# A Low Energy Recoil Tracker (ALERT) at Jefferson Laboratory

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French-Ukrainian meeting

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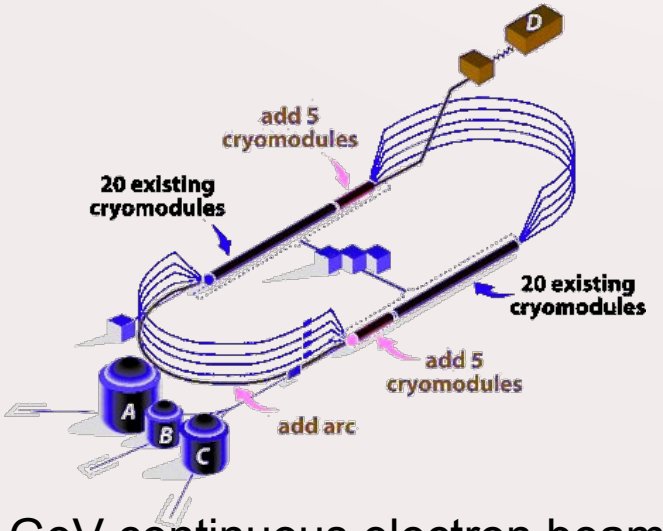
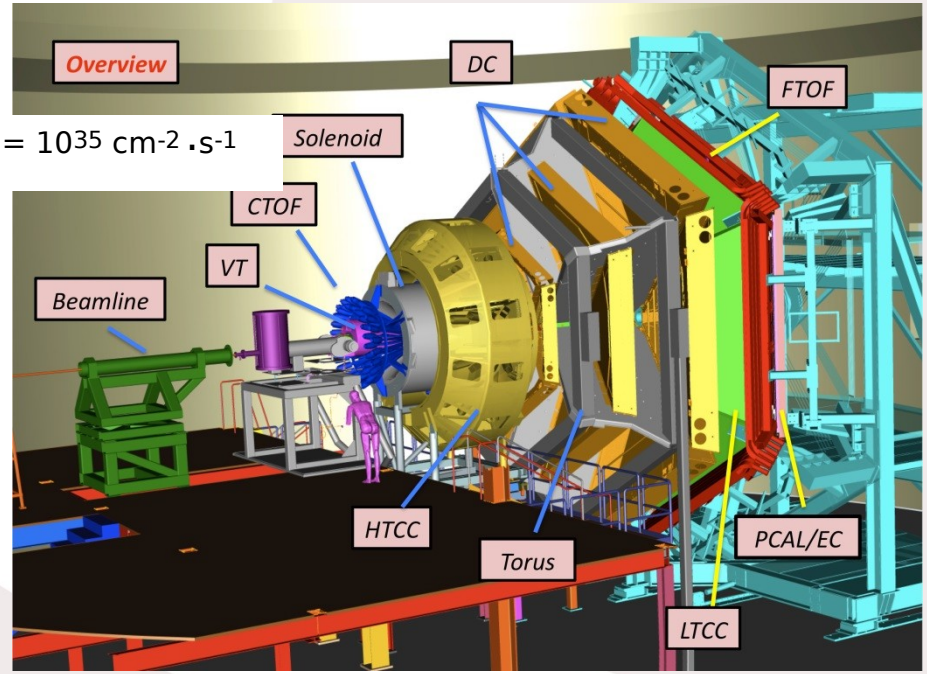
# Jefferson Laboratory, Virginia, USA


12 GeV continuous electron beam



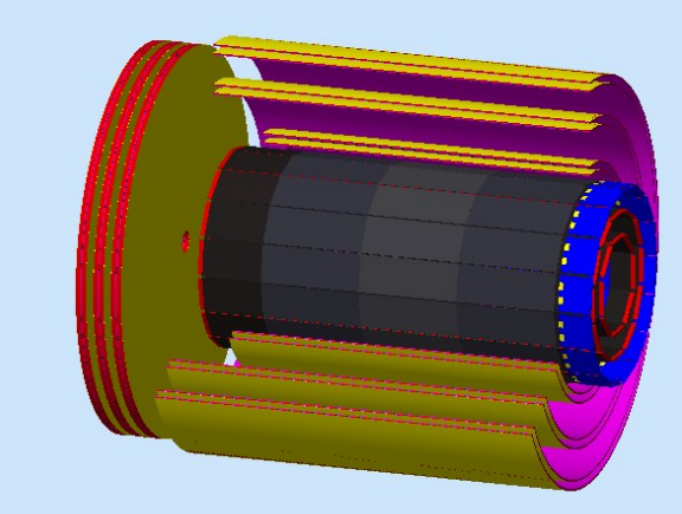

$L = 10^{35}\ cm^{-2} \cdot s^{-1}$

Scheme of CLAS12 (Hall B)

**The Hall B will adress the following questions:**

- What is the longitudinal and transverse structure of the nucleon?
- What is the 3D structure of the nucleon?
- What is the hadronic spectrum?
- What can we learn about hadrons and cold nuclear matter?

