SVT Performance and Operations 2015-2016

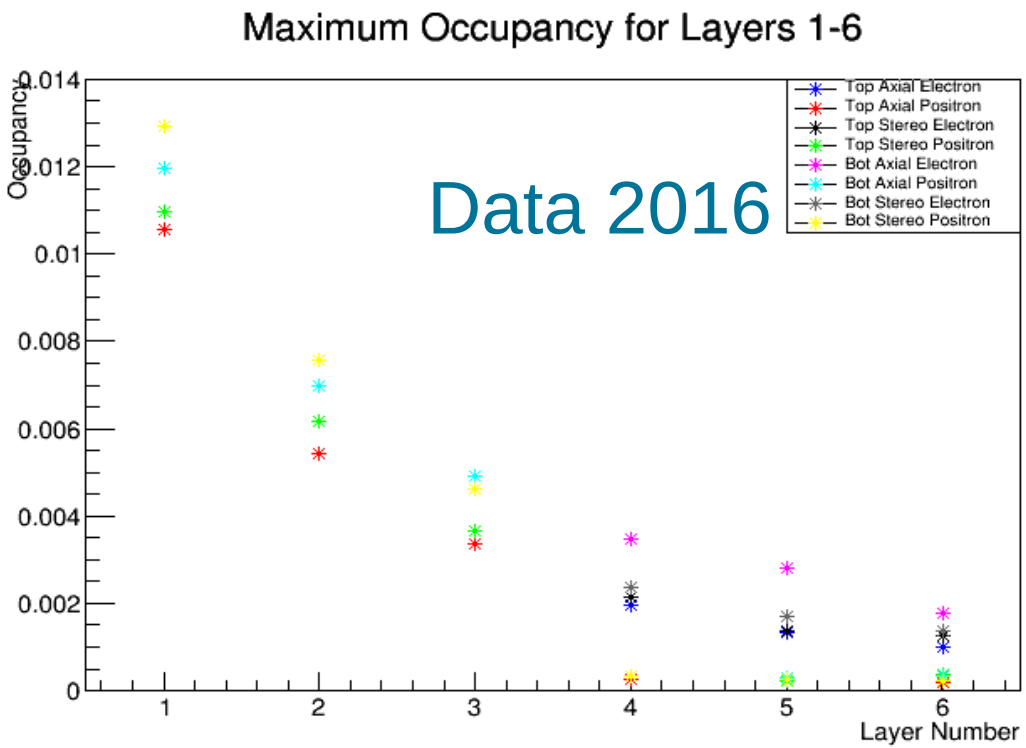
Matt Solt
11/16/2016
Stanford University

Introduction

- SVT performance 2015 and 2016 runs
  - Review of hit level performance and preliminary Data/MC comparison
  - 2015 data uses run 5772; 2016 data uses run 8087; MC is wab-beam-tri
- Operations overview
  - Successes and improvements, DAQ difficulties, Single Event Upsets, SD card failures
- SVT Status
  - Cooling system, strange channels in L6, and bias scans
- NIM paper update

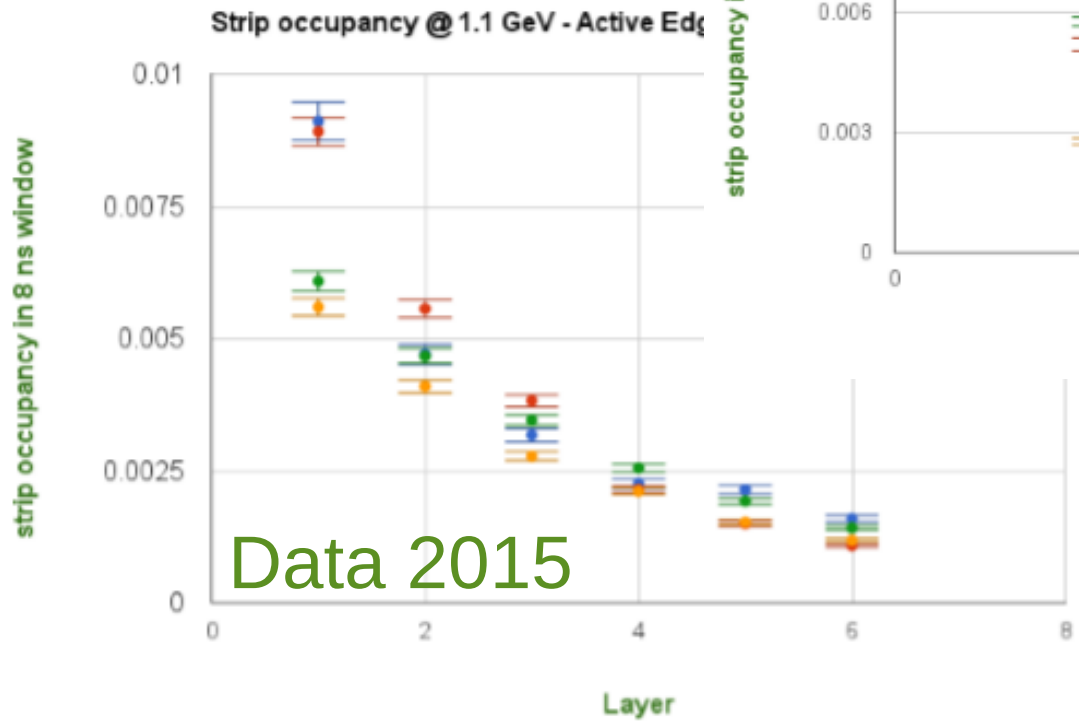
SVT Performance - Occupancy

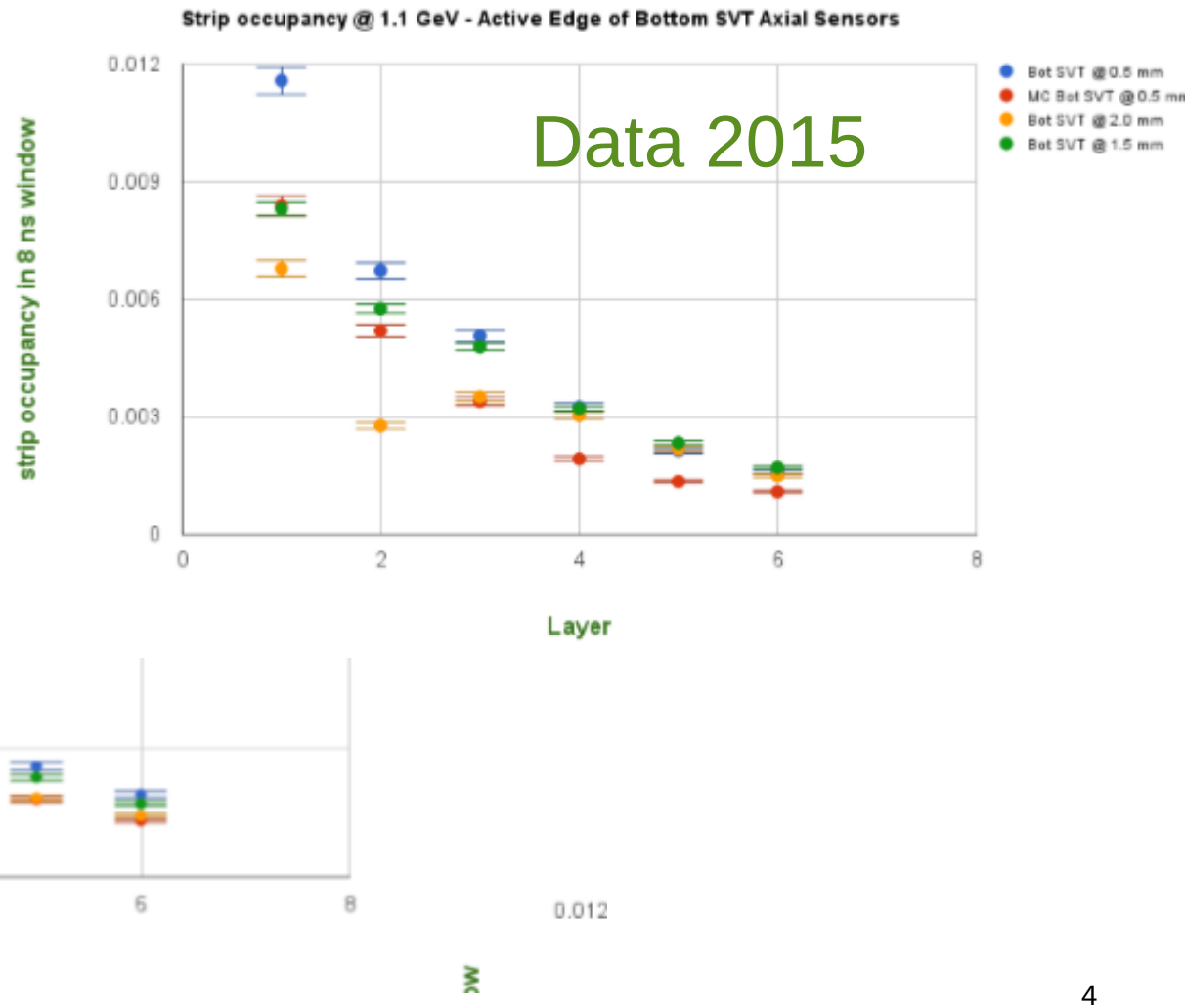
- Take maximum strip occupancies in each sensor and plot as function of sensor.
- Design expectations are 1.5% occupancy. **Occupancies as expected.** To be compared to MC soon…



SVT Performance - Occupancy

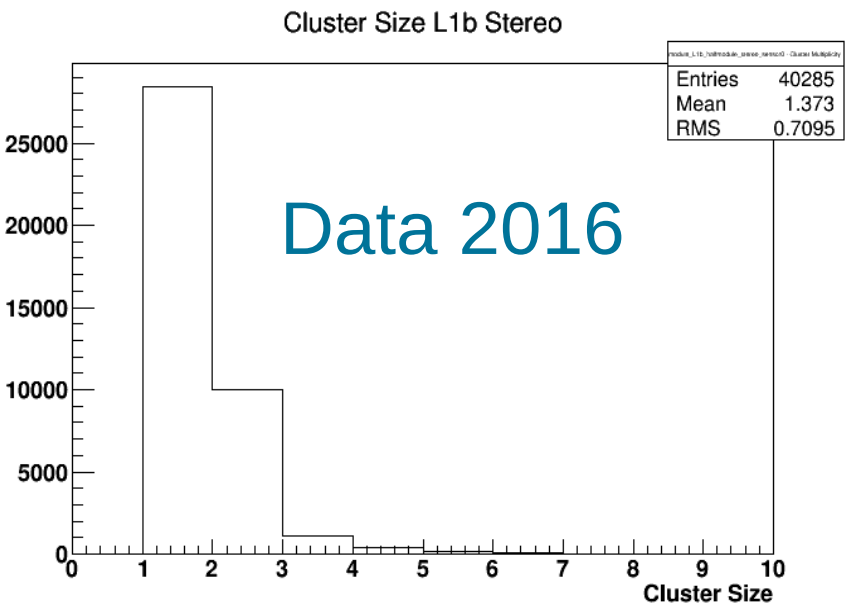
- Strip occupancies in 2015 data comparison to MC
- **Everything as expected**

