

Energy resolution dependence on the tile gaps' width, for tilted beam

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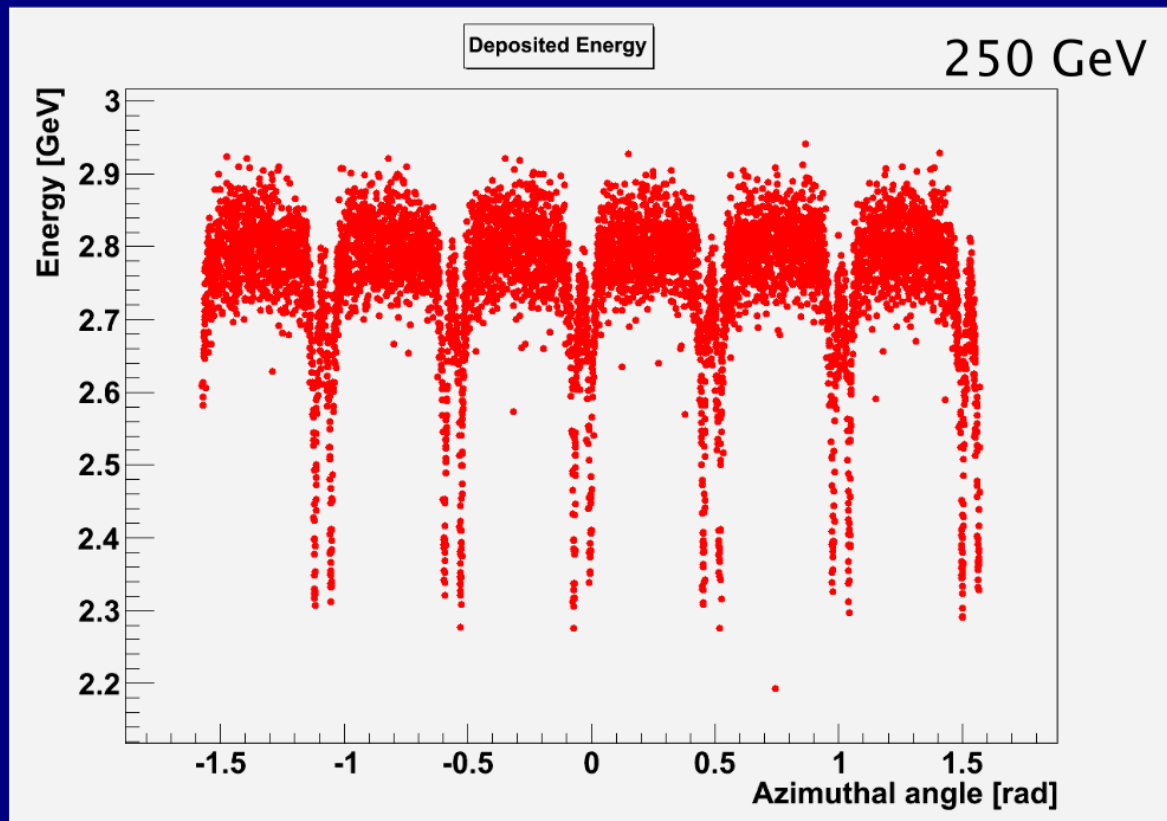
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¹University of Warsaw

LumiCal results

Slide from
“Tile gaps and
energy resolution in
LumiCal” by
Jonathan Aguilar
and Bogdan Pawlik
IFJ-PAN, Krakow

Energy Loss in Gaps

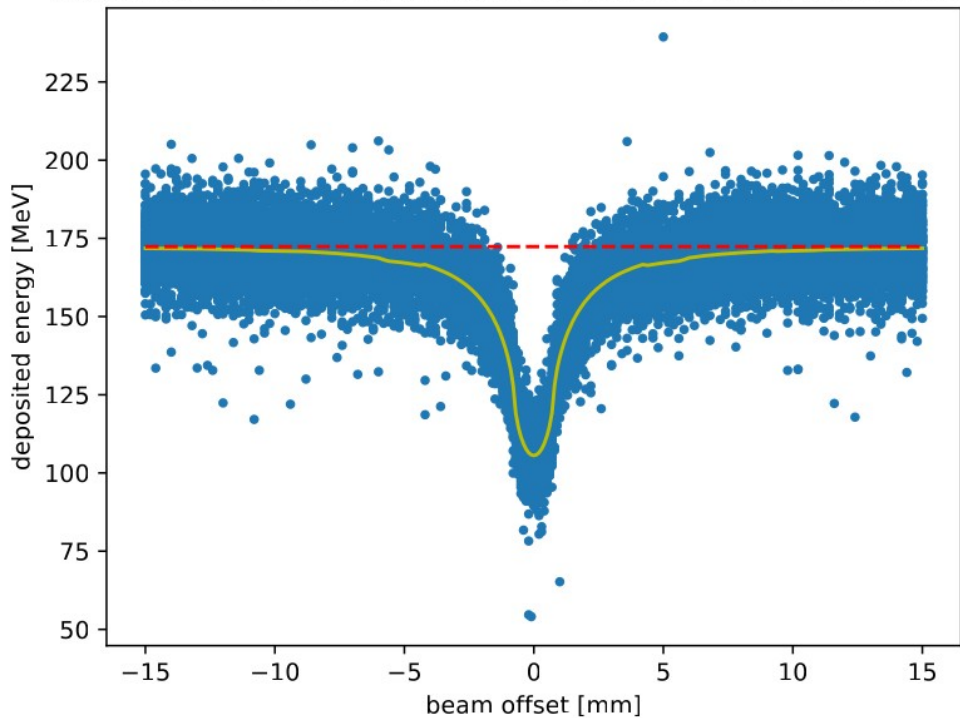


Analysis setup

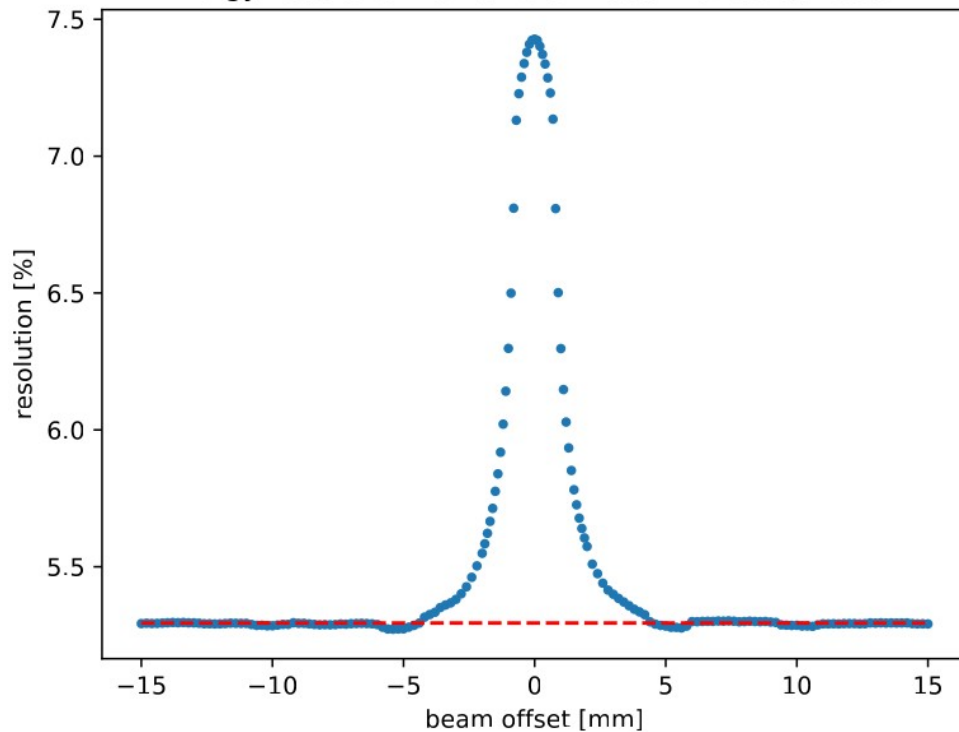
- Files used: mc21.singlePositron_*GeV_ECALP_run2.G4gun.SIM.se0003.root,
- Single positron hitting centre of the ECAL-P perpendicularly with energy from 2.5 to 15 GeV with 2.5GeV step, 20k events, 320 μ m silicon sensor,
- Plain silicon layer in MC \rightarrow structure of sensors and pads implemented 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,

Previous results

Random 100 deposited energies for different beam offsets, 15GeV

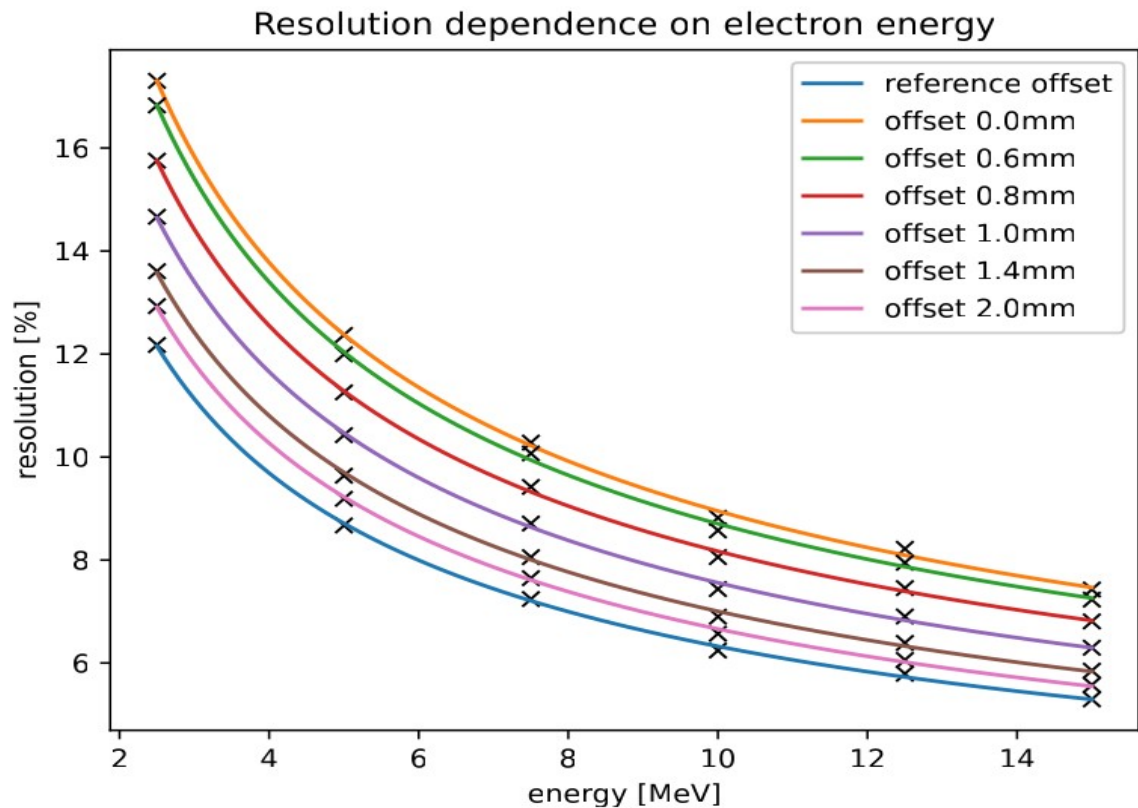


Energy resolution for different beam offsets, 15GeV



Previous results

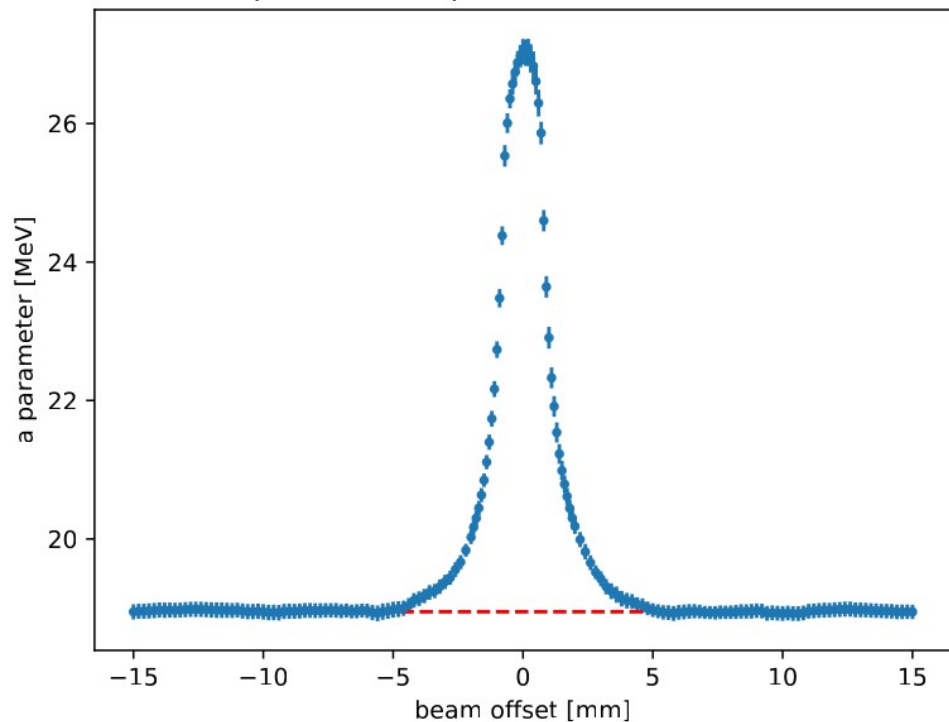
1.52mm gap



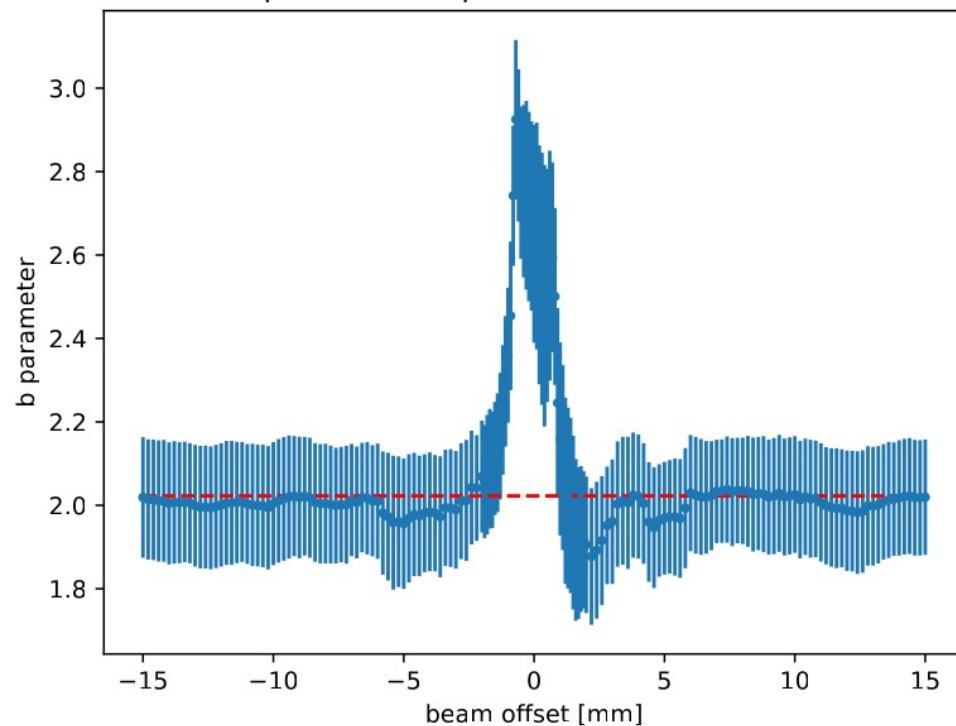
Previous results

$$\frac{\sigma}{E}(E) = \sqrt{\frac{a^2}{E} + b^2}$$

a parameter dependence on beam offset



b parameter dependence on beam offset

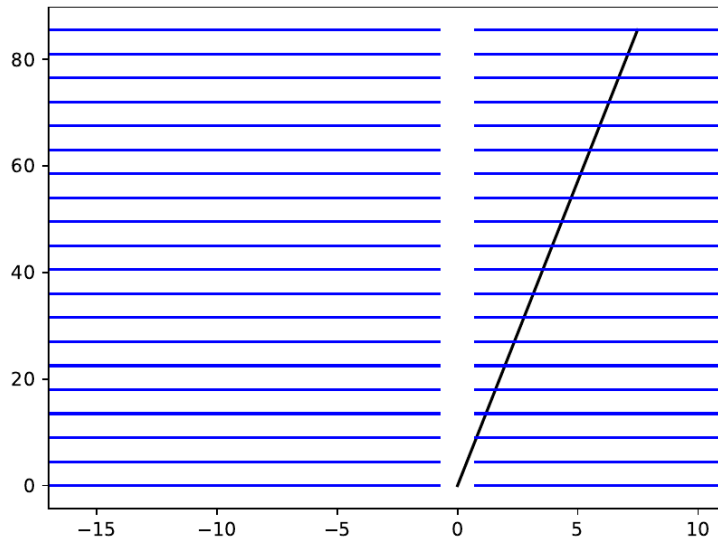


Previous results and conclusions

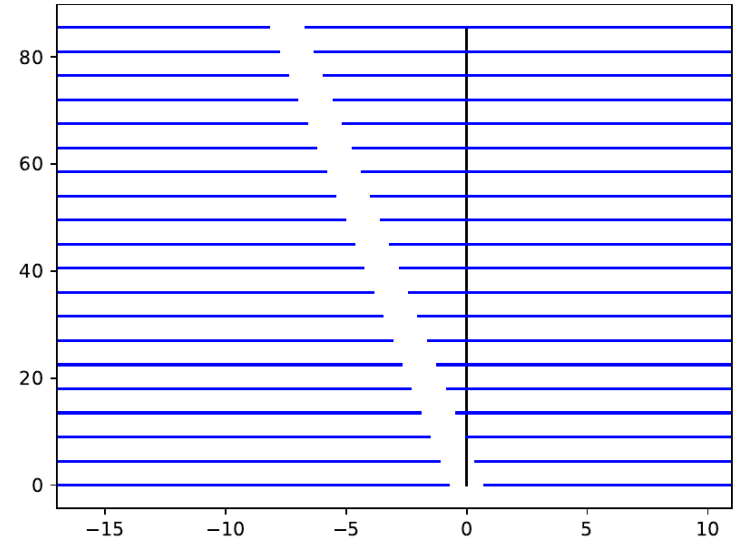
- Significant worse (from 35% to 55% worse than reference) of resolution when particle hits center of the tile gap
- Cascade core is very narrow → even small tile gap impacts resolution
- If the hit is located more than 3mm from the centre of the tile gap, resolution hardly depends on the width of the gap

Approximation of tilted beam

- No MC with positrons hitting ECAL-P at an angle
- Inclined trajectory of a positron can be approximated by small shift of each layer



\approx

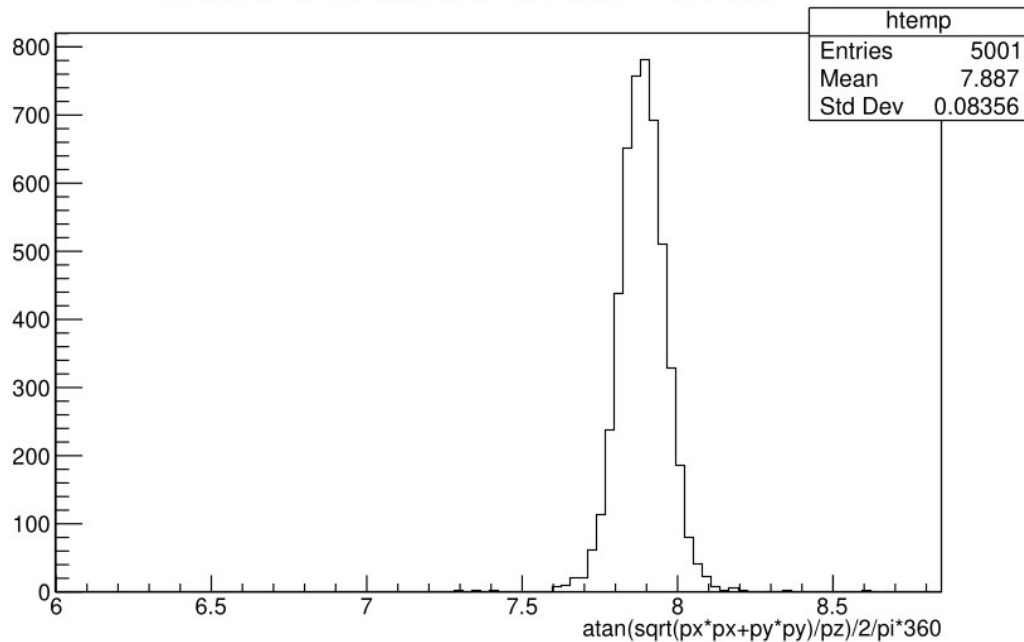


Remarks on the approximation

- n^{th} layer is shifted by $n \cdot d \cdot \tan(\theta)$, θ – incident angle, d – thickness of the layer
- Effective thickness of each layer increases as $1/\cos(\theta)$ which **is not** taken into account
- Analysis was performed for 1.52mm (1.32mm dead sensor edge and 0.2mm physical gap) gap and following angles: 0° , 1° , 3° , 5° , 7° , 10° (and 15°)
- Angles were chosen basing on the MC simulation with magnetic field

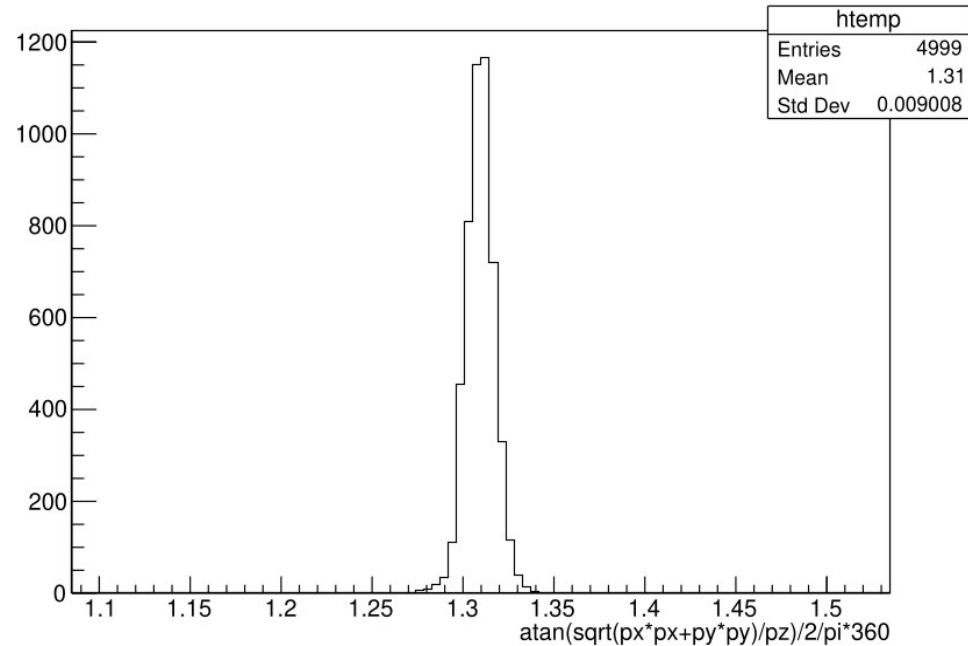
Distributions of angles from MC with magnetic field

