

First results of the APD calorimeter November 2015 BFT test

Padme meeting LNF 14/1/2016

Fabio Ferrarotto (RM1)

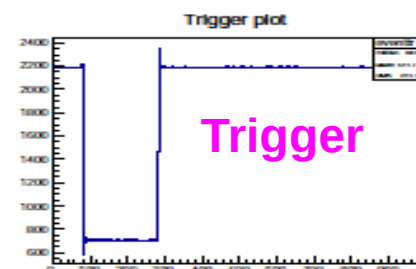
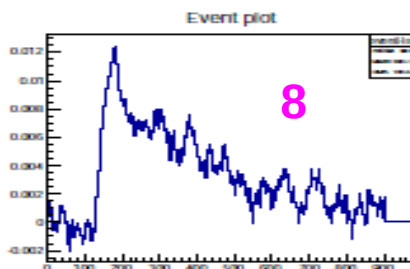
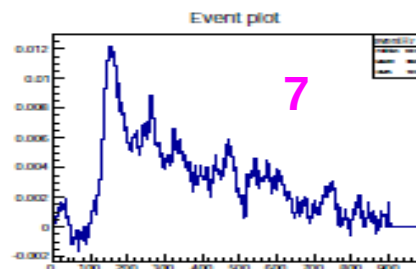
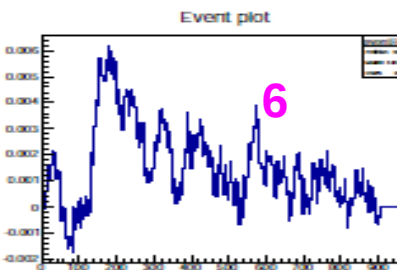
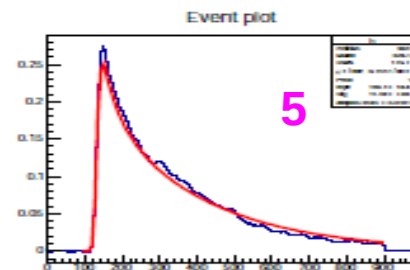
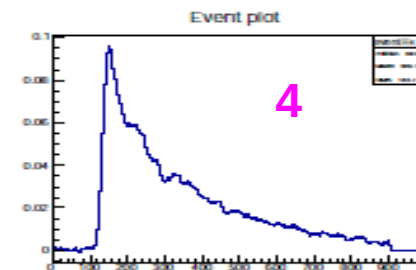
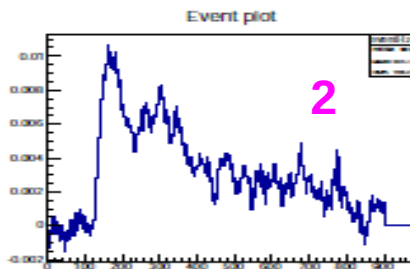
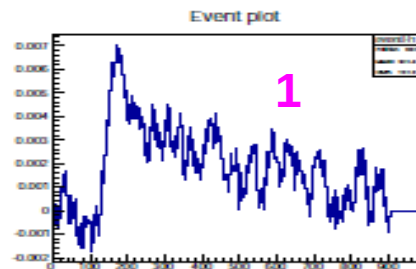
APD Calo runs : 313 (150 MeV), 311 (295.6 MeV), 312 (448 MeV)
2x2 cm crystals – new – rewrapped by me and G. Piperno

Always used positive signal - pedestal subtracted

Normalized at 1 V

9 read detectors + trigger signal

APD Calo Event - run 313



Signals much smaller than PM
Apparently more "noisy"
Problems fitting pedestal at signal start

Signal fit detector 5 unsaturated

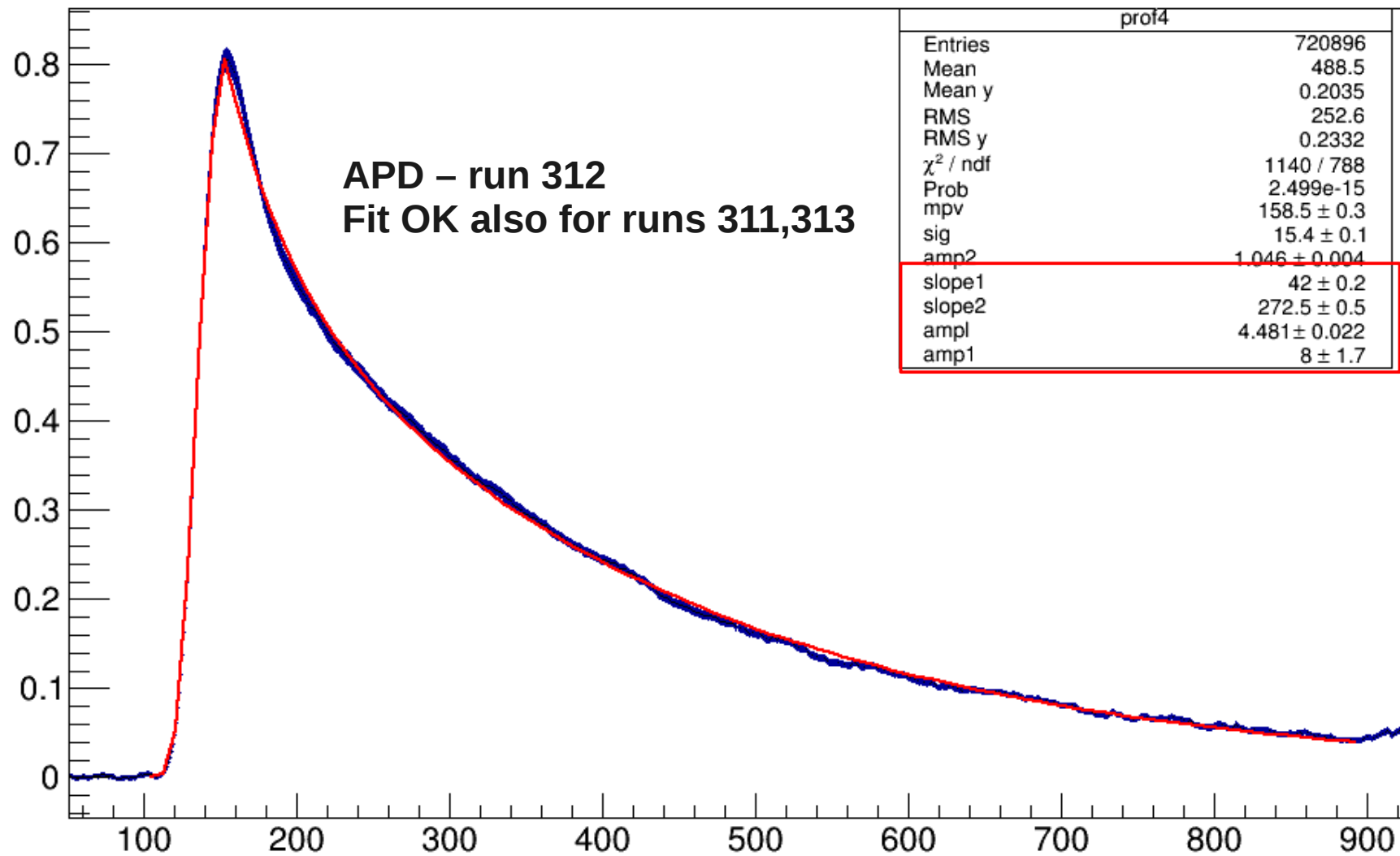
Profile plot fit of detector 5
(center crystal - 5 point smoothing) :

Signal rise : $A_{\text{landau}} * \text{Landau}(\text{mpv}, \text{sigma})$
Until Landau mpv

Signal descent - After Landau mpv :
 $A_1 * \exp(-t/\tau_1) + A_2 * \exp(-t/\tau_2)$
("fast" component + one with \sim BGO decay time)

