Tracker to Solenoid Alignment

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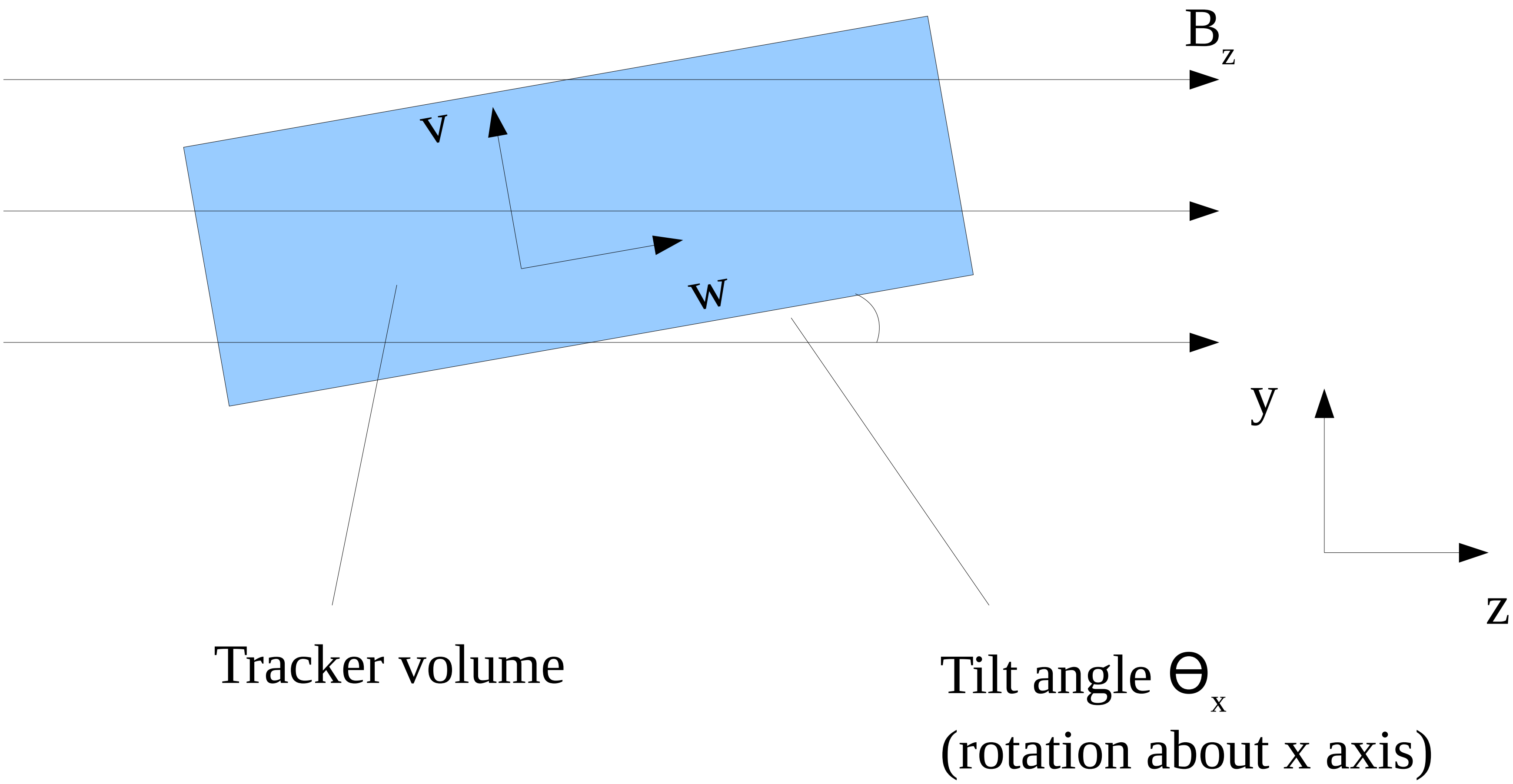
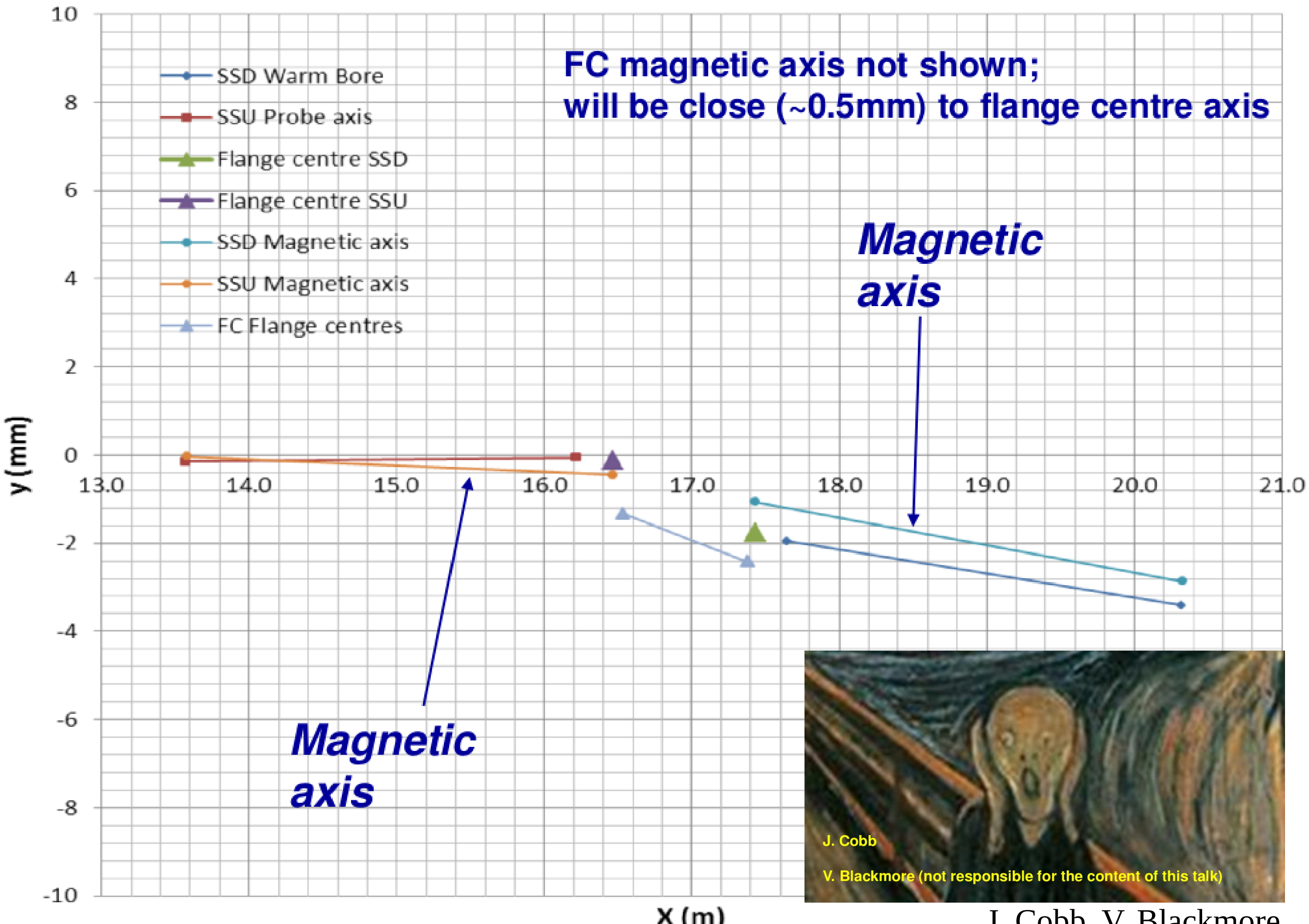
Tracker to Solenoid Alignment

