UNIVERSITE DE MONS-HAINAUT

# Physique Générale et Physique des Particules Elémentaires

## PMT : Single photoelectron signal from variable Cerenkov light intensity

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The results we presented in PNPE 354 showed that the intensity of the Cerenkov light perceived by the OM, operated at the level of single photoelectron, was reduced with a TMI layer placed in front of it. The details of the experimental set-up can be found in this internal report.

Quite similar negative results have been obtained with several other types of wave length shifters (WLS) like PPO, PPO+POPOP, Butyl PBD…, with different thickness and concentrations, sometimes at the expense of worth mechanical behavior. Until now, no positive WLS effect has ever been observed!

The reduction of the single photoelectron signal looks surprising as the WLS samples to be tested showed quite good fluorescence emission when placed under a UV lamp ($\lambda$ = 254nm, 365nm). This signal reduction has been interpreted as being due to the fact that the WLS samples globally absorb more than they re-emit detectable light.

In PNPE 351 we have simulated the signal profiles that can be expected from an AMANDA PMT as a function of $\mu$: the average number of photoelectrons from the photocathode ($\mu$ is the product of the average number of Cerenkov detectable photons per CR times the quantum efficency of the photocathode). We showed that, when the PMT is operated at the level of single photoelectron, the signal is nearly proportionnal to $\mu$, i.e. the light intensity.

Nevertheless, in order to make sure that the attenuation of the single photelectron signal is really due to the attenuation of the light intensity perceived by the PMT, we have recorded charge ADC spectra with circular holes in the screen (see PNPE 354) of three different diameters: 0.85cm; 1.00cm; 1.15cm. With this minor alteration in the geometry of the PMT light collection, the detectable light intensity would vary approximately as the square of the diameter, i.e. : 0.72; 1.00; 1.32. It is to be expected that the single photoelectron signal would follow the same trend.

The attached figures show the spectra of counts relative to the total number of detected CR's in the the water tank, from the three different hole diameters together with the spectrum, for background subtraction, obtained with a blind screen.

Fig. 1: The whole spectra: it can be seen that the spectra beyond the single photoelectron signal coincide practically with the background (blind) spectrum

Fig. 2: The same spectra around the single photoelectron signal.

Fig. 3: The spectra obtained with the three holes after subtraction of the background. Their integral between abscissa 60 and 280 gives the total number of recorded signals by the PMT relative to the total number of detected CR's in the water tank.

The following table gives the relative integrated numbers of counts between abscissa 60 and 280:

| **Hole diameter** | Relative number of counts (%) | Total after subtraction of bg. (%) | Last total divided by central one | Squared diameter divided by central one |
|---|---|---|---|---|
| Blind | 3.15 | - | - | |
| 0.85 cm | 6.99 | 3.84 | 0.67 | 0.64 |
| 1.00 cm | 8.87 | 5.72 | 1 | 1 |
| 1.15 cm | 10.43 | 7.28 | 1.27 | 1.32 |

**Conclusion:**

The numbers in the last two columns of the table show good consistency. They give support to the conclusion that the various tests we performed with different WLS's have up to now given negative results and in particular that the test with TMI as reported in PNPE 354 lead effectively to a reduction of about 5% of the PMT signal.

Figure 1.

