INFN
Istituto Nazionale
di Fisica Nucleare

First look at TB data

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Used data

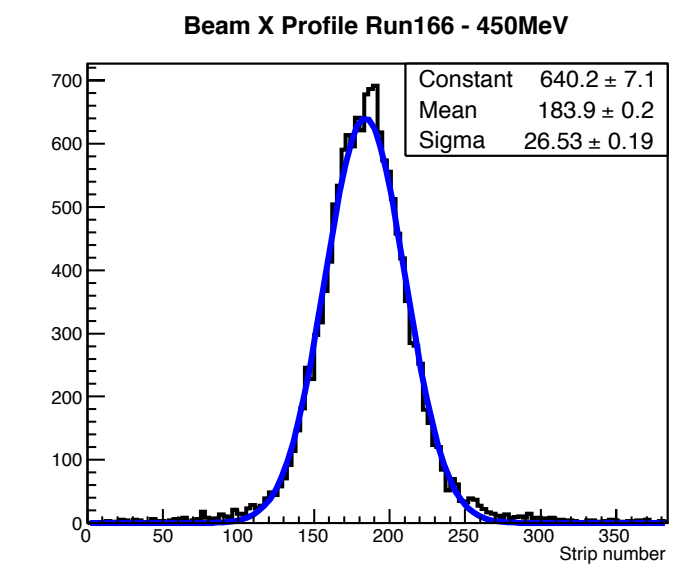
- Calibration
  - All cosmic run after "equalization" of HV
    - 140,171,172,173,195,234
    - **Total events 64409**
- Resolution
  - All run with beam on Crystal6 without magnetic field after beampipe
    - **Run166 -> 450MeV**
    - **Run167 -> 400MeV**
    - **Run168 -> 300MeV**
    - **Run169 -> 200MeV**
    - **Run170 -> 100MeV**
  - All run with beam on Crystal9 without magnetic field after beampipe
    - **Run201 -> 450MeV**
    - **Run203 -> 400MeV**
    - **Run204 -> 300MeV**
    - **Run205 -> 200MeV**
    - **Run206 -> 100MeV**

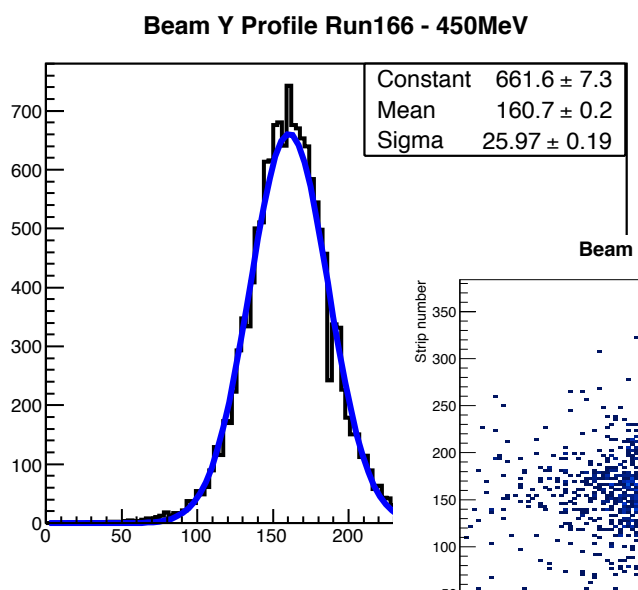
Calibration

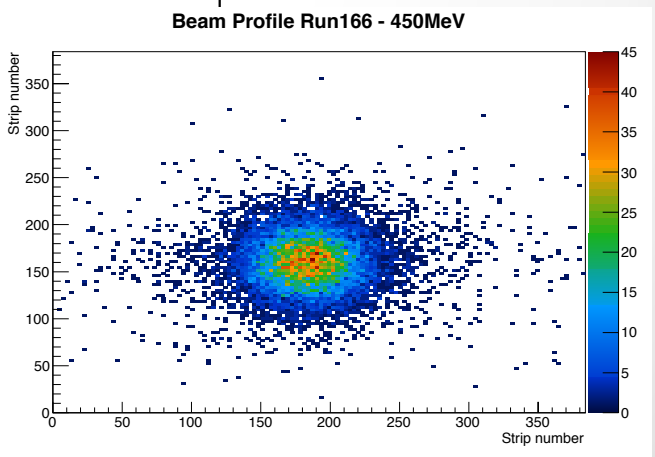
- Request that cosmic went through one single column of the matrix and no signal over the rest of the crystal
- Fit with Langau (Landau convoluted with gaussian) to extract signal amplitude
- Noise extracted reversing the request of the signal
  - No signal in the entire column
- Reference for calibration chosen as the mean value between the two APDs of crystal 5

Selection for Energy resolution

- For each run three cuts are applied:
  - Only 1 cluster reconstructed on each plane
  - Position selection of ½ σ around the mean value
    - Mean value change slightly between different run
  - Only crystal with maximum value greater then 1 times the baseline RMS
    - Baseline RMS evaluated from random trigger run112

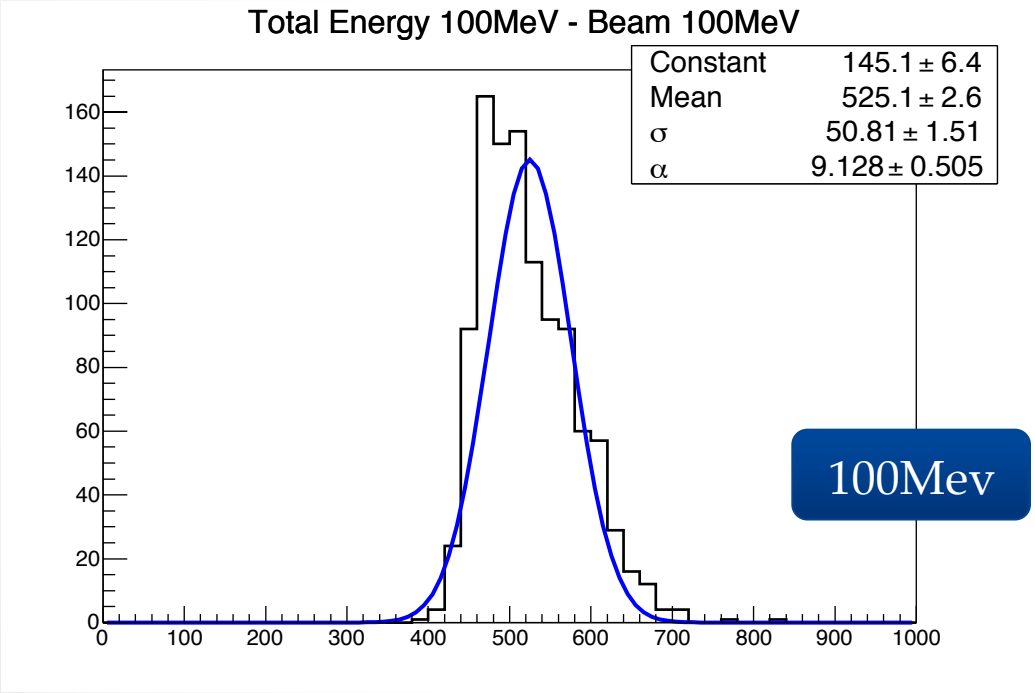


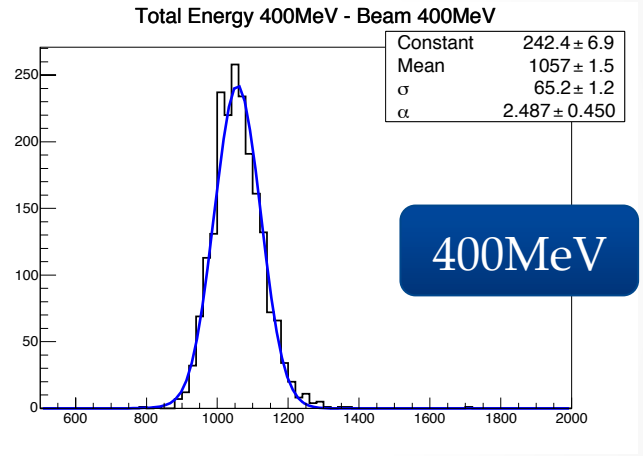




Some distribution

- Fit with Crystal Ball function
  - Parameter n (exponential tail index) fixed to 20

