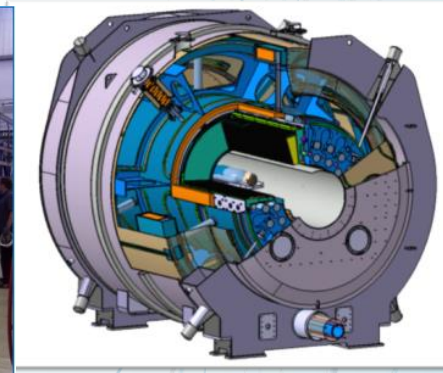
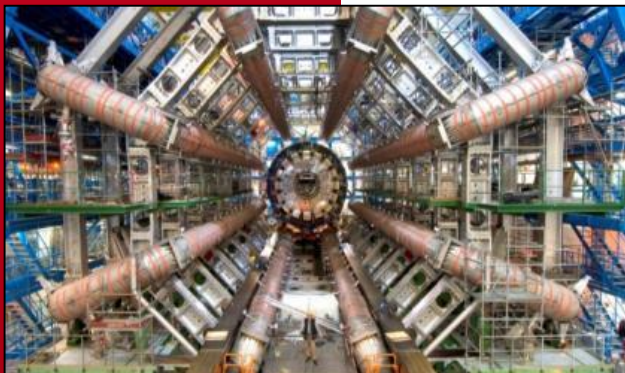


DE LA RECHERCHE À L'INDUSTRIE



Irfu : overview



www.cea.fr

Anne-Isabelle Etiennevire
Head of Institute

EIC User meeting - Trieste
July 2017

■ Basic Research in Physics in link with large scale facilities

Researches into the fundamental laws of the Universe

- Co-Leader in France with CNRS (INSU & IN2P3), Universities
- Goals: 4 key questions and associated technology



What are the ultimate constituents of matter?



What is the energy content of the Universe?



How is the Universe structured?



What are nuclear matter self-organisation processes?

