

Dependence of energy resolution on width of the tile gaps

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Analysis setup

- Files used: mc21.singlePositron_*GeV_ECALP_run2.G4gun.SIM.se0003.root,
- Single positron hitting centre of the ECAL-P perpendicularly with energy from 2.5 to 15 GeV with 2.5GeV step, 20k events, 320 μ m silicon sensor,
- Plain silicon layer in MC $\rightarrow$ structure of sensors and pads implemented in the analysis,
- Default position of the gun is such that positron hits in the middle of the gap (dead area) between 3rd and 4th sensor,

Analysis setup

- Position of the gun with respect to the centre of the ECAL-P layer is parameterized by offset/gun_position parameter (by shifting the sensor and pad borders),
- Adjusting width of the tile gap by changing the size of sensor pitch
 - Sensor pitch: 90mmx90mm
 - Sensor size: 89.7mmx89.7mm
 - Sensor size (active):
88.48mmx88.48mm

Analysis setup

- Deposited energy was measured for different offsets and widths of the tile gap:
 - 1.22mm: no spacing between sensors,
 - 1.52mm: nominal gap, 0.3mm spacing between sensors
 - 1.82mm and 2.02mm: bigger gap between sensors
- Tungsten parameters:
 - Thickness: $1X_0=3.5\text{mm}$
 - Moliere radius: $R_M=9.33\text{mm}$

Transverse profile of the cascade

- Even for small gap comparing to Moliere radius fraction of lost energy is significant
- The core of the cascade is very narrow
- For cylinder with radius $0.1R_M$, 35% of the energy is inside this cylinder

Picture from Phys.
Rev. 149,201 (1966)

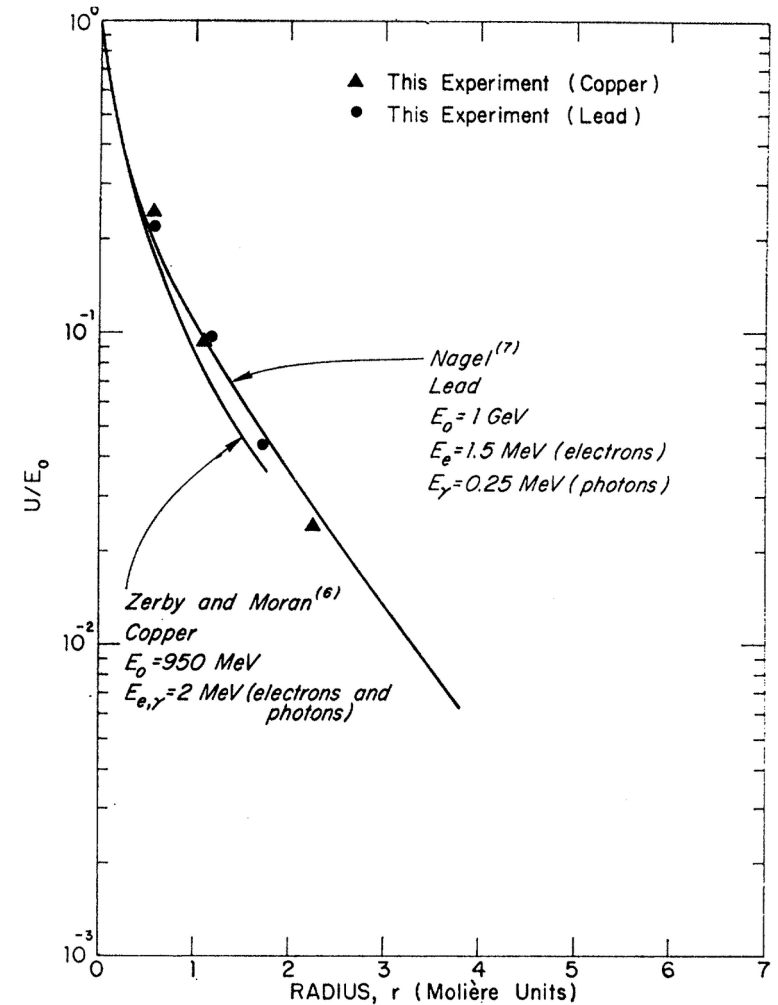
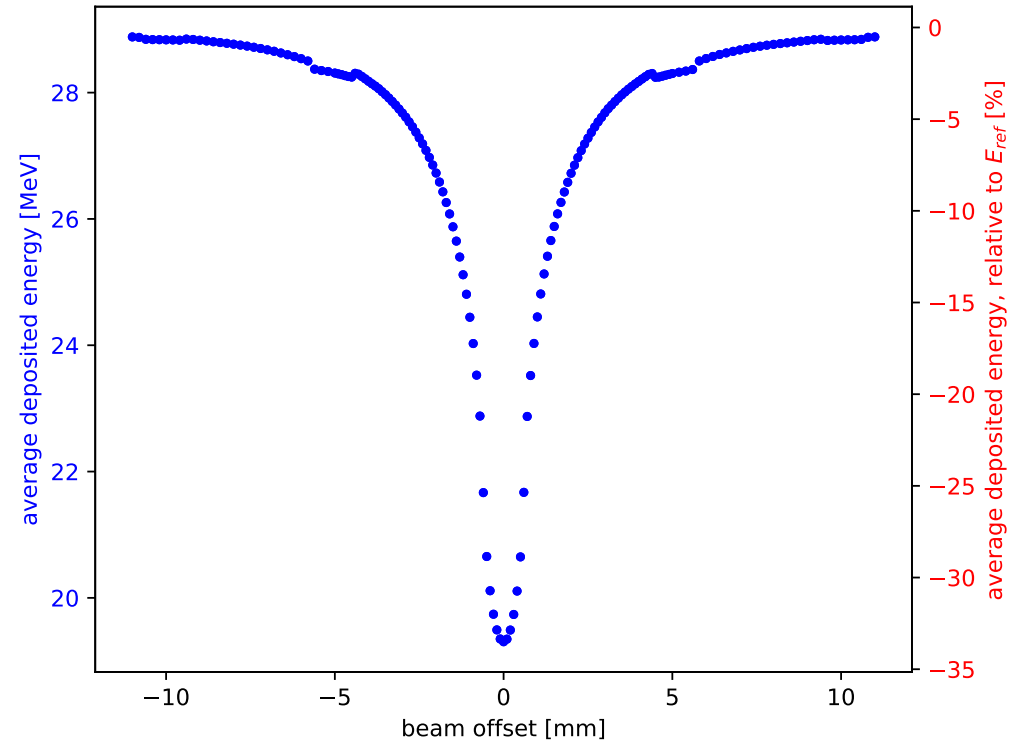
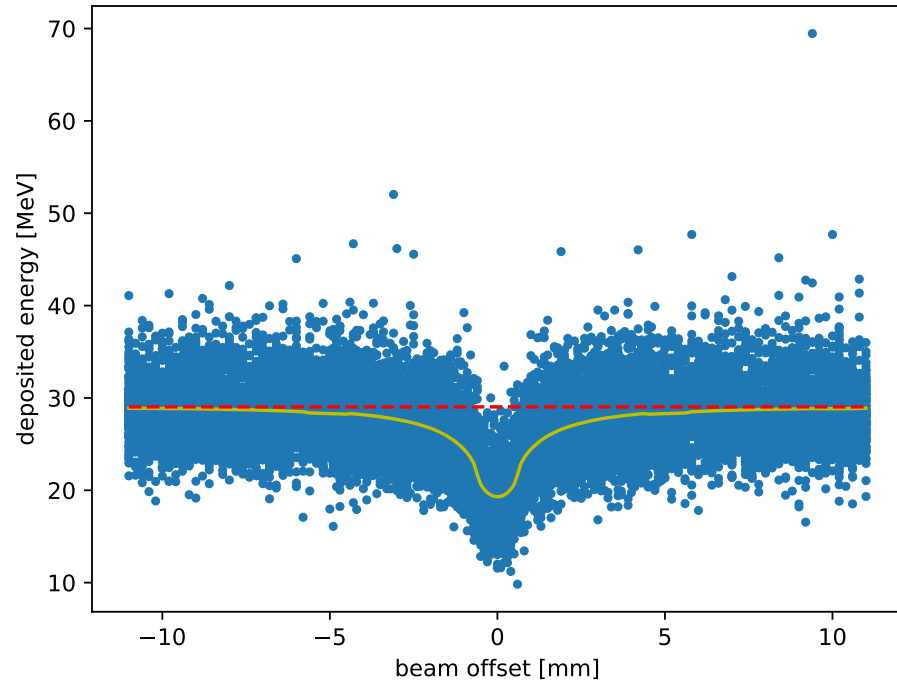


FIG. 12. Fraction of the incident energy that escapes various cylindrical volumes. A comparison of this experiment with Monte Carlo calculations.

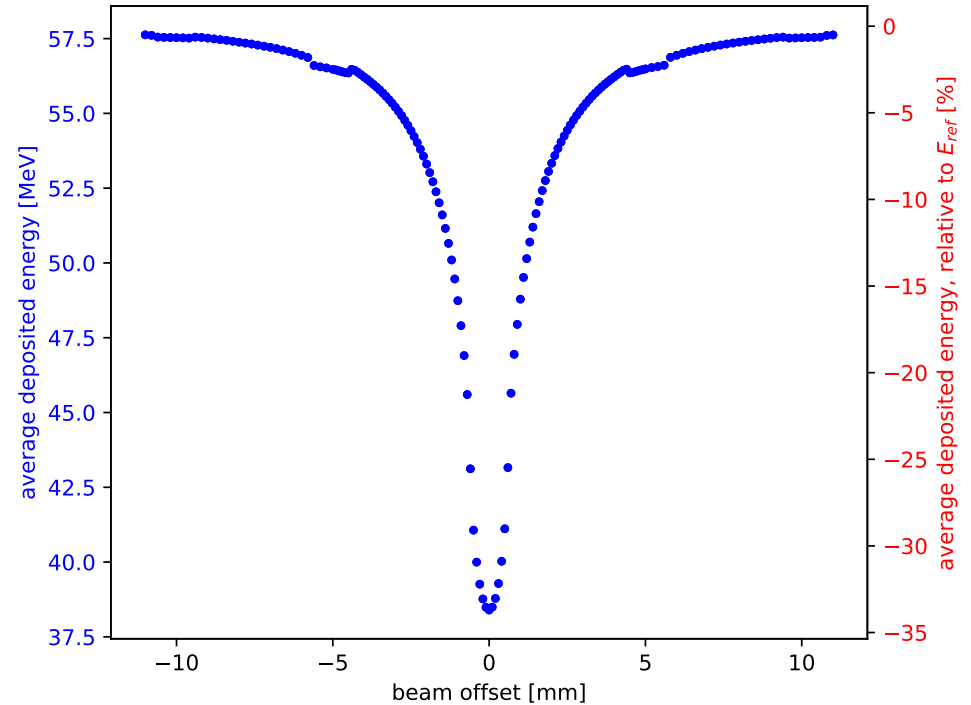
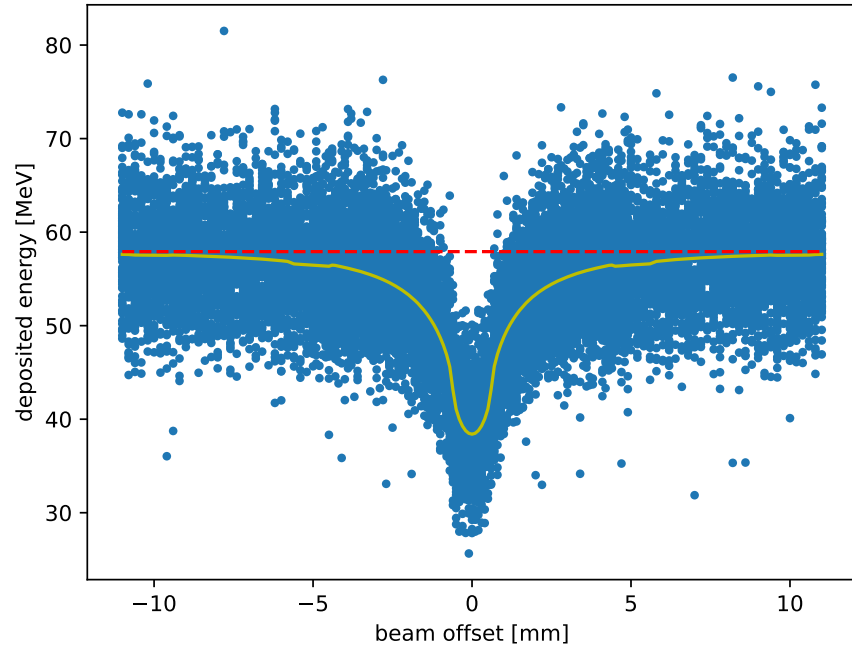
Results for 1.22mm gap gun position vs deposited energy

Random 100 deposited energies for different beam offsets, 2.5GeV



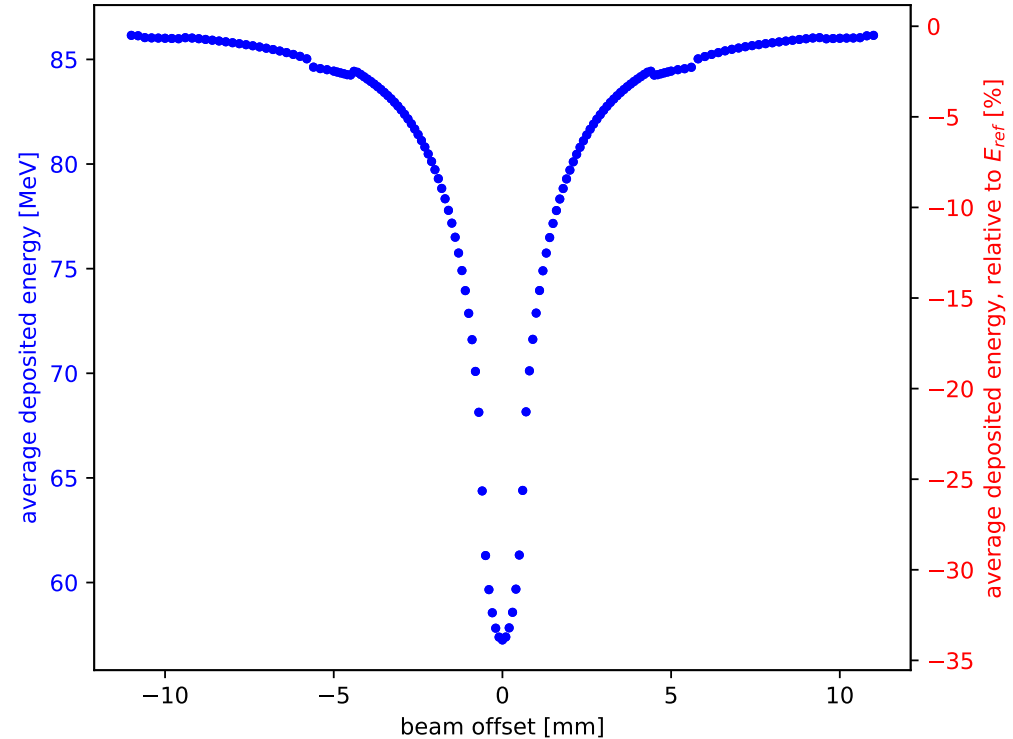
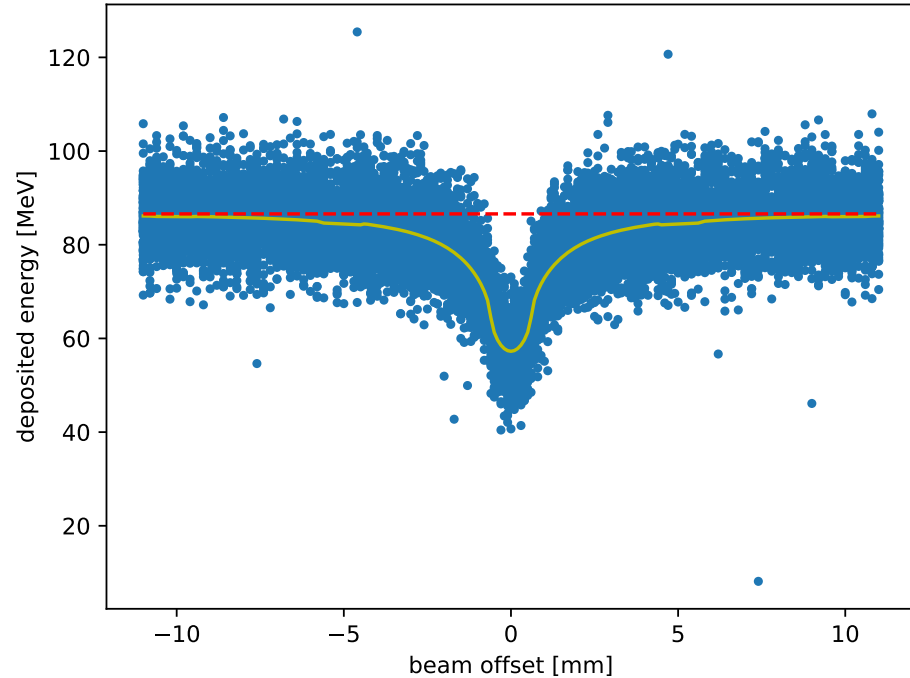
Results for 1.22mm gap gun position vs deposited energy

Random 100 deposited energies for different beam offsets, 5GeV

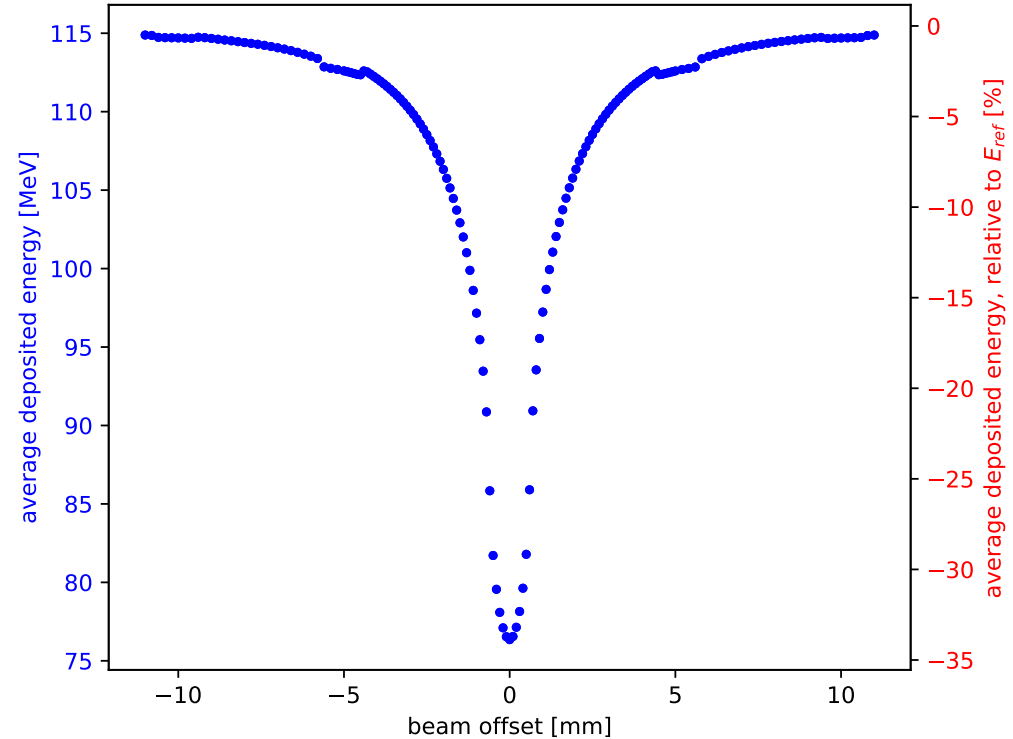
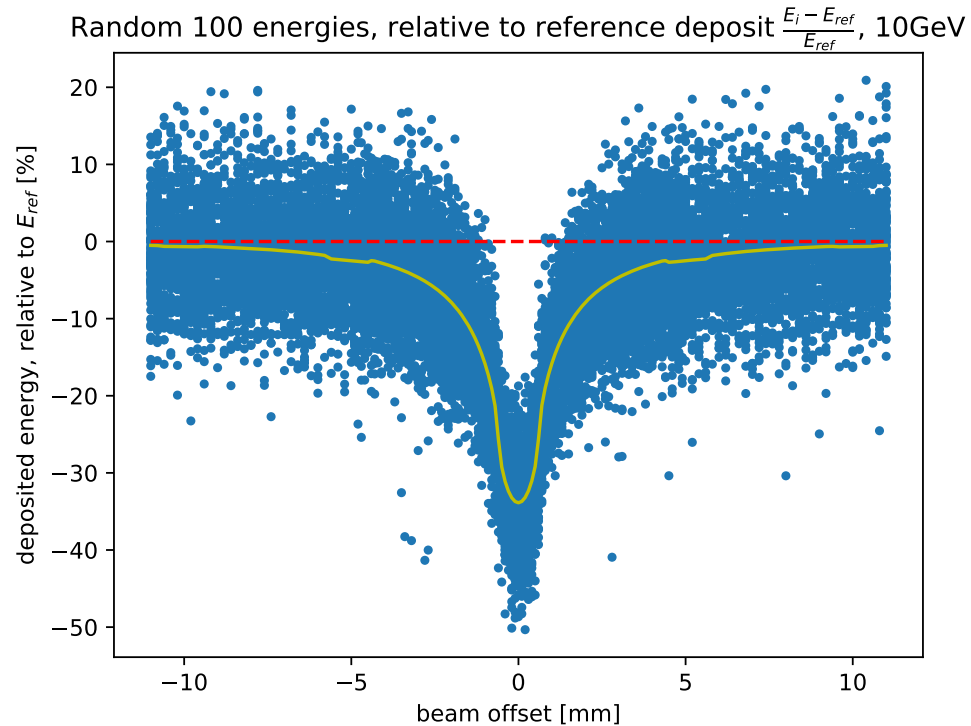


Results for 1.22mm gap gun position vs deposited energy

Random 100 deposited energies for different beam offsets, 7.5GeV

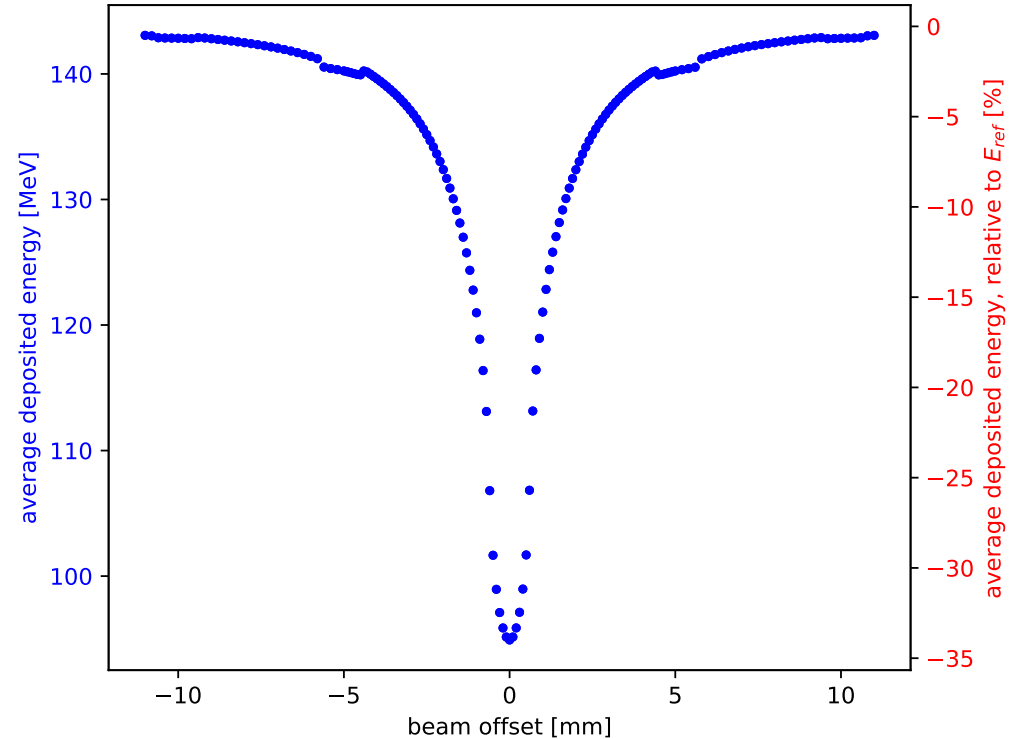
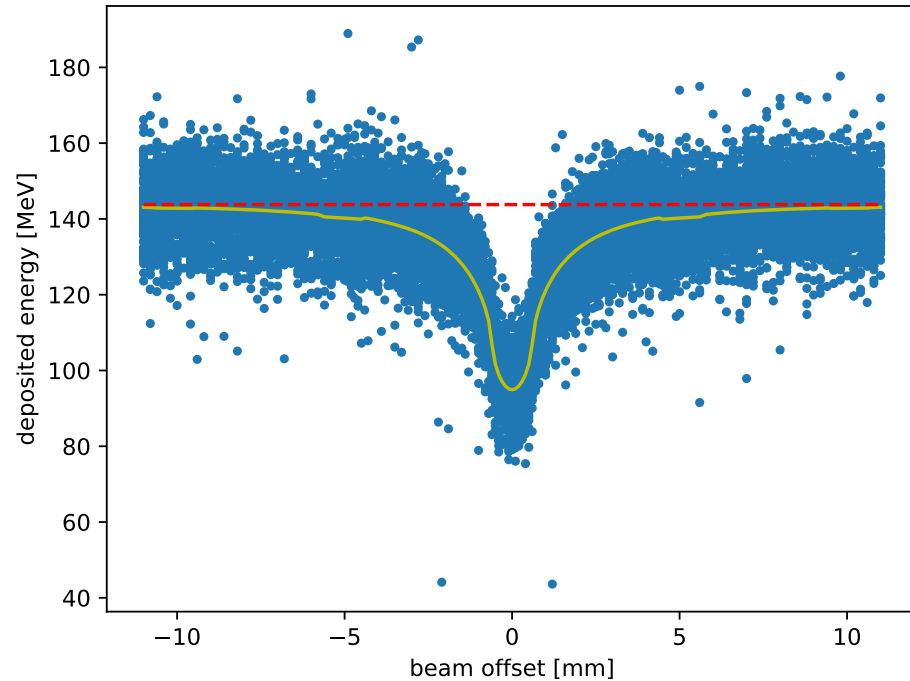


Results for 1.22mm gap gun position vs deposited energy



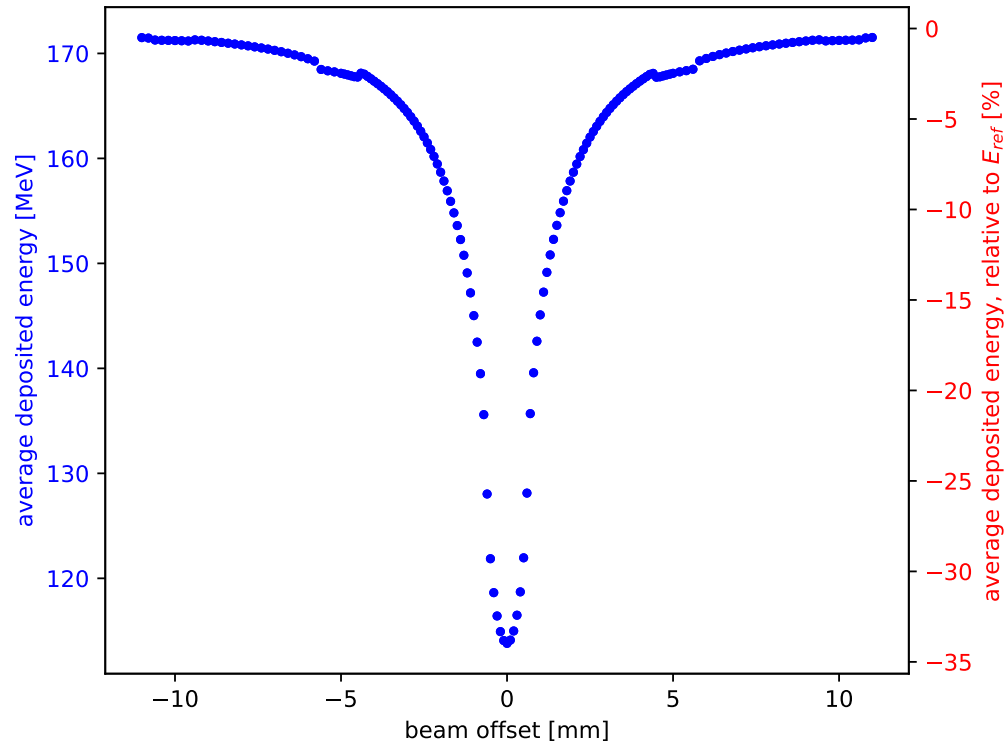
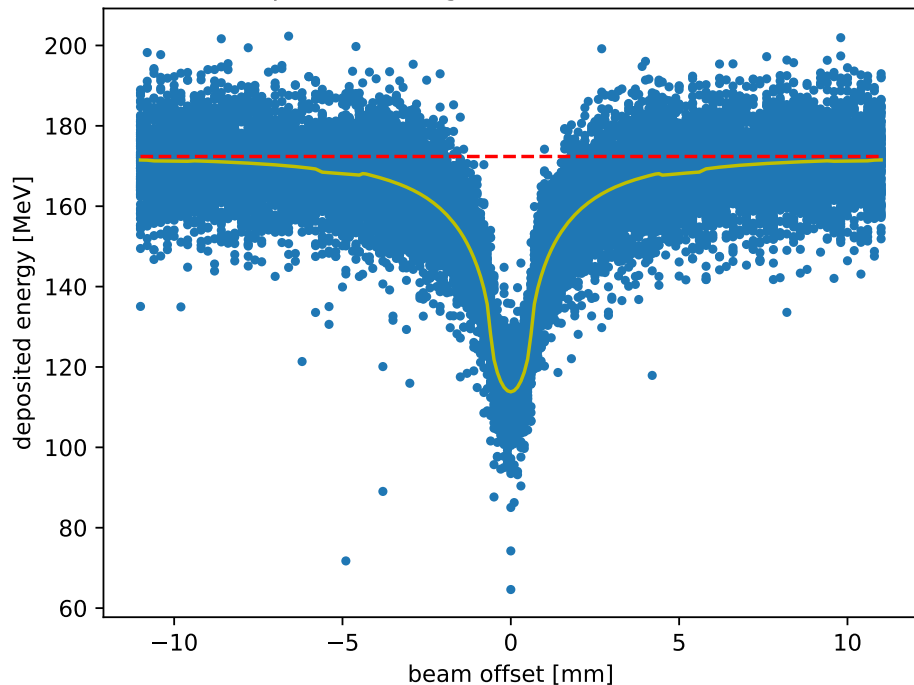
Results for 1.22mm gap gun position vs deposited energy

Random 100 deposited energies for different beam offsets, 12.5GeV



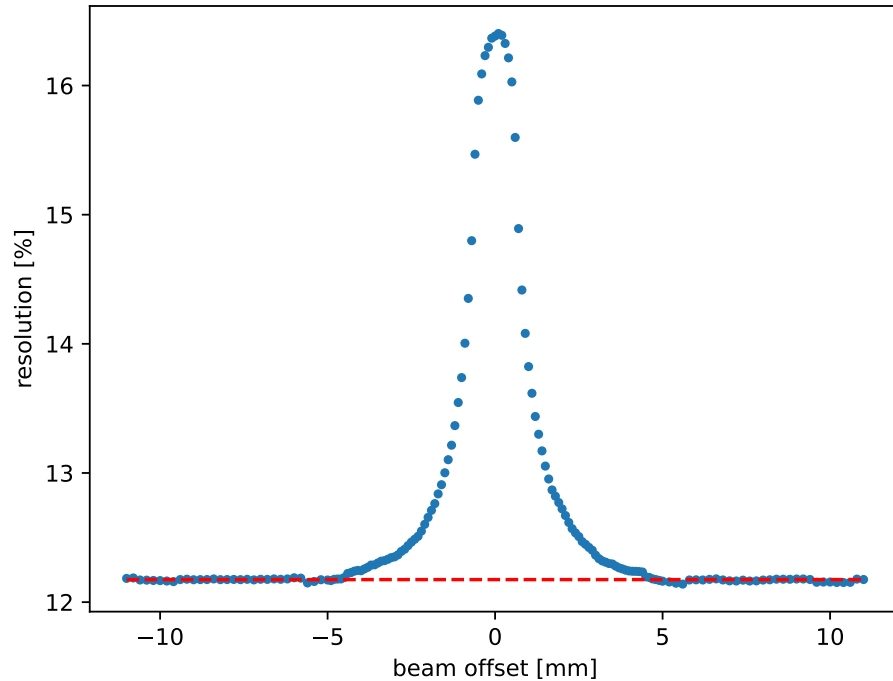
Results for 1.22mm gap gun position vs deposited energy