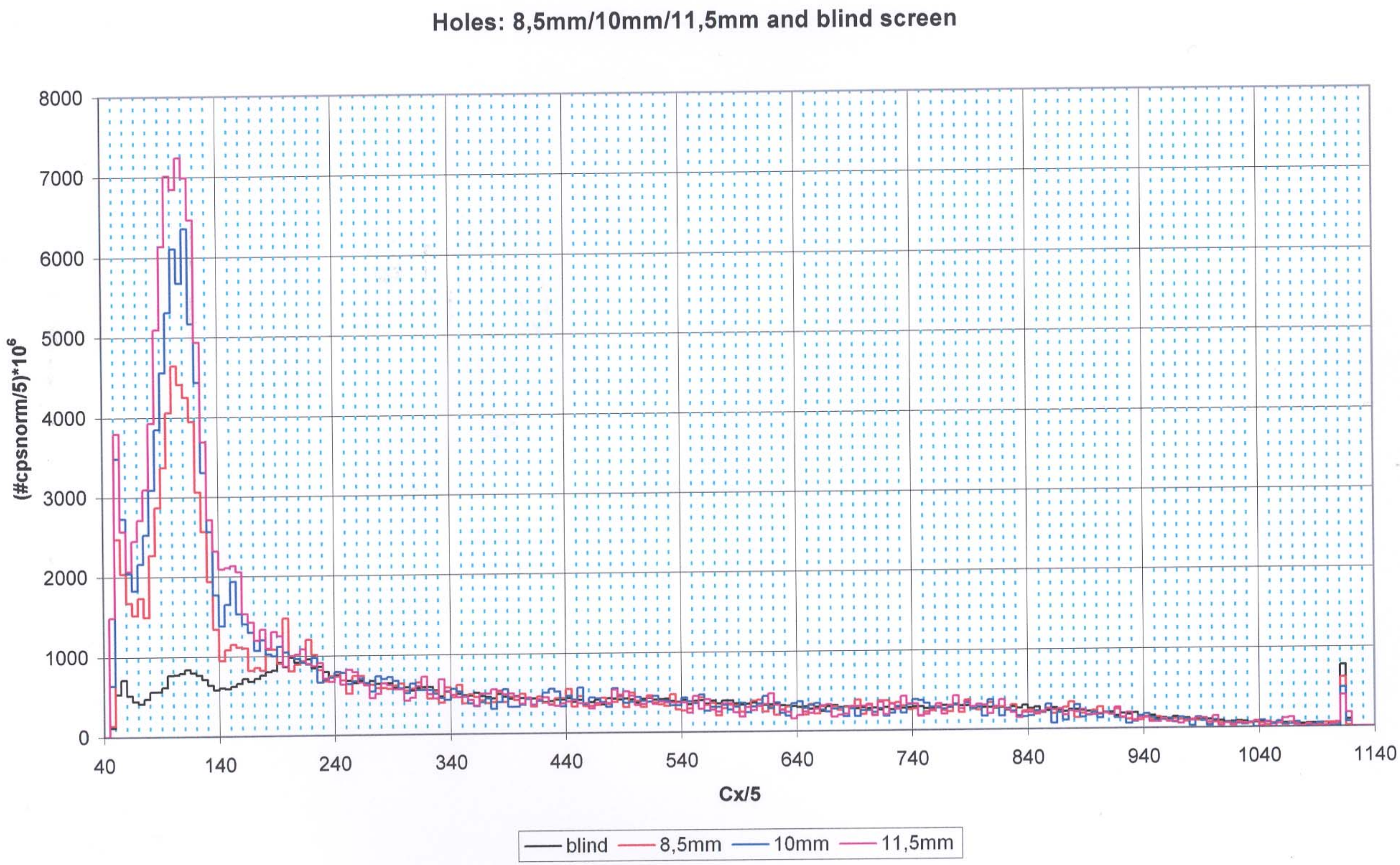
Holes: 8,5mm/10mm/11,5mm and blind screen
(#cpsnorm/5)*10^6
8000
7000
6000
5000
4000
3000
2000
1000
0
40
140
240
340
440
540
640
740
840
940
1040
1140
Cx/5
blind
8,5mm
10mm
11,5mm

Figure 2.