■ Broader approach, large scale facilities and Cryotechnologies

- Goals: 2 specific technological topics



Superconducting Magnets



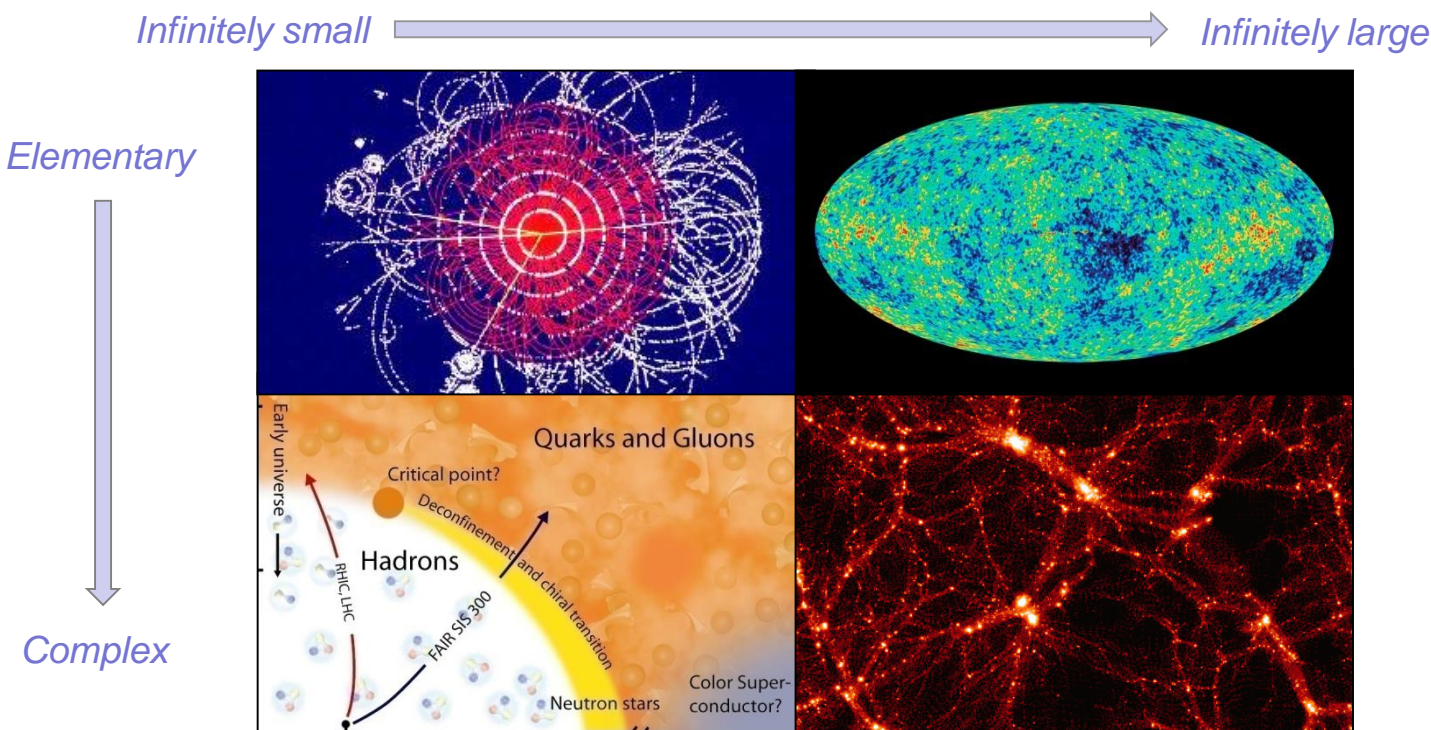
Particle Accelerators

What are the ultimate constituents of matter ?

- *LHC* (ATLAS, CMS)
- *Neutrinos* (accelerator, reactor, source)

What is the energy content of the Universe ?

- *Dark matter & energy* (CTA, DESI, EUCLID)
- *Antimatter* (GBAR)



What are the origins of particles and nuclei ?

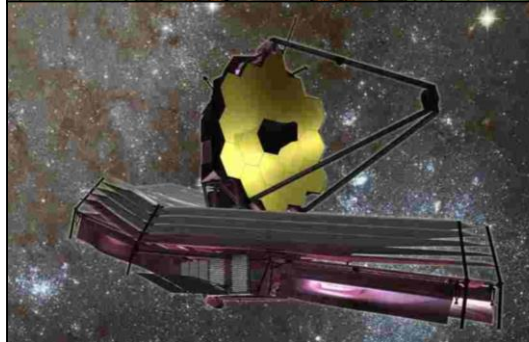
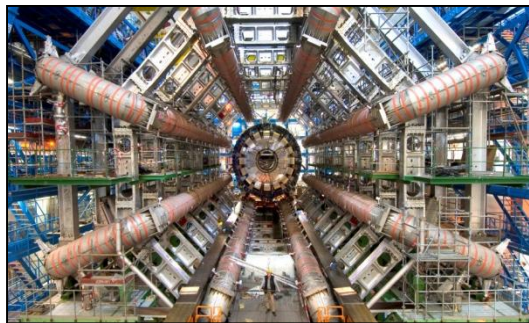
- *Exotic nuclei* (Riken, Ganil)
- *QGP* (Alice)
- *Structure* (Compass, Clas12, EIC)

What are the origin and structure of the Universe ?

- *Star and galaxies* (Artemis, JWST, ELT)
- *Planets* (Solar Orbiter, Plato)
- *Violent phenomena* (SVOM, ATHENA)

Accelerator and superconducting magnets

- *ESS* (RFQ, cryomodules)
- *FAIR* (proton Linac, magnets)
- *Saraf* (Linac)
- *Spiral2* (Source, RFQ, cryomodules)
- *HL-LHC, FCC* (magnets)
- *Fusion projects*

