SVT Calibration and STI tracking status

An update of work since the SVT review
and the STAR upgrades meeting

STAR Collaboration Meeting

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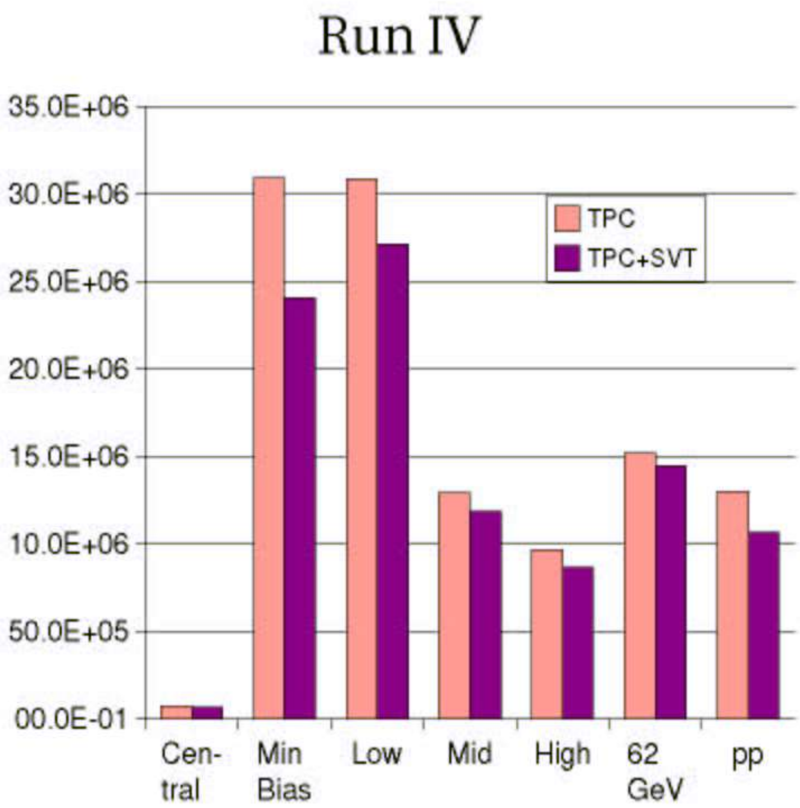
July 2004

Overall Statistics



Trigger Type	SVT Presence
Central	98.6%
MinBias	77.9%
Low	87.7%
Mid	91.9%
High	89.3%
62 GeV	95.1%
pp	81.8%

- 87.6% of Lost MinBias were in Jan.
  - 48% of those from 25th -31st
- Down Feb. 7th, 8th, and 9th
  - Problems with TCD Position
  - Missed ~2.51 M evts.

Detector Status

- Averaged Over the Run: ~85% of the SVT is good

- Three Half-Ladders (~1.5% each): L07B3, L11B3, & L12B2
  - L07B3: no HV above -350 V
  - L11B3: lost ¼ during '02, rest during shutdown
  - L12B2: exhibiting abnormally high noise (Dave)

- RDOE7 (~4.2%) Lost due to electronics failure, March 6th

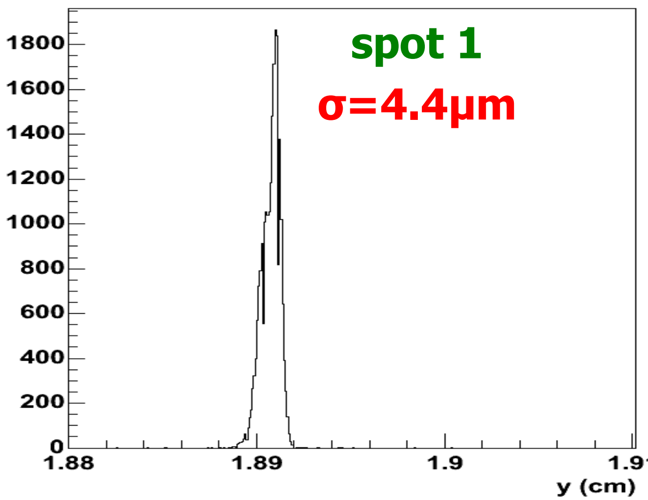
- RDOW3 & RDOW4 Down, bridge failure in PS, March 29th
  - Recovered April 2nd
  - Typical fluctuation ~3%

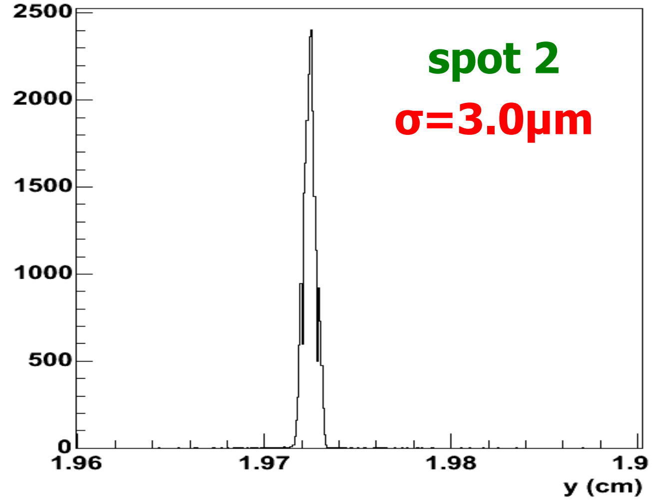
Calibration Tasks

- Gain
  - Hybrid to hybrid and within hybrid.
    - Look at hits placed on tracks with given mtm and average charge should be the same. Scale “gain” to force them to be.
- Drift Velocity
  - Hybrid to Hybrid and within hybrid.
    - Look at start and stop of hits – Know drift == 3cm, calc $V_{dhybrid}$
    - Use laser spots to monitor temp. variation event by event.
    - Use bench measurements to account of non-linearity of drift.
    - Use bench measurements to account for temp. profile across anodes.
- Alignment
  - Global, Barrel, Ladder, Wafer.
    - Project TPC tracks to SVT hits, calc. residuals.
    - Refit TPC tracks with SVT hits, calc. residuals.
    - Refit matched SVT hits and primary vertex, calc. residuals.
      - Deviations from means of zero give shifts.
      - Try shifts and rotations to minimize offsets.
      - Some offsets due to TPC distortions not ONLY SVT.

