



中國科學院紫金山天文台
Purple Mountain Observatory, Chinese Academy of Sciences

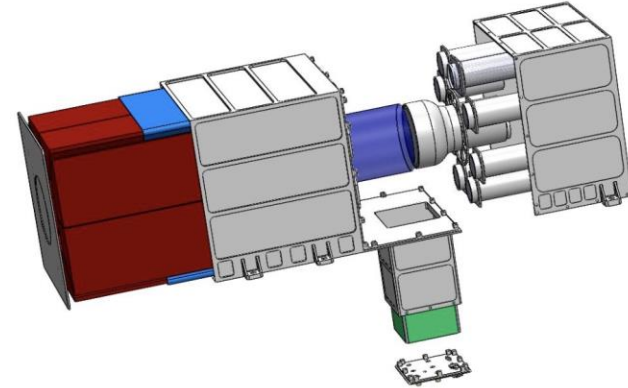
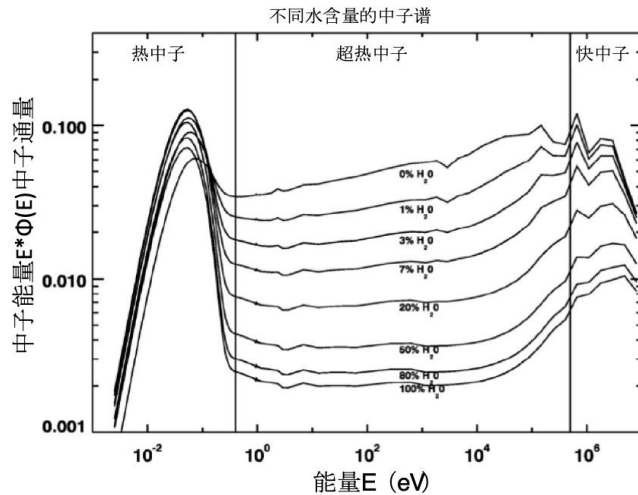
Introduction to My Master's Research work

@Yu Kai

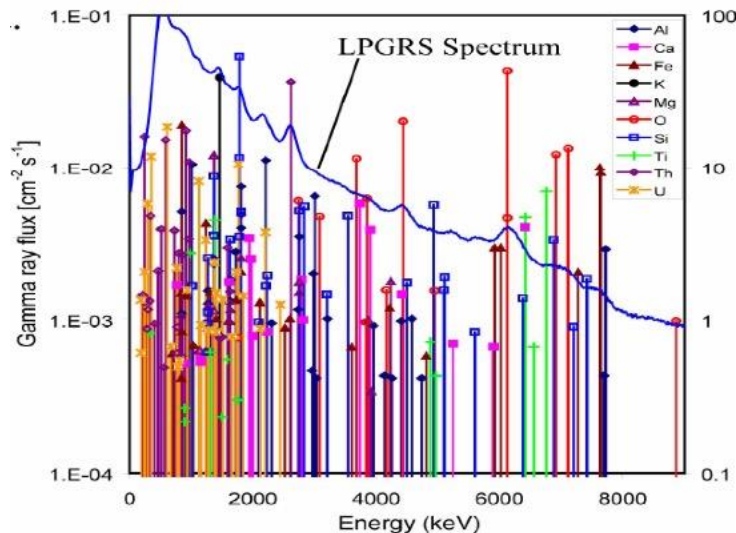


- Testing System for the Chang'e-7 Lunar Neutron and Gamma Spectrometer
- Study on SiPM Array Readout Methods for MeV Gamma-Ray Detection

