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MINOS: nuclear MagIc Numbers Off Stability
A vertex tracker for in-beam gamma spectroscopy

Alexandre Obertelli,
CEA/DSM/IRFU/SPhN

Outline

- **Objectives and general description**
- H2 target
- TPC and electronics
- Summary

MINOS

MINOS
Magic Numbers Off Stability

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Research on **very** exotic nuclei

- Quest for the picture of shell evolution

- Develop an **original detection-target system**
- Dedicated program at fast-beam facilities
- **RIKEN** and GSI-FAIR

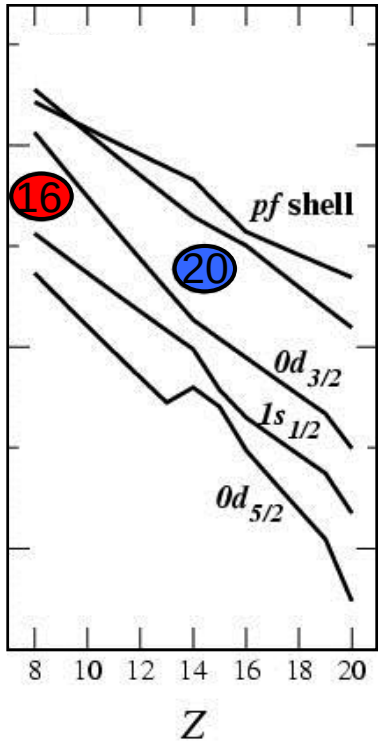
- Project started on October 2010
- Funded by the EU for 5 years

erc

MINOS: study the in-medium nuclear force

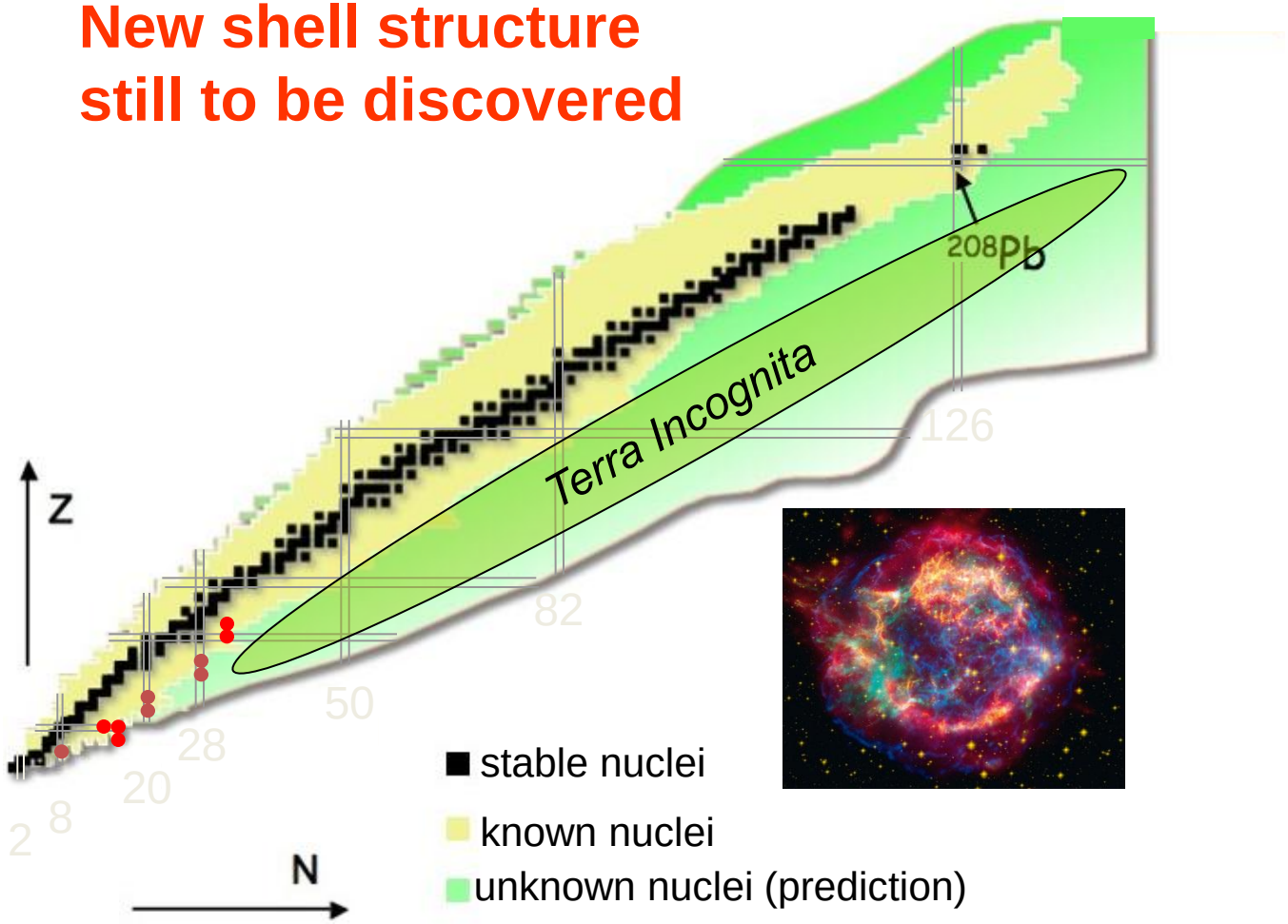
Magic numbers: a fingerprint of the NN interaction

