Calibration of test beam PMTs and scintillating glass p.e. yield

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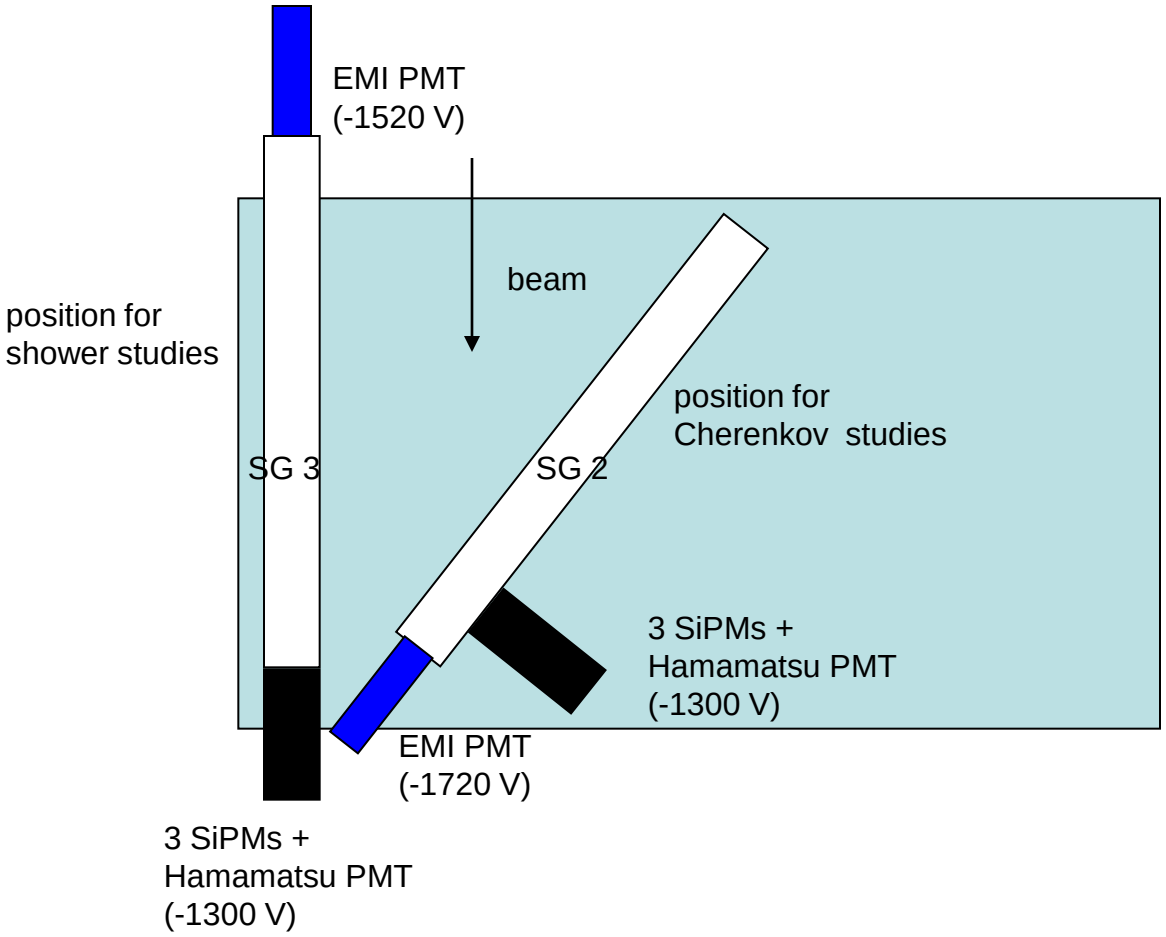
Fermilab

PMT calibration

- The aim is to determine the absolute gain of the PMTs used in the November test beam
- This will allow us to extract from the test beam data the number of photoelectrons produced in the glasses
- The calibration of EMI and Hamamatsu PMTs is done with the 1-photon peak method

Test beam set up



The 1-photon method

- The number of collected p.e. is a poissonian random variable
- The mean number of p.e., μ, is related to the total number N_{tot} of events collected in the ADC and the number N_0 of zero-photon events (i.e. the pedestals) by the relation

$$\mu = \log \frac{N_{tot}}{N_0}$$

The 1-photon method

- To a collected charge *Q*, it corresponds an ADC channel $n = Q/\gamma$
- Where γ is the ADC constant (0.25 pC/channel for the LeCroy 2249W)
- The mean charge, corresponding to the average number of p.e. μ multiplied by a gain *G*, is $\langle Q \rangle = \mu G e$
- So we can determine *G* as

