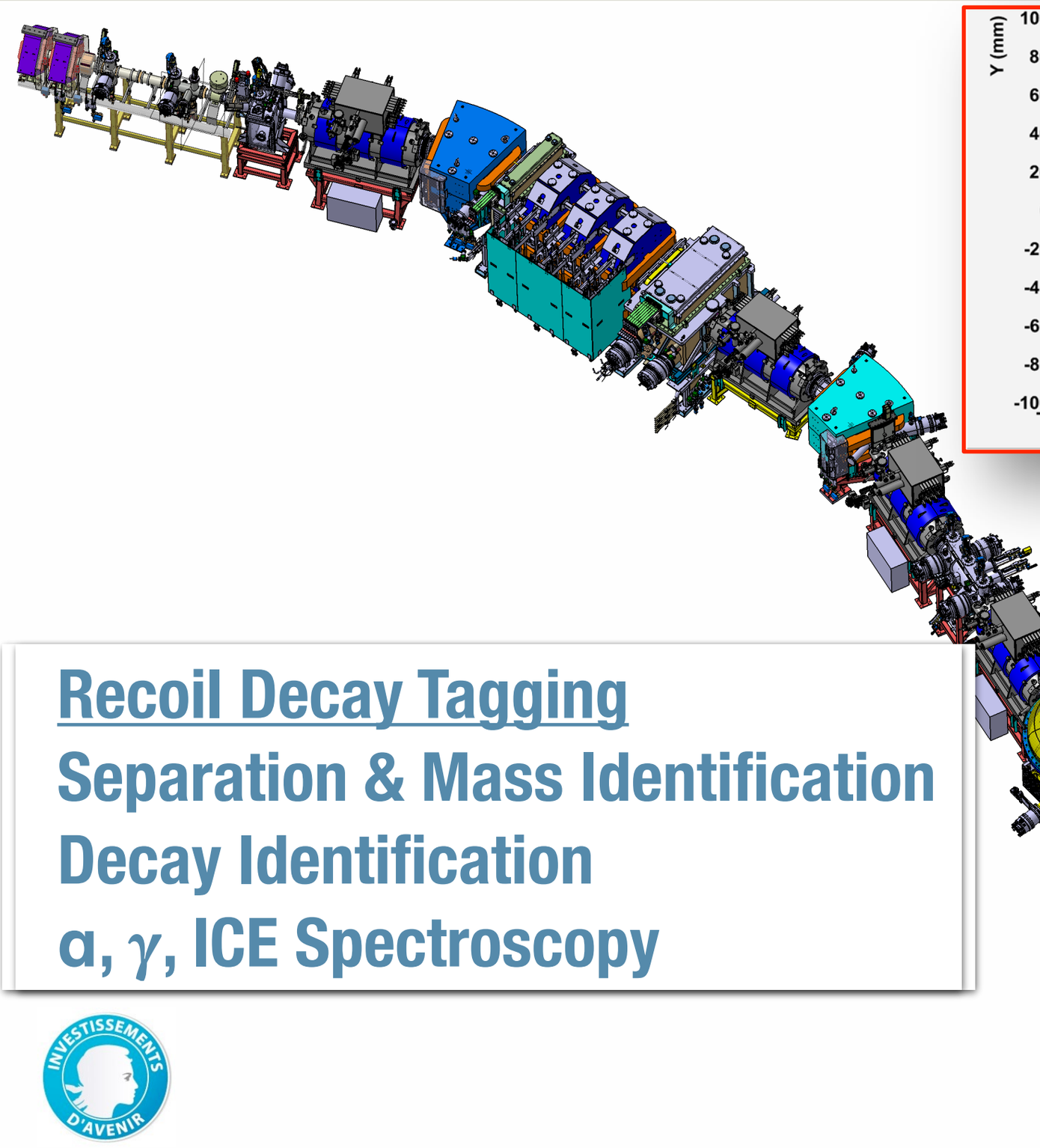
laboratoire commun CEA/DSM spiral2 CNRS/IN2P3

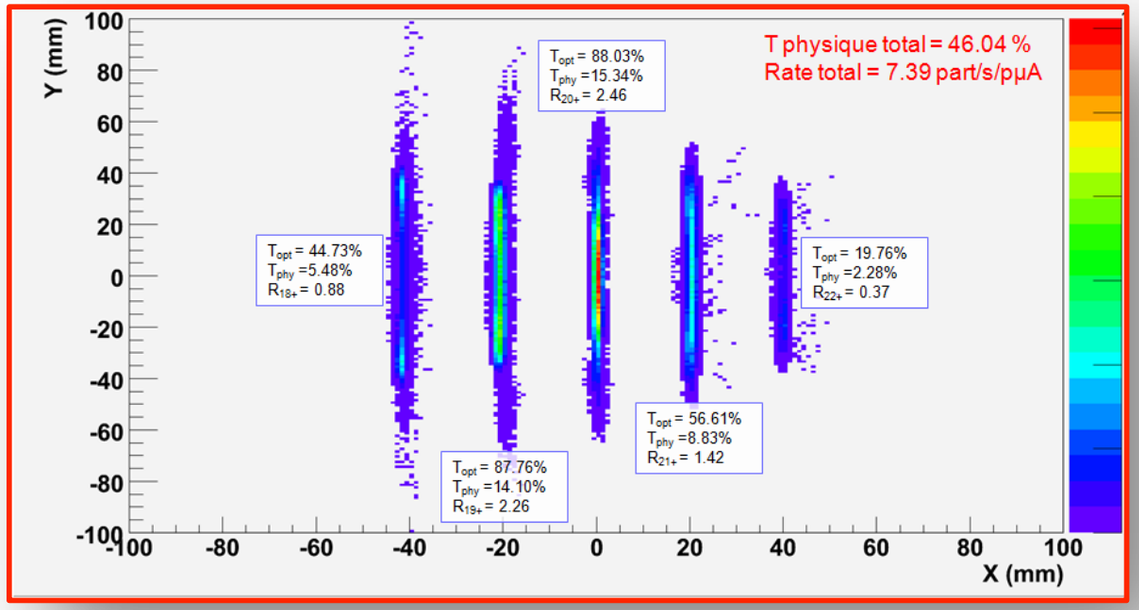
SYSTEM FOR THE INVESTIGATION OF RECOILING IONS USING S^3

J. PIOT ON BEHALF OF THE SIRIUS COLLABORATION

Vallée de la Seine
RÉGION NORMANDIE
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
PRÉFET DE LA RÉGION BASSE-NORMANDIE
INVESTISSEMENTS D'AVENIR
UNION EUROPÉENNE
Ce projet est cofinancé par le Fonds européen de développement régional

