Calibration of the sPHENIX hadronic calorimeter system

Ejiro Umaka$^1$, Hanpu Jiang$^2$, Shuhang Li$^2$

1. Iowa State University, 2. Columbia University on behalf of the sPHENIX collaboration

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sPHENIX Hadronic calorimetry (HCAL)

- **First at RHIC at mid-rapidity**
  - Coverage: \( |\eta| < 1.1, \ 2\pi \text{ in } \phi \)
  - Plastic scintillating tiles with embedded WLS fibers + tilted (steel) aluminum plates (oHCAL) iHCAL
  - Hadrons traversing the HCALs shower due to the plates. The deposited energy in the tiles are directed to silicon photomultipliers (SiPMs)
  - The signal from the SiPMs is then aggregated into towers

- **HCAL geometry**
  - 32 sectors
  - 48 towers/sector
  - 24 towers in \( \eta \), 2 towers in \( \phi \)
  - 4 tiles/tower (iHCAL); 5 tiles/tower oHCAL
  - Overall tile segmentation of \( \Delta \eta \times \Delta \phi \approx 0.1 \times 0.1 \)
Cosmic muon data taking with HCAL Sectors

- **Cosmic muon event selection**
  - A sector is divided into thirds (shown in teal, yellow & magenta in the plot below)
  - Each third has the same trigger for cosmics. The sum of the signal of a third of the towers must surpass a given threshold.

- **Offline cuts**
  - Vertical towers, i.e., 2 towers in $\phi$ are hit
  - No horizontally neighbor towers are hit (i.e., immediate towers in $\eta$)

Cosmic muon data for all towers in 1 HCAL sector over the course of 1 hour
(black = no offline cuts; red = with offline cuts)
Simulated single $\mu^-$ event on 1 HCAL sector

- A muon is simulated going through one sector with energy and angular dependence described in arXiv:1606.06907
- The energy loss distribution is then extracted for each tower
- This simulation result is used to calibrate the ADC signal peak in each tower with:

$$C = \frac{E_{\text{dep}}^{\text{cosmic}}}{E_{\text{dep}}^{\text{ADC}} \times SF(\text{muon})}$$

- Where, $E_{\text{dep}}^{\text{cosmic}}$ is the peak of the e.loss distribution extracted from GEANT4 cosmic simulation, $E_{\text{dep}}^{\text{ADC}}$ is the ADC peak measured from the cosmic data, and $SF(\text{muon})$ is the muon sampling fraction
Summary

• **sPHENIX** will be the first new collider detector at RHIC in over 20 years!
  o First hadronic calorimetry at RHIC at mid-rapidity
• The outer and inner HCAL sectors are now fully assembled at BNL!
  o Future calibrations will include the sectors in their fully assembled configuration

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