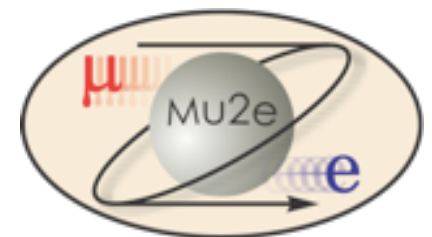


Crystal Test

MUSE outreach program for university student
LNF - INFN



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Purpose

- One crystal per group
- Evaluate the Light Yield (LY)
- Evaluate the Longitudinal Response Uniformity (LRU)
- Evaluate time performance

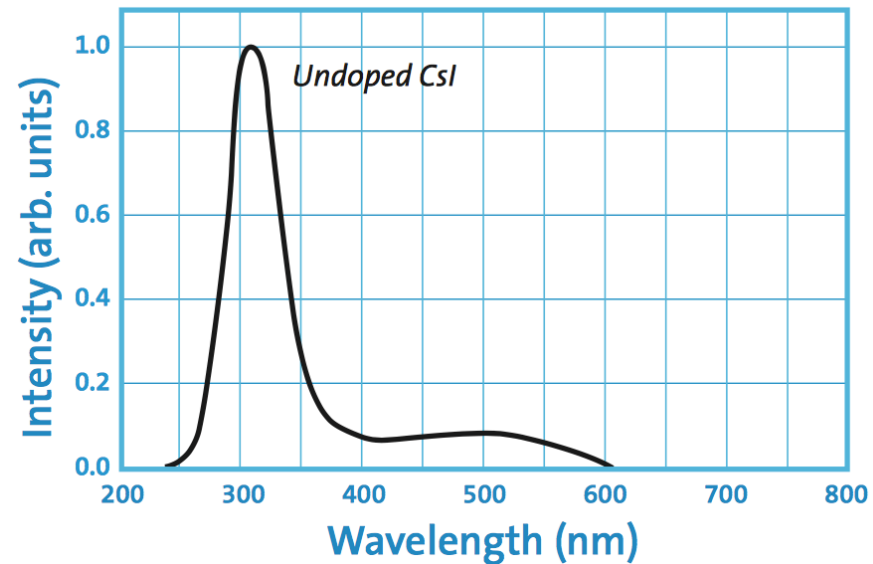
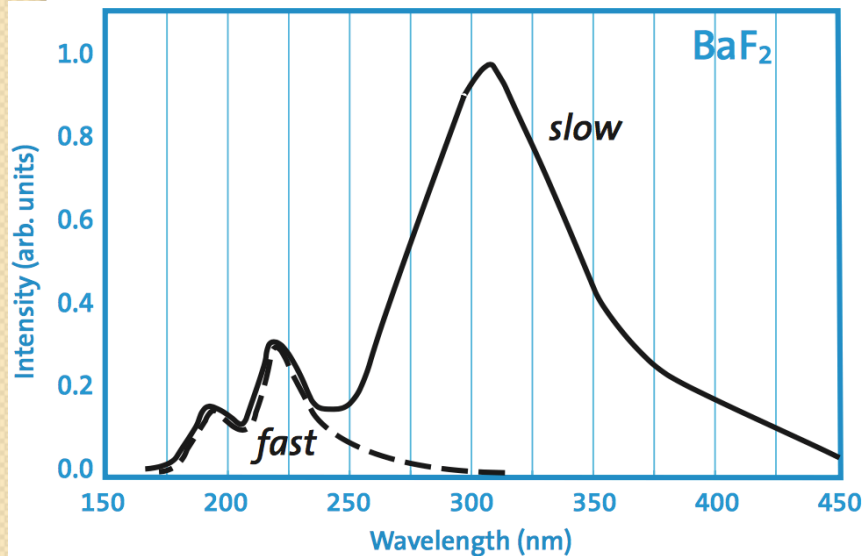
Crystals for HEP

