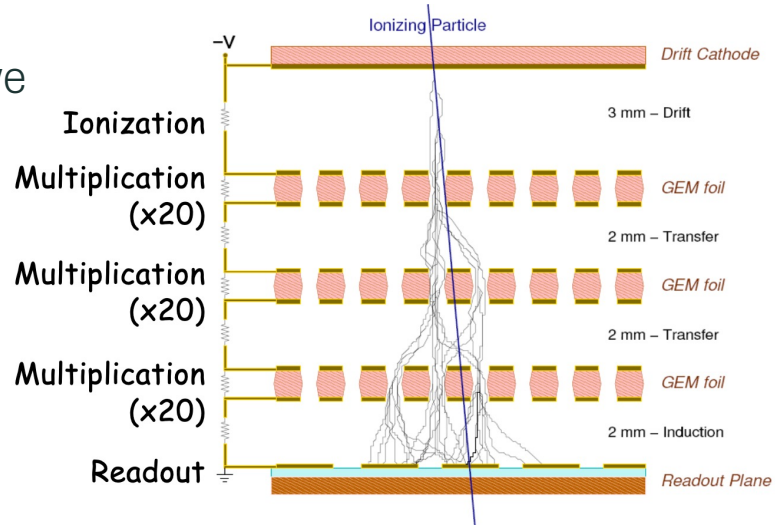
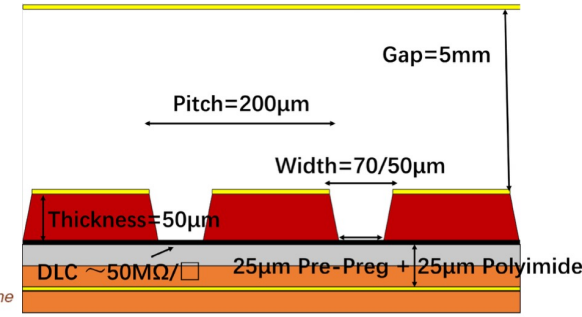
Beam Test: Tracking Detectors

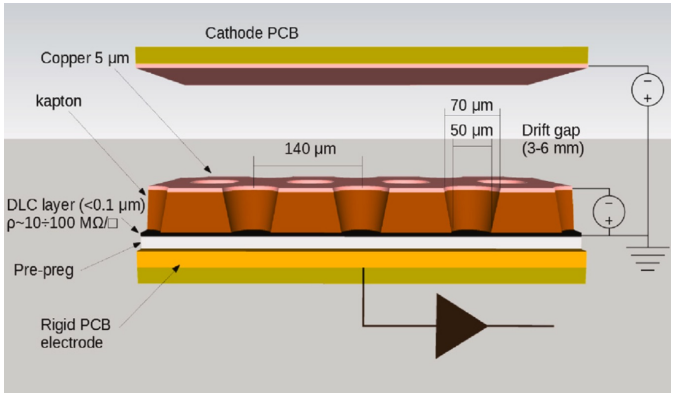
Ching Him Leung

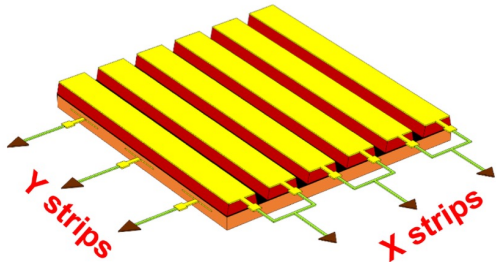
GEMs, µRwells and µRgrooves

- GEMs and µRwells readout are at the bottom, so we mostly detect electrons
  - Except for the one µRwell which had XYU readout
- µRgrooves have one view on the top of the groove (getting ions) and the other at the bottom (getting electrons)
- Three-stage amplification (GEMs) vs single-stage (µRwells and µRgrooves)
- Type of gas used: Ar:CO2 (75:25) vs Ar:CO2:Isobutane (93:5:2)



