Istituto Nazionale di Fisica Nucleare

Update on low-energy electron reconstruction in CYGNUS

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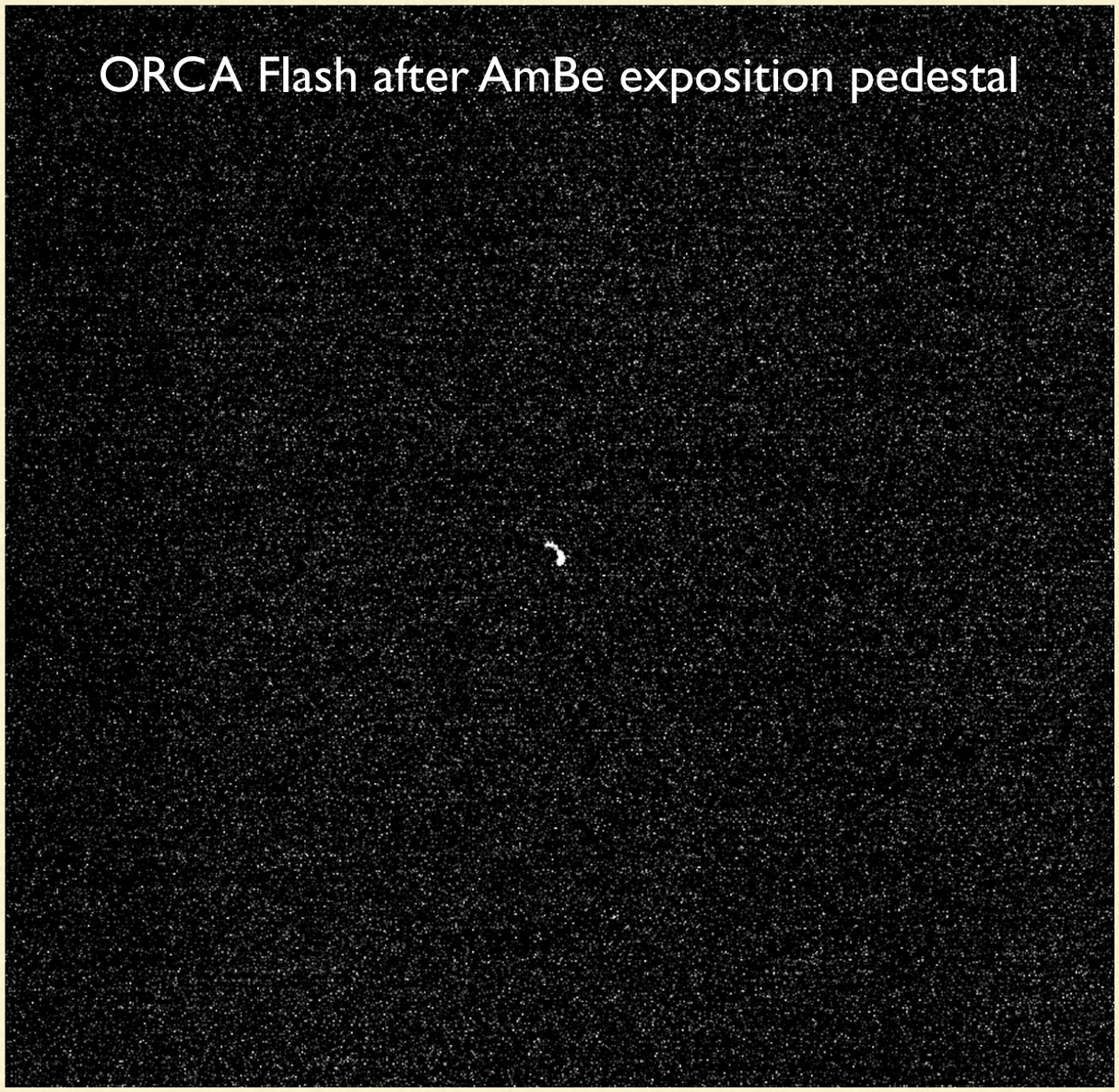
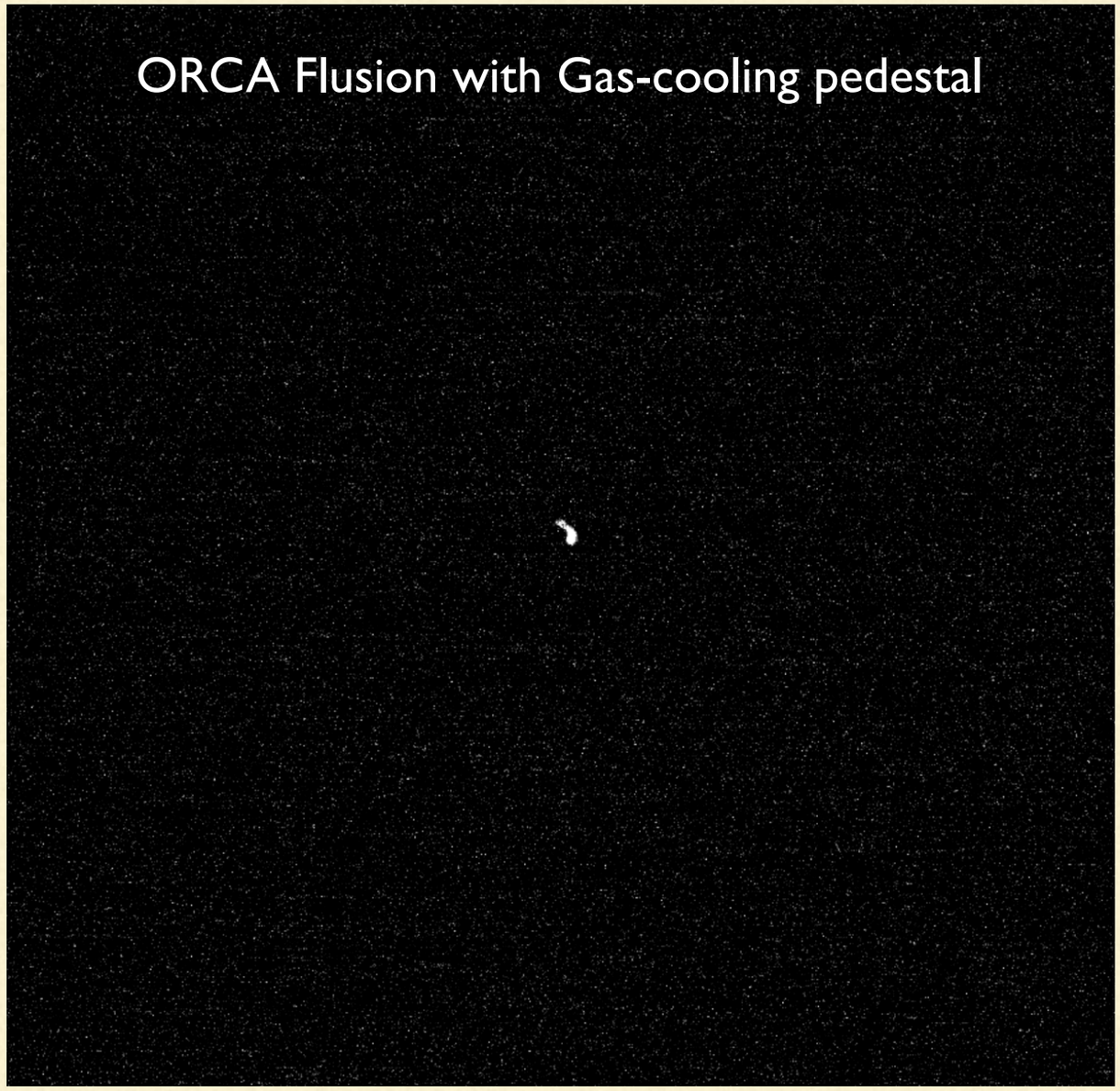
The 3944 and 3797 pedestals





