GRINCH Status

Bradley Yale

SBS Collab. meeting
07/14/2020

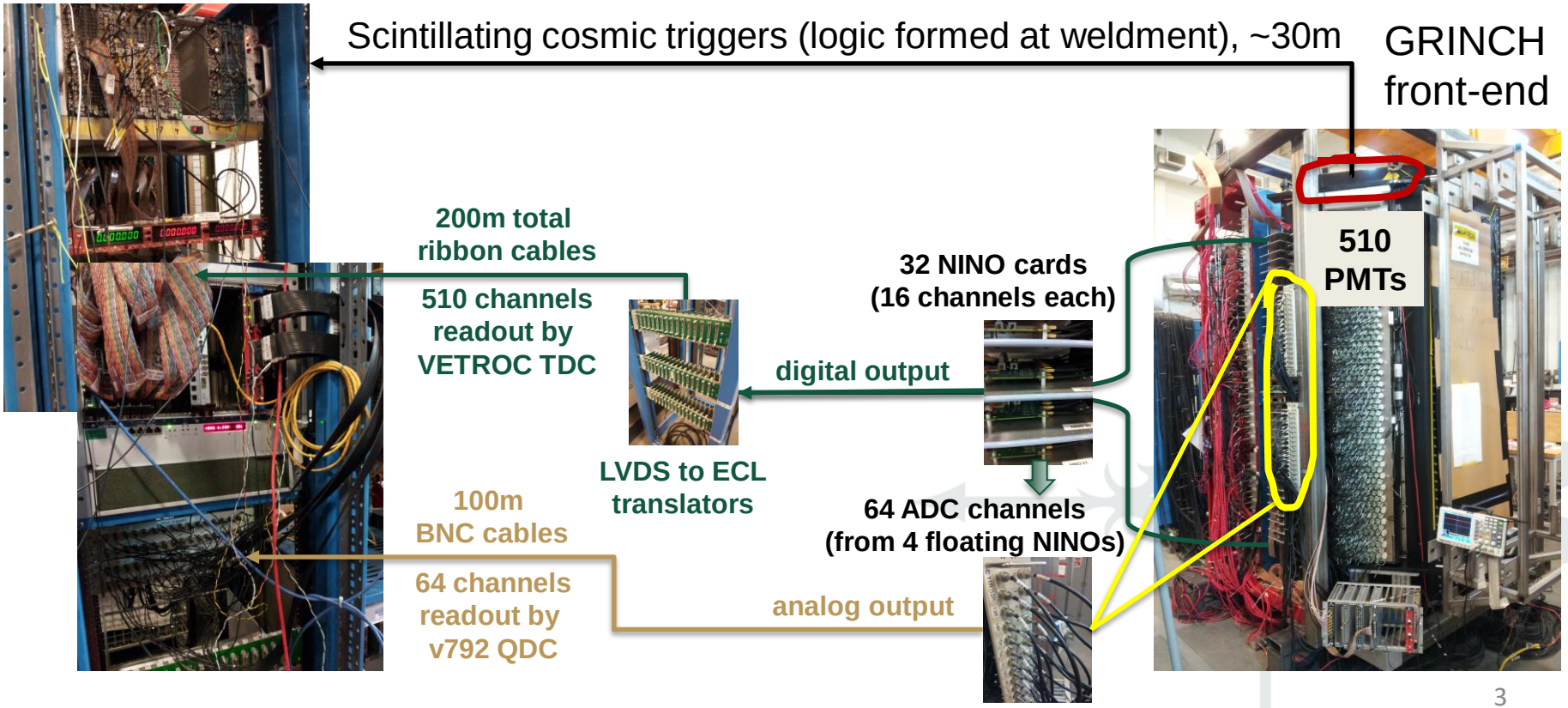
WILLIAM & MARY
CHARTERED 1693

GRINCH Task List

- **Hardware (needs to be scheduled)**
  - Test ribbon cables (< 1 day)
  - Check mirror alignment (several days? Todd/Bogdan must be present)
  - Seal the door and leak test (preferably 1 full day)
  - Gain Match PMTs (weeks)

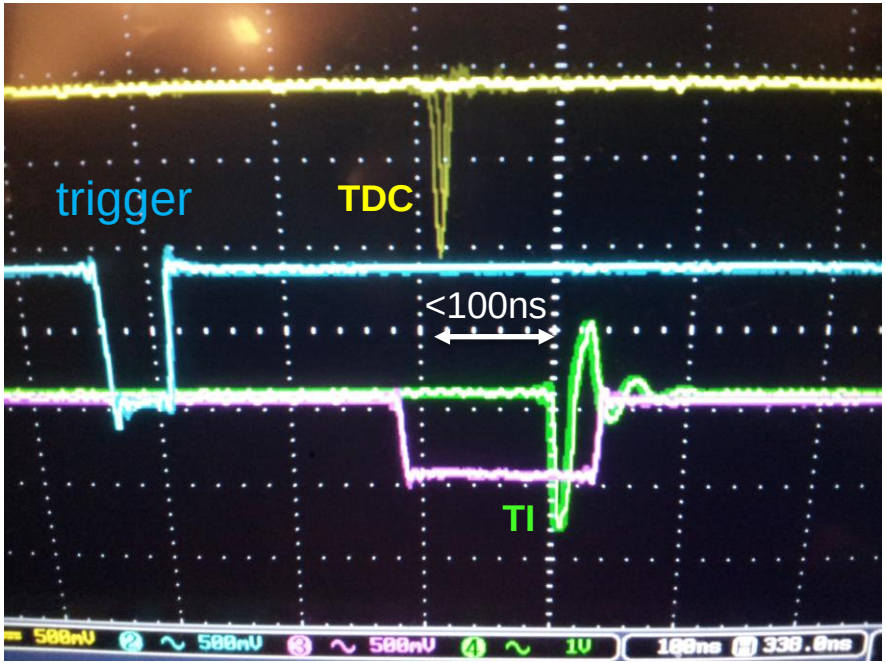
- **Software (“anytime”)**
  - Test CODA3
  - “Online” monitoring histograms
  - “Offline” analysis software
  - PID trigger?

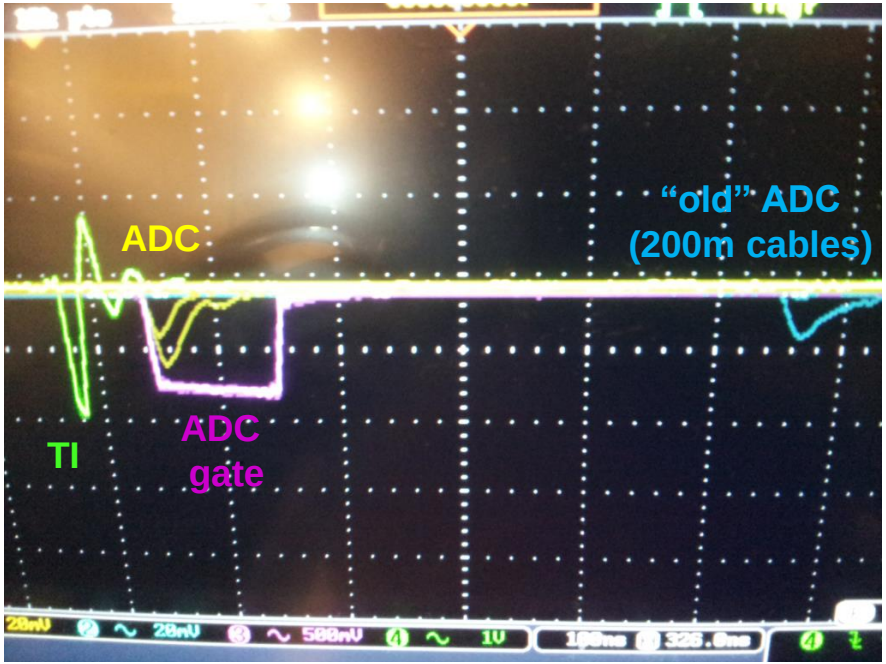
GRINCH Layout



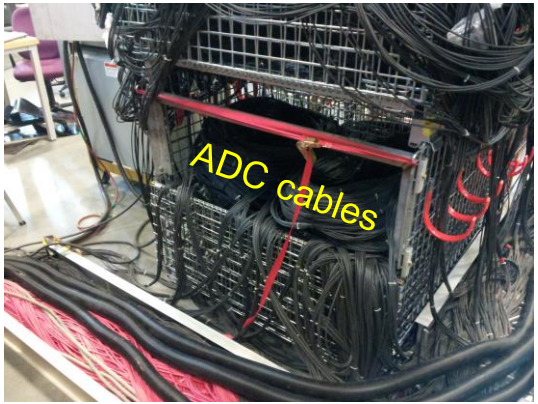
Readout Signals

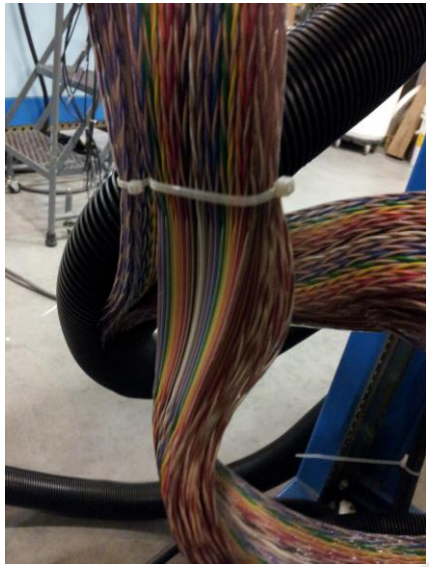
Everything (now) fits within a ~450ns window



