SAPIENZA
UNIVERSITÀ DI ROMA

Studio del segnale di una TPC a lettura ottica per la ricerca di Dark Matter

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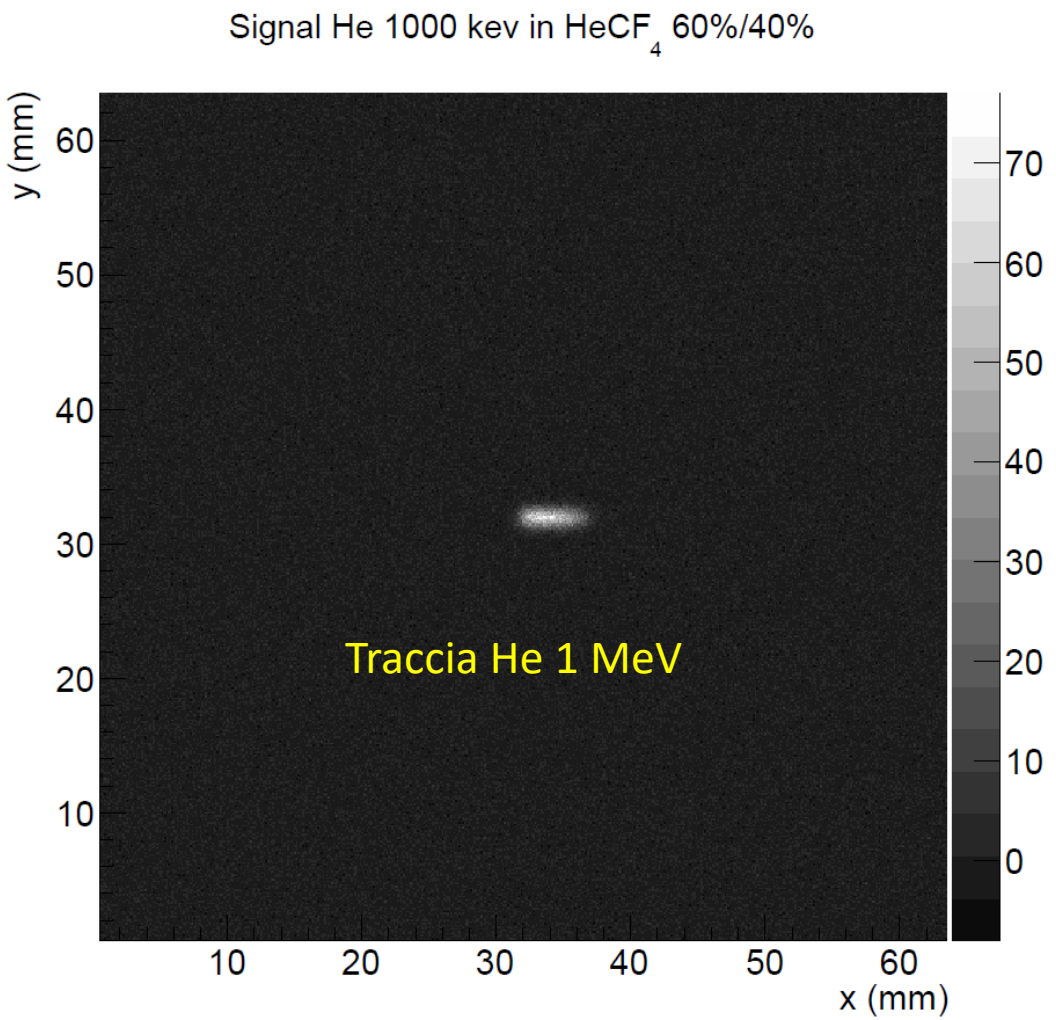
Relatore: Dott. Davide Pinci

Signal simulation

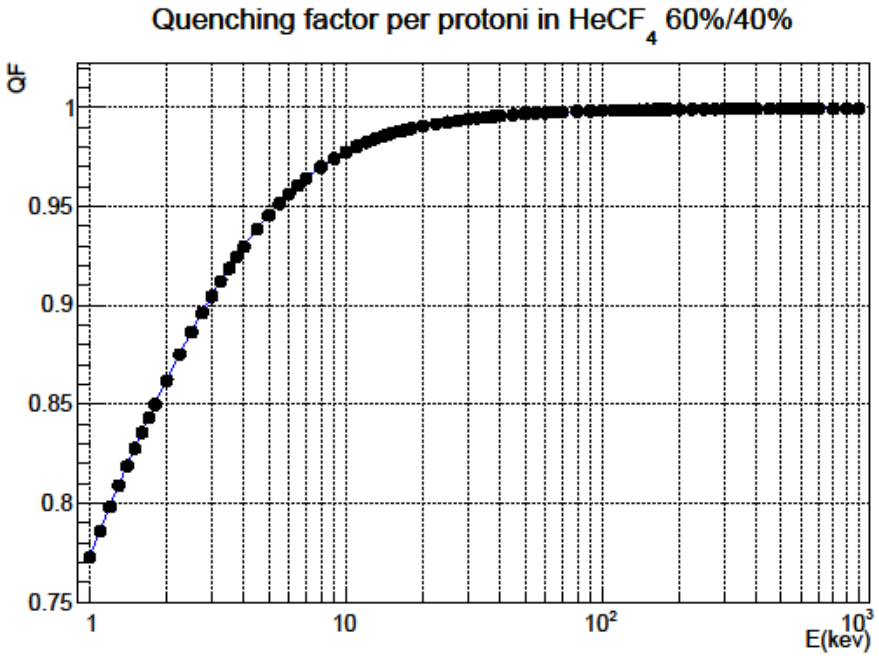


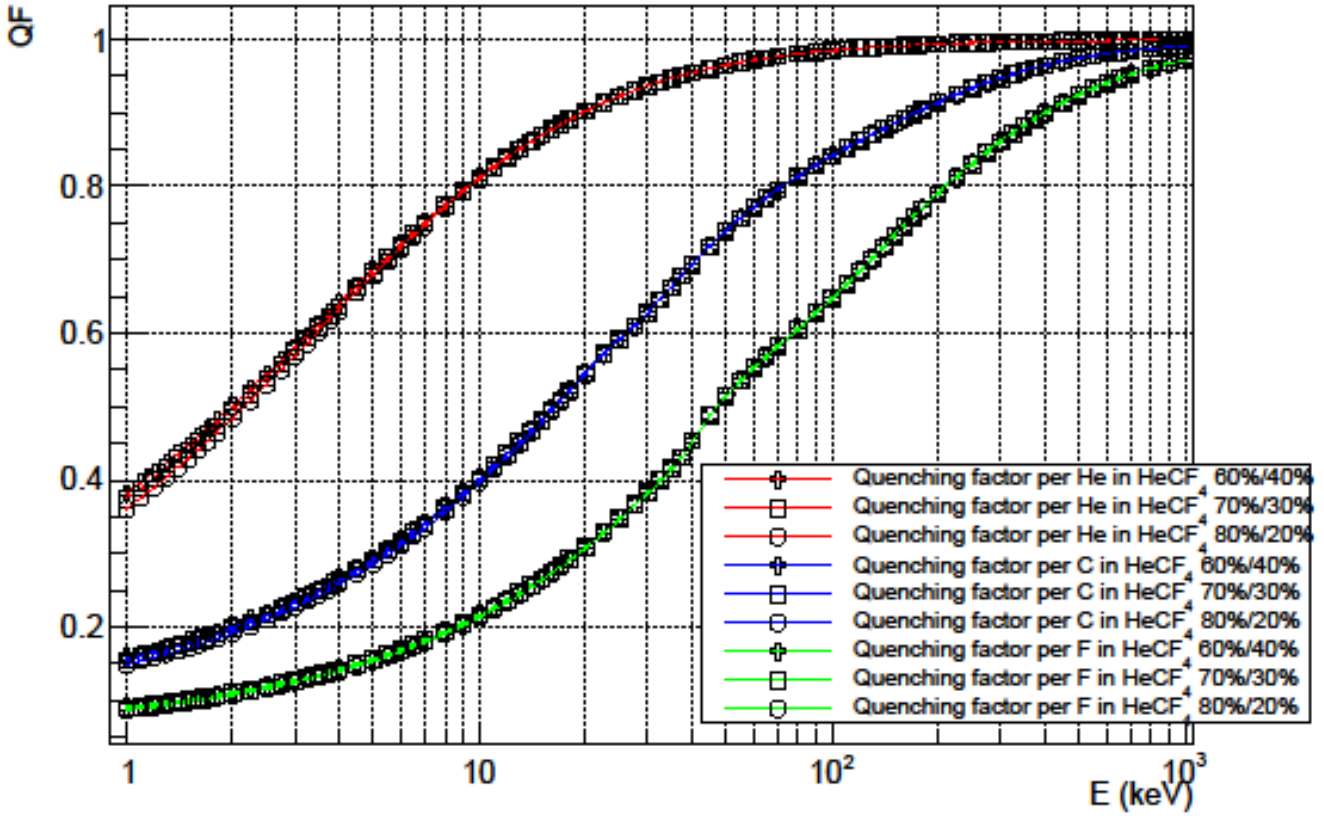
We simulated signals by using:

- SRIM:
  - energy loss
  - Range
  - straggling
- Garfield:
  - drift velocity
  - attachment
  - diffusion
- Light yield from experiment

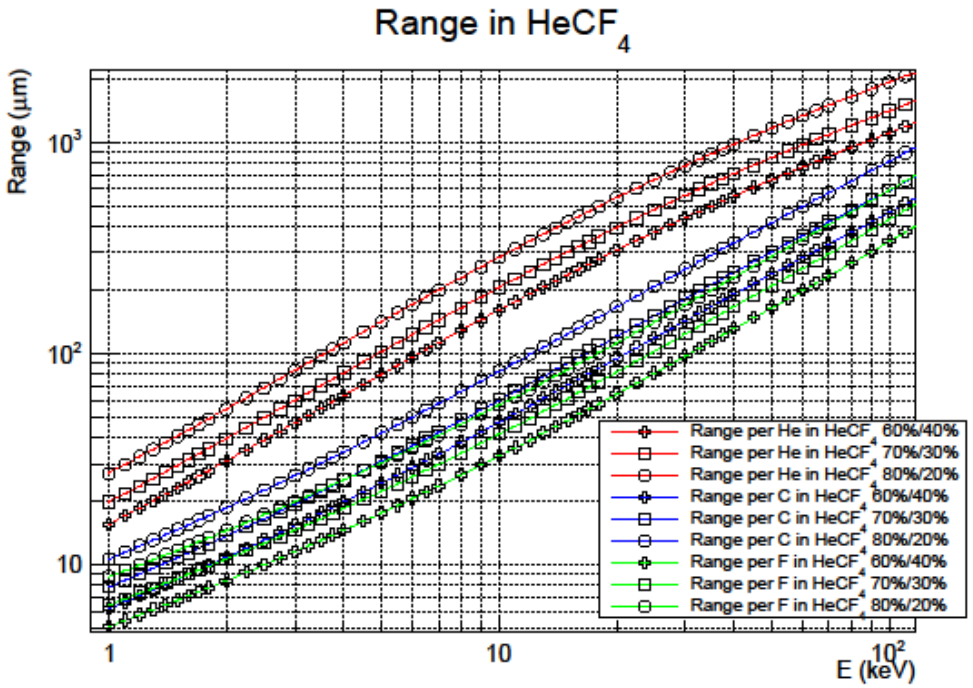
Quenching Factor

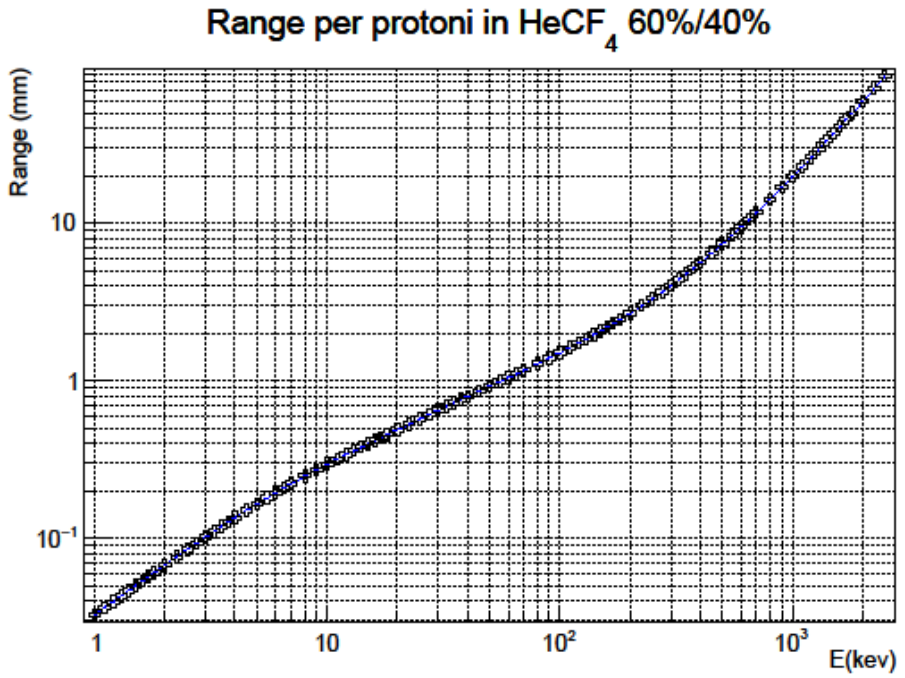
$$QF = \frac{\left(\frac{dE}{dx}\right)_{ion}}{\left(\frac{dE}{dx}\right)_{ion} + \left(\frac{dE}{dx}\right)_{rec}}$$



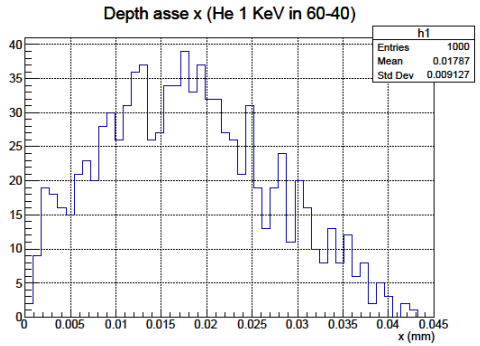


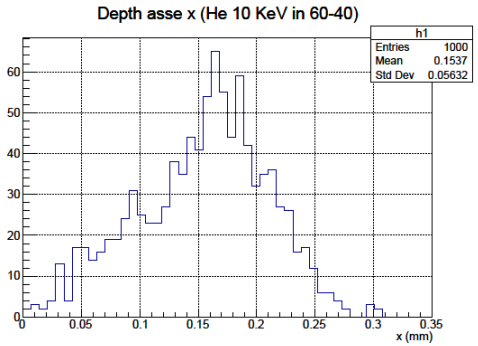
Range

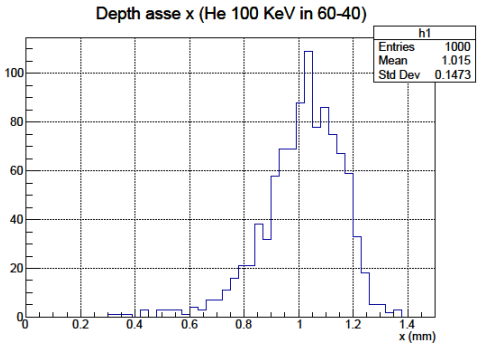




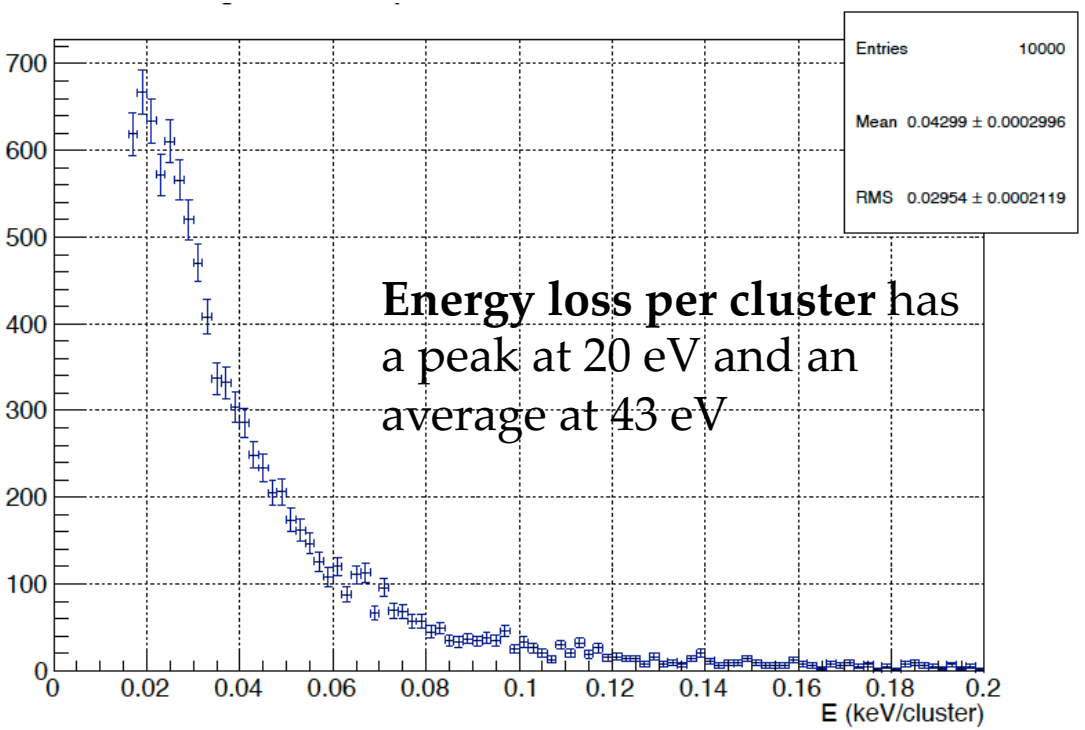
Helium from 1 to 100 keV has range from tens of μm up to millemetres.



