THE CALIBRATION AND MONITORING SYSTEM FOR THE PHENIX LEAD SCINTILLATOR ELECTROMAGNETIC CALORIMETER

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Summary

The PHENIX experiment at RHIC is now well into its construction phase and many of the major detector systems are now starting to be assembled at Brookhaven. The main part of the electromagnetic calorimeter for PHENIX consists of a 60 m^2 lead-scintillator shashlik type detector segmented into 15552 individual towers, each read out with its own phototube. The calibration, stabilization and gain monitoring of such a large system of phototubes is a formidable task, and an extensive precison calibration and monitoring system has been developed to provide an overall gain stability of less than 1% for the entire calorimeter.

The system is based on a UV laser which supplies light to the calorimeter through a system of optical fibers and splitters. The calorimeter is arranged into 108 supermodules, each consisting of a 6×6 array of individual modules. Each module consists of four readout towers with four phototubes. Light is injected into each module through a "leaky fiber" which excites the plastic scintillator stack with a distribution in depth that simulates an electromagnetic shower. The intensity of the light at each supermodule is monitored with a PIN photodiode that is used for normalization. The light intensity is also monitored with additional PIN diodes at each intermediate splitter, and directly from the laser and initial beam splitter using a biplanar phototube. Figure 1 shows the final PHENIX monitoring system configuration.

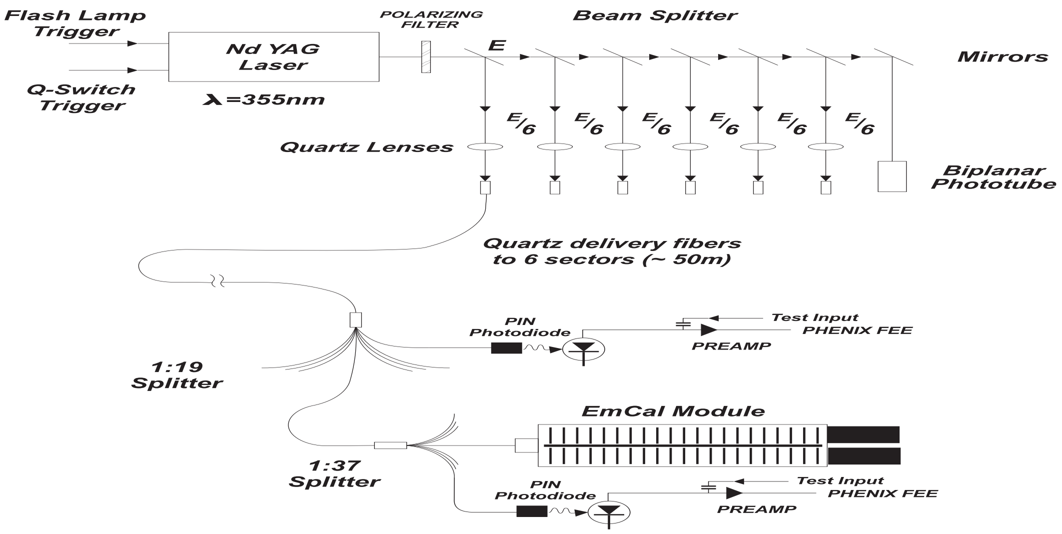

Figure 1: PHENIXLead Scintillator EMCAL Calibration System

A prototype version of the monitoring system is currently being used in conjunction with cosmic ray muons to calibrate each supermodule after assembly. This system was also used to measure and follow gain variations in selected supermodules which were tested in a test beam at the Brookhaven AGS. In addition, the system is also used for testing and calibrating all photomultiplier tubes which are used in the entire calorimeter. Data will be presented on each of these topics, along with preliminary results from the final monitoring system.

