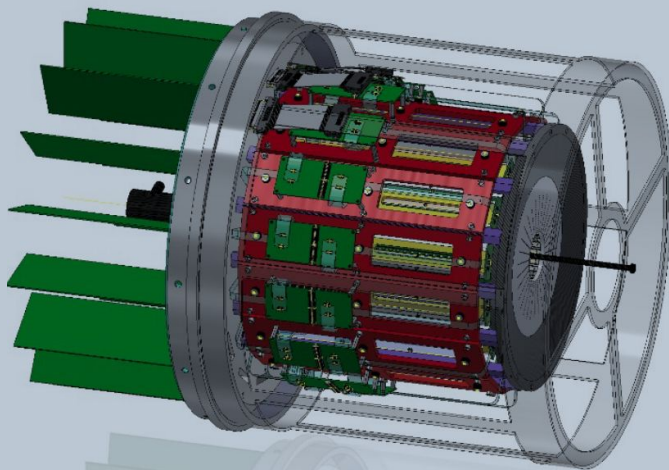


A Low Energy Recoil Tracker (ALERT) Hyperbolic Drift Chamber

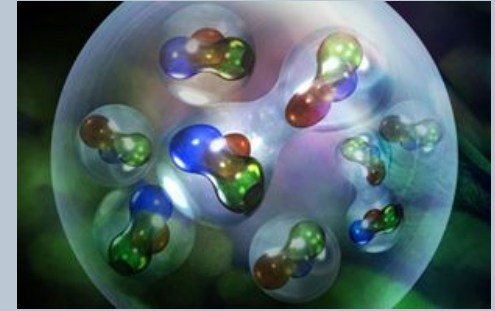
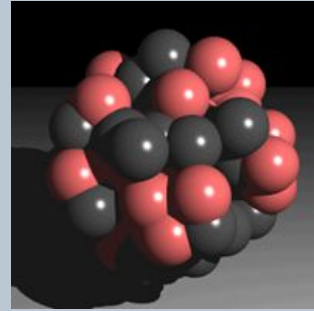


Lucien Causse

Parton Distribution Function

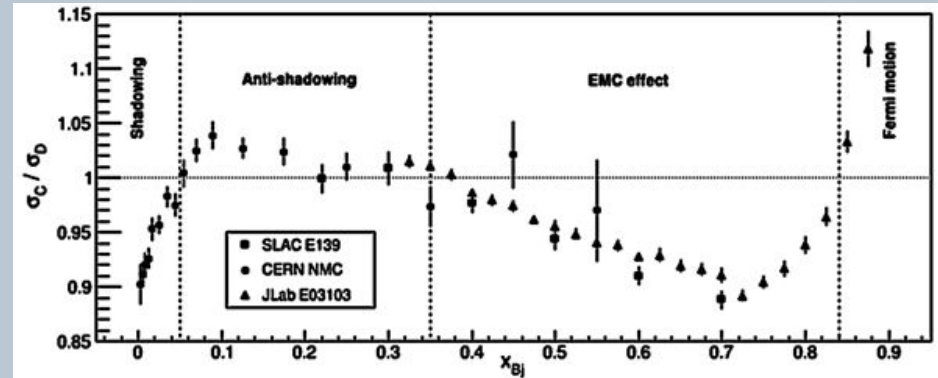
Two coexisting pictures of nucleus

- Nucleus made of protons and neutrons
- Nucleus made of quarks and gluons



Structure through deep inelastic scattering

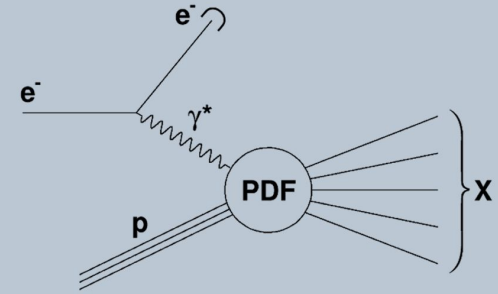
- some effect still not fully understood



