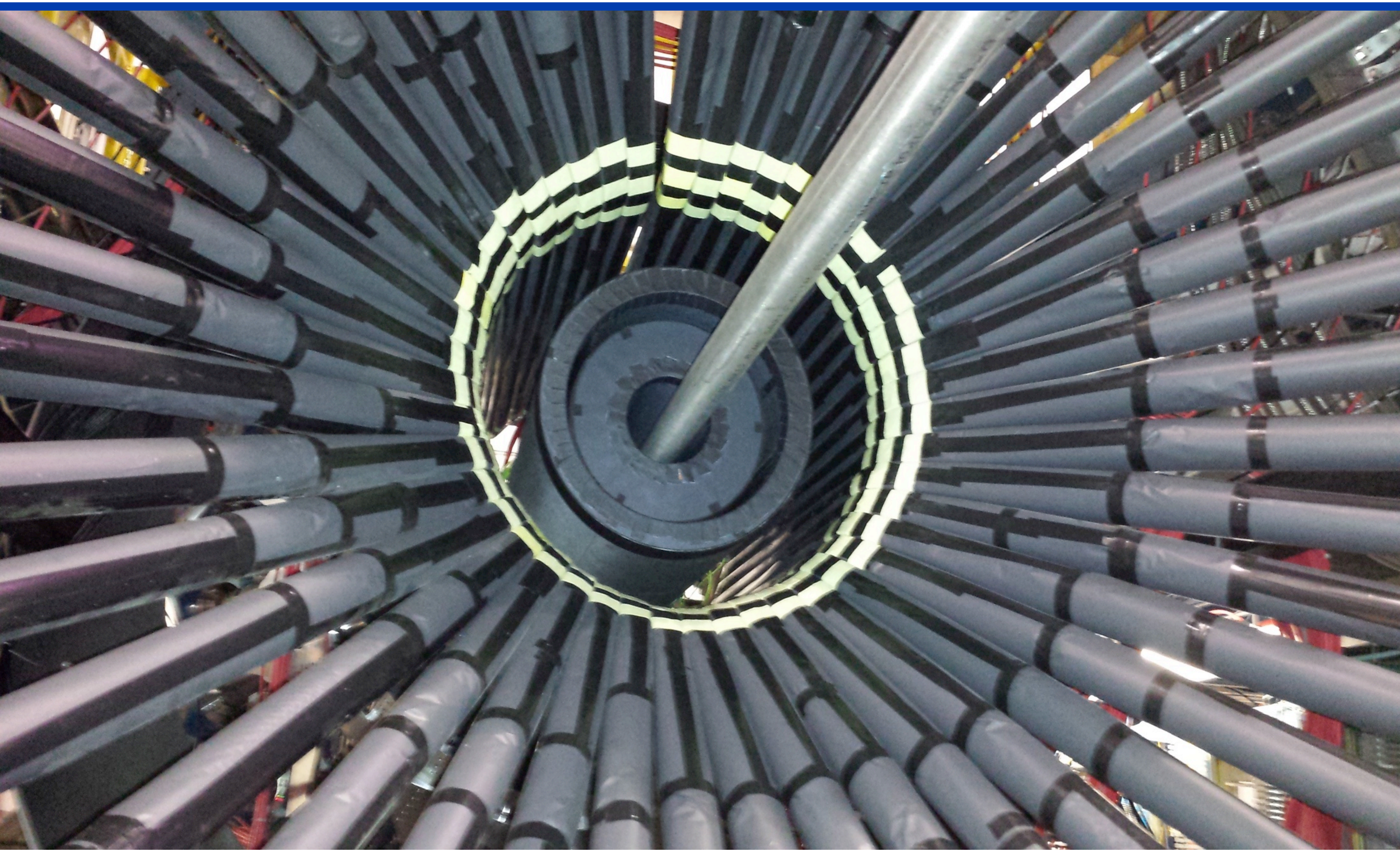
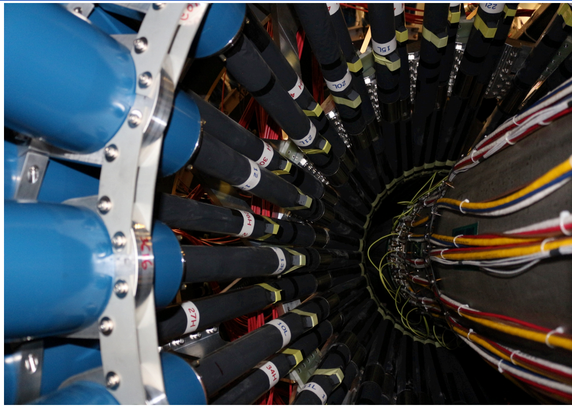
CLAS12 Silicon Vertex Tracker

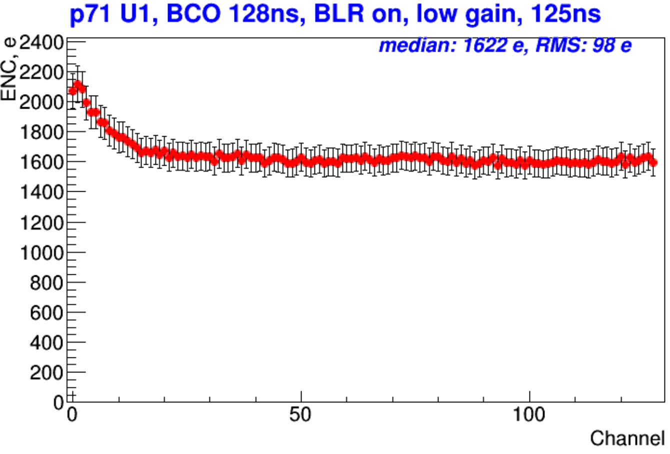


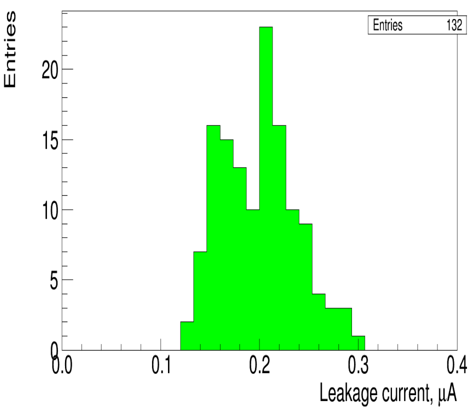
System Operation during KPP

- SVT system installed, cabled, checkout complete in 4 days
  - Great joint effort with DSG and Mechanical Engineering Group
- For cosmic data the standalone SVT SD based trigger was used
  - Trigger rate was 6.5 Hz (compared to 9 Hz in EEL)
  - 85% standalone SVT trigger events have reconstructed tracks
- All channels calibrated, no new bad channels observed
- In R1 U1/U3 chips have noise shoulders on the left side of ENC plots
  - Disappeared when the beam pipe was removed
- Data taking and reco chain validated
- Confirmed signal and noise performance on KPP data
- 6.7 k tracks reconstructed in KPP runs 803, 809, 810
- Completed SEE monitoring test, no readout or data corruption
- Stable running with 99.9% channels operational



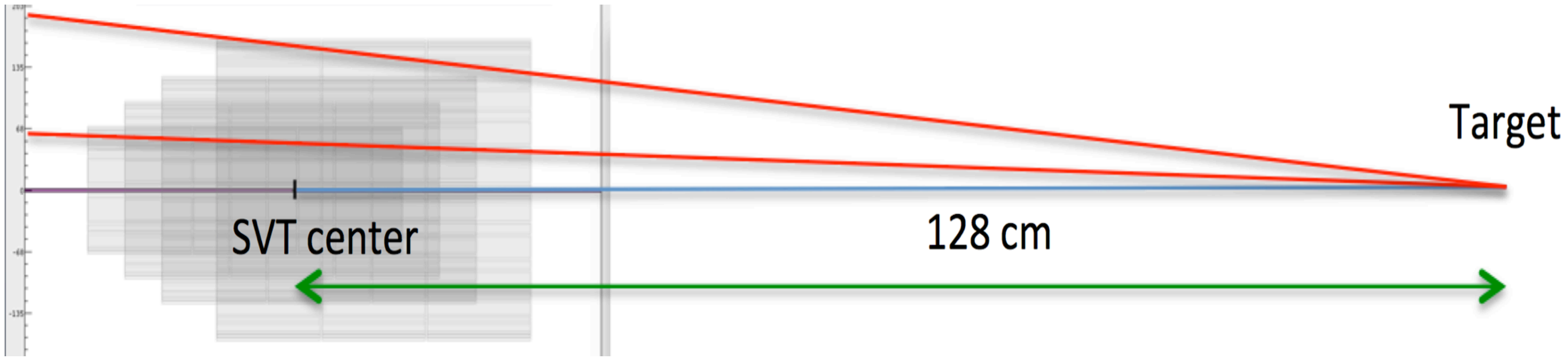
Hall B counting room



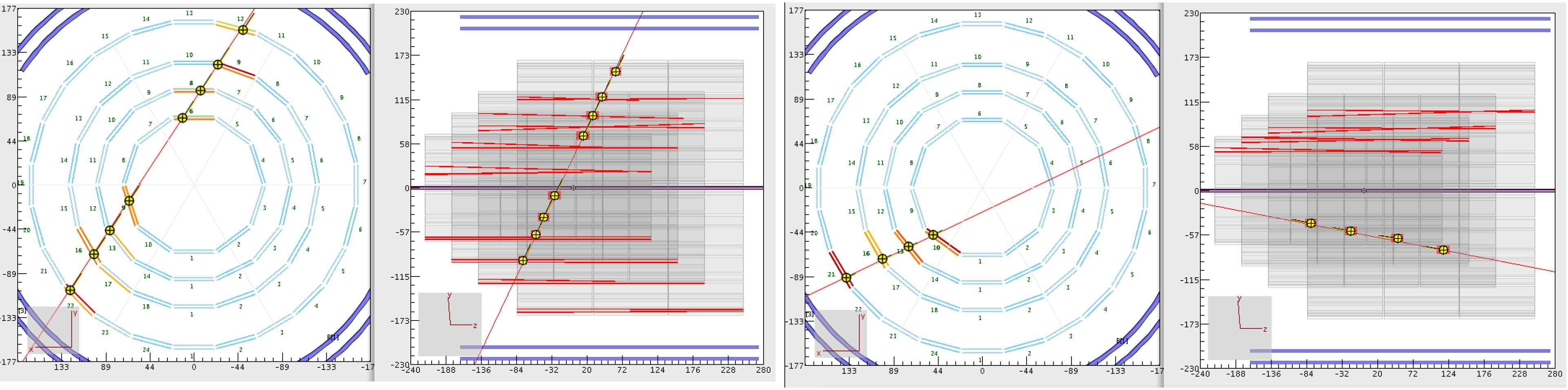


Partition	Channels	% operational
Region 1	5120	100
Region 2	7168	99.98
Region 3	9216	99.96
Region 4	12288	99.99