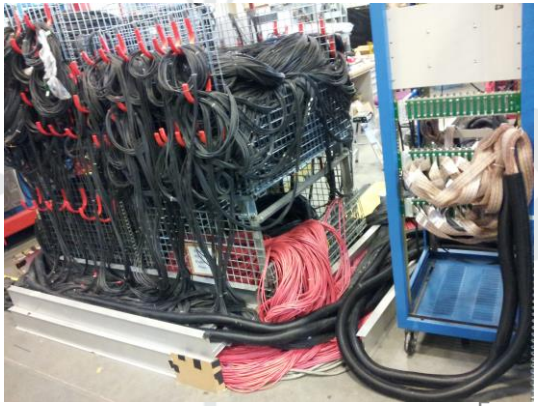


TDC Ribbon cables now in conduits





Need to check for damaged wires
Using the scalers is fastest, but requires HV



Mirror Alignment

Angular calibrations have been performed years ago, but should be verified in case something has shifted

To do this, several small holes will be drilled into the GRINCH's back window (😬) to reflect lasers off the mirrors, and then repaired

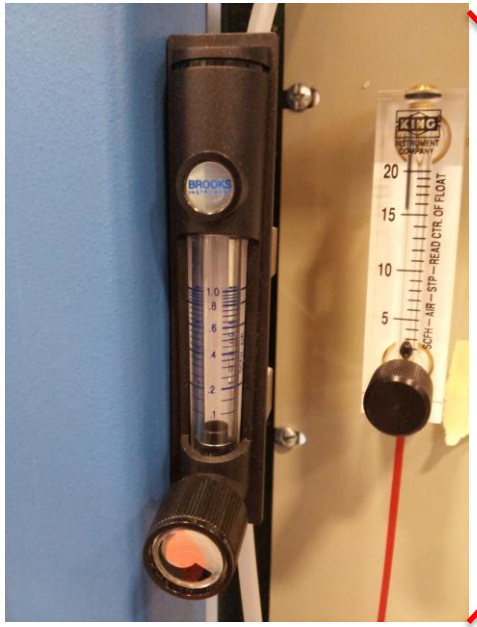
A good (and rare) opportunity for new collaborators to witness how the GRINCH interior works!

Sealing the GRINCH door

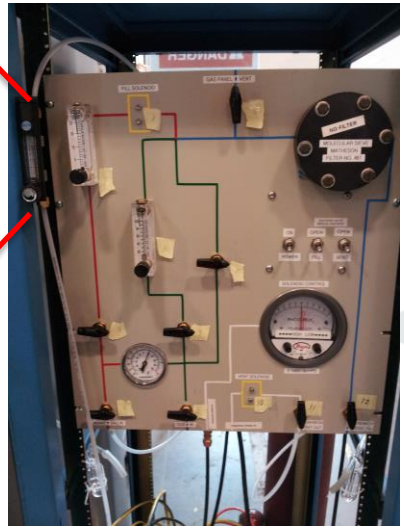
A long-broken screw was finally repaired just before the lockdown

Once the mirror alignment check is complete, the door can be re-sealed, and leak tests performed

Leak Rate Measurement



New, finer-precision flow meter installed in the gas panel, to measure the flow rate into the GRINCH

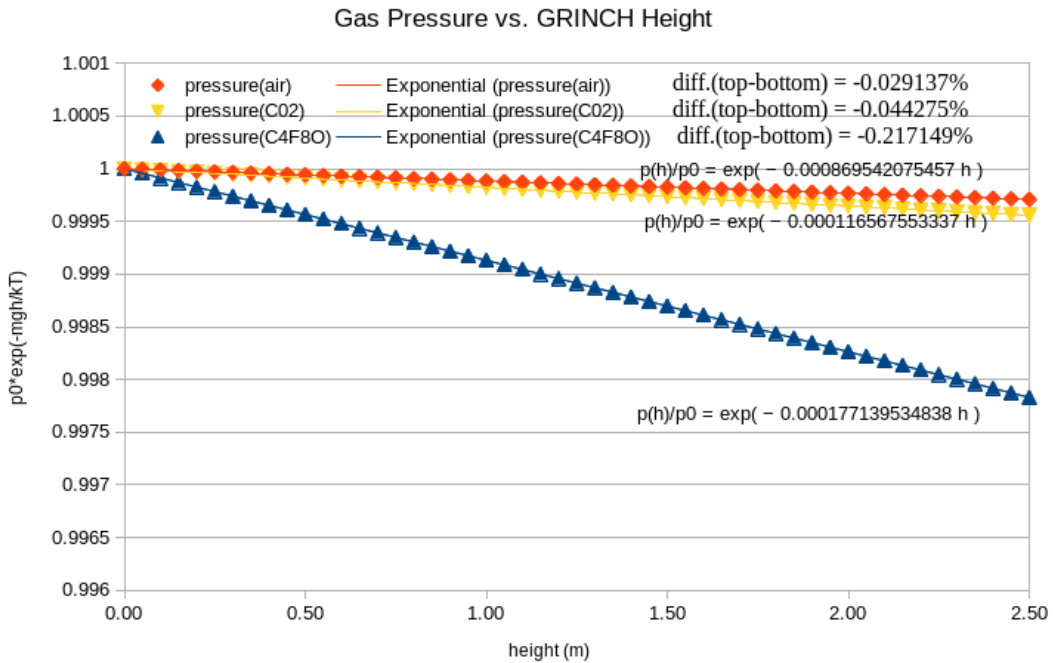


Initial measurement over 6hrs. indicates that the leak rate is ~0.15 SCFH at 0.5” H2O (fill rate to maintain equilibrium)

Needs to be rechecked after sealing the door

Measured **open vent rate** at 1”: 0.4 SCFH → “Stay below that”

Another potential task: Verify pressure vs. height model



"1 GRINCH window"

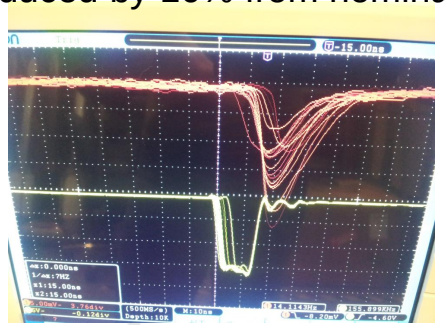
"0.217%" = 0.0318 psi = 49 $\mathrm{lb/m^2}$

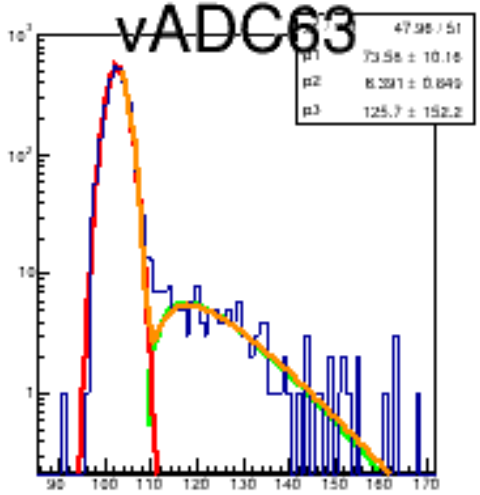
→ "Only measure from the bottom"

GRINCH pressure should be integrated into the online monitoring

PMT Gain Matching (cosmics)

HV was reduced by 16% from nominal





$$\frac{250\ \text{pC}}{3840\ \text{channels}}(113.589 - 102.598) = 0.70\ \text{pC}$$

Prev. value from LED test was ~12pC

Fit:

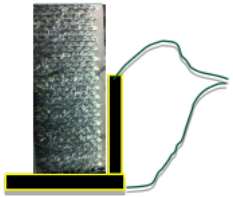
$$Ae^{-(x-\mu_{sig})^2/2\sigma_{sig}^2} + (x - \mu_{ped} - n\sigma_{ped})e^{-(x-\mu_{ped})/\sigma_{ped}}$$