- Aim is to measure the tracker tilt angle wrt solenoid field



Magnet Mapping – Plan (CM42)



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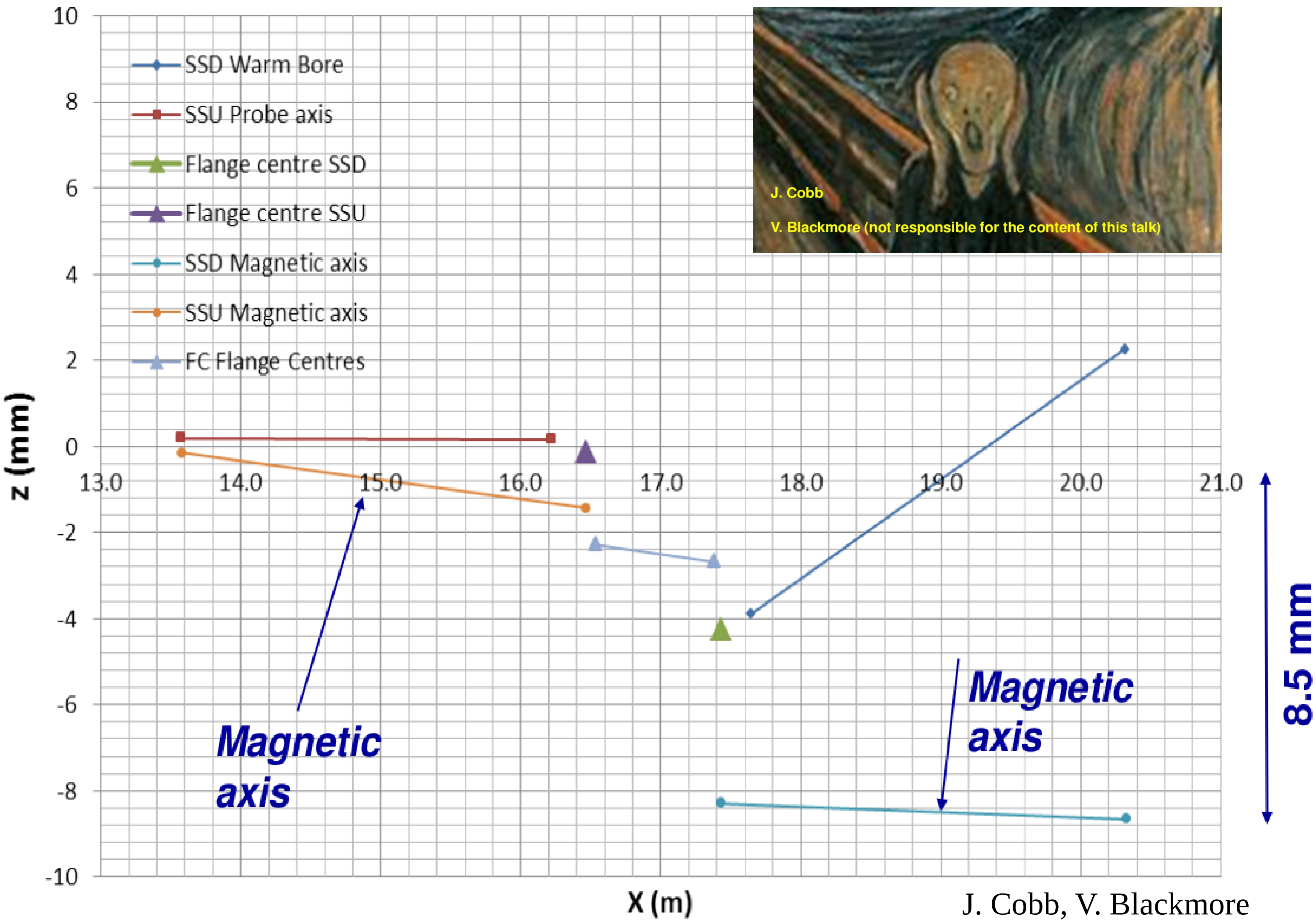
Magnet Mapping – Elevation (CM42)



