Tracking Update

## Simon Taylor/JLab

- Updates to the repository
  - Efficiency
  - Resolutions
- Normalized residuals
- Multi-particle final states
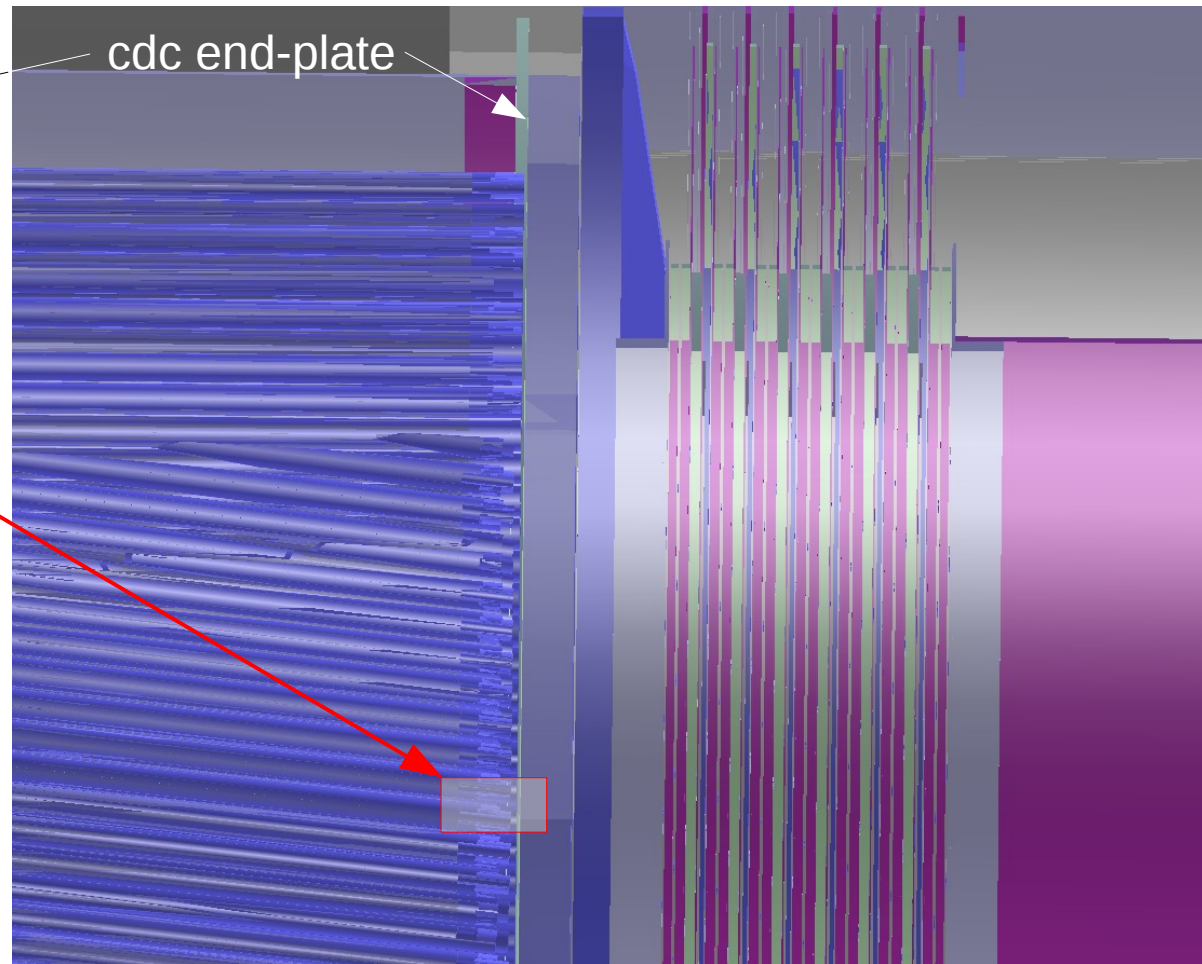 - Reconstruction rates

Recent changes to code repository

- CDC geometry changed to correspond to engineering drawings
  - Added donuts and feed-throughs at ends of straws
  - Read wire positions from XML

- Made code more robust for low-momentum particles stopping within active tracking region

- New "vertex point" configuration parameters (relevant for thin targets)

- Numerous enhancements for speed
  - Streamlined generation of reference trajectories
  - Reduced number of calls to GetField from fine-mesh field map
  - Tuned number of iterations per pass
  - Optimized frequent matrix operations (unrolling loops)
  - ... and numerous other small changes...

- Tweaks to broken track recovery code (spurred by changes to CDC geometry)