from T. Otsuka *et al.*



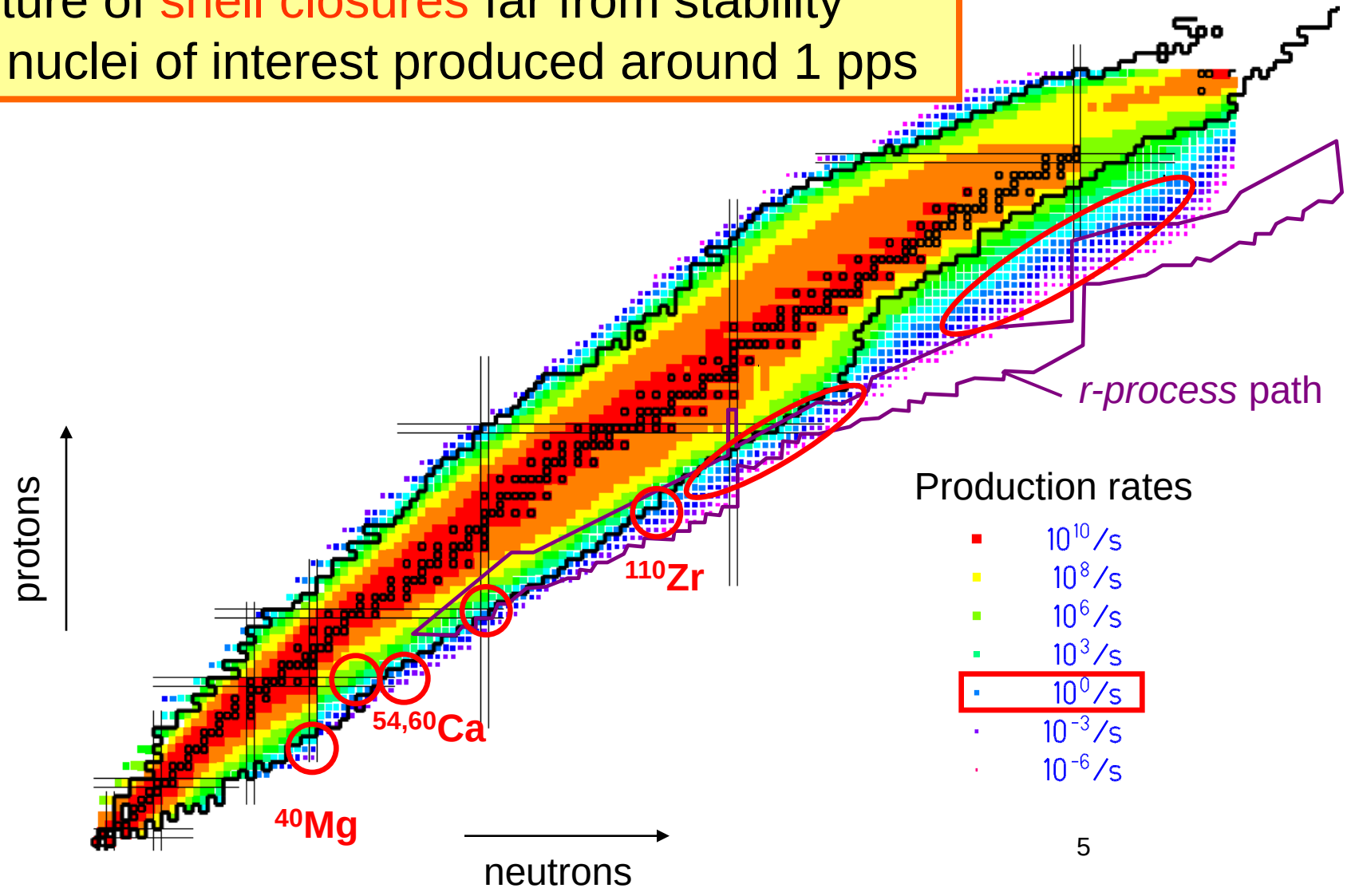
- new magic
- not magic

New shell structure still to be discovered



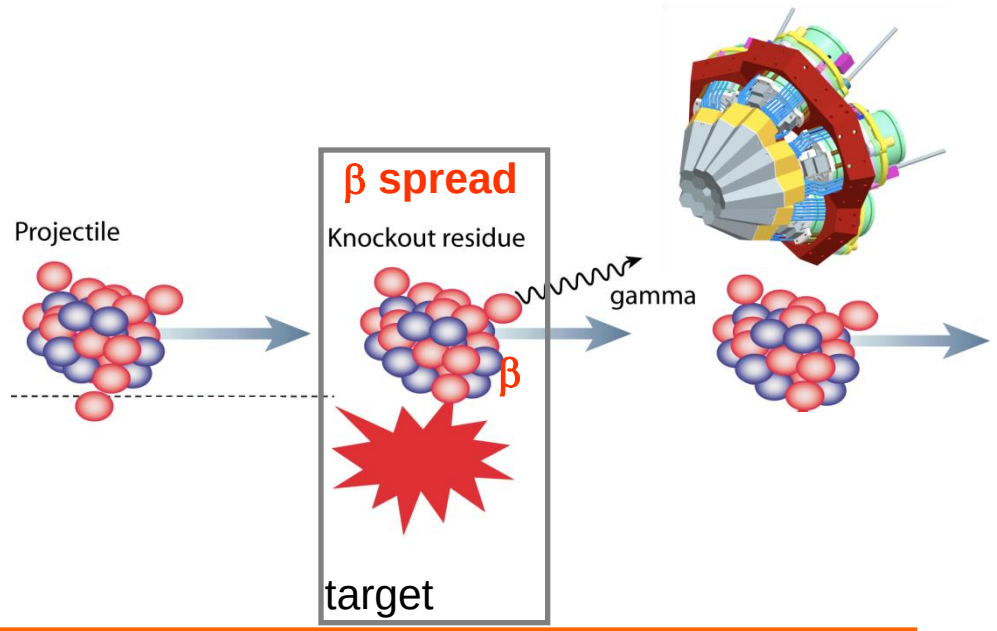
Unique physics opportunities at RIKEN

New picture of shell closures far from stability
Several nuclei of interest produced around 1 pps

