Tracker alignment issues

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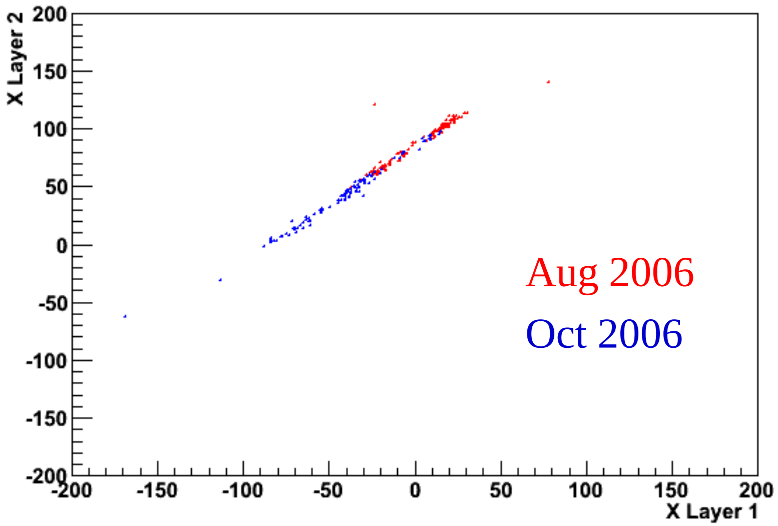
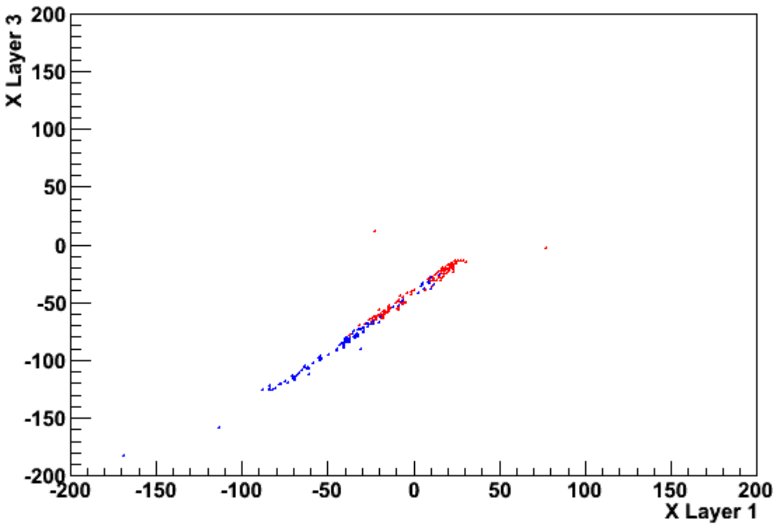
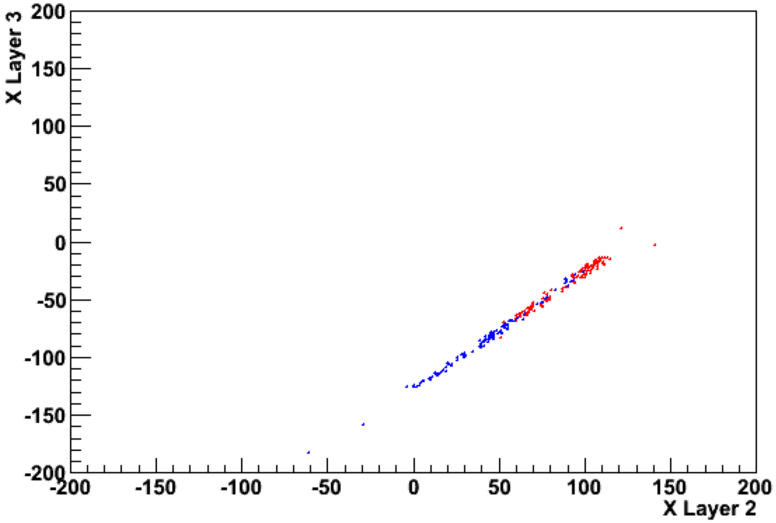
General method

- Go through rec_v0406 files for CERN 2006 and 2007
  - Find tracking hits in each x and y layer; chose random one if more than one
  - Find ECAL hit in first layer (if any) with largest energy
  - Find average position over run of each layer and ECAL hit in both x and y
  - Find correlated spread of these values
- For each run, have two (x and y) sets of averages and “error” matrices
  - Use these to get alignment
  - First look at averages; spreads are harder to interpret...

Correlations of average x values, 2006

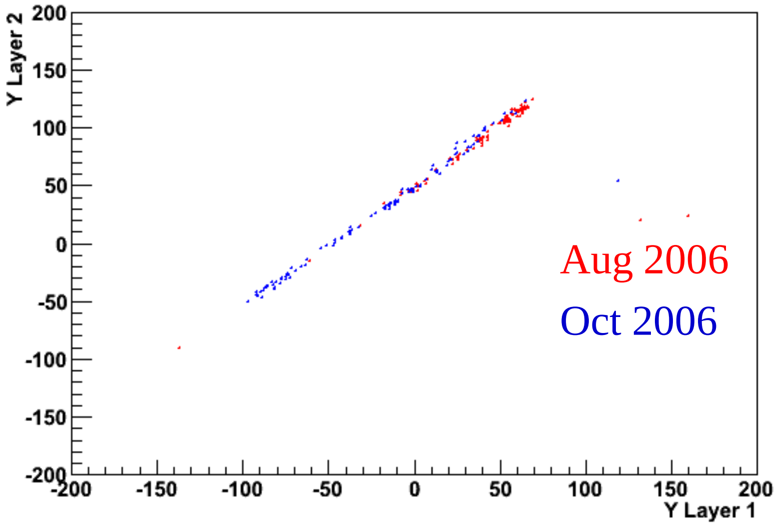


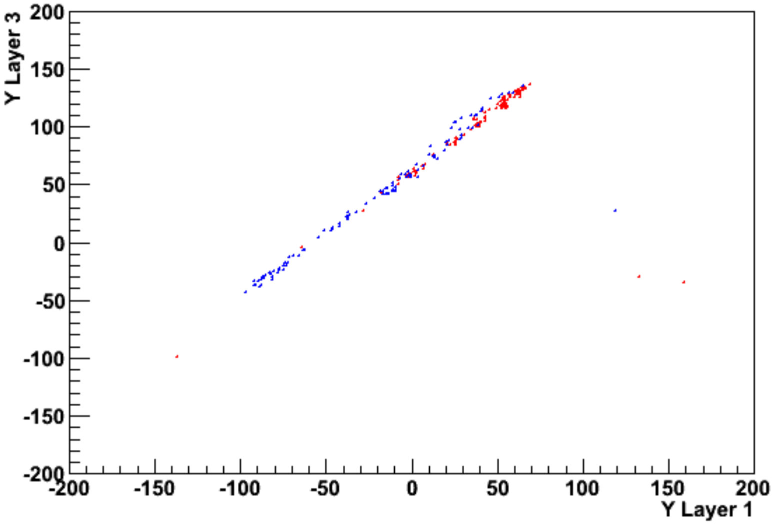


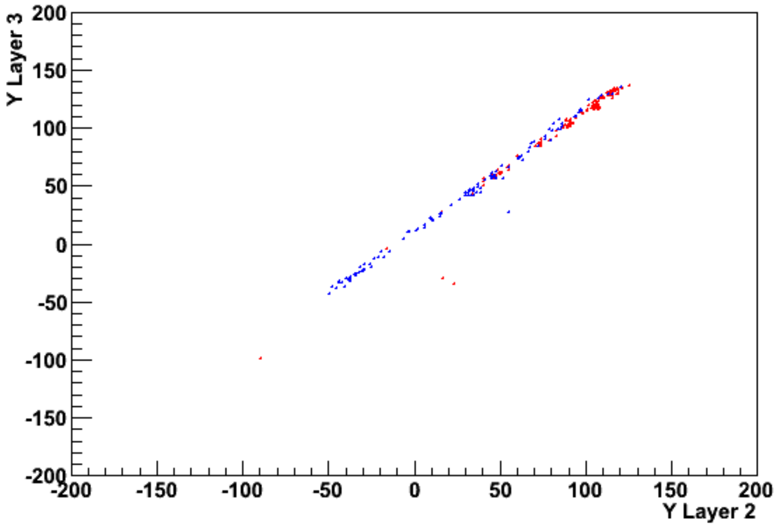


- Good correlation for ~all runs
- Implies motion is due to beam, not tracking
- Means alignment was constant for all of 2006
- Average position has shifted between Aug and Oct
- How to define x=0?