Laser - Hit position reproducibility

anode

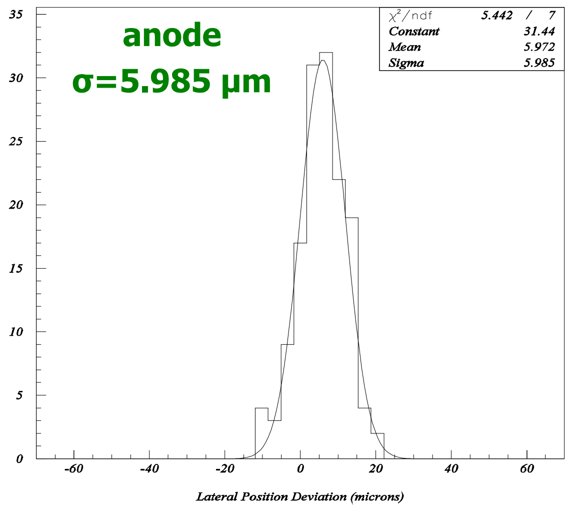




3 laser spots

2 spots are at:
hybrid=1, layer=6,
ladder=15, wafer=7

1 spot is at:
hybrid=2, layer=6,
ladder=7, wafer=1



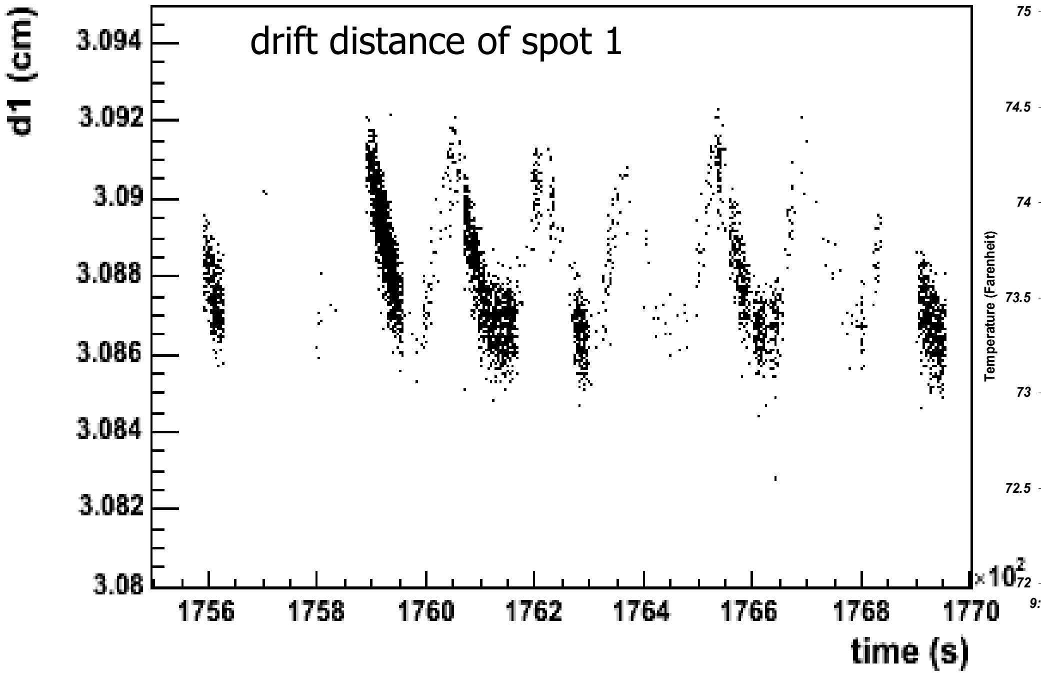
♦ SVT proposal

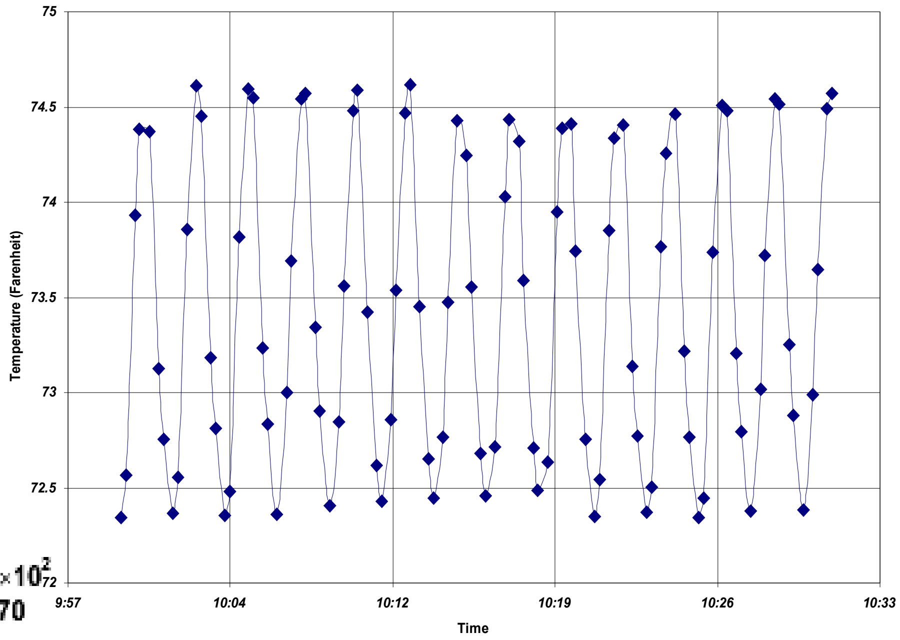
Laboratory laser tests:
anode direction: σ=6 μm

Similar resolution in STAR as on bench

Time variations of laser spot - cooling

slow-control temperature measurement



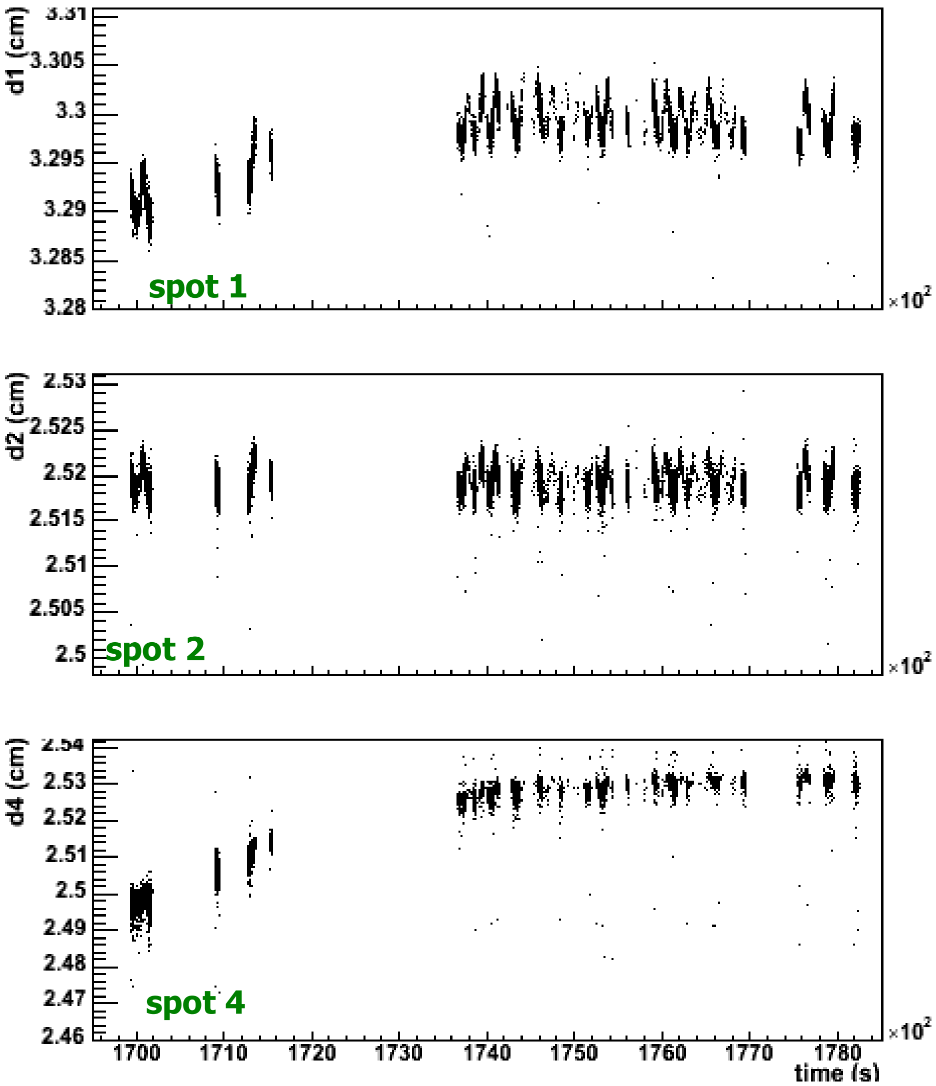


Temperature oscillations have a period of ~2.5 min

Temperature oscillation is ~1^{o}c peak-to-peak

Position peak-to-peak change is ~70 μm

Time variations of laser spot – burn-in



water cooling → time variations of laser spot positions

spot positions change in phase

BUT

spots behave differently after SVT is switched on and gets stabilized

(~ 1 hour !)

