Two recoil detectors at Jefferson Lab for low energy particles

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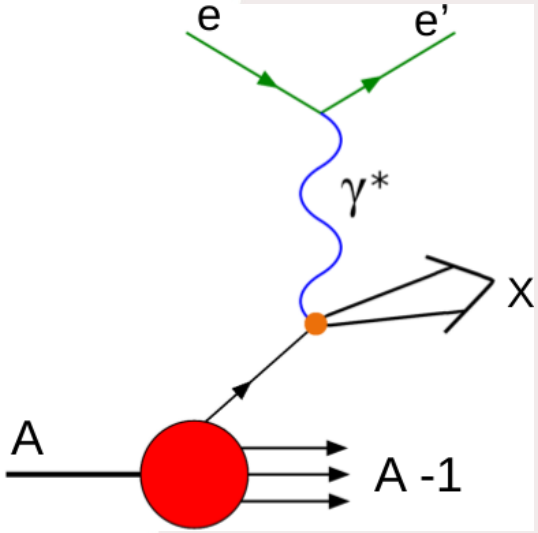
Université Paris-Sud

Reaction studied



Deuterium or helium target

Detection of the **electron** and **recoil nucleus**

To avoid interaction of the recoil nucleus with fragments measure the **recoil particle** at high angle and low momentum

=> $p < 150$ MeV/c, $\theta > 100°$ 4π detection

Recoil nucleus can be :

proton, deuterium, tritium, helium 3, alpha

(p) (1p,1n) (1p,1n) (2p, 1n) (2p, 2n)

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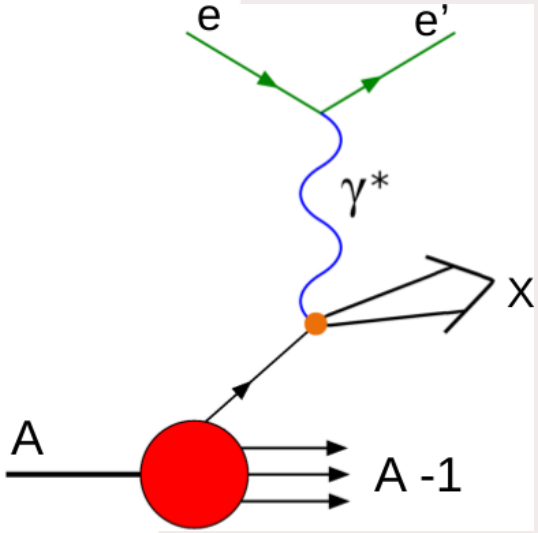

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BONuS

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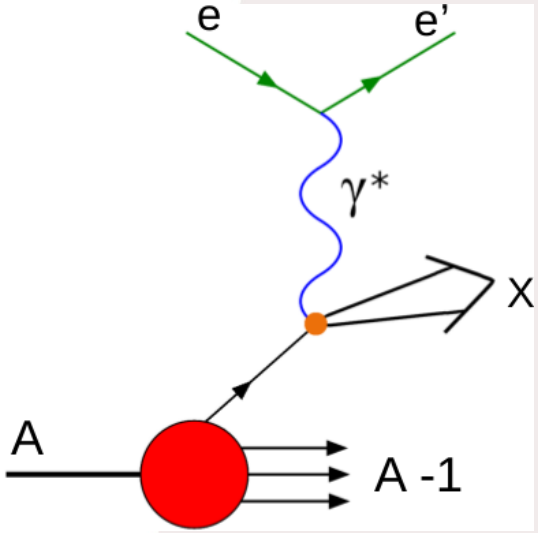

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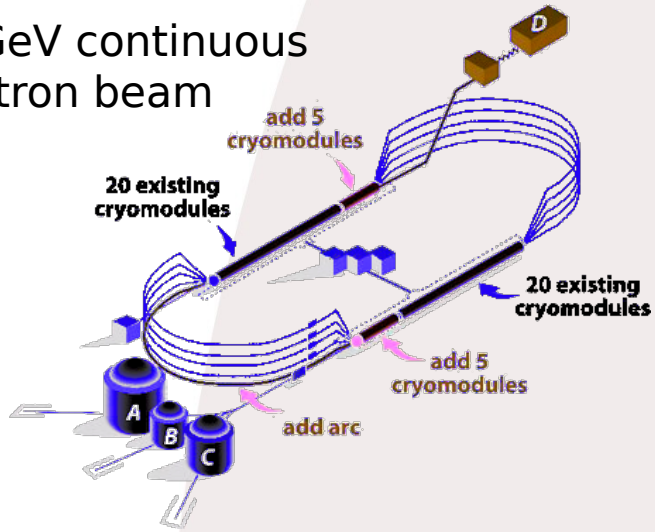
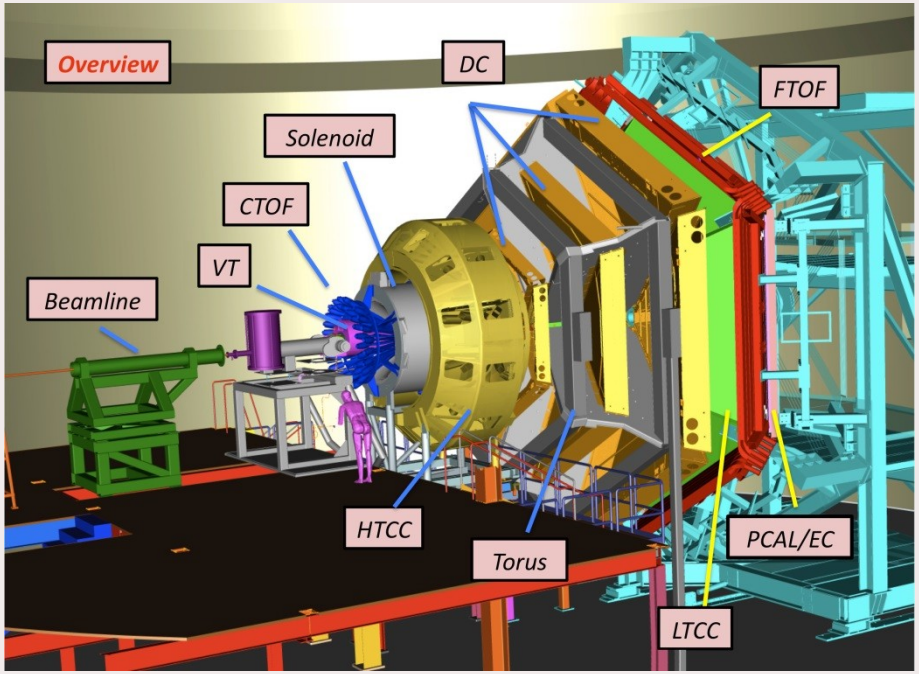
BONuS ALERT

Jefferson Laboratory, Virginie, USA

12 GeV continuous electron beam



CLAS12 (Hall B)



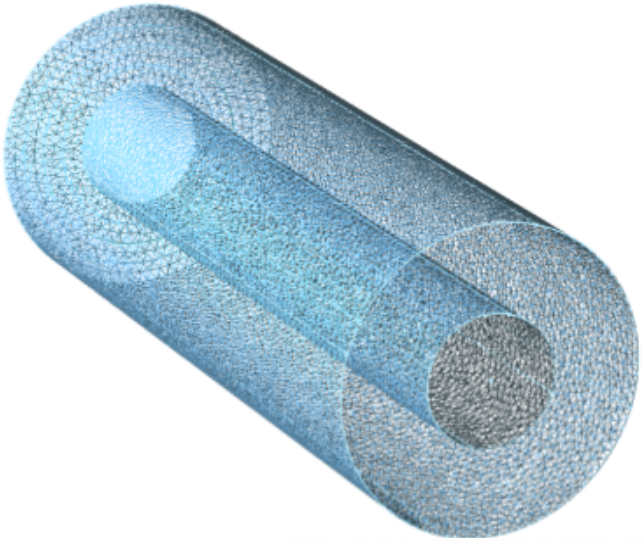
Forward part of CLAS12 perfect to reconstruct the electron
Central tracker has too high energy threshold