Crystal	NaI(Tl)	CsI(Tl)	CsI	BaF ₂	BGO	LYSO(Ce)	PWO
Density (g/cm ³)	3.67	4.51	4.51	4.89	7.13	7.40	8.3
Melting Point (°C)	651	621	621	1280	1050	2050	1123
Radiation Length (cm)	2.59	1.86	1.86	2.03	1.12	1.14	0.89
Molière Radius (cm)	4.13	3.57	3.57	3.10	2.23	2.07	2.00
Interaction Length (cm)	42.9	39.3	39.3	30.7	22.8	20.9	20.7
Refractive Index ^a	1.85	1.79	1.95	1.50	2.15	1.82	2.20
Hygroscopicity	Yes	Slight	Slight	No	No	No	No
Luminescence ^b (nm) (at peak)	410	550	420 310	300 220	480	402	425 420
Decay Time ^b (ns)	245	1220	30 6	650 0.9	300	40	30 10
★ Light Yield ^{b,c} (%)	100	165	3.6 1.1	36 4.1	21	85	0.3 0.1
d(LY)/dT ^b (%/°C)	-0.2	0.4	-1.4	-1.9 0.1	-0.9	-0.2	-2.5

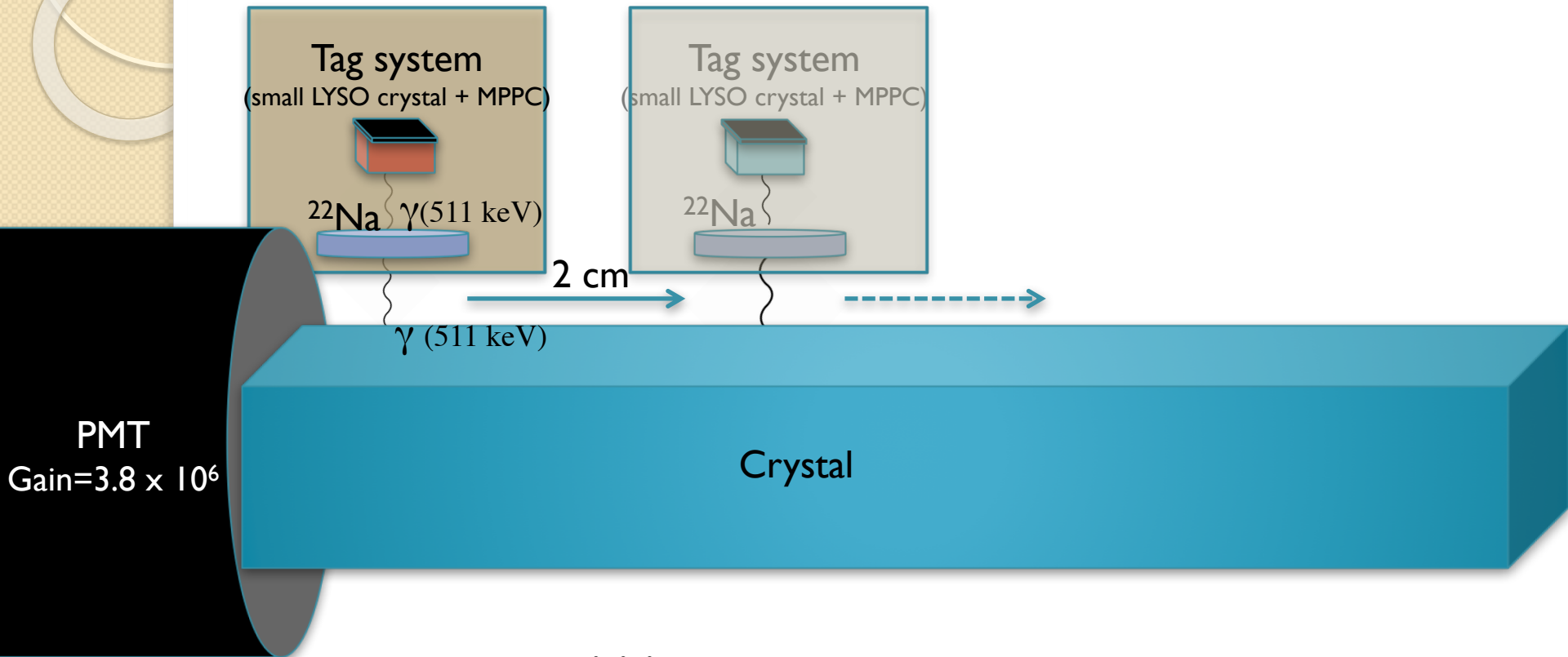
Broad variety of scintillator parameters: relative importance depends on the application

