DE LA RECHERCHE À L'INDUSTRIE

SIRIUS @ S3

Spectroscopy & Indentification of Rare Ions Using S3

B. SULIGNANO (IRFU/SphN)
on behalf of the SIRIUS collaboration

First Physics with the Super Separator Spectrometer S3
27-30 Mars 2017, CEA Saclay

SIRIUS PHYSICS @ S3

Where is located the island of stability?

Ground state properties

•Measure ground states properties of SHE such as their masses, spin, charge radii, nuclear moments etc

Superheavy nuclei

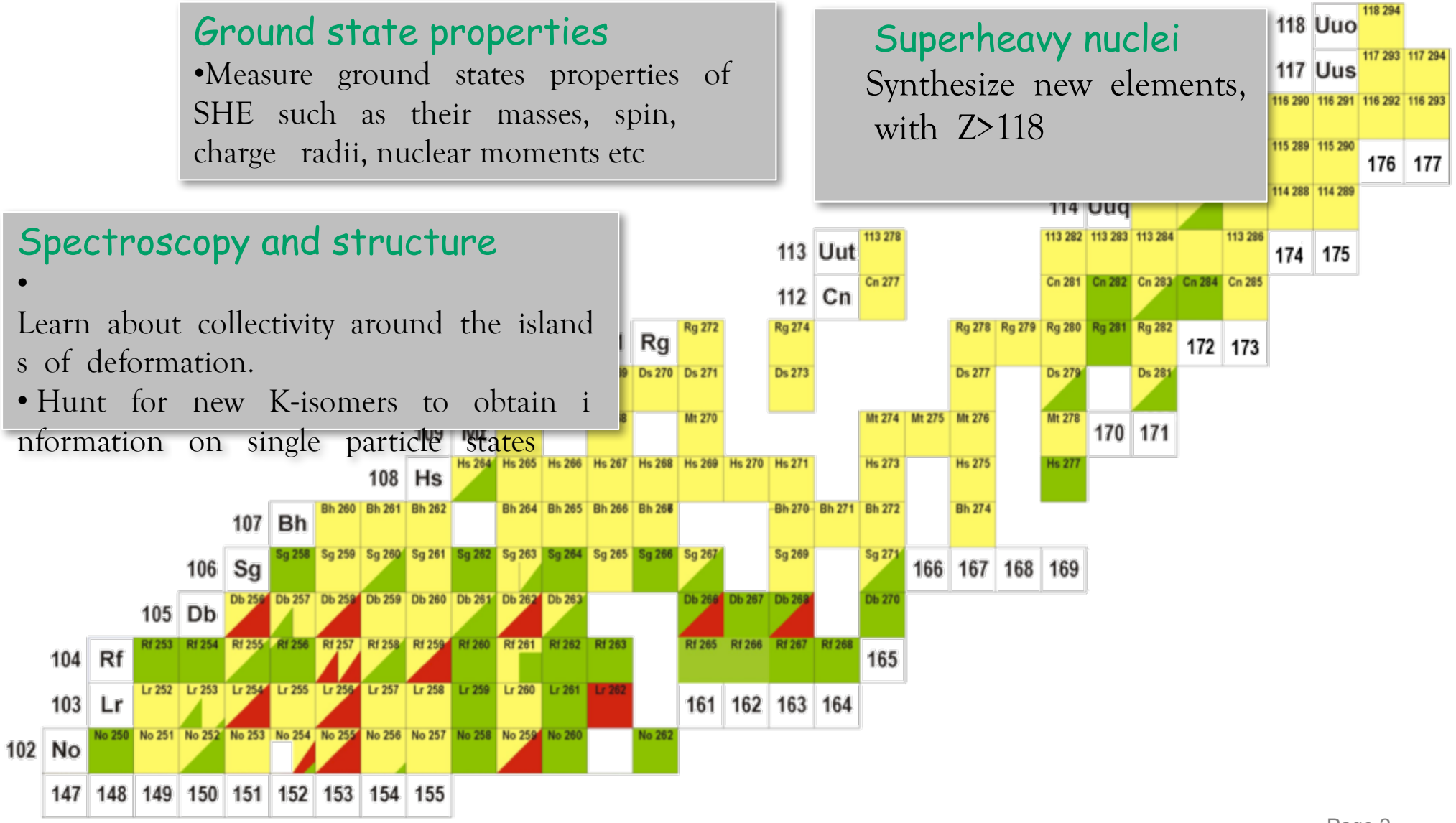
Synthesize new elements, with Z>118

Spectroscopy and structure

•

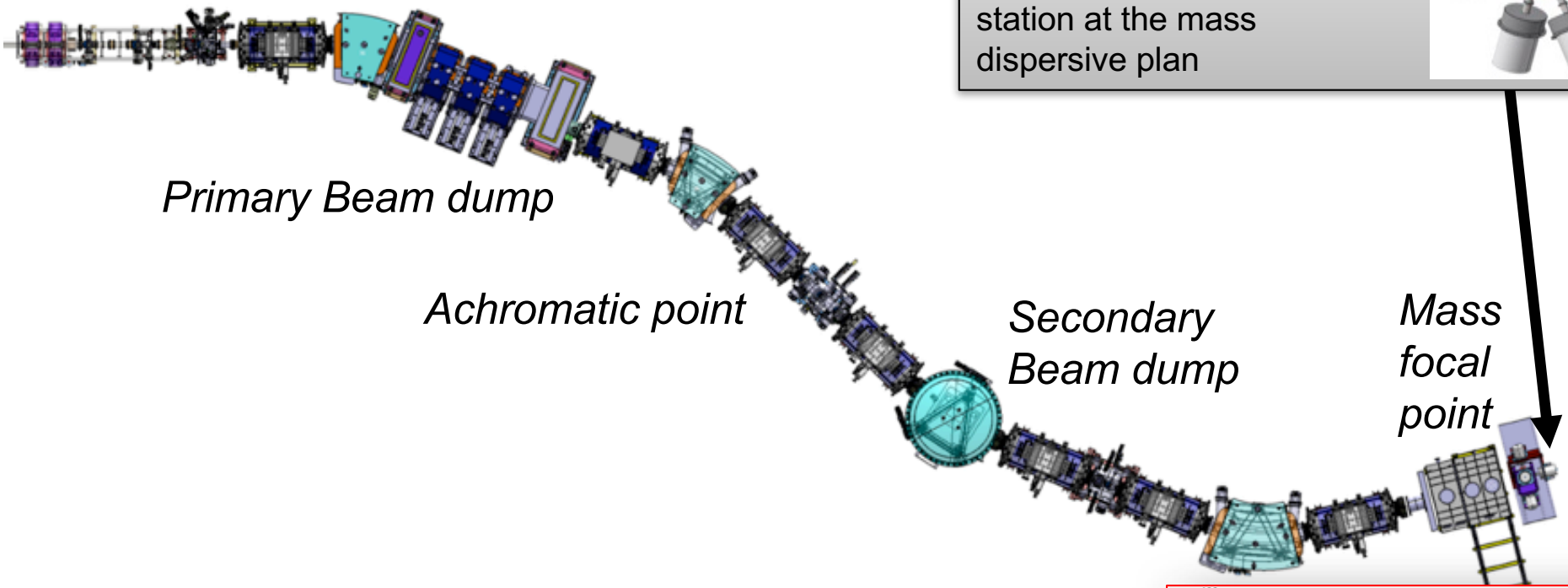
Learn about collectivity around the island s of deformation.

