DarkLight Trigger System Update

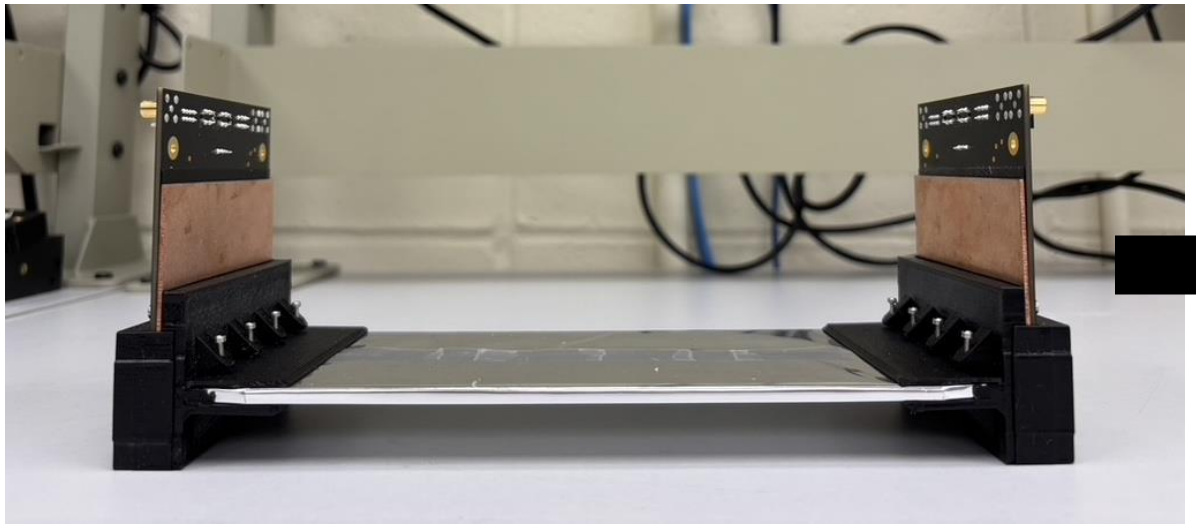
Gabby Gelinas

July 2, 2025

See my (upcoming) thesis for more detailed explanations

Hardware reminder

"Paddle" = Two scintillators held together and their pre-amplifier boards



x4

One array per arm

Installation Status

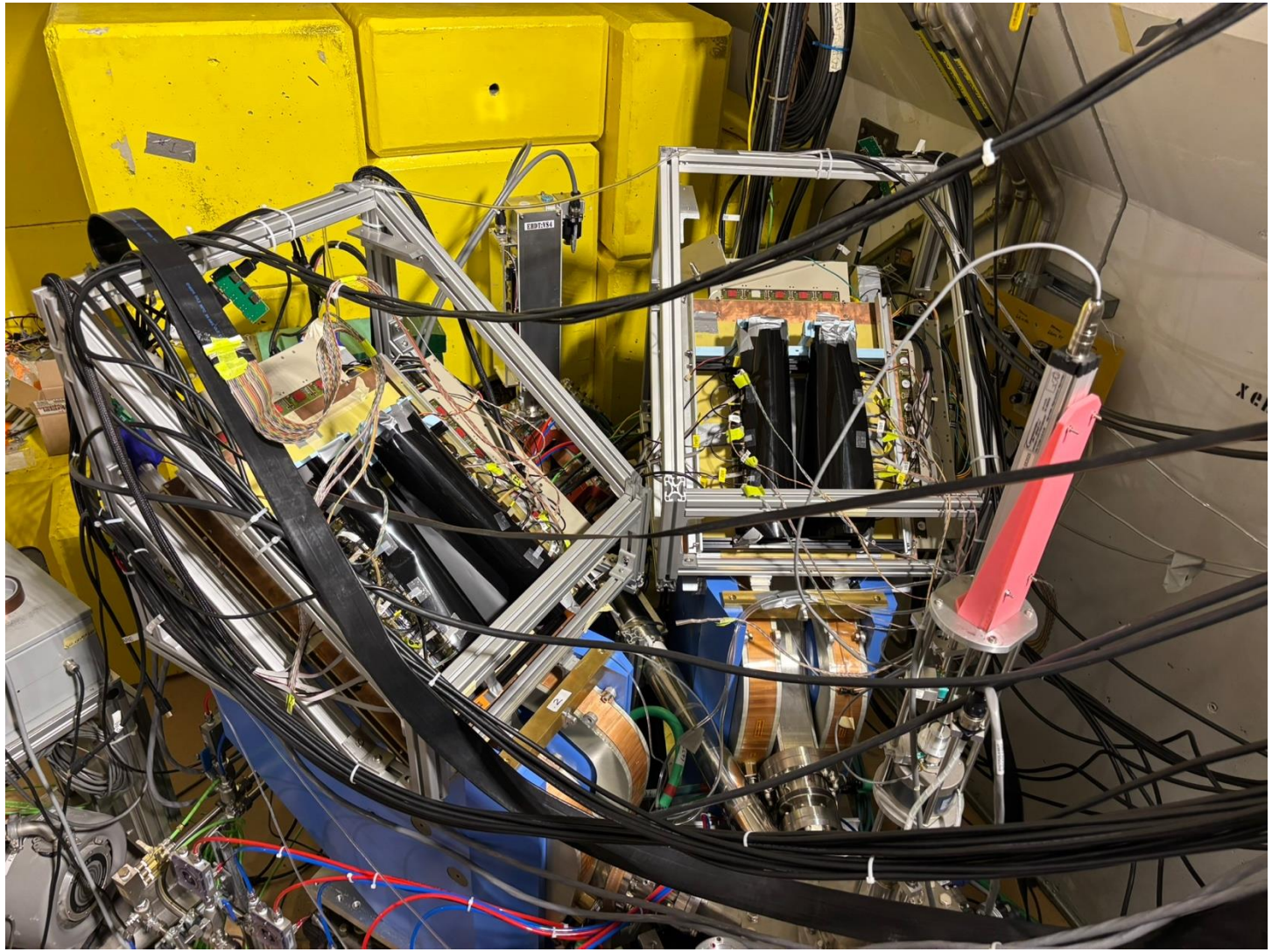
Done

- Detectors installed
- All cables run to e-hall
- All rack power supplies mounted
- All cables from distribution board to detector hooked up
- All TDC cables connected
- All low voltage cables connected
- Fans mounted

