

Light Readout Update

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LArIAT Meeting – April 8, 2014

Since last update:

- A lot of progress in last few months
 - Cleared out lab space at UChicago and set everything up
 - Mounted TPB foil, copper “cathode”
 - Sealed PMTs and mock TPC in inner dewar and achieved vacuum ($\sim 10^{-5}$ mbar)
 - **Full run in liquid argon April 1-4**
 - Cosmic muon samples, Co60, simple majority trig
 - Analysis and summary in progress

Lab space



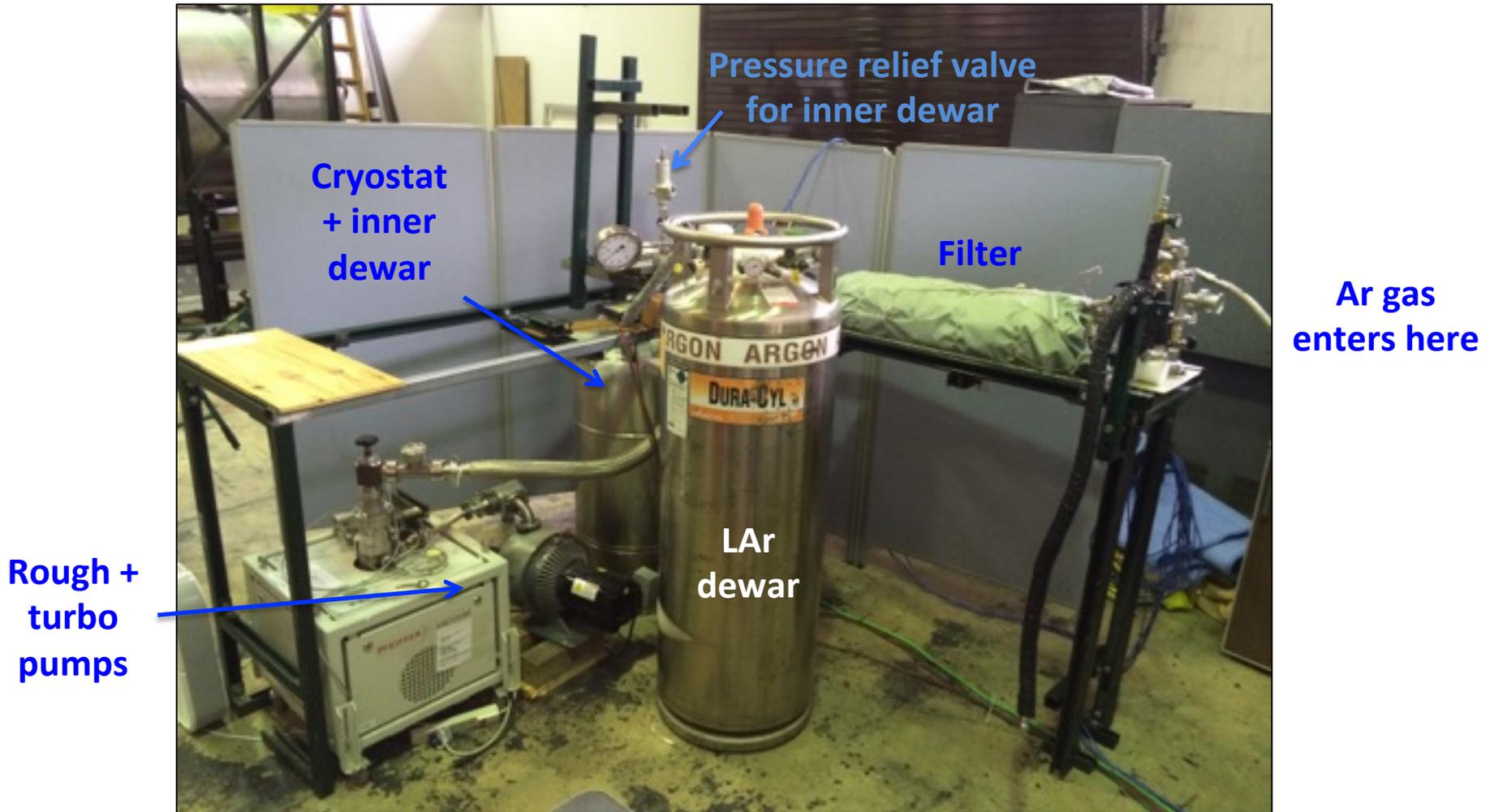
Previously
occupied by...