Random 100 deposited energies for different beam offsets, 15GeV

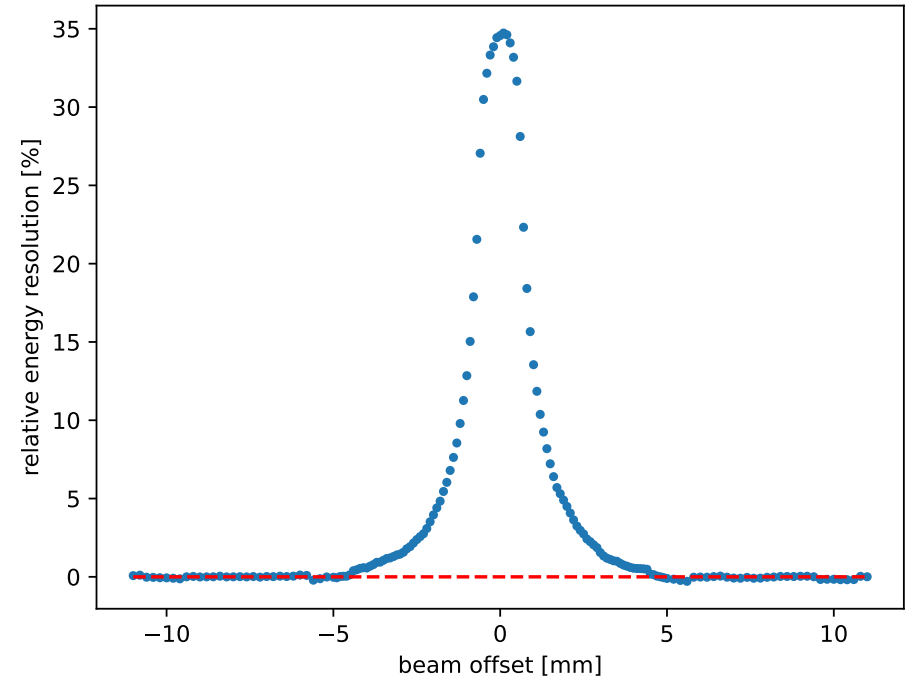


Results for 1.22mm gap gun position vs resolution

Energy resolution for different beam offsets, 2.5GeV



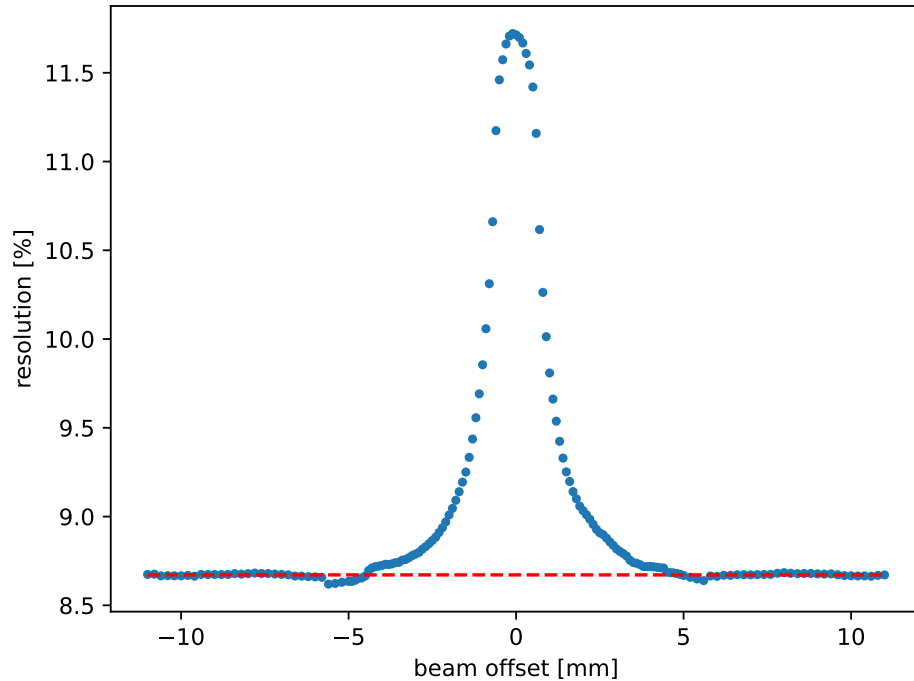
Energy resolution, relative to reference resolution, 2.5GeV



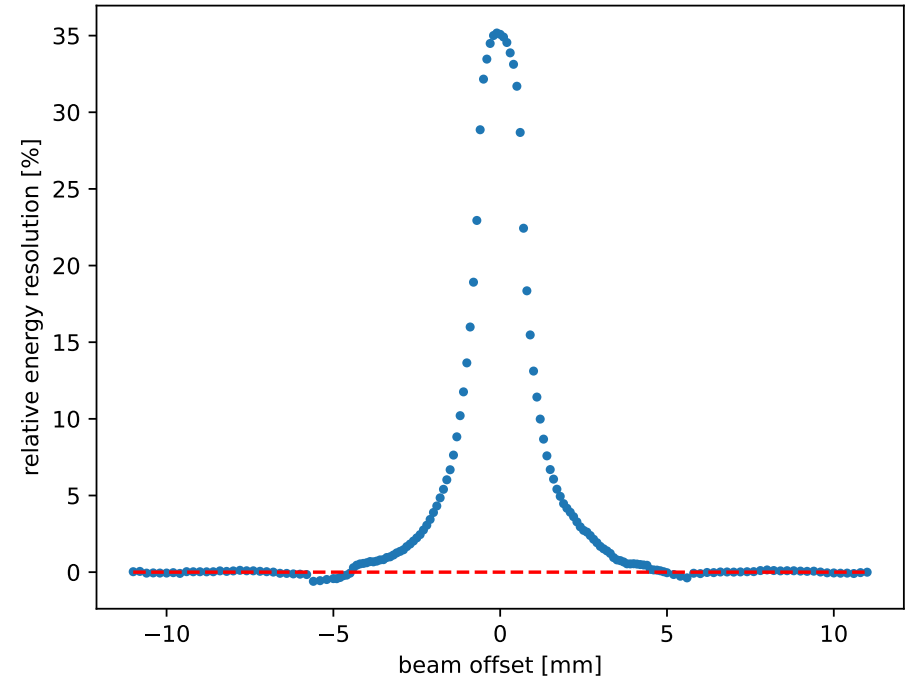
Results for 1.22mm gap

gun position vs resolution

Energy resolution for different beam offsets, 5GeV

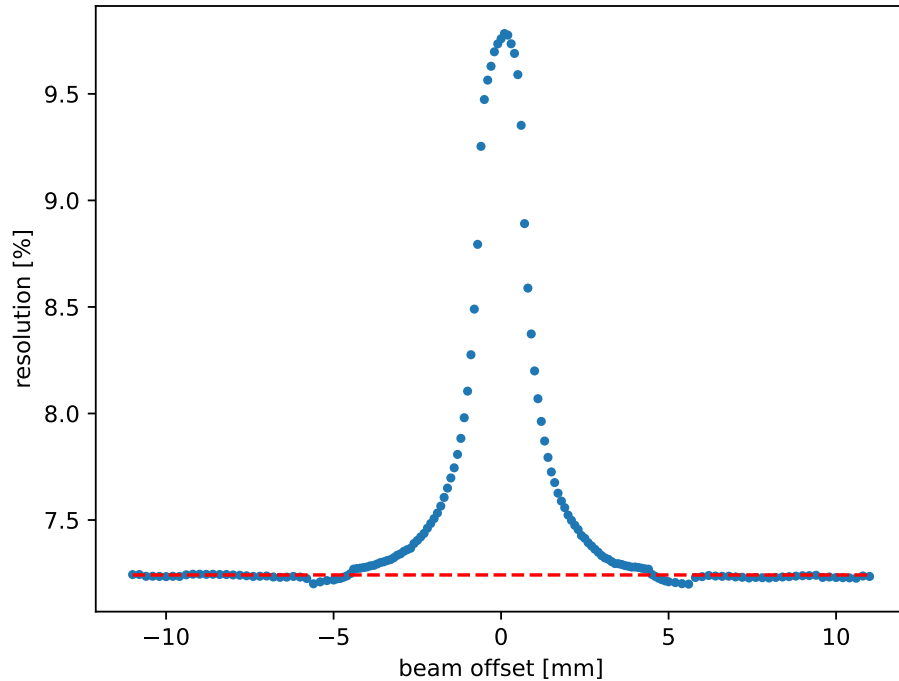


Energy resolution, relative to reference resolution, 5GeV

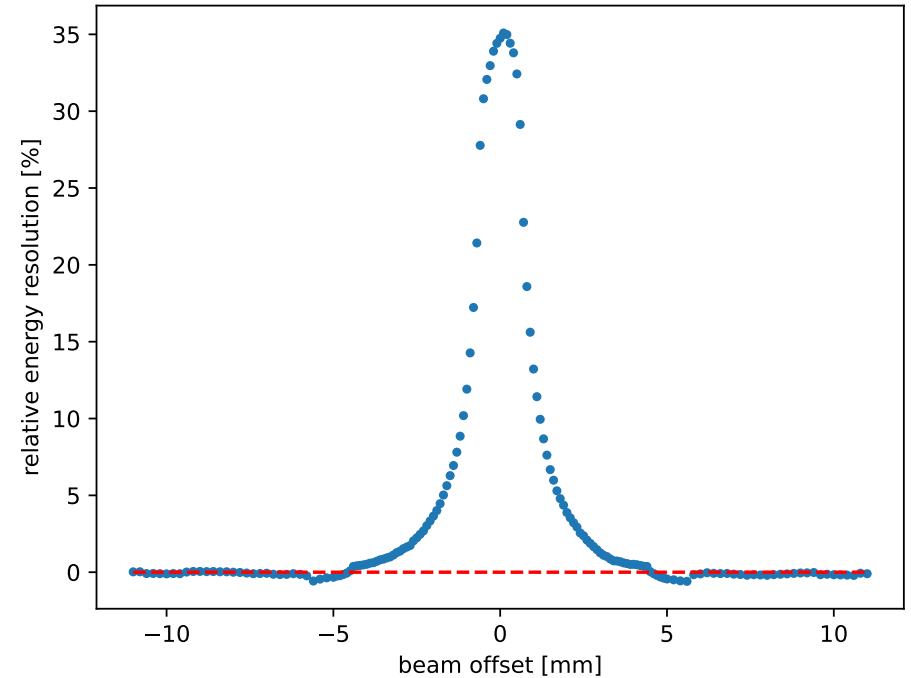


Results for 1.22mm gap gun position vs resolution

Energy resolution for different beam offsets, 7.5GeV

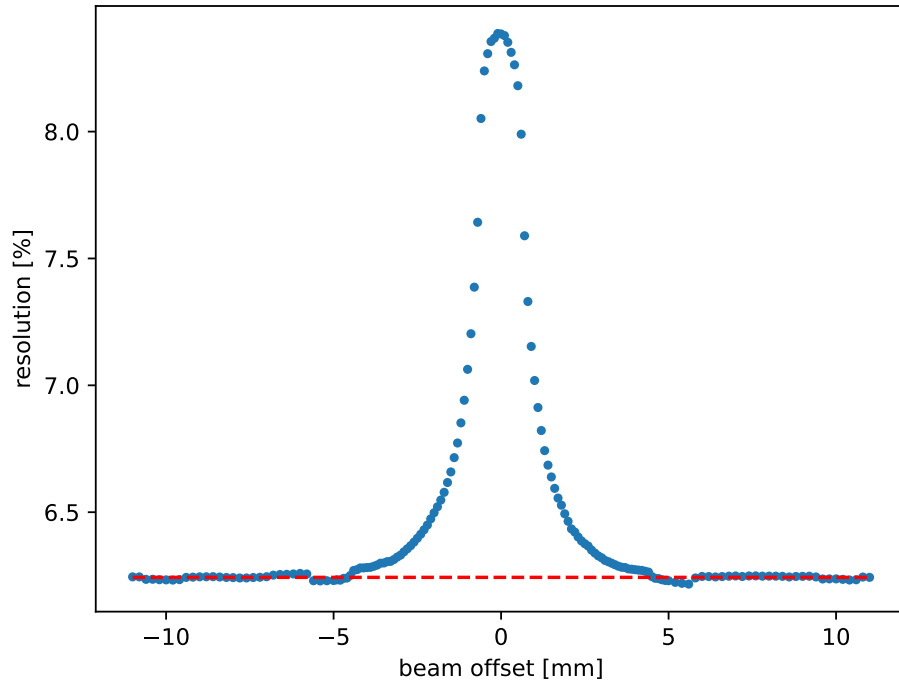


Energy resolution, relative to reference resolution, 7.5GeV

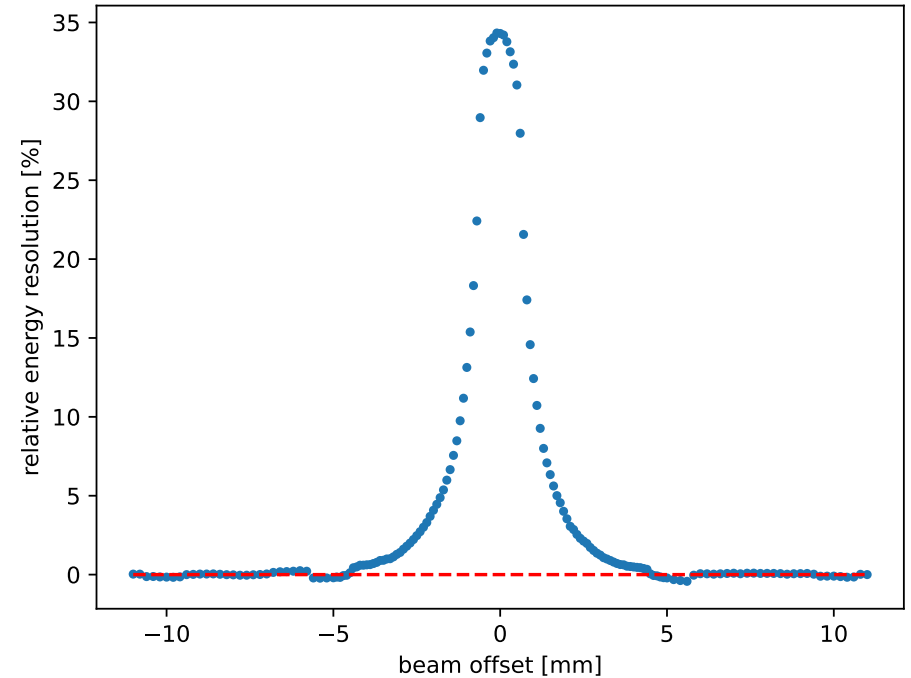


Results for 1.22mm gap gun position vs resolution

Energy resolution for different beam offsets, 10GeV

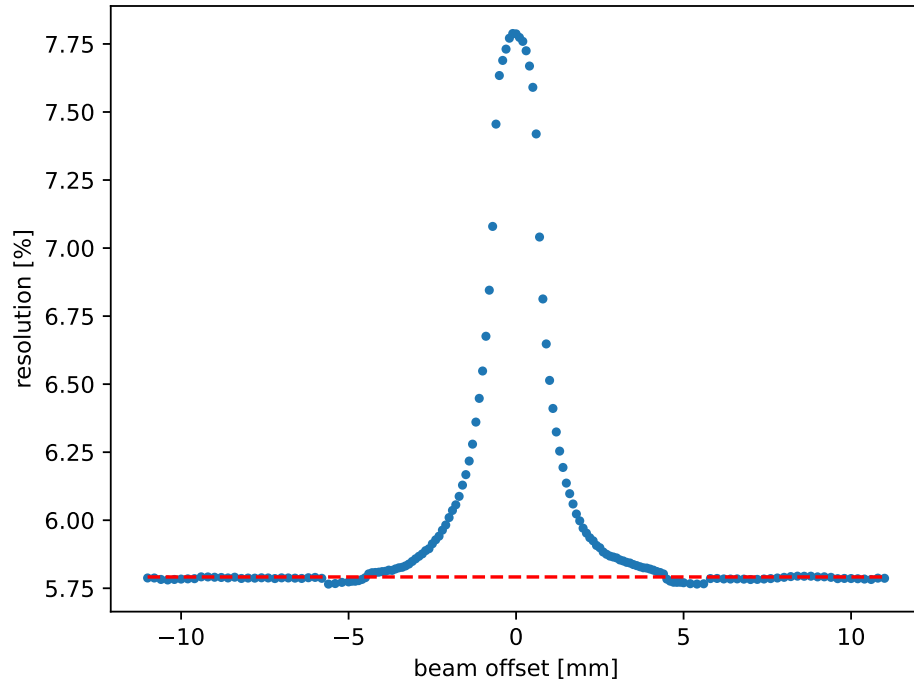


Energy resolution, relative to reference resolution, 10GeV

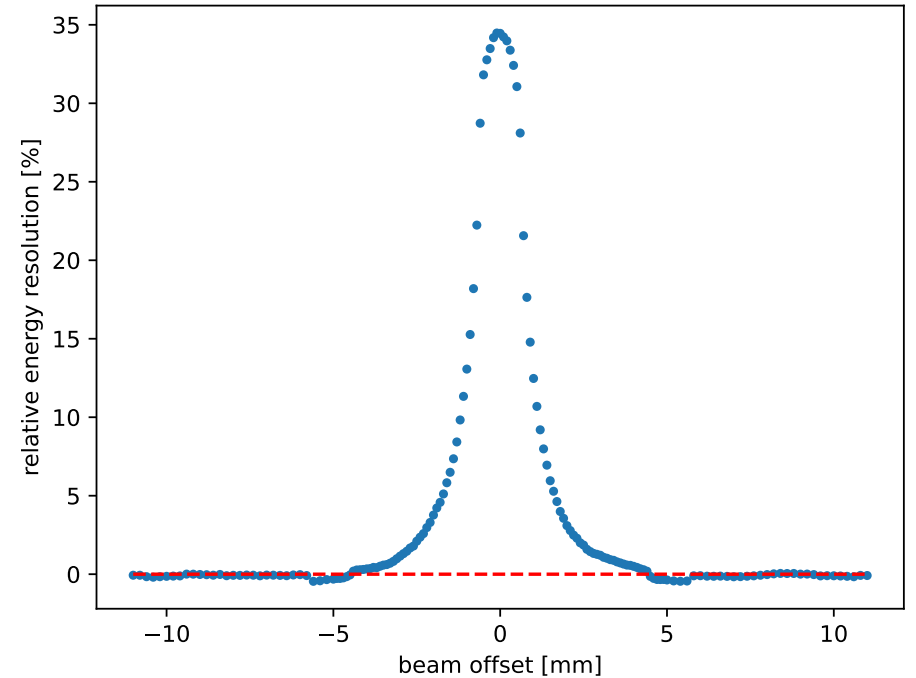


Results for 1.22mm gap gun position vs resolution

Energy resolution for different beam offsets, 12.5GeV

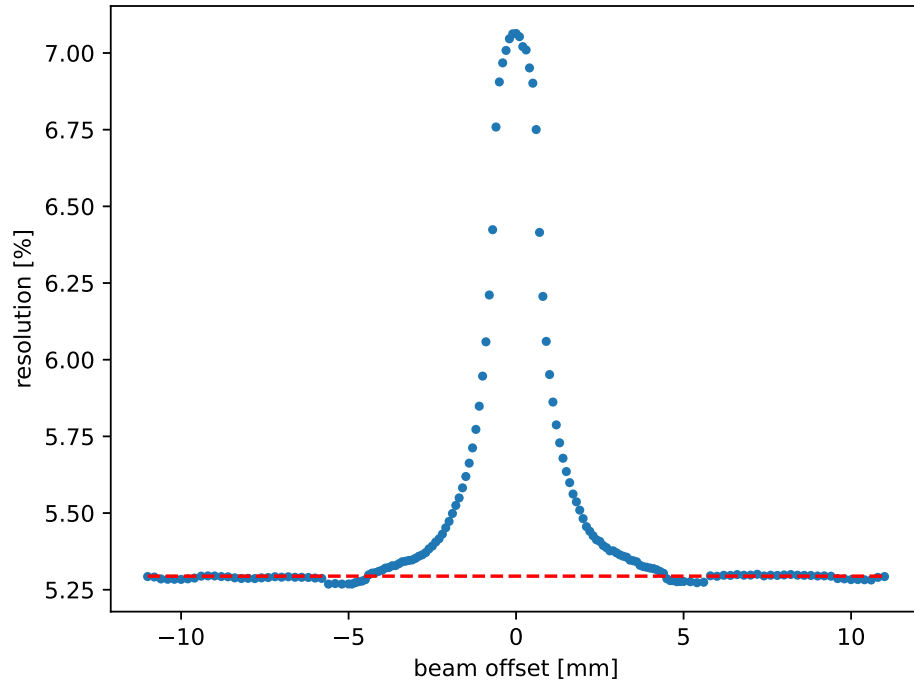


Energy resolution, relative to reference resolution, 12.5GeV

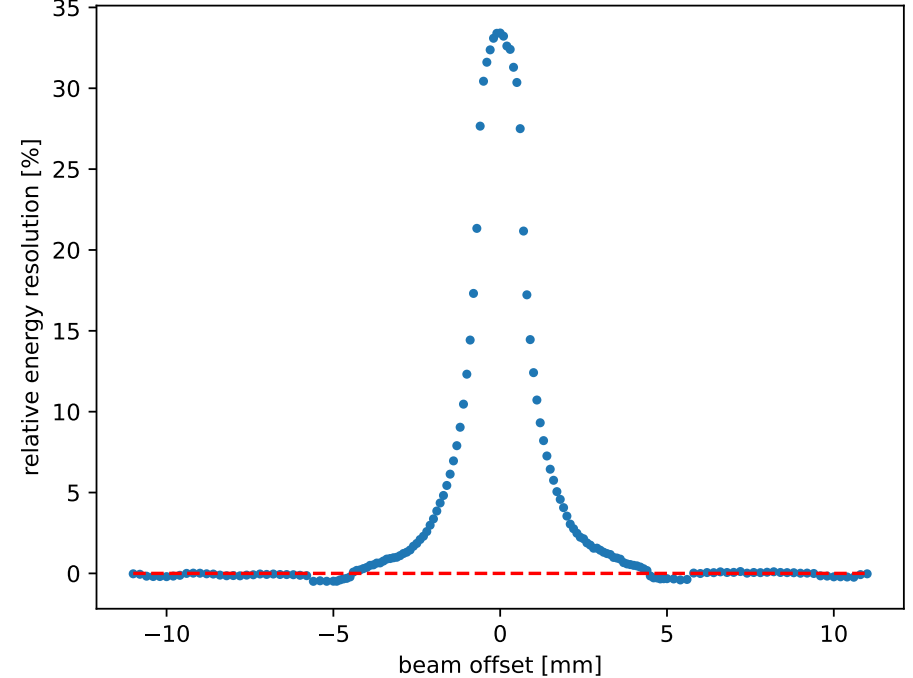


Results for 1.22mm gap gun position vs resolution

Energy resolution for different beam offsets, 15GeV

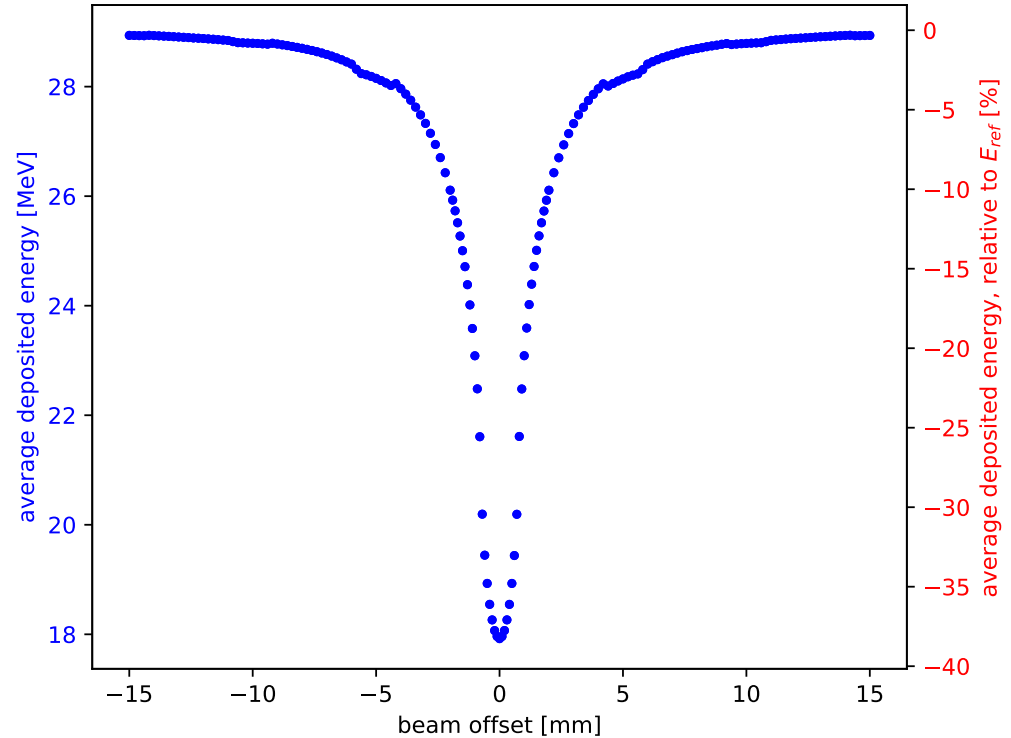
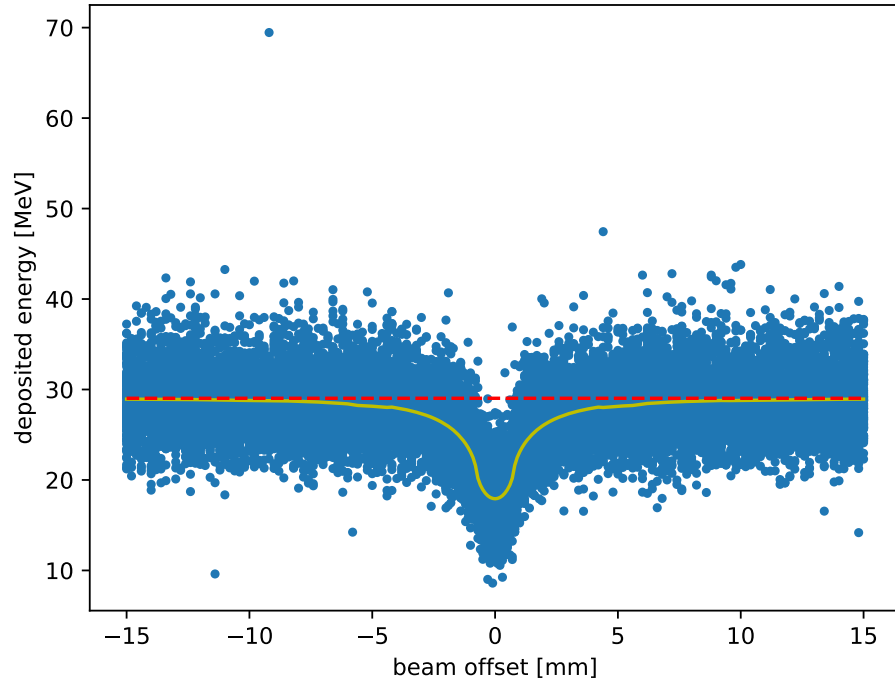


Energy resolution, relative to reference resolution, 15GeV



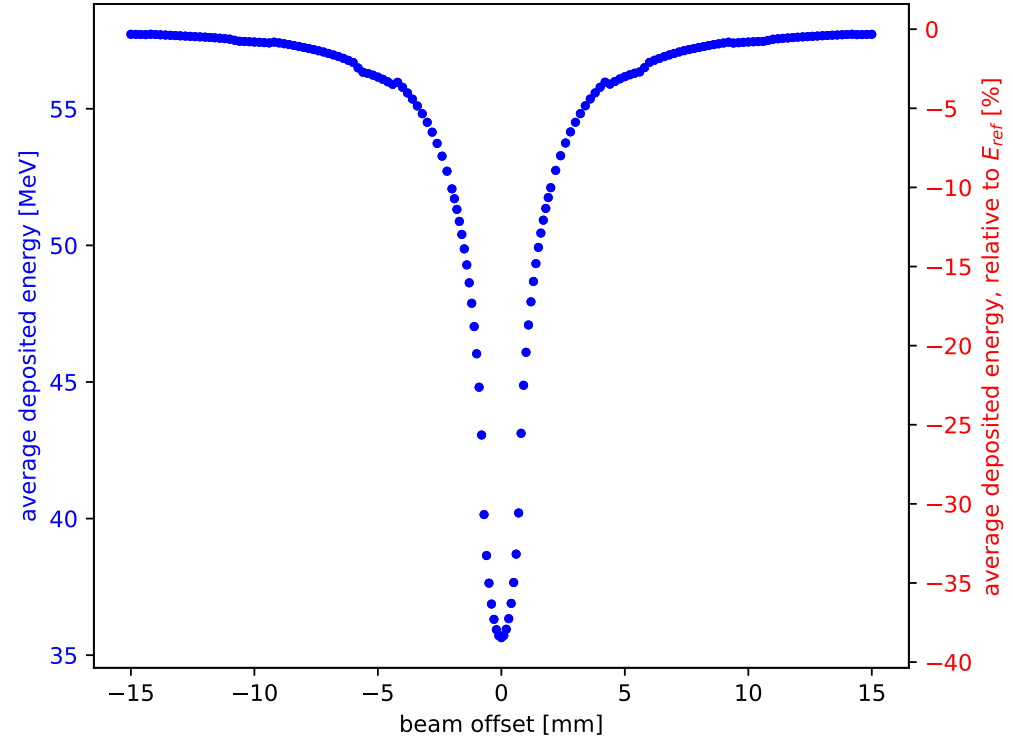
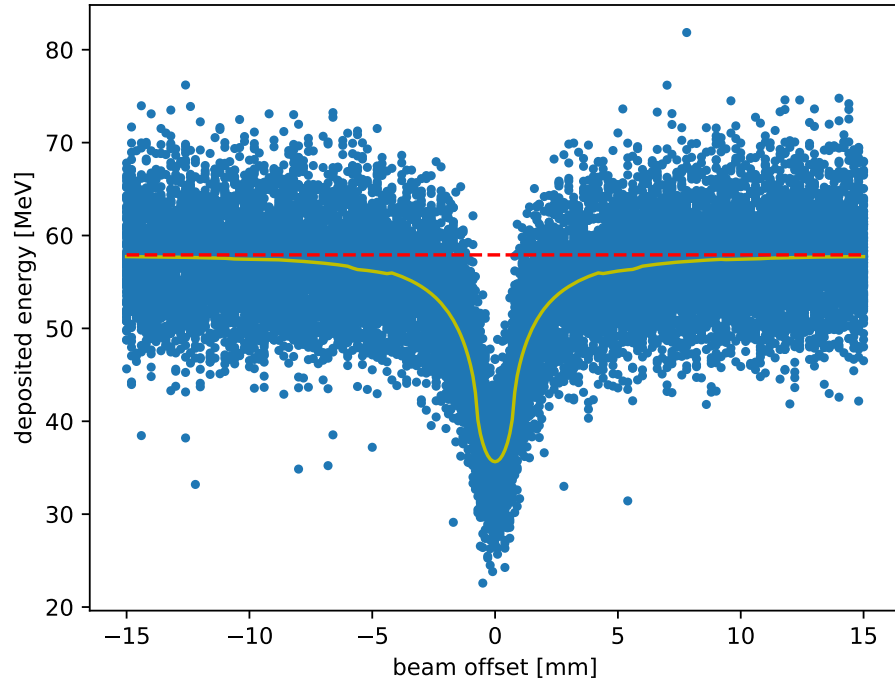
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 2.5GeV



