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SCHOOL OF ADVANCED STUDIES
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Update on directionality of low energy electron recoil

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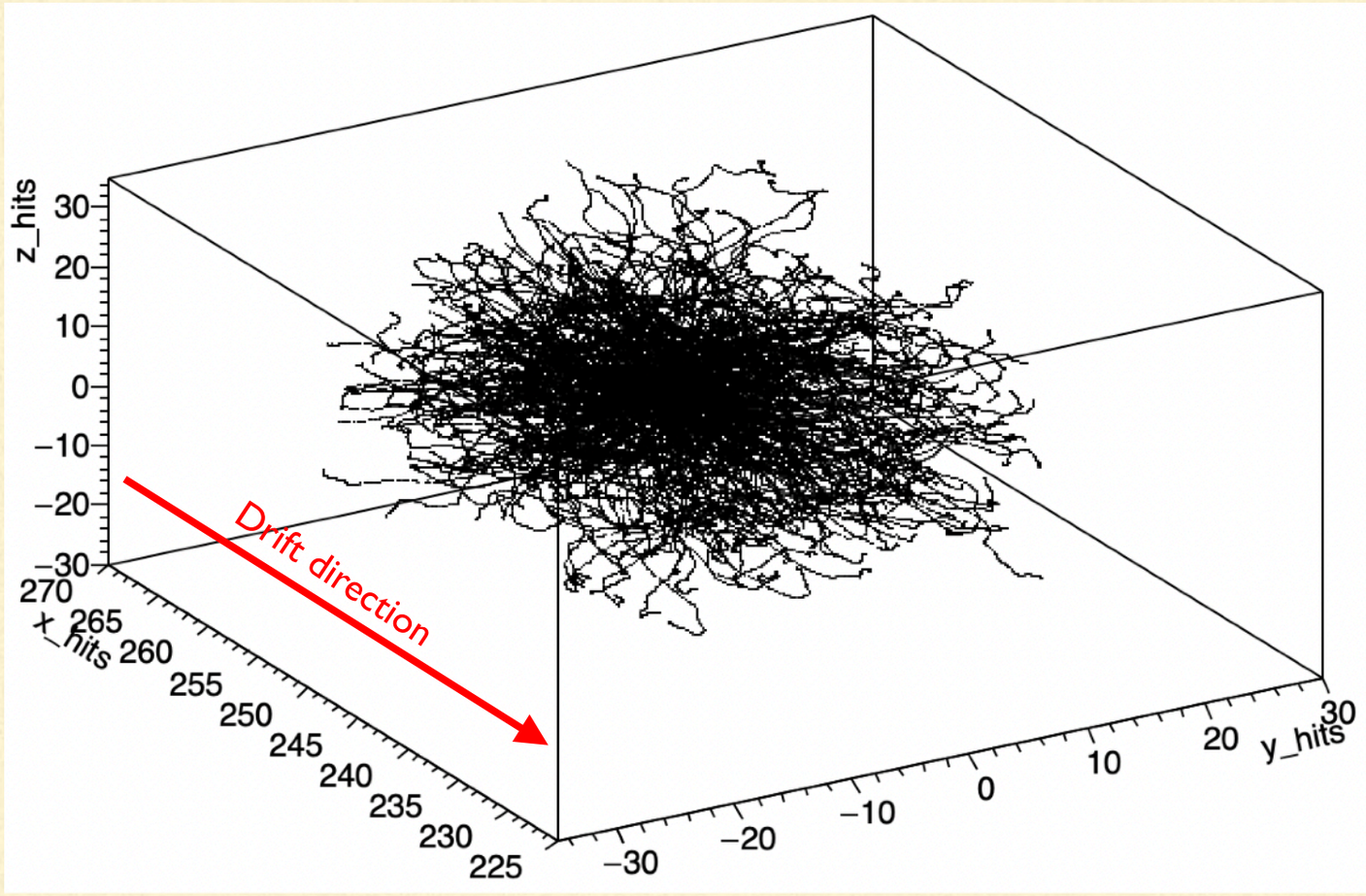
Dataset

- Previous results from tracks produced parallel to amplification plane

- Data has been produced isotropically at the center of the detector



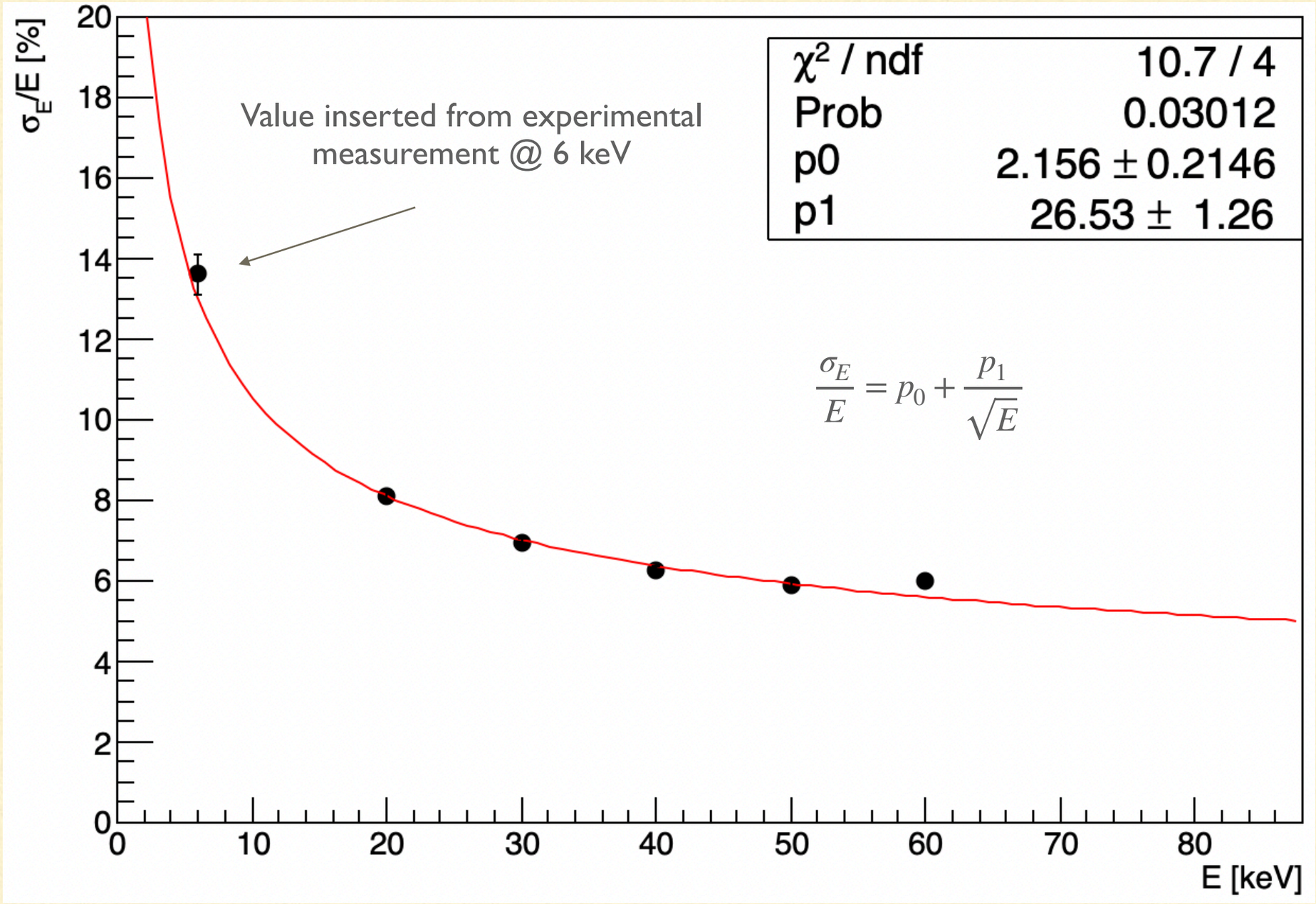
- Each track has been digitized with a random z within 5 cm and 45 cm

