GRINCH GMn Readiness Review

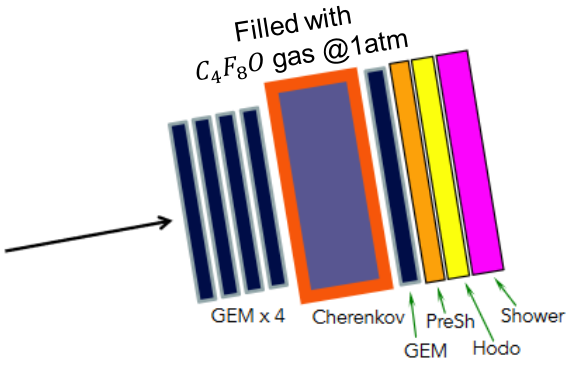
Bradley Yale

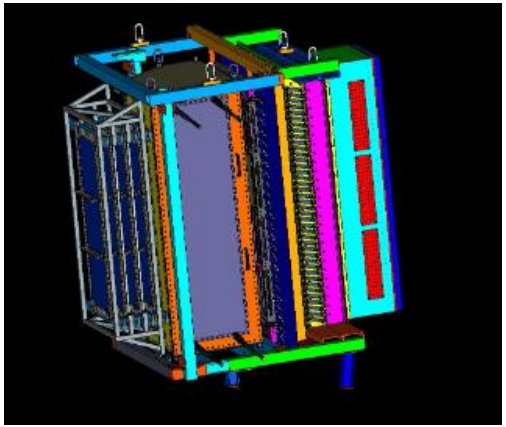
02/17/2021

WILLIAM & MARY
CHARTERED 1693

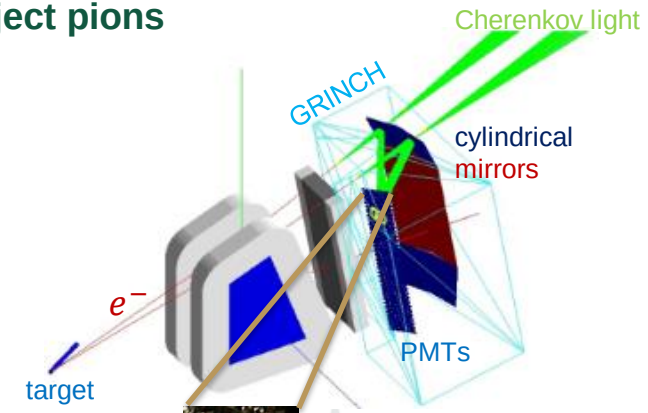
GRINCH Overview

Purpose: identify electrons, reject pions

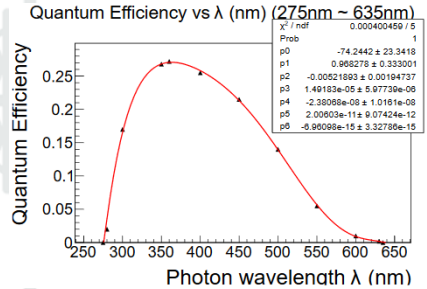




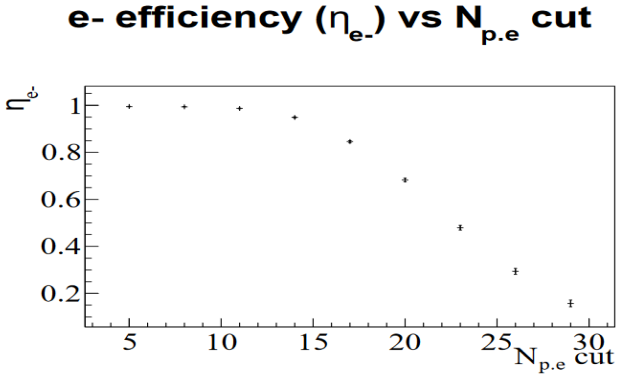
interior

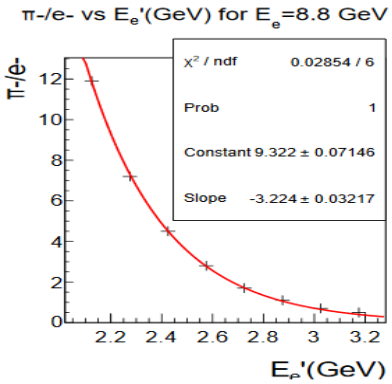


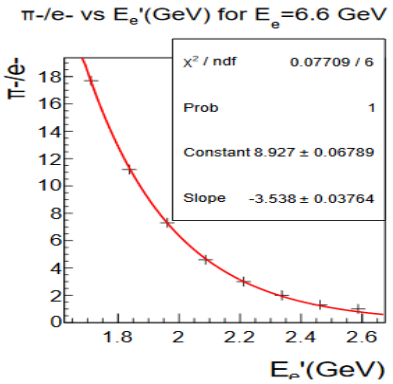
PMT cluster rings
from Cherenkov cones

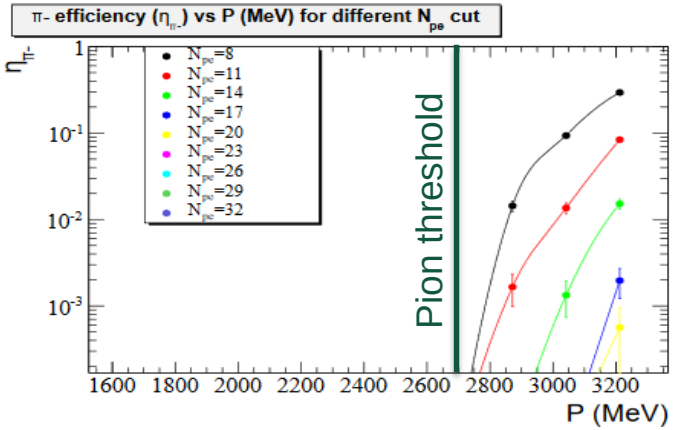


Expected e^-/π^- Efficiencies

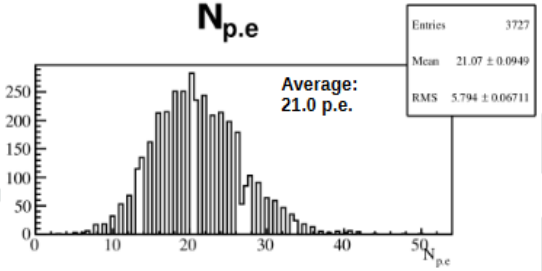






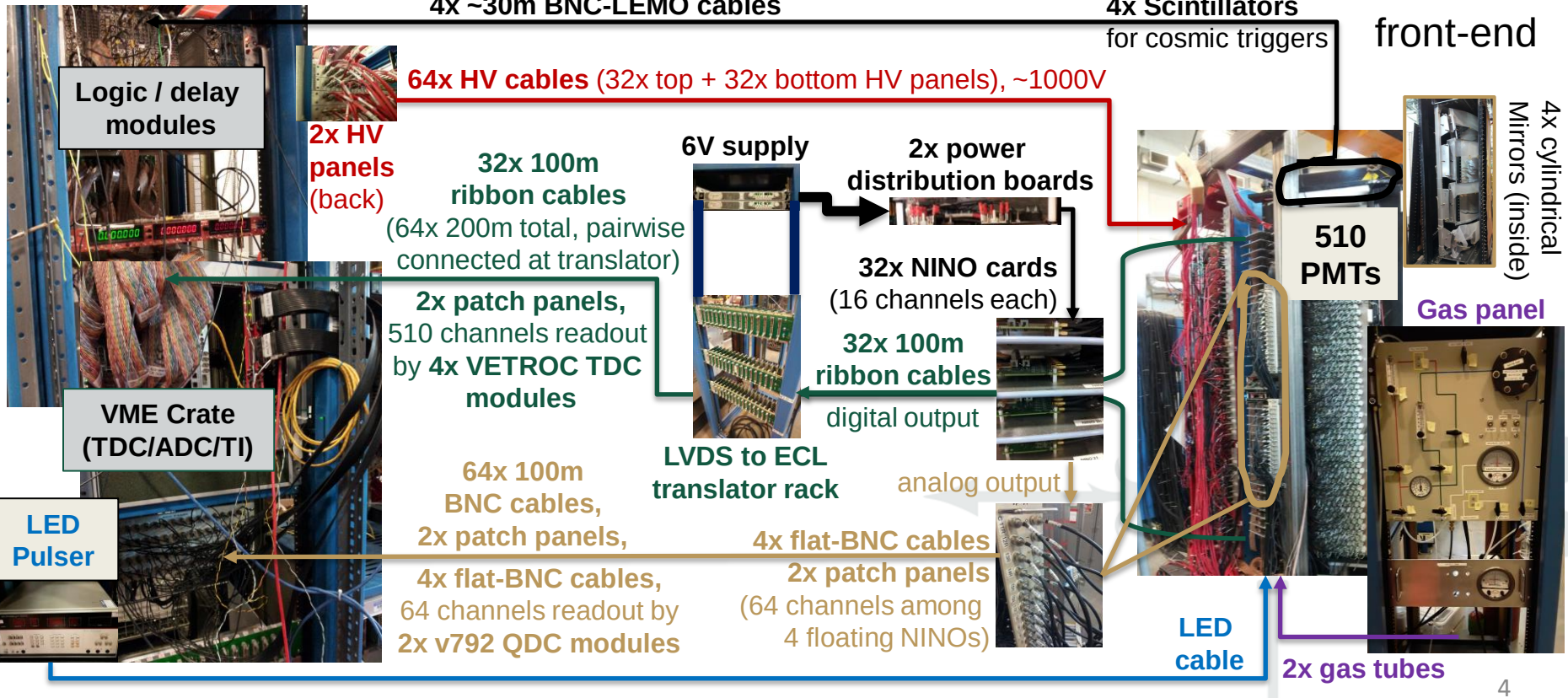


Pion threshold @ 1atm: 2.7*GeV*
To achieve $\eta_\pi < 0.05$, $\eta_{e^-} \approx 1$
=> **9 p.e.** needed per electron