- Redigitization and reconstruction of all dataset used for this study with new pedestal

Parameters used for the digitization

```
'diff_coeff_B'          : 0.0196,       #diffusion parameter [mm/sqrt(cm)]^2
'diff_const_sigma0'     : 0.0784,       # diffusion constant [mm]^2
'z_dim'                 : 350,          #first dimension of the detector
'y_dim'                 : 350,          #second dimension of the detector
'z_pix'                 : 2304,         #number of pixels in the first dimension
'y_pix'                 : 2304,         #number of pixels in the second dimension
'x_gem'                 : 510,          #coordinate of the cam in the simulation (x the is drift direction in geant4 sim) [mm]

'tag'                   : 'Data',
'noiserun'              : 3944,
'Conversion_Factor'     : 3000./6,      #Number of photoelectrons emitted per keV (iron calibration) [LIME has 60% light wrt LEMON]

'ion_pot'               : 0.0462,       #ionization potential for He/CF4 60/40 [keV]
'GEM_gain'              : 123,          #gain in a single GEM foil, value chosen to reproduce the measured light yield in LEMON
'photons_per_el'        : 0.07,         #number of photons per electron produced in the avalanche
'sensor_size'           : 14.976,        #sensor dimension [mm]
'camera_aperture'       : 0.95,

'bckg'                 : True,          #if 'True' background is added
'rootfiles'             : True,         #choose input type: True for G4 root iput, False for SRIM txt files
'events'                : 500,          #number of events to be processed, -1 = all
#'donotremove'           : True,            # Remove or not the file from the tmp folder
}
```

