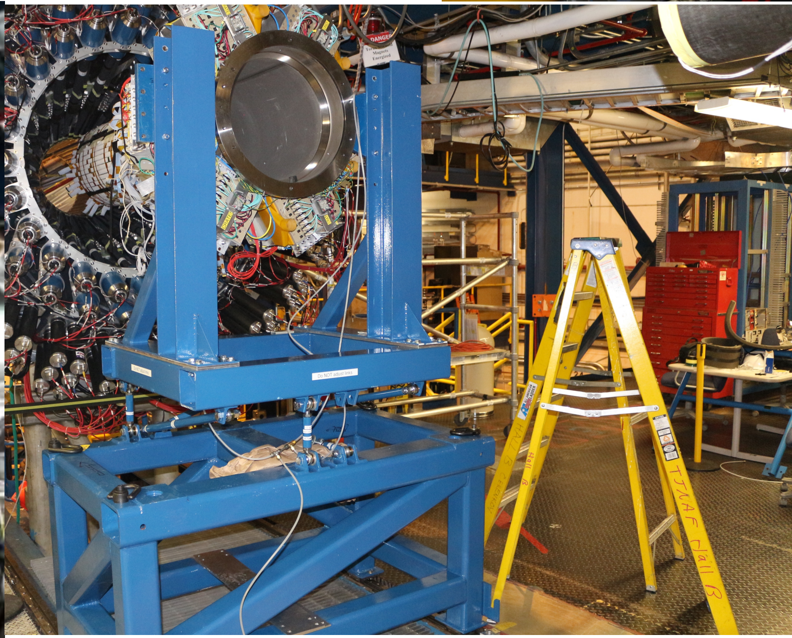
CVT Update

Yuri Gotra
On behalf of the CVT team

MVT Detector Update

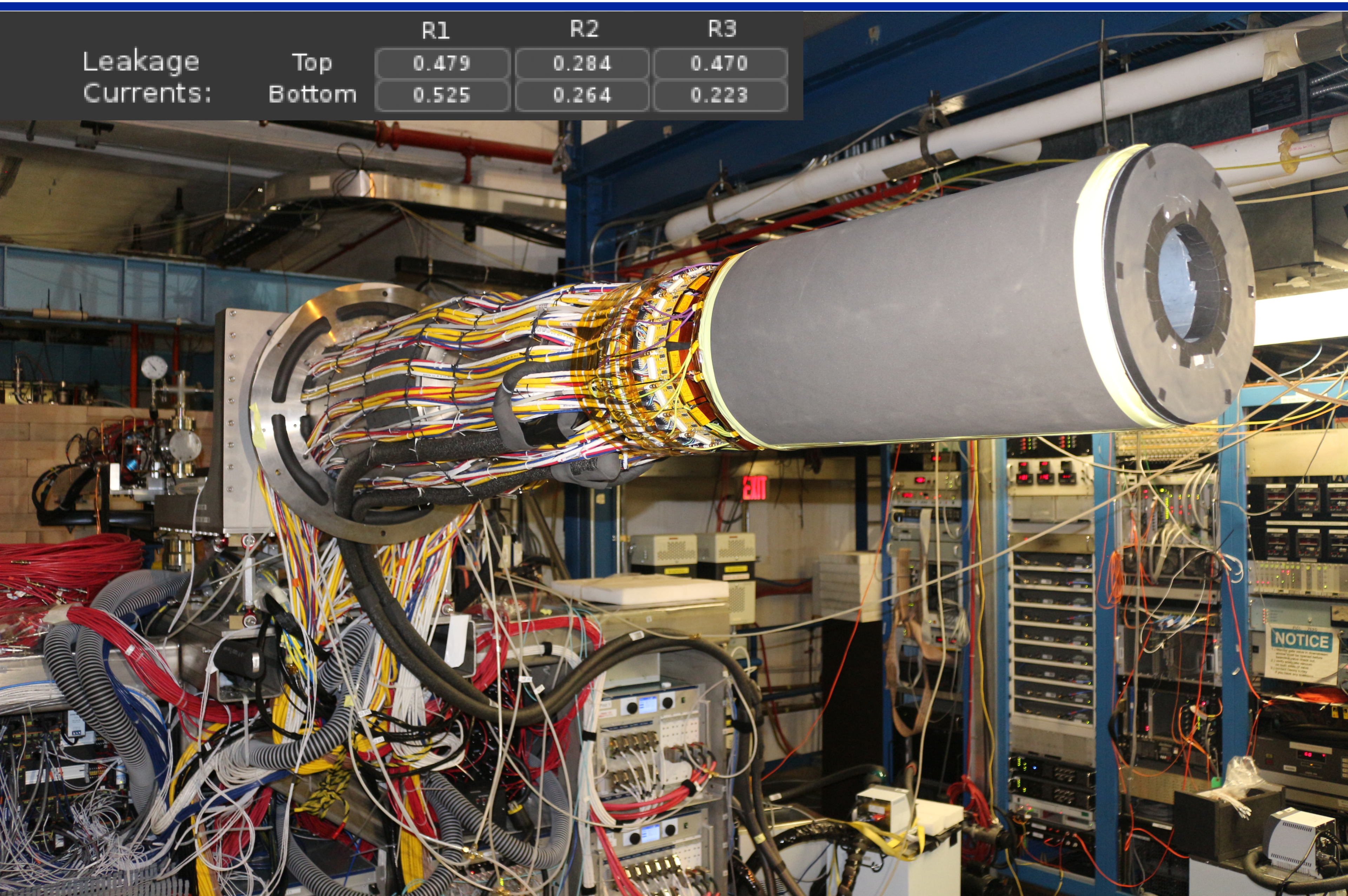
- Gas mixing system:
  - Improvements made in thermal insulation and control system
- Detector HV:
  - FMT and layer 5 BMT tiles tested at Saclay, shipping back to Jlab
- Thermal insulation:
  - Options of extra insulation are available if needed
- Detector monitoring:
  - HV patch panels being modified to accommodate ambient sensor cables
- Detector re-integration:
  - MVT team arrive on July 23rd to work on detector assembly and commissioning



SVT Detector Update

- Sensor leakage currents:
  - Keeping sensors cold to reduce reverse annealing
  - Lowering bias voltage
  - Reducing ambient temperature
  - Active cooling of the sensors
  - Thermal screen on the outer shell of the Faraday cap
- Cooling system:
  - More insulation of the cooling lines
  - “tube-in-tube” nitrogen cooling
  - PR submitted for a new chiller, Julabo FP51-SL, better pump to match higher viscosity of glycol mixture, 1 kW cooling power at -20 C
  - Additional ambient temperature and humidity monitoring installed
- Gas purging system:
  - Distributed lines inside SVT bore, between SVT and BMT, inside BMT to reduce humidity
  - Sealed openings in the mounting tube
- Hit occupancy:
  - Tungsten shield (CLAS note written, to be posted)
  - FSSR2 thresholds and timing windows optimized
  - GotHit timing in the new VSCM firmware