• Hunt for new K-isomers to obtain i nformation on single particle states



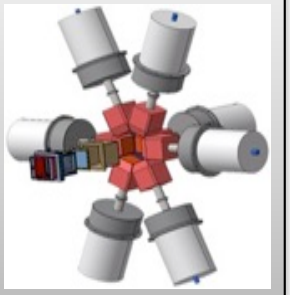
Decay spectroscopy with S^3

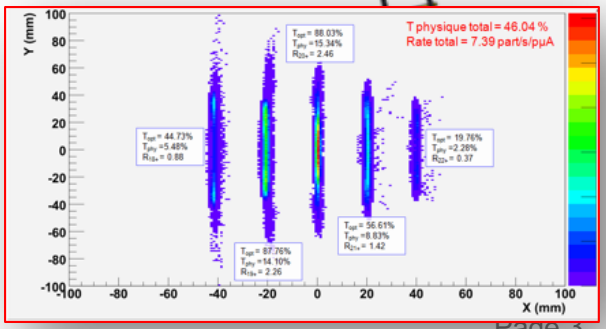
FP reconstuction



Decay spectroscopy

SIRIUS setup
Implantation-decay station at the mass dispersive plan

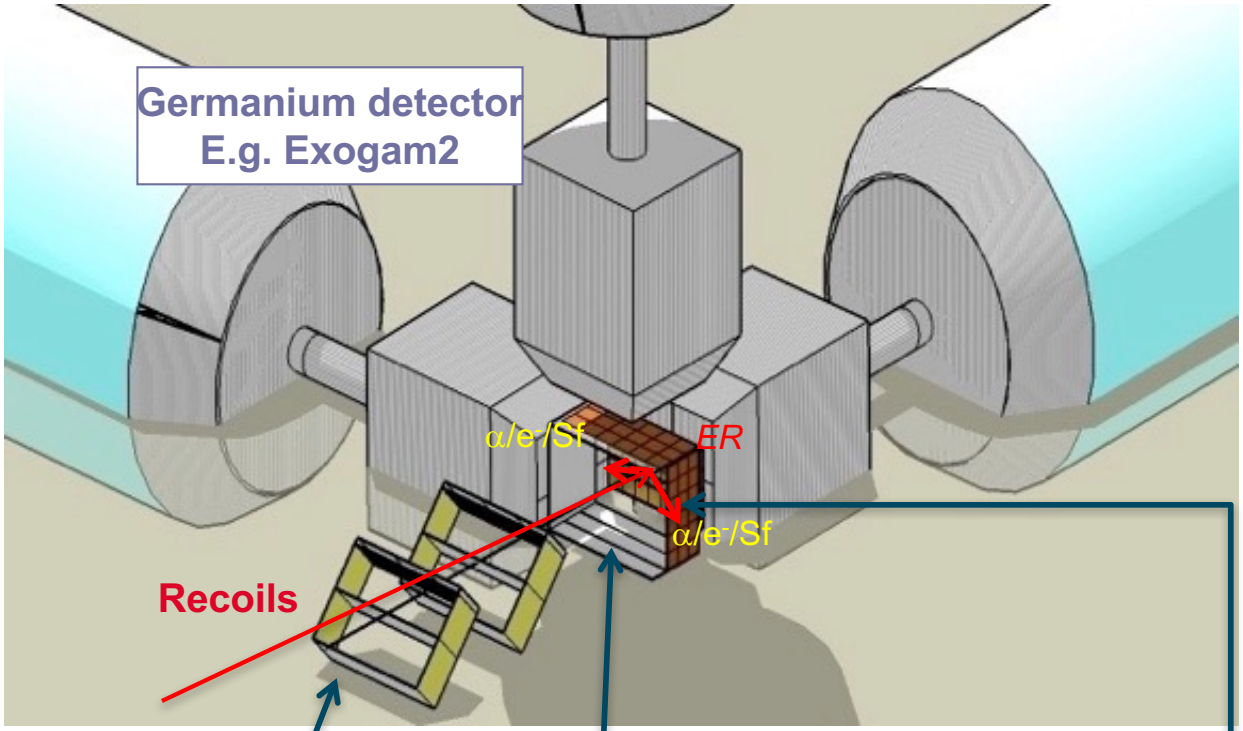




- Tracking for mass estimation
- Time of flight + Energy meas.
- Decay spectroscopy (α,e^-,fission,γ)

SIRIUS

SPECTROSCOPY & INDENTIFICATION OF RARE IONS USING S3



Time of flight + tracking detector

Tunnel detector for escaped e- and α

Implantation detector:
Heavy Ions, α and e-, Sf
(Spontaneous fission decay)

PERFORMANCE OF SIRIUS

Physics Constraints DSSD

- Large size because of S^3 optics;100x100 mm^2; 128x128 strips
- Large dynamics: electrons, alpha, Heavy ions
- Energy range and resolution:
- Alpha/e⁻: 0÷20 MeV FWHM≈20 keV
- Heavy Ions: 50÷500 MeV FWHM<5-10 MeV
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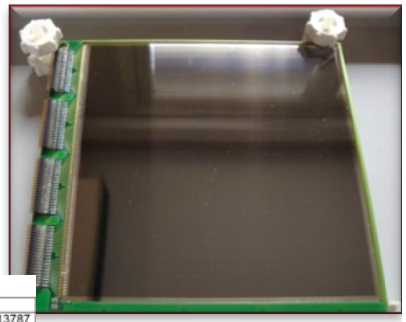

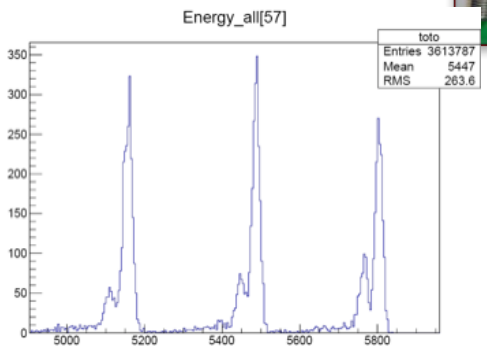

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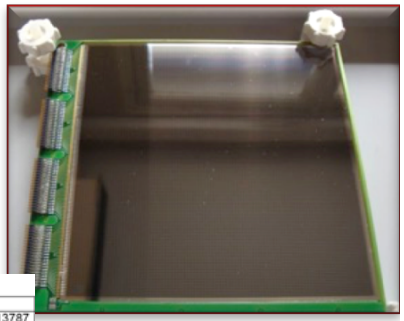
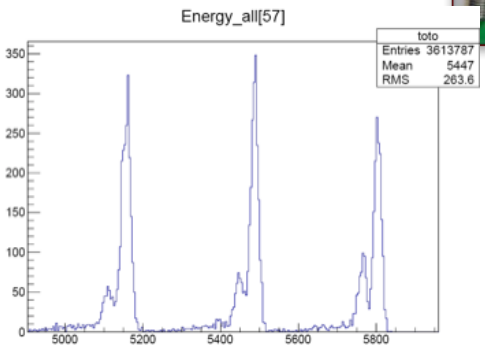
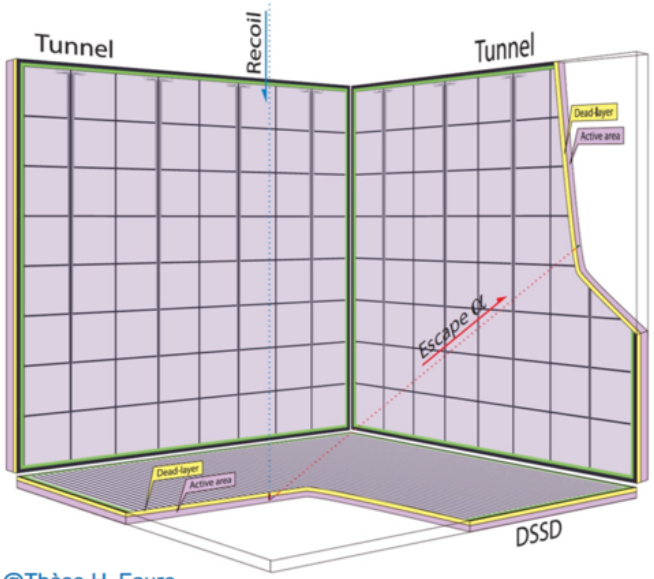