JSA

Jefferson Lab

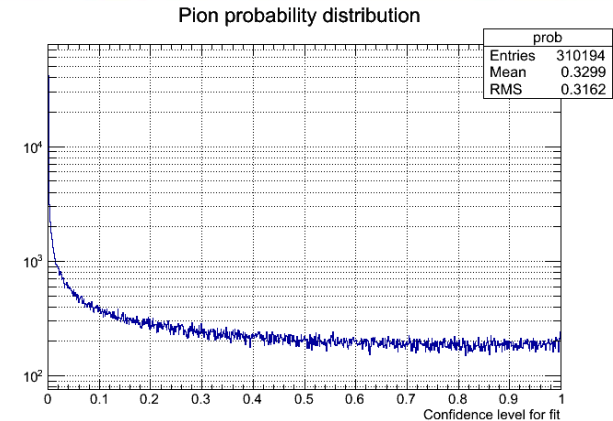# Details of CDC geometry near end-plate

cdc end-plate
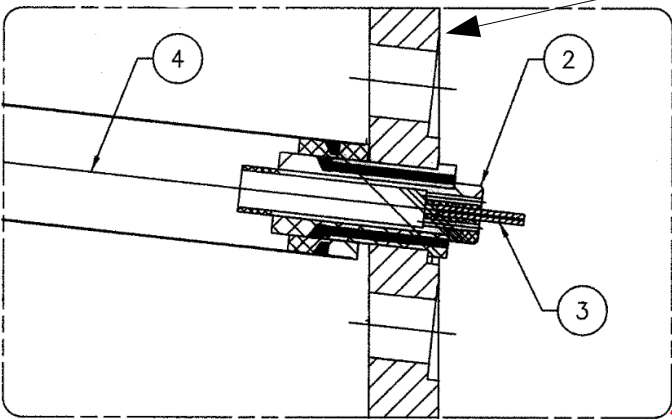
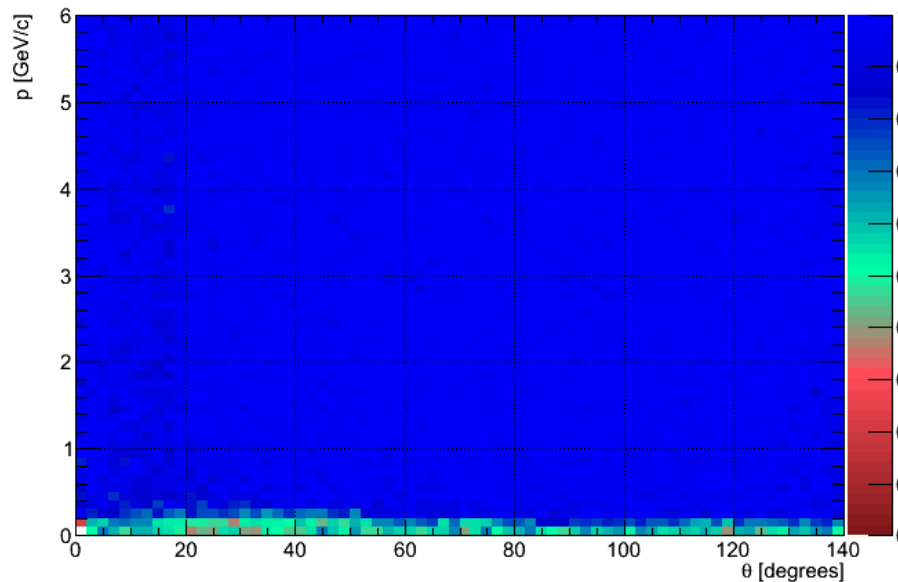• Downstream end: implemented plastic donuts, inserts and feed-throughs in CDC xml

Efficiency

- Generated 440,000 π^- tracks
  - p=0.1-6.1 GeV/c
  - θ=1-141°
  - z=65 cm
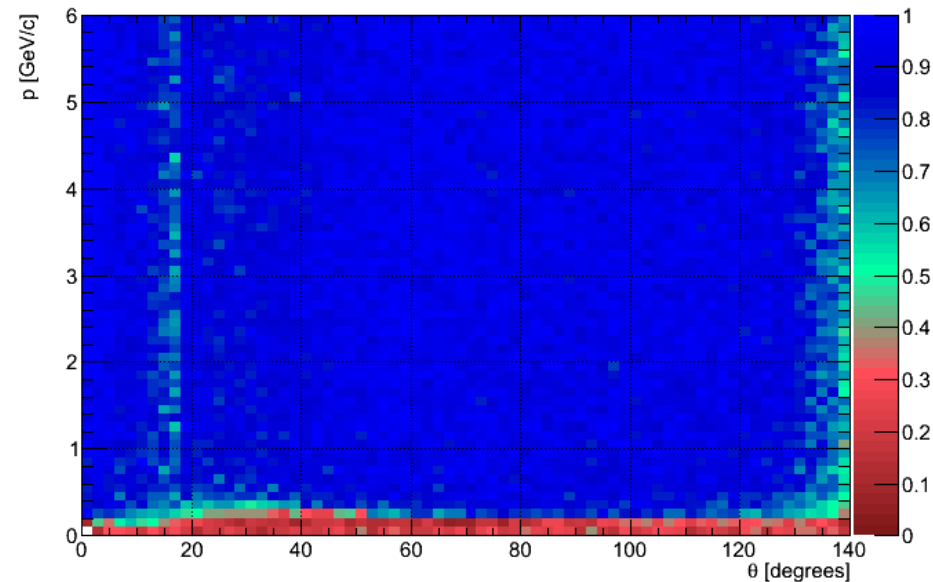
Used scripts for automated single-track reconstruction

