EMCal Cosmic Teststand

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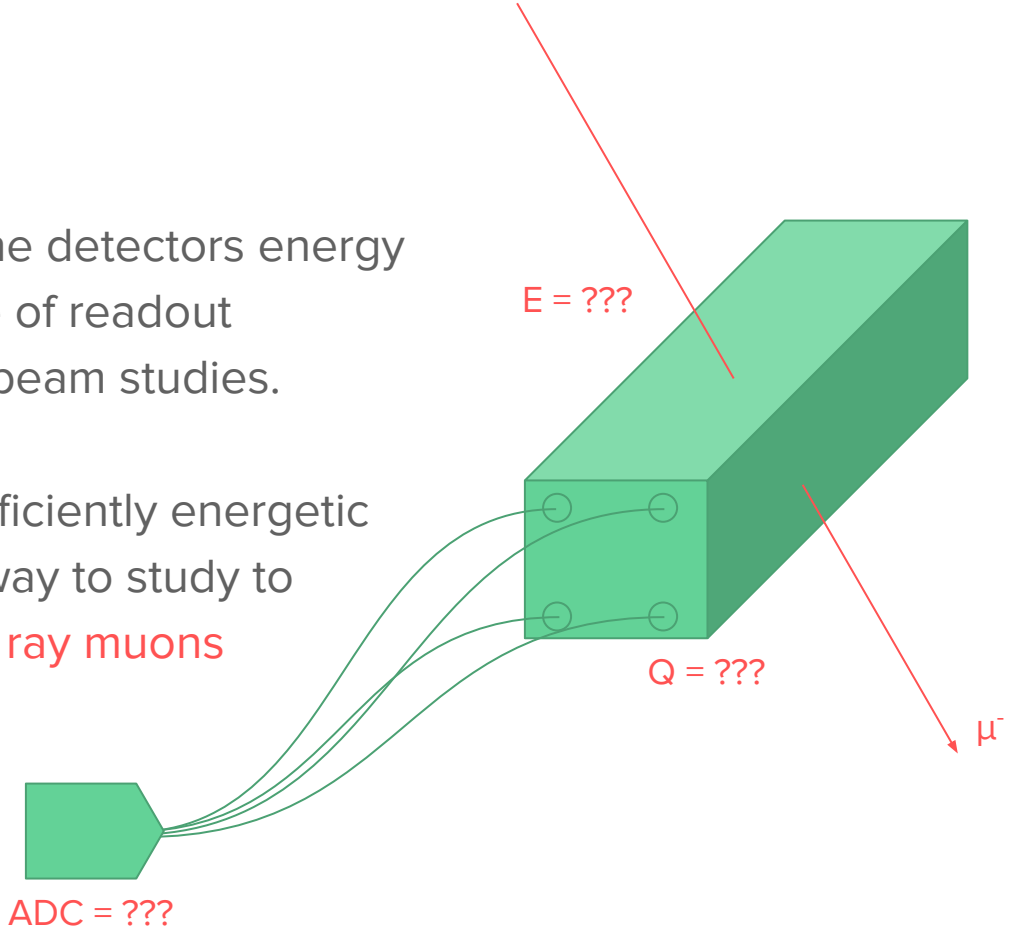
Motivation

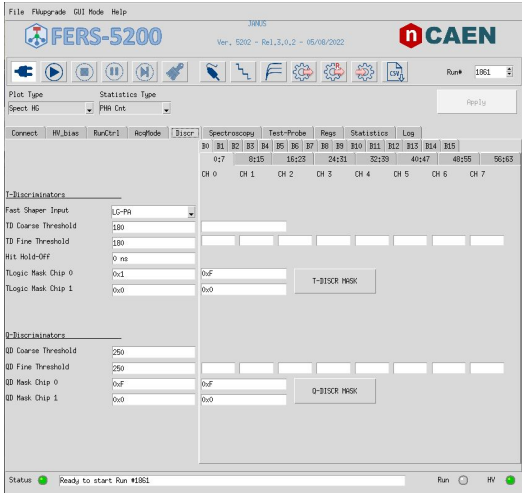
- A baseline understanding of the detectors energy response and functional range of readout electronics is vital prior to testbeam studies.

