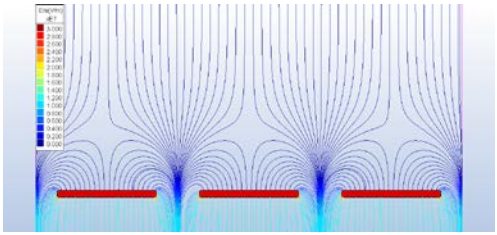
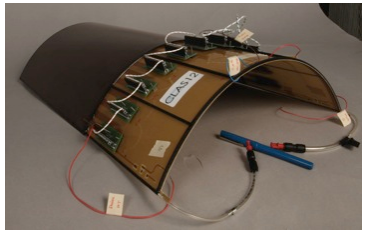
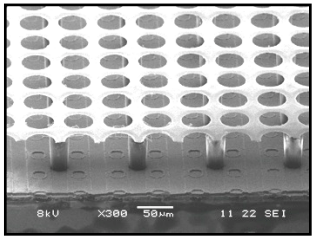
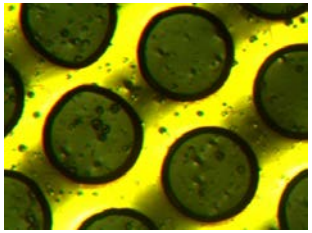
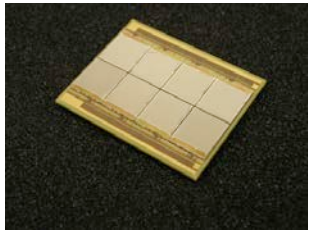
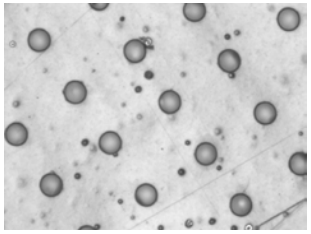
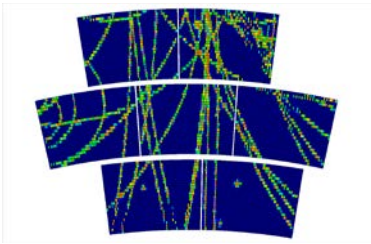
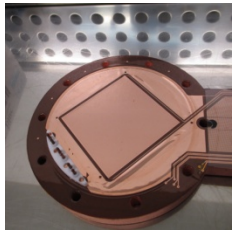
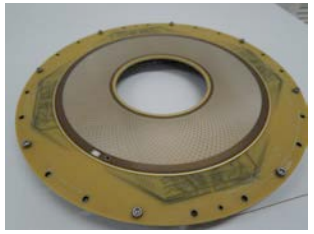
Micromegas detectors

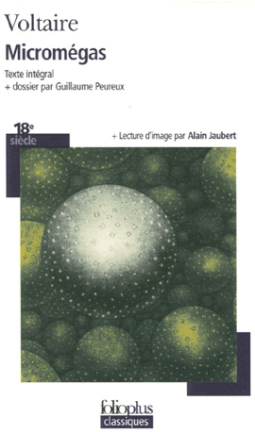




Esther Ferrer Ribas
IRFU/SEDI
AERES – 8th January 2014

Irfu - CEA Saclay
Institut de recherche
sur les lois fondamentales
de l'Univers

Invention



Nuclear Instruments and Methods in Physics Research A 376 (1996) 29–35

ELSEVIER

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

MICROMEGAS: a high-granularity position-sensitive gaseous detector for high particle-flux environments

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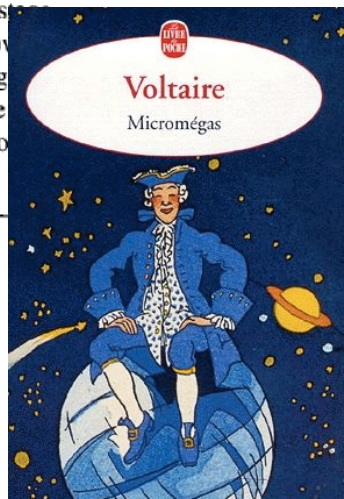
[b]*Ecole Superieure de Physique et Chimie Industrielle de la ville de Paris, ESPECI, Paris, ESPCI, Paris, France*
and *CERN/AT, Geneva, Switzerland*