SIRIUS at S^3





Final Focal plane

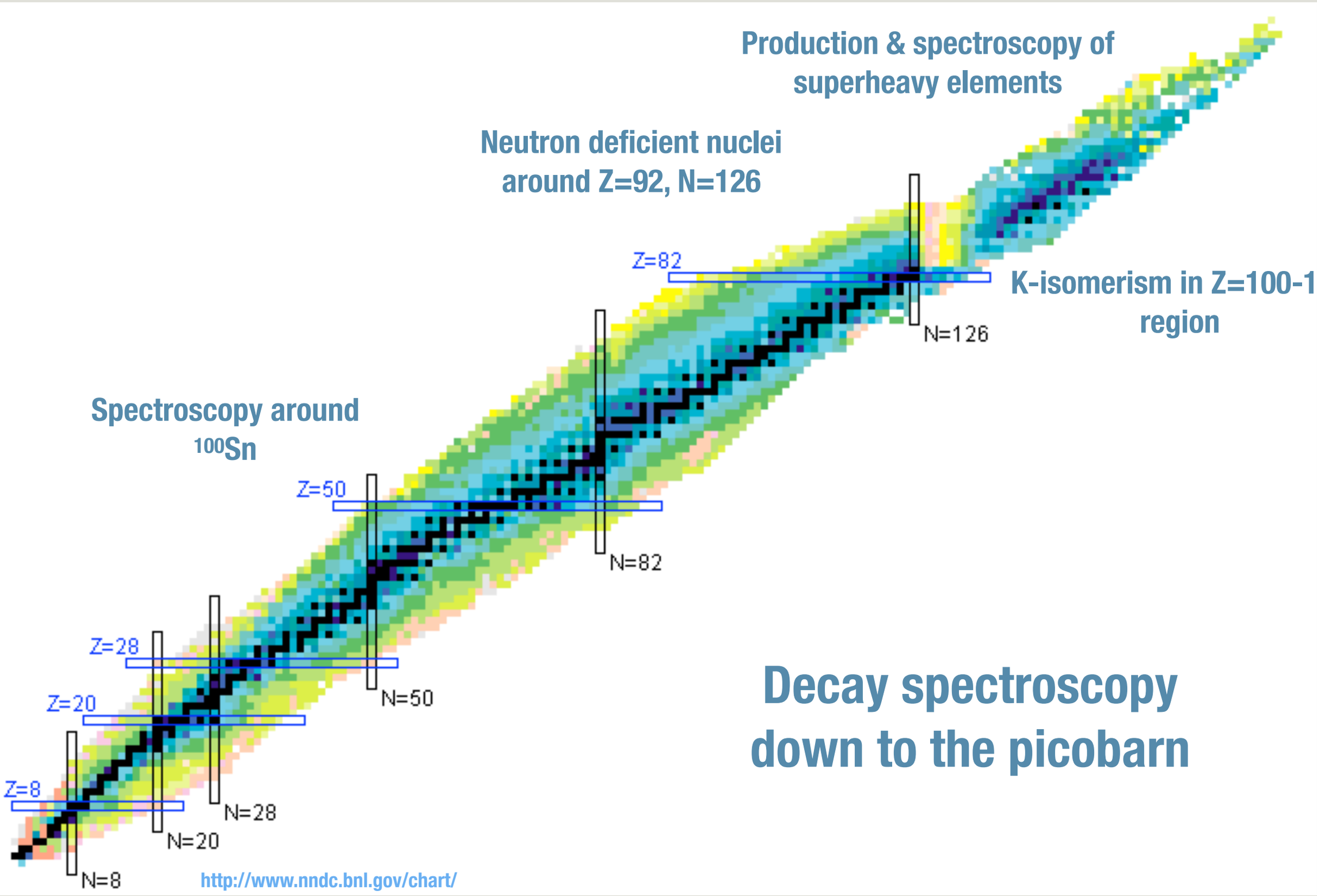
Recoil Decay Tagging

Separation & Mass Identification

Decay Identification

α, γ, ICE Spectroscopy

Physics with SIRIUS

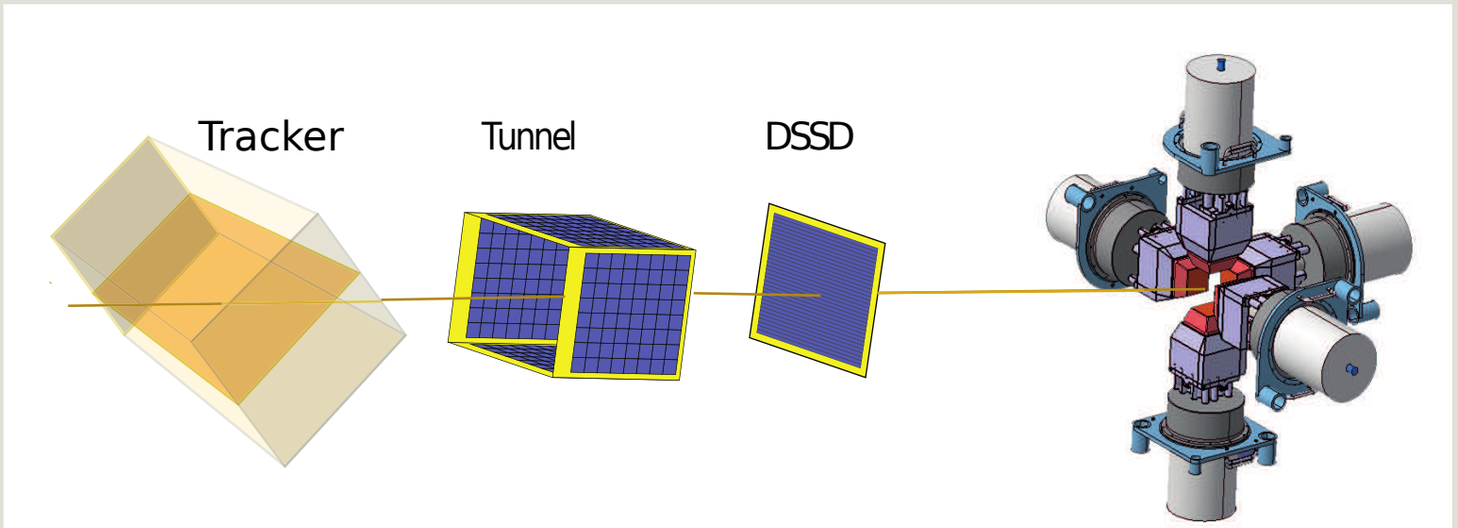


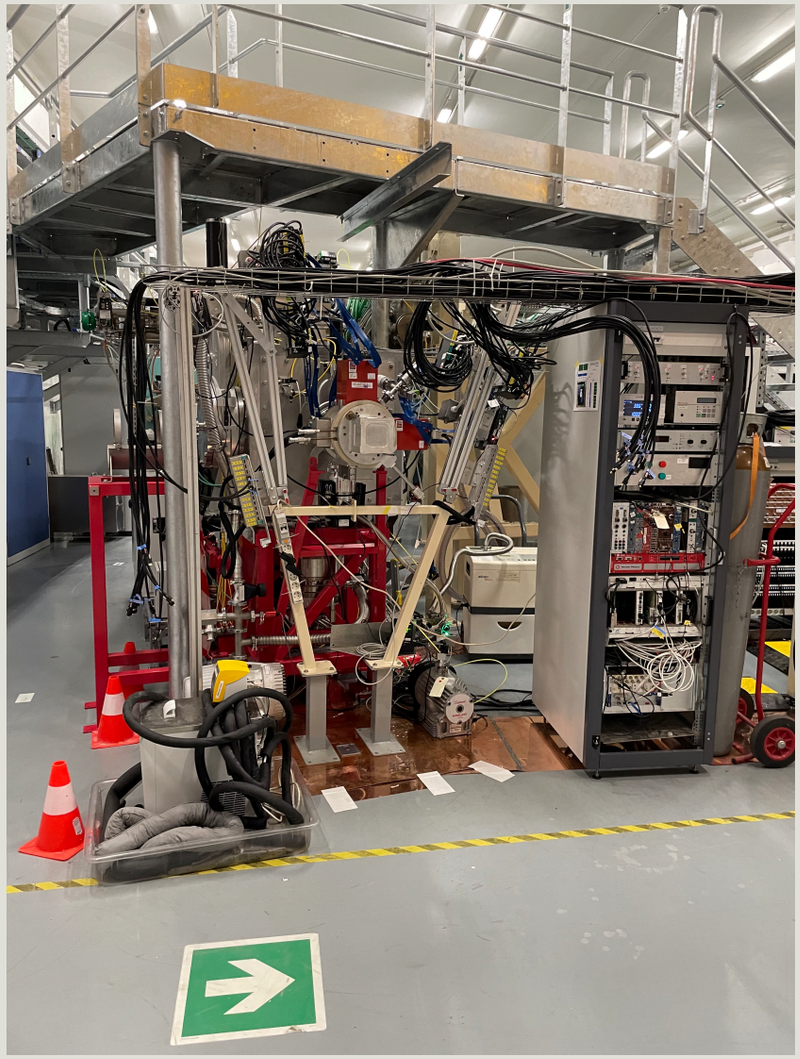
Decay spectroscopy down to the picobarn

System for the **I**nvestigation of **R**ecoiling **I**ons **U**sing **S**^{3}

Silicon Tunnel :
Large size
α/e- discrimination

Implantation detector :
Large size
High energy resolution
Adapted granularity





Time of Flight :
Emissive foils
Thin windows

γ-ray detection :
5 EXOGAM clover detectors

Front-end & back-end electronics :
Digital signal processing
Triggerless
Dual gain

Ion Tracker (GANIL)

Position measurement at the optical focal plane

Start Time of Flight measurement

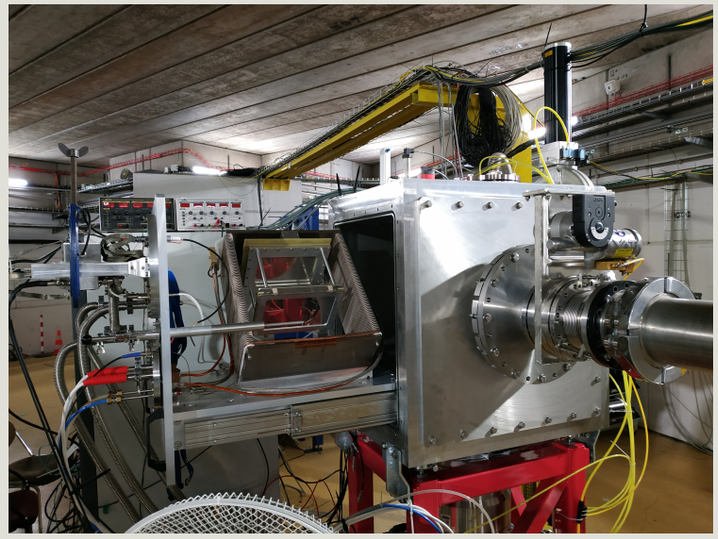
Secondary electron detector :