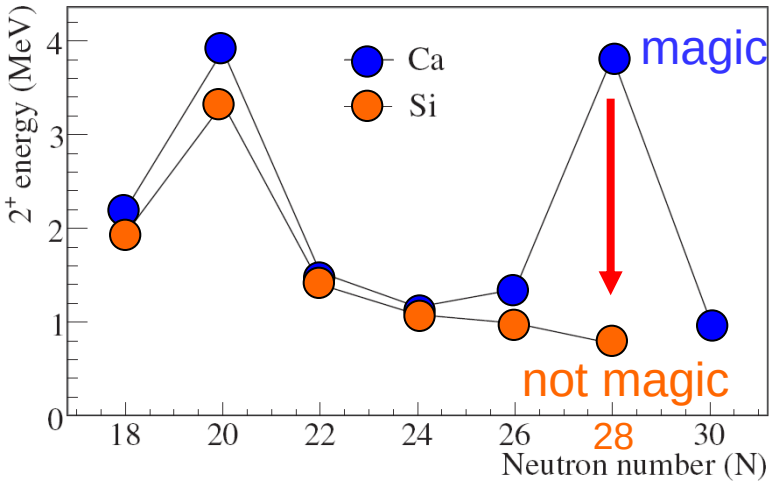


In-beam γ spectroscopy and knockout

In-beam γ spectroscopy and **knockout** best to reveal new shell effects



Clear signature for (non-)magic nuclei



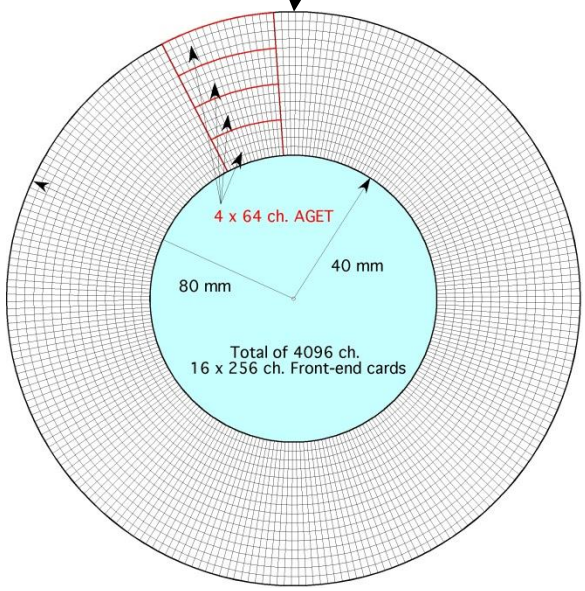
from B. Bastin, S. Grévy *et al.*

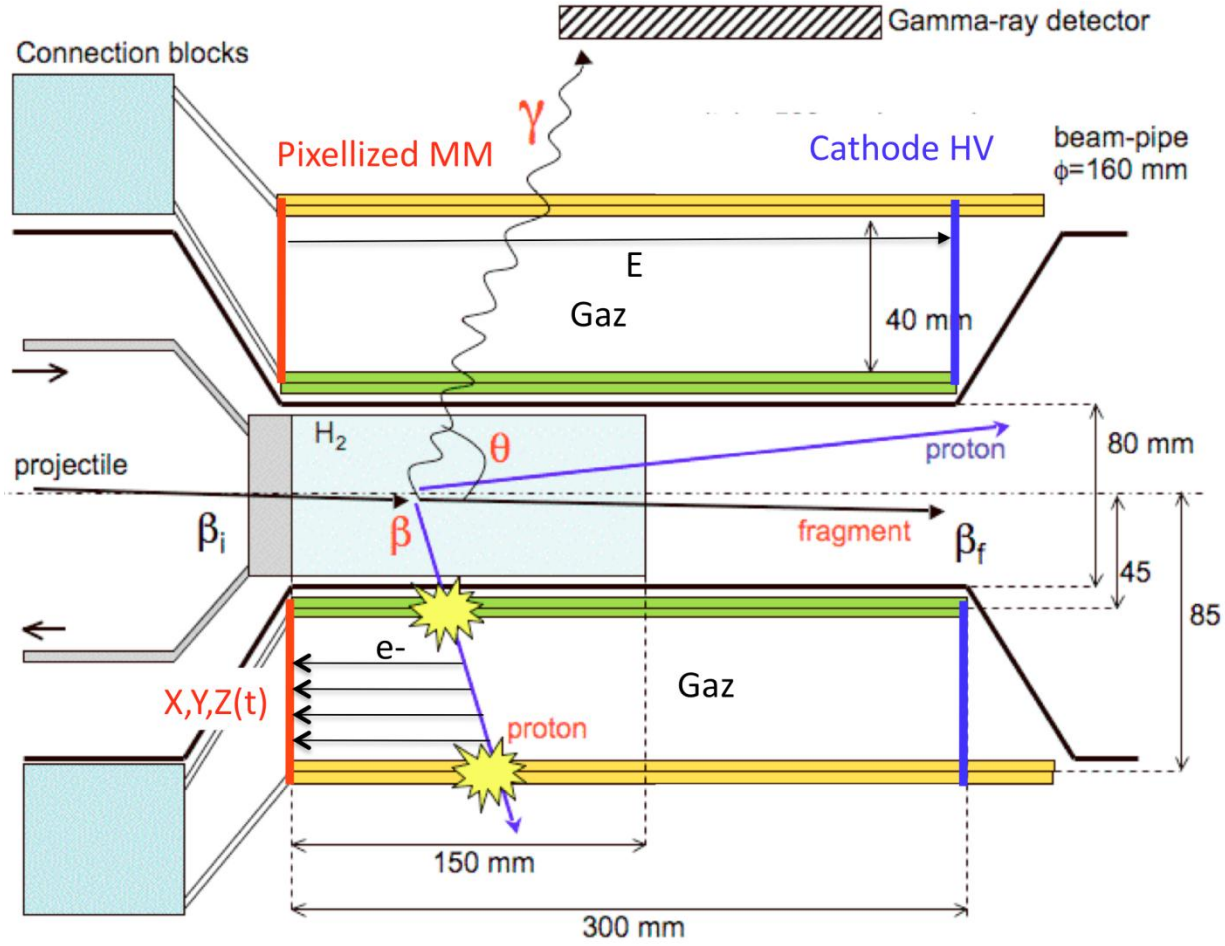
In-flight: velocity β needed for Doppler correction
β not measured in standard techniques

Target thickness: trade off between statistics and resolution
⇒ a **bottleneck** for experimental sensitivity

