Colloque GANIL

2017 - Amboise, France

laboratoire commun CEA/DSM — SPIRAL2 — CNRS/IN2P3

SYSTEM FOR THE INVESTIGATION OF RECOILING IONS USING S^3

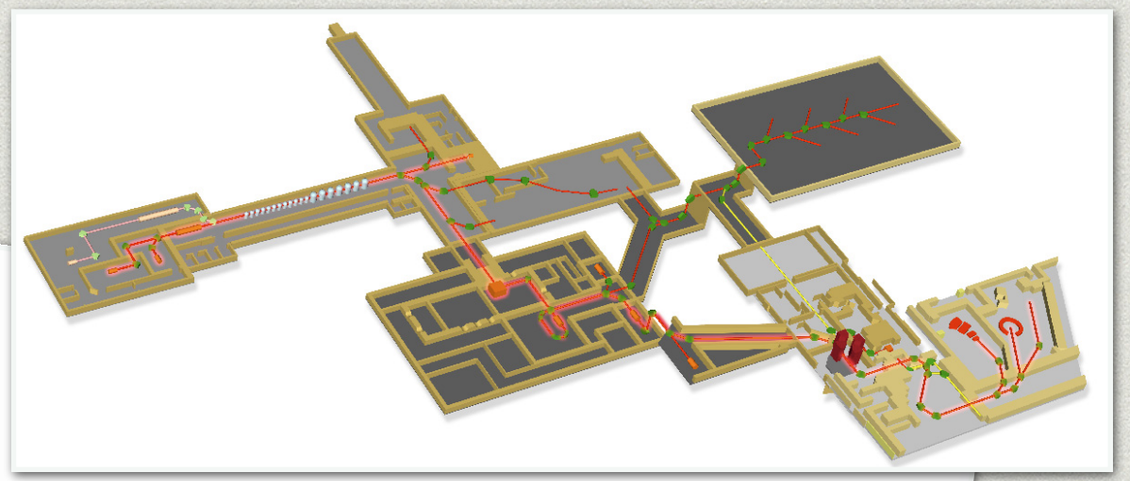
J. PIOT FOR THE SIRIUS COLLABORATION

INVESTISSEMENTS D'AVENIR

cea

cnrs dépasser les frontières — IN2P3 Les deux infinis

S^3 : Super Spectrometer Separator



Use the very intense beams From the SPIRAL2 injector

Separation

1. **in momentum**
2. **in mass**

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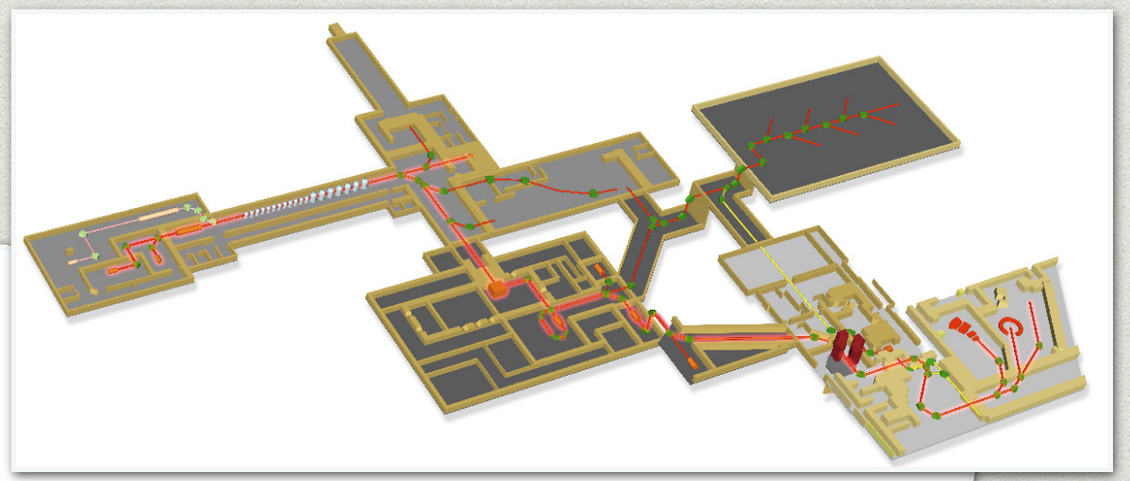

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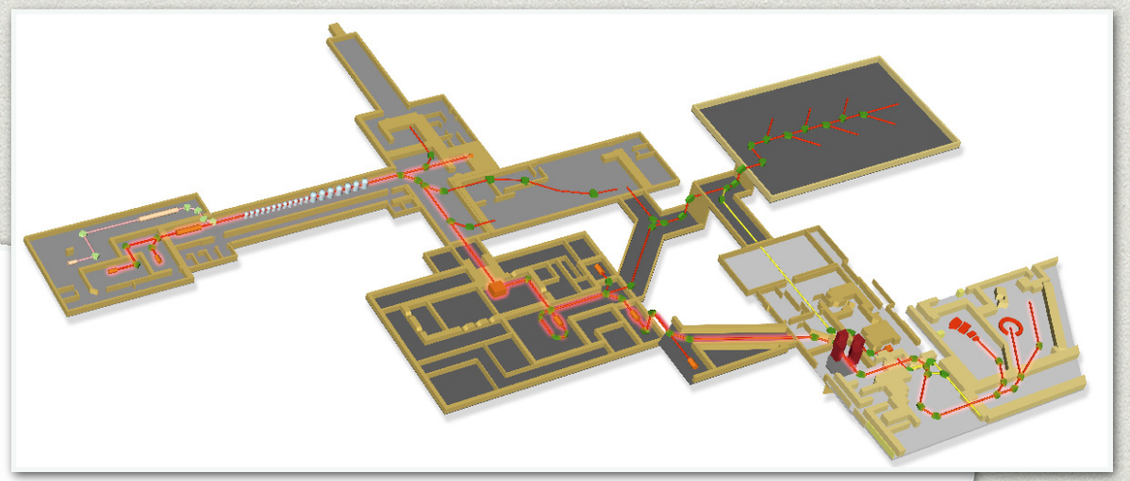
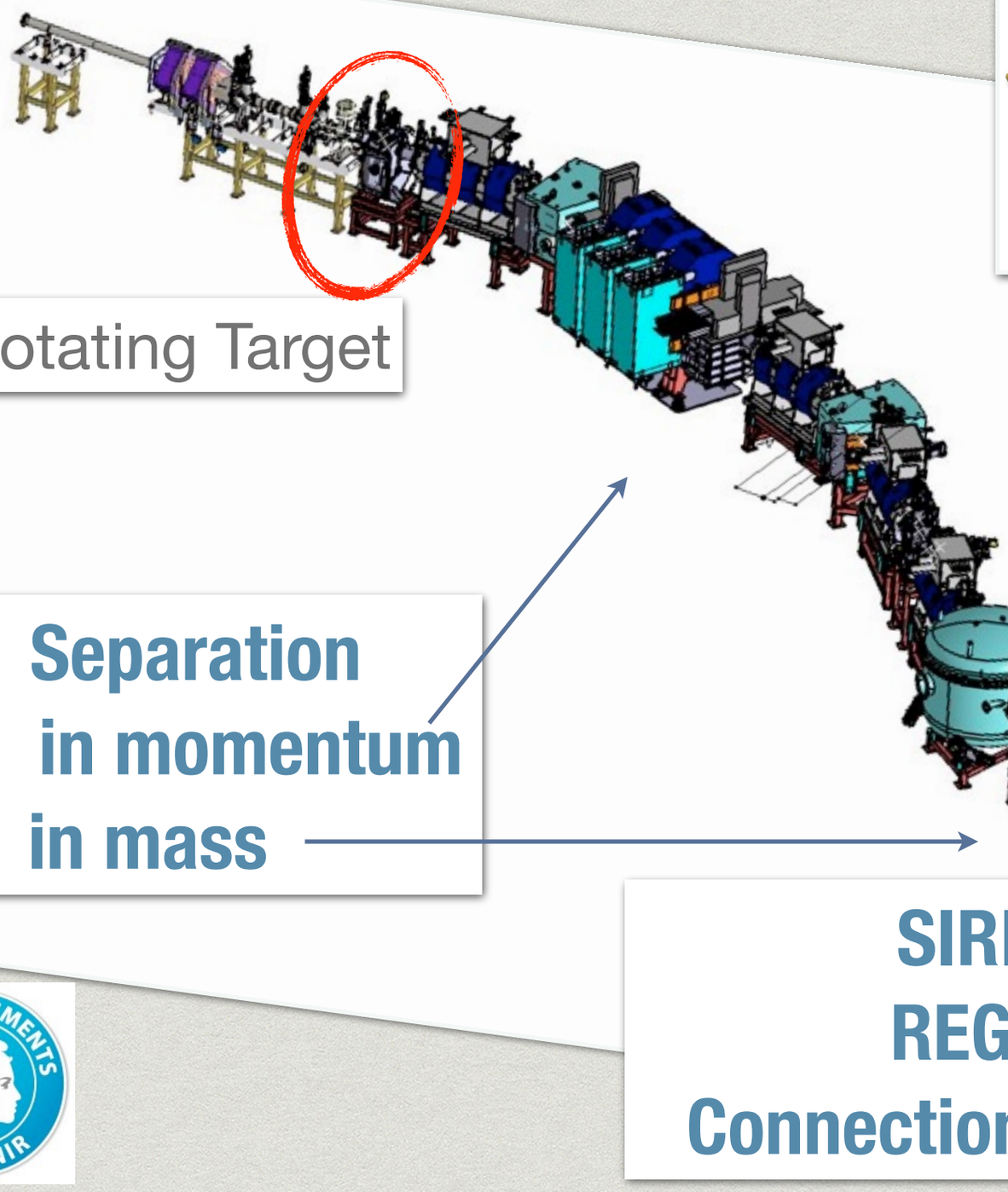