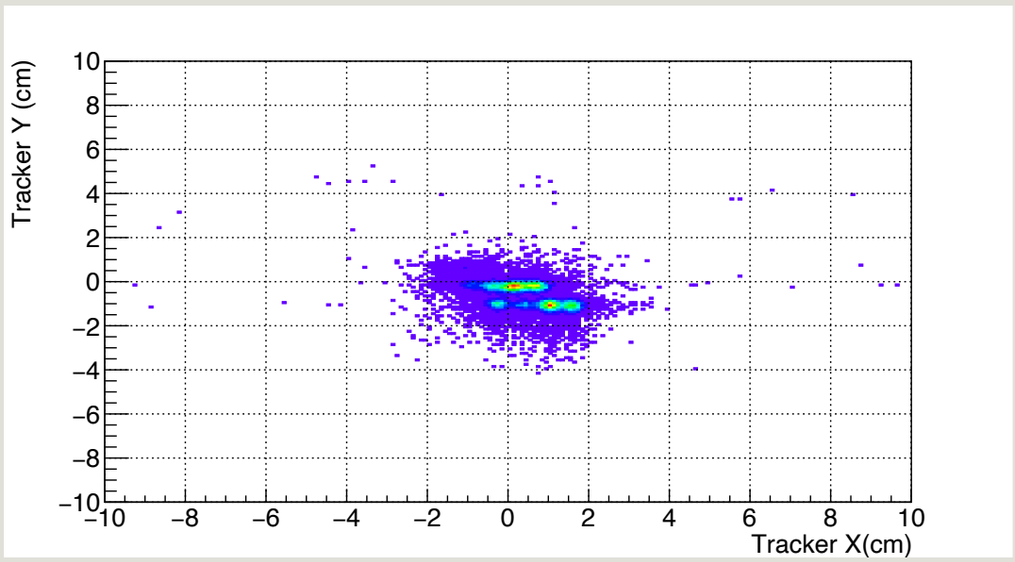
Active area (in beam) : 20x10 cm2

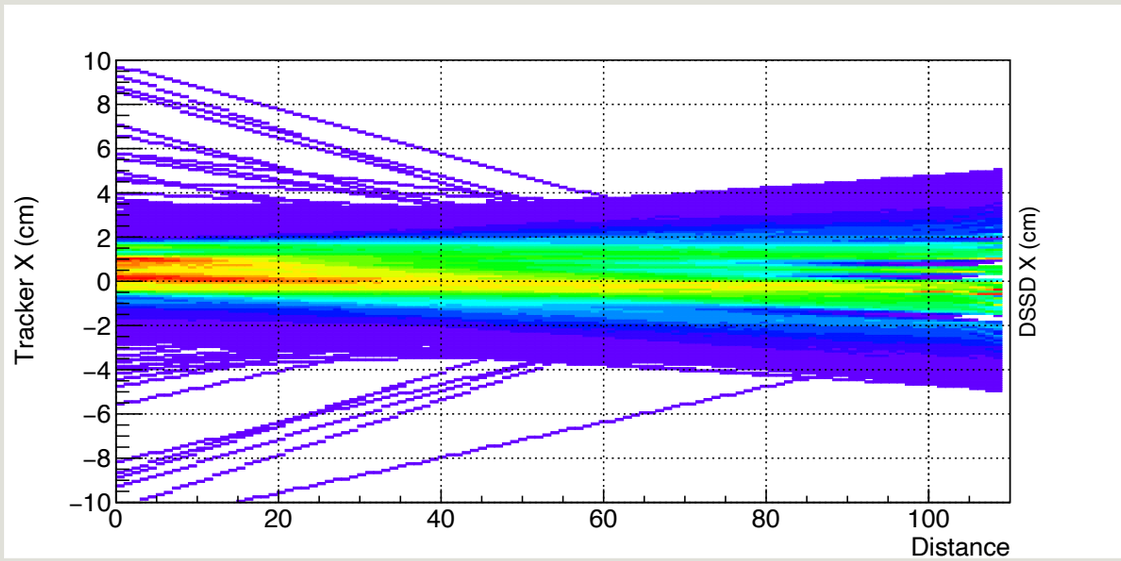
Mylar foil thickness : 0,9 µm

Gas pressure (CF4) : 6-7 mbar

Time resolution : 761+/- 148 ps FWHM





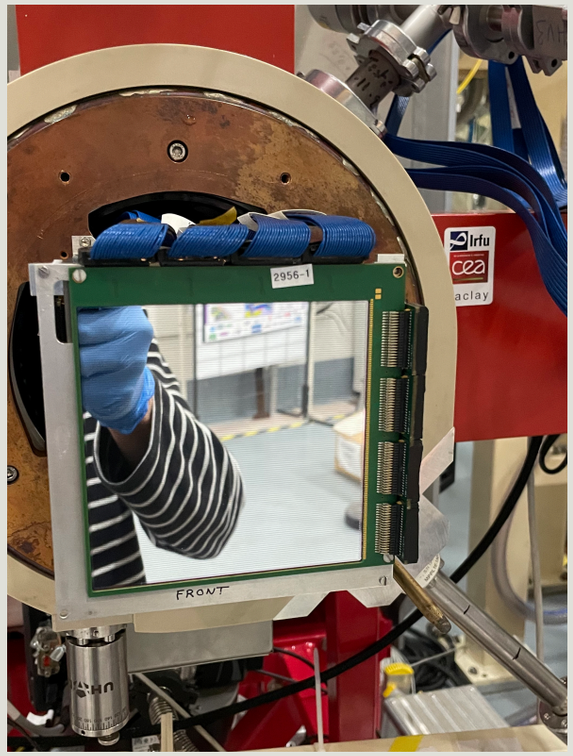


Time of Flight Resolution : 2,2 ns FWHM

Figures courtesy of R. Chakma

Silicon Box

DSSD + 4 Tunnel detectors



Maximum detection efficiency
for the escaping alpha particles &
conversion electrons
Best energy resolution at low energy

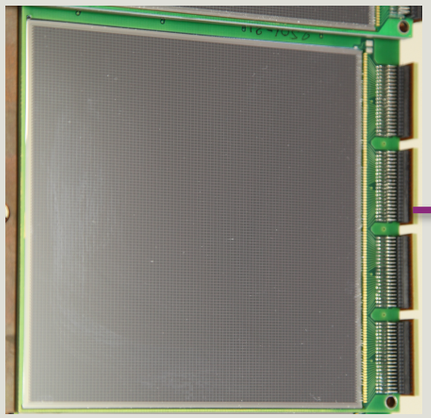
Ability to process decay chains:
Large pulse (>50 MeV) followed quickly (~10 µs)
by a weak pulse (<15 MeV)
No dead time to detect short lived decay chains

Windowless detectors (<50 nm)
Cooling through ceramic frames
Dual-gain electronics with fast reset

DSSD (IRFU)

DSSD

128 strips x side
128 strips y side

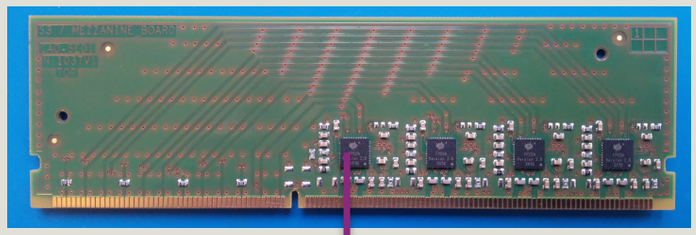


Mother board

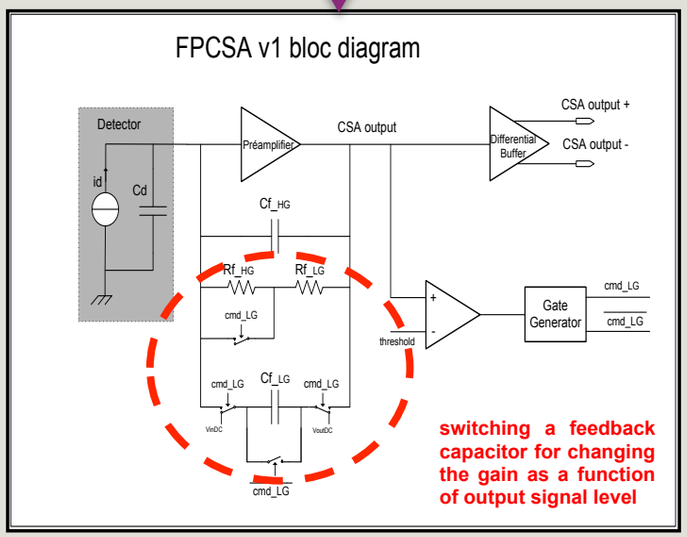
- Each motherboard control 32 channels
- 8 mother boards are needed to control DSSD

Daughter board

- Each daughter board carry 4 ASICs (2 strips)
- 8x8 cards are needed to control DSSD



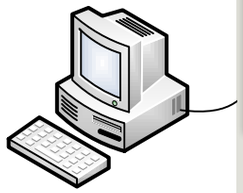
ASIC Principle of floating point



Adaptation board

FEE Specifications

Low gain resolution	65kev
High gain resolution	21keV
Linearity	<1.5%
Dead time	2,5µs
Power by detector	30W