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Algorithm

- Tracks make a helix through the field
- Projection onto solenoid x-y is a circle
- Use polynomial expansion for a circle
  - $R^2 = (x-x_0)^2 + (y - y_0)^2$
- Transform to tracker coordinate system (u, v, w)
  - Small angle approximation
  - $R^2 = (u+\Theta_x w-x_0)^2 + (v +\Theta_y w - y_0)^2$
- Expand and divide through by constant term
  - $\{ - 2x_0u - 2y_0v+ (u^2+v^2) + 2\Theta_x wu + 2\Theta_y wv - 2(y_0\Theta_y+x_0\Theta_x)w \}/a_2 = 1$
  - $a_2 = R^2-x_0^2+y_0^2$
- This is a sum of polynomial terms; we can fit track by track using linear least squares
- Then histogram the resultant angles
  - The mean might be the measured angle

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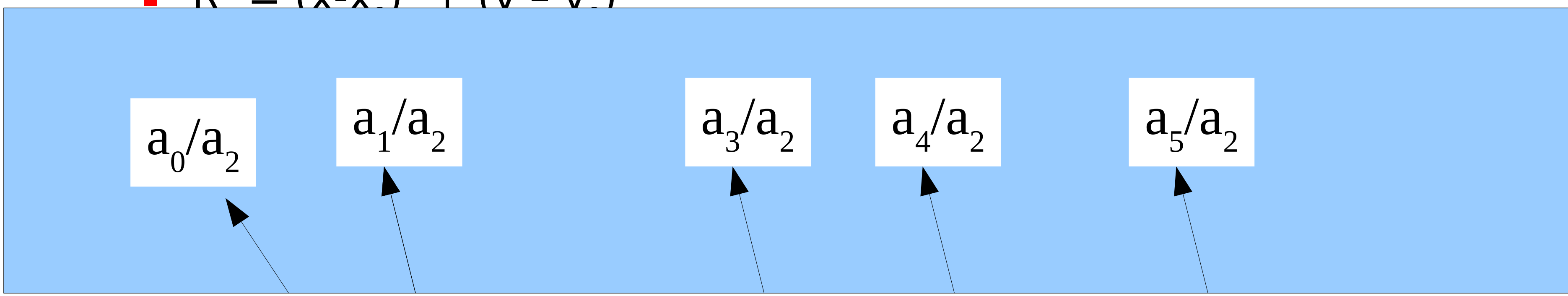

  - $\{ -2x_0u - 2y_0v + (u^2+v^2) + 2\Theta_x wu + 2\Theta_y wv - 2(y_0\Theta_y + x_0\Theta_x)w \}/a_2 = 1$
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Job List

- ~~Clipping of tails in distribution; ROOT calculation of RMS is incorrect – Done~~
  - Now use fit to peak
- ~~Tracks fitted with Θ_x ~ 0.1 rad are not small angles~~
  - Now use fit to peak
- ~~Compare *w* coefficient with *uw*, *vw* coefficients~~
  - See slides
- ~~Try fitting with Θ_x (and Θ_y) forced to 0~~
- Try a chi squared cut
- ~~Turn into an iteration; fit, rotate, fit, rotate, ...~~
  - No improvement
- Check vs MC
- Look at beam distributions to check run conditions were same
- Try a “global fit” i.e. invert a big matrix with individual x_0, y_0, r, but global Θ_x, Θ_y
- Be careful to define Θ_x, Θ_y Rogers to define convention

