Brunel University London

Tracker Report

Slides from Melissa Uchida and Chris Hunt

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Tracker Operation

- Tracker systems have been stable since CM43.
  - No major changes to Hardware/Controls/DAQ, just minor improvements.
- Calibration operating well, master updates before each cycle and daily calibration runs to account for small shifts.
- Helium in both trackers and working well, with no unacceptable leaks.
- Hall probes operating well,
  - Caveat: One was pulled out by the cable and damaged and one is down due to a readout hardware failure. Spares are ordered.
- Data taking going very well with no interruptions from the Trackers.
- Online and offline reconstruction performing well.

HW Issues

- Cryo-coolers have run towards the end of their operational lifetime – they are less efficient.
- The cryostats originally ran at 9K.
- We are now running 0.25 to 0.5K higher.
- There is no deleterious effect on tracker data.
- The estimate is that we can afford to run at 10K

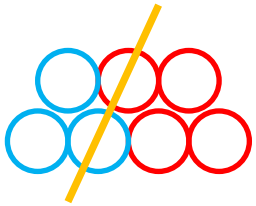
- We have ordered spares so that if it becomes necessary to renovate the cryo-coolers we have the required parts
- The risks associated with doing this work, means we will not make a pre-emptive intervention

Tracker Analysis

Signals from the fibres are

digits

Adjacent hits over threshold form



clusters

Three clusters from adjacent planes form a

space-point

(Remaining 2/3 clusters can also be used)