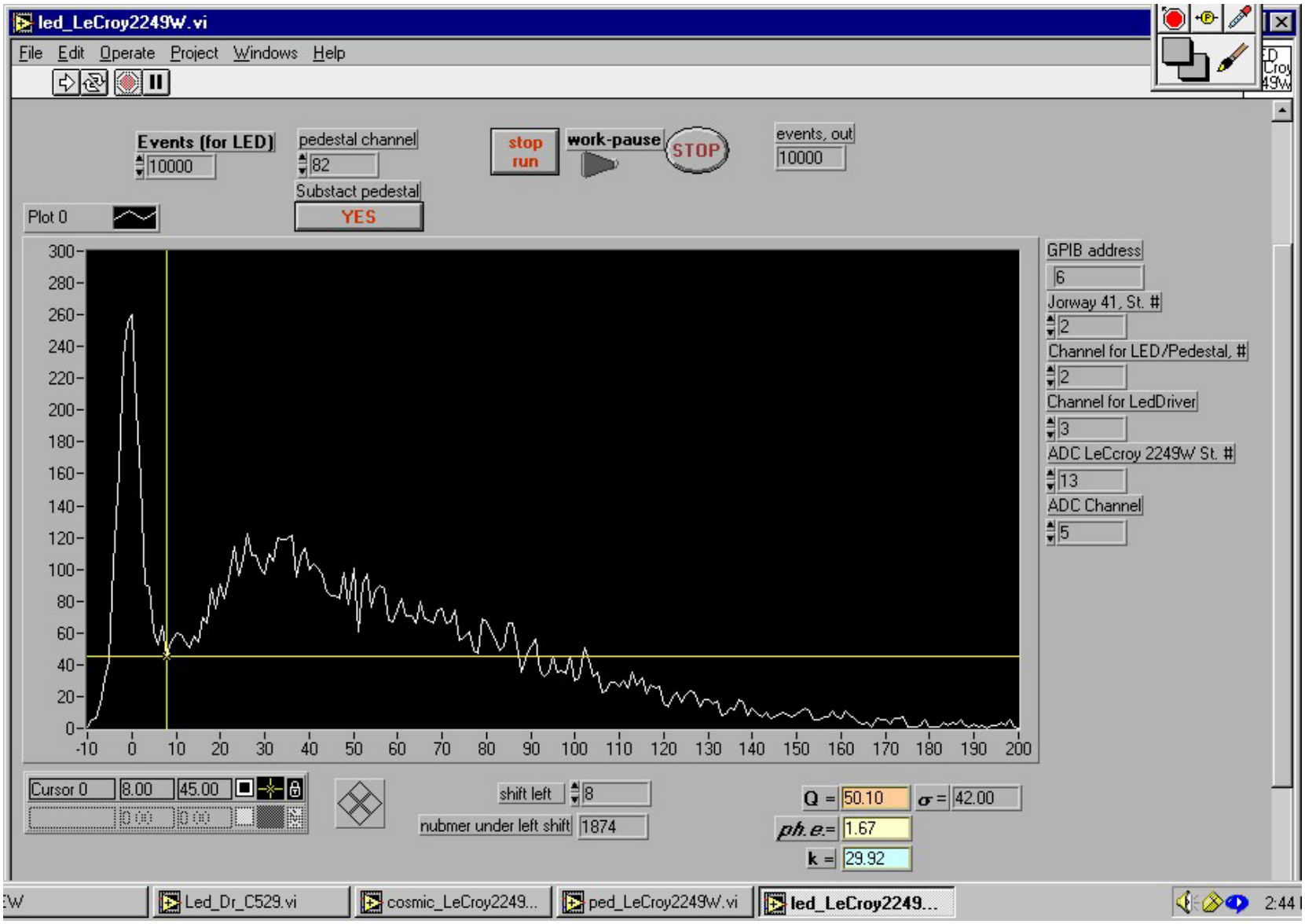
$$G = \frac{\langle Q \rangle}{e\mu} = \frac{\gamma \langle n \rangle}{e\mu}$$