7 free parameters in fit

APD - Signal fit detector 5 unsaturated



APD – Fit detector 5 unsaturated

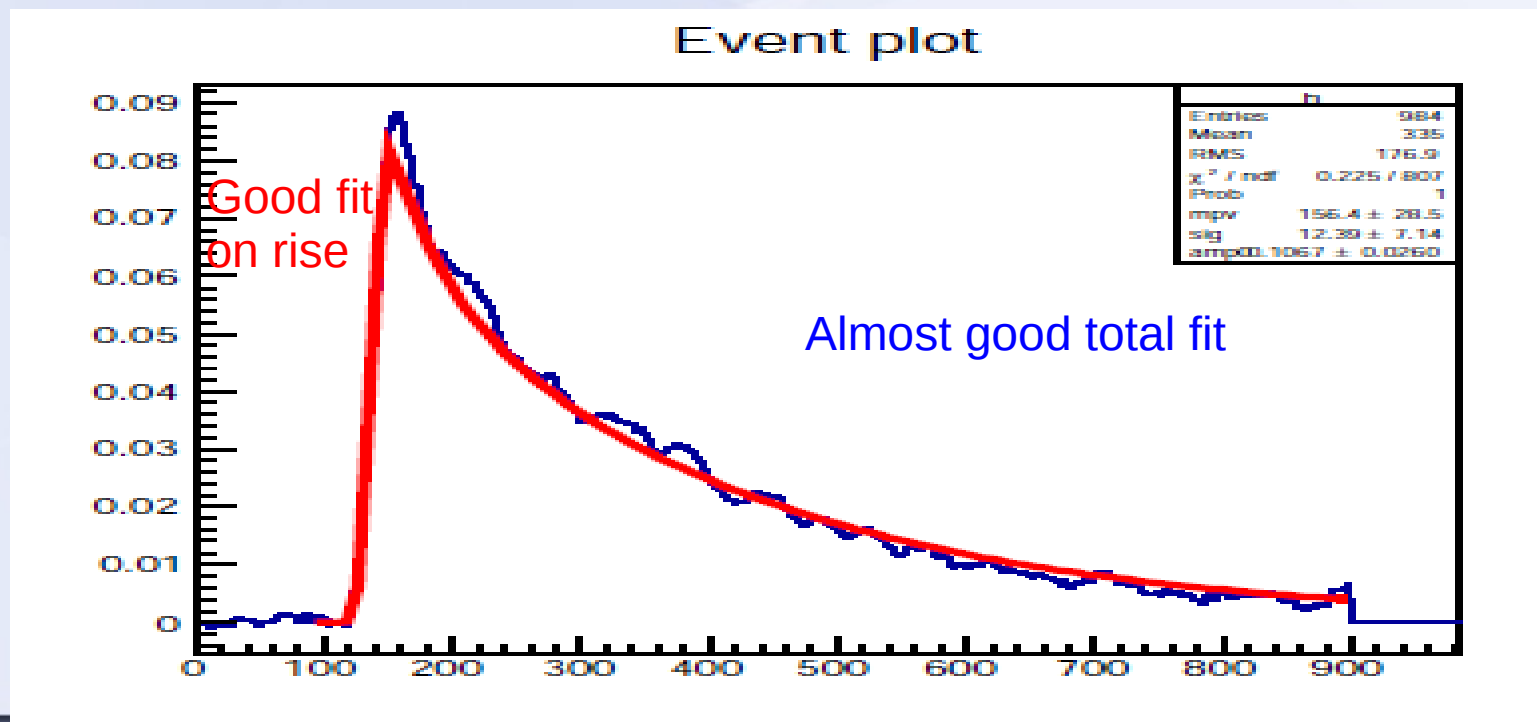
Only 3 free parameter fit : A_2 , mpv, sigma

Fit made on range (90:900 nsec) of signal

Amplitudes fixed as proportional to A_2 (free in fit)

$$A_{\text{landau}} = 4.284 \cdot A_2 \quad ; \quad A_1 = 7.648 \cdot A_2$$

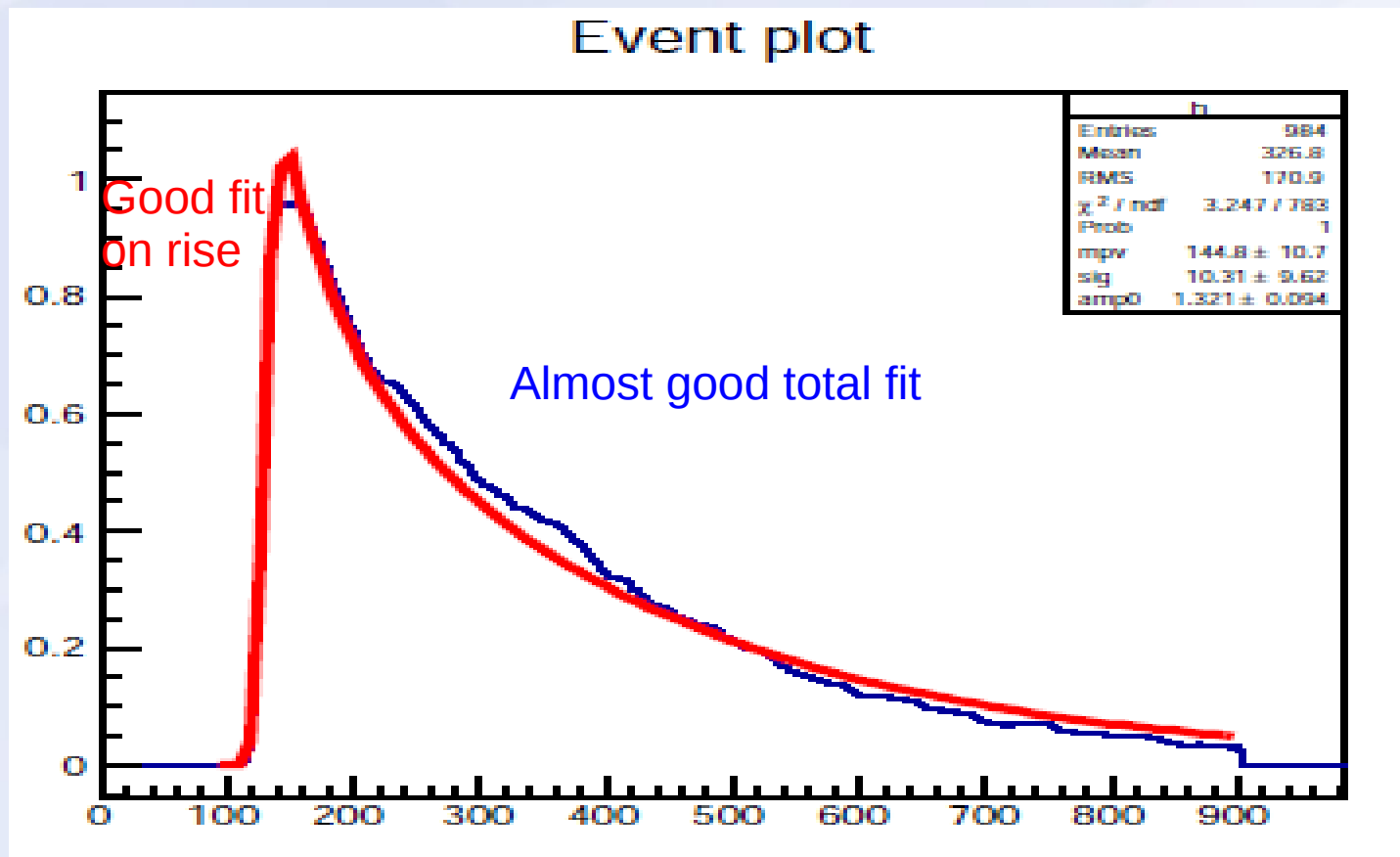
Fixed $\tau_1 = 42$ nsec , $\tau_2 = 272.5$ nsec (expected 300 nsec x BGO)