Requirements

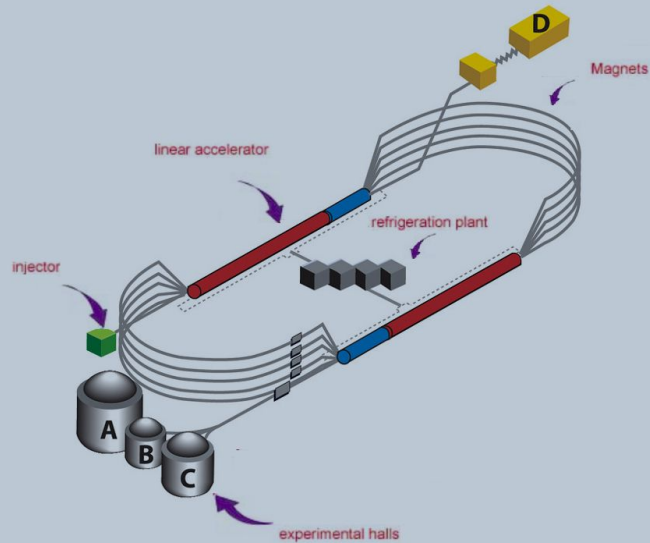
To study the partonic structure of bound nucleons through deep inelastic scattering

- detect scattered electron
- detection of low energy nuclear recoil fragments

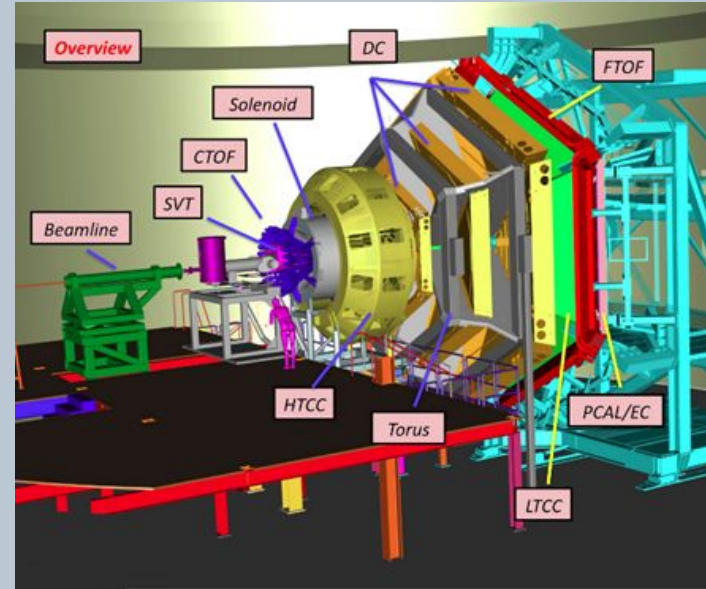


Measurement	Particles detected	p range	θ range	rate
Nuclear GPDs	^4He	$230 < p < 400 \text{ MeV}/c$	$\pi/4 < \theta < \pi/2$ rad	60 MHz
Tagged EMC	p, ^3H , ^3He	$70 < p < 250 \text{ MeV}/c$	As close to π as possible	60 MHz
Tagged DVCS	p, ^3H , ^3He	$70 < p < 250 \text{ MeV}/c$	As close to π as possible	60 MHz

