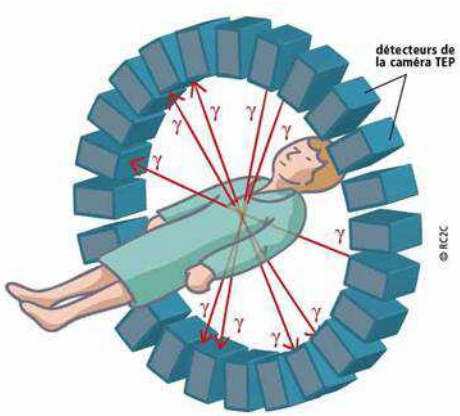
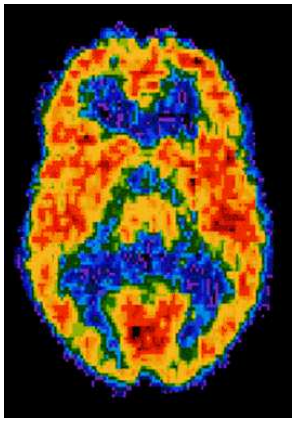
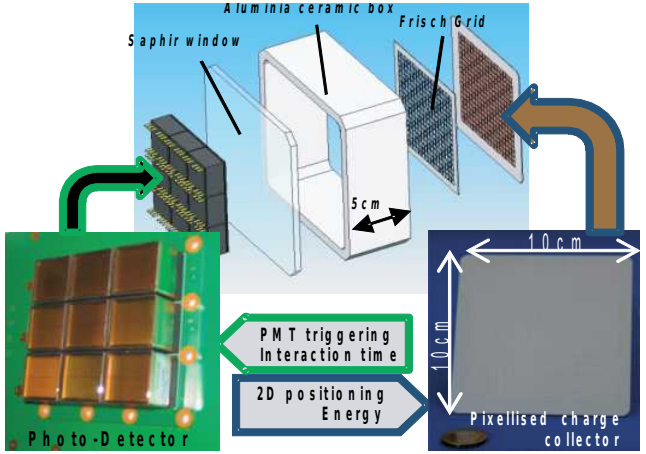
Technologie détecteur de charge ultravide multipixellisé avec électronique ASIC bas bruit et ultrapurification

I. Physical principle
II. Ultrapurification
III. Single pixel detector
IV. Electronics
V. Measurements
VI. Conclusion







Physical principle

Optical detector

Cherenkov Emission → Time resolution

Cherenkov Emission → Z position*

Ionisation

Ionization detector

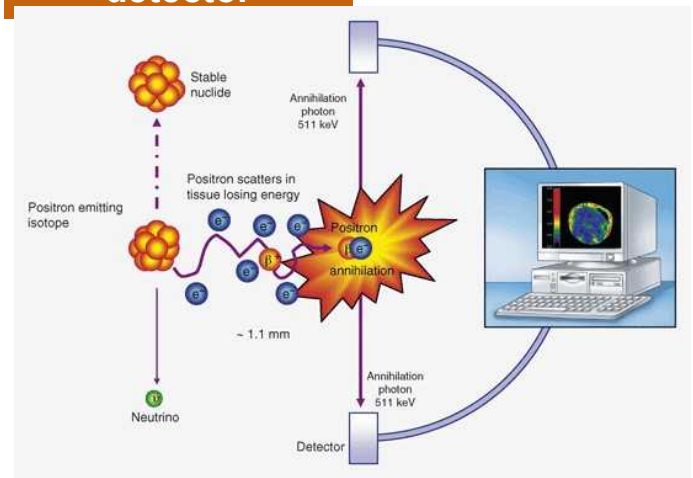
Electrons drift → XY position, Z position*

