HFT Survey/Alignment work update

S. Margetis

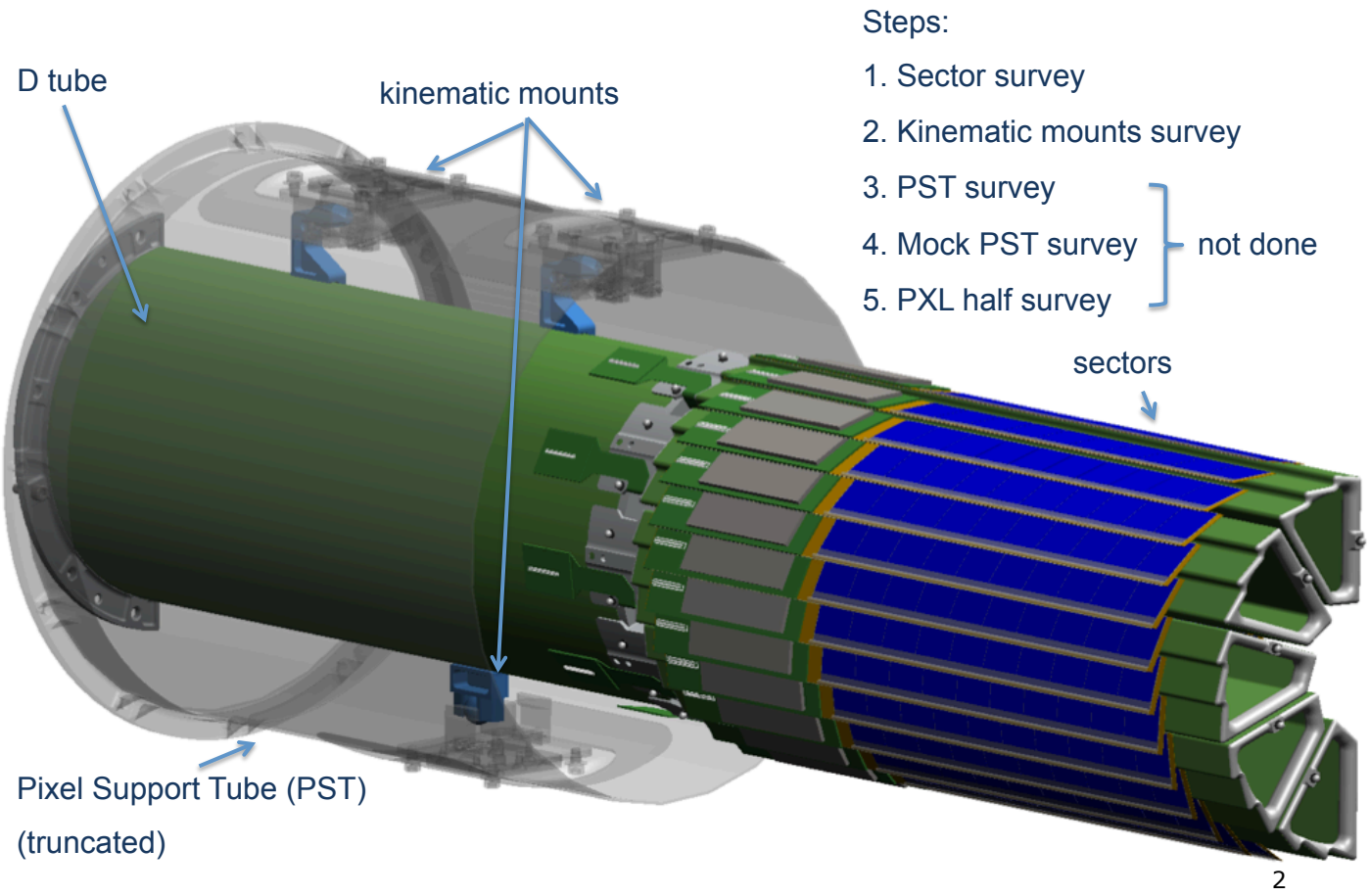
- **Overall Survey status and plans for all three systems**
  - some of the issues encountered and discussed
- **Alignment work progress**
  - with Ideal and Survey geometry as input
  - with dirty and cleaner data
    - masking, beam constraint, space charge
  - Plans for all three
- **Using the pxl ladder overlap**
  - checking/monitoring

Overall Survey Status

- **PXL**
  - Run-13 prototype exercise very useful
  - All 3 sectors measured, 3 times, methods/structures established, data extracted and put in "geometry"-form in Db
  - Chip surface variations mapped and in Db
  - Extensive studies of repeatability, time-dependencies
  - Methods etc ported to other systems

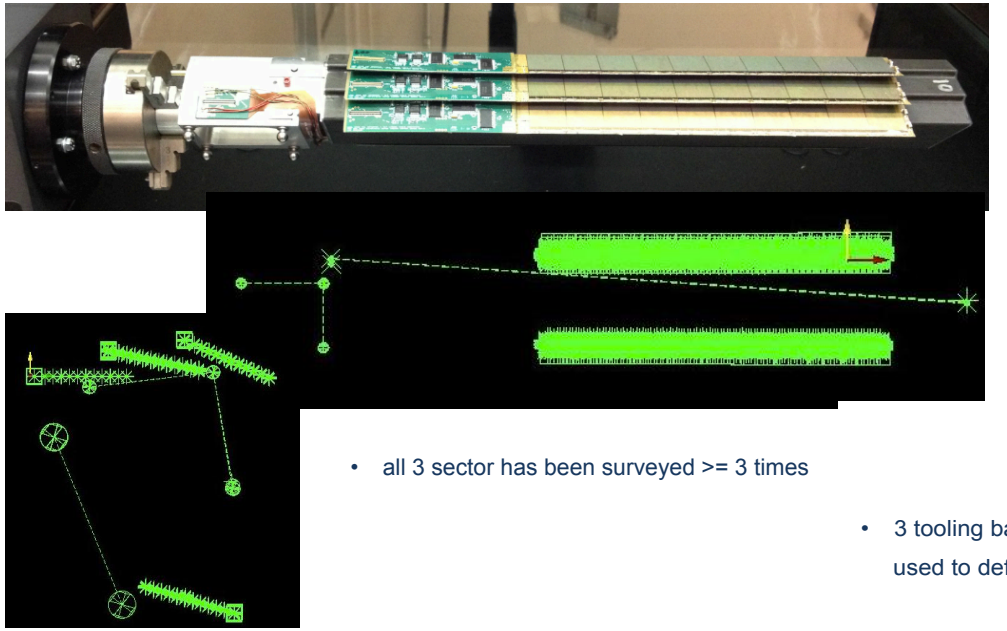
- **PXL**
  - All 3 sectors measured, 3 times, methods/structures established, data extracted and put in "geometry"-form in Db

Overall Survey Plan



- **PXL**
  - All 3 sectors measured, 3 times, methods/structures established, data extracted and put in "geometry"-form in Db

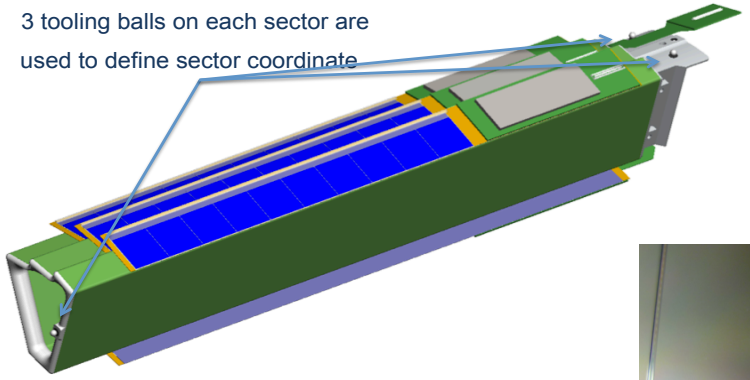
Sector Survey Results

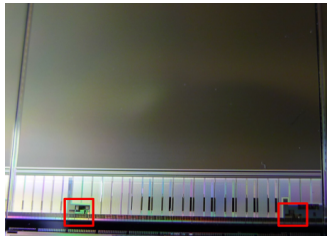


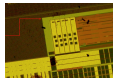
- all 3 sector has been surveyed >= 3 times

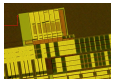
Sector Survey

- 3 tooling balls on each sector are used to define sector coordinate





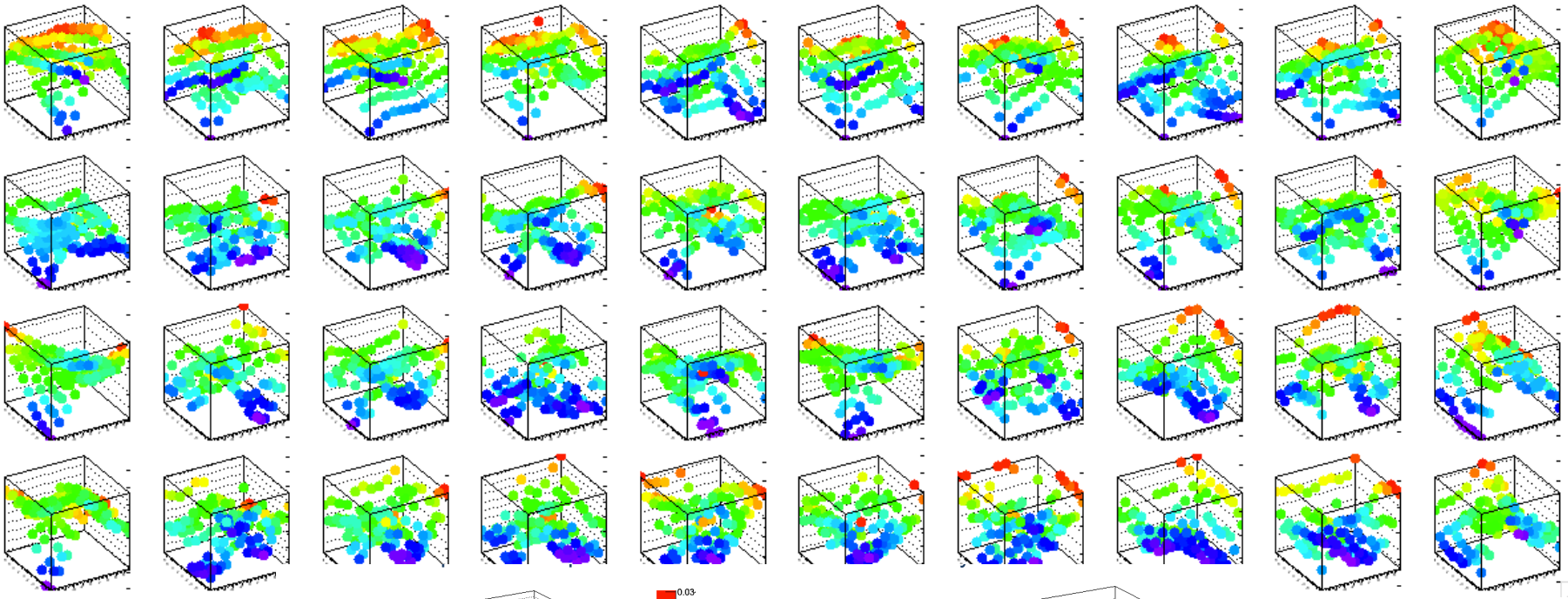


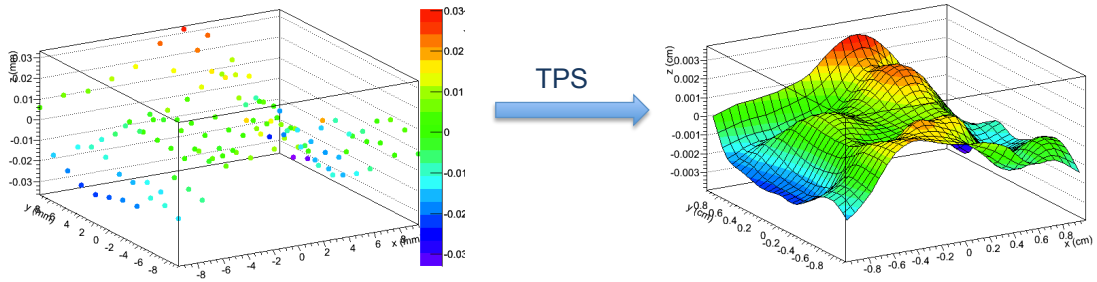


- 2 features on each chip/wafer are used to define chip local coordinate
- Each chip is scanned with 121 points to get the surface profile

