SoLID Cherenkov Prototype: Beam Test in Hall C (Spring 2020)

Simona Malace

June 8 2020

SoLID Collaboration Meeting

Outline

→ pre-R&D goals

→ Putting together the detector package

→ Cosmics tests in the ESB

→ Installation in Hall C

→ Calibrations with a random trigger

→ Beam data

→ Beam data analysis

→ Plan going forward

SoLID Cherenkov Pre-R&D Goals

→ From the first quarterly report:

Milestone	Objectives	Expected Completion Date	Status
1	Construction and delivery of Cherenkov tank to Jefferson Lab.	Early January 2020	Complete
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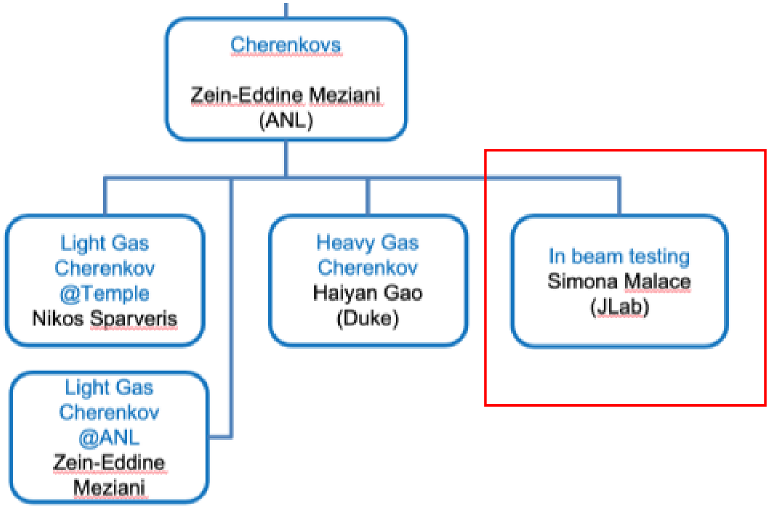
4	Collection and analysis of high rate data with MAROC electronics.	End of Year 2020 (+4 Month Contingency)	Not Started



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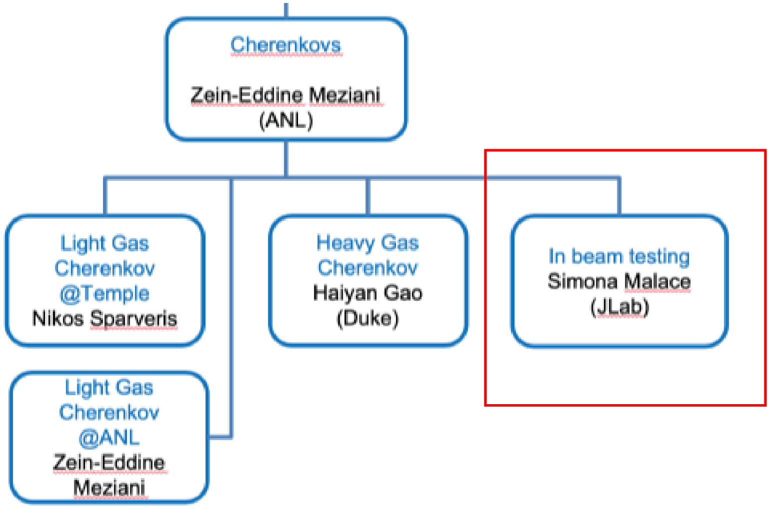

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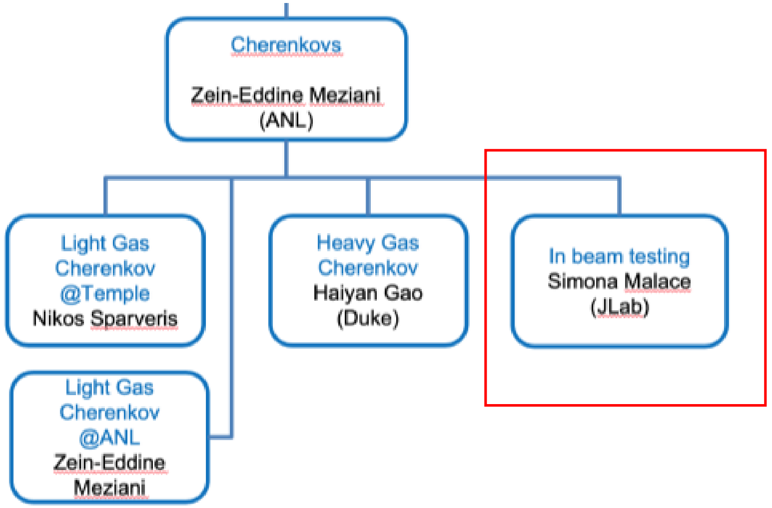

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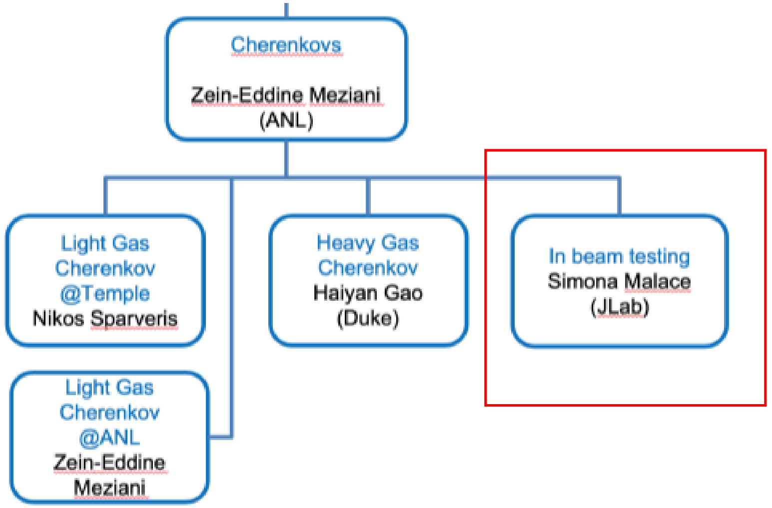

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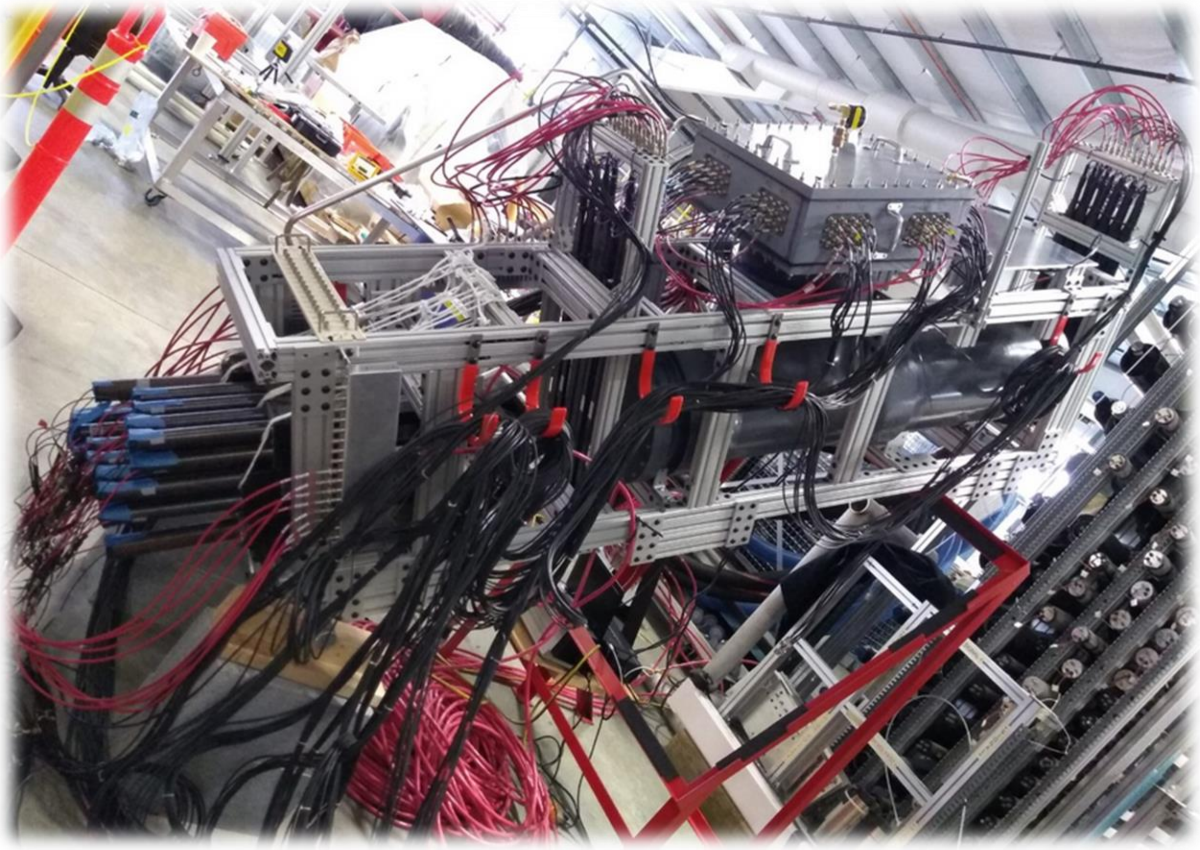
- Milestone 3: we collected data for about two days before the COVID-19 shutdown in the low rate configuration