Pion probability distribution
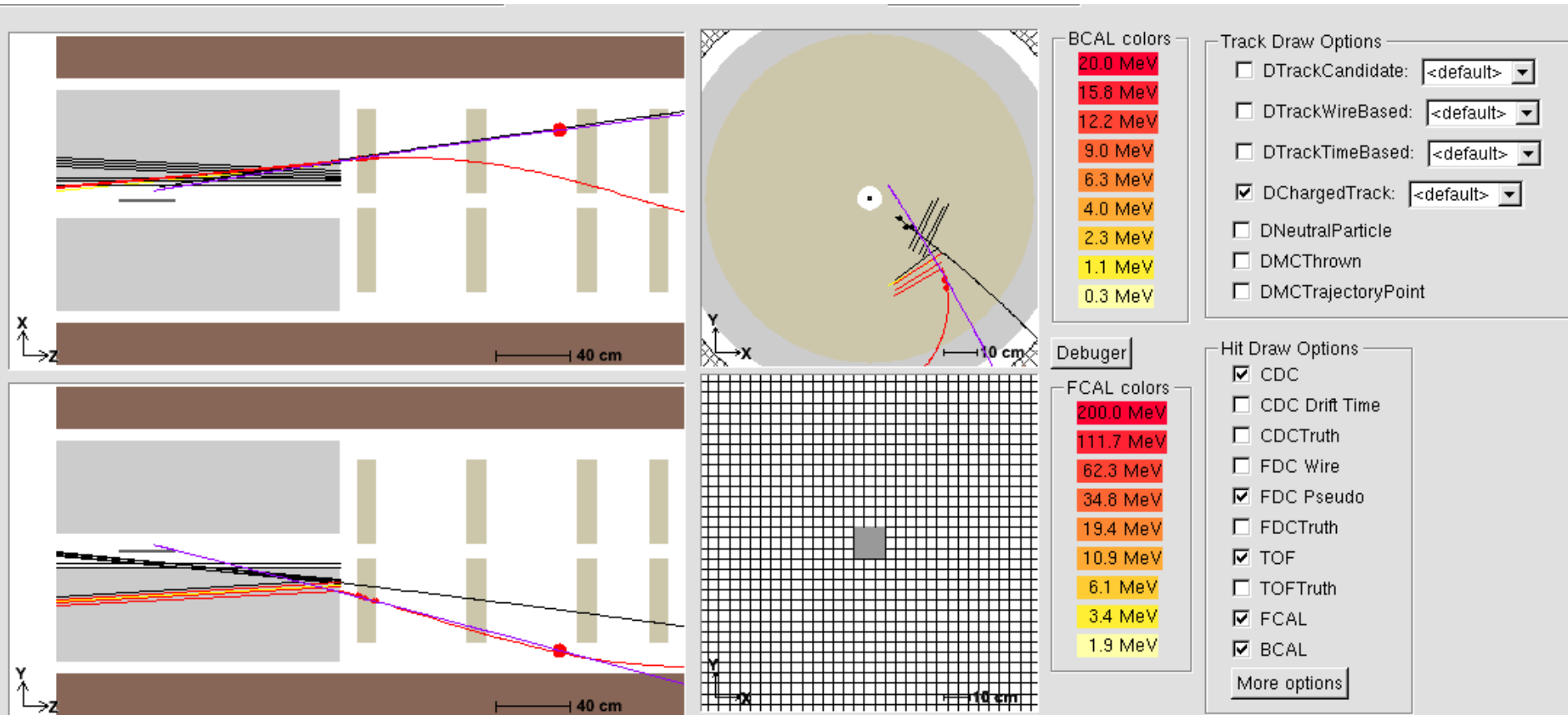

Pion reconstruction efficiency

Pion reconstruction efficiency, P(χ^2)>0.001

ε=0.965

ε=0.866

Issues with CDC/FDC matching

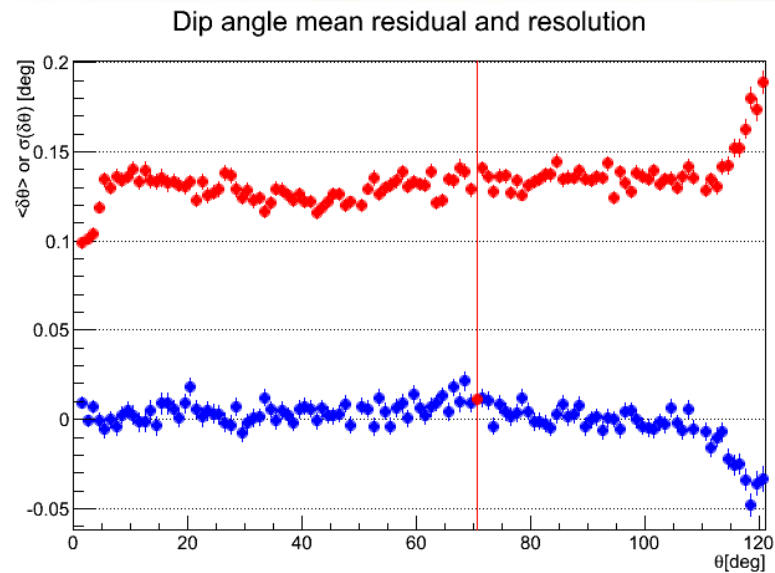Problem region: one FDC track segment in FDC, first axial layer in CDC only

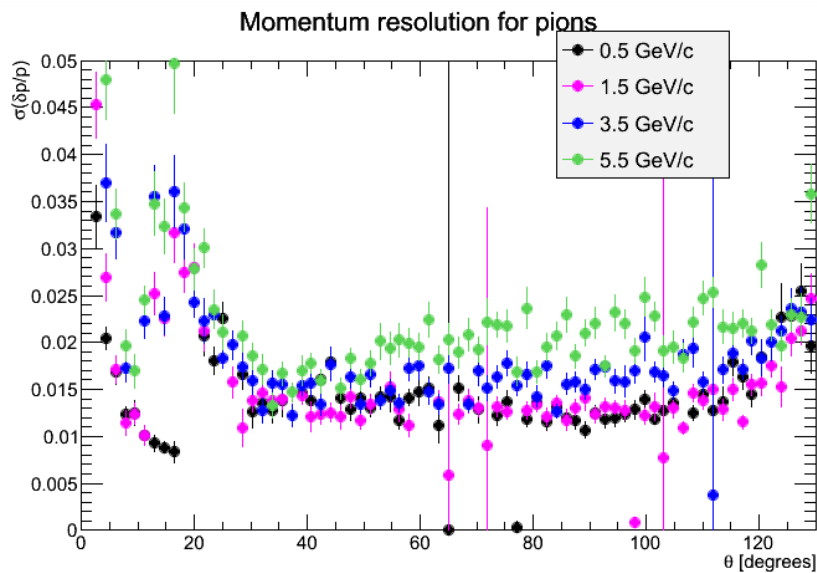# Improved matching

Several changes to *DTrackCandidate_factory_XXX* routines in my dev. version...