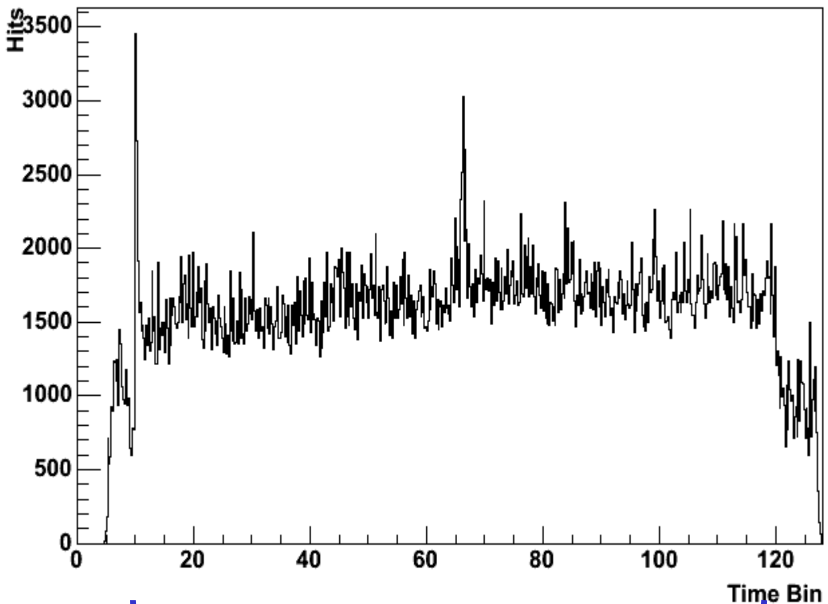
spot 1: 80 microns

spot 2: stable

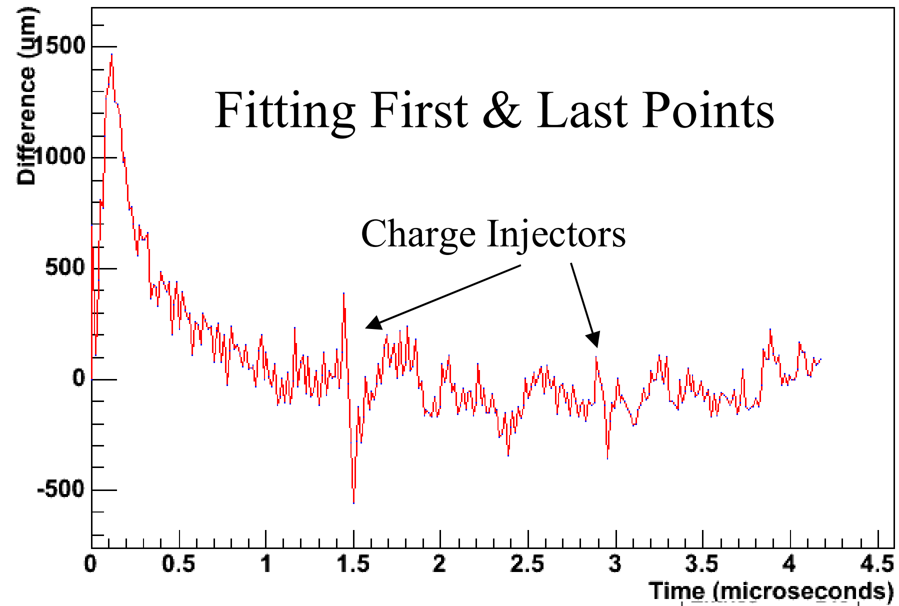
spot 4: 300 microns

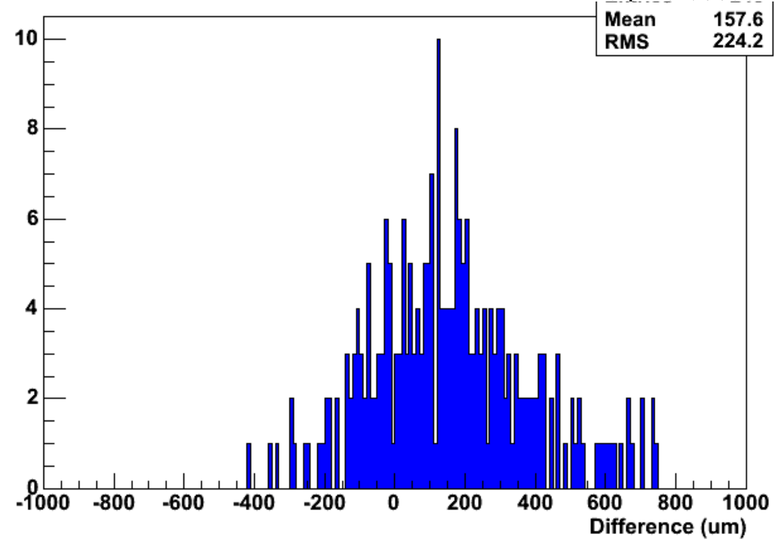
Detailed study shows that this behavior is not common to all runs or SVT downtime. Most runs show no strong burn-in variation. We have decided to not to try to calibrate this effect out

Drift velocity from hits (single value per wafer)



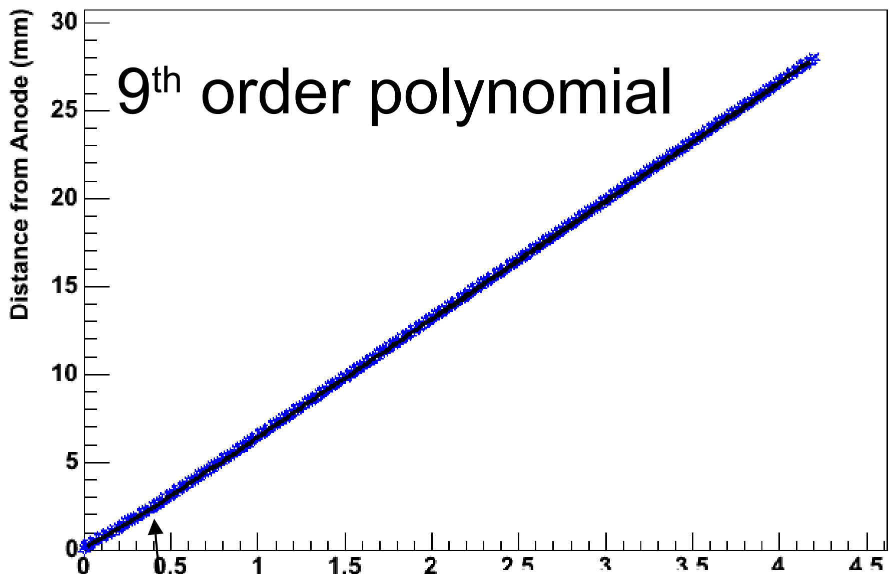
3 cm

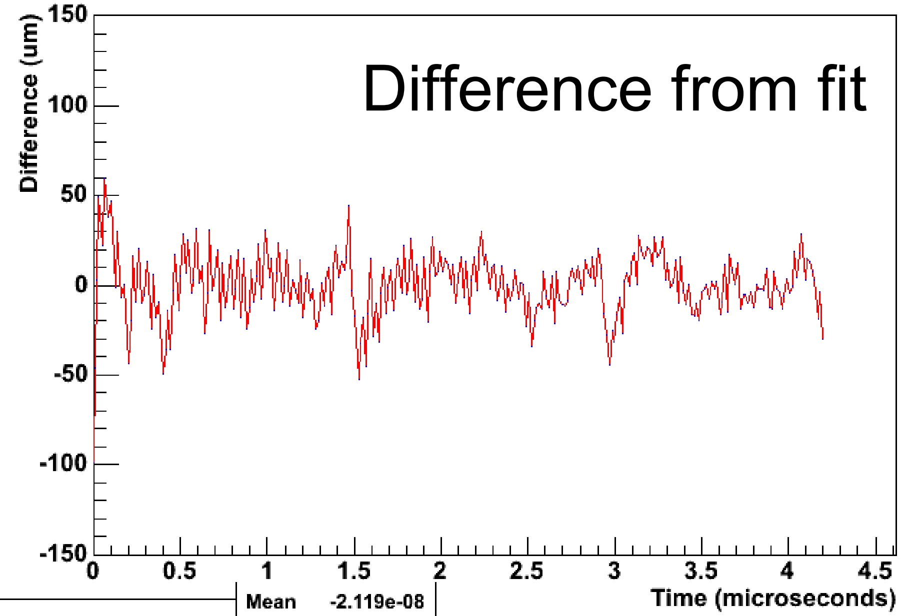




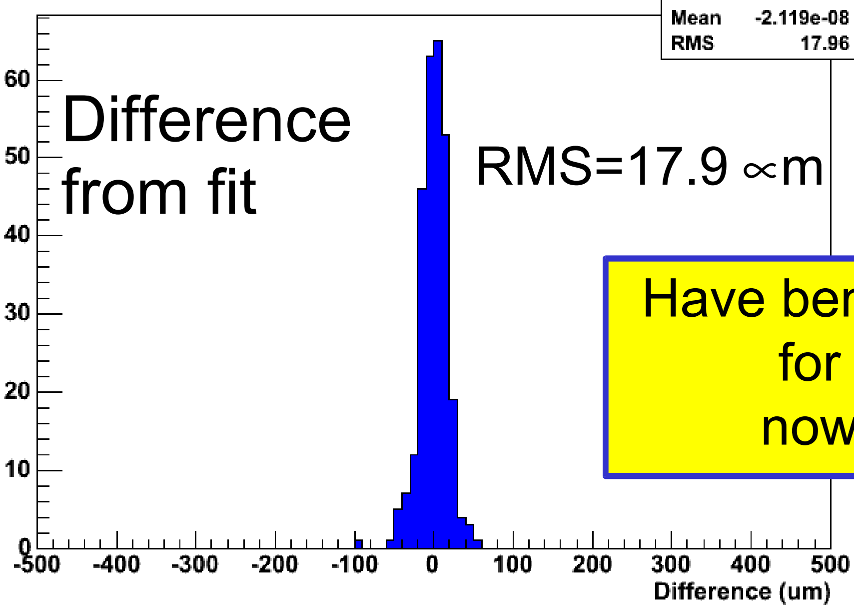
Mean distortion is a few 100 μm

Polynomial drift representation



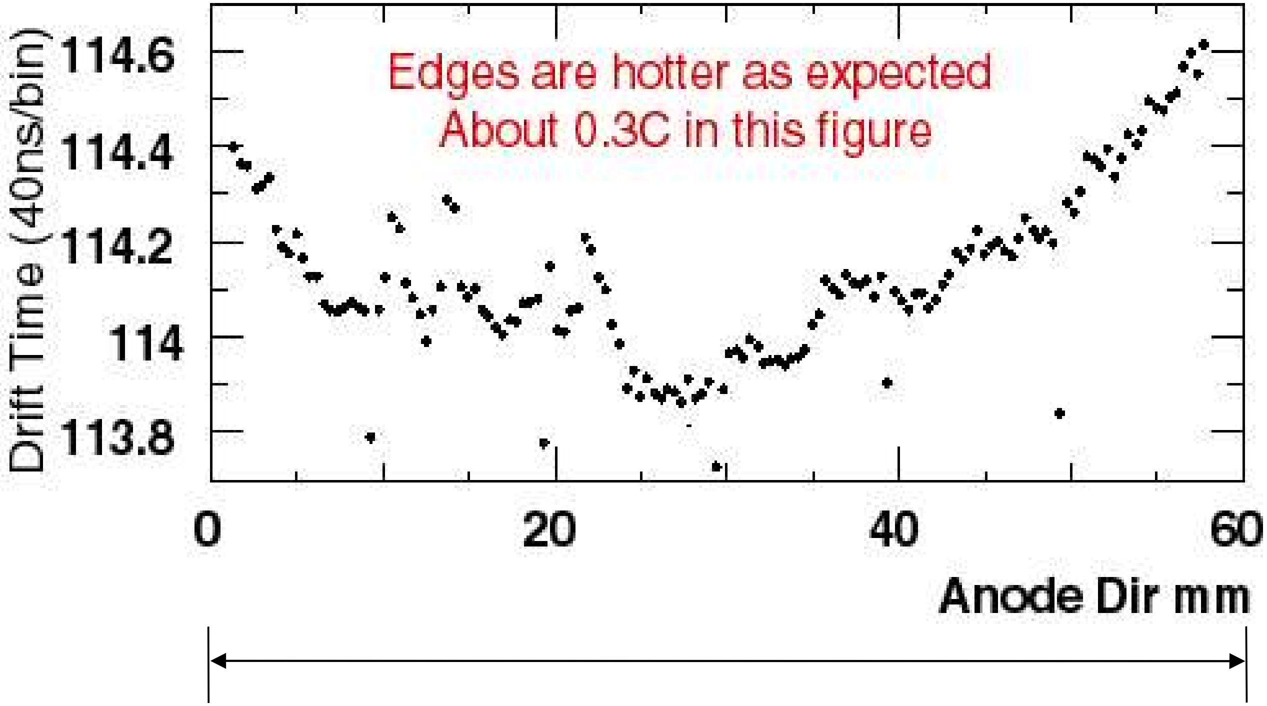


Account for focusing region



Have bench measurement for each hybrid now in database

Anode temperature profile



Wafer width

- 40 ns/TB = ~270 ∝m/TB
- ~150 μm max shift

- Temperature gradient across wafers must be taken into account
- Due to resistor chains at edges

Have bench measurement for each hybrid now in database

Alignment

We seek for 6 parameters that must be adjusted in order to have the SVT aligned to the TPC:

- x shift
- y shift
- z shift
- xy rotation
- xz rotation
- yz rotation

Have to calculate for each wafer – 216 in total

The Question

- How to disentangle and extract them without ambiguity from the data?
- Many approaches are possible. We are using two of them...

