Performance Characteristics Study for the sPHENIX Inner Hadronic Calorimeter Scintillating Tiles

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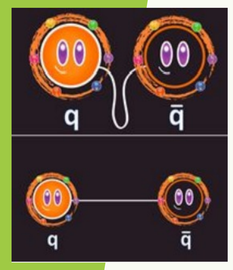
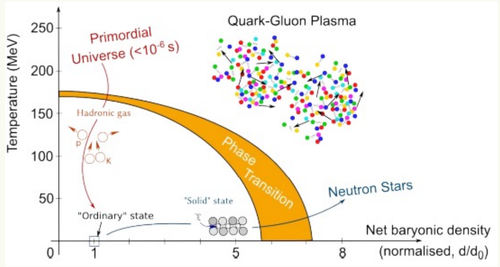
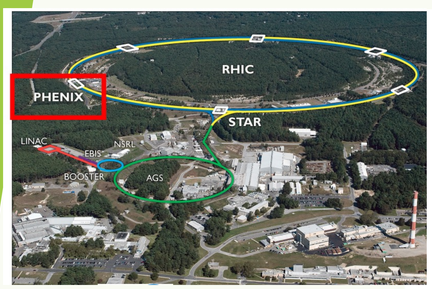
Quark Gluon Plasma (QGP)





- Strong force binds quarks together, similar to a string
- No free quarks! QGP only gives quarks asymptotic freedom (predicted by quantum chromodynamics)
- QGP is a state of nuclear matter that appears at ultra-high temperature and density
- It is a hot, dense soup of quarks and gluons that existed a few millionths of a second after the Big Bang
- QGP can be recreated in heavy ion collisions

sPHENIX



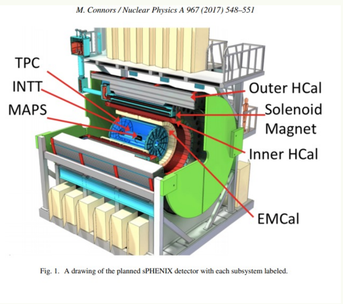
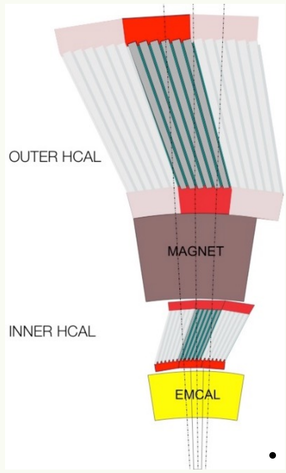


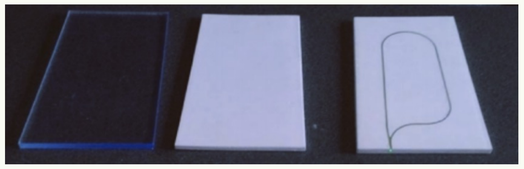
Fig. 1. A drawing of the planned sPHENIX detector with each subsystem labeled.

- sPHENIX: Upgraded particle detector at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL)
- Goal: Measure jets in heavy ion collisions to study the property of Quark Gluon Plasma (QGP)
- sPHENIX on schedule to start taking data in 2023
- Georgia State University Nuclear Physics Group focuses on the Hadronic Calorimeter (HCal), which is currently under construction at BNL

Hadronic Calorimeter Tiles

Hadronic Calorimeter (HCal) measures energy of hadrons that composes jets produced in heavy ions collisions.

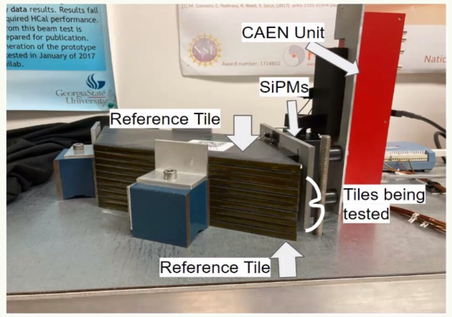




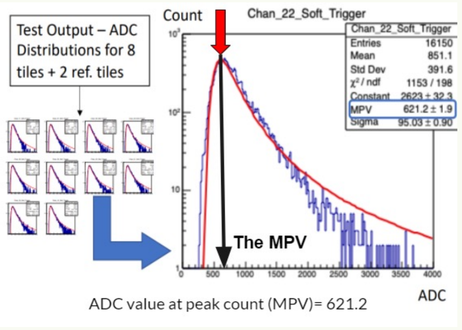
Inner HCal tile composition: Scintillating plastic (left); Reflective coating (middle); Bonded wavelength shifting fiber (right).

