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Beam Tracking Detectors

Status and Perspectives

Radioactive Beam Studies at GANIL

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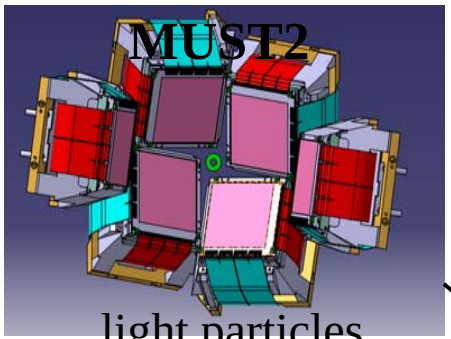
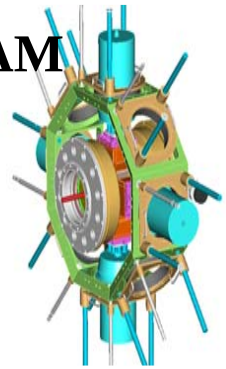
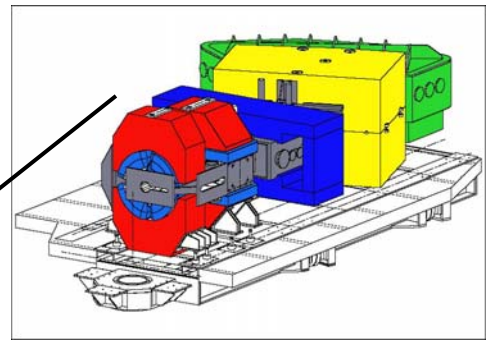


EXOGAM

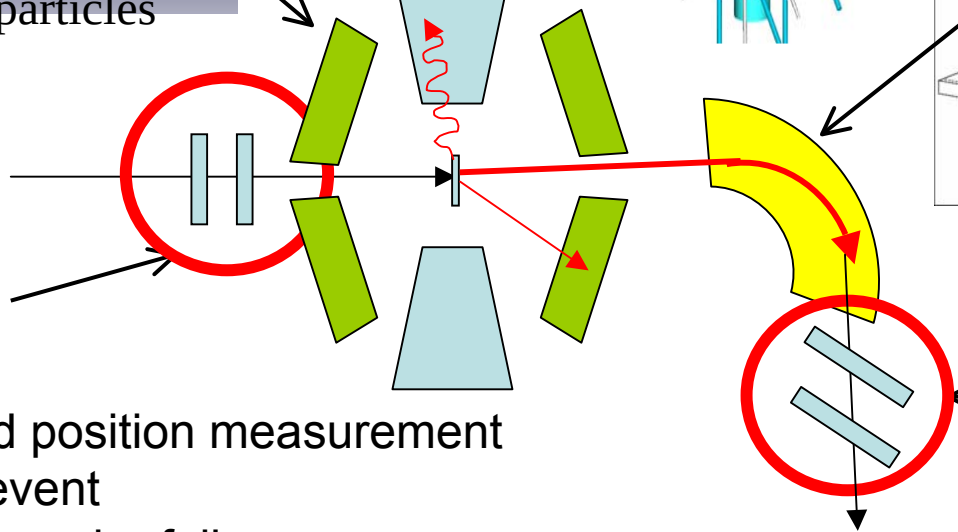


γ

VAMOS



Heavy Ions



CATS

- Time and position measurement event by event
- 2x0.9 μm mylar foils
- 2x1.5 μm mylar foils
- 2x3.2 mm of iC_4H_{10} at 8 mbar (CATSI)
- 2x1.6 mm of iC_4H_{10} at 8 mbar (CATSII)

⇒ 550 μg/cm² in beam

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- Time and position measurement
- 1x0.9 μm aluminised mylar foils

⇒ 75 μg/cm² in beam

Low Pressure Gaseous Detectors

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- Few materials in beam (no angular or energy straggling) and operation in vaccum $\Rightarrow$ low pressure gas detector
- Use of pure iC_4H_{10} for its low ionisation energy (about 100 % efficiency) and its high quenching power (very low pressure of several mbar)
- Important gain (E/P…) even in low field region : natural spread of the avalanche (good spatial resolution)
- Mean free path of electrons much higher : high electron drift speed and good timing resolution
- Low drift gap and fast ion collection for high rate capabilities