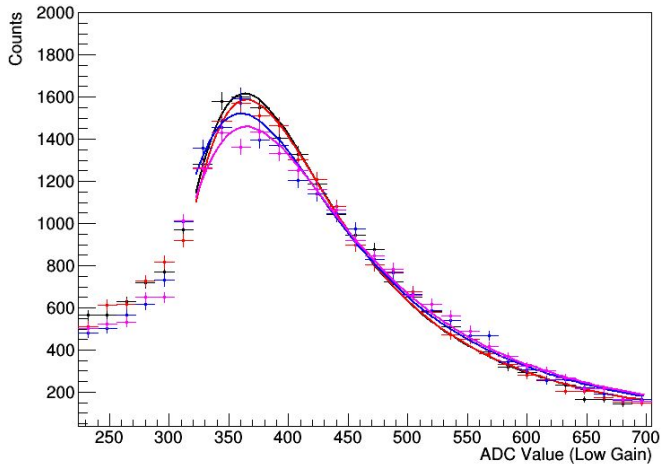
- Without access to beam or sufficiently energetic radioactive sources, the only way to study to EMCal modules is with cosmic ray muons



Self Triggered Studies

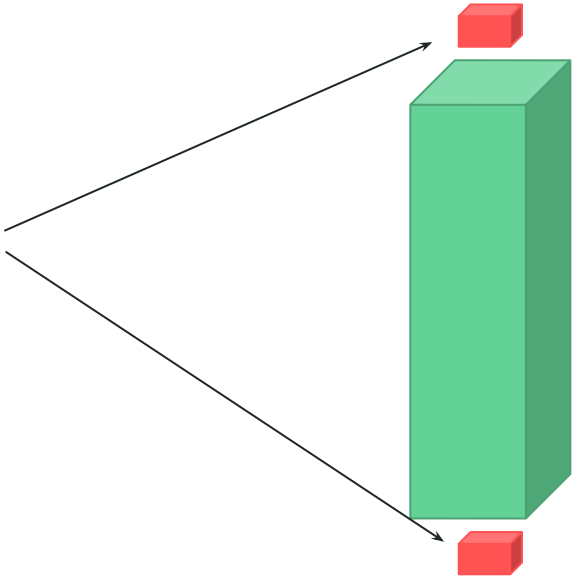
- Initial measurements were done with the detector running in “self triggered” mode
  - Janus software suite used to control the CitiROC can trigger readout when any combination of channels goes over a certain threshold
  - Expect a broad Landau distribution from random trajectories of muons in the detector
- Useful for learning to use software, and also cross-calibrating different channels to ensure uniform energy response





