THE PHENIX MUON ARMS

PHENIX Collaboration

(For a list of ORNL authors, see article "PHENIX Experiment at RHIC.")

The Muon Arms are a major contributor to the overall PHENIX physics program. The primary goal of the PHENIX Relativistic Heavy-Ion Physics program is to detect the quark-gluon plasma (QGP) and to measure its properties with as many different experimental probes as the detector will allow. The Muon Arms will be used to measure the production of vector mesons decaying into dimuons in heavy-ion collisions for masses ranging from that of the ϕ to the Υ. Measurement of the differential suppression of the J/Ψ, Ψ', Υ(1S) and Υ(2S+3S) production will provide information concerning "deconfinement," i.e., the Debye screening of the QCD potential. The Muon Arms also allow studies of the continuum dilepton spectrum in a much broader region of rapidity, mass, and transverse momentum than is accessible in the central electron arms alone. In addition $e-\mu$ coincidences, using electrons detected by the central arms, will probe heavy-quark production and aid in the understanding of the shape of the continuum dielectron spectrum. This is because unlike-sign $e-\mu$ pairs result primarily from $D\overline{D}$, while like-sign pairs are mainly due to the combinatorial background.

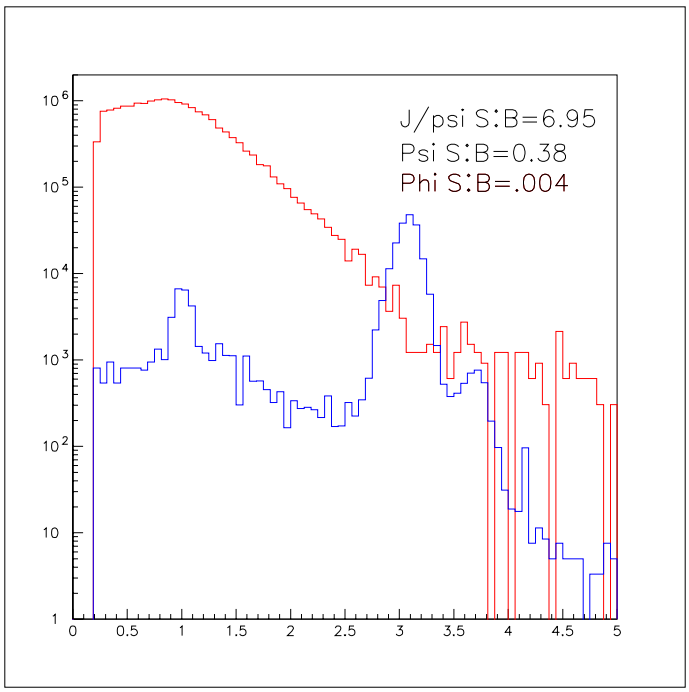

Figure 1: Contribution due to combined signals (blue) and including backgrounds as well (red). Distribution corresponds to one RHIC-year of Au+Au minimum bias collisions at design luminosity.

The primary goal of the PHENIX Spin Physics program is to study polarized proton-proton collisions at 50 $< \sqrt{s}$ (GeV) $<$ 500 in order to determine the helicity distributions

of quarks and antiquarks and of the gluon polarization in the nucleon. This information is obtained by studying the polarized Drell-Yan process, vector boson production, polarized gluon fusion, and polarized gluon Compton scattering. Antiquark structure function measurements rely on analyzing Drell-Yan and vector-boson production data. Gluon polarization measurements rely on analyzing heavy quark, J/Ψ, and prompt photon data. Efforts to understand the contributions of the spin of sea quarks and the polarization of gluons to the total nucleon spin may help explain the lack of the agreement between the experimental data and the Ellis-Jaffe sum rule.

The Muon Arms consist of a Muon Tracker (to track the muons and provide sufficient mass resolution to separate the Υ(1S) from the Υ(2S+3S)) and a Muon Identifier (to provide an additional 100:1 π: μ rejection). ORNL has lead responsibility for the design and construction of the PHENIX Muon Identifier and the development of the corresponding Front-End Electronics (FEE).

In addition to π: μ rejection requirements, the Muon Identifier is required to meet the following criteria:

Ten-year lifetime: the Muon Identifier is installed behind a permanent shield wall, eliminating access to the sensitive elements for the lifetime of PHENIX.

Affordable large-area coverage: about 0.5 acres, to use a conventional unit, must be instrumented.

Level-1 trigger input: within a few μsec of every RHIC beam crossing (every 106 nsec) the Muon Identifiers must be able to produce an event selection decision in order to significantly reduce the bandwidth required to write all muon events to storage media; such a decision must be produced for each crossing, i.e., every 106 nsec, in a “pipelined” fashion.

The Level-1 input must also identify “roads” traversed by candidate muons whose momenta are then measured by the Muon Tracker.

Significant progress in the areas of detector design, construction and installation; FEE design and prototyping; and software development will be described in following sections of this progress report.