New device for **high-resolution γ spectroscopy**

150 cm^2
3750 to 15000 pads
of 1 to 4 mm^2





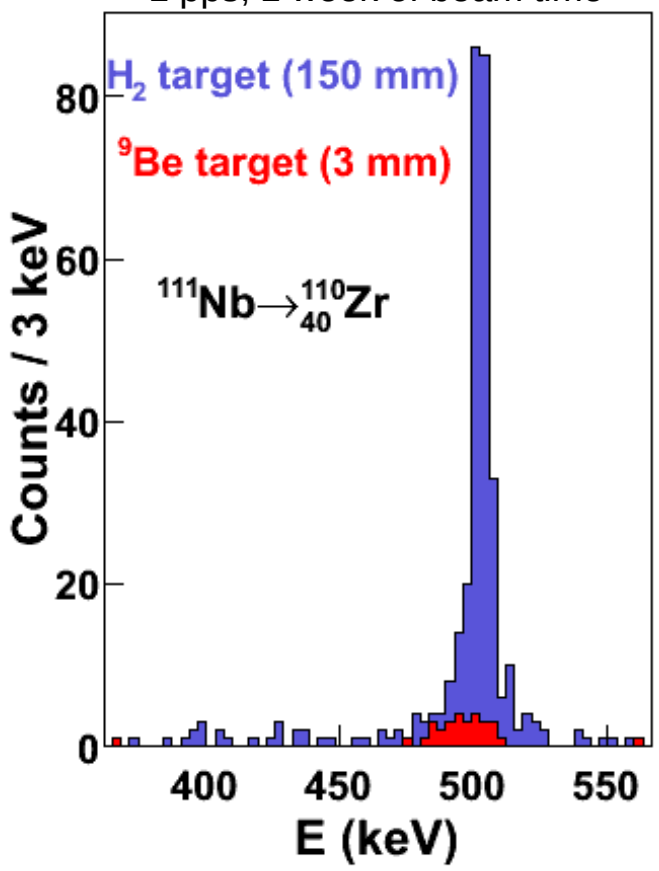
Source A. Delbart

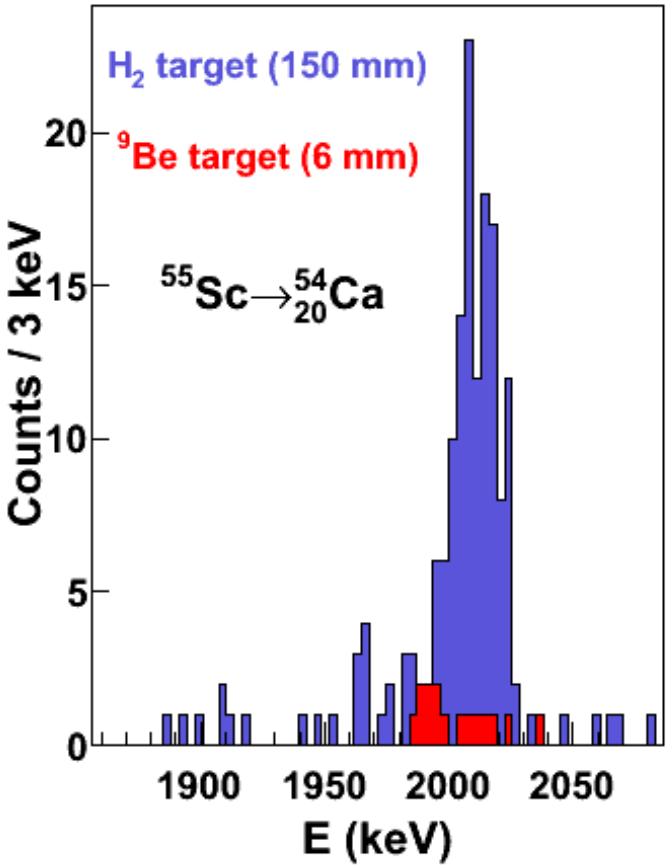
Goal: vertex resolution < 3 mm FWHM, efficiency > 80%