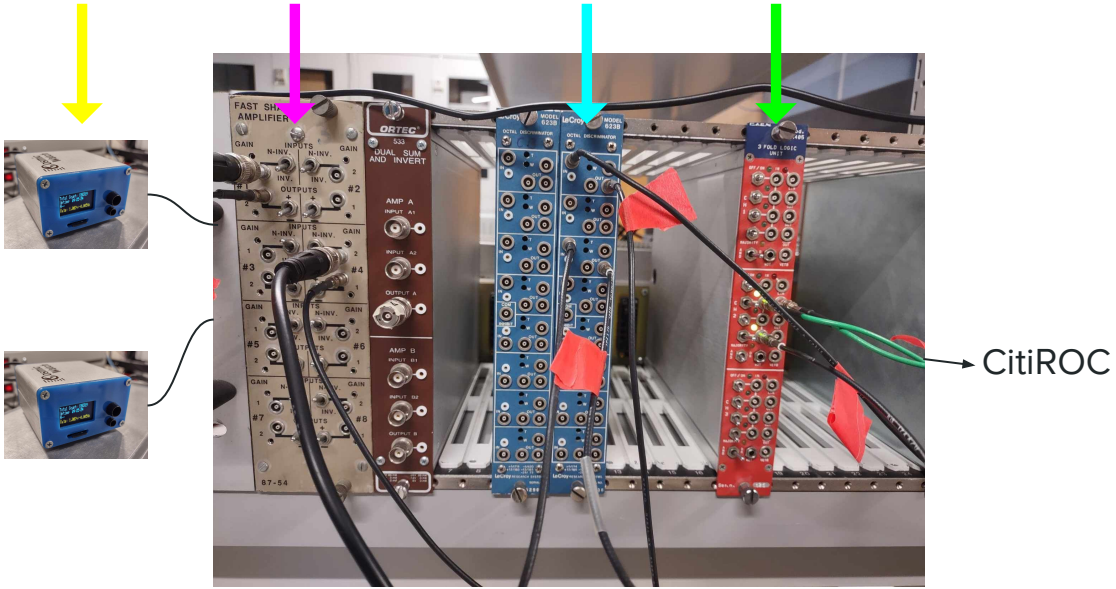
External Trigger: CosmicWatch

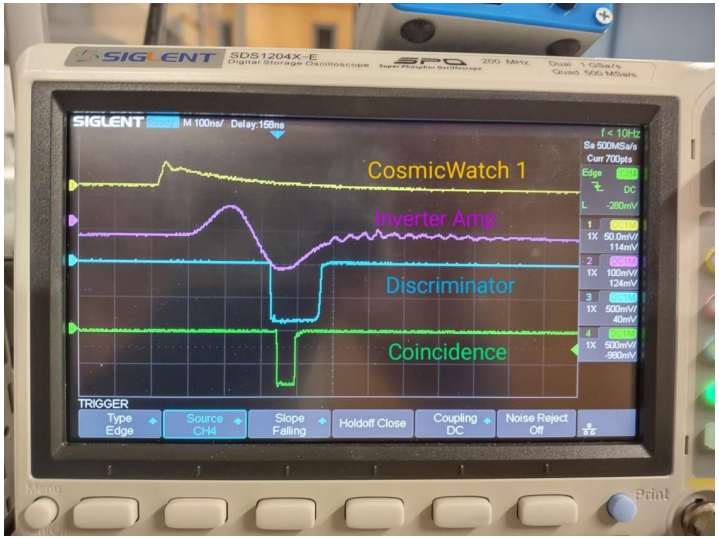
- To get a more precise sense of how much energy is deposited in the detector, an external coincidence trigger was constructed using CosmicWatches:
  - Arduino based muon detector using a SiPM and small scintillator tile



External Trigger: CosmicWatch

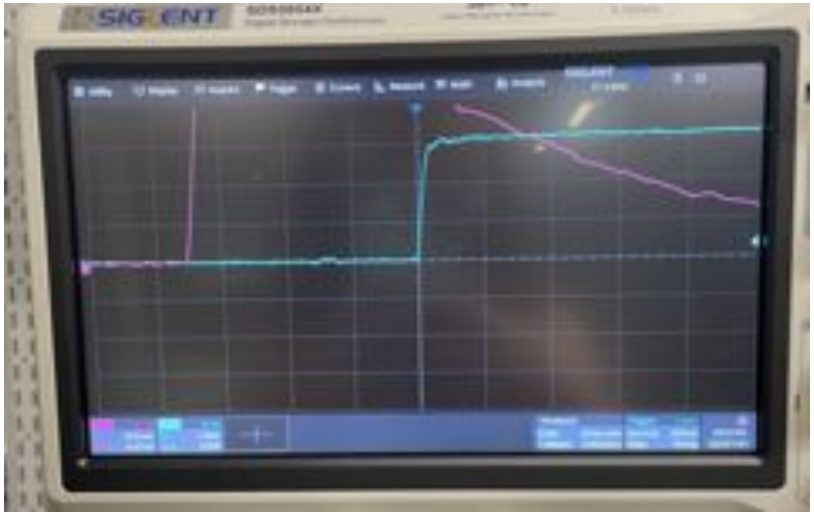
- Trigger logic originally provided by a string of NIM modules
  - Introduces irreducible ~300ns delay between muon hit and trigger pulse. Not usable for this readout board