Physics Constraints TUNNEL

Principle of a « tunnel » detection system for alphas and electrons



@A Lopez-Martens

@Thèse H. Faure

Closest to the implantation detector (i.e. DSSD), more sensitive to alpha/electron detection in tunnel detector

PERFORMANCE OF SIRIUS

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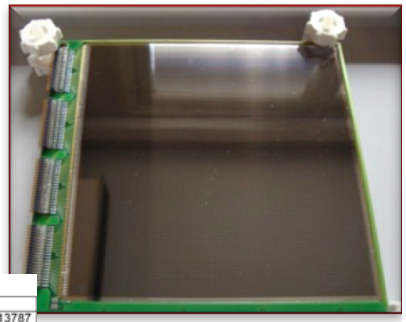

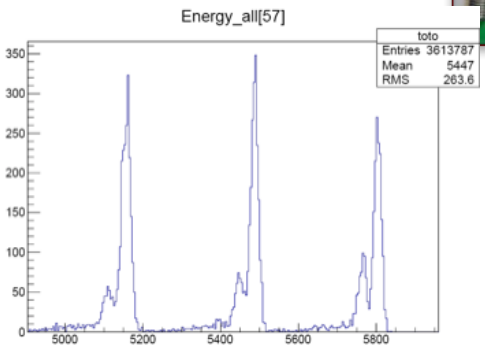

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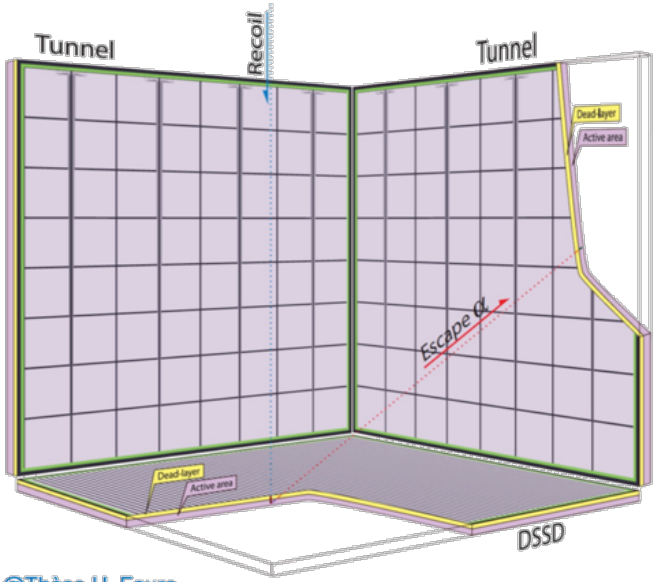
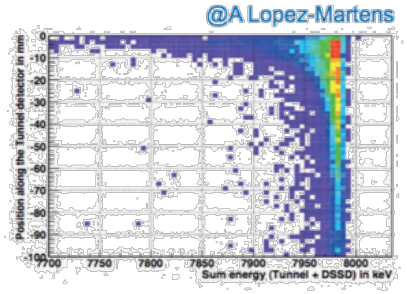


@Thèse H. Faure



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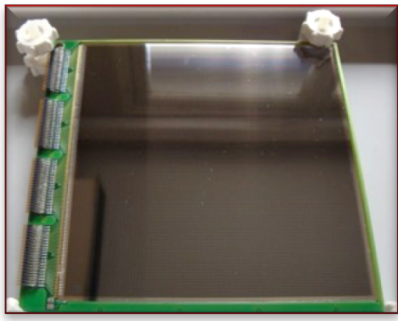

