Samples for IDAO

Samples for IDAO

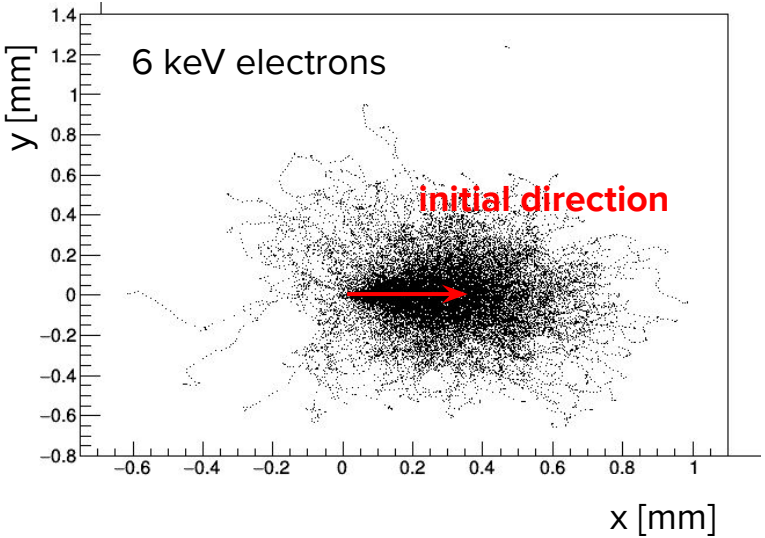
- First step simulation (not for IDAO)
  - MC-truth simulations with GEANT/SRIM (for electron/nuclear recoils) of the particles interactions in gas
    ➔ contain info of position and energy released for each interaction (x,y,z,dE)

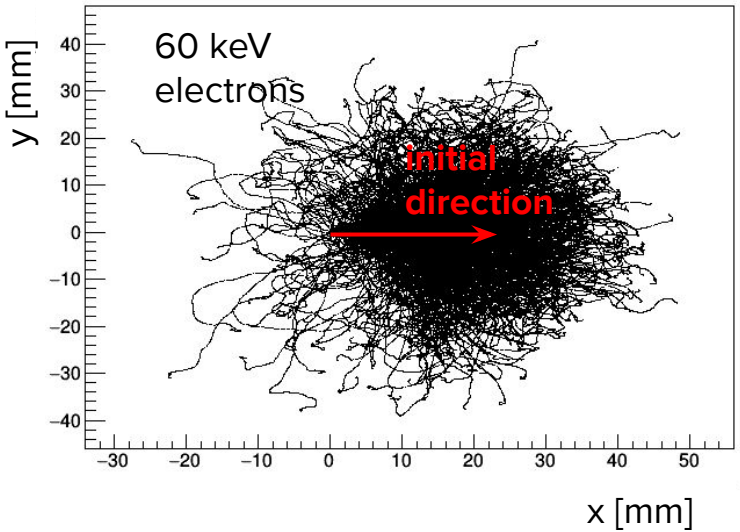
- For IDAO:
  - “Digitized” simulations of **signal only,** for electron recoils (ER) and nuclear recoils (NR): include detector effects like diffusion and GEM gain fluctuations
    ➔ chosen values: drift field E_drift = 930 V, distance from GEM d_GEM = 30 cm
  - Final images: **Signal + camera noise**

- Format of images: ROOT TH2 histograms

Geant4/SRIM simulation

- ER simulated with Geant4
- He NR simulated with SRIM
- 1000 events starting from the center
- Energies 1, 3, 6, 10, 30 keV
- Initial direction (1,0,0)