★ Typical LY of NaI ~ 40000 γ /MeV

CsI – BaF₂ emission spectra



Experimental setup

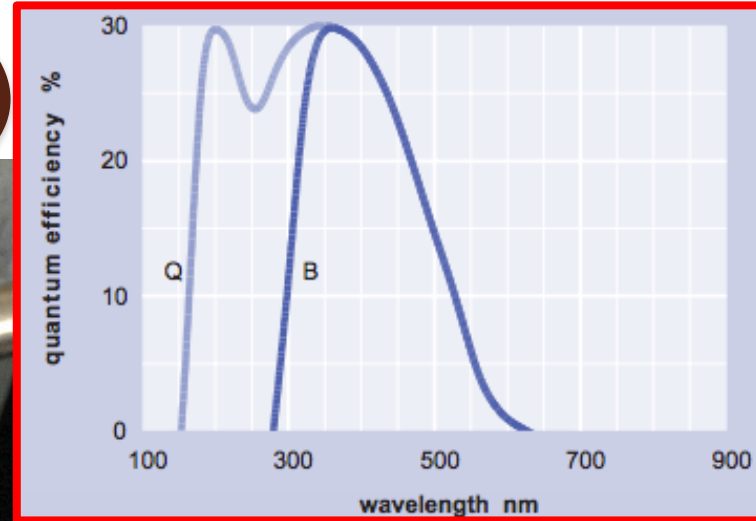


Data acquisition run:

- Tag system + source can move through the longitudinal crystal axis
 - 8 different positions, within 2 cm step from the PMT
- 20000 events per position
- Trigger: Tag system

Experimental setup (2)

Tag system (LYSO)