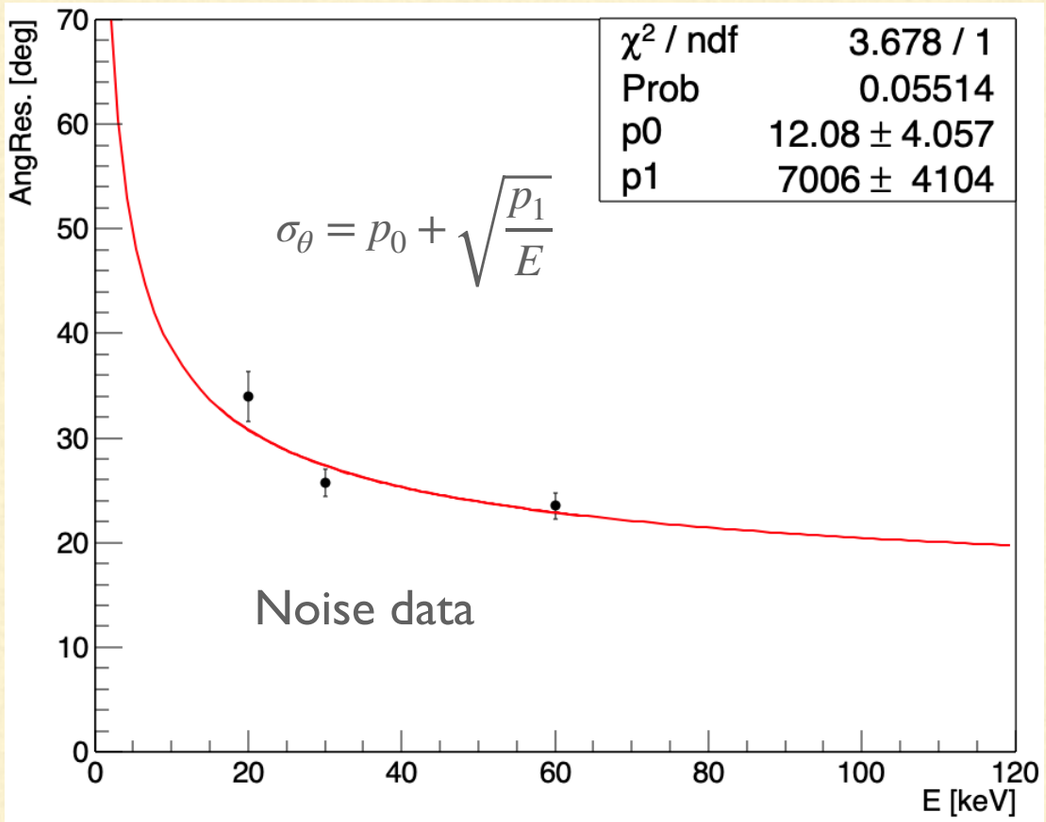
Angular resolution on new data

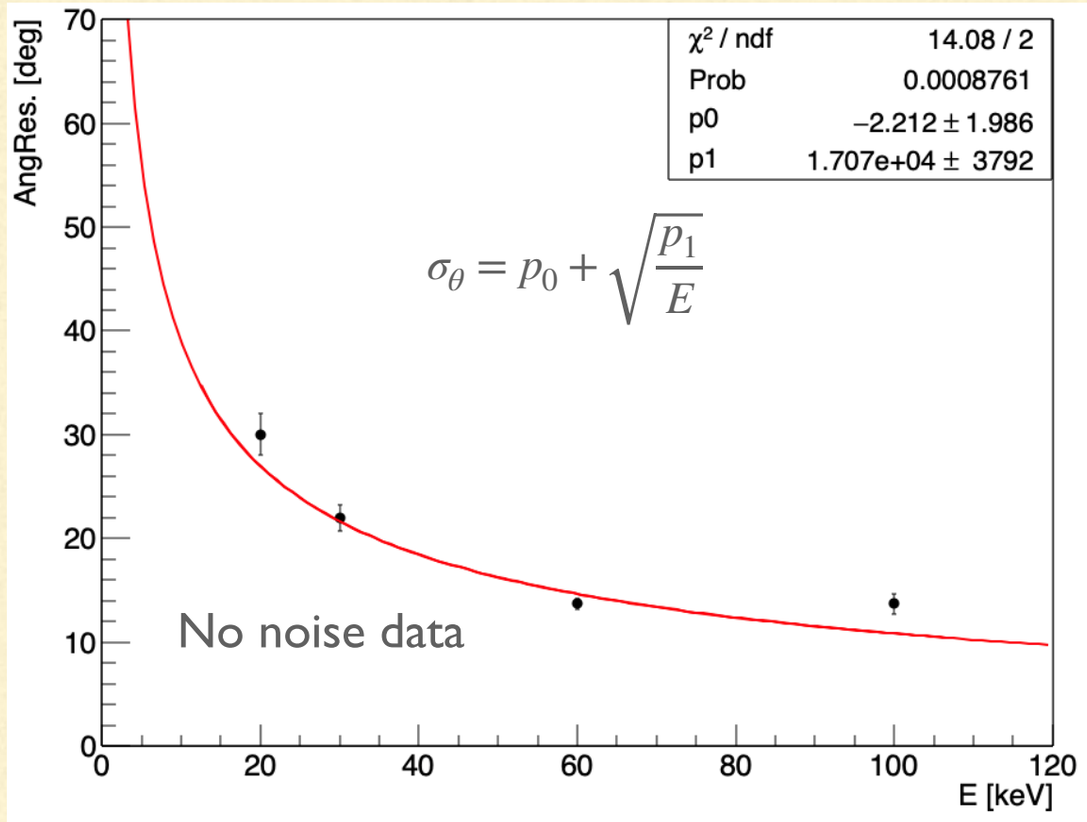
	Noise data		No noise data	
$20\ keV$	$\sigma_\theta = 34.0 \pm 2.4°$	HT=82.2%	$\sigma_\theta = 30.0 \pm 2.0°$	HT=88.8%
$30\ keV$	$\sigma_\theta = 25.7 \pm 1.3°$	HT=86.2%	$\sigma_\theta = 22.0 \pm 1.26°$	HT=89.0%
$60\ keV$	$\sigma_\theta = 23.5 \pm 1.2°$	HT=81.0%	$\sigma_\theta = 13.7 \pm 0.5°$	HT=91.1%
$100\ keV$			$\sigma_\theta = 13.8 \pm 1.0°$	HT=85.7%
$0\ cm$	$\sigma_\theta = 16.4 \pm 0.7°$	HT=88.6%	$\sigma_\theta = 13.3 \pm 0.7°$	HT=90.4%
$10\ cm$	$\sigma_\theta = 21.9 \pm 1.3°$	HT=86.8%	$\sigma_\theta = 16.6 \pm 0.7°$	HT=88.8%
$25\ cm$	$\sigma_\theta = 25.7 \pm 1.3°$	HT=86.2%	$\sigma_\theta = 22.0 \pm 1.2°$	HT=89.0%
$40\ cm$	$\sigma_\theta = 30.3 \pm 1.5°$	HT=86.4%	$\sigma_\theta = 25.8 \pm 1.1°$	HT=88.4%

