AM, 03/14/02

Light yield uniformity and attenuation length along the WLS fibers in the ACD tile

Introduction. We have previously studied the uniformity of light yield across the fibers; the uniformity along the fibers was assumed to be high, except maybe very close to the tile edge. Now we have this issue in the action items list. The best test would be performed in a beam, using coordinate-sensitive detectors. However, we have done a measurement of the light yield uniformity in the lab.

Approach. The light yield was measured by measuring the PMT current resulting from a radioactive source on the tile (fig.1,2). The flight-like tile prototype with 2 PMT readout (R647 with negative HV) was used for this test. The source was collimated with a hole of 2.5 mm diameter and lead collimator thickness 12 mm. The source used was $Co^{57,}$ which emits two X-ray lines, 122 keV and 136 keV.

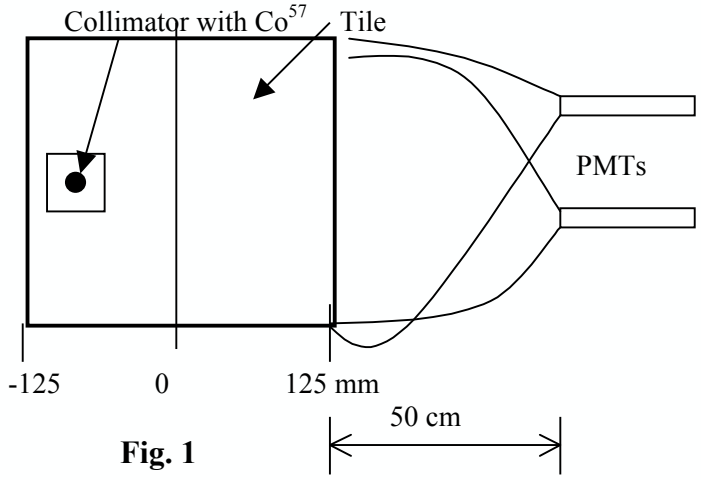

Fig. 1

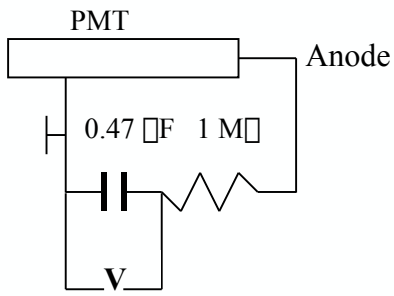

Fig. 2

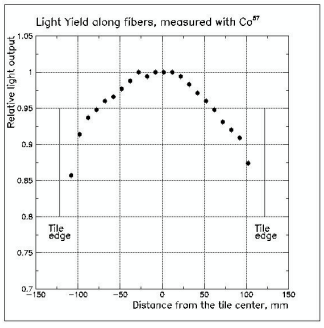

Fig.3. Light yield along fibers measured with Co^{57}

The results are given in fig.3. The **non-uniformity is estimated to be <10%** except in the area very near the tile edges, where the light output is ~15% lower than that at the tile center.

The light output from the tile edge farther from the PMT was not observed to be significantly less than that from the nearer edge. Such a reduction could occur due to light attenuation in the green fibers embedded in the tile. But in fact the light emission from the radiation absorbed in the scintillator is shared by several fibers over some length, which smears out a possible light reduction effect due to the attenuation in the fibers.

Light yield measurement with muons. For the cross-check, the test was done with the use of 2 triggering plastic scintillators, 5cm by 5cm each, with tested tile placed between them. The pair of triggering scintillators was moved along the tile, providing the scanning of the tile area. According to the triggering scintillators size, the area of each measurement was assumed to be equal to 5cm by 5 cm. Obtained results are shown in fig.4 along with previously shown results obtained with Co^{57}. The results obtained with both methods are consistent. It is worth to notice that again no significant light yield reduction due to the light attenuation in the fibers inside the tile was noticed.

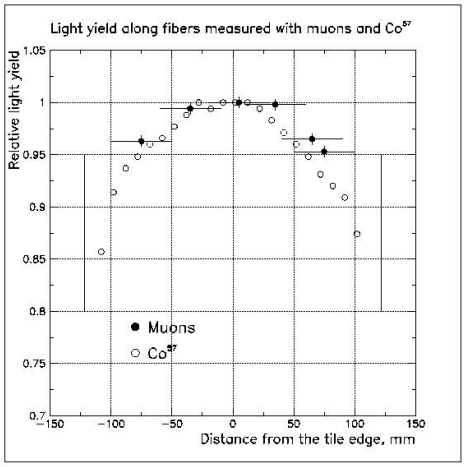

Fig.4. Results obtained with muons compared with that obtained with Co^{57}

First attempt to measure the light attenuation in WSF fibers. The knowledge of attenuation length for BCF-91 is very important for the ACD design. Bicron data sheet gives the value of attenuation length for BCF-91 of > 3.5 meters. We should be careful to take this number for granted, which could be significantly lower (Pawel de Barbaro, private communication).

The attenuation length for BCF-91A (**single-clad!**) was estimated in our laboratory, using scintillating tiles with embedded BCF-91A built for SLAC'97 beam test. Each of these tiles has different length of fiber between the tile and the PMT (due to the mechanical layout for that experiment). Assuming that the tiles itself yield the same light (which is definitely not obvious) the difference between measured light yield was assigned to the different length of fibers, and consequently different attenuation. The results of measuring the PMT current induced by the Co^{57}, are given in Table 1. Since there were the tiles of different size, 8cm by 24 cm, and 6cm by 24 cm, I treated them separately due to likely different light output between them. **Attenuation length for this fiber is estimated to be 122 cm** for the set of 8cm by 24cm tiles, and **120 cm** for the smaller tiles. These numbers are in a good agreement between each other, but because of small number of tiles tested, the result in the attenuation length measurement is very preliminary. It is also possible that multi-clad fiber, which is in use in GLAST ACD, has longer attenuation length.

Tile	Fiber length between tile and PMT	Light yield, arbitrary units
8cm by 24cm	55.9 cm	52.5
- " -	48.3 cm	55.7
- " -	40.6 cm	59.5
6cm by 24cm	28.6 cm	61.5
6cm by 24cm	16.6 cm	68.0

Conclusions. The results given above in principle are in not in conflict with our current understanding and with ACD design. But still the presence of some non-uniformity in the light yield along the fibers (10-15%) is surprising for me – I expected it to be less. More precise measurements would be good to perform. The knowledge of the light attenuation for the WLS fibers is important, and the special tests for its measurement shall be performed in the nearest future. It may have an impact on the final optimization of the ACD design