External Trigger: CosmicWatch

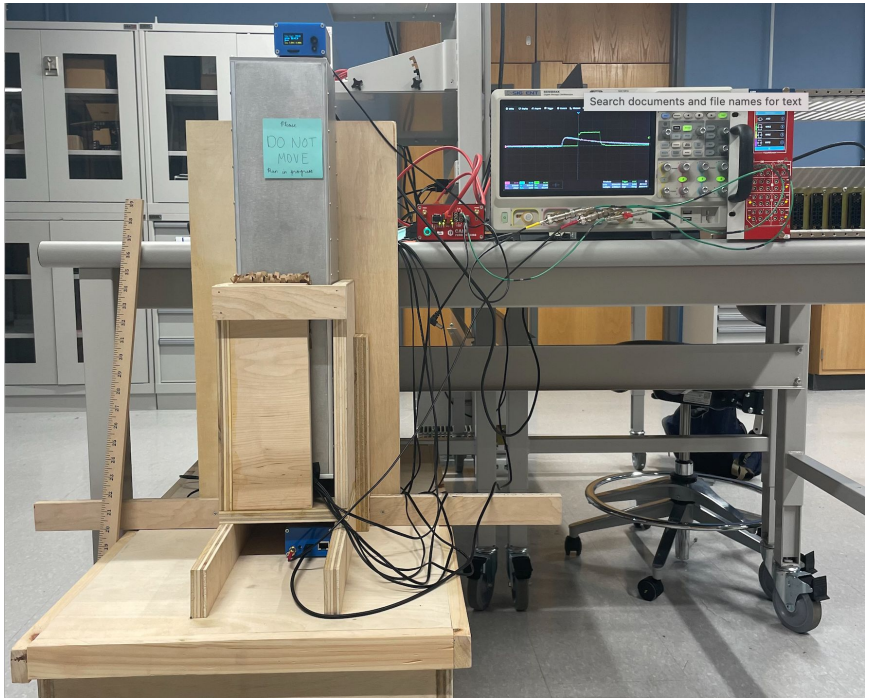
- All discrimination and logic function replaced by a single CAEN N1081B multipurpose logic module
- Lag from CosmicWatch pulse to trigger signal is much smaller (~70ns), which is within maximum window of the CitiROC shaping circuit



External Trigger: CosmicWatch

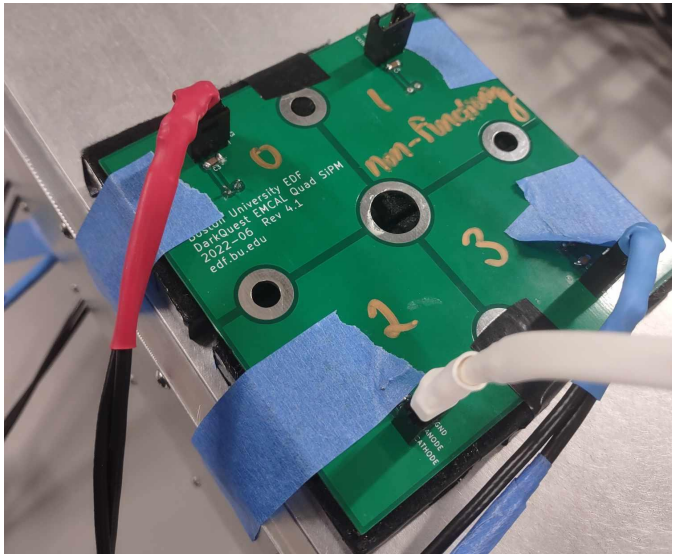
- Completed setup shown for a “straight through” cosmic run
  - Both CosmicWatches are oriented above and below the same tower
  - Any triggering muons will have to enter and exit the detector on that channel with a nearly fixed path length

