TRT Alignment Status Report

ID Week , 2/5/2007

Andrea Bocci (Duke University)

Outline:

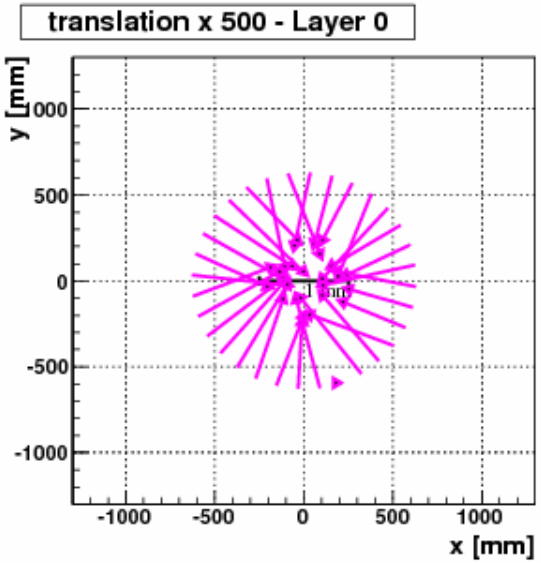
- Activity I: L2 Alignment (J. Alison et al. @Penn)
- Activity II: Integration With ID and FDR Preparation (Andrea)
- Plan and To Do List

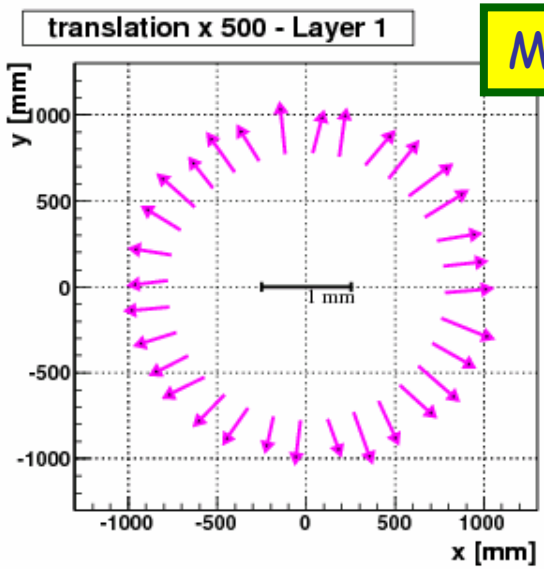
Introduction

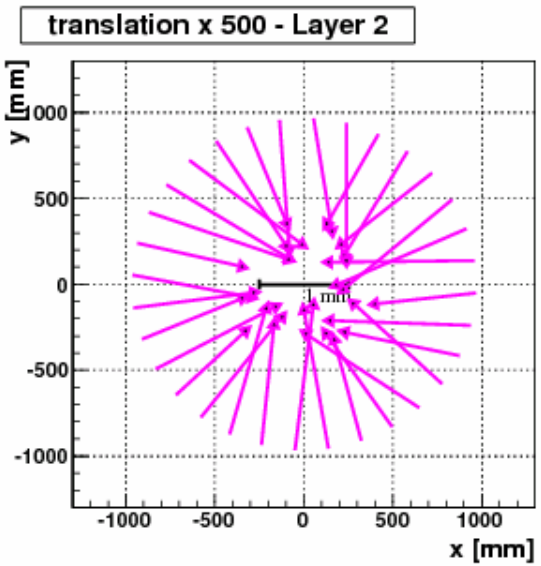
- Big effort during last year to exercise the TRT alignment alogorithm on CSC misaligned multimuon sample
- End of last year the first set of alignment constants for the Inner Detector was released in time for the detector paper
- Old scheme used for the occasion: align Si first and then TRT.
  - Step 1: After the Si was aligned standalone we align TRT @L1
    - L1 == TRT barrel (endcap) as a whole
  - Step 2: Once TRT was aligned w.r.t. Si we align the TRT internally (L2)
    - L2 == TRT modules are aligned individually
- Although the first set of constants are quite good, studies to further improvement the TRT alignment are underway
  - Main Focus: Improve the L2 alignment !
    - John Alison and colleagues from Penn have been working on this

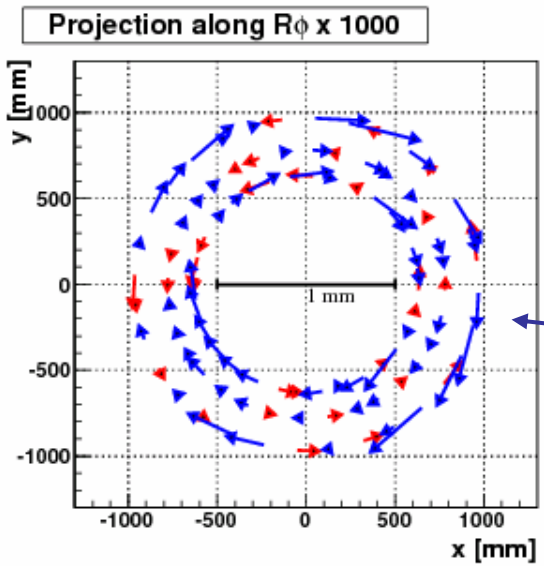
The CSC misalignment in the TRT (barrel)

There is a global shift (L1) and module movements mainly along R (L2)









Module displacements w.r.t. ideal

The L1 misalignment has been masked

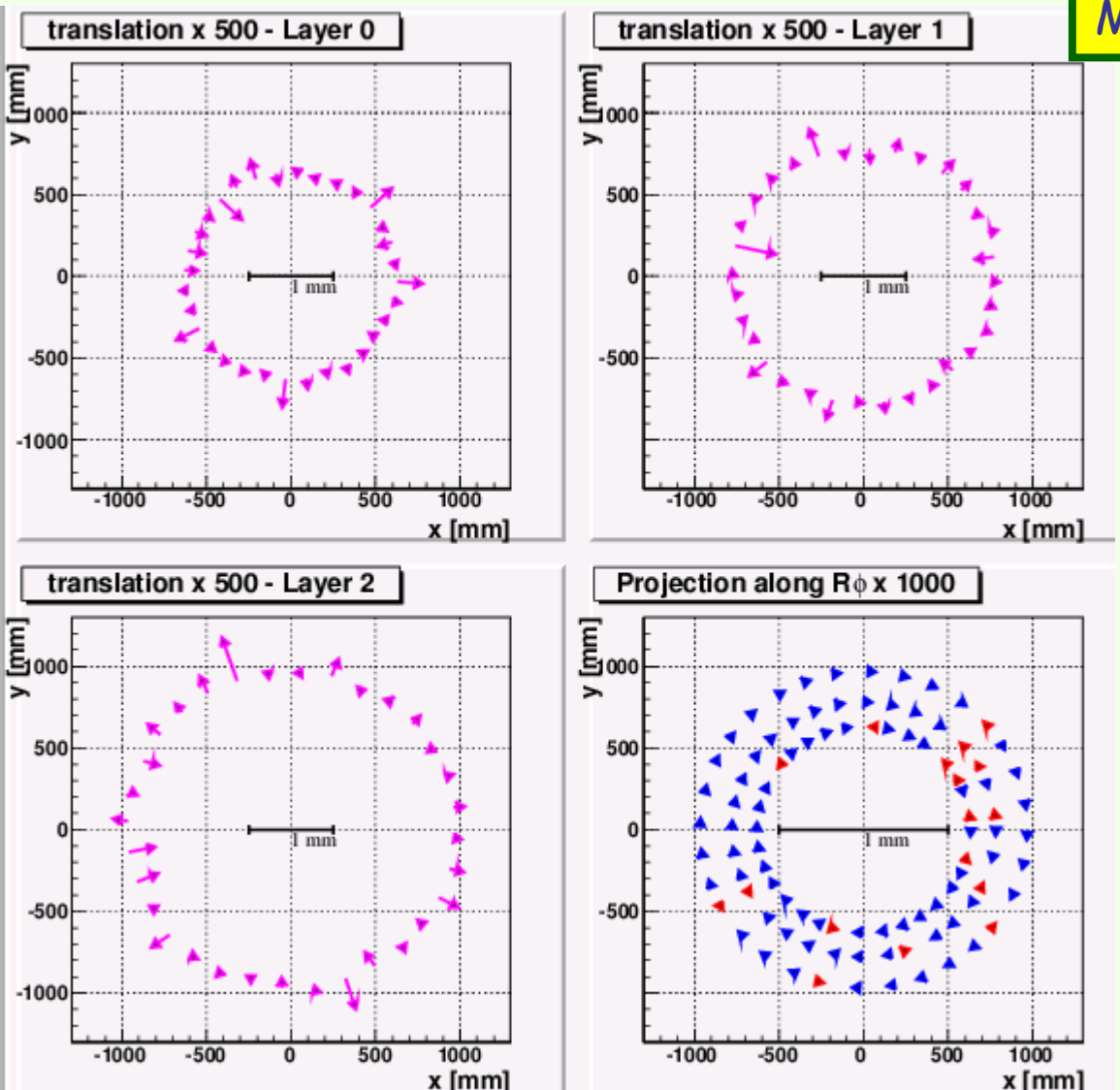
This is if we do not provide any alignment constants for the TRT at L2

Random shifts along (x,y) prompt a "clocking effect"

