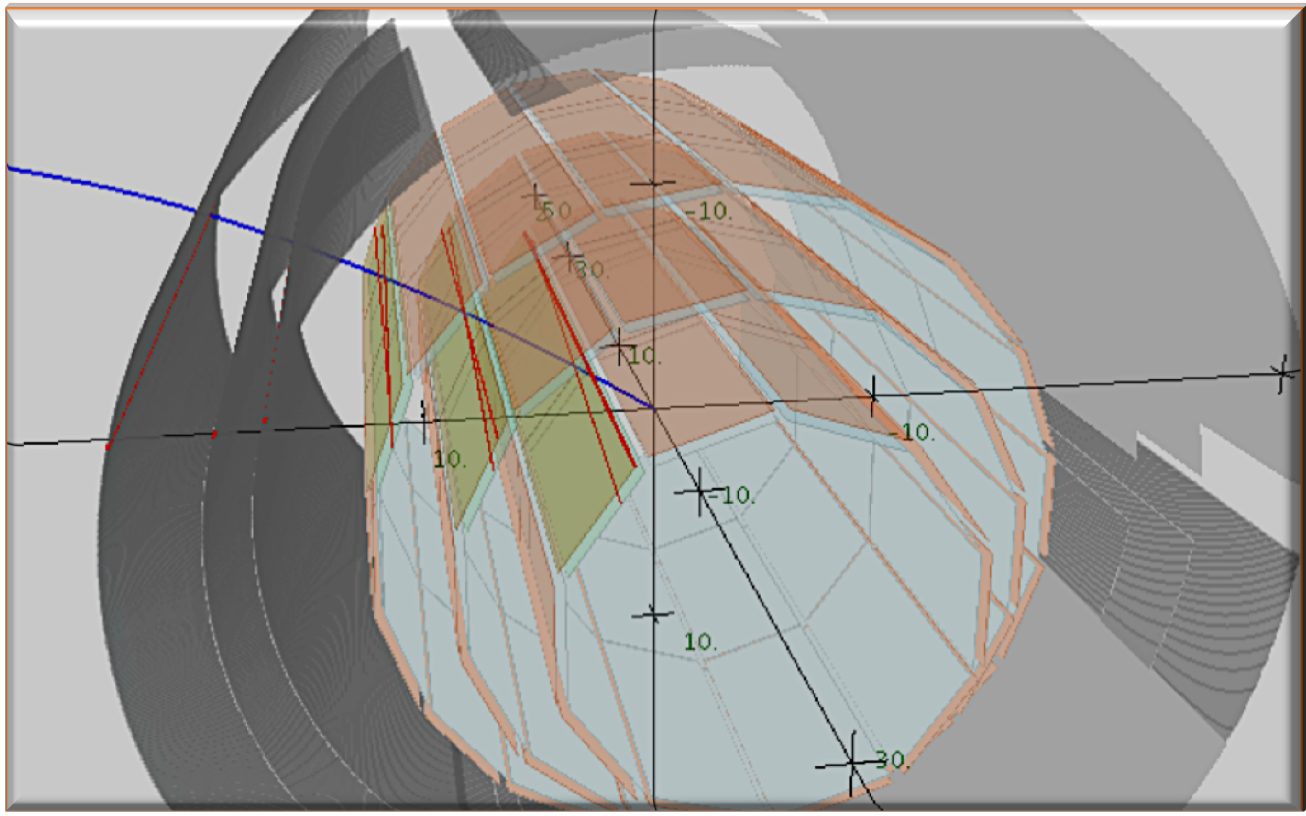
CLAS12 Collaboration meeting

November 13, 2020

SVT Reconstruction Updates

Veronique Ziegler

For the CVT Team



CVT Software Overview

Hit selection
- Studying timing cuts (ongoing)

Cluster selection
- Line representation (track doca to line used in fitting)

Cross selection
- Used for seeding
- SVT isolated clusters on track search

Track seeding
- Straight track finder
- CA
- Secondary pattern rec → + efficiency
- SVT stand-alone tracking

Geometry with functionality to do rotations and shifts (alignment)
- SVT geometry
- BMT geometry

Services

Straight Tracks
- From the target (helical track parameter repr. – assume fixed p = 10 GeV)
  - Input to Kalman Filter
- Cosmics (line parametrization)
  - Global fit only

Helical Tracks
- Track helix parameters
- Doca wrt ref. axis (beam spot)
- Input to Kalman Filter

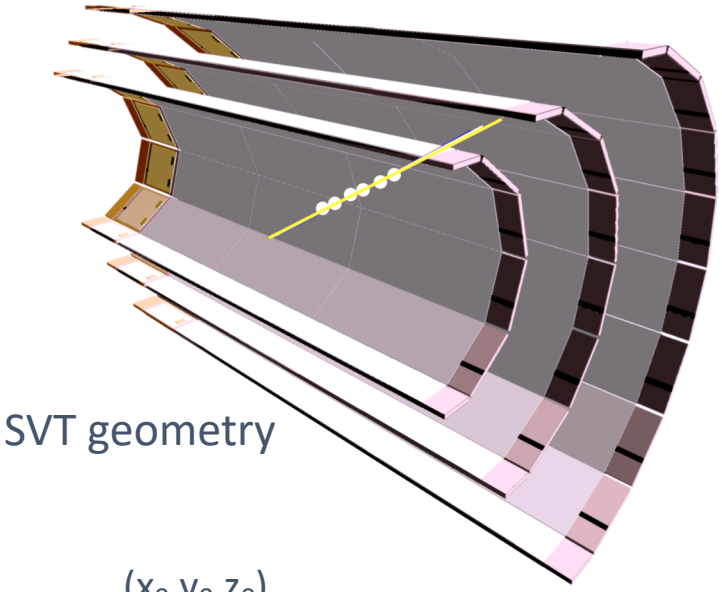
Track fitting
- Helical track parameters

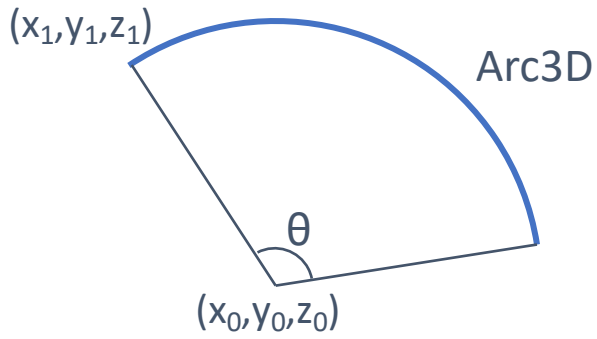
Generic Kalman filter
- Fitter → filtering
- Measurements → uses Surface class; MeasVecs class to handle projection to the measurement surfaces
- State Vector class to handle propagation of state vector and covariance matrix
- Produces a trajectory (state vecs components, residuals)

- New development

CVT geometry (R. deVita)

- Update of SVT and BMT geometry to support alignment
- SVT:
  - Using already available geometry service
  - Implementation of global position
  - Independent alignment of individual top/bottom parts of a module (in progress)
  - In use in KF-based alignment (see Sebouh's talk)
- BMT:
  - Z and C strips described as Line3D and Arc3D
  - Shifts and rotations for each layer and sector
  - Methods to identify closest strip to a point in local or lab frames
  - Switch to new geometry in progress