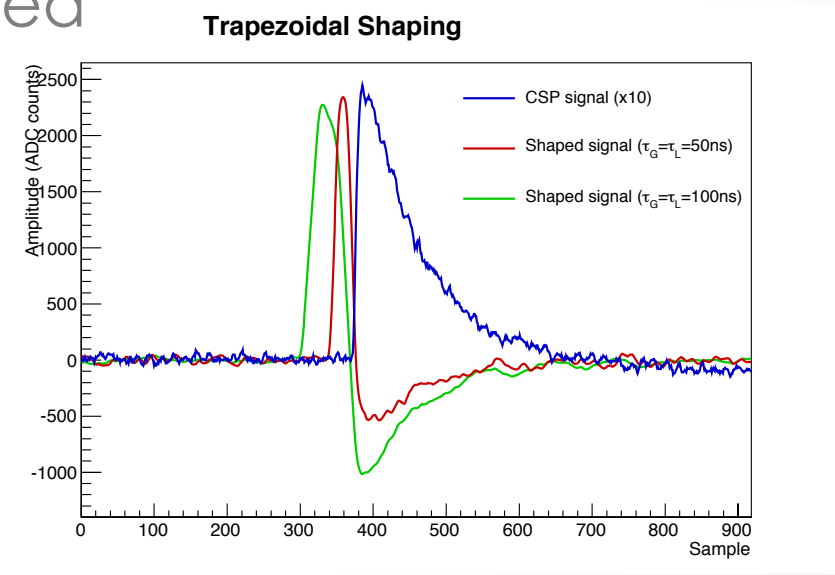




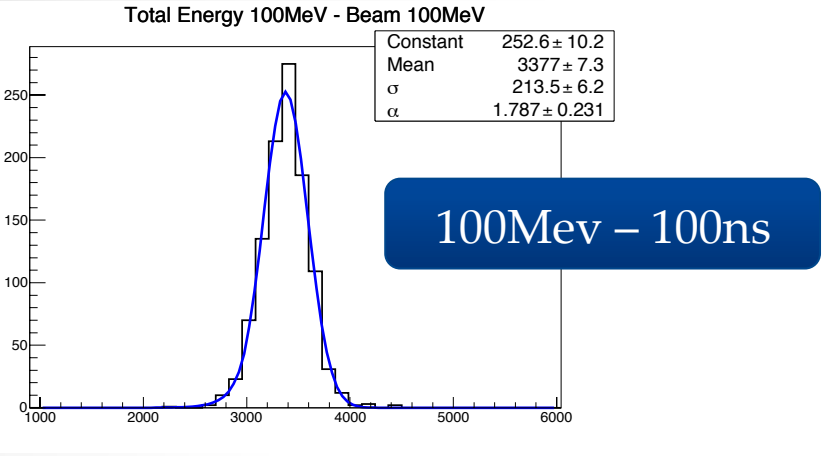
Shaping

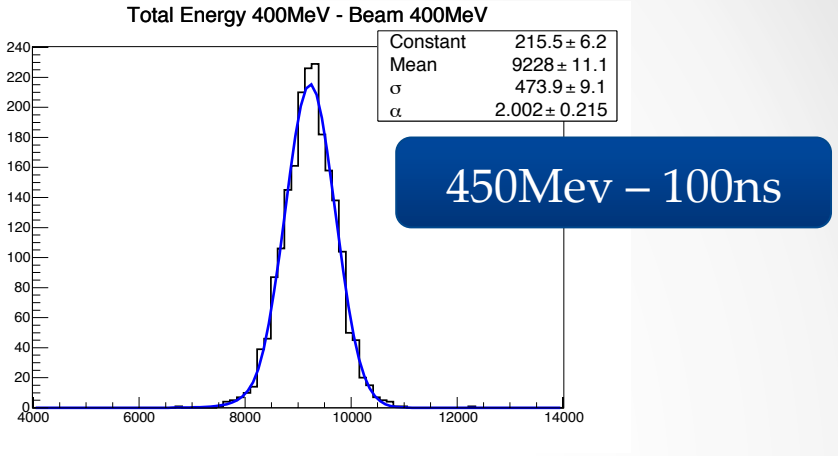
- Trapezoidal shaping

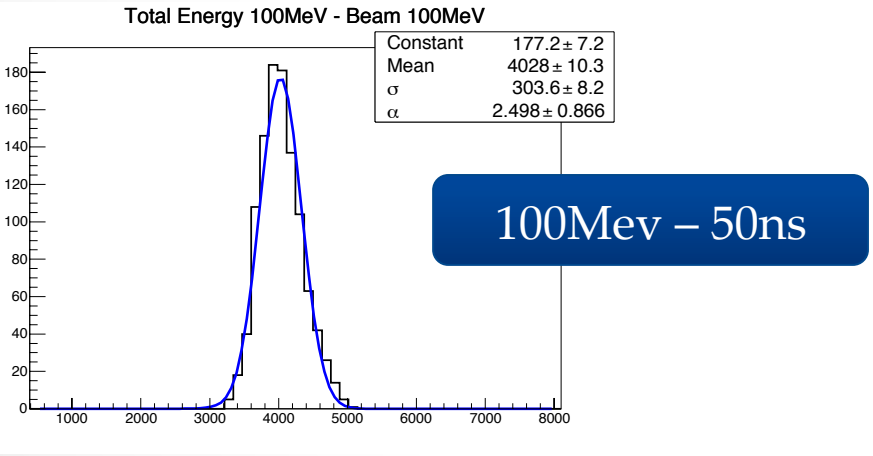
- Same calibration constants evaluated w/o shaping
- Two configuration tested
  - $\tau_G = \tau_L = 50ns$
  - $\tau_G = \tau_L = 100ns$