SVT Cooling System Modifications

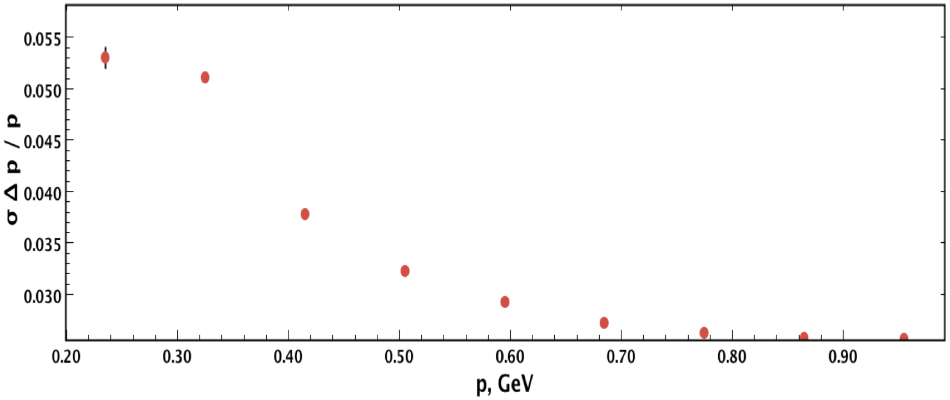


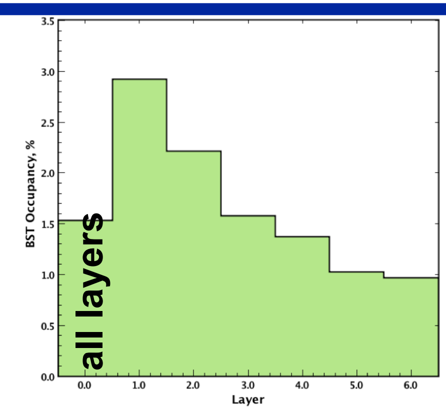
Leakage Currents:		R1	R2	R3
	Top	0.479	0.284	0.470
	Bottom	0.525	0.264	0.223

SVT Detector Summer Work Schedule

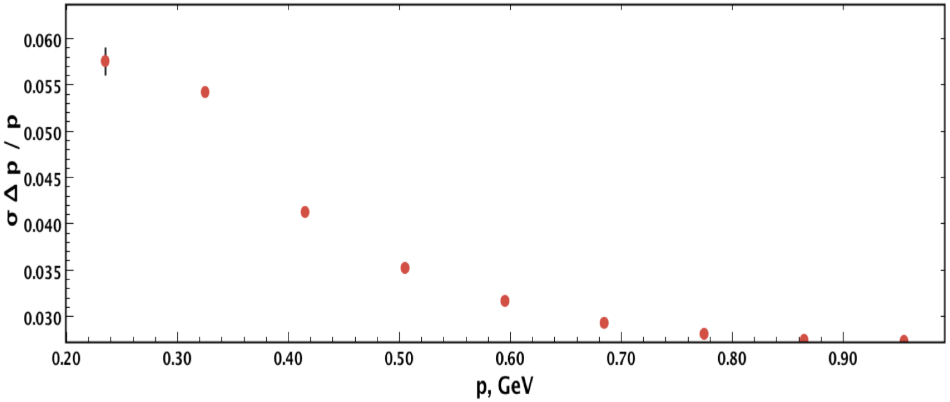
Activity	Status	Due Date
Design and fabrication of the CVT separation tooling	complete	06/15
Separation of the CVT detectors, preparing for the SVT cooling system modifications	complete	06/18
Modification of the SVT nitrogen purging system and replacing the insulation on the liquid coolant lines	complete	06/20
Fabrication of the temporary Faraday cage cap and sealing the L1C area to prepare for the active sensor cooling test	complete	06/22
Testing the active sensor cooling system using room temperature nitrogen	complete	06/25
Procuring extra insulation materials (SVT Faraday cage, mounting tube)	complete	06/27
Assembling the test stand for nitrogen cooling, testing performance	complete	06/28
Modification of the SVT patch panel (DSG)	complete	07/02
Modification of the SVT cooling system for active sensor cooling with “tube-ion-tube” nitrogen cooling	complete	07/02
Testing the modified active sensor cooling system	complete	07/06
MC simulation of additional CVT insulation in the active tracking volume	complete	07/10
CVT integration	on time	07/23
VSCM firmware upgrade to read GotHit timing data (removal out-of-time hits)	on time	07/18
Testing the VSCM firmware	on time	07/20
Re-commissioning the CVT with cosmic rays	on time	08/06
Kludging spare SVT modules (HV trace on the HFCB bottom side)	on time	08/31

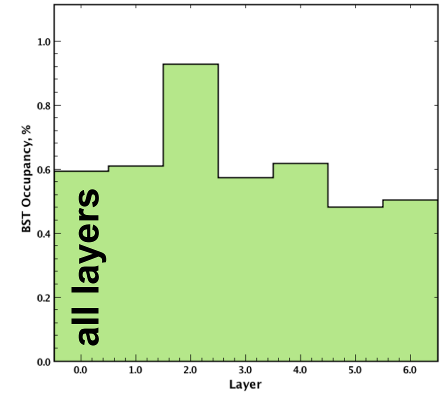
Tungsten Shield to Reduce Gamma Background