The two approaches

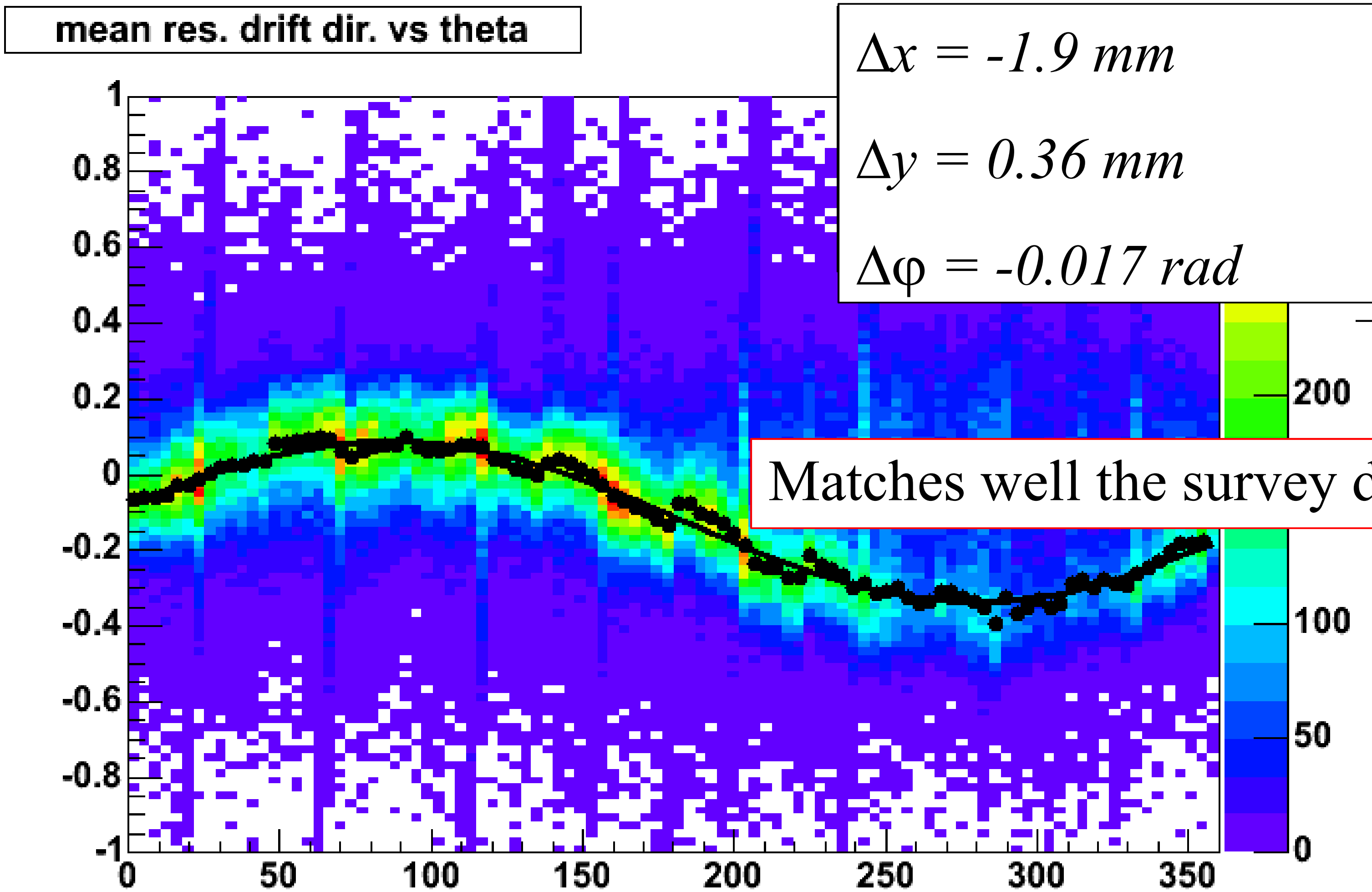
First approach:

- Calculate the “residuals” between the projections of TPC tracks and the closest SVT hit in a particular wafer.
- **Advantage**:
  - can be done immediately TPC calibration is OK (not final), even without B=0 data.
- **Disadvantage**:
  - highly dependent on TPC calibration.
  - the width of these “residuals” distributions and therefore the precision of the procedure is determined by the projection resolution.

Second approach:

- Use only SVT hits in order to perform a self-alignment of the detector.
- **Advantage**:
  - a better precision can be achieved.
  - does not depend on TPC calibration.
- **Disadvantage**:
  - it is harder to disentangle the various degrees of freedom of the detector (need to use primary vertex as an external reference).
  - depends on B=0 data (can take longer to get started).

Δx, Δy, $\Delta\varphi$ corrections



$\Delta x = -1.9\ mm$

$\Delta y = 0.36\ mm$

$\Delta\varphi = -0.017\ rad$

Matches well the survey data

Looks pretty good after 2nd iteration

Next step ladder by ladder

- Look at "residuals" from the SVT **drift direction** (global x-y plane).
- Study them as a function of drift distance (x_{local}) for each wafer.
- Now influence of mis-calibration (t_0 and drift velocity) cannot be neglected.

$$res_{drift} \cong \Delta x \cdot \sin\left(\varphi\left(x_{local}\right)\right) + \Delta y \cdot \cos\left(\varphi\left(x_{local}\right)\right) + \Delta\varphi$$

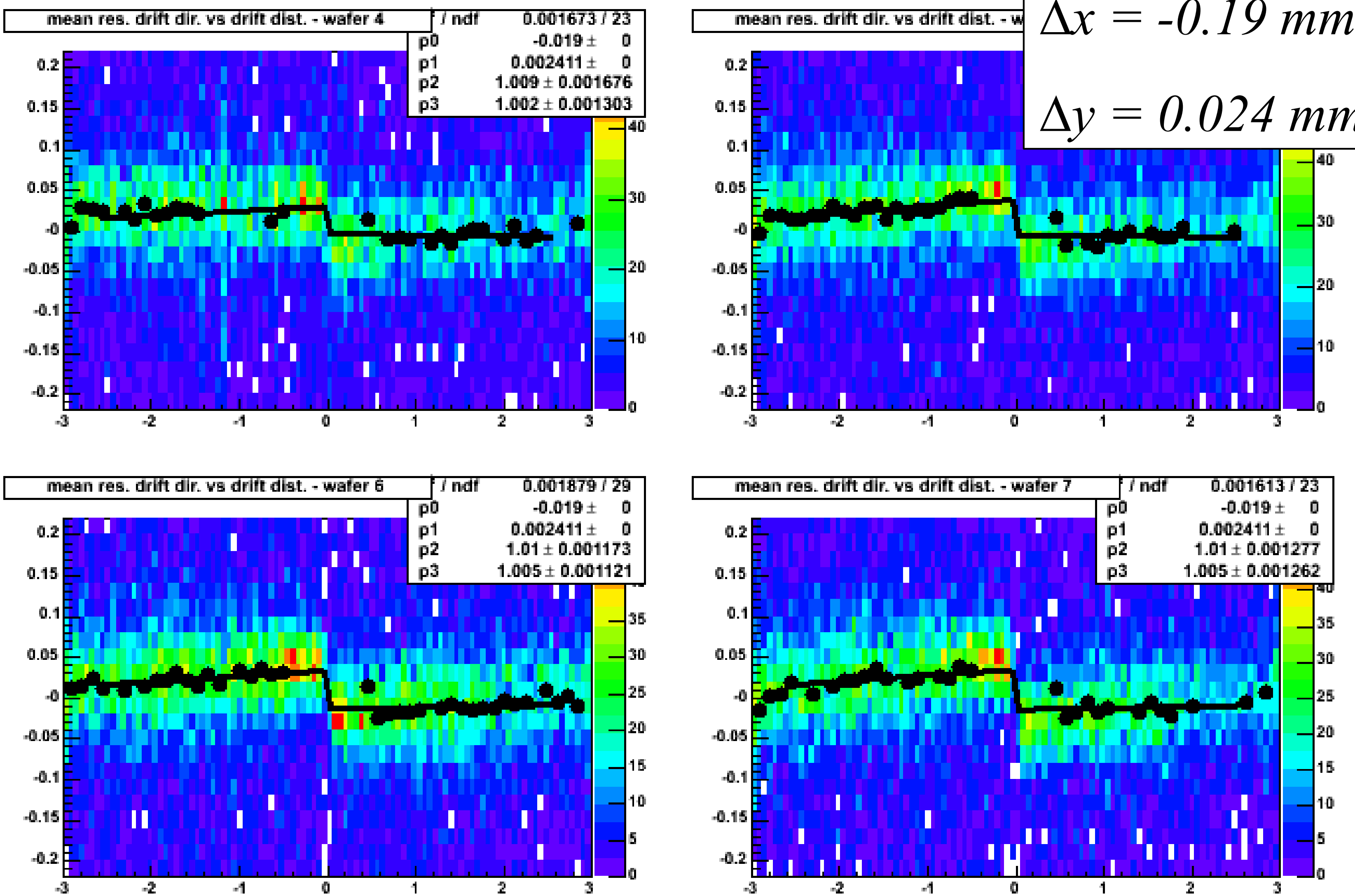
0, if t_0 is Ok

$$res_{drift} = x_{local} - \frac{v'}{v}\left(x_{local} + L\right) + v'\left(t'_0 - t_0\right) + L$$

v` is the correct drift velocity and $t_0$` is the correct time zero.