Putting Together the Detector Package



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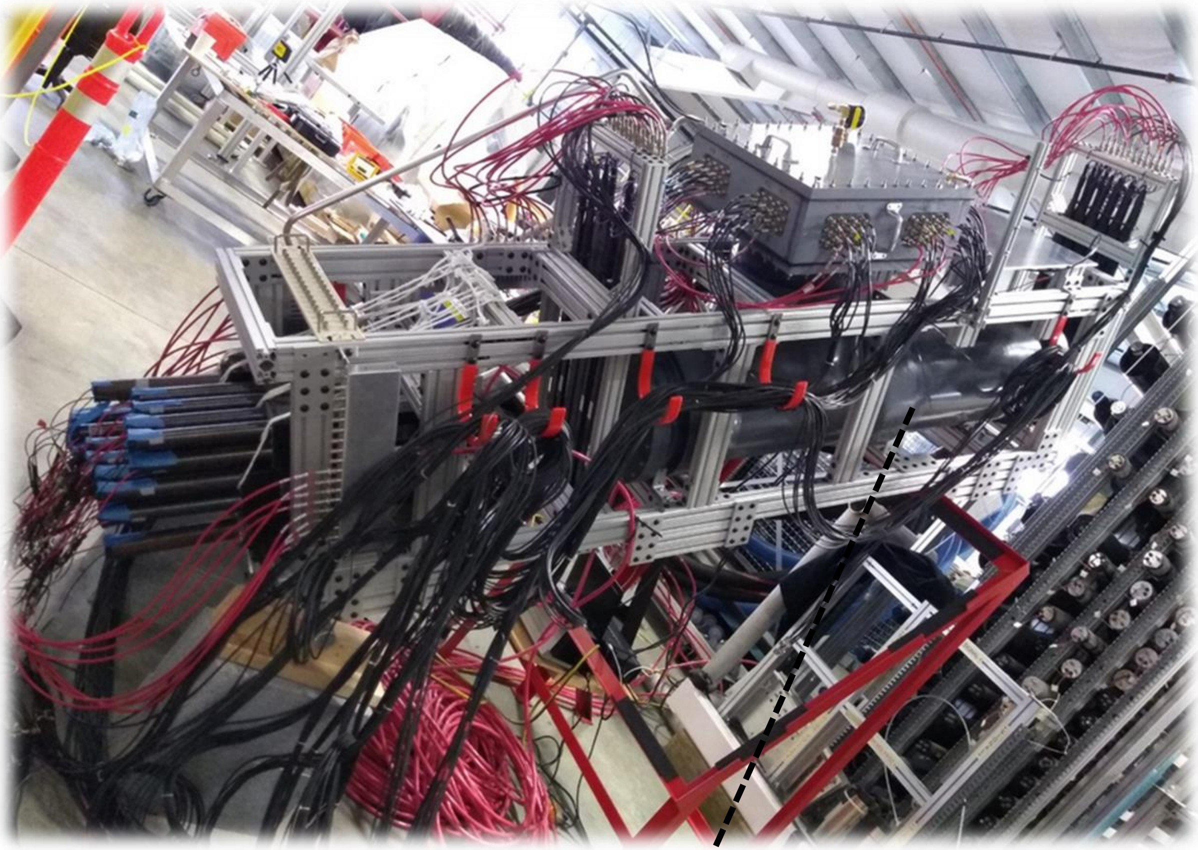

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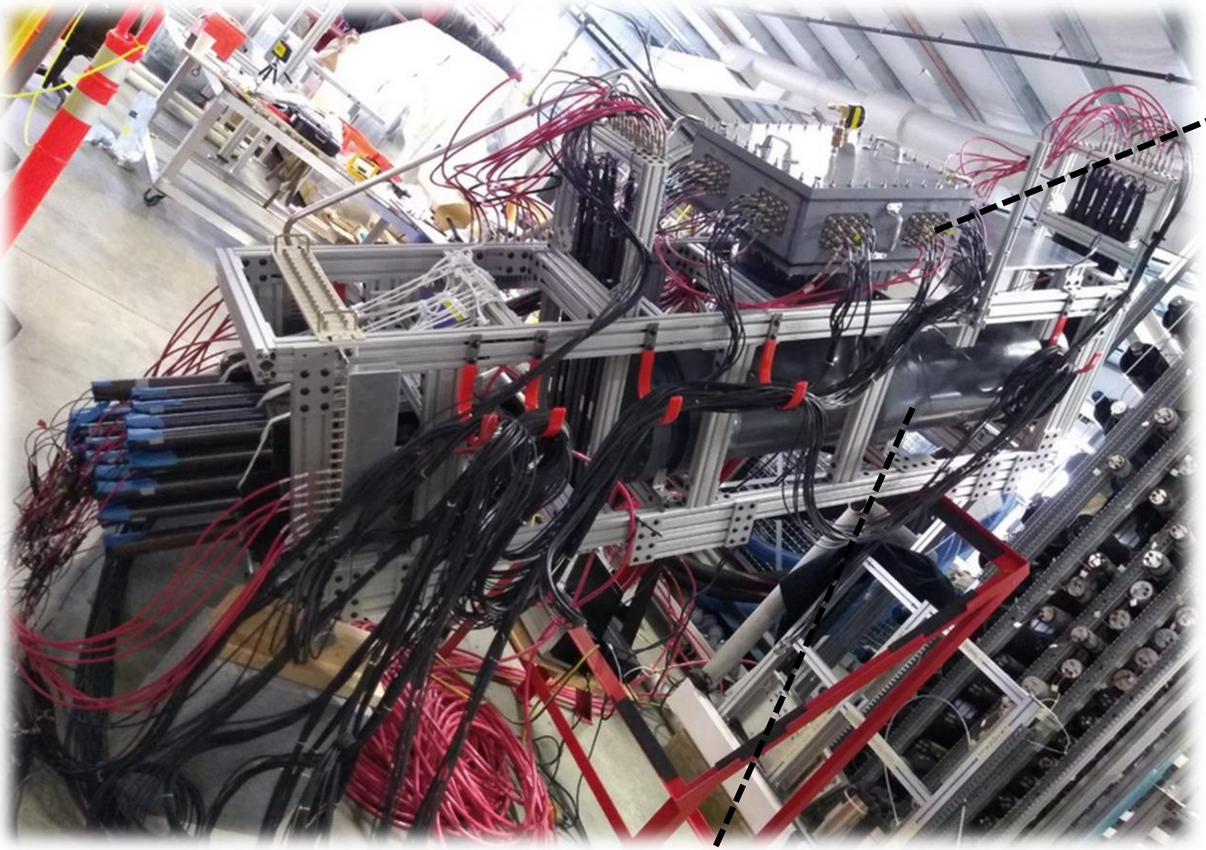
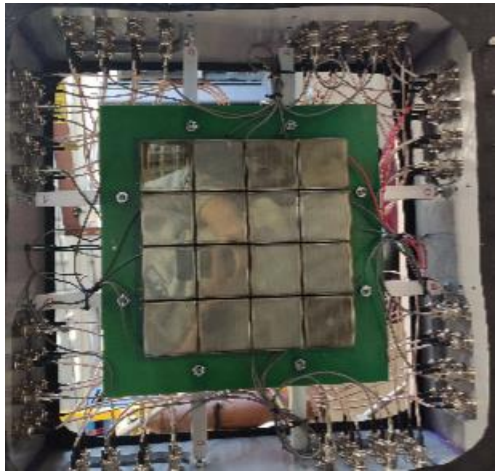


→ Box containing the 16 maPMTs tile on the electronics board



I gain matched the maPMTs on the scope to get SPEs of 10 mV amplitude

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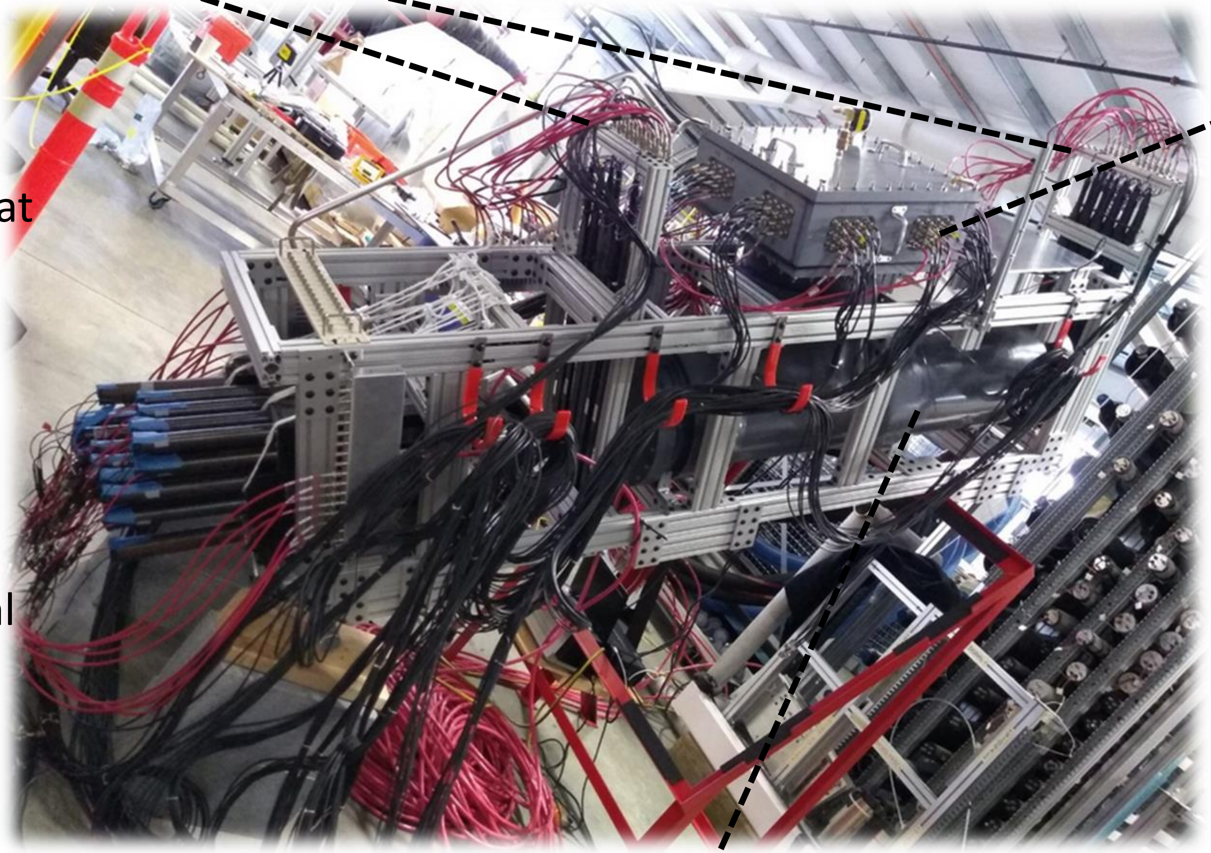
Putting Together the Detector Package

→ Two scintillator planes flanking the Cherenkov tank

I sorted through bunch of paddles that were part of an old SLAC detector until I found 22 that were still usable (~ 1 inch width, 0.25 inch overlap between paddles; readout 0.5 inch Hamamatsu PMTs)

I calibrated the paddles/PMTs with a 60Co source to get a signal of ~ 200 mV amplitude



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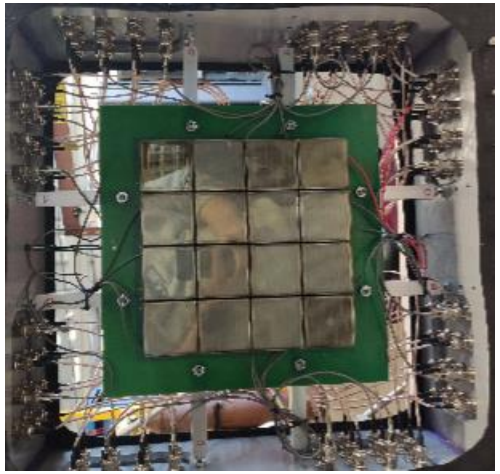