Holes: 8,5mm/10mm/11,5mm and blind screen

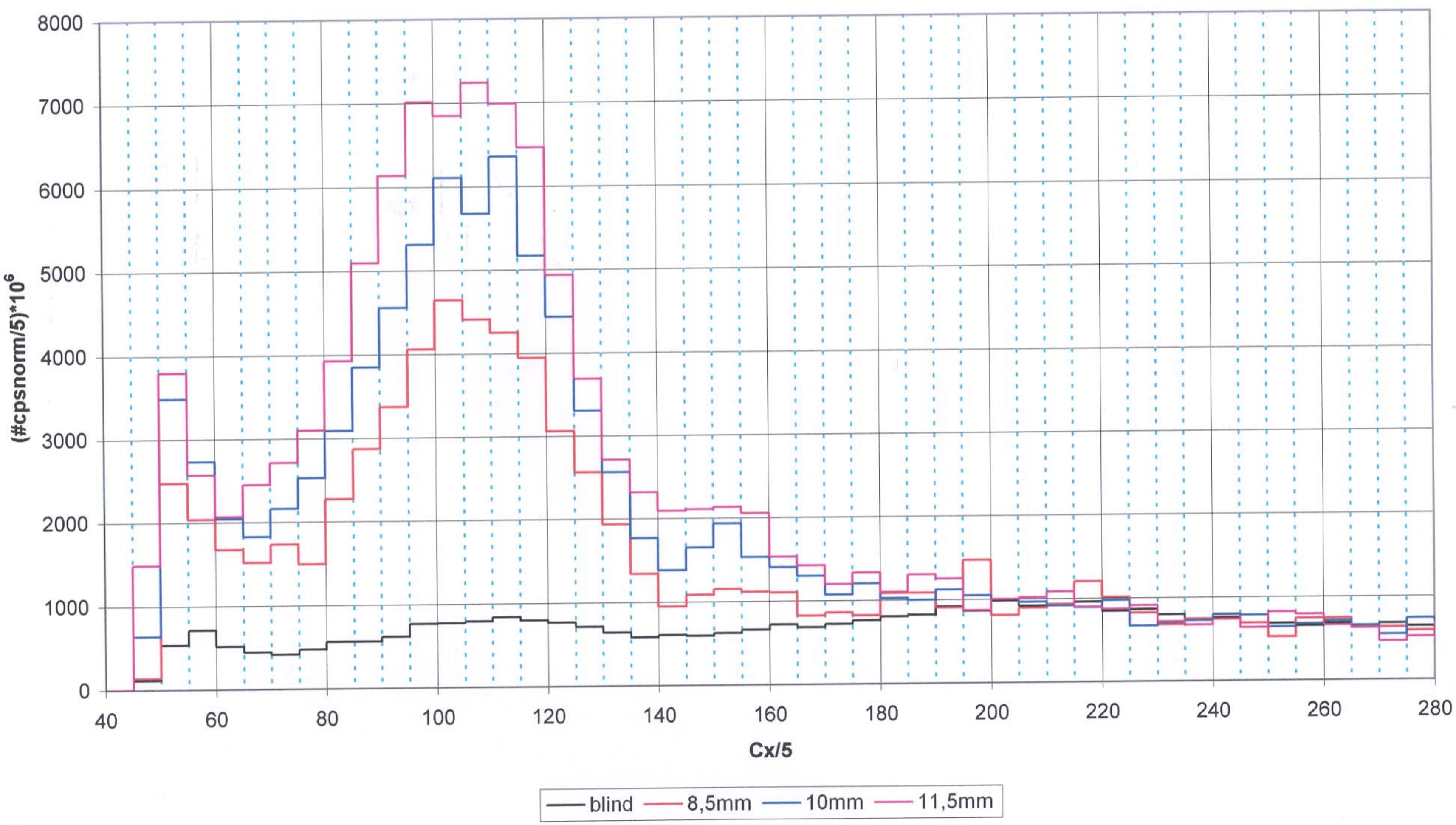

Figure 3.

Holes: 8,5mm/10mm/11,5mm and blind screen
7000,0
6000,0
5000,0
4000,0
3000,0
2000,0
1000,0
0,0
-1000,0
(#cpsnorm/5)*10^6
40
60
80
100
120
140
160
180
200
220
240
260
280
Cx/5
8,5mm - blind
10mm - blind
11,5mm - blind