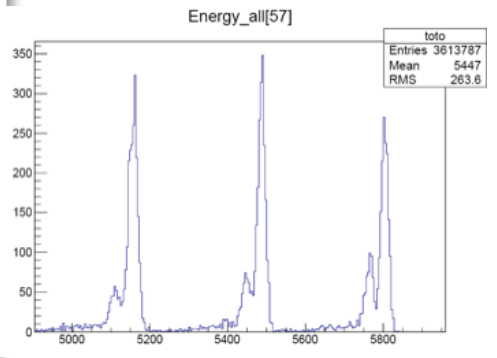

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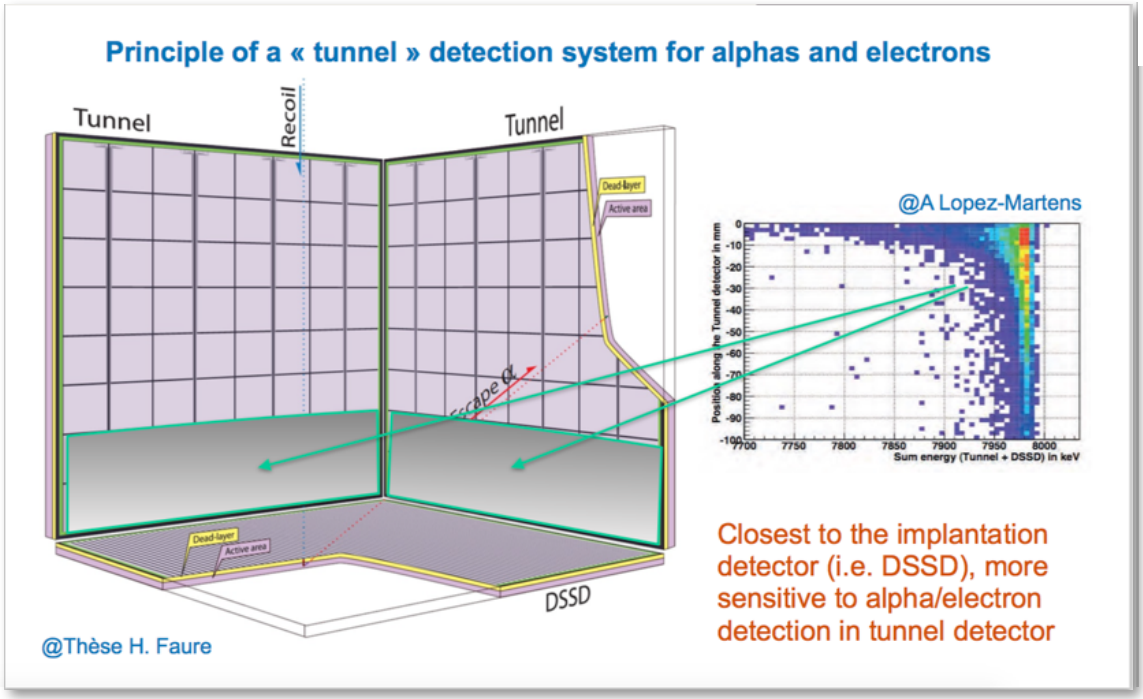
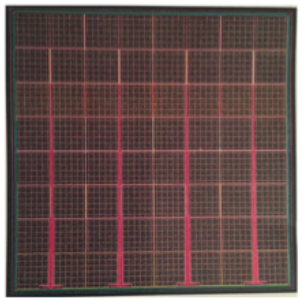
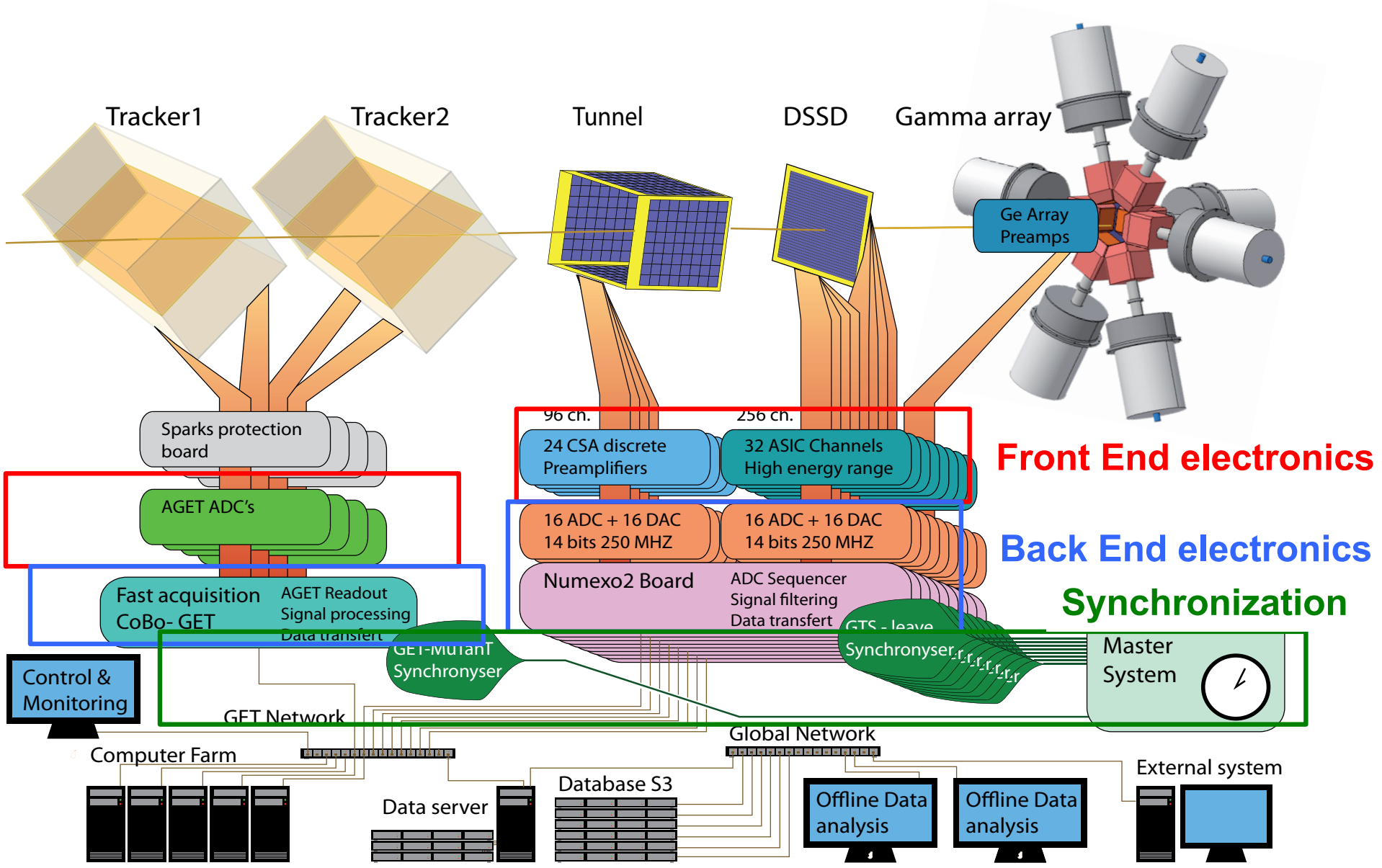




Physics Constraints TUNNEL

- Size : 10x10 mm²
- Thickness: 1mm
- Window less
- Need for segmentation in the first centimeter of the tunnel Si !
- Counting rate < 10 kHz (total)
- Good energy resolution
- Detector type: SSSD (8x8 pads)

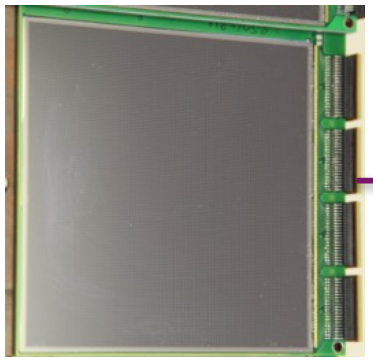
SIRIUS LAYOUT



DSSD (IRFU)

DSSD

128 strips x side
128 strips y side

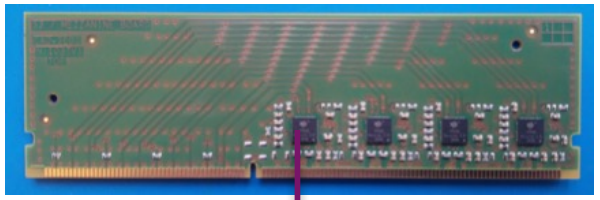


Mother board

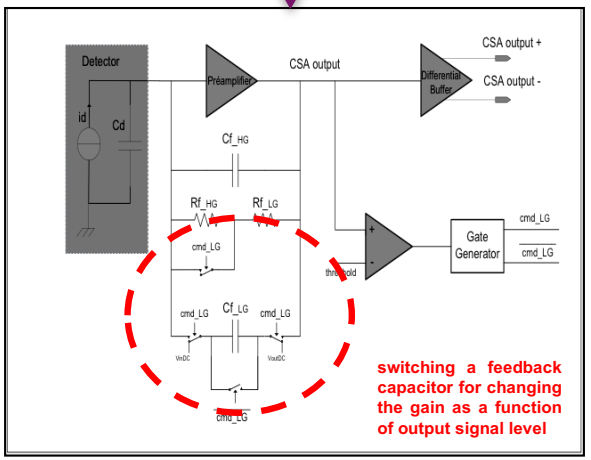
- Each motherboard control 32 channels
- 8 mother boards are needed to control DSSD