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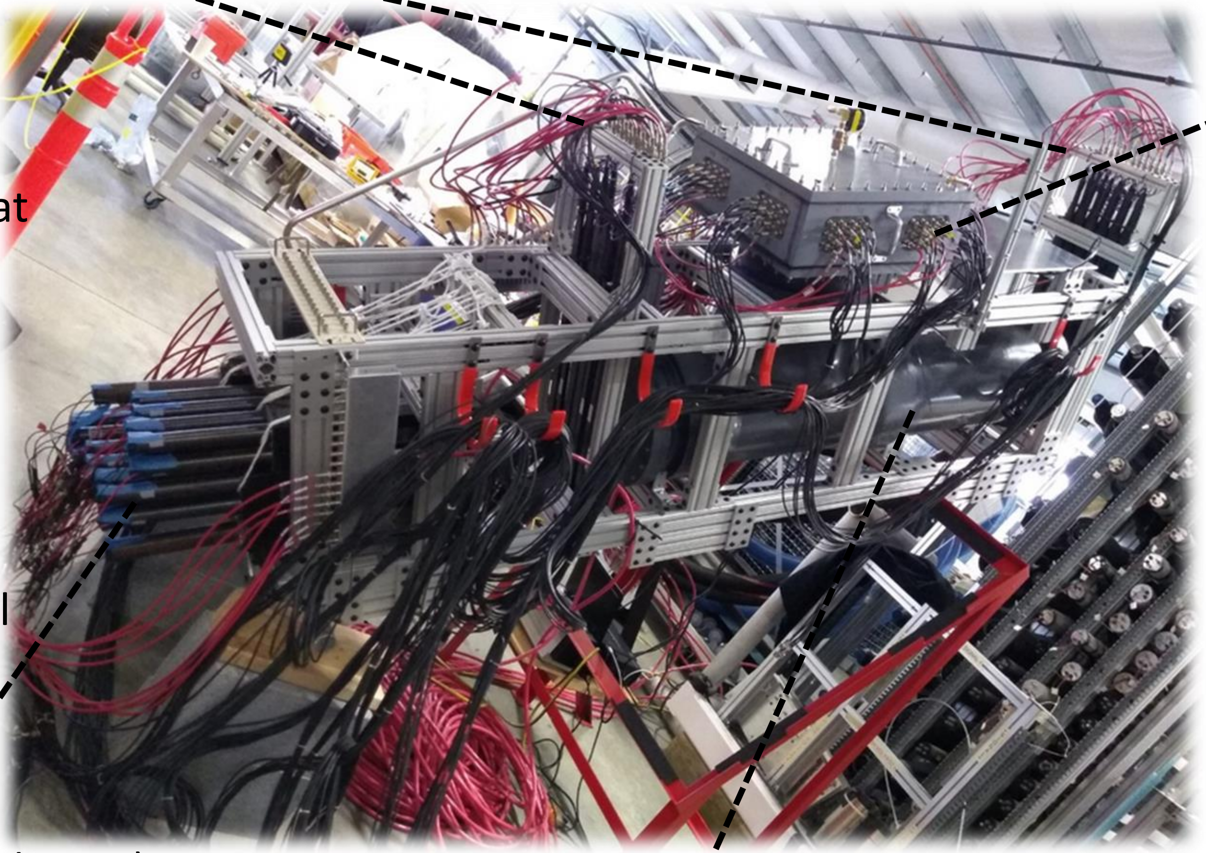

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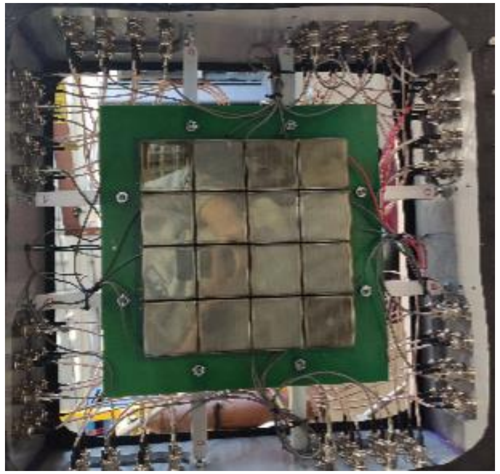

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→ 9 calorimeter blocks (Shashlyk type) arranged in a 3 x 3 array; 4 locks are read by one PMT only (per block) while the remaining 6 are read by 4 PMTs (per block) – the blocks were gain matched with comics and later on with beam

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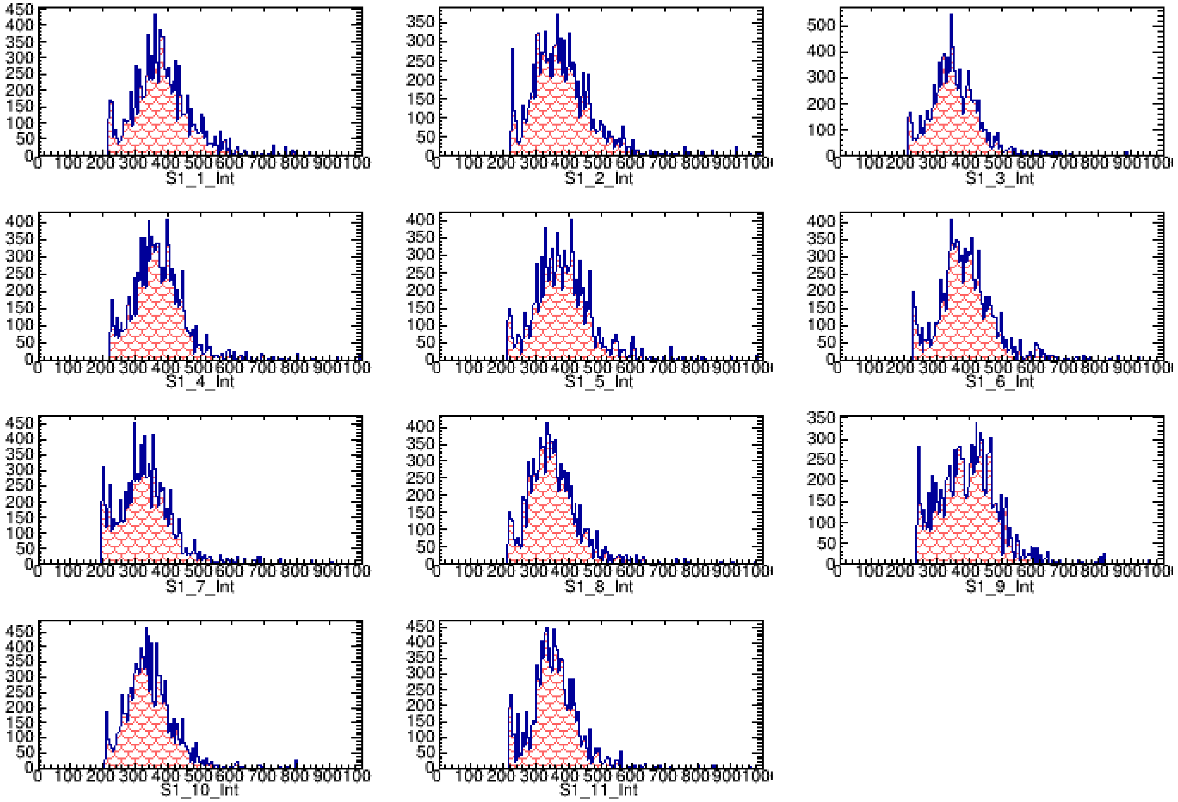
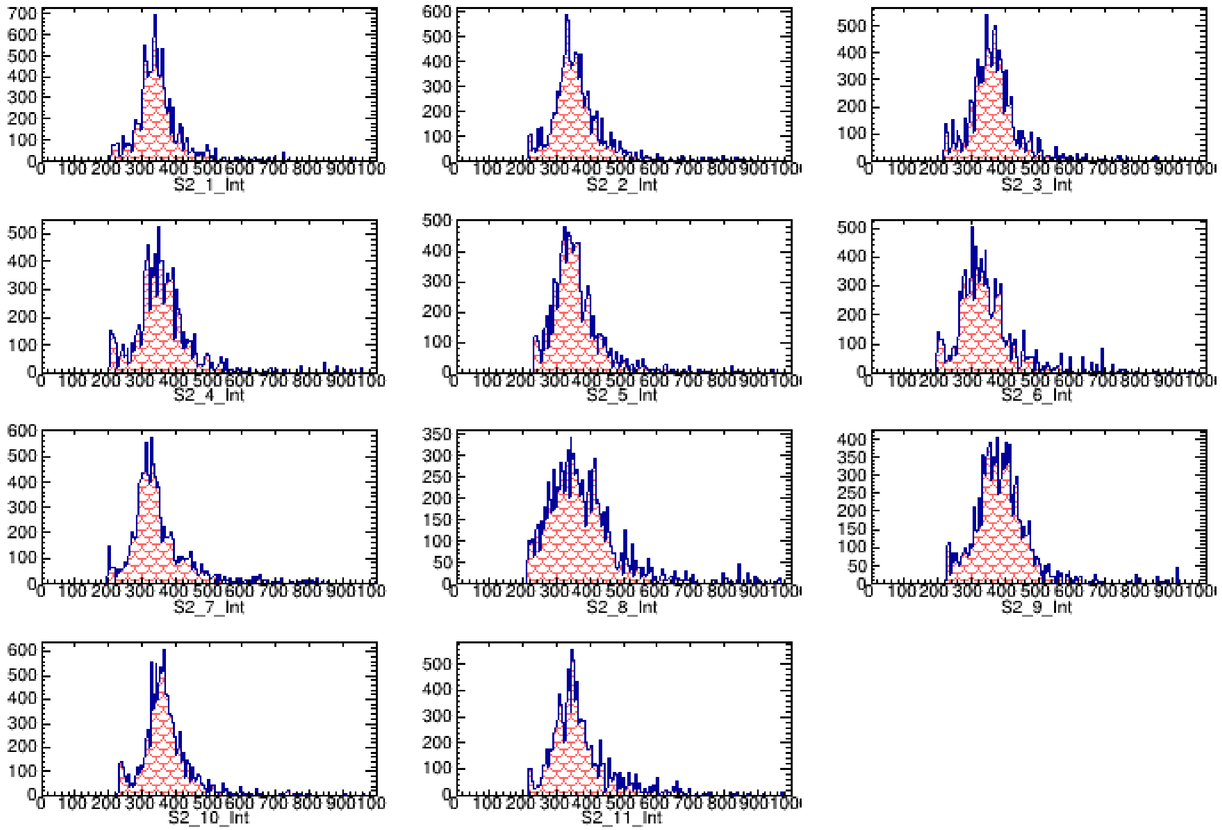
Tests with Cosmics in the ESB

Response of first plane of scintillators



Response of second plane of scintillators



→ The trigger was a three-fold coincidence between the 2 scintillator planes and the calorimeter

→ All detector channels (scintillator, calorimeter, maPMTs) are read with FADC250s

Installation in Hall C

Low rate configuration (~300 kHz rate on maPMTs):

