ALERT

A Low Energy Recoil Tracker for CLAS12 at Jefferson Lab

Unité mixte de recherche

CNRS-IN2P3
Université Paris-Sud

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
http://ipnweb.in2p3.fr

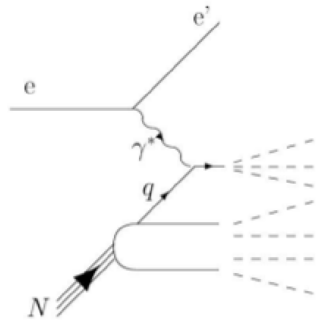
Raphaël Dupré

IPN Orsay

Generalized Parton Distributions

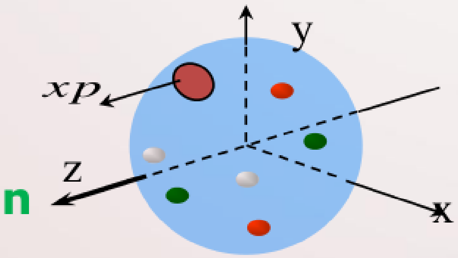
ep ⇨ eX

(DIS)



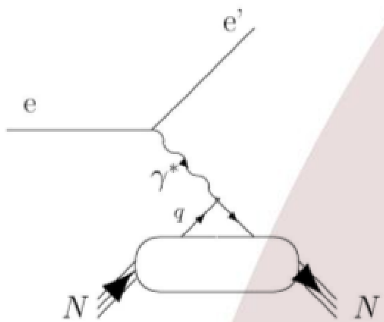
$f_1(x), g_1(x)$

(Parton Distribution Functions: PDF)



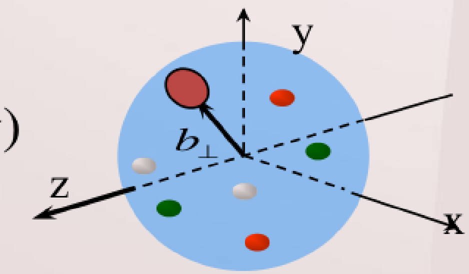
ep ⇨ ep

(elastic)



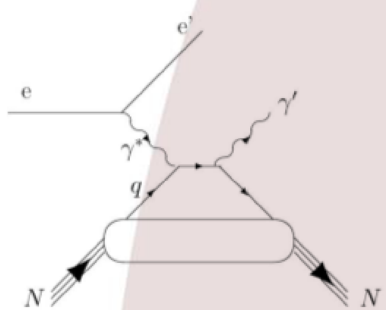
$F_1(t), F_2(t), G_A(t), G_P(t)$

(Form Factors: FFs)



ep ⇨ epγ

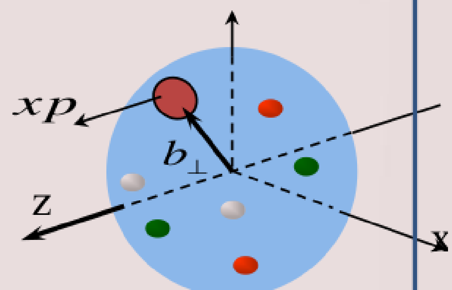
(DVCS)