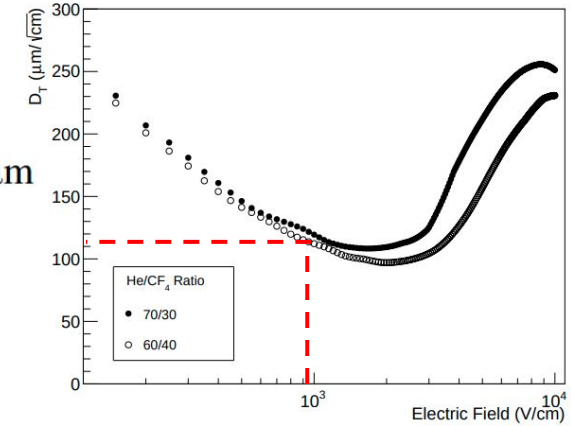




Digitization parameters

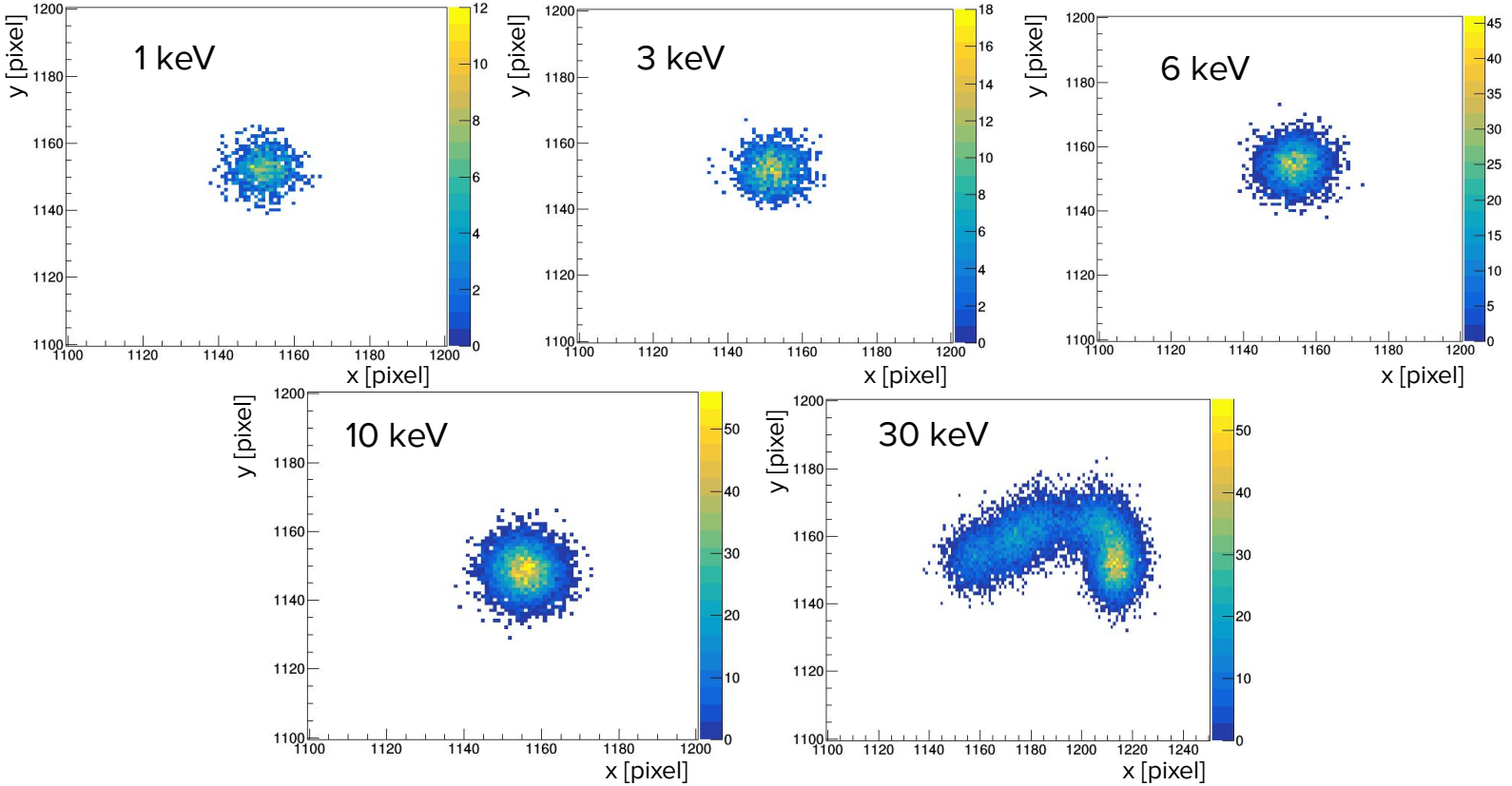
- Transverse diffusion from https://arxiv.org/abs/2007.00608 for an electric field of 0.93 kV/cm

$$\sigma_T = \sqrt{\sigma_{T0}^2 \oplus D_T^2 \cdot z} \qquad D_T^{60/40} = 115 \ \frac{\mu m}{\sqrt{cm}} \qquad \sigma_{T0}^{60/40} = (280 \pm 60)\ \mu m$$

