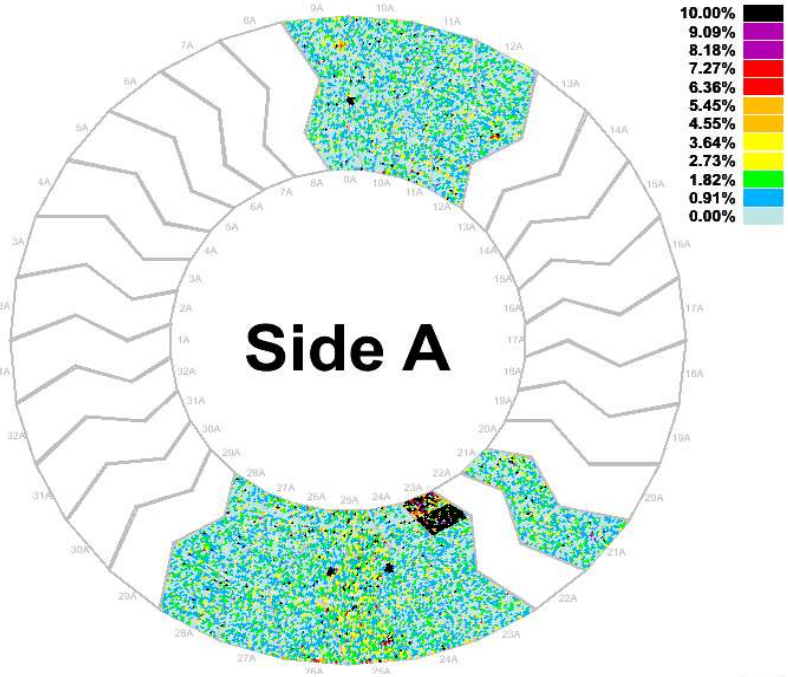
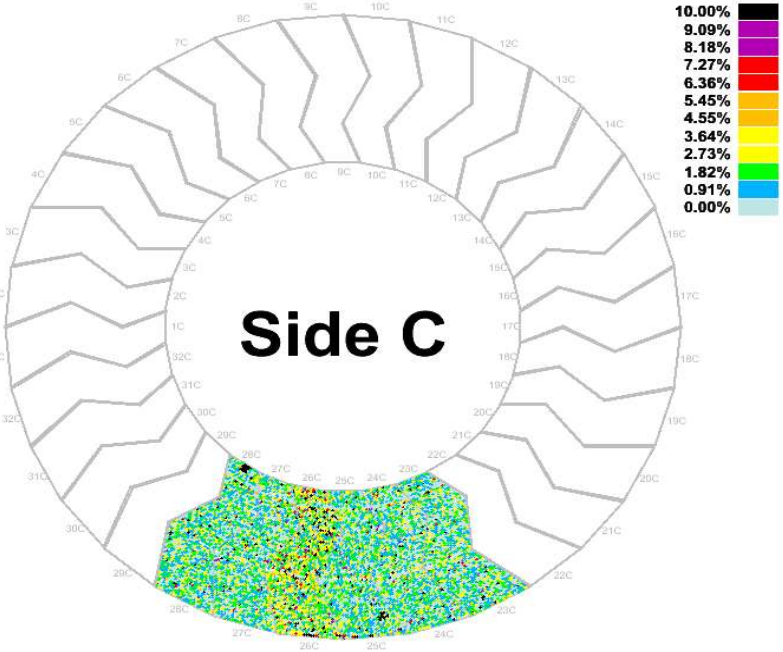
Alignment of TRT wrt SCT in M6 Data

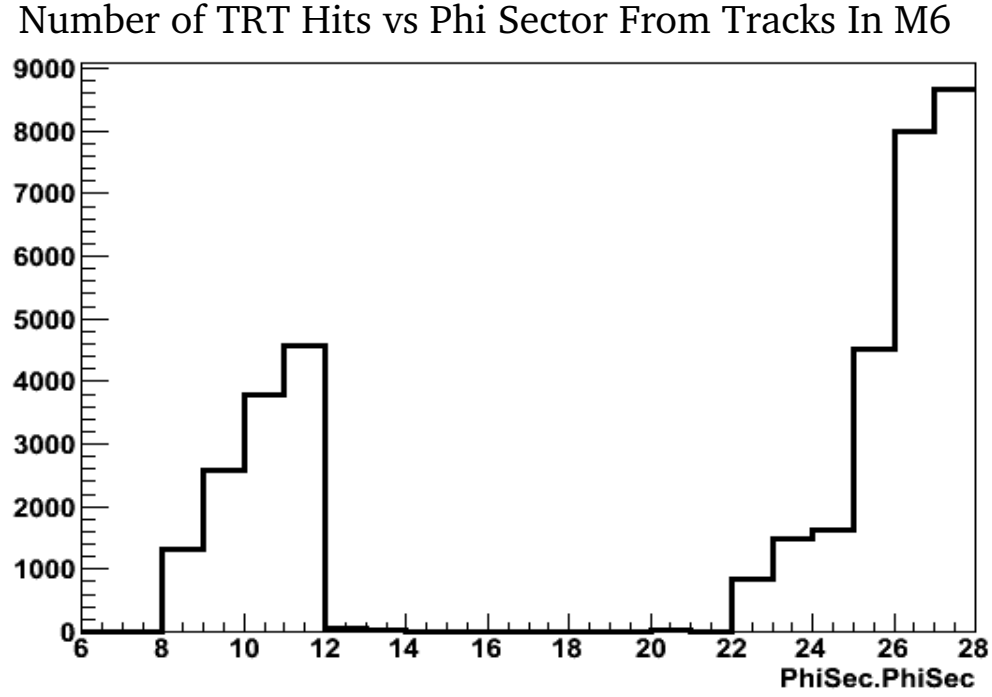
John Alison
Andrea Bocci
Christian Schmitt

M6 Cosmic Run





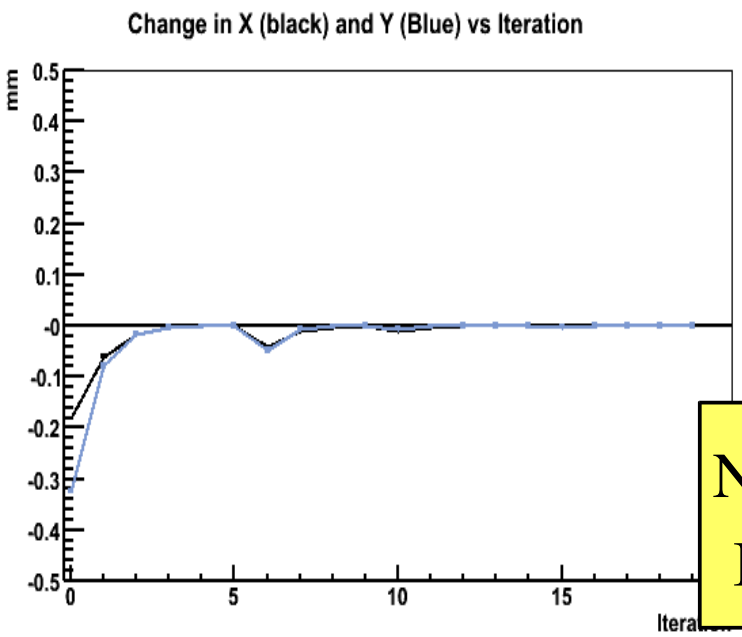
- First combined cosmic run of SCT and TRT since SR1
- TRT modules from the top and bottom of the barrel and from sides A and C were read out in M6

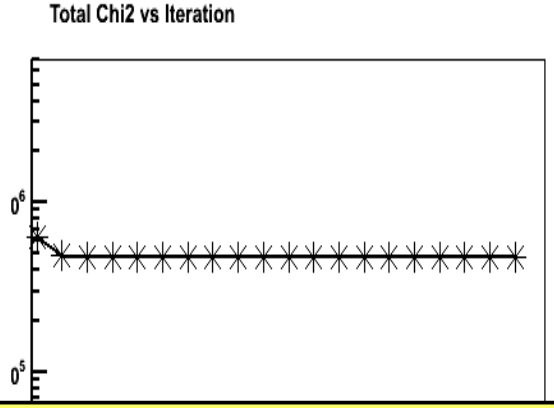


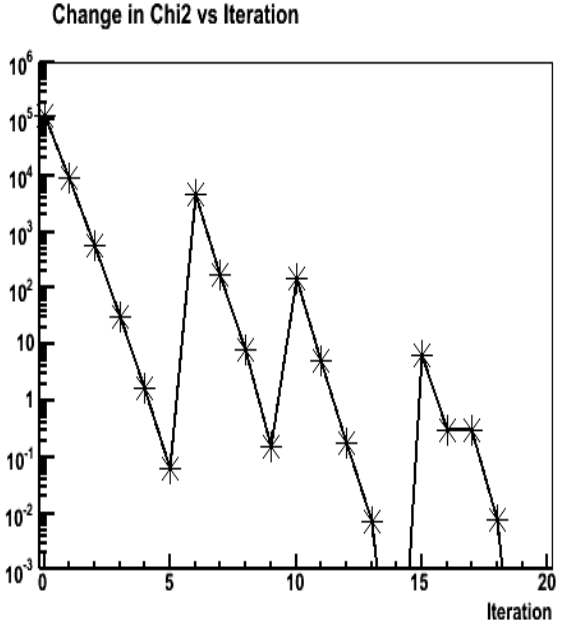
M6 TRT Alignment

- Ran the L1 (global) TRT alignment using data from the entire M6 run.
- Ran alignment using tracks with:
  - > 5 SCT hits
  - > 20 TRT hits (Threw away tube hits)
    No additional cuts on track or hit Chi2 were used.
- Totals Events: 11,319 (expected 12534 from email in hypernews ?)
  Tracks: 3,973
- Aligned 5 Dof (2 translations, 3 rotations)
- Used internal alignments derived for SCT