- **PXL**
  - Chip surface variations mapped and in Db

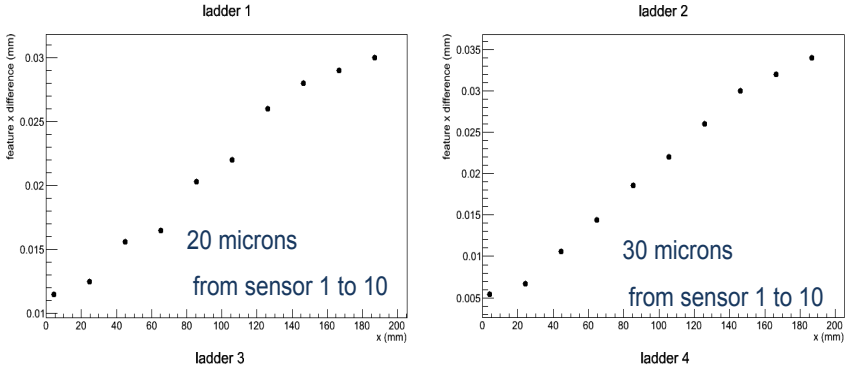
Sector Survey Results



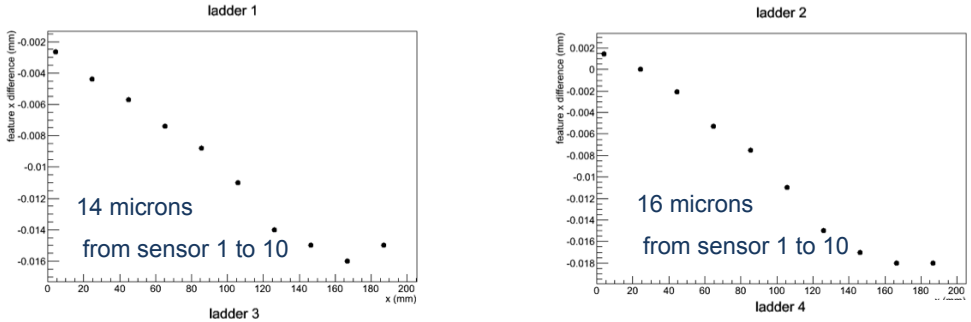


- **PXL**
  - Extensive studies of repeatability, time-dependencies

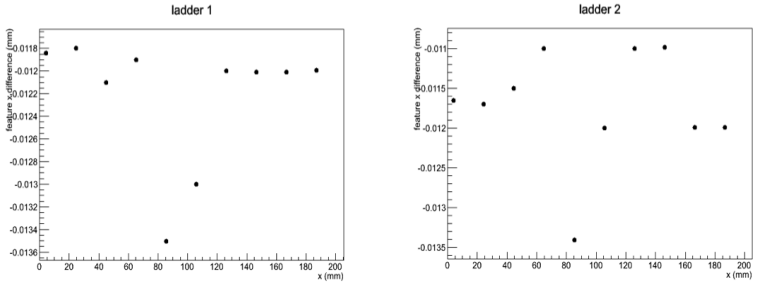
The Ladder Extension



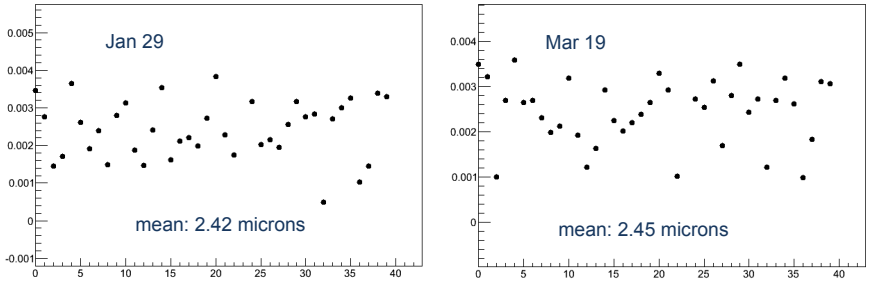
The Ladder Contraction



No Apparent Change with Dehydrant

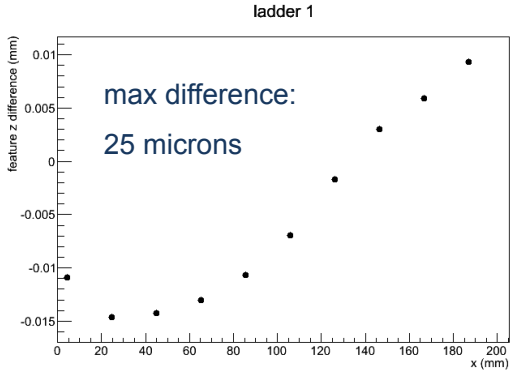


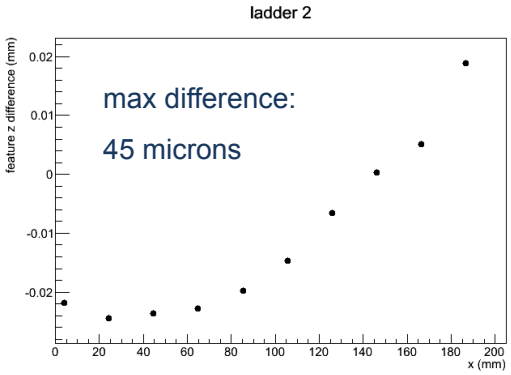
Feature Distance within a Sensor



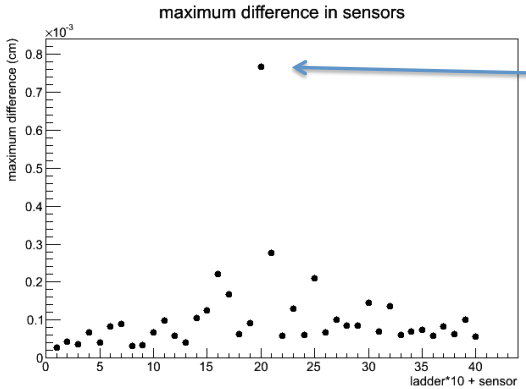
- **PXL**
  - Extensive studies of repeatability, time-dependencies
    - **This year's sector construction done with reduced standards**

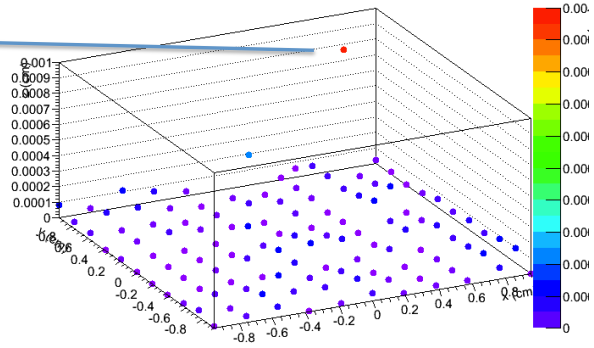
The Ladder "Sagging"





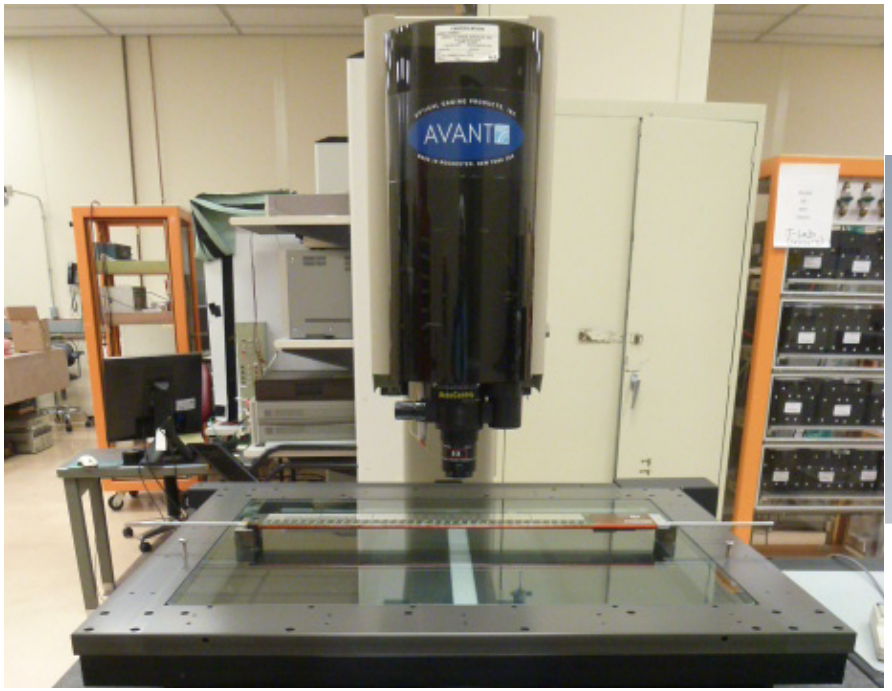
Repeatability within Sensors

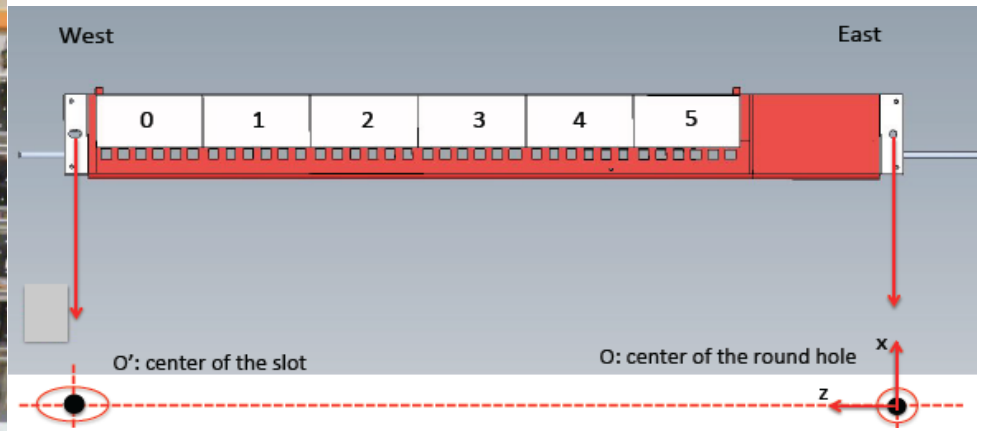


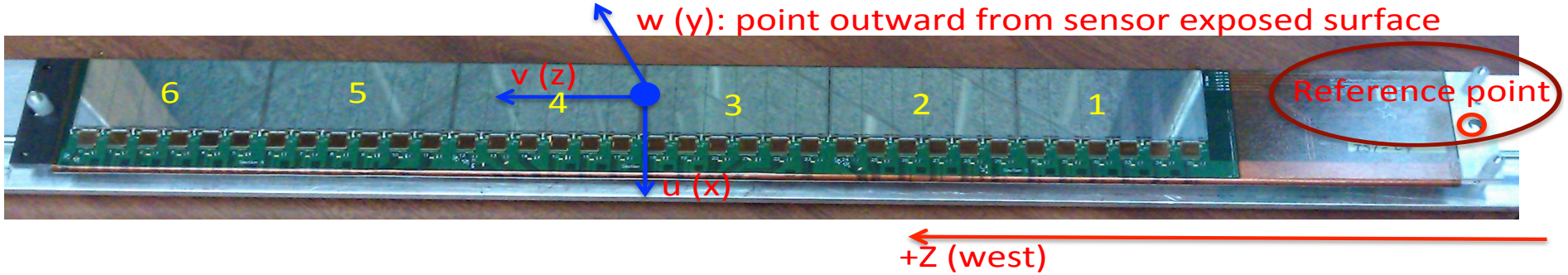


minimum difference between 4 survey runs

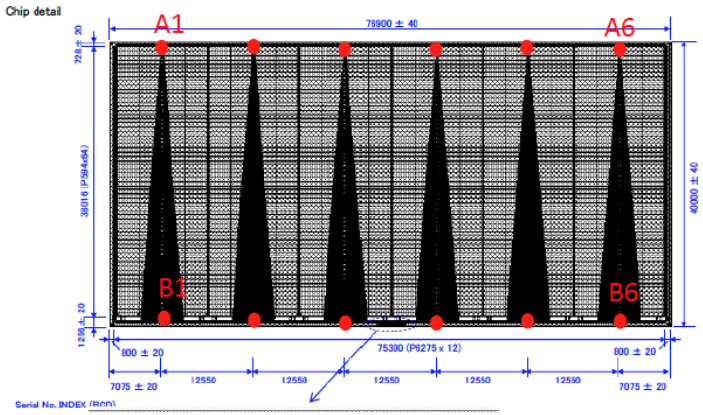
- **IST**
  - Survey done at two places: Fermilab and BNL
  - All ladder survey completed – also the mounting positions on ISC
  - Data organized according to system conventions and structures
  - Some initial tests with geometry -> O.K.

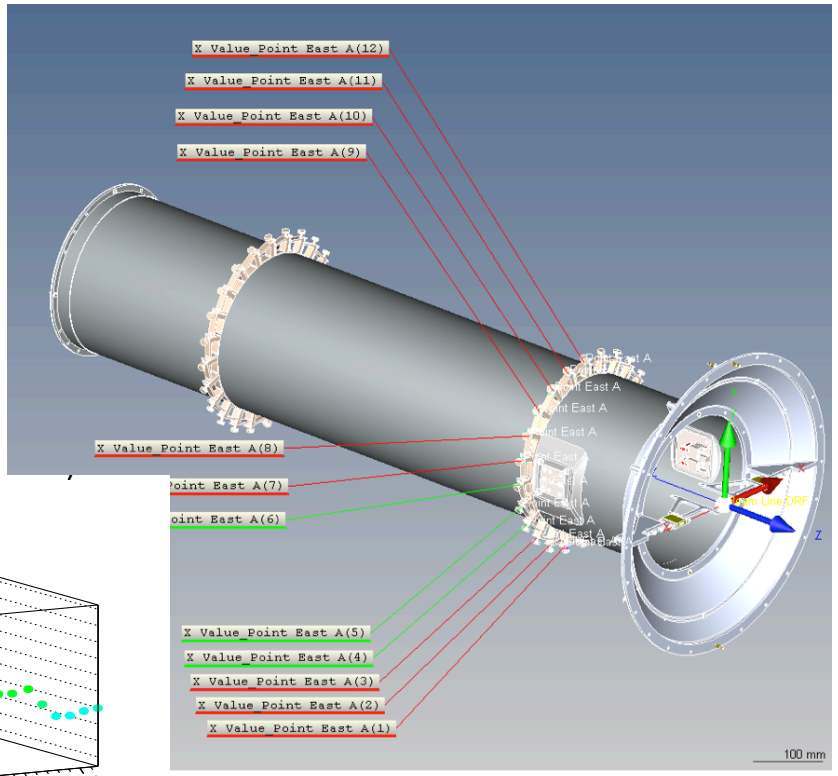




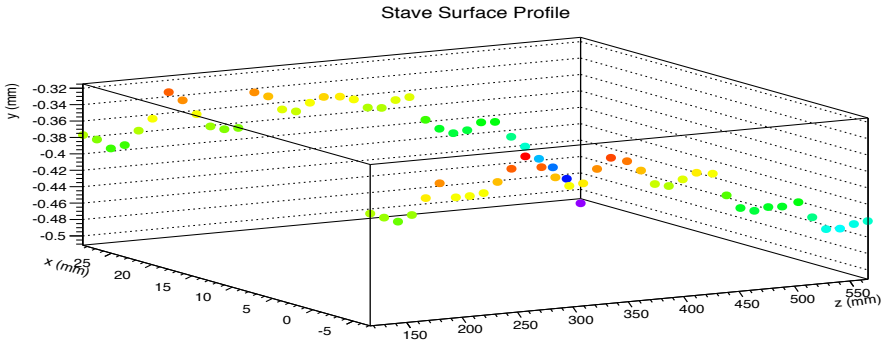


- **IST**
  - *All ladders survey completed – also the mounting positions on ISC*

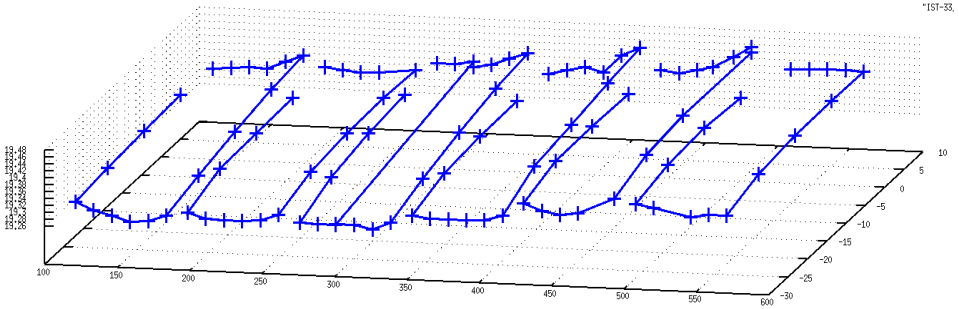




UIC/FNAL survey



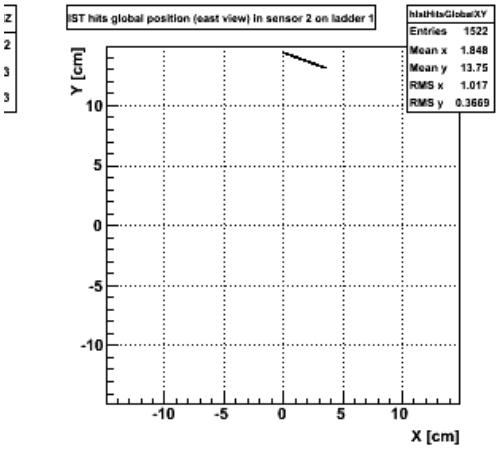
MIT/BNL survey



- **IST**

  - Data organized according to system conventions and structures
  - Some initial tests with geometry -> O.K.