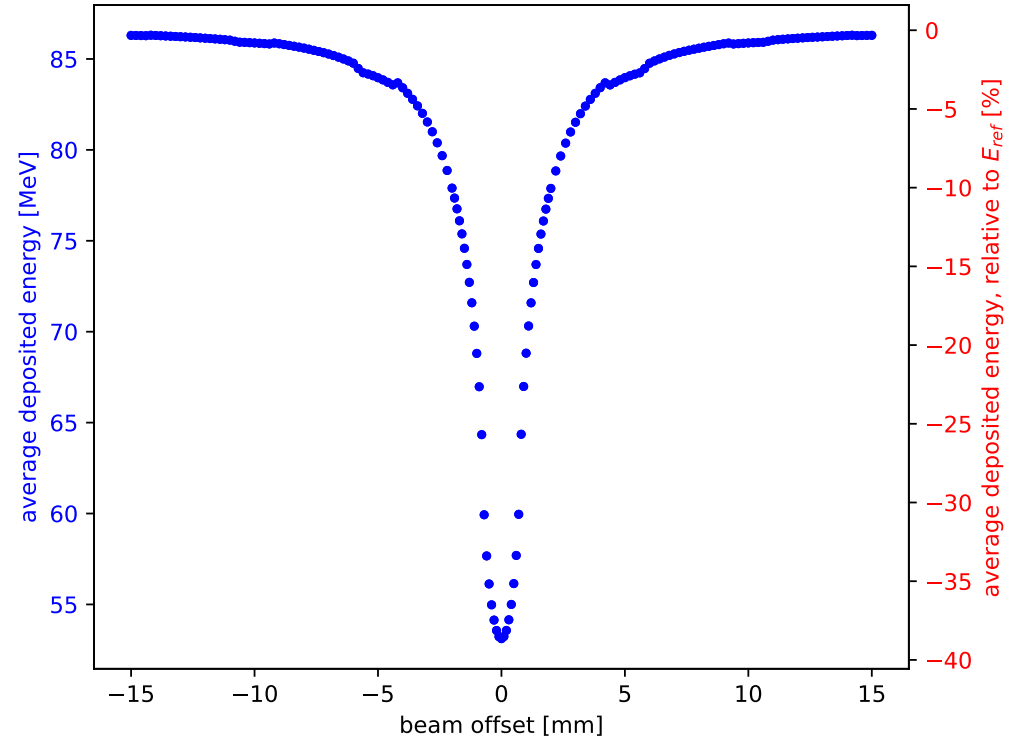
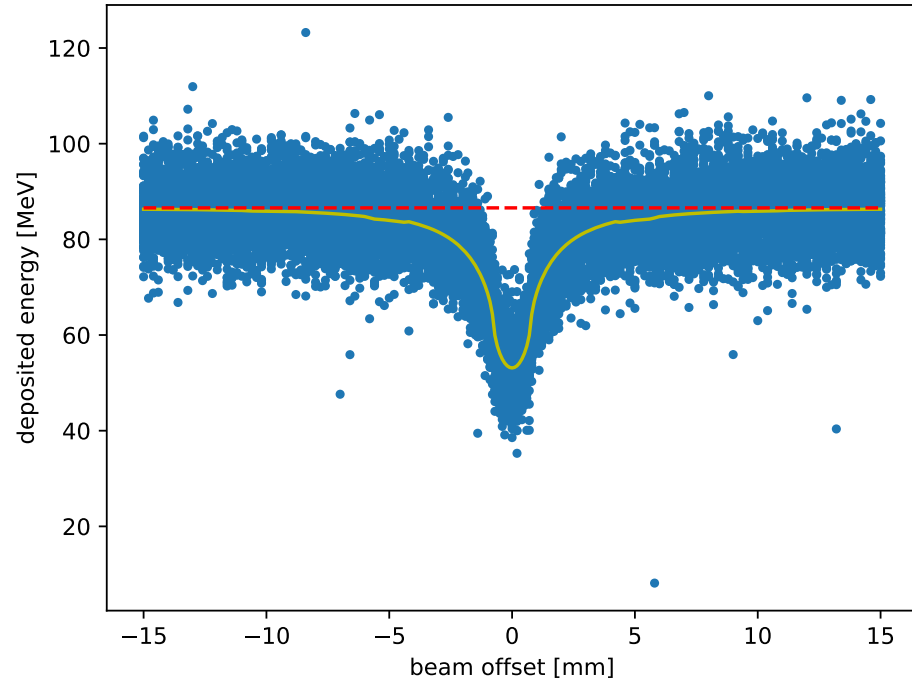
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 5GeV



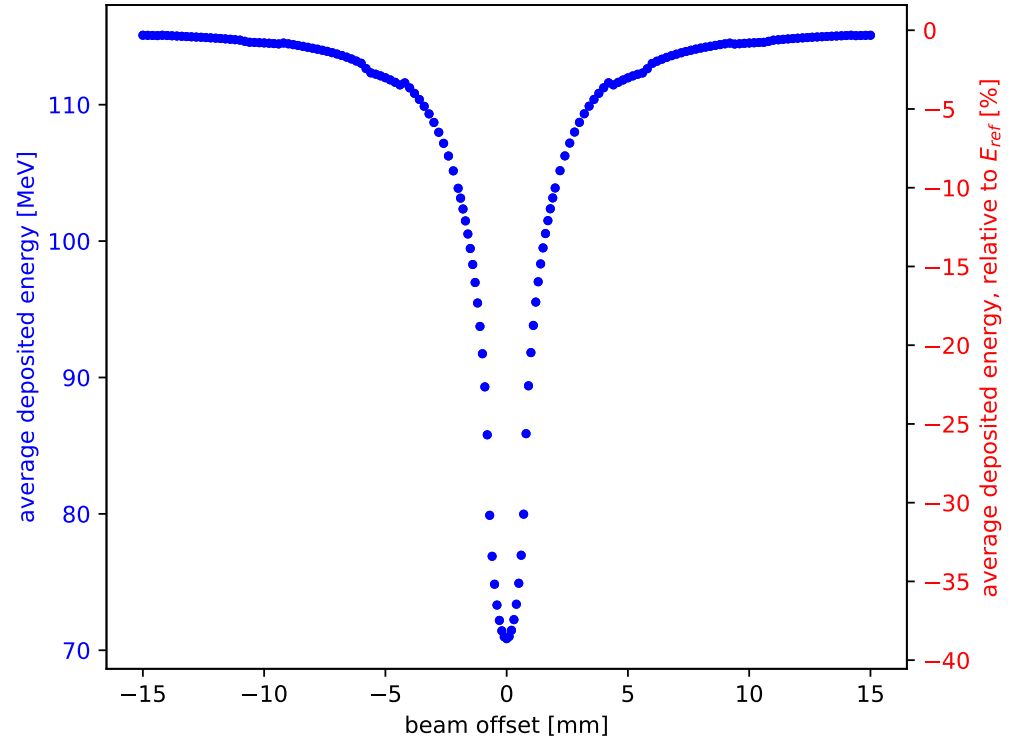
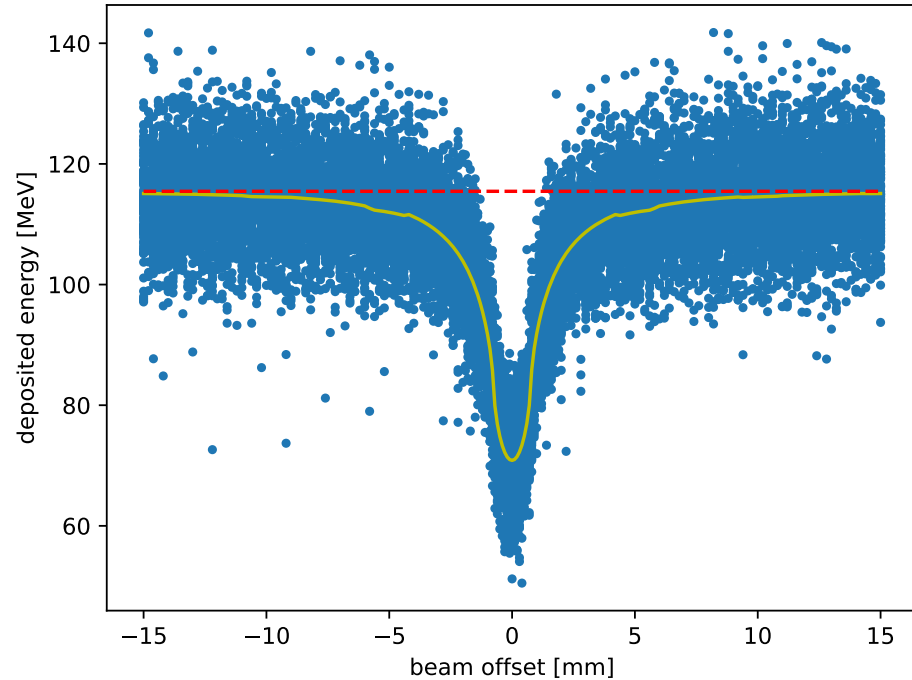
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 7.5GeV



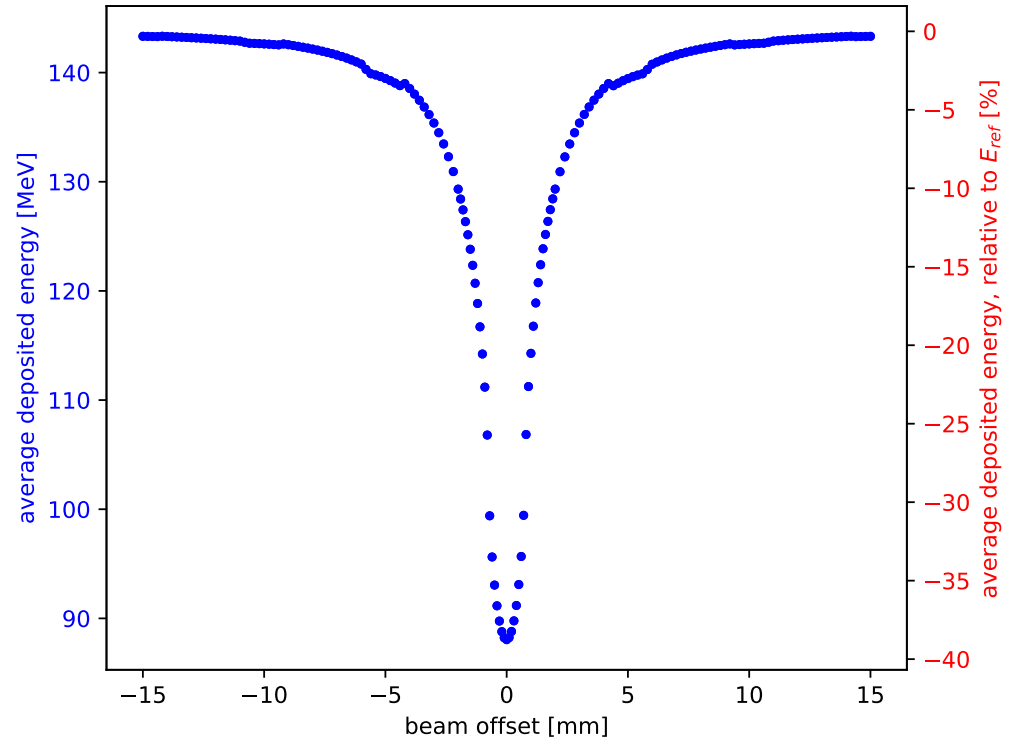
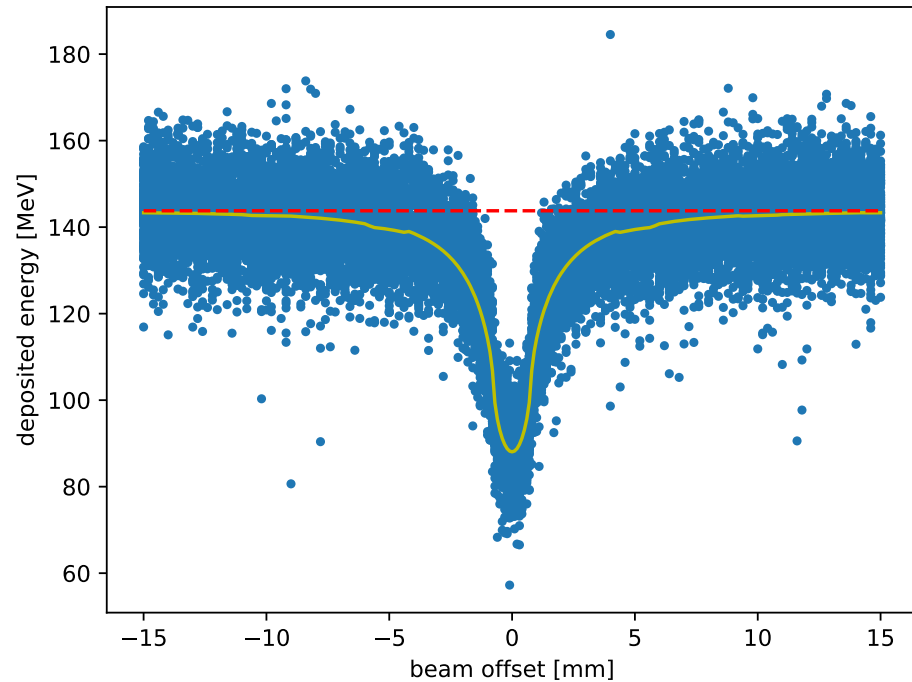
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 10GeV



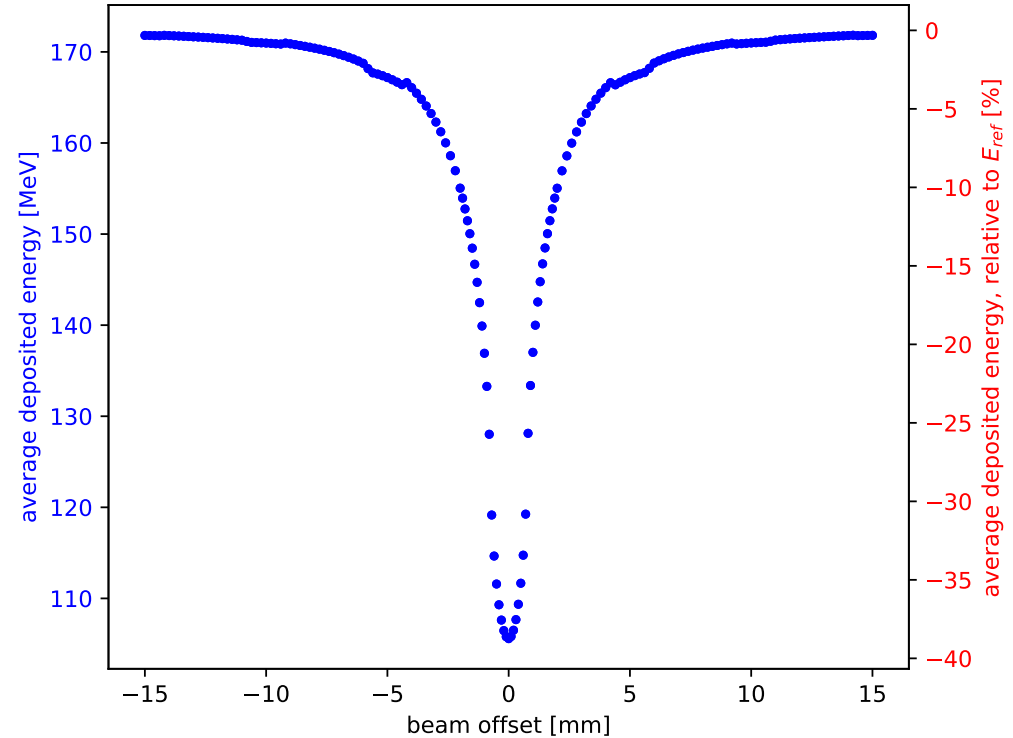
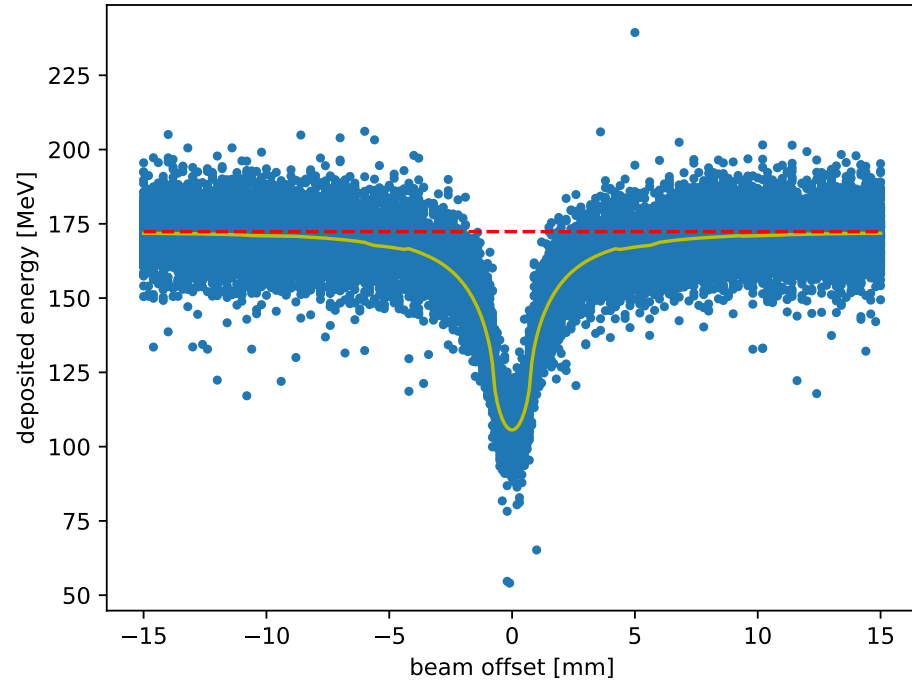
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 12.5GeV



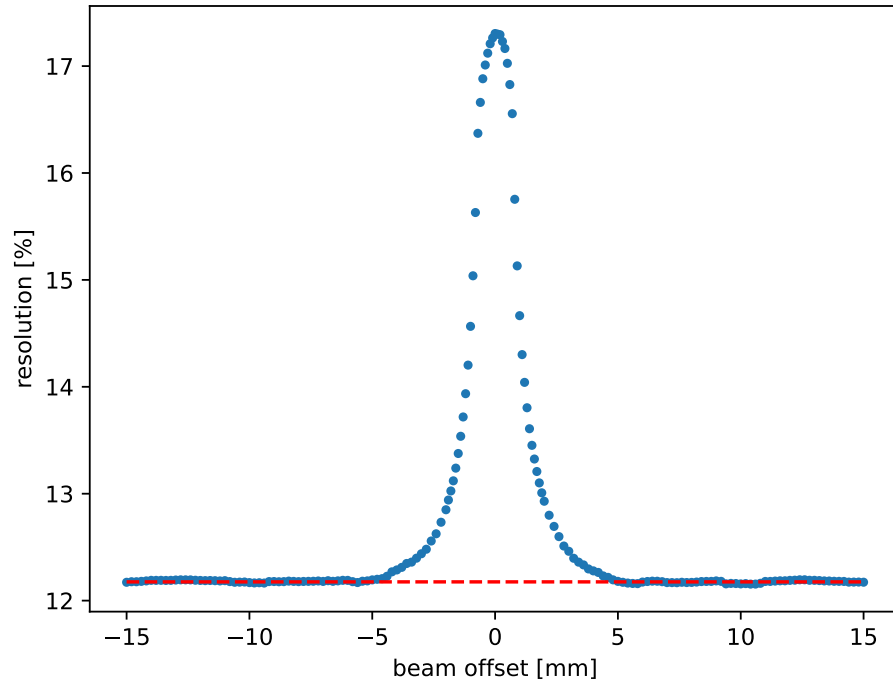
Results for 1.52mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 15GeV