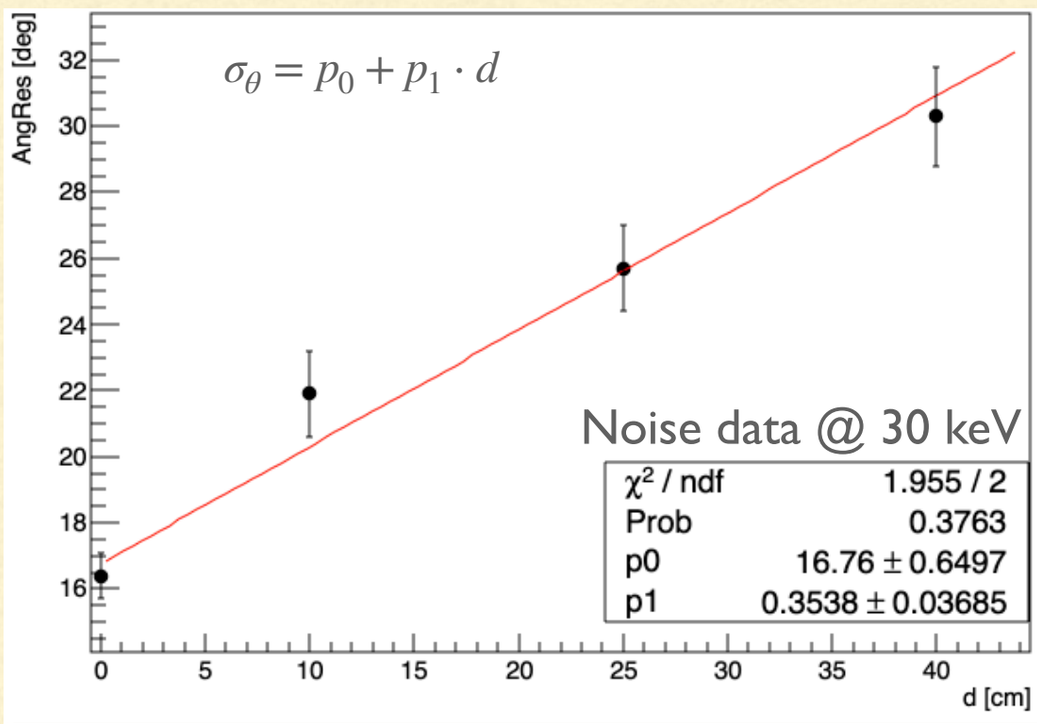
Worse due to: same pixel size, but larger sensor dimension → Less granularity