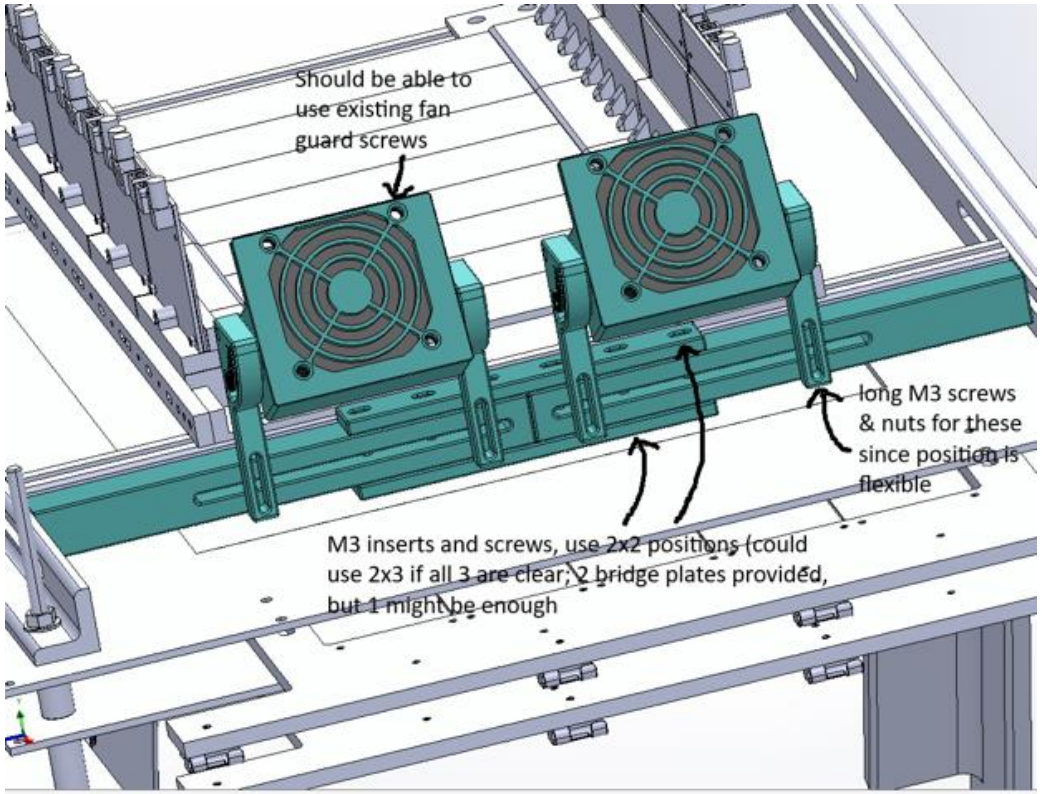
To do

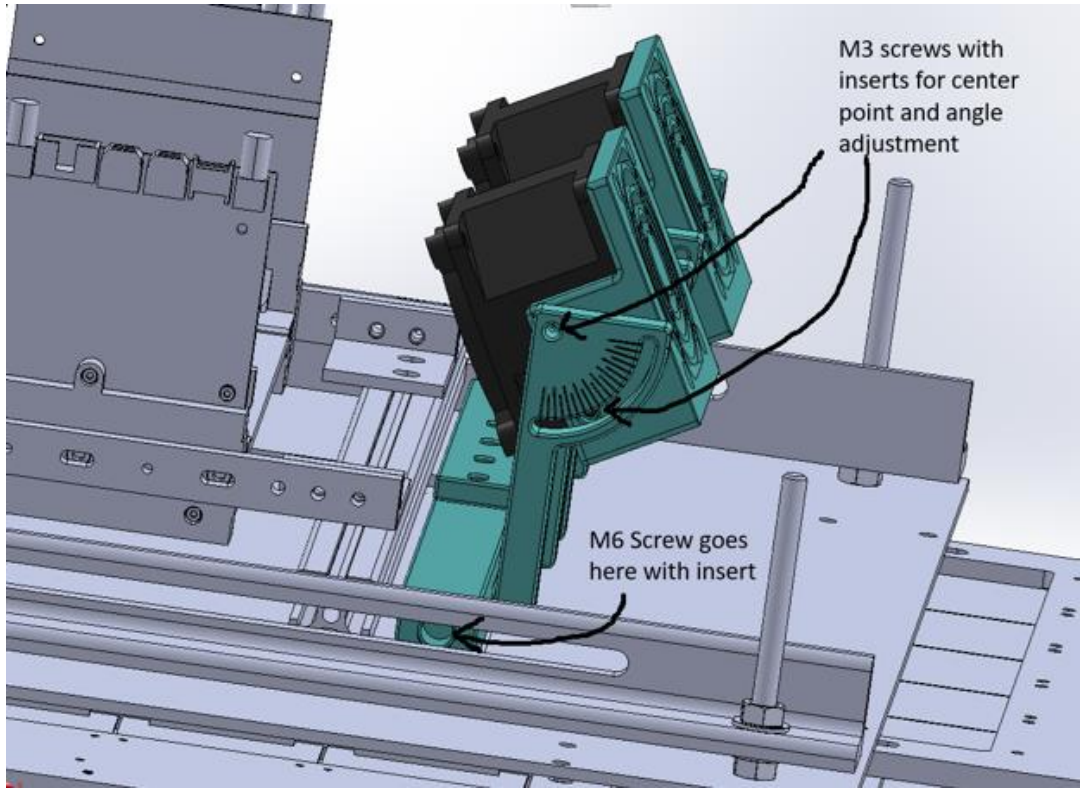
- Need adapter to connect the bias voltage/I2C control cable to distribution board (from Konstantin)
- Hook up low voltage power supplies (Alex)
- Connect analog signal cables to detectors (Mike/Gabby)
- Need longer cables to power fans (made by Konstantin/Alex/Sidney)
- Need new power supply for the fans (eventually, have one that will work for now)

Installation Status



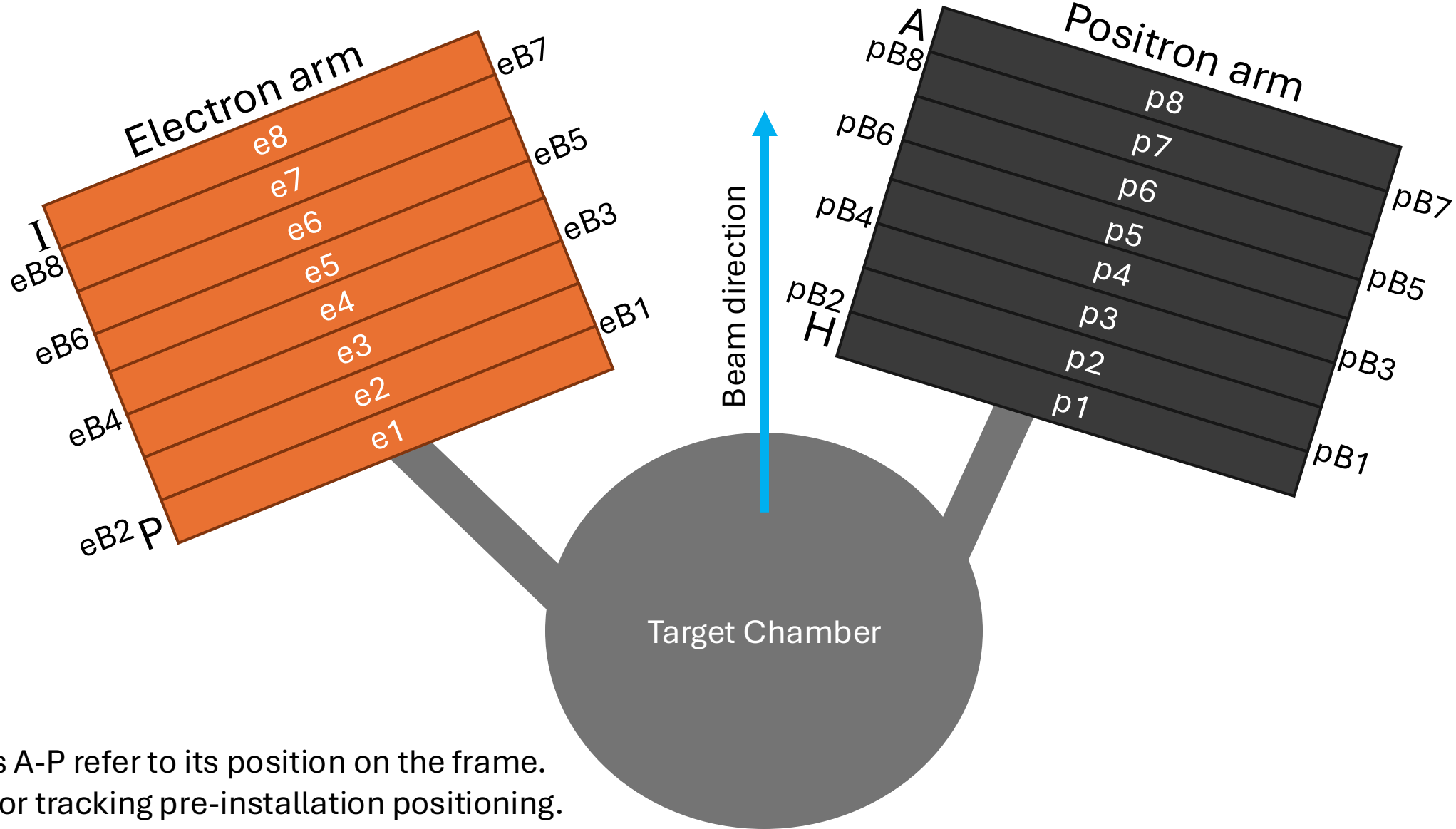
Installation: Still to come





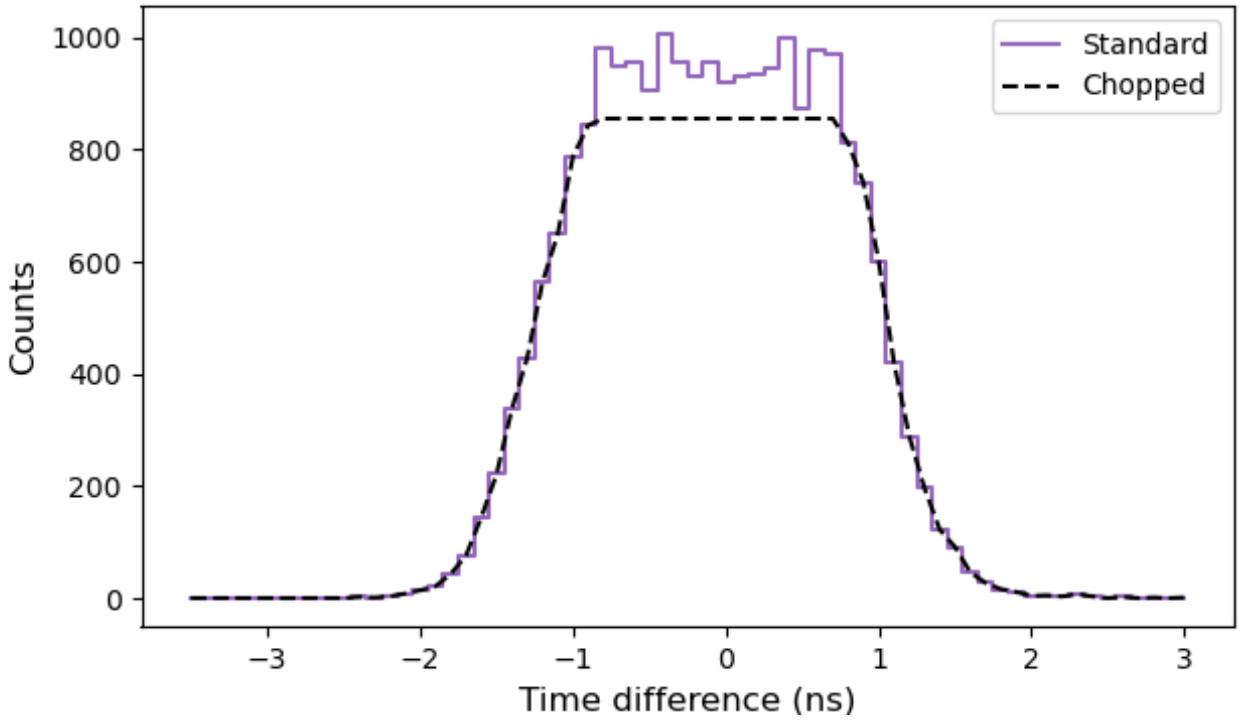
- Have the fans and the supports
- Need power cables and power supply
- Can turn on without them, just not ideal