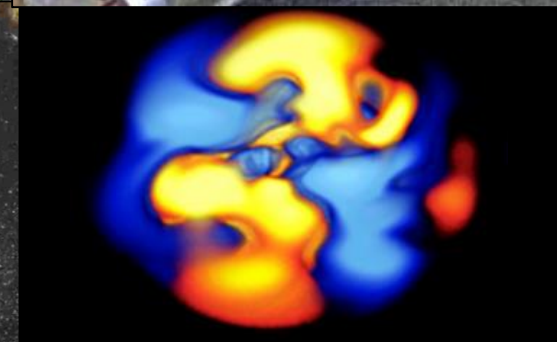


Observing : spatial devices

- *Camera, spectroimaging*
- *cryomechanisms*

Detecting

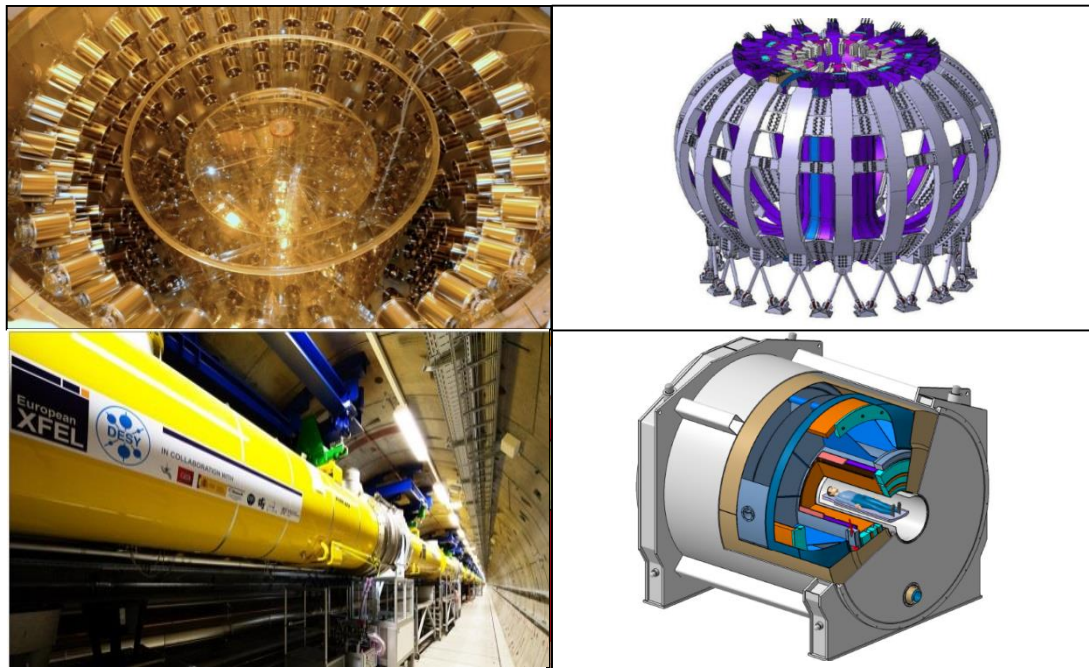
- *Gaseous detectors* (Micromegas)
- *Solid detectors* (bolometers)
- *Electronics* (ASICs)



Simulating

- *HPC*
- *Grid*

Knowledge and know-how for other communities



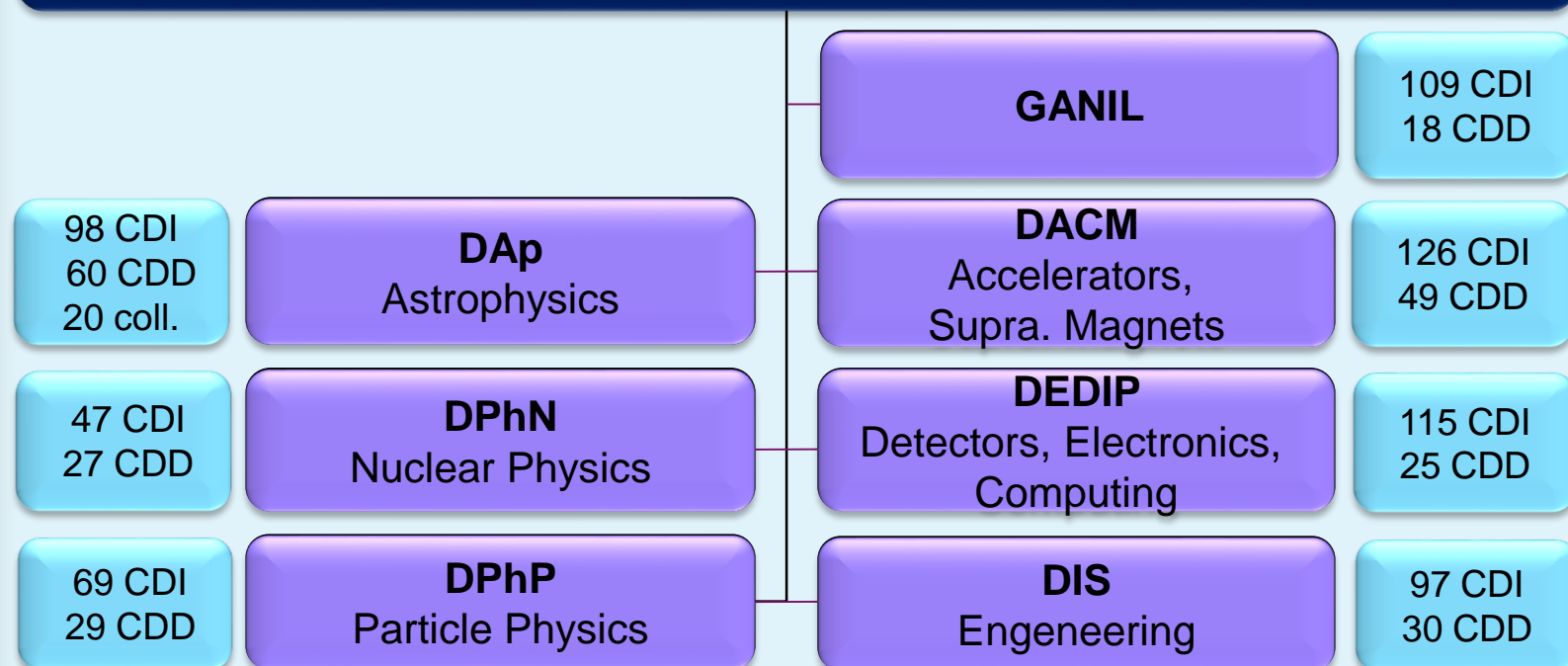
- *Fusion (broader approach: IFMIF, JT60-SA)*
- *Light sources (major contribution to E-XFEL)*
- *Energy*
- *Health: MRI (11.7 T Magnet Iseult), detectors*