ırrent GEANT geometry)



Db tables for StIstDbMaker

- GlobalXYZ = TpcOnGlobal*IdsOnTpc*PstOnIds*IstOnPst*istLadderOnIst*istSensorOnLadder

TGeoHMatrix parameters for ladder/sensor geometry (current IST GEANT geometry dev14, based on SolidWorks drawings rev. August 2012):

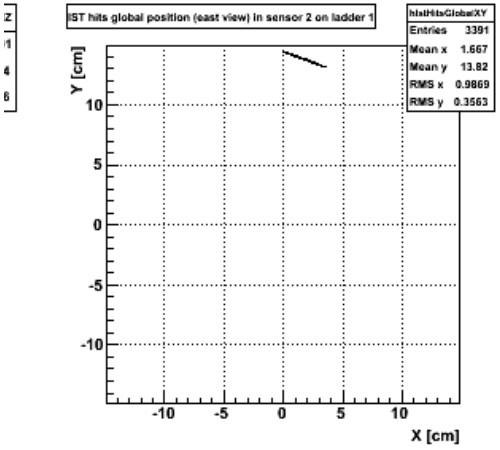
1st ladder Db table

-0.9405848	-0.3395589	0.0	1.77085
0.3395589	-0.9405848	0.0	13.77975
0.0	0.0	1	0.0

1st sensor on Ladder

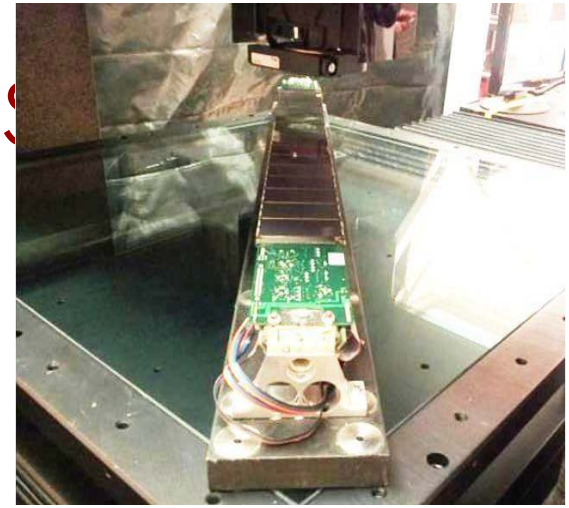
1	0	0	0
0	1	0	0
0	0	1	-19.3250

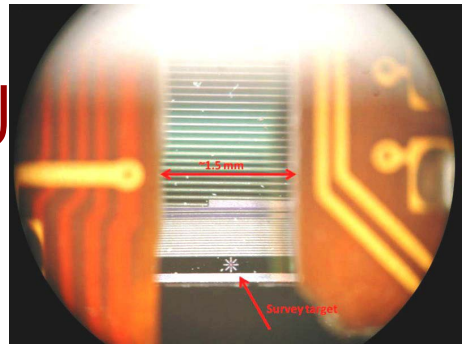
StIstDbMaker with Db



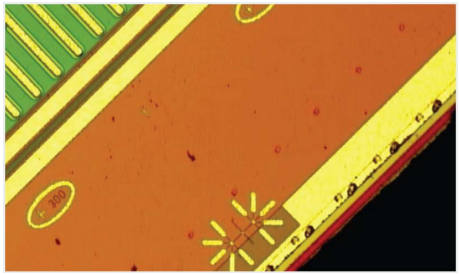
- **SSD**

  - Survey done at same machine at LBL as PXL
  - All ladders completed
  - Pending data organization

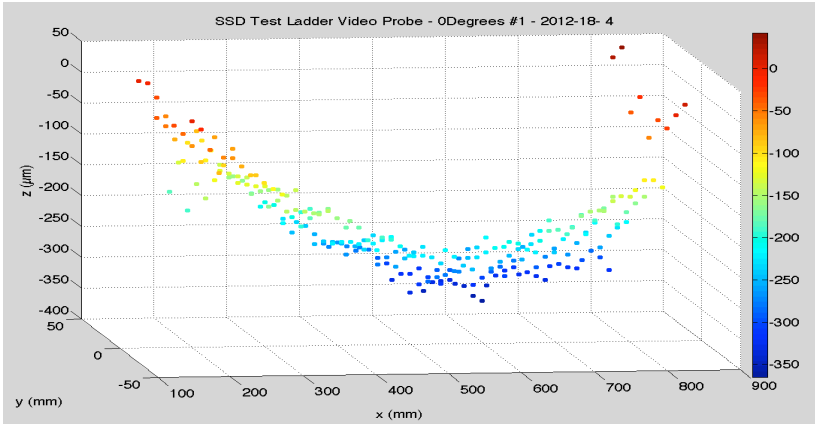


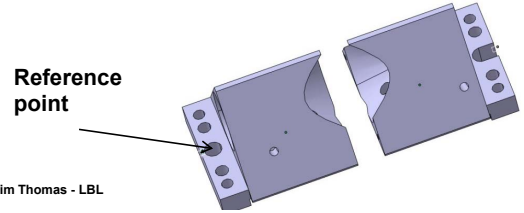


Target on end of wafer (backside)



Targets on edges of wafer (front)

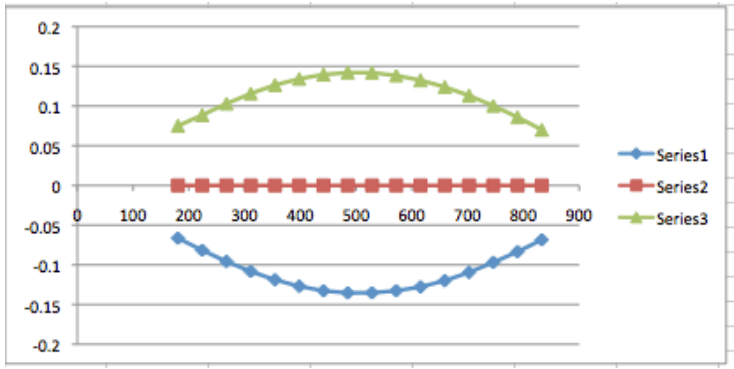




Jim Thomas - LBL

9

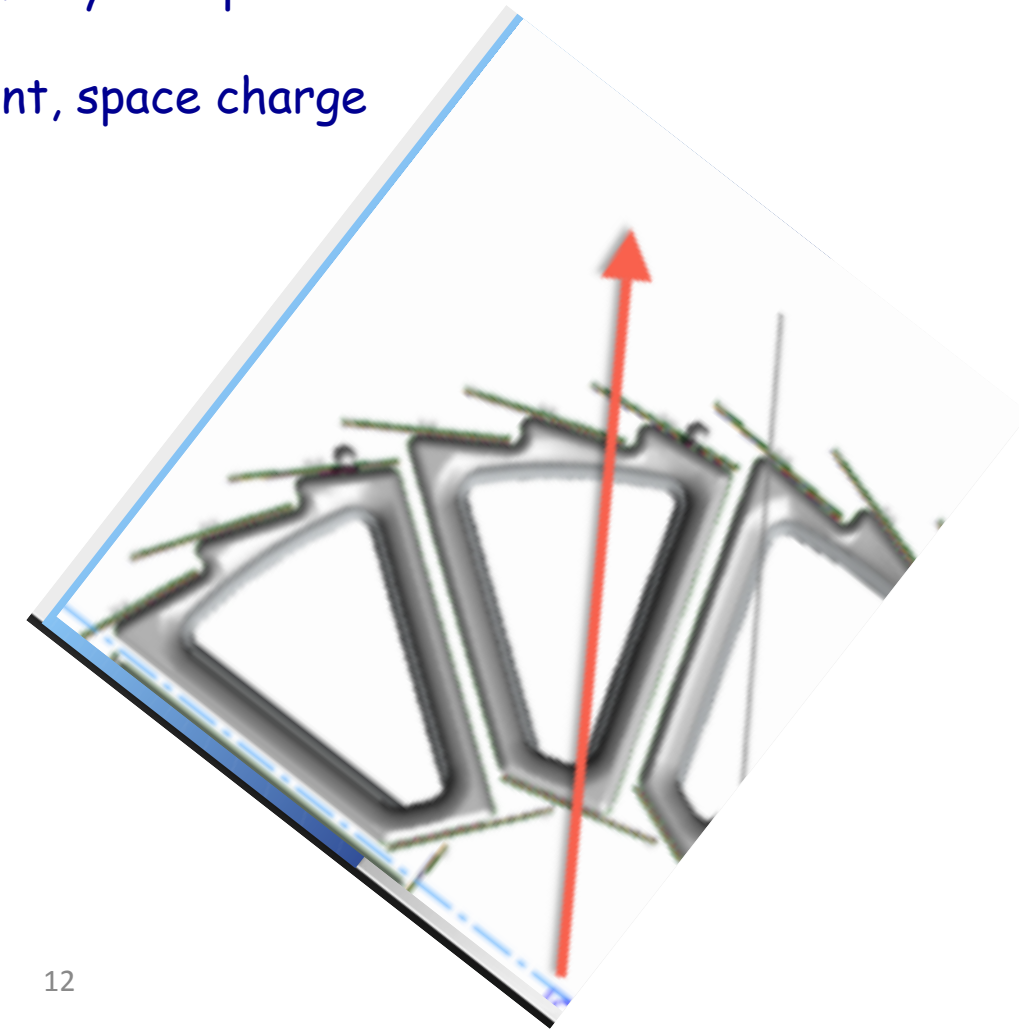
Ladder's sagitta ~ 300 microns



Alignment Status

- **Alignment work progress**
  - **Methods ported from SVT/SSD era with modifications**
  - with Ideal and Survey geometry as input
  - with dirty and cleaner data
    - masking, beam constraint, space charge
  - Plans for all three

- **Using the pxl ladder overlap**
  - checking/monitoring



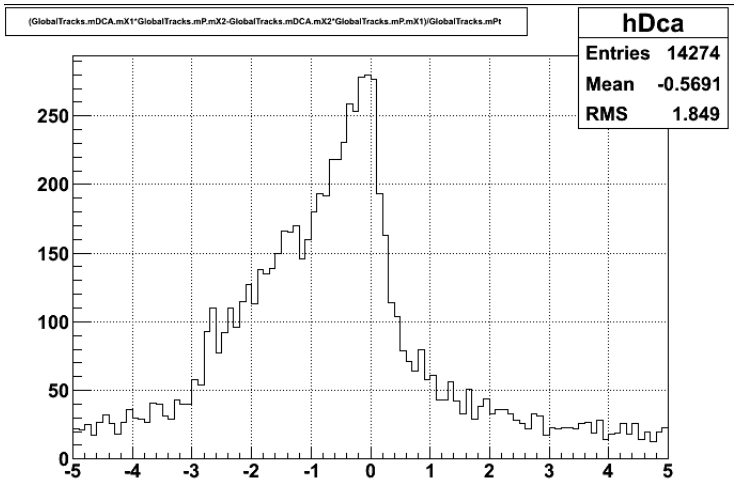
space charge

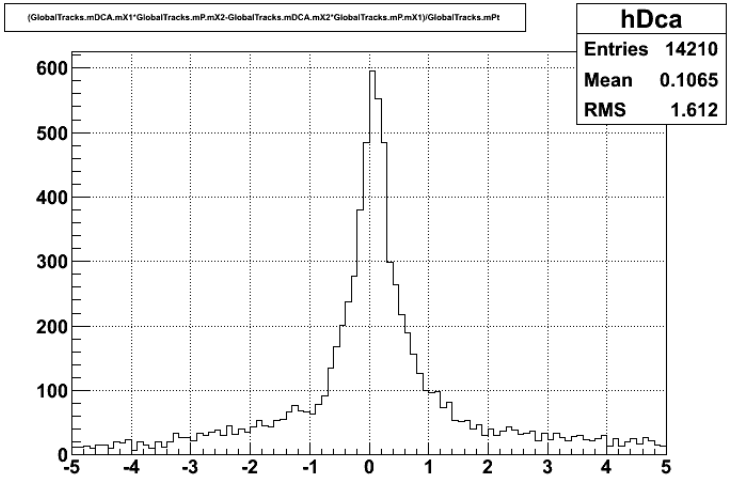
- Standard DB:

fullFieldB	satRate	factor	detector	offset	ewratio
2.649e-14	10000000000.0000000000	2.00000000	0.00000000	0.00000000	1.00000000
5.665e-10	10000000000.0000000000	1.00000000	0.00000000	-27390000.00000000	1.00000000

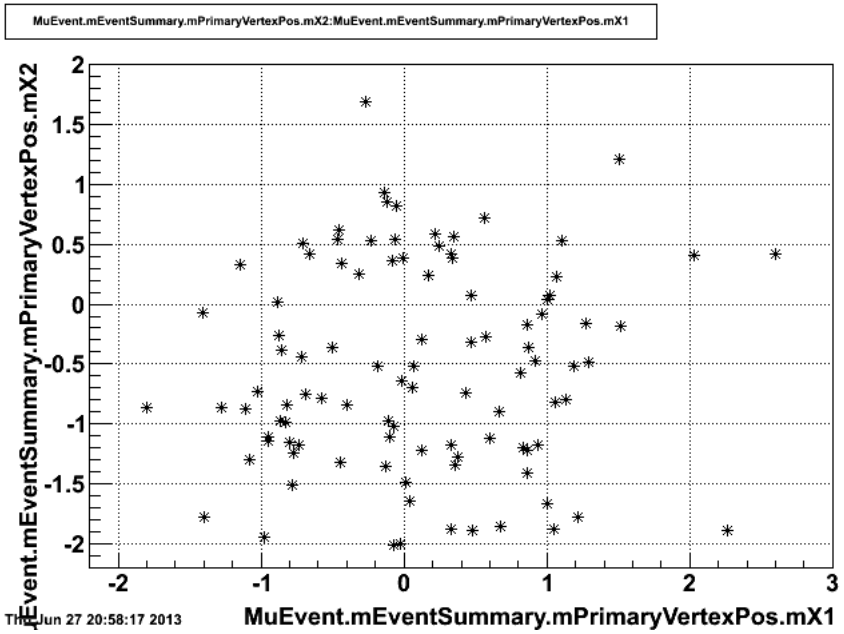
- SpaceCharge = Σ fullFieldB*(scalerRate – offset)^factor
- non 0 offset means some correction even with no beam, not good for low luminosity data