↓

(worse condition possible)

- 3000 track per Energy ranging from 20 keV to 60 keV with step of 2 keV

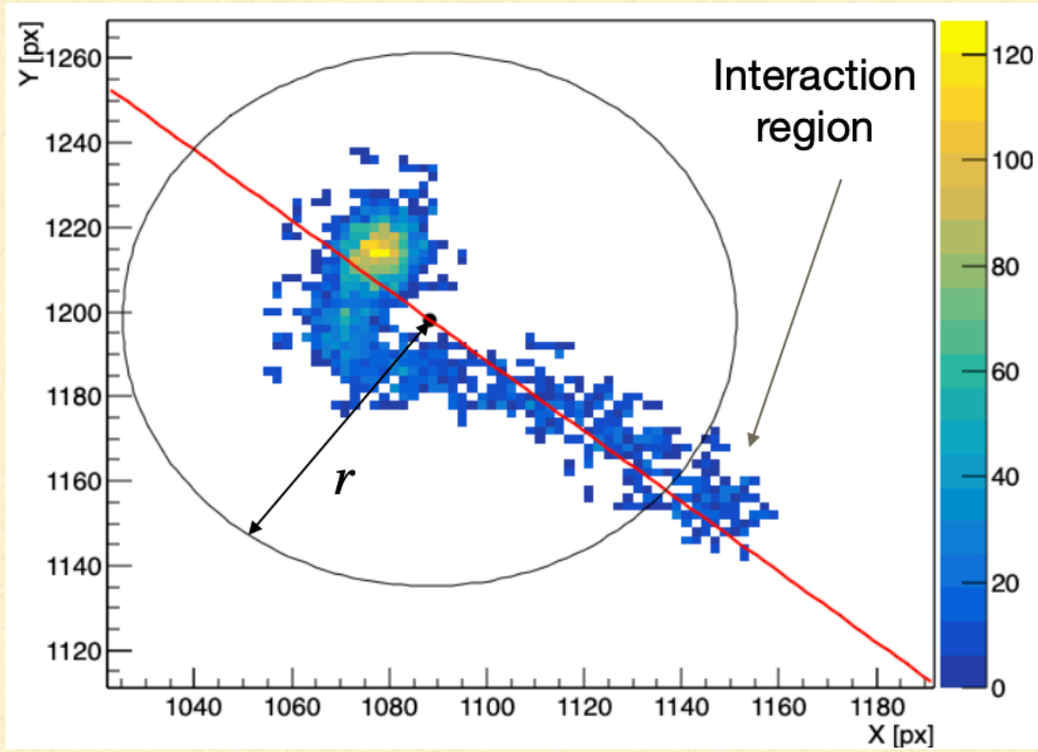
Energy resolution



- Compatible with the typical resolution of a gas detector

Reminder: Algorithm parameters

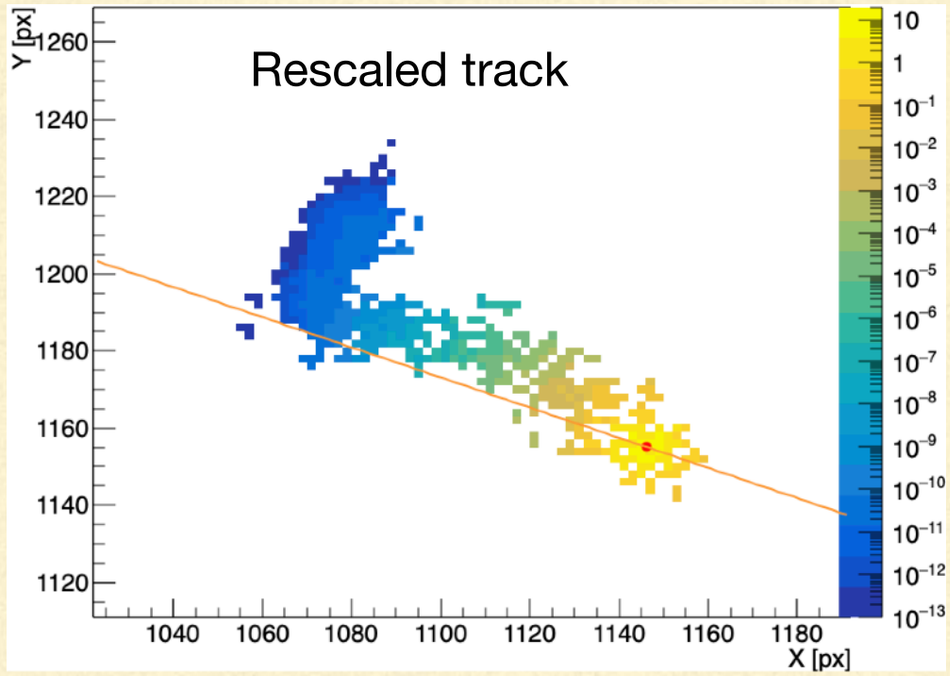
1. N_{pt} : Number of points required to determine the interaction region



