SVT Overview

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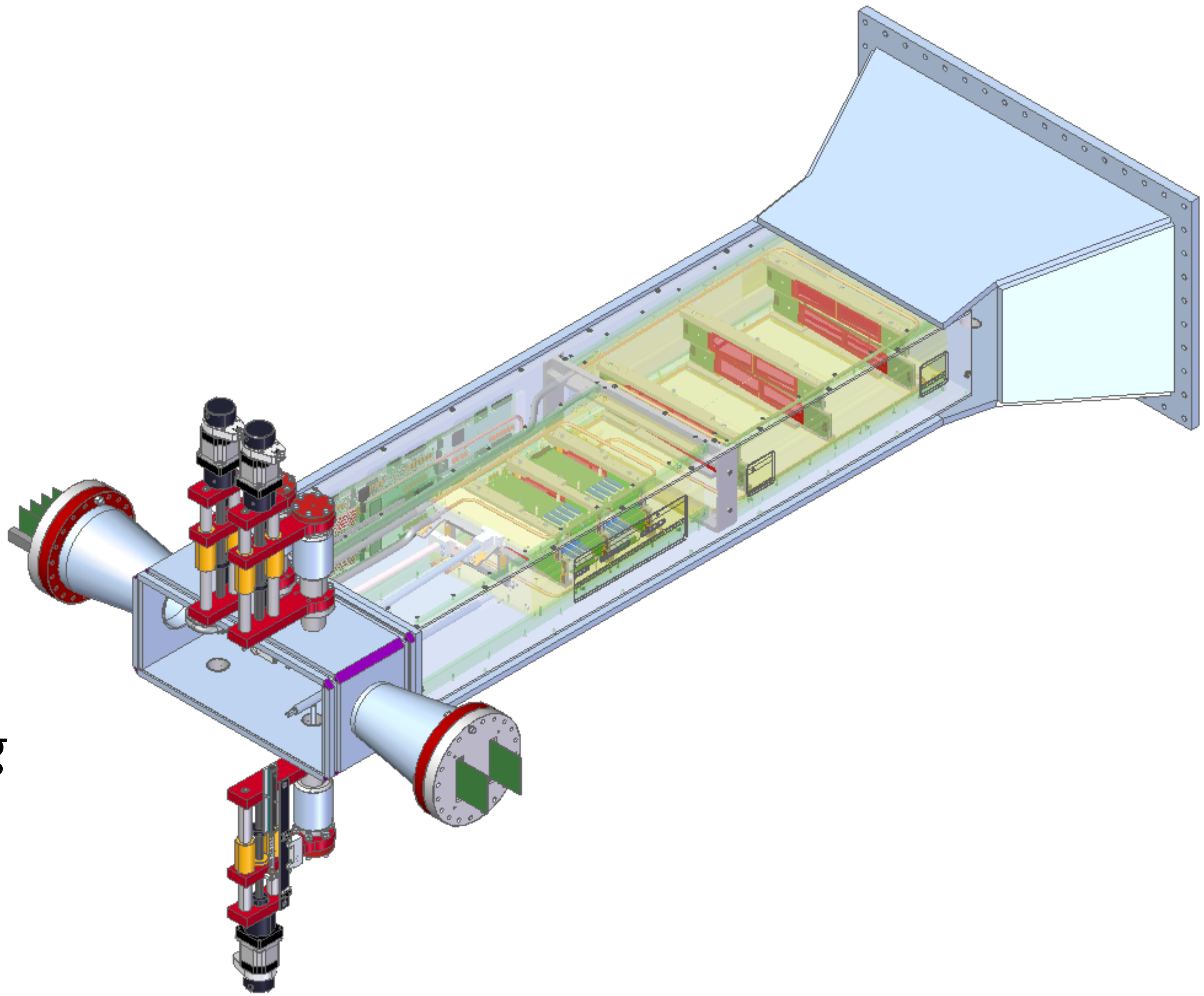
(for the SVT group)

HPS Collaboration Meeting

JLab - October 27, 2015



Engineering Run Review

We had a very successful first run with the SVT…

- mechanics, cooling, vacuum…
- charge collection, noise, hit efficiency…
- operation and occupancy at 0.5mm

…and nearly all operational goals were met or exceeded.

