Dependence of energy resolution on width of the tile gaps

Kamil Zembaczyński[1]

Advisors: Aleksander Filip Żarnecki[1], Grzegorz Grzelak[1]

[1]University of Warsaw

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, 320µm silicon sensor,
- Plain silicon layer in MC → 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: $1X_0$=3.5mm
  - Moliere radius: R_M=9.33mm

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

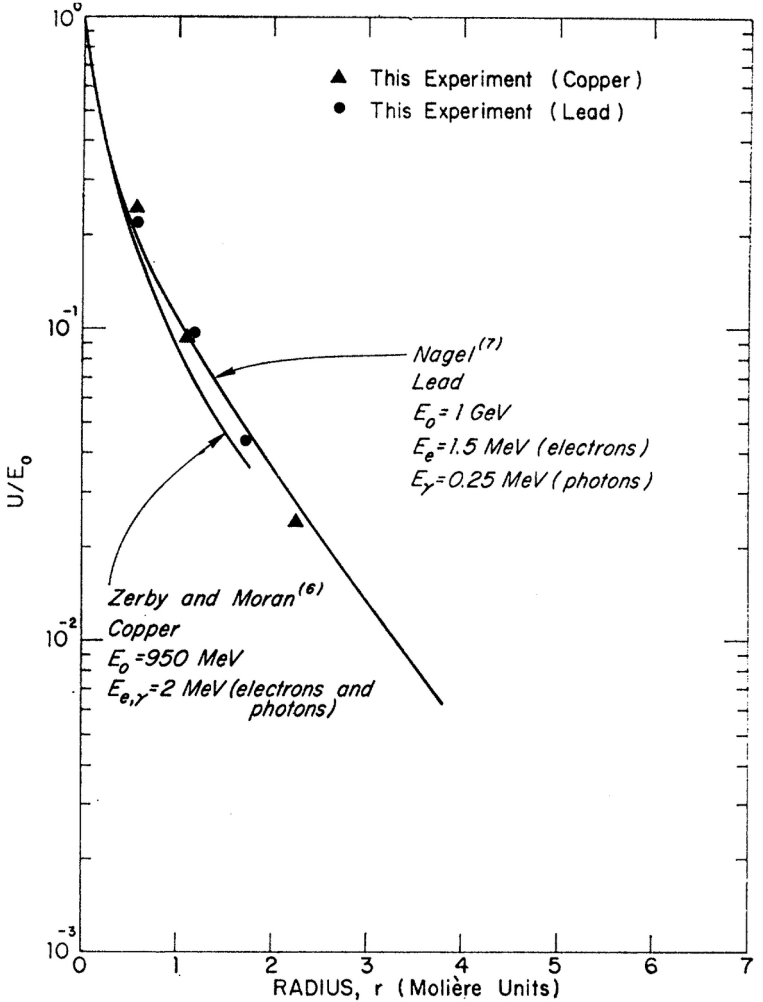
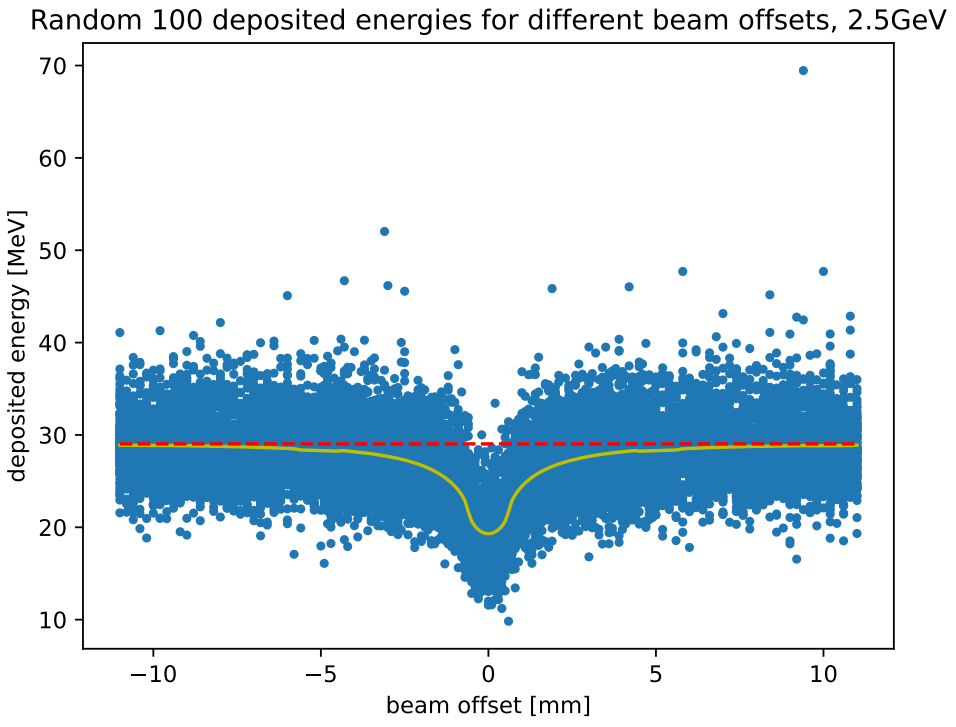
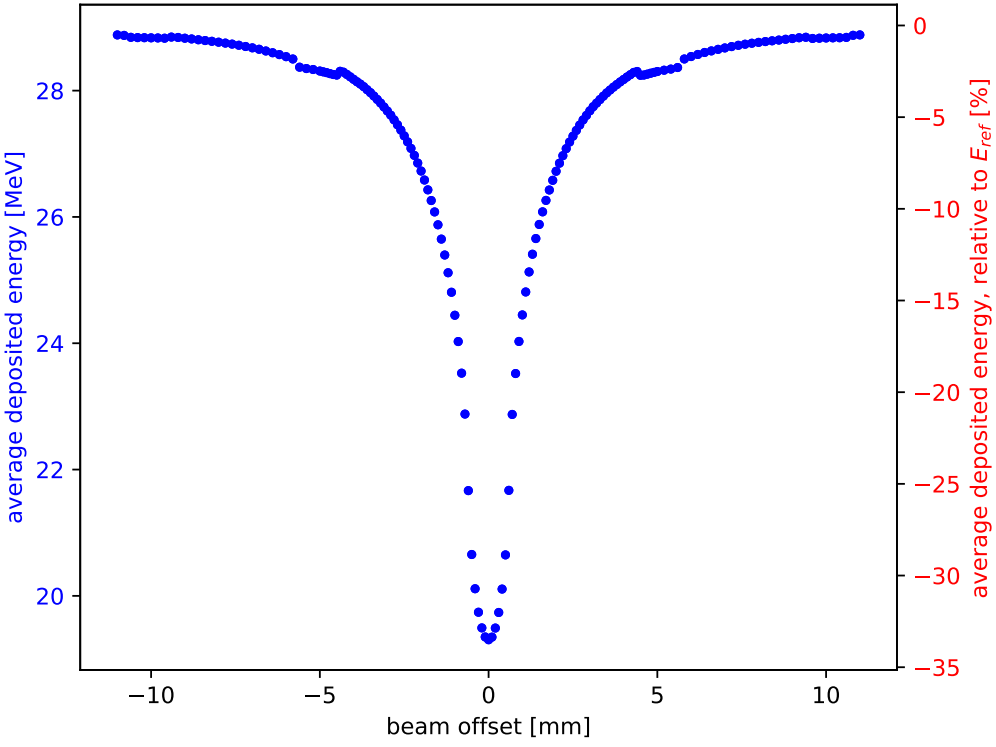


FIG. 12. Fraction of the incident energy that escapes various cylinderical volumes. A comparison of this experiment with Monte Carlo calculations.

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

Results for 1.22mm gap
gun position vs deposited energy





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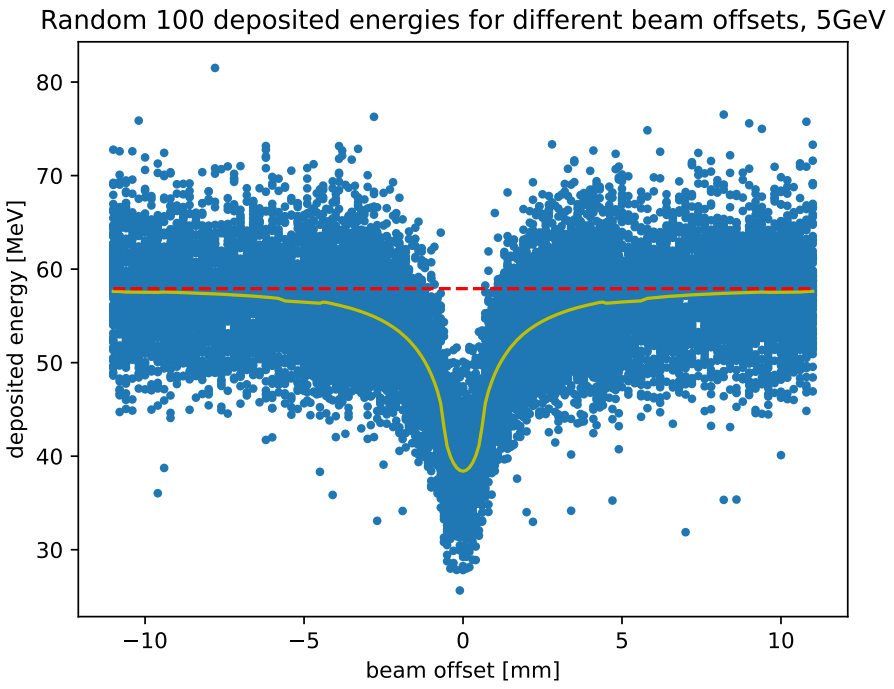

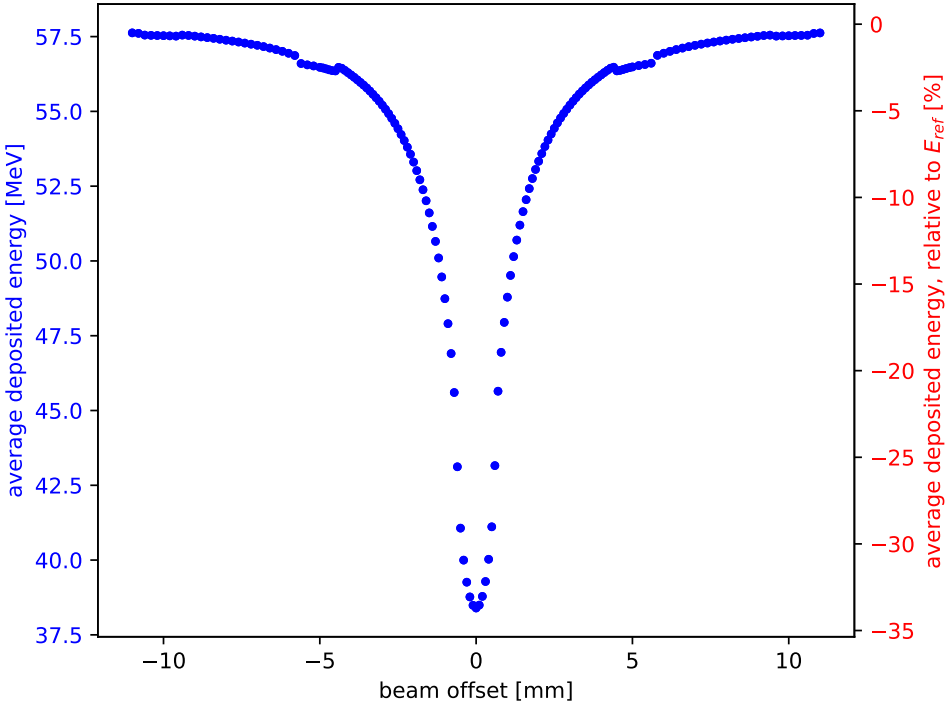

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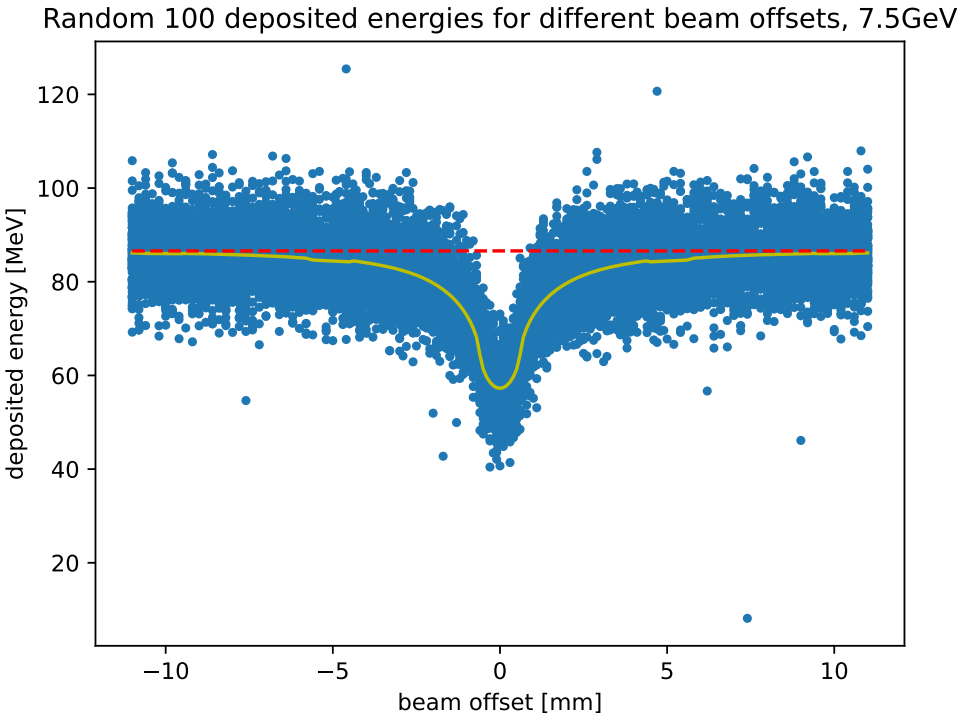

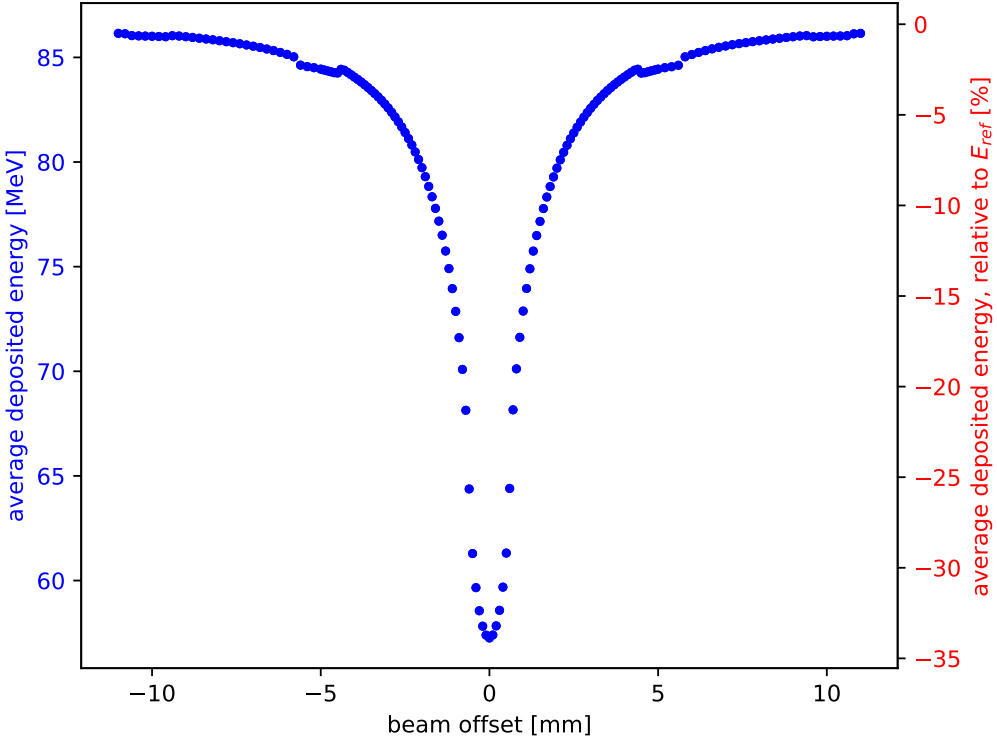

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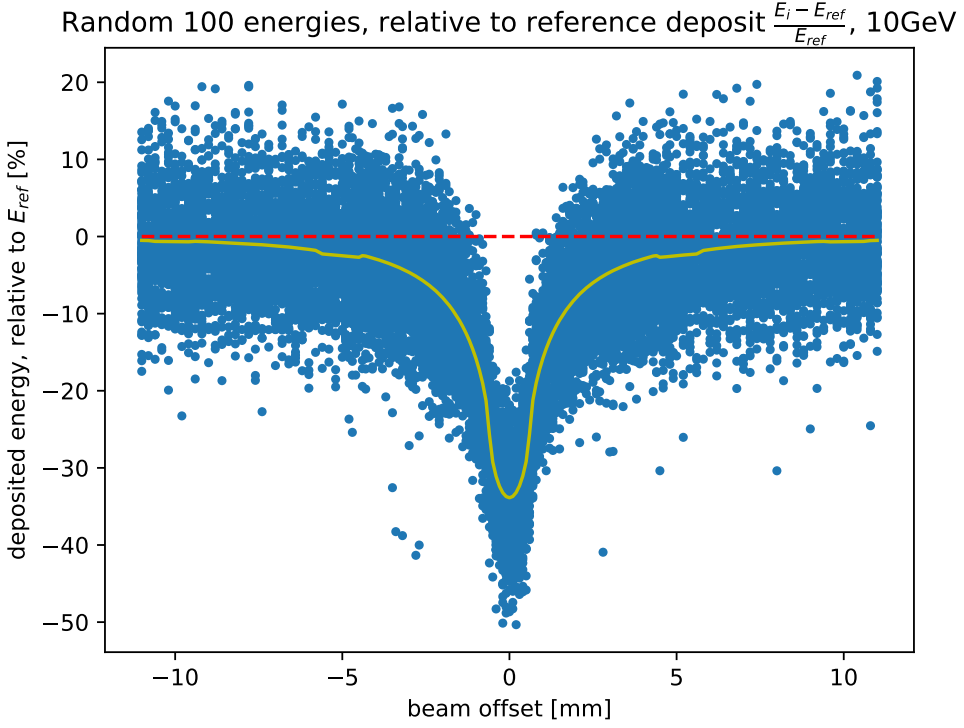

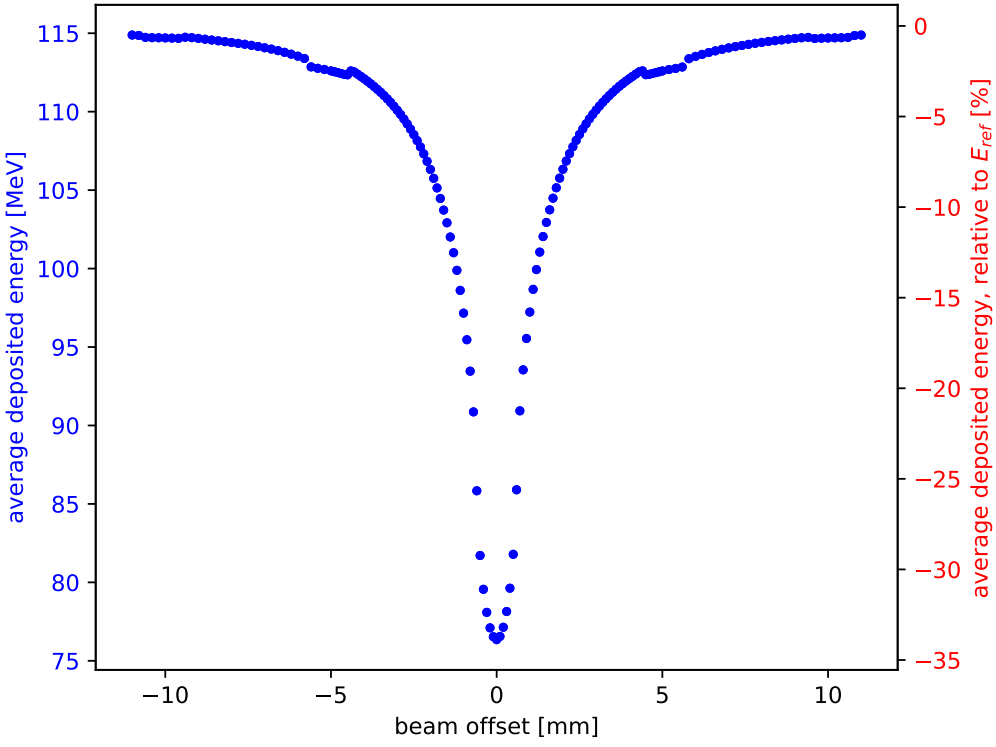

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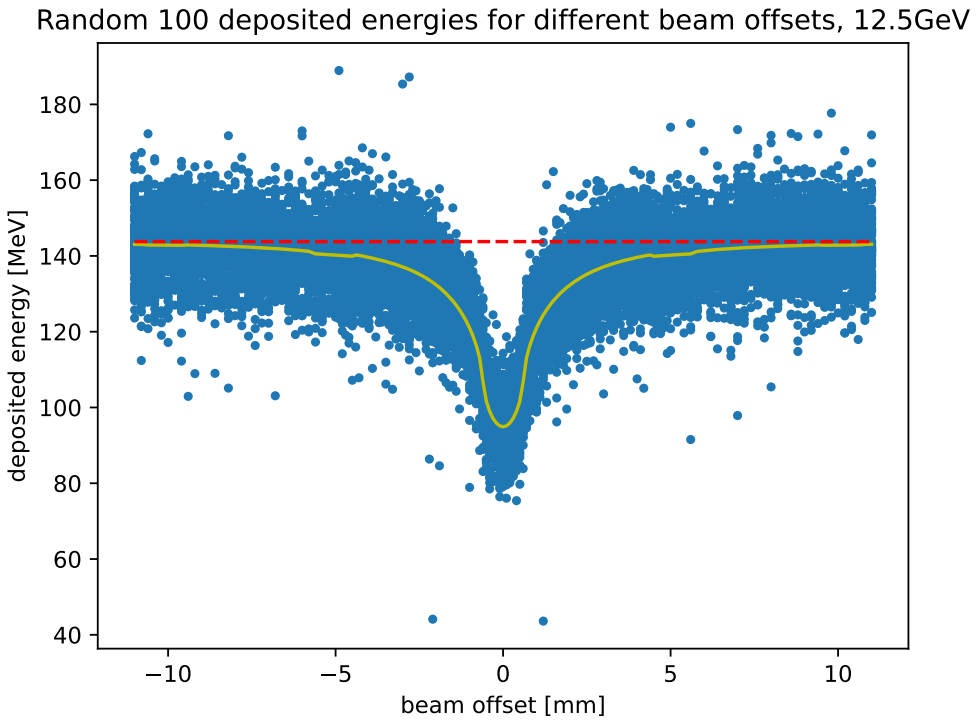

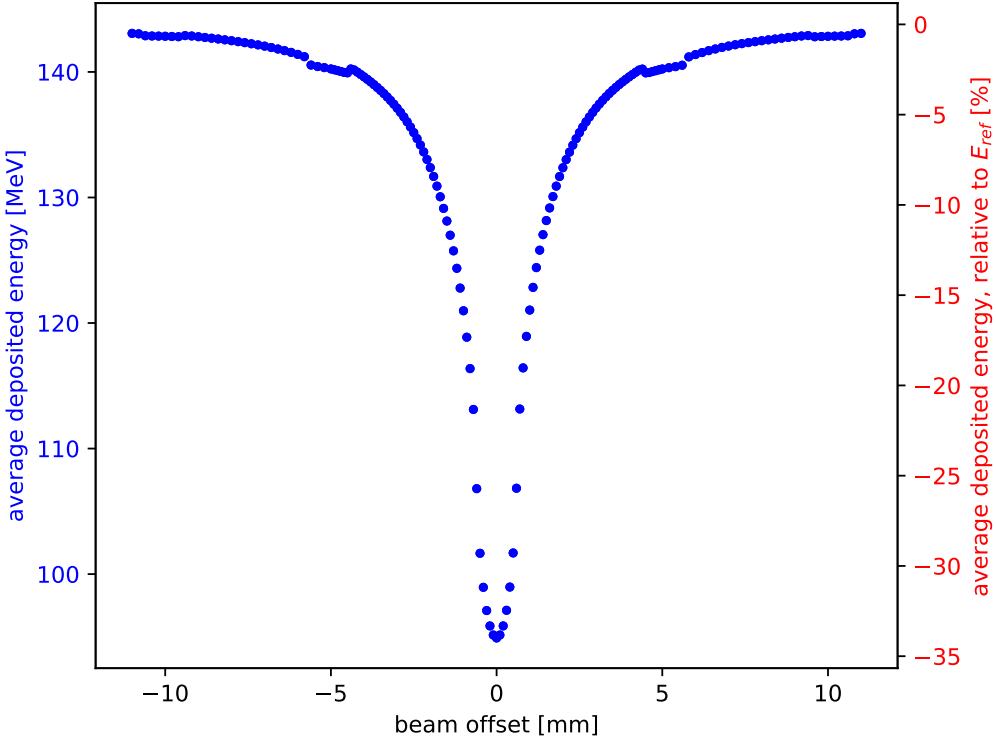

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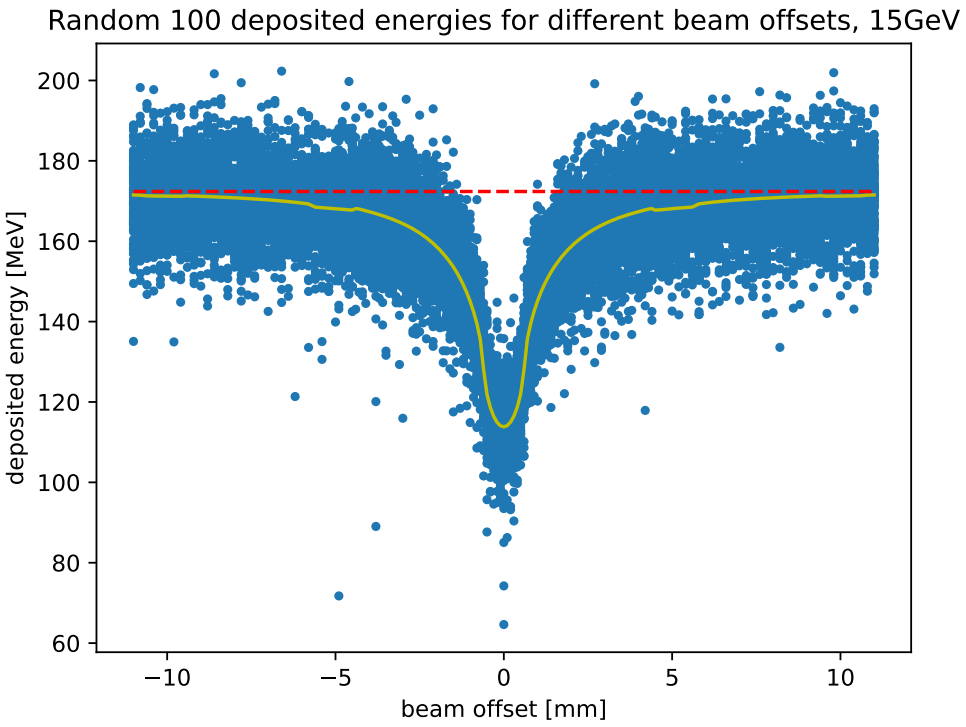
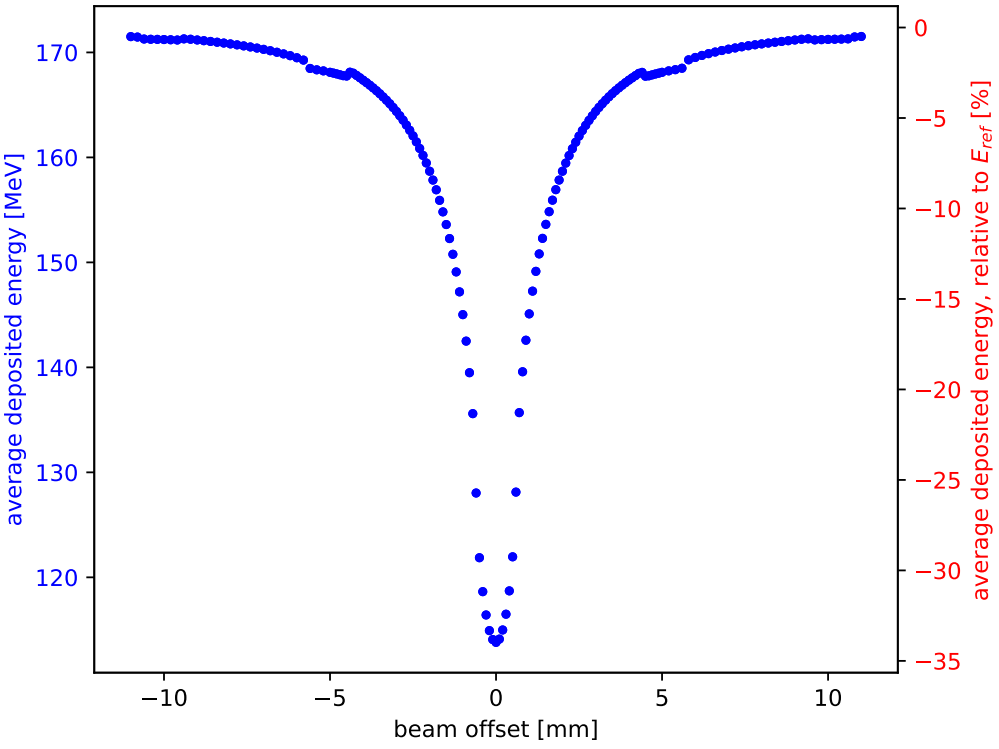
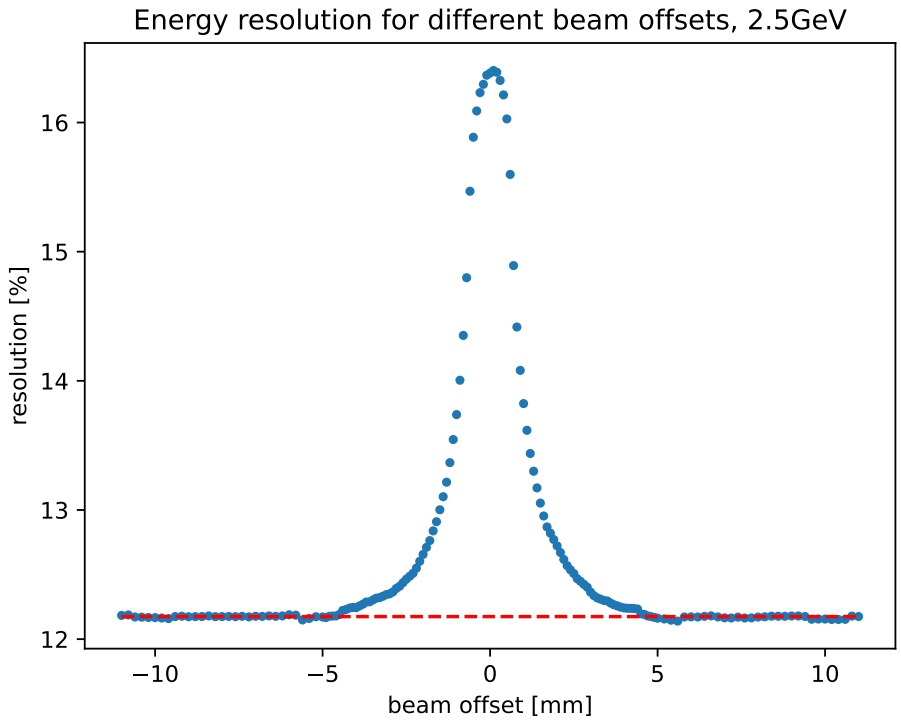
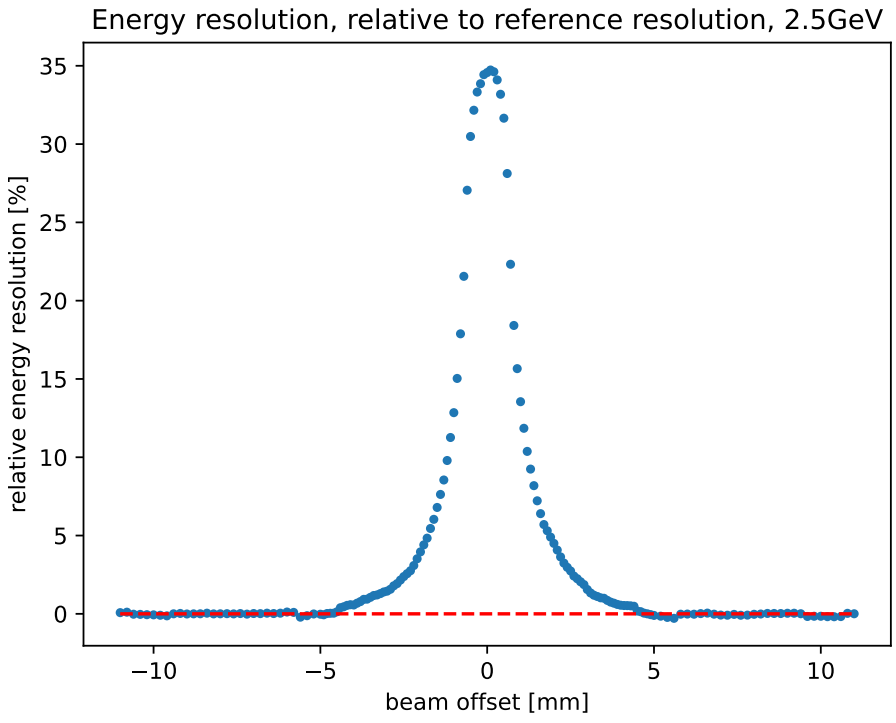