Scintillator numbering



Letters A-P refer to its position on the frame.
Used for tracking pre-installation positioning.

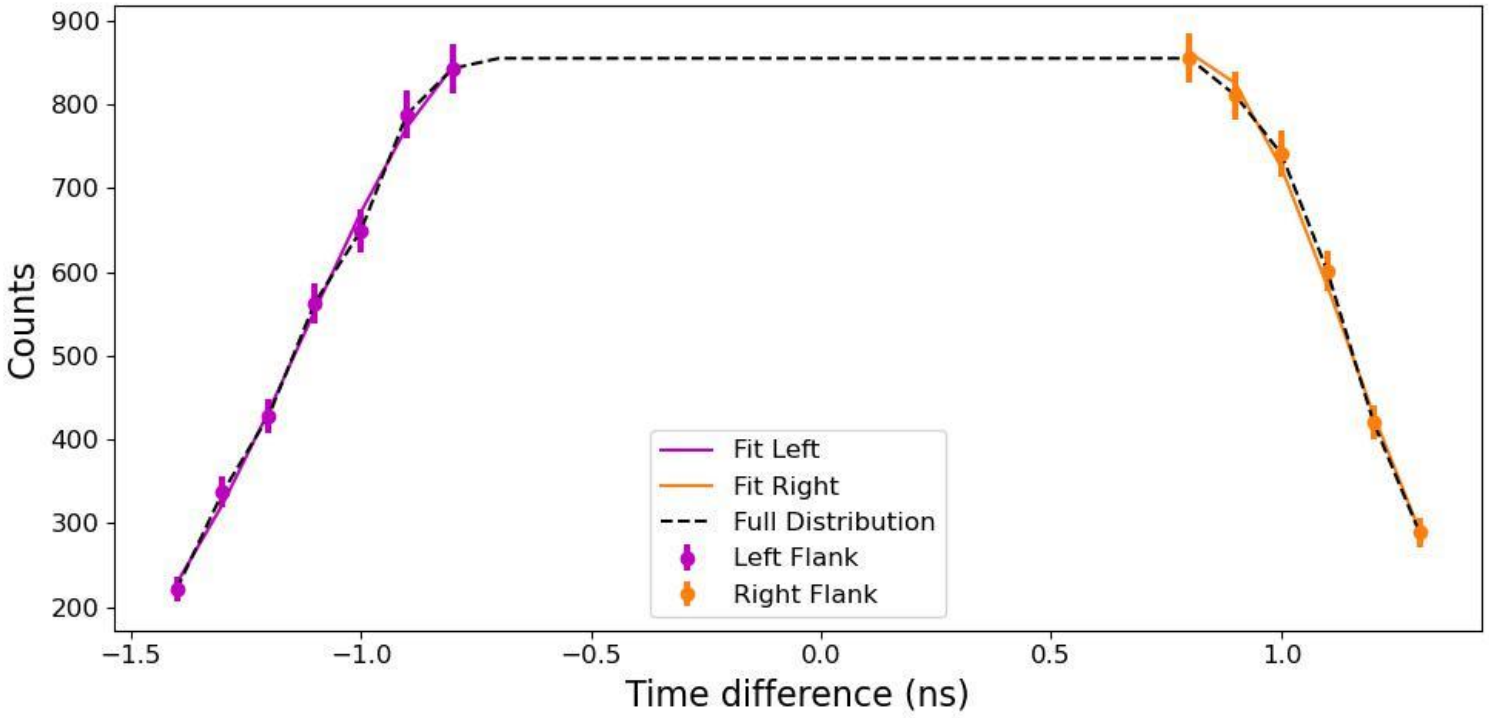
Time resolution



Bumpy time difference distributions means they are very hard to fit! Some are getting better after Konstantin's work.

To fix this, we chop the top off (thanks Jan!)

Time resolution



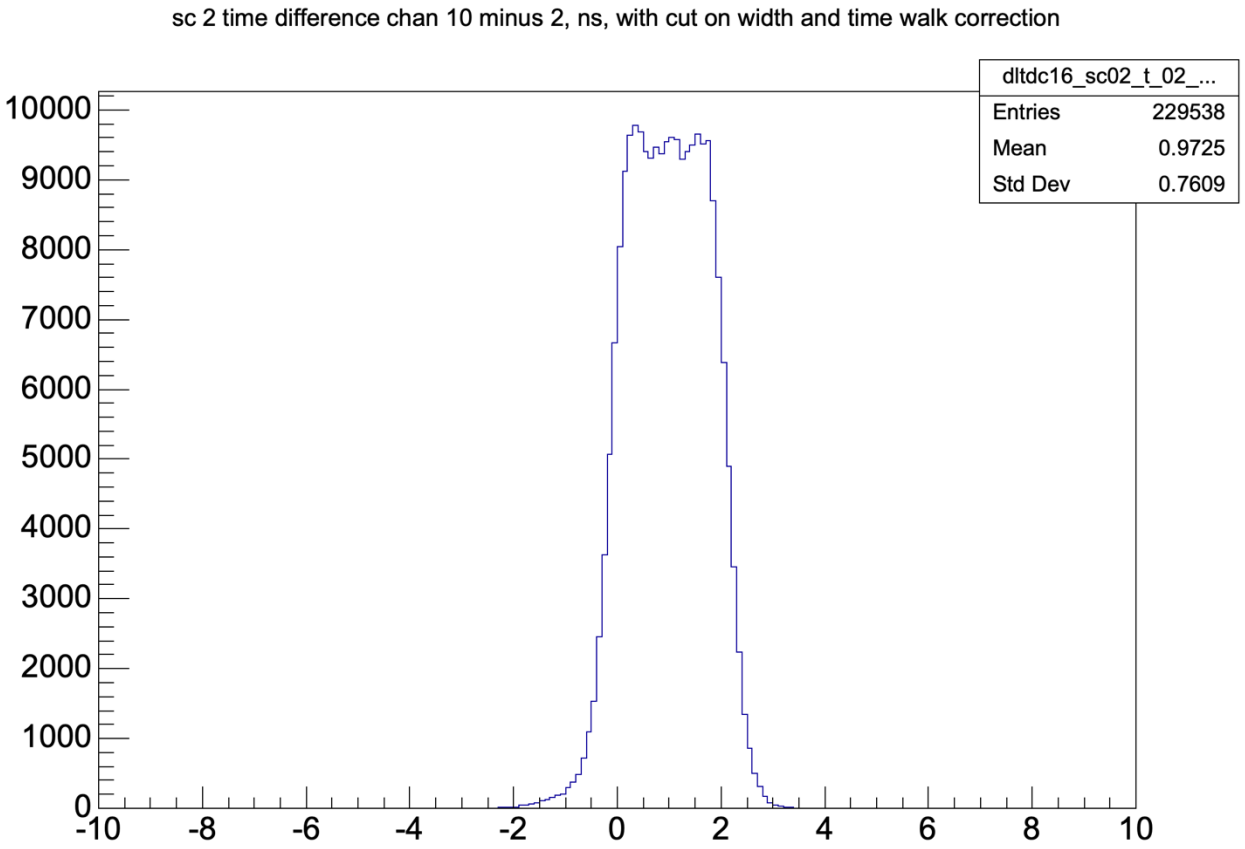
The whole function should be represented by a Gaussian convoluted with a square wave. Still hard to fit.