Displacement after alignment

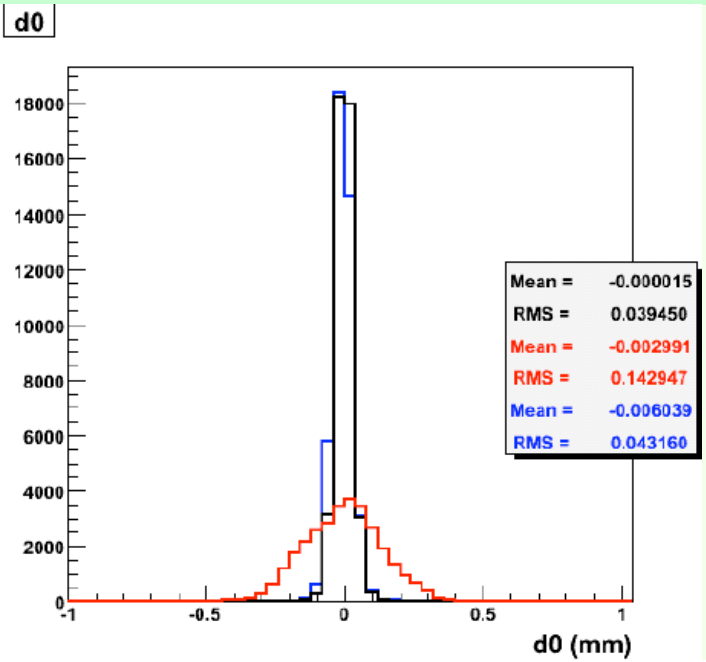
L2 TRT with TRT+Si tracks with Si ideal

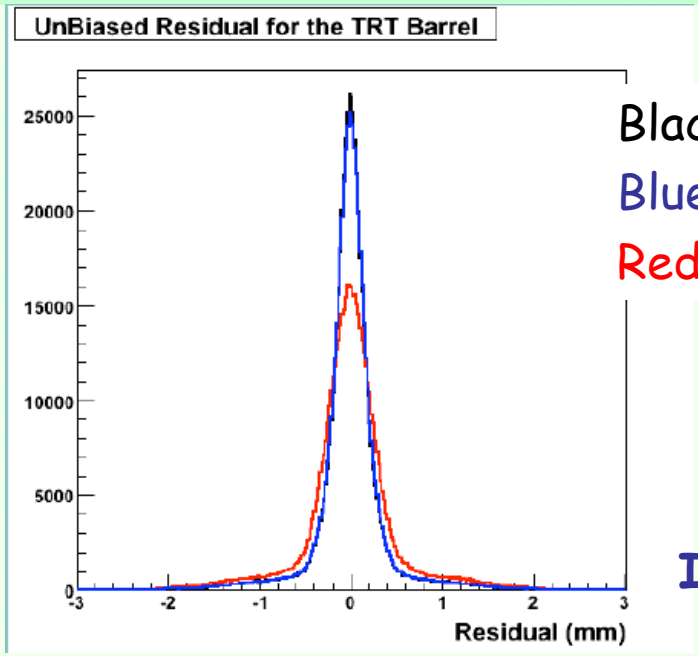
Module displacements w.r.t. ideal



Clocking effect reduced
but not eliminated

Impact of the TRT



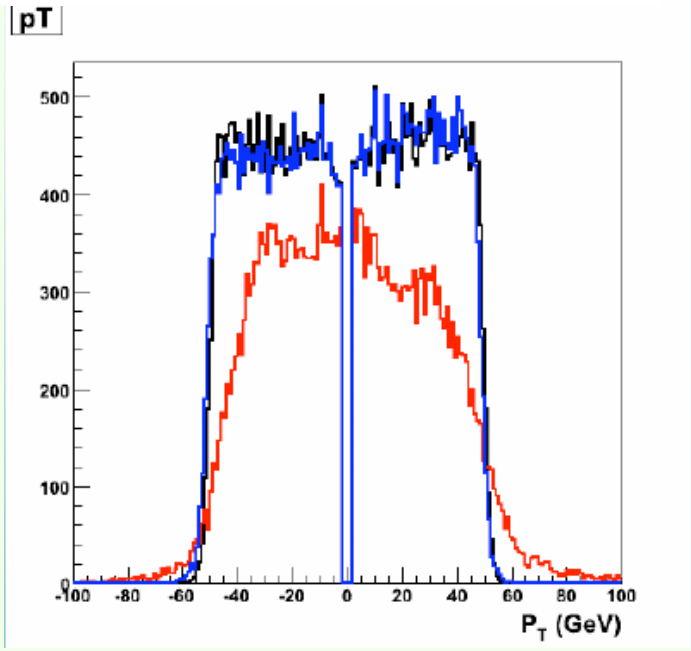


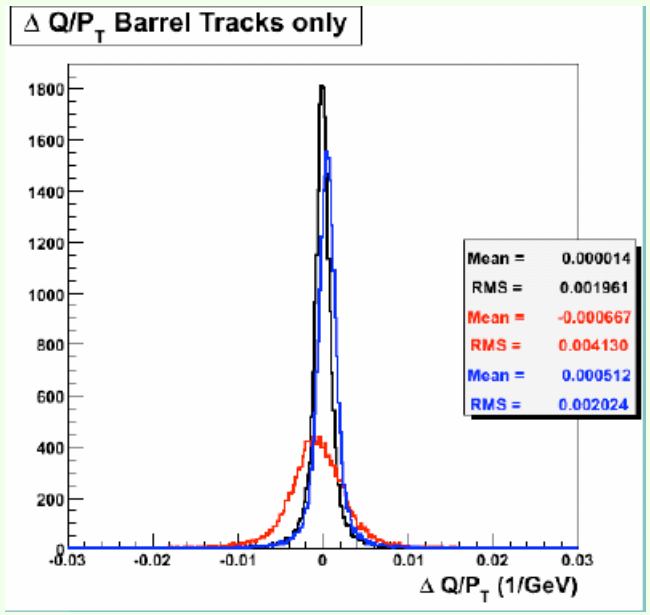
Black: Ideal

Blue: After TRT align

Red: After Si align

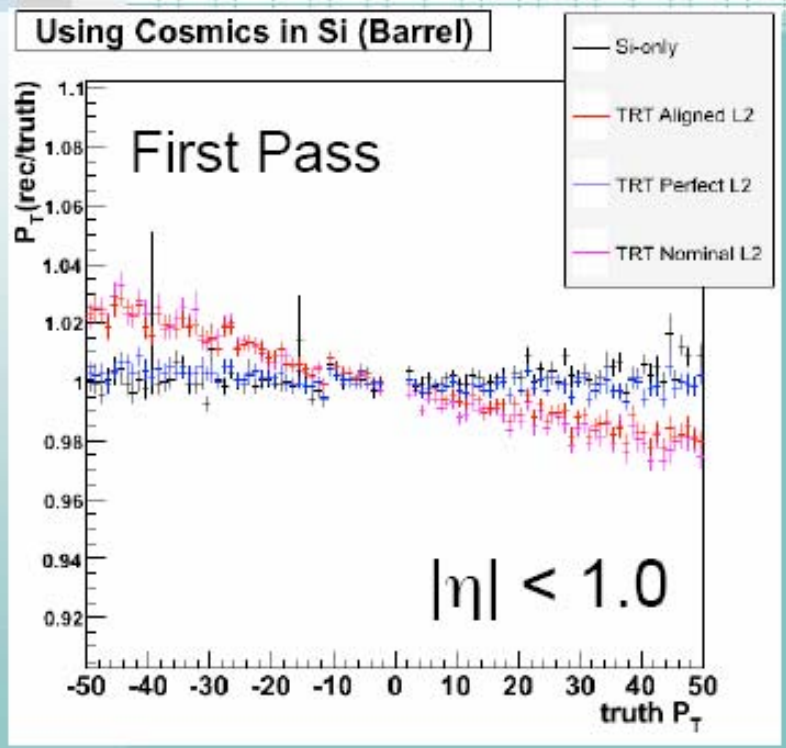
Improvement mainly due to the L1 alignment

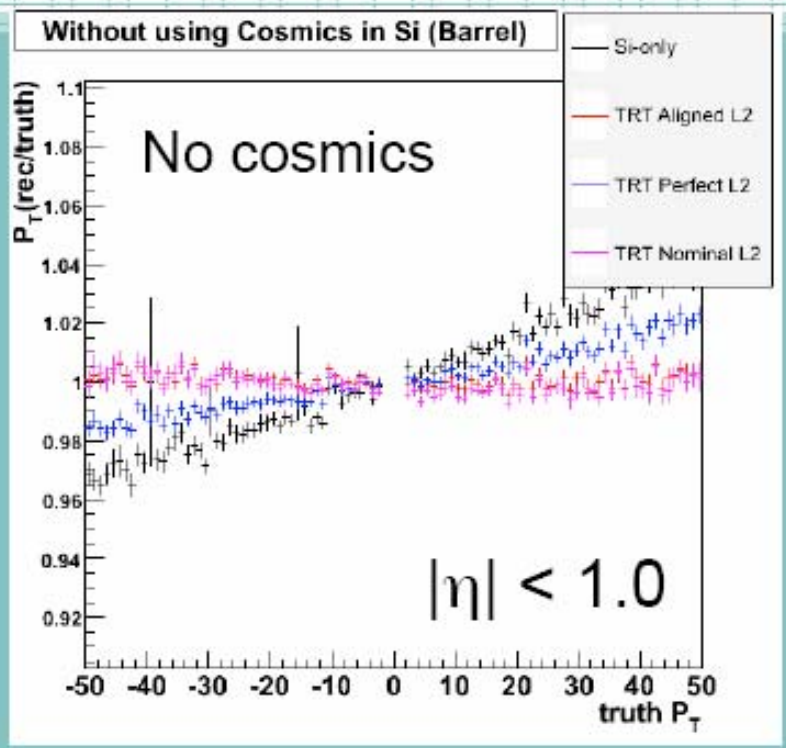




Interplay between Si and TRT clocking effect

P_T reco. bias in multimuons





- In "No Cosmics" case clocking of L2 TRT cancelled by clocking of Si.