=> new central detector

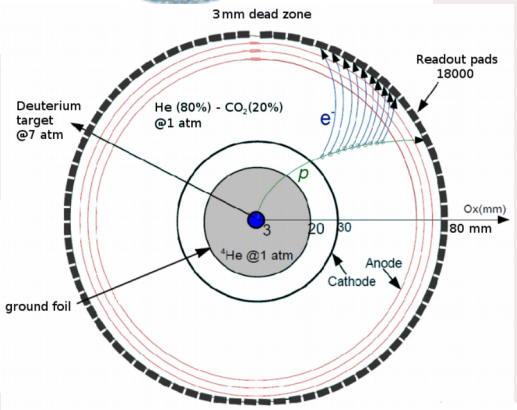
Which detectors?

BONuS

A **radial time projection chamber (RTPC)**



Radial to stand higher rates (20 MHz)



Which detectors?

BONuS

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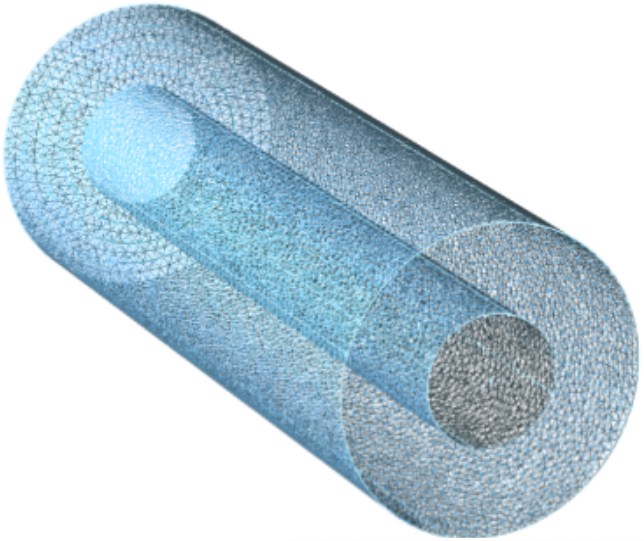
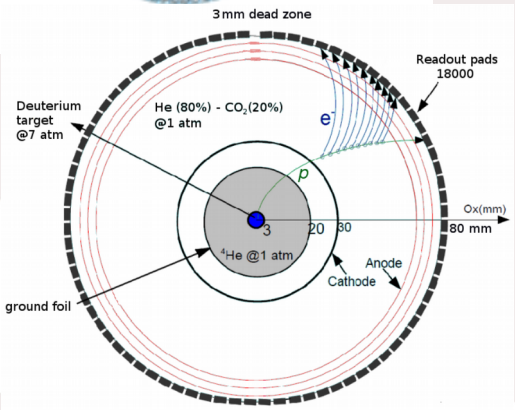
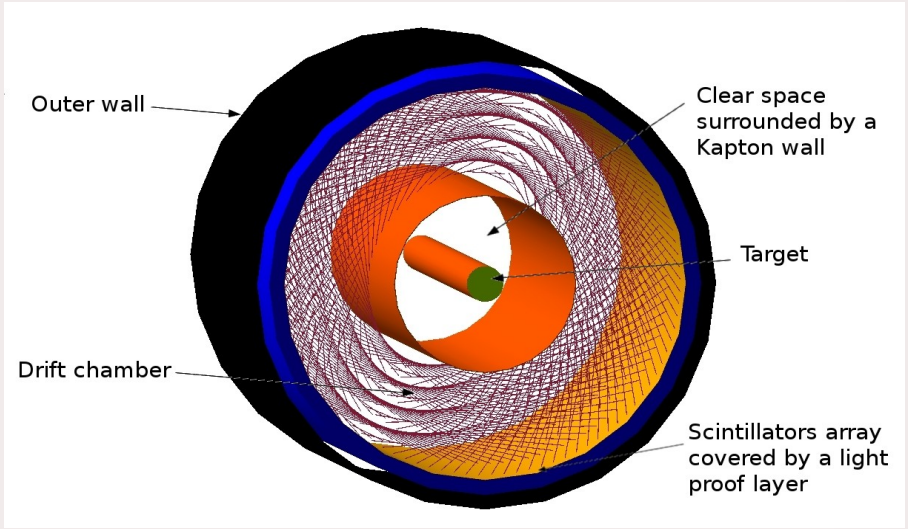




Radial to stand higher rates (20 MHz)

ALERT

A **drift chamber** for tracking completed by **scintillators** for particle identification.



All elements are about 300 mm long and place in a 5 T longitudinal magnetic field

Complicated parts for BONuS and ALERT

Target

- Both detectors will use a Kapton straw target
- Straw thickness is a key point to let particle escape the target
- Straws are expected to be 25 µm thick
- BONuS 7 atm, ALERT 3 atm (but 7 could be needed to)

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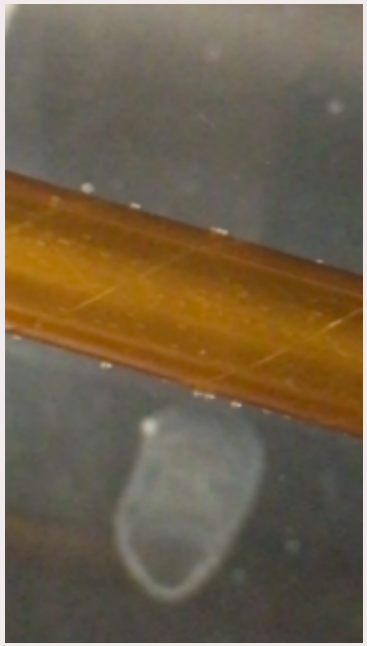

Leaks!

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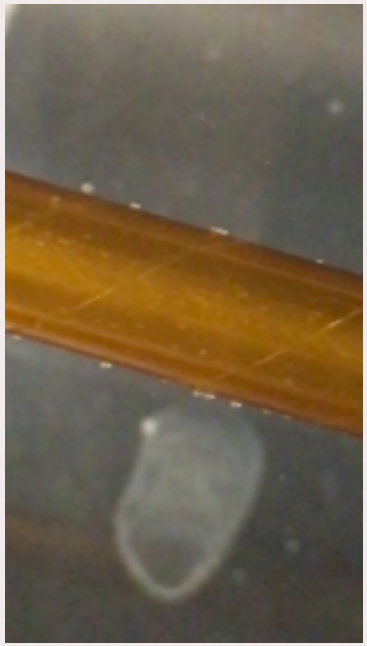


Leaks!

=>

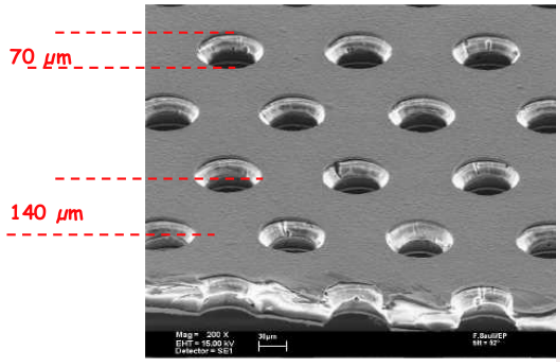
Aluminized straw?