- Introduction to LNGS

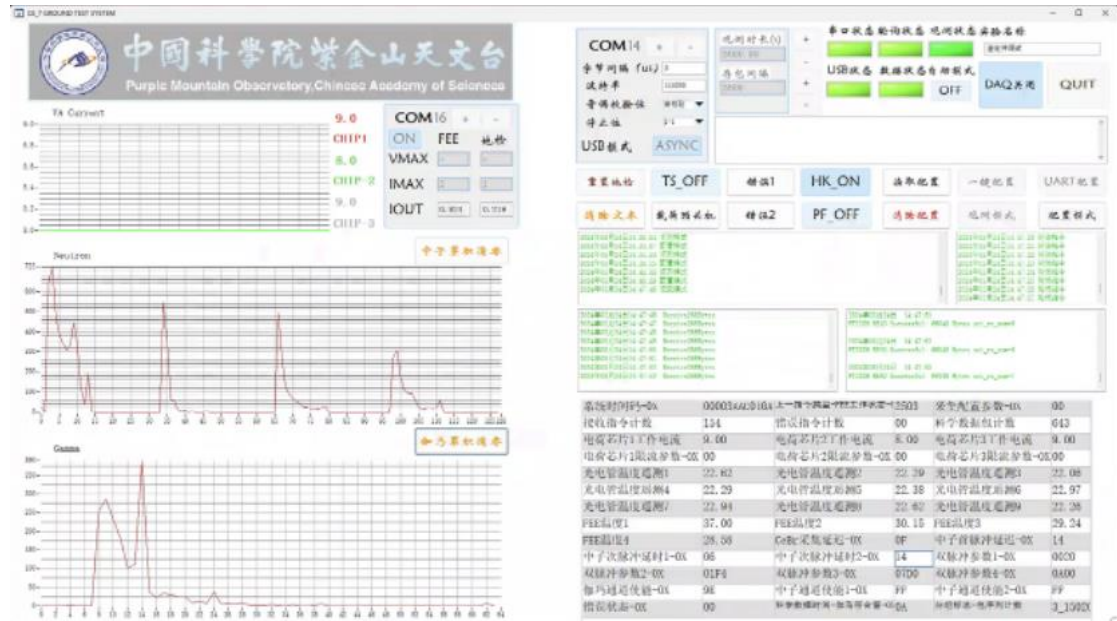


Lunar Neutron and Gamma Spectrometer(LNGS)



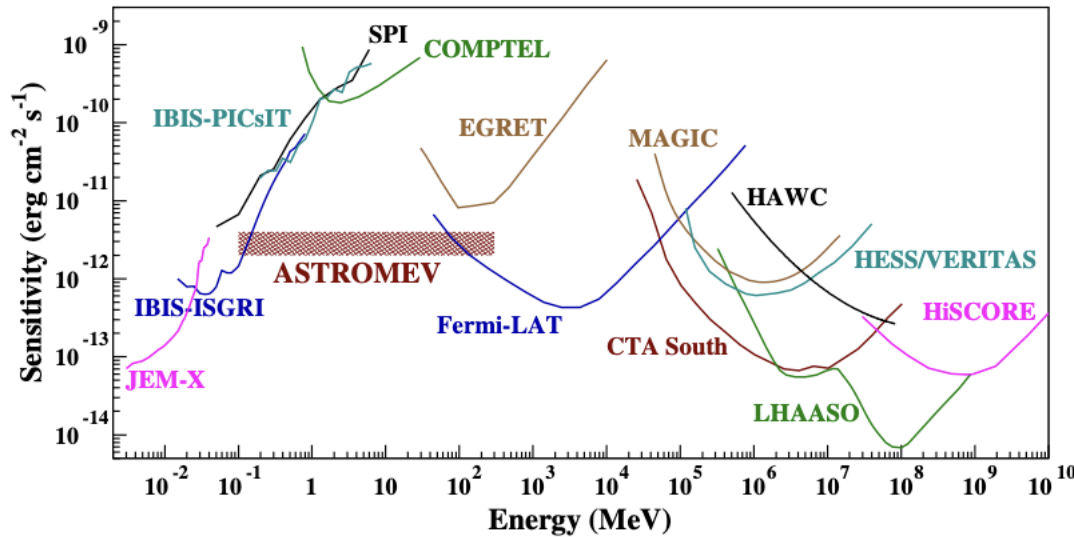
- The Flux of Epithermal Neutrons Shows a Significant Negative Correlation with Hydrogen Content.
- The Energy of Gamma Rays is Related to the Atomic Number of Naturally Radioactive Substances.