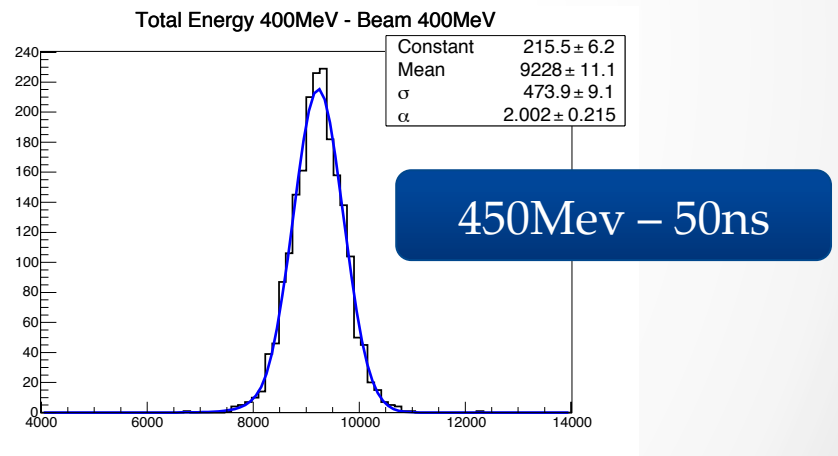


After Shaping



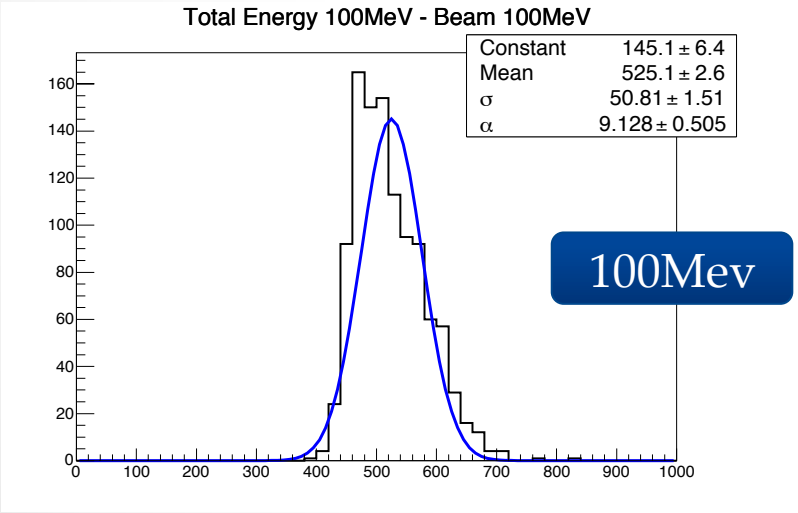


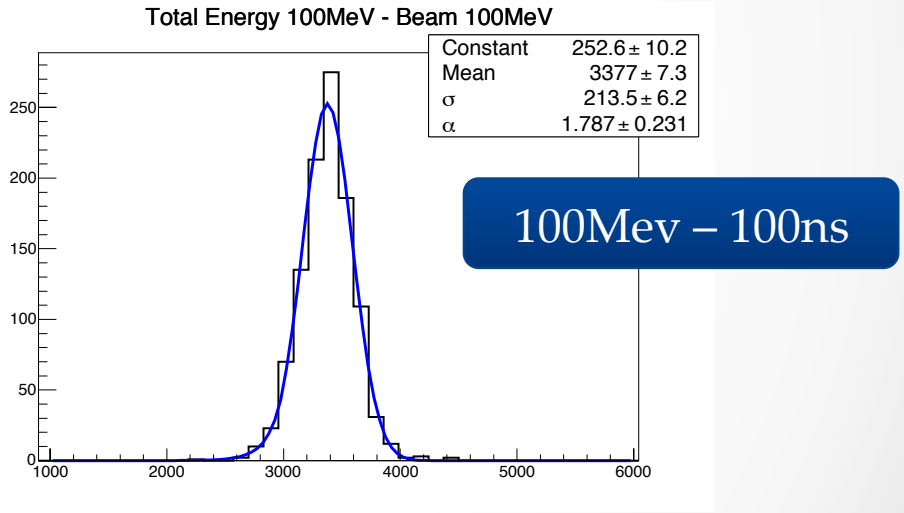




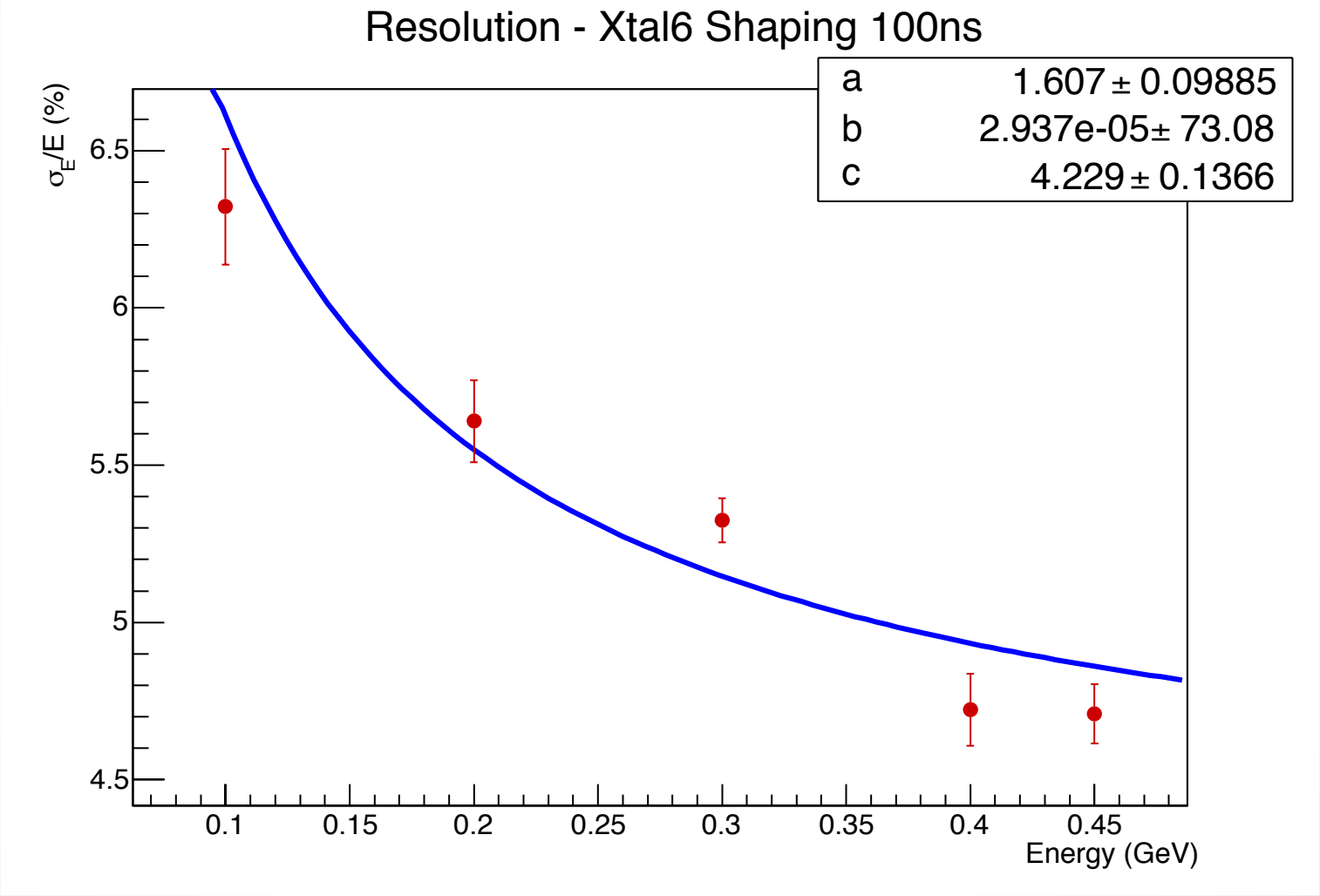
Distribution Comparison

- Different shape between CSP data and Shaped data

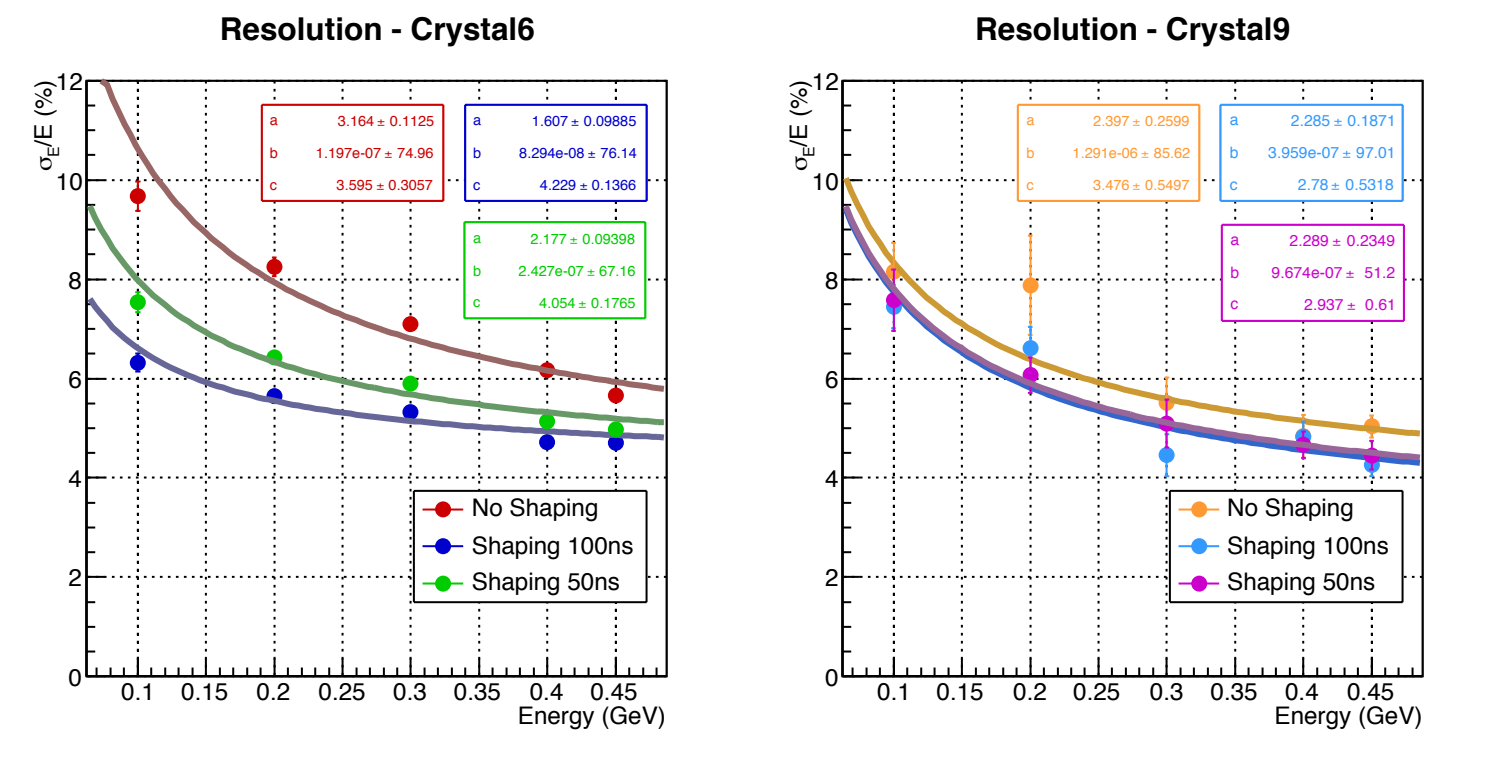




Xtal6 – Shaping 100ns



Resolution



- Small difference between runs on Xtal6 and runs on Xtal9

Extract Beam Spread

- Assumption
  - The difference between resolution at XMeV with 1 electron and with 2 electron of energy X/2 is only due to the Beam Spread (Germani's method)

Two Particles TB Resolution Componenets →

$$\frac{\sigma^2_{TB}(100+100)}{200^2} = \frac{\sigma^2(200)}{200^2} + \frac{1}{2}\frac{BS^2_{100}}{100^2}$$

Knowing BS_{200} we can measure BS_{100} →

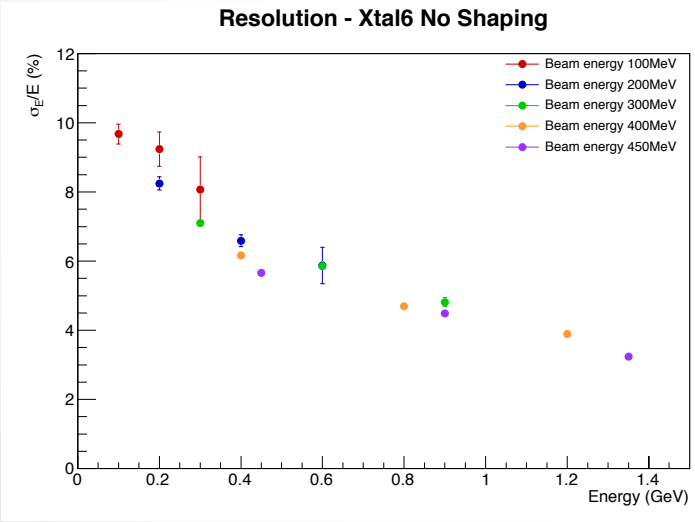
$$\frac{\mathbf{BS^2_{100}}}{\mathbf{100^2}} = \mathbf{2} \times \left(\frac{\sigma^2_{\mathbf{TB}}(\mathbf{100+100})}{\mathbf{200^2}} - \frac{\sigma^2_{\mathbf{TB}}(\mathbf{200})}{\mathbf{200^2}} + \frac{\mathbf{BS^2_{200}}}{\mathbf{200^2}} \right)$$

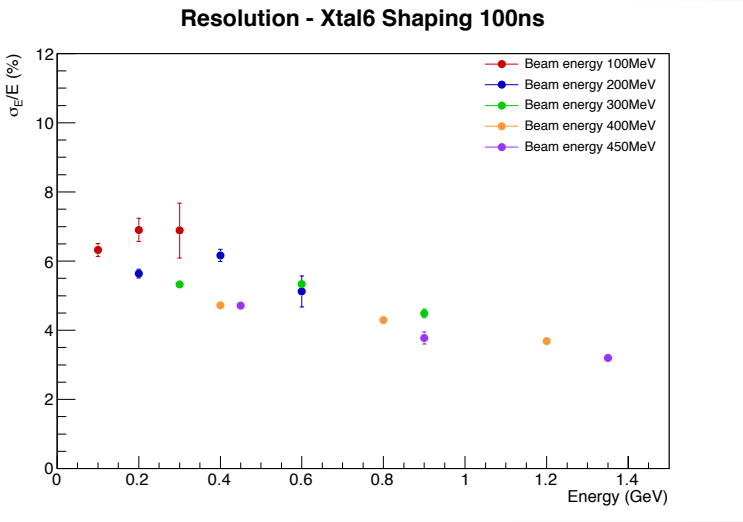
Knowing BS_{100} we can measure BS_{300} →

$$\frac{\mathbf{BS^2_{300}}}{\mathbf{300^2}} = \frac{\sigma^2_{\mathbf{TB}}(\mathbf{300})}{\mathbf{300^2}} - \frac{\sigma^2_{\mathbf{TB}}(\mathbf{3\times 100})}{\mathbf{300^2}} + \frac{\mathbf{1}}{\mathbf{3}}\frac{\mathbf{BS^2_{100}}}{\mathbf{100^2}}$$

Fit to multi e events

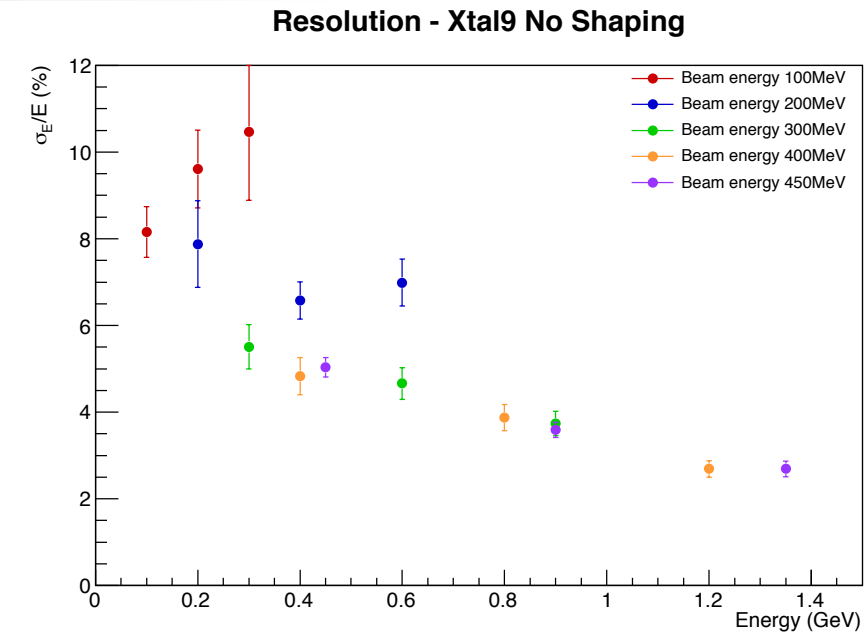
- Select events with 2 and 3 electron
- Relax selection on silicon position to have enough events
  - Maximum distance between particles 1 σ for 2 part. and 2 σ for 3 part