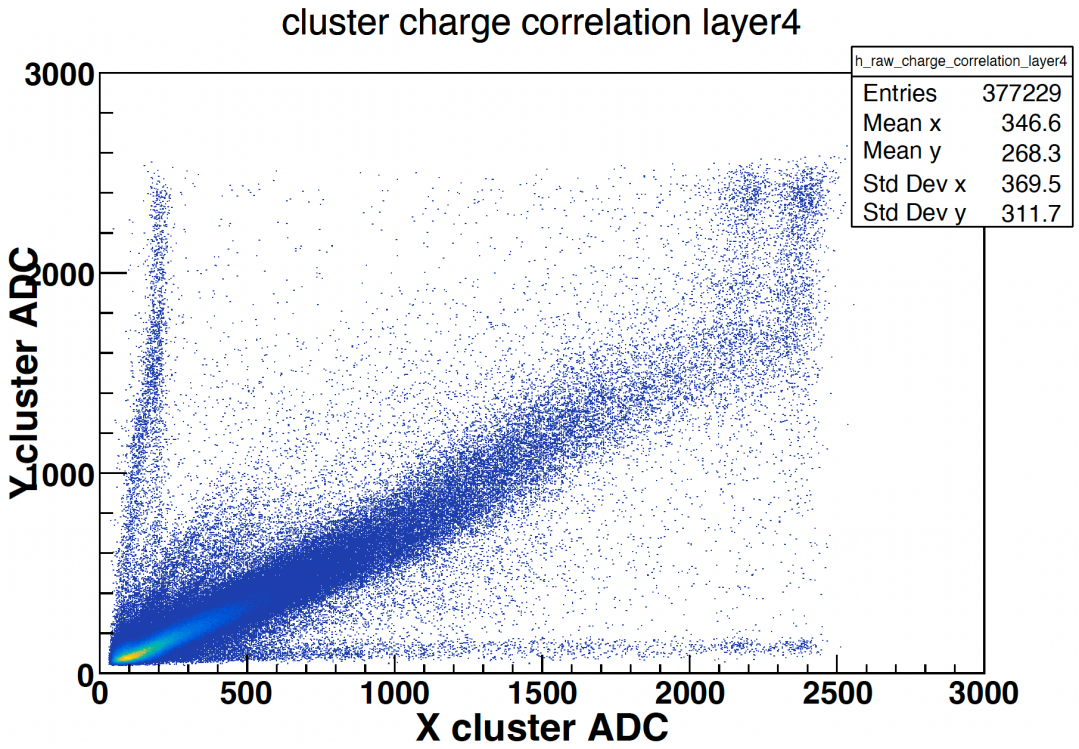




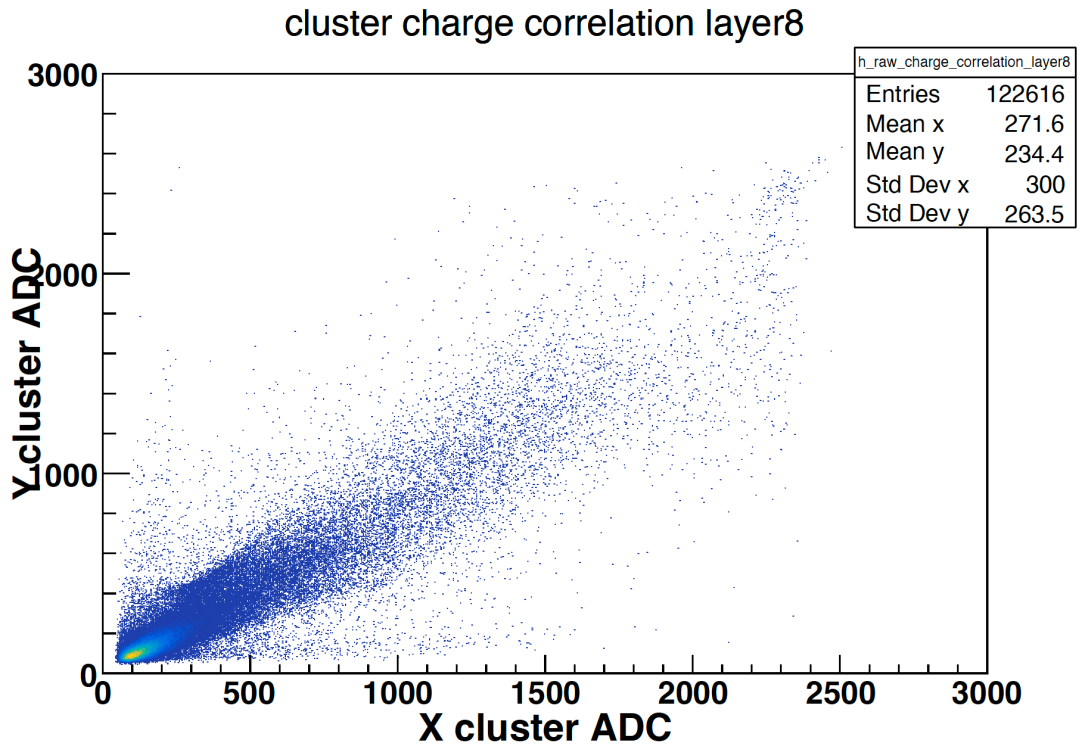


Preliminary figures from the beam test data

GEMs



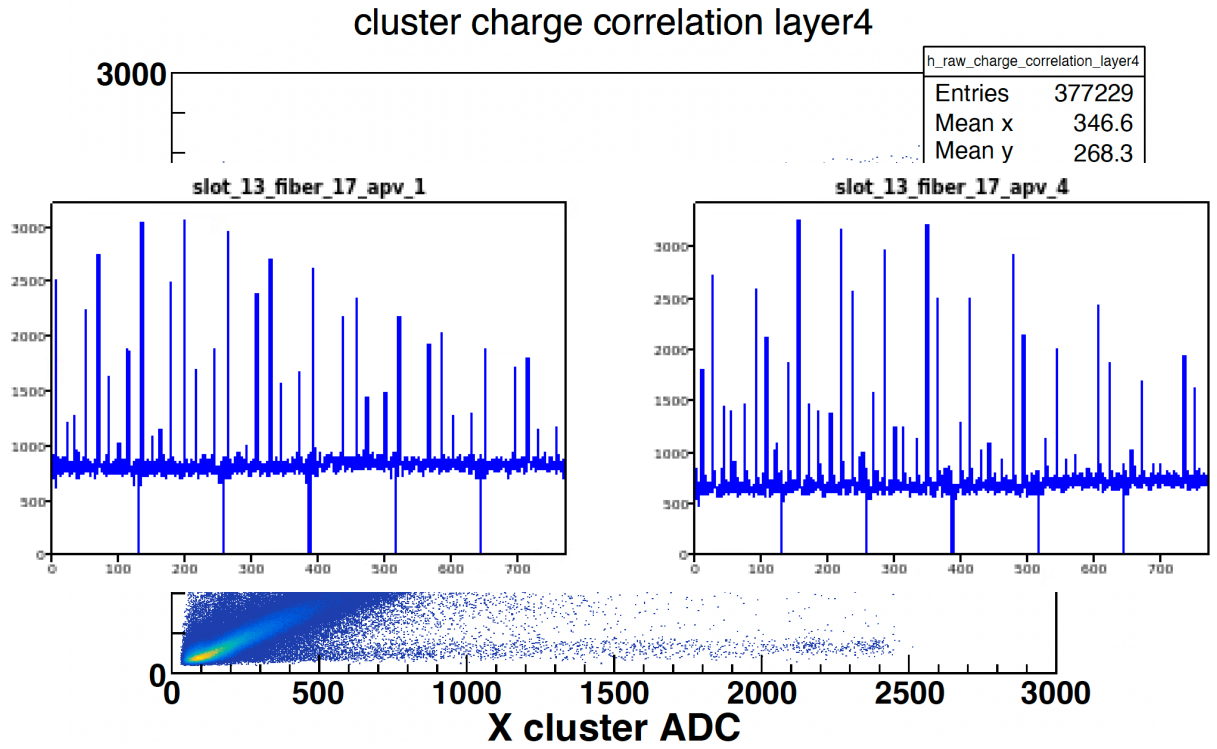
µRwells



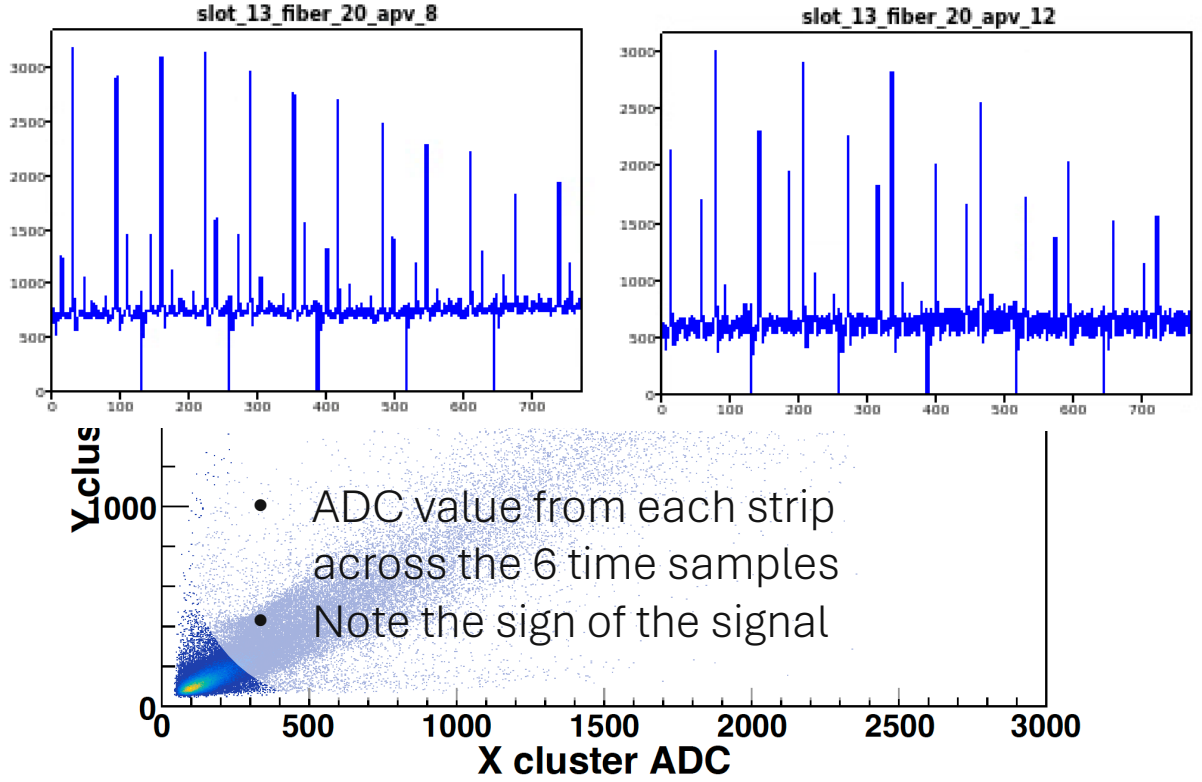
Not surprisingly, the µRwells tend to have lower gain than GEMs, but not by much