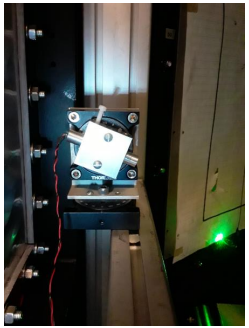
Independent simulations by Huan Yao and Eric Fuchey found ~**21 p.e.** per electron on average (2.4 p.e. /PMT * 8.6 PMTs /e^-), after accounting for quantum efficiency, mirror reflectivity

GRINCH Equipment List

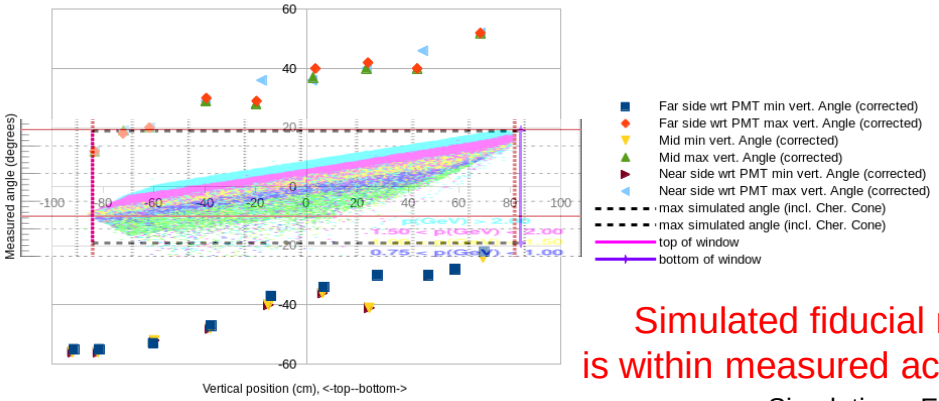


Mirror Alignment Check

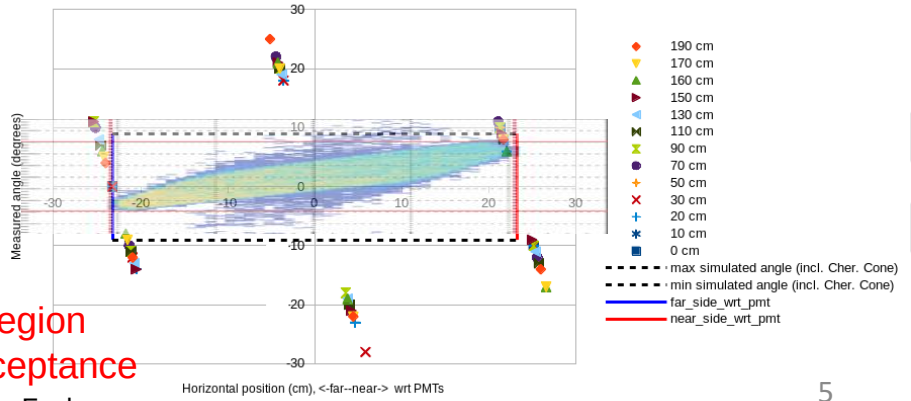





Dispersive Angles vs. Vertical Position (corrected)



Non-dispersive Angles vs. Horizontal Position (corrected)

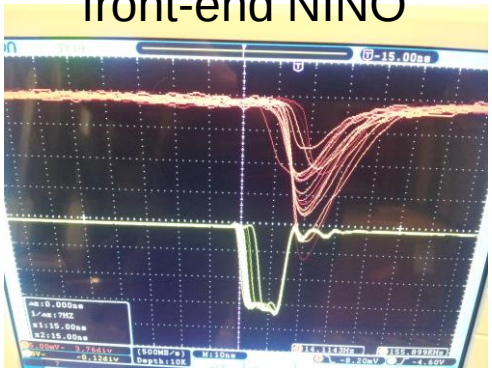


Simulated fiducial region
is within measured acceptance

Simulations: Eric Fuchey

Signal Timing (cosmics)

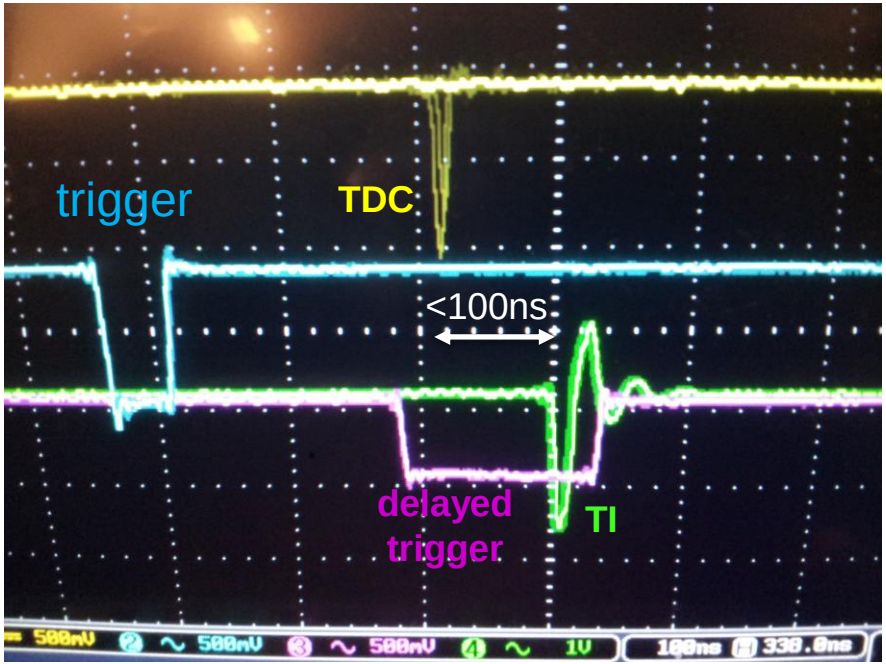
front-end NINO

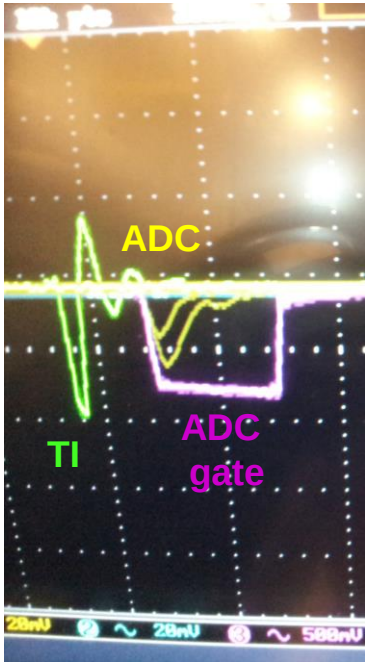


signal width: ~20ns

Thresholds tuned to minimally reject noise (~1.3V measured)

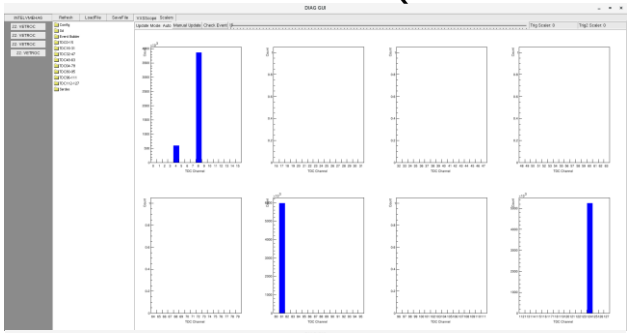
All readout signals fit within a ~450ns window