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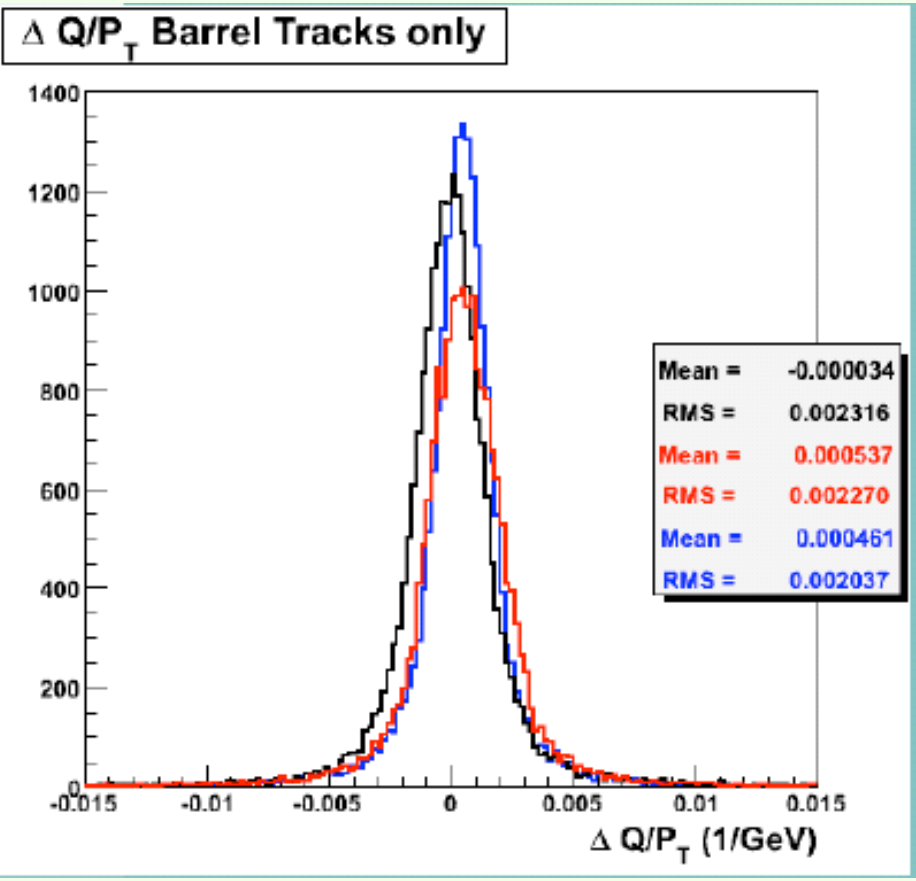
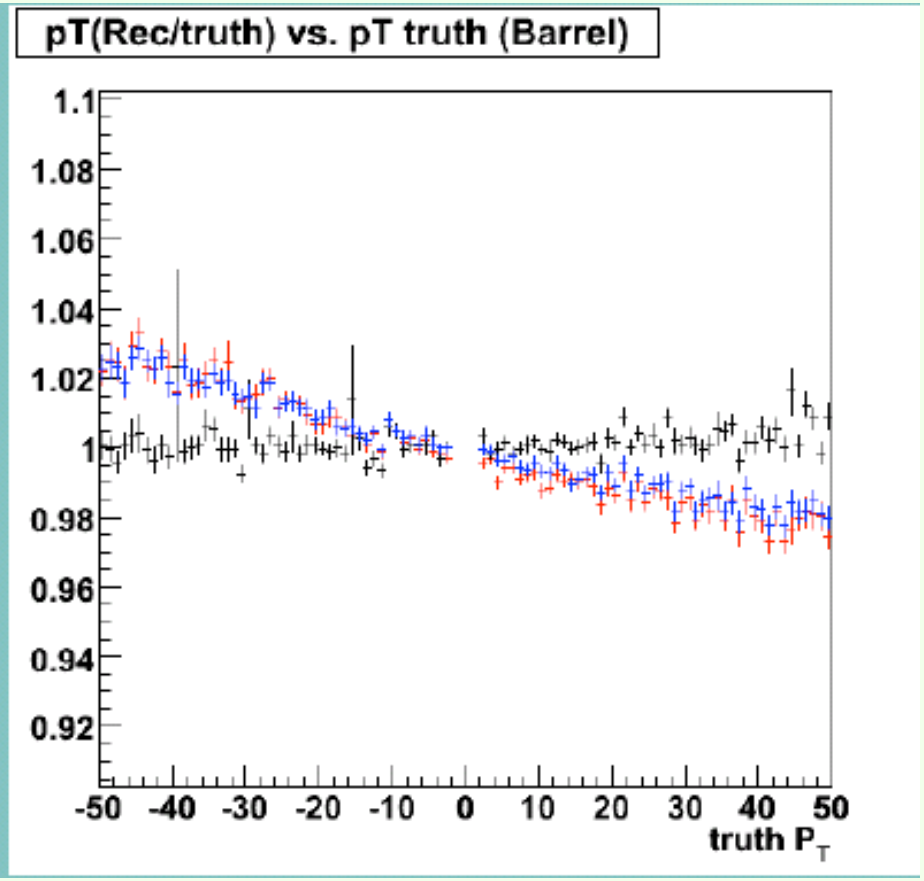
TRT Alignment Plan – New People

Black: Si only

Blue: Si+ TRT aligned @L1 + TRT aligned @L2

Red: Si + TRT aligned @L1 + TRT misaligned @L2



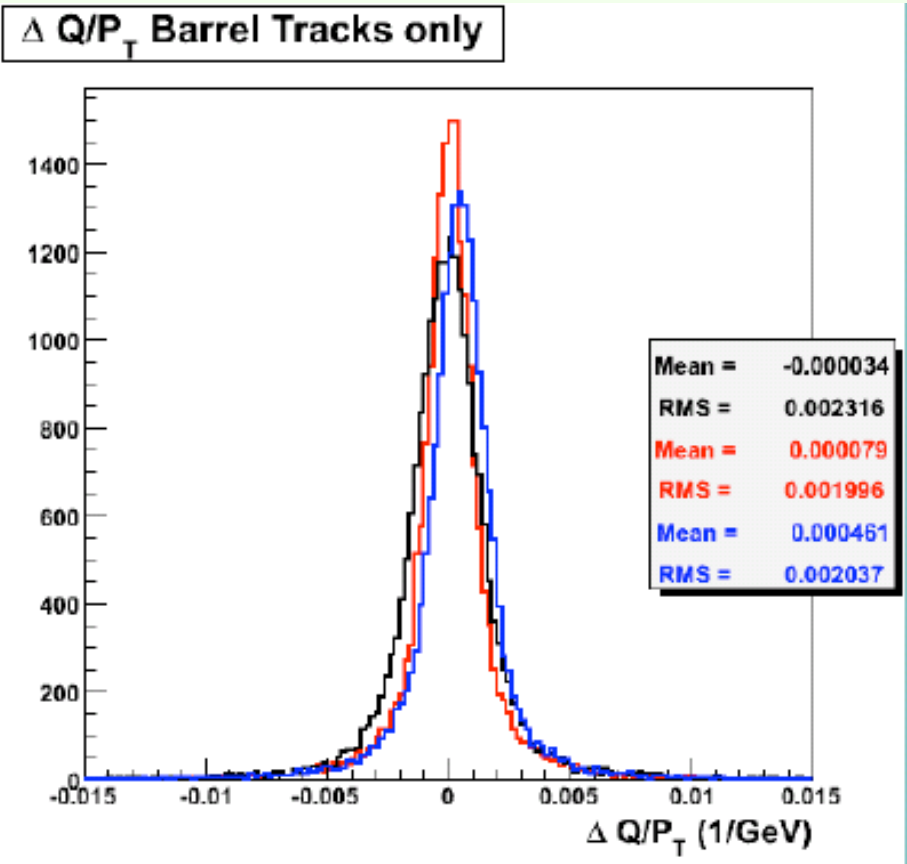


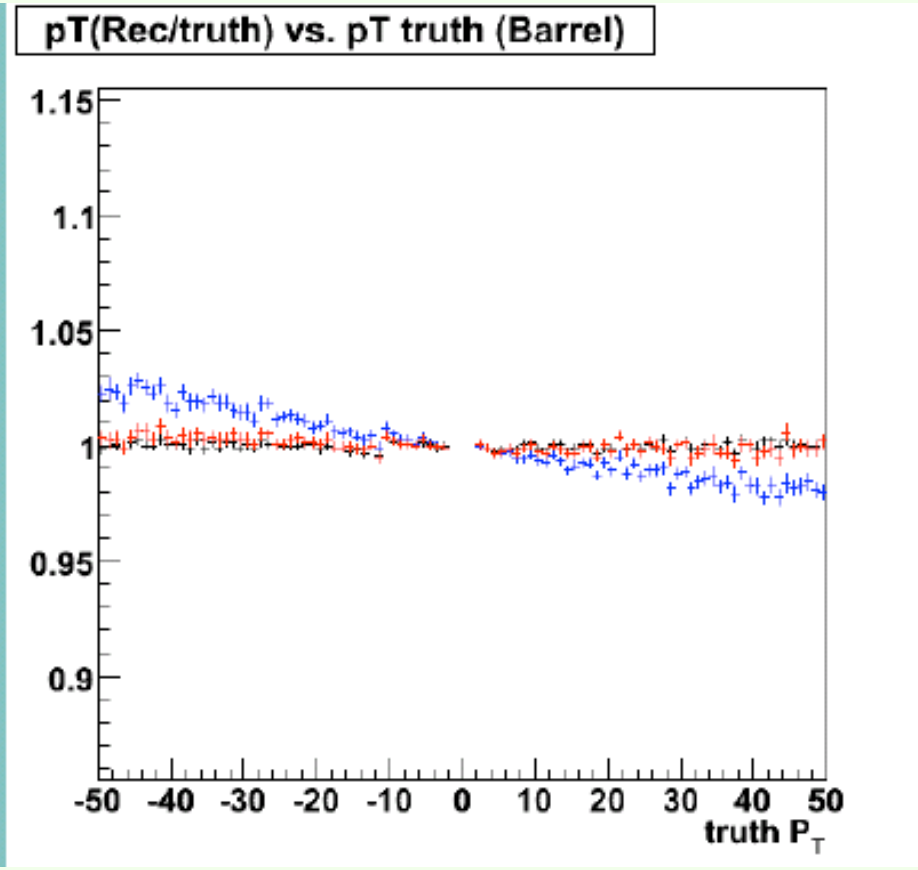
TRT Alignment Plan – New People

Black: Si only

Blue: Si+ TRT aligned @L1 + TRT aligned @L2

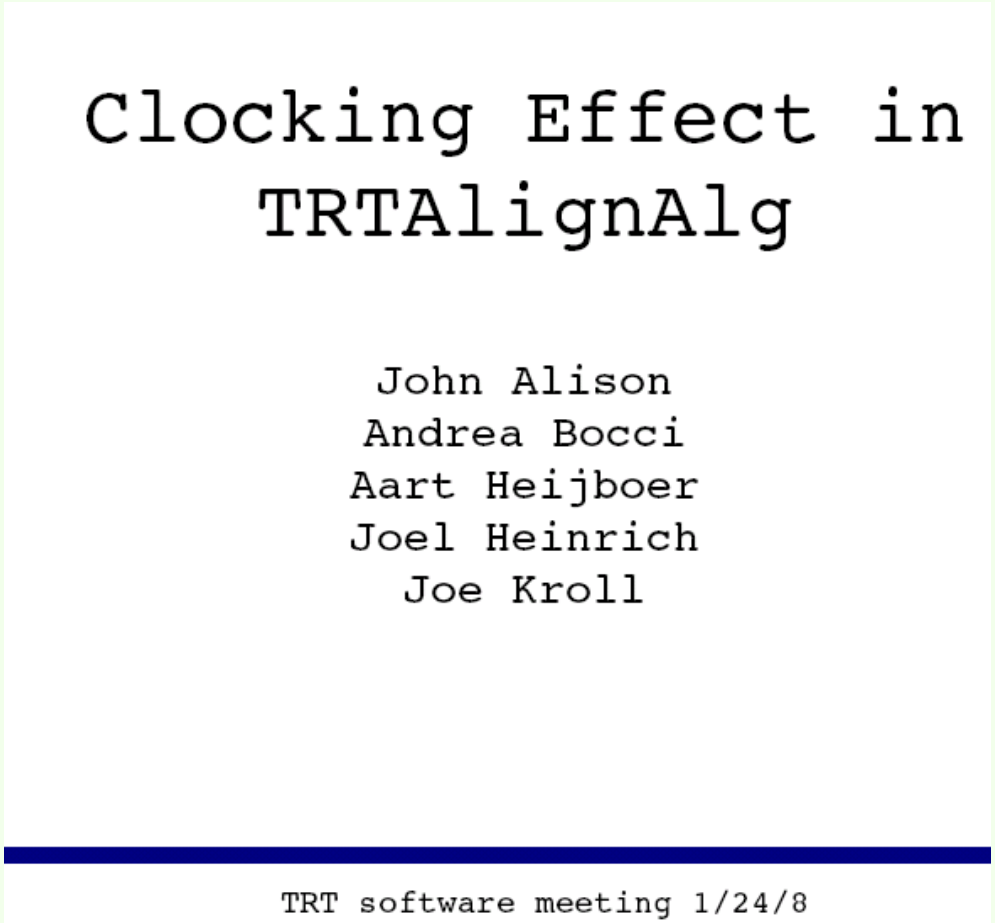
Red: Si + TRT aligned @L1 + TRT perfect @L2