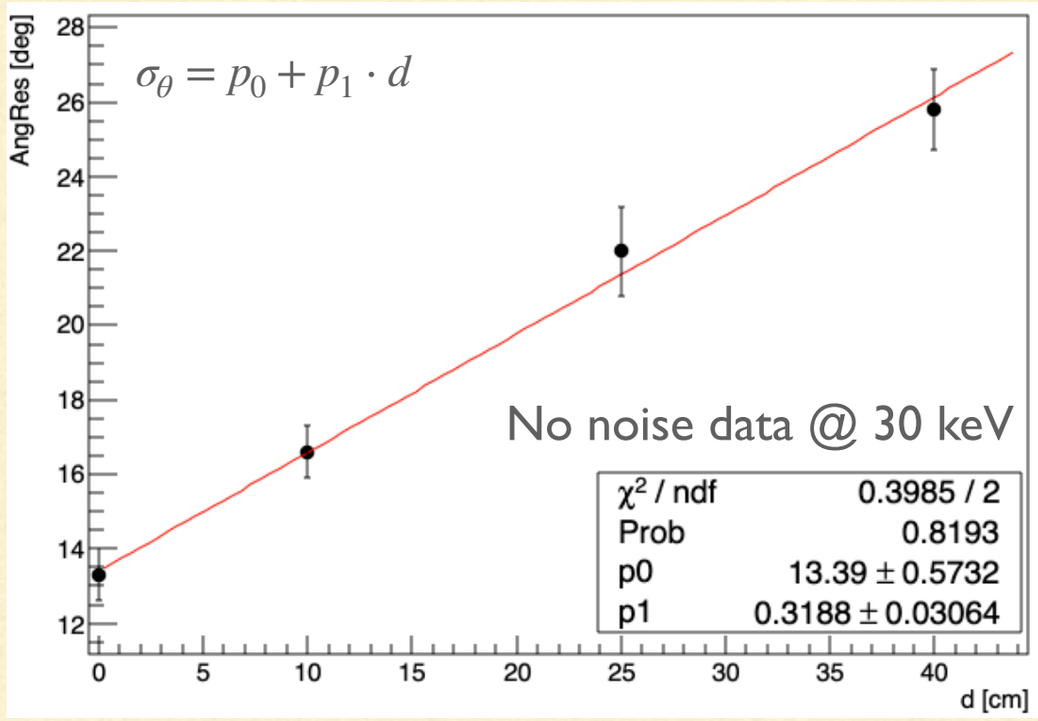
Scaling of the data consistent vs energy and vs drift distance - HT>80% in all cases