Lab space



Setup

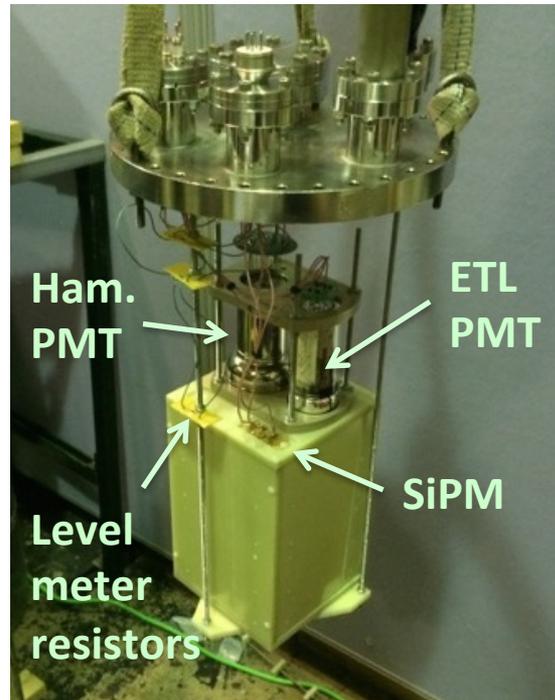


Closing the inner dewar (Mar 11)

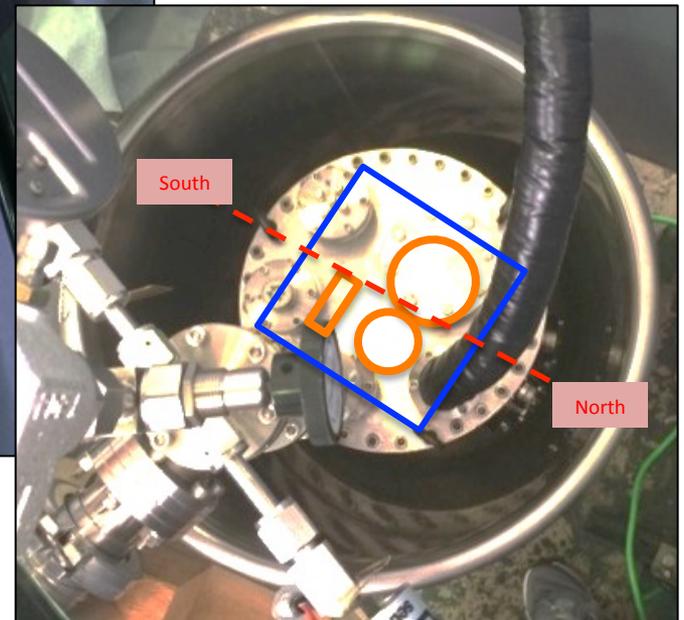


Mounting
TPB

Lowering setup into
inner dewar



Closing the inner dewar



Timeline of events

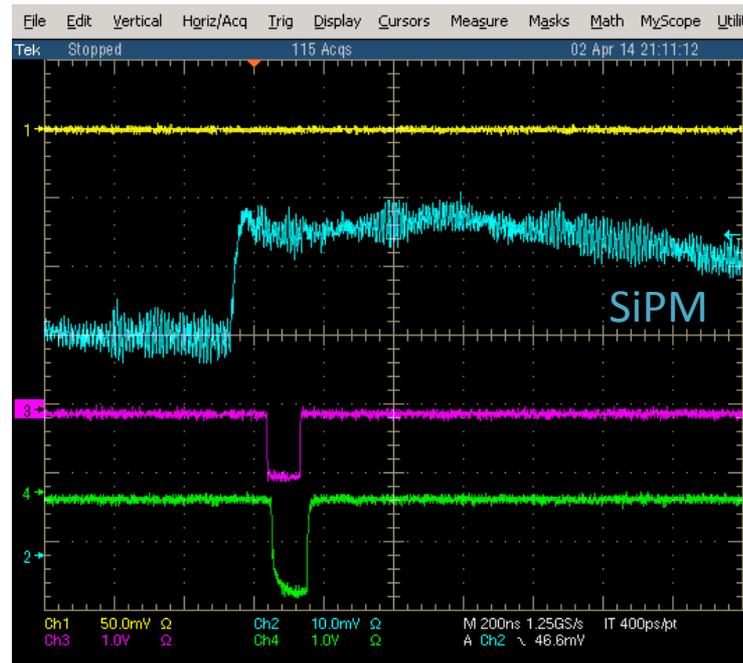
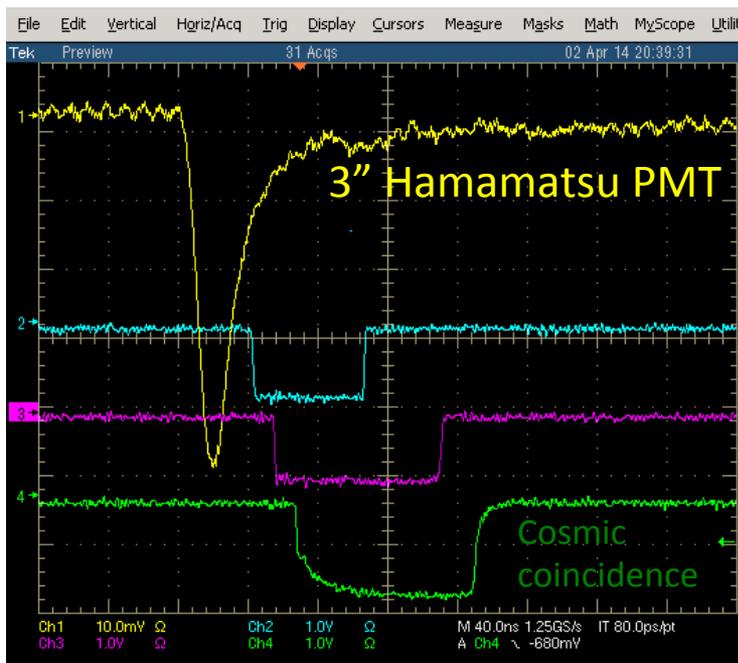
Tue	Wed	Thu	Fri	Sat
Apr 1	2	3	4	5
				