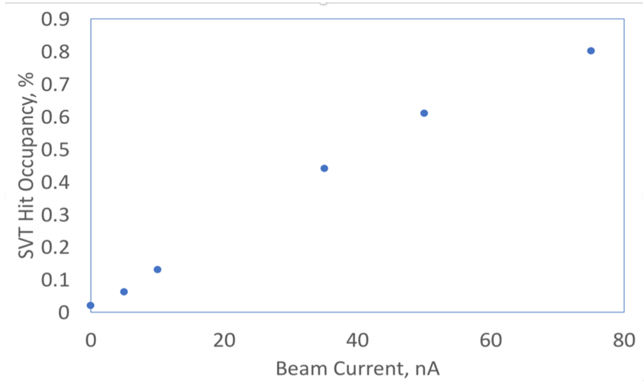
No shielding



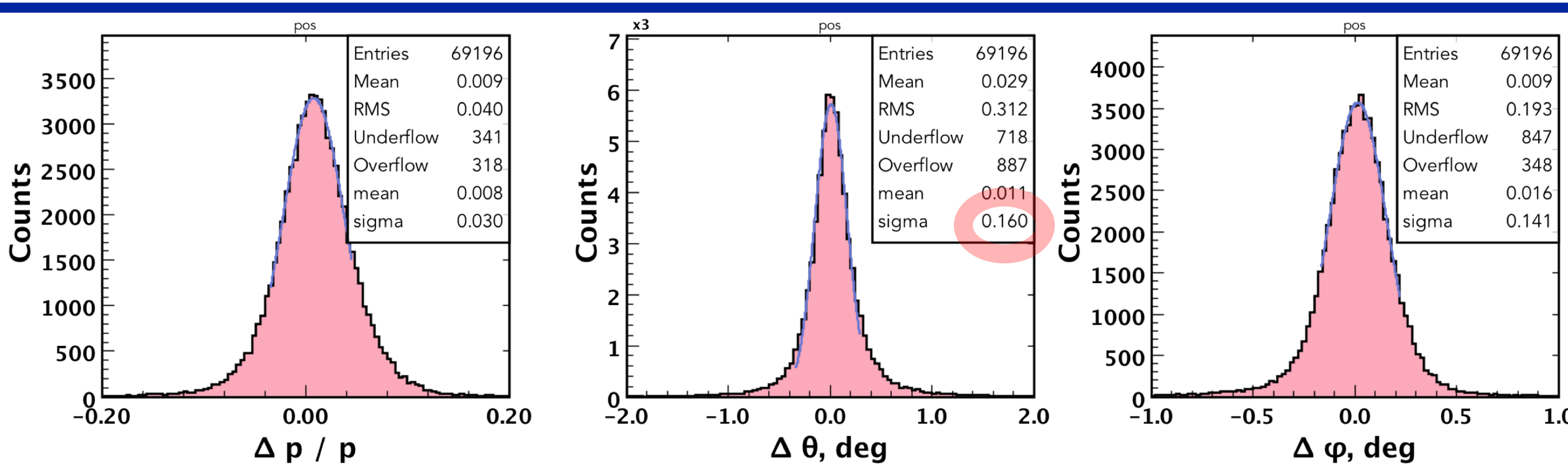


50 µm tungsten shielding

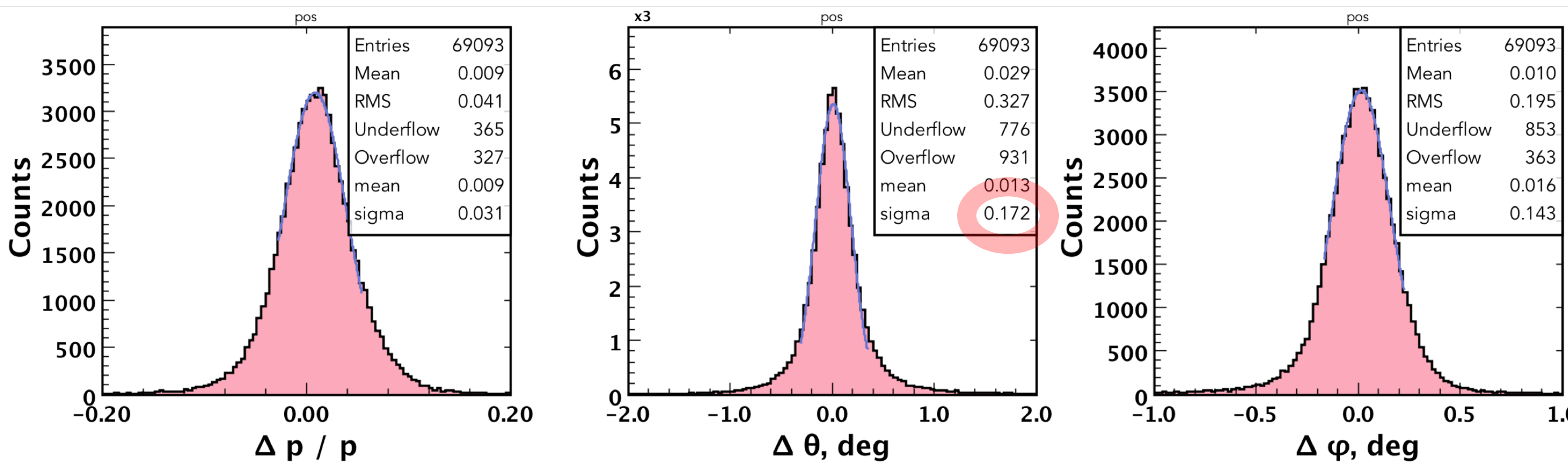
Luminosity scan, 03/29/2018



SVT Faraday Cage Insulation



no FC insulation

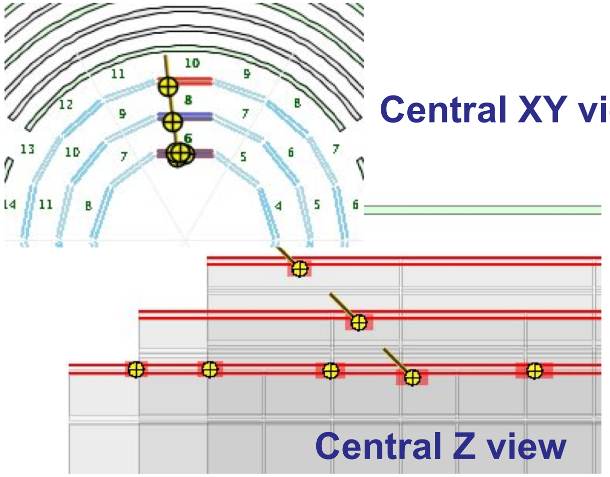


with FC insulation

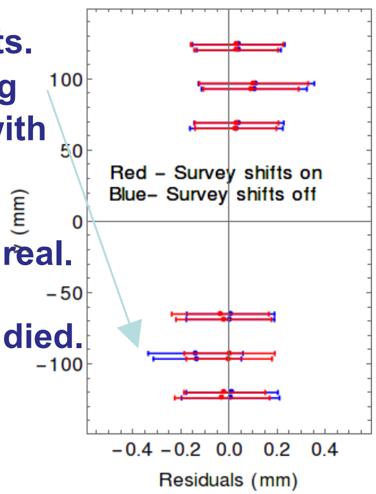
SVT Alignment Status

- Precise alignment of SVT needed to reach design resolution (~65 μm).
- First step is to include the results of the survey of each SVT sector.
- SVT geometry code written and passed initial validation and testing in 2016-2017.
- Initial tests with data in January, 2018 showed sporadic, large discrepancies in strip endpoints.
  - Traced to bugs (sign errors) that have now been fixed.
  - Validated with simulated cosmic rays and transformation tests.
  - Now using simulated events from the target.
- Revised code tested with straight tracks (no-field) events from engineering run (run 2467).
  - Used with type-1 events in upper and lower portions of SVT.
  - Only use SVT hits (no MMs).
  - Region 2, sector 1 had large residuals with ideal geometry (130 μm) that were corrected with application of survey shifts.
  - Other regions have smaller residuals (less than 40 μm) using ideal geometry and show only minor changes in residuals with application of survey shifts.
- Future work
  - Finish validation with events from the target, simulated and real.
  - Developing set of geometric tests for all strips.
  - Thread contention in reconstruction speed of SVT being studied.

Jerry Gilfoyle



Central XY view

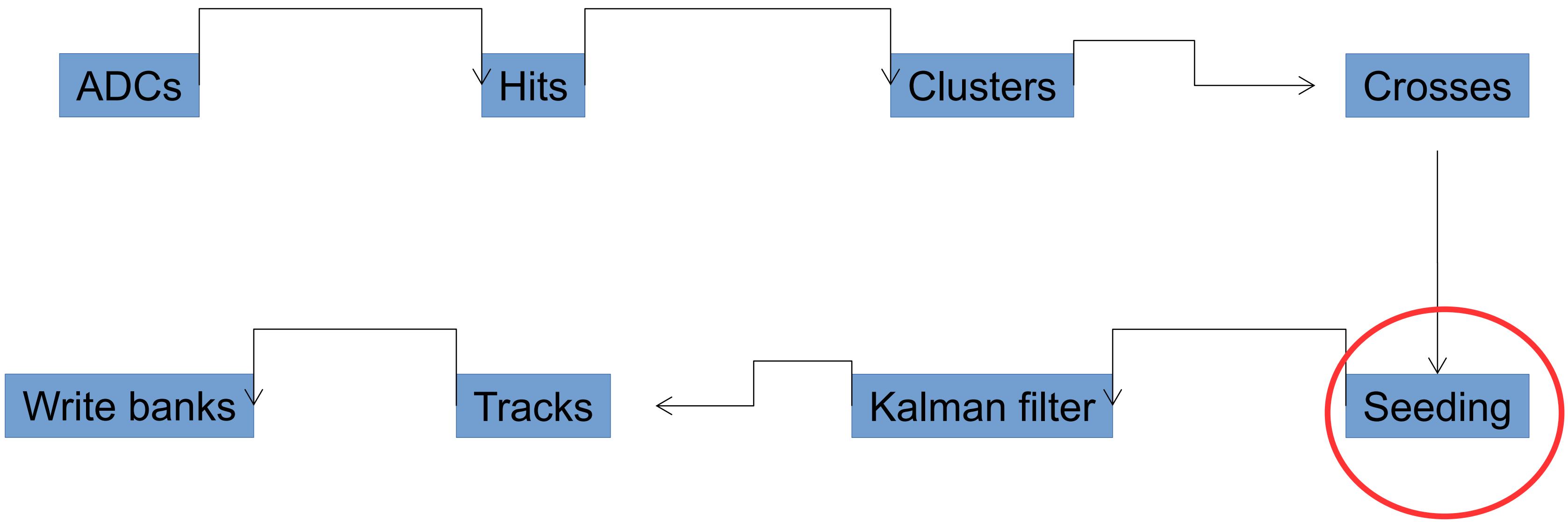


Vertical axis – vertical position of SVT modules.