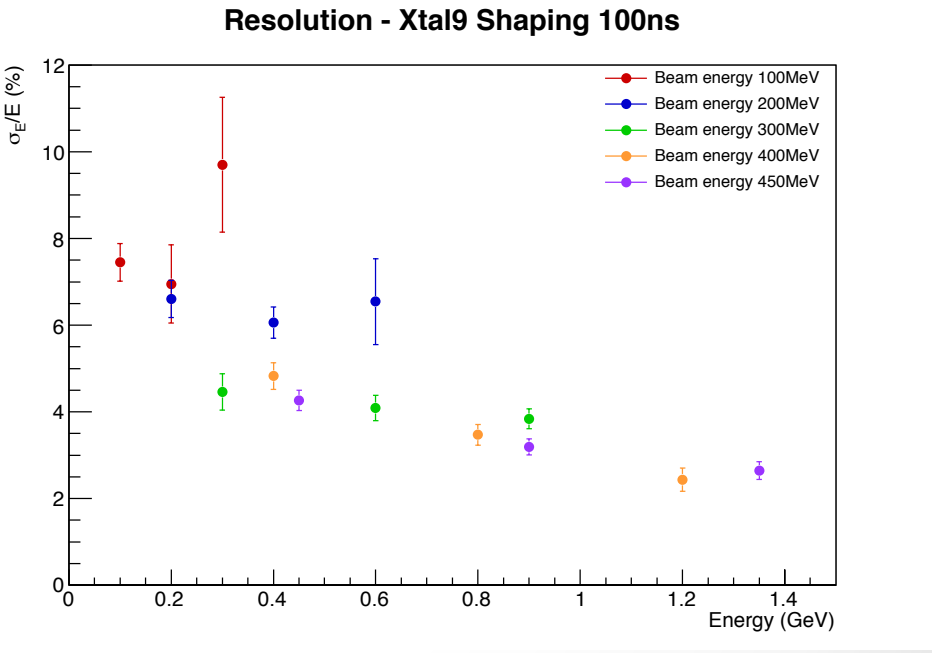




Fit to multi e events

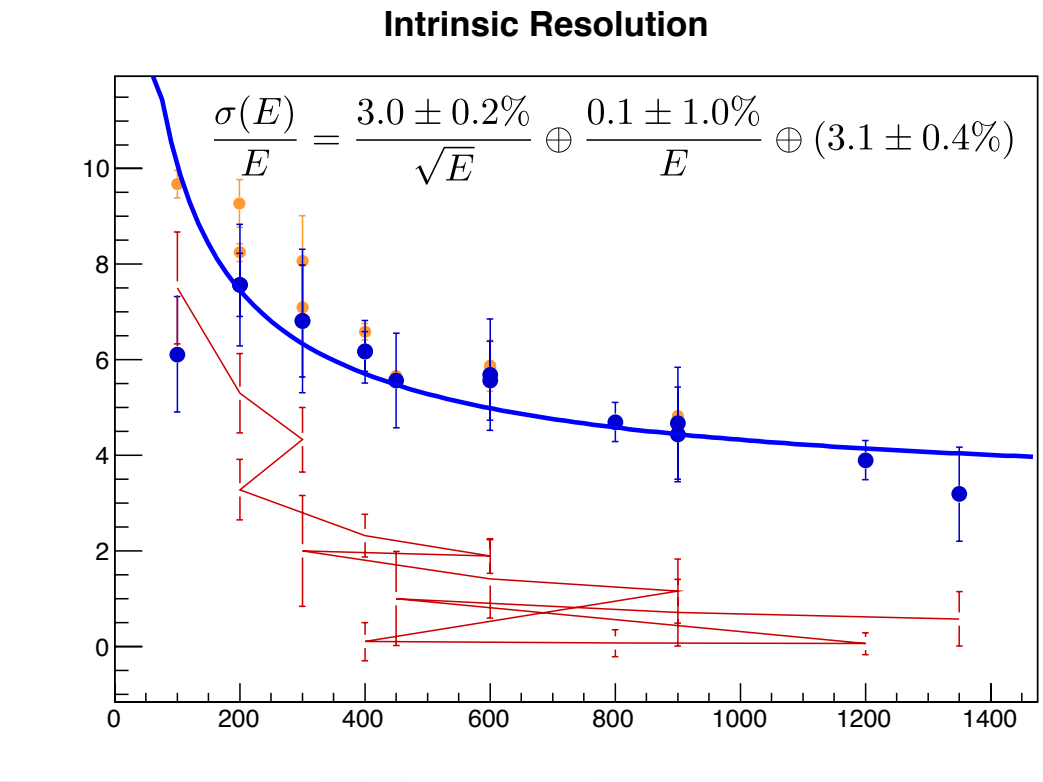
- Crystal 9

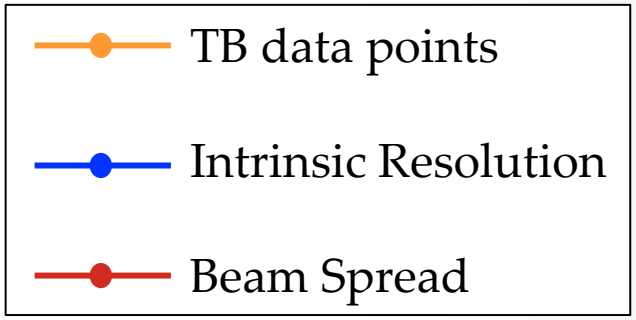




Fit toRresolution and BeamSpread

- First try -> Xtal6 no Shaping Data



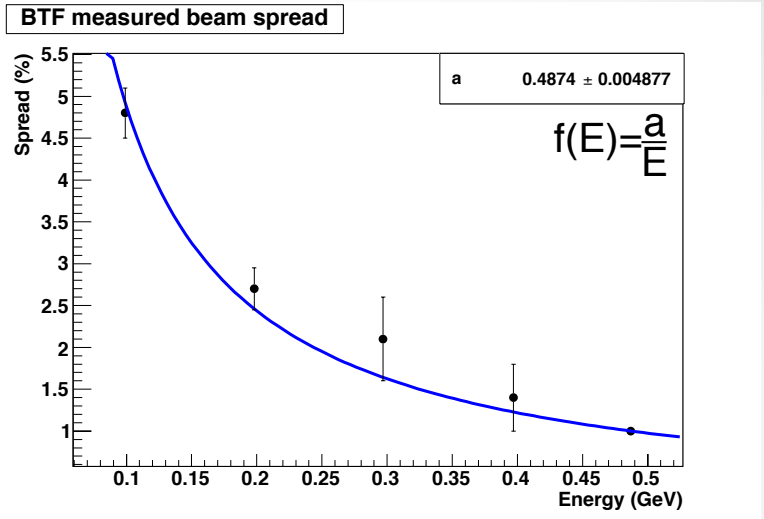


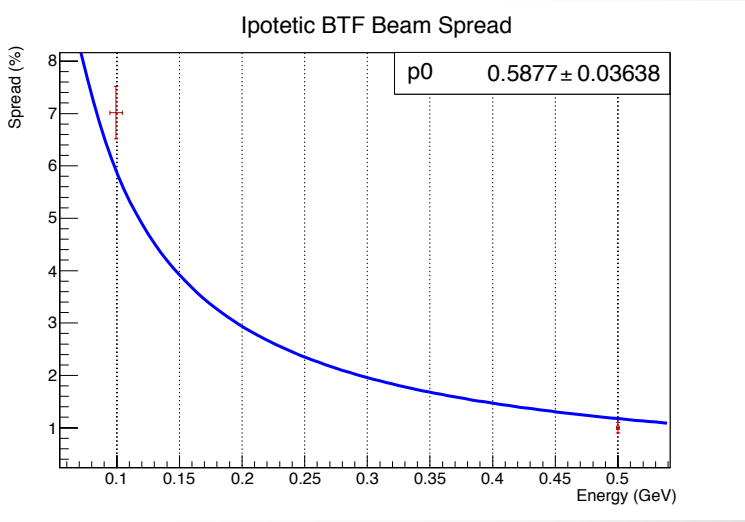
- Results not good
- Beam Spread
  - 100MeV: 7.49814 +- 1.17117
  - 200MeV: 3.27882 +- 0.634743
  - 300MeV: 1.99919 +- 1.16335
  - 400MeV: 0.1 +- 0.4
  - 450MeV: 1 +- 0.984181

- Fit failed on all the other data

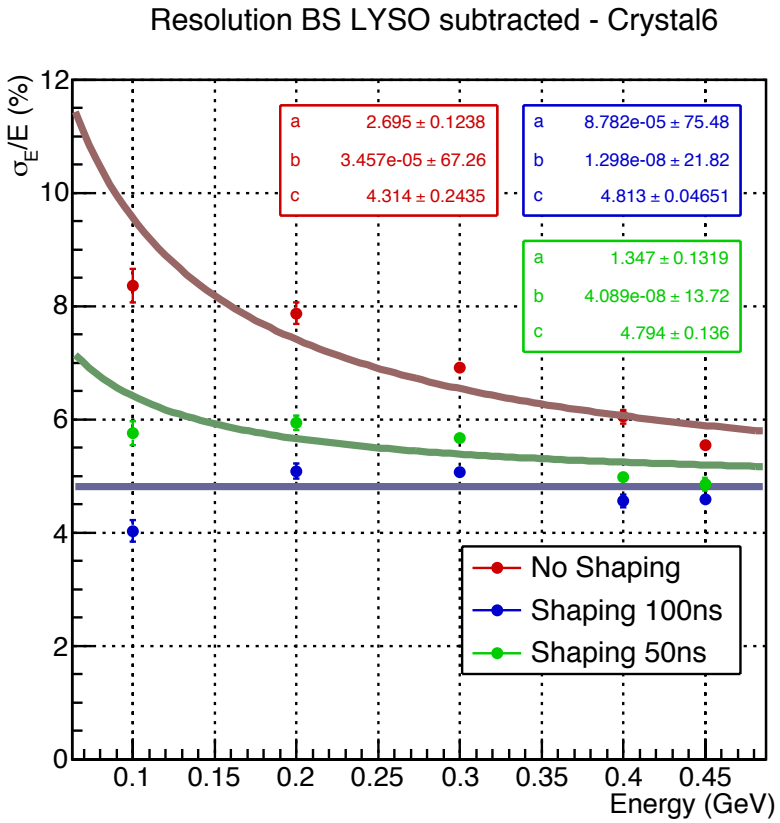
Beam Spread

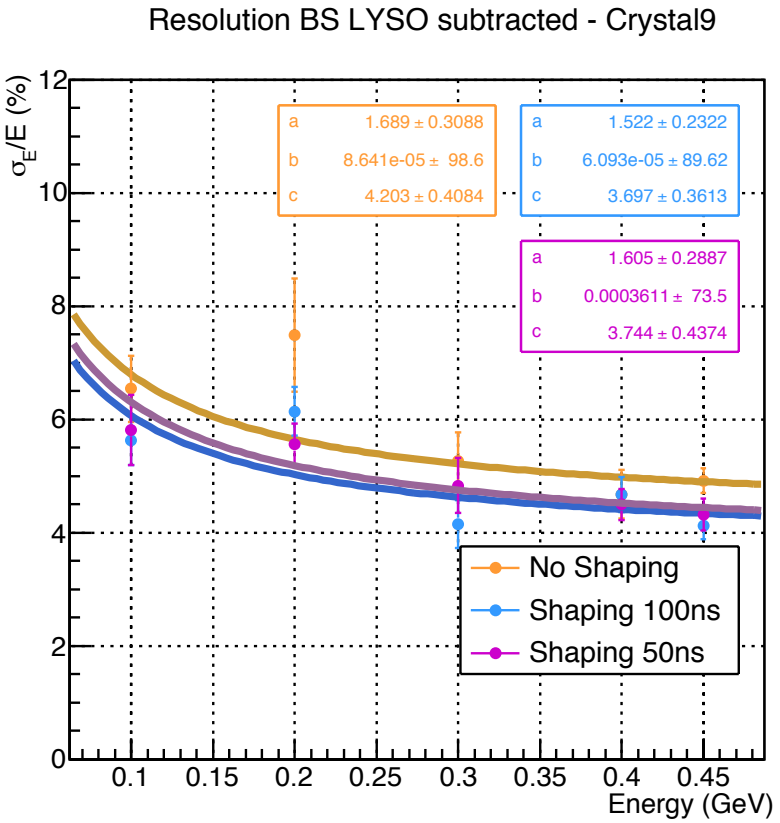
- Two further attempts:
  - Subtract BS as measured with LYSO Matrix
  - Subtract BS as evaluated by BTF Staff