3-6

Should be checked with existing LEDs

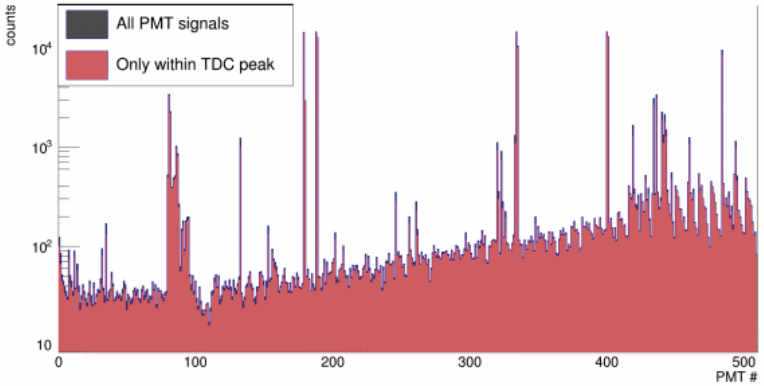
GRINCH trigger configurations

"Corner paddle" ← **Used for the following plots (more efficient)**



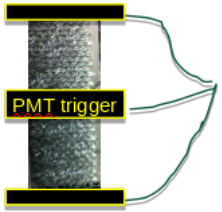
'and' logic

PMT Signals During Run

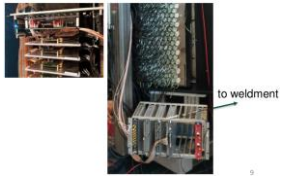


top PMTs → bottom PMTs

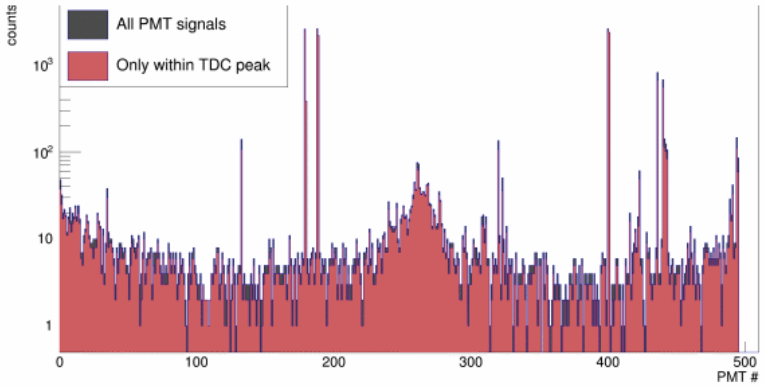
"3 trigger"



pairwise 'and'