SVT Operation during KPP



SVT location in KPP



SVT Cosmic trigger data

KPP CLAS trigger data

VSCM SEE Monitoring (SEM)

- VSCM firmware modified (V2.14) to include SRAM error checking
- Added SEM controller for monitoring FPGA configuration SEUs
- Removed ICAP interface from VME register space since SEM controller needs this VSCM FPGA can no longer be reloaded by VME commands and requires a power cycle after a firmware update to get newly loaded firmware running
- DAC test pulse logic uses programmable delays instead of PLL phase shifted clock to write the data to the DAC chip (done to free up a global clock needed for SEM)
- Command line interface and test method implemented
- Monitoring data are saved with time stamps every 10 min

Ben Raydo

Expected Radiation Rate Levels for CLAS12 Operations

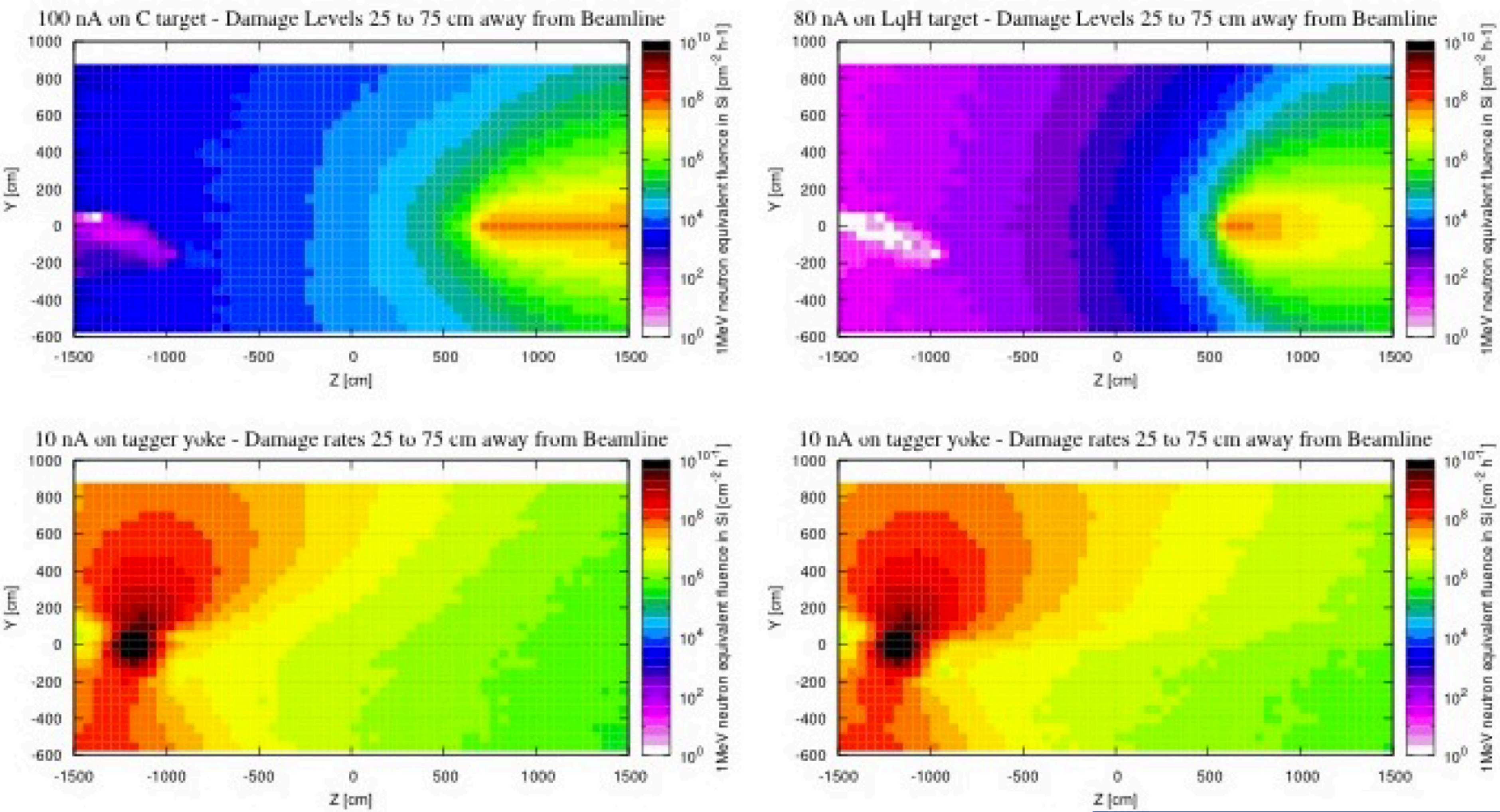
FLUKA Monte Carlo code used to calculate radiation damage levels in Hall B for the following conditions:

1. 11 GeV, 100 nA beam on 1 mm carbon target located at Z = 650 cm. The target has 0.1 mm Al windows up & downstream.
2. 11 GeV, 80 nA beam on 5 cm liquid hydrogen target located at Z = 550cm. The target has 30 µm Al windows upstream and downstream.
3. 11 GeV, 10 nA beam is dumped inside the tagger magnet yoke at Z = -1200 cm. Iron and polyethylene shielding is added between the tagger magnet and the collimator box. Blank Ni collimator is inserted.
4. 11 GeV, 10 nA beam is dumped inside the tagger magnet yoke at Z = -1200 cm. Iron shielding is added between the tagger magnet and the collimator box. Blank Ni collimator is inserted.

Levels of radiation damage are estimated in terms of 1MeV neutron equivalent fluence in Si and high energy hadron equivalent which is proportional to the rate of SEE.

George Kharashvili
JLAB RadCon Dept

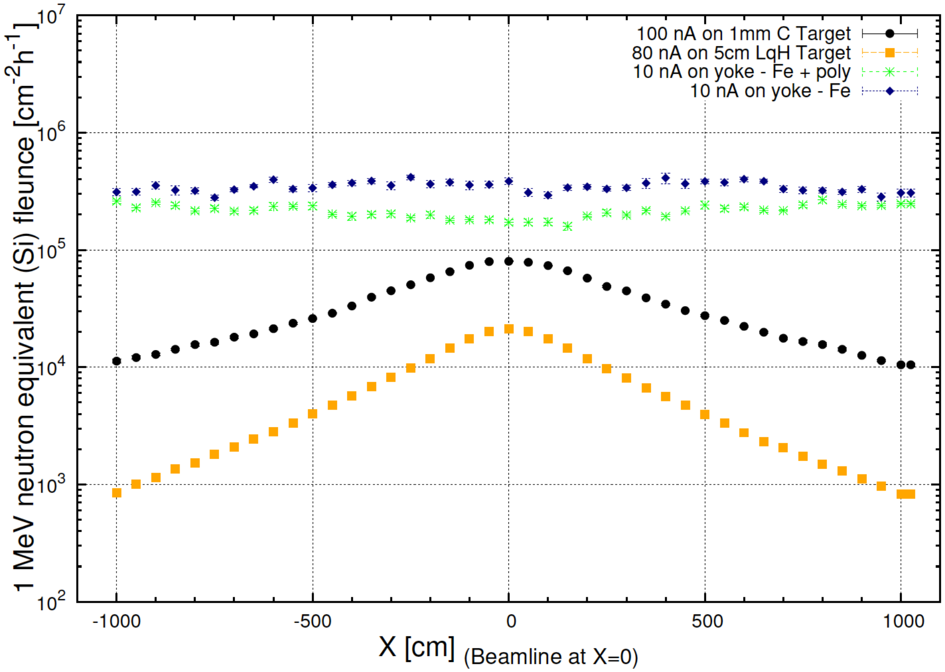
Radiation damage levels in $\Phi_{eq}^{1\ MeV}$ in silicon

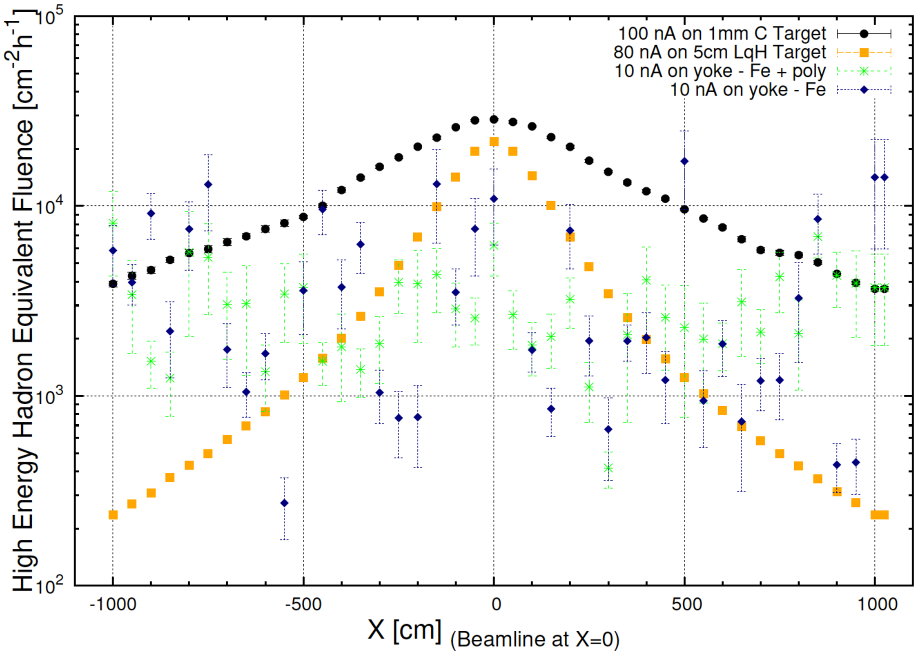


Levels in the vertical plane 50 cm from the beamline.