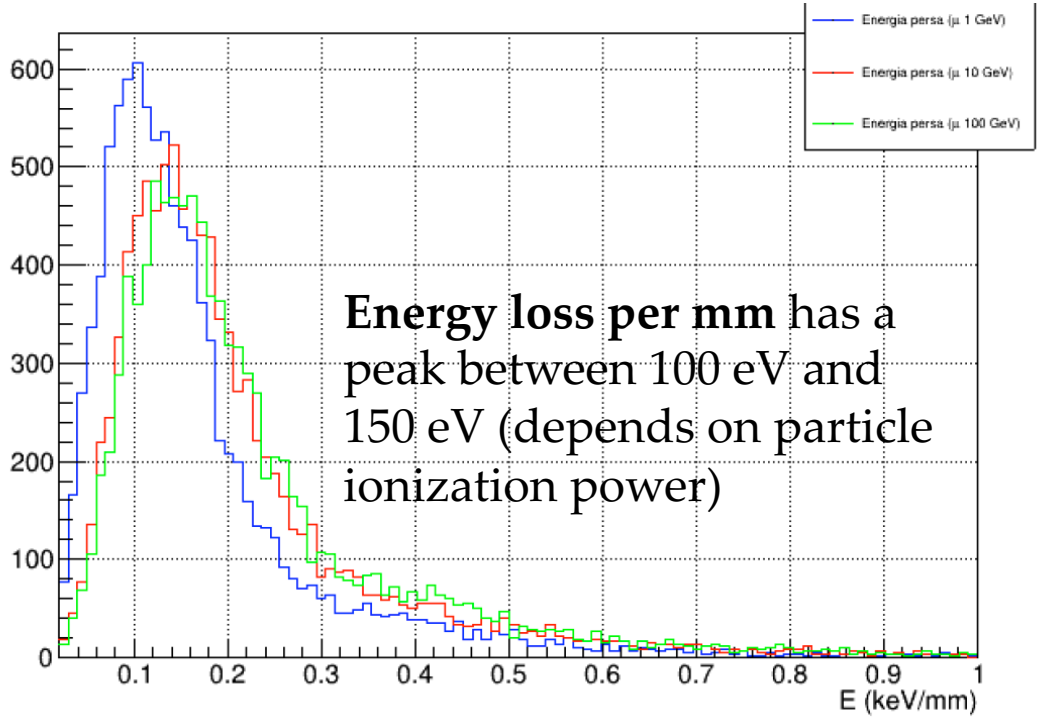




Gas ionization



Energy loss per cluster has a peak at 20 eV and an average at 43 eV

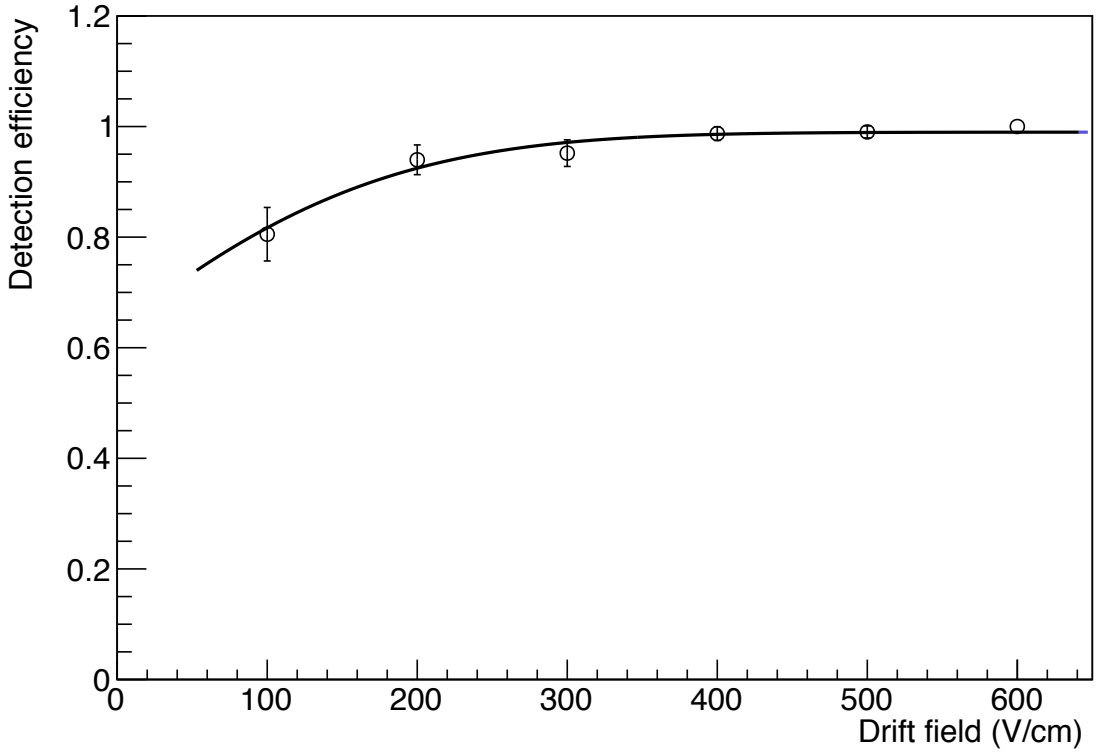


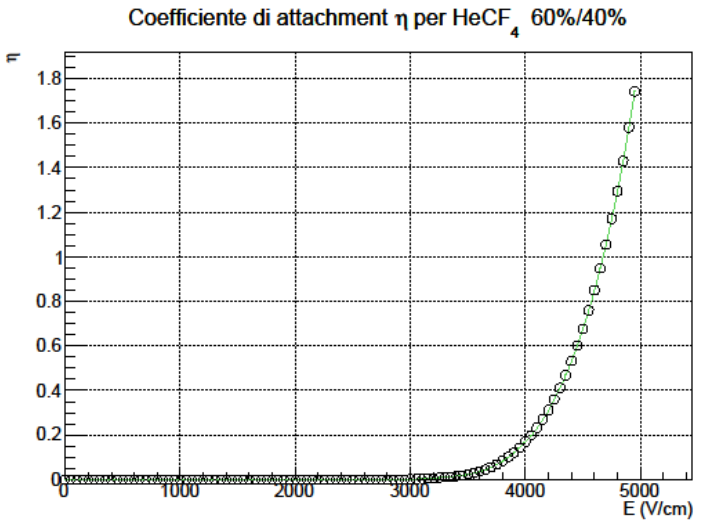
Energy loss per mm has a peak between 100 eV and 150 eV (depends on particle ionization power)

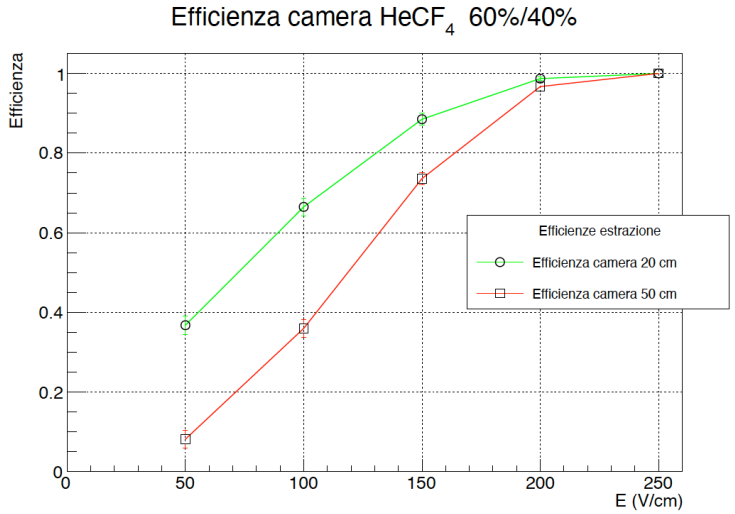
Number of electrons per cluster is in average 3