Effects of Trajectory Reconstruction with BTD

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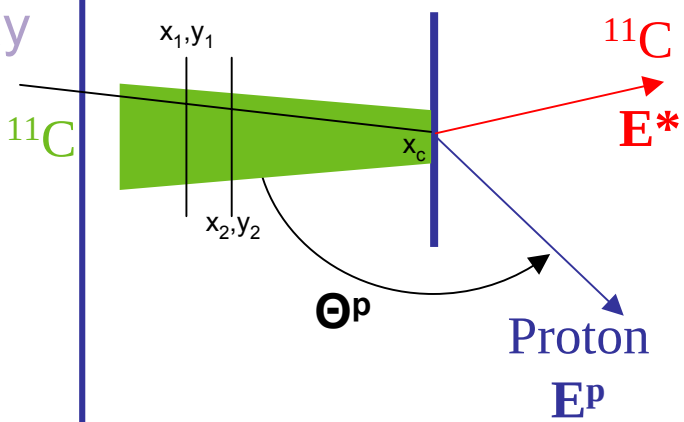
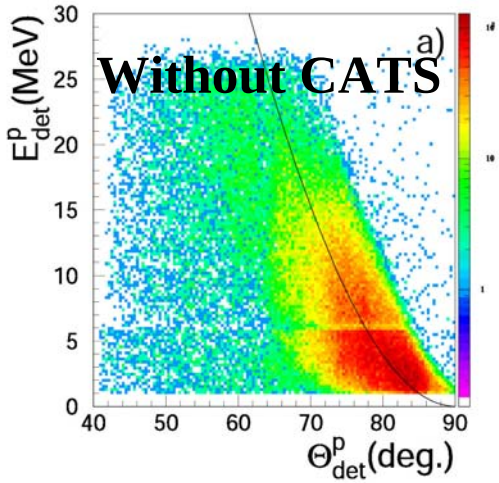
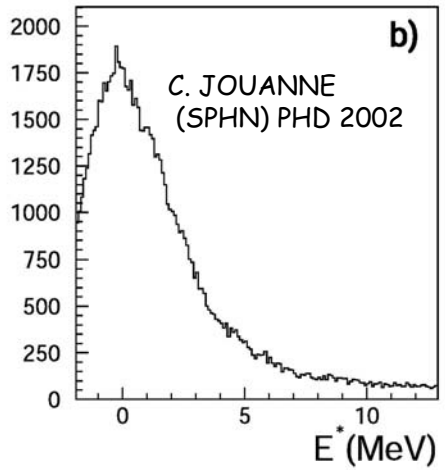
^{11}C (p,p') 40.6 MeV/n