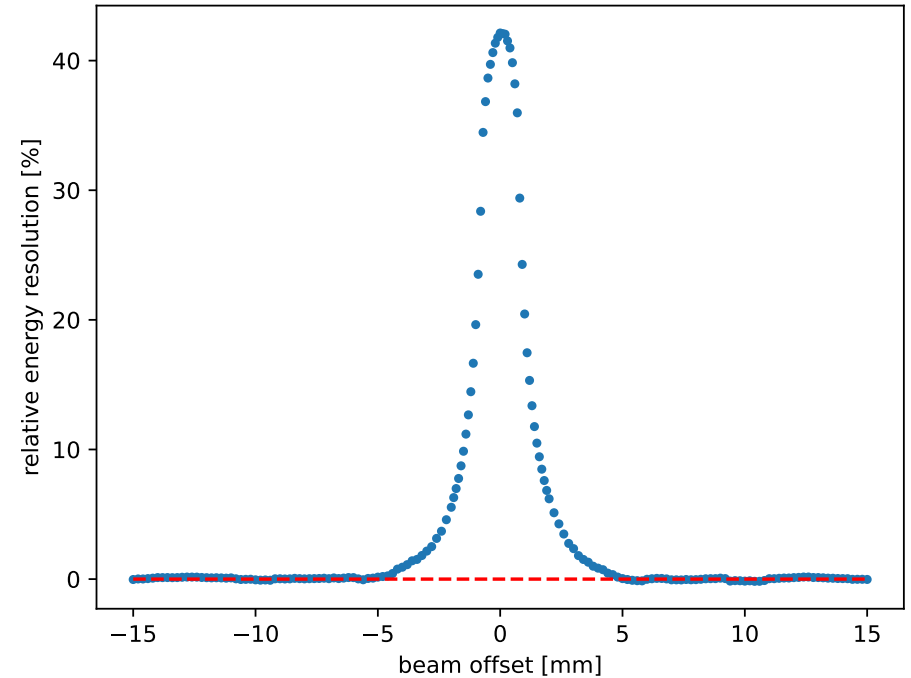


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 2.5GeV

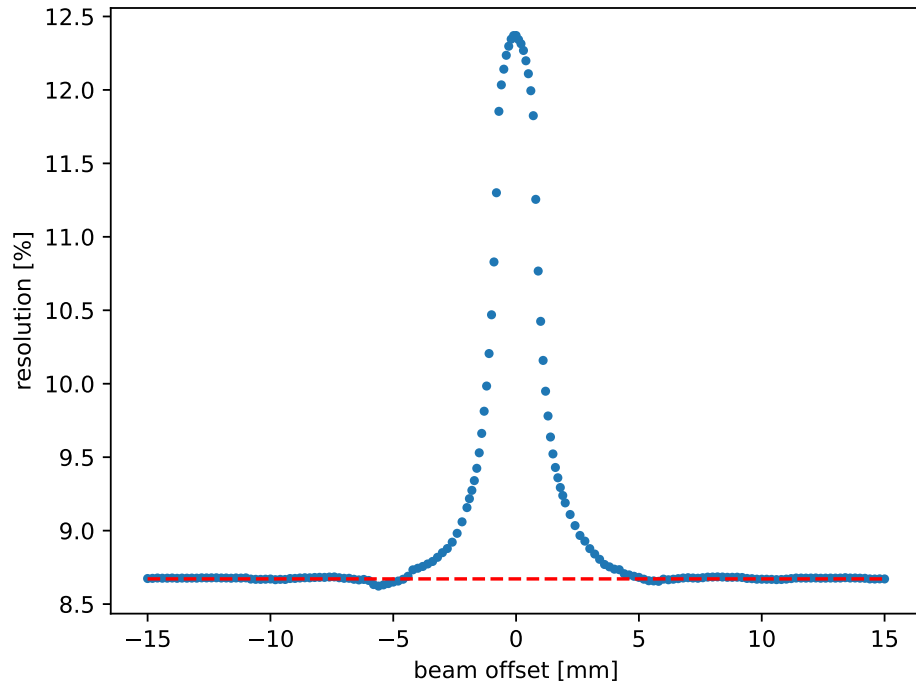


Energy resolution, relative to reference resolution, 2.5GeV

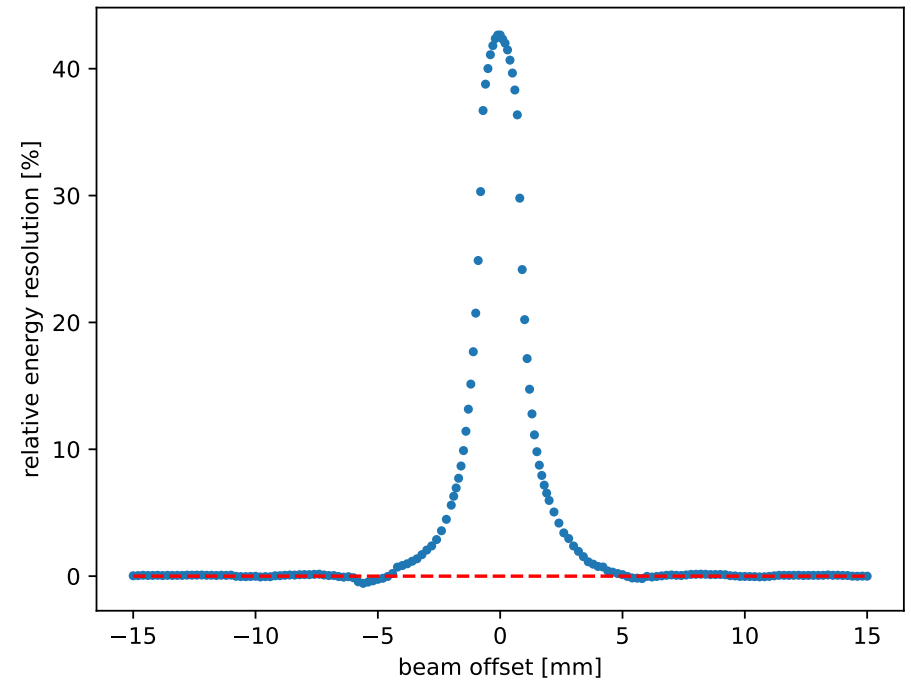


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 5GeV

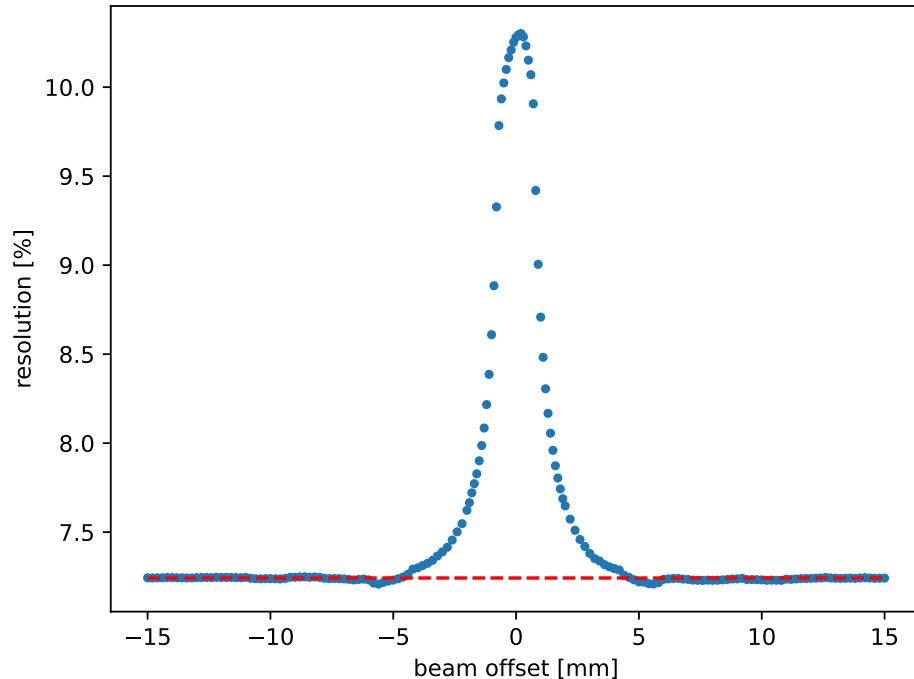


Energy resolution, relative to reference resolution, 5GeV

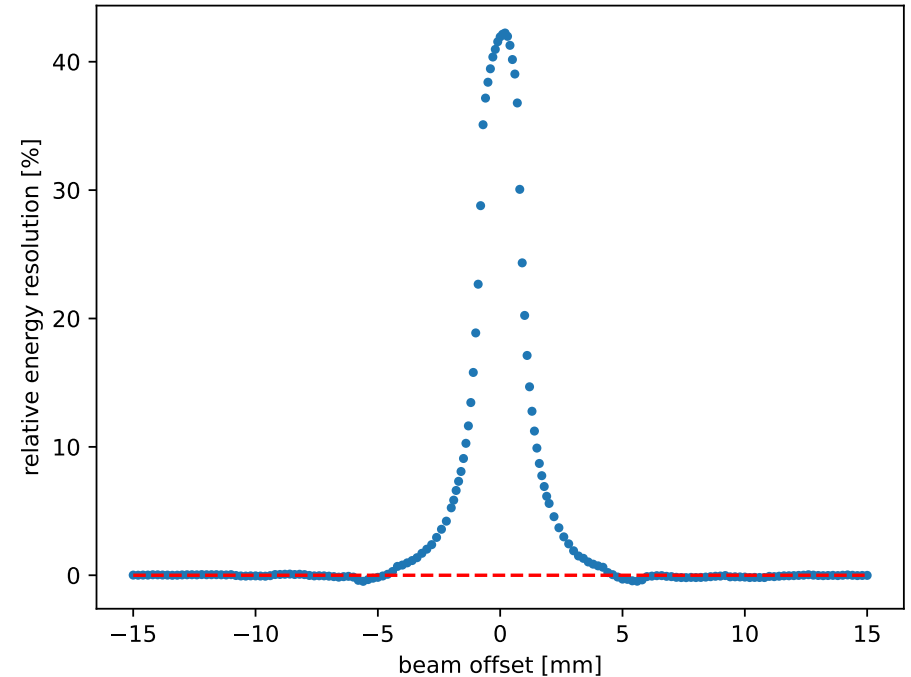


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 7.5GeV

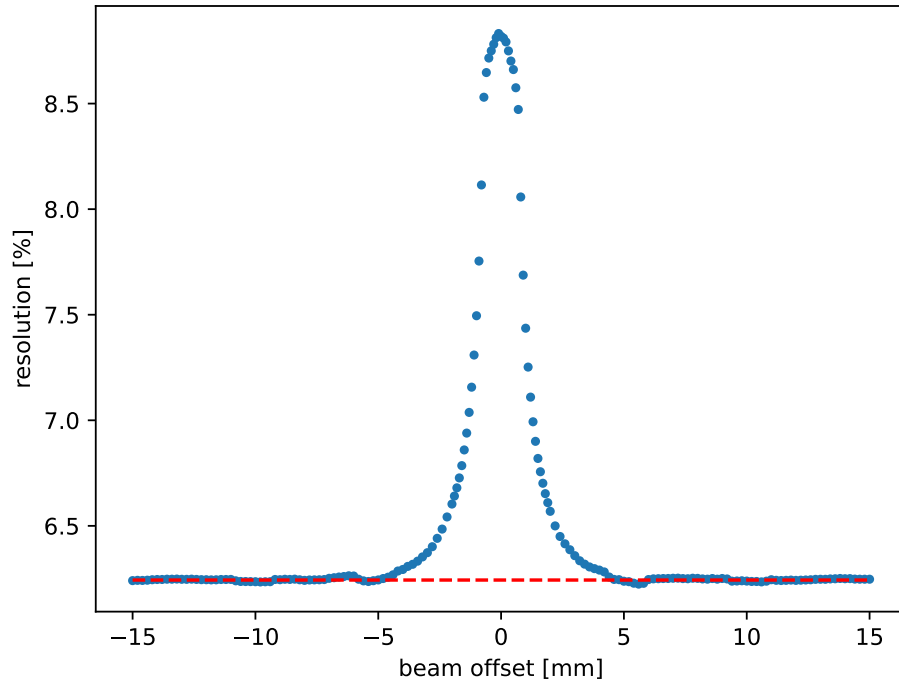


Energy resolution, relative to reference resolution, 7.5GeV

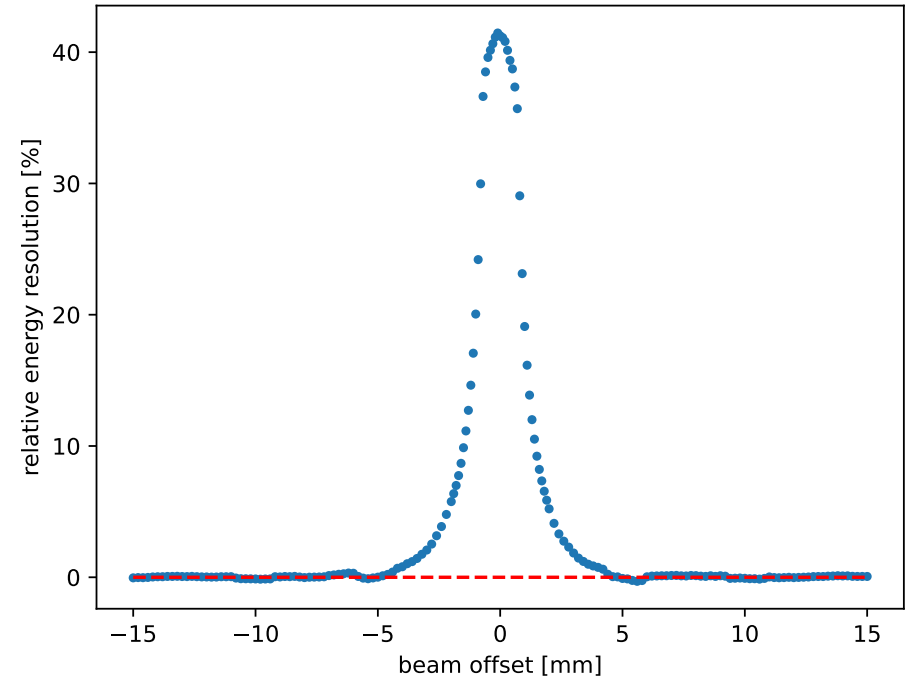


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 10GeV

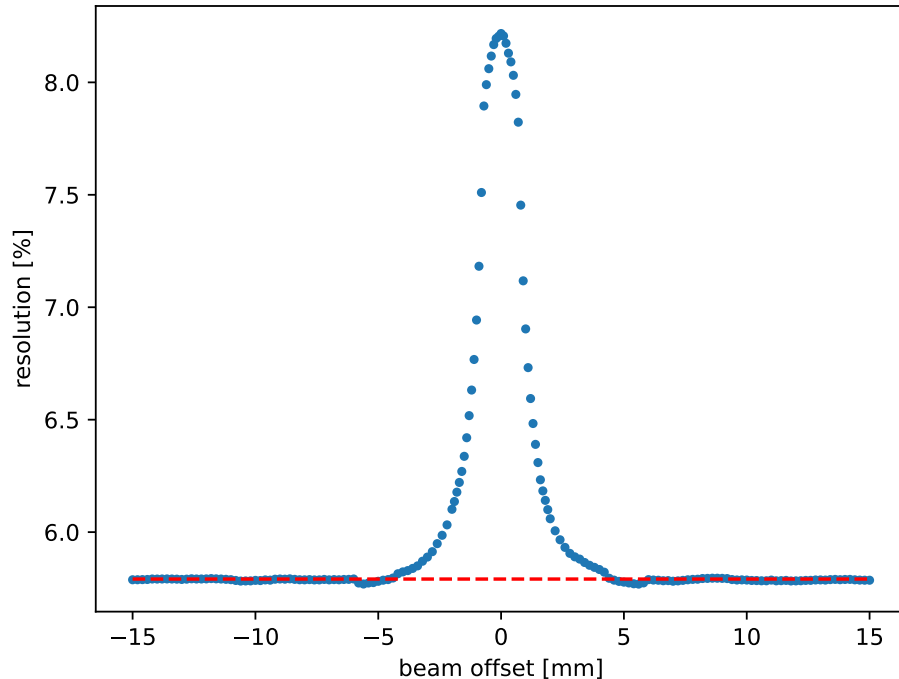


Energy resolution, relative to reference resolution, 10GeV

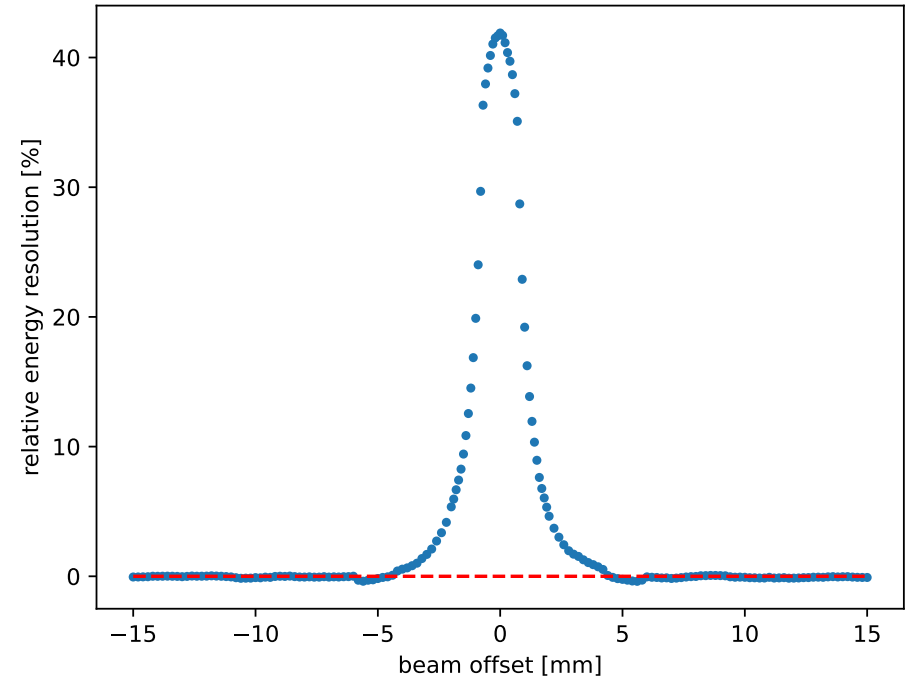


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 12.5GeV

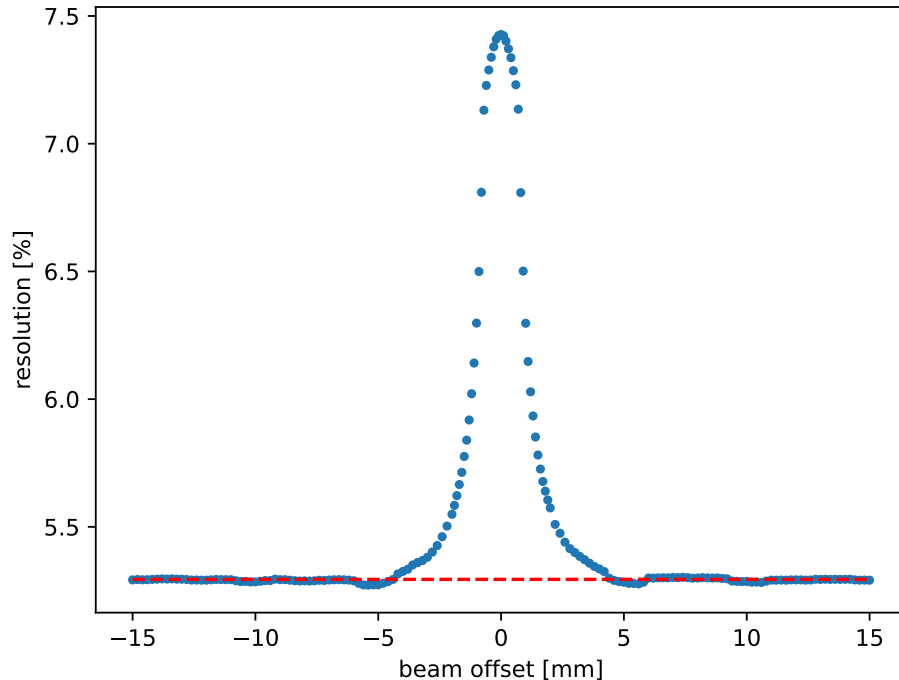


Energy resolution, relative to reference resolution, 12.5GeV

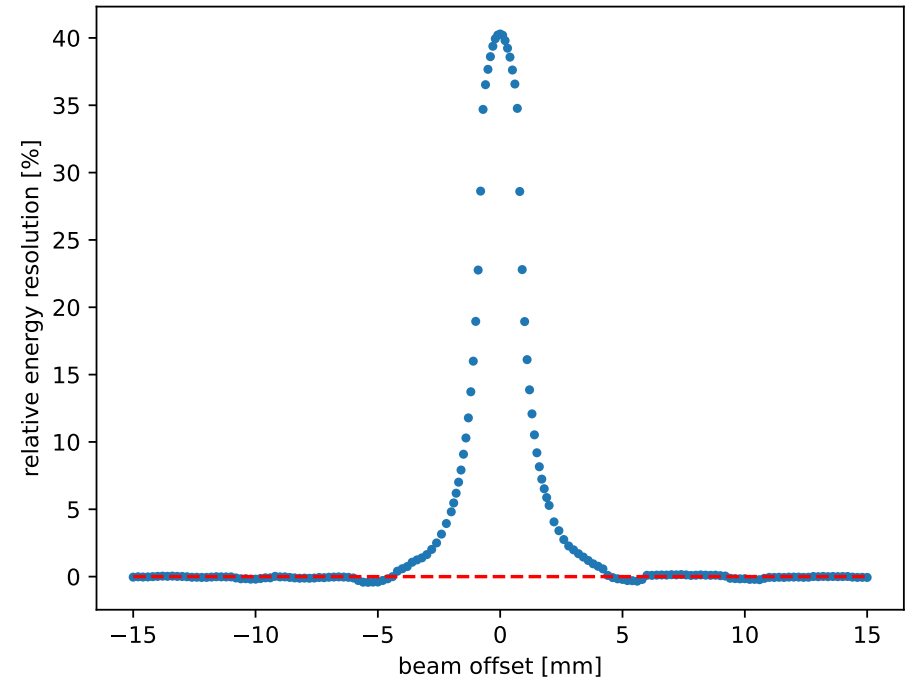


Results for 1.52mm gap gun position vs resolution

Energy resolution for different beam offsets, 15GeV



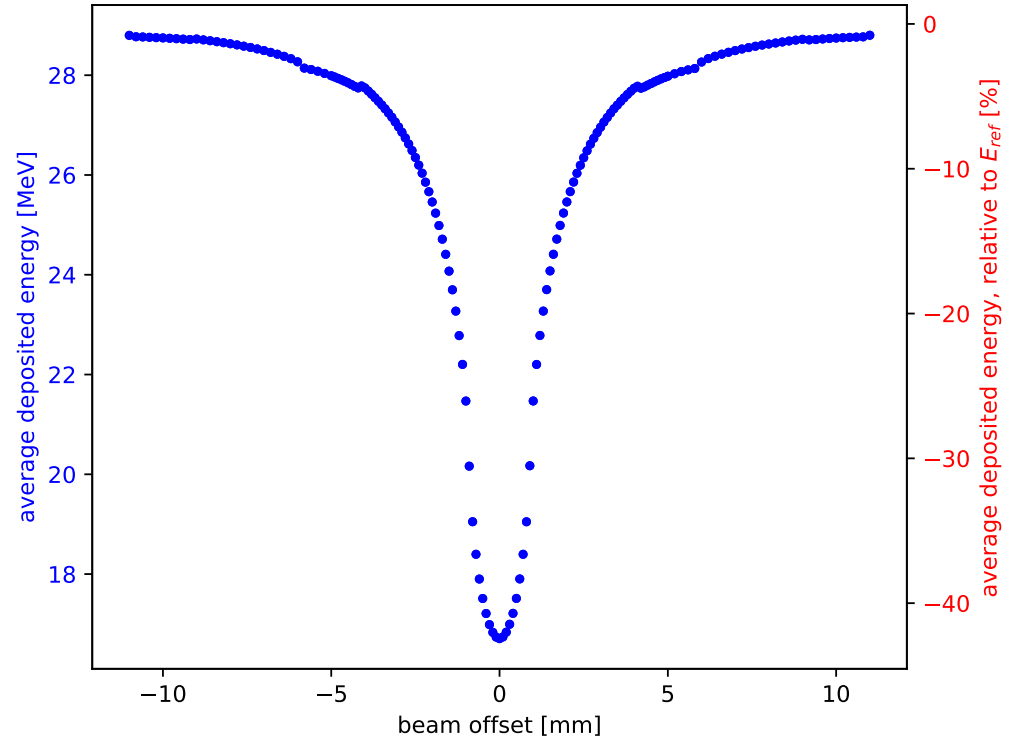
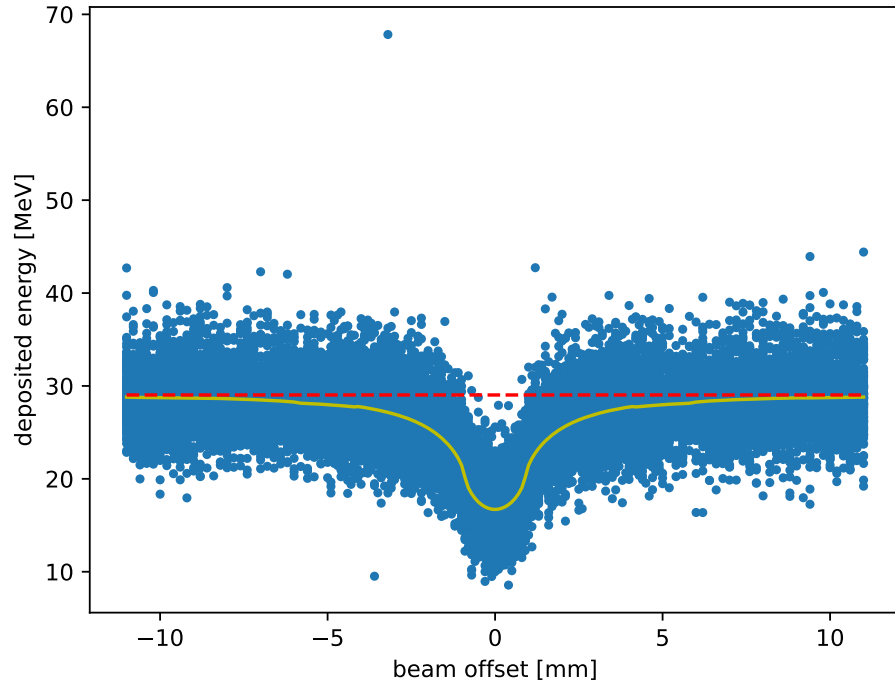
Energy resolution, relative to reference resolution, 15GeV



Results for 1.82mm gap

gun position vs energy

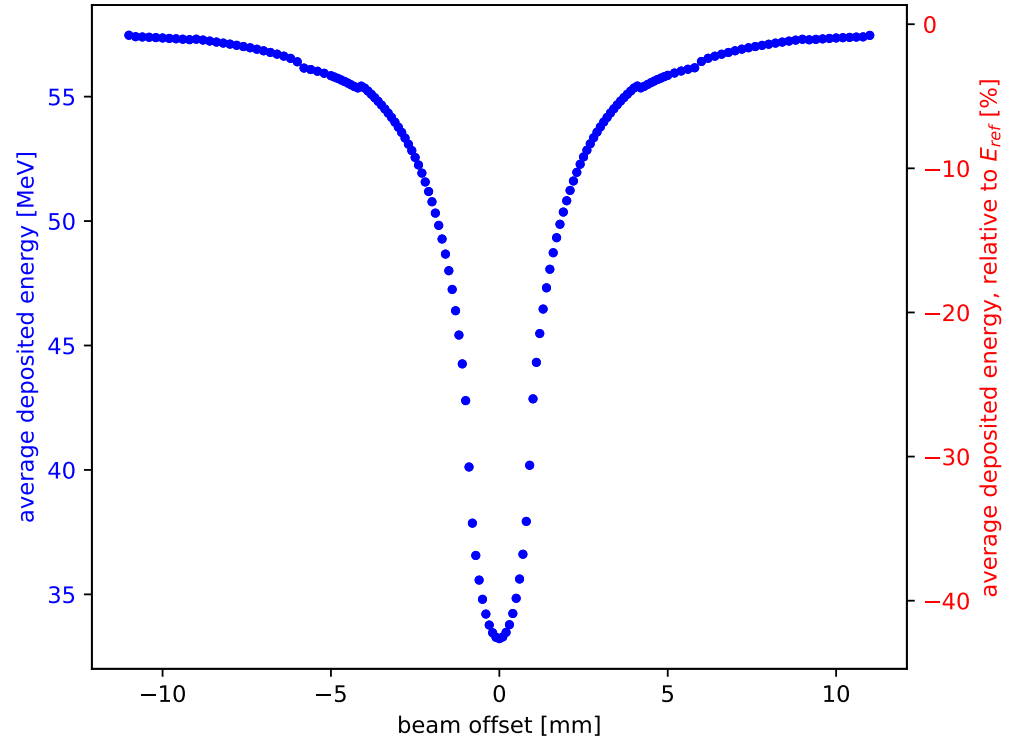
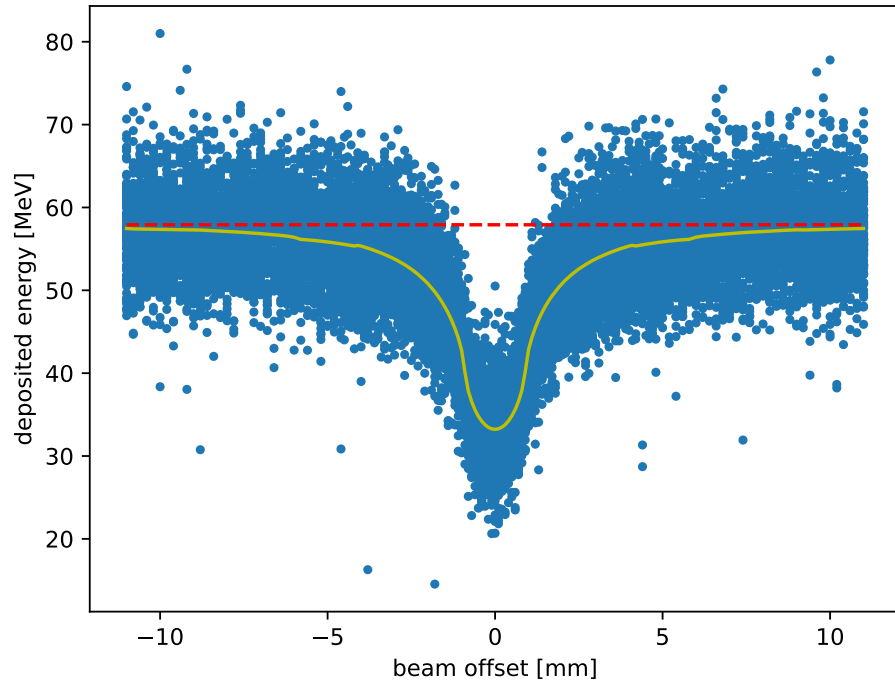
Random 100 deposited energies for different beam offsets, 2.5GeV



Results for 1.82mm gap

gun position vs energy

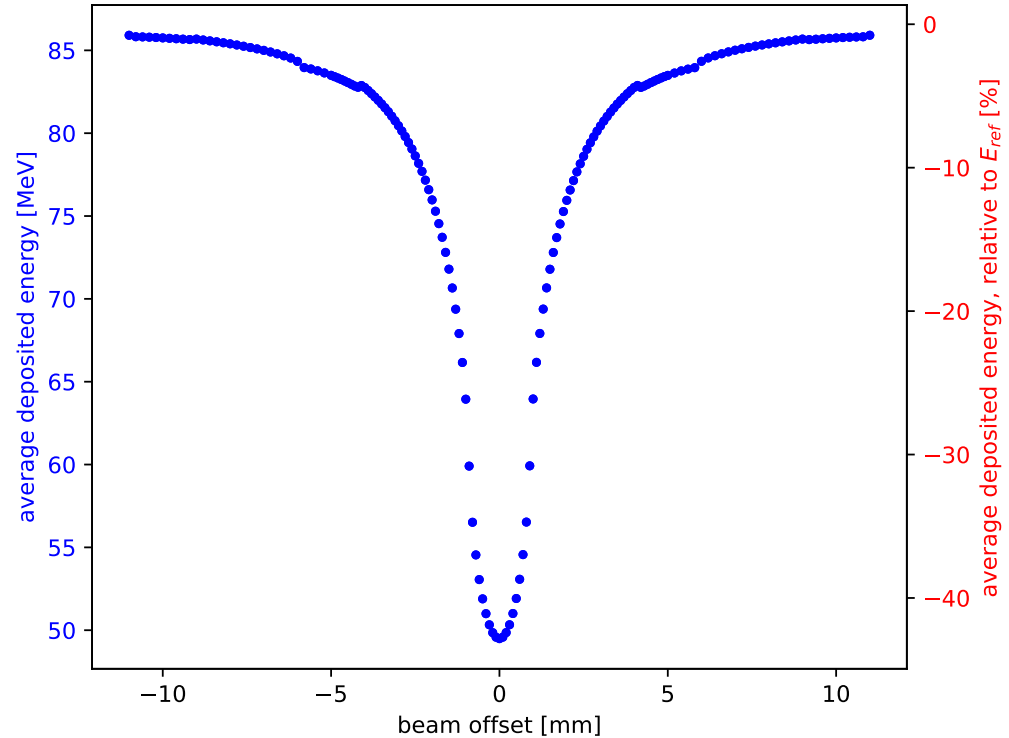
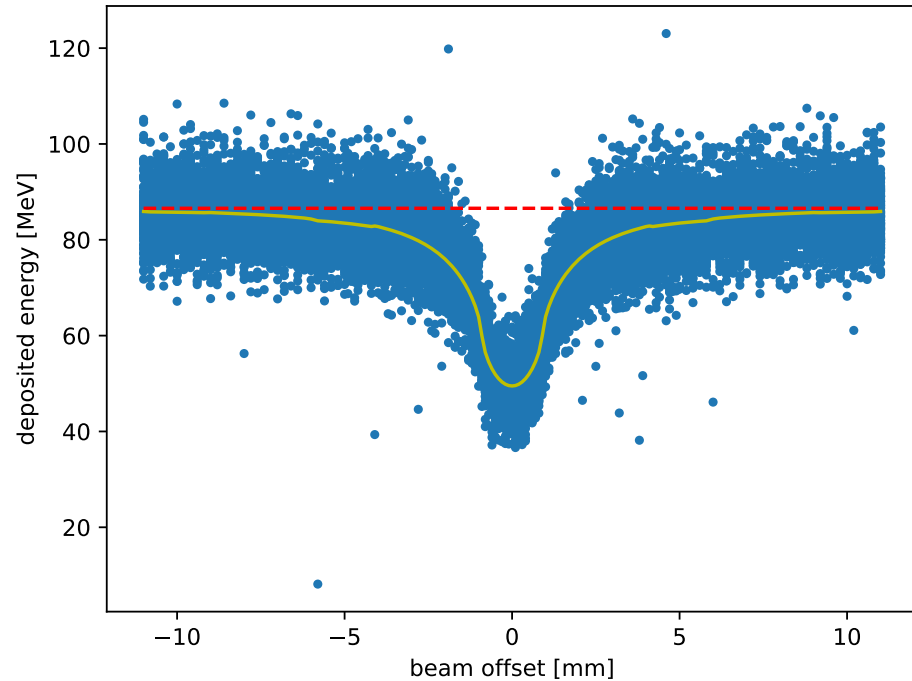
Random 100 deposited energies for different beam offsets, 5GeV



Results for 1.82mm gap

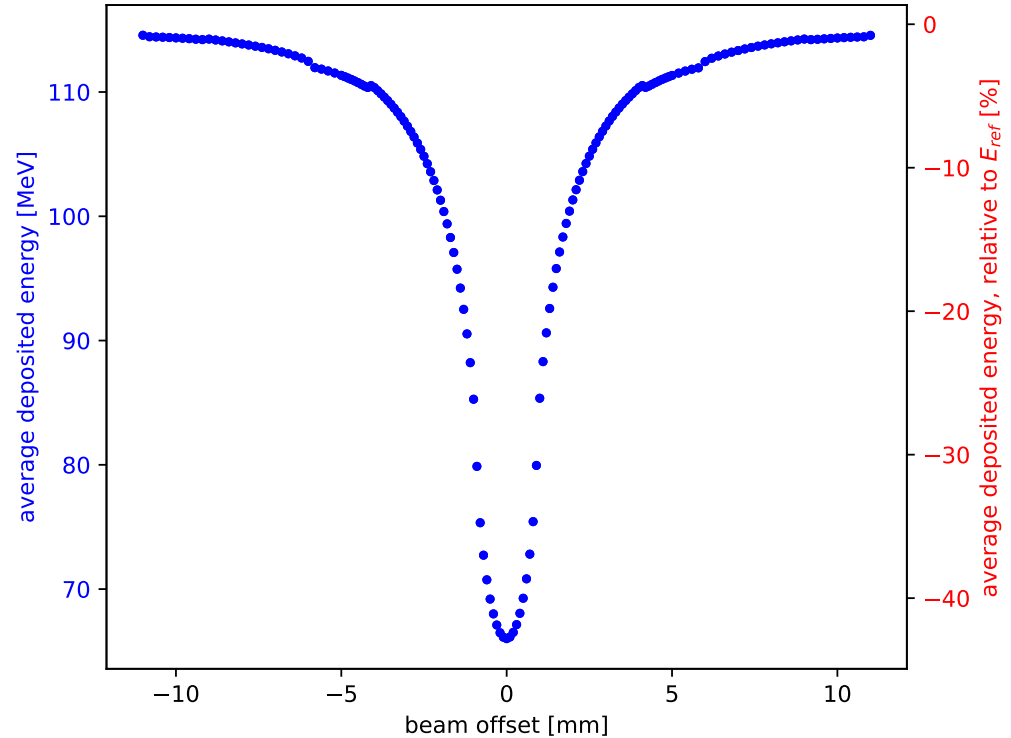
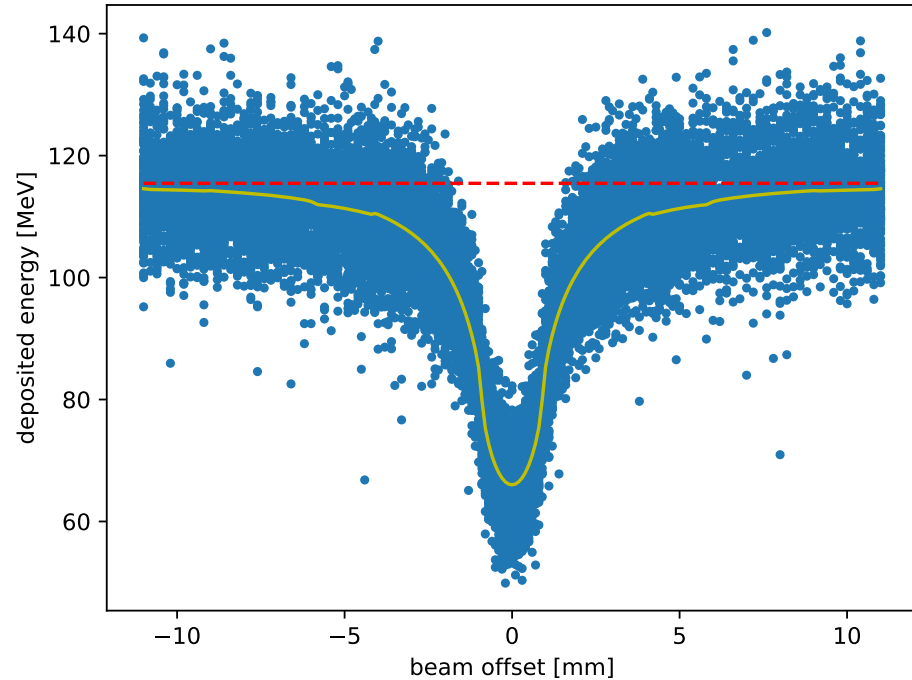
gun position vs energy

Random 100 deposited energies for different beam offsets, 7.5GeV



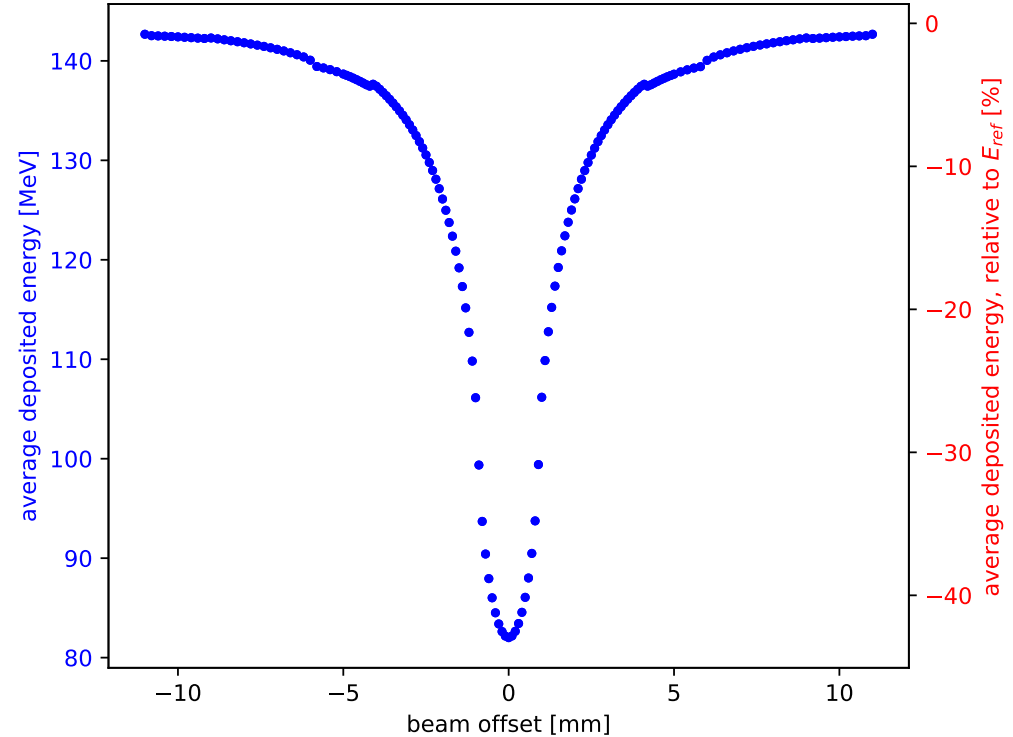
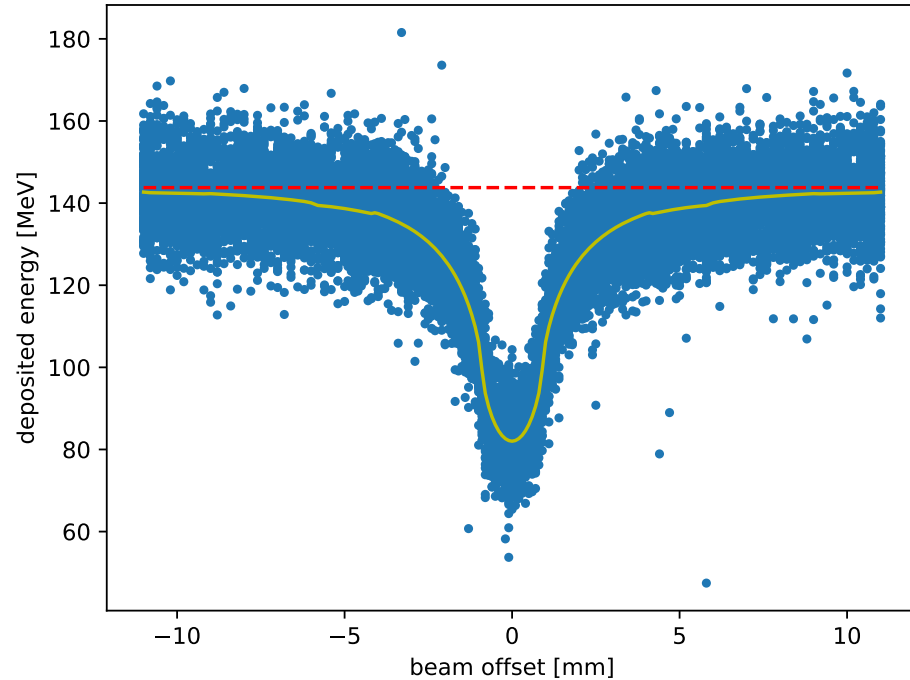
Results for 1.82mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 10GeV