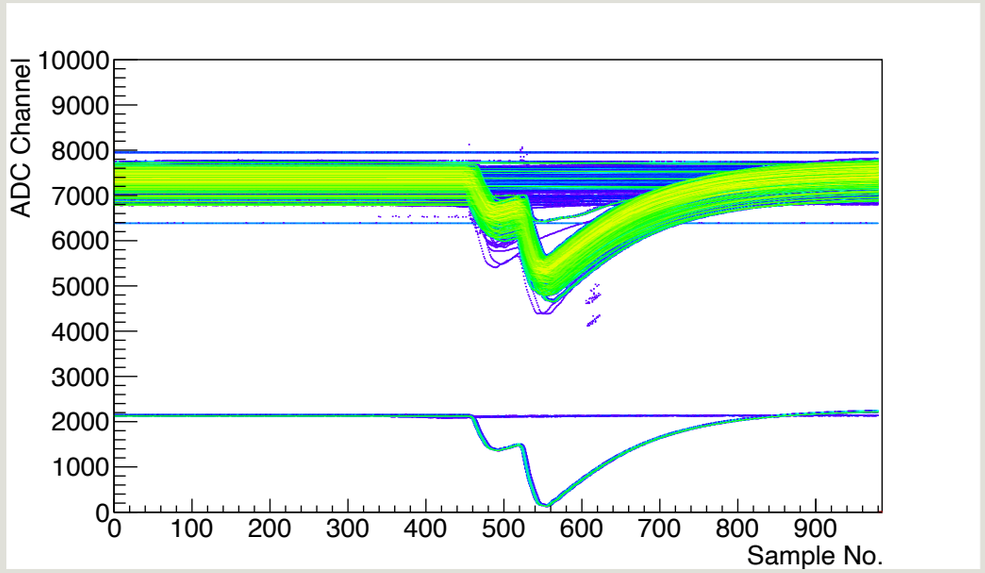


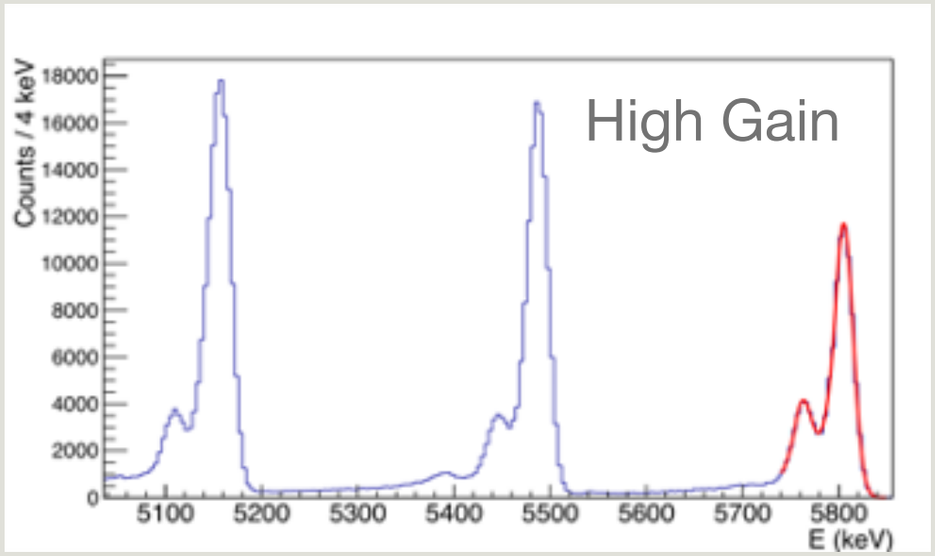
Software analysis

Numexo2 with 4 FADC-DAC

DSSD Tests (GANIL & IRFU)

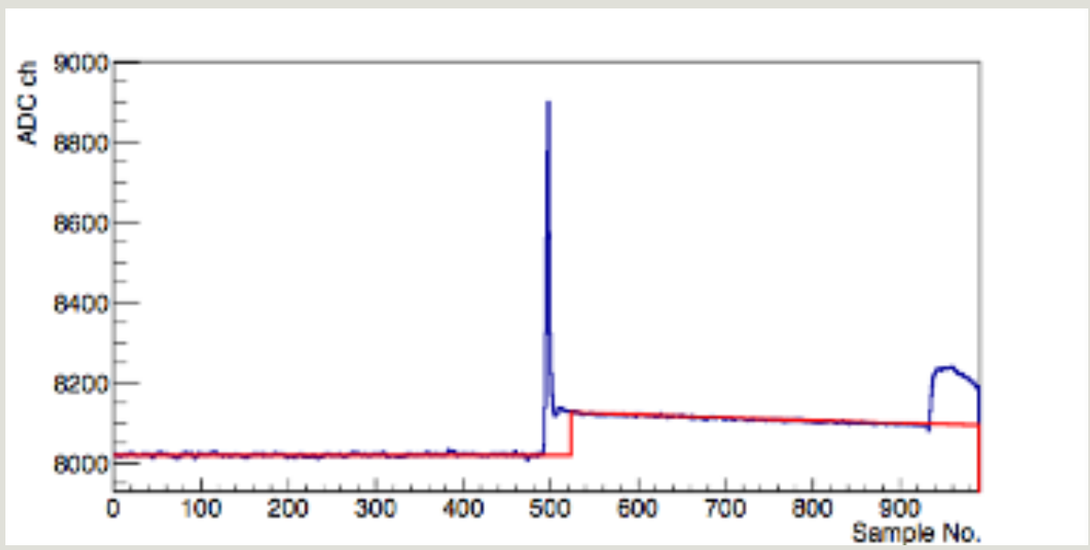
Preamplifier pulse digitized by NUMEXO Boards

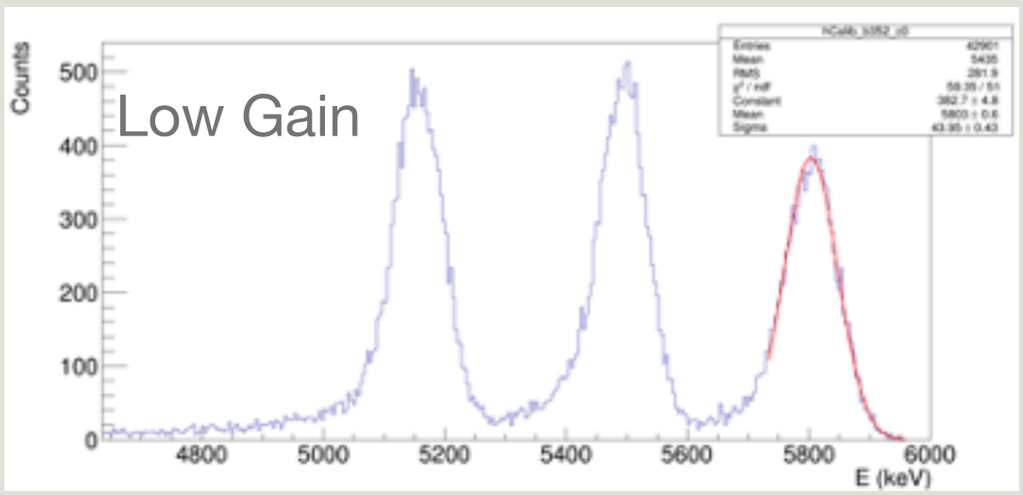




20.9 keV FWHM @ 5.8 MeV

Automatic gain switch :