- 17 ERC
- 975 publications
- 65 active patents

~ 1000 FTE

Institut de recherche sur les lois fondamentales de l'univers



DETECTORS

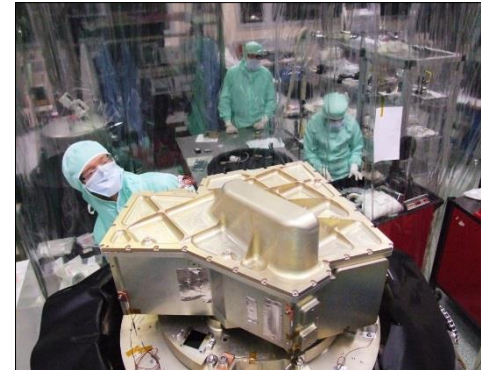
Large migromegas detectors integration and tests (LHC UPGRADES)

Clean room - 130m²



SPACE

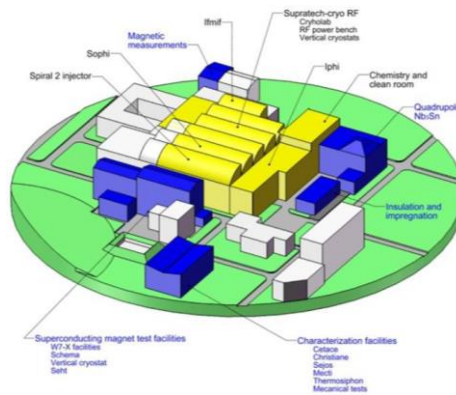
**Clean rooms for space
instruments
integration and tests**