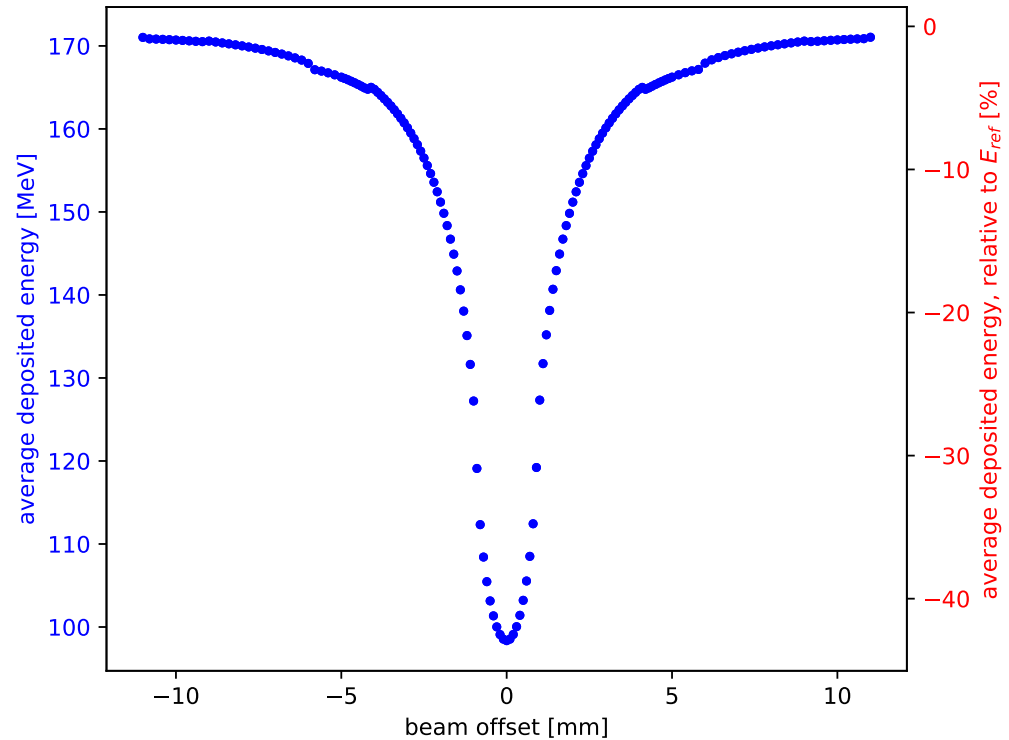
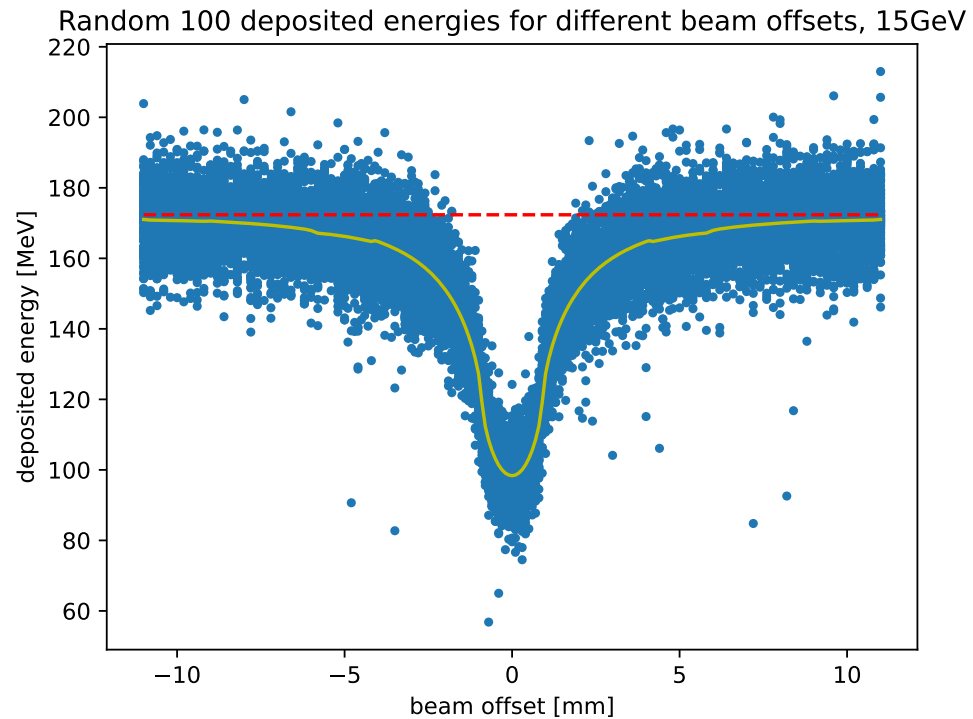


Results for 1.82mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 12.5GeV



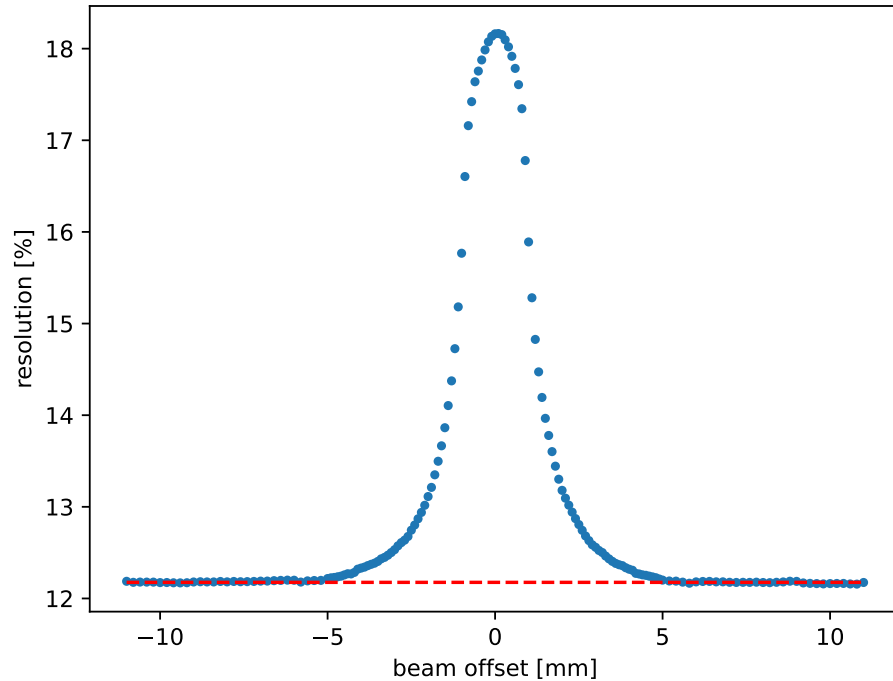
Results for 1.82mm gap gun position vs energy



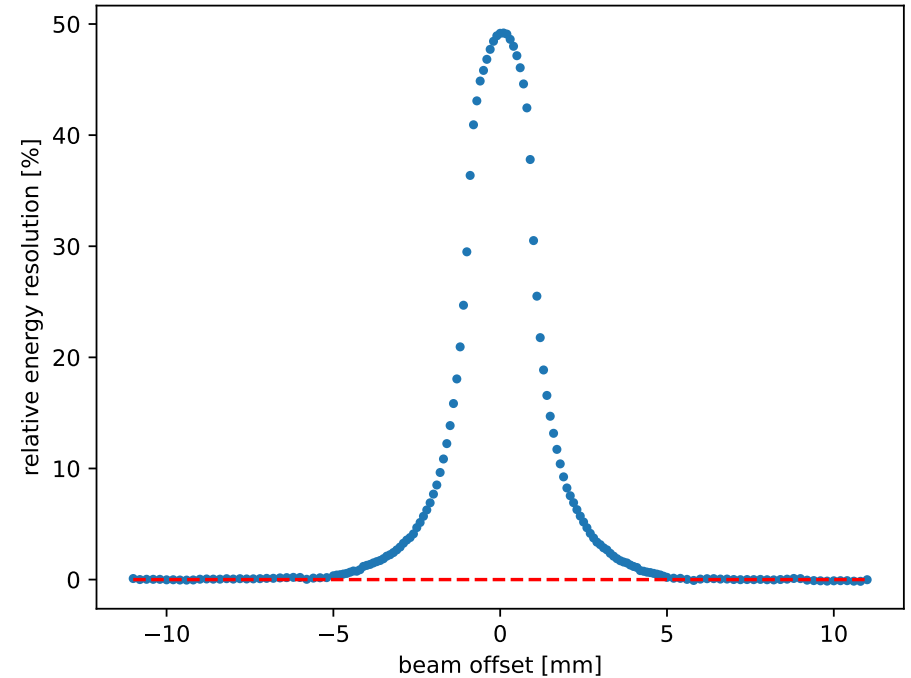
Results for 1.82mm gap

gun position vs resolution

Energy resolution for different beam offsets, 2.5GeV

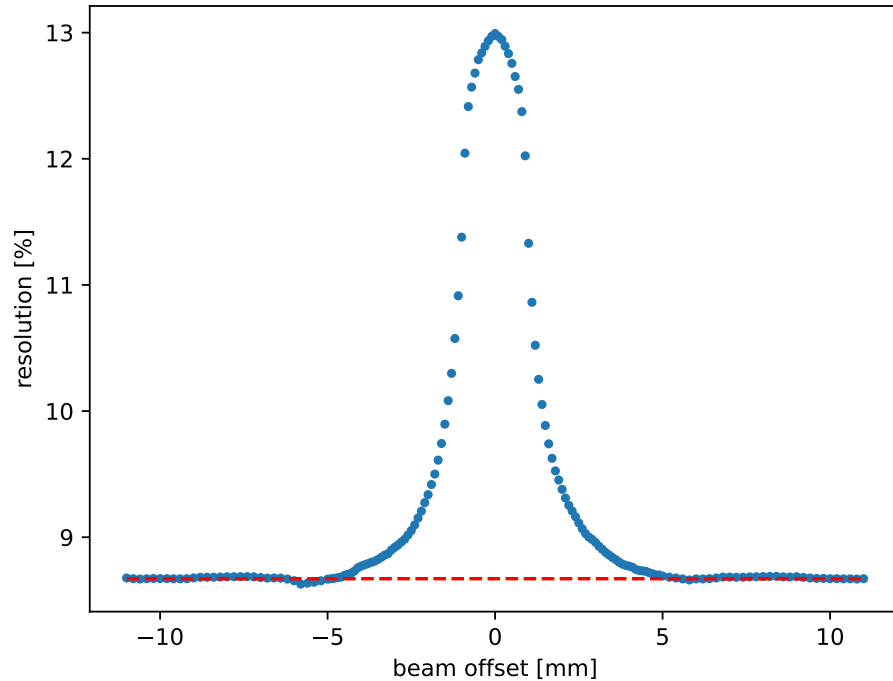


Energy resolution, relative to reference resolution, 2.5GeV

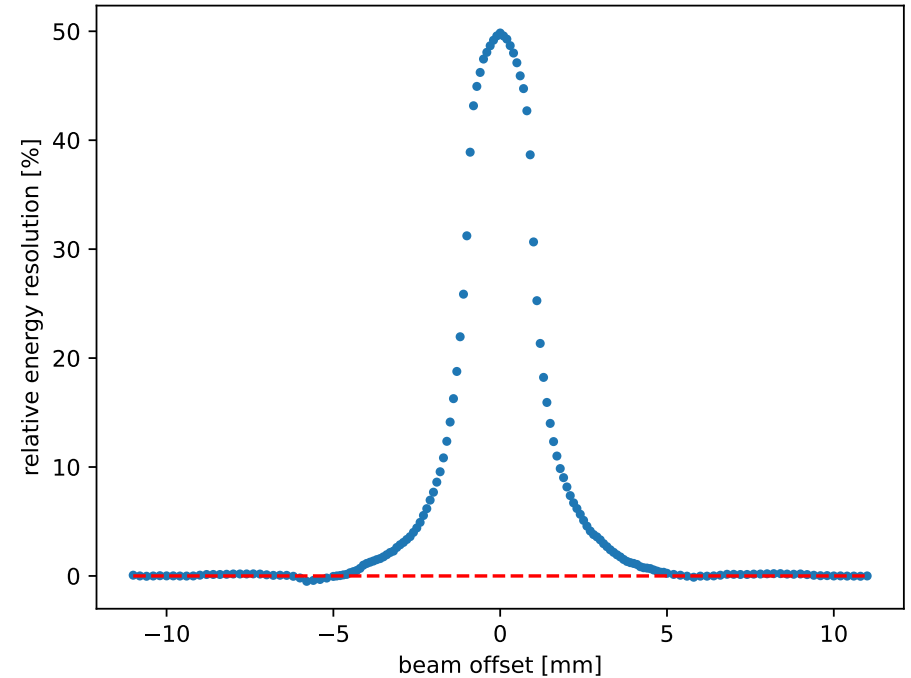


Results for 1.82mm gap gun position vs resolution

Energy resolution for different beam offsets, 5GeV

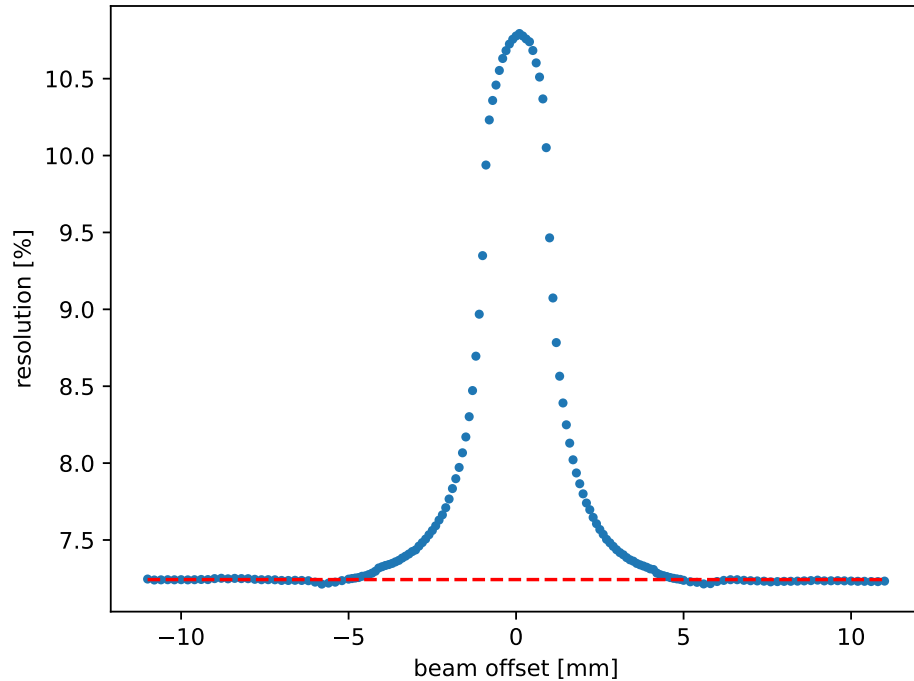


Energy resolution, relative to reference resolution, 5GeV

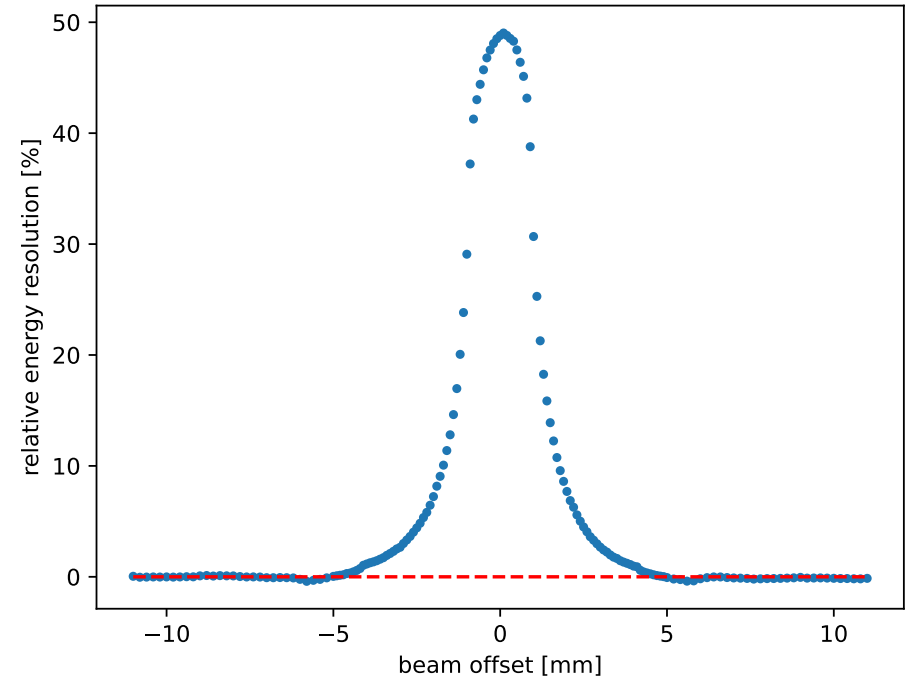


Results for 1.82mm gap gun position vs resolution

Energy resolution for different beam offsets, 7.5GeV



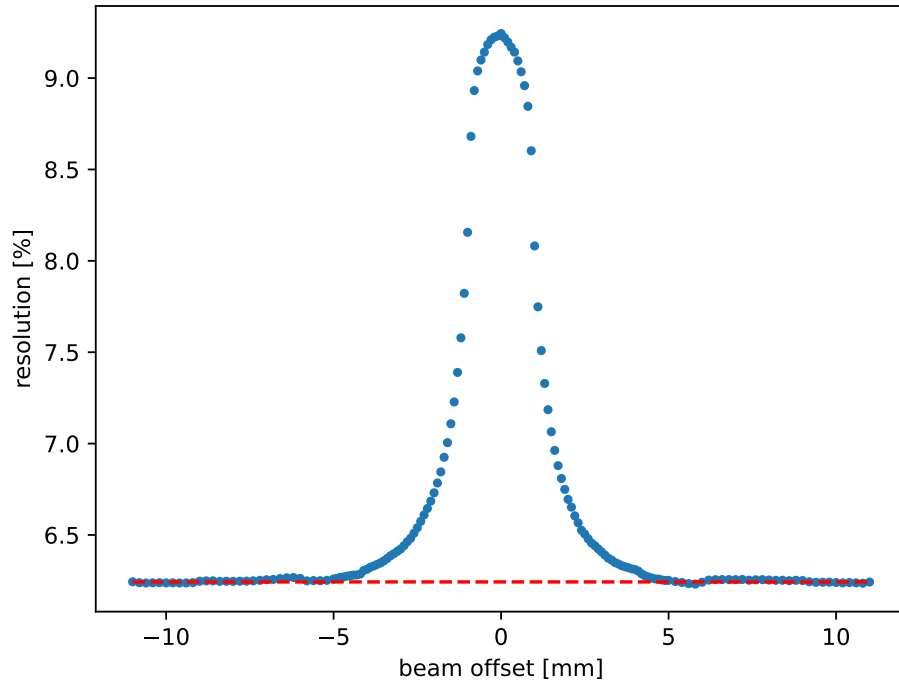
Energy resolution, relative to reference resolution, 7.5GeV



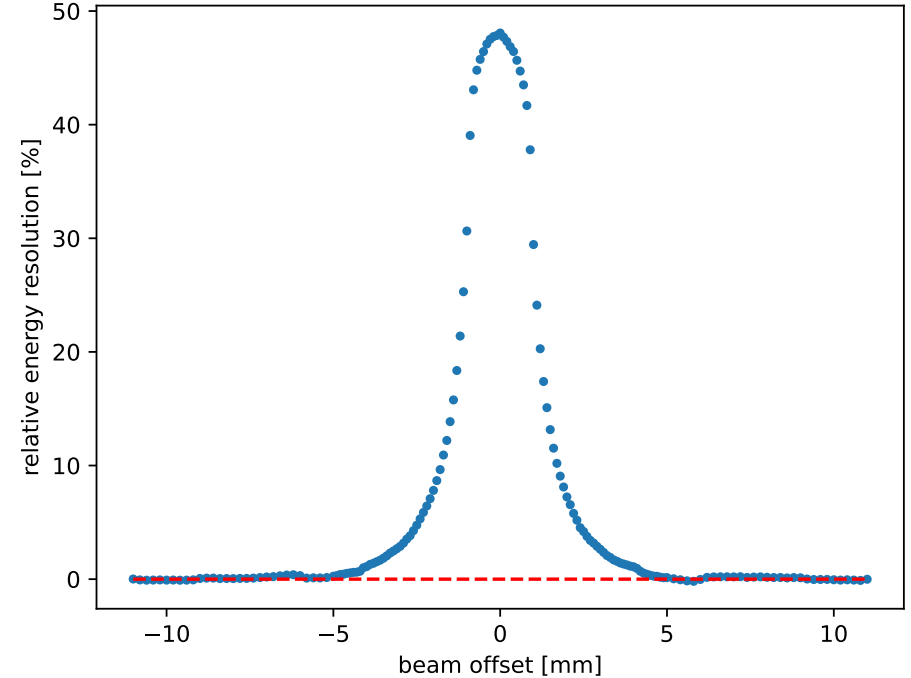
Results for 1.82mm gap

gun position vs resolution

Energy resolution for different beam offsets, 10GeV

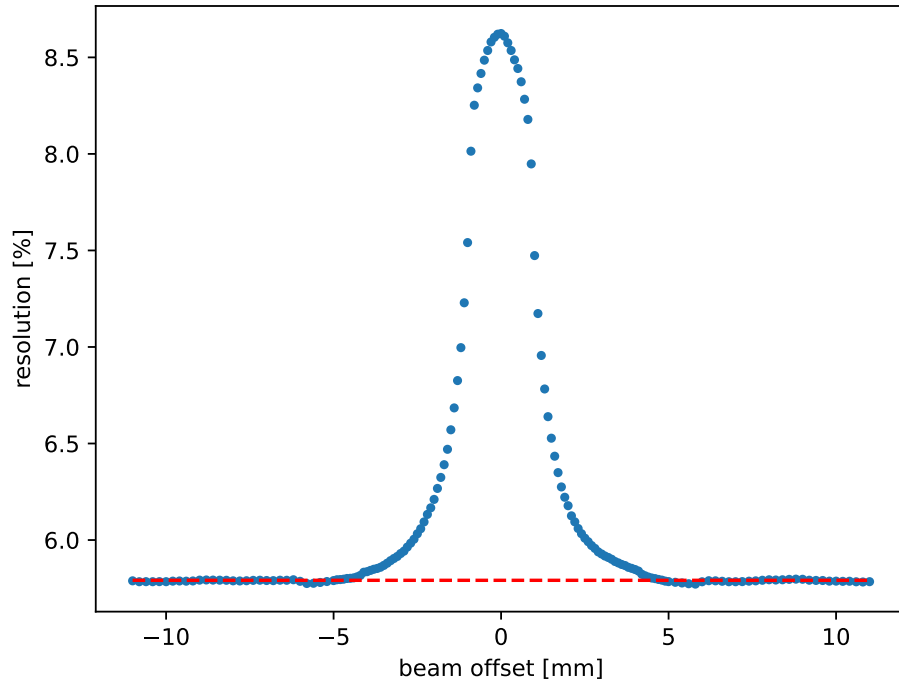


Energy resolution, relative to reference resolution, 10GeV

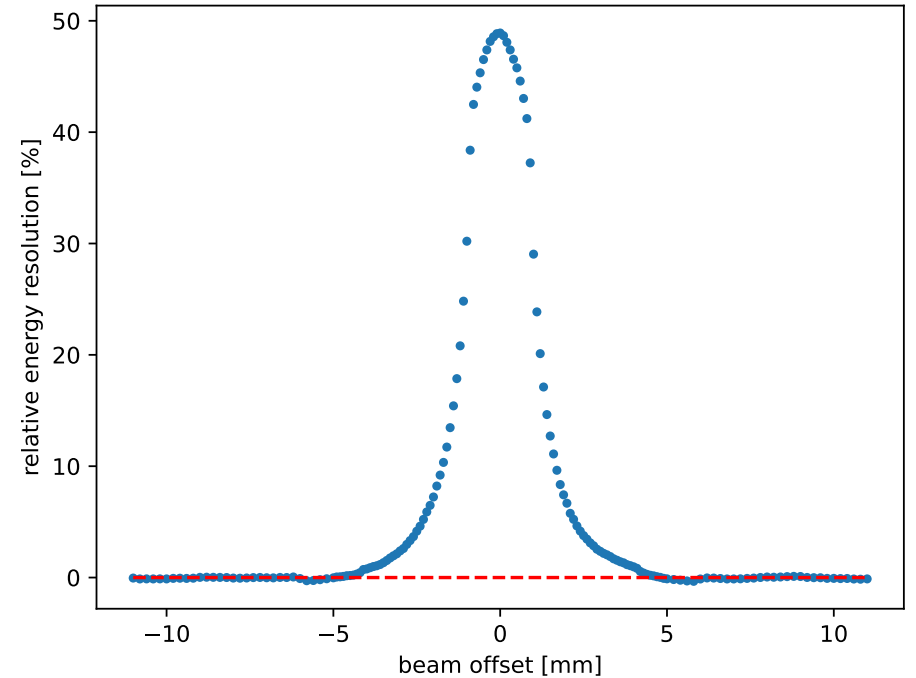


Results for 1.82mm gap gun position vs resolution

Energy resolution for different beam offsets, 12.5GeV



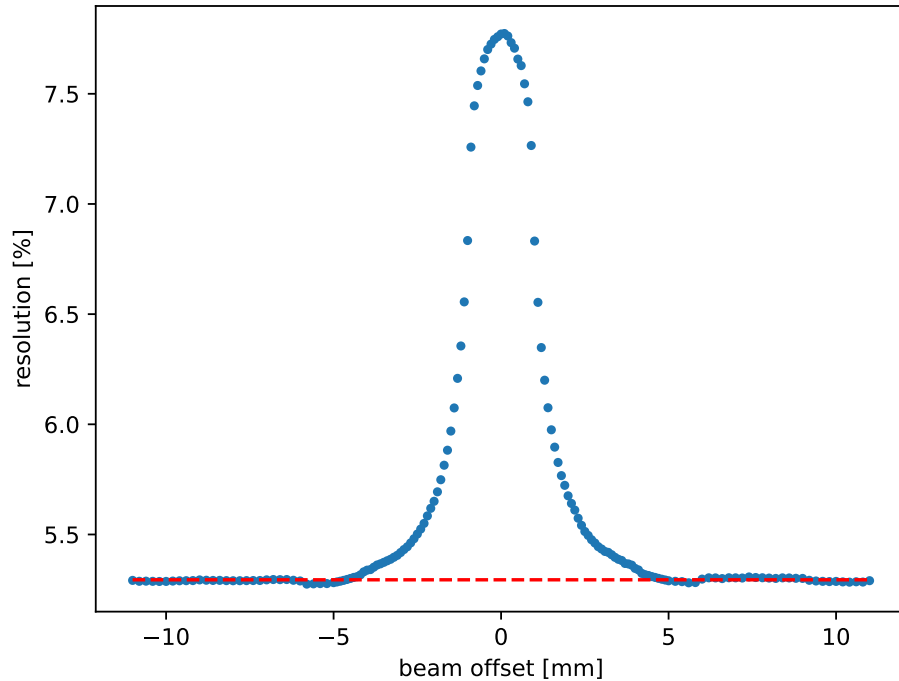
Energy resolution, relative to reference resolution, 12.5GeV



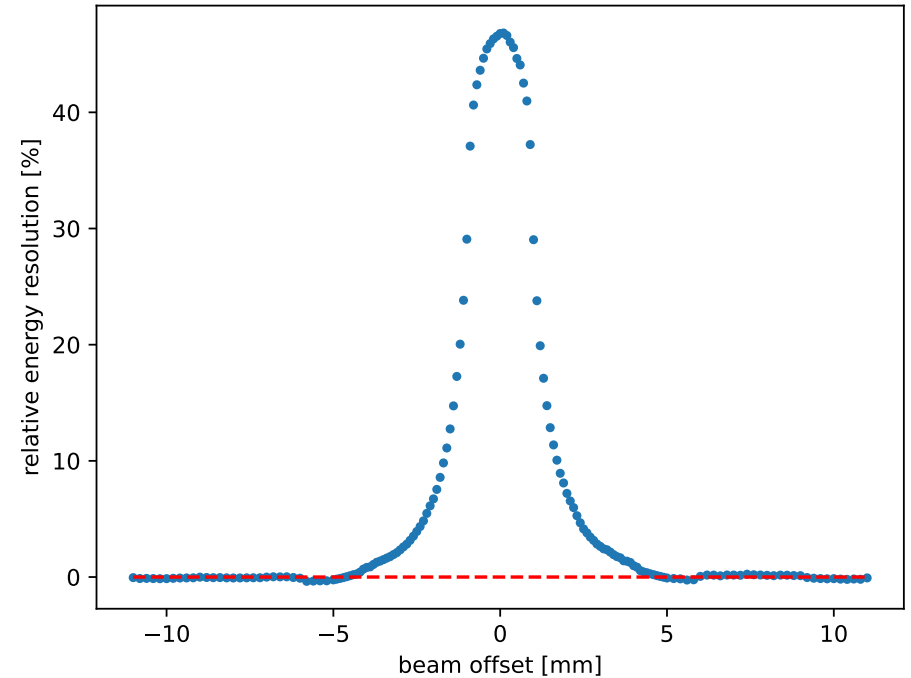
Results for 1.82mm gap

gun position vs resolution

Energy resolution for different beam offsets, 15GeV



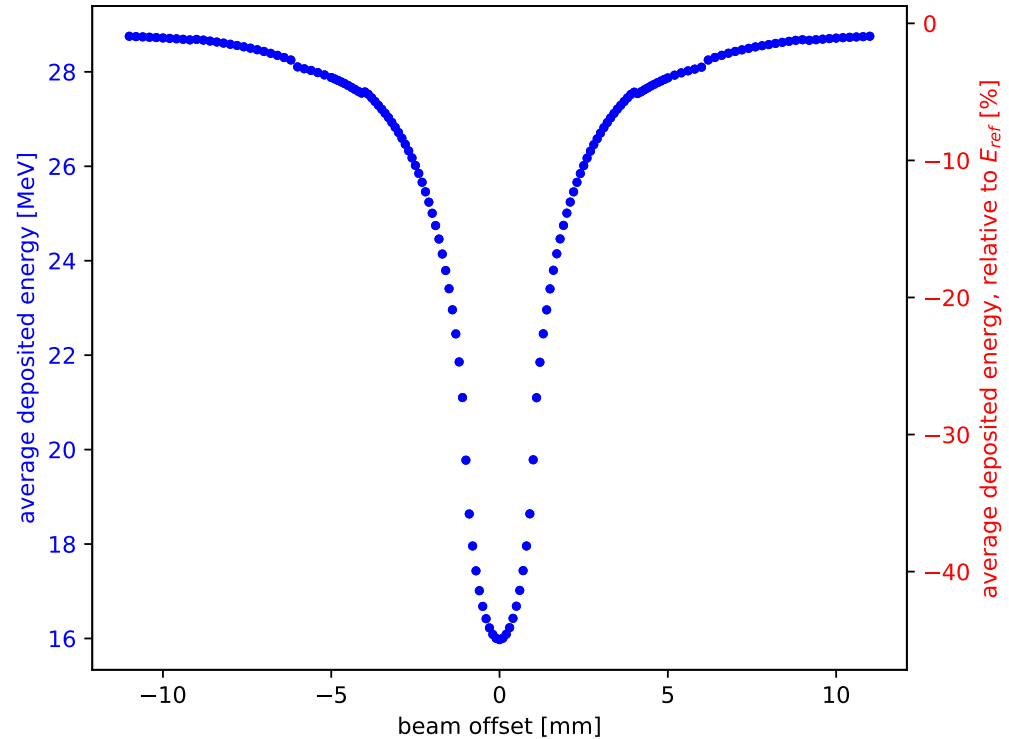
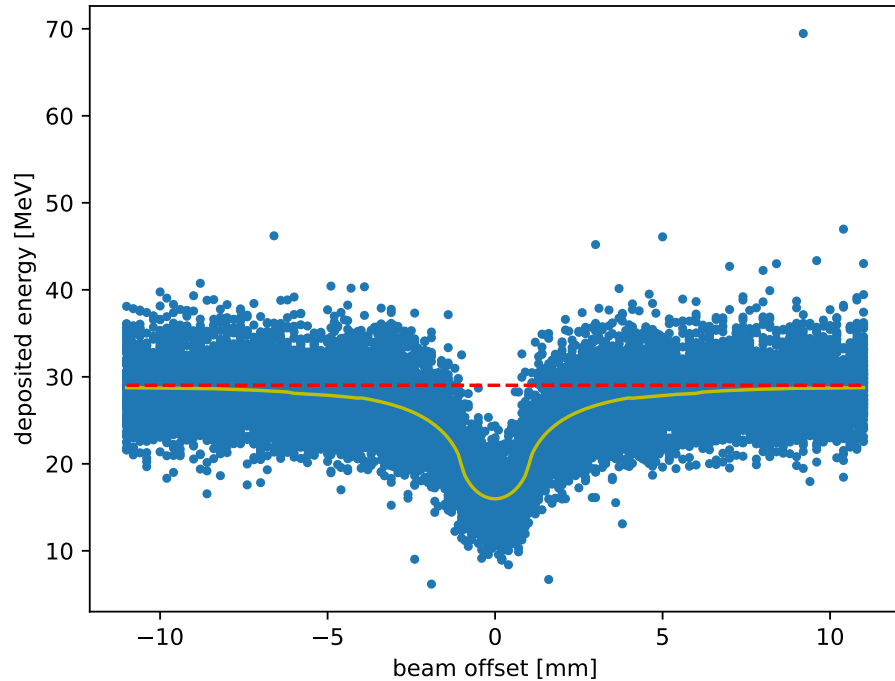
Energy resolution, relative to reference resolution, 15GeV