Preliminary figures from the beam test data

GEMs

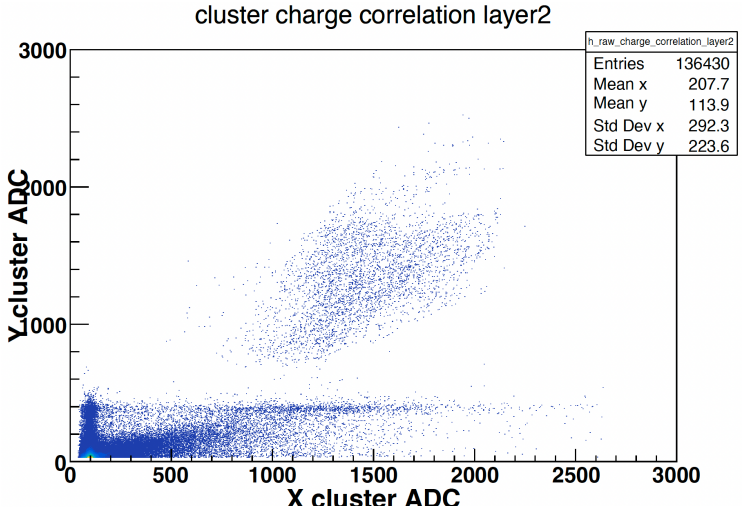


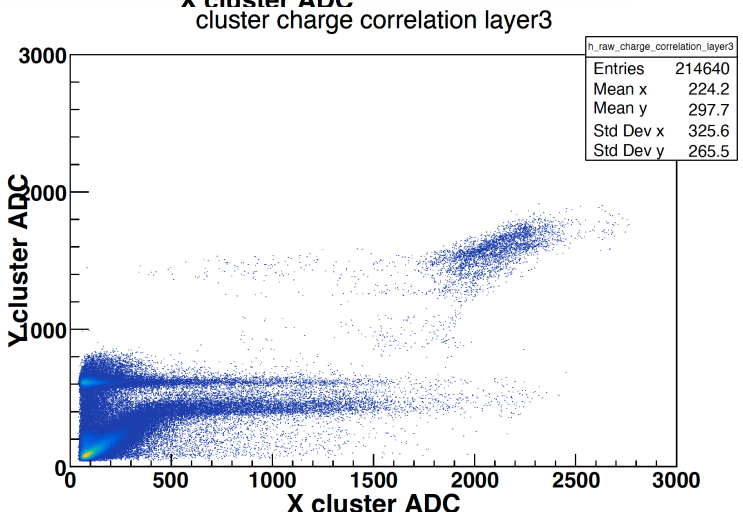
µRwells



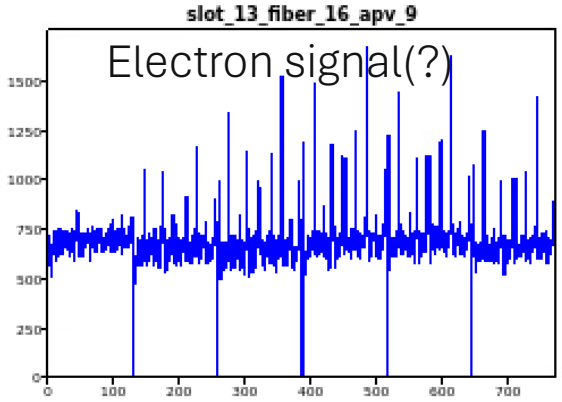
Not surprisingly, the µRwells tend to have lower gain than GEMs, but not by much

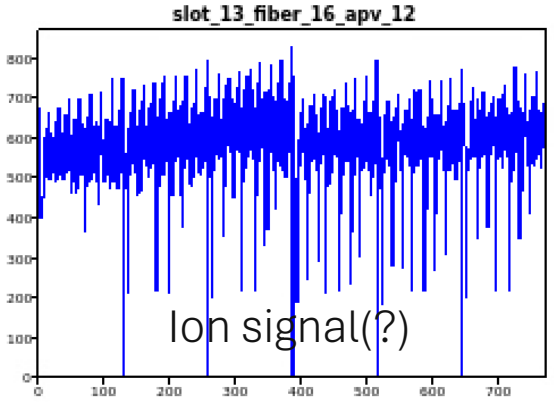
µRgrooves





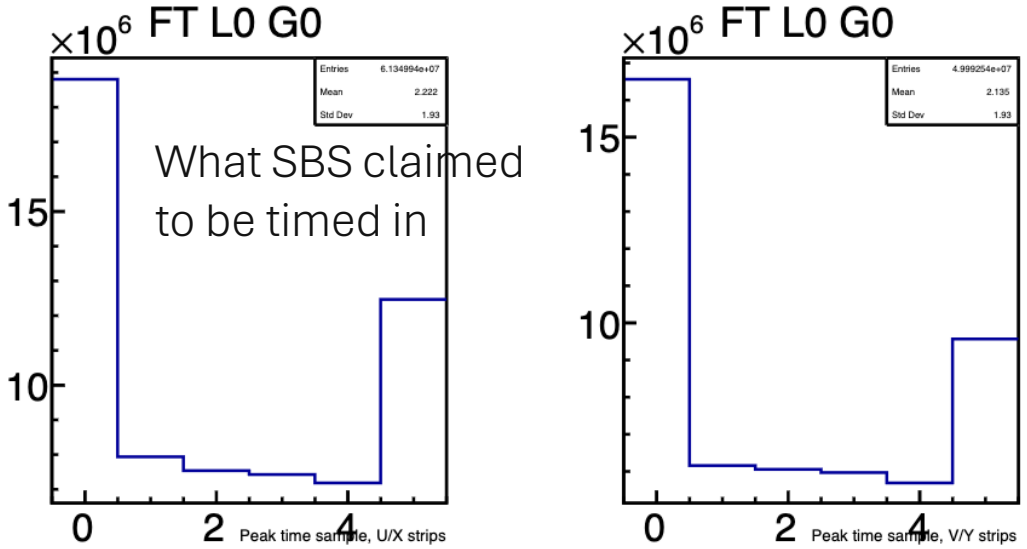
- The strip mapping may be incorrect
- The ion signal is still not processed correctly
  - Perhaps the timing of the ion signal is not correct; ions are heavier than electrons
  - Issues with readout electronics?
- Because we are used to detecting electron signals, the dynamic range may not be correct for ions
  - Note the signs
  - The signal may be truncated or clipped