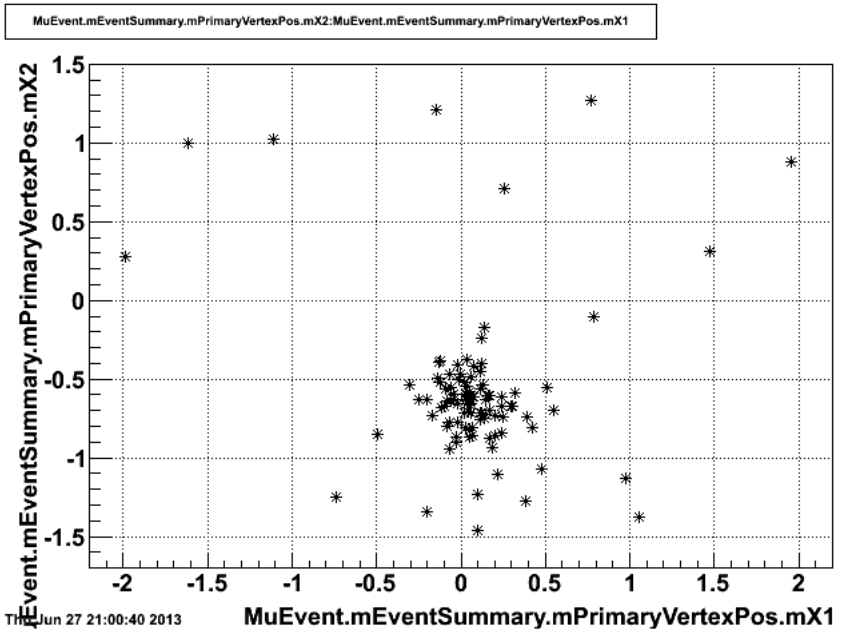
- Local DB: offset set to 0



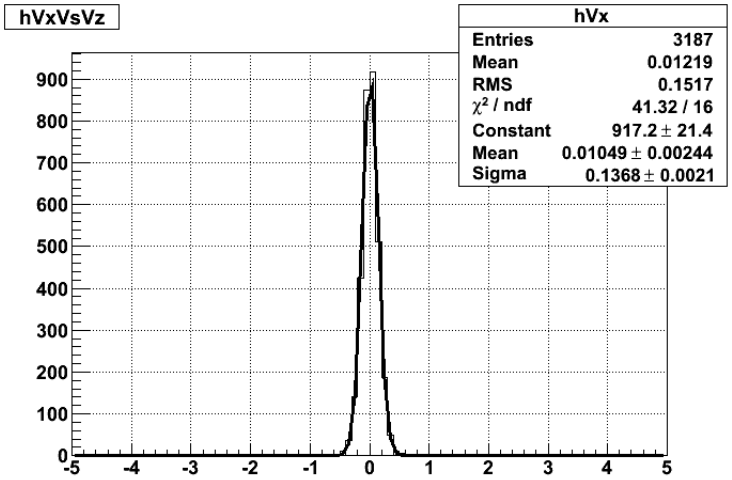


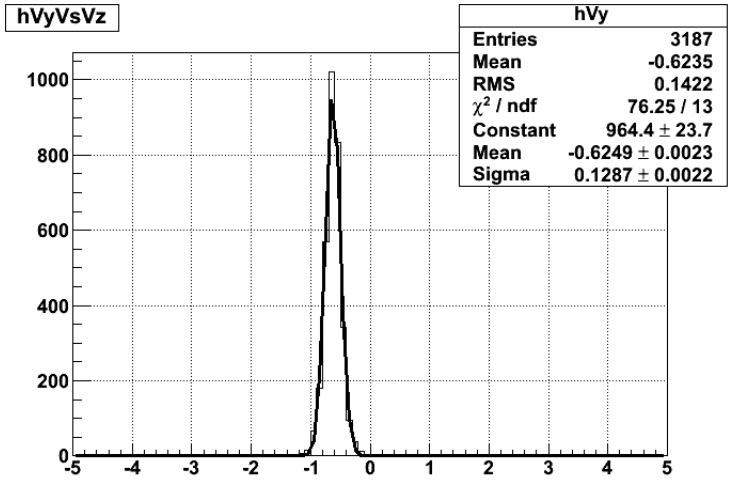
primary vertices with new space charge

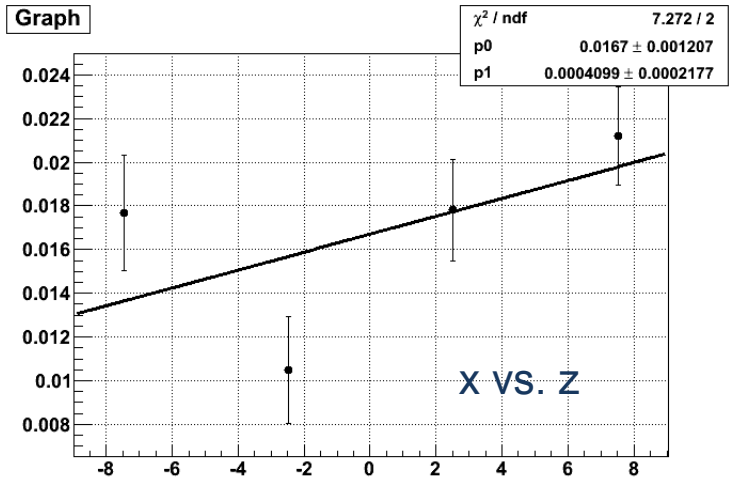


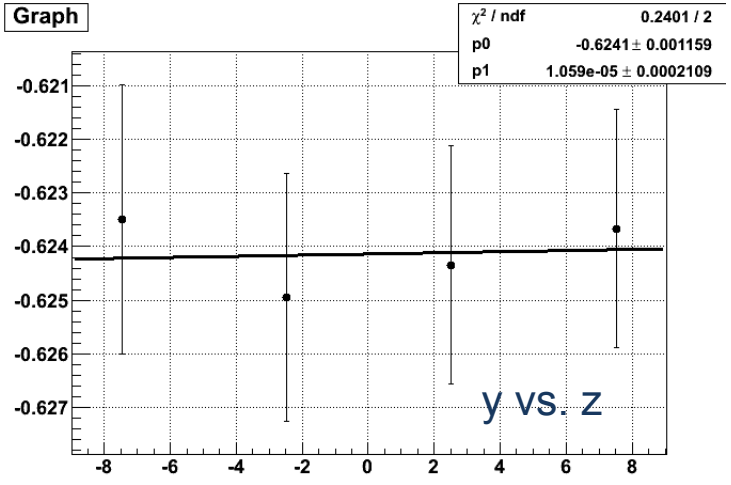


beam line



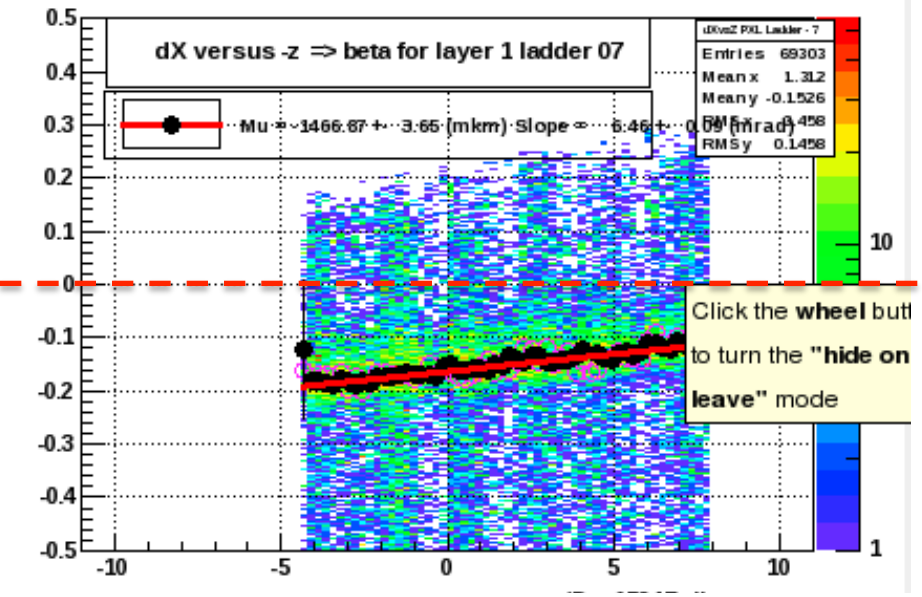


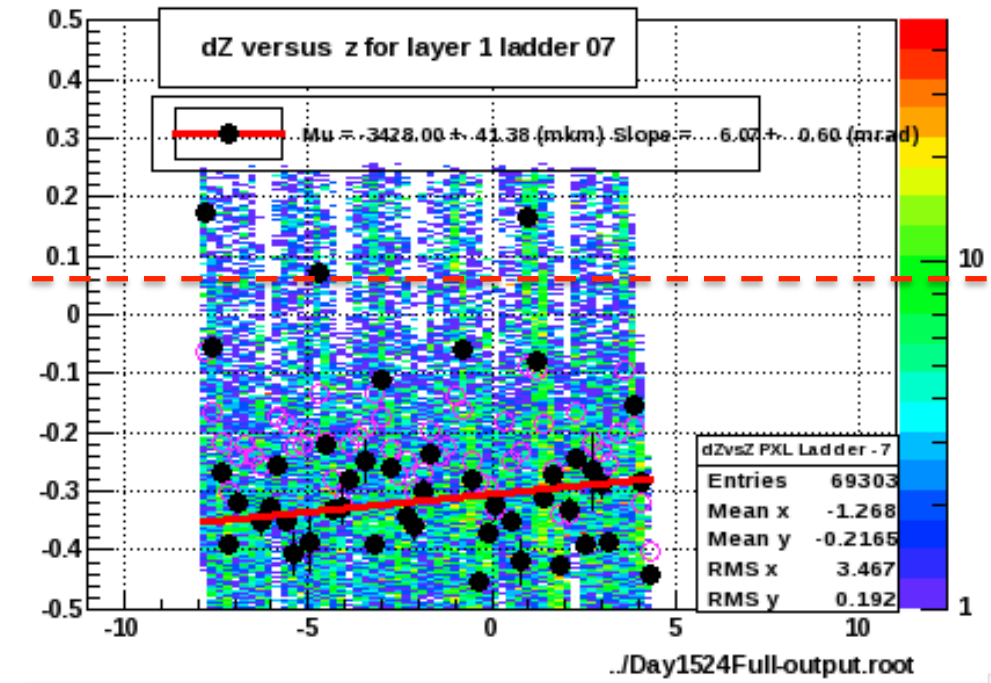




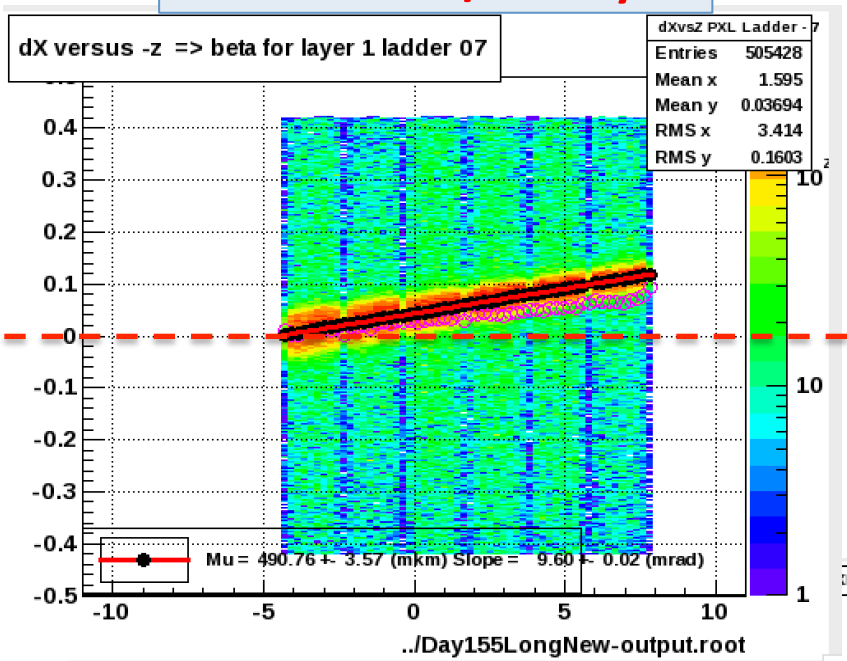
- Calibrated fill by fill
- new space charge and beam line set up is used for production of day 150