4 or 5 space points can form a

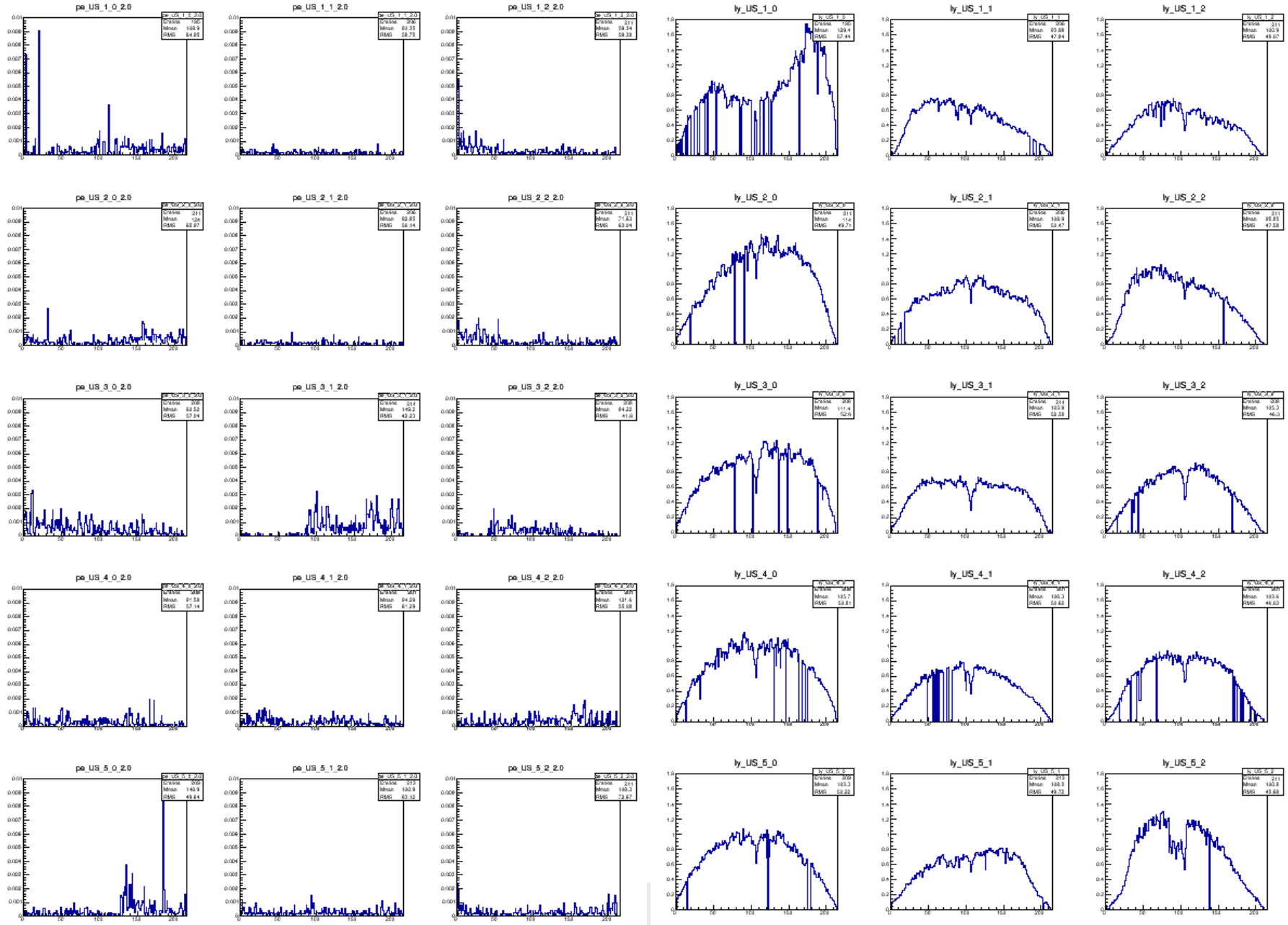
helical (pattern recognition)track

PRTs are are fed into the Kalman filter

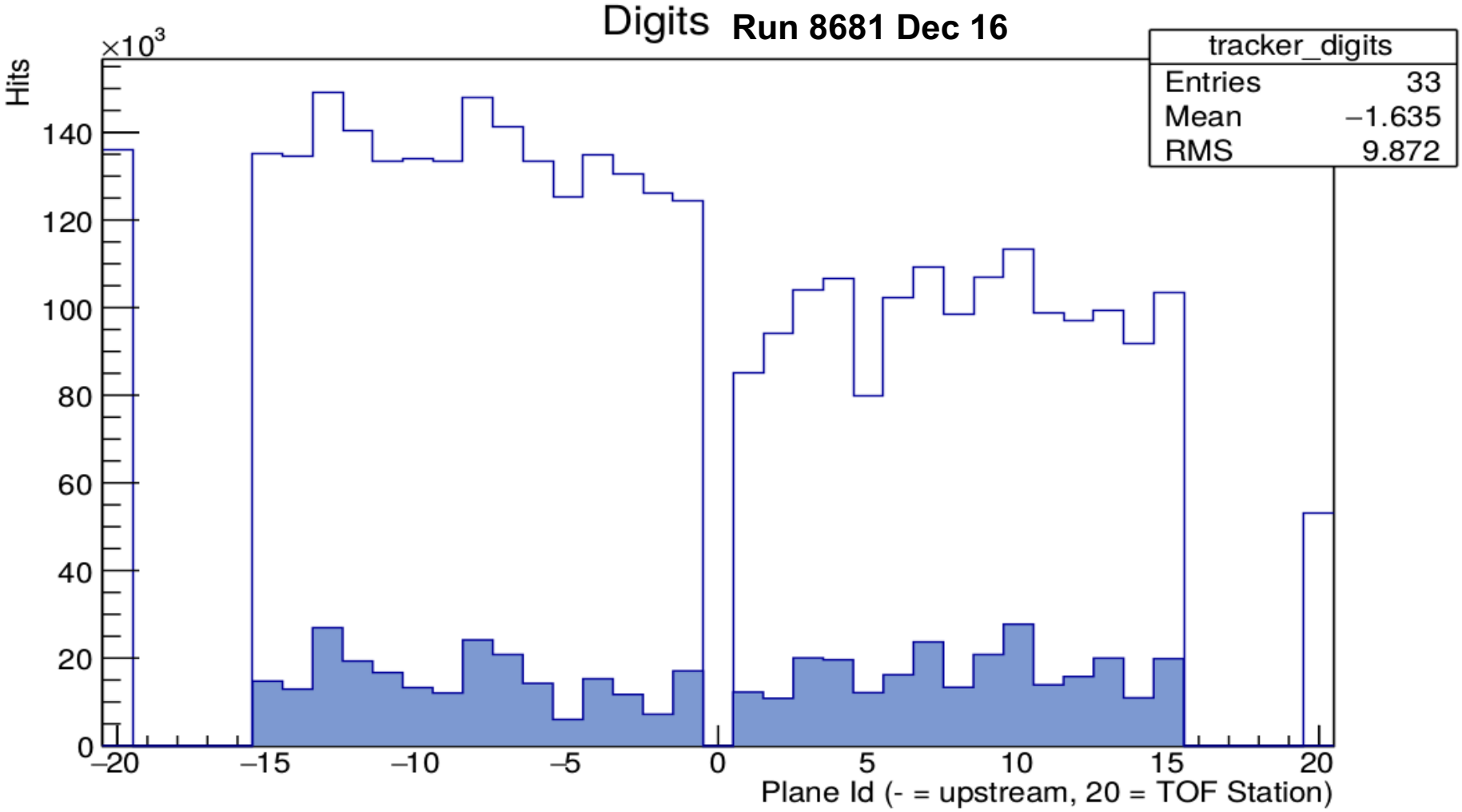
tracks

NOISE

Tracker Calibration LED



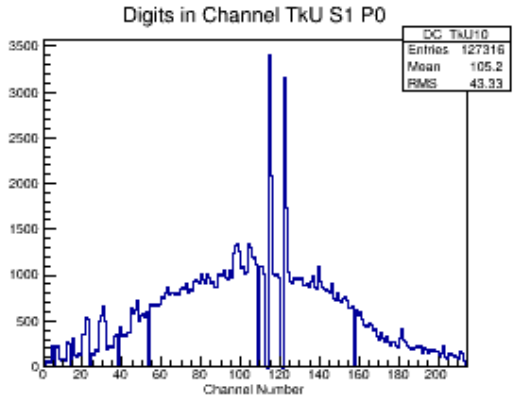
Signal to Noise ratio – V Good

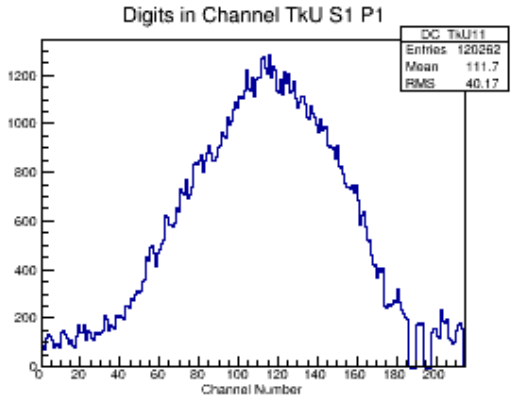


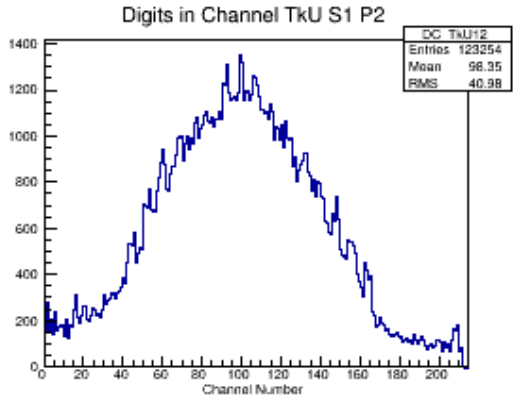
Tracker Reconstruction and Data Validation

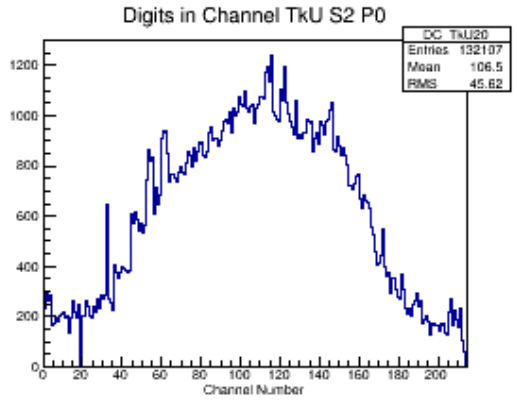
- Data is analysed for validity within ~24 hours turnaround.
- All reconstruction level plots and efficiency are available online through http://www.hep.ph.ic.ac.uk/~mgeorge/Files/2016MICEData/
- There are two scripts available through MAUS for validation and efficiency work.