George Kharashvili
JLAB RadCon Dept

Levels vs. lateral distance from the beamline at Z = 400 cm*



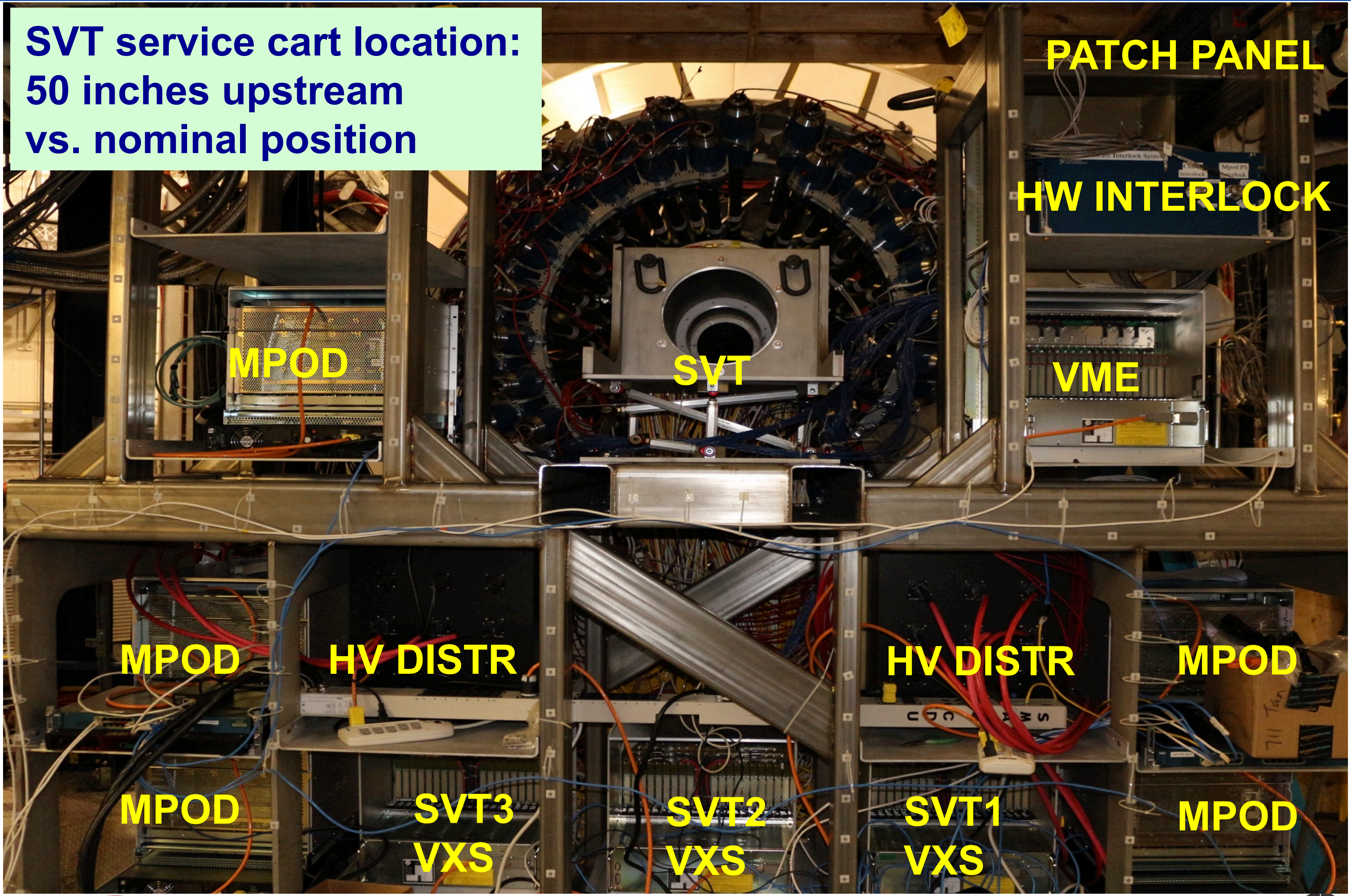


George Kharashvili
JLAB RadCon Dept

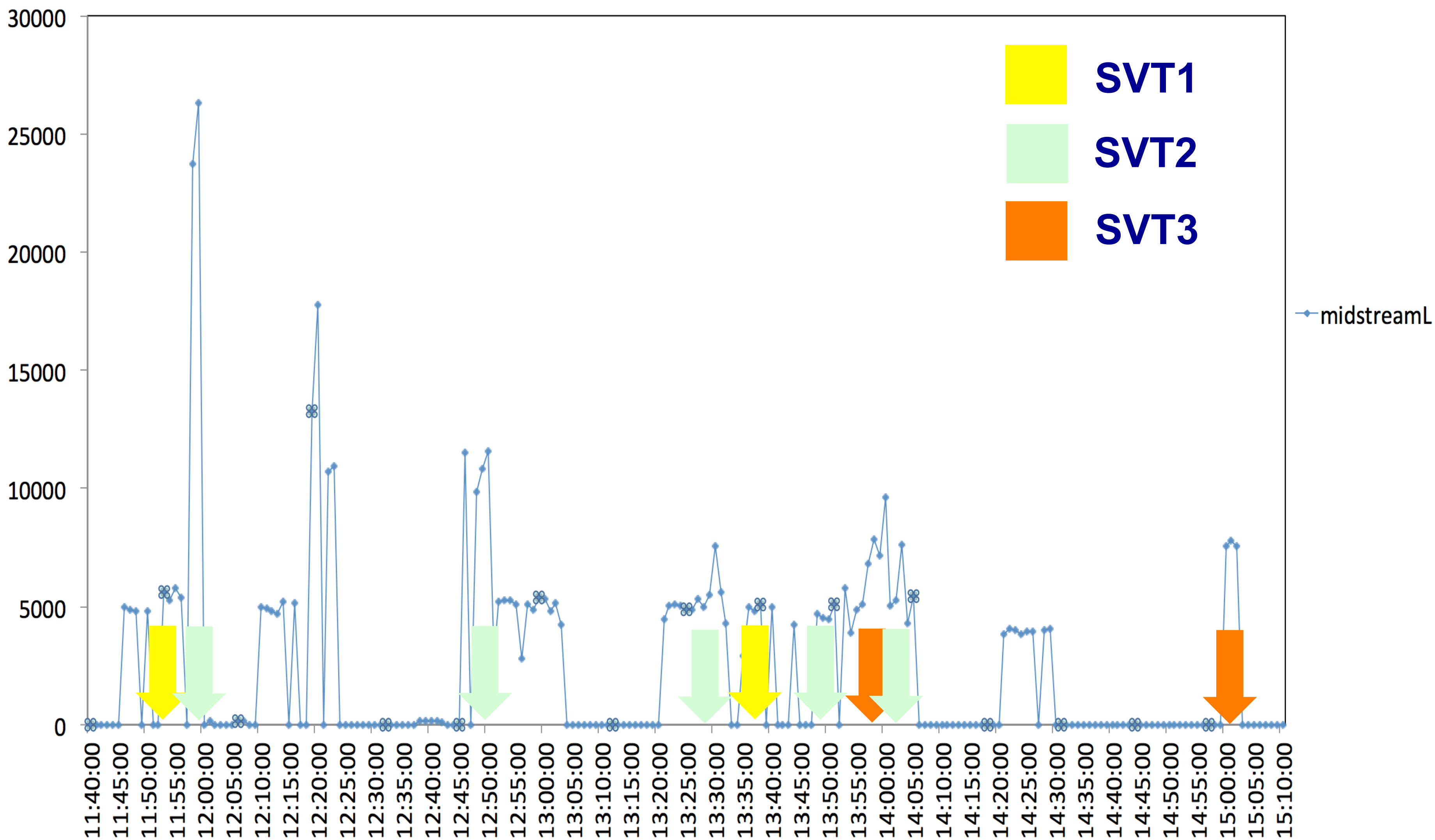
*** Location of the SVT service cart**

SVT SEE Test Setup in the Experimental Hall

SVT service cart location:
50 inches upstream
vs. nominal position



SEM Reports 02/03/2017



SEM Test Summary and Outlook

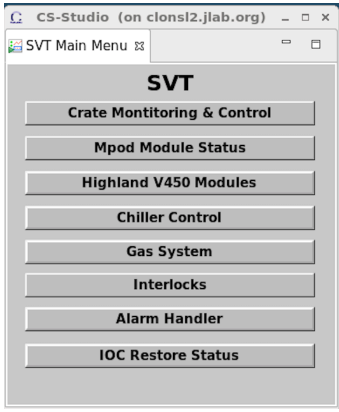
- Radiation rates from LH_2 target are much less than what comes from the dump or carbon target
- Tests performed with yoke dump during KPP are sufficient to address the recommendation
- Relatively minor SEUs were recorded in SVT readout electronics
- VSCM SEE Monitor recorded events are correlated with beam conditions in the experimental hall during the KPP run
- No errors were recorded during 1 week SEE Monitor testing in EEL
- SVT readout and PS crates were operational during KPP, no rebooting required
- No readout or data corruption issues were observed
- SVT readout electronics and PS are operational after the KPP
- Action items:
  - review beam loss prevention and detector protection measures
  - evaluate possibility of installing extra shielding of the SVT cart
  - keep the SVT crates in OFF state during the beam tuning
  - move network switches to the SVT rack
  - add heart beat to SEM