Received 24 Janua 1996

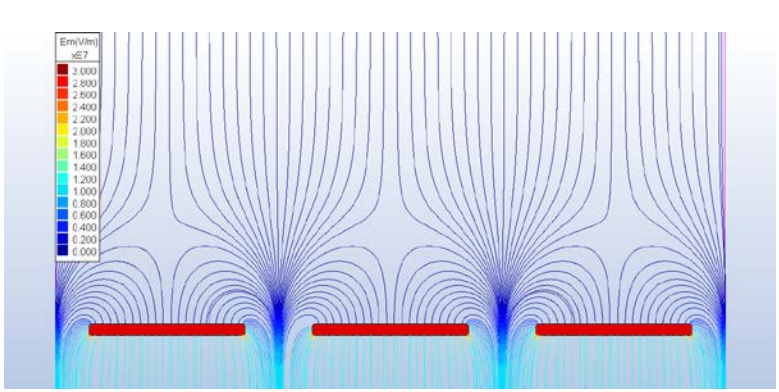
Abstract

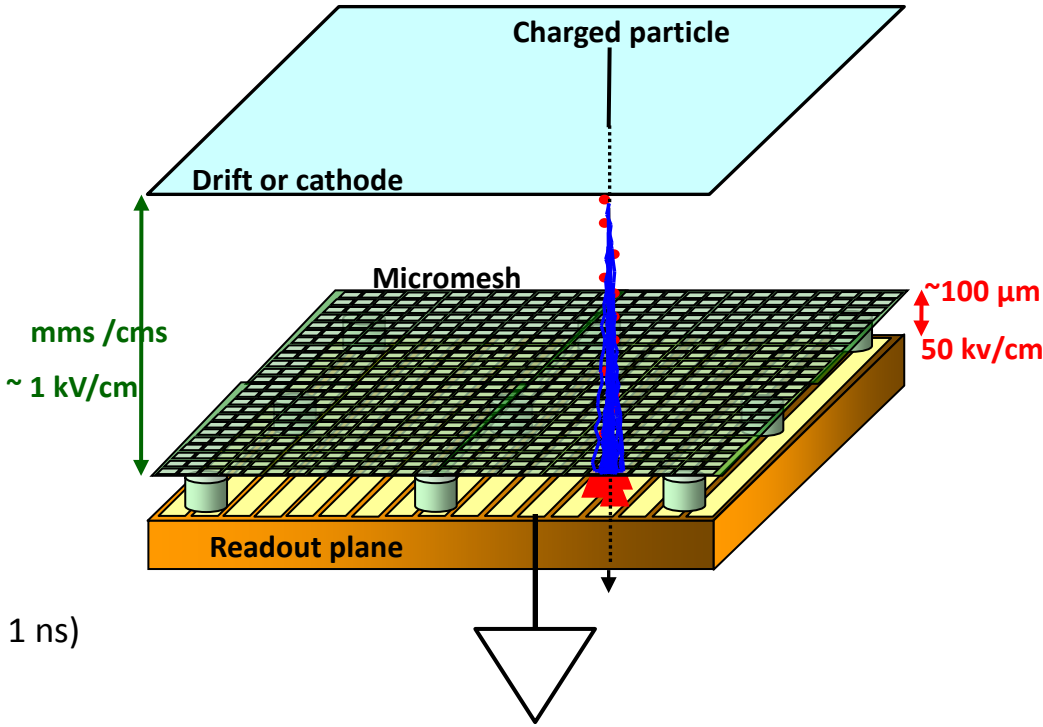
We describe a novel structure for a gaseous detector that is under development at Saclay. It consists of a two-st parallel-plate avalanche chamber of small amplification gap (100 μm) combined with a conversion-drift space. It follo fast removal of positive ions produced during the avalanche development. Fast signals (≤1 ns) are obtained during collection of the electron avalanche on the anode microstrip plane. The positive ion signal has a duration of 100 ns. The evacuation of positive ions combined with the high granularity of the detector provide a high rate capability. Gas gains o to 10^5 have been achieved.

spacers. The device operates as a two-stage parallel plate avalanche chamber and it is called MICROMEGAS (MI-CRO-MEsh-GAseous Structure).

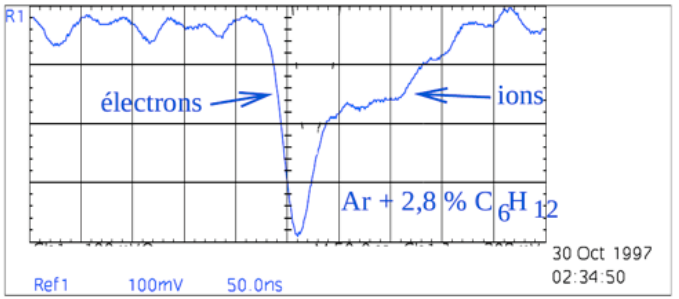


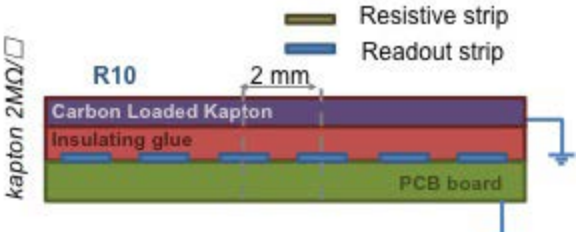
Principle





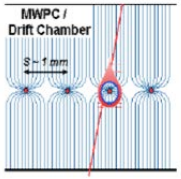
- High gain (>10^4)
- Good energy (11% @ 6 keV) and time resolution (< 1 ns)
- Good spatial resolution (< 50 µm)
- Reduced ion feedback < 1%
- Radiation hardness (10^{16} p/cm^2)
- Fast ion collection→ operation at high flux
- Cope with sparks: resistive coating