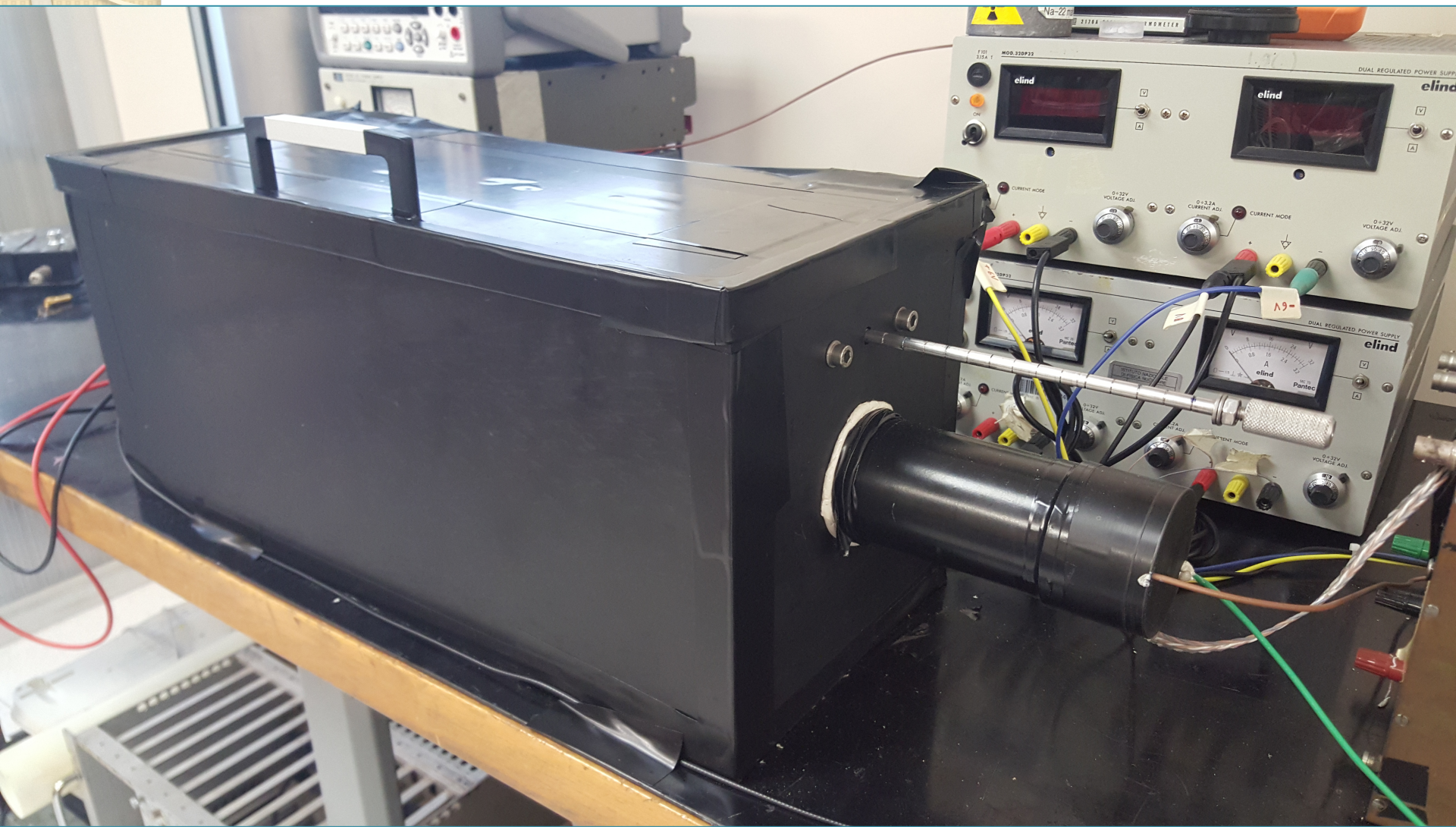
PMT

Source

^{22}Na

Crystal

Light tight black box

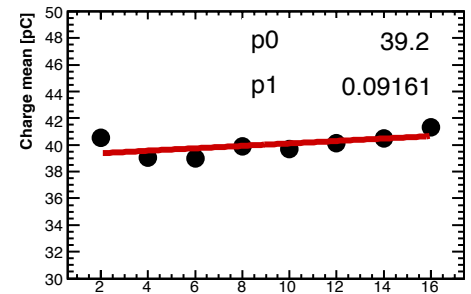
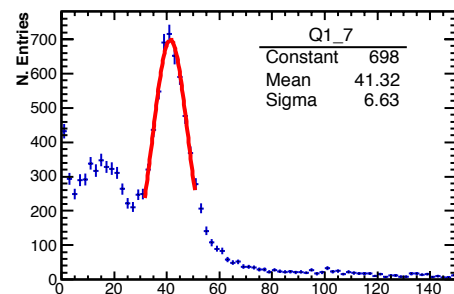
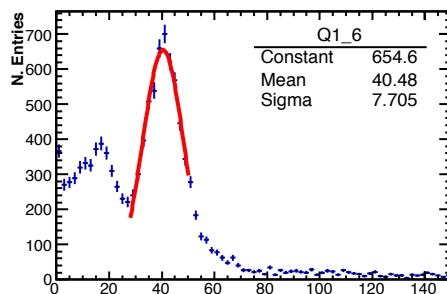
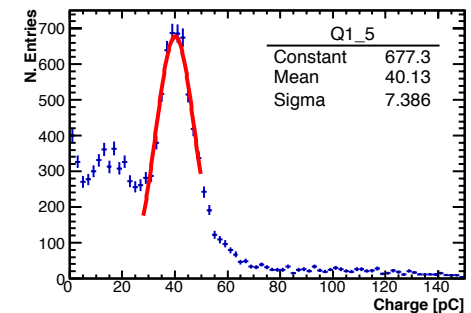
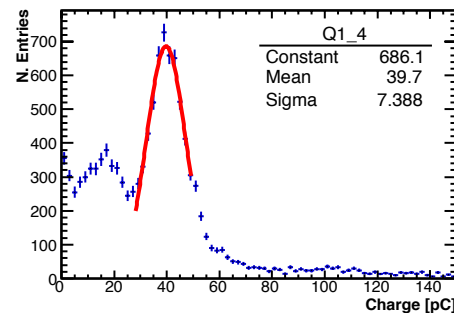
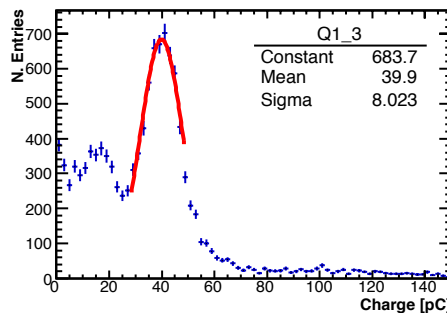
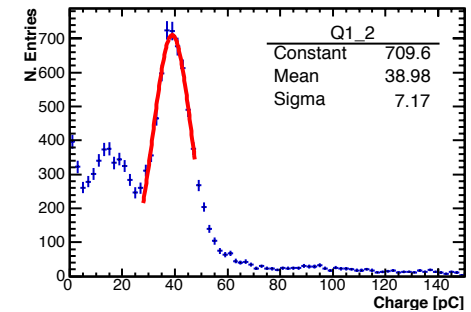
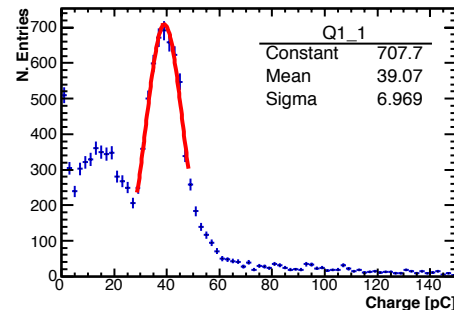
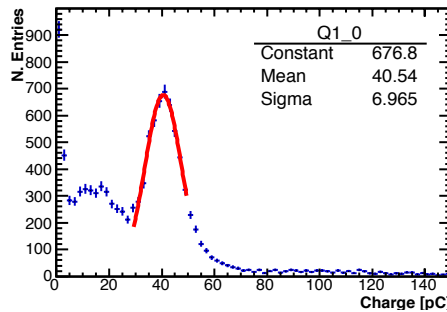


