Building an SiPM Test Station at Augustana University

Geyang Zhou

Department of Physics, Augustana University

sPHENIX

- sPHENIX built to measure
  - Fully-reconstructed Jets
  - Heavy flavor-tagged Jets
  - Upsilons

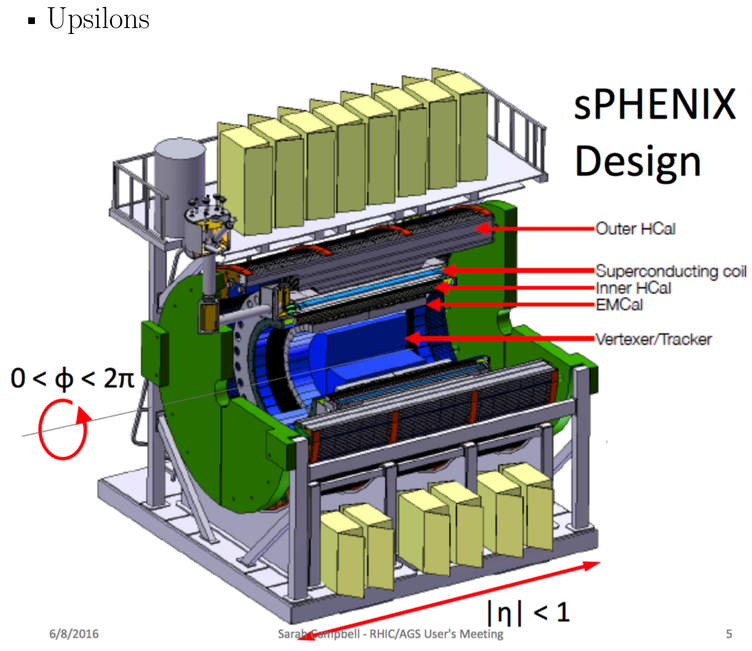

Figure 1: Schematic of the proposed sPHENIX detector composed of inner tracking, an electromagnetic calorimetr (EMCAL), and two components of hadronic calorimetry (HCAL) and utilizing the 1.5 T solenoid magnet from BaBar.

sPHENIX EMCAL

- Electromagnetic Calorimeter (EMCAL) composed of tungsten with scintillating fibers (upper left of Figure 2)
- Light collection from calorimeters utilize Silicon Photomultipliers (SiPMs) (right panel of Figure 2)
- Four SiPMs per light guide or about 125k SiPMs total.
- All SiPMs must be tested before use in the experiment.

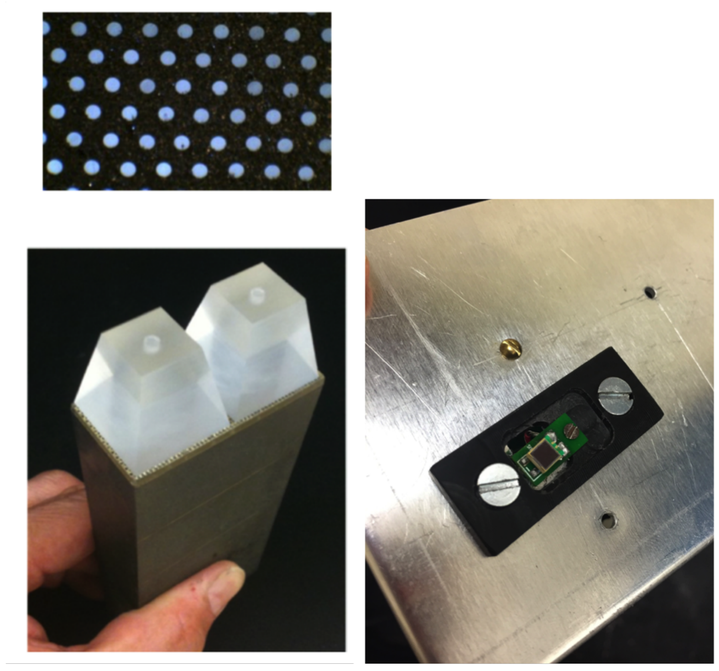

Figure 2: *Top Left:* Cross section of EMCal Module showing the Tungsten and Scintillator. *Bottom Left:* 2x2 modules with light guides. *Right:* SiPM on test stand holder.

SiPM Test Stand

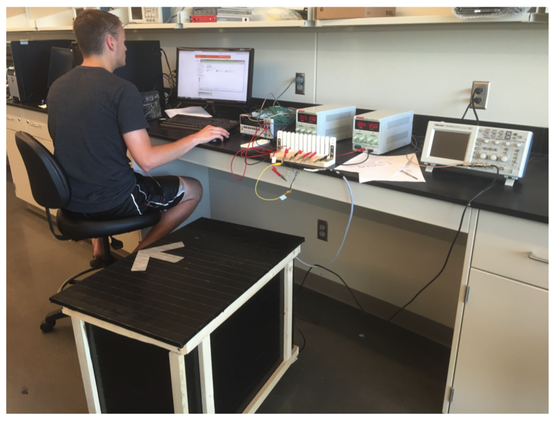

Figure 3: Test bench with dark box and the bench with power supplies for the SiPM and preamp.

- Dark box contains a pulsed LED, SiPM and sPHENIX dual-gain pre-amplifier board.
- SiPM drew tens of μA current at $\sim$ 65 V suggested operating point.
- DSR4 Evaluation Board for time and voltage digitization.