- The tiles are inserted between aluminum plates
- Similarly performed tiles will be grouped together into towers
- The Inner HCal assembly has begun

Tile Testing



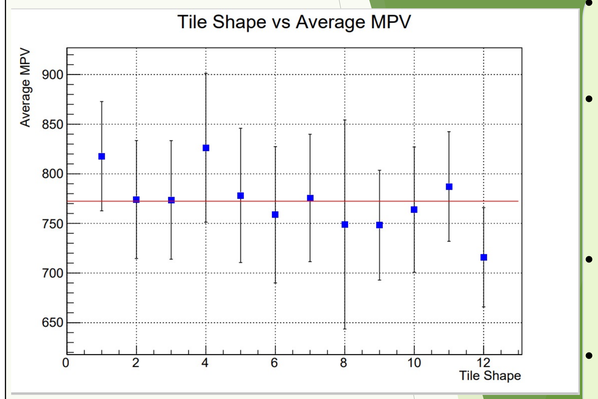
- Tiles' performance measured via response to cosmic rays, which strikes the scintillating plastic to produce photons
- Fiber collects the photons and routes photons to SiPM
- CAEN unit converts the analog signal to digital signal
- Inner HCal tiles: 8 tiles + 2 reference tiles for testing 30 minutes

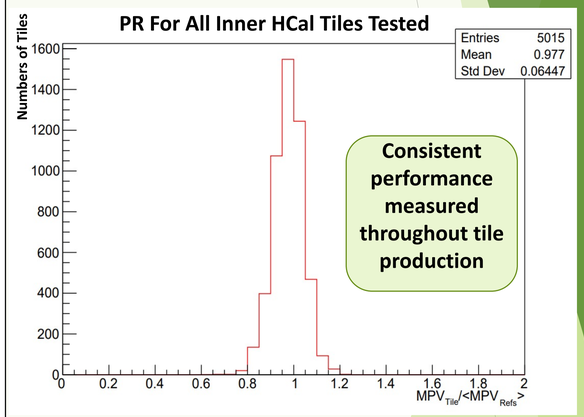


- **ADC distribution plot**: Graph of analog to digital conversion
- **MPV value**: Mean Peak Value for ADC distribution
- **PR value**: Performance Ratio for the same tile shape

$$PR = \frac{MPV_{Tile}}{MPV_{AvgRef}}$$

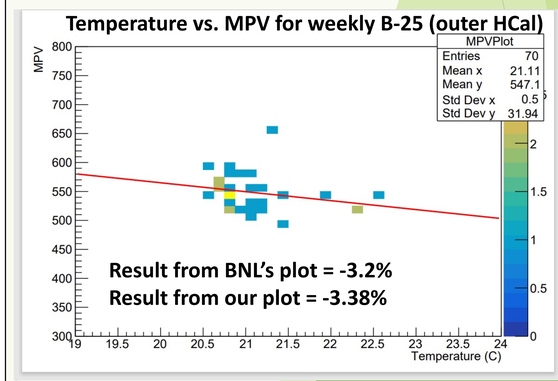
Data Analysis





- Compare the average MPV for different tile shapes
- Z12, due to its shape of fiber routing, has the expected lowest MPV value.
- Red line is the global average MPV value
- Error bars is the standard deviation in tile data

- The total number of inner HCal tiles are 6,360.
- By early October, We have tested of 90% all the Inner HCal tiles at GSU. Our goal is to finish all the tile testing by the end of October, 2021.



- SiPM performs differently based on the environmental temperature.
- We want to calibrate the data based on temperature correction
- By studying weekly tests, we obtained a similar temperature correction result as BNL's

Acknowledgement

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