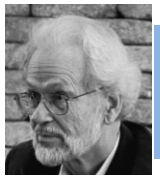




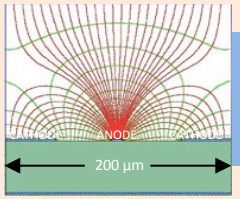
Historical context

MWPC
Multi-Wire Proportional Chamber
G. Charpak et al., 1968





TPC
Time Projection Chamber
D. R. Nygren et al., 1974

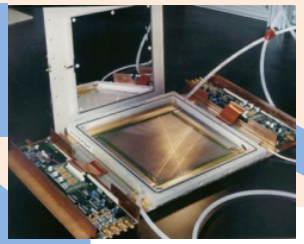


MSGC
Micro-Strip Gas Chamber
A. Oed, 1988

Micro Pattern
Gaseous Detectors: MPGD

GEM
Gas Electron Multiplier
F. Sauli, 1997

MICROMEGAS
MICRO-MEsh GAseous Structure
I. Giomataris et al., 1996



CLASSICAL
1996

BULK
2003

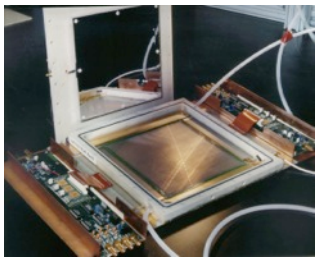
INGRID
2005

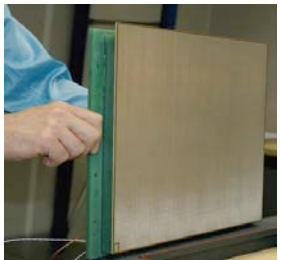
MICROBULK
2006

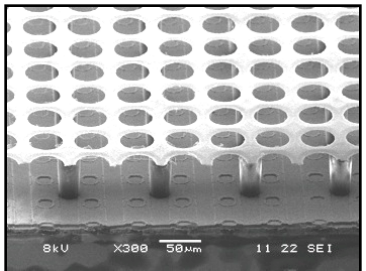
RESISTIVE ANODE
2005-2013

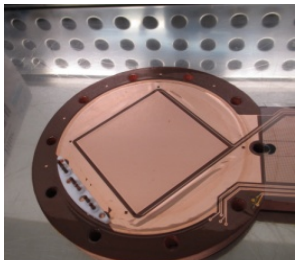
Micromegas family

	CLASSICAL 1996	BULK 2003	INGRID 2005	MICROBULK 2006
Mesh Readout plane	TWO mechanical entities	INTEGRATED: ONE single entity		
Type of mesh	Any type	30 µm Stainless steel	1 µm Aluminium	5 µm Copper
Advantages	Demontability Large Surface	Robust Industrial manufacturing process (PCB)	Excellent energy resolution Single electron efficiency	Intrinsically Flexible Low mass Radiopure





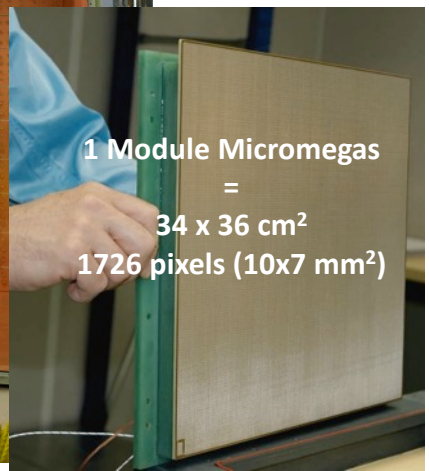




TPCs

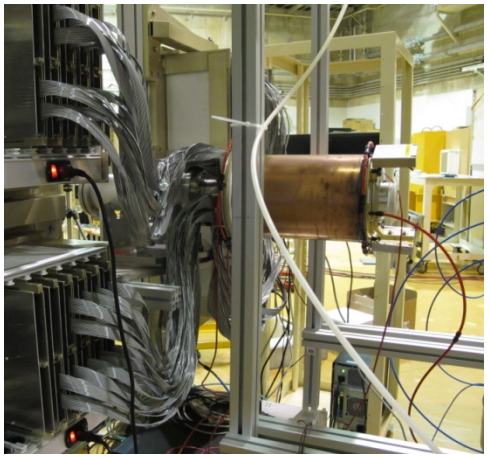
T2K first large TPC with MPGD

IRFU's Responsability :
readout planes + electronics (125 k channels)

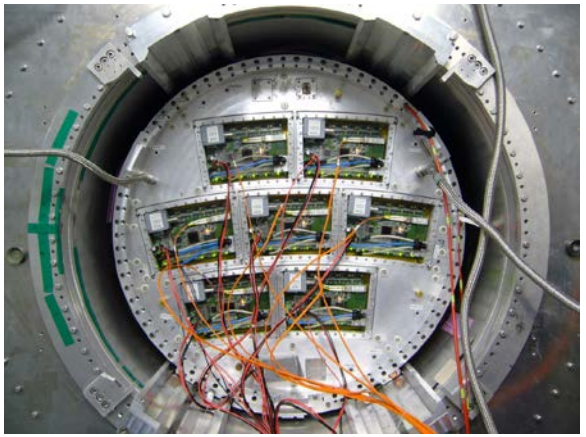


MINOS: MagIc Numbers Off Stability

First test in HIMAC (Japan) in Oct 2013
Experiment in RIKEN April 2014



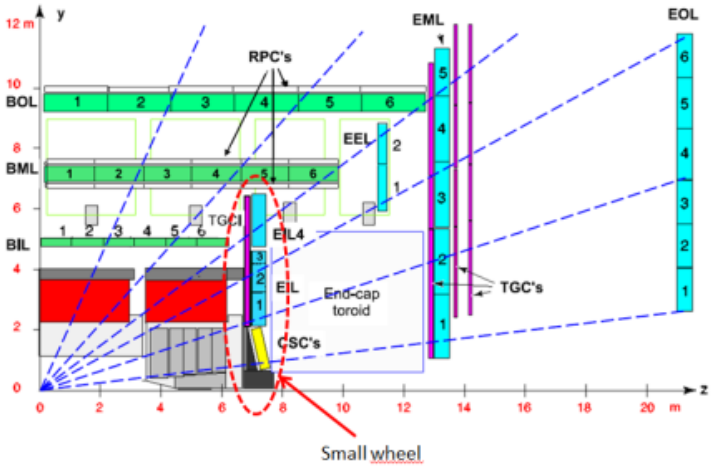
ILC TPC miniaturize the T2K electronics

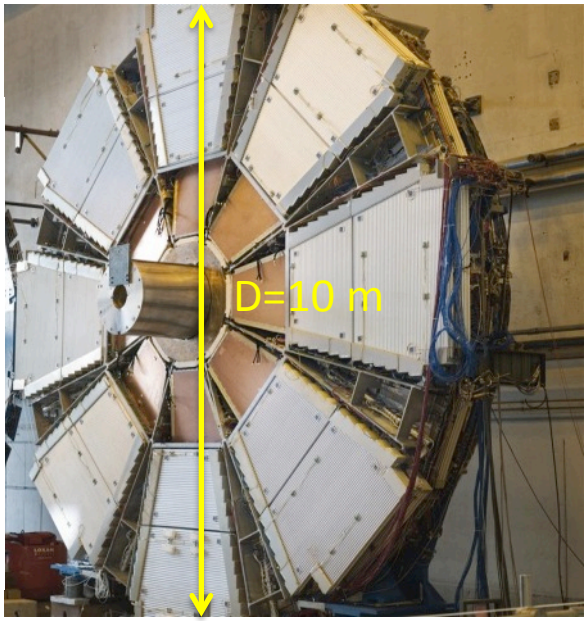


ATLAS NEW SMALL WHEEL

2 new wheels (NSW):

