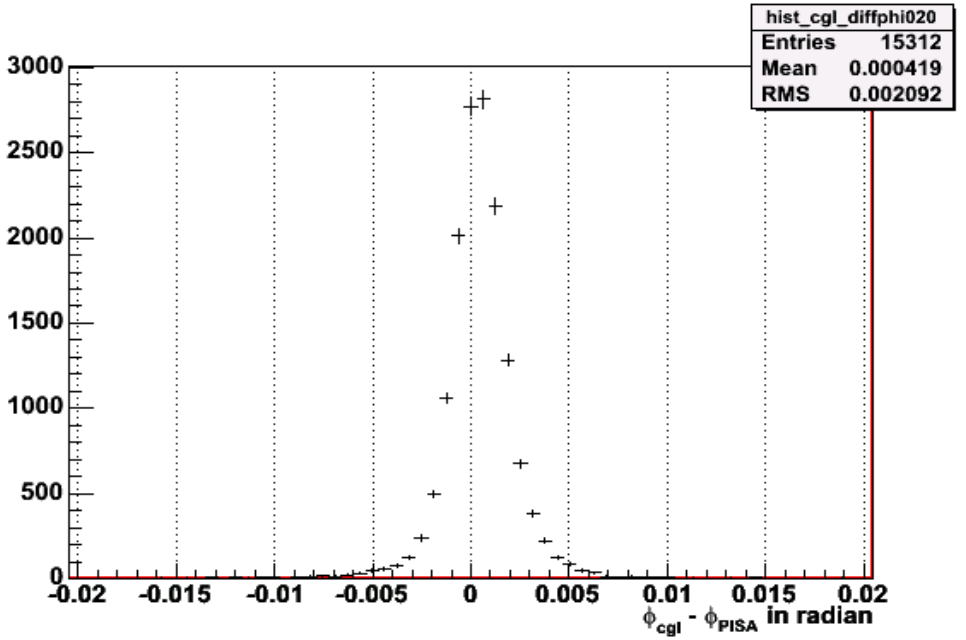


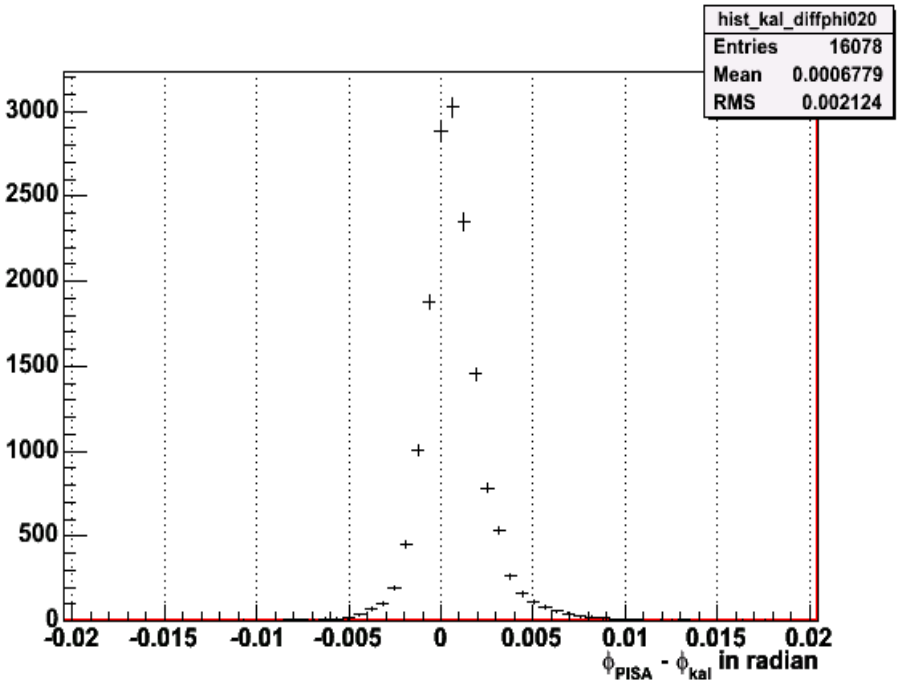


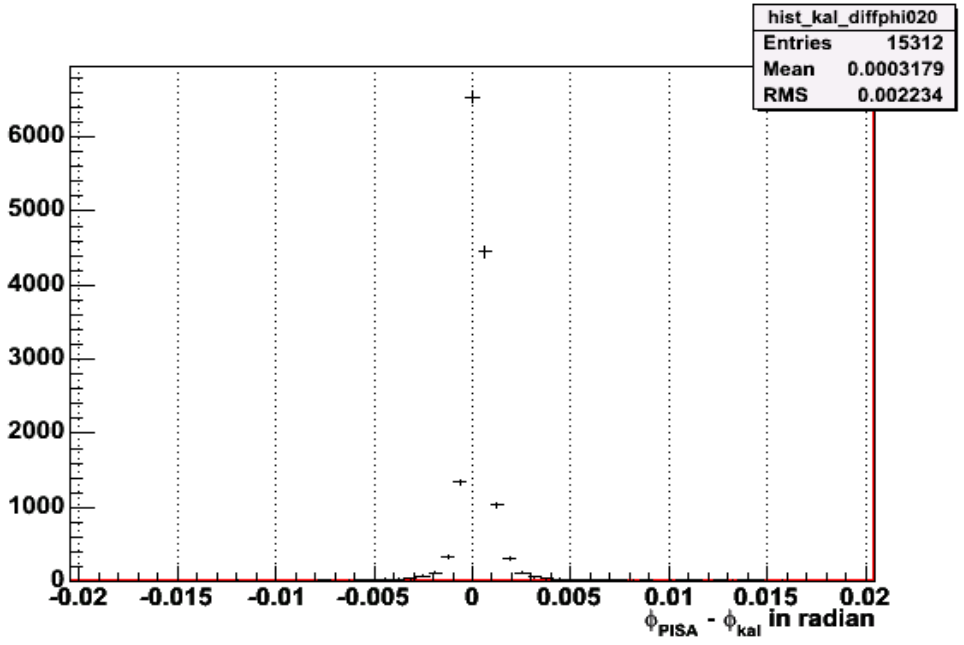


Single pi+: φ residual of Layer 2 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

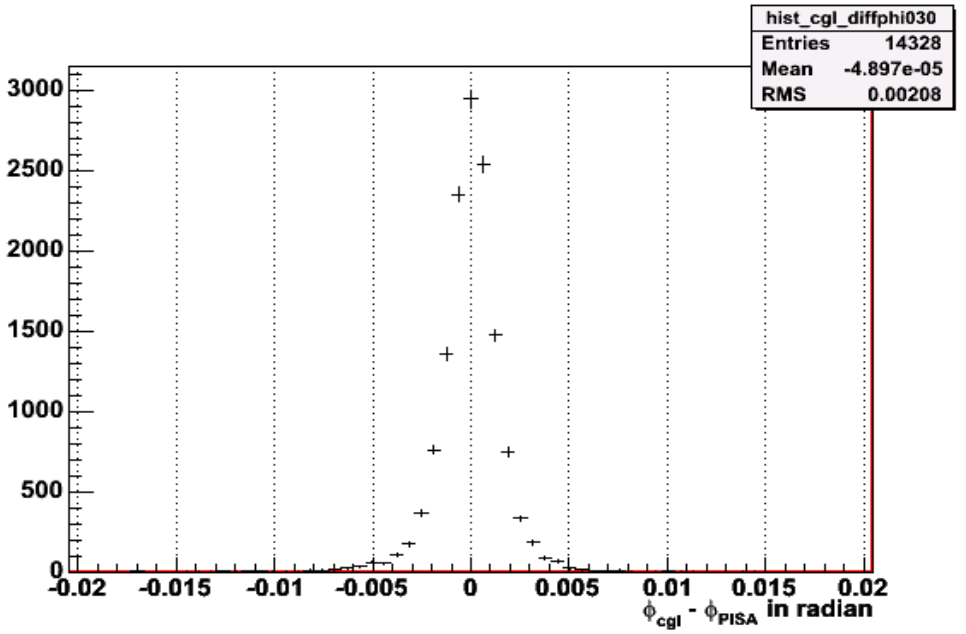


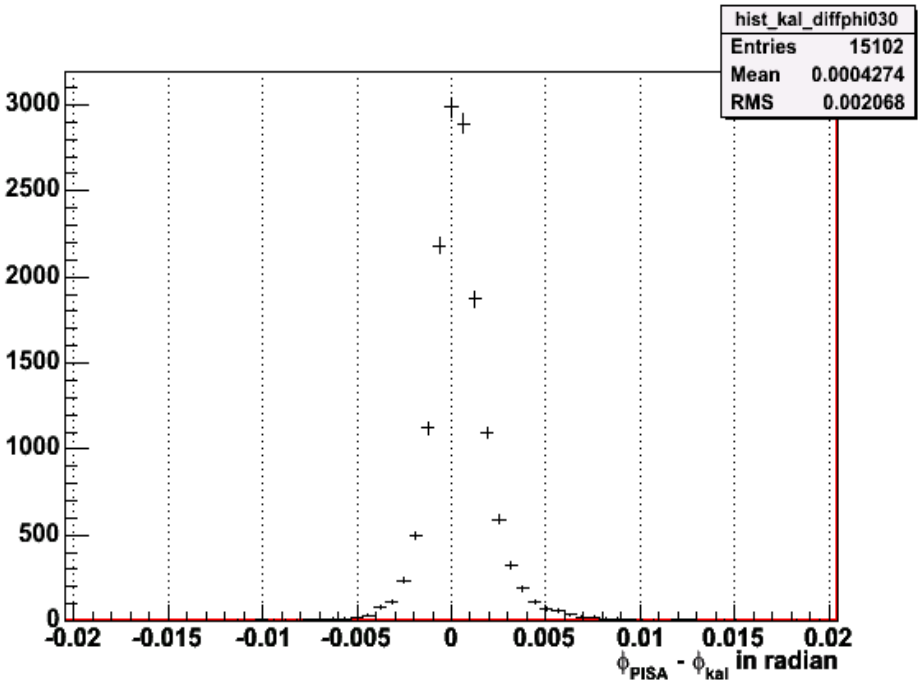


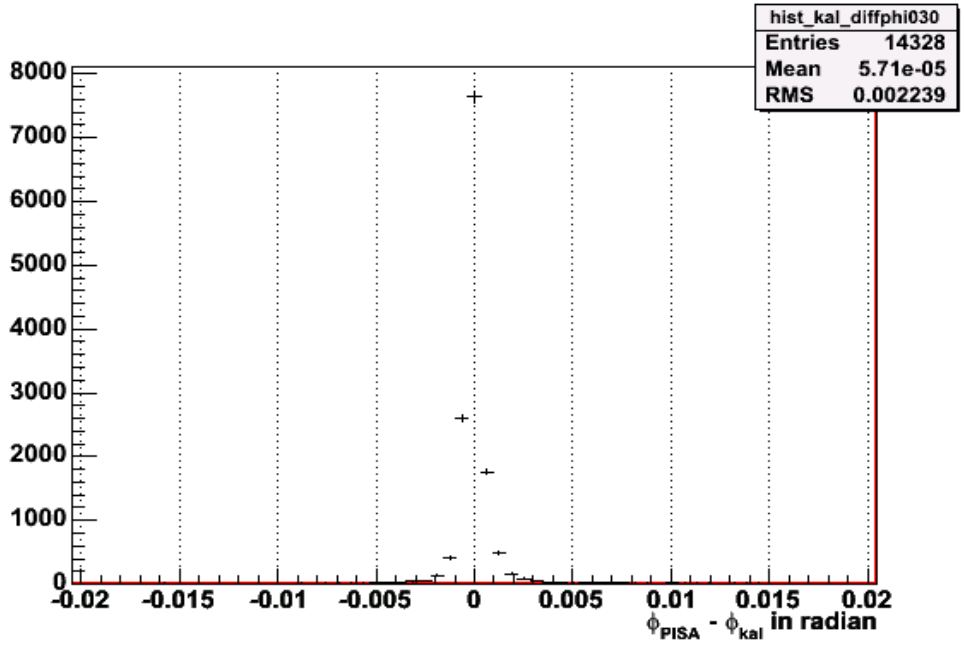


Single pi+: φ residual of Layer 3 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