$\text{atan}(\sqrt{p_x^2+p_y^2}/p_z)/2/\pi*360$ {detid==2000 && pz>1.2}



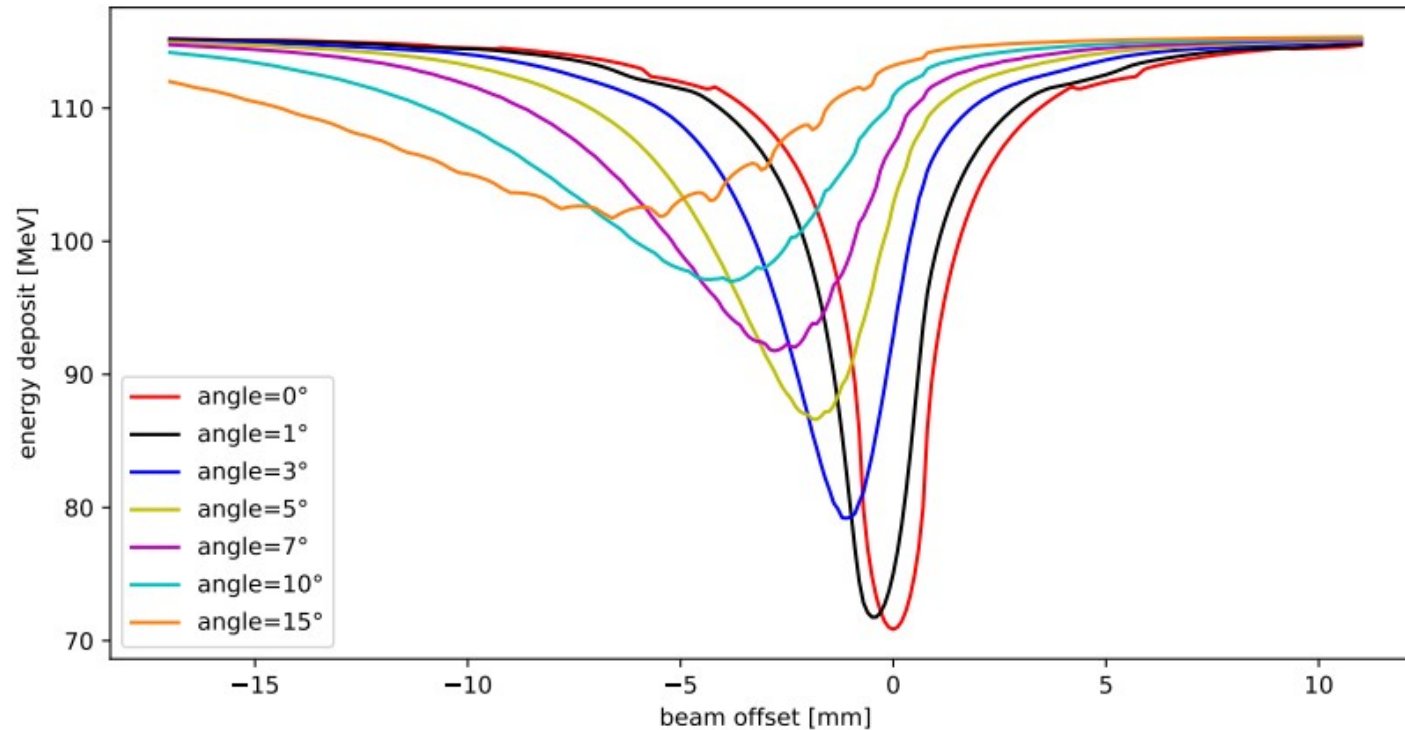
2.5GeV

$\text{atan}(\sqrt{p_x^2+p_y^2}/p_z)/2/\pi*360$ {detid==2000 && pz>7.5}

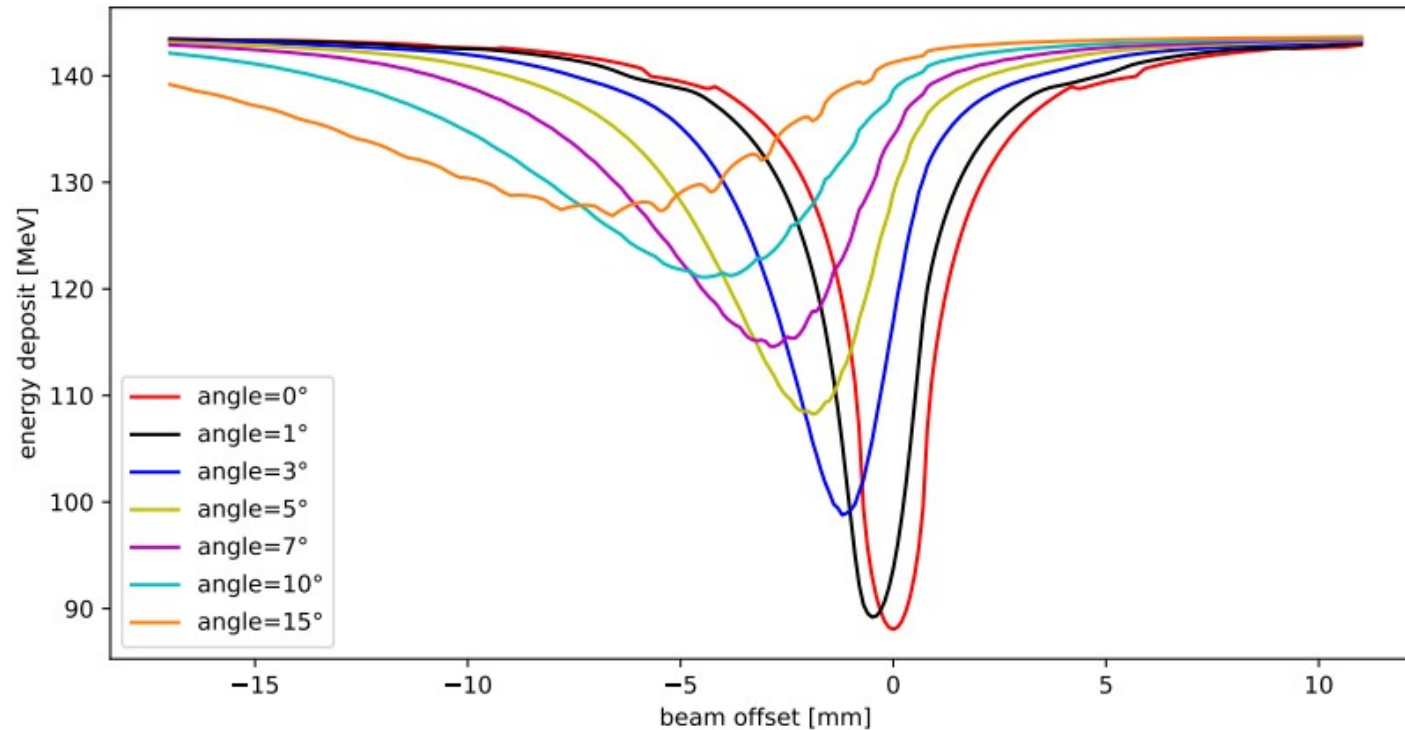


15GeV

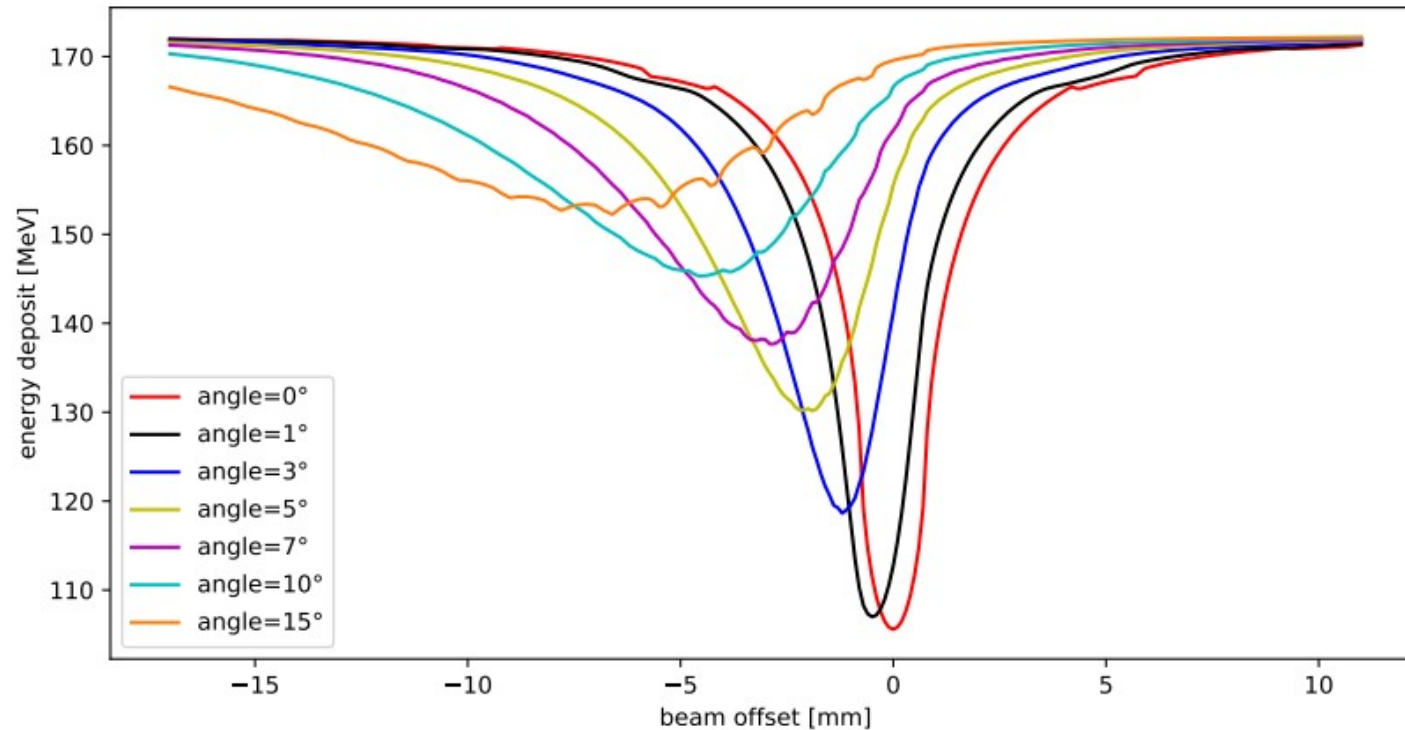
Deposited energy vs position, 10GeV



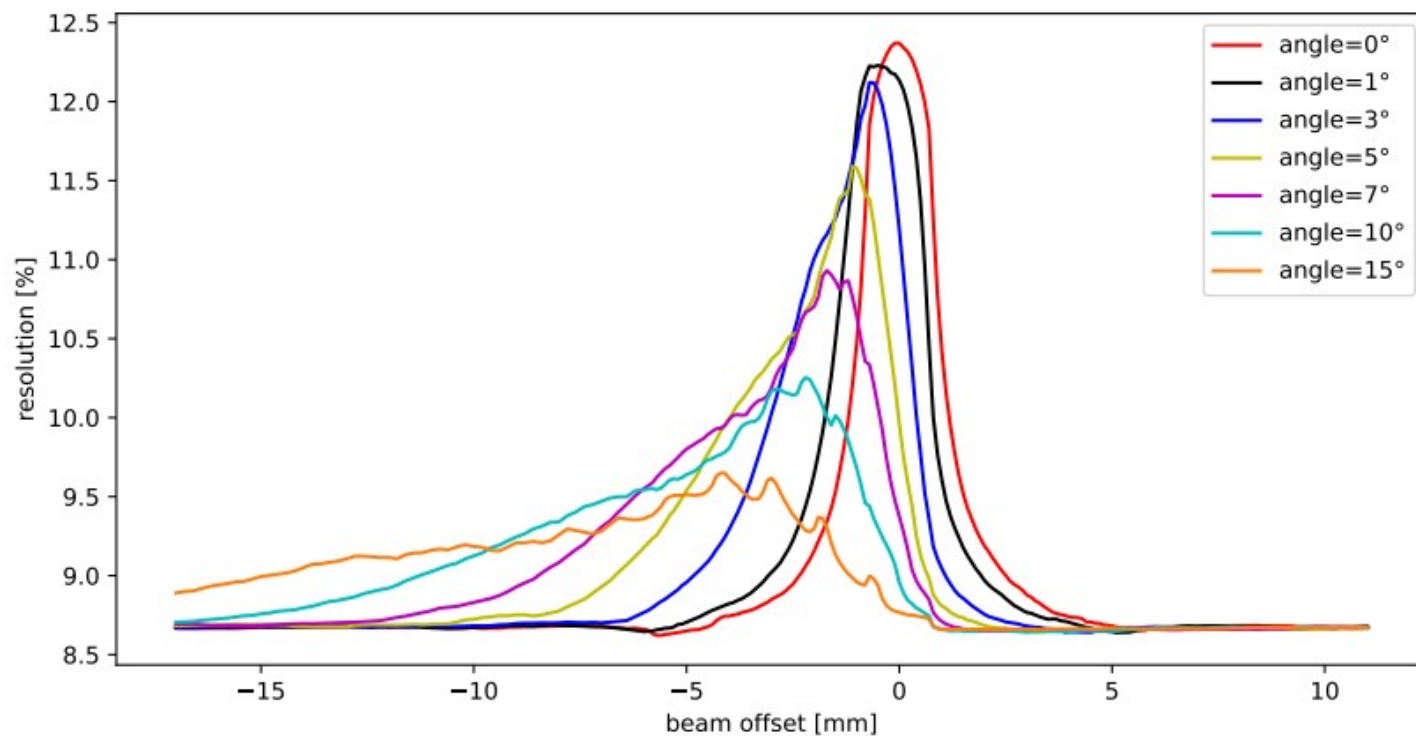
Deposited energy vs position, 12.5GeV



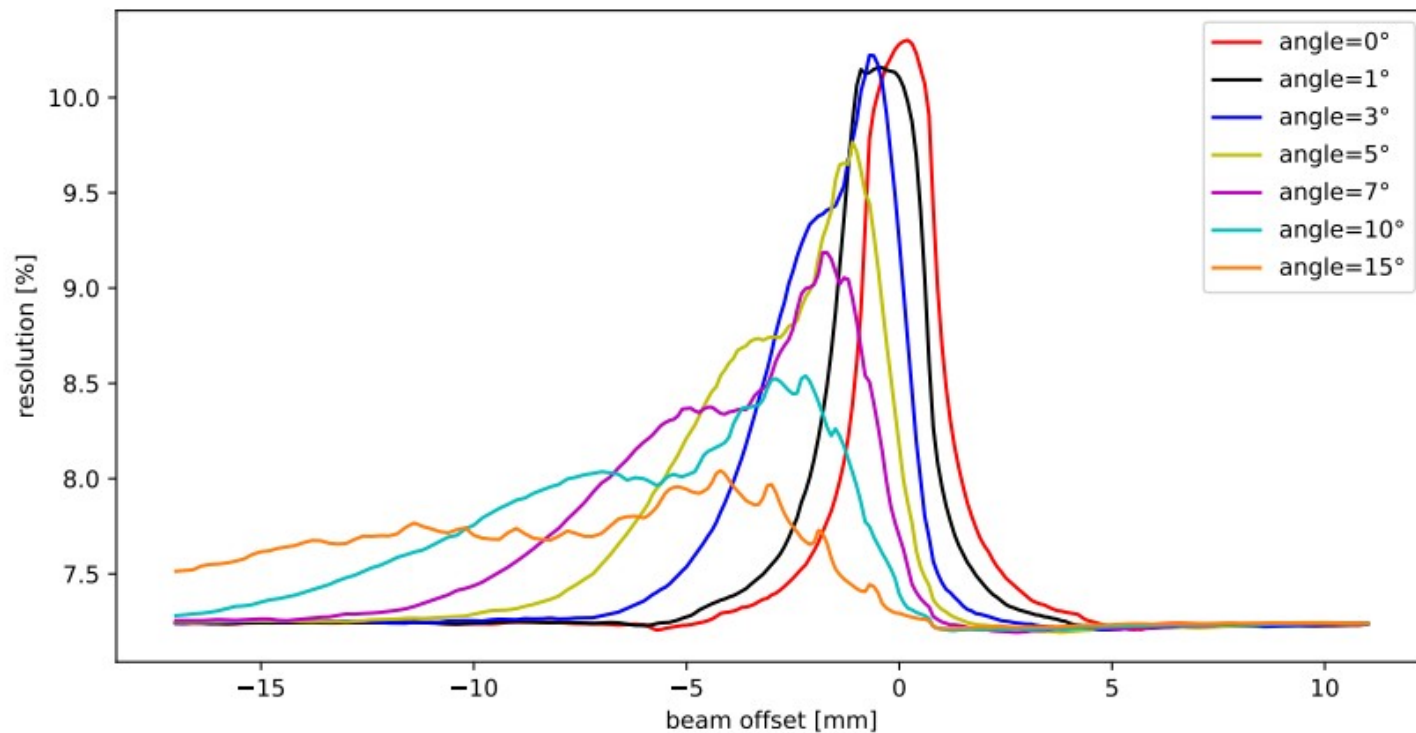
Deposited energy vs position, 15GeV



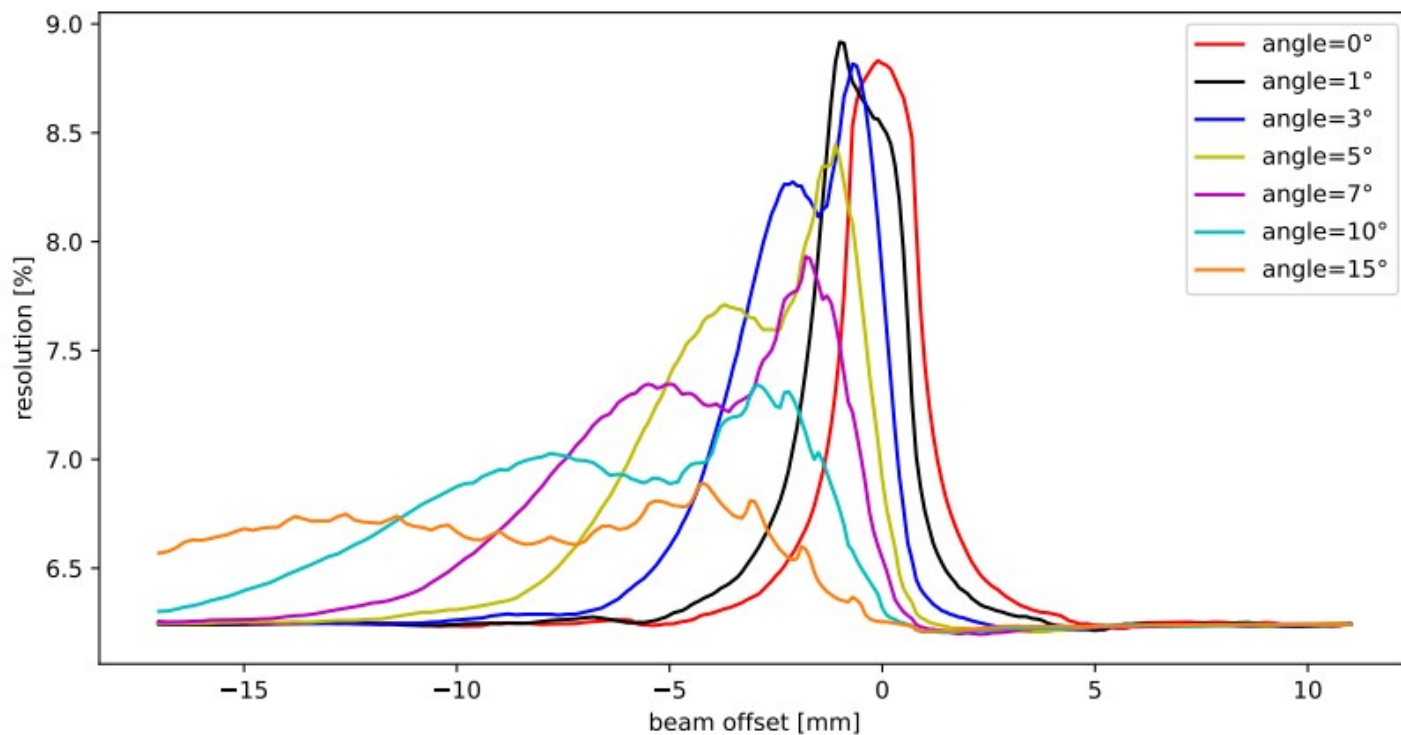
Resolution vs position, 5GeV



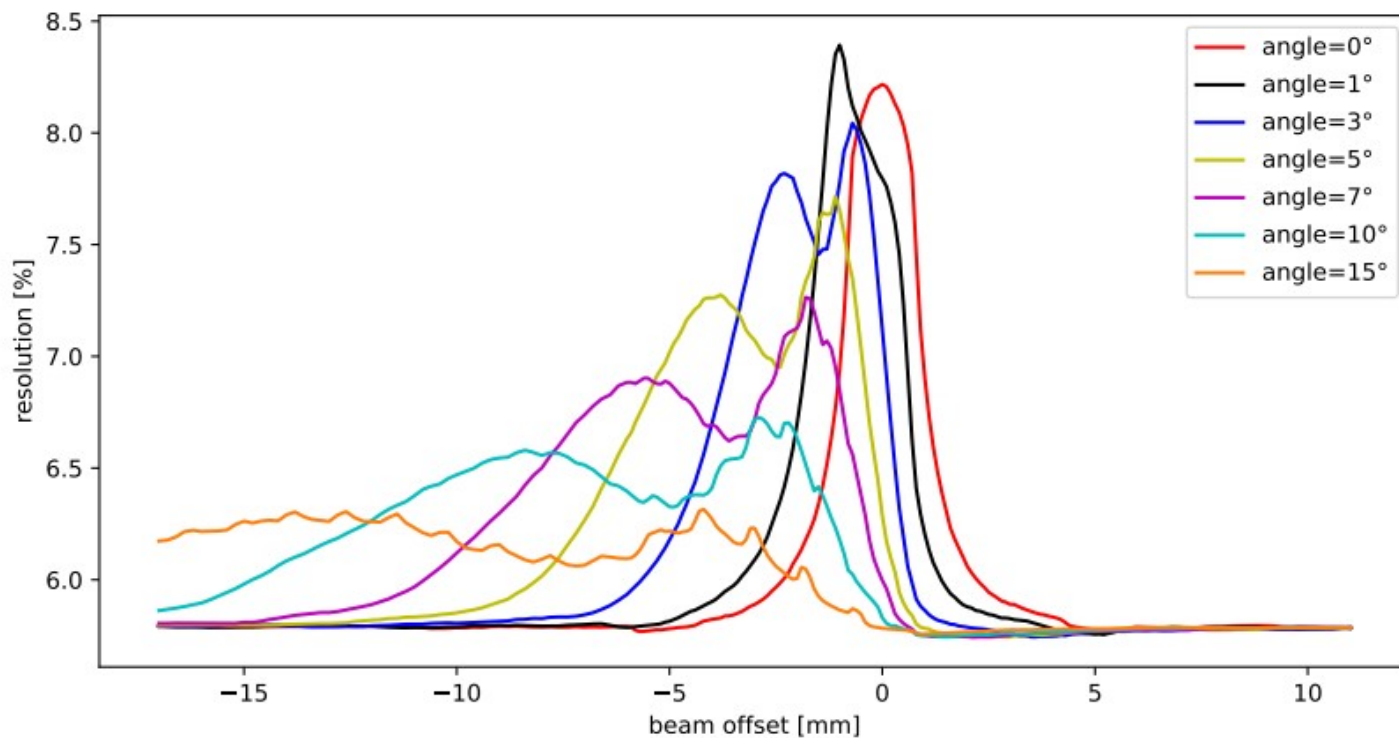
Resolution vs position, 7.5GeV



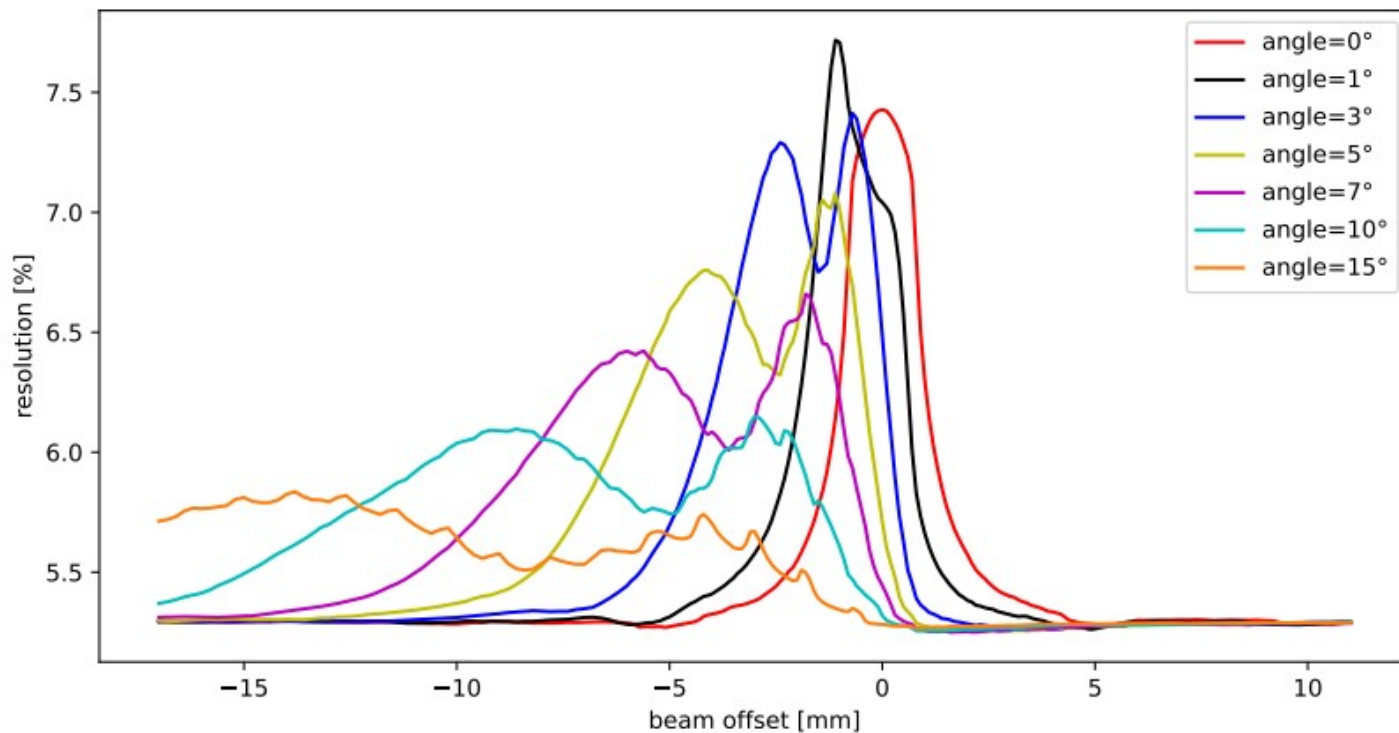