- 1200 m^2 of resistive Micromegas
- More than 2M electronic channels

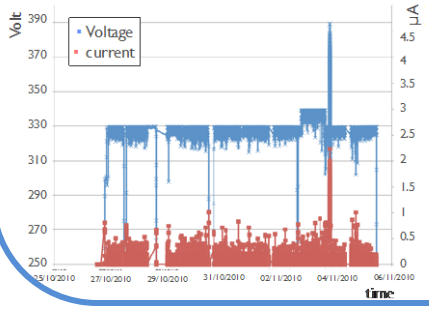




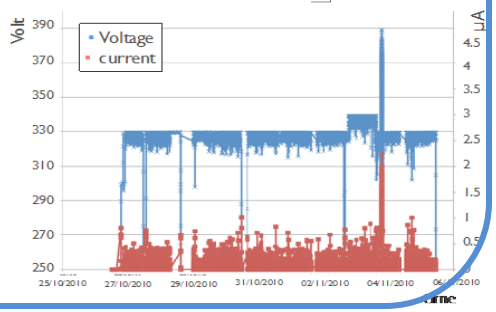
Resistif anode:

- Spark amplitude reduced
- No dead time
- Robustness

Non resistif



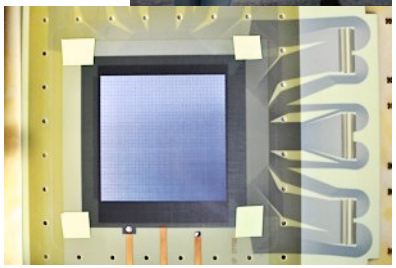
Resistif



- Maximum surface ~ 2 m^2
- Production: 1024 plans (2015-16)

Industrial transfer:

- ELVIA group (France)
- ELTOS (Italy)

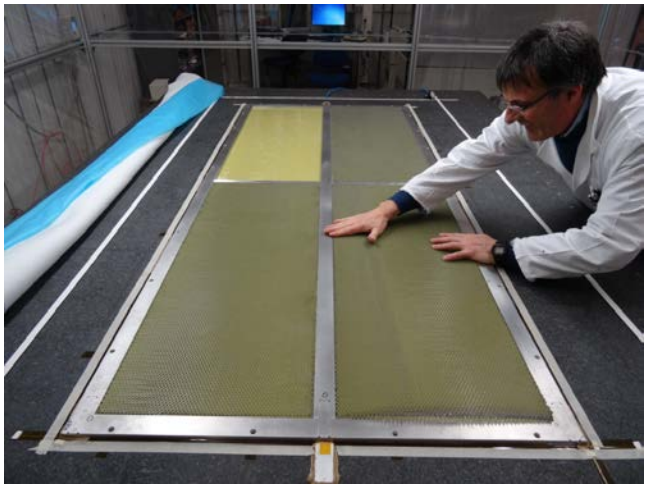


Collaboration RD51

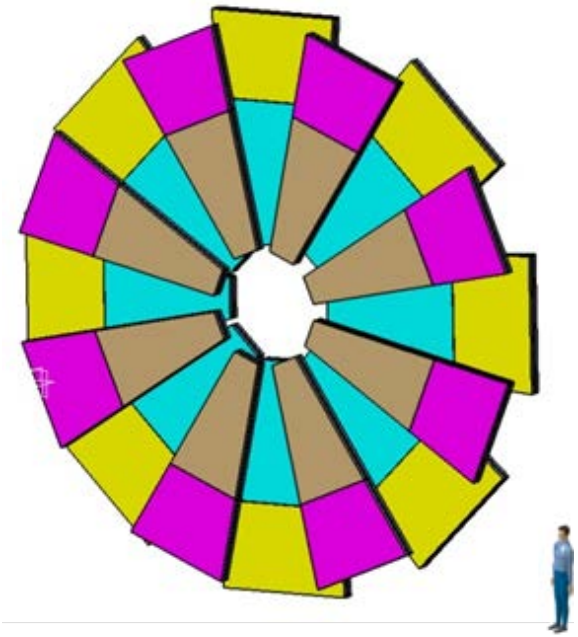
ANR « SPLAM »