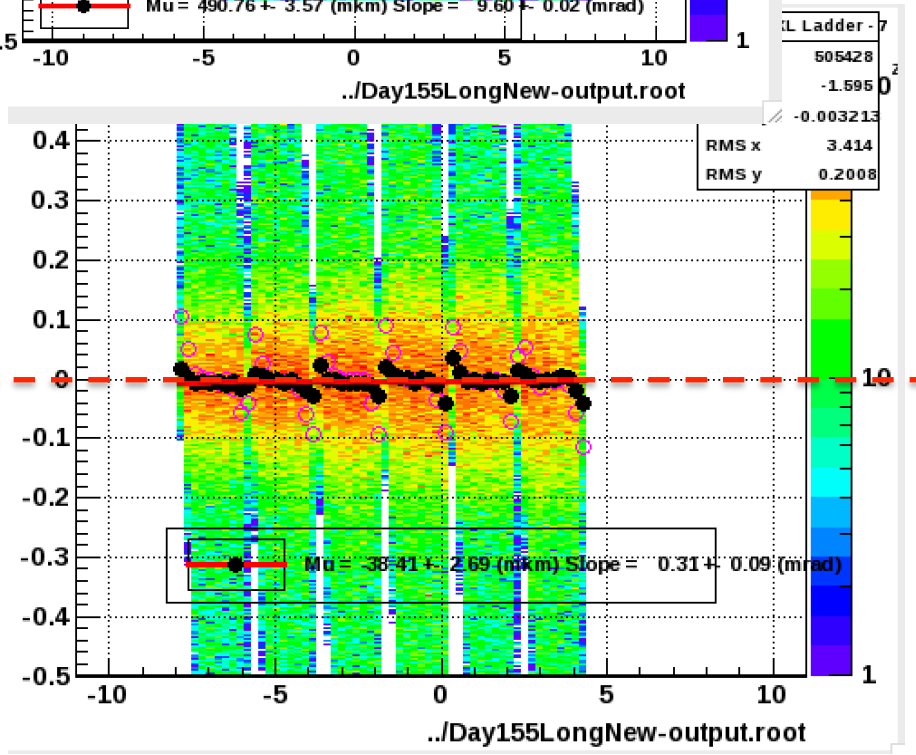
Un-Calibrated/Ideal





Calibrated/Survey

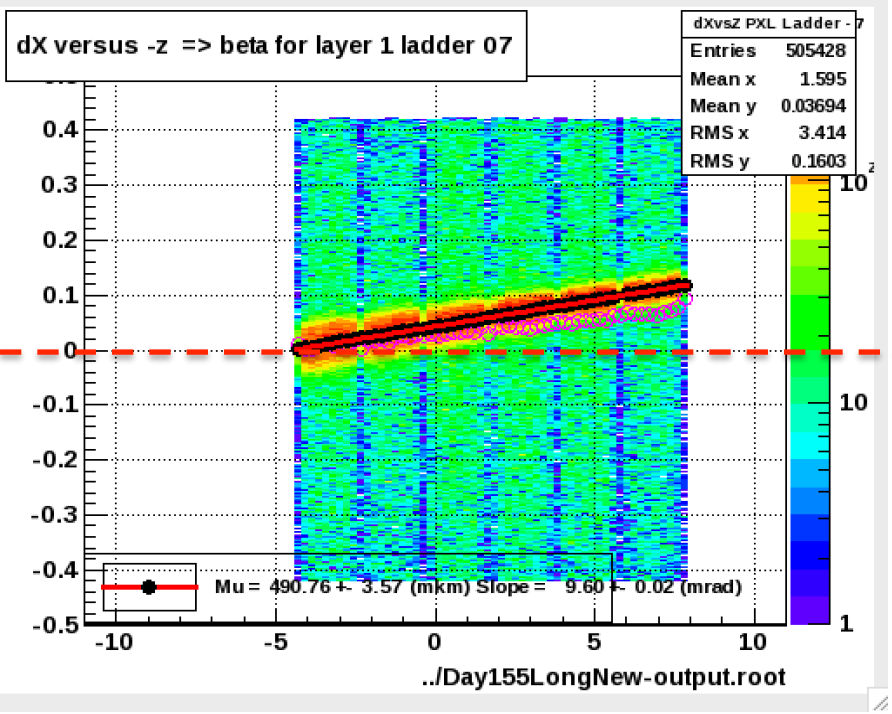


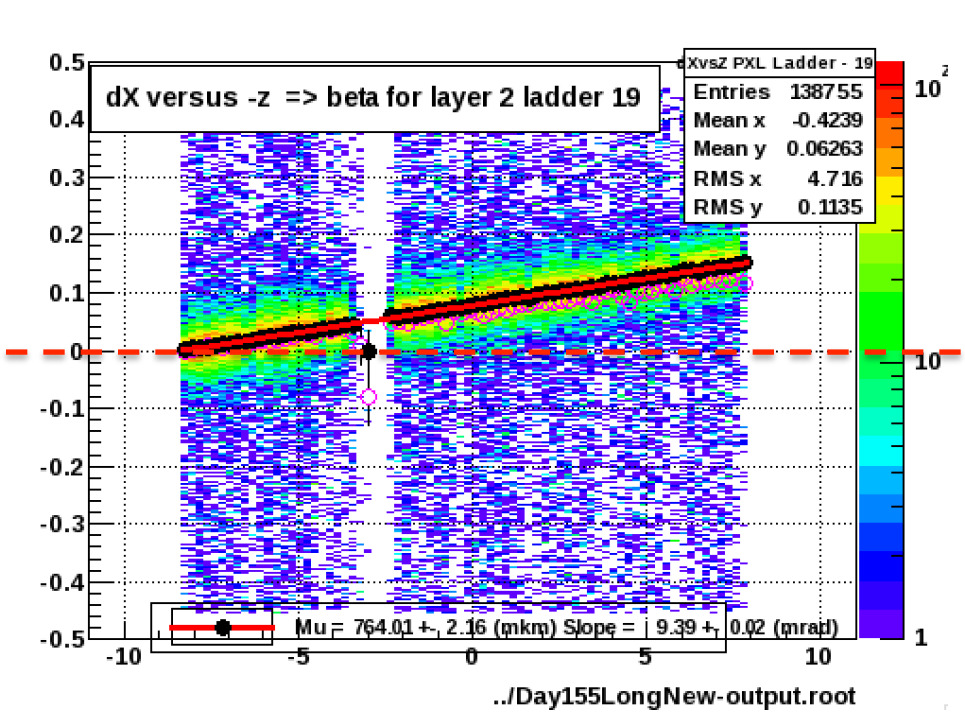


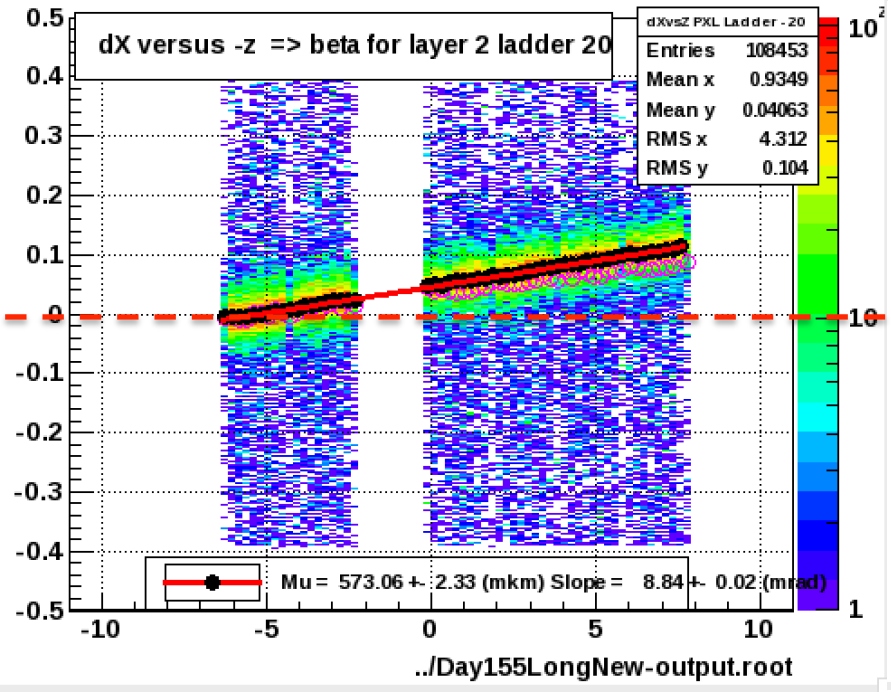
Q: Is it a Sector thing or individual Ladder ?

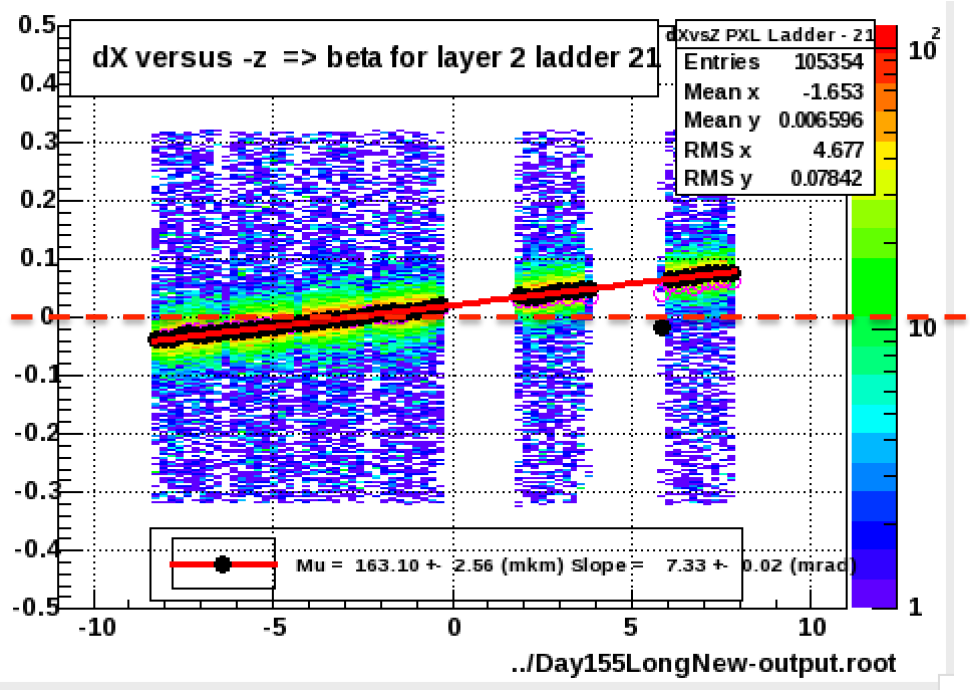
A: Rotations are common

Survey geometry with calibrations was used in production


dX versus -z => beta for layer 1 ladder 07
dXvsZ PXL Ladder - 7
Entries 505428
Mean x 1.595
Mean y 0.03694
RMS x 3.414
RMS y 0.1603
Mu = 490.76 +- 3.57 (mkm) Slope = 9.60 +- 0.02 (mrad)
../Day155LongNew-output.root


dX versus -z => beta for layer 2 ladder 19
dXvsZ PXL Ladder - 19
Entries 138755
Mean x -0.4239
Mean y 0.06263
RMS x 4.716
RMS y 0.1135
Mu = 764.01 +- 2.16 (mkm) Slope = 9.39 +- 0.02 (mrad)
../Day155LongNew-output.root

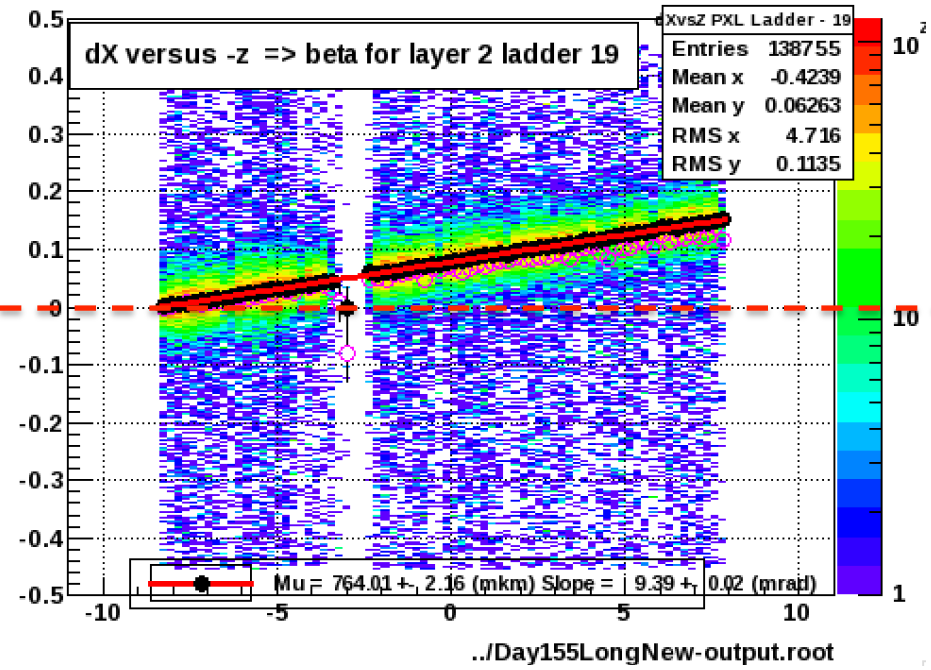

dX versus -z => beta for layer 2 ladder 20
dXvsZ PXL Ladder - 20
Entries 108453
Mean x 0.9349
Mean y 0.04063
RMS x 4.312
RMS y 0.104
Mu = 573.06 +- 2.33 (mkm) Slope = 8.84 +- 0.02 (mrad)
../Day155LongNew-output.root

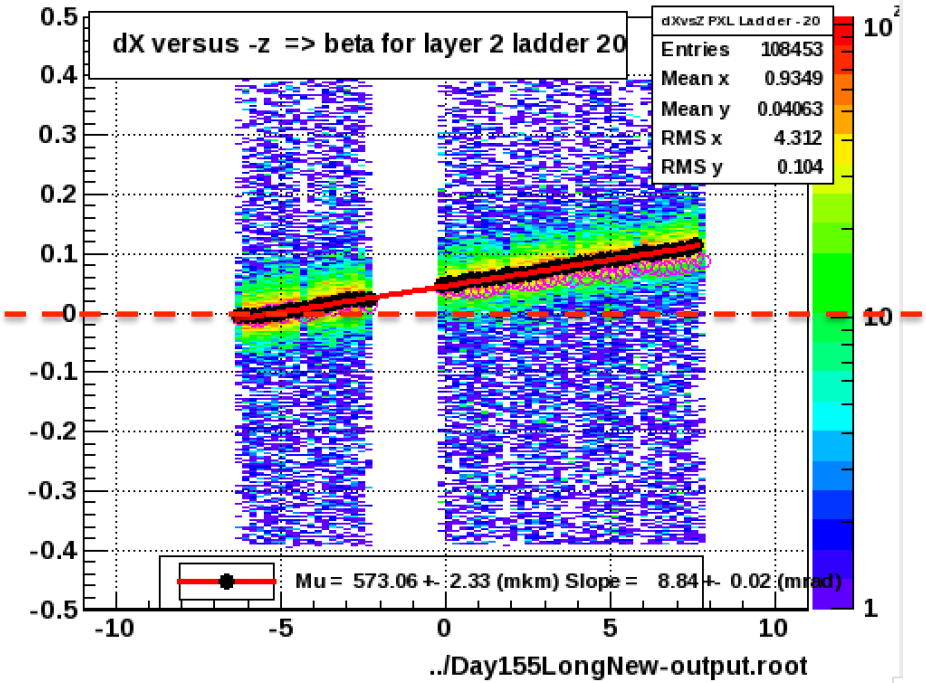

dX versus -z => beta for layer 2 ladder 21
dXvsZ PXL Ladder - 21
Entries 105354
Mean x -1.653
Mean y 0.006596
RMS x 4.677
RMS y 0.07842
Mu = 163.10 +- 2.56 (mkm) Slope = 7.33 +- 0.02 (mrad)
../Day155LongNew-output.root

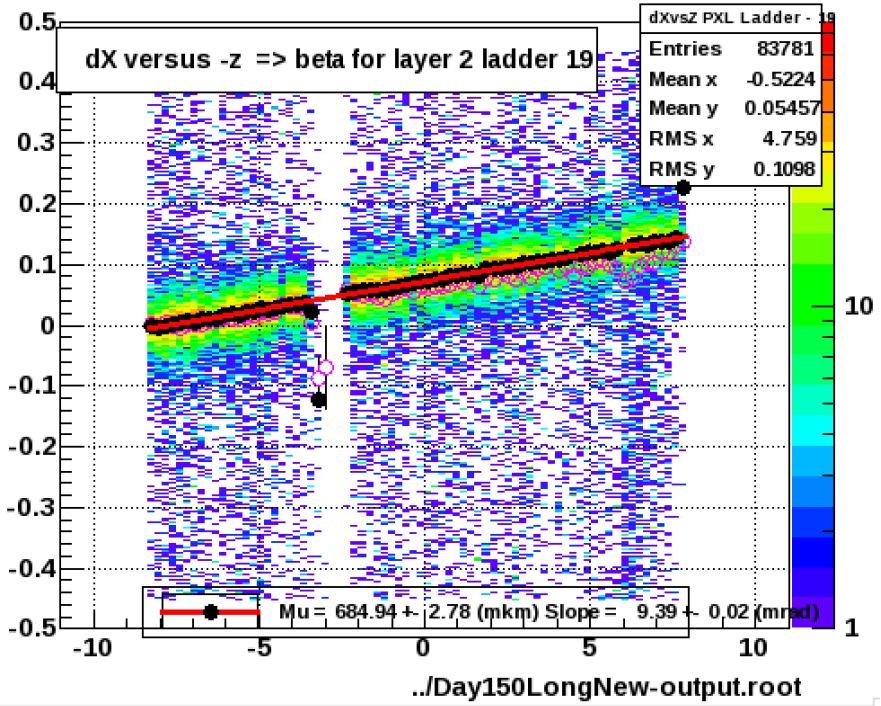
Q: Is there stability over two different runs?