- Finished external connections to smaller feedthrough
- Filled external cryostat (inner at $3e-6$ mbar)
- Tested DAQ
 - Fixed problem with drifting baselines – powering down or insert/remove in same slot fixes it
 - Left to continue pumping on inner overnight
 - Loss of vacuum (spike to 10^{-3} mbar) probably due to leak as dewar cooled in liquid bath

Timeline of events

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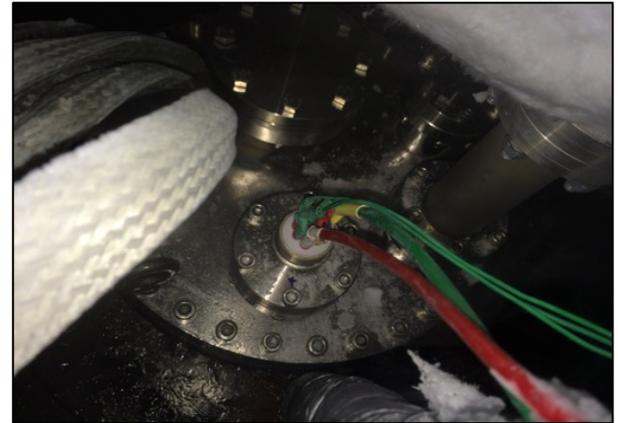
- Started gas fill of inner
 - More pure argon gas condenses into liquid in dewar
- First light from PMTs and SiPMs captured on scope!
- Took preliminary cosmic events with Hamamatsu



Timeline of events

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- **Problems starting Wed afternoon...**
 - No signals from 2" ETL PMT, trips at 300V
 - R from HV to gnd changed from 5M Ω to 2.7M Ω (something connecting in parallel...)
 - Connections on FT2 (SiPM and level meter) coming loose
 - Signals plagued with mysterious noise
 - Next liquid dewar expected on Wed would not arrive until Thurs
 - Had to power everything down and vent off internal gas to maintain stability