E. Blanc (IPNO) deposited 1 µm of Al on the straw

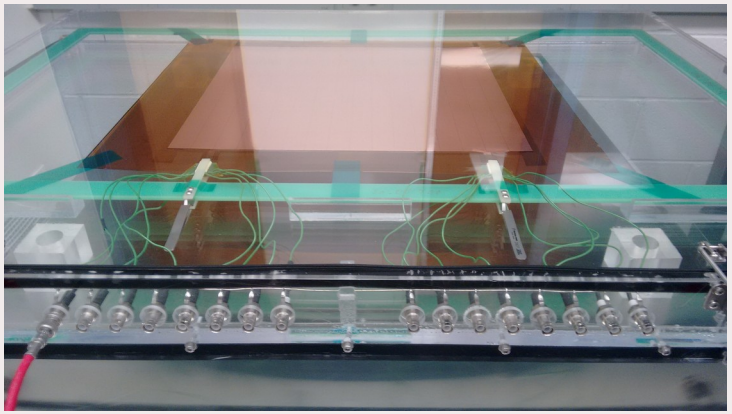
Complicated parts for the RTPC

R(TPC) => Cylindircal GEM foils

From a flat GEM foil to a cylindrical one



F. Sauli, Nucl. Instrum. Methods A386(1997)531



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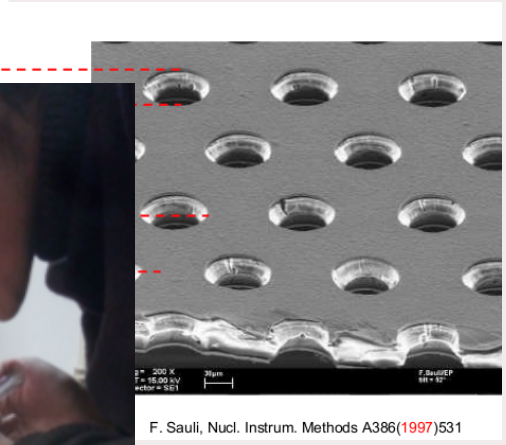

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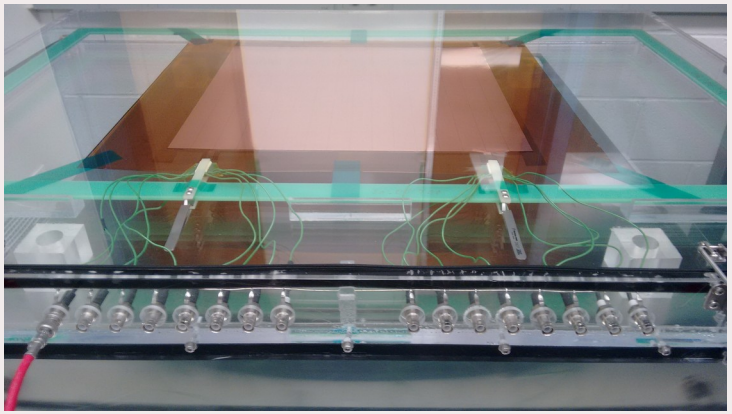

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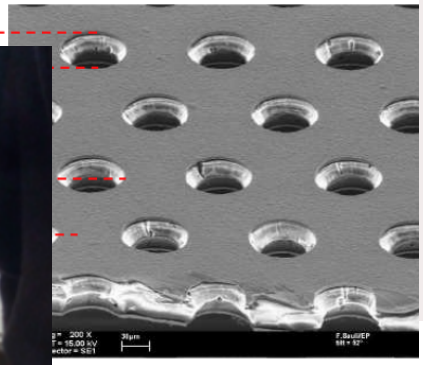

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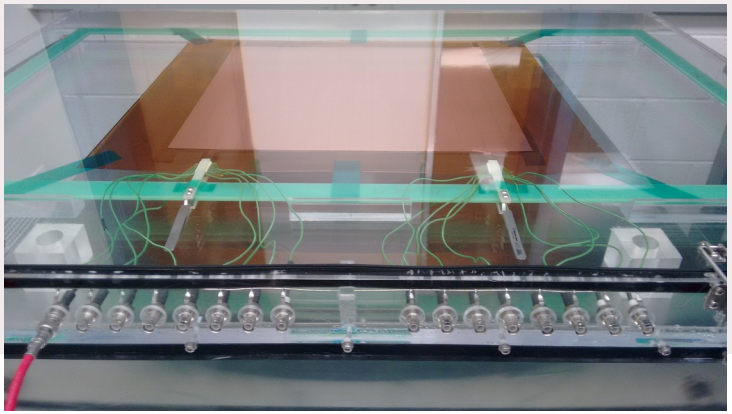
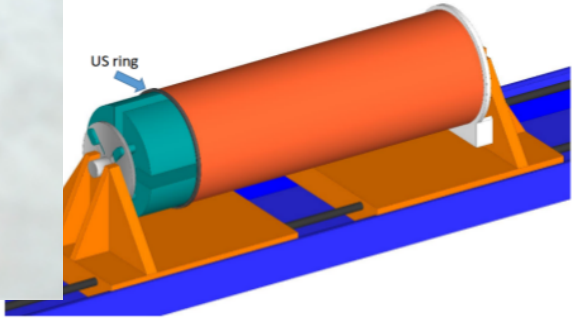
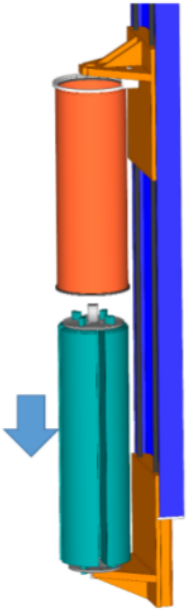
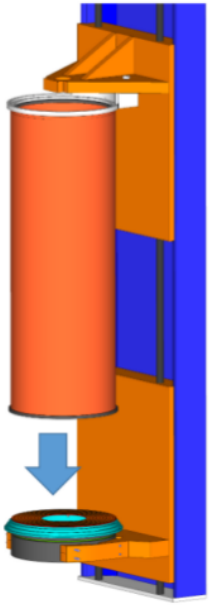
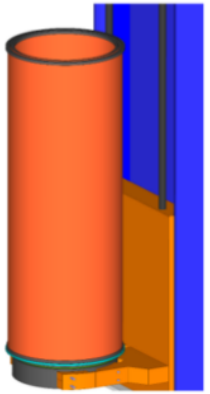




