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Temperature Effect on Scintillator Tile/Fiber Assemblies

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Abstract

Studies of the light yield dependence from temperature had been performed on extrusion PS scintillator tile/ Kuraray Y11 fiber assembly. Experimental set up, measurements and results are described. Light output stability of PS extrusion scintillator is less than -0.25%/^{0}C that is typical for PS scintillator.

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Introduction

The goal of the measurements presented here is to study the dependence of light yield of extrusion PS scintillator tile/fiber assembly from temperature in the region from 24^0C to 40^0C in conditions that are similar to those anticipated for the STAR Barrel EMC. The light yield variation can affect the calorimeter calibration and possibly resolution.

Measurements

The size of sample scintillator tiles was 110 x 110 $(mm)^2$. Commercially available extrusion scintillator (PSM-115 + 1%pTP + 0.01% POPOP) of 5 mm thickness were used. The sample tiles are fabricated by WSU Department of Physics and Astronomy group. A peripheral σ - groove was mashined in the tile, where green wavelength shifting (WLS) fiber diameter 0.83 mm was embedded. The groove has rectangle shape with width 1.25 mm. The distance of the groove from the tile edge was 1.5 mm. The groove makes a turn by 90^0 at the tile cornes at radius of 30 mm. The depth of groove was 2 mm. The non-polished tile edges are painted white with Bicron reflective paint. White bond paper is used on both sides of the tile as reflector. 5 tiles are grouped into a package. Packaging tiles was set between a pair of aluminum blocks(see Fig.1). Light from 5 tiles re-emitted by the Y11 (200ppm) WLS fibers is transported to a 10-stage R580-17 green extended PMT isolated mechanically from dark box. The temperature inside the box was stabilized with system of fans and was continuously monitored.
There were two cosmic muon scintillation counters 80 x 80 $(mm)^2$ of 25 mm thickness coupled by short light guide to a Hamamatsu photomultipliers. One muon counter was positoned in front of the package and another was positioned behind. In oder to ensure minimum ionizing particles a 5 cm lead layer was inserted between package of scintillators and top cosmic muon scintillation counter. Triggering was made with the coincidence signal of the two muon counters. The trigger rate was 0.06 Hz. A LeCroy 2249A ADC was used for signal digitization. The ADC gate width was 100 ns. Data were taken with a personal computer through CAMAC. Typicaly, 3000 events were collected for each point of measurements. Histogram h1089.h1d shows the typical ADC spectrum from 5 tiles. This histogram shows also the pedestal peak, wich was measured and subtracted.
We kept samples of scintillation tiles and heated there with system of fans. The time for stabilazing of temperature with accuracy 2%-3% inside box was approximately 5-6 houres.
Fig.2 present the results of our measurements. The light yield normalized by that with 24^0C. The line on the figure is to guide the eye and are not fits. The light yield decrease between 3% and 4% when the temperature increase from 24^0C to 40^0C. The large sorce of error in these type

of measurements is temperature stability of the photocathode of PMT R580-17. Temperature of PMT was continuously monitored and during measurements was 24^0+/-0.5^0 C.
As was established long ago, the light output of some commonly used plastic scintillators is practically temperature independent between -10^0C and + 20^0C and has a temperature stability of about -0.125%/^{0}C between +20^0C and +60^0C[1]. According to our measurements, the light output stability of the PS extrusion scintillator/Kuraray Y11 fiber assemblies is -0.25%/^{0}C in the ragion 24^0C-40^0C and light output stability of scintillator is less than -0.25%/^{0}C that is typical for PS scintillator[2].

References

[1] J.F.Camberon, Nucl.Electr.(I.A.E.A.) 1(1962)93;

[2] V.G. Vasil'chenko et al., NIM A369(1996)55.