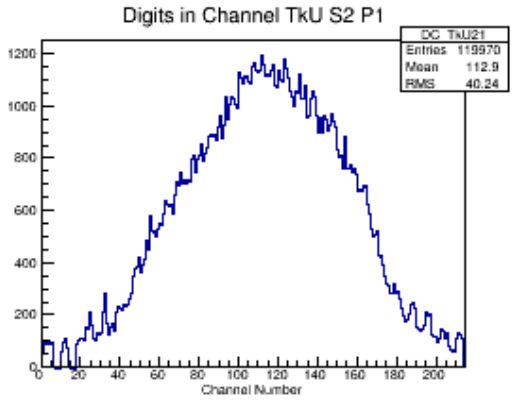
Digits. US. MAUS v2.6.5. 8777

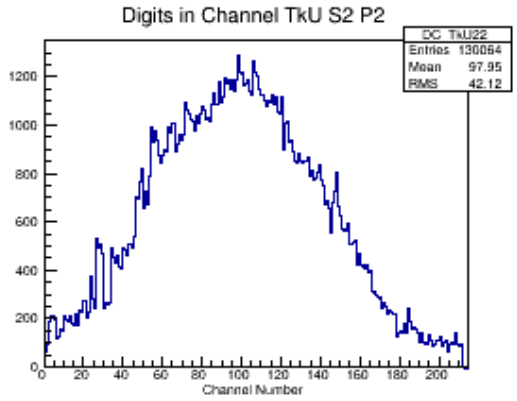


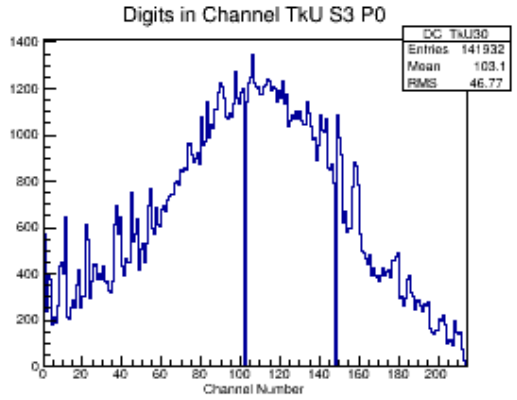


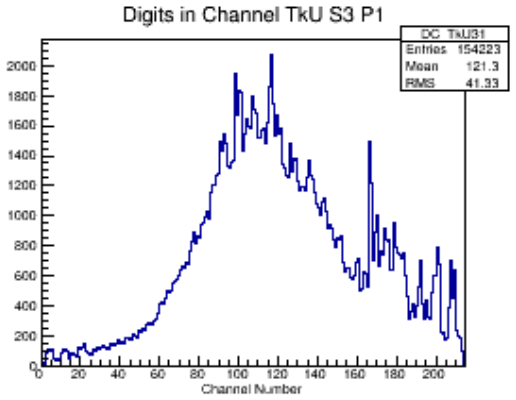


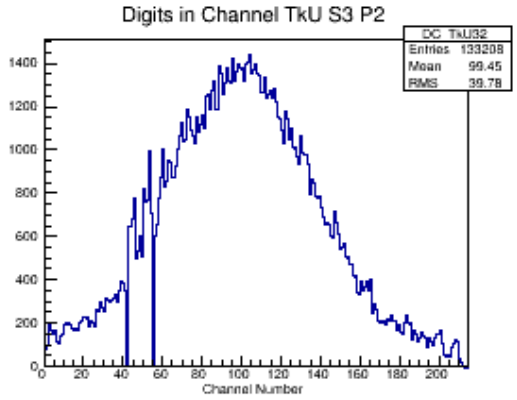




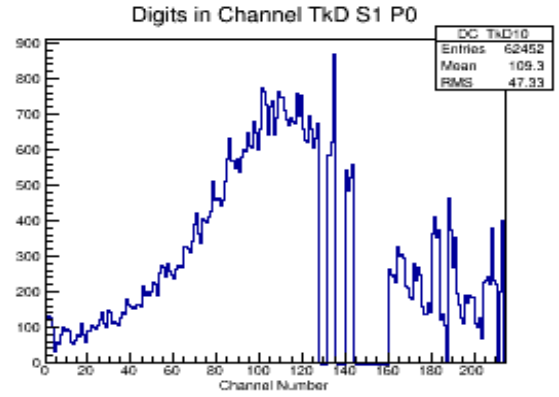


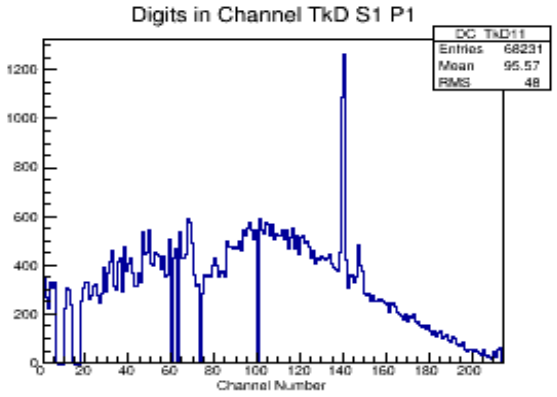


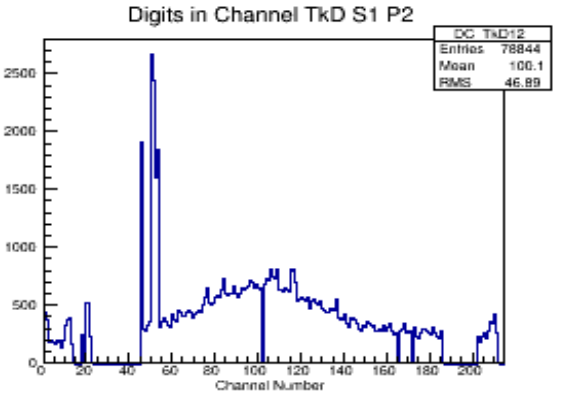


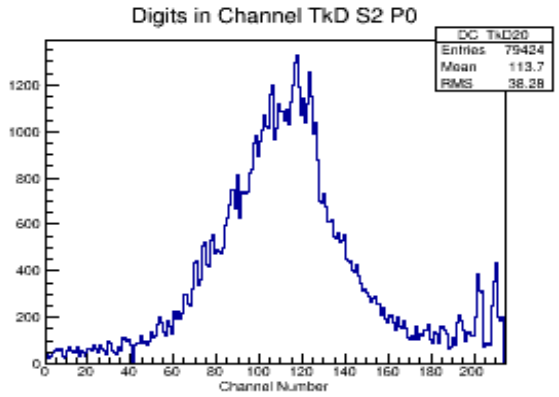


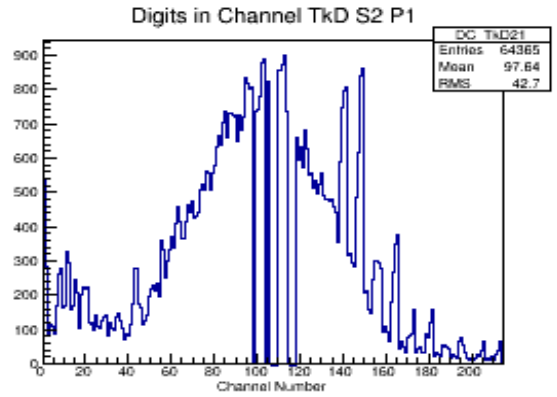
Digits, DS, MAUS v2.6.5, 8777

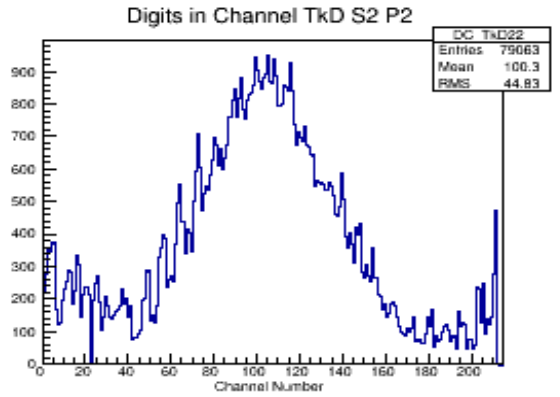


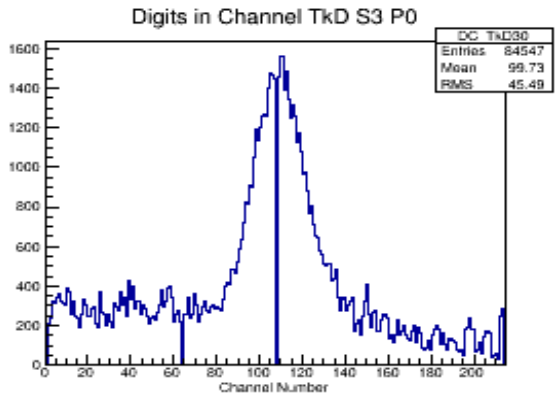


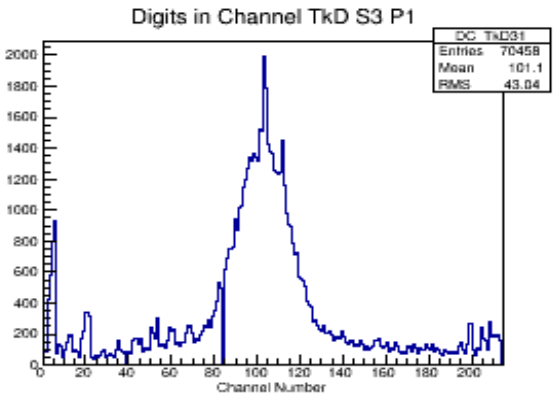


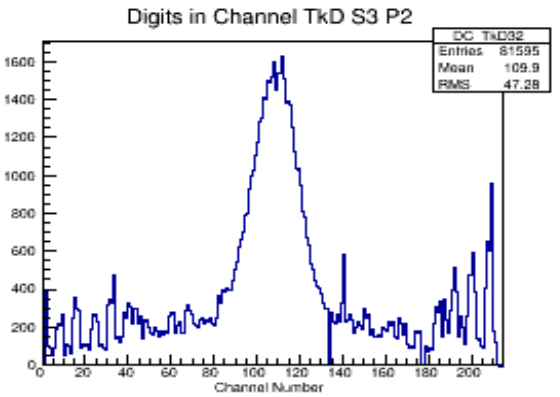




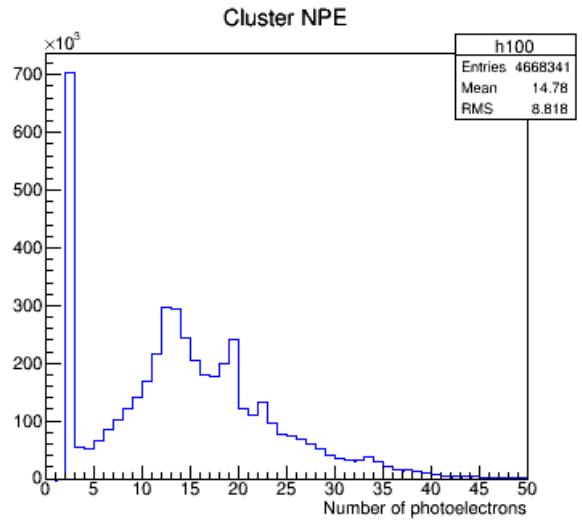


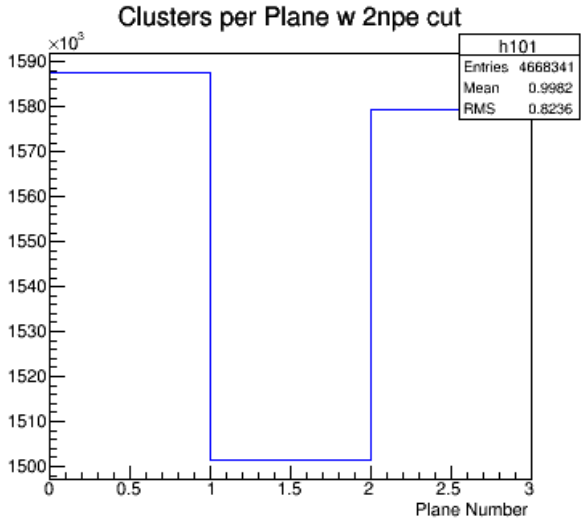


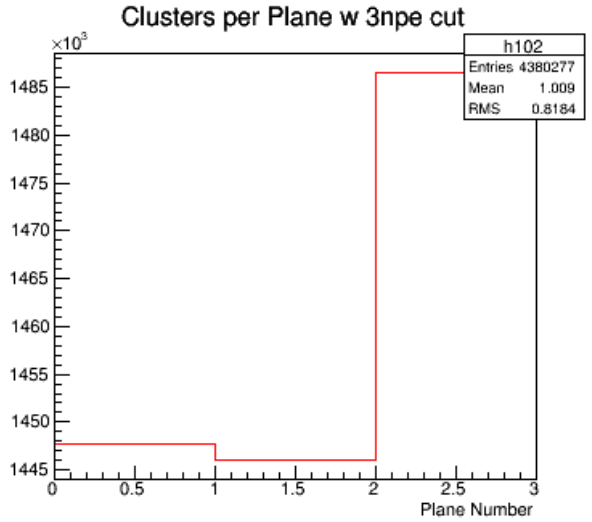


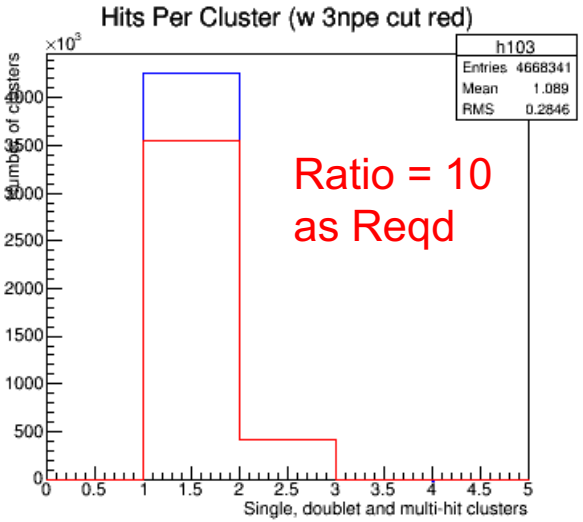


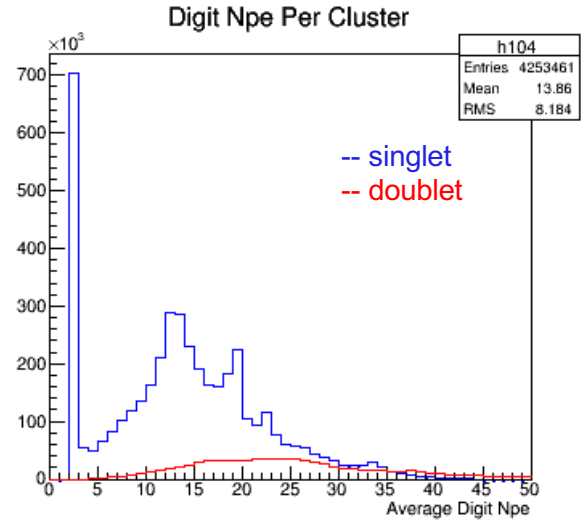
Clusters, Helical,8752