2. w : Normalization factor for light rescaling with the distance from IP

$$W(d_{ip}) = exp(-d_{ip}/w)$$

Distance from IP

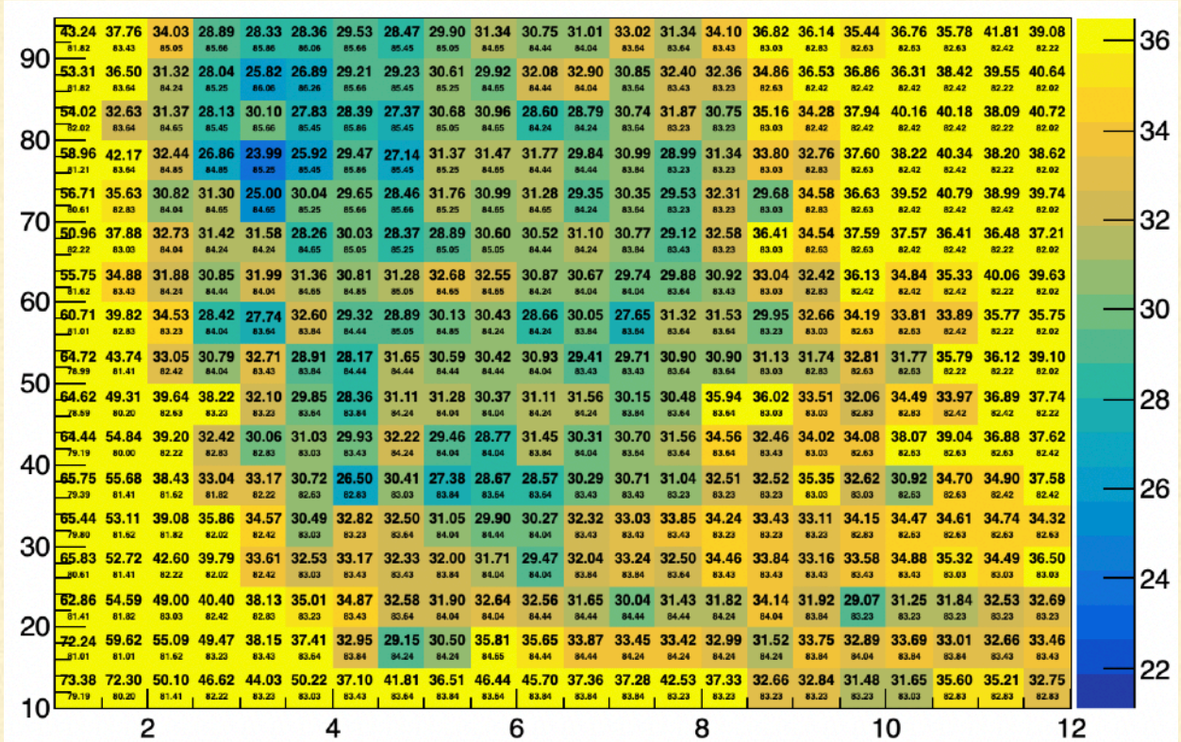


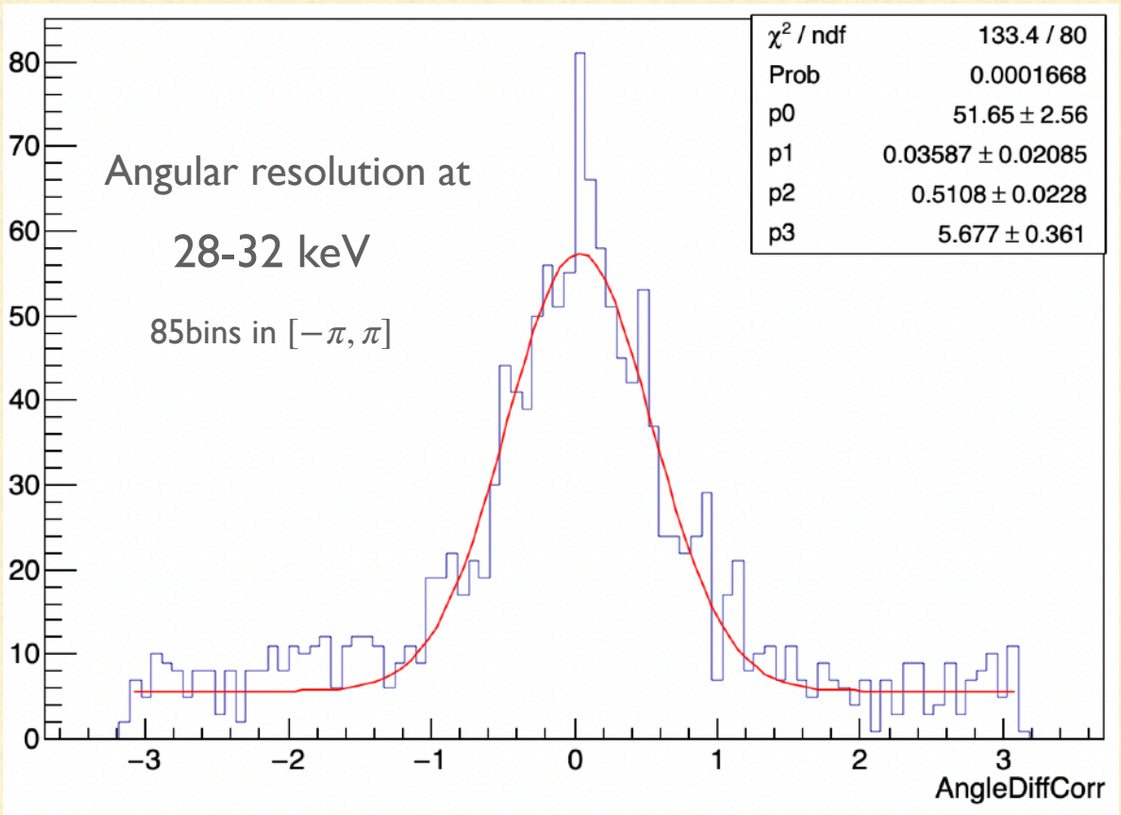
Angular resolution parameters

40 keV

- Optimal parameters obtained with a scan on previous dataset of lower statistic

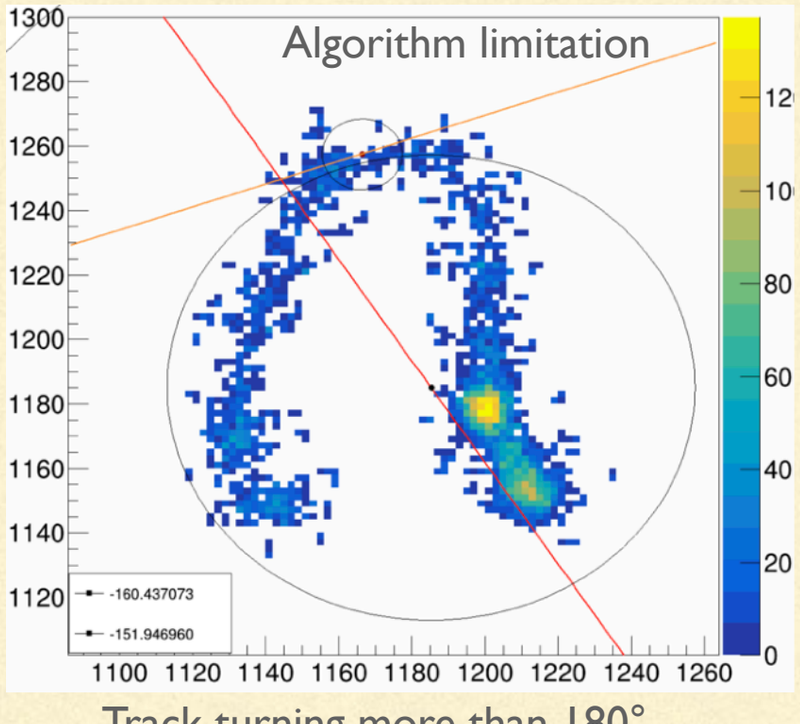
	20keV	30keV	40keV	50keV	60keV
w	1.5	2	3	3.5	6.5
N_{Pt}	60	70	75	80	45



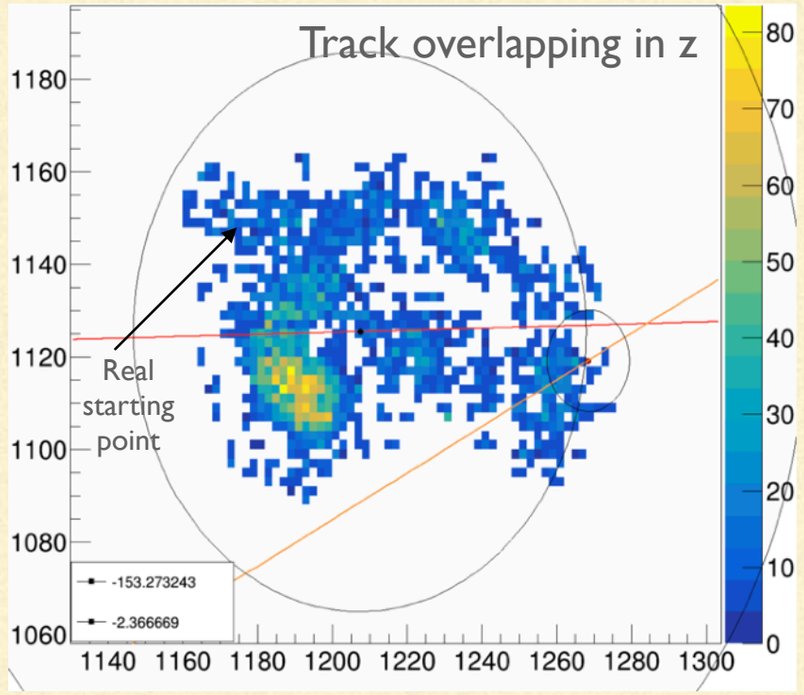


- Resolution distribution fit with a gaussian + a flat component (p3)
- Flat component not present for tracks parallel to readout plane (previous results)
- Must be taken into account in future studies

