PHENIX MUON IDENTIFIER — FABRICATION AND INSTALLATION

PHENIX Collaboration

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

The north and south Muon Identifiers are identical, each consisting of five gaps instrumented with plastic proportional tubes interleaved with steel wall absorbers. The first absorber layer is the 30-cm-thick steel end-plate flux return of the muon magnet. The next two absorber layers are 10-cm-thick, and the last two are 20-cm-thick. This segmentation gives a low-energy muon threshold of $\sim$1.9 GeV. A muon incident normal to the steel surfaces loses $\sim$2.7 GeV passing through the entire stack. Four large and two small panels are used to tile each gap with tubes. Large panels are $\sim 5 \times 5 \times 0.1\mathrm{m}^3$ and weigh more than 3000 pounds. The individual proportional tubes are Iarocci limited-streamer tubes operated at reduced gain in order to maximize their longevity. Iarocci tubes were chosen because they satisfy all of the required detector performance criteria. They have proven reliability and longevity, compactness, low cost, and are available from a commercial vendor. The eight anode wires in each tube are ganged together into one readout unit to allow for low-resolution tracking and to provide signals corresponding to a useful geometrical segmentation for the first and second level muon triggers. The panels have two x and two y measuring sets of tubes. The two sets in each orientation are offset by 5 mm to provide higher efficiency and shorter effective drift times. Custom-printed circuit boards distribute high voltage and house a preamplification circuit which is capacitively coupled to the tubes' anode wires. Signals are differentially driven on twisted-pair cables to mass-terminated bulkhead connectors at the panel edge. Segmentation of power, gas, and high voltage was chosen to provide a high degree of fault tolerance.

The principal activity of the period covered in this Progress Report was the assembly and installation of all muon identifier panels (two weeks prior to the deadline specified by the installation schedule of the permanent shield wall). This required the muon identifier effort to evolve from laboratory prototyping to operation of assembly factories on two continents and the installation of 60 unwieldy multiton detectors into the PHENIX experimental area. There were many steps in between:

- The full-scale prototype at ORNL was completed.
- Extensive R&D was performed concerning tube operation with a variety of different multicomponent gases. A non-flammable mixture of 9% isobutane and 91% CO2 was selected as the operational gas (more details can be found in a separate page of this Progress Report).
- The mechanical design of the large and small panels was finalized.
- The mechanical design of all other devices used in manipulating and supporting the panels was finalized.
- A full installation plan was developed and tested.
- A final design review and multiple safety reviews were passed. Feedback from the reviews was incorporated into the designs.

- Very detailed procedures were developed for assembly and lifts.
- The in-panel electronics was designed, prototyped, and fabricated.
- Longevity requirements demanded the development of rigorous QA procedures of all elements that were installed into the panels.

Figure 1: Full-scale prototype panel at ORNL. The streamer tubes (white) are mounted on the panel's aluminum midplane (tubes in the orthogonal orientation are on the underside of the midplane). The copper sheet serves as RF shielding and a capacitively coupled ground return path to terminate the anode signals.

Figure 2: Amplifier/HV distribution cards installed in a panel.

Figure 3: A large panel being installed into the PHENIX Experimental Hall.