Electrons drift → Energy

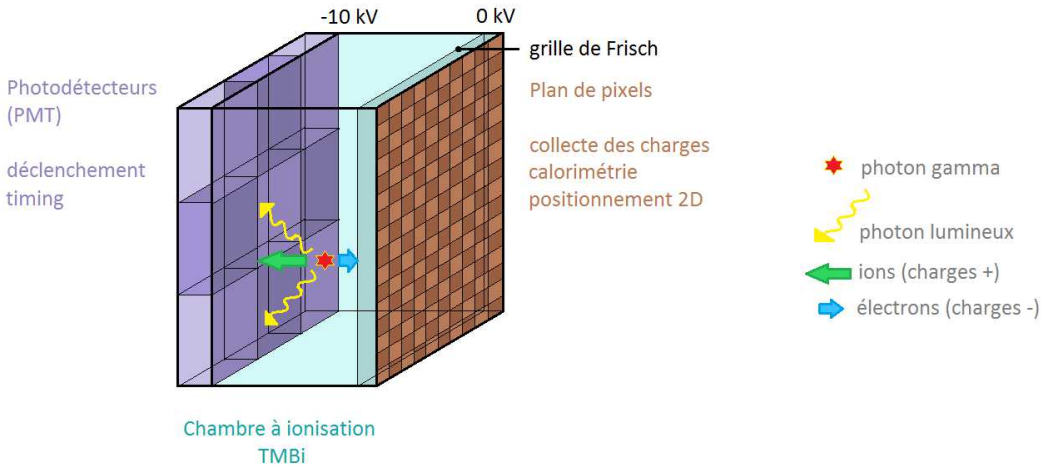
CaLIPSO

Expected performances:

- 3D positioning: **1 mm3**
- time resolution ~ **100 ps**
- energy resolution ~ **10%**



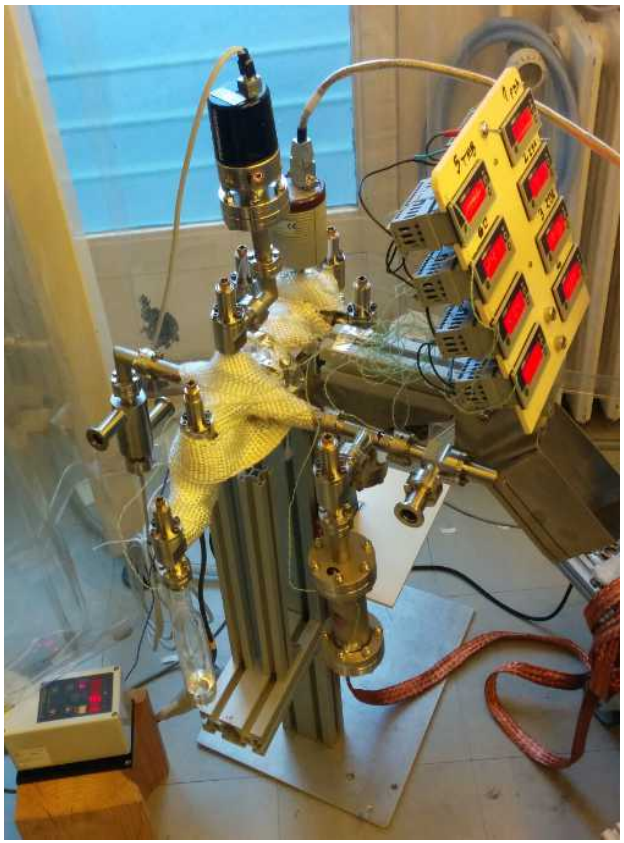
PET principle



CaLIPSO detector principle

ultrapurification

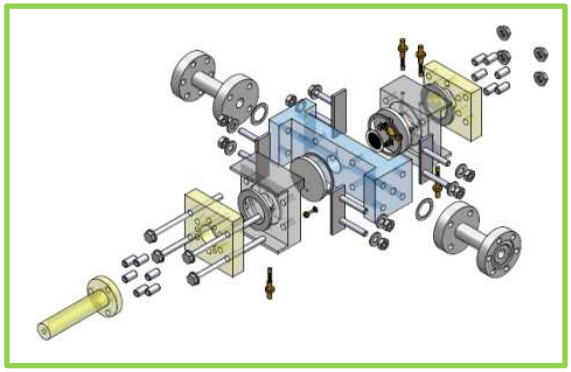
- Electronegative impurities reduce the signal by capturing electrons
  - ultrapurification < 0,1 ppm oxygen equivalent (electrons lifetime > 10 µs)
  - **molecular sieve (3A, 4A, 5A and 13X zeolites)**
  - batch and column devices