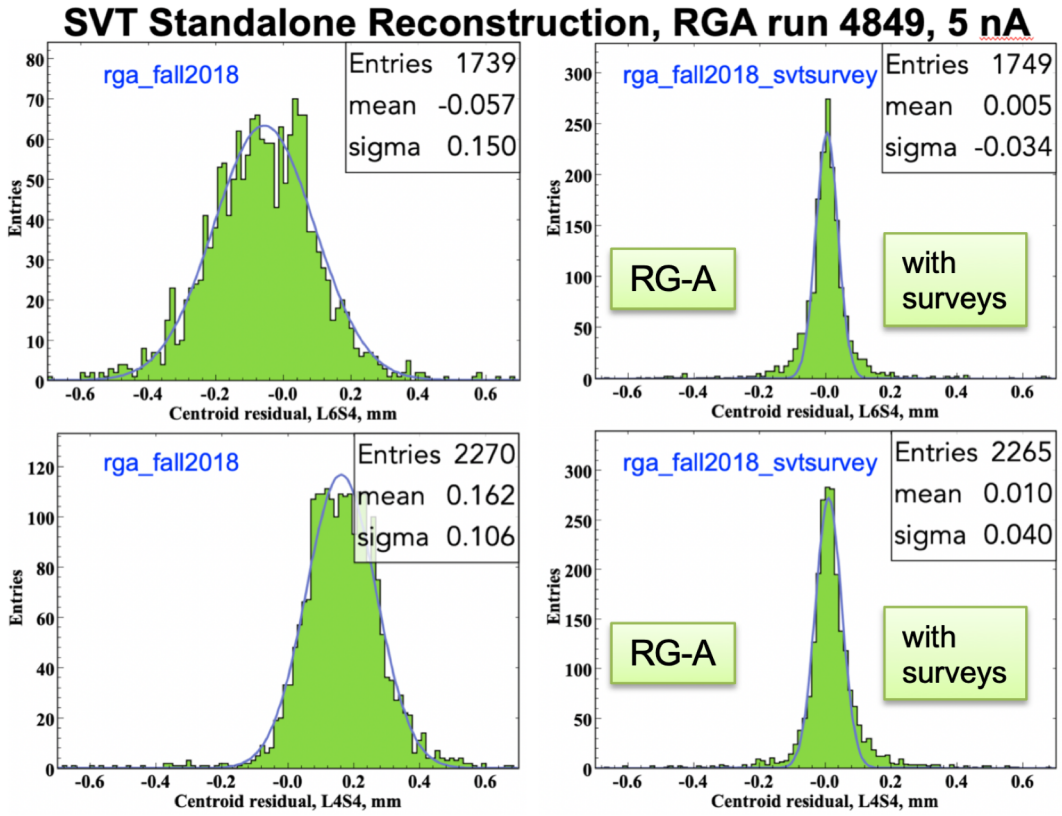




Geometry

• SVT Geometry

- The geometry package has the capability of doing translations and rotations of the SVT modules and to import survey numbers. The implementation of survey shifts using this package has been studied using MC and data.
  - ➢ Better results with pre-alignment (Sebouh's presentation)

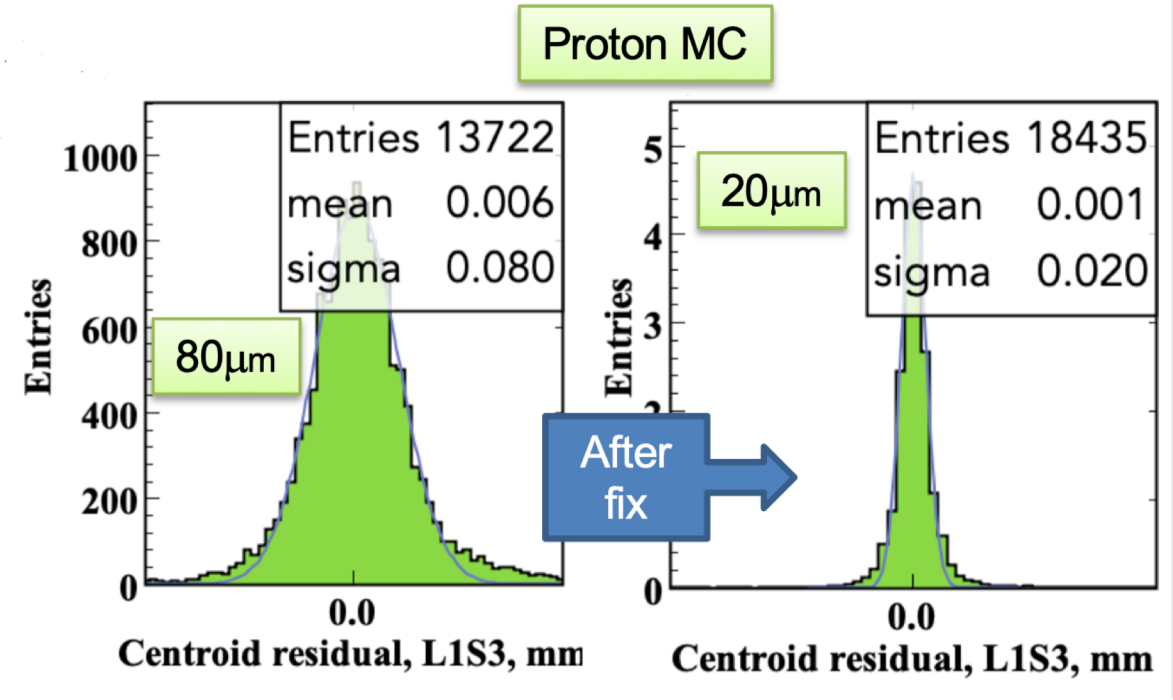


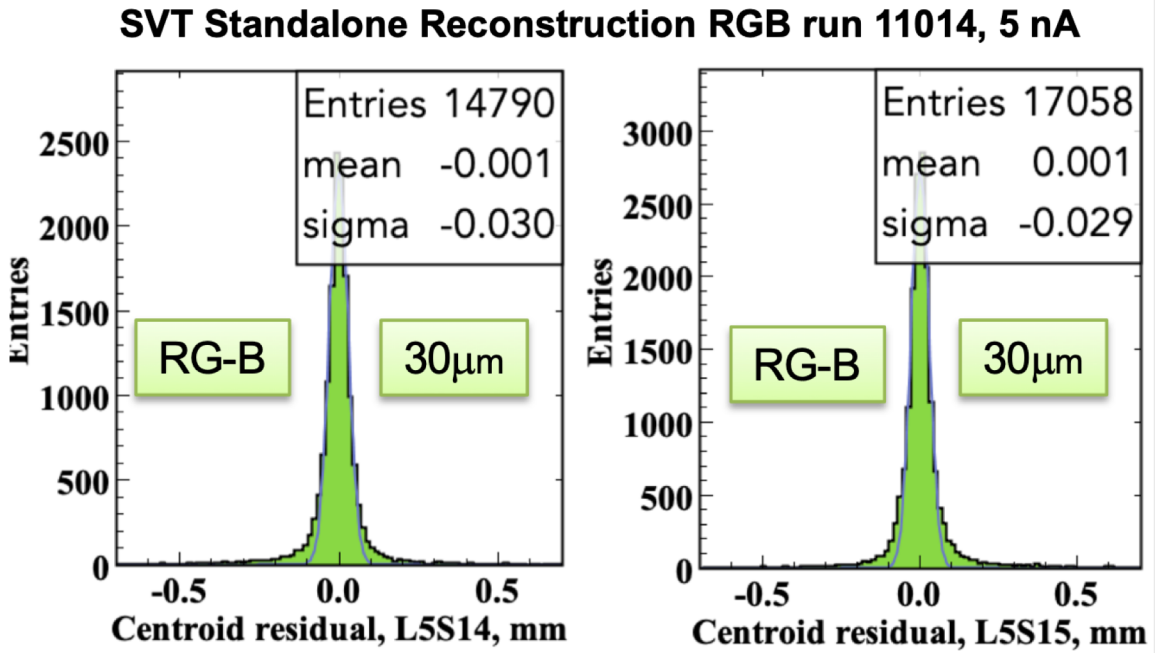
Track Fitting - Generic Kalman Filter

- New Kalman Filter package included in track-tools (part of common tools in coatjava)
- Developed for any tracking in a solenoidal field (could be extended for torus)
- KFitter, StateVec, MeasVec classes do not have any ”built-in” geometry to propagate state vector to measurement sites, and to compute projector value and matrix.
- Surface class and surface Type enum to represent measurement surfaces and objects ➔ surfaces constructed to allow all translations and rotations degrees of freedom
  - Surfaces: planes & cylinders with measurement points, lines, strips.
  - Strips/clusters object with centroid, position and uncertainty on position
  - Projector computed as track doca to cluster line
  - Functionality to choose unit (cm, mm)
- Generic implementation of multiple scattering (process noise) in fit [implementation in Surface class]
- E-Loss package under development
- Ability to reject hits in fit (outliers)
- Can run on 0-T samples (tracks from target)
- Implementation for CVT
  - Computation of pseudo-line representing clusters in lab frame
  - CVT service creates surfaces ➔ passed to KF in initialization