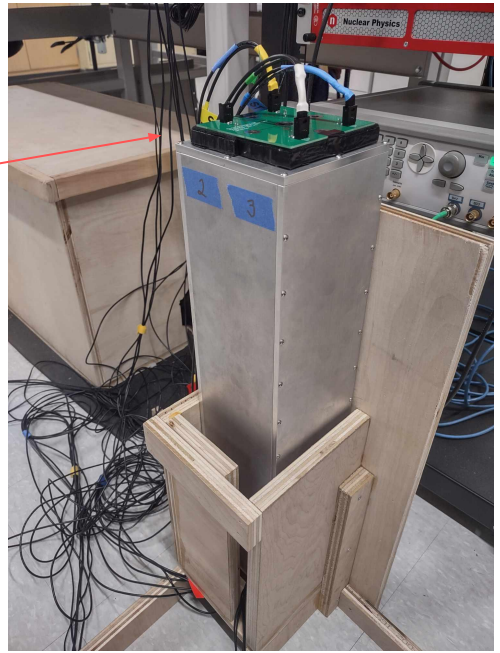
- Allows for approximate correlation between light read-out and expected “energy deposition” in the detector
  - More in Catherine’s talk



External Trigger: Custom Hodoscope

- CosmicWatches replaced with 4 tile scintillator array, to test multiple channels at once
  - Miniature DP-Hodoscope (mini-Hodo)

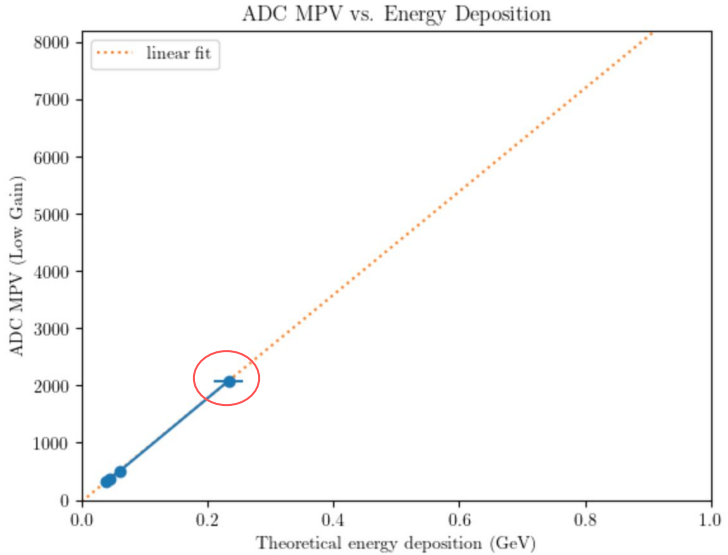




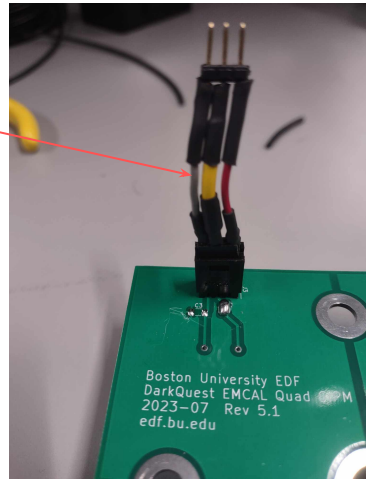
Electrical Signal Attenuation

- Tests of the average readout energy when triggering on muons passing through the detector at different lengths indicated that the CitiROC ADC would saturate for energy depositions much lower than will be expected in practice

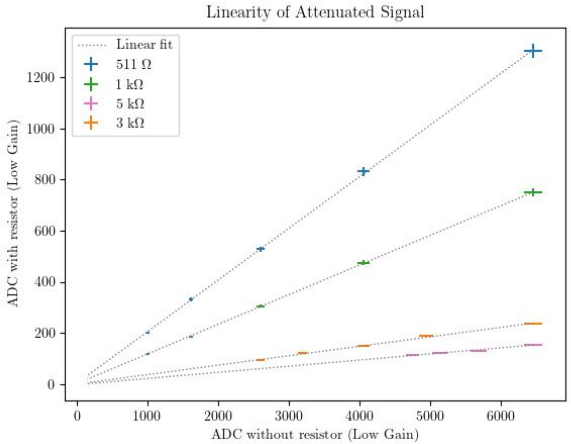
- Need a method to scale down the size of the pulse coming off the SiPMs