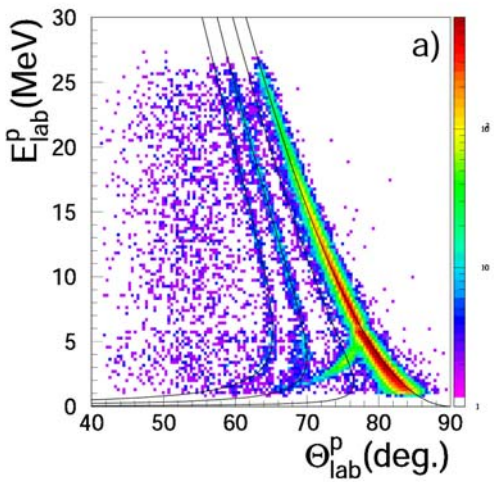


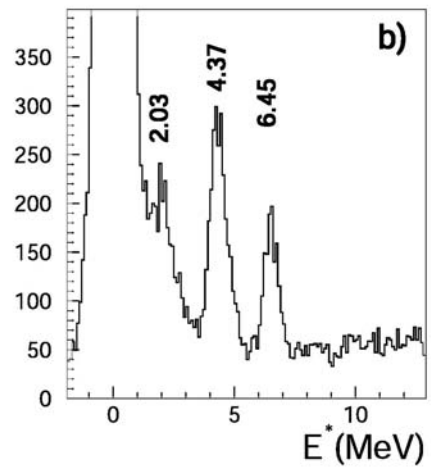
Exotic Beam
Large emittance

⇒ Need of Time & position measurement
Event by event









CATS : Detection Principle

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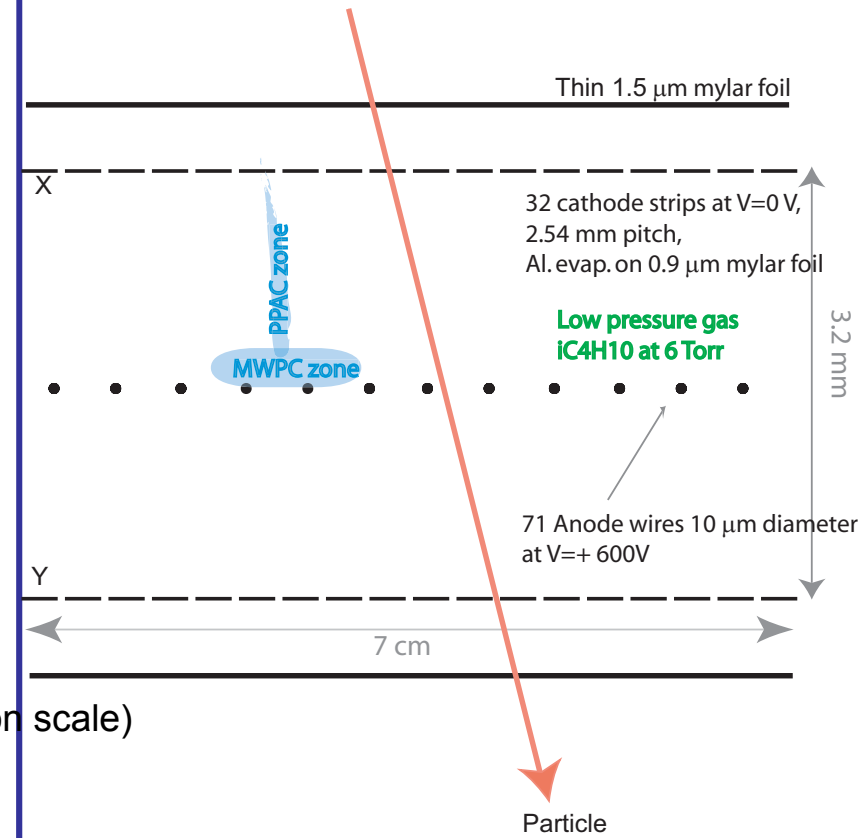
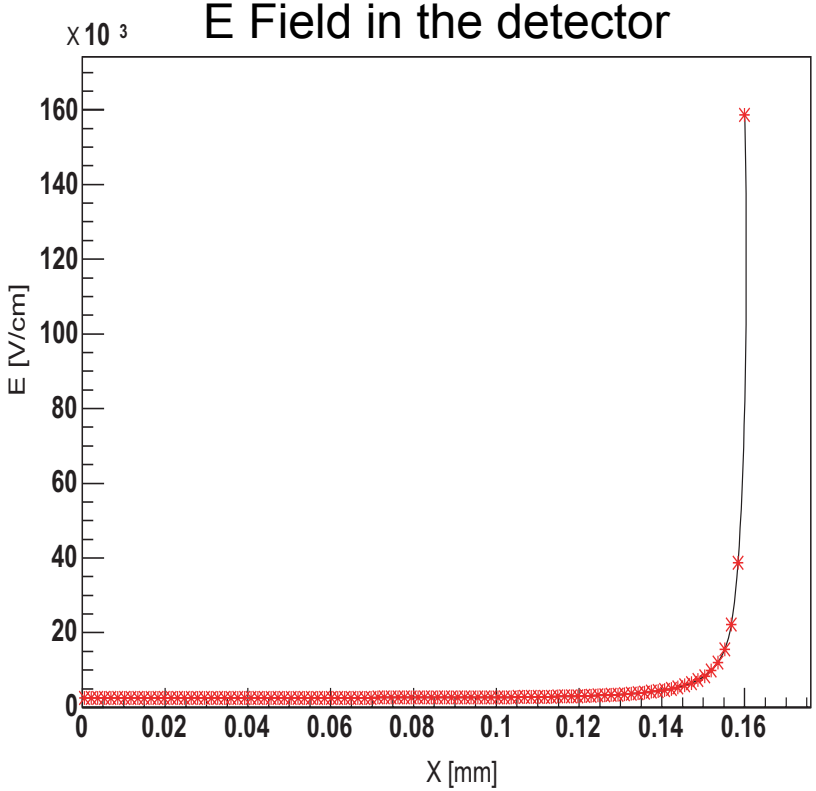


(Not on scale)



- Constant field zone: PPAC, position signal on the strips
- High gradient field zone: MWPC, time signal on the wires