→ On the SHMS side at ~ 105 deg, 17 feet away from the target

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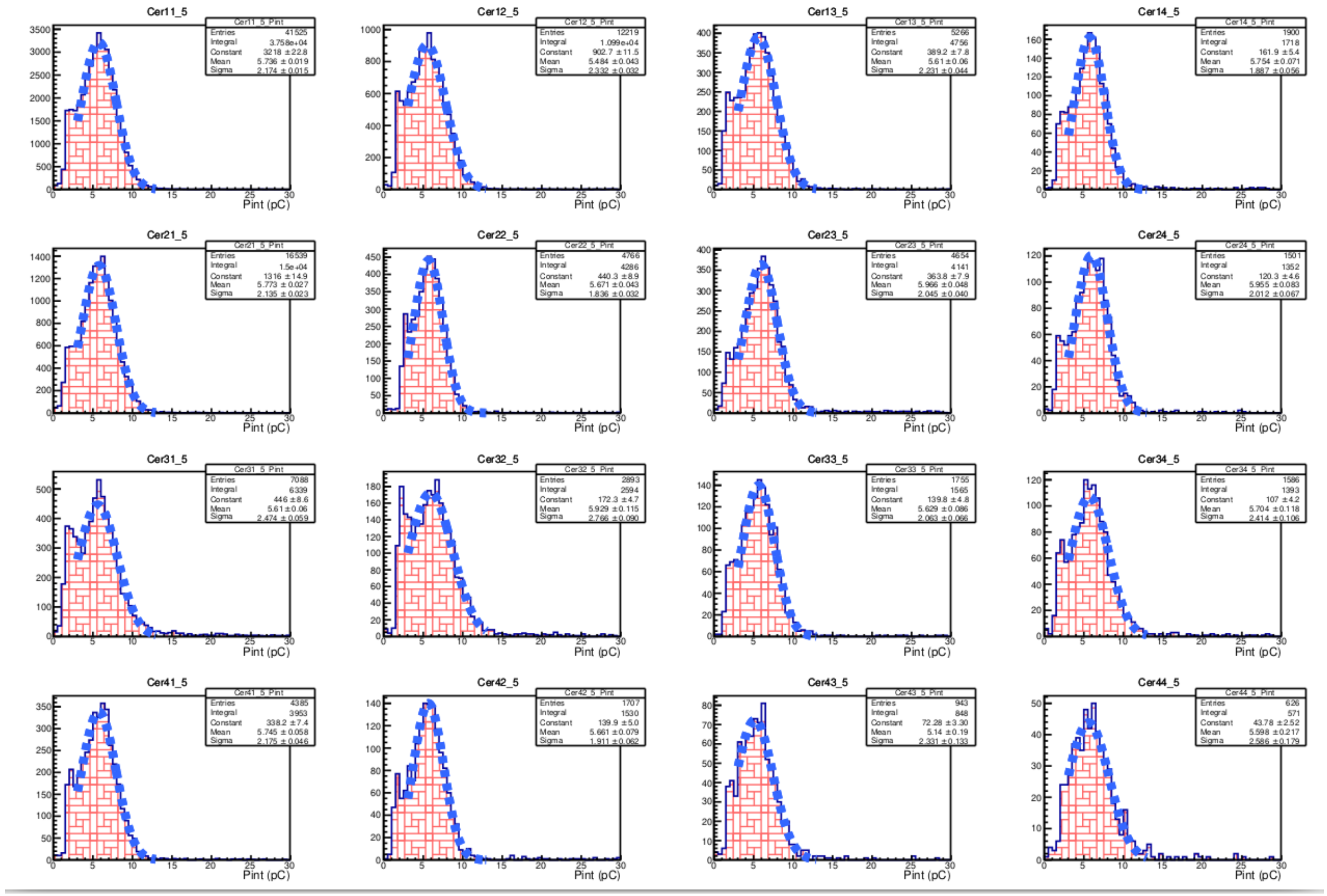
→ All the power supplies are protected from radiation by a bunker

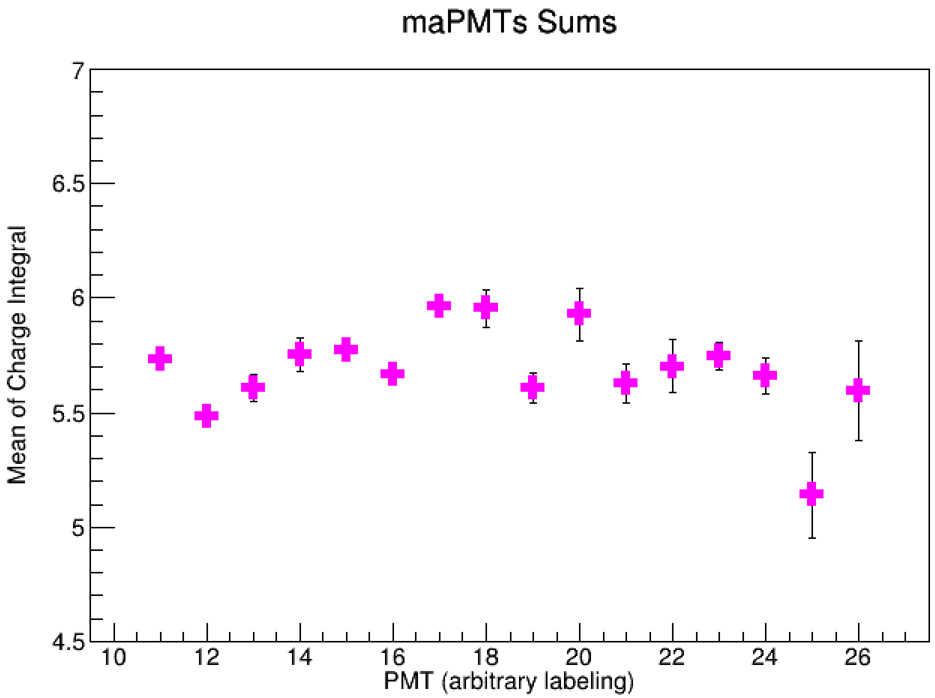
It took me one week (long days) to install everything in Hall C (thanks to Walter and the Hall C techs for helping out with craning and building the bunker)

Calibrations with a Random Trigger

→ After the installation in Hall C and before beam was sent into the Hall I refined the calibration of the maPMTs by taking data with a random trigger and detecting SPEs

SPE distributions for all 16 maPMTs (integrated charge)





maPMTs HV range: 1005 – 1170 V

Beam Data in the Low Rate Configuration

<u>MODE 3 Beam Runs</u>: Scintillator and Calorimeter Gain matching

Runs 113 – 134 (scintillator)
Runs 135 – 157 (calorimeter)

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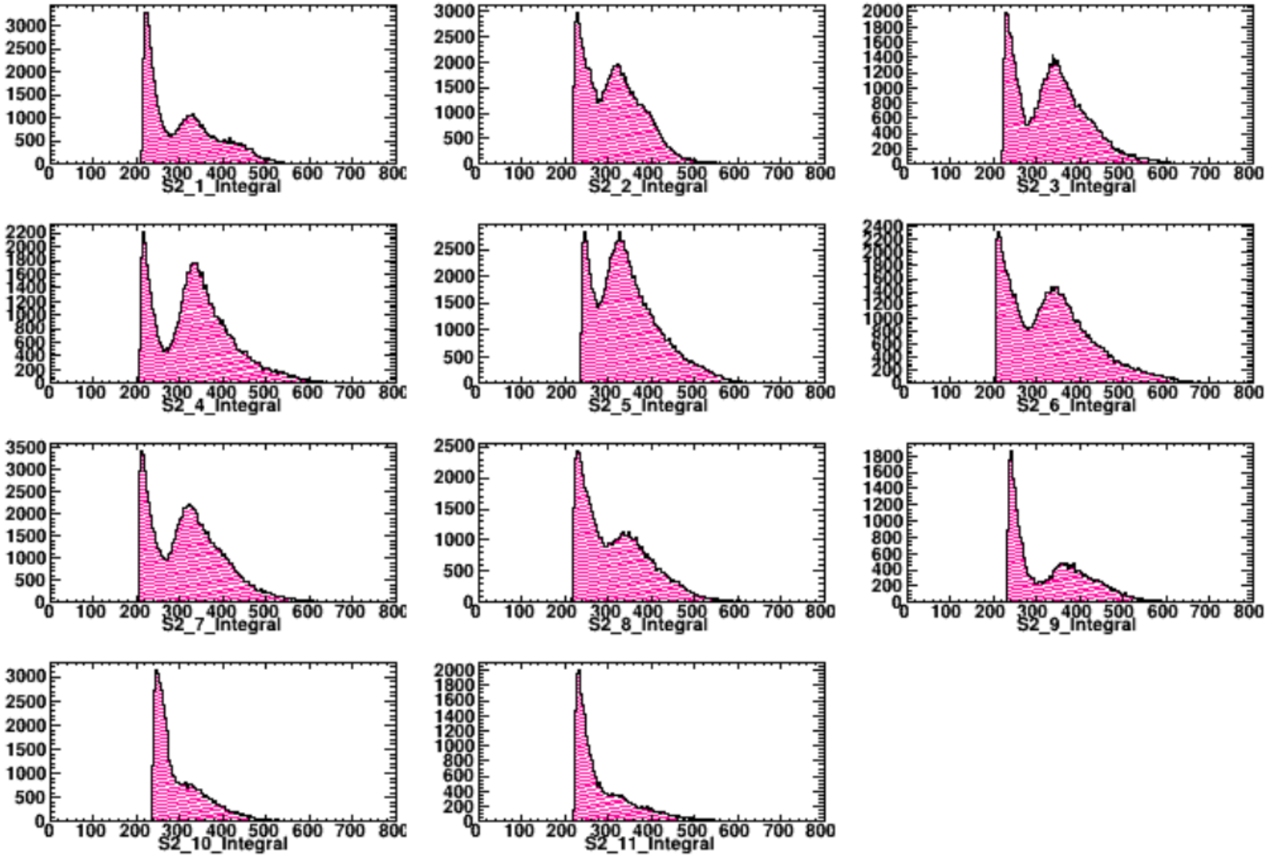
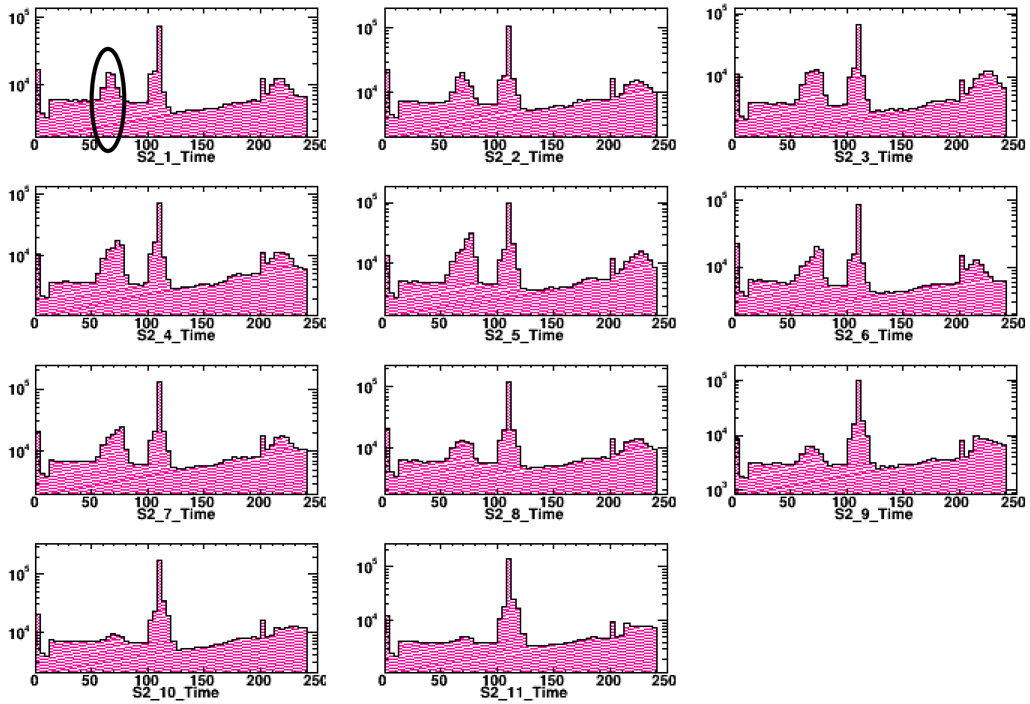
Scintillator 2 plane charge integral