- Introduction to test system

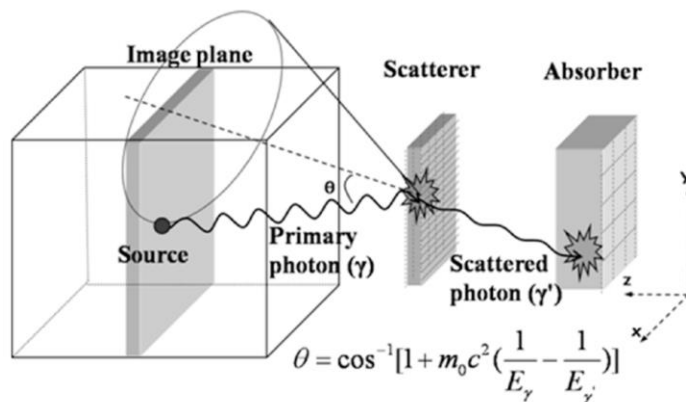


The Testing System Primarily Includes Two Components: the Ground Detection Board and the Host Computer, Developed Using FPGA (Field Programmable Gate Array) and LabWindows/CVI, Respectively.

- Background Introduction

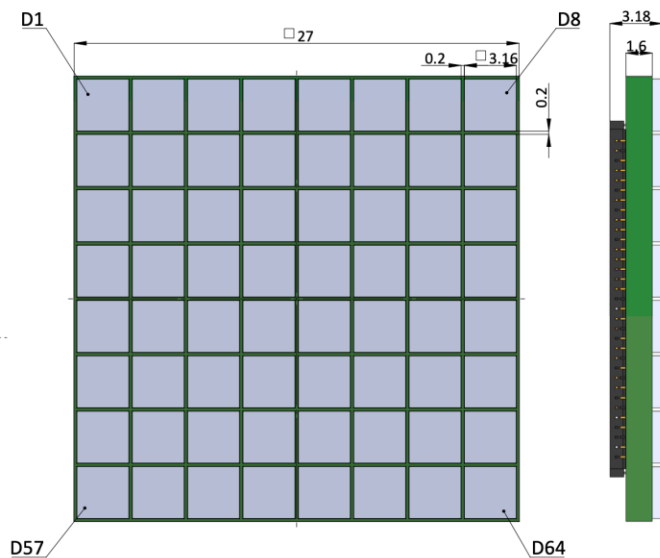


The Sensitivity of Gamma-Ray Detectors in the 0.2 MeV-100 MeV Energy Range is Relatively Low Compared to Other Bands.

