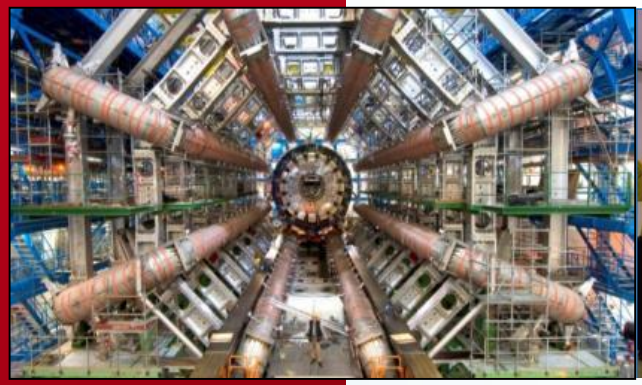
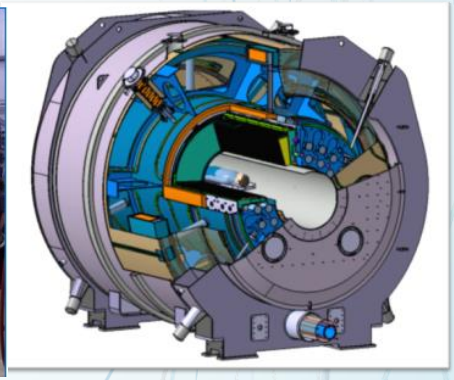
DE LA RECHERCHE À L'INDUSTRIE

cea

Irfu : overview





Anne-Isabelle Etienvre
Head of Institute

EIC User meeting - Paris
July 2019

www.cea.fr

IRFU : GENERAL STRATEGY

- **Answer to the main questions** concerning the four fundamental interactions, at different scales, from the very smallest to the largest
- **Design, construction, operation of high technology instruments**
  - for these research topics
  - …and beyond
- **Key actor within major international collaborations**
- **Core fundamental research actor of CEA strategy**
- **Teaching, training**
- **Long range plan (IRFU 2030) achieved in 2018, strongly supported by the french national evaluation agency**

EXPLORING THE FUNDAMENTAL LAWS OF UNIVERSE

Scrutinizing the Standard Model and beyond

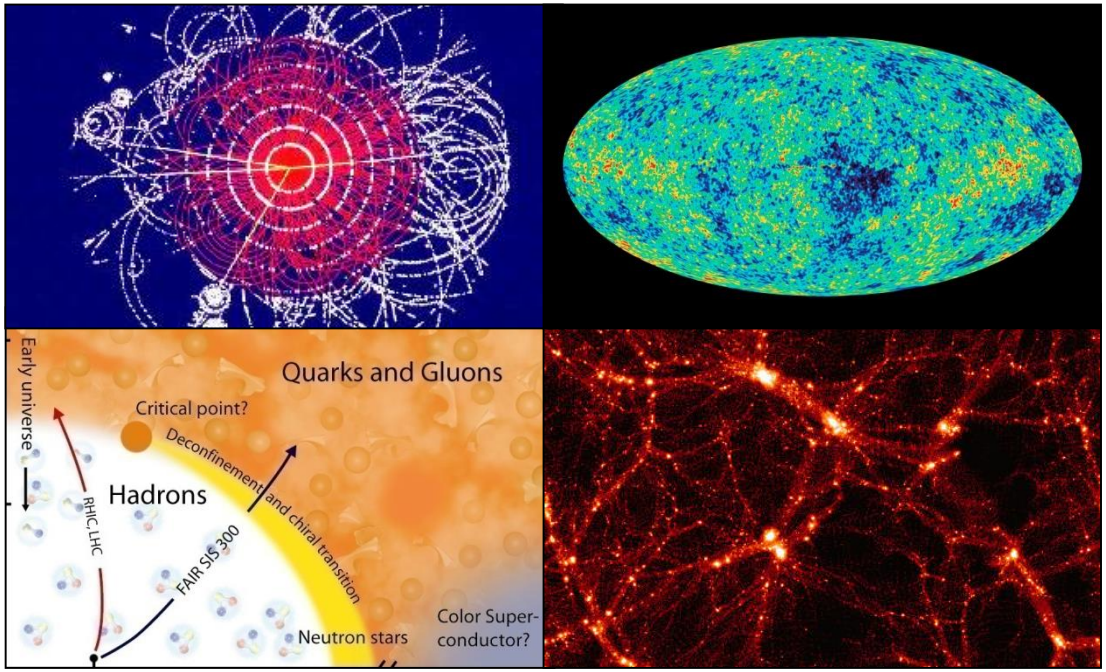
- *LHC : ATLAS, CMS*
- *Neutrinos: accelerator (Japan, US), reactor, $\beta\beta0\nu$*

