$^{12}C(n,cp)$: risultati preliminari con GEMpix

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INFN - LNF & ENEA Frascati

n_TOF Italy Meeting
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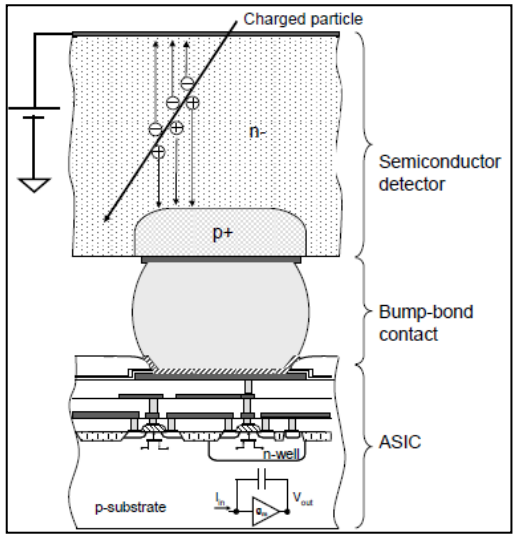
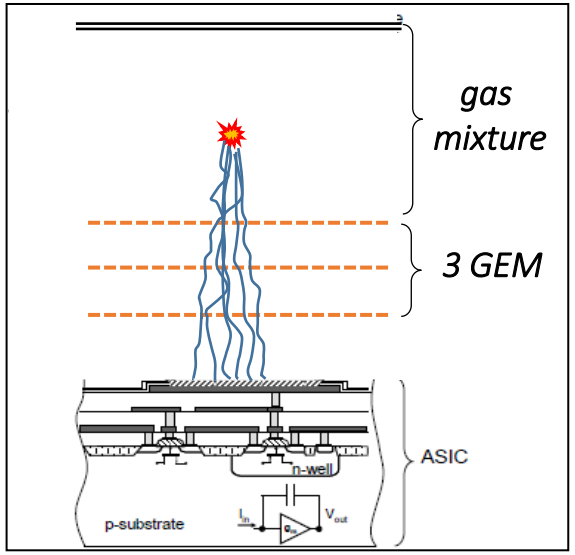
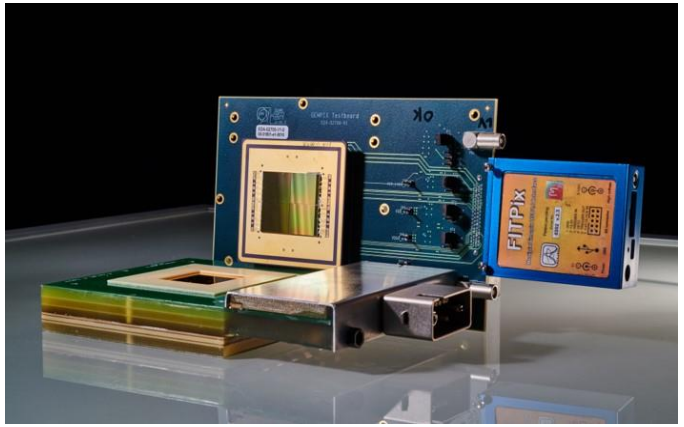
GEMpix @ n_TOF for reaction products measurements: detector layout and acquisition modes

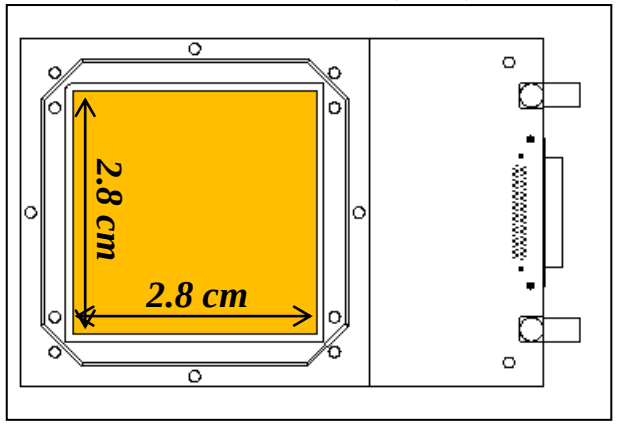


from Silicon to Triple-GEM

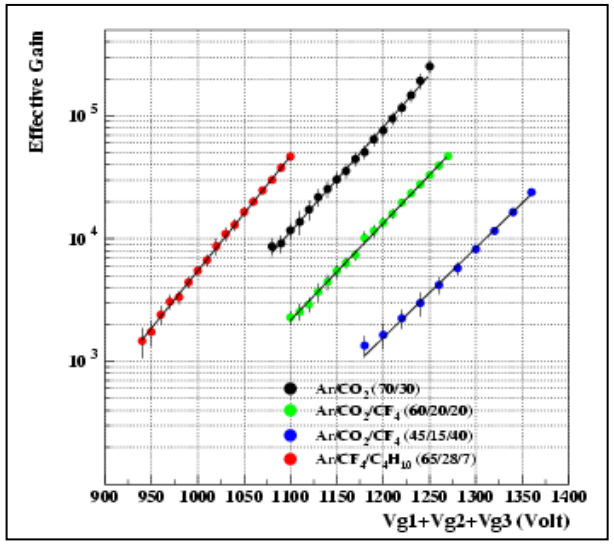


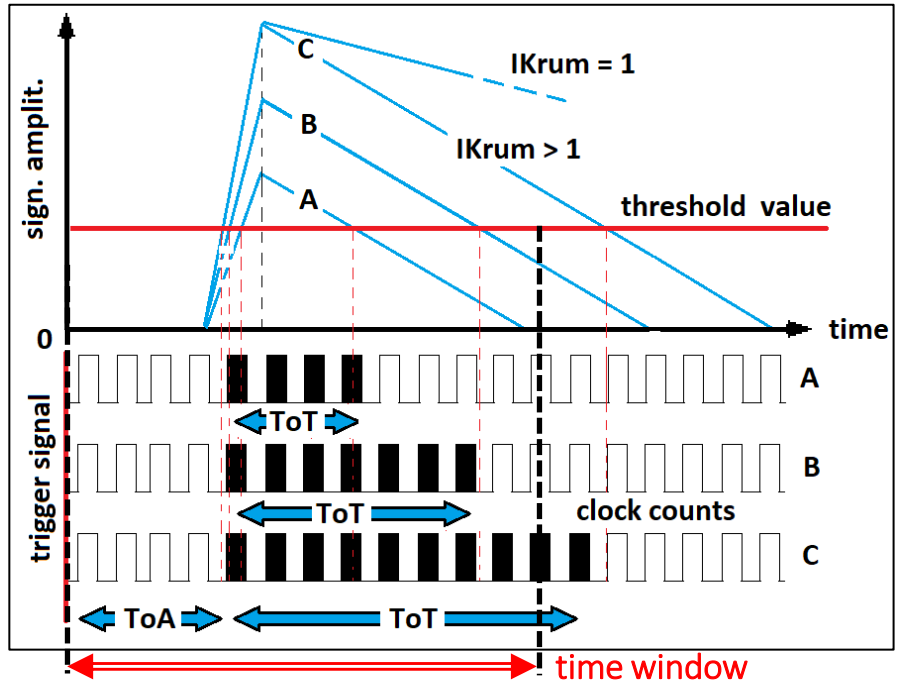


High Dynamic Range and high spatial resolution (55 x 55 µm^2 pixels)



Quad Medipix is made of 4 medipix chip hold together (512 x 512 pixles).

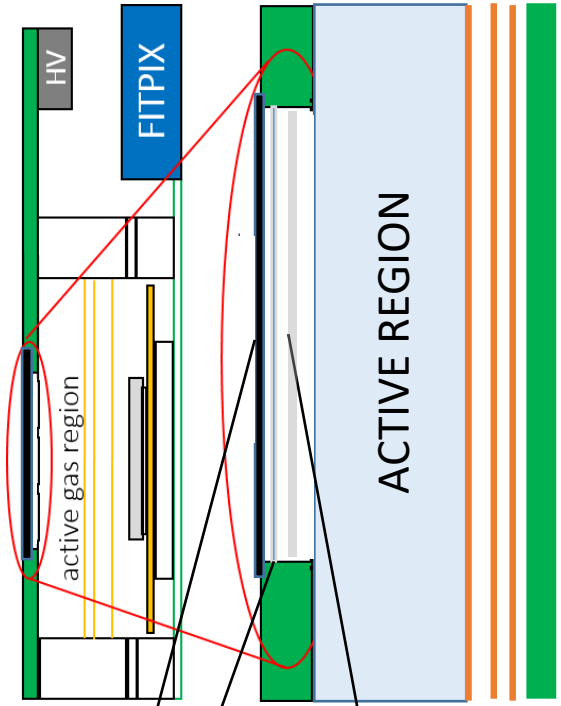


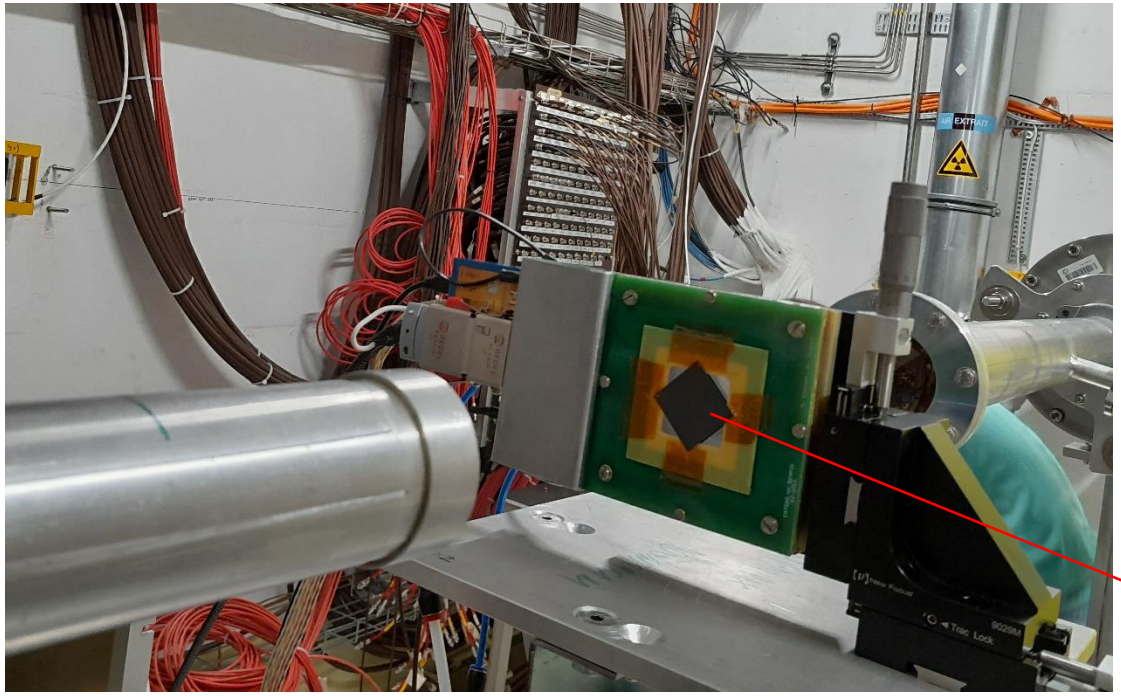


It can work alternatively in counting, ToT or ToA!

Time window limits measurements in ToT!

GEMpix @ n_TOF for reaction products measurements

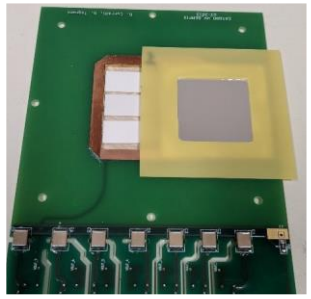




GEMpix acquisition parameters:

- Time window 120µm
- $ArCO_2$ gas mixture
- HVGEM 870 V
- Drift 900 V

Alumina sheets

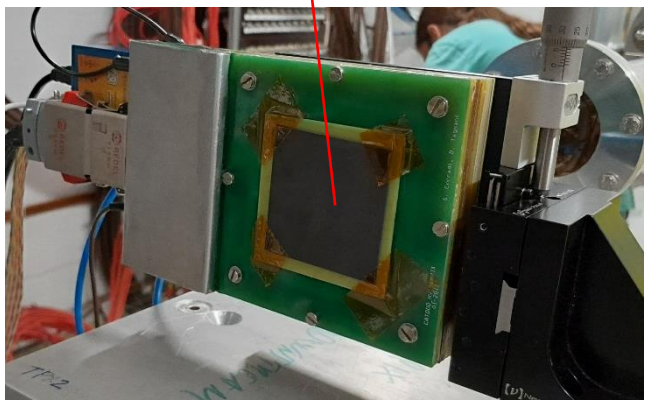


Aluminized mylar:
15 µm Mylar + 100 nm Al

Graphite target: 500 µm

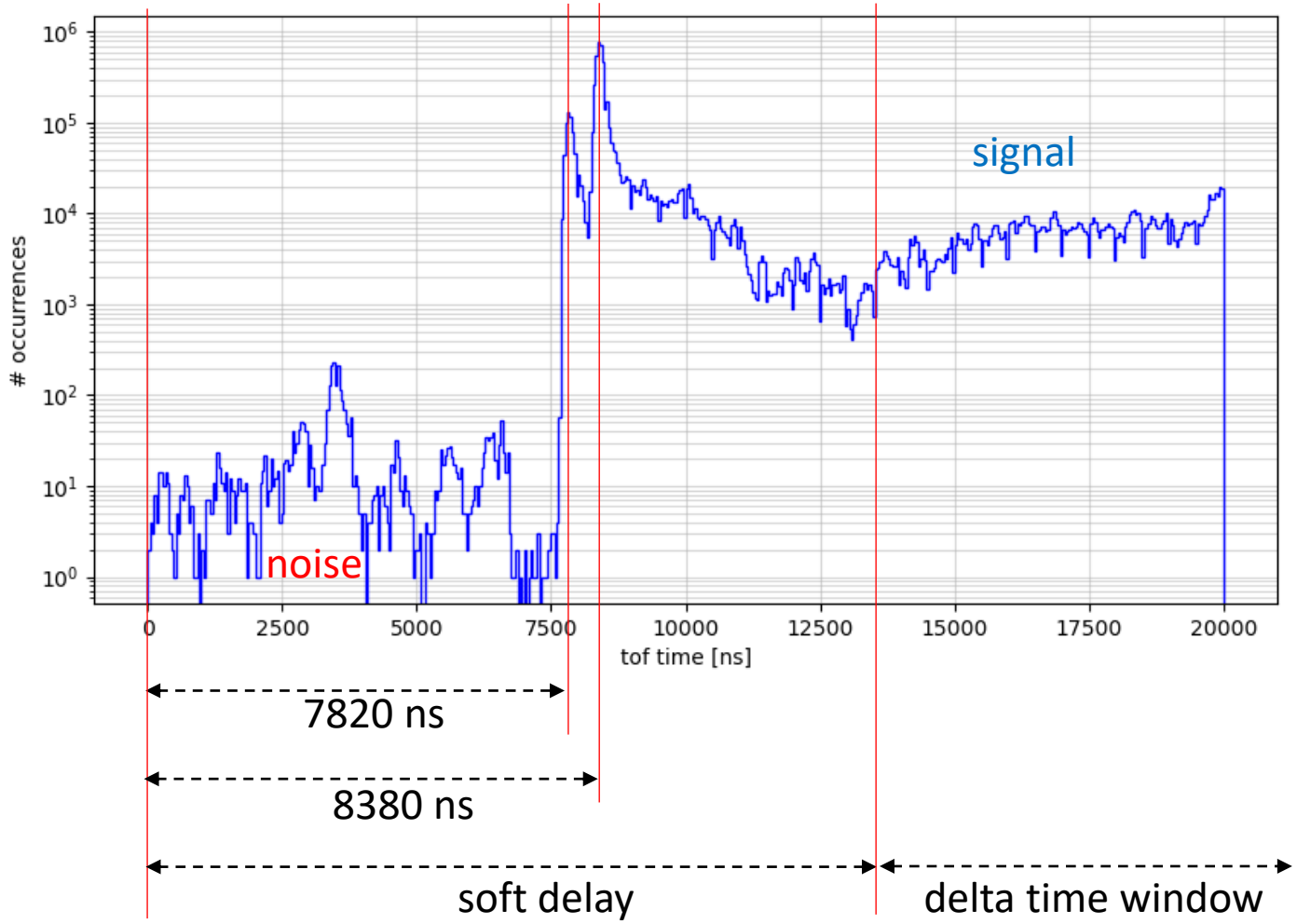
- ✓ Measurements started with GEMpix having Alumina (Al_2O_3) sheets inside.
- ✓ Substitution of the Alumina sheets with the Carbon target caused the breaking of the mylar window.
- ✓ The GEMpix has been substituted with another one, but the target could not be inserted inside.
- ✓ Geometry of the second GEMpix is the same as the first and operational conditions (gas flux, high voltages and control module) were the same.

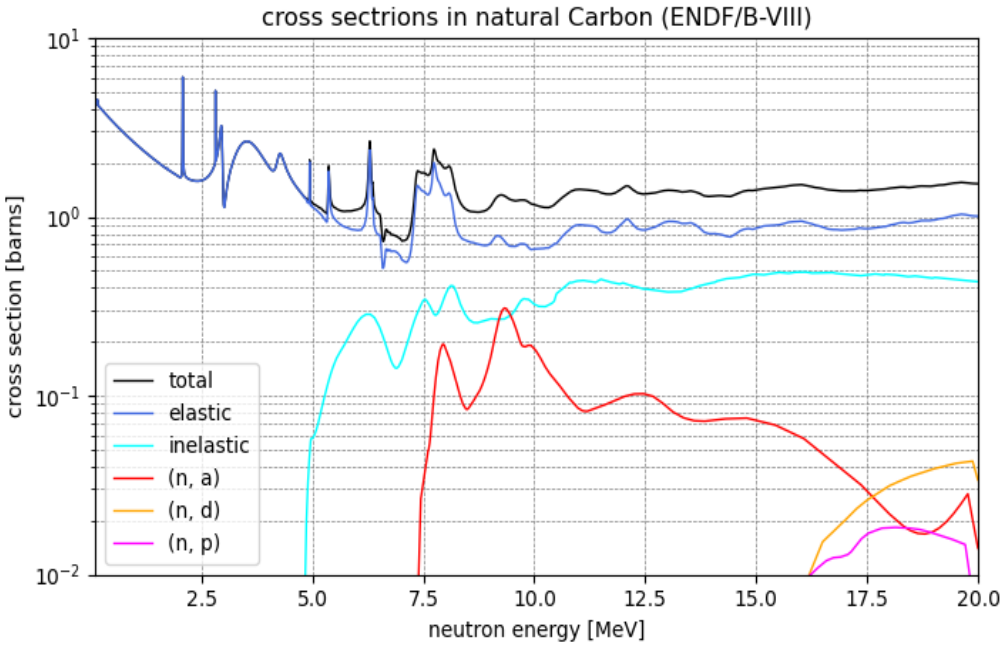
Graphite target: 500 µm

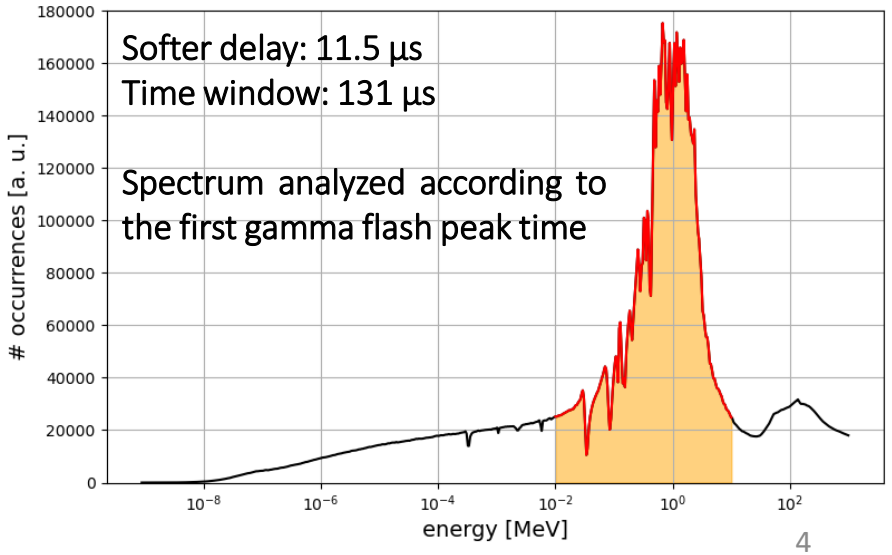


GEMpix @ n_TOF for reaction products measurements

Measures of gamma flash in Time-of-Arrival with GEMpix. It is located in EAR1 at about 187 m from the neutron source.



