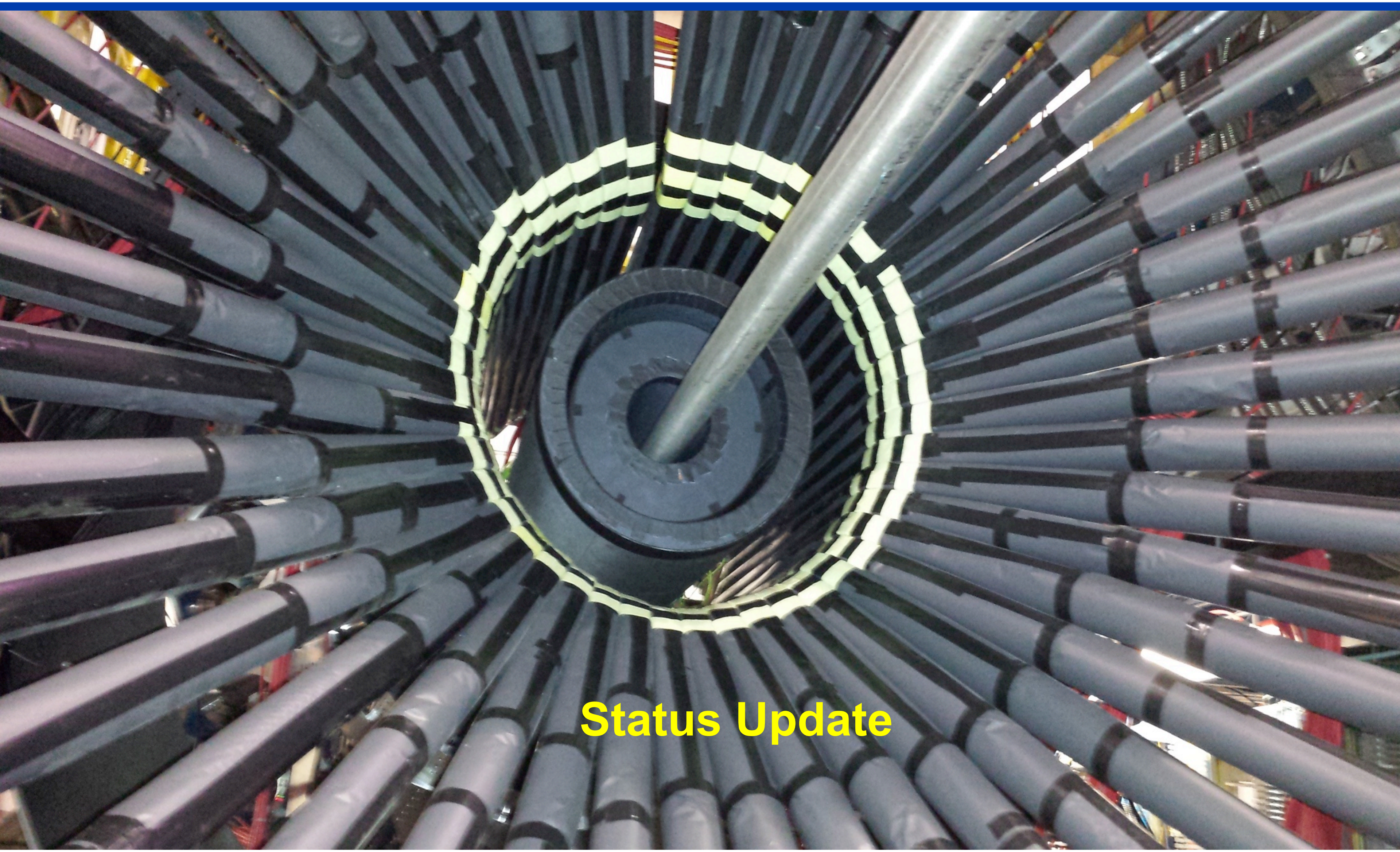
CLAS12 Silicon Vertex Tracker



Status Update

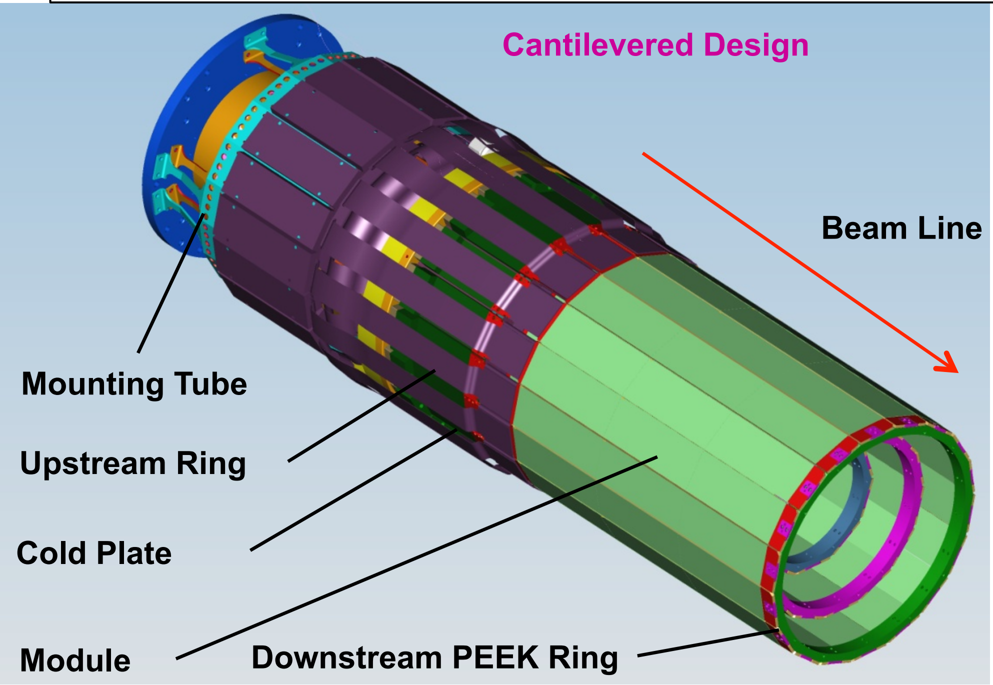
Outline

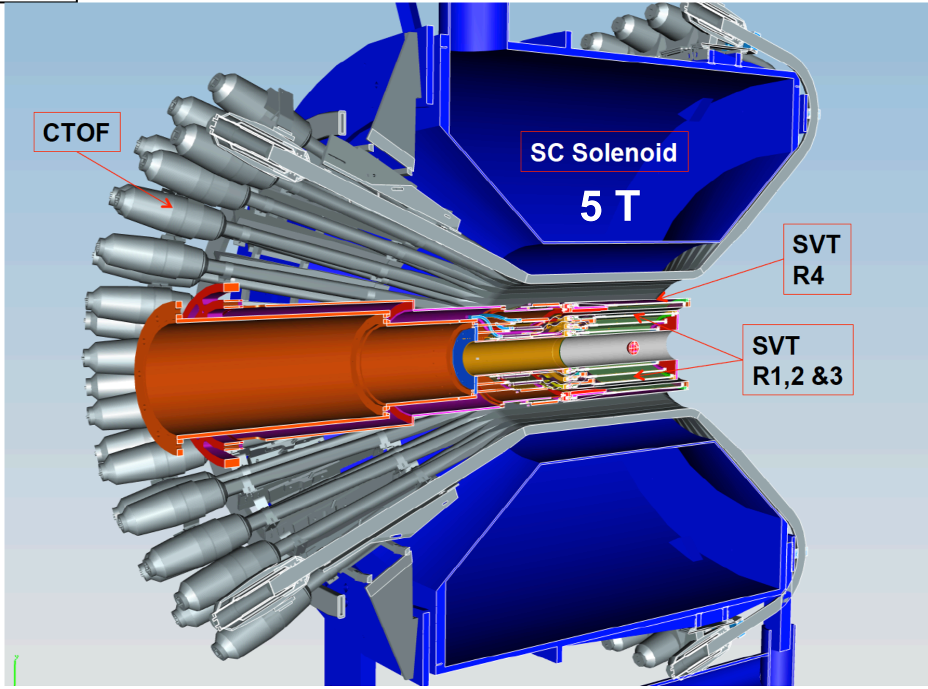
- System Overview
- DAQ Status
- Slow Controls
- Operation and Safety
- Documentation
- Geometry Validation
- Alignment Status
- Calibration
- Detector Monitoring
- Detector Commissioning with Cosmics
- Performance in KPP
- CVT Integration
- Summary and Outlook

System Overview

- Four regions (radii 65, 93, 120, 161 mm)
- 1% of radiation length per region
- 66 sectors/modules (10, 14, 18, 24)
- Two concentric barrels (MicroMegas upgrade)

- Silicon area ~1.5 m²
- Channels: ~34,000
- Bonds: ~200,000

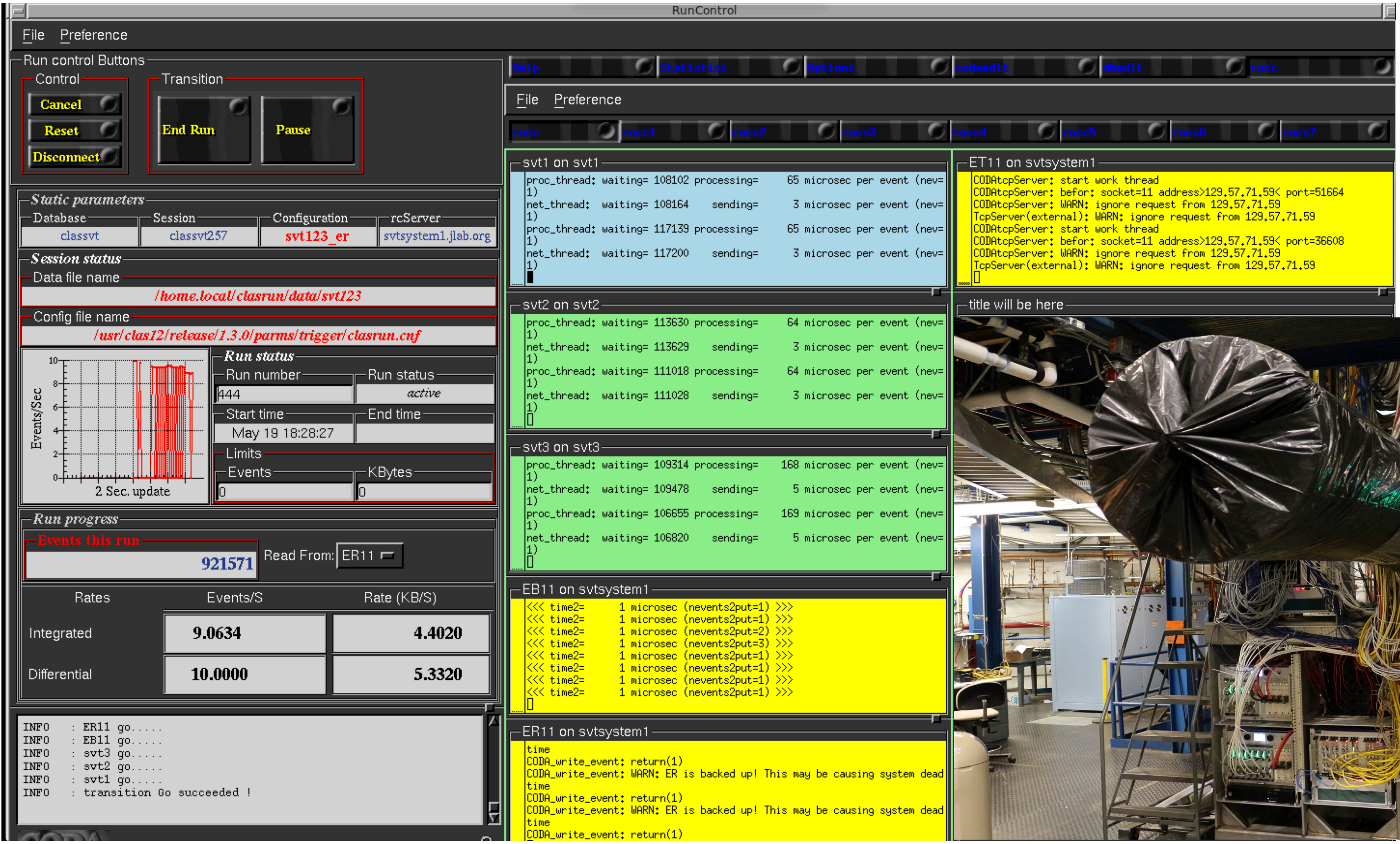




- Cantilevered cylinders with support rings
- Double sided modules with 3 daisy chained sensors
- Single sided sensors with graded pitch
- Rigi-flex hybrid with extended L1 disconnect

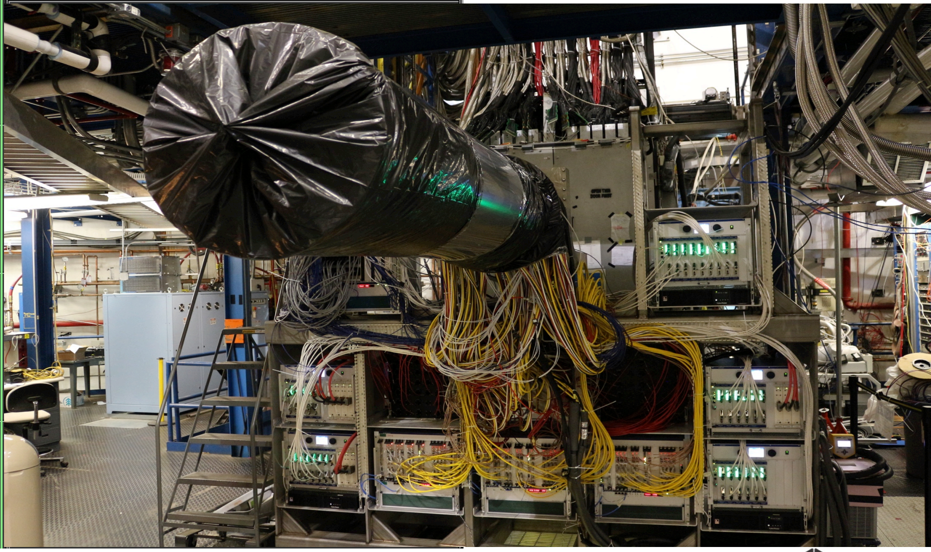
DAQ Status

- Running stable, tested with week long runs
- Tested with SVT standalone (SD) and CLAS triggers
- High trigger rate test (80 kHz) with simplified configuration done
  - Will complete the test in normal operating conditions



Sergey Boiarinov

Ben Raydo



Slow Controls

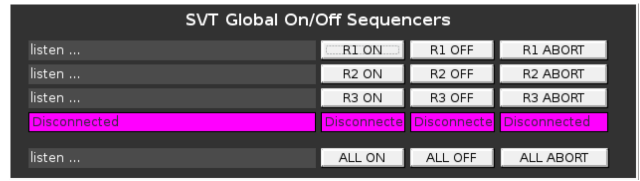
Slow Control and Monitoring System transferred to CS-Studio

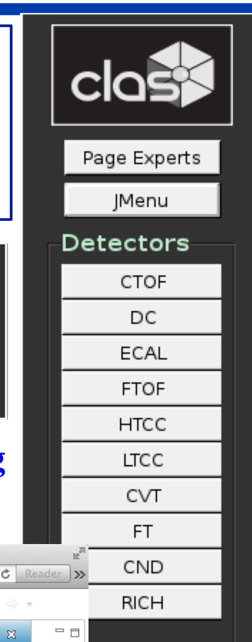
- **summary status records and overview screen**
- **soft IOCs running on CLAS machines**
- **all screens converted from EDM, tested in CS-Studio, with improvements**
- **alarms converted to BEAST**
- **moved soft interlocks from AIH into IOCs**
- **remote access to the system with VDI and VNC**
- **stable running on a clon pc**
- **autosave / restore to IOCs**
- **SVT ON/OFF GUI, HV control script**

Future improvements:

- **authentication**
- **ANOVA chiller control**

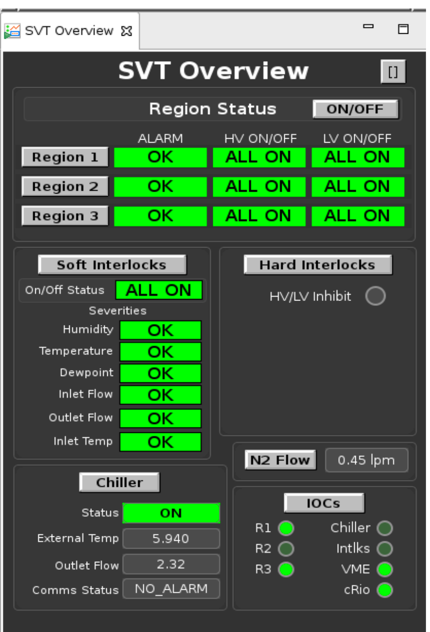
Nathan Baltzell
Wesley Moore
Ken Livingstone

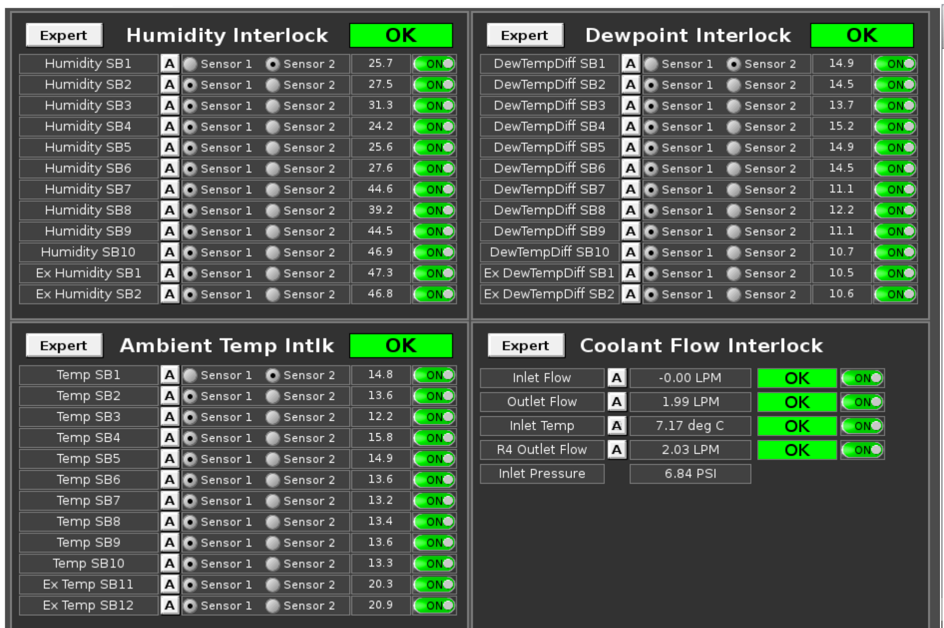




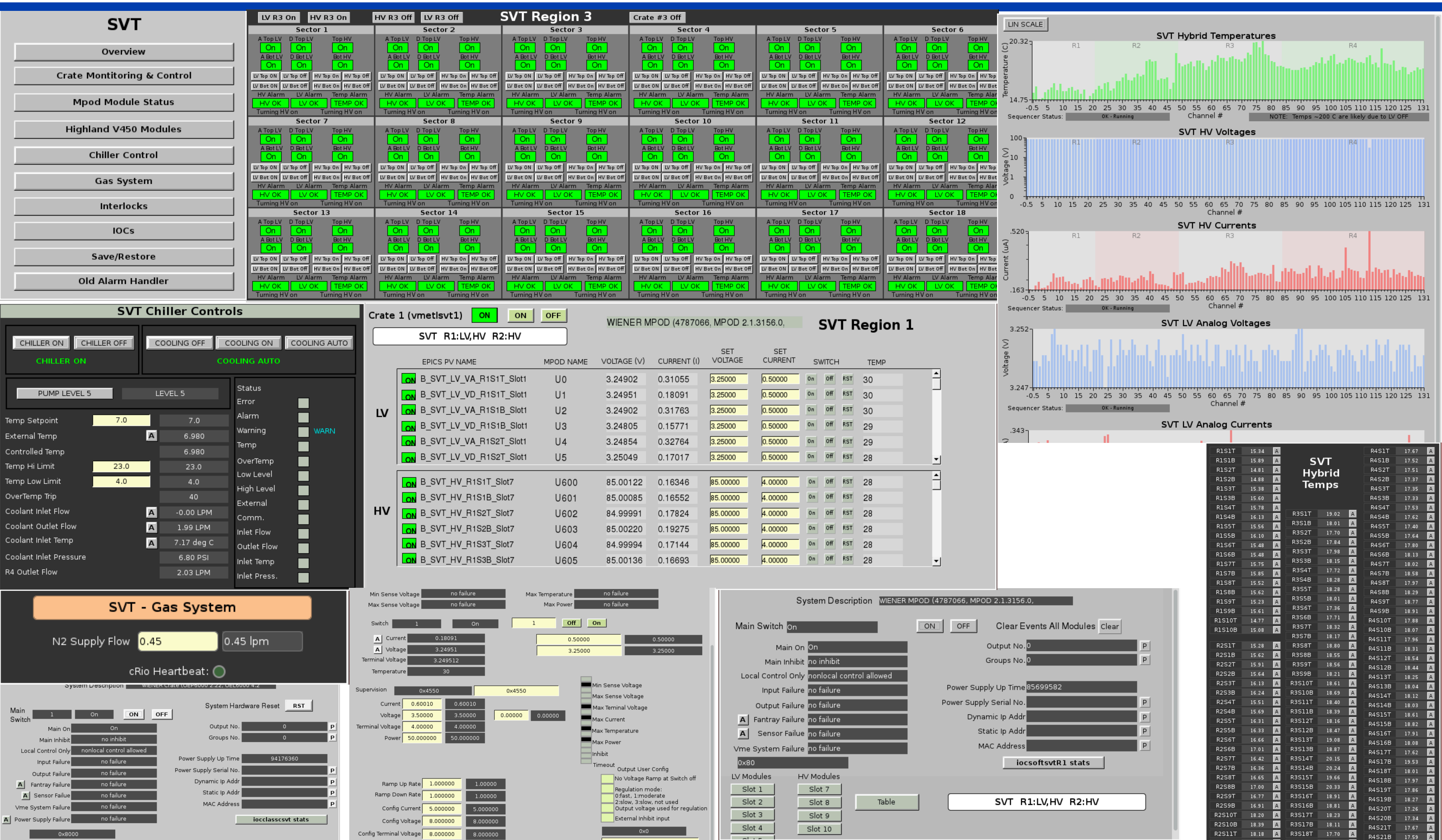
https://hallbopi.jlab.org

Web OPI





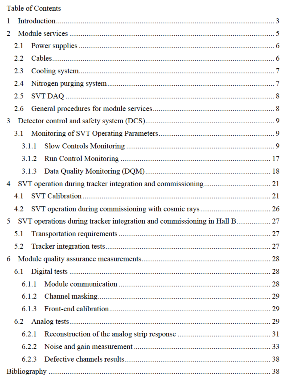
Slow Controls (Expert Level)