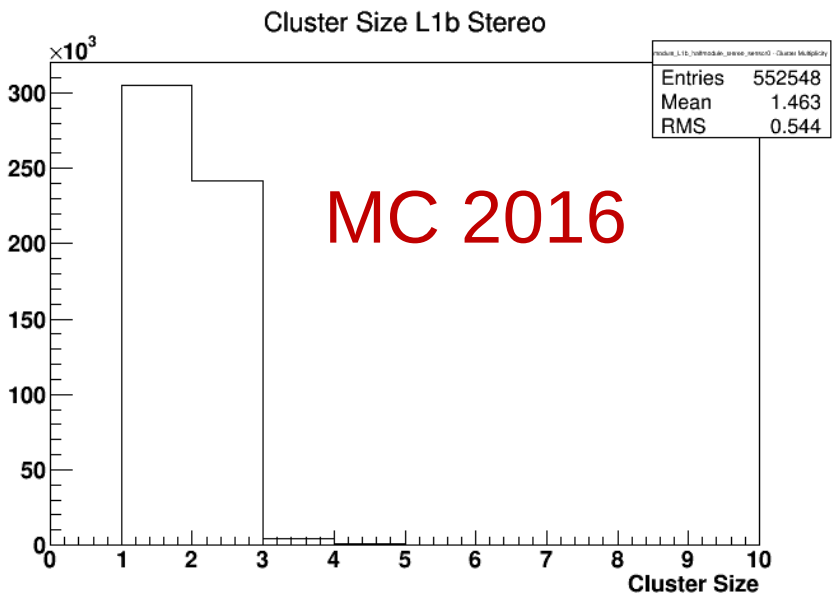




SVT Performance - Cluster Size

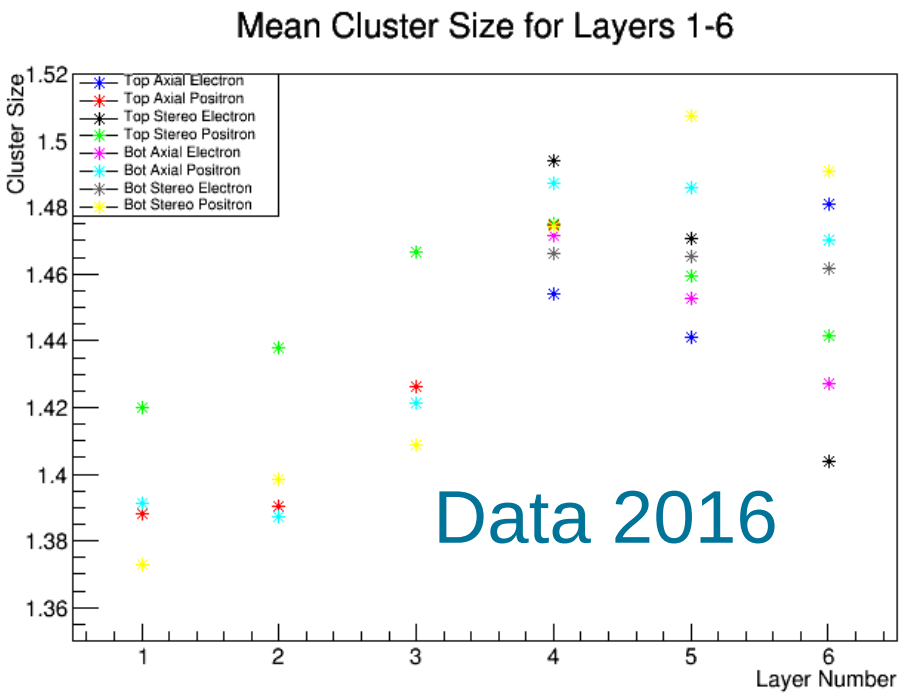
- Comparing cluster size for Data/MC
- There is a discrepancy between cluster sizes of 1 and 2

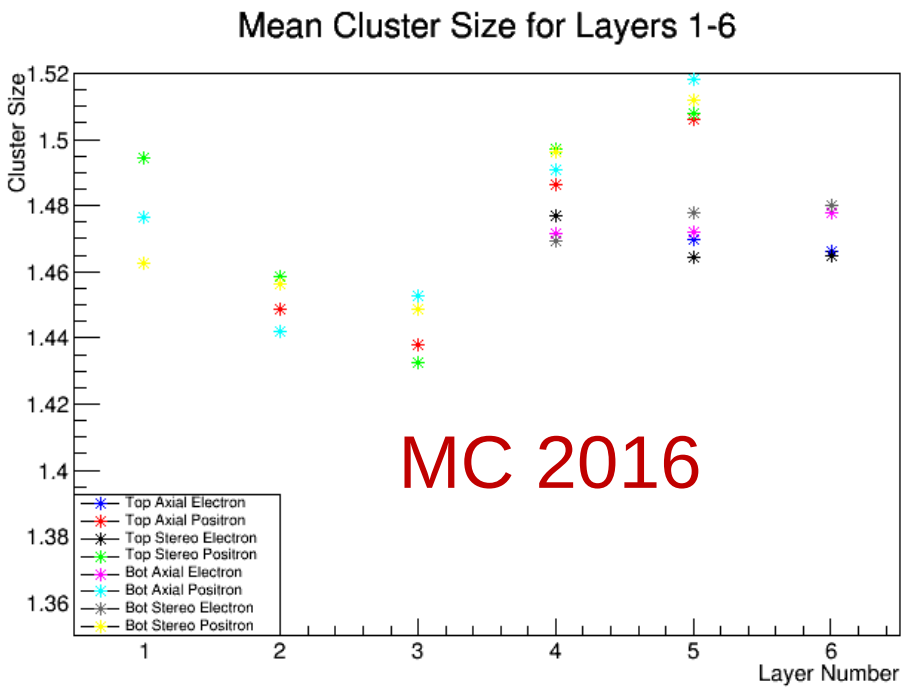




SVT Performance - Cluster Size

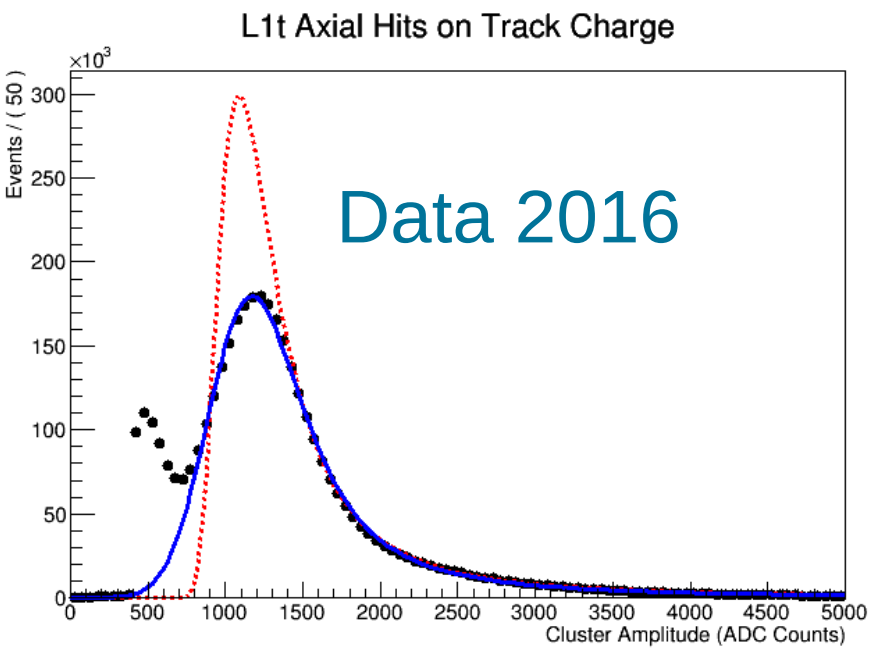
- Plot the mean of the cluster size to compare data/MC
- The discrepancy is worst in the first few layers, but appears to agree roughly in L4.
- Perhaps baseline shift at high occupancies? Need to do more work to show that if it's of concern

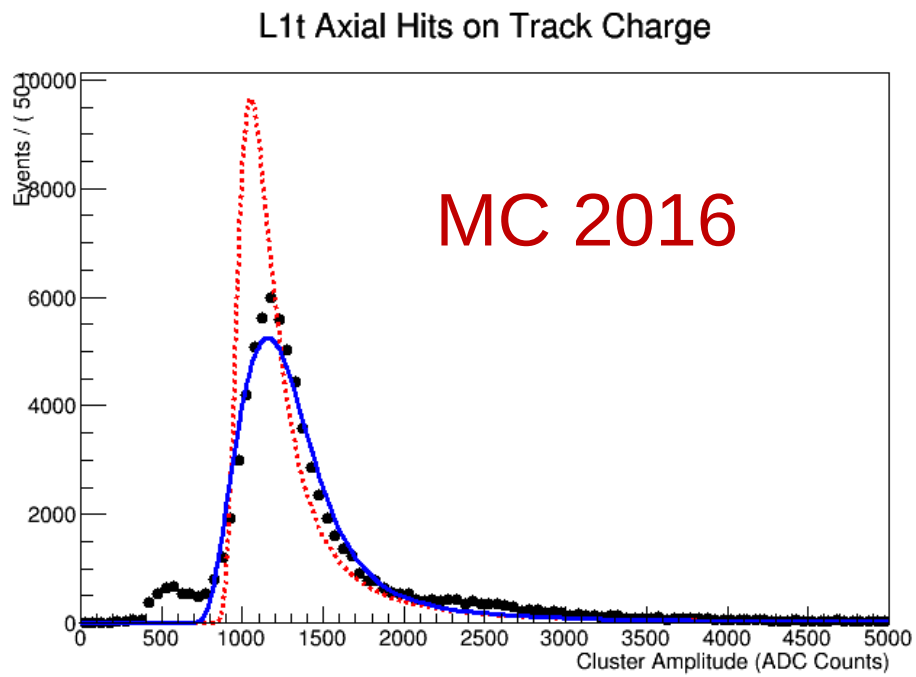




SVT Performance – Cluster Amplitude

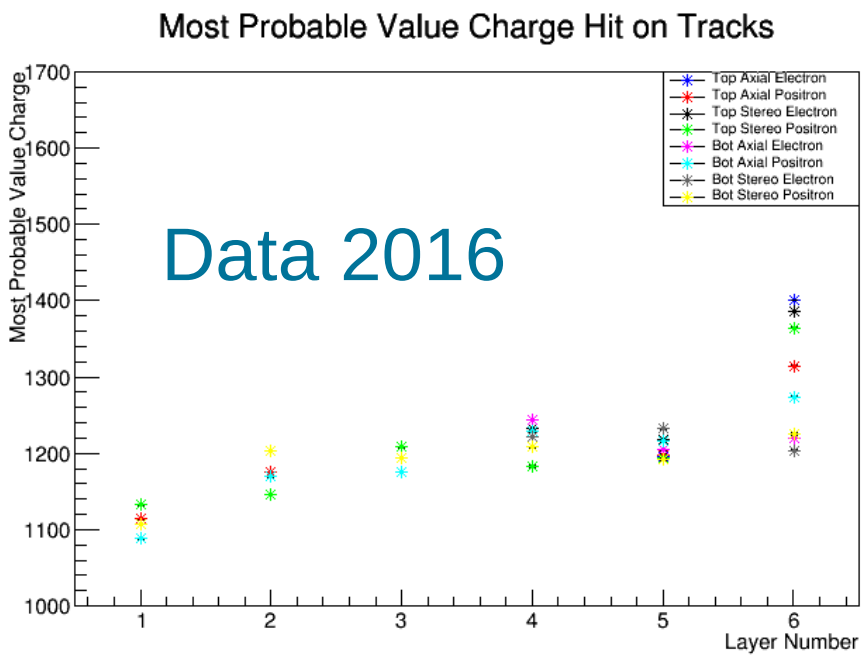
- Take the cluster amplitude for each sensor and fit a Landau convoluted with a Gaussian.
- Only use hits on track - minimizes low-charge x-ray peak
- MC distributions appear to be narrower in each sensor, also do not have the low-charge x-ray peak