EMI PMT

$$G = 40 \cdot 10^6$$

$$G = k\frac{\gamma}{e}$$

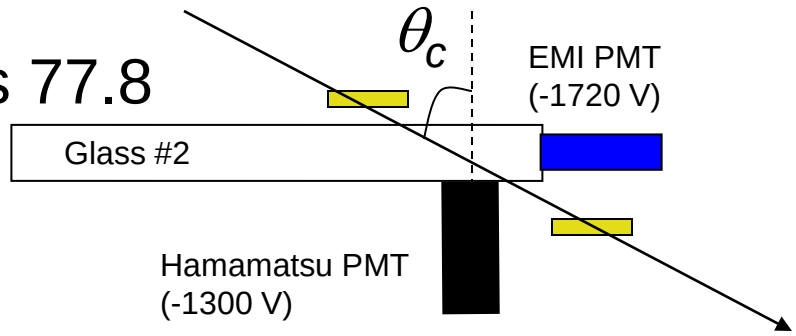
Hamamatsu PMT $G = 47 \cdot 10^6$

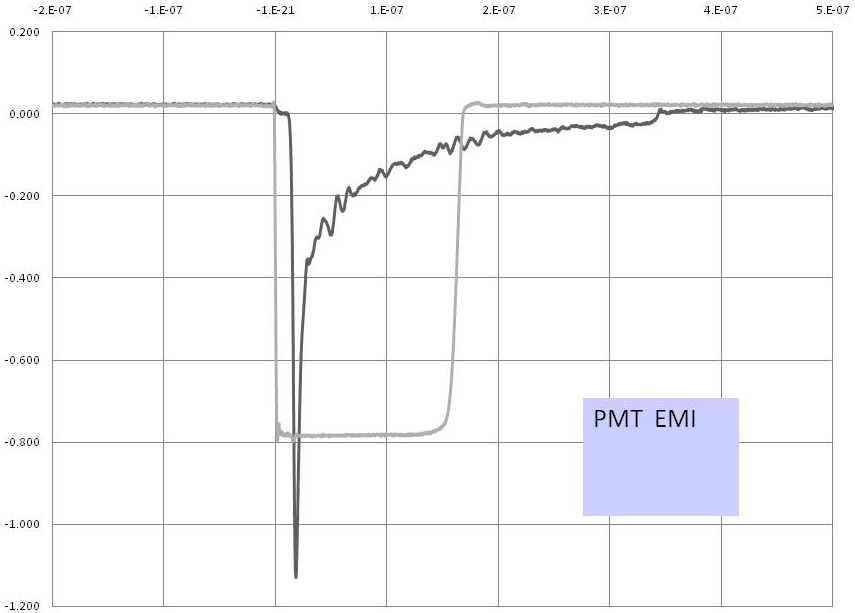


Measurement with cosmics

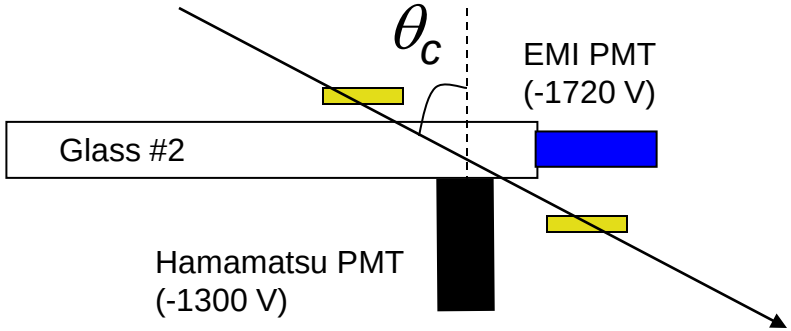
- Using the calibration, we can now determine the number of p.e. generated by a mip traversing the glass
- We set the trigger for the glass so that to select the Cherenkov angle w.r.t. the vertical (as was in the test beam)
- The Hamamatsu PMT (ϕ=1.5 cm) detects, on average, 10.1 p.e. for a track length of 12.1 cm
- The EMI PMT (ϕ=5 cm) detects 77.8 p.e.