APD – Fit detector 5 saturated

Only 3 free parameter fit : A_2 , mpv, sigma

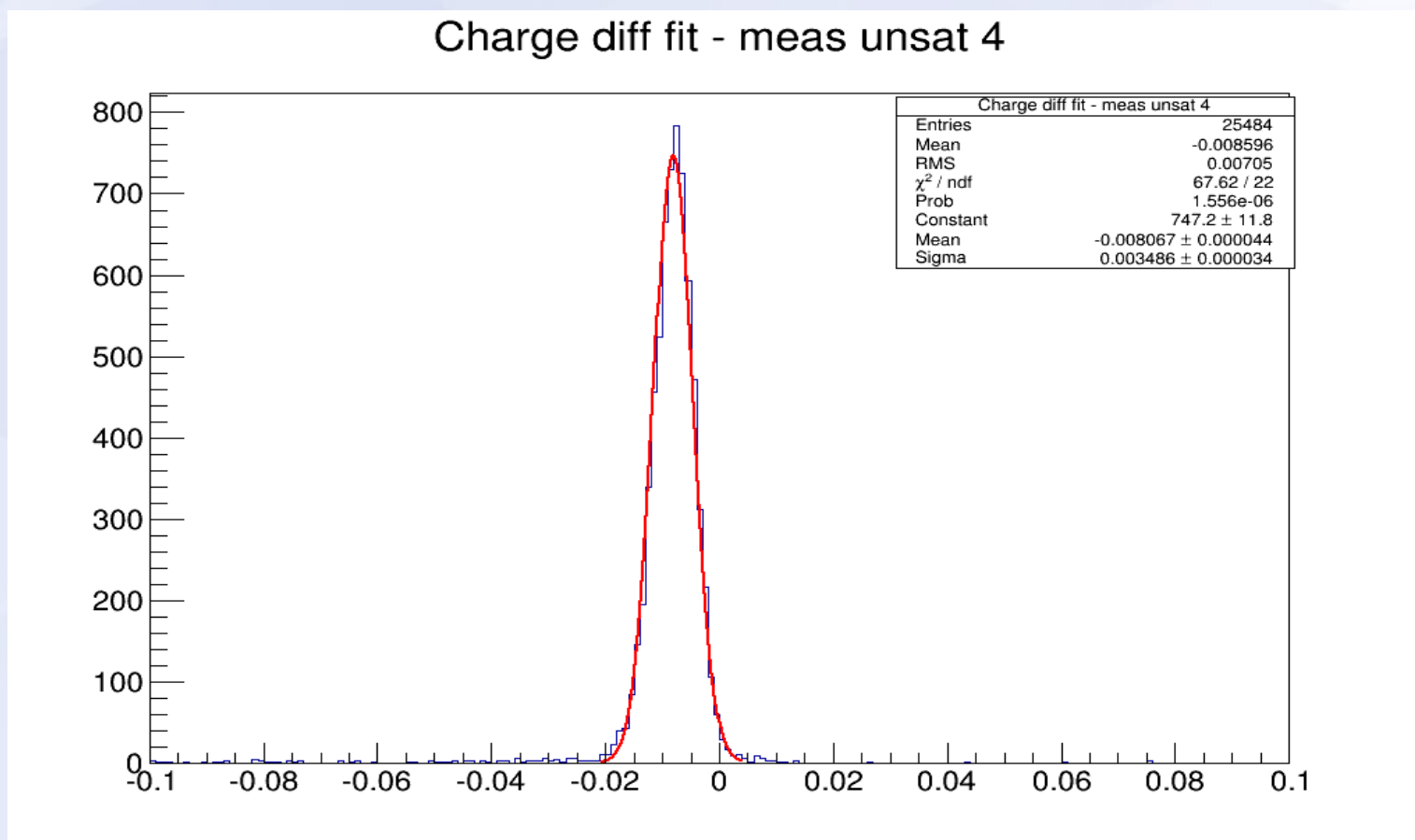
Used same fixed and proportional values as unsaturated fit.
On saturated events fit made **only on unsaturated range**
(signal < 0.95 V) **and then we may show on all range**



APD - Q fit - meas difference

Percentage difference fitted -measured charge (signal)
on unsaturated events – center detector
Similar for all runs

Fitted mean : $-0.81 \pm 0.004 \%$



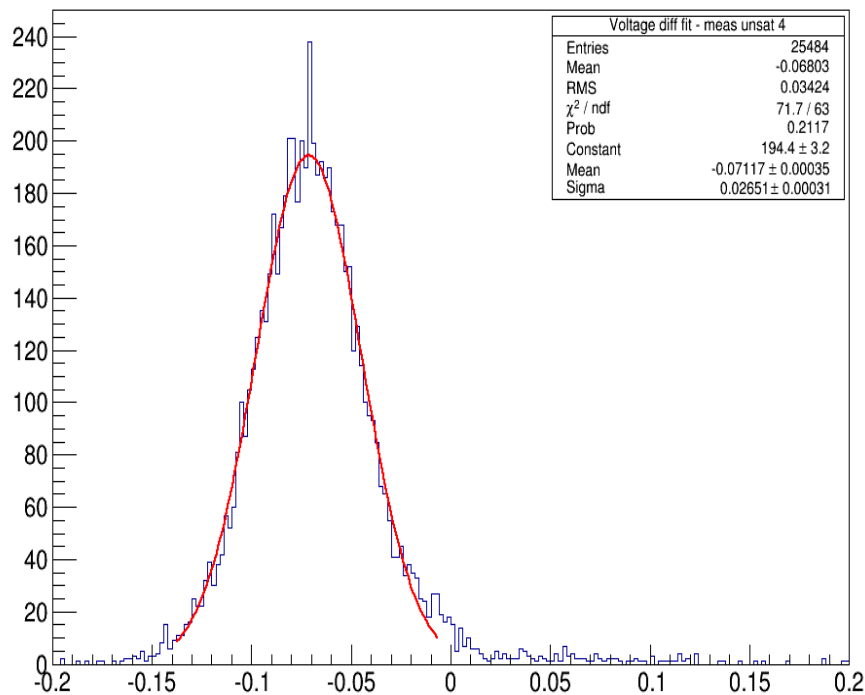
APD - Vmax fit - meas difference

Percentage difference fitted -measured Vmax (signal)
on unsaturated events – center detector
Similar for all runs

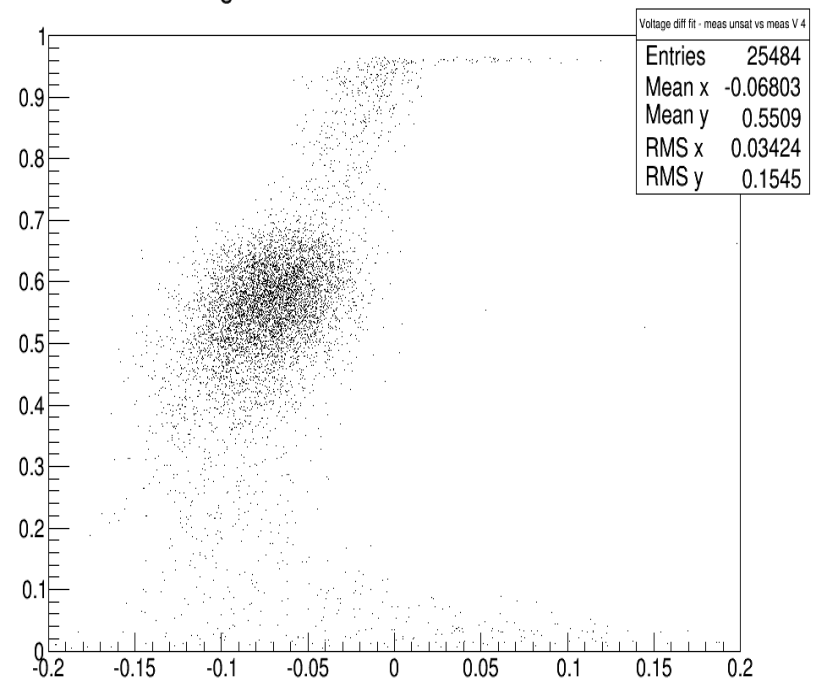
Fitted mean : $-0.7 \pm 0.04 \%$

Peak mostly at bulk value – to be used for correction ?
or value at highest Vmax to be used ?