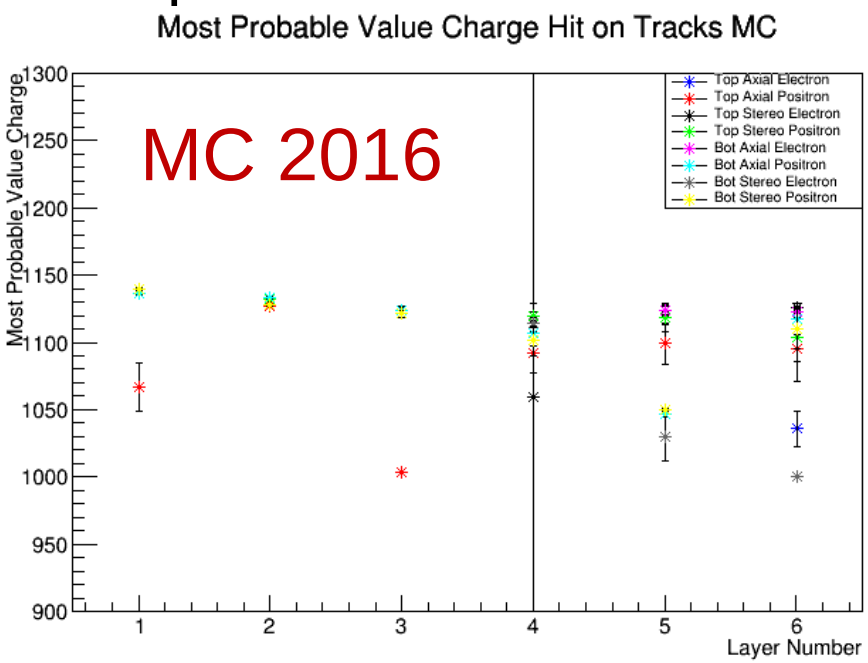




SVT Performance – Cluster Amplitude

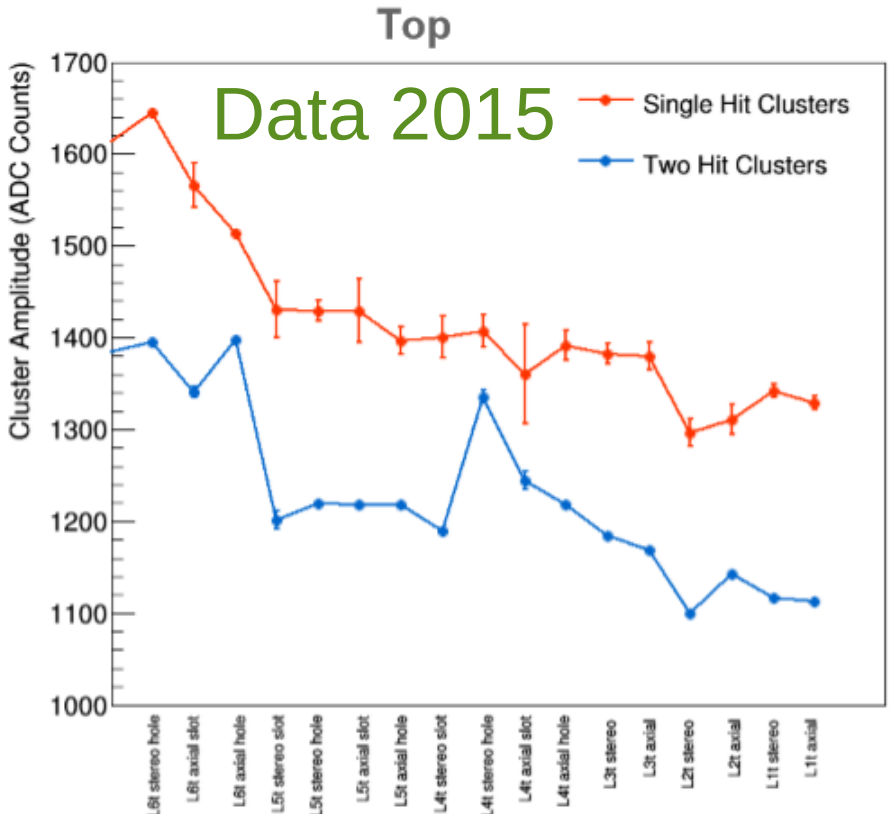
- Plot the most probable value (MPV) of cluster amplitude for each sensor for hits on track
- MPV for data rises with layer number, MC stays more constant.
- Need to compare single and multiple hit clusters

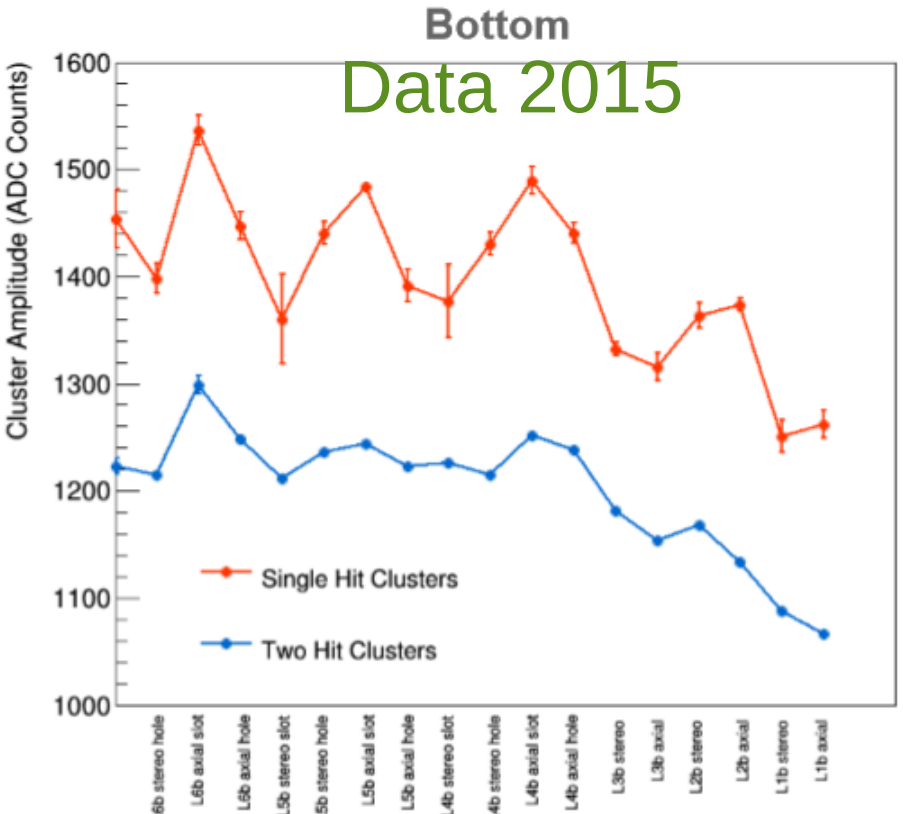




SVT Performance – Cluster Amplitude

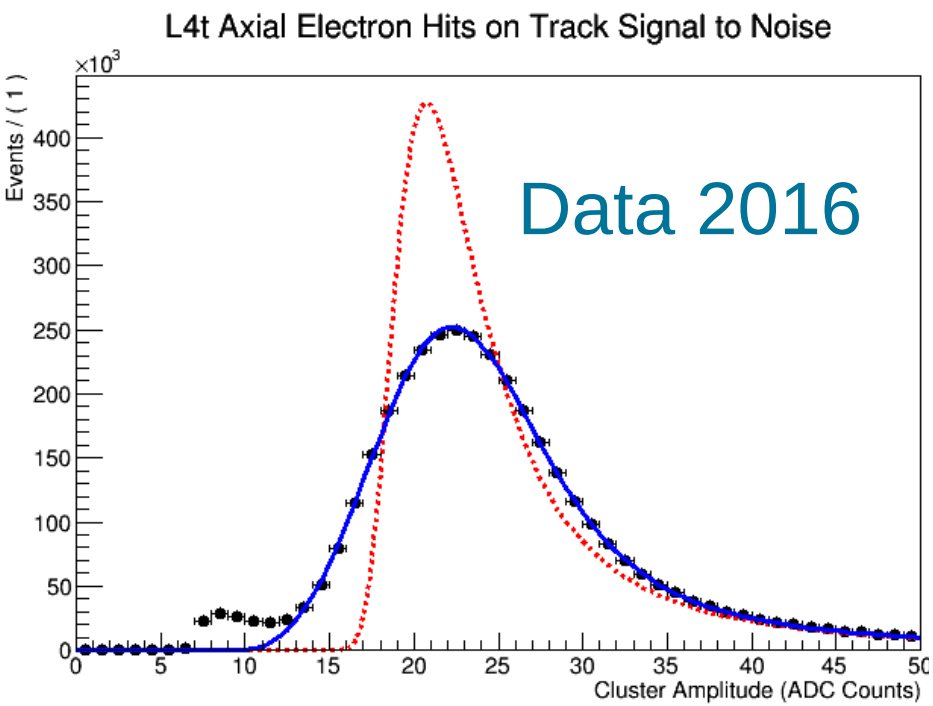
- These are 2015 data comparing single hit clusters to two hit clusters (2016 plots are hits on track)
- Reduced amplitude in 2016 data due to shaper parameter optimization. Looks acceptable compared to 2016