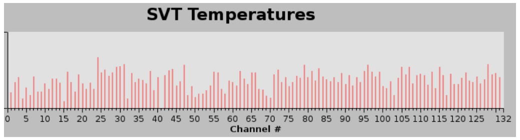
Slow Controls

Nathan Baltzell

Status of Slow Control and Monitoring System transfer to CS-Studio:

- 4 soft IOCs running and tested on CLAS machines
- all screens converted from EDM, tested in CS-Studio, with improvements
- 1 VME IOC ready to move CLAS setup for testing soon (~week)
- alarms converted to BEAST
- moved soft interlocks from AIH into IOCs
- setup remote access to the system with VDI
- stable running on a clon pc

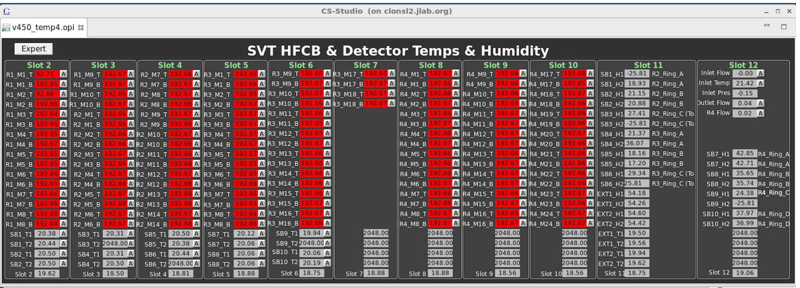


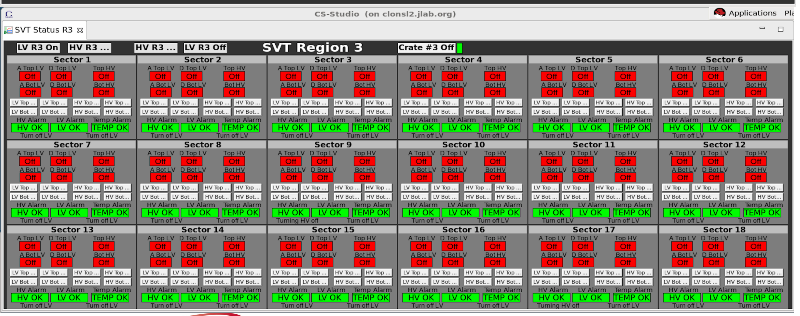


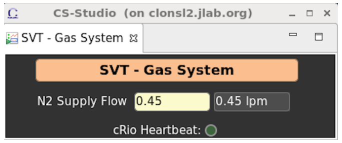
Expect checkout of full conversion to CLAS in early / mid-April

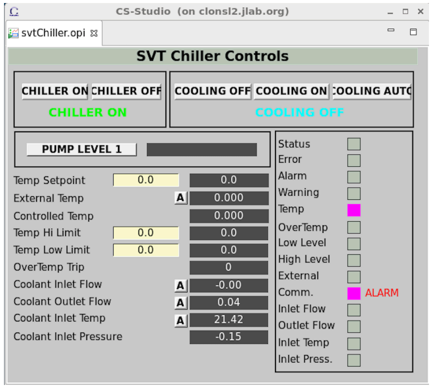
Future improvements:

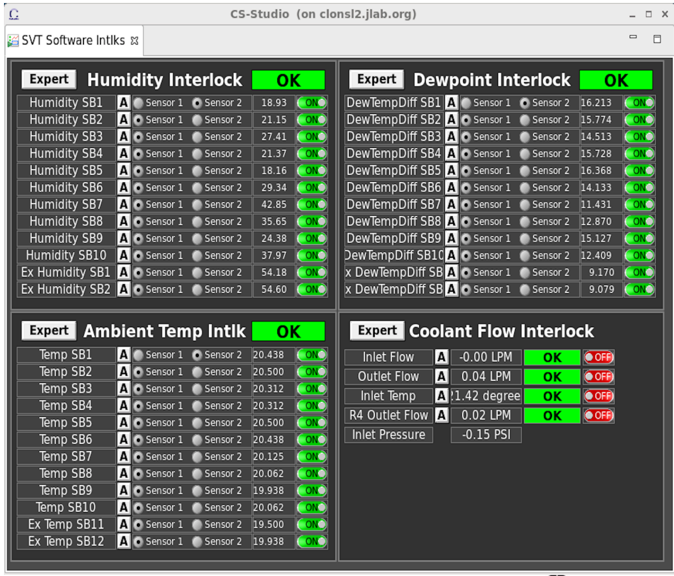
- add autosave / restore to IOCs
- implement summary status records and simpler overview screens, including webopi