Causes of the flat component



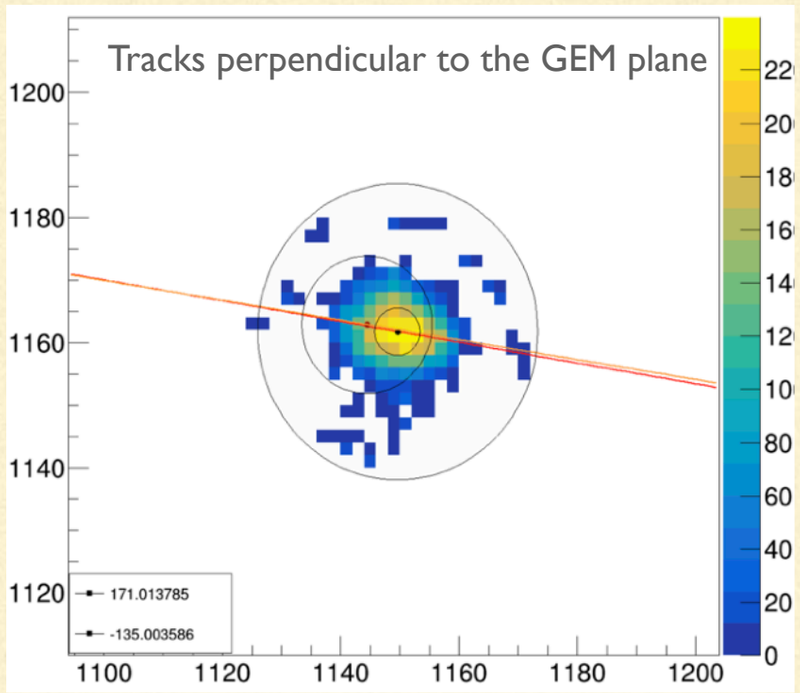
Track turning more than 180°
Wrong main axis



Wrong skewness

- In all this cases the algorithm reconstruct a random direction (flat distribution)

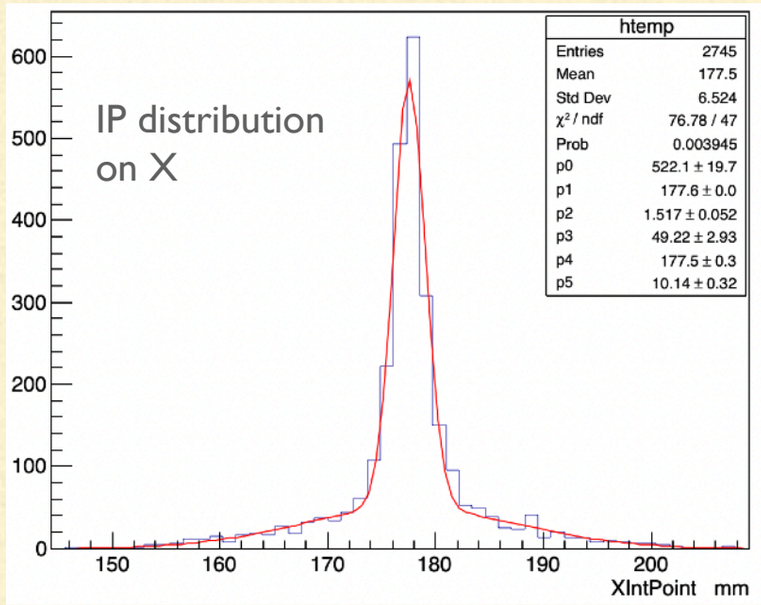
- This cases have in common a wrong IP

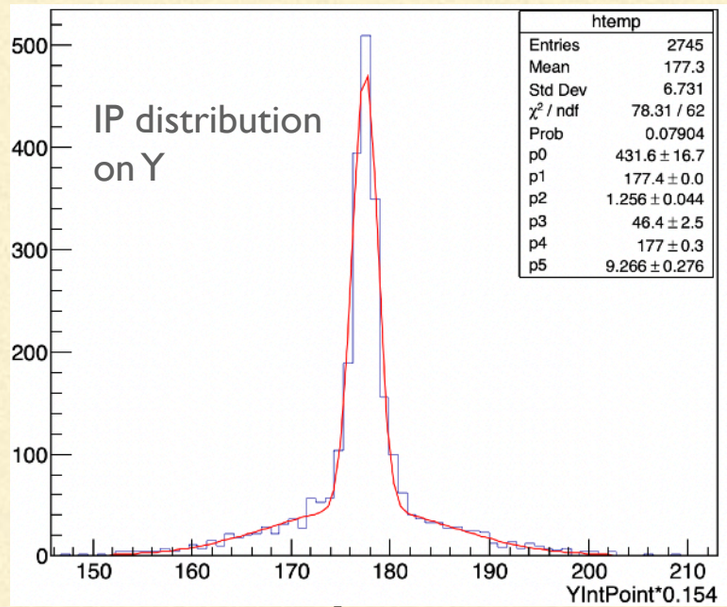


Influence of IP reconstruction @ 60 keV

- IP resolution has two gaussian components

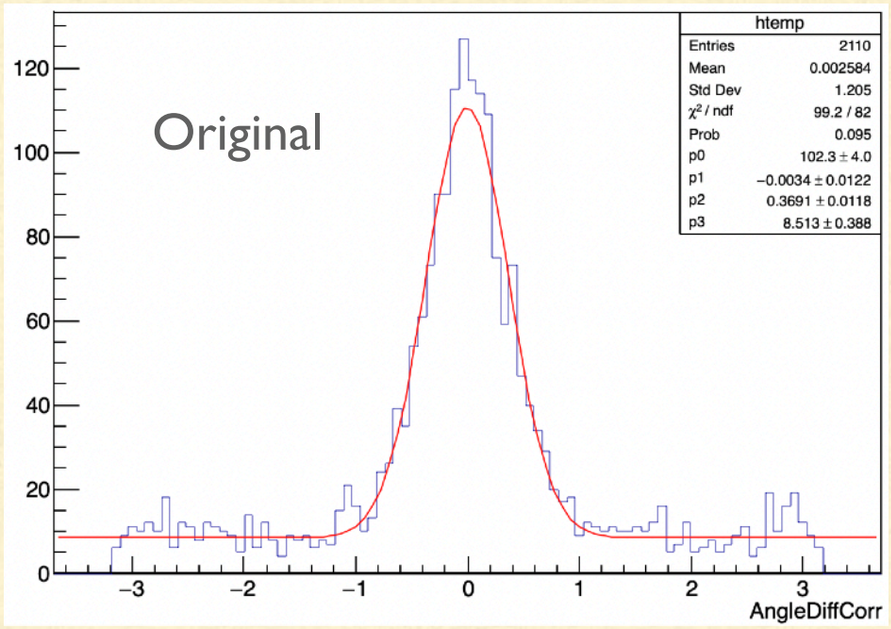
- Attempt to cut on IP to see effects on gaussian tails