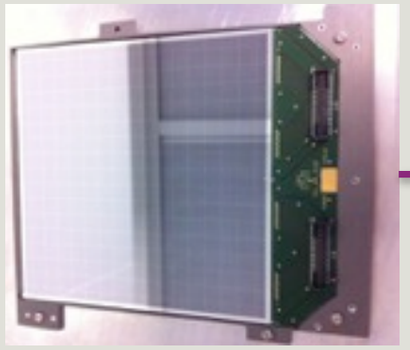


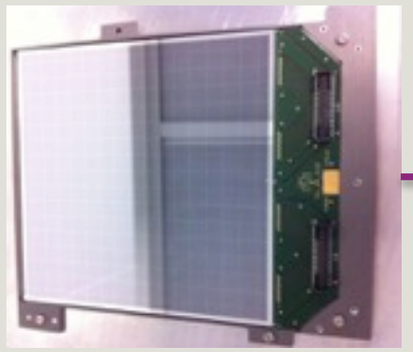
100 keV FWHM ~1%

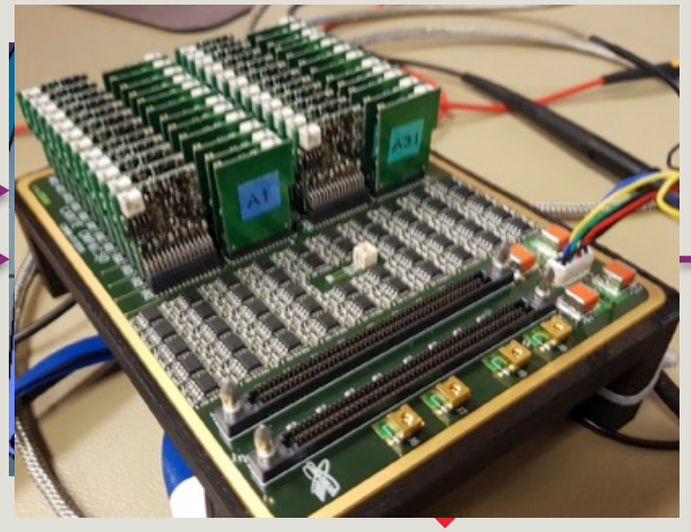
Figures courtesy of R. Chakma

Tunnel (IPHC & IJCLab)