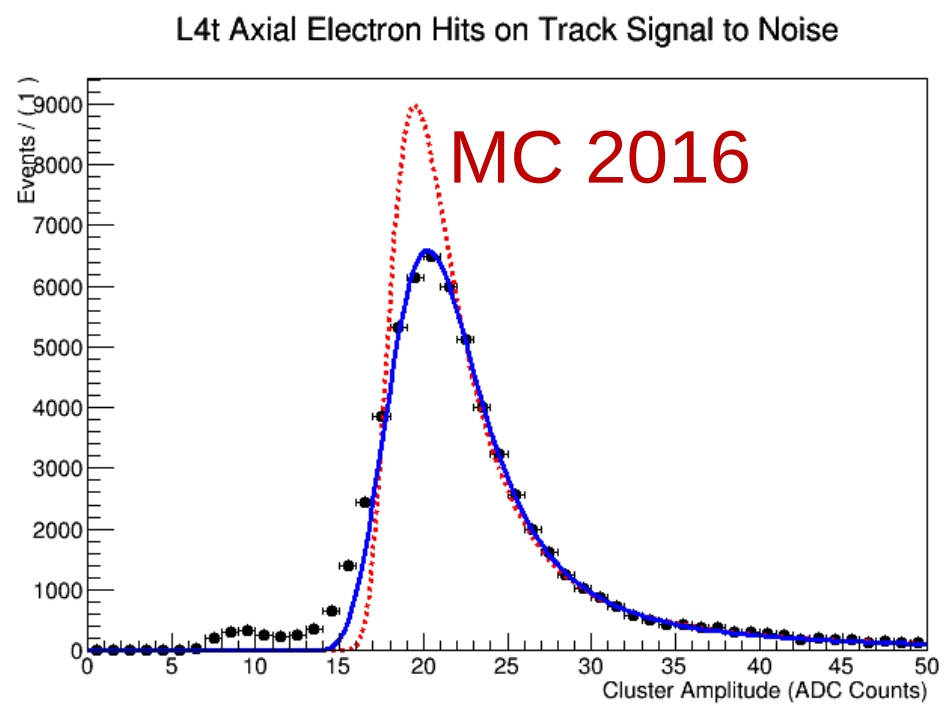




SVT Performance – Signal to Noise

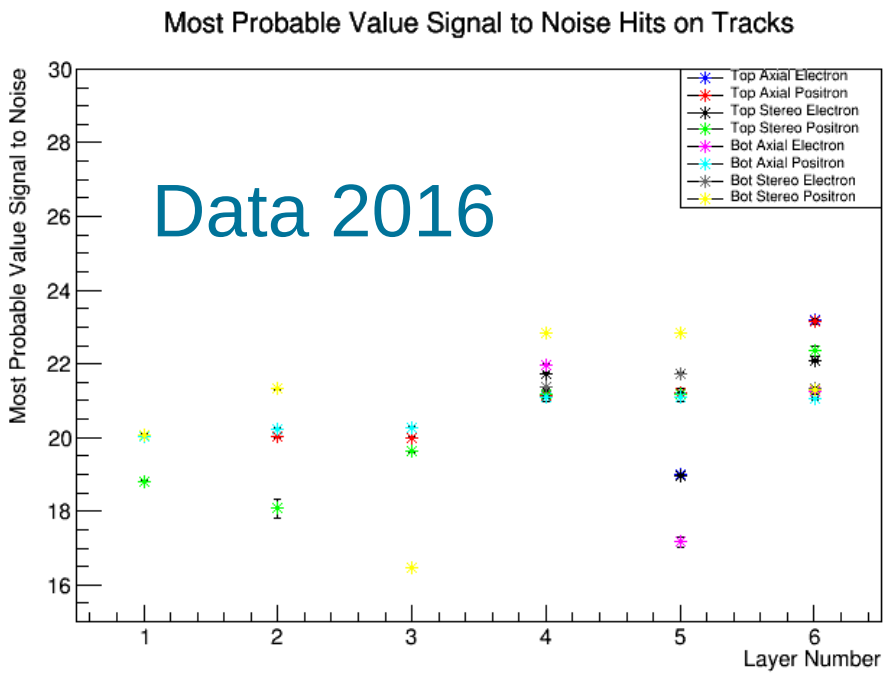
- Take the signal to noise for each sensor and fit a Landau convoluted with a Gaussian.
- Only use hits on track – minimizes low-charge x-ray peak
- MC distributions appear to be narrower in each sensor

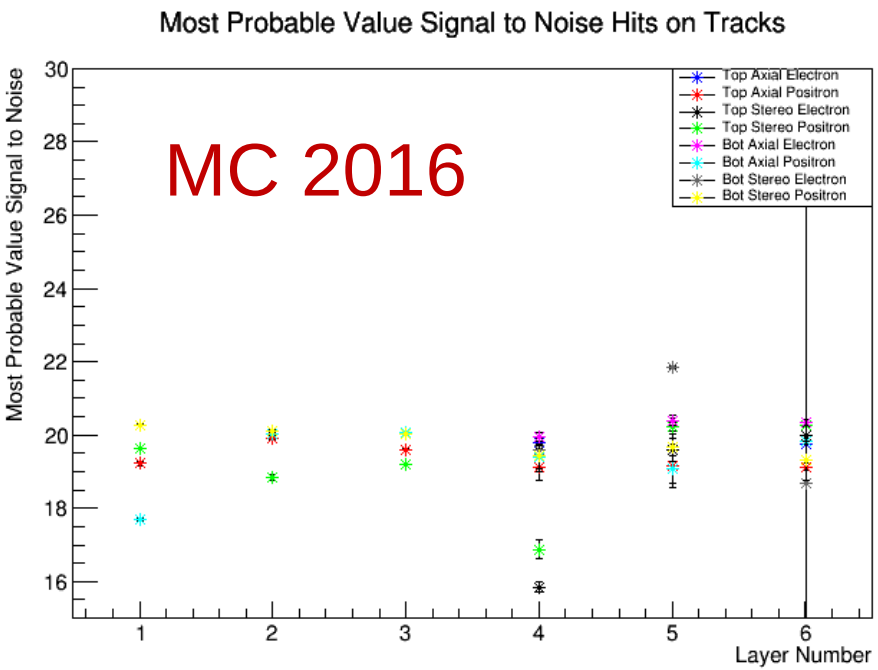




SVT Performance – Signal to Noise

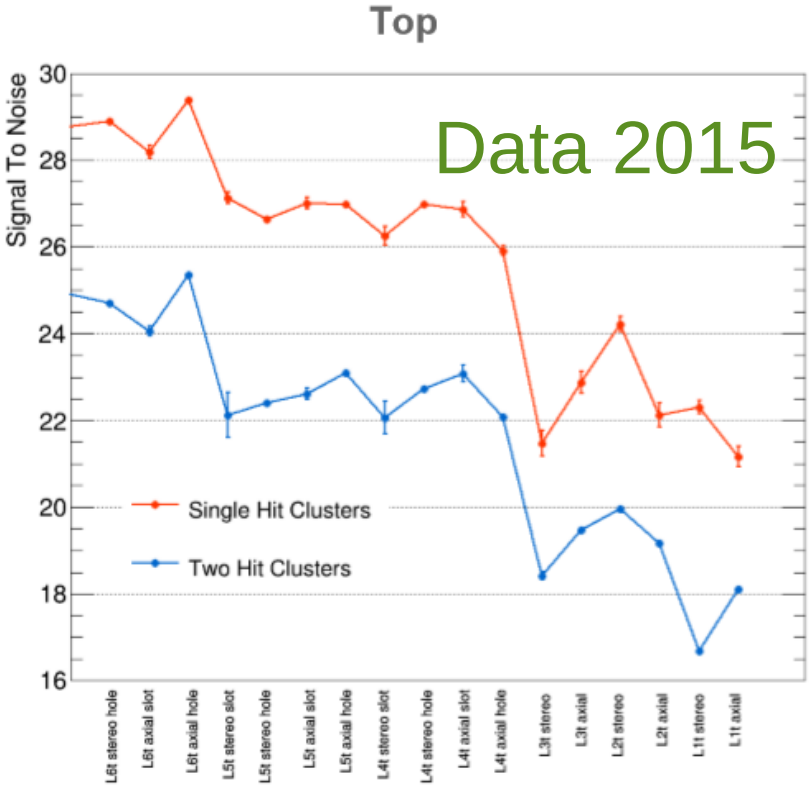
- Plot the most probable value of signal to noise for each sensor
- MPV for data rises with layer number, MC stays more constant.
- Need to compare single and multiple hit clusters

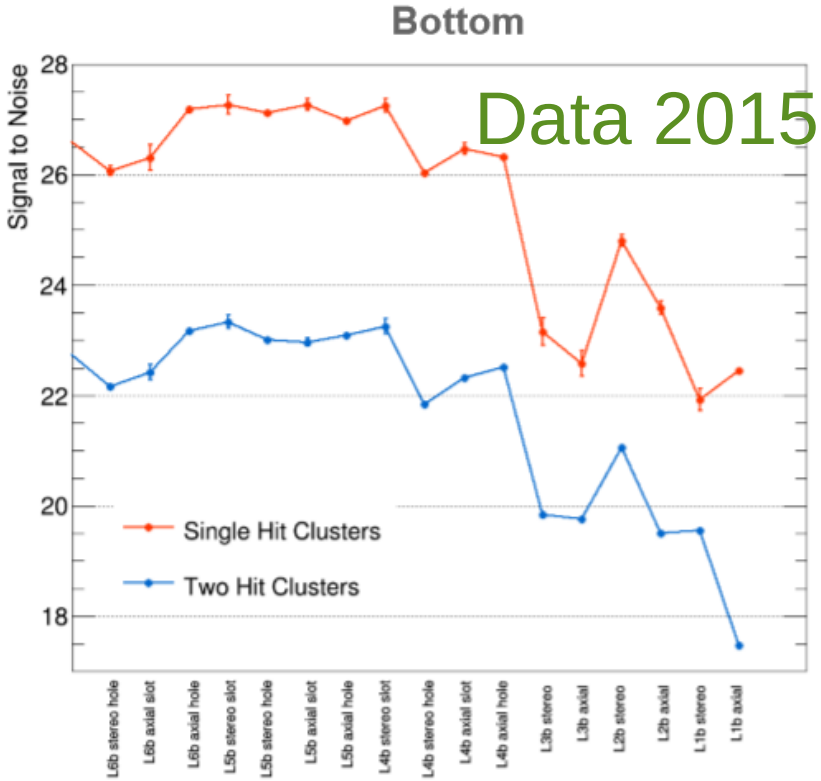




SVT Performance – Signal to Noise

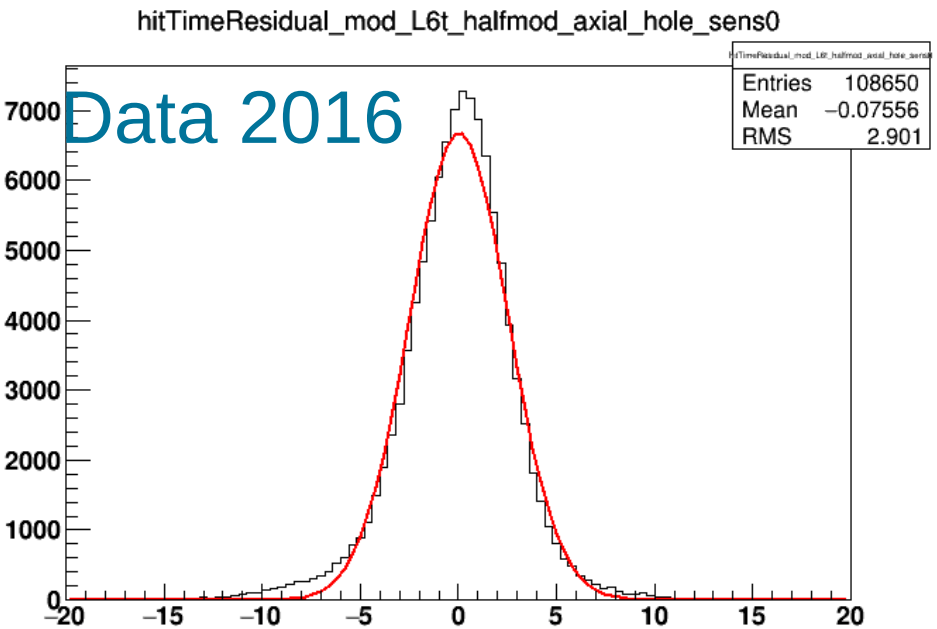
- These are 2015 data comparing single hit clusters to two hit clusters (2016 plots are hits on track)
- Reduced signal to noise in 2016 data due to shaper parameter optimization. Looks acceptable