L2 Studies

Dedicated effort to understand (and improve) the TRT L2


Clocking Effect in TRTAlignAlg

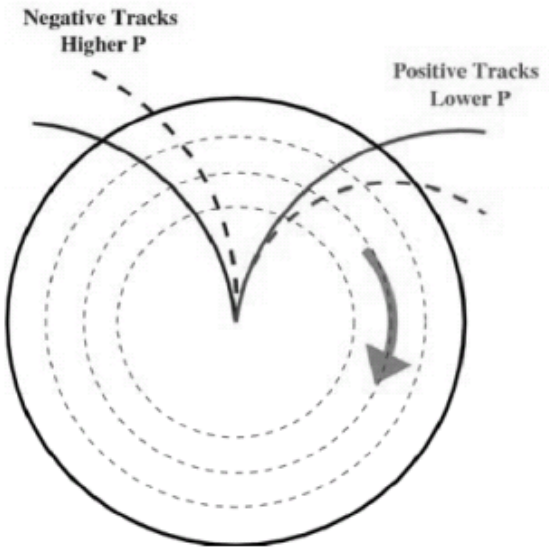
John Alison
Andrea Bocci
Aart Heijboer
Joel Heinrich
Joe Kroll

TRT software meeting 1/24/8

- Mainly 13.0.30
- Si in perfect position
- L1 TRT done
- Run L2 alignment with full tracks

Clocking Effect

- Basic idea – an incorrect residual minimum is found by systematically shifting modules around the beam axis leading to a biasing of the track Pt.



- Hard to detect in real data b/c
  - residuals are minimized
  - Effect tends to cancel in processes with opposite charged tracks (eg:Z->mumu)

L2 Studies

- Incomplete list of the studies have been performed
  - Impact of statistics
    - 5K vs 50K events
    - Multiple indipendent samples
  - Radial study (no random x,y displacement)
  - Alignment starting from Ideal position
  - Impact of poorly constrained DoF
  - Use global chi2 method instead of local chi2
  - Align only 1 or 2 layers at the time
  - Etc…

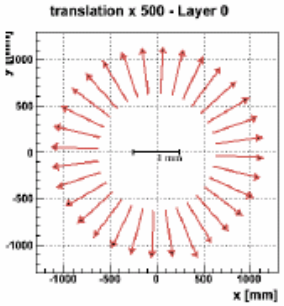
- Another maybe correlated problem is the error calculated by algorithm
  - Off by a factor 4-5, somehow not a surprise but probably too much

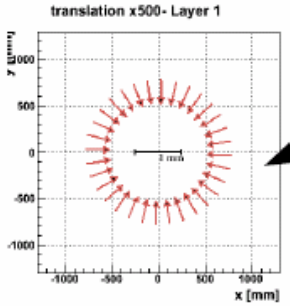
I will show few plots from these studies in the following slides
(thanks John!)

L2 Studies: Radial Study

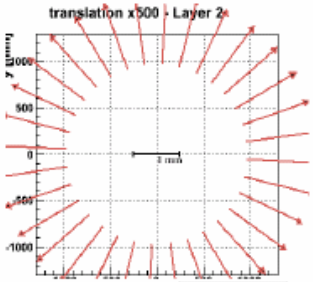
Radial Study

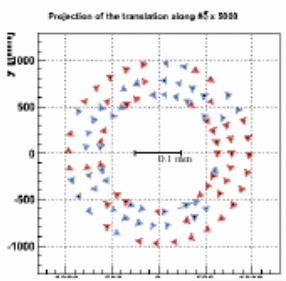
Initial displacements





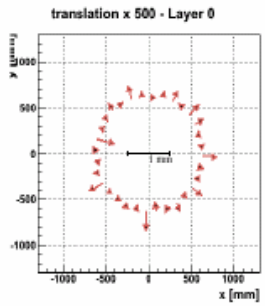
Initial displacements are radially only

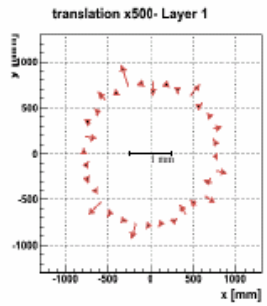


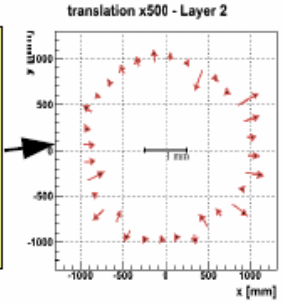


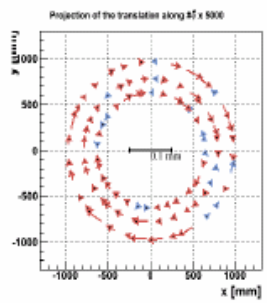
alignment recovers radial displacements while introducing clocking

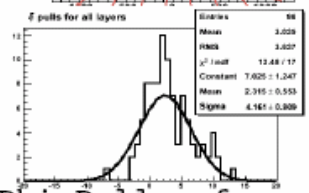
Residual displacements

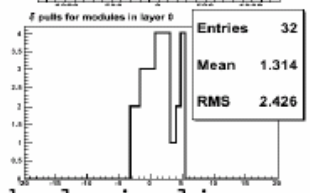




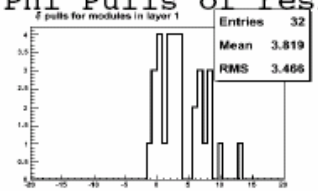


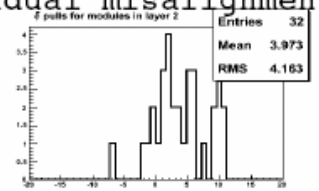






Phi Pulls of residual misalignments





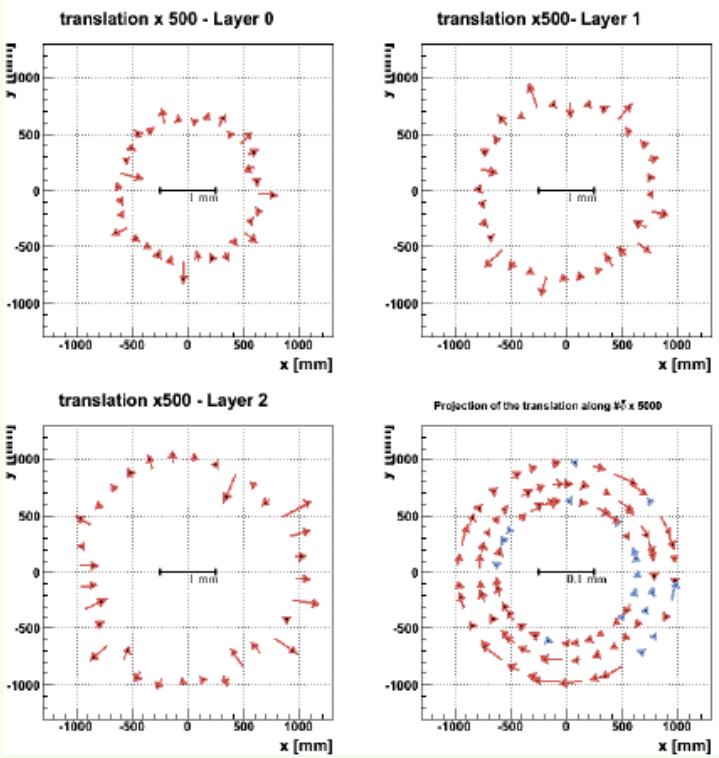
Alignment done for 9 Iterations using 5000 multi-muon events

L2 Studies: Global Chi2

Global Chi2 Method

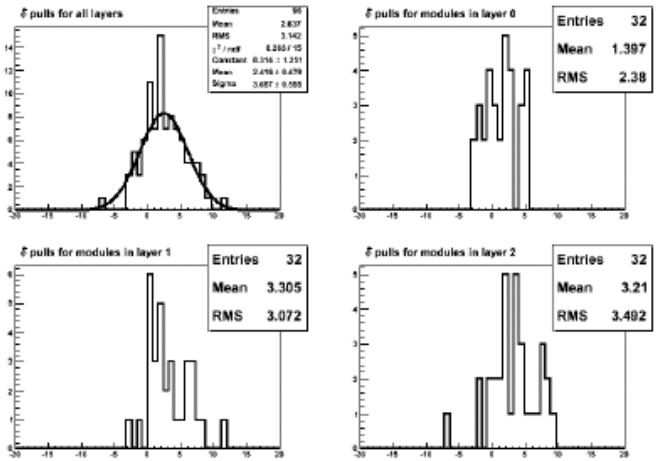
- Ran alignment using the Global chi2 method in TRTAlignAlg to solve for the alignment constants.