There were a few unresolved issues…

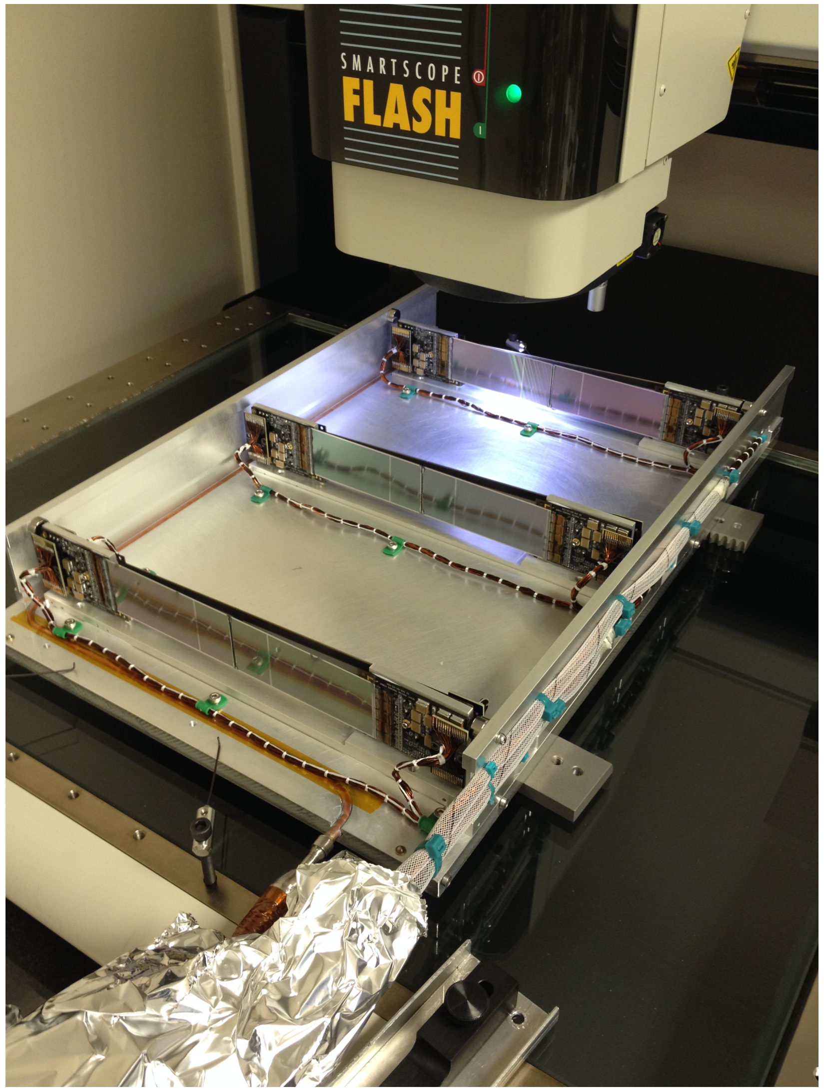
- SVT DAQ: rate limitation, data volume, errors/sync issues, APV25 tuning, header noise… (Pelle)
- JLab DAQ: stability, inability to pause when detector not ready (Sergey)
- Miscellaneous: beam tails, surface currents, monitoring, DQM, documentation/instructions

…and these are the immediate focus.

Mechanics

Mechanical precision and stability were excellent.

- Survey shows internal and global alignment each within ~50 μm.
- From tracking, as-built alignment roughly as good as survey and is stable and repeatable.
- *N.B. global survey shows vacuum chamber is ~2.4 mm further downstream than design.*