Resolution

Momentum resolution for pions
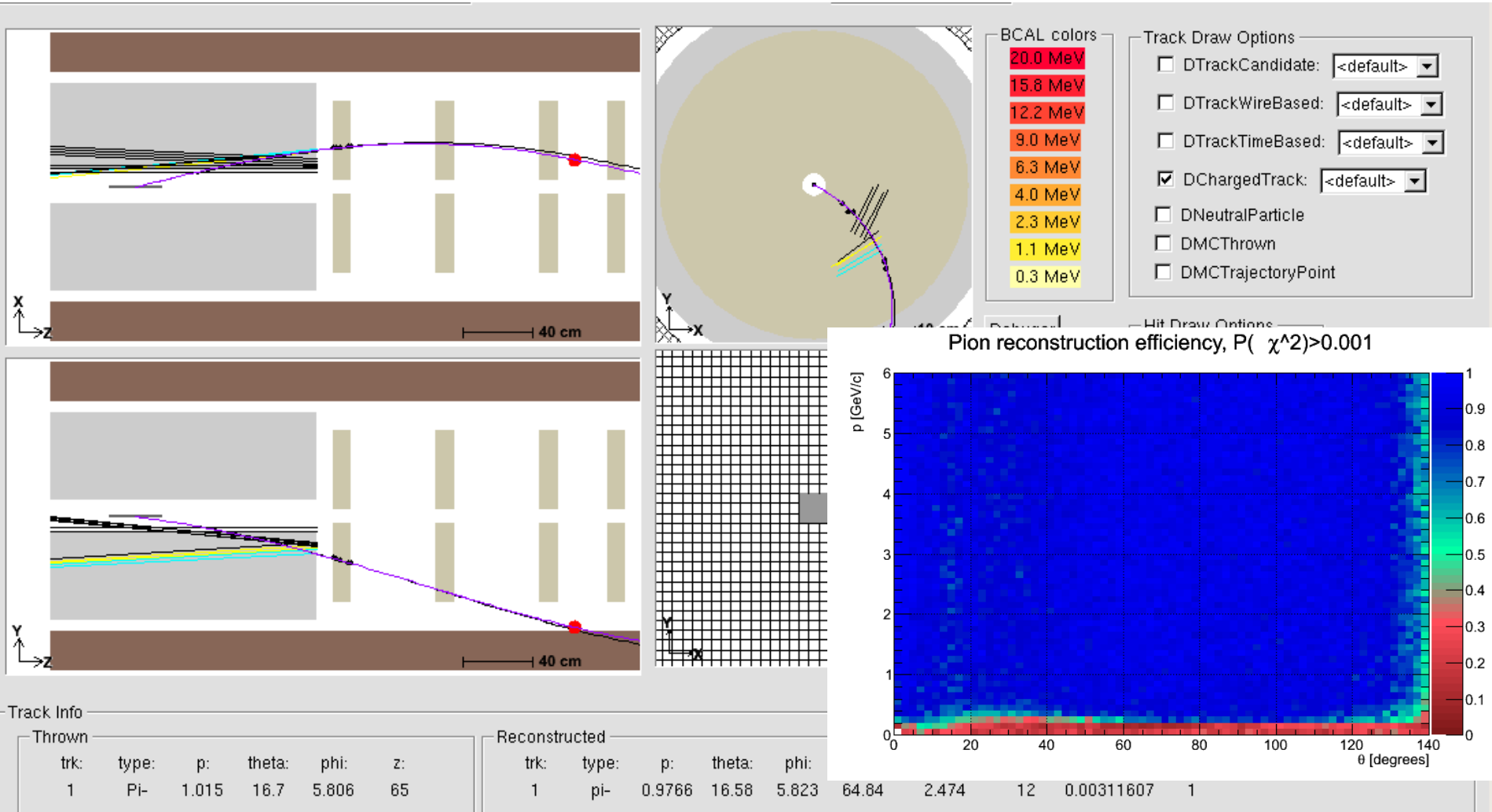
Dip angle mean residual and resolution
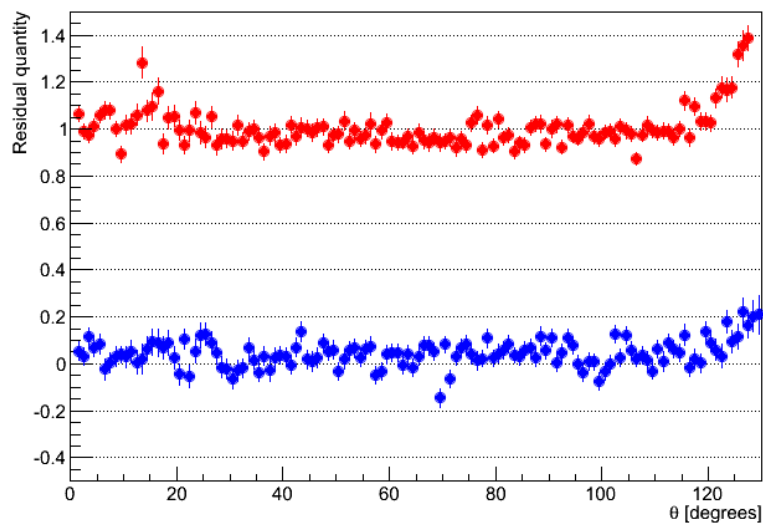
Azimuthal angle mean residual and resolution
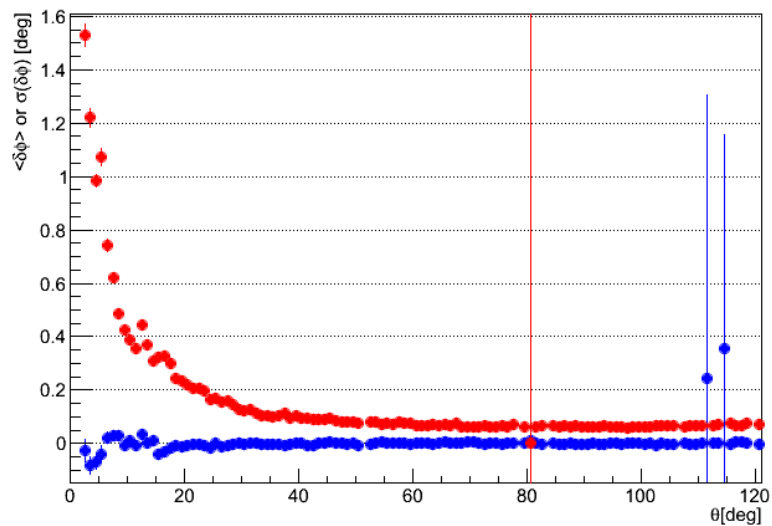
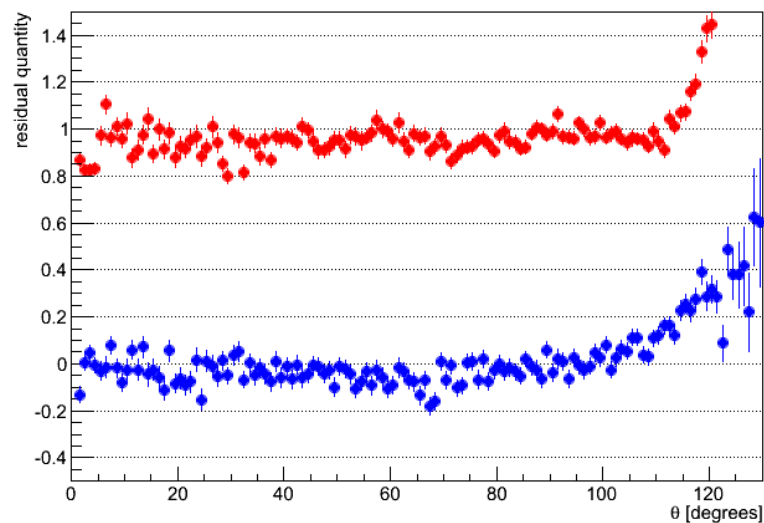# Normalized residuals
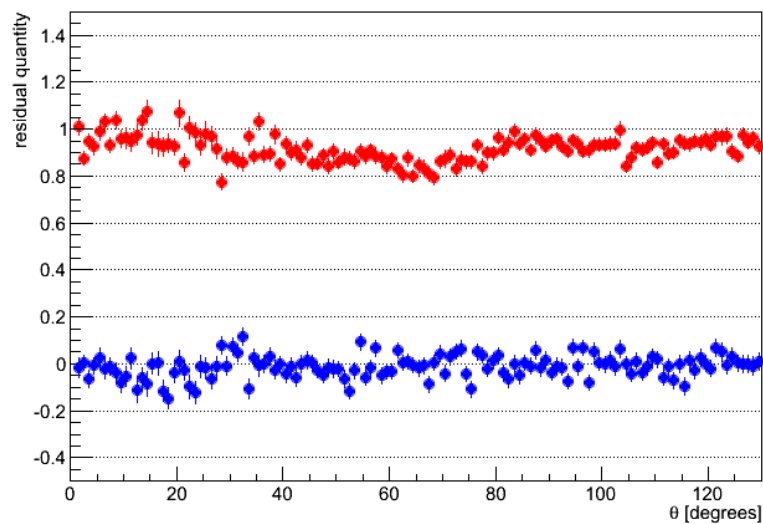