Correlations of average y values, 2006

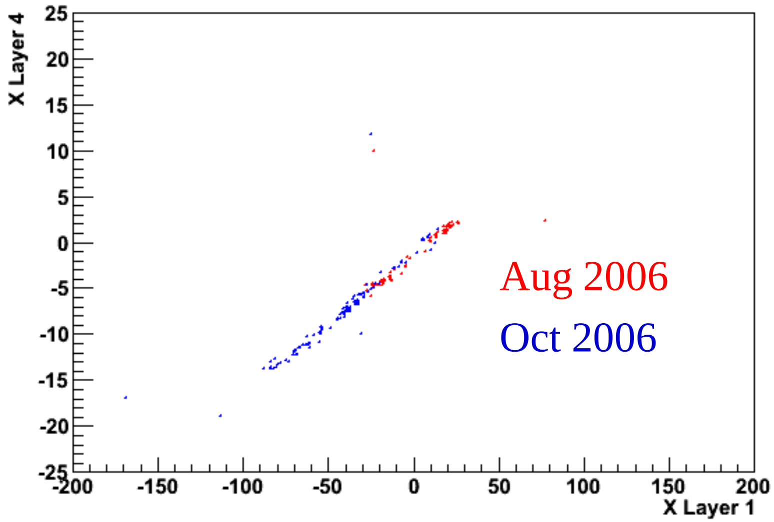


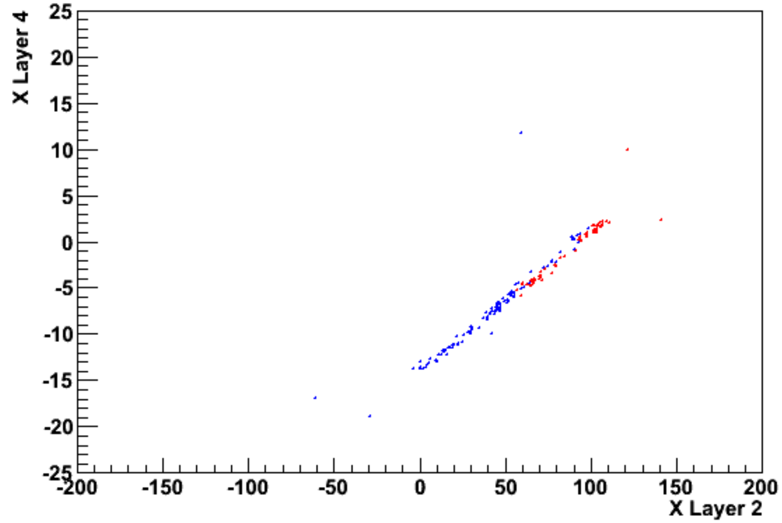


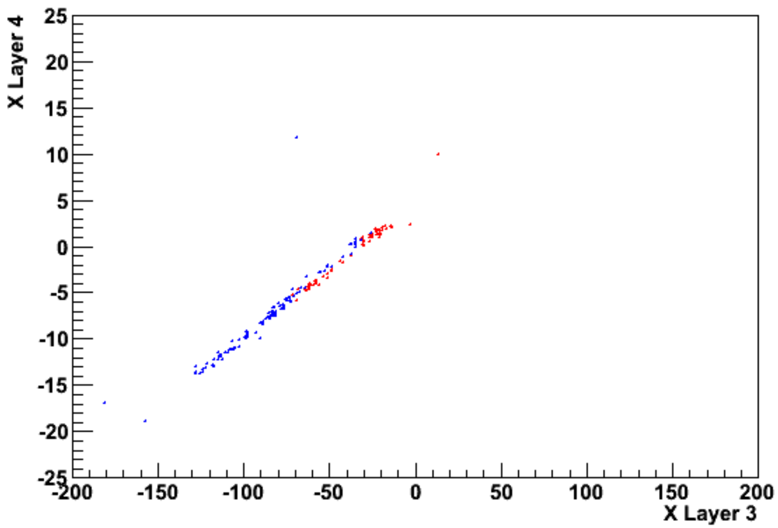


- Same conclusions for y

Correlations with ECAL in x, 2006

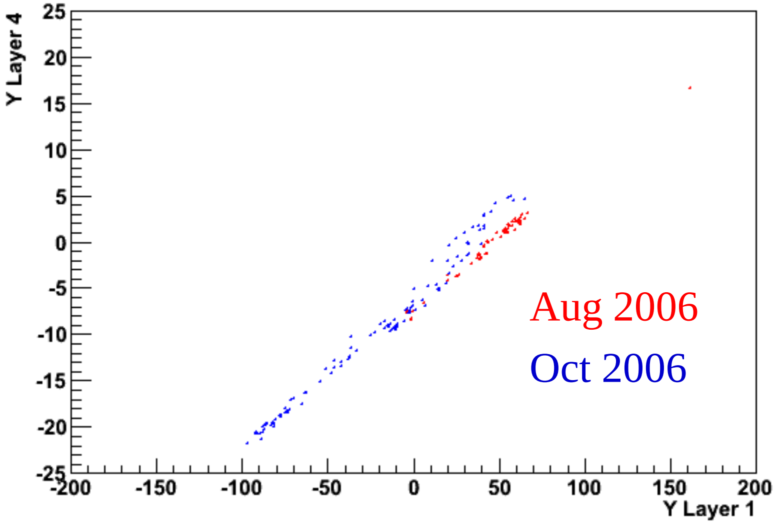


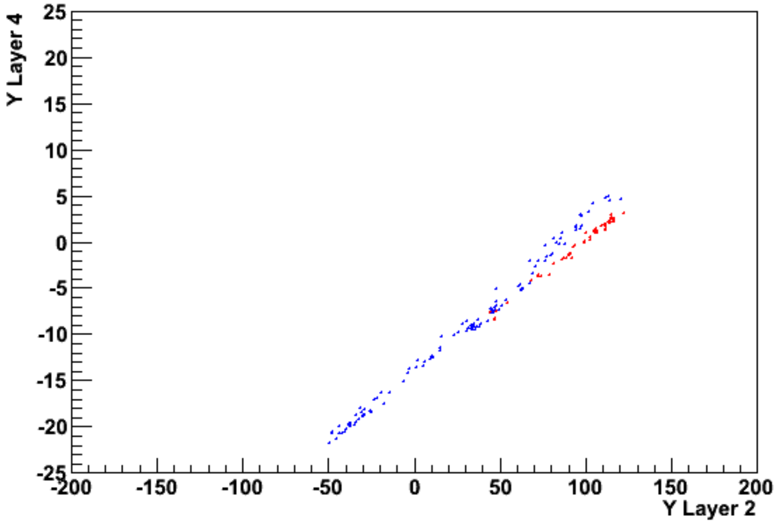


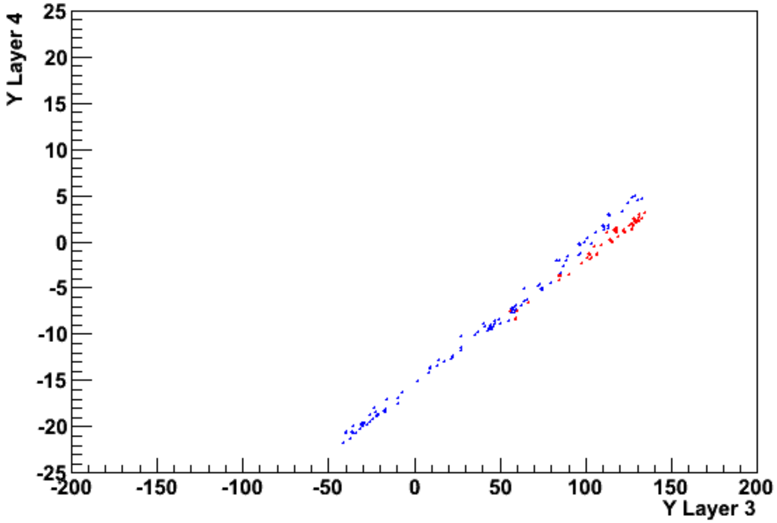


- Looks reasonably stable
- Unexpected; ECAL was moved downstream by ~1.5m between Aug and Oct