Fixes – Pattern Recognition

- Cross reconstruction parallax fix
  - Going from local to global frame

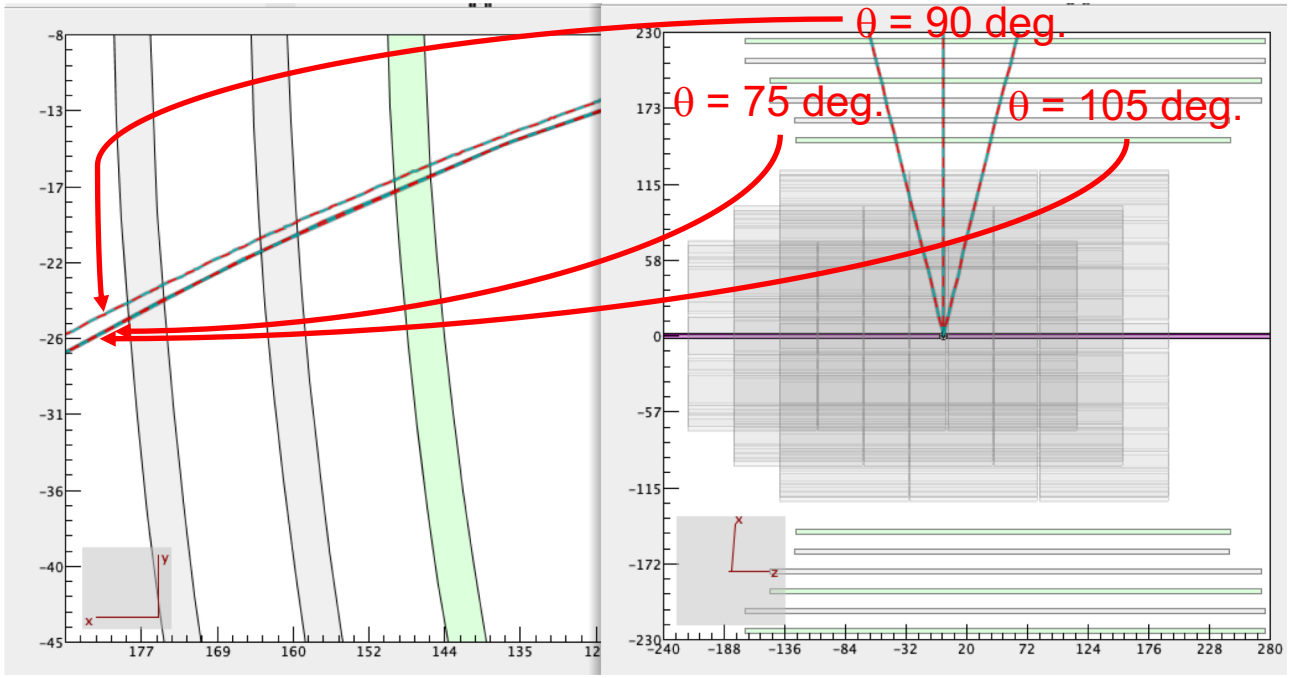


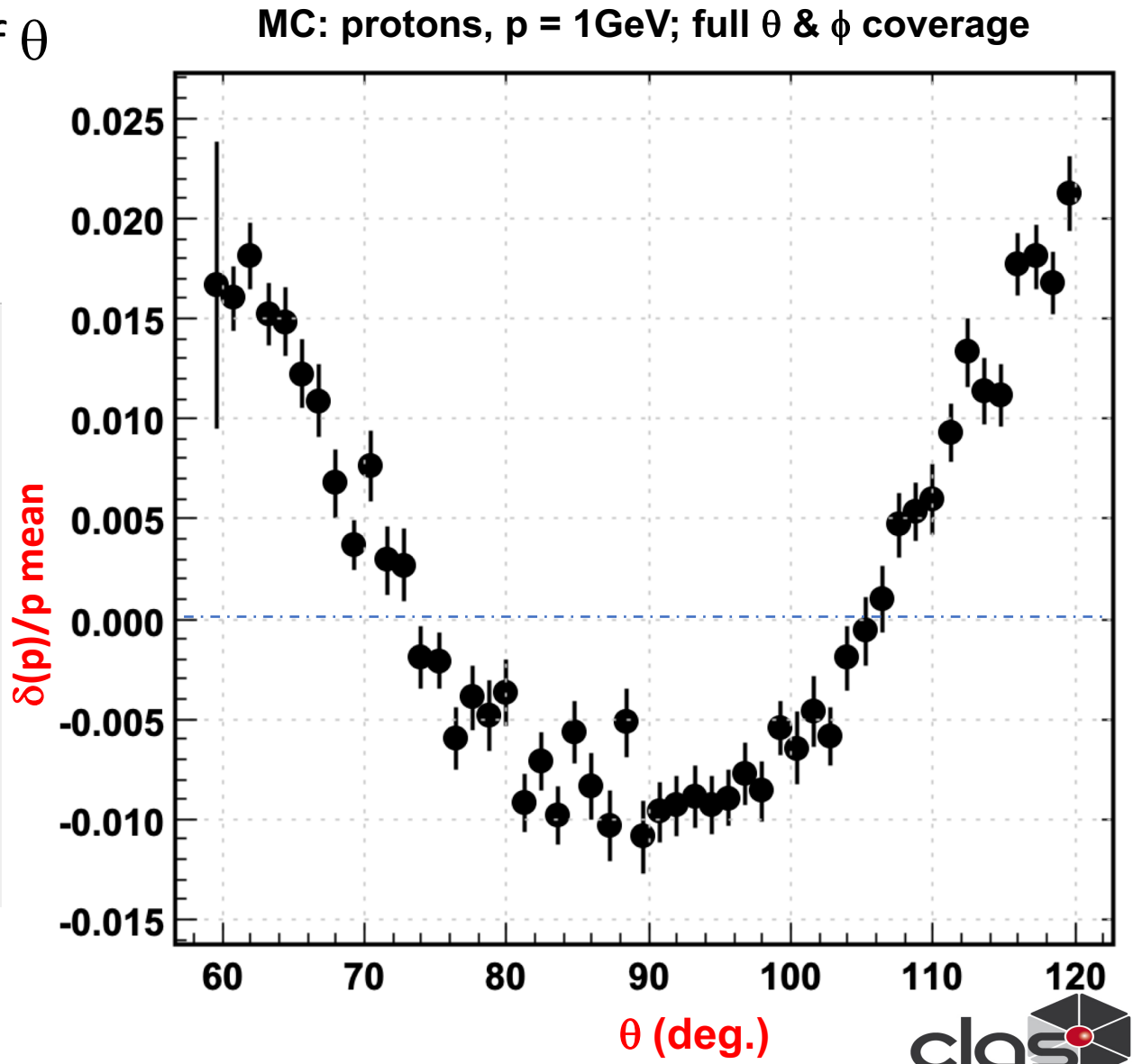


Fixes – Fitting

- Bias in momentum resolution as a function of θ

Curvature different for different polar angles
→ Inhomogeneity of the field at larger radii