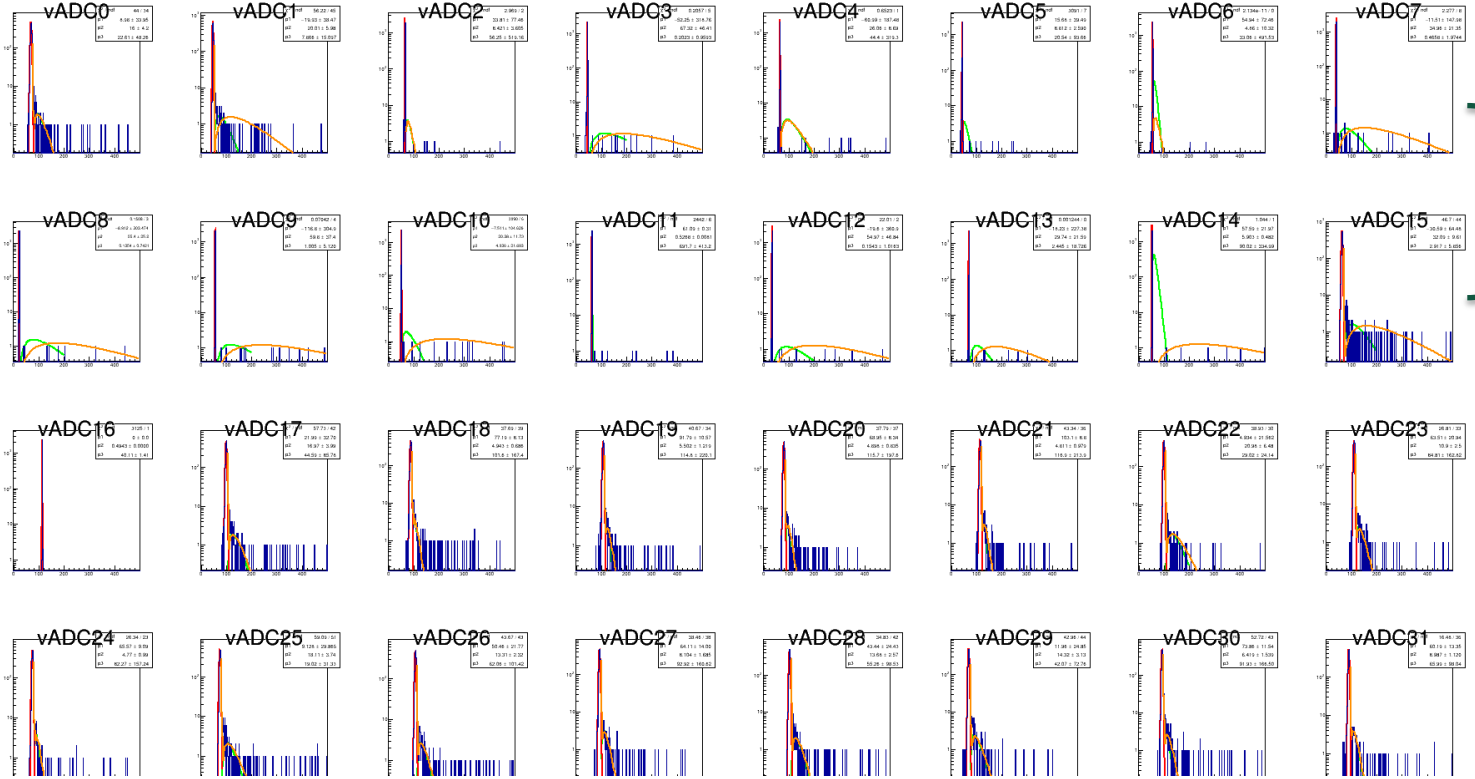


PMT Signals During Run



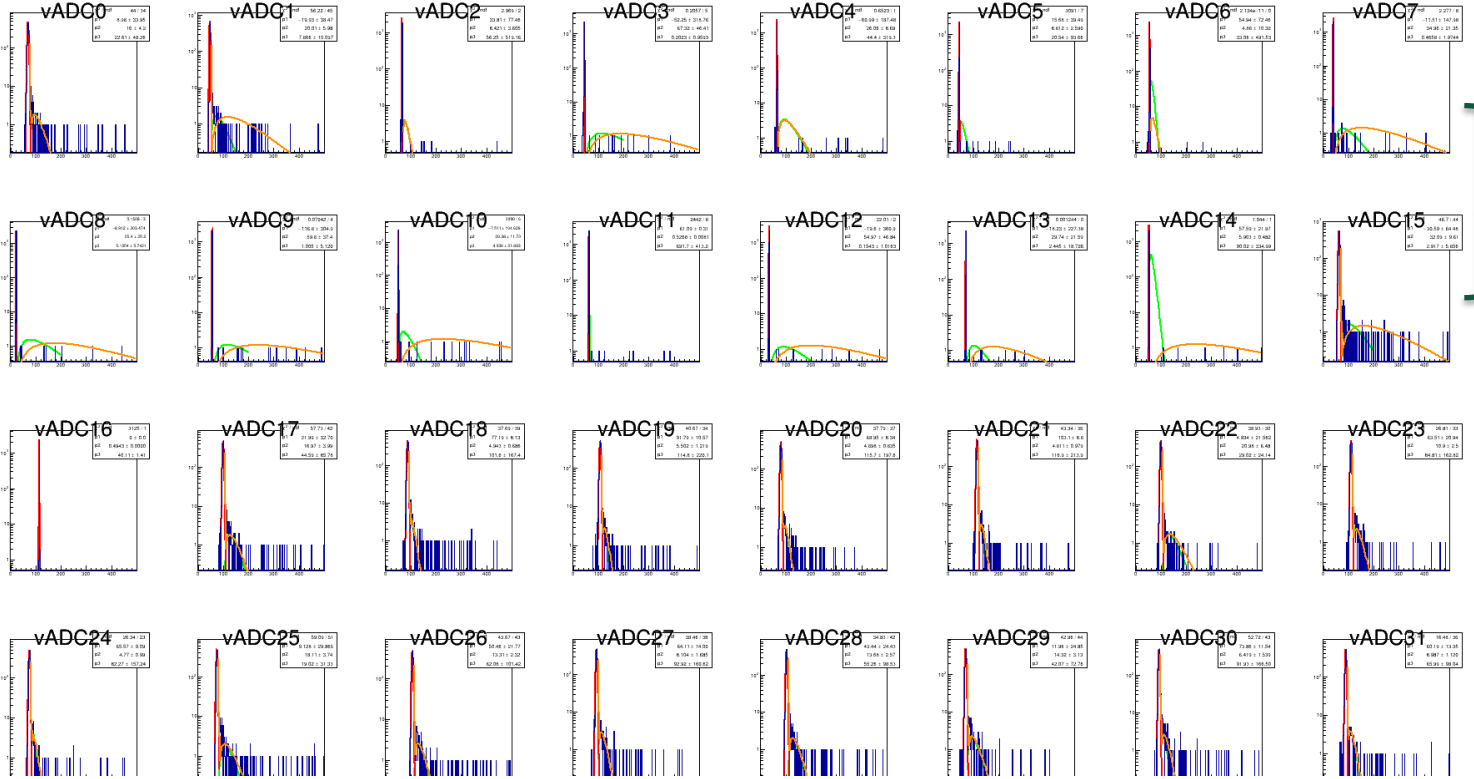
top PMTs → bottom PMTs

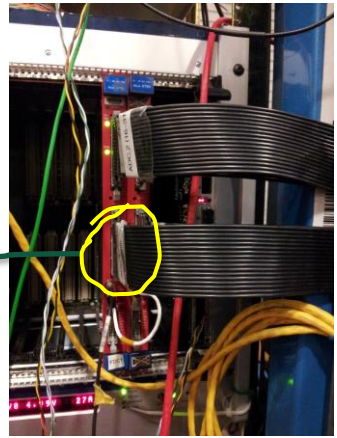
Fit ADC channels (1-32)



These “bad” channels are not from the front-end cables…

Fit ADC channels (1-32)

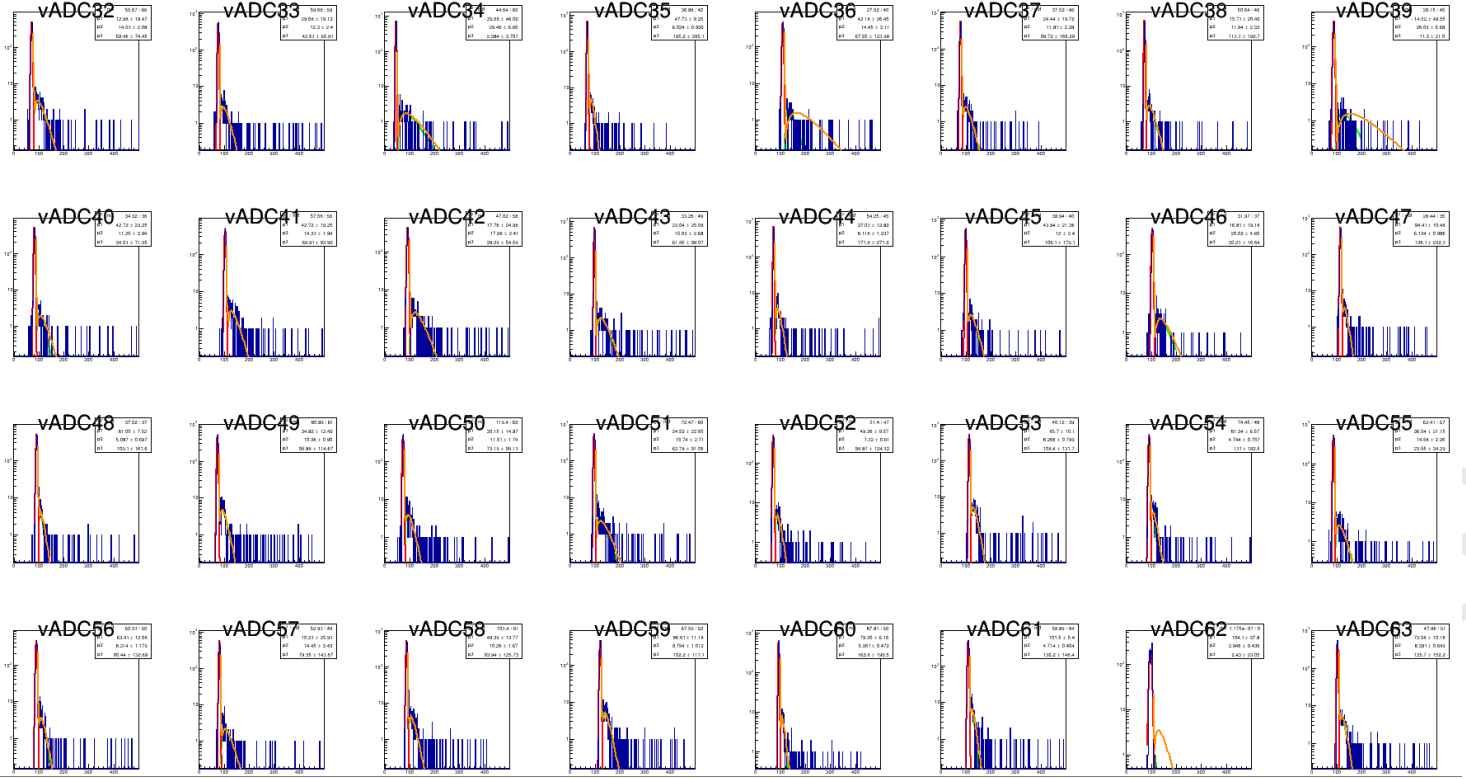




Likely the QDC module with a broken connector latch…

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

Fit ADC channels (33-64)

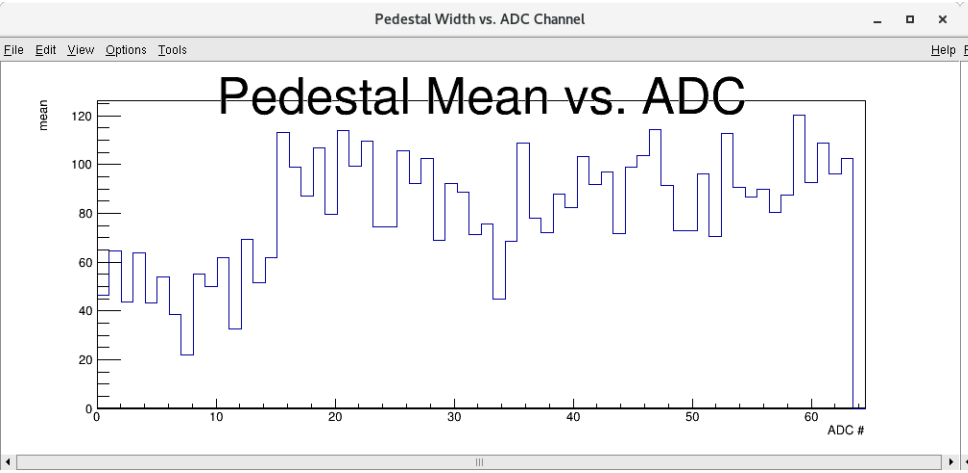


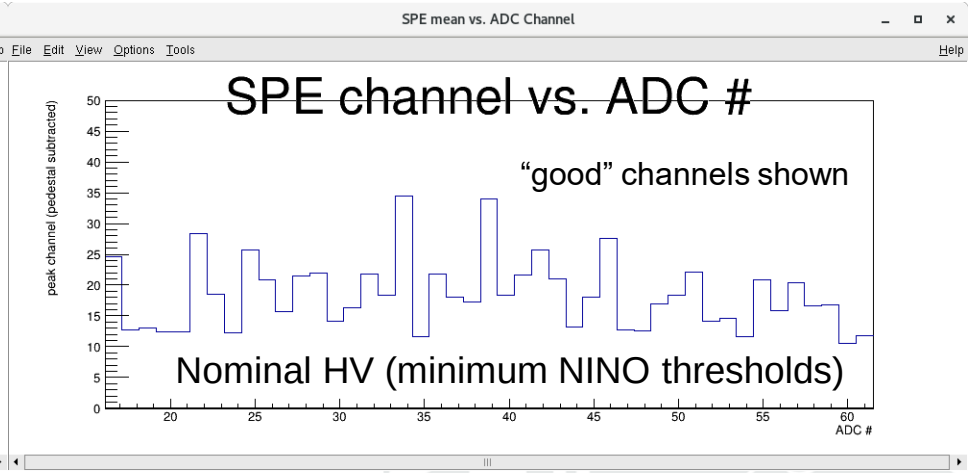
The bottom ¾ channels look ok.

