STAR NOTE 303

Experimental Test Setup for Light Yield and Uniformity Measurements of Mega-tiles

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Abstract

In this paper we are described the experimental test setup for measurements of the light yield and uniformity of mega-tiles. This experimental setup is a part of a quality control program of the barrel EMC production.

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Introduction

A lead-scintillator sampling Barrel Electromagnetic Calorimeter (BEMC) is planned to be part of the STAR detector for RHIC accelerator at the Brookhaven National Laboratory (BNL). We have chosen the concept of embedded wavelength shifting (WLS) fibers to couple the scintillation light from the tiles in a sampling calorimeter to the photon detectors. This approach has opened up some significant technological issues relating to the optical system, namely: the optical system must produce enough light to allow easy identification of minimum ionizing particles penetrating the calorimeter, and possess adequate optical uniformity over a large number of scintillator tile/wavelength shifting fiber assemblies. These are a serious issues for the optical system of EMC, where high performance is required.

In order to study the optical system a specialized test setup has been designed and constructed at WSU during 1996 and extensive tests have been made.

Experimental setup.

Fig.1 shows a schematic drawing of geometry of the test setup[**?**]. The apparatus consist of three independent parts: two fixed frames for mounting trigger counters and a radioactive source, together with a movable table used for mounting the scintillating tile currently under test and the phototubes(PMT). All parts of the setup are mounted in light isolated box.

The tile under test is mounted on a table which is moved by stepping motors controlled by a personal computer, thus allowing the light output of a tile to be scanned transversely as a function of position. The range of motion is 200 mm in both the X- and Y-directions. The precision of motion is 0.25 mm.

Each trigger counter consists of a 2 mm^2 Bicron BCF-12 scintillating fiber coupled to an Hamamatsu RC4044 PMT. These counters are mounted on the fixed frame located above the movable table. By using two trigger counters in coincidence we eliminate non-local and non-penetrating backgrounds such as gamma rays and low energy electrons. The scintillator tile under test is excited by a Ru^{106} 3 Mev β-ray source of 8 mm in diameter, which mounted on the fixed frame below the movable table. At this energy the electrons are approximately minimum ionizing in the first several mm of plastic scintillator. Their range is great enough to penetrate: 1 mm of cardboad, the 5 mm thick scintillator tile under test, and a 2 mm thick trigger scintillator, to finally deposit a signal in the last 2 mm trigger scintillator. Multiple scattering in the scintillator is not too large considering our spatial resolution of 2mm.

Light from the tile/fiber assembly is detected by the PMT currently under test. The signal from the PMT is digitized by LeCroy 2249A CAMAC ADC module with a maximum resolution of -0.25pC/channel and recorded by a personal computer. The single photoelectron peak for the PMT under test had been obtained in previous measurements using the tile/fiber system[**?**]. An LED based flasher system is also used for calibration purposes. The light from a blue LNG992CF9 LED is transported to the PMT via a green Bicron BCF91A WLS optical fiber of 1 mm in diameter. A comparison of the results obtained between the PMT calibration using the tile/fiber assembly and LED system have not shown significant differences.

We estimate the light yield from a tile/fiber system in terms of an average number of photoelectrons produced by the photoelectric effect on the PMT photocathode. We have chosen the α-groove geometry of WLS fiber within the tile for our first study[?]. The results of our first measurements are listed in Table 1.

Table 1

SCINTILLATOR	WLS FIBER	PHOTOTUBE	PHOTOELECTRONS
BCF404A	50cm BCF91A	R580-17	8
BCF404A	50cm BCF91A	FEU115M	10.5
BCF404A	50cm BCF91A + 6m BCF98	R580-17	2.5
BCF404A	50cm BCF91A + 6m BCF98	FEU115M	3
BCF404A	6.5m BCF91A	FEU115M	1.6
PSN	50cm BCF91A	R580-17	6

The uniformity of response of the tile/fiber assemblies have been measured using the collimated Ru^{106} source. Fig. 2 shows the results of a comparison of Bicron and injection molded polystyrene-based PSN(1.5% PT and 0.01% POPOP) scintillator tiles. For these measurements we have used 50 cm lengths of BCF91A green WLS fibers without splicing to 3 m long clear fibers. The PSN scintillator plastic tiles with the α-groove geometry have a slightly higher non-uniformity than that of the Bicron scintillator.

