CLAS12 Silicon Vertex Tracker





Yuri Gotra CLAS Workshop March 28, 2017



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







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



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





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 AI 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.





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



0

-200

-400

-600

-1500



1000



-500

0

Z [cm]

500

-1000

0

-200

-400

-600

-1500

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MeV neutron

10²

100

1500

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-1000

-500

Ô.

500



1000

MeV neutron

 10^{2}

100

1500

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



* Location of the SVT service cart



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SVT SEE Test Setup in the Experimental Hall



SEM Reports 02/03/2017



SEM Test Summary and Outlook

- Radiation rates from LH₂ 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

Jefferson Lab 💻



Slow Controls

- 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



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





	CS	-Studio (on clo	onsl2.jlab.org)	_ = :
SVT Software Intiks ន				- 0
Expert Humid	lity Interlock	ОК	Expert Dewpoint Interlock	OK
Humidity SB1 A	Sensor 1 💿 Sensor 2	18.93 ONO	DewTempDiff SB1 A Sensor 1 Sensor 2	16.213 ONO
Humidity SB2 A	🕽 Sensor 1 🌔 Sensor 2	21.15 ONO	DewTempDiff SB2 A • Sensor 1 • Sensor 2	15.774 🔼
Humidity SB3 🗛 🕻	🕽 Sensor 1 🛛 🔵 Sensor 2	27.41 ONO	DewTempDiff SB3 A • Sensor 1 • Sensor 2	14.513 🔼 🔍
Humidity SB4 🗛 🕻	🕽 Sensor 1 🛛 🔵 Sensor 2	21.37 ONO	DewTempDiff SB4 A • Sensor 1 • Sensor 2	15.728 🔼 🔍
Humidity SB5 🗛 🕻	🕽 Sensor 1 🛛 🔵 Sensor 2	18.16 ONO	DewTempDiff SB5 A • Sensor 1 • Sensor 2	16.368 🔼
Humidity SB6 🗛	🖲 Sensor 1 🛛 🔵 Sensor 2	29.34 ONO	DewTempDiff SB6 A • Sensor 1 • Sensor 2	14.133 🔼 ONO
Humidity SB7 A	🖲 Sensor 1 🛛 🔵 Sensor 2	42.85 ONO	DewTempDiff SB7 A • Sensor 1 • Sensor 2	11.431 ONO
Humidity SB8 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	35.65 ONO	DewTempDiff SB8 A • Sensor 1 • Sensor 2	12.870 ONO
Humidity SB9 A	🖲 Sensor 1 🛛 🔵 Sensor 2	24.38 ONO	DewTempDiff SB9 A • Sensor 1 • Sensor 2	15.127 ON O
Humidity SB10 A	🖲 Sensor 1 🛛 🔵 Sensor 2	37.97 ONO	DewTempDiff SB1C A • Sensor 1 • Sensor 2	12.409 ONO
Ex Humidity SB1 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	54.18 ONO	x DewTempDiff SB 🗛 💿 Sensor 1 🌑 Sensor 2	9.170 ONO
Ex Humidity SB2 🗛 🤇	🕽 Sensor 1 🌔 Sensor 2	54.60 ONO	x DewTempDiff SB A 💿 Sensor 1 💮 Sensor 2	9.079 ONO
Expert Ambie	nt Temp Intlk	OK	Expert Coolant Flow Interloo	k
Temp SB1 🗛	Sensor 1 💿 Sensor 2	20.438 ON	Inlet Flow A -0.00 LPM OK	
Temp SB2 🗛 🕻	🕽 Sensor 1 🛛 Sensor 2	20.500 ONO	Outlet Flow A 0.04 I PM OK	OFF
Temp SB3 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.312 ONO	Inlet Temp A 11 42 degree OK	
Temp SB4 🛛 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.312 ONO	D4 Outlet Flow A 0.02 LDM	
Temp SB5 🛛 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.500 ONO	R4 Outlet Flow A 0.02 LPM OK	
Temp SB6 🛛 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.438 ONO	Inlet Pressure -0.15 PSI	
Temp SB7 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.125 ONO		
Temp SB8 🗛 🕻	🖲 Sensor 1 🛛 🔵 Sensor 2	20.062 ONO		
Temp SB9 🗛	🖲 Sensor 1 🛛 Sensor 2	19.938 ONO		
Temp SB10 A	🕽 Sensor 1 🛛 Sensor 2	20.062 ONO		
Ex Temp SB11 A	🕽 Sensor 1 🛛 Sensor 2	19.500 ONO		
Ex Temp SB12 A	🕽 Sensor 1 🛛 Sensor 2	19.938 ONO		

SVT Temperatures



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Online/Offline Detector Monitoring





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



Local reconstruction (runs 803, 809, 810)





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Local reconstruction (cosmic run 419)





Data Quality Monitoring



Events with signal in SVT and CTOF



Sample KPP event with high SVT and CTOF hit multiplicity







Alignment

 $N_{sectors} \times N_{lavers} \times N_{trans} \times N_{rot} = 66 \times 2 \times 3 \times 2 = 792$

Track-based alignment of SVT requires fitting many parameters:

classes.

Program millepede does linear least squares with many parameters.

Uses matrix form of least squares method and divide the elements into two

Global parameters – the geometry misalignments. Same in all events.

Jerry Gilfoyle

Local – individual track fit parameters. Change event-to-event. Calculate first partial derivatives of the fit residuals with respect to the 0 local (i.e. fit) parameters and global parameters (geometry misalignments). Manipulate the linear least squares matrix to isolate the global parameters Ο (geometry) and invert the results to obtain the solution. Type 1 tracks – Type 1, May 11-18 sensors are Apply to a 'simple' example – Type 1 tracks. 150 Use gemc cosmics for testing and validation. horizontal. 0 Shift layers 1-2 (Region 1) by 2-500 μ m in x. 100 CLAS12 SVT 100 millepede reproduces all shifts. Cosmic Events Blue - uncorrected -90 Apply to Type-1 cosmic ray sample from SVT. Red - corrected 50 Laver 5 Fixed layer 4 in millipede fit to SVT residual. 0 Sector 10 y (mm) Blue - Reconstruction Good agreement between millipede mis-60 Red - millepede, Layer 4 alignment and residuals. fixed at residual Fit residual and resolution improve. -50 40 $\sigma_{\mu} = 86 \ \mu m$ $\sigma_c = 73 \,\mu m$ 204 Code for Type 2 events now being tested. **12** -100 HOF--150 -0.6 -0.4-0.20.2 0 Residual (mm) -0.5 0.0 0.5 CLAS Workshop March 28, 2017 Yuri Gotra Residual/Misalignment (mm)

Alignment



Documentation

22 Jul 2013 21 Jul 2013 22 May 2013 Reviews

Yari Gota

Modale

Ford Sides - JLab Production Reading

Gotta Sildes - Quality Assurance Detylo Sildes - ILab Production Reeds

Finture - Module Storage Box

Page 2

featuring data driven architect

barrel using unique cantilever

Technical Design Report	~		
Geometry Document	~		
Commissioning Document	~		
Reconstruction Algorithms	~		
Manufacturing Drawings and Schematics	~		
Assembly/Service Procedures	~	Performance of the CLAS12 Silicon Vertex Tracker modules M. Anorem V. Bourney, L. Bourney, F. Bartey, M. Lindy, M. Kurley, K. Marker, M. Marker, M. Marker, M. Starker, M. St	
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https://www.jlab.org/Hall-B/cvt/svt/



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Calibration Software

Previous topic

March 28, 2017

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