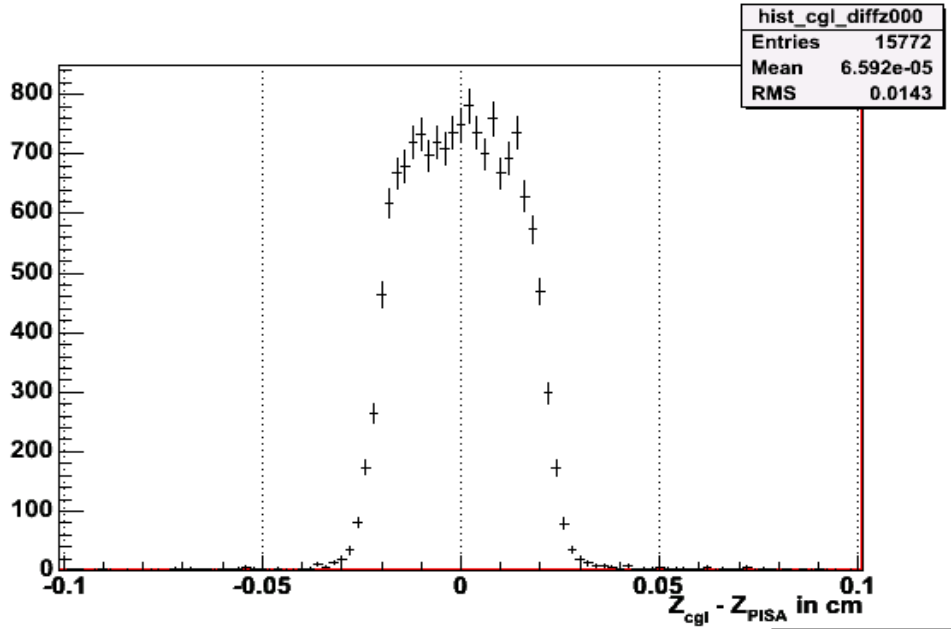


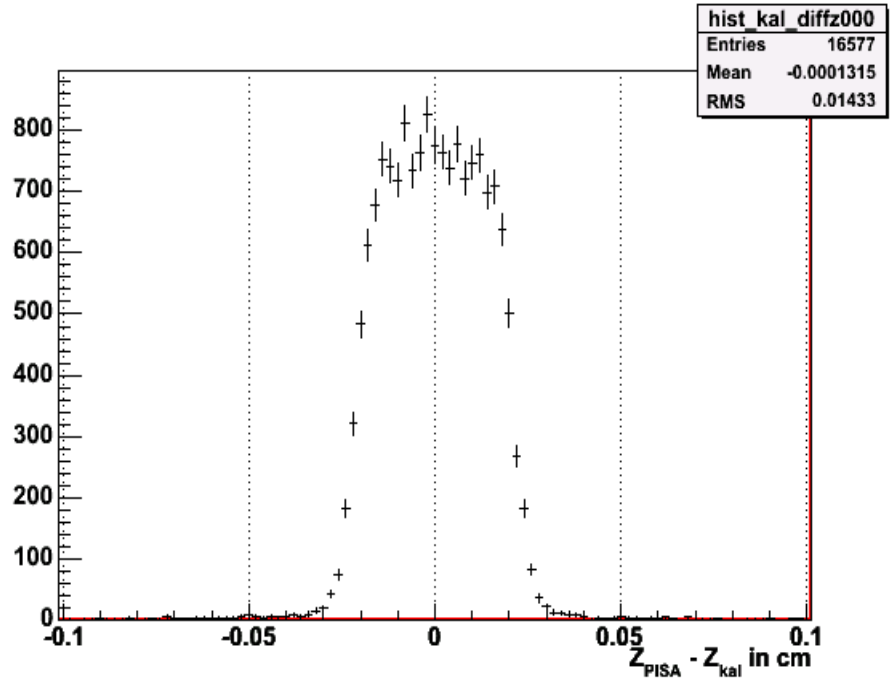


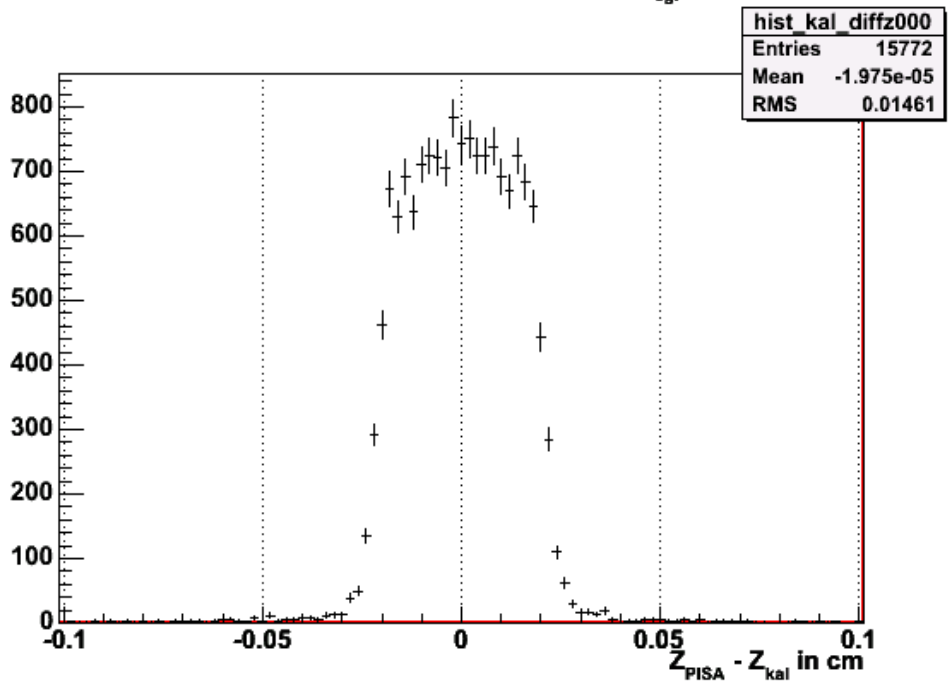


Single pi+: z residual of Layer 0 (pixel)

Top-right: Cgl tracks, a platform of 425um?
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