The CLAS12 spectrometer



11 GeV electron beam in Hall B, Jefferson Laboratory, Virginia, USA



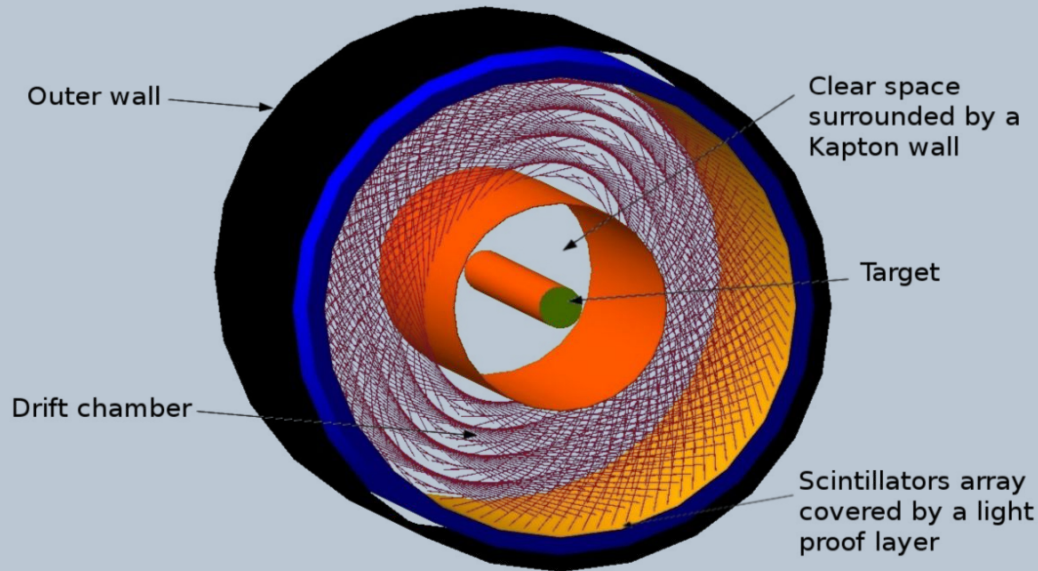
The CLAS12 spectrometer

ALERT Detector

CLAS12 central detector has a too high threshold

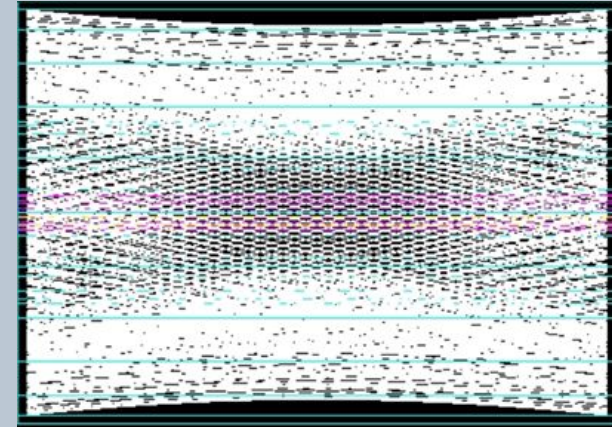
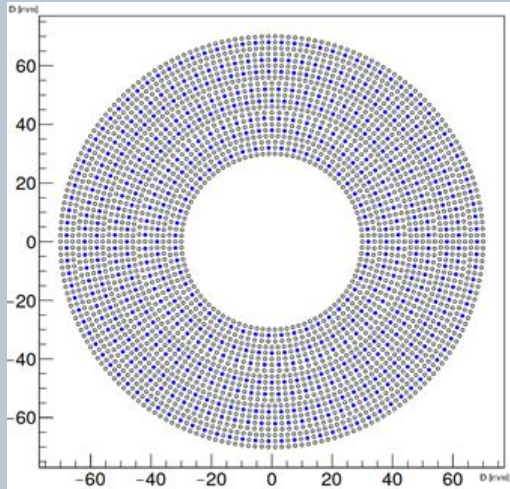
ALERT is composed of a drift chamber and a time of flight detector (TOF):

- Light in materials
- Fast
- Good angular acceptance



ALERT Hyperbolic Drift Chamber

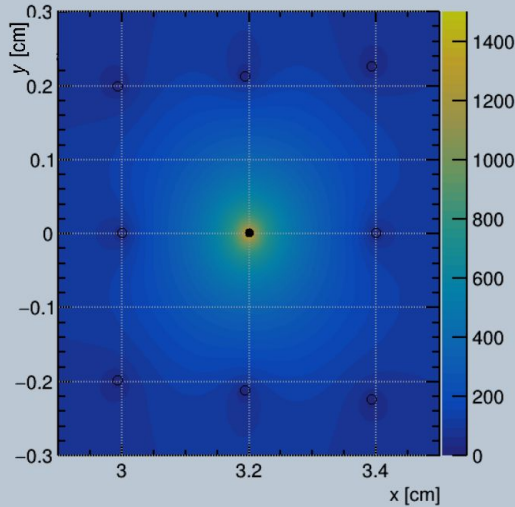
- 30 cm long 7.2 cm external radius
- 3025 30 μm aluminium wires
- 2 mm gap
- 20° stereoangle
- He/CO₂(80/20)
- Up to 10 kV/cm