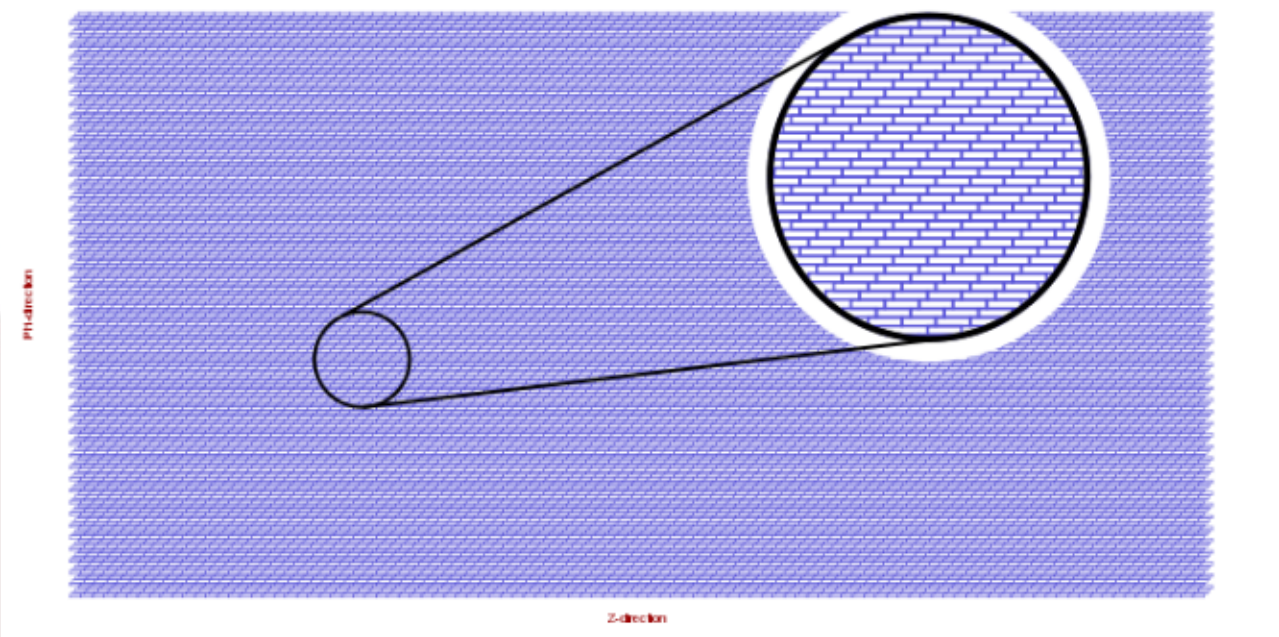






Readout electronics

View of the readout board

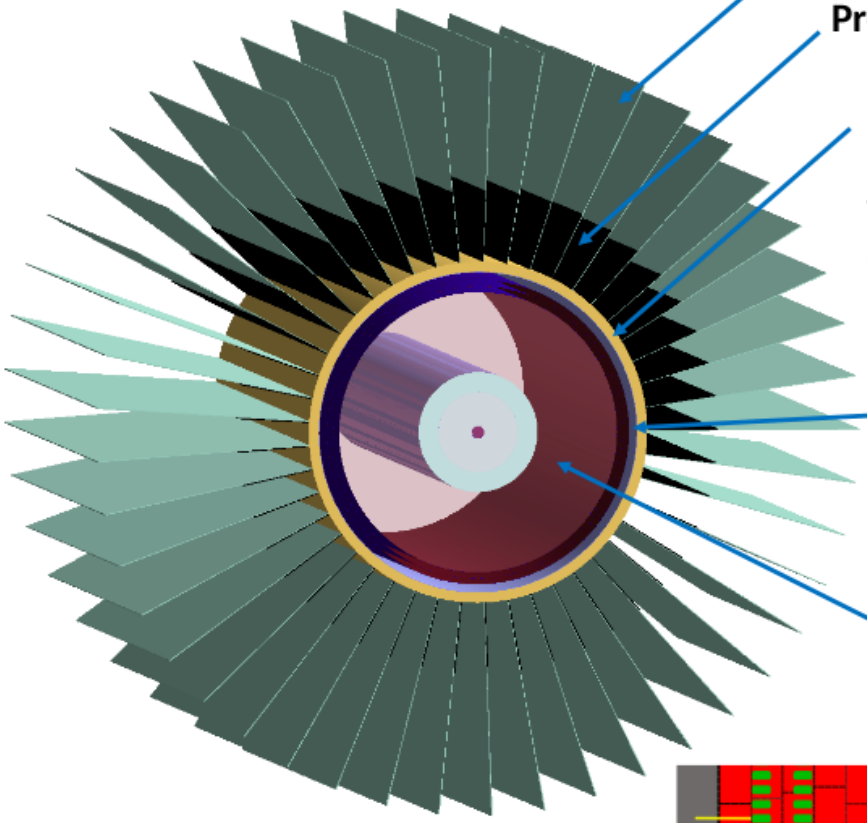


180 rows, 96 columns for a totalk of 17280 pads
Each pad covers 4 mm in z (beam axis) and 2° in φ (~2.7 mm)
Each row is shifted by 1 mm (¼ pad length) in z from the adjacent rows
3 mm dead space once rolled (<3° in φ)

Readout electronics

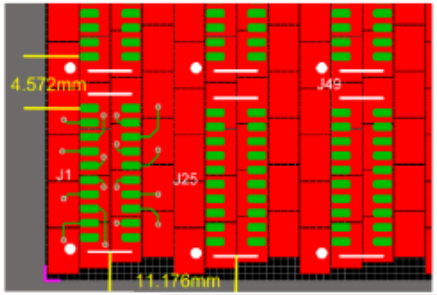
Connect the electronics to about 18000, 4*2.79 mm^2 pads...