Data

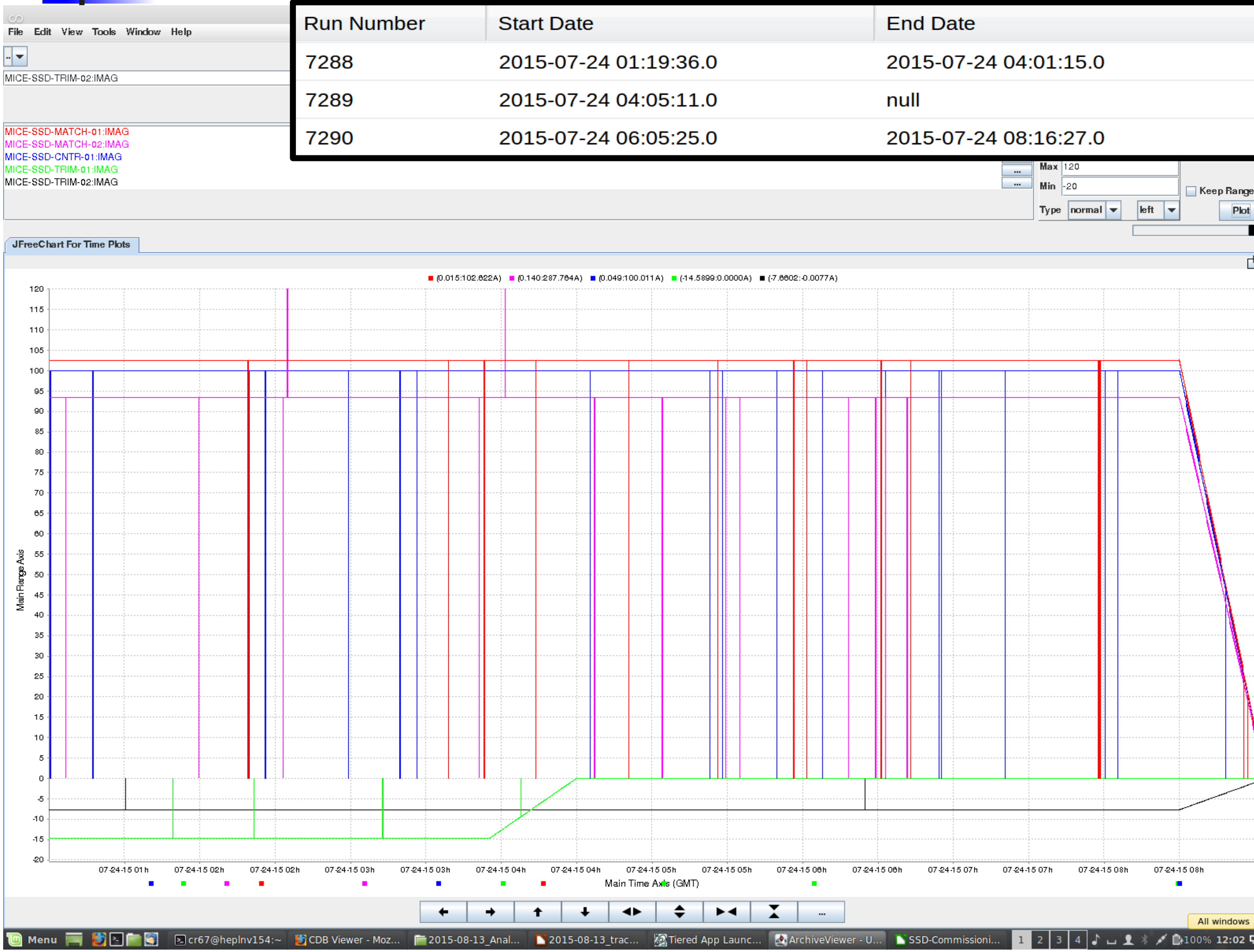
- 2015-07-24
  - SSD run at ~ 1.5 T
  - 3 runs, 7288, 7289, 7290
  - Reconstructed using MAUS ? Legacy geometry
- 2015-09-21
  - SSU run at ~ 1.5 T
  - 4 runs 7367, 7368, 7369, 7370, 7376, 7377
  - Run aborted due to unexpected magnet ramp during 7367/7377
  - Reconstructed using MAUS v1.1.0 geometry: CDB ID 70
- 2015-10-07
  - SSU run at ~ 4 T
  - 2 runs 7469, 7475
  - Reconstructed using MAUS v1.1.1 geometry: Preprod CDB ID 674
- All geometries have known issues
  - May mean that angles (x, y) are mixed

Analysis

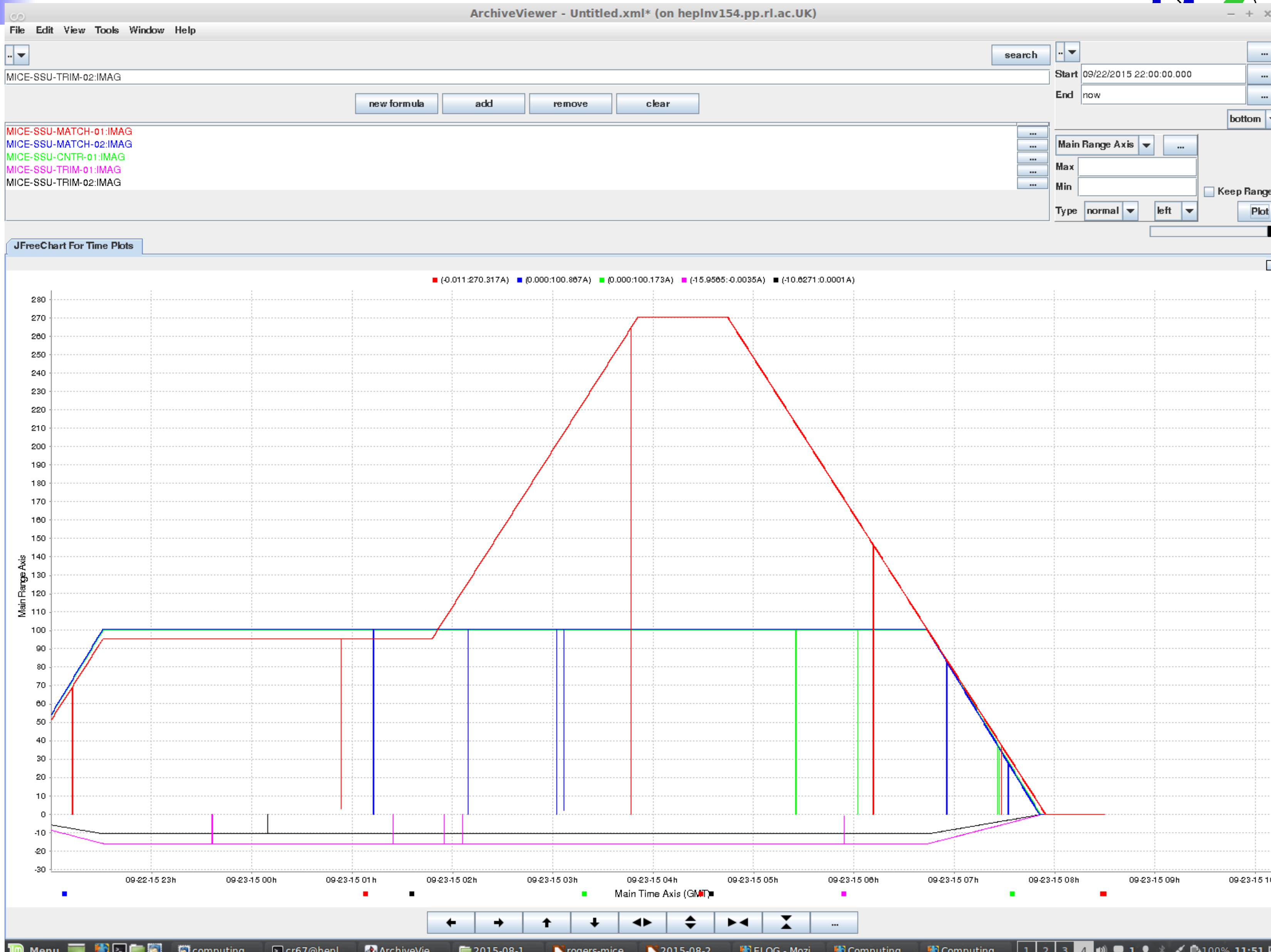
- Cuts as follows:
  - Require exactly one space point in TOF1 and TOF2
  - Require 5 space points in relevant tracker, one per station
  - Require 15 clusters
  - No “muon window” cut
- Calculate theta as $a_5/(2a_2)$
  - Attempted to cross check with $a_3/(a_0a_4+a_1a_5)$ but spread was too big to be useful
- Consistency run to run is ~ a bit rough
  - Errors are raw ROOT TFit errors – may not be correct
- Systematics are under study and have not been folded in
  - See later slides