# Central detector



The planned central detector for CLAS12:

- 4 layers of silicon detector
- 6 layers of central cylindrical Micromegas
- 6 layers of forward Micromegas
- CTOF
- Neutron detector
- 5 T magnetic field
- Separate protons, kaons, pions
- Detect neutrons
- **Energy threshold 200-300 MeV/c**

**Need to be reduced for certain experiments**

**+**

**Keep the possibility to be included in the trigger**

**+**

**Separate protons, deuterium, tritium, alpha, helium 3**

# Which detectors?

After a comparison between existing detectors a **drift chamber and an array of scintillators** have been chosen.

It has the following advantages:

- Low material tracker
- Fast detector if wires are not too far and gas well chosen
- Both detectors can be included in the trigger
- Separate protons, deuterium, tritium, alpha, helium 3

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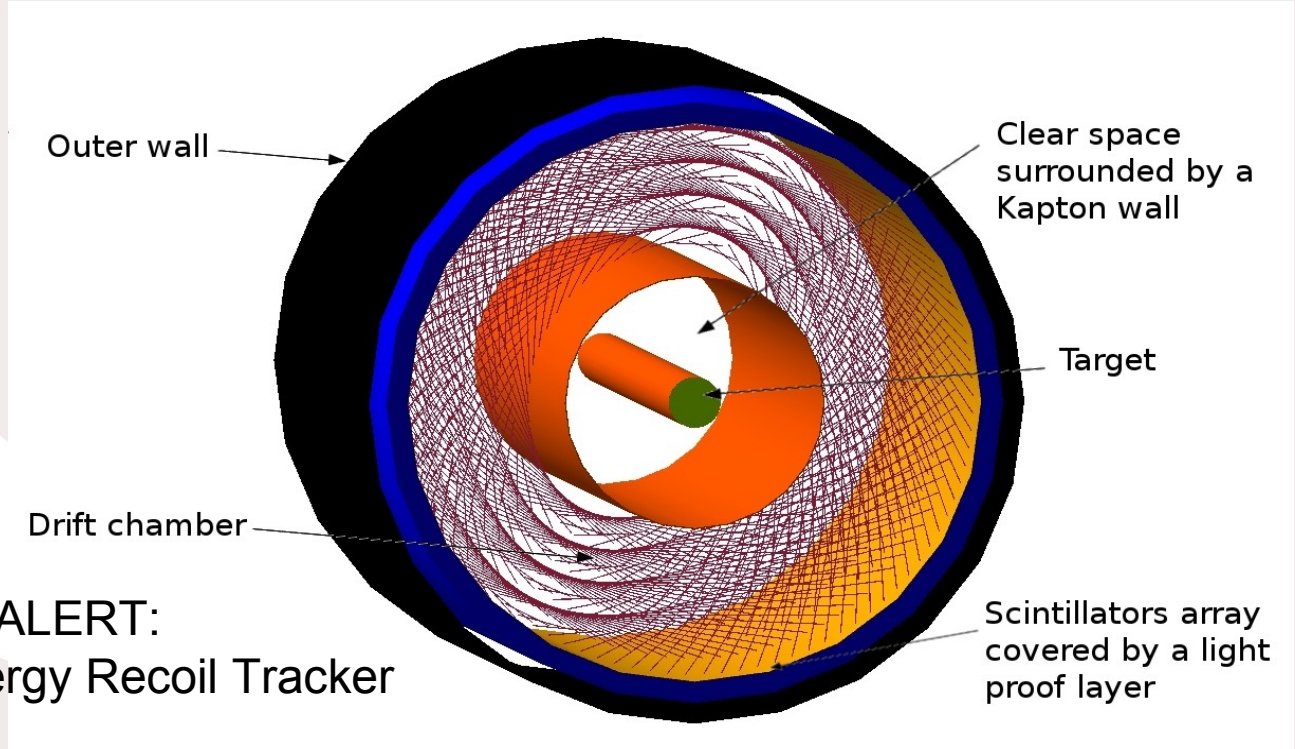
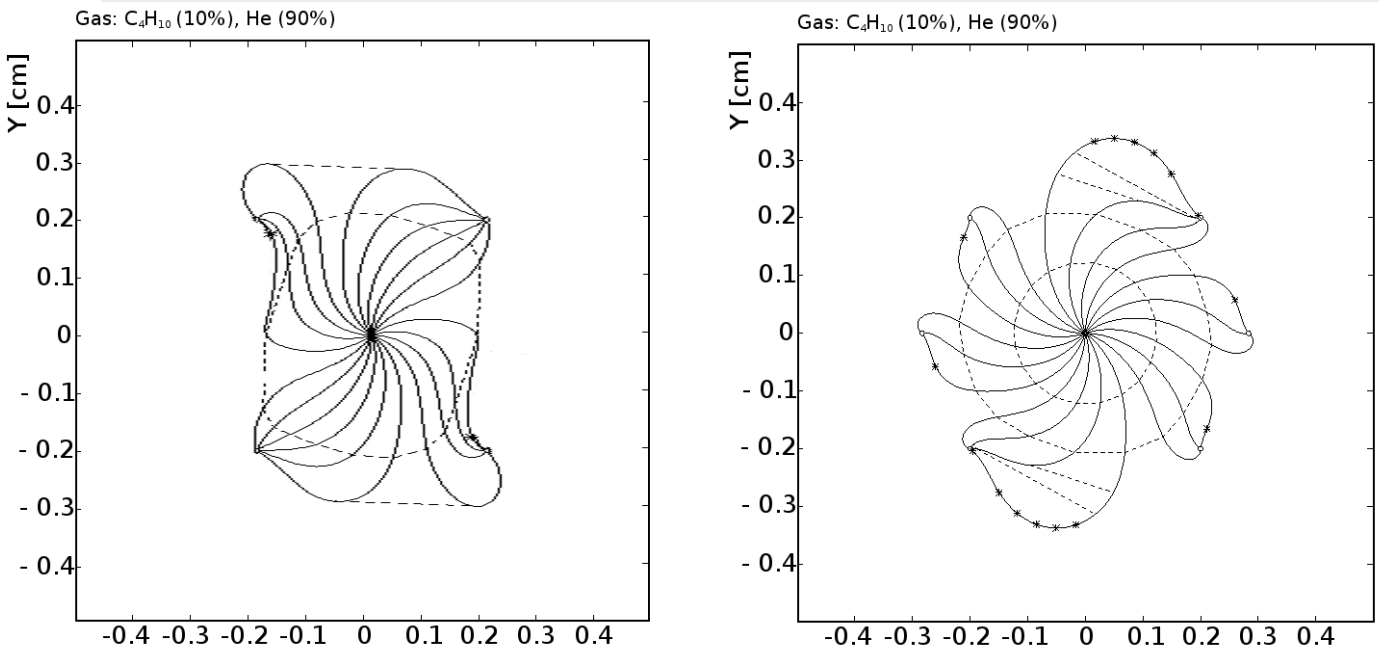



ALERT:
A Low Energy Recoil Tracker

# Drift chamber layout (1/2)

Use stereo angle to determine the position along the beam axis
Space between two wires of different potential: 2 mm

Layout of the wires (elementary cell)