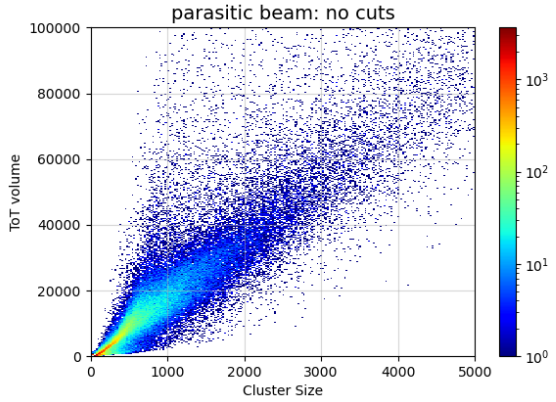


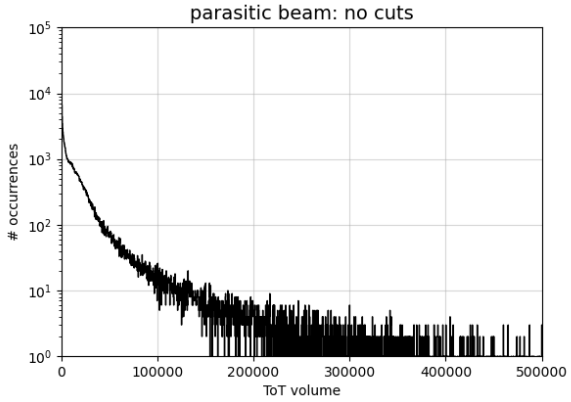


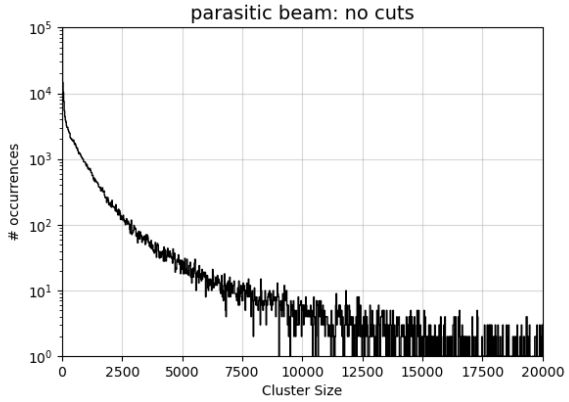
Delta time window was chosen not lower than 100 µs to not saturate charge measurement in ToT with a clock frequency of 10 MHz.

GEMpix with Carbon target: track analysis and treatment of overlapping tracks

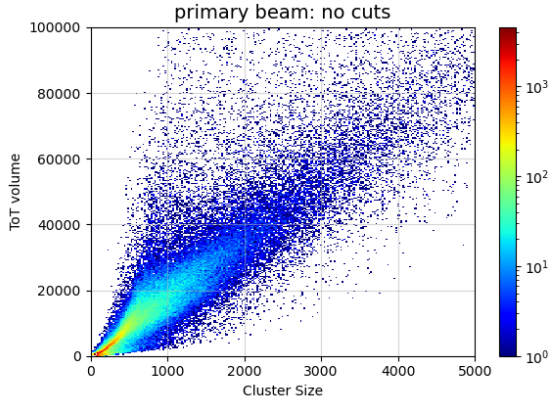
Parasitic beam
0.01 ←→ 10 MeV

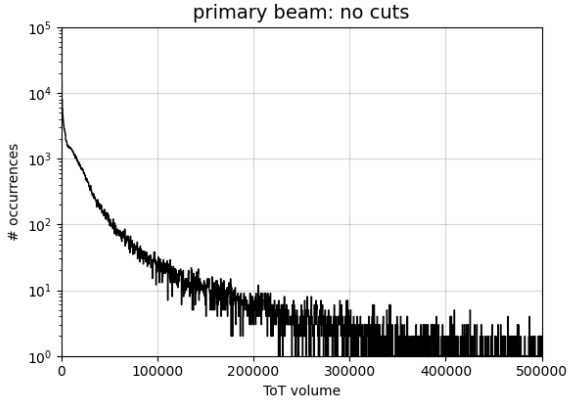


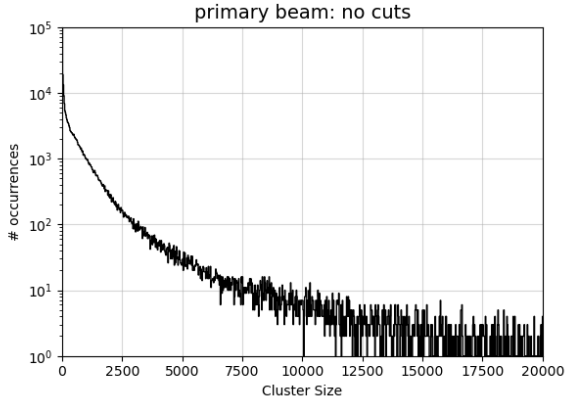


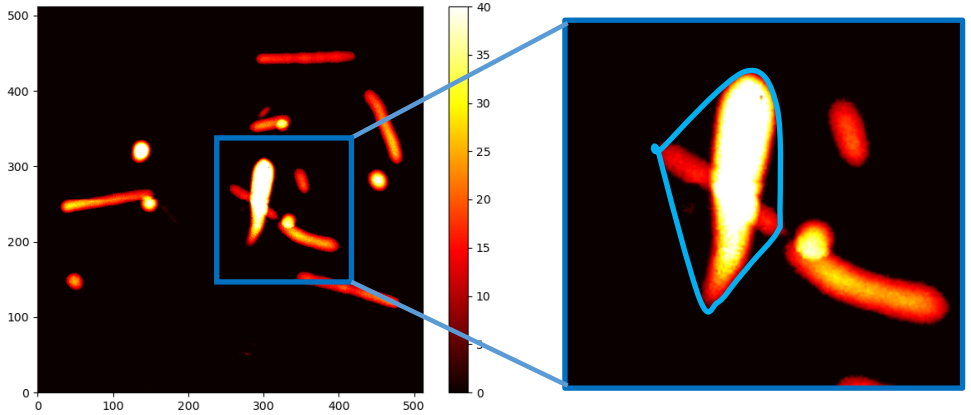


Primary beam
0.01 ←→ 13 MeV







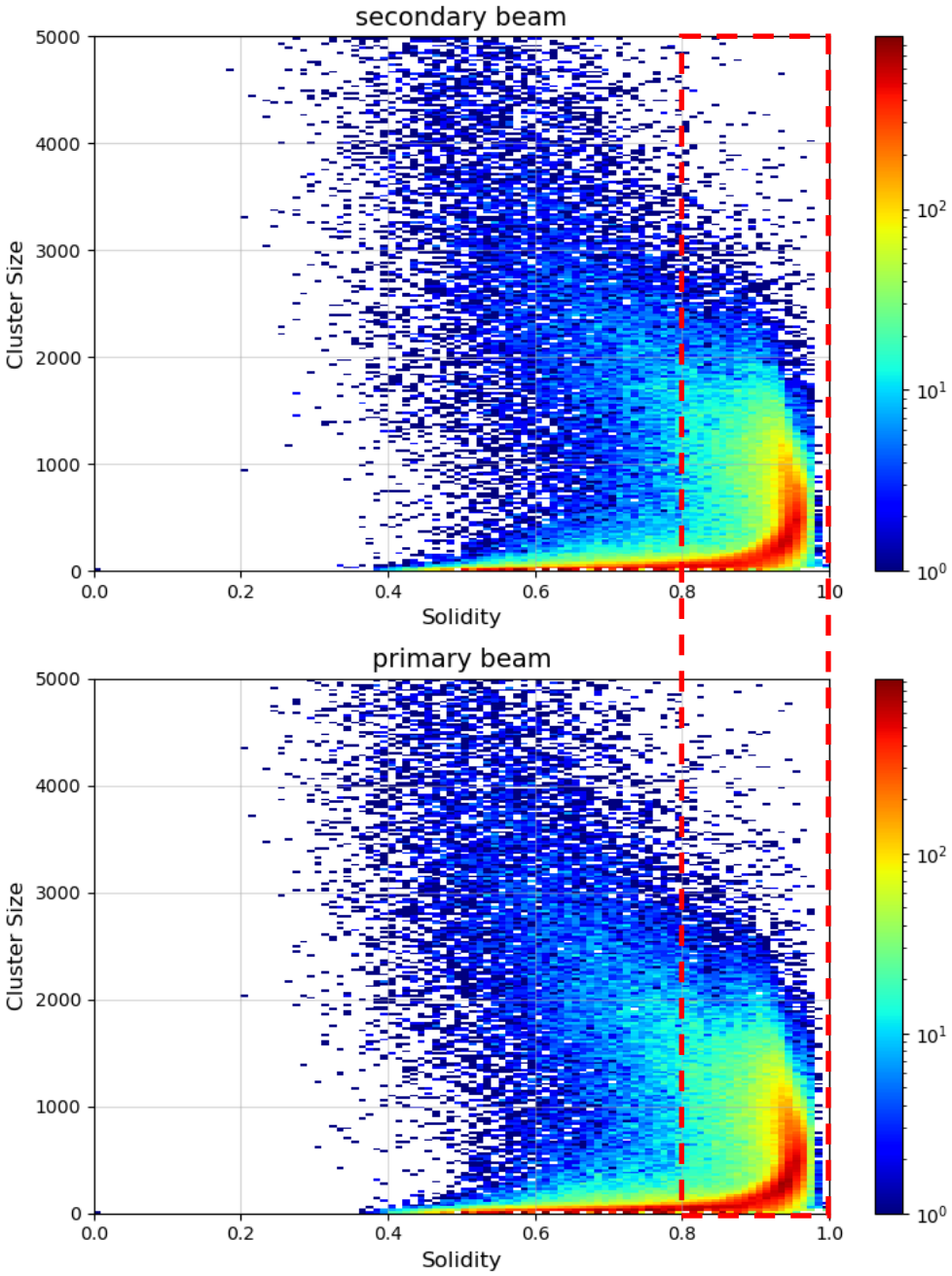


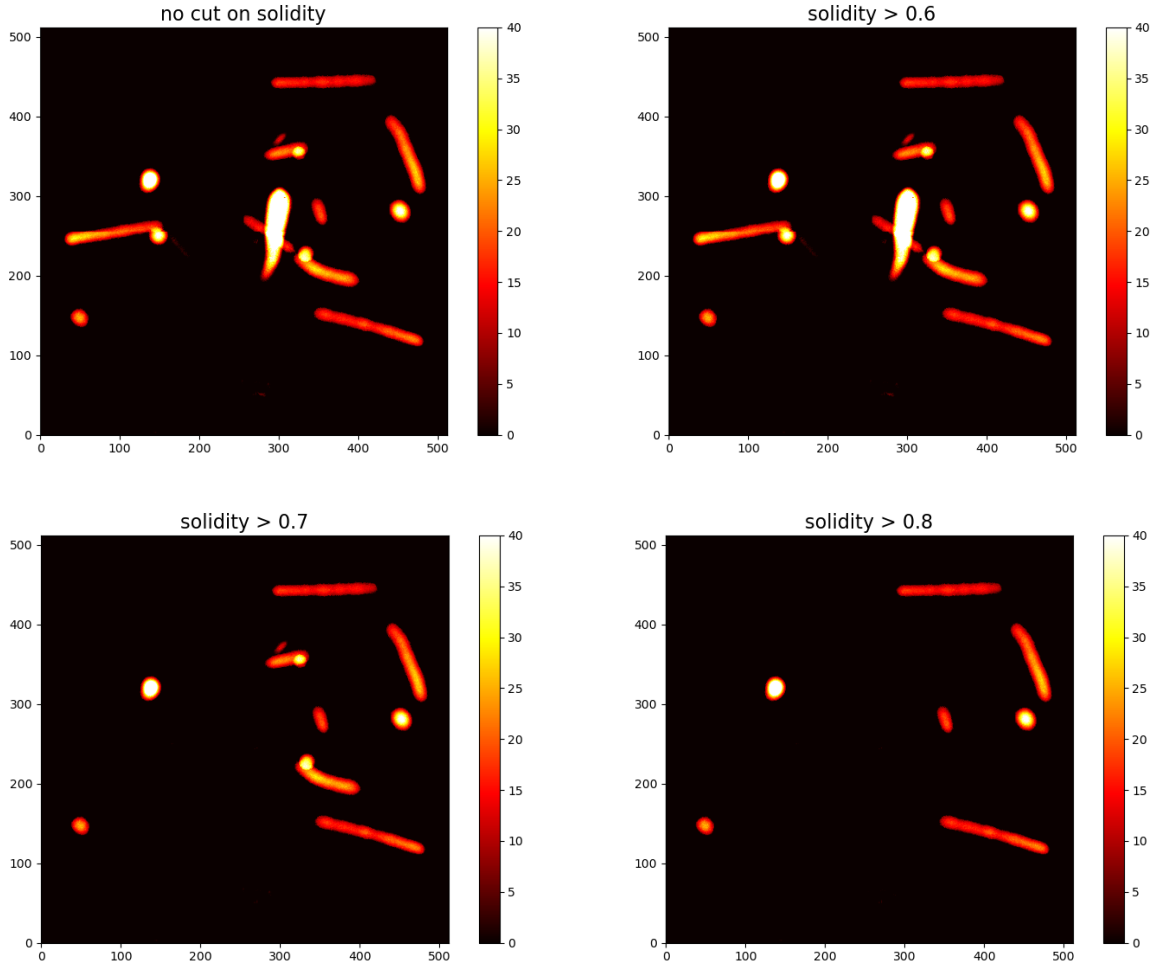
Convex hull: the smallest convex set of pixels that contains it.

Solidity parameter: ratio between cluster size and convex hull.

Overlapped tracks may be excluded.

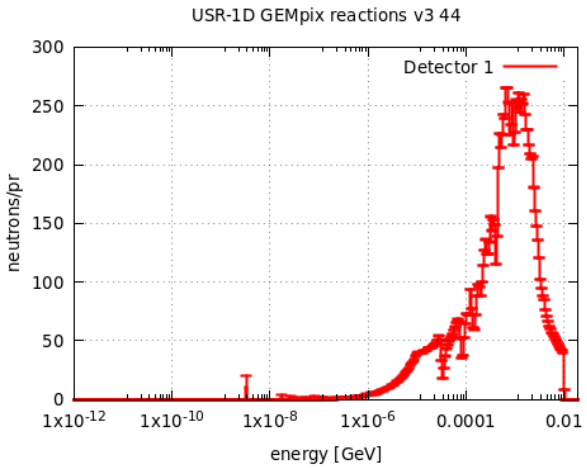
GEMpix with Carbon target: track analysis and treatment of overlapping tracks

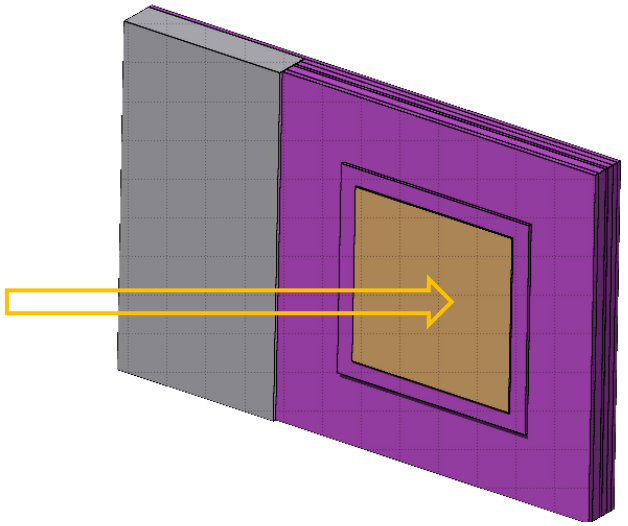




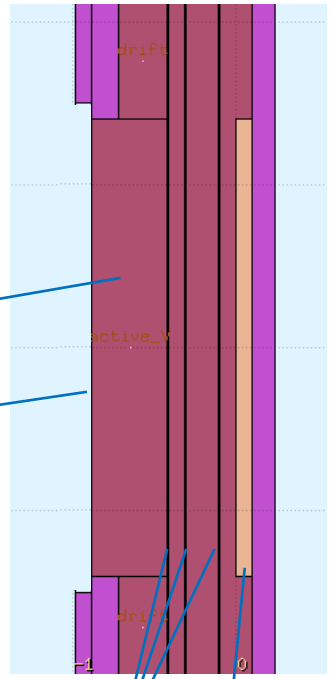
A cut on the Solidity parameter makes it possible to exclude overlapped tracks. They are not considered in the consequent track analysis. All the tracks with Solidity > 0.8 have been selected.