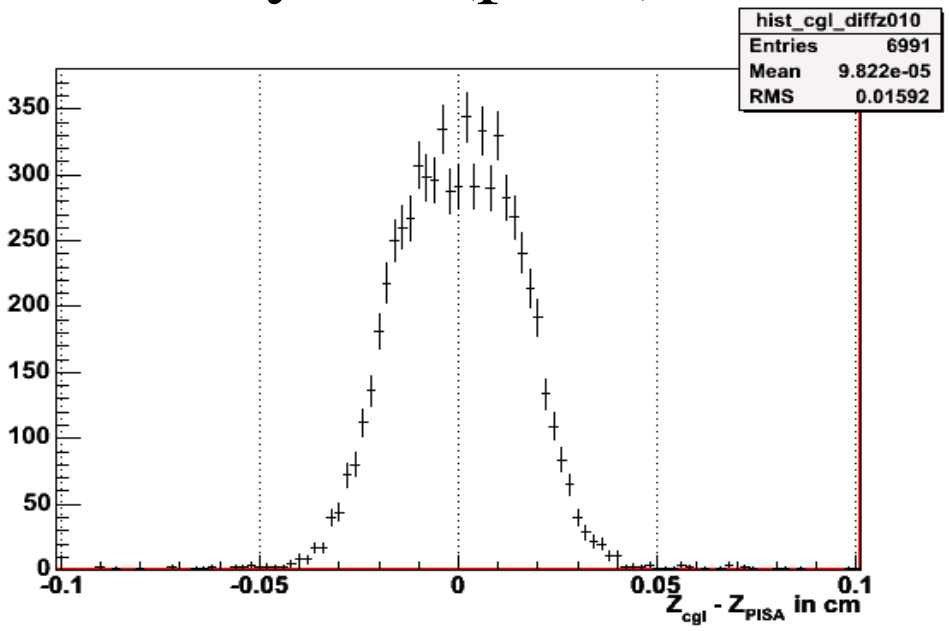


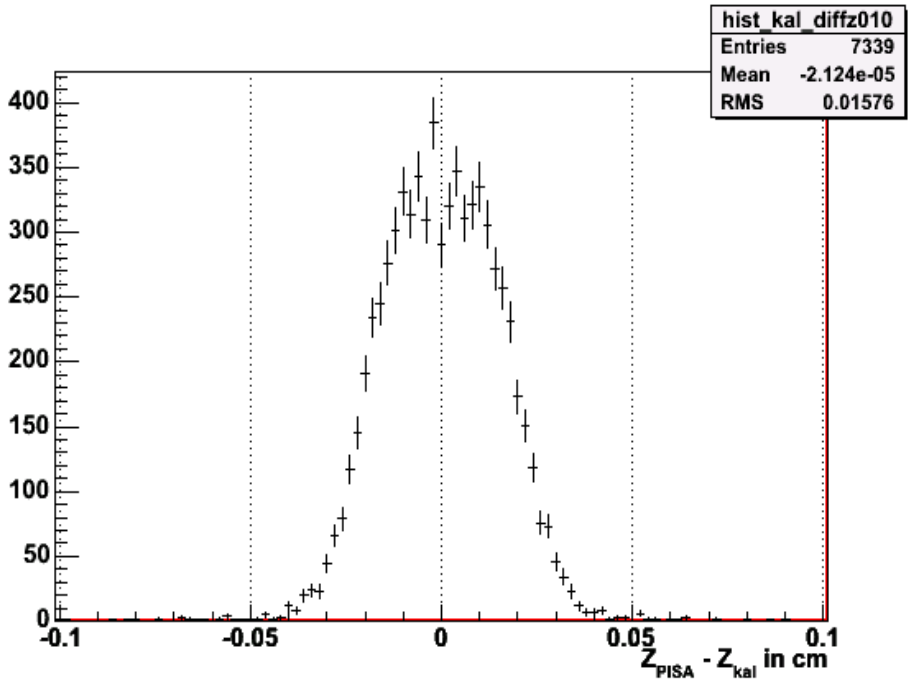


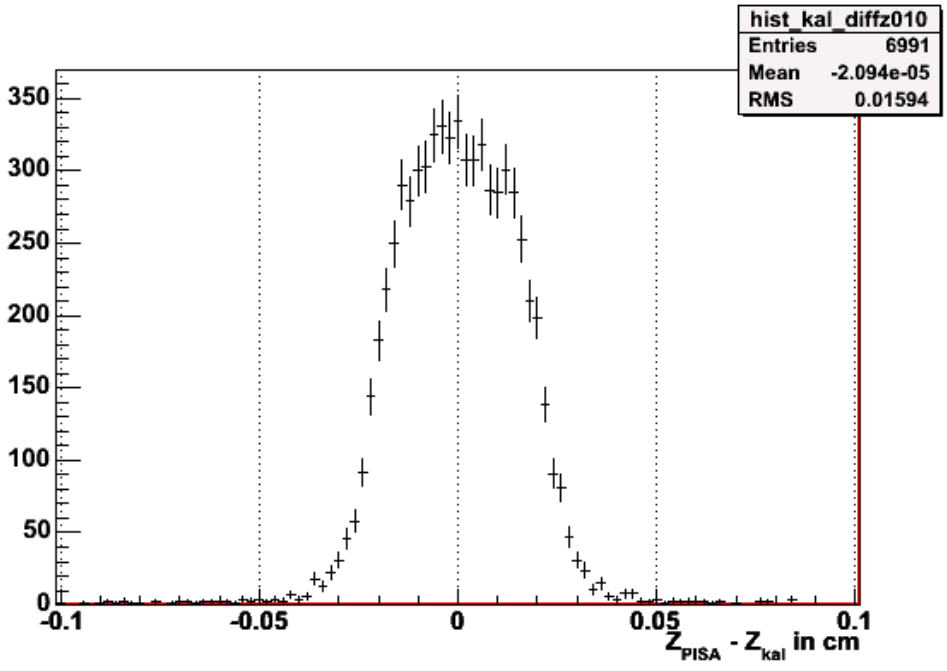


Single pi+: z residual of Layer 1 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

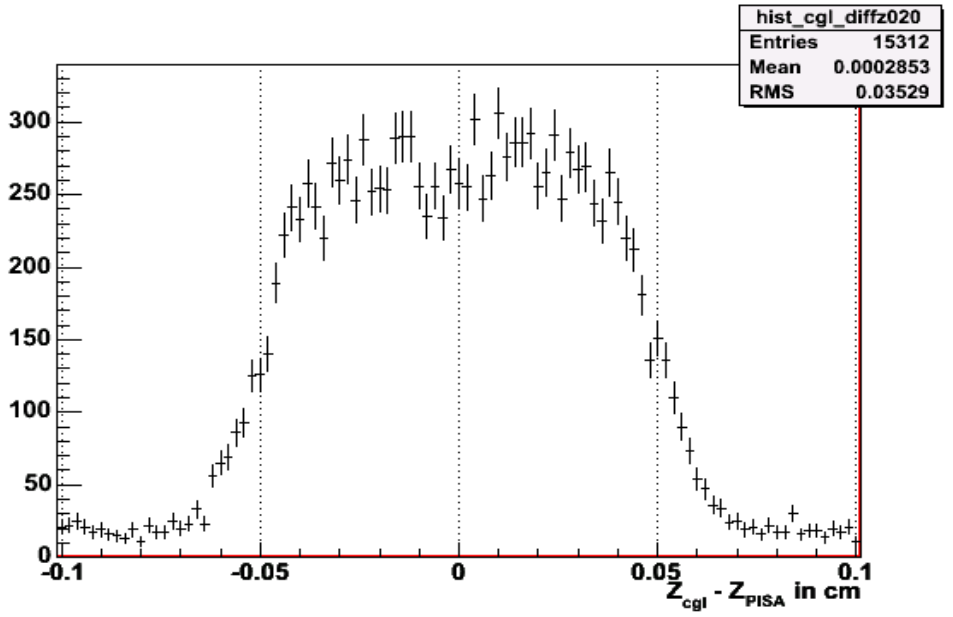


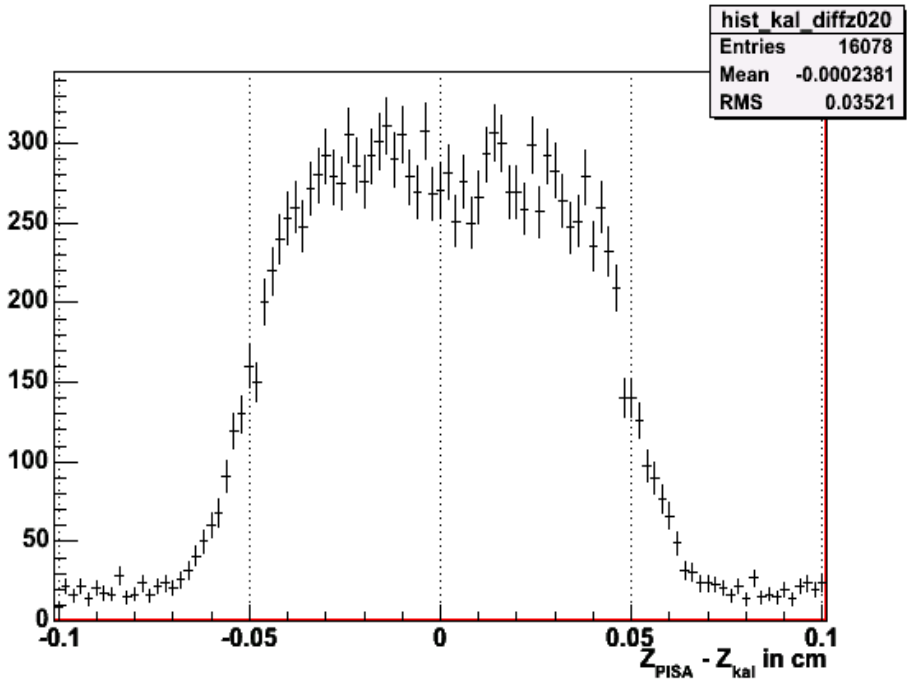


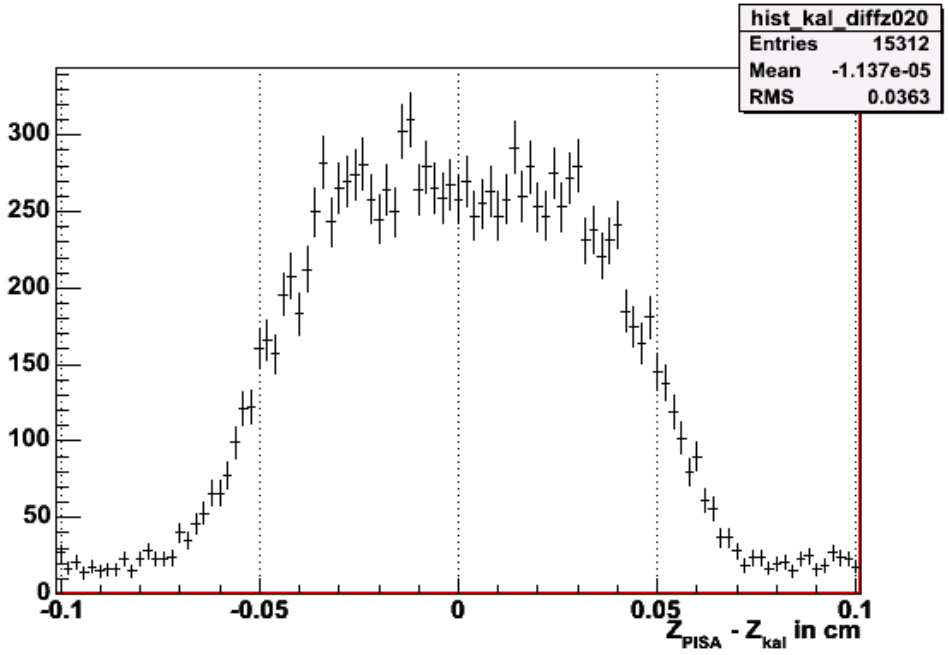


Single pi+: z residual of Layer 2 (strip)

Top-right: Cgl tracks, another platform of 1000um
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