Residual misalignments



-9 iterations of 5000 events, starting from ideal alignment

Phi Pulls of residual misalignments

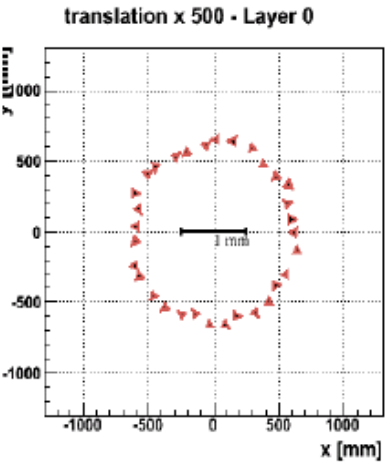


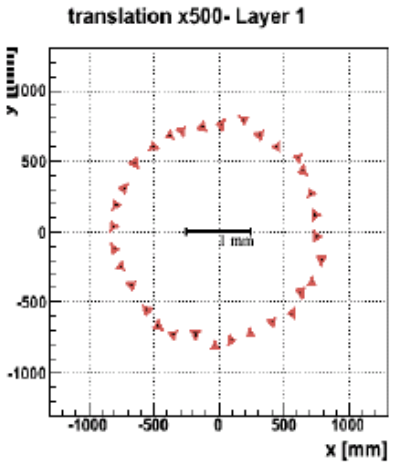
L2 Studies: Start from Ideal Geometry

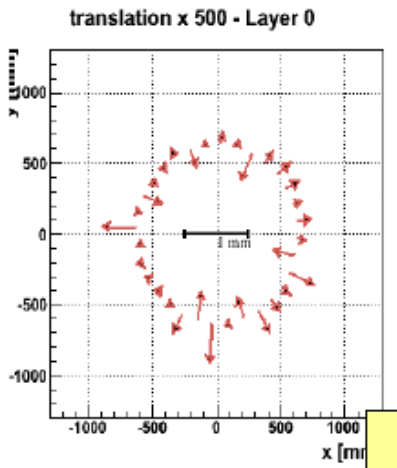
the perfect study

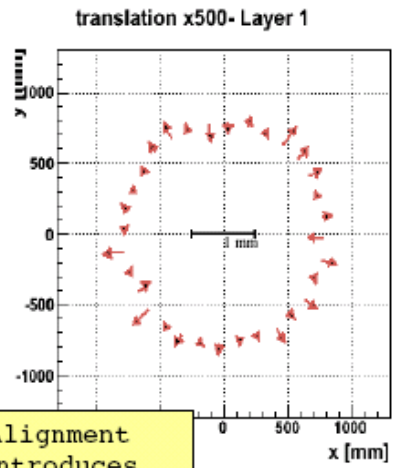
Initial misalignments

typical residual misalignments

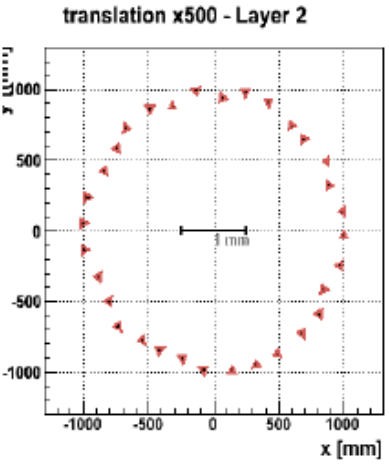


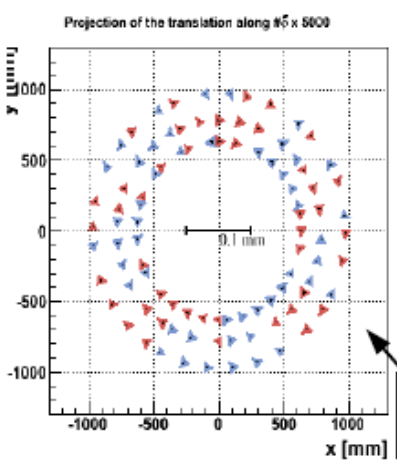




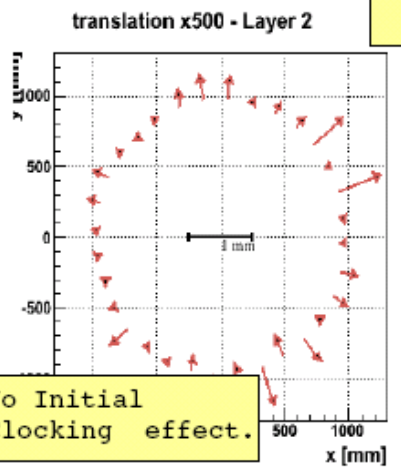


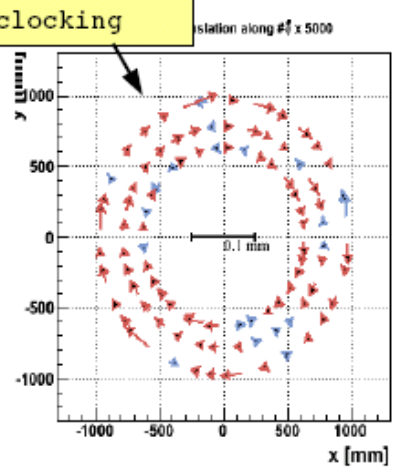
Alignment introduces clocking





No Initial Clocking effect.

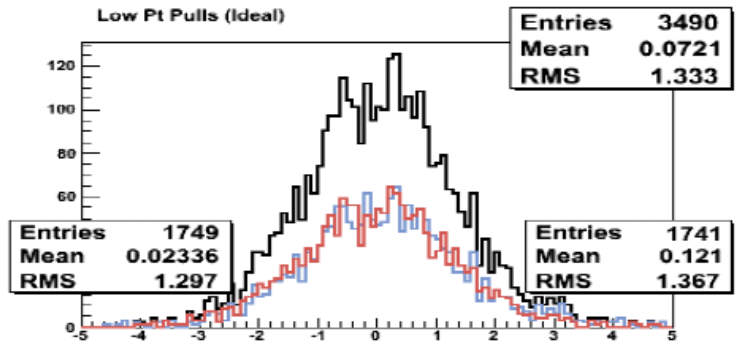


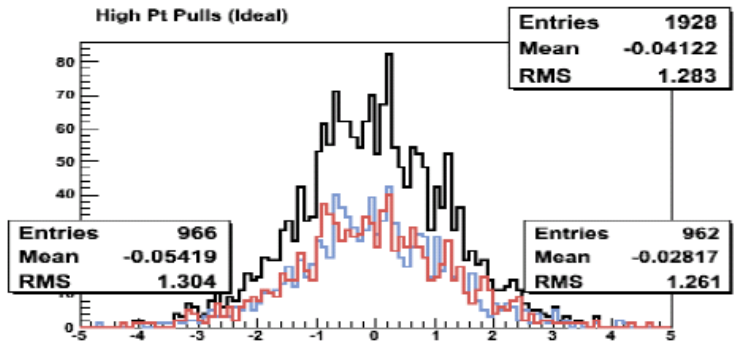


L2 Studies: Start from Ideal Geometry

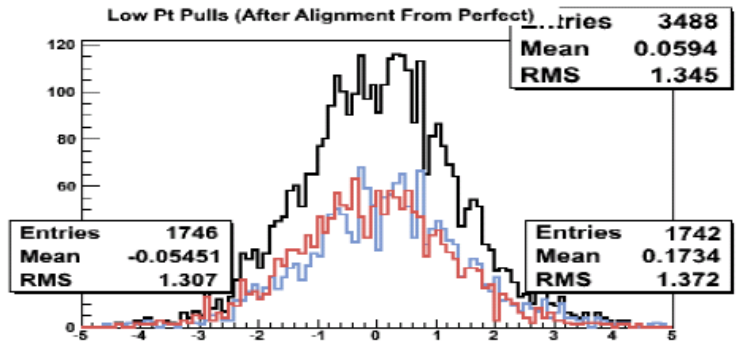
Low Pt

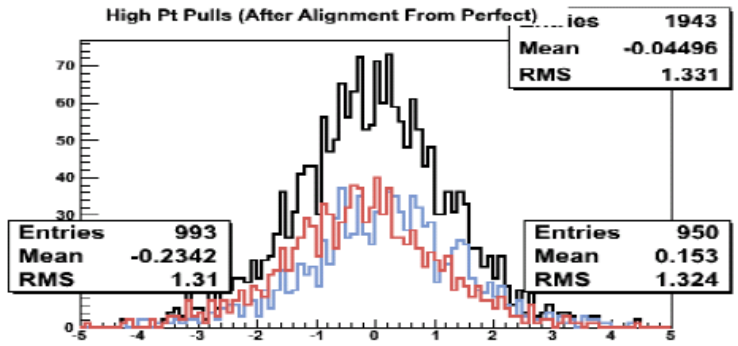
High Pt



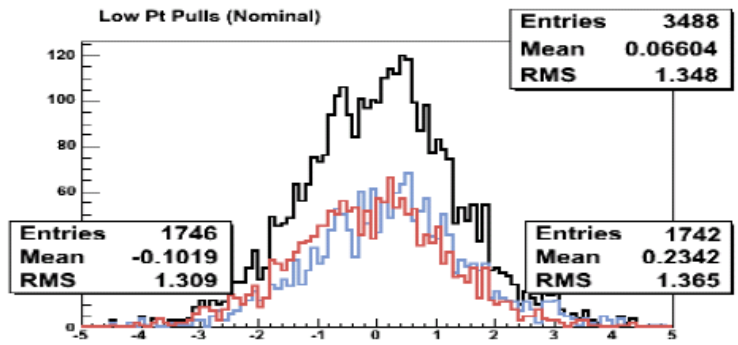


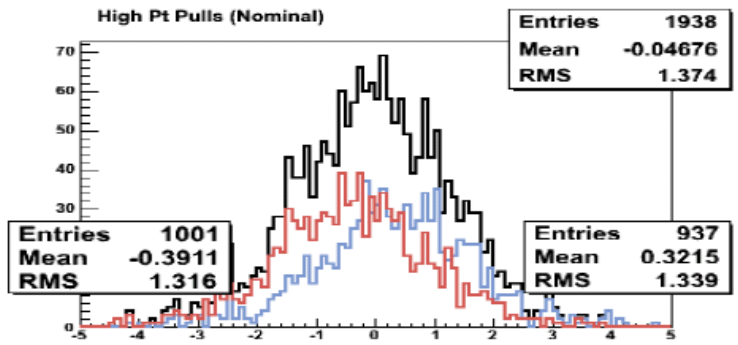
Ideal Geom.