Gain in sensitivity

Example: MINOS+AGATA γ array: gain **>100** *vs* today

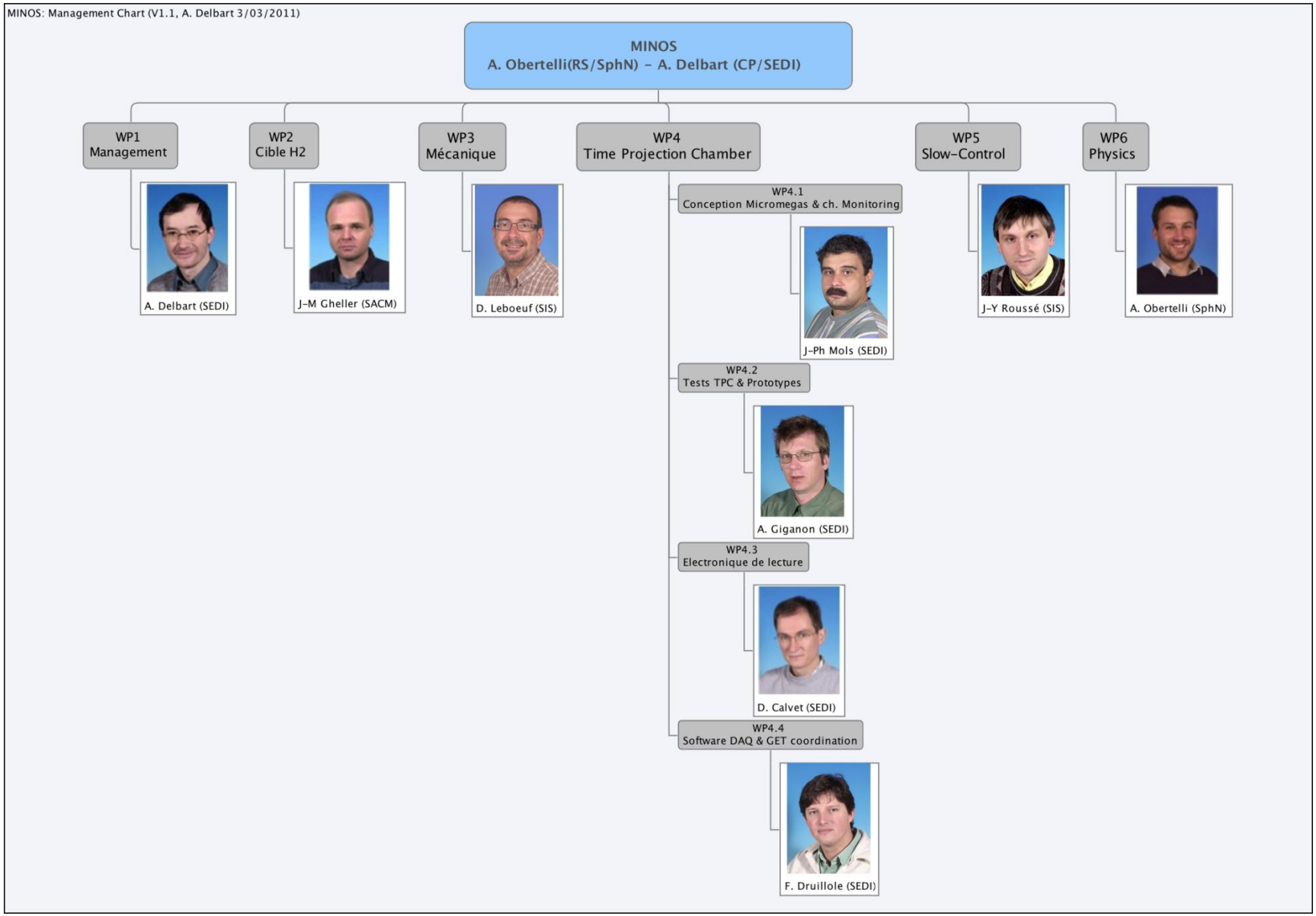
1 pps, 1 week of beam time





Larger statistics, better energy resolution & cleaner spectra

The technical-project team



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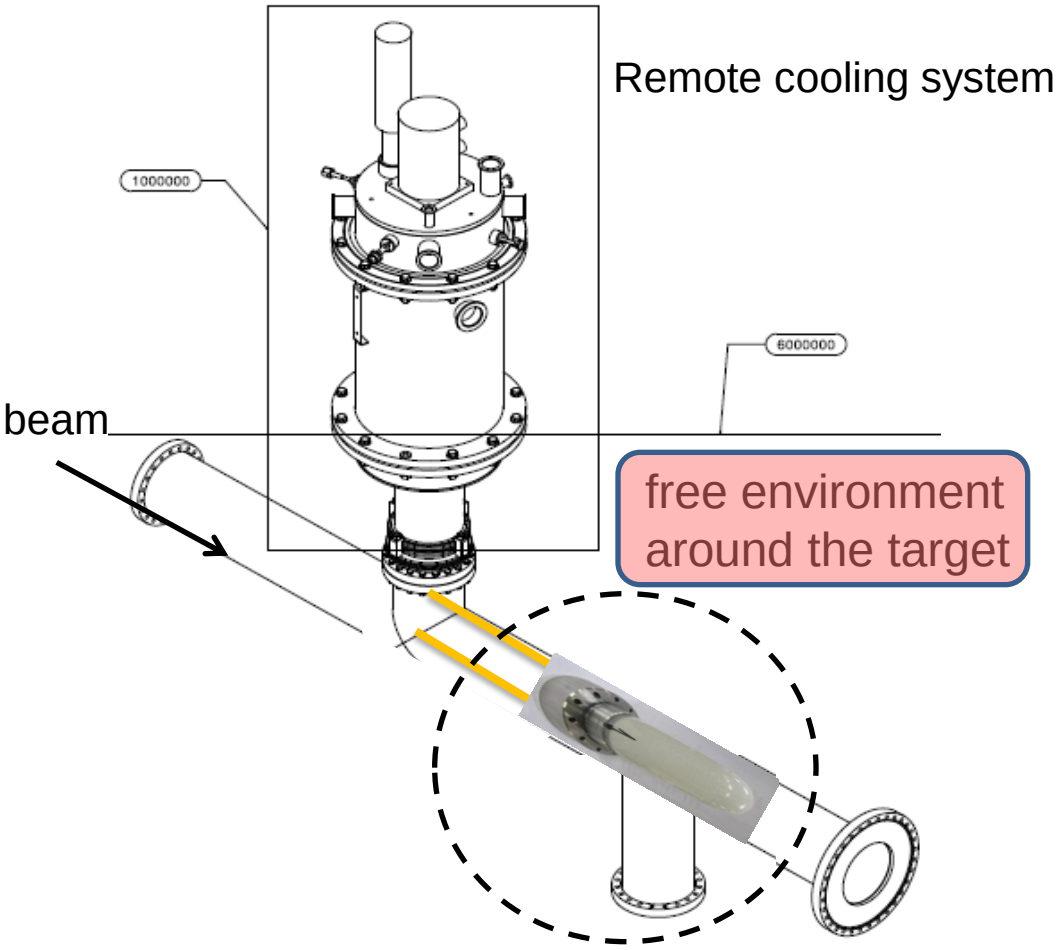
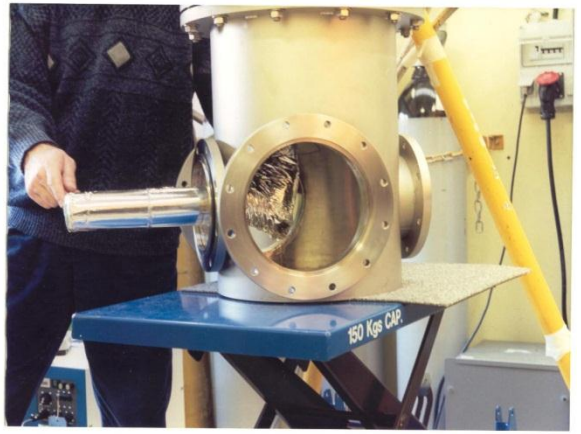
The cryogenic H_2 target