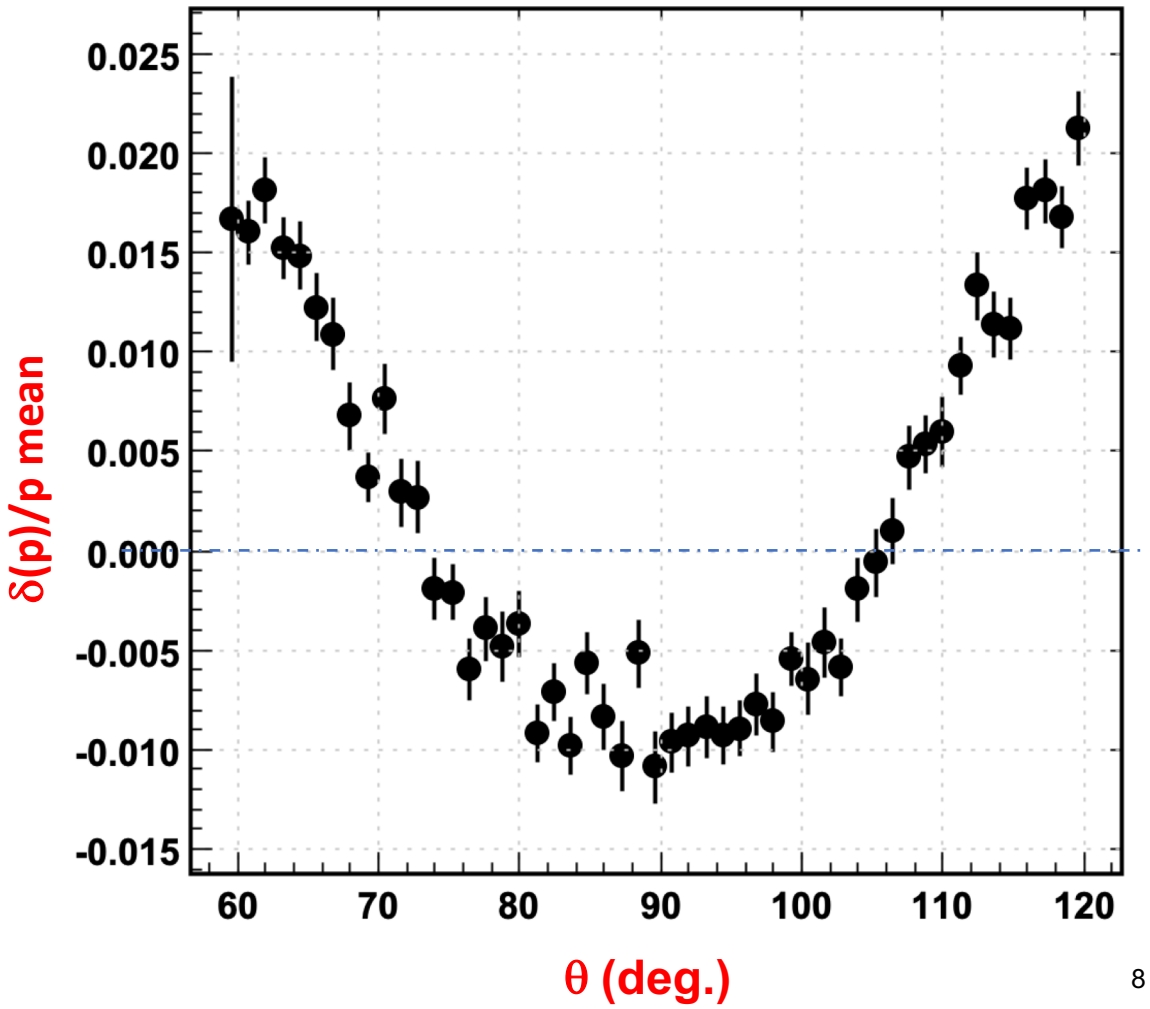


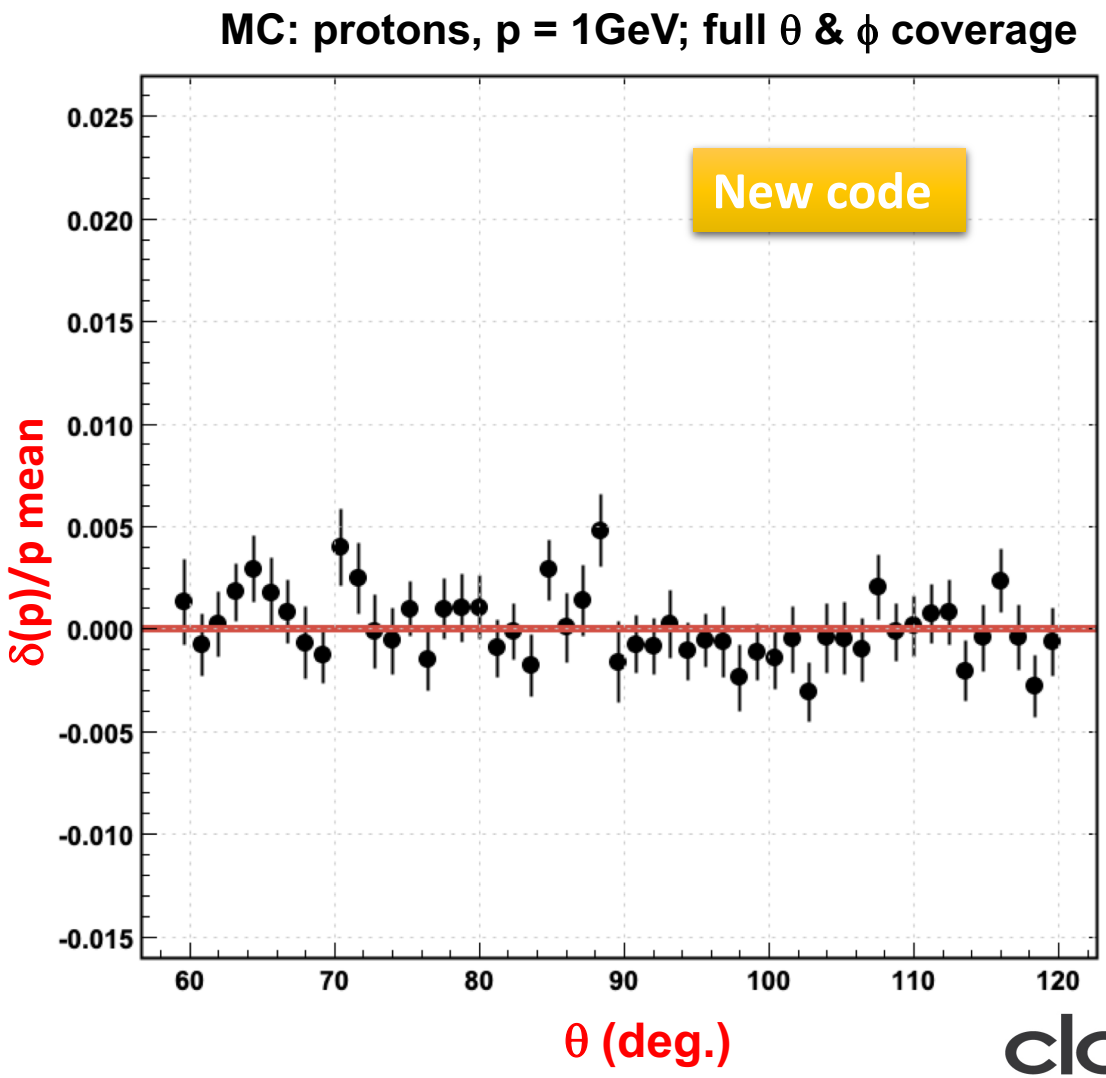


Fixes – Fitting

- Bias in momentum resolution as a function of θ resolved by swimming to the BMT surfaces