ATLAS NEW SMALL WHEEL

At present construction of a mechanical prototype

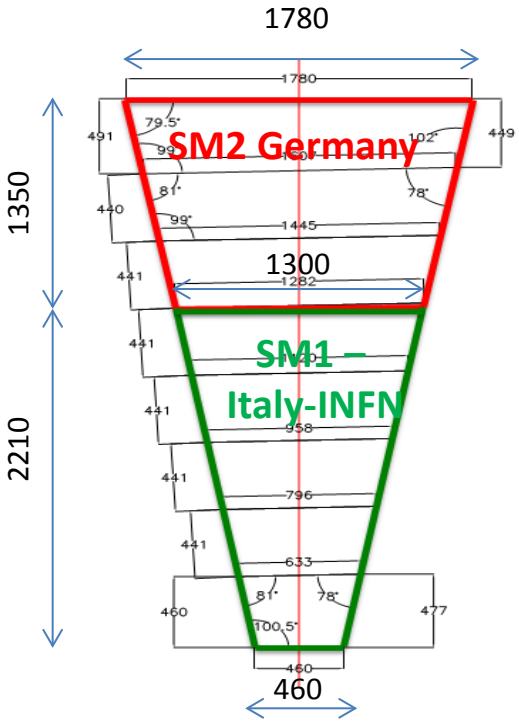


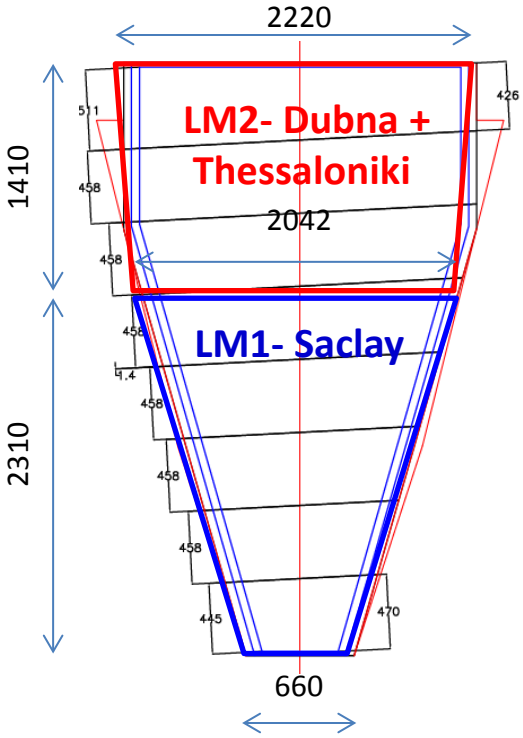
Clean room construction in 2014



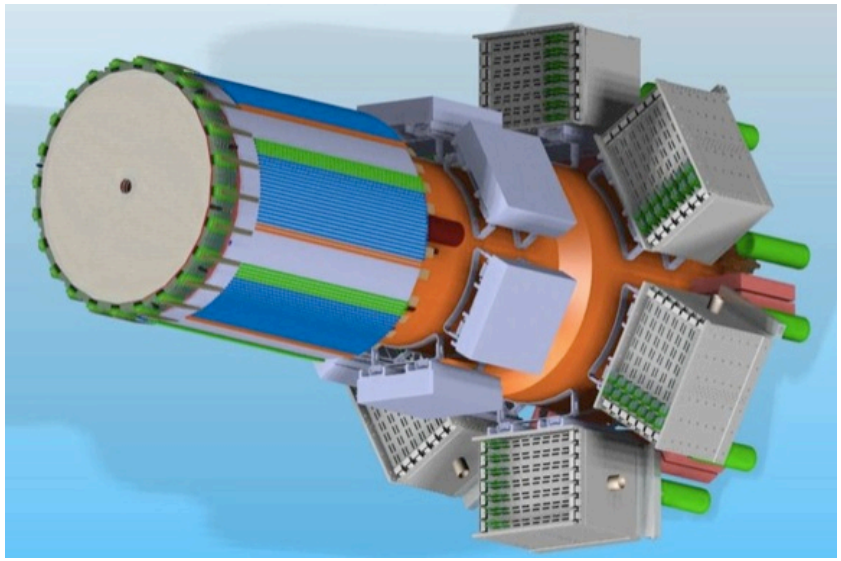
MILESTONES

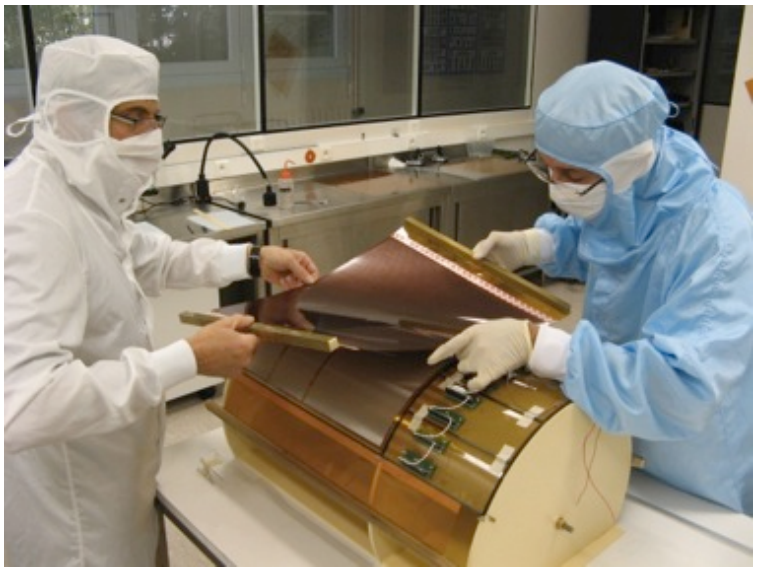
2014: Definition M0 module
2015-2016: Production
2017: Surface Integration
2018: Cavern integration





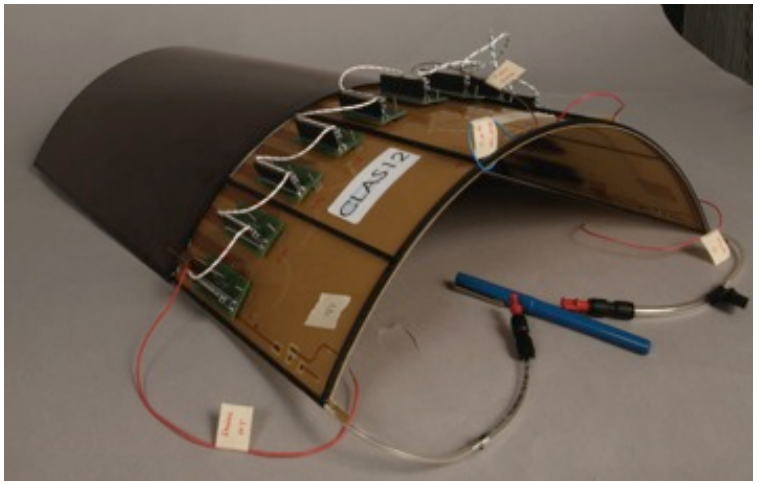
CLAS 12 : cylindrical Micromegas



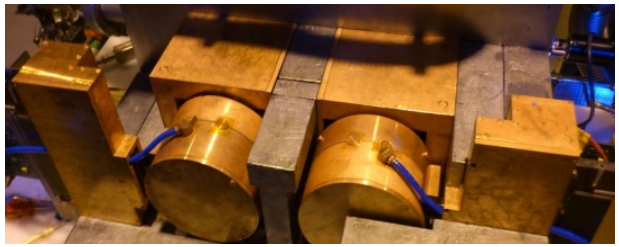


- Cylindrical Flexible Micromegas operating at high magnetic field
- 4 m^2 Tracker
- From conception of detector to electronics
- Developement of new electronics (30 k channels)
- Production in 2014 and installation in 2015
- Spinoff: ASACUSA