Nathan Baltzell, Wesley Moore, Ken Livingstone

System Operation and Safety

- **OSPs – Hazards and mitigations *(subject matter experts)***
  - ***EPICS based Detector Control and Safety System***
  - ***BEAST Alarm Handler (slow controls, cooling and gas purging)***
  - ***Hardware interlocks and hardware parameter limits***
  - ***LV, HV, currents, temperature, humidity, dew point, and flow software parameter limits***
  - ***EPICS monitoring/time histories in MYA database for the past 2 years***
  - ***Cables (UL CL-2 rating – signal and power), QA travelers***
  - ***Grounding (reviewed by Fast Electronics Group and external reviewers)***
  - ***Electronics (UL/TUV approved)***
  - ***Quality Assurance procedures and safety reviews, assembly travelers***
- **Operations Manuals – *details for shift workers and system experts***
- **Data Quality Monitoring, Validation and Calibration suites**
- **Engineering FEA calculations**
- ***ANSYS thermal analysis***
- ***ANSYS quench analysis of the cold plate***
- ***Magnetic fields for the crates in the service cart***
- ***Electronic logbooks for the past 3 years***



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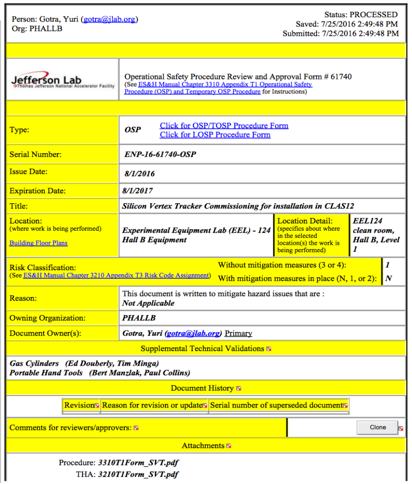


Person: Gotra, Yuri (gotra@jlab.org)
Org: PHALLB

Status: PROCESSED
Saved: 7/25/2016 2:49:48 PM
Submitted: 7/25/2016 2:49:48 PM

Jefferson Lab — Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Review and Approval Form # 61740
(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for Instructions)

Type:	*OSP* Click for OSP/TOSP Procedure Form Click for LOSP Procedure Form		
Serial Number:	***ENP-16-61740-OSP***		
Issue Date:	***8/1/2016***		
Expiration Date:	***8/1/2017***		
Title:	***Silicon Vertex Tracker Commissioning for installation in CLAS12***		
Location: (where work is being performed) Building Floor Plans	***Experimental Equipment Lab (EEL) - 124 Hall B Equipment***	Location Detail: (specifics about where in the selected location(s) the work is being performed)	***EEL124 clean room, Hall B, Level 1***
Risk Classification: (See ES&H Manual Chapter 3210 Appendix T3 Risk Code Assignment)	Without mitigation measures (3 or 4): With mitigation measures in place (N, 1, or 2):	***1*** ***N***	
Reason:	This document is written to mitigate hazard issues that are : ***Not Applicable***		
Owning Organization:	***PHALLB***		
Document Owner(s):	***Gotra, Yuri (gotra@jlab.org)*** Primary		

Supplemental Technical Validations

Gas Cylinders (Ed Douberly, Tim Minga)
Portable Hand Tools (Bert Manzlak, Paul Collins)

Document History

Revision	Reason for revision or update	Serial number of superseded document

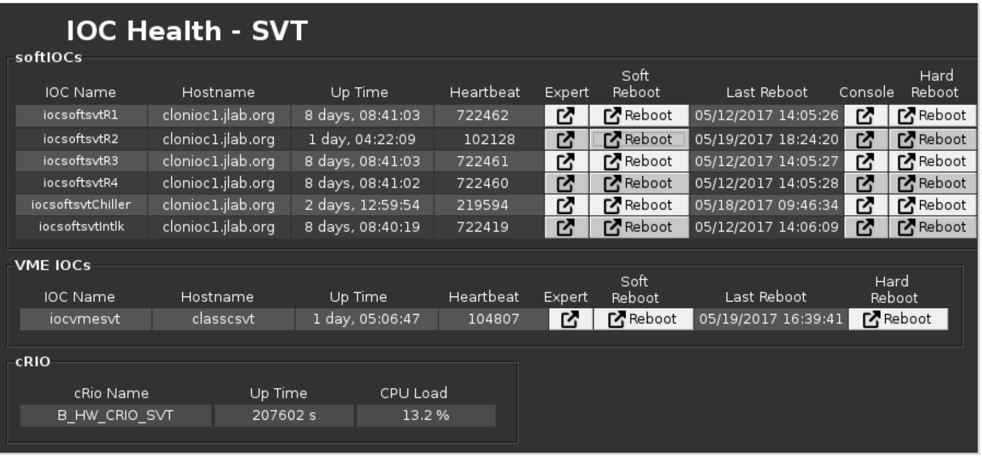
Comments for reviewers/approvers: Clone

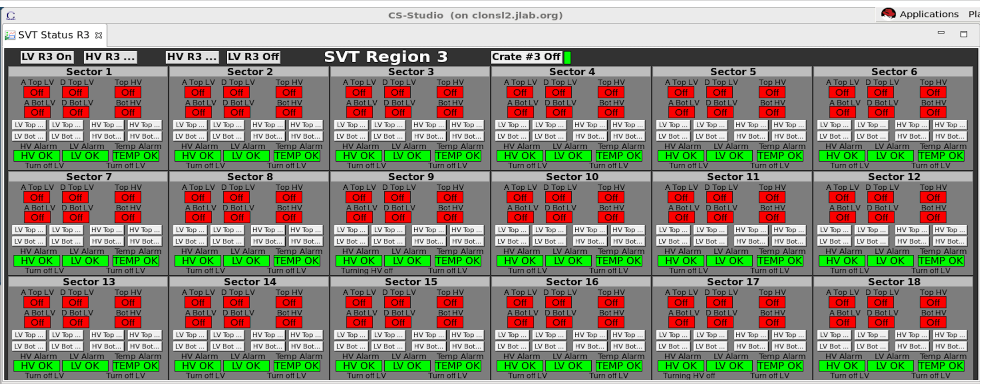
Attachments

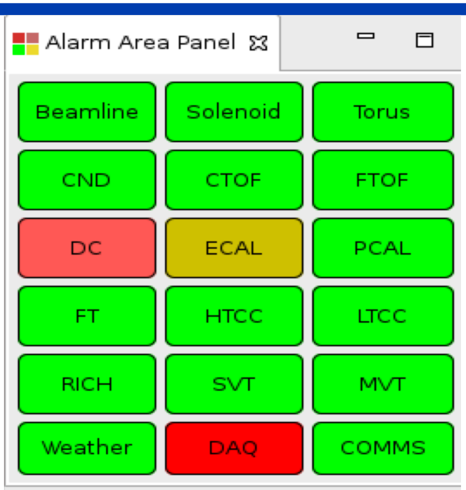
Procedure: ***3310T1Form_SVT.pdf***
THA: ***3210T1Form_SVT.pdf***

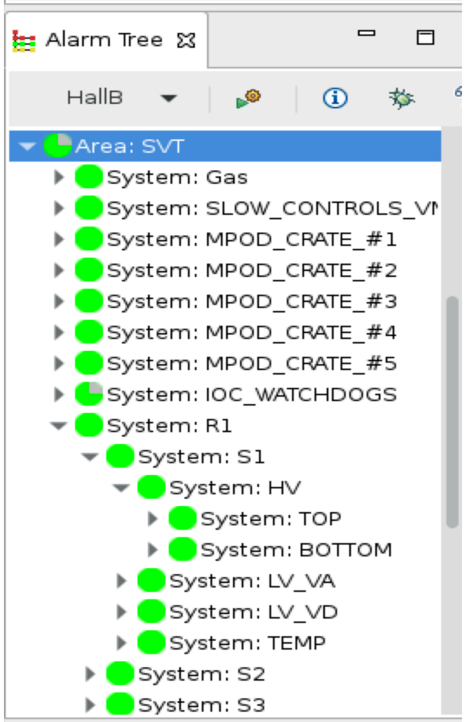
Detector Safety Control and Monitoring: Alarm Handler / IOC

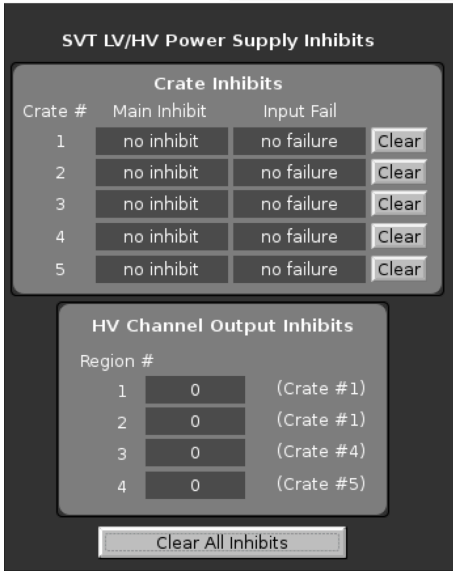
- **Alarm handler in BEAST**
- **Interlocks (hardware, software)**
- **IOC Health**
- **Crate Inhibits**
- **Color coded screens**







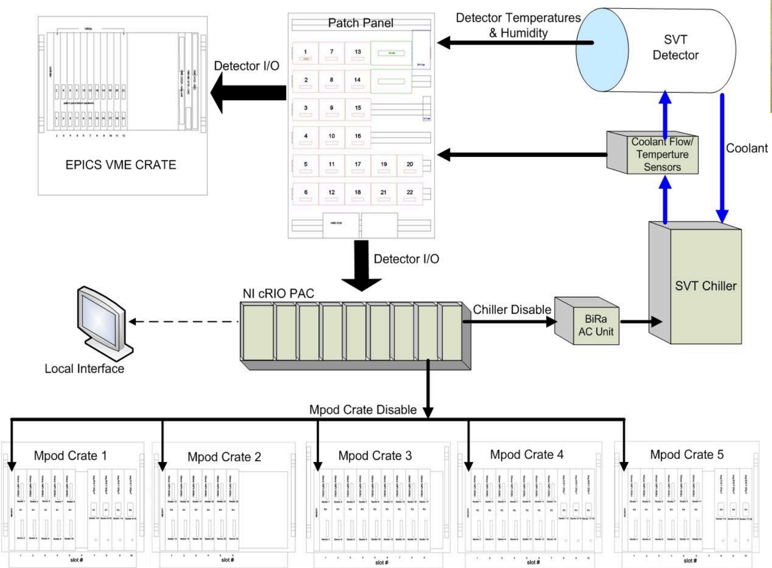


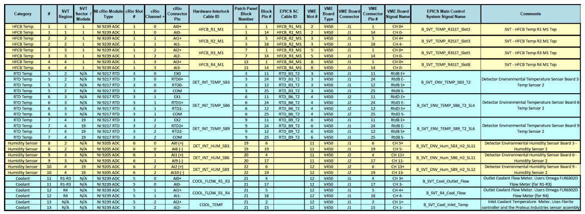


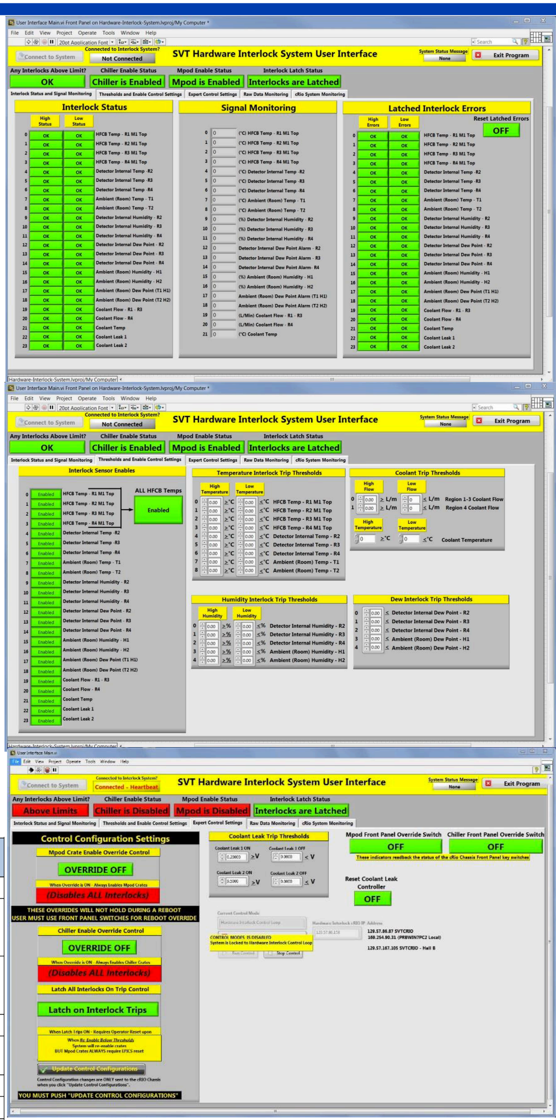
Nathan Baltzell

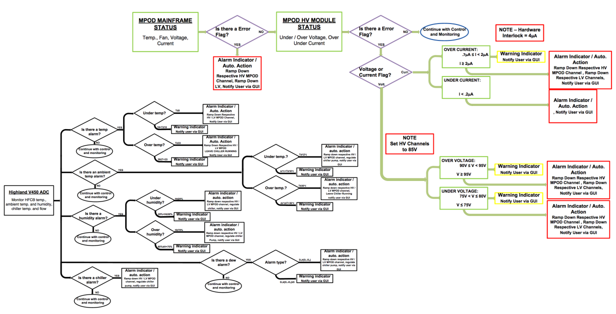
Detector Safety Control and Monitoring: Hardware Interlock

- Fault charts
- Color coded screens
- HW interlock to EPICS / CSS
  - ETA July 2017







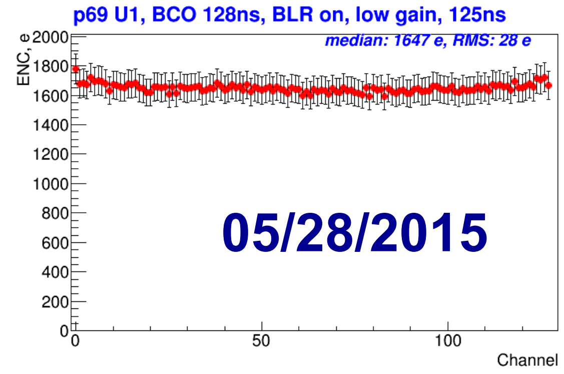


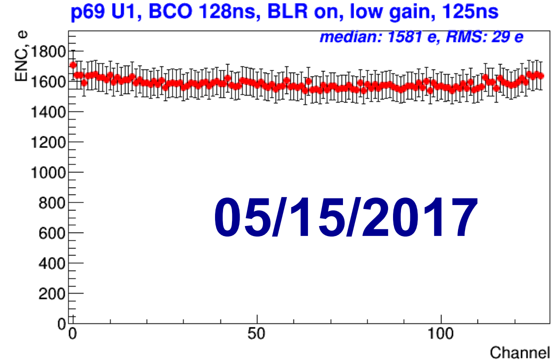
Signal Name	Number of Channels	Input / Output	Description
HFCB Temperature	4	Analog Inputs	Monitors top side of a subset of modules in R1, R2, R3, R4
Detector Internal Temperature	3	RTD Inputs	RTD's are mounted in the support rings, The Hardware Interlock System will use the backup sensors (to be disconnected in EPICS).
Detector Internal Humidity / Dew Point	3	Analog Inputs	Humidity sensors are mounted in the support rings, The Hardware Interlock System will use the backup sensors (to be disconnected in EPICS).
Ambient Temperature	2	RTD Inputs	RTD's are mounted externally to the detector.
Ambient Humidity / Dew Point	2	Analog Inputs	Humidity sensors are mounted externally to the detector.
Coolant Flow	2	Analog Inputs	Measures coolant flow (external from chiller) (R1-3) + (R4)
Coolant Temperature	1	Analog Input	Measures coolant temperature (external from chiller)
Coolant Leak Detection	1	Analog Input	Checks for coolant leaks via sensor mounted in drip pan.
Chiller Disable	1	Analog Output	Signal to BiRa AC Unit - Removes 120VAC from Chiller.
Mpod HV/LV Crate Disable	5	TTL Outputs	Signals to Mpod crate controllers to ramp down LV & HV

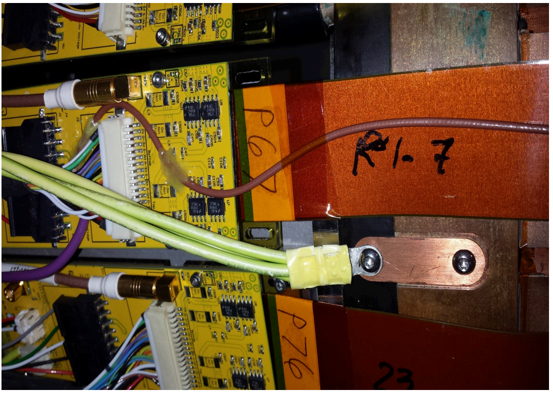
Peter Bonneau

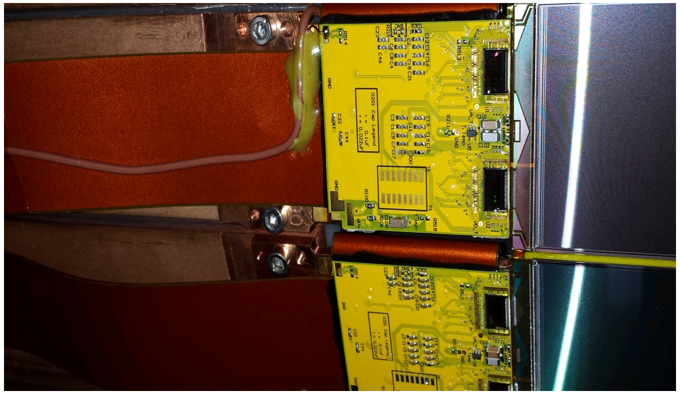
Operational Stability

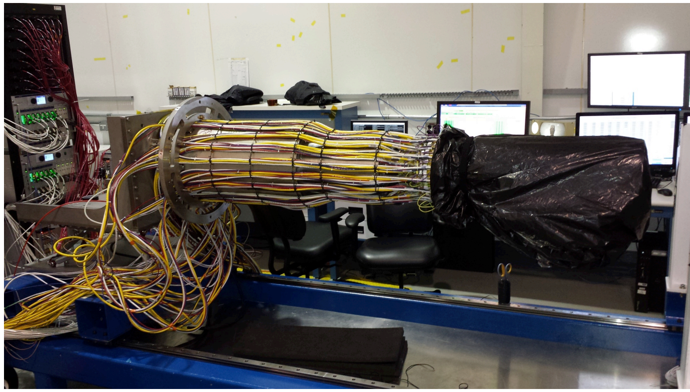
- Detector operating stable since integration time
- Channel calibration data in elog for past 3 years
- Slow controls data in MYA for past 2 years
- 8 modules with hybrid leakage kludged
  - Stable leakage currents
- Stability test operational (8 modules on the bench)
  - 24/7 monitoring for over 6 months
- Large cosmic data sample collected
- No new bad channels
- Outstanding issue:
  - R1S2B high leakage current in the HFCB