Magnets and accelerators

Synergium - 25 000m²

**Integration halls,
clean rooms
cryostats**



Computing

HPC cluster

Node of Grid@LHC



(SOME) HIGHLIGHTS IN HADRONIC PHYSICS AT IRFU

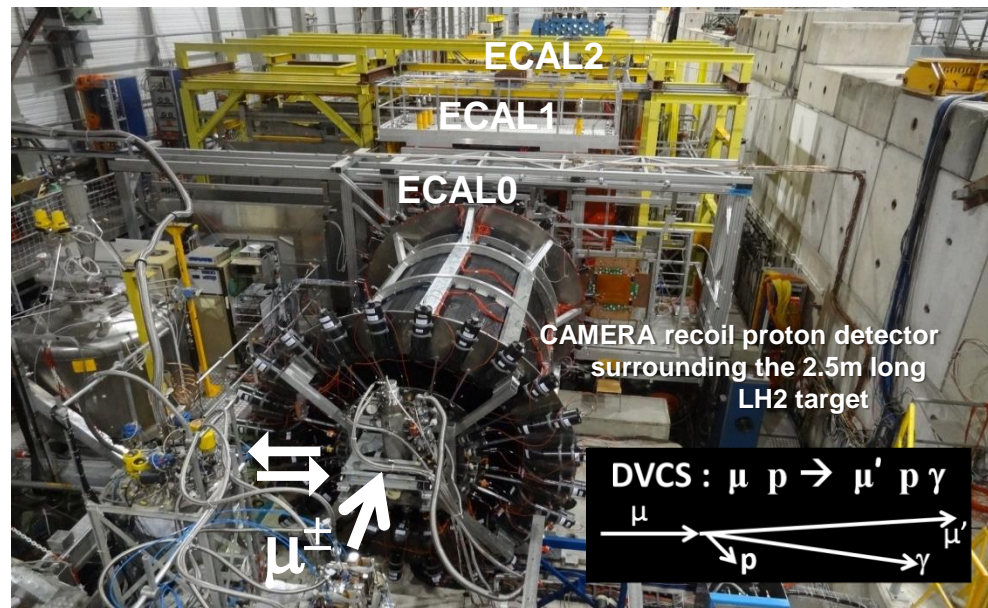
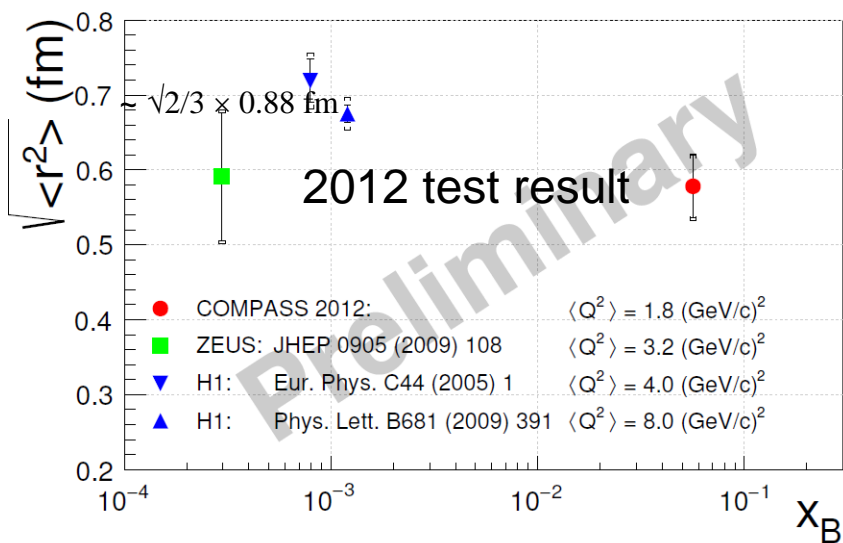
Irfu



- lrfu in charge of a dedicated recoil proton detector (CAMERA)
- Important involvement on DVCS analysis

Data taking:
tests in 2012 and
2 x 6 months in 2016 and 2017

Transverse size of the proton

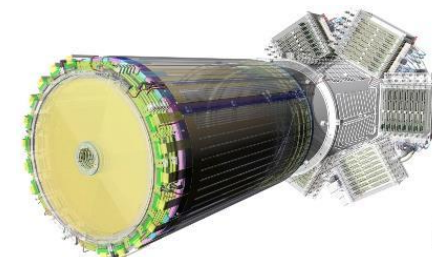


Irfu contribution to CLAS12:

- Micromegas Vertex Tracker,
- Forward Tagger Tracker,
- LH2 target upgrade.

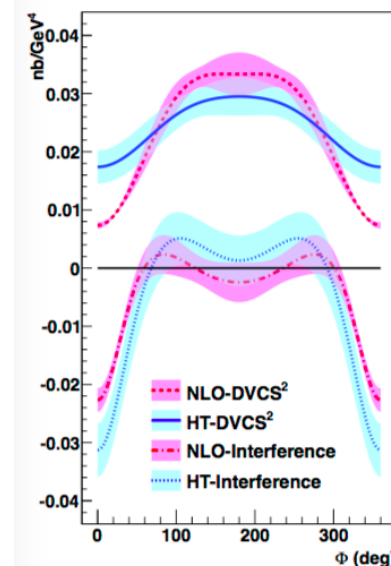
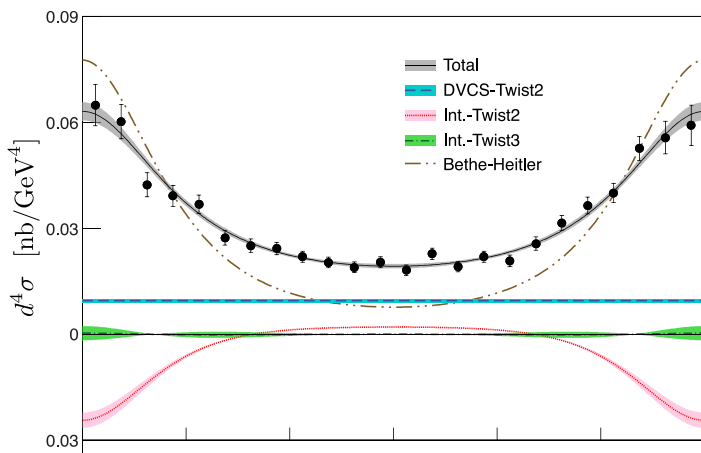
Irfu responsibilities:

- Run Group A leader (13 experiments)
- Spokespersons of DVCS unpolarized and polarized experiments (RG-A, C, G, K)

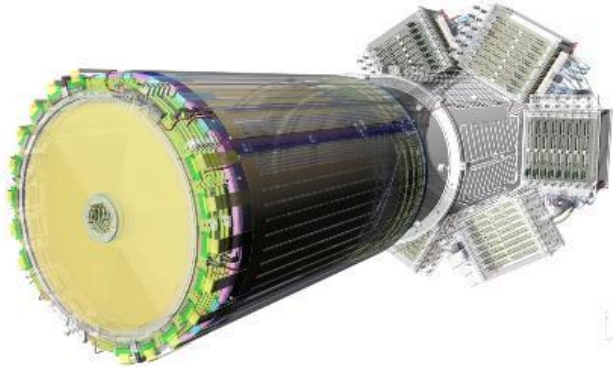


Energy-separated
DVCS cross sections
Submitted to Nature com.

Accurate DVCS cross sections
PRC92 (2015) 5, 055202



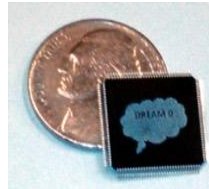
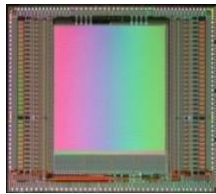
State-of-the-art lightweight tracking detectors for CLAS12



Micromegas Vertex Tracker

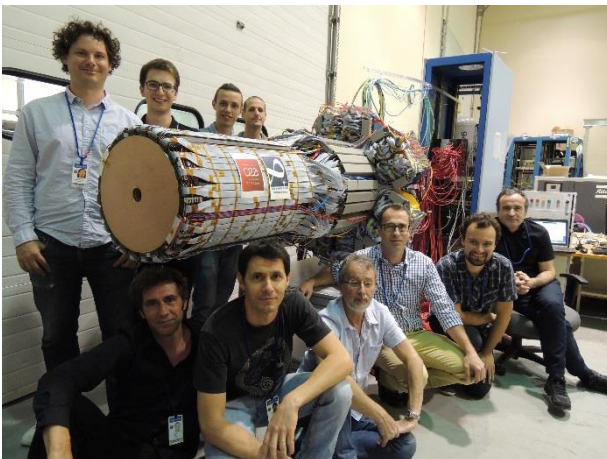
- 18 barrel cylinders
- 6 forward disks
- 25000 channels, DREAM readout
- 10MHz singles rates, 5T magnetic field

Dream : **D**ead-timeless **R**ead-out **E**lectronics **A**SIC for **M**icromegas

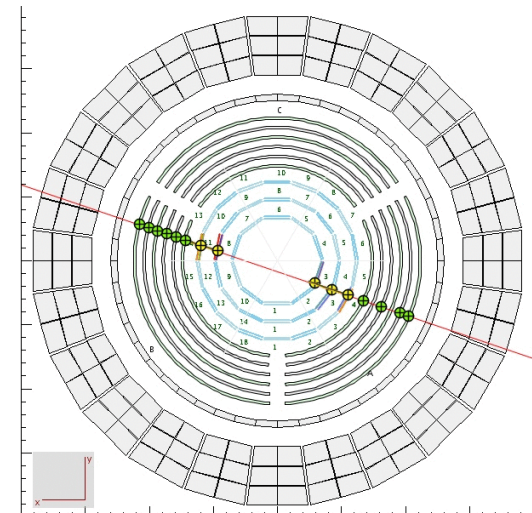


Dedicated ASIC developed
for high-capacitance detectors

Installation and integration with Silicon tracker in June 2017



Works perfectly!
(cosmic ray run)