Results for 1.22mm gap
gun position vs resolution





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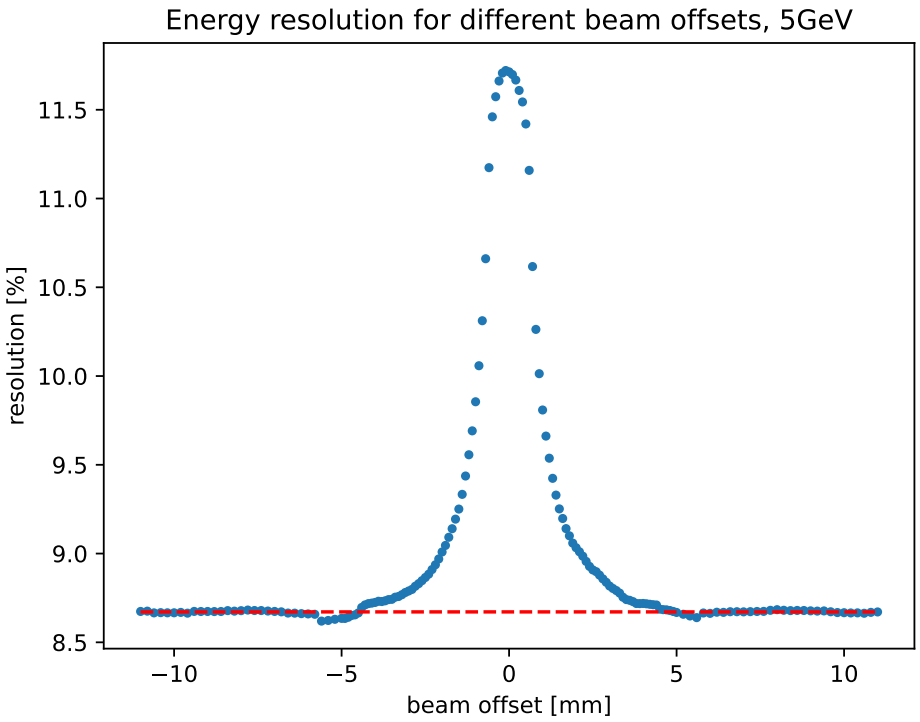

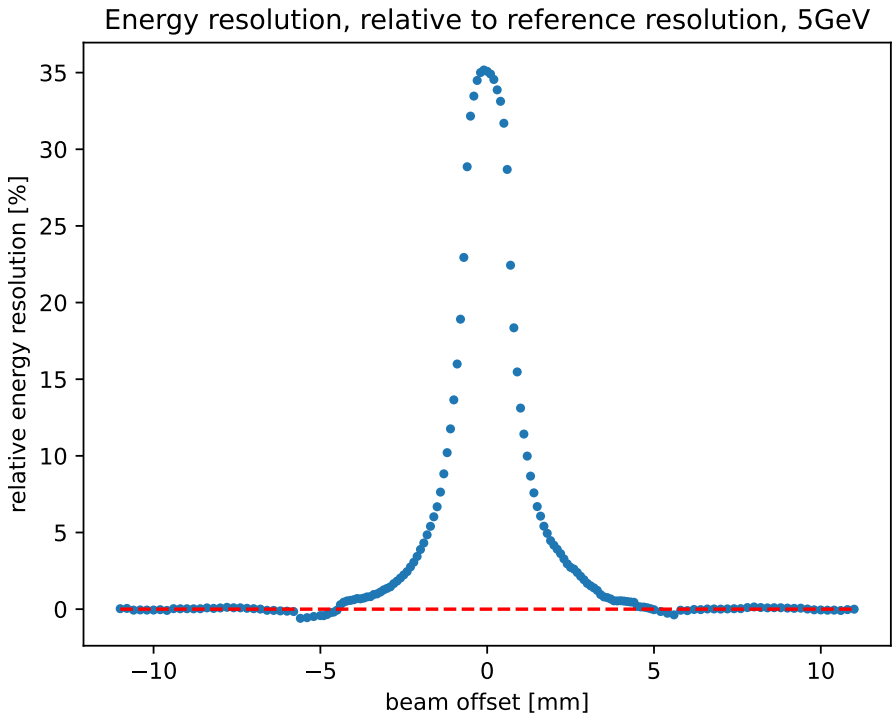

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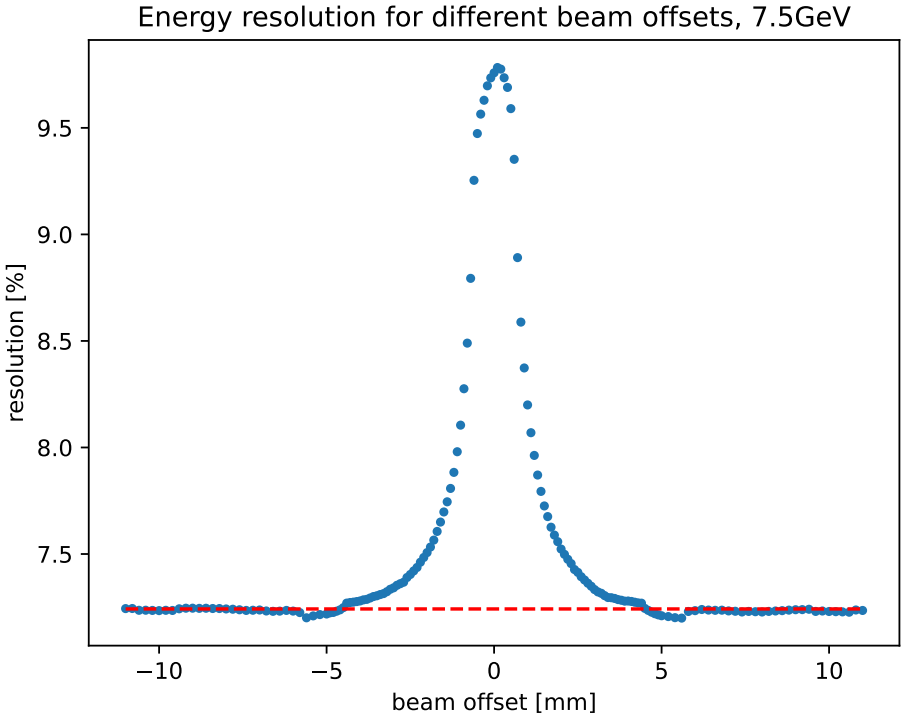

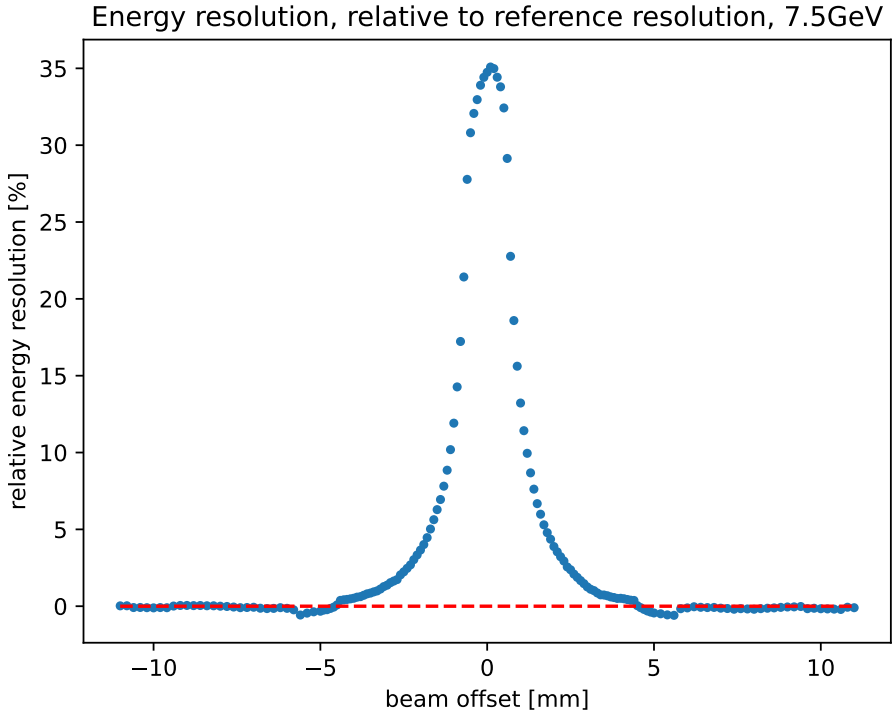

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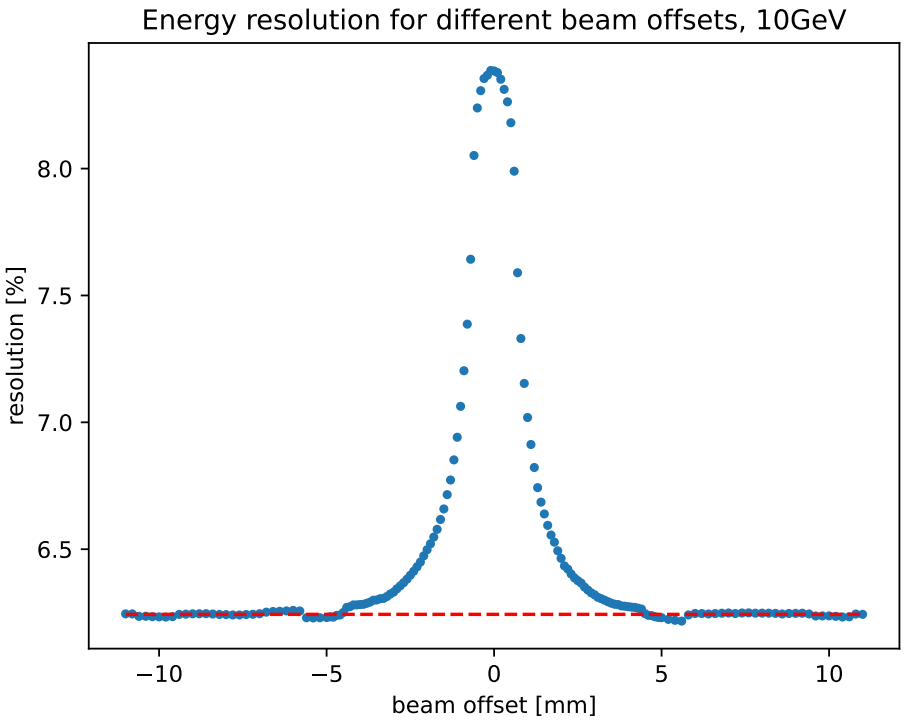

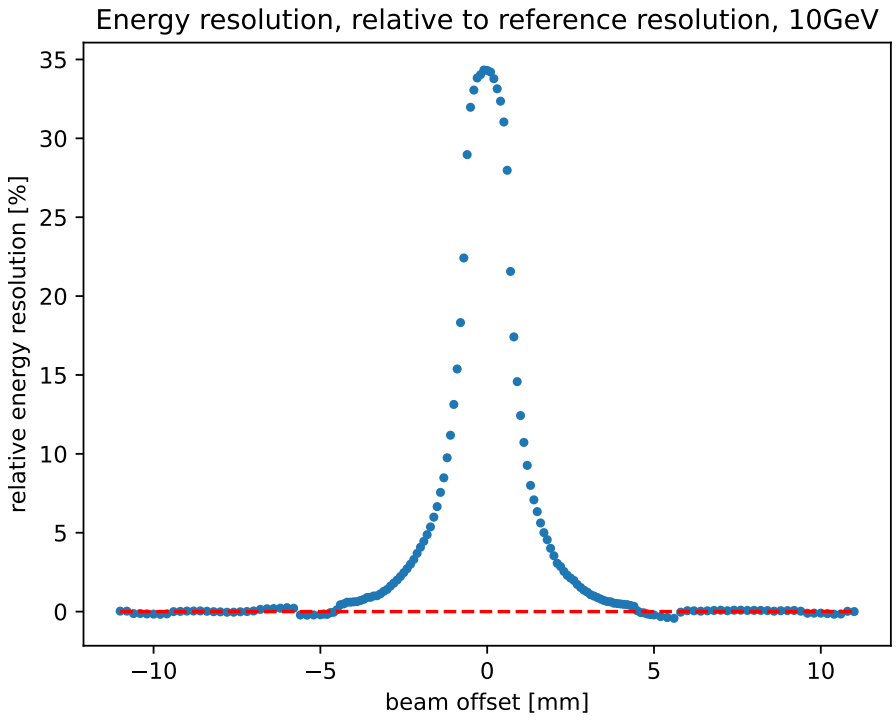

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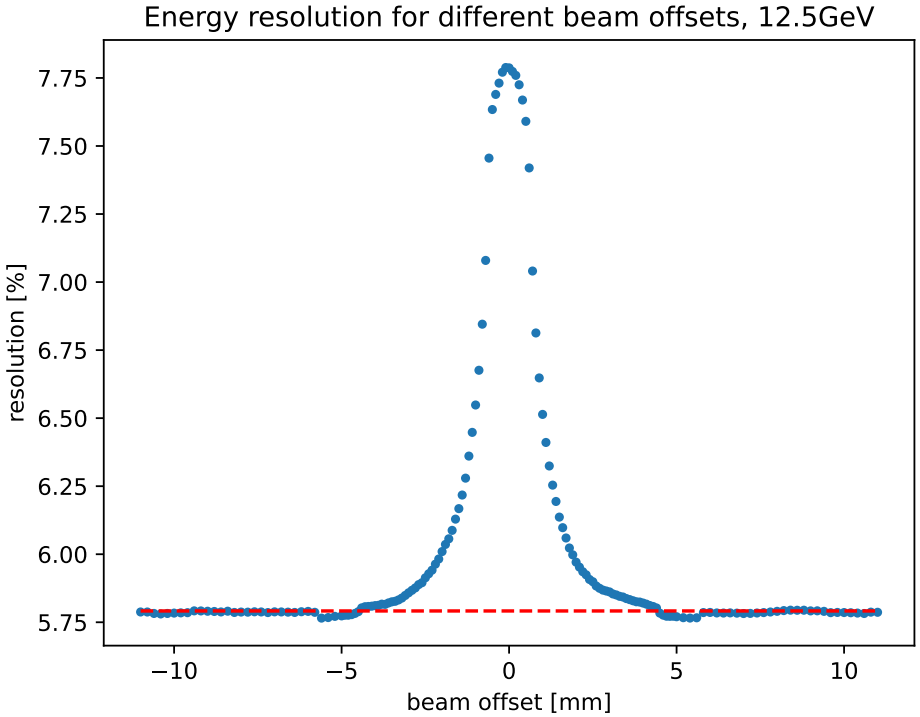

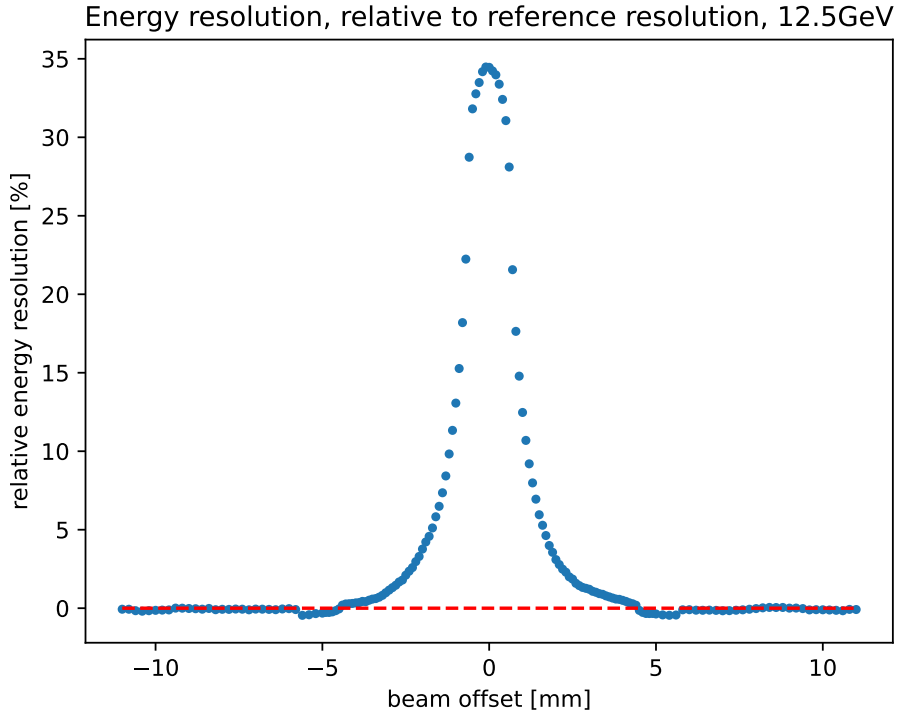

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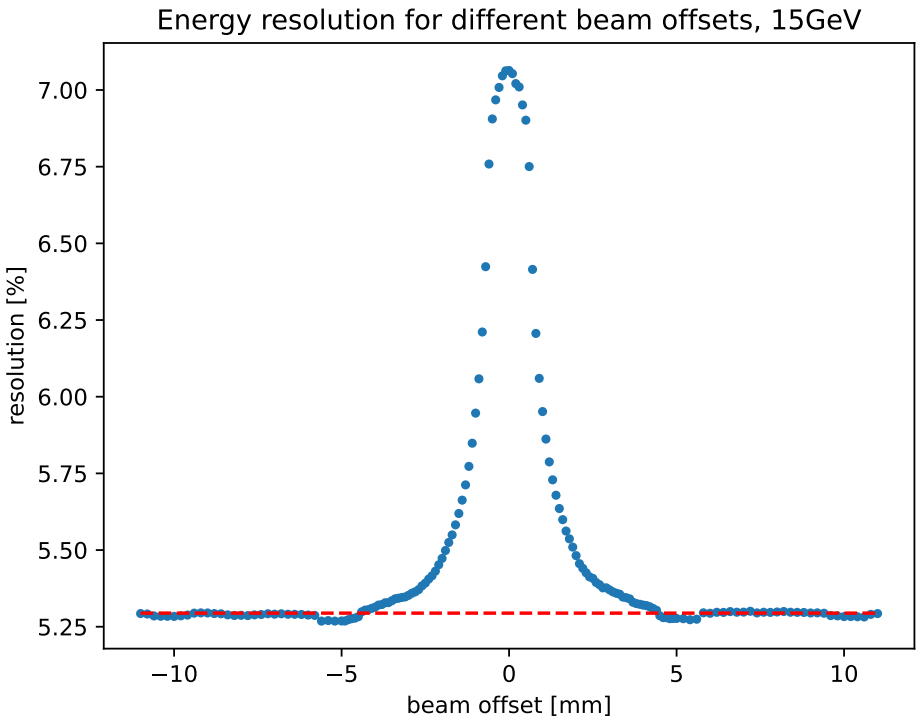
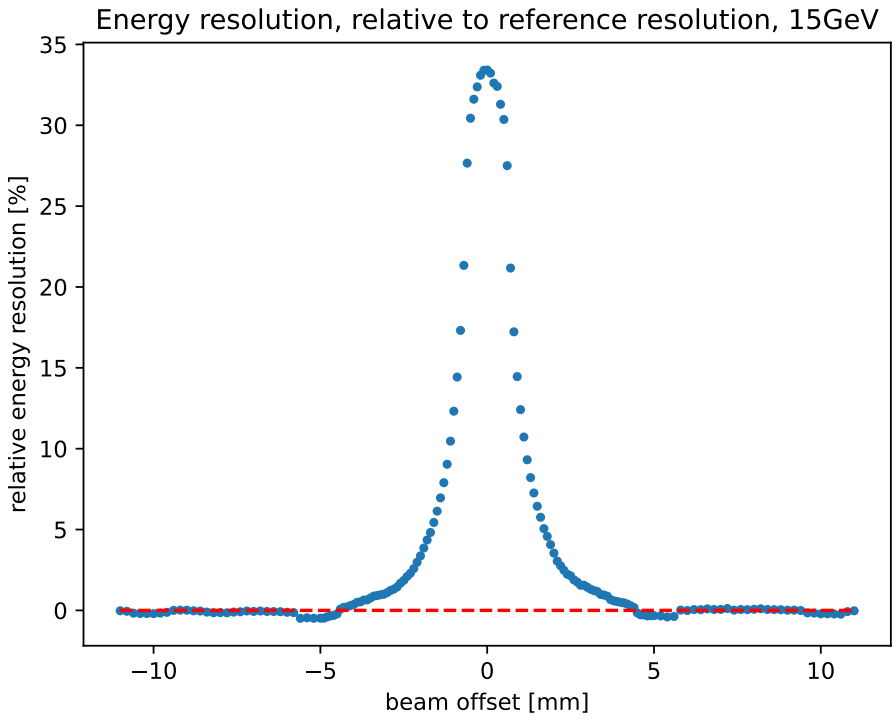
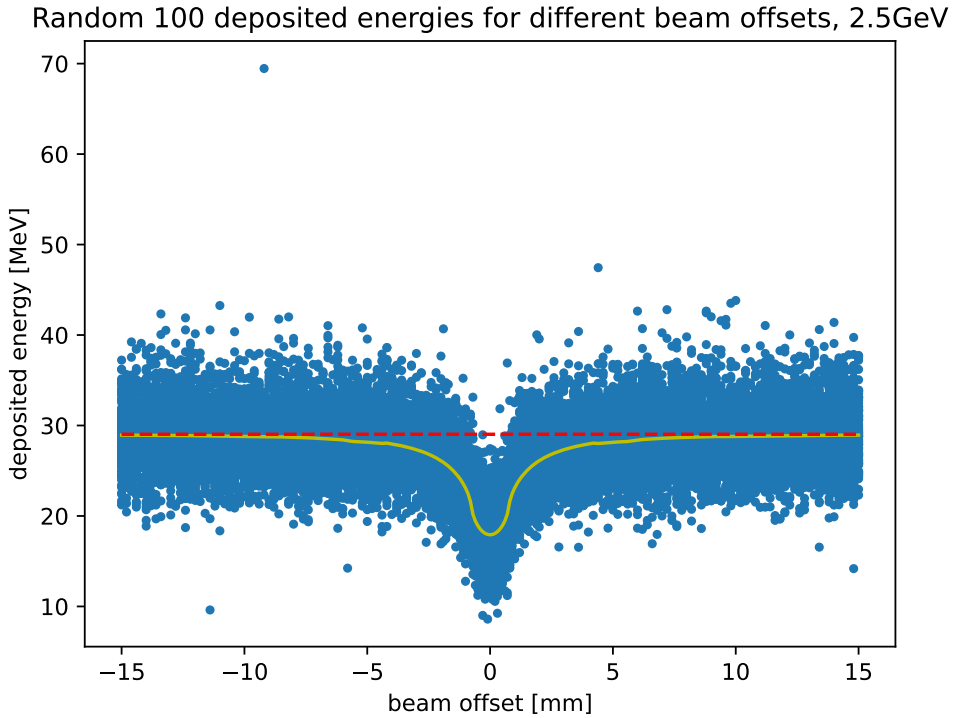
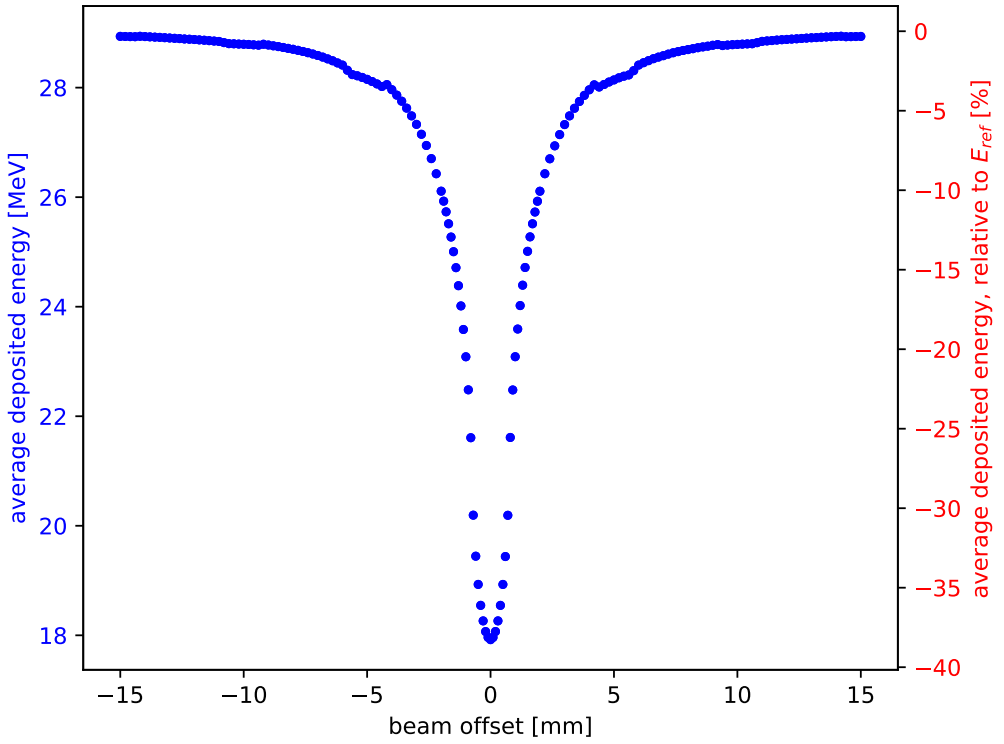


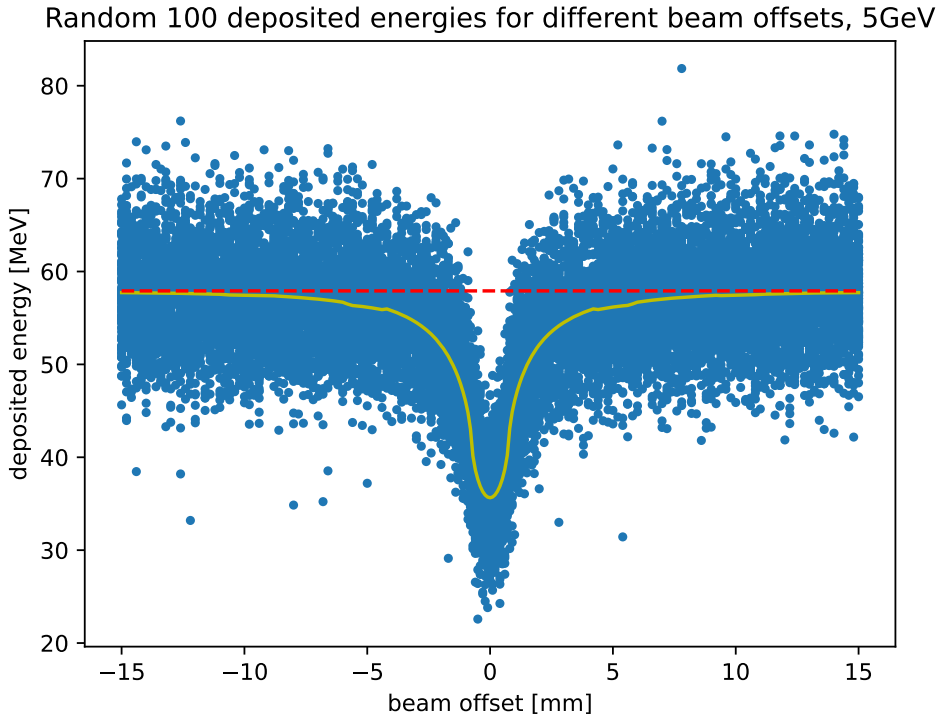


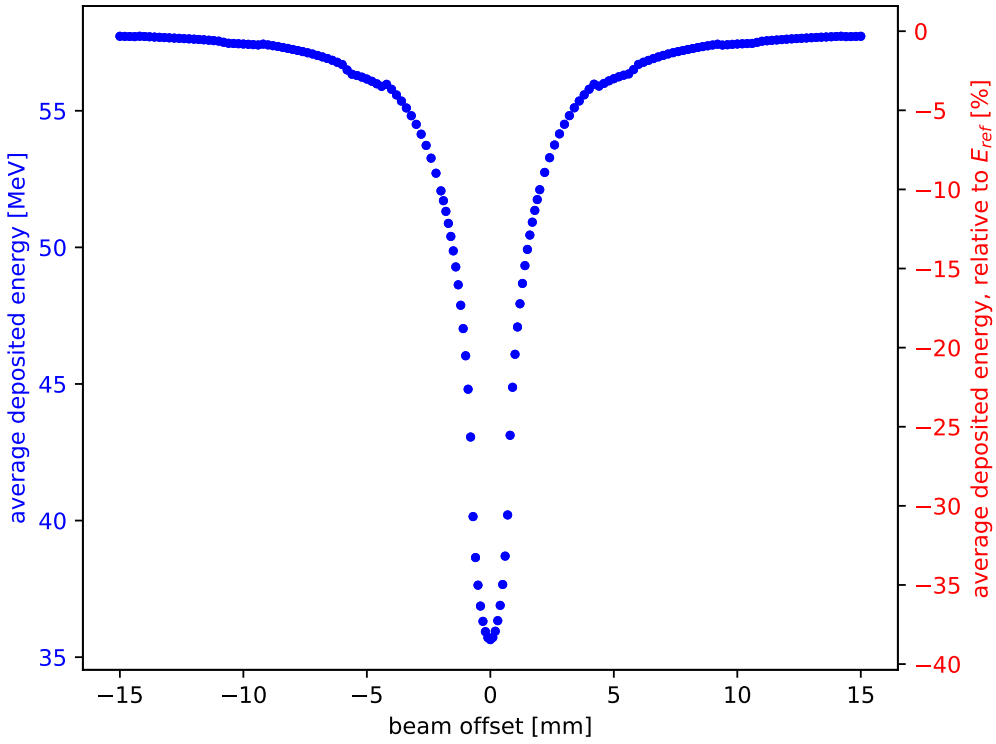
Results for 1.52mm gap
gun position vs energy





Results for 1.52mm gap
gun position vs energy





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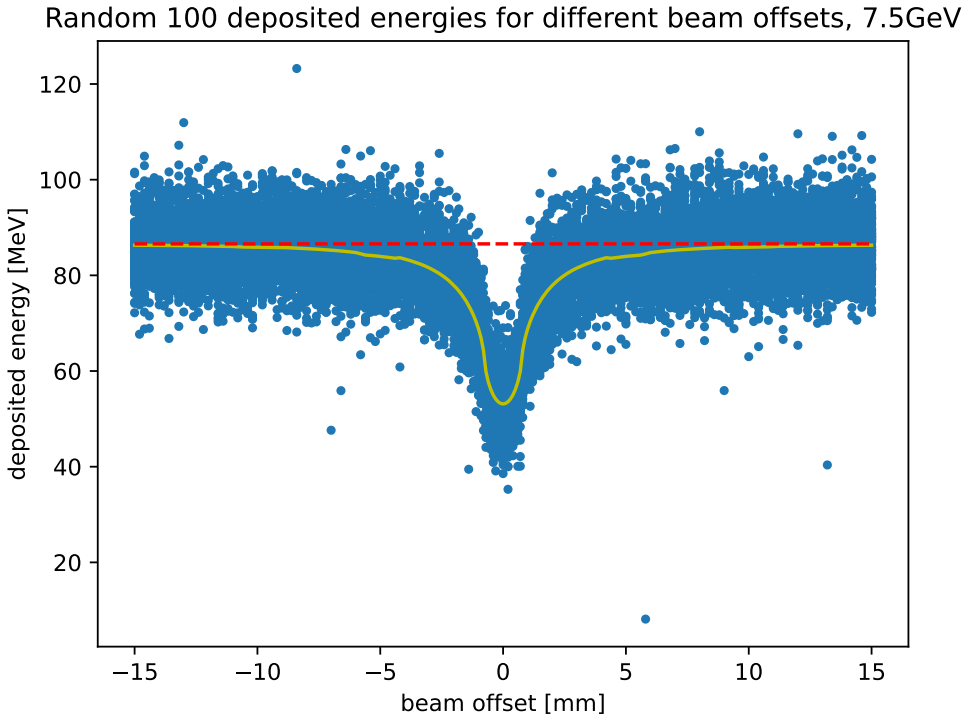