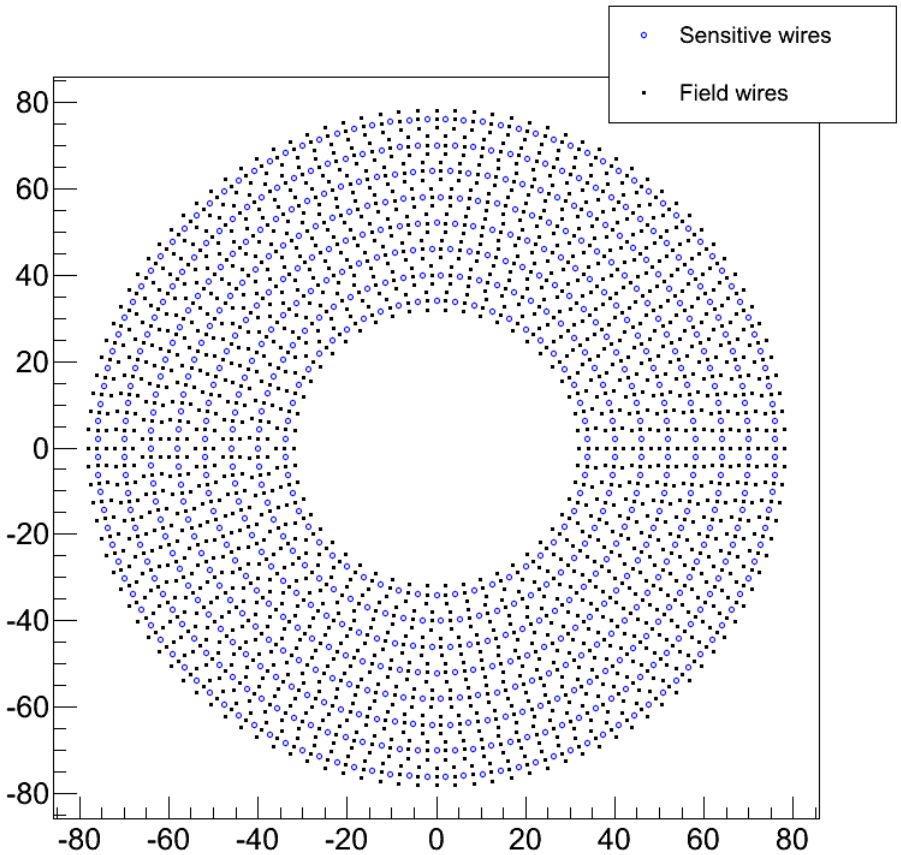



GARFIELD simulations of the electron drift lines, G. Dodge

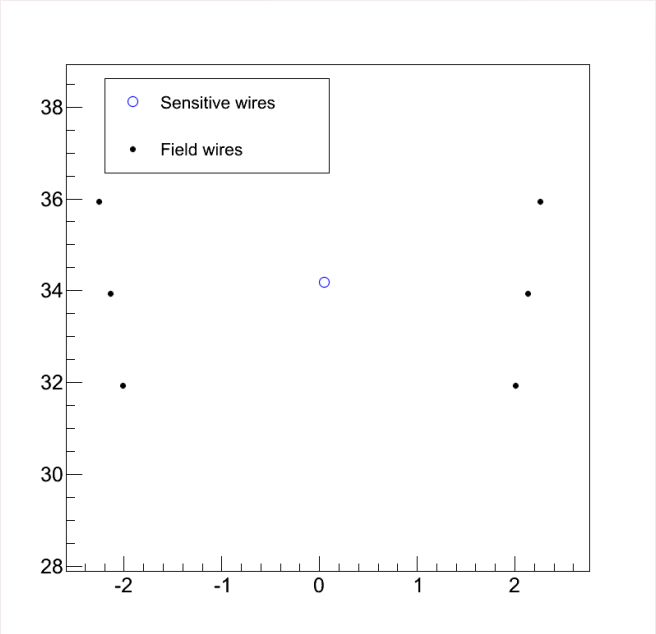
**Maximum drift time estimated to be 200 ns**

A prototype with different cell configuration is being designed.

# Drift chamber layout (2/2)



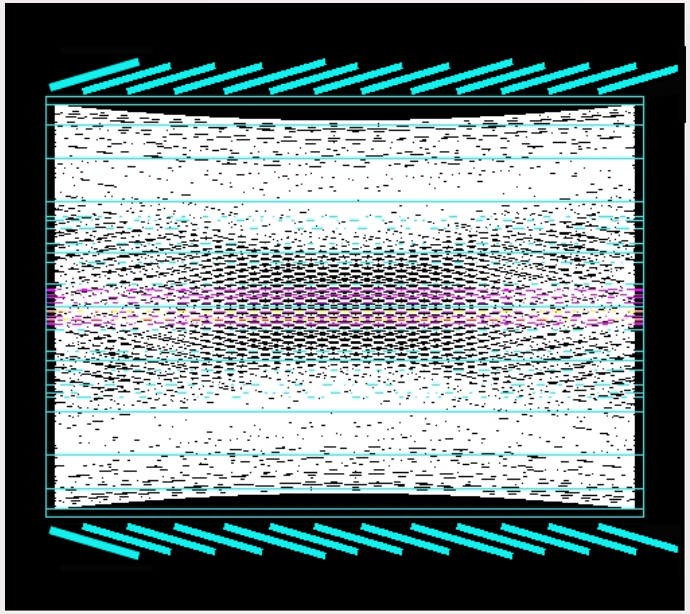

Example of a layout. In this configuration there are 662 sensitive wires and 1986 field wires




View of one cell

To ensure a 20 microns sag, the total weight on the end plate due to the tension is about 600 kg. **Tests will be performed to use lighter wires.**

# Scintillators layout



Configuration under study, signal readout by APDs

Several layers are superimposed which allows to measure dE/dx and help to identify particles.