Study of the energy content of the Universe

- *Dark matter & energy : e-BOSS, DESI, EUCLID*
- *Antimatter: GBAR*

Infinitely small → *Infinitely large*

Elementary ↓ *Complex*



Nuclei structure in extreme conditions

- *Exotic nuclei: Ganil, Riken, GSI*
- *QGP : Alice*
- *Structure: Compass, CLAS12, EIC*

Study of the Universe origin and structure

- *High energy cosmic ray: XMM-Newton, CTA, SVOM*
- *Planets, stars, galaxies formation and evolution:*

  Artemis, Solar Orbiter, JWST, Plato, ARIEL, ELT

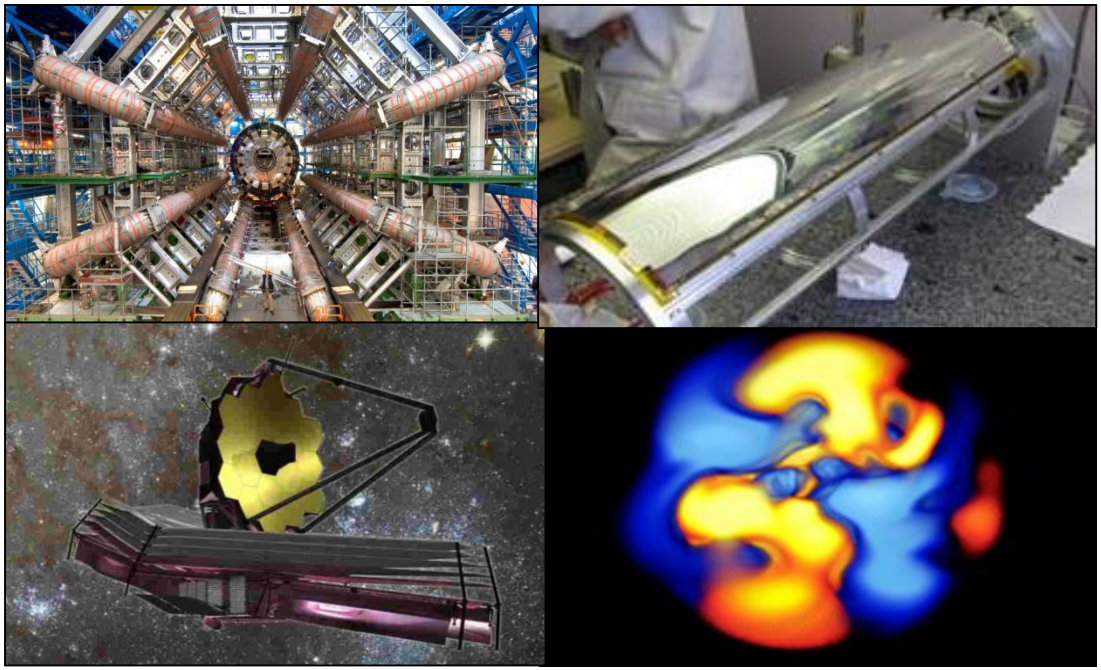
INVENTING AND CONSTRUCTING NEW DEVICES

Accelerator and superconducting magnets

- ***Intense ion sources, RFQ, Cryomodules:***
- ***Superconducting magnets for accelerators and detectors***
- ***Beam dynamics***

Detecting

- ***Gaseous detectors (Micromegas)***
- ***Solid detectors (bolometers)***
- ***Electronics (ASICS)***