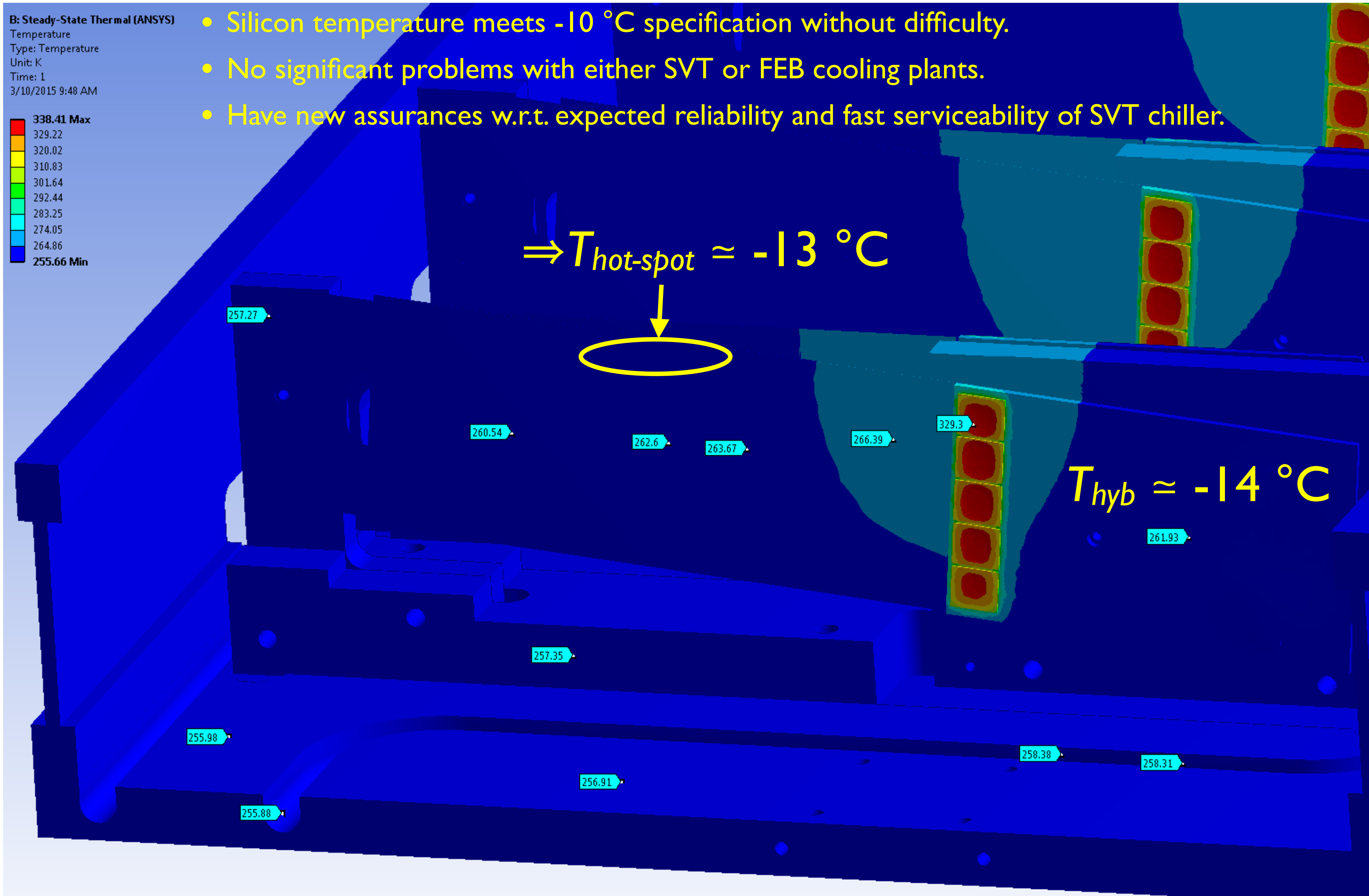
Hall B installation survey

	Measured - Ideal (mm)		
	x	y	z
PS Magnet	0.600	-0.760	-0.340
PS Flange	0.900	-0.470	—
SVT Center	0.017	0.055	2.404

	Measured - Ideal (mrad)
	x
SVT Pitch	0.024
SVT Yaw	0.037
SVT Roll	-0.028
SVT Twist (mrad/m)	-0.021

Cooling

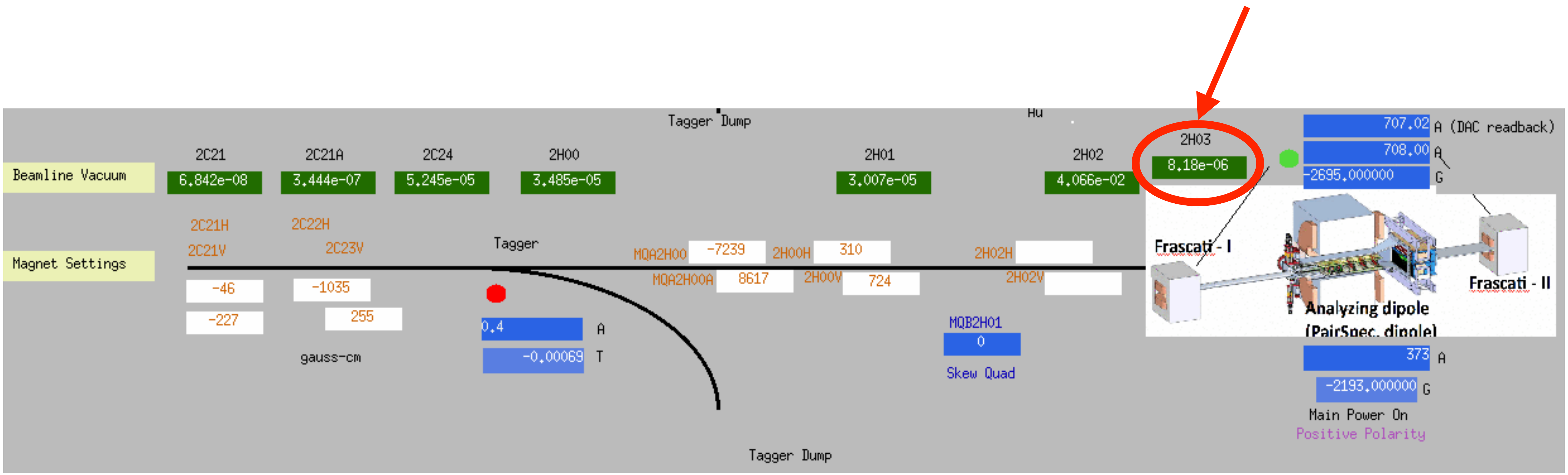
- Silicon temperature meets -10 °C specification without difficulty.
- No significant problems with either SVT or FEB cooling plants.
- Have new assurances w.r.t. expected reliability and fast serviceability of SVT chiller.