Voltage diff fit - meas unsat 4

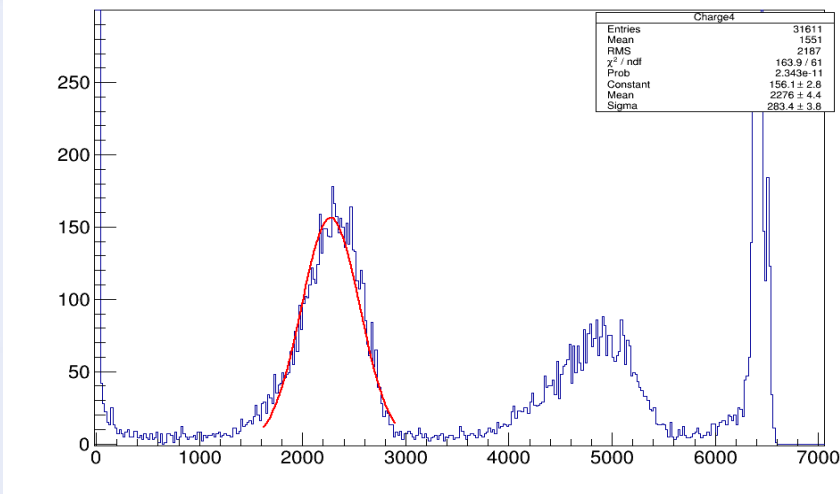
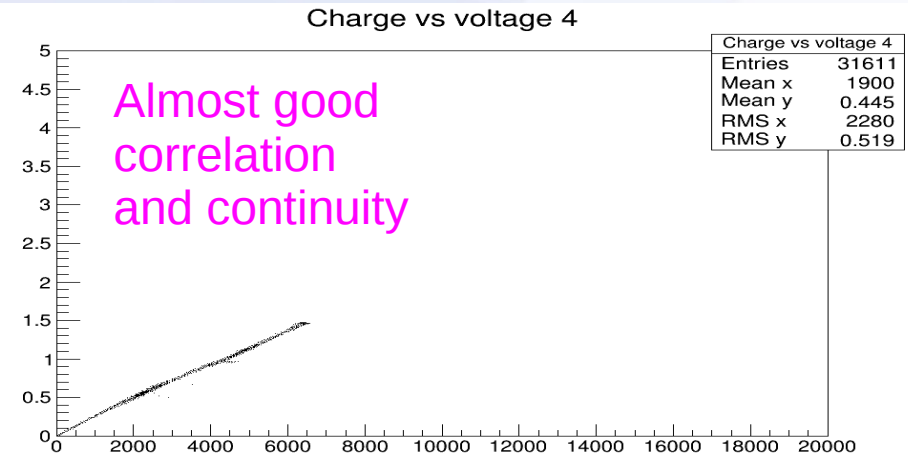
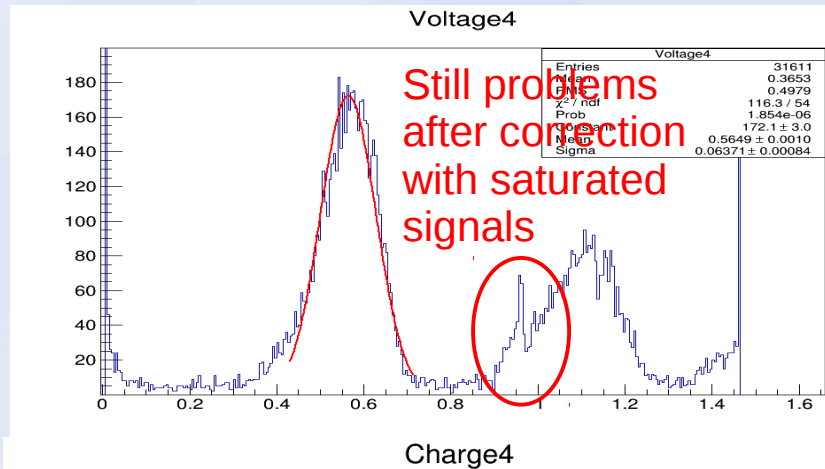


Voltage diff fit - meas unsat vs meas V 4



Results detector 5 – run 312

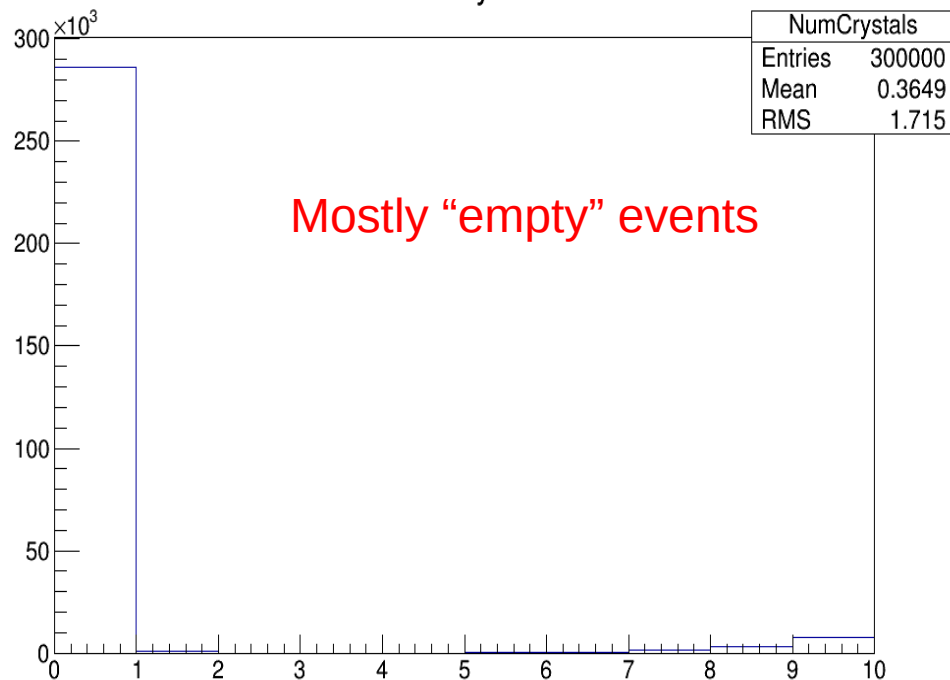
Results on detector 5 (signal center) show still some problems with continuity of signal in Vmax with saturated events – also after correction. After corrections of Q and Vmax we see a good correlation and continuity among them (signal unsaturated, fit saturated – after corrections) Also $T_{corr} = T_{start} - T_{trig}$ from signal is stable on all Vmax range.



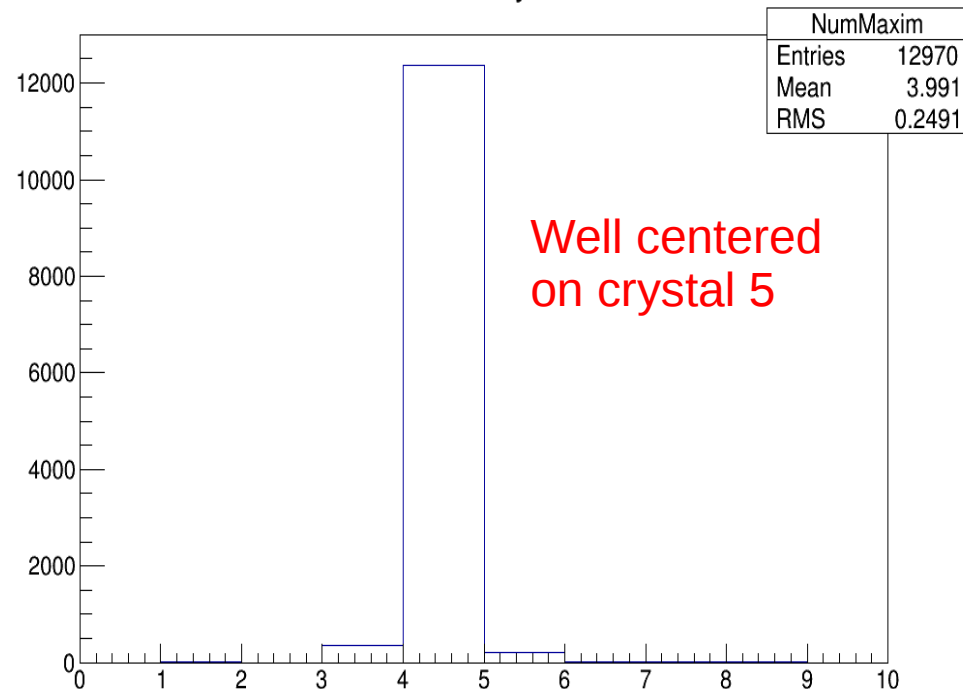
Results – run 312

For the analysis on the whole calo we cut at Ncrystals > 1 and we use only events where the maximum is on detector 5 (central)