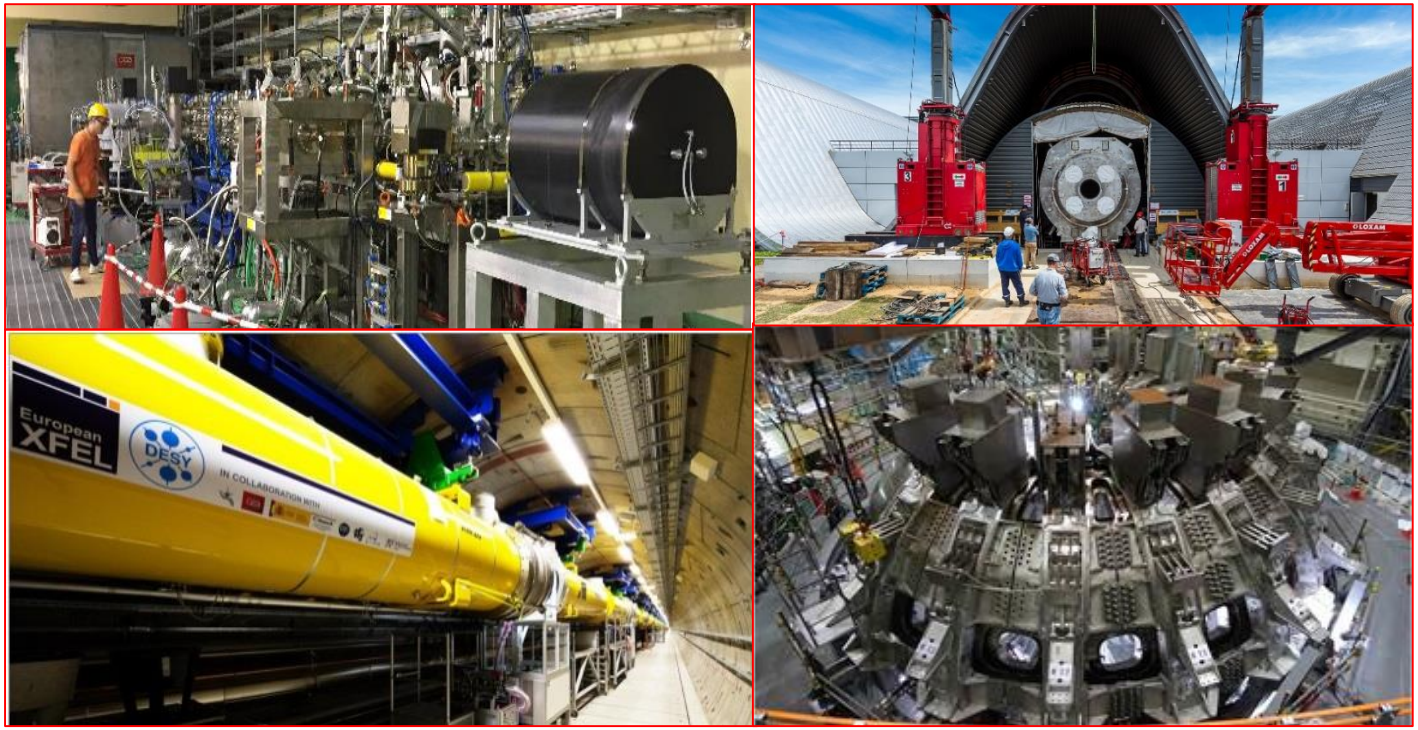
Observing : space devices

- ***Camera, spectroimaging,..***
  From X-ray to sub-mm
- ***cryomecanisms***

Simulating

- ***HPC***
- ***Grid***

Knowledge and know-how for other communities



- *Fusion (IFMIF, JT60-SA, ITER)*
- *Light sources (major contribution to E-XFEL)*
- *Health: MRI (11.7 T Magnet Iseult), detectors*

RECENT HIGHLIGHT (LAST WEEK!)