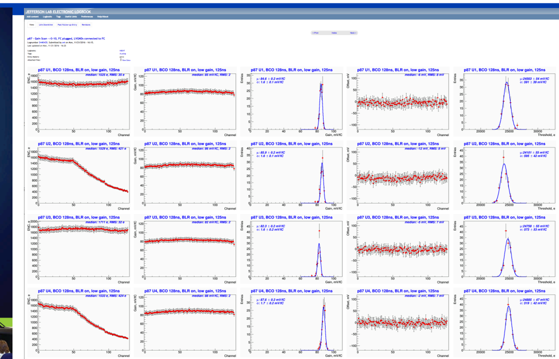


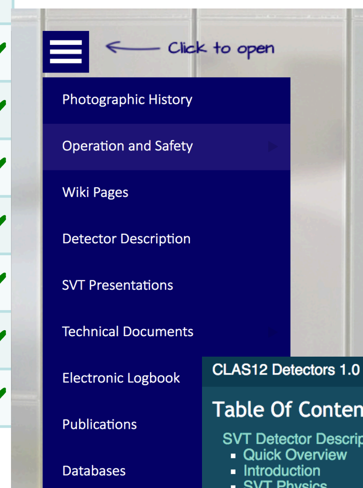


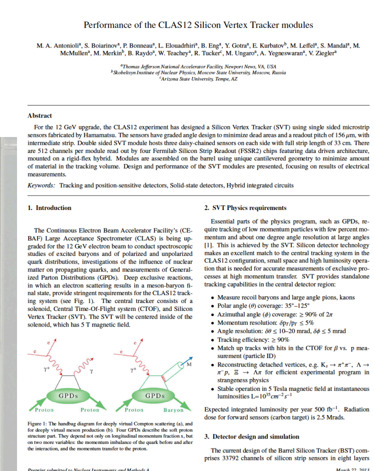


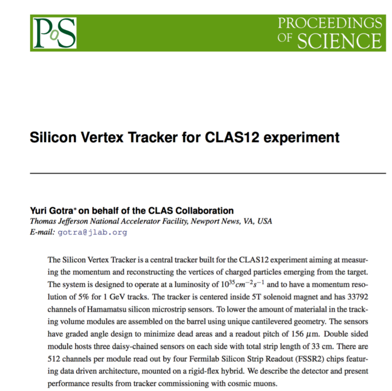
Documentation

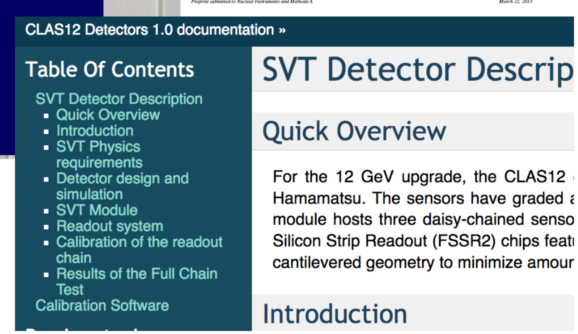
Technical Design Report	✔
Geometry Document	✔
Commissioning Document	✔
Reconstruction Algorithms	✔
Manufacturing Drawings and Schematics	✔
Assembly/Service Procedures	✔
Production, Assembly, and Survey Databases and Travelers	✔
Operations Manual and Safety Procedures	✔
Bench Testing Results	✔
Electronic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

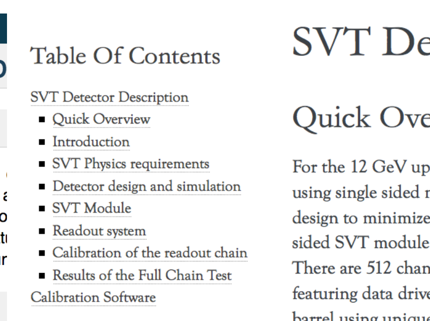








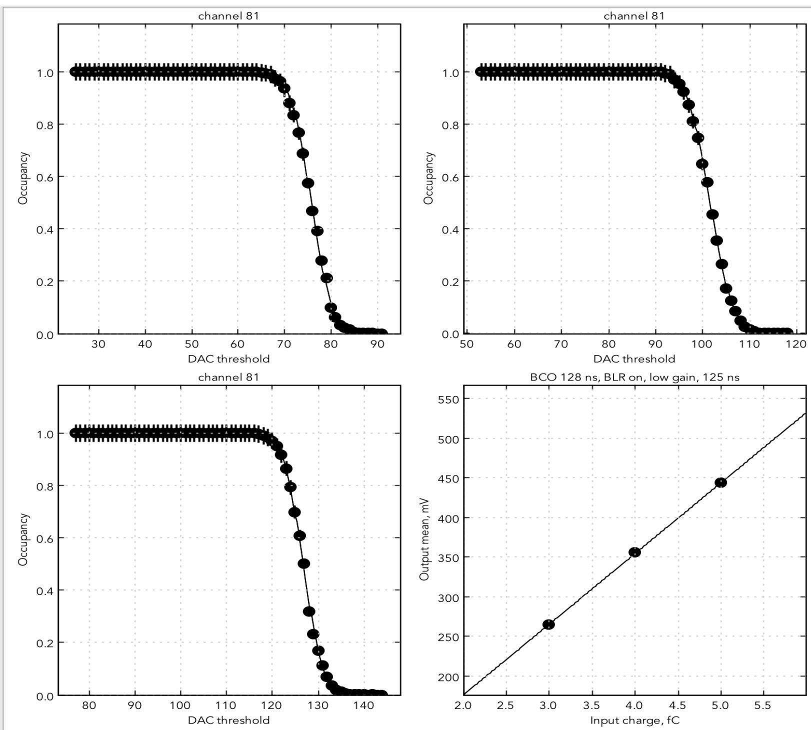


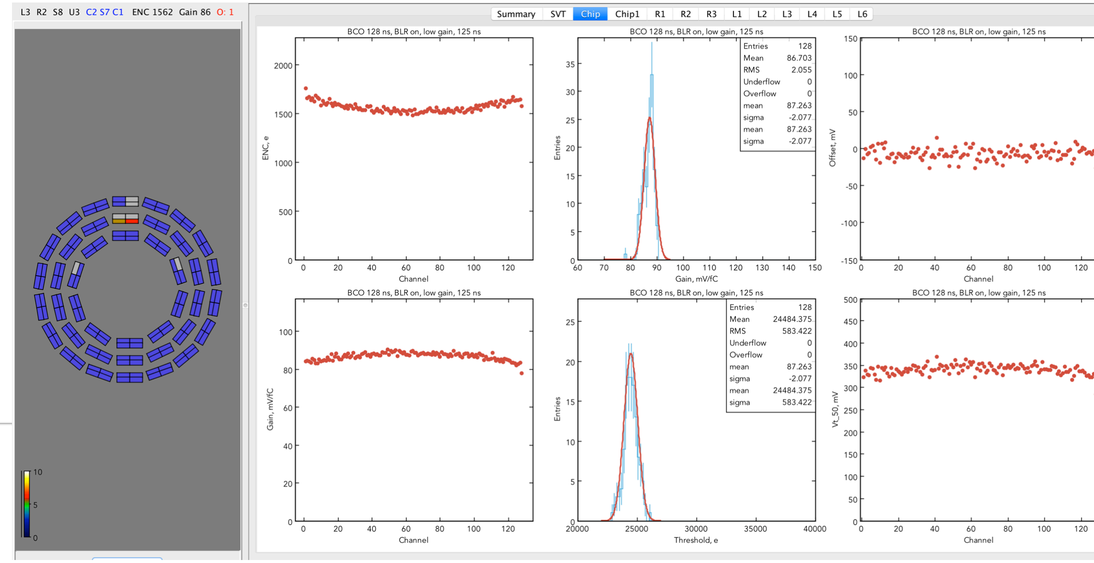


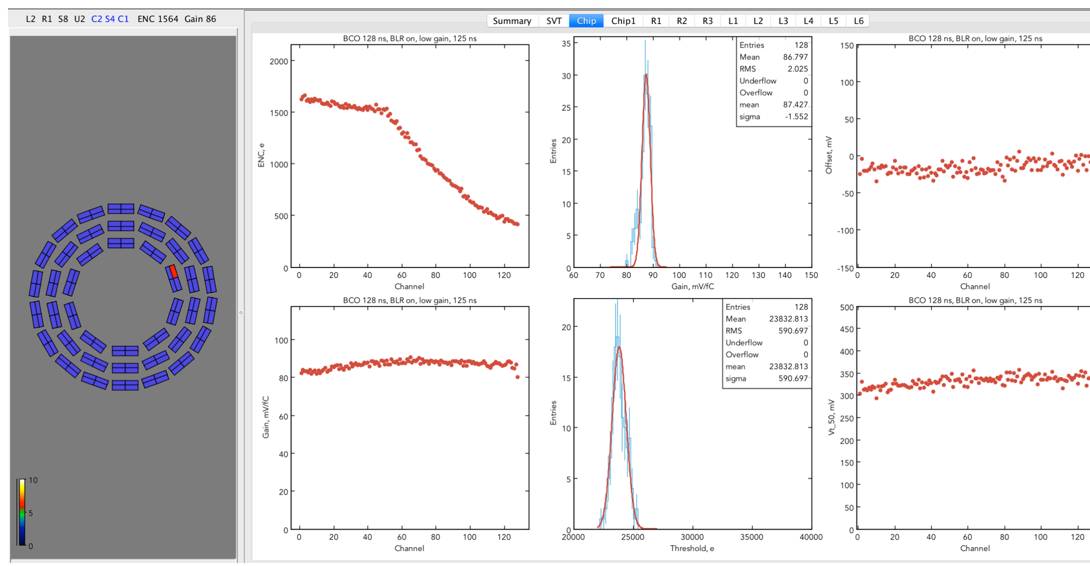
https://www.jlab.org/Hall-B/cvt/svt/

Calibration Suite

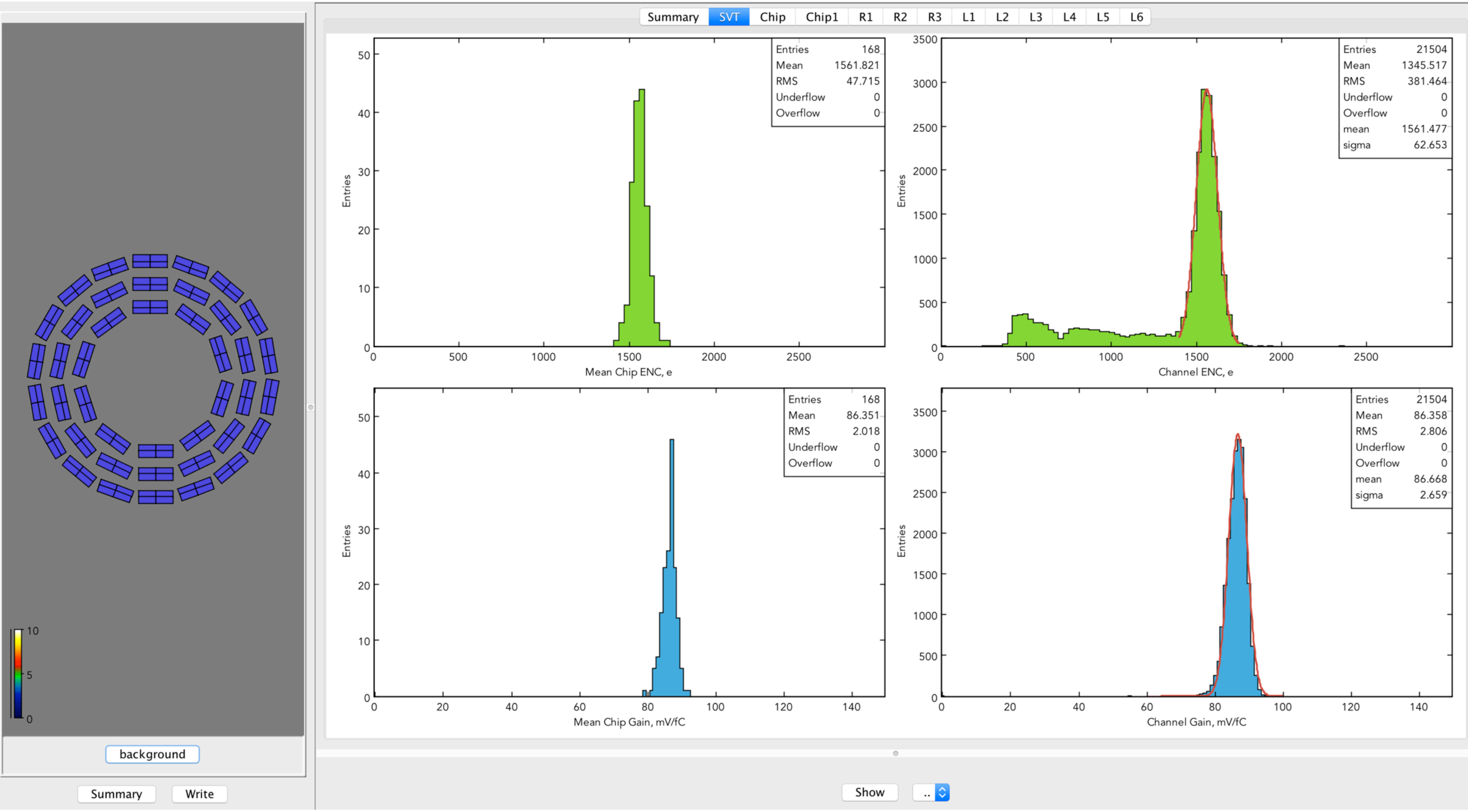
- Regular calibration scans
- Calibration data in elog
  https://logbooks.jlab.org/book/hbsvt
- Mean S.N.R. = 15
- Calibration constants stable
- No new bad channels







Detector Calibration

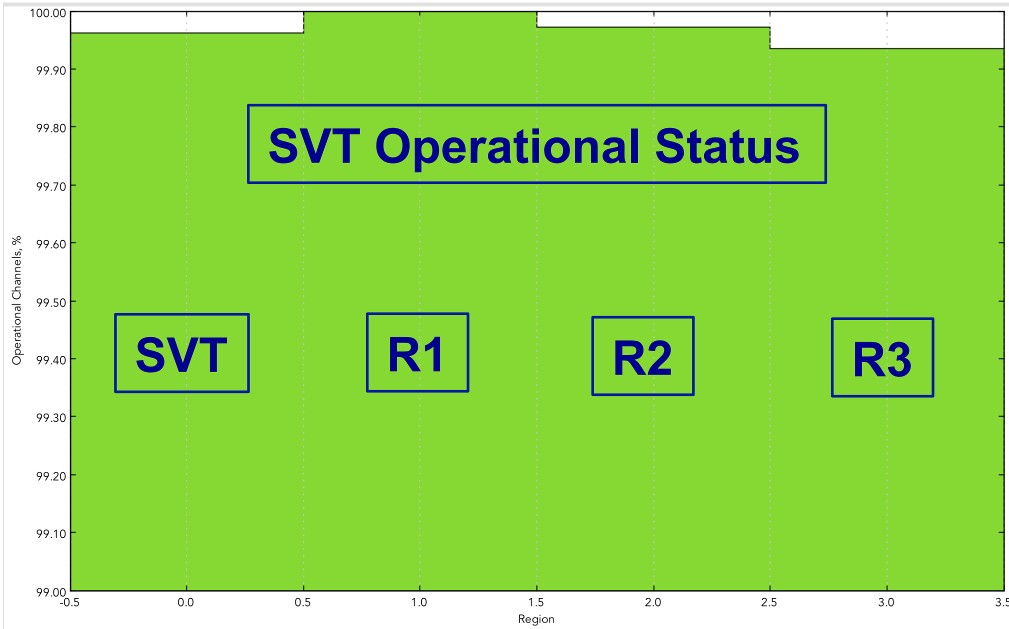


Detector Calibration

Summary

L6 R3 S2 U2 N97 ENC 2362 N
L6 R3 S18 U1 N113 ENC 0 D
L6 R3 S2 U1 N2 ENC 356 O
L4 R2 S7 U2 N56 ENC 286 O
L3 R2 S8 U4 N14 ENC 290 O
L6 R3 S9 U1 N4 ENC 368 O
L6 R3 S11 U1 N17 ENC 348 O
L5 R3 S14 U3 N25 ENC 437 O
======= Region 1 =======
Operational: 100.00%
Mean Chip ENC: 1564
Mean Chip Gain: 85
======= Region 2 =======
2 bad channels: 2 open
Operational: 99.97%
Mean Chip ENC: 1557
Mean Chip Gain: 86
======= Region 3 =======
6 bad channels: 1 noisy 1 dead 4 open
Operational: 99.93%
Mean Chip ENC: 1563
Mean Chip Gain: 86
======== SVT =========
8 bad channels: 1 noisy 1 dead 6 open
Operational: 99.96%
Mean Chip ENC: 1561
Mean Chip Gain: 86

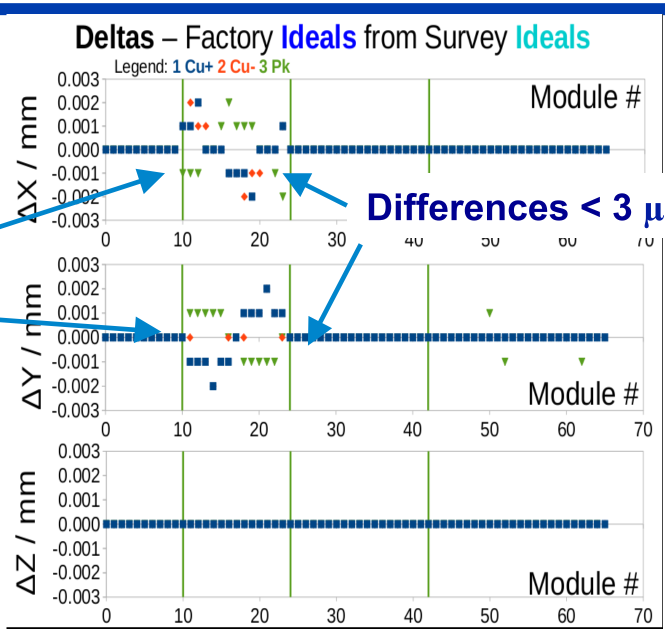
Chips processed: 168



1	2	1	6	0	1645	85	-2	338	24817
1	2	1	7	0	1657	86	-13	331	23990
1	2	1	8	0	1648	85	-24	317	23209
1	2	1	9	0	1669	84	-7	329	24422
1	2	1	10	0	1628	86	-12	332	24083
1	2	1	11	0	1668	85	-33	307	22506
1	2	1	12	0	1649	86	-18	326	23608
1	2	1	13	0	1645	84	-28	310	22886
1	2	1	14	0	1618	85	-18	323	23640
1	2	1	15	0	1621	85	-19	323	23551
1	2	1	16	0	1605	83	-26	306	22938
1	2	1	17	0	1606	86	-16	327	23769
1	2	1	18	0	1617	86	-14	330	23957
1	2	1	19	0	1596	86	-21	323	23411
1	2	1	20	0	1609	88	-33	319	22614
1	2	1	21	0	1592	86	-16	328	23759
1	2	1	22	0	1623	86	-27	319	23009
1	2	1	23	0	1611	87	-9	340	24309
1	2	1	24	0	1581	88	-27	325	23052
1	2	1	25	0	1570	86	-31	314	22683
1	2	1	26	0	1578	86	-18	328	23655
1	2	1	27	0	1589	86	-31	313	22656
1	2	1	28	0	1596	86	-16	329	23759
1	2	1	29	0	1551	88	-28	323	22937
1	2	1	30	0	1595	88	-8	344	24463
1	2	1	31	0	1571	88	-32	319	22671
1	2	1	32	0	1570	86	-18	328	23644

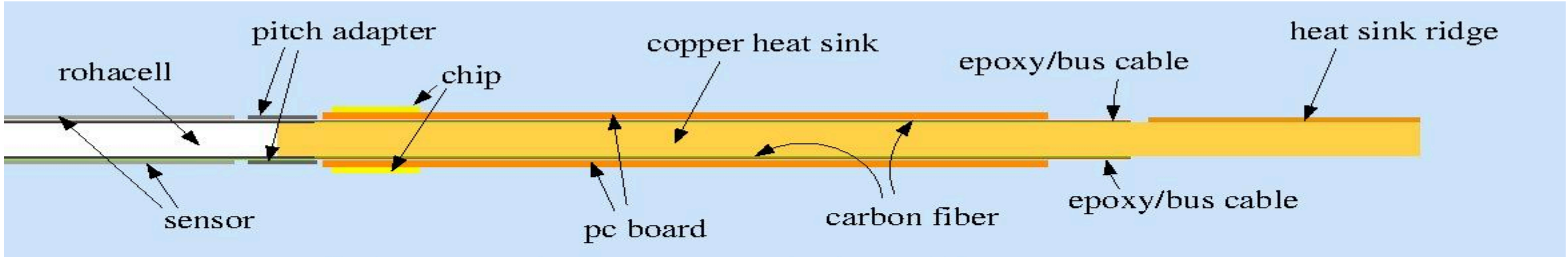
SVT Geometry Database

- **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 is being validated**
  - **Common Java utility in JCSG**
  - **Shifts from ideal geometry to measured fiducials.**
  - **Full inventory of material in SVT for gemc.**
  - **Charles Platt, new Surrey masters student.**
  - **Sereres Johnston – ANL postdoc.**