Daughter board

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



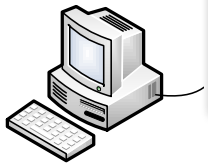
ASIC Principle of floating point



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

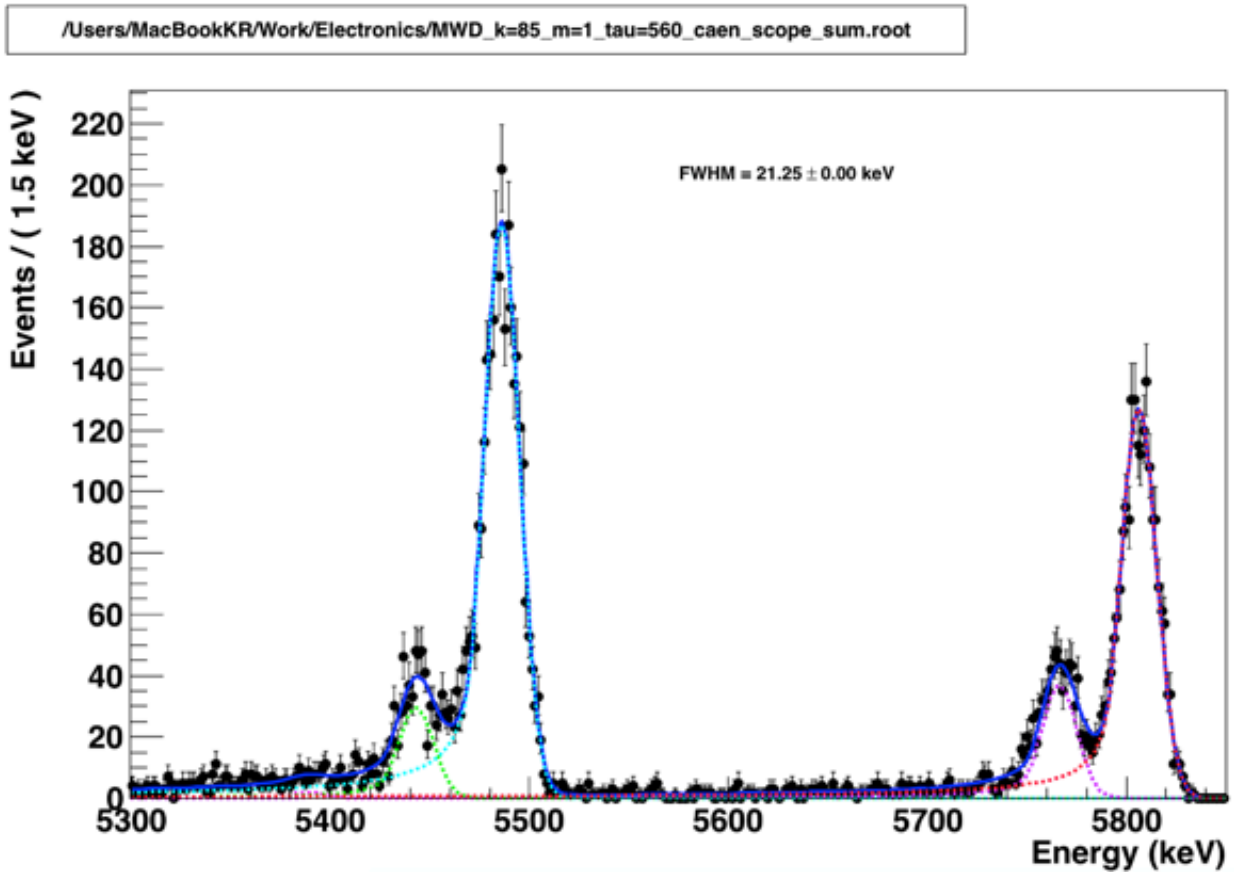
Numexo2 with 4 FADC-DAC

DSSD RESOLUTION

Alpha High gain resolution with S3 DSSD

Test Condition :

- Temperature -20°C
-vacuum 10^{-6} mbar
-3-peak alpha source
-CAEN ADC 14bits
-gain of 1pF
-Trapezoidal filter: 0,45µs

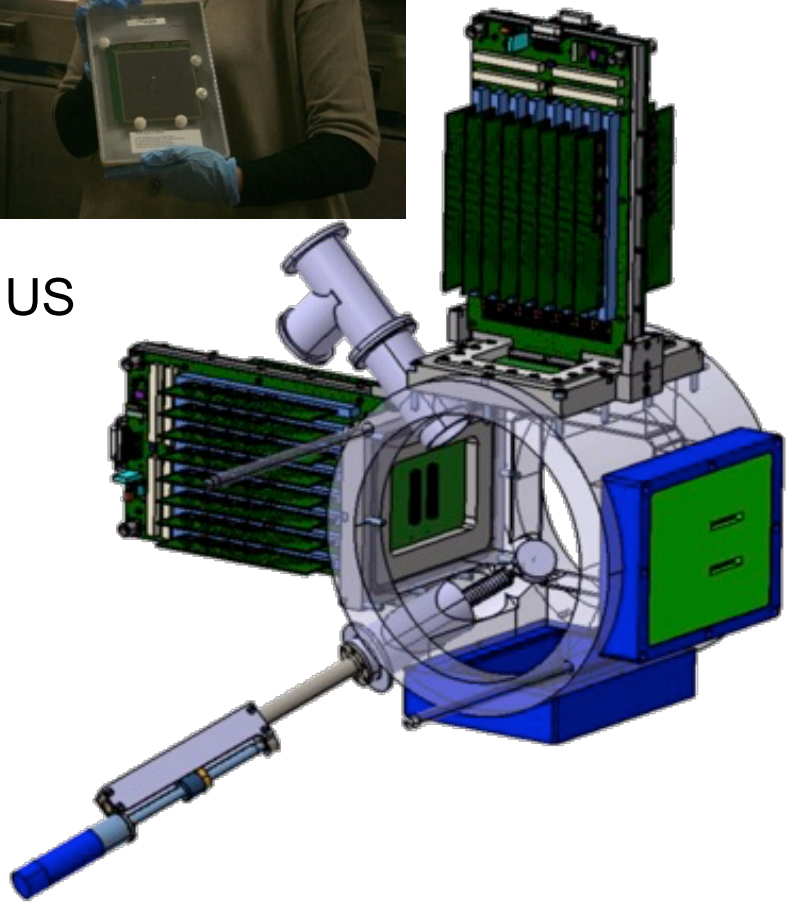


Ksenia Rezynkina (csnsm/KU Leuven)

Peak Resolution <21kev. Can we do better?

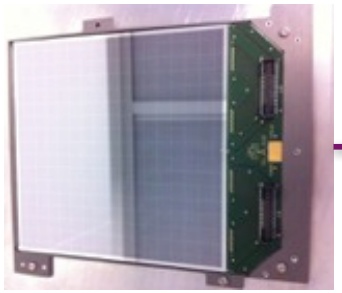
DSSD & TEST BENCH @ SEDI

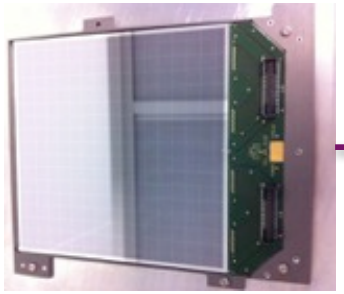
New DSSDs for SIRIUS

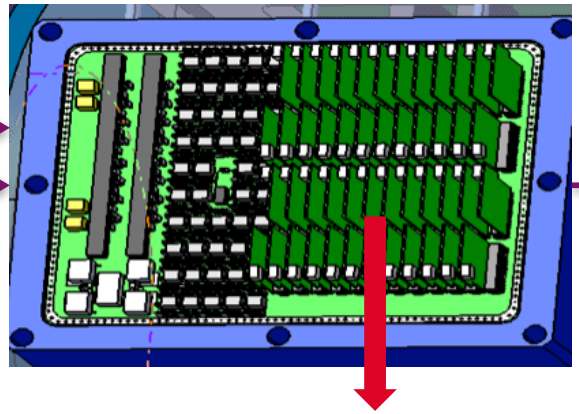


TUNNEL (CSNSM/IPHC)