Horizontal axis – centroid of Gaussian fit with s plotted as the error bar.

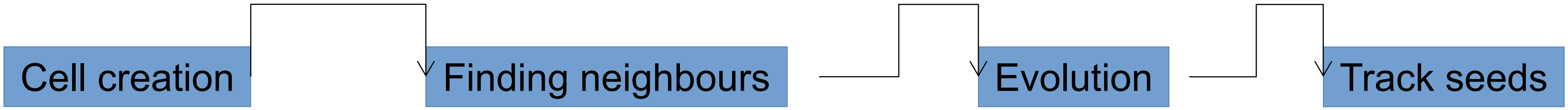
Cellular Automata Track seeding

- New track seeding algorithm based on cellular automata
  - Implemented by Francesco Bossù
- Inspired to the Hera-B CATS algorithm (NIM A 498 (2002))
- Minimal impact on existing CVT code and fully retro-compatible: no modifications to the CVT banks and to the track fitting



Cellular Automaton

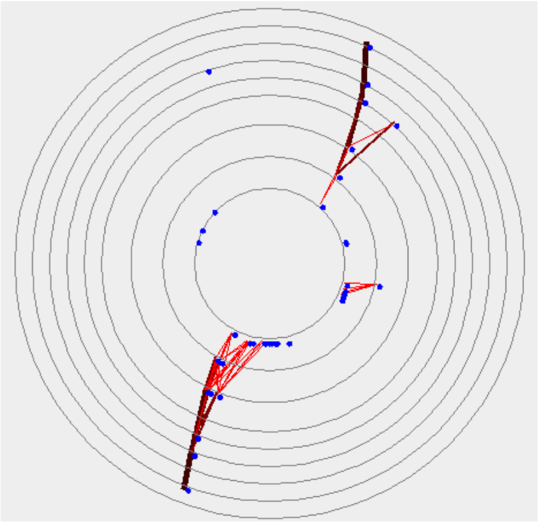
- A cell: segment that connect two crosses
- A cell has a “state” and it is initialized with state value = 1
- A cell has neighbors: they share one cross
- The system evolves. Time*:* iteration step or epoch, all the cell states are updated simultaneously



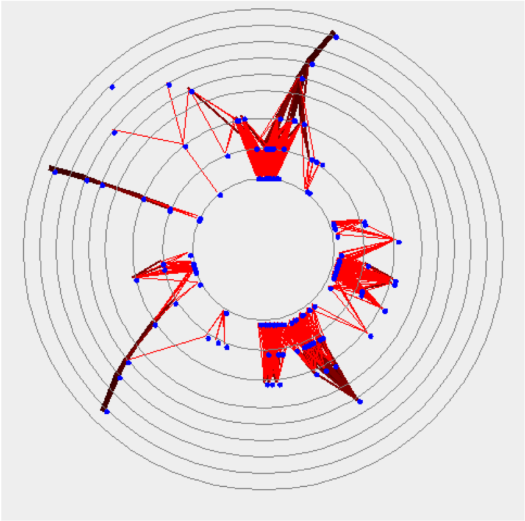
Cellular Automaton

- Run the cellular automaton in the XY plane using SVT and BMTZ crosses
- Then, for each XY candidate:
- take the SVT crosses of the candidate,
- Add all the BMTC crosses of the corresponding sector
- Run the cellular automaton in the ZR plane
- For each ZR candidate, attach all the BMTZ crosses of the XY candidate to form a track seed
  - *Custom "event display", examples in MC with merged background*
  - In blue the crosses
  - In red the cells. The darker and thicker the segment, the higher is the cell state

