CALOR 2016

Contribution ID: **9** Type: **not specified**

Status and New Results for the sPHENIX Calorimeter Systems

Tuesday 17 May 2016 13:30 (20 minutes)

The PHENIX Experiment at RHIC is planning a major upgrade that involves building an entirely new spectrometer based around the former BaBar solenoid magnet that will enable a comprehensive study of jets and heavy quarkonia in relativistic heavy ion collisions. It will include two new calorimeter systems, one electromagnetic and one hadronic, that will cover an acceptance of ±1.1 units in pseudorapidity and 2pi in phi, resulting in a factor of 6 increase in acceptance over the present PHENIX detector. The hadronic calorimeter, which will be the first hadronic calorimeter ever built at RHIC, will be a steel plate and scintillating tile design that is read out with wavelength shifting fibers and silicon photomultipliers. It will be divided into two sections: an Inner HCAL that will be situated inside the magnet and an Outer HCAL that will be located outside the magnet. The electromagnetic calorimeter will be a SPACAL design consisting of a tungsten powder epoxy matrix absorber with embedded scintillating fibers which are also read out with silicon photomultipliers. The current design of the sPHENIX detector, including the EMCAL and inner and outer HCALs, will be described in this talk. Prototypes of all three calorimeter detectors have been built and will be tested in the test beam at Fermilab in April of 2016 to study the energy resolution, linearity and e/pi ratio of the calorimeter system. The first preliminary results from these tests, along with a detailed comparison to Monte Carlo simulations, will also be presented. In addition, plans to upgrade the sPHENIX detector for use as a Day 1 detector at a future Electron Ion Collider at BNL (eRHIC) will also be discussed.

Summary

The PHENIX Experiment at RHIC is planning a series of major upgrades that will enable an extensive set of new physics programs over the next decade. This will involve replacing the current PHENIX Central Arm spectrometer with a new central spectrometer, sPHENIX. It will utilize the former BaBar solenoid magnet and include two new large calorimeter systems, one electromagnetic and the other hadronic. They will cover ± 1.1 units in pseudorapidity and 2 pi in phi and will be used to measure jets in heavy ion collisions, allowing a detailed study of the Quark Gluon Plasma near the region of its critical temperature. The hadronic calorimeter will be the first such calorimeter ever used in a RHIC experiment, and will provide a much better measurement of jets than has previously been possible at RHIC energies. The sPHENIX spectrometer will also include a tracking system and vertex detector that will enable a measurement of heavy quarkonia in heavy ion collisions in order to study the production of upsilon states (1S,2S and 3S) in dense nuclear matter near the phase transition to the QGP.

The hadronic calorimeter will be a steel plate and scintillating tile design that is read out with wavelength shifting fibers and silicon photomultipliers. It will be divided into an Inner HCAL that will be located inside the magnet and an Outer HCAL that will be outside the magnet, and will have a combined depth of ˜ 5.5 hadronic absorption lengths. The steel plates will be oriented parallel to the beam and are tilted in the phi direction to prevent channeling of particles through the scintillating tiles. The thickness of the steel plates increase with increasing radius, while the scintillator tiles will be of constant thickness, thus leading to a sampling fraction that decreases with increasing radius. Based on Monte Carlo simulations, the expected single particle energy resolution with this design is ˜ 100%/sqrt(E). An early version prototype of the hadronic calorimeter was tested in the test beam at Fermilab in 2014 and the measured resolution agreed well with the Monte Carlo predictions.

The electromagnetic calorimeter will be a compact tungsten scintillating fiber SPACAL design consisting of a matrix of tungsten powder and epoxy with embedded scintillating fibers that are read out with silicon photomultipliers. This design was originally developed by the group at UCLA and was shown to give an energy resolution ˜ 12%/sqrt(E) in beam tests at Fermilab. The design is now being further developed for large scale production for the roughly 25,000 absorber blocks that will be required for sPHENIX. Absorber blocks have been now produced by an industrial supplier, Tungsten Heavy Powder (THP), as well as by the groups at the University of Illinois at Urbana Champaign and at Brookhaven Lab.
A new electronic readout system is also being developed for both calorimeters. This includes a new preamp for the SiPMs as well as a new 80 MHz digitizer for the readout. The preamp system will also stabilize the gain of the SiPMs due to temperature variation as well as changes in dark current due to radiation damage. Radiation

damage studies on SiPMs have also been carried out and the effects of this damage on the calorimeter response has also been studied.
New prototypes of the inner HCAL, outer HCAL and EMCAL have been built to simulate the final sPHENIX design and will be tested at Fermilab in April of 2016 along with the new readout system. The HCAL prototypes each consist of 4x4 towers of the tilted plate design and the EMCAL prototype consists of 8x8 towers of absorber blocks produced at THP and UIUC. Tests will be done to measure the energy resolution, linearity, e/pi ratio and various other parameters over an energy range from ˜ 1 GeV up to ˜ 40 GeV. The first preliminary results from these tests, as well as a comparison with Monte Carlo simulations of all three detectors, will be presented at the conference. In addition, the current status of the overall sPHENIX design will also be presented.
The long range plan for RHIC is to transform the current heavy ion and hadron collider into an Electron Ion Collider (EIC) at BNL (eRHIC). It will have the capability for colliding polarized electrons with energies initially up to 21 GeV with hadrons up to 250 GeV and heavy ions up to 100 GeV/A, and will enable the study of nucleon structure and QCD in nuclei over a large range of xF and Q2. A new suite of detectors would then be added to sPHENIX to provide additional capabilities for studying ep and eA collisions. Plans for the evolution of sPHENIX into a Day 1 detector for eRHIC will also be given in this presentation.

Author: WOODY, Craig (Brookhaven National Lab)

Presenter: WOODY, Craig (Brookhaven National Lab)

Session Classification: Calorimeters for future accelerator experiments