Resolution vs position, 10GeV



Resolution vs position, 12.5GeV

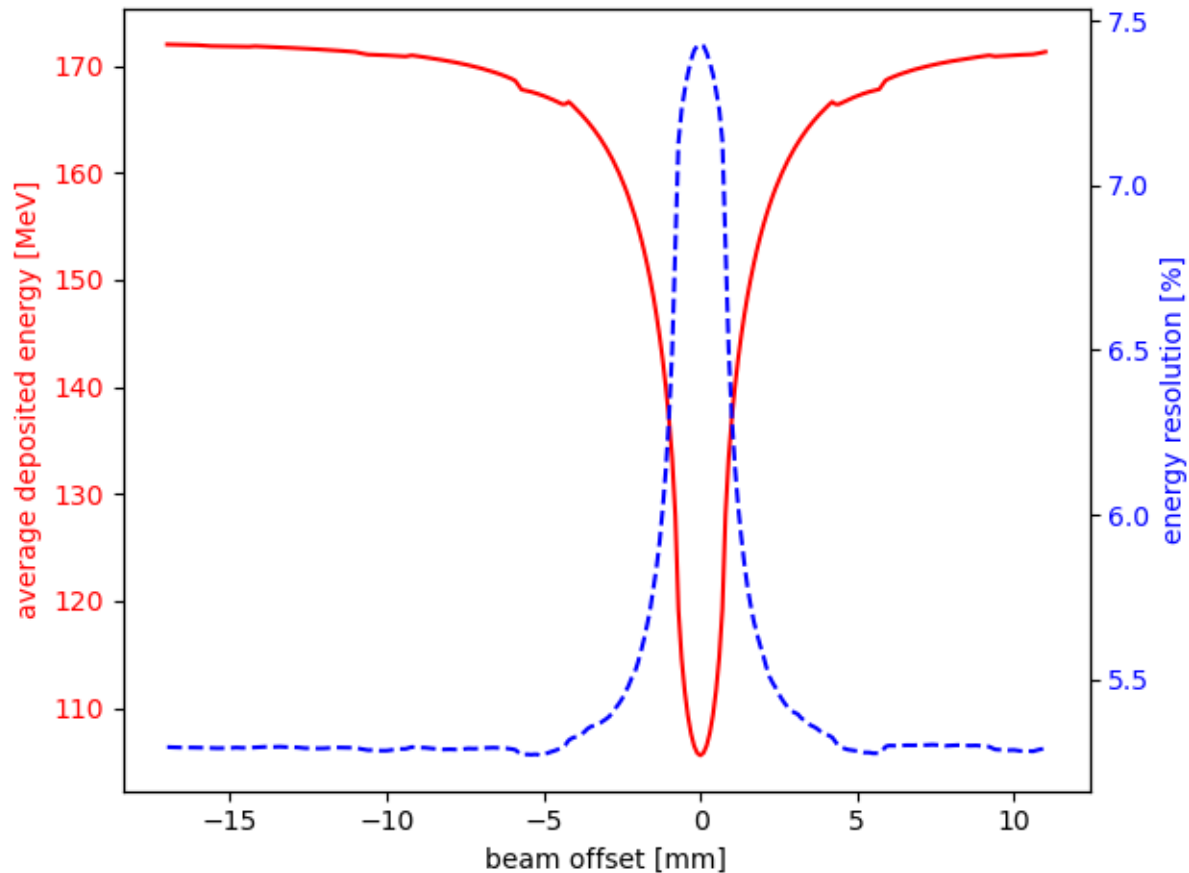


Resolution vs position, 15GeV



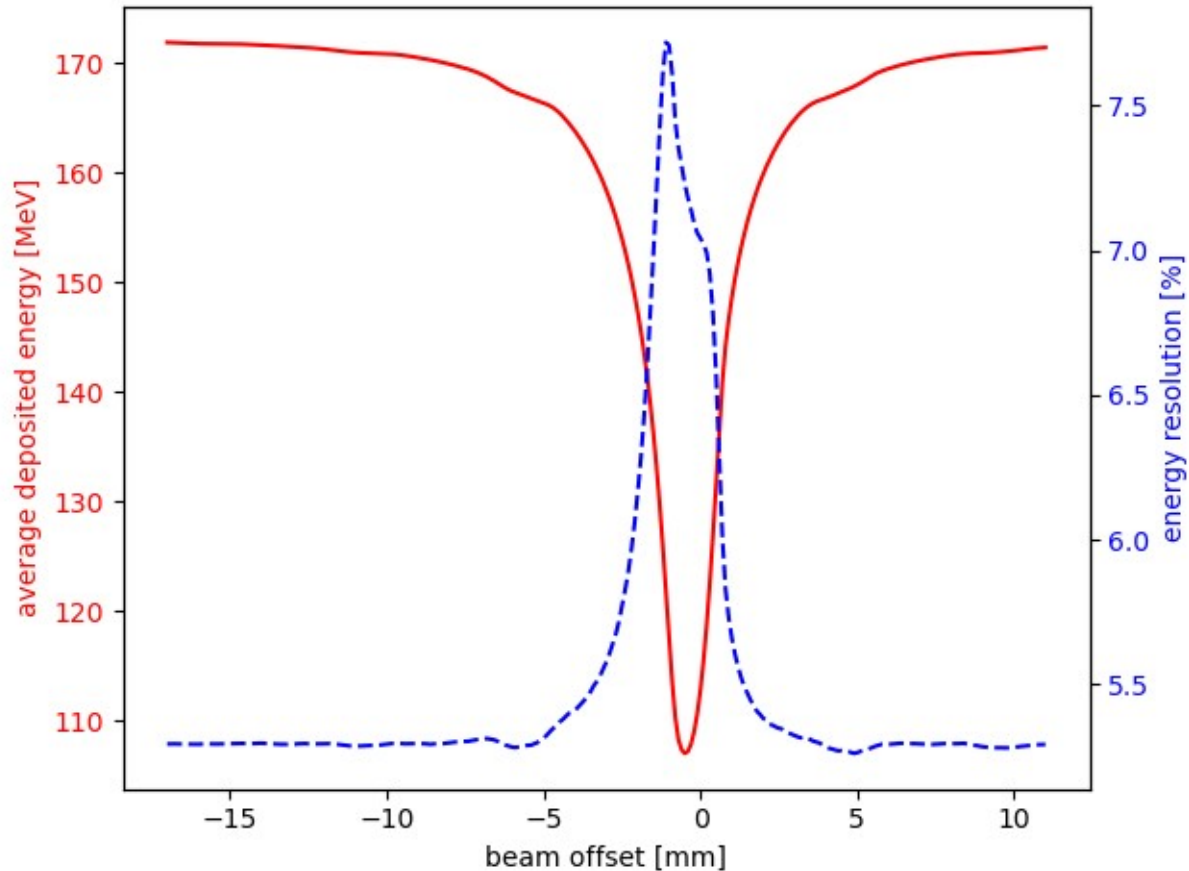
Deposit and resolution vs position, 15GeV

$\theta=0^\circ$



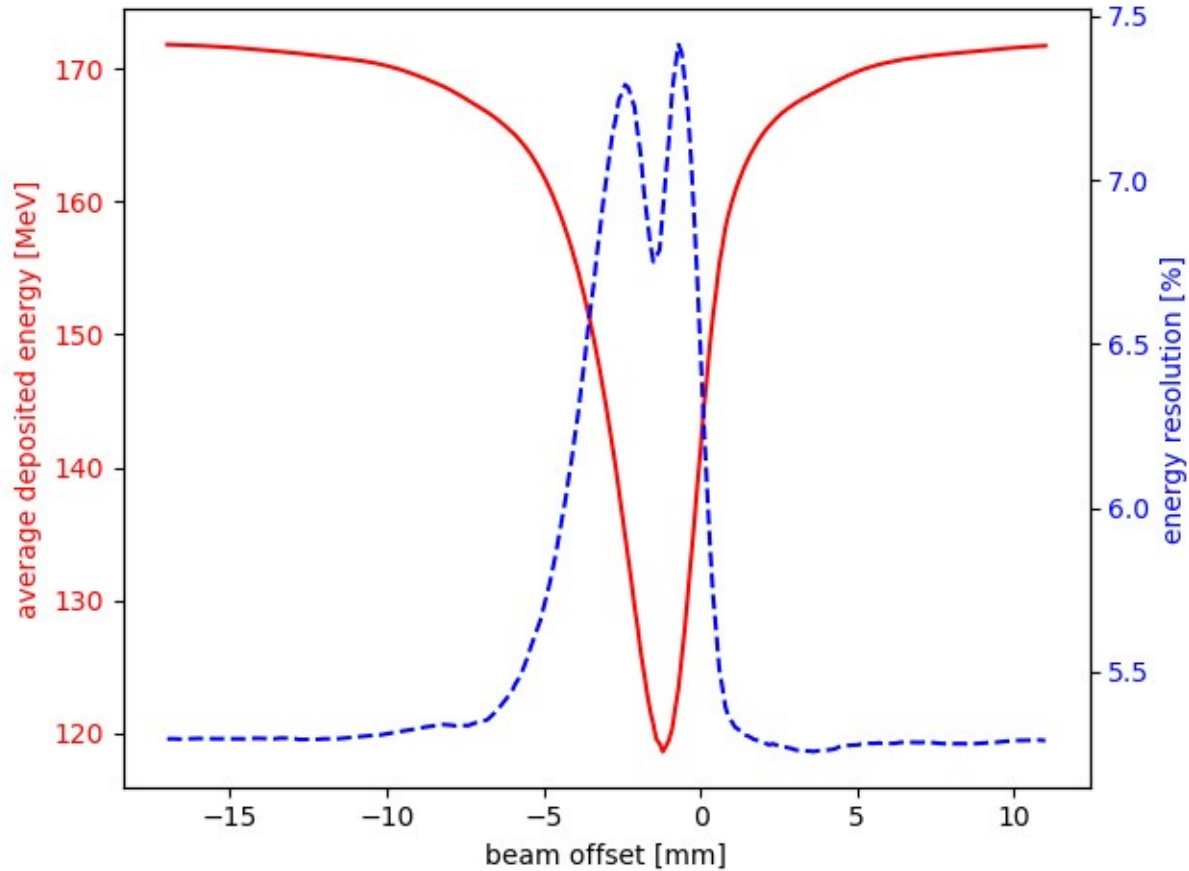
Deposit and resolution vs position, 15GeV

$\theta=1^\circ$



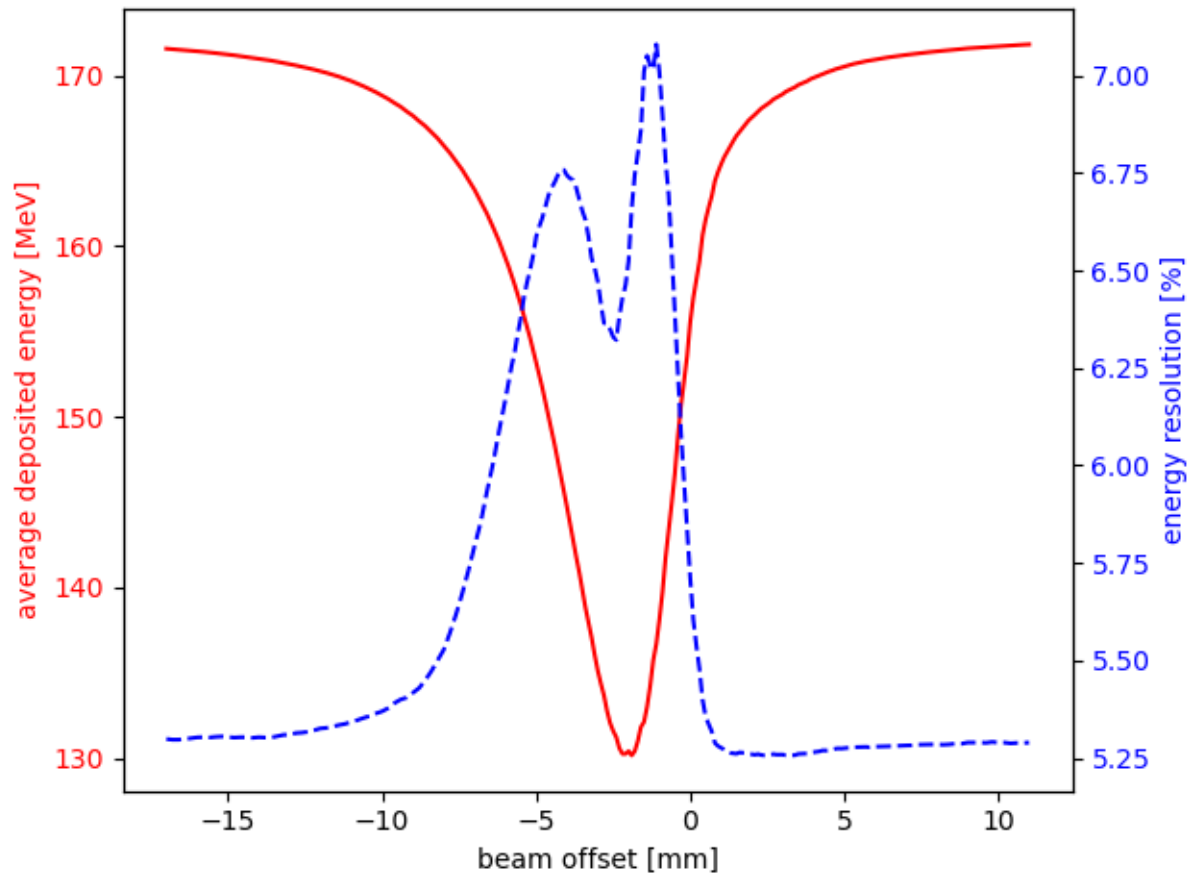
Deposit and resolution vs position, 15GeV

$\theta=3^\circ$



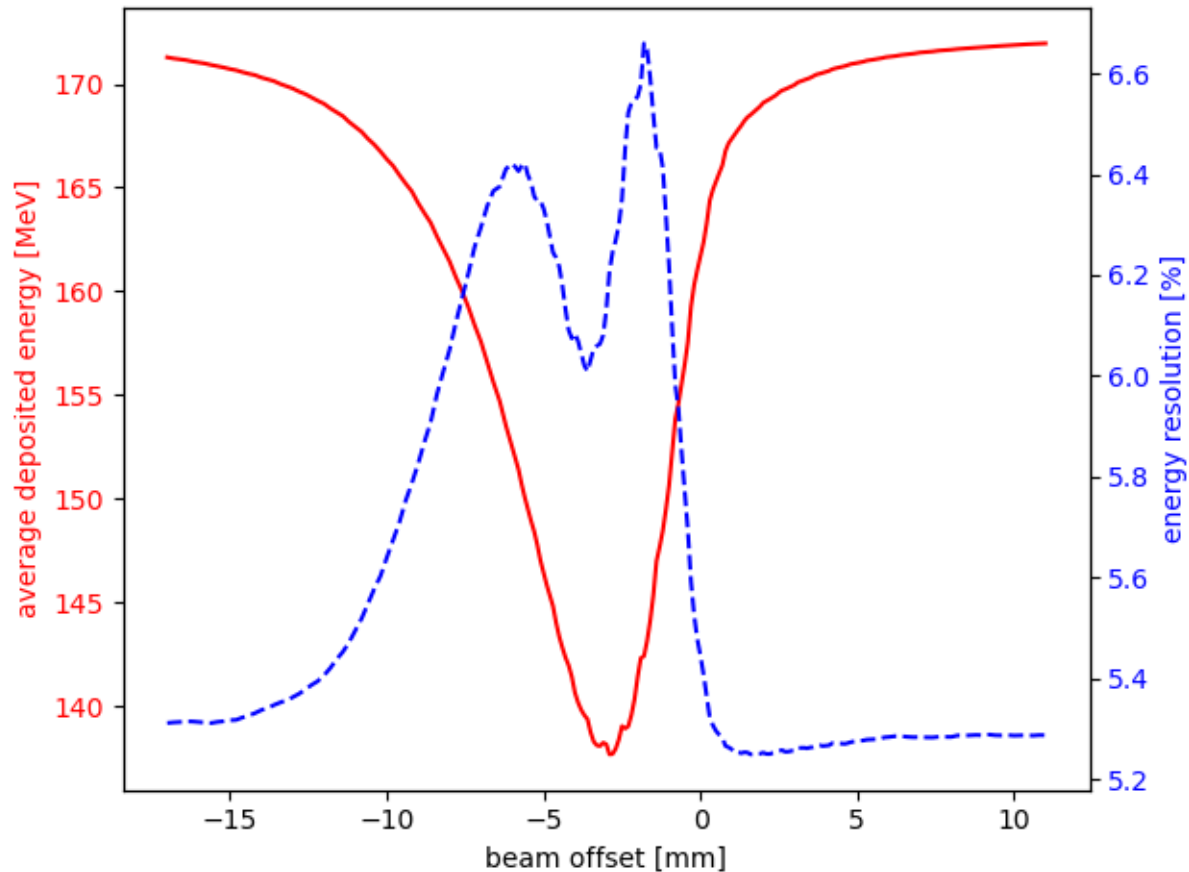
Deposit and resolution vs position, 15GeV

$\theta=5^\circ$



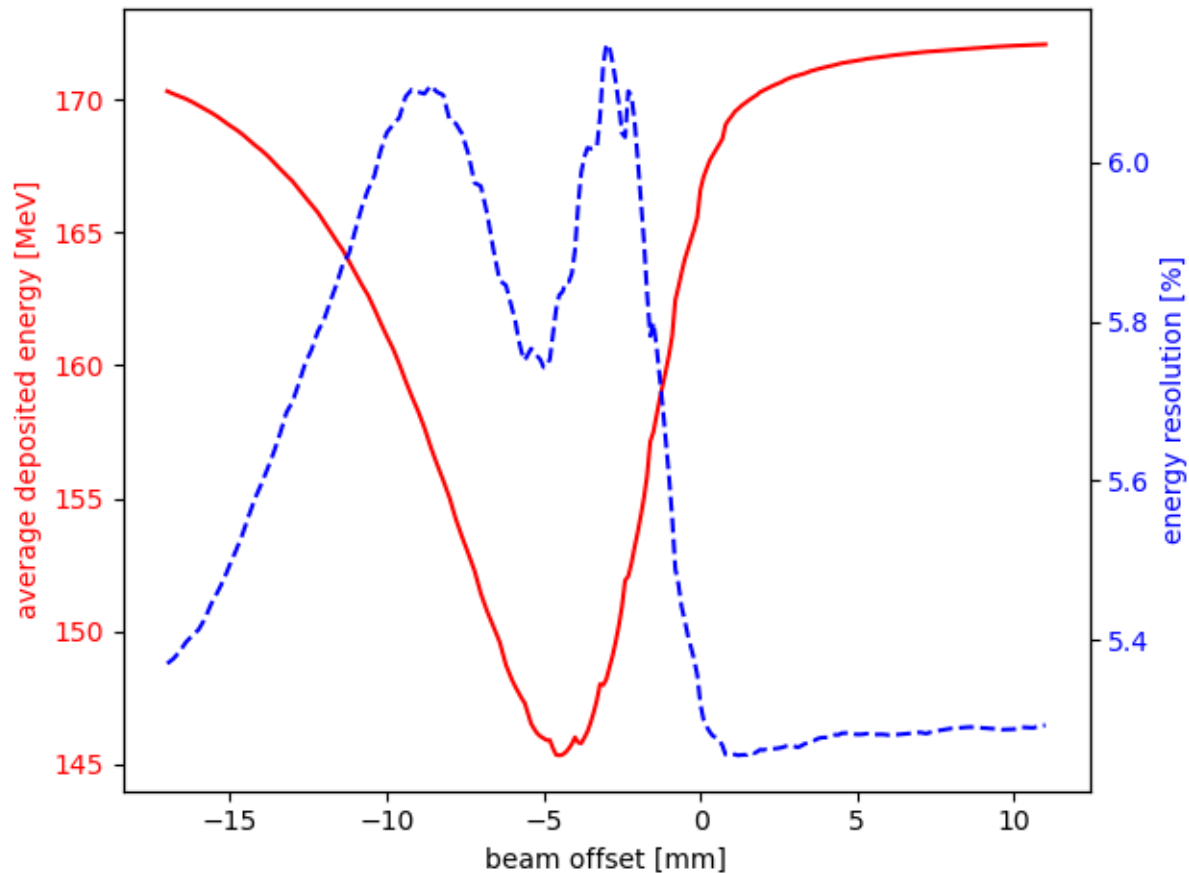
Deposit and resolution vs position, 15GeV