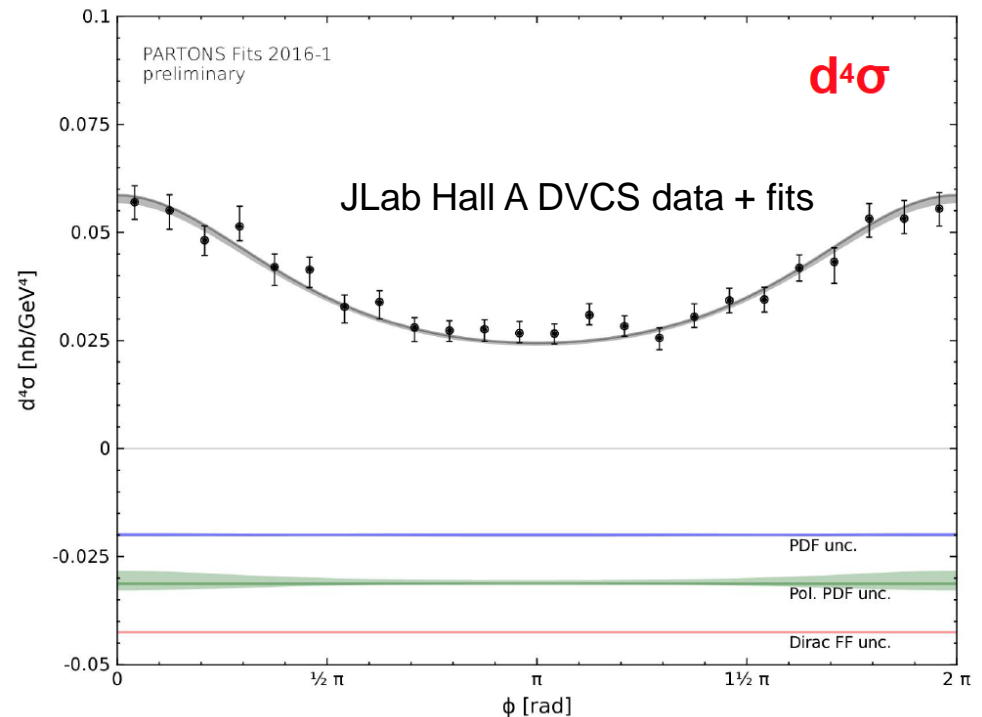
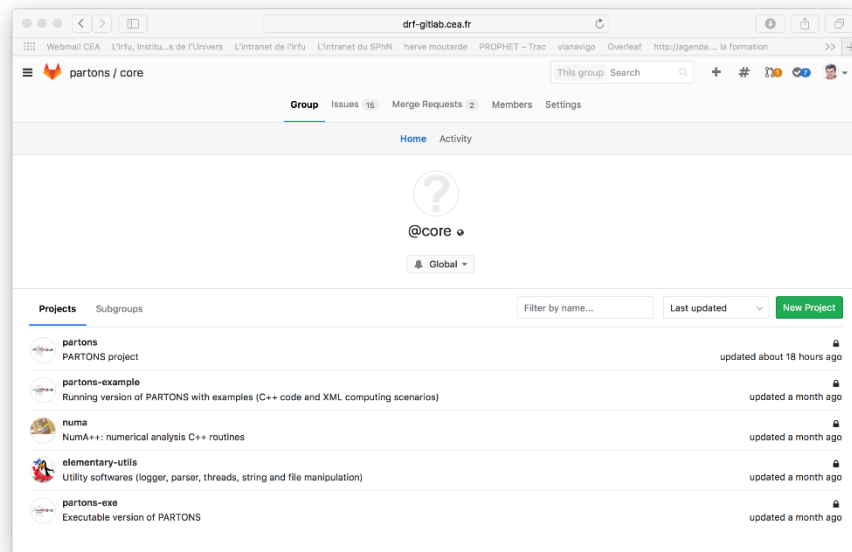


PARtomic Tomography of Nucleon Software (PARTONS)



Collaboration of 13 physicists from 5 countries
Lead: H. Moutarde (CEA-IRFU)

- **Framework** for the theory and phenomenology of Generalized Parton Distributions (GPDs)
- **Open source** release later this year, using gitlab server at CEA/DRF.