Angular resolution on new data







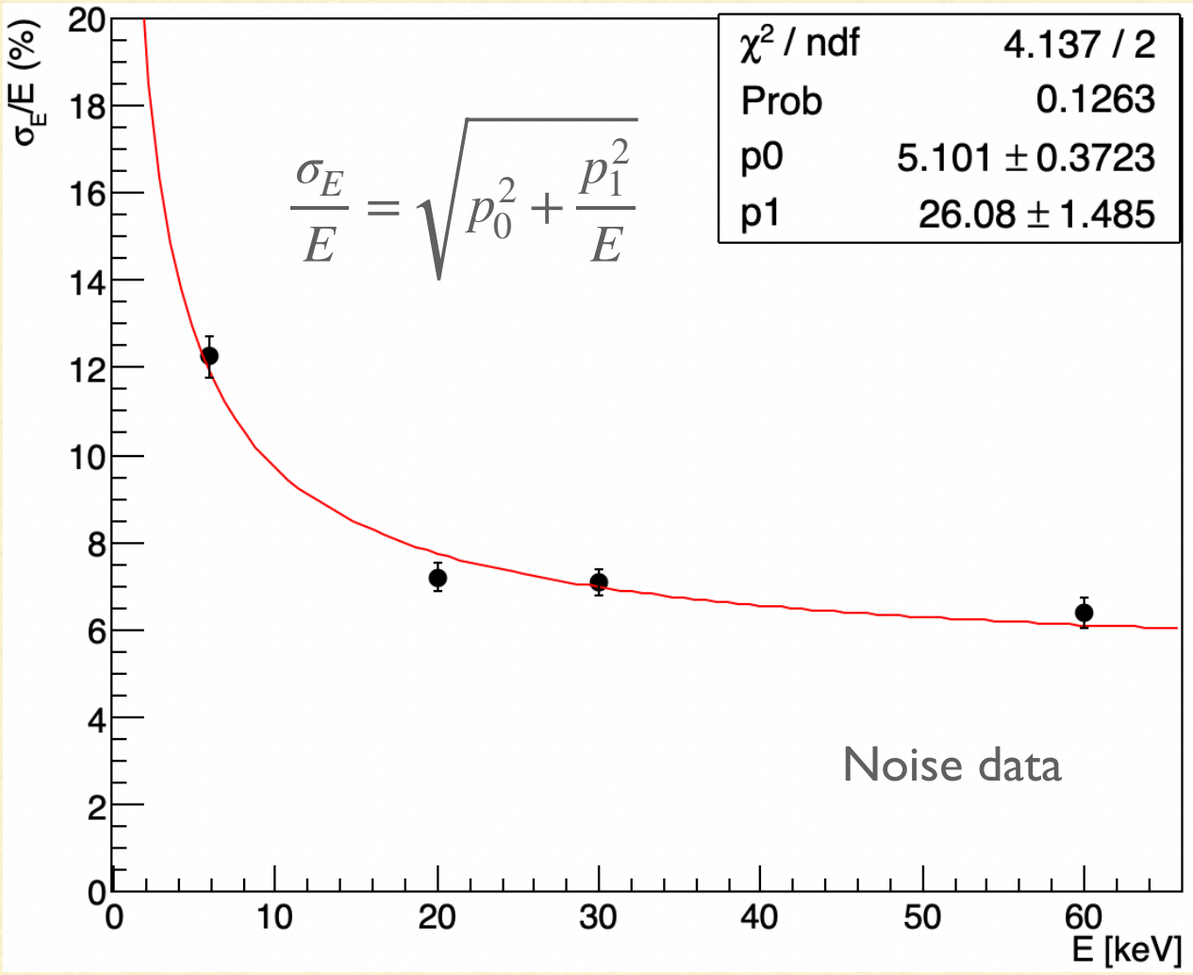


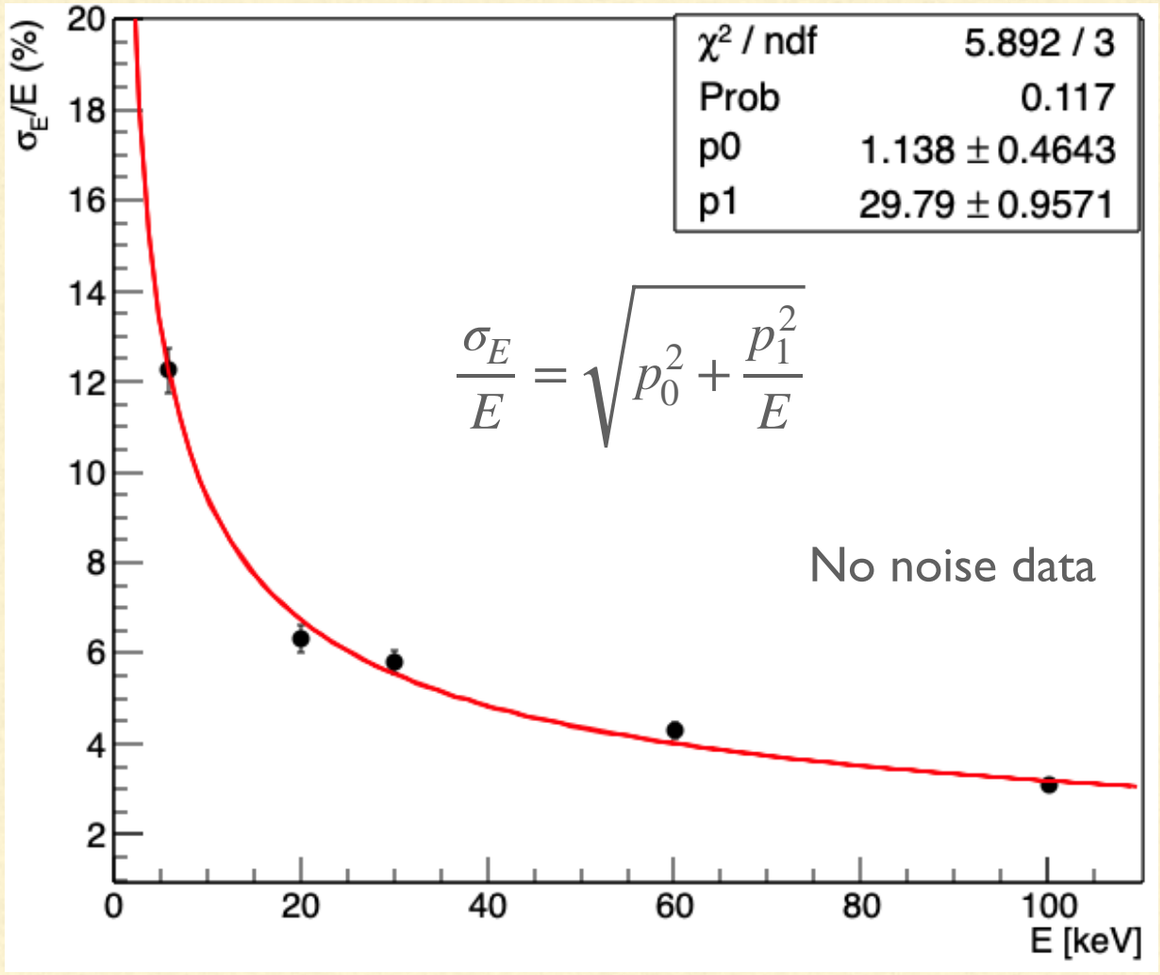
IP resolution on new data

	Data with noise	Data without noise
$20\ keV$	$\sigma_x = (0.548 \pm 0.022)mm$ $\sigma_y = (0.69 \pm 0.03)mm$	$\sigma_x = (0.46 \pm 0.03)mm$ $\sigma_y = (0.797 \pm 0.025)mm$
$30\ keV$	$\sigma_x = (0.99 \pm 0.04)mm$ $\sigma_y = (0.70 \pm 0.05)mm$	$\sigma_x = (0.462 \pm 0.018)mm$ $\sigma_y = (0.68 \pm 0.03)mm$
$60\ keV$	$\sigma_x = (1.56 \pm 0.08)mm$ $\sigma_y = (0.64 \pm 0.03)mm$	$\sigma_x = (0.592 \pm 0.028)mm$ $\sigma_y = (0.324 \pm 0.020)mm$
$100\ keV$		$\sigma_x = (0.67 \pm 0.03)mm$ $\sigma_y = (0.360 \pm 0.025)mm$
$0\ cm$	$\sigma_x = (0.451 \pm 0.020)mm$ $\sigma_y = (0.164 \pm 0.009)mm$	$\sigma_x = (0.267 \pm 0.010)mm$ $\sigma_y = (0.093 \pm 0.006)mm$
$10\ cm$	$\sigma_x = (0.77 \pm 0.04)mm$ $\sigma_y = (0.47 \pm 0.03)mm$	$\sigma_x = (0.421 \pm 0.018)mm$ $\sigma_y = (0.182 \pm 0.012)mm$
$25\ cm$	$\sigma_x = (0.99 \pm 0.04)mm$ $\sigma_y = (0.70 \pm 0.05)mm$	$\sigma_x = (0.462 \pm 0.018)mm$ $\sigma_y = (0.68 \pm 0.03)mm$
$40\ cm$	$\sigma_x = (0.82 \pm 0.04)mm$ $\sigma_y = (0.62 \pm 0.04)mm$	$\sigma_x = (0.526 \pm 0.025)mm$ $\sigma_y = (0.704 \pm 0.024)mm$

Slightly worse than before due to less granularity (still less than $1\ mm$)