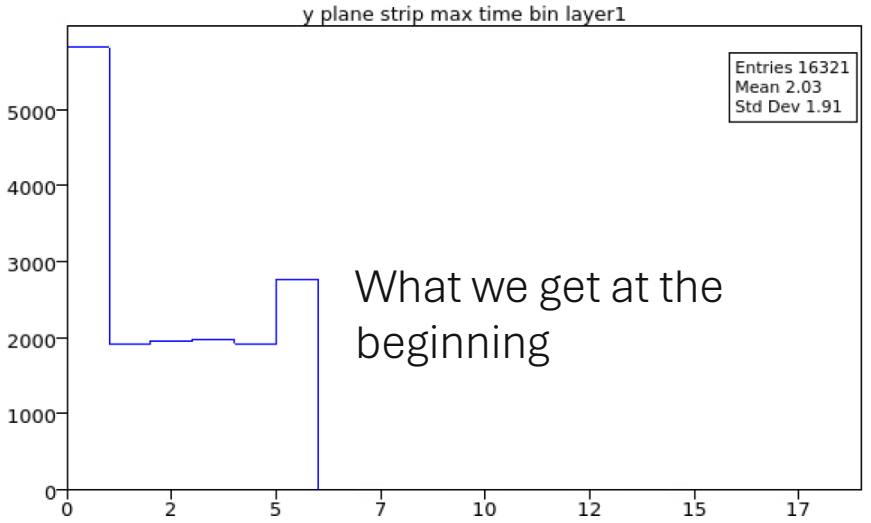


Timing is fun...

- (Perhaps misguided by experience in SBS)



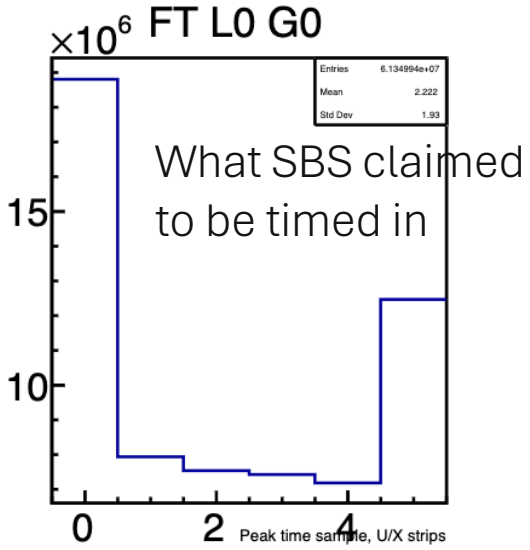
What SBS claimed to be timed in



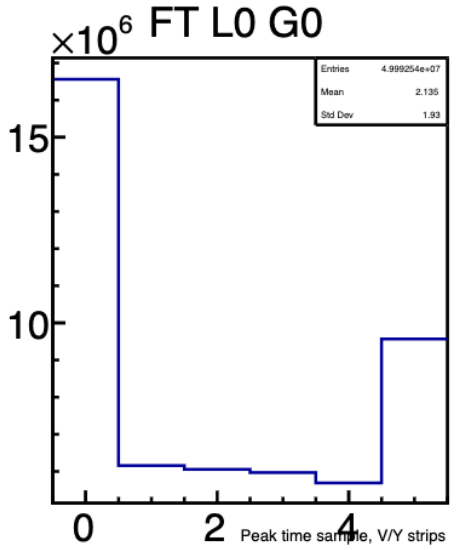
What we get at the beginning

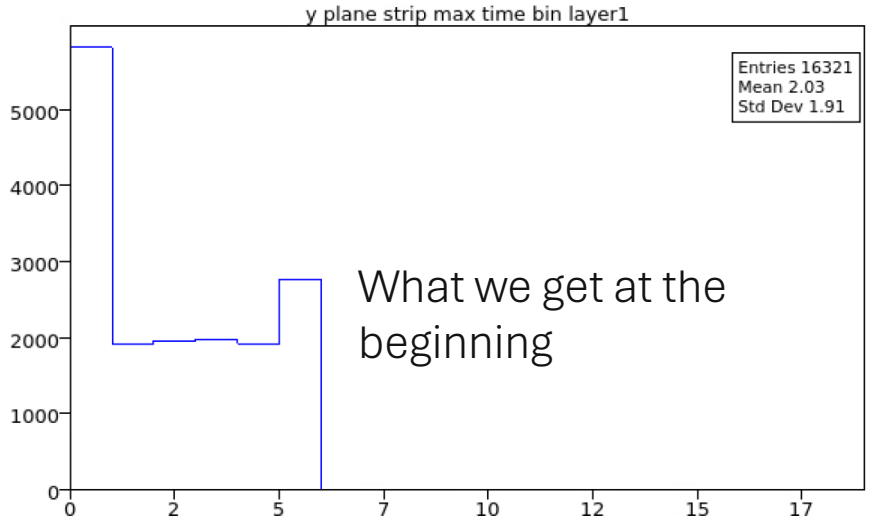
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- (Perhaps misguided by experience in SBS)

