Commissioning of the STAR Endcap Electromagnetic Calorimeter

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The Endcap Electromagnetic Calorimeter (EEMC) for the STAR detector at RHIC is the largest equipment development project undertaken by the I.U. Nuclear Physics group since the closing of IUCF operations was announced. The EEMC is a sampling calorimeter comprising 24 layers of alternating Pb/stainless steel radiators and plastic scintillators, plus a high granularity shower-maximum detector (SMD) to distinguish single photons from π^0 and other neutral meson daughters. It expands STAR's coverage and triggering capabilities for high-energy photons, neutral mesons, jets and electrons/positrons into a kinematic region dominated by asymmetric partonic collisions between the two beams. This coverage is especially critical for the RHIC spin program, where we hope to use quarks of large polarization at sizable Bjorken *x* in one polarized proton beam to probe the polarization of low-*x* gluons and sea quarks in the other proton.

We have led a team including scientists from Argonne and Brookhaven National Laboratories, JINR Dubna, Texas A&M and Kent State Universities, CalTech and MIT on the design, fabrication, installation and commissioning of this 30-ton, 10000-channel upgrade for the STAR detector. The I.U. group had specific responsibility for: project oversight and management; nearly all of the mechanical and much of the electronics design; fabrication of the mechanical structure, the scintillator megatiles [1], the readout optical fibers and electronics for multi-anode photomultipliers (MAPMT); implementation of pulsed uv laser and radioactive source diagnostic/calibration systems; assembly of phototube boxes and quality control measurements on the single-anode tubes; detector installation; and design of commissioning measurements and software. The project was initiated with an NSF MRI grant in Fall 1999. It is essentially completed. The lower half of the mechanical structure and 1/3 of all active elements were installed on the STAR poletip during summer 2002, followed by the upper half and the remaining active elements in Fall 2003 (see Fig. 1). Phototubes, readout and triggering

Figure 1. *The EEMC during Fall 2003 installation on the STAR poletip. Steve Vigdor and Jim Sowinski are seen, respectively, attaching some of the ~30000 readout optical fibers and checking the fit of scintillating megatiles in the detector, before addition of the outer skin and fiber trays to make the detector light-tight. Phototube boxes and readout electronics are mounted on the rear of the poletip.*

electronics for 1/3 of the 720 calorimeter towers were instrumented for the 2003 RHIC run, permitting a first look at the basic detector performance with RHIC p+p collisions. The tower readout was completed for the 2004 run, along with the innovative, compact MAPMT readout for ~3000 channels of special subsystems: SMD (two orthogonal planes of triangular plastic scintillator strips, positioned in depth slightly upstream of the maximum shower development); preshower (alternate readout for the first two tower layers in depth) and postshower (last layer) detectors. During the 2004 run, the EEMC figured prominently in most of STAR's triggering and data acquisition with both Au+Au and polarized p+p collisions at $\sqrt{s_{NN}} = 200$ GeV, allowing complete checkout of the full system performance, reliability and calibration prior to instrumentation during summer 2004 of the final 2/3 of the MAPMT readout.

All EEMC subsystems functioned quite well during the 2004 run. A few percent of problematic readout channels have been mostly repaired during the summer 2004 shutdown. Ongoing analyses of EEMC data from 2004 are focusing first on calibrations of all detector subsystems. Calibrations of the tower energy scale have been carried out by several different methods, involving minimum-ionizing particles (mips) and high-momentum electrons tracked to the EEMC by STAR's Time Projection Chamber, mips identified by the EEMC response alone, and π^0's reconstructed from the tower and SMD energies, with all methods in good agreement. Figure 2 shows a typical SMD transverse shower profile for a detected π^0, together with a preliminary invariant mass spectrum reconstructed from the energies of the two closely spaced daughter photons. We see clear π^0 mass peaks not only for p+p, but also for Au+Au collisions, despite the high detector occupancy in the latter case. We expect to extract significant physics results with the EEMC already from the 2004 data, and to be fully ready for the first long RHIC polarized proton collision run in 2005.

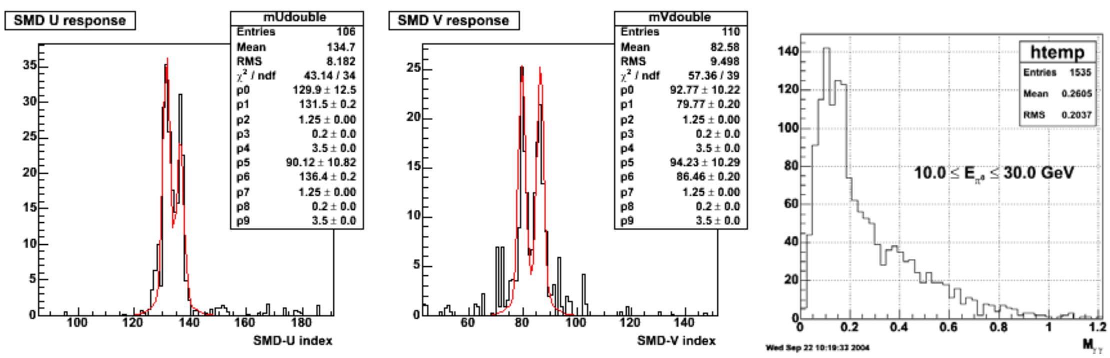

Figure 2. *Transverse shower profiles for a 14-GeV π^0 candidate measured for p+p collisions with the EEMC's shower-maximum detector, showing the closely spaced peaks for both daughter photons in each of two orthogonal planes. On the right is the invariant mass spectrum reconstructed from observed tower and SMD energies and positions for a small part of the EEMC.*

1. C. Allgower *et al.*, Nucl. Instrum. Methods A **499**, 740 (2003).