DAQ

CAEN digitizer:

- 4 channel
 - Ch0 -> tag system signal
 - Ch1 -> Crystal signal
- Sample rate: 1 Gs/s
- TRG: tag system

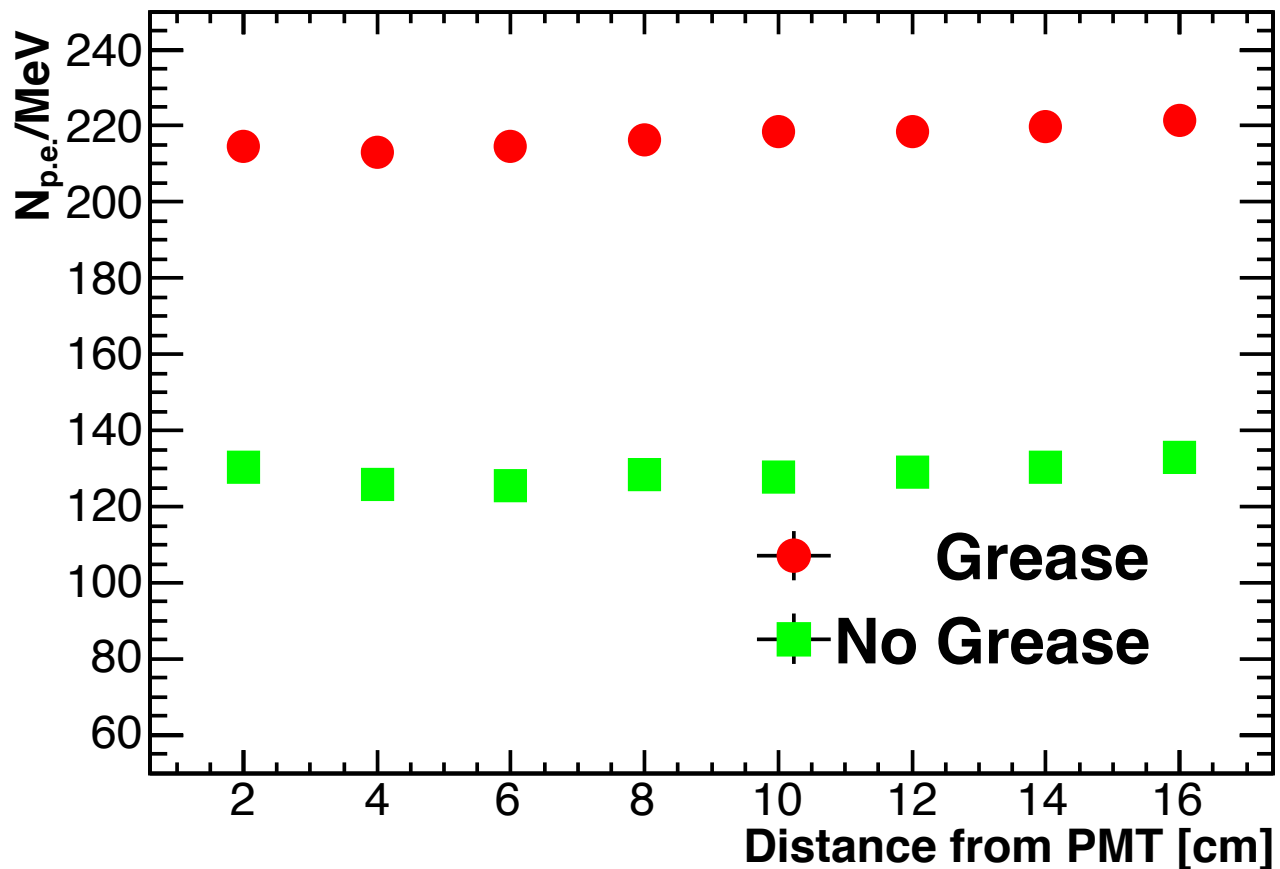
Charge distribution



- Charge distributions obtained with the source in 8 positions
- Gaussian fit applied to extract the peak do to the 511 keV photon