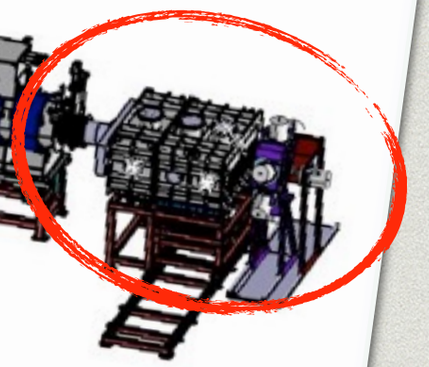
Rotating Target



Use the very intense beams From the SPIRAL2 injector

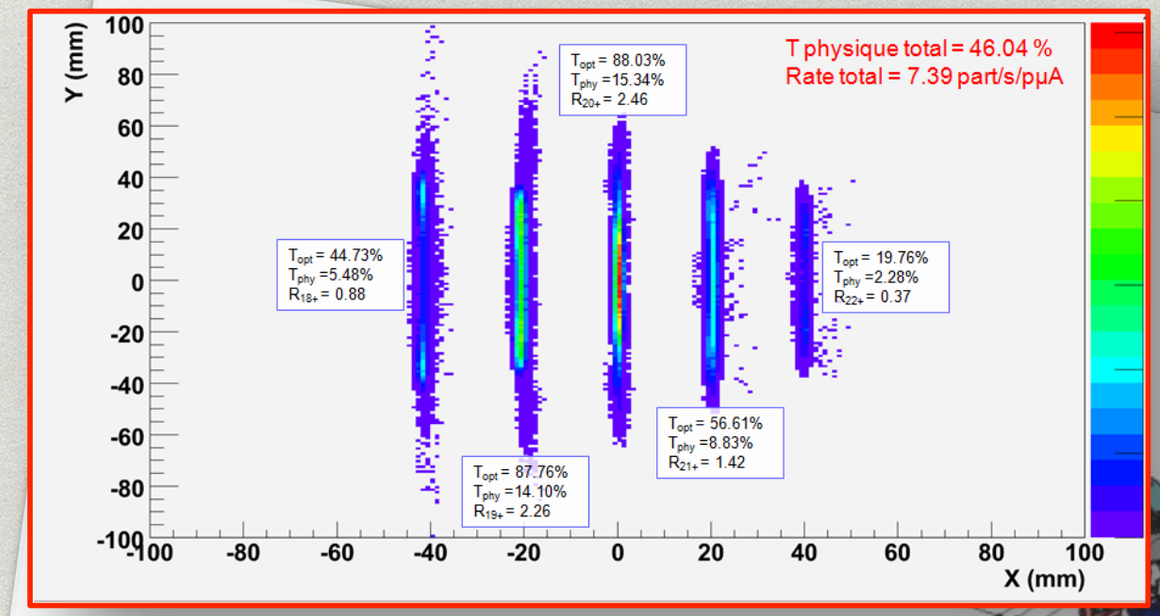
Separation
1. **in momentum**
2. **in mass**

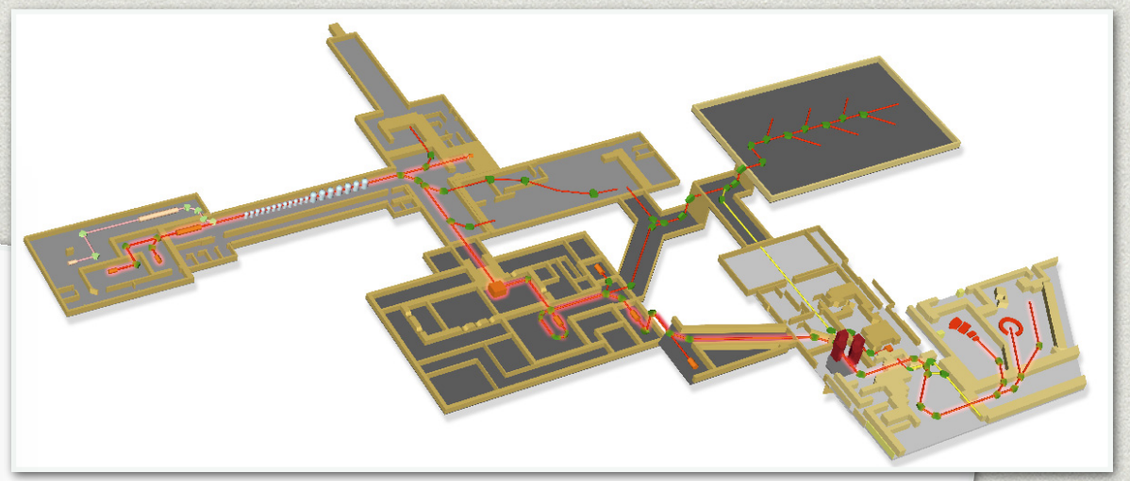
Final Focal plane



SIRIUS
REGLIS
Connection to DESIR

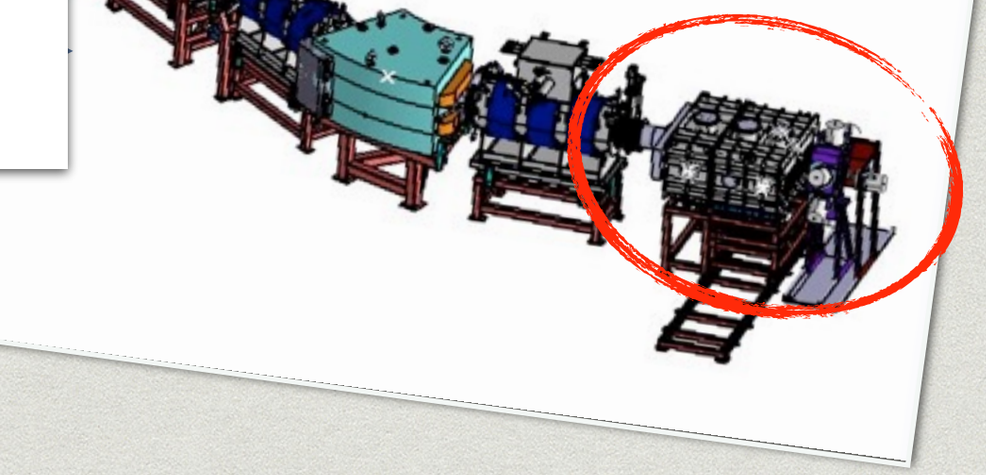
S^3 : Super Spectrometer Separator





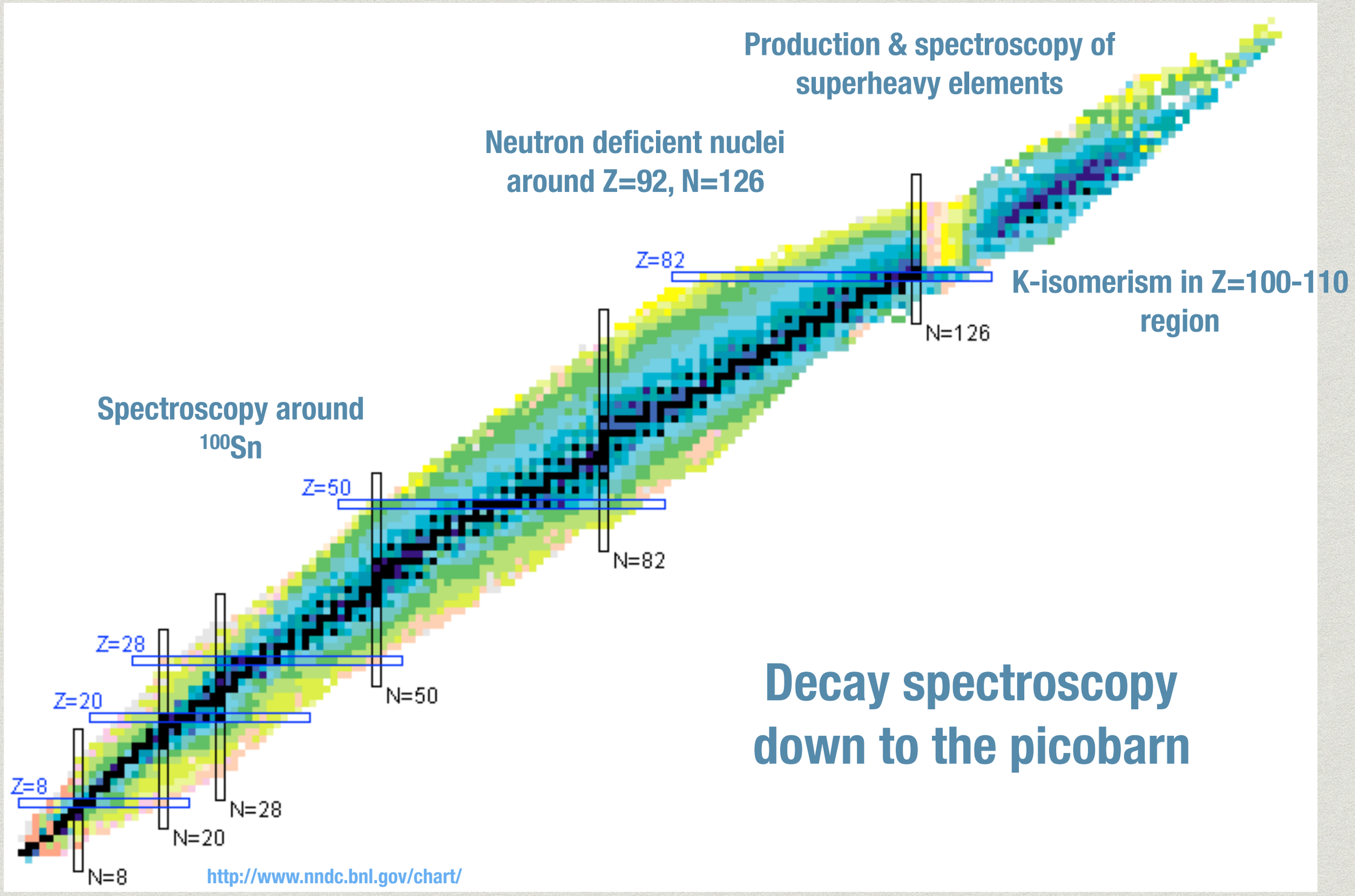
Use the very intense beams
From the SPIRAL2 injector

Final Focal plane



Recoil Decay Tagging
Separation & Mass Identification
Decay Identification
α, γ, ICE Spectroscopy