As an example, one can consider the calibration of each supermodule using cosmic ray muons. Muons are selected which traverse the supermodule perpendicular to its longitudinal axis, producing a signal equivalent to $\sim$ 40 MeV of electromagnetic energy. Approximately 5000 muon tracks per tower are used to define the peak position to a precision of better than 1%. These peak positions can then be used to measure the absolute gain of each phototube within a supermodule, and can be compared at different times in order to measure the effects of gain variations. These variations are typically on the order of few percent for most tubes, but with some tubes exhibiting drifts of more than 10% over a period of weeks. Figure 2 shows a comparison between the muon peak positions in each tower of a supermodule measured over a one week interval. Without laser monitoring, the measured distribution gave an rms of 1.2% with a pronounced high side tail, indicating a systematic upward drift for all phototubes. After correction using laser monitoring, the rms decreased to 0.4% and the distribution is nearly gaussian, which is substantially less than the design goal of the full calorimeter system.

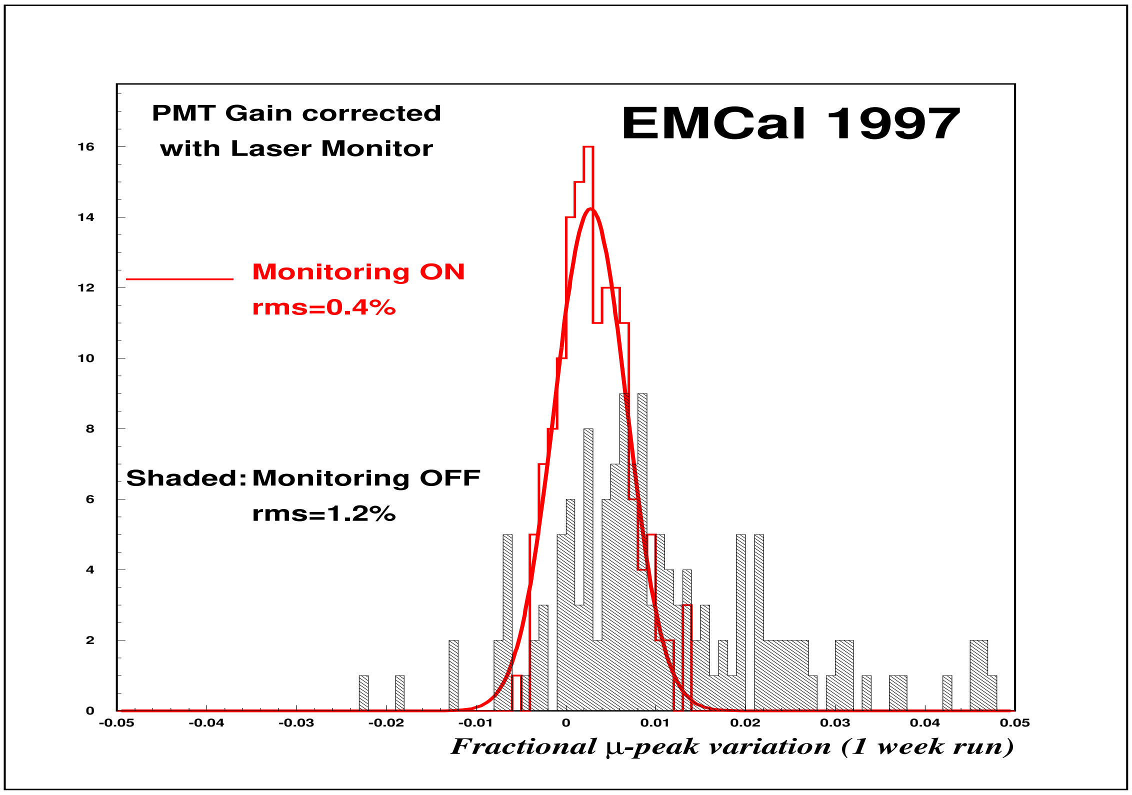

Figure 2: Gain tracking of PHENIX EM Calorimeter phototubes