

# Studies of light yield for prototype layers

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CONSORTIUM

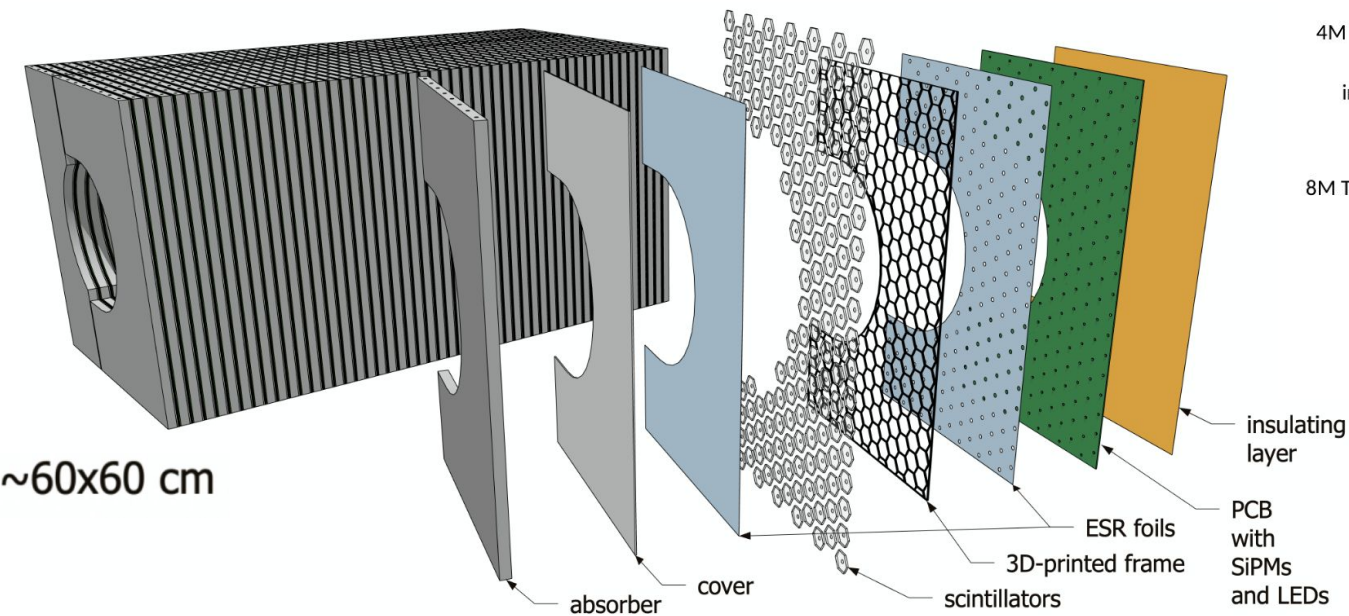
# Outline:

Results of all the Prototype Boards that were tested with Cosmic Rays.

New Painted Scintillators Studies.

Comparison Studies on Injected Molded Scintillators and UCR Machined Scintillators.