--using Dave's adaptive swimmer package





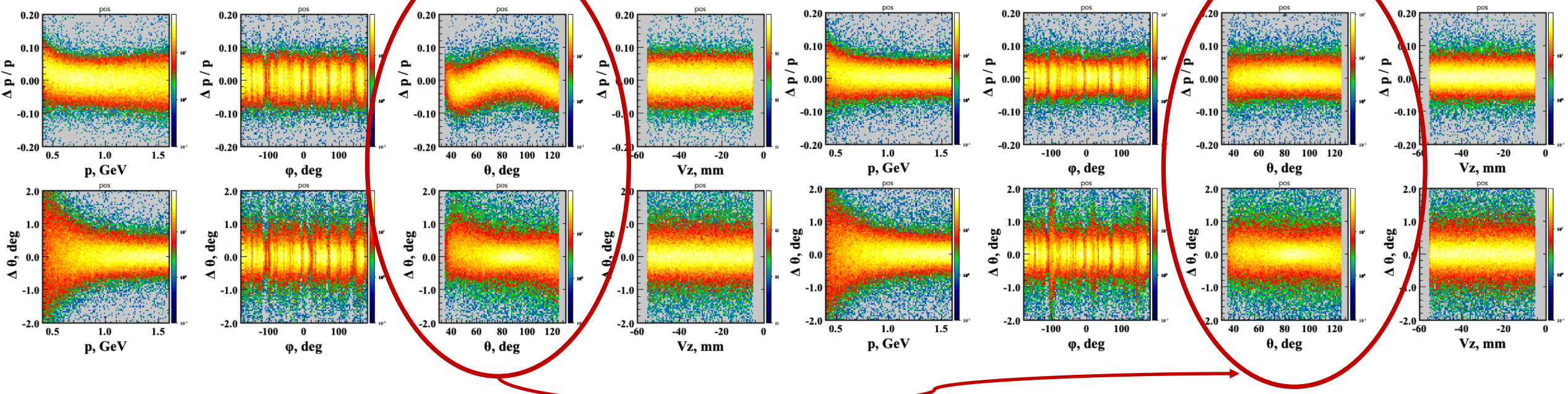
Improvements: Polar Angle Bias

Validations: Yuri

RG-B, 11014, 5 nA

6.5.12

new



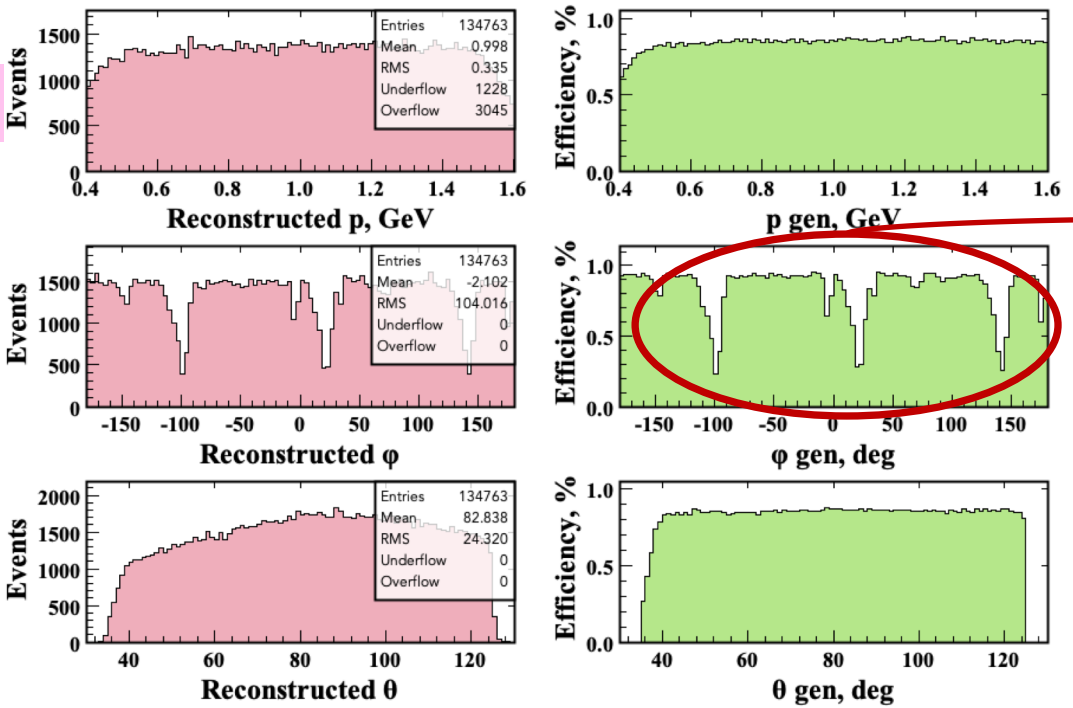
Improvements: Efficiency

- Secondary seeder to search for hits on track not identified by CA ➔ > 7 % increase in reconstructed tracks

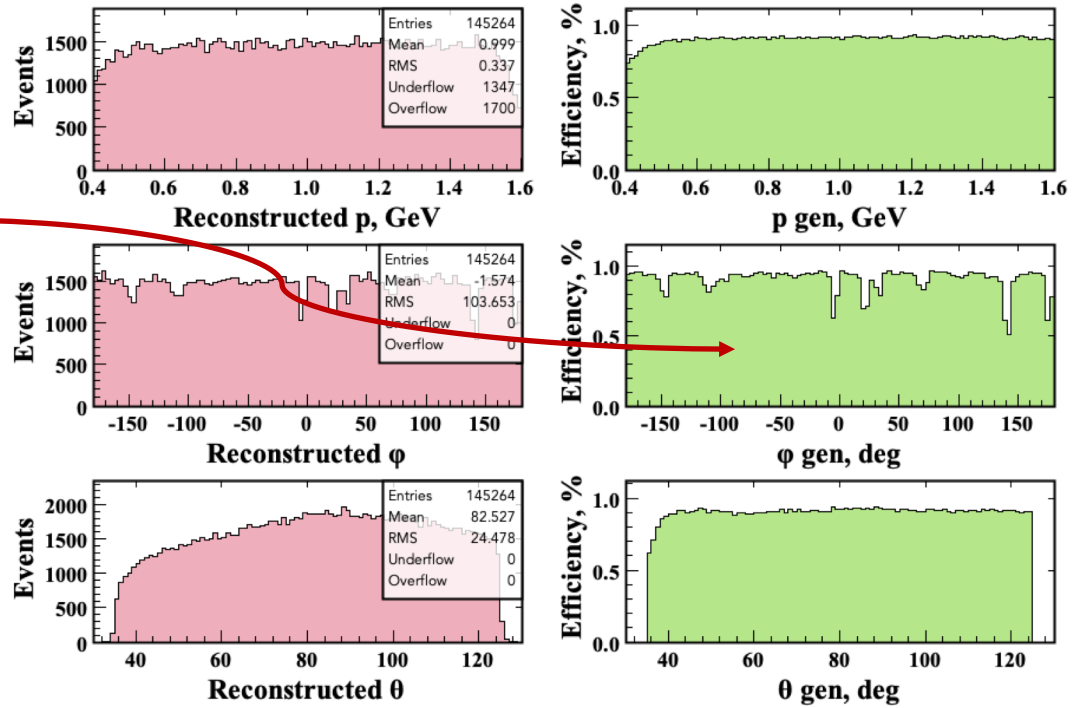
Validations: Yuri

MC: Proton, rga_fall2018

6.5.12



new



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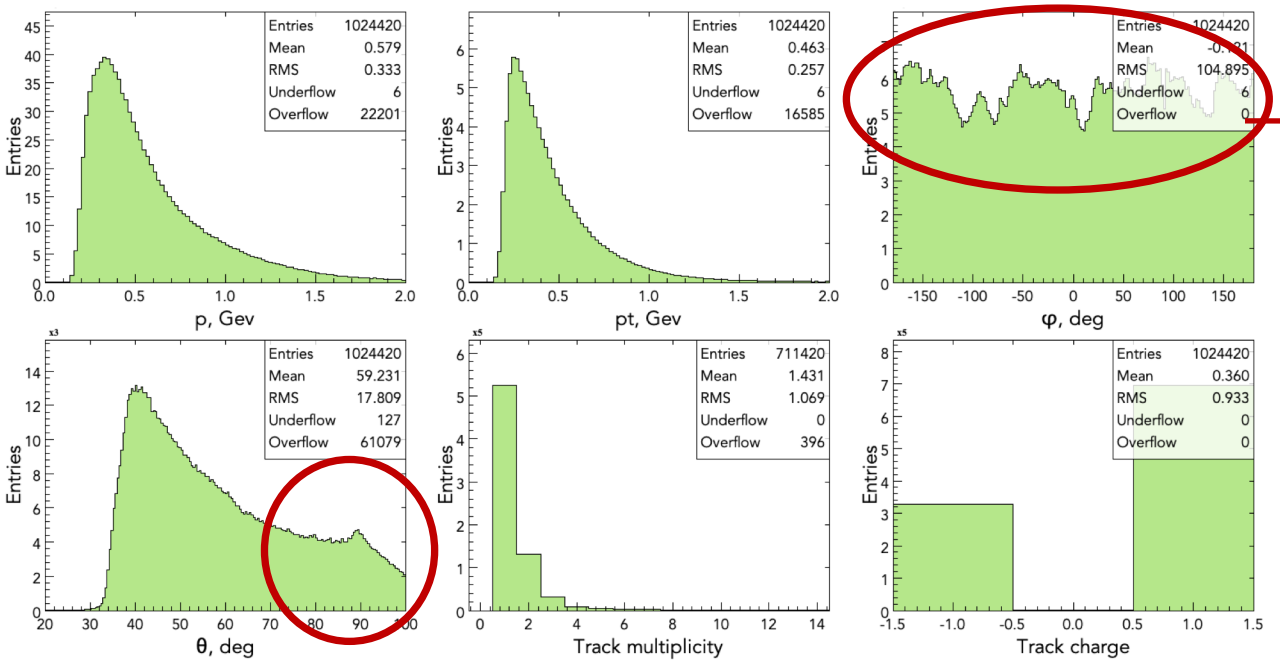
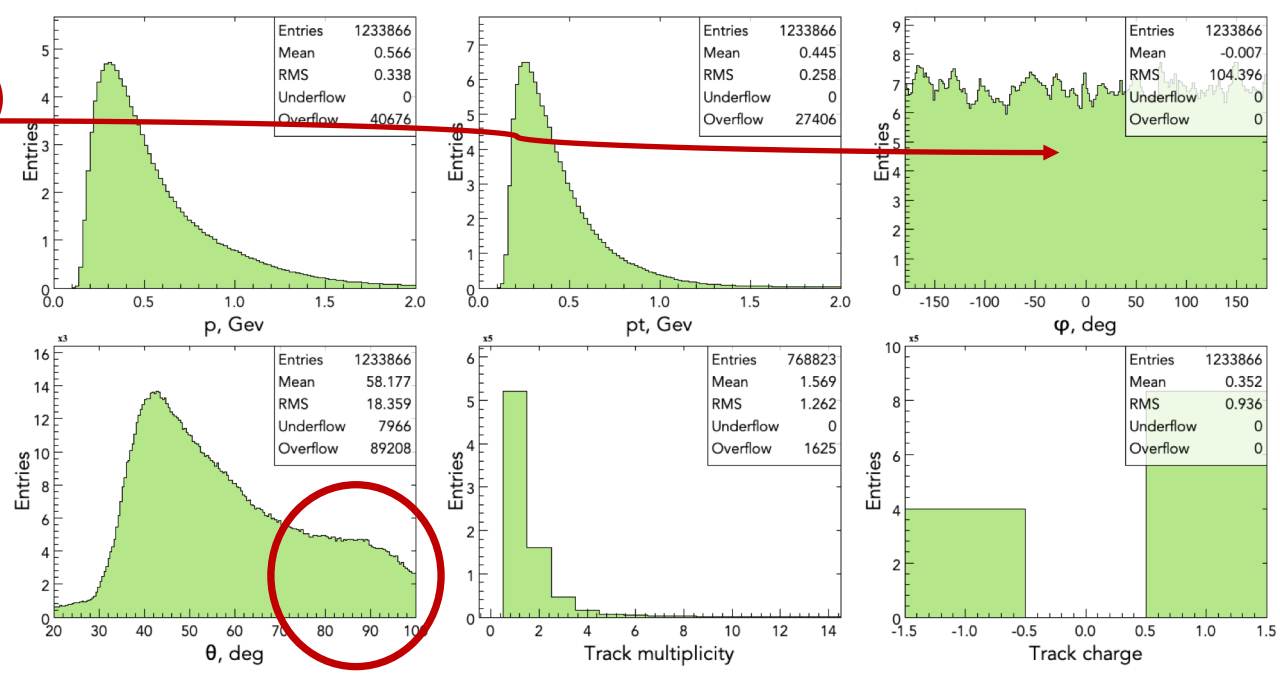