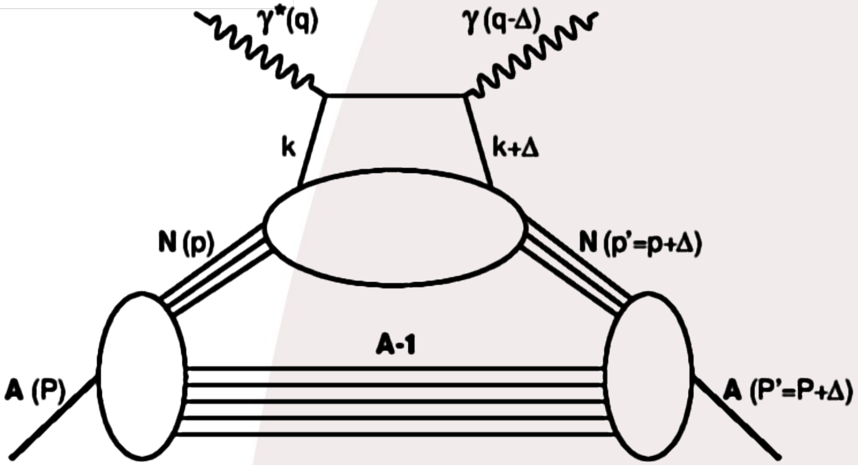
$H(x,\xi,t), E(x,\xi,t),$

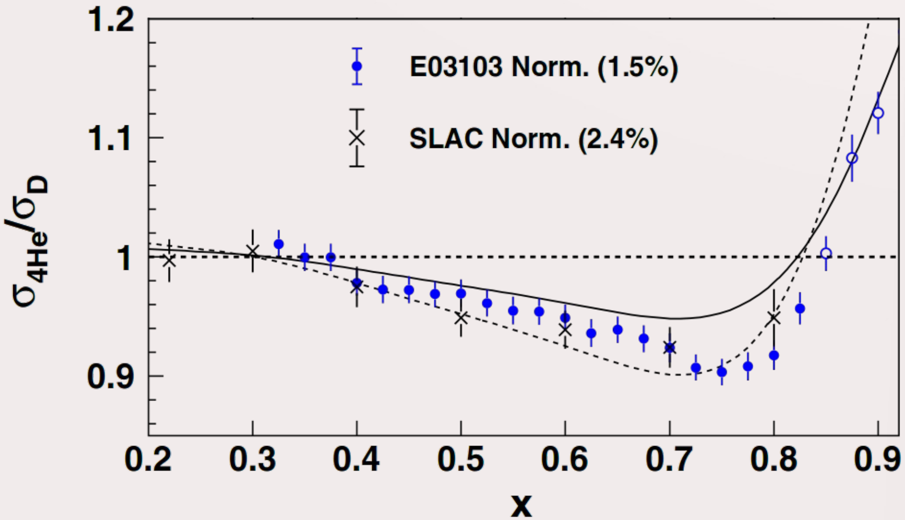
$\tilde{H}(x,\xi,t), \tilde{E}(x,\xi,t)$

(Generalized Parton Distributions GPDs)



DVCS on Nuclei



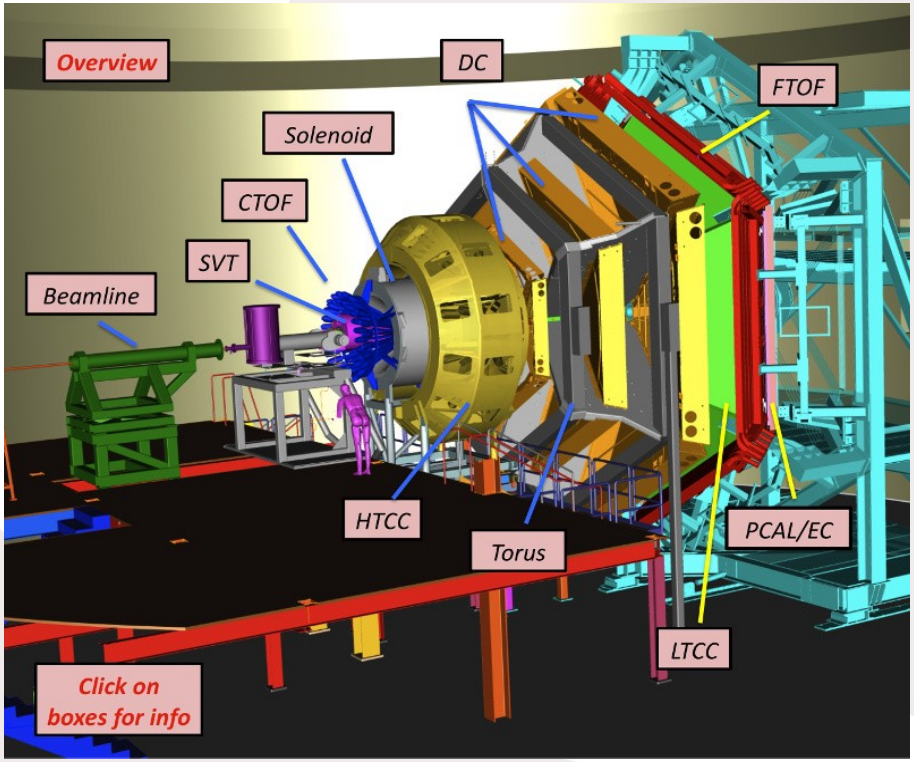


- **An opportunity to study nuclei in term of quarks**
  - Study of the EMC effect
- **The spin-0 simplification**
  - Only one GPD for Helium-4 → 1 GPD → 2 CFFs
- **Impulse partial wave approximation**
  - Convolution of nucleons in nuclei and partons in nucleons distributions
  - Only nucleons are considered
  - No interaction with A-1
  - Fermi motion (including some off-shellness)