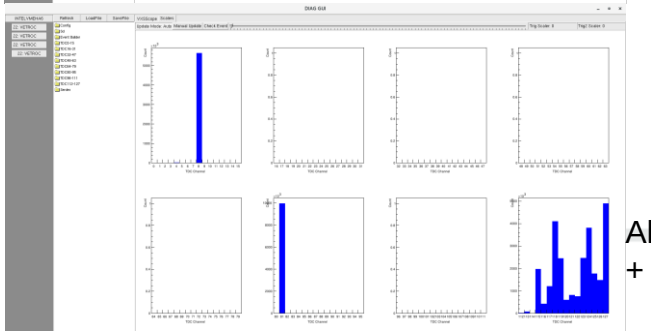


New and pressing issue: AC Noise

GRINCH scalars (VME crate)

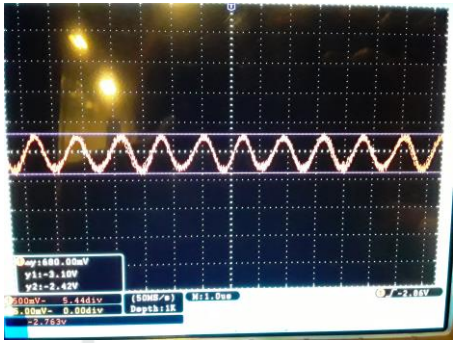


All GRINCH voltages off



All GRINCH voltages off
+ NINO disconnected at front end

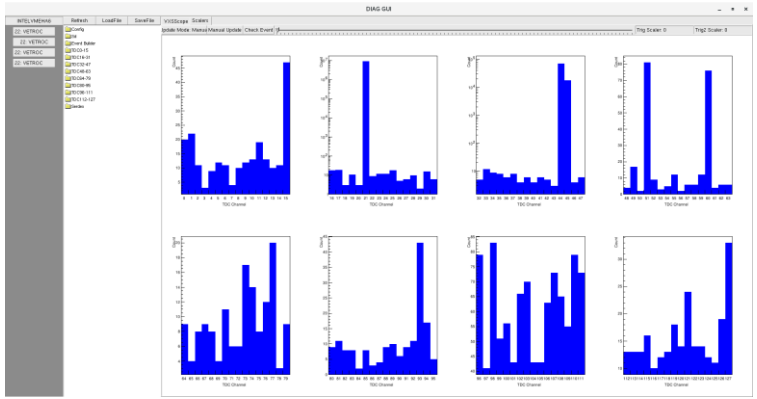
1.4µs noise, measured at weldment



The Hodoscope is also seeing this
Currently under investigation

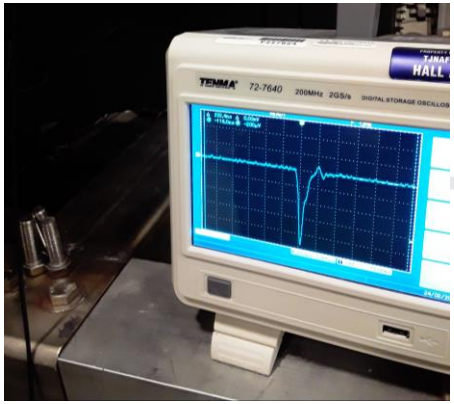
Conclusion: Something is not grounded properly at the translator rack
This must be solved before further electronics commissioning!

Cables, PMTs, DAQ are working



Reflections are present in all 510 channels (so cables are undamaged after conduit work), but the noise issue must be resolved ASAP

Tested HV+PMTs after temporarily resealing door, signals are present at the front end



CODA3 works with the DAQ setup, but the decoder needs to be updated

Pre-Hall Tasks and Workforce

- Me (50% shared w/ Hall B)
  - byale@wm.edu

- Todd Averett (100% minus teaching)
  - tdaver@wm.edu

Task: New gasket installation

Cracks appeared in the gasket used to seal the GRINCH door, and needs to be replaced

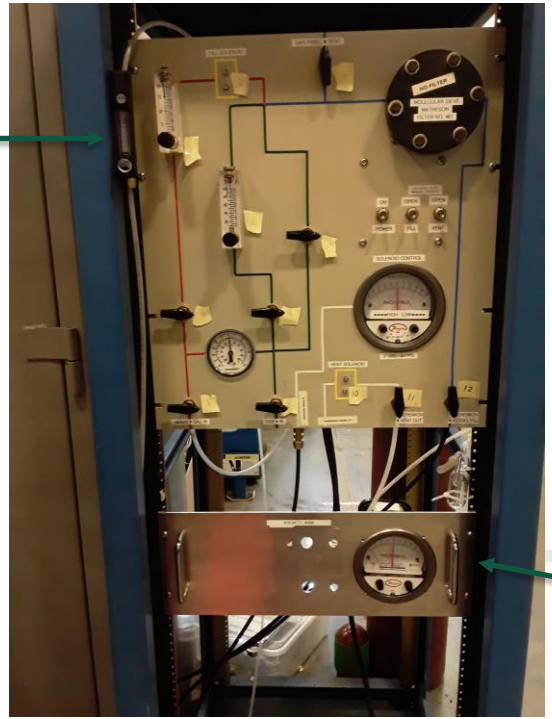
New Viton© material was ordered last year, but delayed (twice)

Expected delivery:
~~12/27/2020~~
02/17/2021?

Will be cut by JLab (<1 wk)
Door sealed by me (mins.)

Task: Leak Rate Measurement

After installing the new gasket and sealing any leaks, the final leak rate needs to be obtained, for regulating gas flow

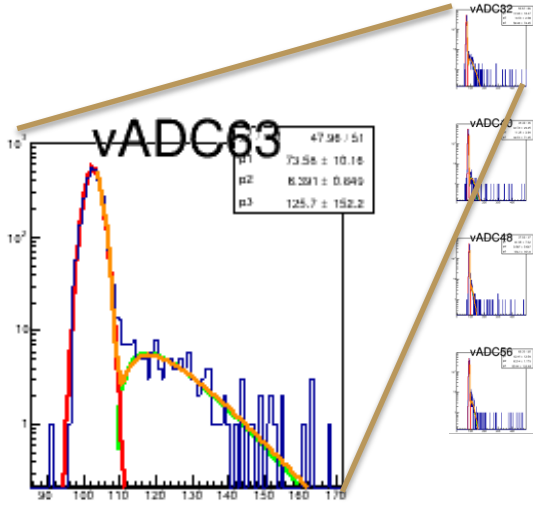


Gas used for leak checks: air + 1% hydrogen

New gauge connected directly to the GRINCH for pressure monitoring, to be tested

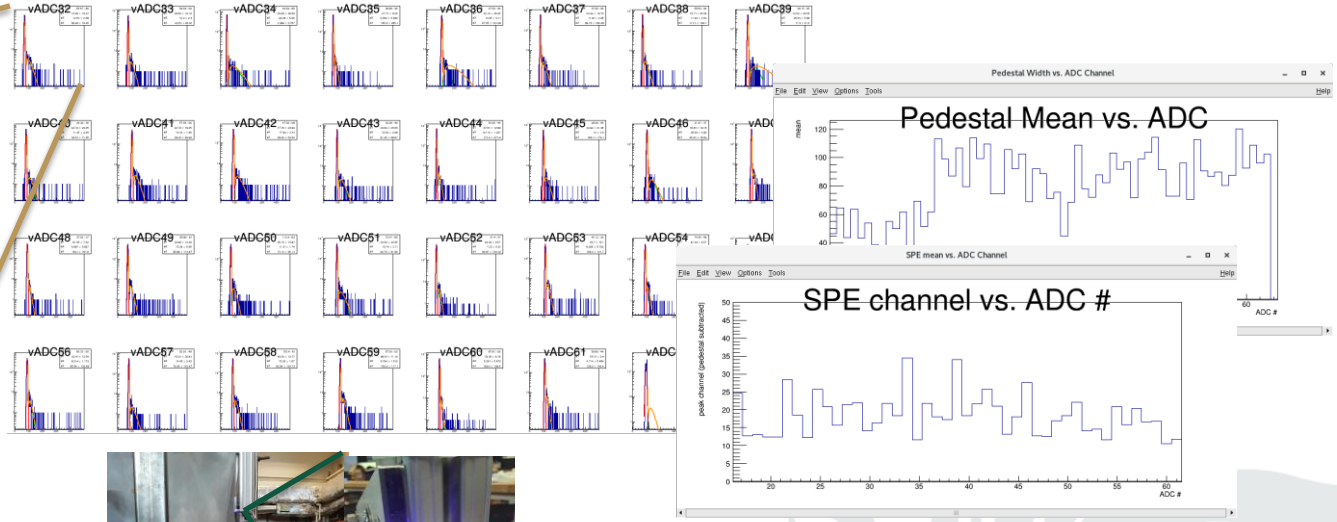
Responsible party: me
Leak check / sealing: 1-2 days
Rate measurement: 1-2 days