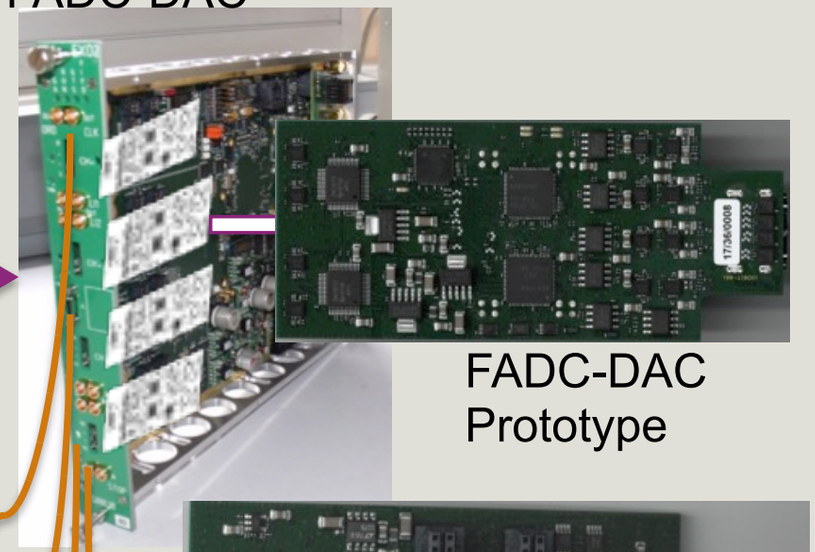
4 x 64 pixel
Si Pad Detector



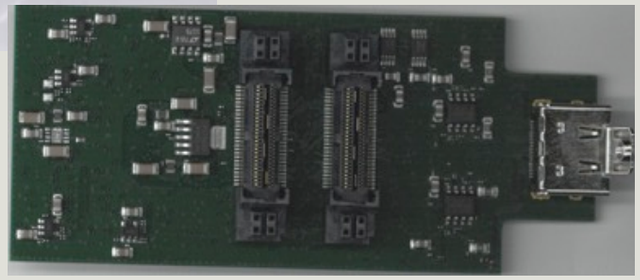




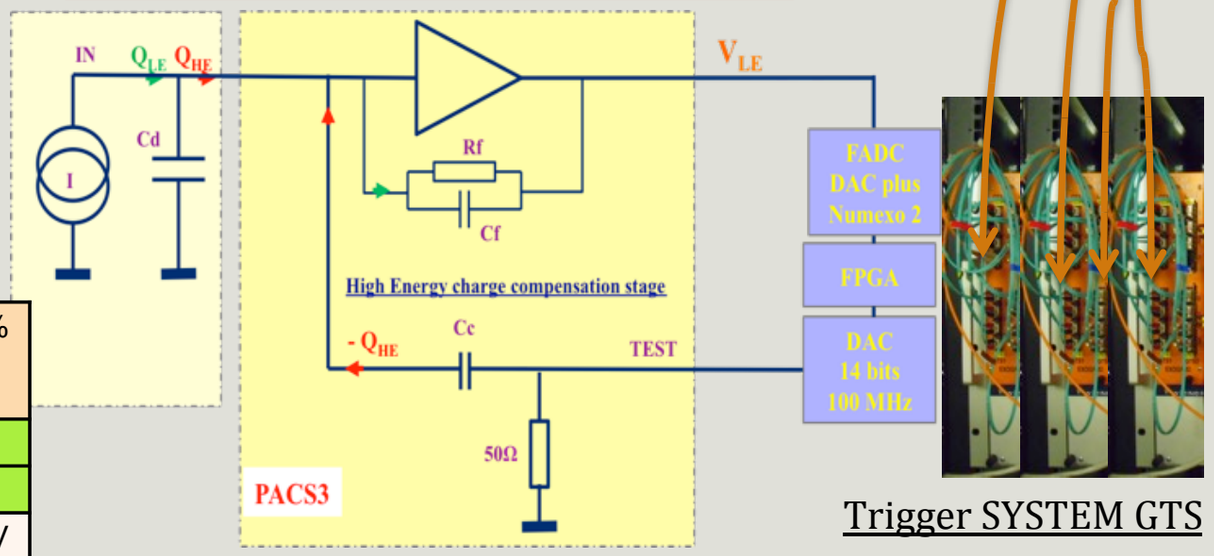
Numexo2 board with 4
FADC-DAC



FADC-DAC
Prototype



Principle of FEE Digital Feedback CSP



Trigger SYSTEM GTS

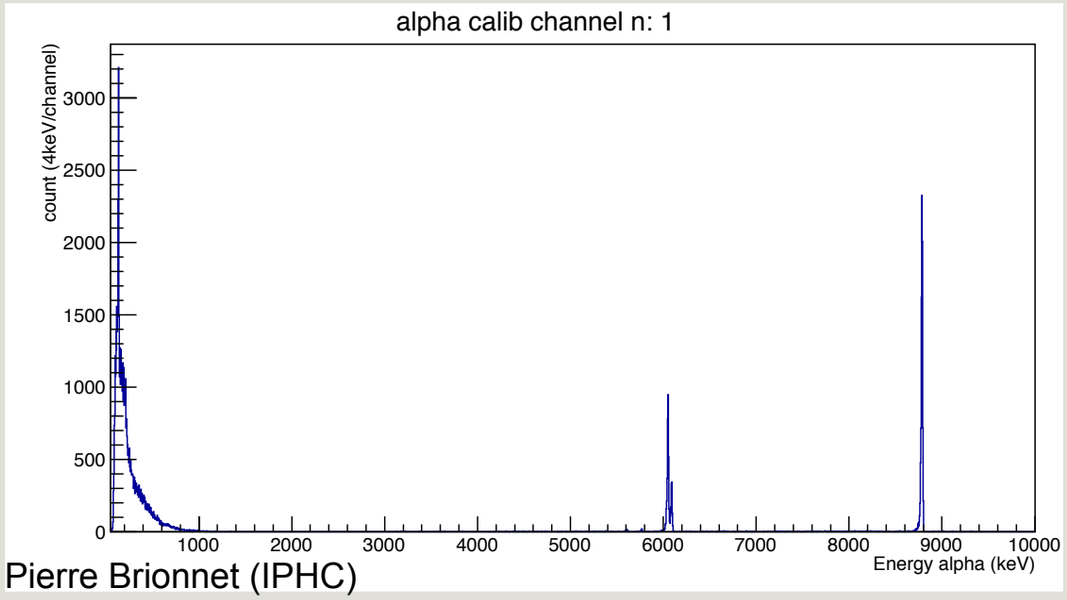
FEE Specifications

High Energy resolution using DFCSP From 20 to 150 MeV	< 0,03 %