Timeline of events

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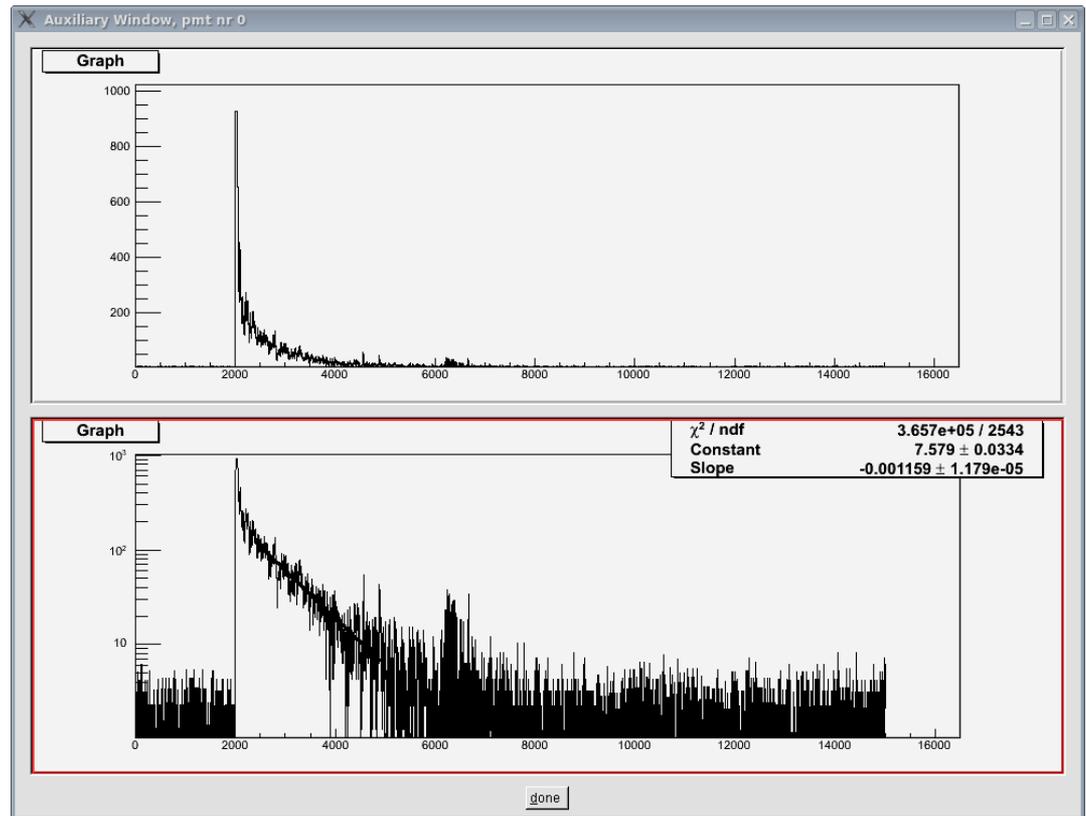
- Our luck starts to turn around...
 - New dewar arrives
 - refilled bath and used leftover gas to refill inner to compensate for lost liquid during warming
 - Added foam to end of hose to prevent liquid minimize turbulence and evaporation while filling
 - **2” ETL miraculously comes back to life (no sign of SiPM...)**
 - Fixed some of the noise related to a connection box
 - < 40 ADC, trigger rate ~1 kHz (all noise)
 - > 40 ADC, trigger rate ~8 Hz (cosmics)
 - Seeing response from Co60 source
 - Rate goes up to 12-14 Hz

Timeline of events



From big events,
seeing lifetime of
~800ns

More or less in line
with expectations
from gas purity itself
(filter did not work?)

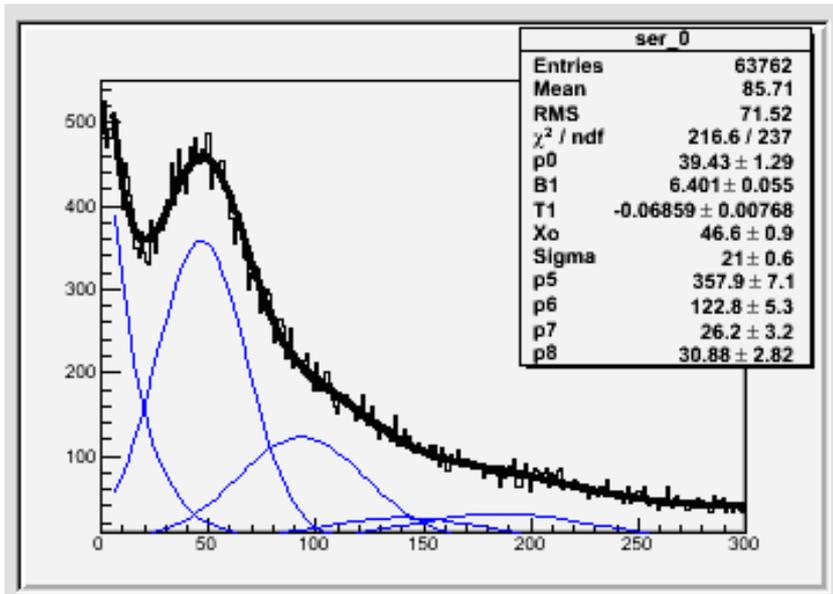


Timeline of events

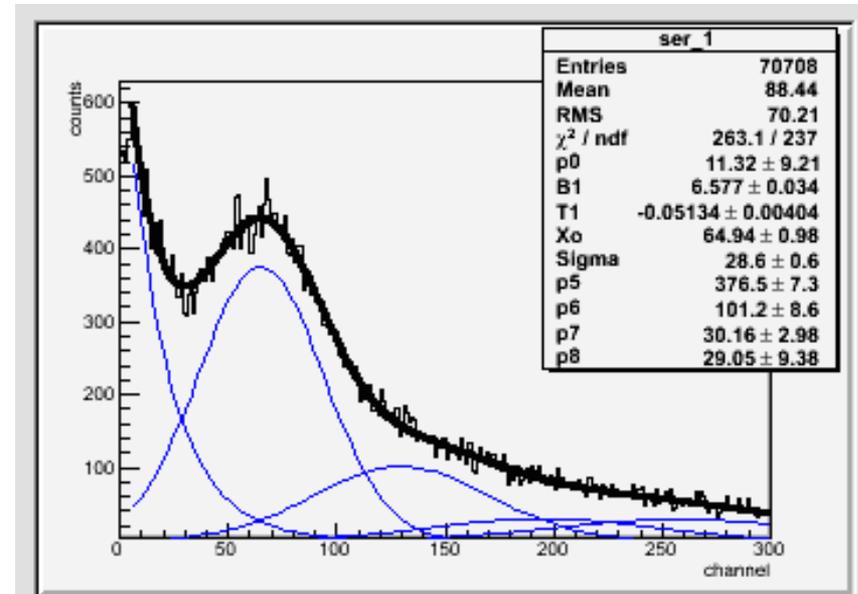
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Seeing SER from both PMTs