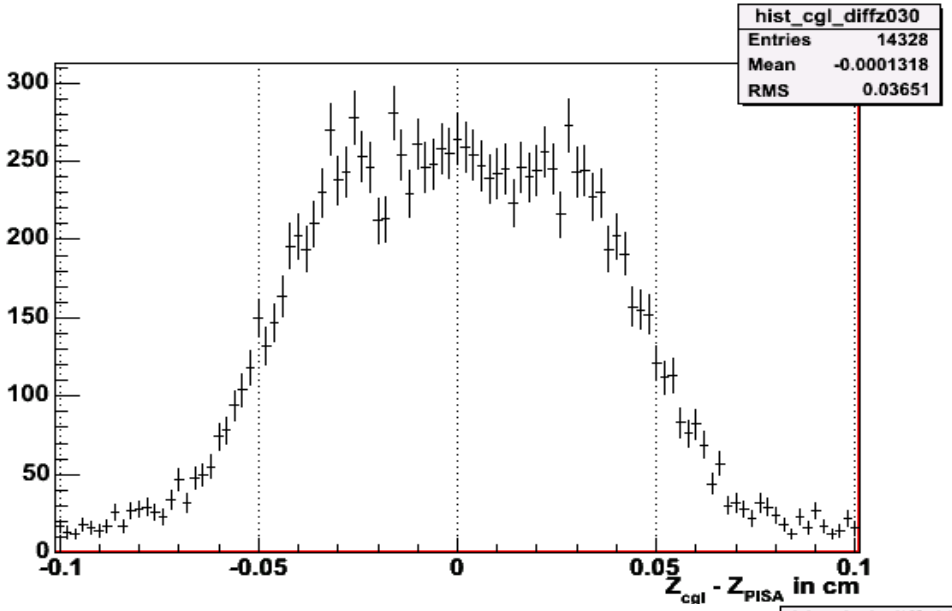


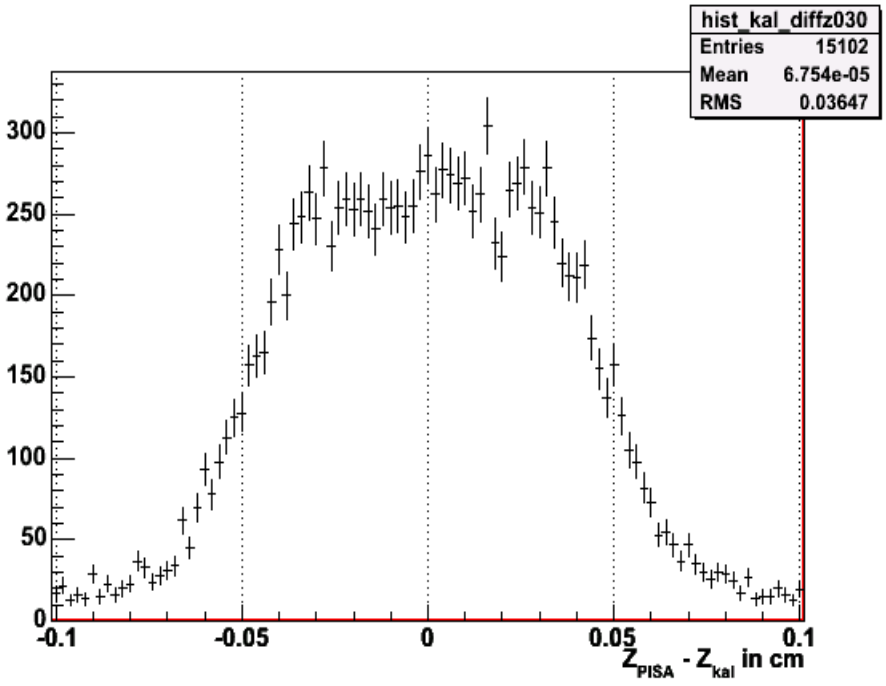


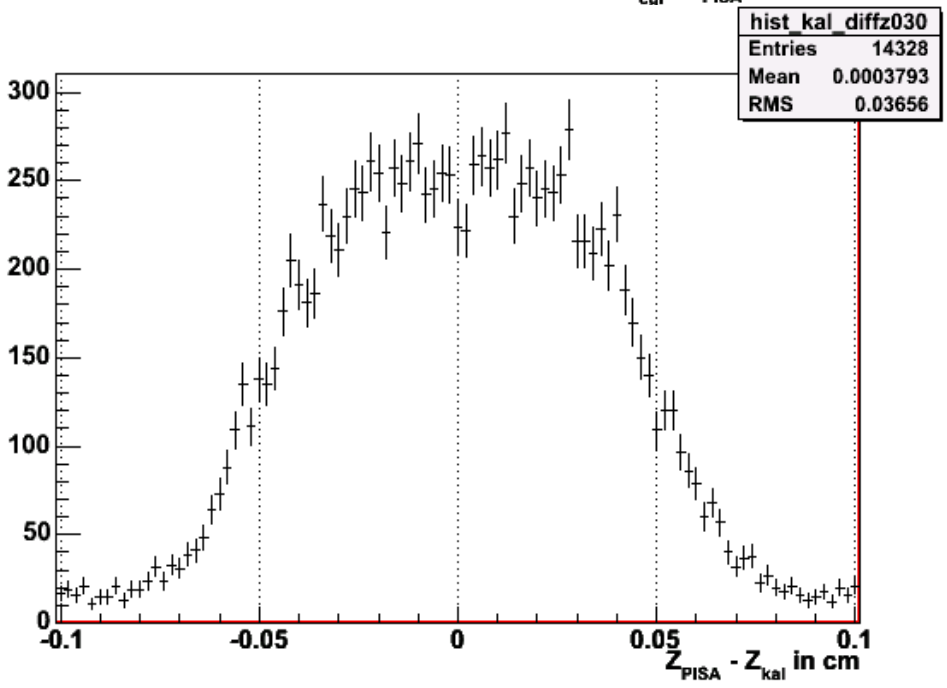


Single pi+: z residual of Layer 3 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting







Comments:

For the φ residual, Kalman track shows obvious improvement over Cgl track, even without fitting. Considering the resolution of SVX sensors: height = 50um (pixel, r=2.5cm or 5cm) and 80um (strip, r=8cm or 10cm)
The φ residual of Kalman Fitting is less than systematic error now.

For the Z residual, Kalman track didn't change much from Cgl track. On the other hand, if we look at the resolution:
width = 425um (pixel) and 1000um (strip)
The Z residual of either track gives out such a 'platform' of exact resolution. This means Kalman didn't try to 'push' track to hits because of Z residual, and we might need do adjustment. The current error constraints are simply length/sqrt(12), either on height or width.

Run Au-Au Event from Exodus

Following will be the residuals of exodus event tracks. I use the 'full PHENIX event' version of exodus from Ralf, where I set dN/dy(y=0) to be 700, with power law distribution. Only pi, K and proton are used.

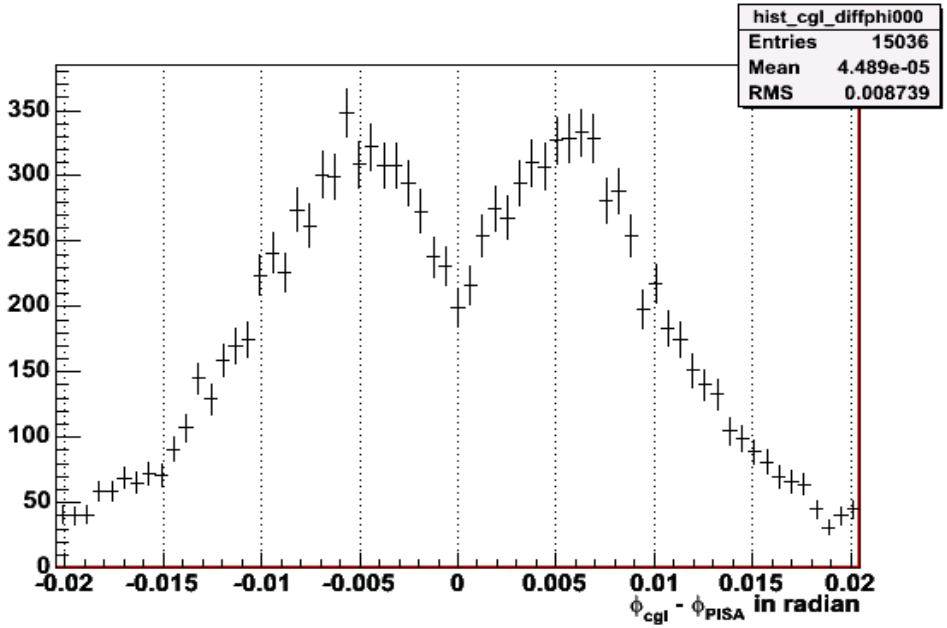
Here Kalman residuals changes much less from single pi+ event than Cgl residuals. My conclusion is that since the associating job is done seperately (Cgl or Kalman), by selecting the nearest hit in certain range around projection of either track, it's much possible in a high-multiplicity event that different hits are associated because of:

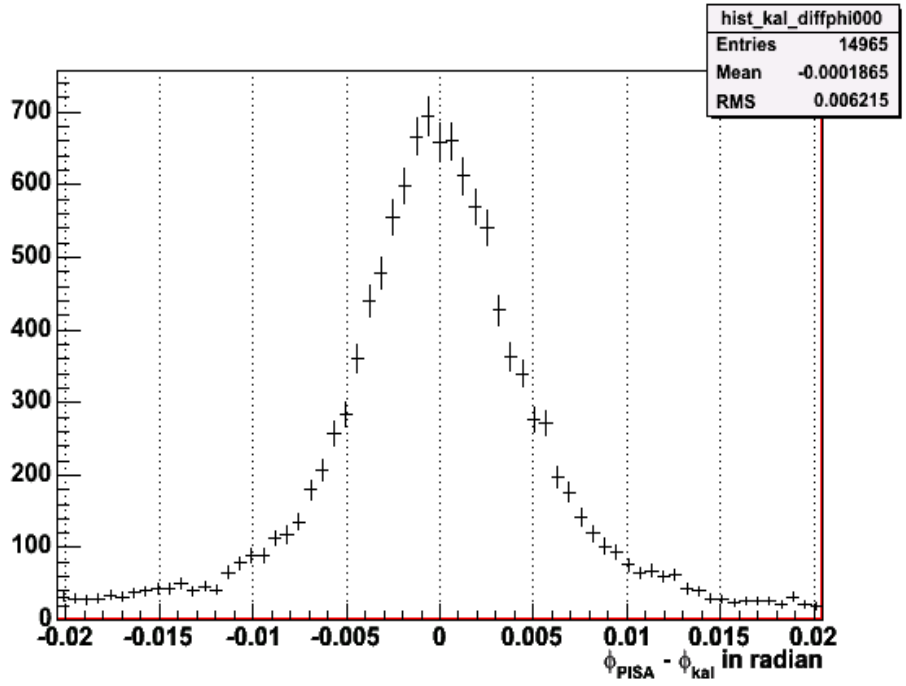
1) Different projections between Kalman and Cgl.
2) After the making of SVX clusters, the nearest cluster may not be produced by the nearest Geant hit.

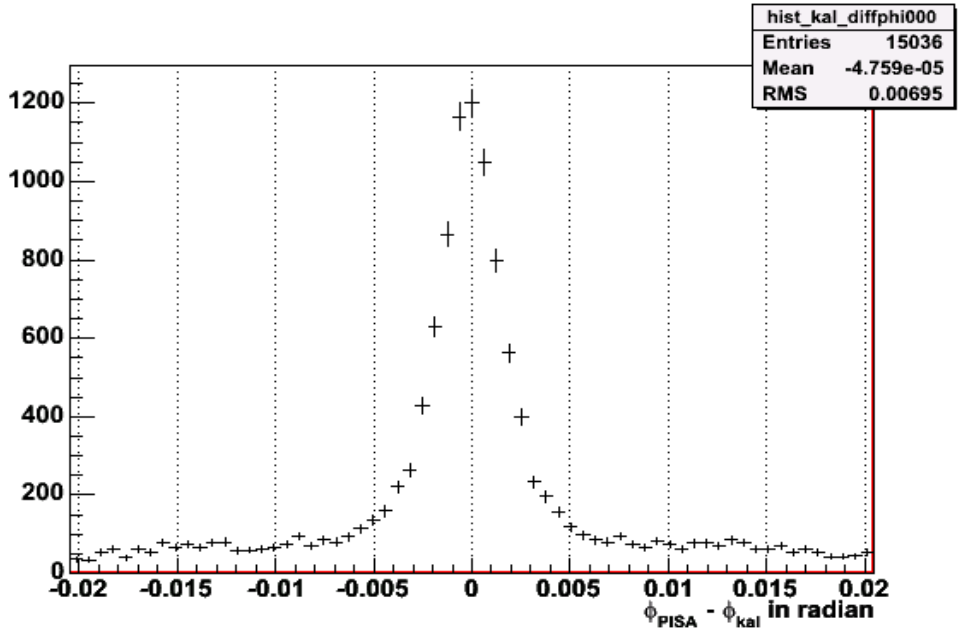
But neither will happen in single pi+ event.