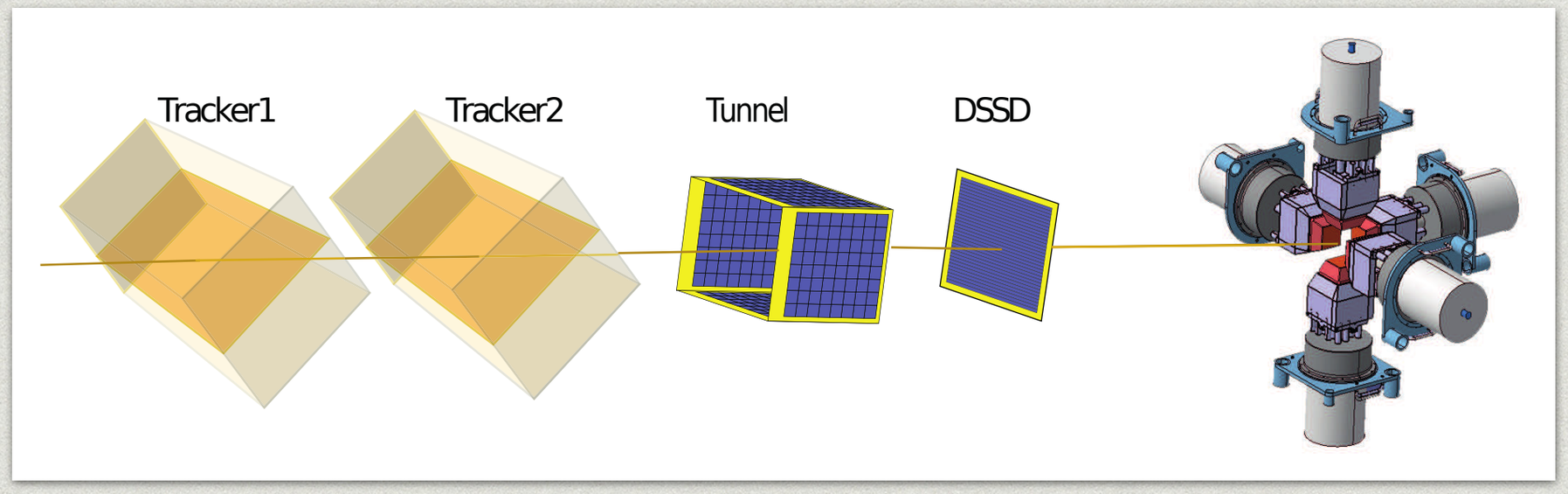
Physics with SIRIUS



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

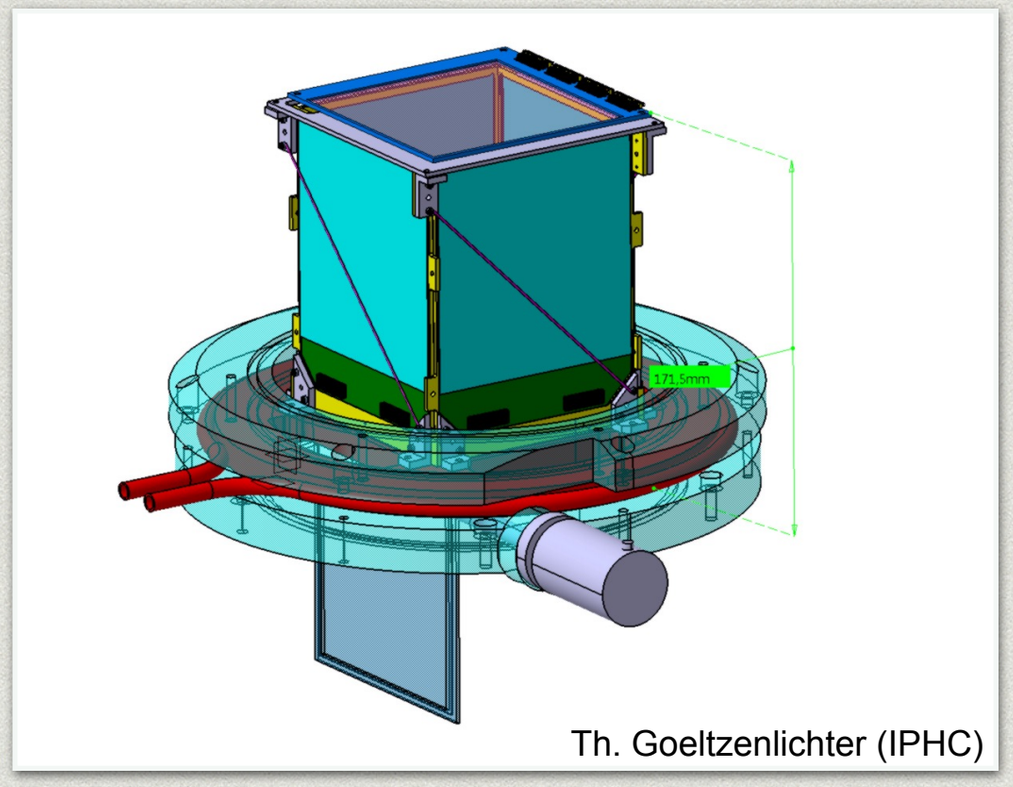


γ-ray detection :
5 EXOGAM clover detectors

Time of Flight :
Emissive foils
Thin windows
High Time resolution

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

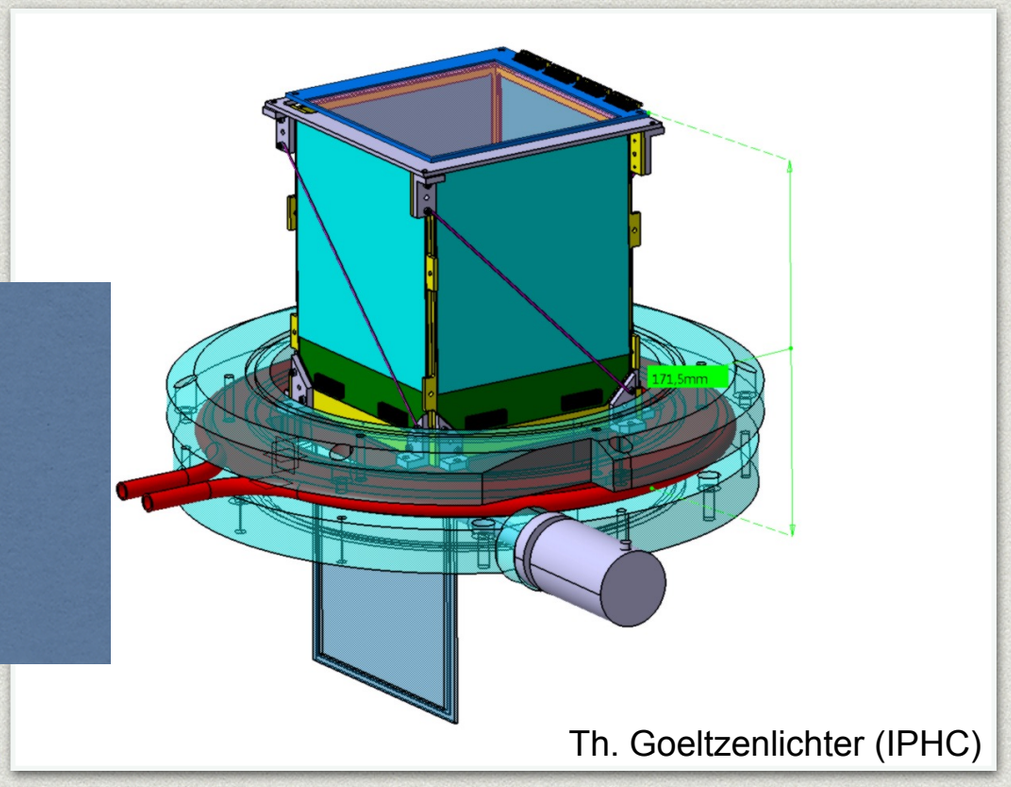
Silicon Box



Th. Goeltzenlichter (IPHC)

Silicon Box

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



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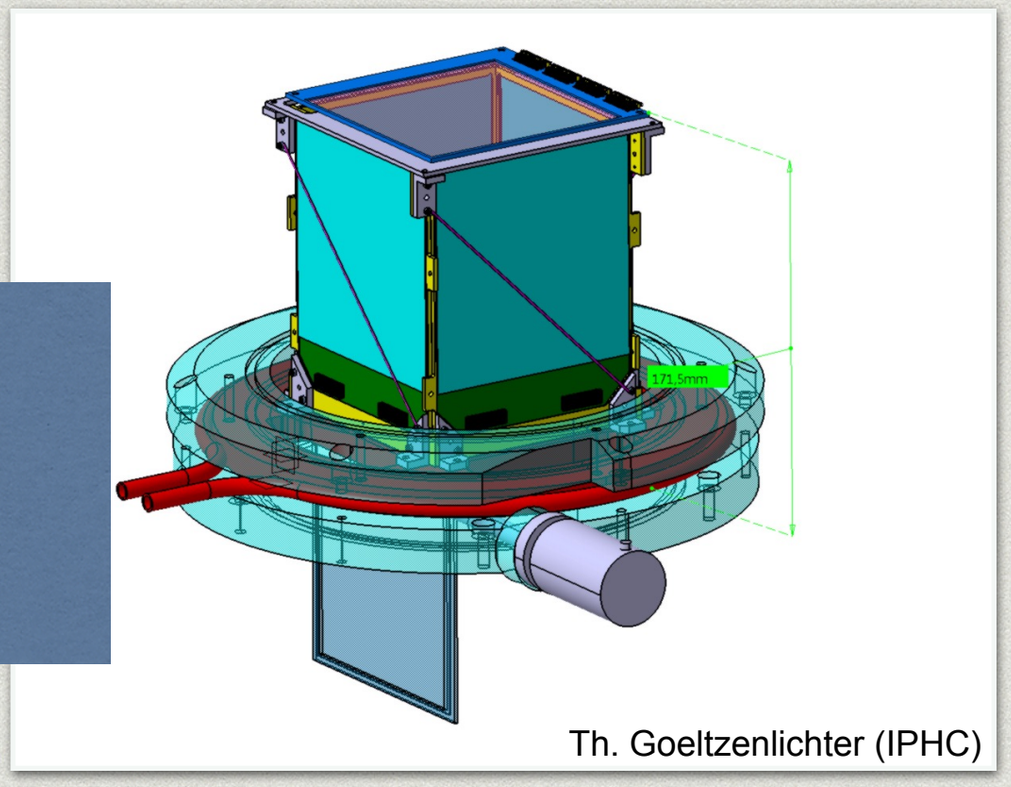

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Ability to process decay chains:
Large pulse (>50 MeV) followed quickly (~10 µs)
by a weak pulse (<15 MeV)
No dead time to detect short lived decay chains