Attachment coefficient

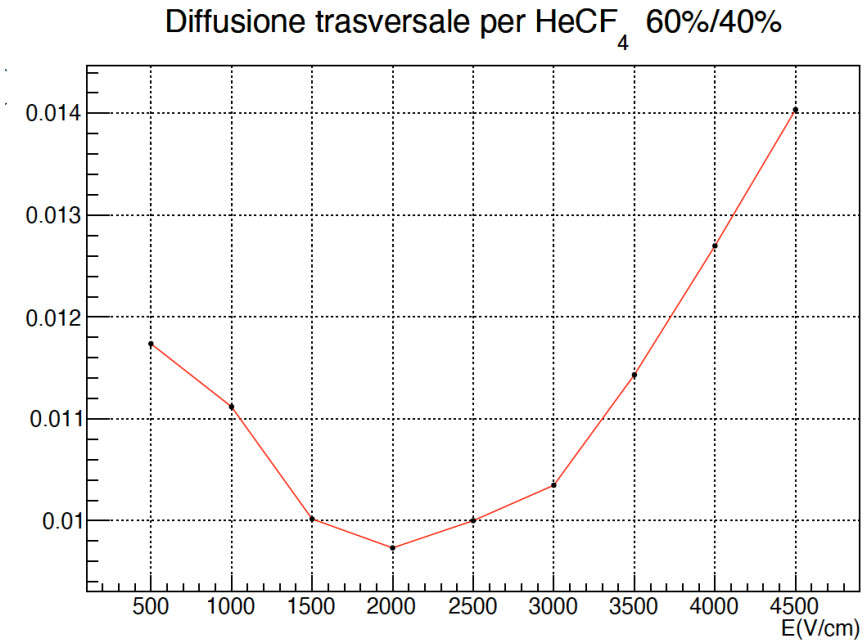
Small ATTACHMENT
coefficient up to 3 kV/cm of our mixture explains the very good transportation efficiency

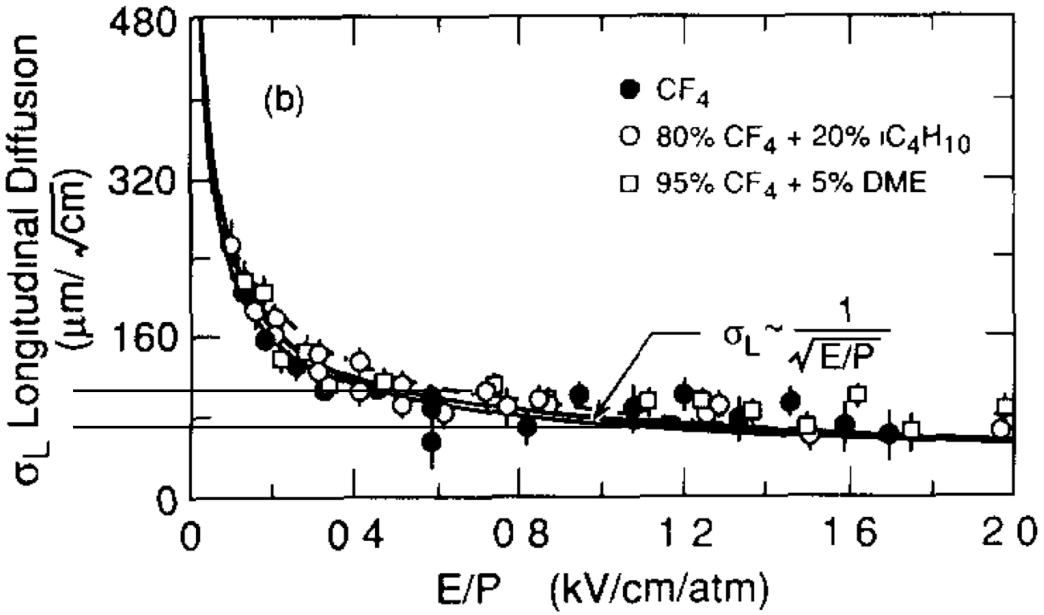






Diffusion

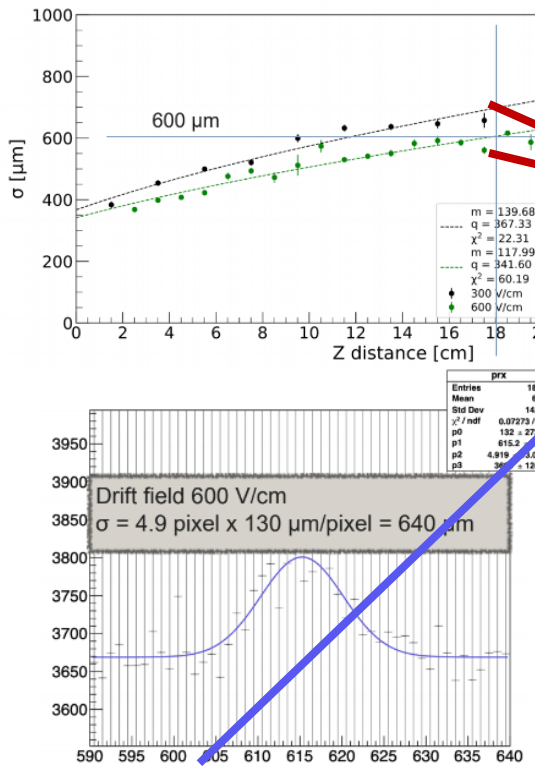


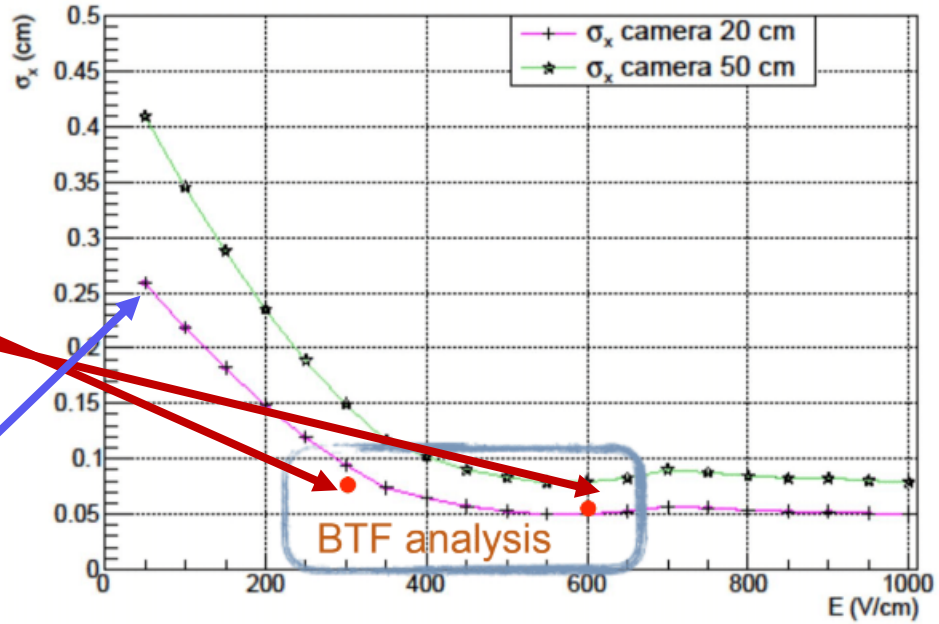


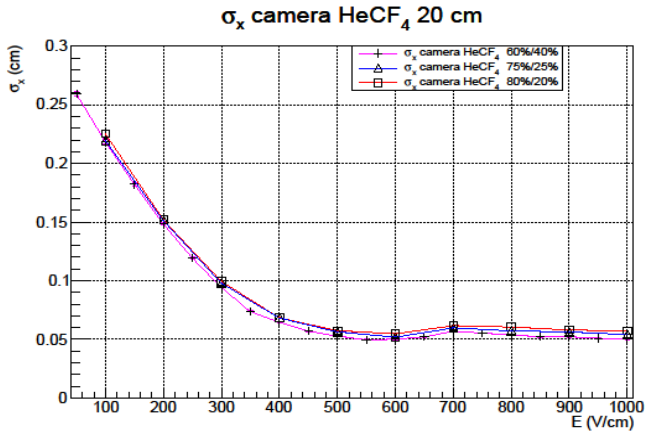
Soimulated Diffusion parameter agrees with measurements