Residual for q/p_T, 0.1-6.1 GeV/c π-
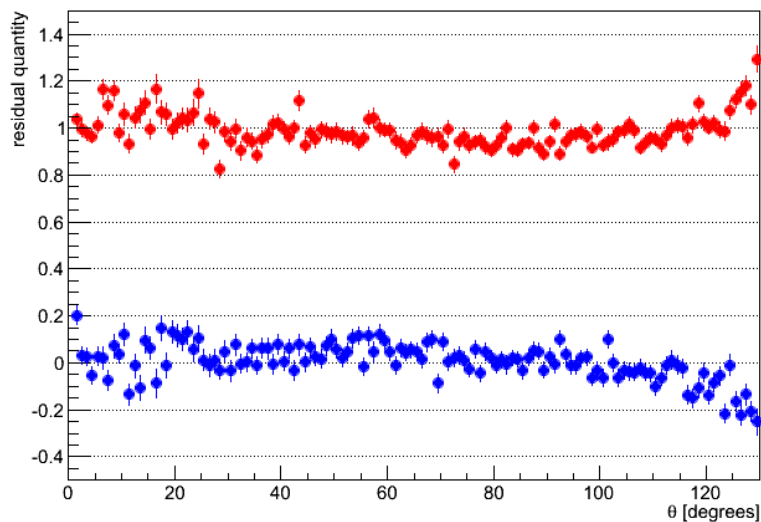

Normalized residual for tanλ, 0.1-6.1 GeV/c π-

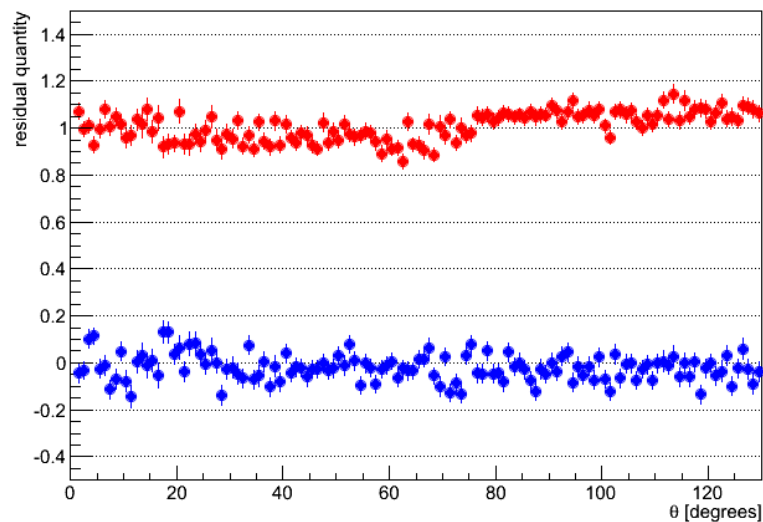Normalized residual for φ, 0.1-6.1 GeV/c π-

sigma
mean

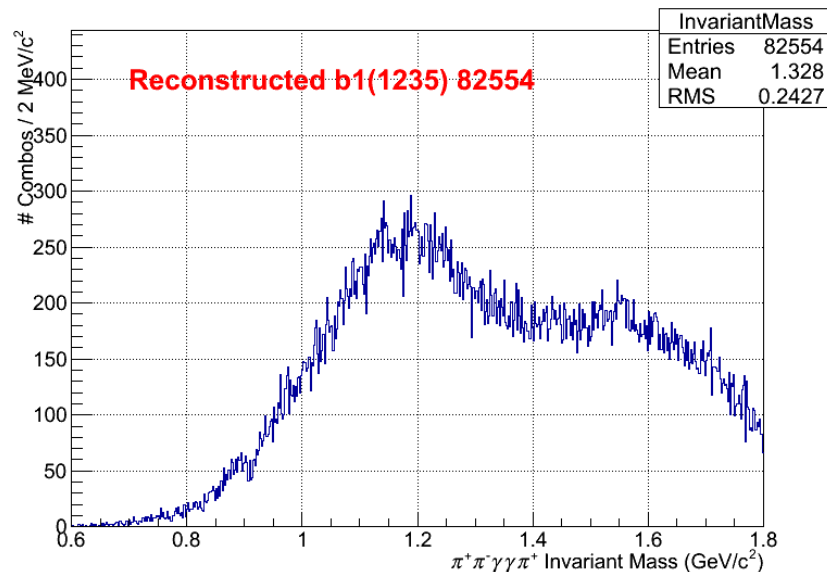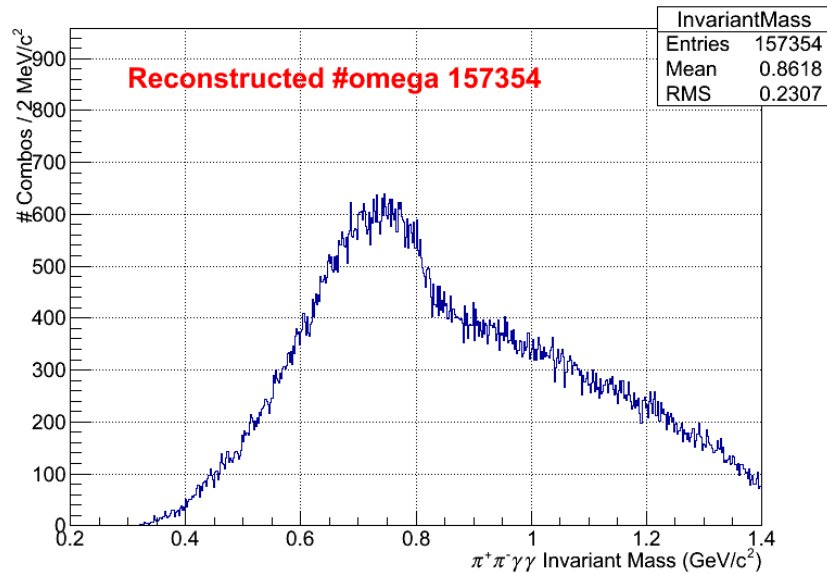# Normalized residuals