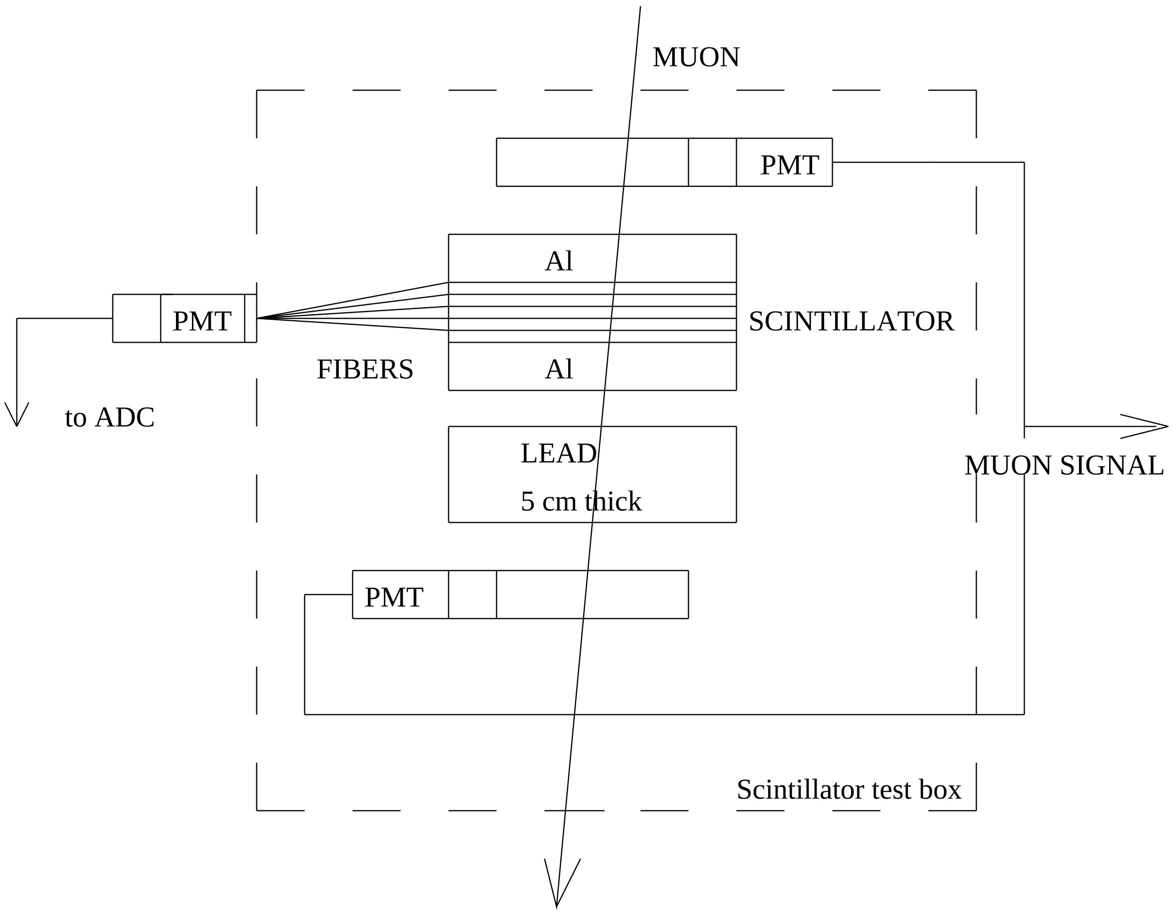
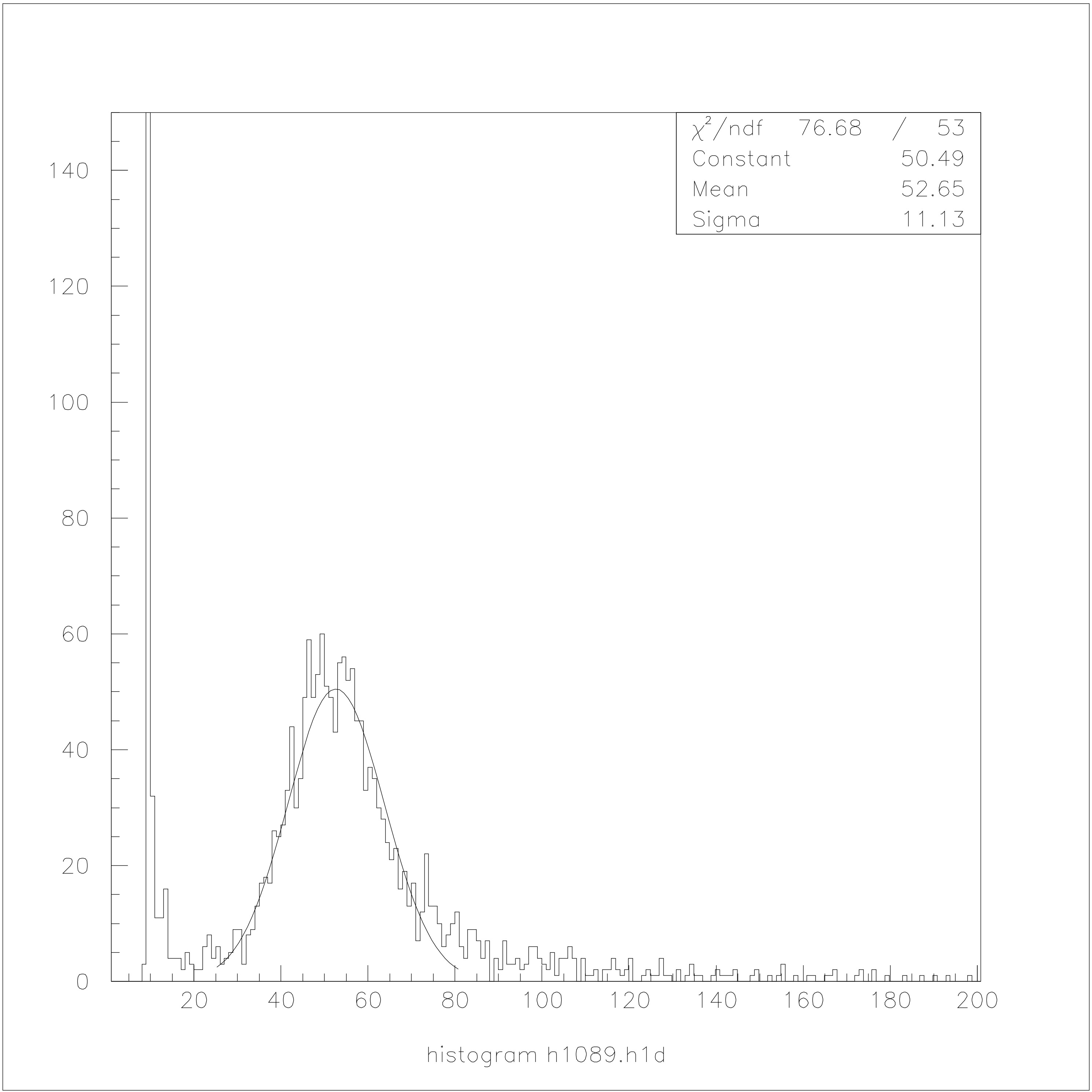
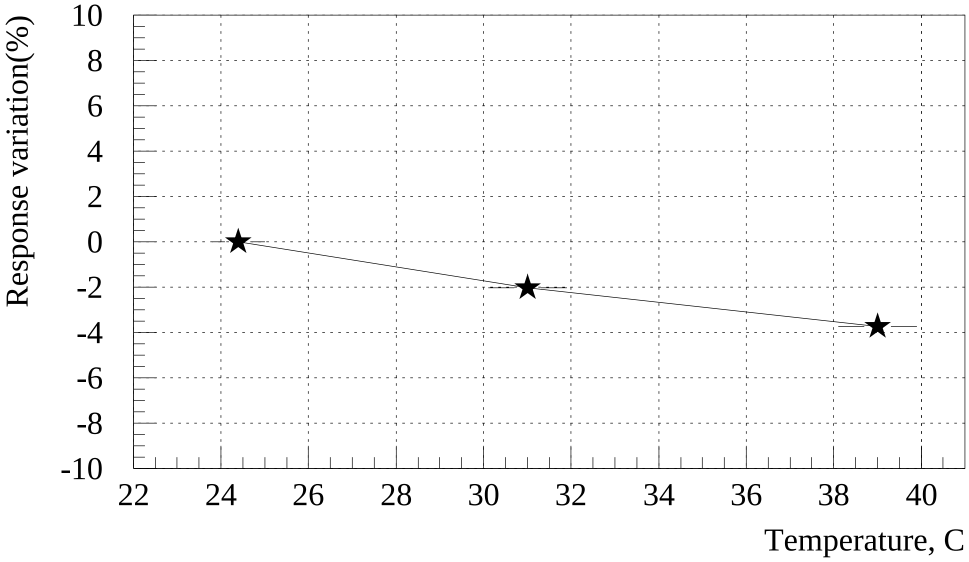


Fig.1 Cosmic muon telescope.


χ^2/ndf 76.68 / 53
Constant 50.49
Mean 52.65
Sigma 11.13
0
20
40
60
80
100
120
140
20
40
60
80
100
120
140
160
180
200
histogram h1089.h1d


Response variation(%)
10
8
6
4
2
0
-2
-4
-6
-8
-10
22
24
26
28
30
32
34
36
38
40
Temperature, C