Hamamatsu



ETL



Timeline of events

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Cosmic trigger runs:

Configuration 1:

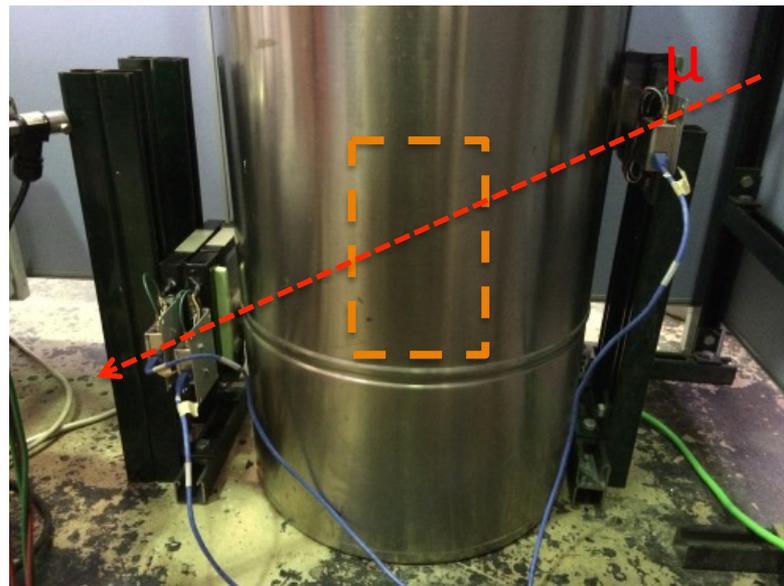
paddles stacked horizontally above cryostat to select vertical muons

- ~0.8 Hz but low efficiency for entering active volume
- Recorded 4k events

Configuration 2:

paddles at angle on sides of dewar (see photo)

- ~0.02 Hz – had to run overnight
- 1k events



Timeline of events

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- Nearly eliminated the noise by re-doing connection box and eliminating ground loops
 - Now at $\pm 1\text{mV}$
- Hamamatsu problems...
 - Baseline dropped 7 mV when powered up again (readjusted DAQ to account for it)
 - SER lower
 - Possibly recovering after voltage ramp-up

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Cobalt-60 runs:

Suspended 0.2 μ Ci Co-60 source at different sides of dewar at varying heights (emits 1.17MeV and 1.33MeV gammas)

30k events each at 4 heights on S, SE, E side of dewar (background runs in between)

With new reduced noise, can trigger on smaller threshold:

- Rate = \sim 100-120 Hz with source
- Background = 40 Hz

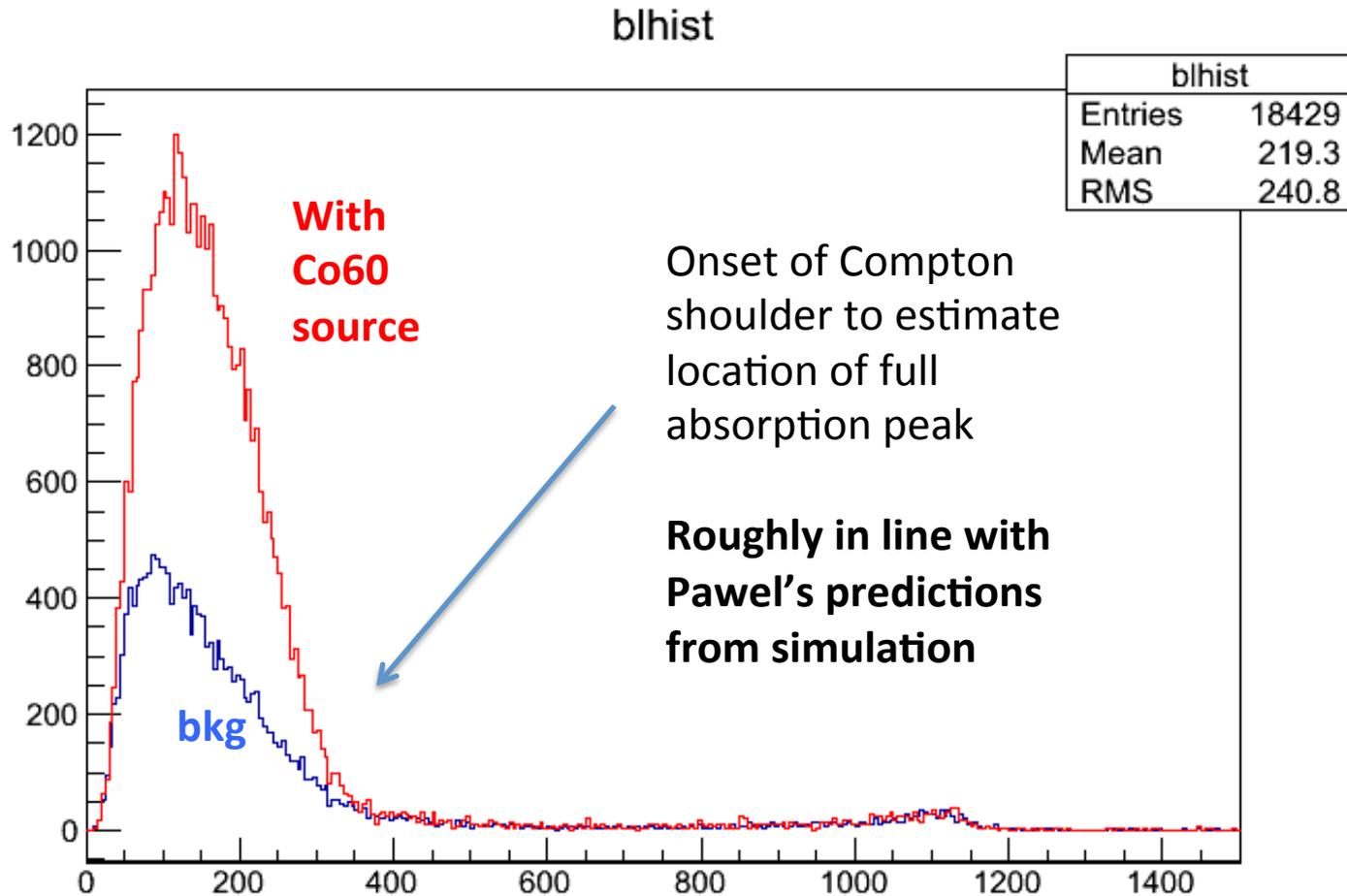


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- Late Friday night while trying to repair SiPM...
 - PMT signals started degrading
 - ETL tripping (probably some weird short)
- Powered down and let inner dewar outgas over the weekend through relief valve