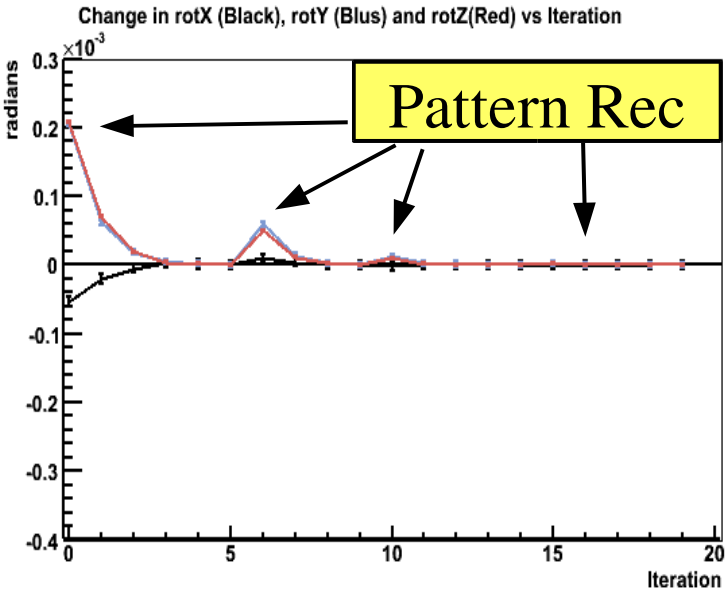
L1 Convergence



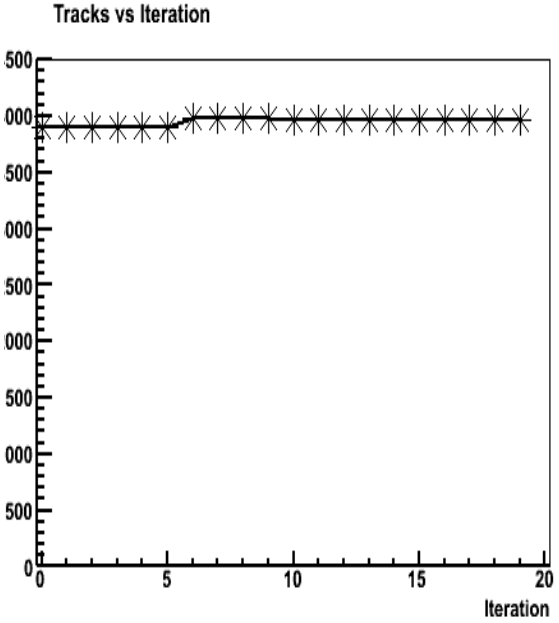


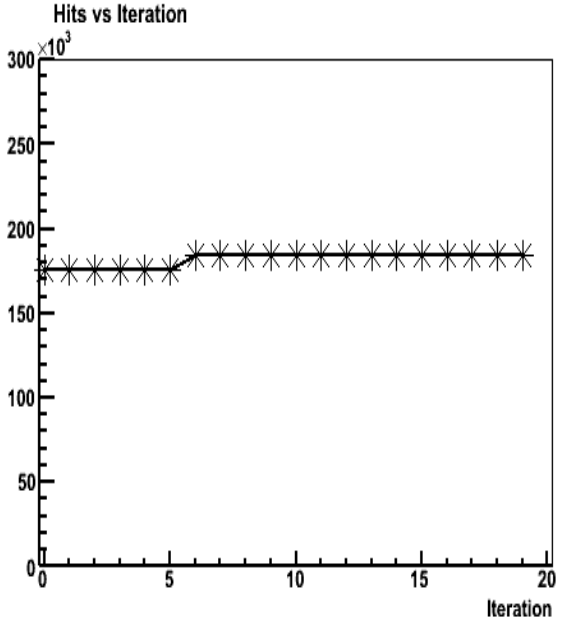


Nice convergence after 2 Iterations of pattern rec.



Pattern Rec





L1 Results

Dx(mm)	Dy(mm)	RotX(mrad)	RotY(mrad)	RotZ(mrad)
-0.331(2)	-0.489(2)	-0.066(6)	0.385(4)	0.378(1)

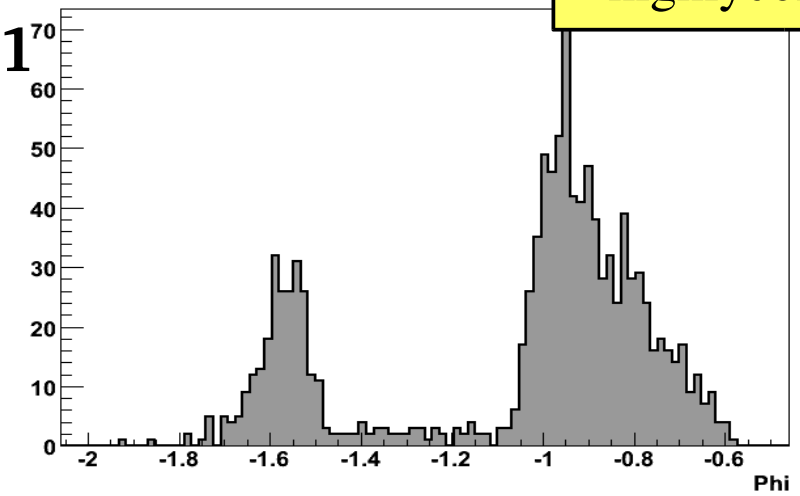
- Errors on the last reported digit are given by TRTAlignAlg and are expected to be underestimated. In the SR1 cosmics the underestimation was thought to be about a factor ~ 7

correlation matrix:

Dx	1	-0.71511	-0.23284	-0.4132	-0.32318
Dy	-0.71511	1	0.36377	0.30412	-0.00544
Rotx	-0.23284	0.36377	1	0.71984	-0.17978
Roty	-0.4132	0.30412	0.71984	1	0.15575
Rotz	-0.32318	-0.0054418	-0.17978	0.15575	1

Some DOFs are highlycorrelated

Track Phi0 distribution in M6

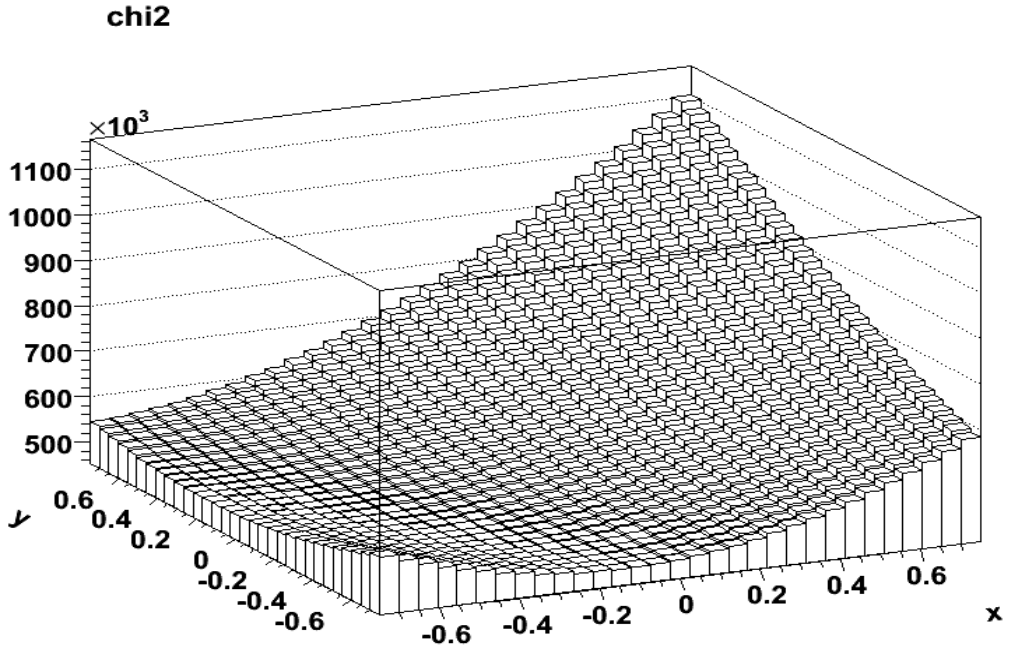


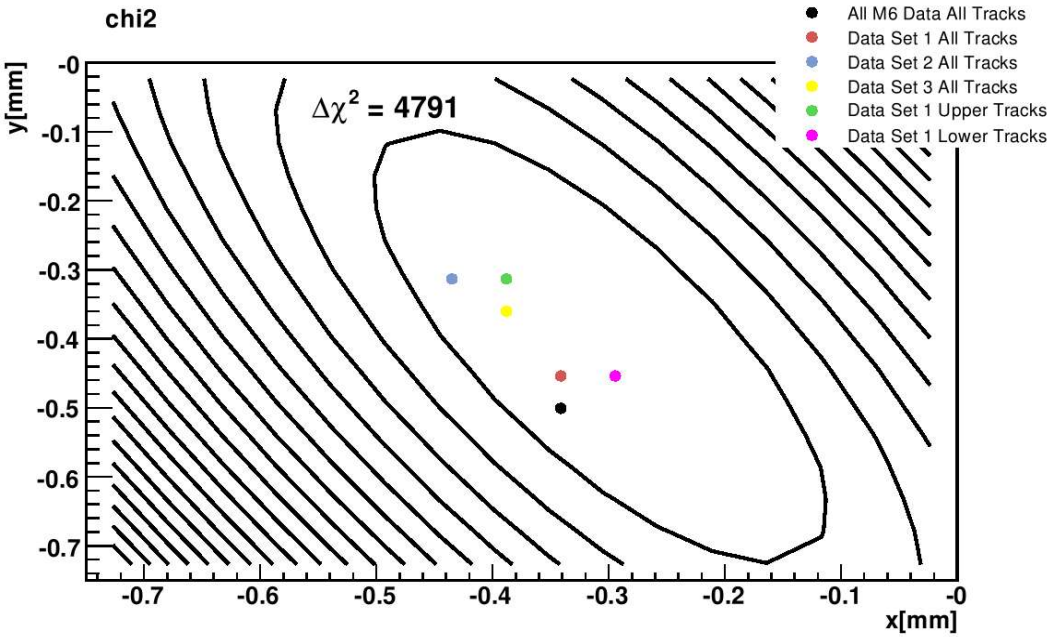
Previous Alignment Results from SR1

Dx(mm)	Roty(mrad)	Rotz(mrad)
-0.269	-0.332	-0.226

Chi2 Study

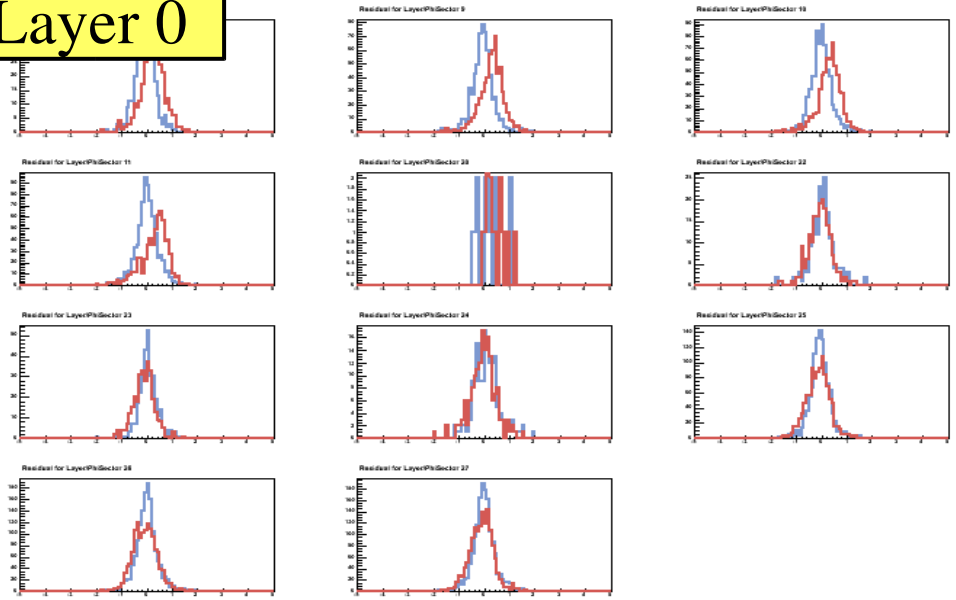
- Ran reconstruction while varying the alignment parameters (x & y) and calculating total Chi2
- Provides a second check on alignment uncertainties
- Ran the alignment using different sets (results similar within a delta chi2 of 4791!!)
- Repeated using various outlier strategies