Results for 2.02mm gap

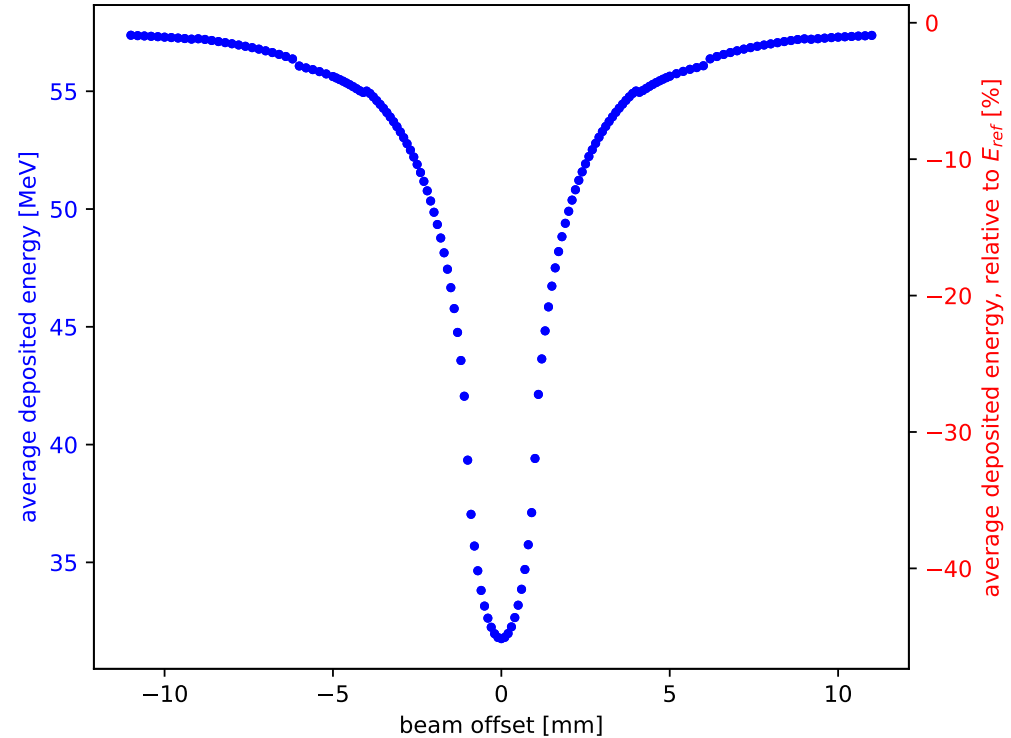
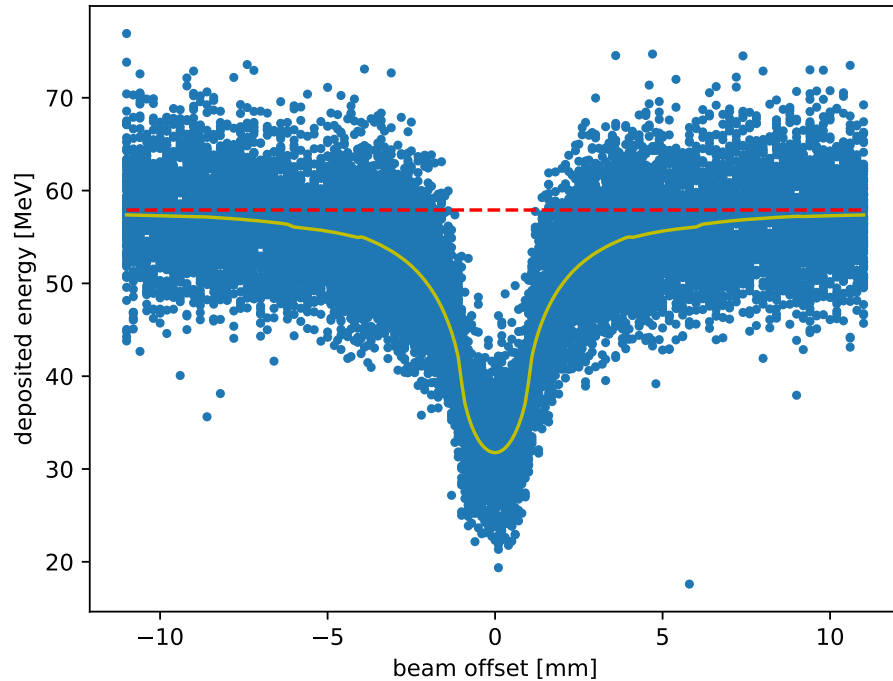
gun position vs energy

Random 100 deposited energies for different beam offsets, 2.5GeV



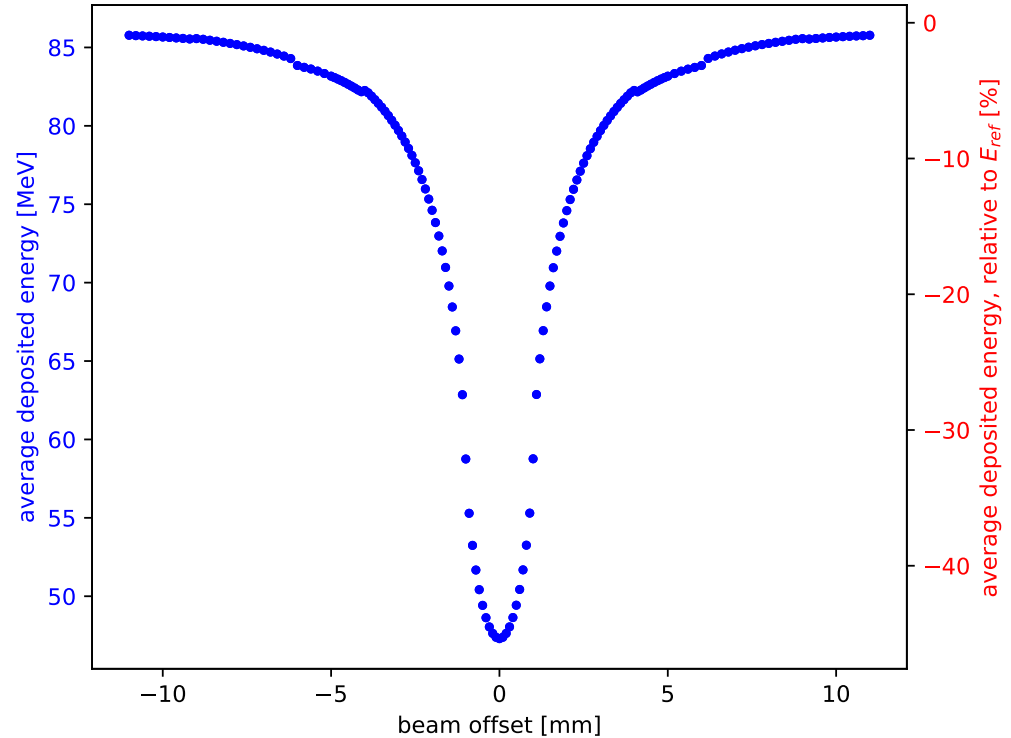
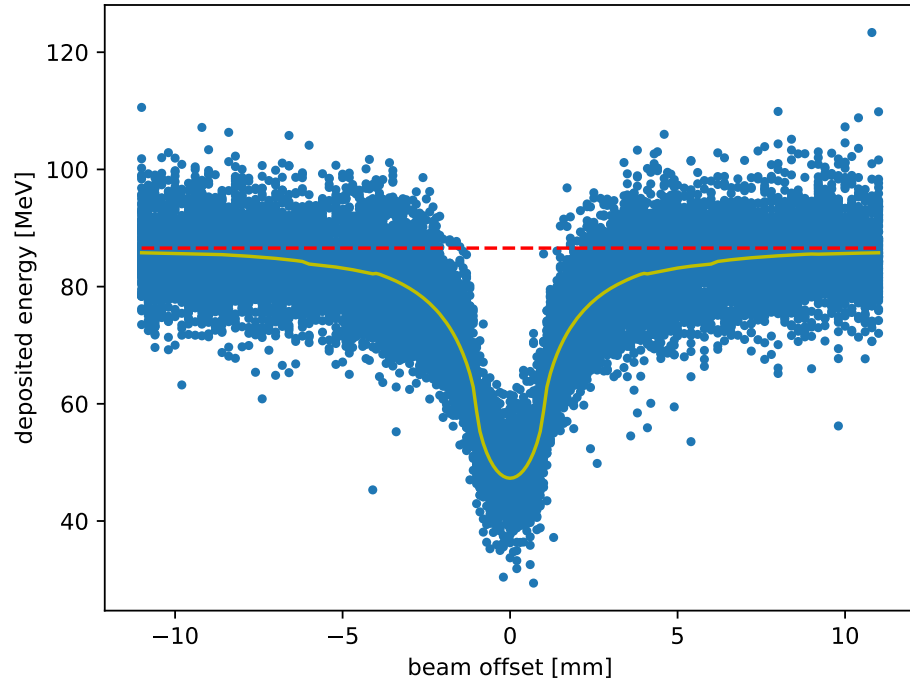
Results for 2.02mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 5GeV



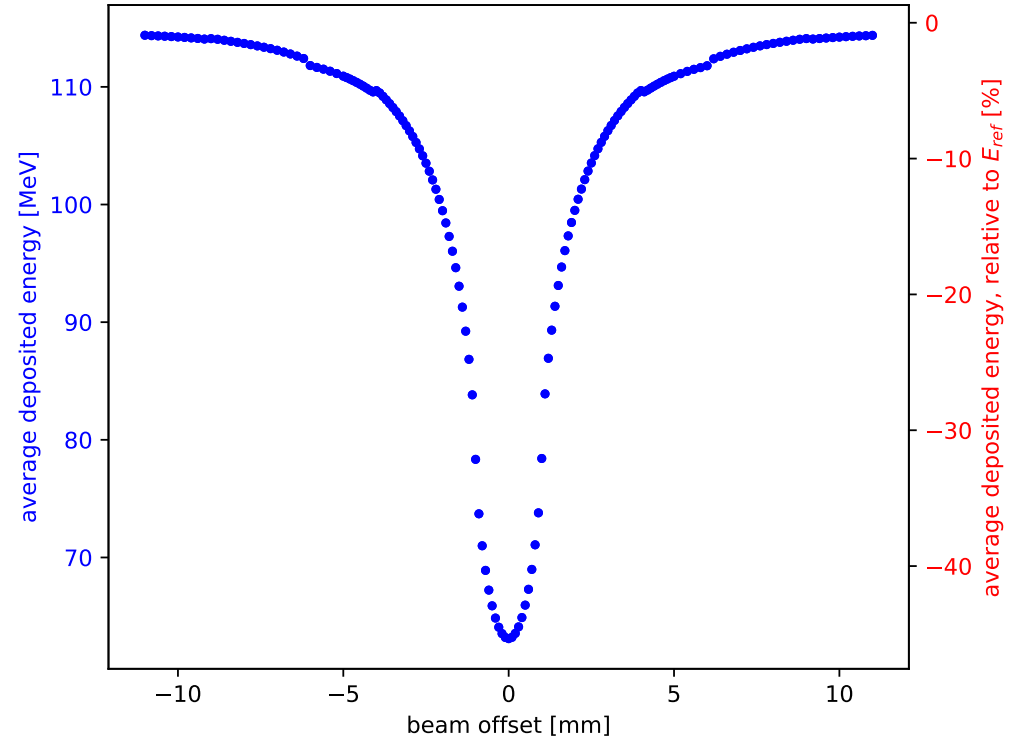
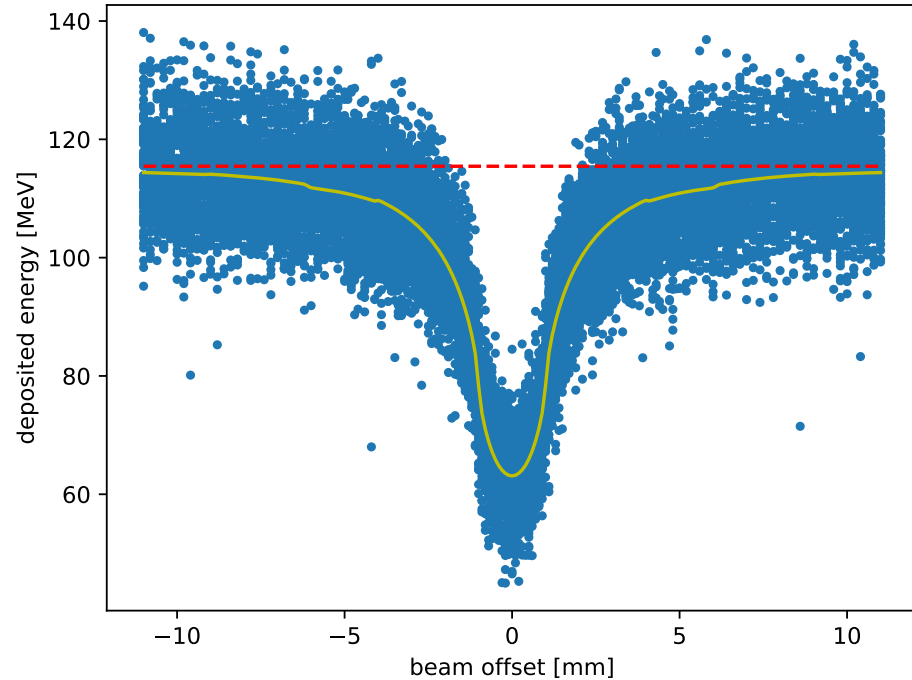
Results for 2.02mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 7.5GeV



Results for 2.02mm gap gun position vs energy

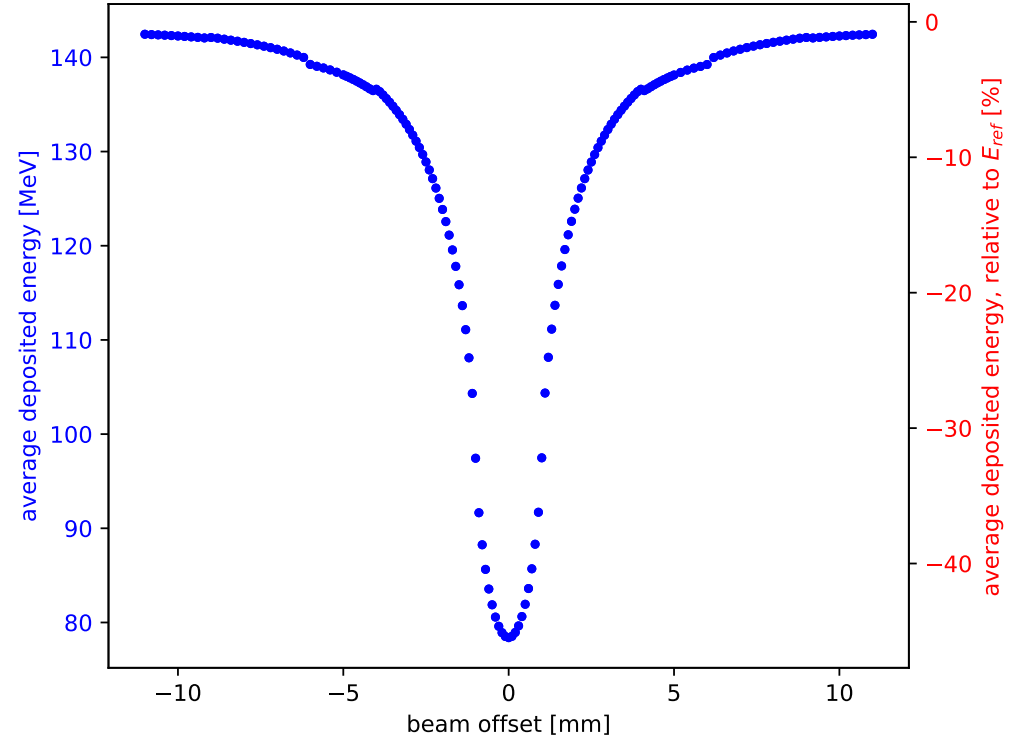
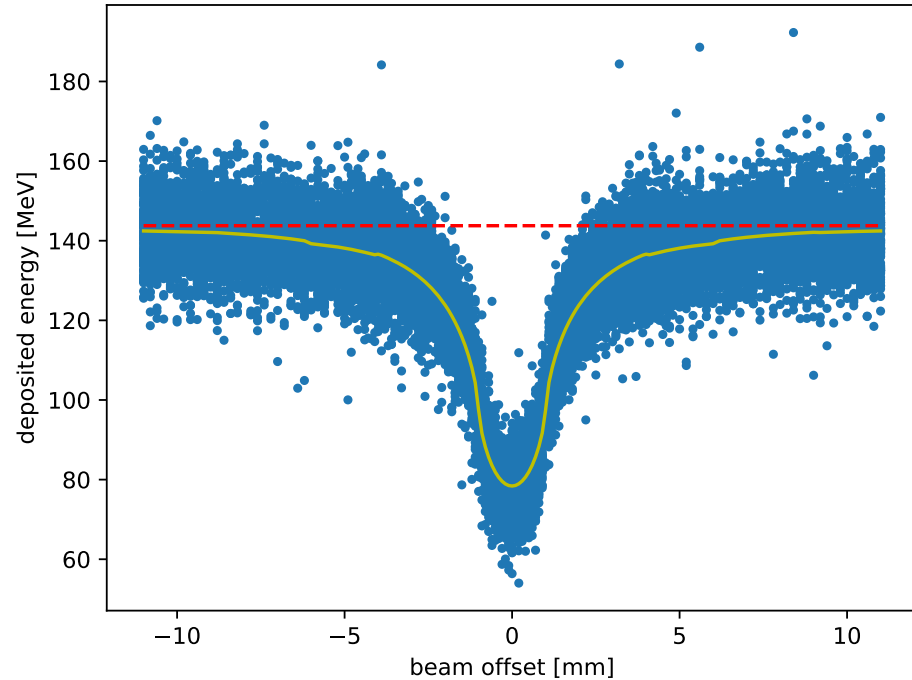
Random 100 deposited energies for different beam offsets, 10GeV



Results for 2.02mm gap

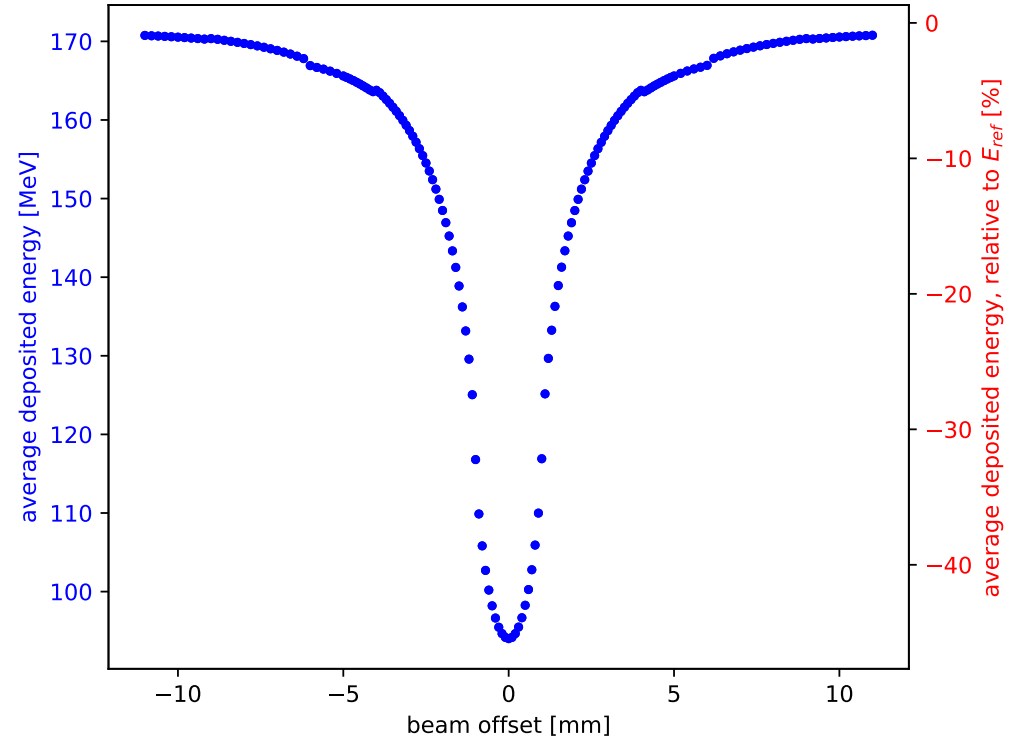
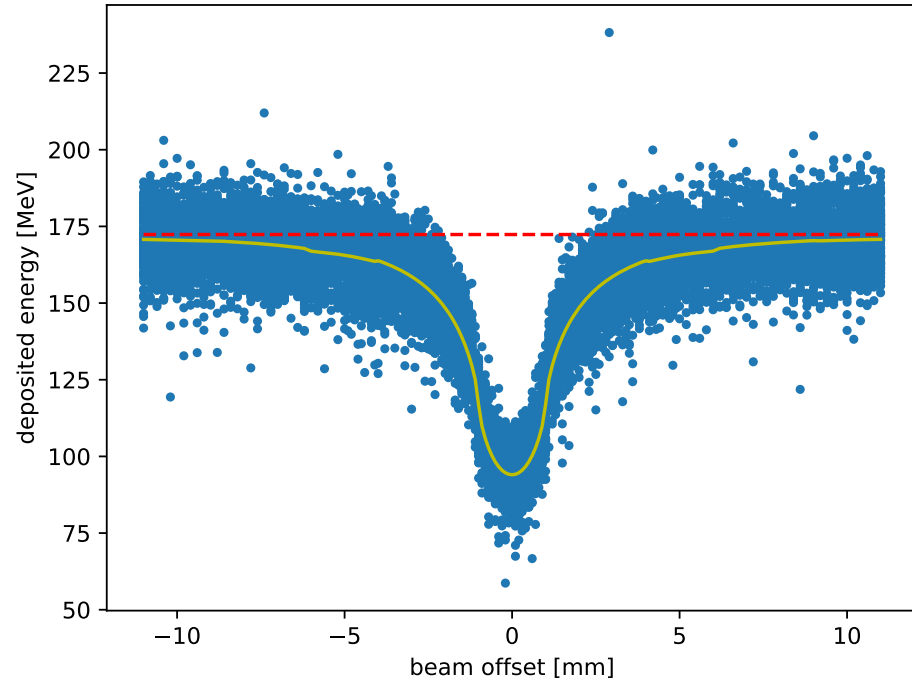
gun position vs energy

Random 100 deposited energies for different beam offsets, 12.5GeV

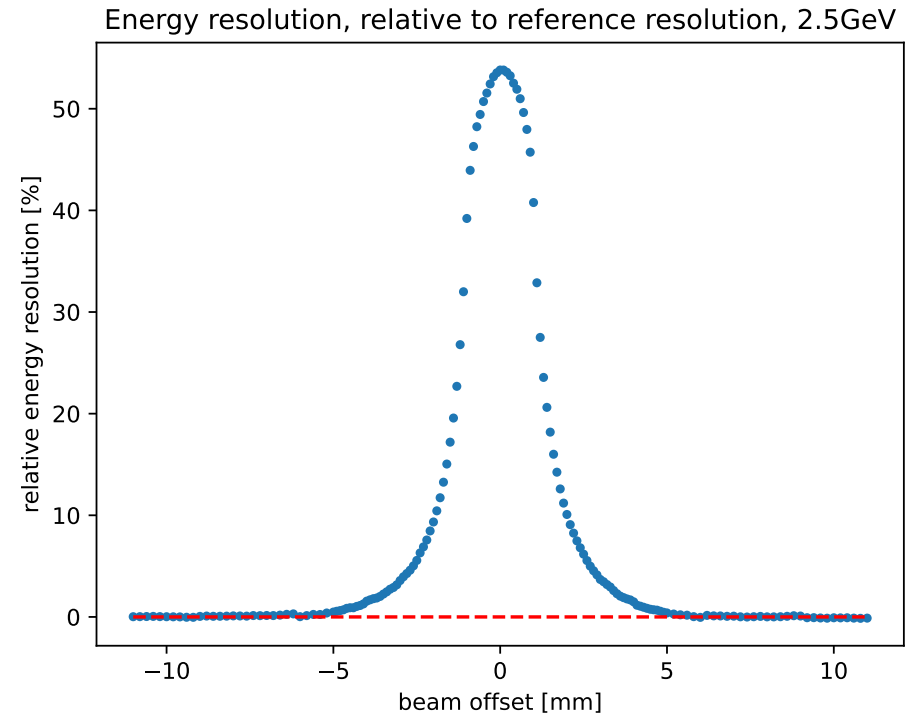
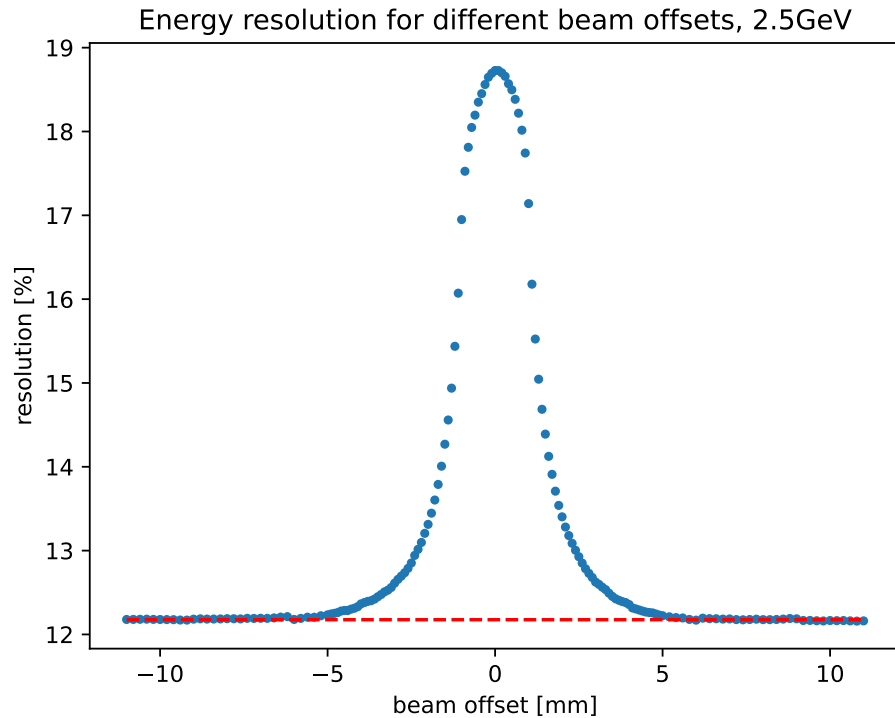


Results for 2.02mm gap gun position vs energy

Random 100 deposited energies for different beam offsets, 15GeV



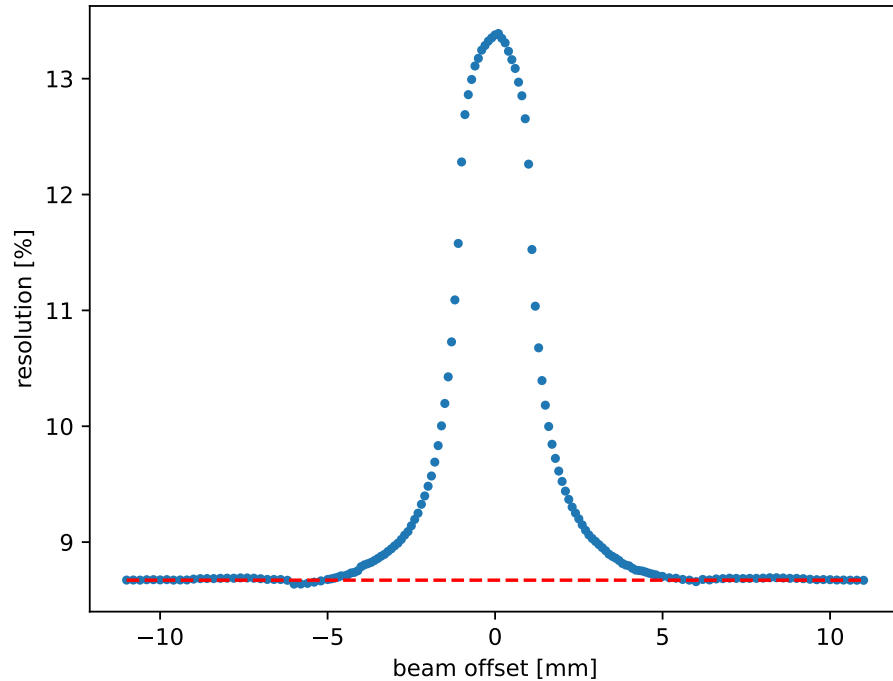
Results for 2.02mm gap gun position vs resolution