Mechanics, Cooling, Vacuum

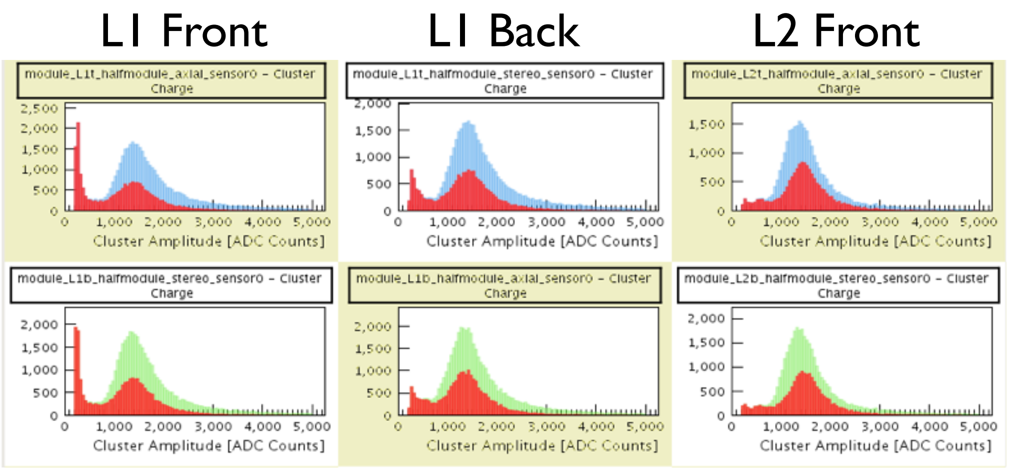
- No difficulties (aside from false alarms) due to *rigorous vacuum testing.*
- Even with borated-HDPE neutron shielding, vacuum is more than acceptable.

Experience in the 2012 Test Run was critical to this success.



Signal, Noise, Hit Quality

Signal



- Signal Landau distributions show full charge collection.
- Rate of hits from x-rays somewhat higher than expected: superposition of L-shell and M-shell energy depositions?

Noise

- With exception of header-induced noise for overlapping triggers when running at high rates, noise is as expected and S/N ~ 25.
- Noise hits are dominated by non-Gaussian tails so rate of random noise hits somewhat higher than naive expectation. Could be eliminated with higher thresholds without compromising hit efficiency. (… but rate is already below proposal assumptions)

Hit Quality

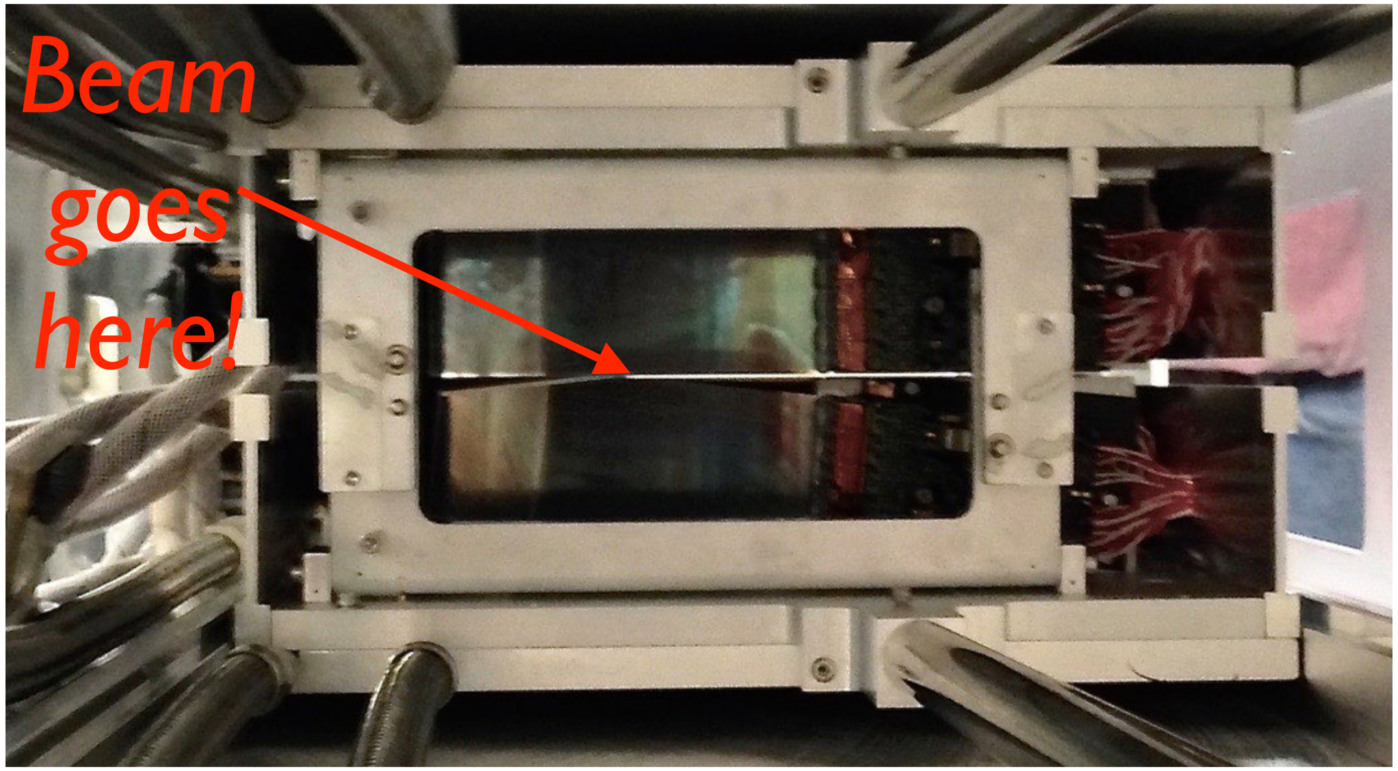
- Hit efficiency is very nearly 100%. Would allow use of "misses" in track reconstruction.
- Hit time resolution is as expected for first pass at timing calibration.