Number crystals/ev

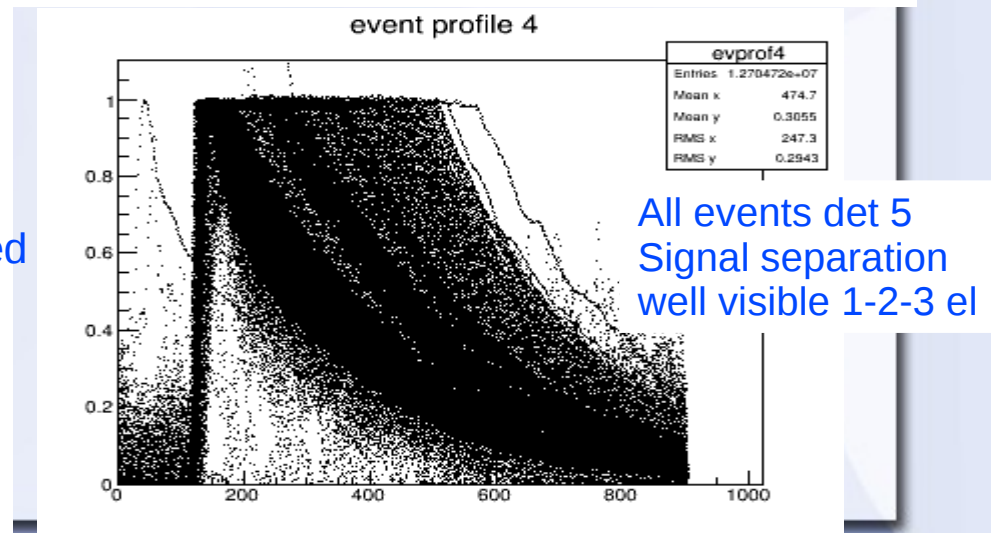
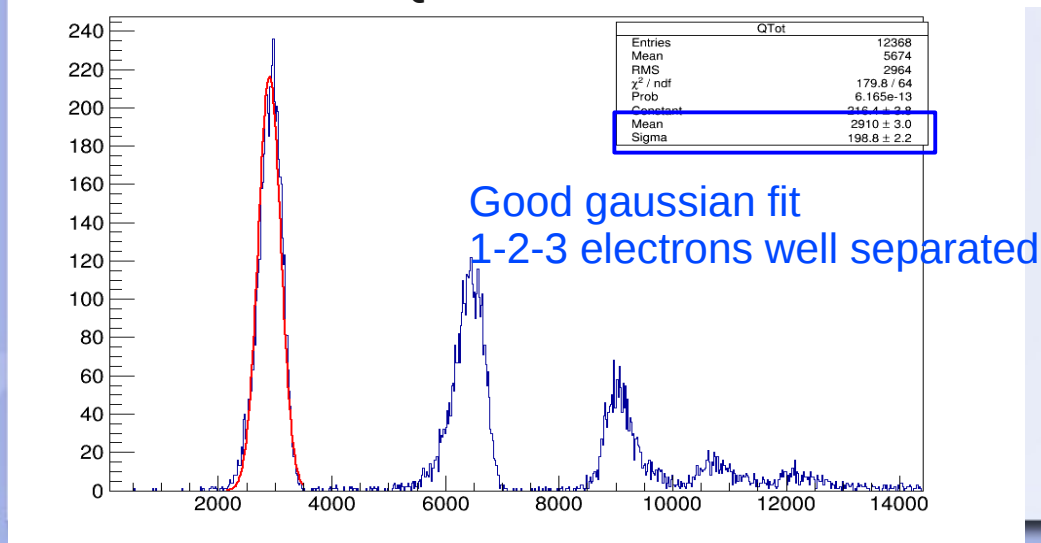
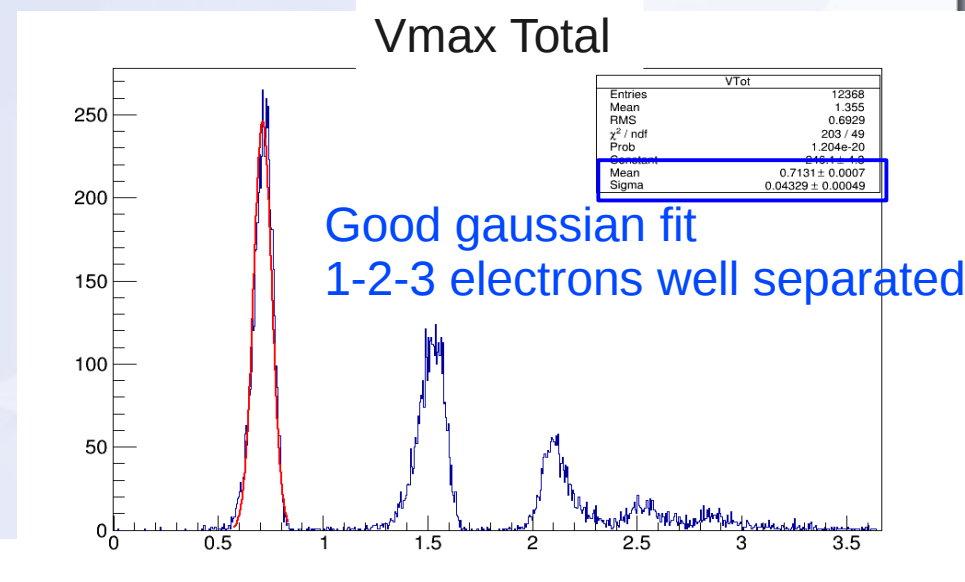
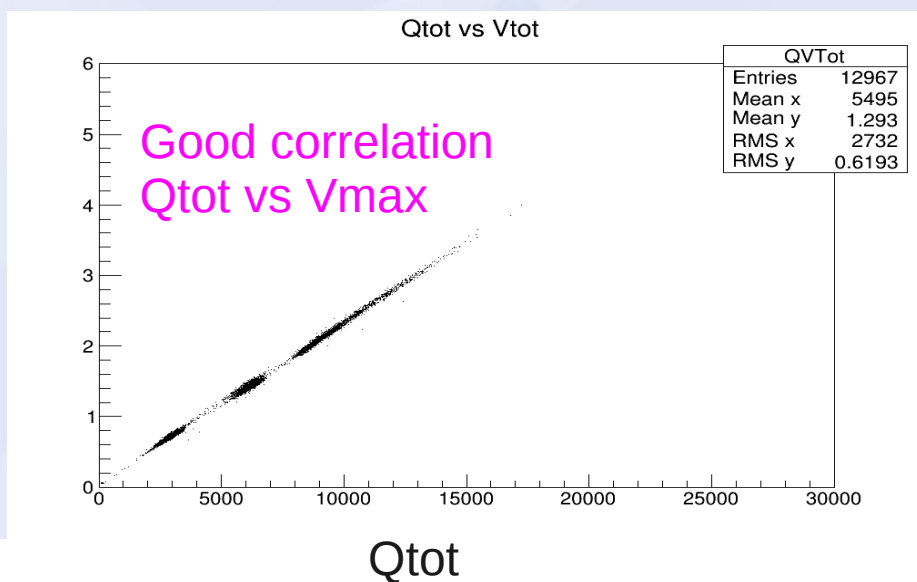