- Note, ECAL position is not centred on zero

Correlations with ECAL in y, 2006



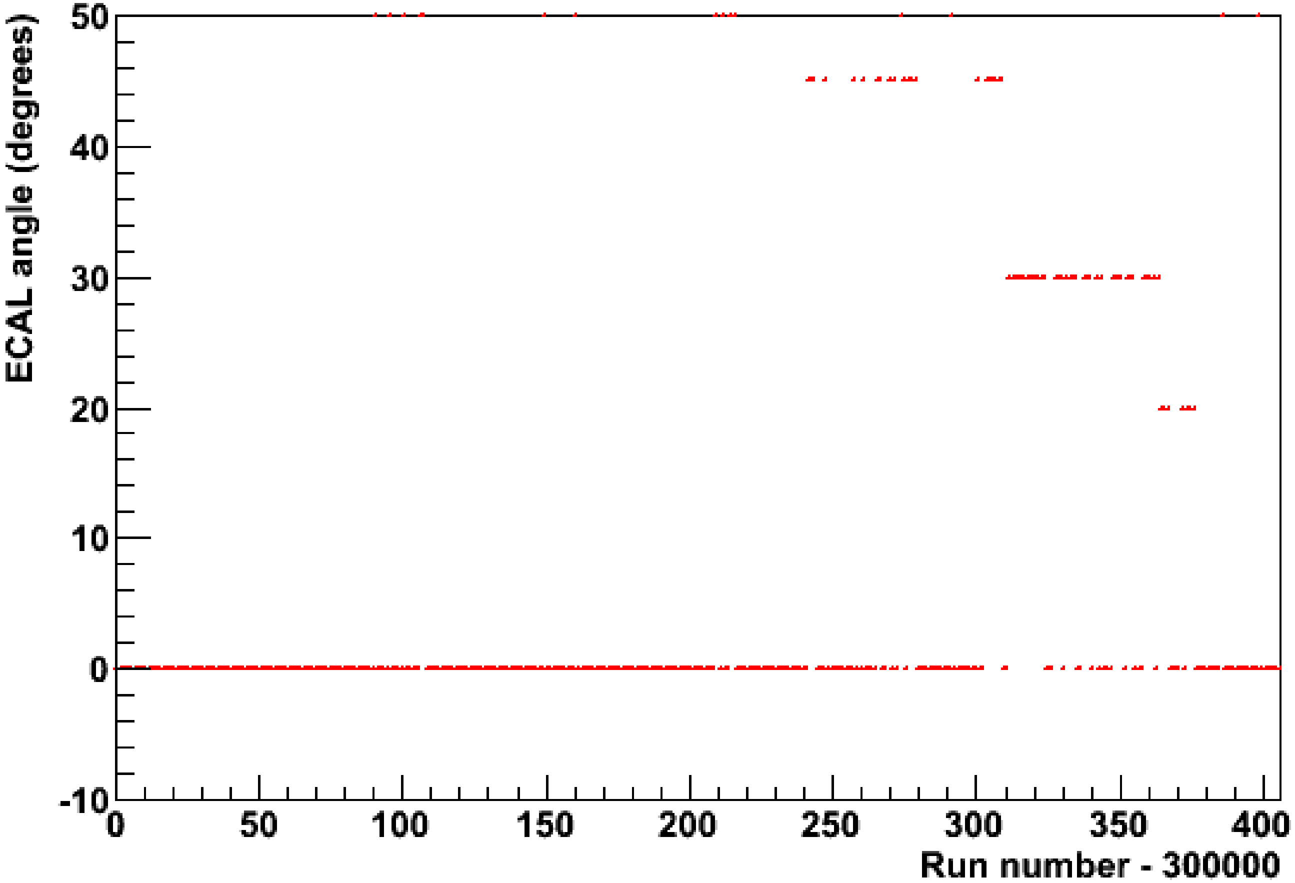




- Not so good; clear shift between Aug and Oct
- Relative ECAL y position will need to be adjusted
- Also difference in slope...

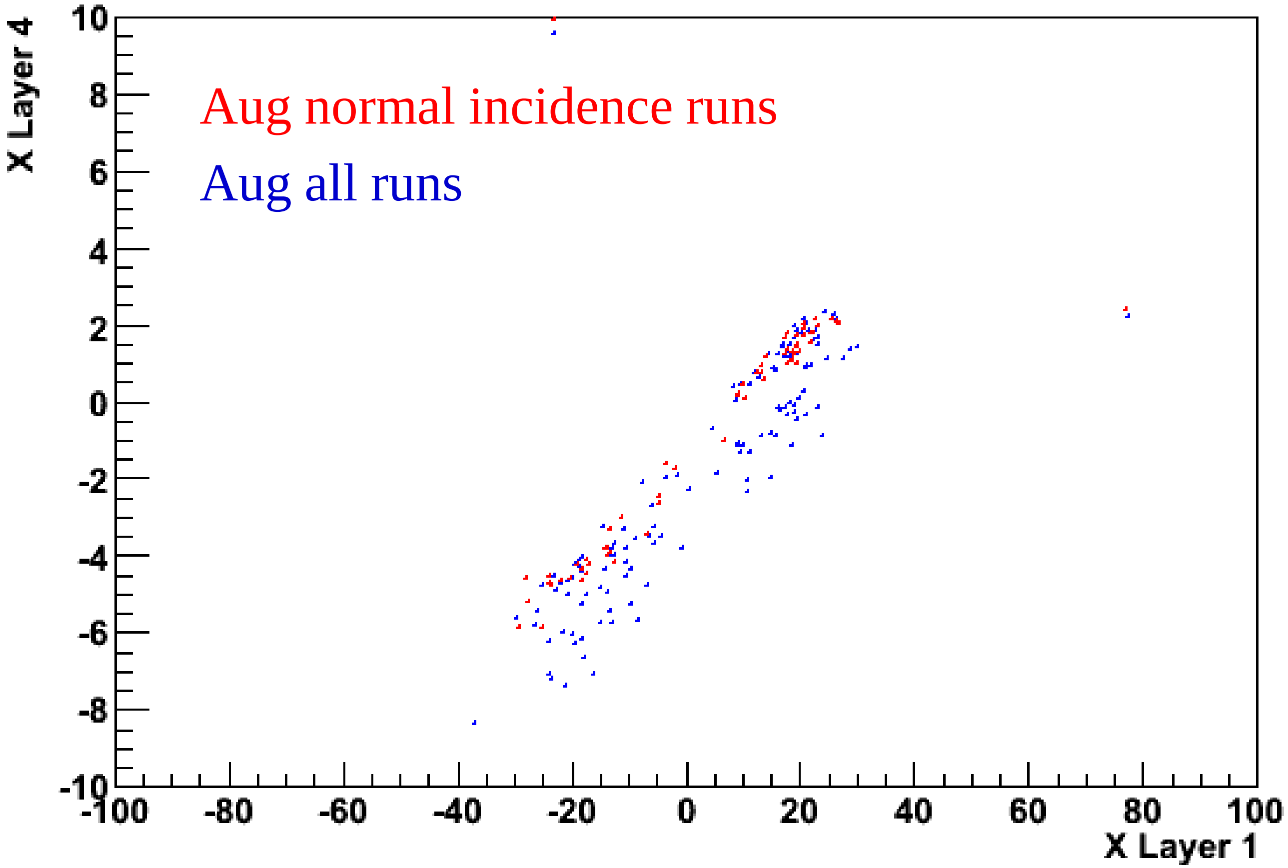
ECAL angled runs

- Some runs had ECAL tilted from normal incidence
  - How to get this information?
  - Reconstruct angle from z dependence of hits for differing x