Fundamental data quality is excellent. Still room for improvement in exploiting the data.

Operation and Occupancy at 0.5 mm

Always THE question for HPS: "can you really run with the silicon 0.5 mm from the beam?":

- **YES.** Success was culmination of efforts in simulation, silicon R&D, mechanics, beam line development, beam diagnostics and continued vigilance!



- Understanding of beam/SVT positions with BPMs, collimators, SVT wires is excellent.
- Occupancies are as anticipated to ±25%, perhaps better.
- Currents and radiation effects roughly as anticipated, with the exception of *surface effects*.

This is still probably the primary challenge for operation of HPS, so a great deal of attention will continue to go into beam diagnostics and monitoring for SVT safety.

SVT DAQ Issues (Pelle's talk next)

The SVT came together beautifully at the last minute, but a number of integration/operational issues were only sorted out once we began running.

- support for overlapping triggers
- timing relative to ECal triggers which is fully efficient for SVT hits.
- efficient handling of beam trips

A few things still remained at the end of the run

- overlapping triggers
  - deadtimes higher than those found during testing at high trigger rates
  - higher noise observed when sample acquisition overlaps APV25 readout: header noise
- no fine adjustment of phase between trigger and SVT DAQ: forced to choose between full efficiency and optimal time resolution in SVT.
- data volume from SVT much larger than proposed.
- errors/loss of APV25 sync on some FEB channels.

Pelle will describe the status of ongoing work to improve the SVT DAQ.

JLab DAQ Issues (Sergey's talk after Pelle)

The Engineering Run was the first time the JLab DAQ confronted with SVT data.

- General stability issues with larger events, much improved during the run.
- Challenges moving data to centralized computing while running simultaneously.

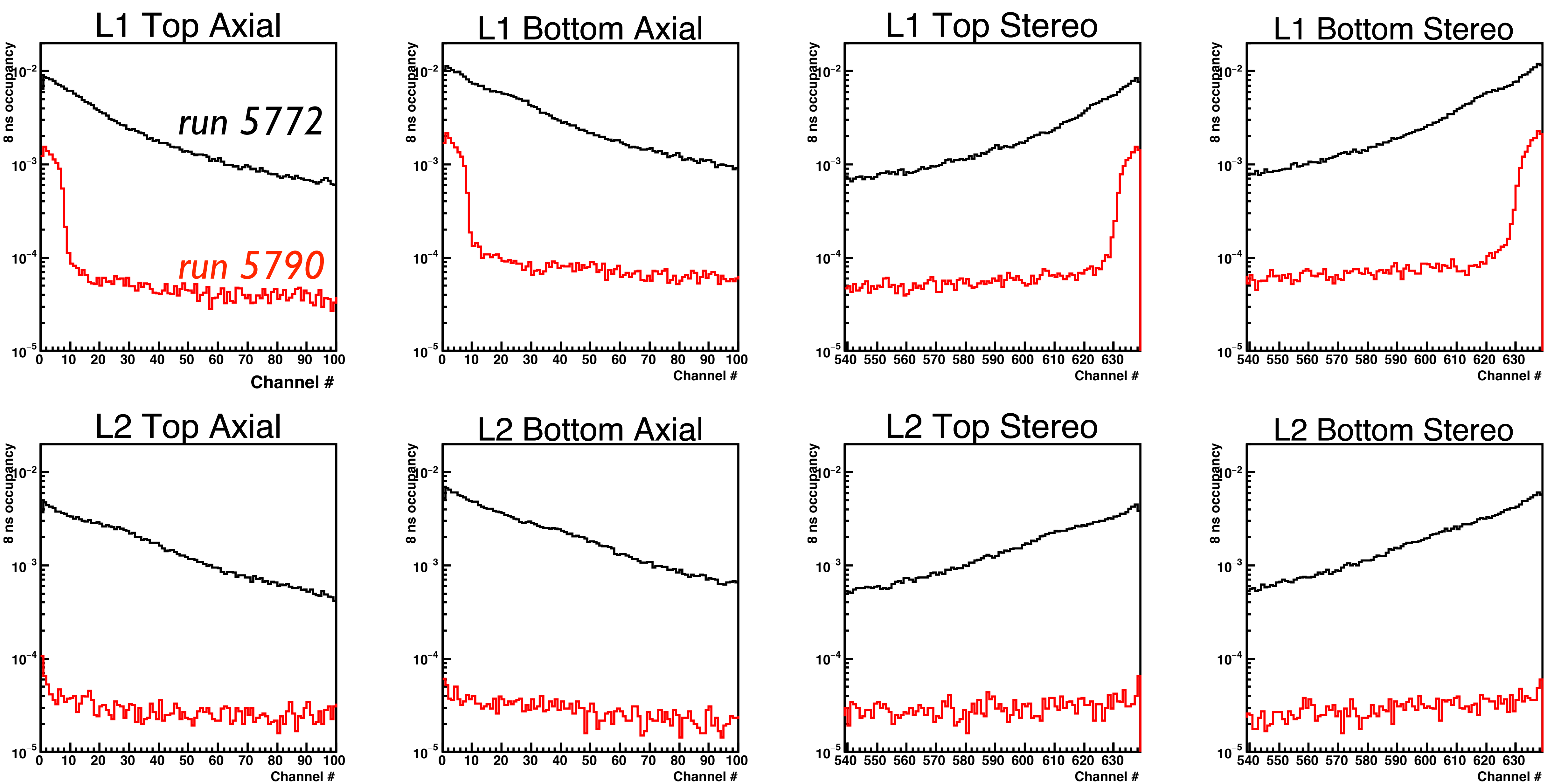
Some key improvements w.r.t. SVT still needed:

- Stable running over multiple hours, through CODA transitions.
- Ability to withhold triggers when SVT not ready (using EPICS signals for HV, SVT position).