CATS : Detector Description

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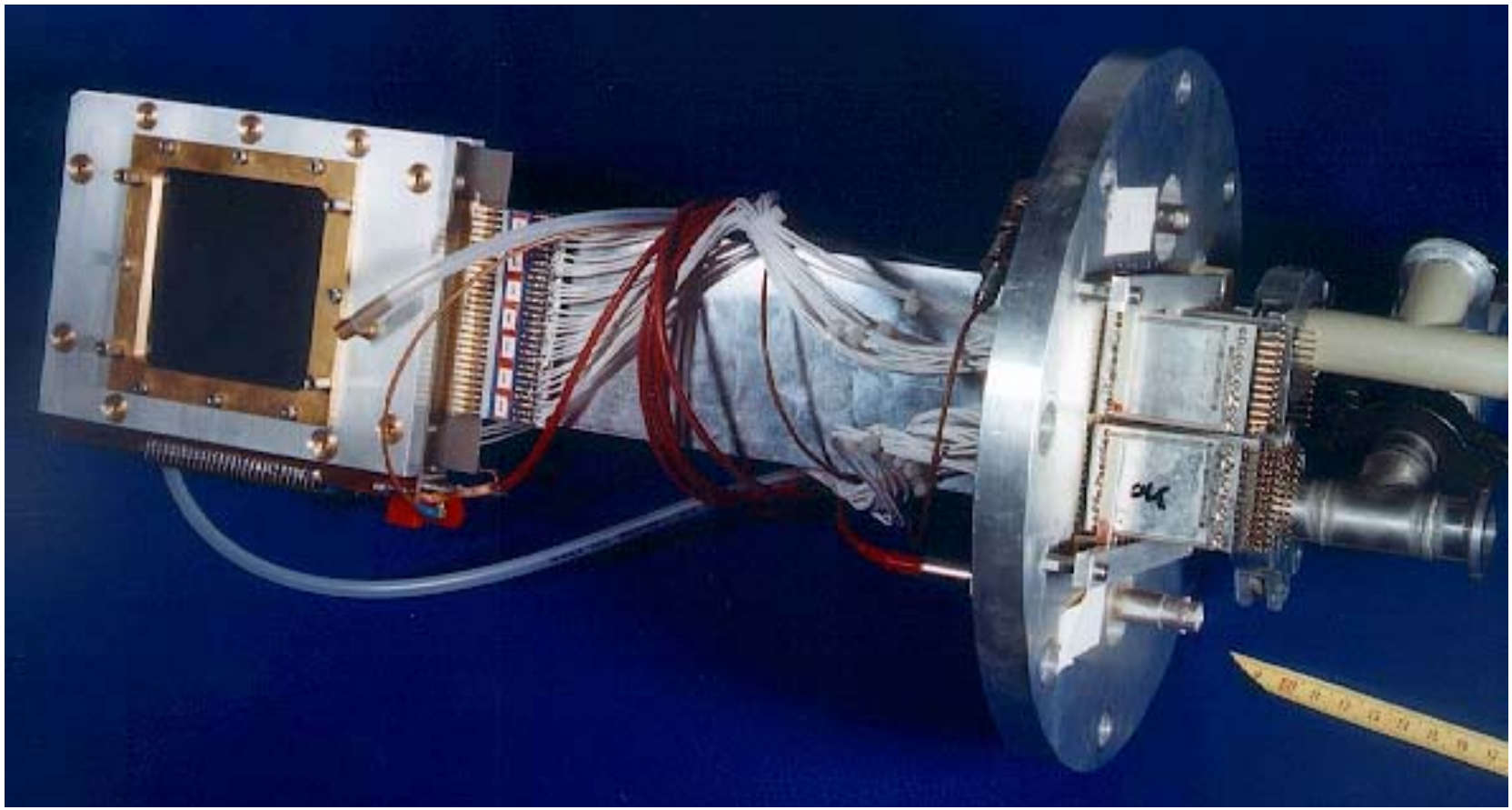
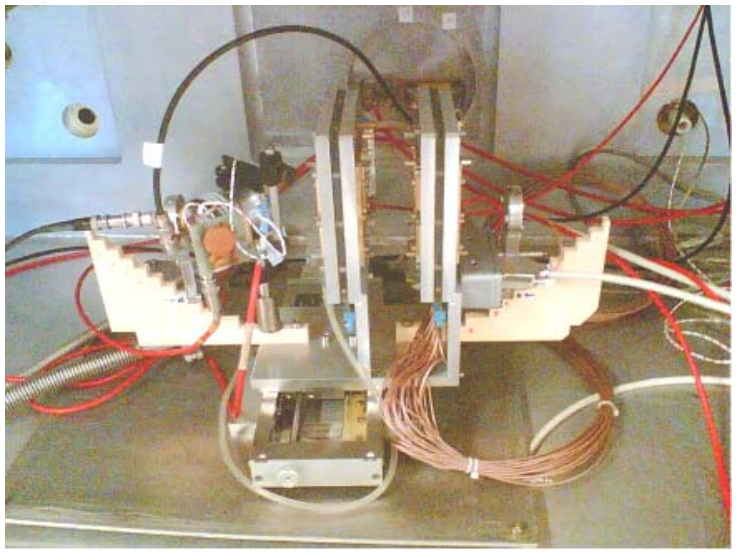
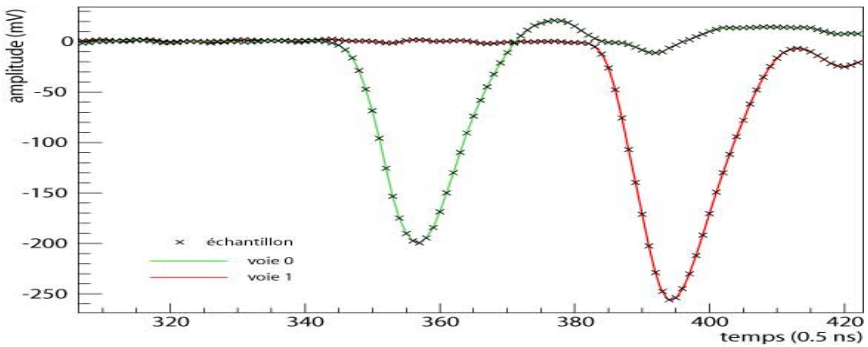