These two equations can be used to fit the "residuals" distribution fixing the same geometrical parameters for all wafers.

Ladder by ladder (One ladder as example)



$\Delta x = -0.19\ mm$

$\Delta y = 0.024\ mm$

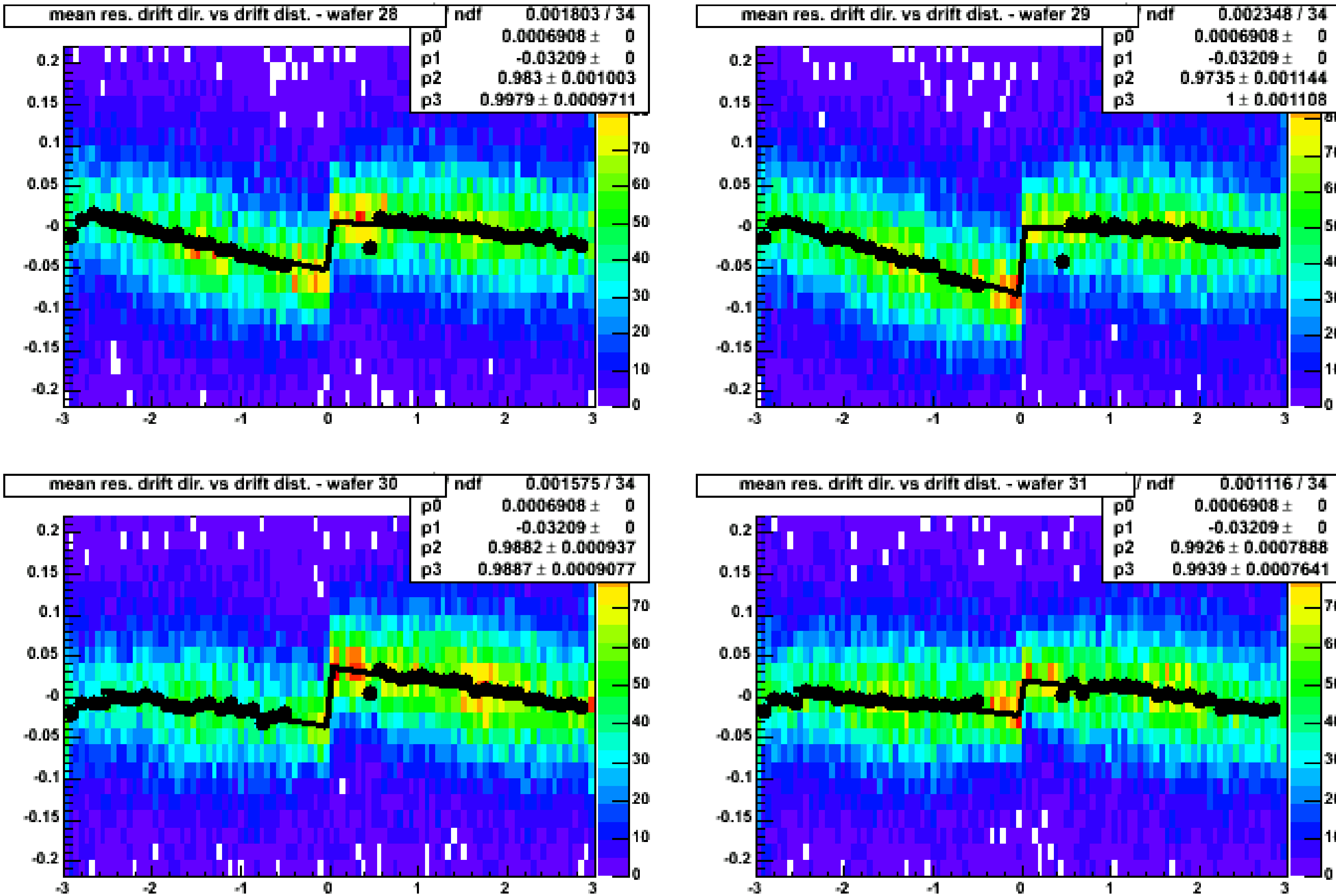
Technique works!

- Done with ladder by ladder (36 total) checking of correction numbers and the effect of them on the "residuals".
- Done with considering the rotation degree of freedom.

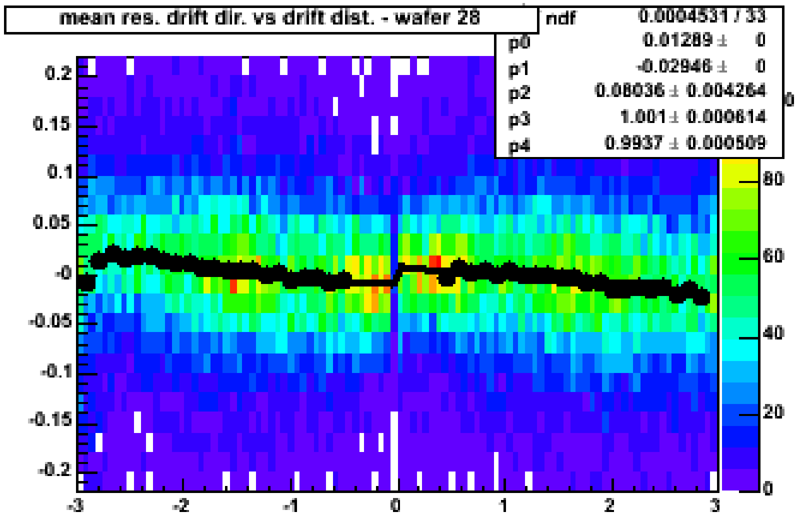
Next step is to fit each wafer separately.

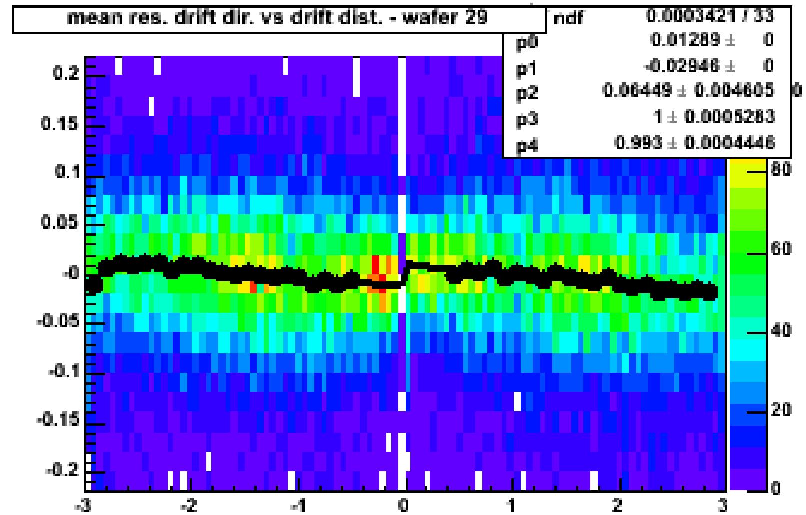
wafer	Δx (μm)	Δy (μm)
1	-190	151
2	-62	67
3	-34	83
4	-92	58