Preliminary light yield from Co60



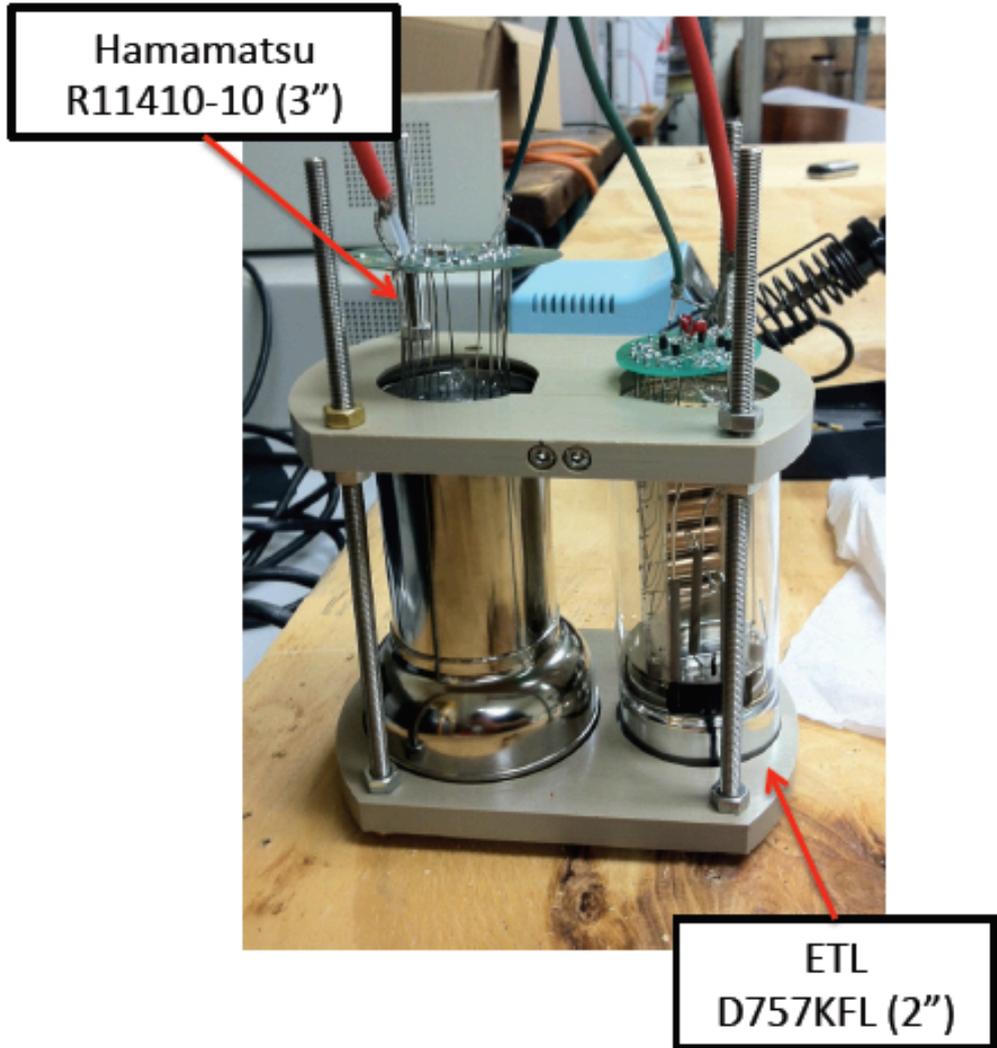
Next steps

- Bring CAEN V1751 board to FNAL for DAQ integration
- Dismantle setup and debug
 - What was the cause of the ETL trip on Fri night?
 - Is the Hamamatsu PMT ok?
 - What happened to the SiPM?
- Bring PMTs to FNAL for test with different power supplies
- Analysis of test data

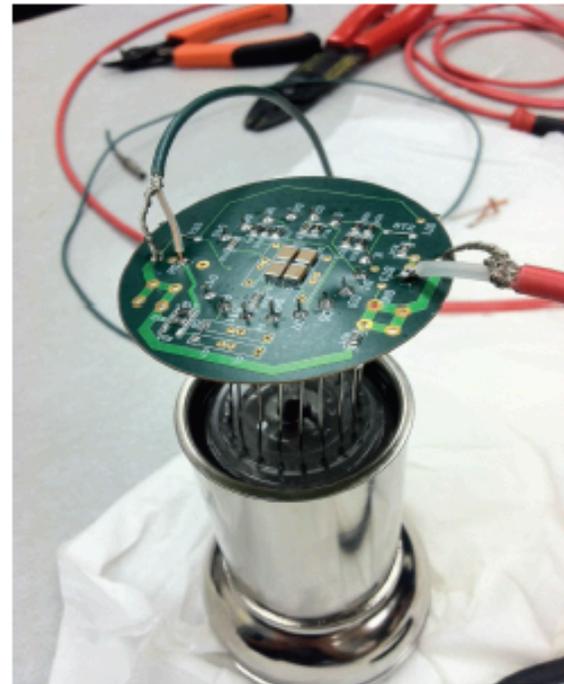
Overall, the test was a great learning opportunity, and a chance to catch mistakes and improve methods before installation in LArIAT.

Extras

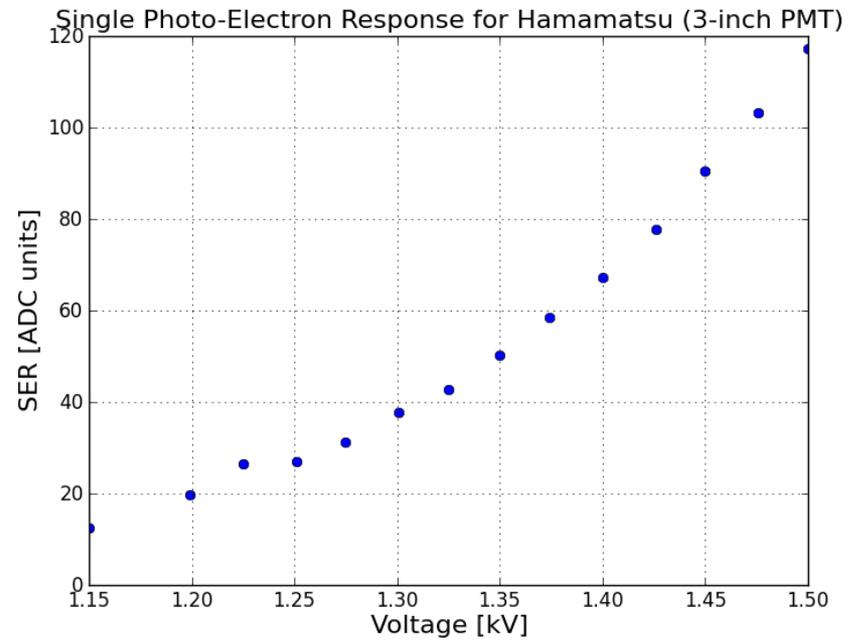
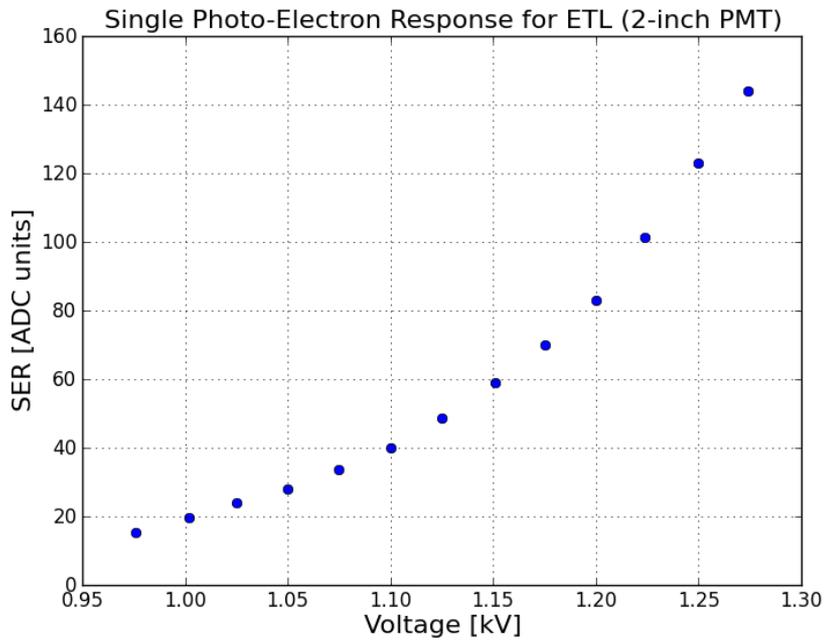
PMTs