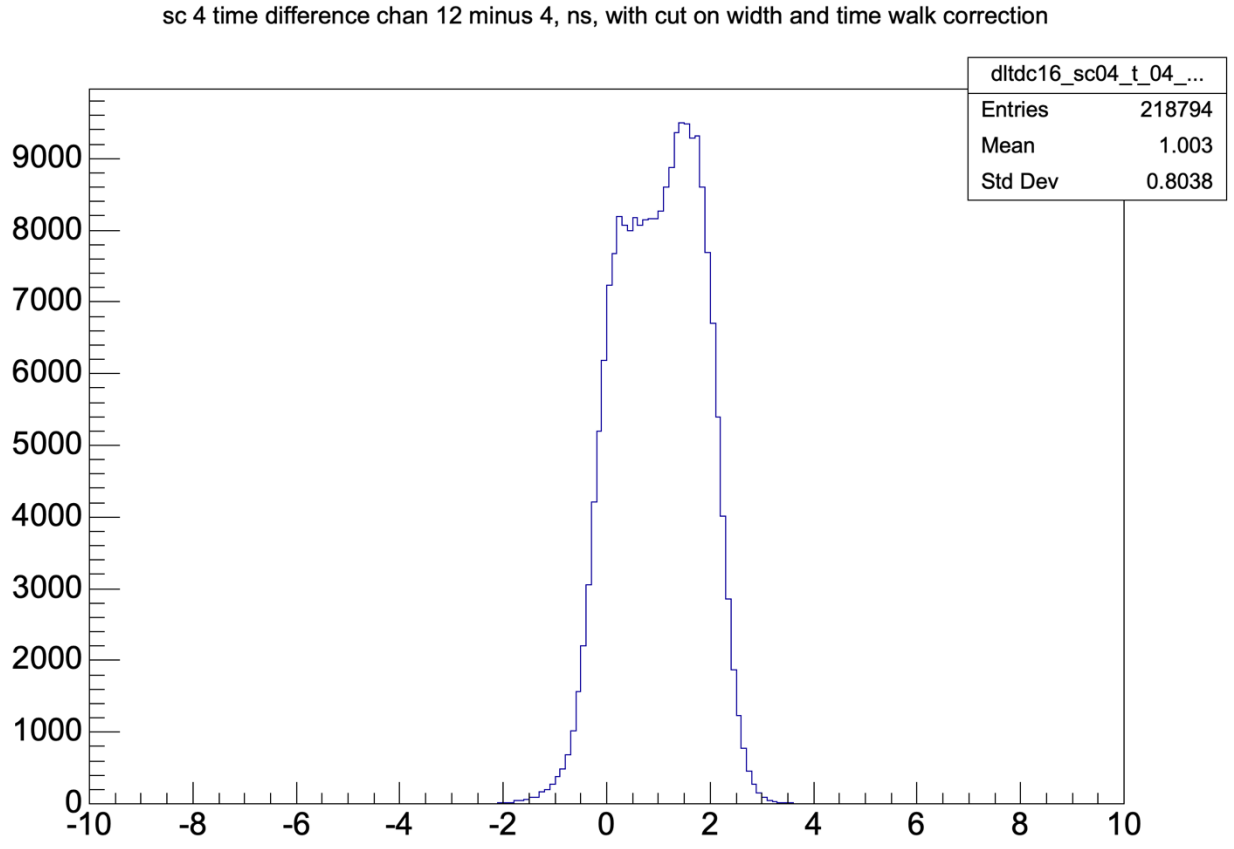
Solution: fit just the flanks (one at a time) with a Gaussian to get the time resolution (thanks Sidney!).

Test with 16 scintillators gave a time resolution of 0.381 ns ± 0.004 ns (cosmic rays).

We need 0.50 ns or better to distinguish bunches by 3σ. We did it!