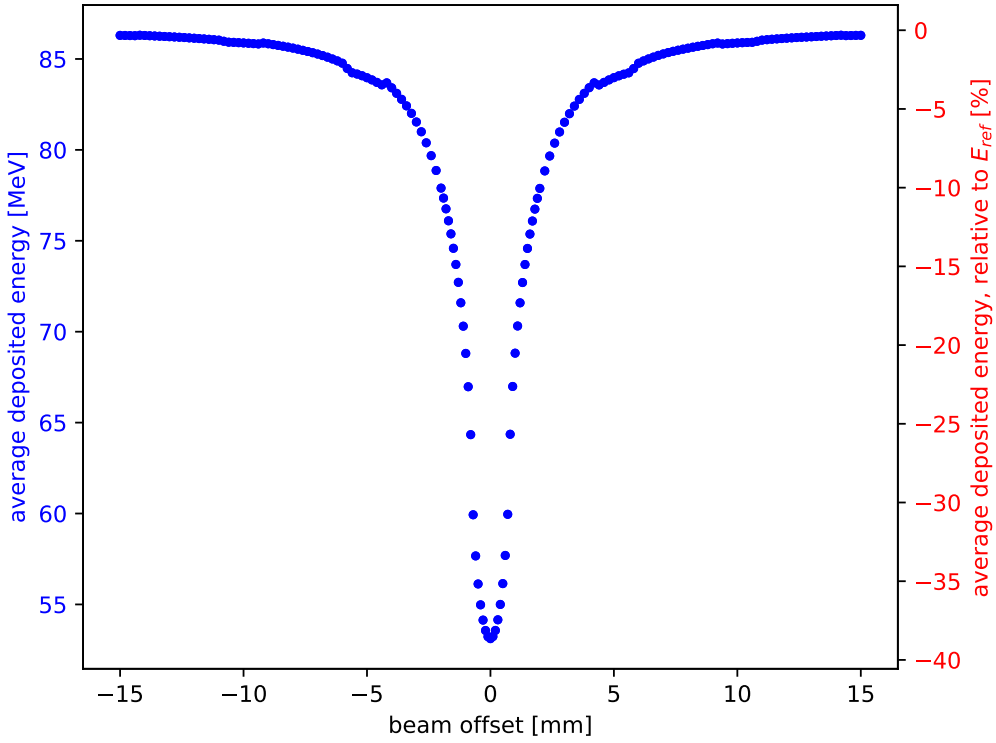

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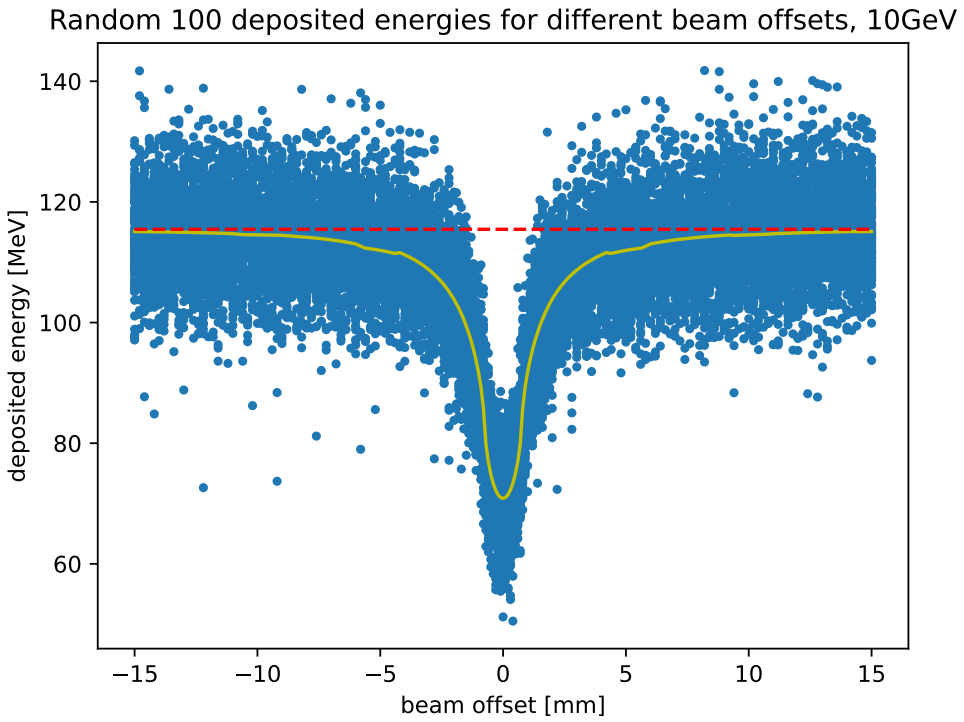
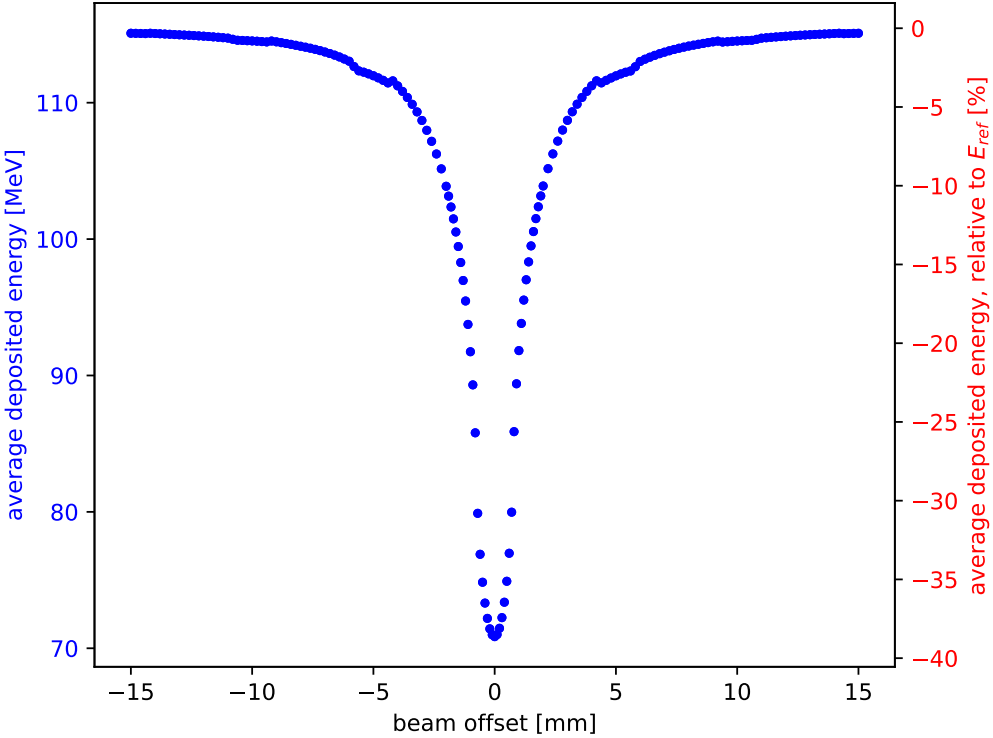
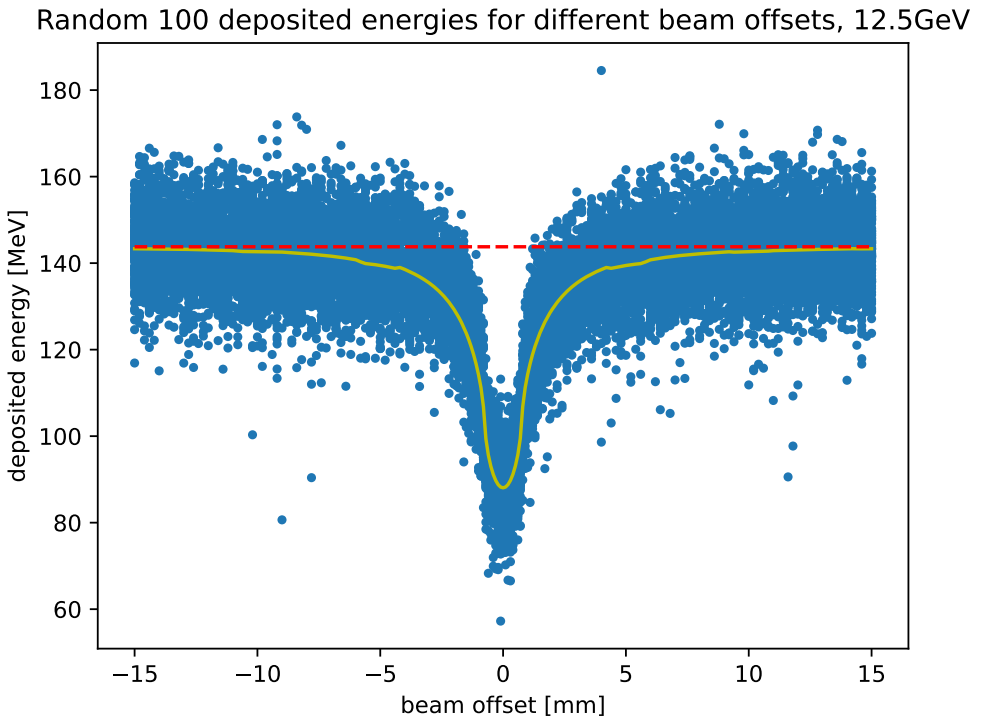
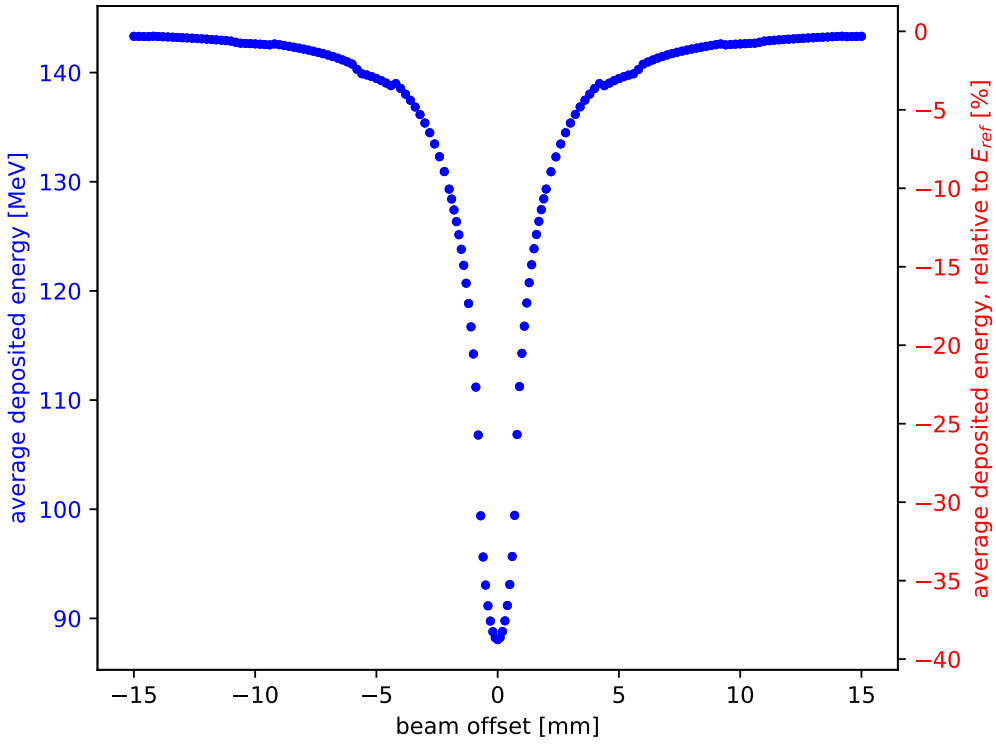




Results for 1.52mm gap
gun position vs energy





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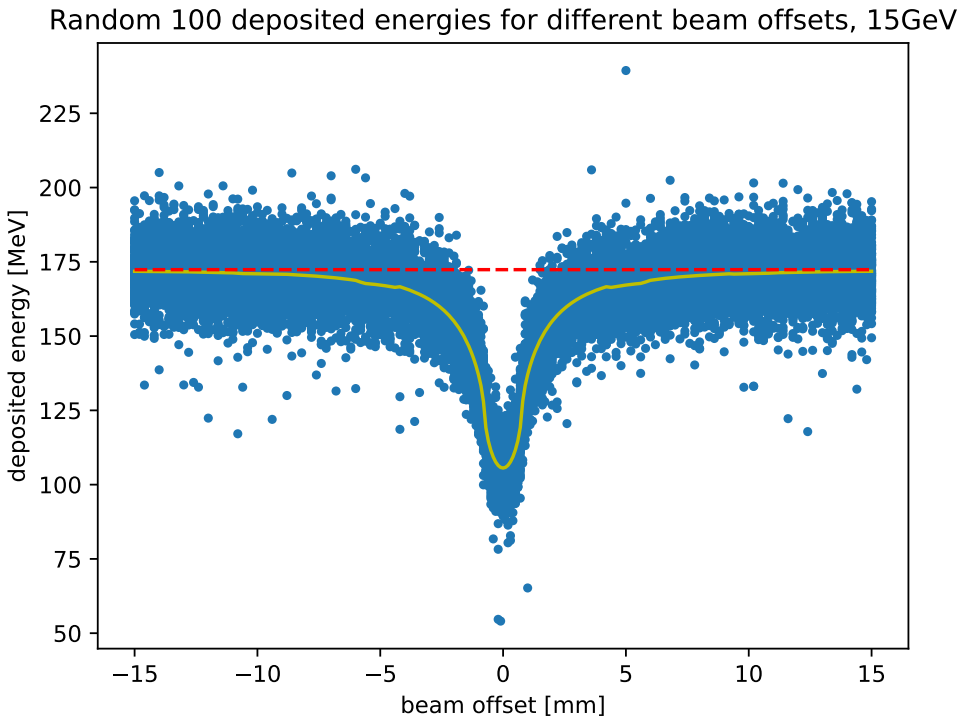
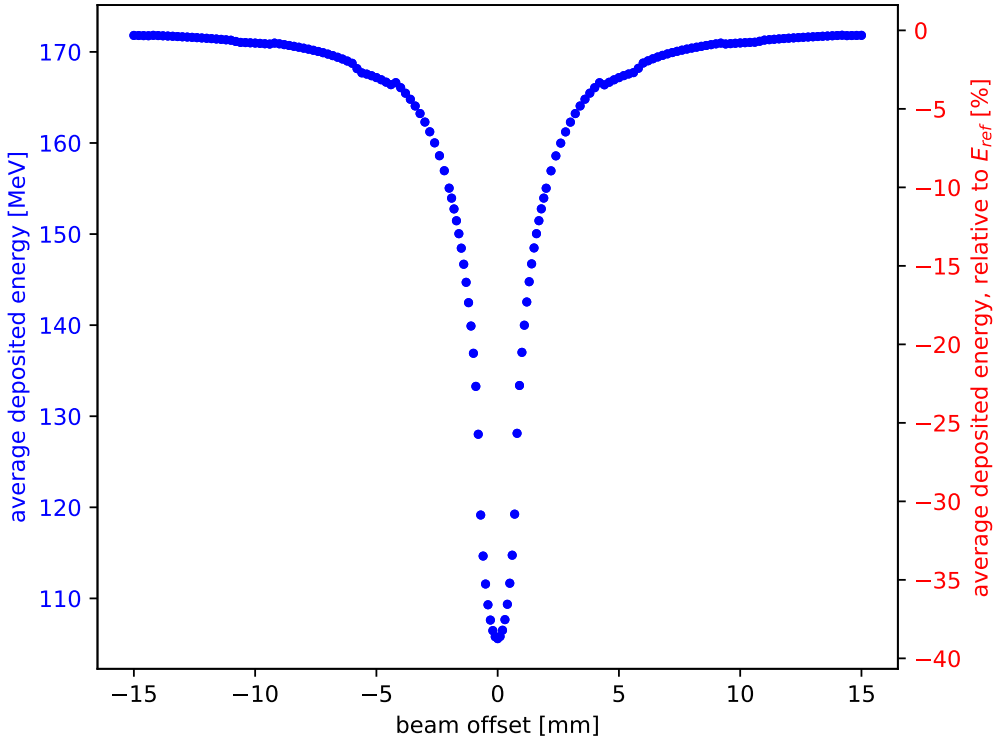
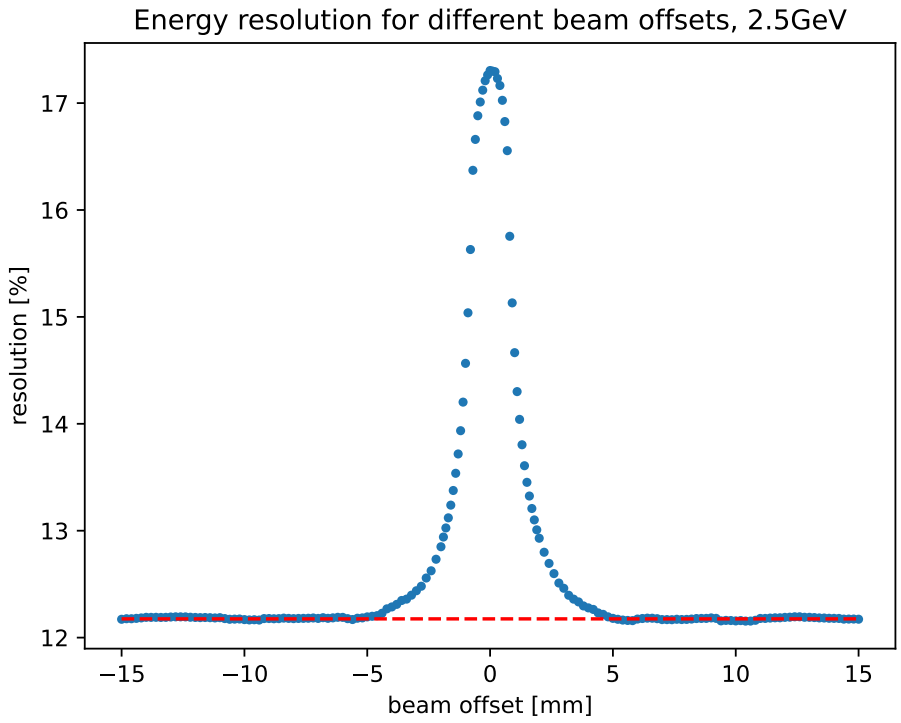
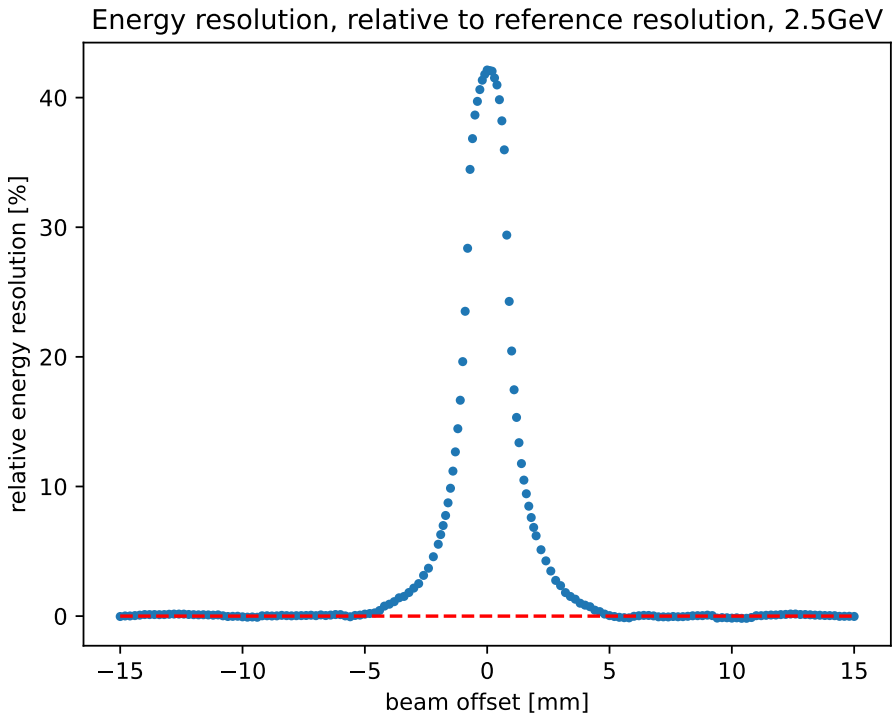


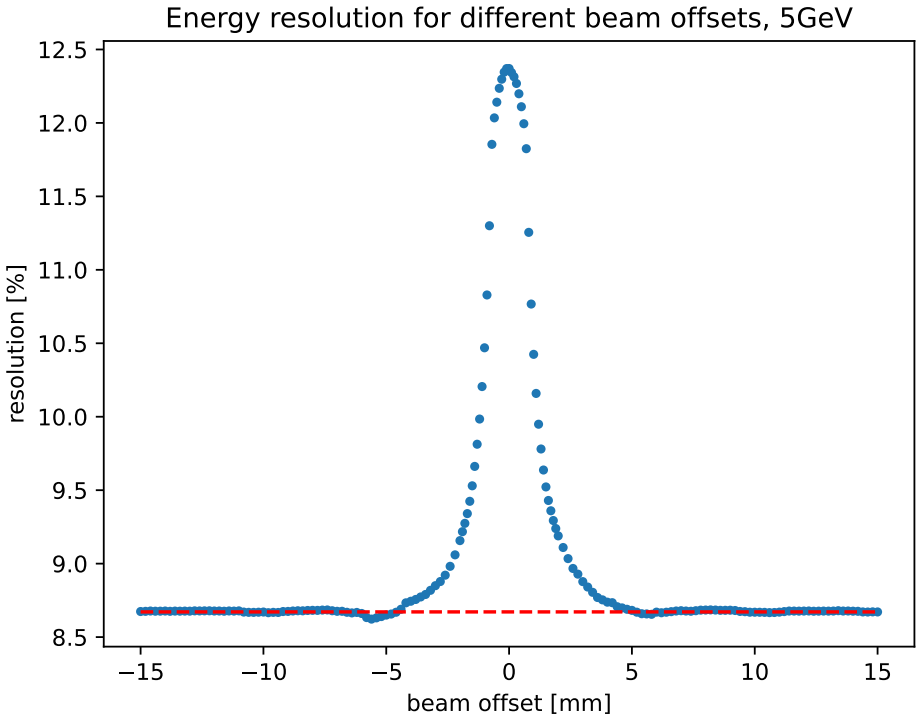


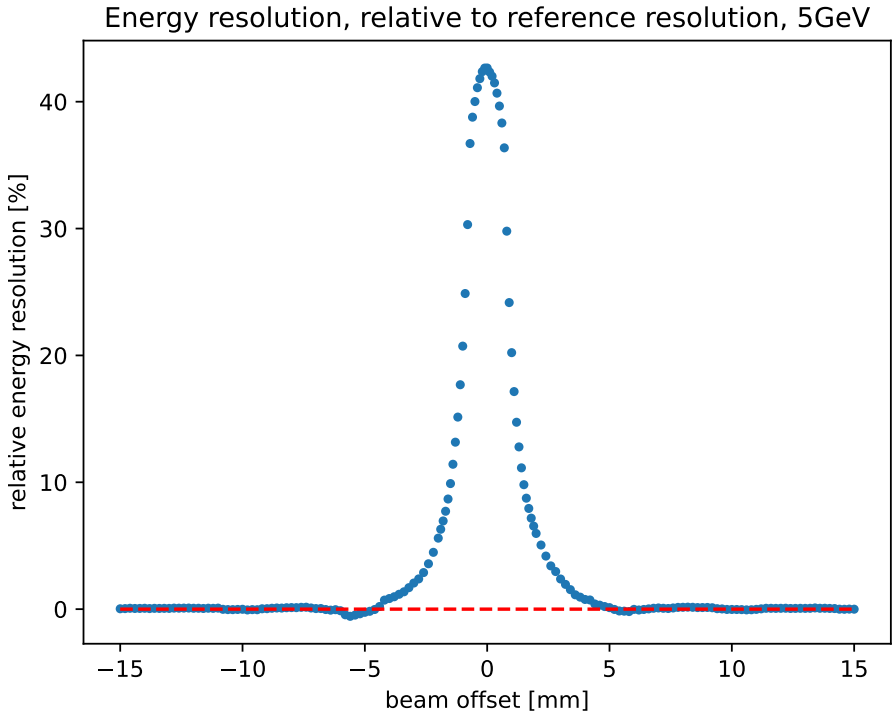
Results for 1.52mm gap
gun position vs resolution





Results for 1.52mm gap
gun position vs resolution





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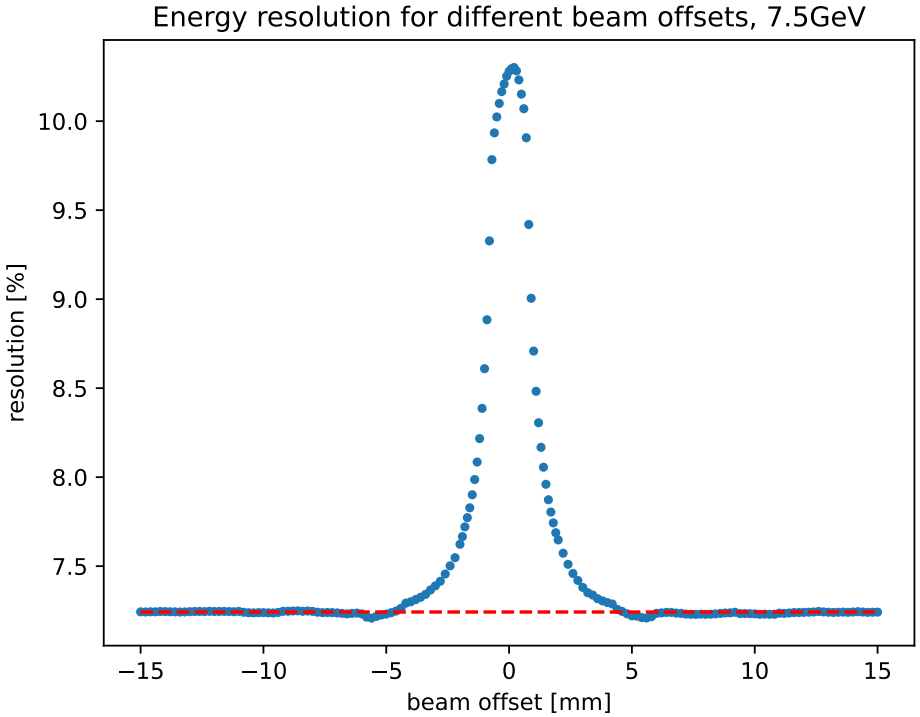

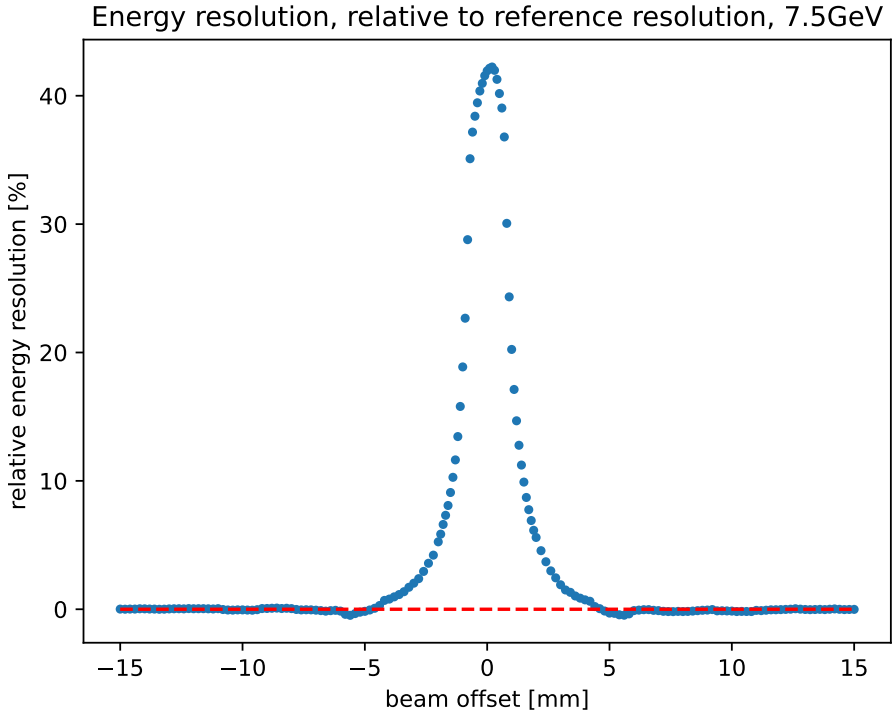

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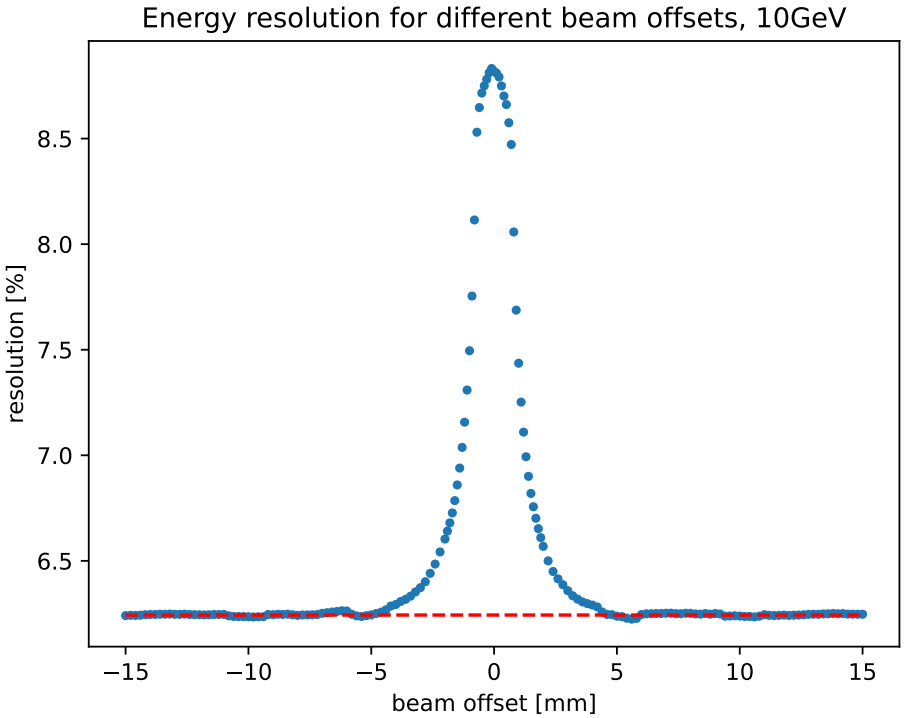
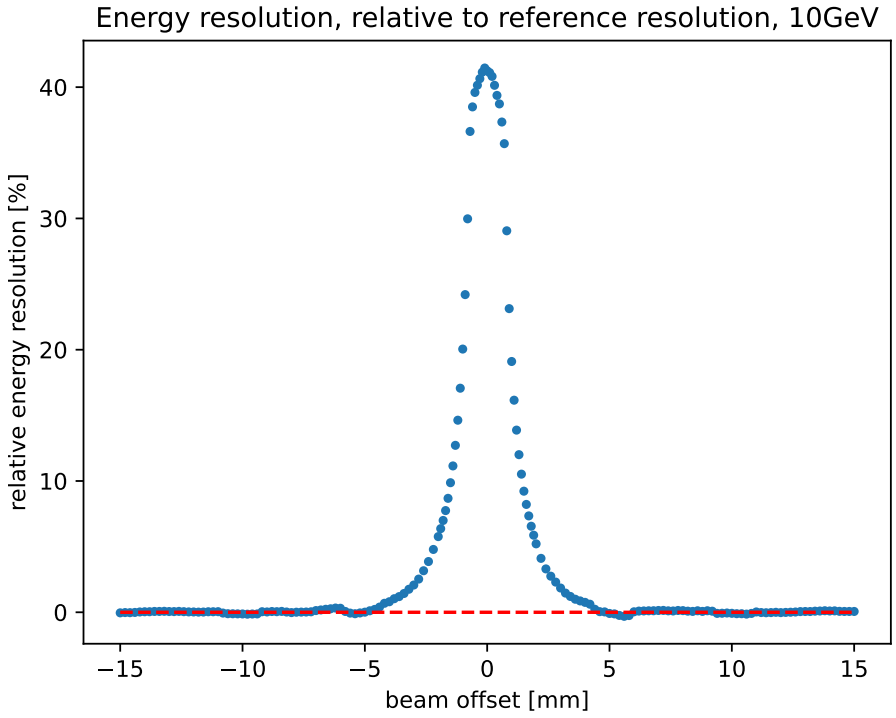
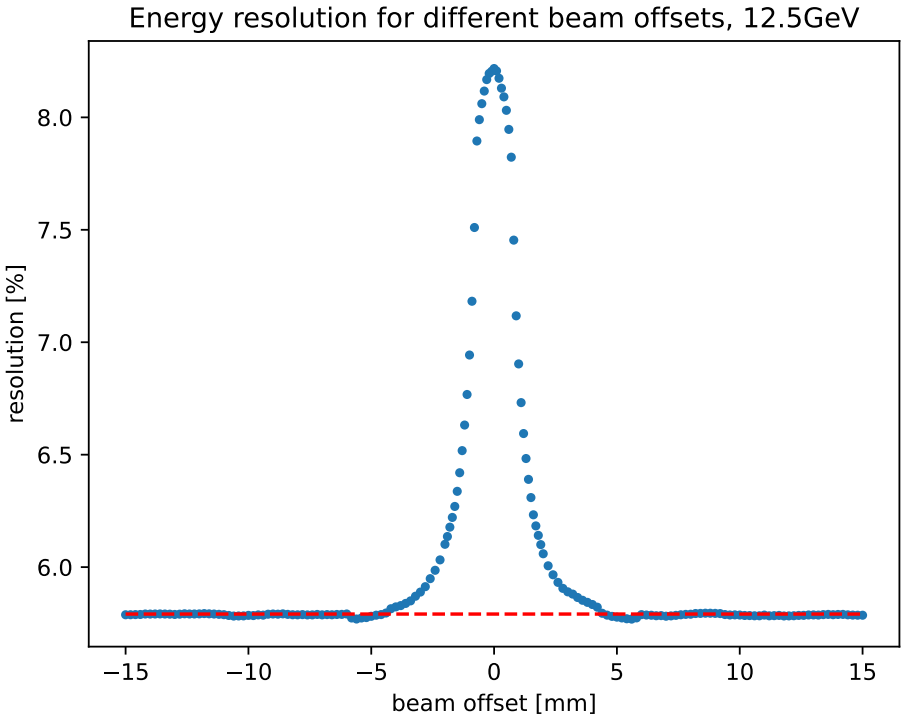
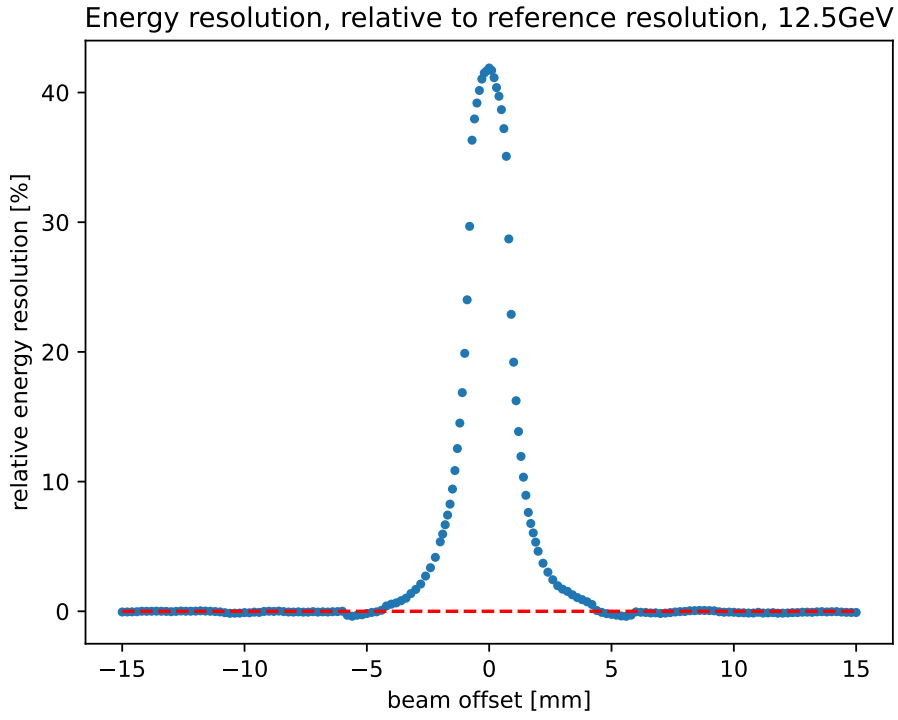