Sergey will describe ongoing work to improve the DAQ/trigger.

Beam Tails

Effect is clearly seen in comparing runs with and without target



Occupancy is roughly 1/5 of physics occupancy, in 8-10 60μm strips.

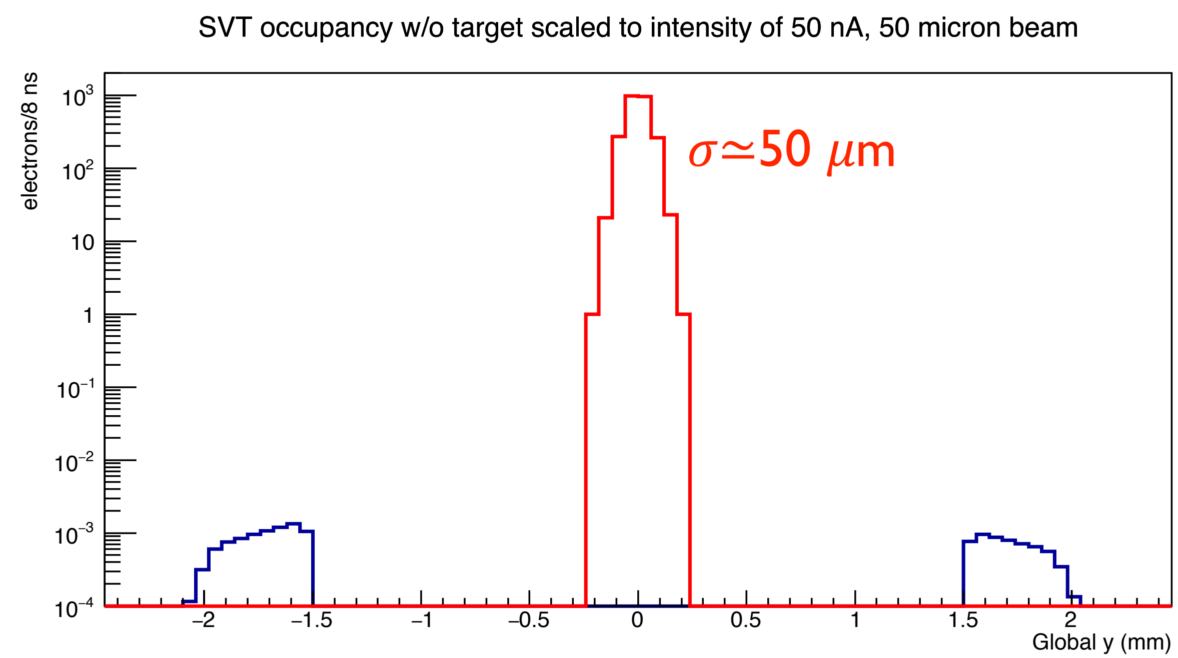
Beam Tails

- Tails are roughly at the expected level.
- Assuming perfect understanding of SVT position and collimator size, a ~100 μrad divergence of this beam component through the collimator.

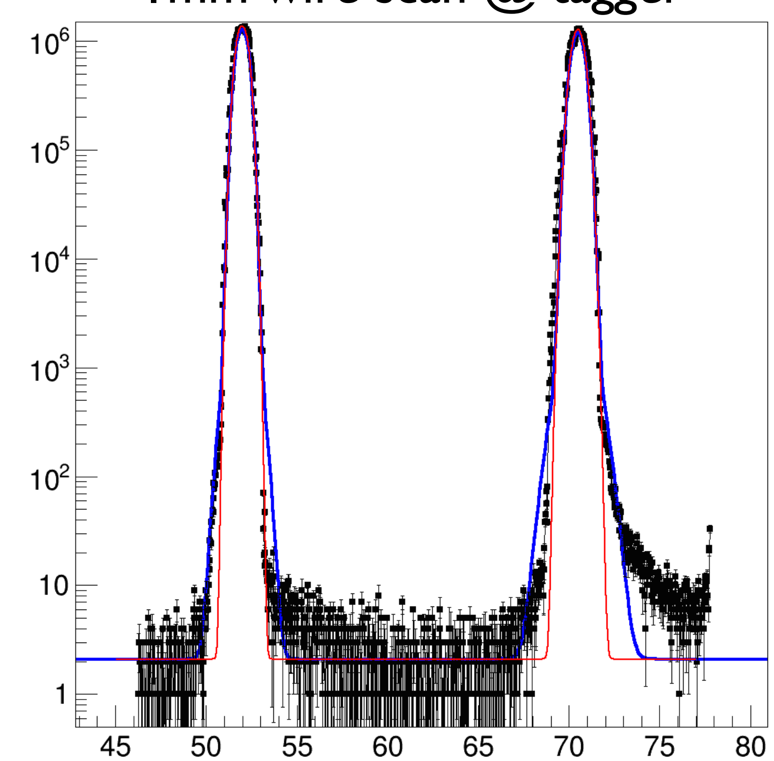
➡ *We should have been looking for this.*

- Tails at this level are not a problem for the SVT. However, *if these tails were to be an order of magnitude larger*, they would dominate the occupancy in the critical regions of L1.
- Data will be used to define collimator design for future running.