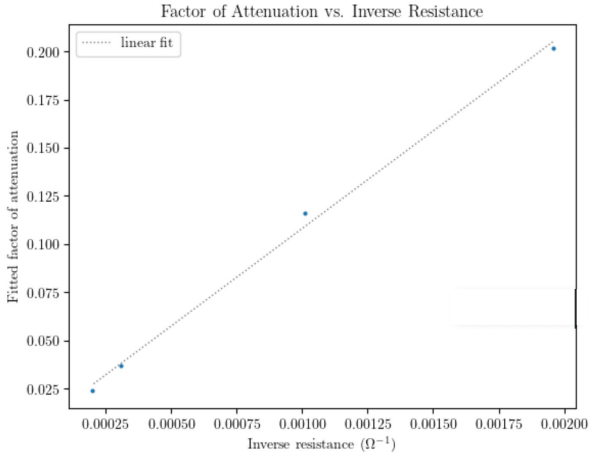


Electrical Signal Attenuation



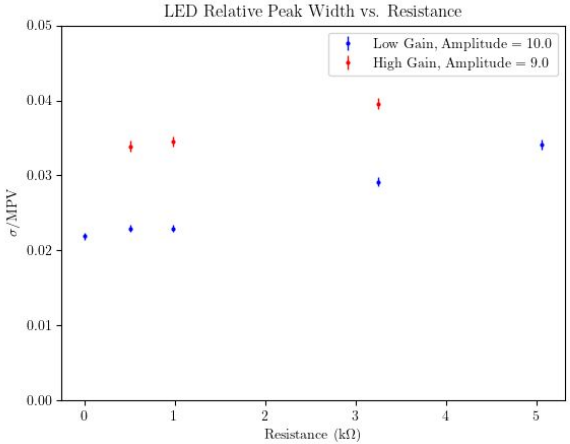
- By placing a resistor in series with the cathode the signal is impeded such that it approximates the effect of an attenuator:
  - This is not good signal transmission praxis!
  - But it is cheap, fast, and easy to swap in and out of the set-up
- It does work and a linear relationship between resistance and signal strength reduction can be shown

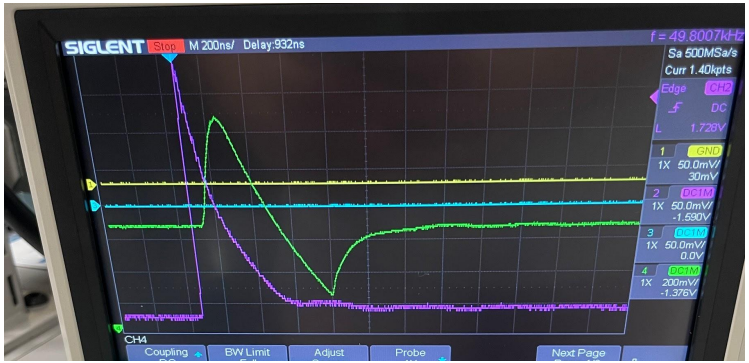




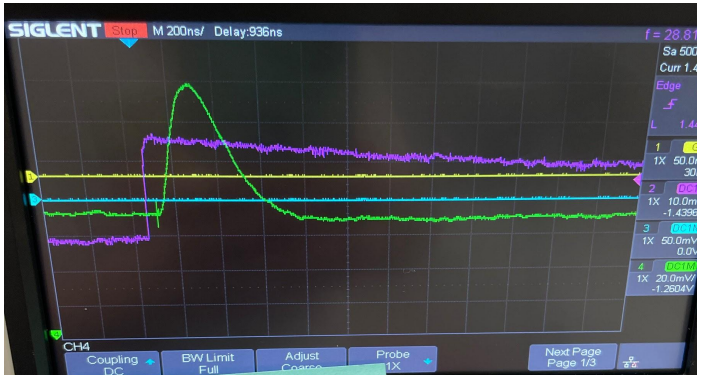
Electrical Signal Attenuation

- The signal shape is significantly affected due to impedance mismatch
  - Pink line shows pulse off of SiPM for the same detector configuration, with and without a resistor
- A small worsening effect on the resolution of the output pulse is also seen