N. Dzbenski



Slide from M. Hattawy

Routing the connector



Complicated parts for ALERT detectors

ALERT layout

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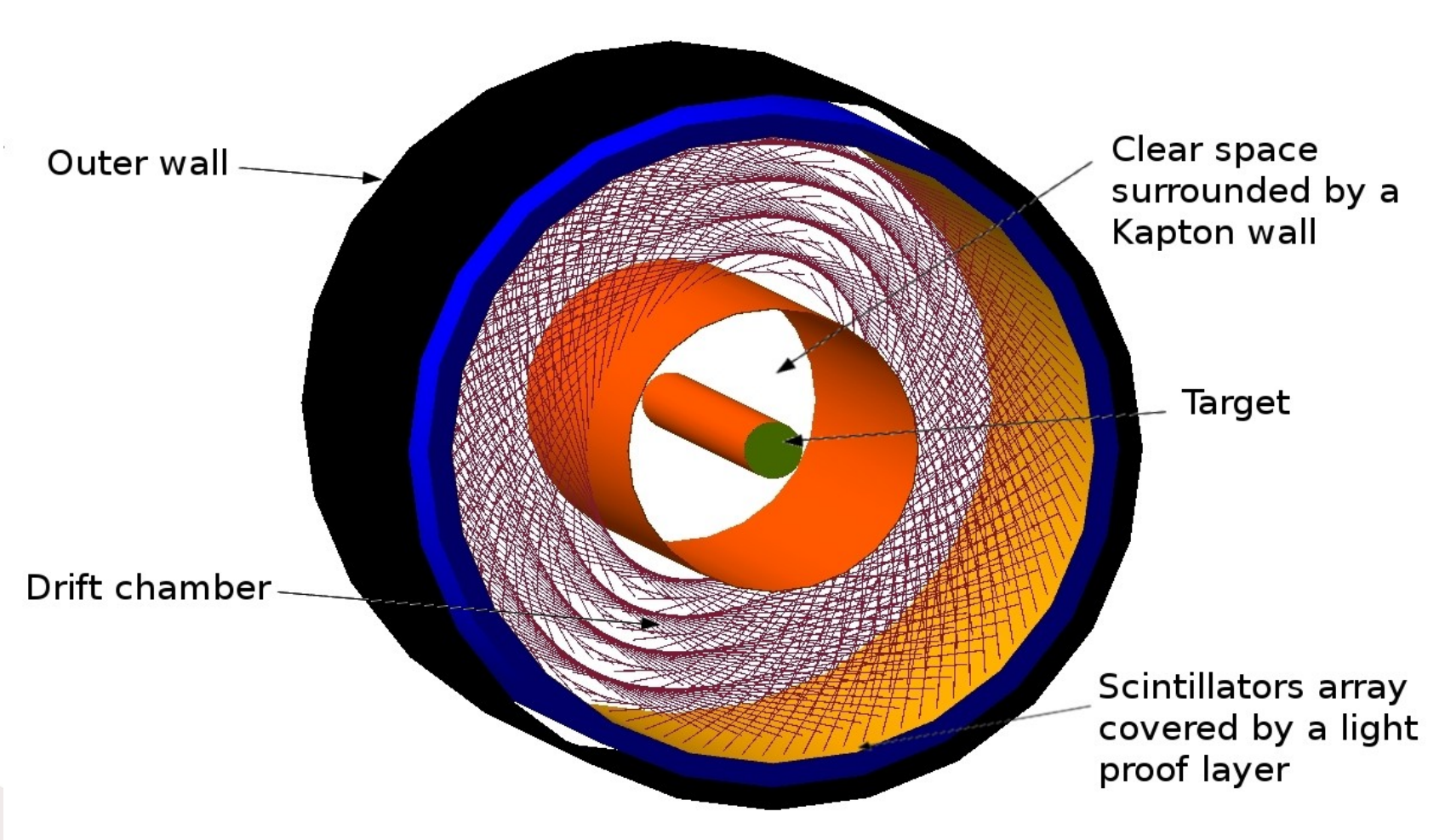
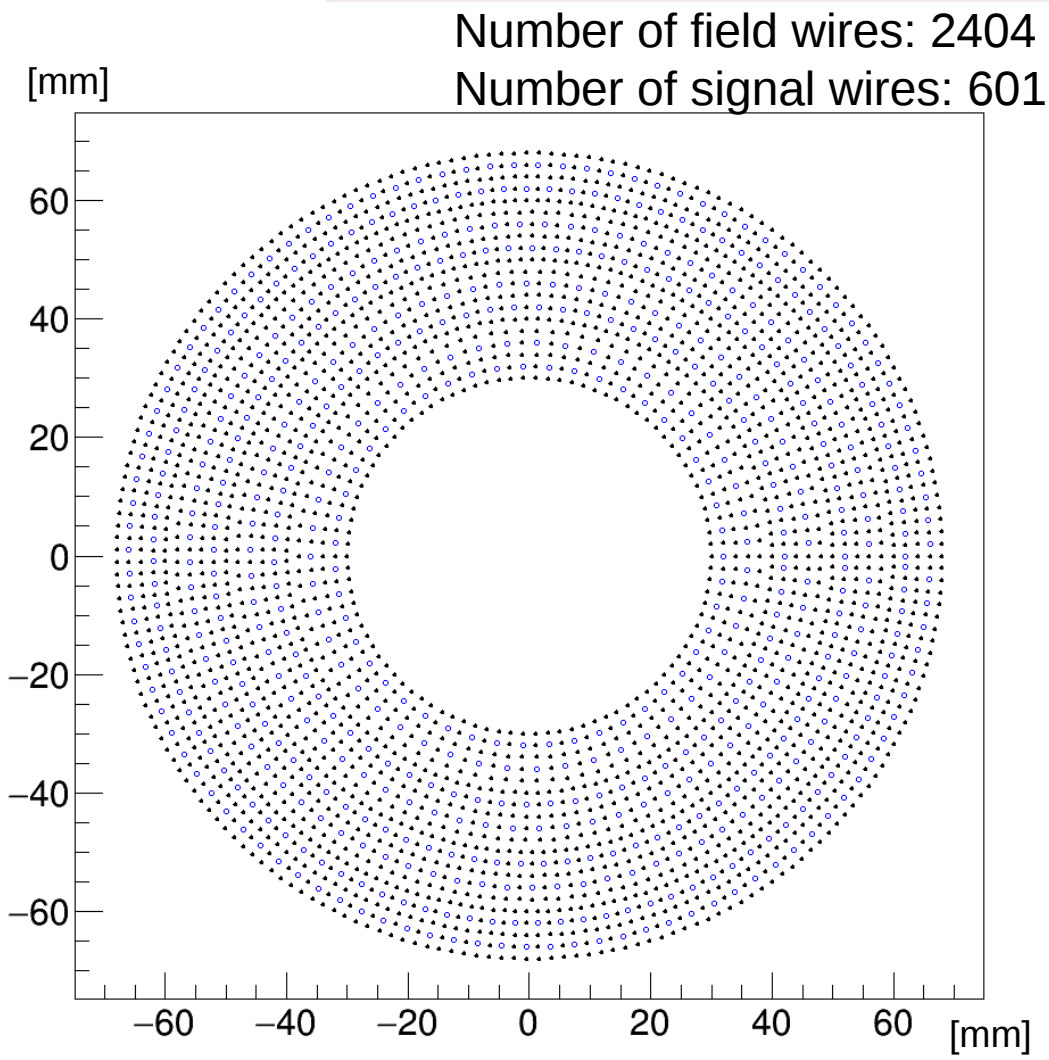


Drift chamber layout (2/2)



With usual gold plated tungstate wires, to ensure a 20 microns sag, the total weight on the end plate due to the tension is about 600 kg.

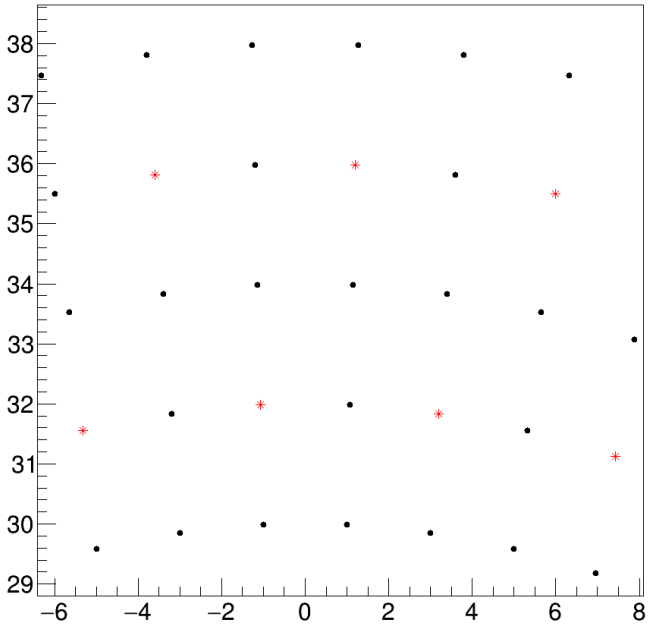
Tests are performed with carbon and aluminum wires.

Aluminum wires are already used in many drift chambers.

The chamber will use aluminum wires

2 mm wire spacing

How to place 2 mm distant wires on a cylinder?



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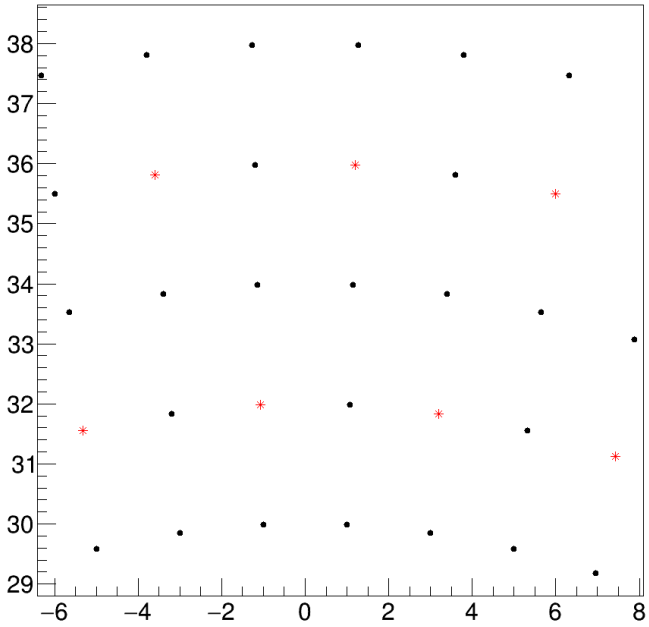
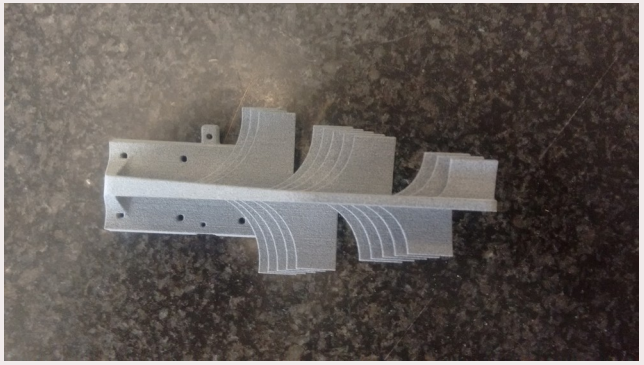


