Validation of Production SiPMs for the sPHENIX Experiment

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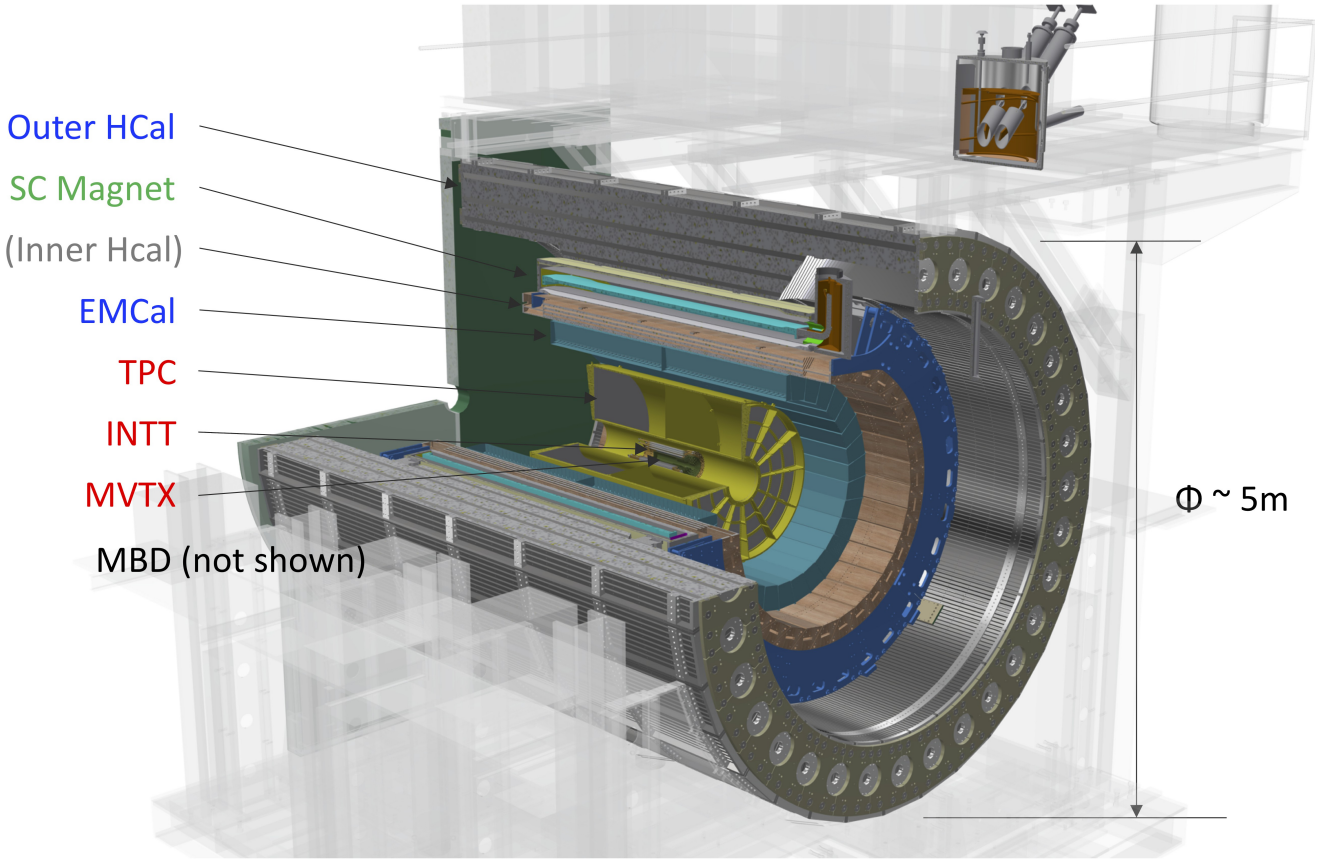
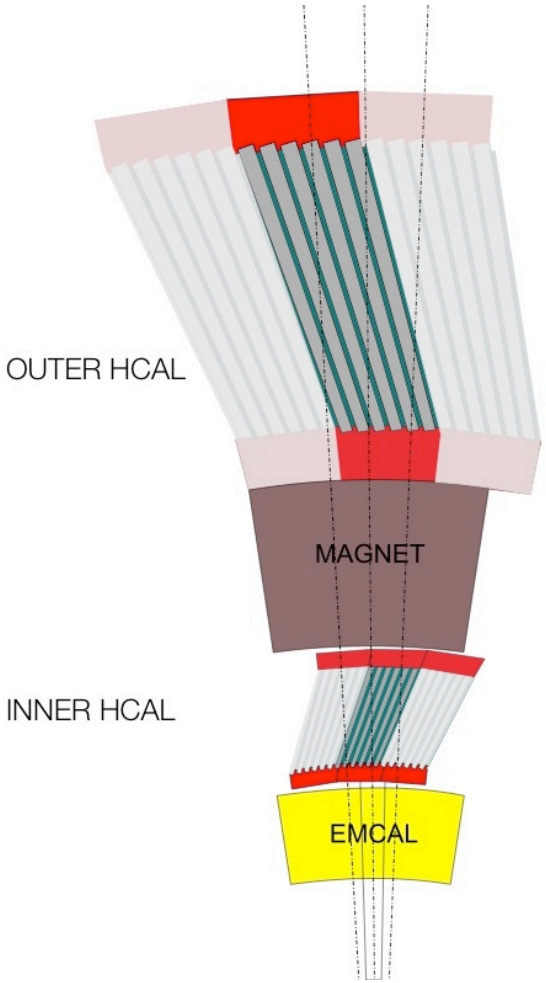
October 17, 2019