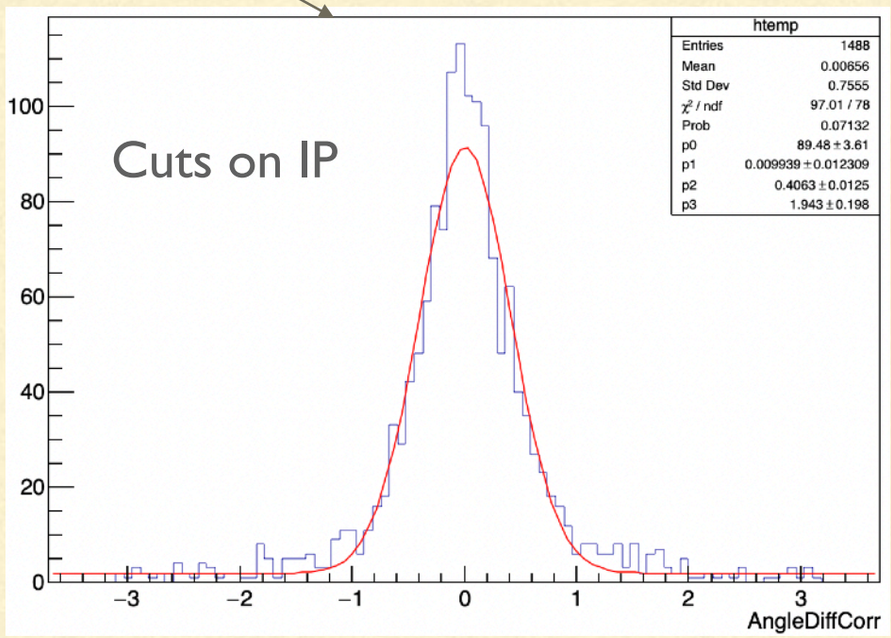




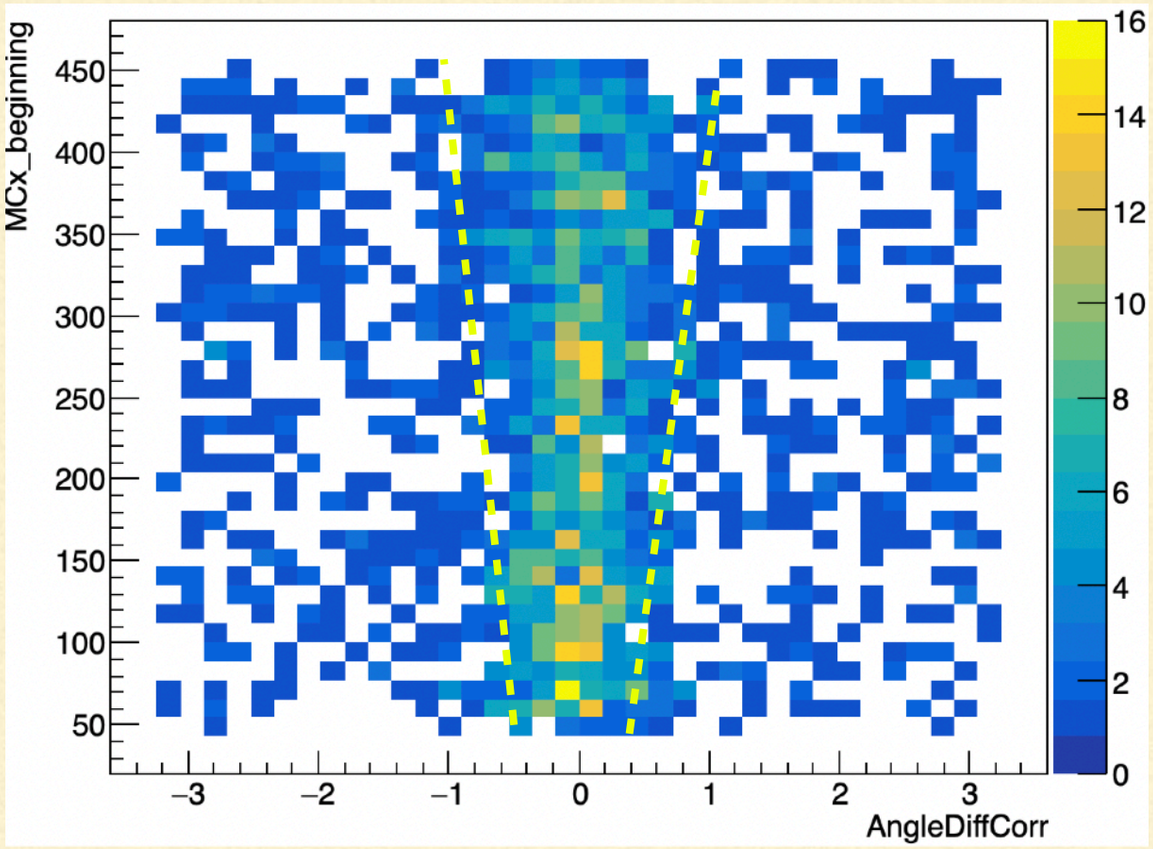
Cuts within 3σ of the main gaussians

- Selecting events within the main gaussian, angular resolution tails disappear

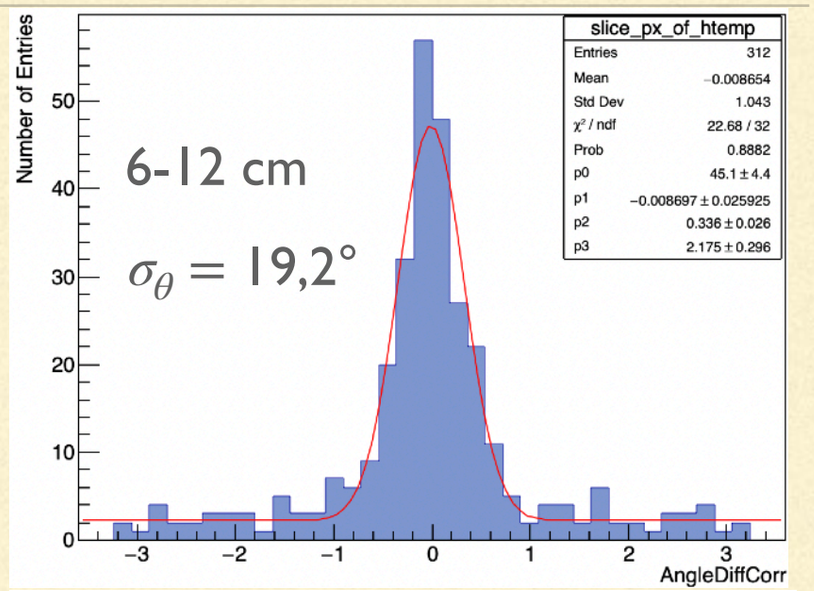


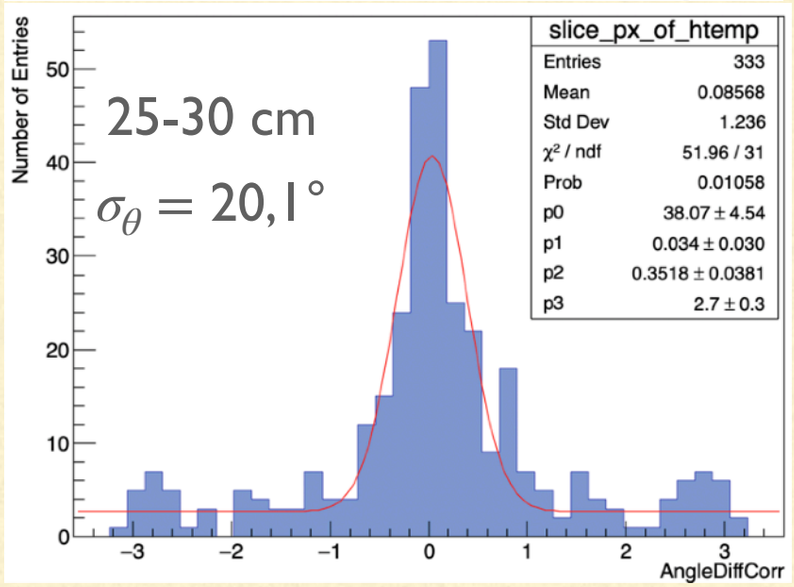


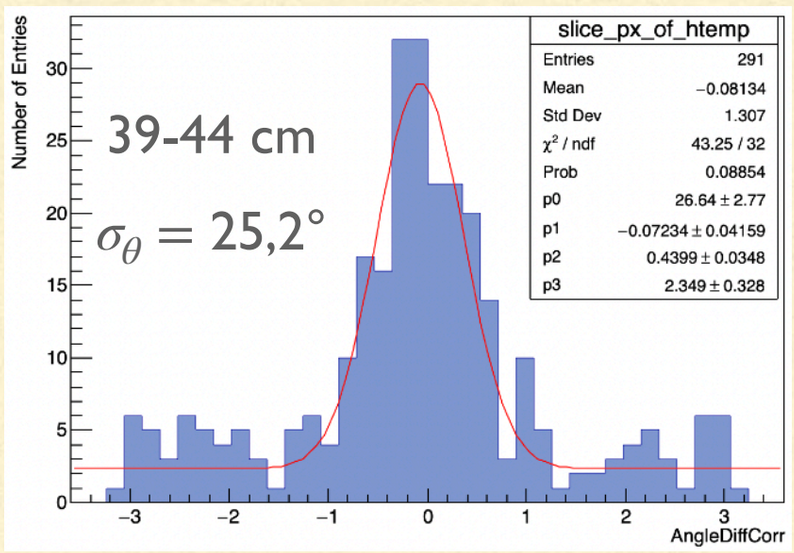
AngRes Vs Drift dist. @ 60 keV