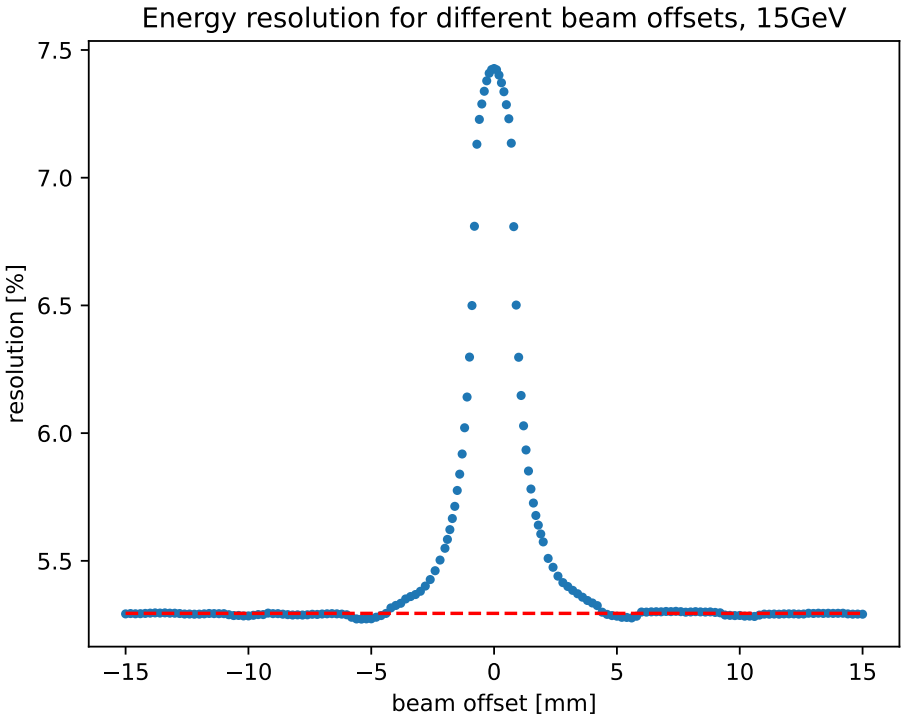


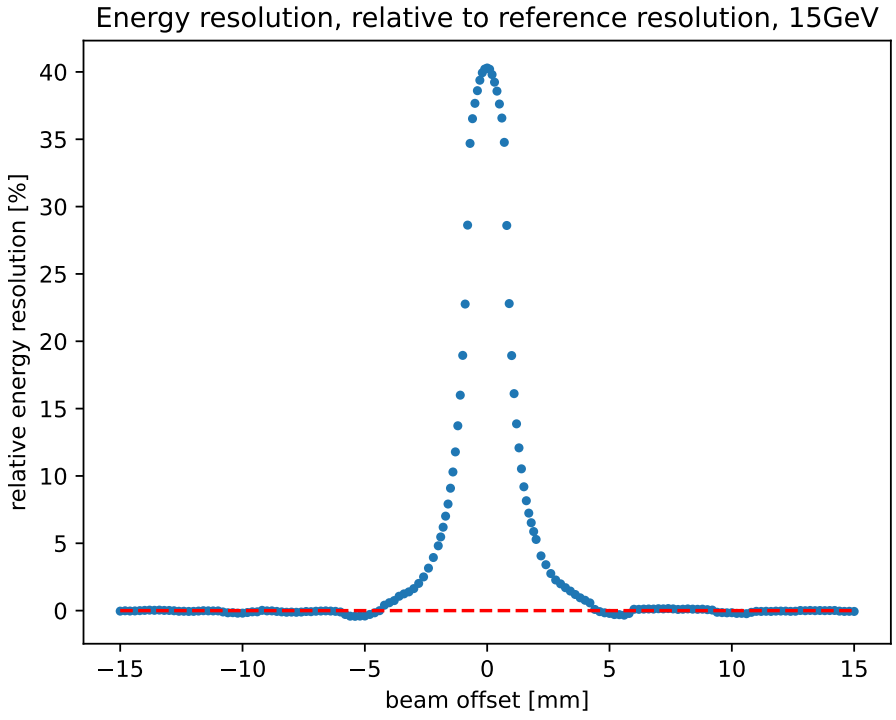
Results for 1.52mm gap
gun position vs resolution



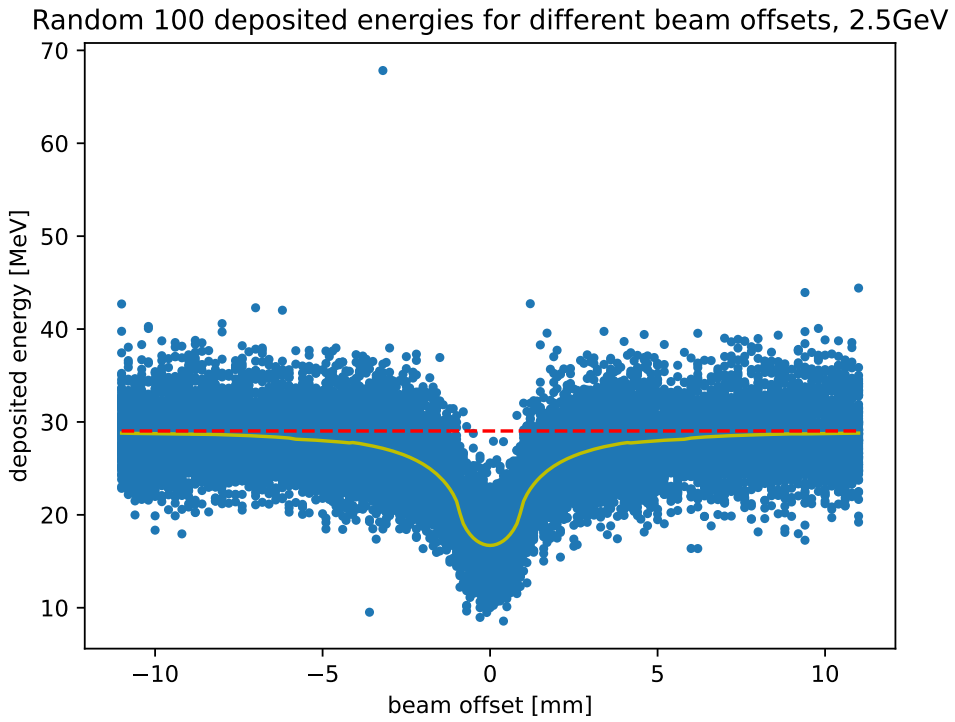


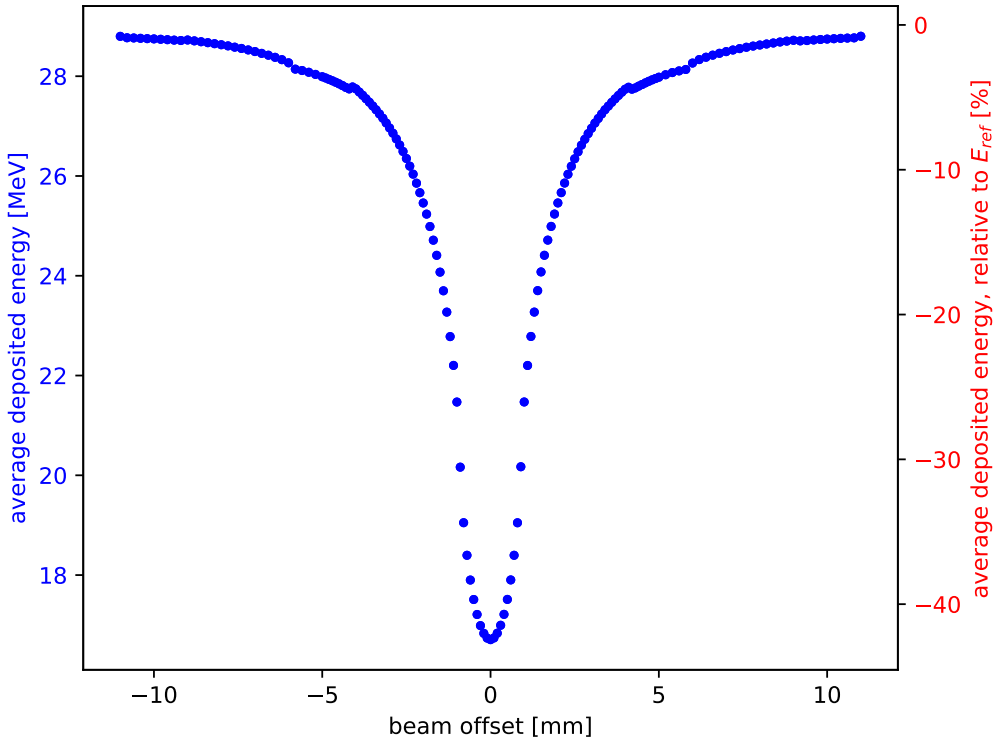
Results for 1.52mm gap
gun position vs resolution



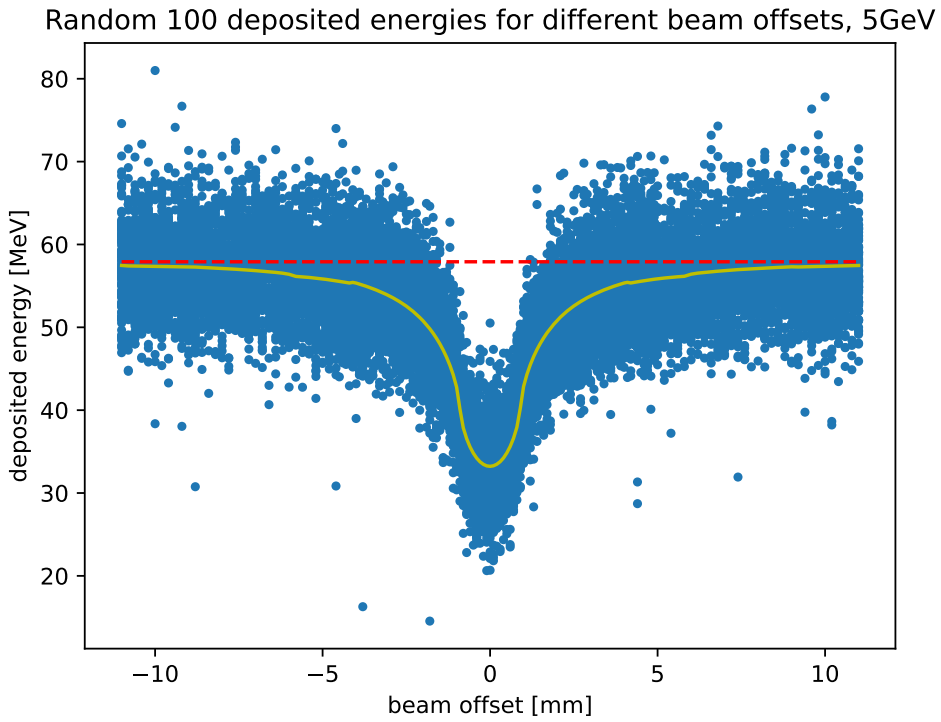


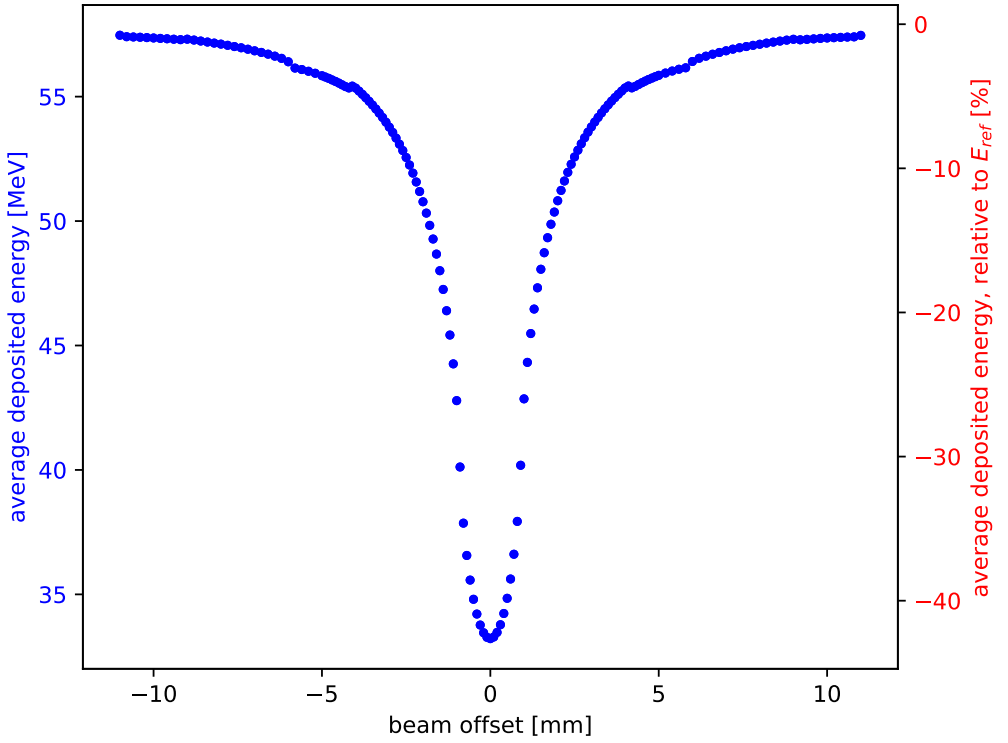
Results for 1.82mm gap
gun position vs energy





Results for 1.82mm gap
gun position vs energy





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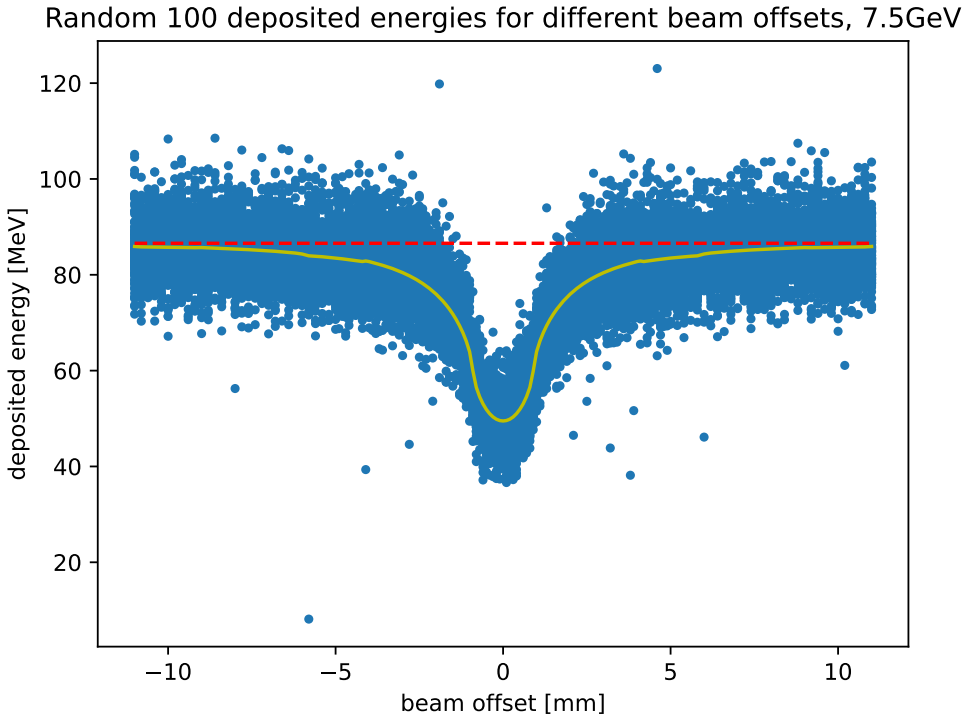
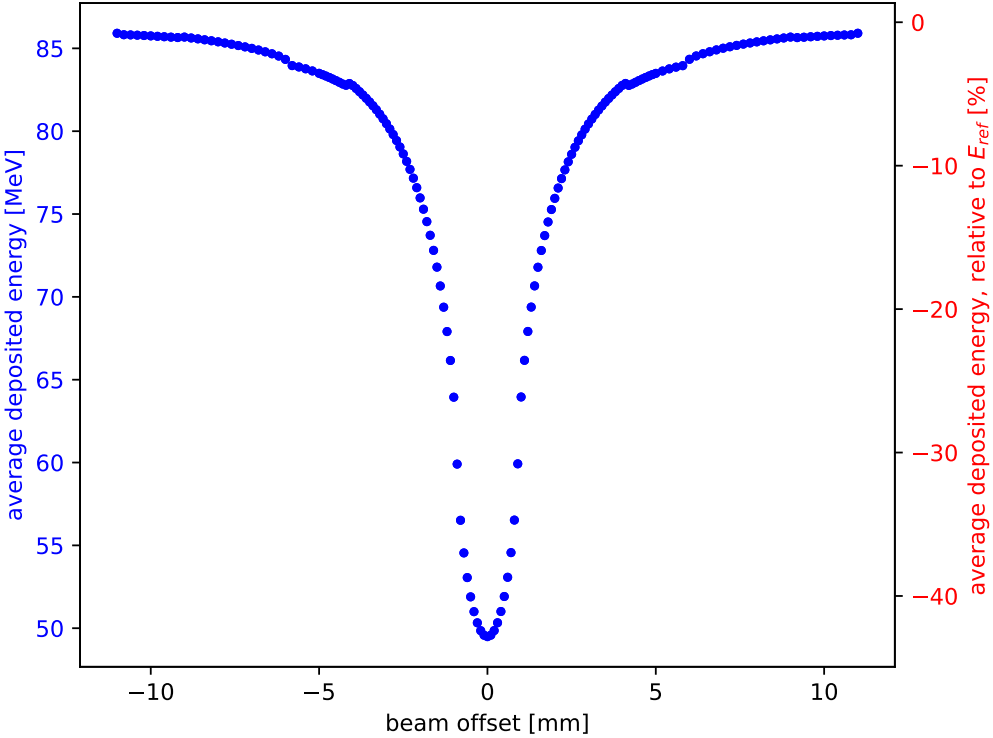
gun position vs energy





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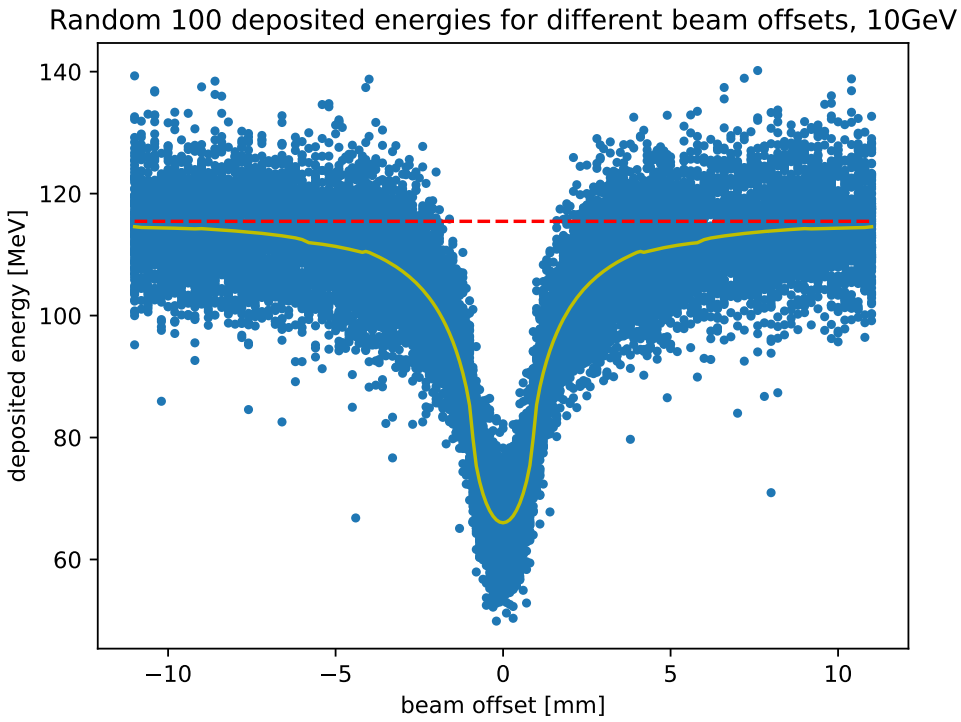
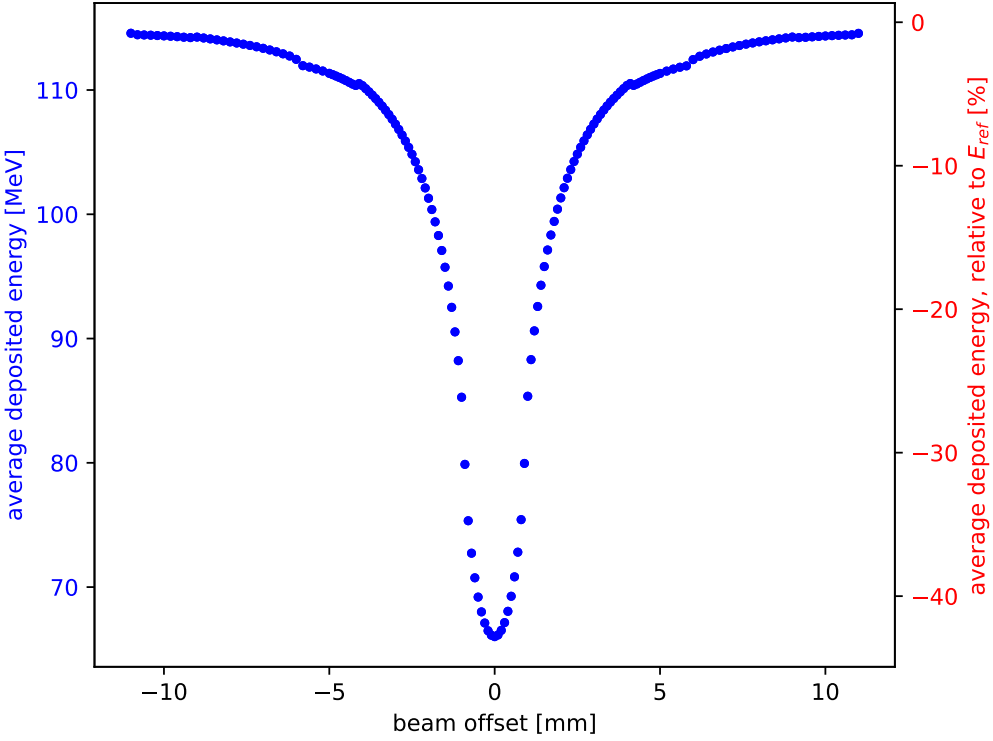
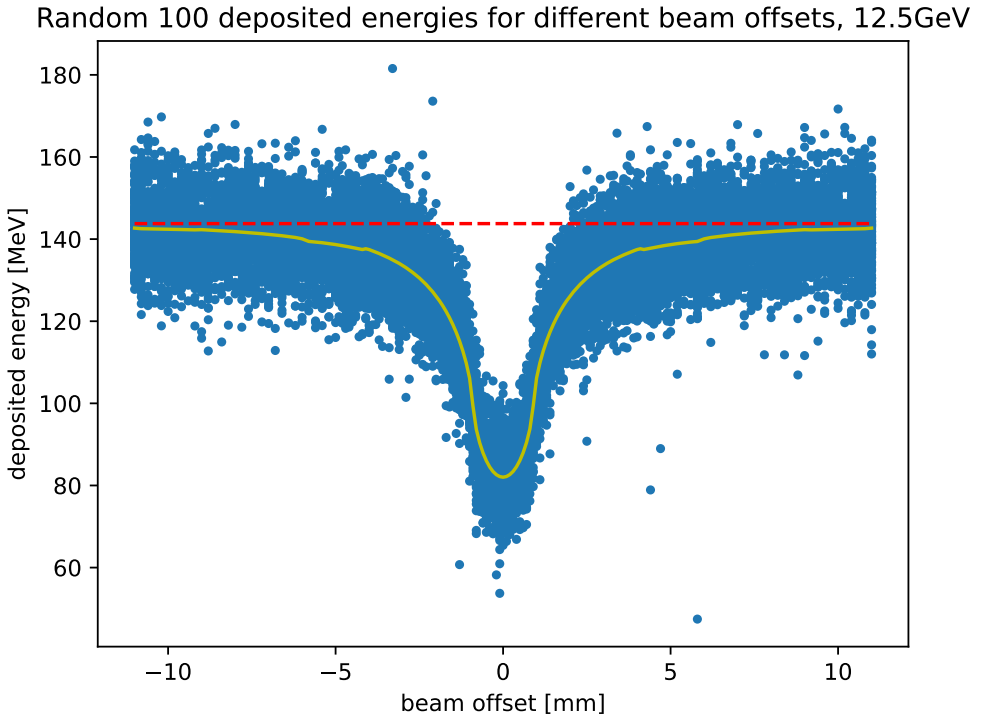
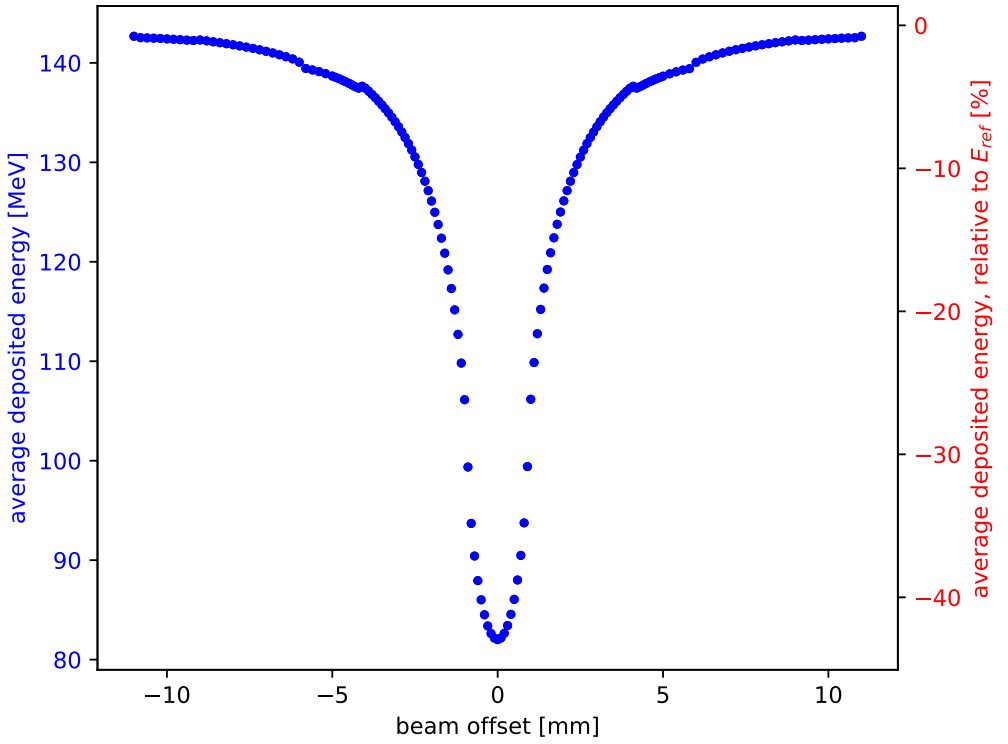
gun position vs energy