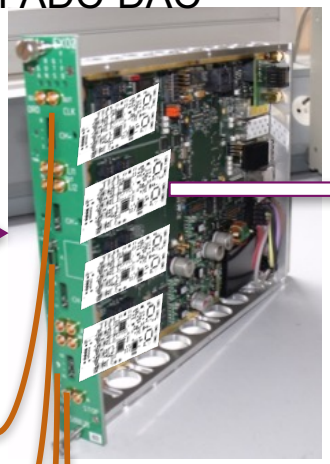
4 x 64 pixel
Si Pad Detector





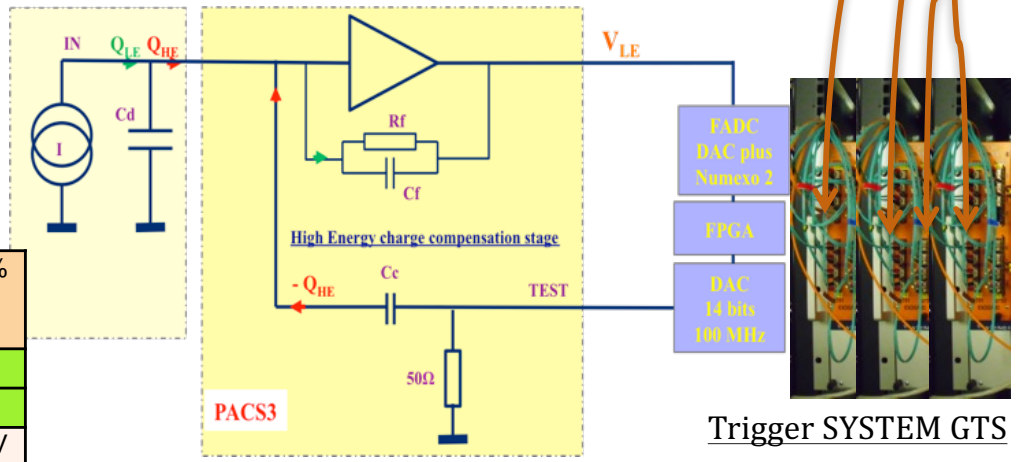


Numexo2 board with 4
FADC-DAC



FADC-DAC
Prototype

Principle of FEE Digital Feedback CSP



Trigger SYSTEM GTS

FEE Specifications

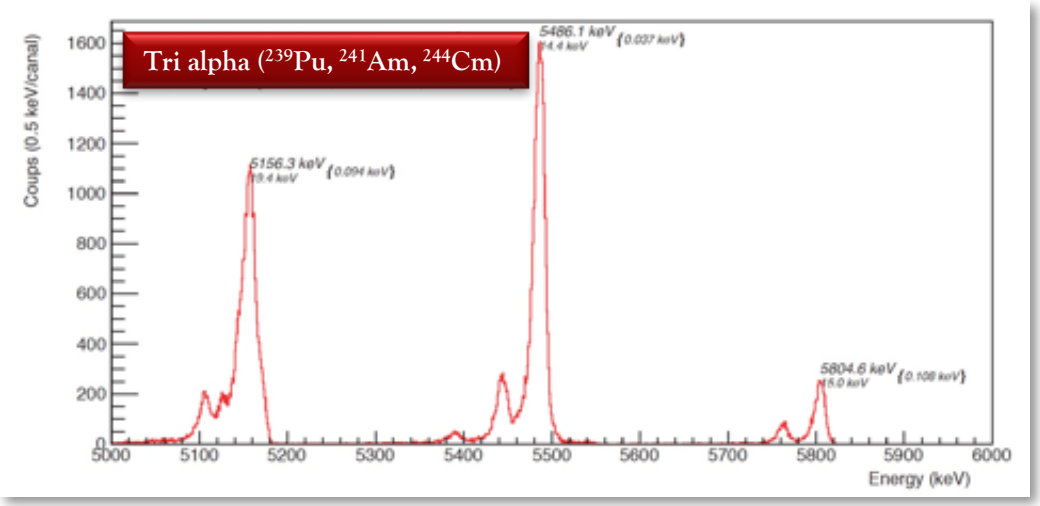
High Energy resolution using DFCSP From 20 to 150 MeV	< 0,03 %
Linearity on overall range	< 1.5%
Dead time	< 5 µs
High gain resolution @ 8 MeV	13,5 keV
Linearity	< 0,8 %
Dead time using MWD	< 8 µs