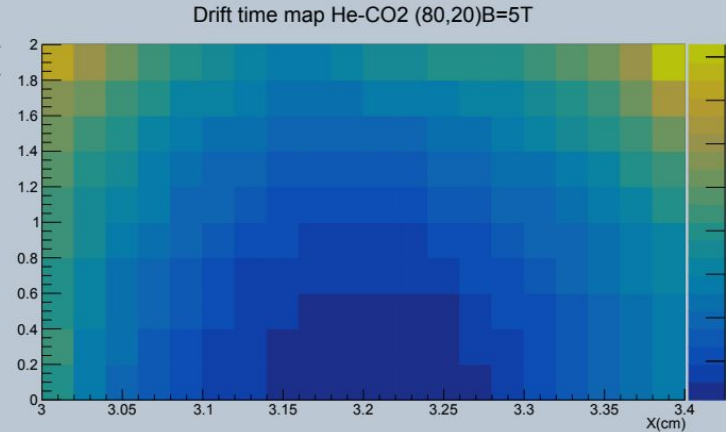
view of the hyperbolic shape

Simulated gain and drift time

Field map simulation with Magboltz

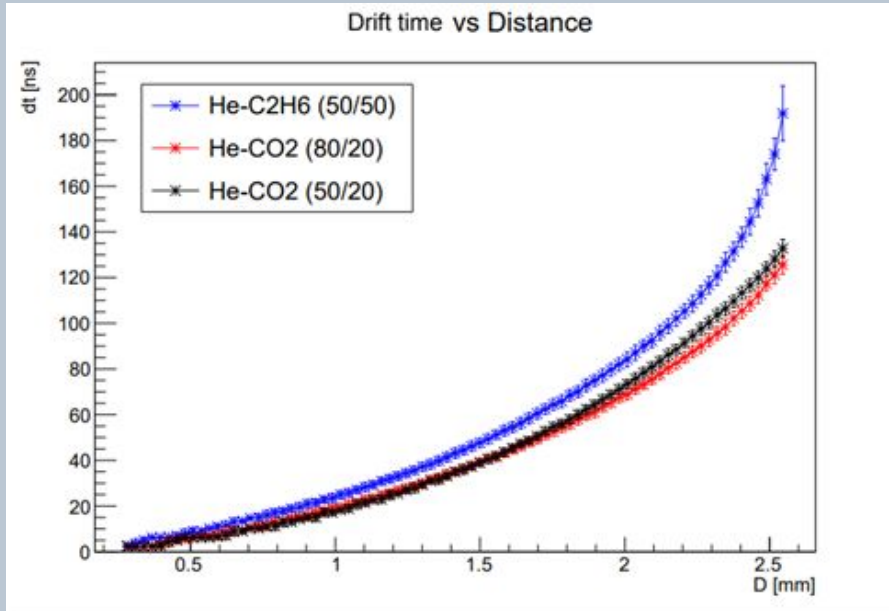


Garfield ++ electron avalanche
simulation
homogeneous drift field due to HV
applied on signal wires

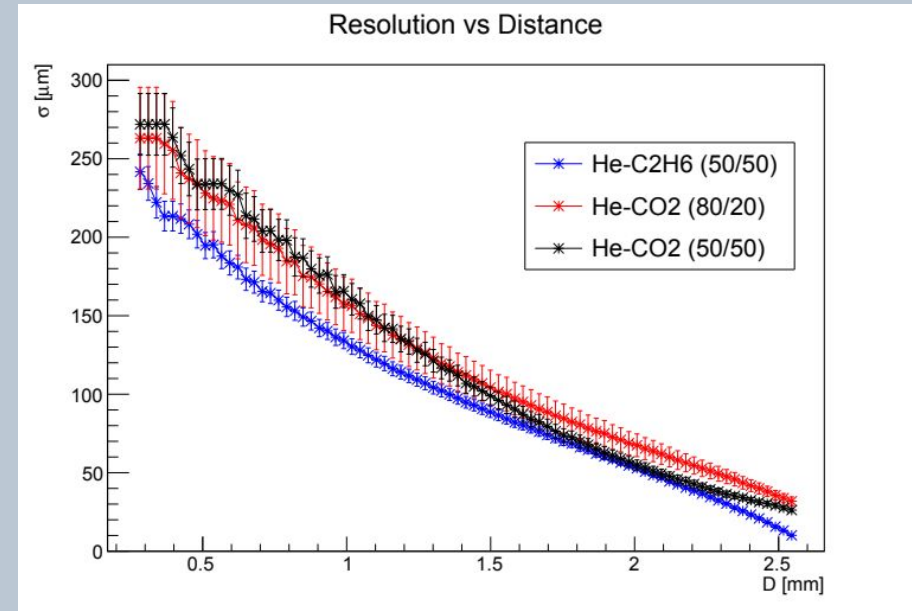


Drift time (in ns) simulation with
Garfield++ (1400V, 1 atm, 300K;5T
magnetic field).