Plotting the means of the individual channels…

Fit ADC channels

Pedestal-subtracted
single photoelectron channels

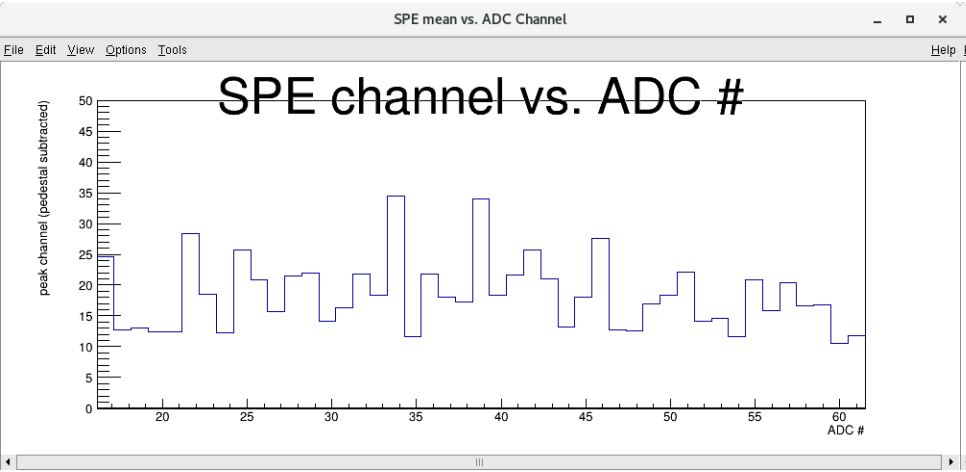




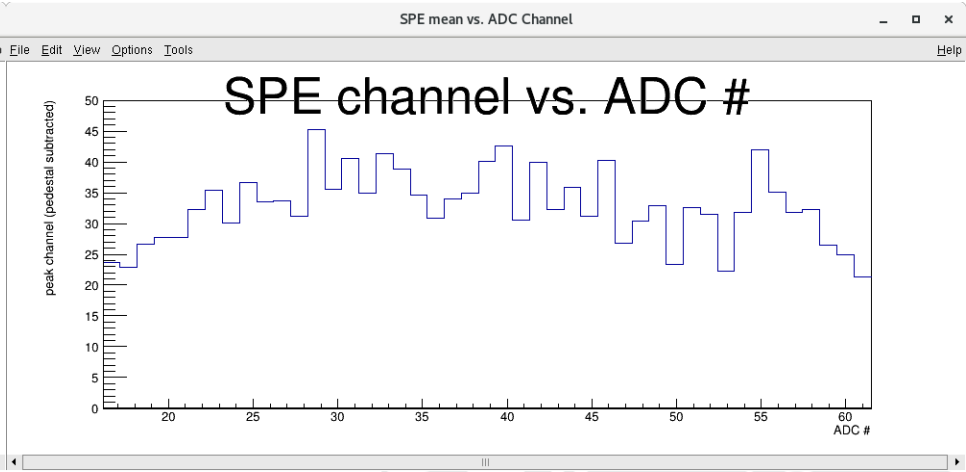
The HV will be increased in steps of 100V to get the gain correlation

Gain Matching (1st step)

Nominal HV



Nominal HV + 100V



Once the other hardware tasks are complete, and the GRINCH is sealed and powered, the complete Gain vs. HV map can be constructed

Monitoring/Analysis Tools

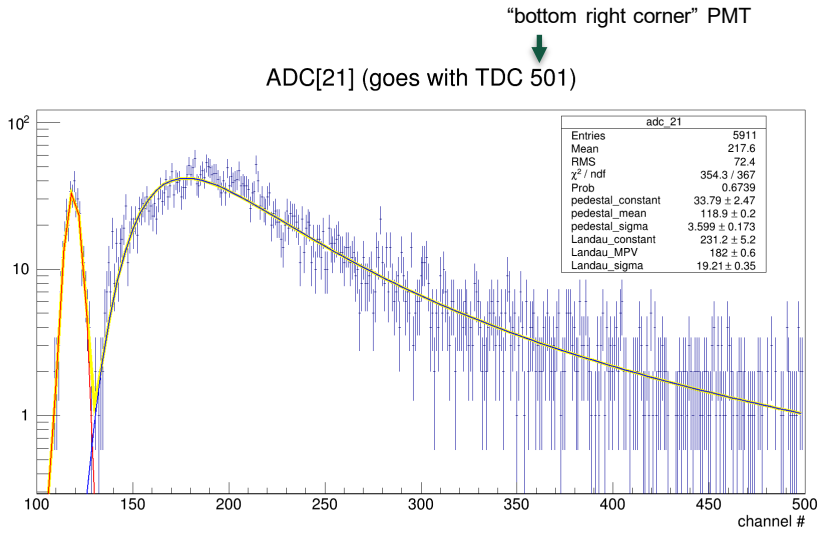
- Software tools are needed for monitoring GRINCH events during the experiment

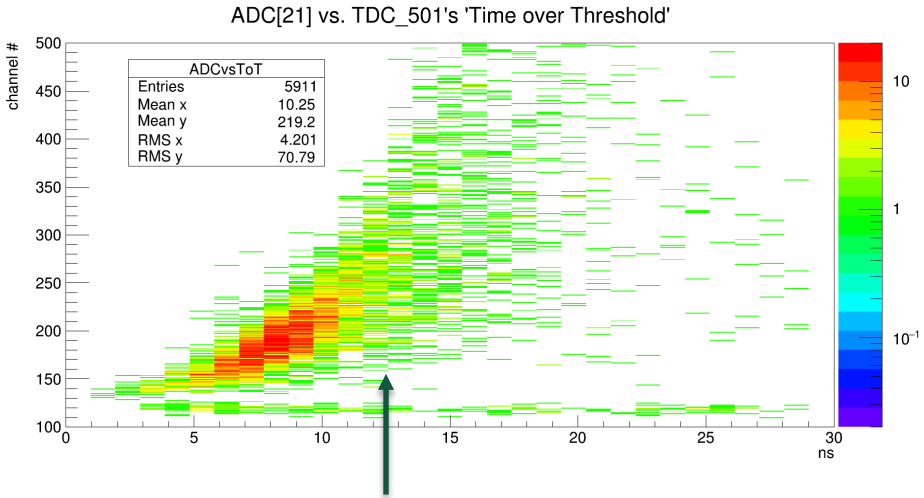
  - Analysis/monitoring software
    - All TDC/ADC channels (+TDC vs. ADC) ✓
    - Single event display ✓
    - PMT rate counter ✓
    - TDC multiplicities

  - Slow Controls
    - Realtime PMT gain adjustments (slow controls)
    - Gas pressure

- Probably a lot more, mostly involving the trigger

ADC – ToT Correlation (TDC vs. ADC)