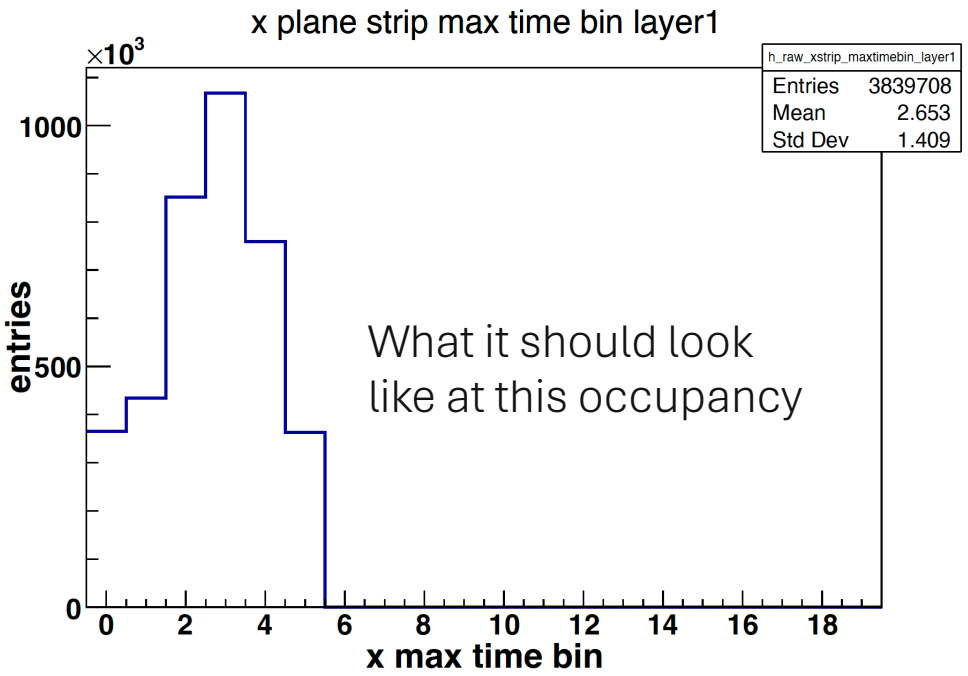


What SBS claimed to be timed in





What we get at the beginning



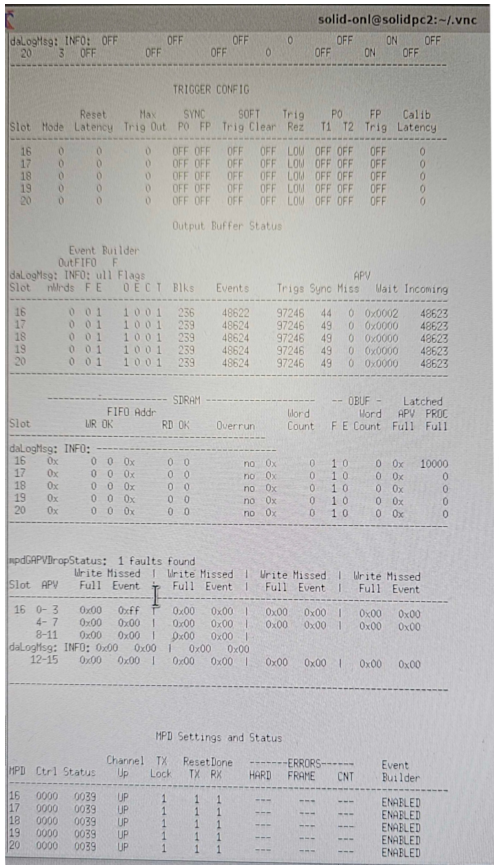
What it should look like at this occupancy

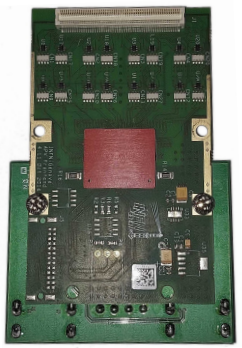
Operational challenges

- DAQ stability
- Noise issue in μRwells
- HV stability
- Inrush currents in μRwells and μRgrooves

APVs are interesting...

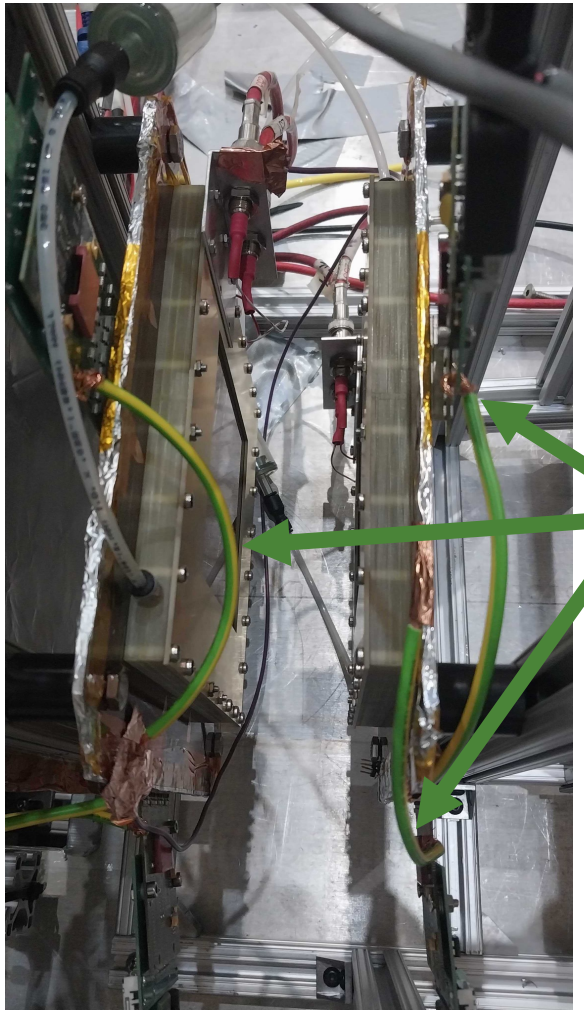
- Old news for those who are in SBS
- The APVs were all tested fine in ESB
- They also work fine when using pulser trigger, even when beam is on
- However, they don't cooperate when using a physics trigger in the hall...
- Not sure what is the origin of the instability or the solution
  - It is unclear whether this is correlated with the types of detectors.
  - While this issue impacted the μRgrooves the most in our beam test, we have also seen similar issues in SBS GEp





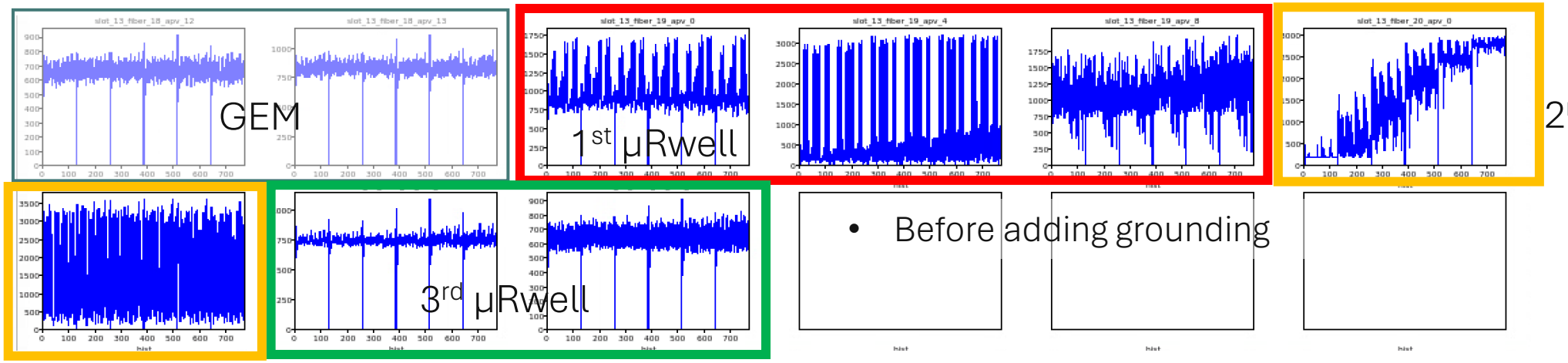
Noise in μRwells

- Before the beam test, Zeke, Florian and I installed additional grounding wires between the APV ground and the HV ground
  - This seems to have reduced the noise level, but the noise returned later in the beam test
- For one μRwell, the noise level is so high that we see “hits” even if the detector is off
- According to Florian, he had better experience when using SRS readout instead of the MPD system