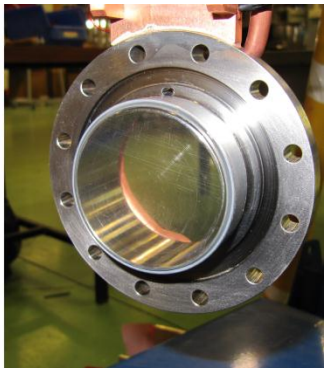


Ex 1: target for GSI (S2)
Ø 60 mm L = 200 mm



Ex 2: Prespec target for GSI
Ø 75 mm L = 60 mm

Mylar cell 200 μm

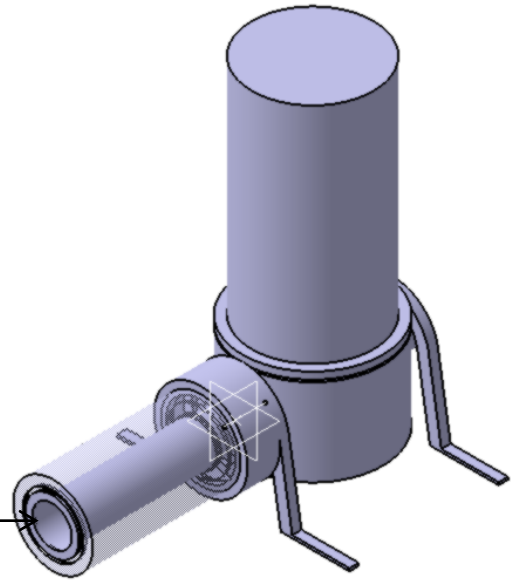


To be designed accordingly
to γ-array geometry (DALI2) / reaction chamber

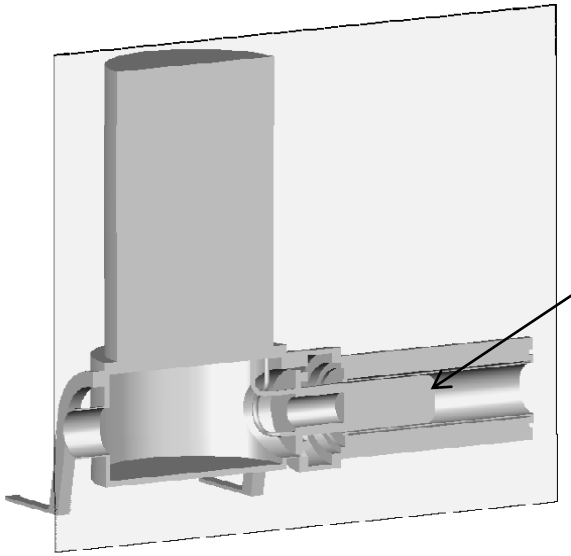
Source J.-M. Gheller

Working conditions: 20 K

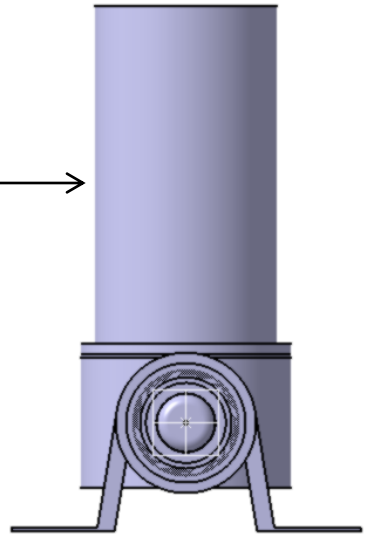
Mecanical structure



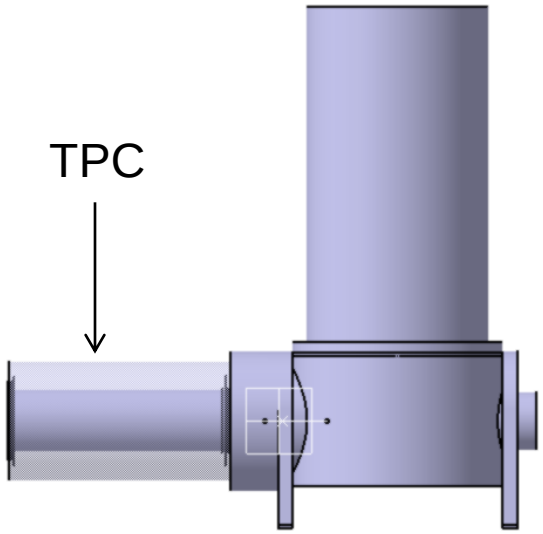
Vacuum chamber



target



cryocooler



TPC

Source D. Leboeuf

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TPC amplification: MicroMegas

Micro Mesh Gaseous Structure, Y. Giomataris, Ph. Rebourgeard, J-P Robert and G. Charpak, NIM A376, 1996, p29 (CEA-biospace patent)

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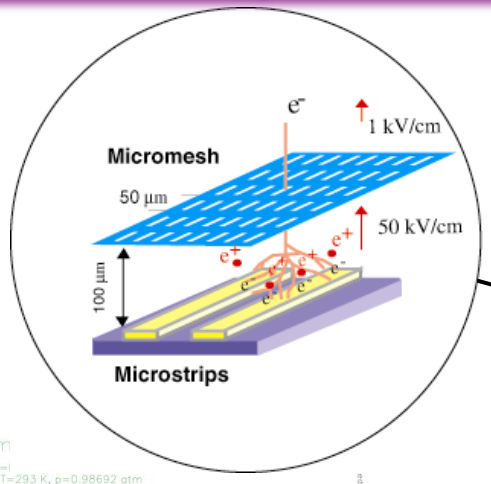
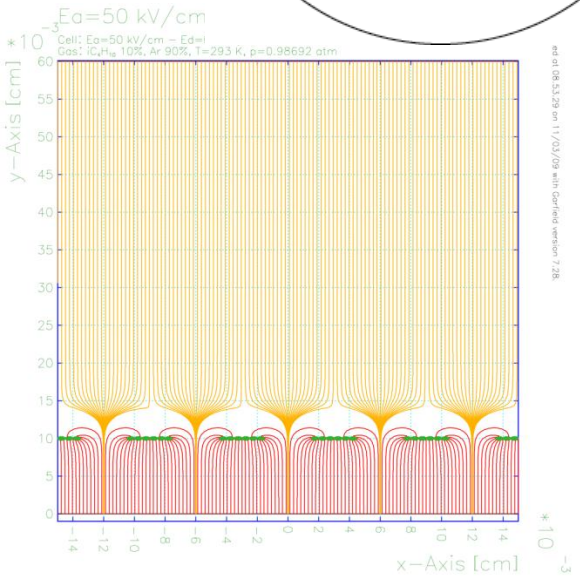
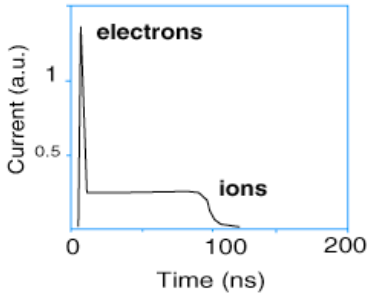
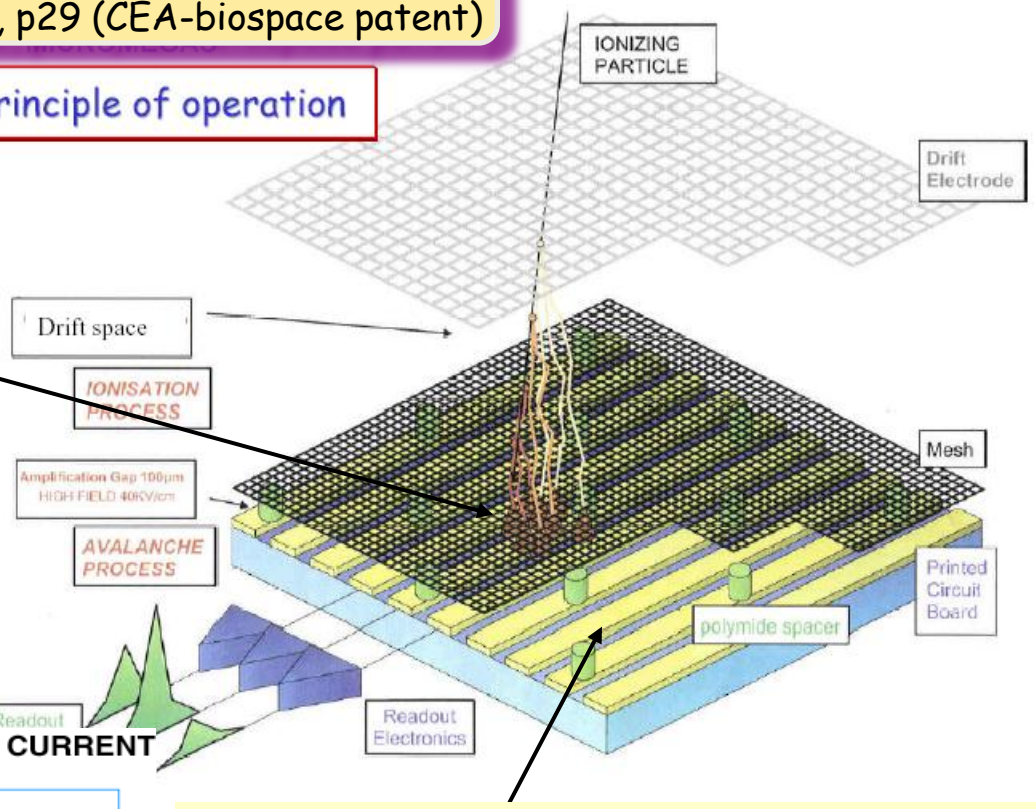
Principle of operation