Exodus tracks : φ residual of Layer 0 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

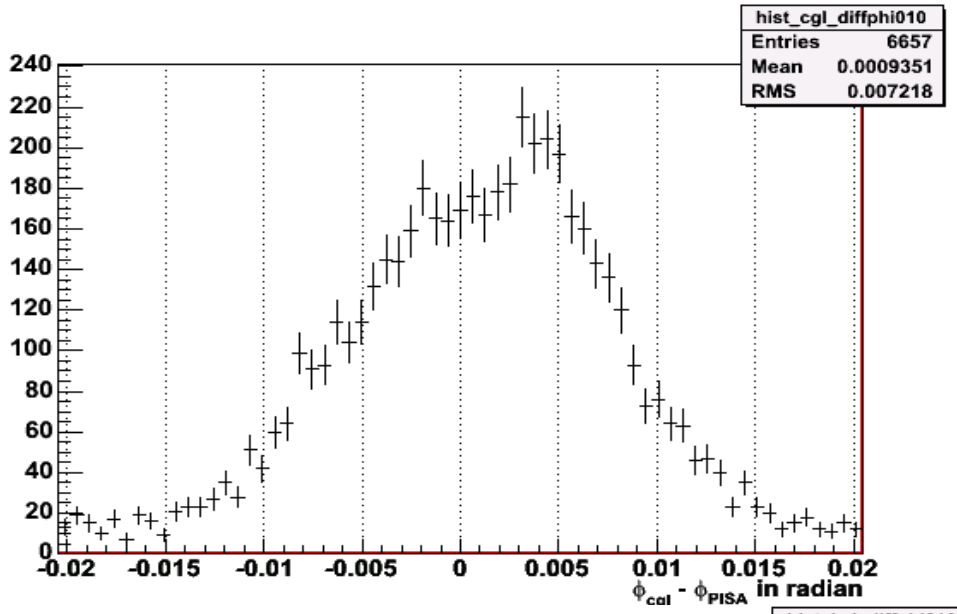


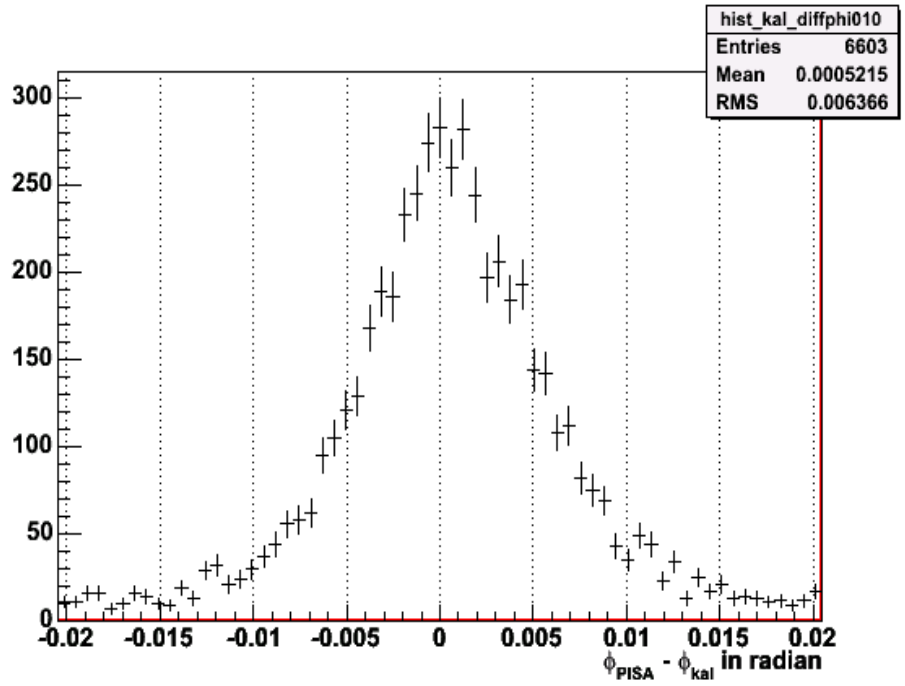


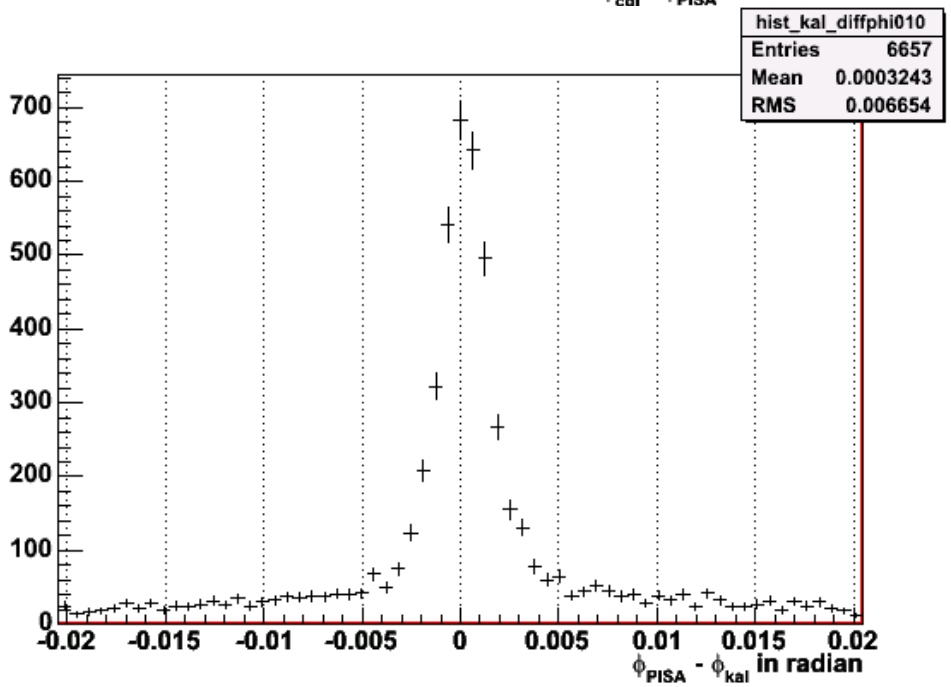


Exodus tracks : φ residual of Layer 1 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

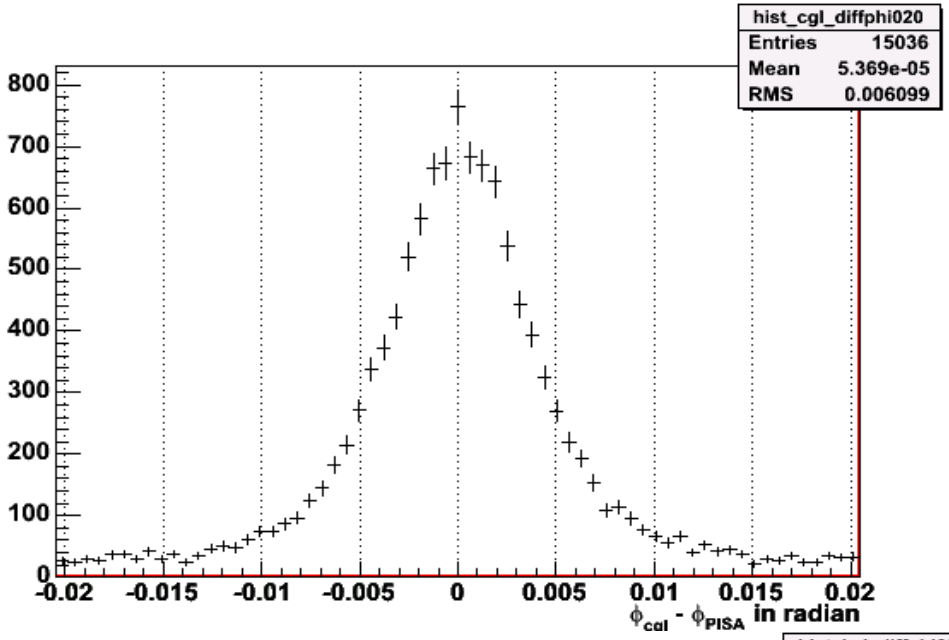


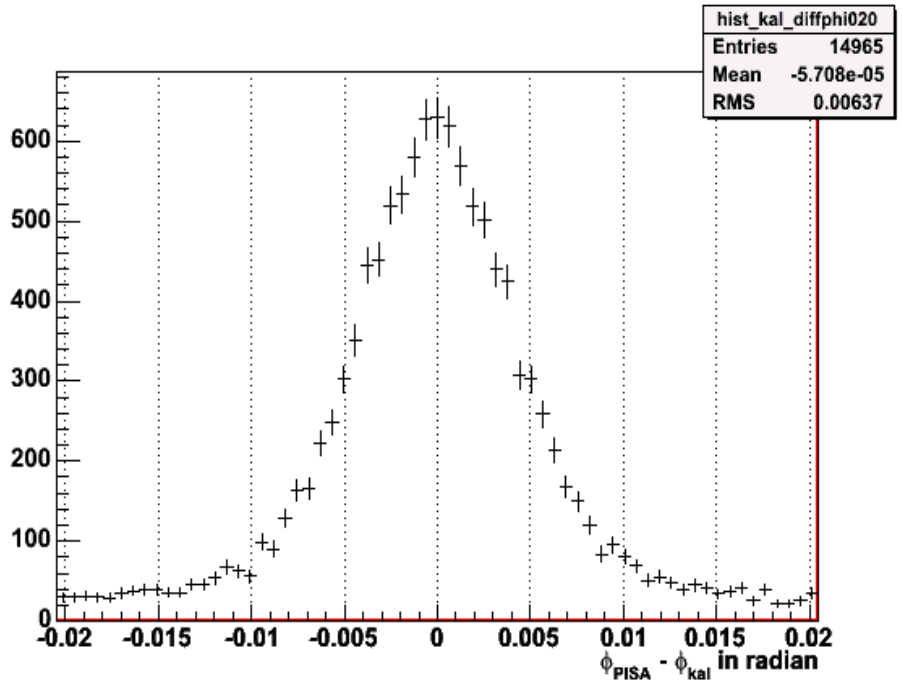


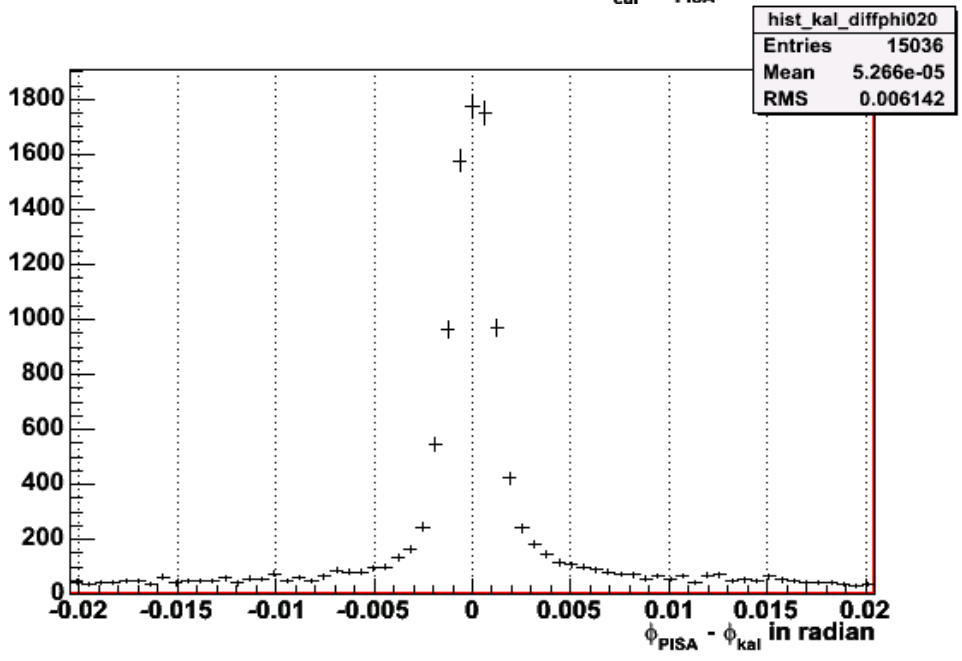


Exodus tracks : φ residual of Layer 2 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