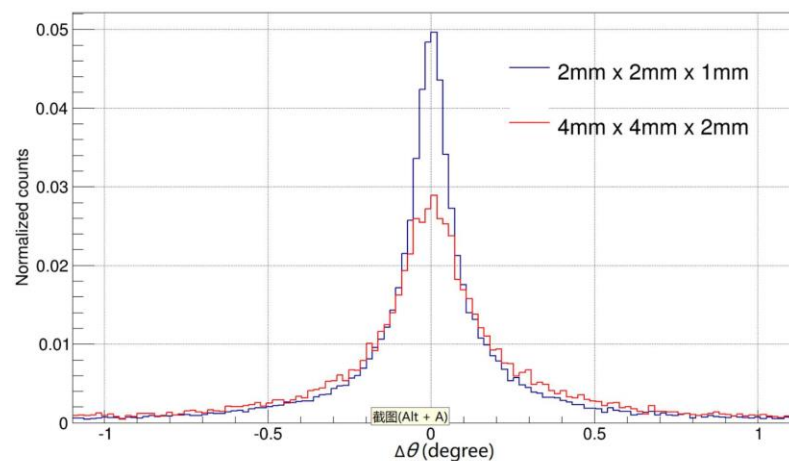
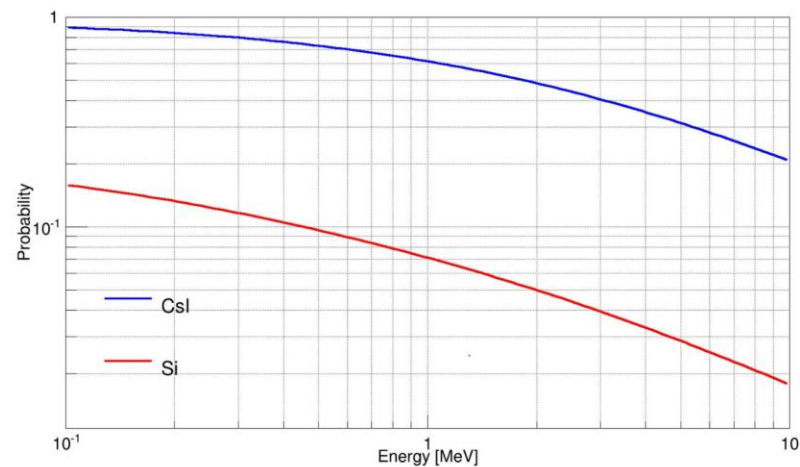


Photons in this energy range primarily interact with matter through Compton scattering, making it impossible to directly measure their incident direction. The common approach is to use a two-layer structure with position detection capability.

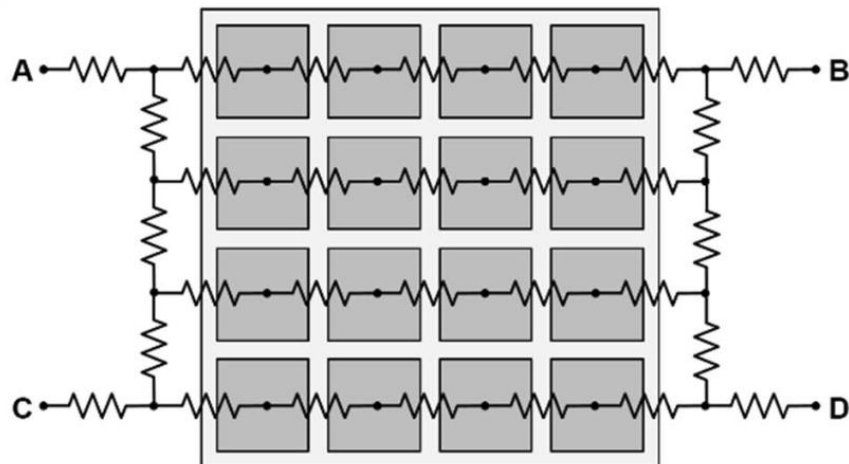
- Materials



Scintillator materials have higher detection efficiency compared to semiconductor materials, and the granularity of the scintillator significantly affects angular resolution. SiPMs, being smaller in size than PMTs, can resolve crystals with finer granularity.