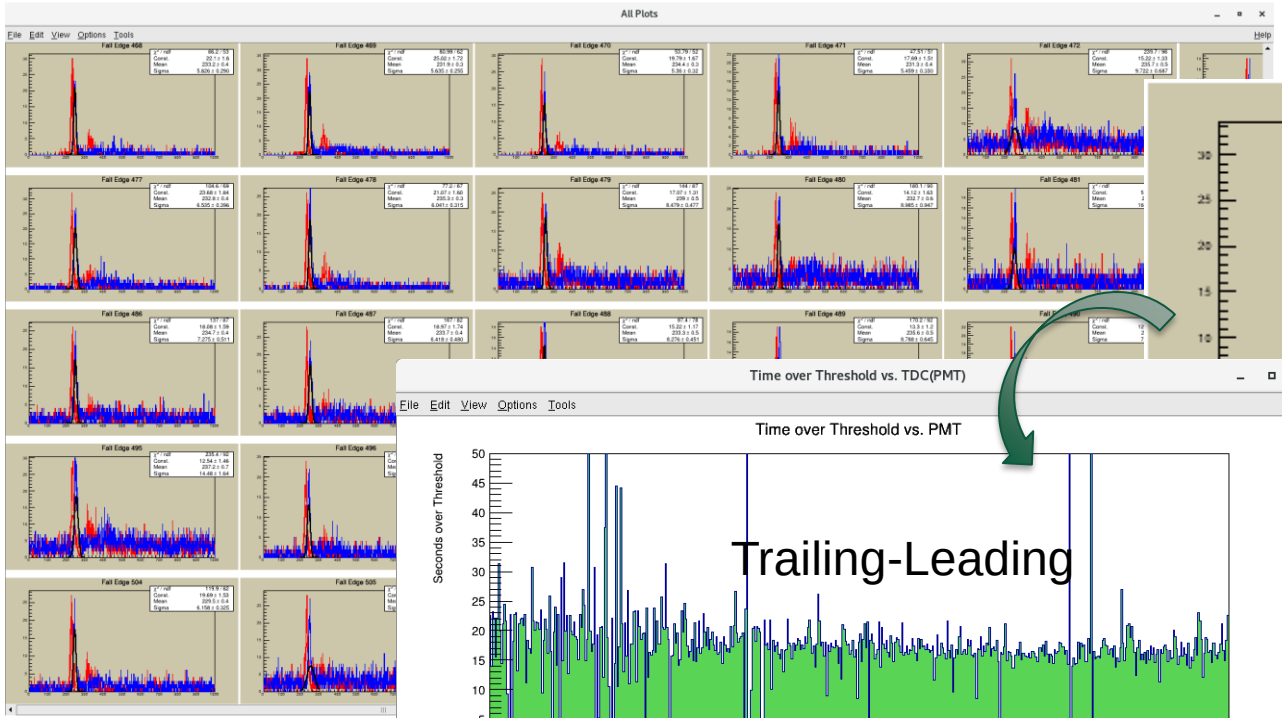


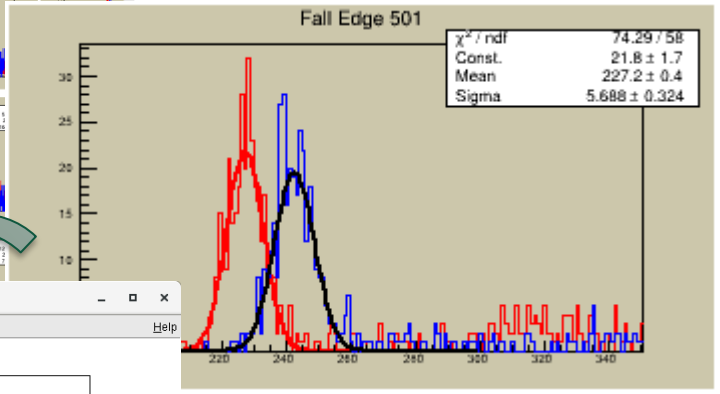


Need to make a version of this plot for all channels

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

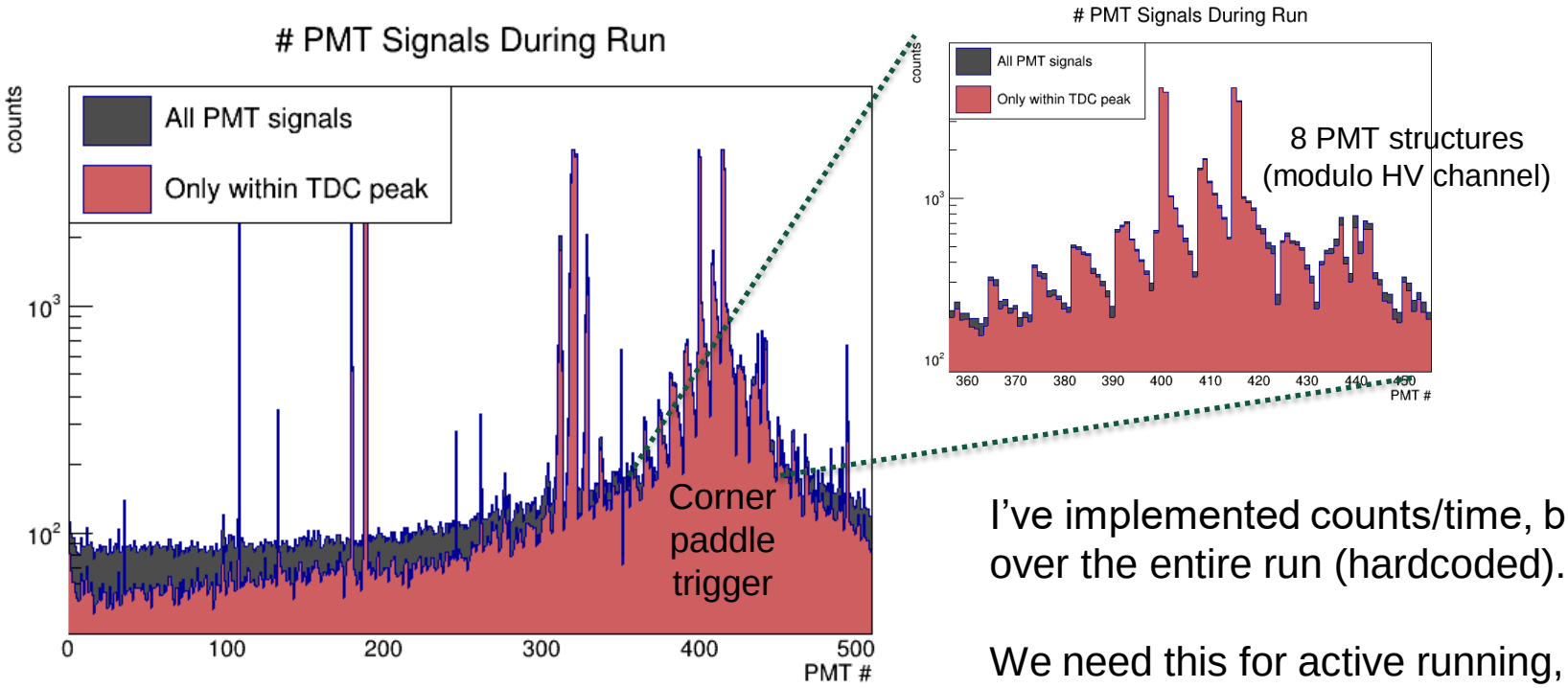
TDC time over threshold (“offline”)





Should probably be (TE+nσ)-(LE- nσ)…

PMT Rate Counter



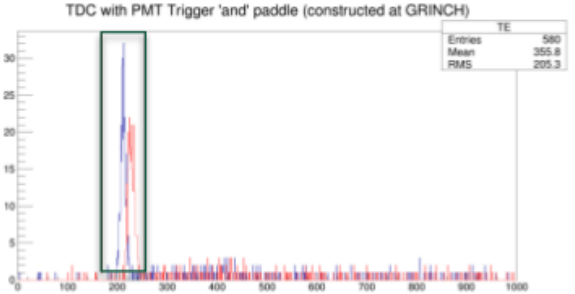
I've implemented counts/time, but over the entire run (hardcoded).

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

Single Event Display

Noisy
PMT trigger

Selecting only
the TDC peak

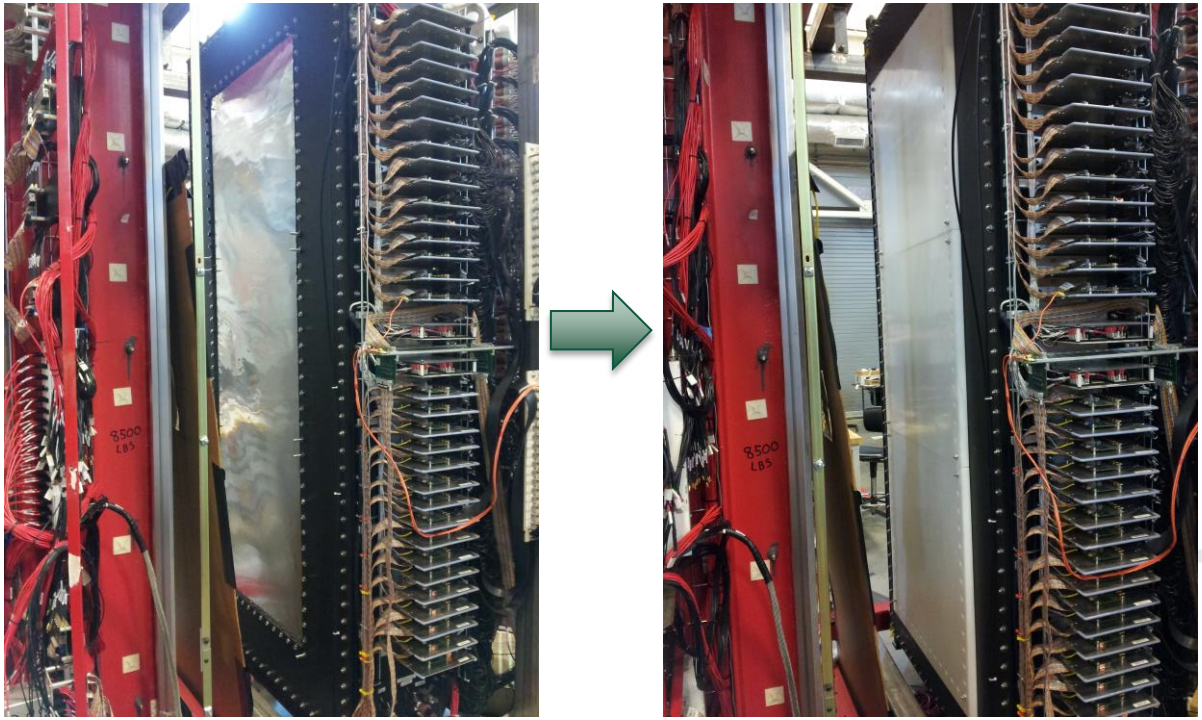


Summary

- There is a robust (but manageable) tasklist for the GRINCH, to prepare for experimental running
  - New people, feel free to get involved
- The hardware tasks obviously need to be well-planned and executed extra-efficiently in this new environment
- Some monitoring plots already exist in some form, but likely need some work to be integrated