$\theta=7^\circ$

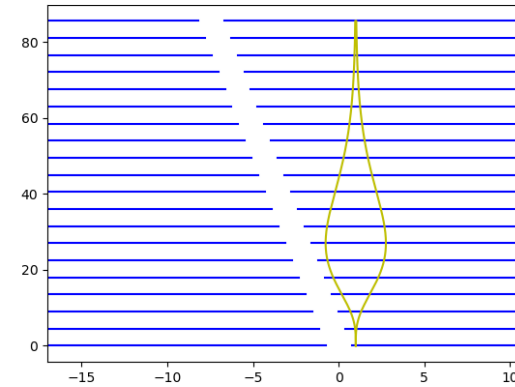
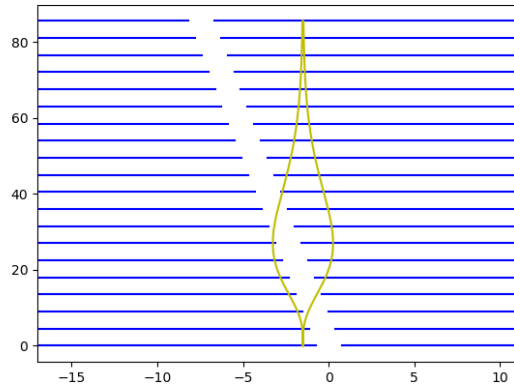
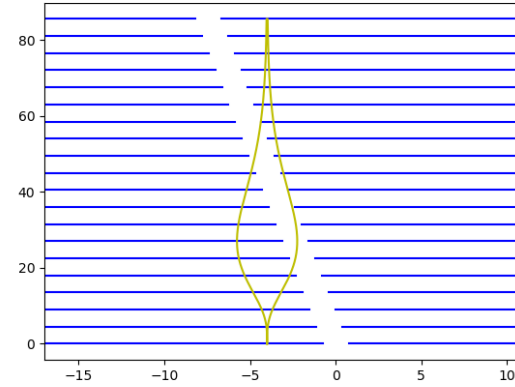
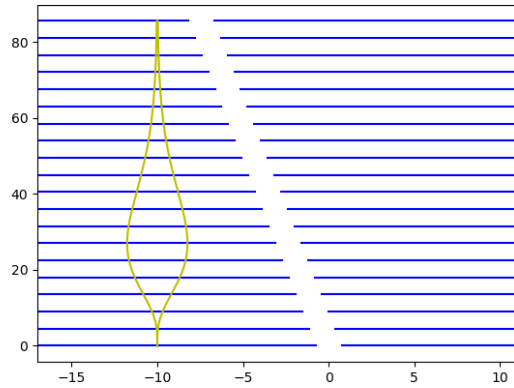


Deposit and resolution vs position, 15GeV

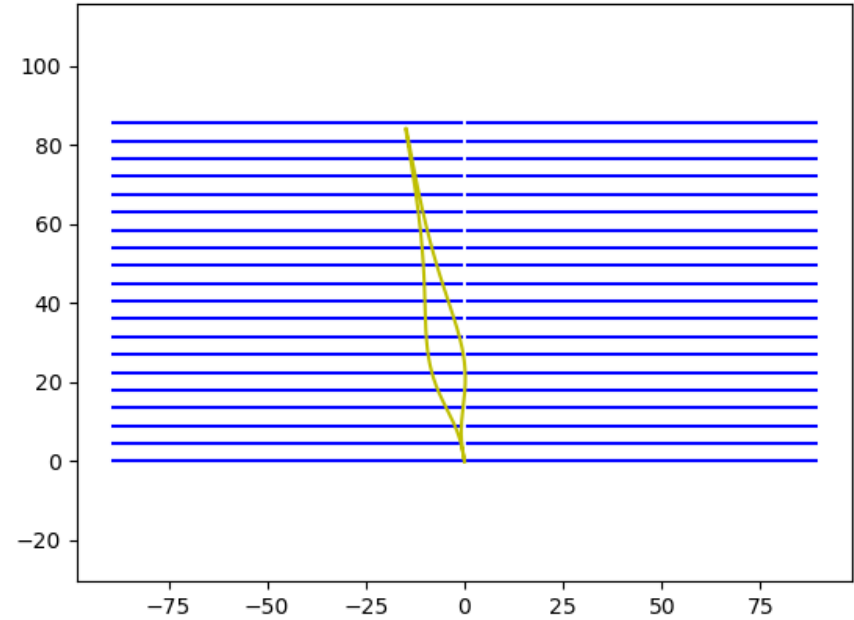
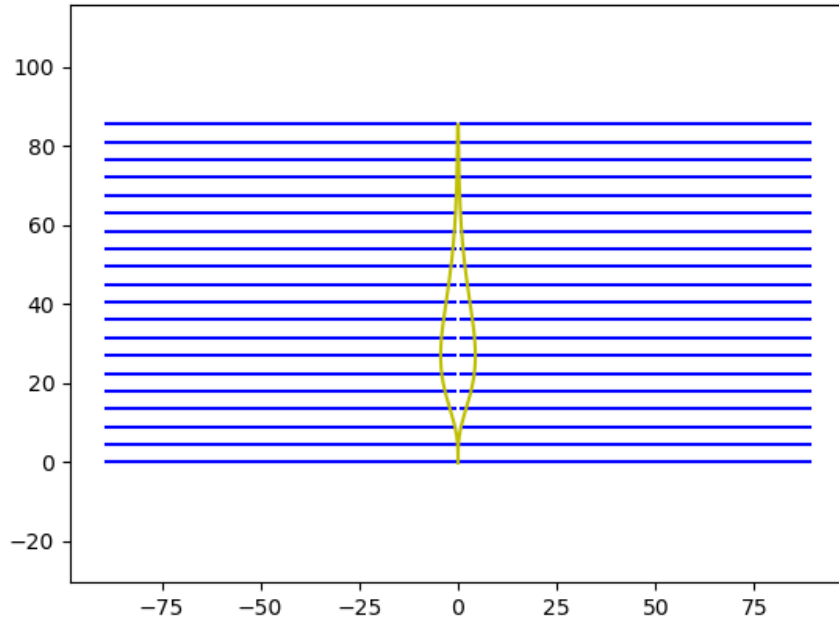
$\theta=10^\circ$