2015-07-24

Run Number	Start Date	End Date
7288	2015-07-24 01:19:36.0	2015-07-24 04:01:15.0
7289	2015-07-24 04:05:11.0	null
7290	2015-07-24 06:05:25.0	2015-07-24 08:16:27.0



2015-09-21



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09-23-15 05h
09-23-15 06h
09-23-15 07h
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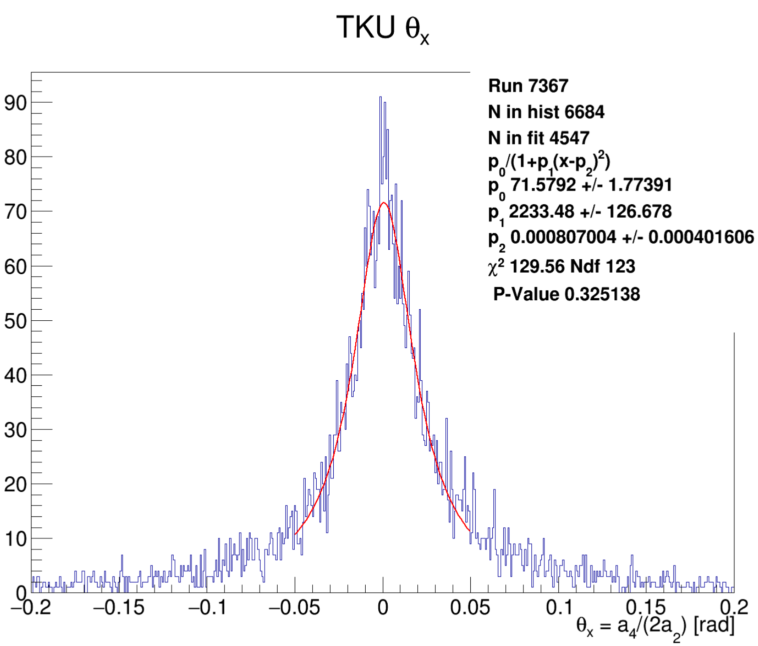
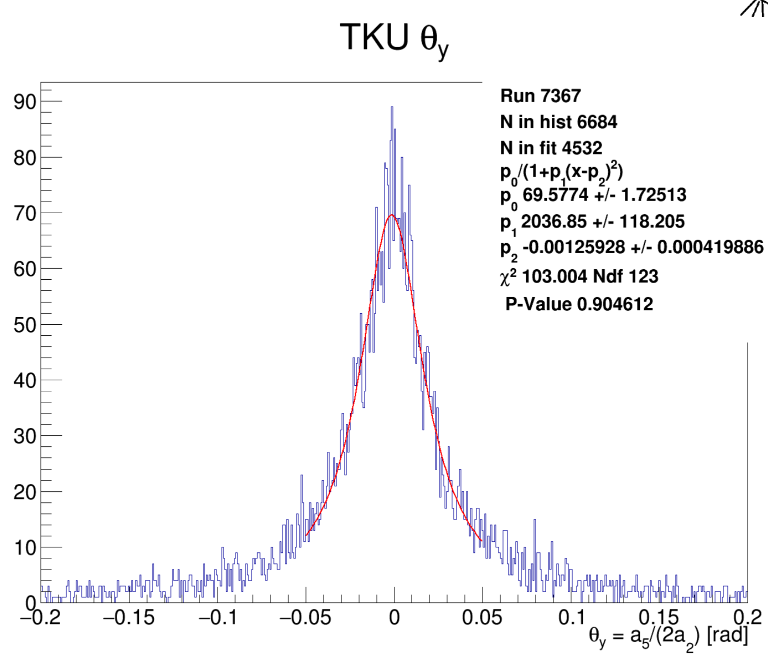
09-23-15 09h
09-23-15 10h