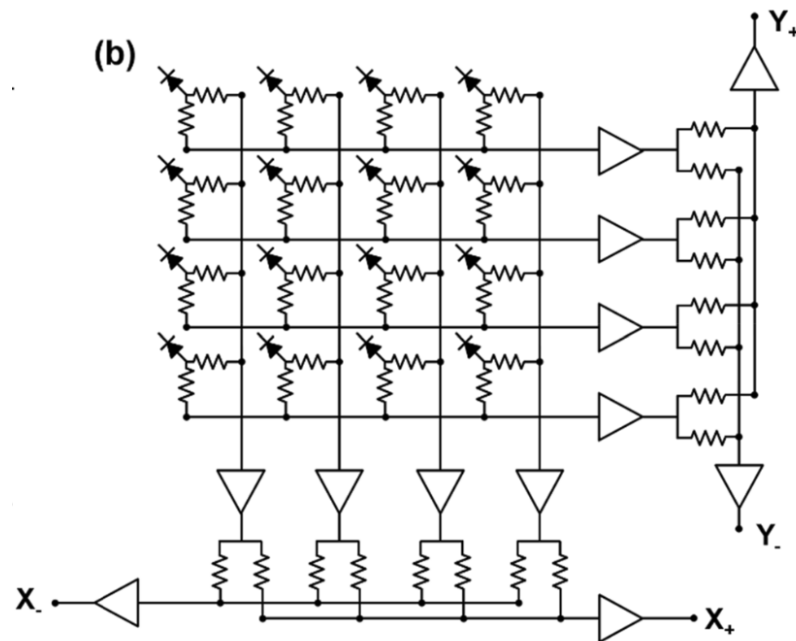


(a)



- DPC

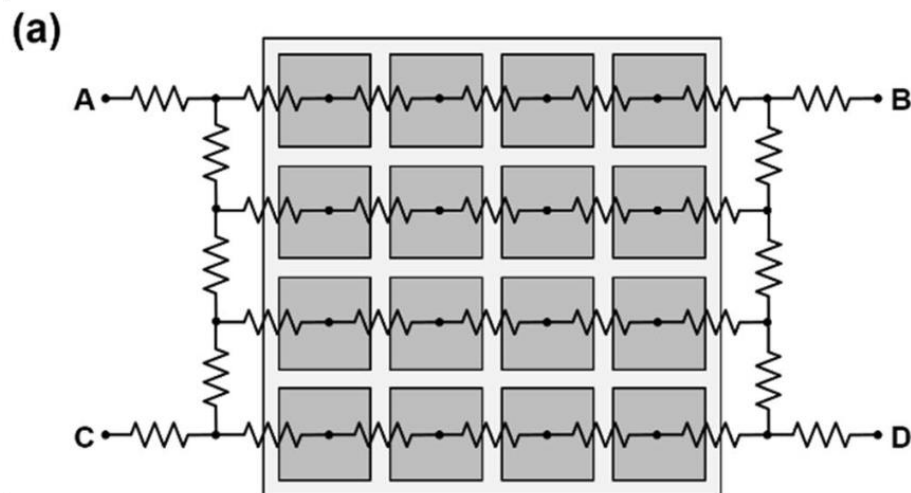
(b)



- SCD

The readout electronics design for SiPM arrays is complex, making it essential to reduce readout channels using suitable methods. Traditional approaches use resistor networks to encode SiPM signals.