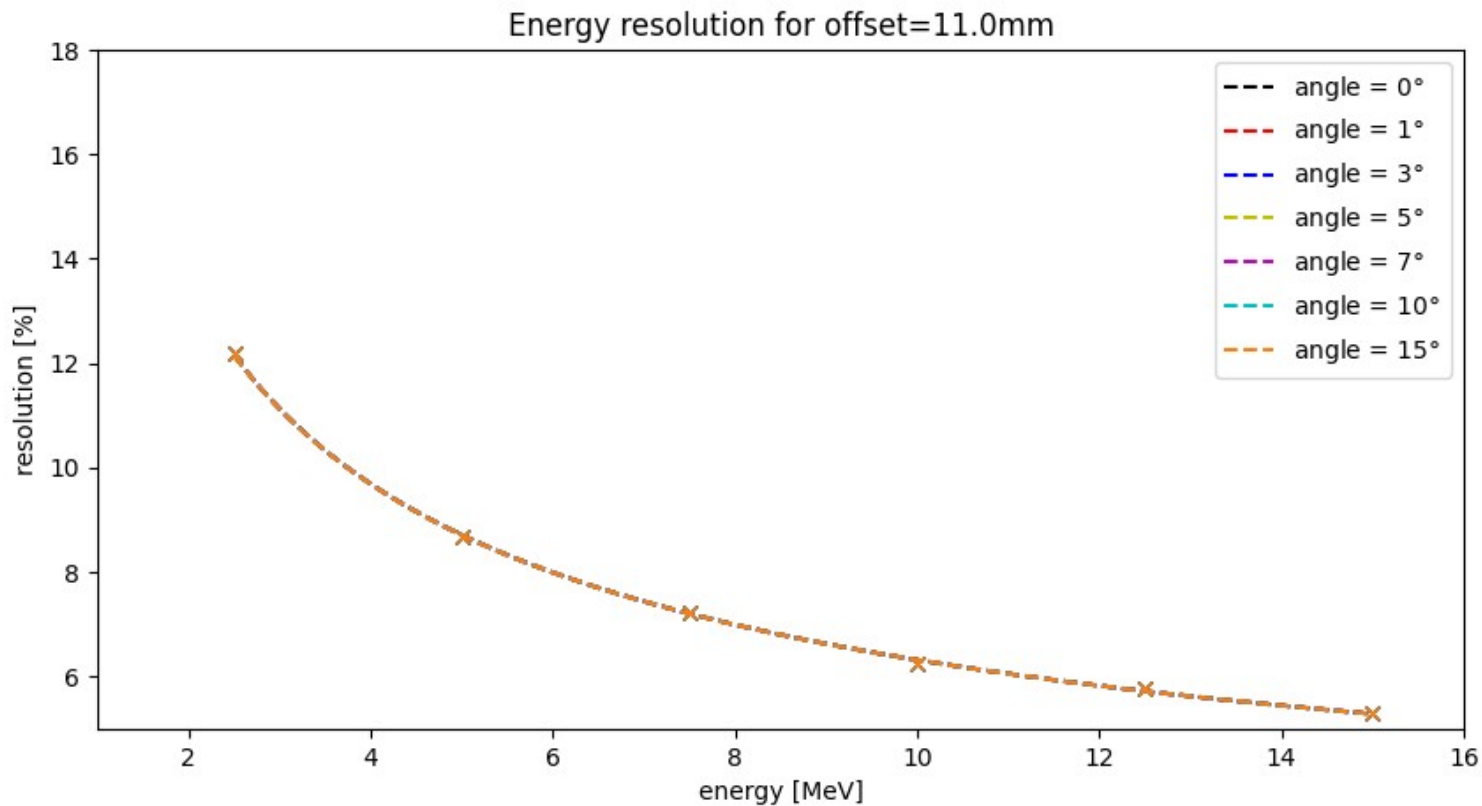
Assymetry in plot with resolution



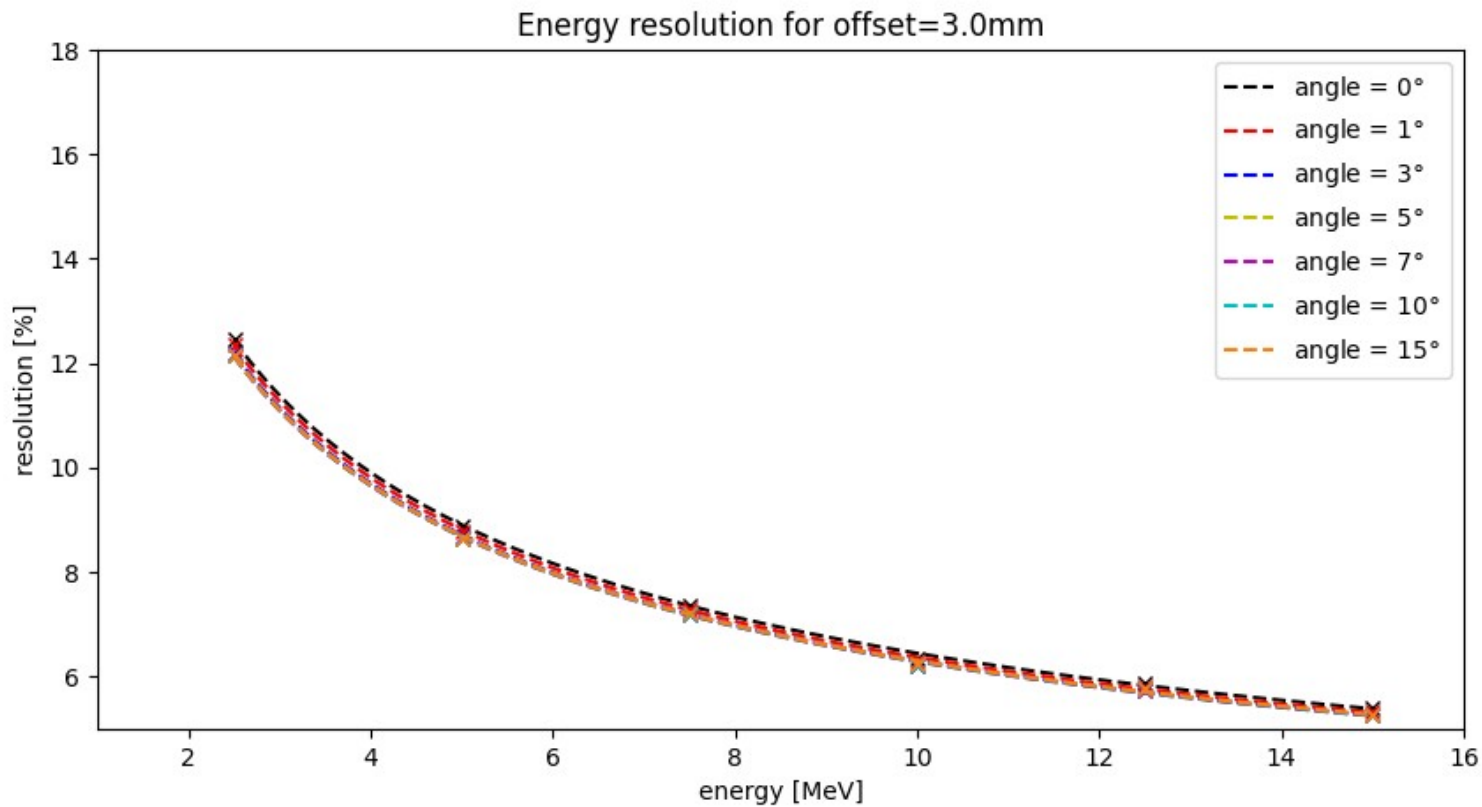
Assymetry in plot with deposit



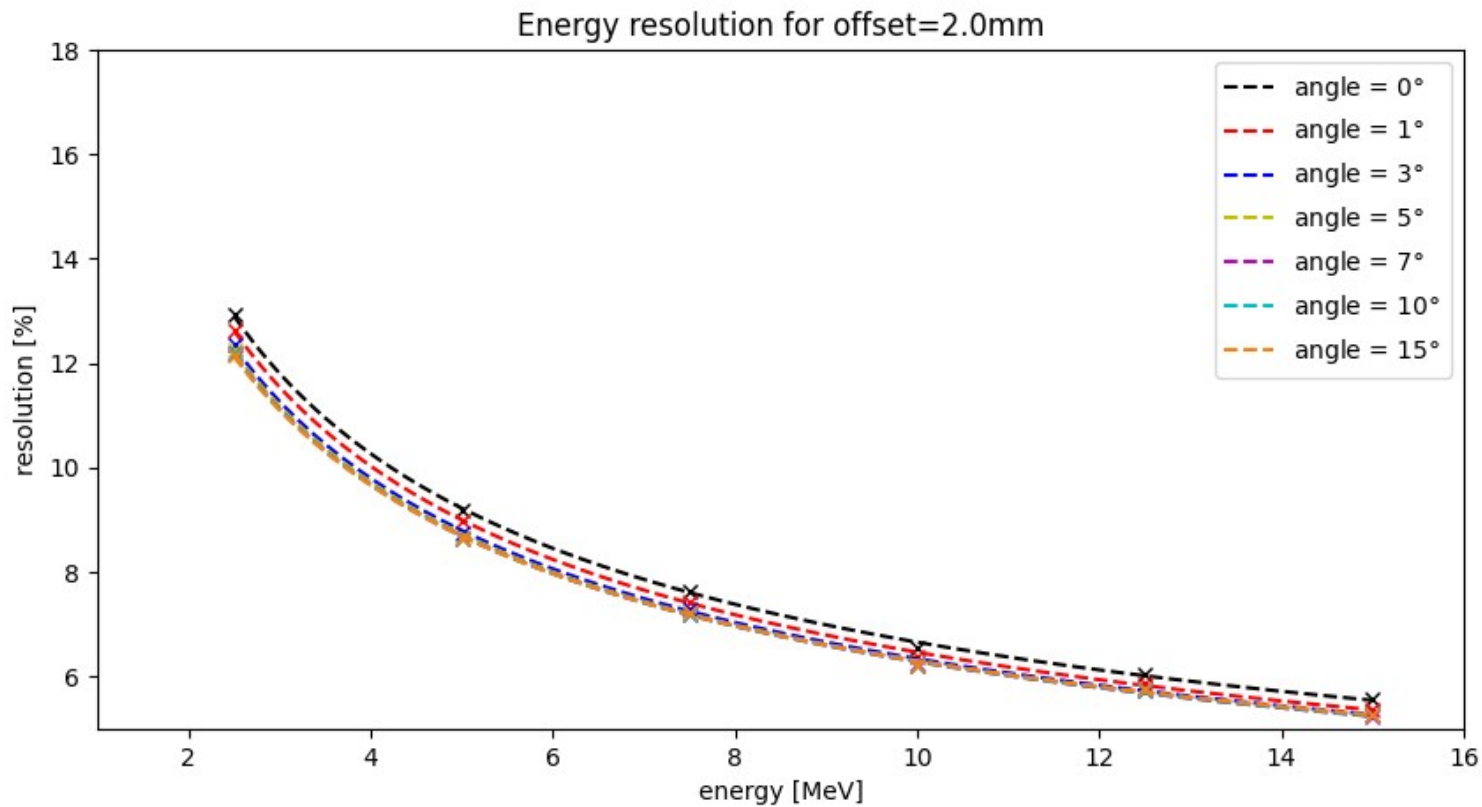
Resolution vs energy



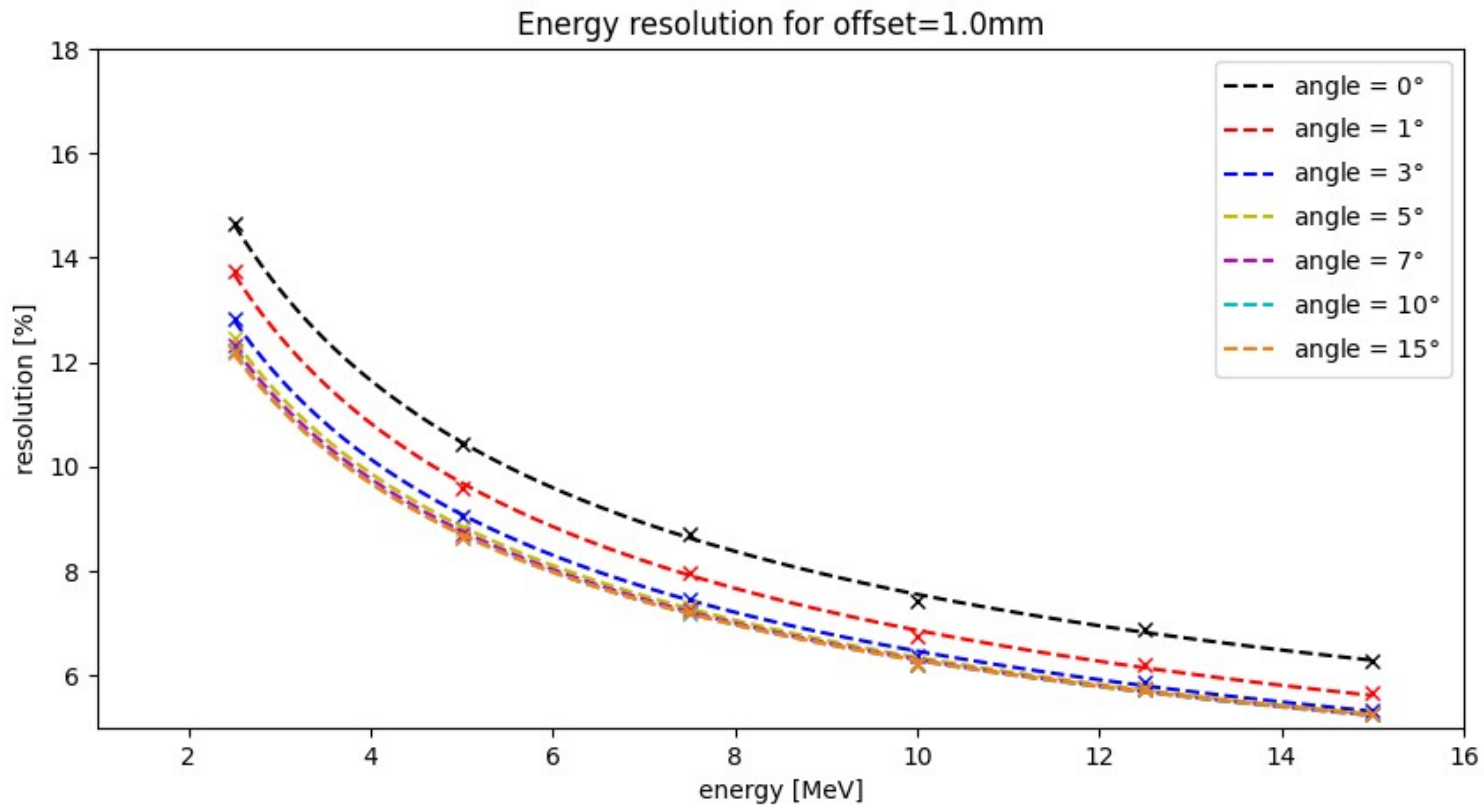
Resolution vs energy



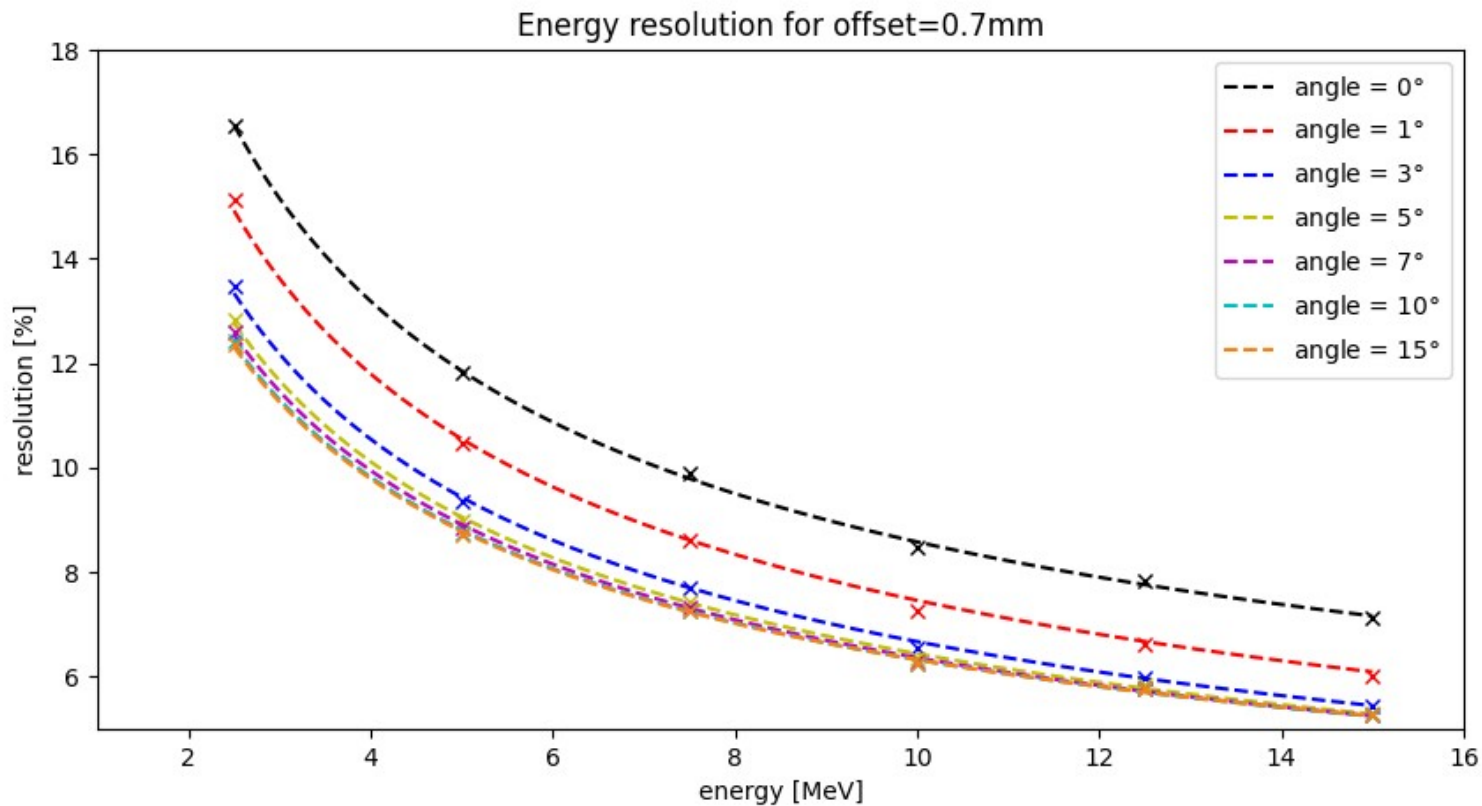
Resolution vs energy



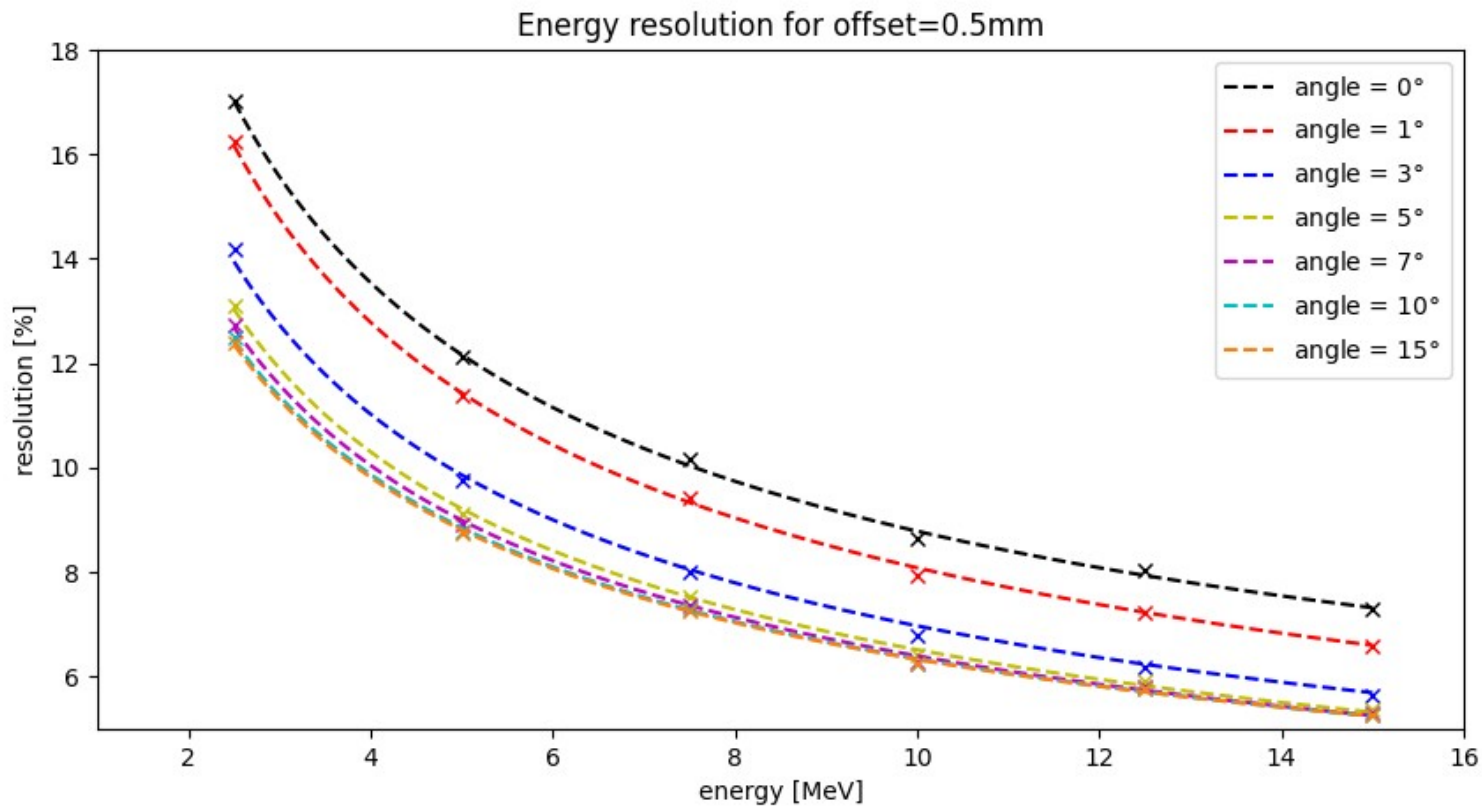
Resolution vs energy



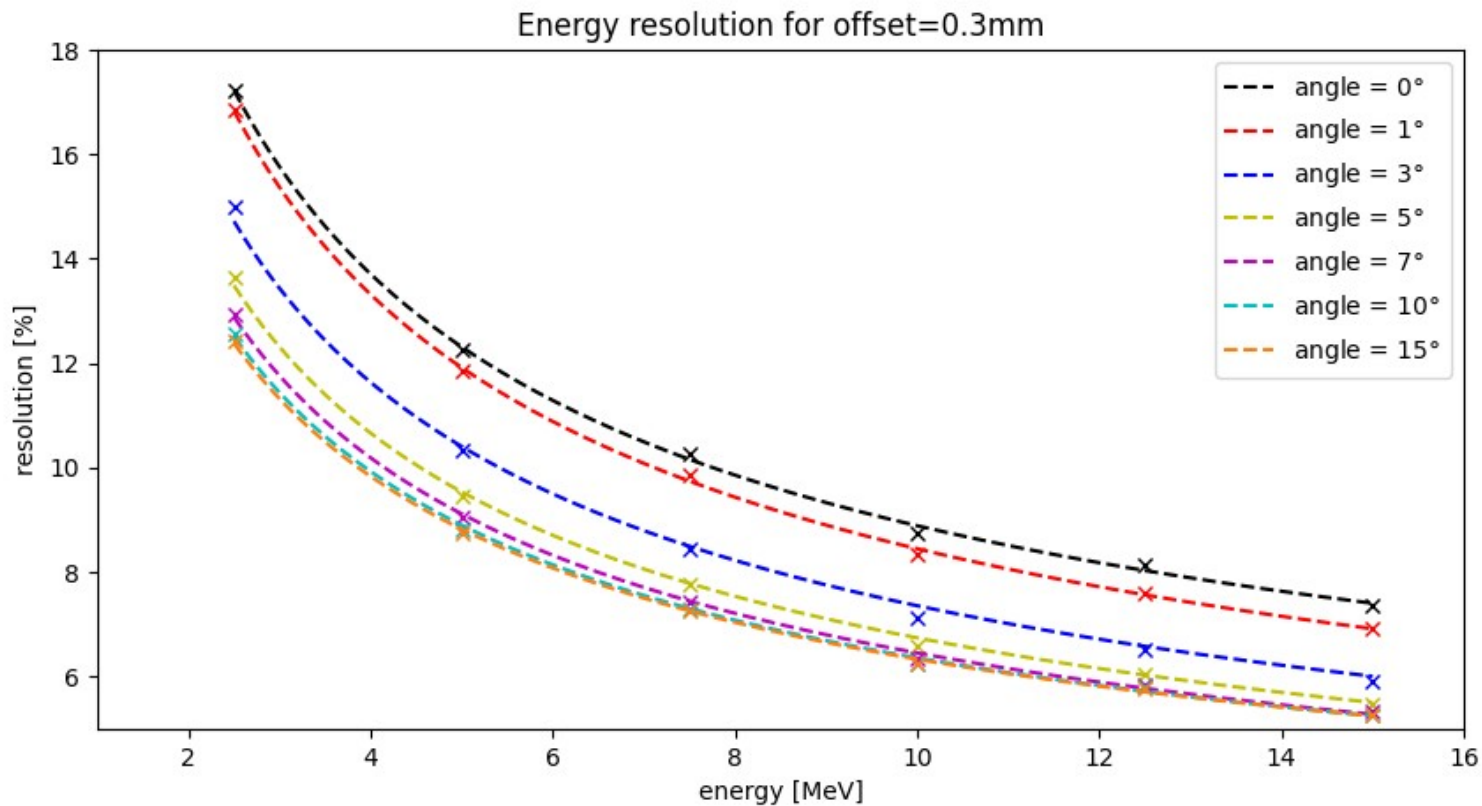
Resolution vs energy



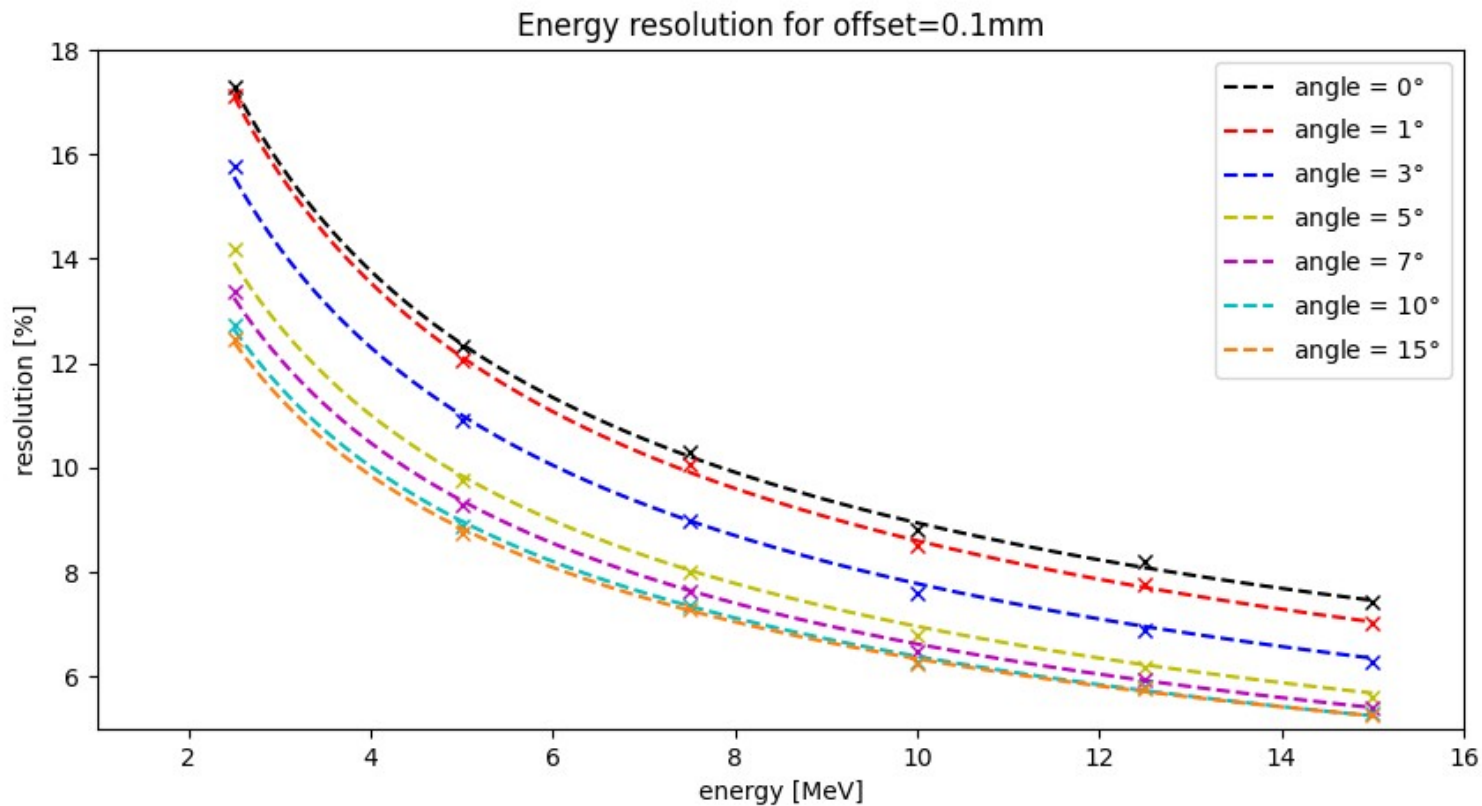