sPHENIX Experiment

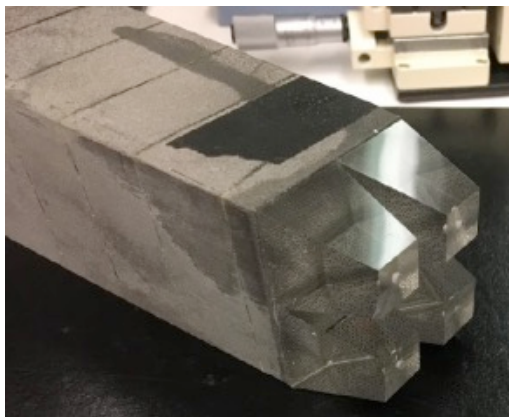


- A new detector at RHIC
- Microscopic properties of the QGP from
  - jets
  - direct photons
  - heavy flavors

Electromagnetic and Hadronic Calorimeter



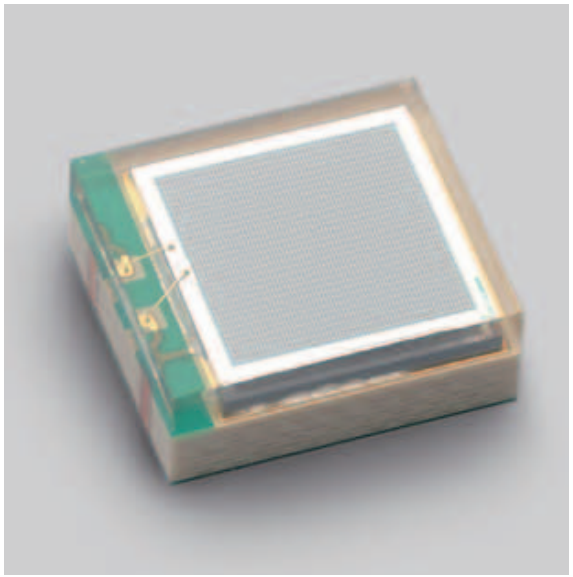
- Electromagnetic Calorimeter: Scintillating fibers embedded in W powder
  - $\Delta\eta \times \Delta\phi = 0.024 \times 0.024$
  - $\sigma_E/E = 16\%/\sqrt{E} \oplus 5\%$
- Hadronic Calorimeter: Plastic scintillating tiles + tilted Steel/Al plates
  - $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$
  - $\sigma_E/E = 100\%/\sqrt{E}$
- Common readout via SiPMs (e.g. 4 per EMCal Tower)



sPHENIX

Hamamatsu S12572-015P SiPMs

Photosensitive Area	3x3 mm^2
Pixel pitch	15 μm
# of pixels	40000
peak wavelength sensitivity	460 nm
photon detection efficiency	25%
Gain	2.3×10^5
Operating voltage	$\approx V_{br} + 4$ V
Voltage-Temperature Slope	56 mV/°C