Normalized residual for z, 0.1-6.1 GeV/c π-
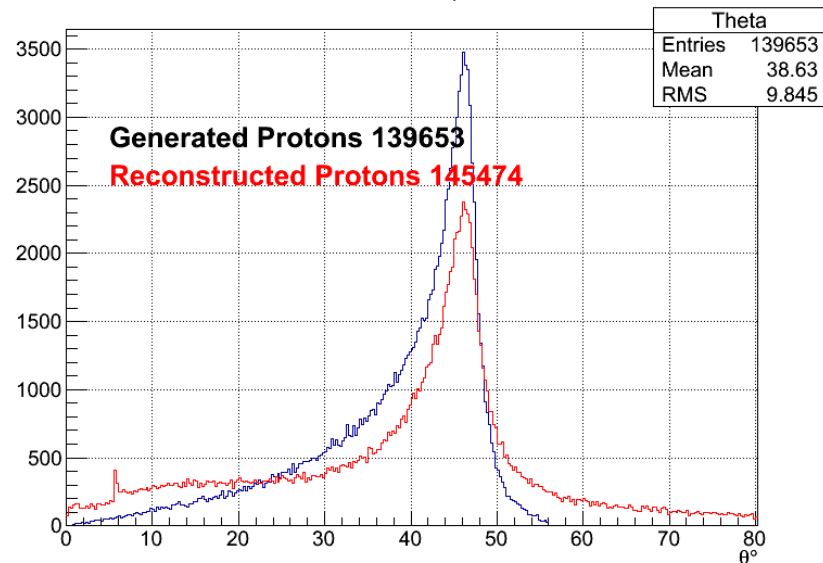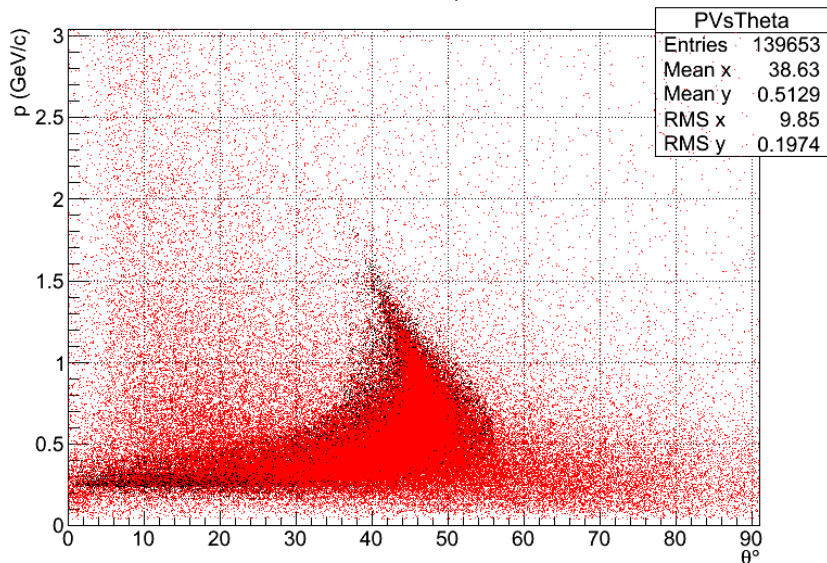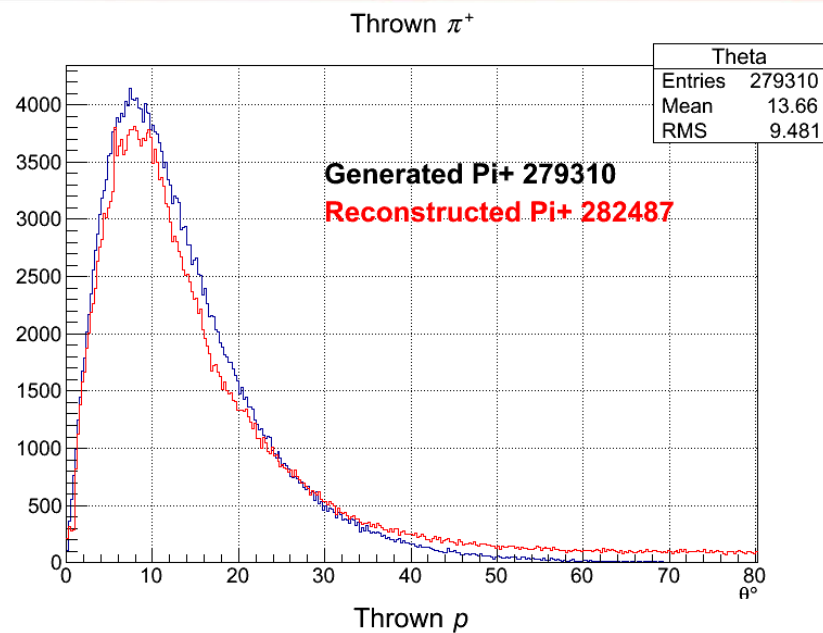
Normalized residual for D, 0.1-6.1 GeV/c π-

sigma
mean

b₁π reconstruction

Reconstructed #omega 157354

InvariantMass	
Entries	157354
Mean	0.8618
RMS	0.2307

Reconstructed b1(1235) 82554

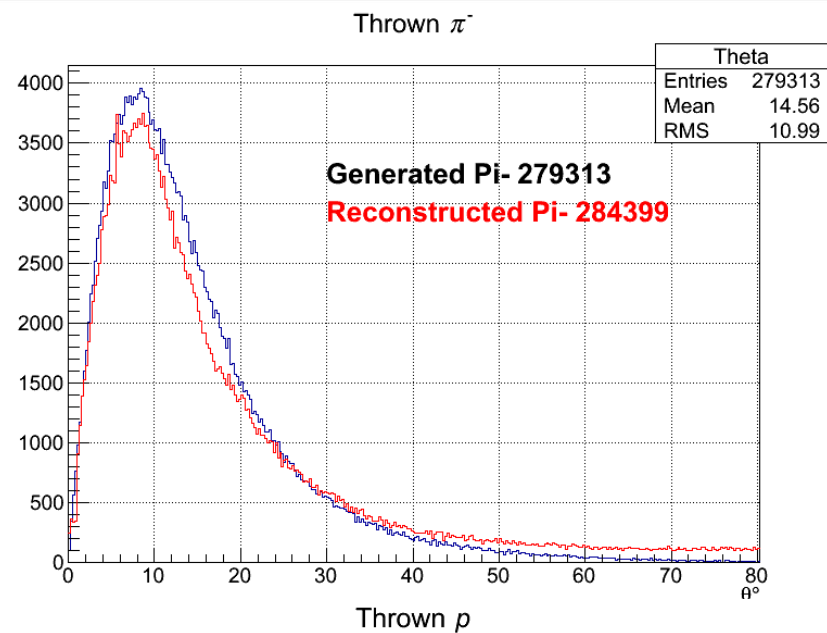| InvariantMass	
Entries	82554
Mean	1.328
RMS	0.2427

- Plots generated using scripts for automated b₁π reconstruction
- Using development version of tracking code with "broken track" recovery and fixes to track candidate code