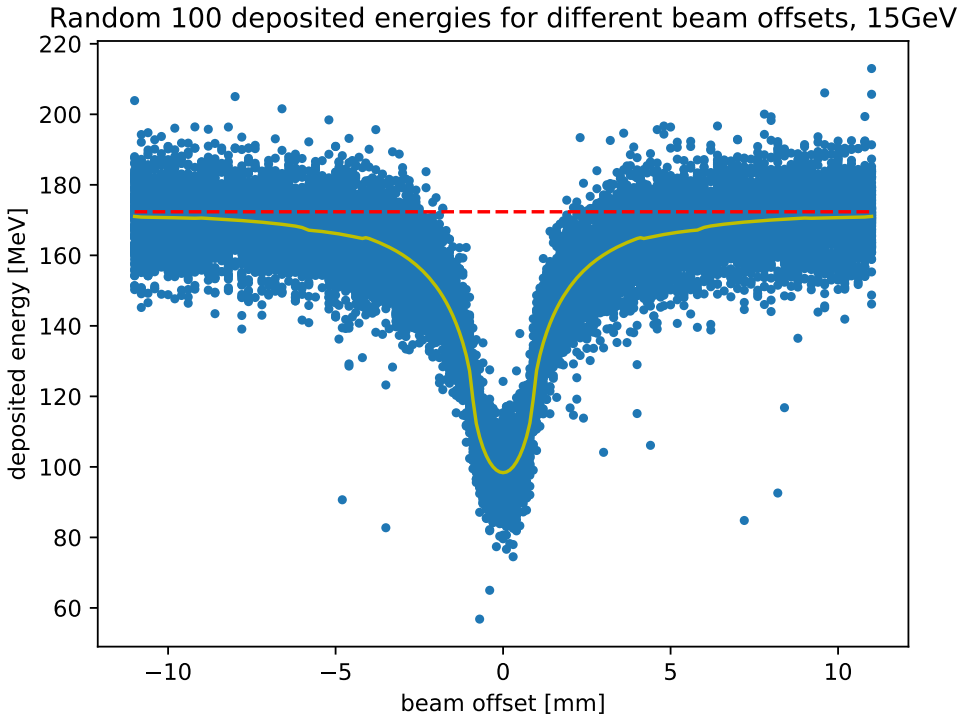


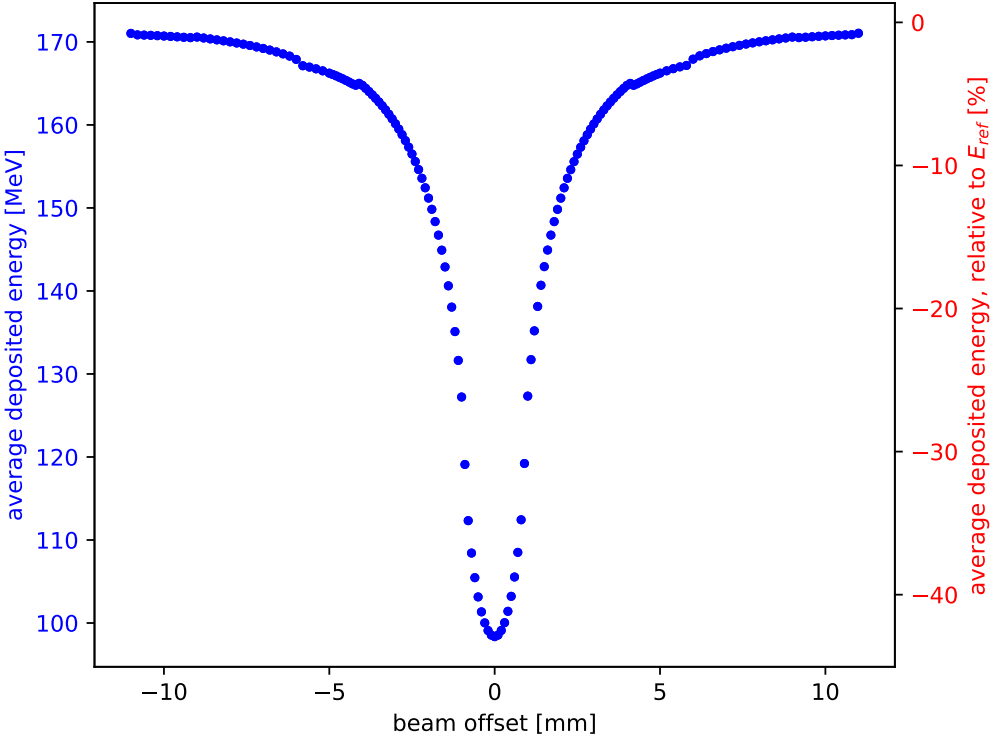
Results for 1.82mm gap
gun position vs energy



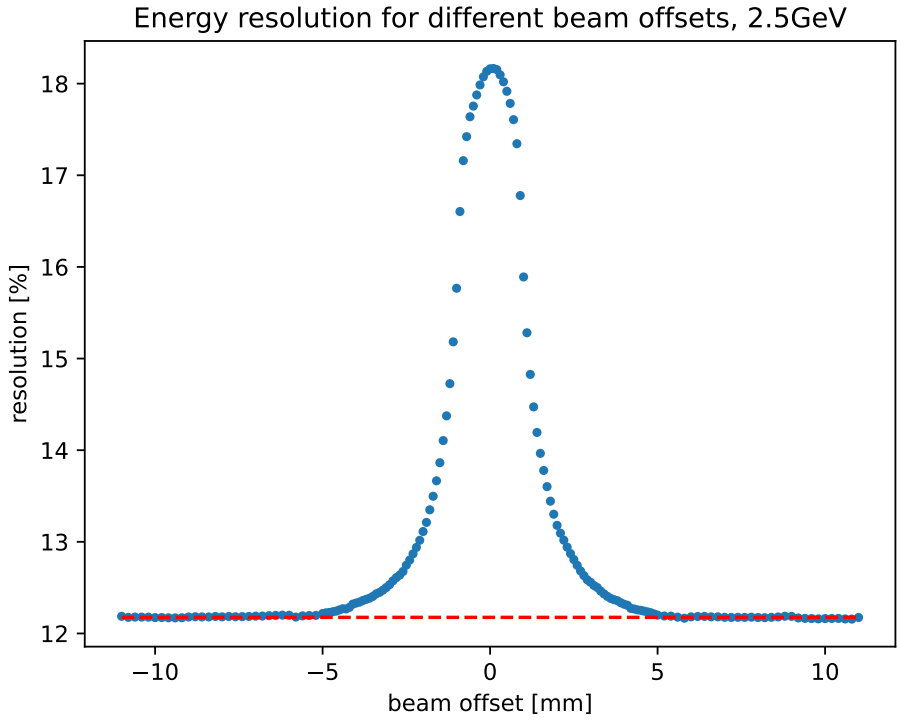


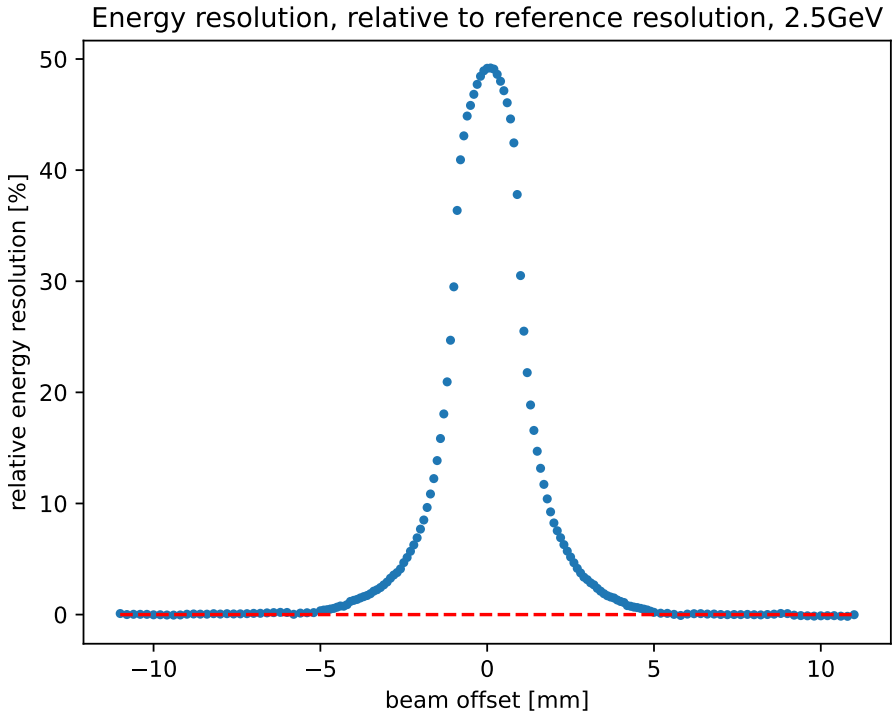
Results for 1.82mm gap
gun position vs energy



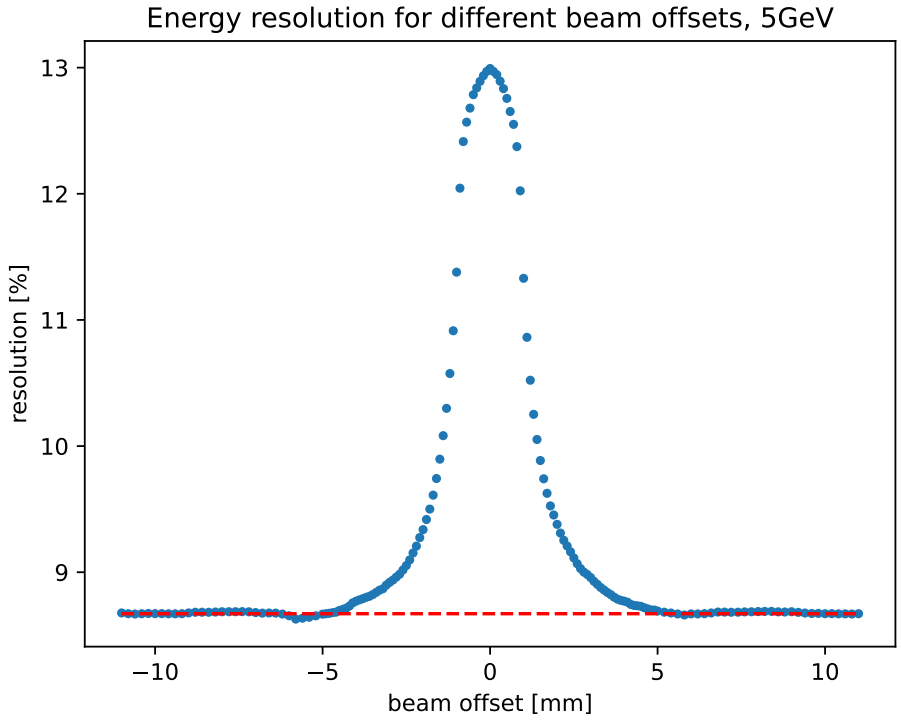


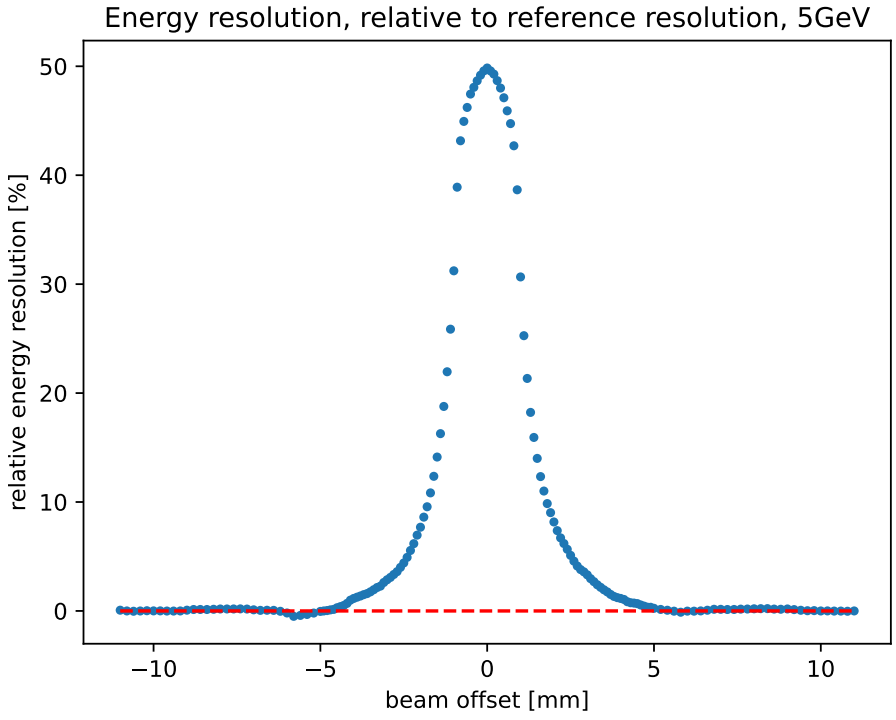
Results for 1.82mm gap
gun position vs resolution



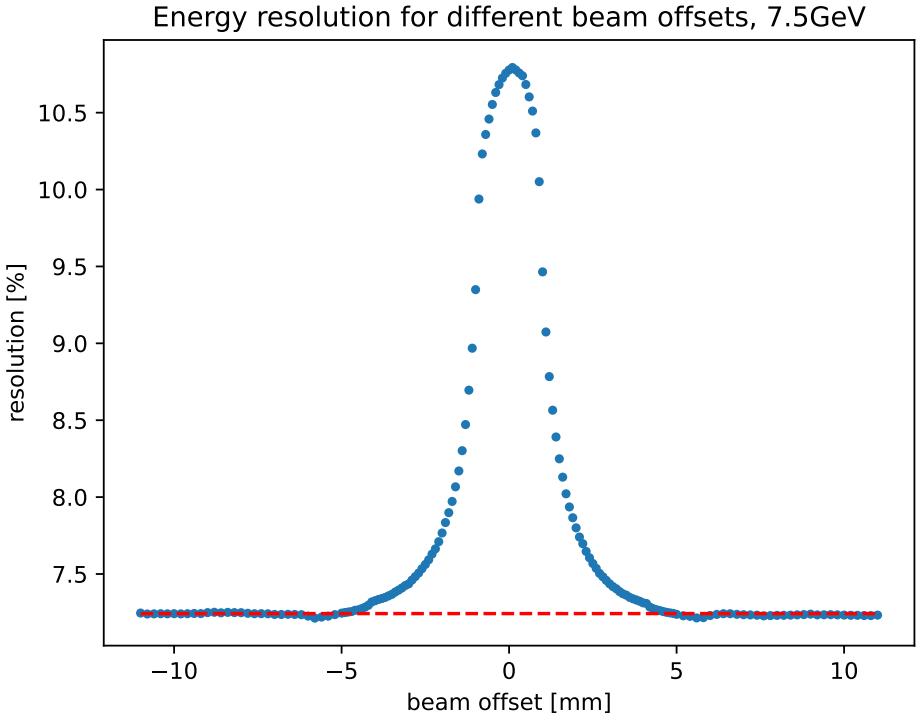


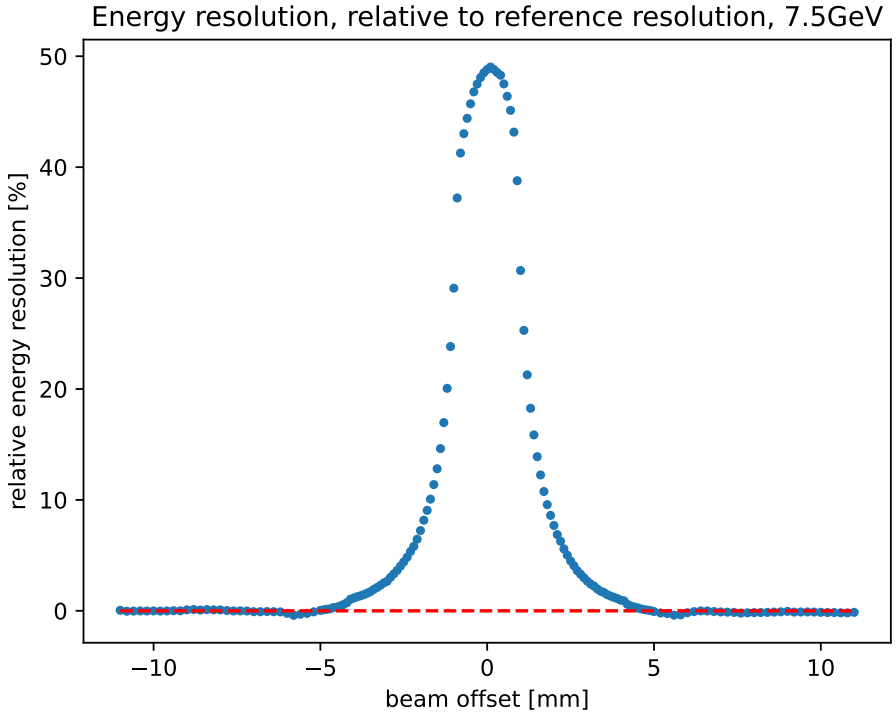
Results for 1.82mm gap
gun position vs resolution



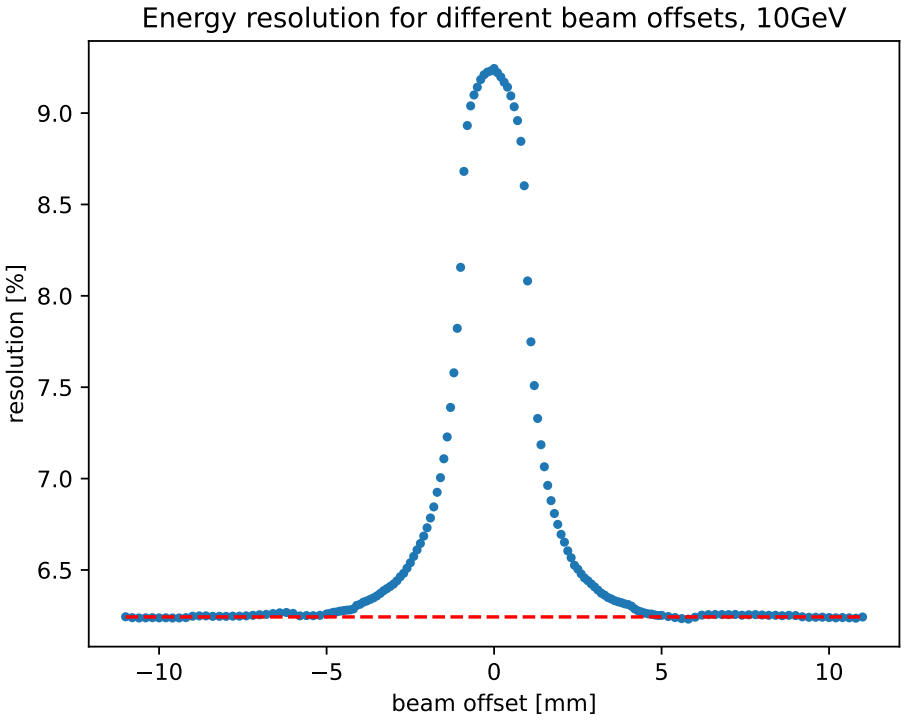


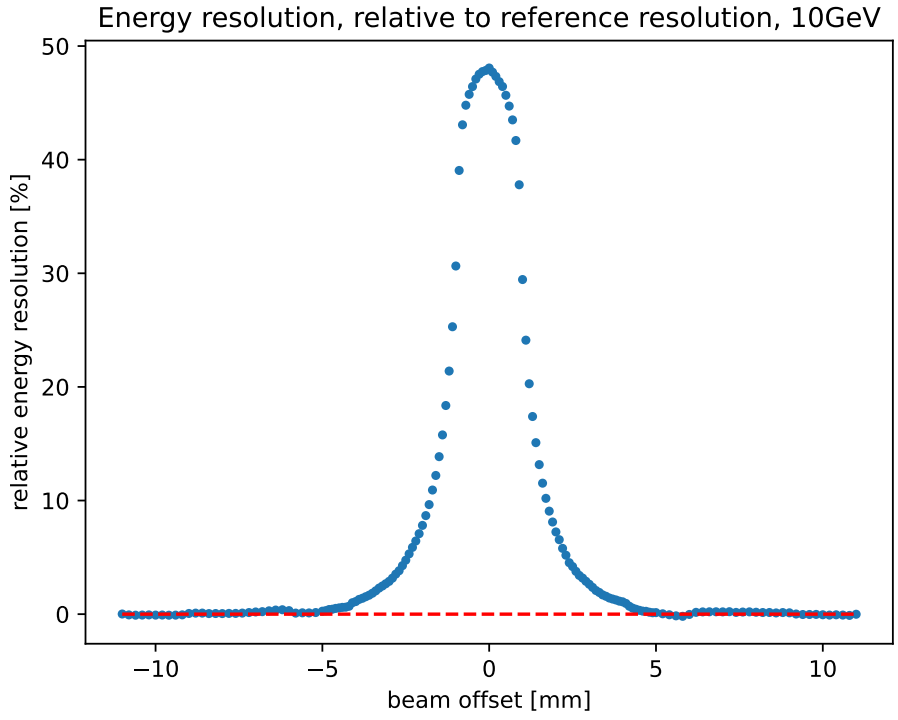
Results for 1.82mm gap
gun position vs resolution



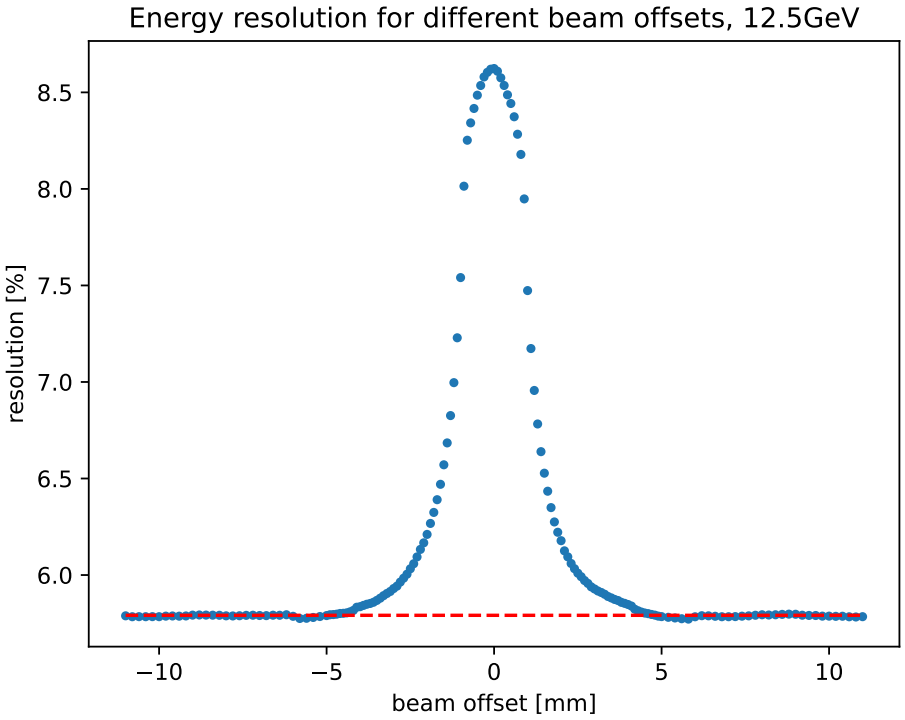


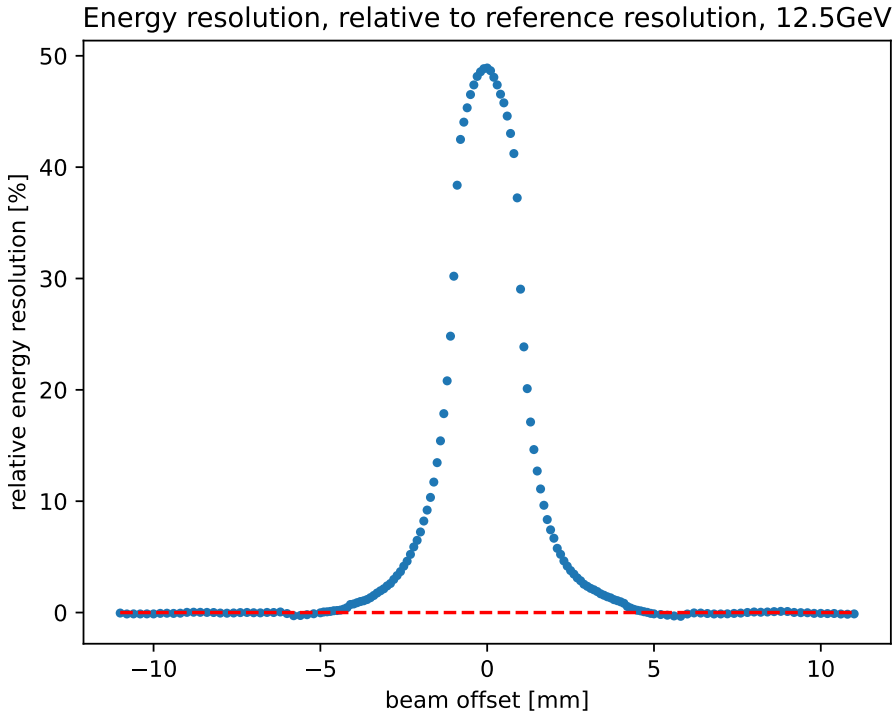
Results for 1.82mm gap
gun position vs resolution



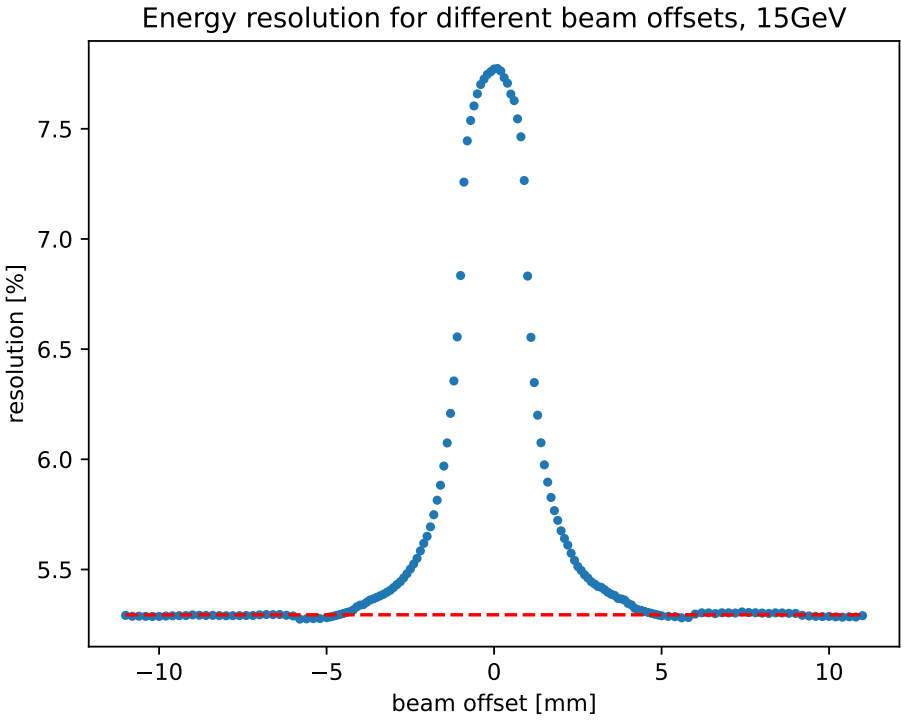


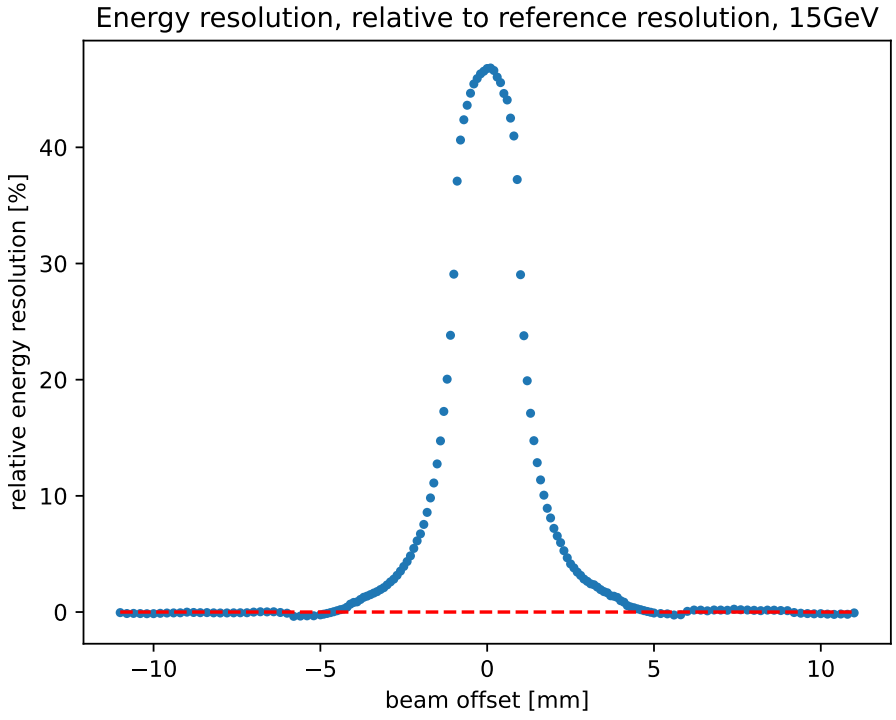
Results for 1.82mm gap
gun position vs resolution



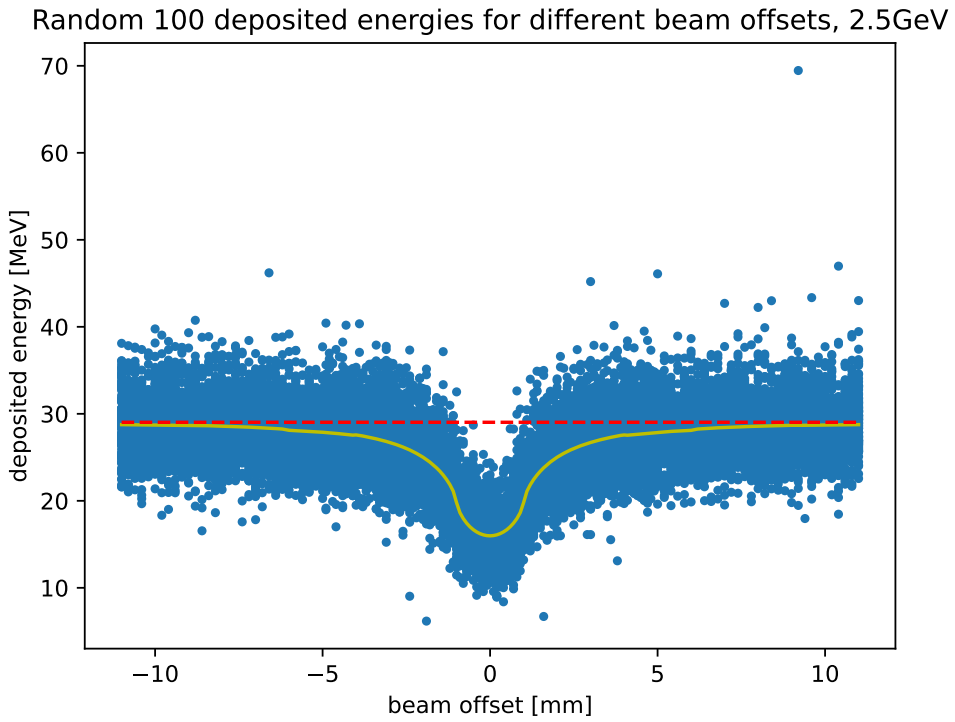


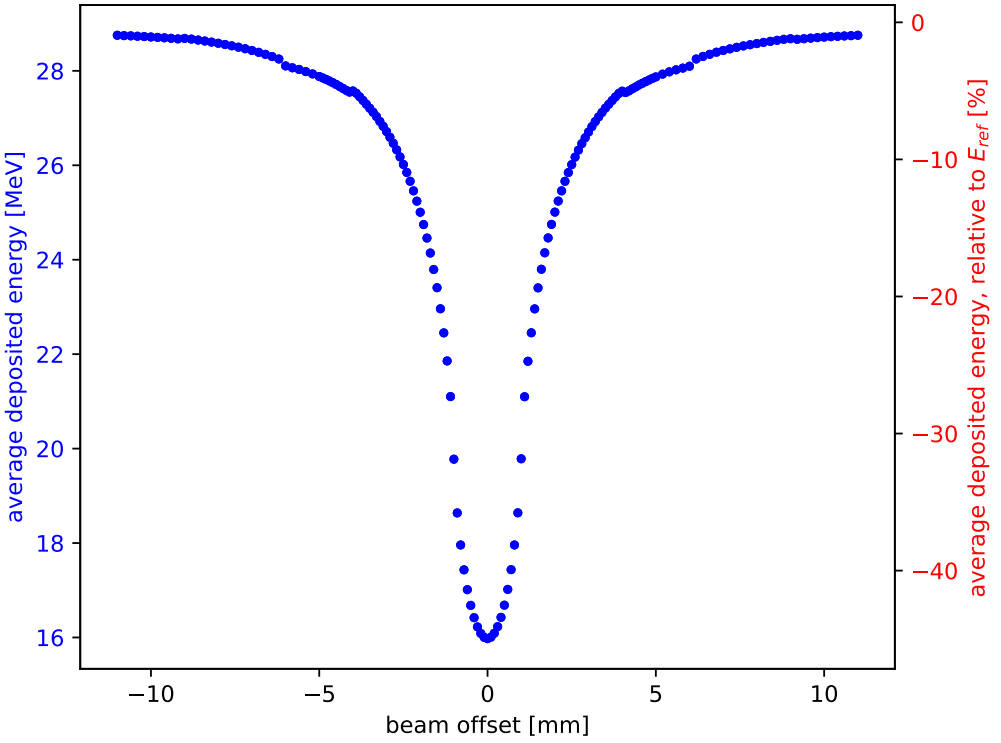
Results for 1.82mm gap
gun position vs resolution