After align. From Ideal

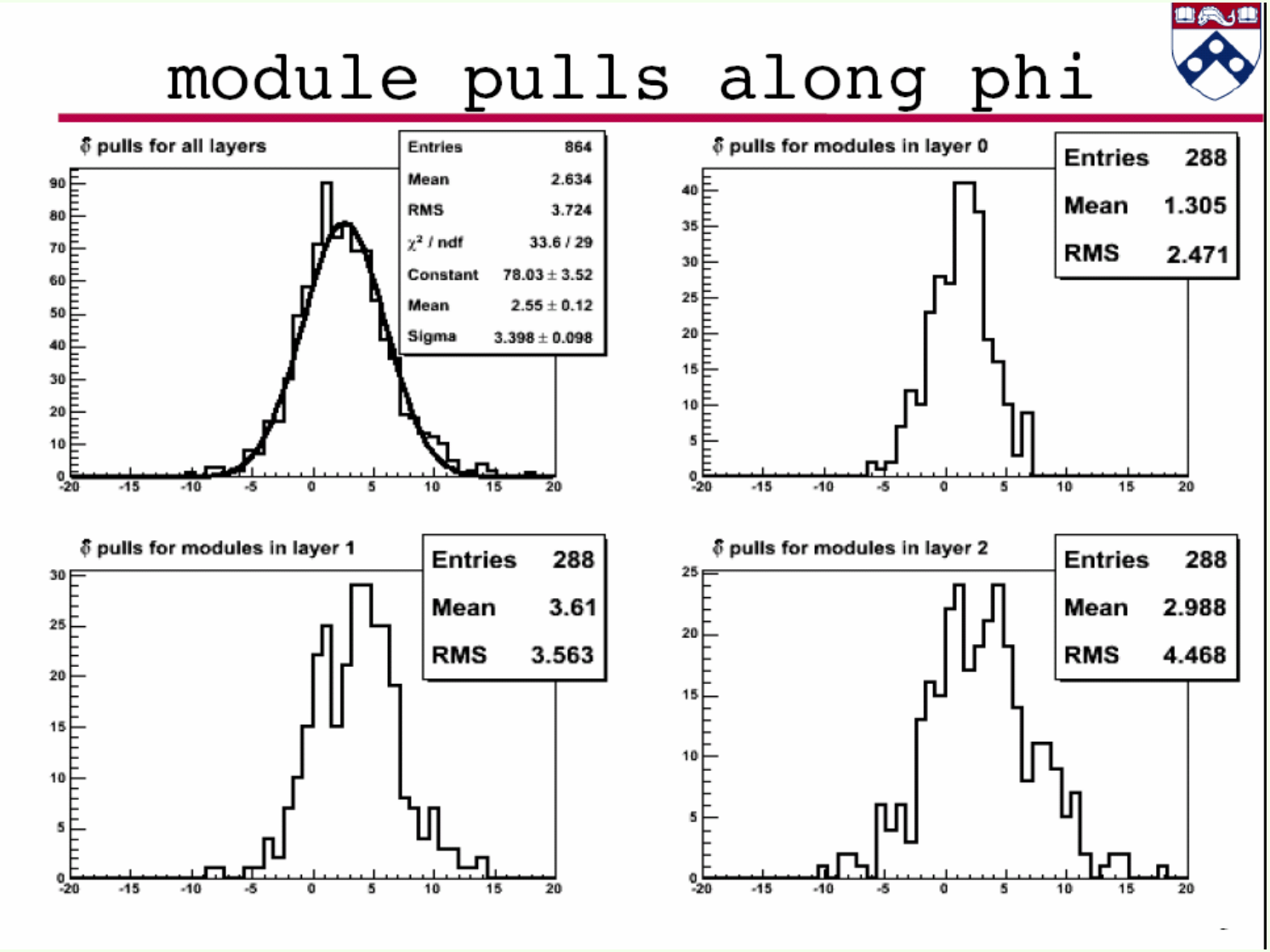




Nominal

L2 Studies: Pulls

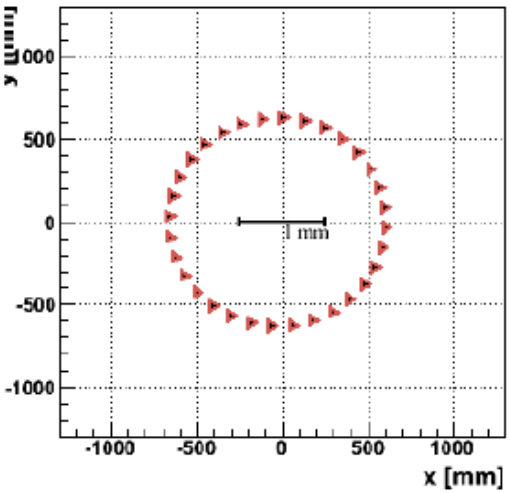
Sigma ~ 4 - Errors are overestimated



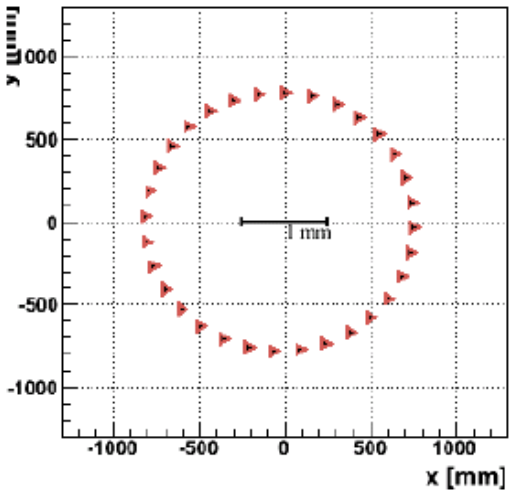
L2 Studies: Layer correlations

Layer 2

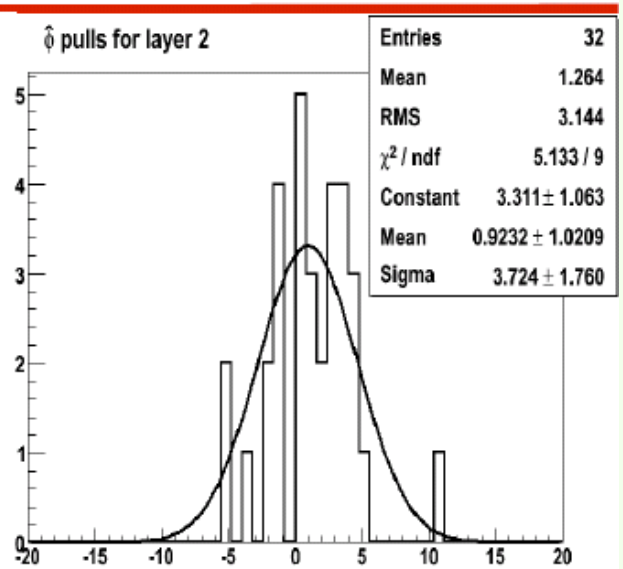
translation x 500 - Layer 0



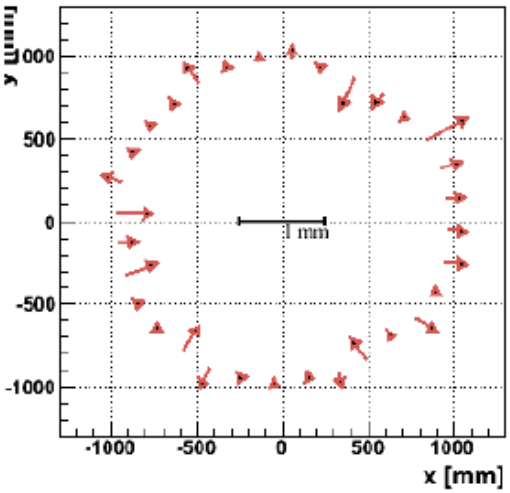
translation x500- Layer 1



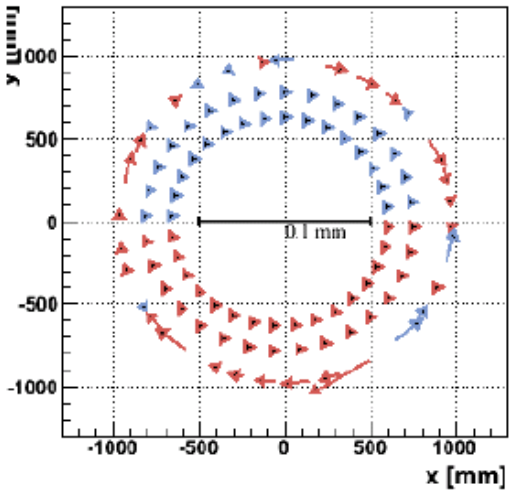
$\hat{\phi}$ pulls for layer 2



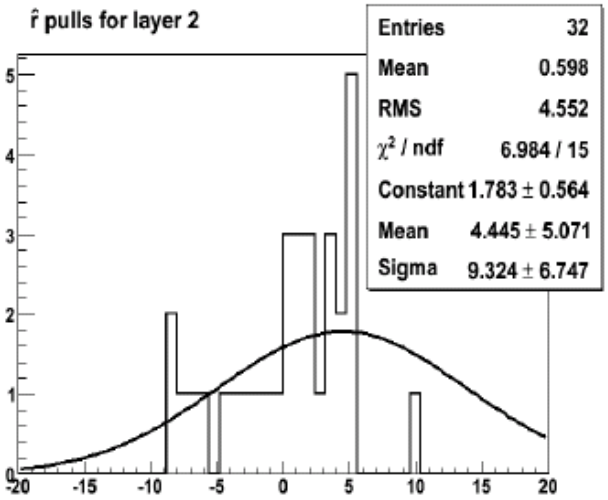
translation x500 - Layer 2



Projection of the translation along #$\hat{\phi}$ x 10000