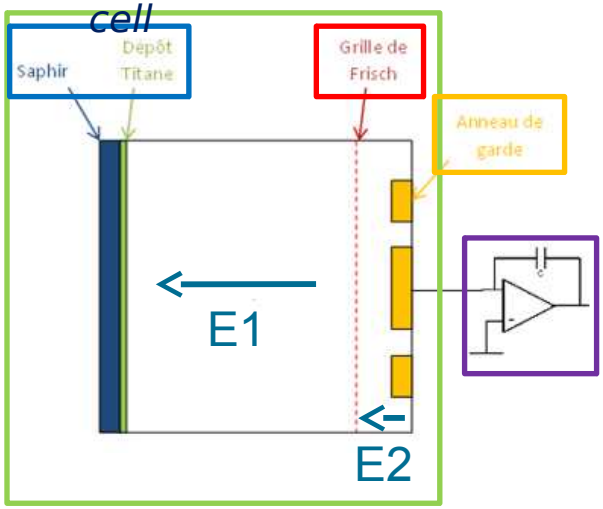
Batch (r.) and column (u.) ultrapurification stations

Single Pixel Detector

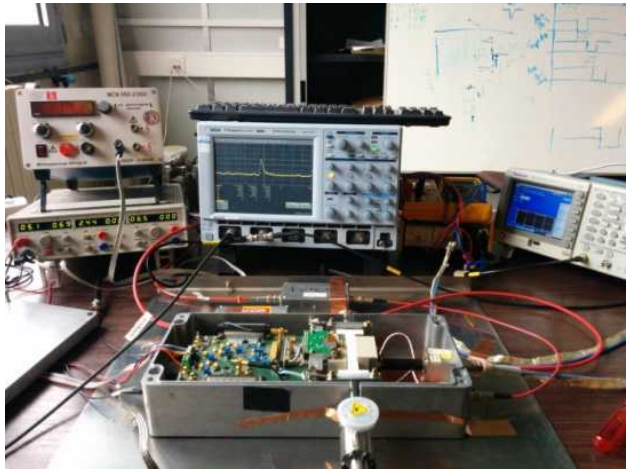
- Ionization chamber
- Very weak signals (pA, fC) Eliminate every noise sources