Scintillator 2 plane timing distributions



→ Signal from minimum ionizing particles clearly seen in scintillator 2 plane when selecting the correct timing peak

→ This is not the case with Scintillator 1 plane (swamped by background) – see back-up slides

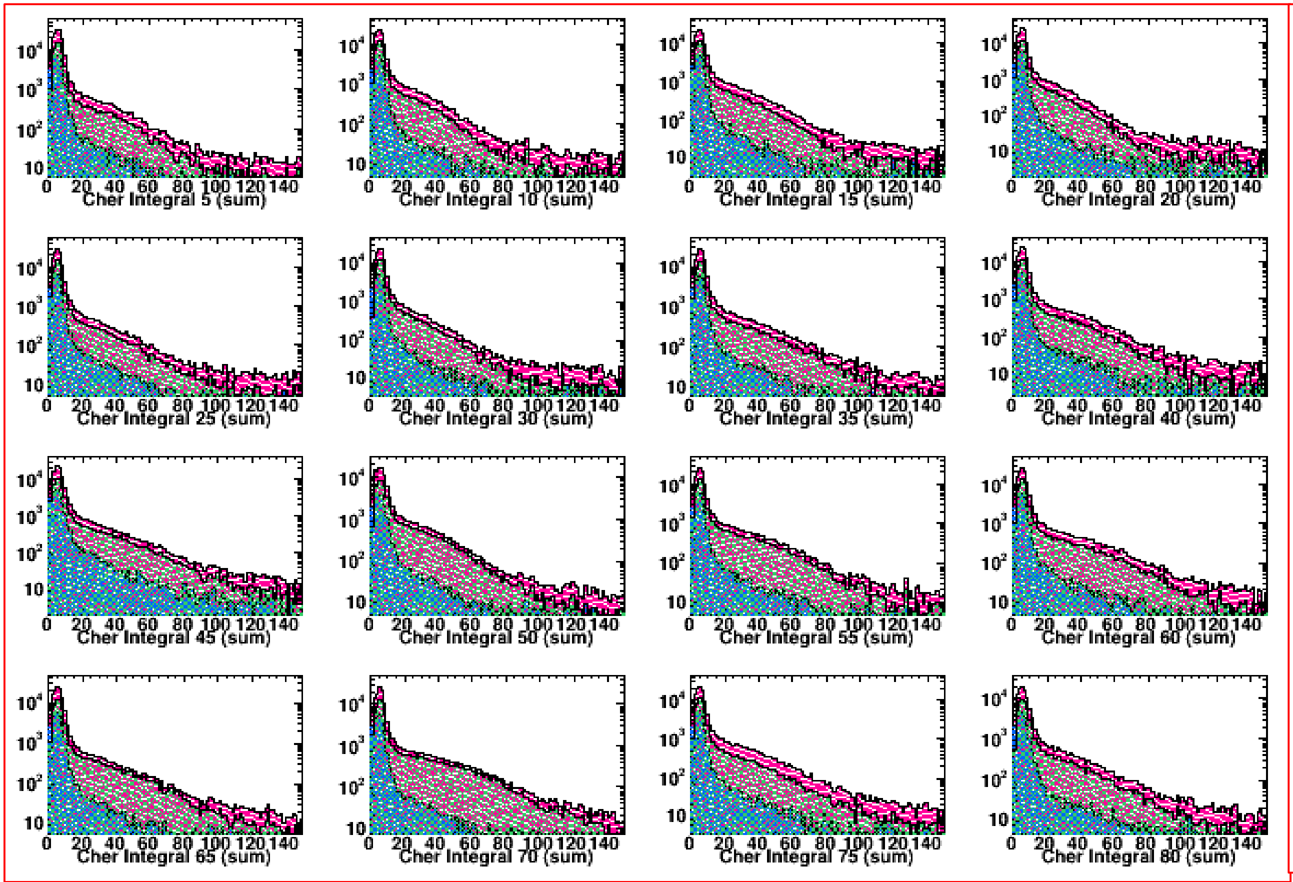
→ We ran with a 2-fold coincidence: calorimeter + scintillator 2 plane

Beam Data in the Low Rate Configuration

<u>MODE 3 Beam Golden Runs</u>

Runs 159 (C optics target), 161 (3He target)

Charge integral distributions from all 16 maPMTs (sums only)



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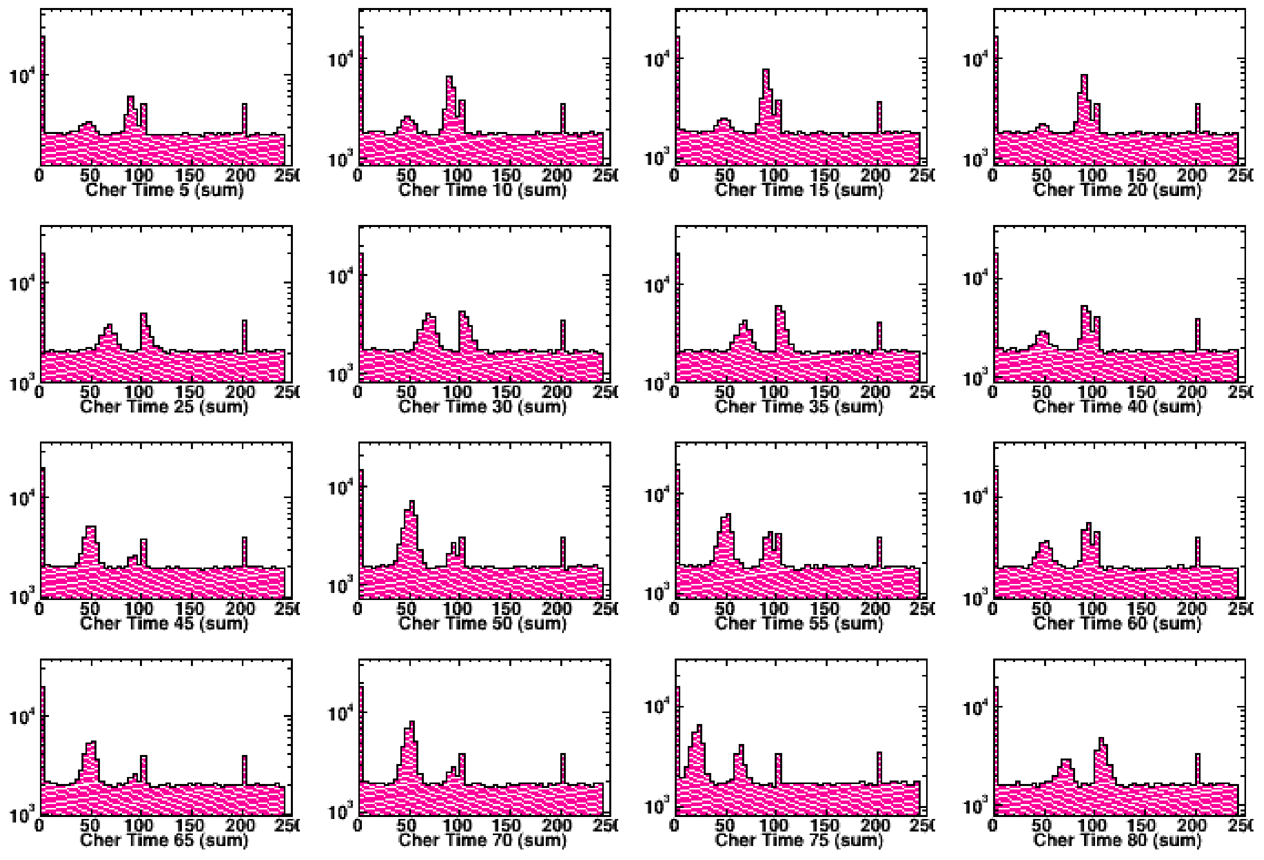

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See Chao’s talk

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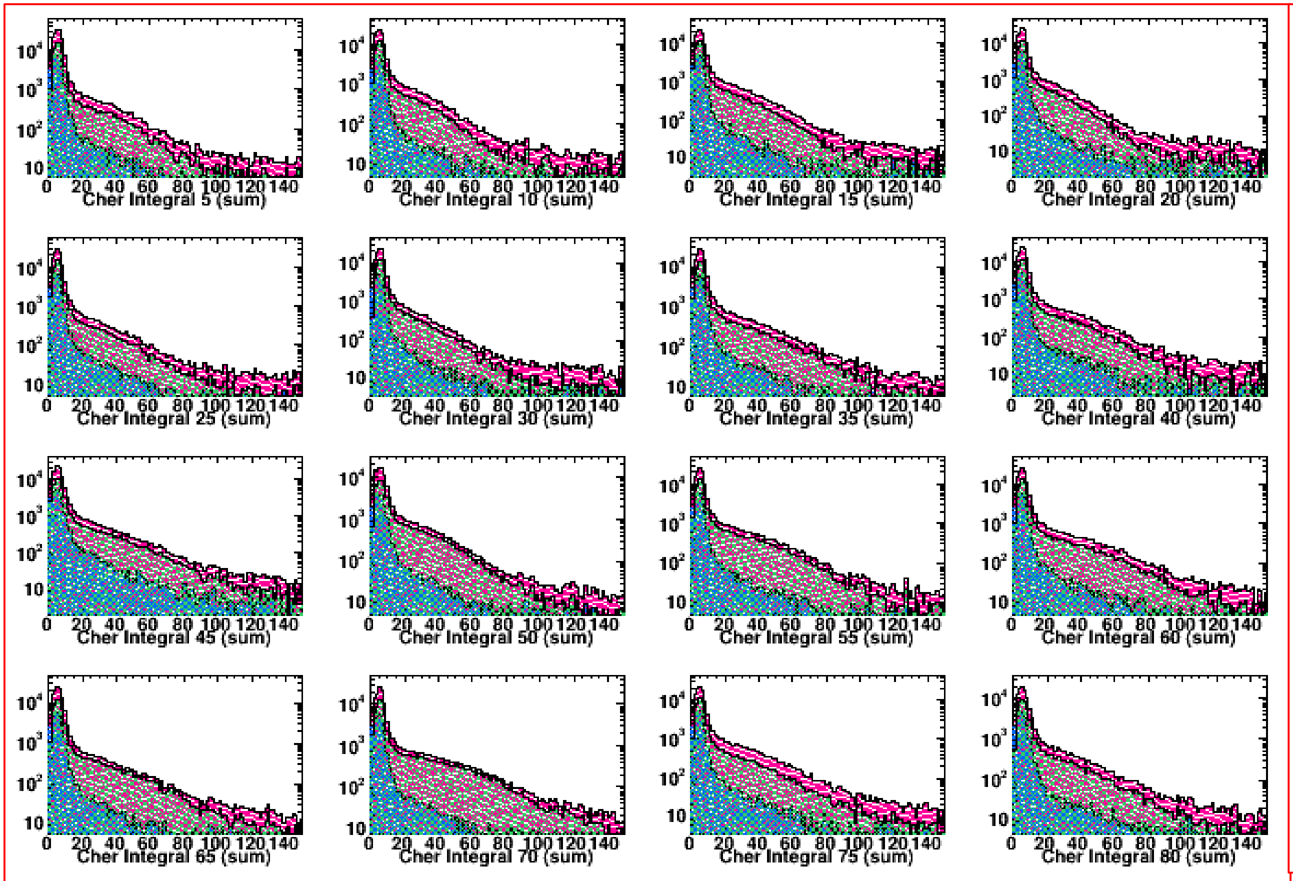