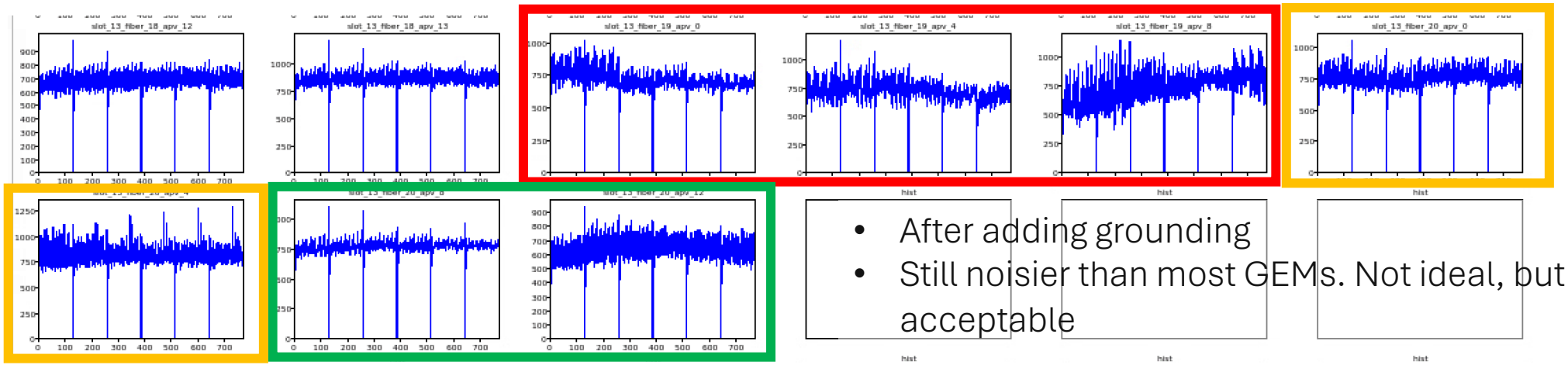


Wires connecting the APVs to the Al shield, which is connected to the HV ground

Grounding reduces noise, sort of

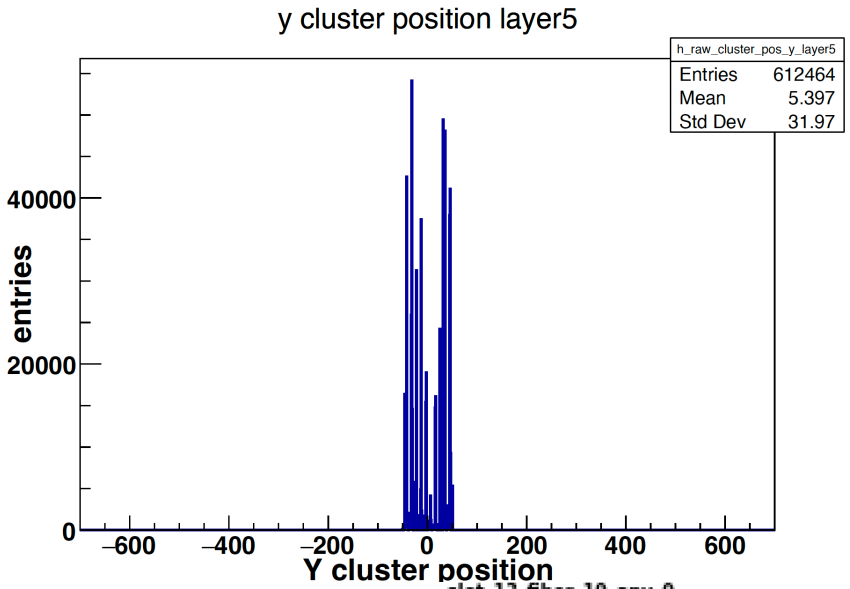


- Before adding grounding

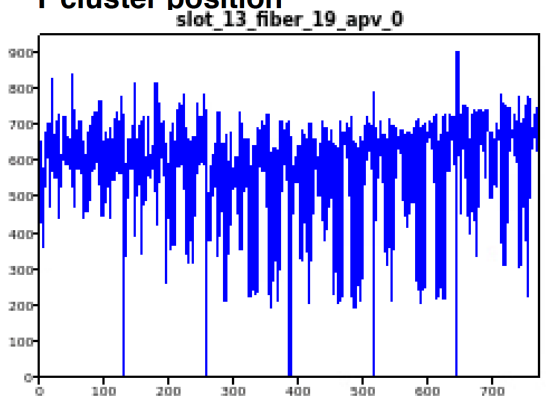


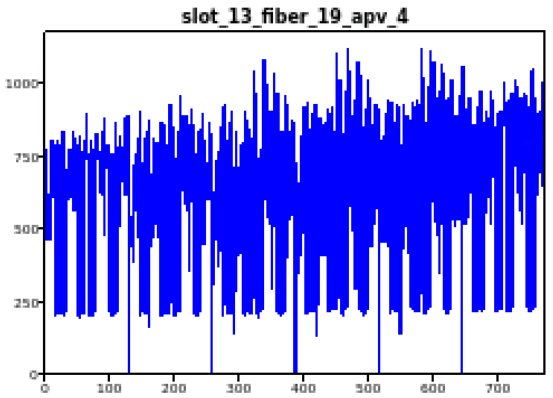
- After adding grounding
- Still noisier than most GEMs. Not ideal, but acceptable

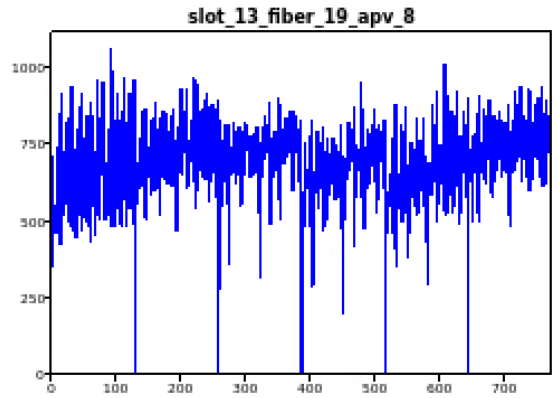
The return of noise…



- Data taken near the end of the test beam
- This μRwell is off when we took this data, and yet we got many, many “hits,” presumably from noise
- We did confirm the grounding wires are still connected