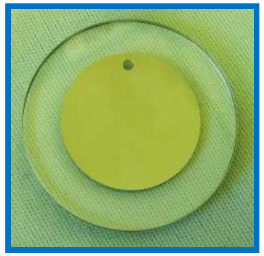
Single pixel cell



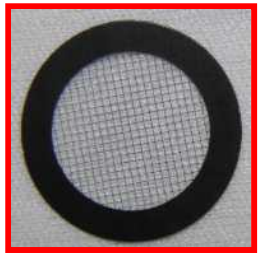
Single pixel cell picture



Single pixel cell electronic readout



Titanium layer on sapphire

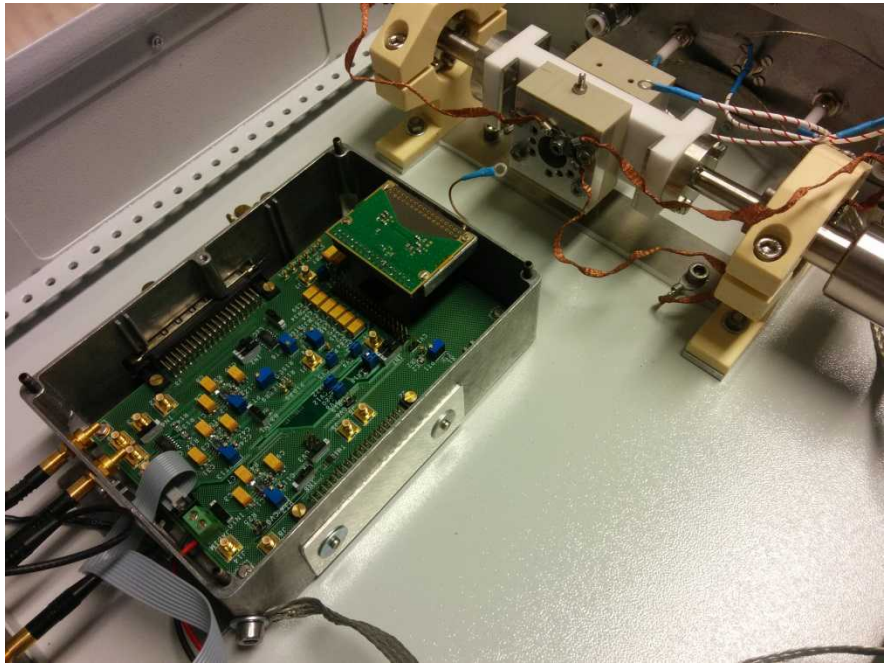


Frisch grid

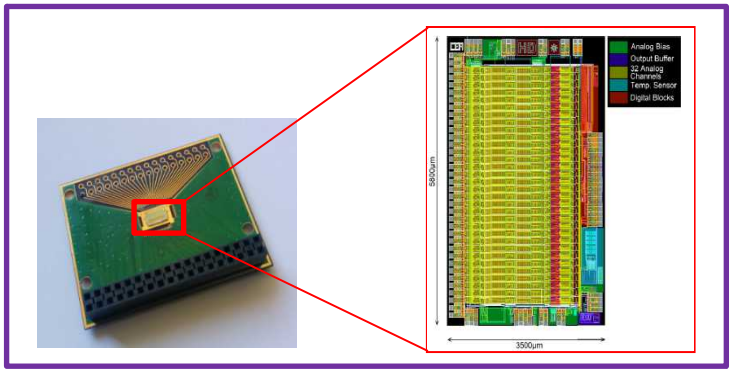
Charge collection surface

Electronics

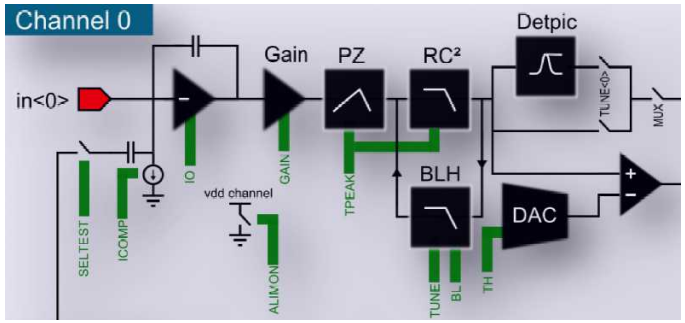
- Charge pre-amplifier Low-noise **iDeF-X** electronic developed at SEDI (O. Gevin et al.)
  - Equivalent Noise charge (ENC) = **33 e- + 5,5 e-/pF**
  - Gain max = **200 mV/fC**
  - 32 independent channels (ASIC)