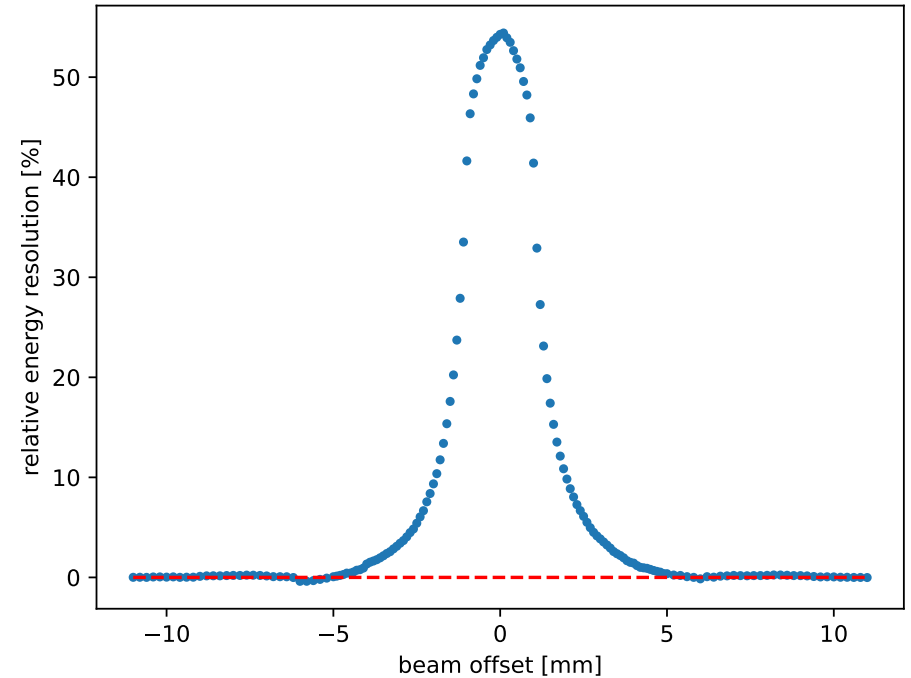
Results for 2.02mm gap

gun position vs resolution

Energy resolution for different beam offsets, 5GeV

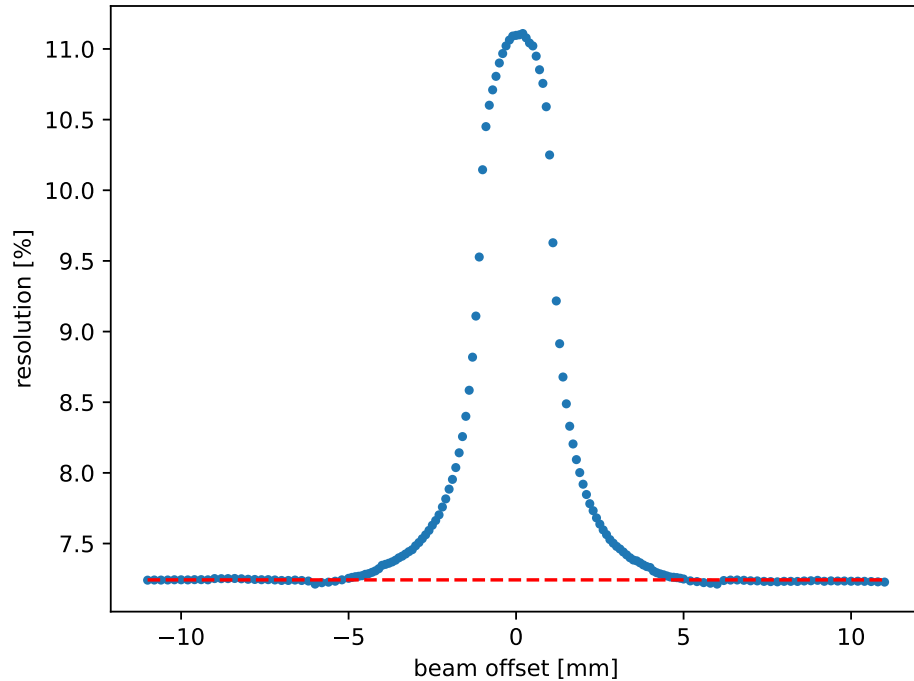


Energy resolution, relative to reference resolution, 5GeV

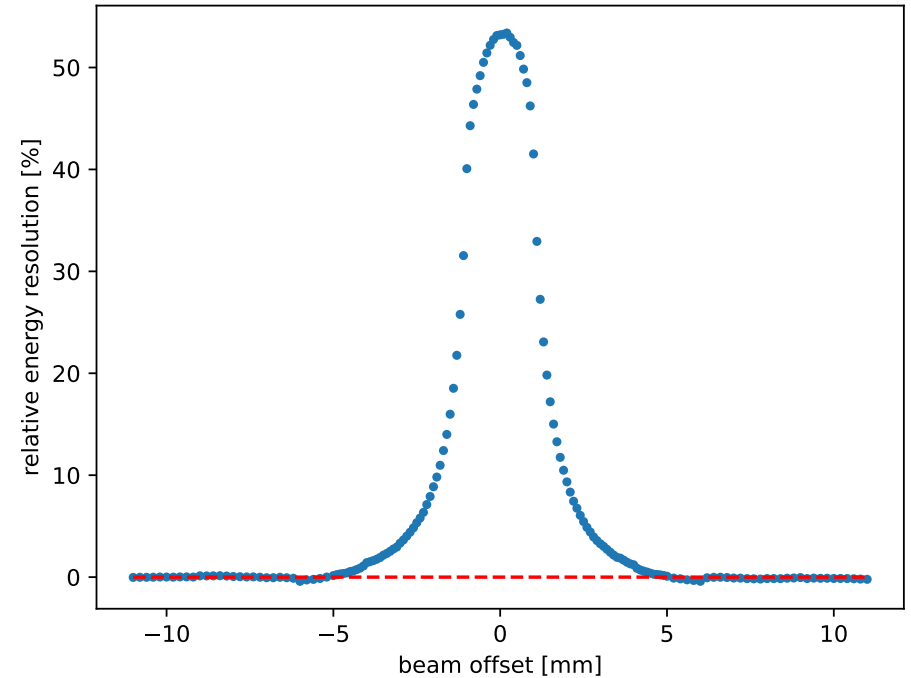


Results for 2.02mm gap gun position vs resolution

Energy resolution for different beam offsets, 7.5GeV

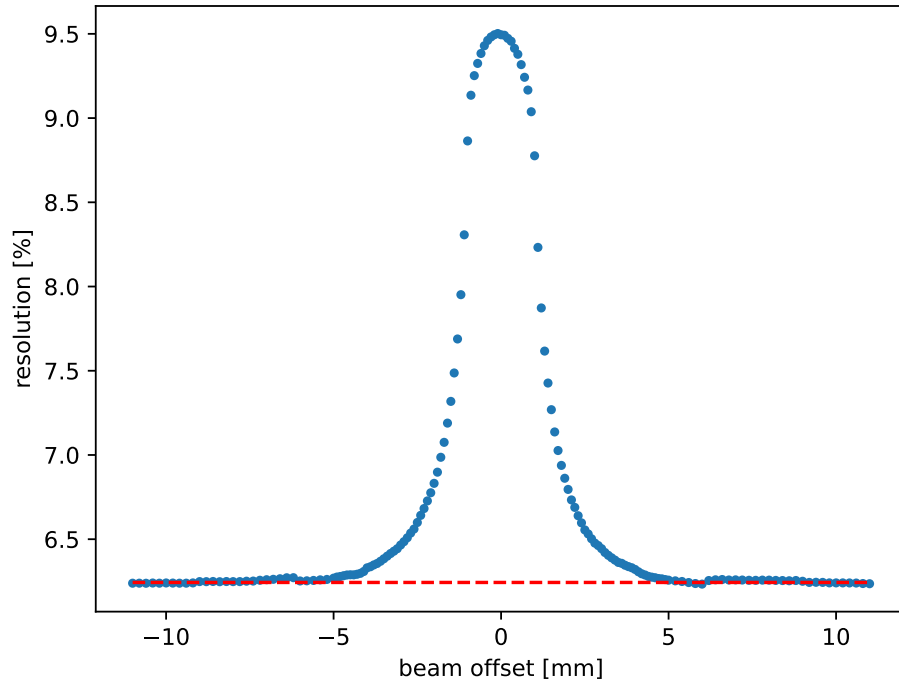


Energy resolution, relative to reference resolution, 7.5GeV

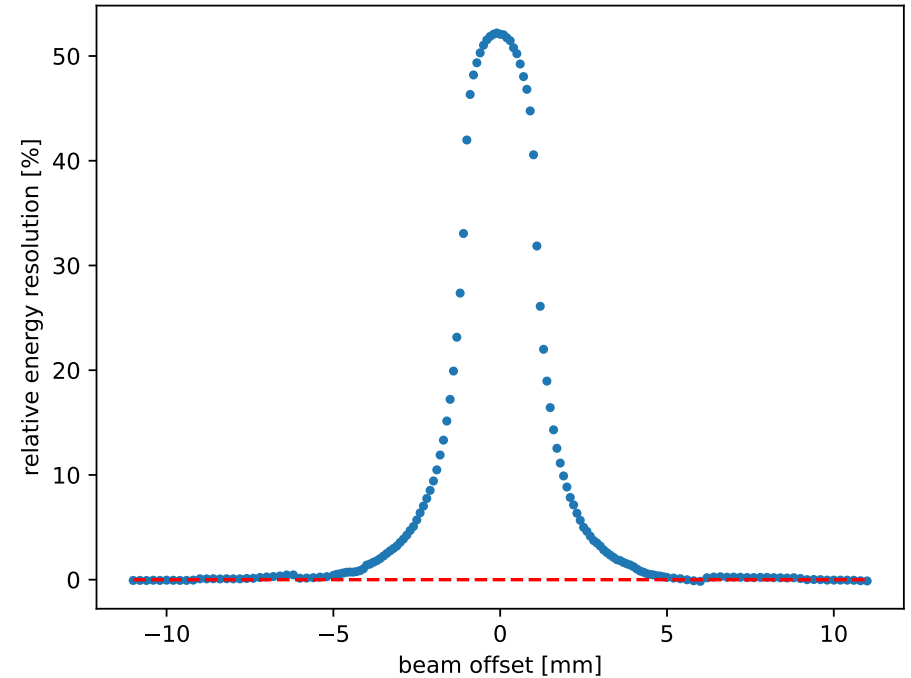


Results for 2.02mm gap gun position vs resolution

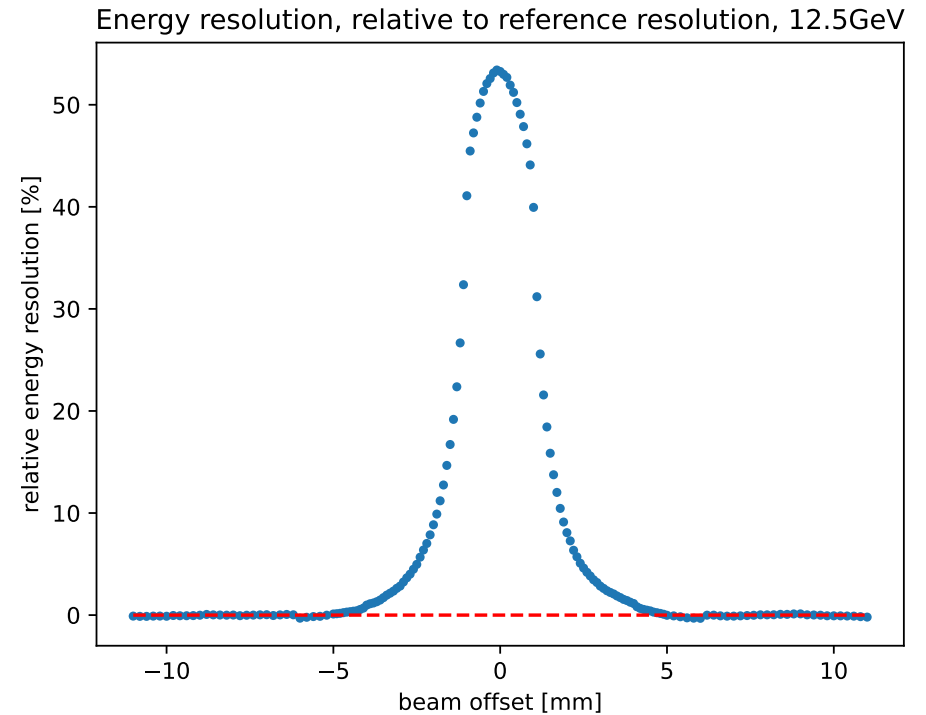
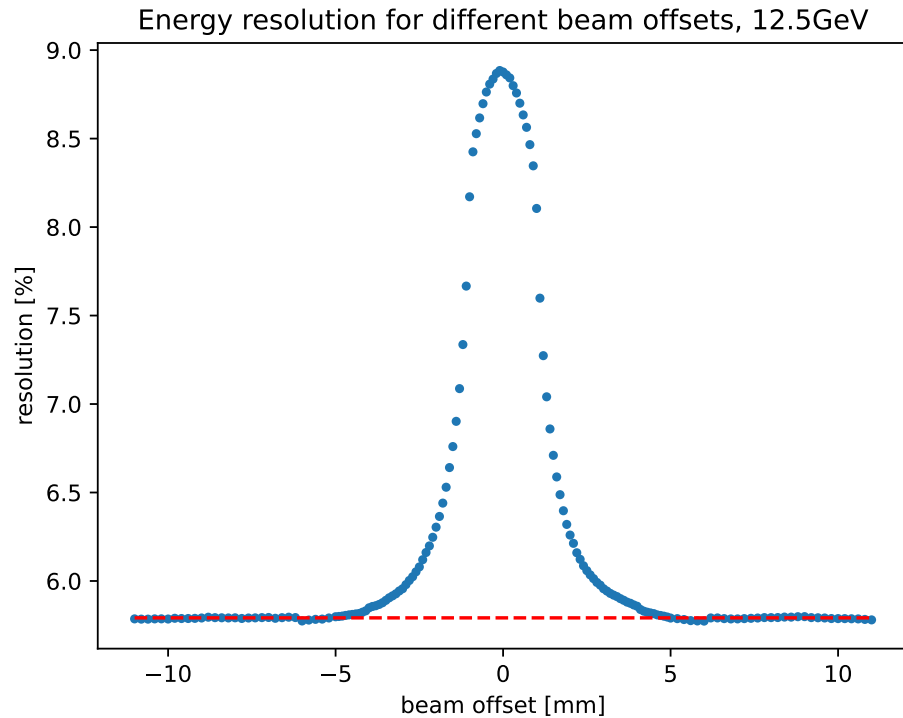
Energy resolution for different beam offsets, 10GeV



Energy resolution, relative to reference resolution, 10GeV

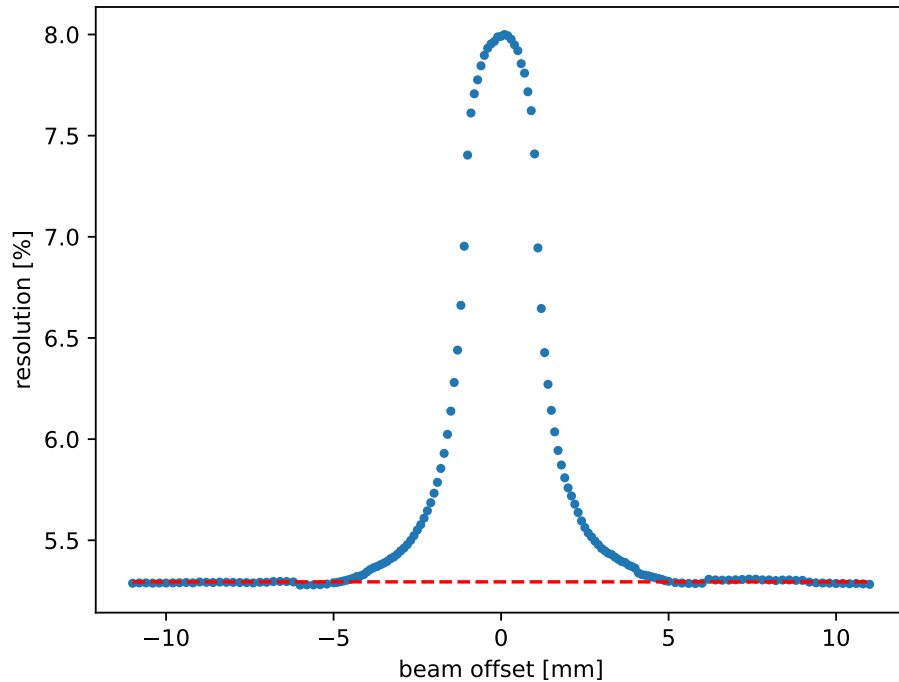


Results for 2.02mm gap gun position vs resolution

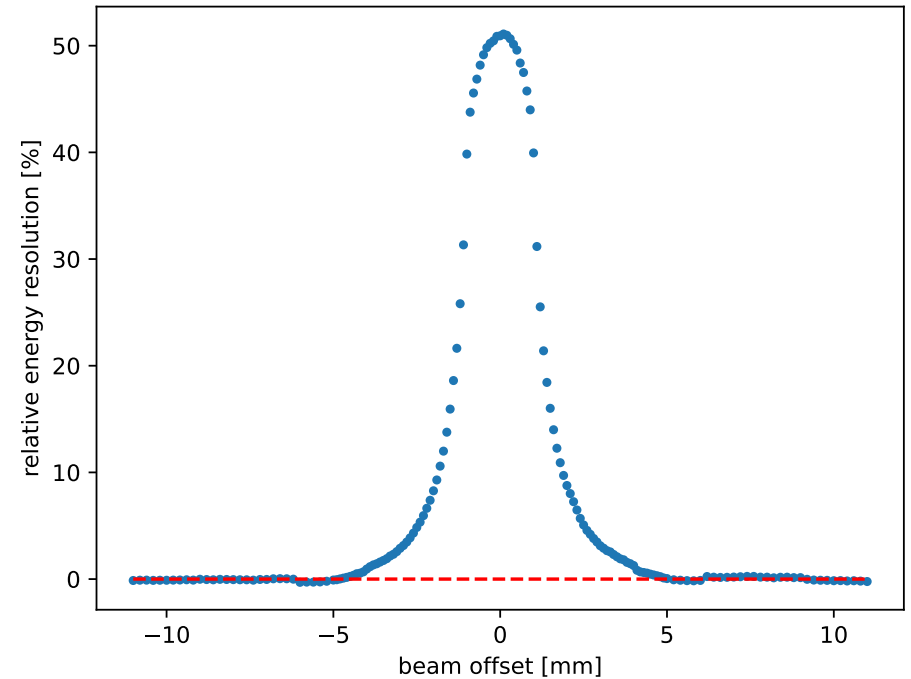


Results for 2.02mm gap gun position vs resolution

Energy resolution for different beam offsets, 15GeV



Energy resolution, relative to reference resolution, 15GeV

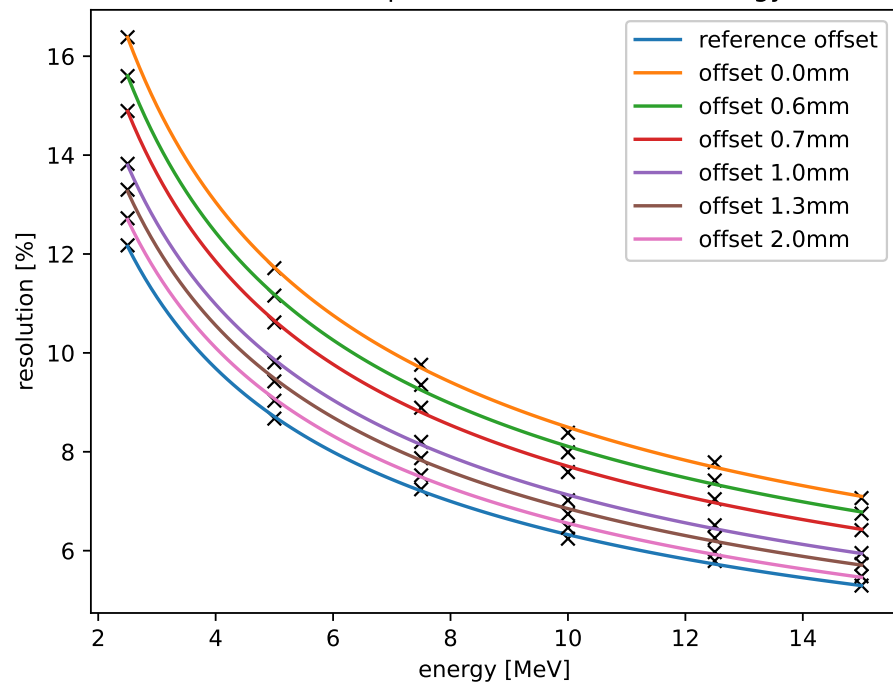


Energy vs resolution

For 1.22mm and 1.52mm gap

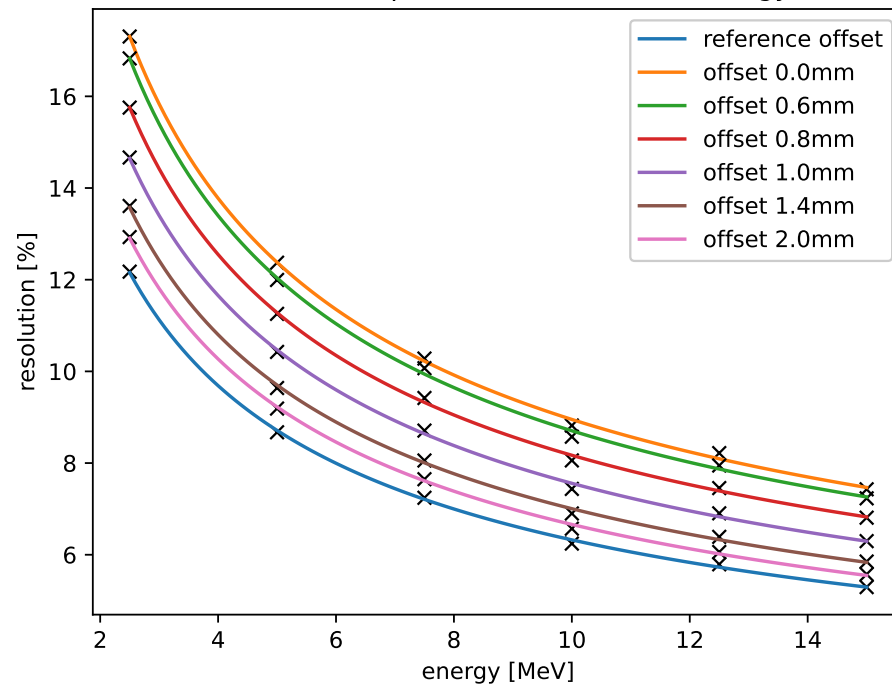
1.22mm gap

Resolution dependence on electron energy



1.52mm gap

Resolution dependence on electron energy

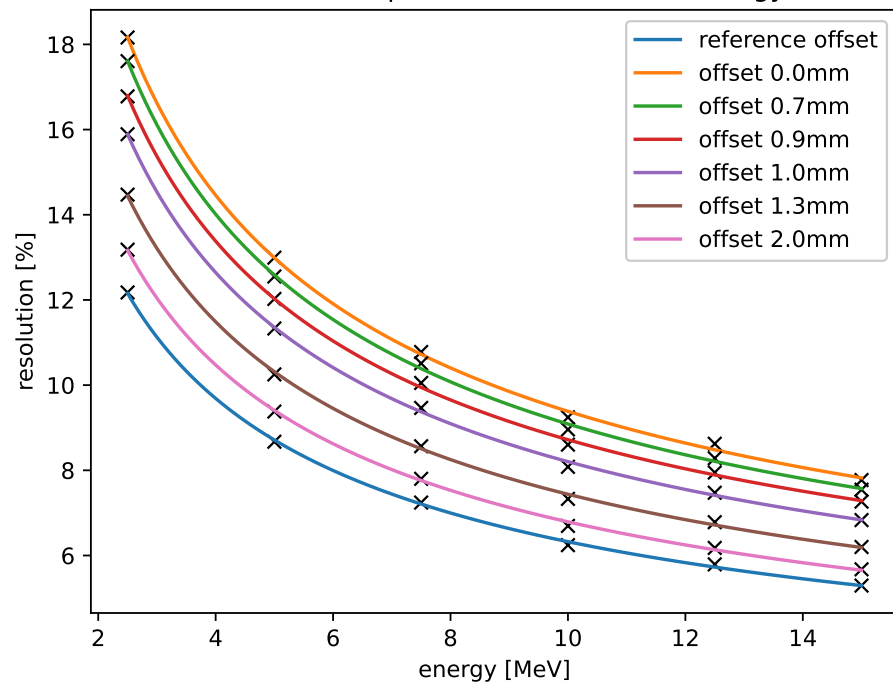


Energy vs resolution

For 1.82mm and 2.02mm gap

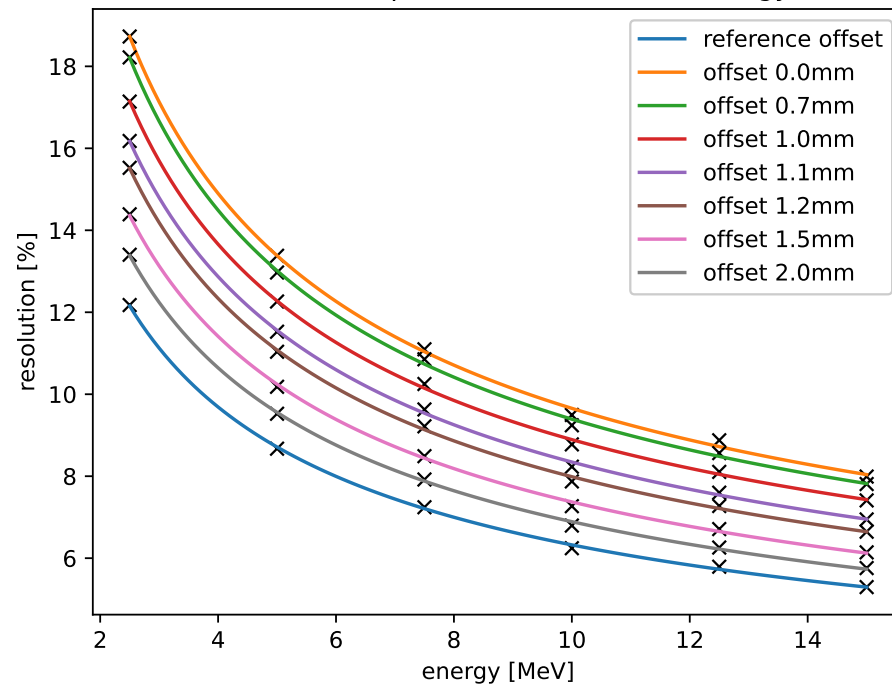
1.82mm gap

Resolution dependence on electron energy



2.02mm gap

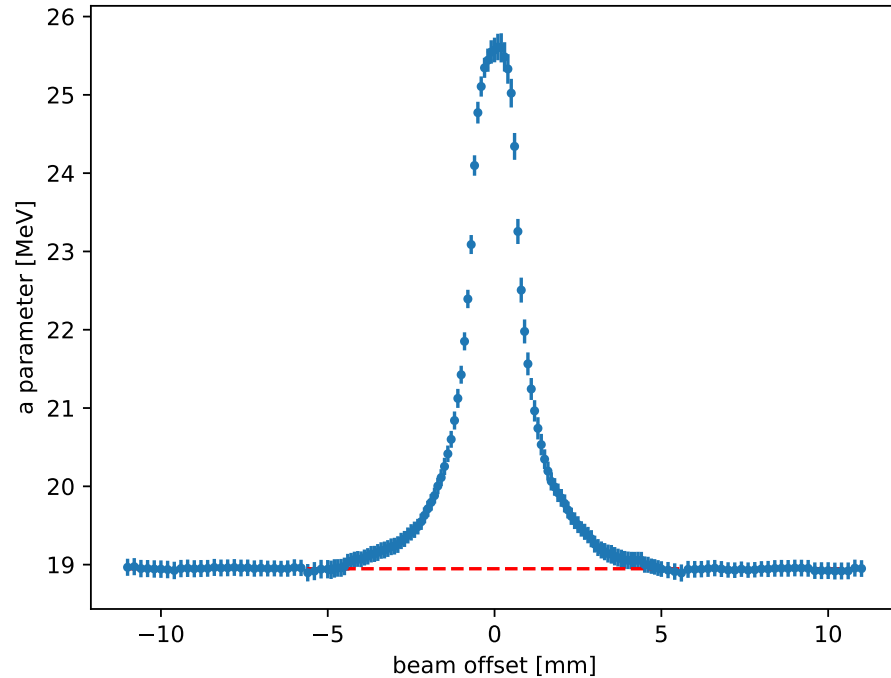
Resolution dependence on electron energy