$\theta_{meas} - \theta_{true}$ vs diff distance





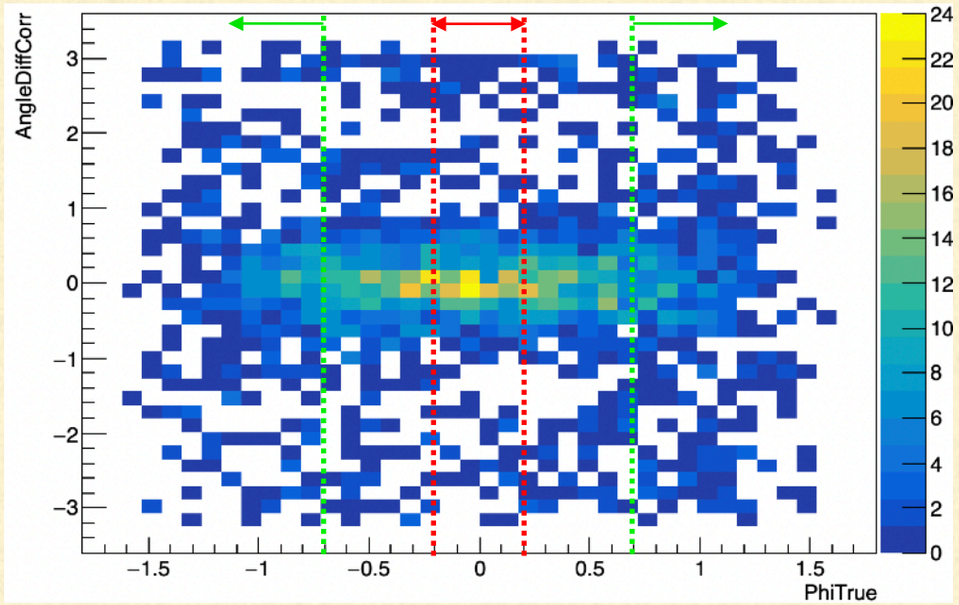


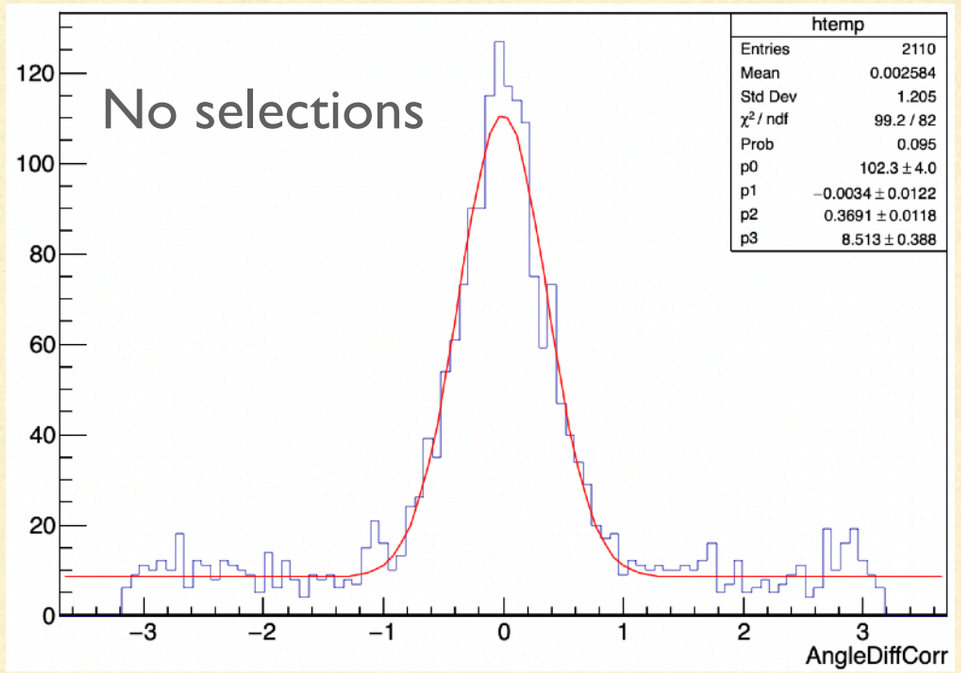
- Angular resolution improves lowering the drift distance
- Flat constant component present in the same amount at all the drift distances
- Ongoing: test the dependence of angular resolution vs drift distance as a function of energy