11.7 T reached in the Iseult MRI magnet – Saclay

- Highest field in the world for a whole body magnet

IRFU structure

1144 FTE

Institute of Research into the Fundamental Laws of the Universe

Head : Anne Isabelle Etienvre

197

Astrophysics Departement

Head: Anne Decourchelle

120

Engeneering Department

Head: Christian Veyssière

110

Particle Physics Department

Head: Gautier Hamel de Monchenault

161

Accelerators, Cryogenics, Magnetism Department

Head: Pierre Vedrine

79

Nuclear Physics Department

Head: Franck Sabatié

150

Electronics, Detectors , Computing Department

Head: Eric Delagnes

290

GANIL Department

Head: Héloïse Goutte

KEY NUMBERS

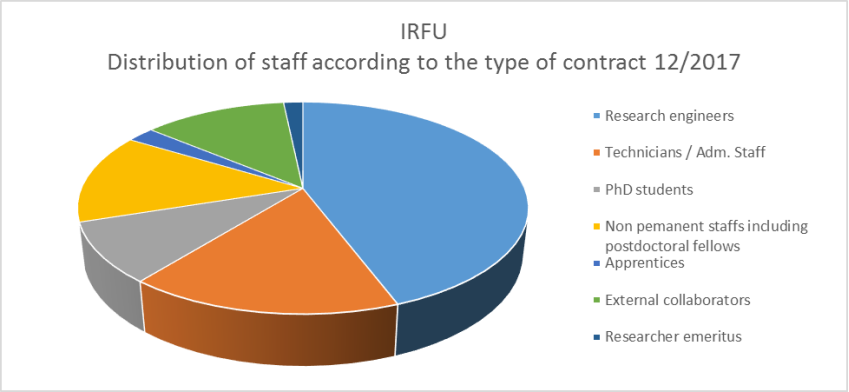
- **800 publications/year**
- **34 european** H2020 projects (2014-2017)

  21 ERC grants
- **1144 FTE:**

  712 permanent CEA staff

  108 PhD and 190 non permanent staff

  134 non CEA staff



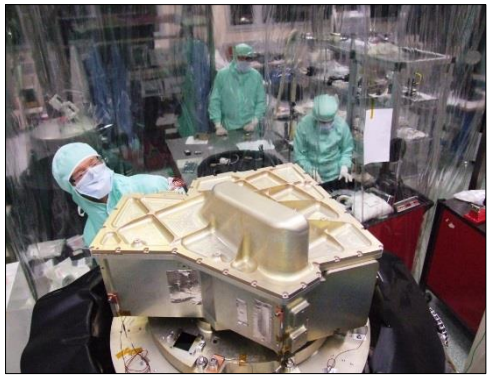
- **65 patents**

LARGE PLATFORMS @ SACLAY (50 000 M²)

DETECTORS

Large migromegas detectors integration and tests (LHC UPGRADES)

Clean room - 130m²



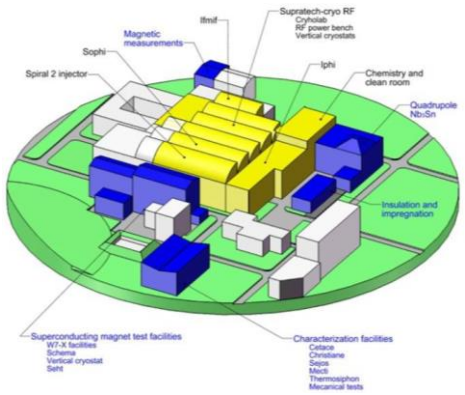
SPACE

Clean rooms for space instruments integration and tests

Magnets and accelerators

Synergium - 25 000m²

Integration halls, clean rooms cryostats



Computing

HPC cluster

Node of Grid@LHC

CEA-CNRS Large infrastructure in CAEN

- Spiral 2 commissioning ongoing (agreement from the safety authority)

Le 3 novembre 2016 le Président de la République Francois Hollande a inauguré l'accélérateur de particules Spiral2 au Ganil.

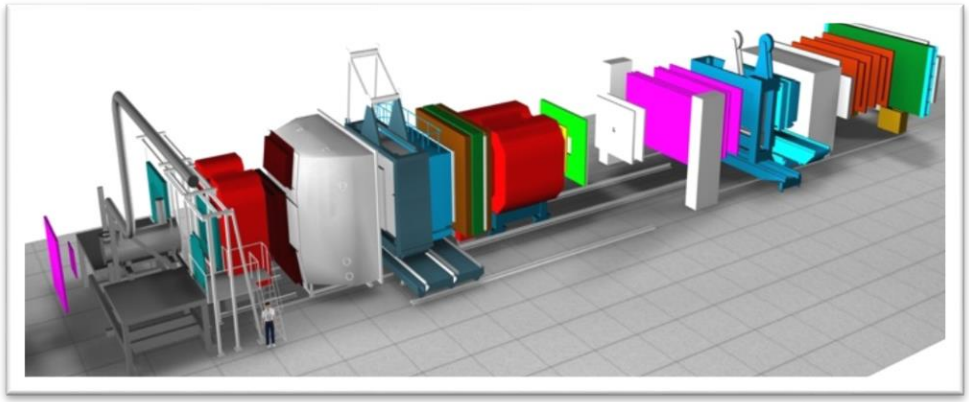
(SOME) HIGHLIGHTS IN HADRONIC PHYSICS AT IRFU