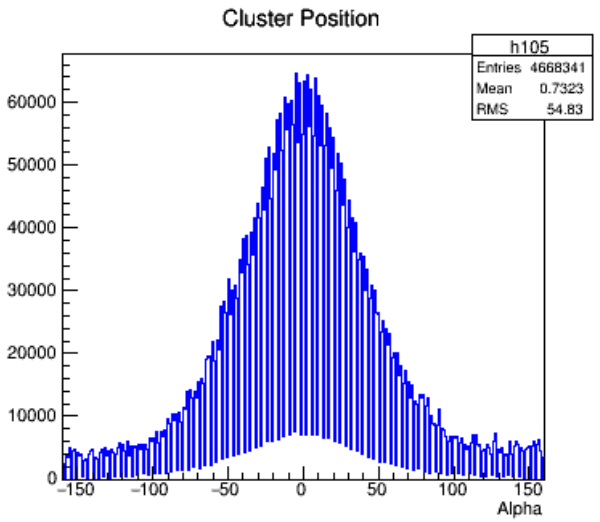




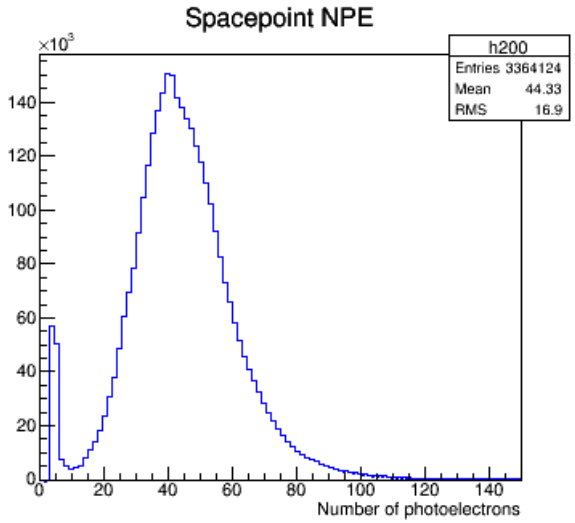


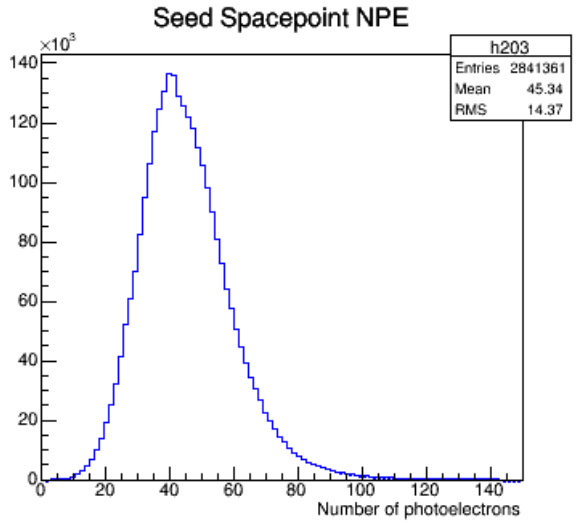


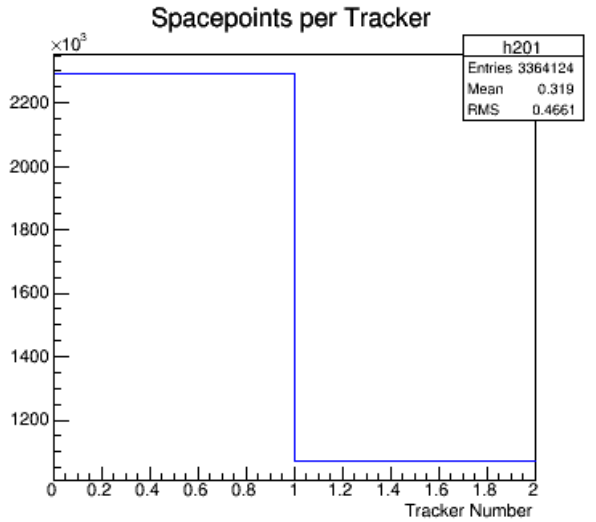


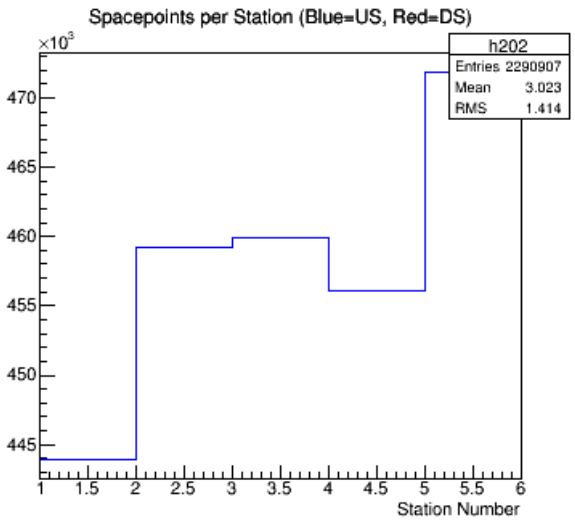


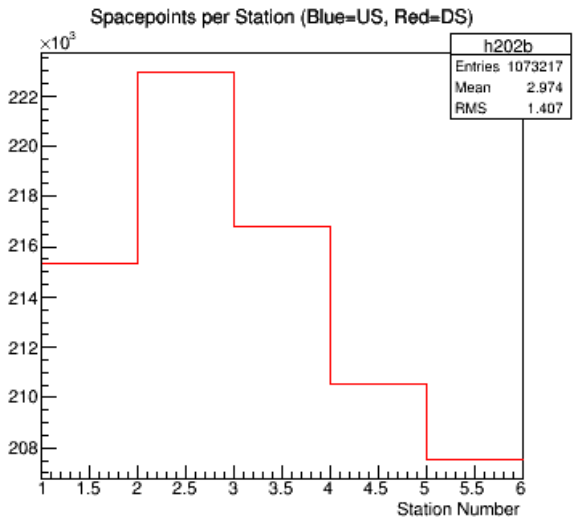
2.7.5 SP Summary 8826



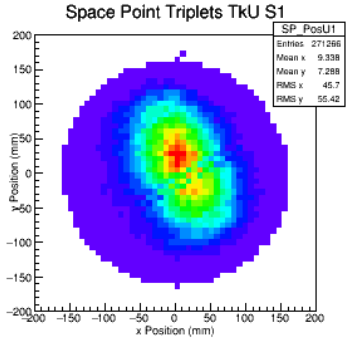


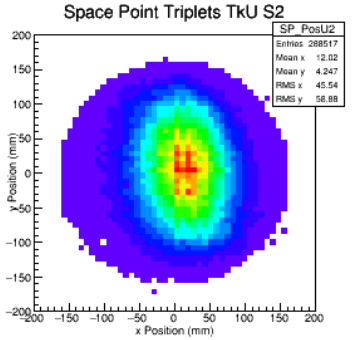


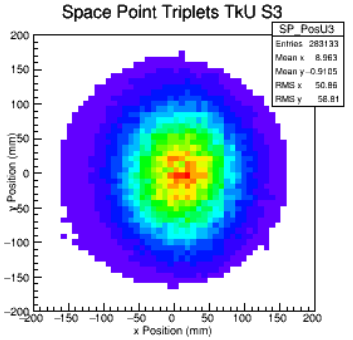


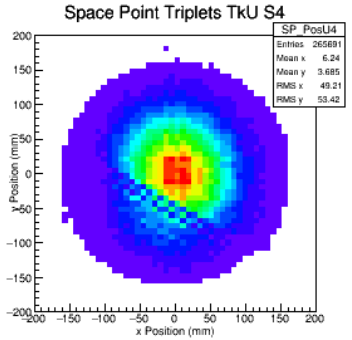


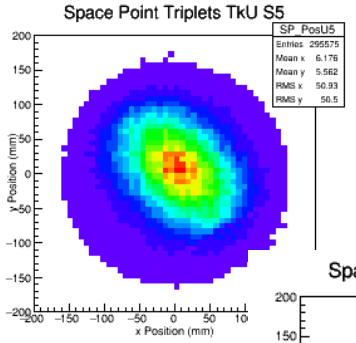
Beam Profiles US MAUS 2.7 8824

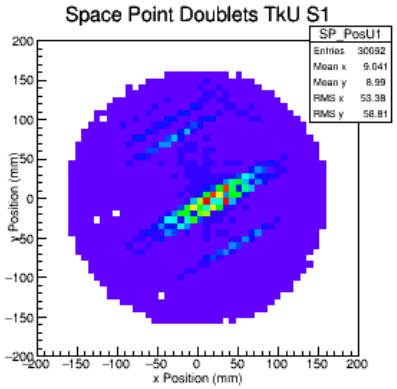


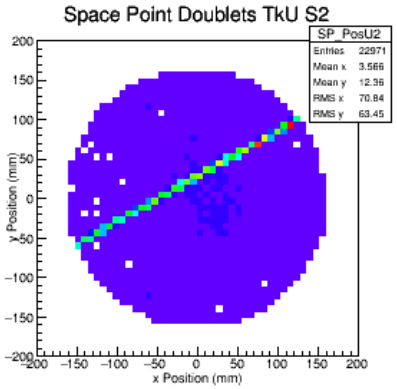


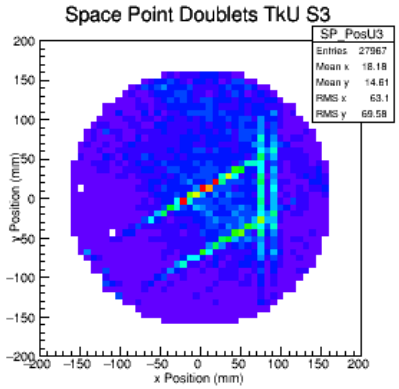


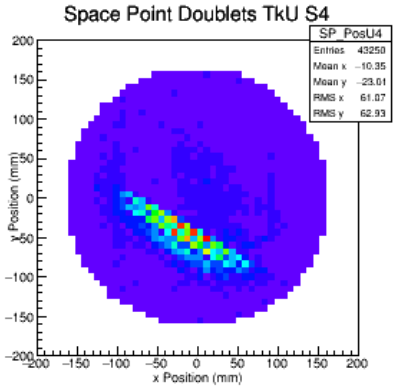


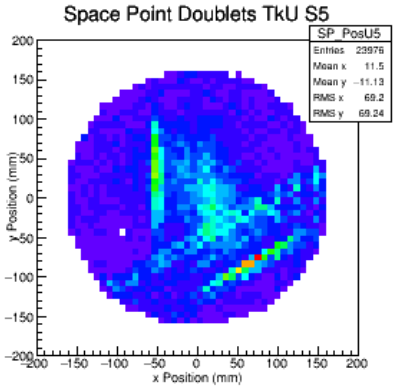


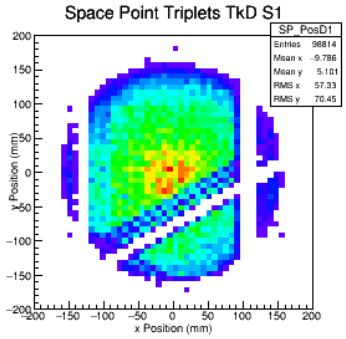


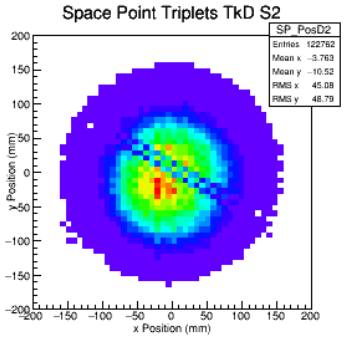


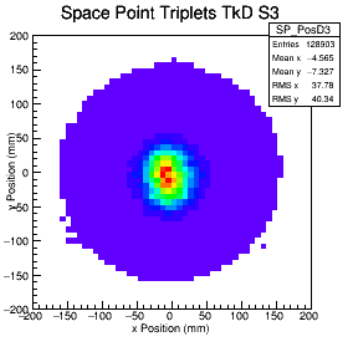


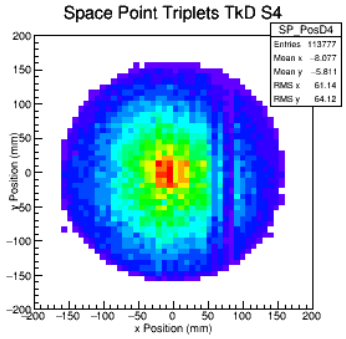