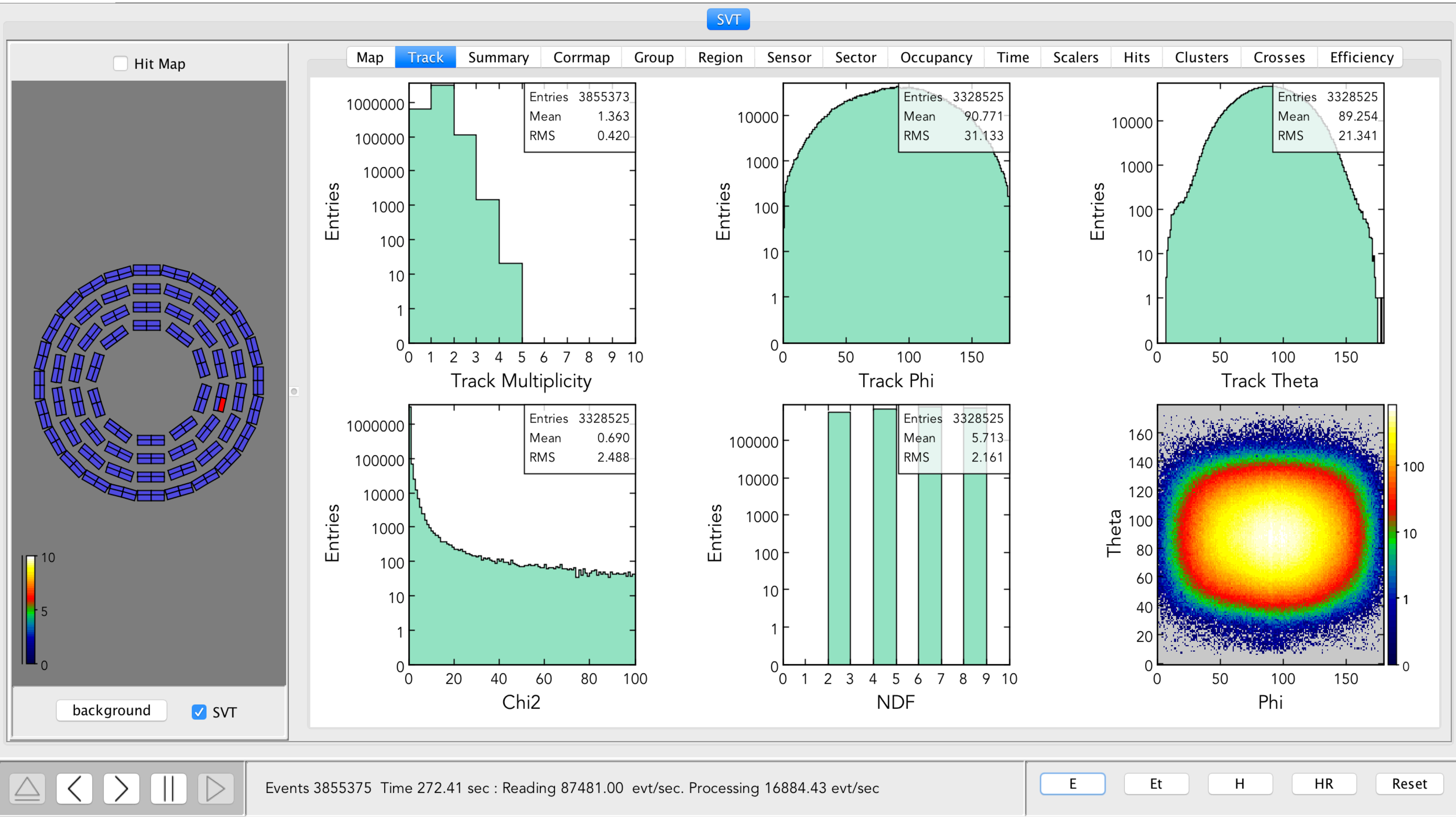




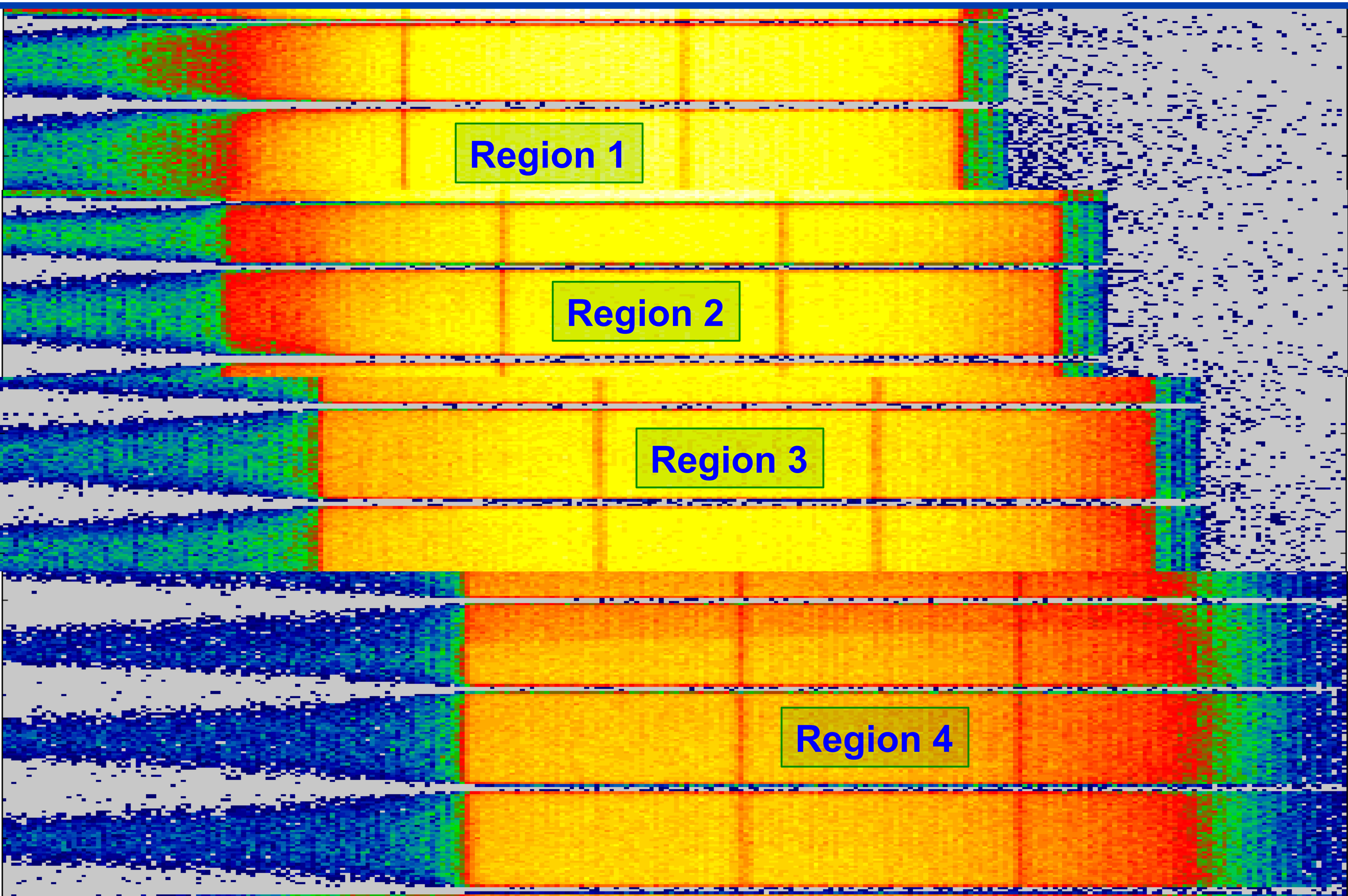




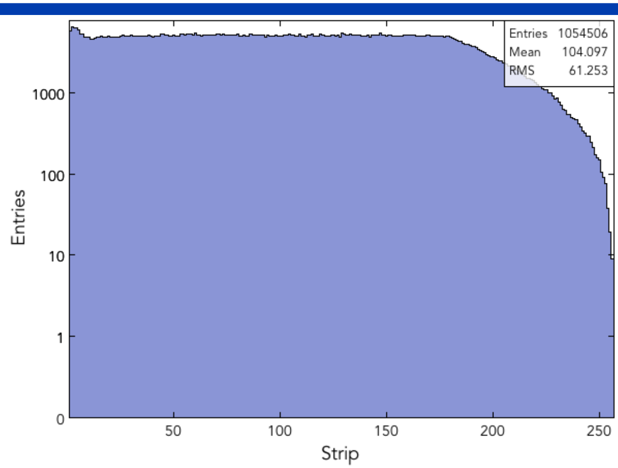
Online/Offline Detector Monitoring

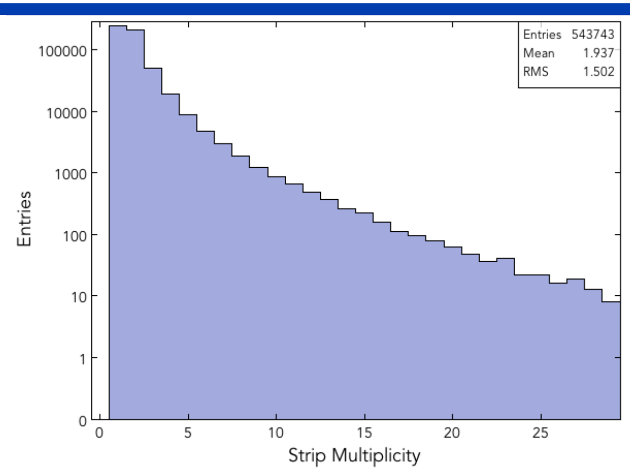


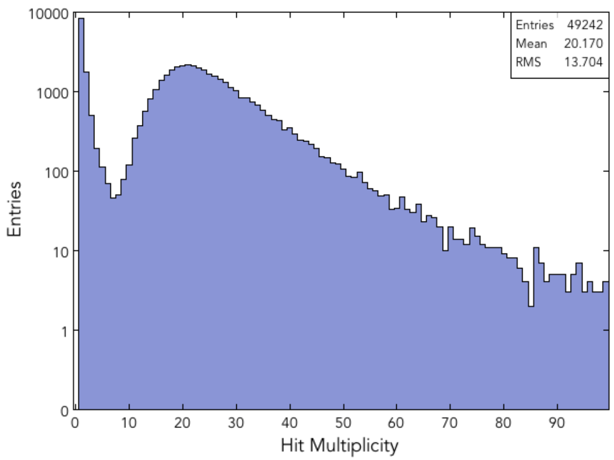
Reconstructed On-Track Crosses in Cosmic Run (March 2017)

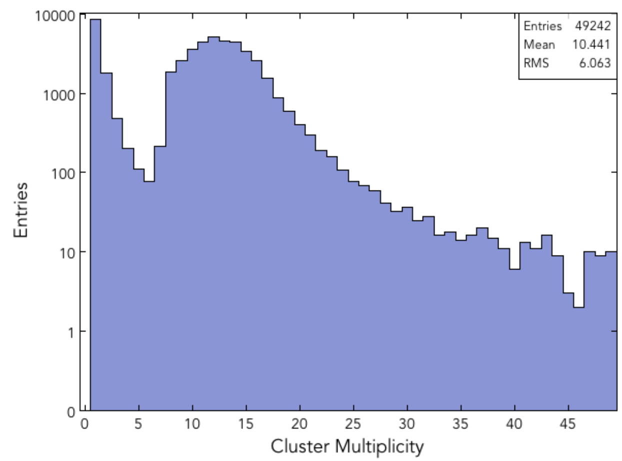


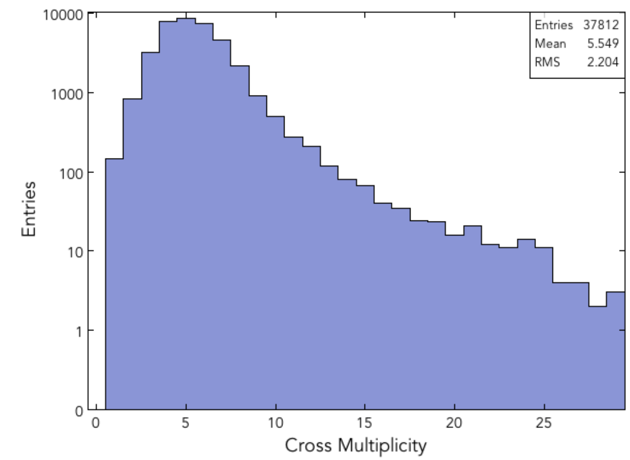
Local reconstruction (runs 803, 809, 810)