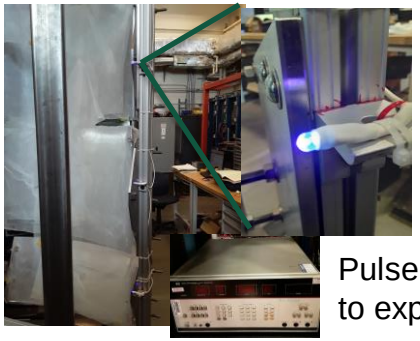
Task: PMT Gain Matching



Fit:

$$Ae^{-(x-\mu_{sig})^2/2\sigma_{sig}^2} + (x-\mu_{ped}-n\sigma_{ped})e^{-(x-\mu_{ped})/\sigma_{ped}}$$

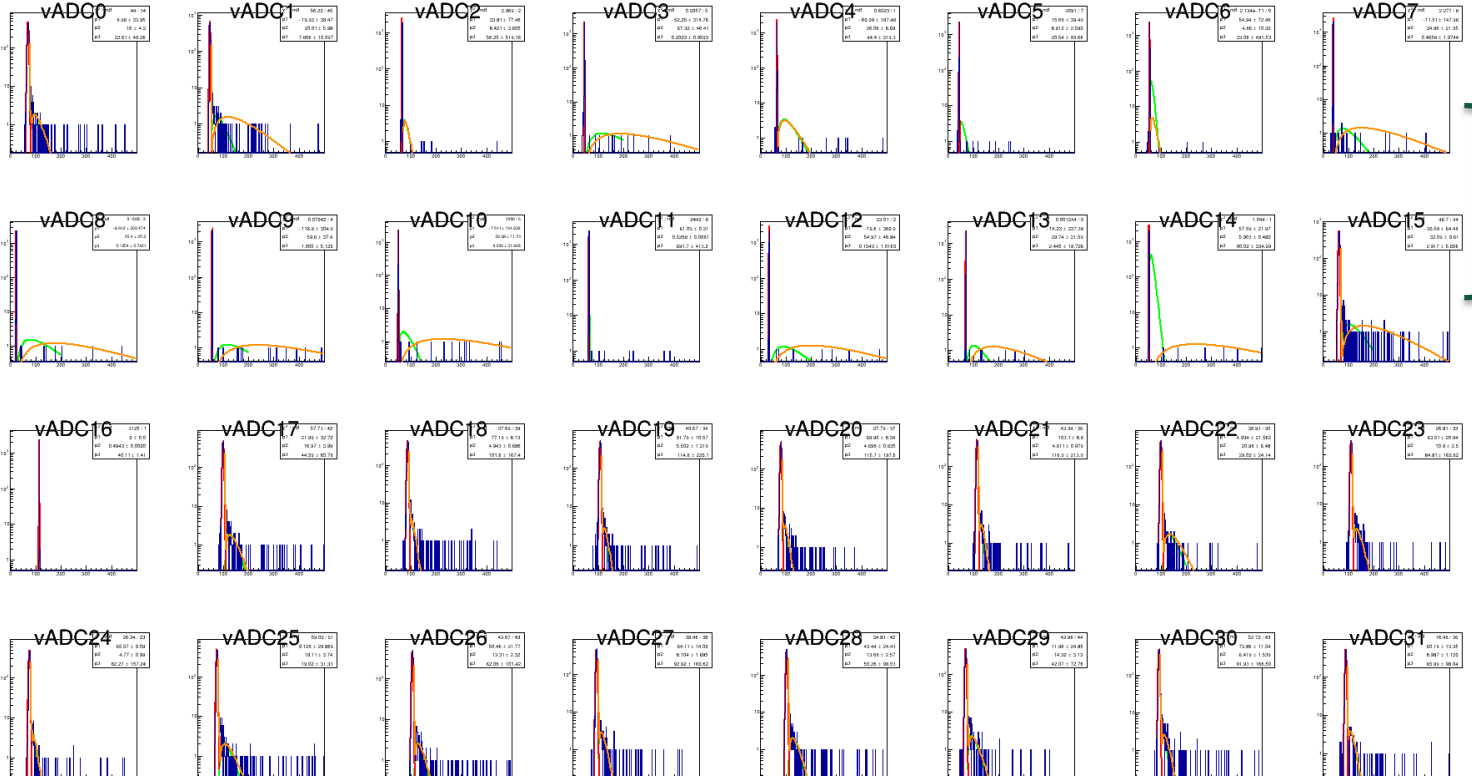


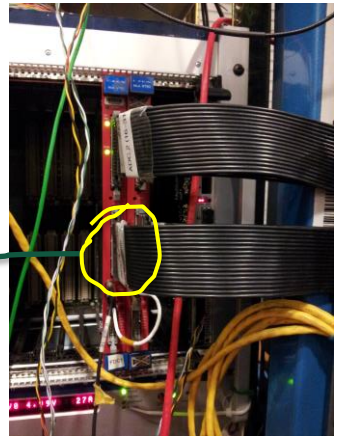


Pulser + LEDs
to expedite this

Responsible party: me
Time needed: ~1 month

Some problem ADC channels



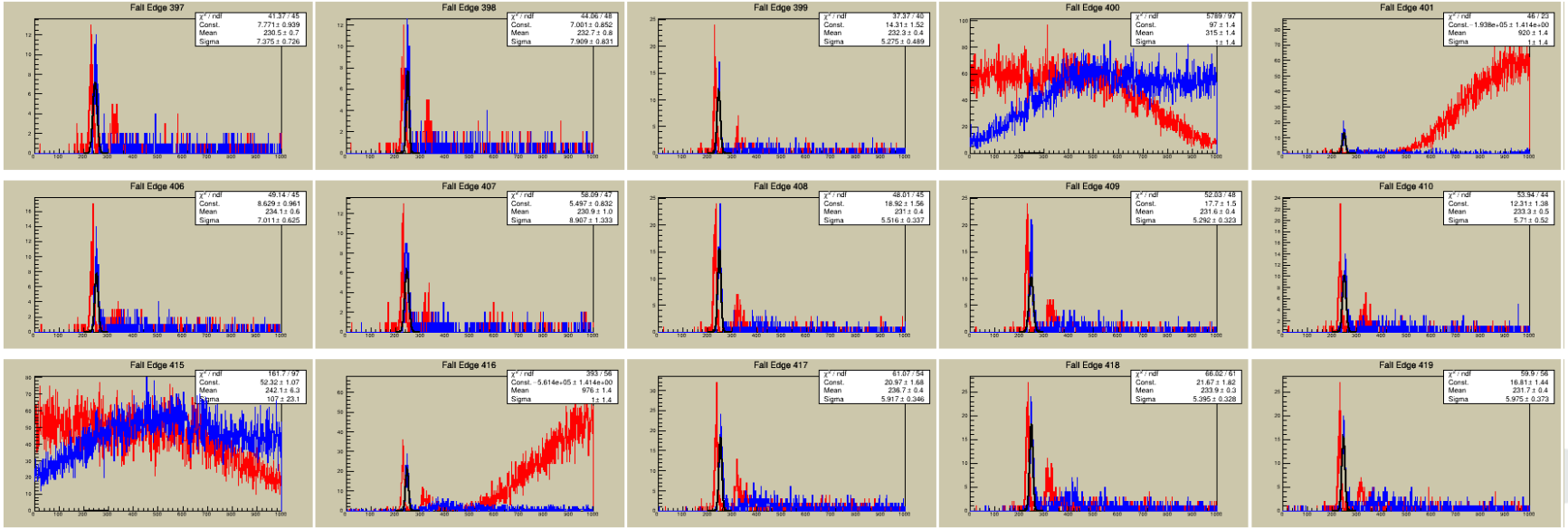


Likely the QDC module with a broken connector latch.