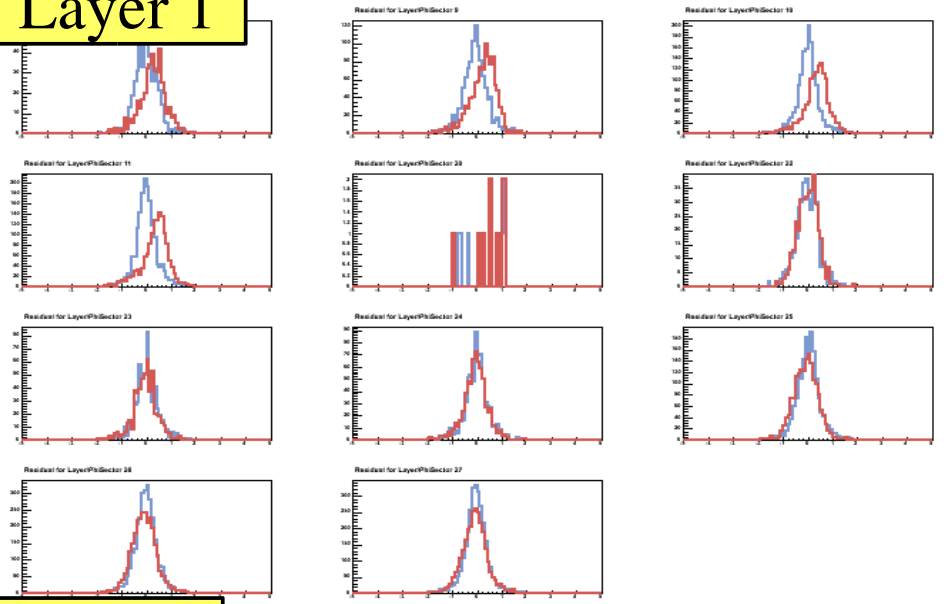


Impact on Residuals

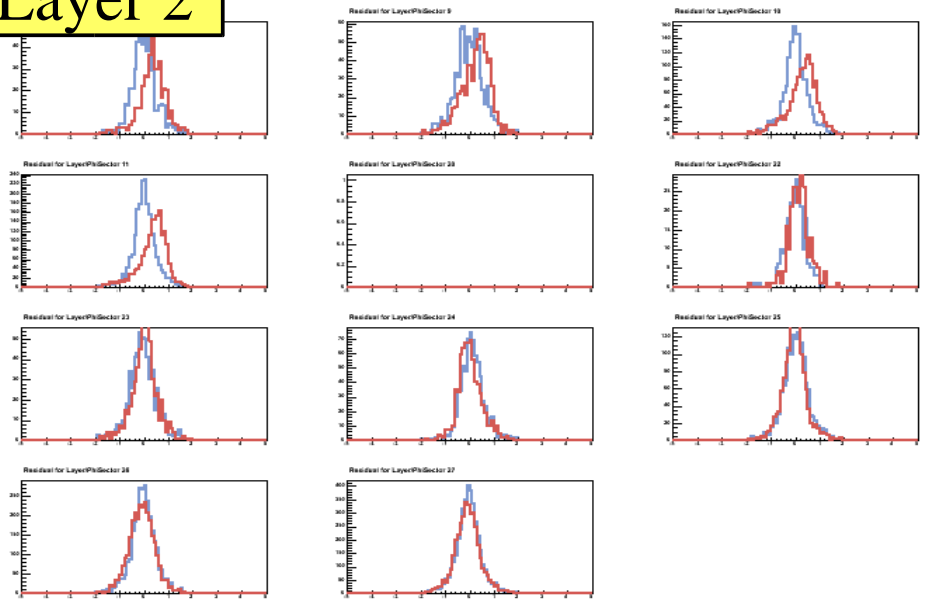
Layer 0



Layer 1

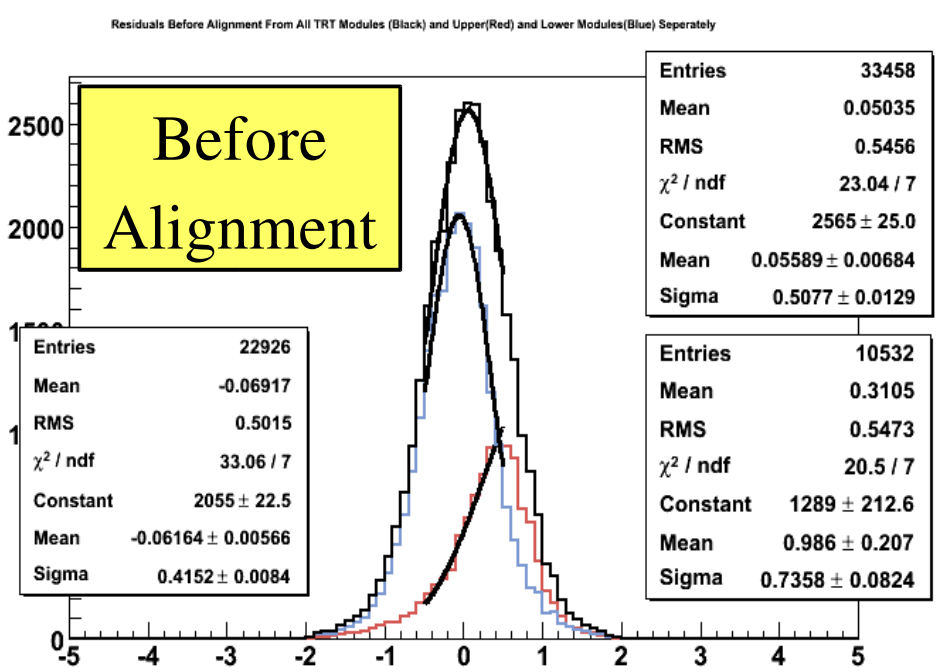


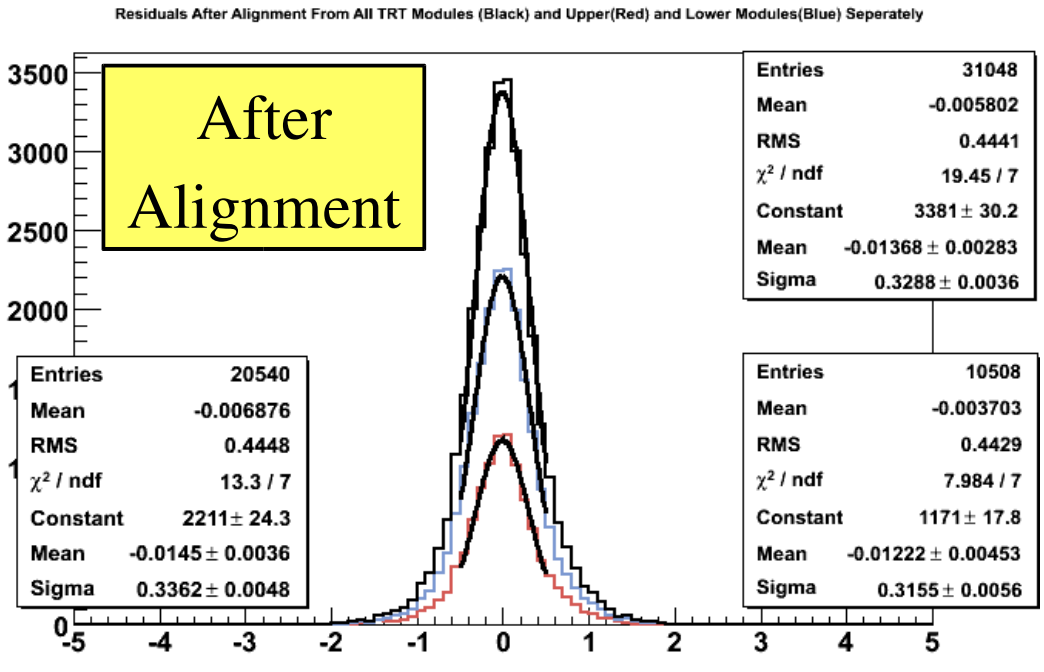
Layer 2



Residuals in each layer and phi sector, before (red) and after (blue) L1 alignment

Impact on Resolution



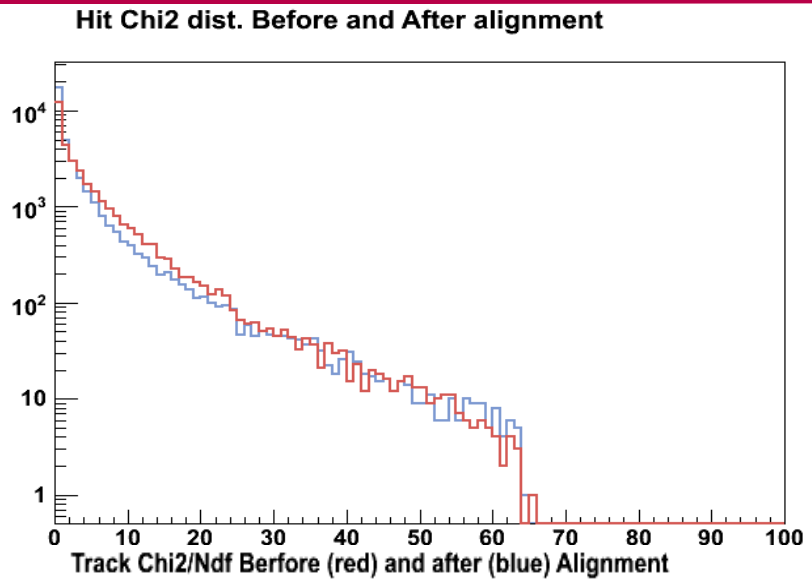


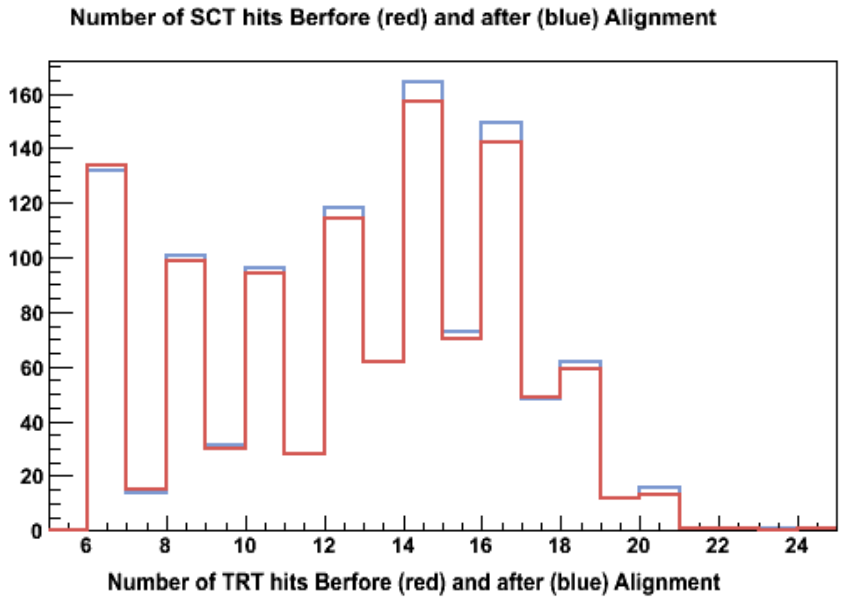
Residuals for all TRT modules (Black) and upper (red) and lower (blue) modules separately