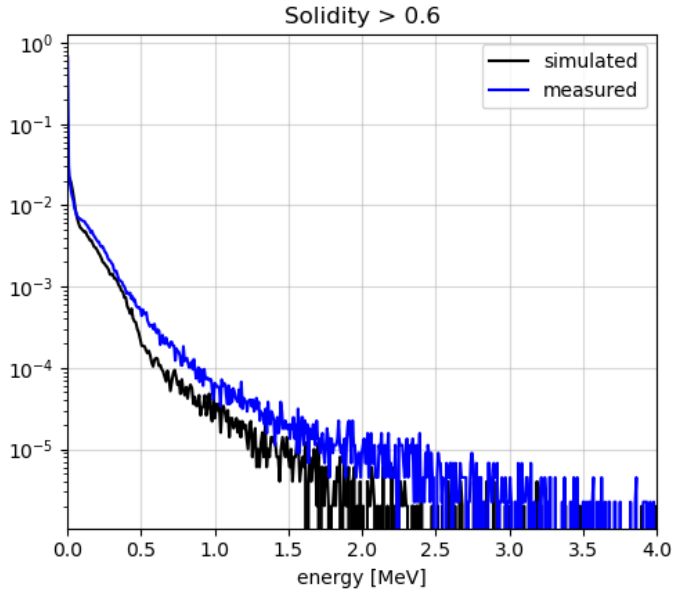
GEMpix with Carbon target: track analysis and treatment of overlapping tracks (10 – 0.01MeV)

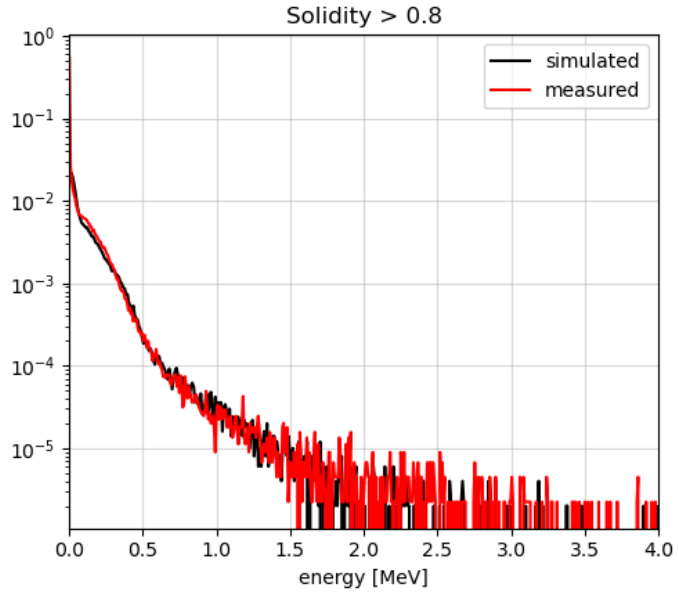


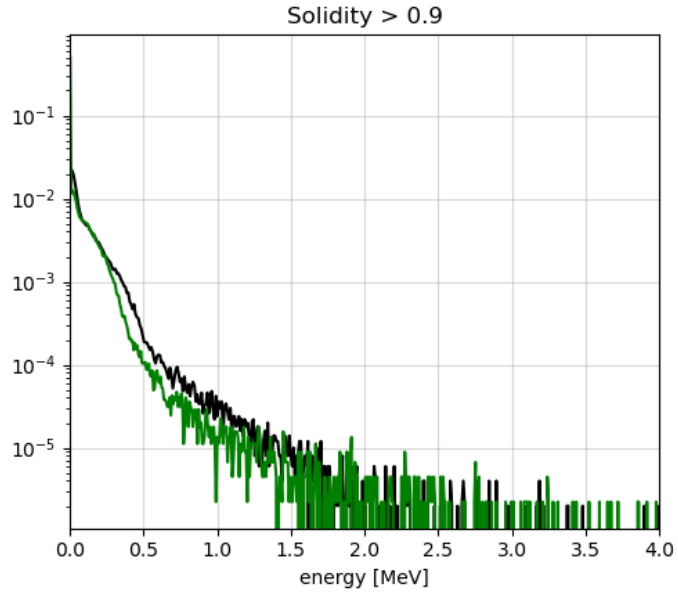


A further confirmation of the 0.8 value for Solidity parameter come from FLUKA simulations.



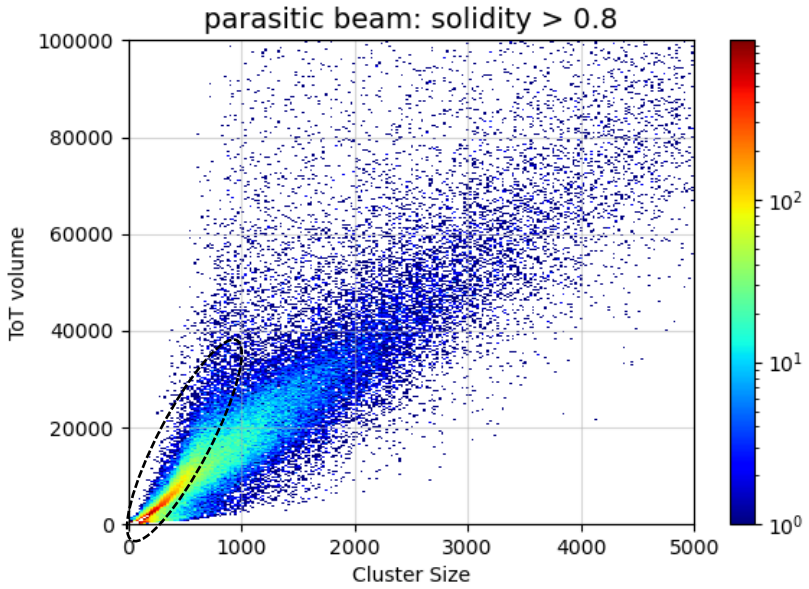


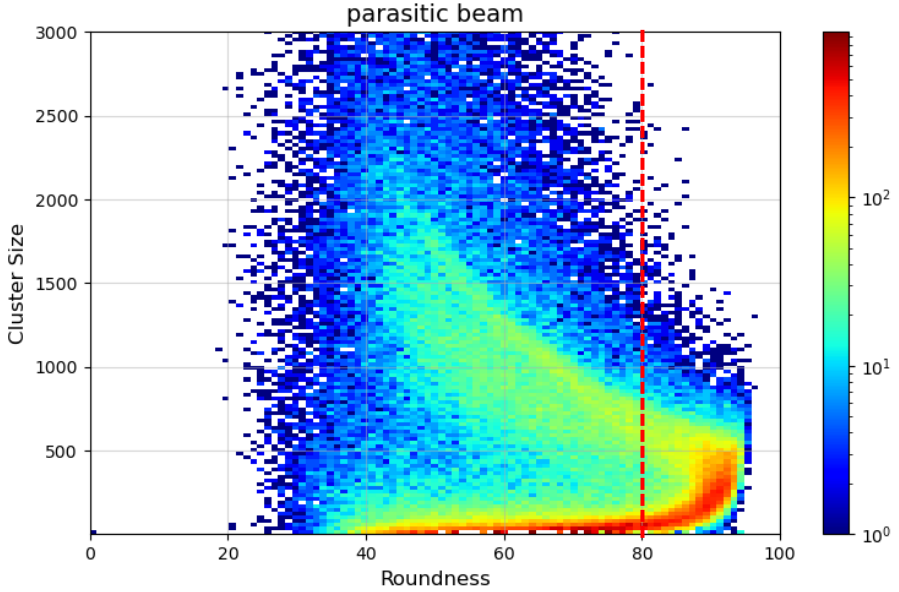


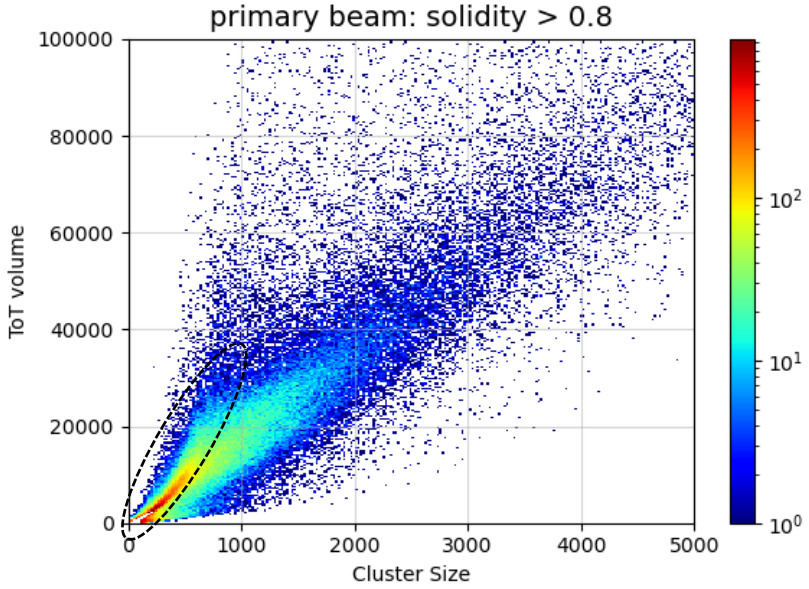


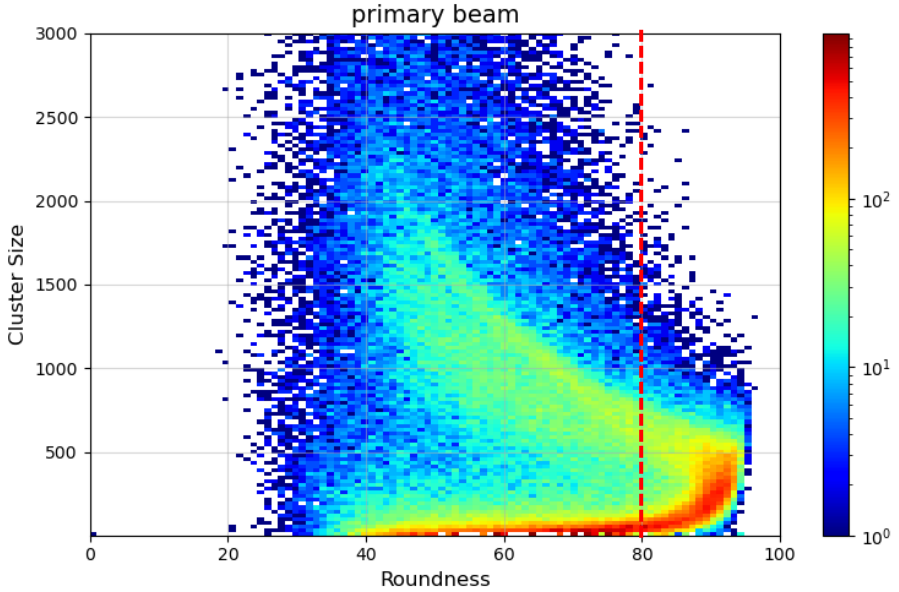
Optimal matching between the simulated deposited charge in the active region of GEMpix and measured charge ToT profiles is obtained with a cut of 0.8 on the Solidity parameter. Comparison provides also an estimation of the calibration conversion factor between ToT and deposited charge (*Energy [MeV] ≈ 1.1E-5 × ToT*)

GEMpix wiith Carbon target: track analysis and particles discrimaination (10 – 0.01 MeV)

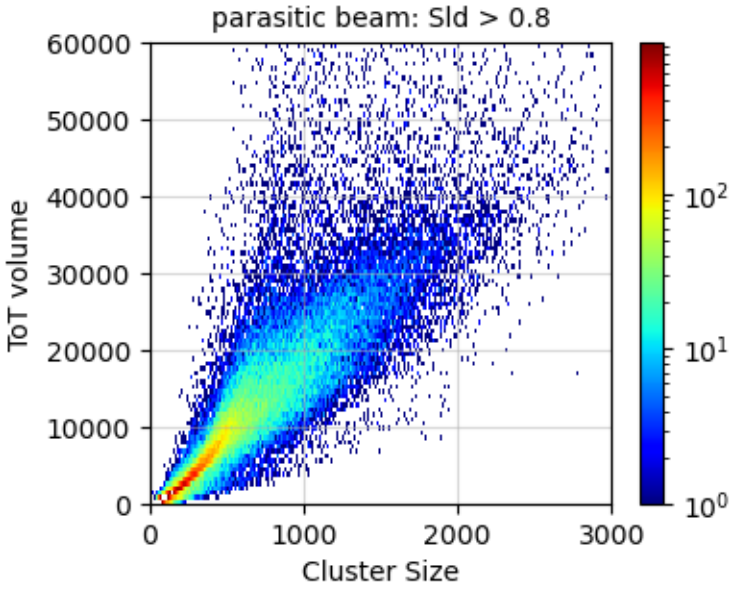


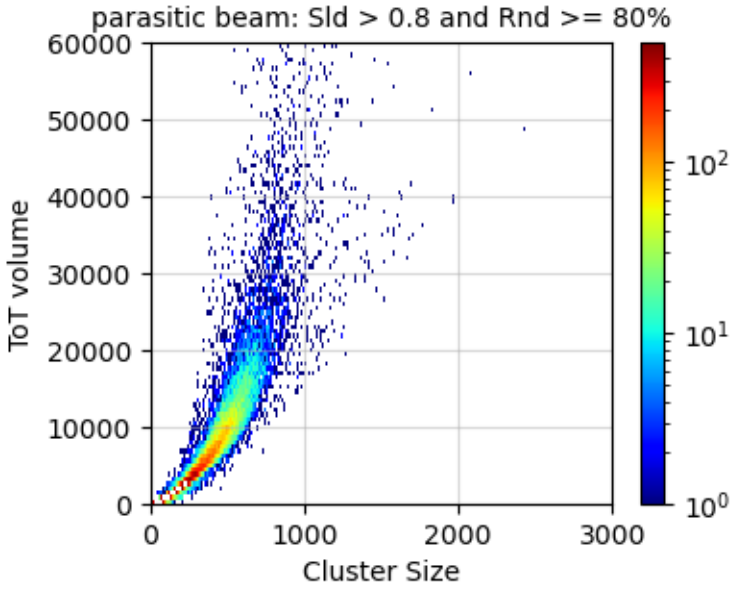


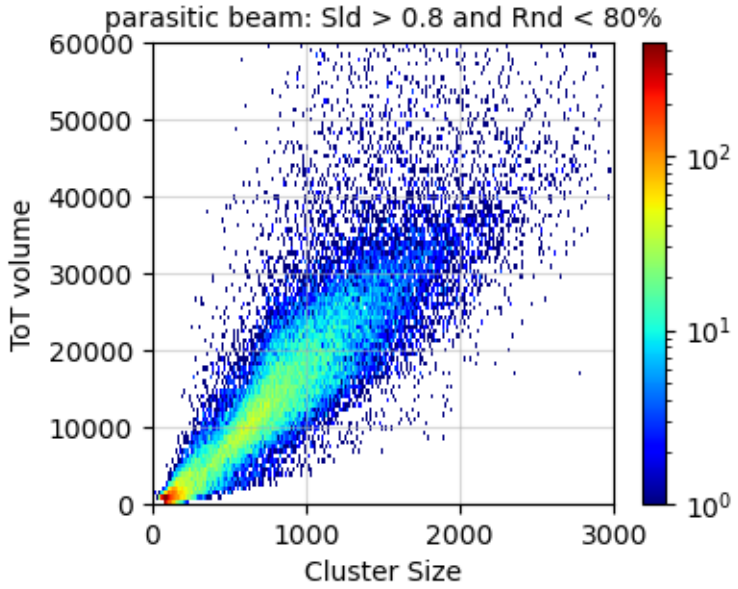


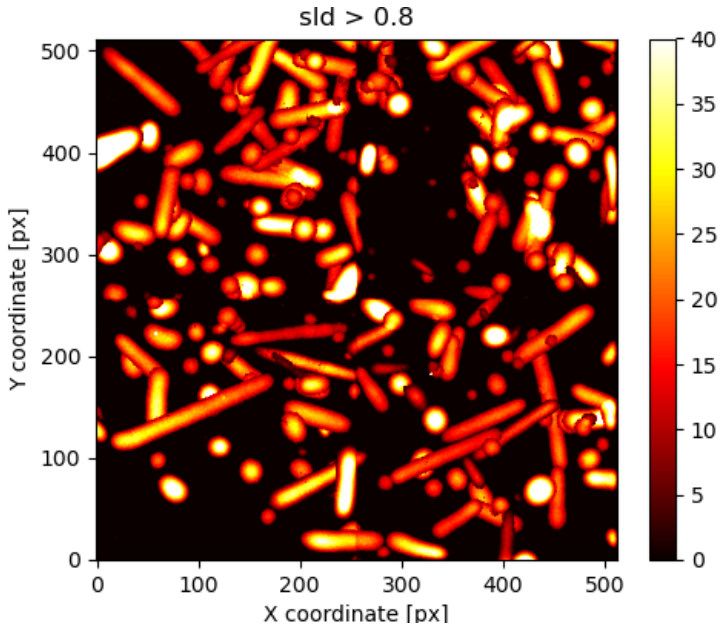


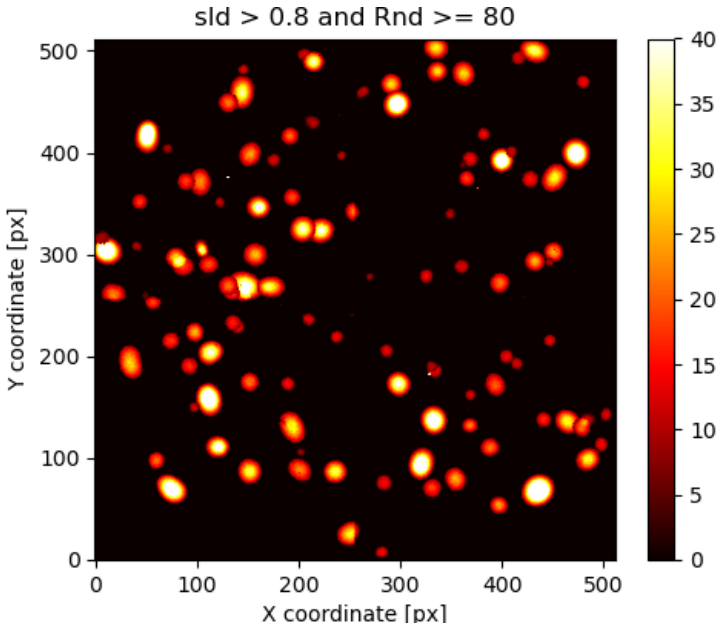
GEMpix with Carbon target: track analysis and particles discrimaination (10 – 0.01 MeV)