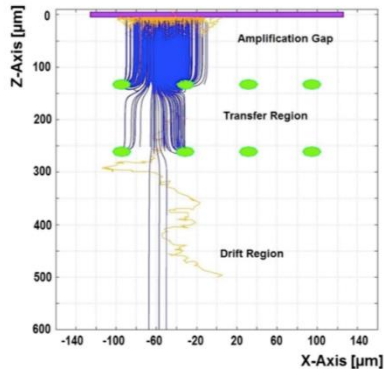


- **Flexible** framework: many processes and observables
- **Already used for global fits of recent Jefferson Lab DVCS data**
(Shown at DIS 2017 conf.).

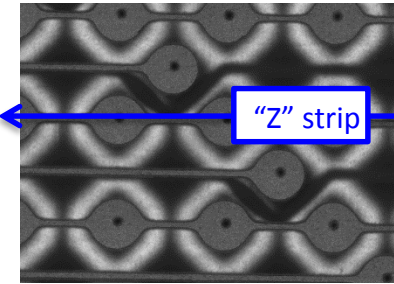
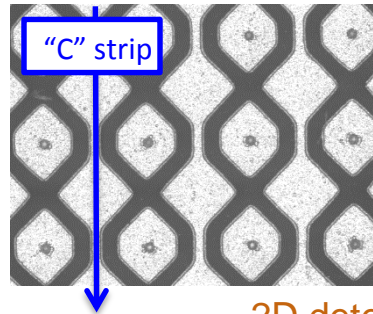
Irfu Micromegas R&D from CLAS12 to sPHENIX to EIC



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

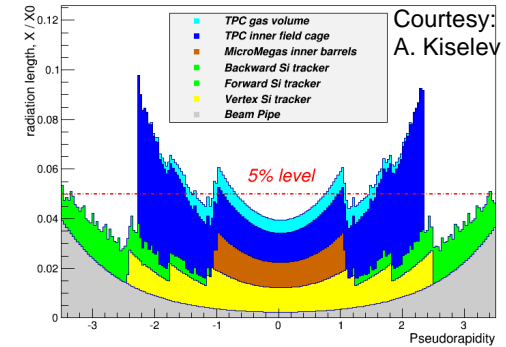


Double-mesh Micromegas

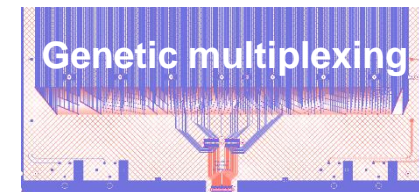


2D detector (ASACUSA)

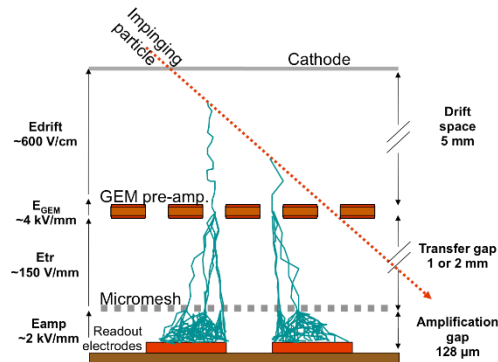
- ▶ **Reduce material budget**
 - 2D detectors
 - Lightweight detectors
- ▶ **Reduce number of electronics channels**
 - Genetic Multiplexing
- ▶ **Reduce ion backflow (for TPC readout)**
 - Hybrid or double-mesh Micromegas



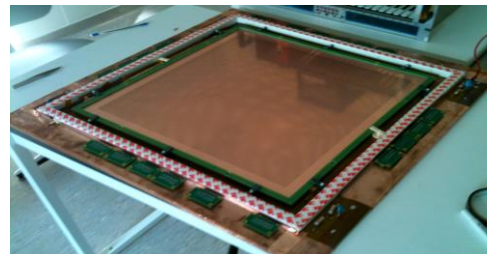
Inner EIC tracker optimization



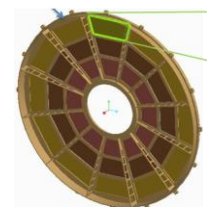
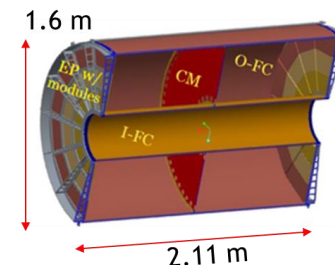
1024 -> 61 channel reduction



Hybrid GEM-Micromegas



COMPASS Hybrid



72 modules
2(z), 12(φ), 3(r)

sPHENIX TPC readout

- Important and long term involvement in hadronic physics within CEA

- Contributions to
 - instrumentation (detectors)
 - data analysis
 - modelisation and phenomenology

- Preparing the next generation with big expectations!