Maximum crystal/ev



Run 312 - Sum all detectors

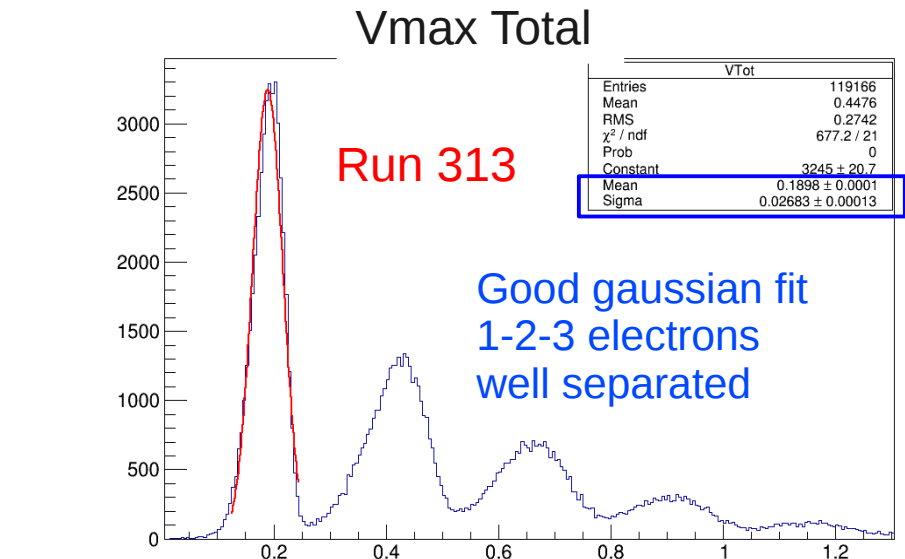
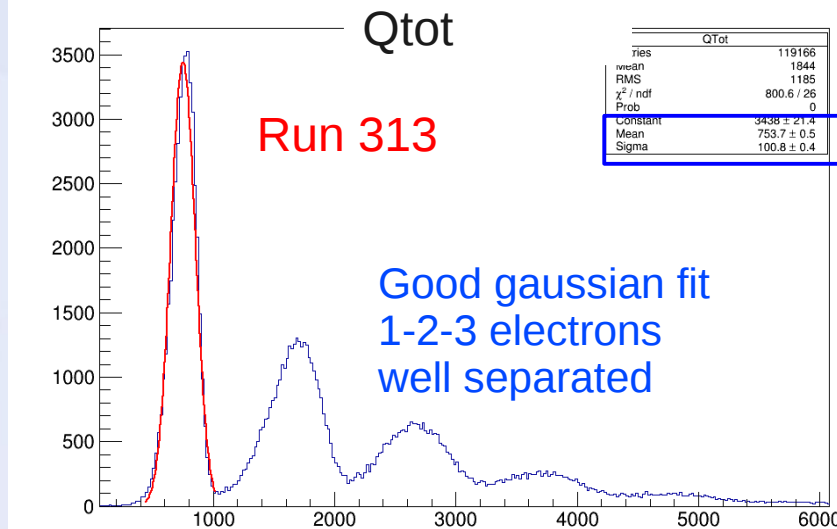
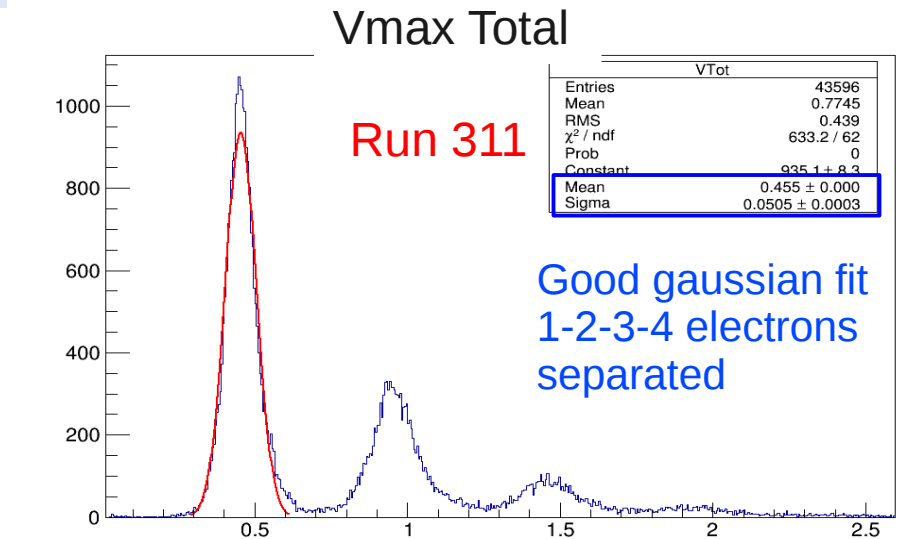
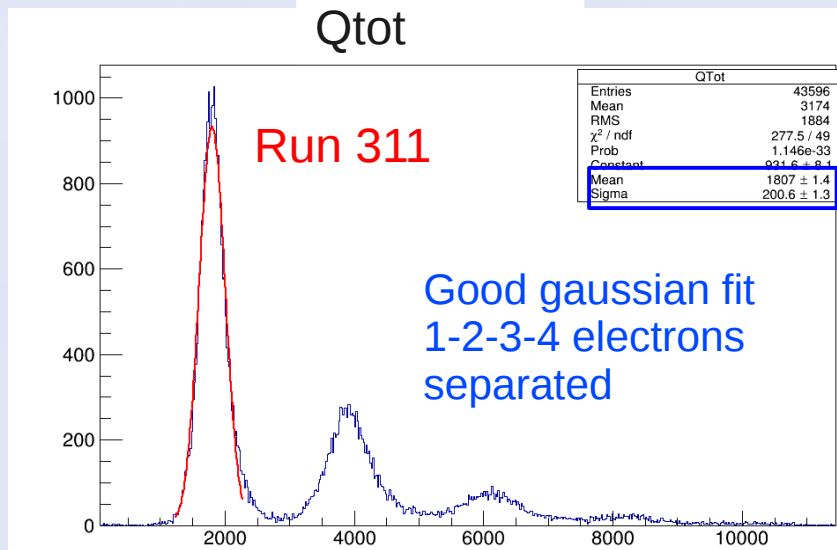
We use corrected Vmax and total integrated charge (Tstart ÷ 900) summed on all detectors over Vmax > 0.006 V
Cuts : > 1 crys/ev ; max on crystal 5 ; Vmax(5) > 0.010 V