The granularity needs to be determined. It depends on:

- the time resolution
- the rate
- matching with the drift chamber.

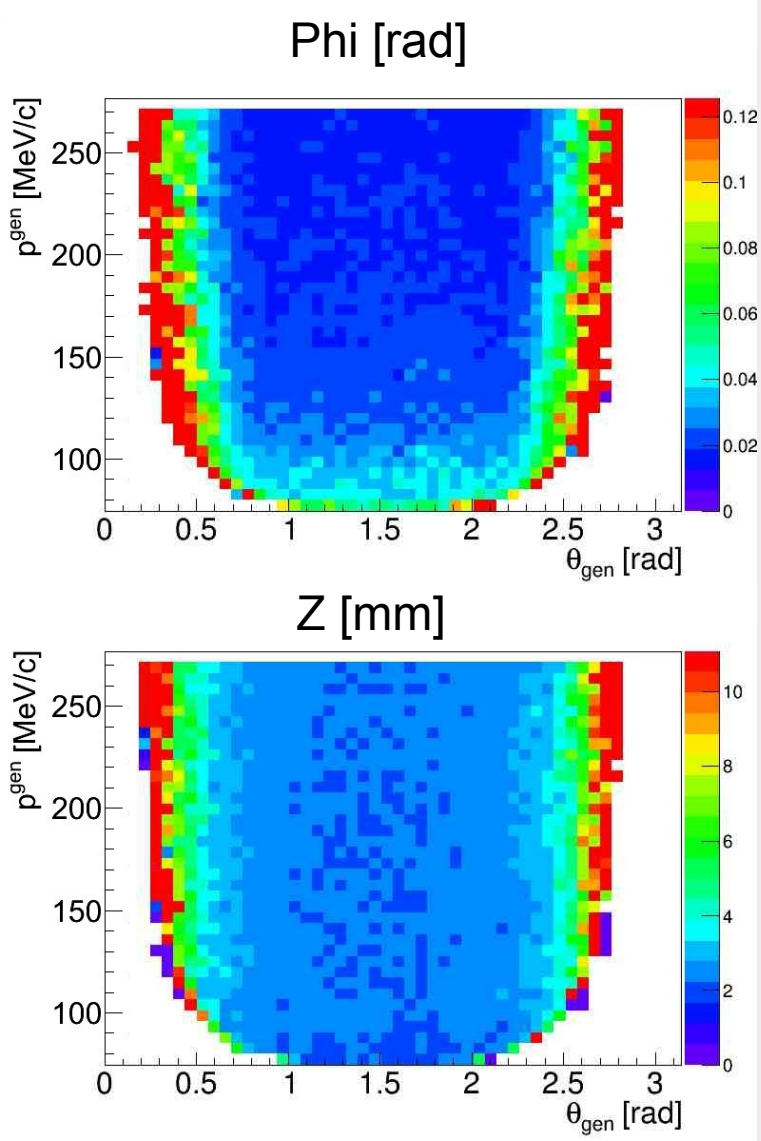
The scintillators must also have the ability to detect particles from alphas to protons. A multi-layer scintillator may be needed.