Resolution vs energy



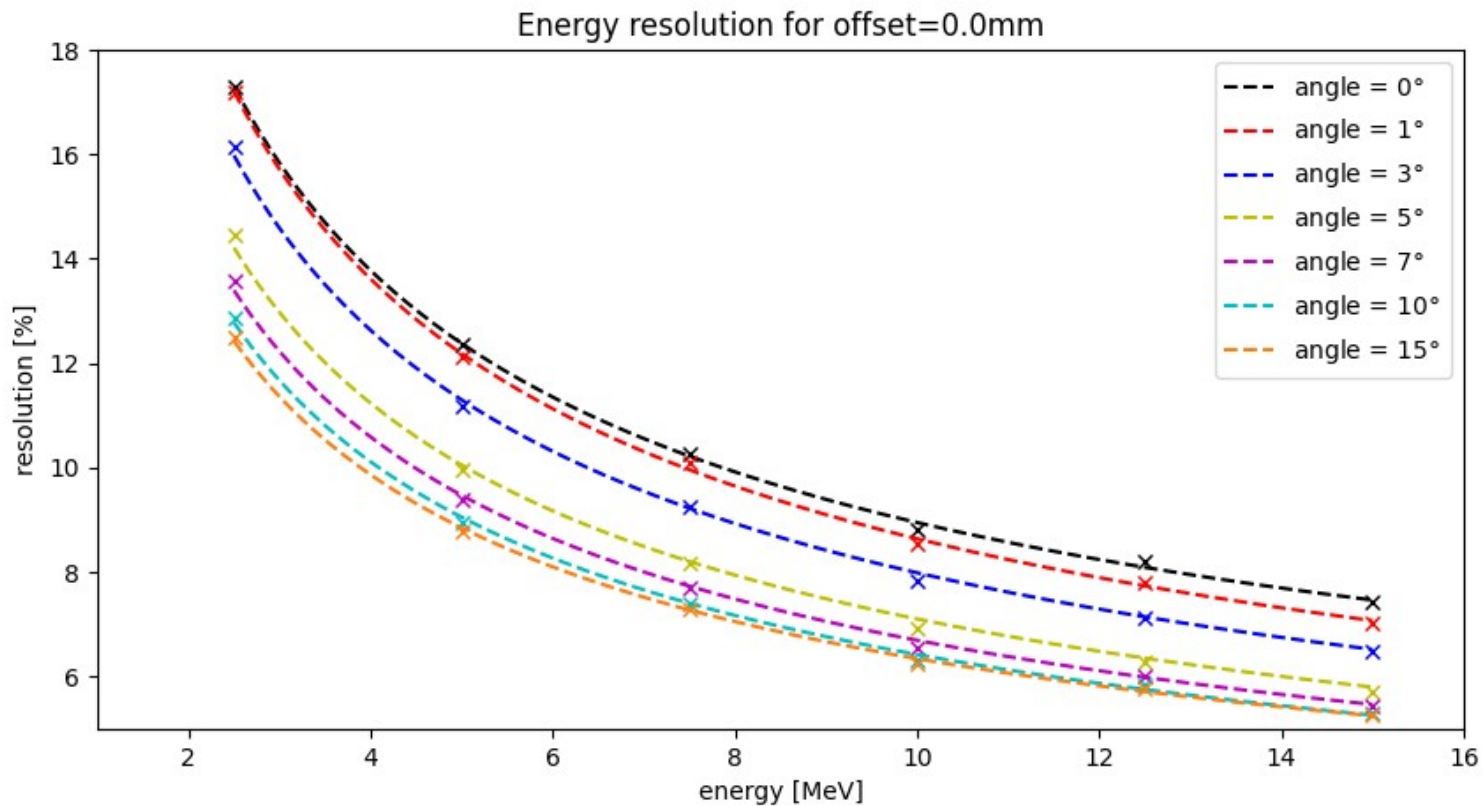
Resolution vs energy



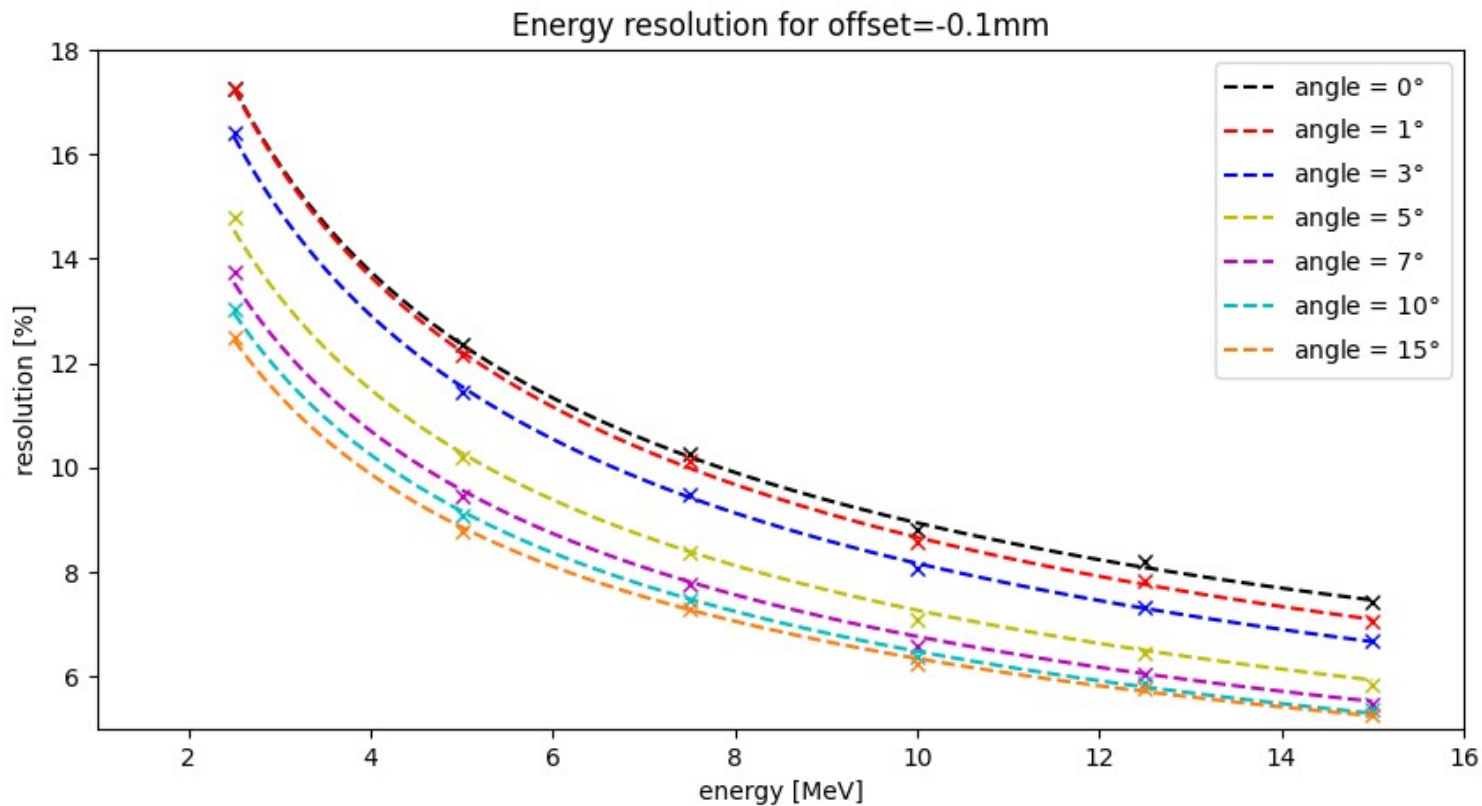
Resolution vs energy



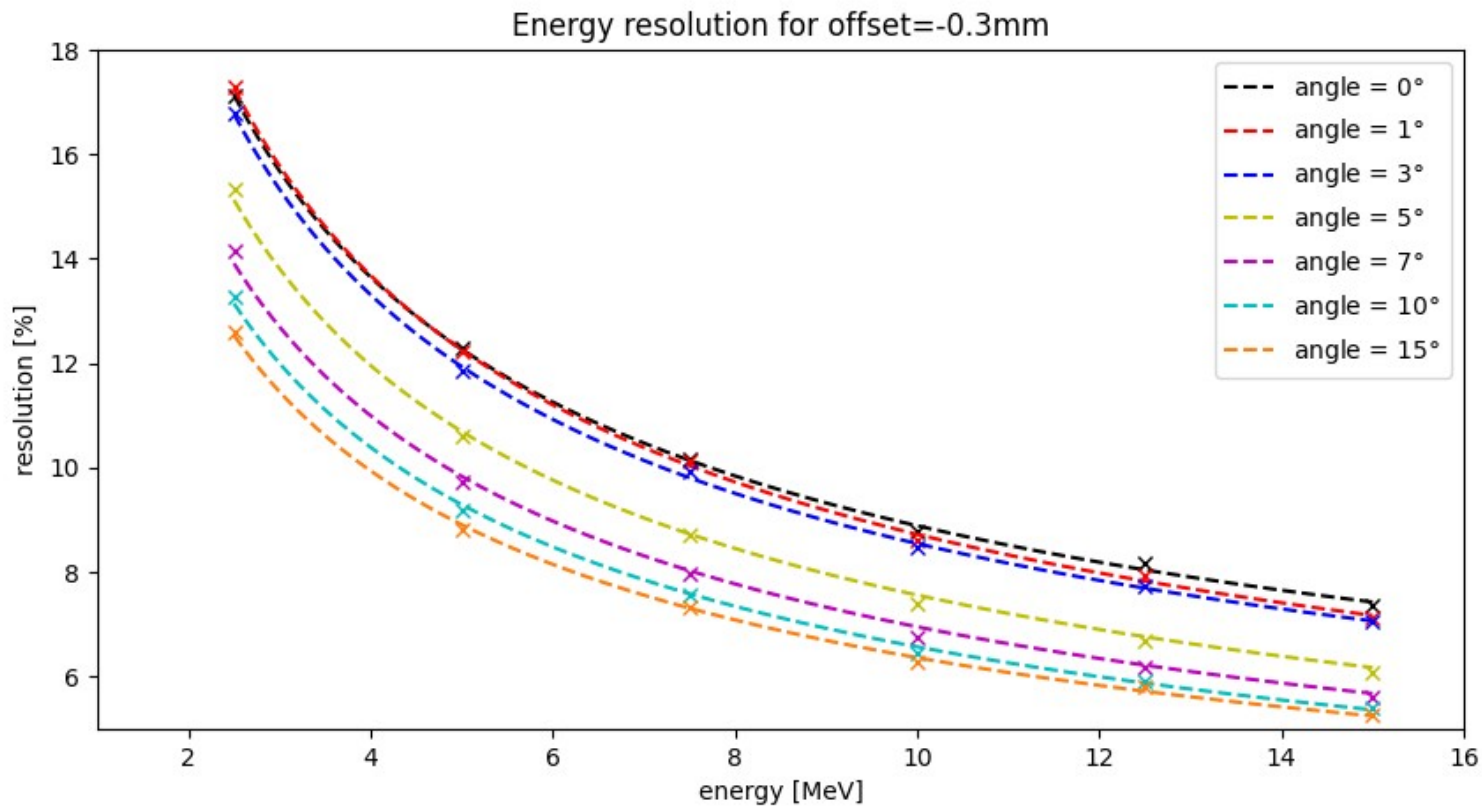
Resolution vs energy



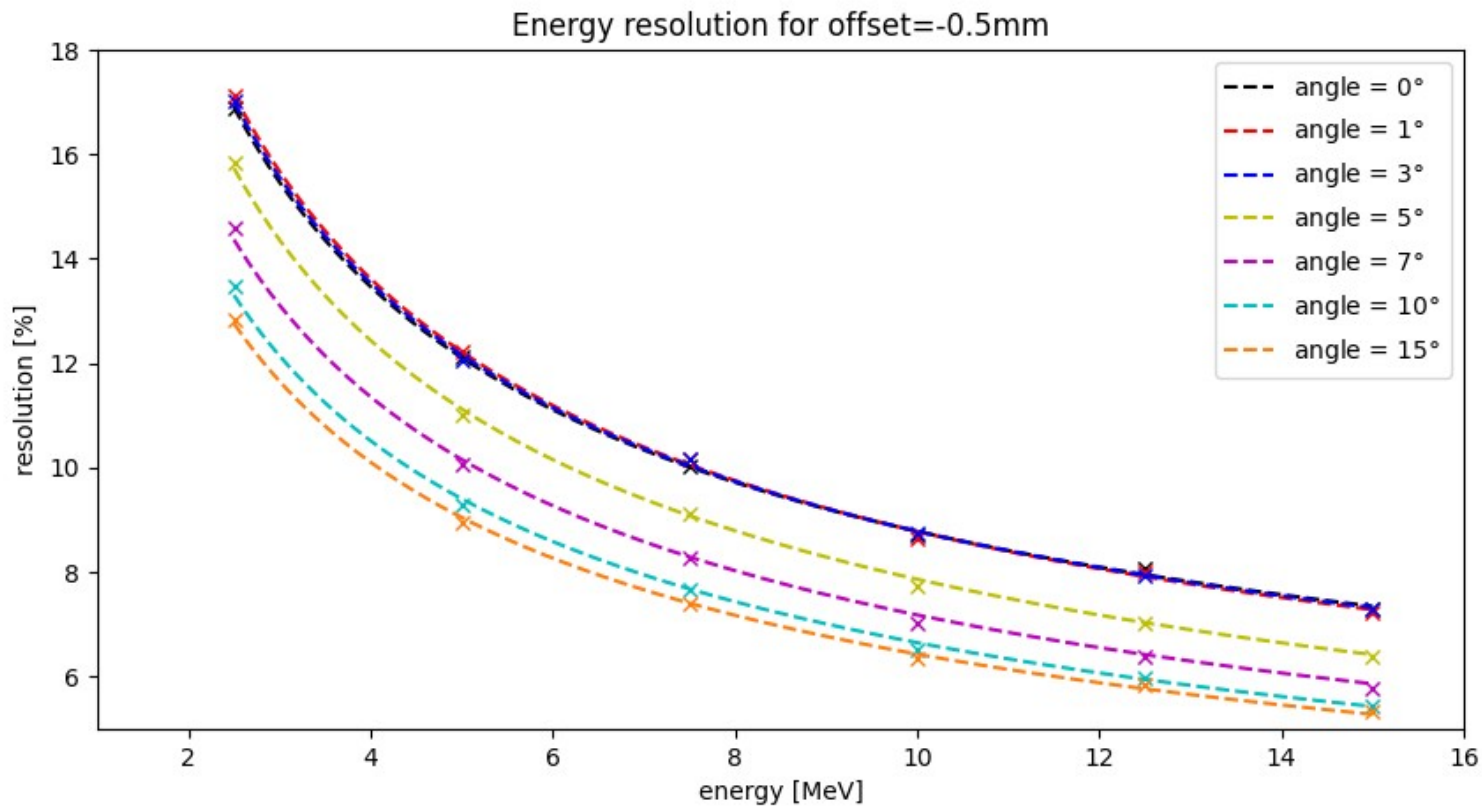
Resolution vs energy



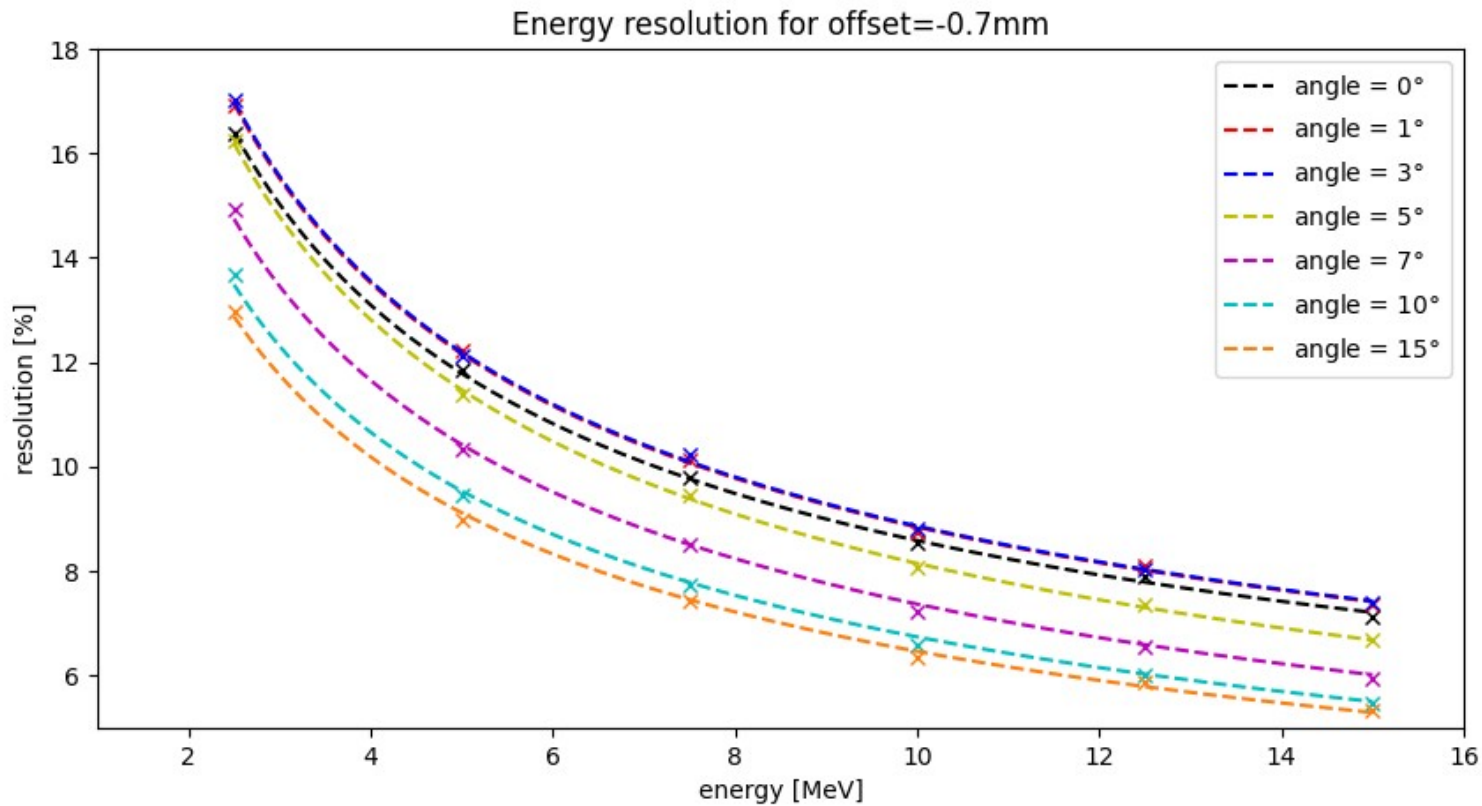
Resolution vs energy



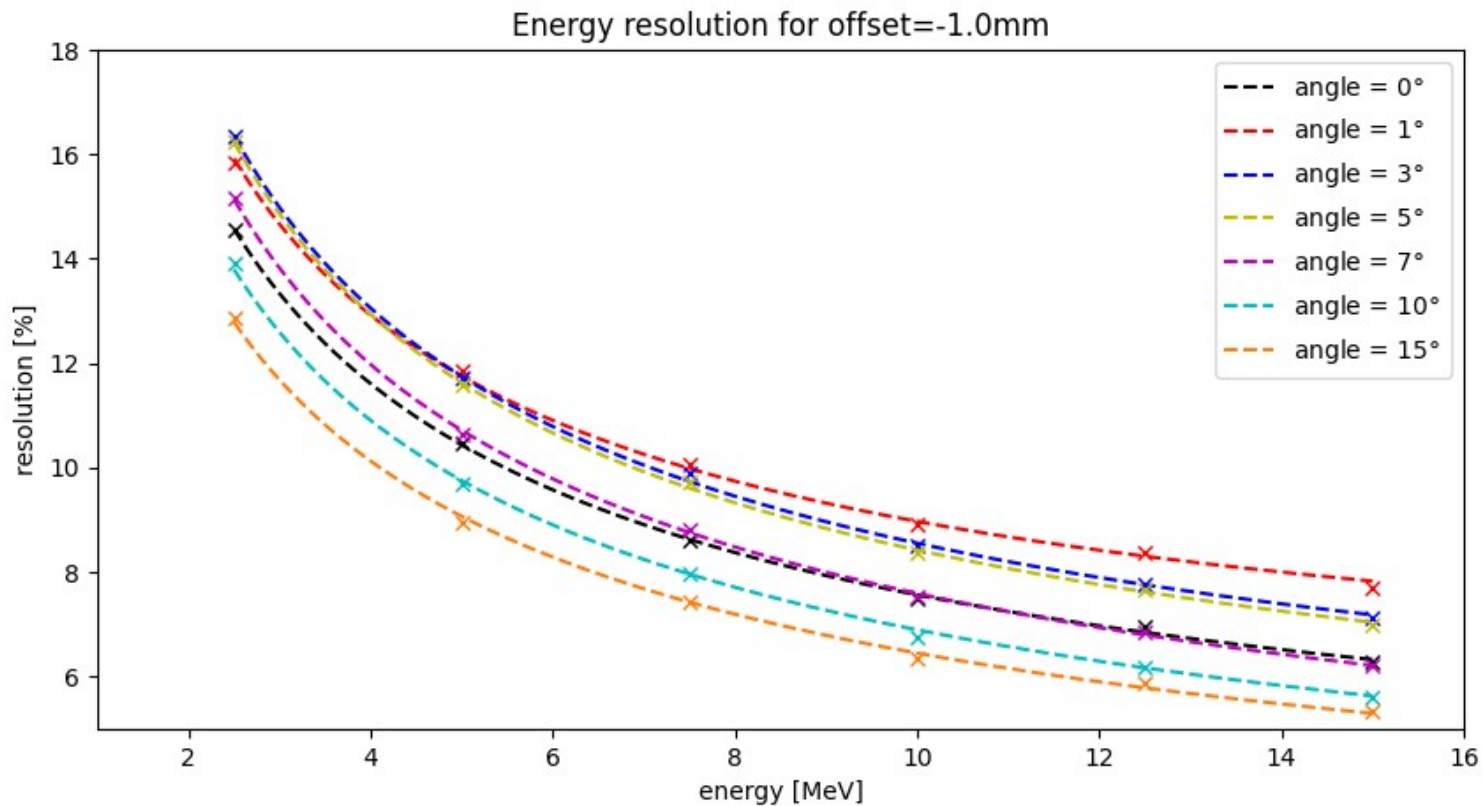
Resolution vs energy



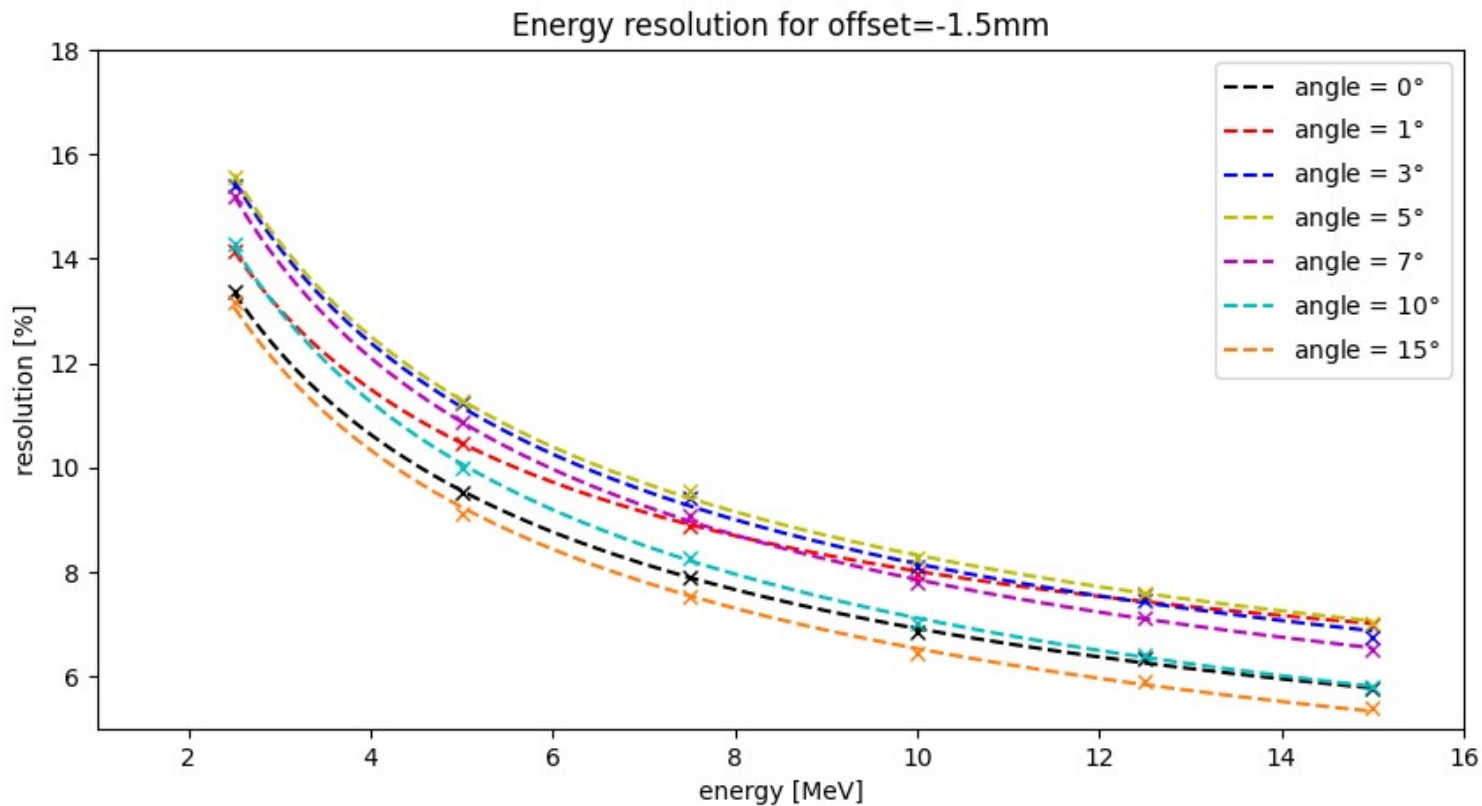
Resolution vs energy



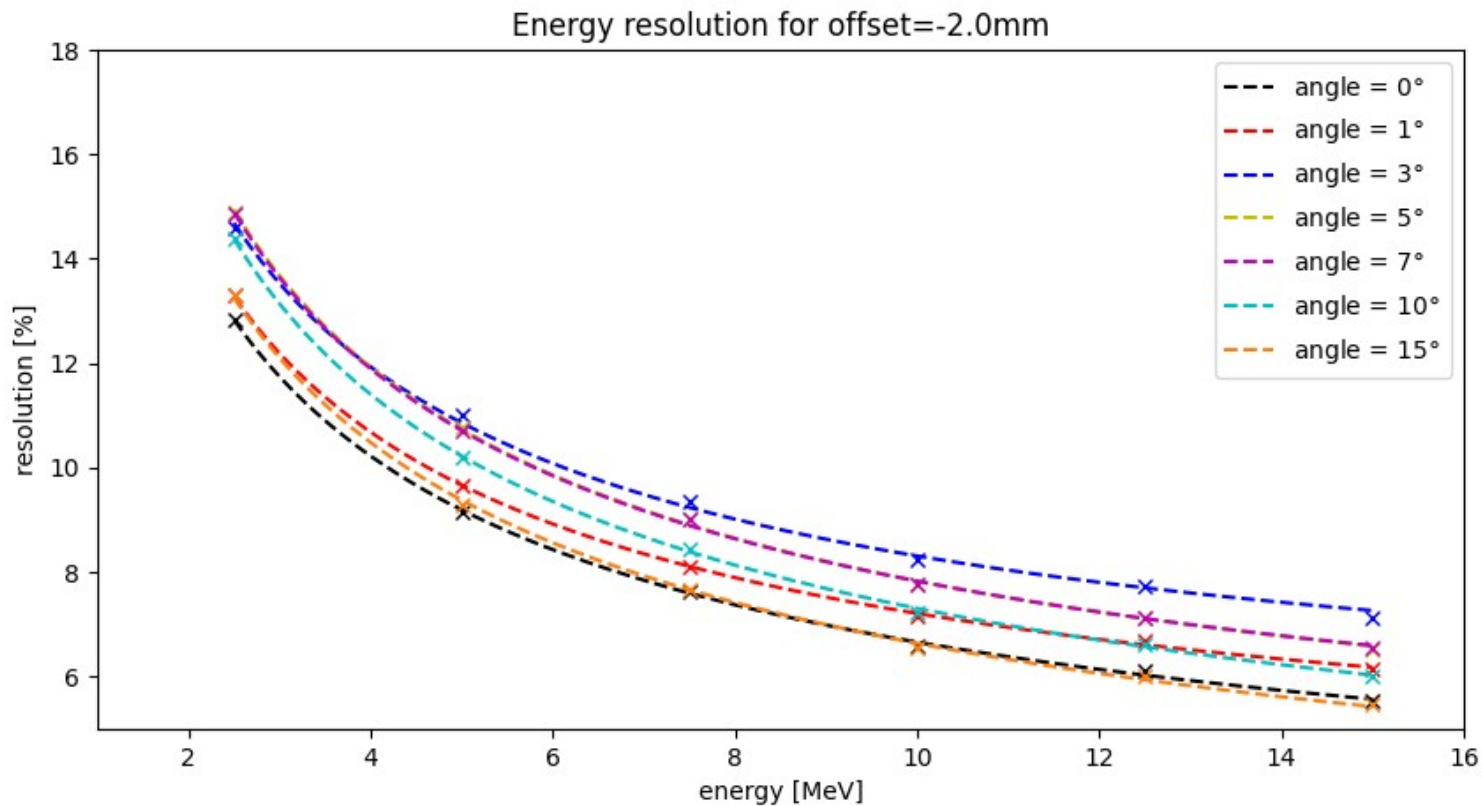