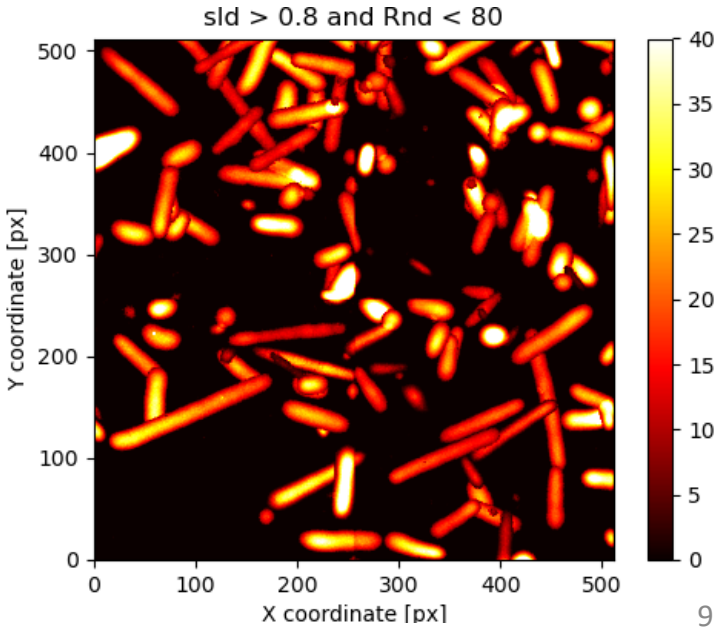




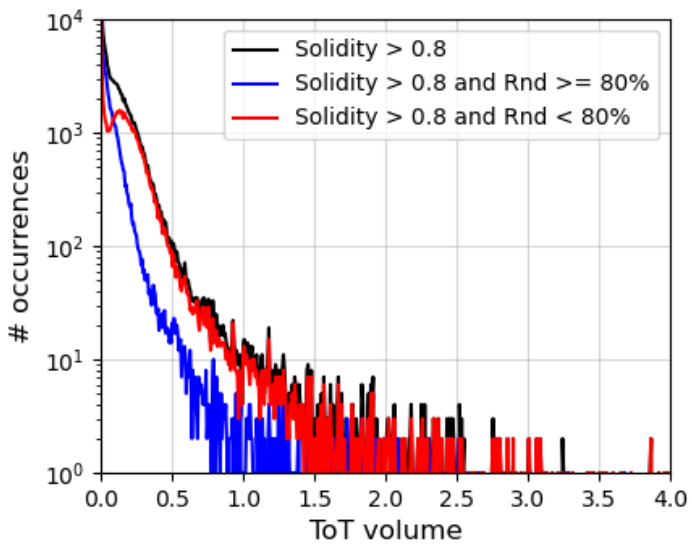


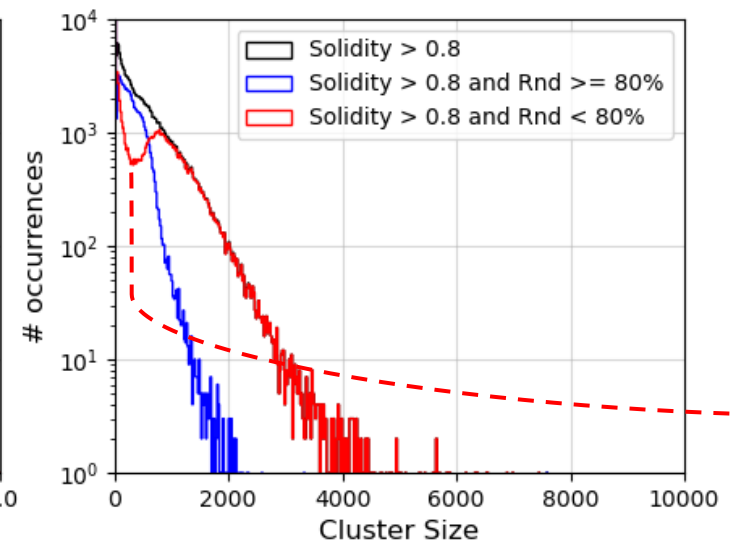


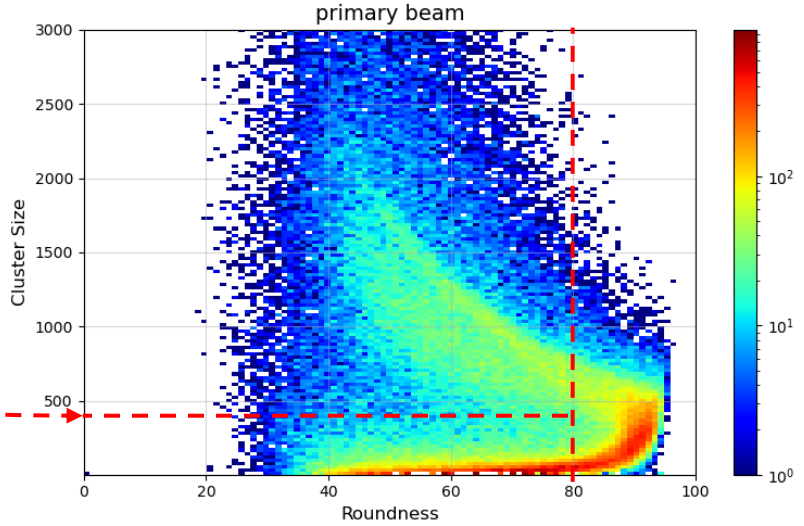




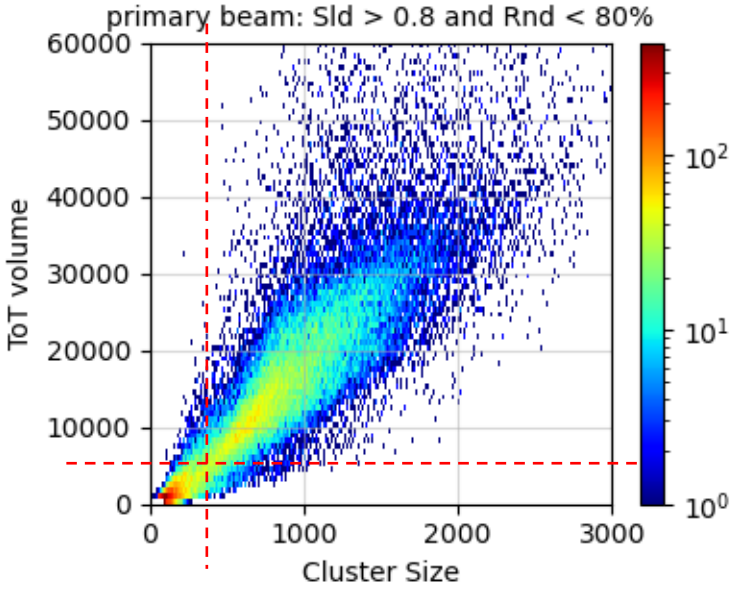
GEMpix with Carbon target: track analysis and particles discrimaination (10 – 0.01 MeV)

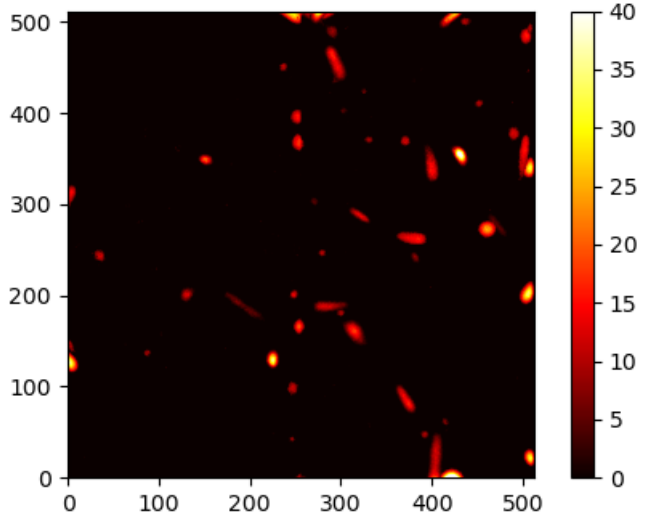


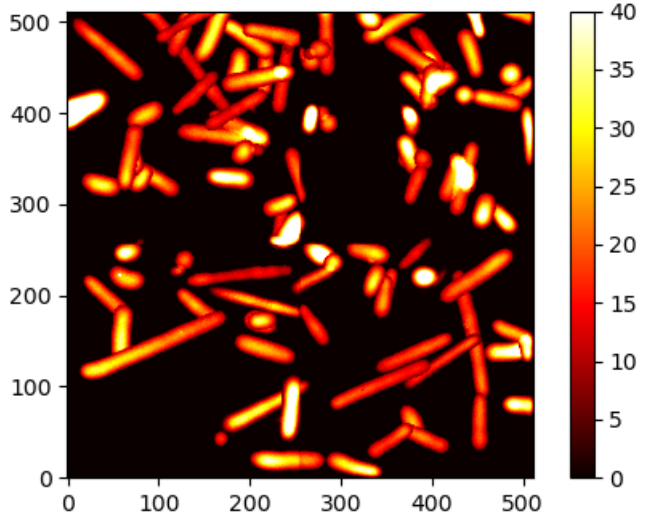




A minimum both on ToTv and CS distributions highlights a second population, the same observed on CS/Rnd plane.

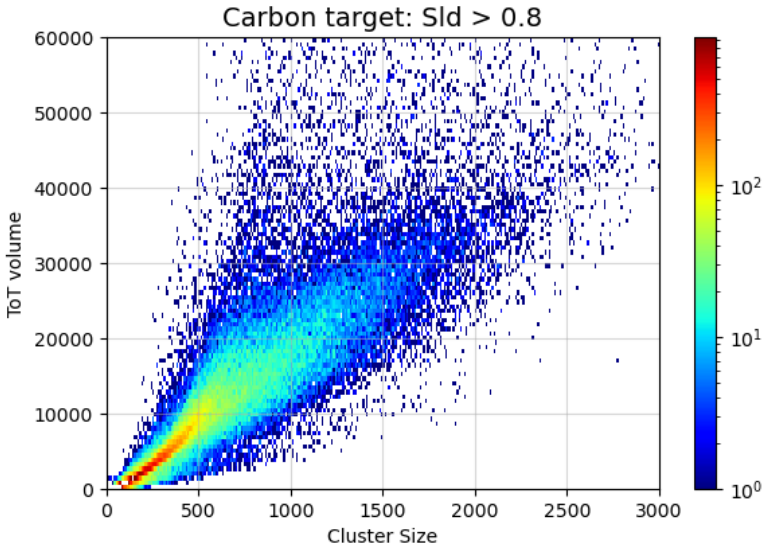


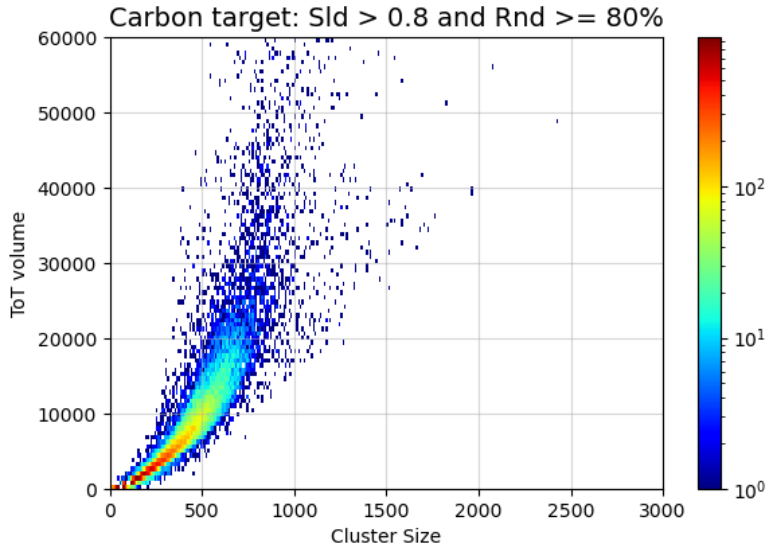


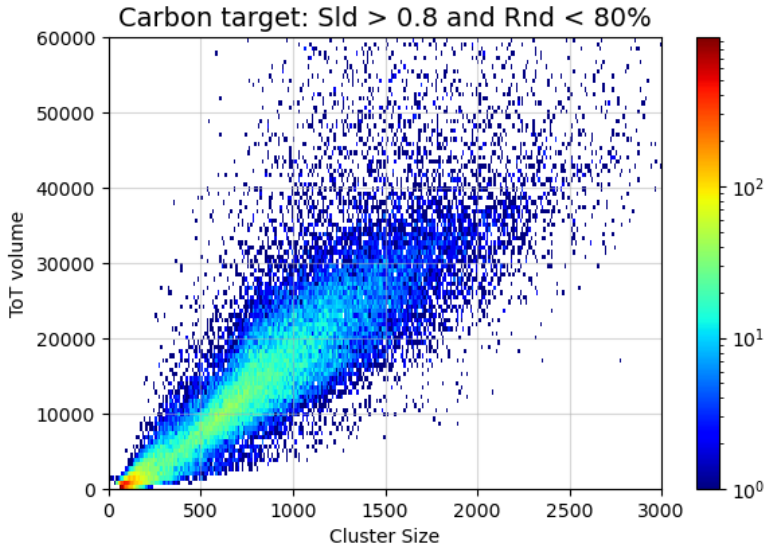


GEMpix: comparison between distributions with and without target (10 – 0.01 MeV)

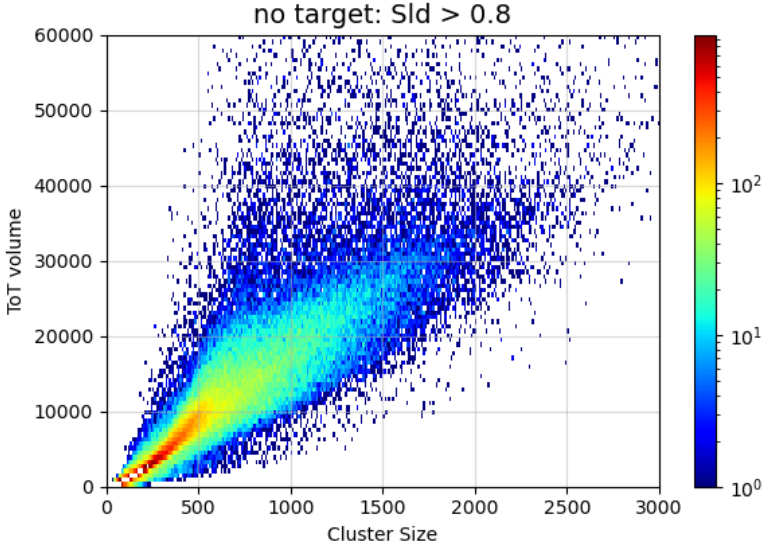
Carbon TARGET

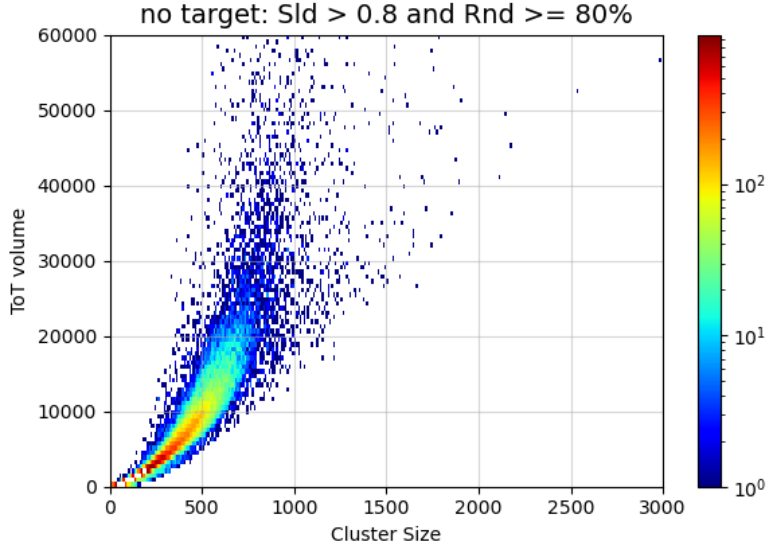


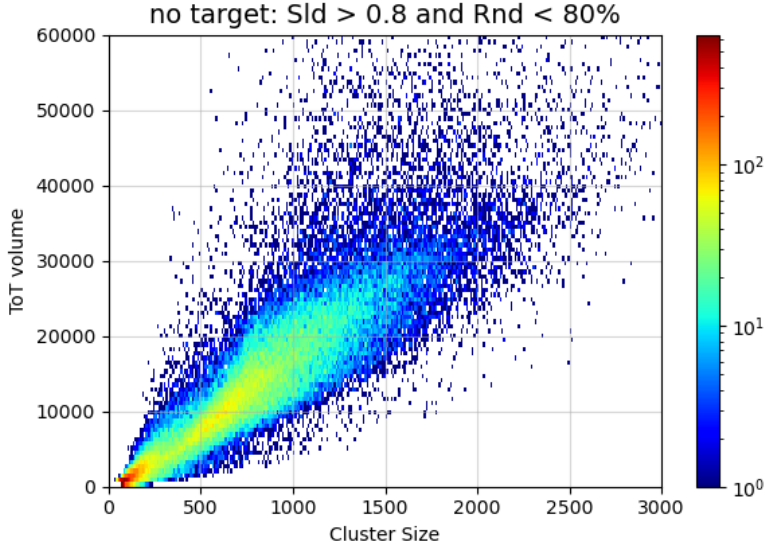




NO TARGET

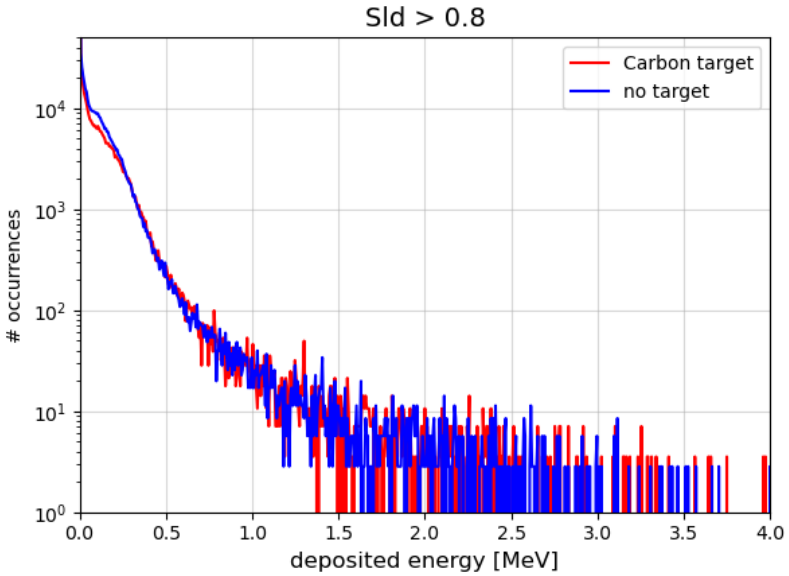


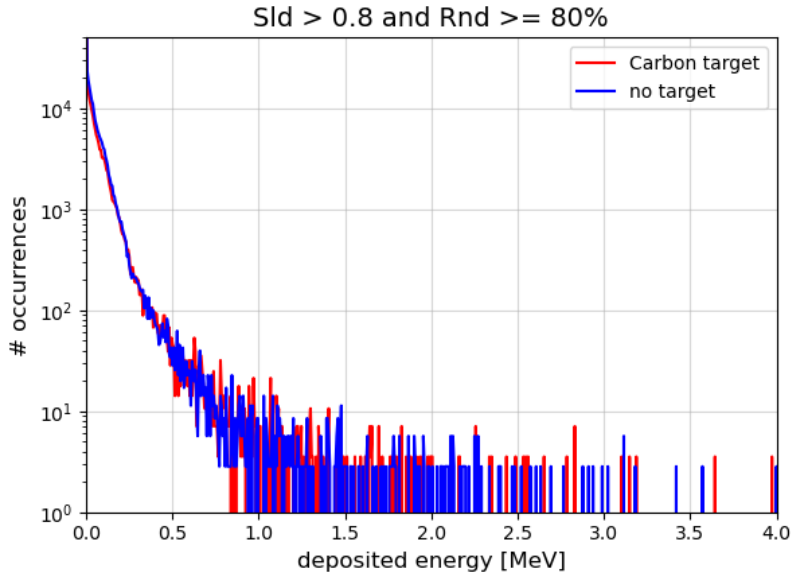


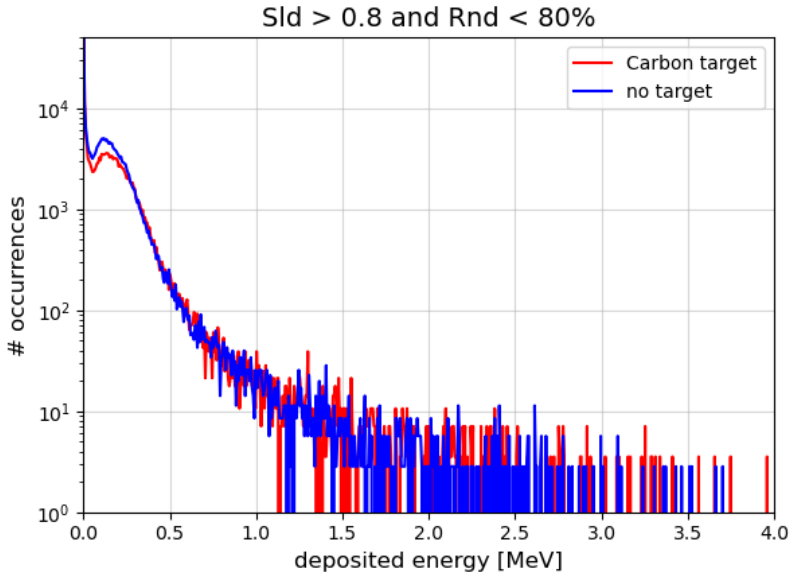


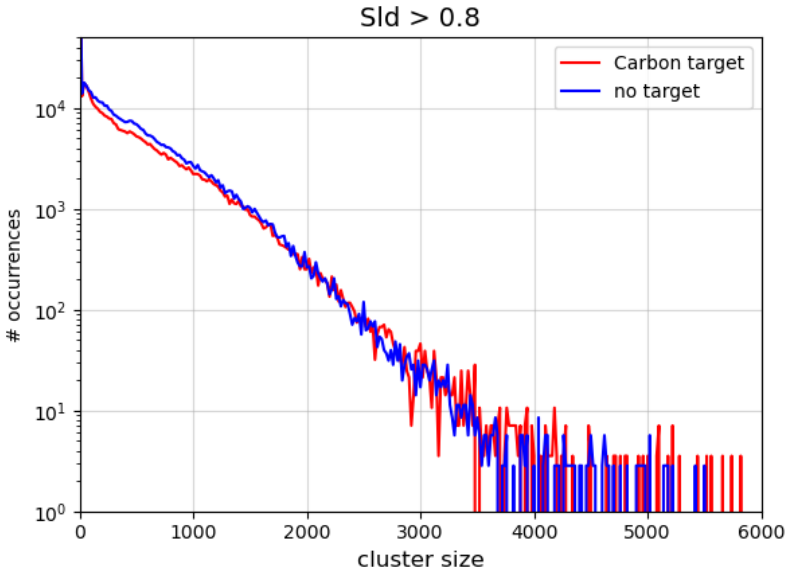
No significant differences have been observed between the two configurations!!!