ECAL angled runs (cont)

- Correlation of tracker and ECAL is washed out if using the angled runs
  - Implies alignment of ECAL not correctly compensated for tilt
  - Have not used these runs in previous plots

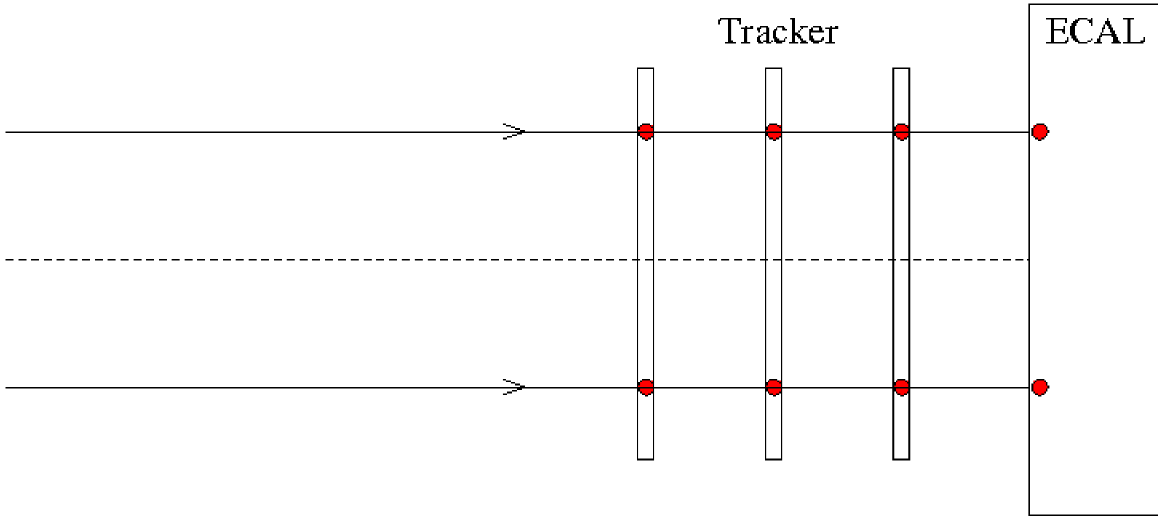


Extraction of alignment values

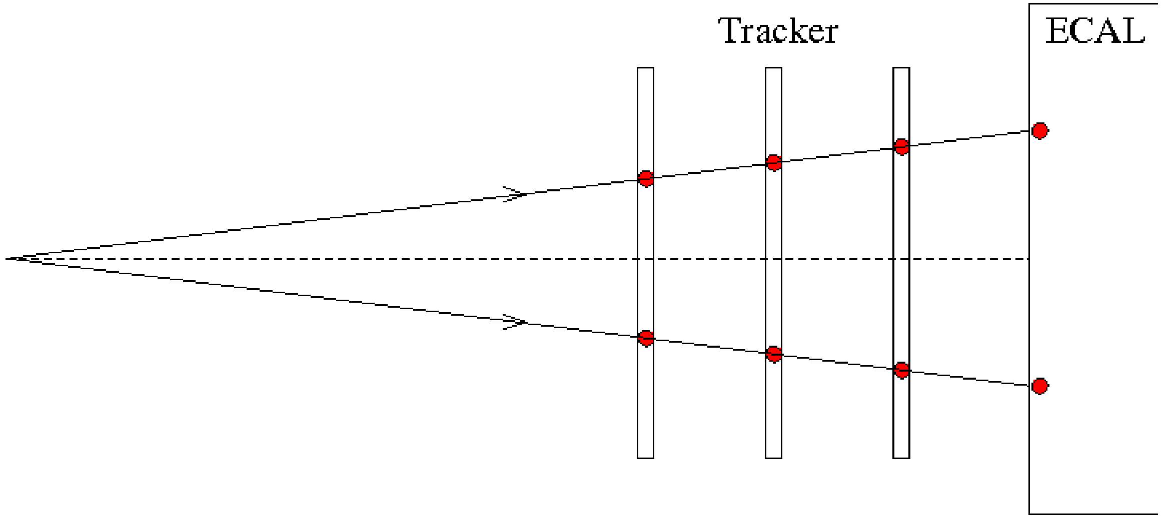
- Need constant (t_0) and linear (v_d) values to convert TDC time to position
  - $x = v_d(t-t_0)$ and similarly for y
- Nominal beam line is supposed to define x=0
  - Hence t_0 is "average" time of TDC hit
  - Take some value in centre of range for all of 2006?
  - Take two values; one for Aug and one for Oct?
  - Semi-arbitrary but either will require ECAL to be repositioned
- Use ECAL as fixed "ruler" to give absolute scale of v_d
  - Use correlation of ECAL and tracker averages
- But... does not nail down system uniquely
  - Does beam move because of angle or position?

Beam shift vs tilt

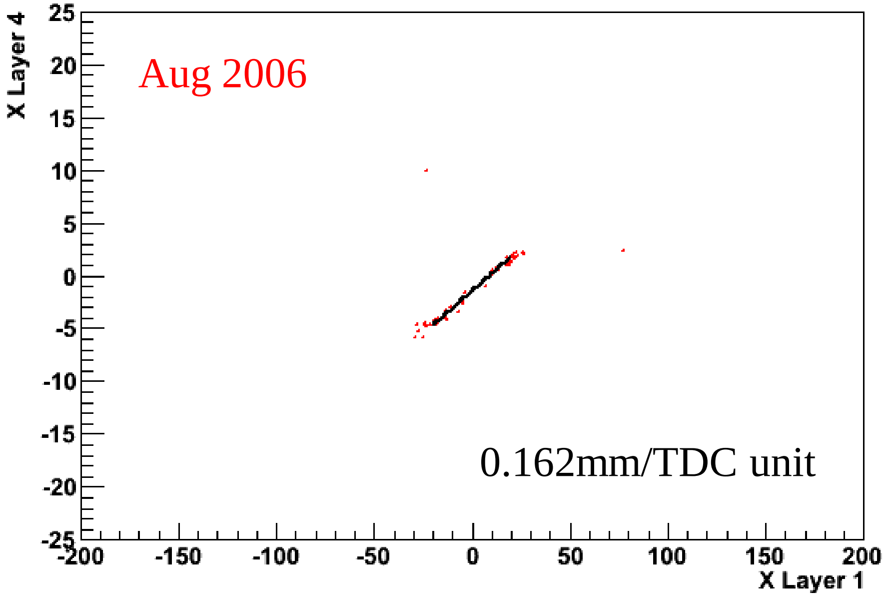
- Assume beam motion is mainly position
- All averages move 1:1