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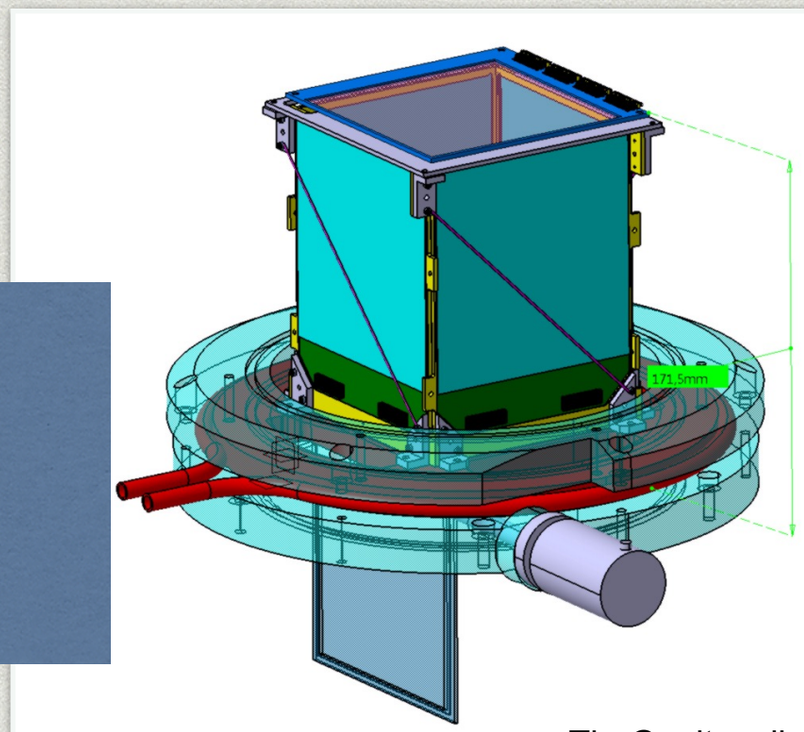

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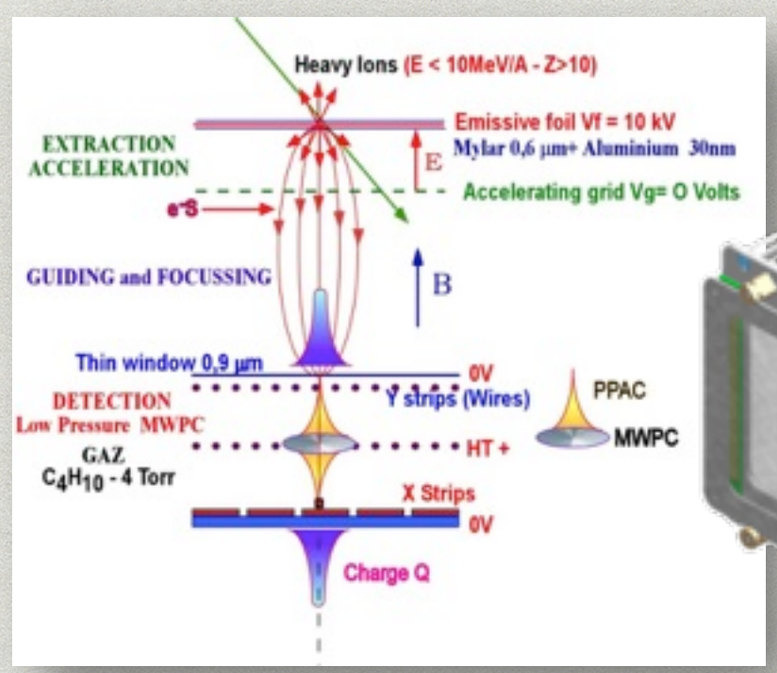
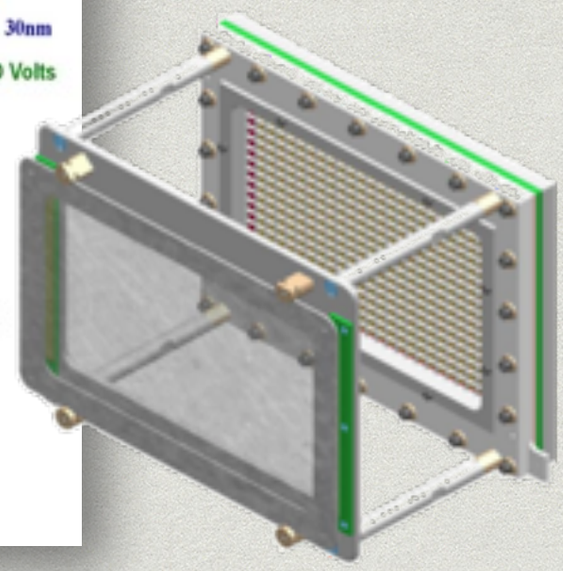
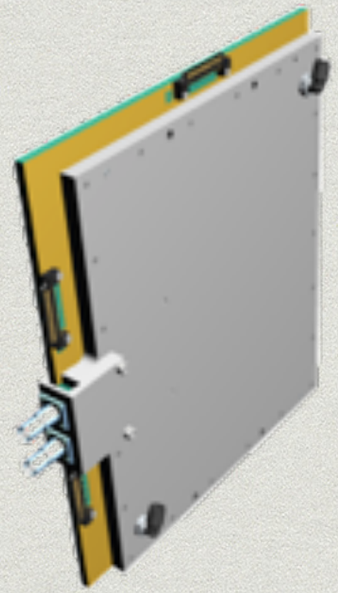
No dead time to detect short lived decay chains

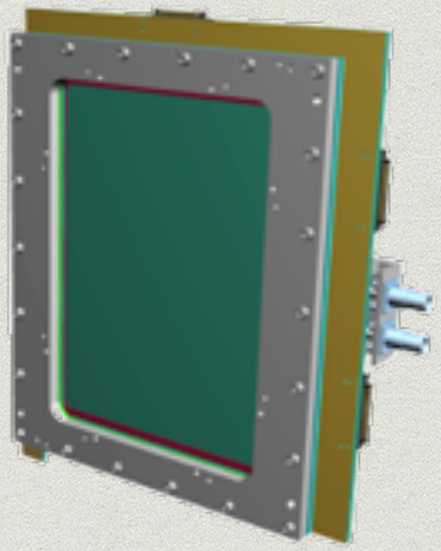
Windowless detectors (<50 nm)
Cooling through ceramic frames
Dual-gain electronics with fast reset

Tracker (GANIL)



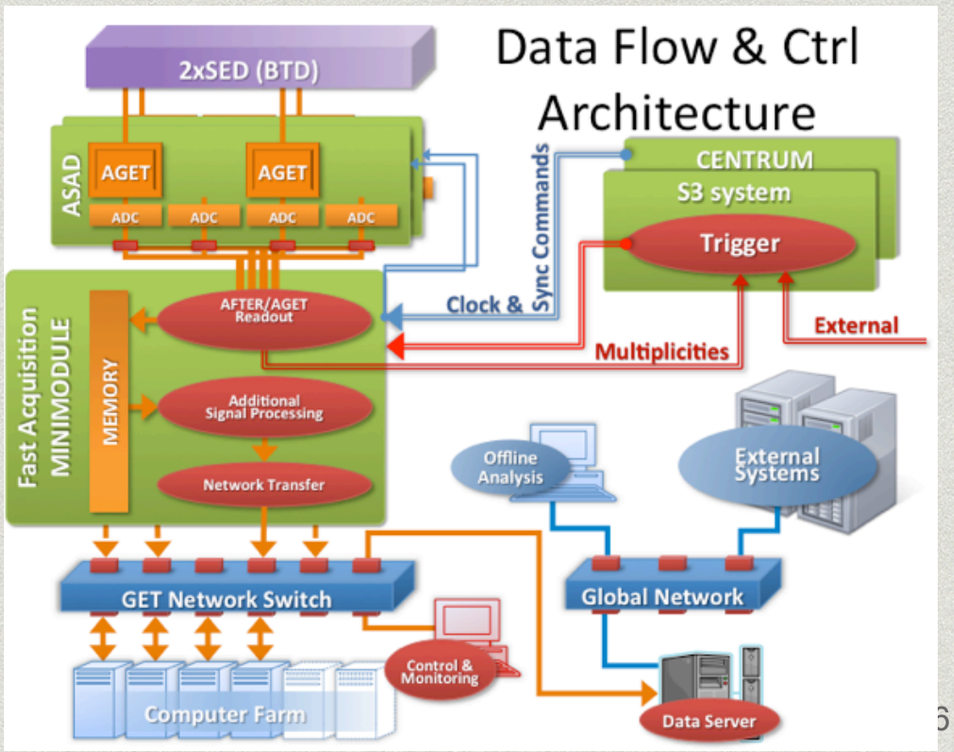






Real size prototype:

- Dimension ≃ 260 x 210 mm²
- Active surface ≃ 200 x 140 mm²
- Strongback with 92.5 % transmission for gap thickness homogeneity
- 67+47 cathode strips with 3 mm pitch
- Time resolution = 150 ps
- Spatial resolution = 1.5 mm FWHM

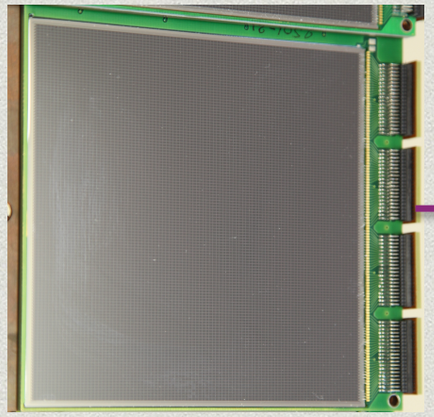


Courtesy of J. Pancin

DSSD (IRFU)

DSSD

128 strips x side
128 strips y side

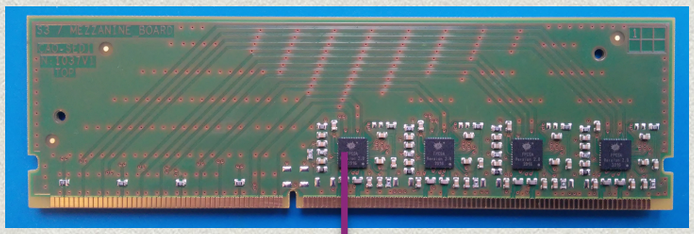


Mother board

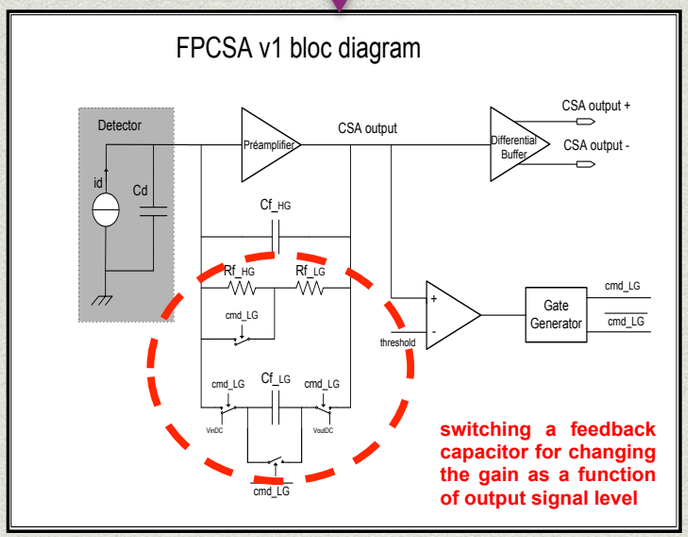
- Each motherboard control 32 channels
- 8 mother boards are needed to control DSSD