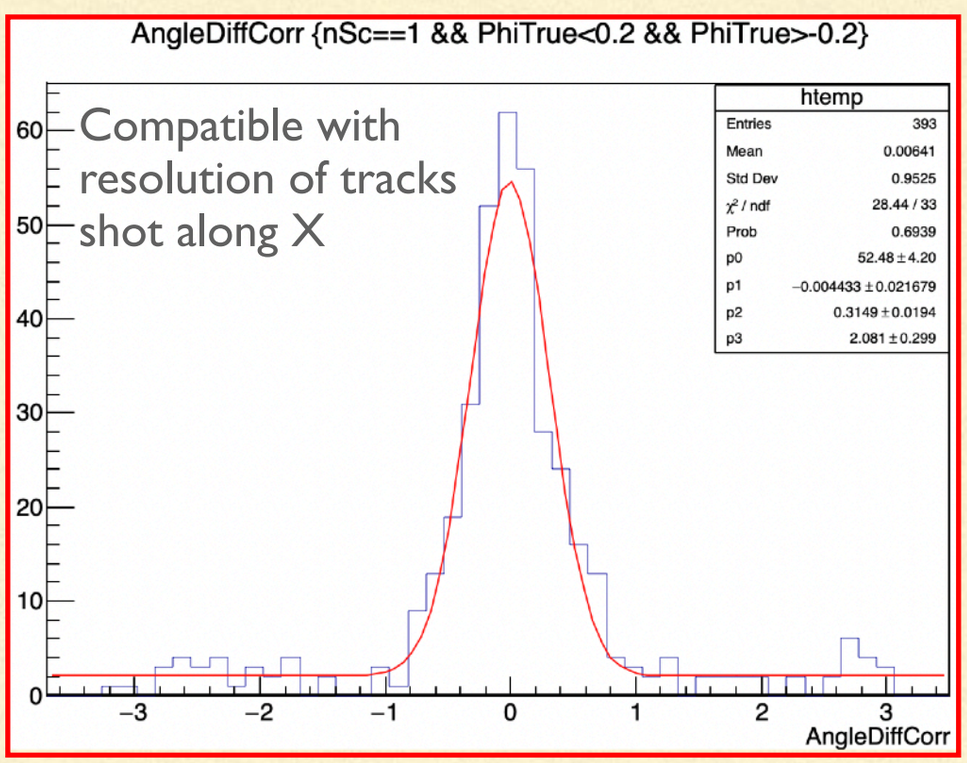
AngRes Vs Phi @ 60 keV

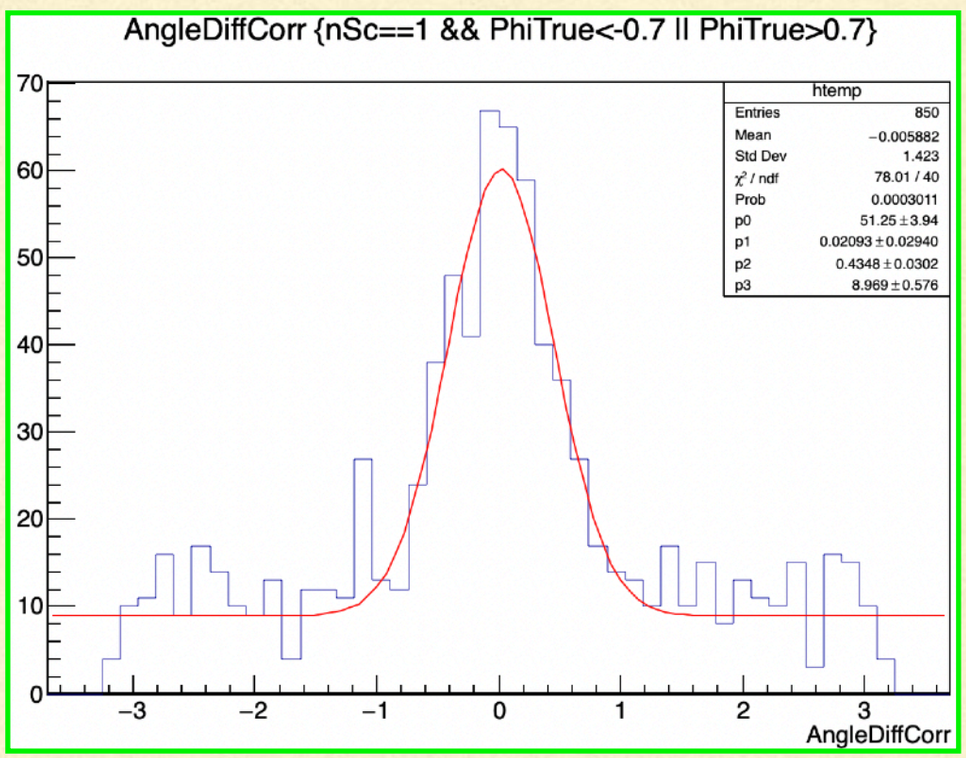
$\phi = 0$ parallel to the GEM plane

$\phi = \pm \pi/2$ perpendicular to the GEM plane



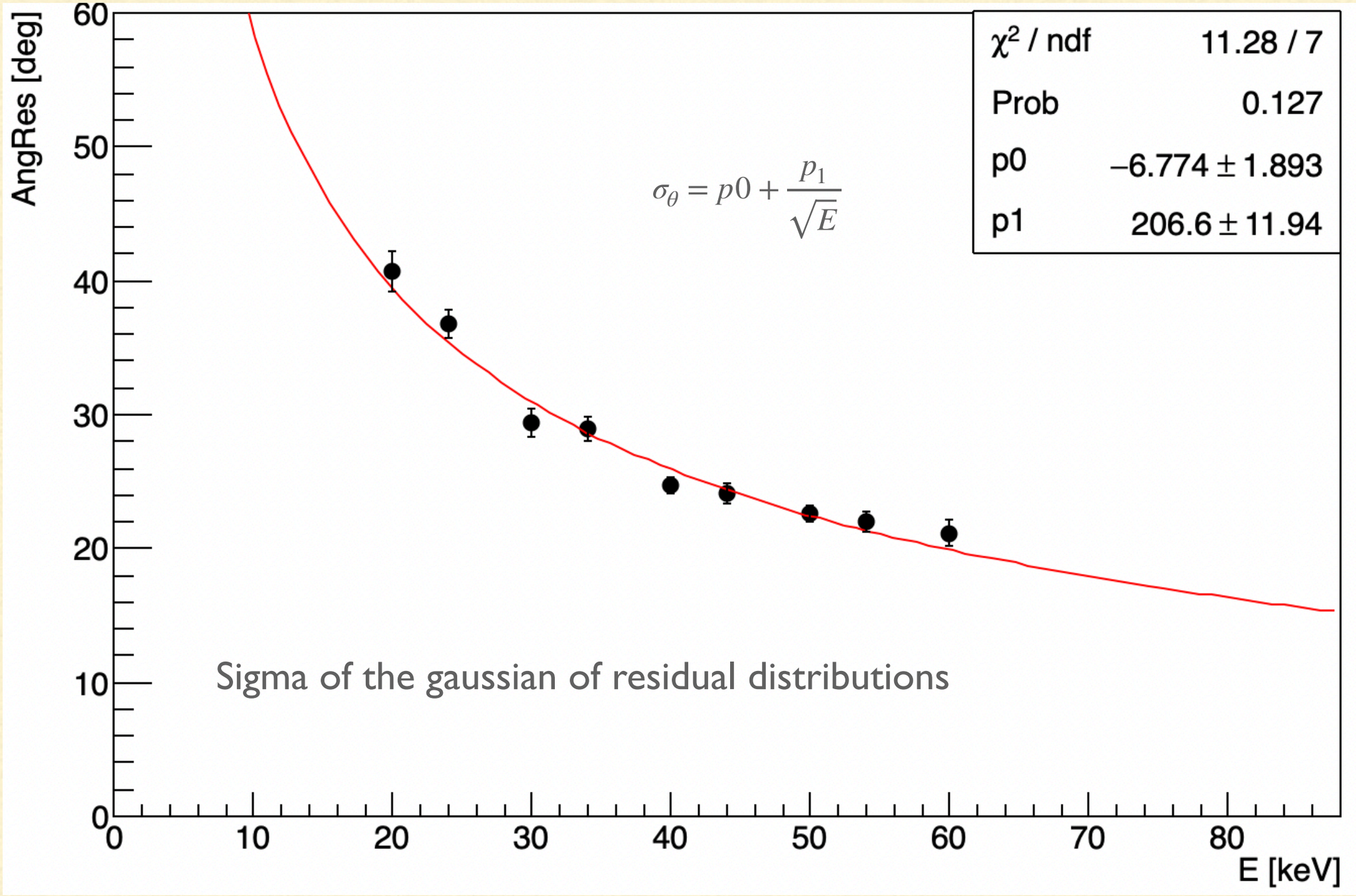






Tracks perpendicular to the GEM plane contributes to the tails

Results on angular resolution



Considerations on directionality application

- Angular resolution studied on sCMOS images (2D detector), this implies some limitations