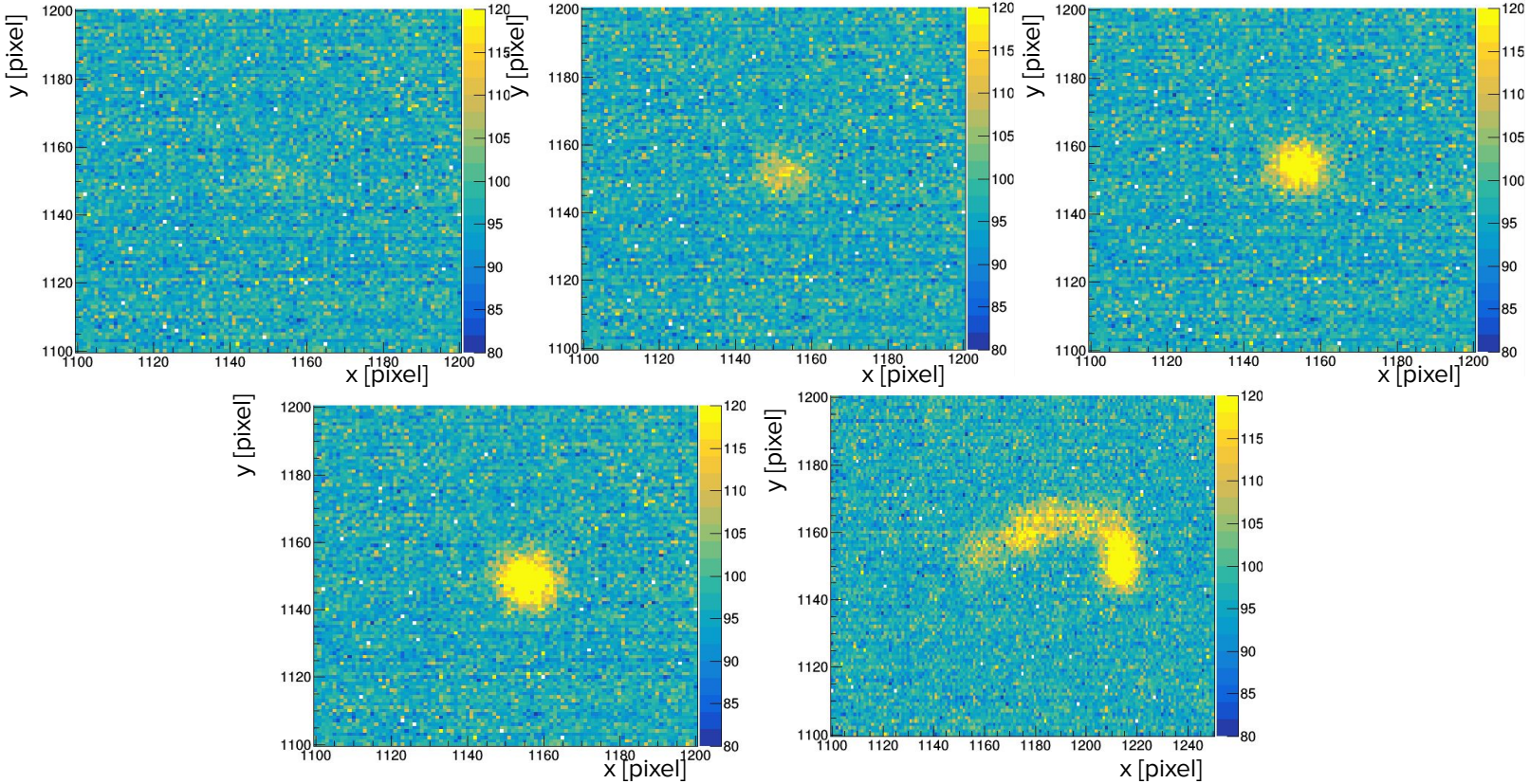


- Active area: 35 cm x 35 cm
- ORCA Fusion:
  - 2304 x 2304 pixels (1 pixel 6.5 um x 6.5 um)
  - Camera aperture 0.95
  - Sensor size 14.976 mm Orca Fusion
- Ionization potential: 46.2 eV (Garfield simulations 42-49 eV)
- Single GEM gain: 123 (see IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 65, NO. 1, JANUARY 2018)
- light yield: 0.07 photons/electrons