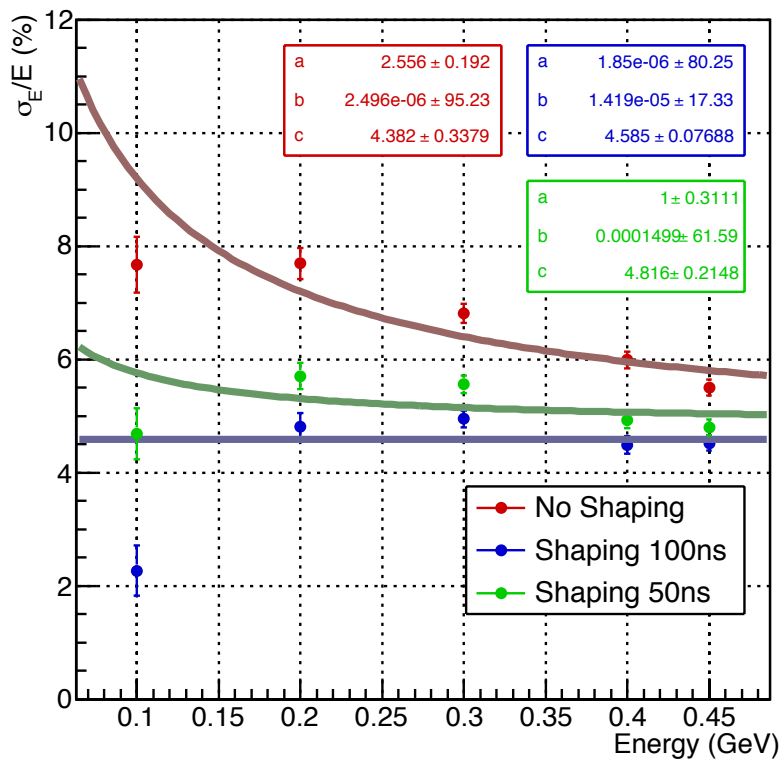


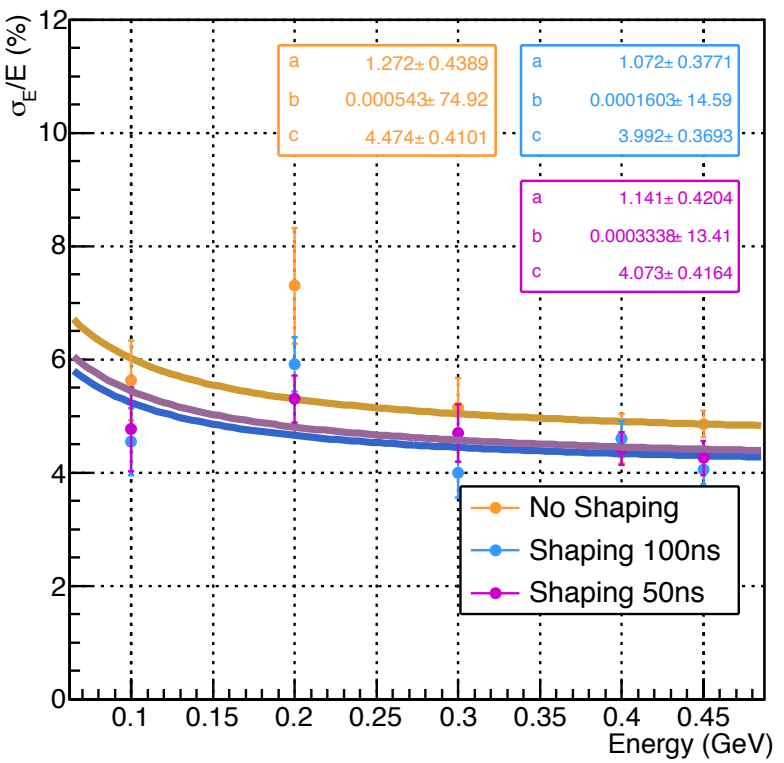
Beam Spread LYSO





Beam Spread BTF





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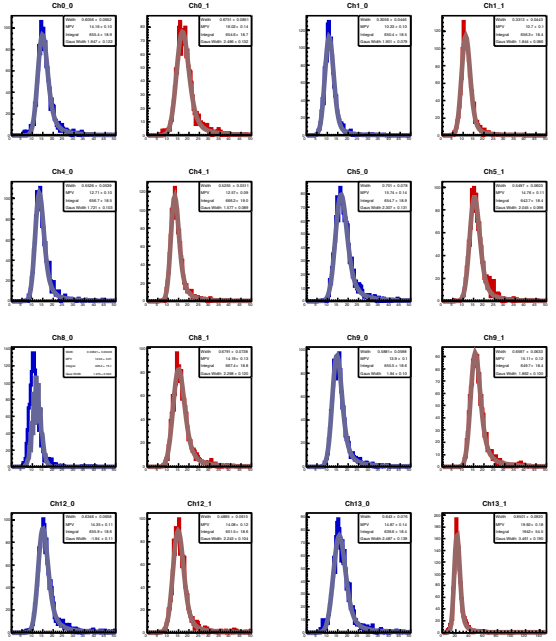
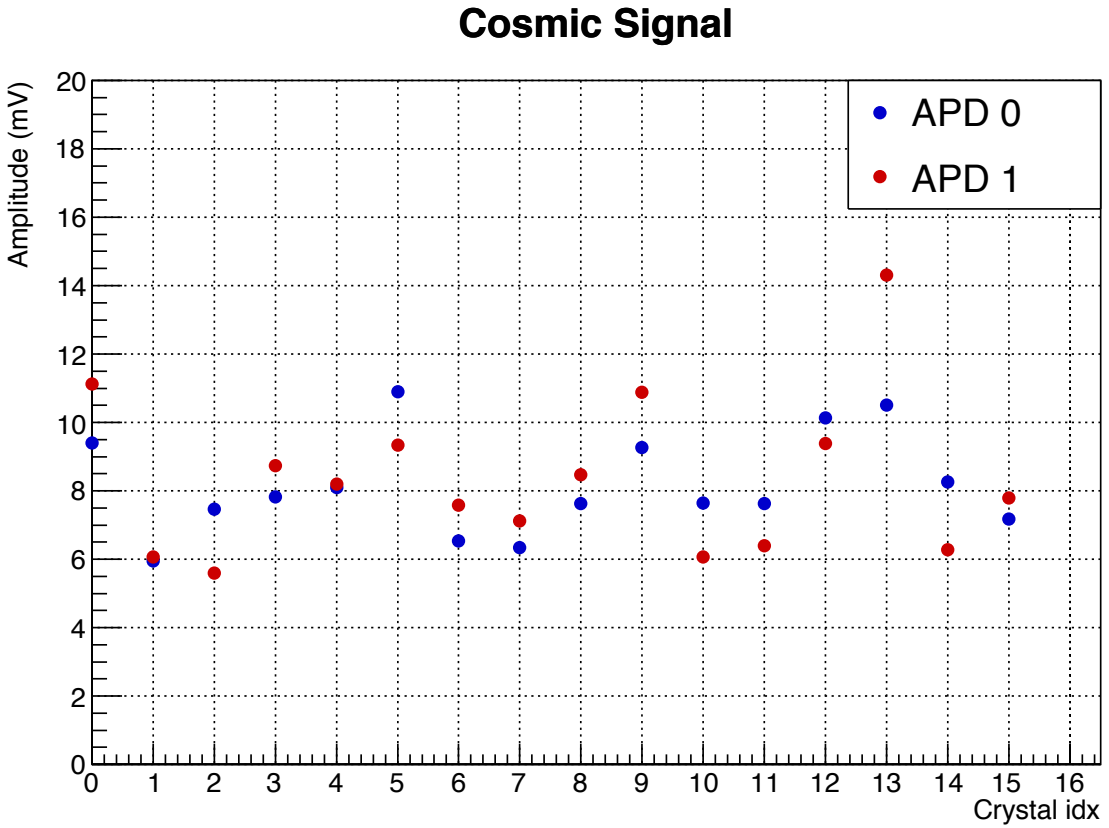
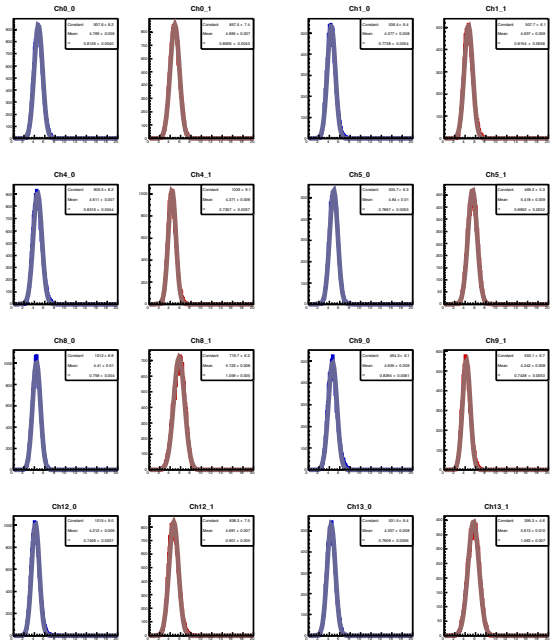
Backup