We are low on v792 modules (1 spare), but might need to replace it

There are also broken BNC heads on the front-end to be fixed

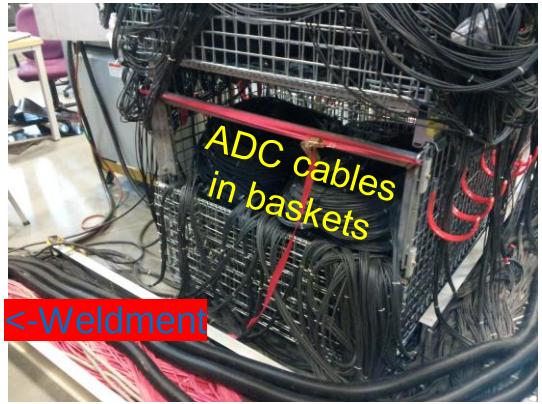
A few noisy NINO channels

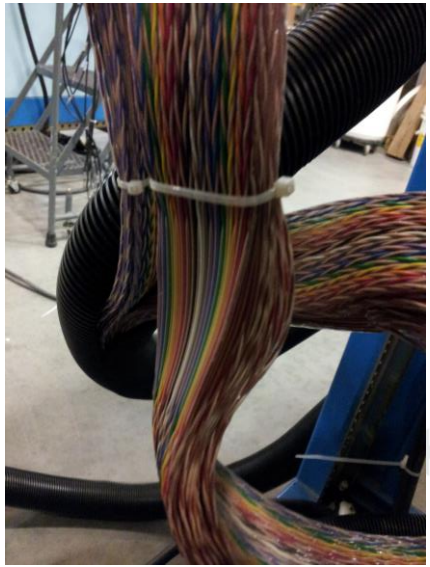


1-2 NINOs may need to be replaced (~1 week)

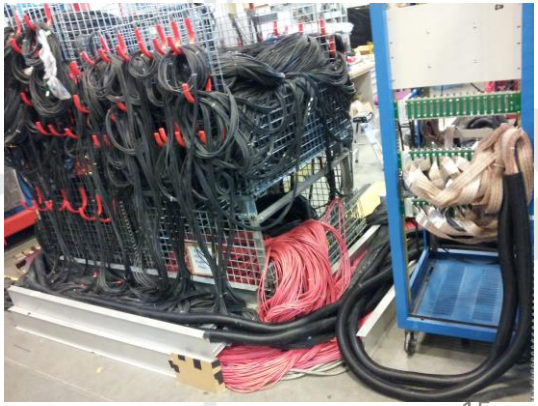
Task: Prepare cables for transport

Responsible party: me
Time needed: 1-2 days
(after prev. tasks completed)





TDC ribbon cables
in conduits

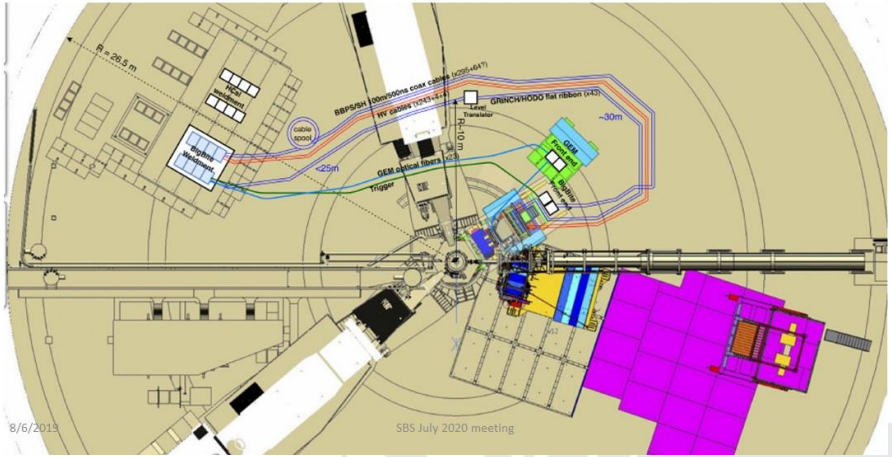


Pre-Hall Timeline

- **Leak rate measurement, seal door:** ~Feb. 22* – Mar. 5*
  - *Dependency: gasket delivery
- **v792/NINO repair, Gain matching:** Mar. 1* – Apr. 15*
  - *Dependency: translator rack noise eliminated
- **GRINCH ready for Hall transport:** < May 1
- **Software development, Documentation:** Now – May 15

Preparing for Beam

Once in the Hall, all GRINCH systems need to be installed and re-checked:



- TDC / ADC cables and signals
- PMTs / readout modules / DAQ
- Final gas system and leak check
- All software to be tested and ready

GRINCH Software Needed

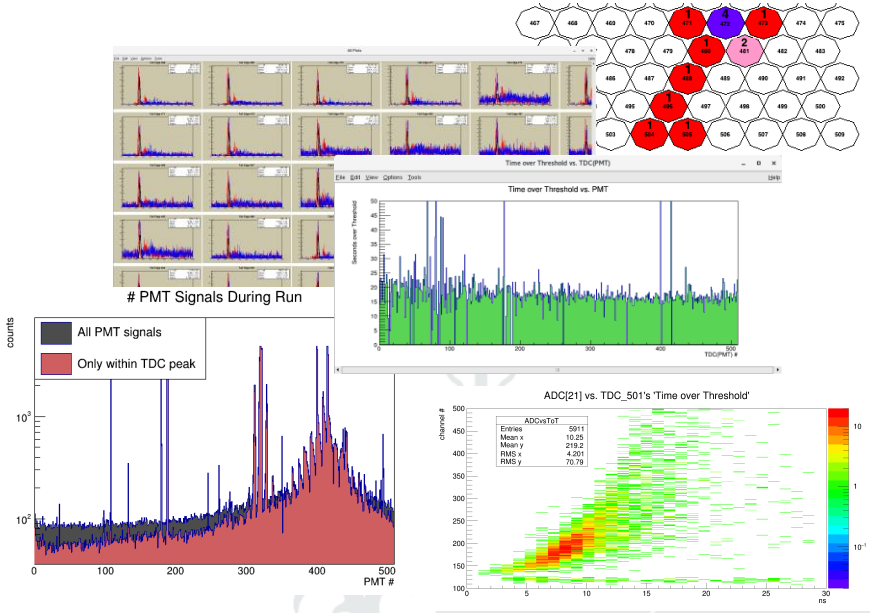
- **Offline analysis software**
  - PMT vs. PMT for track/cluster finding
  - All TDC / ADC channels, time over threshold ✓
  - Single event display ✓
  - PMT rate counter ✓
  - TDC multiplicities ✓

Could really use help with the online software + integration

- **Online Monitoring**
  - HV / LV monitoring
  - Online PMT rate counter, TDC / ADC
  - Gas pressure monitoring

- **Slow Controls / EPICS**
  - Realtime PMT gain / voltage controls ✓
  - Gas flow

- **Clustering, Integration with other SBS subsystems**



With beam, we need to verify simulated PMT acceptances, p.e. yield, study blind spots in the mirrors

GRINCH Documentation

- **GRINCH wiki (fairly extensive):**

https://hallaweb.jlab.org/wiki/index.php/BigBite_GRINCH

  - Presentations, background information
  - Cable maps and schematics, technical drawings, spare inventory
  - All past equipment tests, specs, measurements, and studies

  Needed: Instructions for running software, shift instructions, any missing safety documentation

- Approved TEDF GRINCH tasks on halist:

http://devweb.acc.jlab.org/CSUEApps/halist/atlis.php (JLab computer needed)

  - #1595: GRINCH PMT checks and gain matching
  - #1596: GRINCH gas pressure and leak tests

- Additional safety information:

https://hallaweb.jlab.org/12GeV/SuperBigBite/documents/ERR2017/final/GRINCH_OSP.pdf
https://hallaweb.jlab.org/wiki/images/8/8e/C4F8O_Safety_Data_Sheet.pdf

Summary

- Except for the current noise issue, the GRINCH is capable of taking data, and has analysis software to be further developed
- Pre-Hall tasks:
  - Leak checks, Gain matching
- Ongoing tasks:
  - Decoder work, Software, Documentation
- Everything should be ready for the scheduled move

Backup slides

Expected Gas Performance

Gas	n	e^- thr. (MeV/c)	π thr. (MeV/c)
C_4F_8O	1.0014	9	2637
N_2	1.0003	21	5926
CO_2	1.0004	17	4671
Freon12	1.0011	11	2984
C_4F_{10}	1.0015	9	2522

Assumes a 40cm electron track

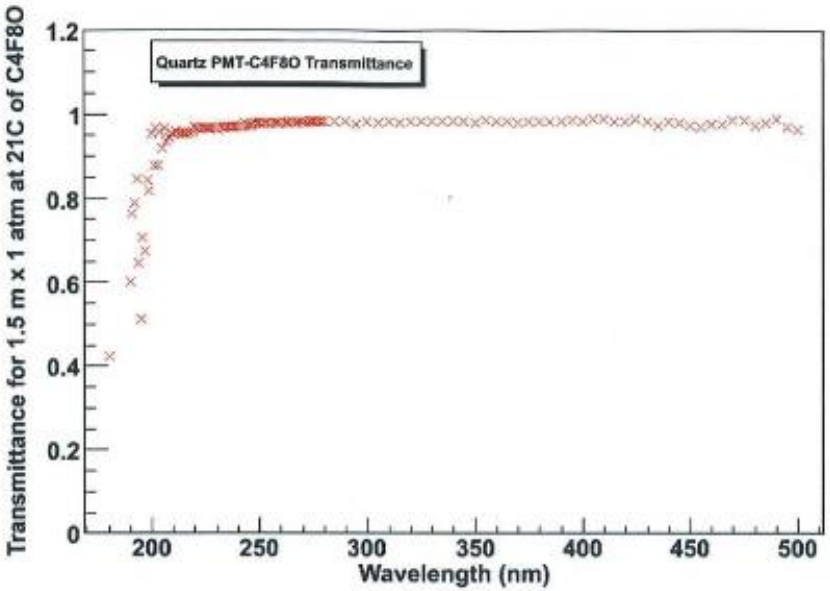


Figure 11: Transmittance for 1.5 m of C_4F_8O at 1 atm and 20°C (Kubarovsky *et al.*).