- Sensor calibration ➔ 1 photon = 0.5 sensor counts
- Distance from the GEM: 30 cm

Digitized ER images (no camera noise)

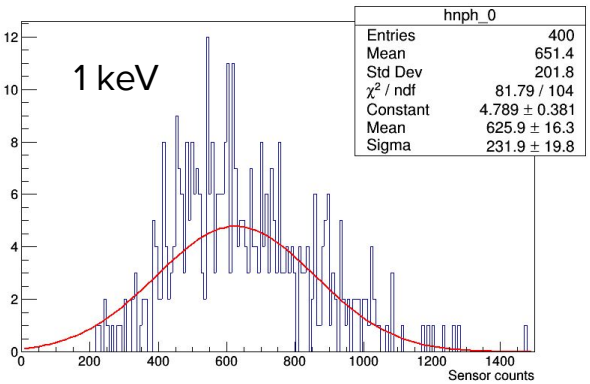


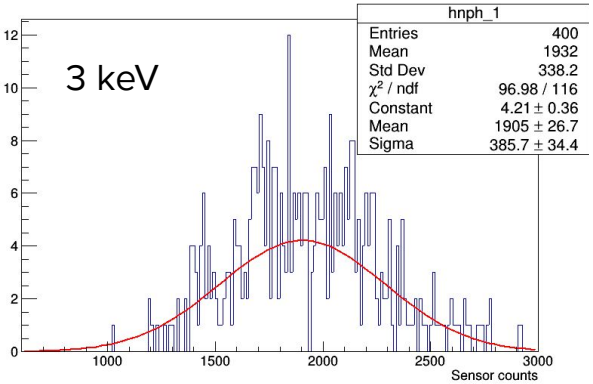
Digitized ER images (with camera noise)

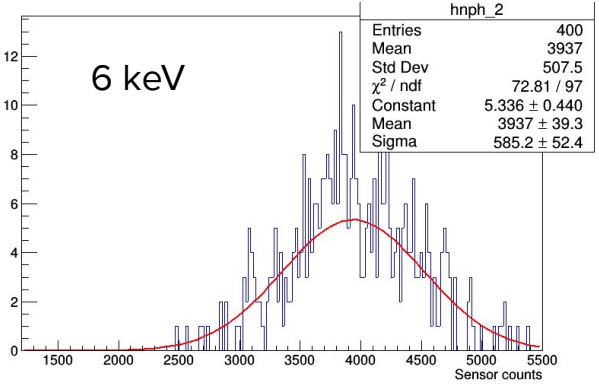


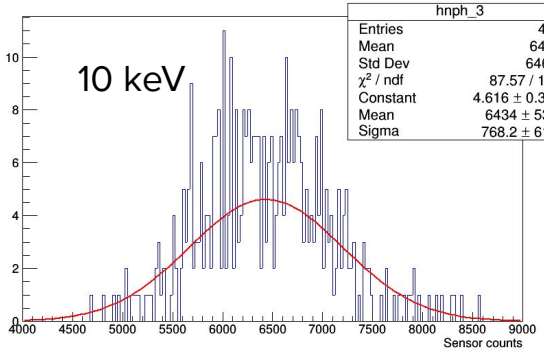
Sensor counts distributions

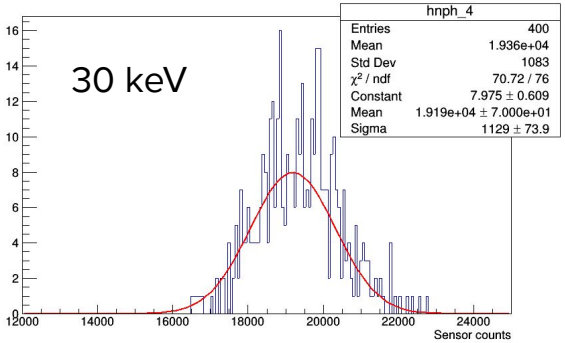
Energy resolution is dominated by gain fluctuations