- In an ideal world the PMT spacial resolution would be the same of the sCMOS

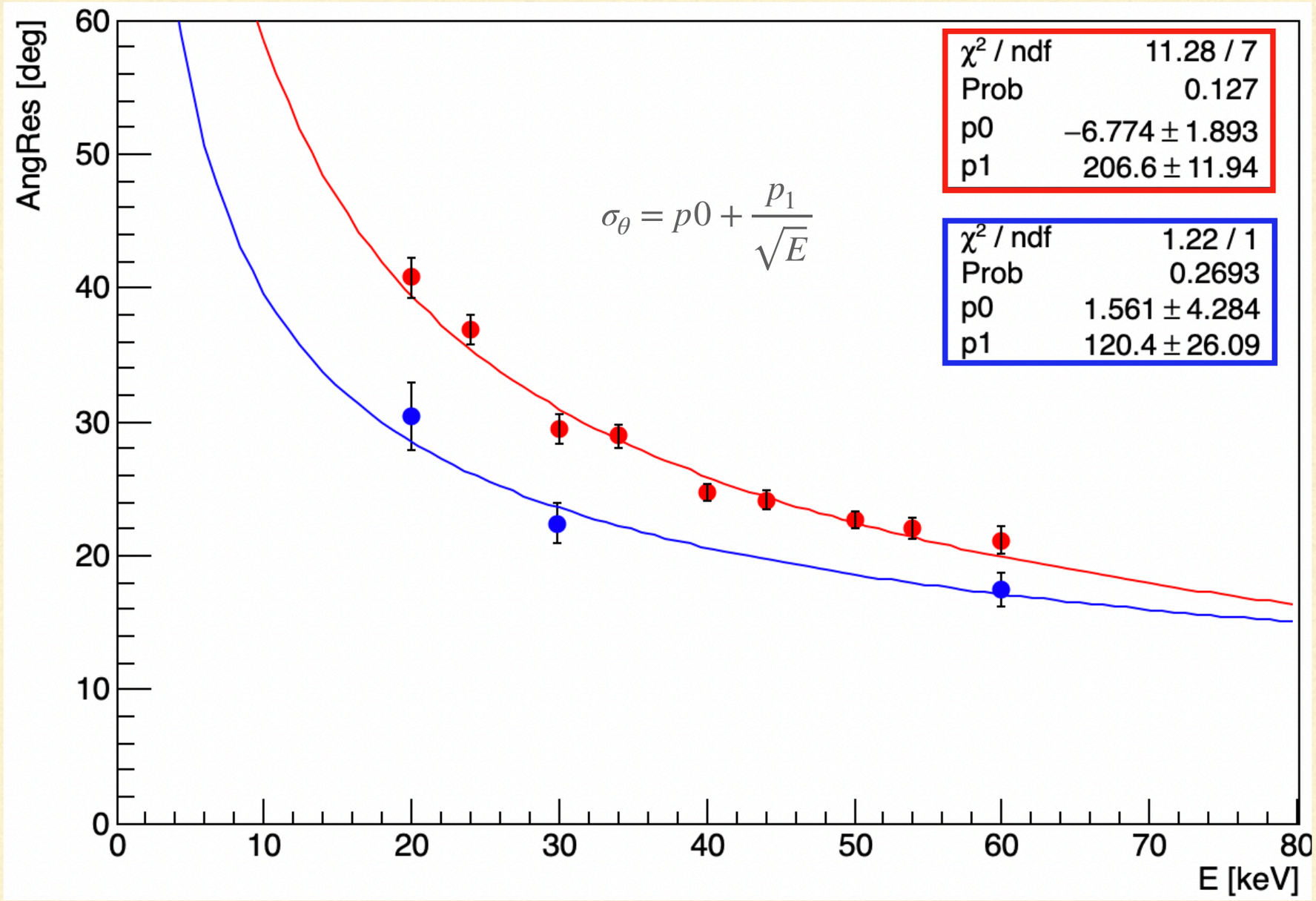
- Two scenarios can be supposed:

1. PMT doesn't help at all with 3D reconstruction: one must use the distribution obtained with 2D and study the feasibility in 2D

2. PMT resolution comparable with the sCMOS one: feasibility study in 3D with the same angular resolution on θ and ϕ

- The truth will be in the middle

Scenario comparison

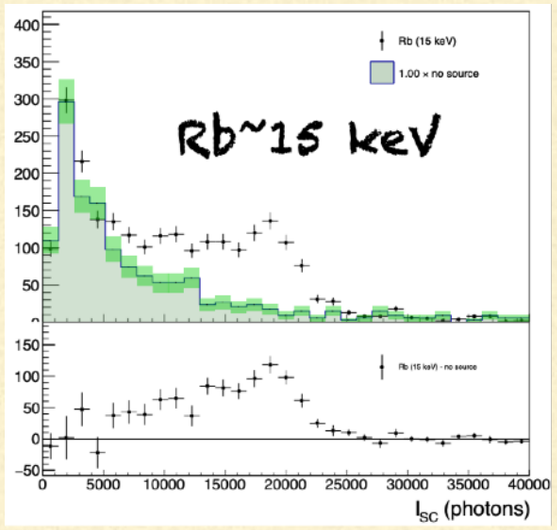


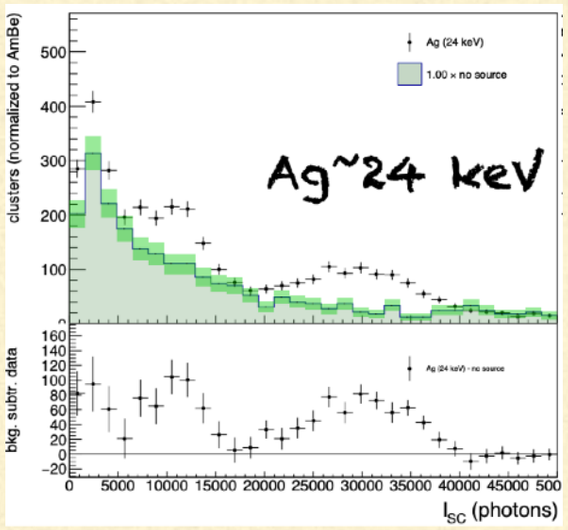
Worst case scenario: Isotropic tracks at random diffusion

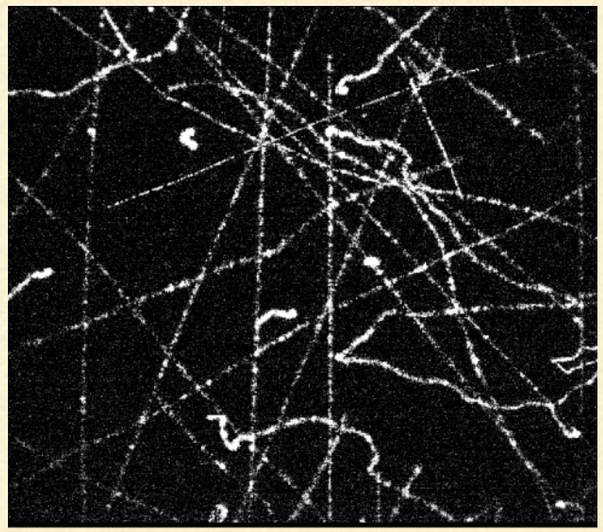
Ideal inclination scenario: Tracks produced along the positive direction of x axis @ 25 cm diffusion

Conclusions and next steps

- Directionality performances have been assessed with completely random track in the whole detector volume
- For completeness purpose the Montecarlo must be validated with a MC-data comparison
  - We have data of multi-energy X-ray (@ 8 keV, 15 keV, 18 keV, 24 keV) on LIME







- In 50l volume of LIME images are full of cosmics, dedicated reconstruction code developed, could be suitable even for directionality purpose