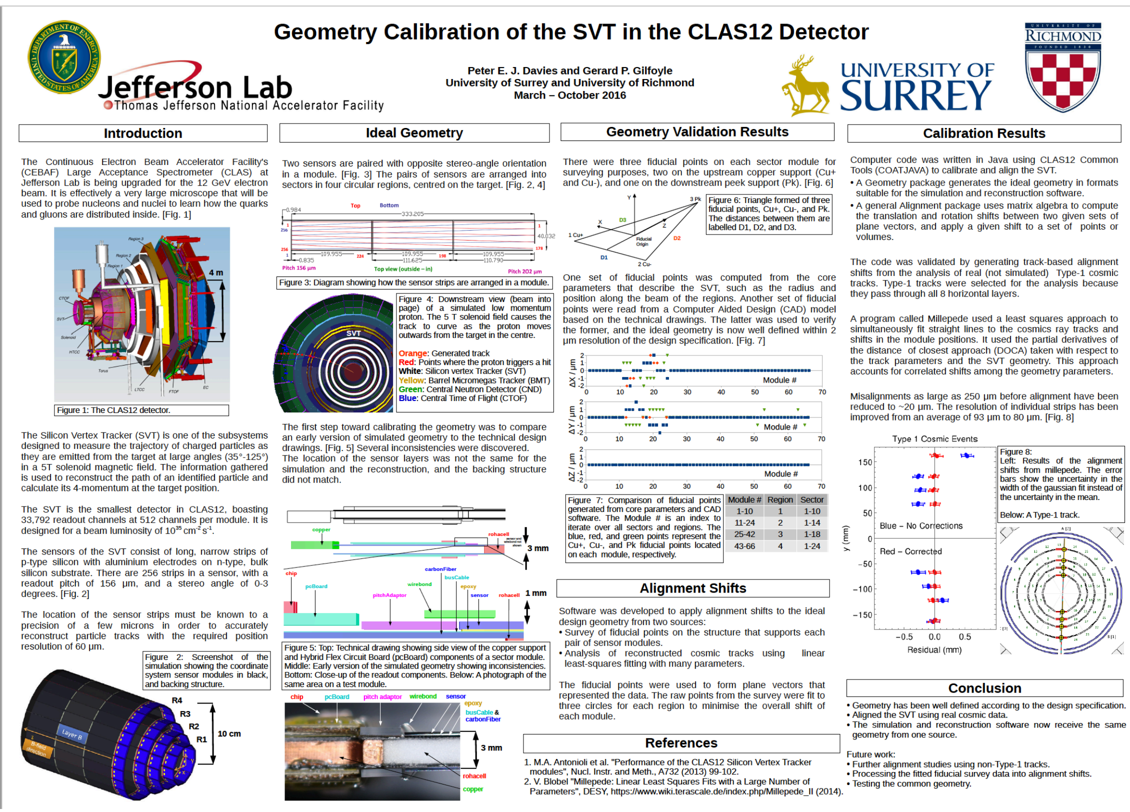
Jerry Gilfoyle, Peter Davies



Side view of upstream end of module in gemc

SVT Geometry Validation

- Master thesis of Peter Davies
- Poster by Peter Davies
- CLAS Note near completion



Geometry and Alignment Software for the CLAS12 Detector

P. Davies[1], V. Ziegler[2], M. Ungaro[2], Y. Gotra[2], A. Kim[3], and G.P. Gilfoyle[4]

[1] *University of Surrey, Guilford, UK*
[2] *Jefferson Lab, Newport News, VA*
[3] *University of Connecticut, Storrs, CT*
[4] *University of Richmond, Richmond, VA*

May 1, 2017

Abstract

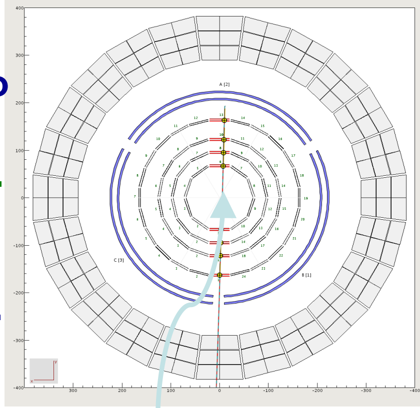
The CLAS12 detector is currently under construction in Hall B as part of the CEBAF 12 GeV Upgrade. The Silicon Vertex Tracker (SVT) is a position sensitive detector subsystem in CLAS12, and is the closest one to the target. This document is designed to be a comprehensive guide to the geometry of the SVT, and the software used to model it for simulation and reconstruction. The sensors of the SVT consist of long, narrow strips of p-type silicon with aluminium electrodes on an n-type, bulk silicon substrate. There are 256 strips in a sensor, with a readout pitch at the upstream end of 156 μm, and a stereo angle of $0-3^\circ$. The location of the sensor strips must be known to a precision of a few microns in order to accurately reconstruct particle tracks with the required position resolution of 60 μm specified in the CLAS12 design. The geometry of the SVT has been well defined according to the design specification after consultation with the design team, and software was been developed to align the sectors using real cosmic data. The simulation and reconstruction software now receive the same geometry from one source.

Jerry Gilfoyle, Peter Davies

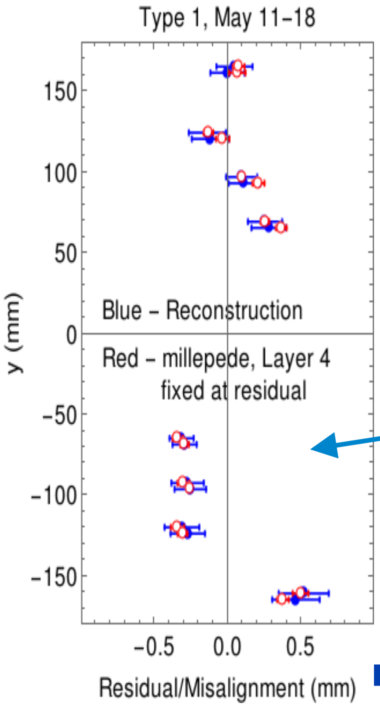
Alignment Status

Jerry Gilfoyle

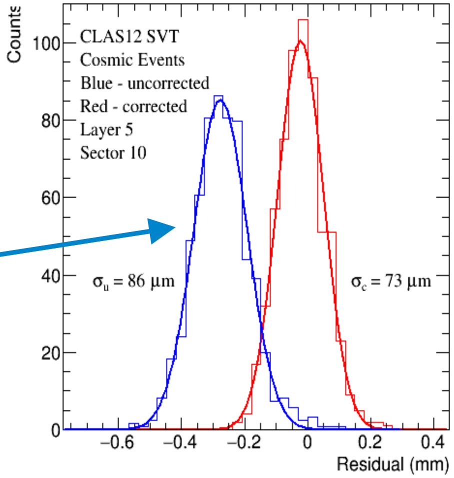
- **Track-based alignment of SVT requires fitting many parameters:**
  $N_{sectors} \times N_{layers} \times N_{trans} \times N_{rot} = 66 \times 2 \times 3 \times 2 = 792$
- **Program millepede does linear least squares with many parameters.**
  - **Uses matrix form of least squares method and divide 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.**



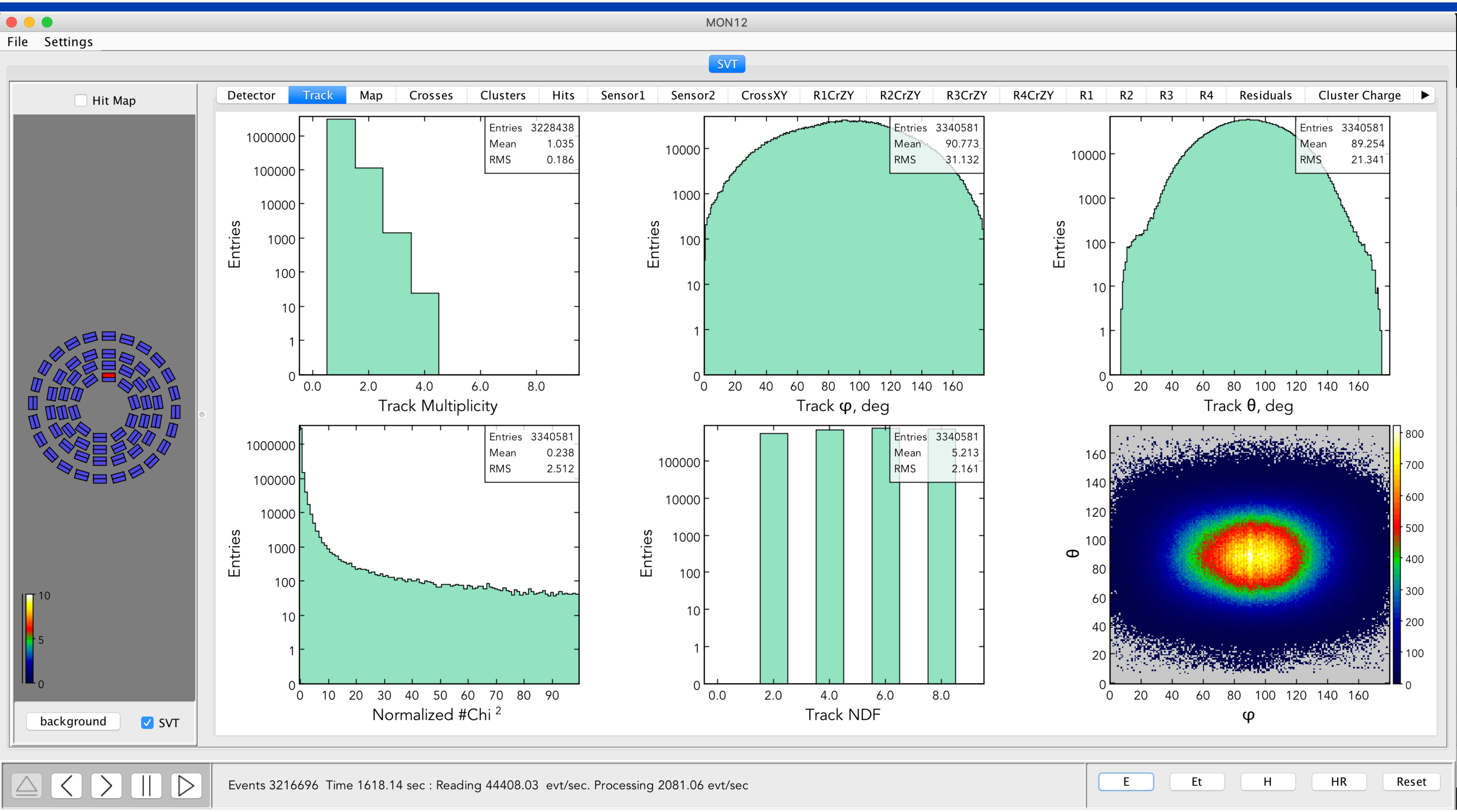
Type 1 tracks – sensors are horizontal.



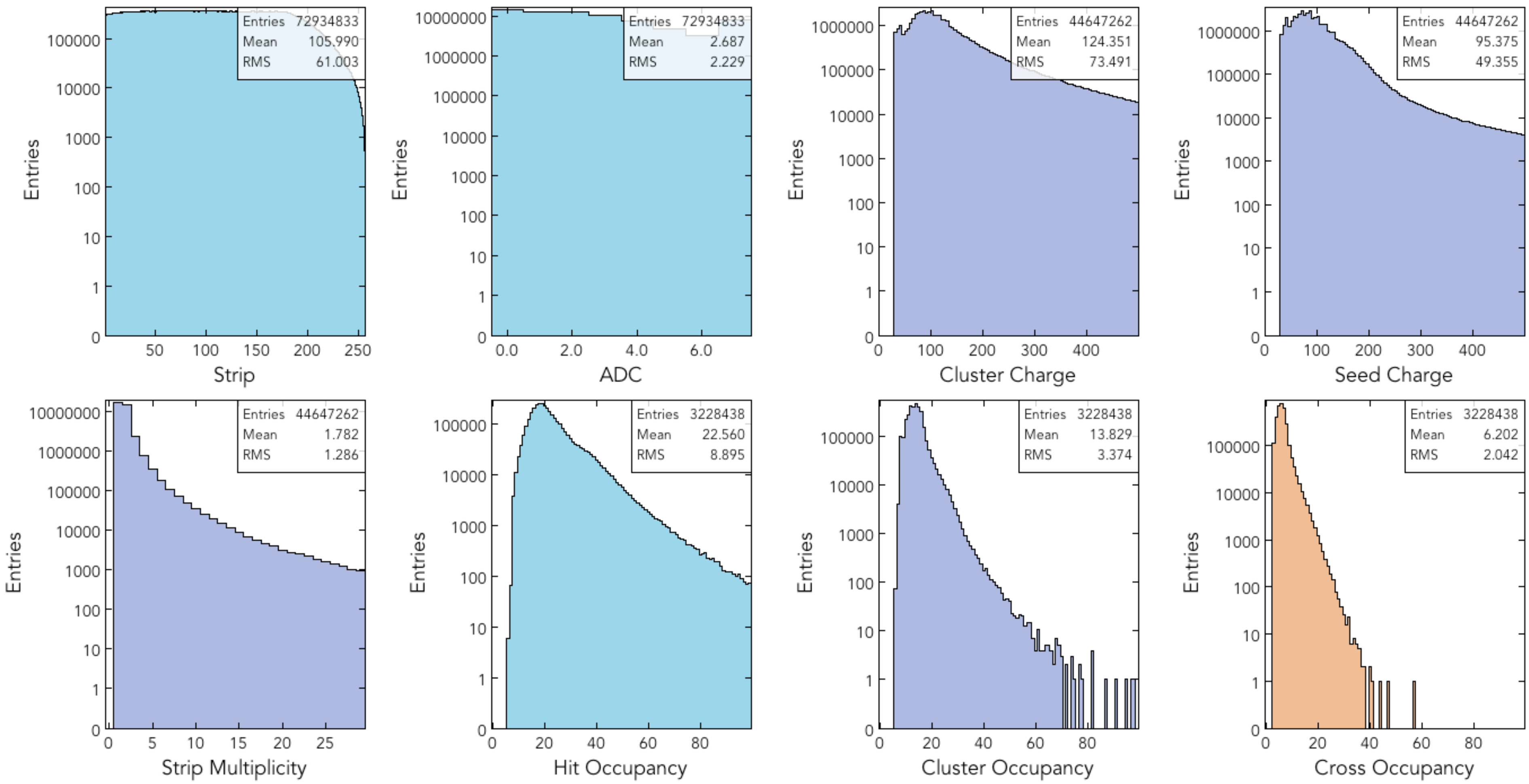
- **Apply to a 'simple' example – Type 1 tracks.**
  - **Use gemc cosmics for testing and validation.**
  - **Shift layers 1-2 (Region 1) by 2-500 μm in *x*.**
  - **millepede reproduces all shifts.**
- **Apply to Type-1 cosmic ray sample from SVT.**
  - **Fixed layer 4 in millepede fit to SVT residual.**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



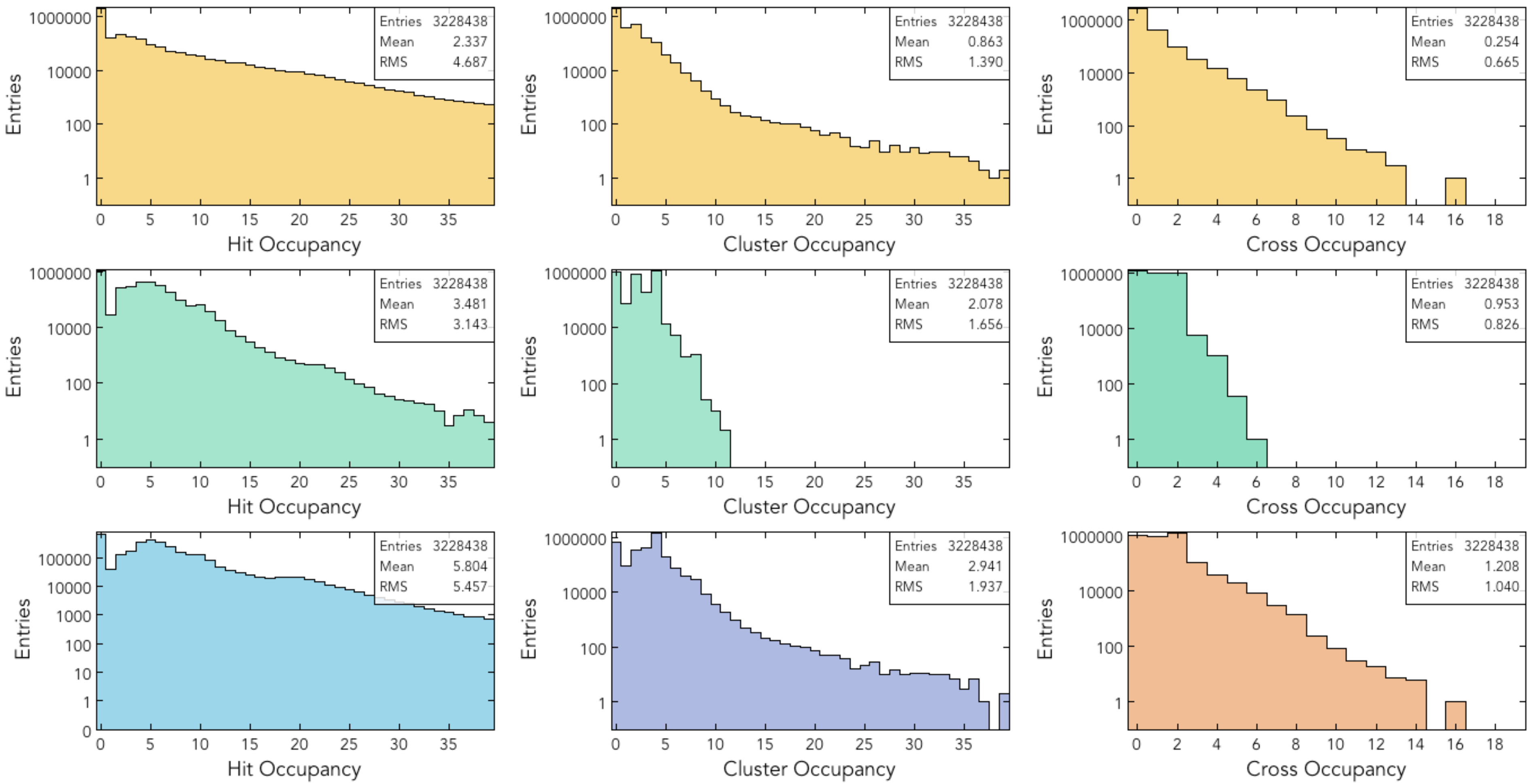
Detector Monitoring Suite: Tracking



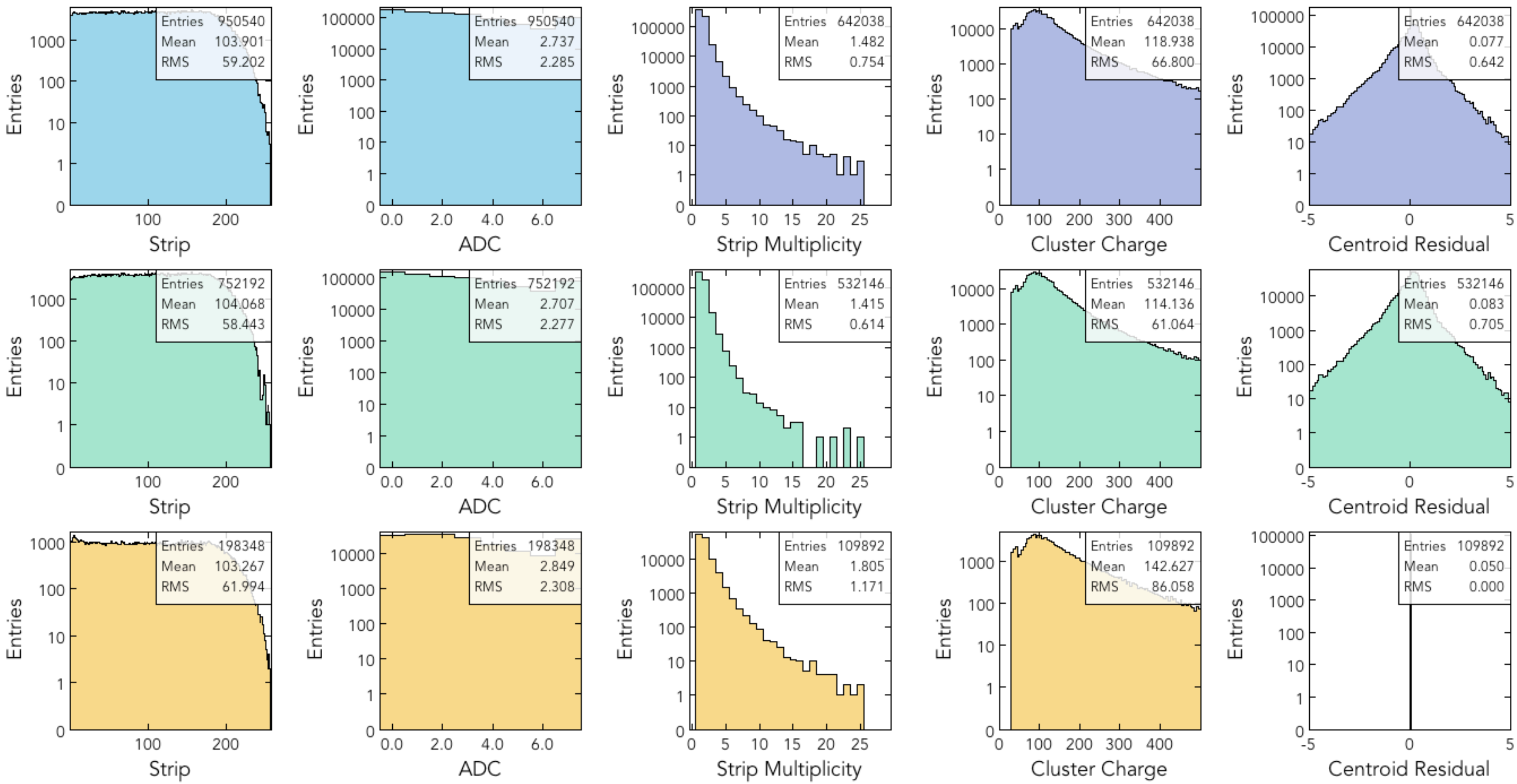
Detector Monitoring: Detector Level Histograms