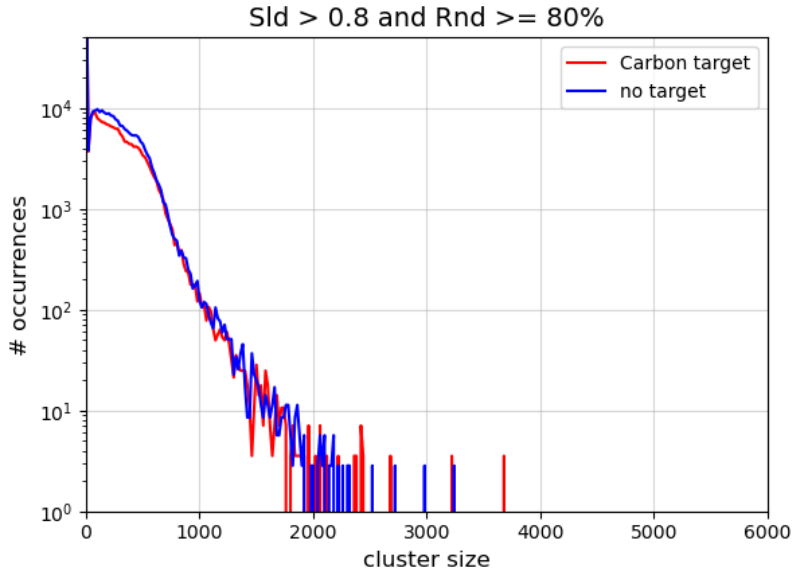
GEMpix: comparison between distributions with and without target (10 – 0.01 MeV)

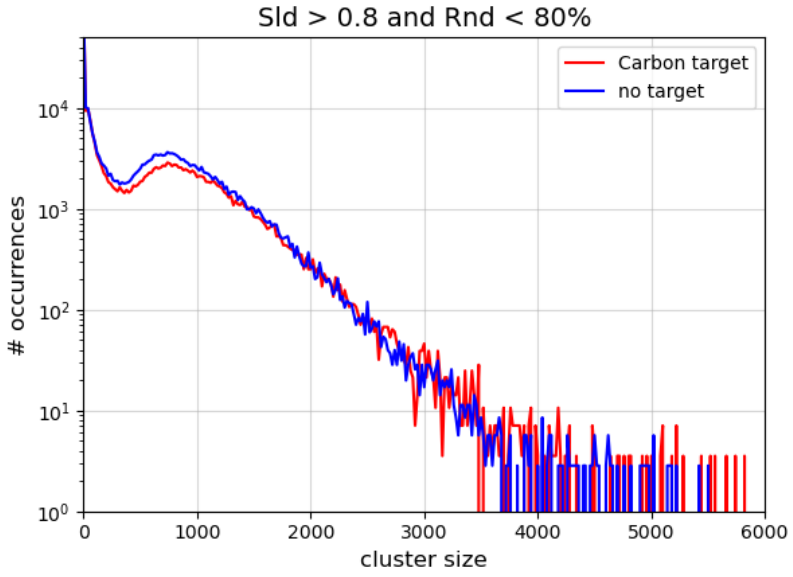






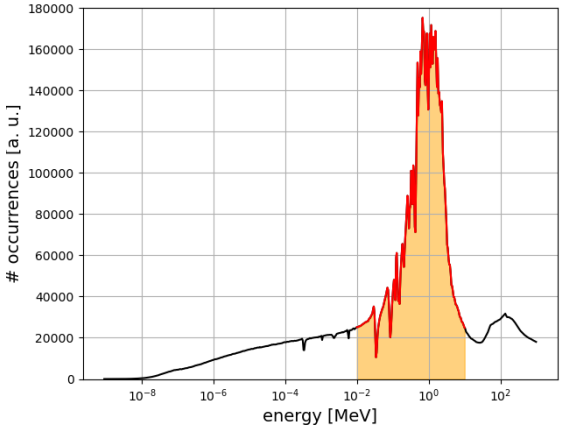


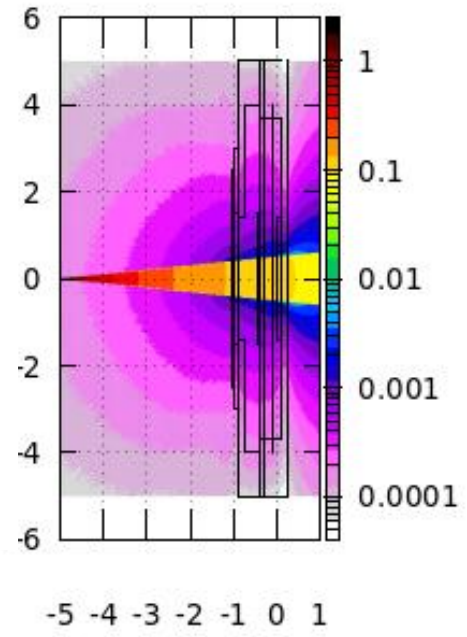




GEMpix: FLUKA simulations and particles discrimination (10 – 0.01 MeV)

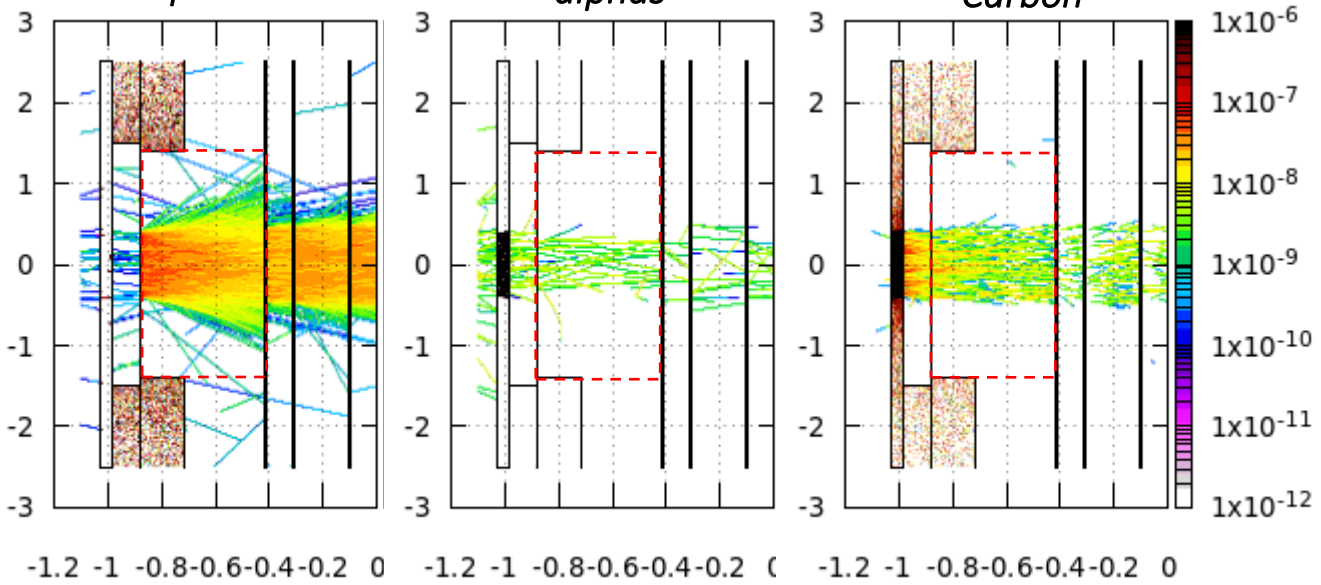
Input spectrum for simulation



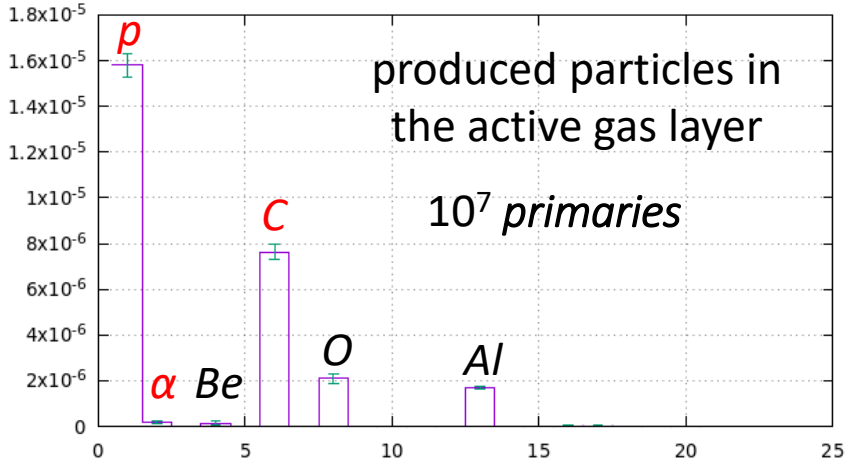


WITH TARGET

protons *alphas* *Carbon*



RESNUCLE GEMpix reactions v4 70

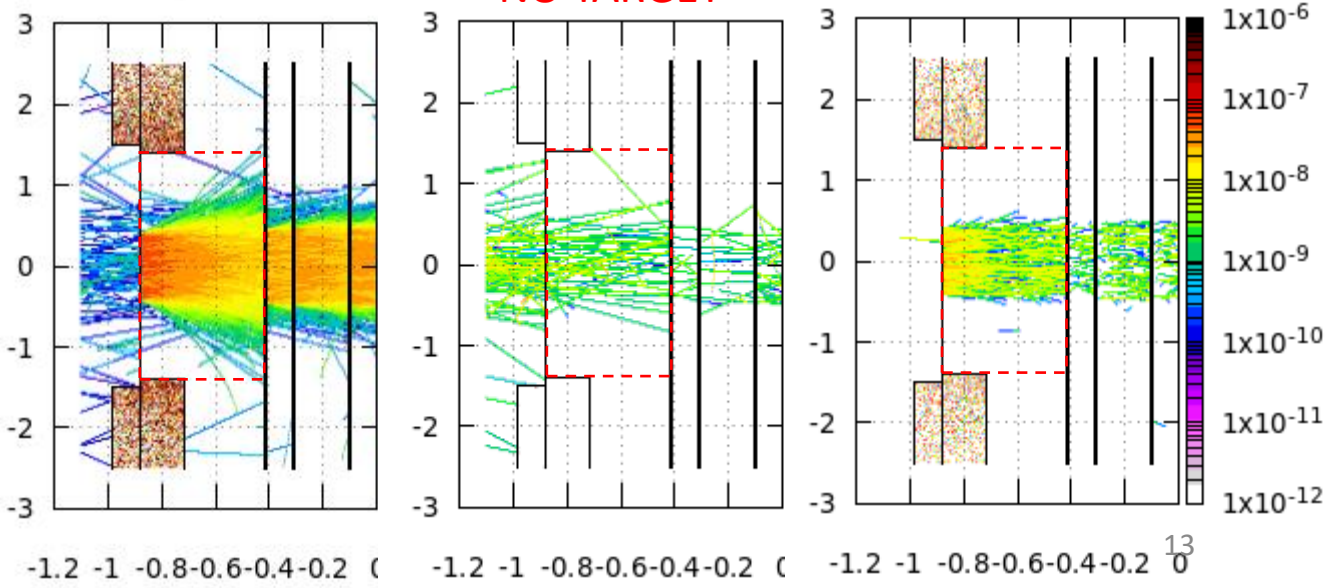


produced particles in the active gas layer

10^7 *primaries*

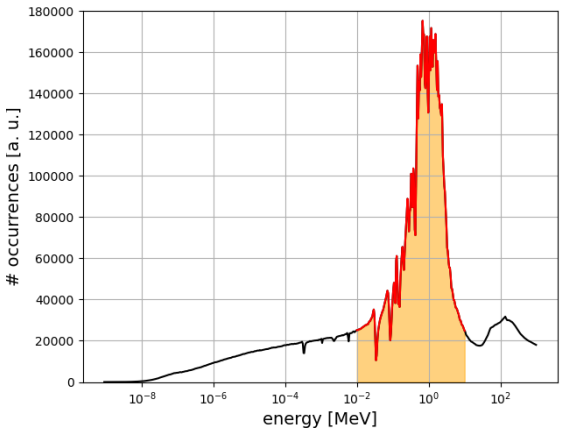
No significant differences have been found with and without target.

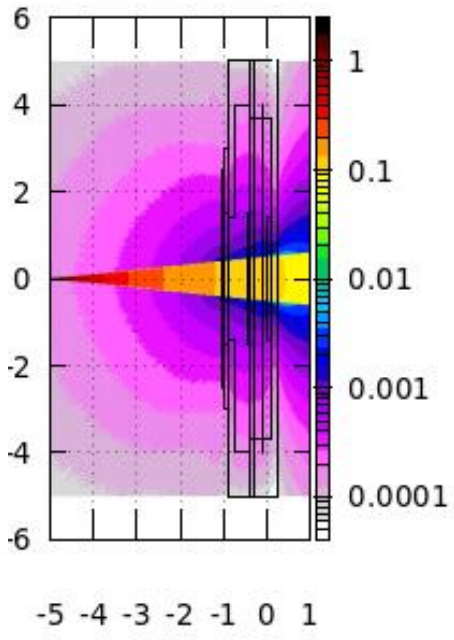
NO TARGET



GEMpix: FLUKA simulations and particles discrimination (10 – 0.01 MeV)