V. Guzey and M. Strikman Phys. Rev. C 68, 015204

Measuring DVCS on Helium

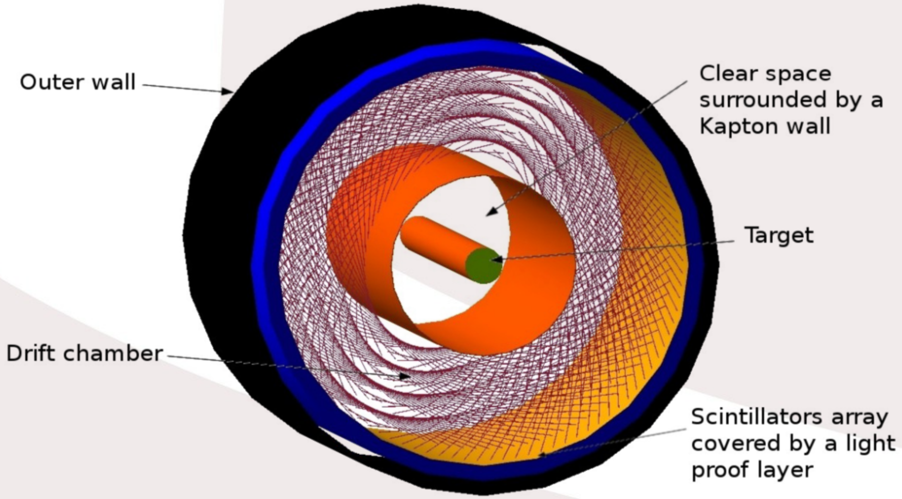
- **Jefferson Laboratory**
  - High intensity 12 GeV electron beam
  - High quality beam
    - 100% duty factor
    - Around 150 µm wide
    - Intensity up to 100 µA

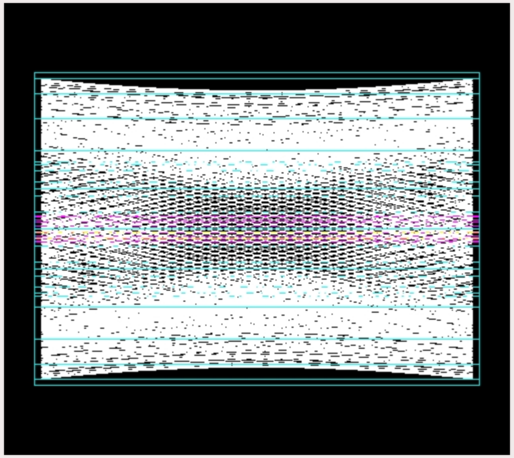


- **CEBAF Large Acceptance Spectrometer: CLAS12**
  - Nearly 4π
  - Offers electron and proton identification for our experiment
  - Recording rates up to 40 kHz
  - **No capabilities to detect slow nuclei**

Detection Needs

- **Need capabilities at very low momentum**
  - Down to ~200 MeV/c for 4He (5-6 MeV kinetic energy)
  - Our main limitation is from recoil stopped in target material
  - Target is planned to be only 3 atm, 0.5 cm radius with 15 µm kapton walls
  - Need to be able to handle high rates to measure DVCS
- **The solution**
  - Very light wire chamber placed right outside the target
    - With stereo angle between wires
  - Small scintillating tiles for time of flight measurement
  - Capabilities to handle high rates
    - Short drift time <250 ns
    - Translate into an average 0.6 background track per event