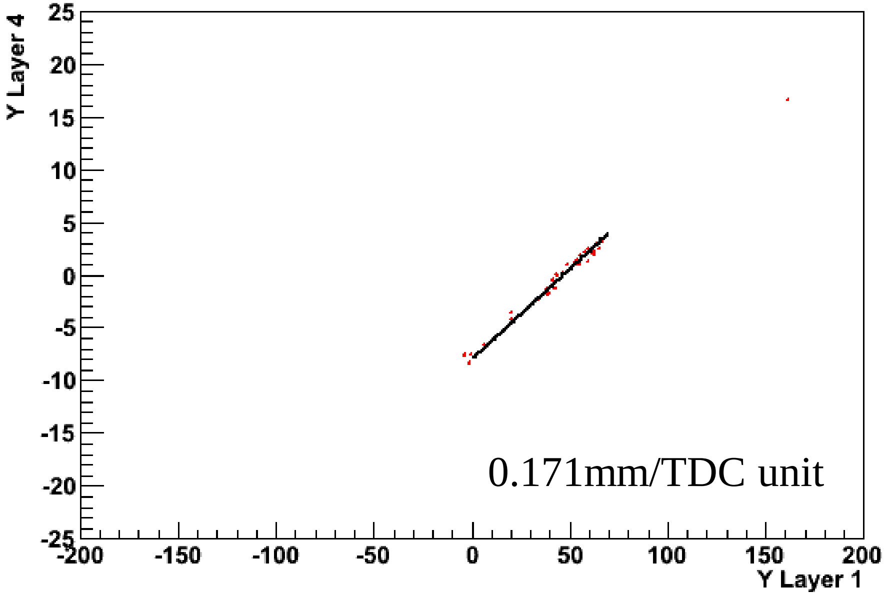


- Assume beam motion is mainly angular
- Averages move depending on z position; ~5% effect



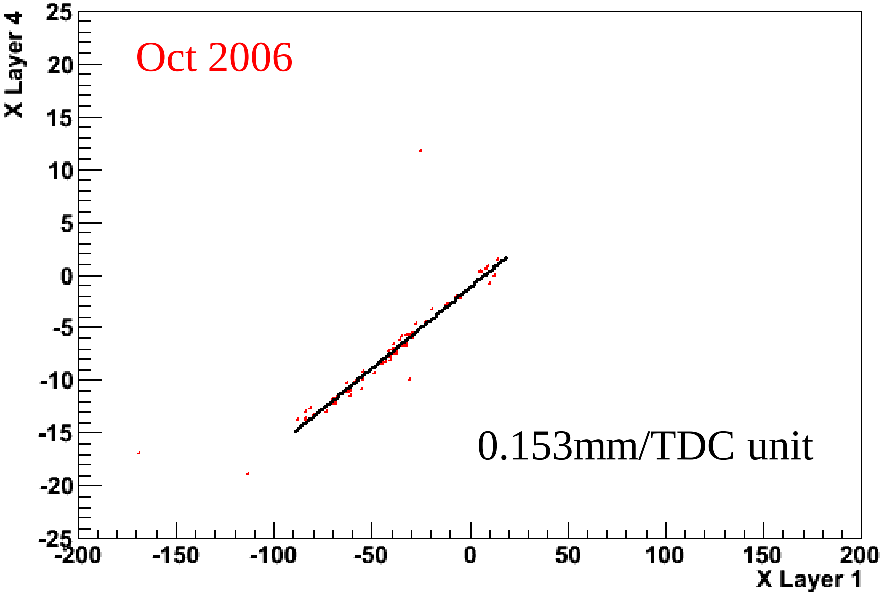
Typical fits, Aug 2006

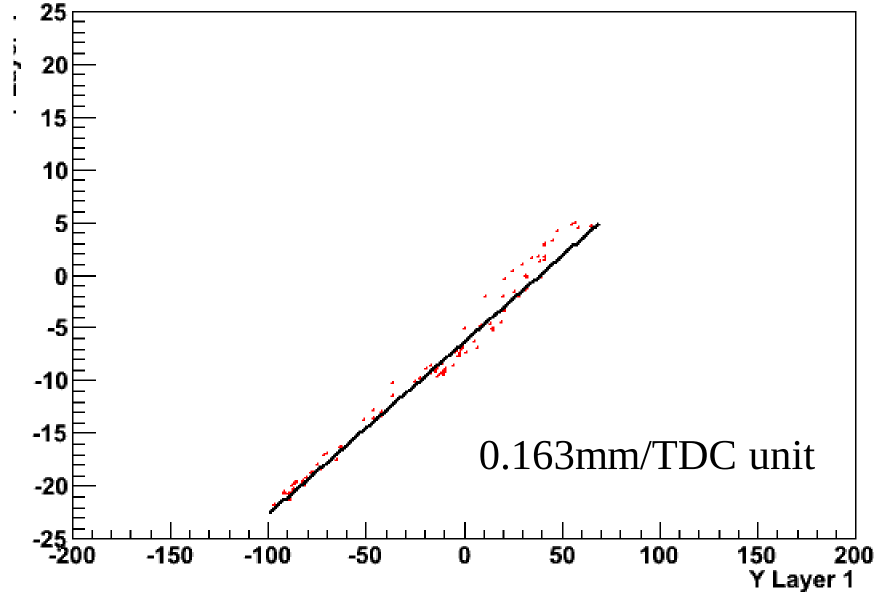




- Values assume beam position, not angle, varies run-to-run
- Fits are limited in statistics
- Note: if beam was very stable, this method would not work