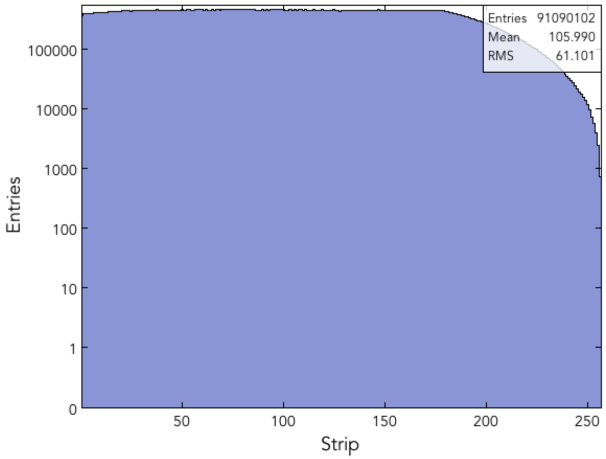


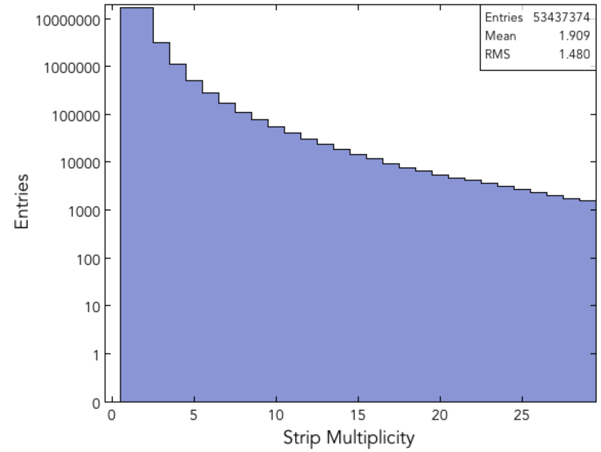


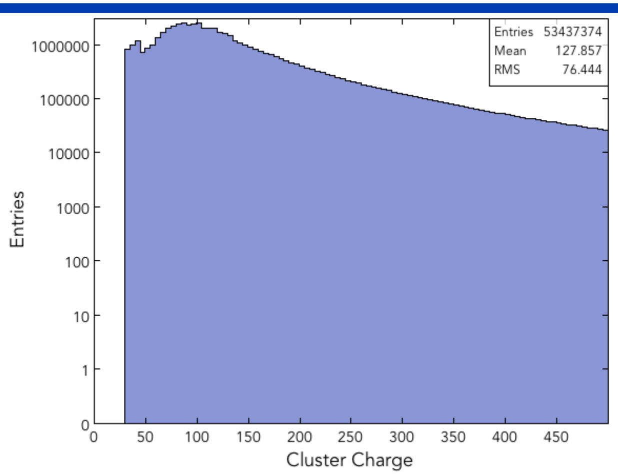


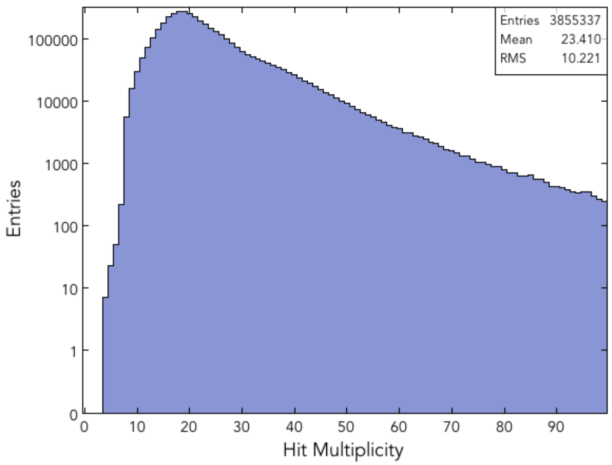


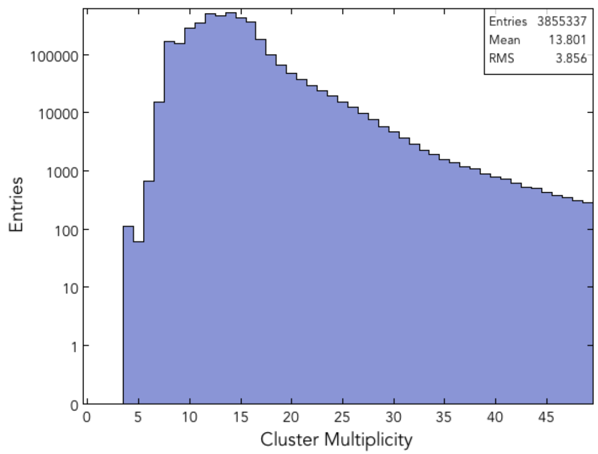
Local reconstruction (cosmic run 419)