Ideal Resolution



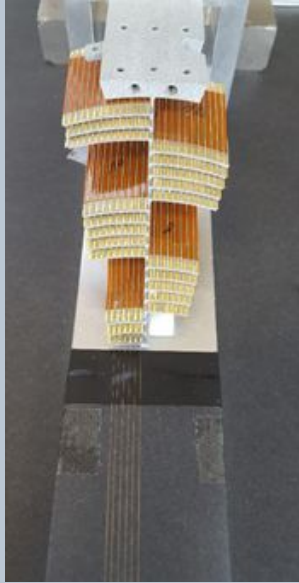
Drift time simulation



Ideal resolution

He/CO2 for a good resolution and drift time compromise

Attach the wires



First prototypes

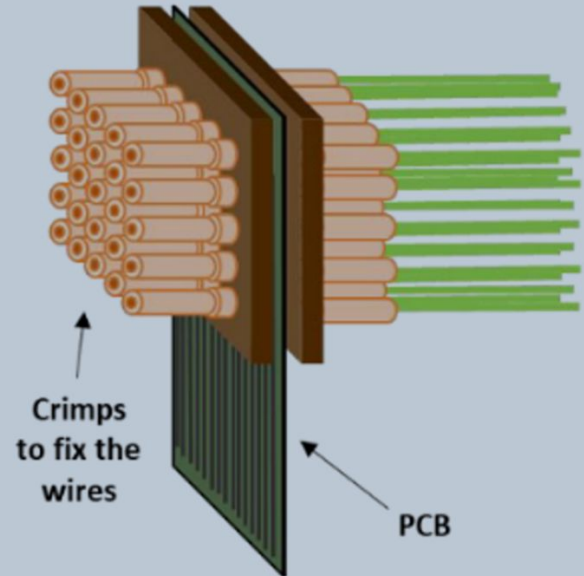
Wires welded onto Kapton
glued on a plastic structure

Problems

- Flexion of the structure with one part
- Hard to weld with the solution with 5 parts
- All wires must be glued



Chosen solution



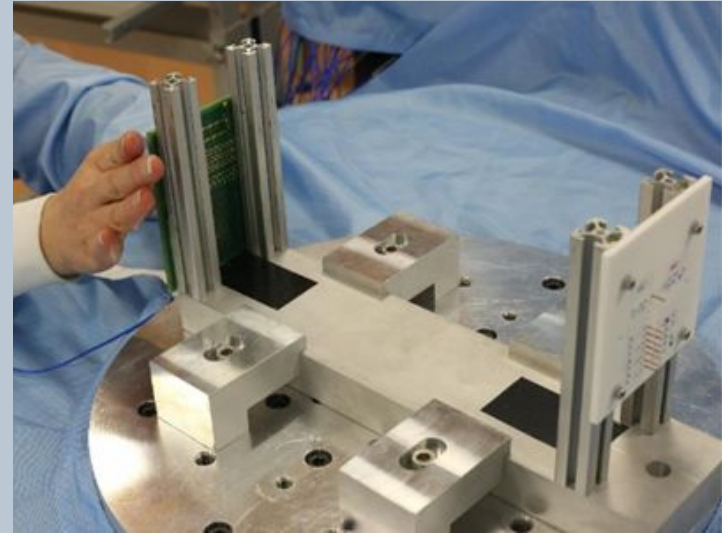
Mechanical tests

Is pre tensioning necessary?



- 36kg stress
- Compression:
 - PCB Epoxy (+Alu endplate)= 0,08 mm
 - Macor(+Carbonendplate)= 0,1mm