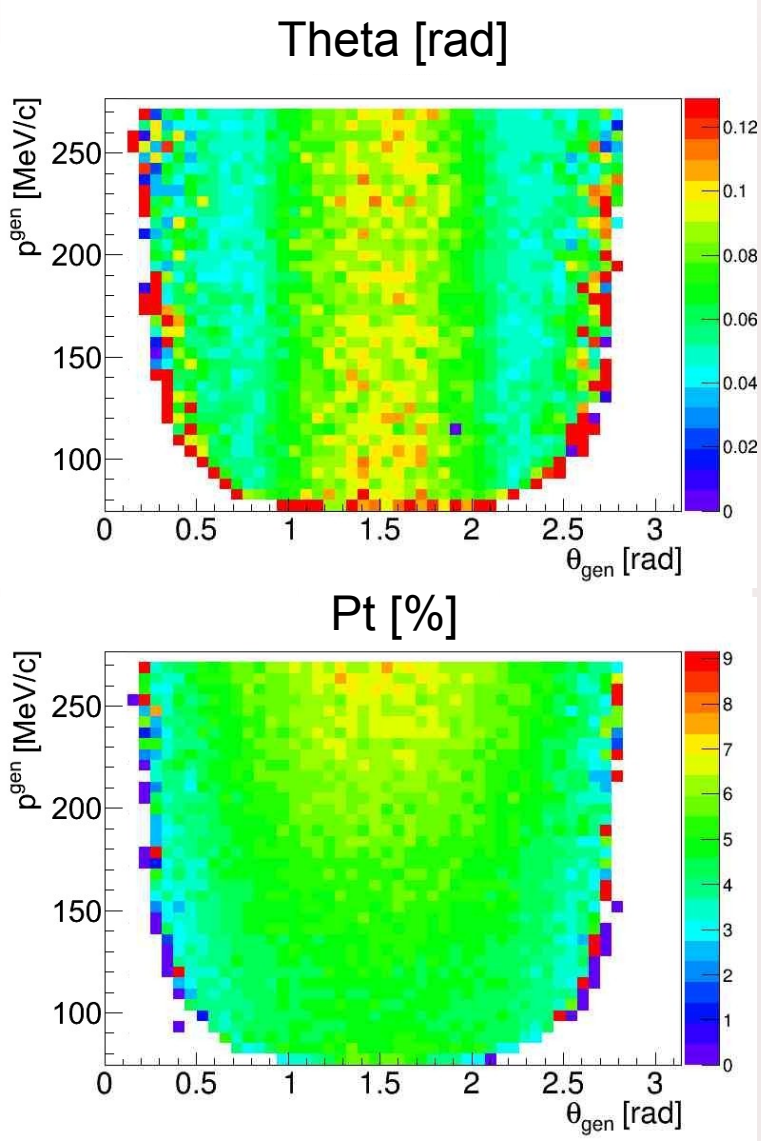
# Hardware → software

**or trying to understand what to expect from ALERT**

# Simulated