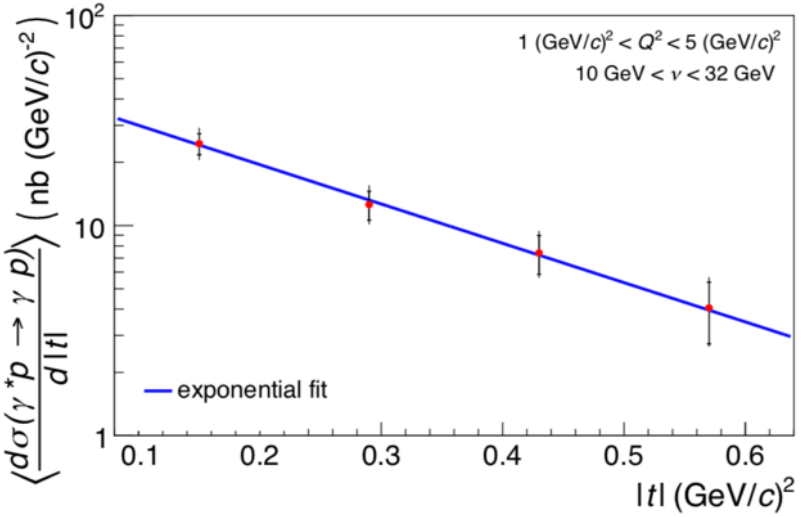
Irfu

Past involvements, new trends

- Contributions to INT Workshop
- Participation in the EIC White Paper
- Co-organization of POETIC V and this meeting in Paris
- EIC R&D – eRD3 on lightweight trackers
- LDRD R&D with BNL on « Zigzag »
- <u>New trends:</u>
  - Recent hiring of an EIC physicist at CEA Saclay
  - Recent hiring in GPD theory/phenomenology at CEA Saclay
  - Involvement of CEA Saclay on sPHENIX

Deeply Virtual Compton Scattering with COMPASS



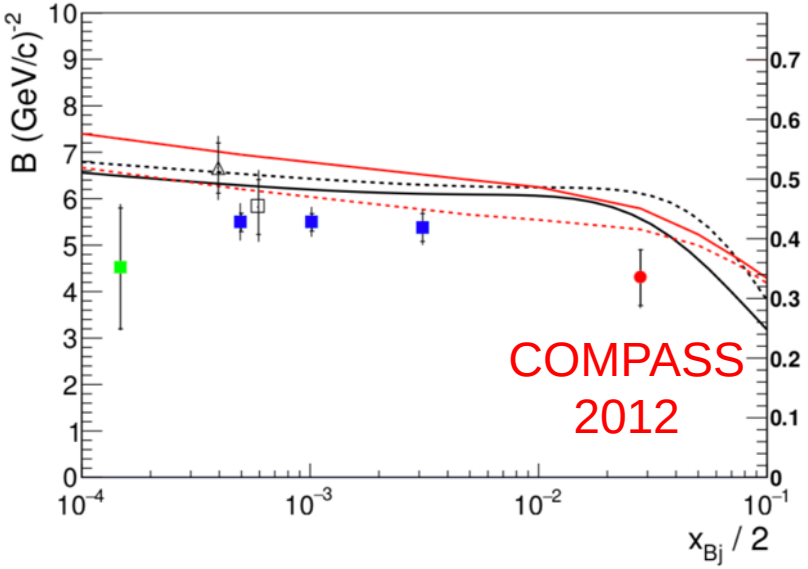


Final result of DVCS 2012 run

Differential DVCS cross section in t
⇔ Transverse proton size at $x = 0.028$

$$\sqrt{\langle r_\perp^2 \rangle} = (0.58 \pm 0.04_{\text{stat}} \, {}^{+\,0.01}_{-\,0.02}\big|_{\text{sys}} \pm 0.04_{\text{model}}) \text{ fm}.$$