Courtesy of N. Karkour

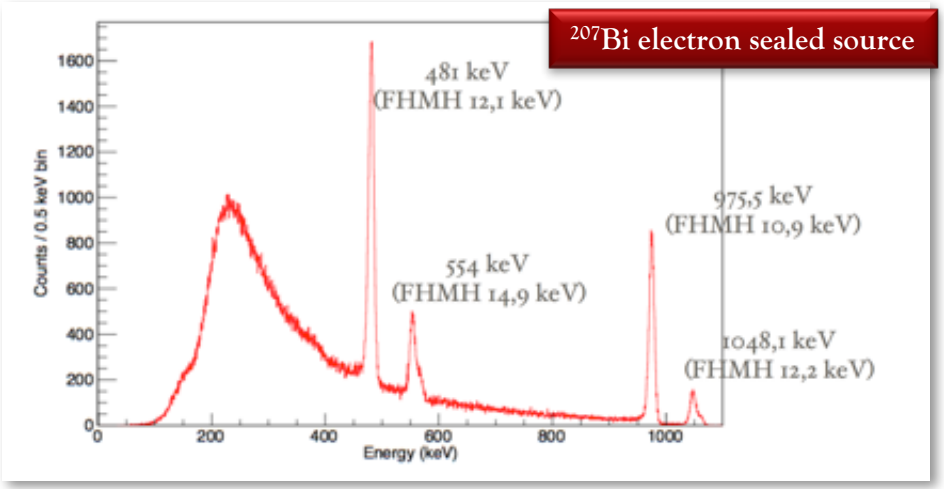
TUNNEL RESOLUTION

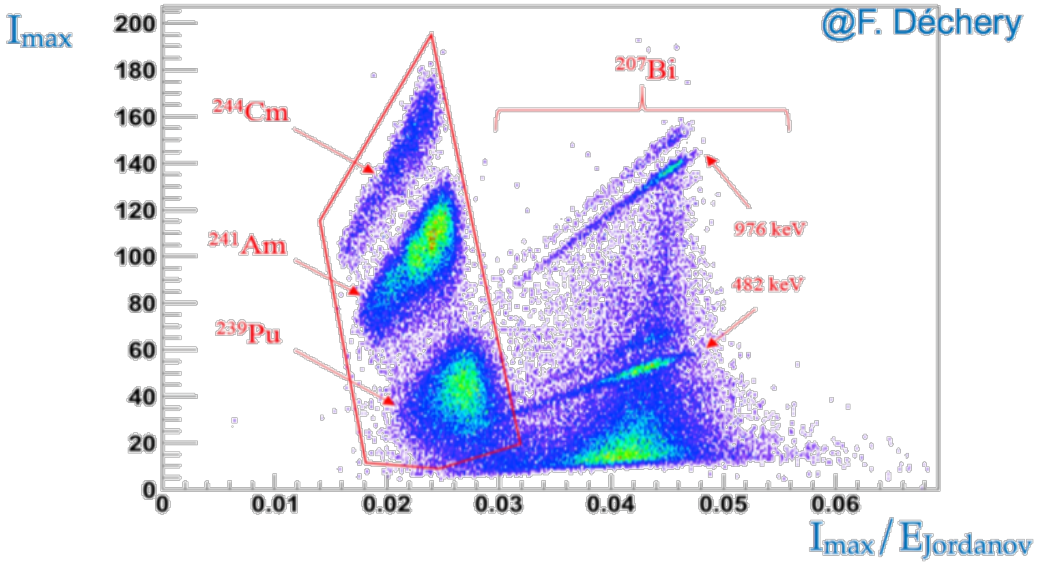
Alpha energy resolution

The best **single pixel energy resolution** for the 5486 keV line: **14.4 keV**
Mean energy resolution at the same energy for all pixels is typically of **16.5 keV.**



Electron energy resolution

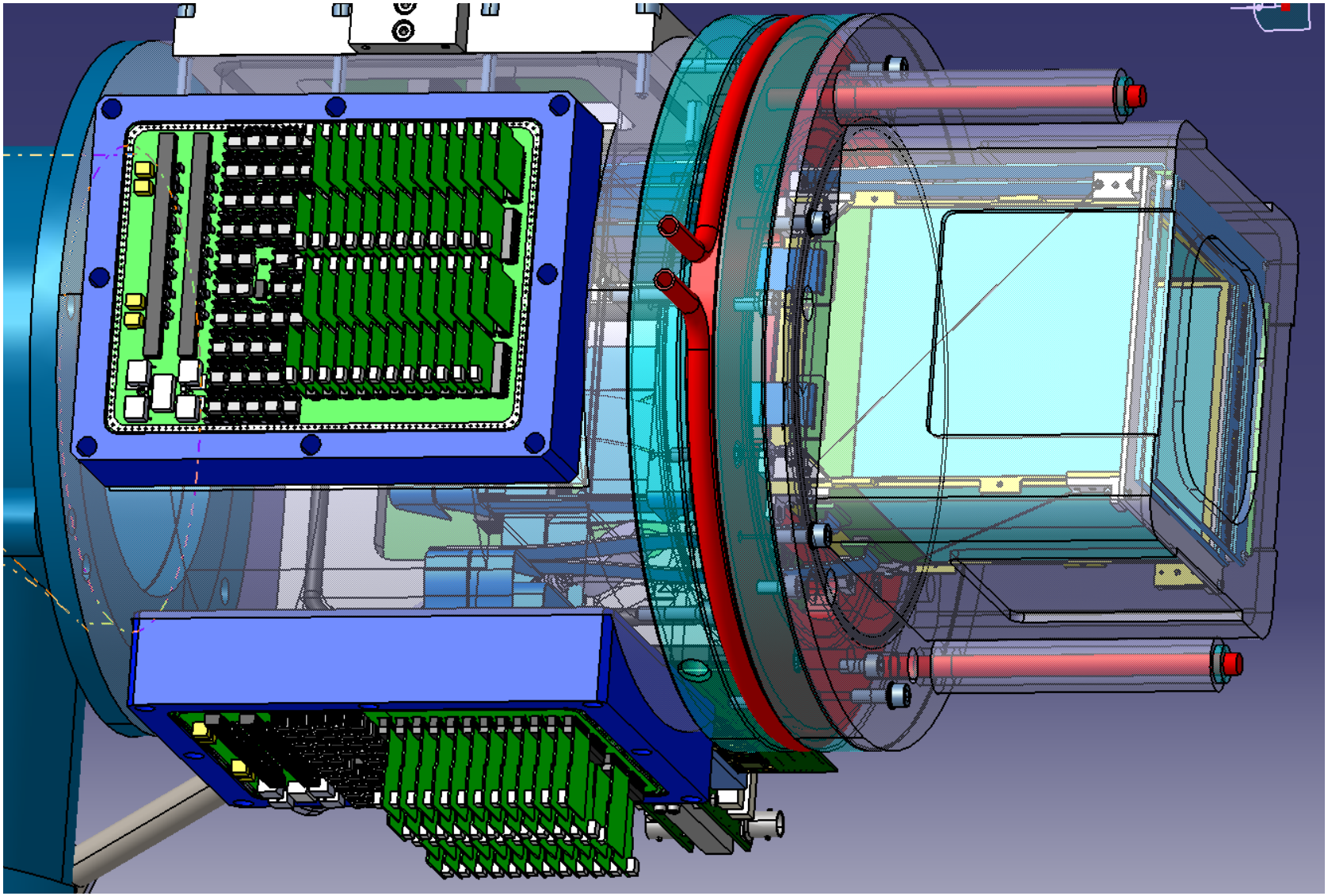




Courtesy O. Dorvaux

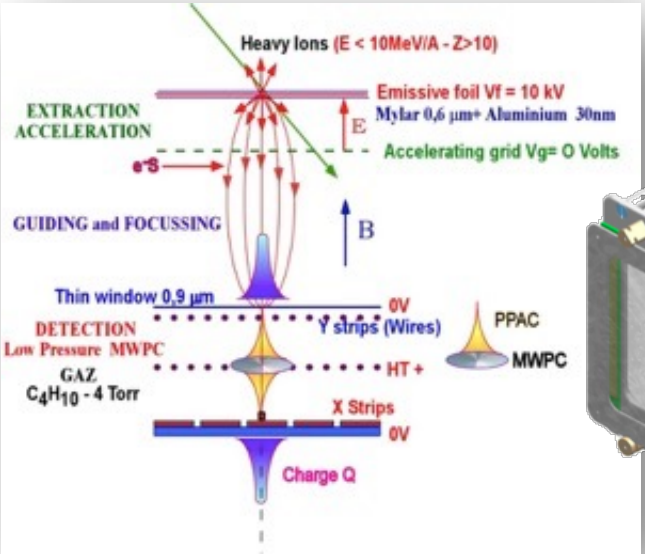
Possible to discriminate α/e⁻

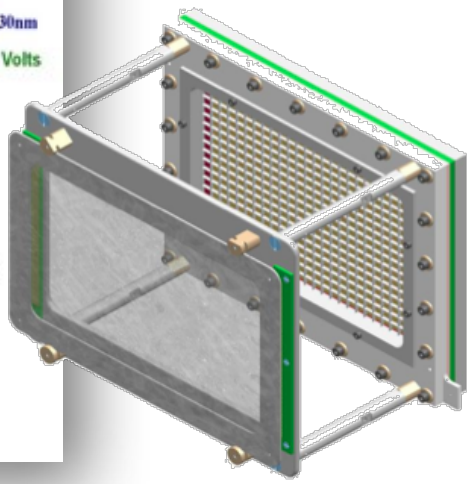
TUNNEL (CSNSM/IPHC)