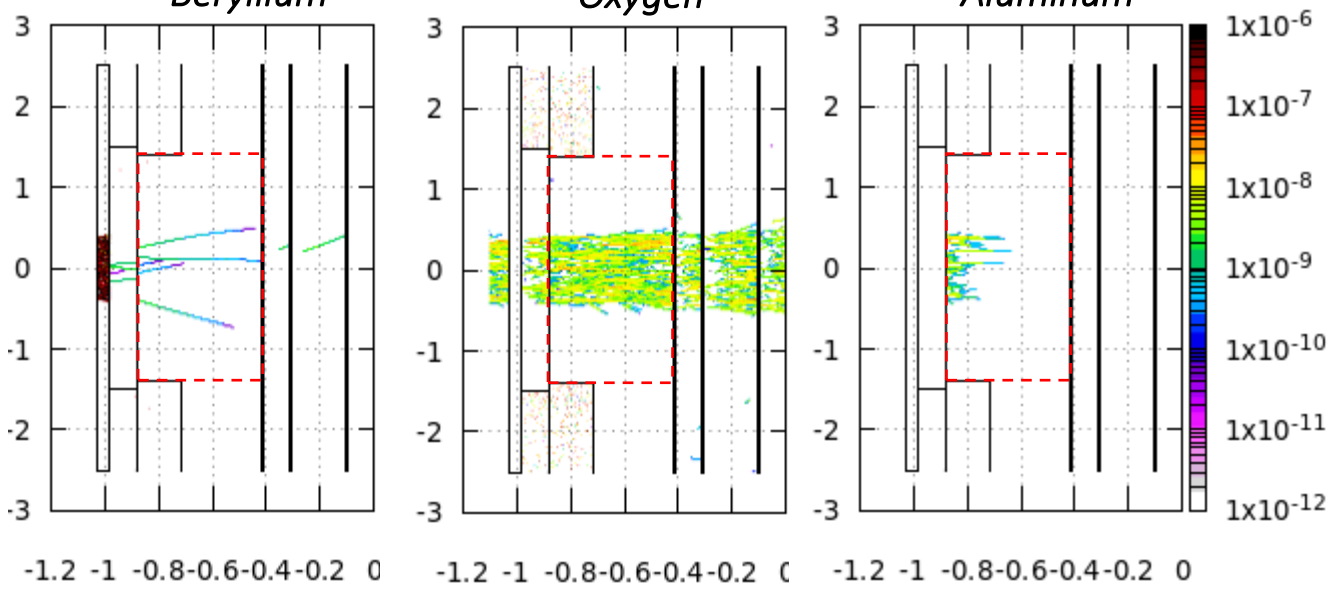
Input spectrum for simulation



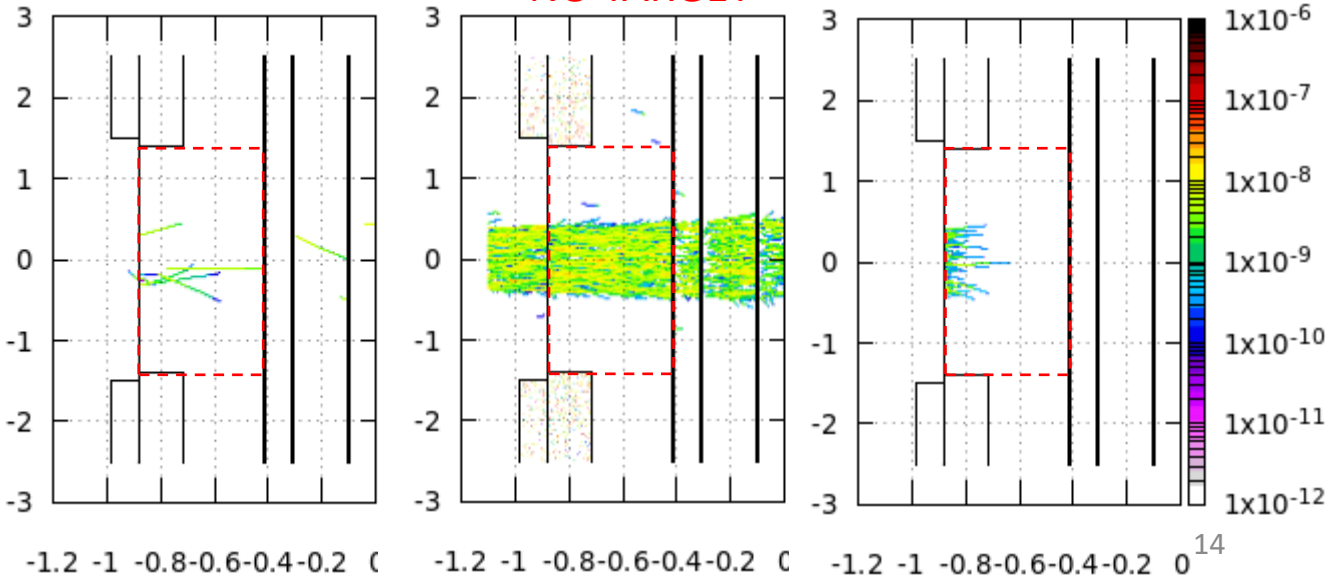


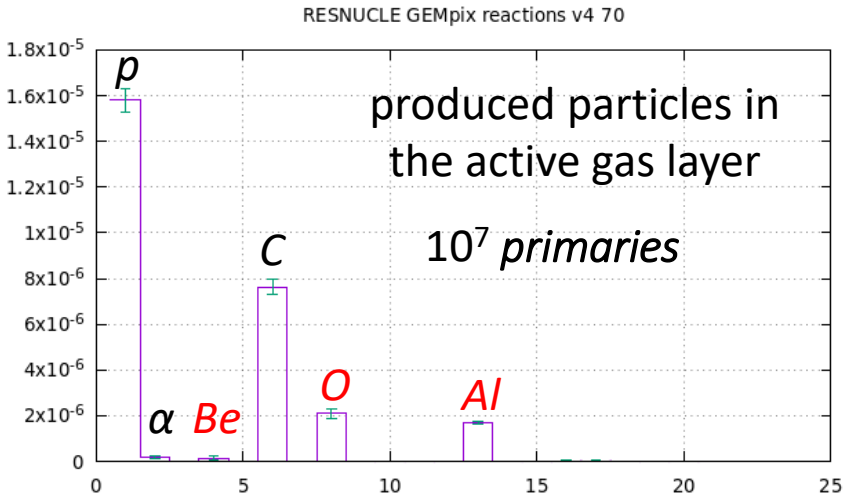
WITH TARGET

Beryllium *Oxygen* *Aluminum*



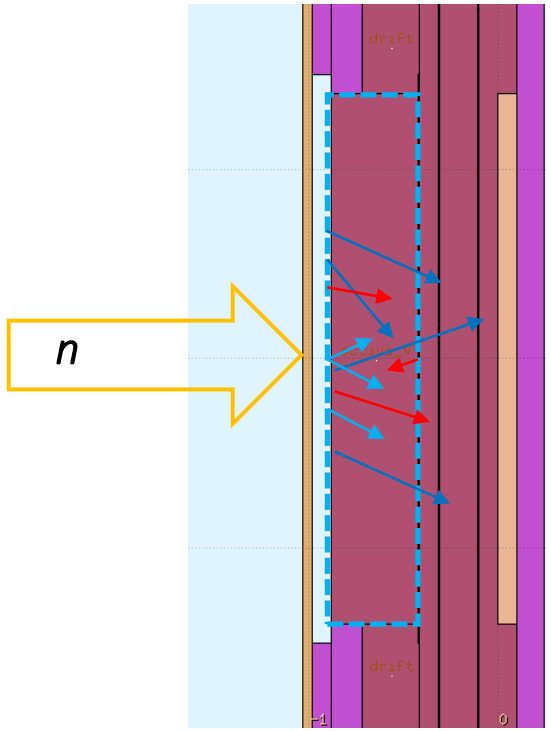
NO TARGET



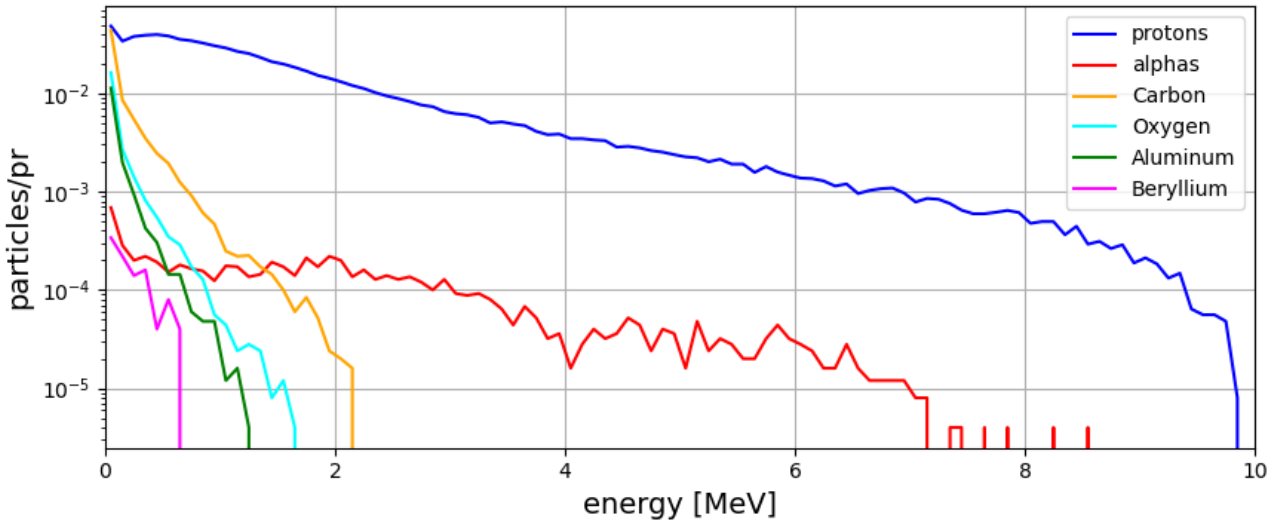


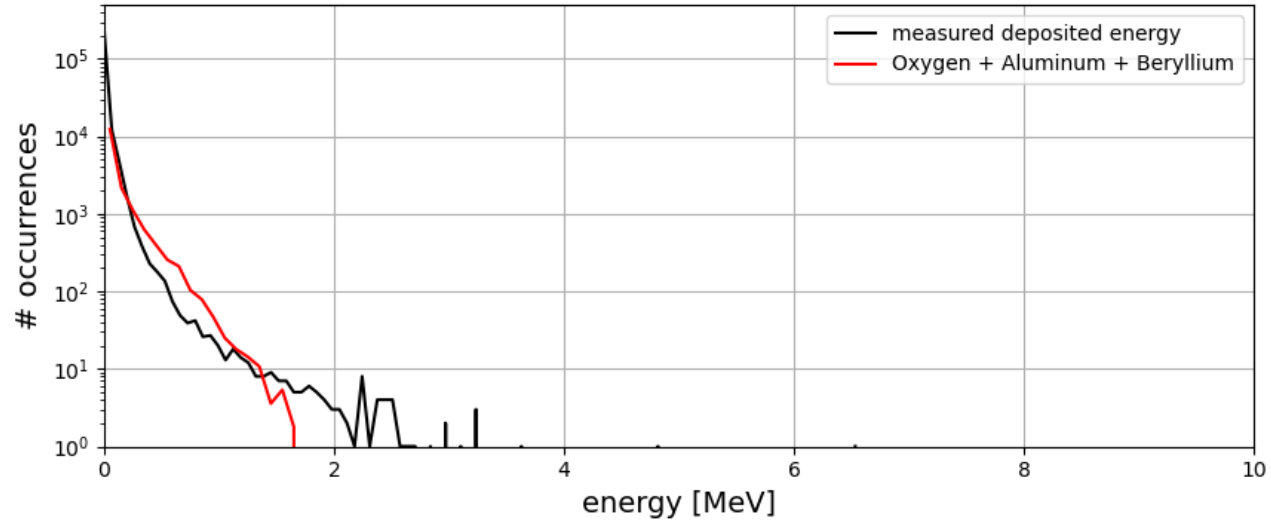
No significant differences have been found with and without target.

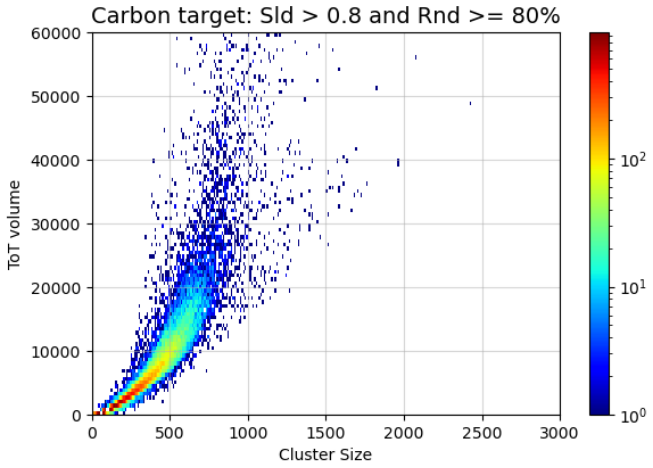
GEMpix: FLUKA simulations and particles discrimination (10 – 0.01 MeV)



Simulated spectrum of the particles entering in the active gas region







It seems that deposited charge distribution of the first population comes mainly from heavy ions like Oxygen, Aluminum and Beryllium

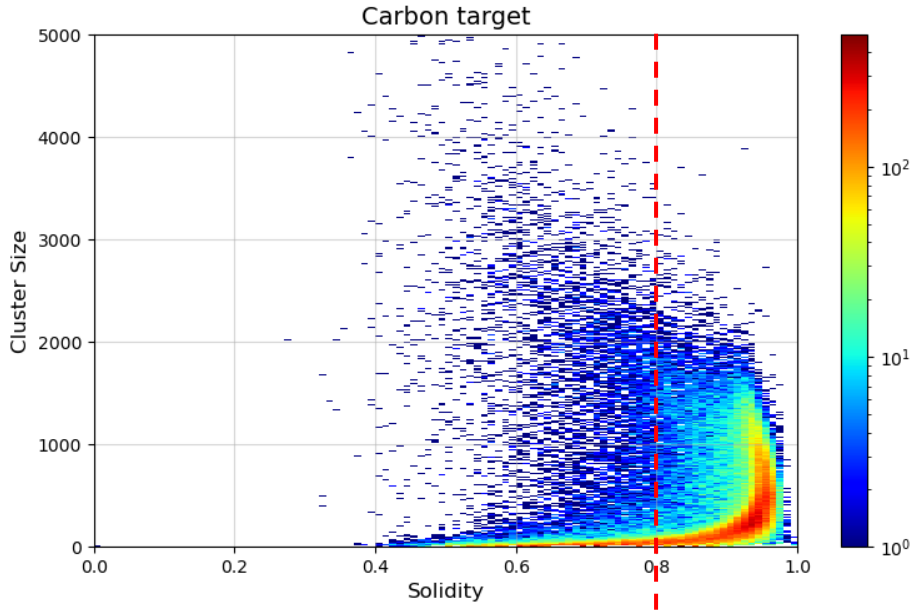
As a consequence, charge distribution produced by protons, alphas and, to a lesser extent, Carbon can be associated to the other population.

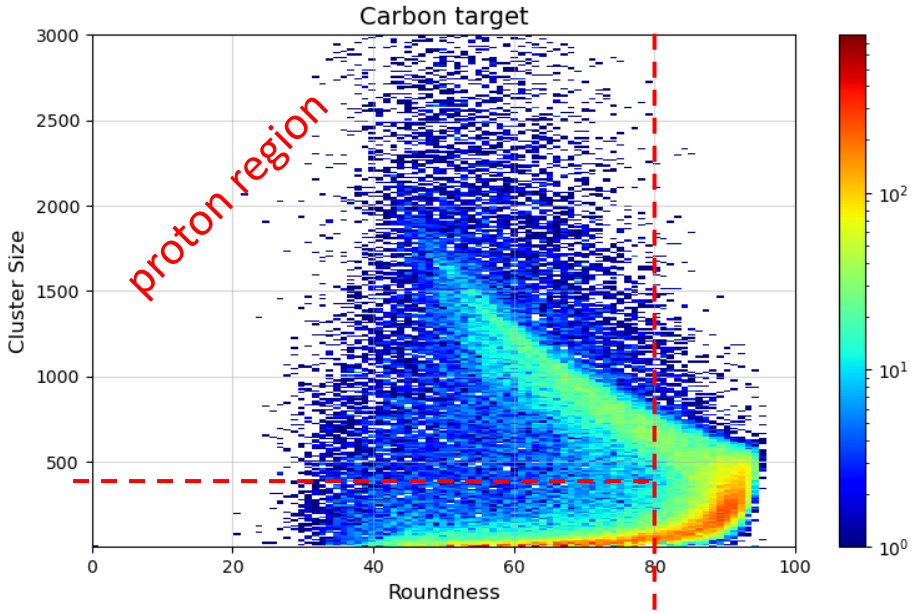
Further simulations will allow to estimate the charge contribution of all the produced particles!

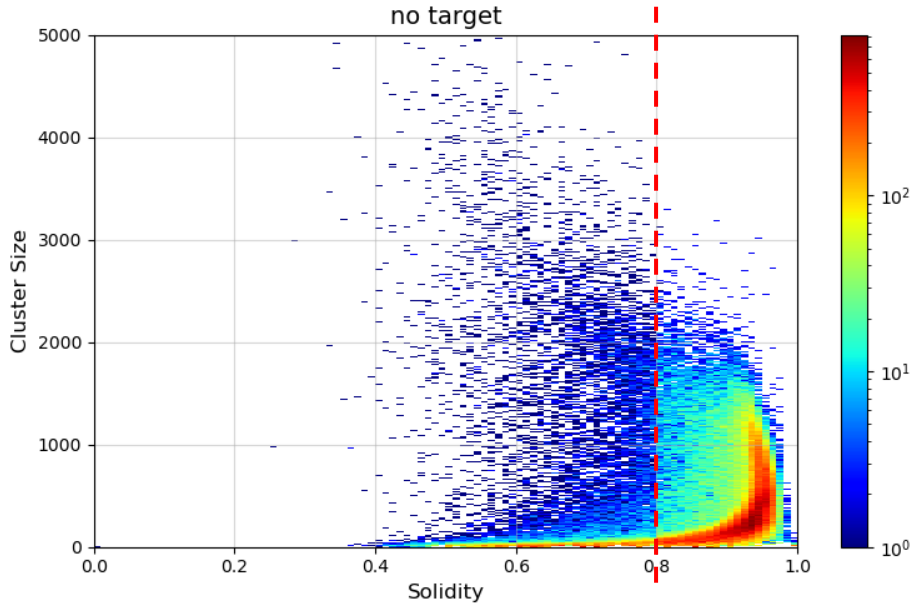
GEMpix with and without Carbon target (1.0 – 0.01 MeV)

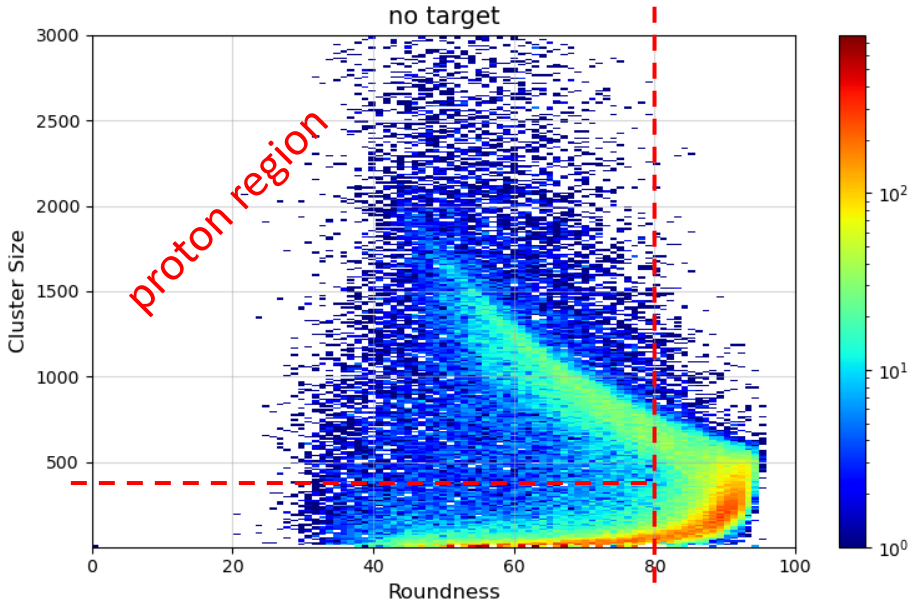
Carbon TARGET

NO TARGET



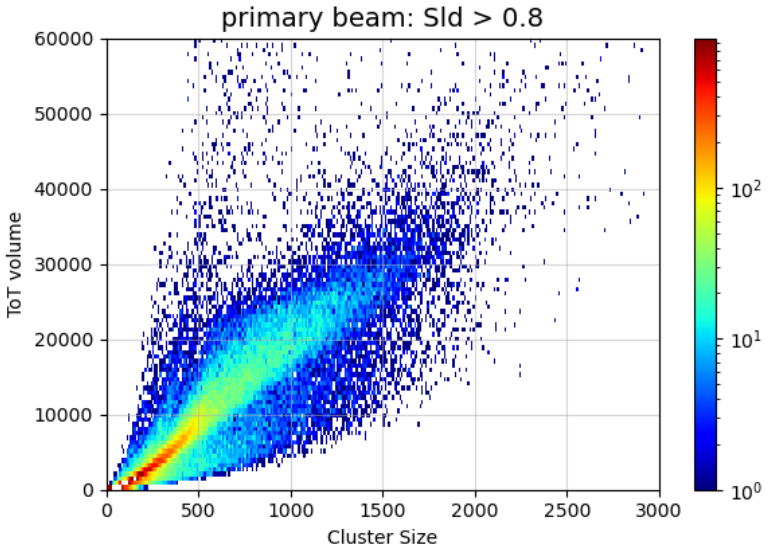


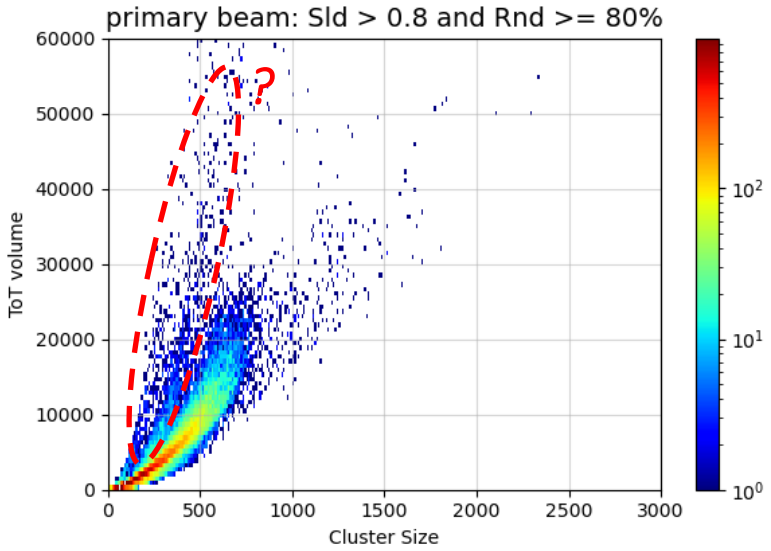


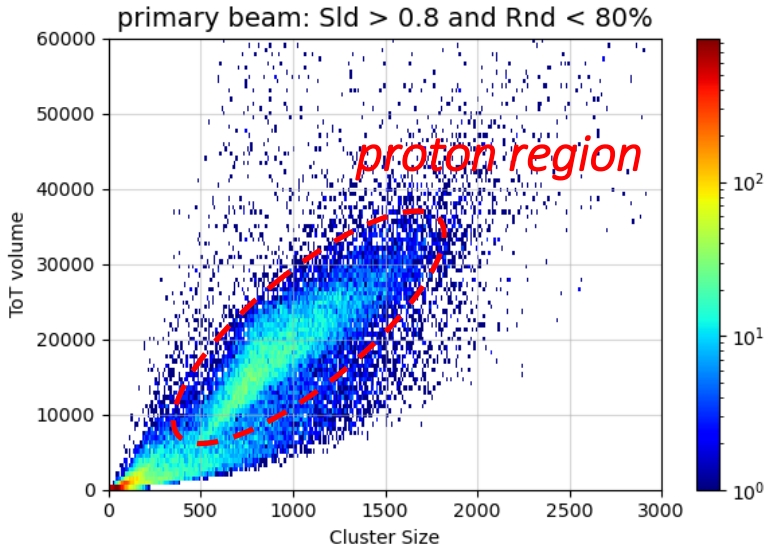


GEMpix: comparison between distribution with and without target (1.0 – 0.01 MeV)