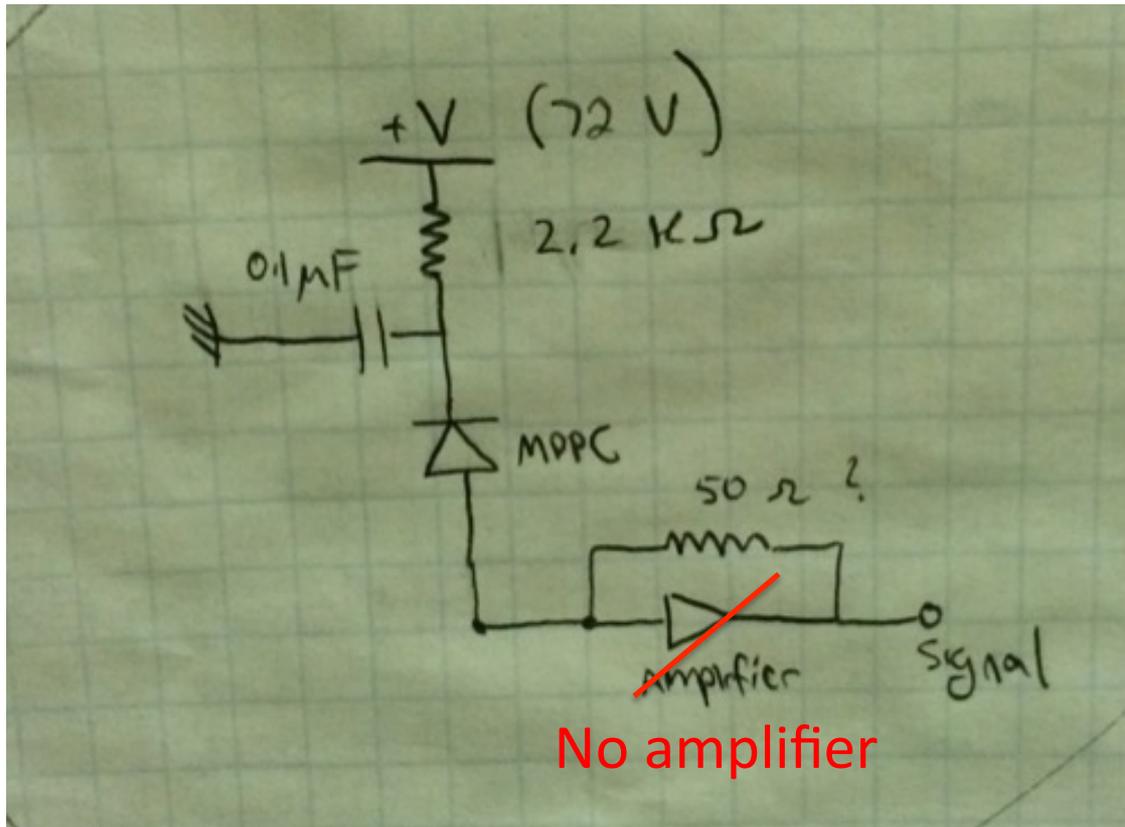
- HV leads and ground connections soldered to bases



PMT gain tests in air



Present SiPM circuit



Based on suggestions from Hamamatsu MPPC manual