For transportation

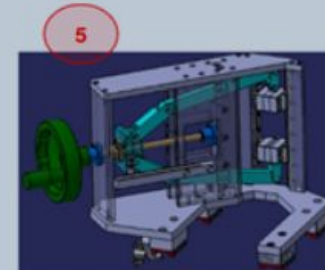
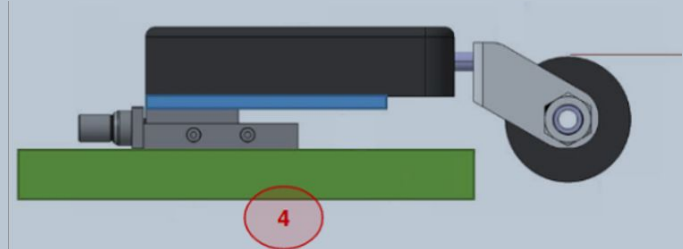
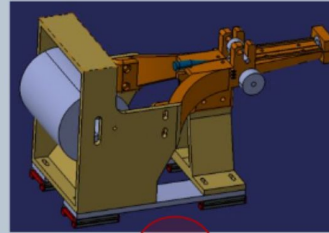


Transport vibration test-No broken wire
Rocket lift off vibration test- untightened wires

Tooling to weave the wires

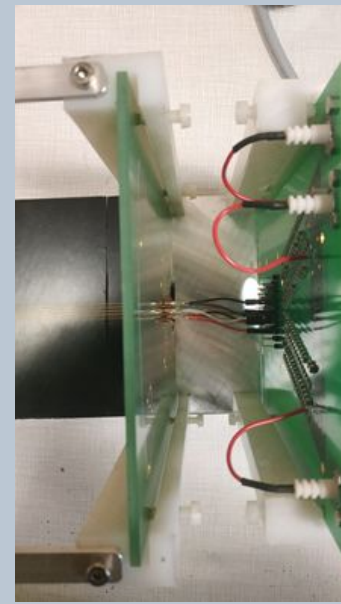
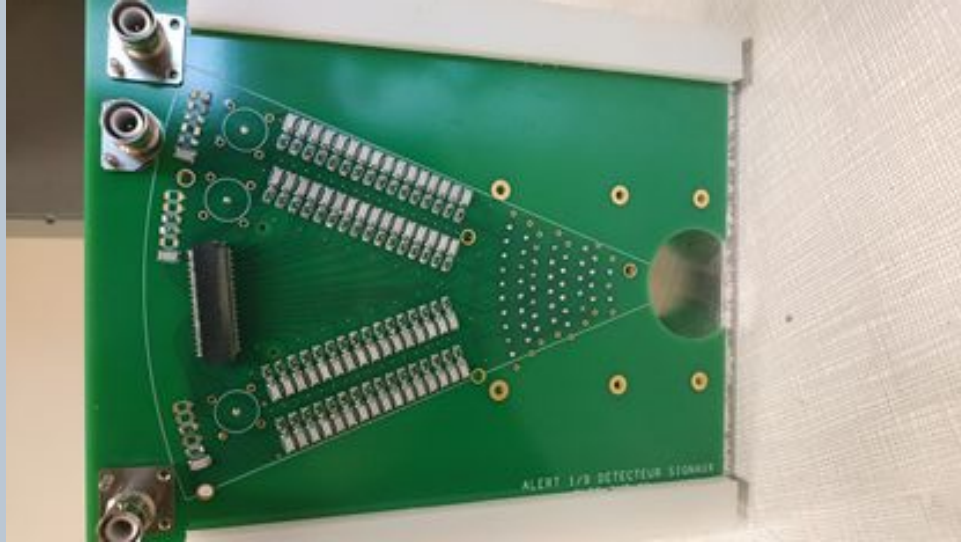
5 steps to weave the wires

1. Inserting of the wire through the pin
2. Moving of the wire, from back part to the front .
3. Crimping it with handmade tool.
4. Putting the tension on the wire.
5. Crimping with mechanical tool



Estimated duration of the construction : 3 to 6 months

Leak Current



Signal wire at the high voltage

- Low pass filter
- Decoupling circuit

Even if the PCB was designed to withstand up to 3 kV/mm, we experienced some leak current problems.