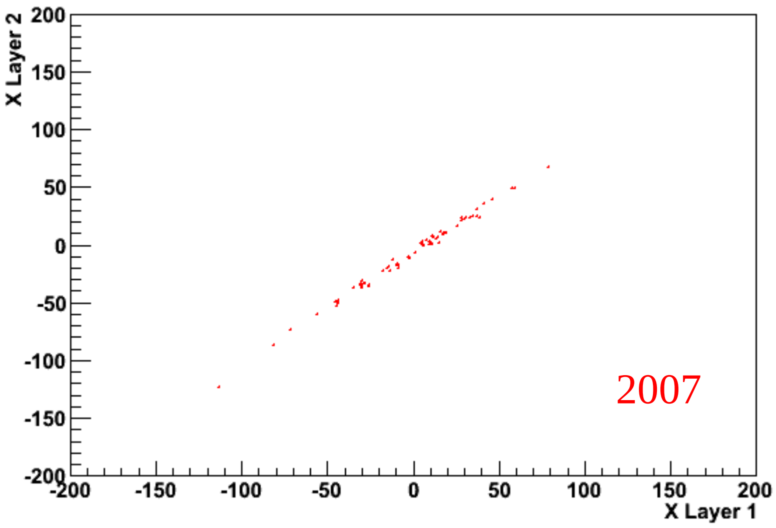
Typical fits, Oct 2006

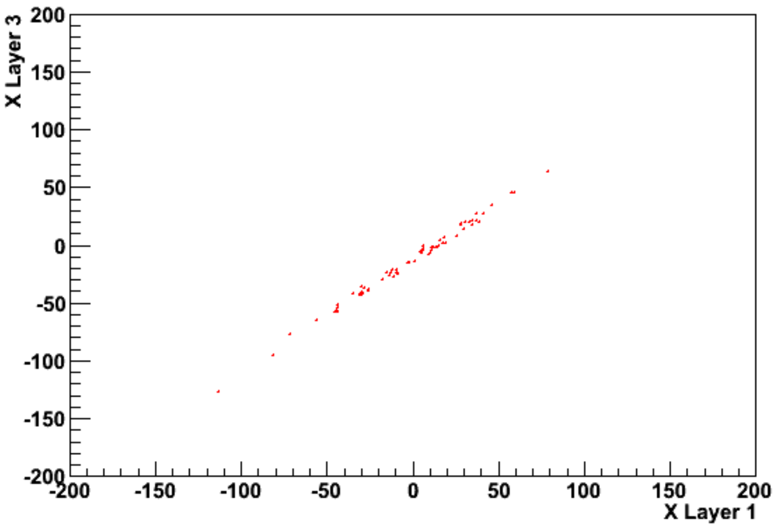


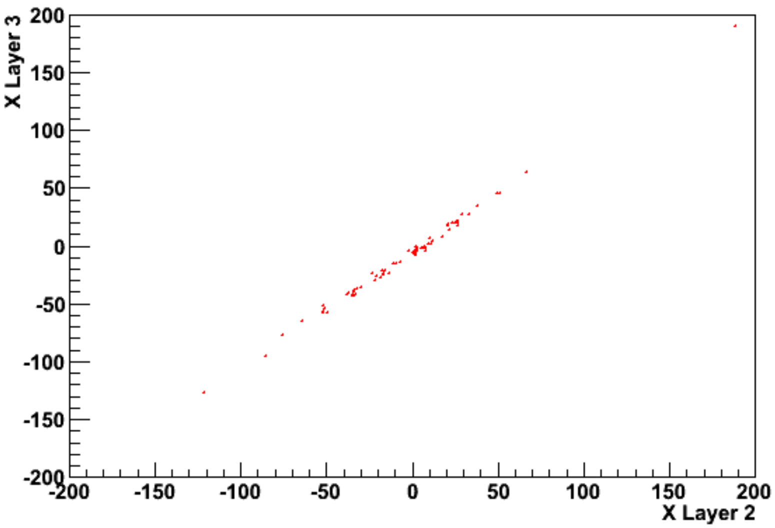


- Slope values differ, even though tracking correlations are stable
- Fit for y does not look good