resolutions for protons

## (based on a simplified simulation)



# Simulated resolutions for alphas

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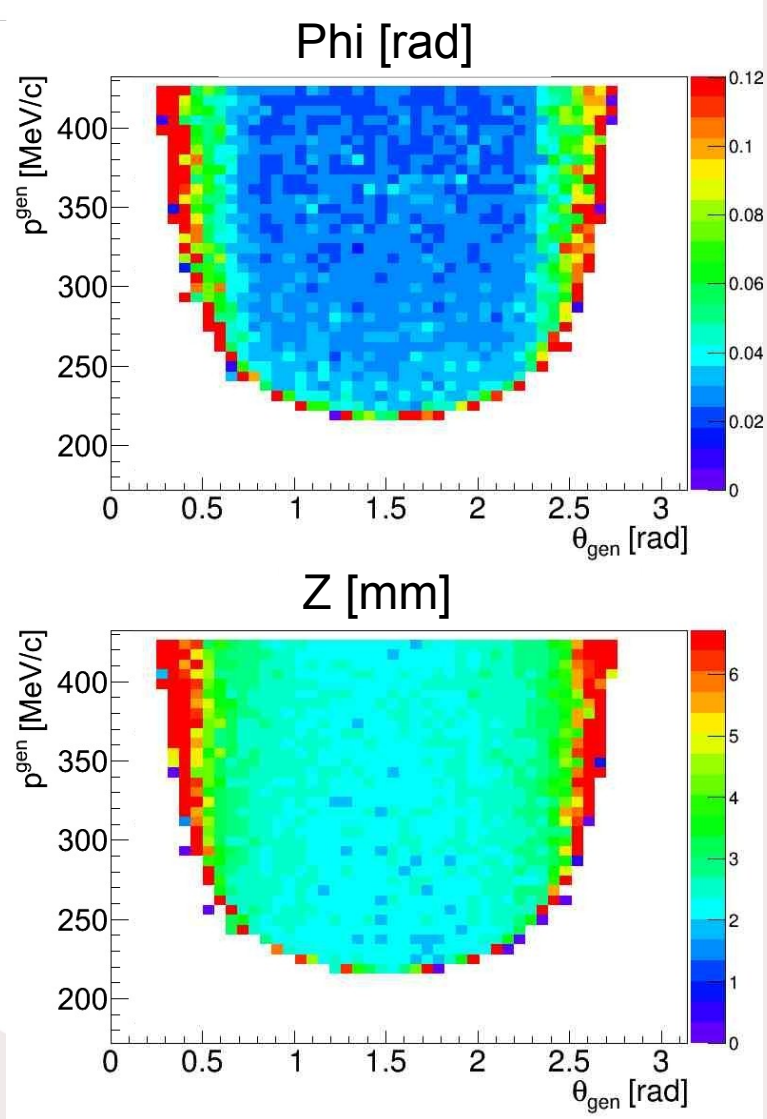
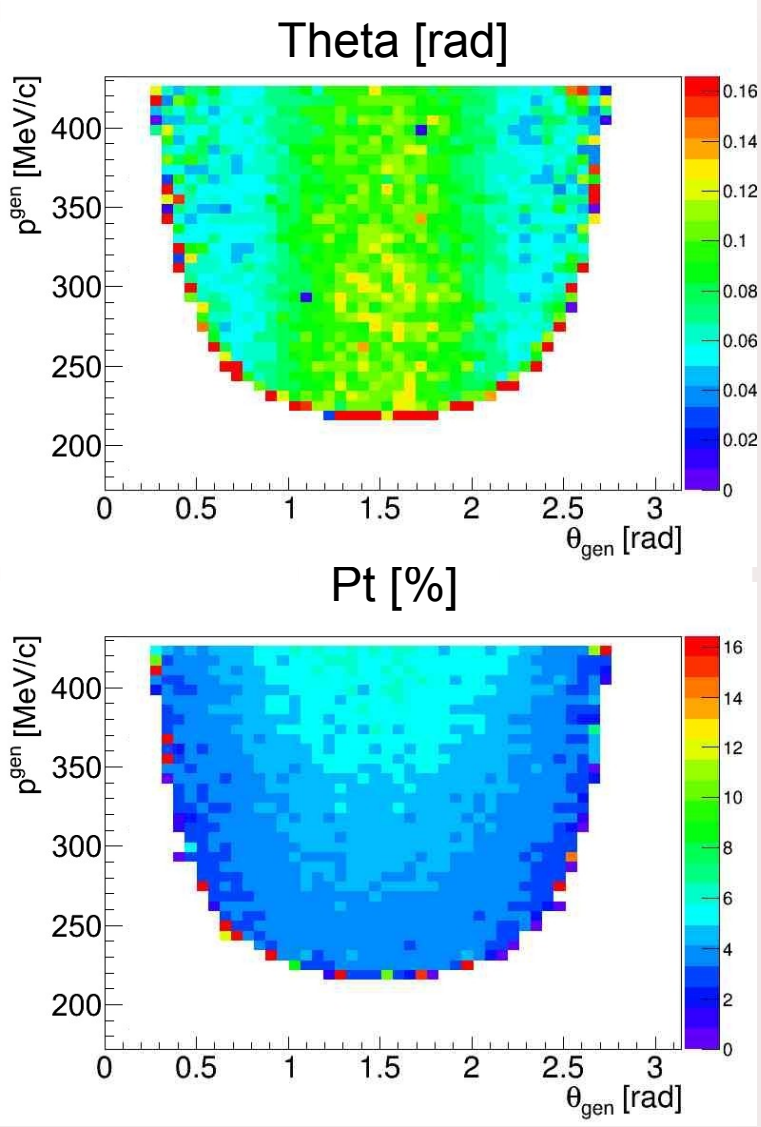
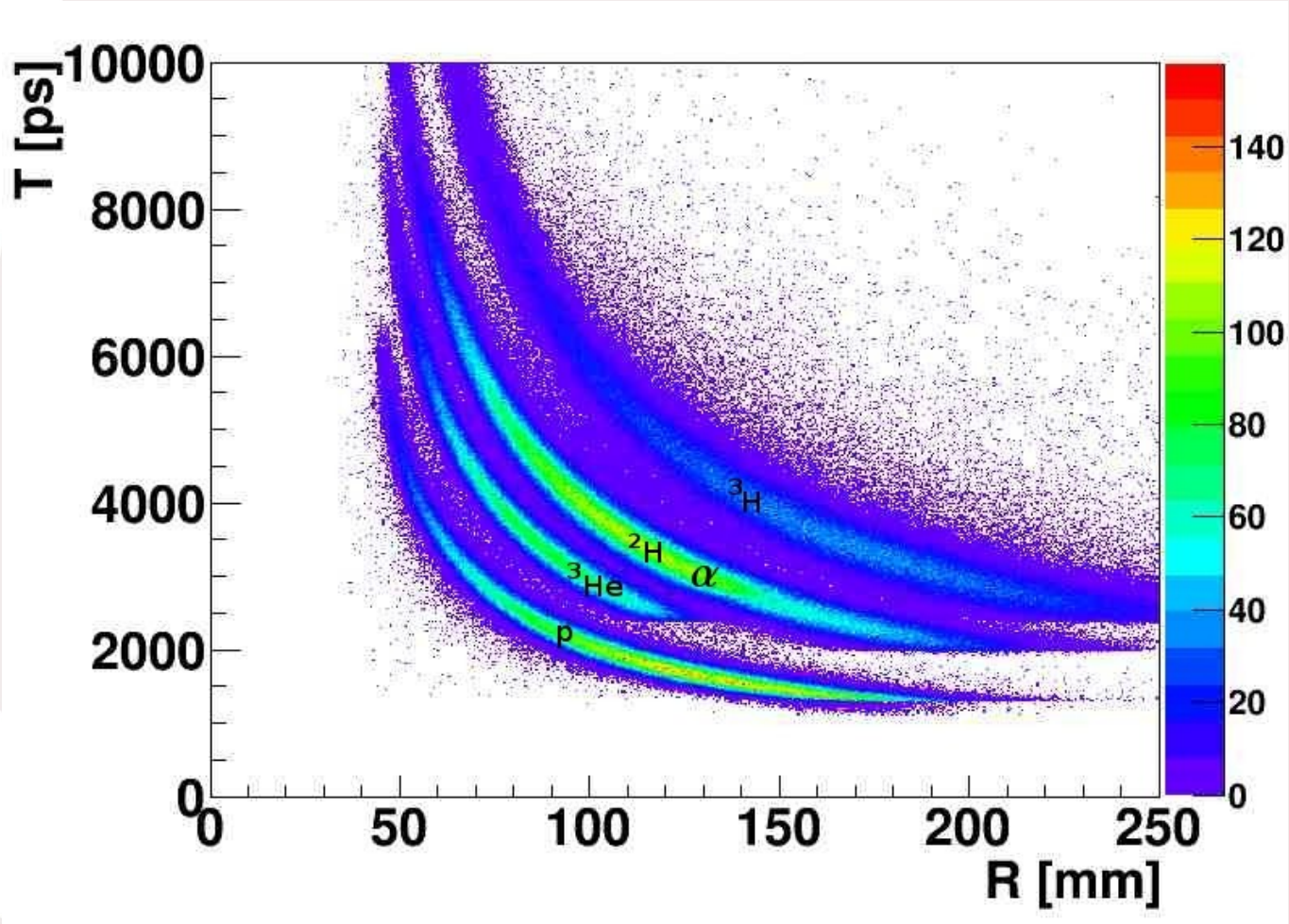