2015-10-07

- Haven't looked at archiver yet

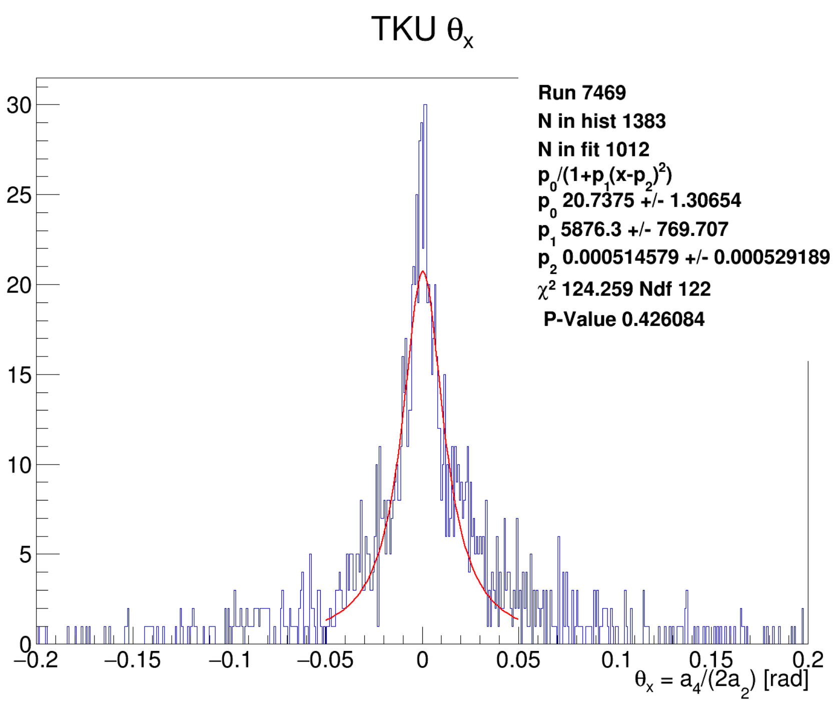
Run 7367 - SSU 1.5 T

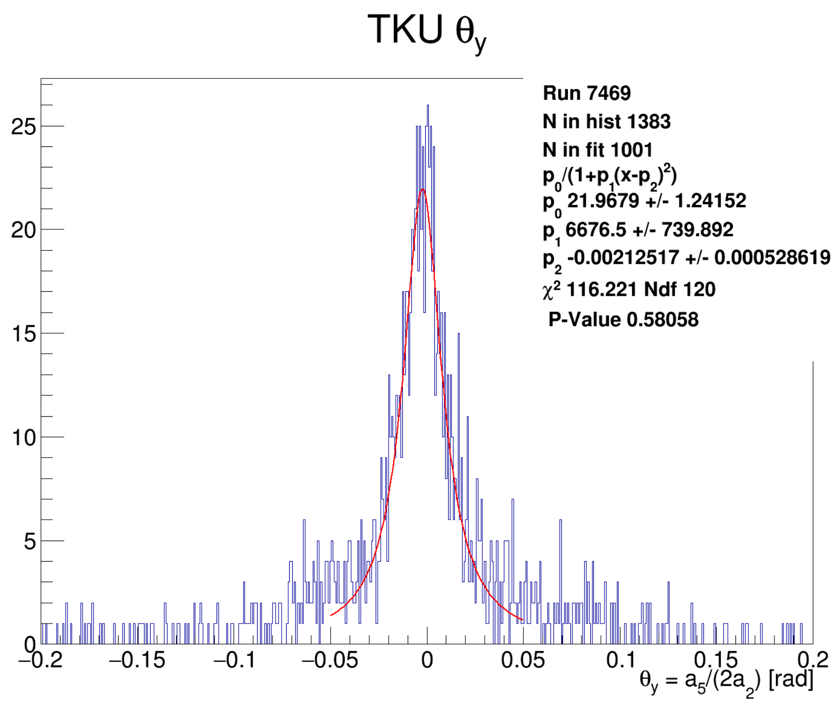




Run	θ_x [mrad]	Err(θ_x) [mrad]	θ_y [mrad]	Err(θ_x) [mrad]	Notes
7367	0.81	0.4	-1.26	0.42	Pion reference run
7368	-0.36	0.79	-3.28	0.78	Pion reference run
7369	0.16	0.42	-1.29	0.39	Pion reference run
7370	0.68	0.45	-1.04	0.47	Pion reference run
7376	0.77	0.43	-0.45	0.43	Magnets were ramping up
7377	1.62	0.91	1.26	1.27	Magnets were ramping up