Diffusion

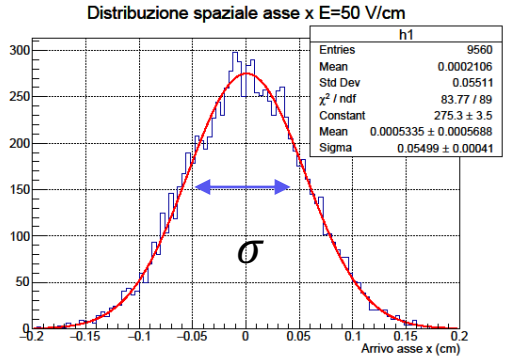
Experimental data

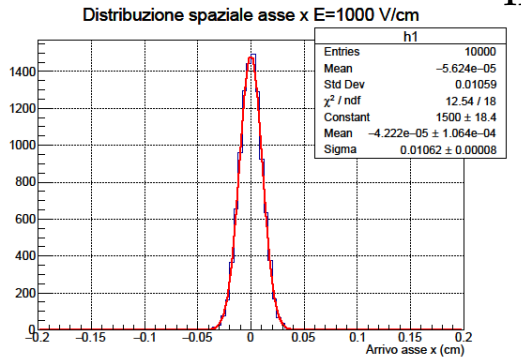




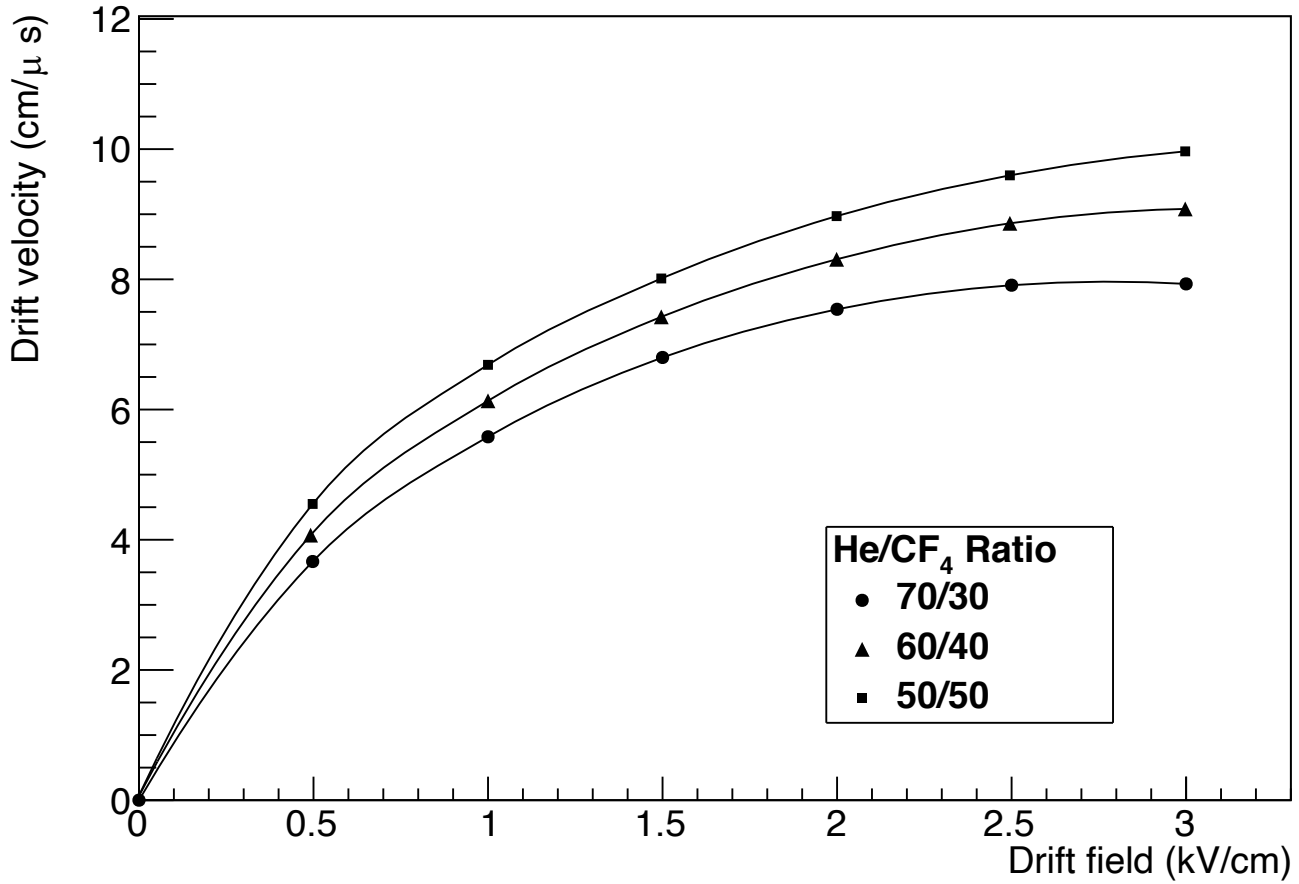


Diffusion almost independent from gas mixture





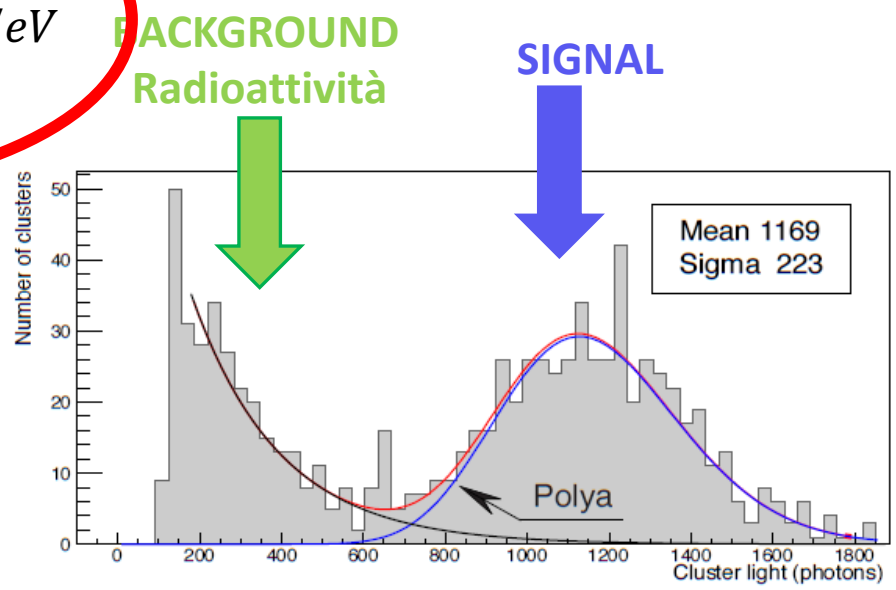
Drift velocity

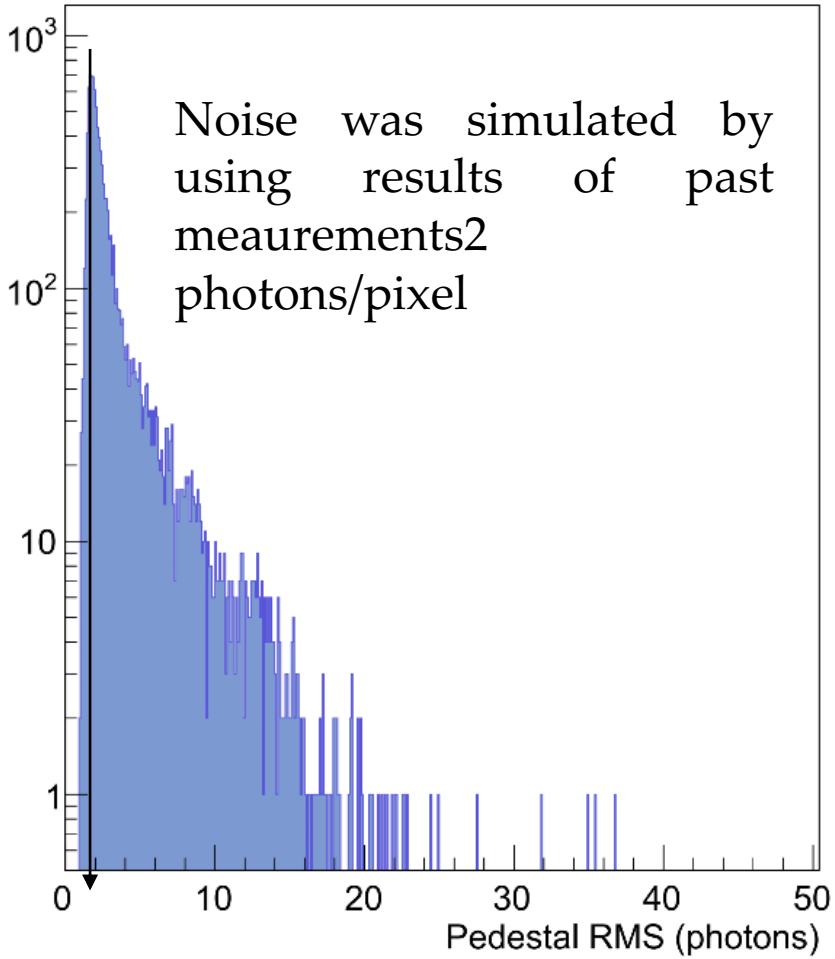


Light Yield

Light yield was evaluated from published measurements.