Soldering



Complex geometry, and complicated soldering

Crimping, method learnt from colleagues from ILL, Grenoble

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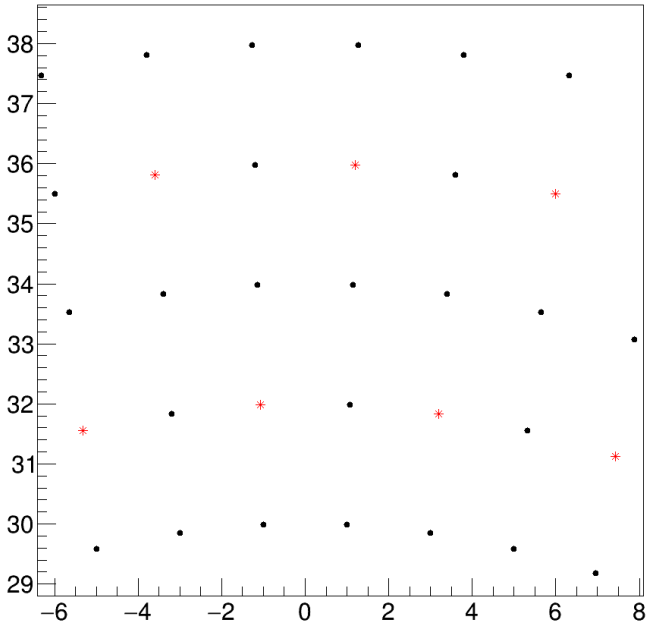

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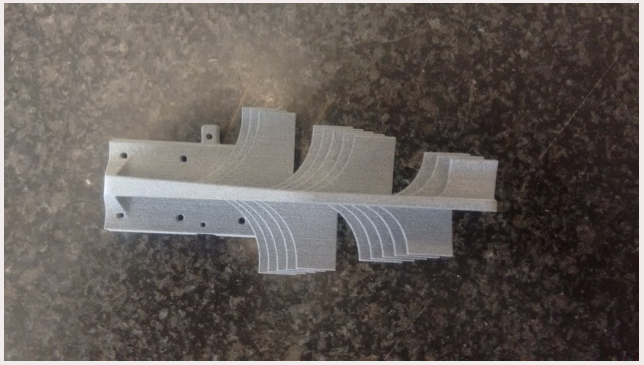

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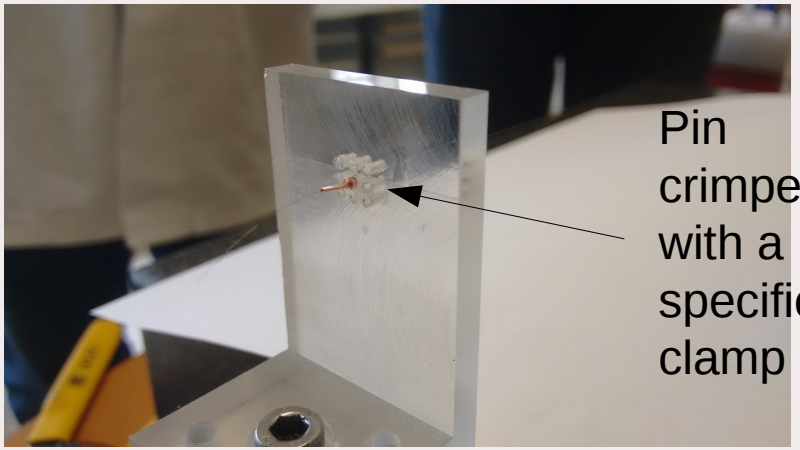
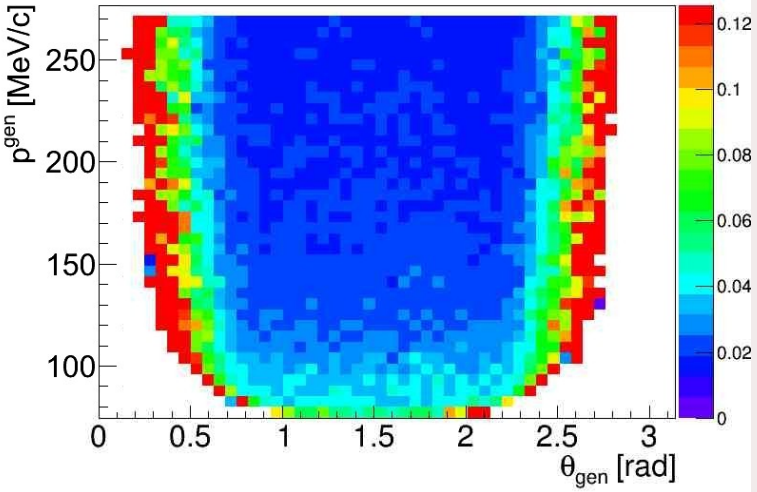


Can we build a small enough clamp?
How to connect the wires?

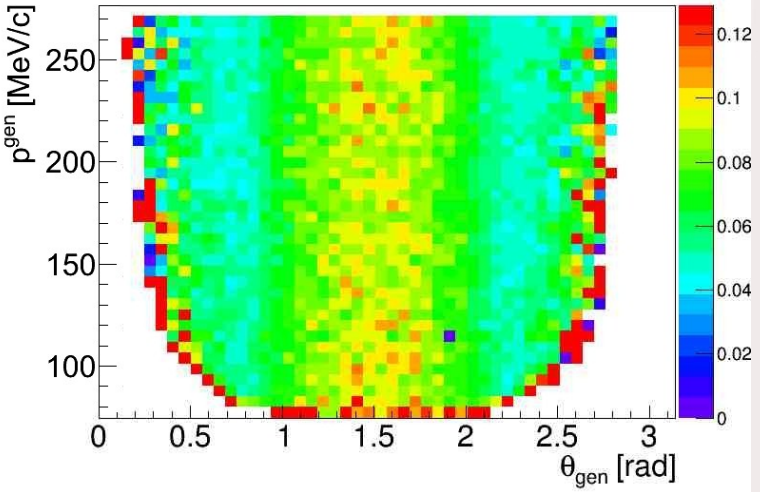
Hardware → software

Resolutions for protons

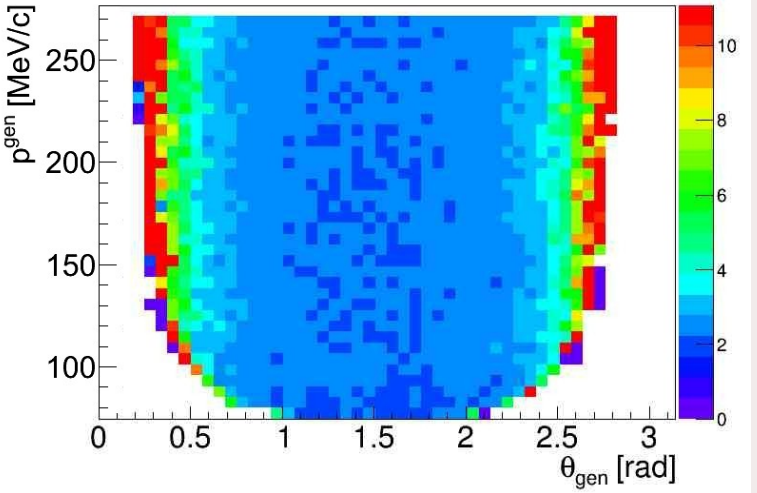
Phi [rad]