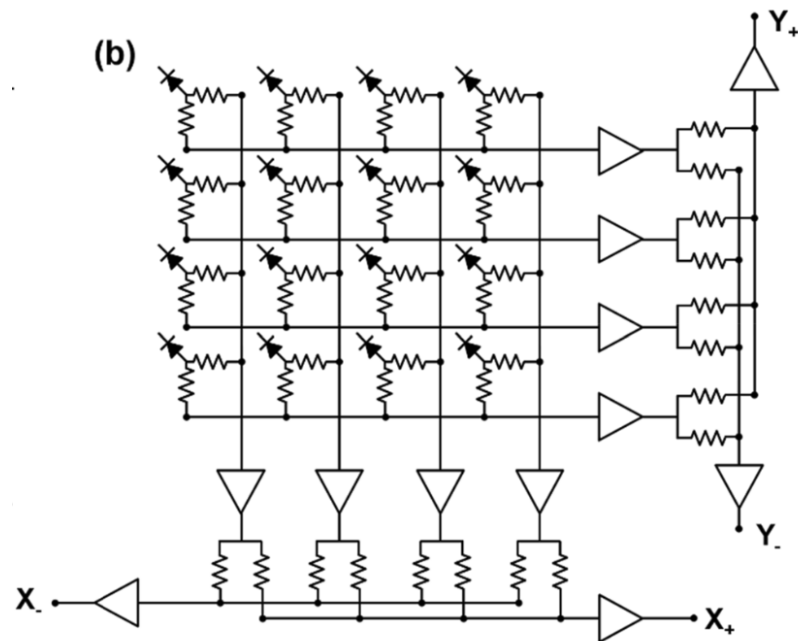
- SiPM Array Readout Method



- DPC

$$X = \frac{B + D - A - C}{A + B + C + D}$$

$$Y = \frac{A + B - C - D}{A + B + C + D}$$

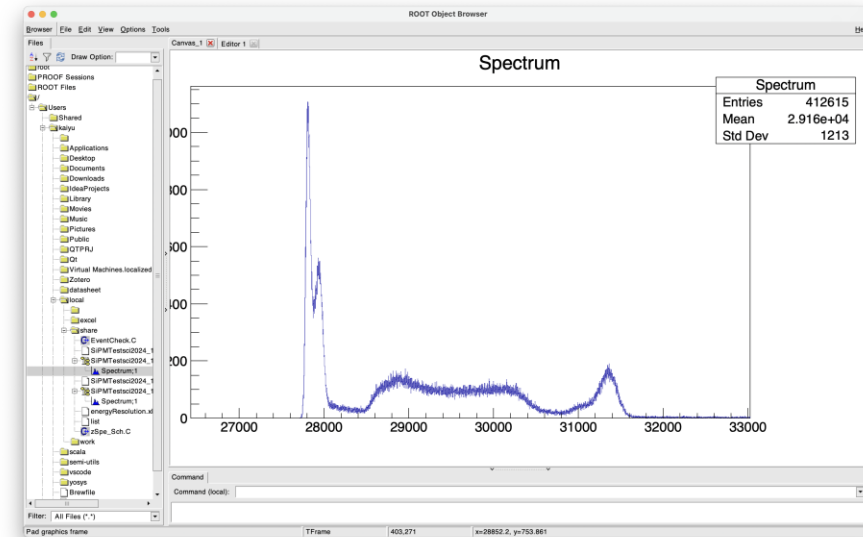
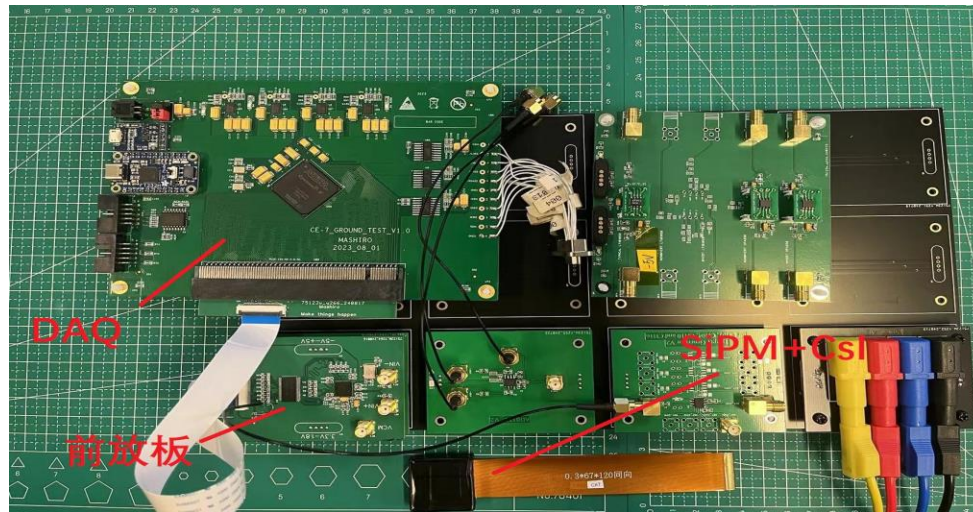