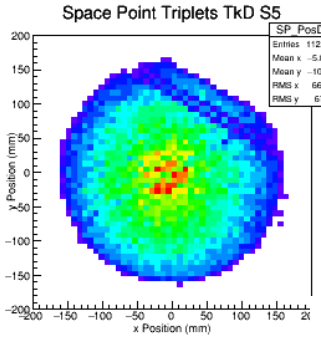




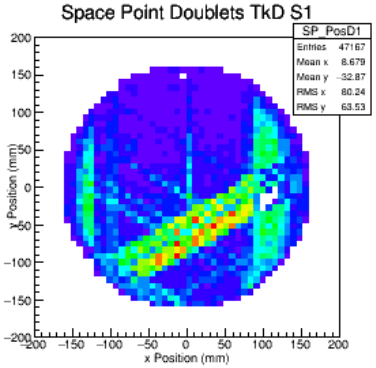


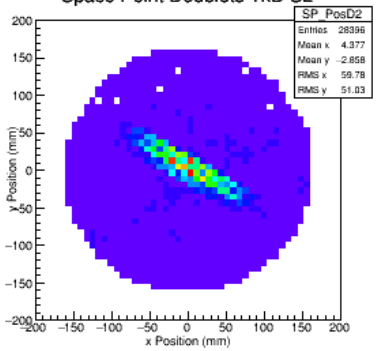


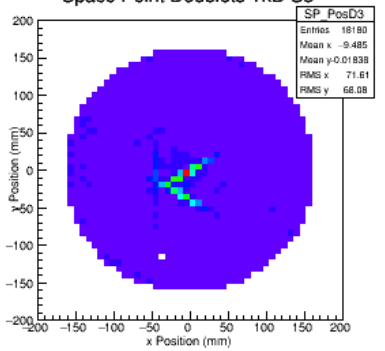


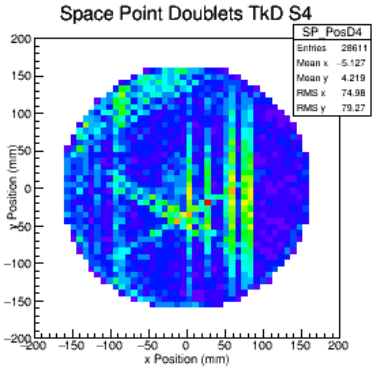


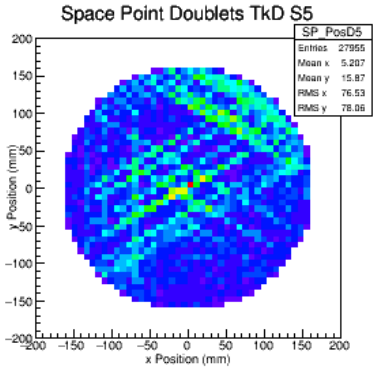
Beam Profiles DS MAUS 2.7 8824











Efficiency Issues

Straight Track Efficiency

Straight Track Efficiency	
TkU 5 spacepoint tracks	98±1%
TkU 4–5 spacepoint tracks	∼100%
TkD 5 spacepoint tracks	95±2%
TkD 4–5 spacepoint tracks	99.9±0.01%

Table 1: Straight Track Efficiency.

- For all straight track data taken to date.
- Efficiency of finding a track with any number of spacepoints in the trackers is ~100%.
- ~4% lower efficiency DS to US in finding a five spacepoint track in a five spacepoint event has been fully investigated:
  - 50% due to scattering
  - 25% due to increased noise DS