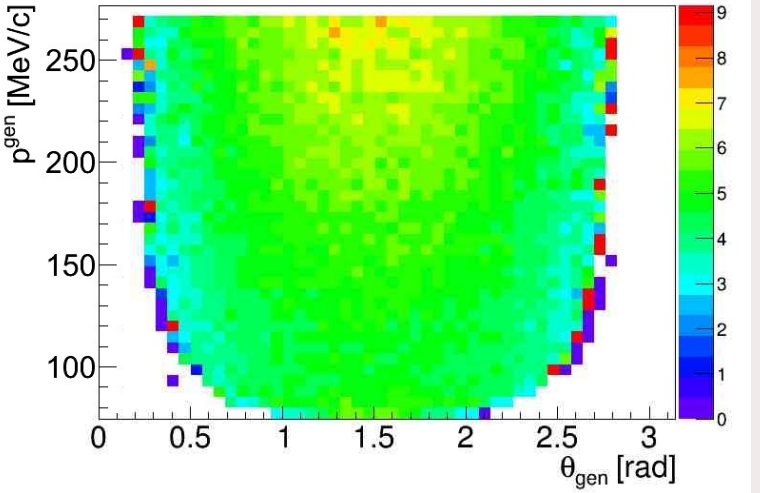
Theta [rad]



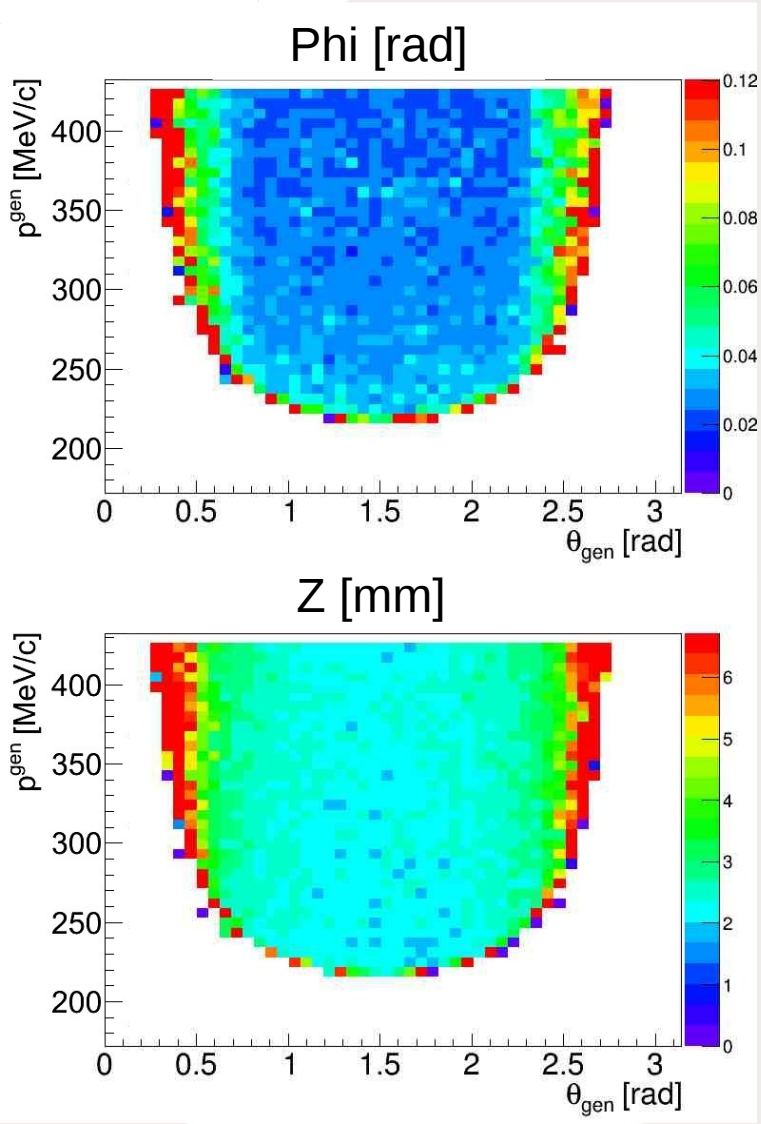
Z [mm]

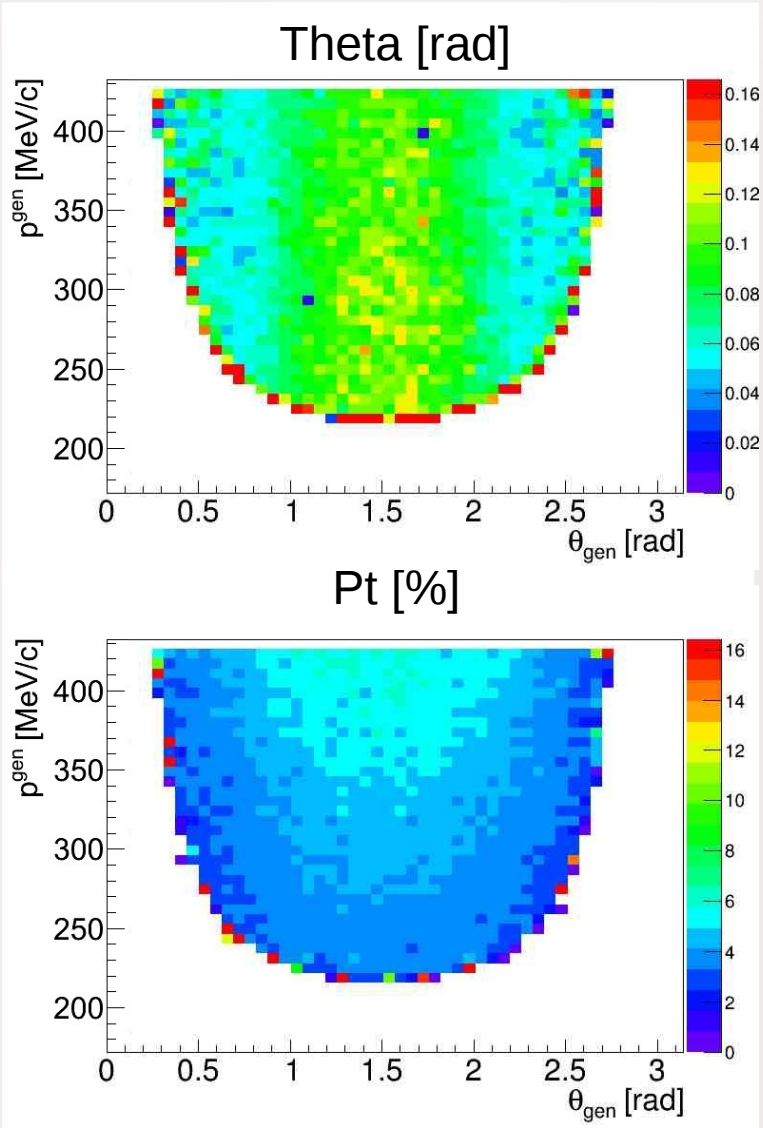


Pt [%]