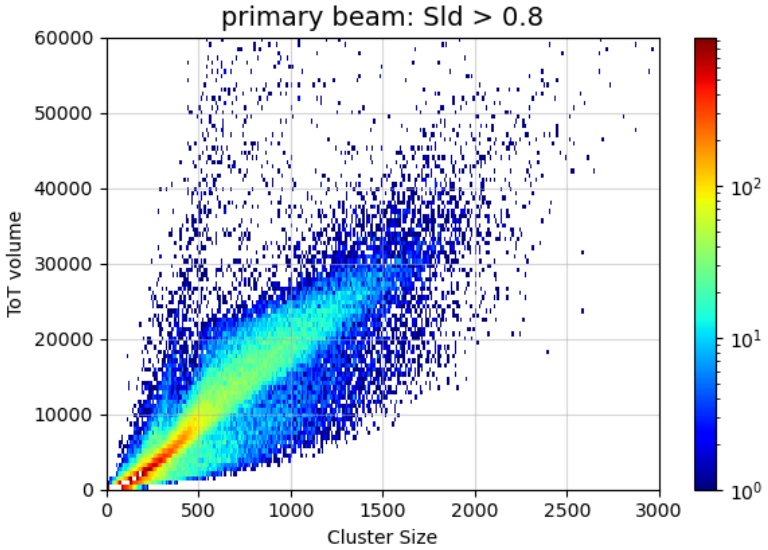
Carbon TARGET

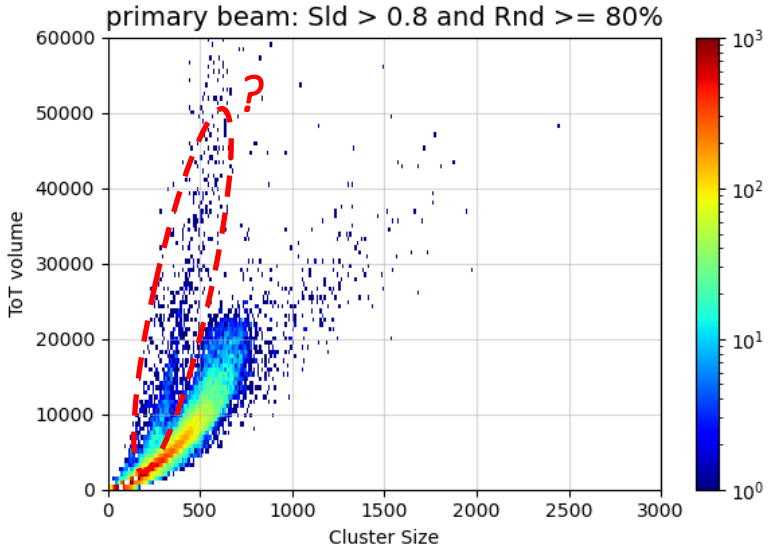


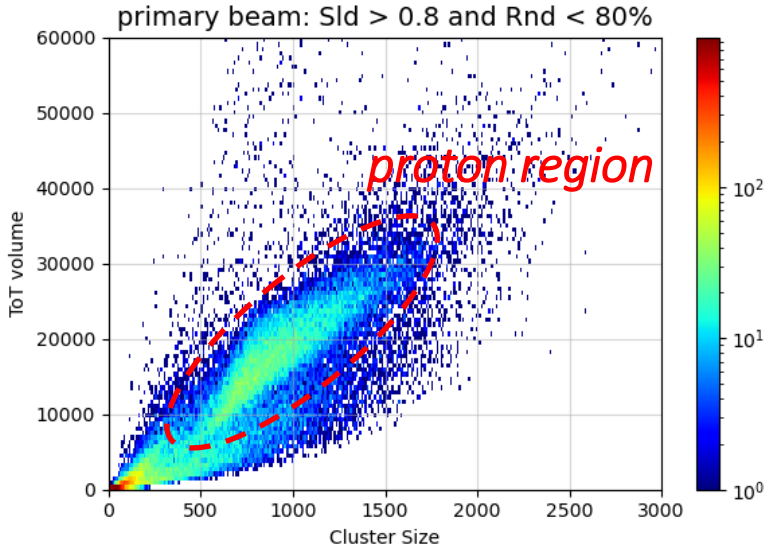




NO TARGET



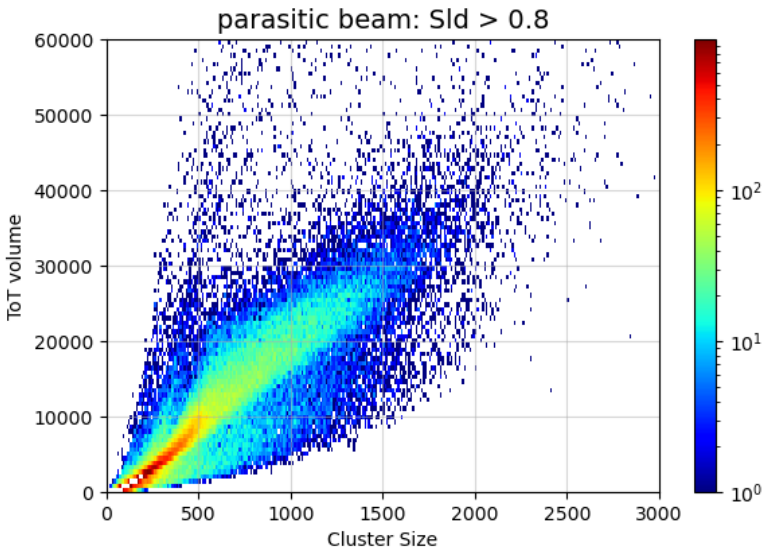


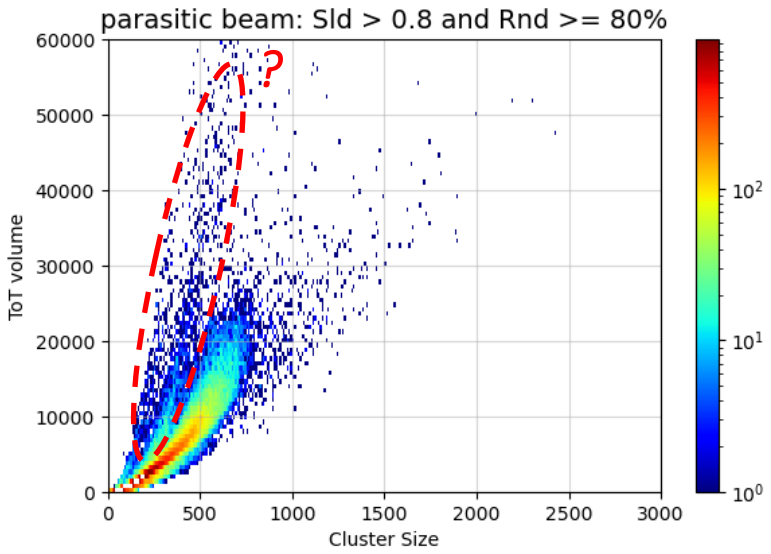


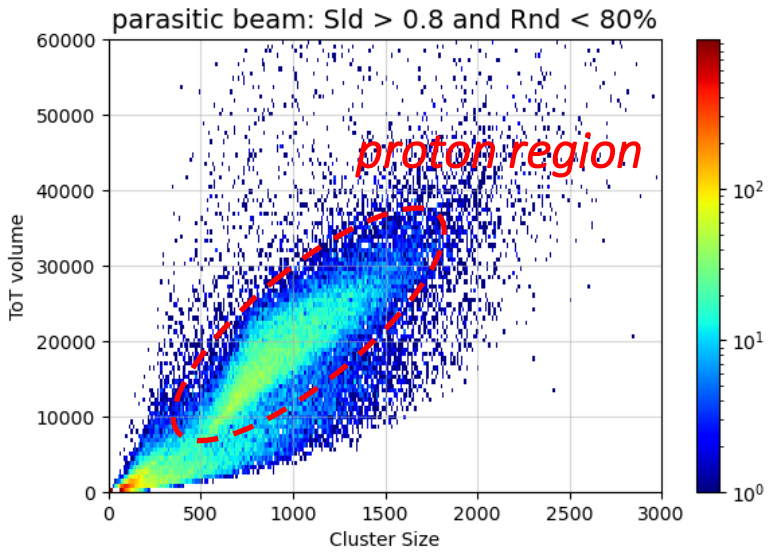
No significant differences have been observed between the two configurations!!!

GEMpix: comparison between distribution with and without target (1.0 – 0.01 MeV)

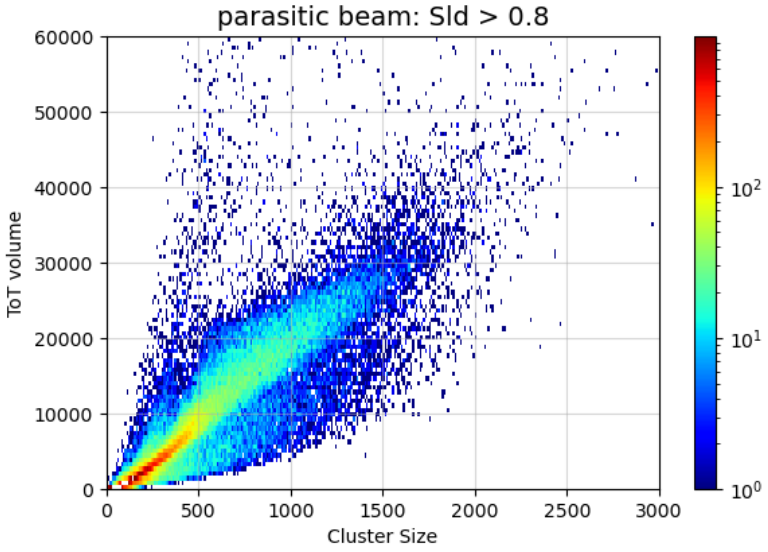
Carbon TARGET

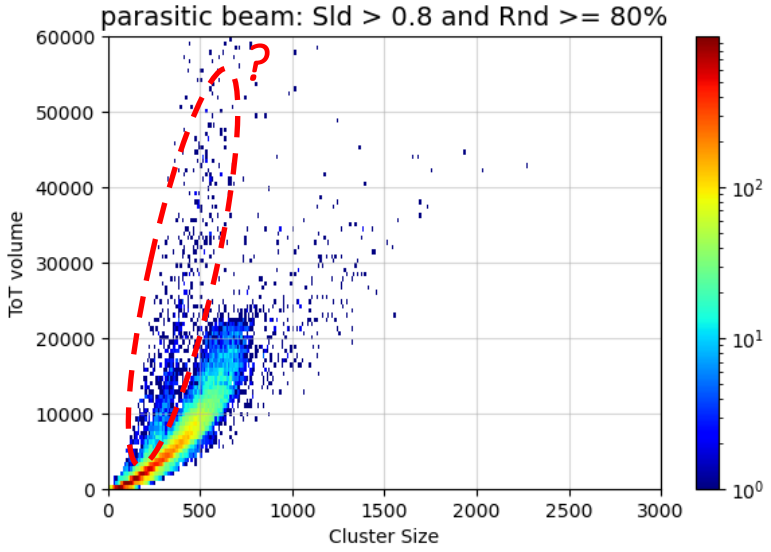


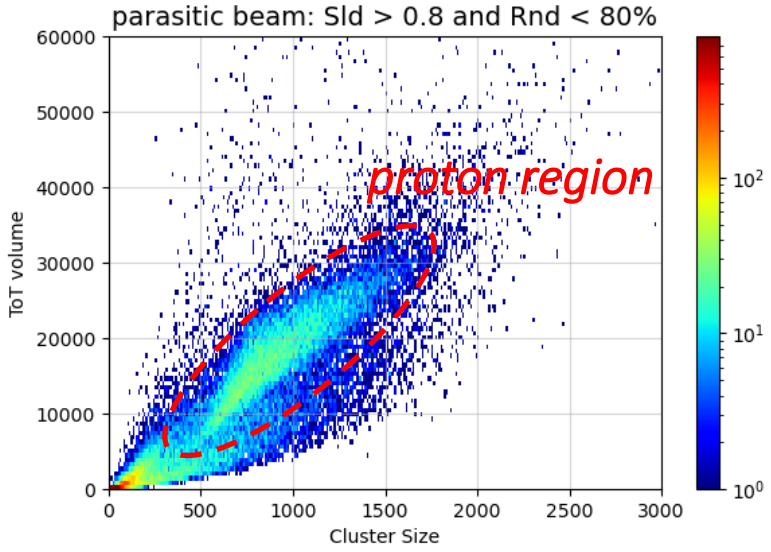




NO TARGET

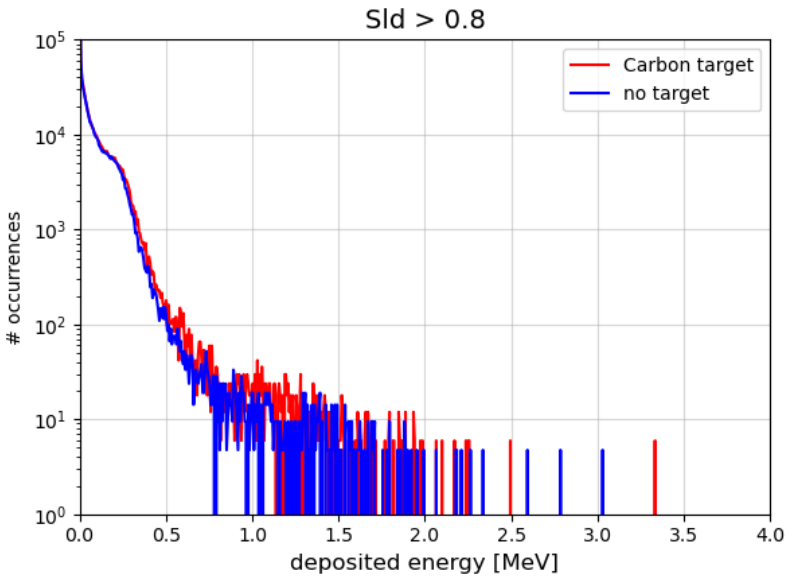


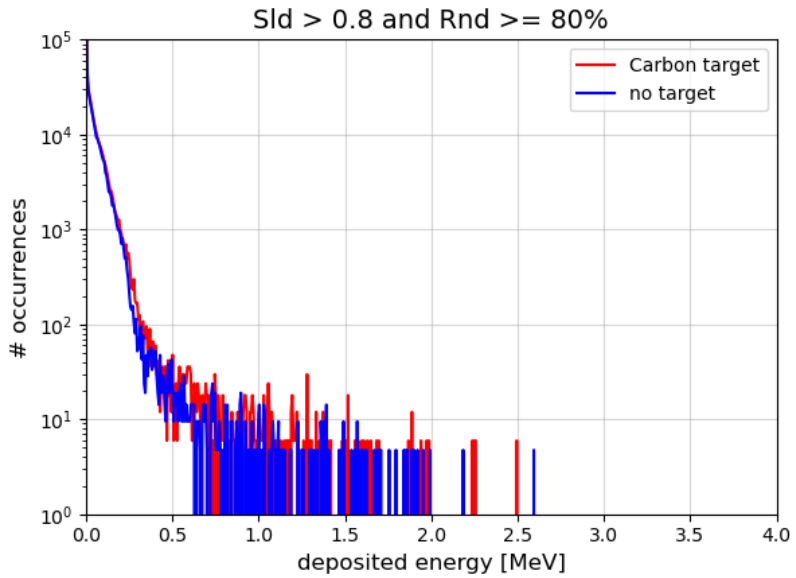


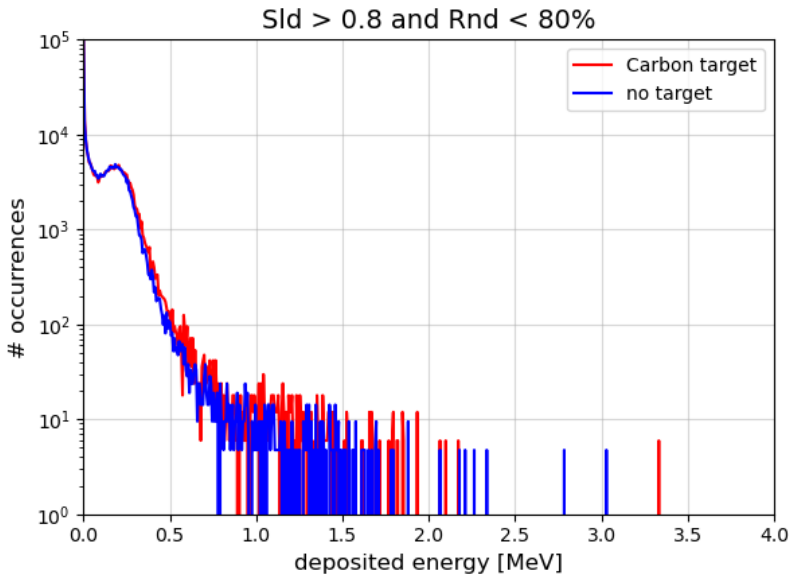


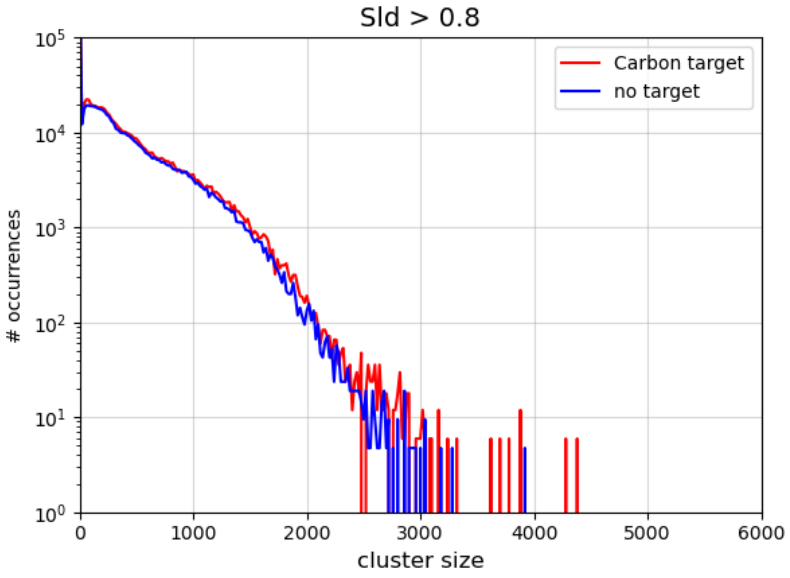
No significant differences have been observed between the two configurations!!!