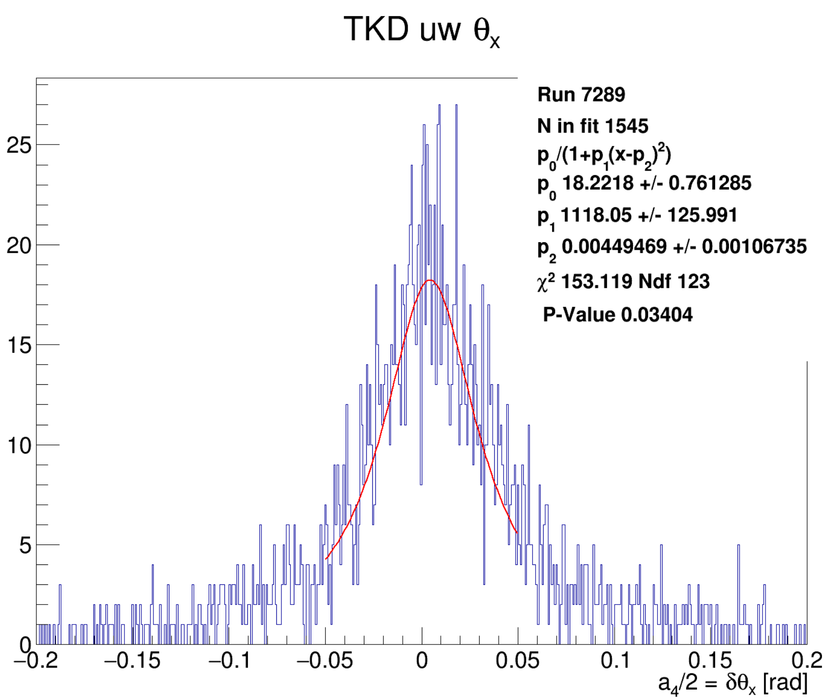
Run 7469 - SSU 4 T

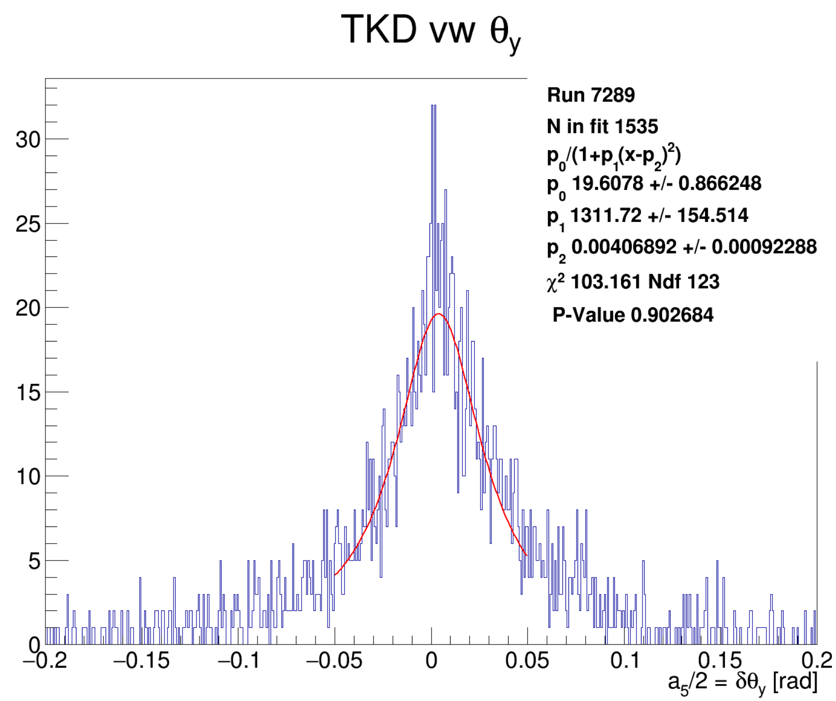




Run	θ_x [mrad]	Err(θ_x) [mrad]	θ_y [mrad]	Err(θ_x) [mrad]	Notes
7469	0.51	0.53	-2.1	0.53	3-200 Muons
7475	0.34	0.17	-0.57	0.17	Pion reference run

Run 7289 - SSD 1.5 T





Run	θ_x [mrad]	Err(θ_x) [mrad]	θ_y [mrad]	Err(θ_x) [mrad]	Notes
7288	5.1	0.7	3.9	0.8	6-140 muons
7289	4.5	1.1	4.1	0.92	6-140 muons
7290	6.6	0.8	1.5	0.81	6-140 muons