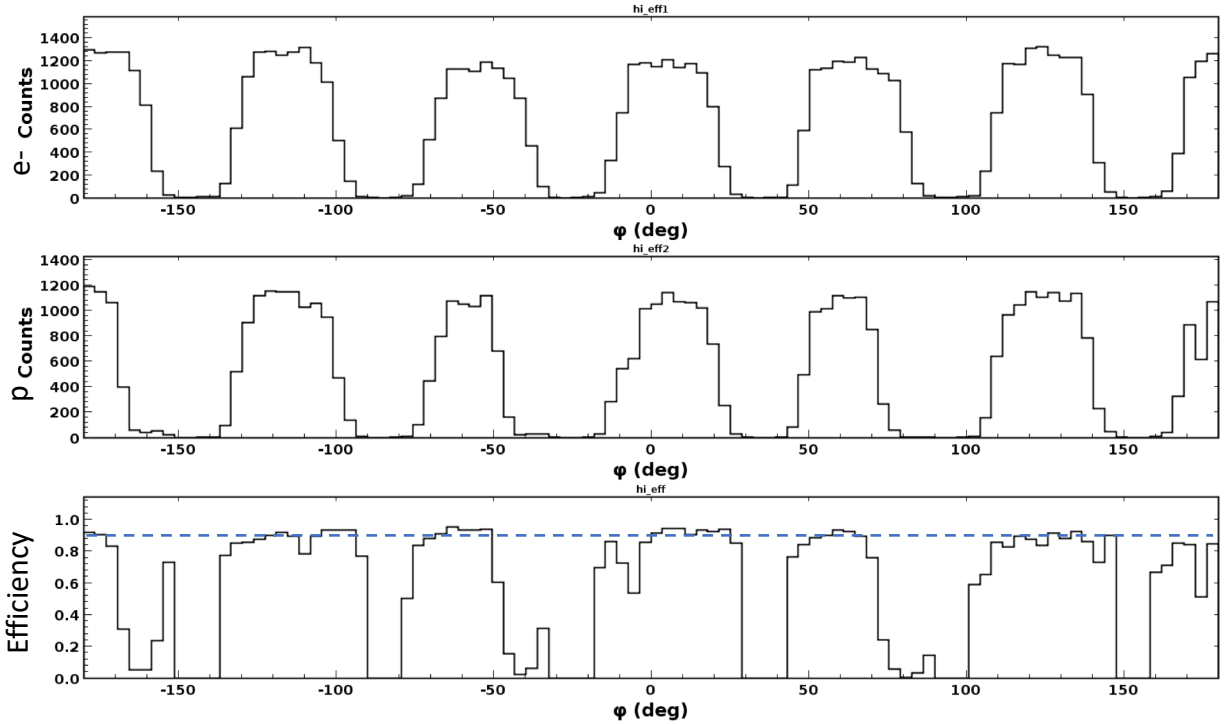
90% peak resolved

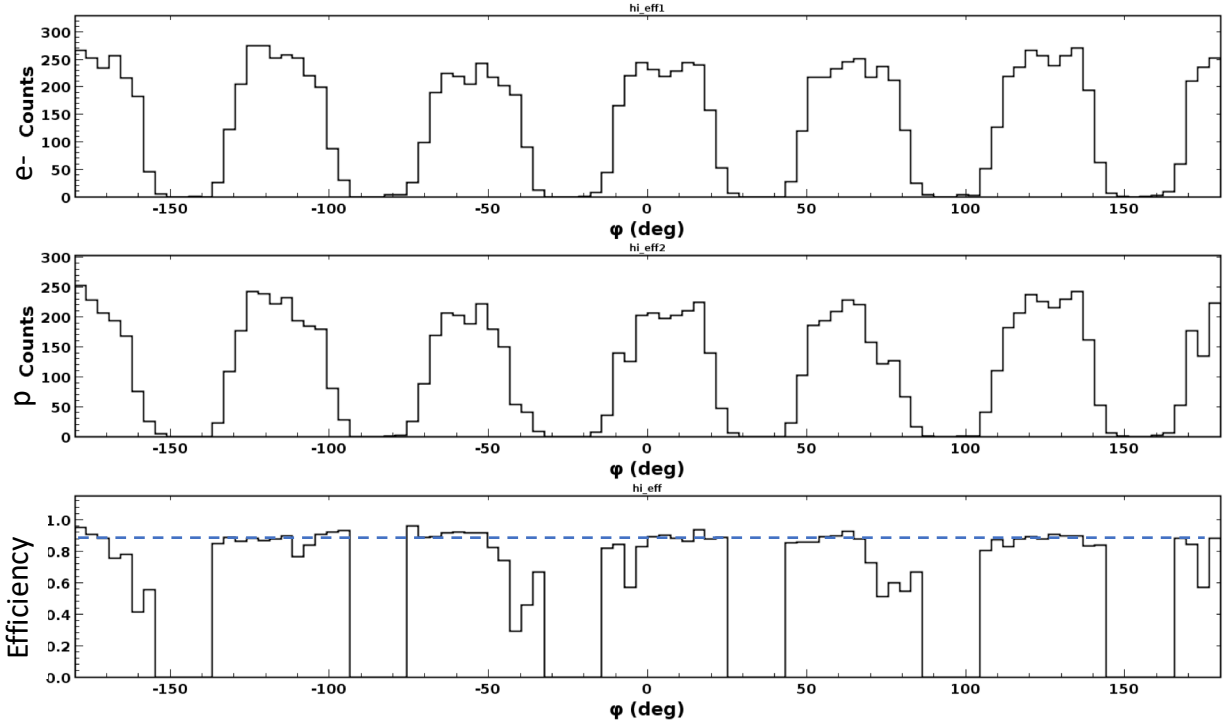
Improvements: Efficiency

- 6.5.12

Elastics, **Run 5990 (6.5 GeV)**

- New results: noticeable efficiency increase in some sectors

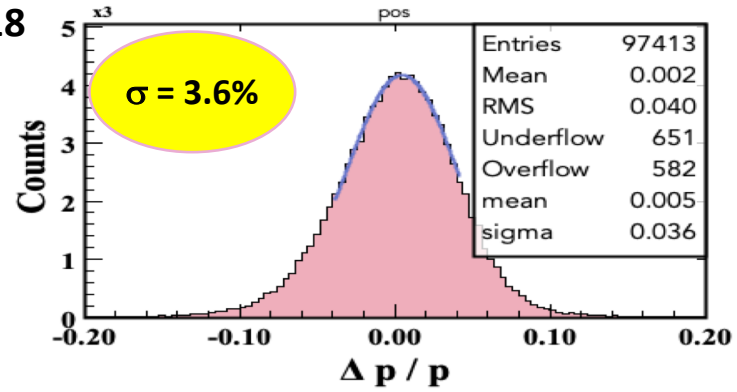


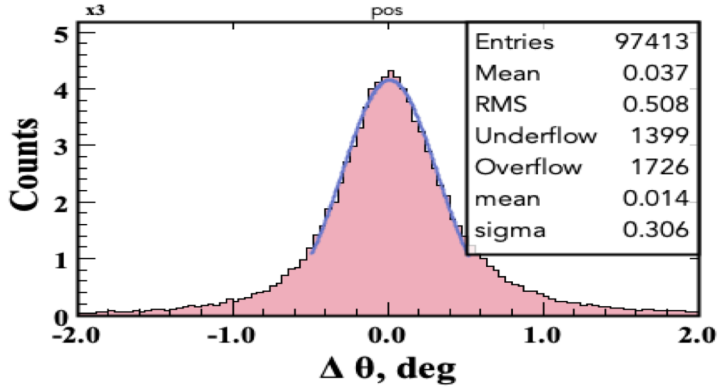


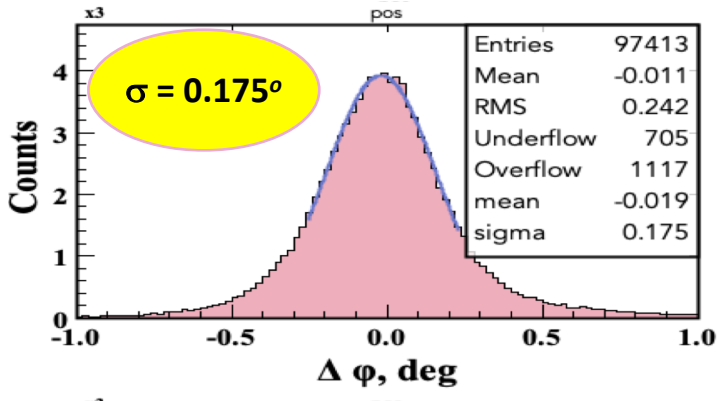
Improvements: Track Parameters Resolution