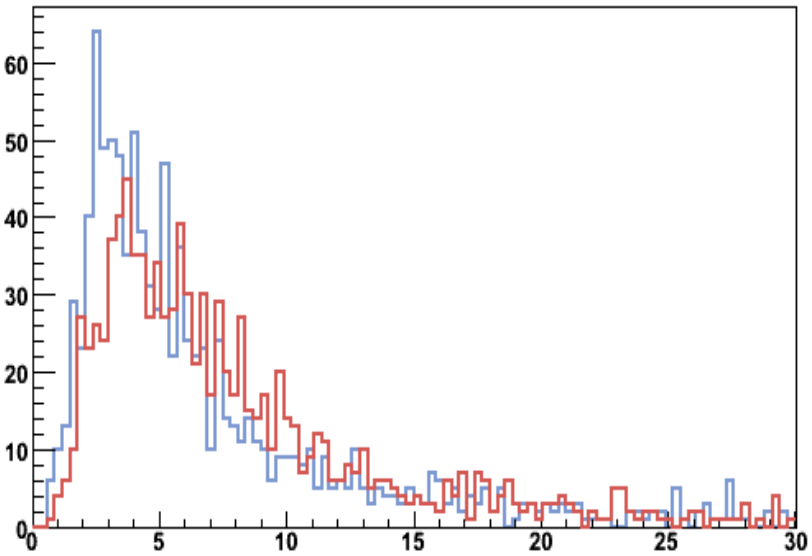
<u>Resolution improvement:</u>

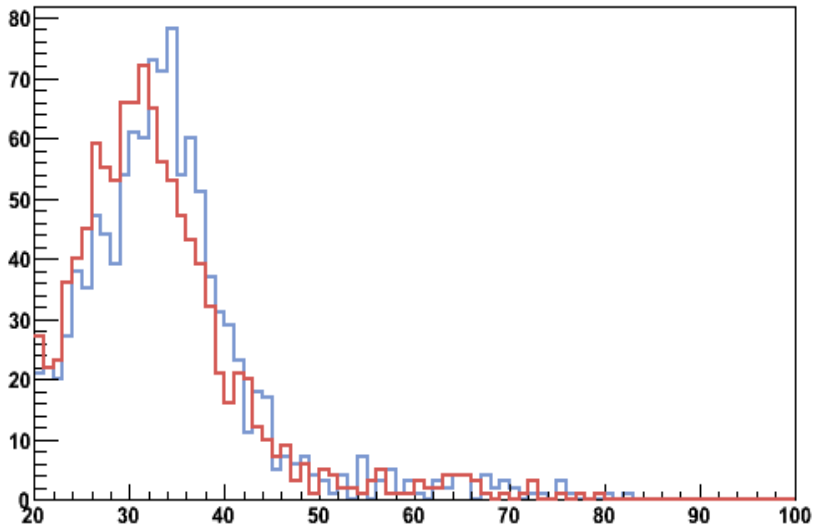
500 -> 330 mircons

Alignment Validation





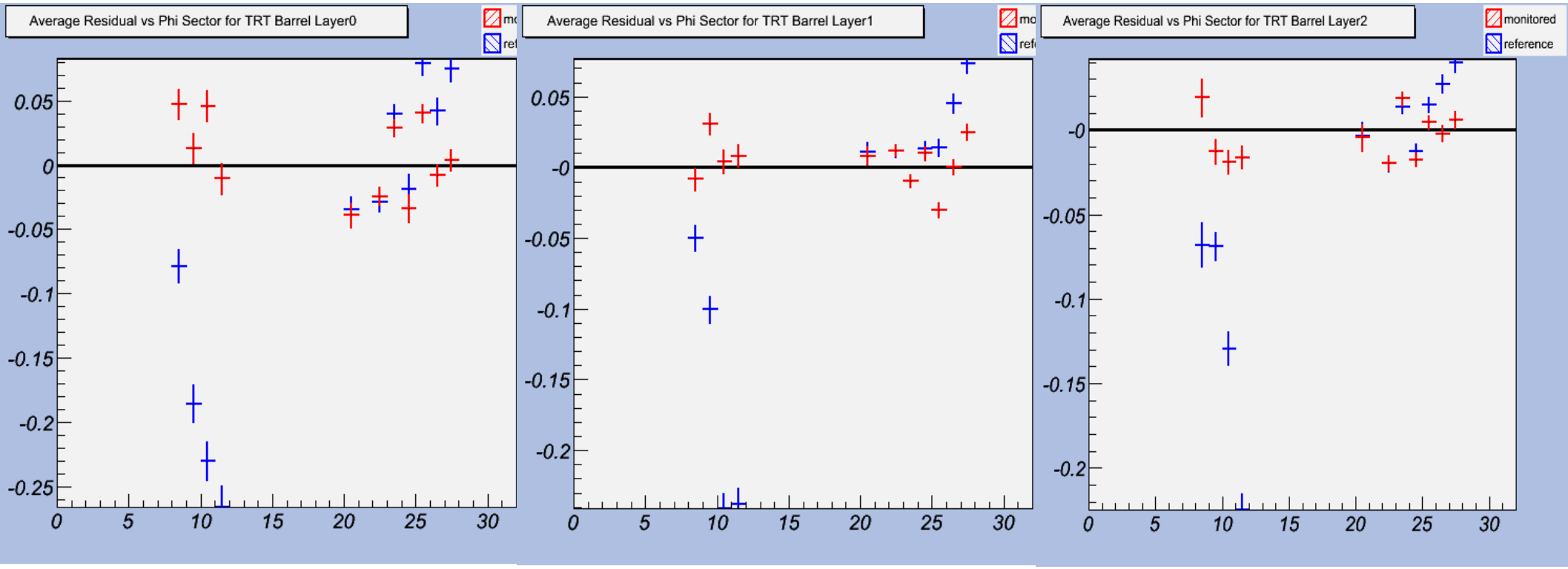




IDAlignment Monitoring

First test of alignment monitoring package on real data.

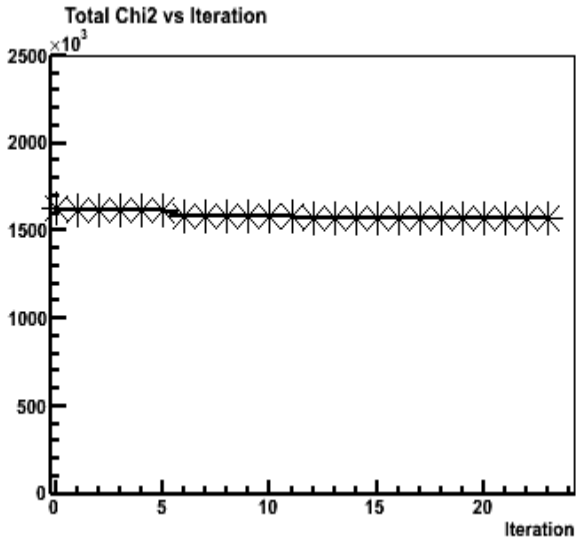
- Reference in blue is prior to alignment.
- Monitored in red is uses the updated alignment constants

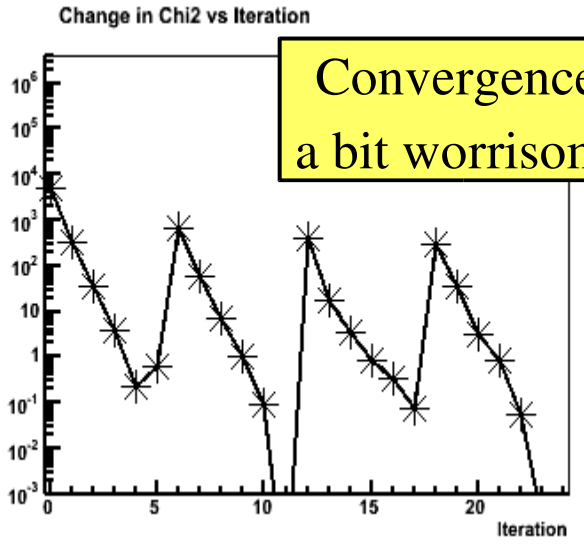


Internal TRT Alignments

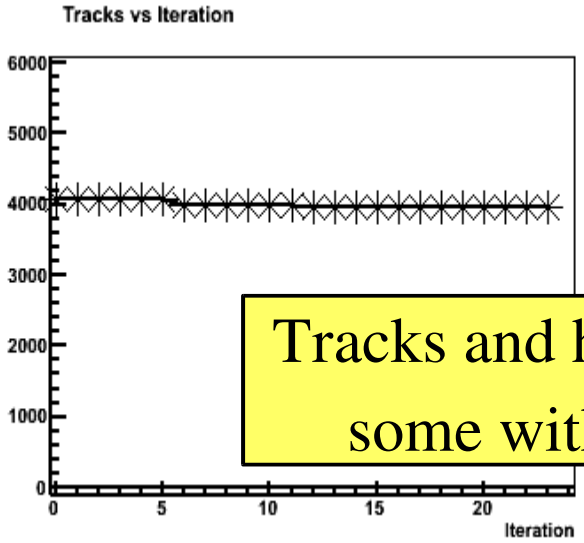
L2 (TRT internal) M6 alignment done using

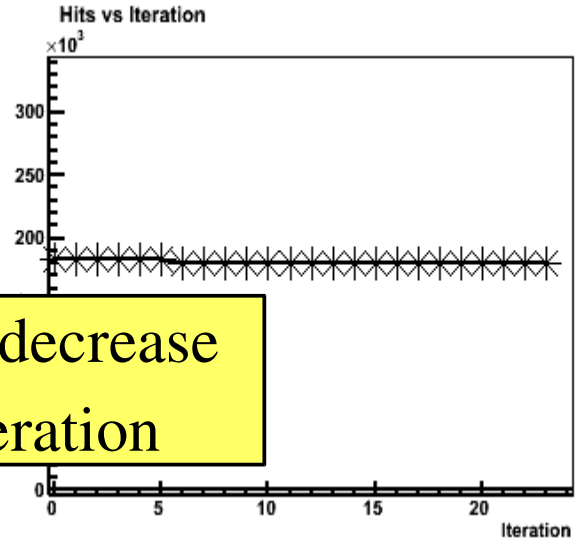
- Combined ID tracks
  (>1 SCT hits > 20 TRT hits)
- Aligning 5 degrees of freedom
- Using Si alignment constants + L1 result
- 30 modules used in alignment
  (required > 500 hits per module)