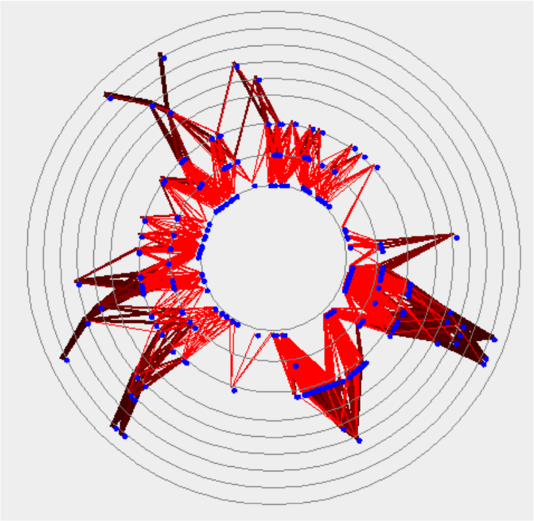
Small bkg from GEMC



Bkg for 35 nA



Bkg for 70 nA



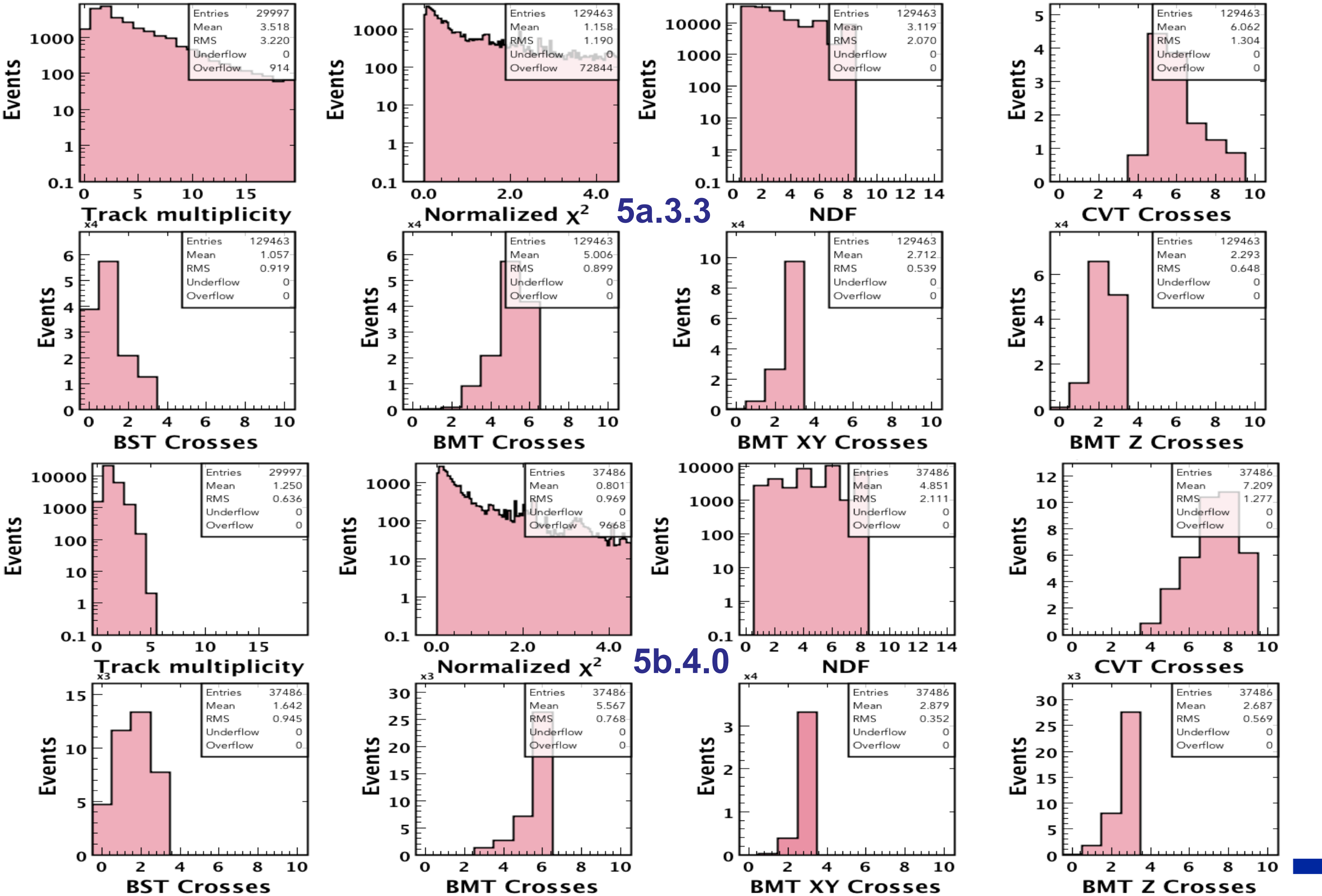
Cellular Automata Status

- Performance studied in MC, verified on the data
- Samples with a single proton simulated per event with and without merged background
- Resolutions are similar to the previous algorithm
- Tracking efficiency improved
  - At 50 nA, tracking efficiency is ~75% for protons with $p > 1$ GeV/c

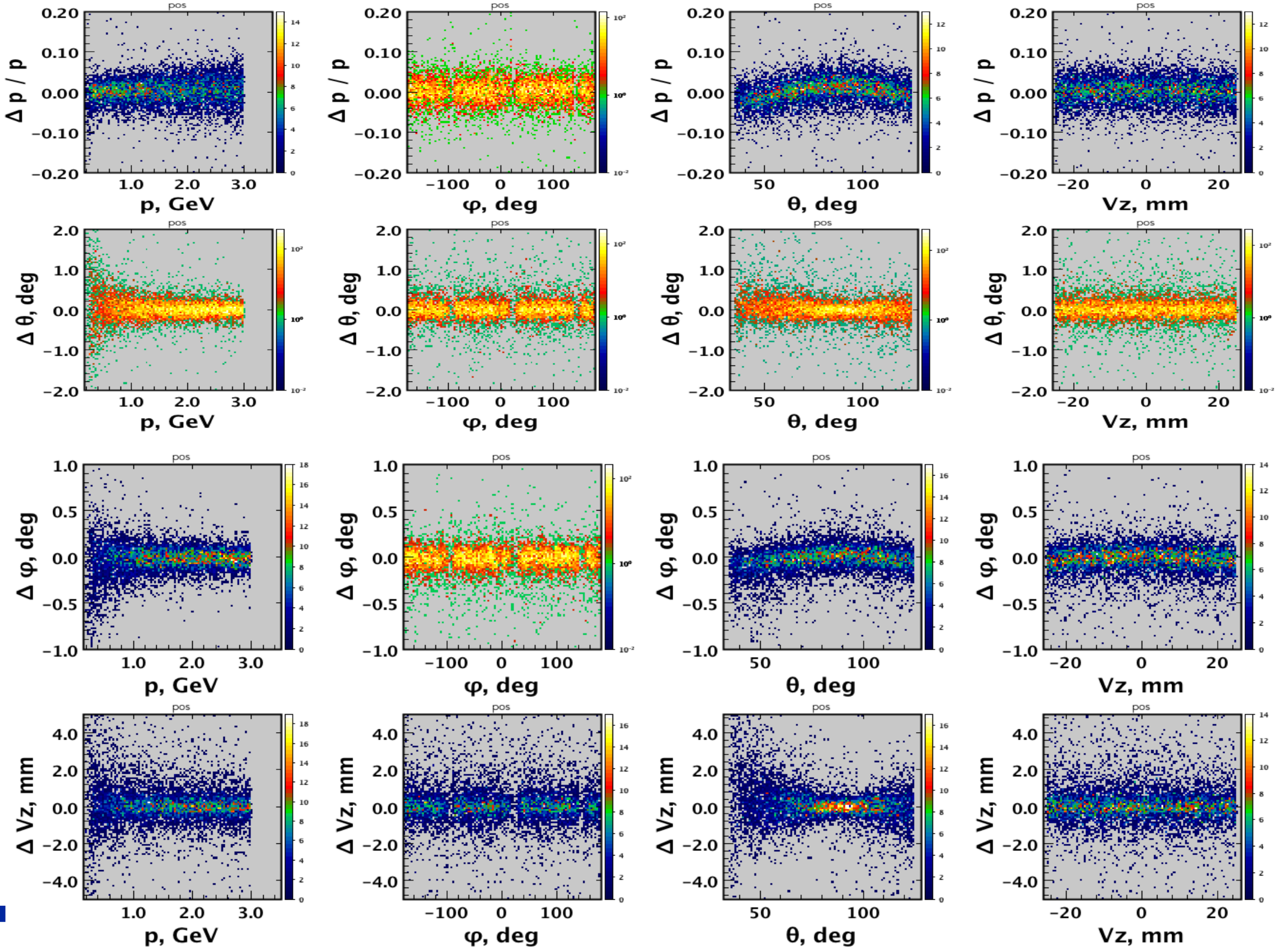
Latest developments:

- Candidates in ZR plane: SVT crosses matched to BMTC linear fit
- Trajectory bank fixed
- 8 mm MVT shift in Z fixed in 5b.5.0
- Clone track removal
  - Done at the end of the KF
  - Tracks considered clones if share at least 2 crosses.
  - Best candidate, the one with the largest number of crosses
- Processing time: ~100 ms / event