Test environment



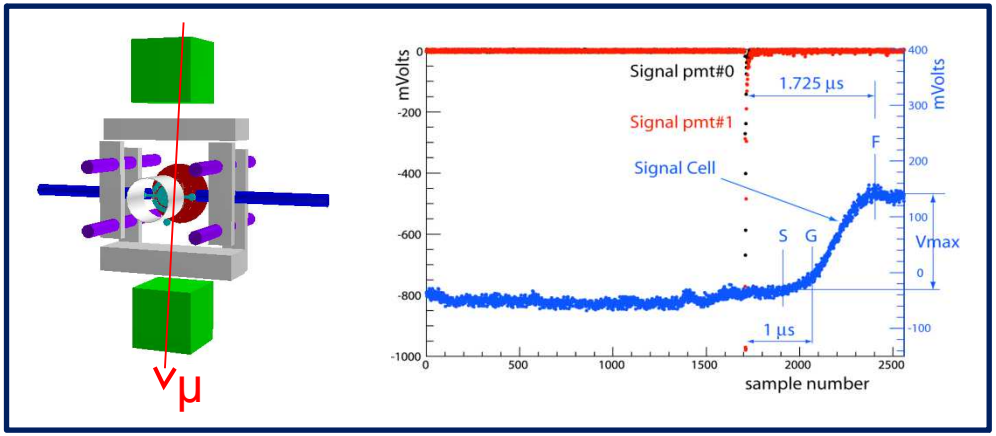
IDef-X chip

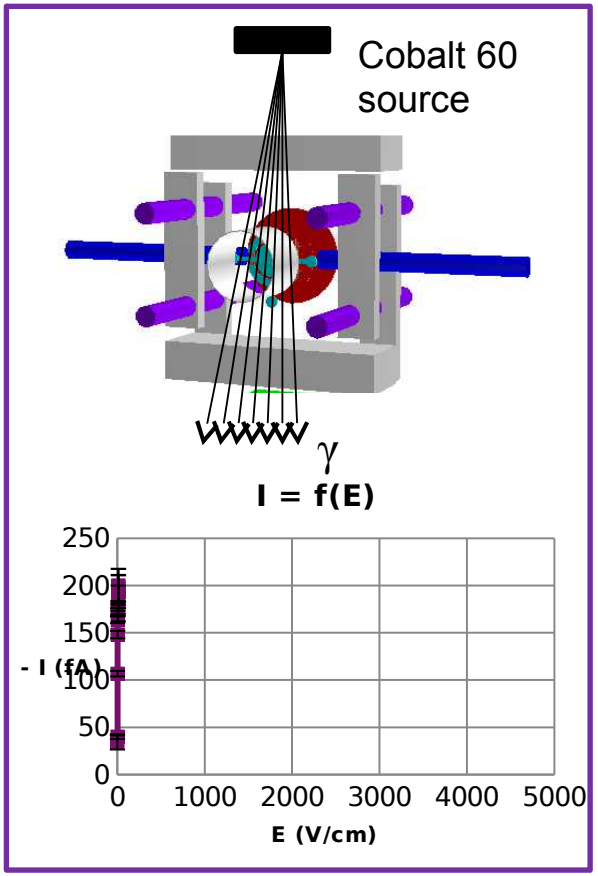


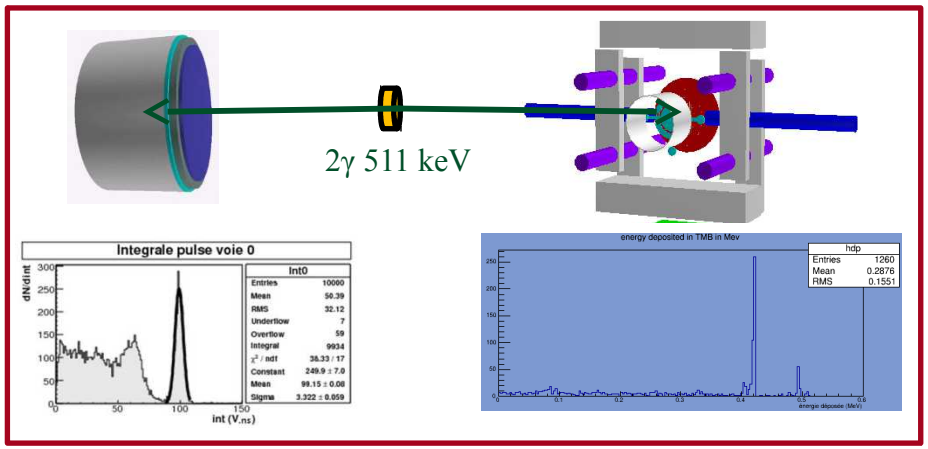
Schematic of an IDeF-X channel

Measurements: 3 methods

- Detection in coincidence of a muon on two scintillators : **Electron mobility**
- Curbility produced by a 60Co gamma rays source : **Charge collection yield (Cfi)**
- Detection in coincidence of two 511 keV γ from a β+ 22Na source : **Ultrapurification**