Runs 311,313

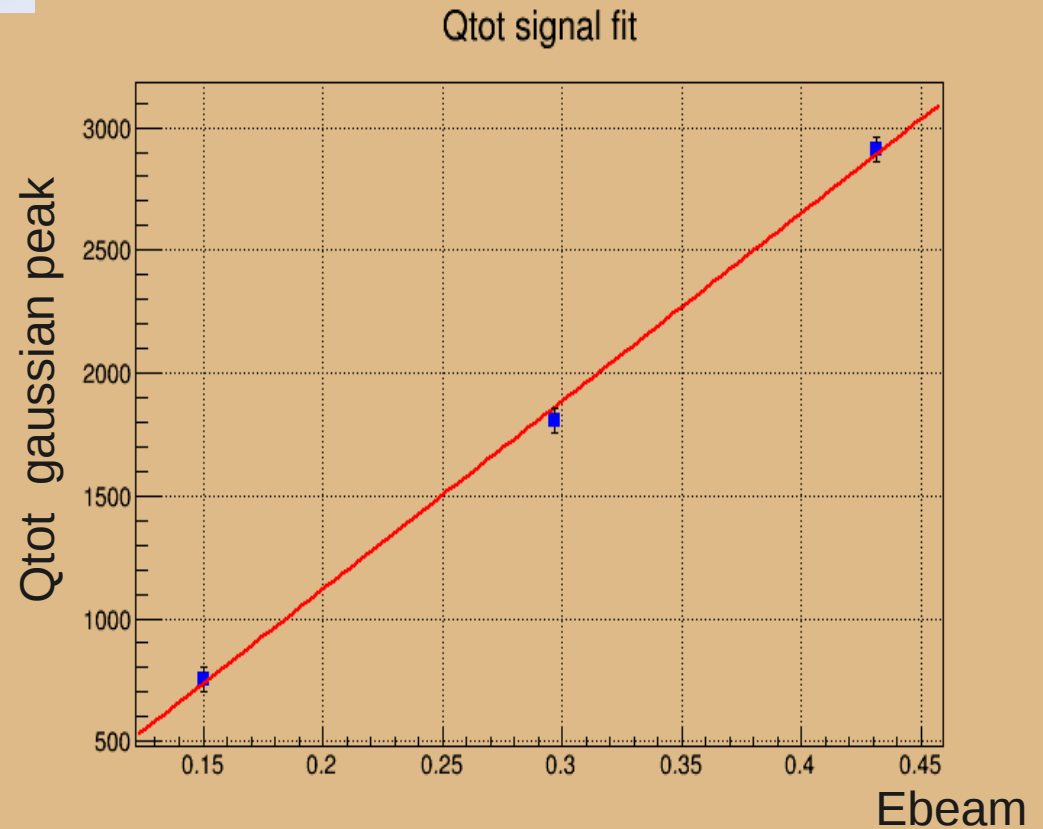
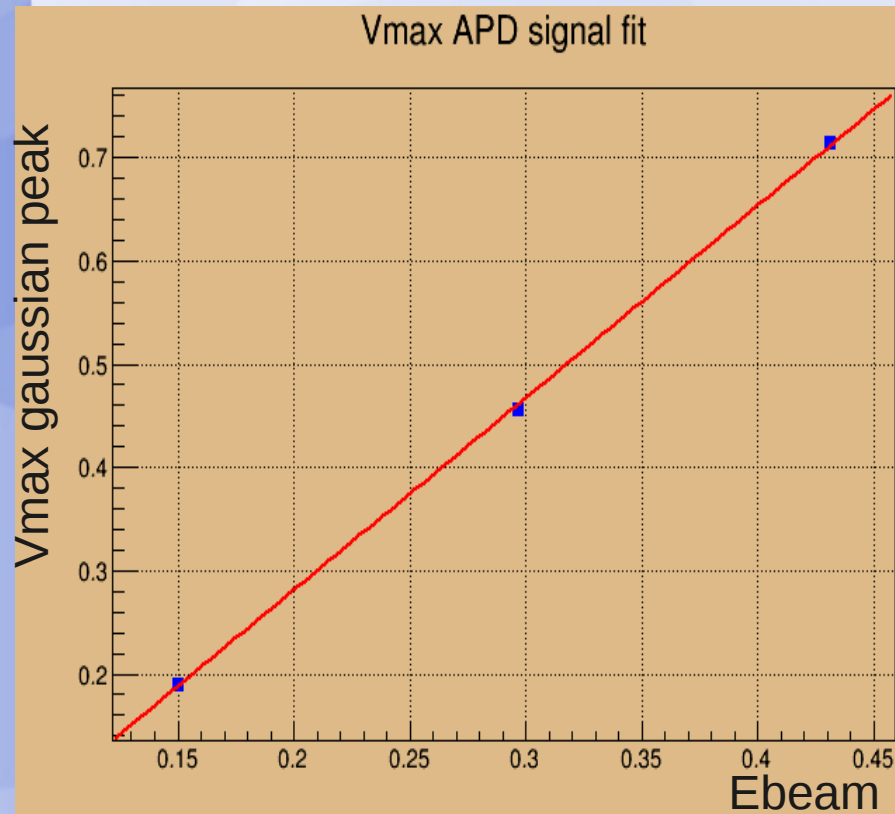
Sum all detectors