# The Calorimeter Insert (CALI)



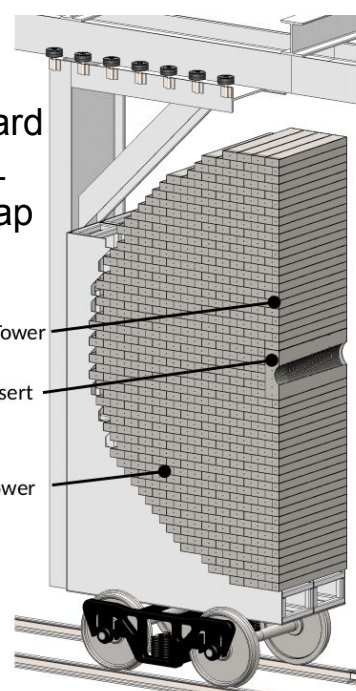
Forward  
HCAL  
Endcap

4M Tower

insert

8M Tower

$3 < \eta < 4$

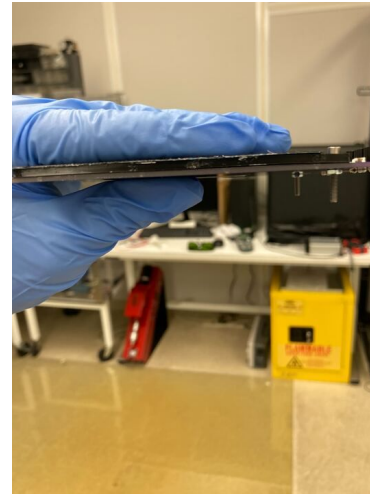
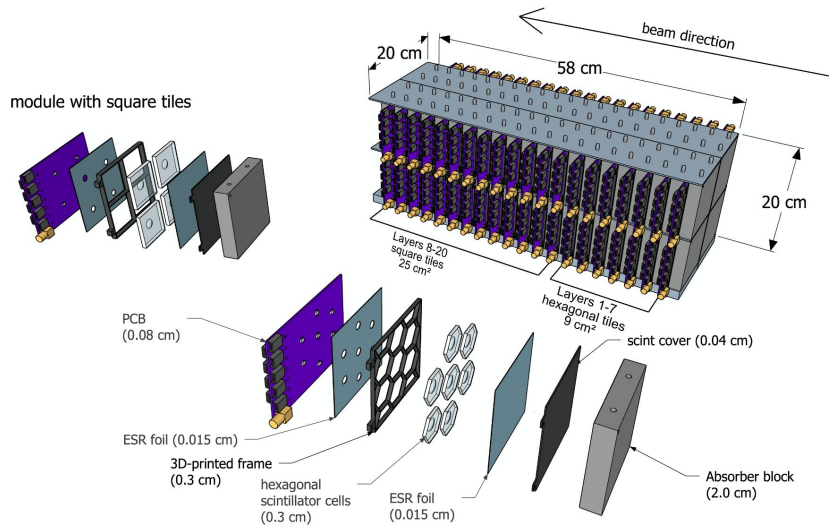


M. Arratia et al. NIMA 1047 (2023) 167866

# Prototype Board Construction and Layer Tests

# SiPM Boards and the Prototype.

We have been working to put together a working prototype with 300 channels. This prototype will have a combination of Square and Hexagonal Scintillators.



# Prototype Layers

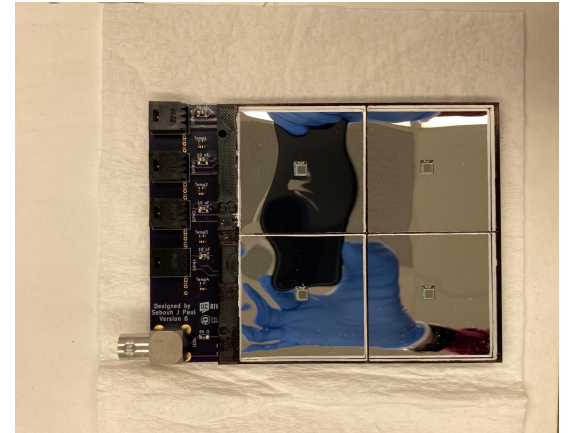
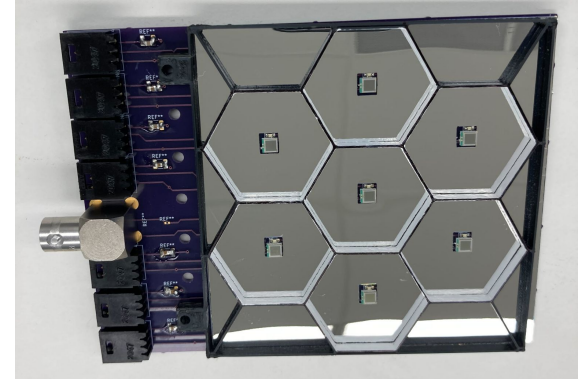
59 Boards Total.

7 with 1.3mm SiPM

52 with 3mm SiPM

Mix of Square geometry and Hexagonal geometry.