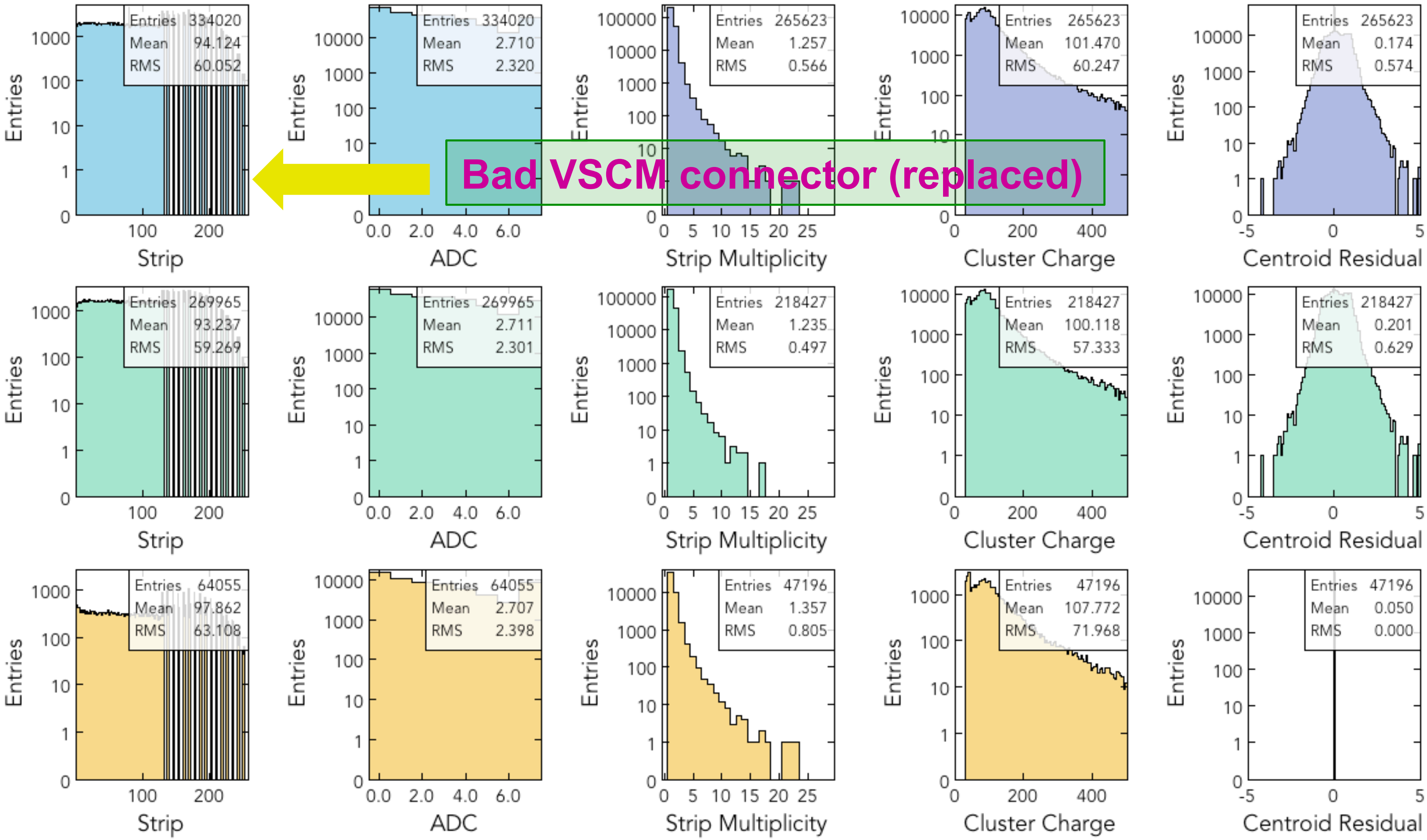
Detector Monitoring: Region Summaries



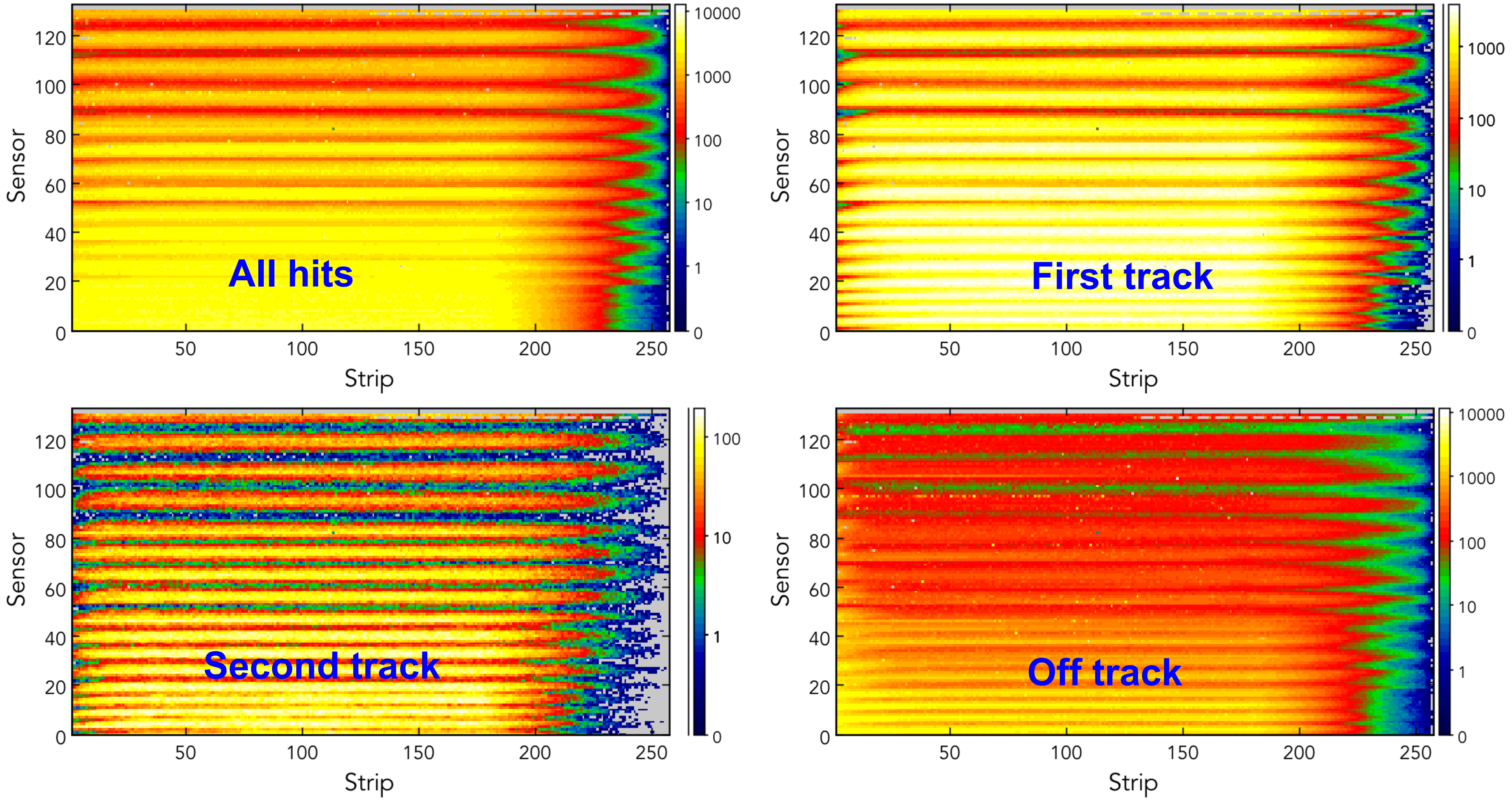
Detector Monitoring: Sensor Level Histograms



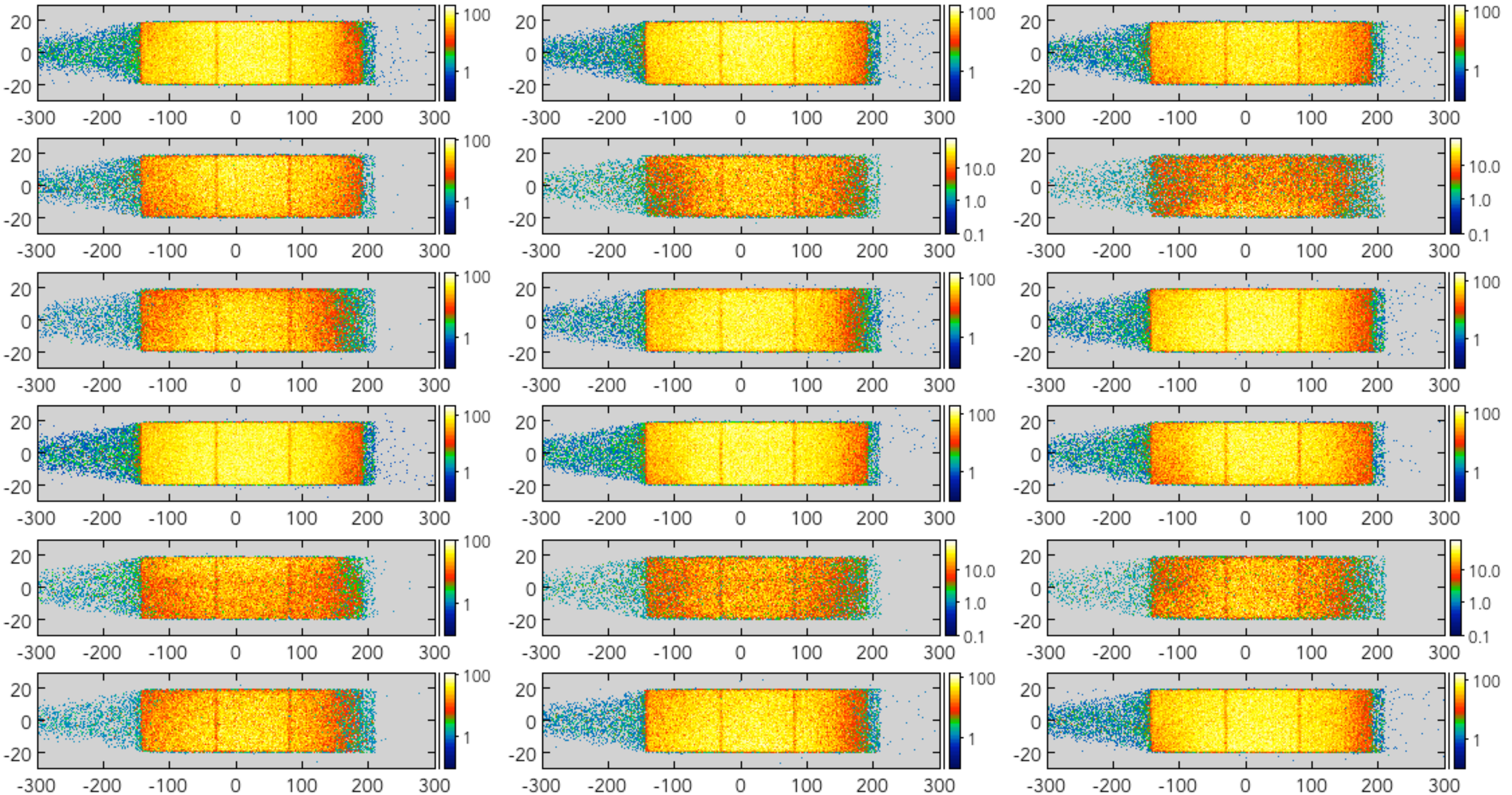
Detector Monitoring: Sensor Level Histograms



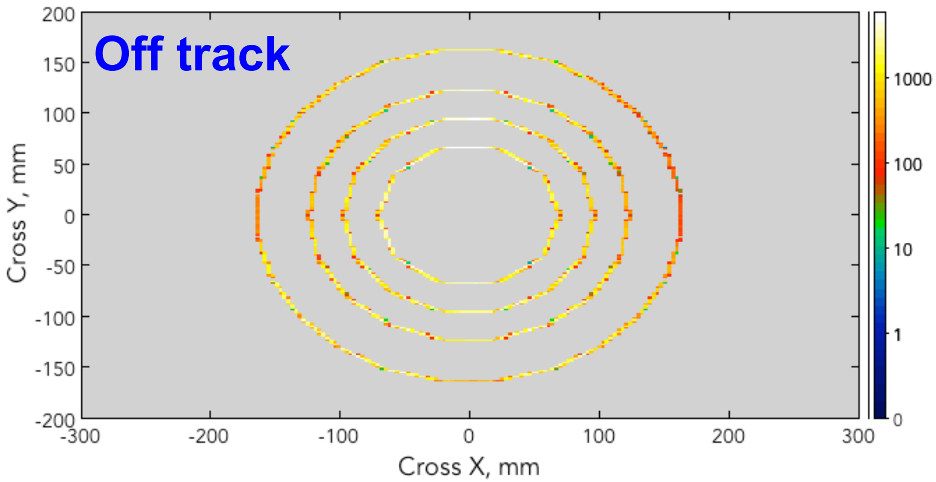
Commissioning with cosmic rays

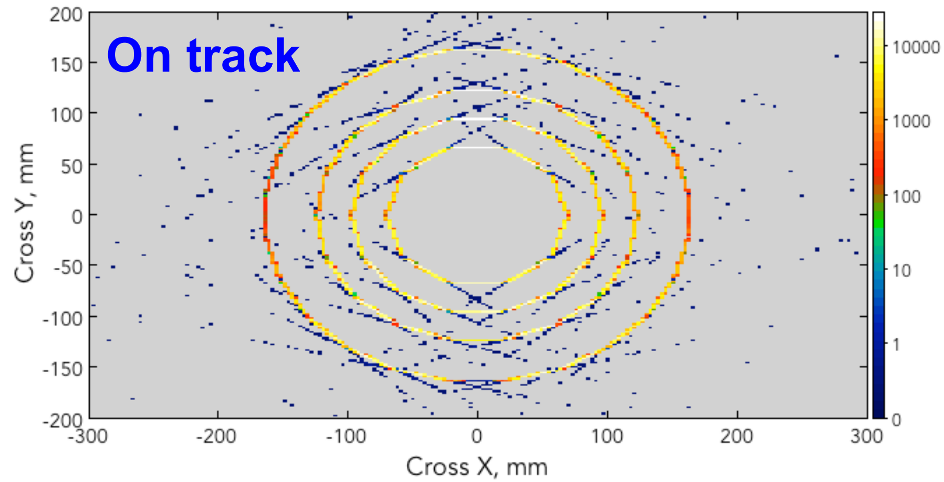


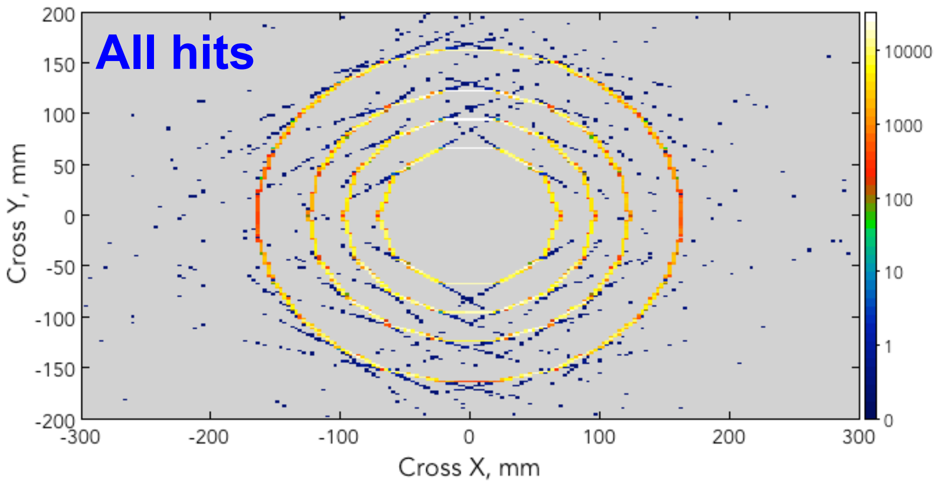
Reconstructed On-Track Crosses in Cosmic Run (March 2017)



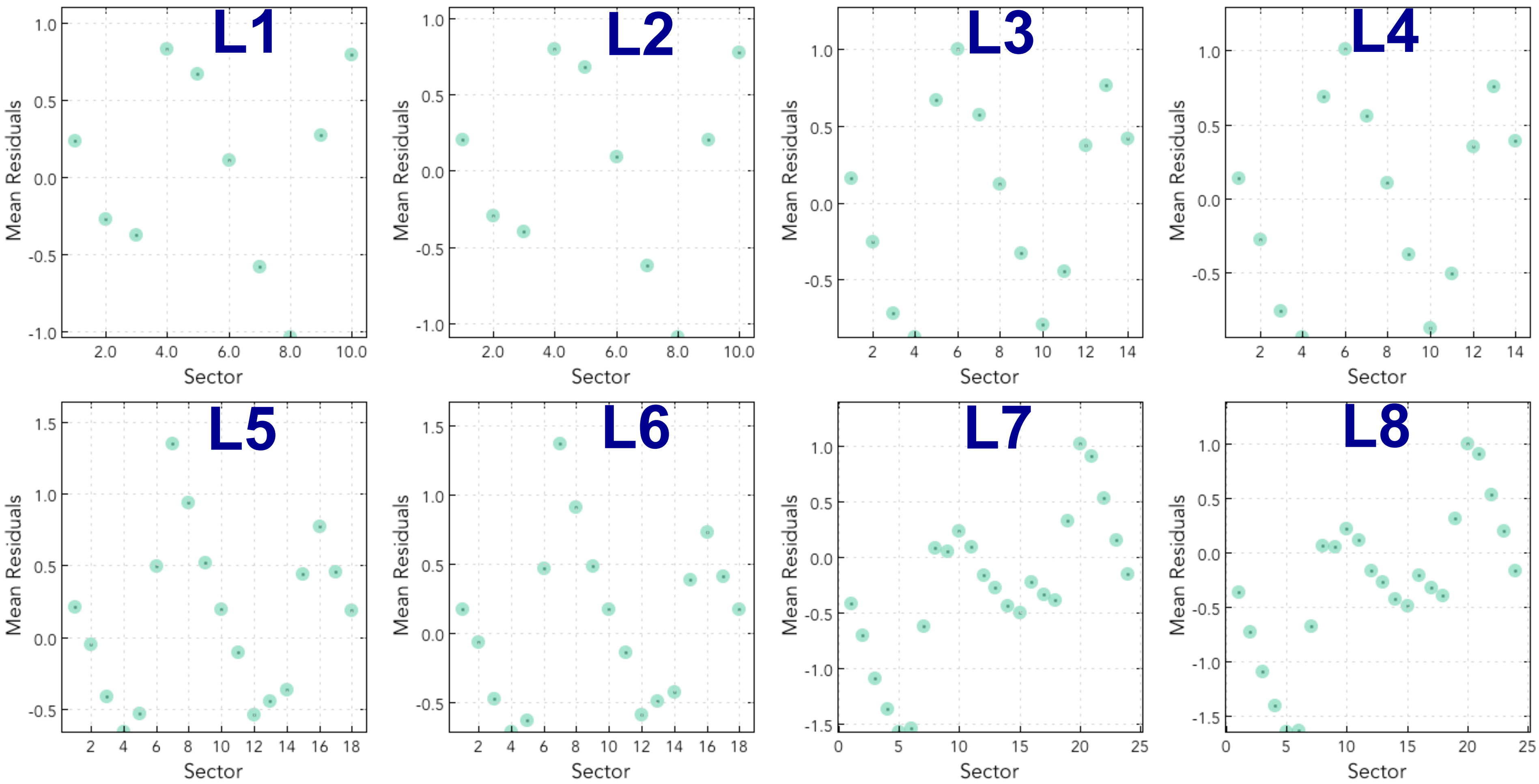
Cosmic run: reconstructed crosses (global track finder)