conclusion

- Now Operational
  - Optical detector
  - Ionization electronic readout
  - Single pixel cell modelisation
  - First ionization signals after purification on 3A zeolites in powder form

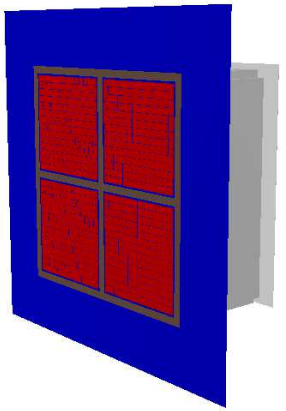
- On going
  - TMBi ultrapurification
  - Single pixel cell performance study
  - Mechanical conception of final CaLIPSO detector with « bureau d'étude »
  - Physical modelisation of final detector

Thank you for your attention

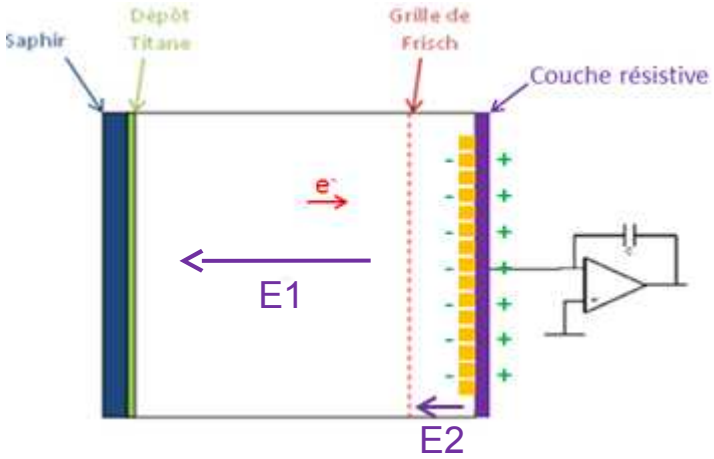
Future : multipixelisation – UHV Vacuum

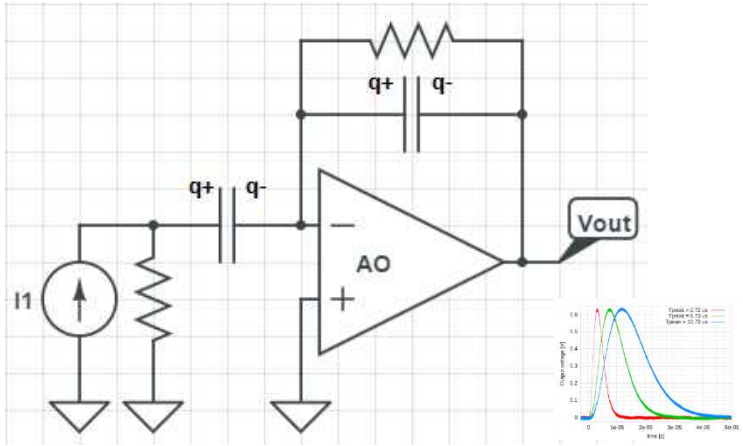
Signal readout by capacitive coupling

- No feedthrough
- Alumine 300 µm + resistive layer => **readout by capacitive coupling**
- Thin film deposits on alumine performed by the CSNSM in Orsay (L. Dumoulin et L. Berge)



Pixellised detector





Capacitive readout principle