  - 25% the effect of the road cut (viability study of changing the cut ongoing but user can always change through configuration defaults)

Helical Track Efficiency

Straight Track Efficiency		
Efficiency	MAUS v2.6.5	MAUS v2.7.0
TkU 5 spacepoint tracks	57.4%	87.5%
TkU 4–5 spacepoint tracks	91.4%	99.1%
TkD 5 spacepoint tracks	39.5%	76.3%
TkD 4–5 spacepoint tracks	82.7%	97.2%

Table 2: Helical Track Efficiency MAUS 2.7 includes improved sz cut.

- Massive improvements made to efficiency since CM46 and work still ongoing.
- Improved sz cut, chi Sq implementation, error propagation, circle fit and ndf.
- Made possible by the great amount of new helical data.
- Massive effort on this → many more improvements to come.

Helical Track Efficiency

Helical track finding efficiency Run 8681

	MAUS 2.6.5	MAUS 2.8
TkU 5 space point tracks	57.4%	92.7%
TkU 4 and 5 space point tracks	91.4%	99.9%
TkD 5 space point tracks	39.5%	84.5%
TkD 4 and 5 space point tracks	82.7%	99.6%

- Significant improvements made to efficiency since CM46.
- Improvements on chi squared calculation and tuning of cuts.
- Made possible by the great amount of new helical data.
- Current work on getting details a detailed measurement of purity.
- Release of 2.8 next week

Helical Track Efficiency

Looking at this has involved re-examining the interface between Pattern Recognition and the Kalman fit.

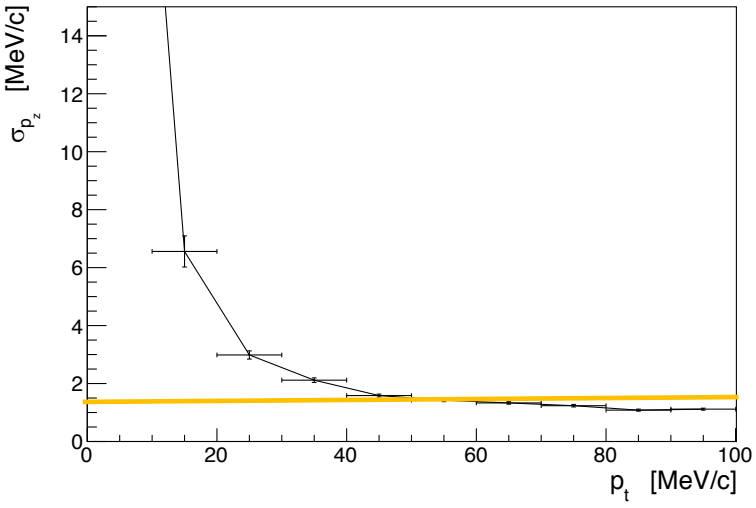
Discovered a number of problems and they have been fixed, which has lead to three improvements

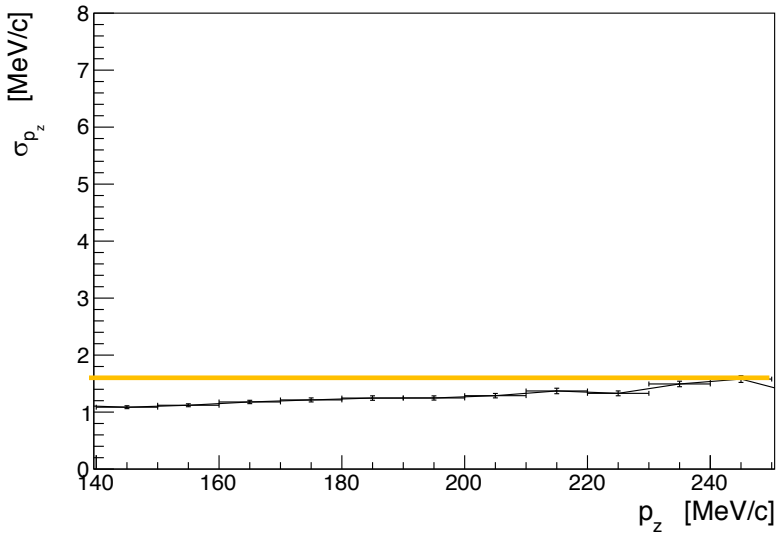
- The total momentum bias now appears to be uniform across a wide range of momenta
- The pz reconstruction now has a resolution < 1.5MeV/c which is a big improvement over the 3-4MeV/c
- Multiple seed algorithms for the Kalman fit are now possible due to an improved architecture for the algorithm.