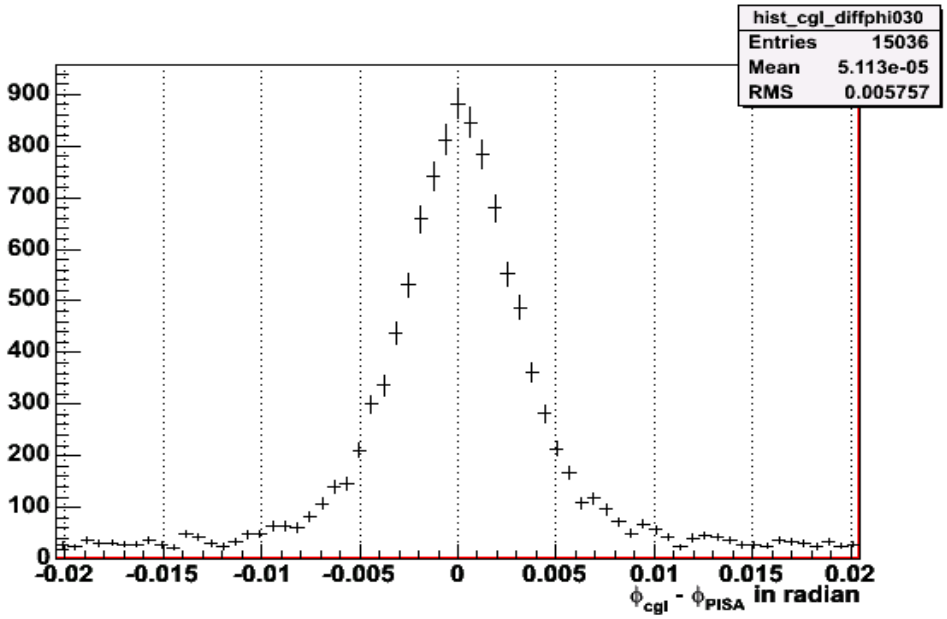


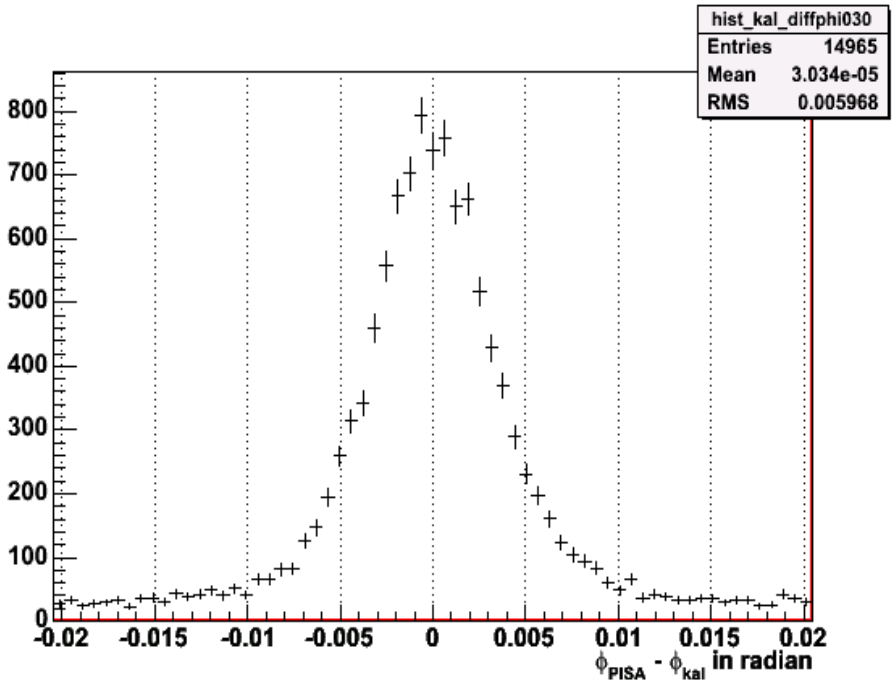


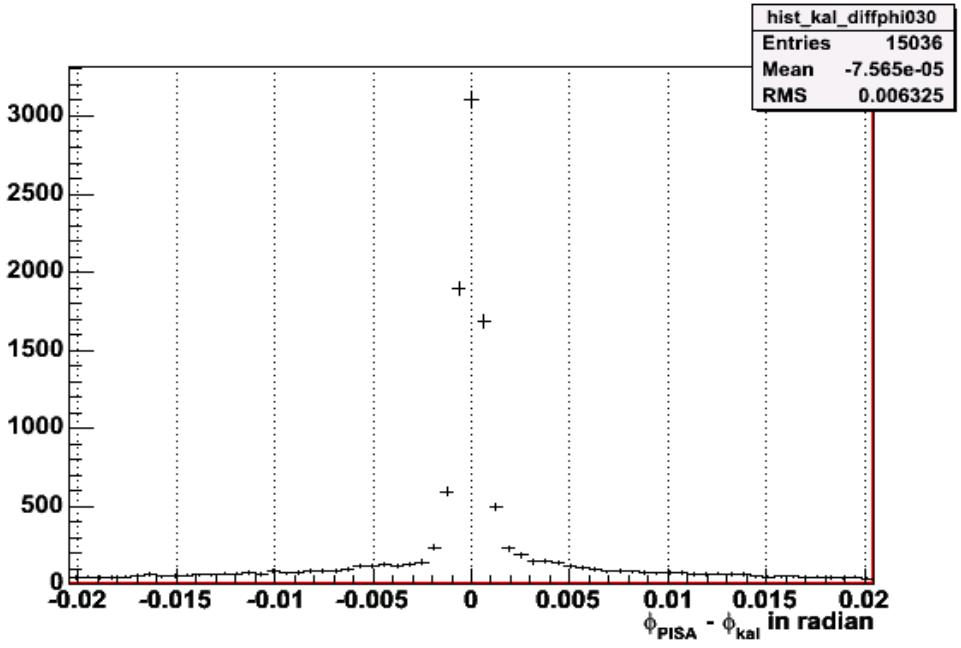


Exodus tracks : φ residual of Layer 3 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

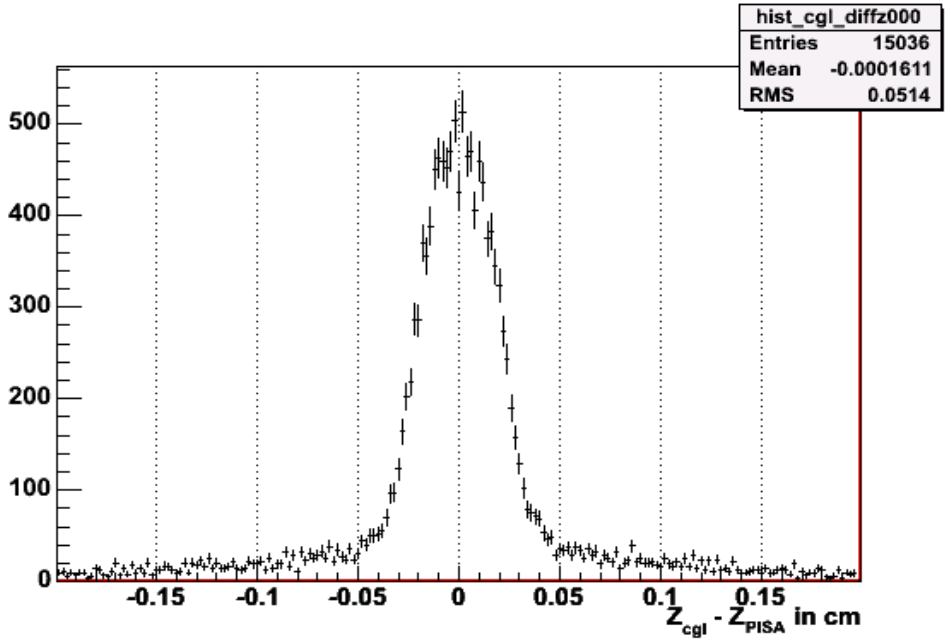


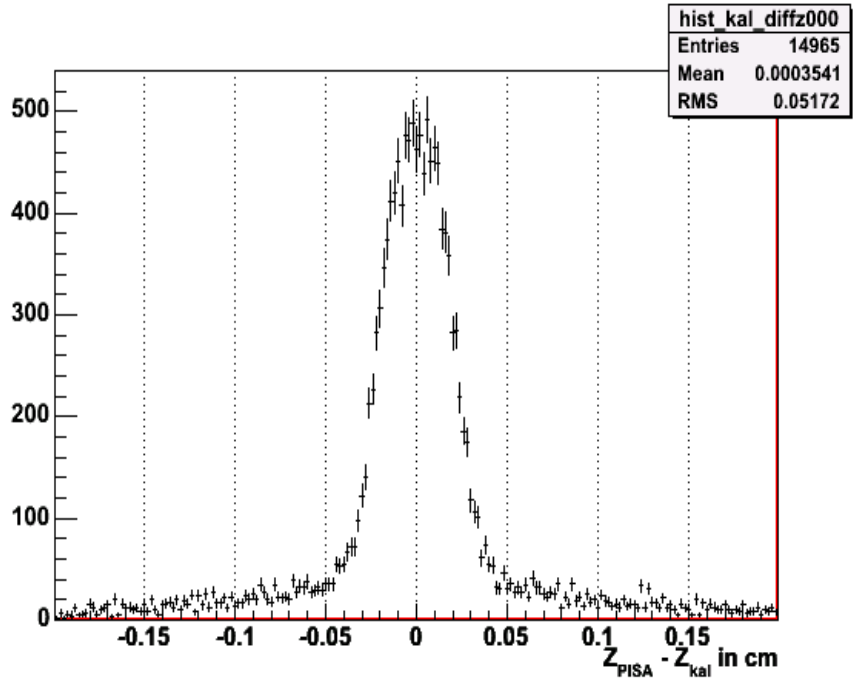


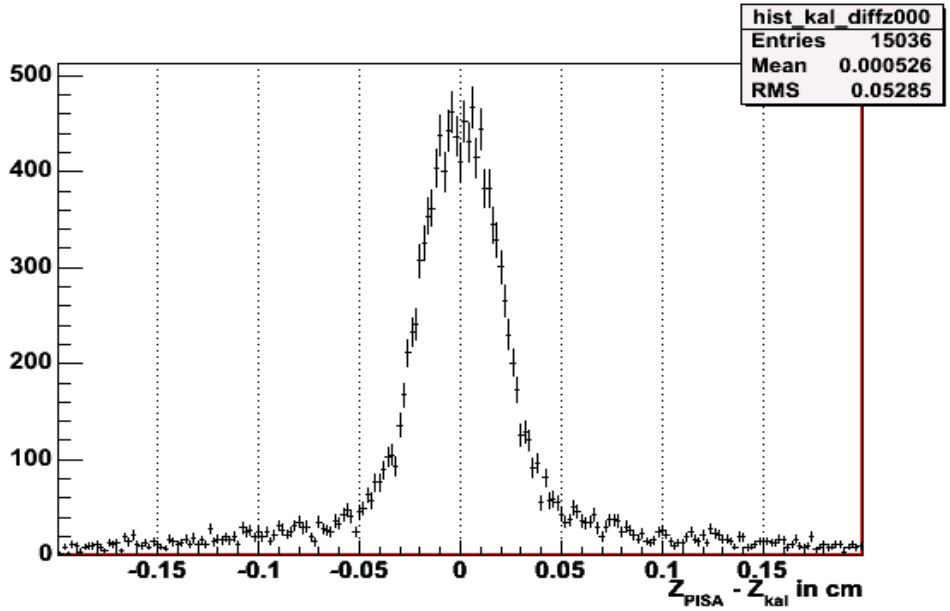


Exodus tracks : Z residual of Layer 0 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