Daughter board

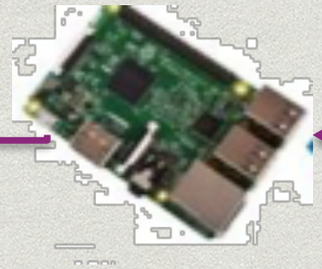
- Each daughter board carry 4 ASICs (2 strips)
- 8x8 cards are needed to control DSSD



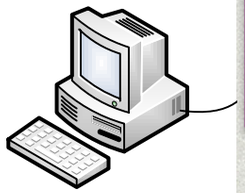
ASIC Principle of floating point



Adaptation board



Numexo2 with
4 FADC-DAC



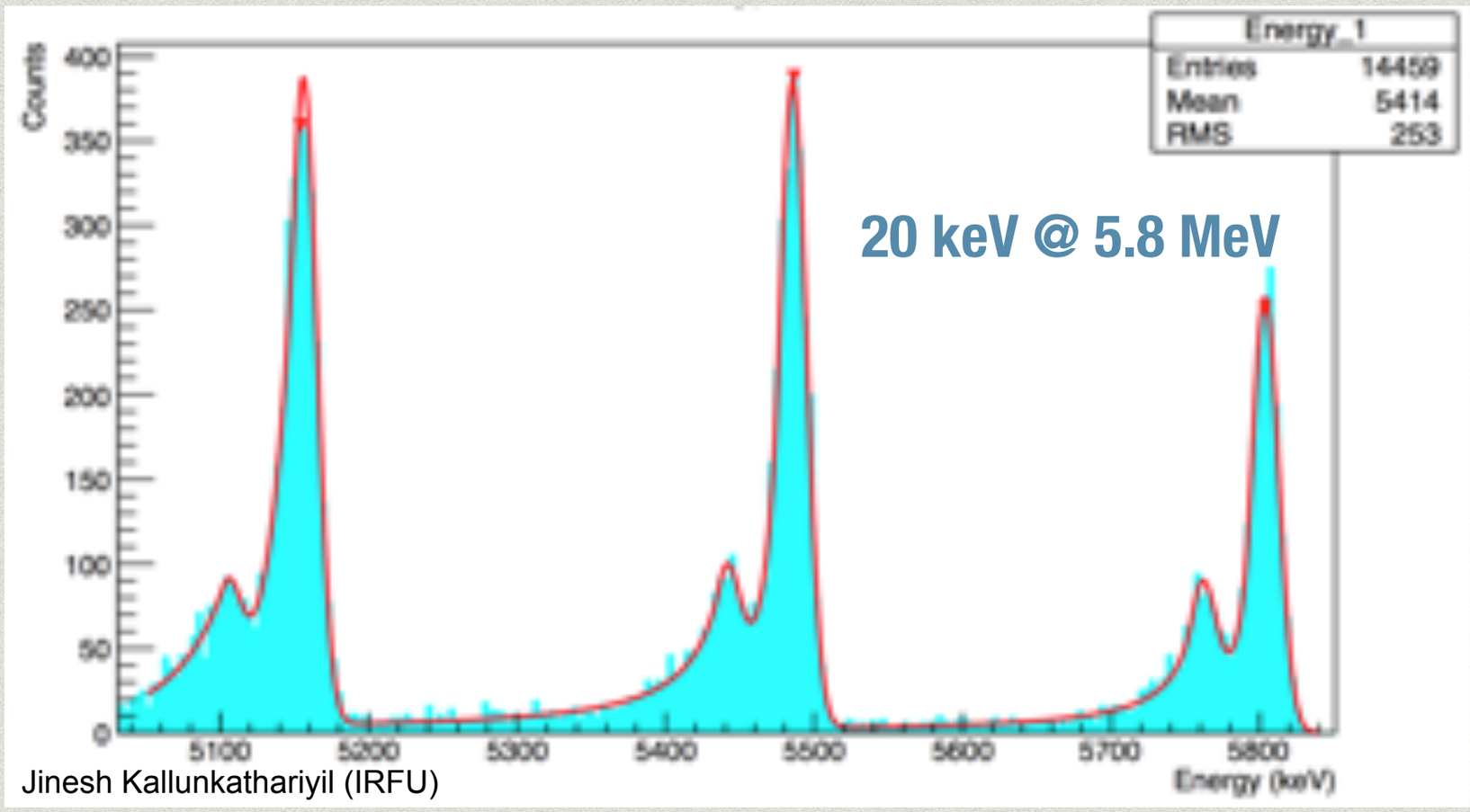
Software analysis

FEE Specifications

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

Courtesy of T. Chaminade

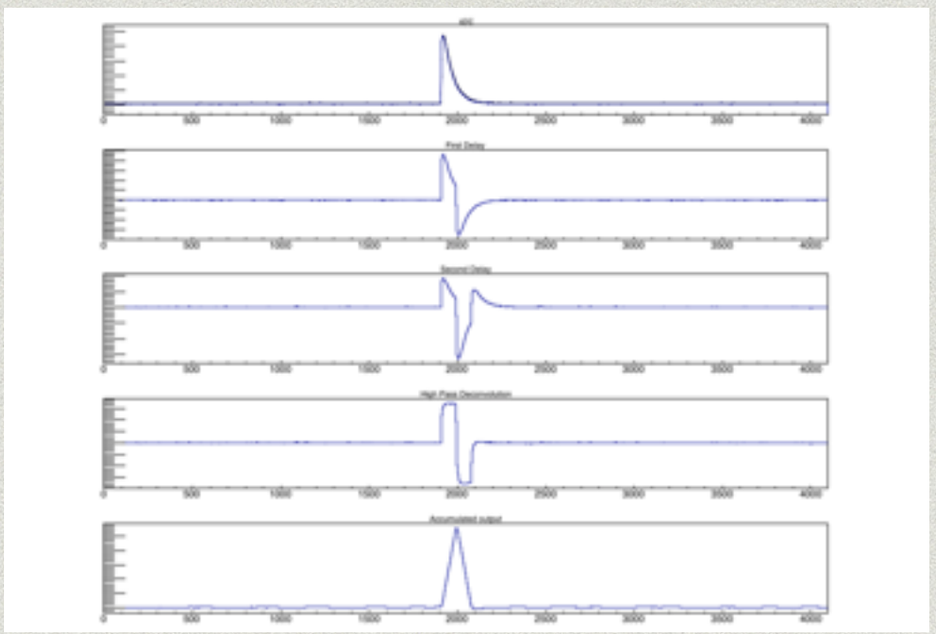
DSSD Tests



20 keV @ 5.8 MeV

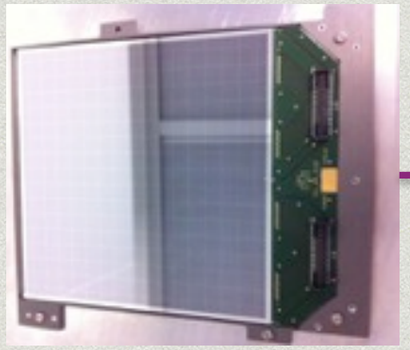
Jinesh Kallunkathariyil (IRFU)

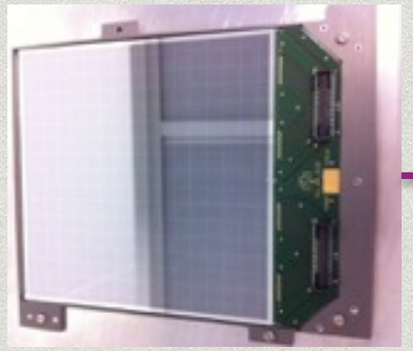
MWD readout from NUMEXO Boards

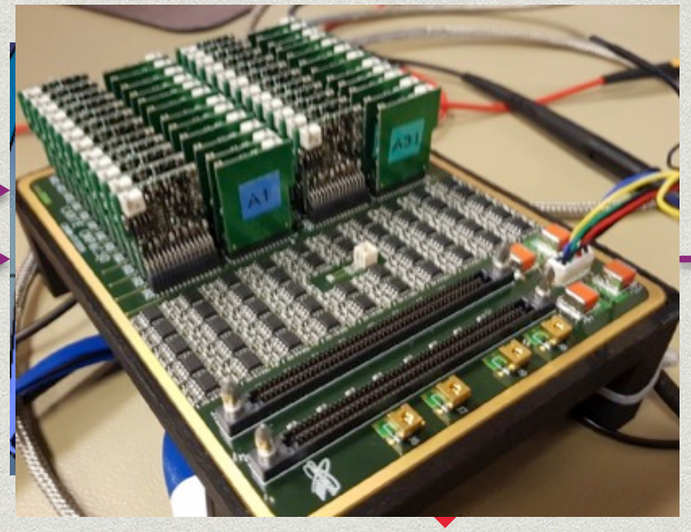


Tunnel (IPHC & CSNSM)