Same cuts as run 312 used



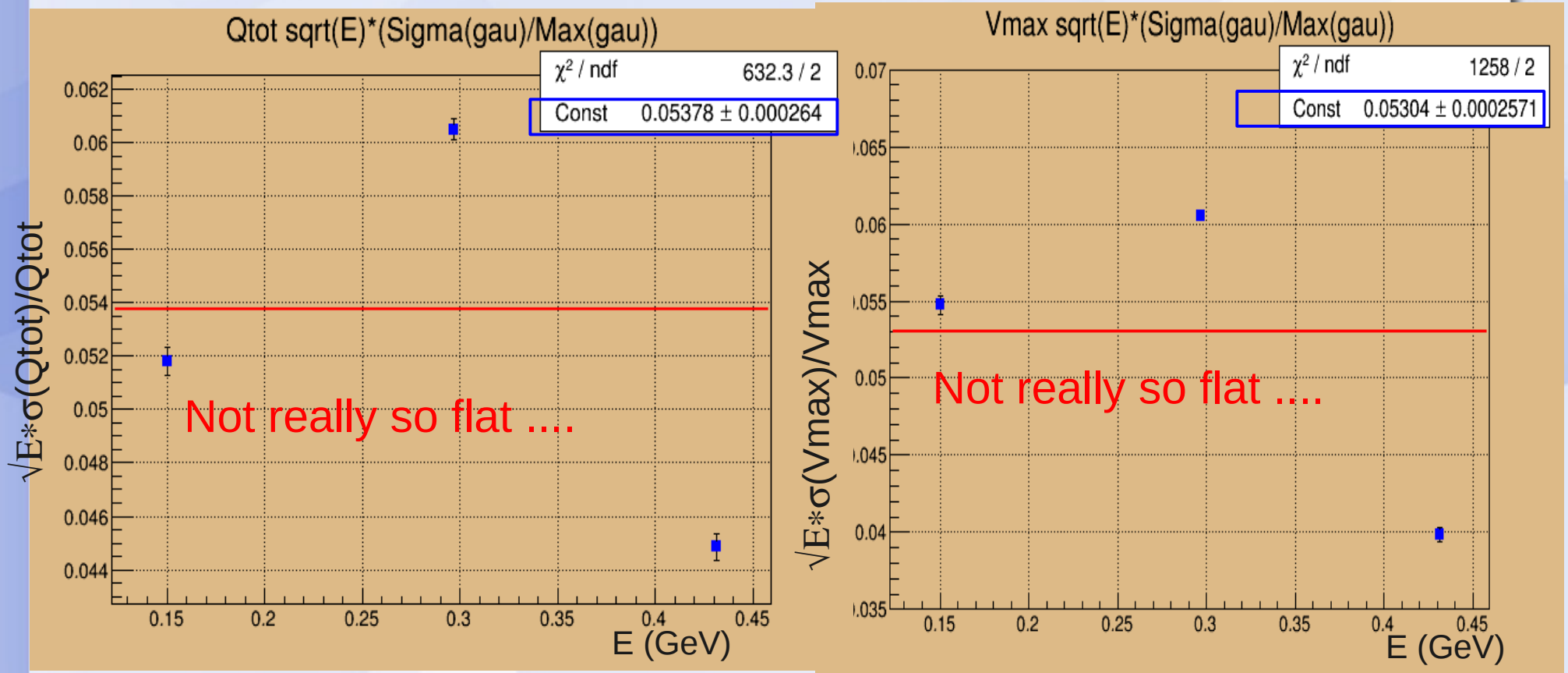
Linearity APD

We have a good energy linearity both for V_{max} and Q_{tot}



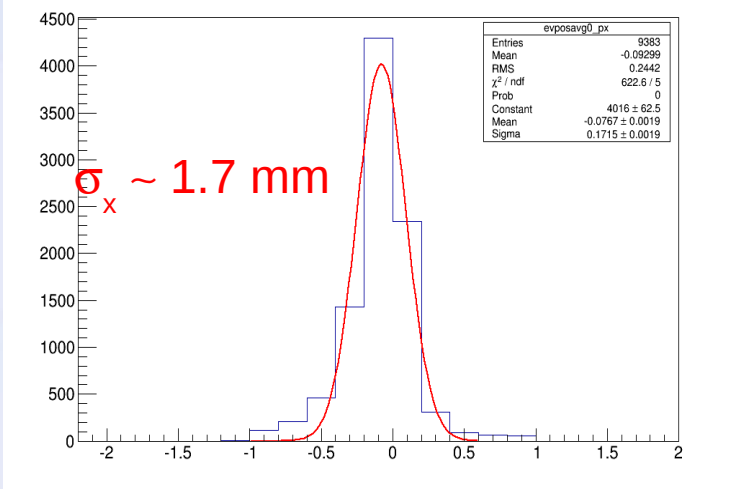
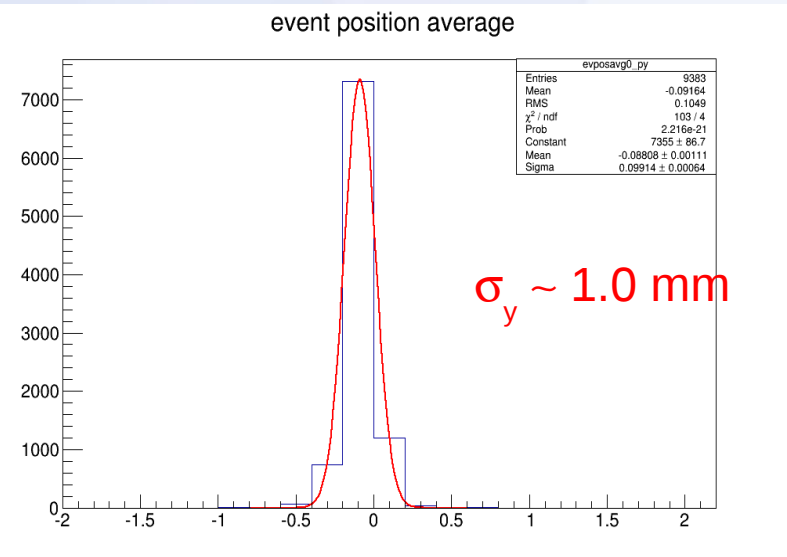
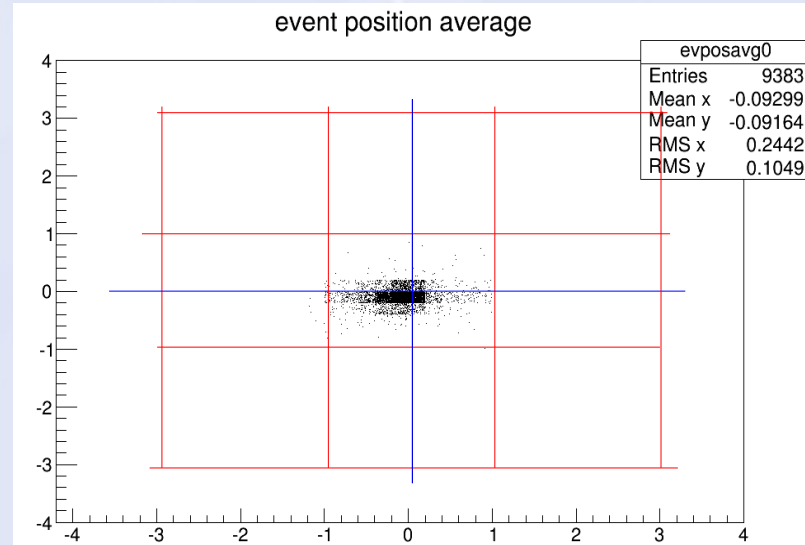
Resolution APD

$\sigma(E)/E \sim (5.3-5.4 \pm 0.03)\% / \sqrt{E}$ - Not so bad, we may still improve
Worse than PM as expected with lower amplification of APDs



Run 312 - Position Resolution

We take the position using the energy-weighted avg (using Vmax) of each crystal center for each detector signal : **distribution under the first Vmax peak is ~ gaussian.**



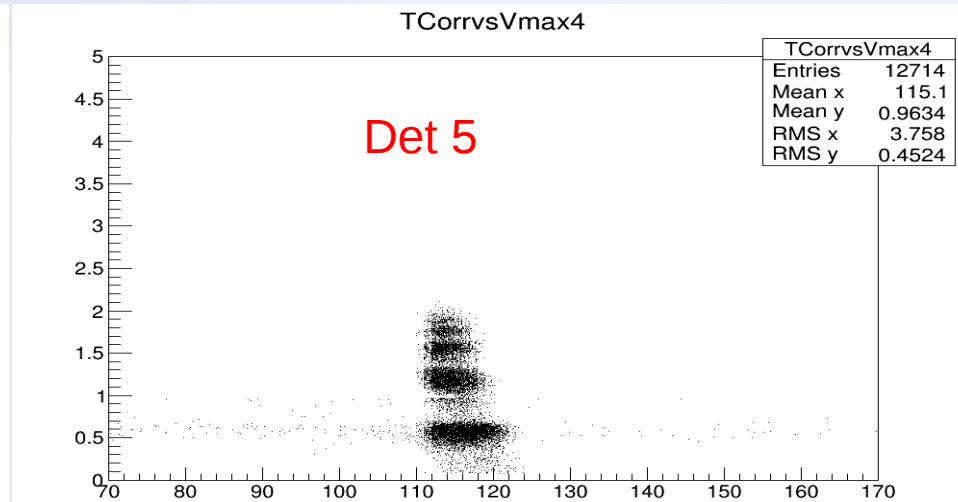
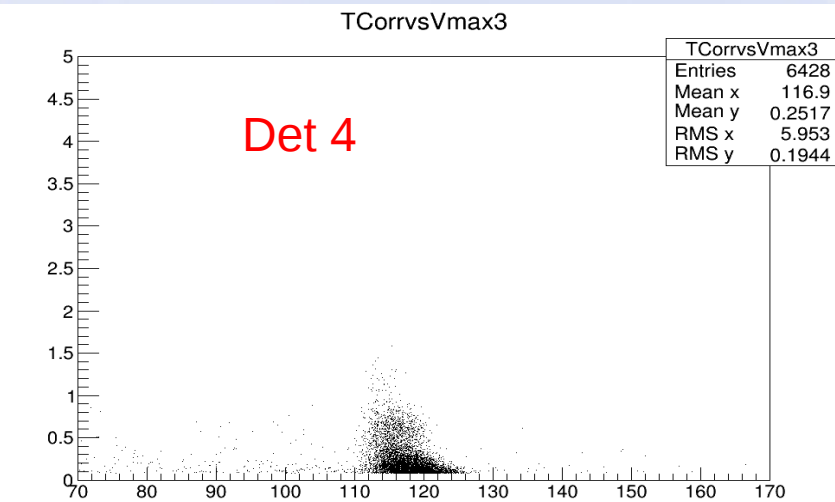
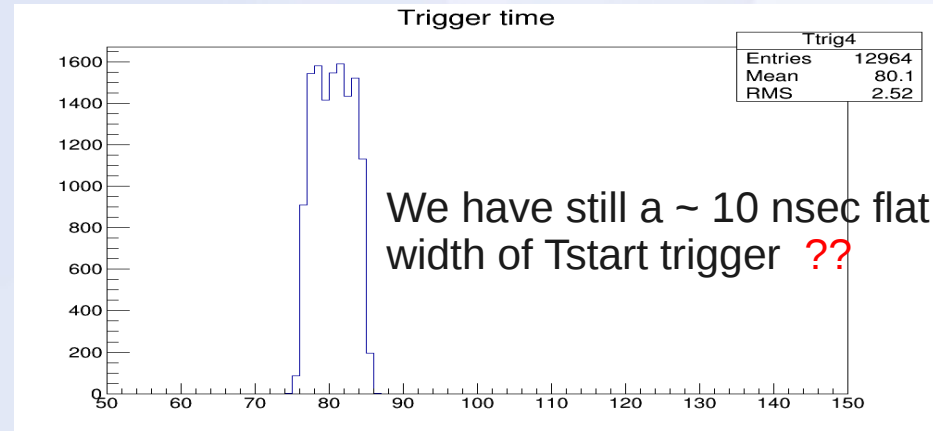
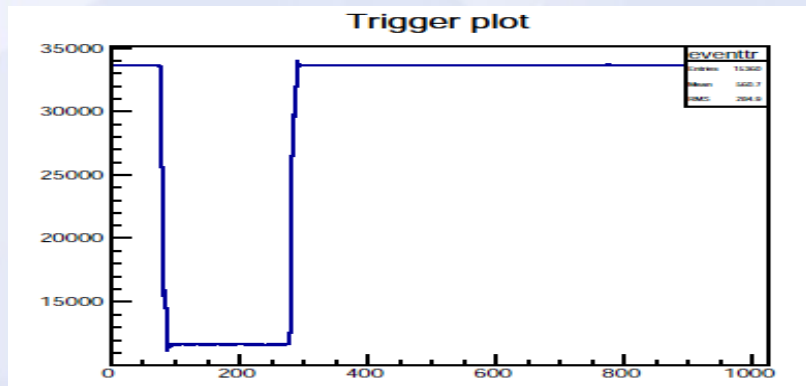
Center of crystal 5 is (0,0)

The crystal boundaries are shown in red

Similar resolutions for other runs as well

Time resolution

Same problems with BTF Ttrig as with PM Calo



Corrected Tstart – Ttrig of signal (all dets) bad resolution depends (as Pms runs) from Tstart_trig + problem of signal Tstart for small signals due to noise at start of signal – [under study](#)