Bonus (not BONuS) slides

New window panel installed



Tuning HV and NINO Thresholds

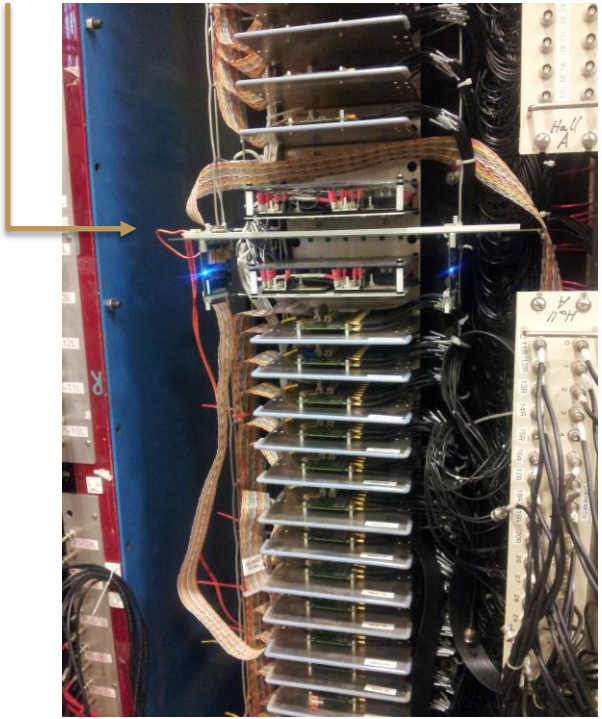
- To promote PMT longevity, the voltages powering them should be set as low as possible (before gain matching)

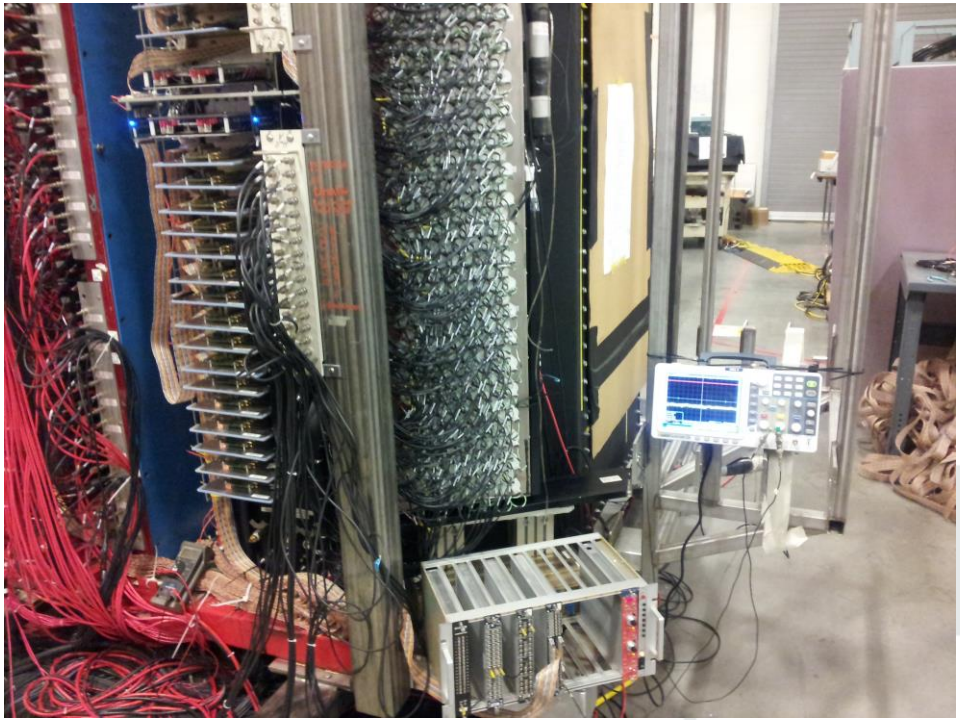
- The measured NINO thresholds were first reduced from $\sim 1.87V$ (near maximum) to $1.30V \pm 0.02V$
  - $1.25V$ is the absolute min., but accepts too much noise

- All HV's powering the PMTs were reduced by 16%
  - Found to be the highest reduction, while still allowing for a signal

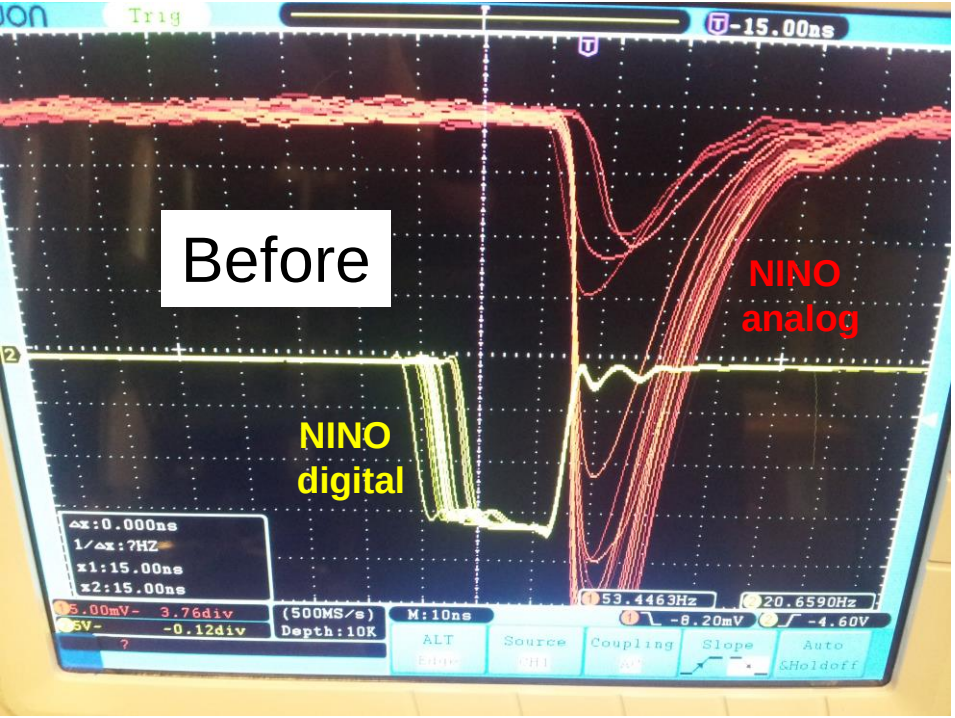
GRINCH front end

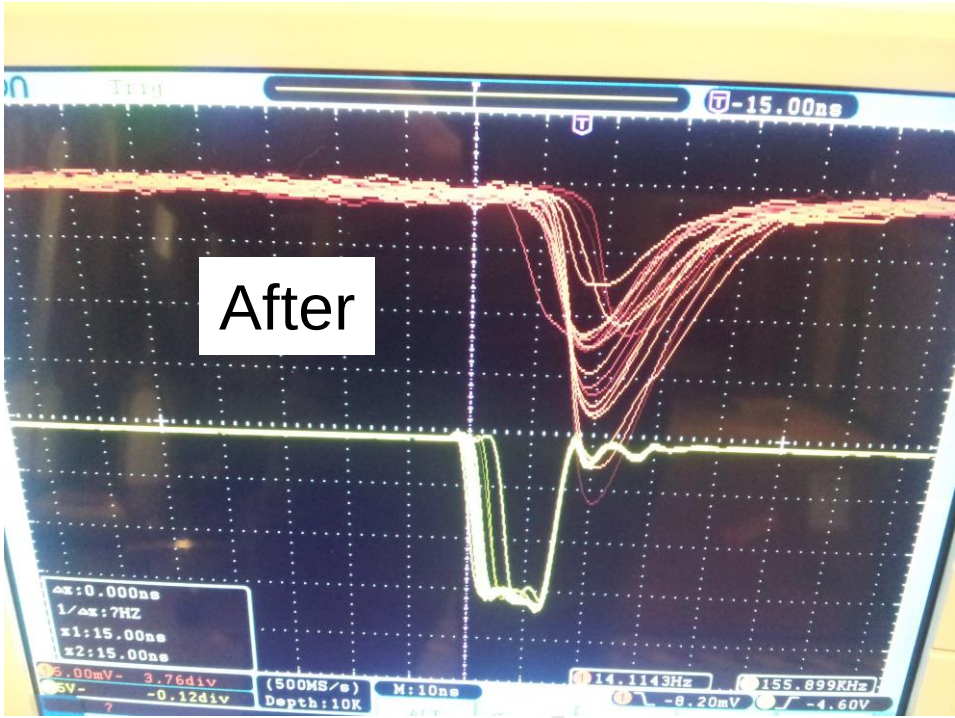
LVDS to ECL translator for front-end signal viewing