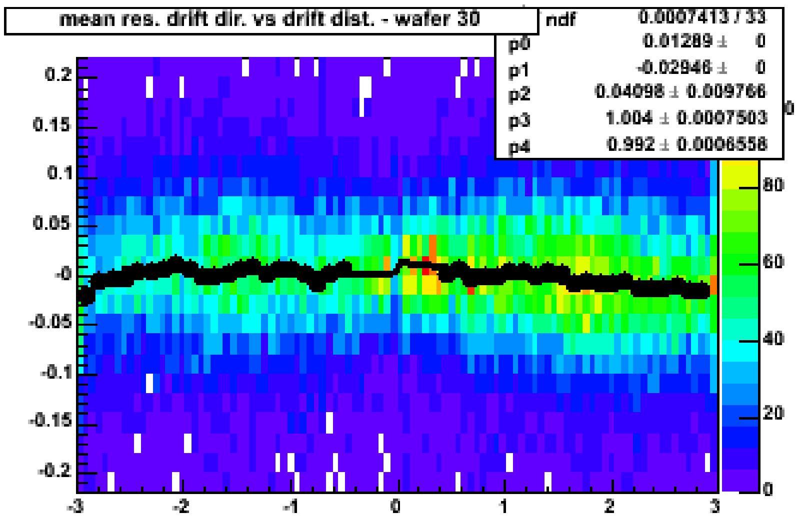
Alignment progress adding survey data

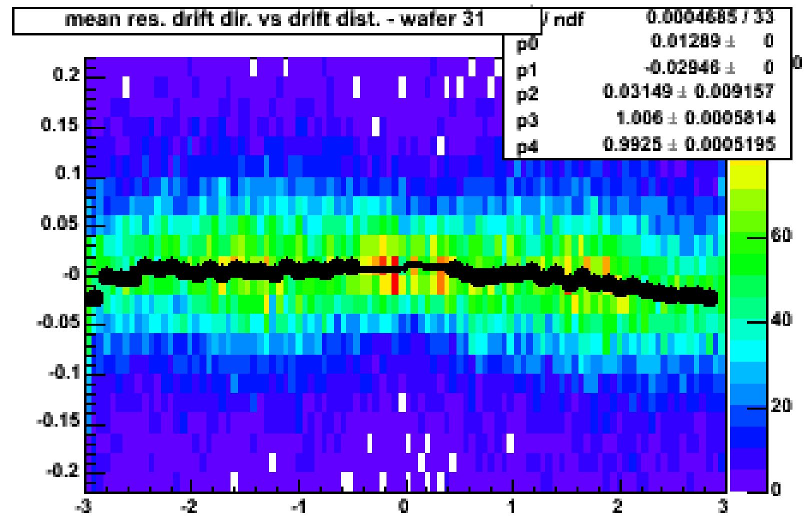


Alignment progress adding drift velocity



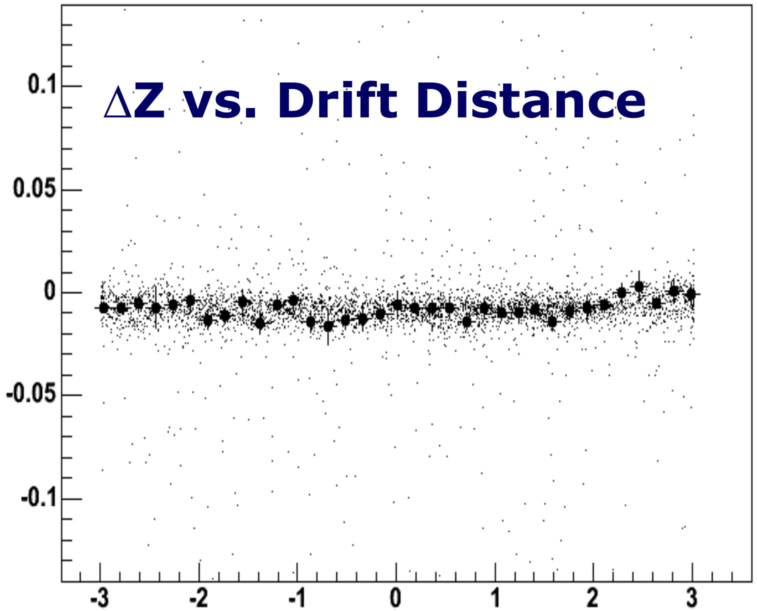


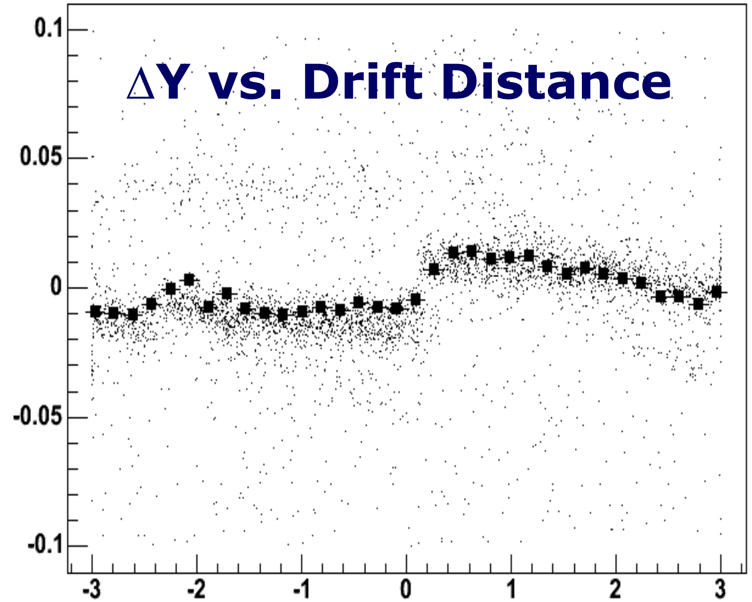




Track Residual: AuAu Prod 62 GeV

	Anode Direction	Drift Direction	Solution
Average over all Barrel 2	180 um	300 um	
Ladder 03	84 um	140 um	Ladder Alignment
L03/wafer 48	60 um	140 um	Wafer Alignment
L03/wafer 48/hybrid-02	60 um	60 um	T0 and drift velocity

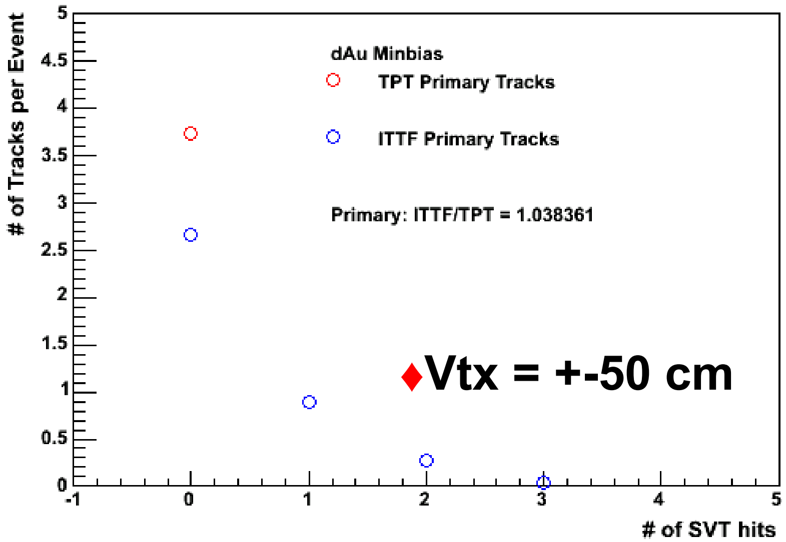


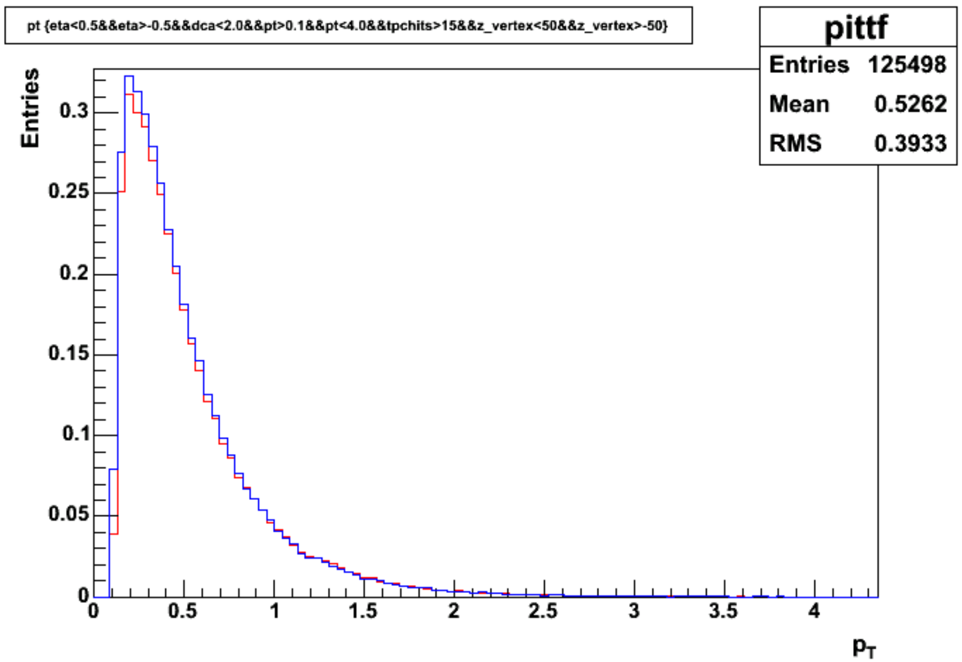


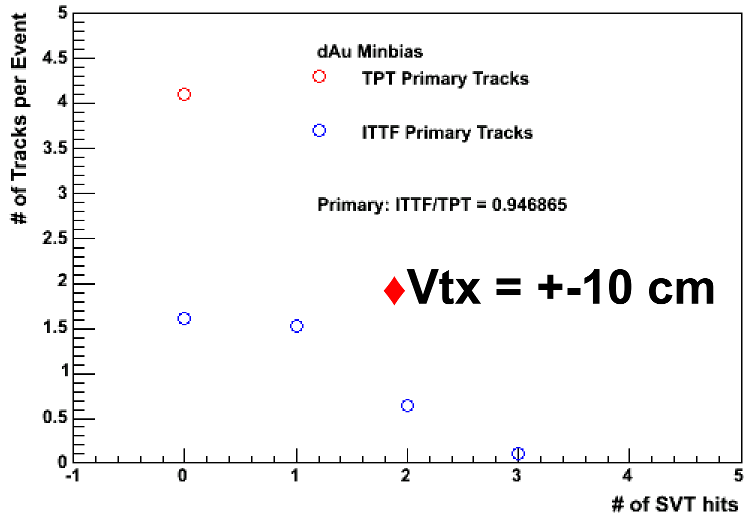
Status of calibration tasks before production

Task	Detail	Fully tested	In chain now	In chain by Aug.1st
Drift velocity calibration	Different constant for each hybrid	yes	yes	
	Different polynomial for each hybrid	in a week	no	yes
	Temperature variation in drift based on laser	yes	yes	
	Burn-in correction based on laser	yes	no (no plans)	no
	Temperature variation in anode based on bench meas.	yes	yes	
Alignment	Software alignment (ladder)	yes	yes	
	+ survey geometry (wafer)	in a week	no	yes
Gain calibration		yes	no	for 2005
Slow simulator		yes		