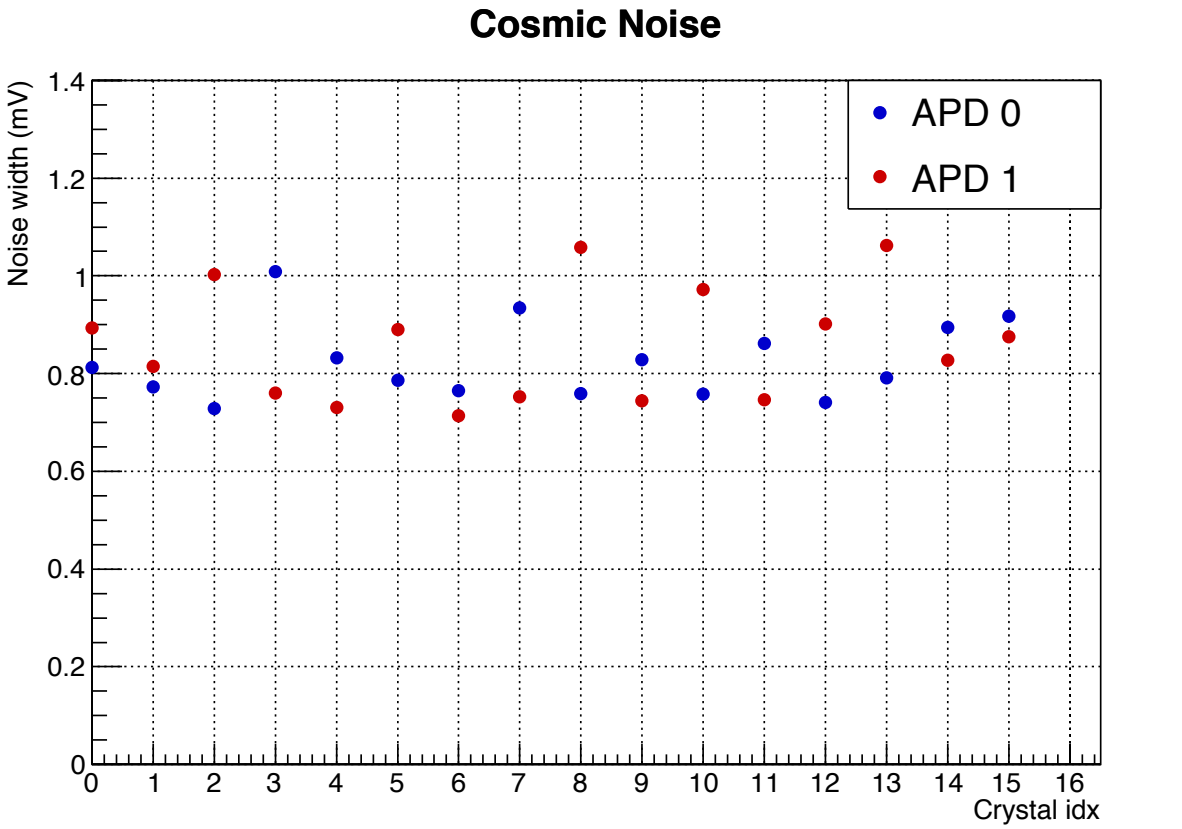
Calibration – Signal





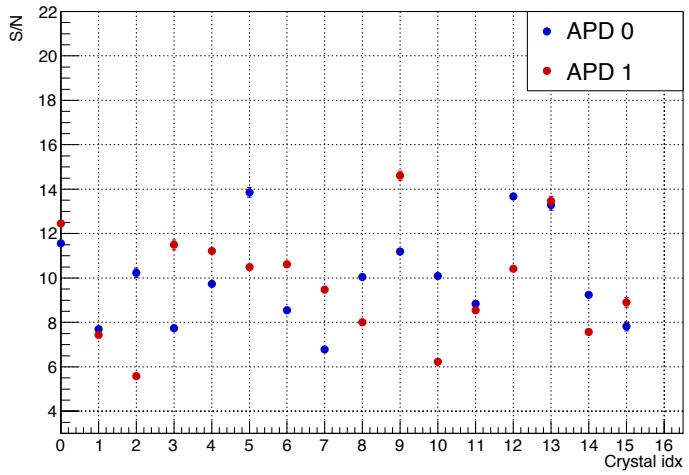
Calibration – Noise

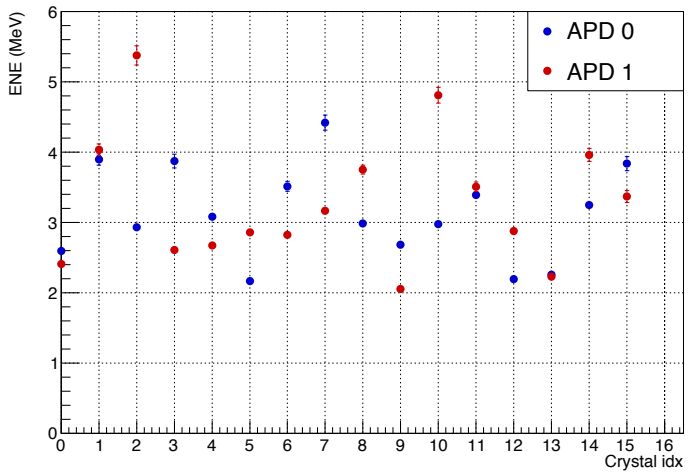




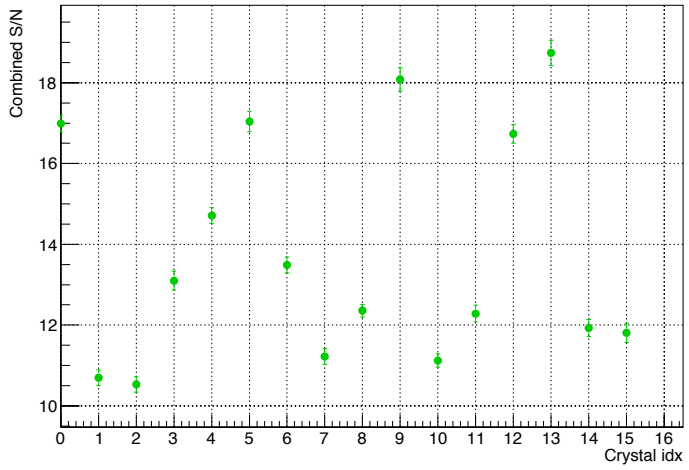
Calibration – S/N and ENE

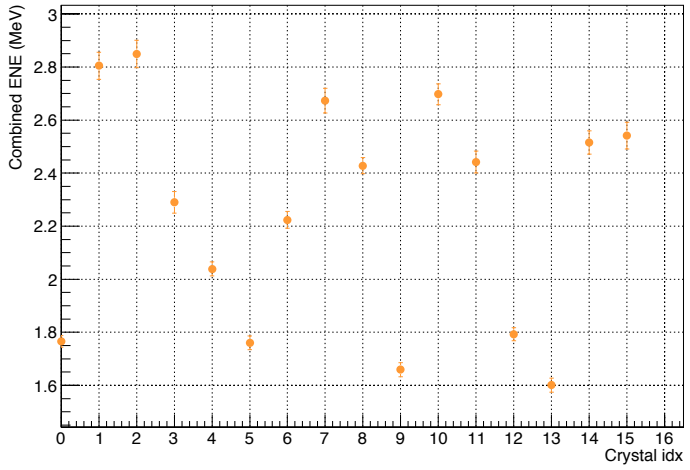
Single channel



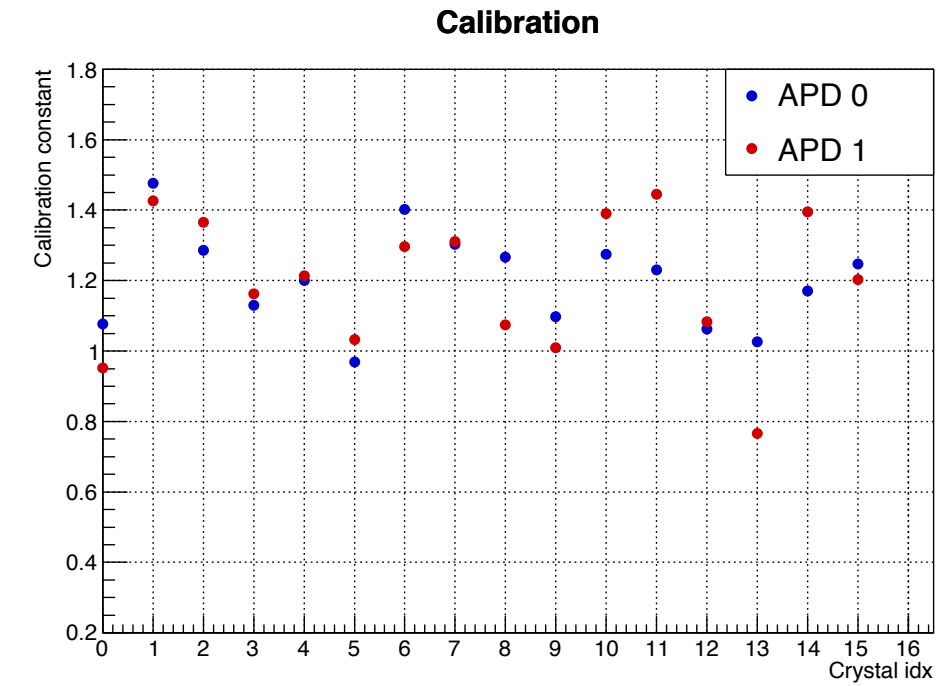


Combined channel





Calibration constant

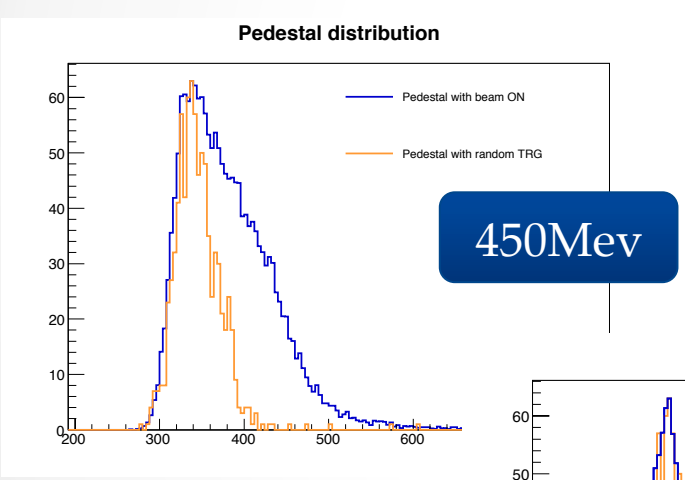


Crystal	APD0	APD1
0	1.077	0.952
1	1.476	1.426
2	1.286	1.366
3	1.130	1.163
4	1.200	1.213
5	0.969	1.033
6	1.402	1.297
7	1.303	1.311
8	1.267	1.074
9	1.097	1.009
10	1.275	1.390
11	1.230	1.445
12	1.063	1.083
13	1.026	0.766
14	1.171	1.395
15	1.247	1.203