The solution adopted is to use two separate PCB for the high voltage and the ground

Experimental Setup

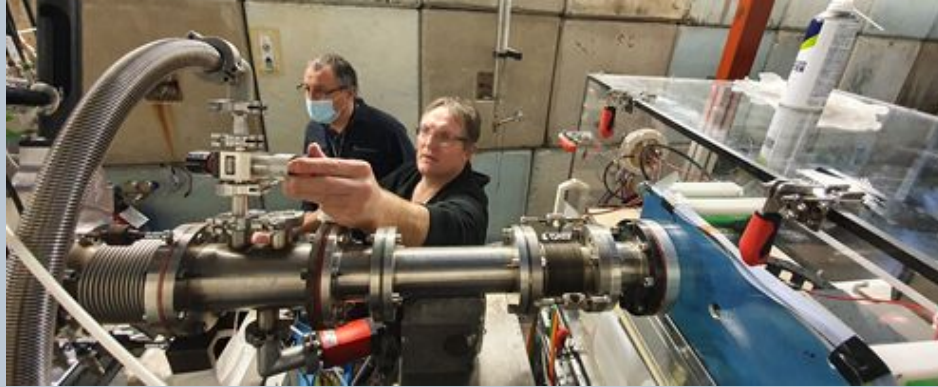
Alto is a facility that can produce nuclear beams delivered by the Tandem, an electrostatic accelerator.



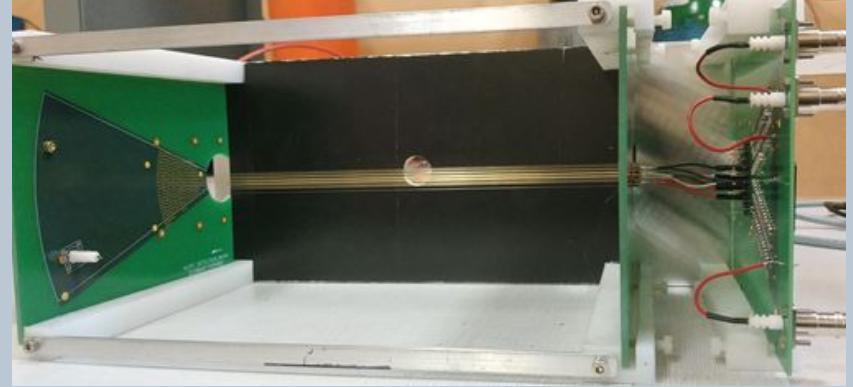
Run Conditions:

- Protons: 4, 6, 8, 10, 15, 18 MeV for different HV
- Alphas : 6, 8, 10, 12, 15 MeV for different HV

Alto test runs

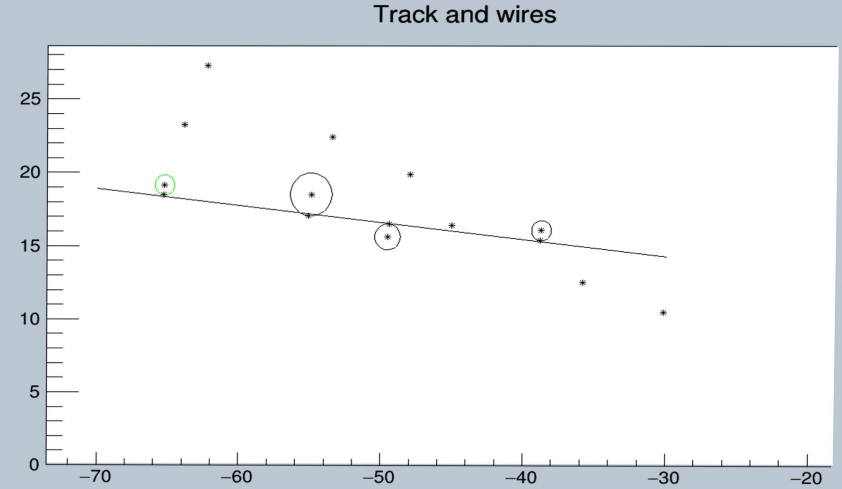
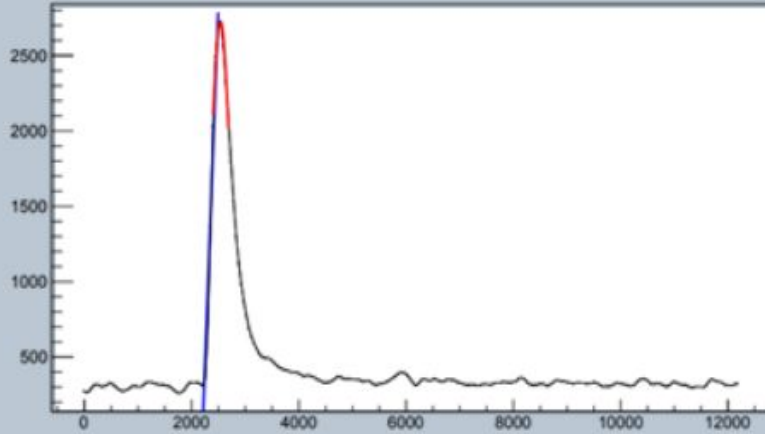