STI in dA test production - primaries

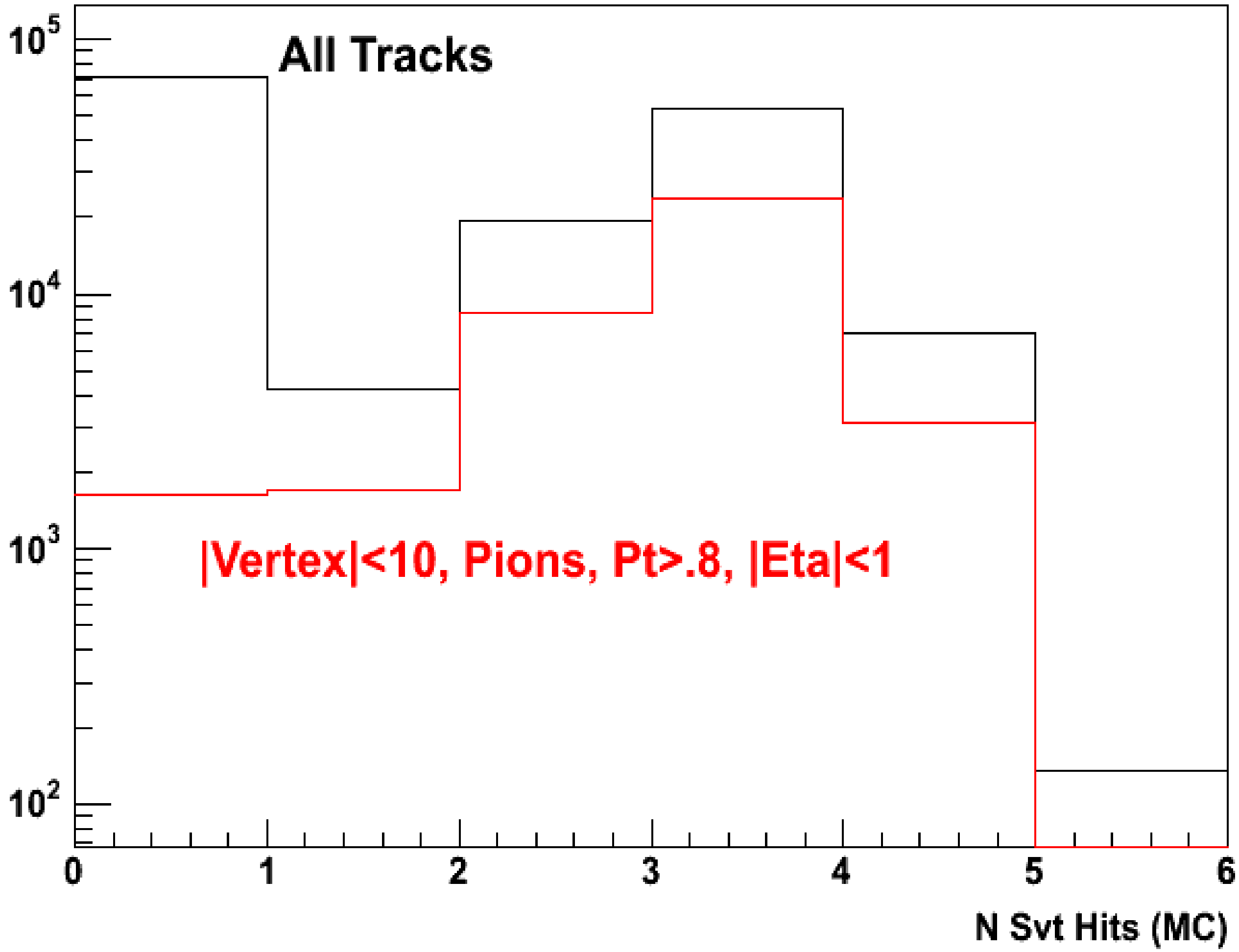




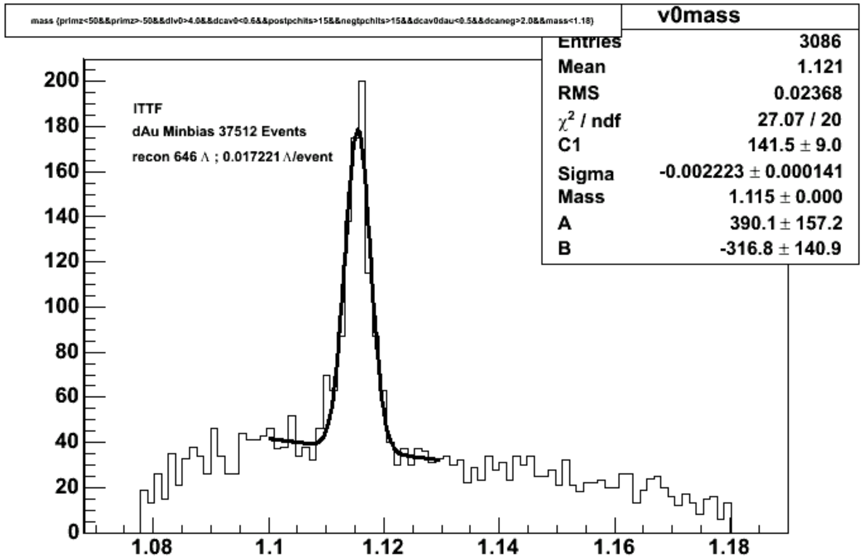


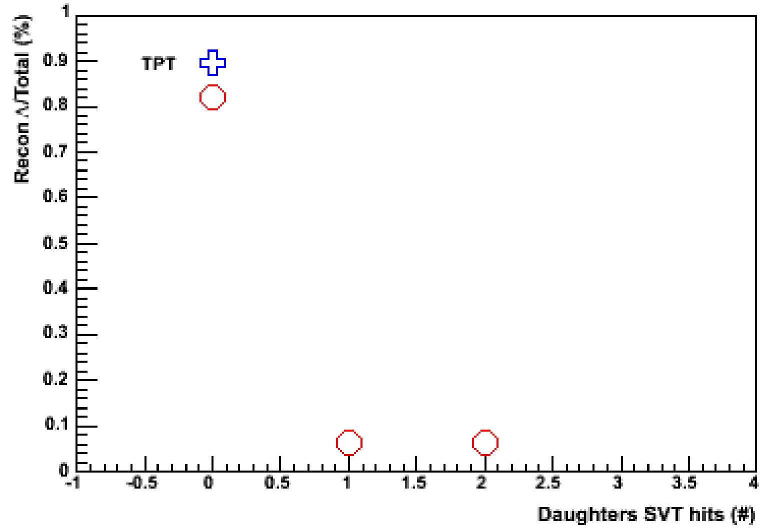
- Still 30% of TPC primaries have no SVT hit, another 30% have only one SVT hit
- STI for SVT not fully tuned yet

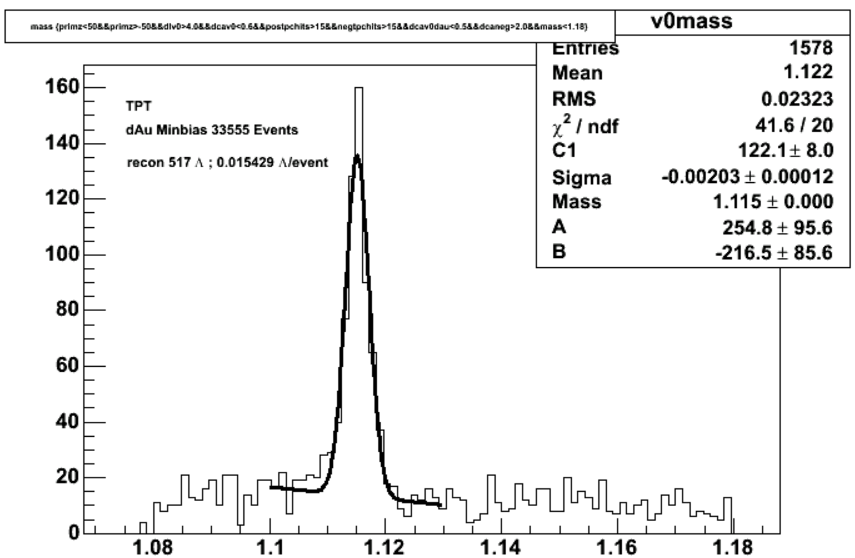
STI performance in central AA simulations