Simulations: Eric Fuchey

e' < 6 GeV

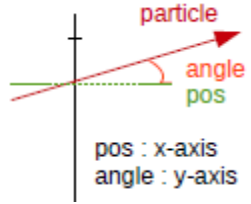
15 deg < θ < 50 deg

-50 deg < ϕ < 50 deg

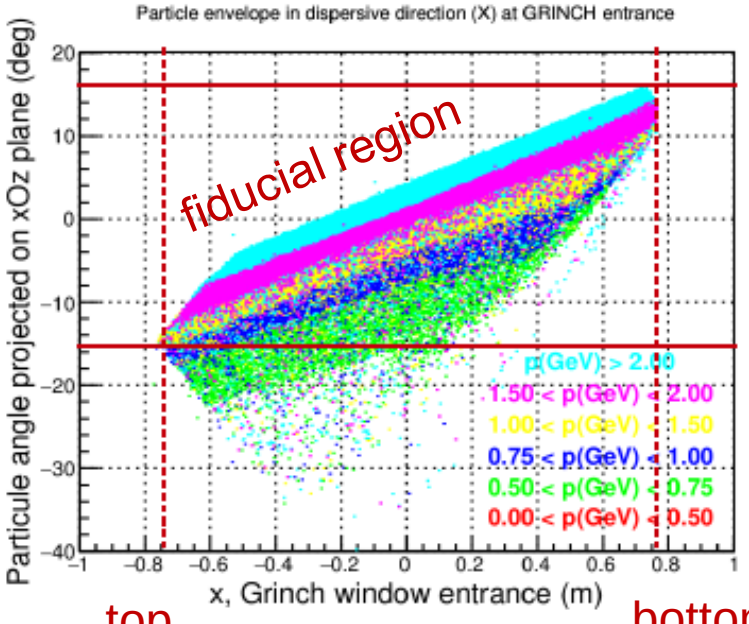
-27.5 < z_vtx < +27.5 (x_vtx, y_vtx =0)

5 GEM hits, BB angle: 30deg.

Done: verify simulated acceptances

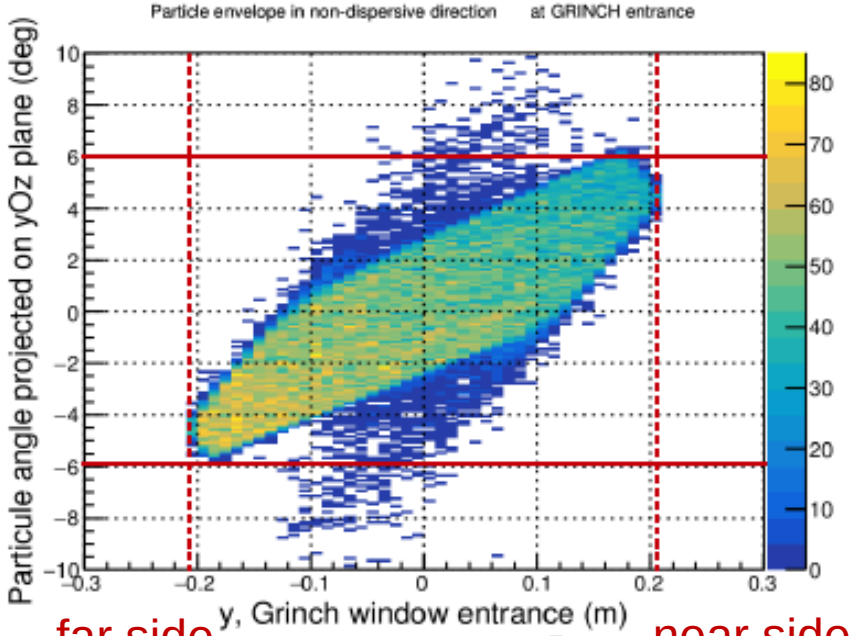


(y)



top

bottom



far side
(wrt PMTs)

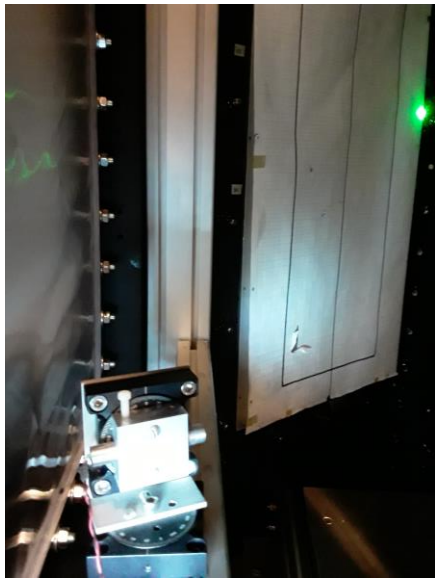
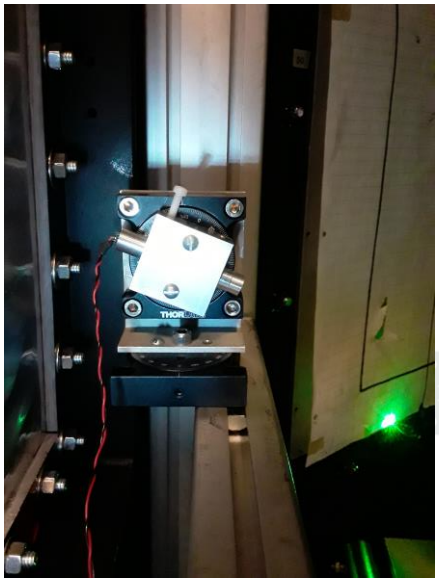
near side
(wrt PMTs)

Angular acceptance measurements

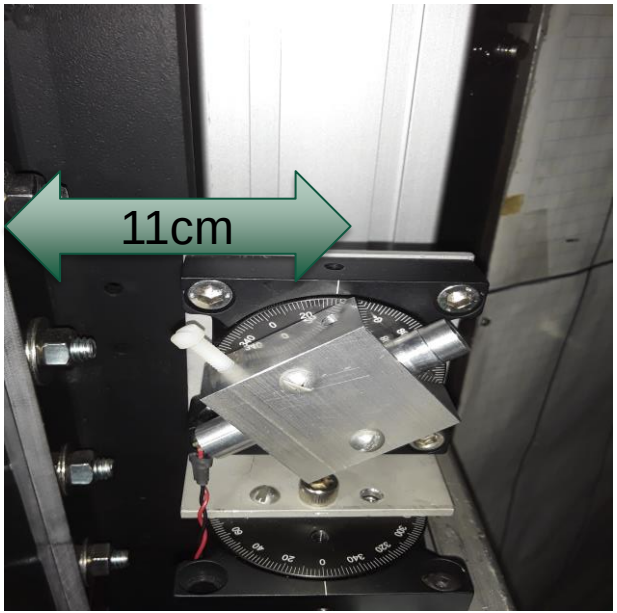
156 total measurements =
[(max+min) horiz. angles + (max+min) vert. angles]*(3 horiz. pos.)*(13 vertical pos.)

