Performance Characterization Studies of sPHENIX Hadronic Calorimeter Scintillating Tiles

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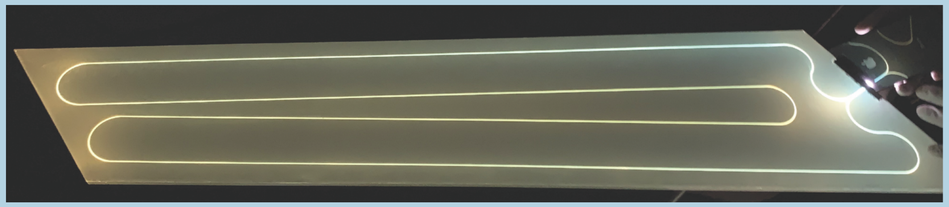
Introduction

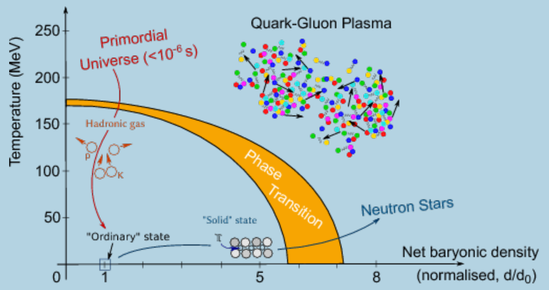
sPHENIX is an upgrade to the previous PHENIX detector at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab (BNL). RHIC collides Au+Au at relativistic speeds, producing Quark Gluon Plasma (QGP) at very high temperatures. Studying QGP gives us a deeper understanding of the nuclear strong force and a glimpse into the early universe.

At GSU, we test the scintillating tiles that will go into the Hadronic Calorimeter, which detect sprays of hadrons that occur during collisions called “jets.”



Quark Gluon Plasma

- Right after the Big Bang, the universe was made of a hot, dense soup of quarks and gluons
- These particles carry the nuclear strong force, which holds structures like the proton or neutron together
- In Quark Gluon Plasma, these hadrons become deconfined
- This state of matter is recreated in near light speed collisions between heavy ions such as gold or lead at the Relativistic Heavy Ion Collider (RHIC)



sPHENIX

- sPHENIX will measure sprays of hadrons formed after collisions called “jets”
- Use jets to probe energy loss effects in QGP
- Data collection will start in 2023
- GSU focuses on outer/inner Hcal
  - Comprised of steel towers with scintillating tiles
  - Measures energies of jets

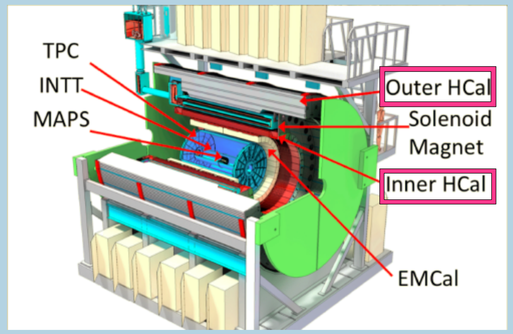
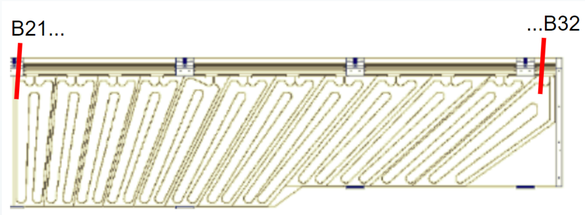


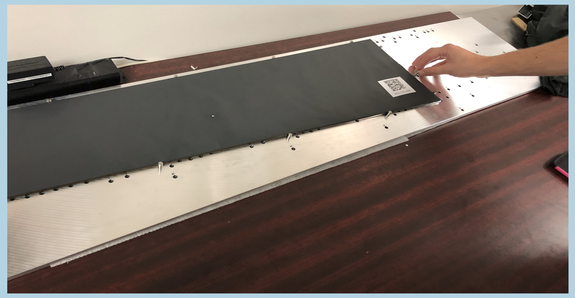
Diagram of the sPHENIX detector

Scintillating Tiles

- Composed of scintillating plastic and wavelength shifting fiber
- Light goes from fiber into a silicon photomultiplier, where we record the amount light
- Have twelve different shapes, from B21-32



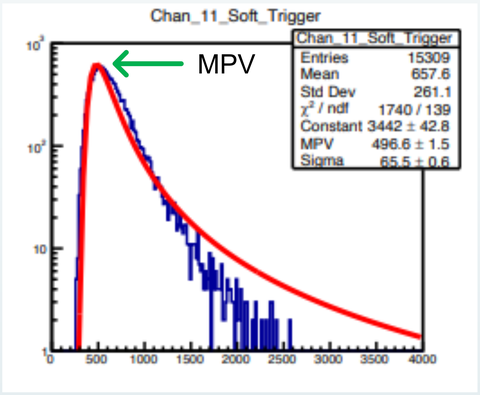
Tile test stand, where 10 tiles (2 reference) are tested for 20 minutes.



Dimension tester, where tiles are tested to make sure they are the proper size and will fit in the Hcal towers.

Tile Testing at GSU

- Check the dimensions of the tile to make sure it will fit properly in the detector
- Test for differing light response
  - Cosmic rays strike tile, which we use as a calibration tool to measure how much scintillation light is produced
  - Test for 20 minutes at a time
  - Each tile has two reference tiles, and we test in stacks of eight
  - Get the Most Probable Value (MPV) of light count, which tells us about its performance
  - Also get Performance Ratio, which determines how tiles are sorted in Hcal
  - PR = MPVtile/<MPVref>



Test output, plotting ADC vs. Count

Results

- GSU has tested 5,853/6,360 (92%) of the tiles set to go into the outer Hcal
- Only 1.3% of these tiles have had low performance
- Getting ready to receive inner Hcal tiles, after finishing the outer tiles