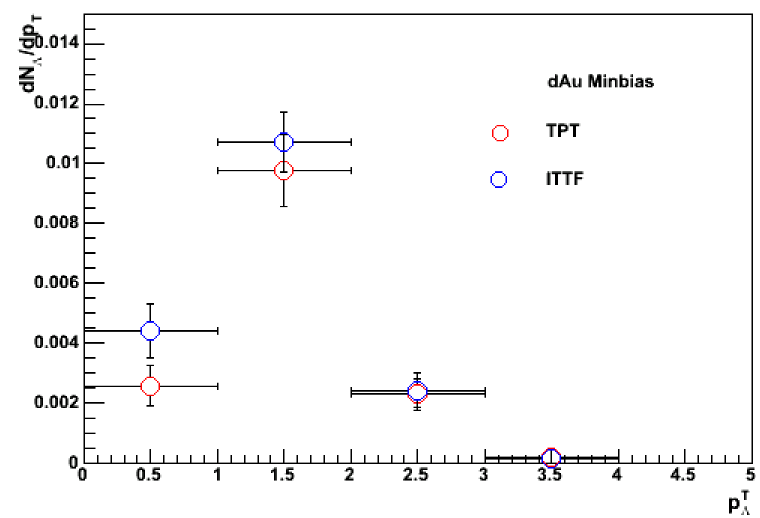


STI in dA test production - Lambdas



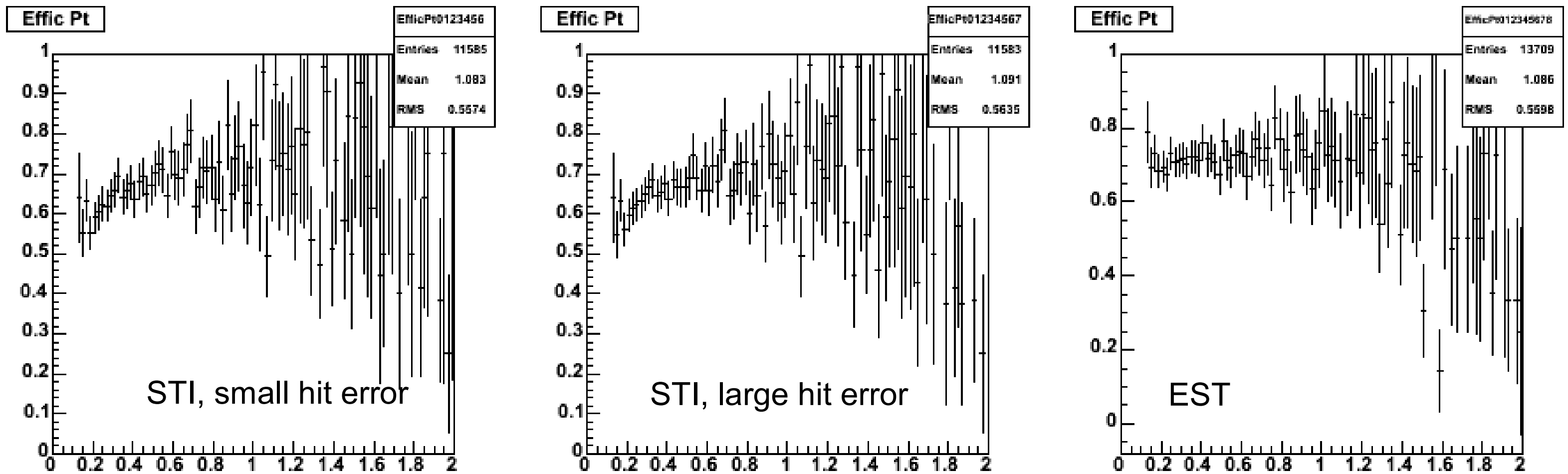




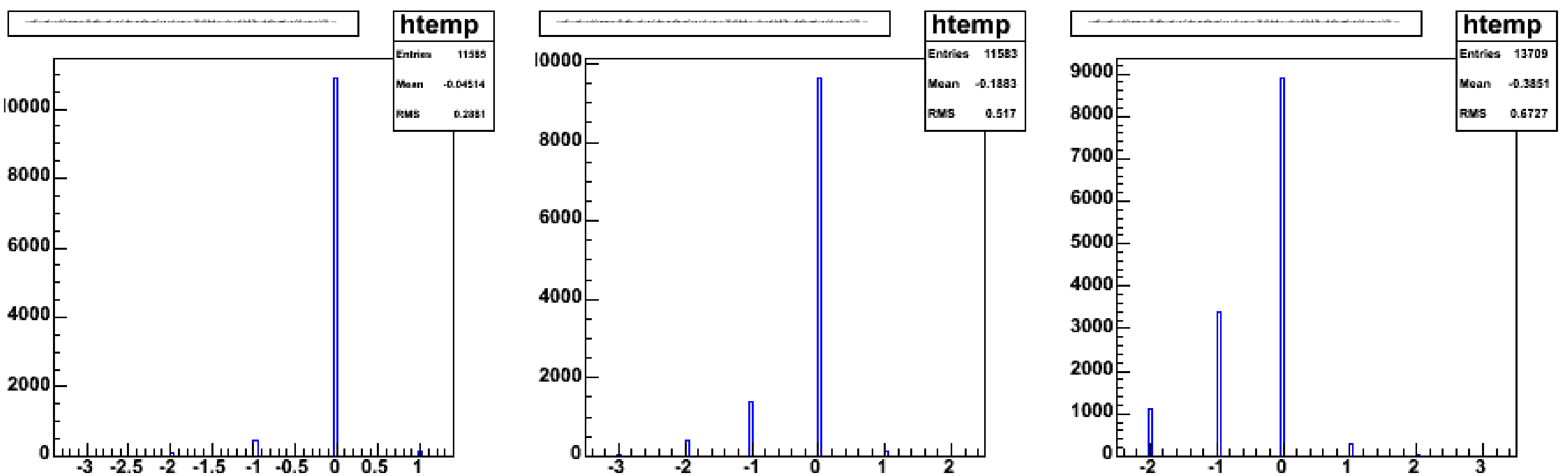


STI performance in minbias AA simulations

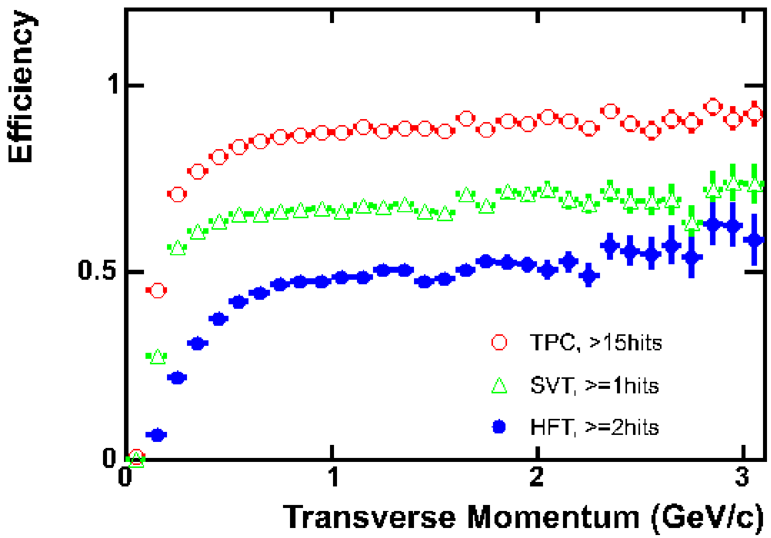
- Matching Eff.: >1 SVT hit common / > 1 SVT hit MC, 15 good TPC hits



- Purity: common hits – reconstructed hits

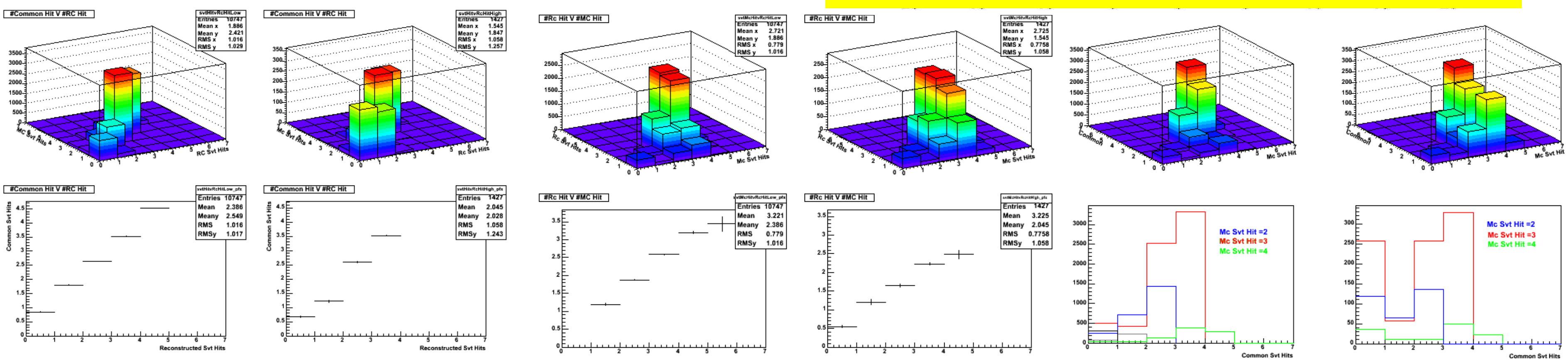


STI performance in central AA simulations



♦Final tracking numbers (from Kai):
Central HIJING (0-5%)

TPC tracking efficiency: 86%
SVT tracking effic. (2 hits): 60%
2 or more SVT hit matching: 70%
1 or more SVT hit matching: 87%



STI performance summary

1.) The number of SVT hits assigned to the TPC track is low in central AA simulations, and to some extent in the dA production. Need to find the reason. (geometry problem ?)

2.) The purity of SVT hits assigned to the TPC tracks is very high.

3.) minbias AA simulations show that the STI performance is presently comparable to EST in terms of momentum resolution and efficiency and superior to EST in terms of purity when small hit errors for the SVT are used in the STI tracking.

4.) we will continue to tune the STI-SVT tracking parameters until the production starts. Present level of performance is sufficient when compared to EST.

Are we ready to go ?

1.) we need about 2-3 more weeks to finish all necessary calibration and alignment steps.

2.) we will use that time also to continue further tuning of the SVT tracking parameters in STI.

We expect to be ready by August 1st.