End

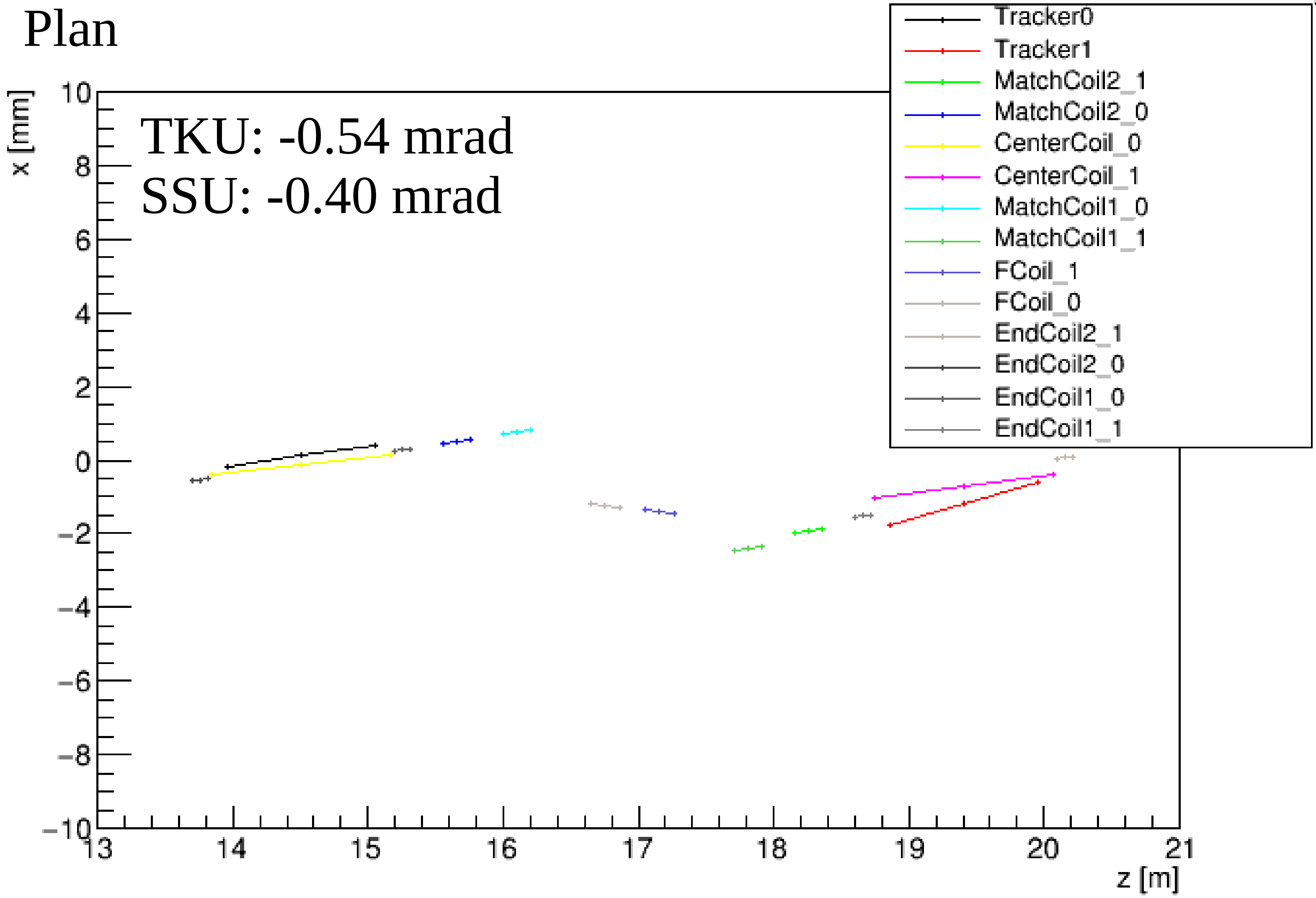
- Thanks for your attention

Monte Carlo

- What about errors?
  - Systematic in particular
- Try Monte Carlo

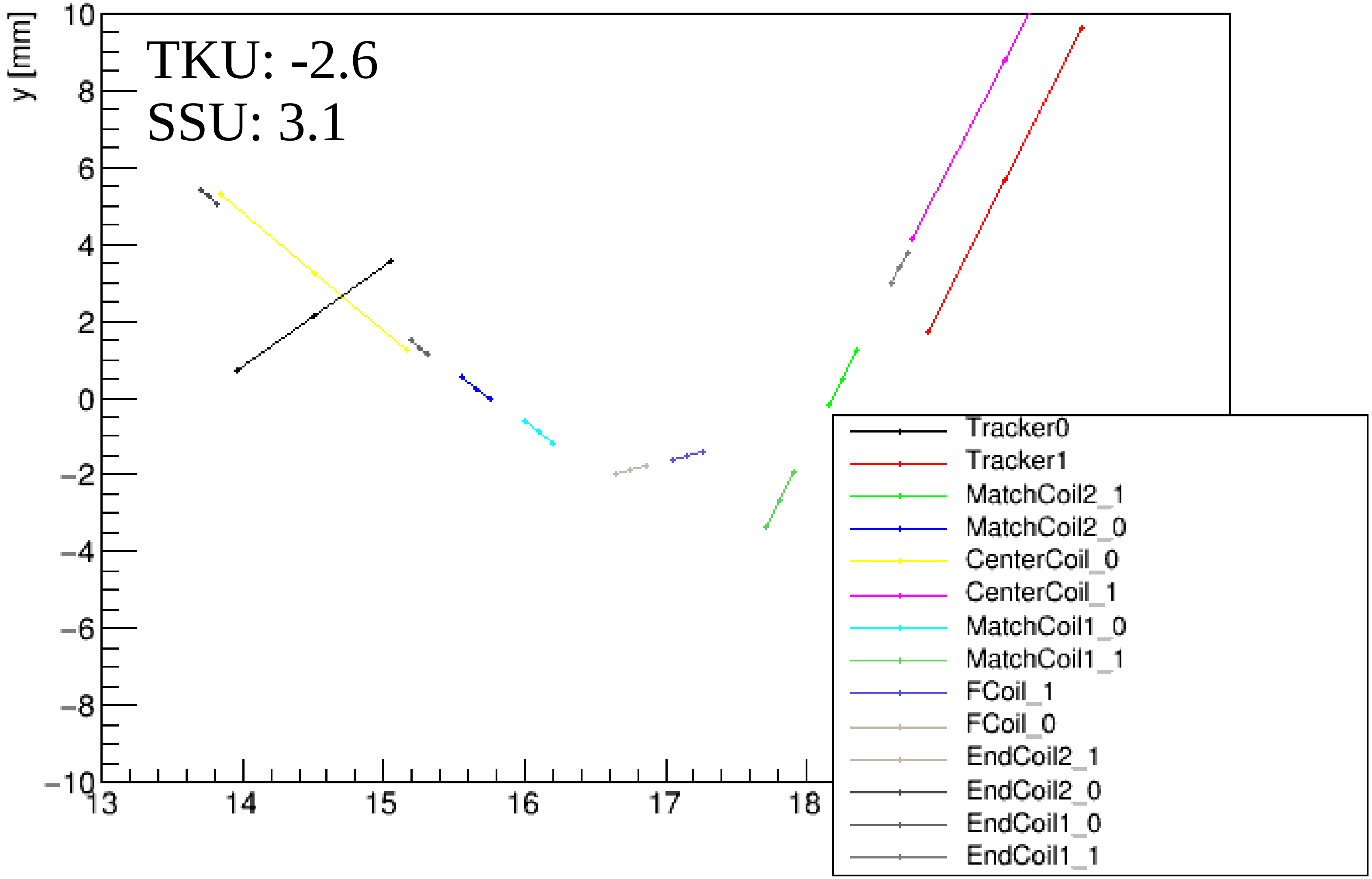
Monte Carlo Geometry ID 72

Plan



Monte Carlo Geometry ID 72

Elevation



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