Reconstructed X(2000) 45931
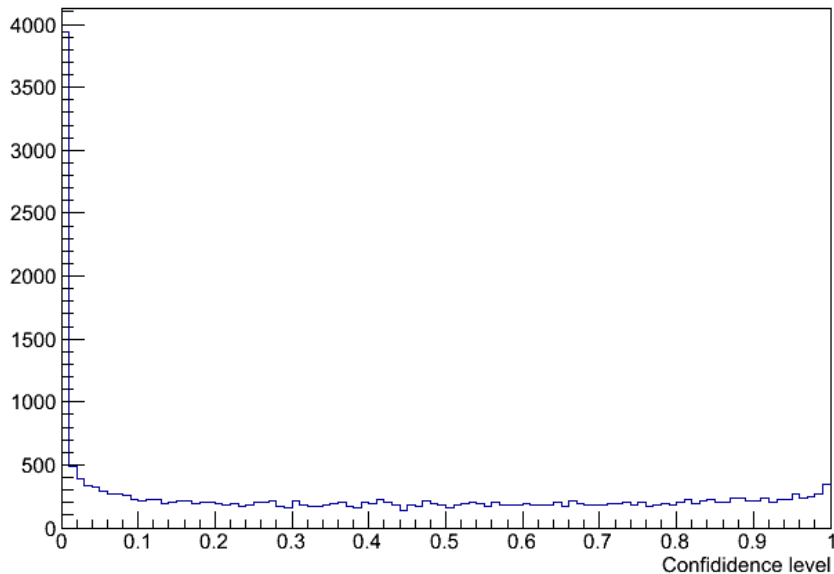
InvariantMass	
Entries	45931
Mean	1.973
RMS	0.2621

Jefferson Lab
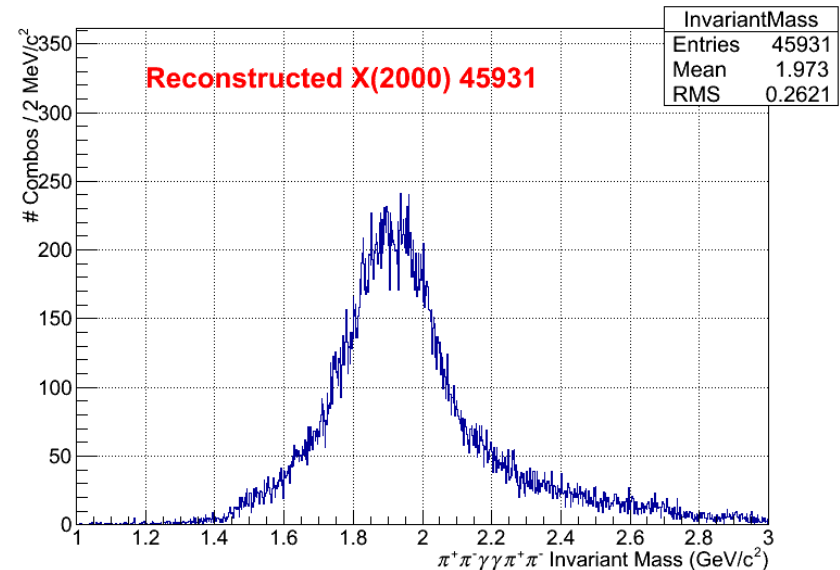
b₁π reconstruction

Kinematic fitting of pρ events

- Generated 200000 γp→ρp events, E_γ =9 GeV, t-slope=5 GeV^{-2}, vertex z=50-80 cm
- Simulated detector response with *hdgeant* and standard smearing
- Standard reconstruction
  - Require 1 proton, 1 π^-, 1 π^+, nothing missing
  - 2 mass hypotheses (π^-, K^-) for negative tracks
  - 3 mass hypotheses (π^+, K^+, p) for positive tracks
- Four-vectors and covariance matrices passed to old kinematic fitter (need to update my tests to use Paul's kinematic fitter...)
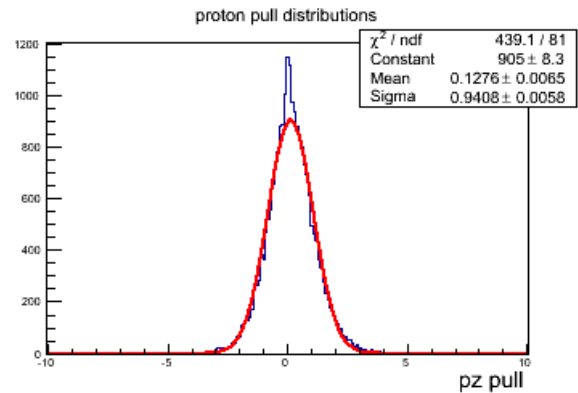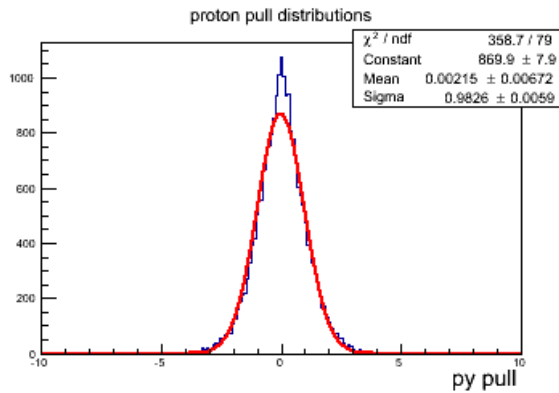
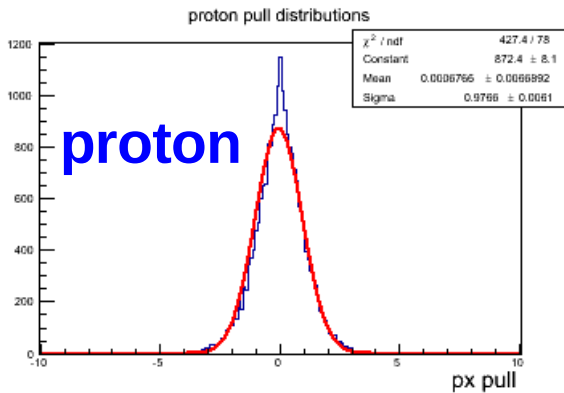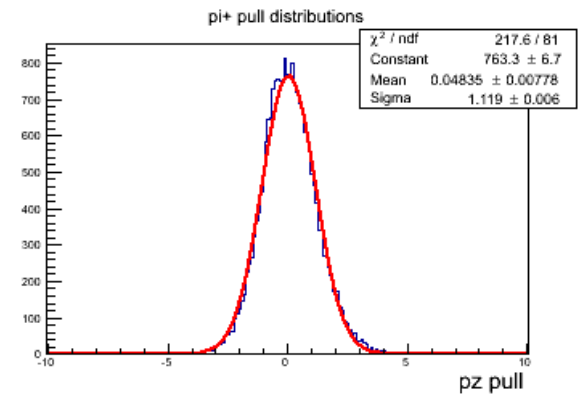*4C fit*

pππ kinematic fit prob.