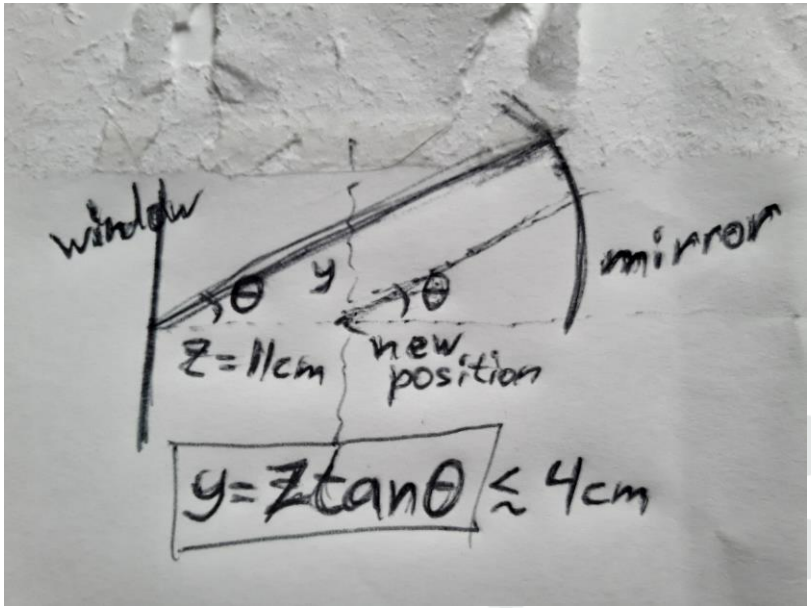
far, mid, near wrt PMTs

0, 10, 20, 30, 50, 70, 90, 110,
130, 150, 160, 170, 190cm wrt window

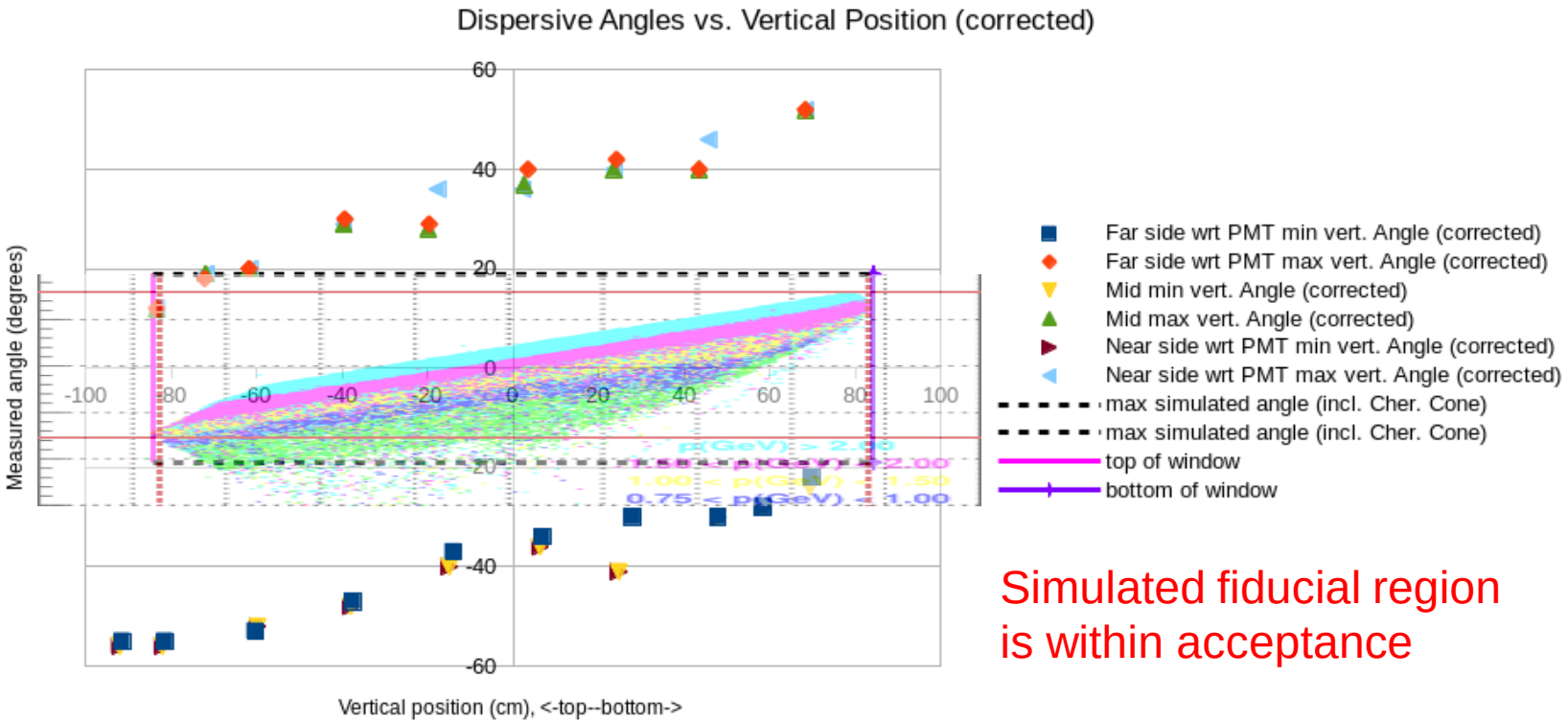





Position corrections



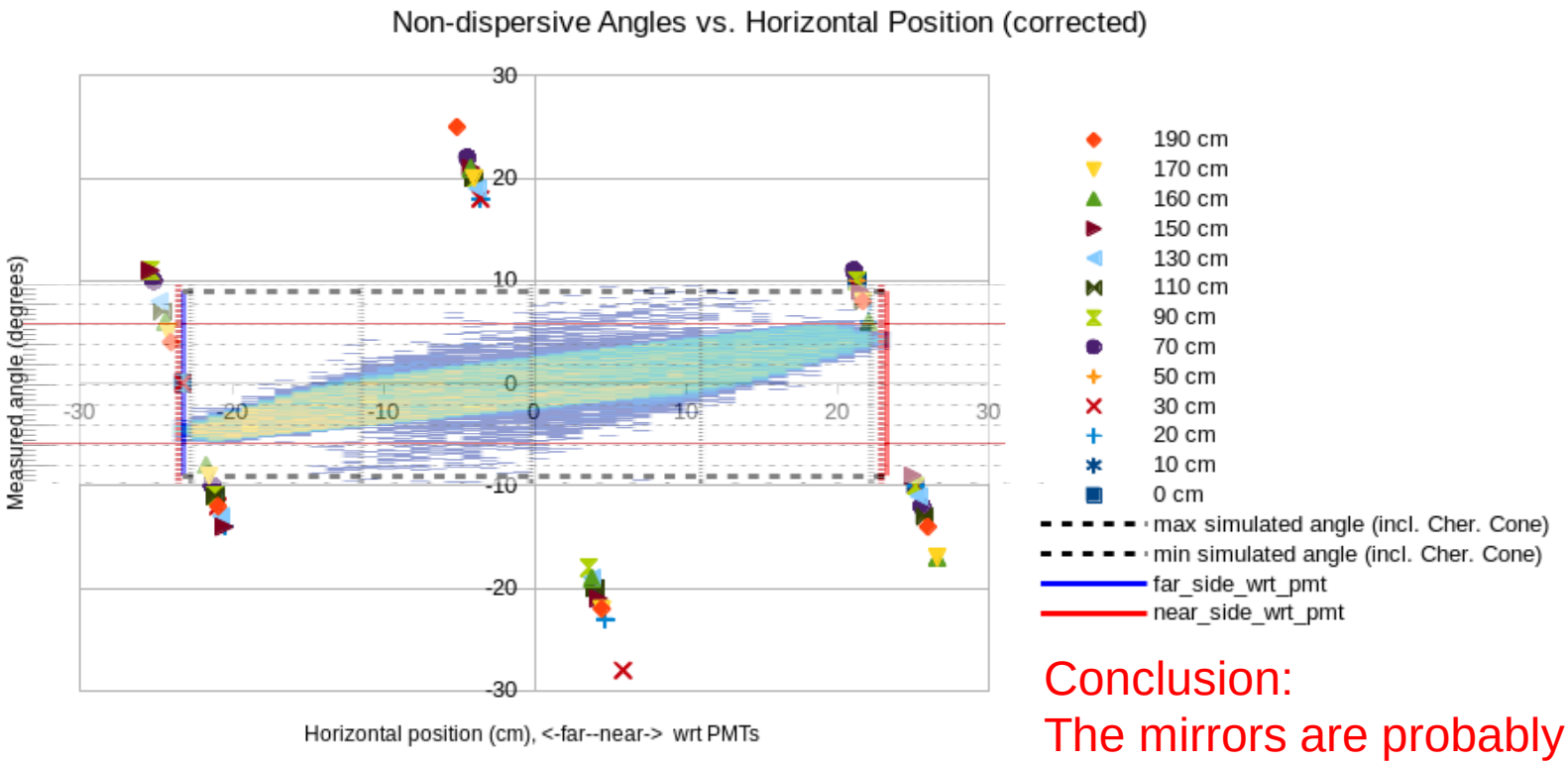


Angular acceptance (vert.)



Simulated fiducial region is within acceptance

Angular acceptance (horiz.)

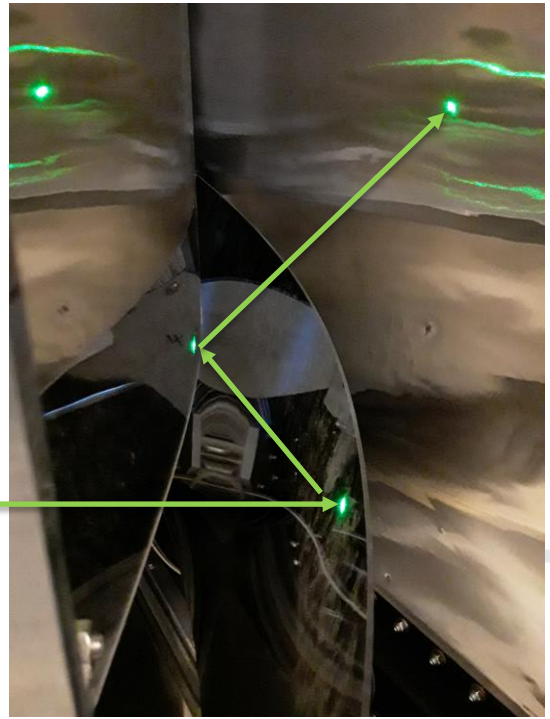


Conclusion:
The mirrors are probably fine!

