Electron yield in BTEM crystals

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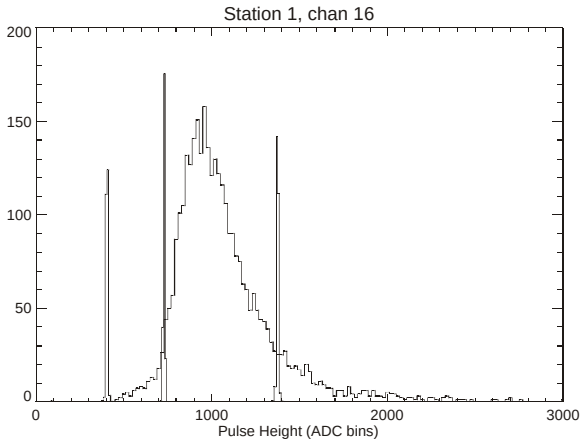
We have measured the electron yield (i.e. the number of electrons in the Si photodiodes per MeV deposited energy) in several Crismatec and STCU 310mm crystals using the custom Hamamatsu dual PIN.

We calibrated three preamp + shaper + ADC channels by injecting a known charge at three levels at the preamp test input (1 pF). We used 2.3, 4.5, and 9.3 mV tail pulses from the BNC 9010 pulser (5 μs rise, 25 μs plateau, 200 μs decay times injected give an output pulse that has a similar shape to the muon pulse). The figure below shows pulser peaks in one channel along with the muon peak.

Muon data were collected from one end of all 30x23x310 mm crystals for the BTEM calorimeter with a trigger generated by coincidence between two 500mm square wire chambers. The 23mm dimension of the crystals was vertical. The mode of the muon distribution should be approximately the most-probable energy loss. I assumed that the typical muon angle of incidence is 20 deg and that the muon energy is minimum-ionizing (1.25 MeV/g in CsI). This gives a typical muon energy deposition of 13 MeV.



The following is the IDL code used to calculate the electron yield in three channels for the large PIN in four muon runs (i.e. for a total of 12 crystals). We conclude that with 6 μs shaping in the CAENs, the **yield is ~3000 e/MeV** in the 1 cm^2 photodiode and **~750 e/MeV** (not shown below) in the ¼ cm^2 photodiode.

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ped = [replicate(110,4),replicate(100,4),replicate(103,4)]                    ; pedestal data number
pul = [replicate(729,4),replicate(776,4),replicate(703,4)]                    ; pulser data number
muon = [950,1050,1125,1125, 950,1000,1150,1200, 1050,1050,1125,1075]          ; muon peak
voltage = replicate(0.0045,12)                                                ; test pulse amplitude

chg = voltage * 1e-12 / 1.6e-19                          ; charge deposited in 1 pF test capacitor
dE = replicate(1.25 * 2.3 * 4.51 / cos(20/!radeg),12)    ; energy dep in 2.3 cm CsI,20 deg, min ion.
e_per_chan = chg / (pul-ped)                             ; electrons per ADC data number
MeV_per_chan = dE / (muon-ped)                           ; MeV per ADC data number
yield = e_per_chan / MeV_per_chan                        ; electron yield, electrons per MeV

print, total(yield)/n_elements(yield)
;     3126.10
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