Linearity on overall range	< 1.5%
Dead time	< 5 µs
High gain resolution @ 8 MeV	13,5 keV
Linearity	< 0,8 %
Dead time using MWD	< 8 µs

Courtesy of N. Karkour

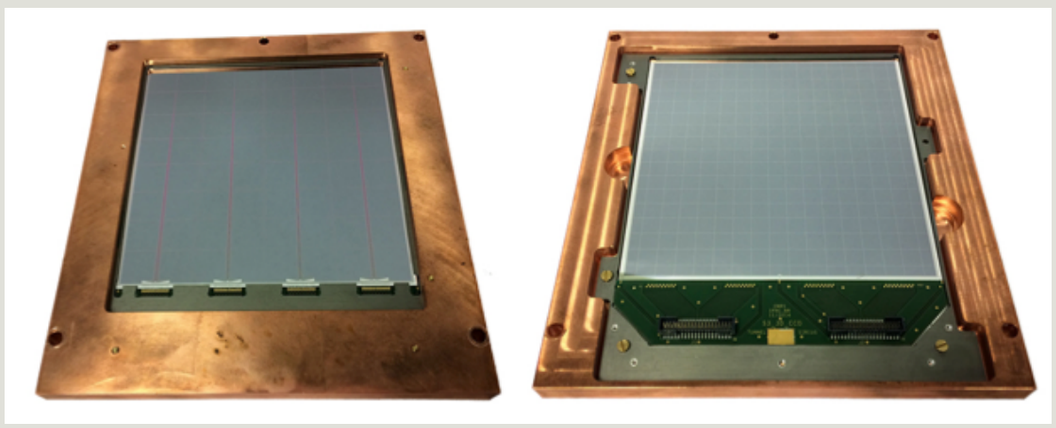
Tunnel tests (IPHC)

Pad Energy resolution (TNT2 + CREMAT PAC) : 13.6 to 17.8 keV

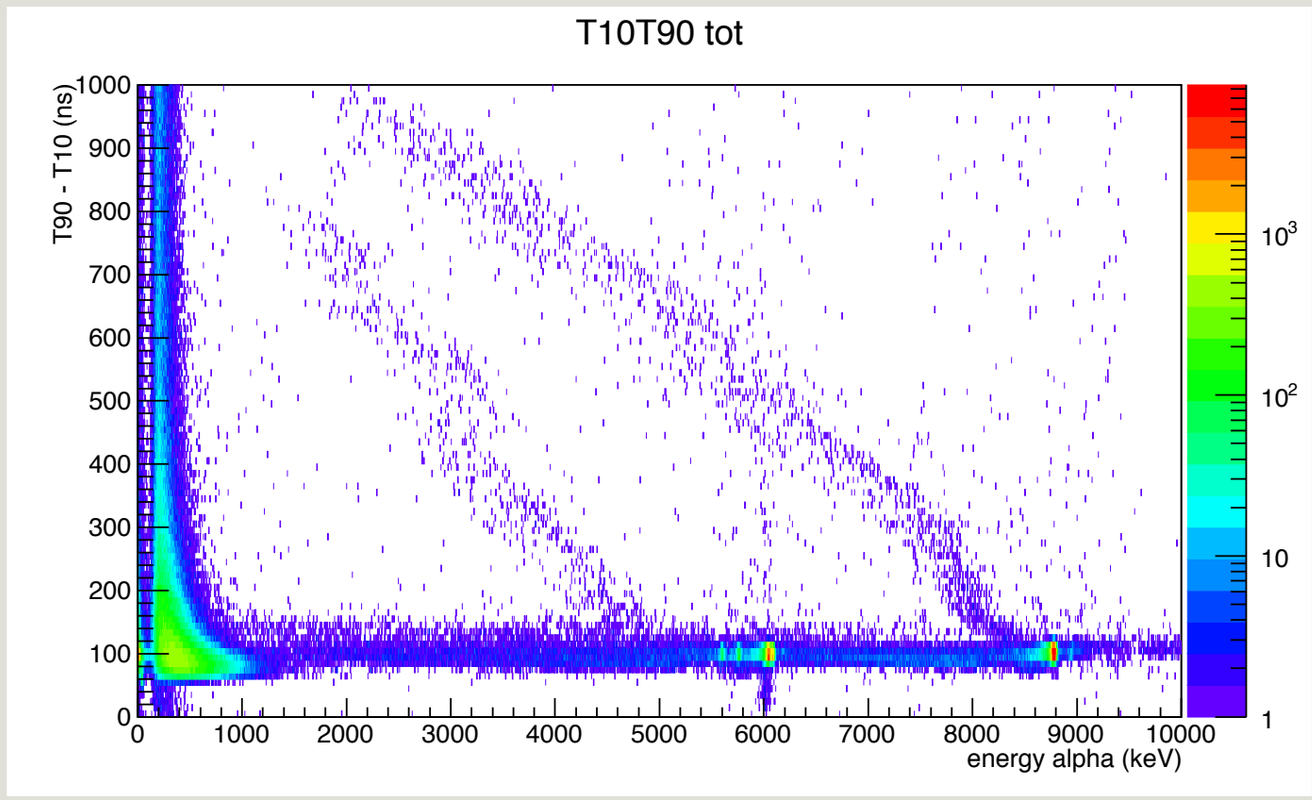


Pierre Brionnet (IPHC)