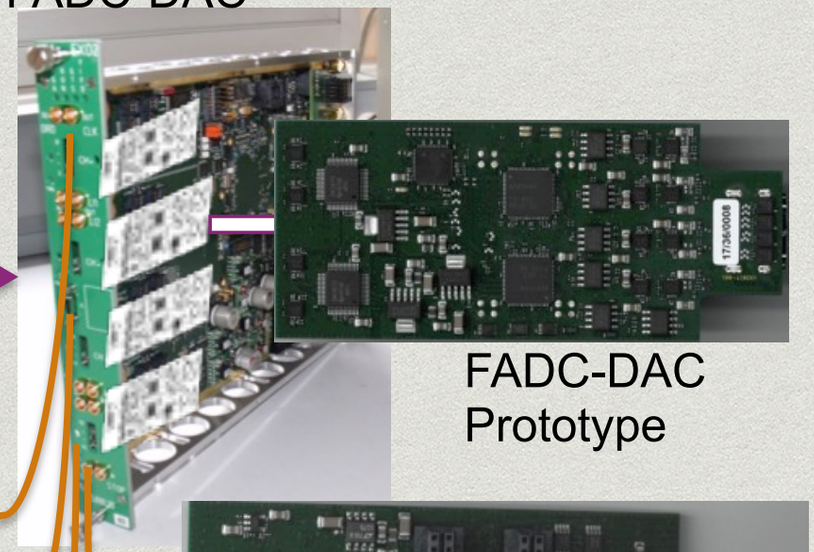
4 x 64 pixel
Si Pad Detector



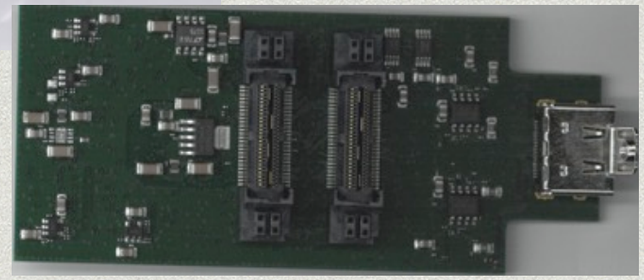




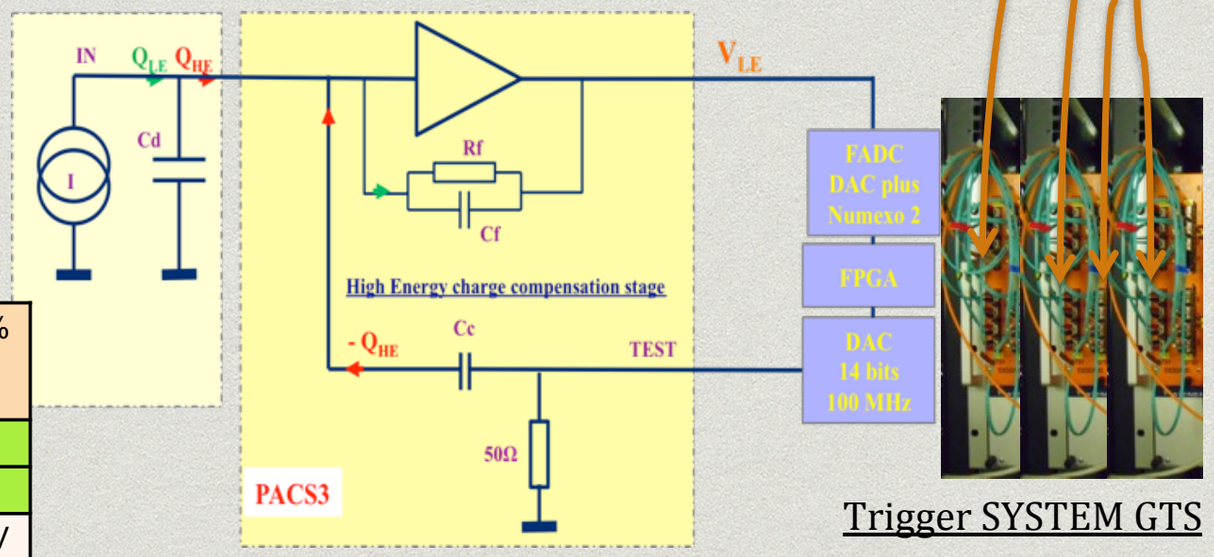
Numexo2 board with 4
FADC-DAC



FADC-DAC
Prototype



Principle of FEE Digital Feedback CSP



Trigger SYSTEM GTS

FEE Specifications

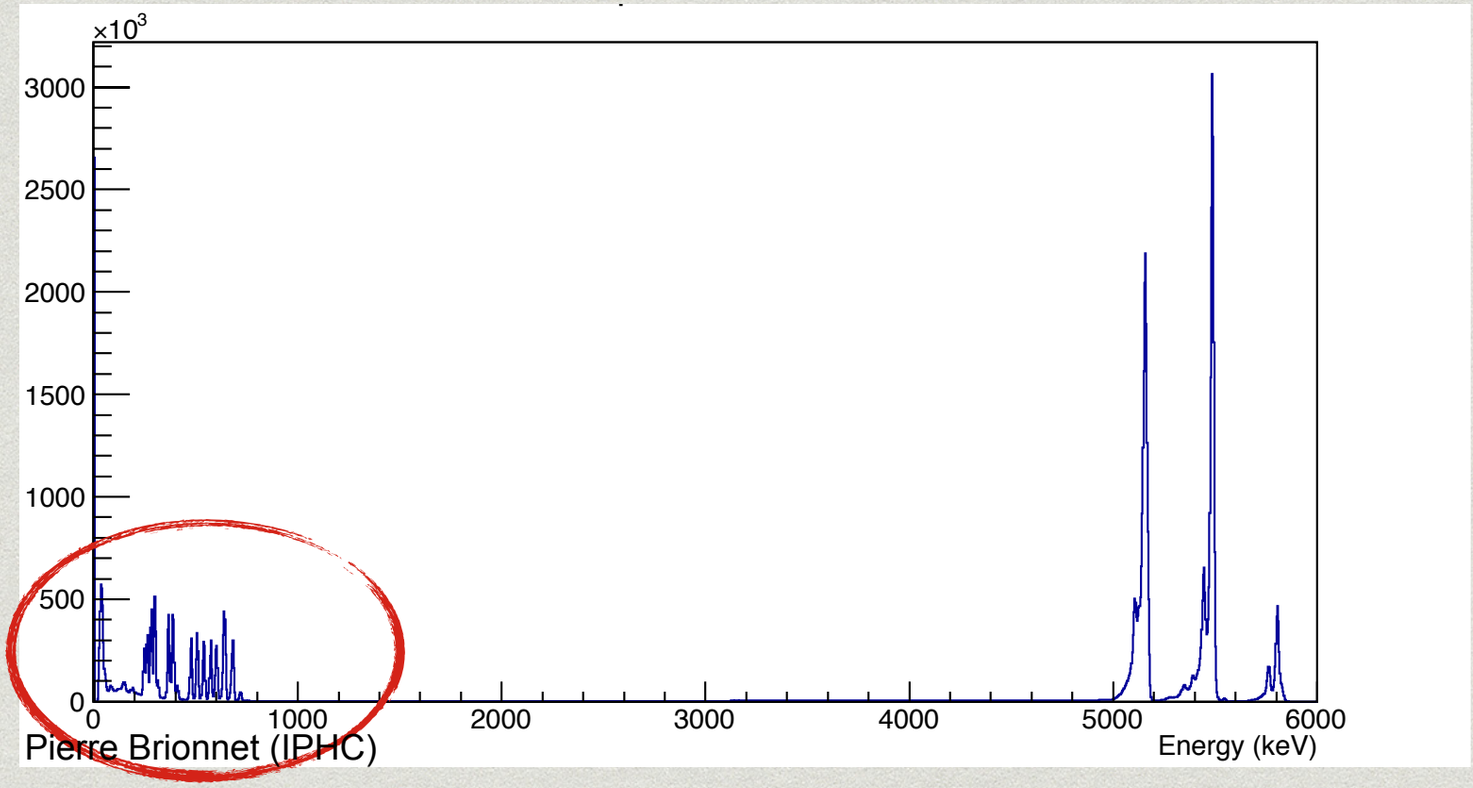
High Energy resolution using DFCSP From 20 to 150 MeV	< 0,03 %
Linearity on overall range	< 1.5%
Dead time	< 5 µs
High gain resolution @ 8 MeV	13,5 keV
Linearity	< 0,8 %
Dead time using MWD	< 8 µs

Courtesy of N. Karkour

Tunnel (Junks)

The first batch of Stripy pad detectors had spurious peaks at low energy.

Detector production seemed to be the cause



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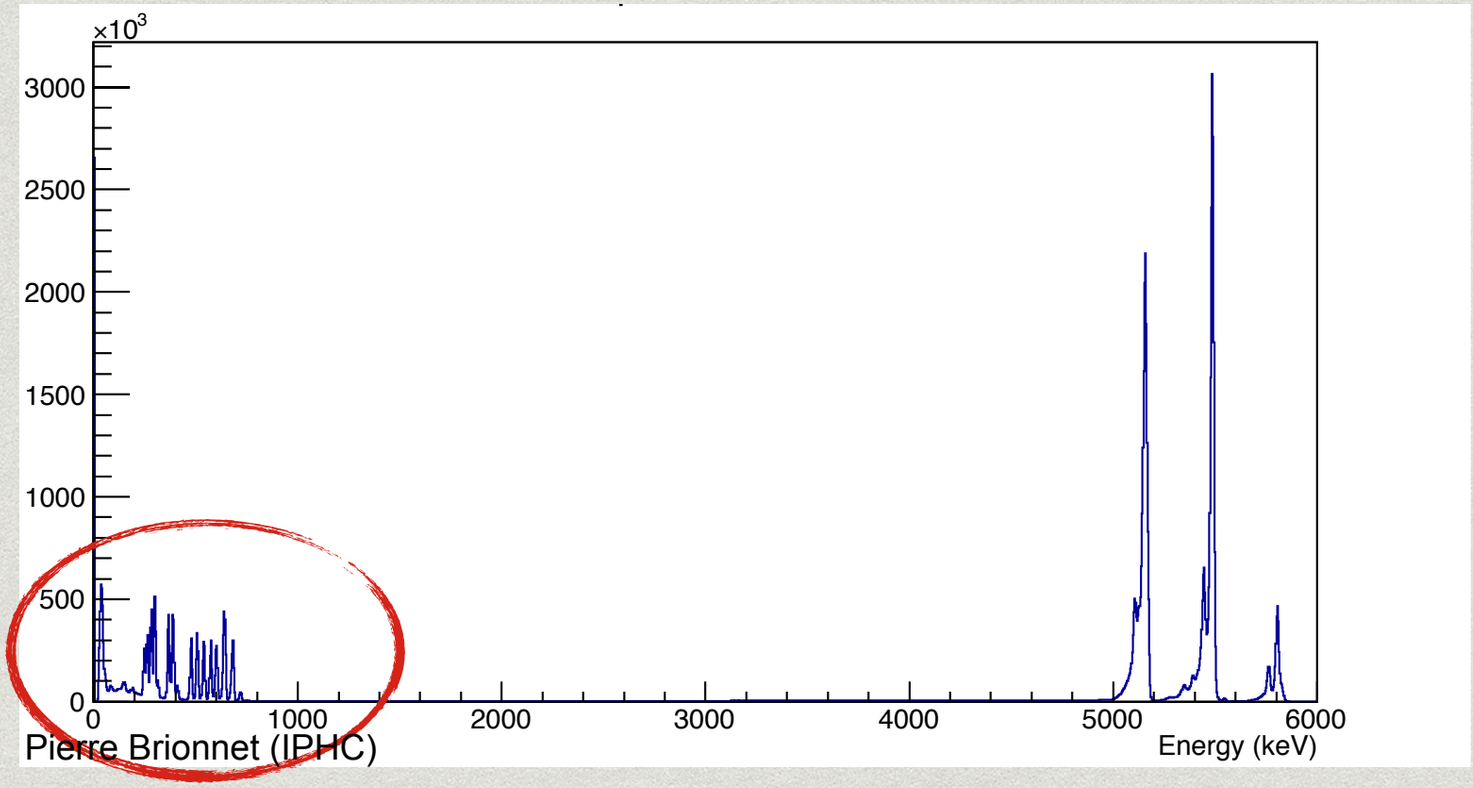
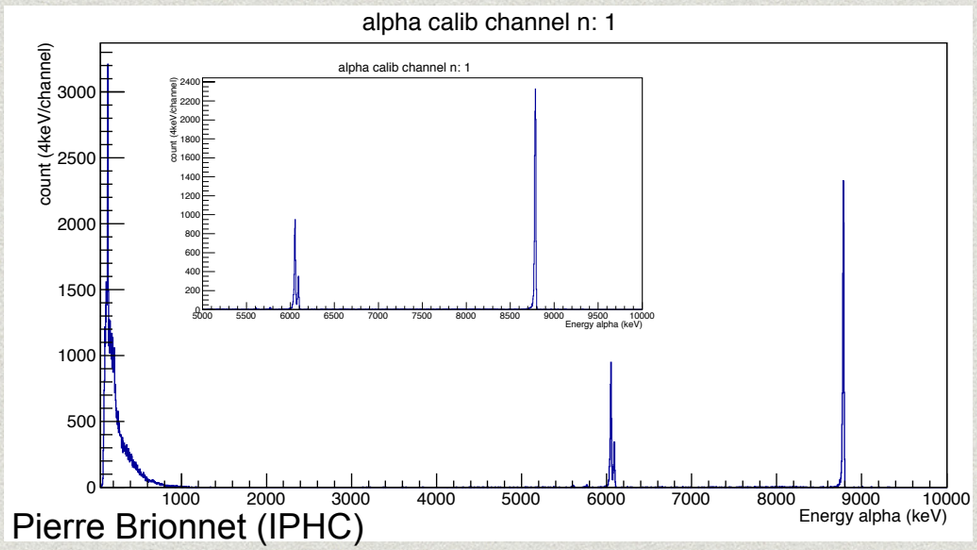