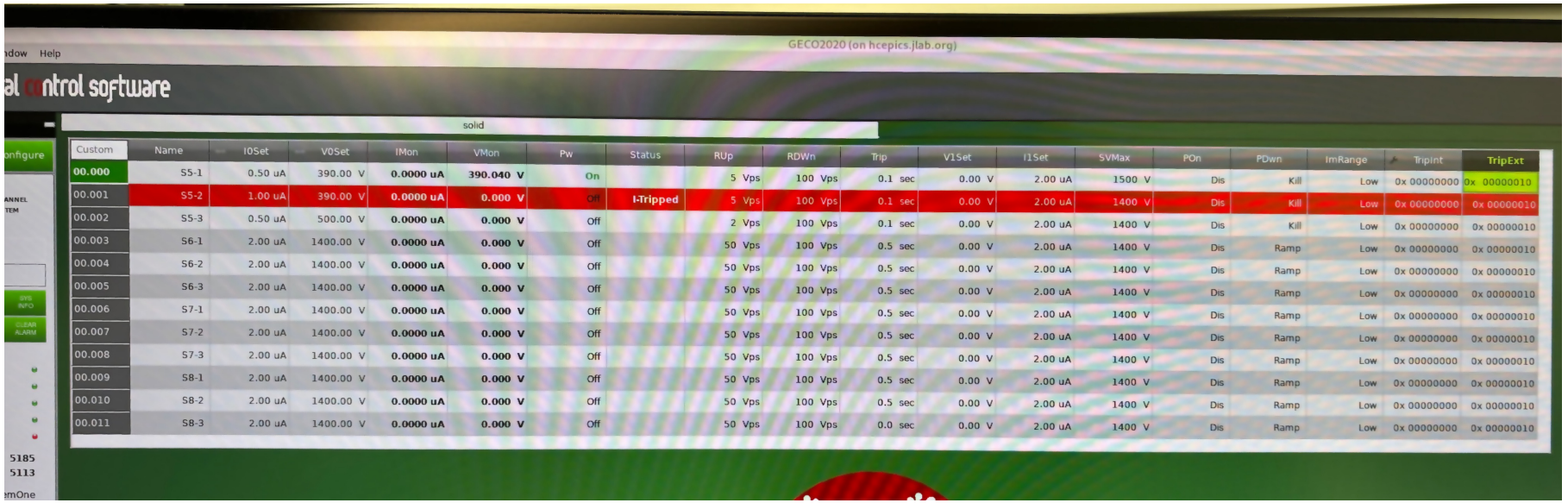






Stability in beam

- One µRgroove tripped repeatedly overnight, we did notice the current increasing with time during beam
- We were not able to capture the current draw when beam is off, so the cause is not obvious at the moment



Custom	Name	I0Set	V0Set	IMon	VMon	Pw	Status	RUp	RDWn	Trip	V1Set	I1Set	SVMax	POn	PDwn	ImRange	TripInt	TripExt
00.000	S5-1	0.50 uA	390.00 V	0.0000 uA	390.040 V	On		5 Vps	100 Vps	0.1 sec	0.00 V	2.00 uA	1500 V	Dis	Kill	Low	0x 00000000	0x 00000010
00.001	S5-2	1.00 uA	390.00 V	0.0000 uA	0.000 V	Off	I-Tripped	5 Vps	100 Vps	0.1 sec	0.00 V	2.00 uA	1400 V	Dis	Kill	Low	0x 00000000	0x 00000010
00.002	S5-3	0.50 uA	500.00 V	0.0000 uA	0.000 V	Off		2 Vps	100 Vps	0.1 sec	0.00 V	2.00 uA	1400 V	Dis	Kill	Low	0x 00000000	0x 00000010
00.003	S6-1	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.004	S6-2	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.005	S6-3	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.006	S7-1	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.007	S7-2	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.008	S7-3	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.009	S8-1	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.010	S8-2	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.5 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010
00.011	S8-3	2.00 uA	1400.00 V	0.0000 uA	0.000 V	Off		50 Vps	100 Vps	0.0 sec	0.00 V	2.00 uA	1400 V	Dis	Ramp	Low	0x 00000000	0x 00000010

Inrush currents in µRwells and µRgrooves

- The designs of the µRwells and µRgrooves do not include any current limiting resistors between the detector and HV supply
- The output voltage from the power supply is less stable at lower voltages and when the supply is first turned on.
- This resulted in the detector tripping when we turned them on
  - This can be partially mitigated by slowly increasing the voltage, with much larger current limits.
  - Note that the power supply does include a ramp rate control, but even setting it to the minimum can still lead to trips at the beginning
- This might be fine for a beam test, but it’s unclear if the regular shift crew will tolerate it



What we need for the next beam test

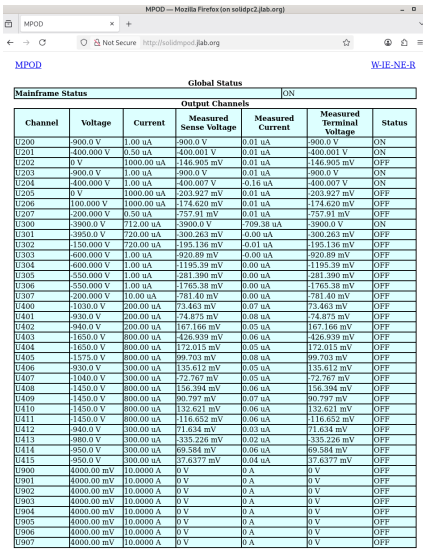
- EPICS
  - While controlling the power supply using SNMP commands is fun, it is very hard to monitor and log the status. Also, more prone to mistakes
- Perhaps a better way of turning the detectors on?
  - This could be done through hardware or software modifications
- Understand the noise
  - Shielding, grounding (they are black magic)
  - Better low voltage power supply for the APVs?
- Better handling of the ion signal
  - We should be able to raise the APV baseline, though it's unclear whether this can be done on a per-APV basis
- Pressure systems are fun...

switch all channels of all modules on:
snmpset -v 2c -m +WIENER-CRATE-MIB -c guru 192.168.0.80 groupsSwitch.0 i 1
WIENER-CRATE-MIB::groupsSwitch.0 = INTEGER: on(1)

switch all channels off:
snmpset -v 2c -m +WIENER-CRATE-MIB -c guru 192.168.0.80 groupsSwitch.0 i 0
WIENER-CRATE-MIB::groupsSwitch.0 = INTEGER: off(0)

switch all high voltage channels (ISEG modules) off:
snmpset -v 2c -m +WIENER-CRATE-MIB -c guru 192.168.0.80 groupsSwitch.64 i 0
WIENER-CRATE-MIB::groupsSwitch.64 = INTEGER: off(0)

RESET ISEG HV Modules after Safetyloop error:
snmpset -v 2c -m +WIENER-CRATE-MIB -c guru 192.168.0.80 groupsSwitch.64 i 10
WIENER-CRATE-MIB::groupsSwitch.64 = INTEGER: clearEvents(10)


MPOD — Mozilla Firefox (on solidpc2.jlab.org)