π+π- mass, CL>0.01

pip_pim_mass_cut	
Entries	21631
Mean	0.7733
RMS	0.1404
pip_pim_mass_kin	
Entries	21631
Mean	0.77
RMS	0.1311
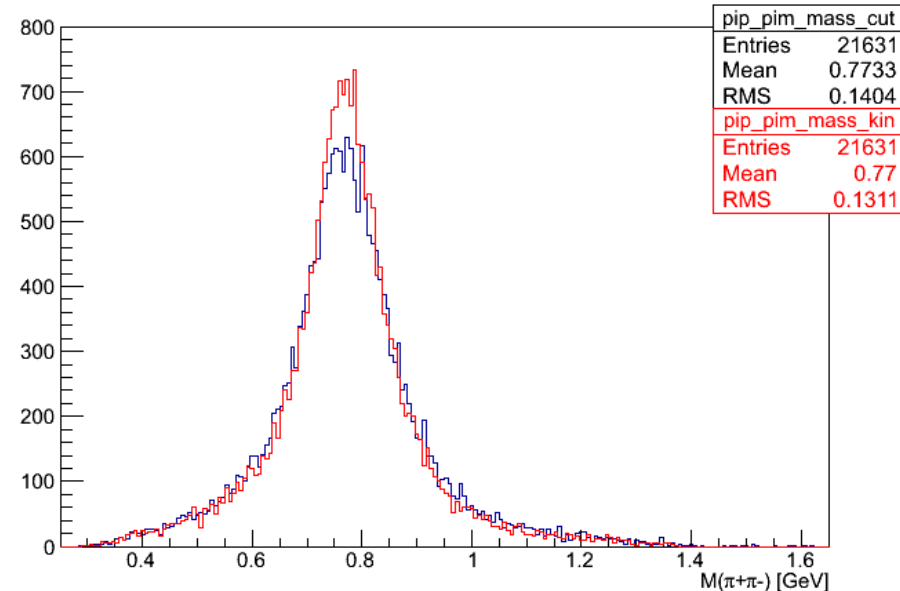
Pull distributions
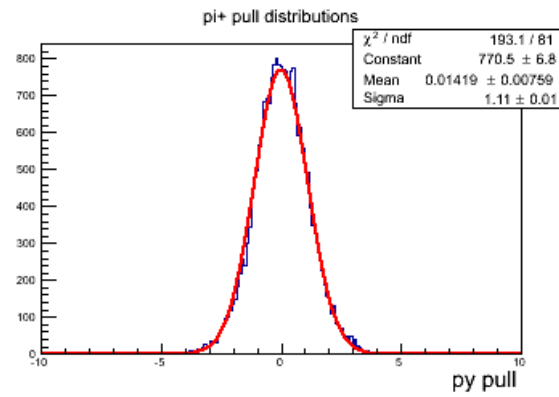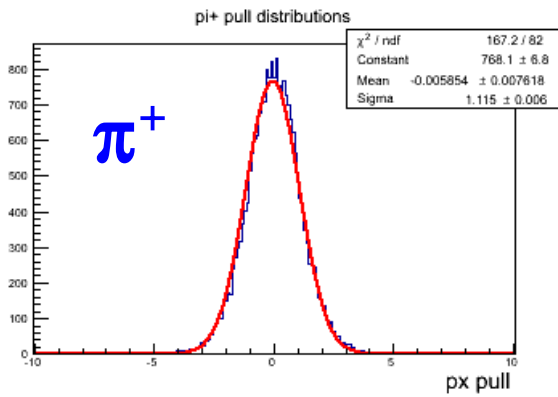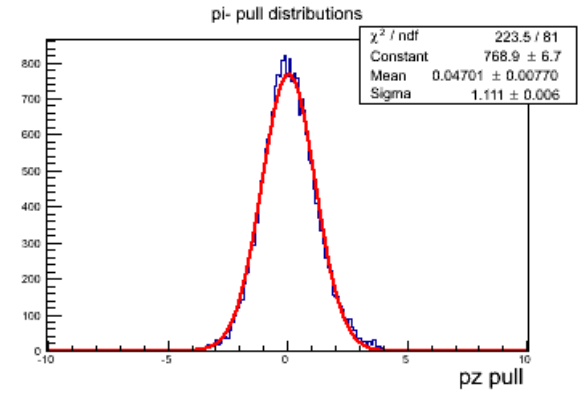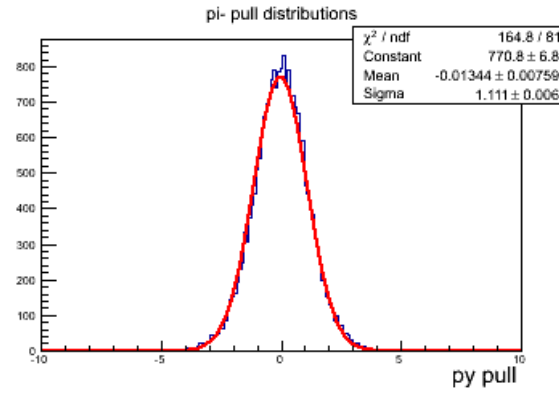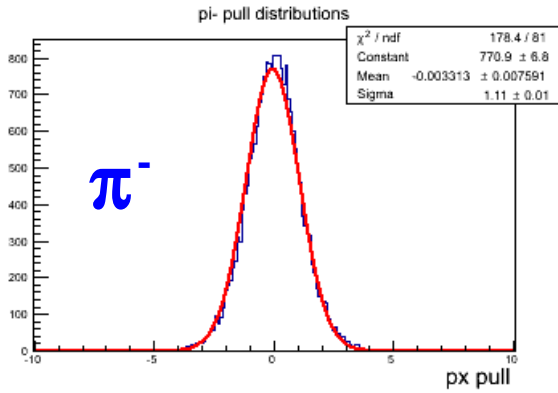
Reconstruction Rates

Tests done on ifarm1101(2.0 GHz Opteron CPU, 512KB cache, gcc 4.4.6)
Tests done on ifarm12s01 (2.0 GHz Xeon CPU, 20480KB cache, gcc 4.1.2)

Topology	Rate (one thread) [Hz]			
	Oct'12($p,\pi^{\pm}$)	Feb'13 ($p,\pi^{\pm}$)	Feb'13($p,\pi^{\pm},K^{\pm}$)	
π^- (1°-141°, 0.1-6.1 GeV/c)	34.3	52.6	30.4	44.0
p (1°-141°, 0.1-2.1 GeV/c)	33.0	46.7	32.7	44.4
$p\rho$, $\rho\rightarrow\pi^+\pi^-$	10.5	14.0	9.5	13.9
$n\rho\pi^+$, $\rho\rightarrow\pi^+\pi^-$	5.6	9.2	6.0	9.2
$pb_1\pi$	2.8	4.8	3.2	4.8

... using revised version of Track Candidate code ...

Summary

- Changes to the CDC geometry lead to modifications in broken track recovery and CDC/FDC track candidate matching (fixes will be check in soon...)

- Tracking code more robust: trap for "stopping" particles

- Tracking reconstruction running ~30-50% faster than previous benchmark