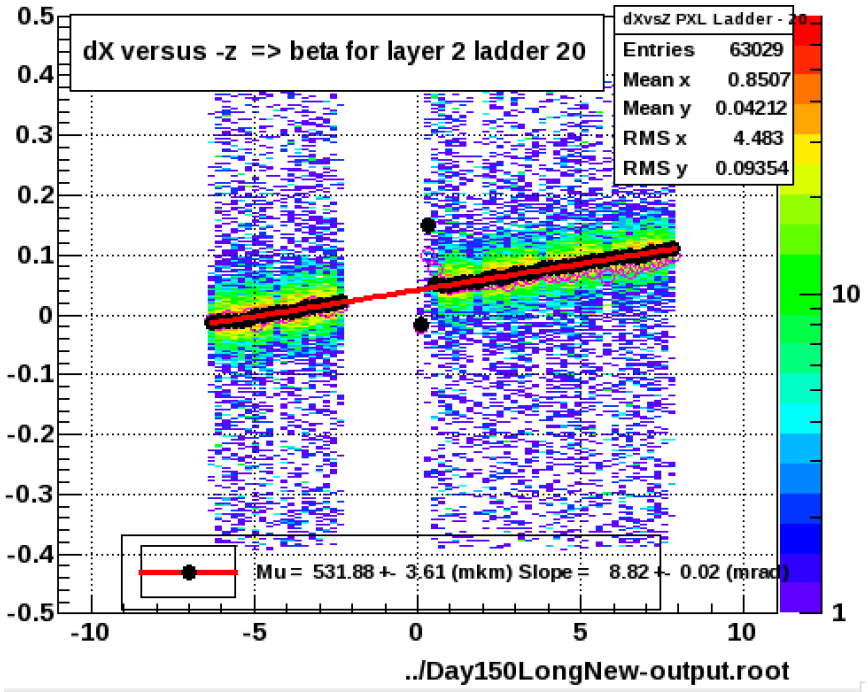
A: YES: Rotations are very stable, shifts <100um within calibration errors

Survey geometry with calibrations was used in production


dX versus -z => beta for layer 2 ladder 19
dXvsZ PXL Ladder - 19
Entries 138755
Mean x -0.4239
Mean y 0.06263
RMS x 4.716
RMS y 0.1135
Mu = 764.01 +- 2.16 (mkm) Slope = 9.39 +- 0.02 (mrad)
../Day155LongNew-output.root


dX versus -z => beta for layer 2 ladder 20
dXvsZ PXL Ladder - 20
Entries 108453
Mean x 0.9349
Mean y 0.04063
RMS x 4.312
RMS y 0.104
Mu = 573.06 +- 2.33 (mkm) Slope = 8.84 +- 0.02 (mrad)
../Day155LongNew-output.root


dX versus -z => beta for layer 2 ladder 19
dXvsZ PXL Ladder - 19
Entries 83781
Mean x -0.5224
Mean y 0.05457
RMS x 4.759
RMS y 0.1098
Mu = 684.94 +- 2.78 (mkm) Slope = 9.39 +- 0.02 (mrad)
../Day150LongNew-output.root


dX versus -z => beta for layer 2 ladder 20
dXvsZ PXL Ladder - 20
Entries 63029
Mean x 0.8507
Mean y 0.04212
RMS x 4.483
RMS y 0.09354
Mu = 531.88 +- 3.61 (mkm) Slope = 8.82 +- 0.02 (mrad)
../Day150LongNew-output.root

Day 152 – First Pass Alignment Update

- With the ~600K events I got from Long, I ran the alignment code and got precise estimates (see slide-2)

- Produced the “corrected” geometry and re-run the full BFC with updated geometry
  - about 50K event so far

FIRST PASS ESTIMATED Corrections (angles [only] need a minus sign)

SECTOR 4

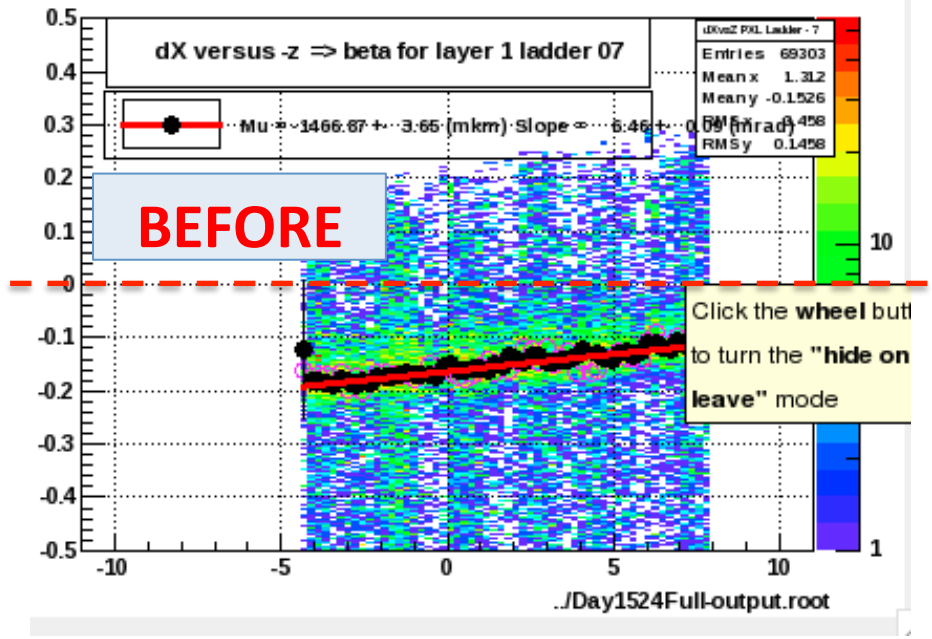
dX mkm	dY mkm	dZ mkm	alpha mrad	beta mrad	gamma mrad	Comment
-100	300	2900	0	0.	-0	Average for PXL sector 4 Ladder 1
-20	150	2970	0	0.	0	Average for PXL sector 4 Ladder 2
-100	350	2700	0	0.	-0	Average for PXL sector 4 Ladder 3
-200	+400	3000	0	0	0	Average for PXL Ladder 4

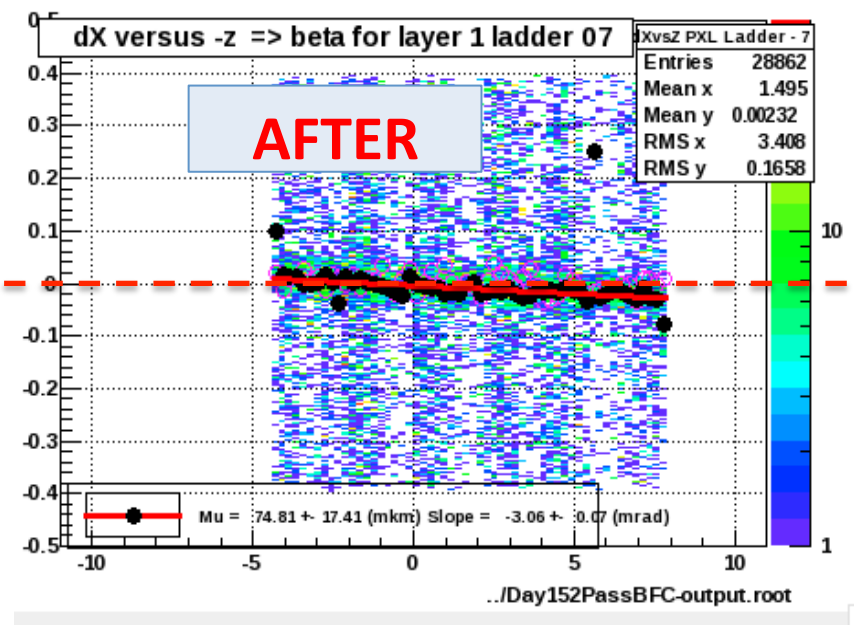
SECTOR 7

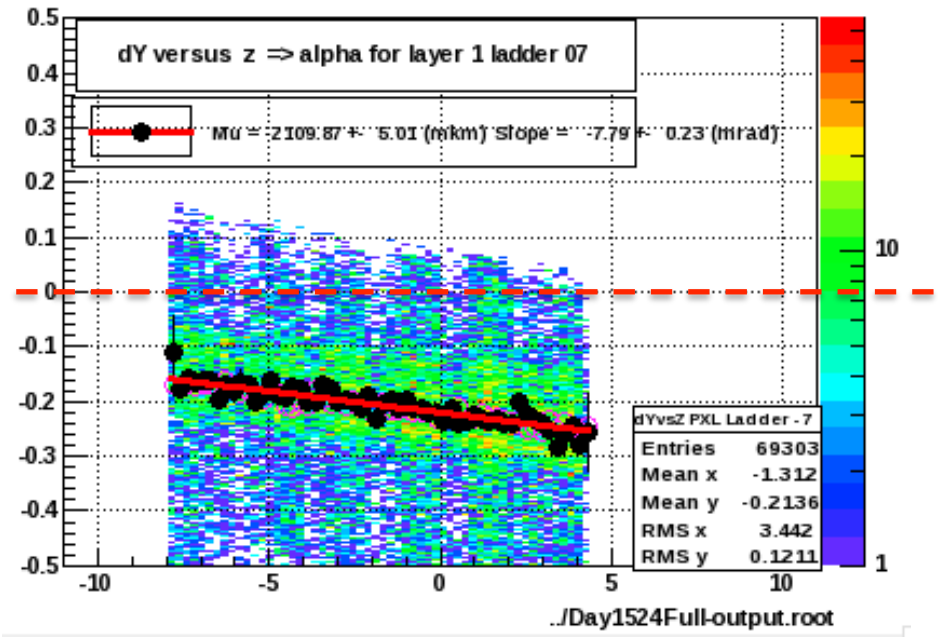
!!!

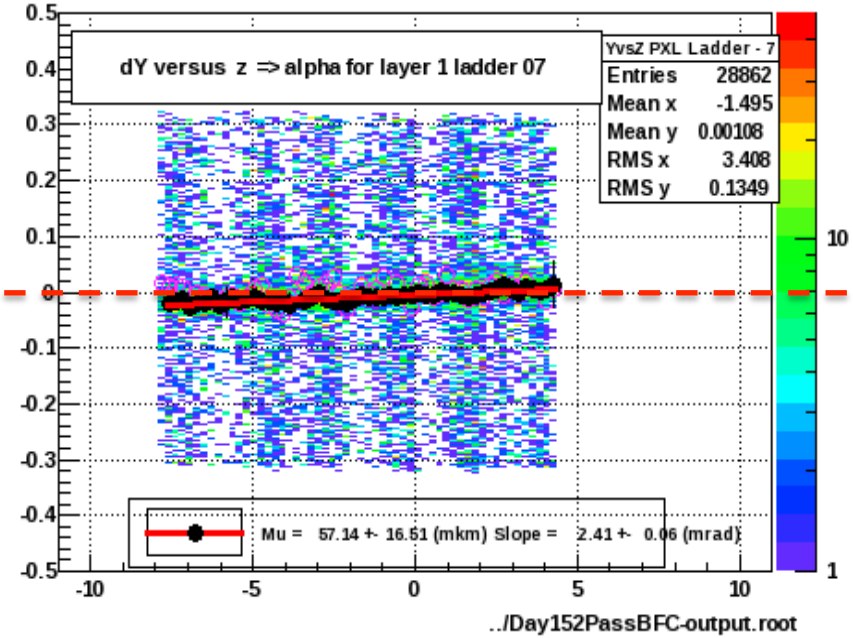
1500	2100	3000	-10	10	80	Ladder 1
2350	1150	2900	-15	10	80	Average for PXL sector 7 Ladder 2
2330	1800	2440	-15	20	80	Average for PXL Ladder 3
2230	2710	2570	-10.	20	80	Average for PXL Ladder 4