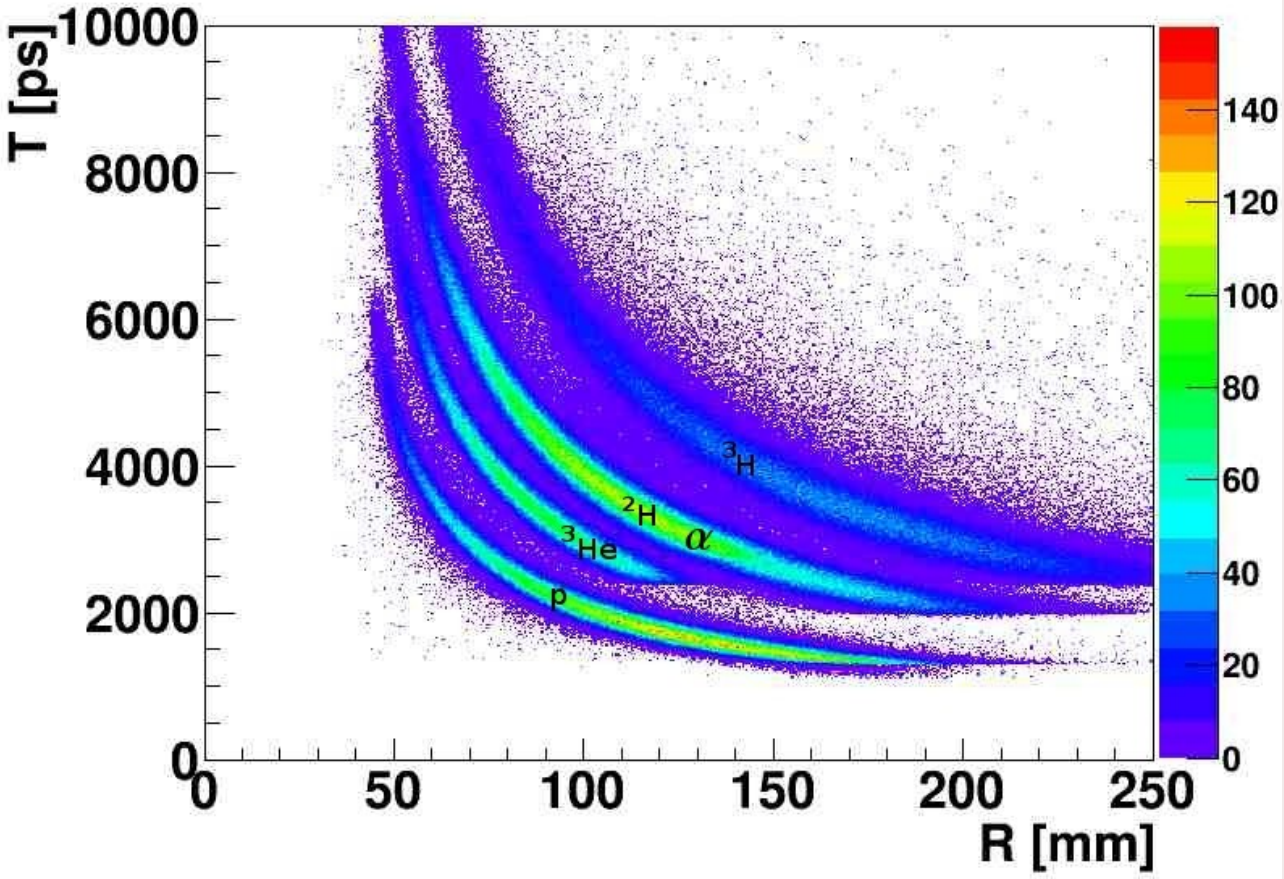
Resolutions for alphas





Particle identification: method (1/2)

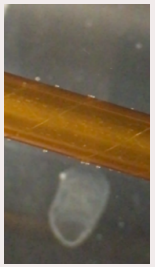
Using the reconstructed radius in the wire chamber and the time of arrival in the scintillator, protons, helium 3 and hydrogen 3 can be separated.



H2 and alphas will be separated via energy deposition in the drift chamber, stopping power and dE/dx in the scintillators

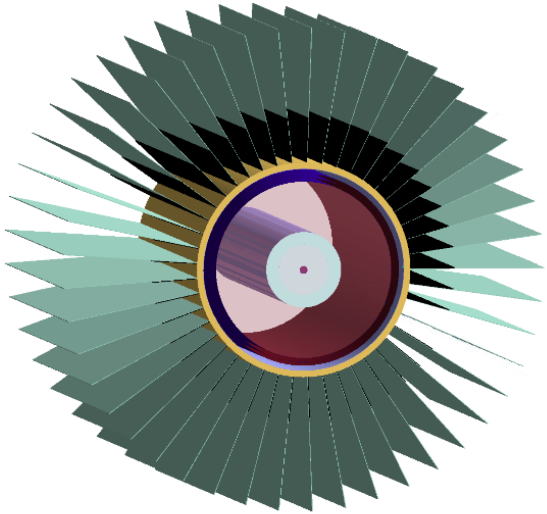
Schedule and conclusion

BONuS tentatively scheduled for the first semester of **2020**
Detector is being **built now**

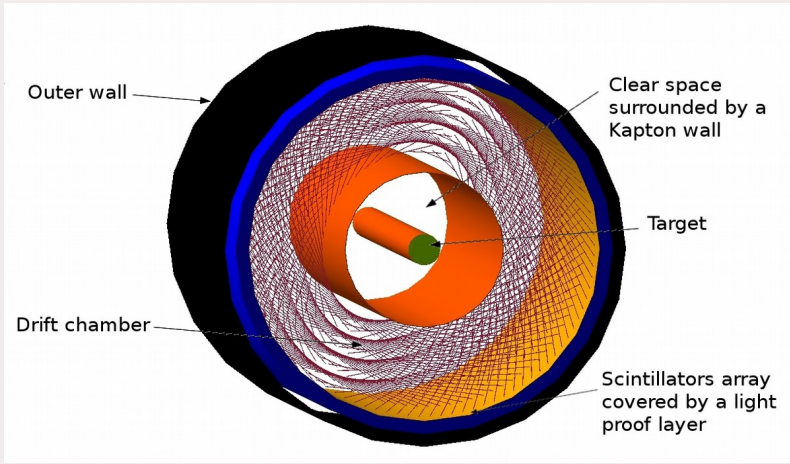


Target leaks

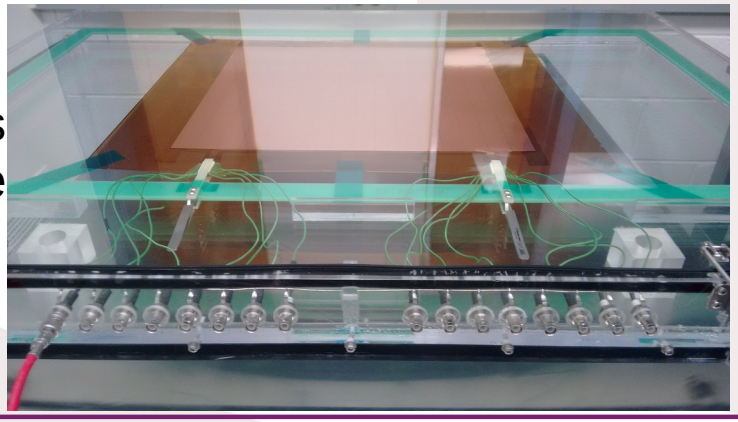
ALERT not yet schedule, detector is under R&D phase
Design must be **completed by May 2019**



Connection to elecronics is not easy



Precise mechanics to form the GEM cylinders



How to connect the wires with a 2 mm gap?