302 Channels.

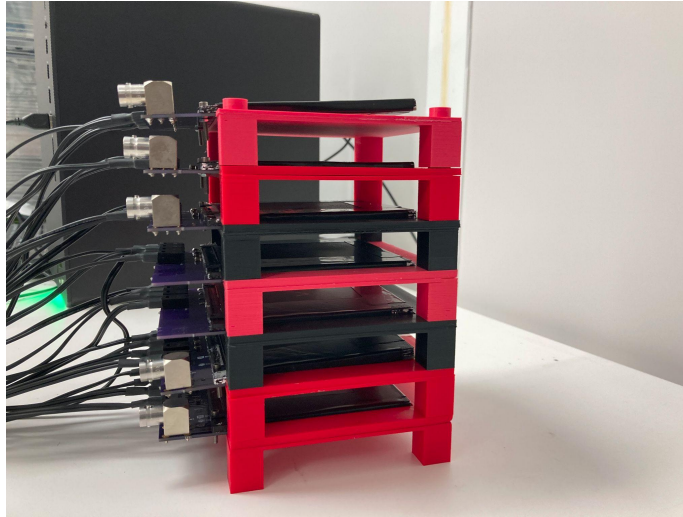


# Testing the Prototype boards: Set-Up

Multiple Boards were placed in a vertical set-up to be tested using cosmic rays.

Two boards were always placed above and below to act as the triggers.

Same Set-up was done  
for all 59 Boards.



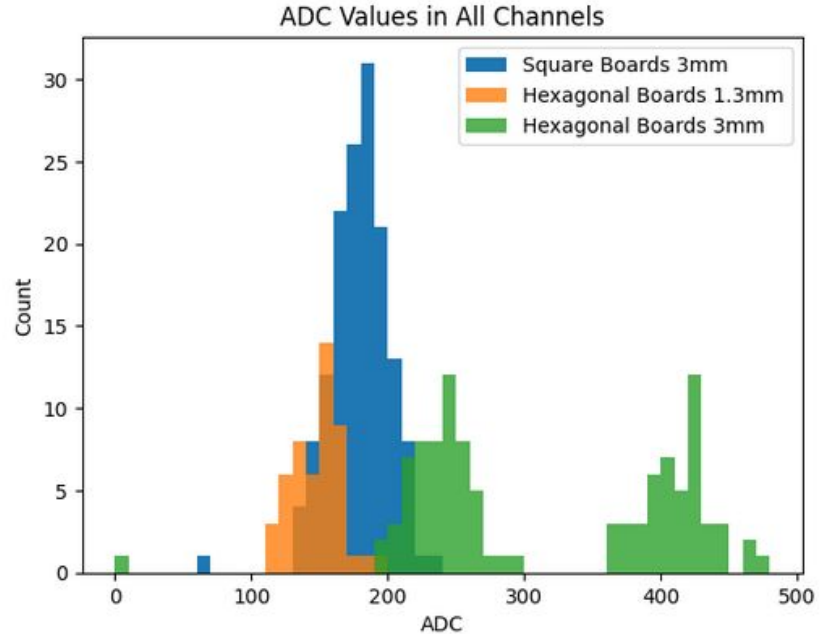
# Results

MIP Values for 3mm Square Boards peak at ~190ADC.

MIP Values for 1.3mm Hexagonal Boards peak at ~150ADC.

MIP Values for 3mm Hexagonal Boards Appear to peak at two values: ~250ADC & ~400.