Sector 7 ladder 1 (inner) **GLOBAL after BFC rerun (50K)**

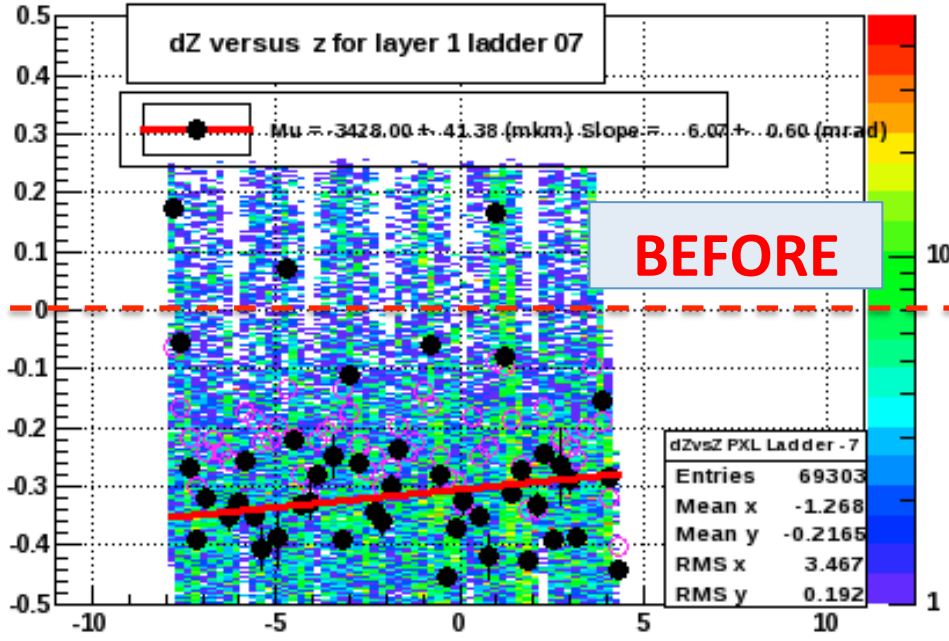


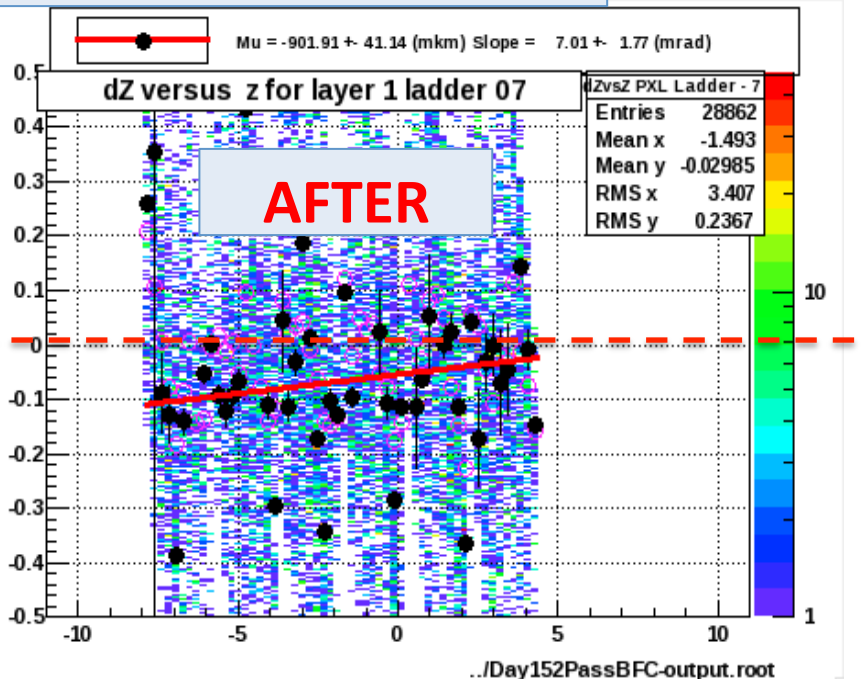


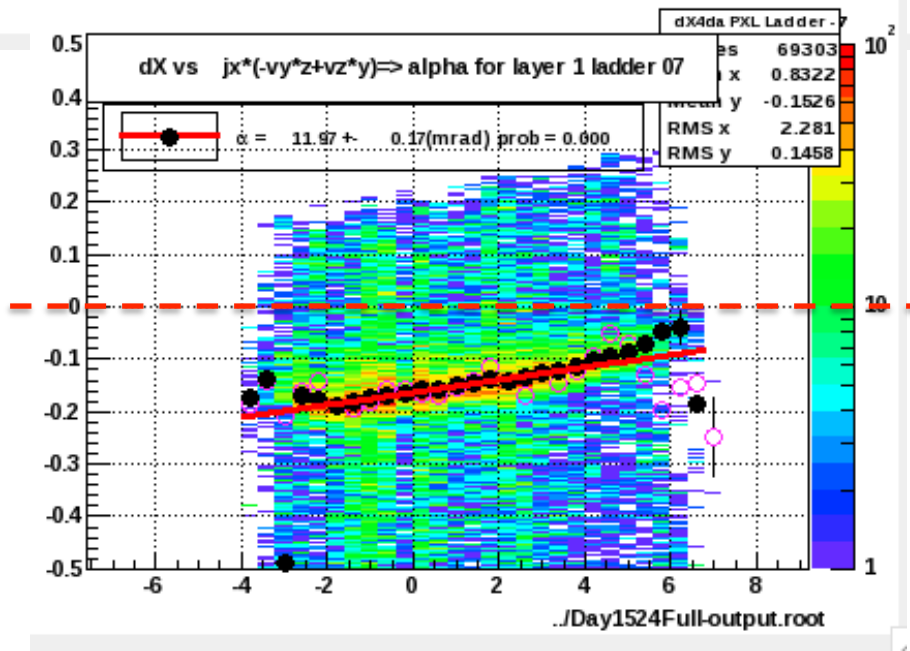


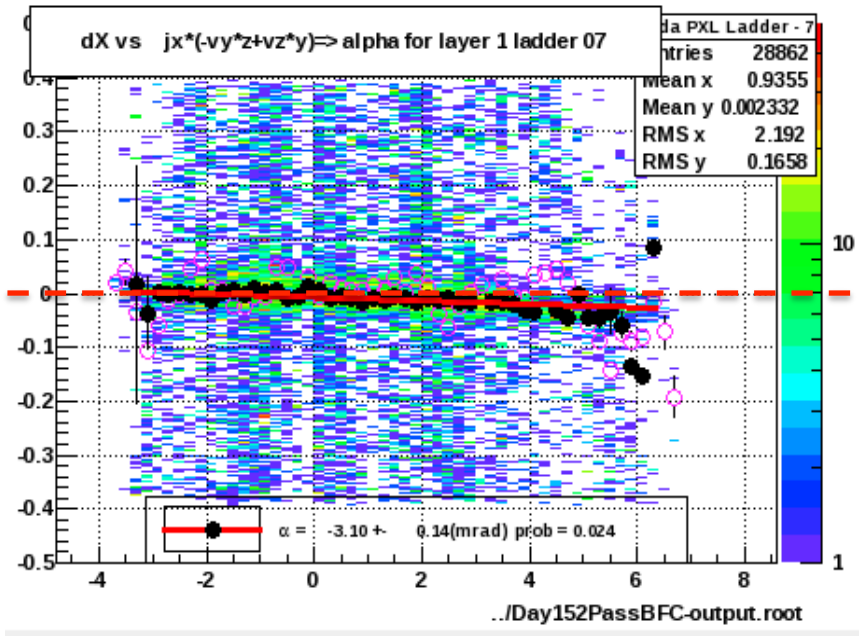


Sector 7 ladder 1 (inner) **GLOBAL after BFC rerun**

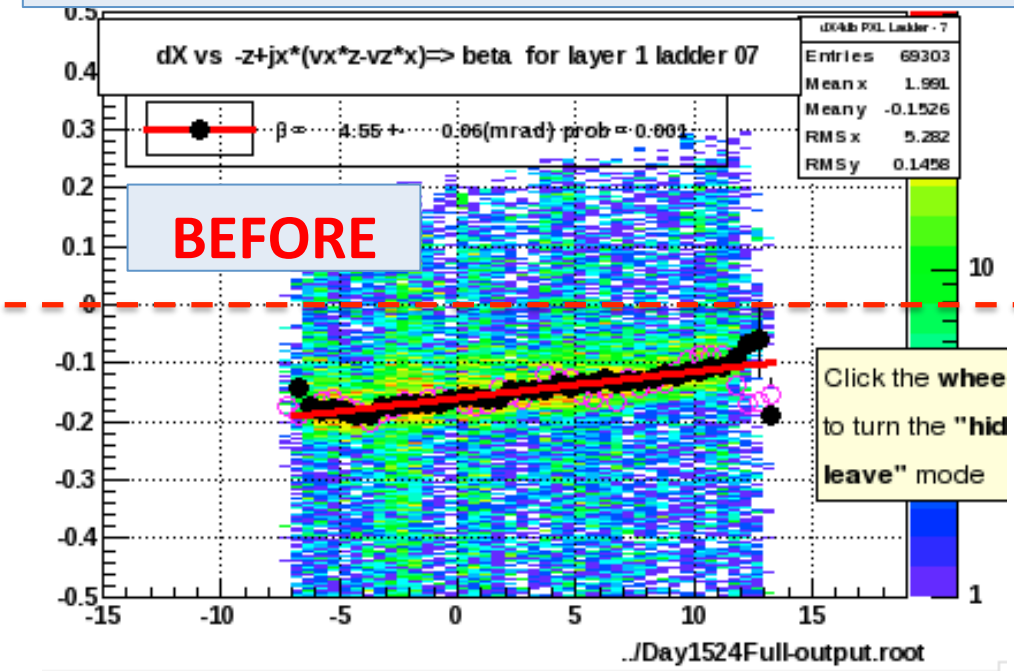


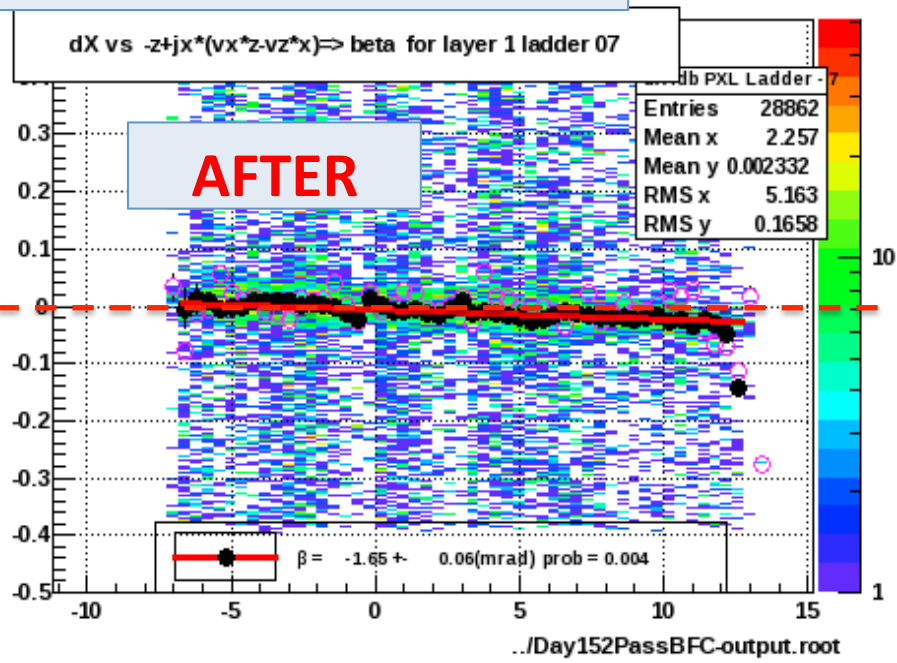


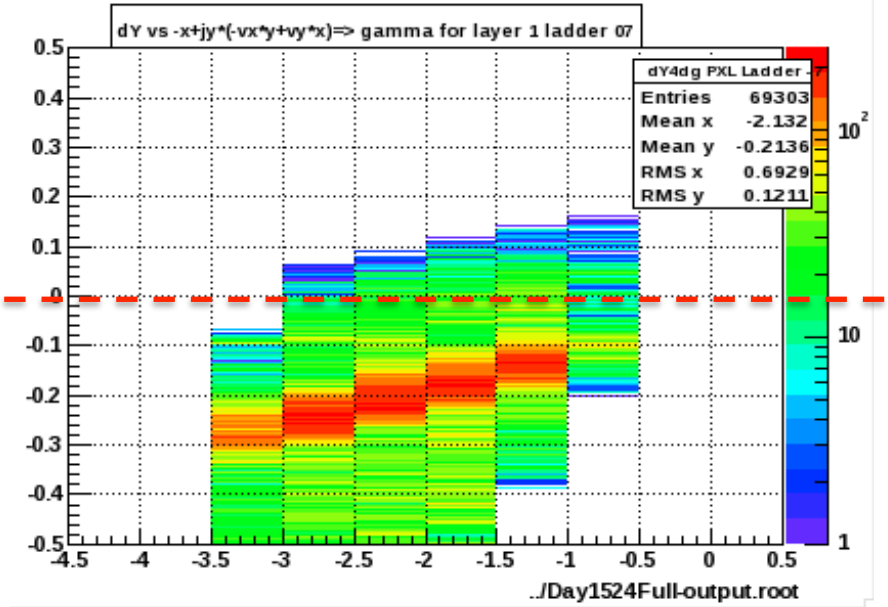


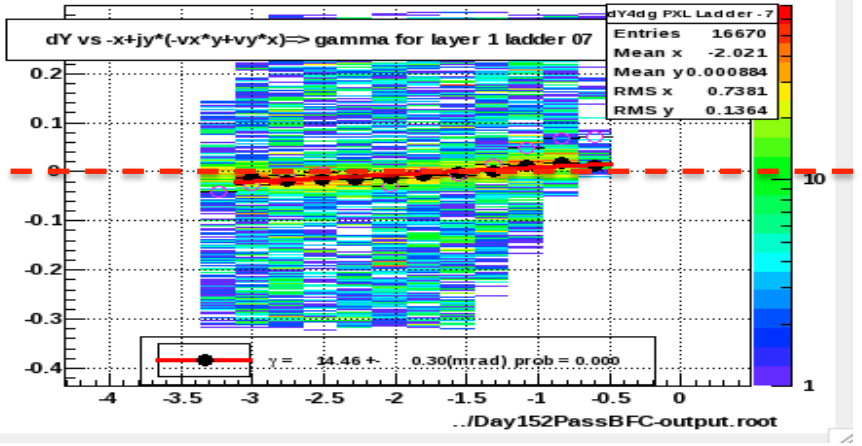


Sector 7 ladder 1 (inner) **GLOBAL after BFC rerun**







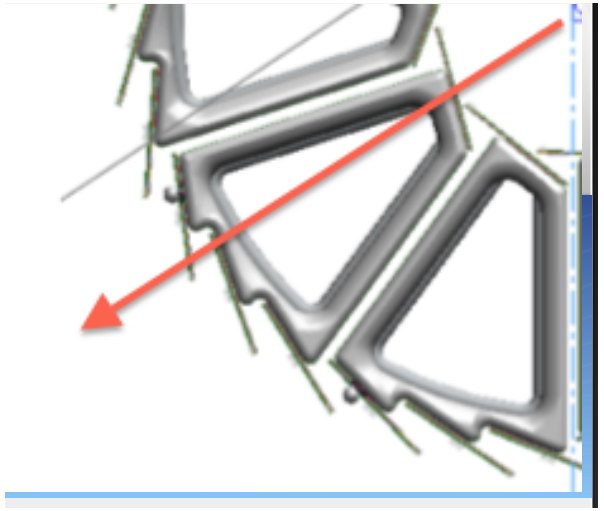


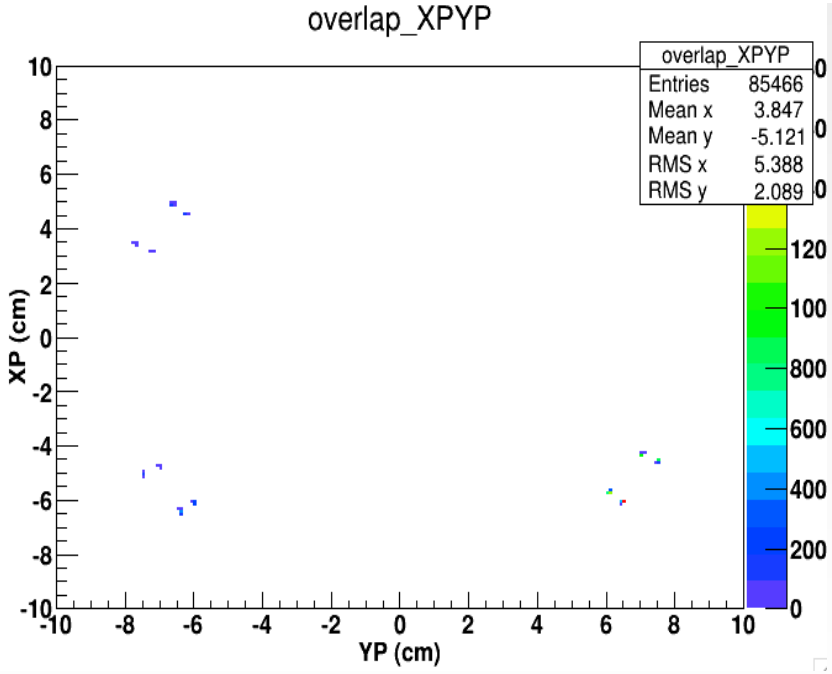
To Do list

- Simulation:
  - Individual ladder rots/transls
    - rots in progress
  - Thorough tests is a must
- Code/methods synchronization
- Multi-pass chain implementation/establishment
- Align, monitor time-dependences, understand

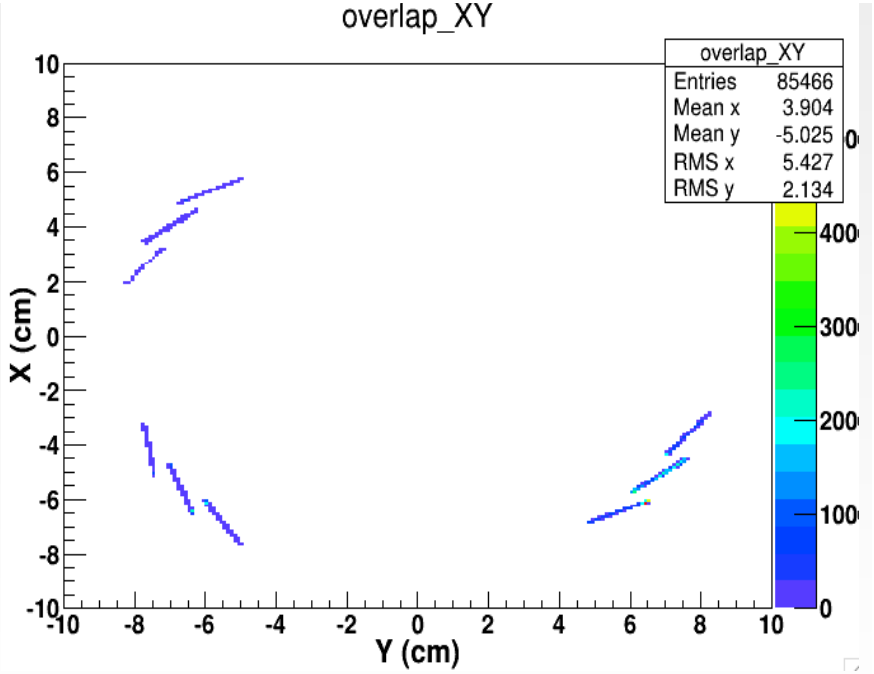
Clean/Calibrated Data a MUST for proper Alignment