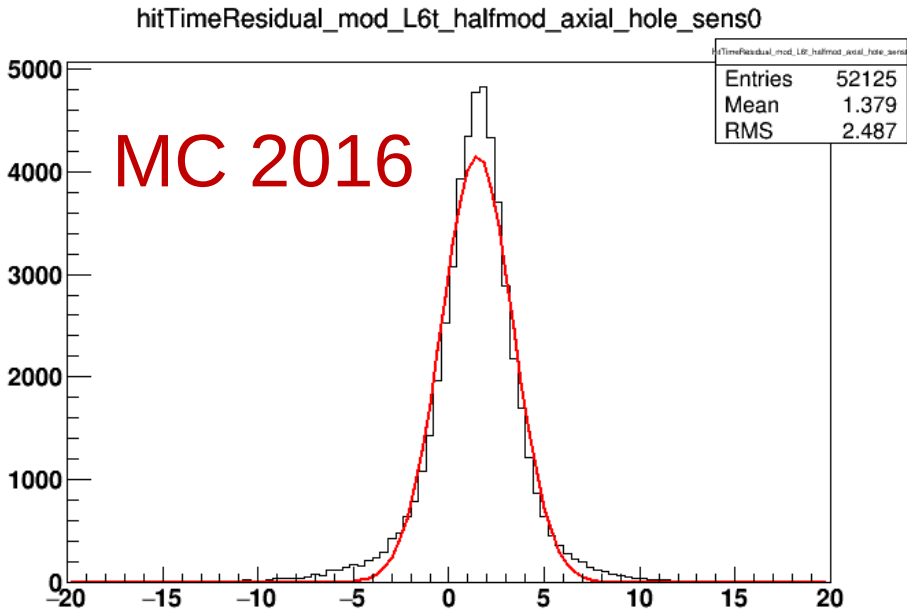




SVT Performance – Timing Resolution

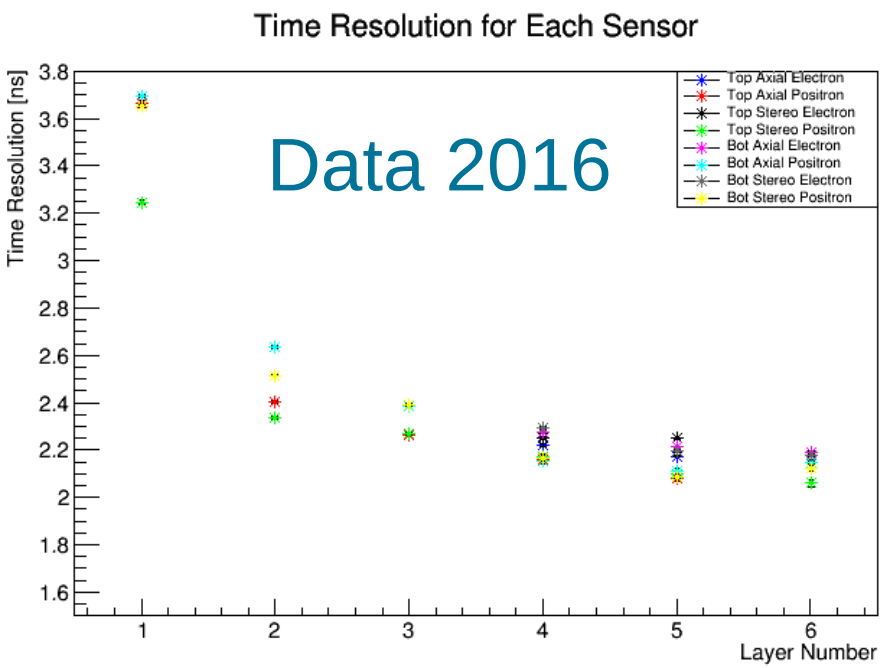
- Take the difference between track and hit times, fit Gaussian, and grab fitted sigma to obtain time resolution

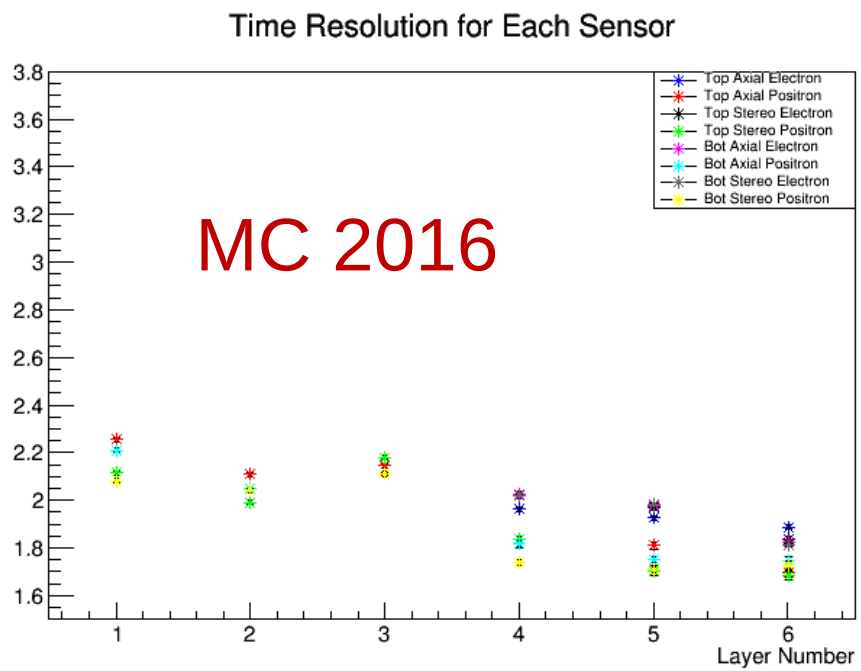




SVT Performance – Timing Resolution

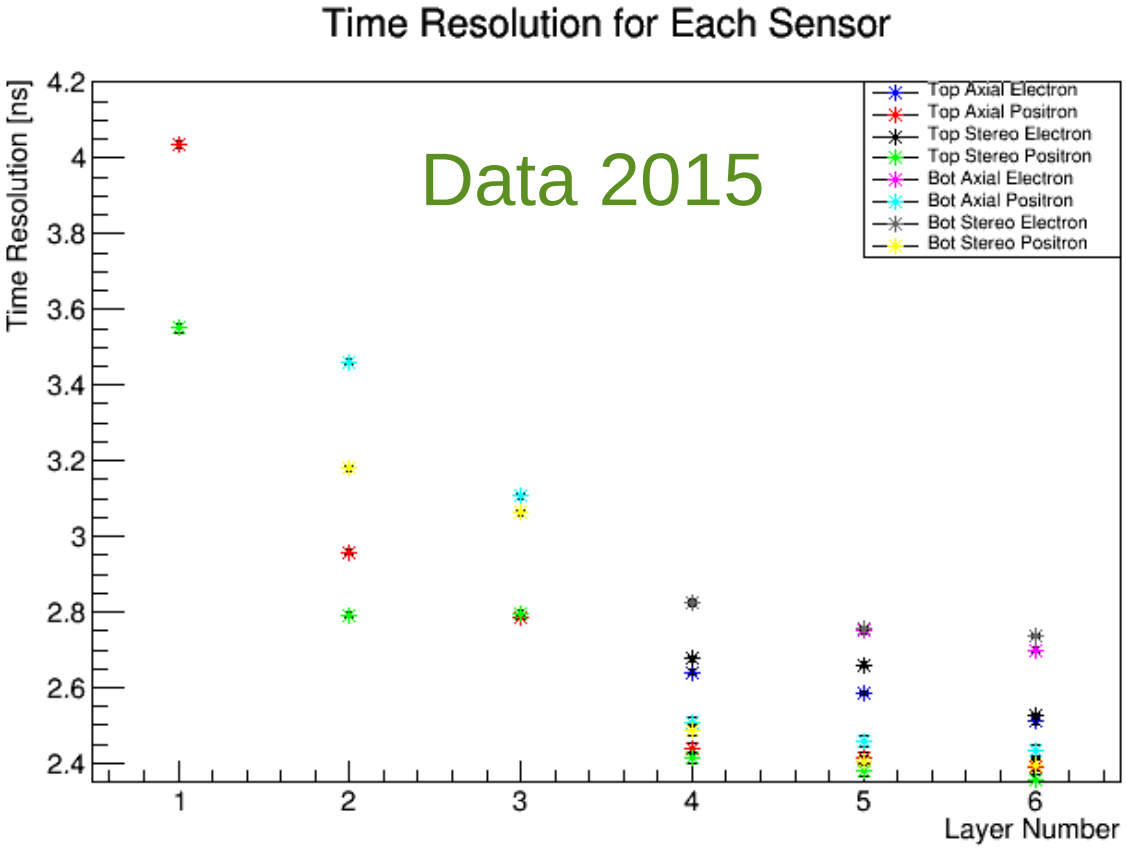
- Data timing resolution is as expected based on 2015 results (next slide)
- The timing resolution is significantly better in MC, especially at the first few layers. Need to think more about this…





SVT Performance – Timing Resolution

- The timing resolution for 2016 is improved compared to 2015 (~10-20%) due to optimization of shaping parameters. Other than that, timing resolution looks very similar to 2016