- SCD

$$X = \frac{X^+ - X^-}{X^+ + X^-}$$

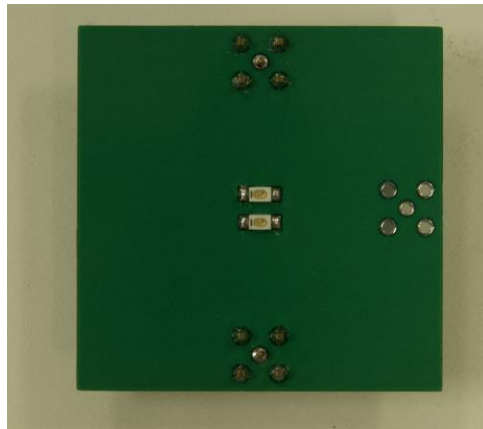
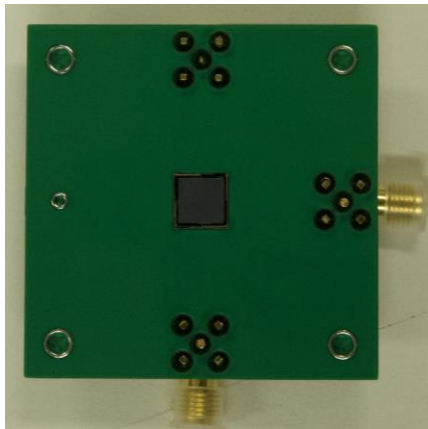
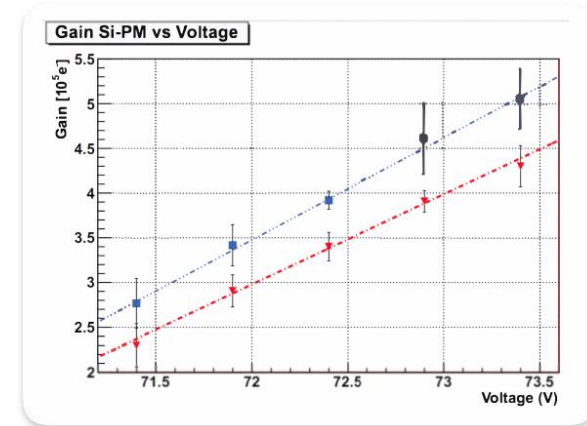
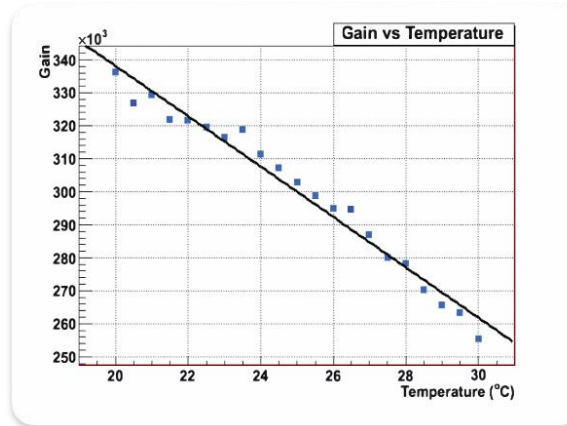
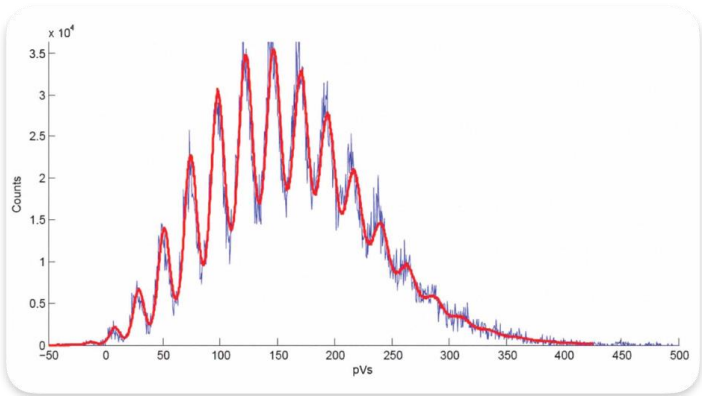
$$Y = \frac{Y^+ - Y^-}{Y^+ + Y^-}$$