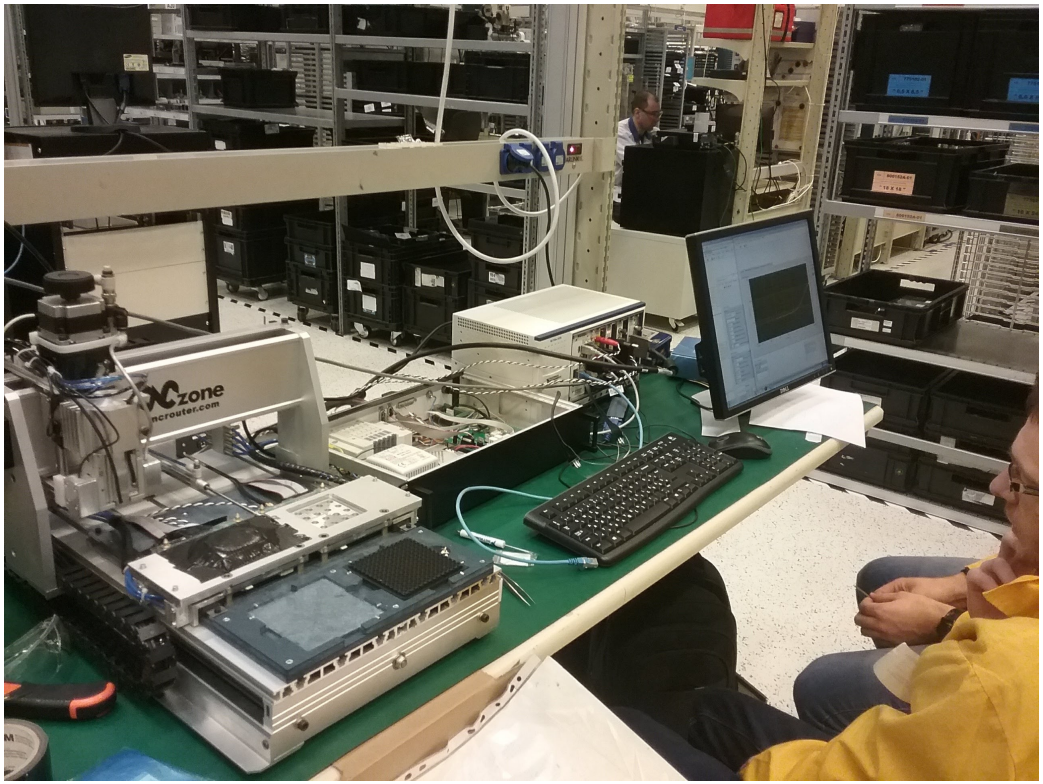


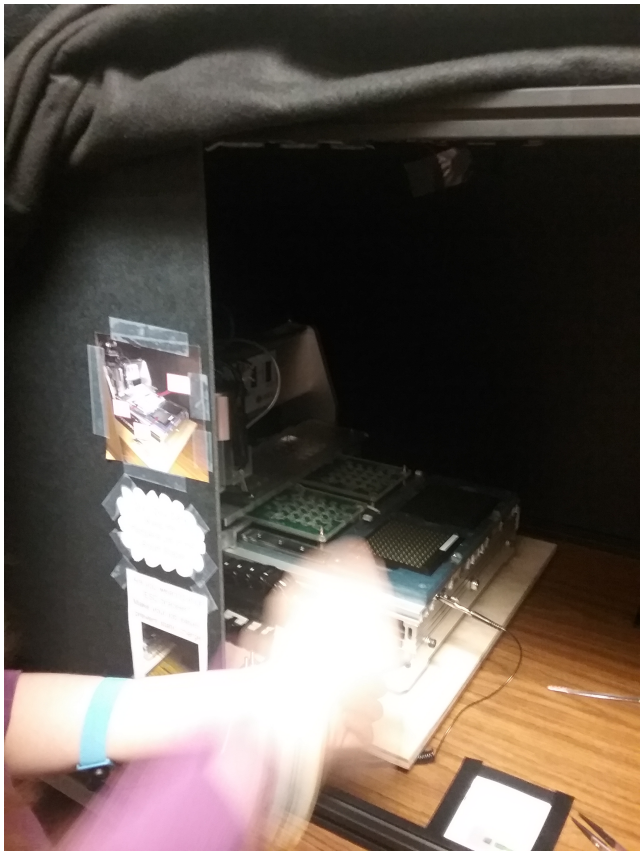
- Immune to magnetic fields
- Susceptible to radiation damage

Shipment Schedule

- 8000 devices shipped monthly to University of Michigan for testing
- Trays of full 12x13 or partial trays in 40 mV bins of operating voltage