**The cause for this was found to be due to the painting of scintillators.**





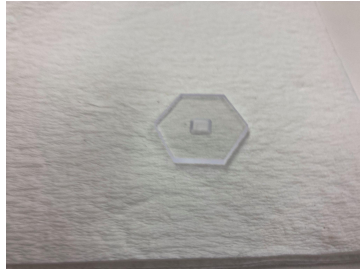
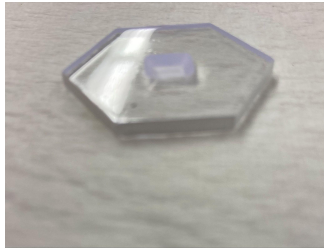
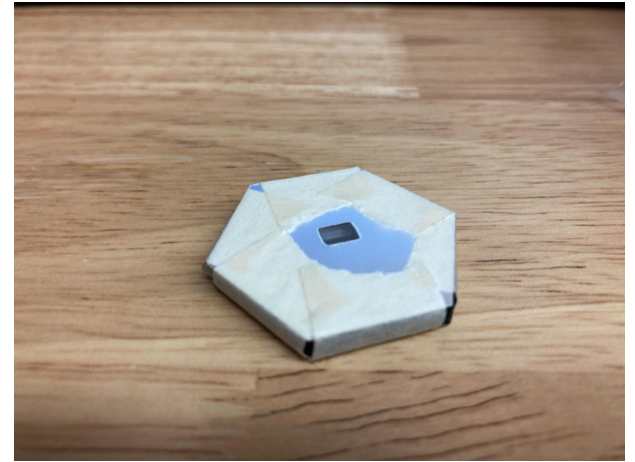
# Painted Scintillators Studies

# Painted Frames

A previous experiment done between the frames that house the scintillating cells showed that painting the frames instead of the scintillating cells would provide equal amount of light yield.



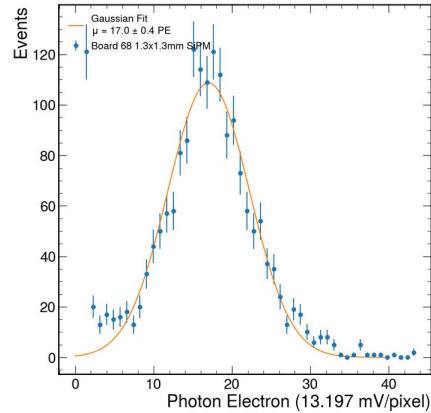
Frame made to fit a single tile painted with reflective paint



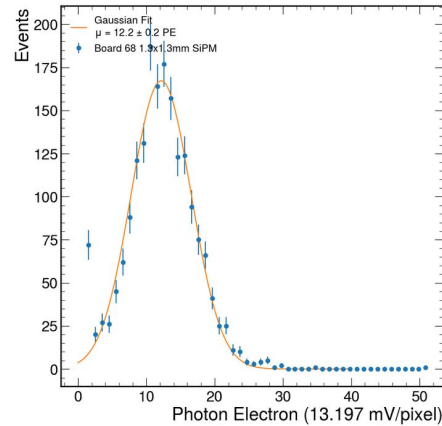
# Painted Frames

Sr-90 results showed that painting the frame would be superior for increasing light yield when compared to only painting the scintillator.