I-V Curve

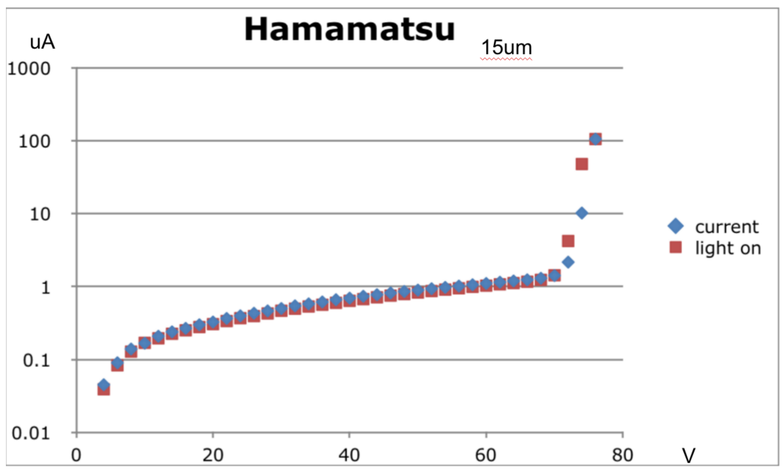

Figure 4: I-V curve for the 15 μm Hamamatsu S12572-015P with (red) and without (blue) the lights on in the lab.

Building EMCal Modules

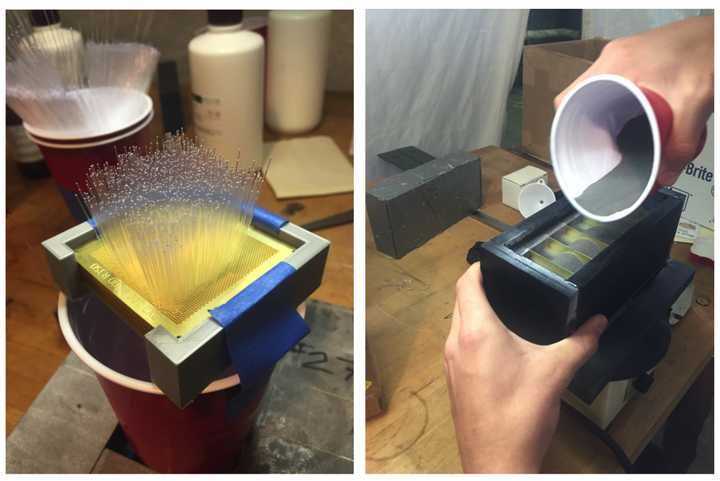

Figure 5: *Left:* Filling scintillating fibers that are projective in two dimensions. *Right:* Filling tungsten powder. Epoxy will be poured over the tungsten to produce the modules.

Integrated Charge

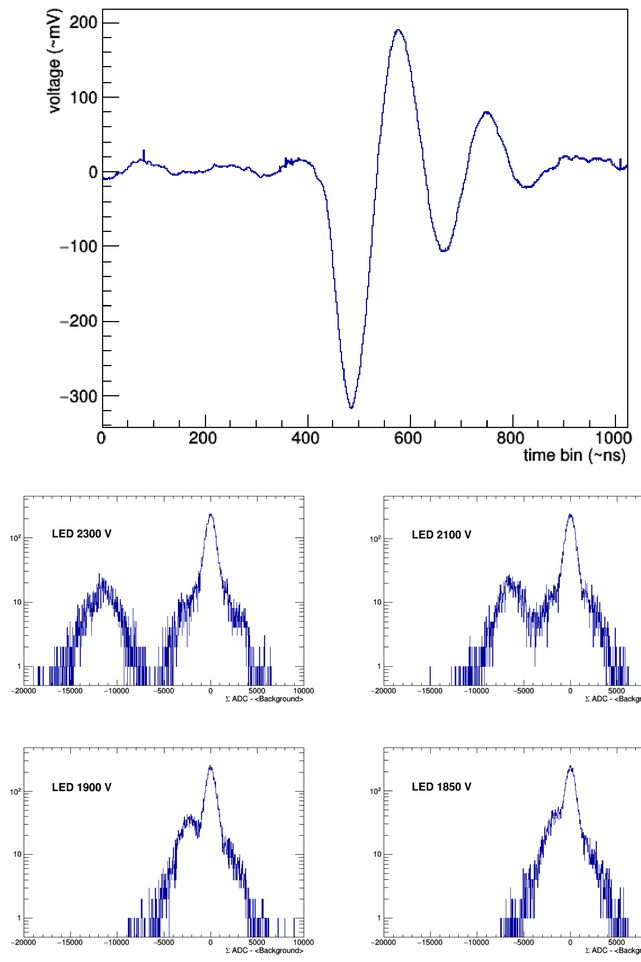

Figure 6: *Top:* High-gain ADC signals for an LED event in the SiPM. *Bottom:* Time integration of the digitized signals for several thousand LED triggered events and several different LED voltages.

- Digitizer triggered on LED pulse. Example high-gain digitized signal shown in Figure 6 (Top)
- 1 ADC $\approx$ 1 mV, $\approx$ 1 ns.
- Figure 6 (Bottom) are the high-gain integrated charge distributions. Peak at zero is from noise/pedestal. Peak < 0 is SiPM response to the LED.
- Integration range is from $\sim$ 400 ns to 600 ns.
- As the LED voltage (intensity) is lowered, SiPM integrated charge decreases indicating that the SiPM is responding to the LED pulses.
- Decreasing the LED voltage to observe individual photoelectron peaks not possible with the level of noise we have.

Acknowledgements

- sPHENIX and Brookhaven National Laboratory for equipment and technical help
- University of Illinois for opportunity to learn their SiPM setup and help build EMCal modules
- National Science Foundation RUI for funding.