New Detectors just received

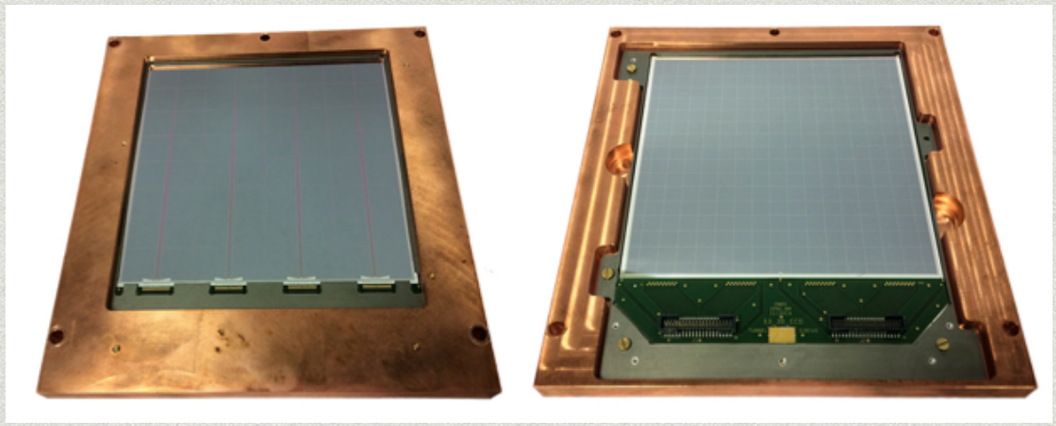
Tunnel tests (IPHC)

Validation tests for stripy pad detectors V 2.0

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



14.8 keV FWHM @ 6MeV



Pierre Brionnet (IPHC)

Tunnel tests (IPHC)

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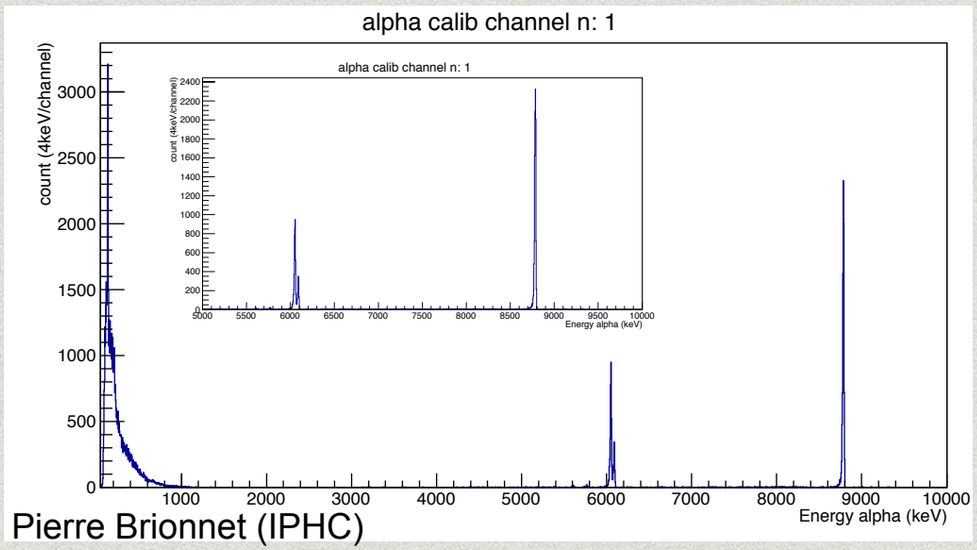

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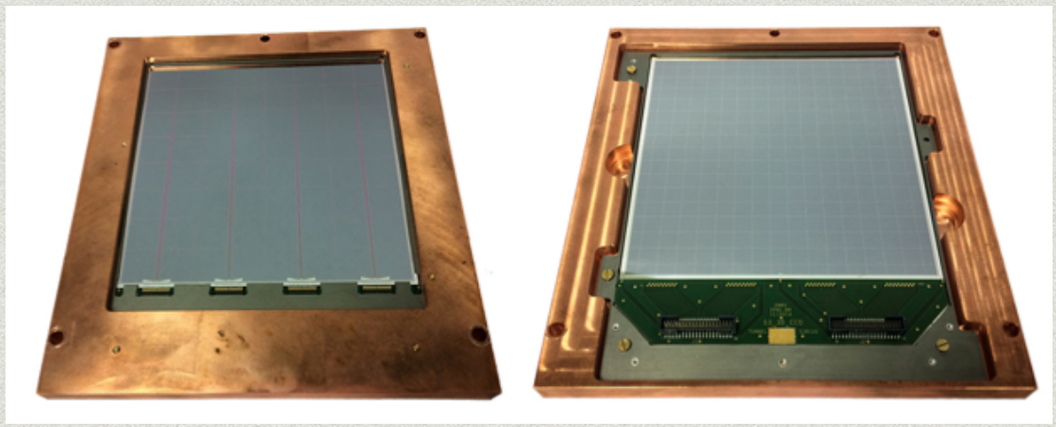

PSA Discrimination degraded α / β

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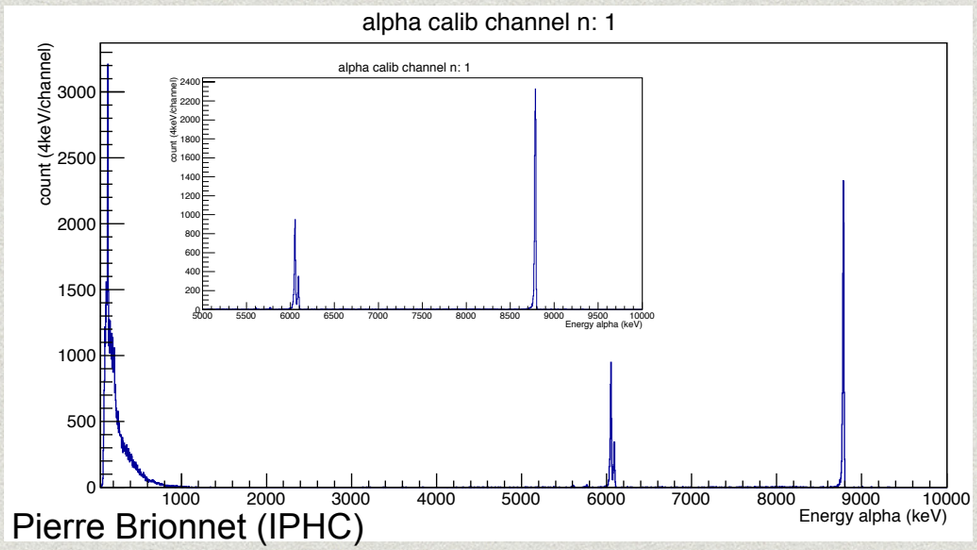

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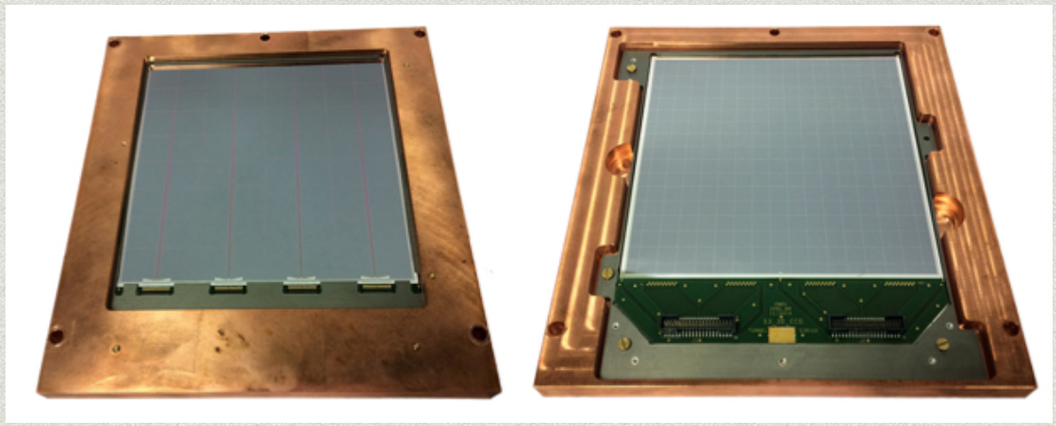