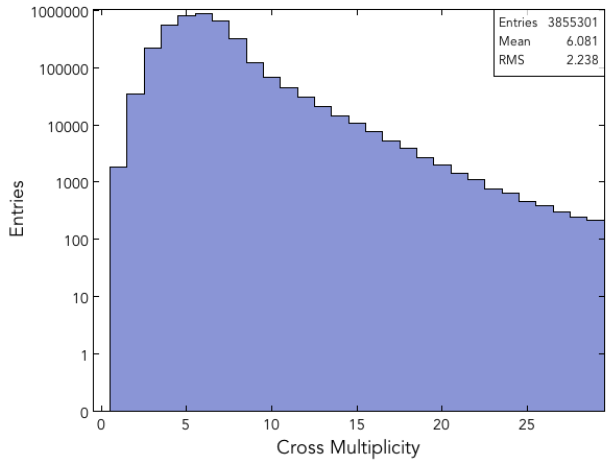




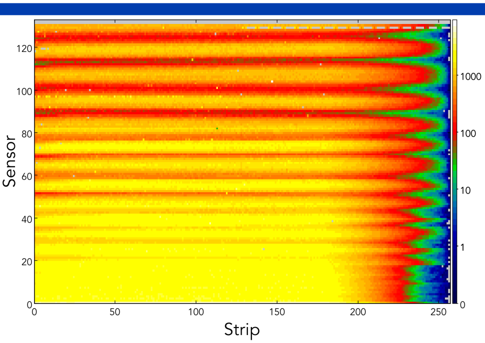




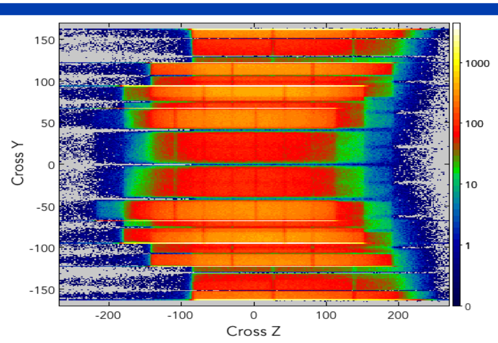




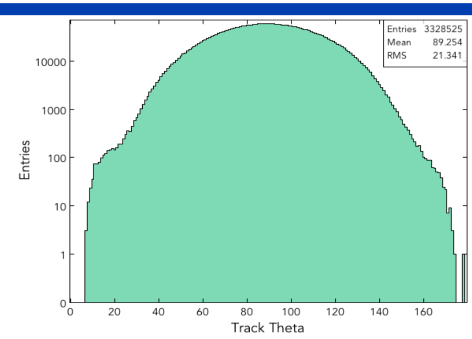
Data Quality Monitoring



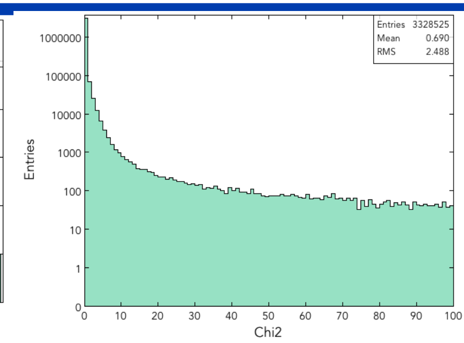
Hit occupancy



Track crosses

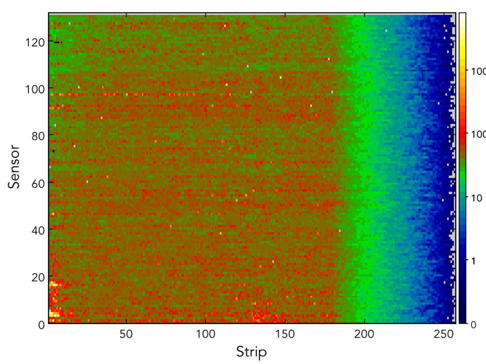


Track θ angle

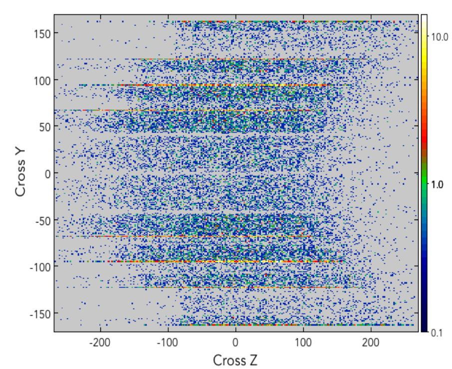


Normalized χ^2

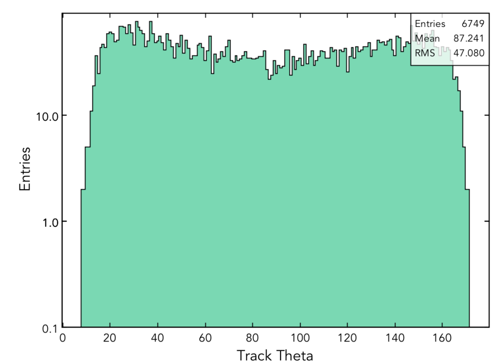
SVT Cosmic trigger data



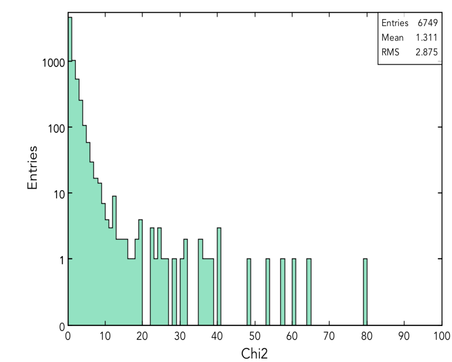
Hit occupancy



Track crosses



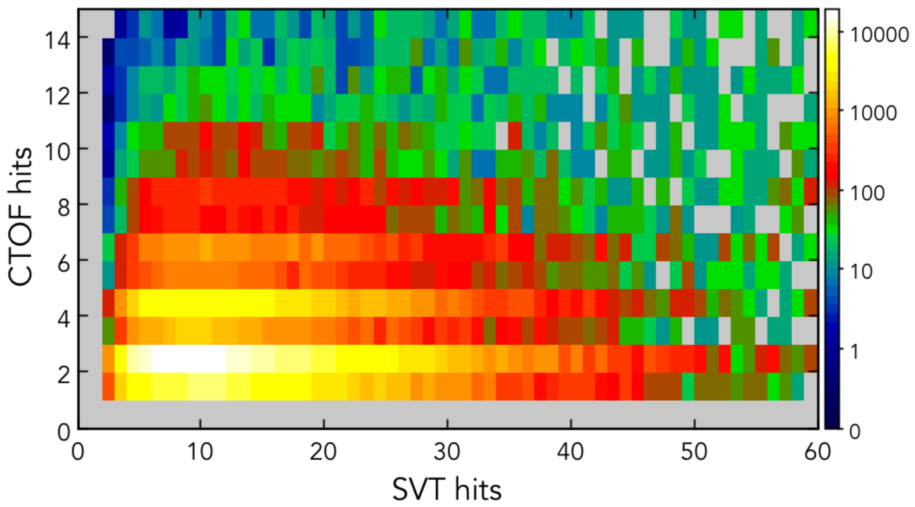
Track θ angle

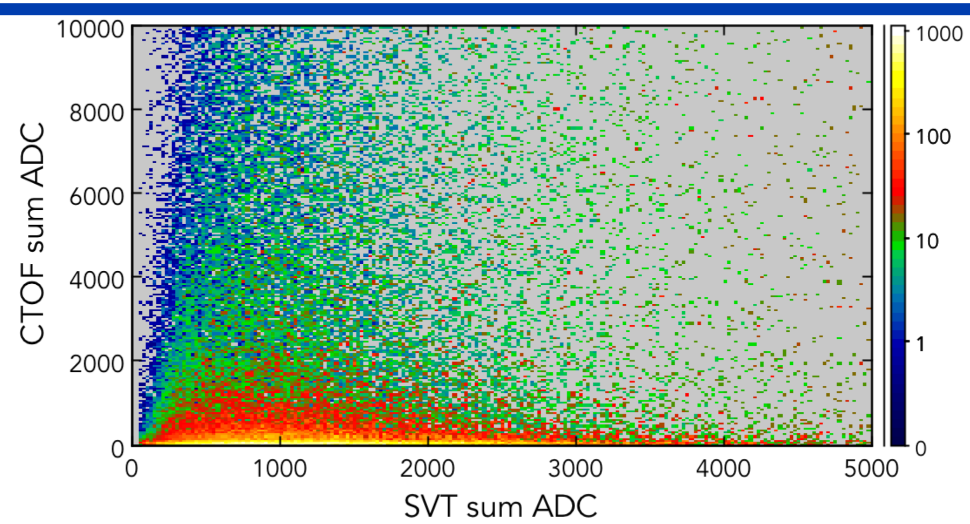


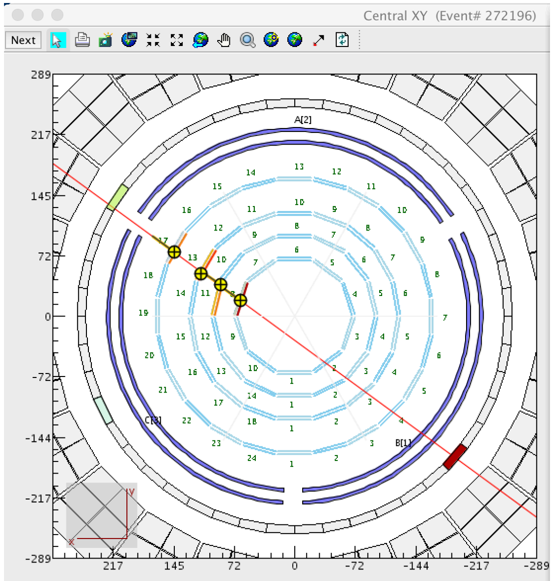
Normalized χ^2

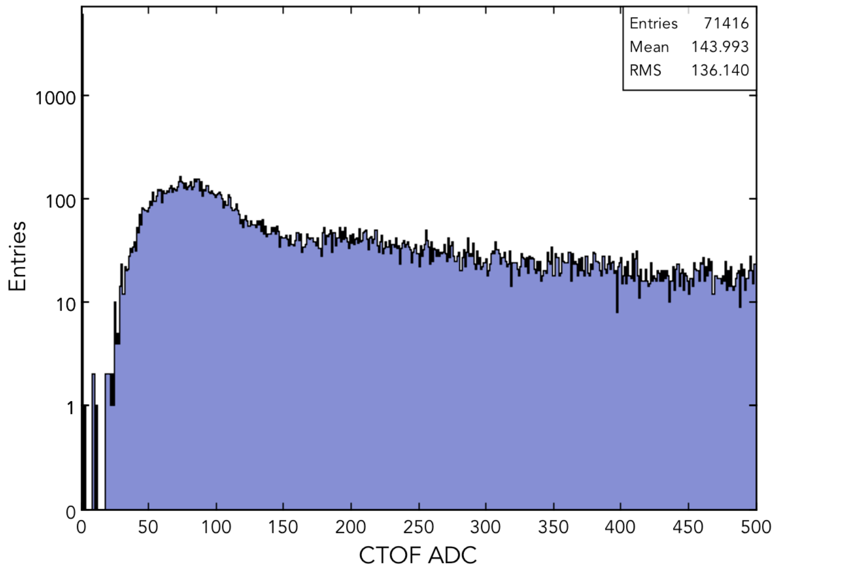
KPP CLAS trigger data

Events with signal in SVT and CTOF

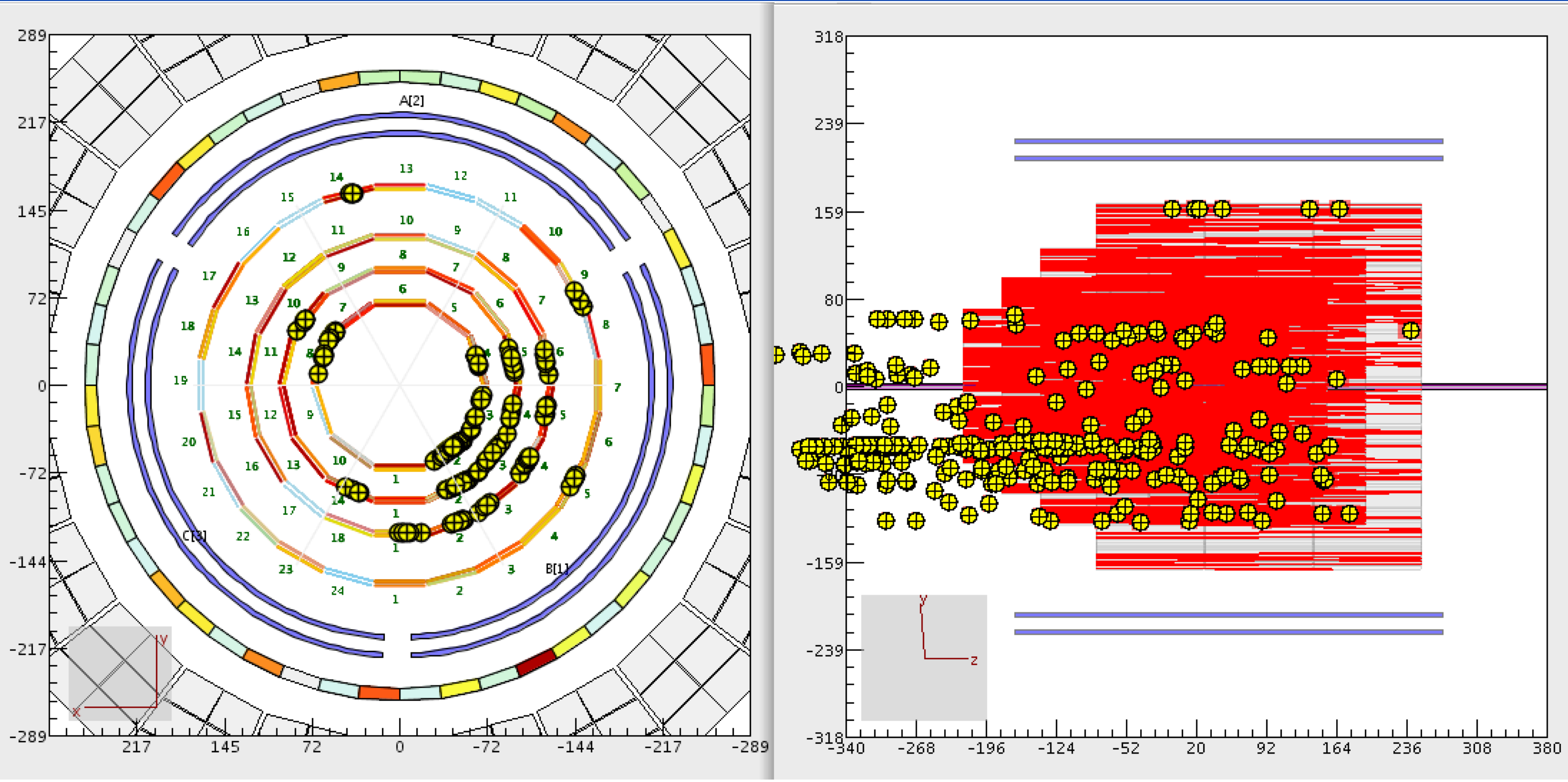








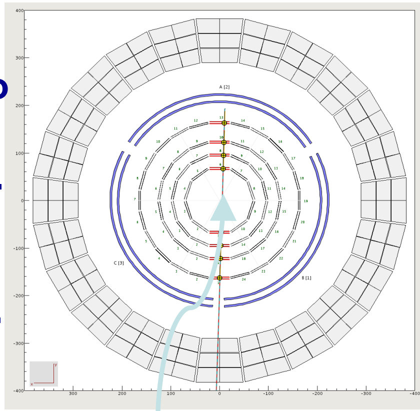
Sample KPP event with high SVT and CTOF hit multiplicity



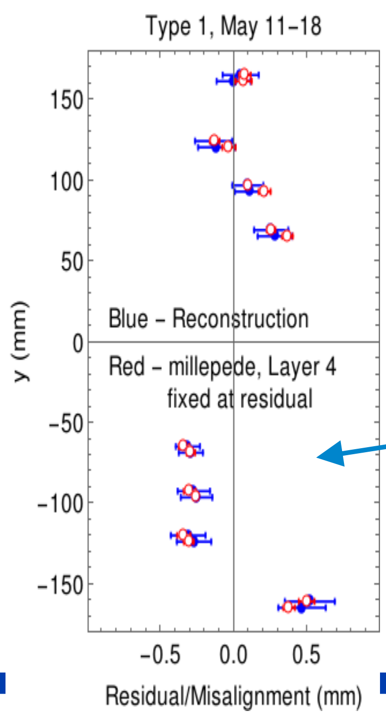
Alignment

Jerry Gilfoyle

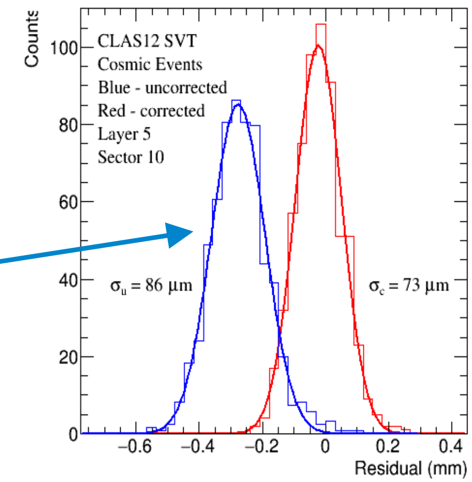
- **Track-based alignment of SVT requires fitting many parameters:**
  $$N_{sectors} \times N_{layers} \times N_{trans} \times N_{rot} = 66 \times 2 \times 3 \times 2 = 792$$
- **Program millepede does linear least squares with many parameters.**
  - **Uses matrix form of least squares method and divide the elements into two classes.**
    - **Global parameters – the geometry misalignments. Same in all events.**
    - **Local – individual track fit parameters. Change event-to-event.**
  - **Calculate first partial derivatives of the fit residuals with respect to the local (i.e. fit) parameters and global parameters (geometry misalignments).**
  - **Manipulate the linear least squares matrix to isolate the global parameters (geometry) and invert the results to obtain the solution.**



Type 1 tracks – sensors are horizontal.