Kalman Performance P_z

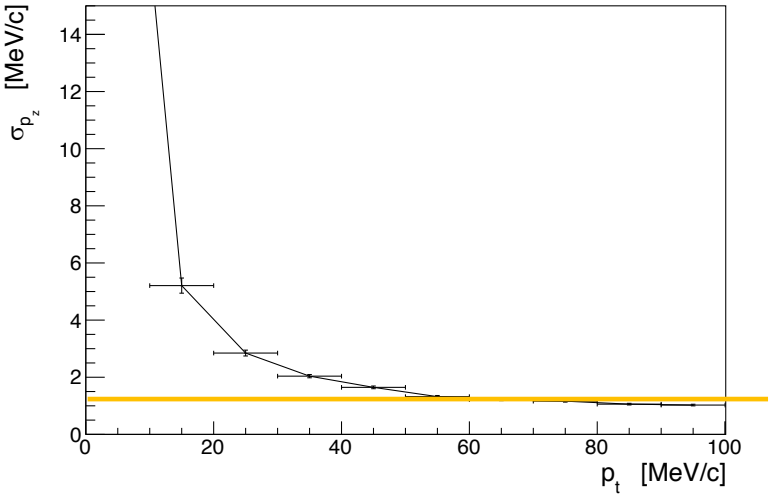
Upstream

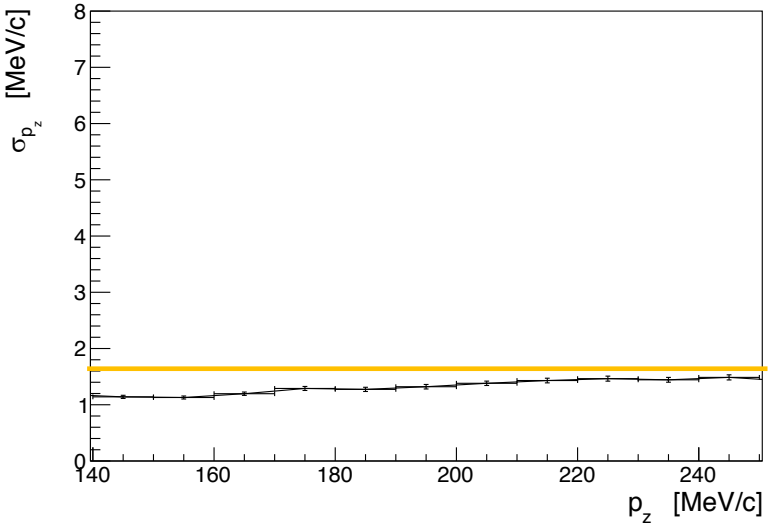
1.5 MeV





Downstream

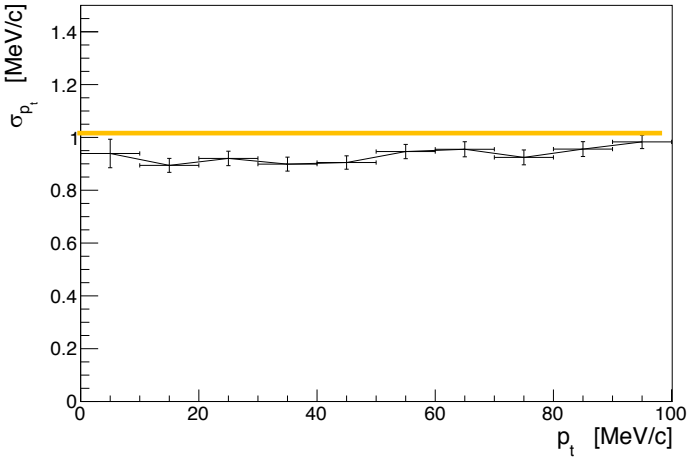


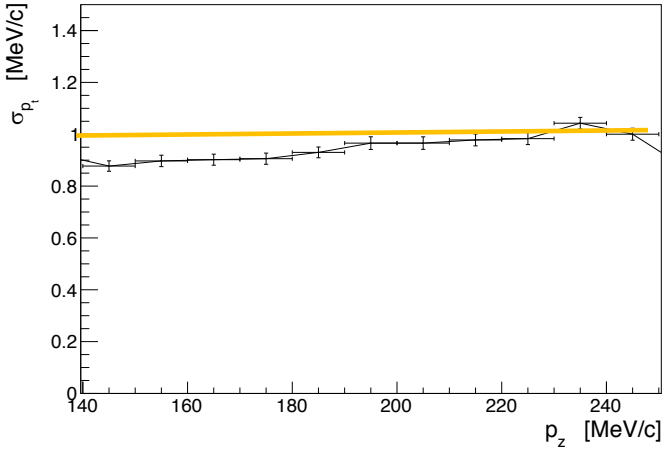


Kalman Performance P_t

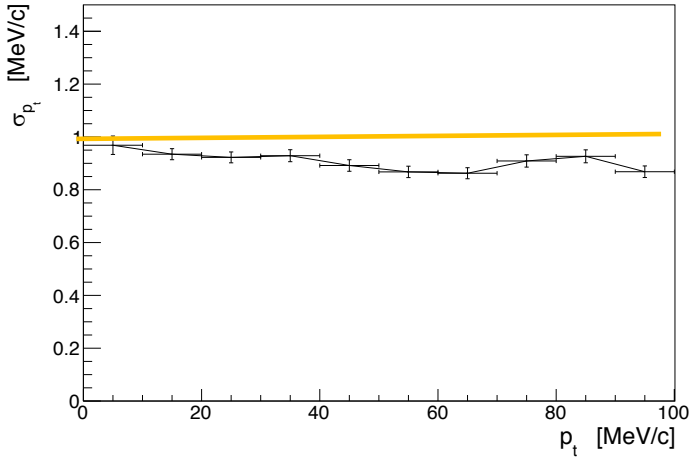
Upstream

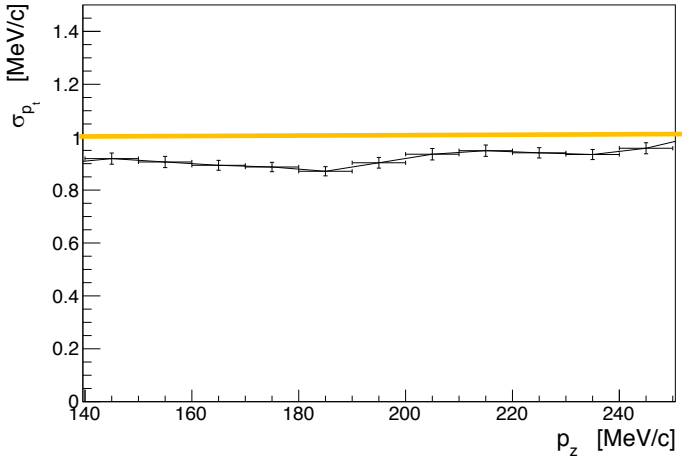
1.0 MeV





Downstream





Integration Tests

- Increasing the number of integration tests
- Now store some of the numbers from the tests permanently to allow historical comparisons.
- Looking at increasing the spread of the tests and including plots.
- Directory structure for such information, such that any detector can add suitable information

Thank you