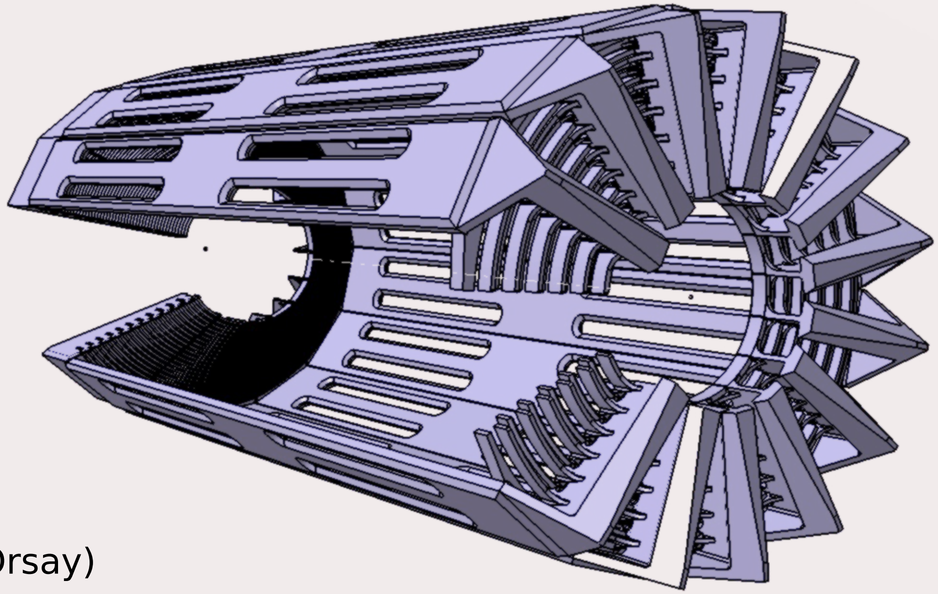




Several R&D questions

- **Can we design such a detector ?**
  - The steroangles complicate things a lot
  - Tension of thousands of wires correspond to hundreds of kilograms
- **Can we make wire chambers lighter ?**
  - Use carbon wires instead of golden tungsten
  - Could find application in many other low energy nuclear experiments, in particular SOFIA at GSI (L. Audouin)
- **How to read out ALERT ?**
  - Drift time are key to this experiment
  - Use last generation front-end chip from CEA-Saclay: DREAM
    - Need to be tested in these conditions
- **Funded by P2IO in 2015**
  - R&D project of 51 k€ for 3 years