Non-Painted Cell with Painted Frame +2V  
Sr-90 Source  
Rectangular Dimple

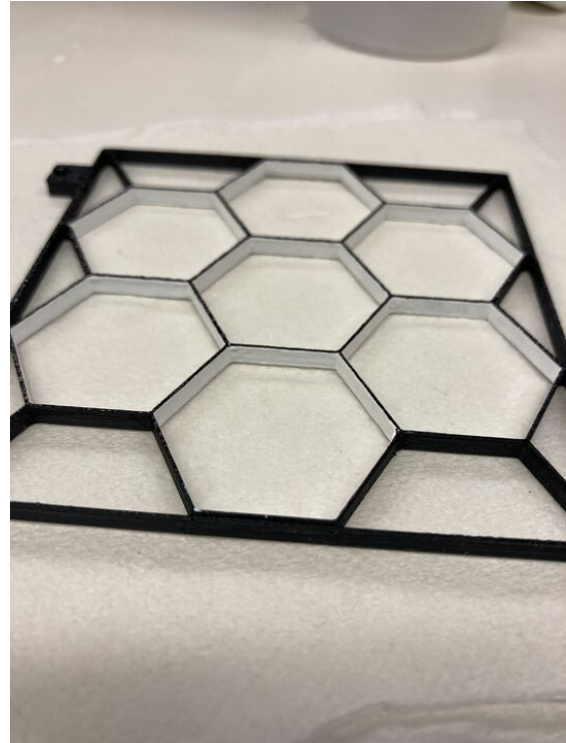


Painted Cell with Non-Painted Frame +2V  
Sr-90 Source  
Rectangular Dimple



# Painted Frames

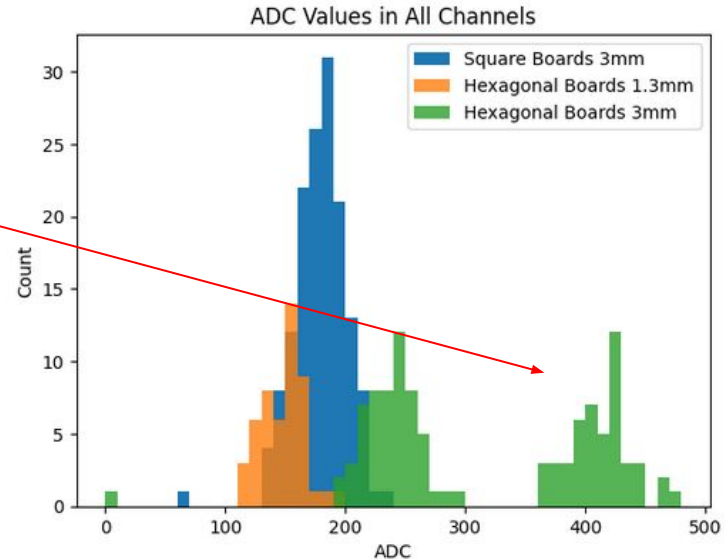
Due to these results, frames were painted and scintillators were no longer painted.



# Prototype Testing

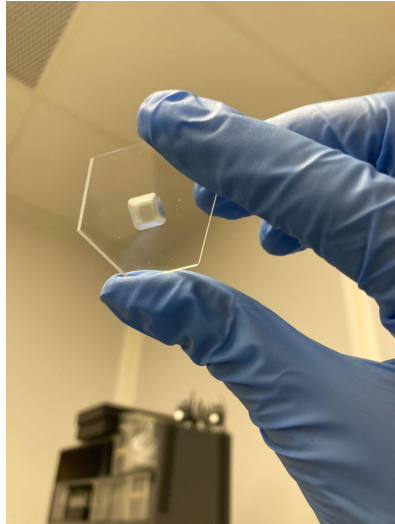
After all boards were tested however, it showed that boards that had their scintillators painted in addition to their frames had a dramatically better light yield.

All boards from this region had painted scintillators.



# Prototype Testing

Further tests were done to confirm this. A board was test with cosmic rays with non painted scintillators. Its scintillators were then painted and retested. This was done for Boards of Square geometry and Hexagonal geometry