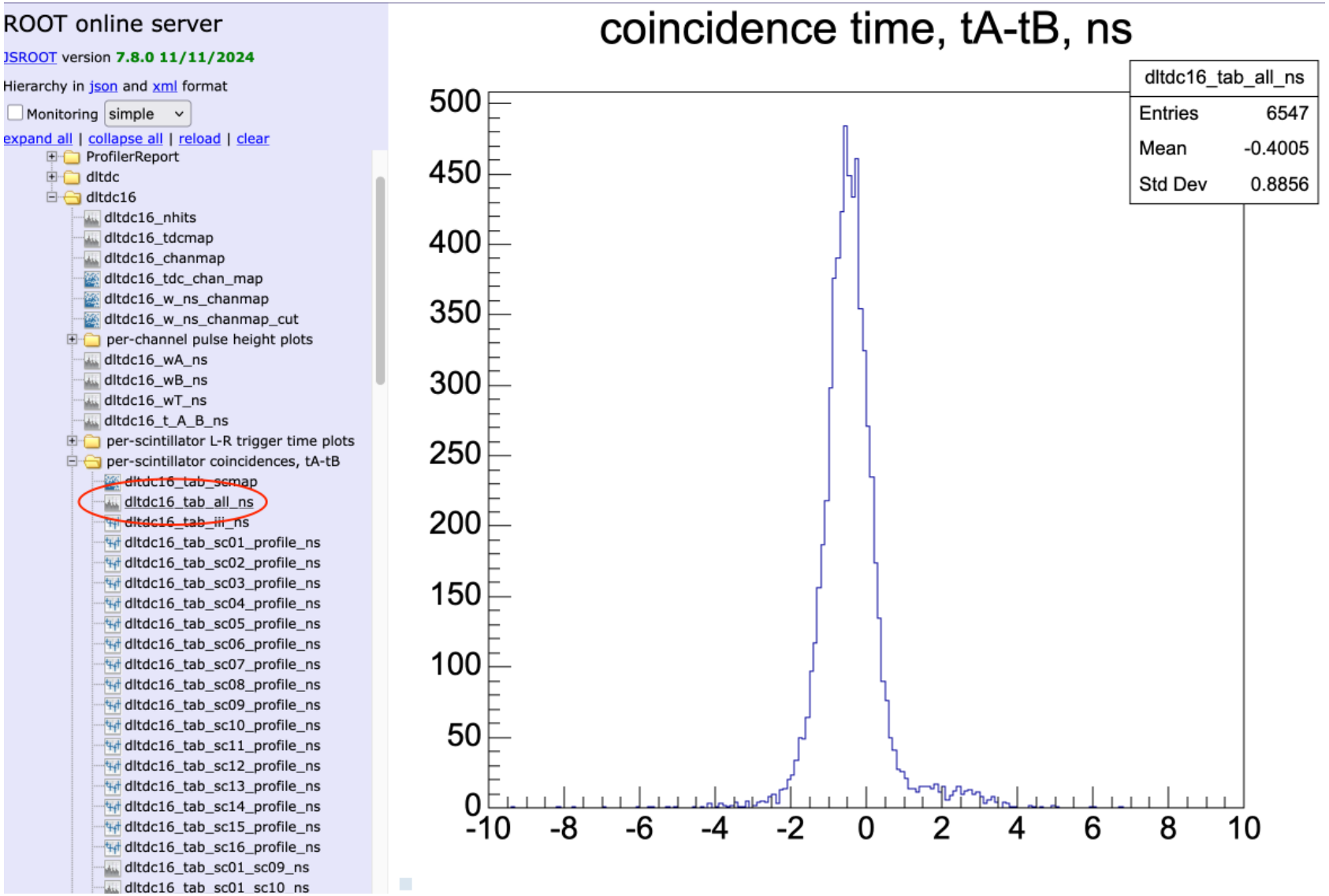
Current peak shape examples





Run 633, June 27

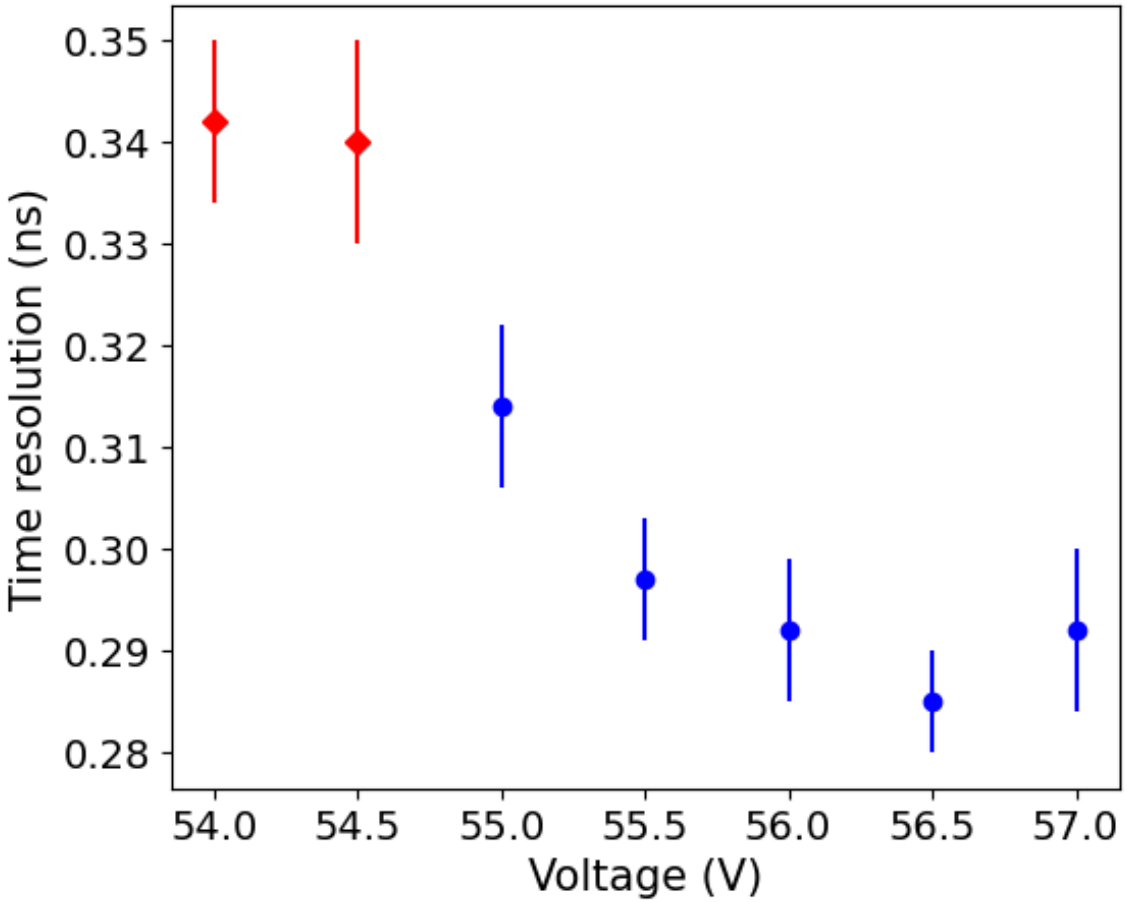
Coincidence Time



Time resolution fine tuning

Can get small improvements in time resolution by fine tuning the voltage applied to the pre-amplifier boards, within the region where the pulse width distribution is separated from the noise.

Further studies coming from Sidney using the test set up.

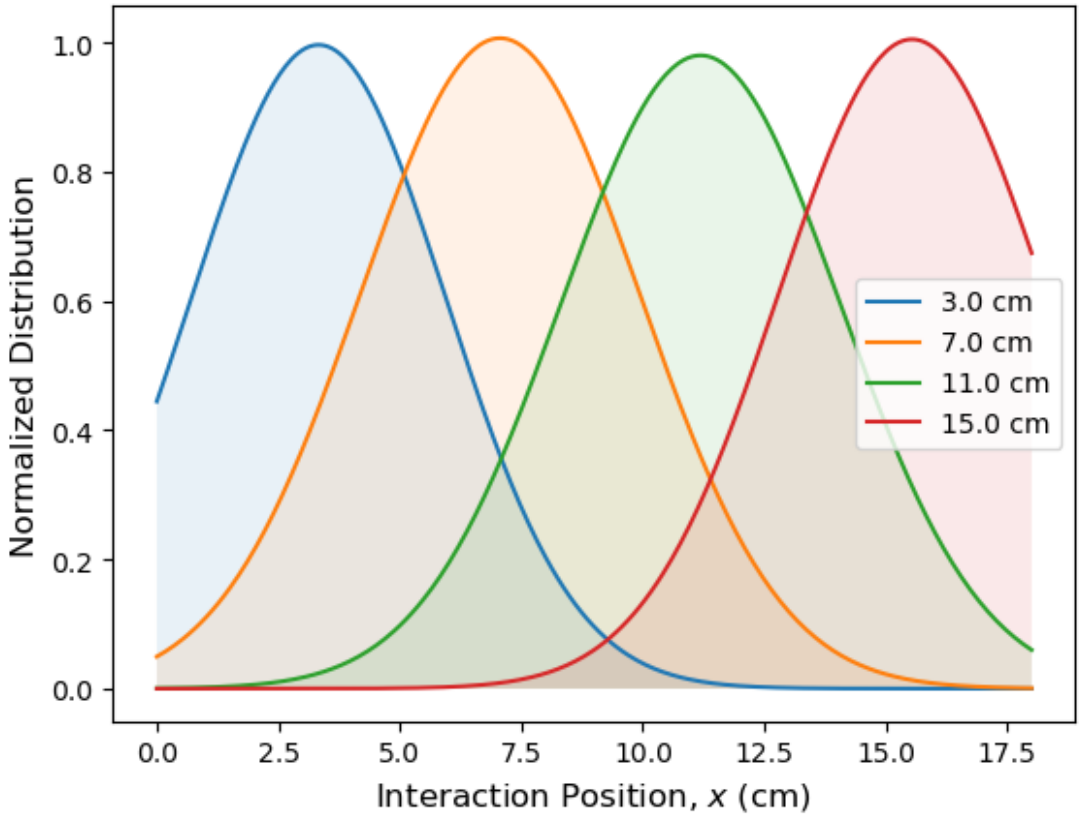


Position resolution

Previously presented at July 2024 collaboration meeting

Position resolution of 2.14 cm ± 0.08 cm

This is how well we can identify the position of one hit. Take three times this value (standard of 3σ) for how well two particles can be distinguished.



Time of Flight

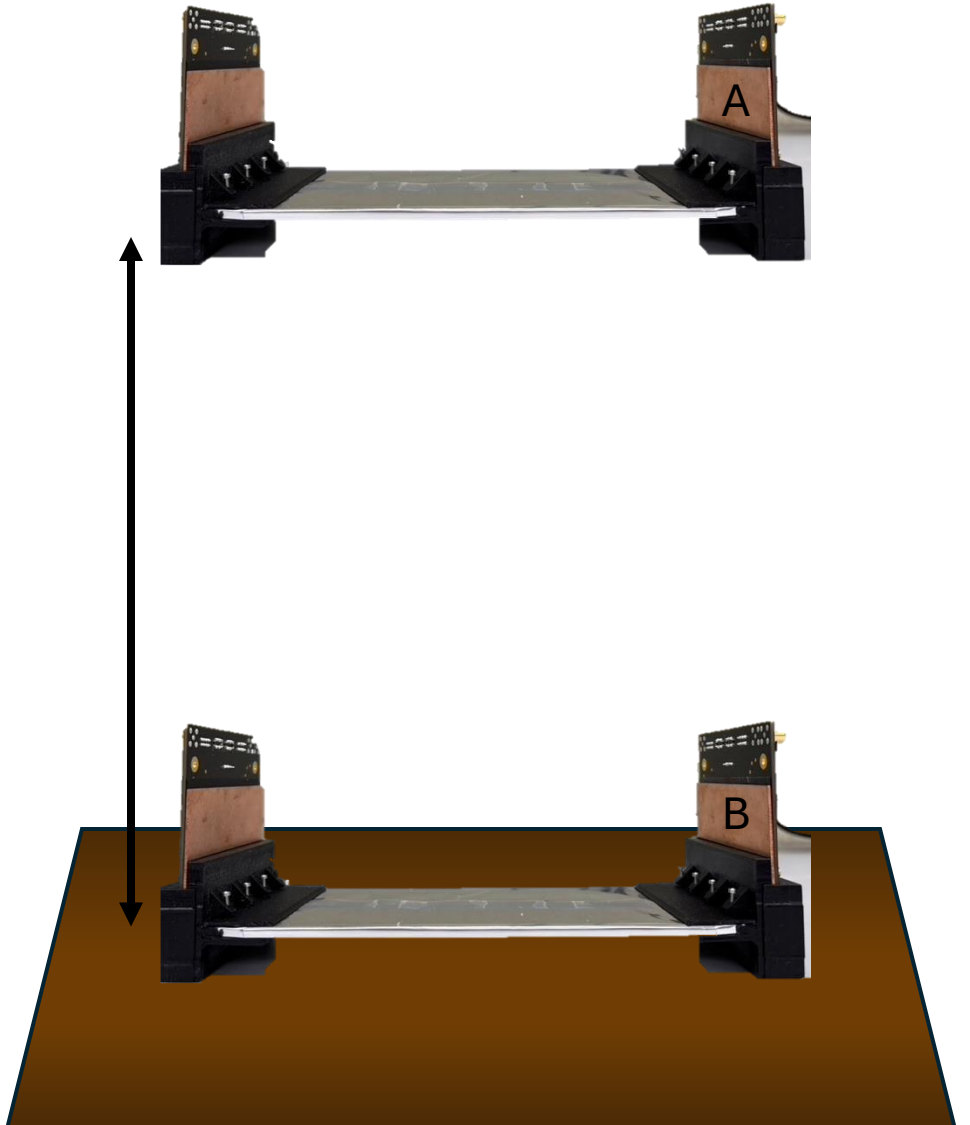
$$t_{tof} = (t_B - t_A)_{distance\ 1} - (t_B - t_A)_{distance\ 2}$$