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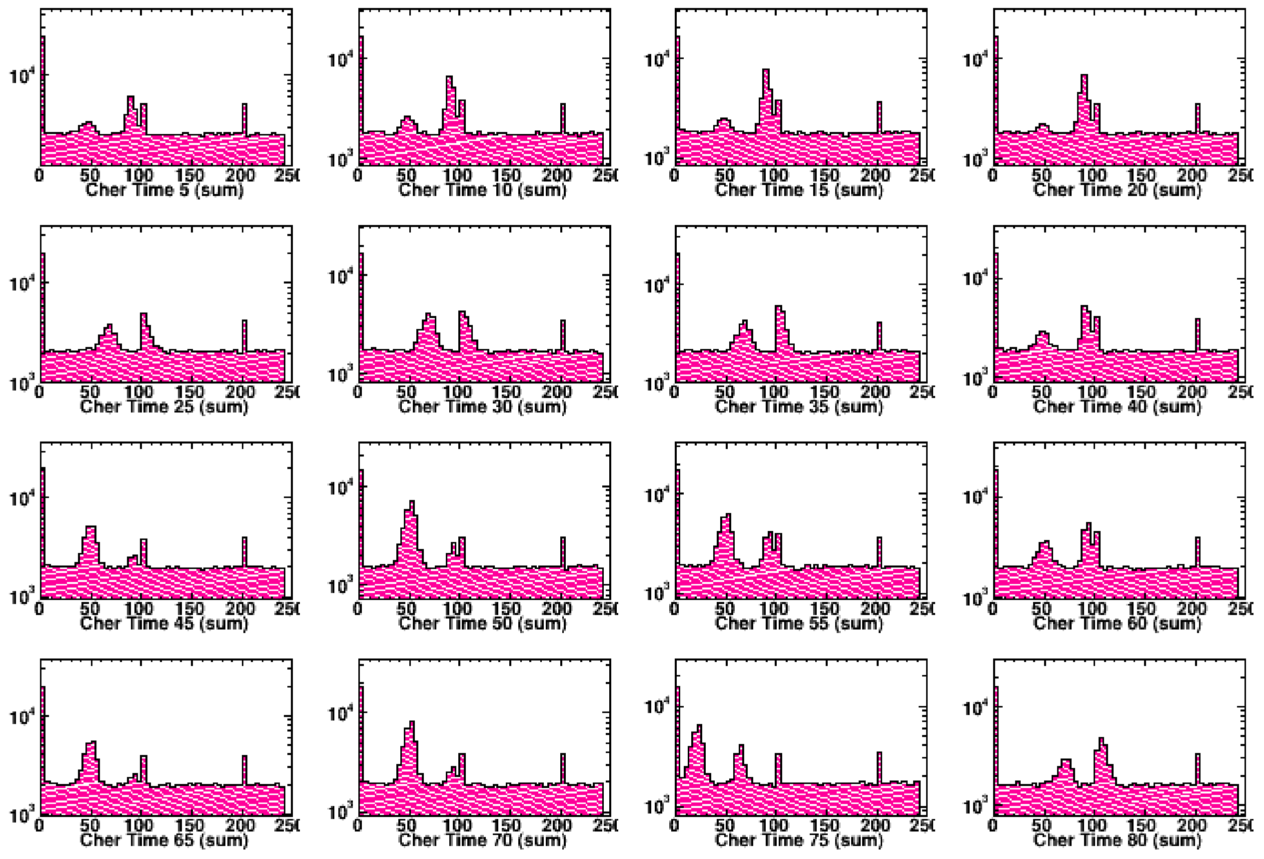

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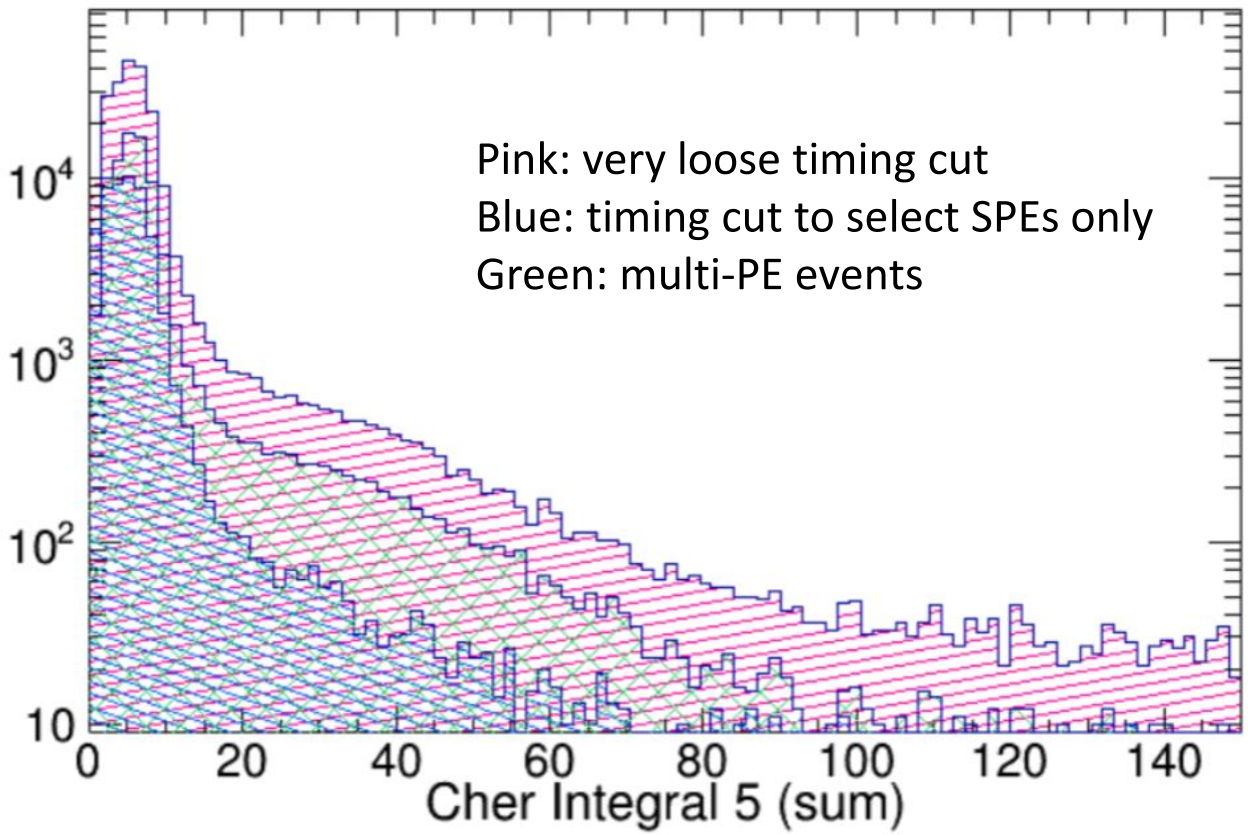
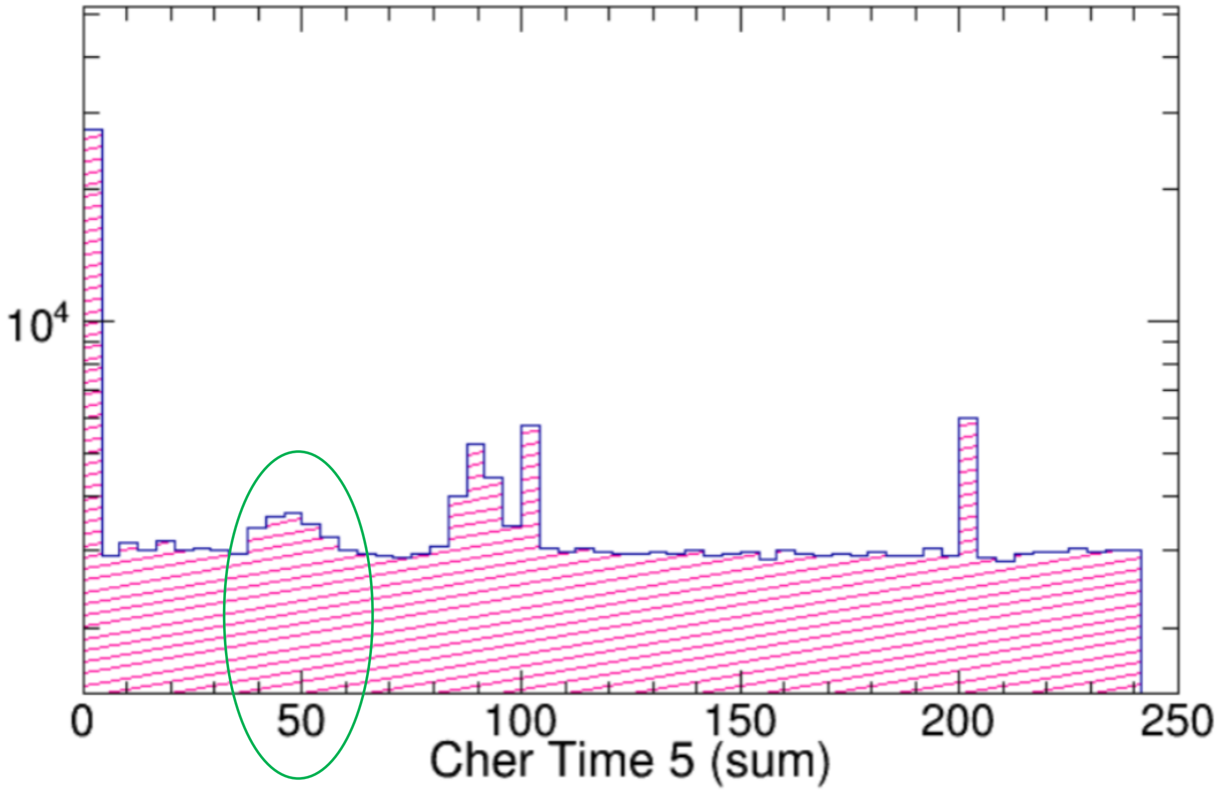