Conclusion

This experimental setup is a part of a quality control program for the calorimeter tile production, and is designed to monitor the light yield variation of individual tiles within a single mega-tile. Prior to full-scale construction of mega-tiles in 1998 larger test facilities are planned at WSU. Our quality control strategy is the same as used by CDF in their calorimeter upgrade project. The CDF experience gives us confidence that this strategy will work well for the barrel EMC of STAR as well.

Acknowledgments

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References

[1] O.Grachov - Report on the 13^{th} STAR Collaboration Meeting, BNL, Aug.11-16, 1996.

[2] O.Grachov and A.Ronzhin - Preprint IHEP 88-74, Protvino, 1988.

[3] O.Grachov - Preliminary Results of Optimization Tile/Fiber Read-out System, STAR-NOTE SN274, BNL, 1996.

Figure Captions

Fig.1 Schematic drawing of geometry of experimental test setup for light yield and uniformity measurement of mega-tile.
Fig.2 Comparison of Russion PSN and BICRON BC-404A scintillating tiles.

Fig.1 Experimental setup for light yield measurement.

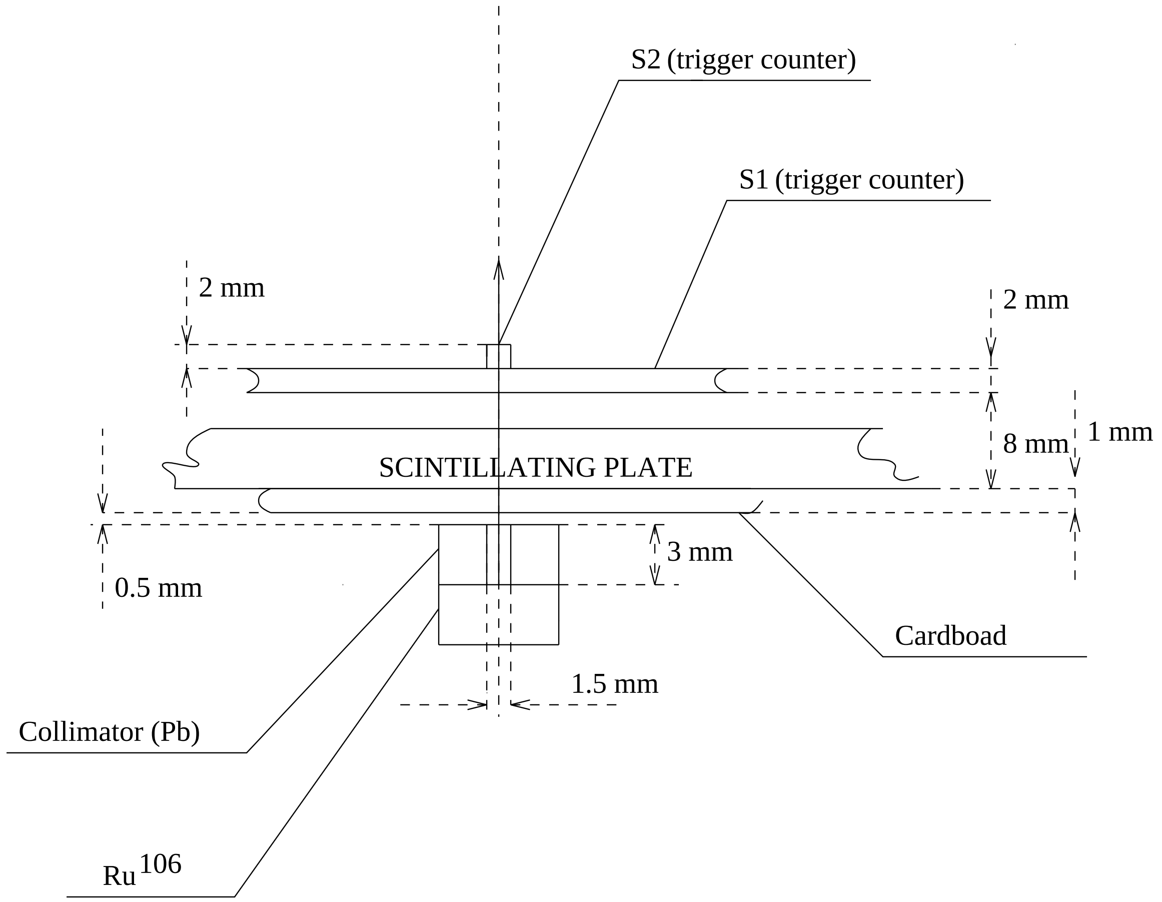

Fig.2 Comparison of Russion PSN and BICRON BC404A scintillating tiles