Cosmic ray speed as a fraction of c for all scintillator combinations

1.00 ± 0.01	1.12 ± 0.01
1.02 ± 0.01	1.13 ± 0.01

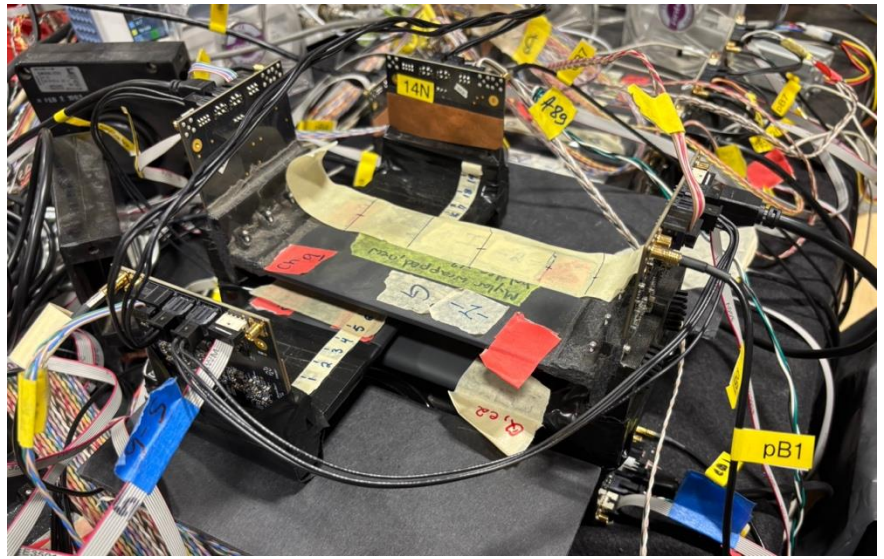
Reproducibility concern

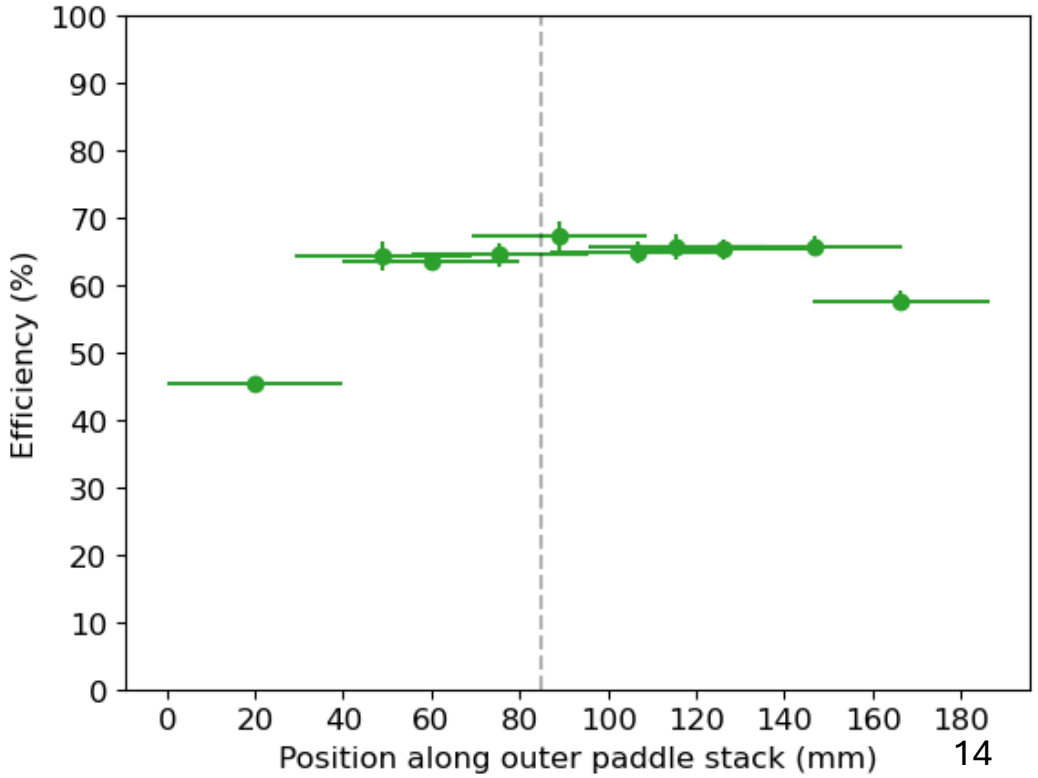
- Do not reliably get values near the speed of light
- Can get self-consistent data sets reliably



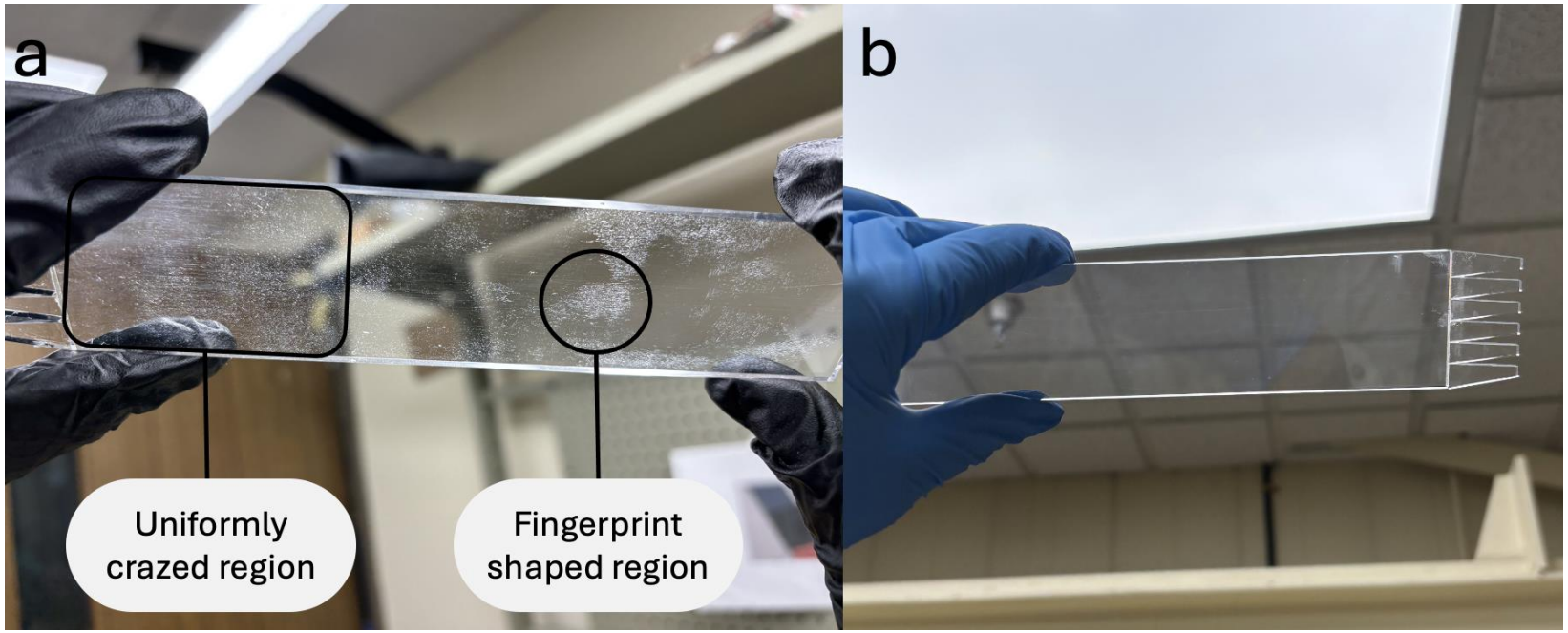
Efficiency

- Across the whole paddle: 63.98% ± 0.03%
- Central region only: 66.22% ± 0.04%
- Lower than expected, but could be impacted by the ~4 cm spacing between upper and lower paddles in the test (forced by holder size)