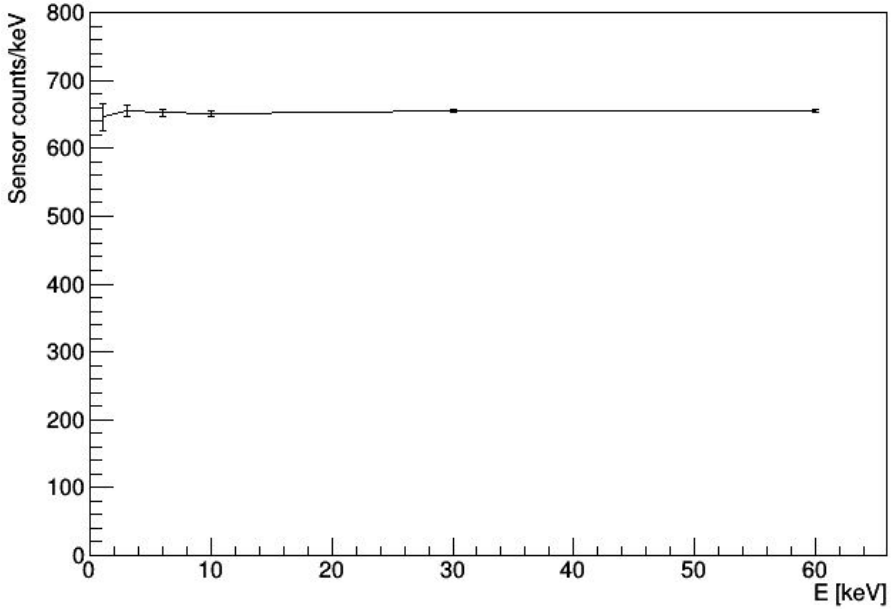


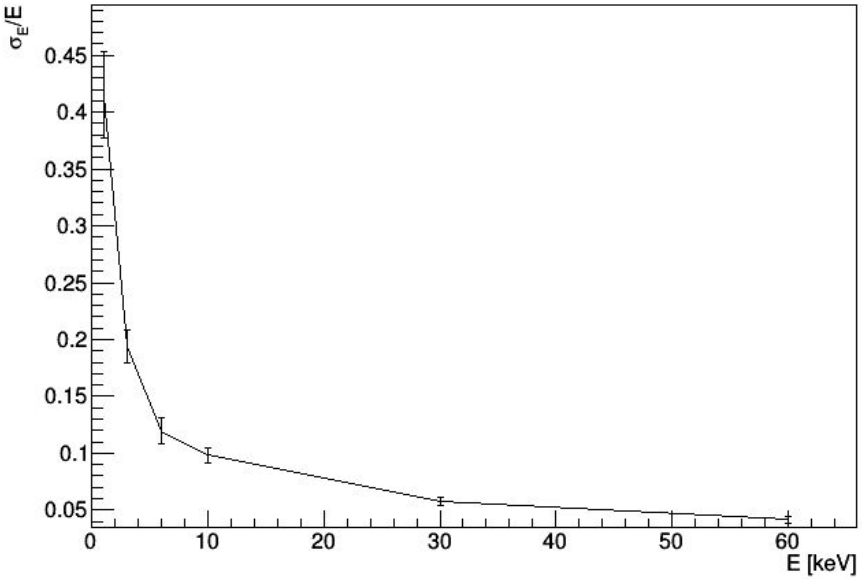




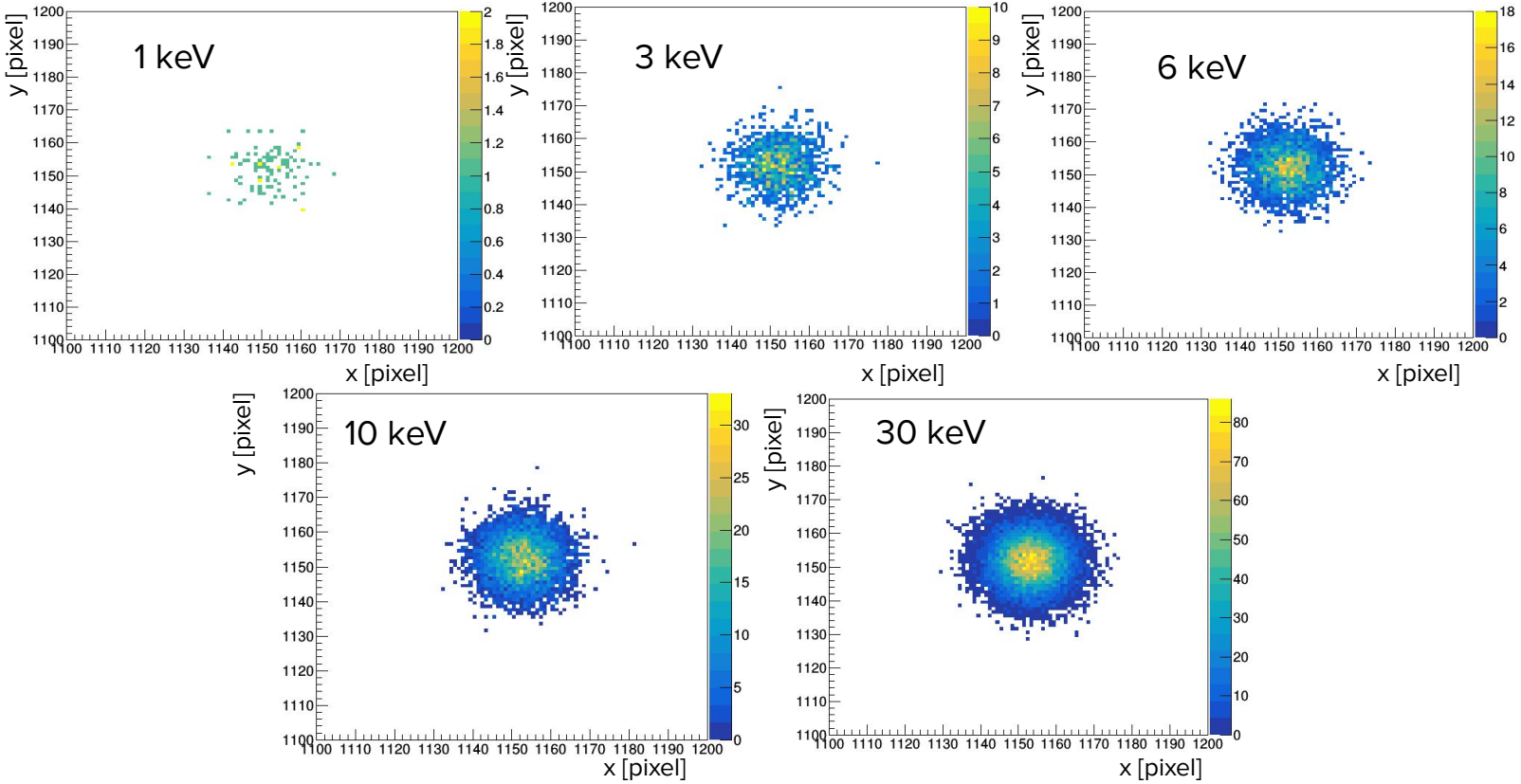
Light yield and energy resolution vs energy

- “Light yield” : average ~650 counts/keV
- Energy resolution ~40% at 1 keV, decreasing to 5% at 30 keV