CATS : Time and Spatial Resolution

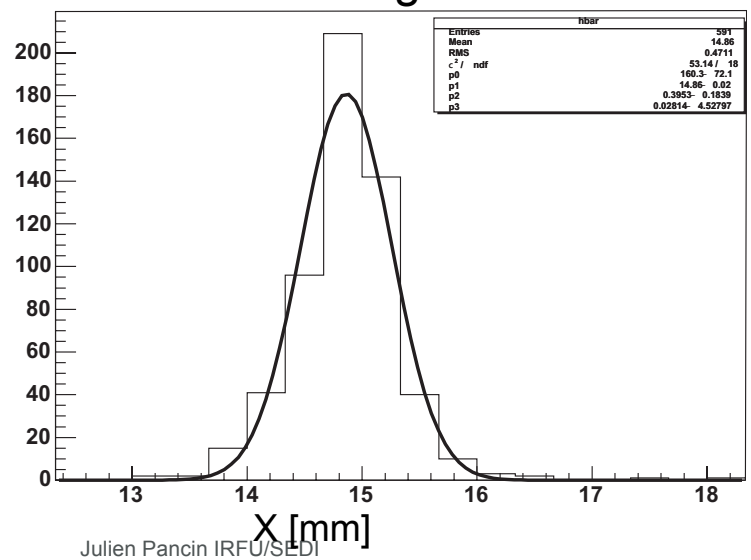
- Time resolution calculated using 3 CATSII detectors





σ_t = 250 ps +/- 20 ps

- Spatial resolution using holes of 2 mm diameter



$\sigma_{x,y}$ = 380 μm +/- 40 μm

CATSII: Electronic Improvements

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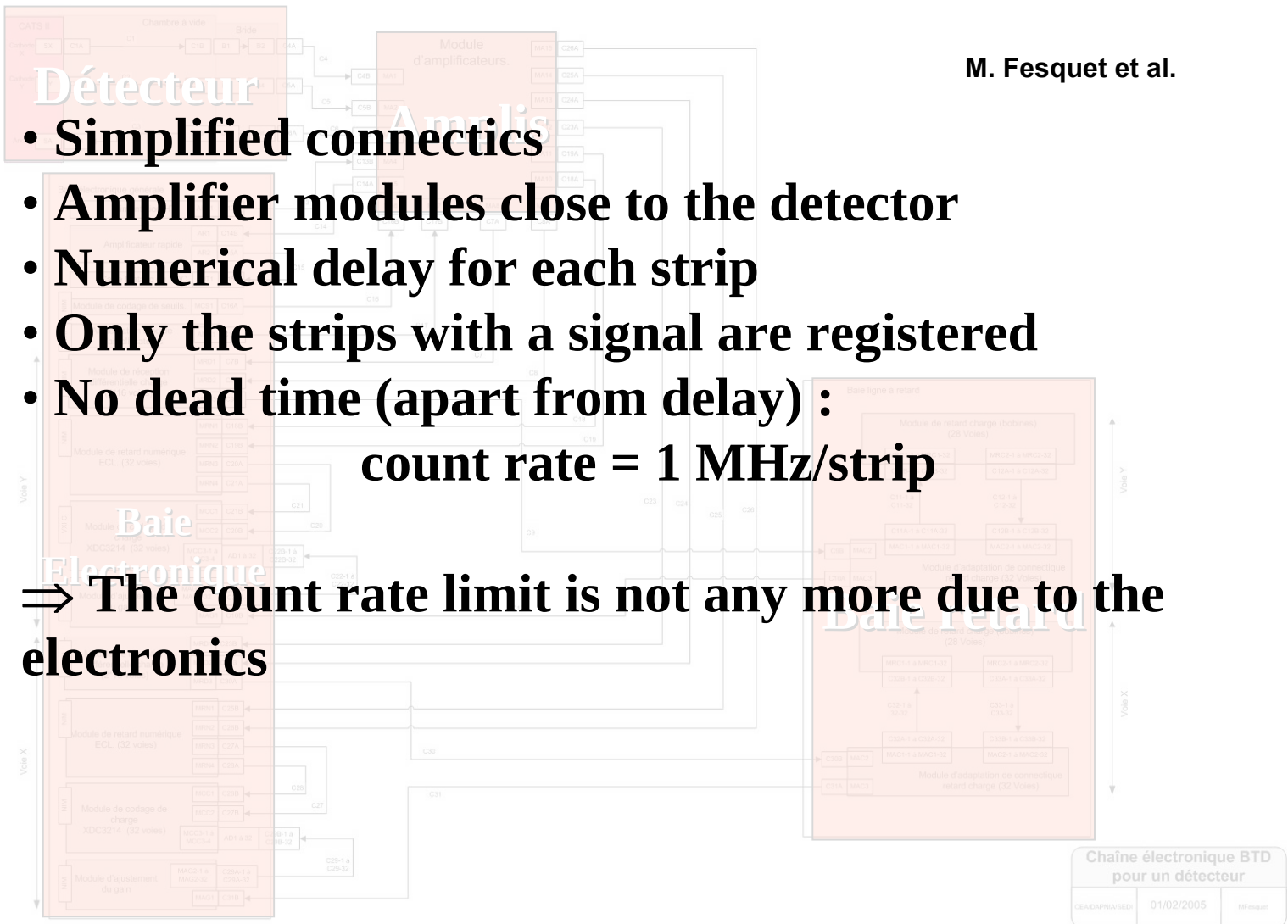
M. Fesquet et al.