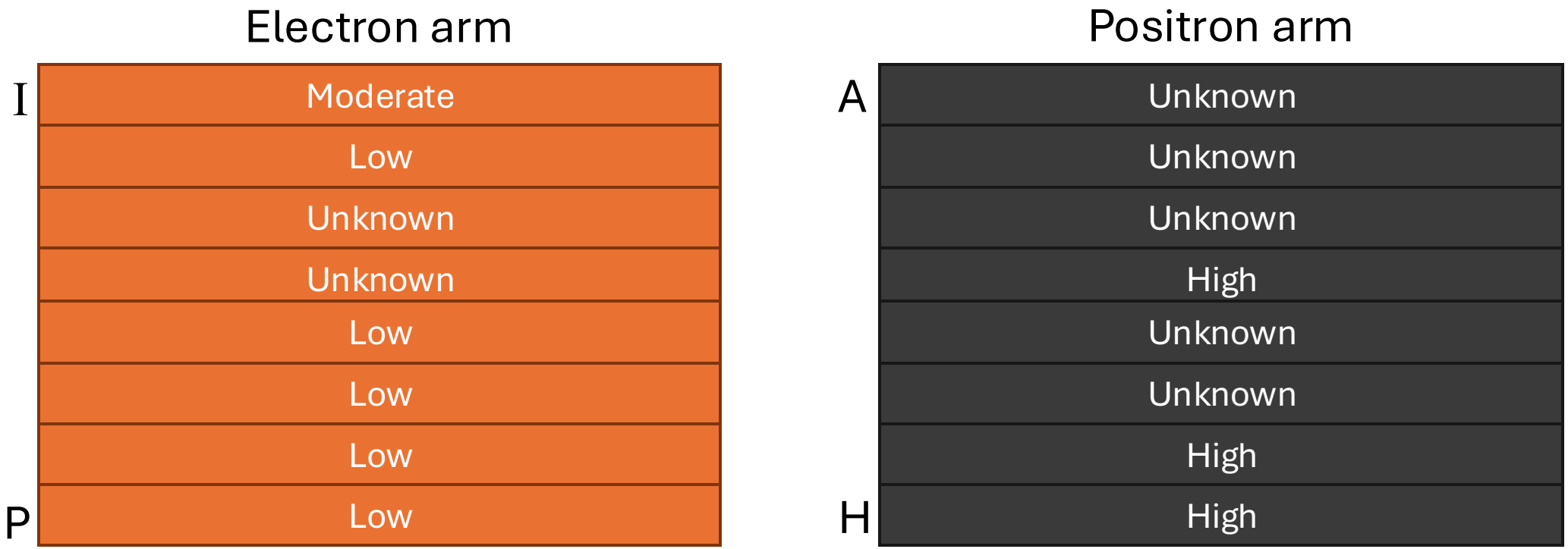


Crazing concerns



- Does not cause a meaningful difference in time resolution
- Average over low/no crazed scintillators: 0.38 ns ± 0.01 ns
- Average over moderate/high crazed scintillators: 0.40 ns ± 0.01 ns

Crazing map

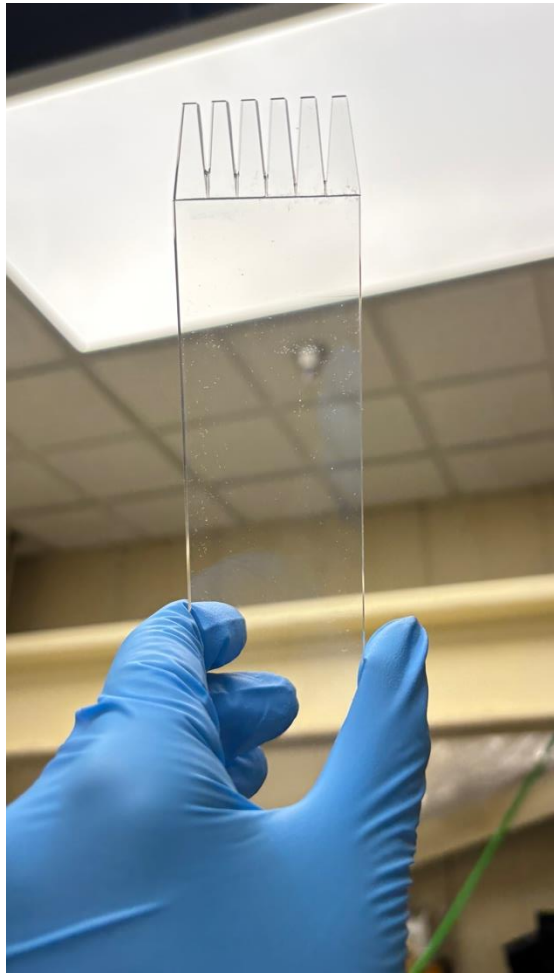


Unknown = wrapped in mylar before crazing level was tracked

Crazing level examples

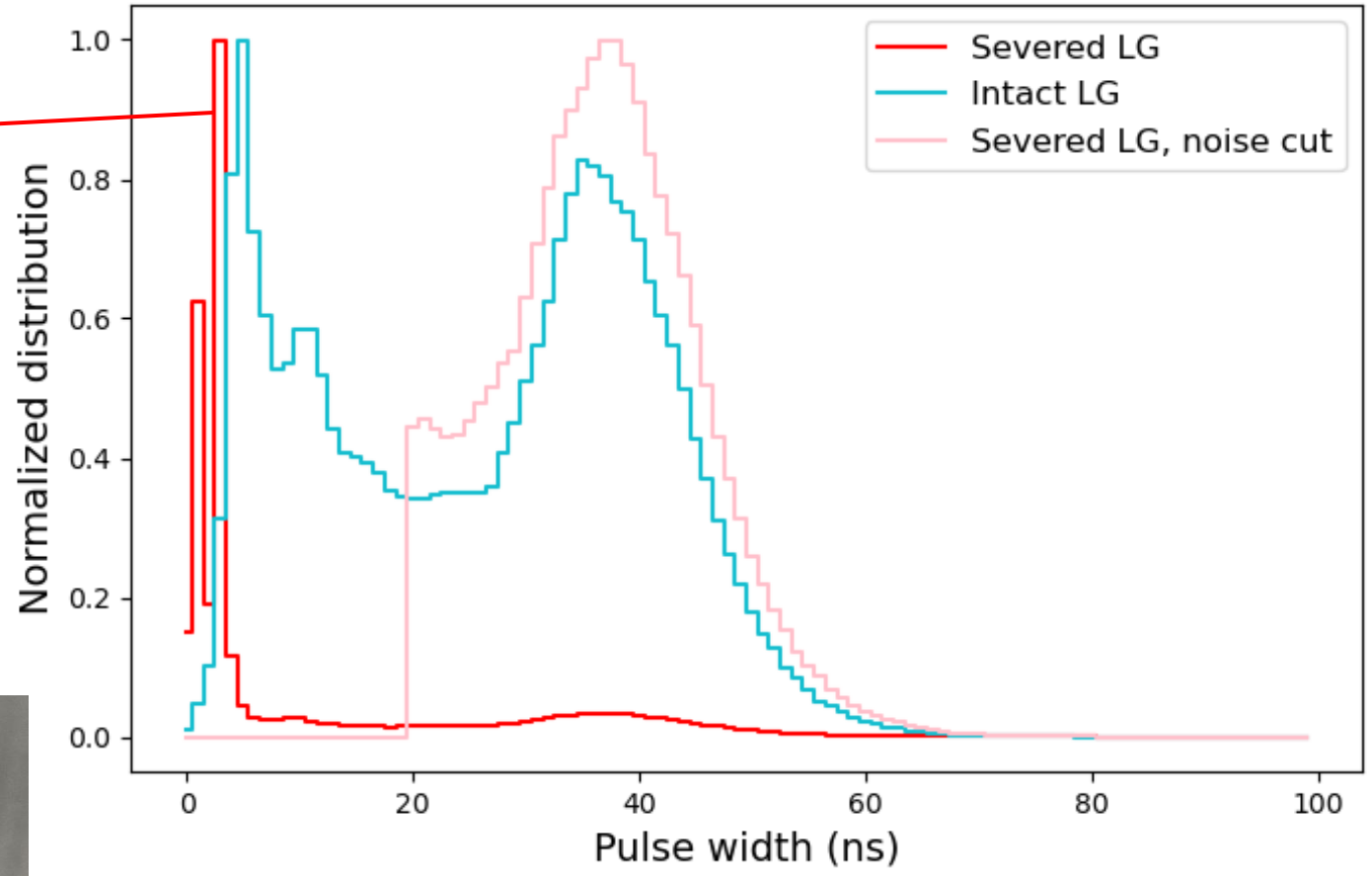
High

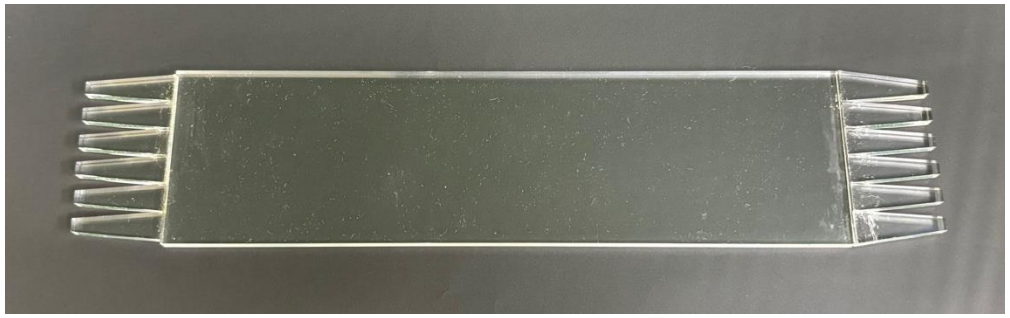
Low



BE GENTLE WITH MY DETECTOR!
(Broken light guides)

