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The Readout and Data Acquisition Design of the sPHENIX Detector at RHIC

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The recently established sPHENIX Collaboration at RHIC is upgrading the PHENIX detector in a way that will enable a comprehensive measurement of jets in relativistic heavy ion collisions. The upgrade will give the experiment full azimuthal coverage within a pseudorapidity range of $-1.1 < \eta < 1.1$. In addition to measuring heavy-ion collisions, the new apparatus will provide enhanced physics capabilities for studying nucleon-nucleus and polarized proton collisions, and eventually allow a detailed study of electron-nucleus collisions at an envisioned Electron Ion Collider at Brookhaven.

The upgraded detector will be based on the former BaBar magnet and will include tracking detectors, a new electromagnetic calorimeter, and, for the first time at a RHIC experiment, a hadronic calorimeter. A new technology using a sampling Tungsten-scintillating fiber design for the electromagnetic calorimeter is what enables the full azimuthal coverage, as it achieves a radiation length of just about 7mm, which allows for a very compact design of the device.

The calorimeter signals are sampled with silicon photomultipliers and waveform digitizing electronics. The digitized waveforms are read out with custom PCIe boards that allow multiple streams with bandwidths of up to 5GBit/s. The goal is to have a sustained event rate to disk of about 15KHz. Focusing on the calorimeters, we will describe the goals and design of the sPHENIX experiment, the design of the digitizers and other parts of the data acquisition system, and the results we got with current prototypes. By the time of the conference, we will have data from a test beam at FermiLab that will test the readout under beam conditions.

We will detail the design of the FPGA-based readout cards, and how we implement the so-called “multi-event buffering” in the front-end, which has traditionally enabled PHENIX to take data at rates rivaling, or exceeding, the LHC experiments.

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