~6 deg. blind spot

Moving from the bottom mirror upward, there is a blind spot of ~6deg. where reflected light hits the back of the next mirror, missing the PMT array

±6deg. ~ Cherenkov cone…



It will be interesting to see if/how this manifests in the data. Incomplete cluster rings?

Something to be mindful of when triggering?

Viton interactions

- http://chemours-site.force.com/CRG_VitonGuide

The cracking is probably from long-term folding/storage

It should be installed and left alone

COMPATIBILITY

Weather Resistance:	Excellent
Ozone Resistance:	Outstanding (2wks/150 ppm)
Oxidation Resistance:	Outstanding

Types of Viton™ for Air, <200°C	Rating
Viton™ Extreme™ ETP	A
Viton™ GFLT	A
Viton™ GLT	A
F-type	A
B-type	A
A-type	A

Types of Viton™ for Hydrogen	Rating
Viton™ Extreme™ ETP	A
Viton™ GFLT	A
Viton™ GLT	A
F-type	A
B-type	A
A-type	A

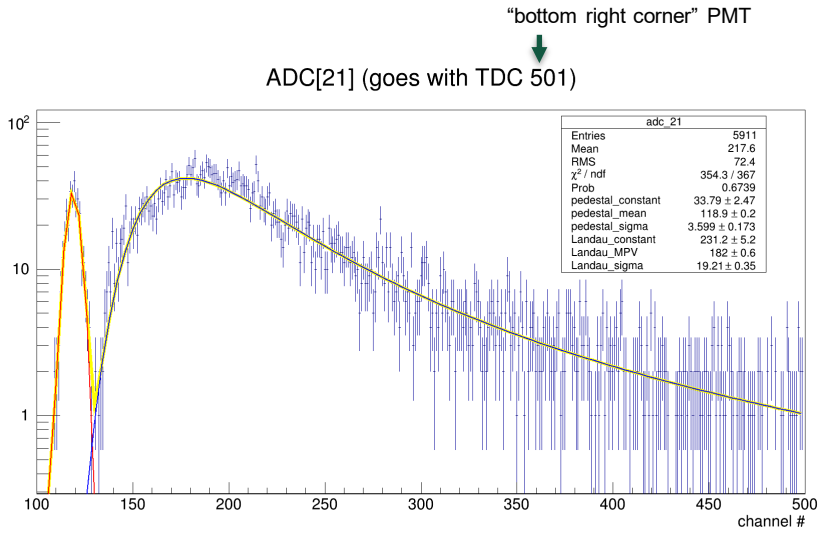
Types of Viton™ for Isopropyl Alcohol	Rating
Viton™ Extreme™ ETP	A
Viton™ GFLT	A
Viton™ GLT	A
F-type	A
B-type	A
A-type	A

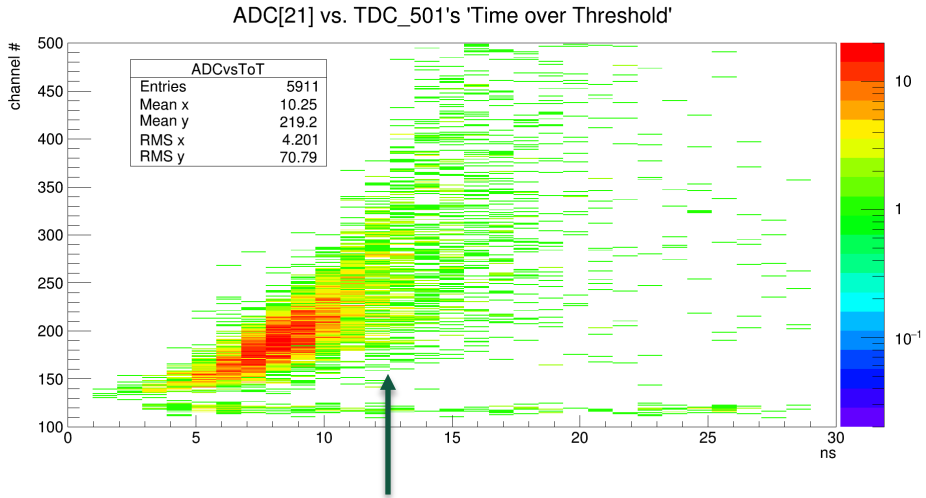
Rating Legend

A	<10% volume swell. Elastomer may exhibit slight swelling and/or loss of physical properties
B	10-30% volume swell. Elastomer affected by chemical exposure (slight visible swelling and/or loss of physical properties).
C	30-50% volume swell. Elastomer affected by chemical exposure (moderate to severe swelling and/or loss of physical properties. Limited functionality possible but must be determined by testing).
D	>50% volume swell. Elastomer shows extreme volume swell and/or loss of physical properties. Not recommended for service.
---	Insufficient Data.

TDC time over threshold (“offline”)

ADC – ToT Correlation (TDC vs. ADC)

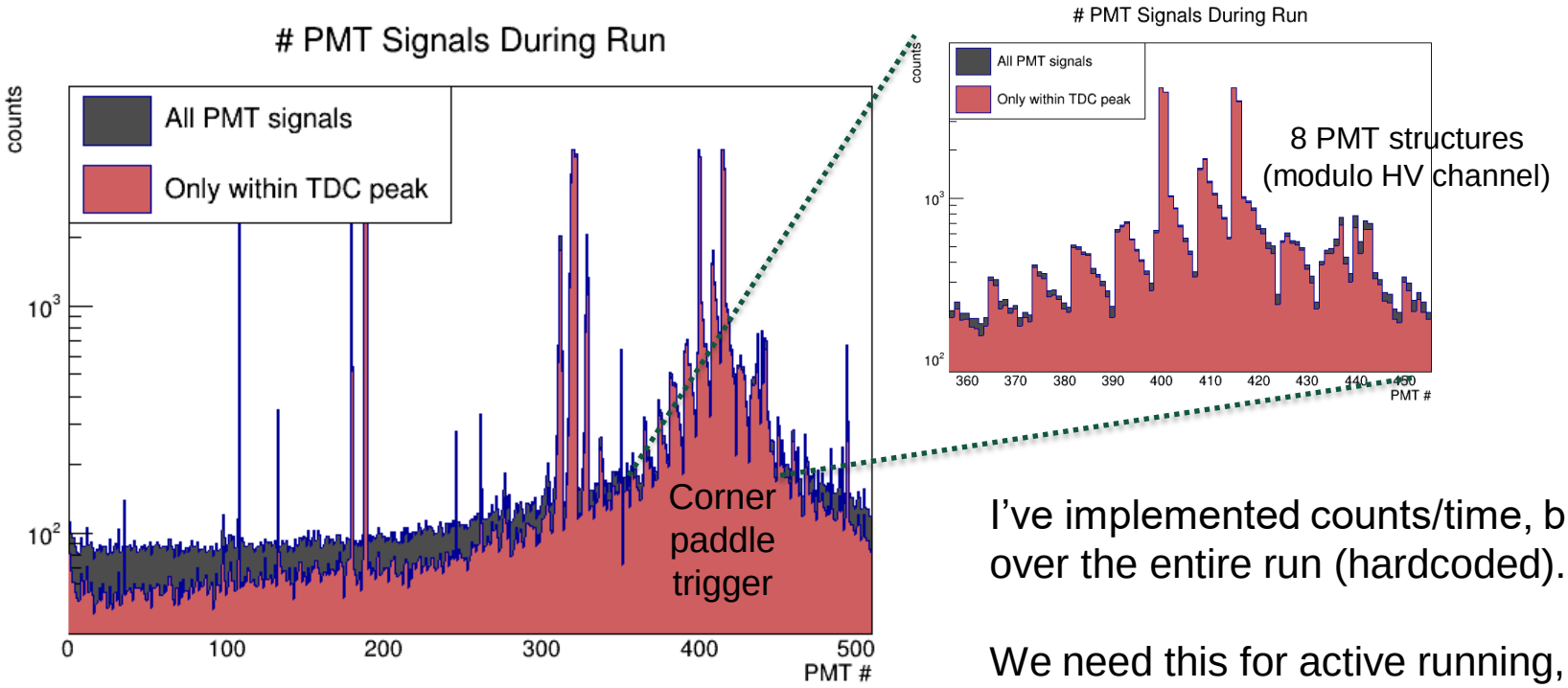




Need to make a version of this plot for all channels

Also standardize the way to keep track of which TDC is tied to each ADC channel at any given time

PMT Rate Counter



I've implemented counts/time, but over the entire run (hardcoded).

We need this for active running, one that regularly updates, etc.