- 50 microns capton foil
- 7 layers prototype
- 2 types of wire



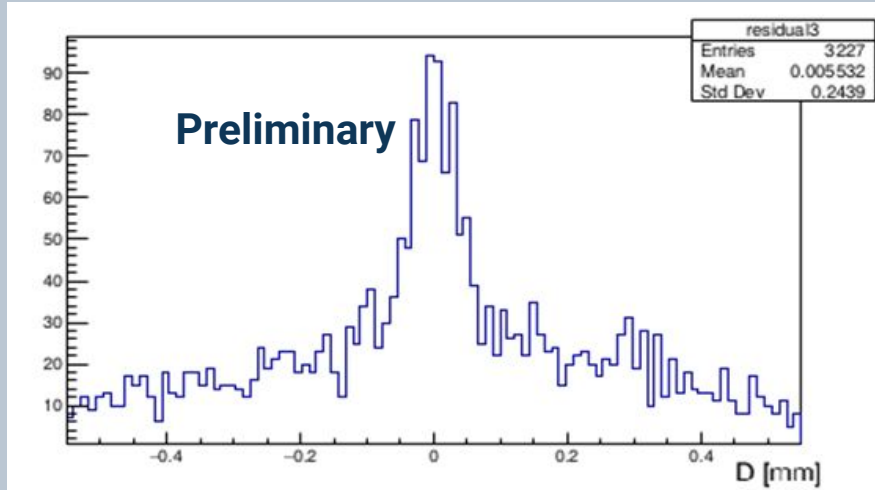
It aims at studying the detector gain, resolution, the maximum handable rate and make a first calibration looking at tracks and energy loss in the gas.

Signal Analysis

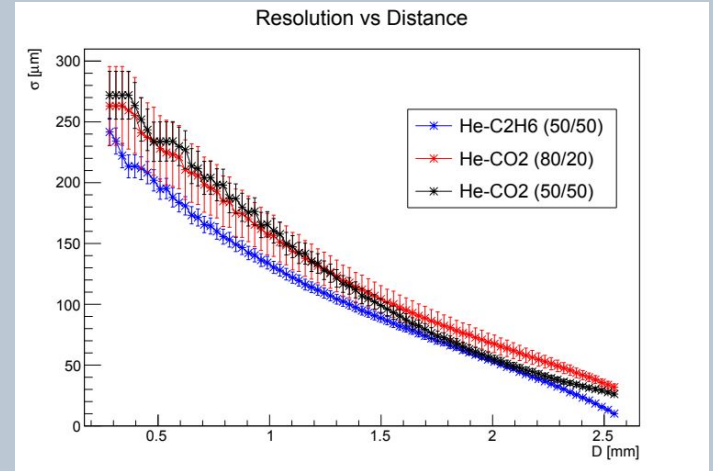


Typical signal shape and track reconstruction

Experimental Resolution

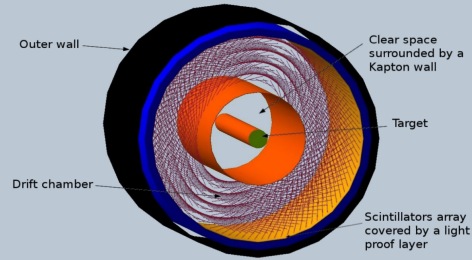


Residuals about 100 μm .
But gas leak in our
chamber

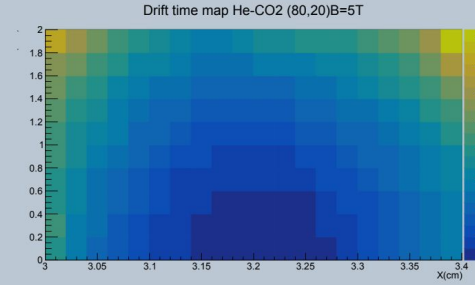


Ideal resolution

Summary



Need to design a specific detector



Simulations to optimize the design



Mechanical validation



experimental checks

Thank you for your attention

My thanks to the whole team working on the detector !

Backup

Overview of the current mechanical design

Exploded view