- **Using the pxl ladder overlap**
  - checking/monitoring



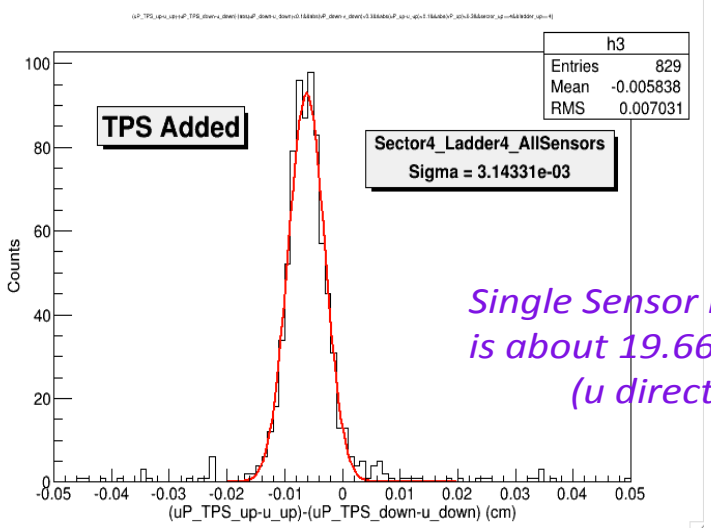


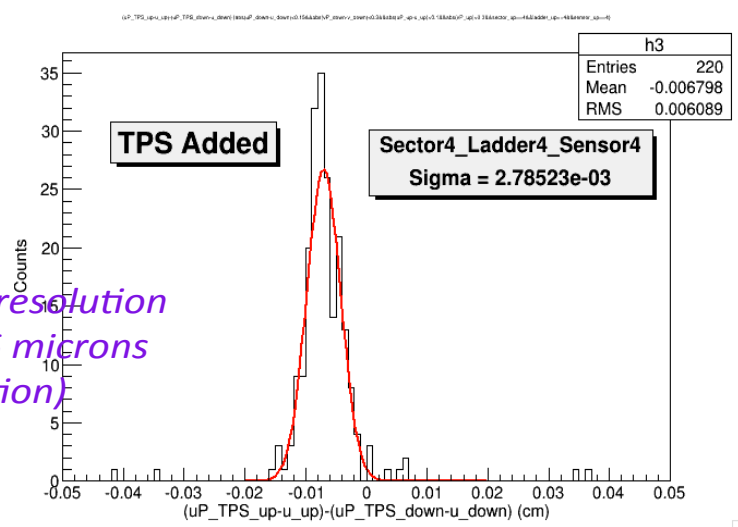
Projection Points 2D-distribution
(overlapping region in Global)



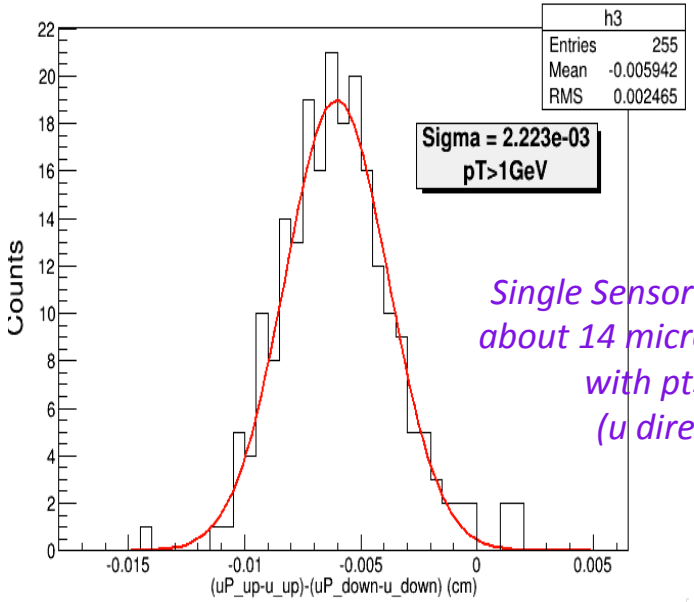
Real read-out hits 2D-distribution
(overlapping region in Global)

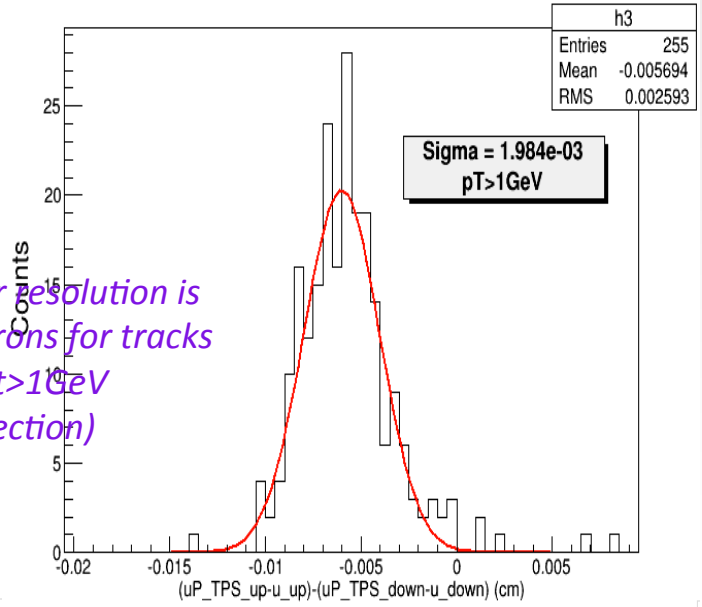
- **Using the pxl ladder overlap**
  - checking/monitoring





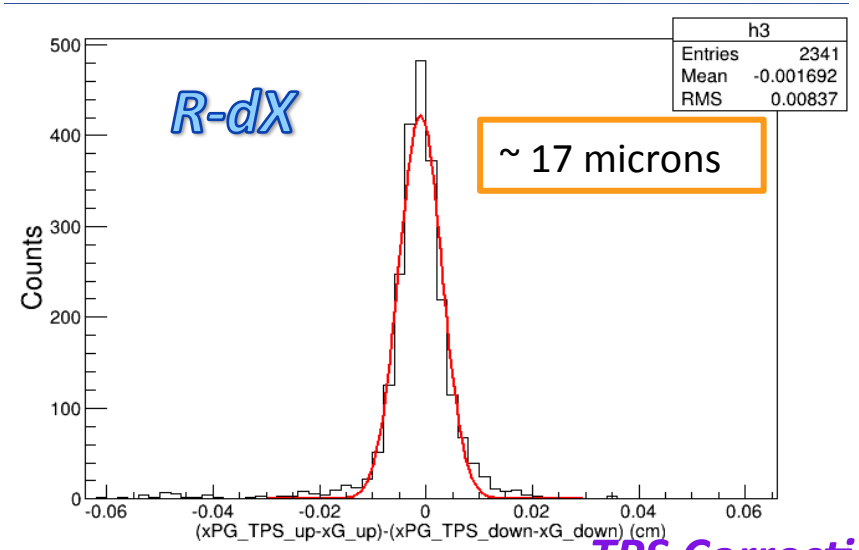
Single Sensor resolution is about 19.66 microns (u direction)

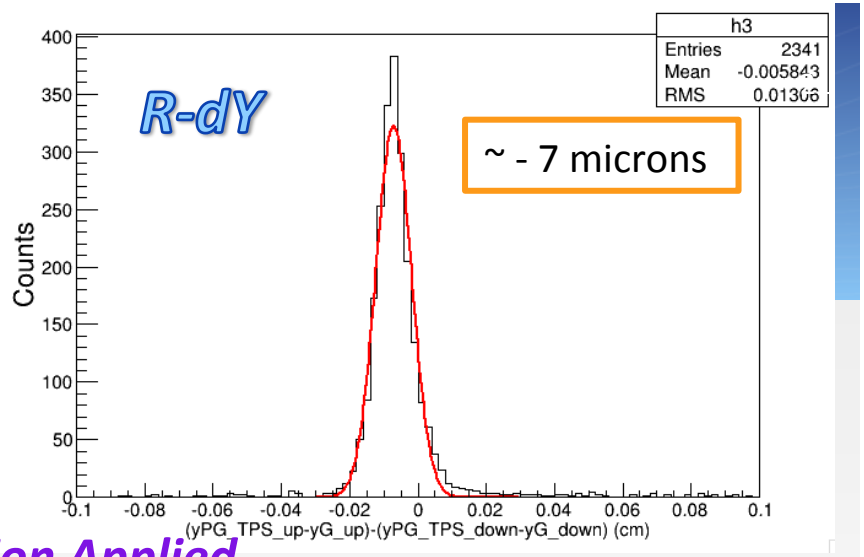




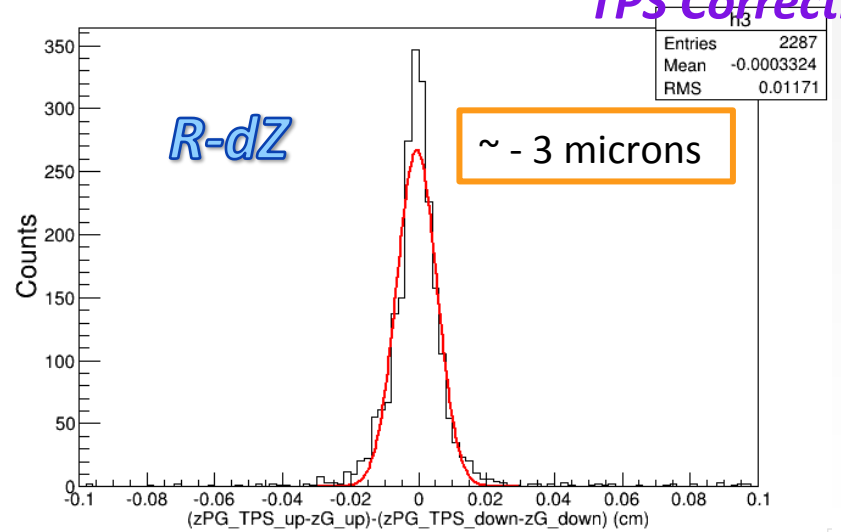
Single Sensor resolution is about 14 microns for tracks with pt>1GeV (u direction)

- **Using the pxl ladder overlap**
  - checking/monitoring





TPS Correction Applied



Example : Relative Misalignments can be seen ***between Sector 4 Ladder 3 and Ladder 4***

See more at:
/star/institutions/lbl_prod/hft/Run13/test/