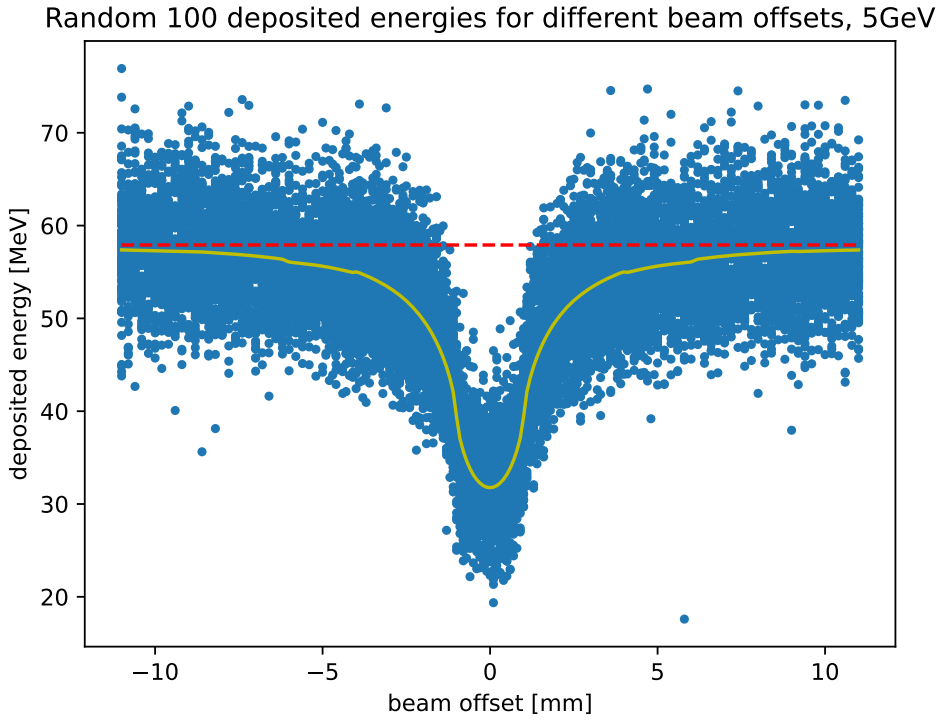


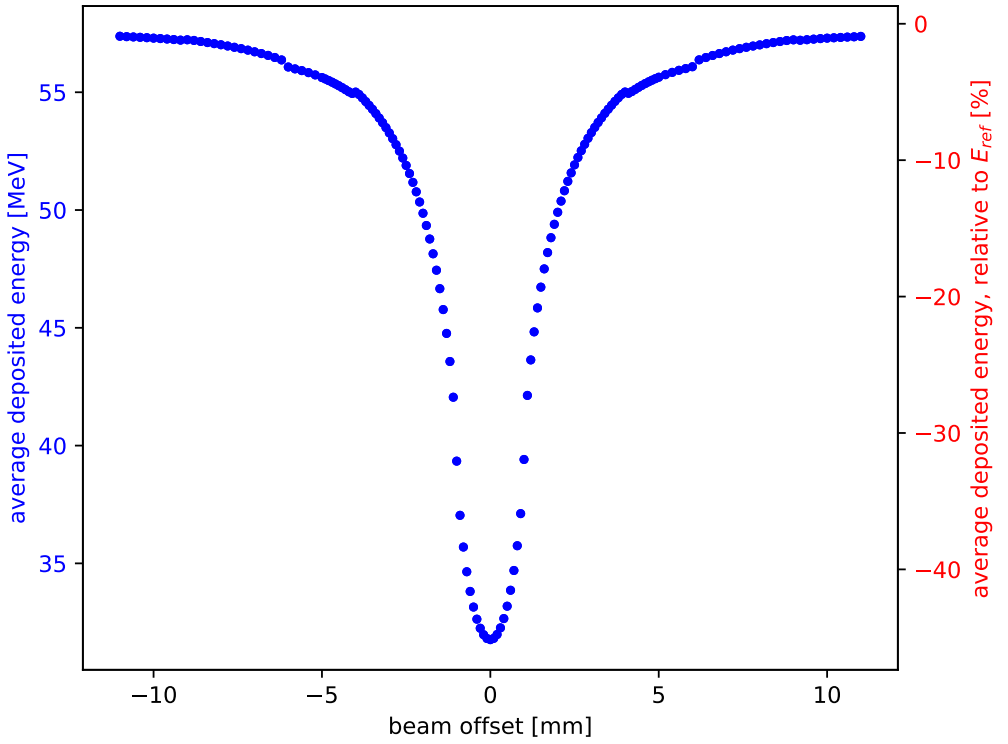
Results for 2.02mm gap
gun position vs energy



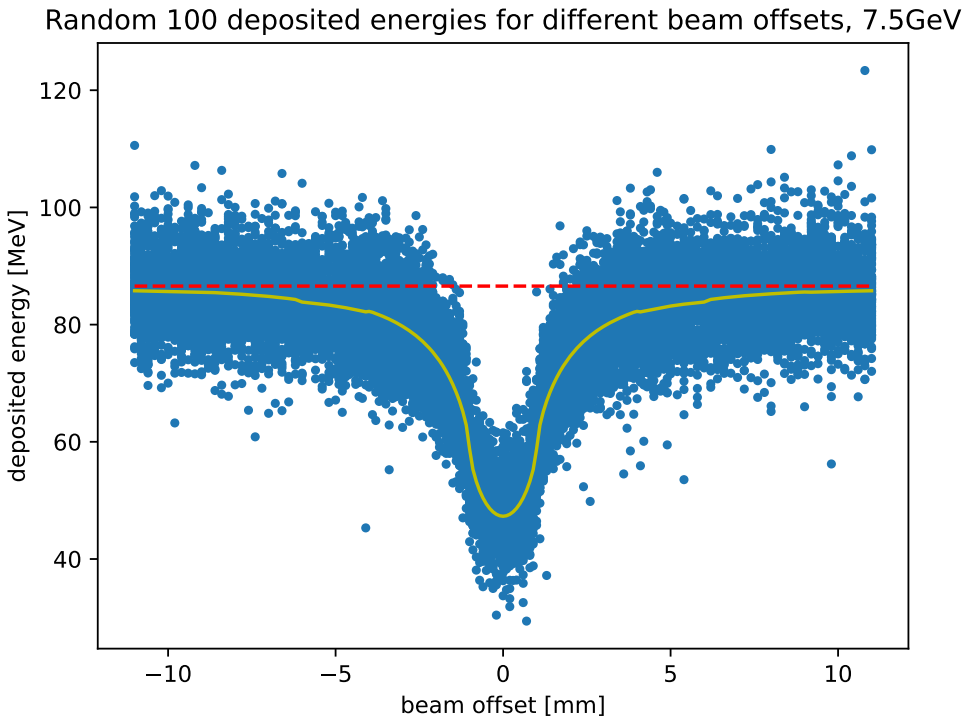


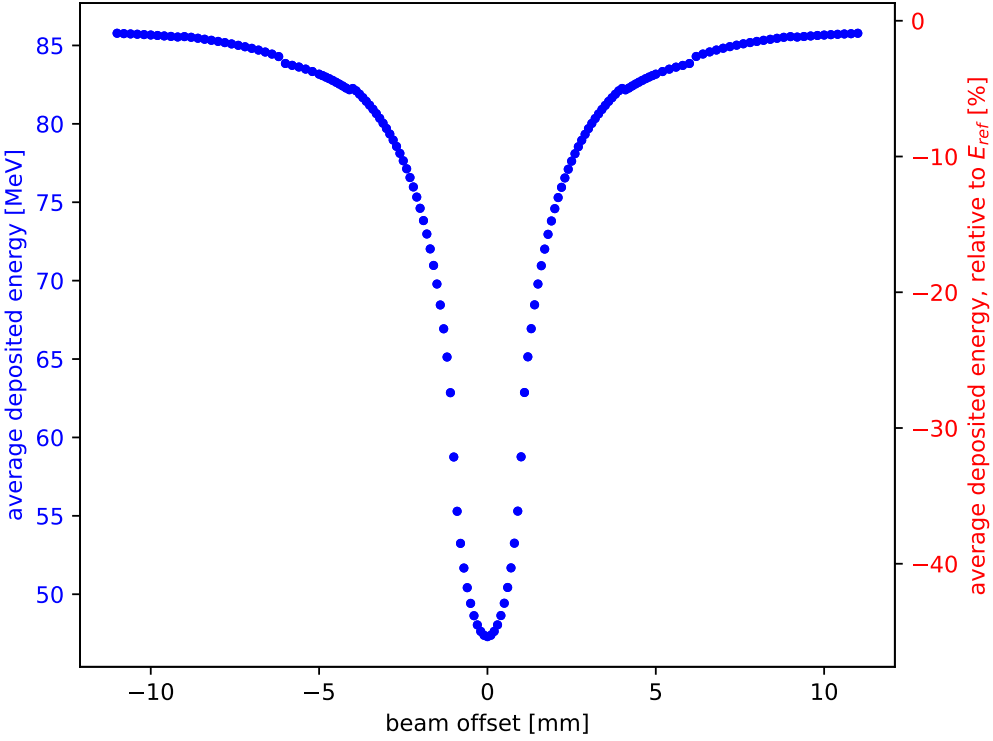
Results for 2.02mm gap
gun position vs energy



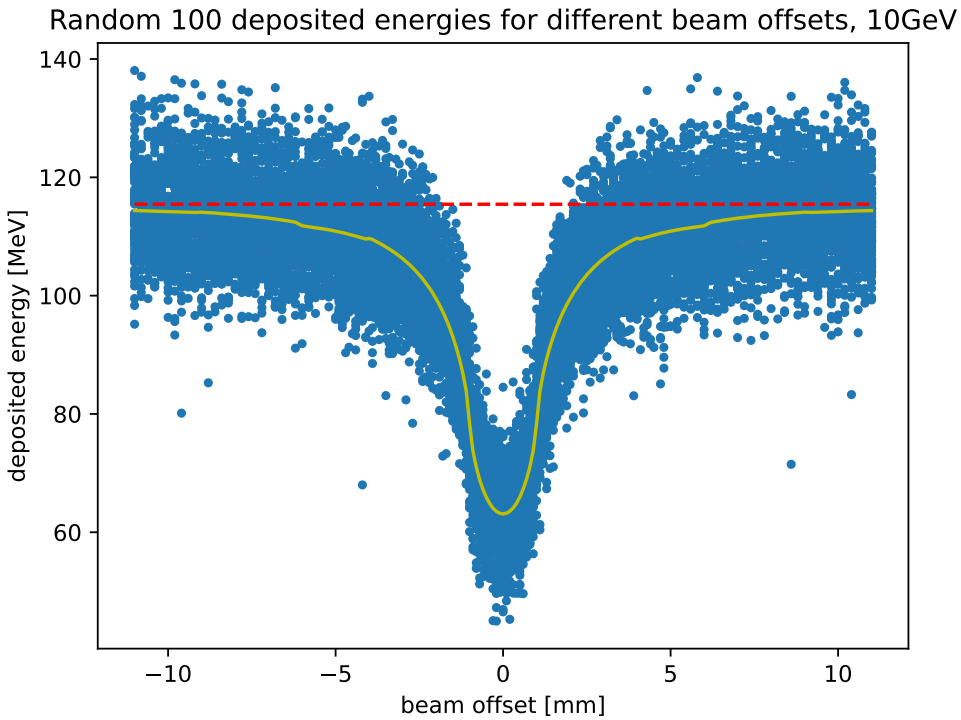


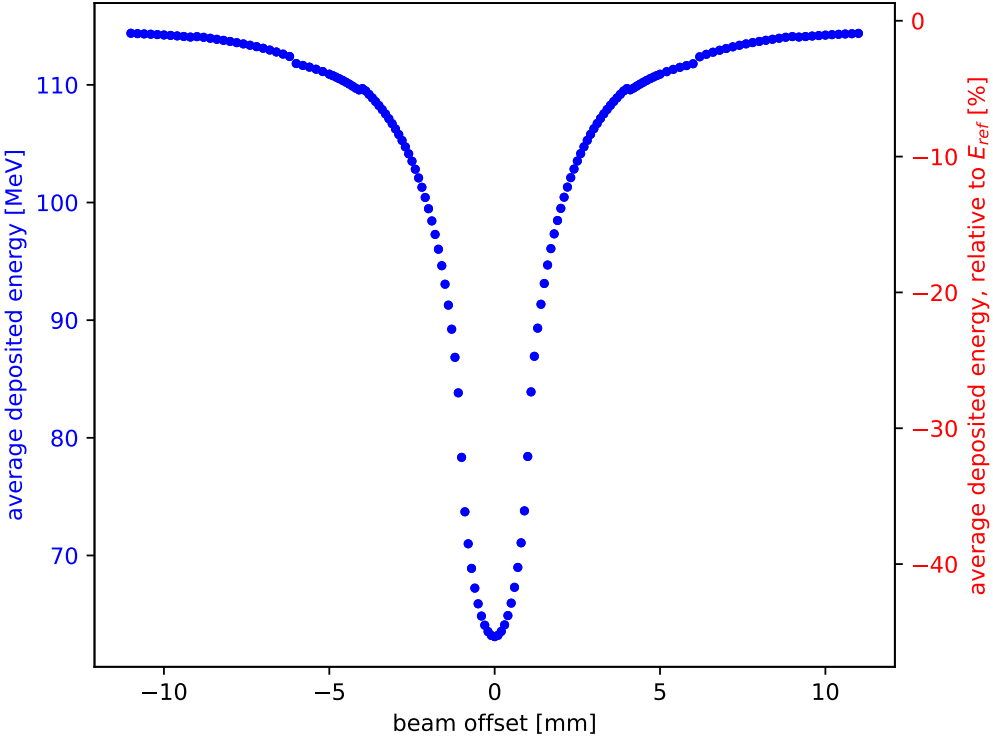
Results for 2.02mm gap
gun position vs energy



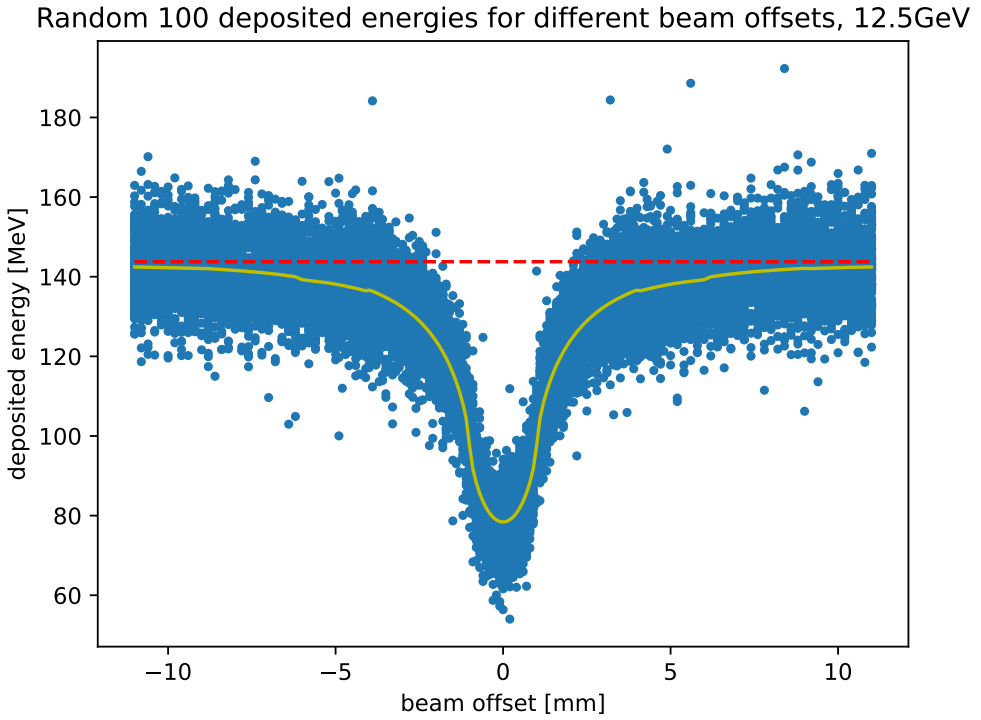


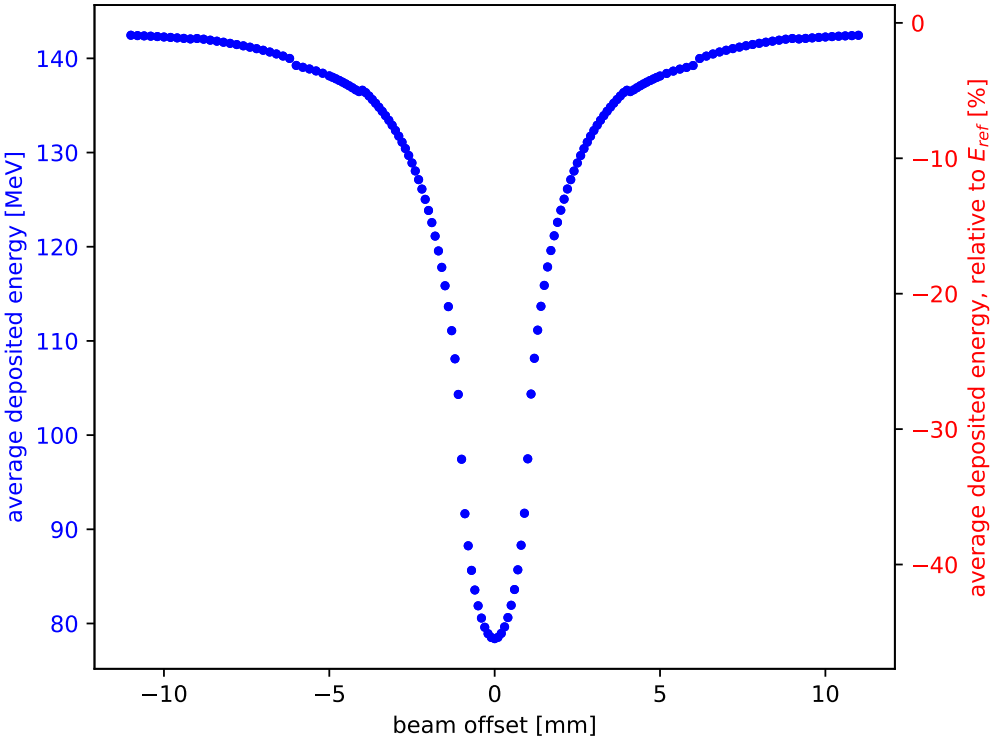
Results for 2.02mm gap
gun position vs energy



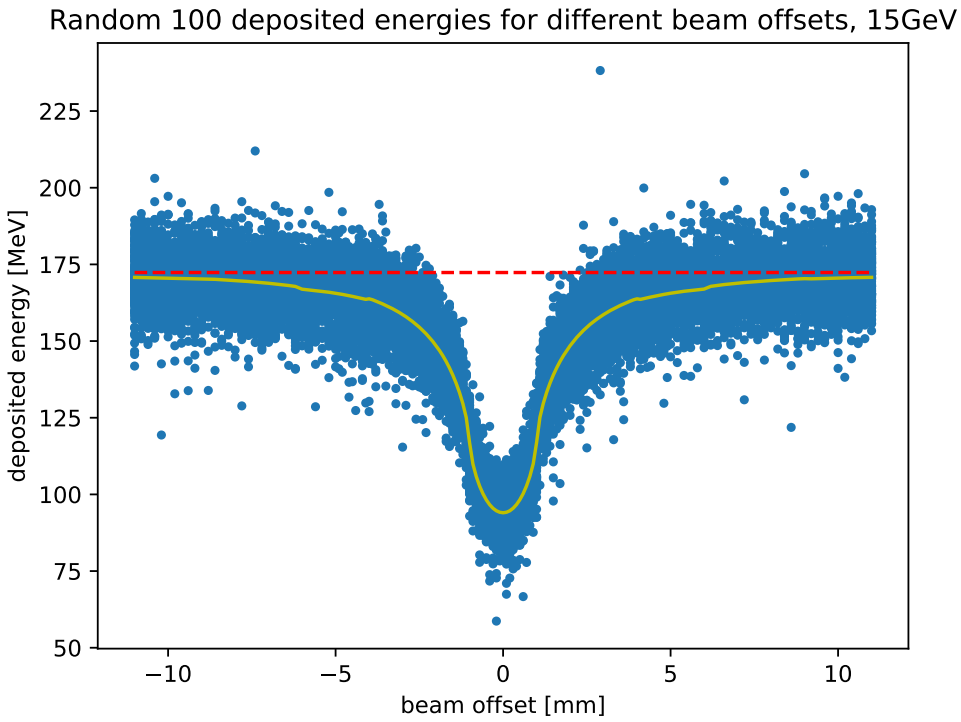


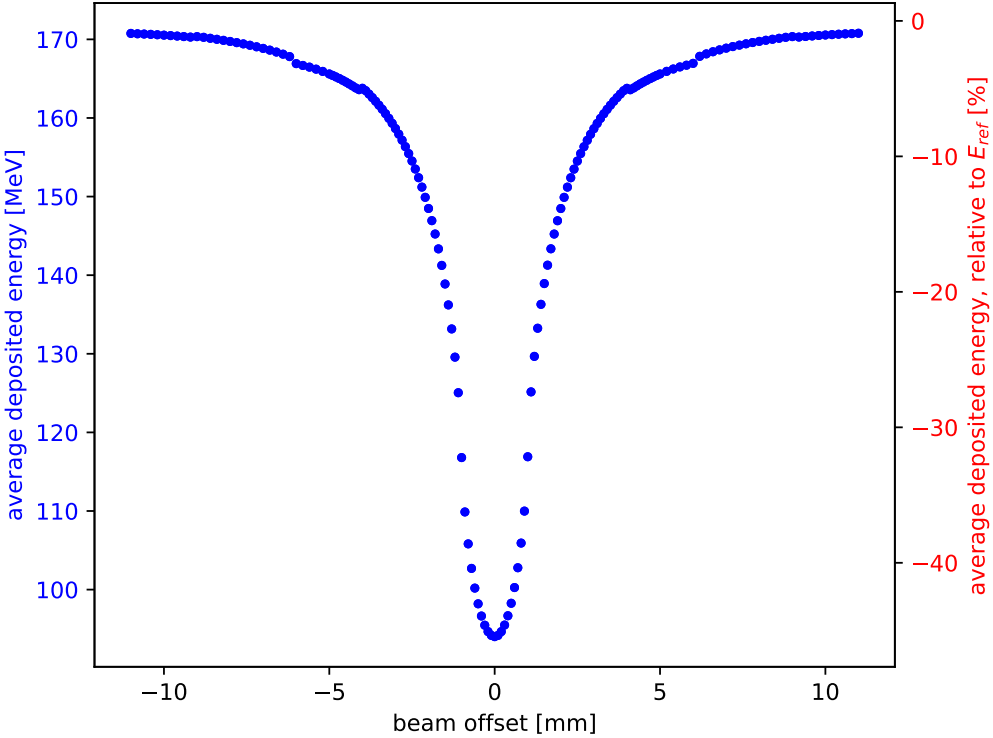
Results for 2.02mm gap
gun position vs energy



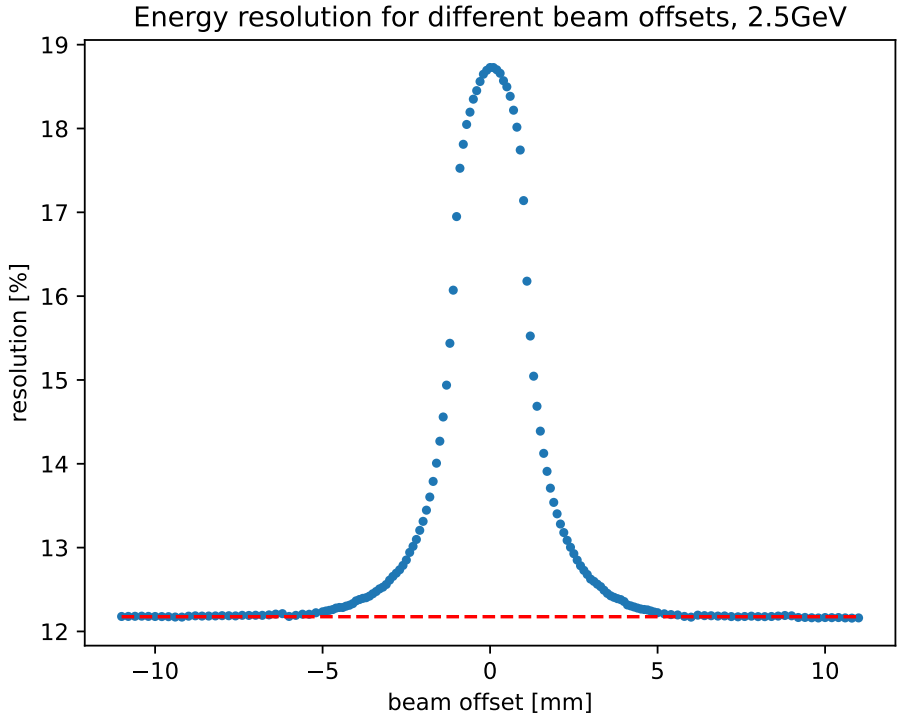


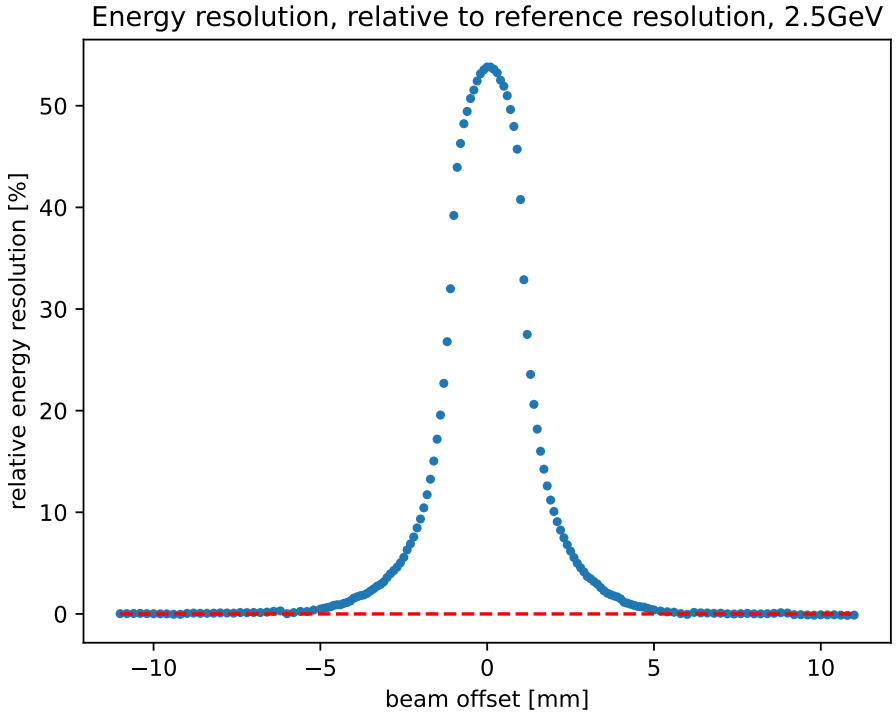
Results for 2.02mm gap
gun position vs energy



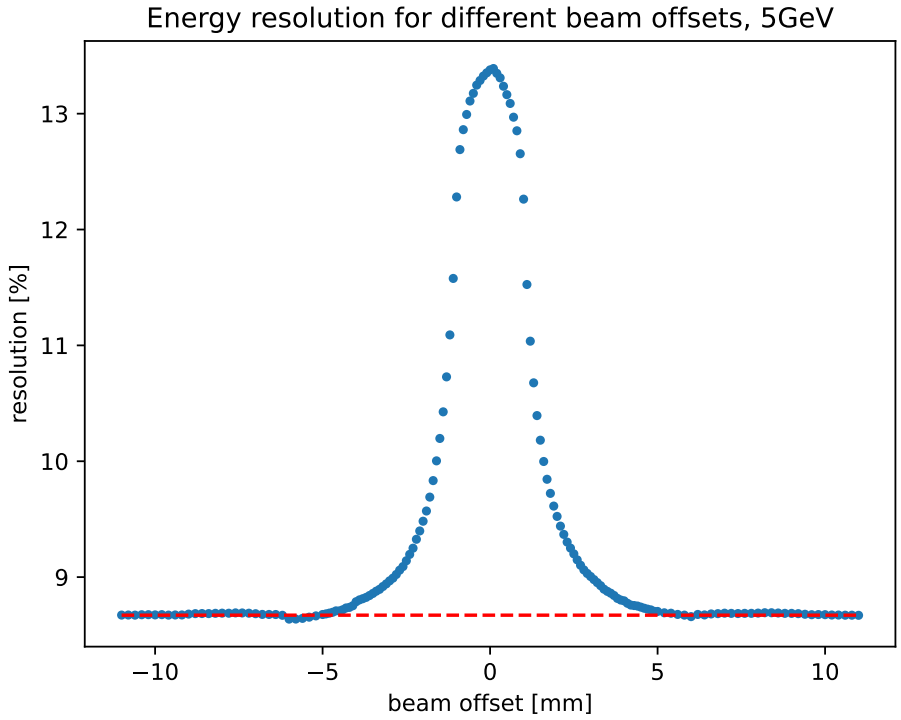


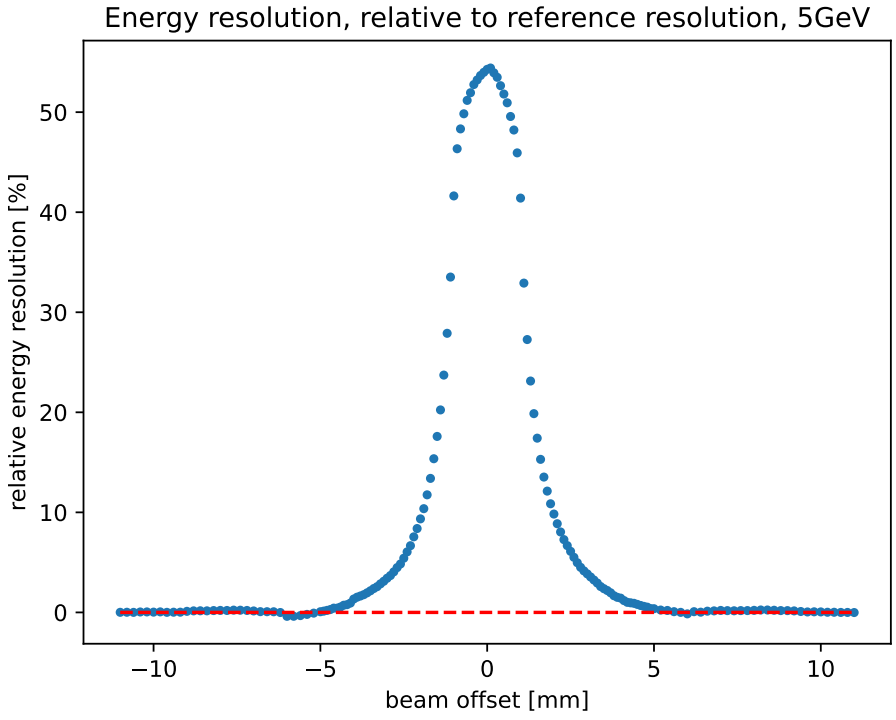
Results for 2.02mm gap
gun position vs resolution