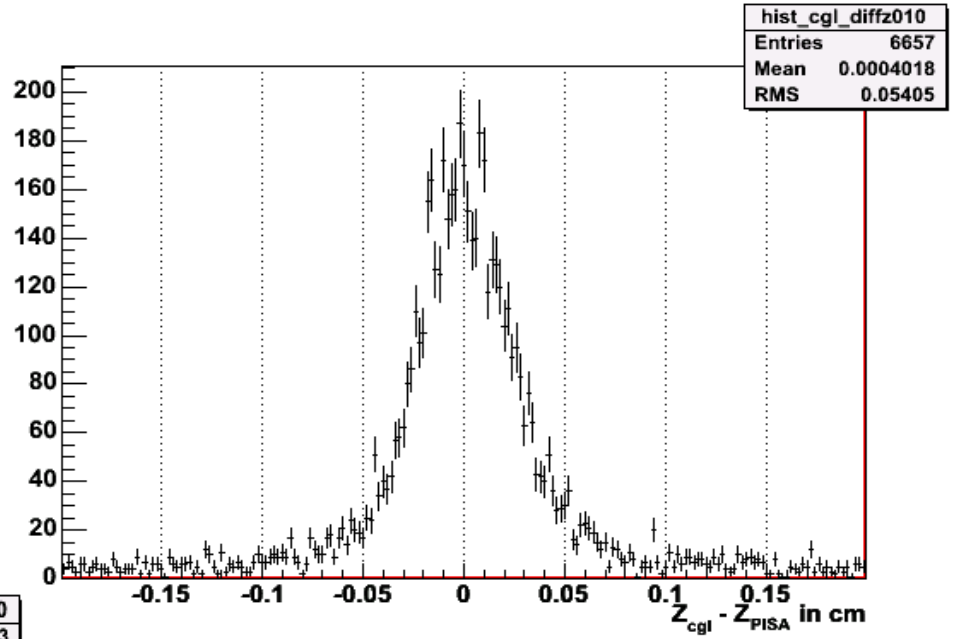


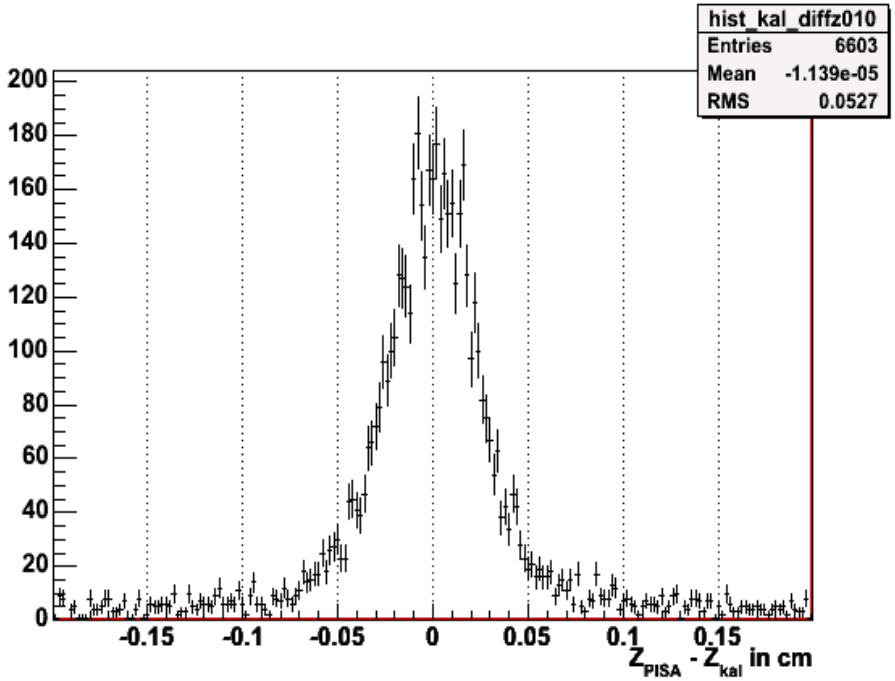


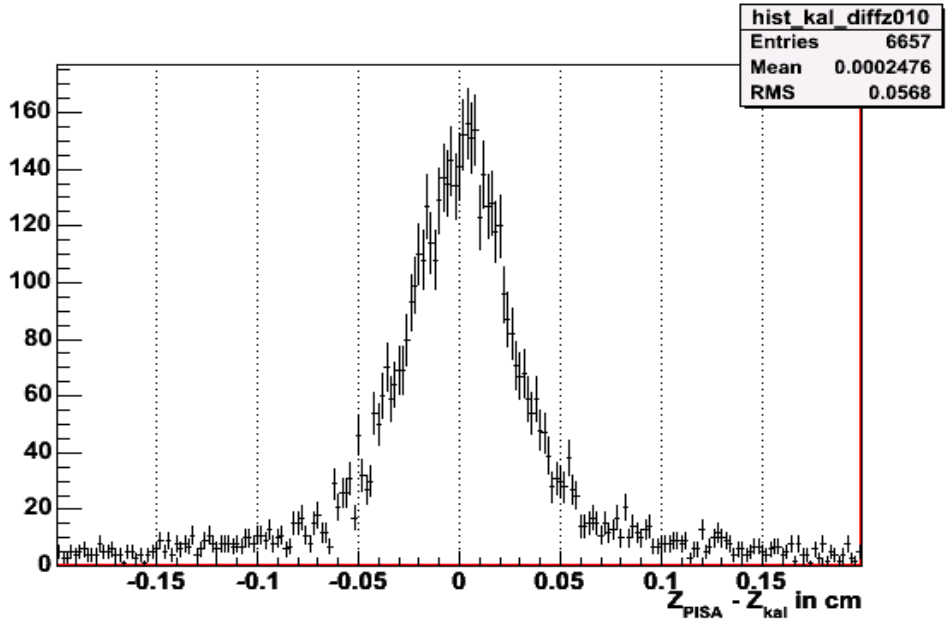


Exodus tracks : Z residual of Layer 1 (pixel)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

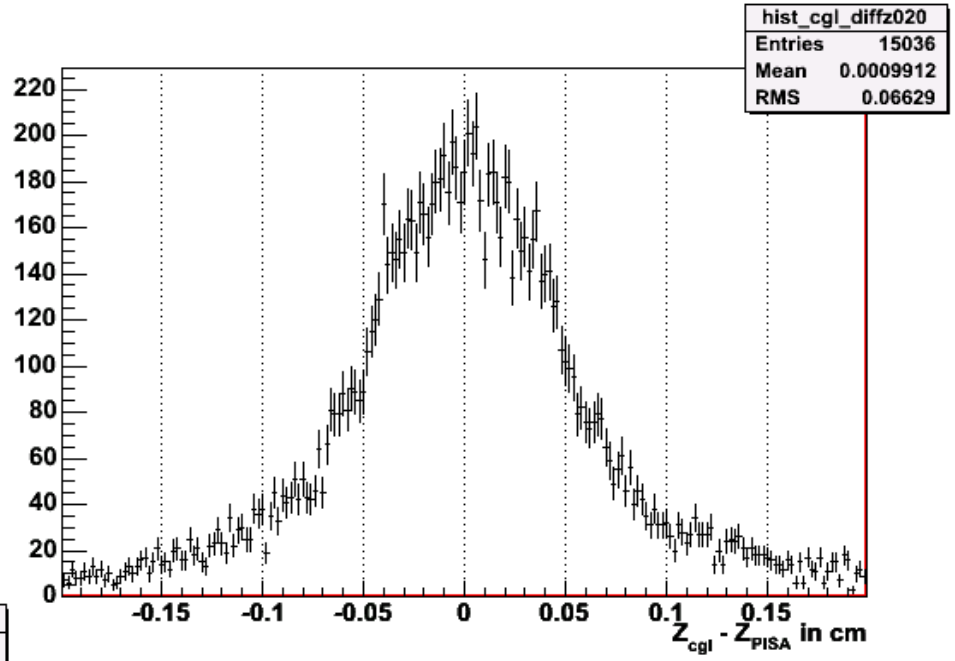


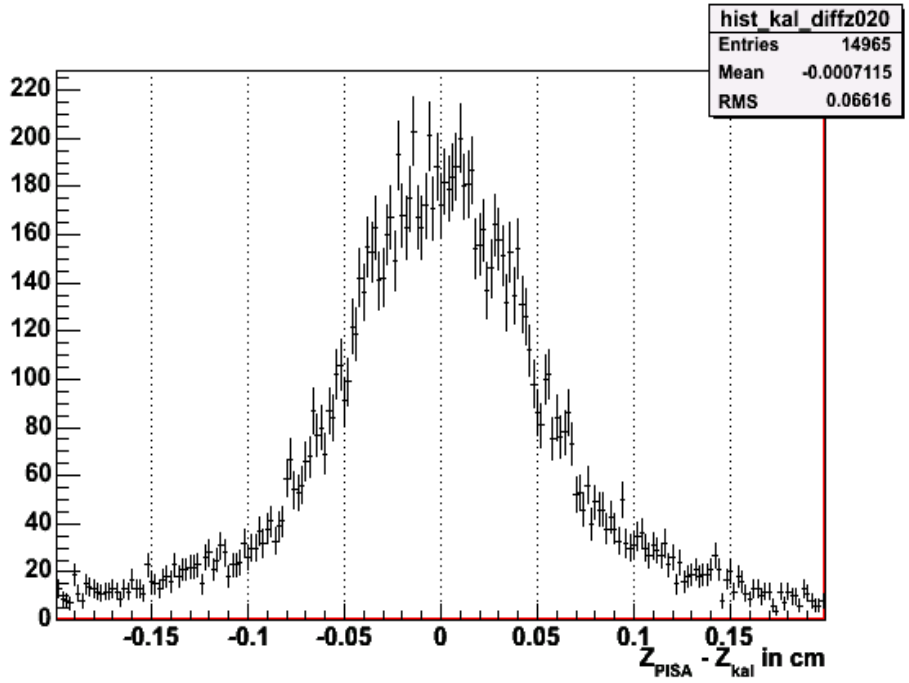


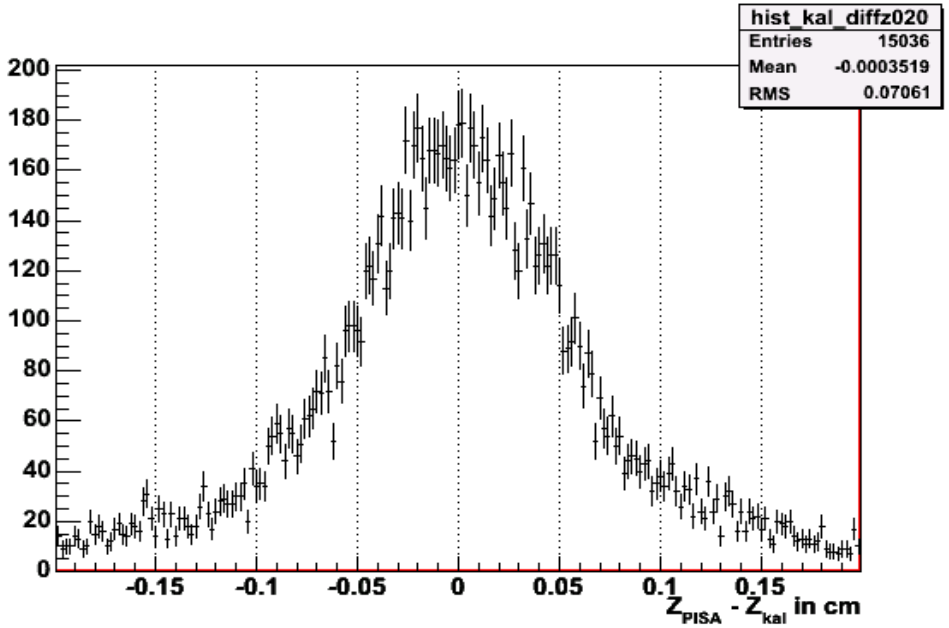


Exodus tracks : Z residual of Layer 2 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