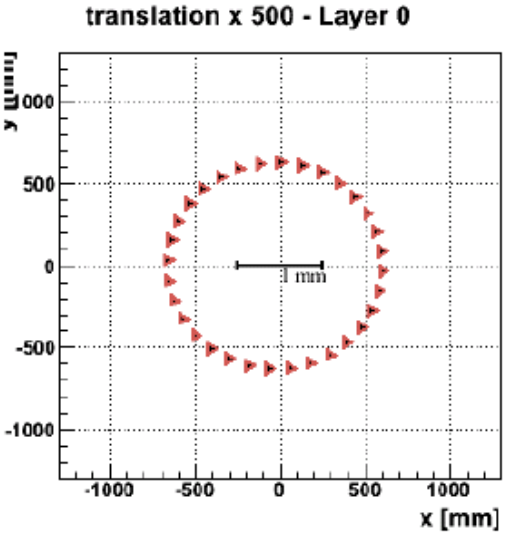


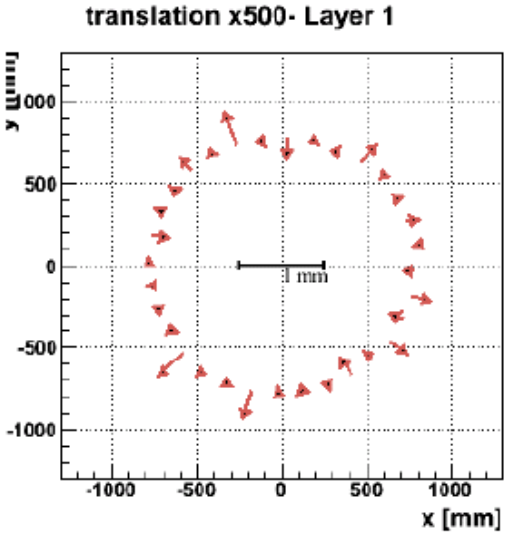
$\hat{r}$ pulls for layer 2

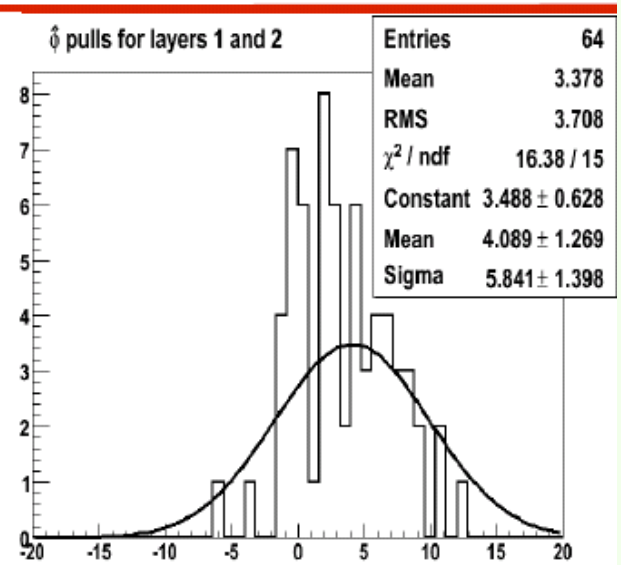


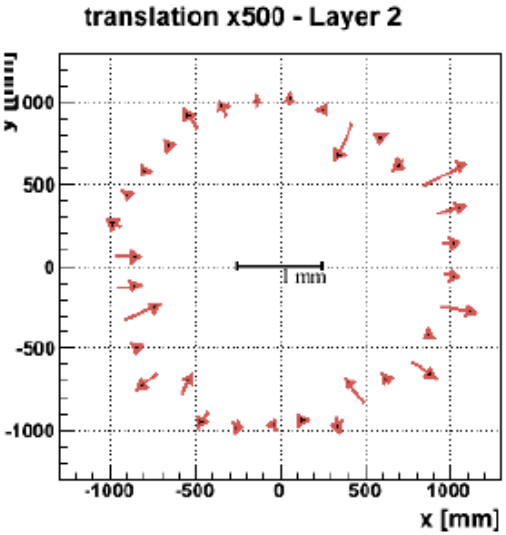
L2 Studies: Layer correlations

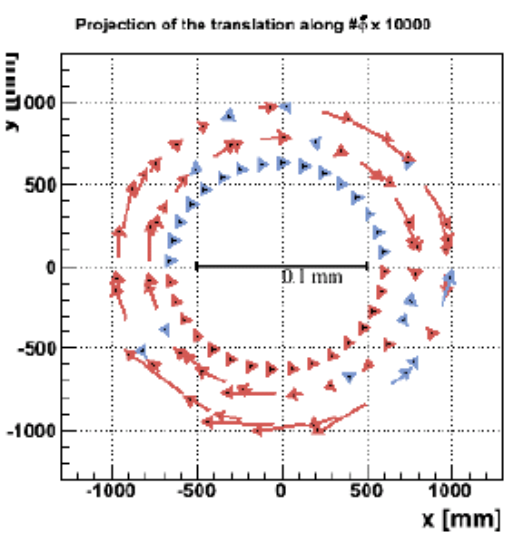
Layers 1 and 2

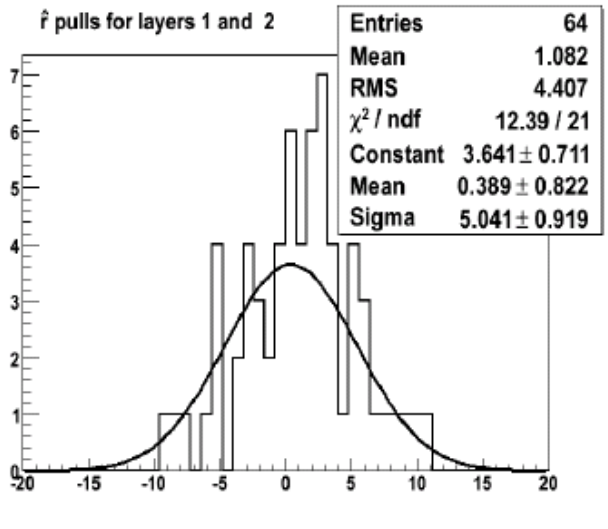






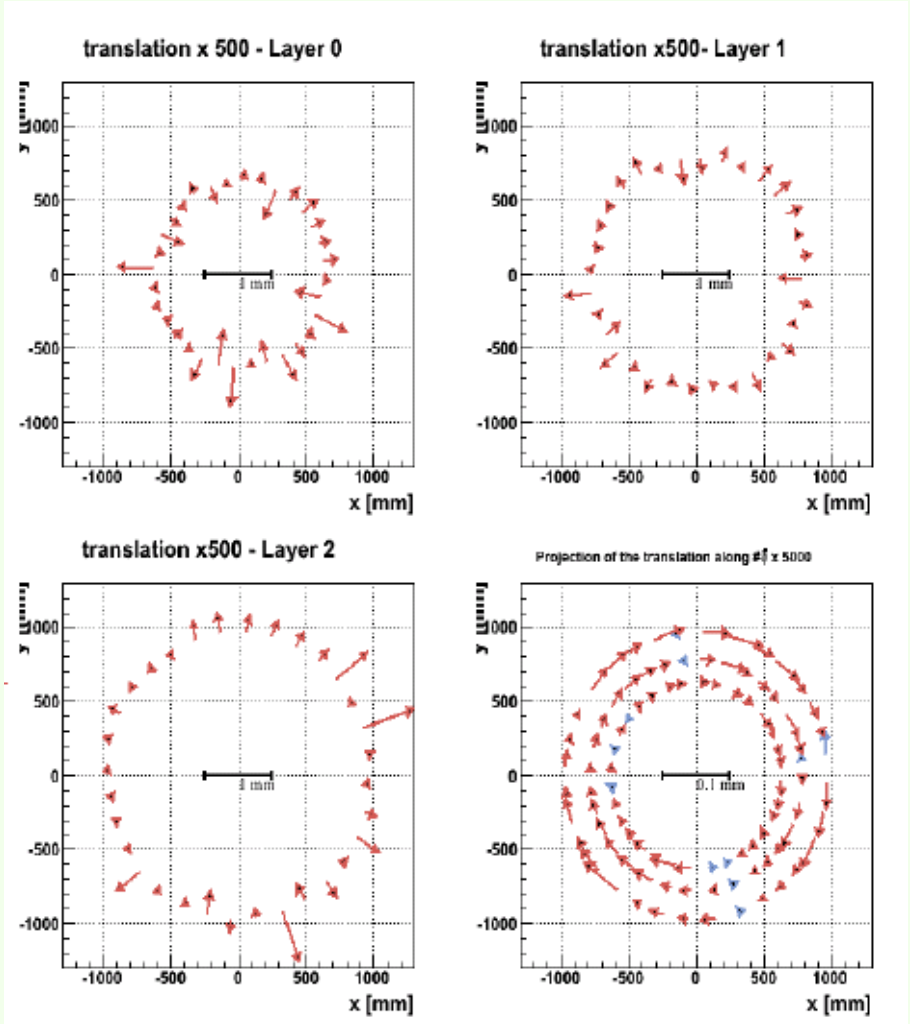






L2 Studies (Just Off the Press!)

13.0.X



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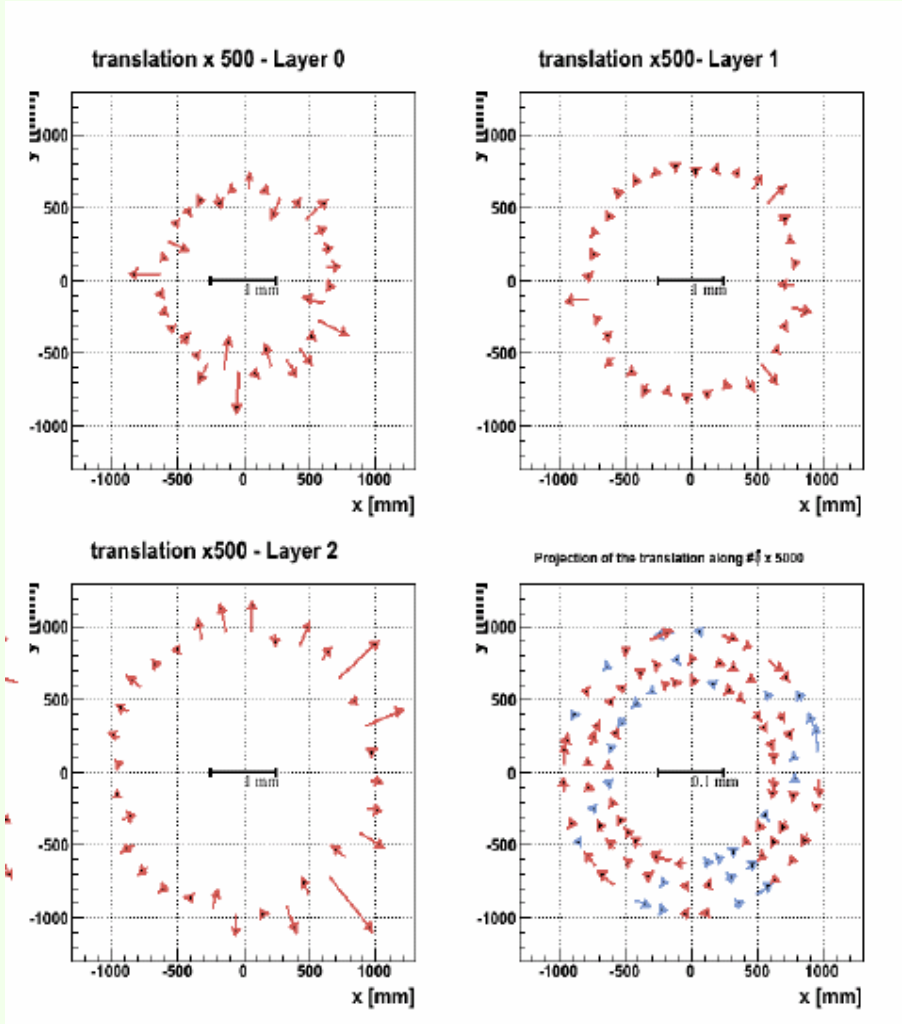
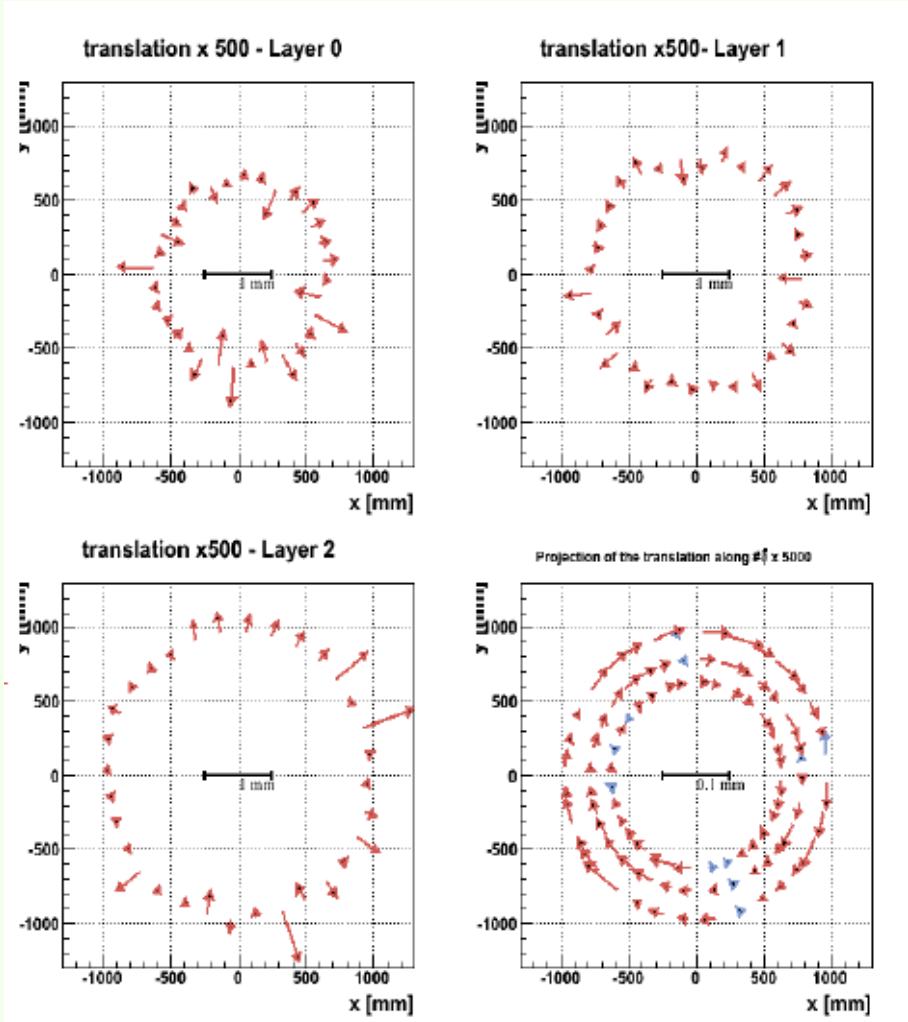