14.8 keV FWHM @ 6MeV



PSA Discrimination degraded α / β



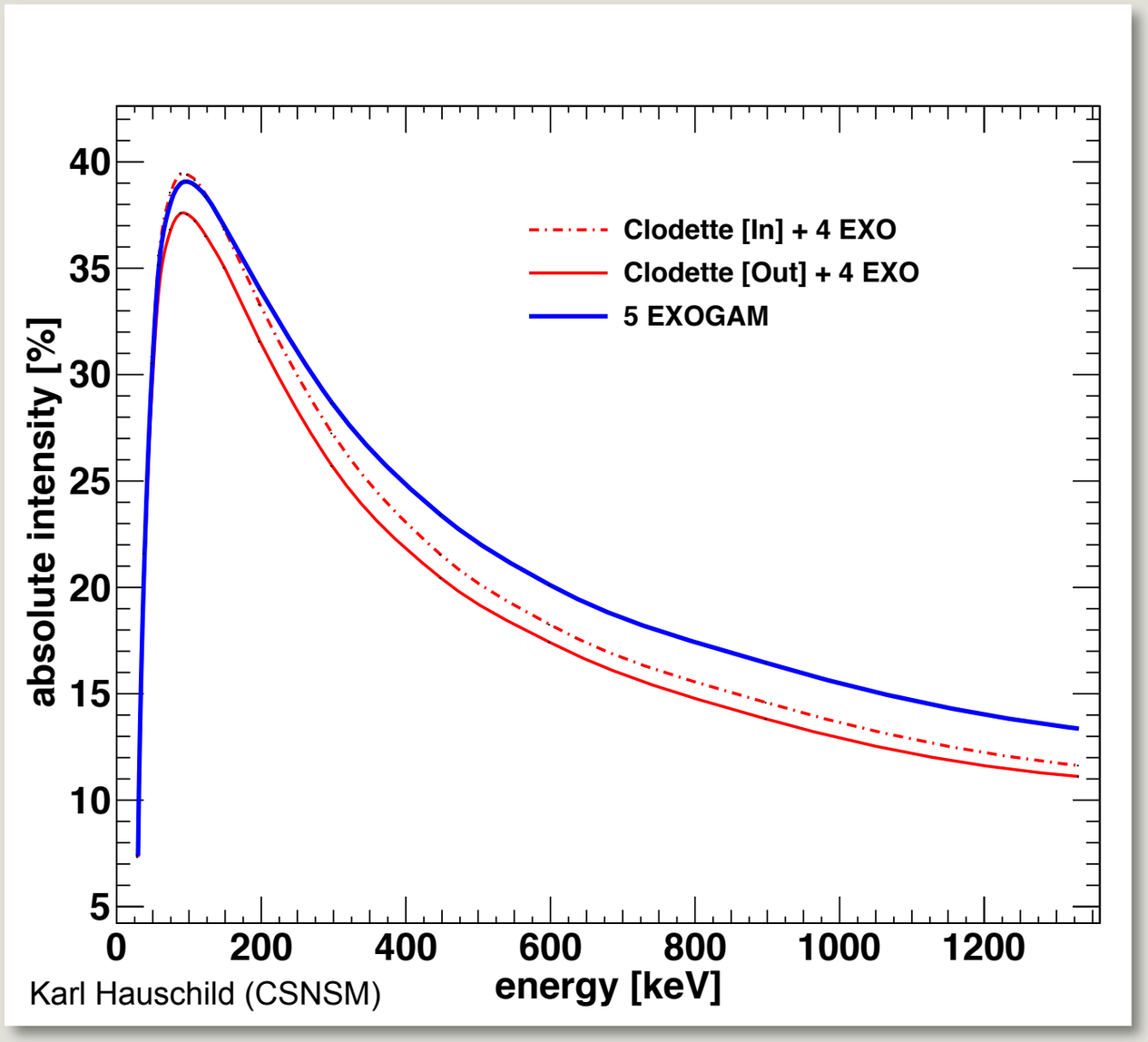
Pierre Brionnet (IPHC)

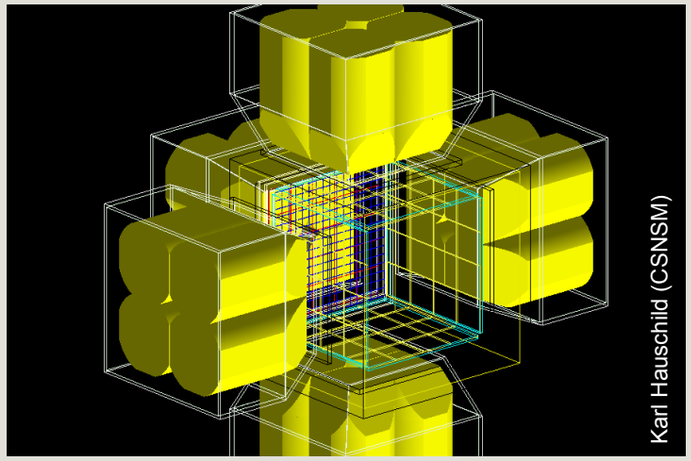
Gamma-spectroscopy (IJCLab)

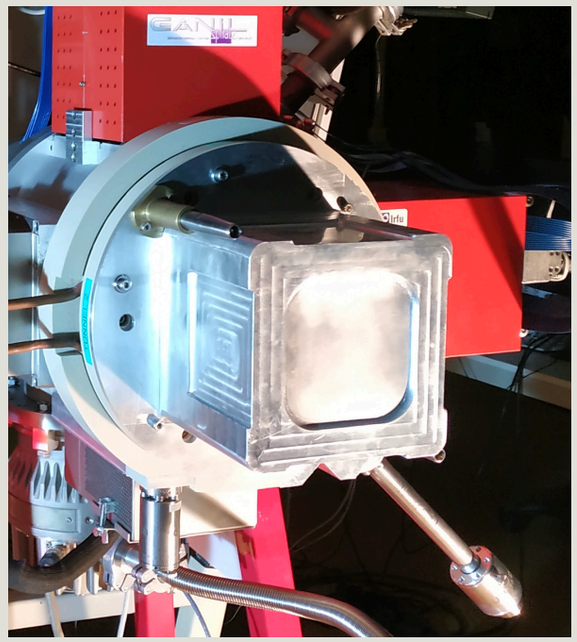
Optimized Gamma efficiency for low energy transitions :

Compact geometry

Thin capsule for the Silicon detectors







The SIRIUS Collaboration

- GANIL : D. Ackermann, M. Blaizot, A. Boujrad, R. Chakma, E. Clément, S. Coudert, J. Goupil, S. Herlant, G. Lebertre, L. Legeard, C. Maugeais, J. Piot, F. Saillant, G. Wittwer
- IJCLab : V. Alaphilipe, L. Gibelin, K. Hauschild, N. Karkour, X. Lafay, F. Leblanc, D. Linget, A. Lopez-Martens & 10 interns from MIT UL ESME universities.
- IPHC : P. Brionnet, F. Dechéry, O. Dorvaux, H. Faure, M. Forge, B. Gall, Th. Goeltzenlichter, K. Kessaci, C. Mathieu
- IRFU : M. Authier, J, Bequet, Th. Chaminade, A. Drouart, J. Kallunkathariyil, B. Sulignano, Ch. Theisen, D. Thisse, G. Tocabens, M. Vandebrouck

Conclusion

- SIRIUS is a decay station designed for rare events with charged particles and gamma-ray detection.
- Dual gain preamplifiers and digital electronics for silicon detectors without deadtime.
- High gamma-ray efficiency.
- High transmission and rejection from S^3.