- **Simplified connectics**
- **Amplifier modules close to the detector**
- **Numerical delay for each strip**
- **Only the strips with a signal are registered**
- **No dead time (apart from delay) :**

count rate = 1 MHz/strip

⇒ The count rate limit is not any more due to the electronics



CATSII vs CATSI

- Count rate capability ~ 10^5 pps/cm^2
- Low dead time ≅ 1 µs / strip
- Spatial Resolution: σ_X, σ_Y ~ 500 µm
- Time resolution < 0.5 ns
- Efficiency > 90 %

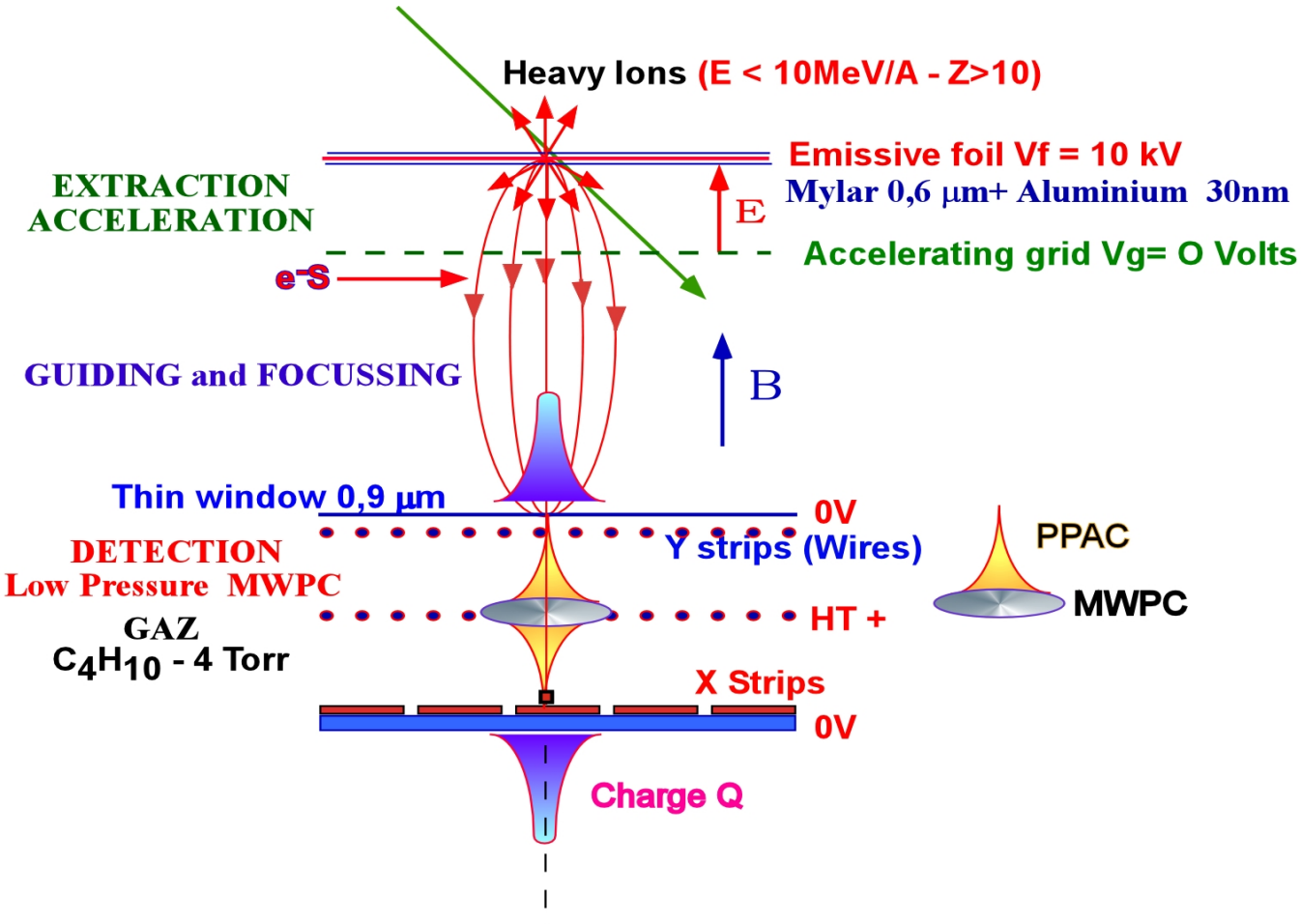
^{8}He@15 MeV/n

10^5
150 µs
400 µm
1,7 ns
83 %

CATSI / CATSII

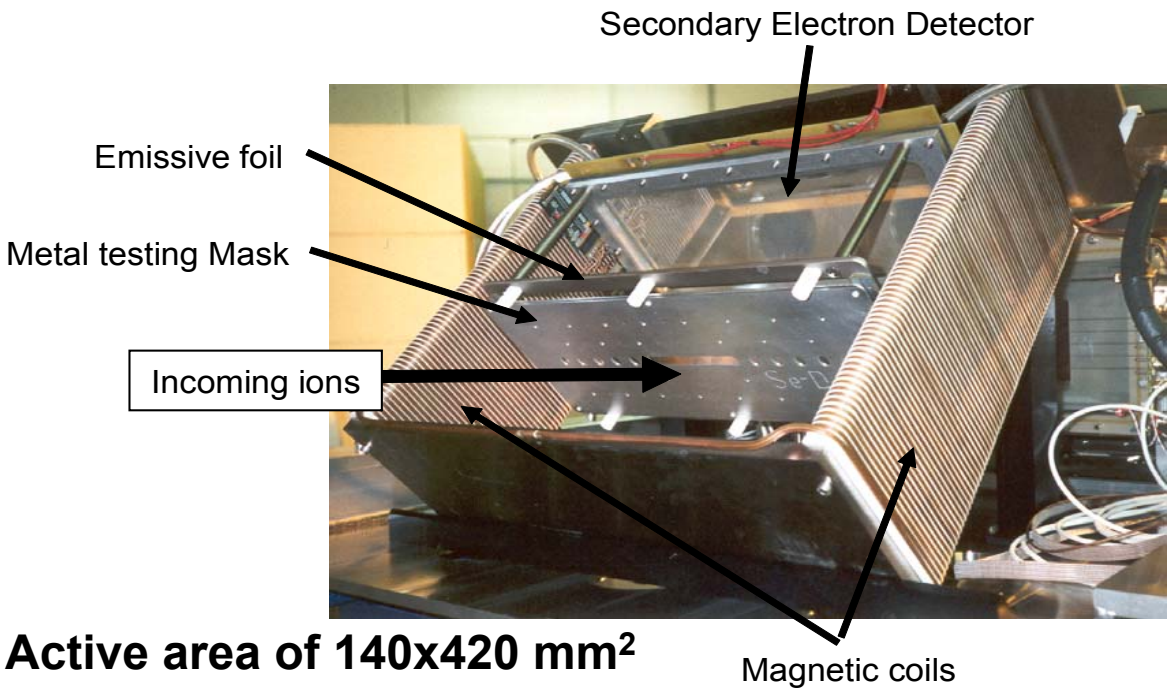
- **Spatial resolution slightly degraded as well as reconstruction efficiency**
- **Better time resolution**
- **Faster electronics**
- **Similar count rate capability (space charge, energy deposit in mylar foils…)**