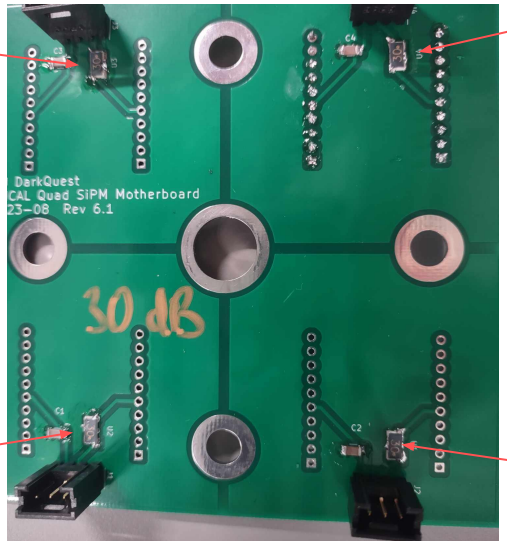
No resistor



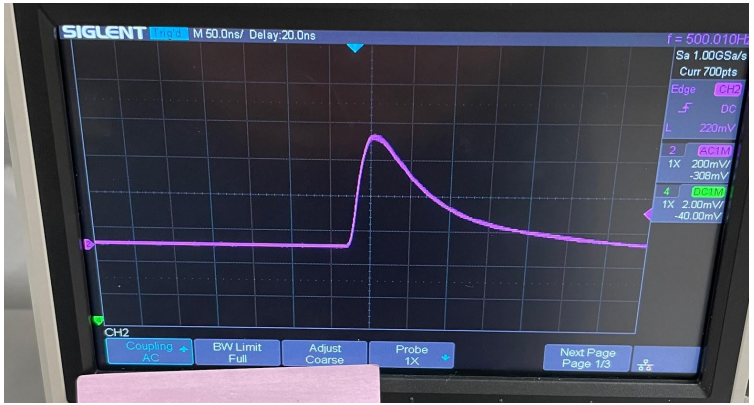
1 kΩ resistor

Electrical Signal Attenuation

- The current version of the board uses a fixed attenuator component
  - Signal shape is unchanged and no effect on resolution is observed



No attenuation

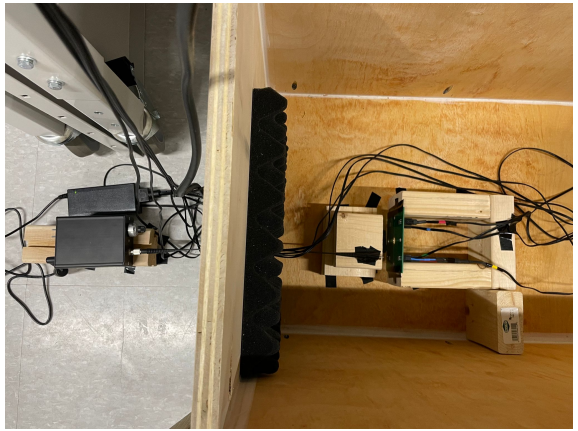


10 dB attenuator

Light Sources

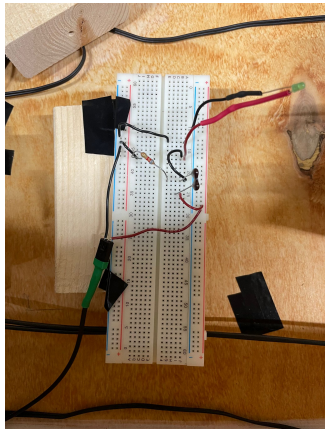
- Recent studies have been focused on testing the limits of the SiPMs, finding when their performance degrades due to oversaturation of photons

- MIPs in the detector cannot generate enough light to enter this regime, so the SiPMs are subjected to light from an LED driver as a proxy



CAEN SP5601 LED Driver*

“Homemade” LED Blinker



Summary

- The BU EMCal teststand has enabled us to make huge progress in understanding the characteristics of the detector, our SiPMs, and the readout electronics
  - Can drive the setup with both cosmic muons and LED pulsers
- Electrical attenuation issue has been fully studied and addressed, clearing the way for SiPM performance studies
- Feel free to check out the set up and offer any feedback or questions!

Backup