Correlations of average x values, 2007

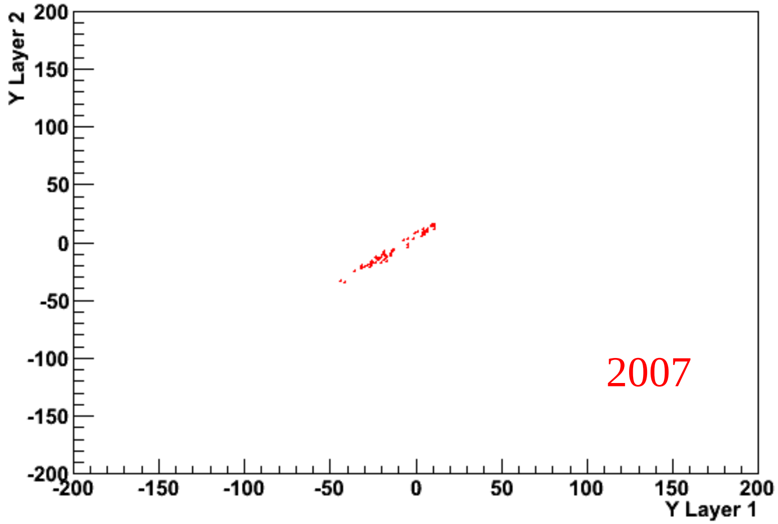


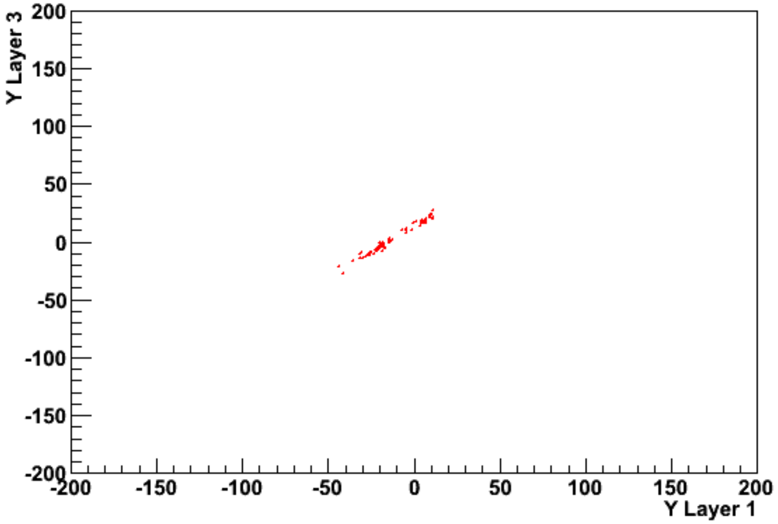


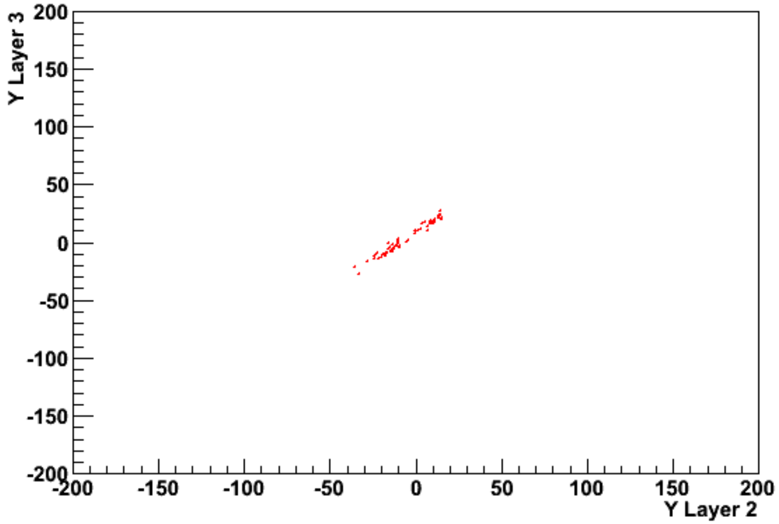


- Good correlation for ~all runs
- Alignment was also constant for all of 2007

Correlations of average y values, 2007

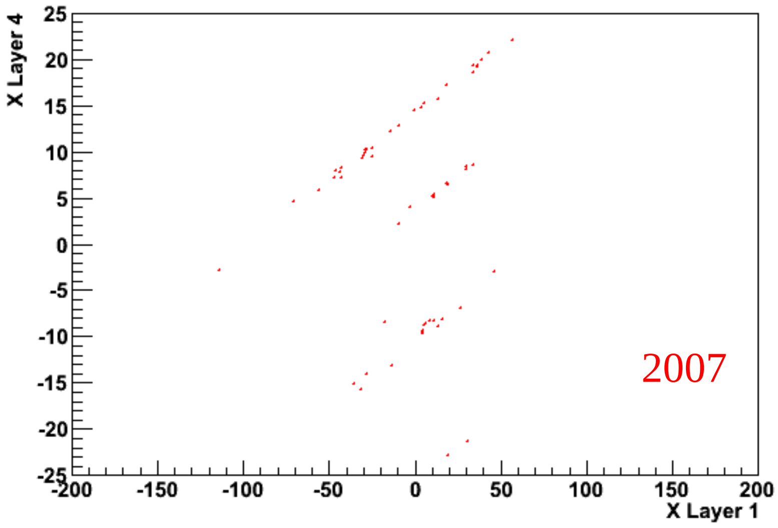


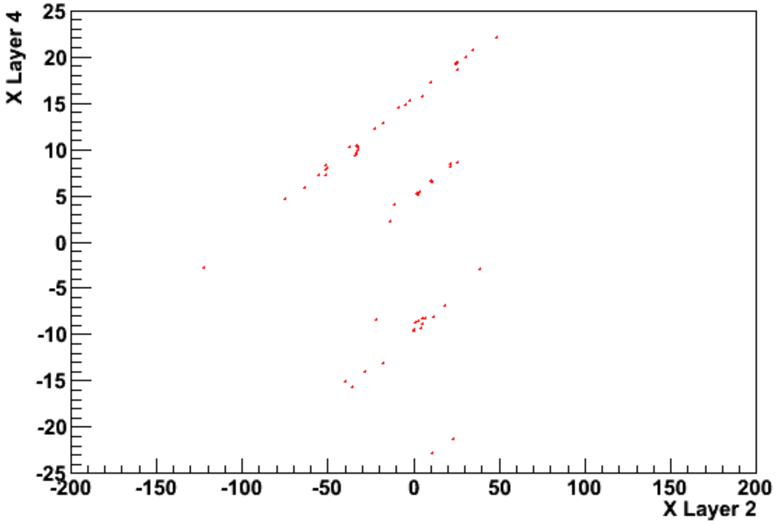


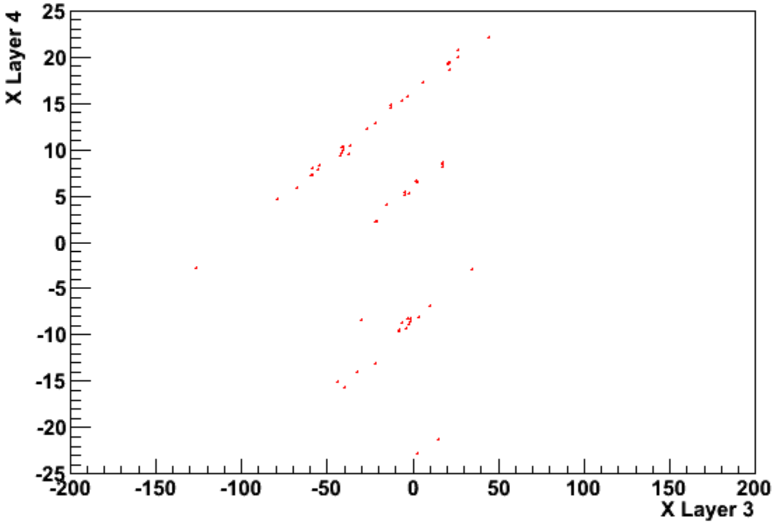


- Same conclusions for y

Correlations with ECAL in x, 2007

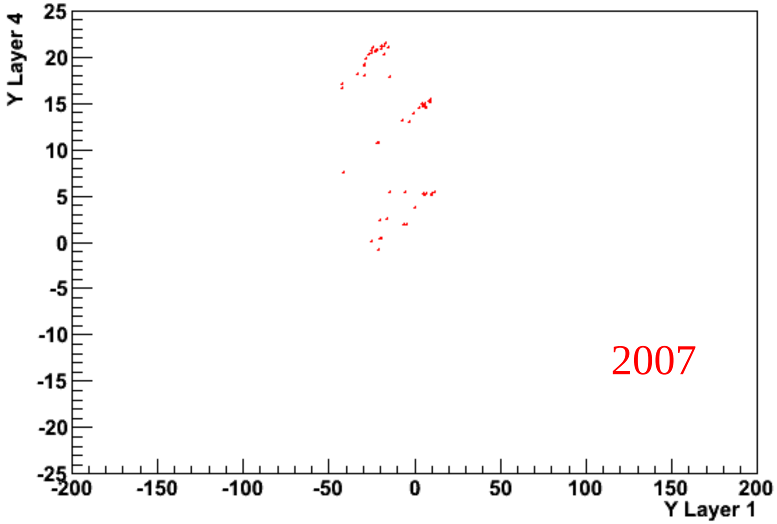


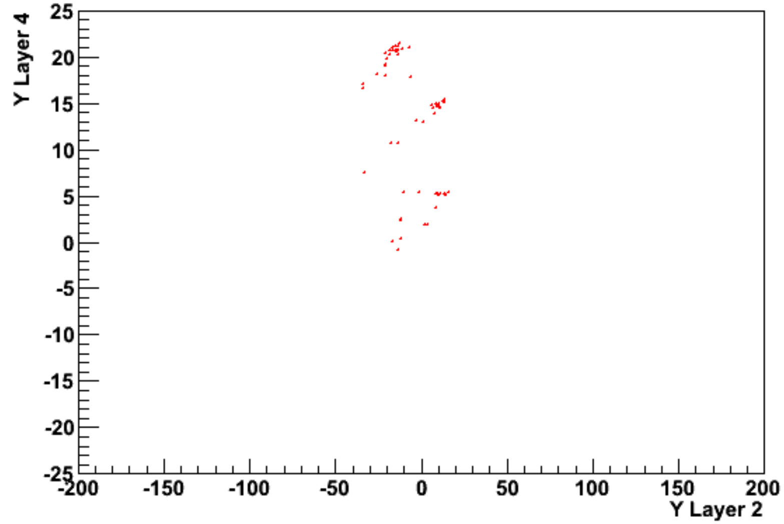


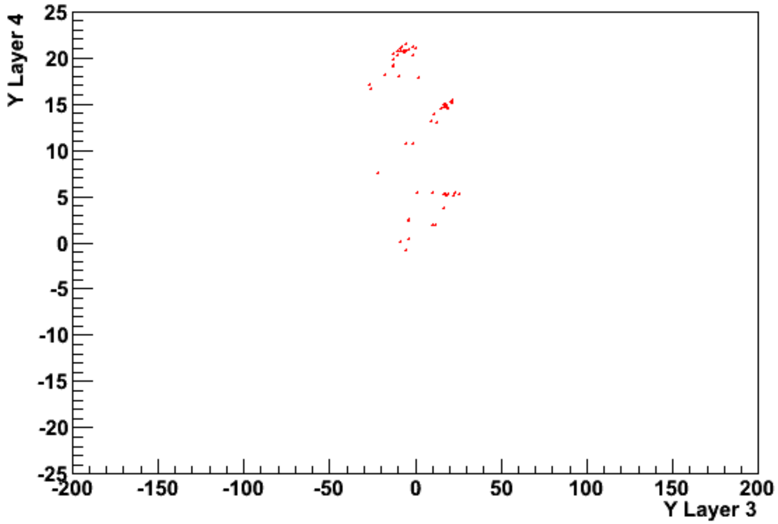


- ECAL motion; 3 or 4 different lines
- Would need to fit to each
- Lacking statistics; only ~70 runs total