- Electronics Design and Energy Spectrum

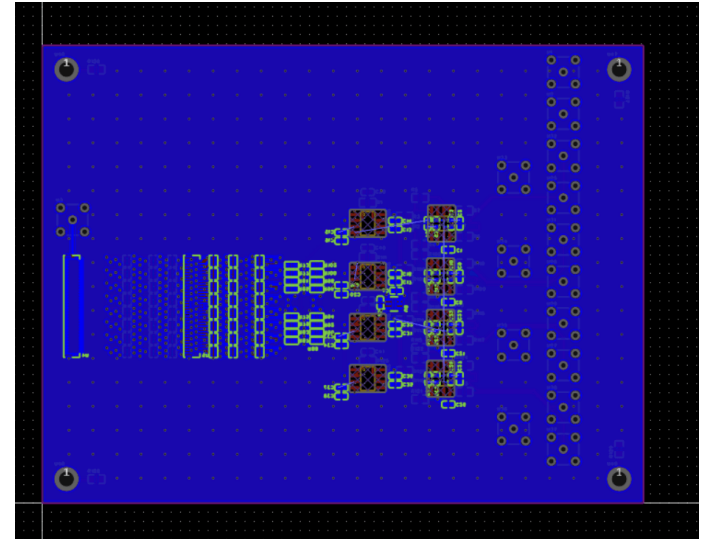
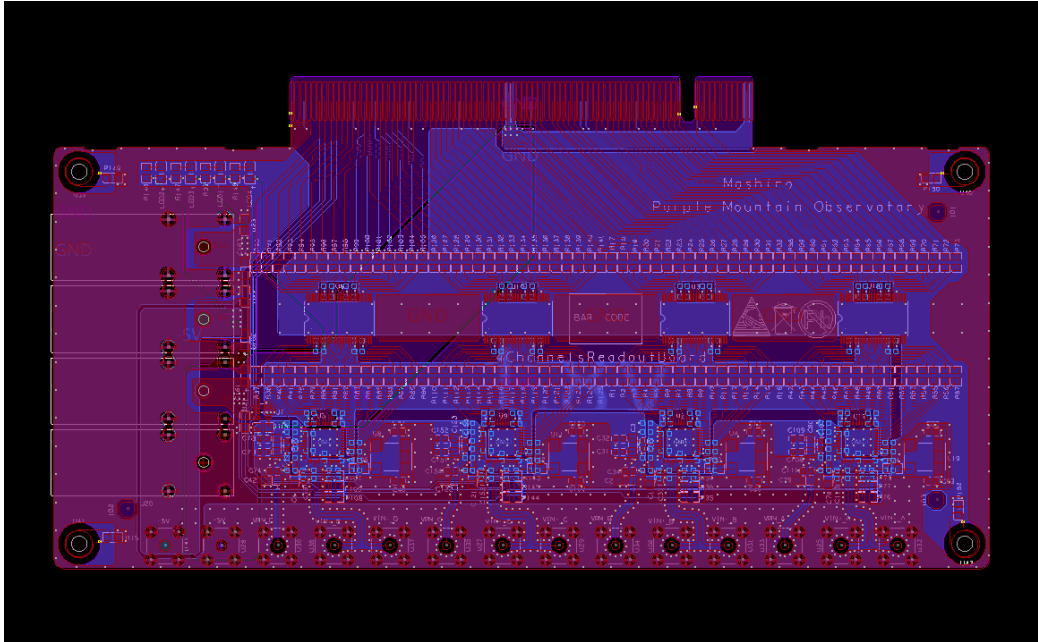


The electronics prototype has been designed and successfully validated, with normal testing results using a Cs-137 radioactive source.

- Temperature Compensation



SiPM gain is highly sensitive to temperature variations. LED pulses are used to measure the SiPM gain and compensate for temperature effects.



The designs for the four-channel acquisition board, resistor network board, and gain measurement board have been completed. Measurements of position resolution, energy resolution, and temperature curves will be conducted after production.