Phys. Lett. B793 (2019) 188-194

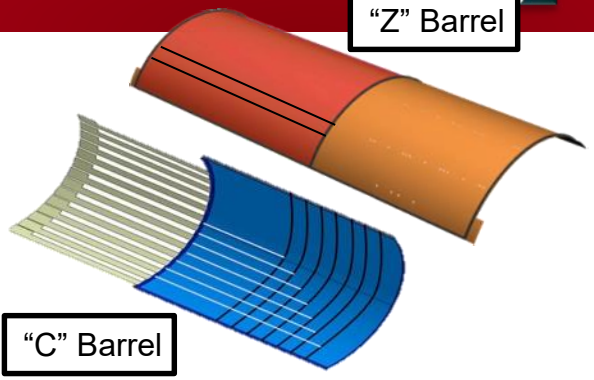


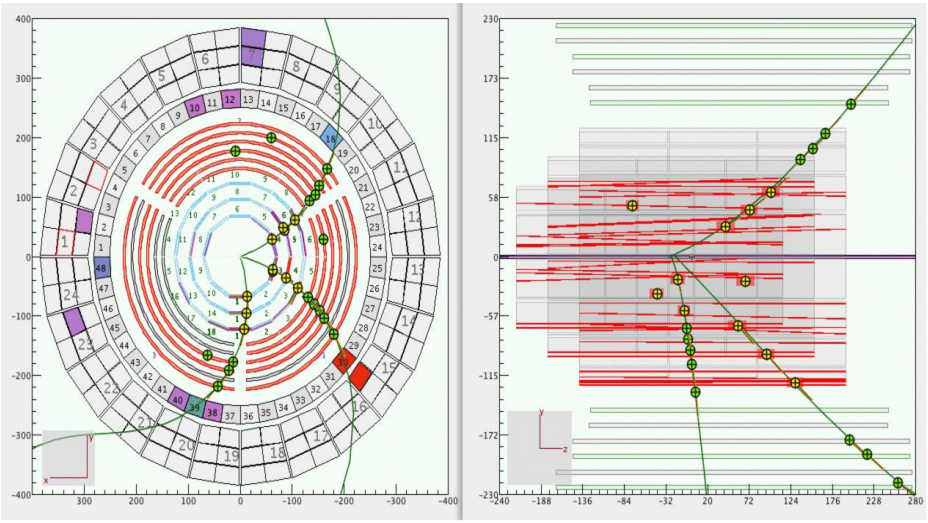
State-of-the-art lightweight tracking detectors for CLAS12

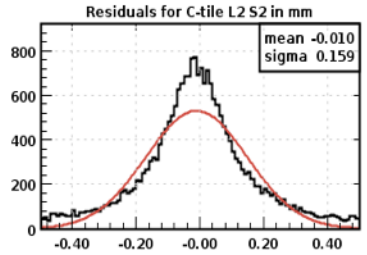
- Cylindrical **Micromegas tracker for JLab/CLAS12** :
  18 detectors in 6 layers of 3 sectors. First of its kind !

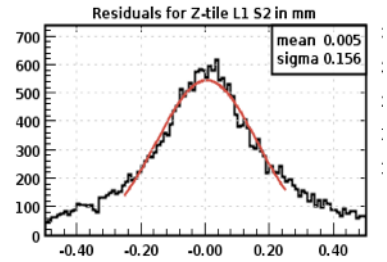
- Final install Fall 2017, commissioning, LH2 data taking in 2018.

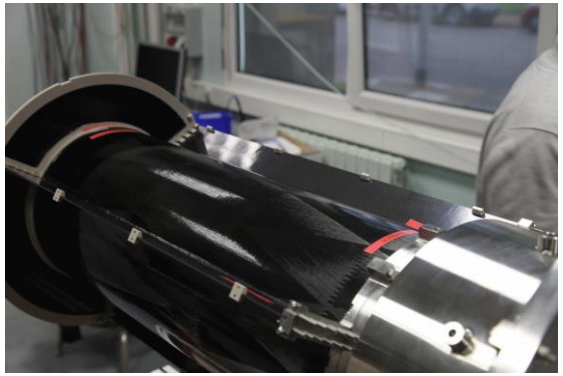
- **Excellent performances in high-rate environnent.**