➡ We should take no-target runs periodically to look for these effects during future runs.



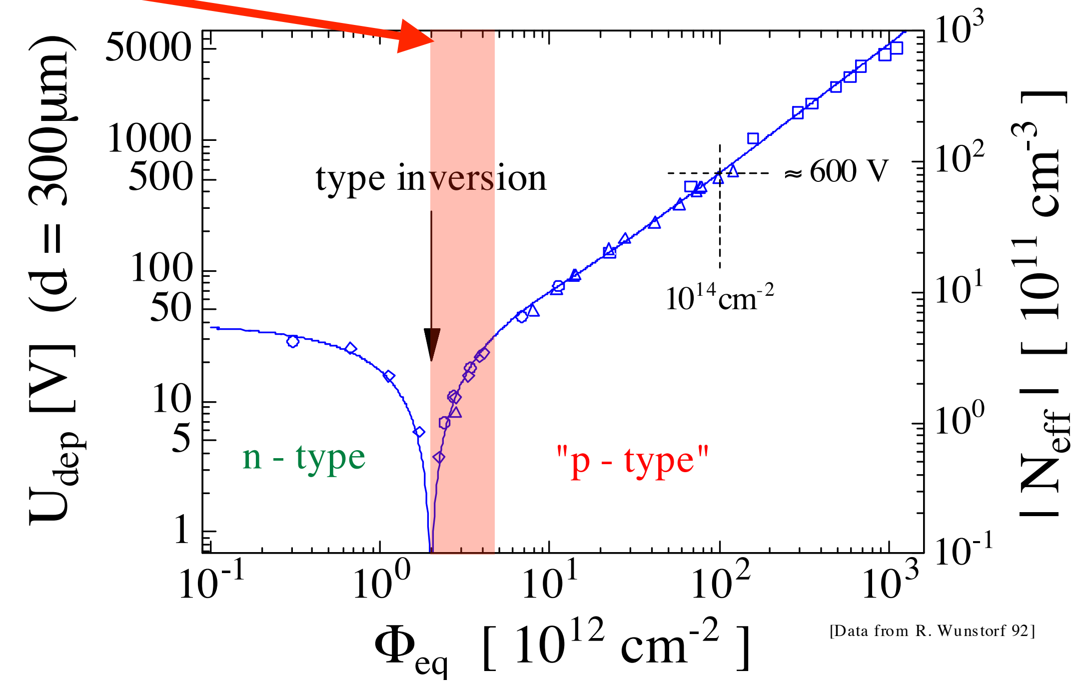
1mm wire scan @ tagger



Irradiation / Surface Currents

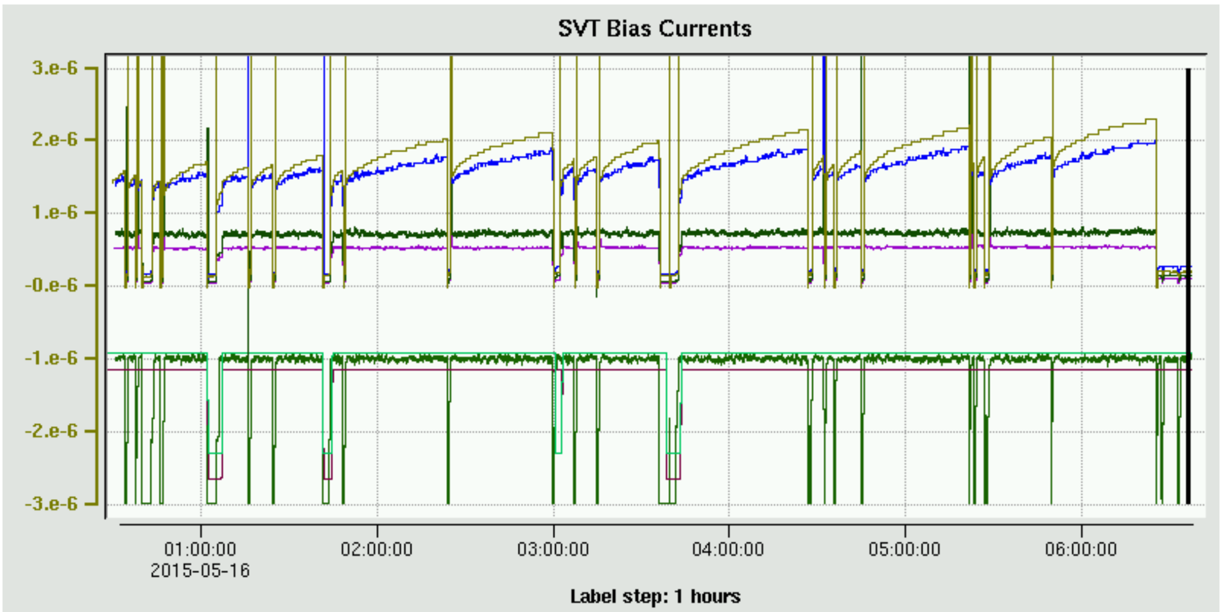
Bulk damage to hot-spot in Layer 1 is already significant

- Have maintained cooling through down period.
- Likely we already have type inversion there.
- Have bias scan data with which we can measure this effect as a function position in silicon.