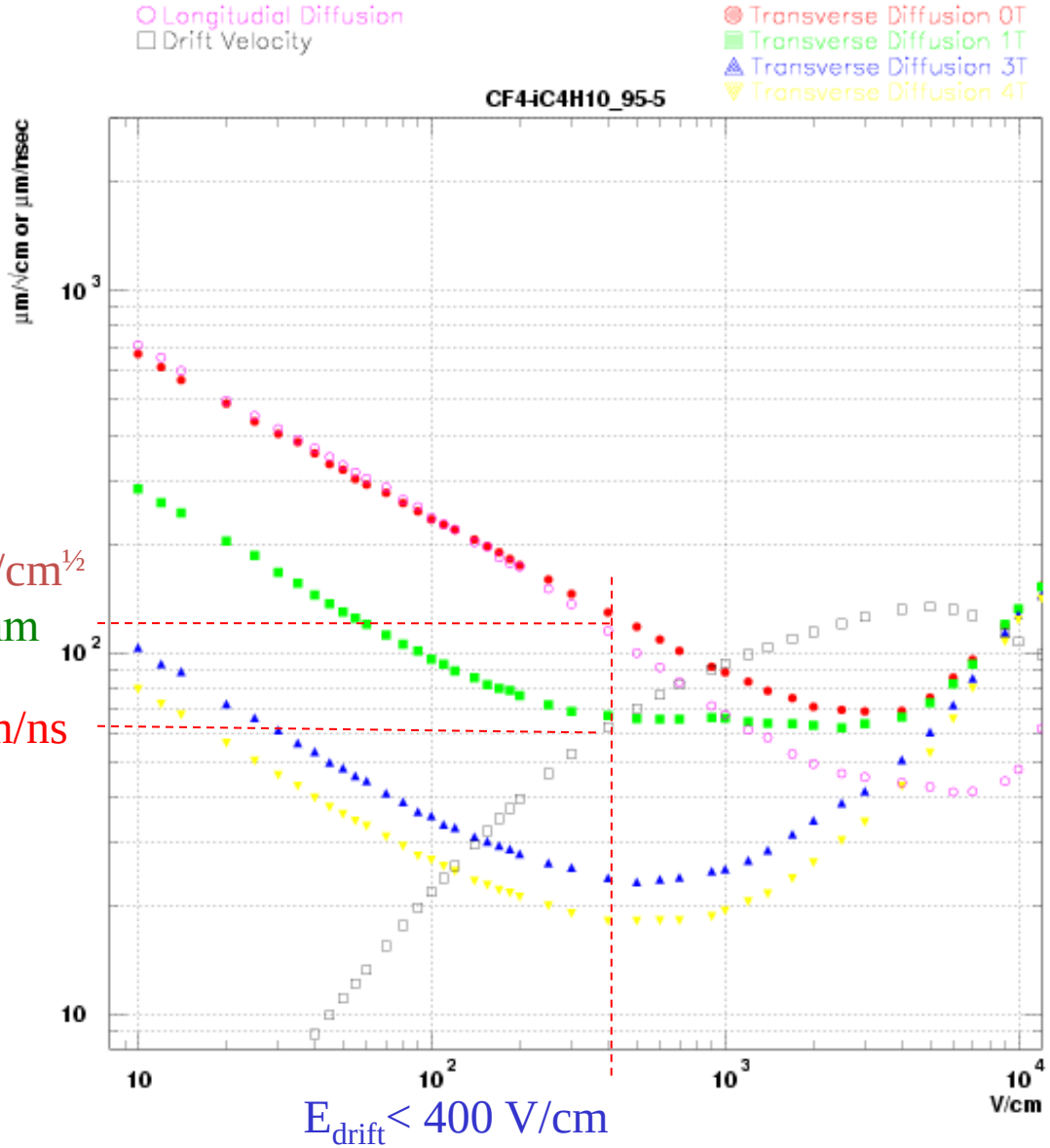
DETECTOR CURRENT



keeping the gap constant **~100 µm gap**

- **Ni or Cu micromesh + pillars on PCB**
- **Self-supported copper micromesh**
- **« bulk » and « micro-bulk » technologies**
- **Recent InGrid techniques** : mesh over Si pixel chip

TPC mode Gas choice : CF_4+ 5% iC_4H_{10}



σ_t & $\sigma_l \approx 120\ \mu m/cm^{1/2}$

σ_t (30cm) ≈ 0,7 mm

V_d=5,9 µm/ns

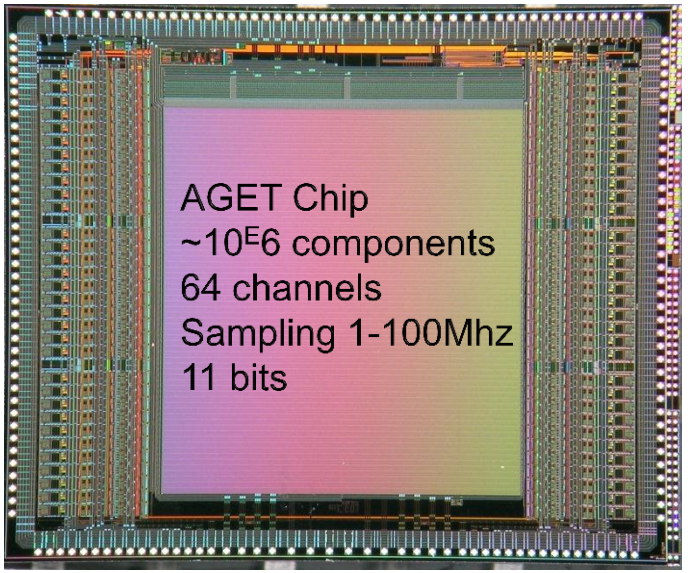
$E_{drift} < 400$ V/cm

Electronics

- 10^{3-4} triggers/s requested
  TPC: time sampling / 100 MHz
  Beam rejection from **spectrometer** (ex: 0-degree)

- Digital & ASIC-based electronics needed
- AGET is a possibility under study
- Back-end to be developed