Correlations with ECAL in y, 2007







- Also see differing lines
- Even harder to fit slopes here

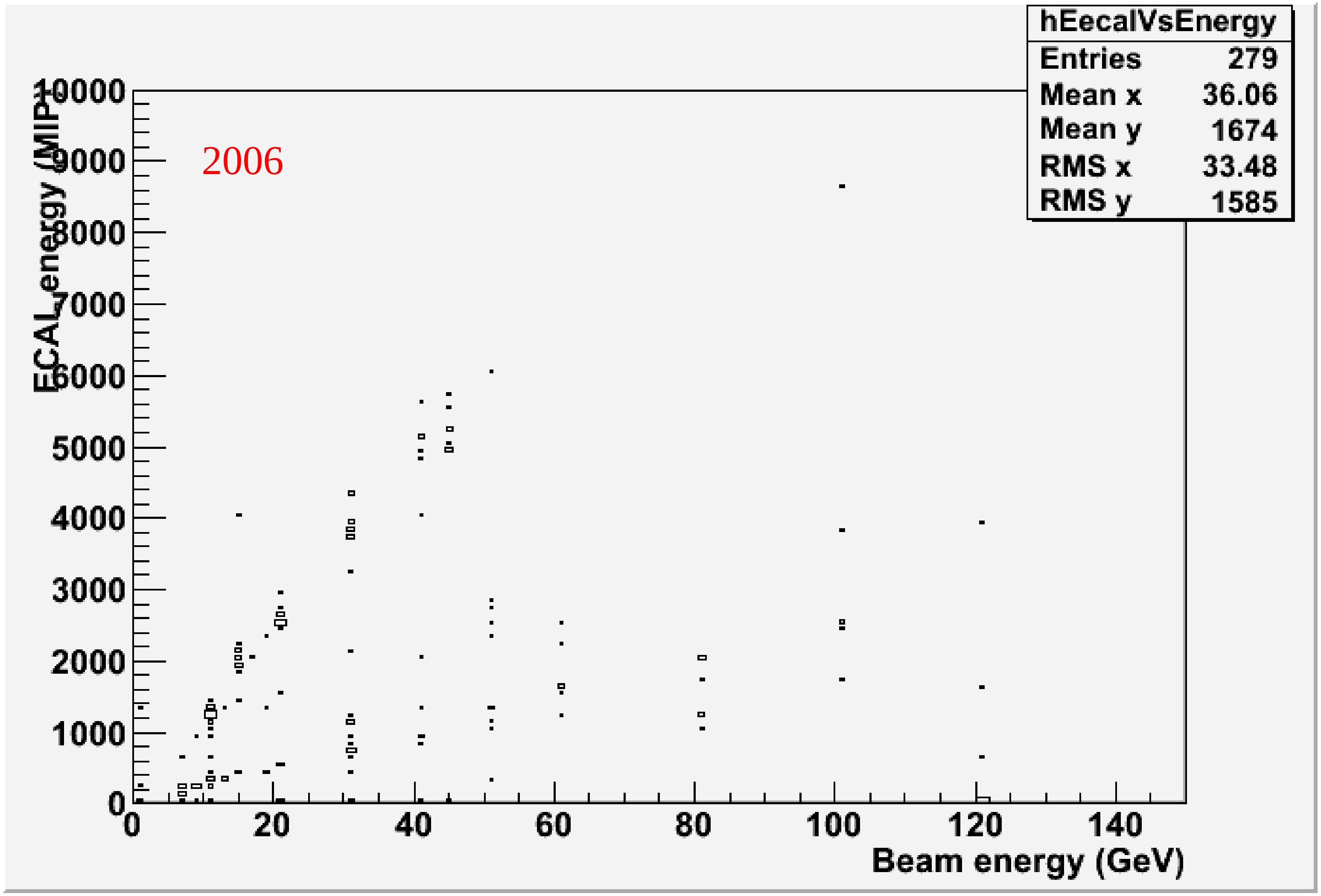
Using spread matrix

- Try to use spread in each run to cross check
  - Measured matrix is in terms of TDC times and ECAL position
  - The v_d parameters convert measured time spreads to position spreads
- Spread arises from three sources
  - Event-to-event beam spread around average
  - Scattering in material in beam line
  - Intrinsic position resolution of the tracker and ECAL
- Adjust parameters to best match measured matrix
  - Need beam energy to know scattering

- So far not successful...
  - Tracker-only matrix works well but no “ruler” to fix v_d precisely
  - ECAL spread seems physically too small; maybe chopping off spread due to finite size of ECAL?
  - Needs further work...

Basic check of nominal beam energy

- Check average energy deposited in ECAL in each run vs nominal beam energy



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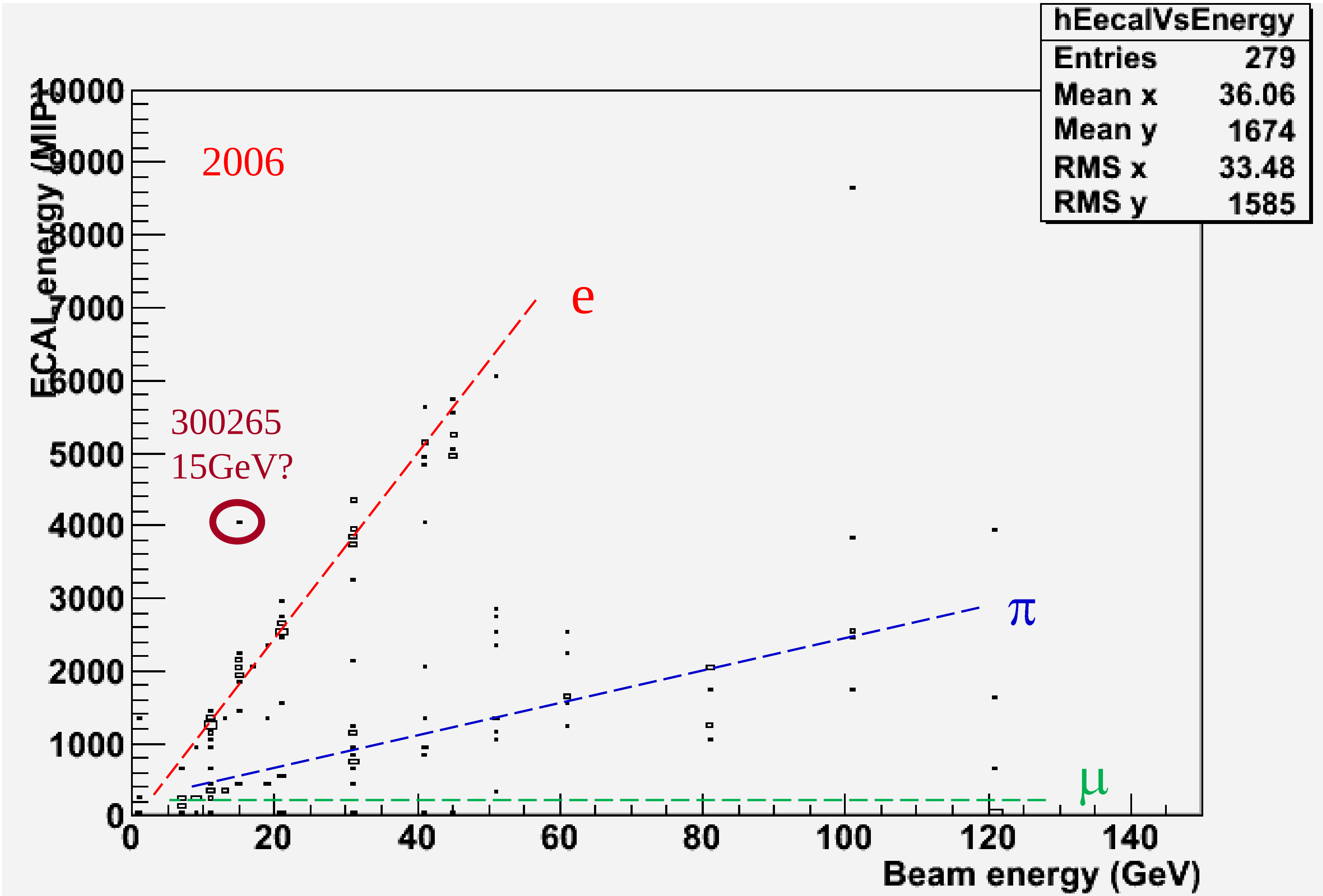

Comments on FitConstants

- Currently has two scattering matrices for use in fitting
  - 6×6 matrix for forward track fit; four tracking layers plus beam spot position and angle constraint
  - 4×4 matrix for backward track fit; only four tracking layers
- Alignment matrix needed here is another scattering matrix
  - Needs backward track fit matrix plus ECAL position (and maybe in future angle); 6×6 matrix
  - Daniel has been calculating these from MC recently
- Choice
  - Keep alignment matrix elsewhere; painful to ensure consistency
  - Enlarge FitConstants to have two 6×6 matrices; not backward compatible with checked out code
- Also, do we put in single scattering matrix and scale by $1/E^2$?
  - Requires nominal energy to be absolutely reliable when running jobs
- Need to decide before we start to put Daniel's values in the database

Conclusions

- CERN 2006: tracker seems stable in Aug and Oct
  - Alignment values still uncertain at 10% level
  - Using ECAL depends on ECAL also being stable; maybe not?
- CERN 2007: tracker is again stable
  - ECAL is not, so needs more work to extract alignment
- This method needs assumption on how beam moves run-to-run
- Cross-check using spreads
  - Need beam energy reliably; always get zero for 2007!
  - Need to understand position spread in ECAL