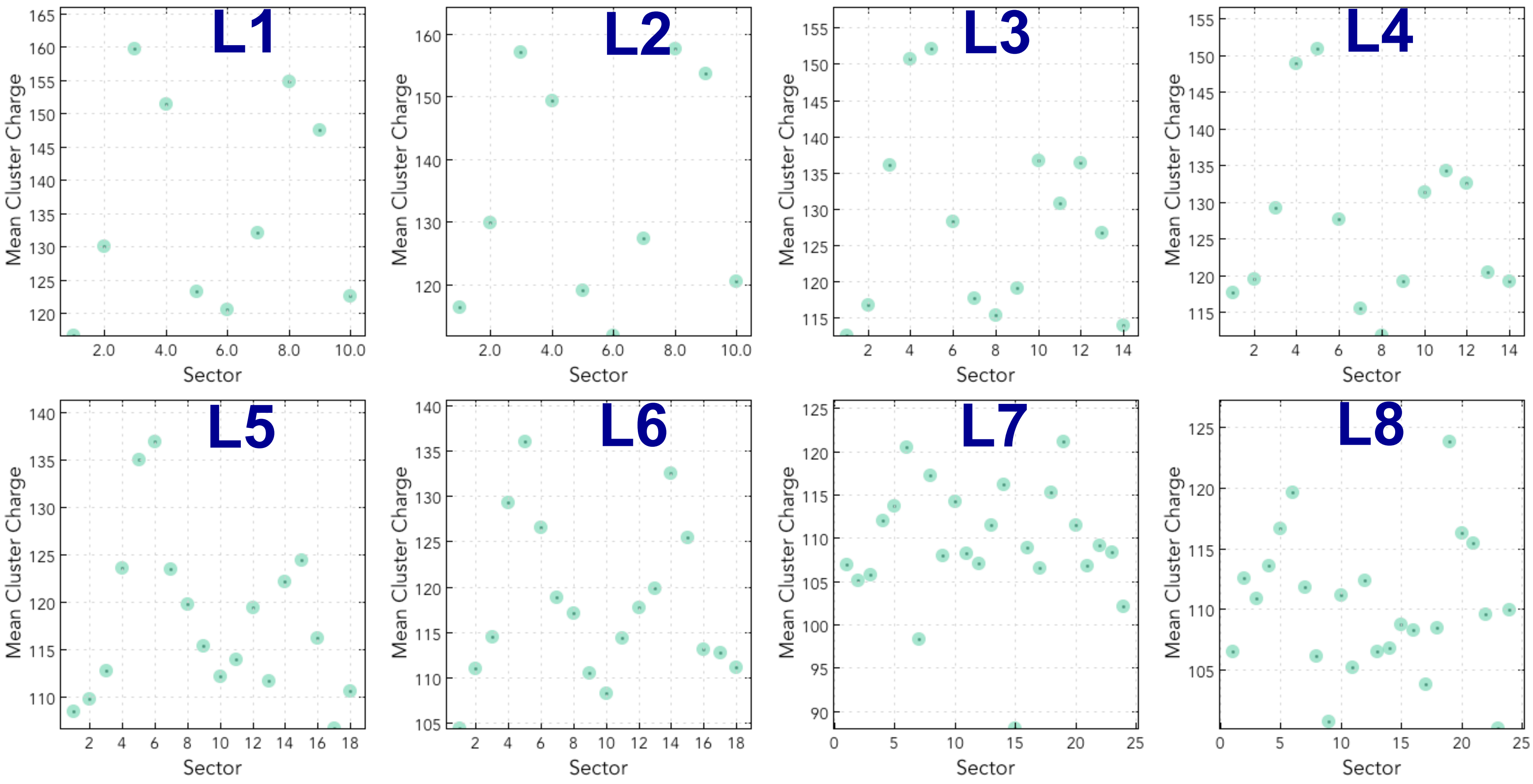




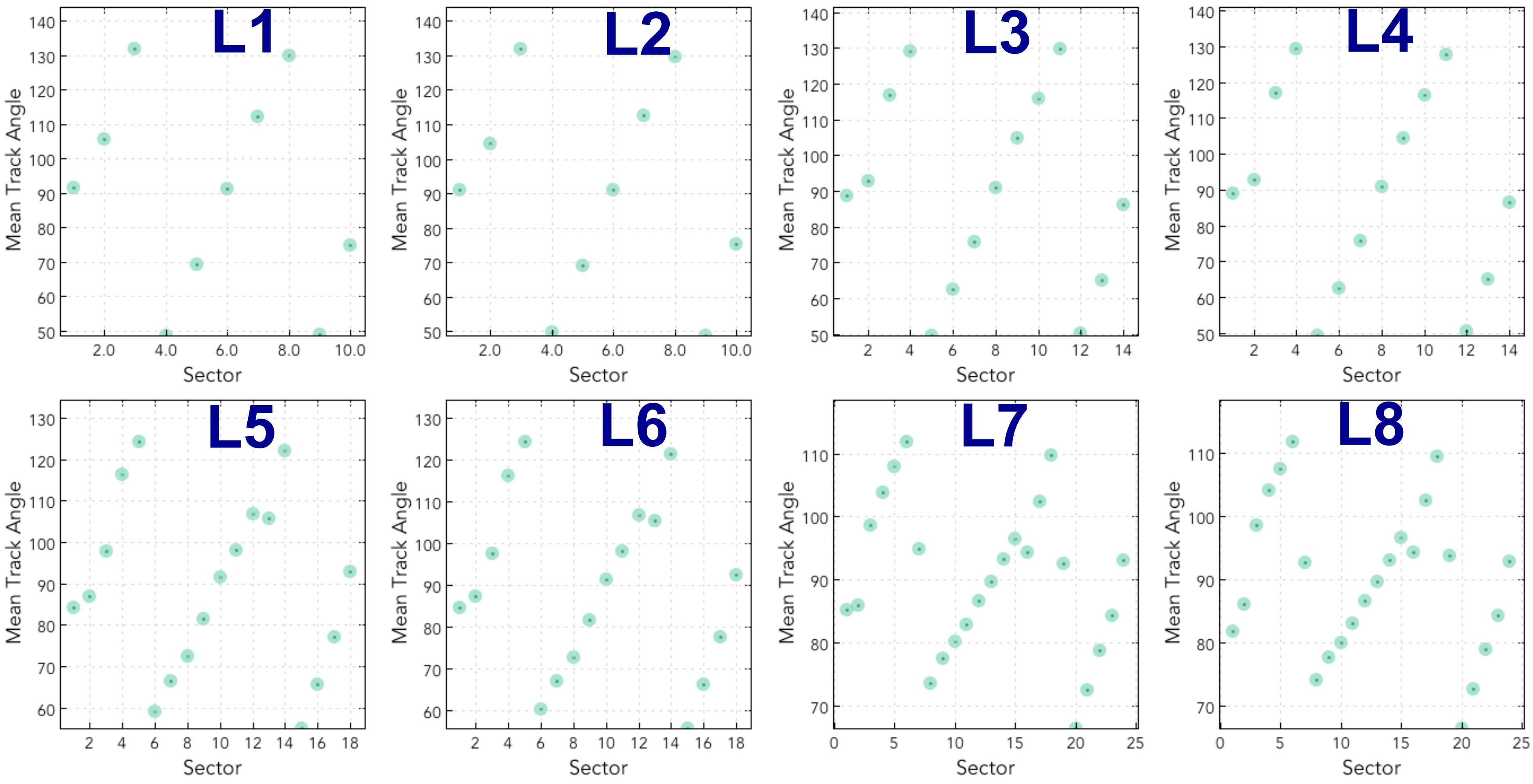
Detector Monitoring: Mean Residuals, mm



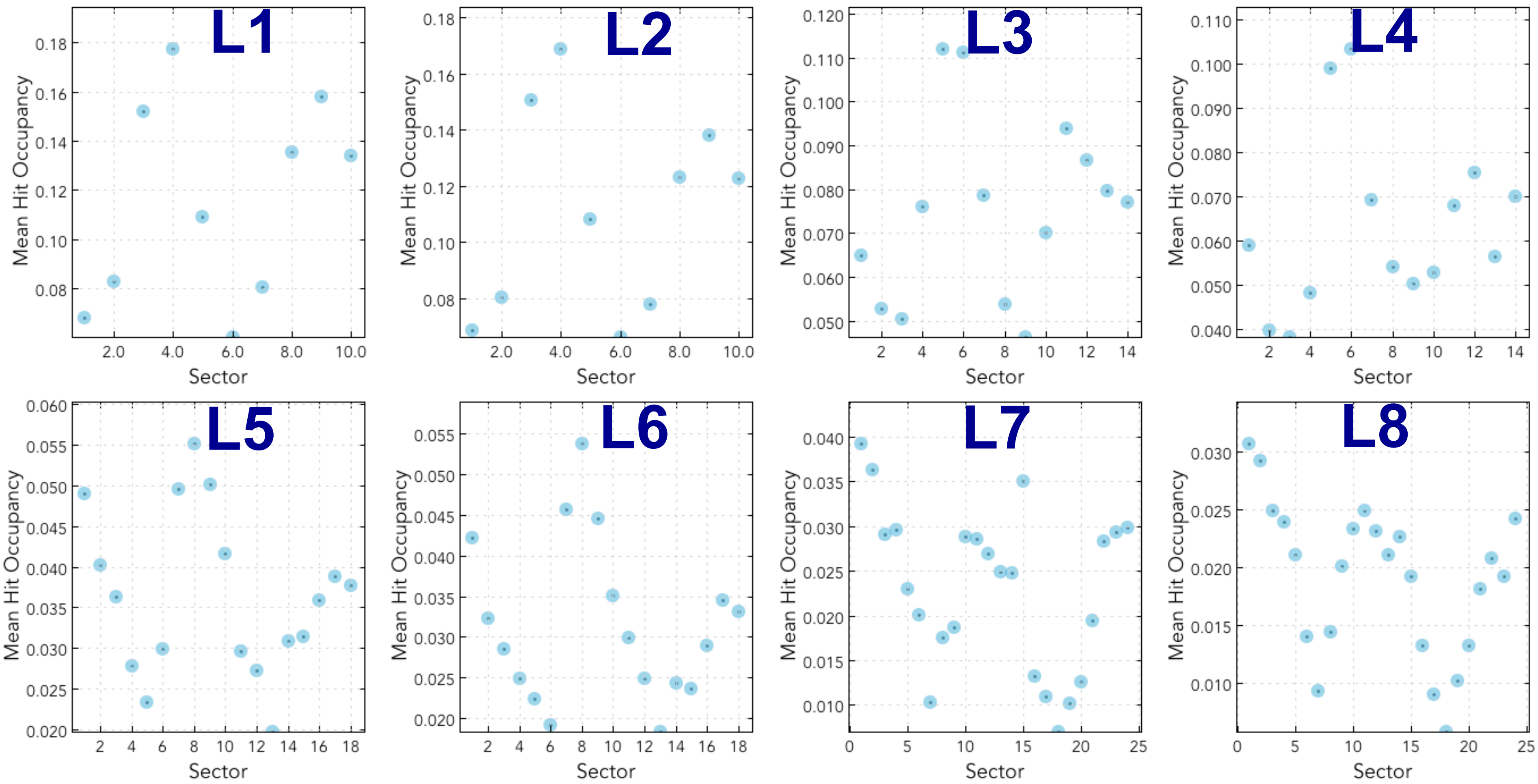
Detector Monitoring: Mean Cluster Charge



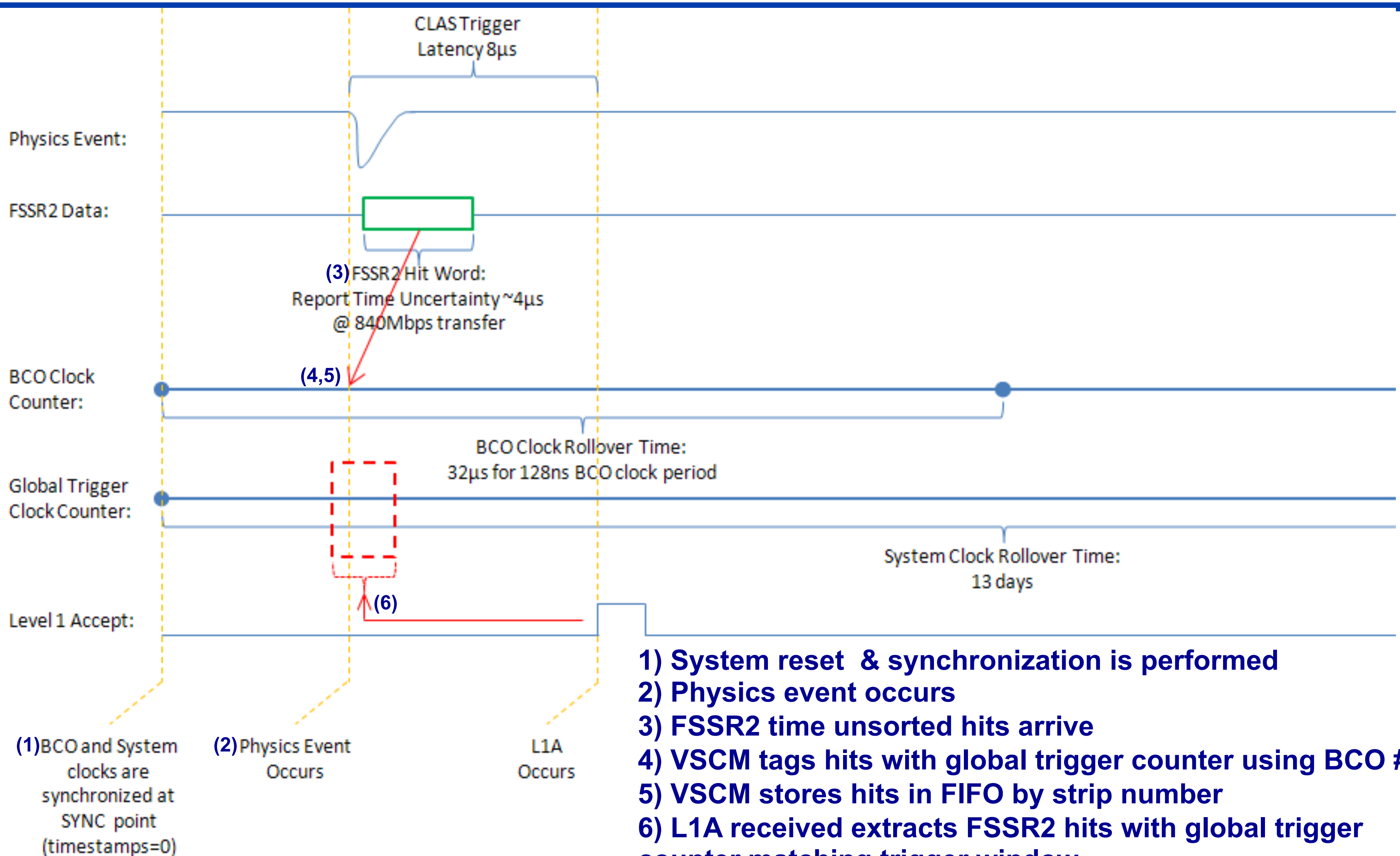
Detector Monitoring: Mean Track Angle



Detector Monitoring: Mean Hit Occupancy



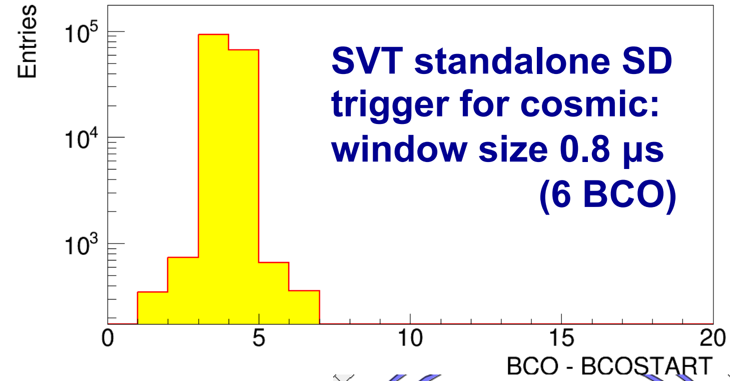
SVT VSCM Event Triggering

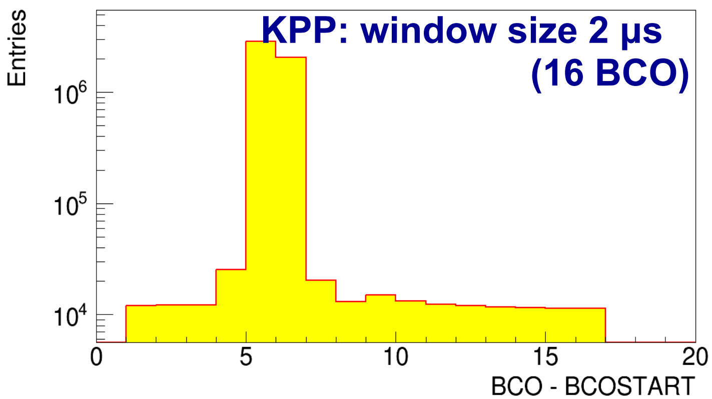


1) System reset & synchronization is performed
2) Physics event occurs
3) FSSR2 time unsorted hits arrive
4) VSCM tags hits with global trigger counter using BCO #
5) VSCM stores hits in FIFO by strip number
6) L1A received extracts FSSR2 hits with global trigger counter matching trigger window

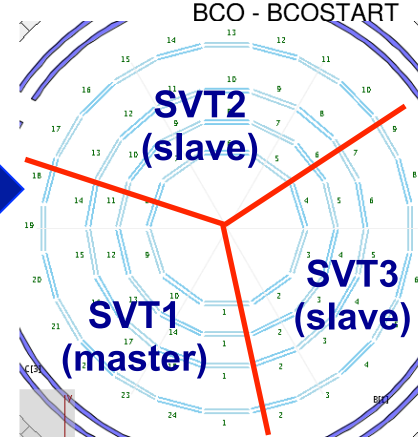
VSCM Trigger Window and Latency Setting (KPP and Cosmic Trigger)

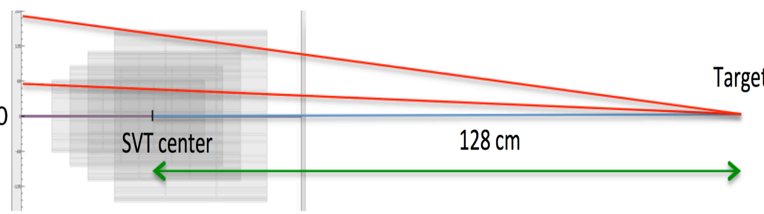
```
$CLON_PARMS/vscm/clasrun.cnf
#   VSCM_BCO_FREQ          <freq>
#
#   VSCM_TRIG_WINDOW    <windowSize> <windowLookback> <bcoFreq>
VSCM_CLOCK_EXTERNAL
# Set BCO frequency to 4 MHz
VSCM_BCO_FREQ       16
# Set Lookback parameters to 256=2 us window, 512=4 us lookback, 4 MHz BCO
# KPP: sync with CLAS trigger (added 6600 ns)
#VSCM_TRIG_WINDOW     256      1064       16
# cosmic trigger from SVT1's SD (96 * 8 ns = 768 ns = 6 * BCO, 1 BCO = 128 ns)
VSCM_TRIG_WINDOW     96       224        16
```



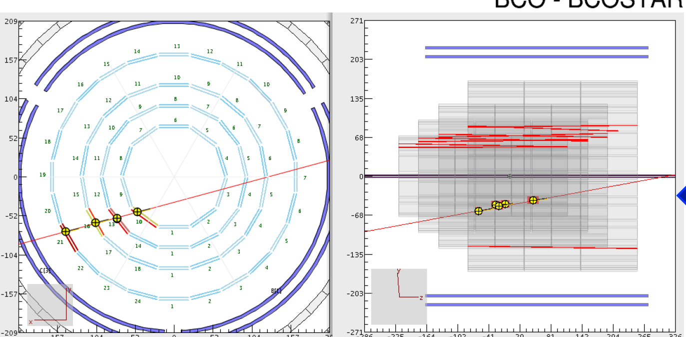


SVT SD based standalone cosmic trigger:
Double hit in 2 out of 3 crates
85% events have reconstructed track

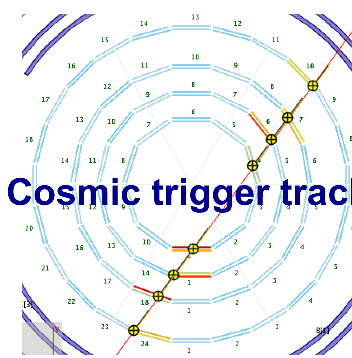




KPP SVT location



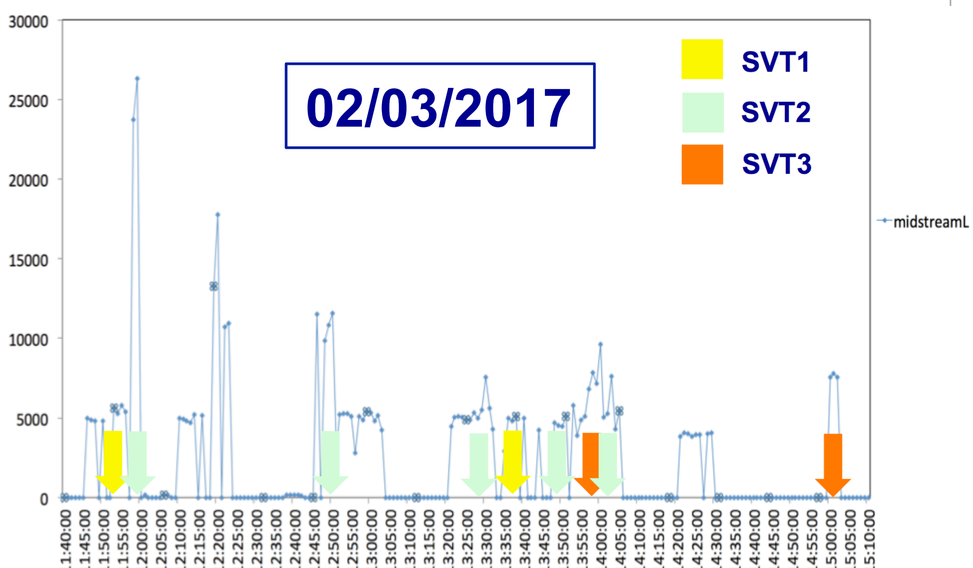
CLAS trigger event with track
27 k tracks reconstructed
in KPP runs 803, 809, 810