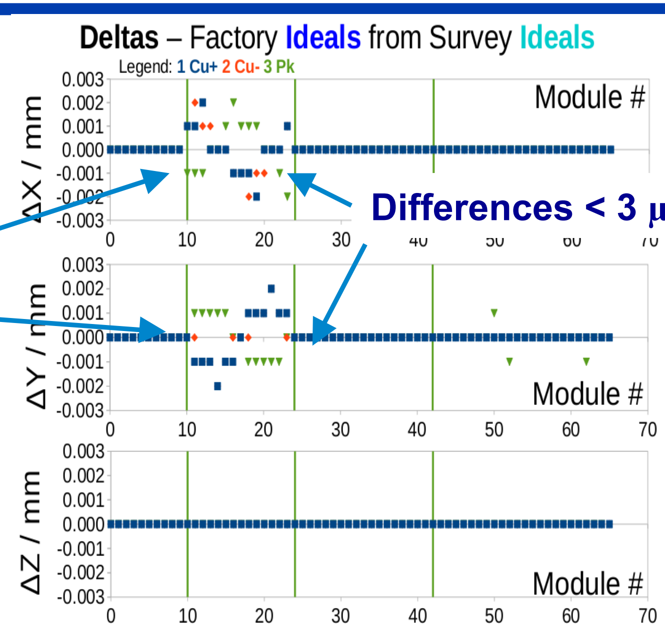


- **Apply to a 'simple' example – Type 1 tracks.**
  - **Use gemc cosmics for testing and validation.**
  - **Shift layers 1-2 (Region 1) by 2-500 μm in *x*.**
  - **millepede reproduces all shifts.**
- **Apply to Type-1 cosmic ray sample from SVT.**
  - **Fixed layer 4 in millepede fit to SVT residual.**
  - **Good agreement between millepede mis-alignment and residuals.**
  - **Fit residual and resolution improve.**
- **Code for Type 2 events now being tested.**



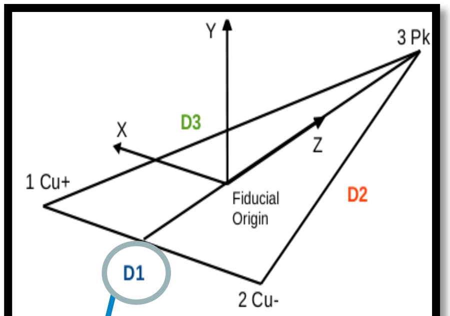
Alignment

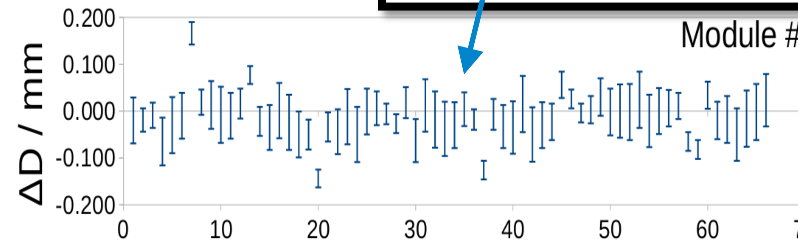
- **Ideal Geometry Validation and Testing**
  - **Calculate ideal fiducial location on each module.**
  - **Observed significant difference with engineering drawings - up to 100 μm. Now reduced to < 3 μm**
  - **Ideal geometry now well defined with parameters from engineering drawings.**
  - **Used by simulation and reconstruction codes.**



- **Geometry package**
  - **Common Java utility (now part of JCSG) to access geometry for gemc and reconstruction.**
  - **Generate shifts from ideal geometry to measured fiducial results.**
  - **Full inventory of material in SVT for gemc.**
  - **Draft CLAS-NOTE written.**
  - **Charles Platt, new Surrey masters student on-site.**

Fiducials form triangle on sensor.

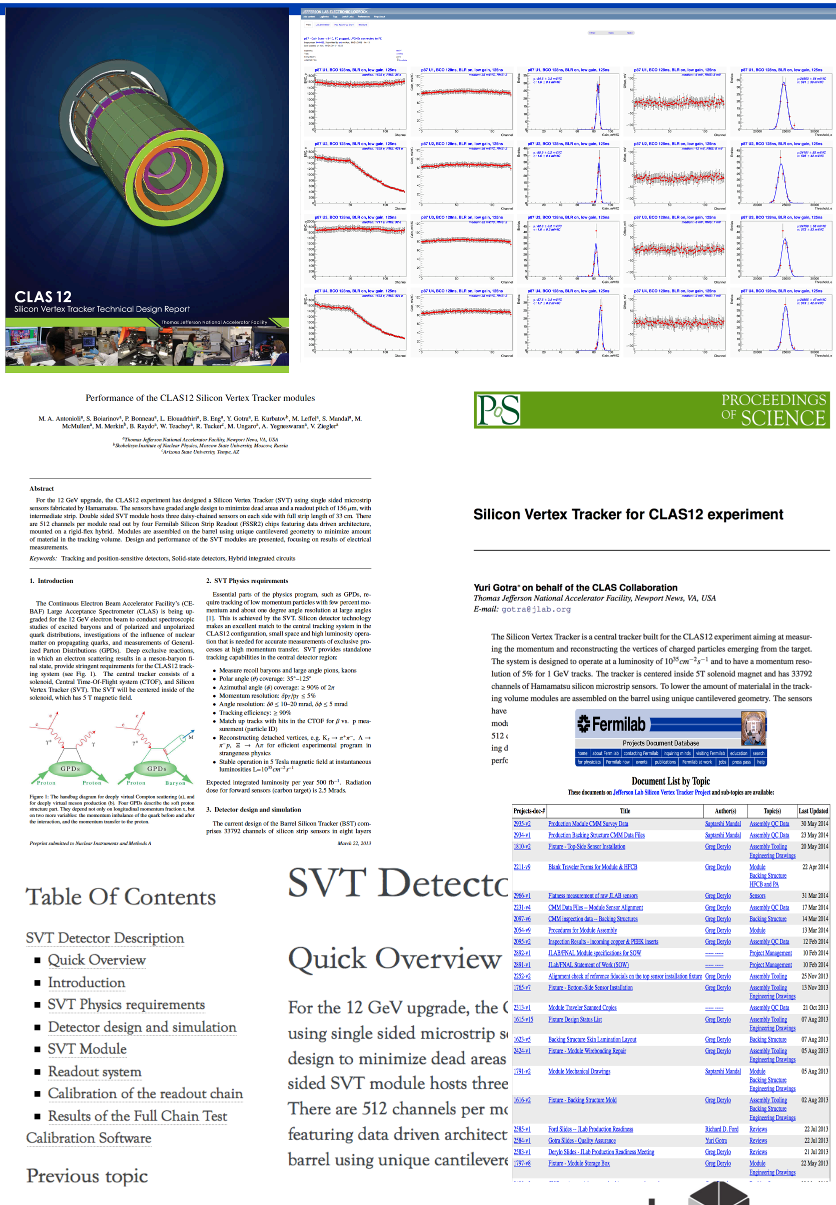




Jerry Gilfoyle

Documentation

Technical Design Report	✔
Geometry Document	✔
Commissioning Document	✔
Reconstruction Algorithms	✔
Manufacturing Drawings and Schematics	✔
Assembly/Service Procedures	✔
Production, Assembly, and Survey Databases and Travelers	✔
Operations Manual and Safety Procedures	✔
Bench Testing Results	✔
Electronic Logbooks	✔
SVT presentations	✔
CLAS Notes and Conference Reports	✔
Photographic History	✔
Wiki pages	✔
Archival webpage	✔



https://www.jlab.org/Hall-B/cvt/svt/

Summary and Outlook

- Passed Experiment Readiness Review in December 2016
- KPP installation and system checkout complete in 4 days
- Confirmed signal and noise performance on KPP data
- 6.7 k tracks reconstructed in KPP runs 803, 809, 810
- Completed SEE monitoring test, no readout or data corruption
- Slow control monitoring system migrated to CS Studio
- 100 M tracks cosmic sample collected, alignment in progress
- Stable running with 99.9% channels operational

- Checkout of full conversion of Slow Controls to CLAS by mid-April
- Complete development of expert level monitoring and validation suite by June
- Complete tracker geometry validation by May
- Add rejection of out of time hits by May
- Add extra checks to SEM by June
- Add channel status info to CCDB by June
- Integration with MVT by mid-summer
- CVT MC validation by mid-summer
- Detector alignment is critical step in validating the tracker performance
    - Complete SVT alignment by mid-summer
    - Complete CVT alignment by September
- Documentation and tutorials