Pink: very loose timing cut
Blue: timing cut to select SPEs only
Green: multi-PE events



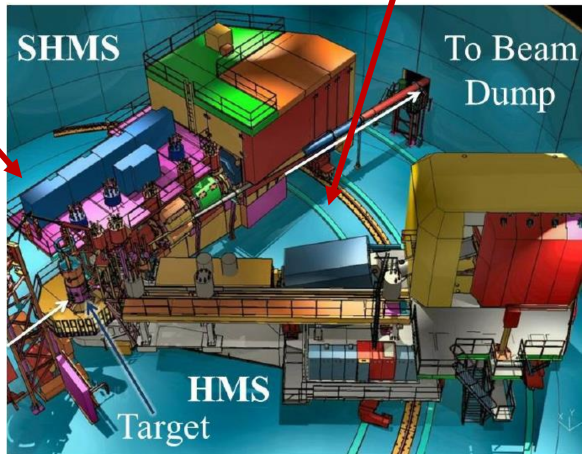
Summary and Plan Going Forward

→ We got enough data in the low rate configuration (SHMS side)

→ Before beam comes to Hall C this Summer the Cherenkov test stand will be moved to the **high rate location** (between the HMS and beamline) – I have a LOT of work to do to make that happen

High rate: to be done

Low rate (done)



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- Mark the floor where the stand is now (we may go back to that location after the high-rate test)
- De-cable the signal cables for all 126 channels
- De-cable the HV
- Remove the bricks that protect the electronics box
- Remove the connections to the gas controller and to the low voltage power supply
- The test stand can then be craned to the HMS location – *Walter and Hall C techs*
- Pull more length for the signal cables – *with the Hall C techs*
- Cable the 126 channels (signal and HV)
- Find a place for the bunker and move it to the HMS side together with all the power supplies and the gas controller as well as the gas cylinder – *with Walter and the techs*
- Make connections to the gas controller and the HV and low V power supplies
- Test every channel from the patch panel behind the green wall (fix issues with one of the calorimeter channels of block 9; maPMT channel 22)
- Purge the tank and fill it with C02 at 0.3 psi above 1 atm
- Add back the shielding bricks
- Take maPMT data with a random trigger for sanity checks
- Take some cosmics data to sanity check the scintillator and calorimeter channels (the cradle will be sitting horizontally so…)
- Align the test stand with the target – *with Jack*

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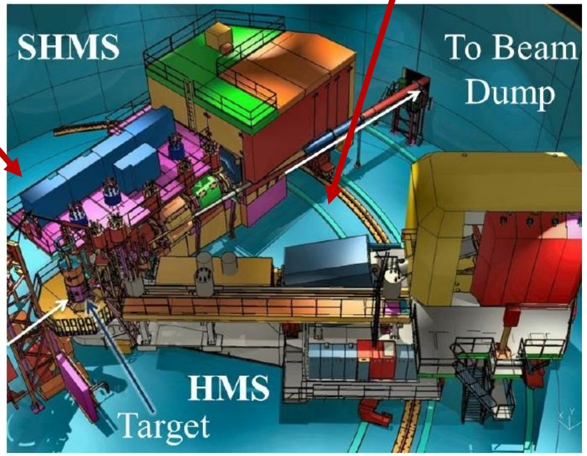

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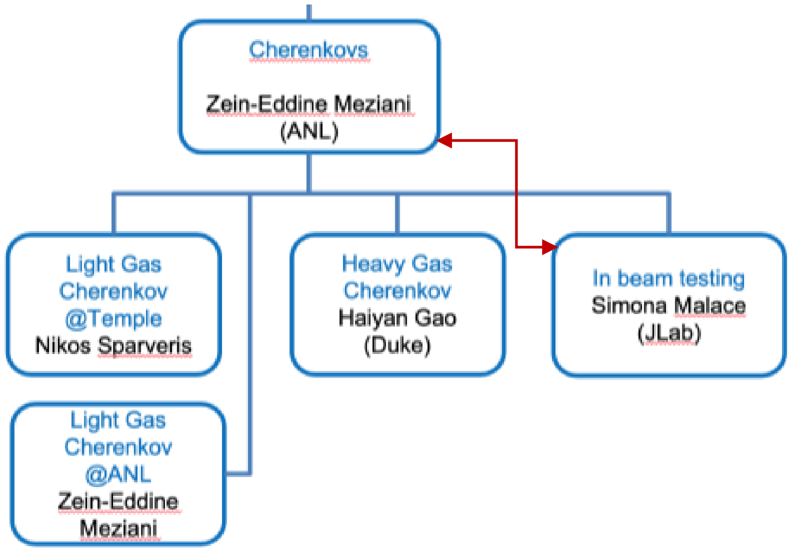
→ The stand will be at the HMS location for a short period only (before it starts to interfere with the current running experiment)

→ After the quick high-rate running the stand will be moved out of the d2 experiment's way (back to the SHMS side to take data with other photon detectors) but ***work can happen opportunistically only***

All the tasks I listed on the previous slide have to be repeated

List of priorities regarding which photon detector to test first has been communicated to me by Zein-Eddine

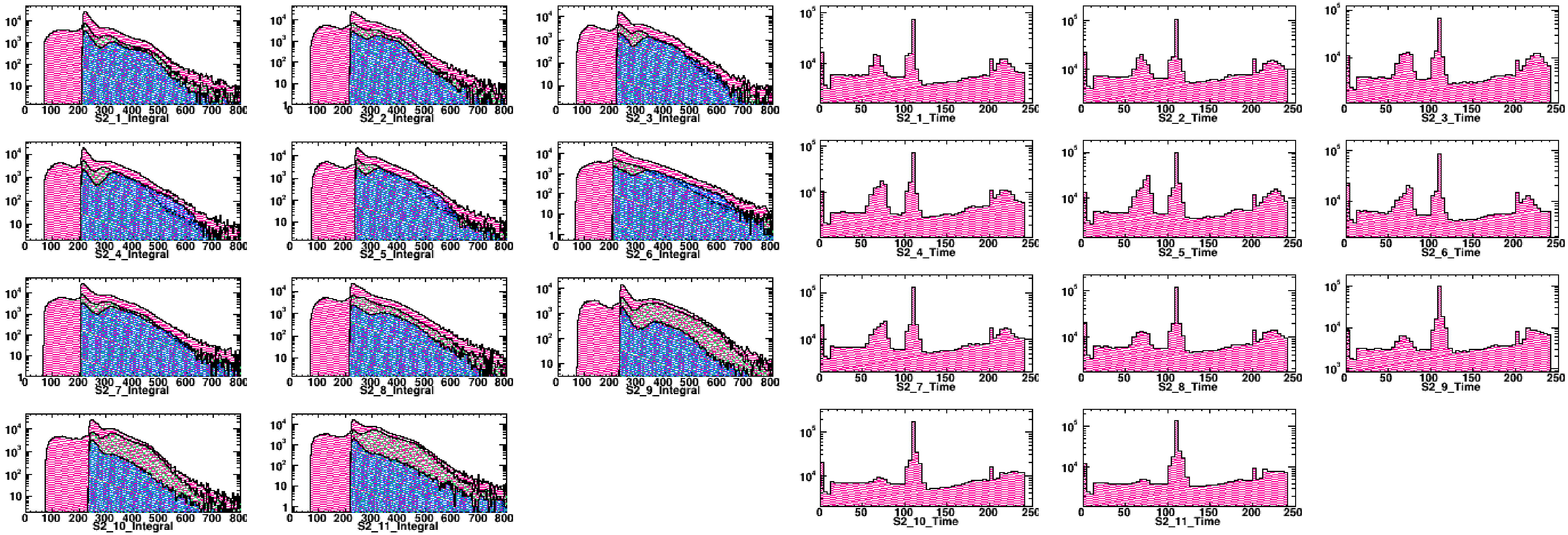
→ At the end of the Summer run the test stand will be removed from the hall and stored in the ESB



Backup

Beam Test in Hall C: Carbon Target

Trigger: coincidence between calorimeter and second plane of scintillators



Second Plane of scintillators

Beam Test in Hall C: Carbon Target

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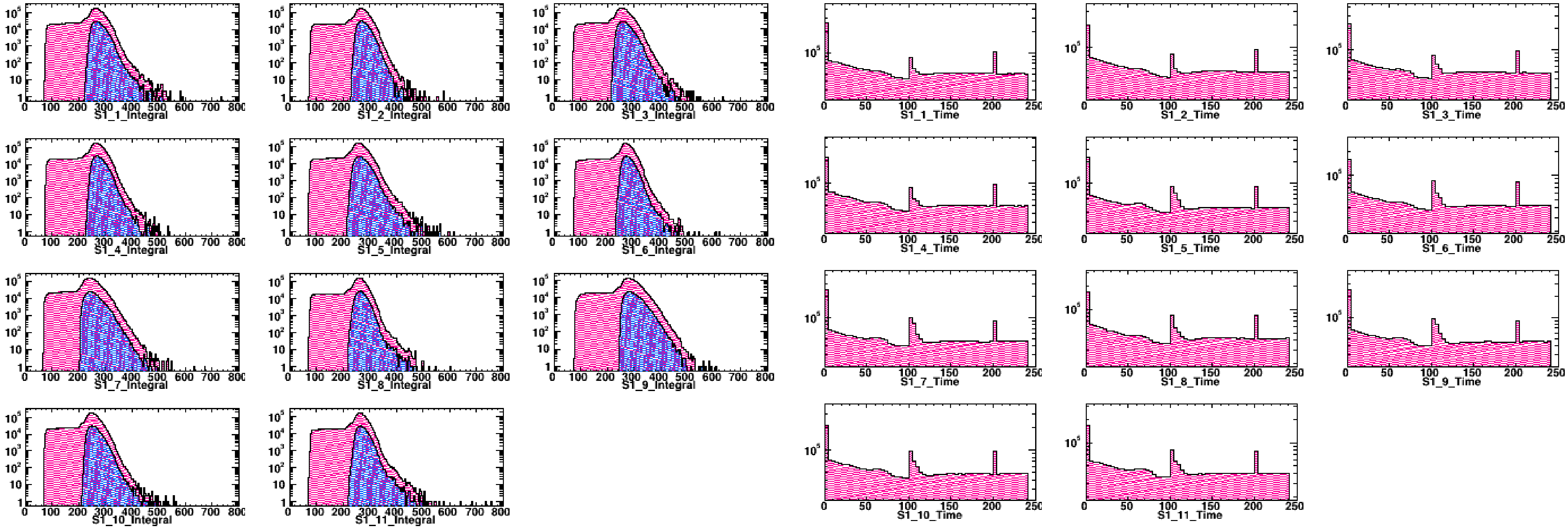