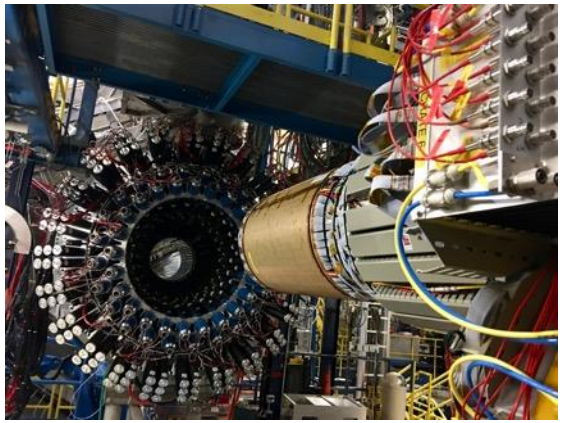






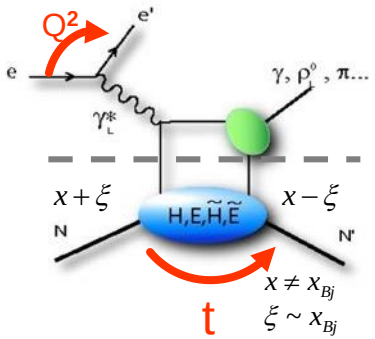


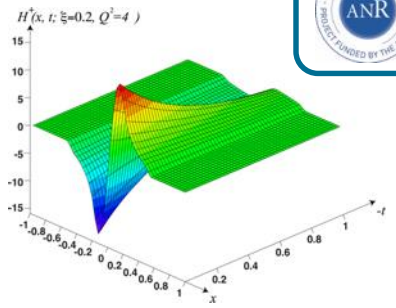


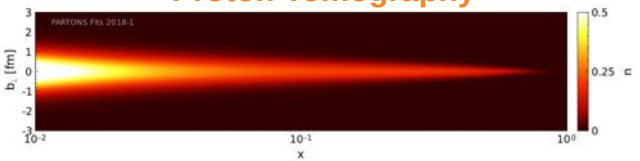


Deeply Virtual Compton Scattering @ CLAS12
PARTONS

EPJ C78 (2018) 11, 890





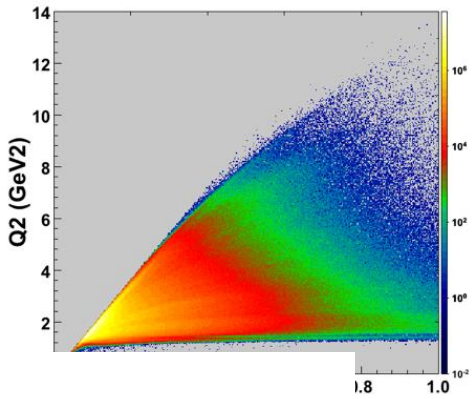


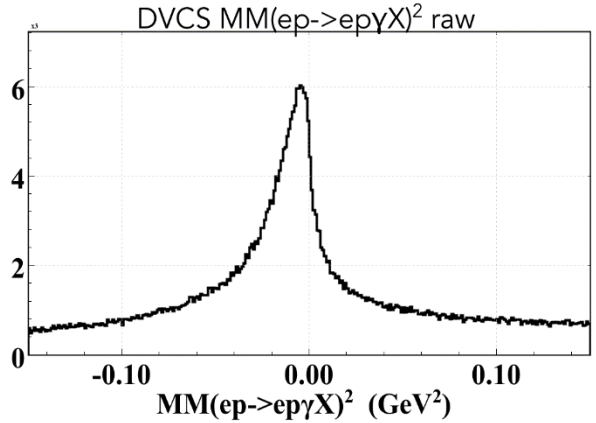
Global analysis of 2600+ measurements of 30 observables published between 2001 and 201

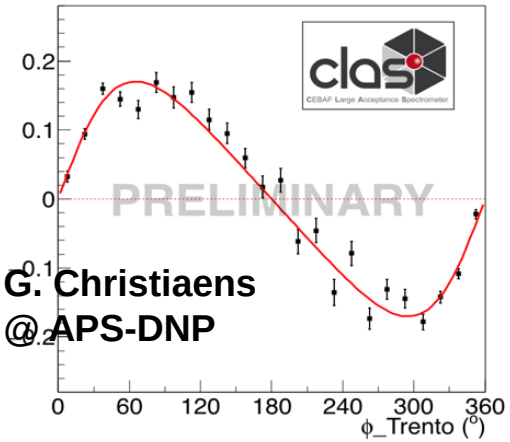
PARTONS : Common framework for multi-channel GPD studies,
from the glue (EIC) to the valence (JLab) kinematic domains,
Extension to TMDs within the European STRONG-2020 project.