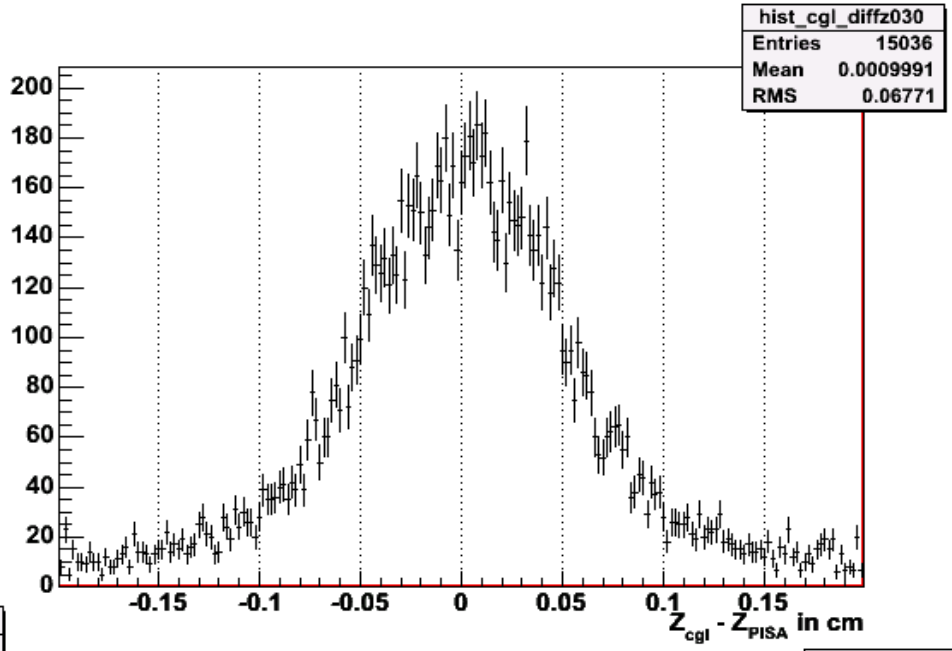


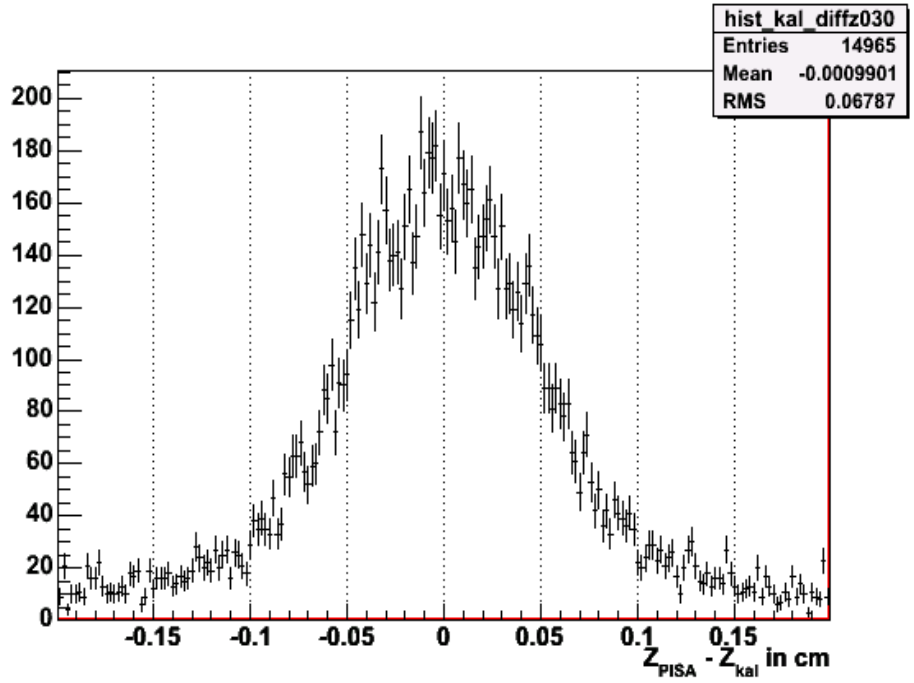


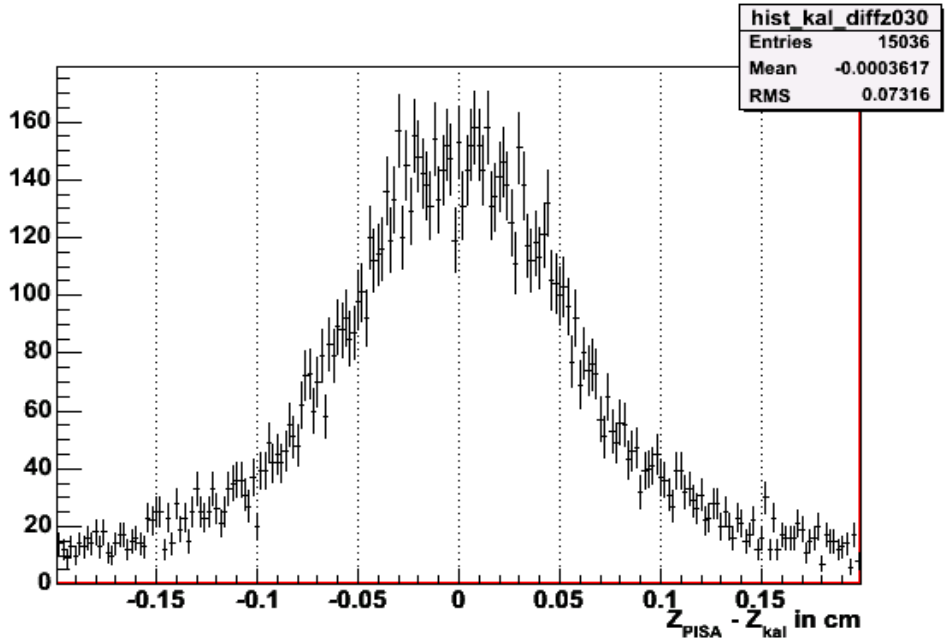


Exodus tracks : Z residual of Layer 3 (strip)

Top-right: Cgl tracks
Bottom-left: Kalman track before fitting
Bottom-right: Kalman track with fitting

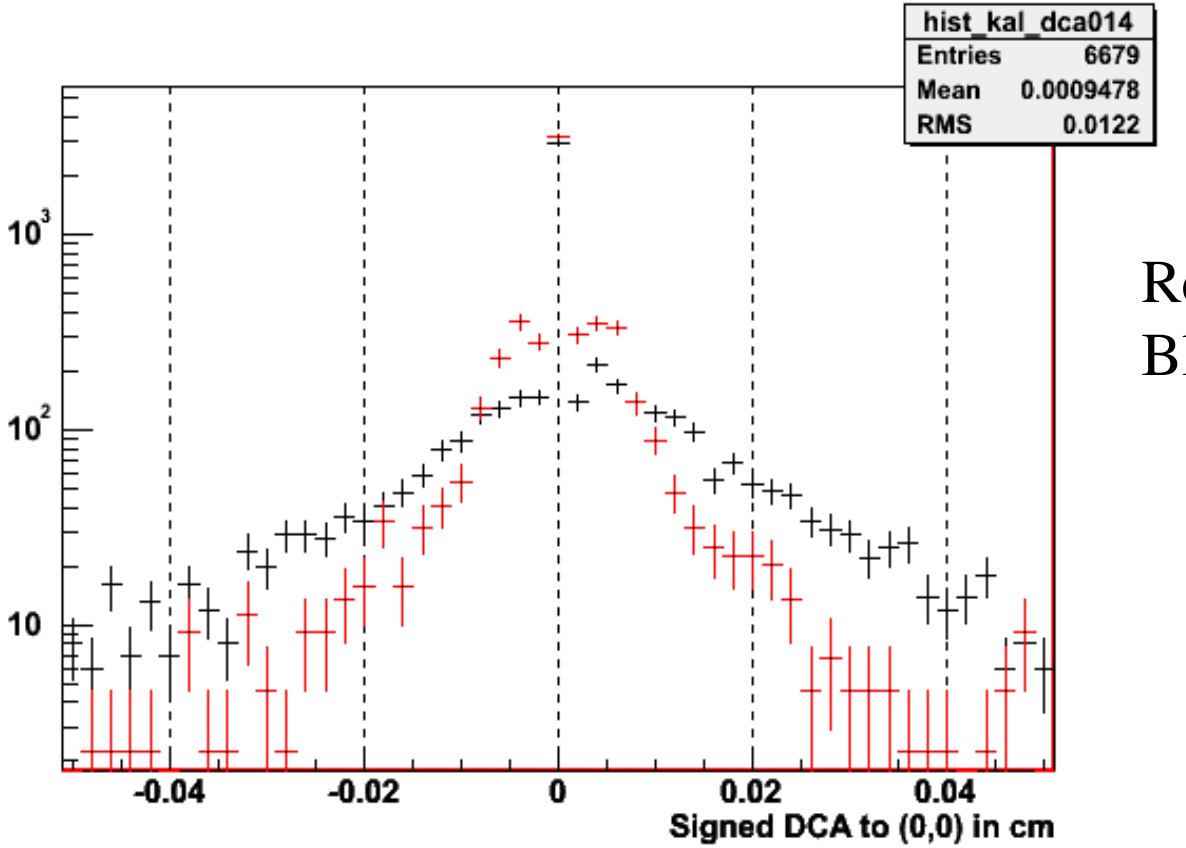






Next step: DCA plot

This is done with the old version of Kalman, when we let Cgl track do the associating job. The current version I used to get residuals has a constraint of collision vertex (r=0), but should work as well after we remove that. The sign of DCA is defined as the direction of R x Pt. This plot is normalized so that direct and decayed tracks have same number of entries.



Red: pi+
Black: K-/pi+ from D

Future Work

Make resolution ajustment of Z such that Kalman works as well as on azimuthal residuals.

Remove the collision vertex constraint in the new Kalman version, and make DCA plot.

Running single D-meson event, and merge the decay tracks into Au-Au event simulation using exodus. Check how Kalman can help picking decay tracks out by fitting different DCA.