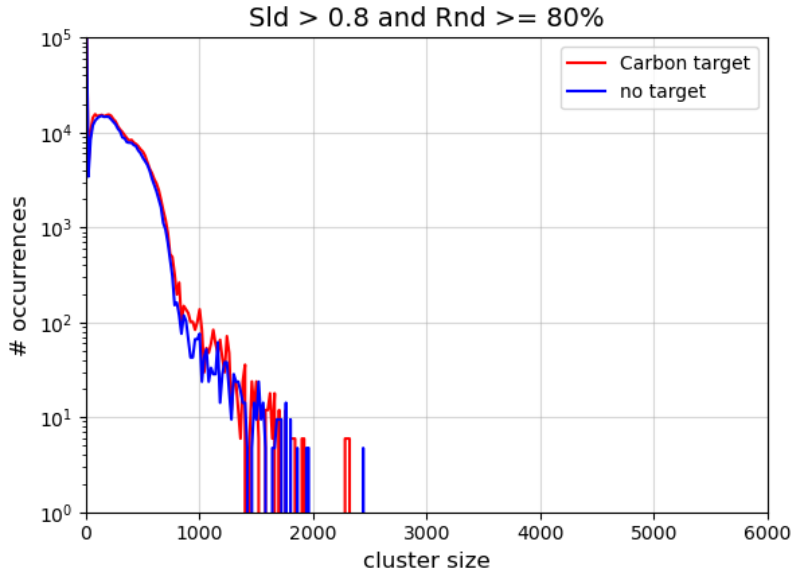
GEMpix: comparison between distribution with and without target (1.0 – 0.01 MeV)

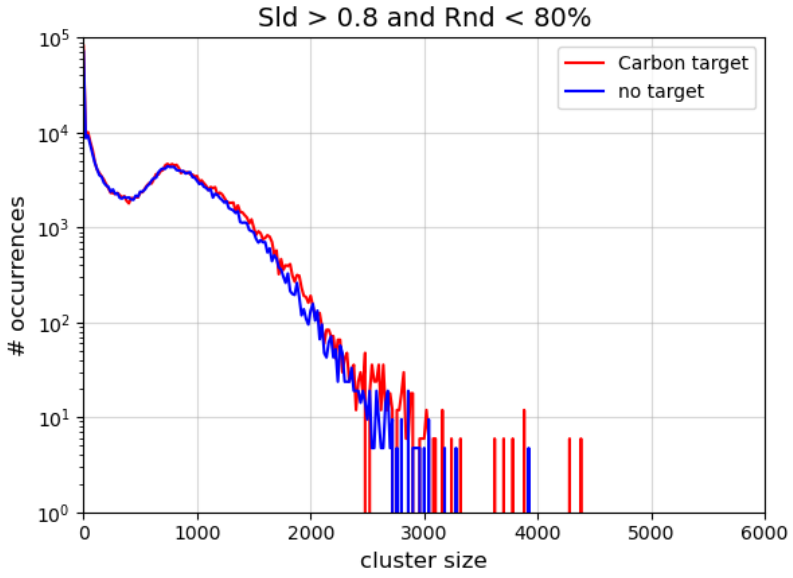






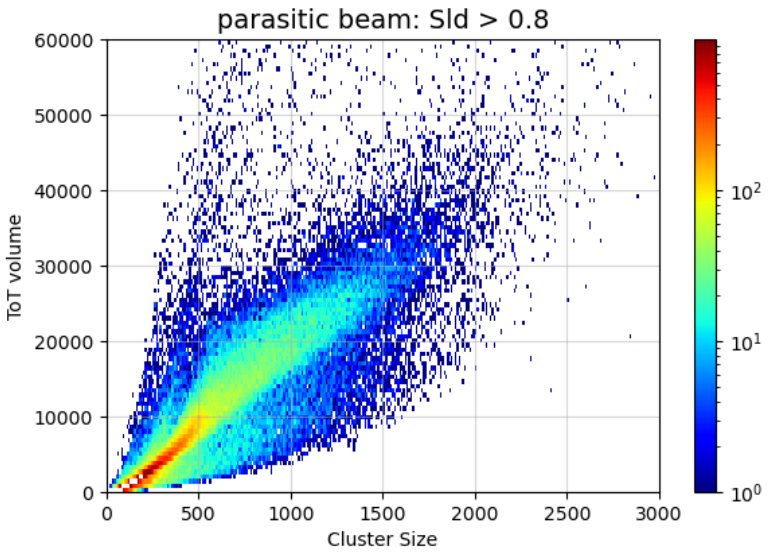


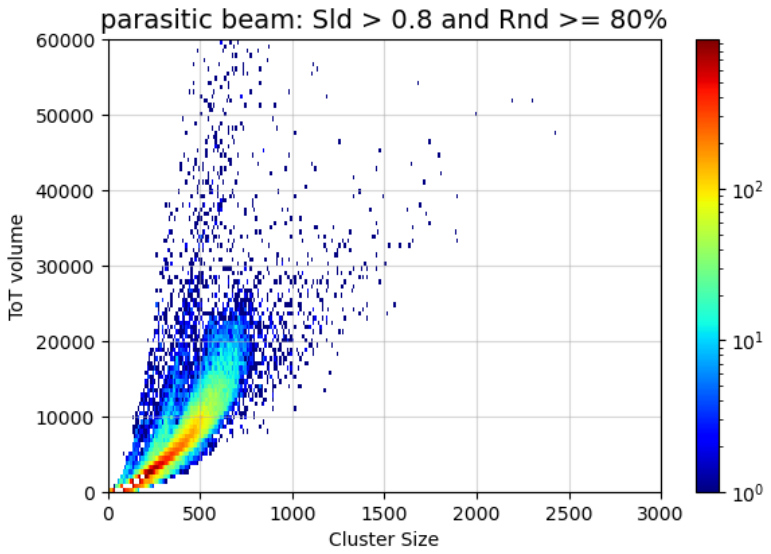


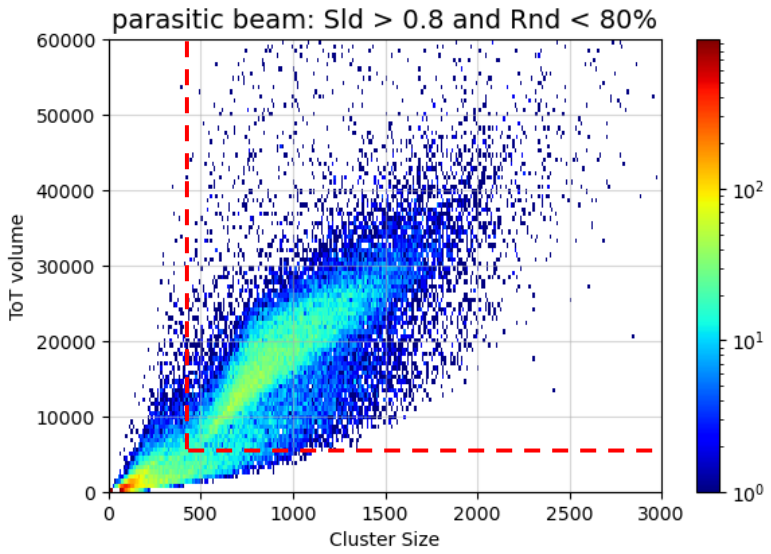


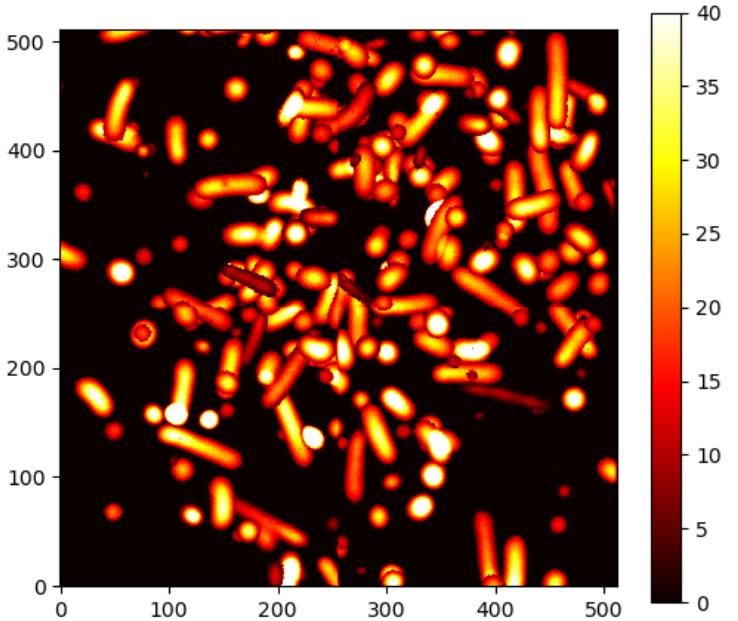
GEMpix: comparison between distribution with and without target (1.0 – 0.01 MeV)

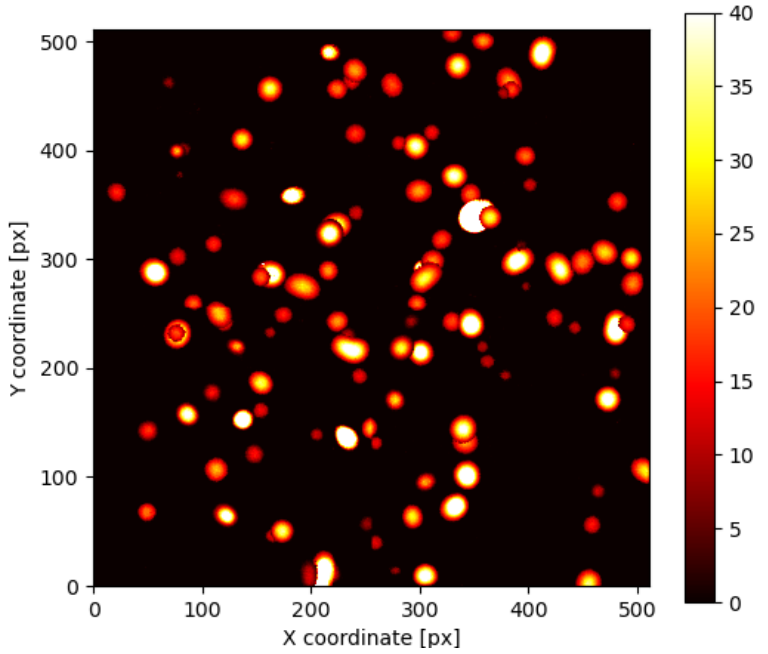
Carbon TARGET

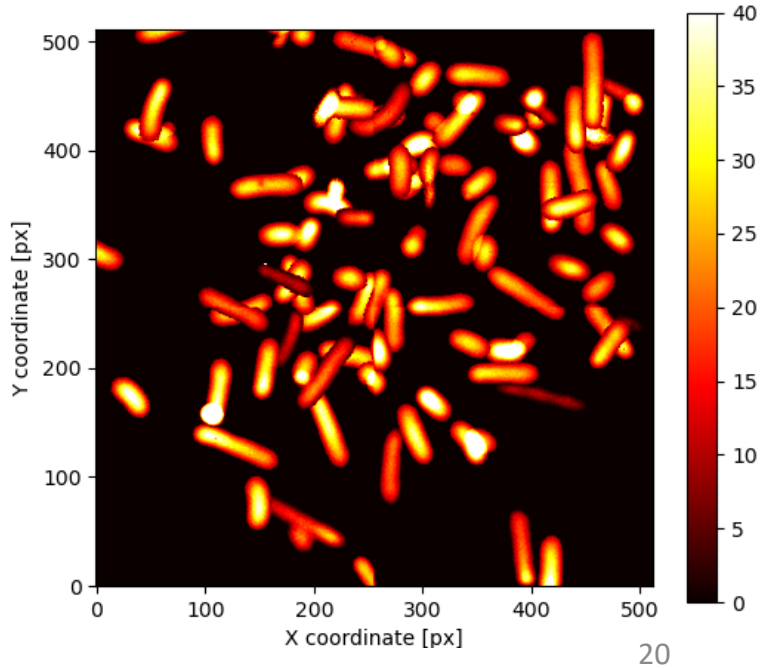






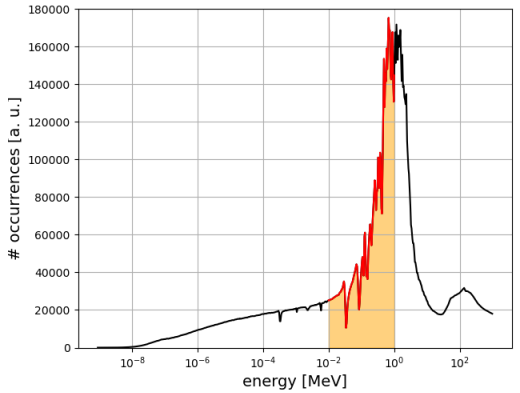


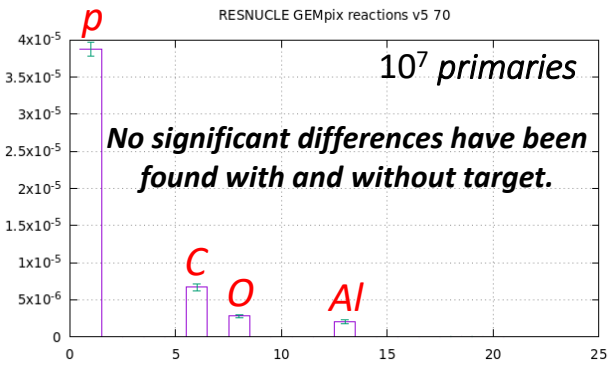


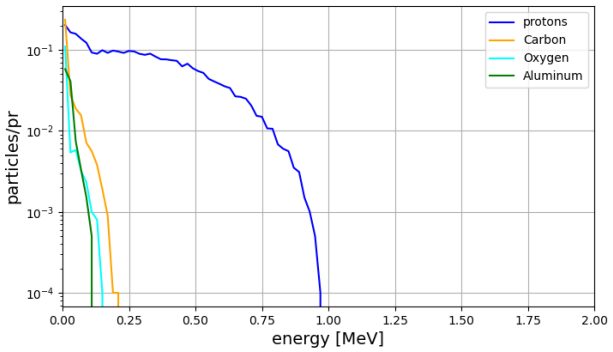


GEMpix: FLUKA simulations and particles discrimination (1.0 – 0.01 MeV)

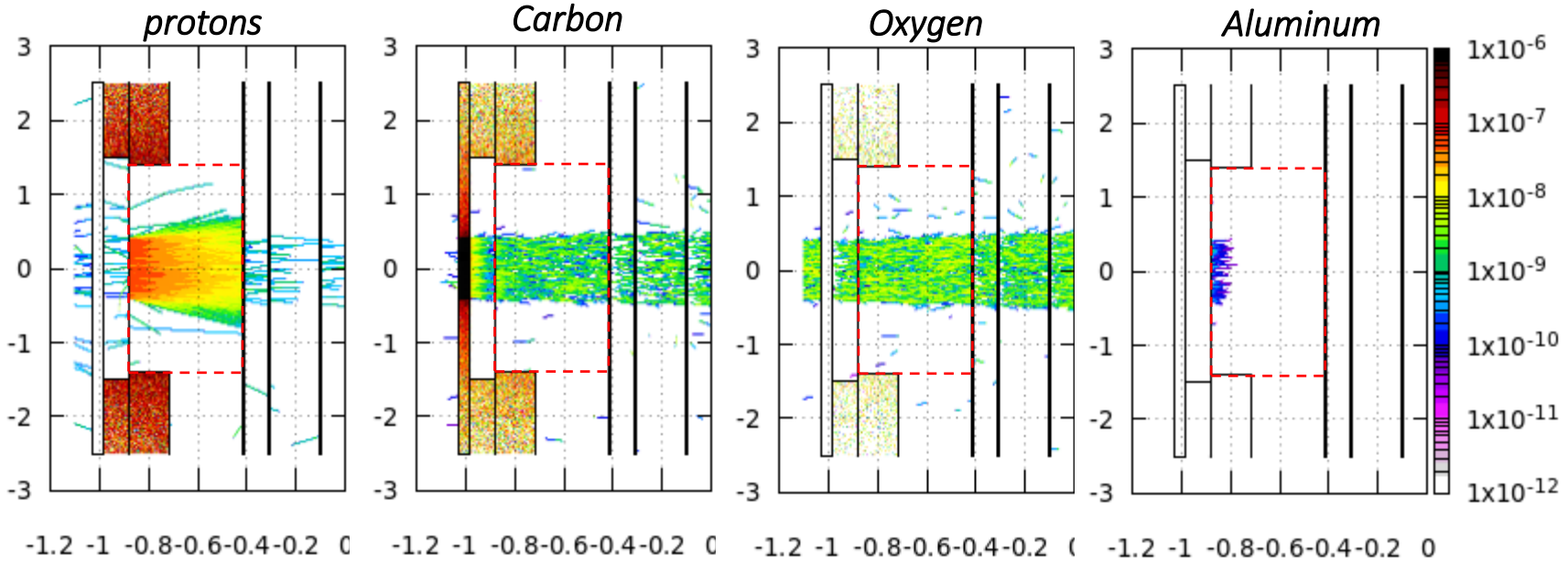
Input spectrum for simulation



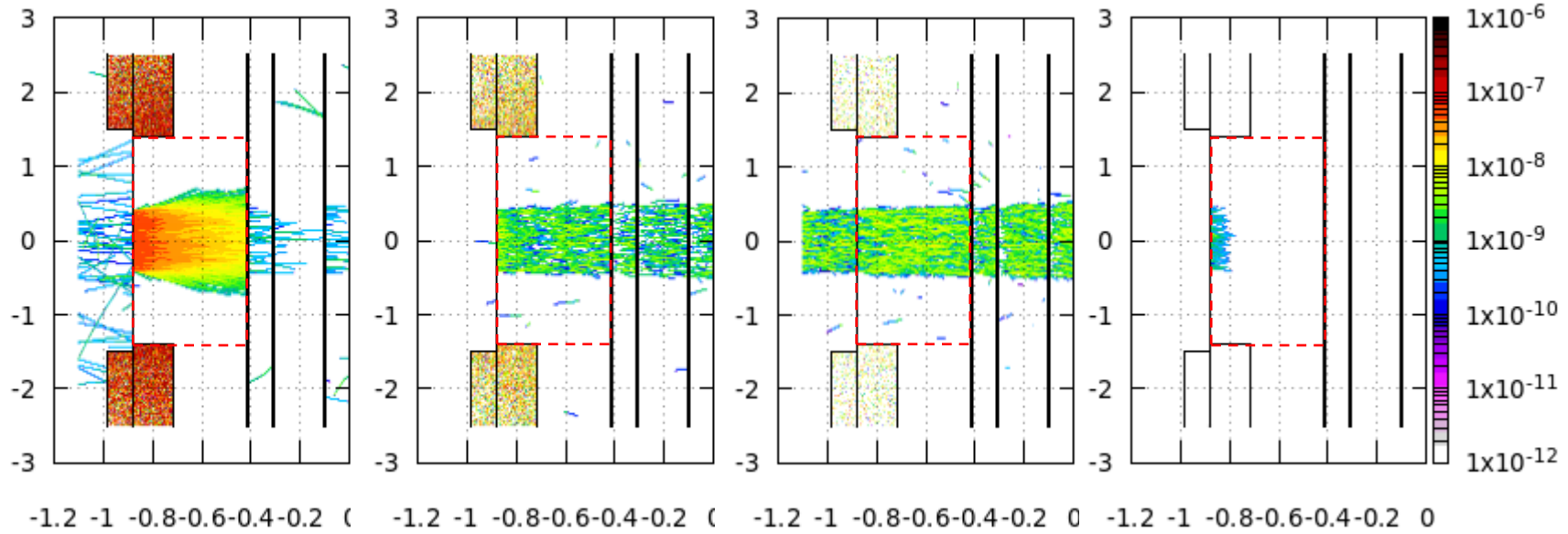




WITH TARGET



NO TARGET



Conclusions

- ✓ The GEMpix works in frame mode and the minimum time window is limited. In this case, in order to avoid ToT saturation, the minimum time window has been set to 100 μs (reaching minimum energies of about 10 keV).

- ✓ The breaking of window did not allow the exploitation of GEMpix potentialities for Carbon target. We worked with a new configuration and the relative track analysis is more complicated.

- ✓ First results shows that a big limitation comes from the mylar window of GEMpix: particles produced on the Carbon target seems to give not a significant contribution in the active gas layer because of the mylar window that stops them.

- ✓ On the contrary, the GEMpix detector worked correctly, and other contributions have been observed working on specific cluster parameters like Solidity and Roundness as well as Cluster Size and ToT volume (released charge)

- ✓ In particular, two main populations have been identified: a low contribution due to heavy ions like Be, O and Al and a big contribution due especially to protons coming from the 15 μm mylar window.

- ✓ At the moment, it seems that there is no signals from the Carbon target. Analysis will be further explored with the help of more accurate simulations and lab calibration measurements.

- ✓ However, the present results provides useful indications on the performance of GEMpix for this type of applications and will improve the realization of the new side-on GEM chambers scheduled for the next year.