Simulation: Proton with 50 nA merged background

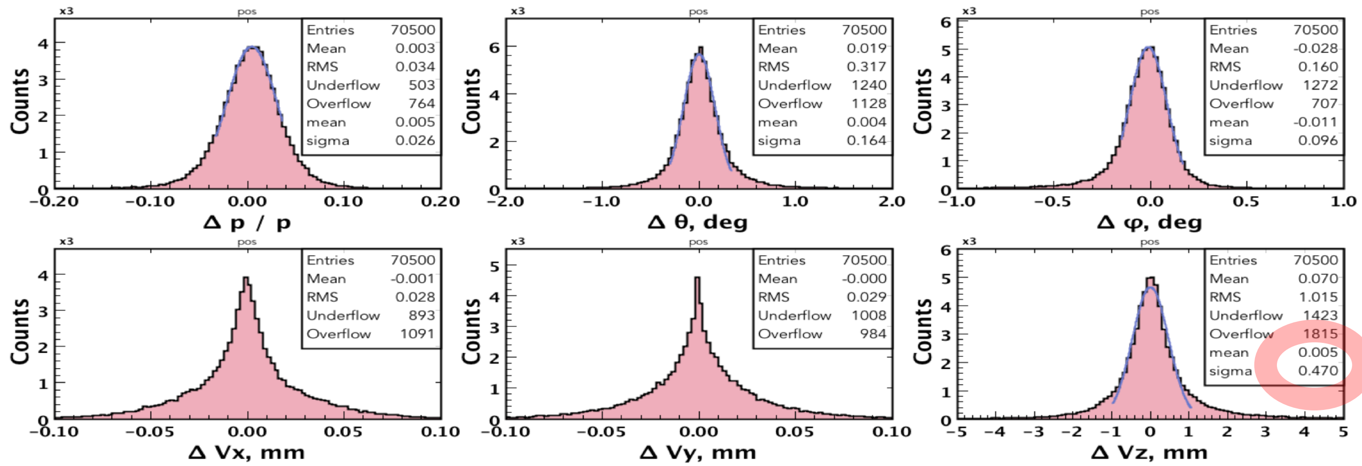


CVT Resolutions

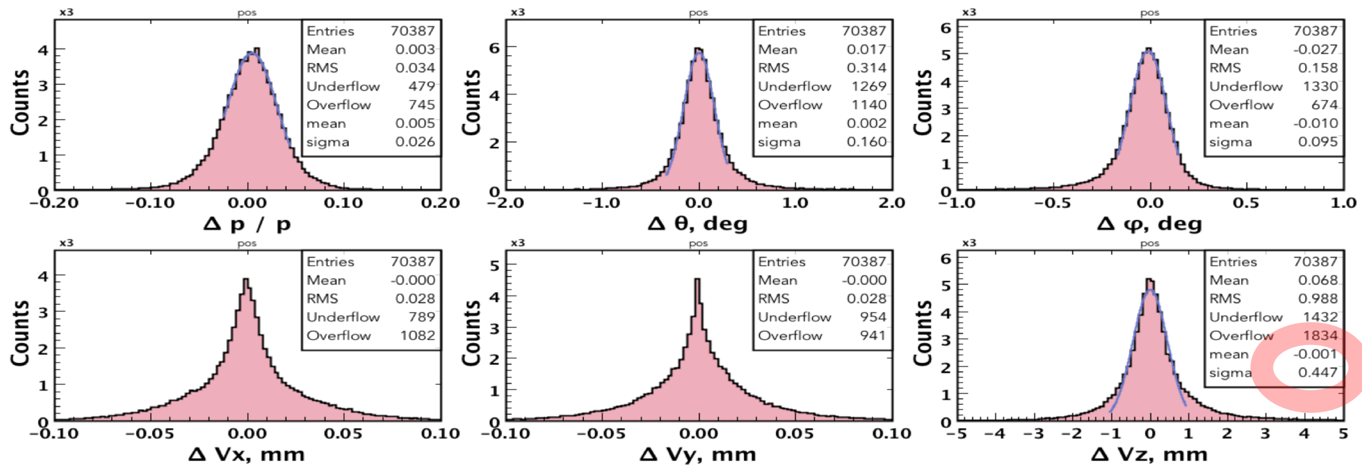


MVT Geometry Validation: Simulation

shim, 4a.2.3



no shim, 4a.2.4

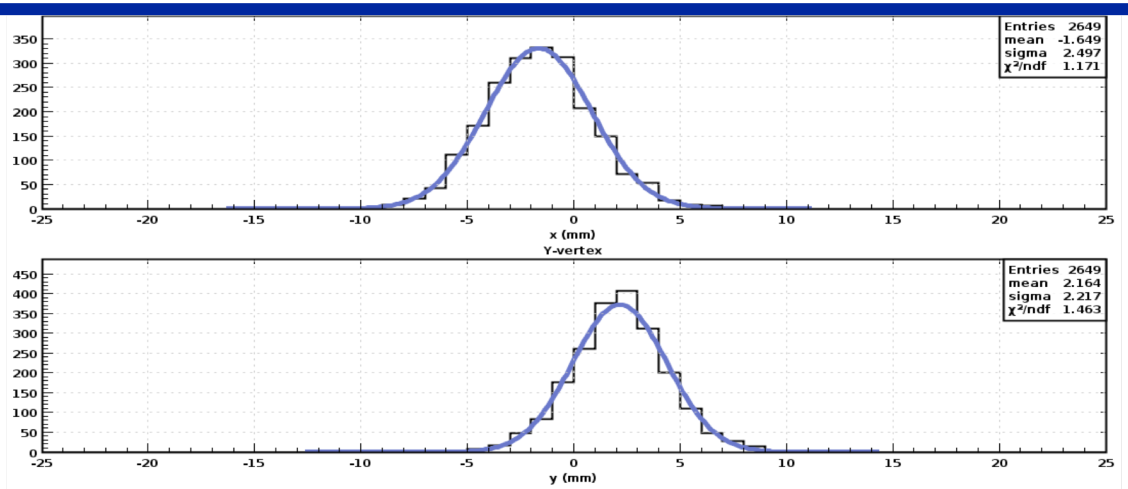


no shim geometry in COATJava 5b.5.0

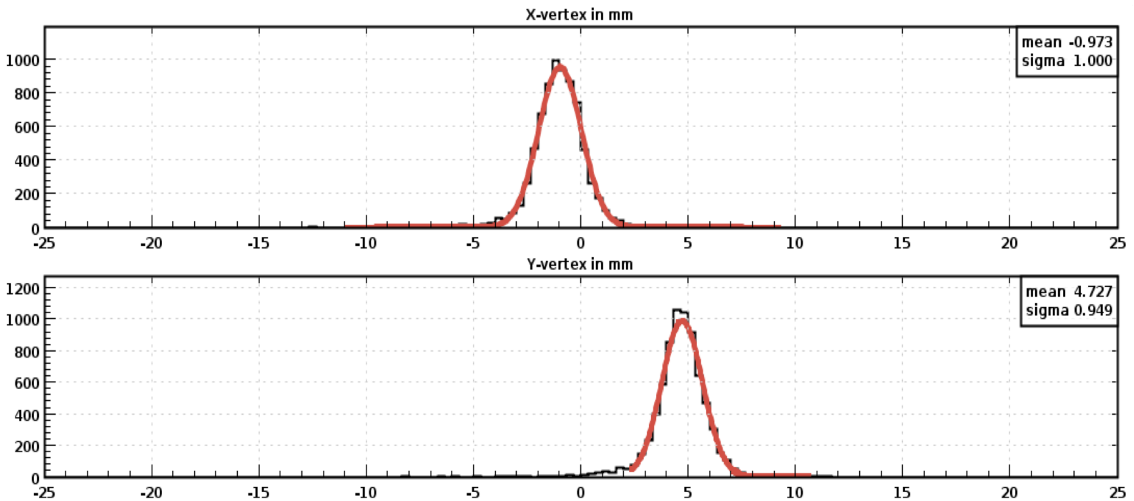
Ideal geometry, no misalignments

MVT Geometry Validation: Alignment Run 2467 (empty target, no solenoid field)