MC: Proton, rga_fall2018

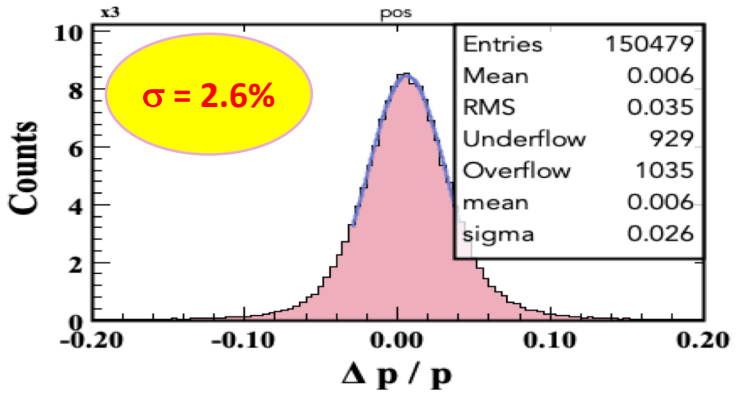
6.5.12

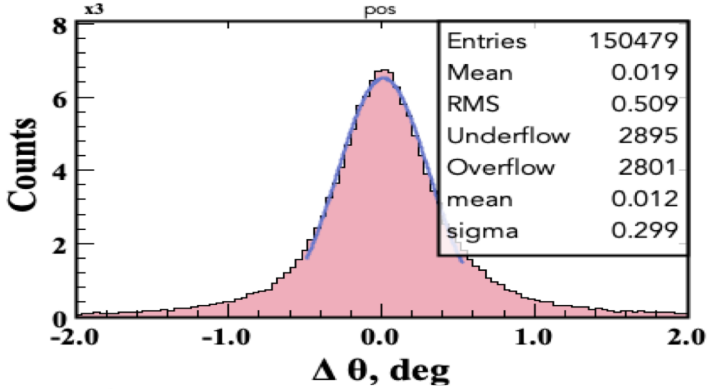


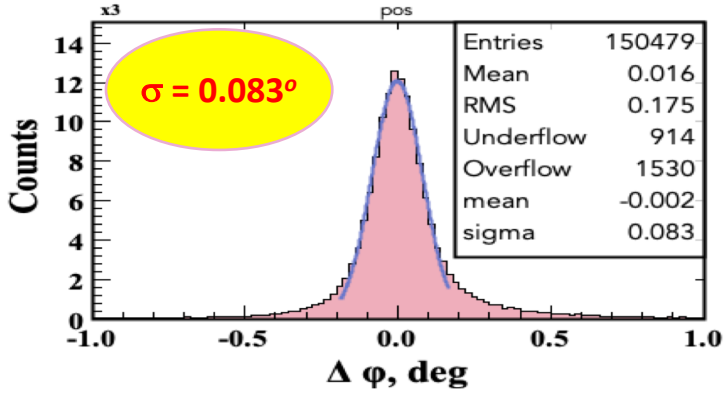




new



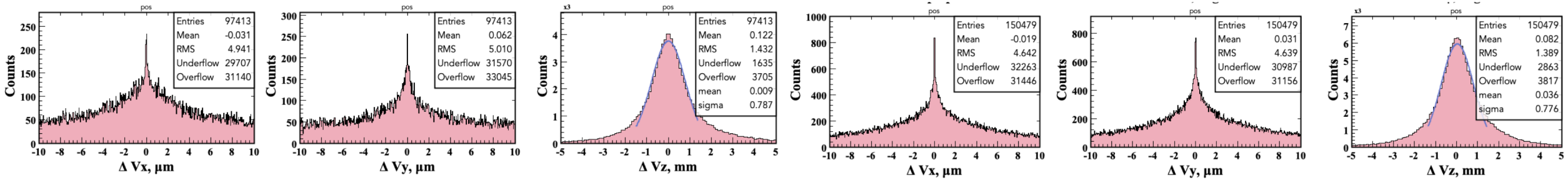




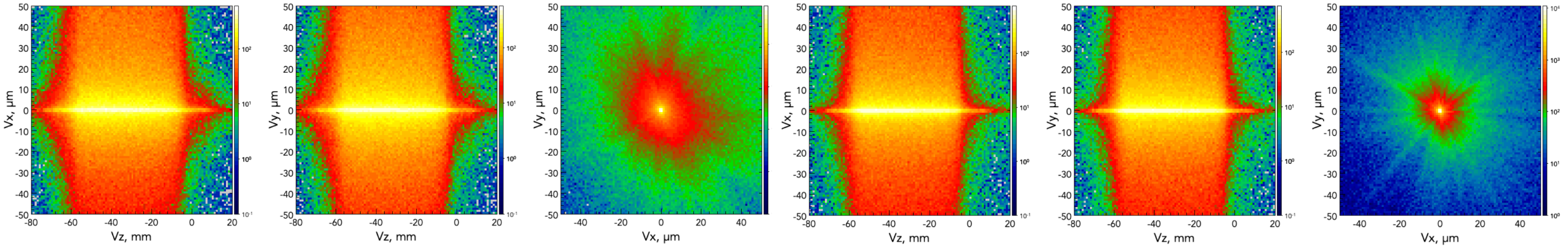
Improvements: xy Vertex Resolution

6.5.12

new



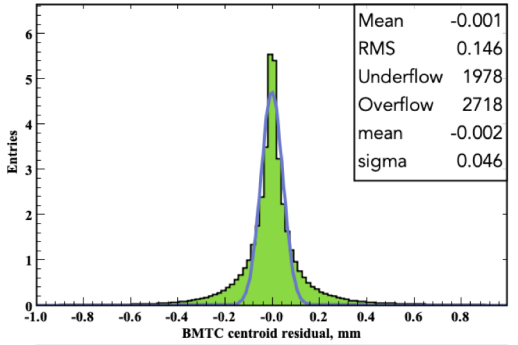
MC: Proton, rga_fall2018

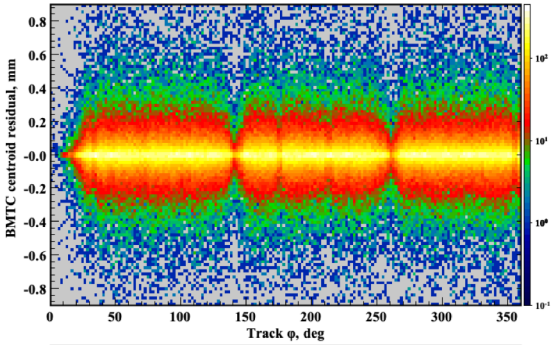


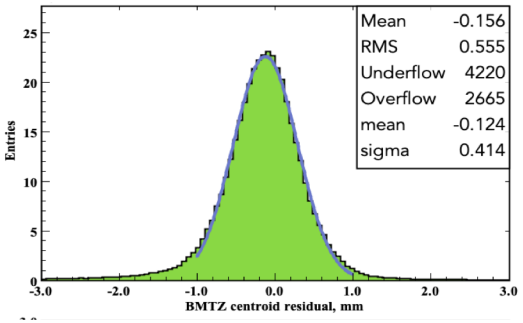
RG-B, 11014, 5 nA

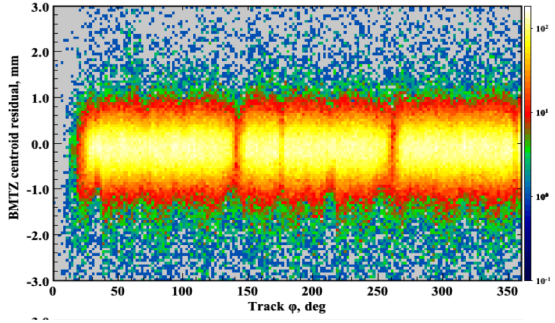
Improvements: Spacial Resolution

- MC (protons)
  - SVT residuals: 6.5.12: ~63 μm → 23 μm
  - BMT residuals
    - Computation fix
- Data: BMT alignment needed