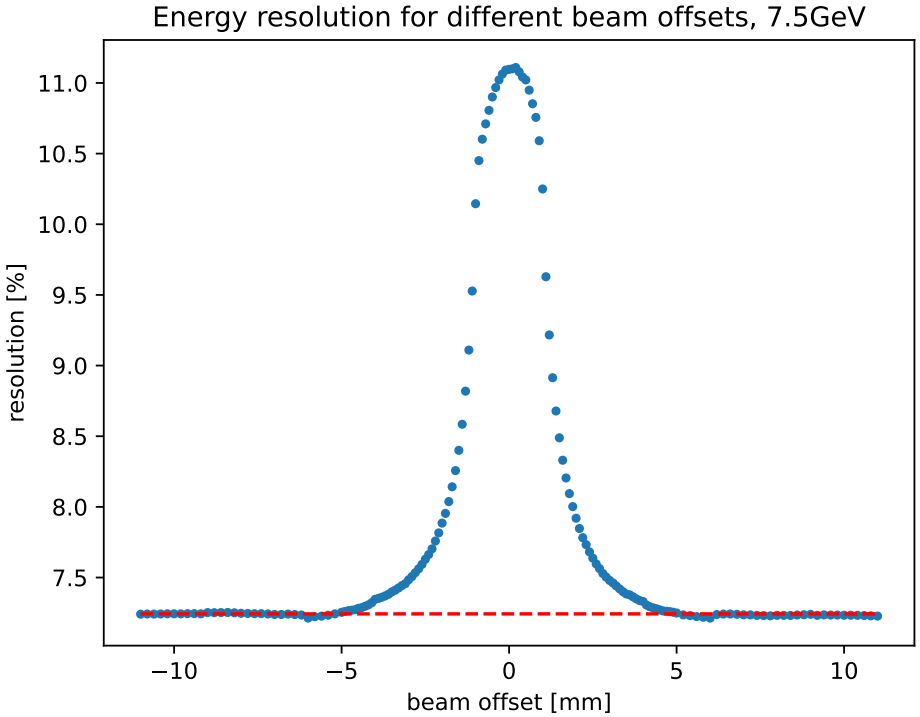


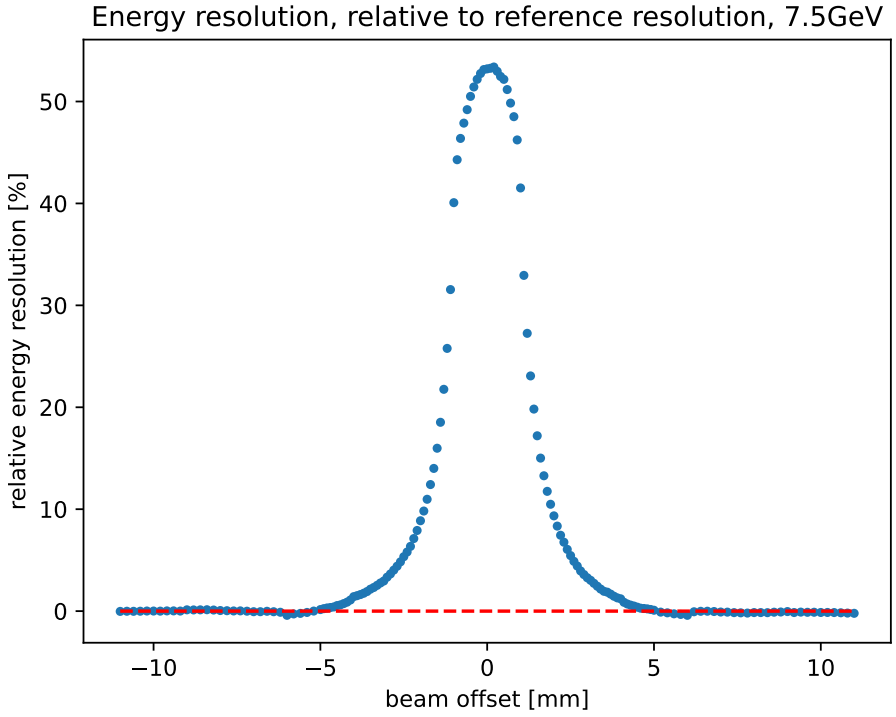
Results for 2.02mm gap
gun position vs resolution



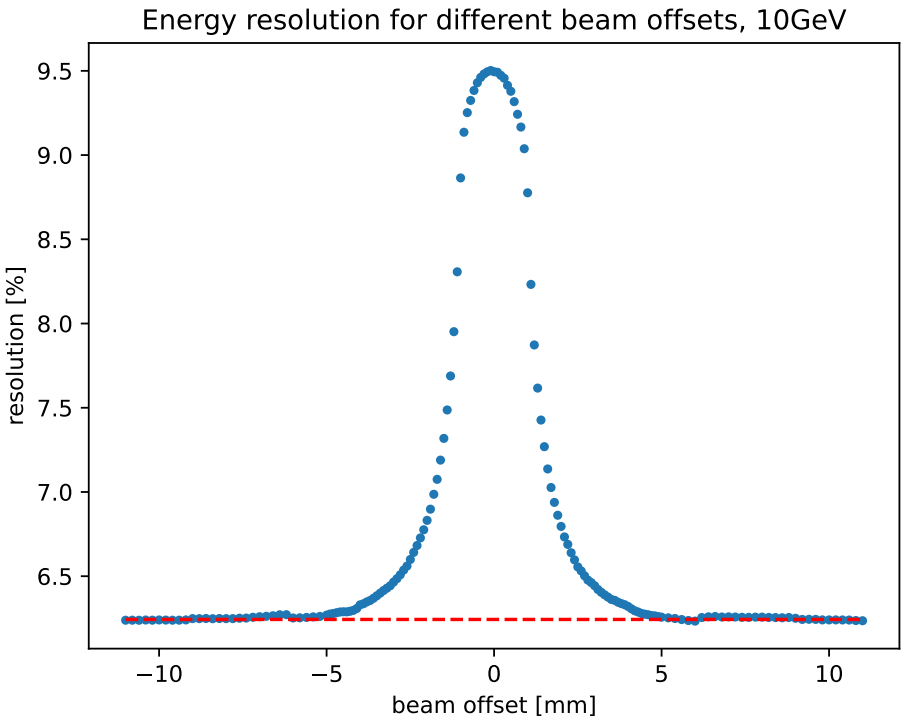


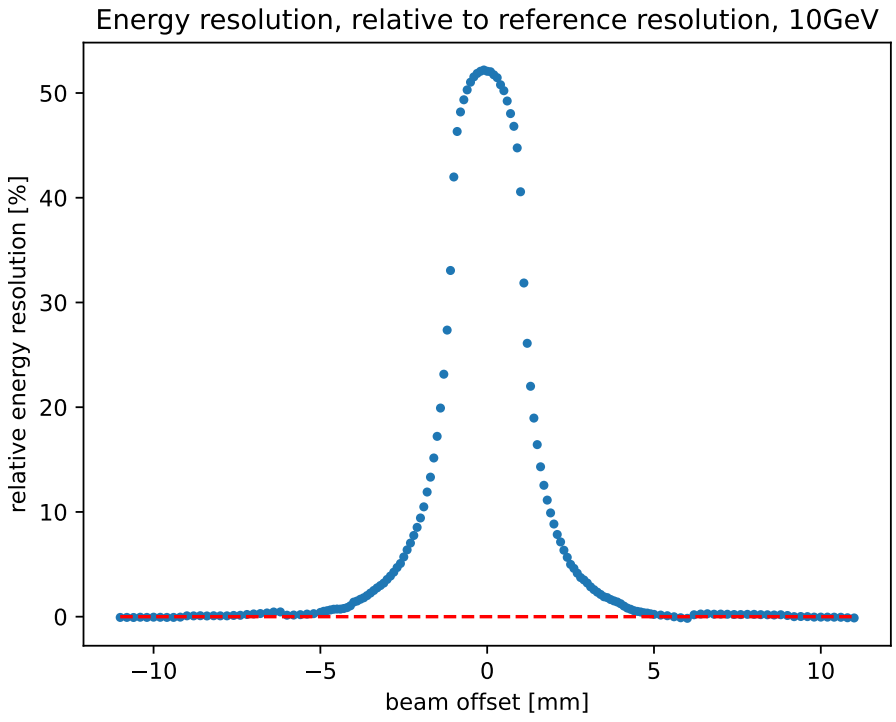
Results for 2.02mm gap
gun position vs resolution



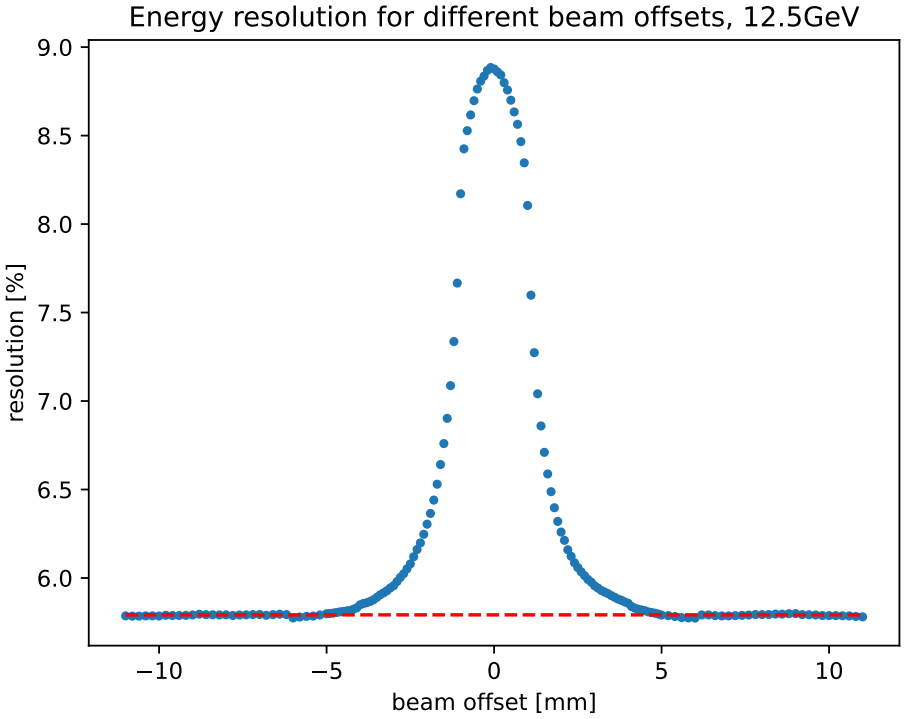


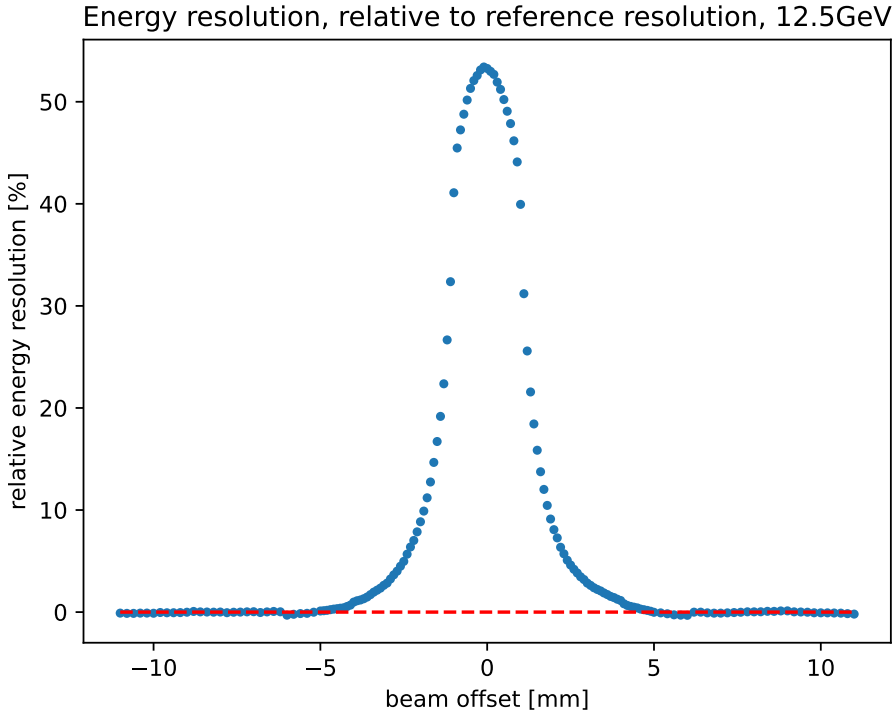
Results for 2.02mm gap
gun position vs resolution



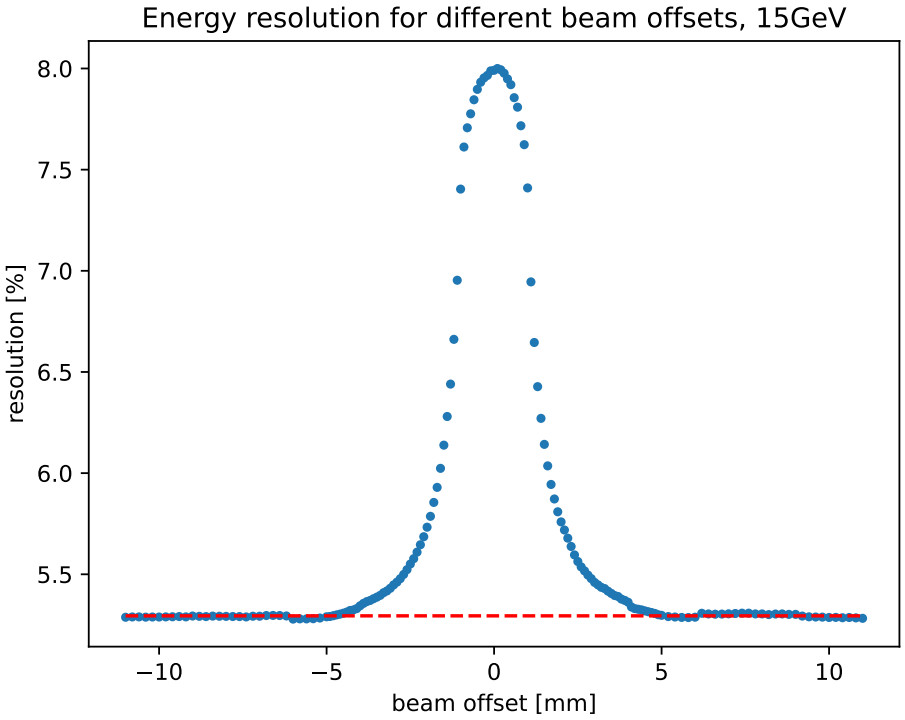


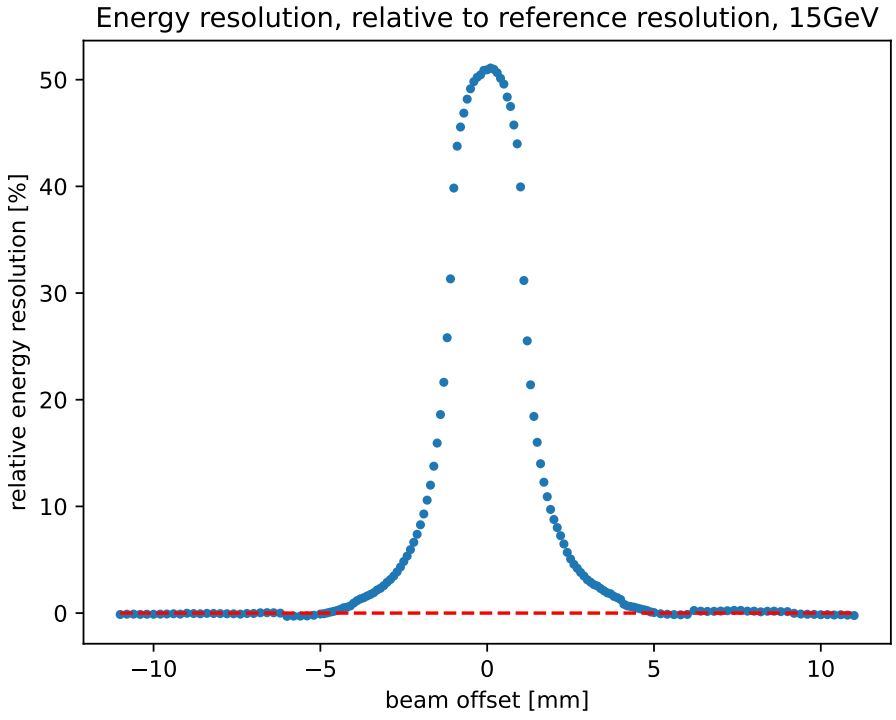
Results for 2.02mm gap
gun position vs resolution





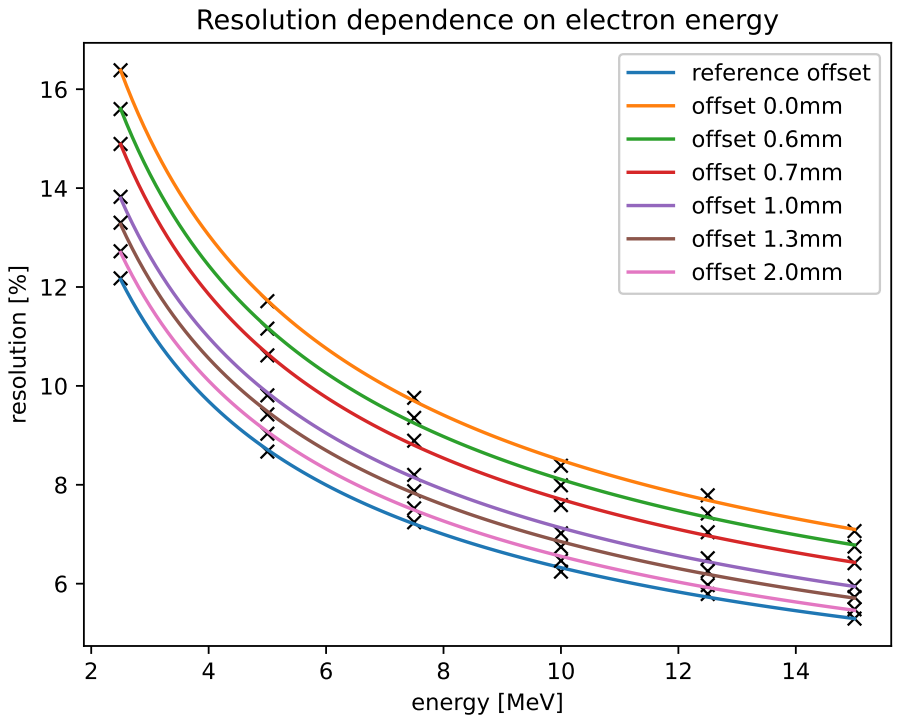
Results for 2.02mm gap
gun position vs resolution