Maxime Defurne

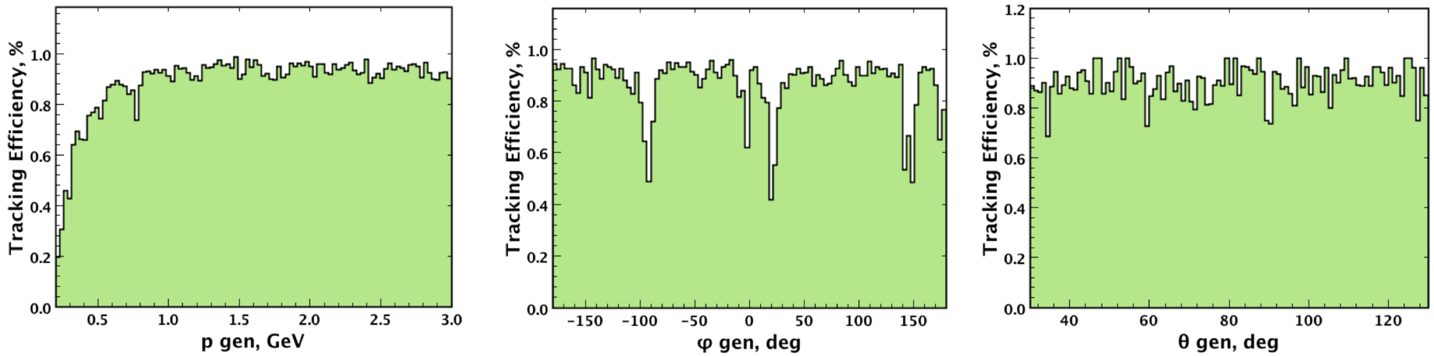


shim

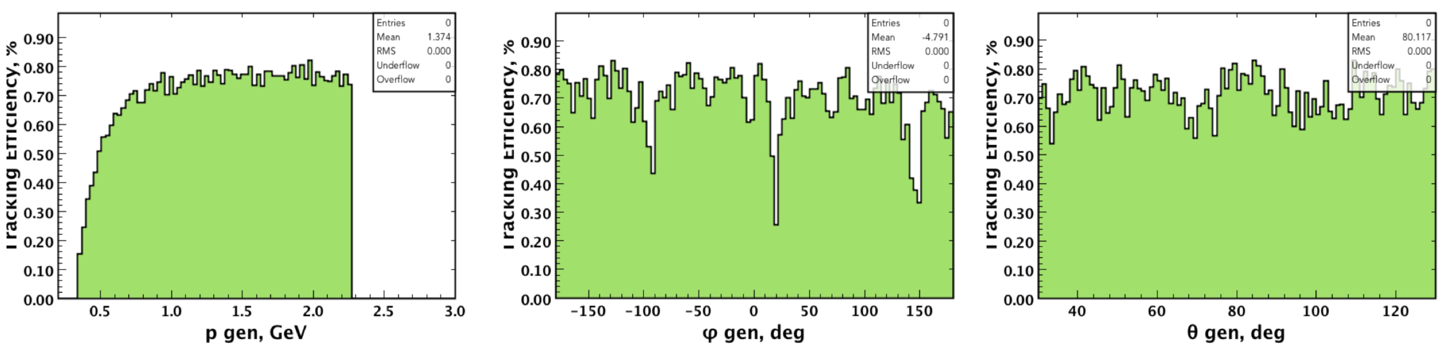


no shim

Track reconstruction efficiency



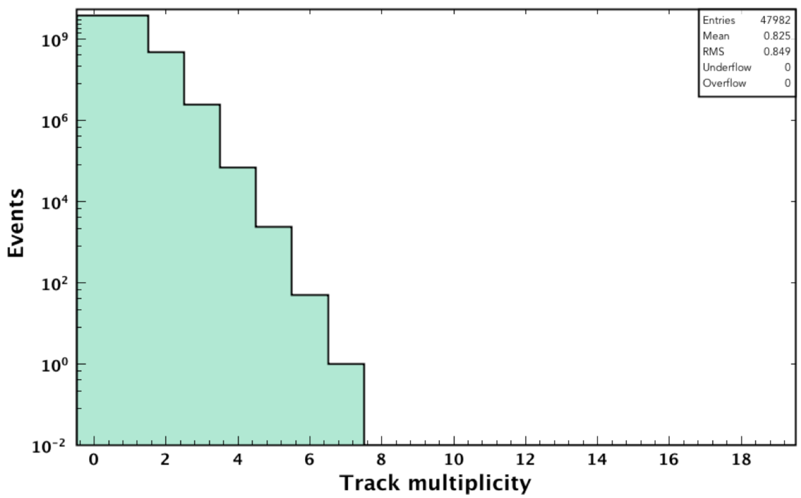
Muon, no background

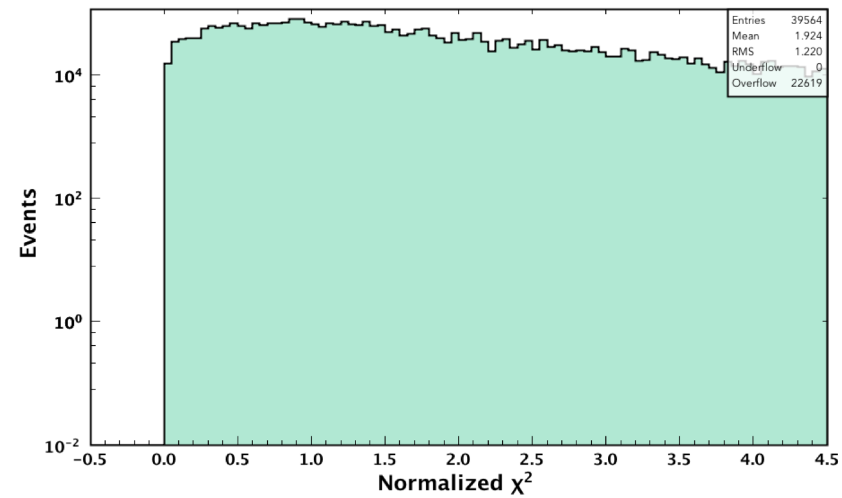


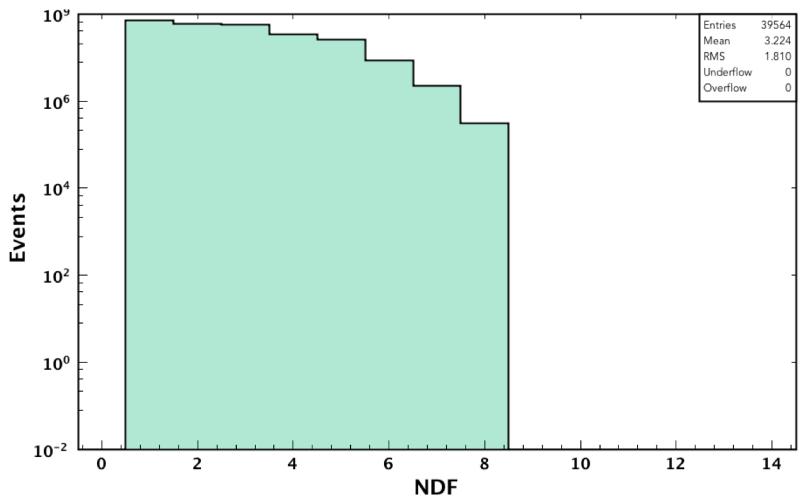
Proton with 50 nA merged background

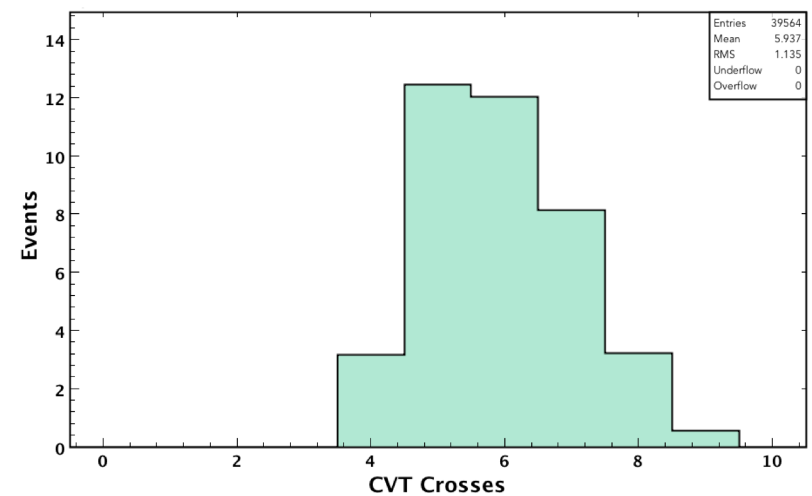
Ideal geometry, no misalignments

Run 4013, 50 nA, CoatJAVA 5b.4.0

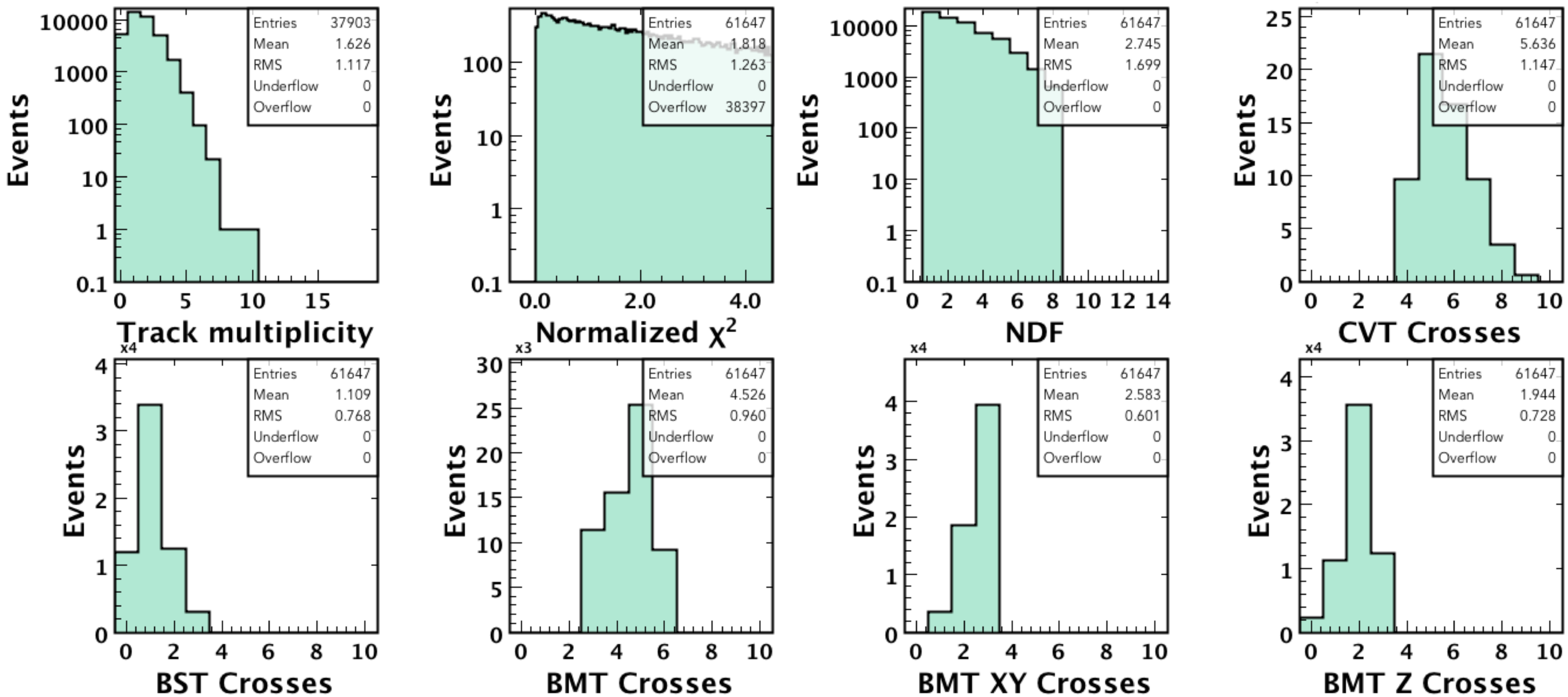








Run 3778, 75 nA, Solenoid -1



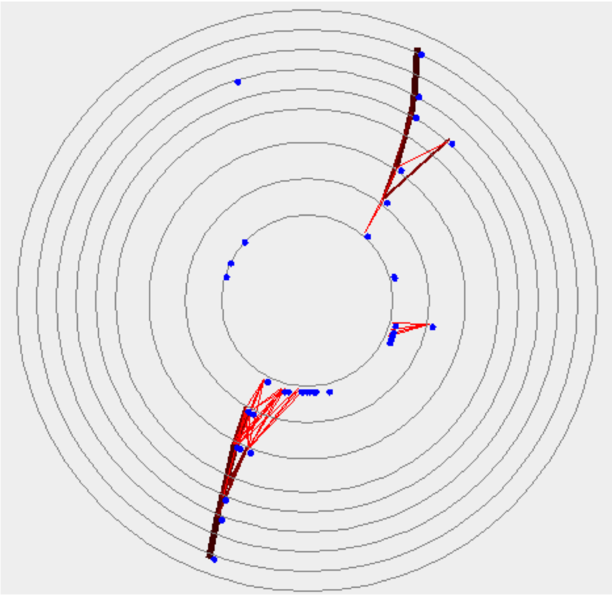
Summary and Outlook

- CVT summer detector activities are on track for the next physics run
- Good progress in development of the CVT tracking
- CVT tracking is being validated on data and Monte Carlo
- Path forward:
  - Better tuning of the CA parameters to catch missing tracks
  - Fix inefficiencies at the BMT tile boundaries
  - Improve efficiency at low momenta and high occupancy
  - Cleaning track duplicates
  - Handling displaced vertices
  - Few tracks with weird path-lengths and χ^2:
    - looking into the Kalman filter part
  - Improve cross finding and matching
  - Local reconstruction (Lorentz angle calibration, clustering)
  - Code optimization
  - Matching GEMC occupancies with data
  - Survey misalignments
  - Alignment with tracks using zero field empty target runs
  - Fixing 19 mm central detector Z shift in geometry

BACKUP

Cellular Automata Rules

- **Cell formation:**
- Two crosses form a cell if they are close in phi (theta) for XY (RZ) plane. Angle cut tuned on MC.
- Crosses should be close-by: allow for one missing layer between crosses.
- **Neighbor formation:**
- Search neighbors from inside out:
- Start close to the beam
- Ex. a cell between layers 1-2,
- If it shares a cross with a cell in layers 2-3
- Then, the cell in layers 2-3 gets a neighbor
- To become neighbors, a cut on the angle between the cells is applied
- Max angle between the cells is tuned on MC.



Cellular Automata Rules

- **Evolution:**
- Evolve the system for 5 epochs
- Each evolution update cell states simultaneously:
- $S = 1 + \max\{ S_{neighbors} \}$
- **Find Candidate:**
- Candidates are formed outside-in
- Start from cells with highest state value
- Follow neighbors with $S_n = S - 1$
- In case of multiple neighbors with the same state, chose the one with the smallest angle between cells
- Flag the cells as used
- Look for other maximum state cells or max-1