Unexpected short-term increase in currents during runs after moving to 0.5 mm.

- Likely due to charge buildup at surface of oxide layer from intense ionizing radiation.
- Not generally a concern in HEP experiments: more often associated with light sources.
- Effect depends upon rate of exposure to ionizing radiation. HPS SVT in poorly charted territory.
- Not clear yet how this behavior will scale to higher integrated exposures.

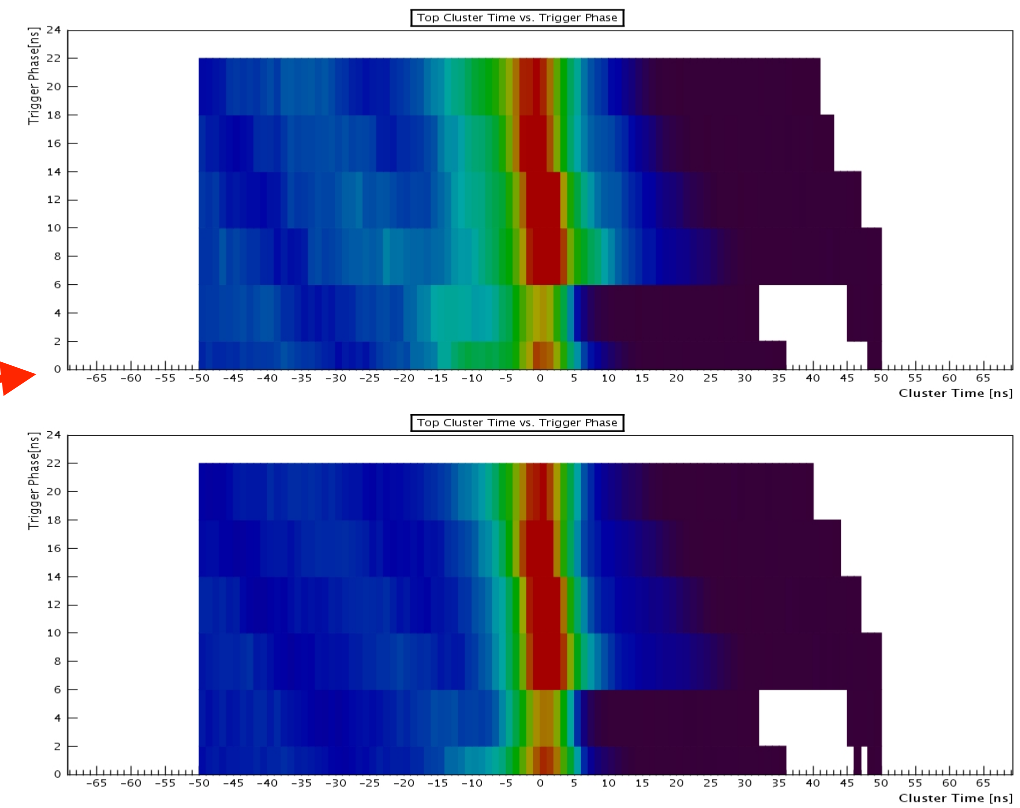


Monitoring / DQM

At the outset of the Engineering Run, there was essentially no monitoring.

- Over time, plots used by experts to commission the SVT became useful monitoring tools for shifters.
- Even so, many plots remained inscrutable to shifters throughout the run.
- Where necessary, these will be improved. Fresh eyes (e.g. Matt Solt) will be critical here.

SVT-trigger timing



Ideas for offline DQM weren't put into practice for the Engineering Run.

- High-level monitoring plots became the de-facto DQM.
- We were lucky and got away with this (mostly.)
- New tools for DQM will allow us to mount a serious effort at offline monitoring, but this requires some real organization.

Documentation

Documentation throughout the Engineering Run was a work in progress.

- by the end of the run, there was reasonable convergence between the level of documentation/instructions and what was required to smoothly run the detector.
- there will be new hiccups as we begin running again, so documentation needs to be improved to meet that challenge.
- many of the changes required will be dependent on the outcome of DAQ improvements and testing which are still ongoing.

There is still plenty of time to improve the documentation and shift instructions but it will be made a top priority as DAQ work winds down.

Once ops documentation is in place, will focus on documentation of SVT performance in technical notes.

The endpoint here will be a NIM paper on the SVT.

Summary

"I'd rather be lucky than good."

- The Engineering Run showed we *can* be both
- We won't always be lucky, so we are currently trying to fill various gaps in both operation and monitoring to ensure we can succeed even when our luck isn't so good.
- As long as things are running smoothly, we have the luxury of thinking about what comes next: *that's for another talk.*