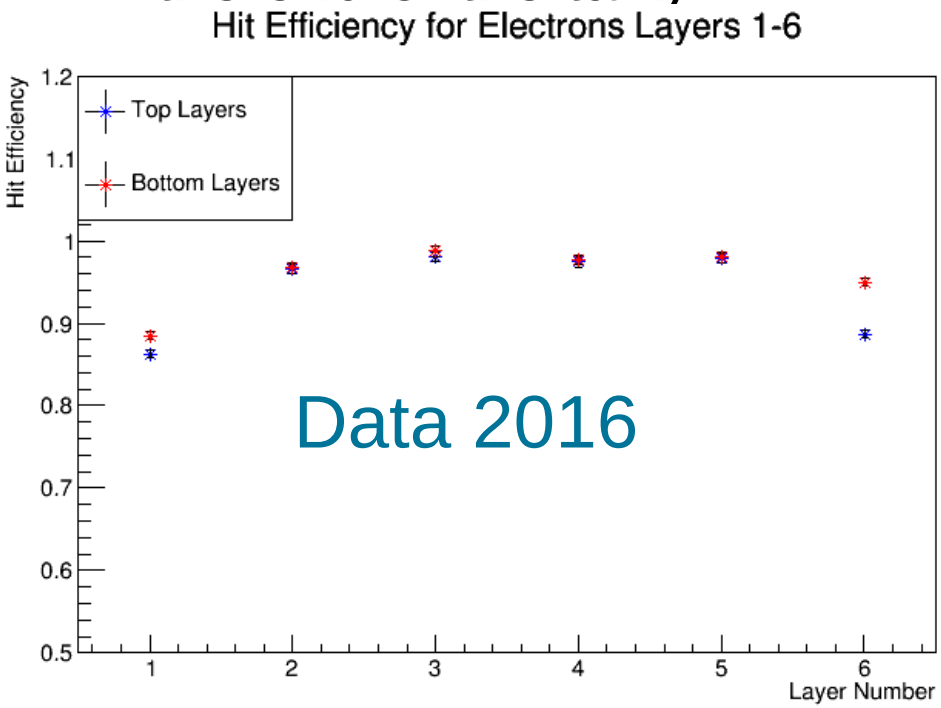


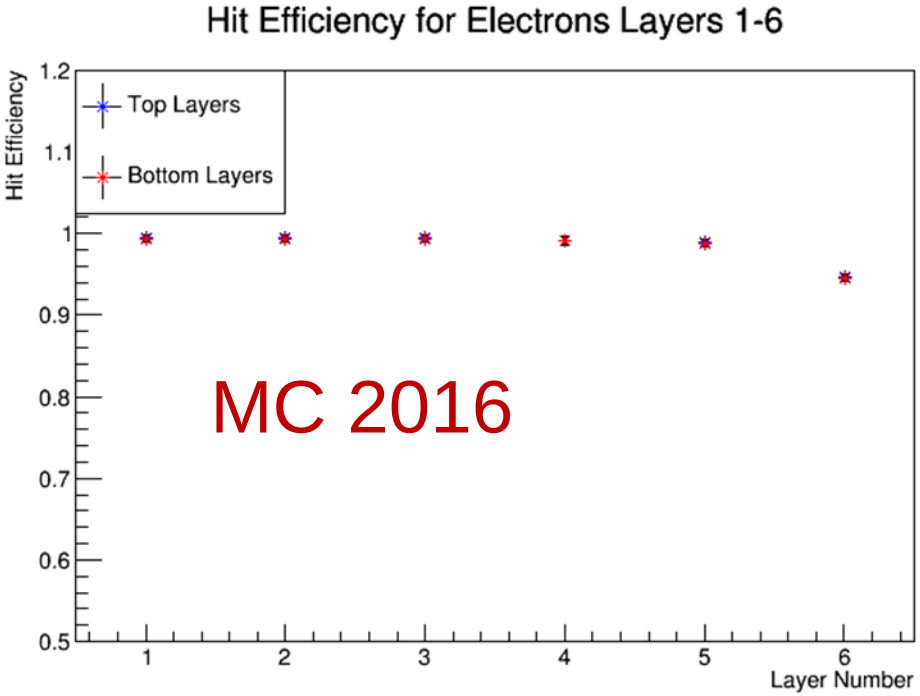
SVT Performance – Hit Efficiency

- Run the recon with different tracking strategies to isolate the layer of interest (3 seed, 1 confirm, and 1 extend)
- Extrapolate track to missing layer and see if it lies with acceptance (number of reconstructed tracks)
- Search for a stereo hit within a narrow region of the extrapolated track – about 5 sigma of the unbiased residual (number of tracks with hits on all layers)
- $efficiency = \frac{number\ of\ tracks\ with\ hits\ on\ all\ layers}{number\ of\ reconstructed\ tracks}$

SVT Performance – Hit Efficiency

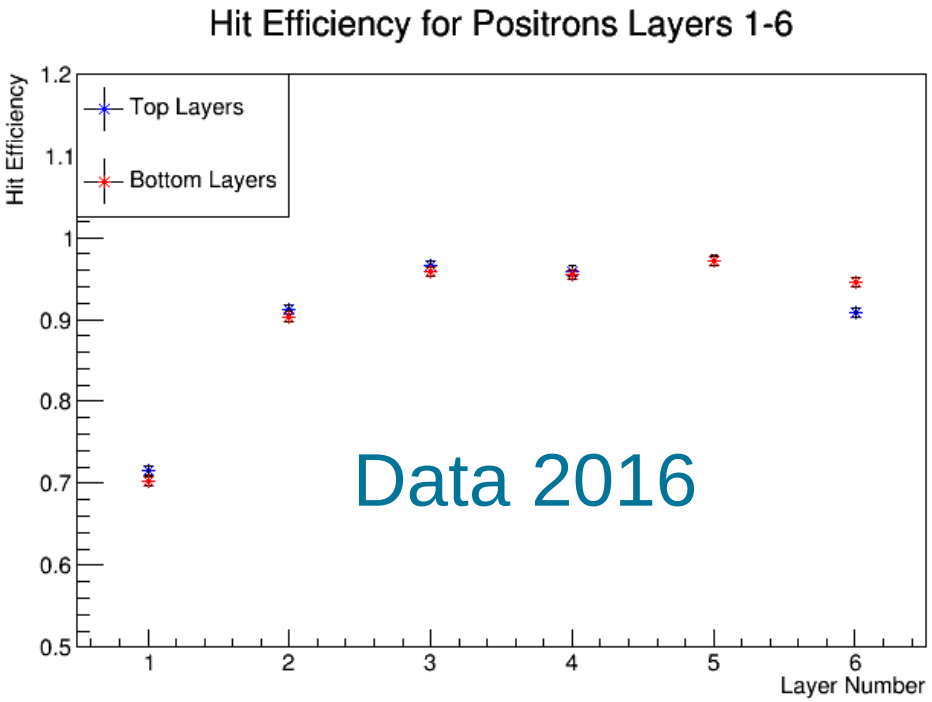
- Hit efficiency plots as function of layer for **electrons**
- Layer 1 in data less efficient due to high occupancies. MC does not show this effect
- Layer 6 top in data show effects of bad channels (shown at the end of the talk)

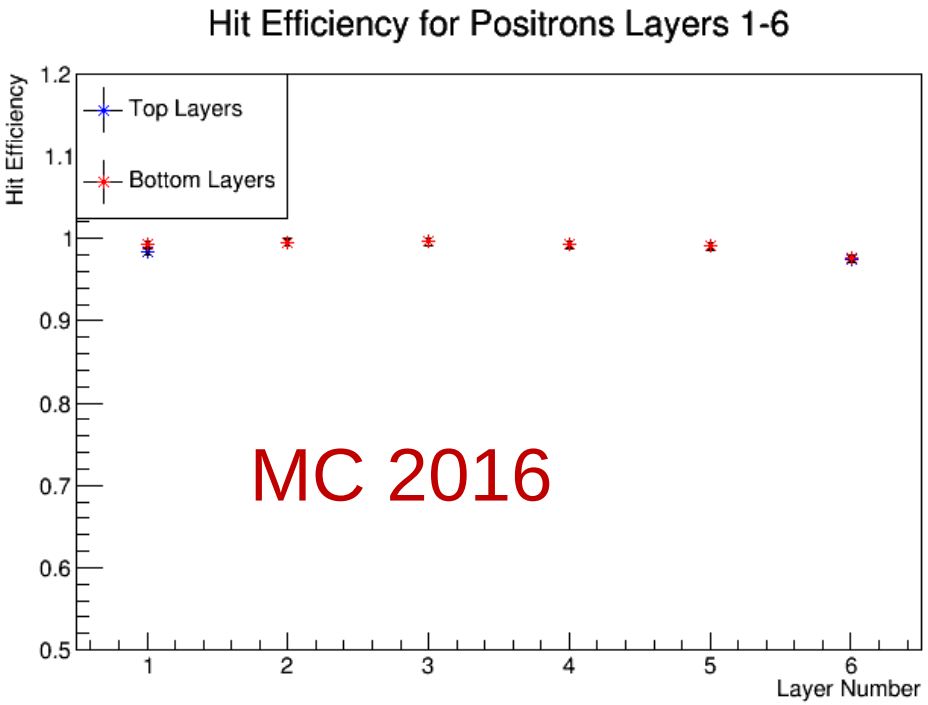




SVT Performance – Hit Efficiency

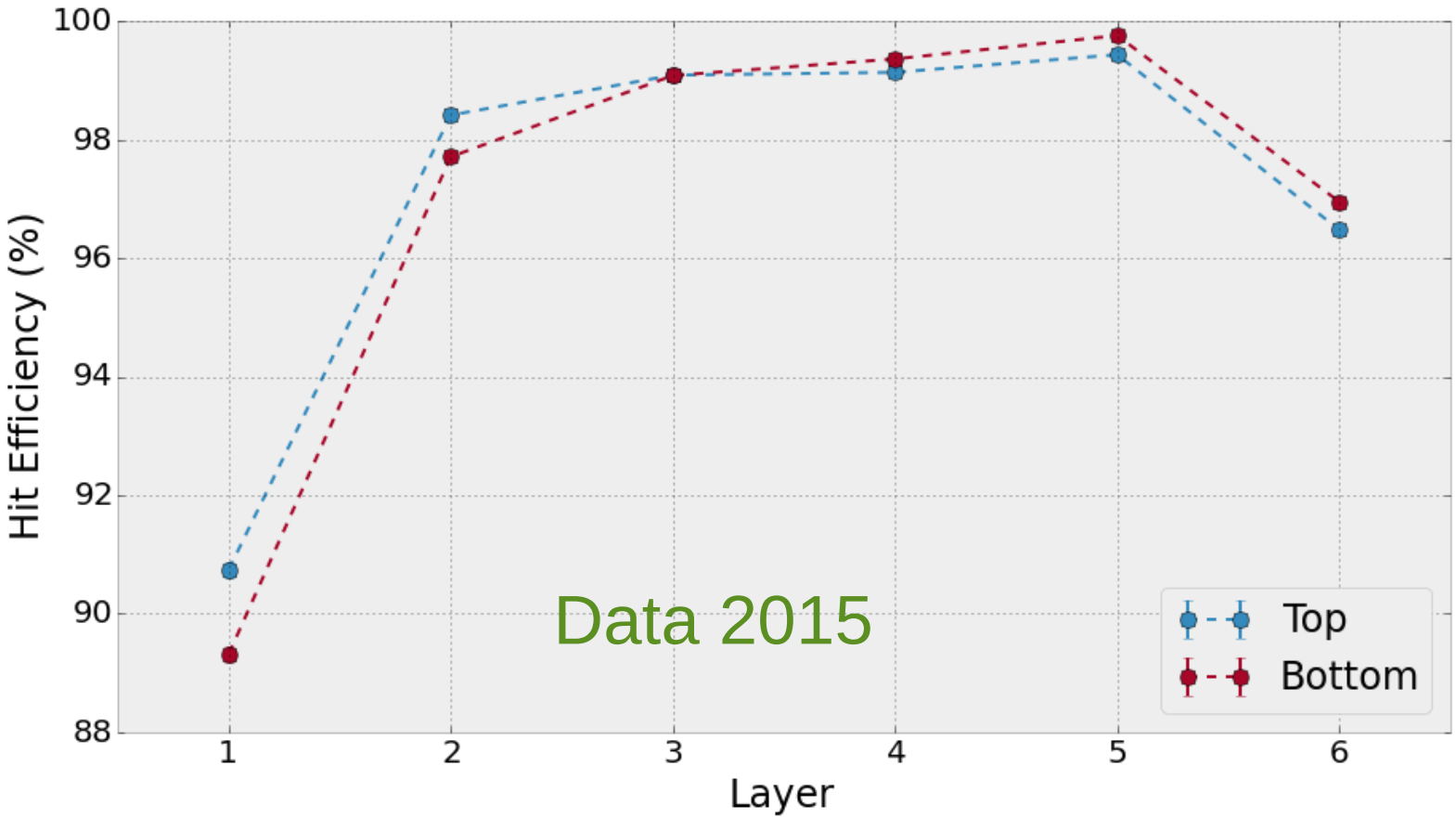
- Hit efficiency plots as function of layer for **positrons**
- WABs greatly affect the efficiency for L1 positrons (15%)
- This is tri-trig MC. Need to re-run on wab-beam-tri