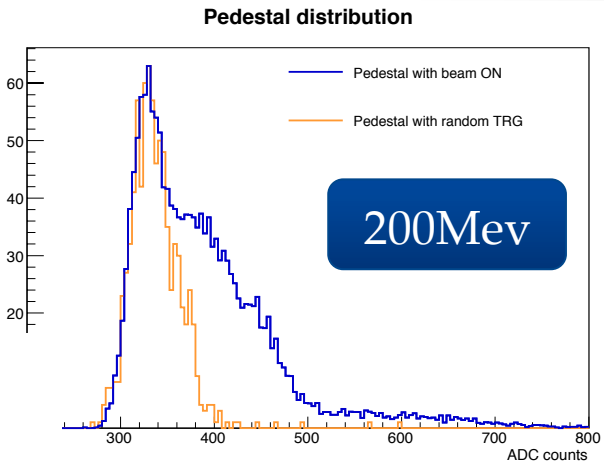
No temperature correction applied

Photons background

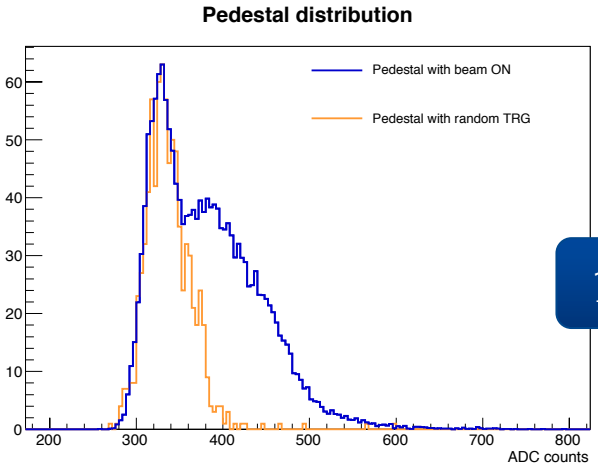
- Not constant
- Depends on primary beam multiplicity on target



450Mev



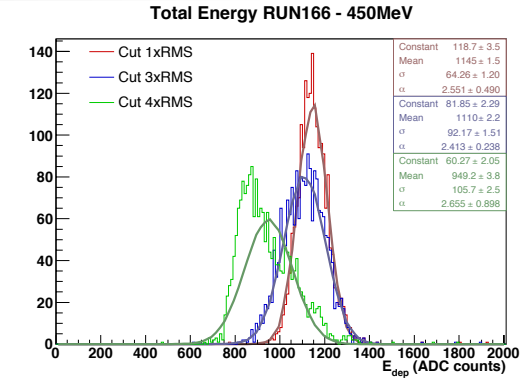
200Mev

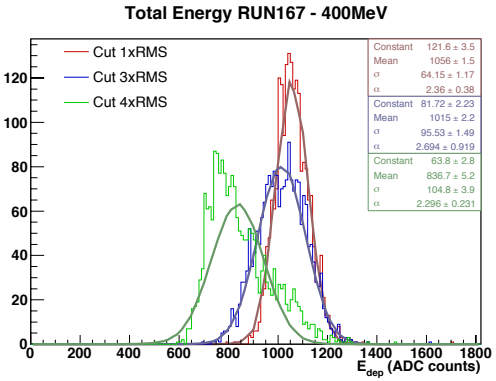


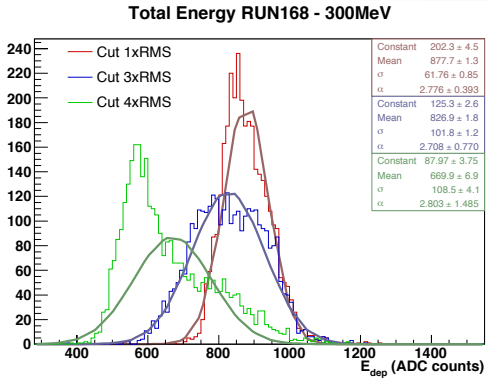
100Mev

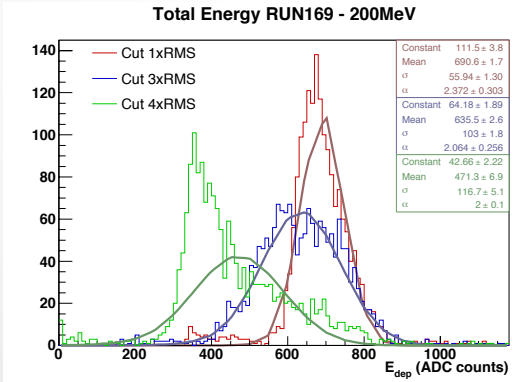
Scan Cut on energy

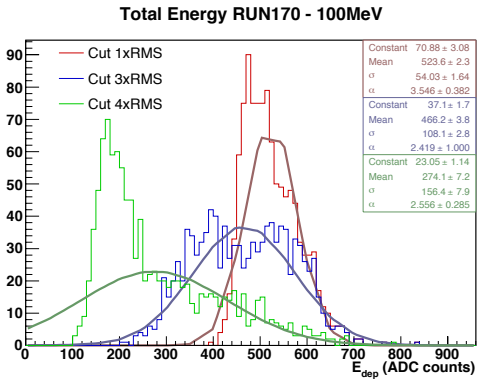
- Default use 3 times the RMS of the baseline
  - Tested 1xRMS and 4xRMS