L2 Studies (Just Off the Press!)

13.0.X



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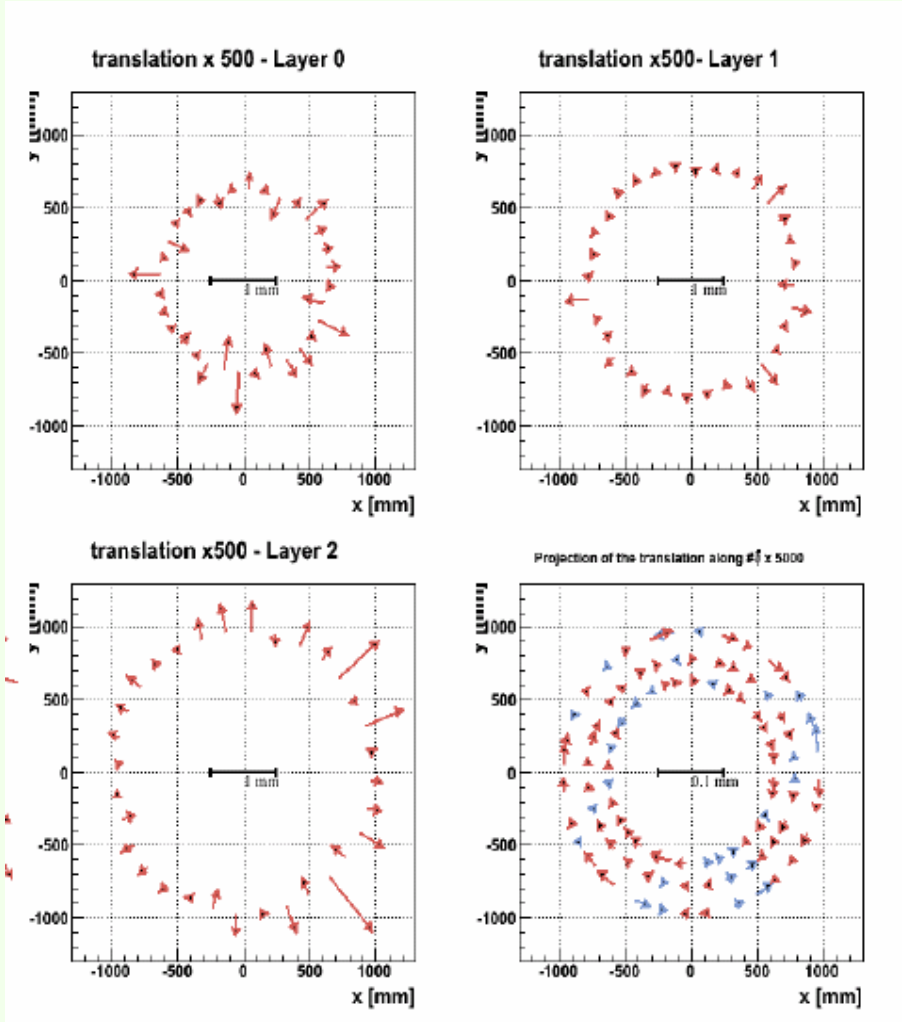
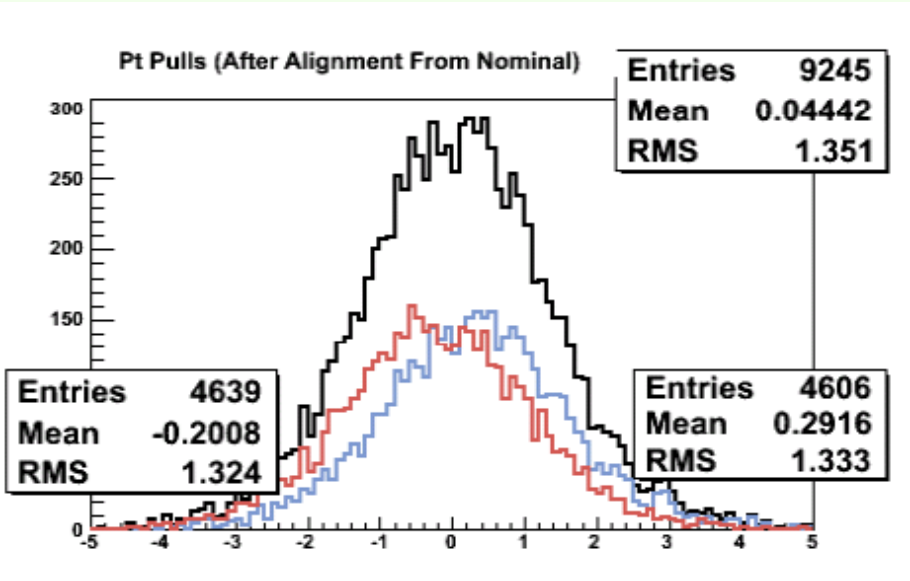


L2 Studies (Just Off the Press!)

13.0.X



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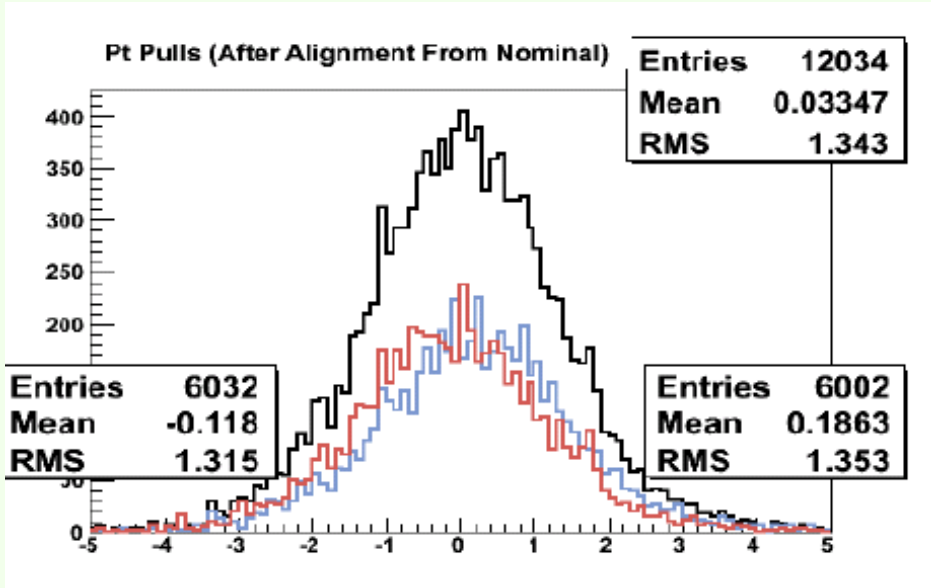

L2 Studies - Plans

- Still work to do to understand the source of clocking effect
  - Part is introduced by the algorithm
  - Part is a residual of the initial clocking configuration

- Several tests performed. No smoked gun yet

- More tests to come with the simplest configuration to single out problems. Other ideas:
    - Single module alignment (cannot do simpler than that!)
    - Distant modules alignment
    - Smart track selection
    - All of the above using cosmics

- Try to find the limitations of the L2 alignment and needs for the best performance
  - How many tracks? We need cosmics? How many?

- The TRT L2 is an essential step for the entire tracking performance
  - It has a huge impact in the momentum resolution

FDR Challenge

- The ID is supposed to run over the FDR calibration stream
  - Basically single tracks with only ROI
- For FDR-I no iteration procedure was foreseen at Tier0
  - It makes run alignment impossible
- Still want to test the whole chain
  - From BS data to final alignment constants in the DB
- Very useful to coordinate Si and TRT alignment. We run sequentially but TRT needs Si aligned before start
- I'm running the TRT software over a (pre-)sample of FDR calib stream as I speak. More complete tests this week and following week
- More details in alignment sessions tomorrow and Thursday
  - Restructure of ID alignment SW
  - Calibration/Alignment operations
  - FDR-II
  - ….