Secondary Electrons Detectors



- **Minimisation of material in beam**
- **Position and time of flight measurements in VAMOS since 2004**

SED



Active area of 140x420 mm²

- Counting rate = **10^3 pps** (limited by electronics dead time)
- Theoretical limit **~10^7 pps**
- Spatial resolution : **1-2 mm**
- Time resolution : **1.5 ns (light ions) to 300 ps (heavy ions Z>40)**
- Total thickness in the beam : 0.9 μm Mylar foil = **75μg/cm²**

Perspectives: Mini-SED

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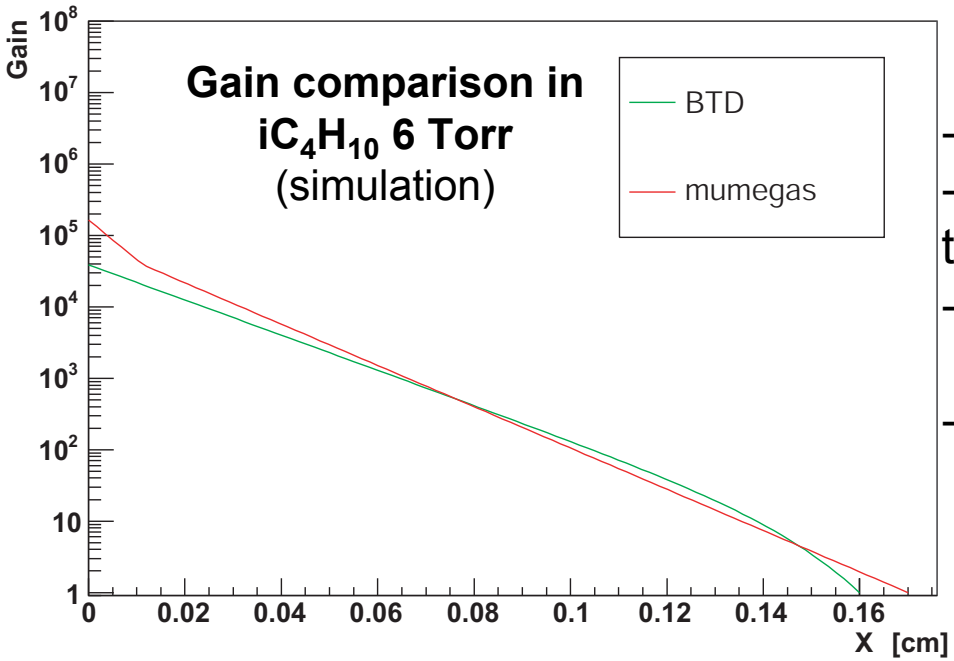
- Based on the SED but only 70x70 mm^2 (to fit mechanically with smaller beam tube)
- Achieve at least the same characteristics (spatial and time resolution)
- Improve the counting rates (effect of thickness of the detector, damage induced on the emissive foil…)