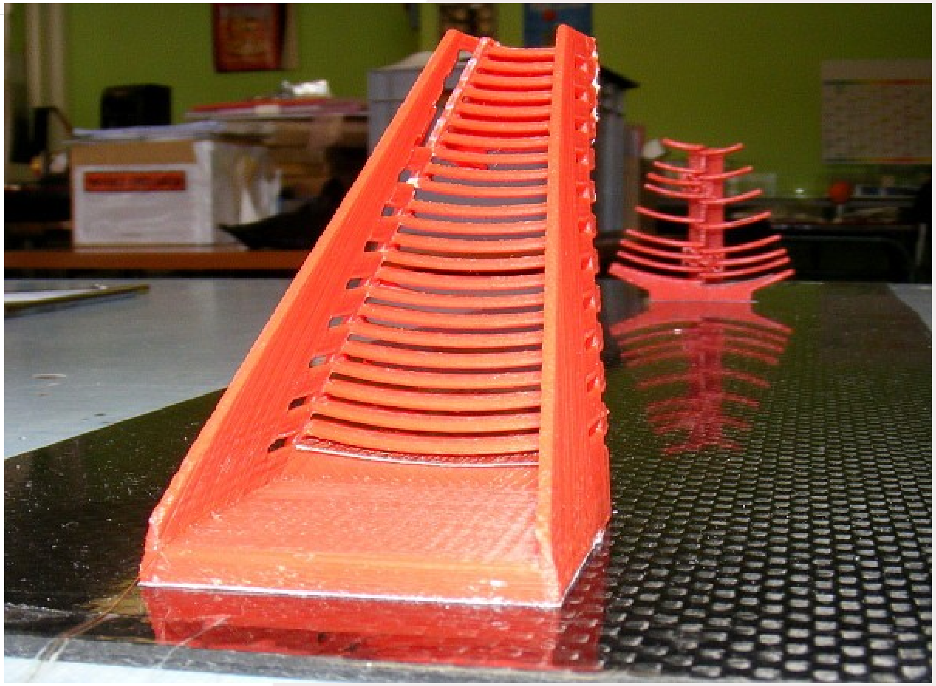
Design and Prototyping

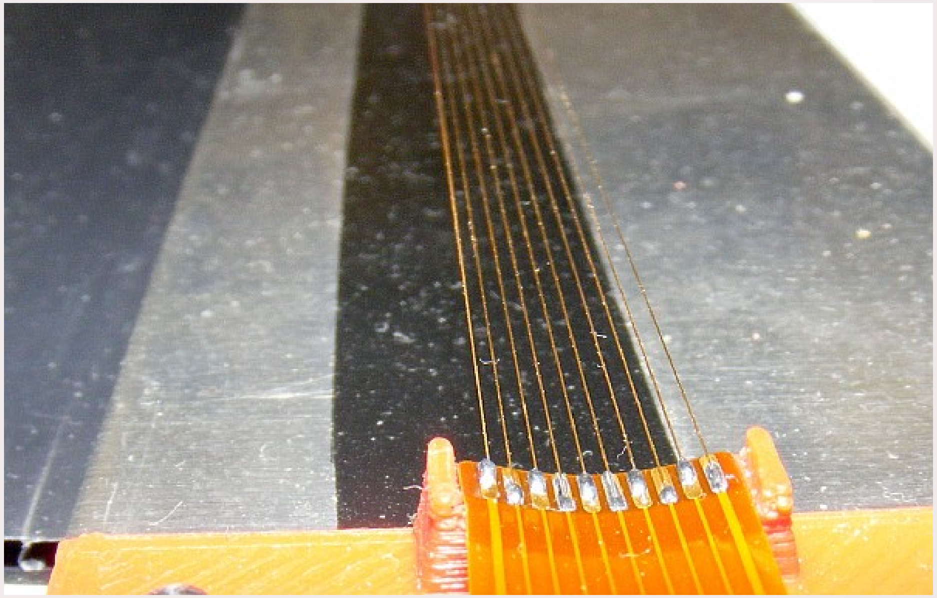


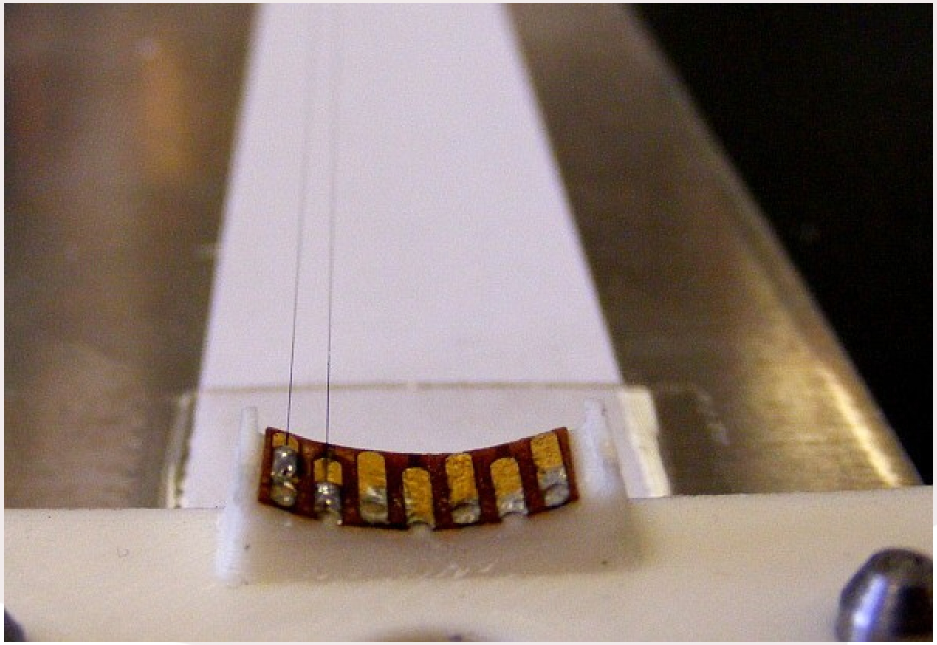
J. Bettane (IPN Orsay)