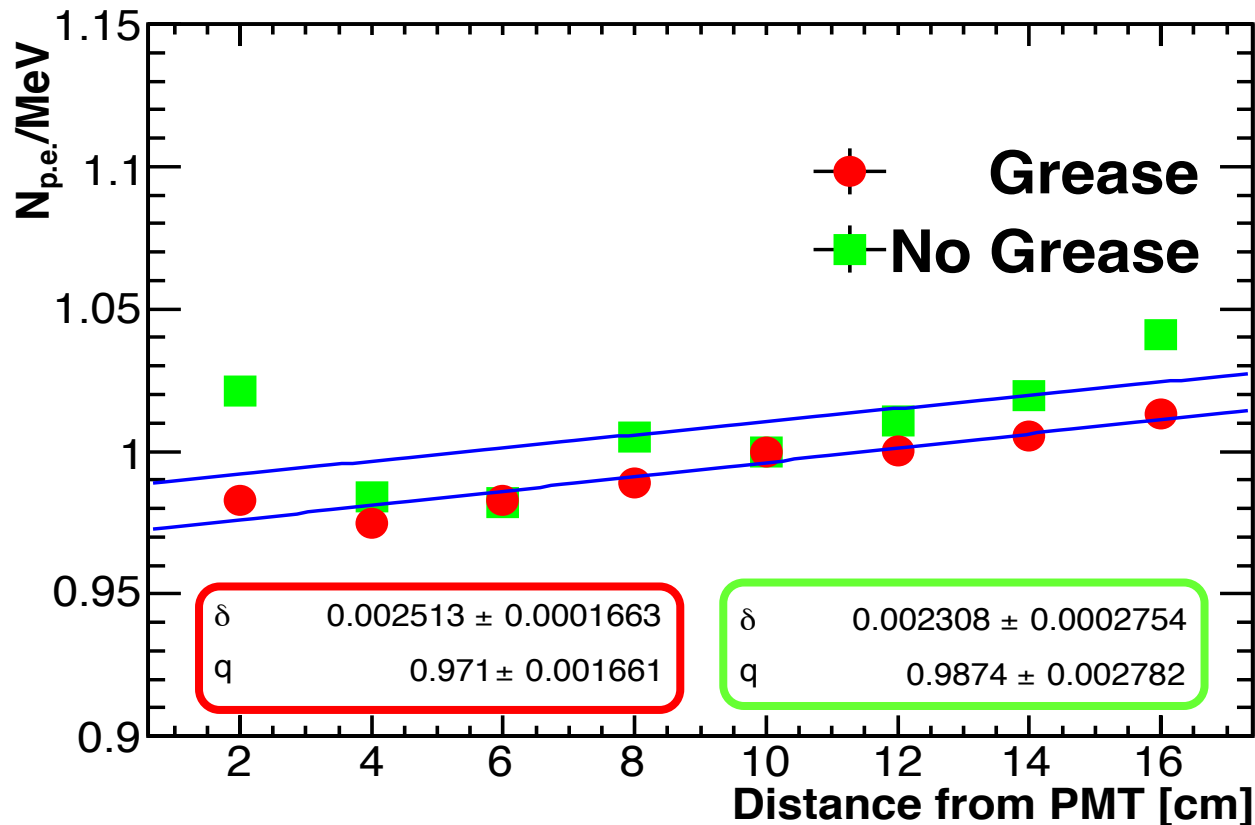
Light Yield

$$N_{p.e.}/MeV = \frac{Q}{Q_{e-} G_{PMT} E_{\gamma}} = \frac{\mu_Q [pC]}{1.6 \times 10^{-7} \cdot 3.8 \cdot 0.511 MeV}$$



Longitudinal Response Uniformity

Slope of the linear fit of the LY normalized to the central value as a function of the distance of the source from the PMT



To do...

- Place the crystal in the black box
 - Bias the PMT and tag system
 - Control the setup by scope means
- Send the input signals and the trg to the VWF digitizer
 - Run the acquisition in 5 position (10000 evt/position)
- Integer the waveforms to evaluate the charge
 - Gaussian fit -> LY
 - Linear fit of the charge peak as function of the position -> LRU