$$N = \frac{Q}{eG} = \frac{\mathcal{M}}{eG}$$

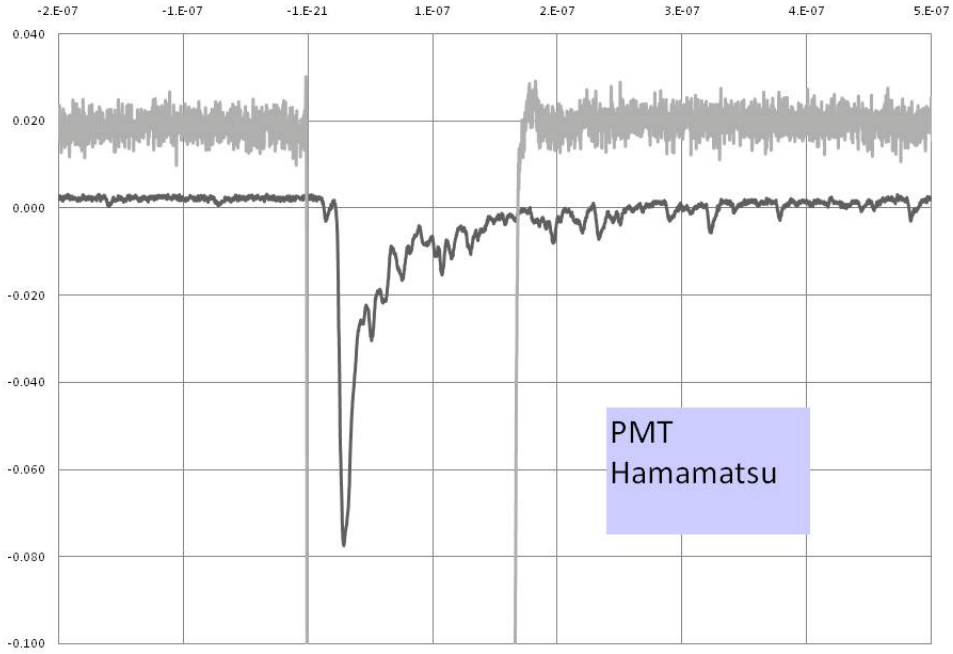


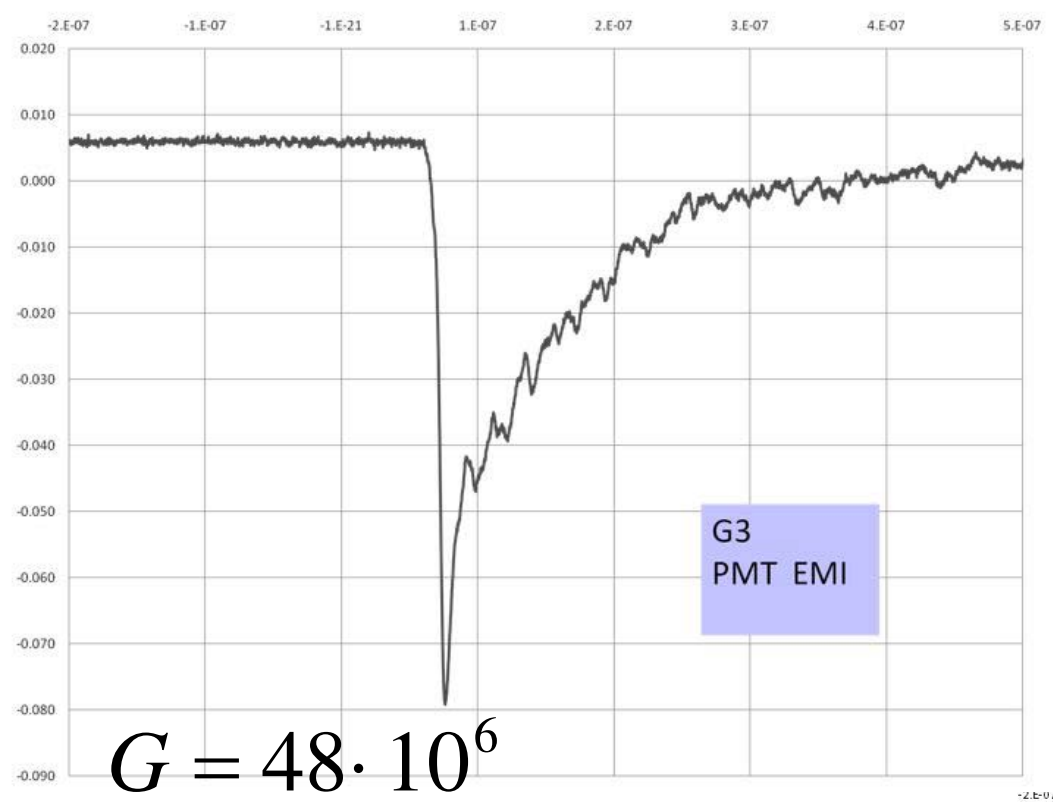


Example of signals from the two PMTs of glass #2 due to cosmics



d_E=14.1 cm
d_H=3.75 cm



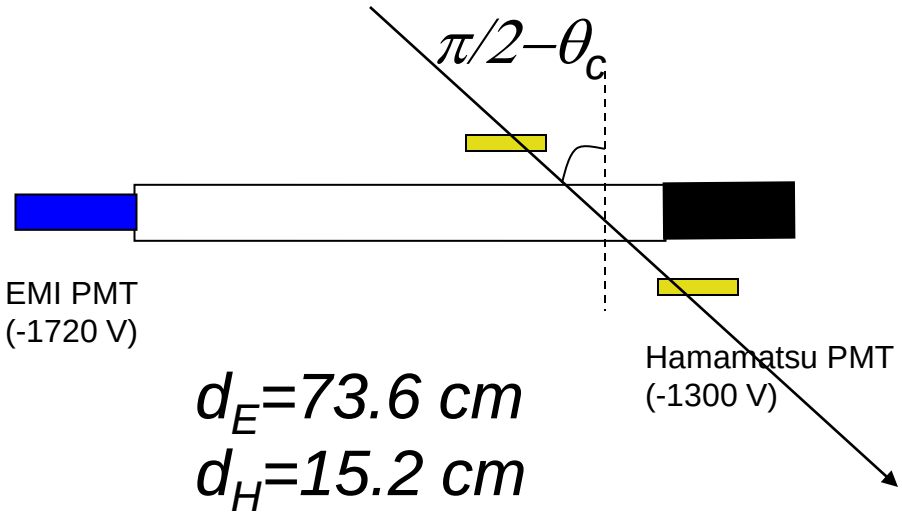


$G = 48 \cdot 10^6$

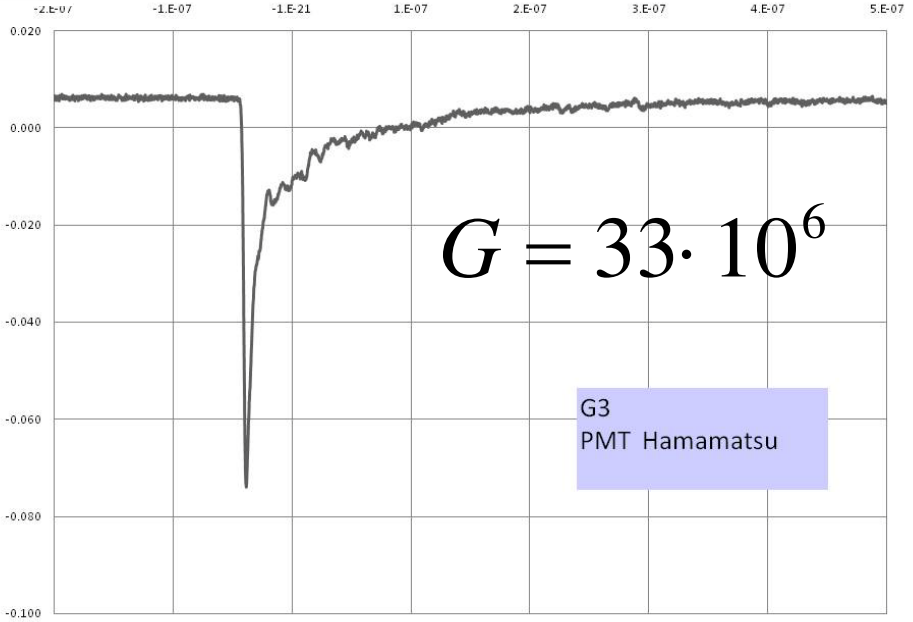
Example of signals from the two PMTs of glass #3 due to cosmics.

The Hamamatsu PMT detects, on average, 8.6 p.e. for a track length of 9.6 cm.

The EMI PMT detects 10.2 p.e..



d_E=73.6 cm
d_H=15.2 cm



$G = 33 \cdot 10^6$

Example of cosmics data taken with glass #3, PMT EMI. The average p.e. yield is 10.