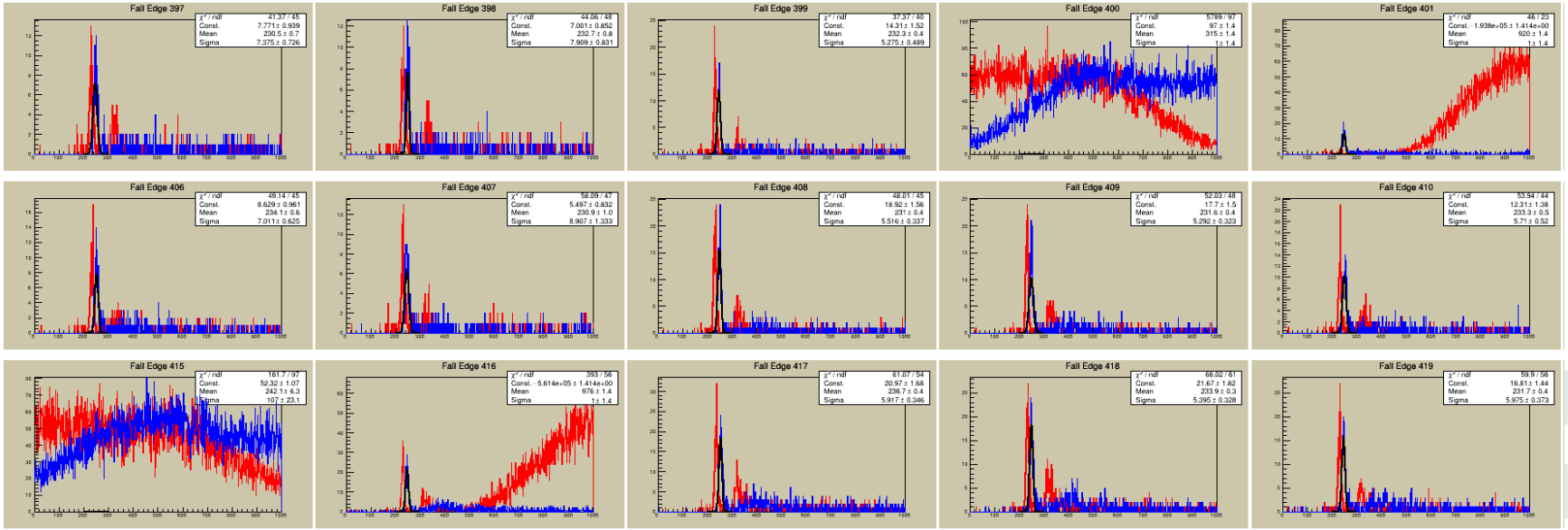


Tuning HV and NINO Thresholds

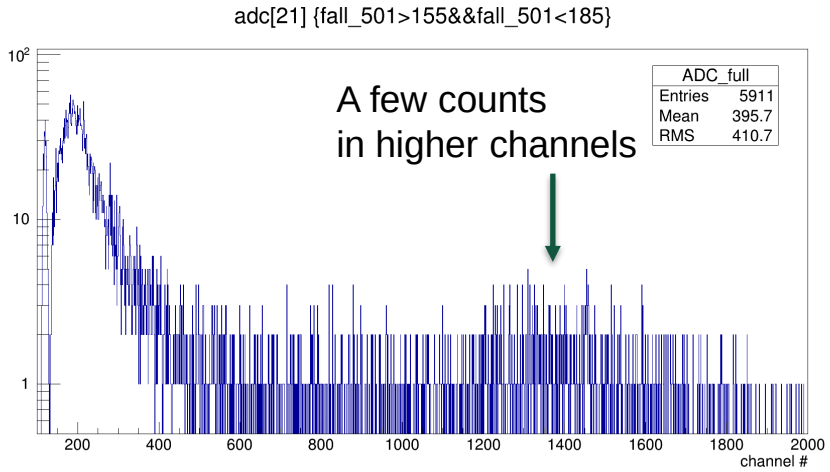


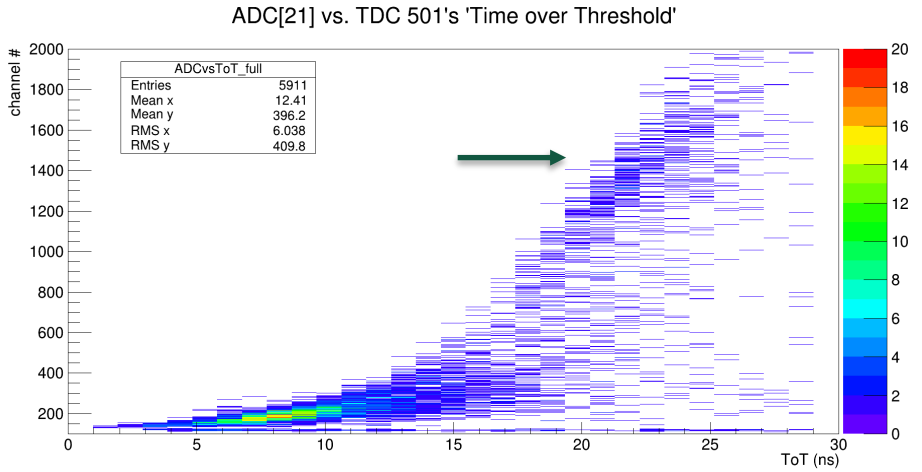


Noisy NINO channels



Zooming out…

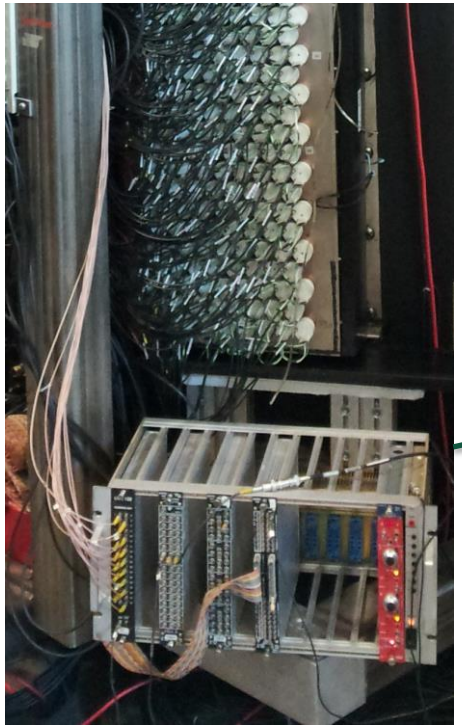




2 different types of PMT hits?
Vertical cosmics passing through more glass?

PMT Trigger

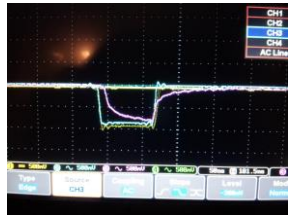
- Analog NINO output can be used to create a trigger signal from PMT rows at the front-end
- This signal can then be sent to the weldment, to be included in trigger logic (same timing)
- In principle, these triggers can be placed anywhere within the GRINCH geometry (so portable)
- In particular, 2 PMT rows surrounding the region wherever the ADC is being output

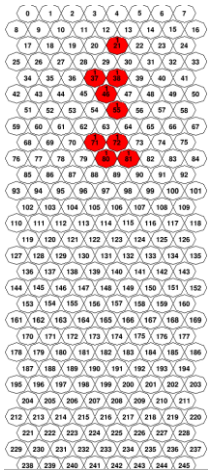


to weldment

“3 Trigger” configuration

- The entire GRINCH is now active, but a top + bottom trigger is slow (~1 event / min)
- To help look for tracks, a PMT row trigger was included in the middle of the GRINCH
- An event is readout if any two of these 3 triggers make a signal
- A cosmic then only needs to pass vertically through ½ of the GRINCH instead of its entirety





TOP

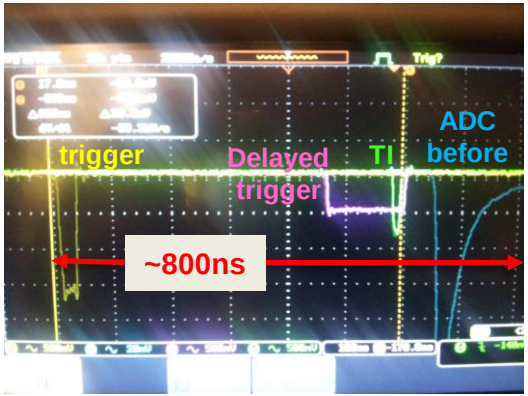
MIDDLE

BOTTOM

(from different events)

ADC cable lengths were halved

- The 200m ADC cables (two 100m sections) necessitated a huge delay in the trigger:



- The “patch panel in the middle” was eliminated, and the 100m cables sent directly to weldment