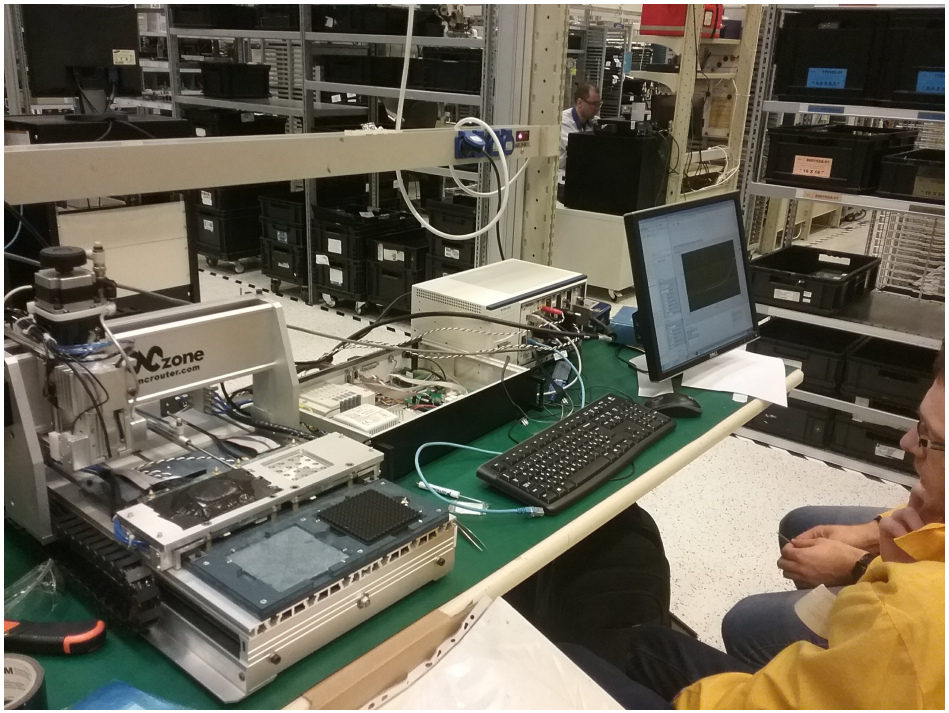
Test Stand





- Developed by University of Debrecen
- Perform both I-V and Single Pixel Spectrum (SPS) tests
- Perform 1 full tray test per day

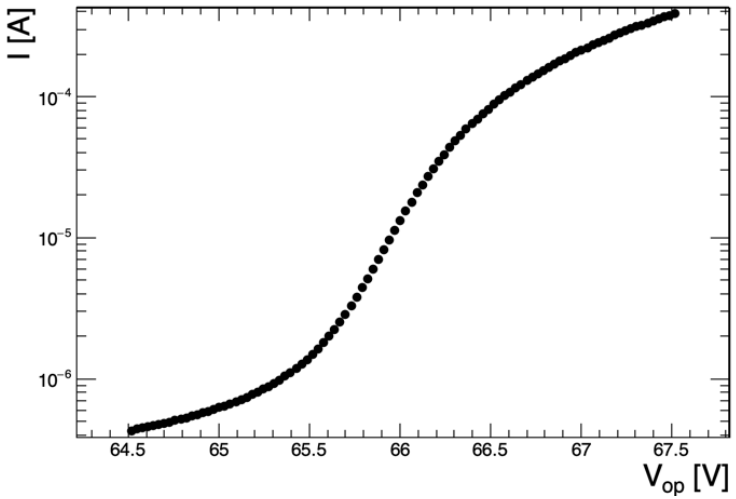
Test Stand

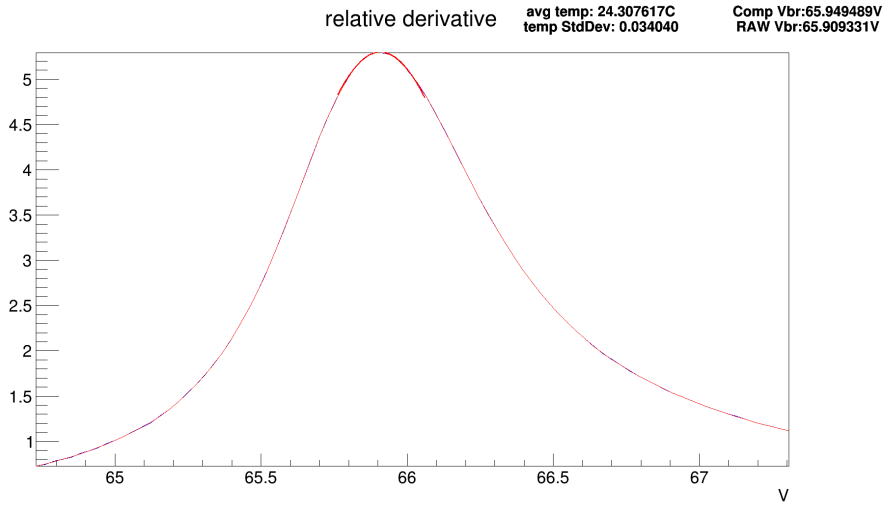


- Motorized arm with micron precision and vacuum nozzle moves SiPMs from tray to test position
- Electrical connections by weight and pressure
- National Instruments crate for high voltage and data acquisition
- 50 temperature sensors with 0.1°C precision