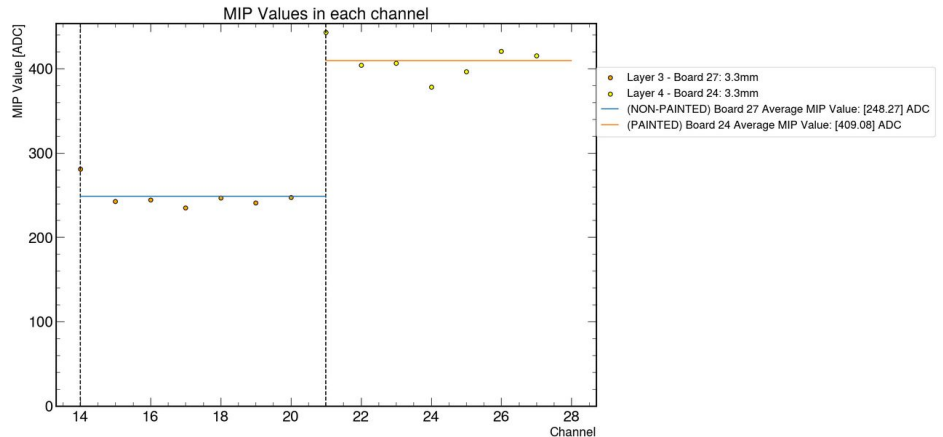
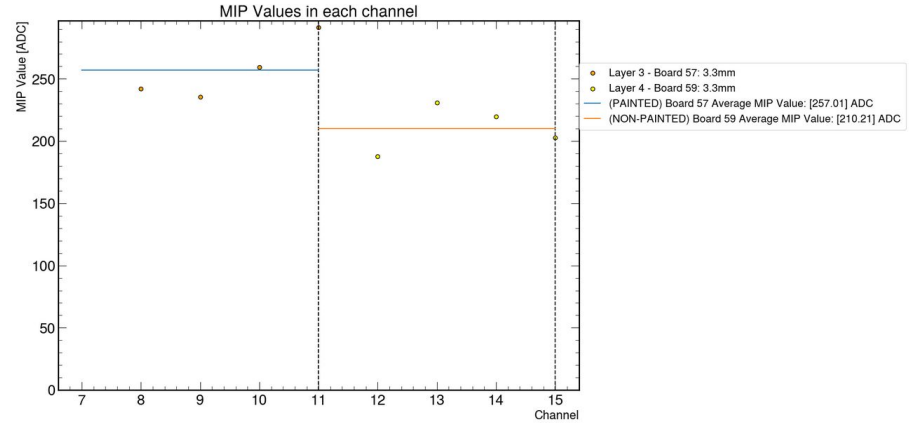
# Prototype Testing

Results show that having painted scintillators will increase light yield more than when it was just painted frames.

This effect is more dramatic when done to tiles of hexagon geometry.

**Square geometry increase after painting: 22%**

**Hexagonal geometry increase after painting: 65%**



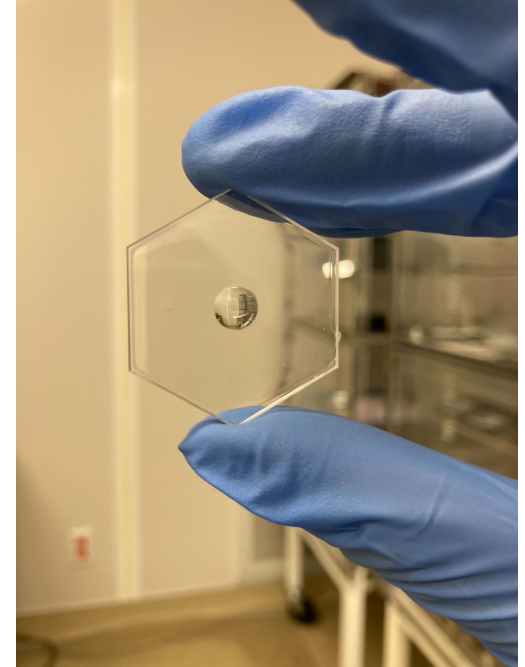
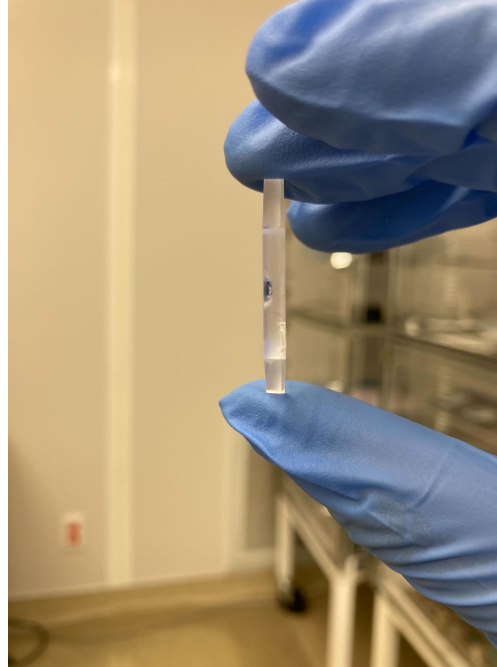
# Comparison Study of the Injected molded Scintillators