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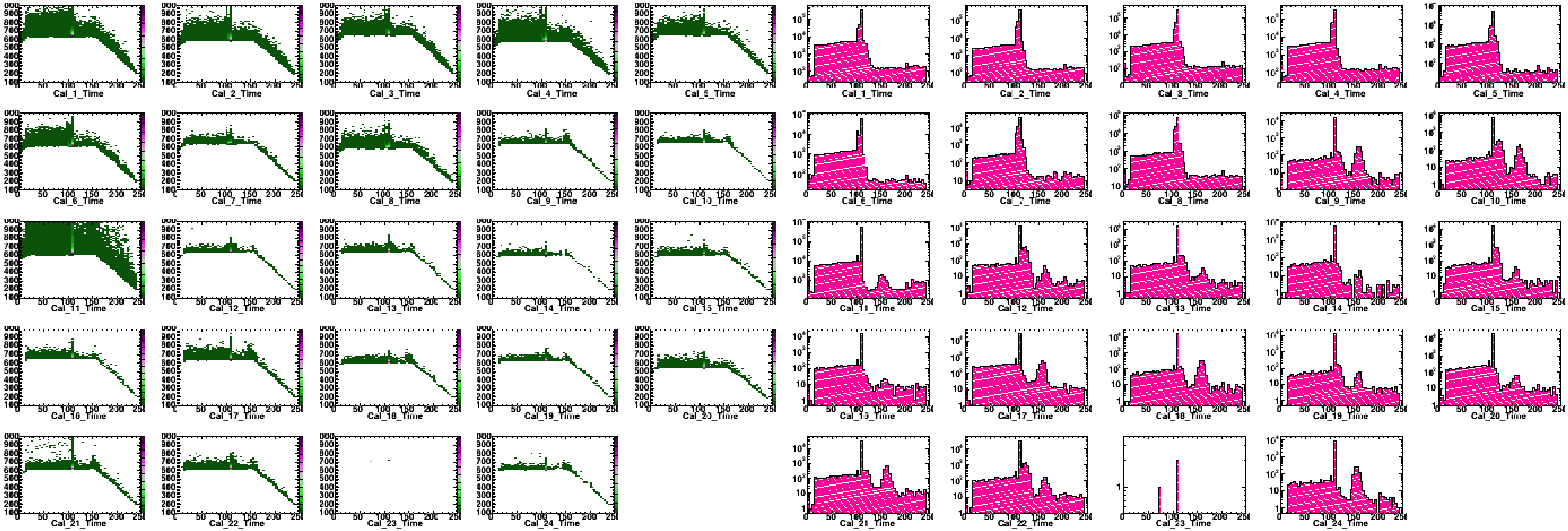

Calorimeter

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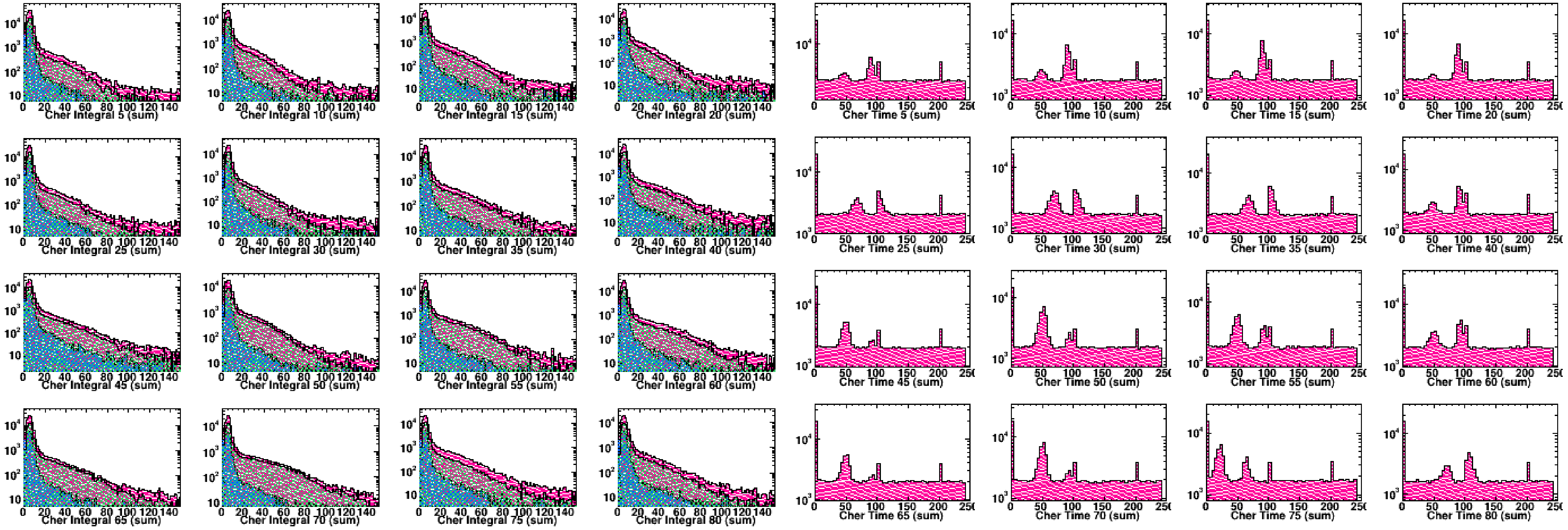

maPMTs - SUMS

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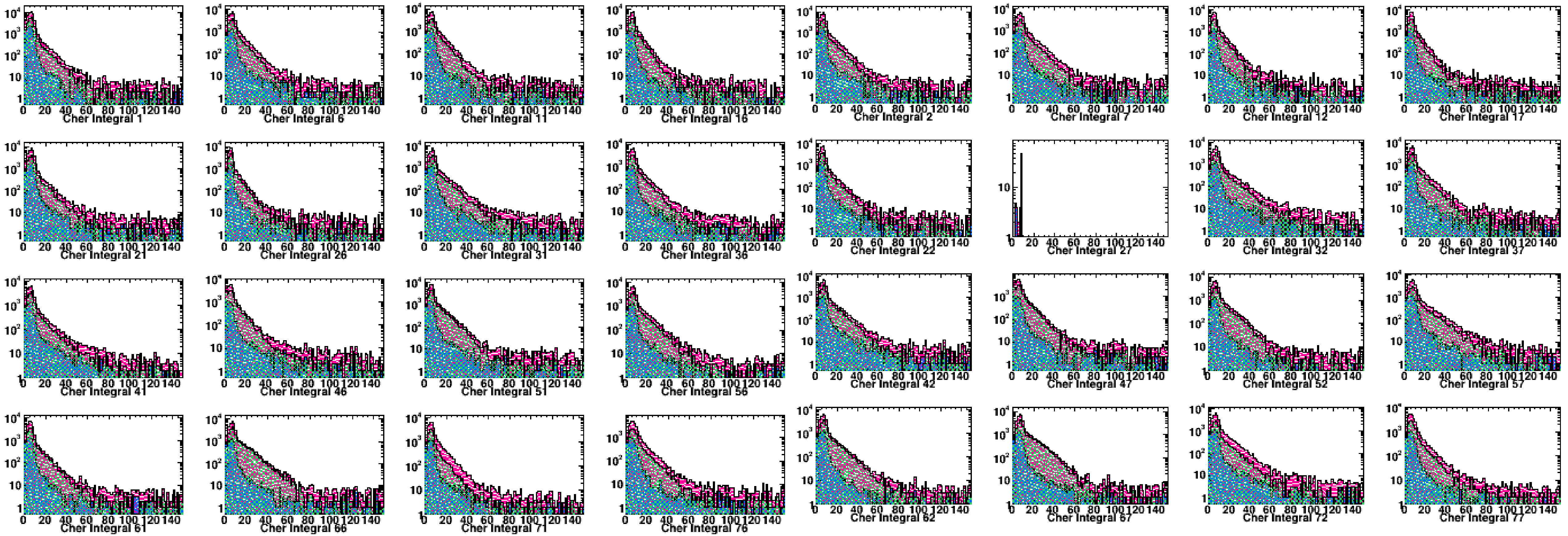

maPMTs - QUADS

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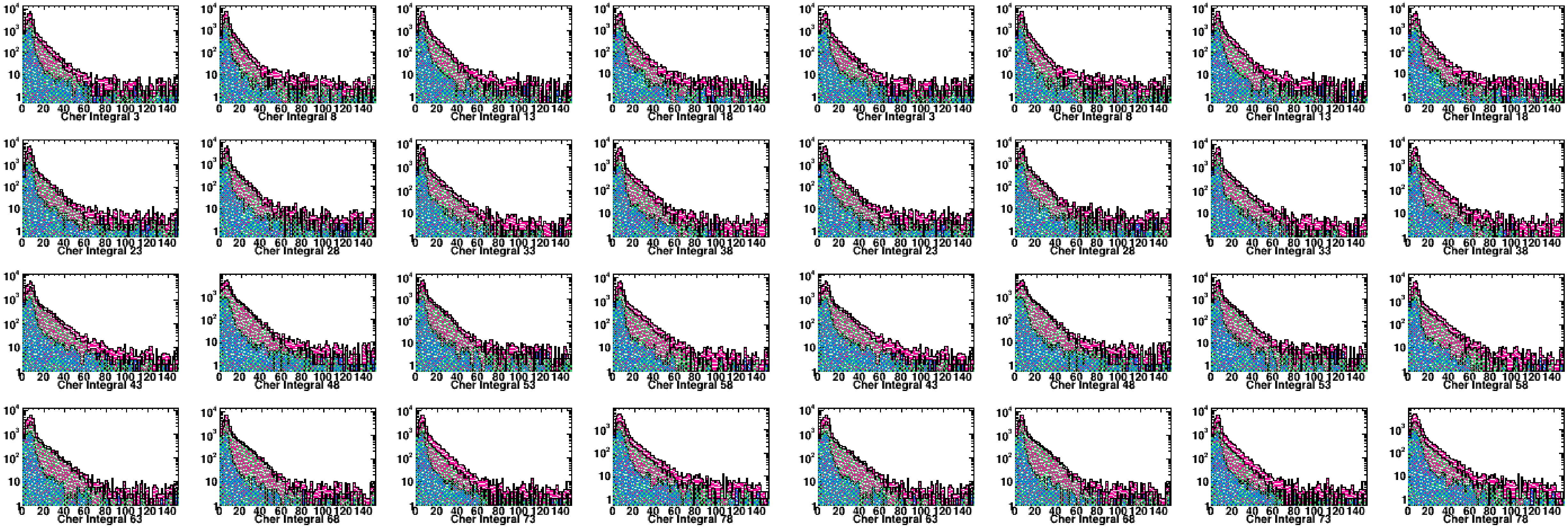

Blue: timing cut to select spe

Green: timing cut to hopefully select multiple photoelectrons

Pink: almost no timing cut

maPMTs - QUADS

I also analyzed the 3He run (not shown here)