Energy resolution of simulated data



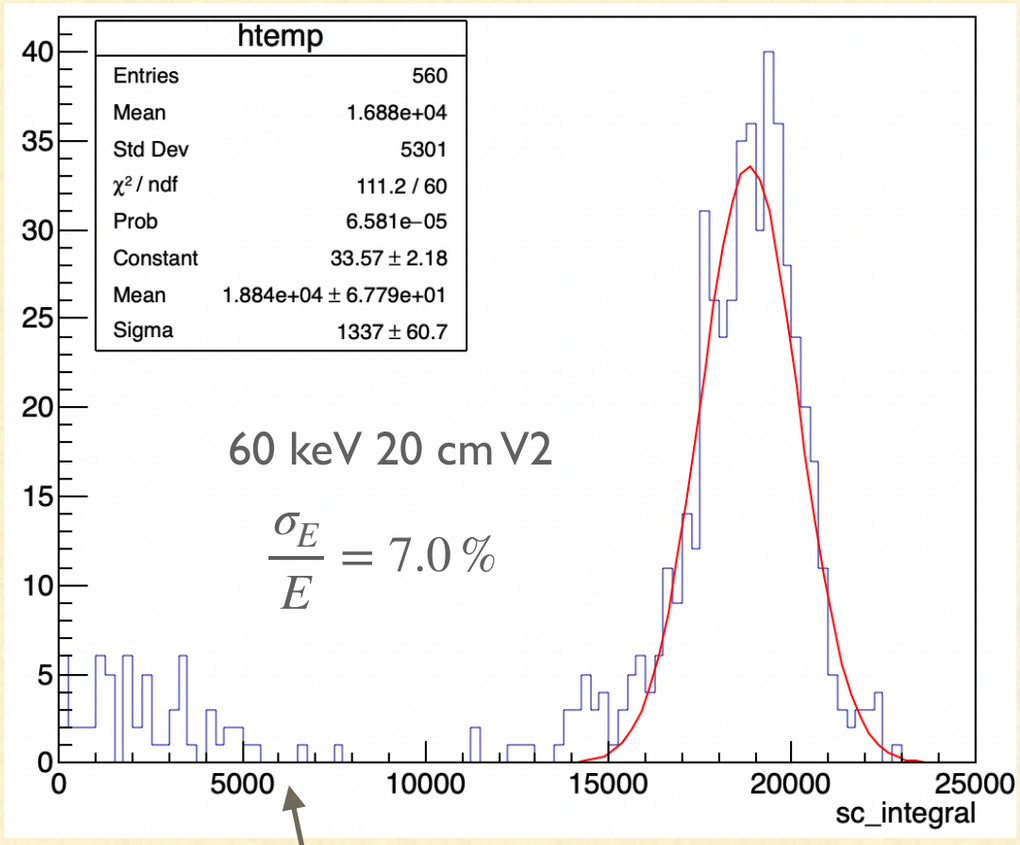


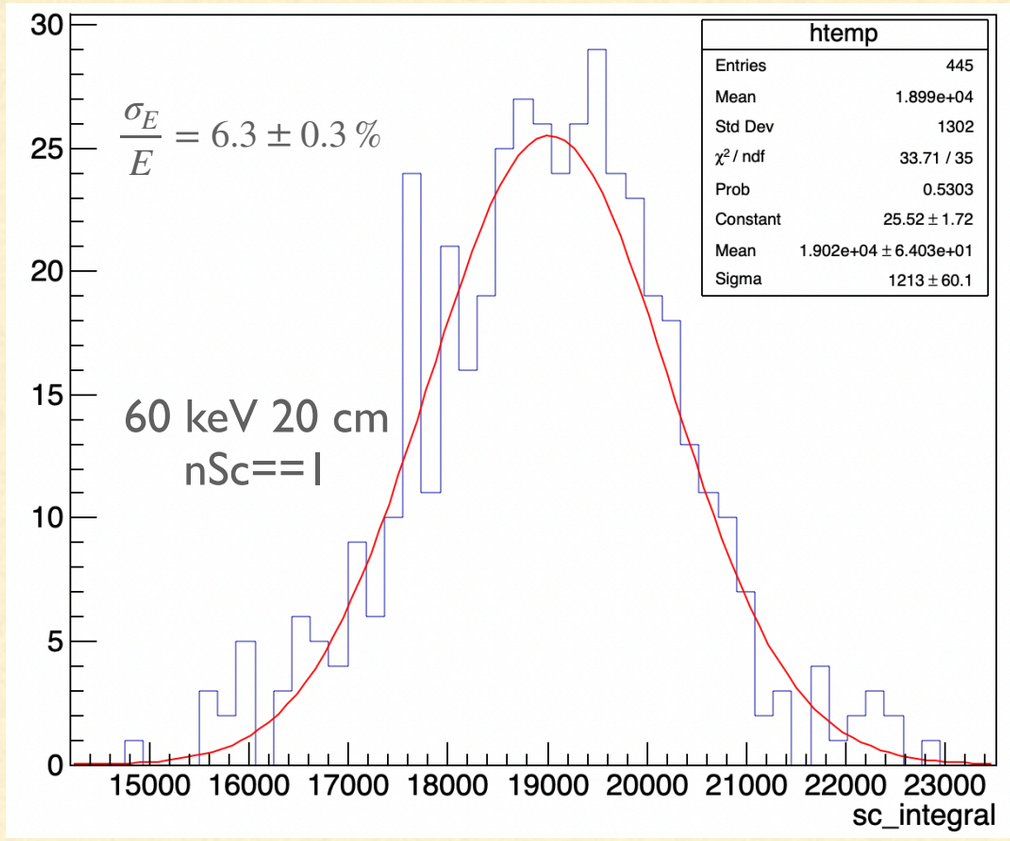
- Energy resolution behaviour vs E consistent with what we expect
- Flat at 30 keV as a function of the distance in data with and without noise

	Dist	Res	Err. Res
Noise	30 keV 0 cm	6,54	0,27
	30 keV 10 cm	6,26	0,30
	30 keV 25 cm	7,08	0,30
	30 keV 40 cm	6,79	0,29

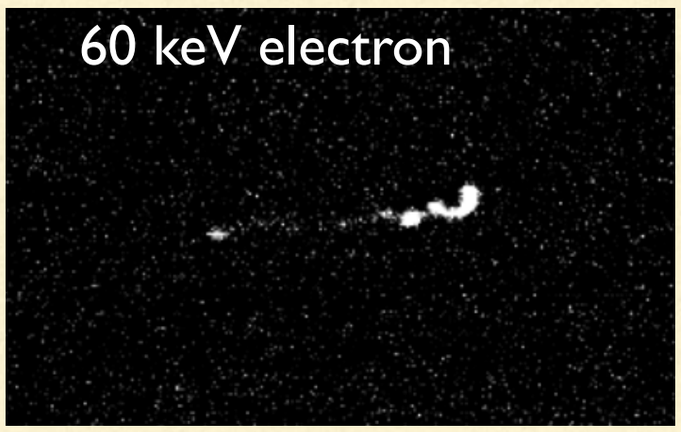
	Dist	Res	Err. Res
No noise	30 keV 0 cm	6,24	0,33
	30 keV 10 cm	5,33	0,31
	30 keV 25 cm	5,79	0,26
	30 keV 40 cm	5,18	0,26

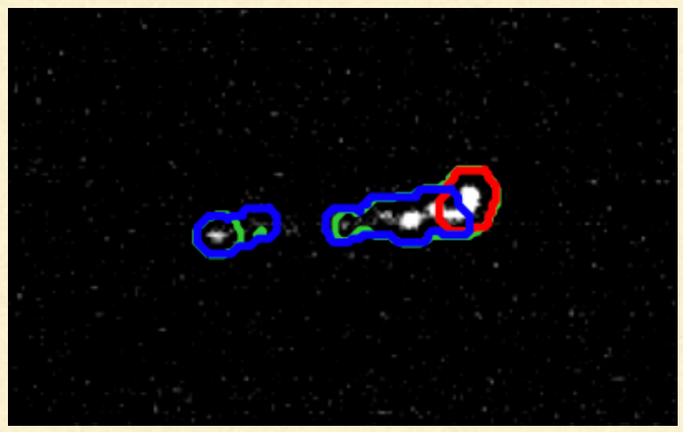
Not perfect track reconstruction





Some tracks not well reconstructed but a selection can be done





Conclusions

- Tracks has been successfully digitized and reconstructed
- Scaling of angular resolution as a function of the energy and the drift distance is consistent
- Impact point determination resolution below 1 mm
- The energy resolution scaling is consistent and compatible with energy resolution expected @ $6\ keV$