Resolution vs energy



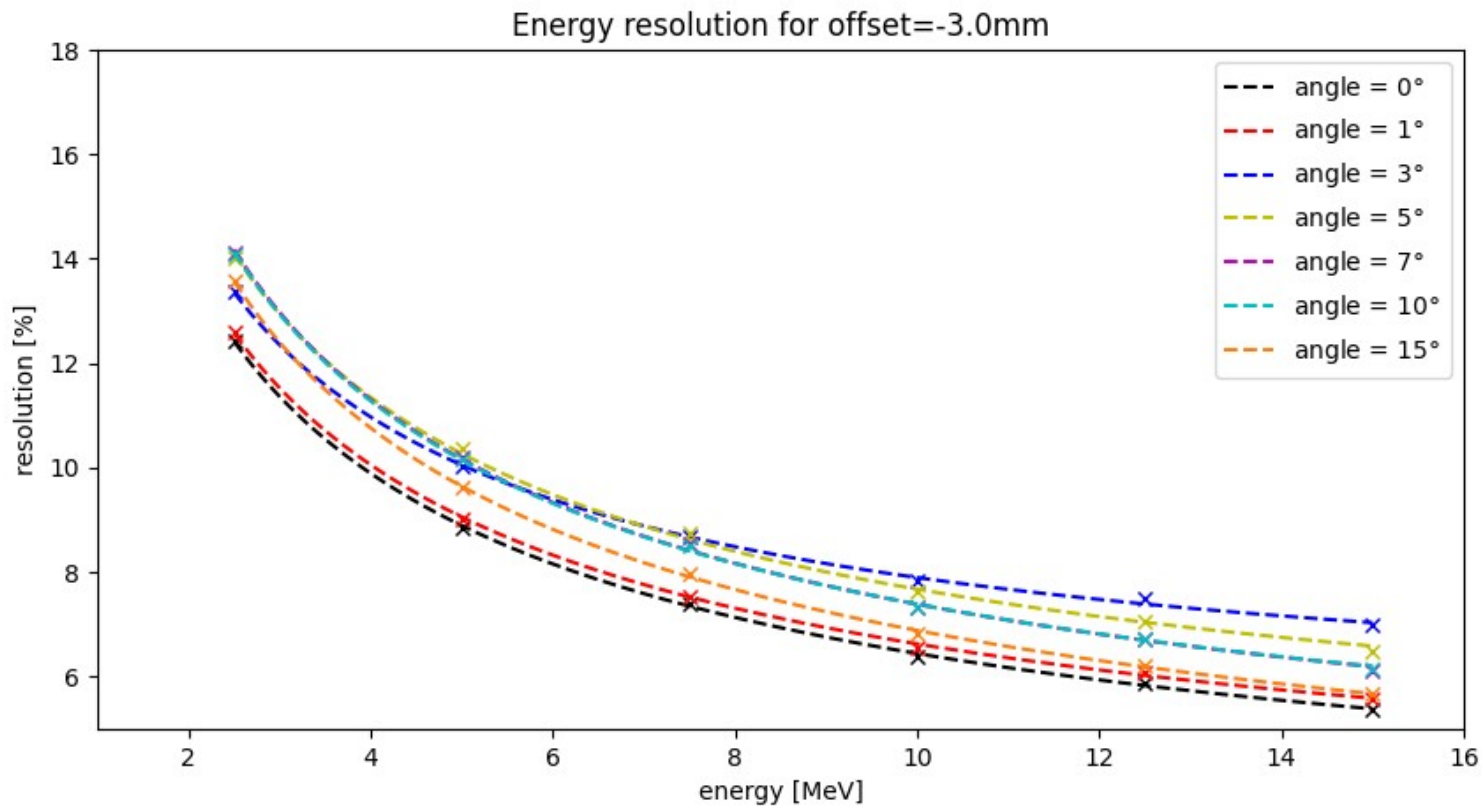
Resolution vs energy



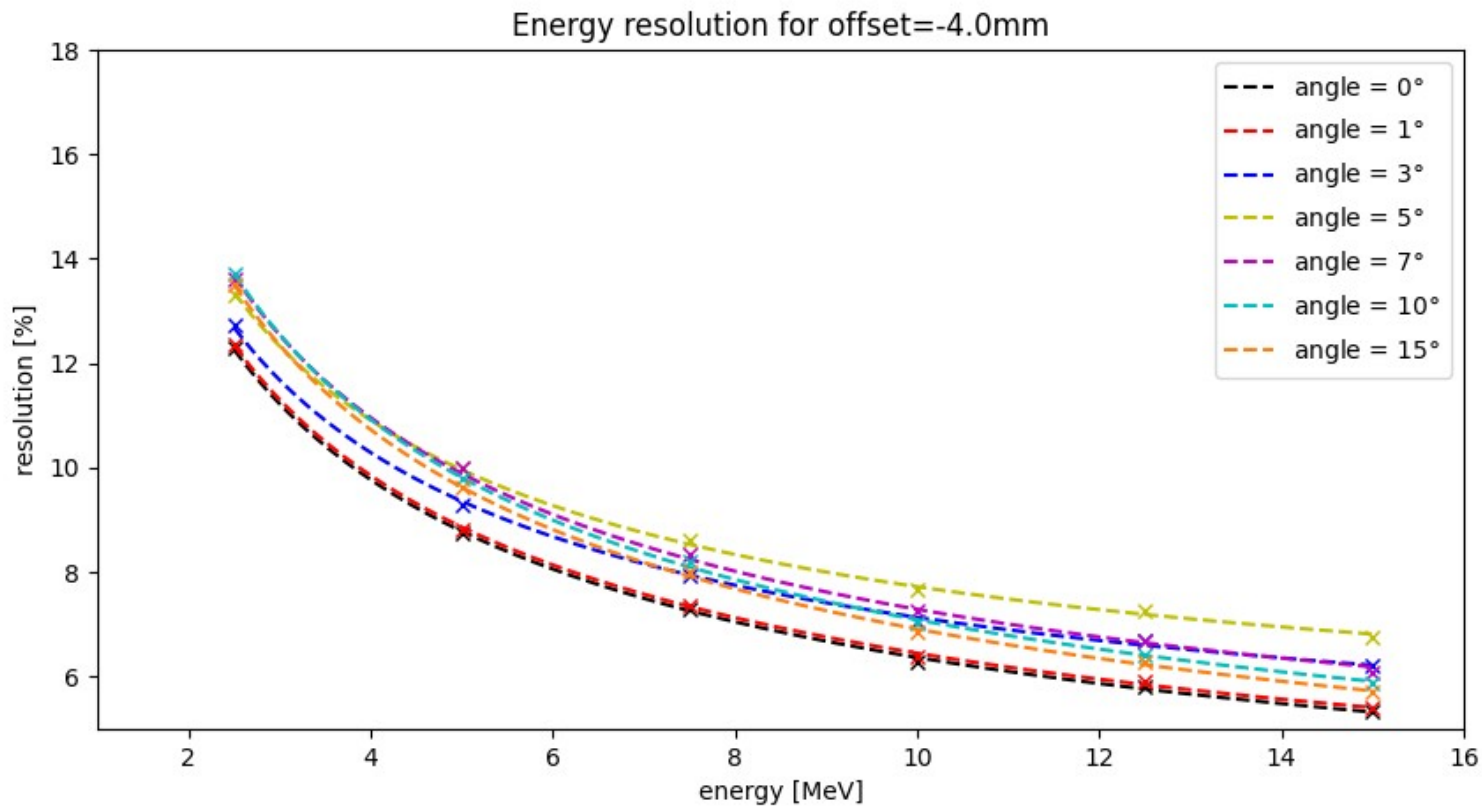
Resolution vs energy



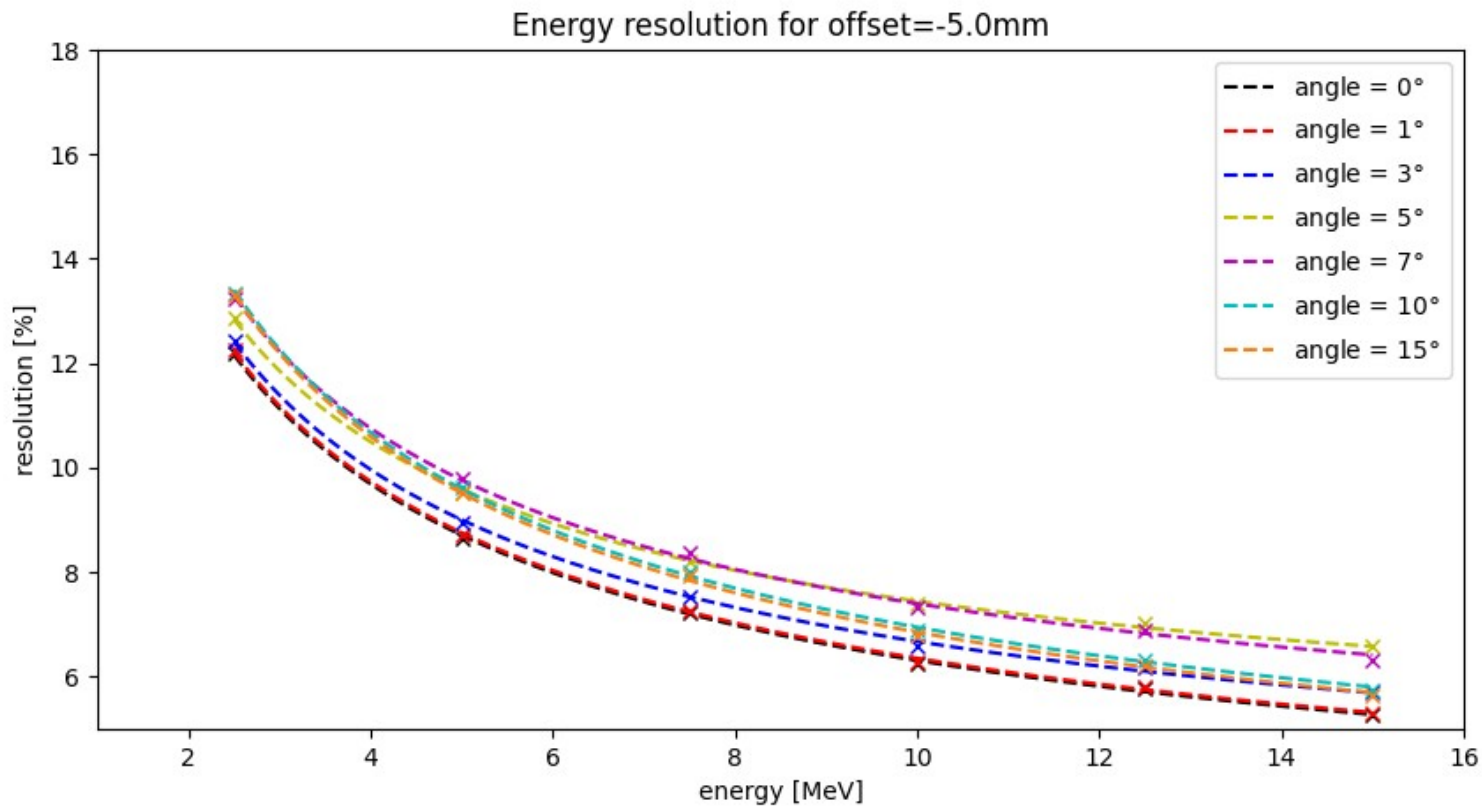
Resolution vs energy



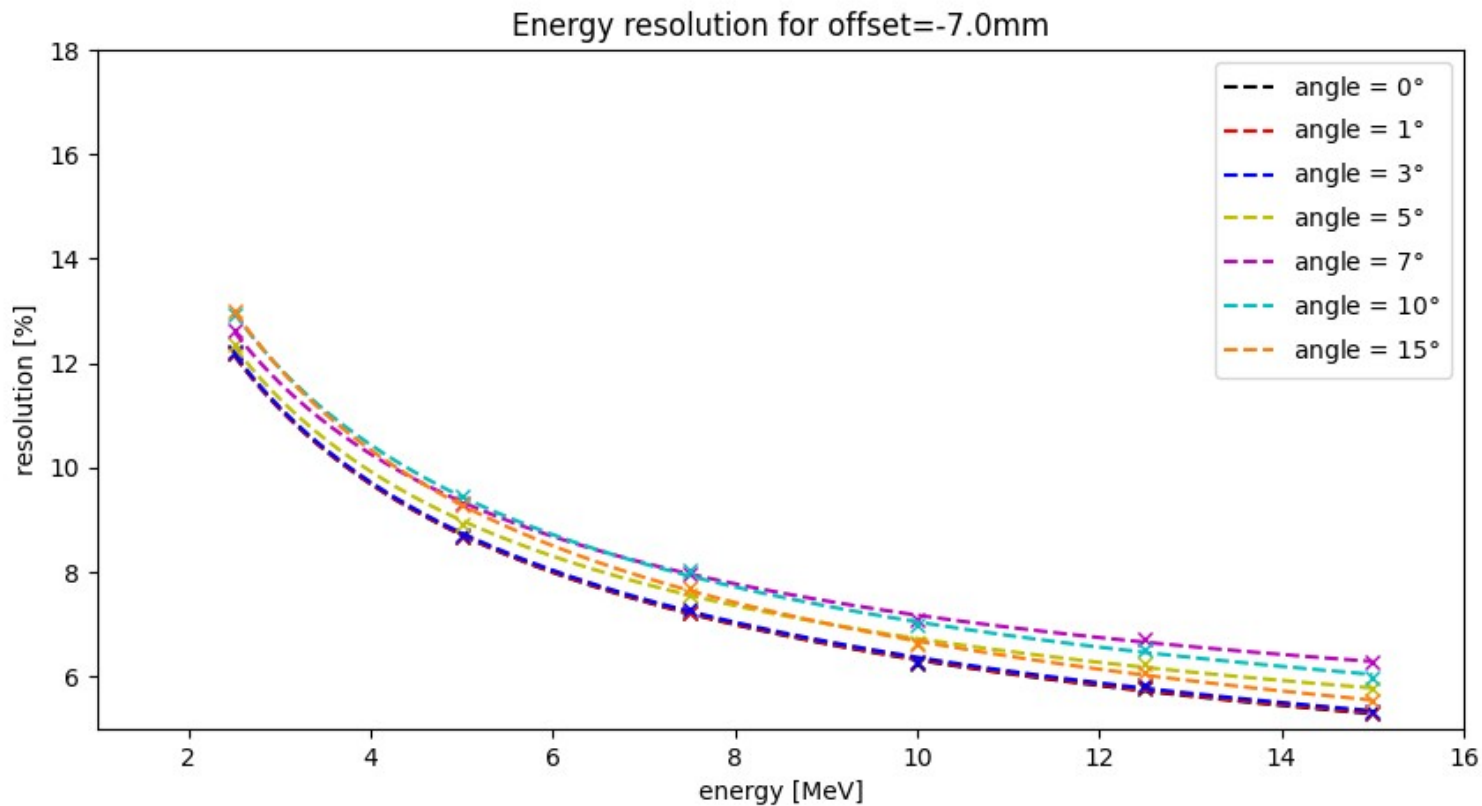
Resolution vs energy



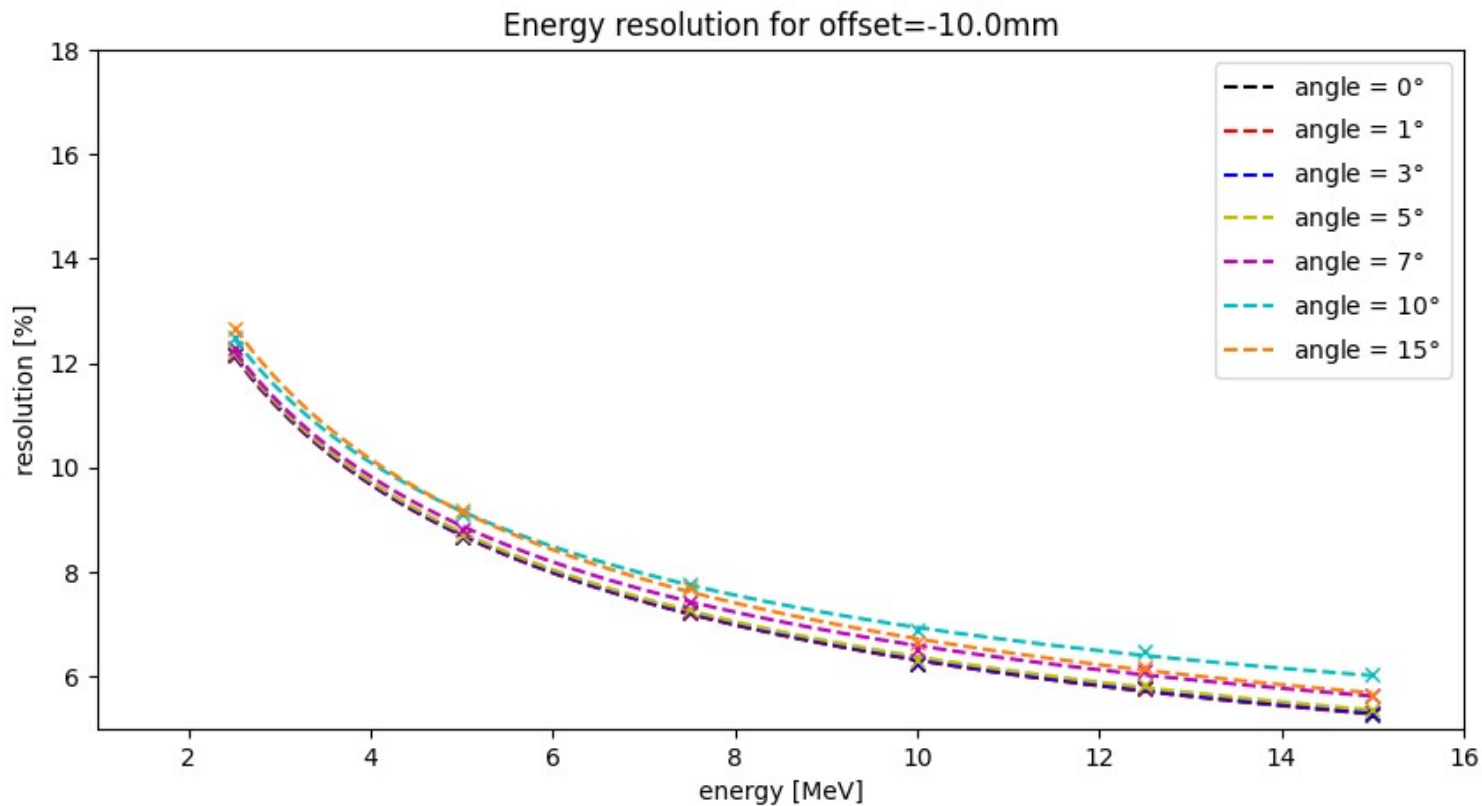
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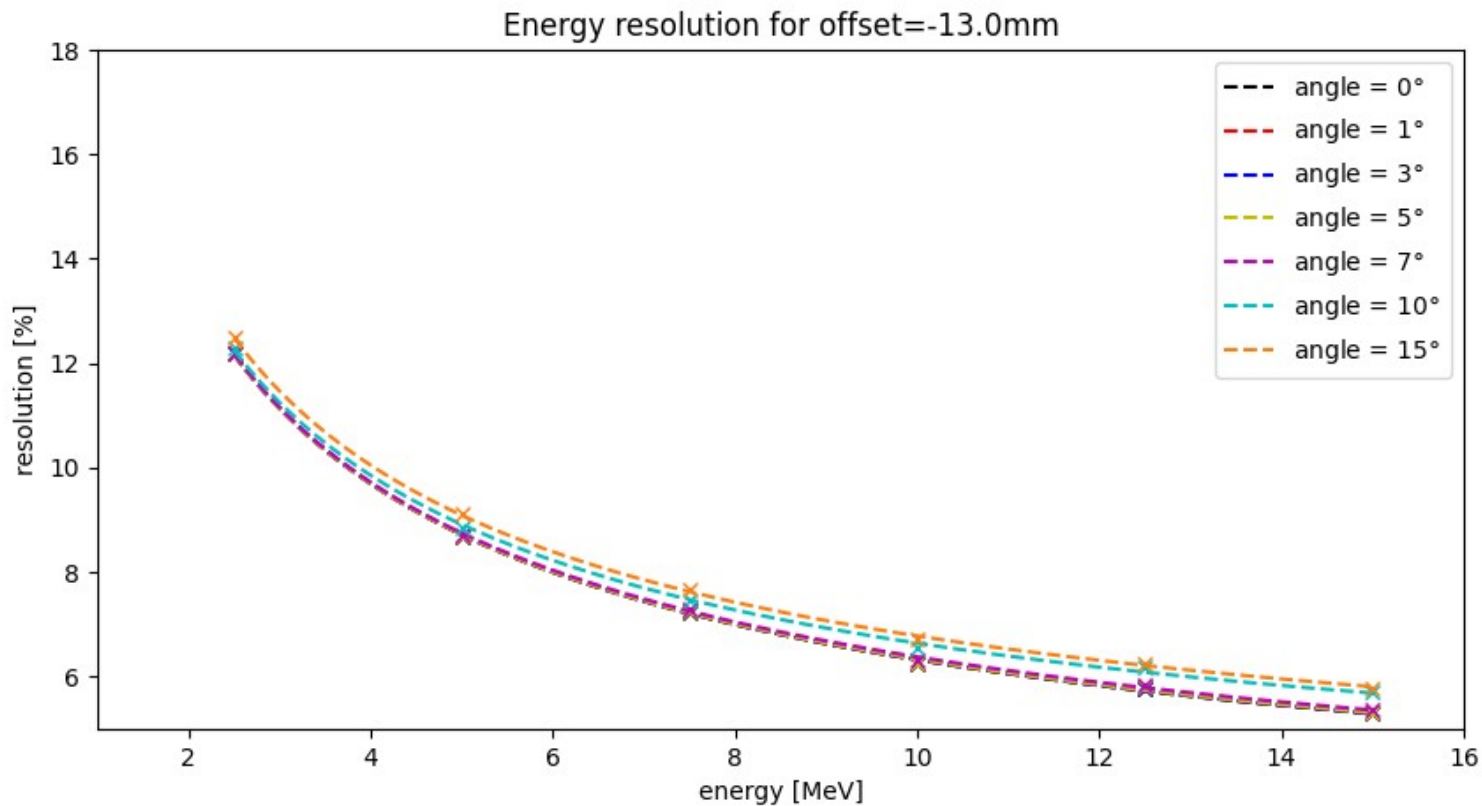
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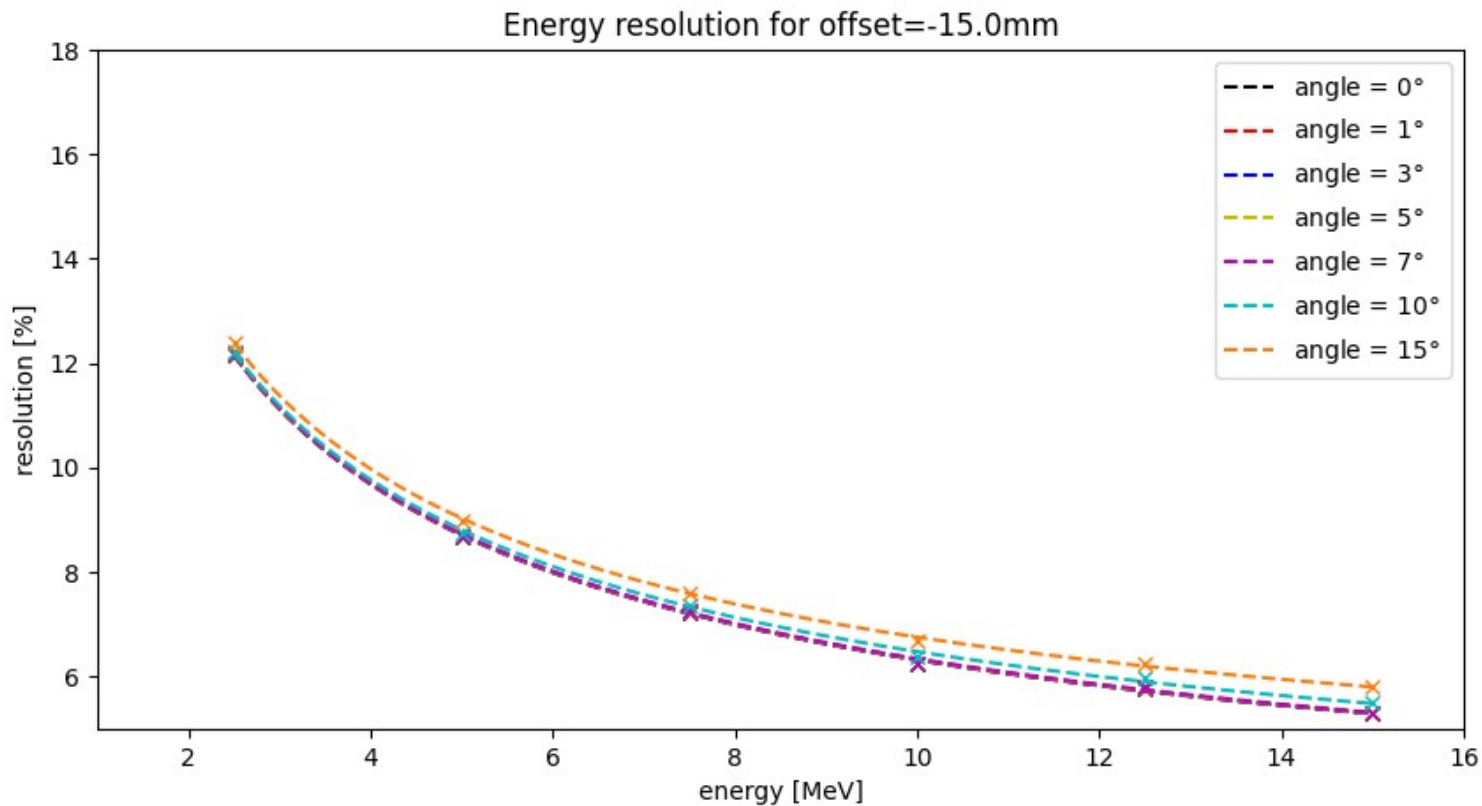
Resolution vs energy