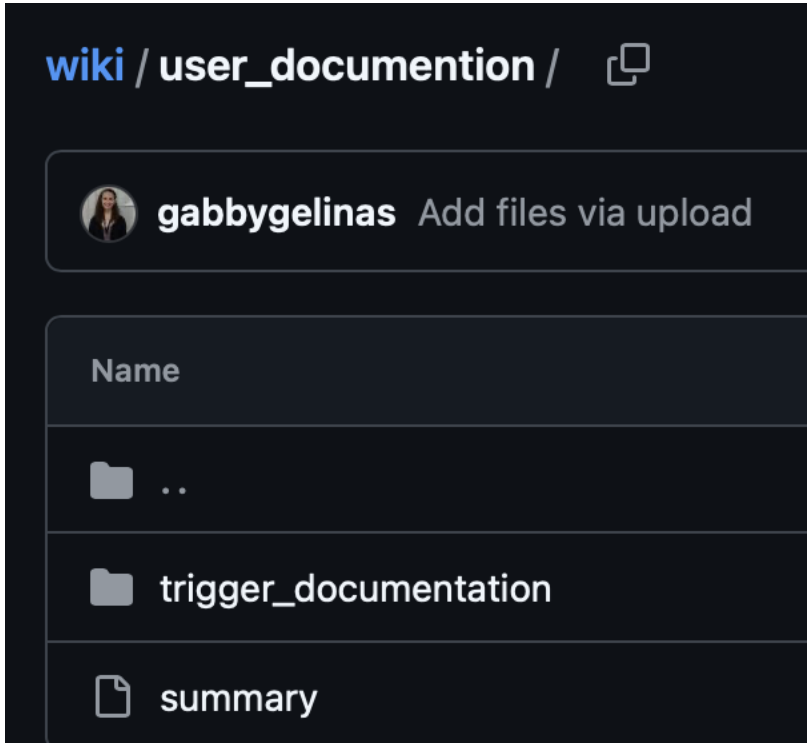
3x as many events as the intact end!





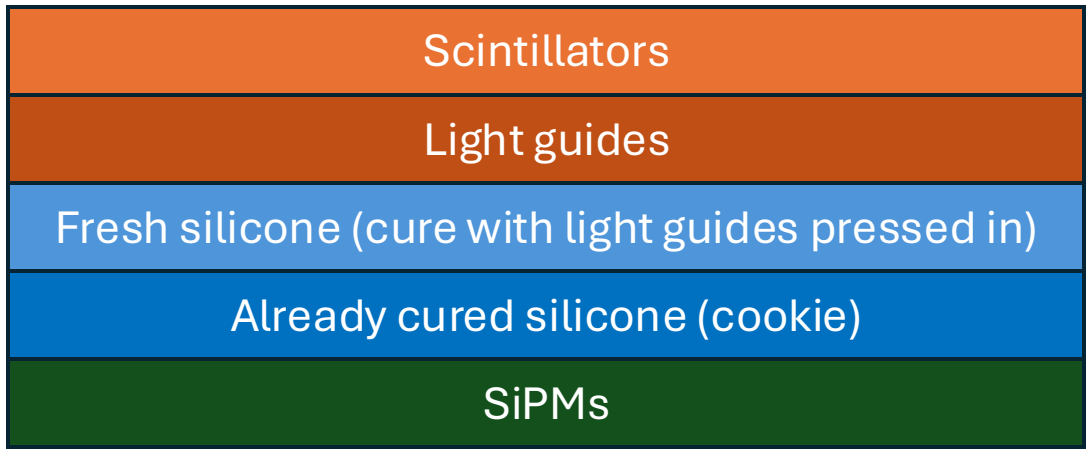
If you break my detectors

- I won’t be around to fix it
- Very detailed documentation on how to repair them on the wiki
  - Also has cabling, channel mapping, and data processing information
- Two spare paddles are prepared. They just need to be light leak sealed after adding the pre-amplifier boards



To save time in paddle repair

- Paddles are assembled as:



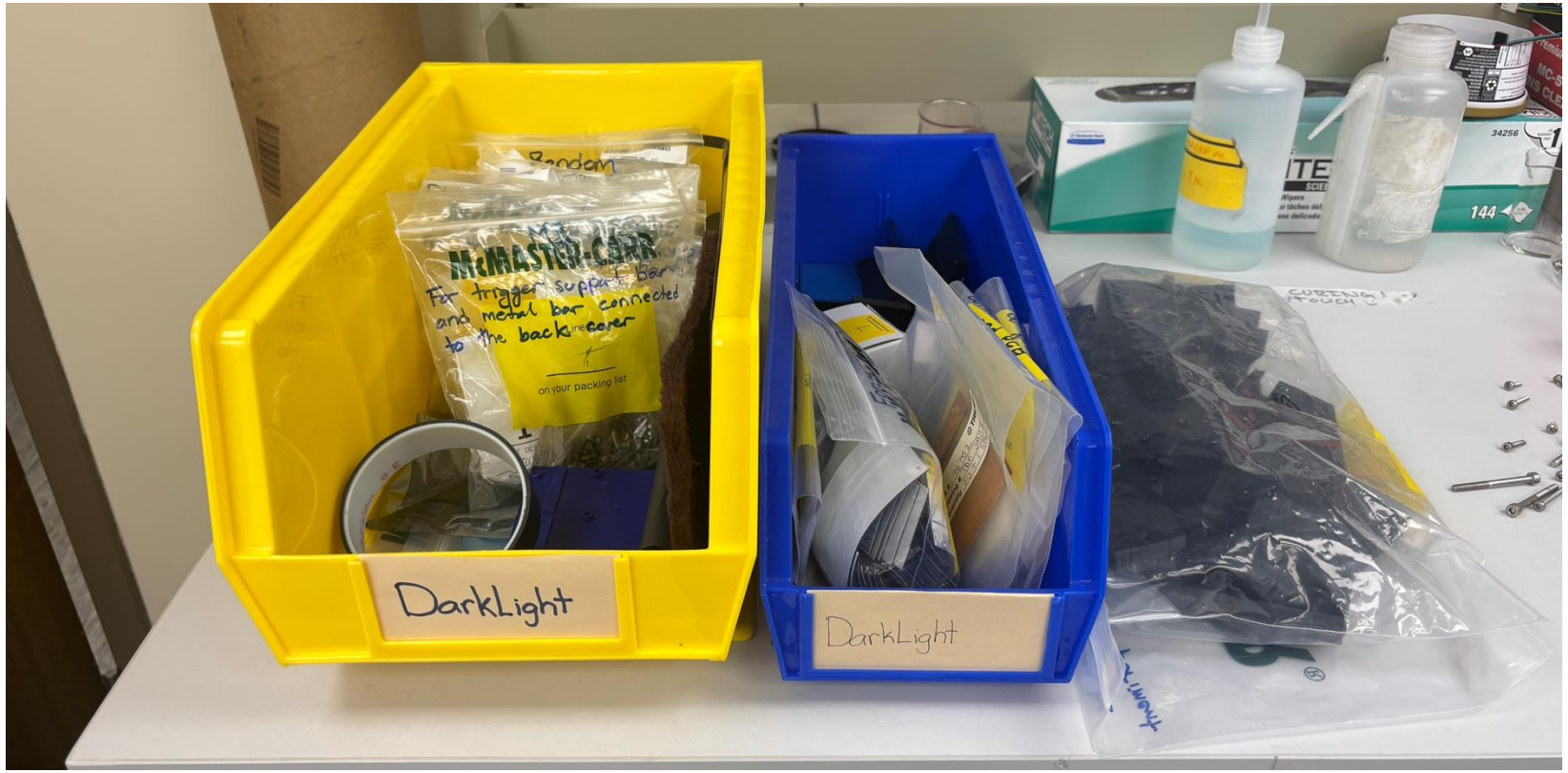
- Fresh silicone step must be done one end of the paddle at a time. Minimum of 8 hour cure time per end.

To save time in paddle repair

- Replace fresh silicone with Dow Corning Q2-3067 optical couplant
- May introduce extra air gaps (possible signal loss/attenuation)
- No curing time

	σ_{avg} (ns)	$u(\sigma_{avg})$ (ns)	Average χ^2/ν
Fully cured silicone	0.378	0.003	0.928
Partially cured silicone	0.346	0.004	1.064
Optical gel	0.350	0.004	0.863

Repair materials



- Everything except glue and silicone mixing materials are here. Bags and boxes are labelled with what you use them for. You should never need this information.

My Final Bow

DarkLight with Gabby

DarkLight without Gabby

- Thesis gets handed in by Friday! (Tell Mike and Kate to be nice)
- Last day is August 13
- Next step: PhD at the University of Calgary (stable isotope mass spectrometry)

Sike! I know you want more Gabby

- Convocation is sometime from November 26-28

- Willing to stay for the weekend and take shifts if Laura and Ethan need a chance to sleep, if DarkLight pays the extra hotel/meal costs