Convergence a bit worrisome

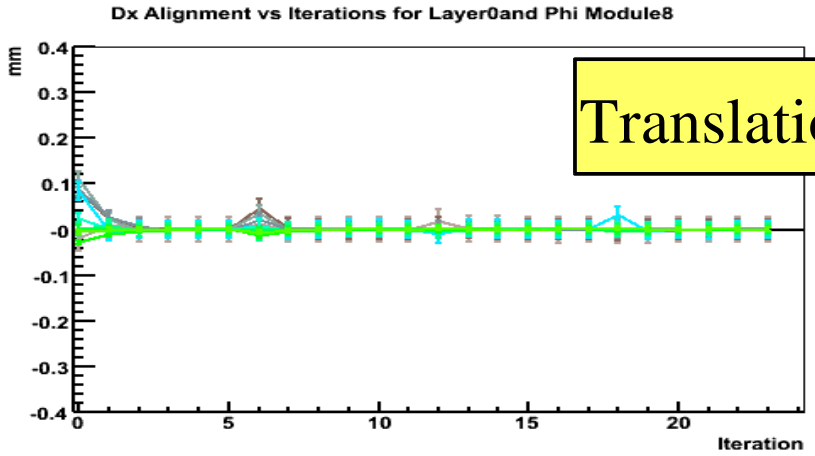


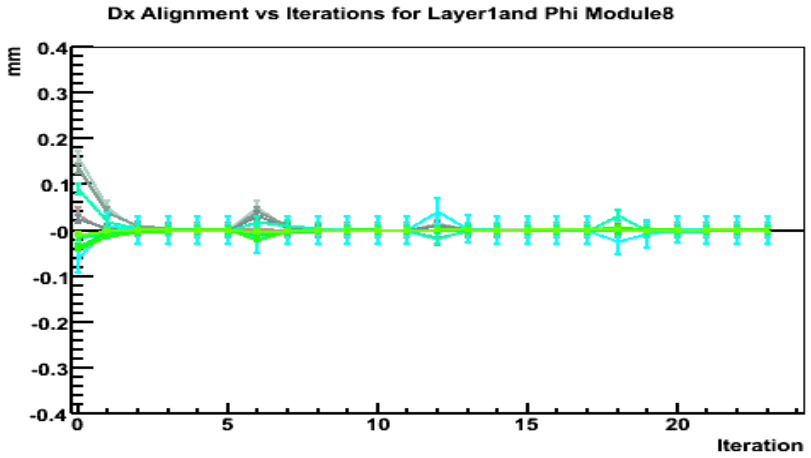


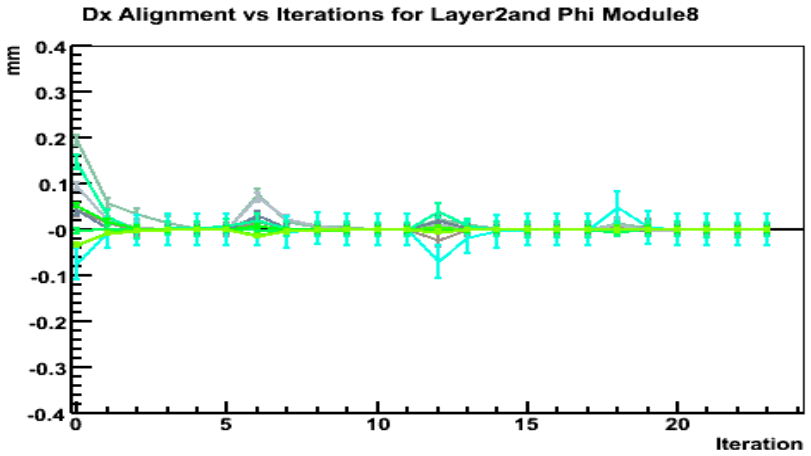
Tracks and hits decrease some with iteration