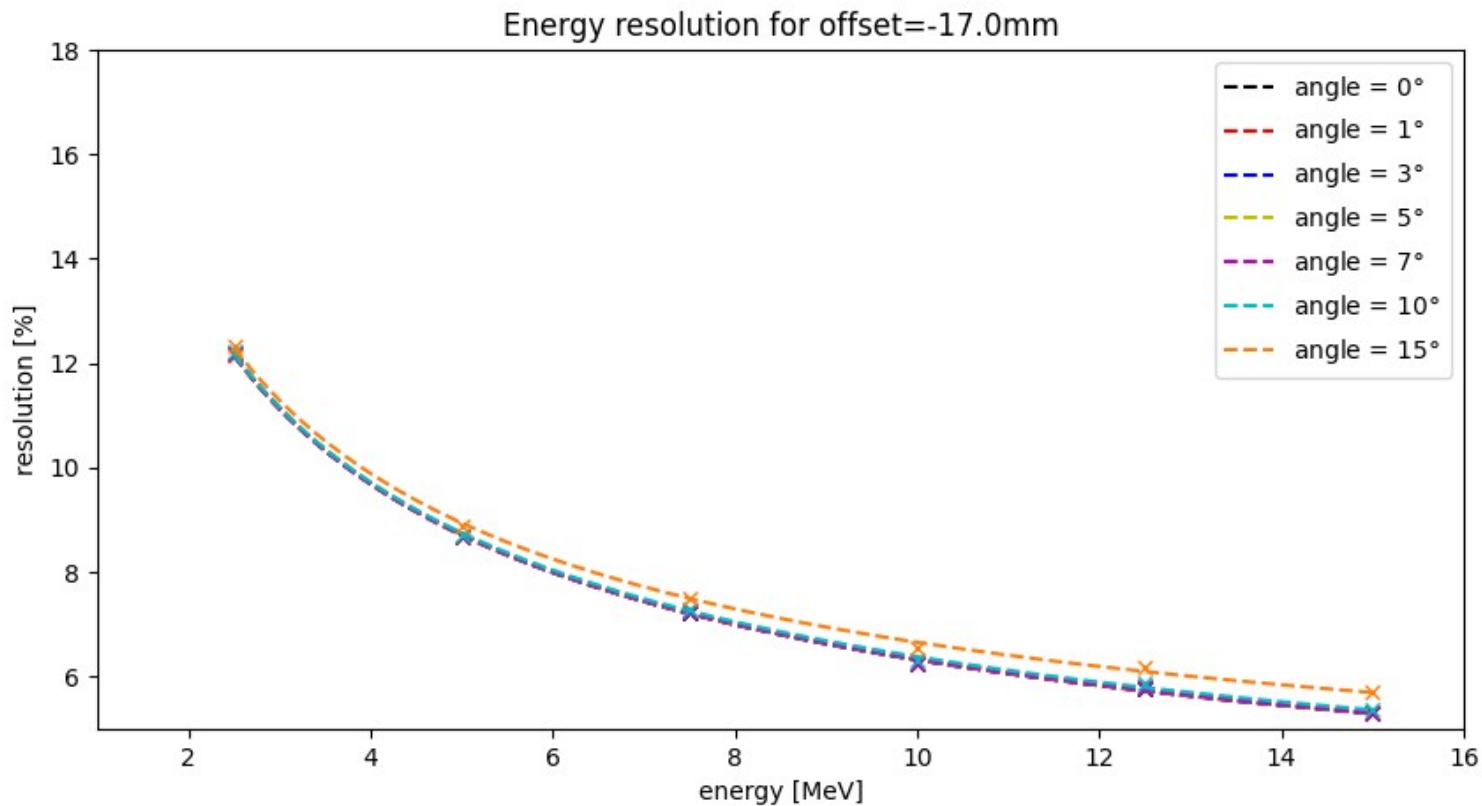
Resolution vs energy



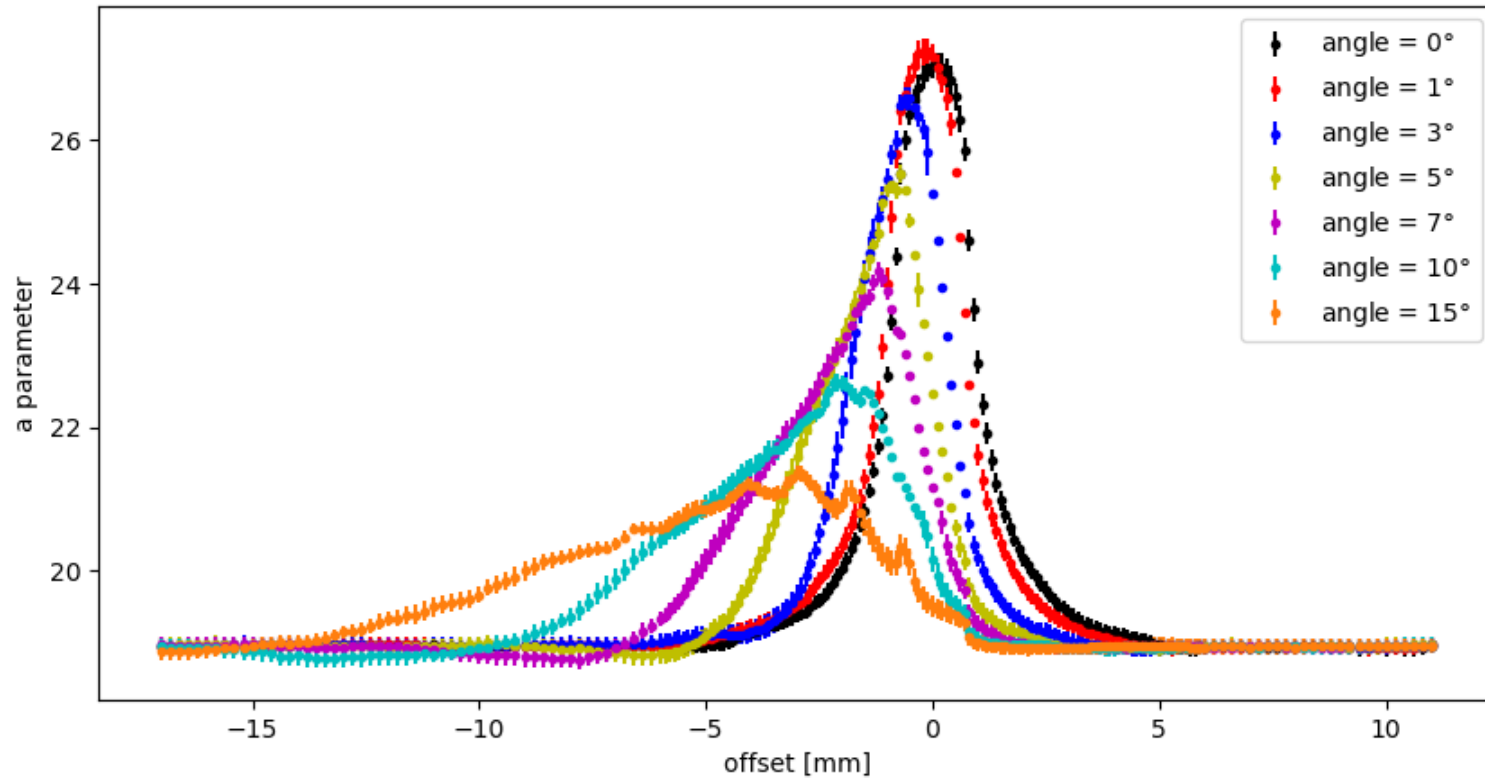
Resolution vs energy



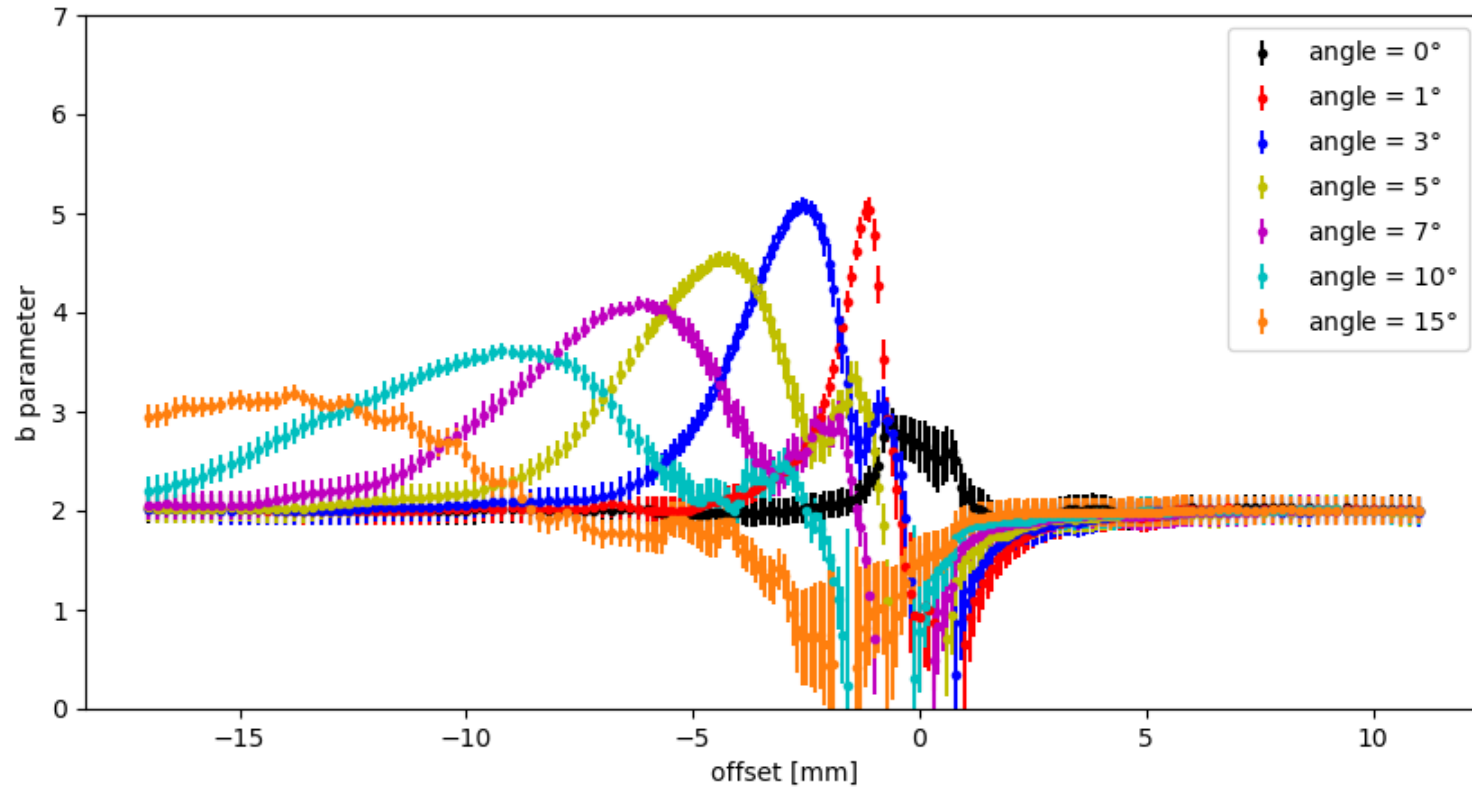
Resolution vs energy



a parameter vs position



b parameter vs position



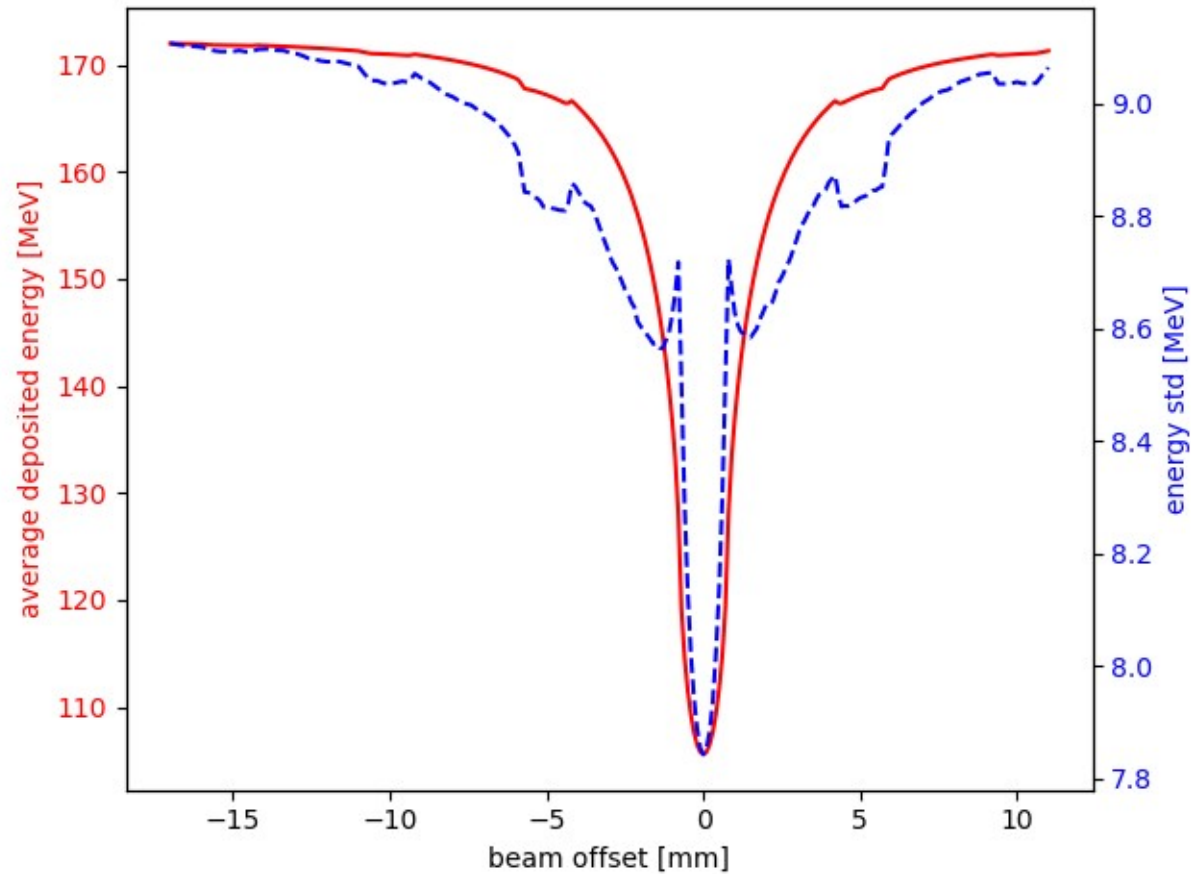
Conclusions

- Effect of the presence of the gap **is not negligible** even for larger angles (10° - 15°)
- Thus it has to be taken into consideration in positron's spectrum reconstruction
- Our current understanding:
two main factors affecting resolution:
 - Energy loss in gap → smaller number of deposits
→ larger Poisson fluctuations (reflected in a parameter)
 - Transverse profile fluctuations → gap loss fluctuations
(reflected in b parameter)

Backup slides

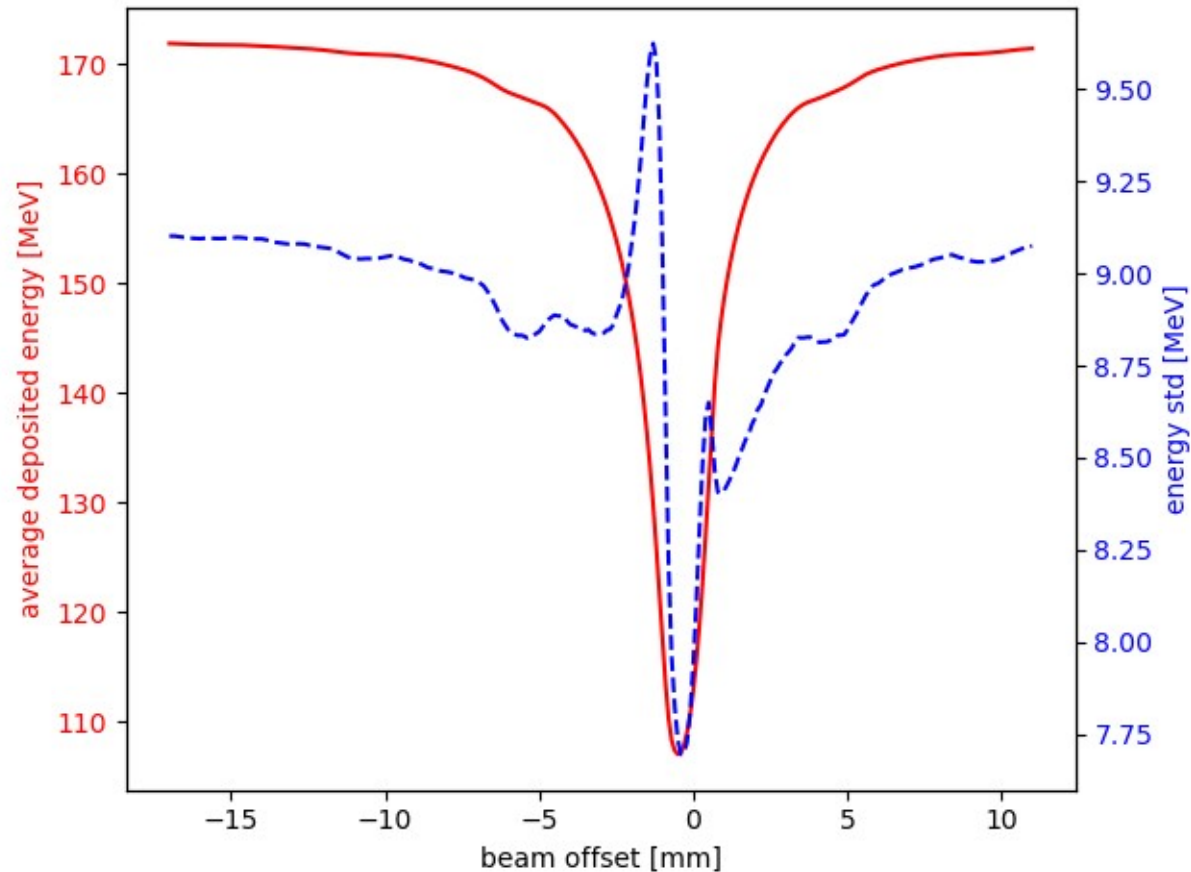
Deposit and std vs position, 15GeV

$\theta=0^\circ$



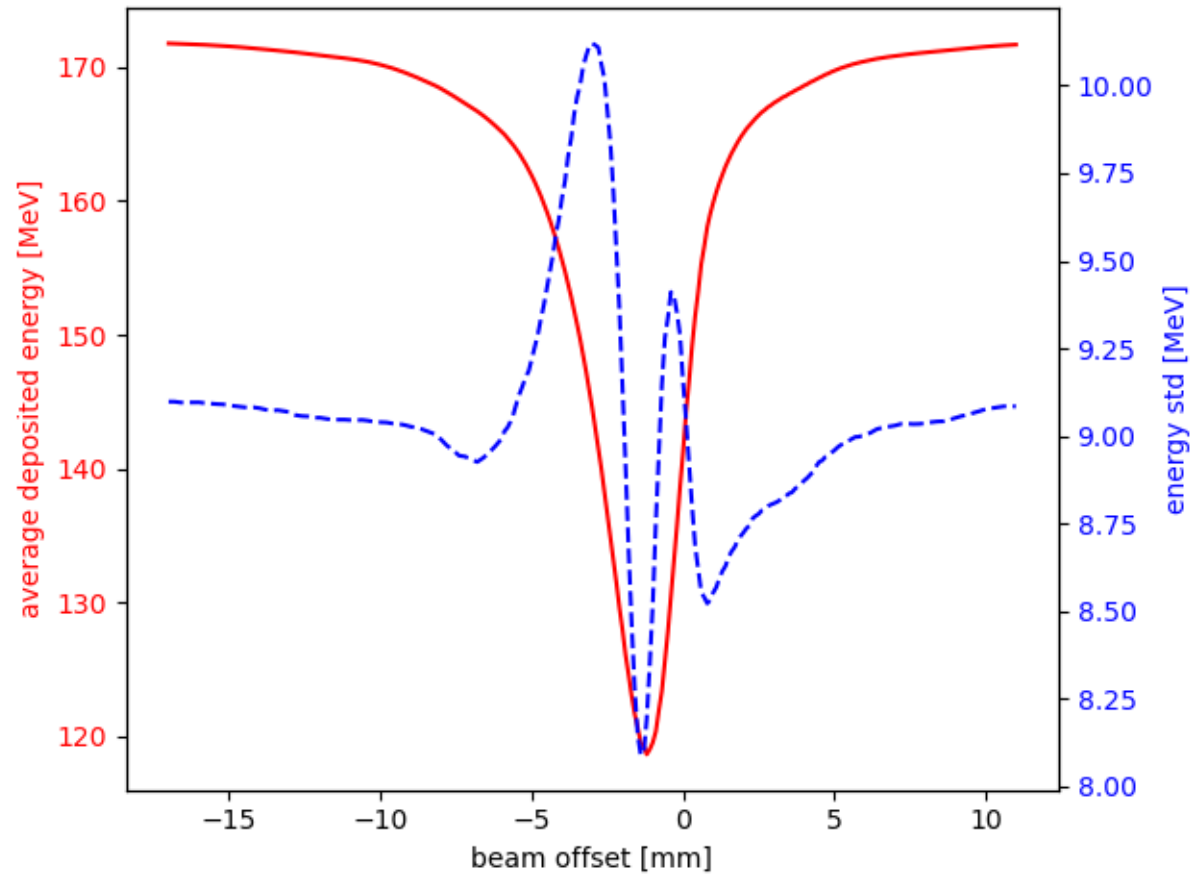
Deposit and std vs position, 15GeV

$\theta=1^\circ$



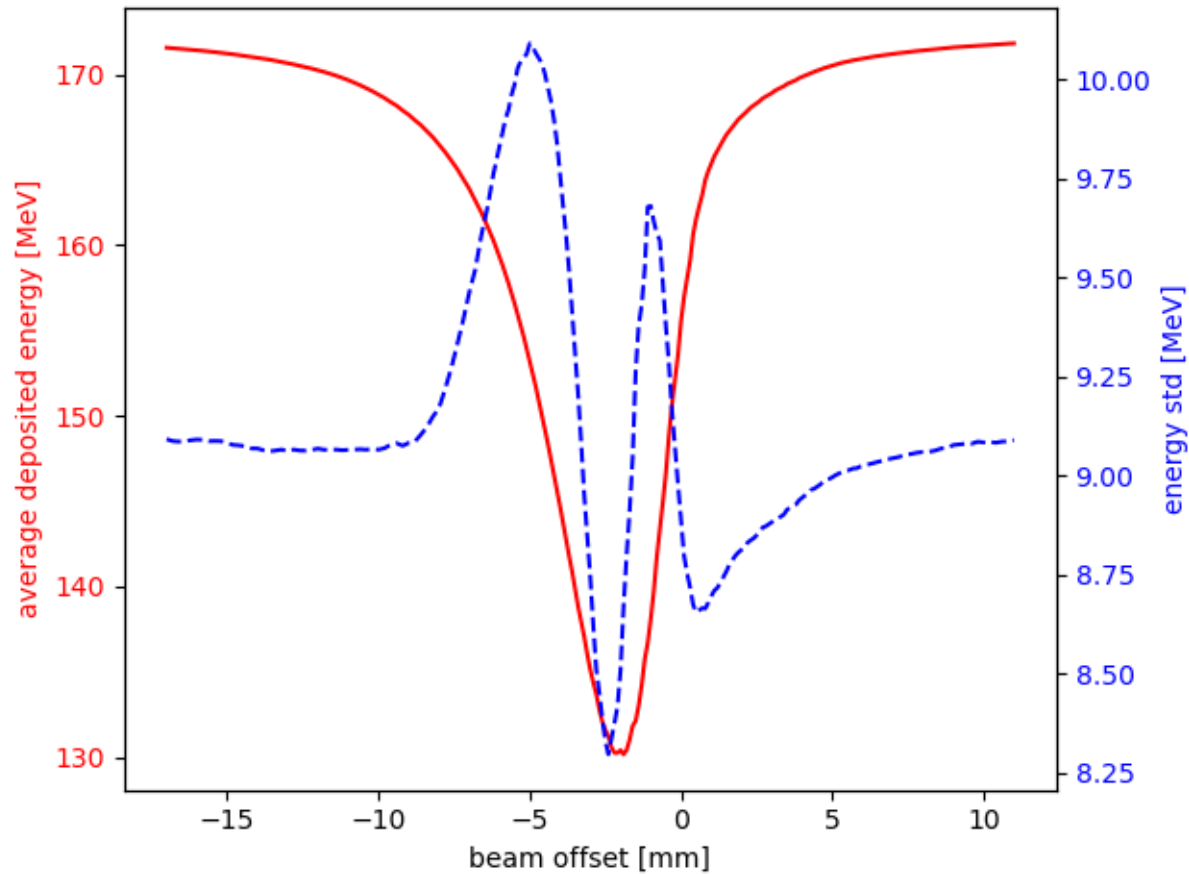
Deposit and std vs position, 15GeV

$\theta=3^\circ$



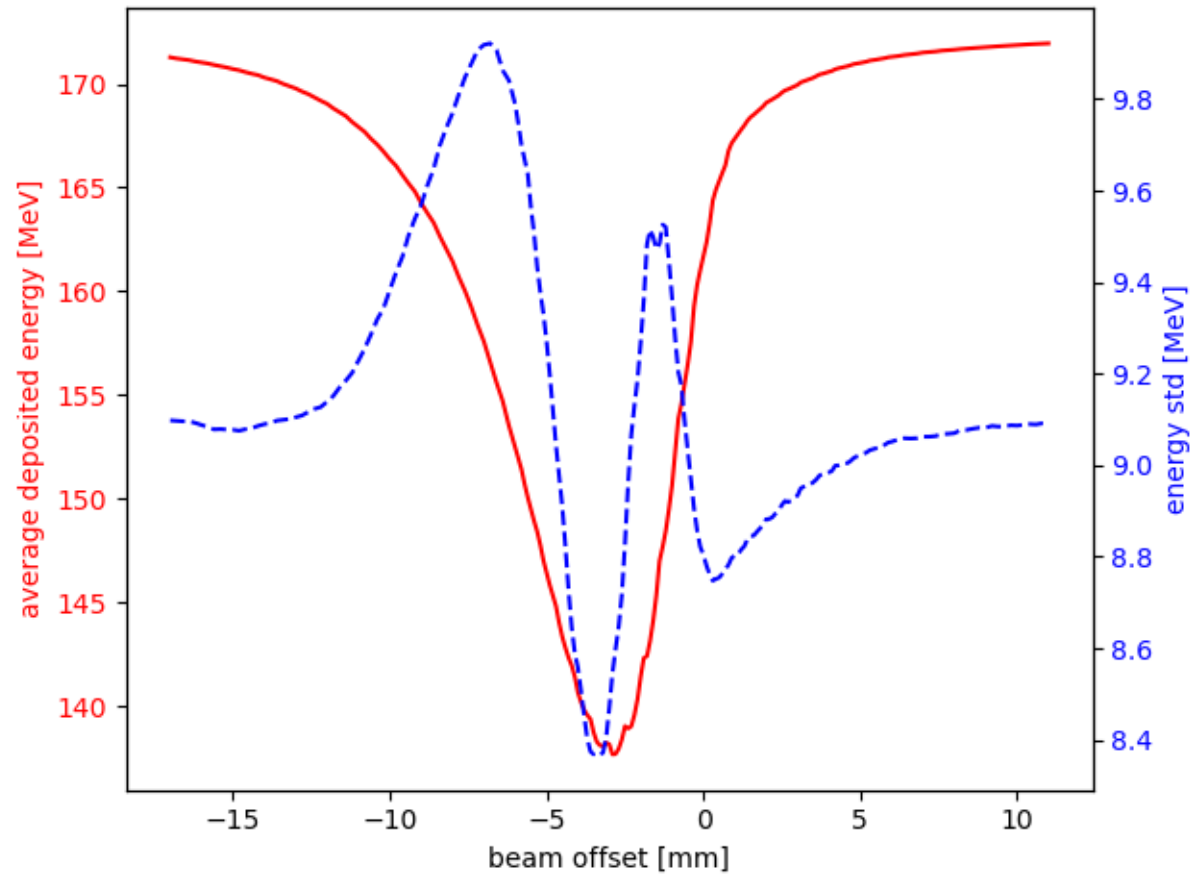
Deposit and std vs position, 15GeV

$\theta=5^\circ$



Deposit and std vs position, 15GeV

$\theta=7^\circ$



Deposit and std vs position, 15GeV

$\theta=10^\circ$