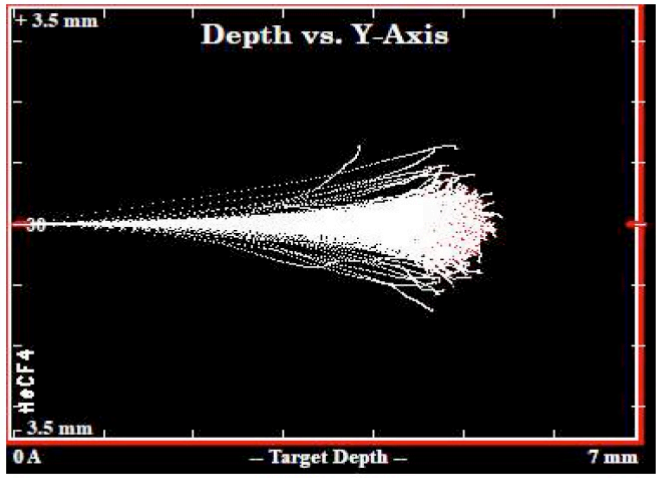
$$\frac{1169\ ph}{5900\ eV} = 0{,}198\ ph/eV$$

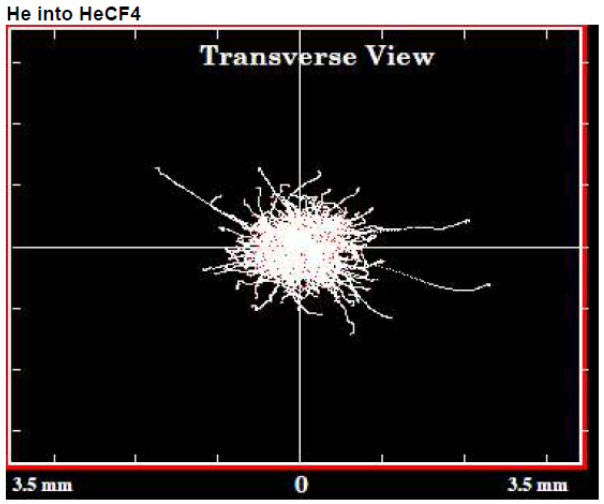


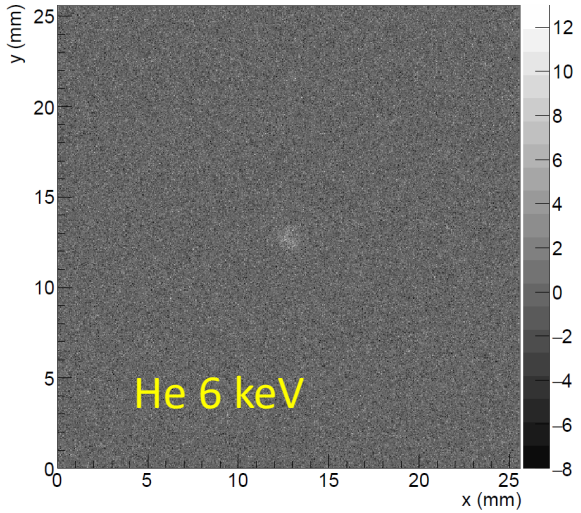


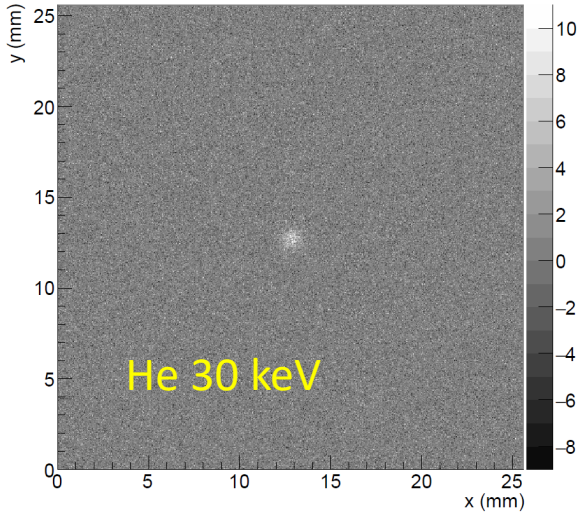
New values quite larger

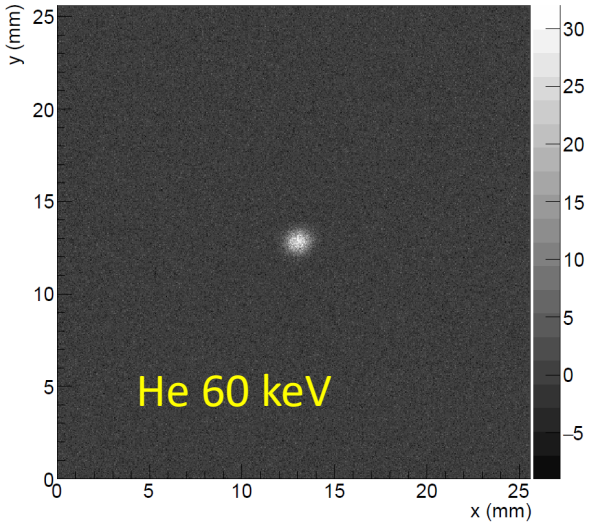
Simulazione del Segnale

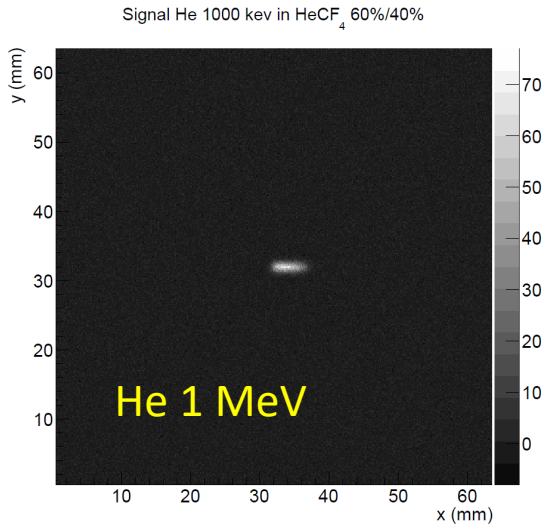