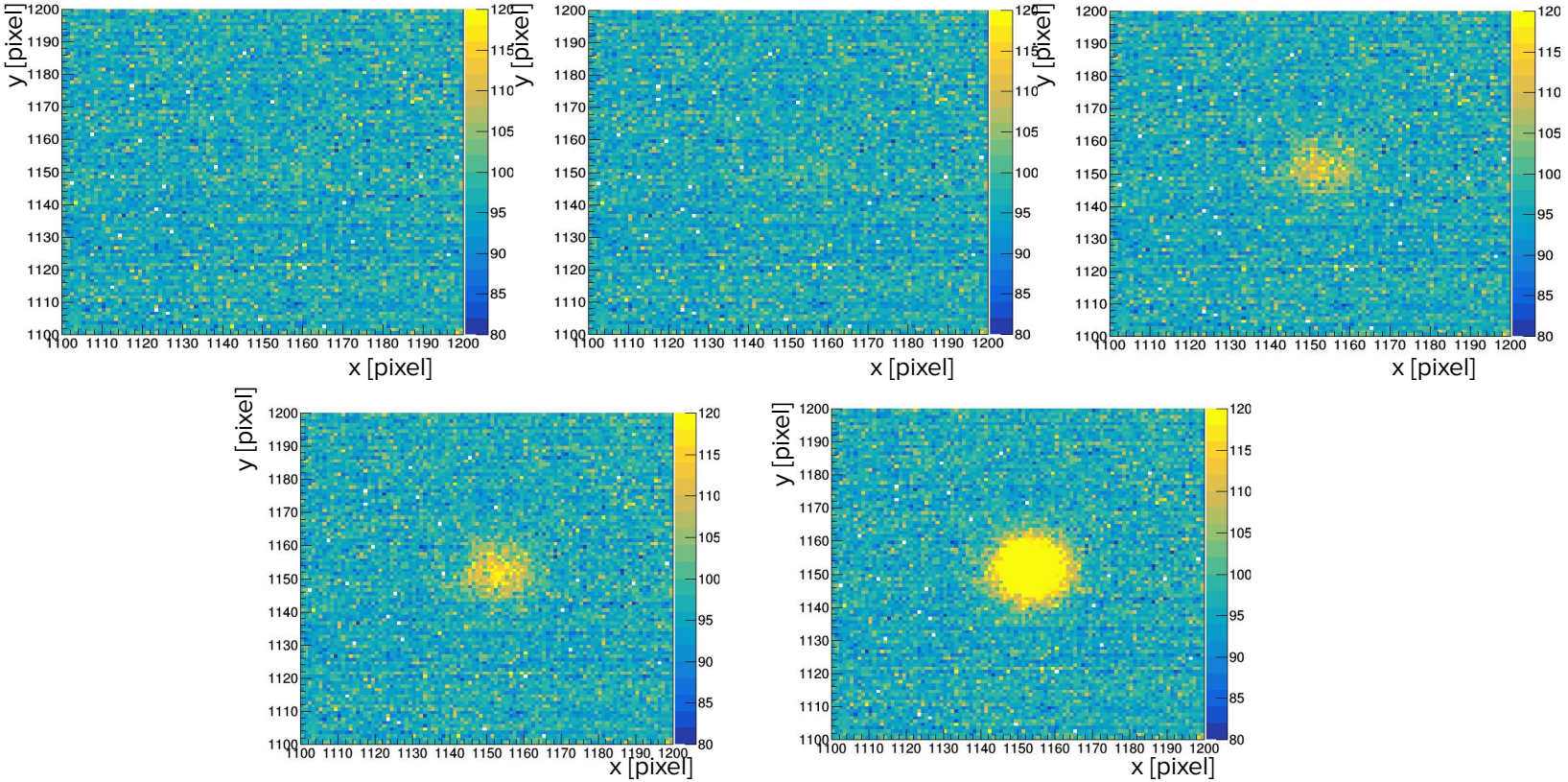




Digitized He NR images (no camera noise)



Digitized He NR images (with camera noise)



Light yield and energy resolution for He NR

- “Light yield” is lower for NR because of the “quenching factor” (QF): not all energy is converted in light. Note that QF is a function of ion energy ➜ light yield is function of energy
- Energy resolution is higher for the NR due to lower light yield