Module Convergences

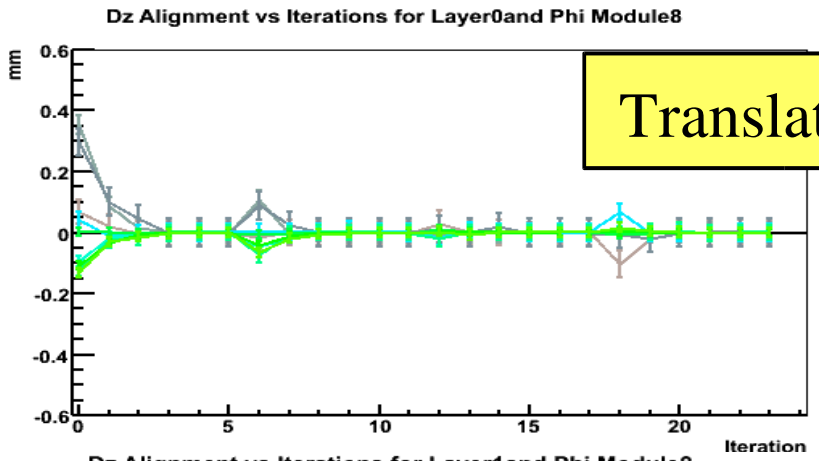
Translation phi

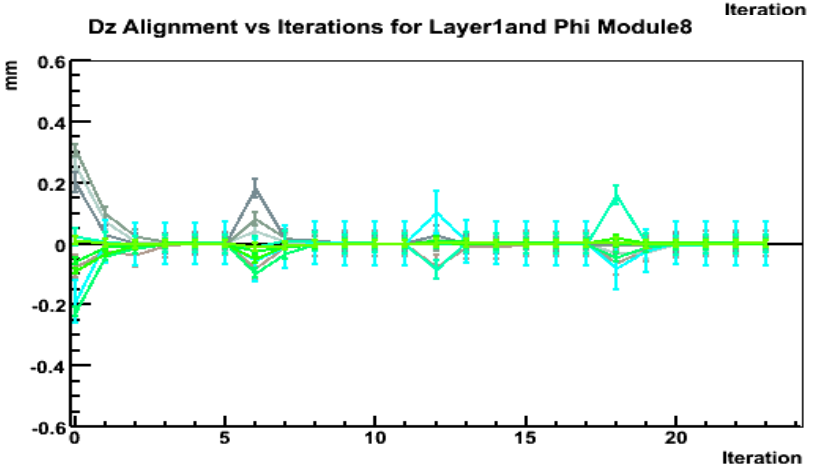


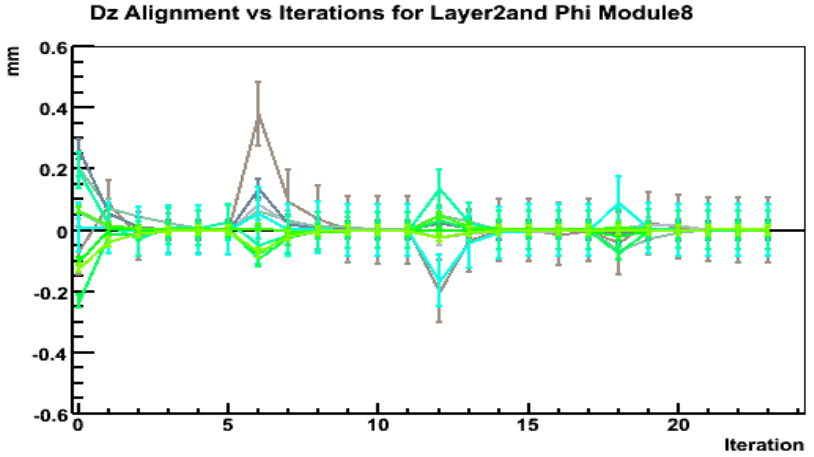




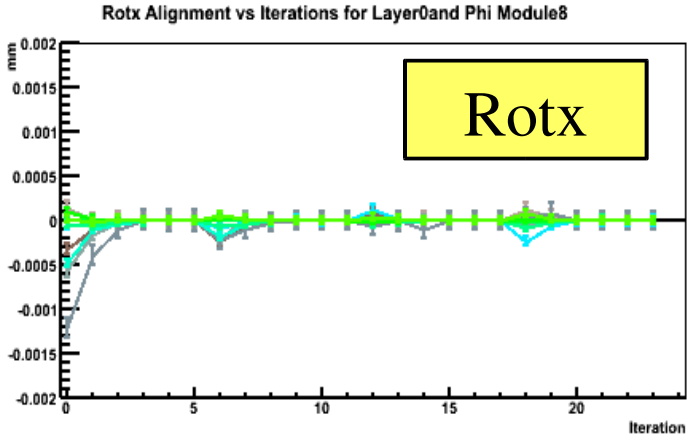
Translation r

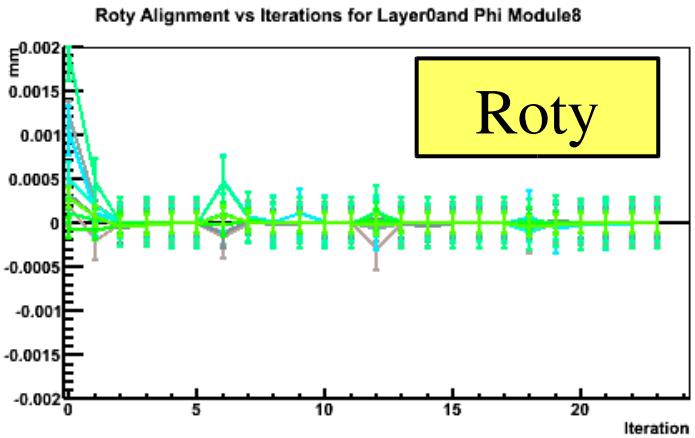


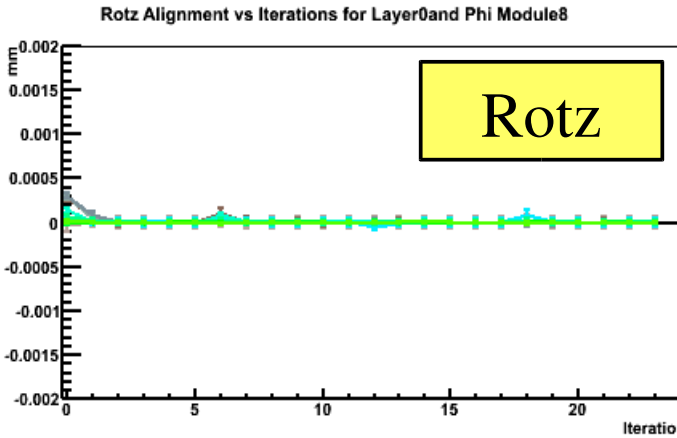


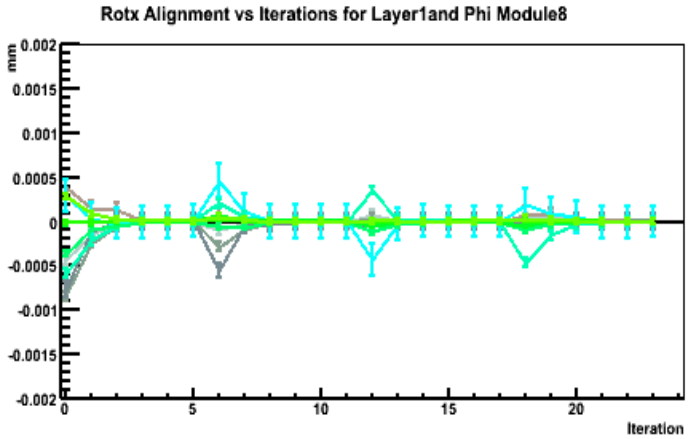


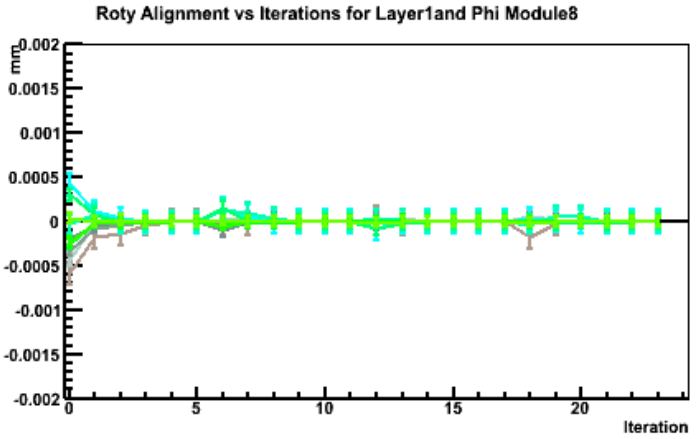
Module Convergences

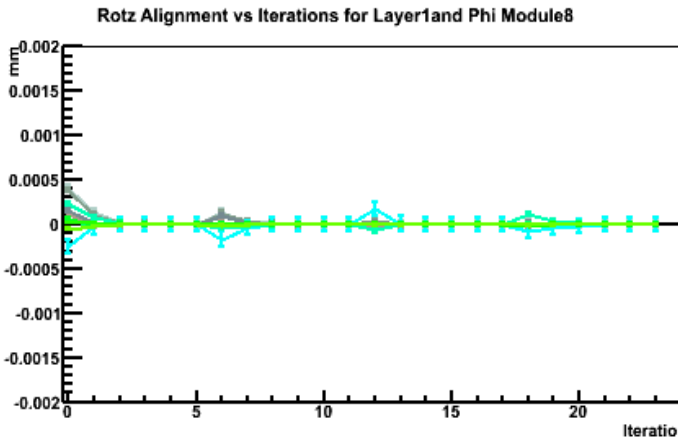


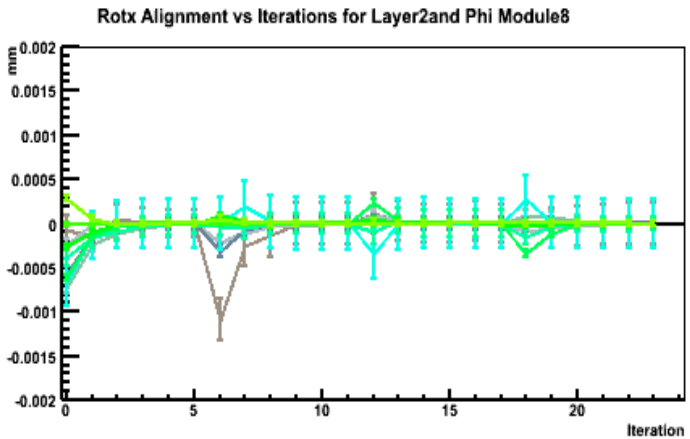


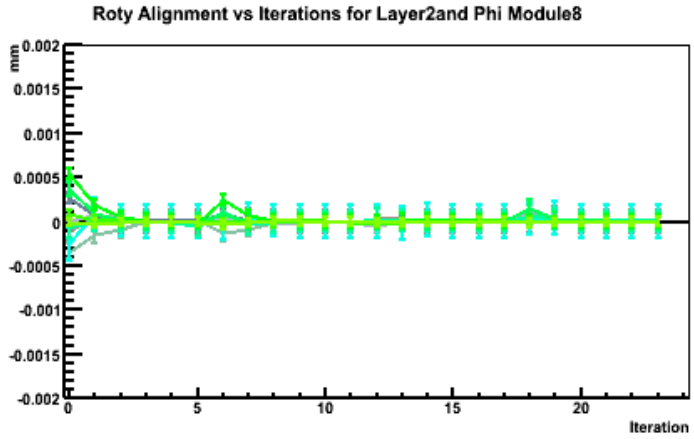


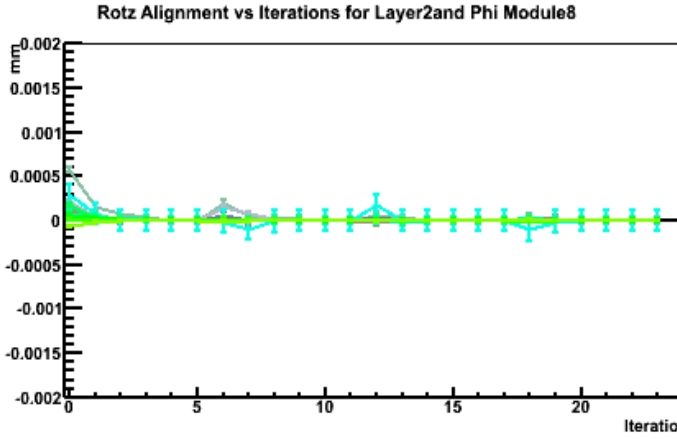




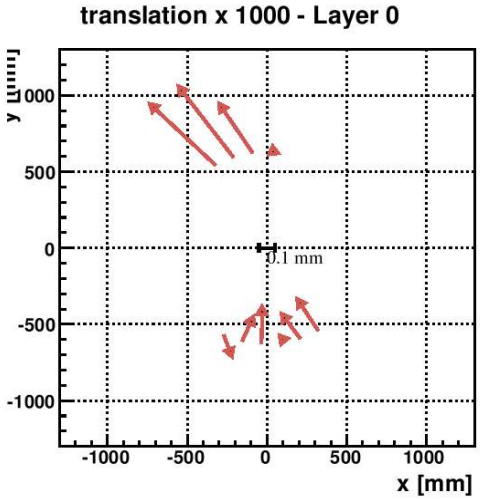


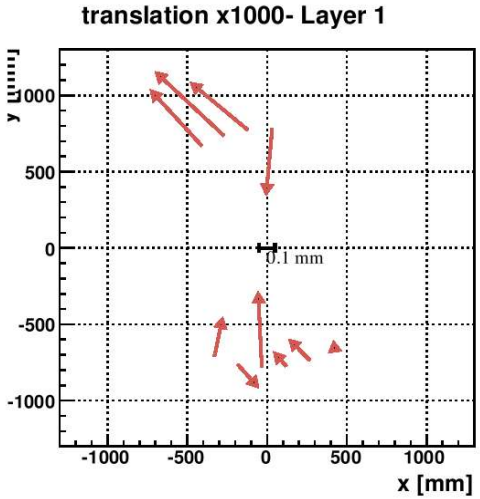


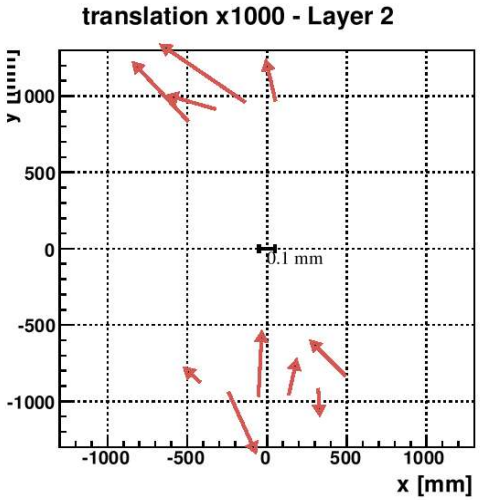




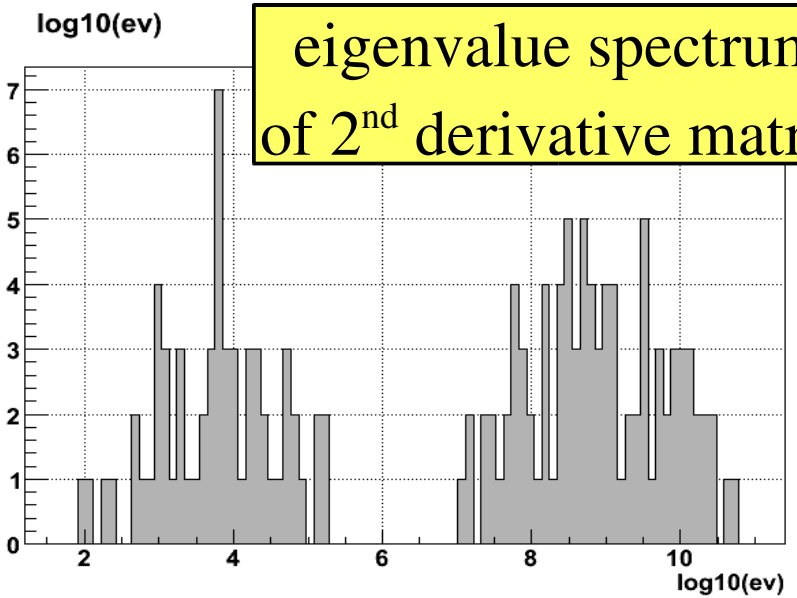
L2 Results







Most L2 alignments larger than L1 alignments, not expected from design specs

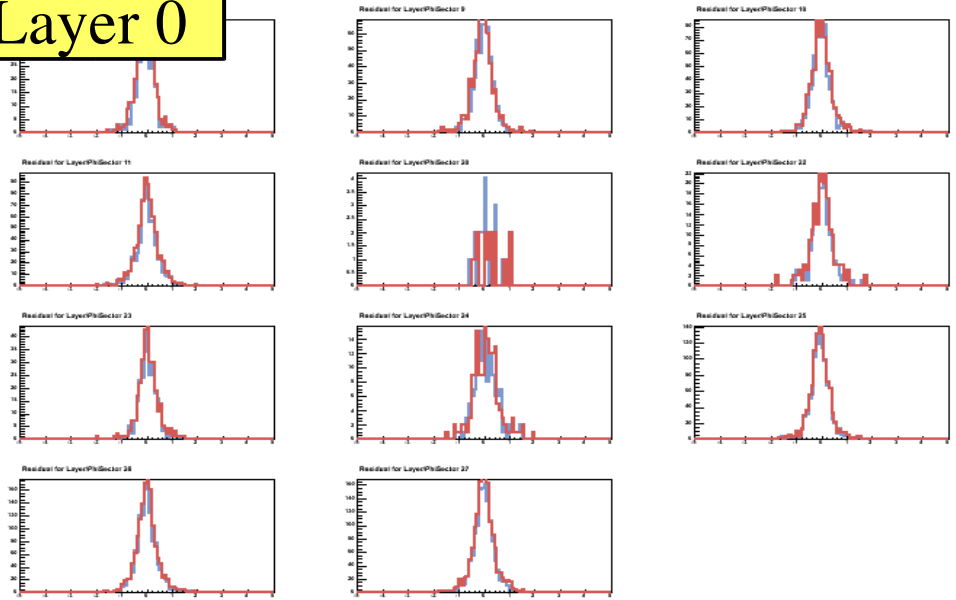


typical correlation matrix:

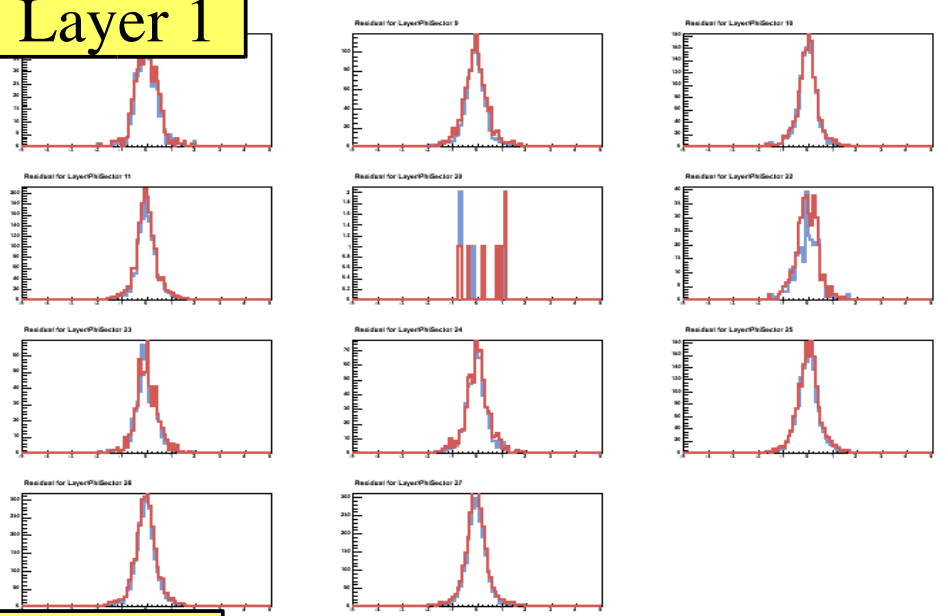
1	0.78303	-0.061427	-0.22419	0.088312
0.78303	1	-0.046269	-0.019082	0.060614
-0.061427	-0.046269	1	0.0027922	-0.81111
-0.22419	-0.019082	0.0027922	1	-0.03164
0.088312	0.060614	-0.81111	-0.03164	1

Impact on Residuals

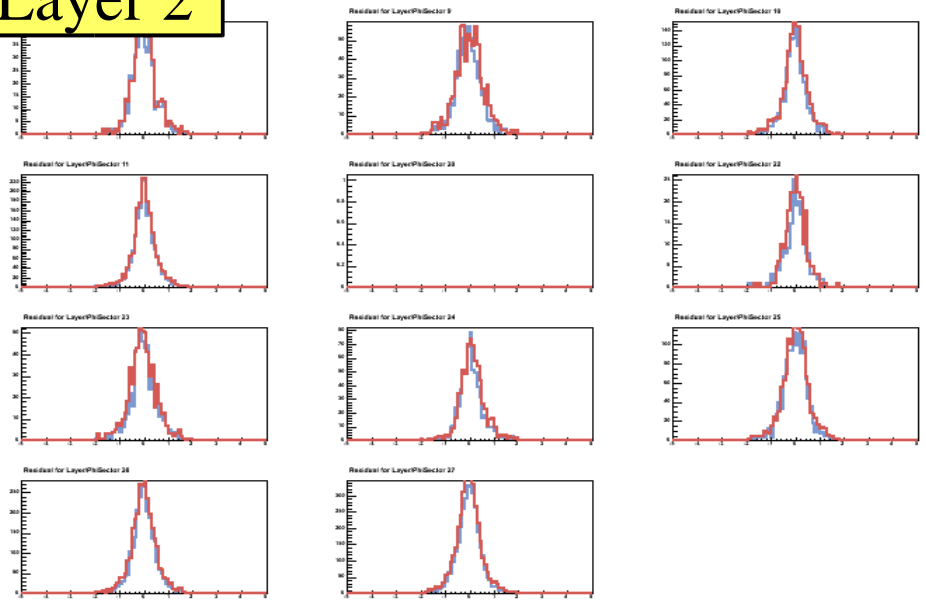
Layer 0



Layer 1

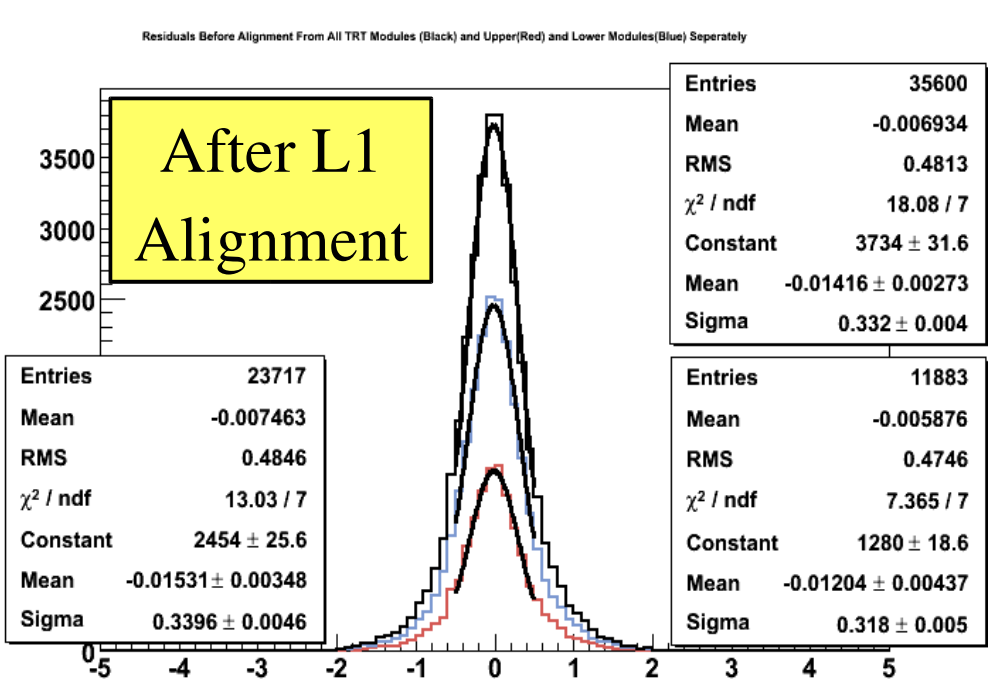


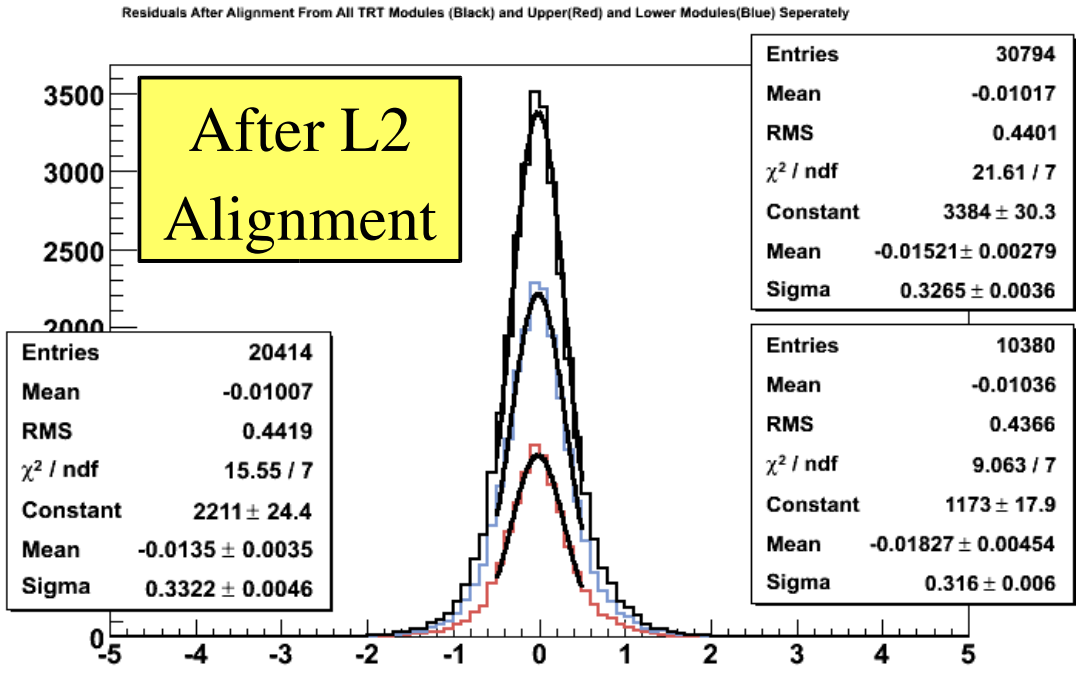
Layer 2



Residuals in each layer and phi sector, after L1 alignment (red) and after L2 alignment (blue)

Impact on Resolution





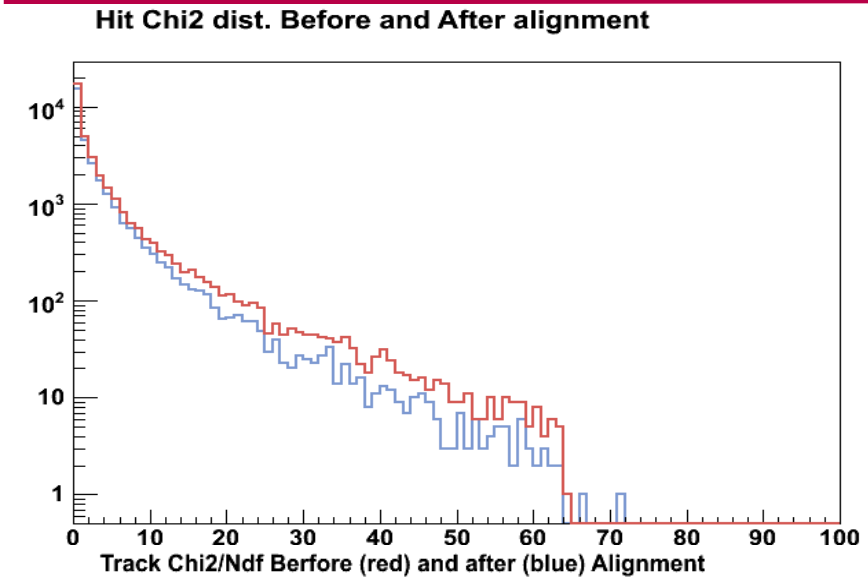
Residuals for all TRT modules (Black) and upper (red) and lower (blue) modules separately