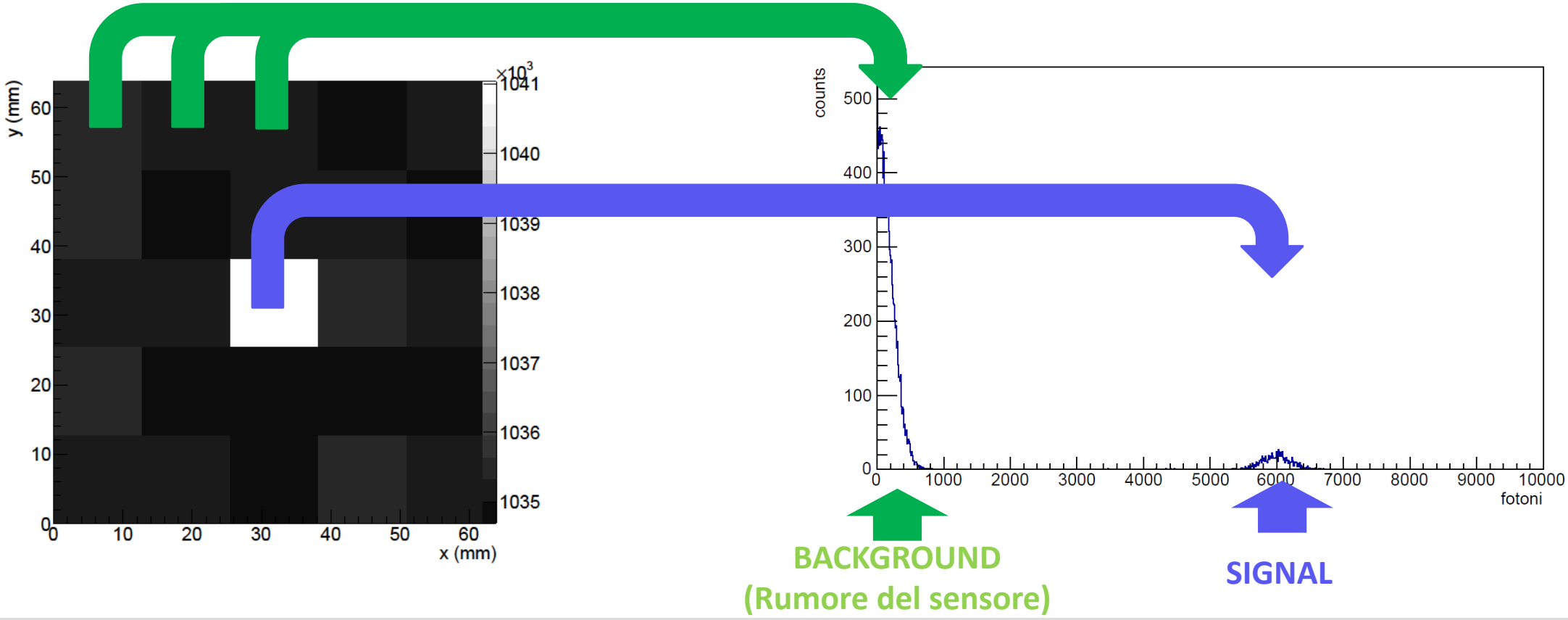




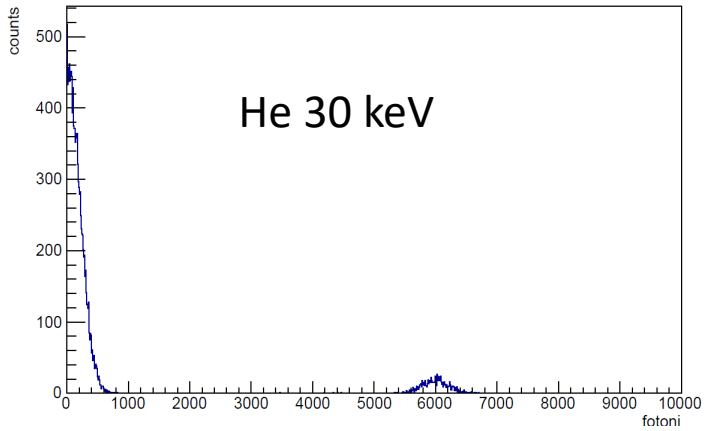


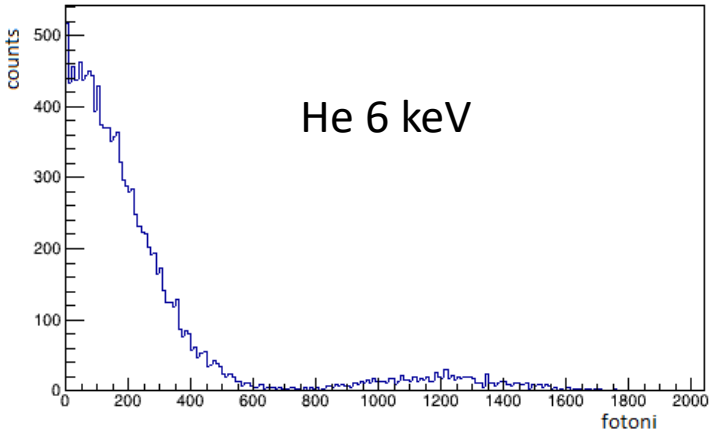
Efficienza di rivelazione

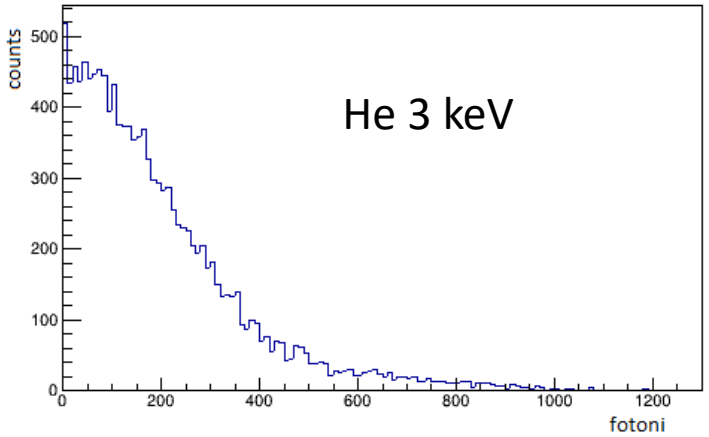
Rebinning istogramma 2D in modo da avere il segnale solo nel bin centrale e tutti gli altri bin solo background.