# Plastic Injection Molded Scintillators

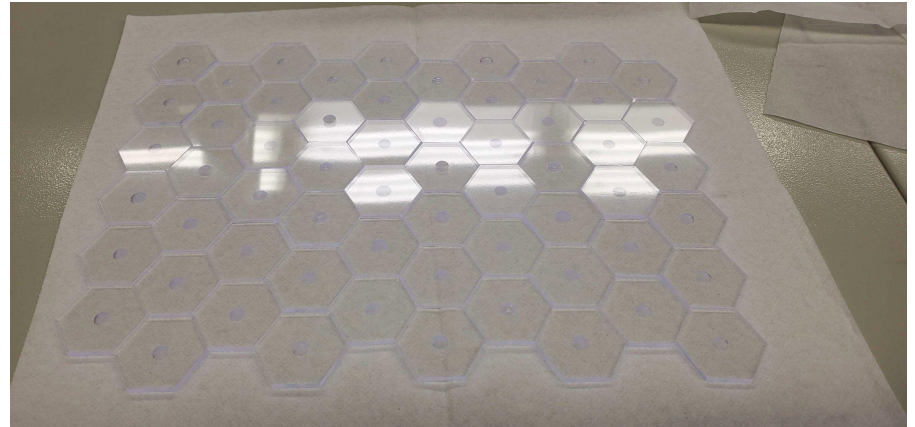
Plastic injection molded Scintillators were received from Friederike.

The scintillators were hexagonal, and appeared physically shiny. They easily fit in the boards we have been using.



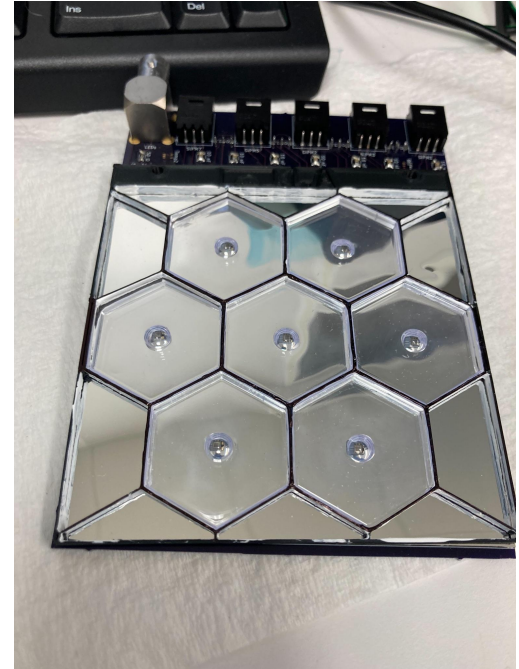
# UCR Machined Scintillators

Using an Eljen Sheet of scintillating Material, we machine cut the sheet into the desired shape.



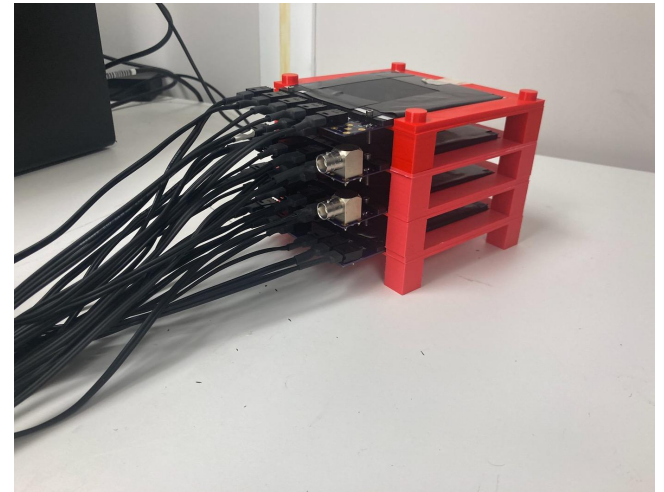
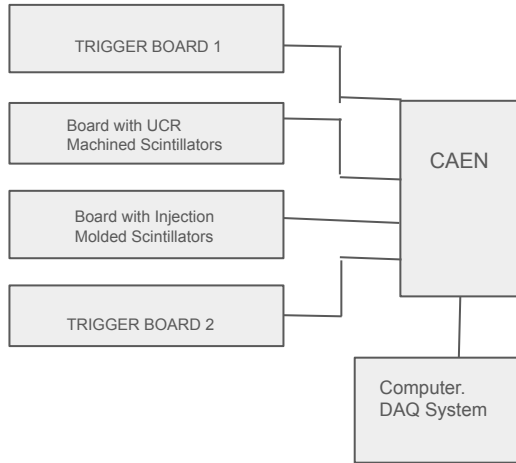
# Experiment:

Two near identical PCB boards containing SiPMs of size 1.3mmx1.3mm from Hamamastu were used and compared. One board had the injection molded scintillator tiles. The other board contained the scintillators that were machined in UCR.



# Experiment (continued)

Two separate boards were used as the triggers, and the two boards that were being tested were placed in the middle. Data was collected from cosmic rays over night. CAEN Unit was used for trigger with DAQ system. Voltage was set to +5 Overvoltage(43V).

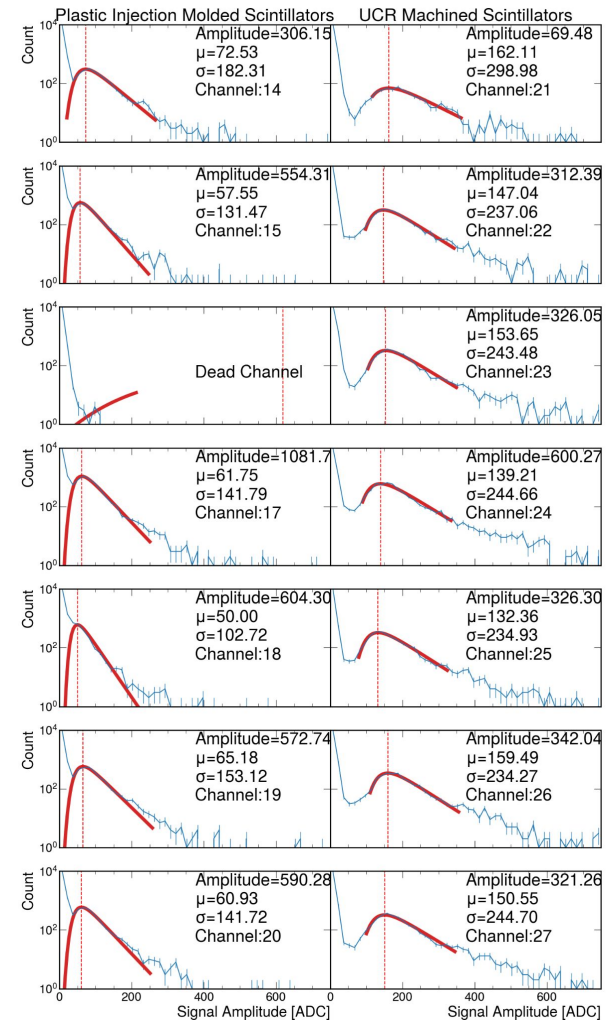


# Results

After data was collected, the pedestal value was subtracted from the mean.

A cut was made in the data. All values below  $4\sigma$  of pedestal peak were cut.

Results show that there is an average of 61 ADC in plastic injected molded scintillators. The machined scintillators had an average of 147 ADC.



# Summary

- 59 Boards have been assembled for our prototype and were taken to Brookhaven Lab. When they were tested with cosmic rays the MIP Values were
- Square geometry MIP value increases after painting by 22%
- Hexagonal geometry MIP value increases after painting by 65%
- Plastic injected molded scintillators give an average of 61 ADC, in comparison to the machined scintillators which had an average of 147 ADC.