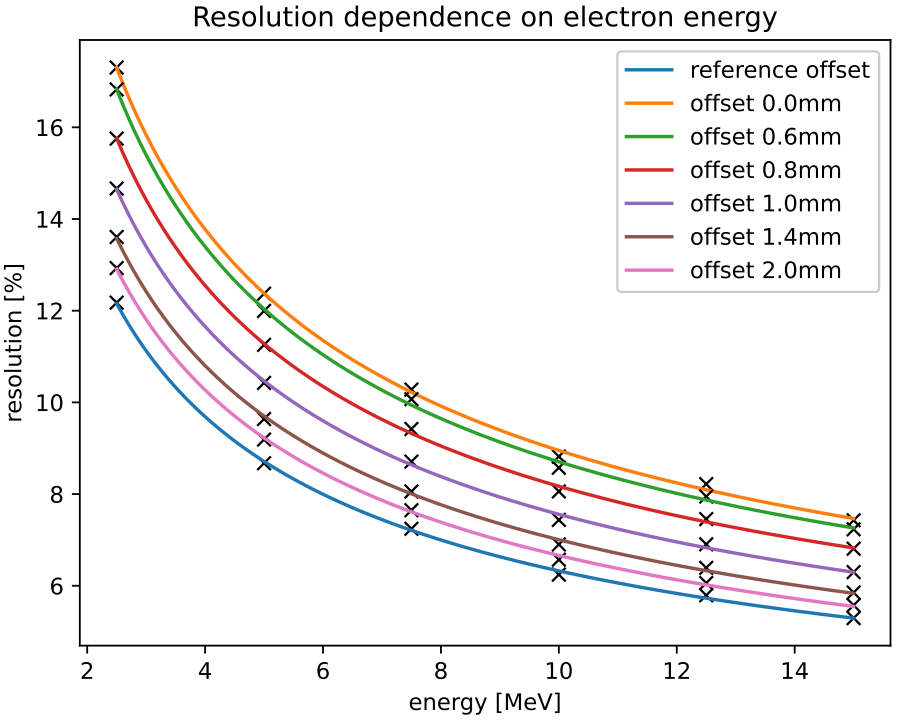


Energy vs resolution
For 1.22mm and 1.52mm gap

1.22mm gap

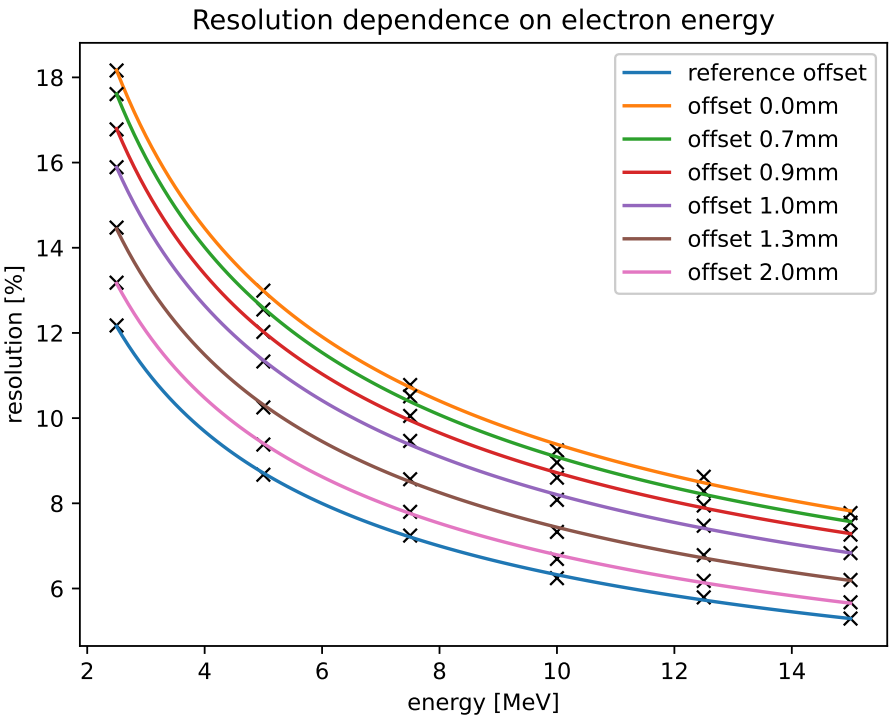


1.52mm gap

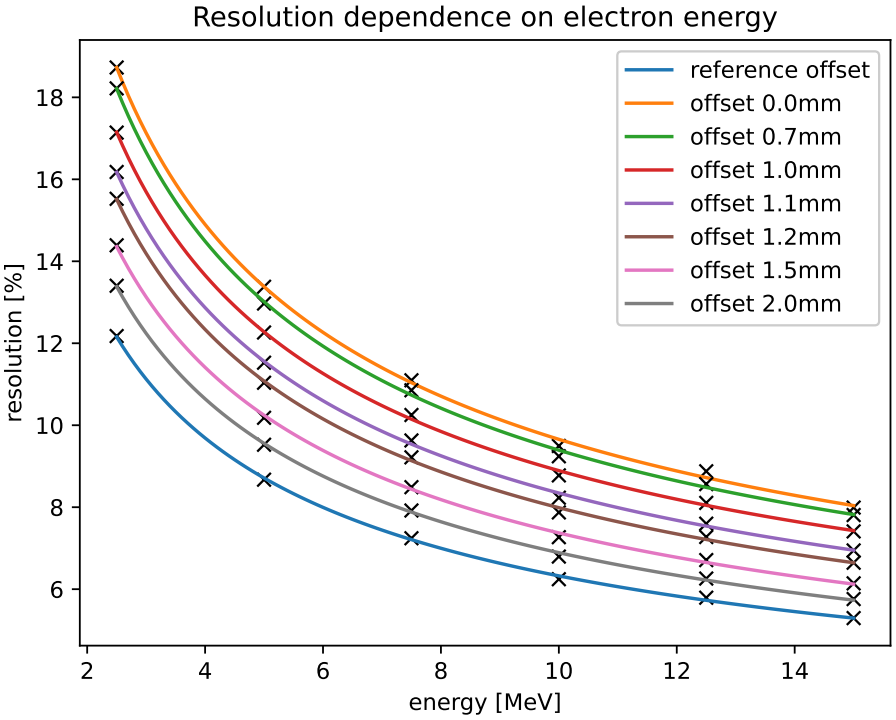


Energy vs resolution
For 1.82mm and 2.02mm gap

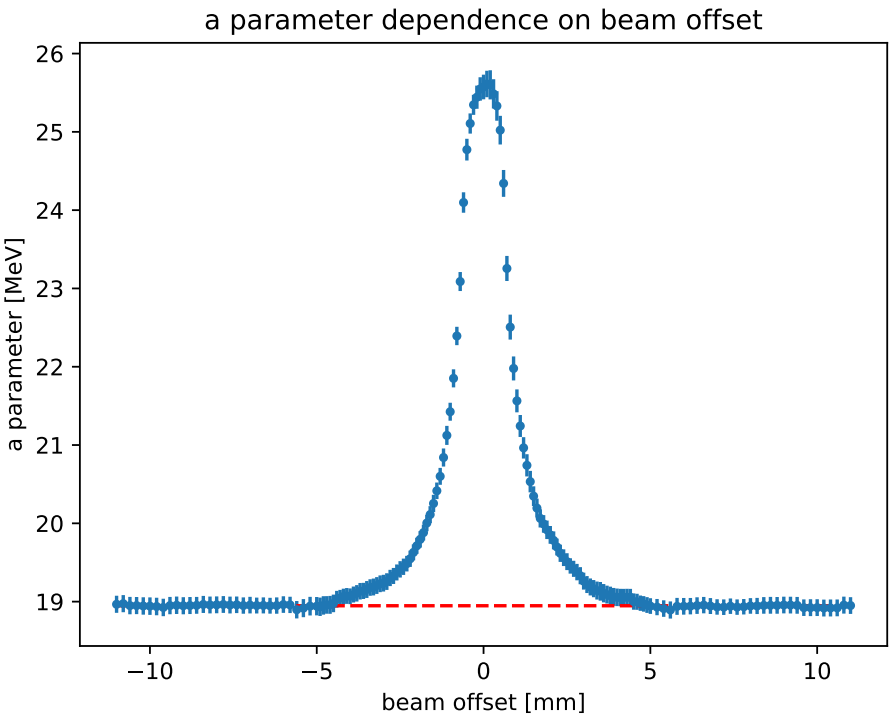
1.82mm gap

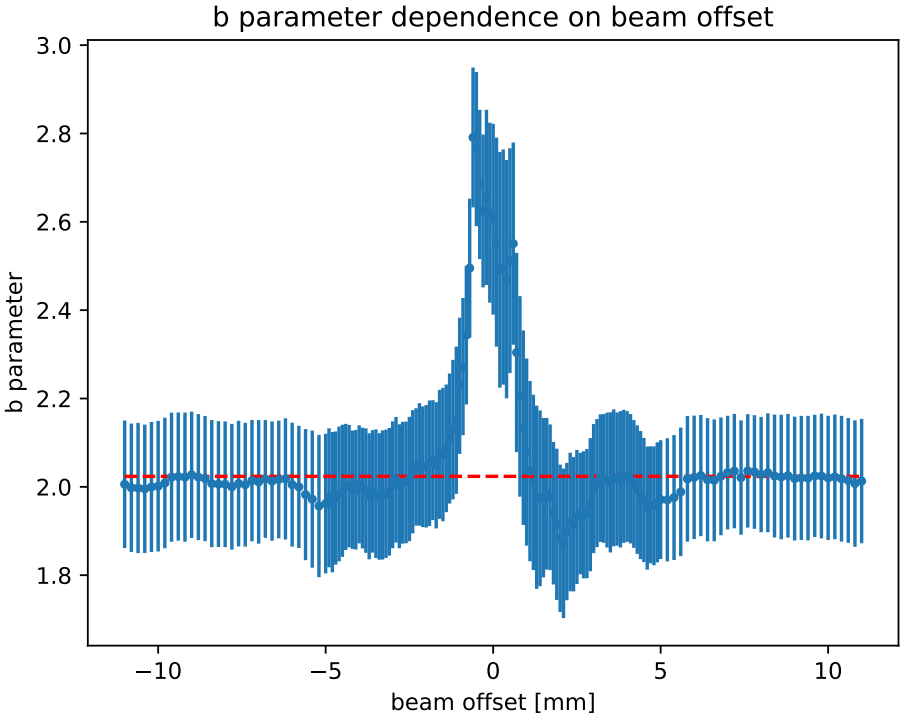


2.02mm gap

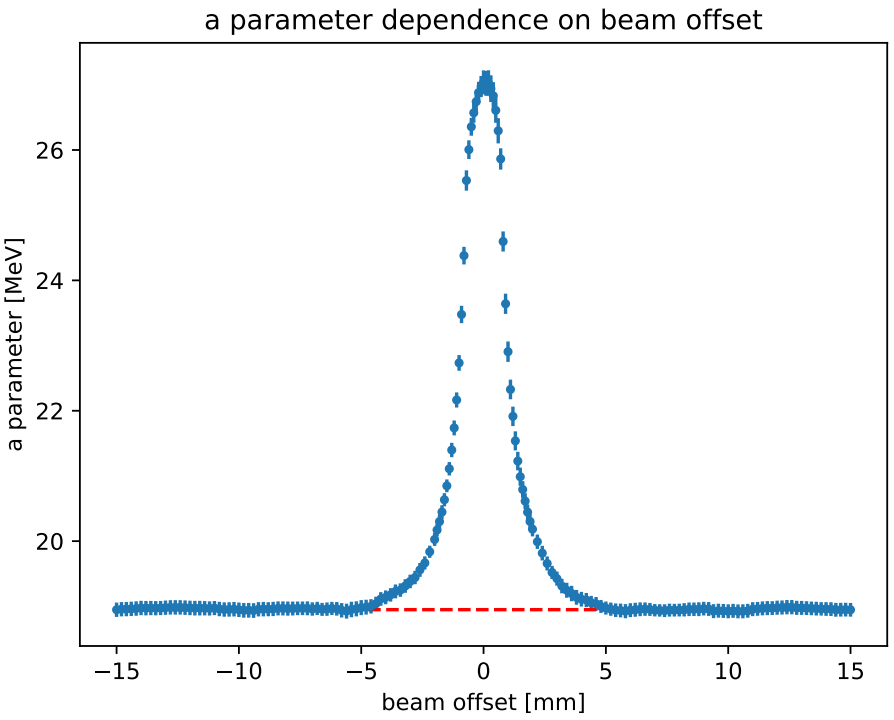


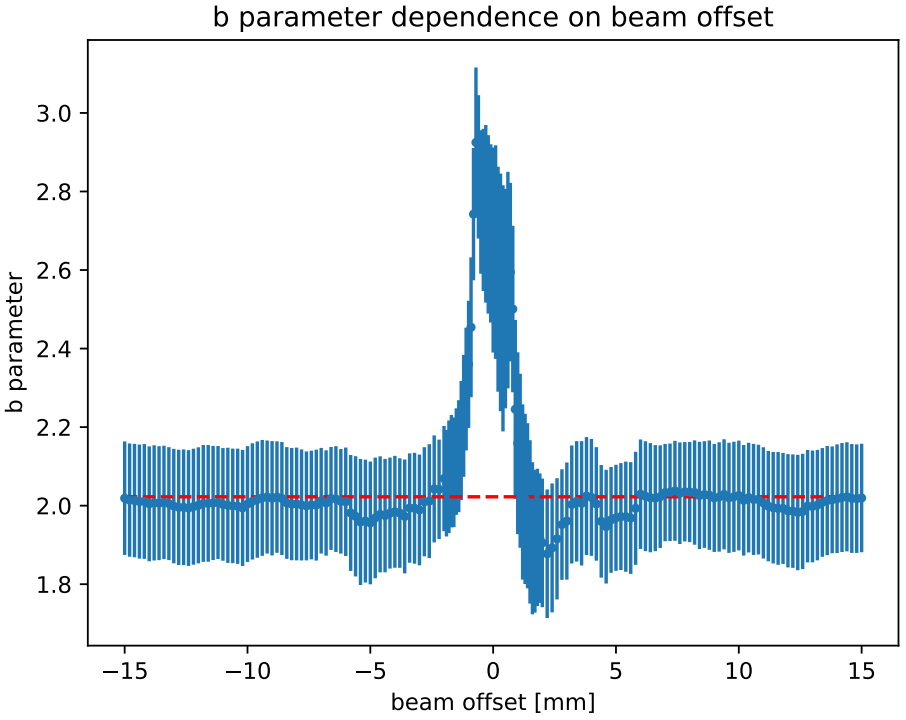
Gun position vs a and b
For 1.22mm gap



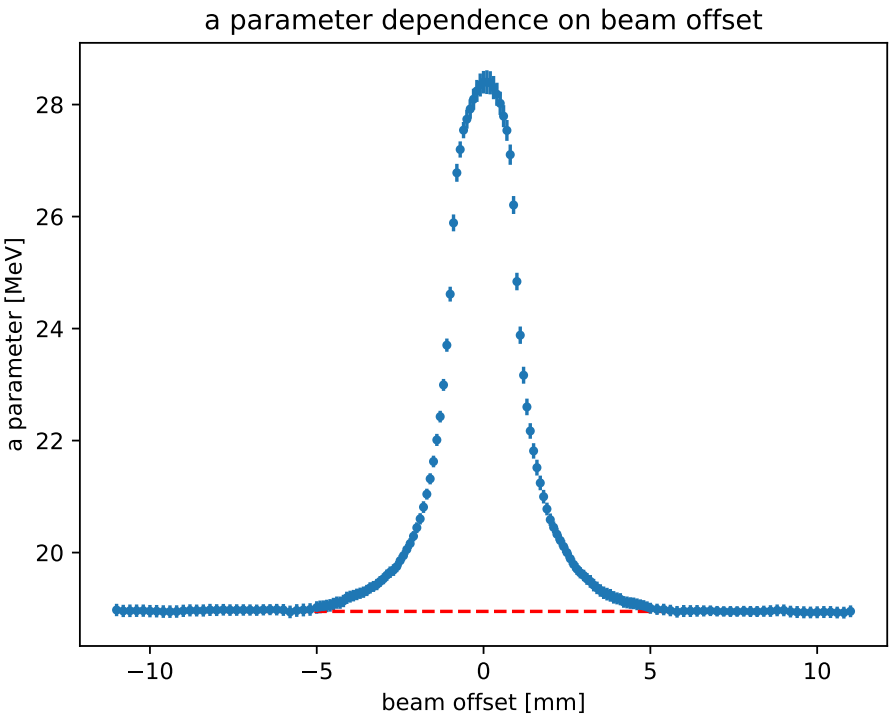


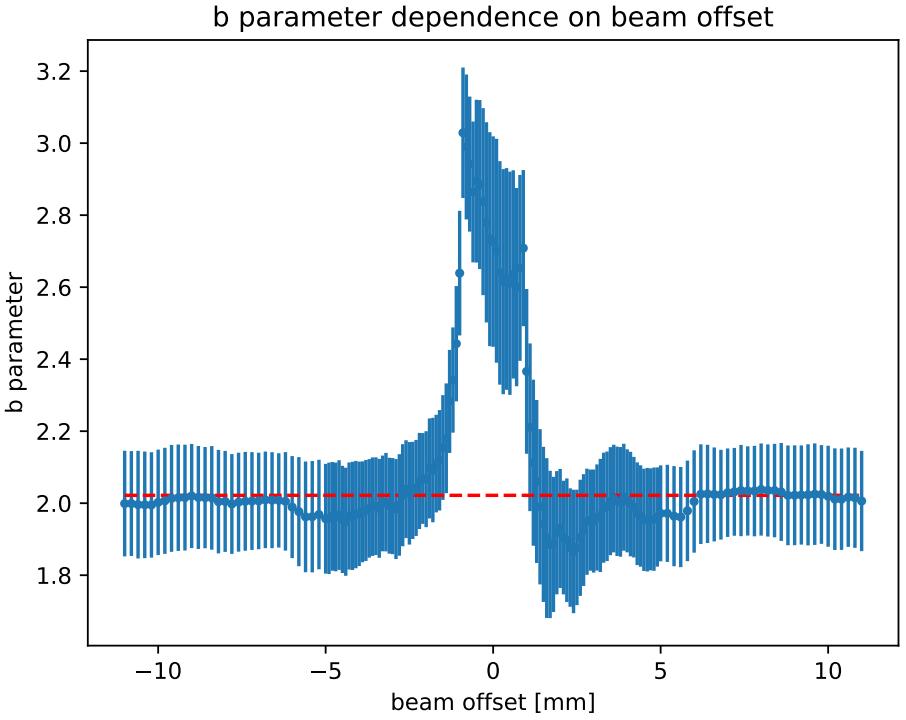
Gun position vs a and b
For 1.52mm gap



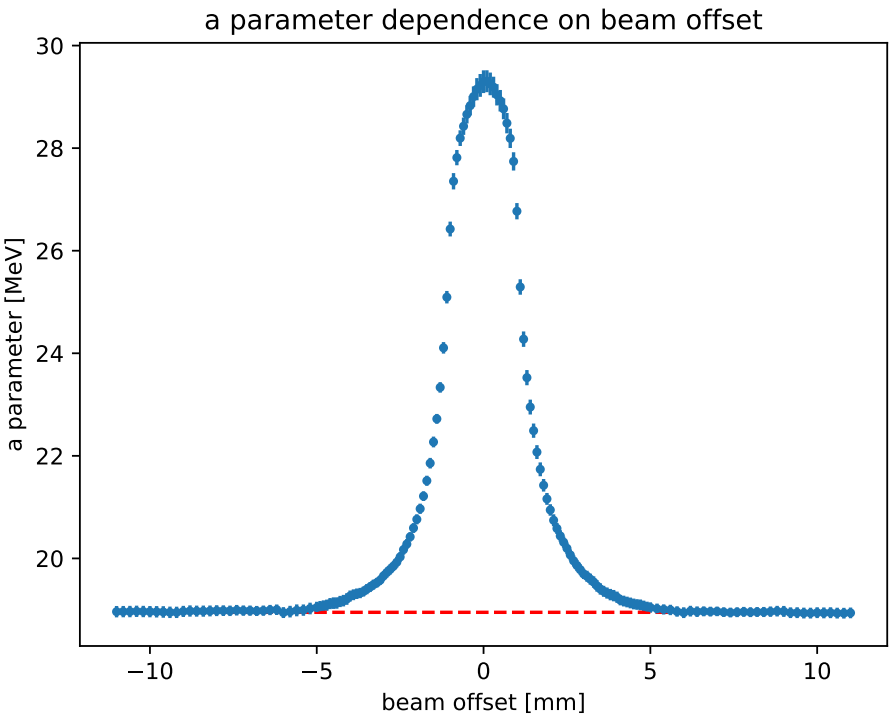


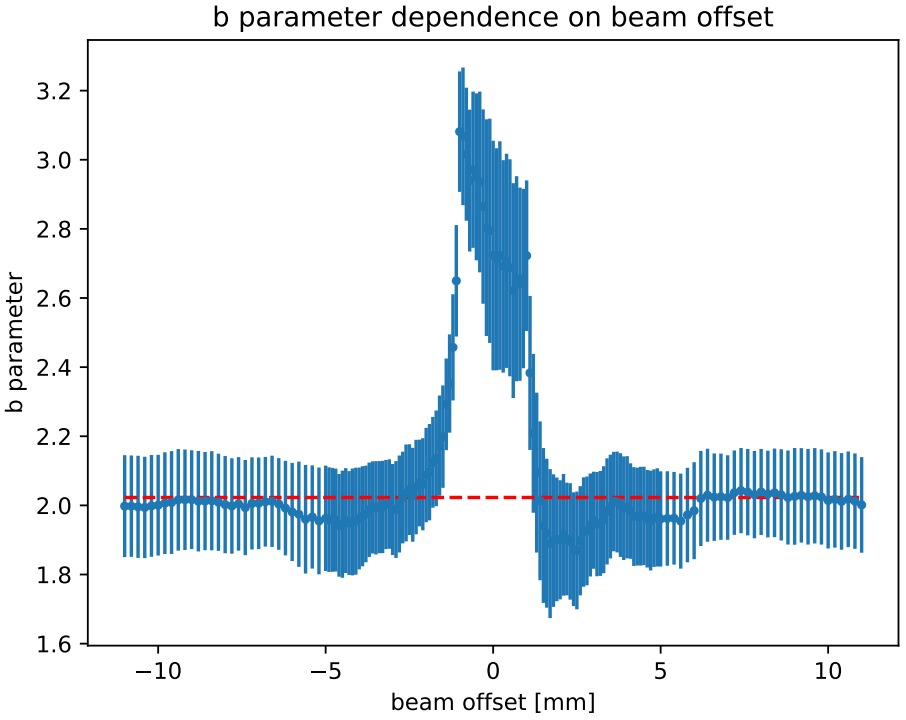
Gun position vs a and b
For 1.82mm gap



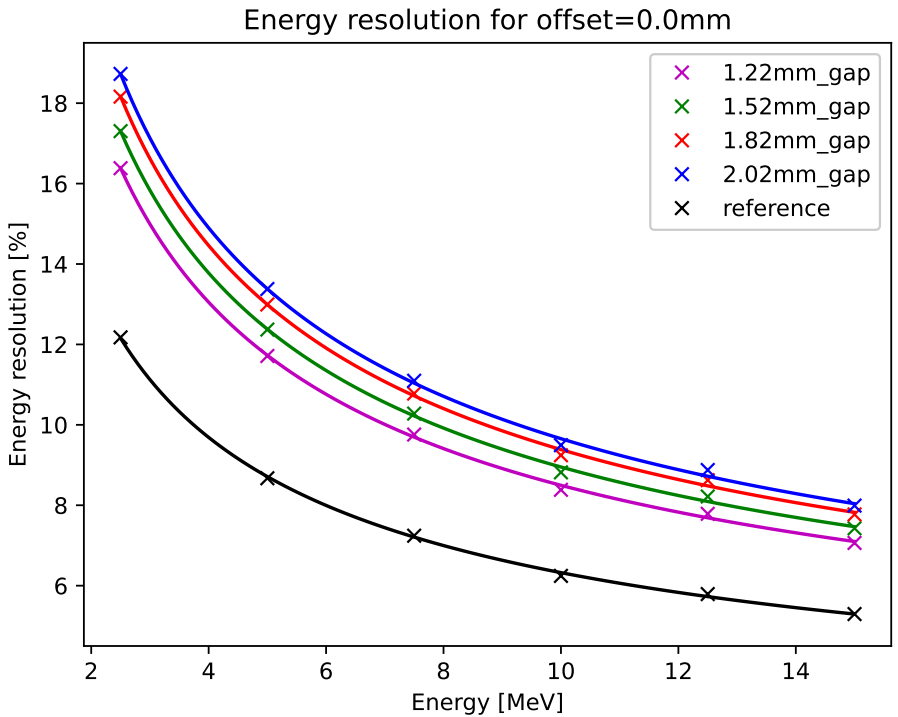


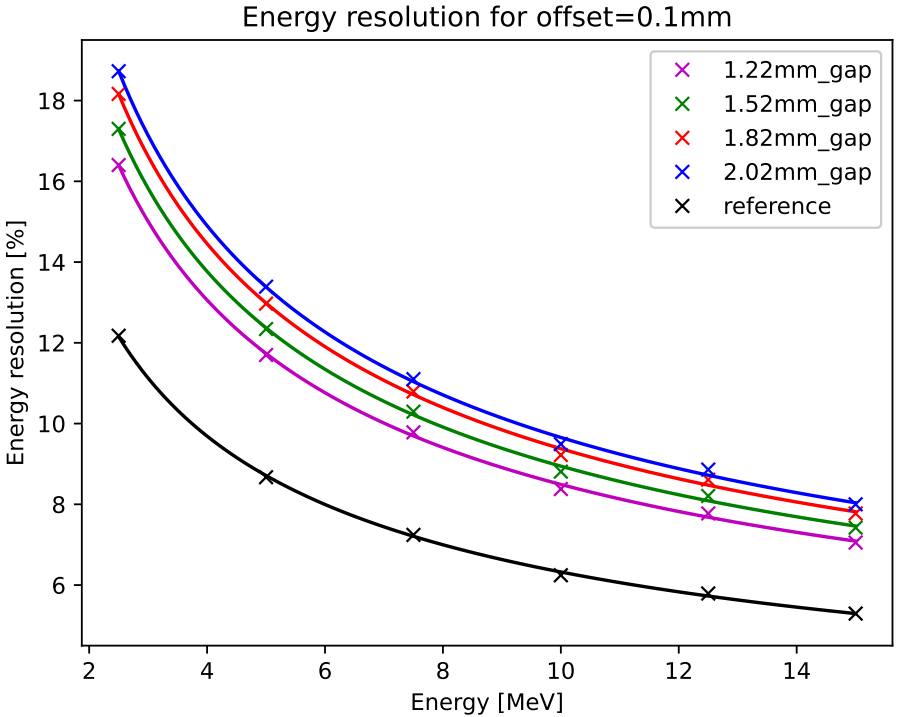
Gun position vs a and b
For 2.02mm gap



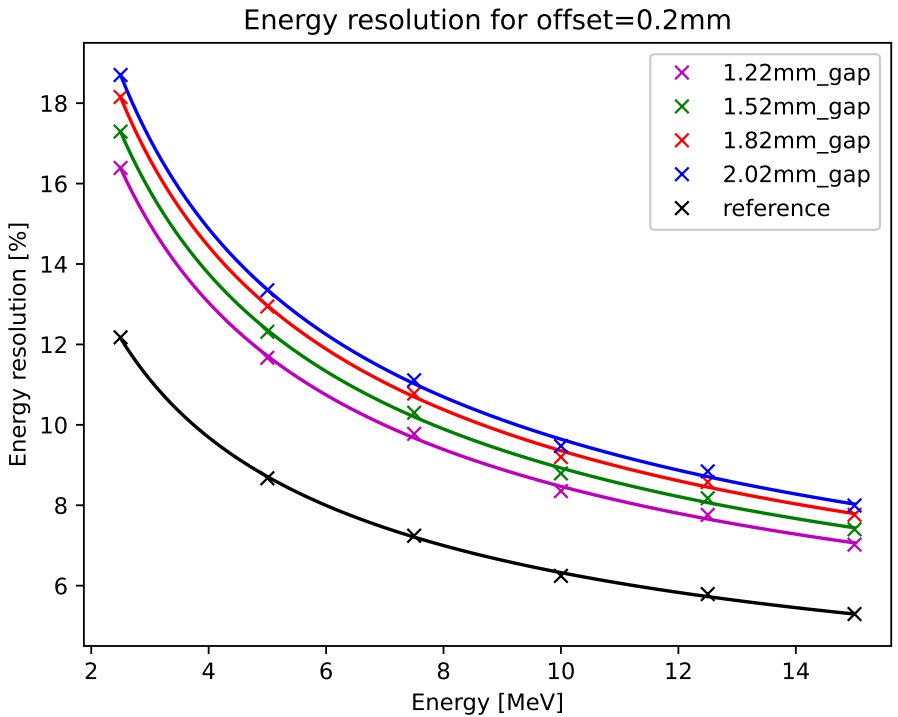


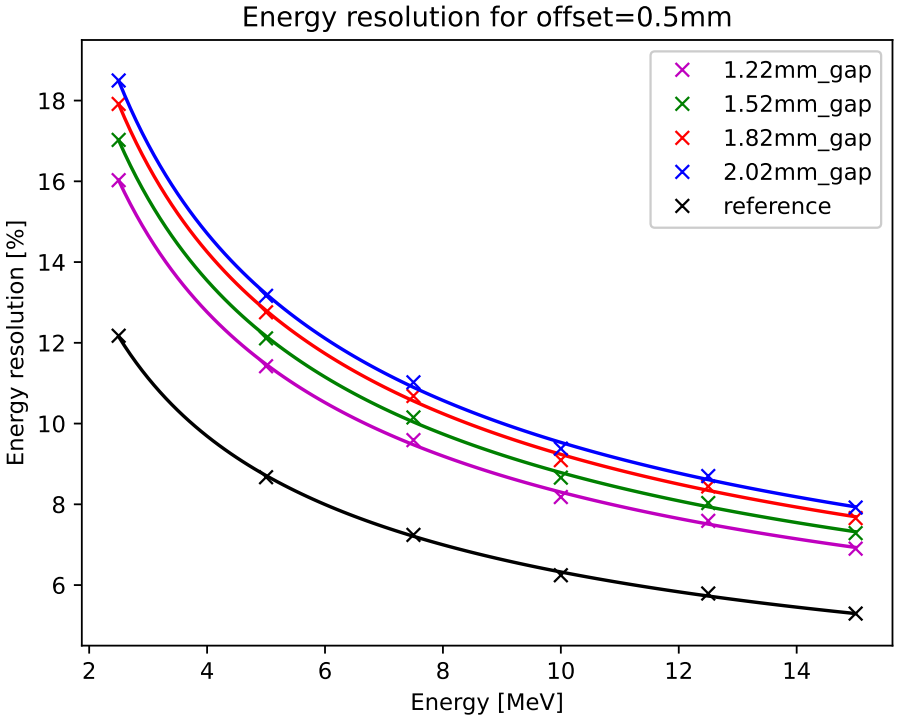
Energy vs resolution
For set offset and every gap sizes



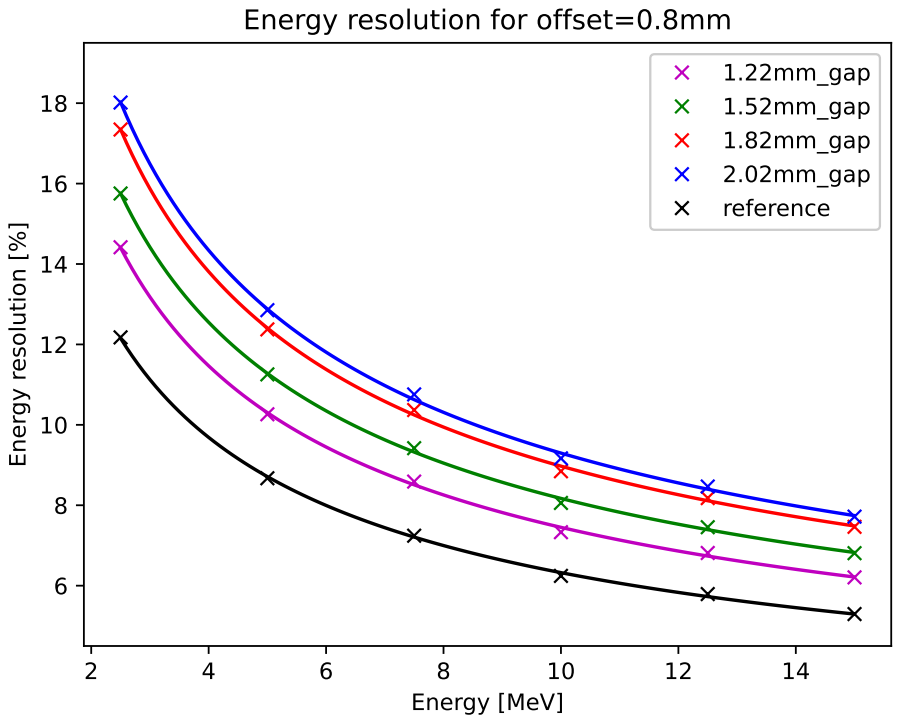


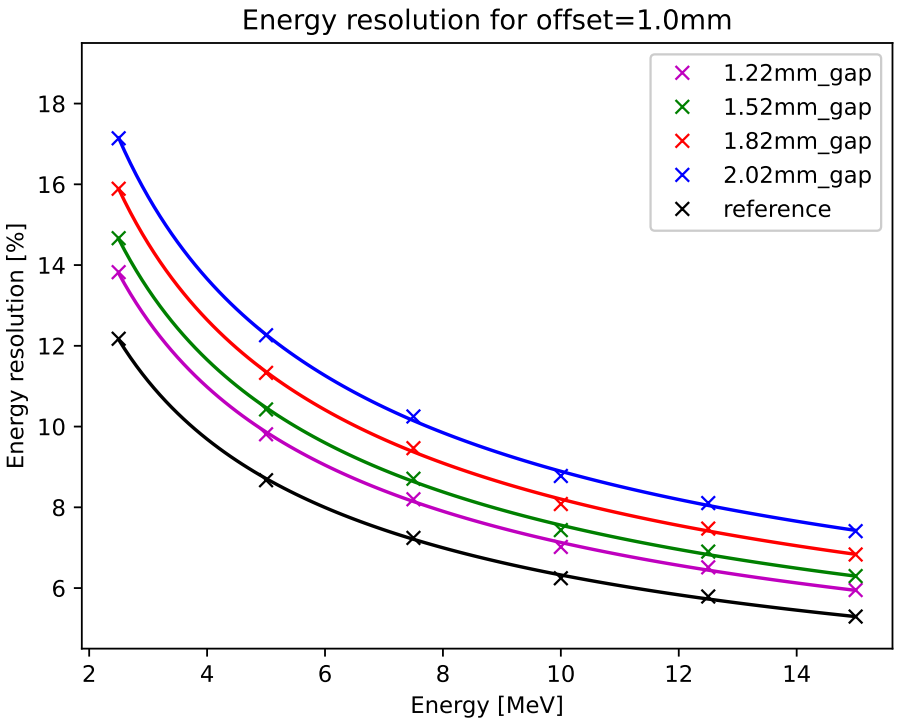
Energy vs resolution
For set offset and every gap sizes



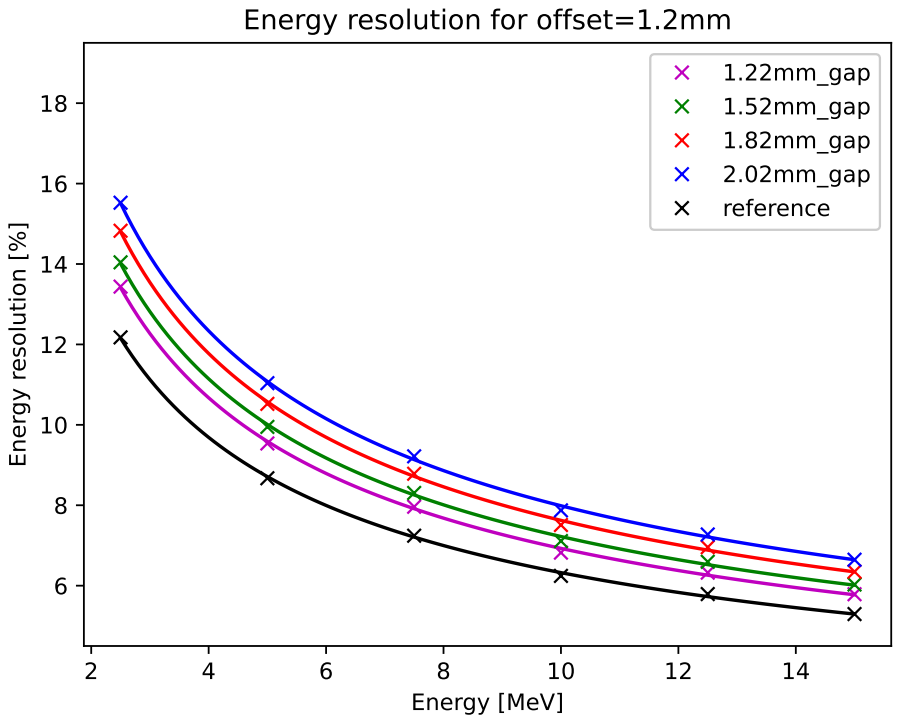


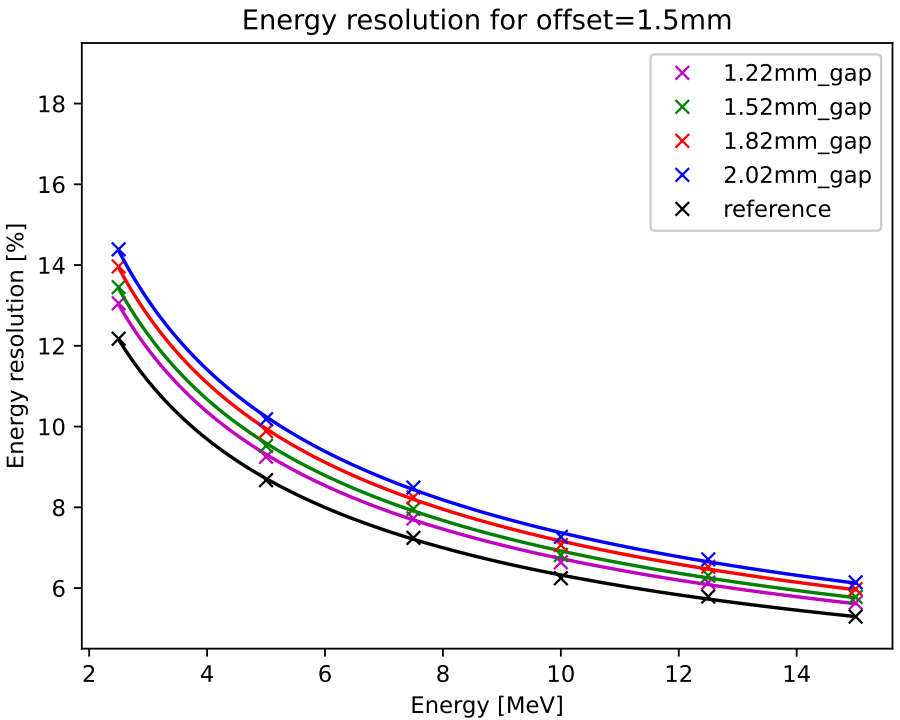
Energy vs resolution
For set offset and every gap sizes



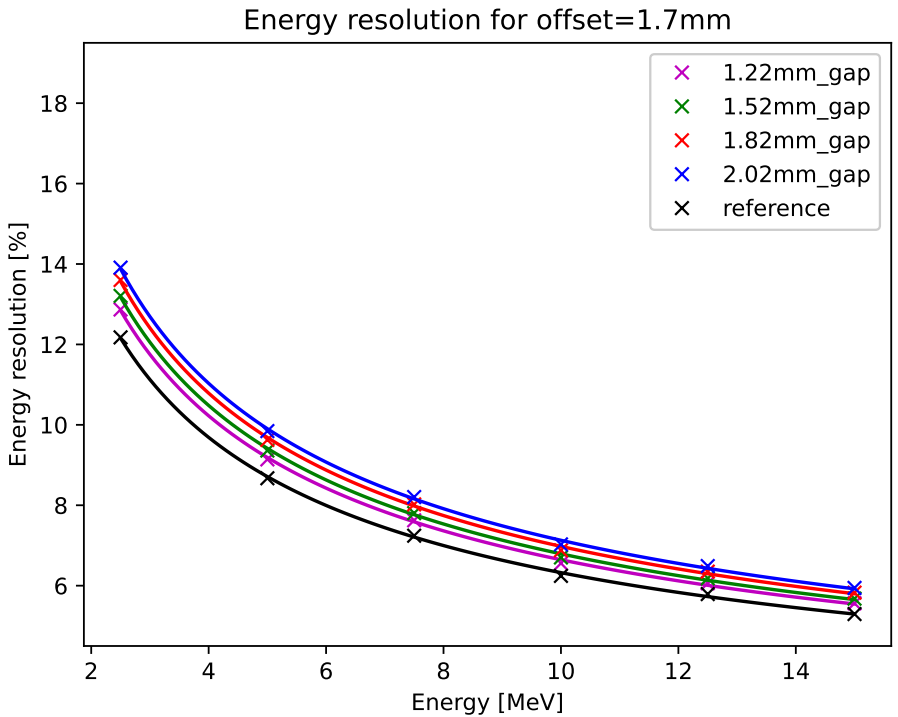


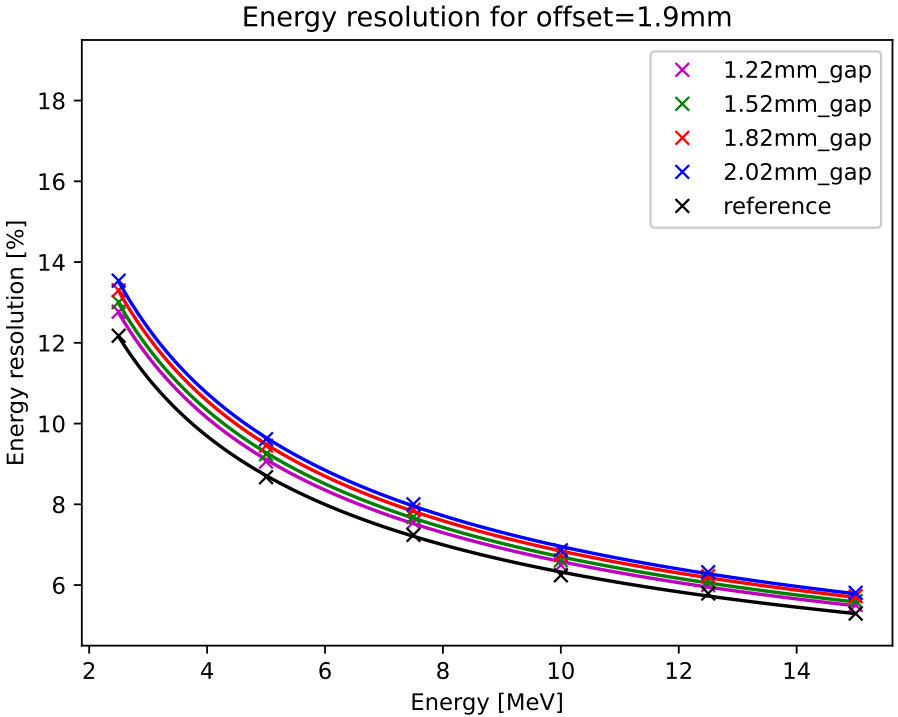
Energy vs resolution
For set offset and every gap sizes



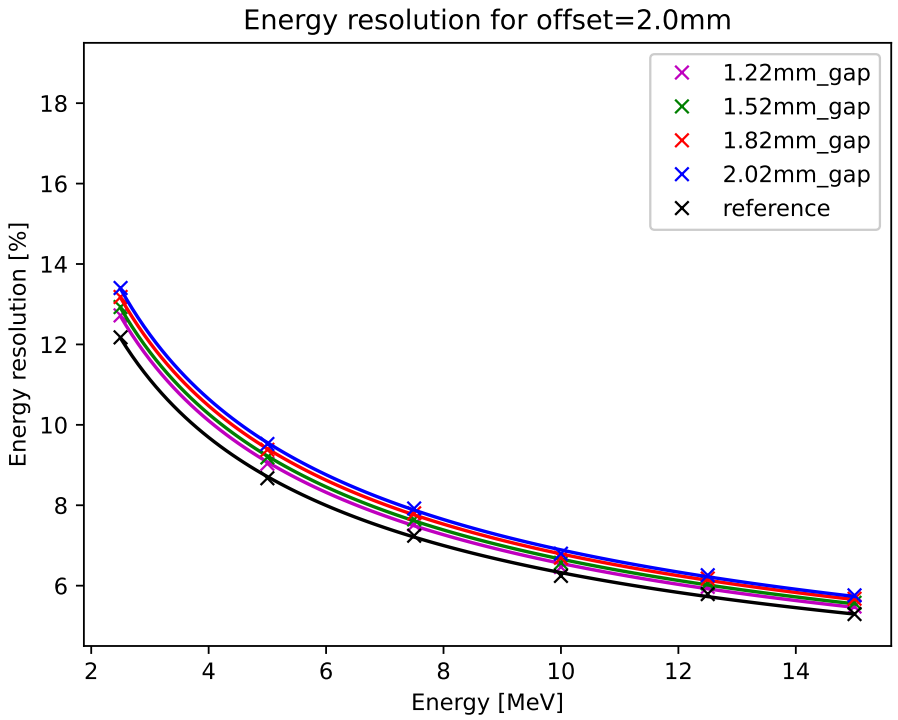


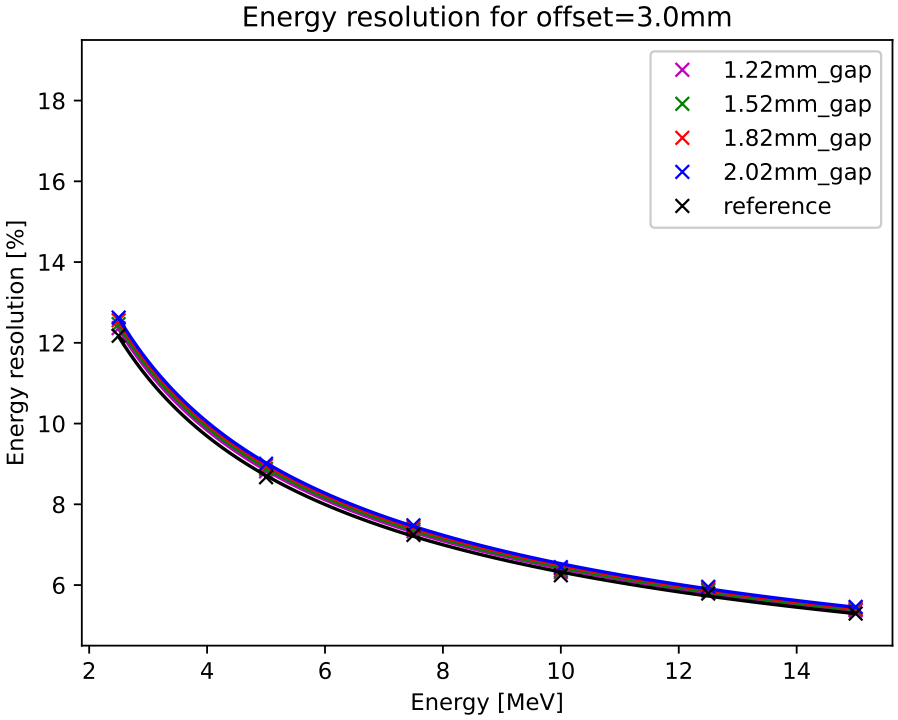
Energy vs resolution
For set offset and every gap sizes





Energy vs resolution
For set offset and every gap sizes





Conclusions

- Significant worse (from 35% to 55% worse that reference) of resolution when particles hits center of the tile gap
- Cascade core is very narrow → even small tile gaps impacts 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