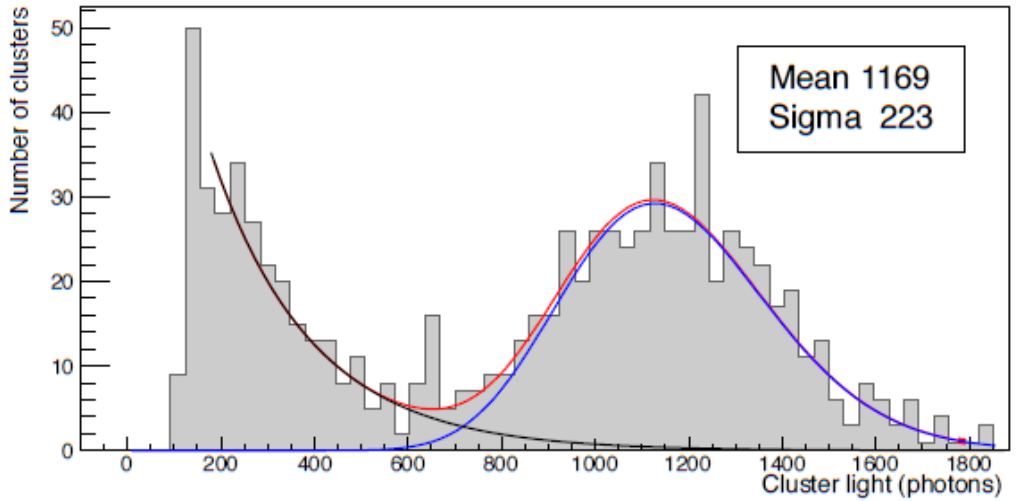


Detection efficiency







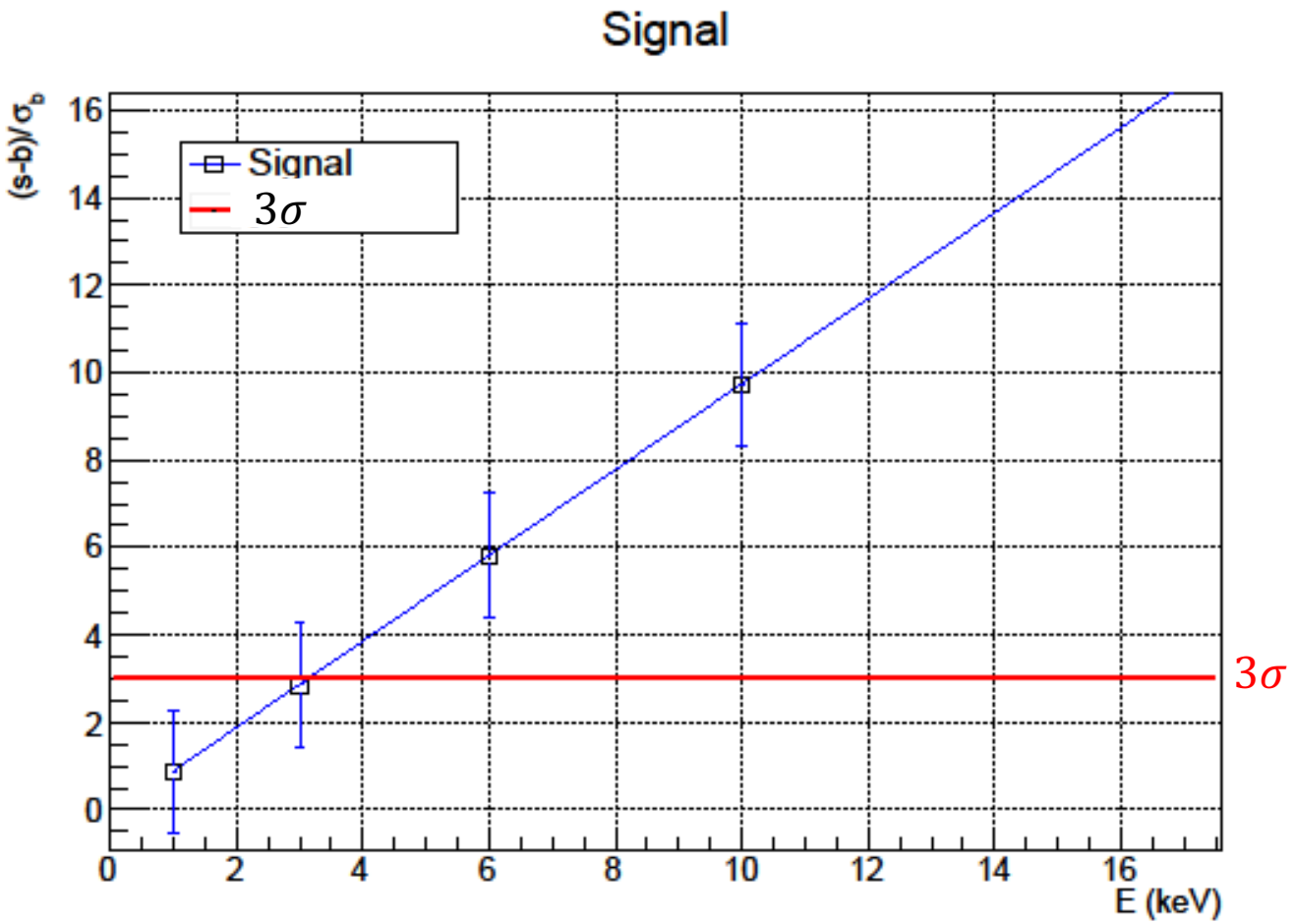


Energy resolution at 6 keV from simulation was found to be 17% in very good agreement with experimental data.

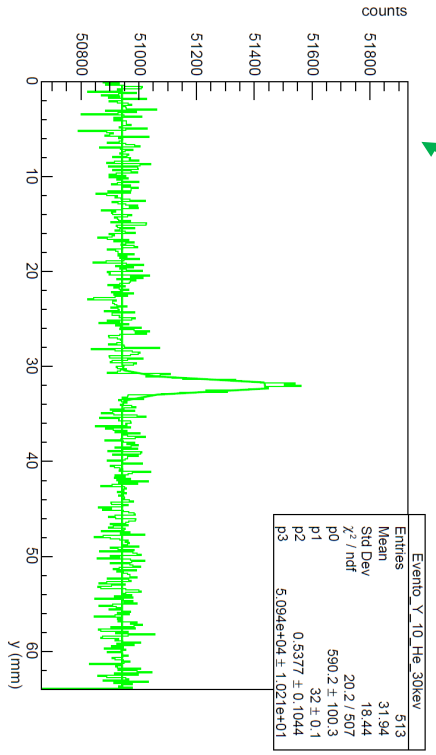
Detection efficiency

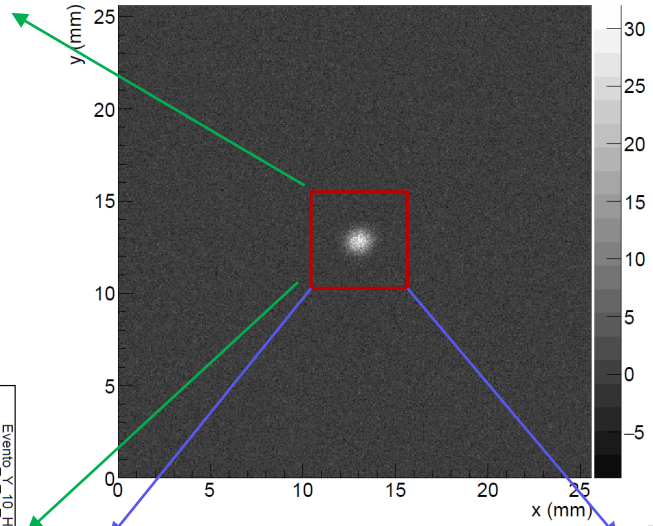
17% at 6 keV means a resolution of 1 keV

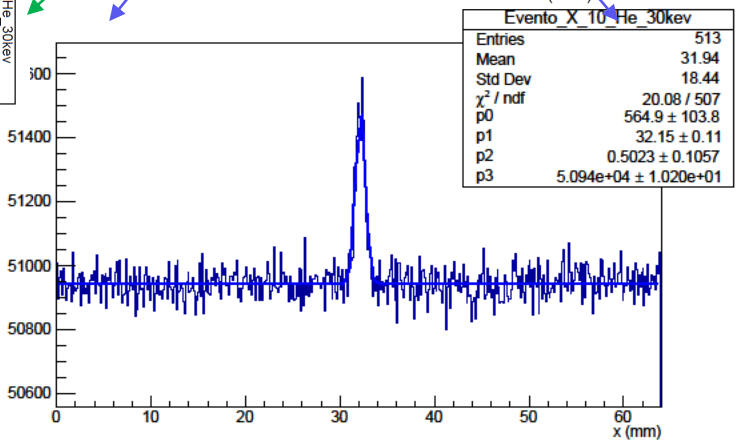
Without a suitable pattern discrimination life is hard under 3 keV

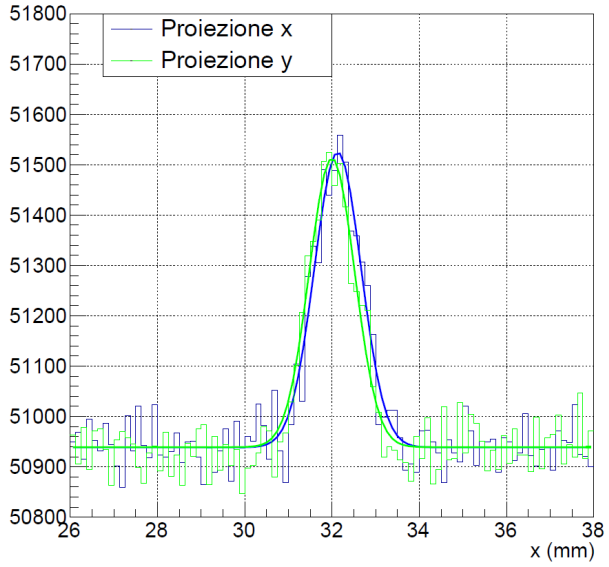


Directionality



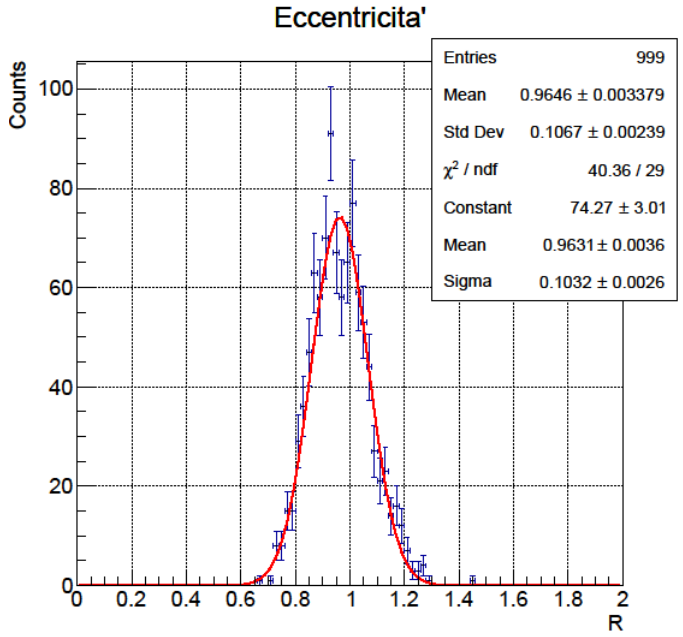






$$R = \frac{h_x/\sigma_x}{h_y/\sigma_y}$$

Distribution of R for 30 keV He;
Very close to 1;



Conclusion

Toy MC seems able to reproduce signals within the detector;

Emanuele produce samples of 1000 events for He at different energies;

His PC broke, so now we have only them. A new window machine is needed to run SRIM;

With them we can play with detector parameters to produces new signals (different light yield or sensor noise)

Efficiency seems good, while directionality seems not. To be checked with better algorithms;