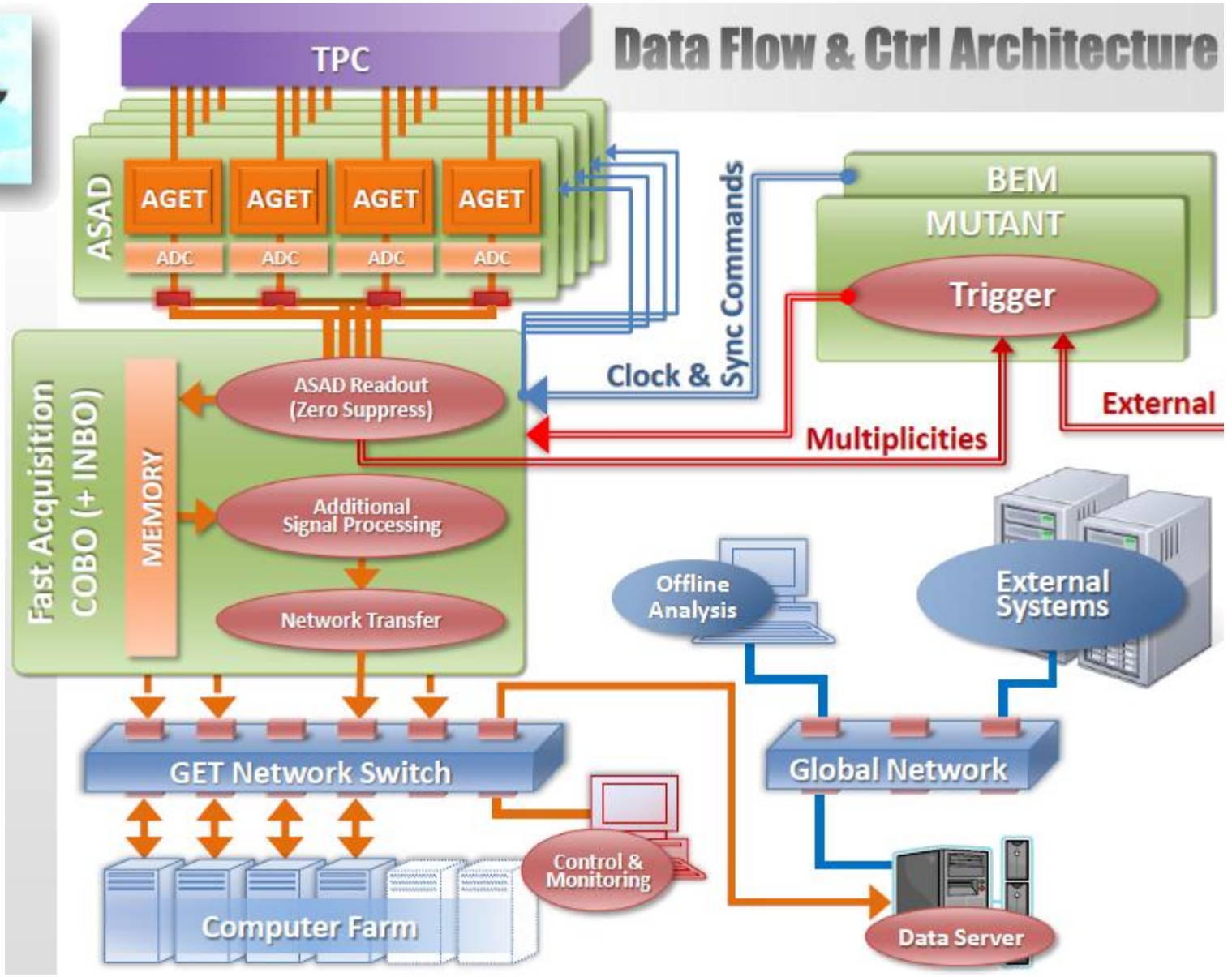
GET: General Electronics for TPCs
CEA-IRFU, CENBG, GANIL and NSCL collaboration



Full detector **simulations** (2011) to:

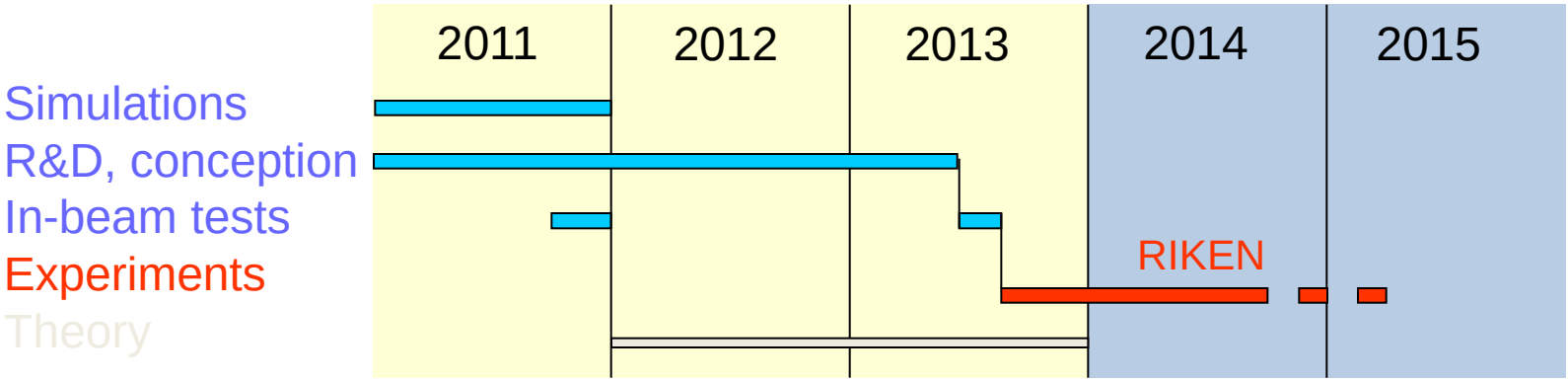
- Define the detector characteristics (pad distribution, gas, geometry)
- Validate the electronics choice (sampling depth, dead time treatment)
- Estimate counting/trigger rates on specific physics cases

The GET electronics



Source F. Druillole

Agenda



Funding (5 years): **1.1 M€**

Project covers

- **Investment :** Target, TPC-tracker, electronics, slow control, mechanics
- **Postdoc**
- **Missions**

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Summary

1- **Physics program**
Participate to the quest for **shell evolution away from stability**

2- **Unique**
original experimental approach / new TPC-H_2 target for *(p,2p)* vertex location coupled to existing or upcoming gamma arrays (DALI2, SHOGUN, AGATA)
[**Vertex resolution < 3 mm FWHM, efficiency > 80%**]

3- Benefit from the **technological expertise** at CEA-IRFU

4- Technical development under progress
Simulations, prototype, H_2 target, electronic design,…

5- Ready to run **from mid-2013**

6- Dedicated program at **RIKEN**

Initially not designed for other purpose than γ spectroscopy but could be advantageously coupled to other setups (ex.: SAMURAI + MINOS + calorimeter)