Singe Event Monitoring (SEM) Test during KPP run

- 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 ERR 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
- 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
  - install extra shielding of the SVT cart (polyethylene neutron shielding installed)
  - post a CLAS Note (done)
  - keep the SVT crates in OFF state during the beam tuning
  - move network switches to the SVT rack
  - add heart beat to SEM

Ben Raydo



CLAS-Note 2017-004

Single Event Effects Test of the Silicon Vertex Tracker Readout Boards

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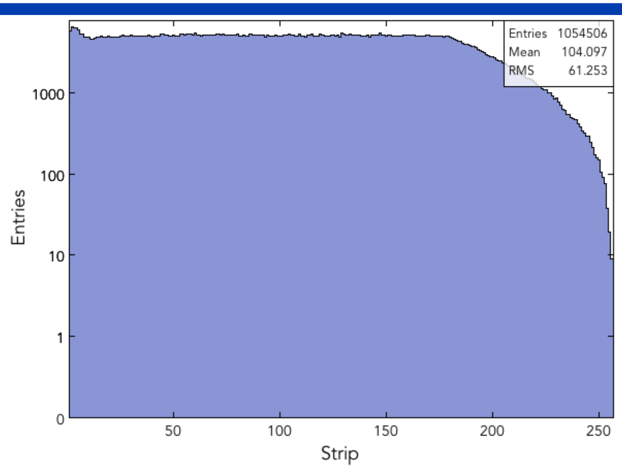
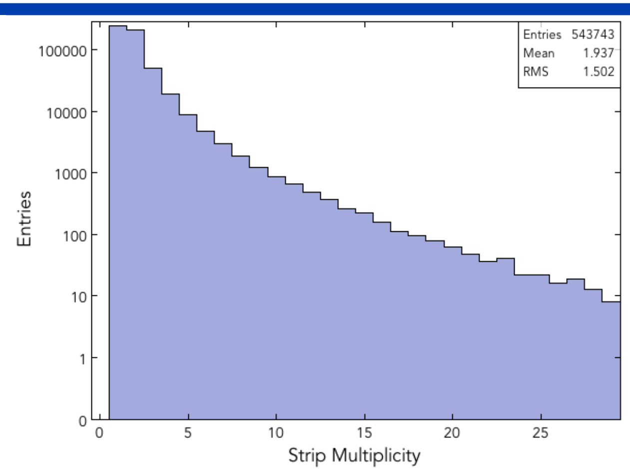
May 4, 2017

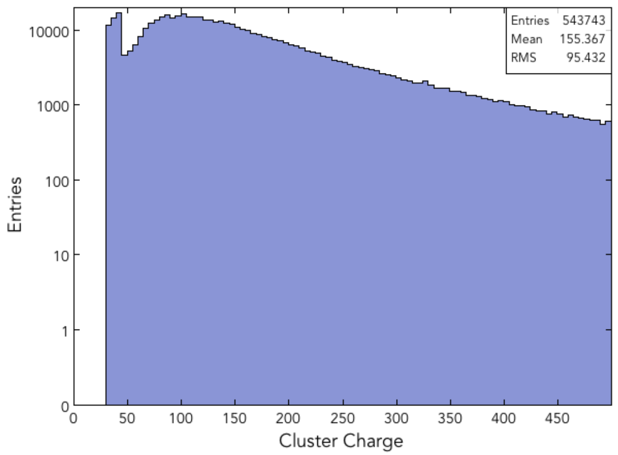
This note describes results of the Single Event Effects test performed during the Key Performance Parameter (KPP) run in February 2017.

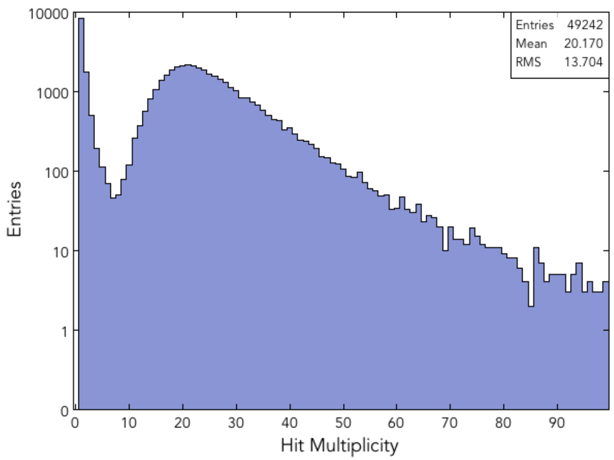
In addition to chronic radiation damage, sensitive electronics may exhibit a change of state (bit flip, transistor state change etc.) due to passage of a single particle, collectively known as Single Event Effects (SEE). SEE could cause important operation consequences: single bit errors in the data due to a Single Event Upset (SEU), freezing the readout chain due to a Single Event Latch-up (SEL), or complete failure of a component due to a Single Event Burn-out (SEB). Single Event Effects have been a serious concern for the readout electronics operating in the high radiation conditions of nuclear physics experiments. SEE are experiment specific as the effects depend on the mixed radiation environment and the electronic components used in the system.
In the high luminosity environment of CLAS12 experiment SEE could become an important issue. Sensitivity to SEE could potentially lead to contamination of physics signals, data corruption, reduced reliability of the detector, or reduced detector lifetime. Although the effects of corruption of small fraction of the collected data are negligible, possibility of loosing control of the critical detector components should be addressed.

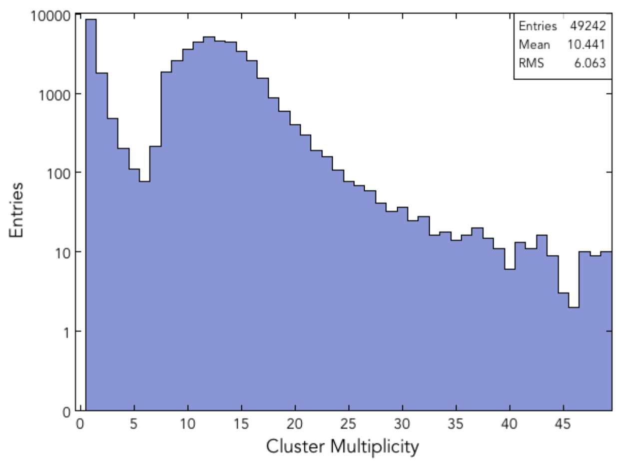
Local reconstruction (KPP runs 803, 809, 810, CLAS trigger)

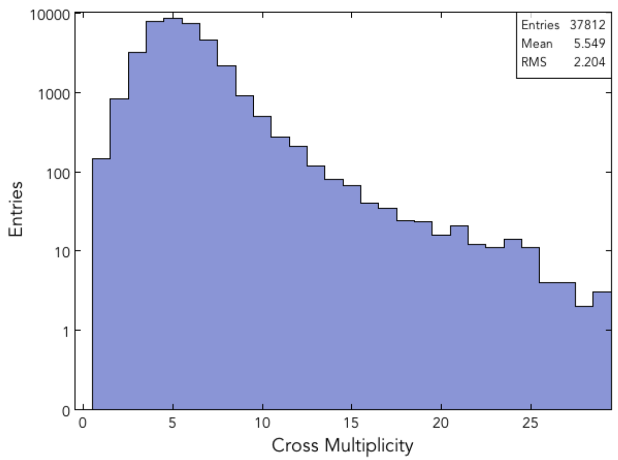




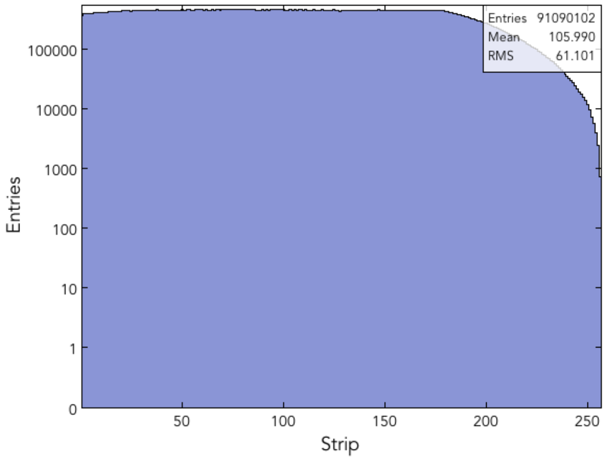


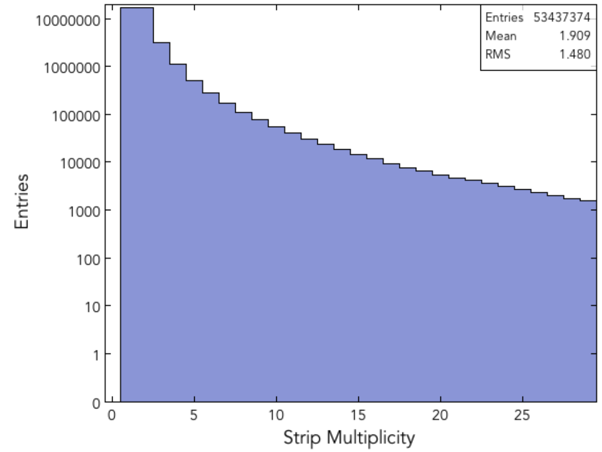


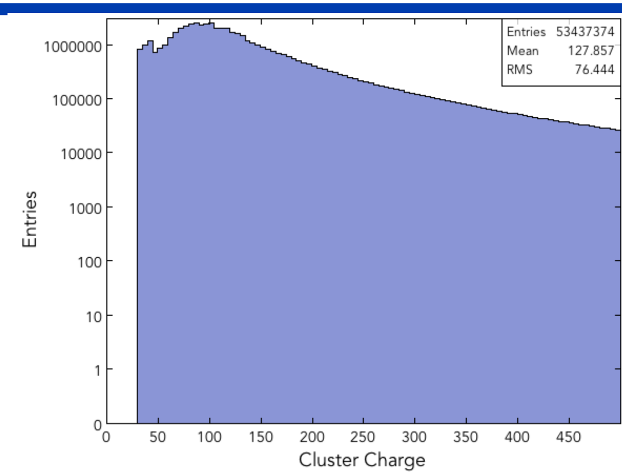


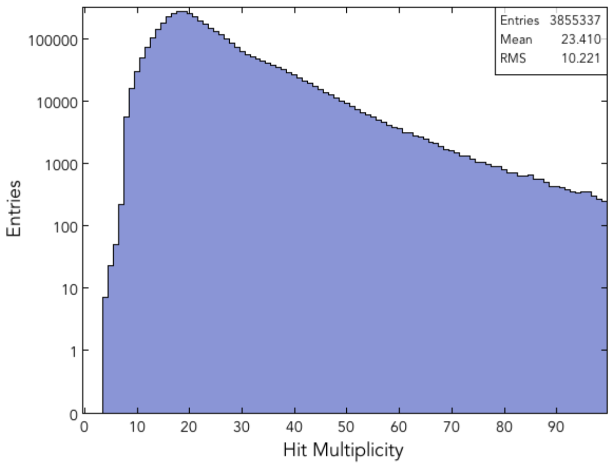


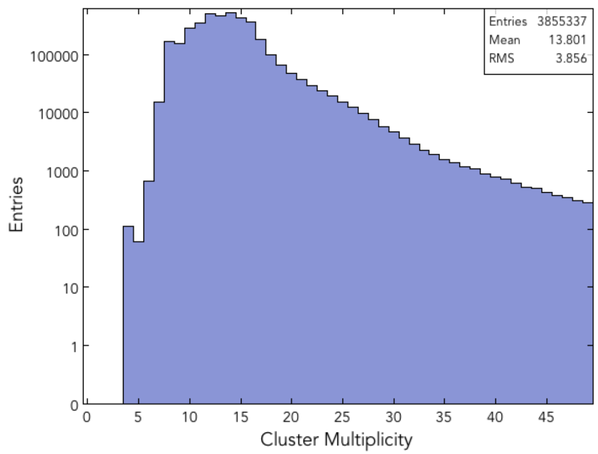
Local reconstruction (cosmic trigger run 419)

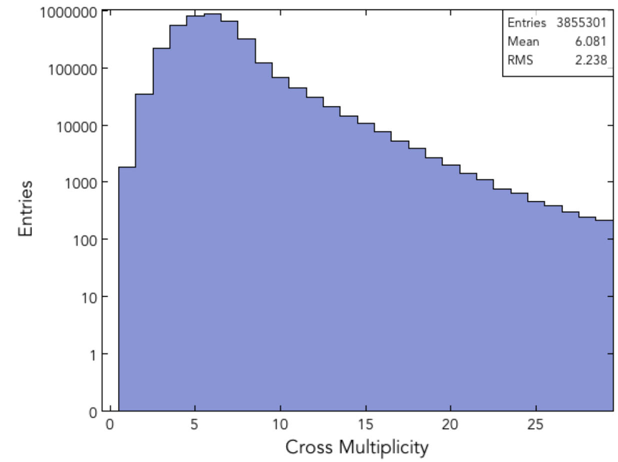




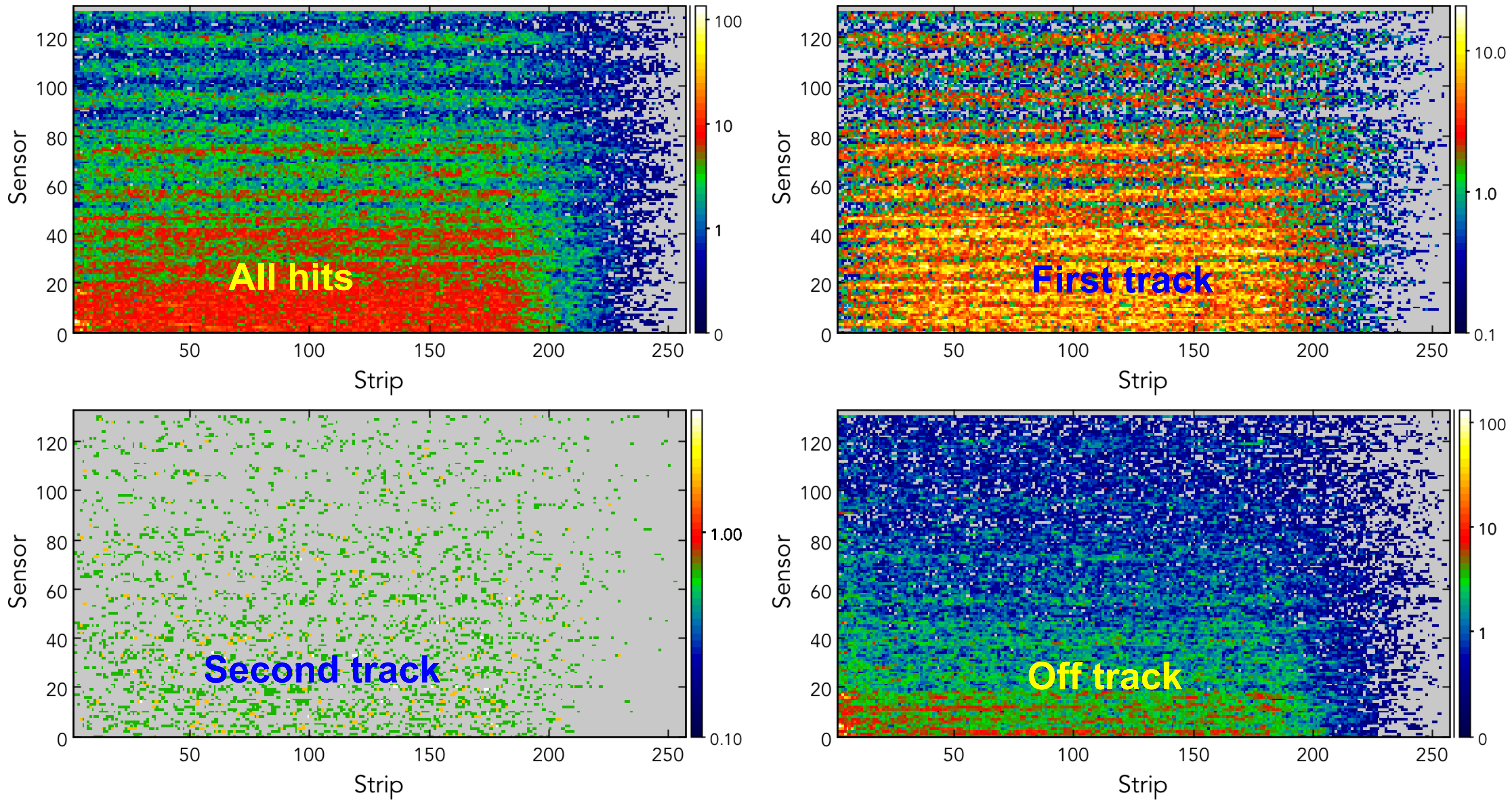






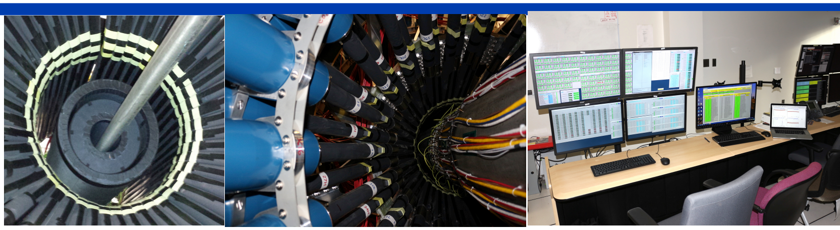


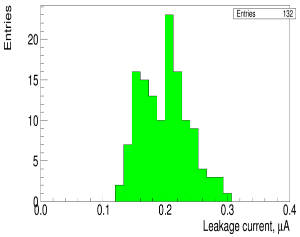
SVT Hit Occupancy (KPP run 799, SVT standalone trigger)



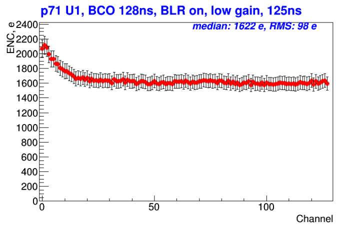
SVT Operation during KPP

- 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
  - Cosmic 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
- 27 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