Patent on curved gaseous detectors



CERN Axion Solar Telescope (CAST)

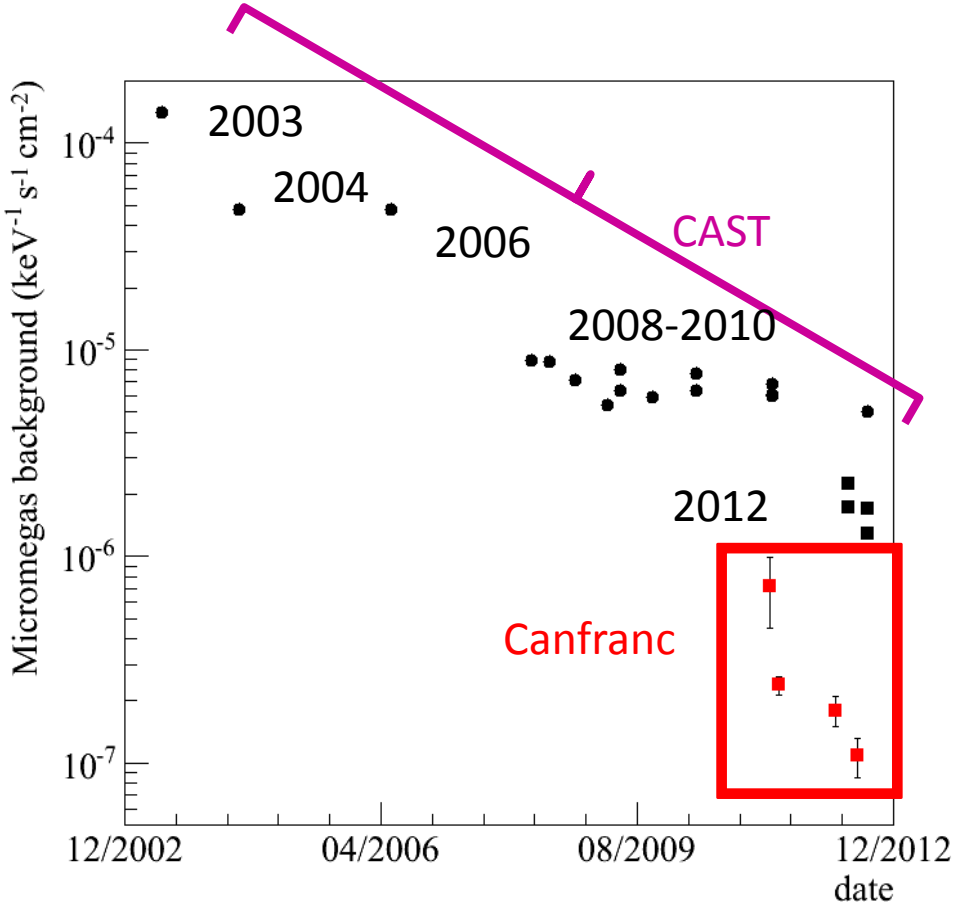


First experiment to use the Micromegas technology for rare event detection

Intensive R&D for optimising the Microbulk technology

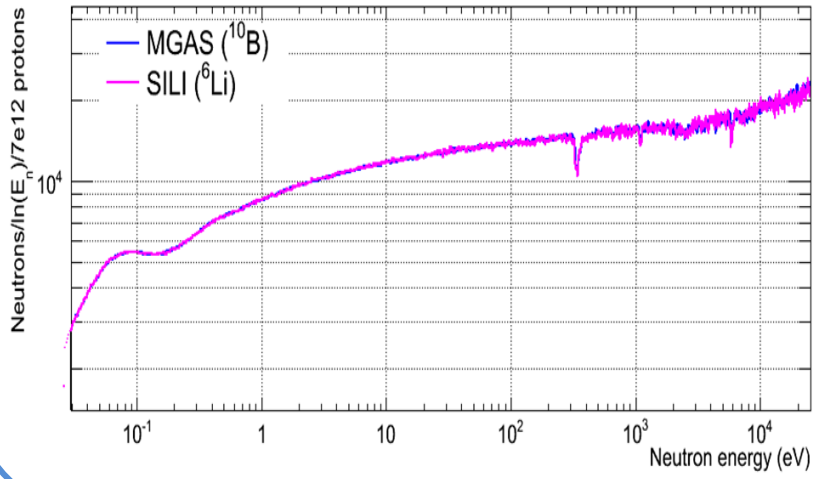
A 100% Micromegas expriment:
today 3 Microbulk + Ingrid

Micromegas are the base line technology for the future IAXO experiment

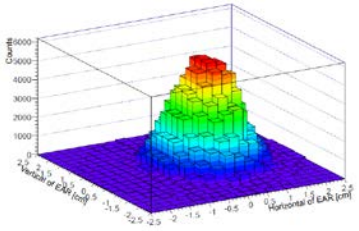


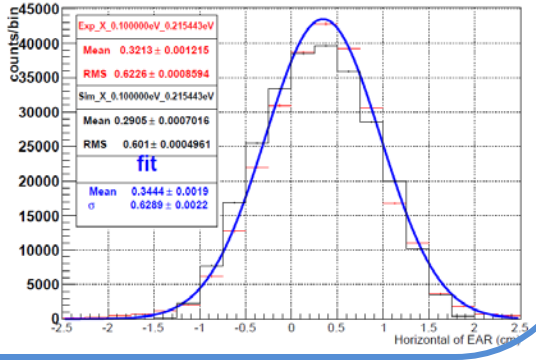
Neutron Detection

NTOF : Neutron flux monitors microbulk (low mass budget), neutron beam profilers and fission x-section measurements