- Rough I-V scan to estimate V_{br}.
- LED pulses at 6 different V_{op} for SPS

I-V Scan

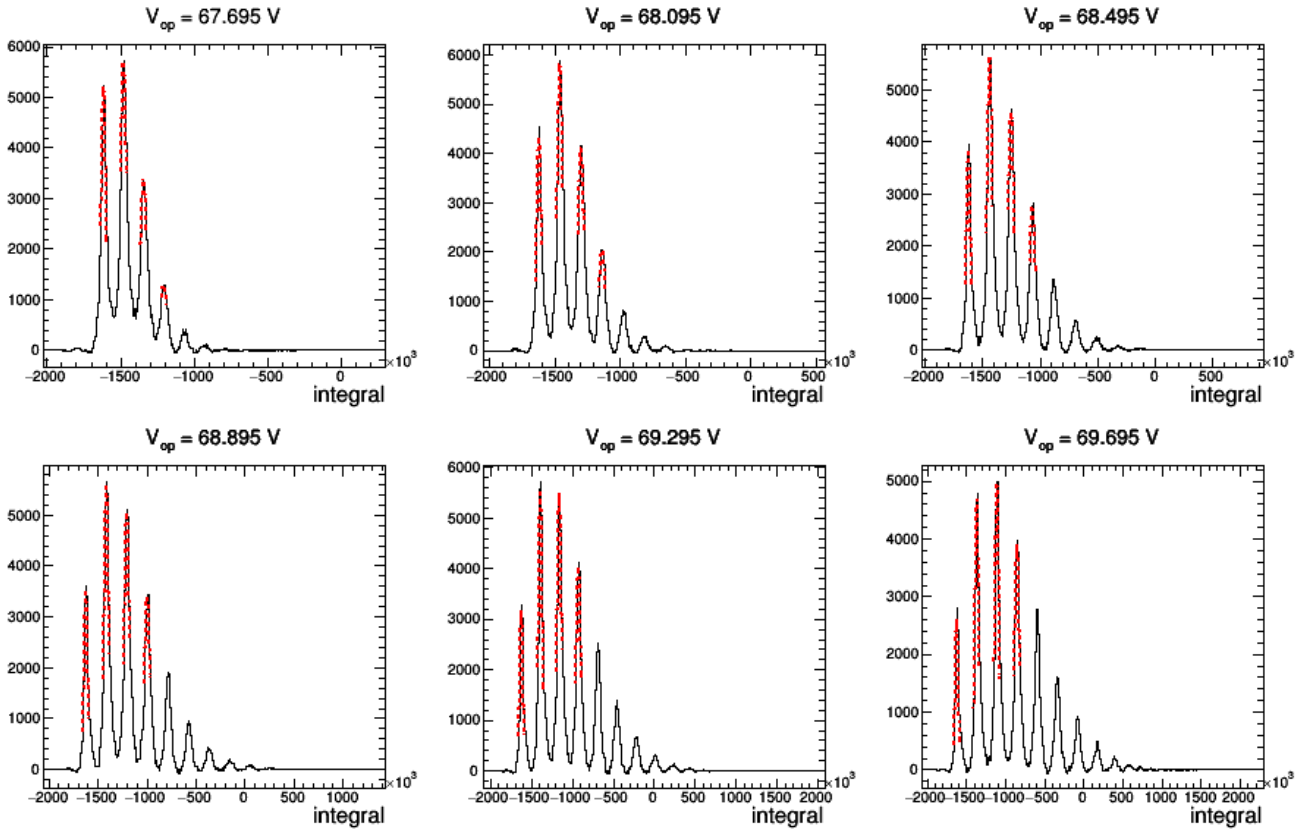




- Example I-V scan for single SiPM
- Measure current draw for low intensity DC LED light
- $d(\ln(I))/dV$ maximum at V_{br}
- Use measured temperature to correct to 25° C

Single Pixel Spectrum

- 100,000 LED pulses at 6 different V_{op}
- GHz digitizer produces output signal that is integrated and histogrammed



Single Pixel Spectrum

- Relative gain is determined by the peak-to-peak differences in SPS
- Linear relationship between relative gain and V_{op}.
- Uncertainties are smaller than the points.