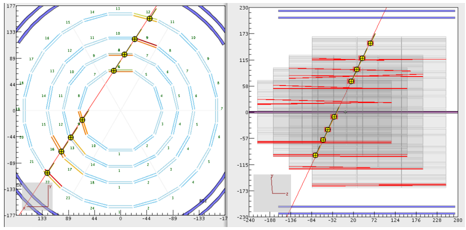




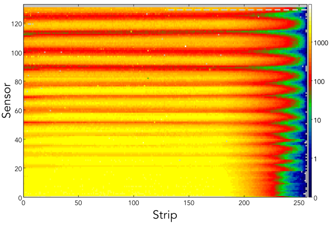
Leakage currents



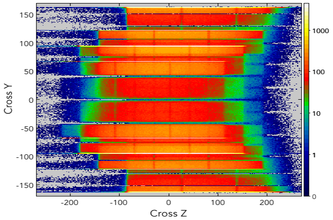
R1 noise shoulder



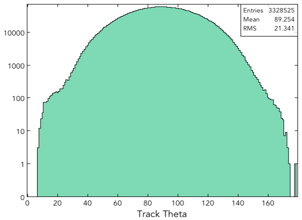
SVT Cosmic trigger data



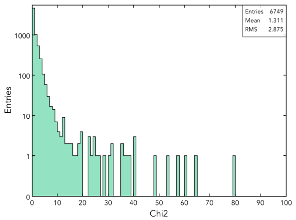
Hit occupancy



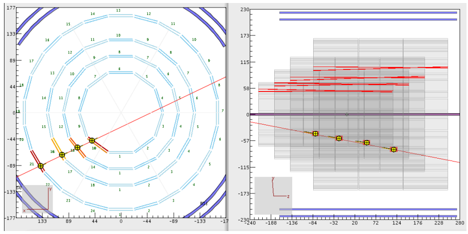
Track crosses



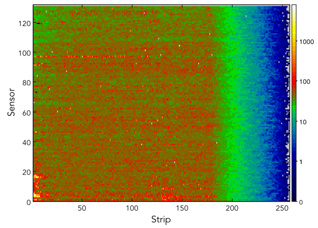
Track θ angle



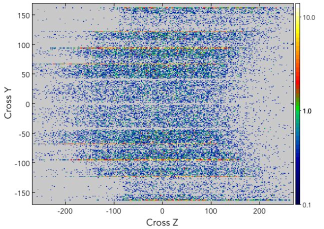
Normalized χ^2



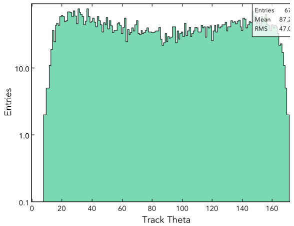
KPP CLAS trigger data



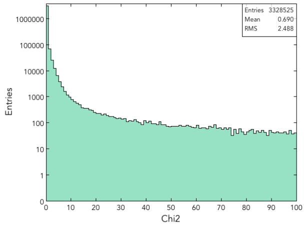
Hit occupancy



Track crosses

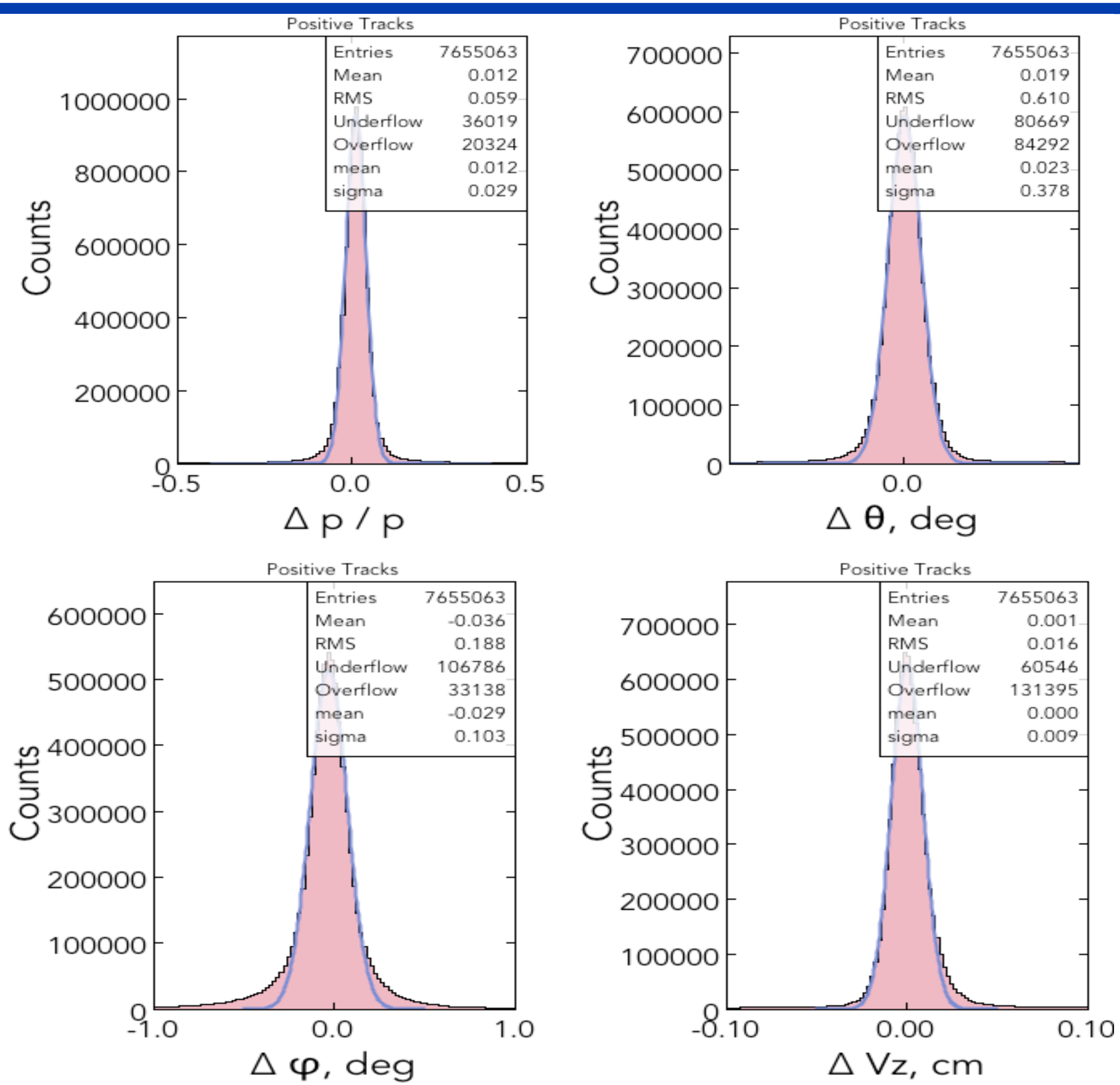


Track θ angle



Normalized χ^2

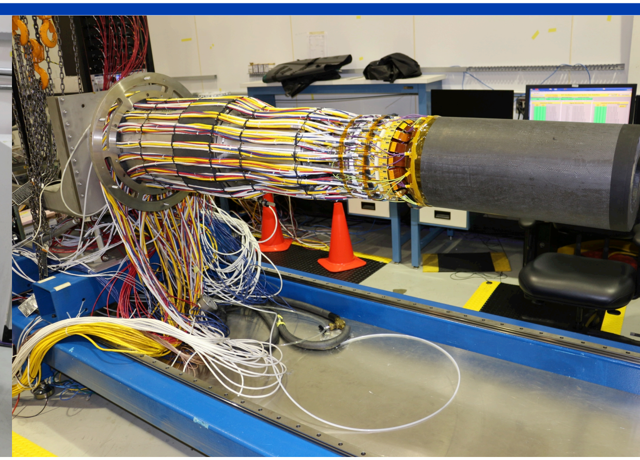
Resolution



Positive Tracks
Entries 7655063
Mean 0.012
RMS 0.059
Underflow 36019
Overflow 20324
mean 0.012
sigma 0.029
Counts
1000000
800000
600000
400000
200000
0
-0.5
0.0
0.5
Δ p / p
Positive Tracks
Entries 7655063
Mean 0.019
RMS 0.610
Underflow 80669
Overflow 84292
mean 0.023
sigma 0.378
Counts
700000
600000
500000
400000
300000
200000
100000
0
0.0
Δ θ, deg
Positive Tracks
Entries 7655063
Mean -0.036
RMS 0.188
Underflow 106786
Overflow 33138
mean -0.029
sigma 0.103
Counts
600000
500000
400000
300000
200000
100000
0
-1.0
0.0
1.0
Δ φ, deg
Positive Tracks
Entries 7655063
Mean 0.001
RMS 0.016
Underflow 60546
Overflow 131395
mean 0.000
sigma 0.009
Counts
700000
600000
500000
400000
300000
200000
100000
0
-0.10
0.00
0.10
Δ Vz, cm

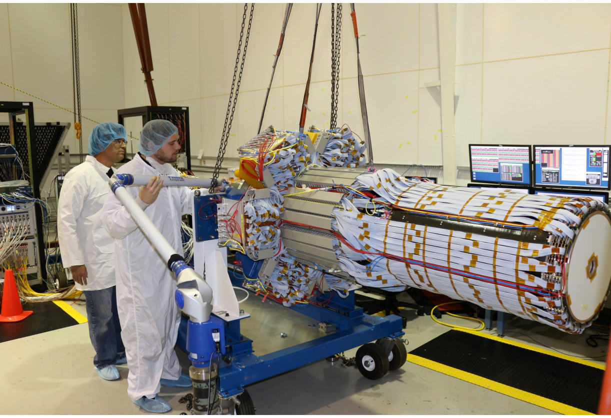
CVT Integration

SVT Region 4 dismounted



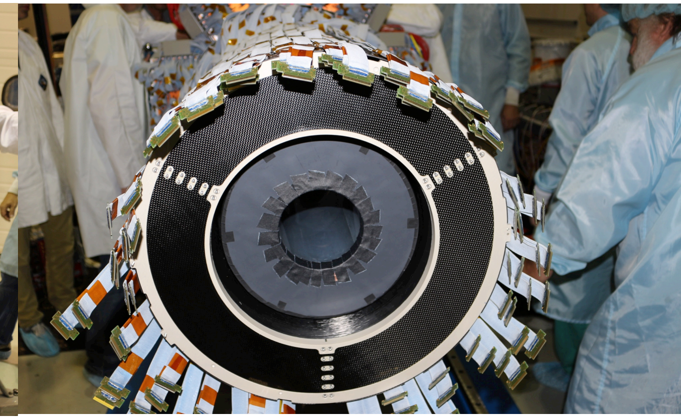
SVT ready for integration

Mounting MVT on the support rods

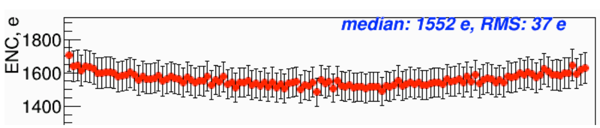


Survey of SVT and MVT
CVT alignment

CVT integration

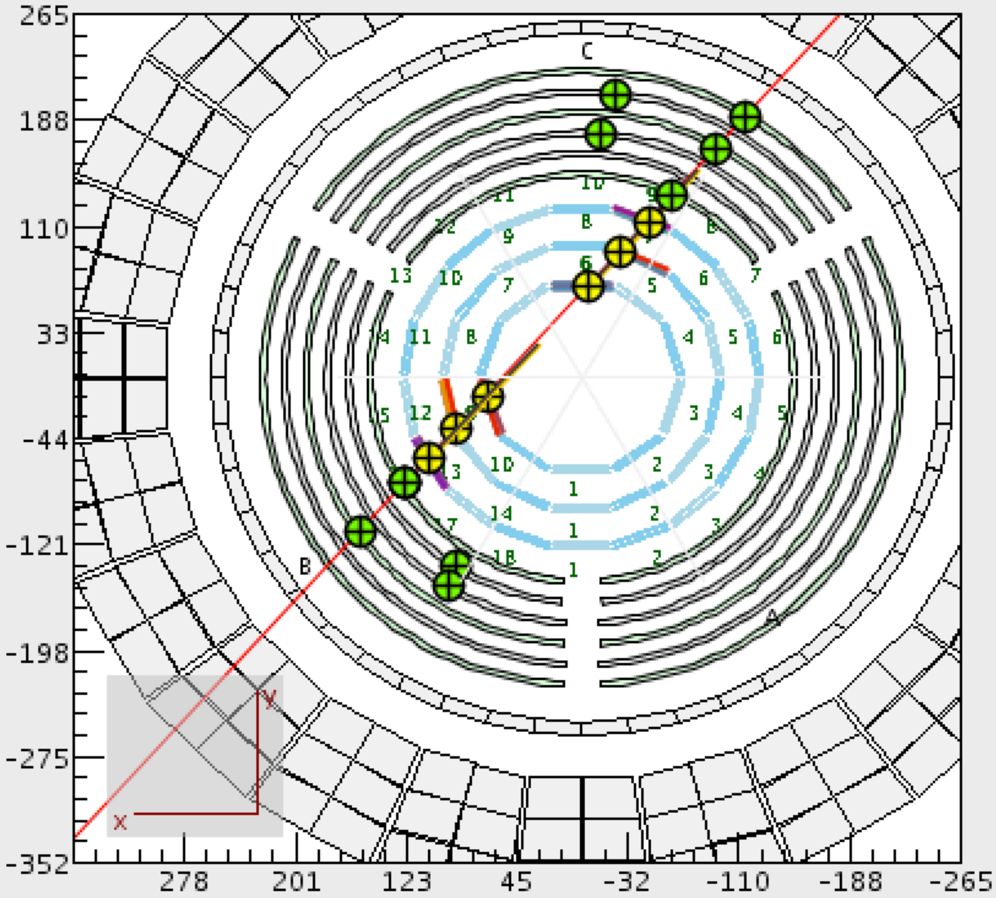


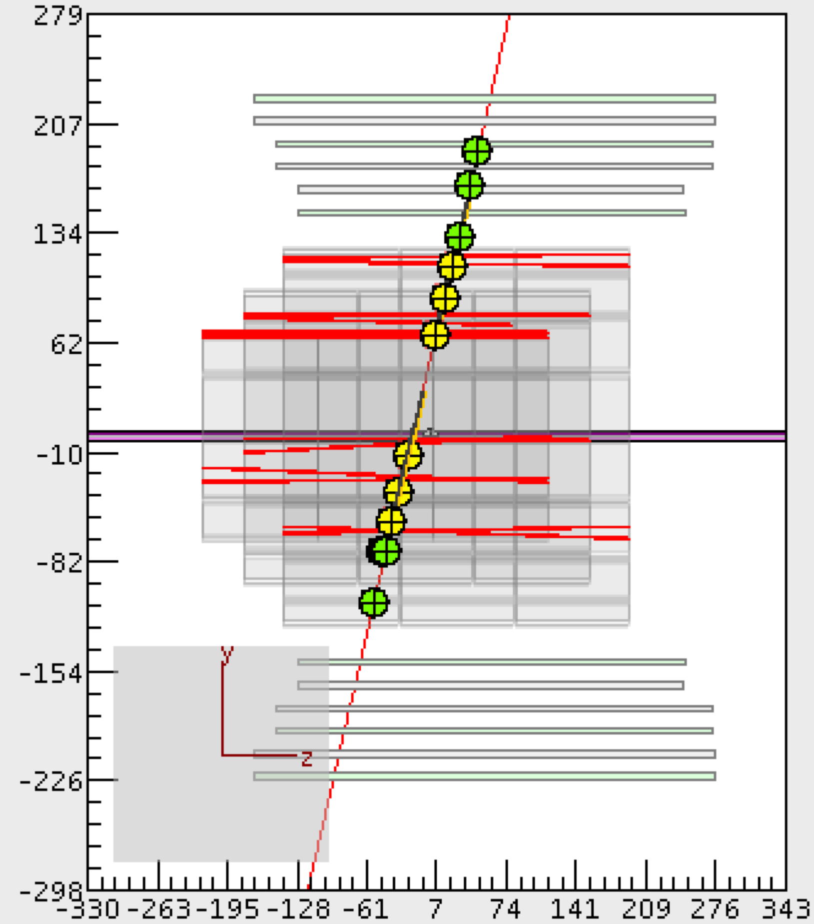
CVT integrated (SVT and BMT)



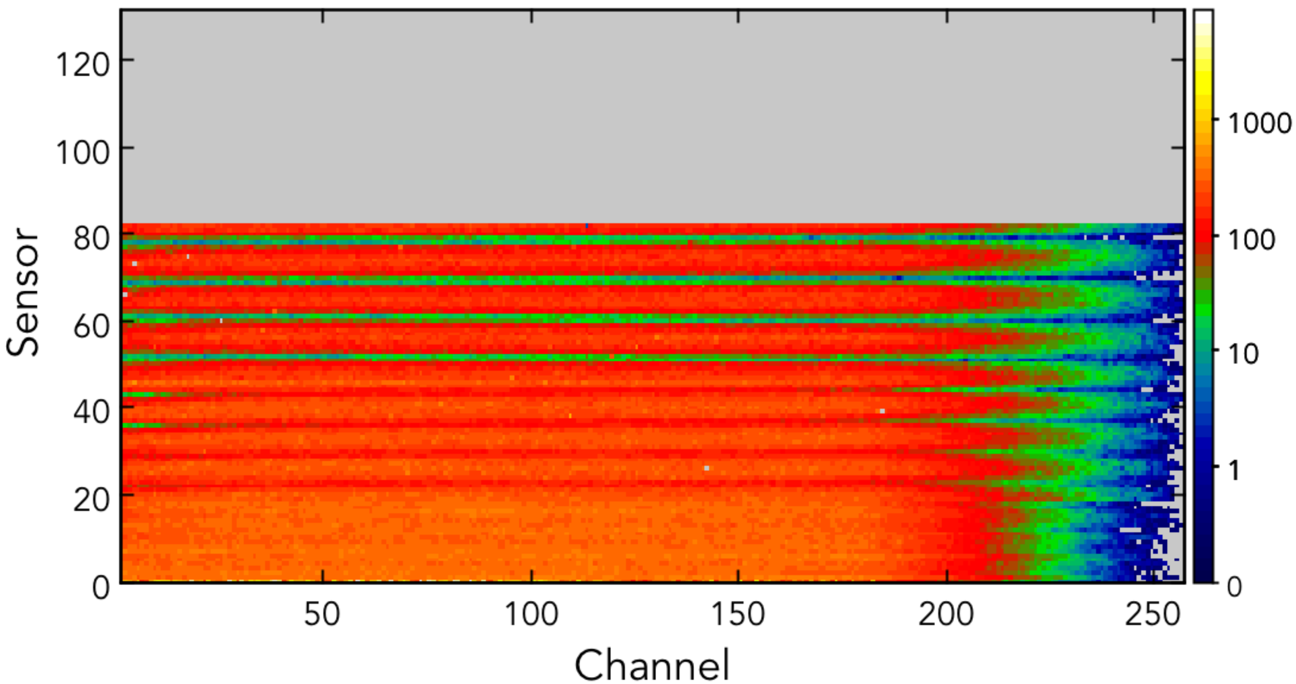
SVT noise the same after integration

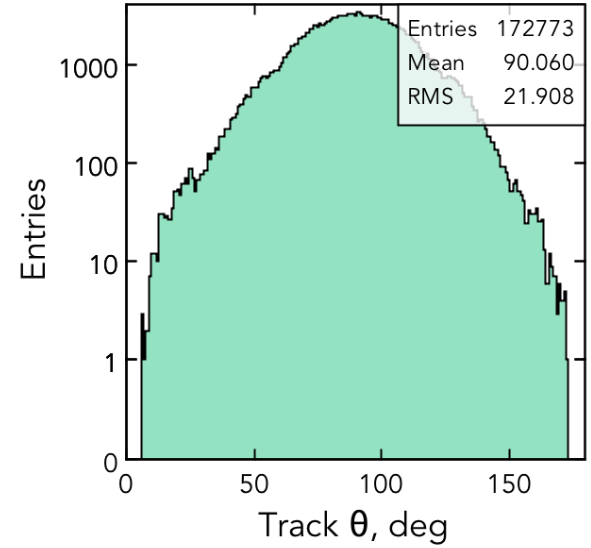
CVT Reconstructed Cosmic Track (run 474)

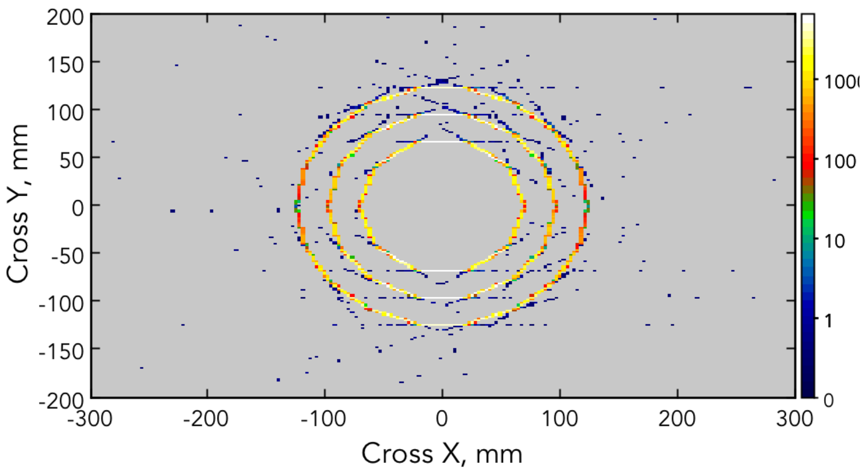


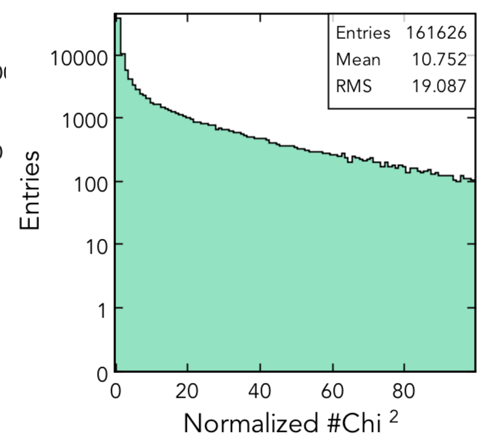


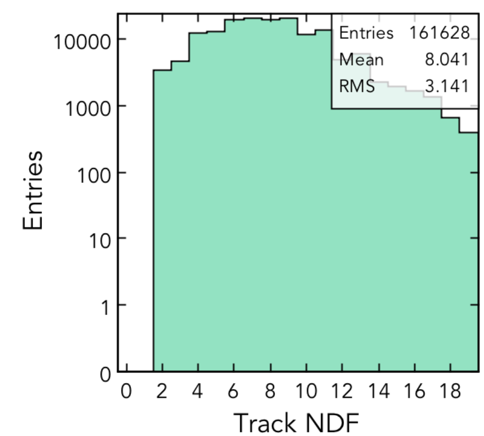
CVT Cosmic Track Reconstruction (run 474)











CVT Commissioning Activities (summer 2017)

- CVT Integration Complete
- Geometry description and validation (June)
- Detector Control and Safety System (June)
- Detector functionality checks (June-July)
- Developing DQM suite (June - July)
- Validation of local and track reconstruction (June - July)
- Monte Carlo tuning on cosmic data (June - August)
- Installation Schedule and Manpower (July)
- CVT calibration (July)
- High trigger rate test (July)
- Detector alignment is critical step in validating the tracker performance
  - Complete SVT survey DB validation by August
  - Complete SVT alignment by September
  - Complete CVT alignment by September
  - CVT alignment validation with MC and Cosmic data (July-September)
- Long term stability test (ongoing activity)
- Detector optimization (July-August)
- Detector performance studies (July-August)
- Documentation (May-August)

Summary

- SVT is fully integrated, surveyed and calibrated
- Checkout of the detector services complete
- Checkout of detector safety system complete
- Checkout of DAQ and trigger complete
- Validation of data integrity and reconstruction chain complete
- No extra noise observed after integration
- Detector operation experience since 2015
- Stable running with 99.9% channels operational
- KPP installation and system checkout complete in 4 days
- Detector installation procedures and performance in the hall validated
- Confirmed signal and noise performance on KPP data
- 27 k tracks reconstructed in KPP runs 803, 809, 810
- Completed SEE monitoring test, no readout or data corruption
- 100 M tracks cosmic sample collected, alignment in progress
- Conversion of Slow Controls to CLAS CSS complete
- SVT calibration suite complete
- Expert level detector monitoring and validation suite complete
- Conference papers published in NIM, PoS, technical paper in the works
- Documentation of hardware and software available

BACKUP