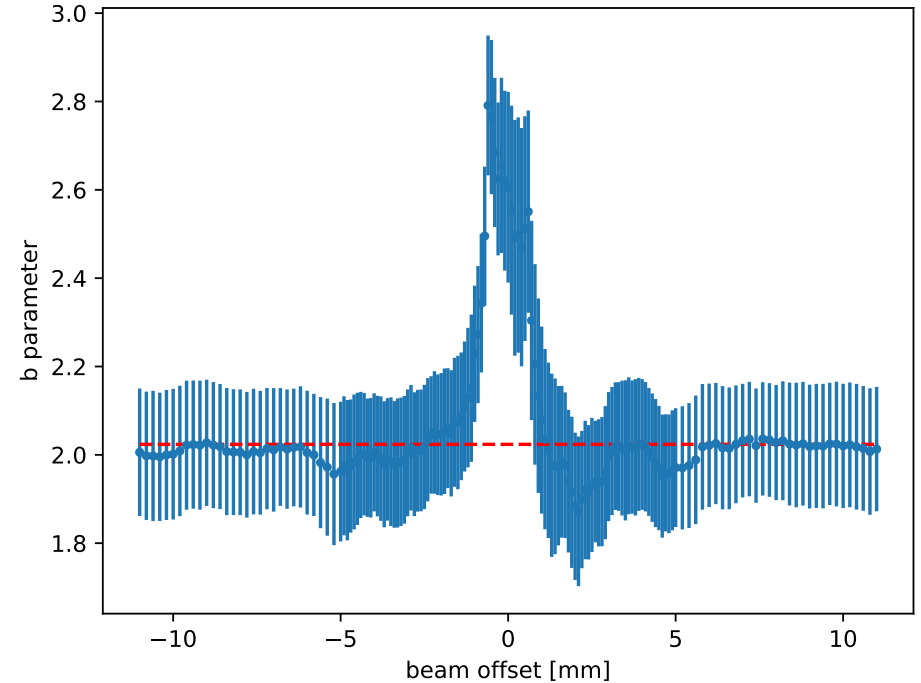
Gun position vs a and b

For 1.22mm gap

a parameter dependence on beam offset



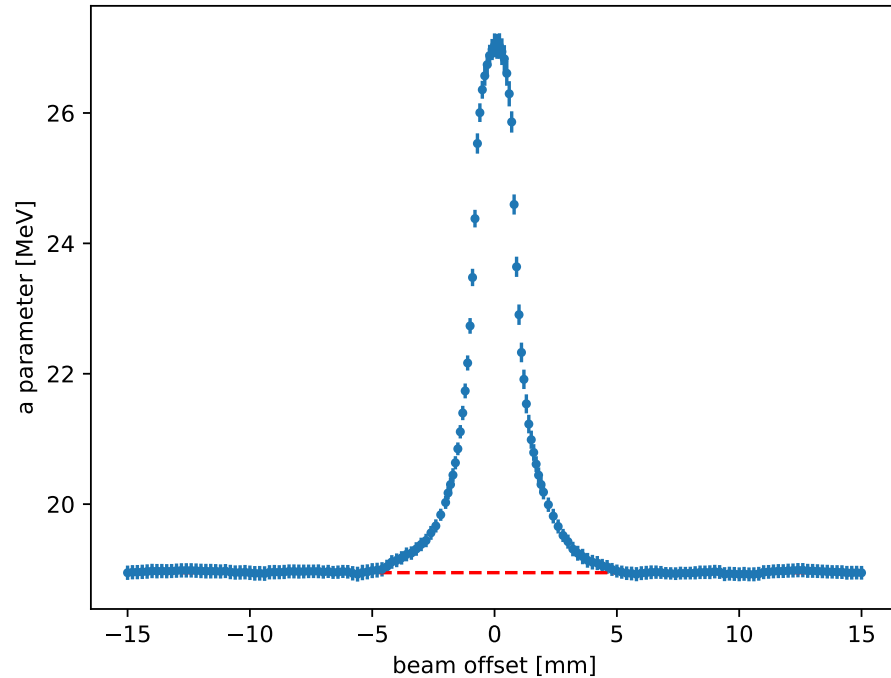
b parameter dependence on beam offset



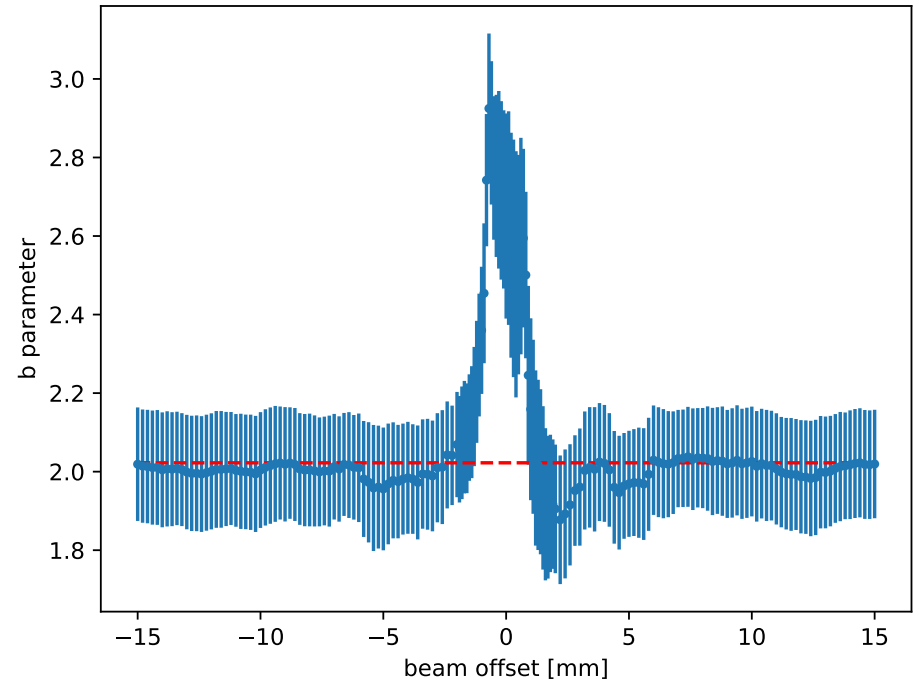
Gun position vs a and b

For 1.52mm gap

a parameter dependence on beam offset



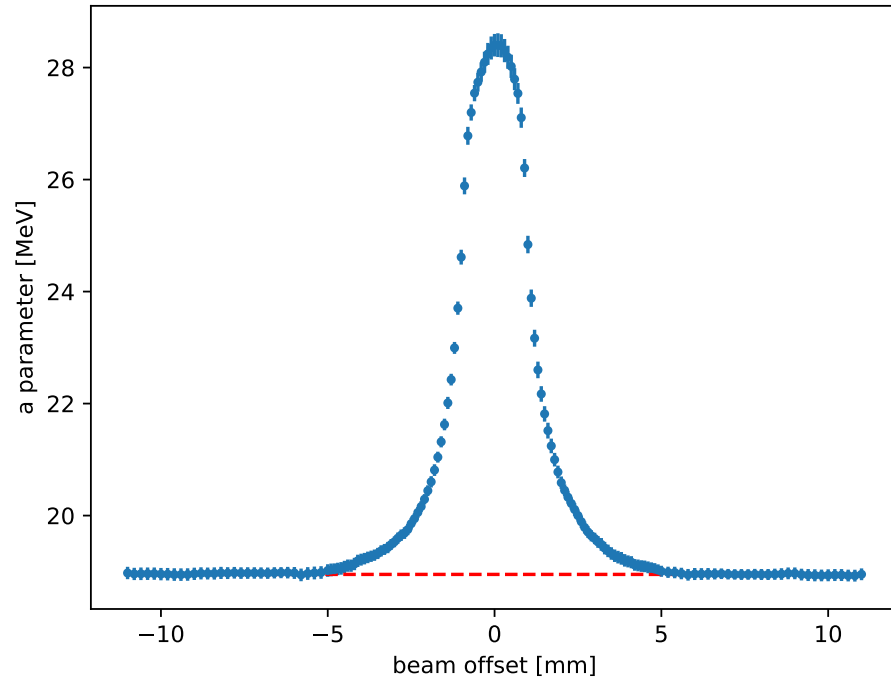
b parameter dependence on beam offset



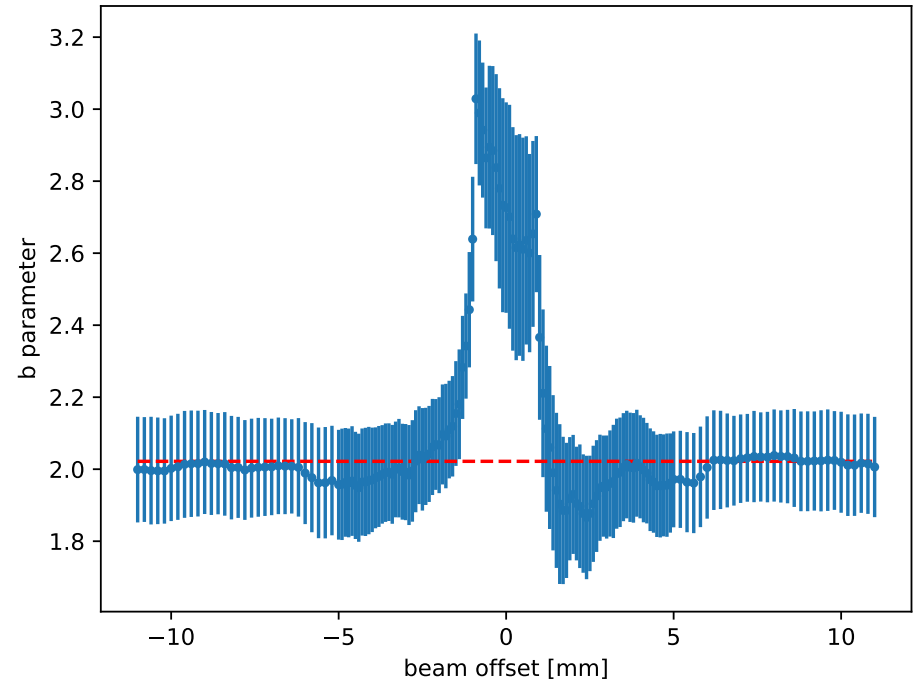
Gun position vs a and b

For 1.82mm gap

a parameter dependence on beam offset



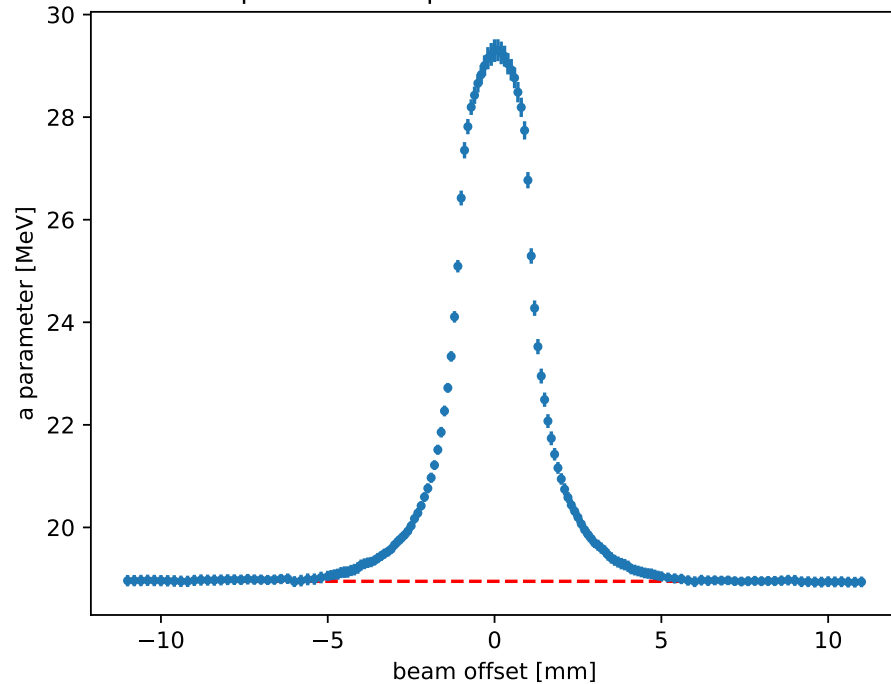
b parameter dependence on beam offset



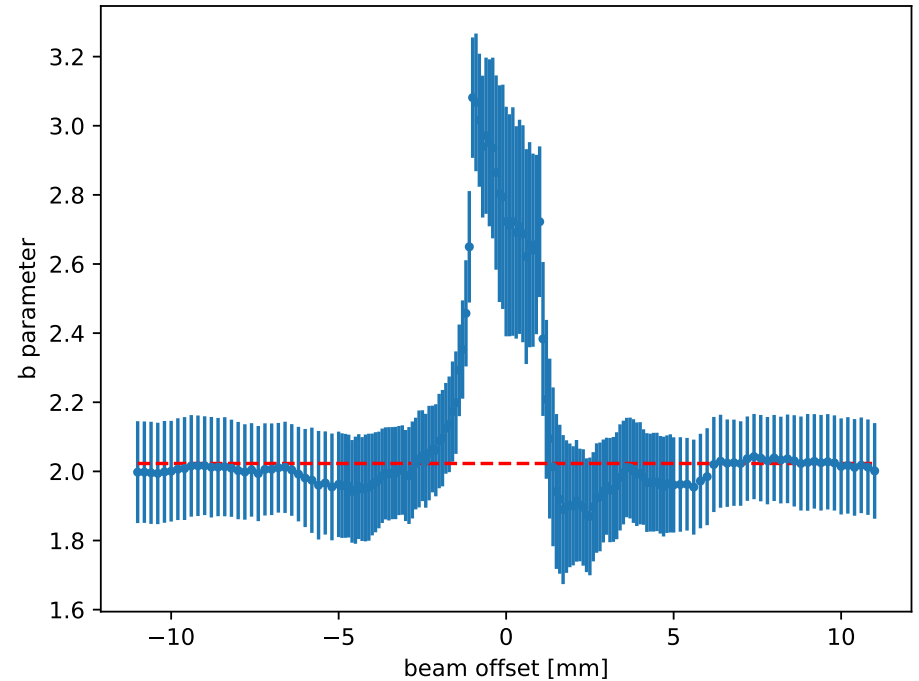
Gun position vs a and b

For 2.02mm gap

a parameter dependence on beam offset



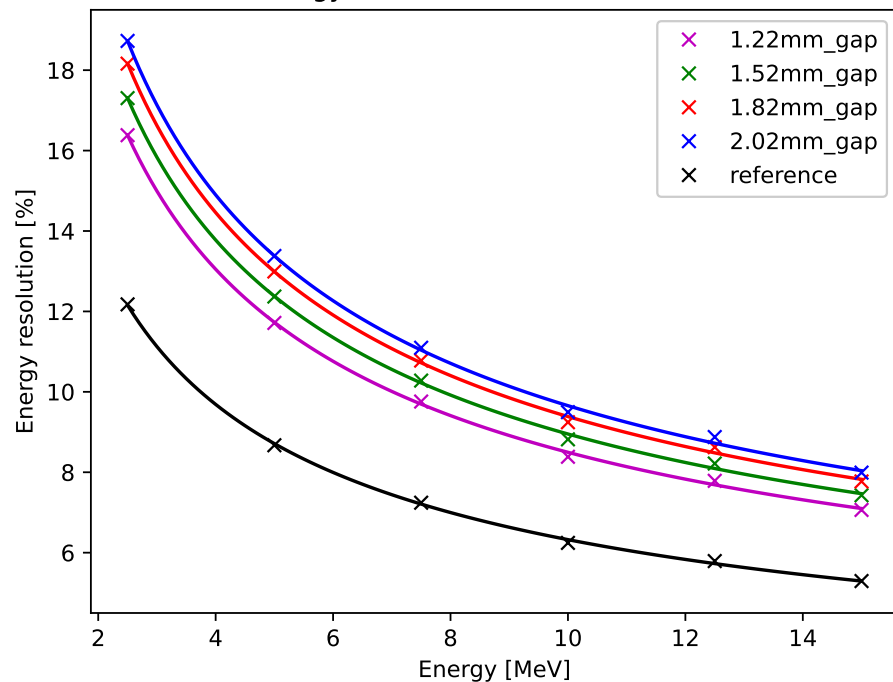
b parameter dependence on beam offset



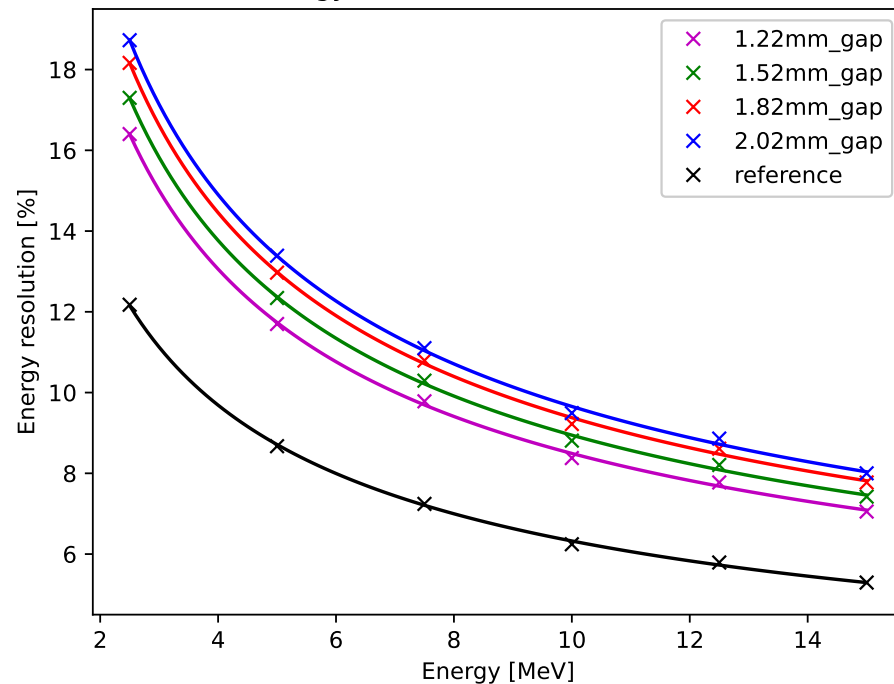
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=0.0mm



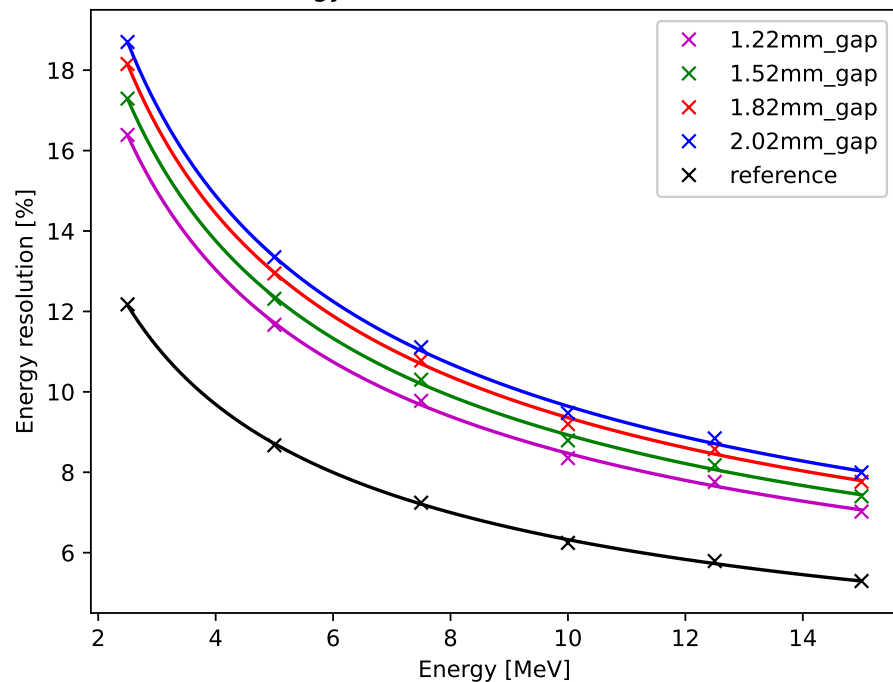
Energy resolution for offset=0.1mm



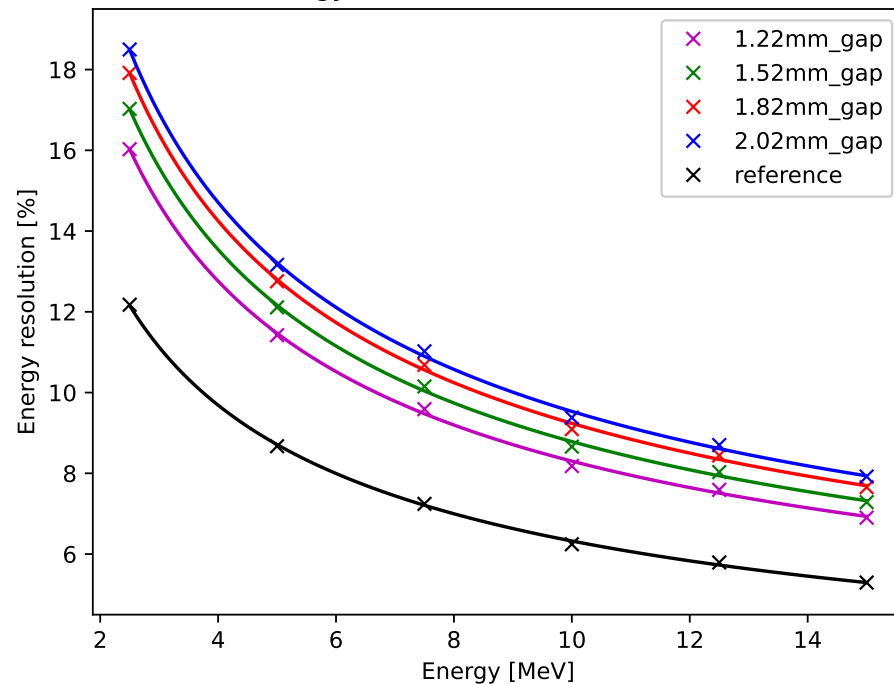
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=0.2mm



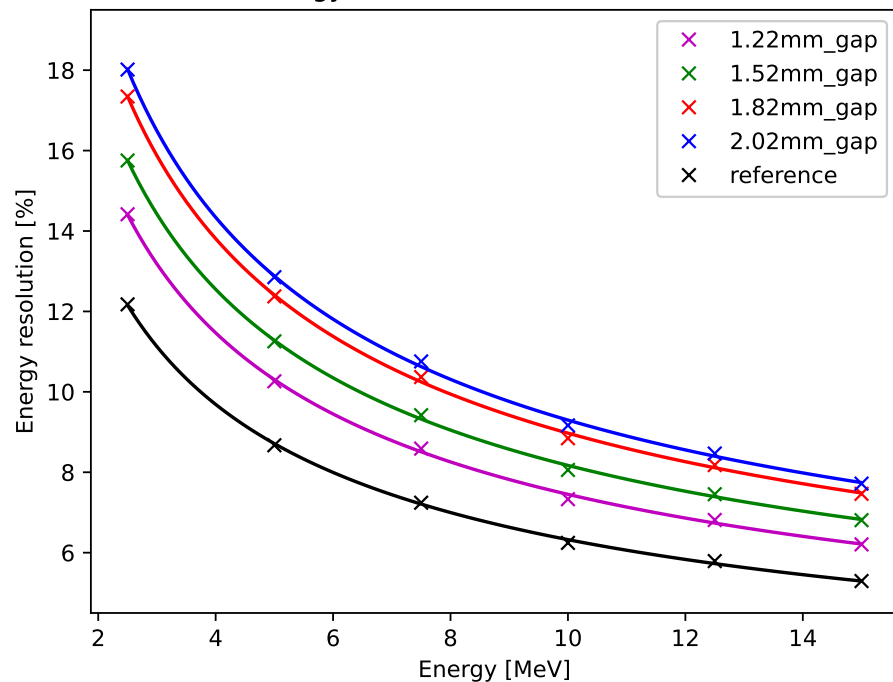
Energy resolution for offset=0.5mm



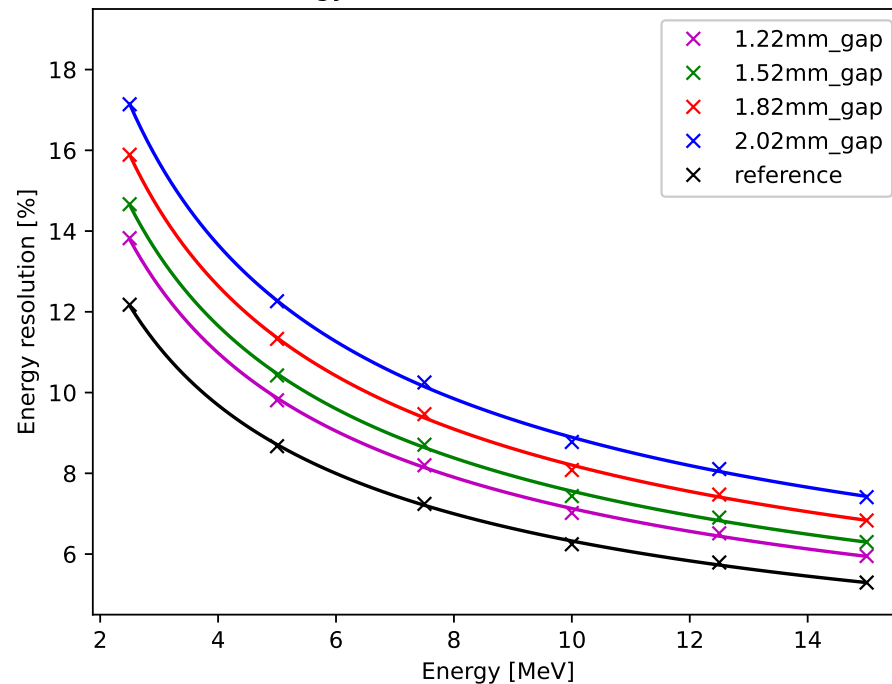
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=0.8mm



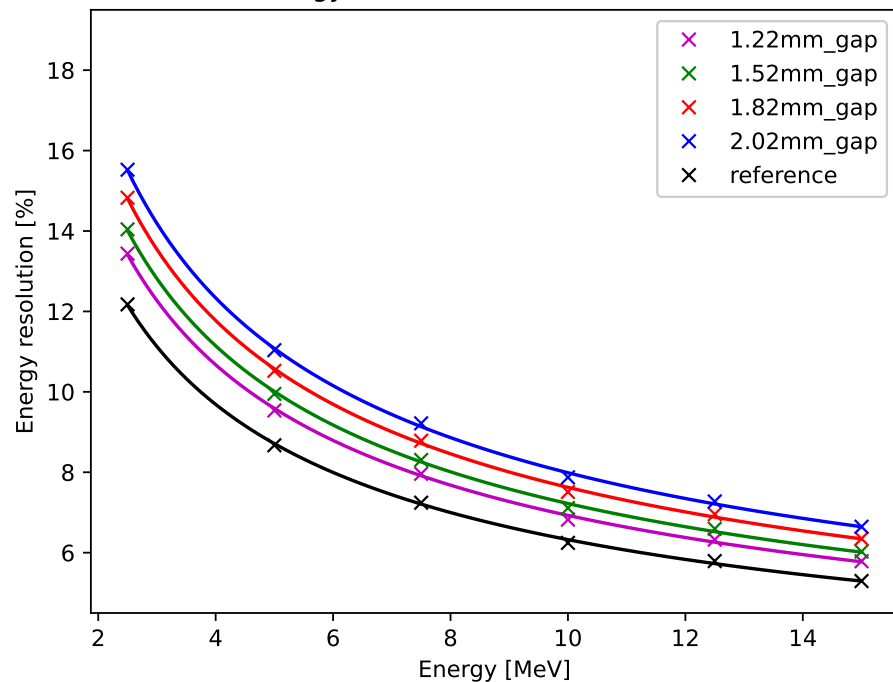
Energy resolution for offset=1.0mm



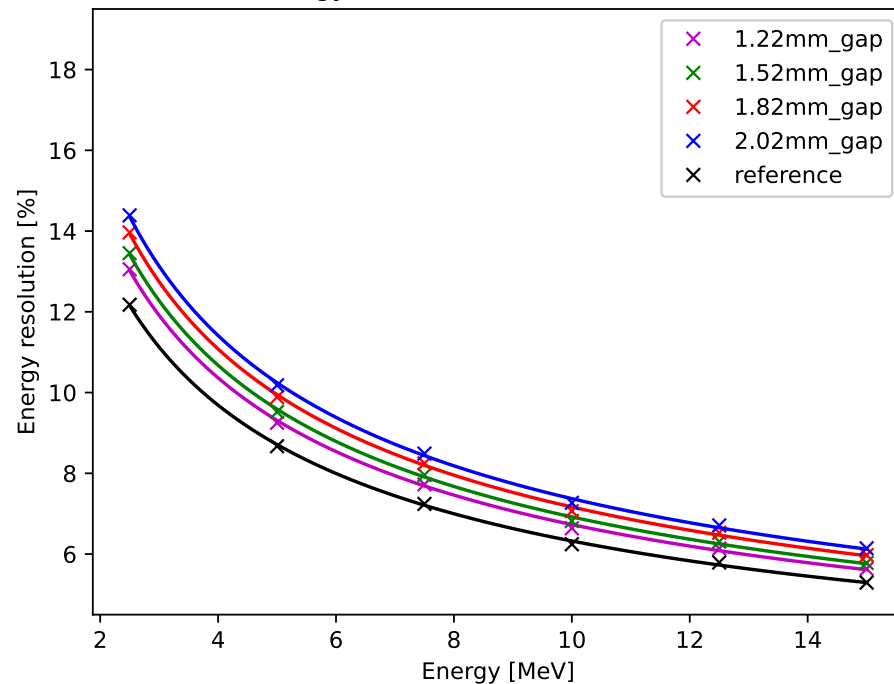
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=1.2mm



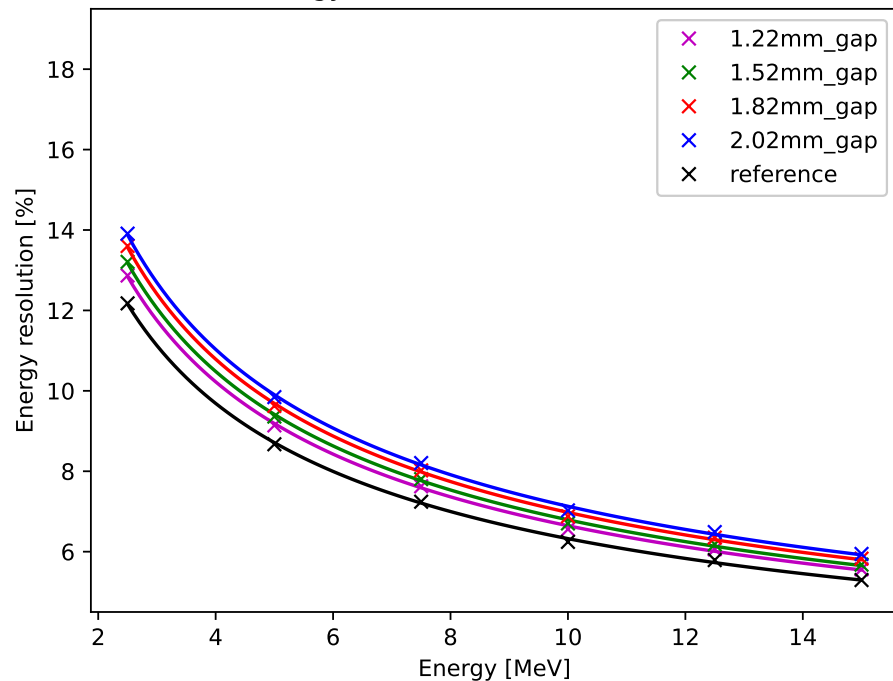
Energy resolution for offset=1.5mm



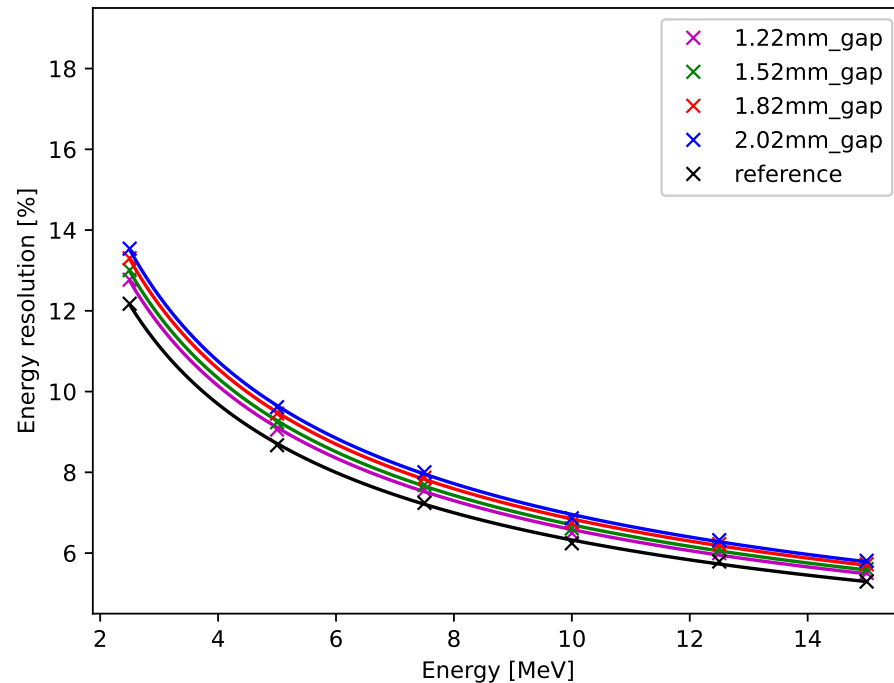
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=1.7mm



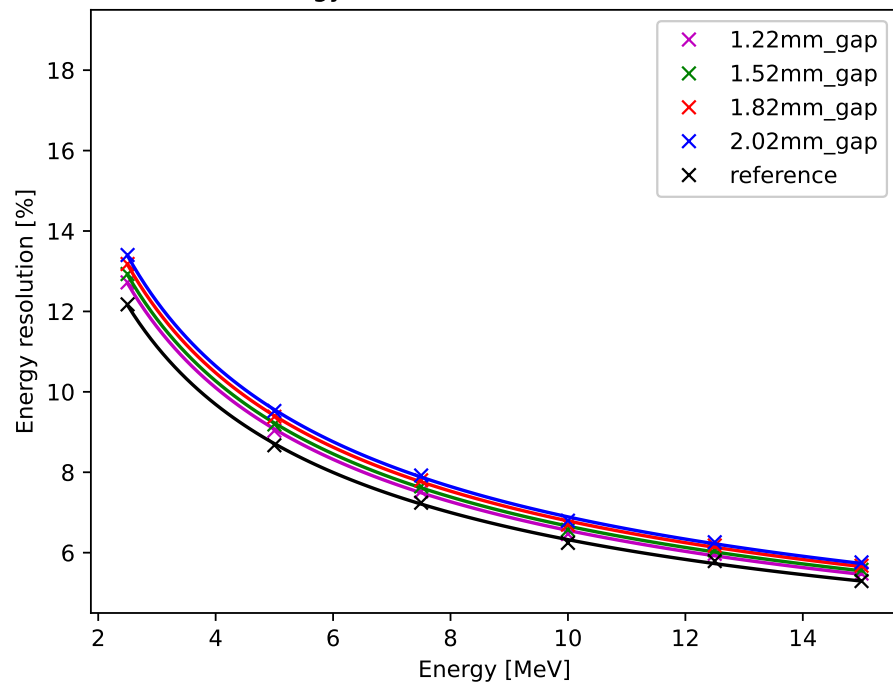
Energy resolution for offset=1.9mm



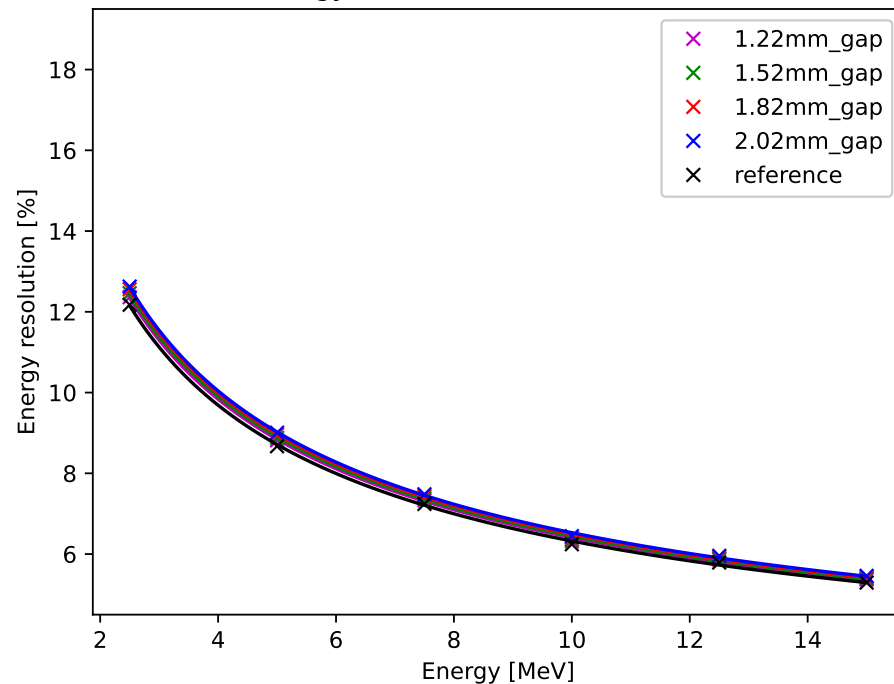
Energy vs resolution

For set offset and every gap sizes

Energy resolution for offset=2.0mm



Energy resolution for offset=3.0mm



Conclusions

- Significant worse (from 35% to 55% worse than reference) of resolution when particles hit center of the tile gap
- Cascade core is very narrow → even small tile gaps impact resolution
- If the hit is located more than 3mm from the centre of the tile gap, resolution hardly depends on the width of the gap,
- Small asymmetry in b parameter → impact of residual magnetic field?

To do

- No MC with positrons hitting ECAL-P at an angle
- Small shift of each layer can be equivalent (for small angles, first approximation) to changing the angle of incident positron
- Way to check the resolution when the track of the incident particles is angled