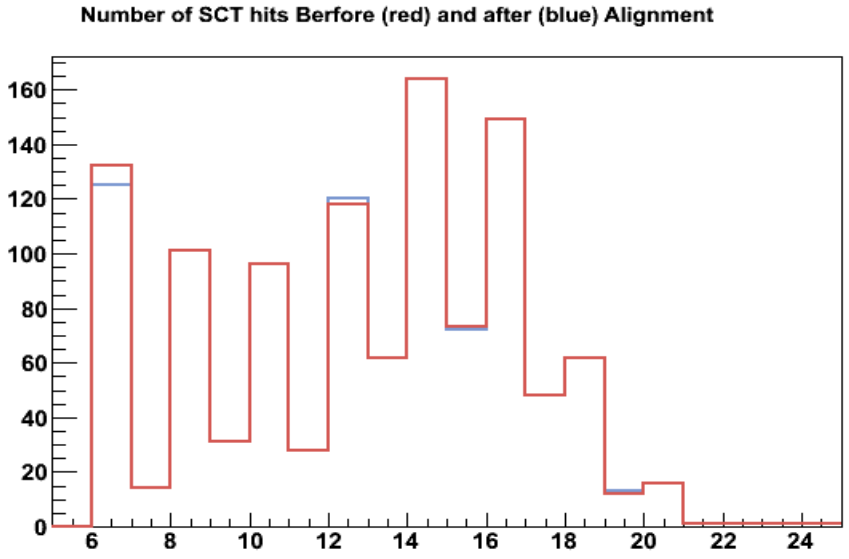
<u>Resolution improvement:</u>

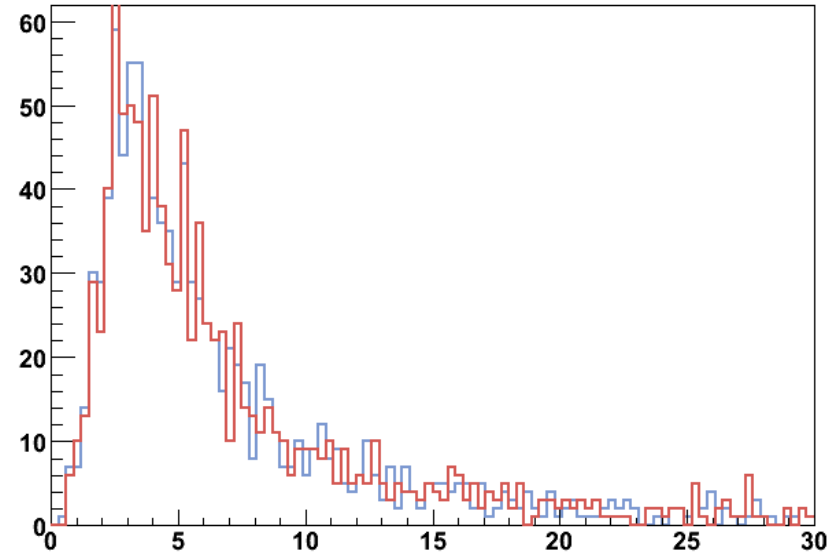
332 -> 326 mircons

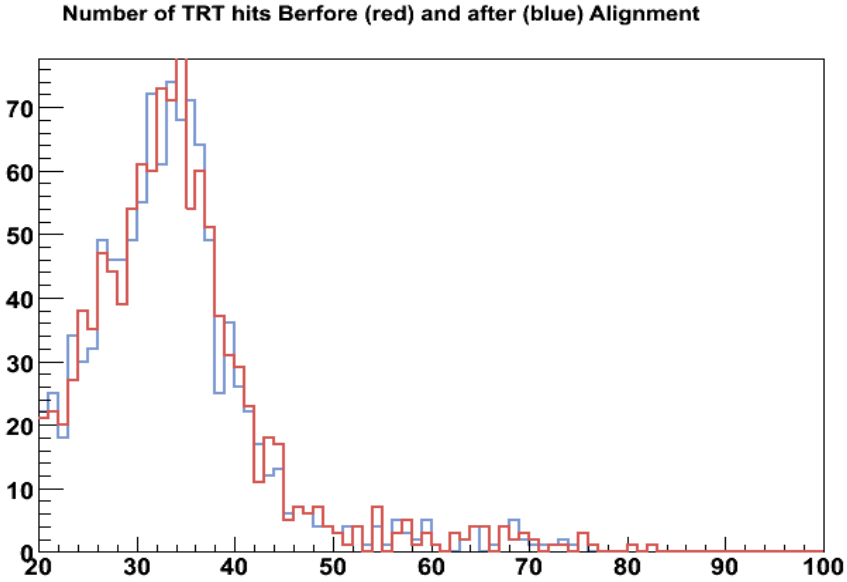
(However mean gets worse)

Alignment Validation





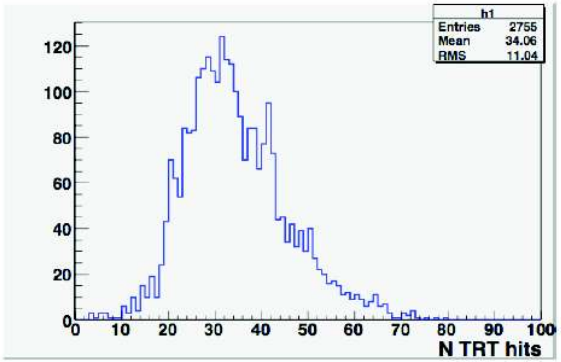




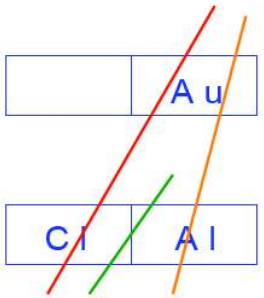
Reinforcements.

Barrel Hits

N Hits on Track



Very few tracks have hits both in upper and lower parts of the TRT.



	A u	A l	C l
A u	501	76	35
A l		1031	222
C l			889

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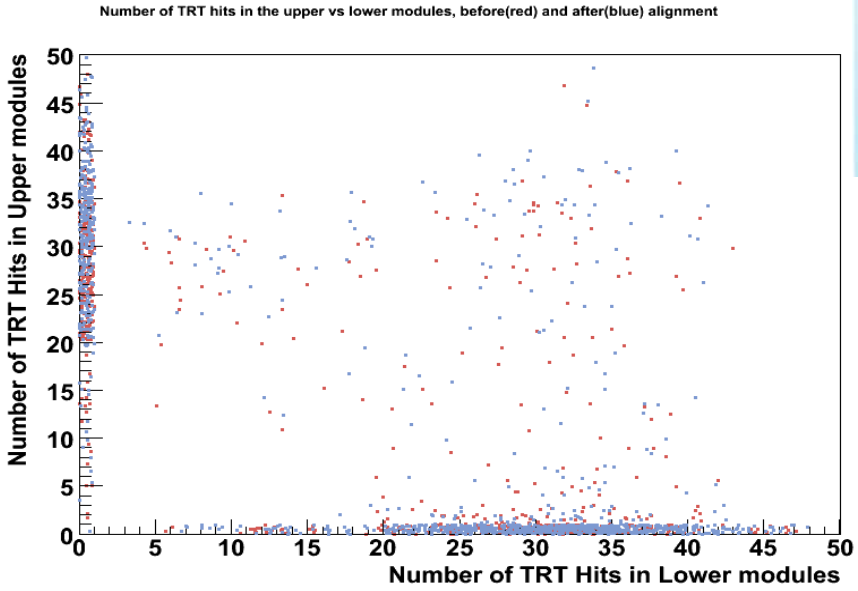
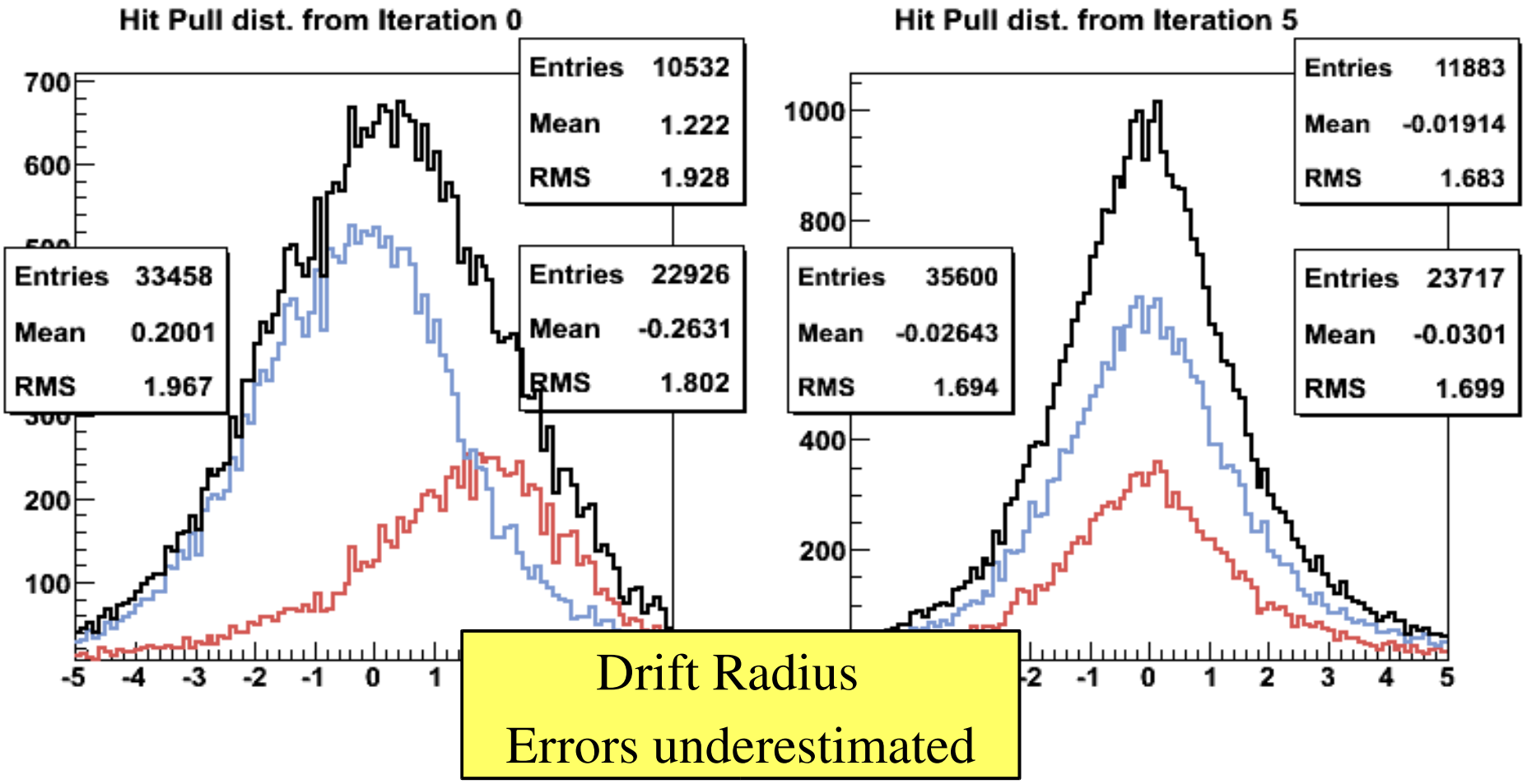
# of TRT hits in upper modules vs # in lower modules, before and after alignment



Hit Pulls



Defined as predicted hit distance from track fit – measures distance

Hit Error