- Modified CATSI replacing the 0.9 μm thick strip plane by a wire plan (50 μm diameter): mini-SED prototype !!
- Currently in test with ^{252}Cf source for time and spatial resolution
- In beam tests fall 2008 with the CATSII electronics

Perspectives: Micromegas at Low Pressure…

- SED with a micromegas instead of the classical wire chamber



First promising tests :

- normal sparking limit
- Gas gain of the same order than CATS
- Rise time about 6 ns

- Still to measure the resolutions

NO WIRE MORE ROBUST

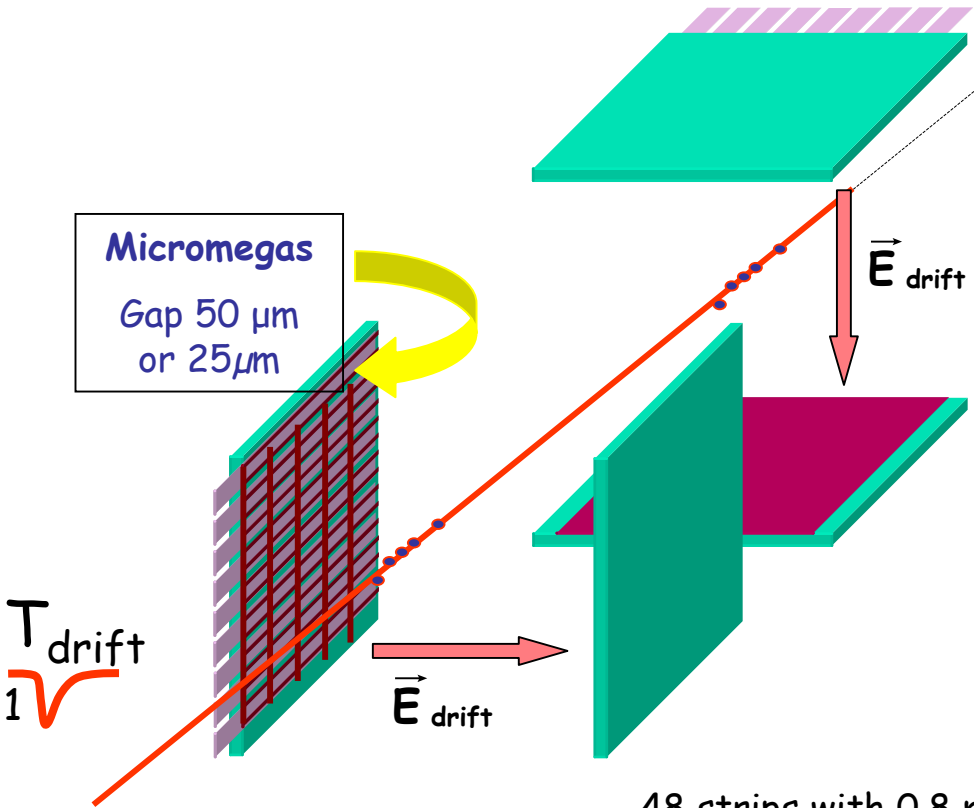
- **Smaller active area: MCP possible**
- **KABES for high energy or light particles**
- **Gas injection in beam tube**

- **Also a simulation work**

Perspectives : KABES/NA48

- Measure direct **CP violation**
- **Detector requirements** for ≥ $2 \cdot 10^9$ K± decays

High intensity beams



- Time resolution < 0.6 ns
- Spatial res. of 70 µm
- 1 GHz (so far 40 MHz)
- Efficiency close to 100 %

48 strips with 0.8 mm pitch

Very low discharge probability

Low Pressure Gas Detector Group

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Electronics :	Thomas Chaminade (IRFU/SEDI)
Scientific coordinator :	Antoine Drouart (IRFU/SPhN)
Detector tests :	Mariam Kebbiri (IRFU/SEDI)
Technical coordinator :	Julien Pancin (IRFU/SEDI)
Informatics :	Yves Piret (IRFU/SEDI)
Mechanics :	Marc Riallot (IRFU/SEDI)

External collaboration : Begona Fernandez (Universidad de Sevilla)

And the others…