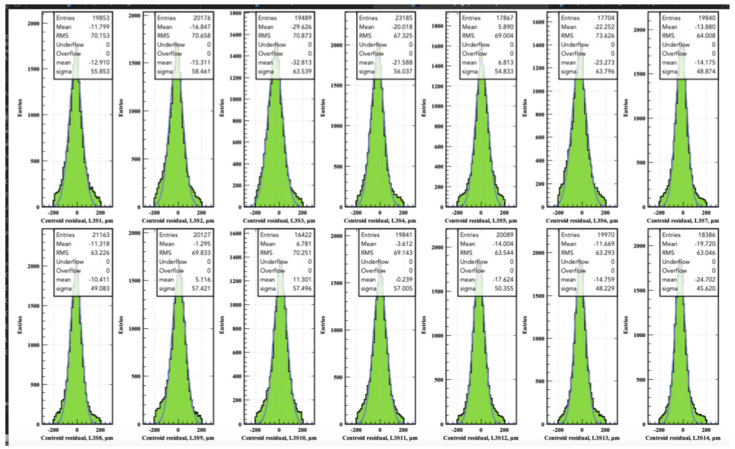


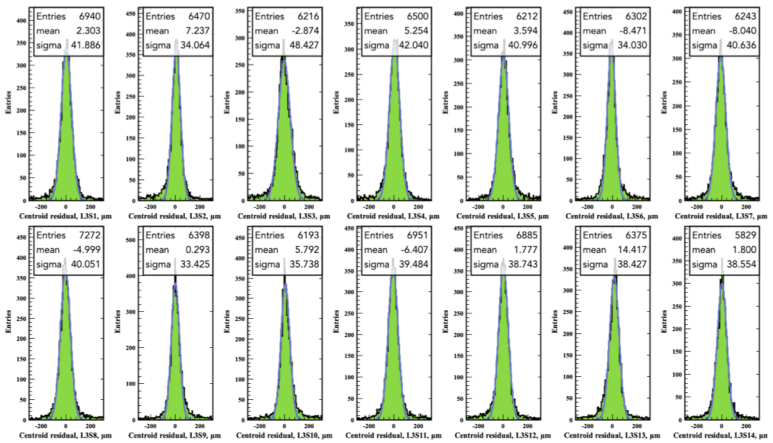






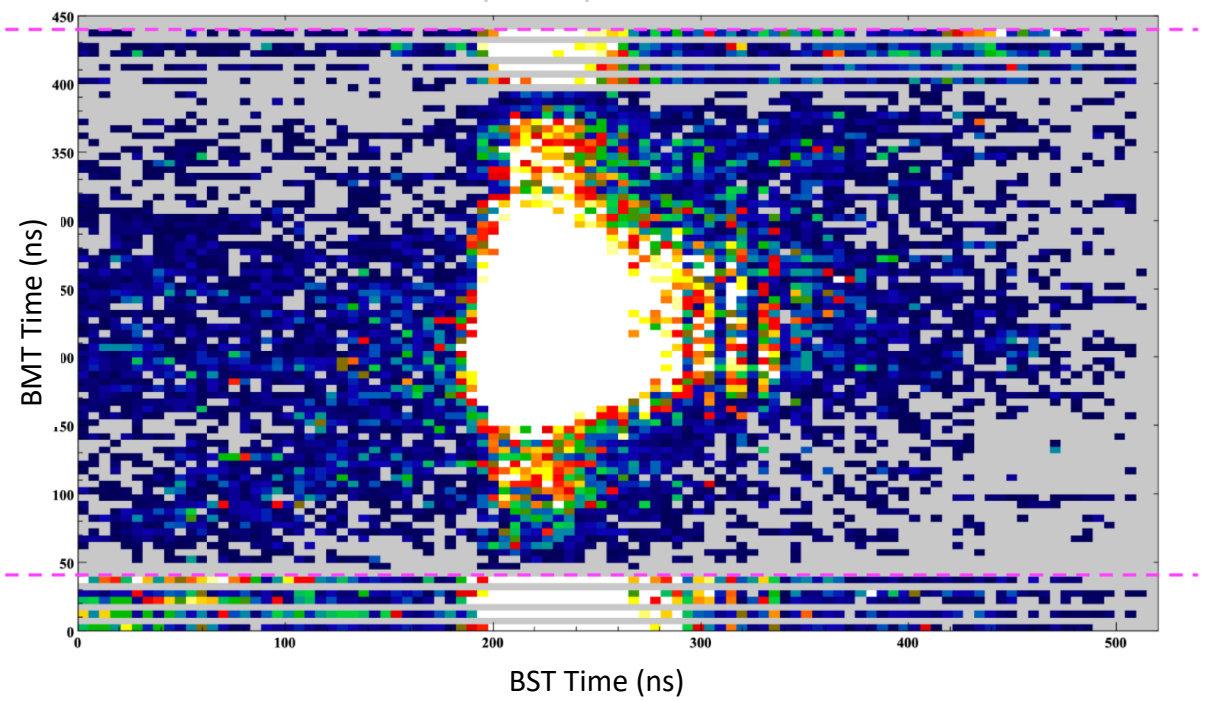
SVT centroid residuals (RGB data) SVT standalone:
~60-45 μm w/o alignment, ~35-40 μm w alignment





Reconstruction Remaining Work

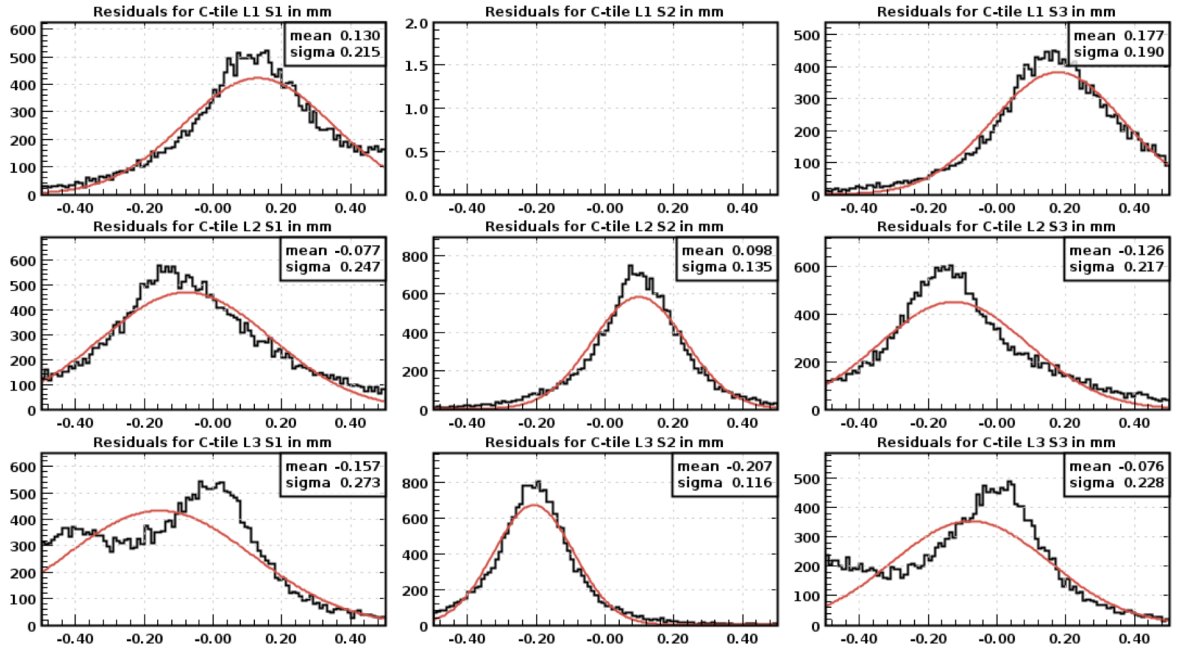
- Study timing cuts (Yuri)
  - For the SVT the ratio of hits_on_track/hits_off_track is 42% when hit_TDC is within 200-250 ns and 7% if it is outside of this window.
- Complete E-loss package
- Complete geometry
- Improve reconstruction speed
  - 5x5 matrix; remove Jama dependency
  - Code cleanup
- Investigate remaining biases
  - Vz mean,
  - Top/bottom SVT modules shift offset (order of few microns),
  - Lorentz angle correction,
  - Cluster residuals (BMT)



Ongoing: Alignment

- Kalman Filter approach → Sebouh's presentation
- Millipede using straight track finding dedicated software (preliminary) →Maxime

  – BMT C-tiles residuals (before miilipede)



(after millipede)