MPOD

Not Secure http://solidmpod.jlab.org

MPOD W-IE-NF-R

Global Status

Mainframe Status	ON

Output Channels

Channel	Voltage	Current	Measured Sense Voltage	Measured Current	Measured Terminal Voltage	Status
U200	-900.0 V	1.00 uA	-900.0 V	0.01 uA	-900.0 V	ON
U201	-400.000 V	0.50 uA	-400.001 V	0.01 uA	-400.001 V	ON
U202	0 V	1000.00 uA	-146.905 mV	0.01 uA	-146.905 mV	OFF
U203	-900.0 V	1.00 uA	-900.0 V	0.01 uA	-900.0 V	ON
U204	-400.000 V	1.00 uA	-400.007 V	-0.16 uA	-400.007 V	ON
U205	0 V	1000.00 uA	-203.927 mV	0.01 uA	-203.927 mV	OFF
U206	100.000 V	1000.00 uA	-174.620 mV	0.01 uA	-174.620 mV	OFF
U207	-200.000 V	0.50 uA	-757.91 mV	0.01 uA	-757.91 mV	OFF
U300	-3900.0 V	712.00 uA	-3900.0 V	-709.38 uA	-3900.0 V	ON
U301	-3950.0 V	720.00 uA	-300.263 mV	-0.00 uA	-300.263 mV	OFF
U302	-150.000 V	720.00 uA	-195.136 mV	-0.01 uA	-195.136 mV	OFF
U303	-600.000 V	1.00 uA	-920.89 mV	-0.00 uA	-920.89 mV	OFF
U304	-600.000 V	1.00 uA	-1195.39 mV	0.00 uA	-1195.39 mV	OFF
U305	-550.000 V	1.00 uA	-281.390 mV	0.00 uA	-281.390 mV	OFF
U306	-550.000 V	1.00 uA	-1765.38 mV	0.00 uA	-1765.38 mV	OFF
U307	-200.000 V	10.00 uA	-781.40 mV	0.00 uA	-781.40 mV	OFF
U400	-1630.0 V	200.00 uA	73.463 mV	0.07 uA	73.463 mV	OFF
U401	-930.0 V	200.00 uA	-74.875 mV	0.08 uA	-74.875 mV	OFF
U402	-940.0 V	200.00 uA	167.166 mV	0.05 uA	167.166 mV	OFF
U403	-1650.0 V	800.00 uA	-426.939 mV	0.06 uA	-426.939 mV	OFF
U404	-1650.0 V	800.00 uA	172.015 mV	0.05 uA	172.015 mV	OFF
U405	-1575.0 V	800.00 uA	99.703 mV	0.08 uA	99.703 mV	OFF
U406	-930.0 V	300.00 uA	135.612 mV	0.05 uA	135.612 mV	OFF
U407	-1040.0 V	300.00 uA	-72.767 mV	0.05 uA	-72.767 mV	OFF
U408	-1450.0 V	800.00 uA	156.394 mV	0.06 uA	156.394 mV	OFF
U409	-1450.0 V	800.00 uA	90.797 mV	0.07 uA	90.797 mV	OFF
U410	-1450.0 V	800.00 uA	132.621 mV	0.06 uA	132.621 mV	OFF
U411	-1450.0 V	800.00 uA	-116.652 mV	0.06 uA	-116.652 mV	OFF
U412	-940.0 V	300.00 uA	71.634 mV	0.03 uA	71.634 mV	OFF
U413	-980.0 V	300.00 uA	-335.226 mV	0.02 uA	-335.226 mV	OFF
U414	-950.0 V	300.00 uA	69.584 mV	0.06 uA	69.584 mV	OFF
U415	-950.0 V	300.00 uA	37.6377 mV	0.04 uA	37.6377 mV	OFF
U900	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U901	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U902	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U903	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U904	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U905	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U906	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF
U907	4000.00 mV	10.0000 A	0 V	0 A	0 V	OFF

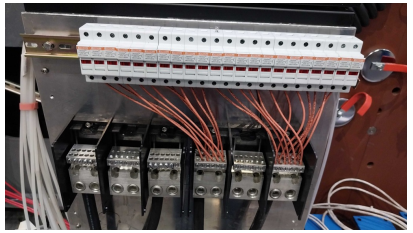
Low voltage power supply

- Perhaps already known to SBS
- I went with the Westcor power supply (top) assembled by JLab Fast Electronics Group.
  - Easier to set up: class 1 electronics, 120VAC input, with 12 A fuses in the same box, plug and cord
- It can be noisier than the TDK-Lambda (bottom) power supplies.
  - The TDK-Lambda is a class 2 electronics, up to 330A at 5VDC, 480VAC input. Need a separate fuse panel for distribution. Some units are hardwired to the breaker.



What we used in test beam





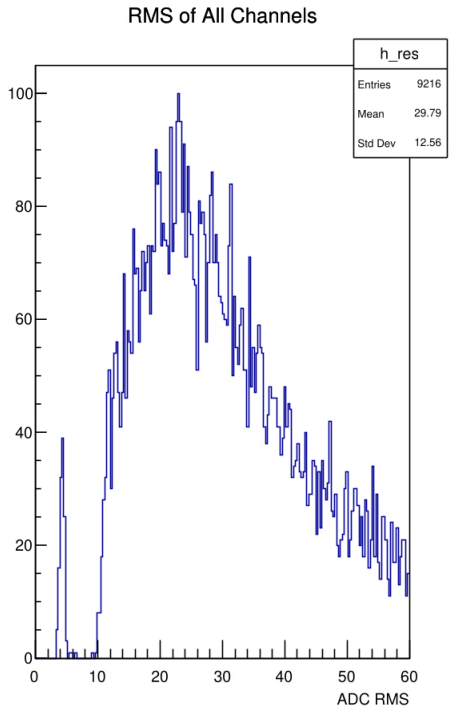
What was used in SBS

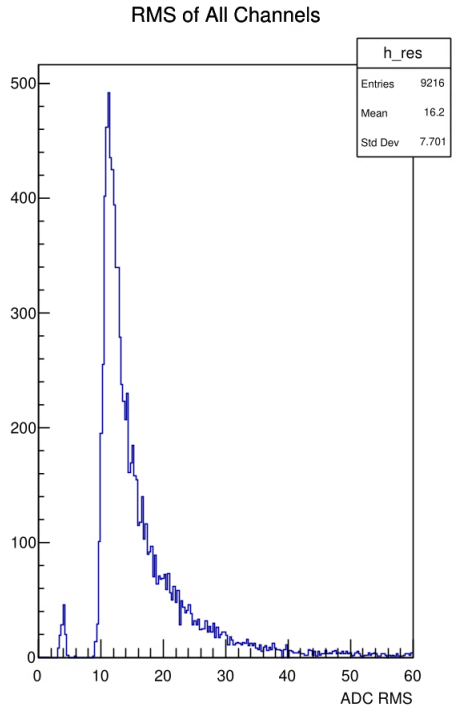
Low voltage power supply

- Study done during LAD (https://logbooks.jlab.org/entry/4368343)
- Note that LAD will have worse noise due to the length of the readout strip and proximity to the beamline and target



Westcor







TDK Lambda

Summary

- Some data is collected on GEMs, μRwells and μRgrooves
- Since we have more experience with GEMs, some of the issues noted are more related to our software and DAQ hardware. They are not always indicative of flaws in the detectors.
- For the μRwells, we need to understand the noise issue, the analysis seems to be working
- For the μRgrooves, we need to understand how to process the ion signals
  - It is unclear whether the artifacts are from the offline analysis or the readout, likely both
- Ensure we have reliable APVs
- For the next beam test, we should invest more time to get the EPICS control working
  - Thank you to Steve, Bill and Jiwan for helping us with controls during this beam test
- Also, thanks to Hall C techs, Spectrometer Support group, and the Hall A/C engineers for their support