# Particle identification: method (1/2)

Using the reconstructed radius in the wire chamber and the time of arrival in the scintillator, protons, helium 3 and hydrogen 3 can be separated.



# Particle identification: results

**In an experiment where ALL 5 species would be present.**

With a 150 ps time resolution and a 10% energy resolution of the scintillator

99% of protons identified are protons
92% for helium 3
98% for hydrogen 3

85% for deuterium
88% for alphas

With a 200 ps time resolution and a 10% energy resolution of the scintillator

97% of protons identified are protons
89% for helium 3
97% for hydrogen 3

83% for deuterium
86% for alphas

**Can be improved using the information carried by the energy deposition in the drift chamber and fine tuning the parameters.**

**FastMC available.**

# Conclusion

The preliminary design for A Low Energy Recoil Tracker (ALERT) has been investigated and several geometry are going to be tested.

Simulation has shown that the resolutions for proton of the drift chamber could be:

| | | |
|---|---|---|
| $\sigma_z \sim 3$ mm | $\sigma_\theta < 0.1$ rad | $\sigma_{P_T} < 8$ % |

ALERT can identify protons, hydrogen 3, helium 3, helium 4 and deuterium with a probability close to 90% for the two last ones and higher for others.

A Fast Monte Carlo, very simply to use, implementing the resolutions, acceptance and soon the identification efficiency is available.

On going work:

- build a small prototype to test several cell layout, test different electronics and try with lighter wires
- write a better fitting algorithm