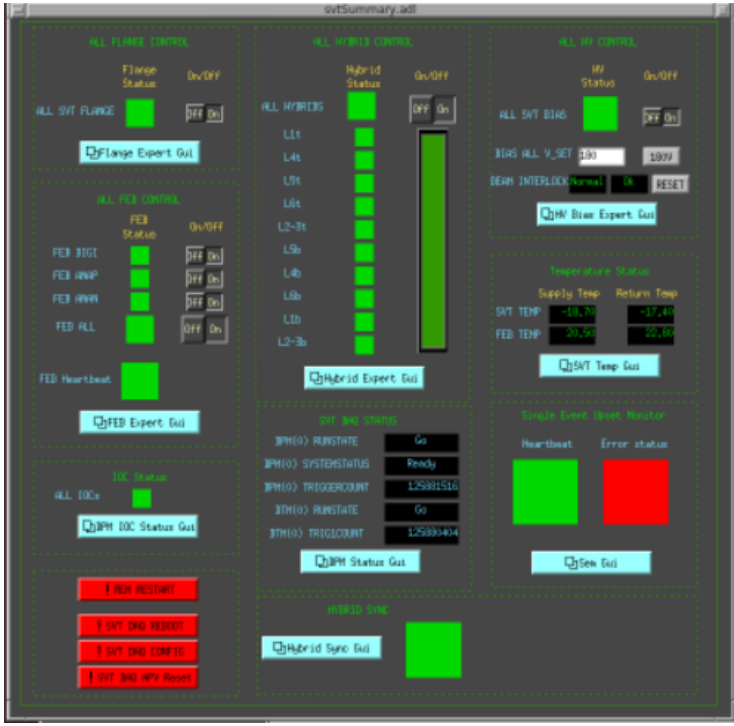
SVT Performance – Hit Efficiency

- Hit efficiencies for data 2015. Looks very similar to data 2016 with the exception of L6 top bad channels.



SVT Operations 2016

- Overall, **SVT operated smoothly during 2016**
- **New SVT summary GUI** for basic monitoring and simpler operations (updated SVT/DAQ manual)
- **Beam trips - more aggressive approach**
  - HV is left on for normal trips
  - For FSD trips, HV is lowered to 5V but SVT is left at 0.5mm
  - Take out SVT for very bad beam Conditions and long downtimes



SVT Operations 2016 – Issues and Lessons Learned

- Some DAQ issues (both major and minor)
  - SD card failures
  - Operator errors – operators struggled with the SVT DAQ towards the beginning of the run (CODA is very finicky…). Improved as operators gained experience and procedures simplified
- Single Event Upsets (SEUs)

SVT DAQ - SD Card Failure

- Observed **3 SD card failures** of the 18 SD cards deployed in crate in the 2016 run. SD cards replaced during run
- What caused it?
  - Bad beam conditions (large neutron flux at DAQ crate)
  - Power cycling ("DAQ Reboots")
- Added neutron shielding (borated polyethylene sheets)

	Date	Node	Comment
#1	2/14/16	dpmX/COB1	Discovered after failed reboot during running; not much lost due to timing in problem).
#2	2/27/16	dpm11/COB1	Failed reboot during running, lost ~15h.
#3	4/4/16	dpm9/COB1	Discovered Mon. afternoon (1st reboot after beam ended?), nothing lost

SVT DAQ - SD Card Failure

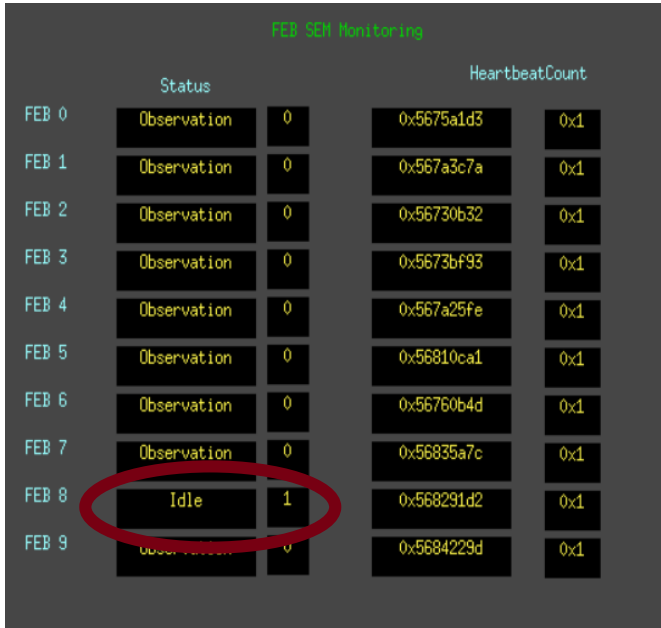
- In the near future, **use network-mounted file system** (nfs) as disk space instead of SD card
- SD cards will be present, but only a small part will be used for booting (once COBs are running it won't use SD cards).
- All **SD cards will have the same image** instead of each one getting its own image (fewer backups needed)
- This is planning on being **completed by the end of 2016** at SLAC, and then the COBs will be shipped to Jlab for implementation
- Do we still monitor radiation levels? Use Shielding?

SVT DAQ - SEU Error

- Several SEU errors in FEBs during 2016 running (did not have monitoring in 2015)
- Strongly correlated with beam tuning/bad beam (none during stable beam). **Did not occur during stable running**
- Difficult to shield FEBs. Procedure was to power cycle at the beginning, then we ignored it for most of the run
- **No noticeable effects in the data**.

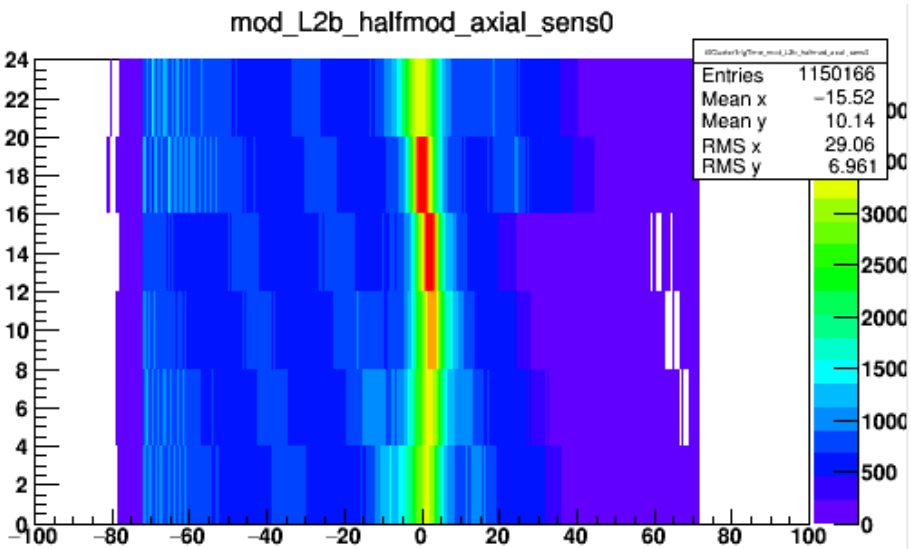
Suggested that we continue to ignore it

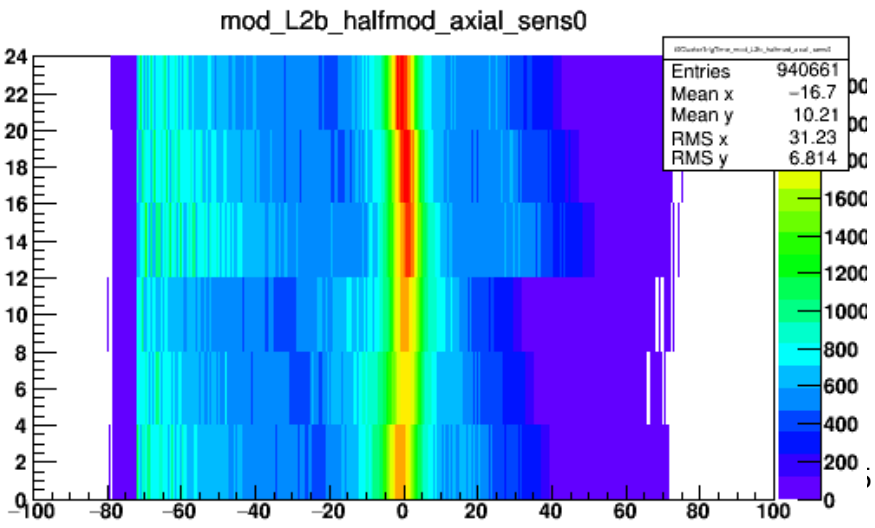
- Open analysis question…



SVT DAQ - Latency Setting

- Latency – how far we look back in the pipeline relative to trigger (takes 6 samples, 3 must be above threshold)
- Latency issues in 2015 data (~15% data loss)
- **Used correct latency in 2016**, but still some data loss
- Planning on **changing the latency setting** from 24 ns increments to 8 ns increments





Detector Status – Hybrid Cooling System

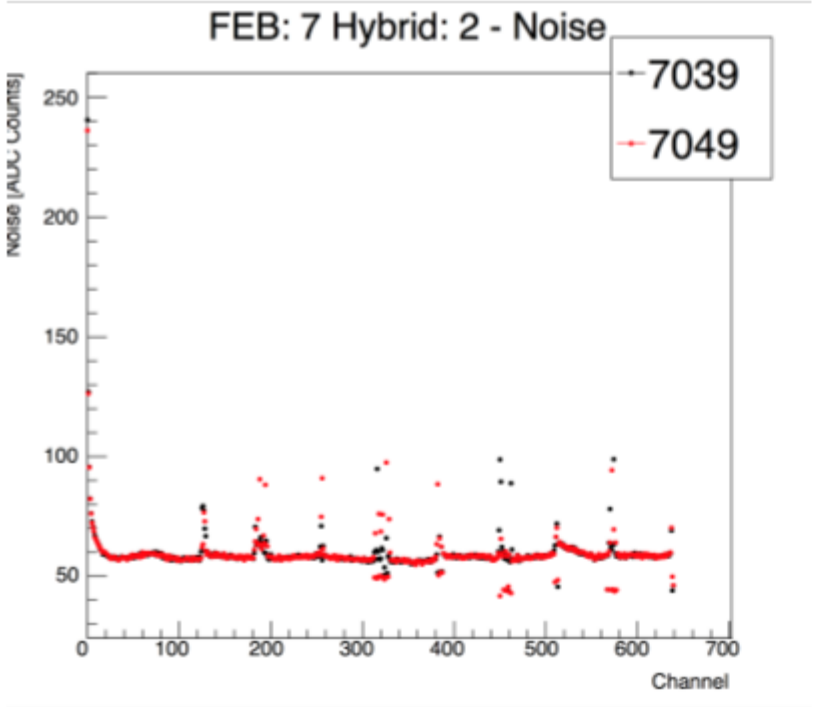
- Operational SVT temperature is 5°C. Downtime temperature is 18°C to minimize silicon radiation damage
- Julabo chiller (old chiller) uses HFE – 7000 (more volatile, refill every 3 weeks) and has an unnecessarily large size
- Anova chiller (new chiller) uses HFE – 7500 (less volatile)
- Anova chiller has new problem with bubbles coming out of the outlet of the SVT
- SVT cooling has been leak checked and is under vacuum. Still no solution…
- **Chiller is sufficient for downtime**, but will take everything apart in the near future