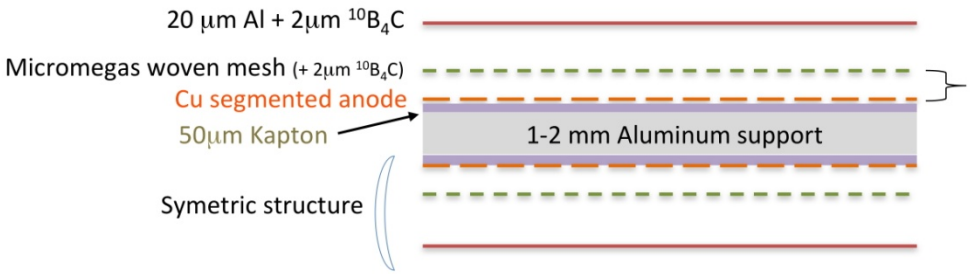


Ultra thin detectors➔
Segmented microbulk 2D
P2IO funding/RD51





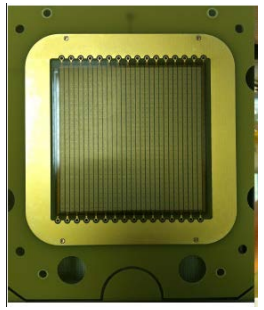
Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy



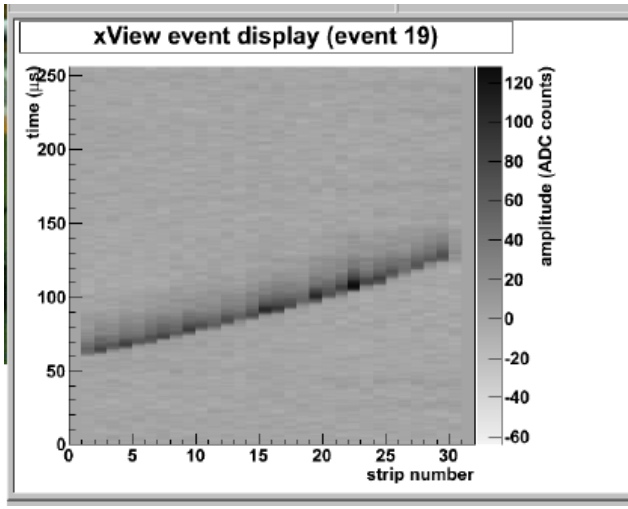
Involvement in the Work Package of the European FP7/NMI3 program (2012-2016) dedicated to the search of alternatives for ^{3}He neutron detectors

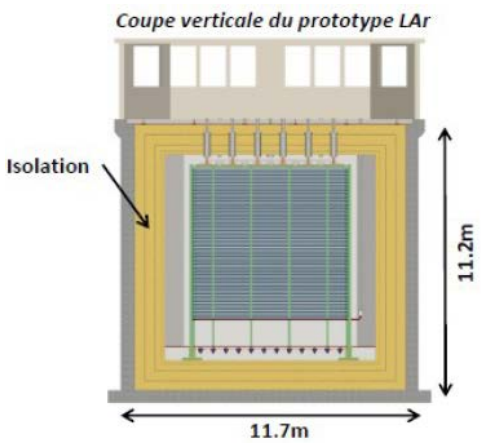
Liquid Argon (CERN/WA105)

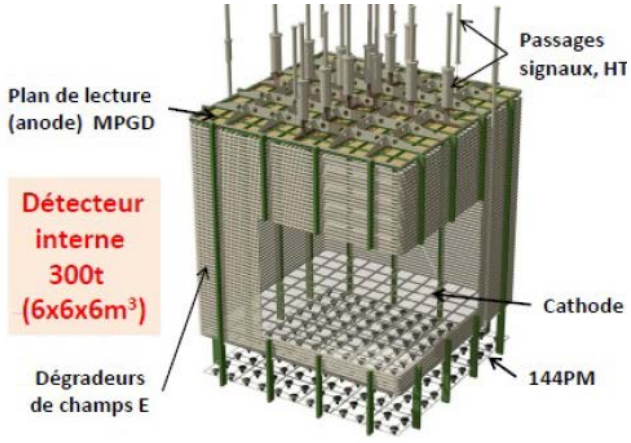
- R&D on large Liquid Argon TPC in the context of LAGUNA-LBNO. Prototype (6x6x6=216 m^3) to test calorimetry with a charged particle beam
- Choice of charge amplification: LEM, Micromegas, GEM