Data collected with **CLAS12** from Feb. to Nov. 2018

0.7% of available statistics



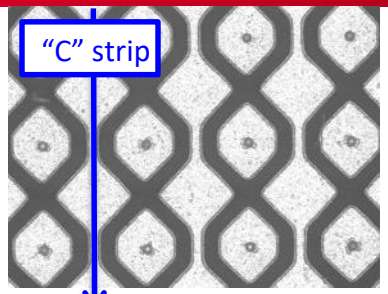




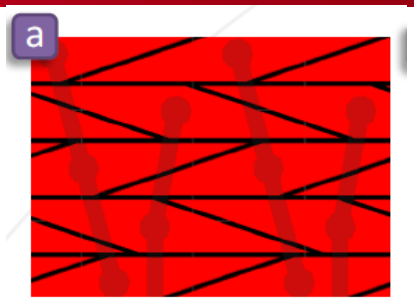
G. Christiaens @APS-DNP

Micromegas R&D from CLAS12 to sPHENIX and EIC

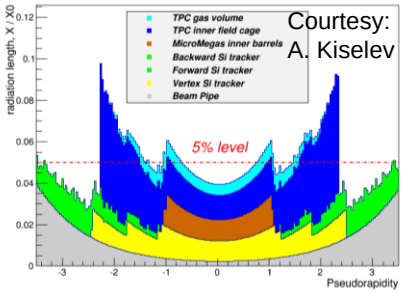
Participation of Irfu in **eRD3 EIC R&D** program with Temple University



2D detector (ASACUSA)

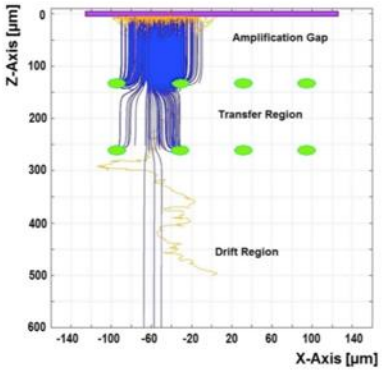


Diamond detector (EIC?)



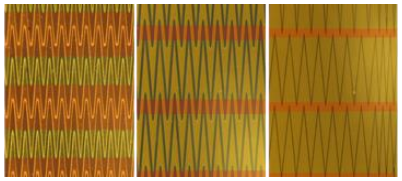
Courtesy: A. Kiselev

Inner EIC tracker optimization

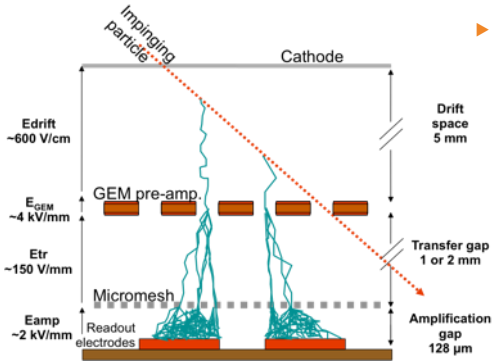


Double-mesh Micromegas

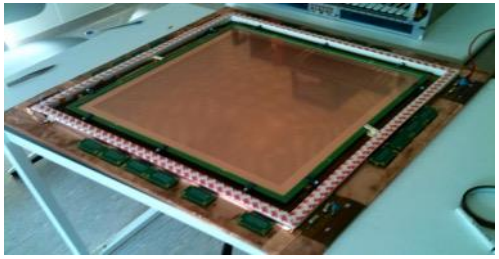
- **Reduce material budget**
  - → 2D detectors
  - → Lightweight detectors
- **Reduce number of electronics channels**
  - → Zigzag R&D with BNL
  - → Genetic Multiplexing
- **Reduce ion backflow** (for TPC readout)
  - → Hybrid or double-mesh Micromegas



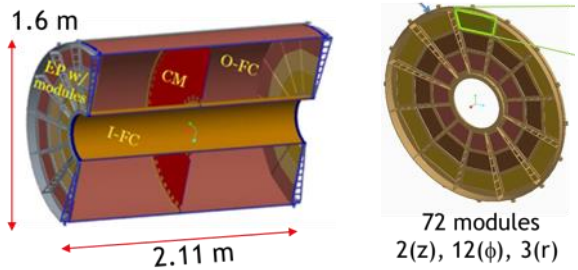
Zigzag R&D (BNL LDRD)



Hybrid GEM-Micromegas



COMPASS Hybrid



sPHENIX TPC readout

CONCLUSION

- *Important and long term involvement in hadronic physics within CEA*
- *Already existing contributions to*
  - *instrumentation (detectors)*
  - *data analysis*
  - *modelisation and phenomenology*
- *Irfu expertise in accelerators and magnets*
- *EIC project belongs to the CEA-Irfu 2030 roadmap*