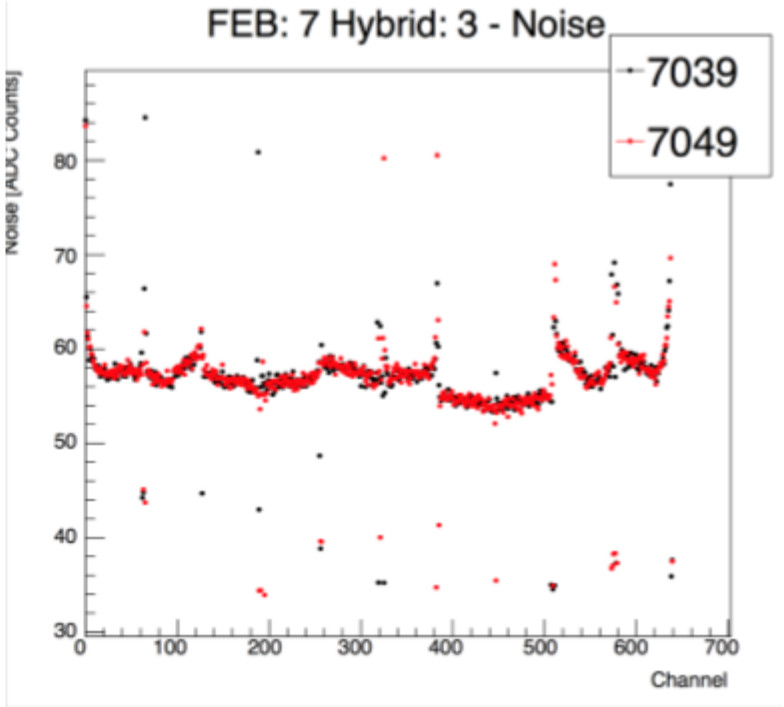
Detector Status – Bias Scans

- Radiation damage in the SVT is inevitable as time goes on
- Took special SVT runs in both 2015 and 2016 varying bias voltage to L1 Hybrids (increments of 20V for 0-180V)
- Bias scans can measure the “type inversion” in high occupancy regions as a function of position in sensor
- **Bias scan runs need to be analyzed**. Will be done in the future
- We think it is still necessary to keep the SVT cold during downtime (5-15°C)

Detector Status – L6 Odd Channels

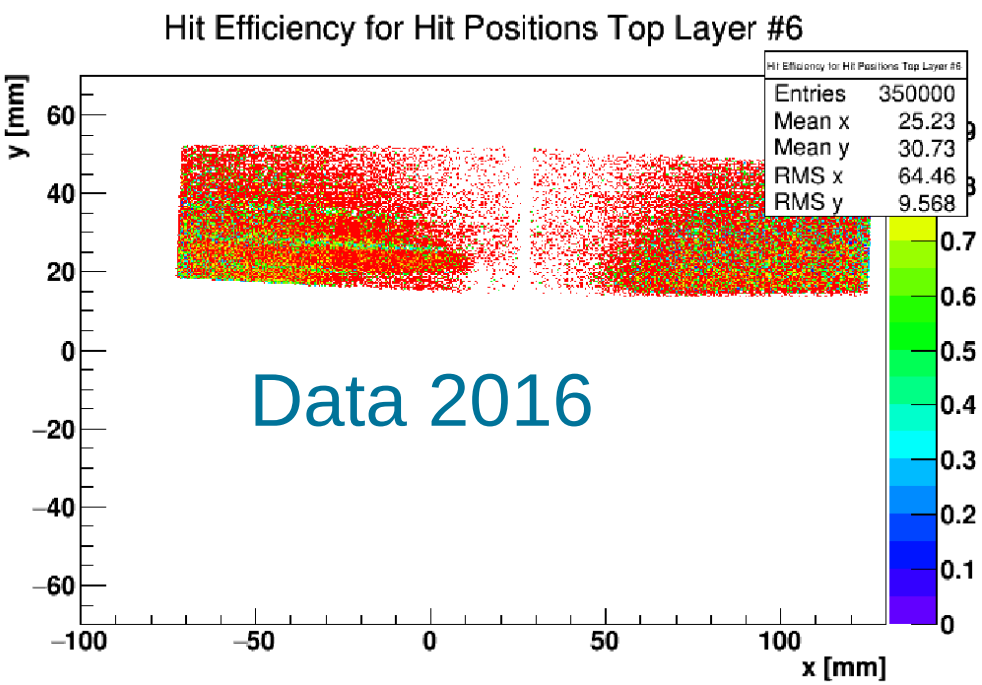
- Bad channels appeared in L6 between 2015-2016 run and persisted. Only affects hybrids in L6 facing the Ecal
- Issue began sometime between the end of 2015 run and DAQ work in September 2015





Detector Status – L6 Odd Channels

- **This is still a mystery to be solved**
  - Radiation? Issue began during period without beam
  - Mechanical? It is only the back of L6
  - Power? Power of APV25 is fed at chip centers/edges where the problem exists
  - FEB/Firmware related?
- Plan on opening up SVT in summer of 2017
- Are tracks still being made in these channels? TBD…



SVT NIM Paper

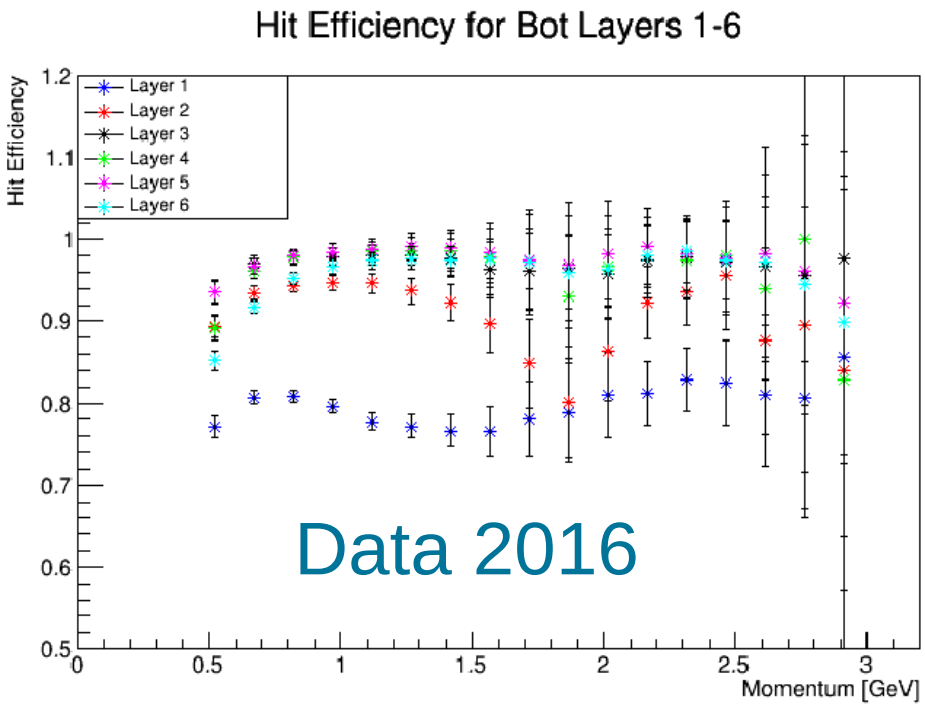
- SVT NIM paper is under construction
- Tim, Pelle, Omar, Sho, Matt S., Matt G., and Ben are all contributing to the writing
- **Pushing aggressively for a complete draft by end of 2016**

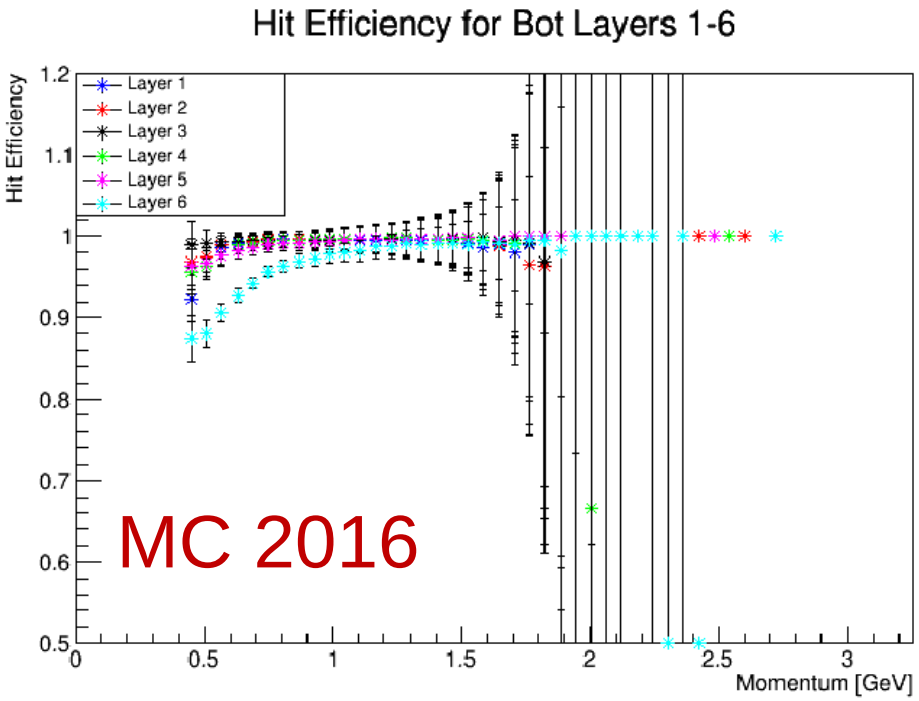
Conclusion

- **SVT performed admirably** during the 2015-2016 runs
- Hit level performance is comparable for 2015 and 2016
- Hit level performance data/MC comparison for 2015-2016 needs a more detailed look. This is currently being explored
- New SVT procedures in 2016 were nice improvements
  - SVT summary GUI, more aggressive beam trip procedures, and ignoring SEUs
- **SD card failure will soon be resolved**, latency will also be improved in the near future
- Chiller bubbles and odd L6 channels are still to be resolved
- NIM paper under construction – **complete draft by end of 2016**

SVT Performance – Hit Efficiency

- Hit Efficiency Plots separated by layer as a function of momentum





SVT Performance – Hit Efficiency

- Hit Efficiency Plots