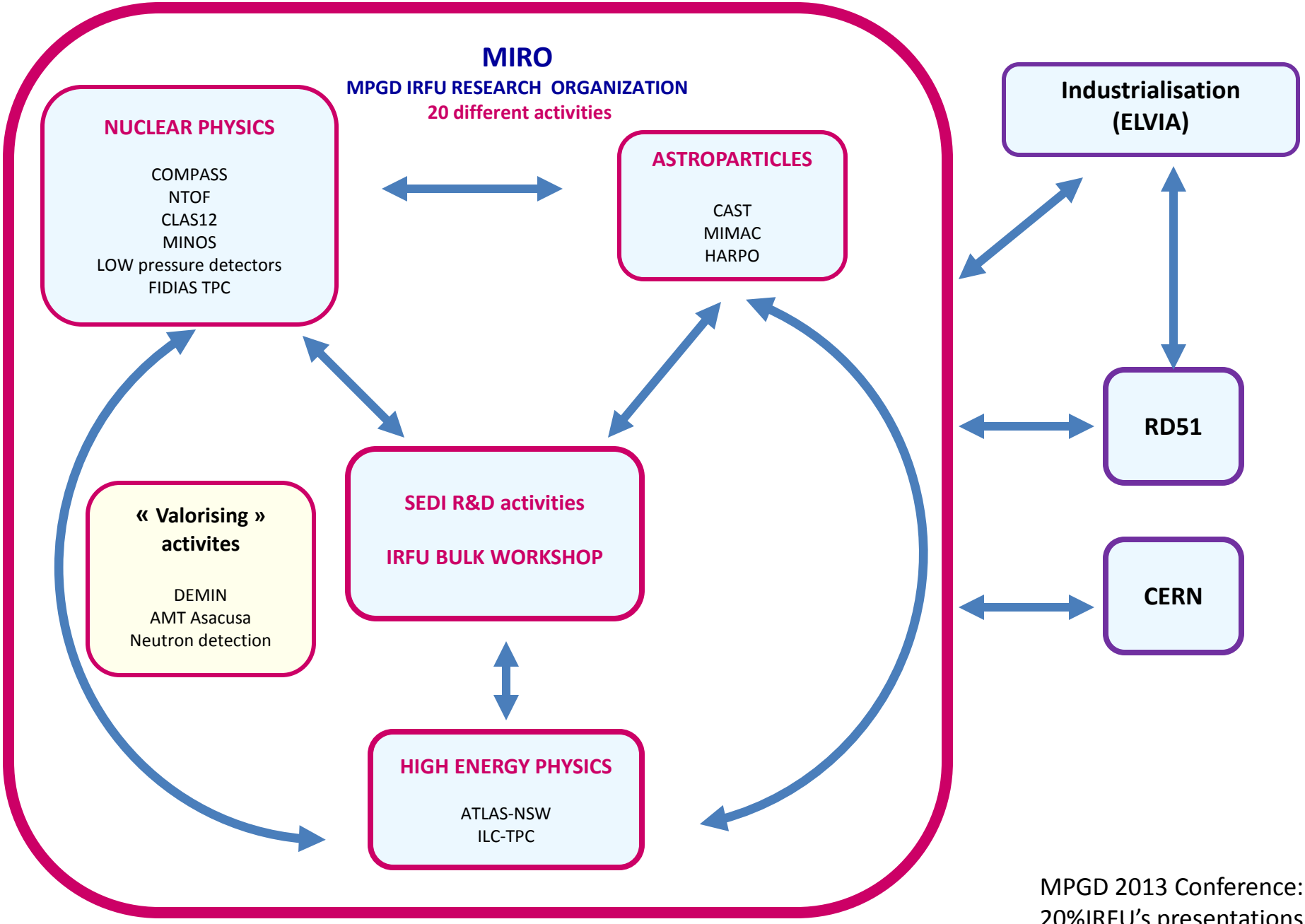


- A T2K bulk was tested in collaboration with ETHZ:
  - cosmic rays observed, gains up to 5 in ultra-pure Argon (ppb level)
- Collaboration with ETHZ: study amplification in pure Argon
- Optimisation of parameters
- Construction and test of 18 m^2







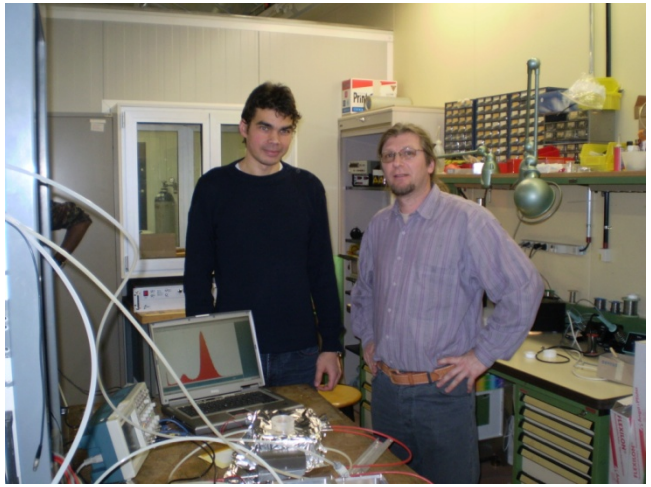


~50 publications in 2008-2013 ~5 patents

MPGD 2013 Conference:
20%IRFU's presentations
for 10% attendance

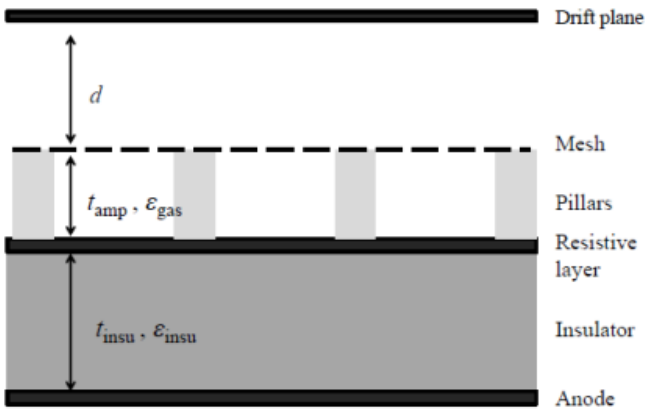
TRAINING AND OUTREACH

- M2 NPAC:
  - Detection lectures
  - Laboratory Works
- Involvement in the Doctoral School PHENIICS
- Organisation « Rencontres de l'infiniment grand et de l'infiniment petit » for M1 students
- PhD related to Micromegas 2008-2013: 10 phD (defended and on going)
- RD51 MPGD training session
- EDIT School 2011 @ Cern
- Outreach
  - Science en marche
  - « Labshow » Les yeux de la physique
  - Scintillation



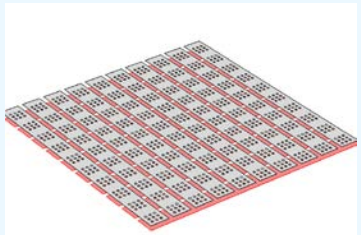
And tomorrow…

Piggyback



Sealed detector
Versatility of electronics to be used

Segmented μ-BULK 2D



Very low mass 2D detector

Neutron Detection

Proposal of Micromegas for neutron beam monitors and physics instruments at ESS (august 2013 call for tender)

Liquid Argon TPC

Photodetection

Genetic Multiplexing

Pixellised TPC