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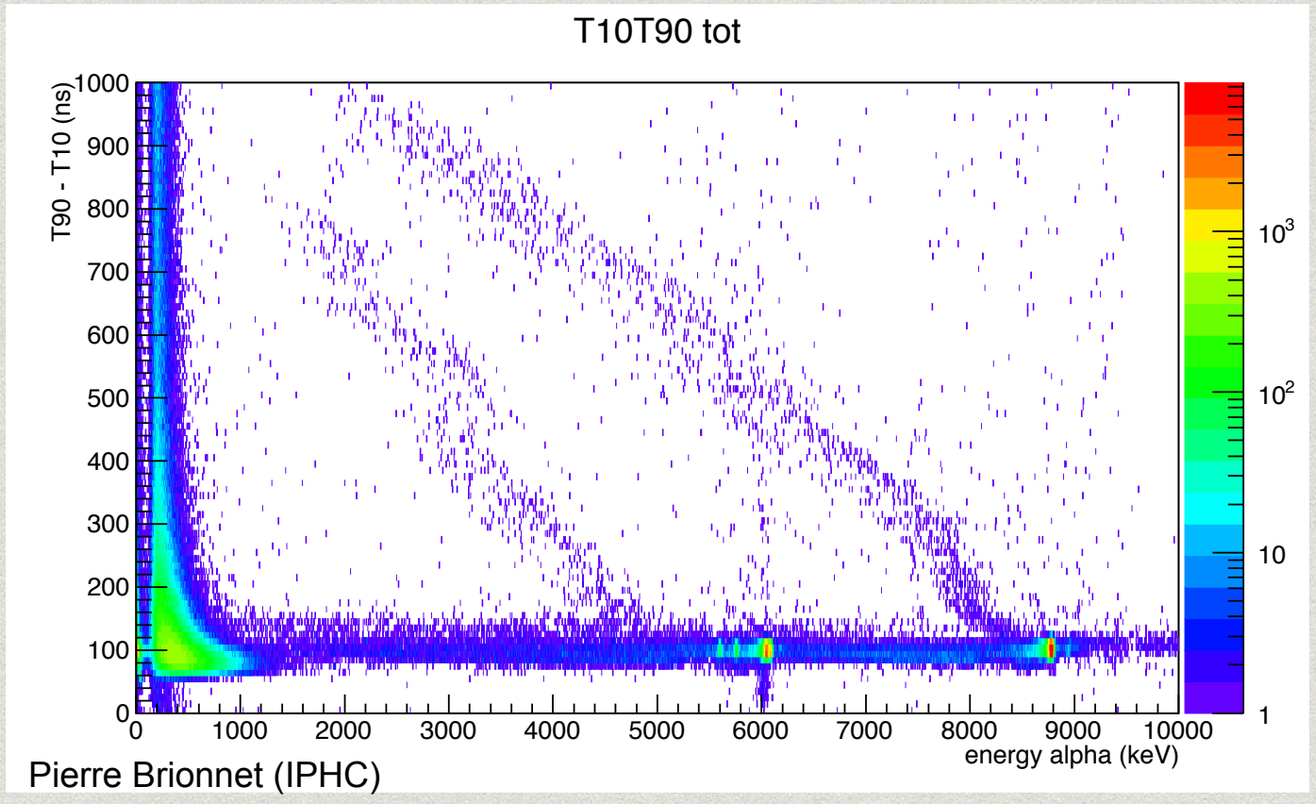
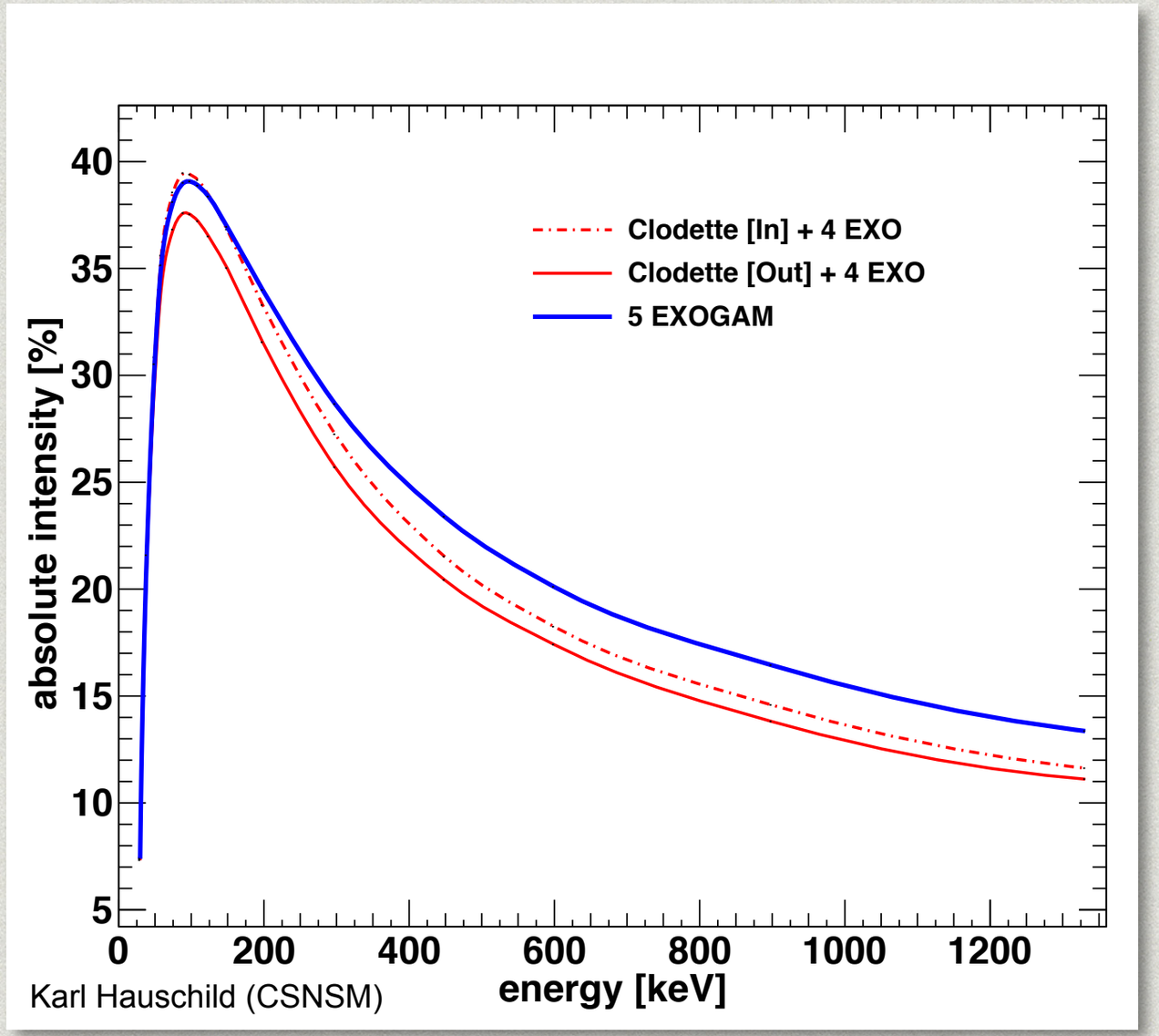


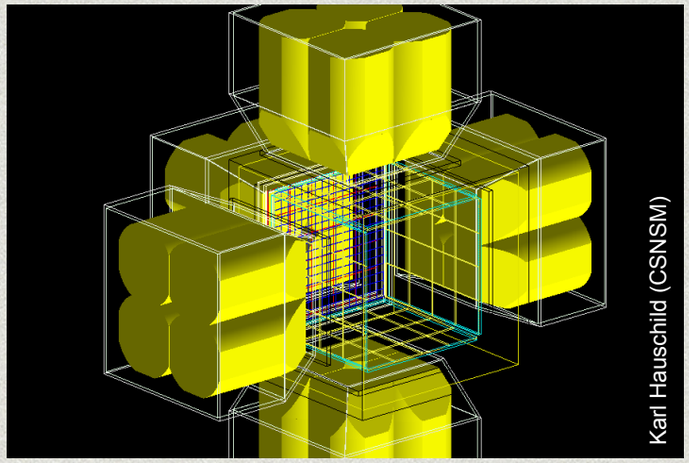
Gamma-spectroscopy (CSNSM)

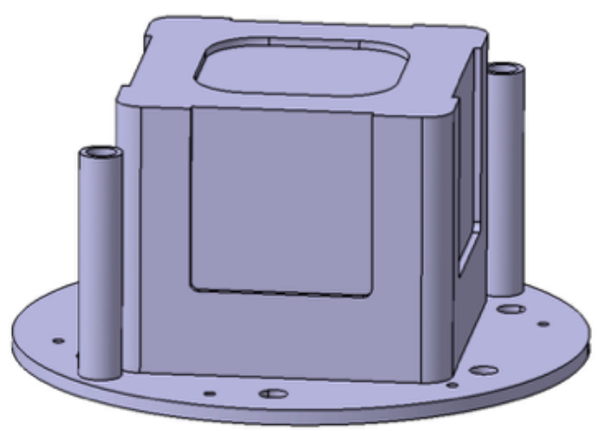
Optimized Gamma efficiency for low energy transitions :

Compact geometry

Thin capsule for the Silicon detectors







Th. Goeltzenlichter (IPHC)

Planning

DSSD Instrumentation

Front End Electronics : Delivered & ongoing validation
Back End Electronics : Test ongoing with the detectors
Firmware development : **ongoing**
Pulse shape analysis **: ongoing**
System Ready in **Q3 2017.**

Tunnel Instrumentation

First detector Prototype **validated partially**
Front End Electronics : **Validated. Production ongoing**
Back End Electronics : **prototype produced under qualification**
Readout data interface : **under development**
System Ready in early 2018.

Infrastructure

Mechanical design Production : **Ongoing**

Tracker

Tests Ongoing

Acquisition

Pulse Shape treatment : **Under development**
Online and off line analysis : **need to be written**

SIRIUS Ready for commissioning September 2018

Conclusion

- All parts are in final production
- Energy resolutions are more than promising
- Junk events in tunnel detector solved
- No element on the critical path
- Commissioning expected in september 2018

The SIRIUS Collaboration

- GANIL : D. Ackermann, M. Blaizot, A. Boujrad, E. Clément, S. Coudert, S. Herlant, G. Lebertre, C. Maugeais, J. Piot, F. Saillant, G. Wittwer
- CSNSM : V. Alaphilipe, L. Gibelin, K. Hauschild, N. Karkour, X. Lafay, D. Linget, A. Lopez-Martens & 10 interns from MIT UL ESME universities.
- IPHC : P. Brionnet, O. Dorvaux, B. Gall, Th. Goeltzenlichter, C. Mathieu
- IRFU : M. Authier, Th. Chaminade, A. Drouart, J. Kallunkathariyil, Ch. Theisen, M. Vandebroucq
- IPNO : L. LeBlanc