- **First prototype is designed**
  - Sector system to simplify maintenance and construction
  - Mechanical structure on the outside
- **To be refined in the future**
  - Optimization of materials to reduce multiple scattering
  - Scintillator system to be integrated in a second version
  - Make access for gas and electronics connections

Orsay Tests



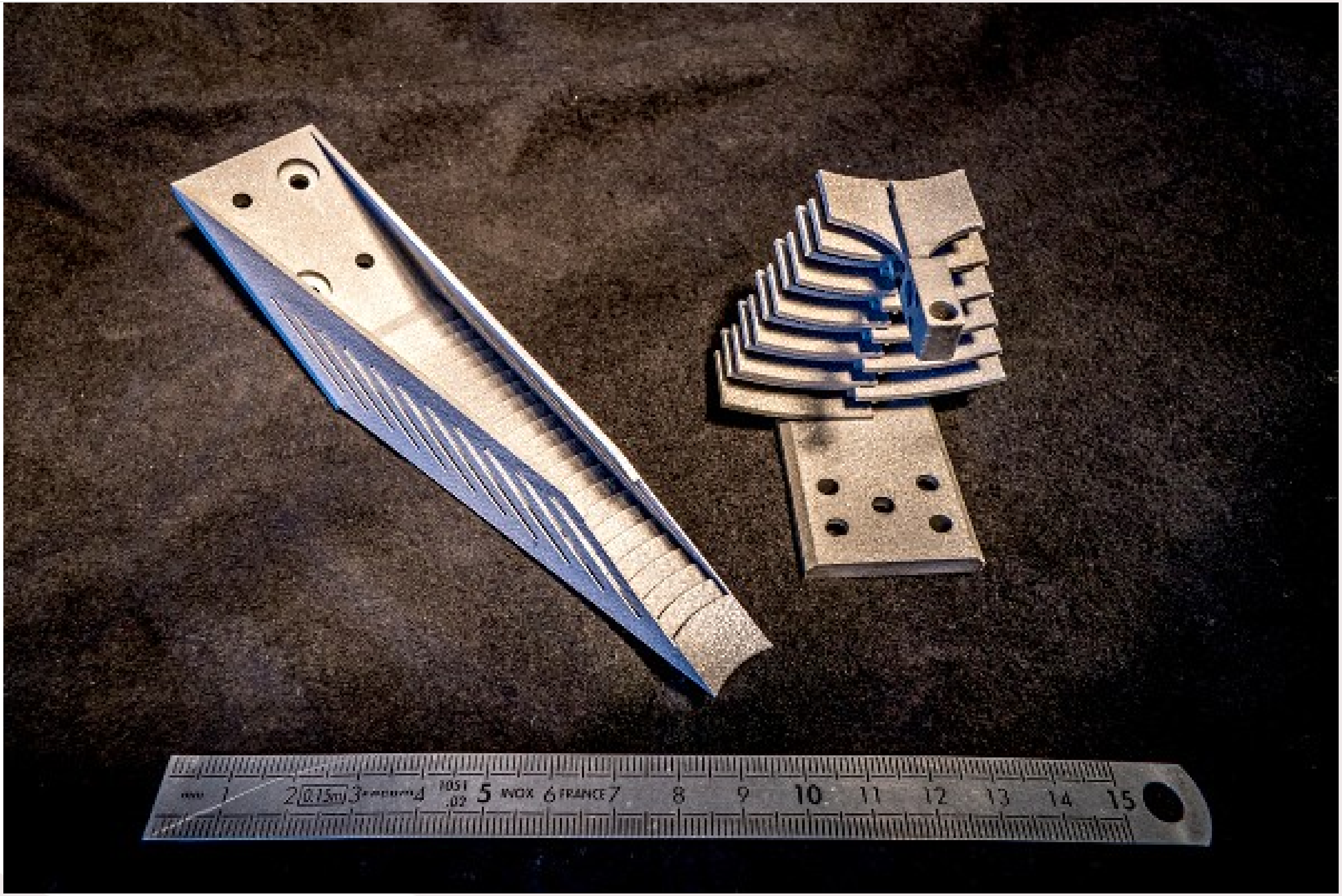




Progress in IPN:

- 3D printed tests
- Soldering wires on curved surface
- Gluing and soldering carbon wires

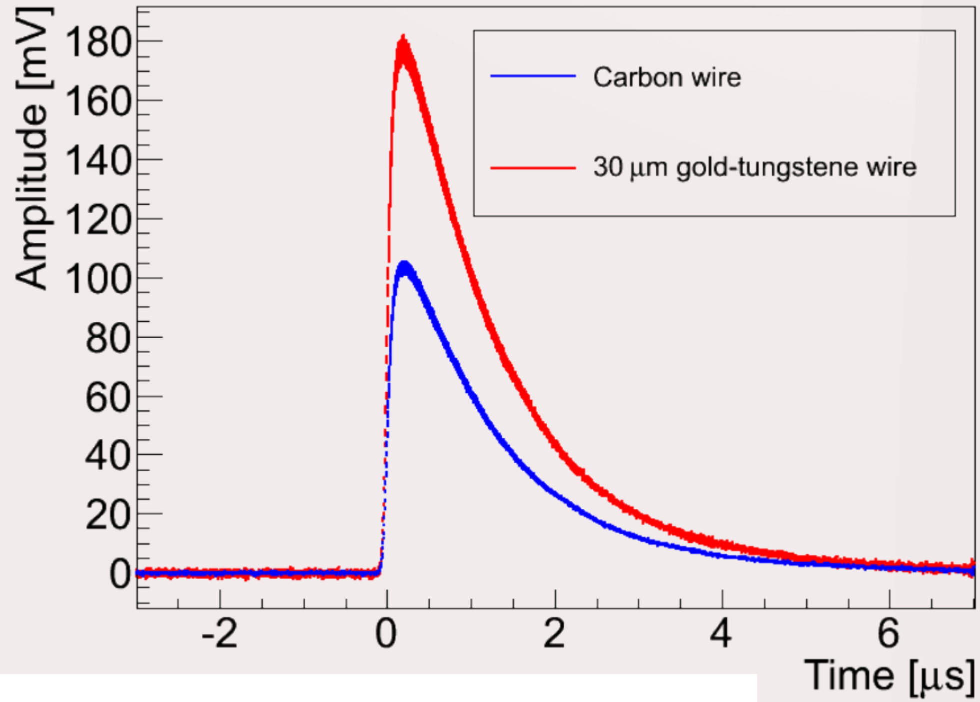
First prototype



To be wired very soon

Carbon Wires

- **Prototype with one carbon wire built**
- **First test show very nice signal**
  - Smaller size might be due to higher resistivity (?)
- **A paper submitted to NIM already**



Paving the way for carbon wire chamber at sub-atmospheric and atmospheric pressure

G.˜Charles[a,*], L.˜Audouin[a], J. Bettane[a], R. Dupre[a], B. Genolini[a], N. Hammoudi[a], M. Imre[a], V. Le Ven[a], B. Mathon[a], A. Maroni[a], T. Nguyen Trung[a], E. Rauly[a]

[a] *Institut de Physique Nucléaire, CNRS-IN2P3, Univ. Paris-Sud, Université Paris-Saclay, 91406 Orsay Cedex, France*

Summary

- **We are extending the GPD program to nuclei**
  - Which necessitates new generation detectors
- **Thanks to P2IO we Started our R&D program**
  - First prototype design will be plugged to electronics before Summer
  - Carbon Wires initial test done → to be published soon
- **Physics program for this detector is developing rapidly**
  - Collaboration with Jefferson Lab, Temple University and Argonne National Laboratory is starting
  - Four proposals submitted this morning to Jefferson Lab PAC use the ALERT detector
- **Future developments**
  - Implement carbon wires on a larger scale
  - Time of flight system studies will start next year

Extracting a 3D Map

- **GPDs can be interpreted as 3D maps**
  - Hankel transform at $\xi=0$ gives the probability density as a function of x and the impact parameter
    M. Burkardt Int.J.Mod.Phys. A18 (2003) 173-208
  - The polarized GPDs give the correlation between spin and position in the nucleon
- **Fits of data**
  - Putting together cross sections and spin asymmetries
  - Global fit allows to extract the 3D map of the proton
    M. Guidal et al. Rept.Prog.Phys. 76 (2013) 066202