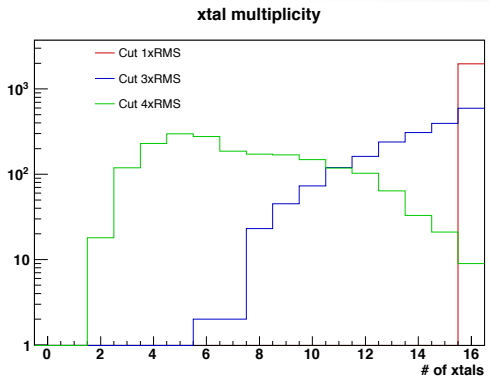






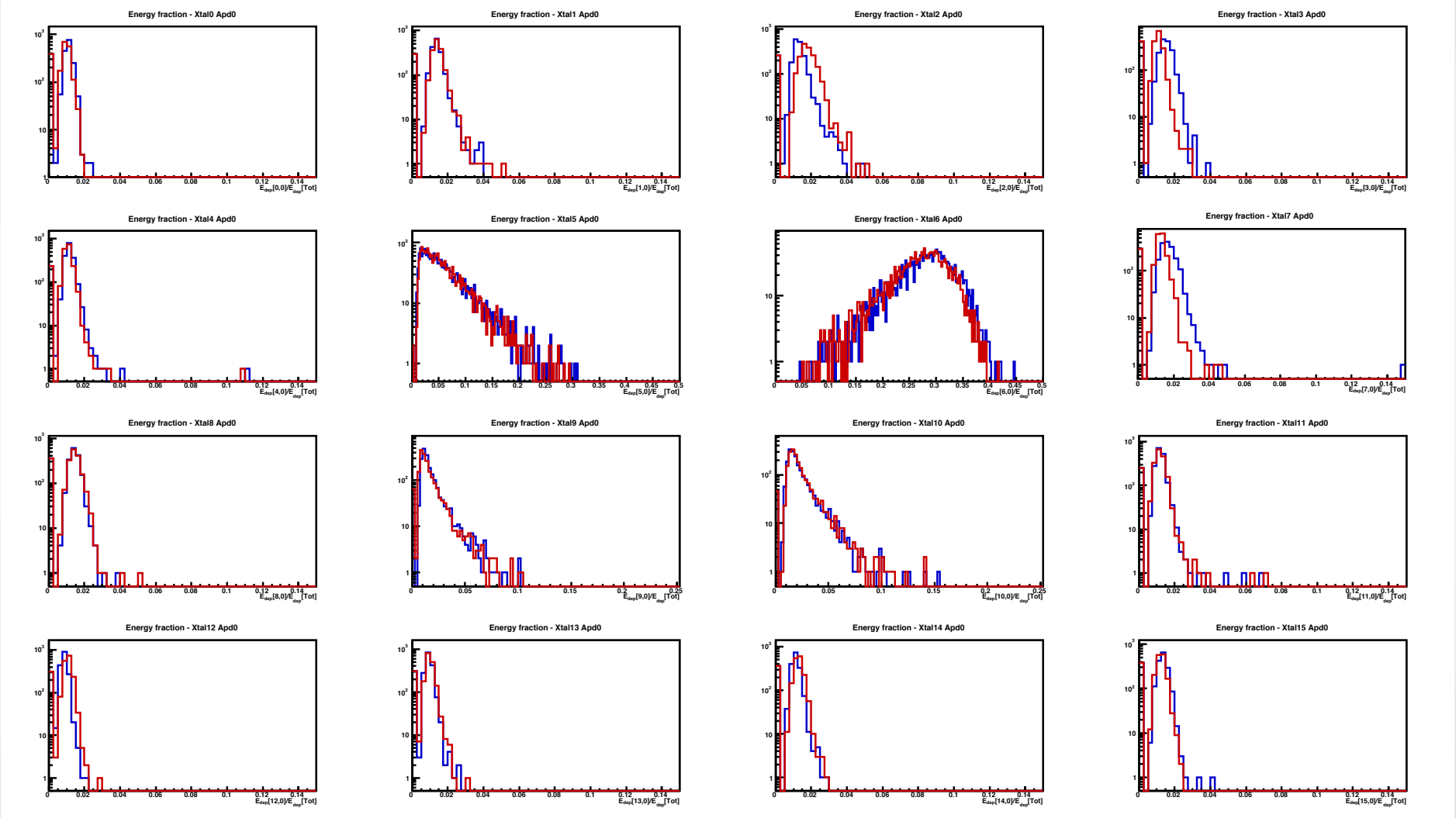




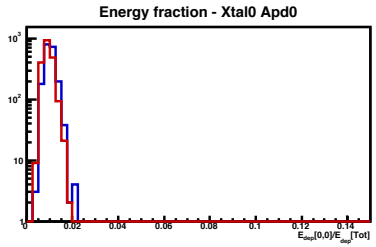


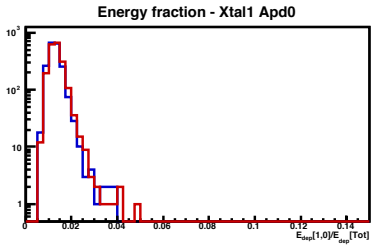
Better results with 1xRMS cut

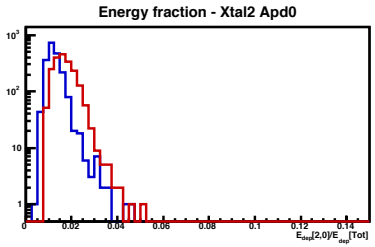
Energy Fraction 3xRMS

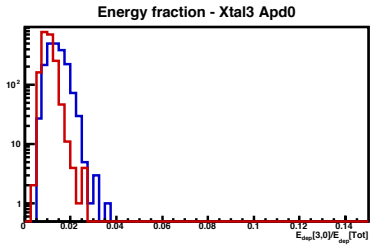


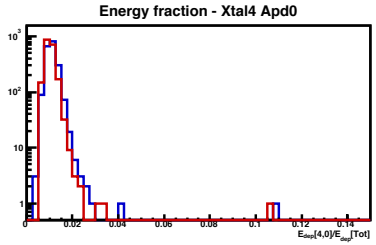
Energy Fraction 1xRMS

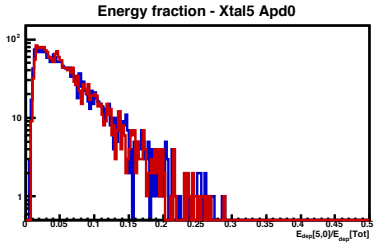


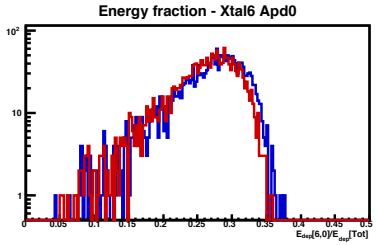


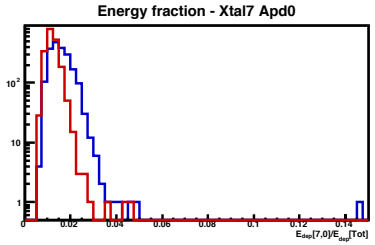


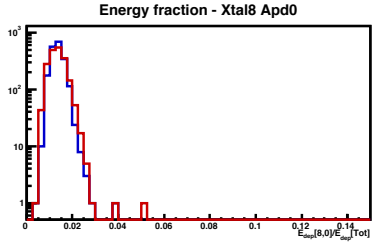


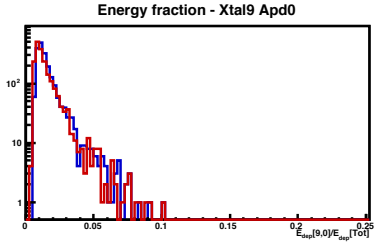


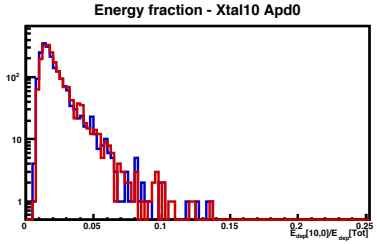


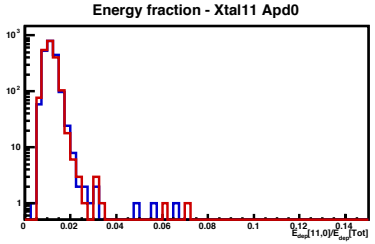


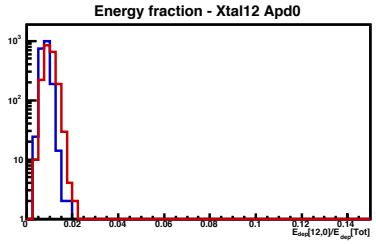


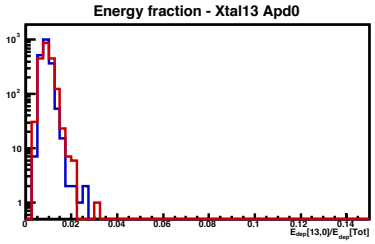


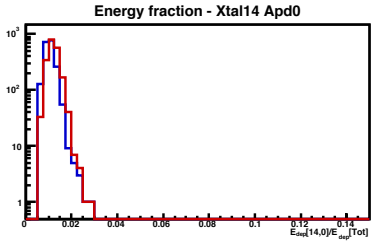


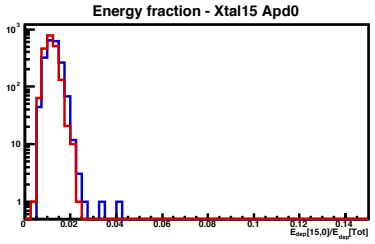




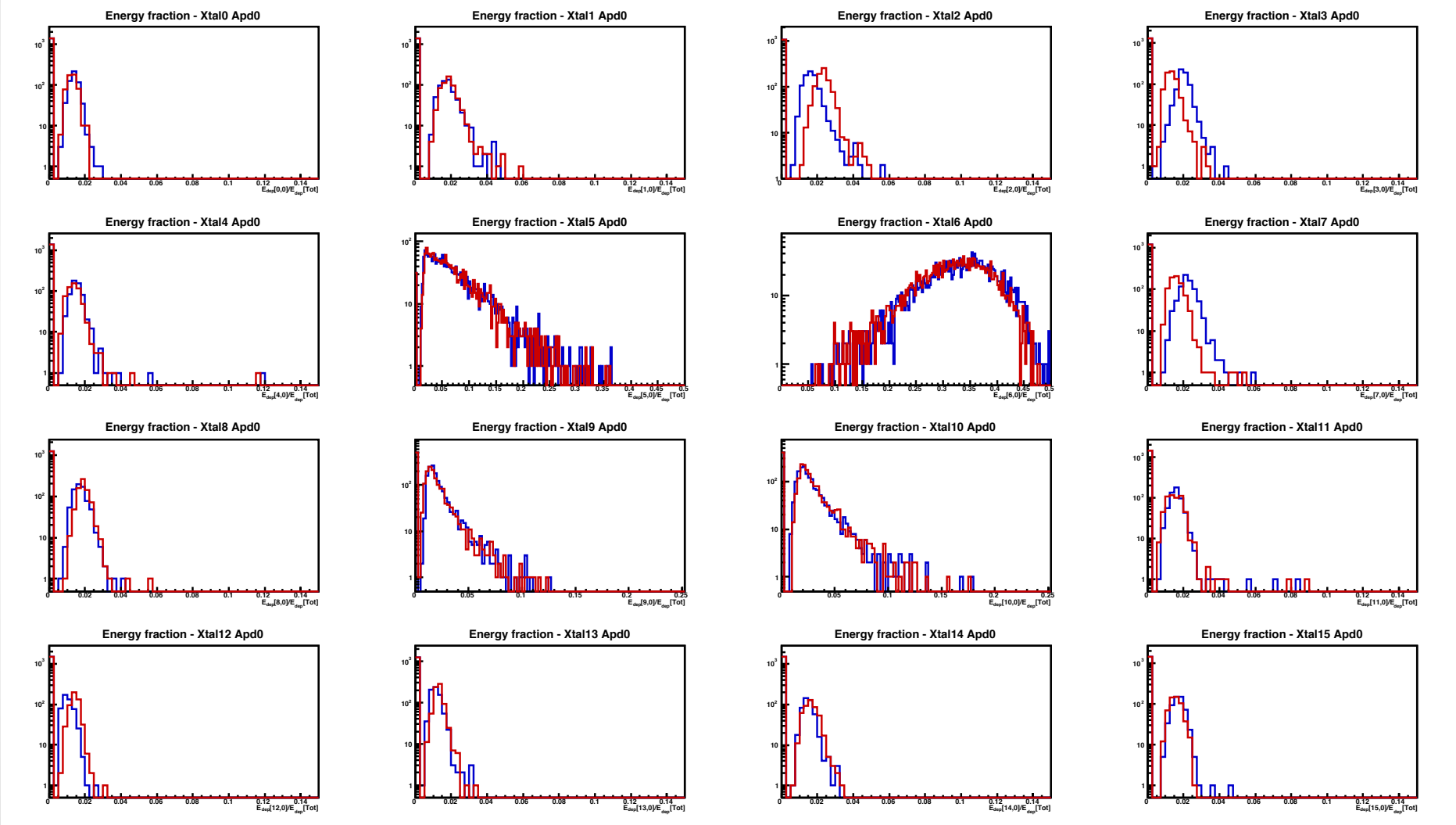




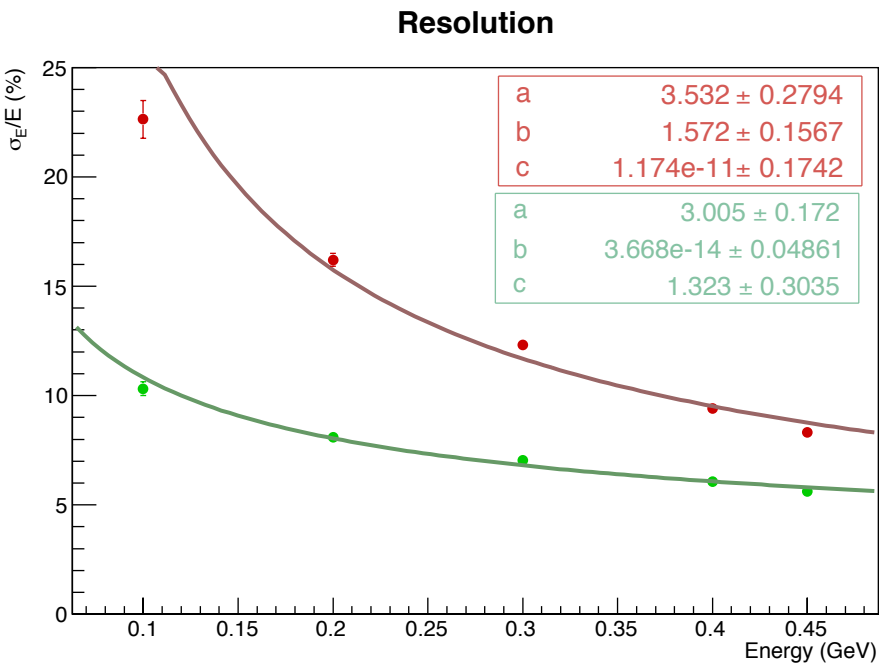




Energy Fraction 4xRMS



Resolution


Resolution
σ_E/E (%)
25
20
15
10
5
0
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Energy (GeV)
a 3.532 ± 0.2794
b 1.572 ± 0.1567
c 1.174e-11± 0.1742
a 3.005 ± 0.172
b 3.668e-14 ± 0.04861
c 1.323 ± 0.3035