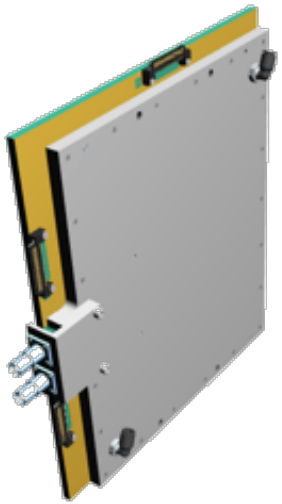


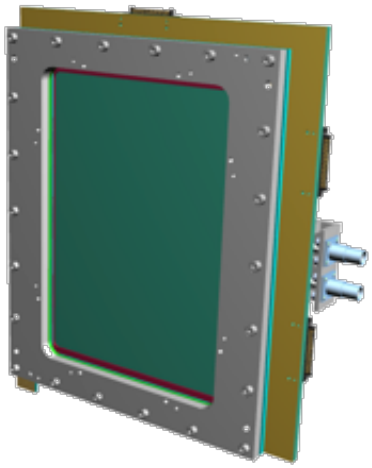
Courtesy of T. Goeltzenlichter

TRACKING DETECTORS
(GANIL/IRFU)





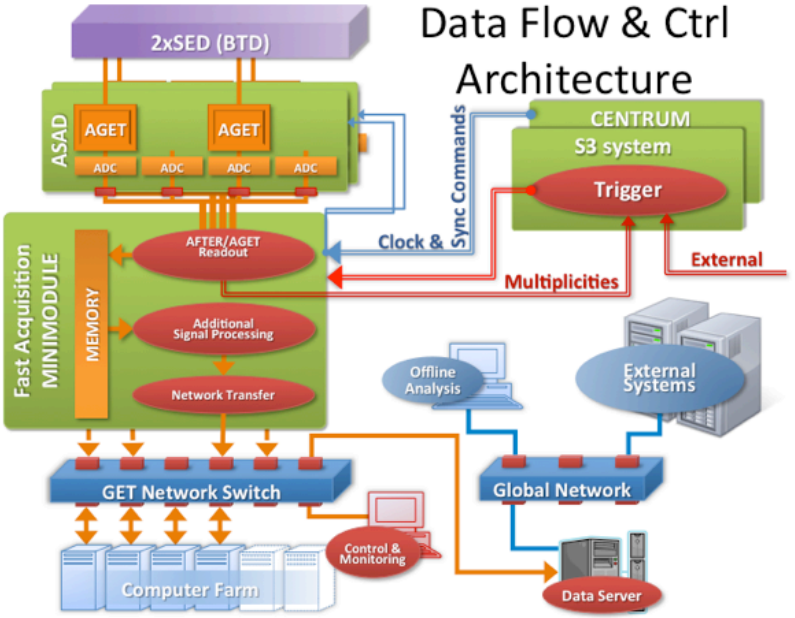




ASIC GET electronics/ ANR GET(SEDI)

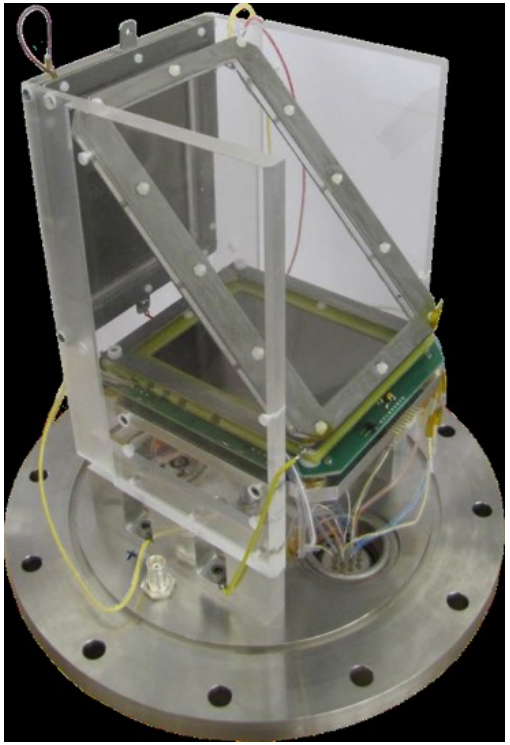
Real size prototype:

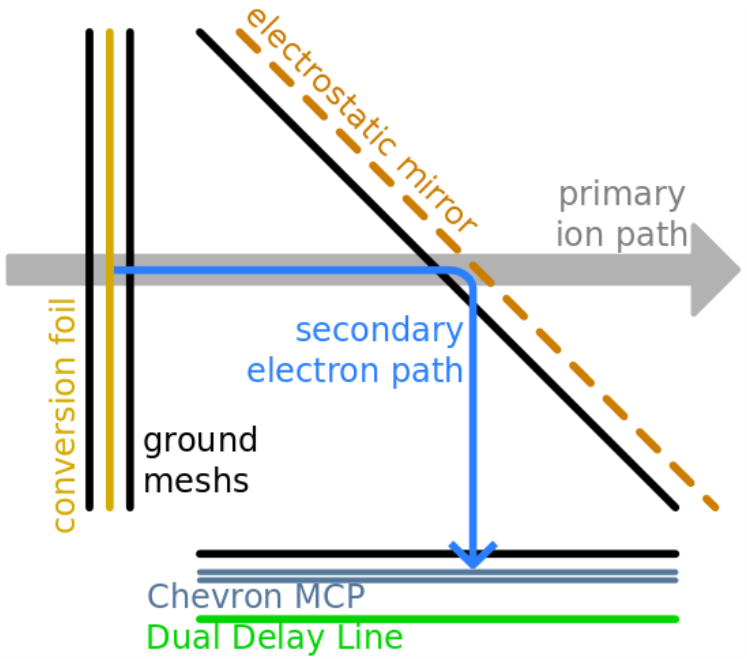
- Dimension ≃ 260 x 210 mm^2
- Active surface ≃ 200 x 140 mm^2
- Strongback with 92.5 % transmission for gap thickness homogeneity
- 67+47 cathode strips with 3 mm pitch
- Time resolution = 150 ps
- Spatial resolution = 1.5 mm FWHM



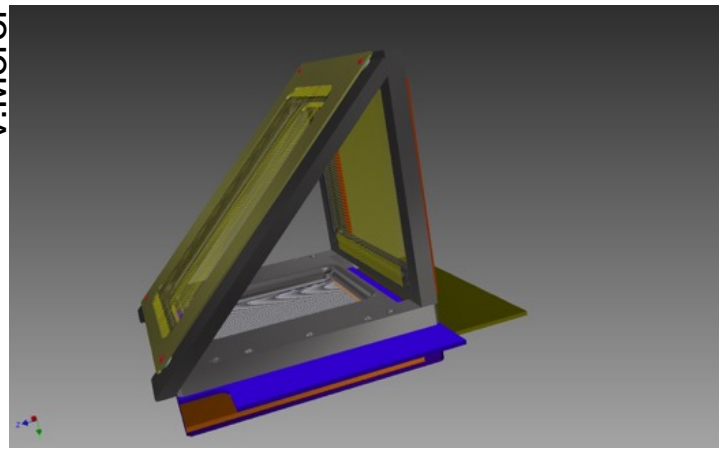
Courtesy of J. Pancin

ALTERNATIVE TOF DETECTOR FOR SHE
90° SED





V.Morel

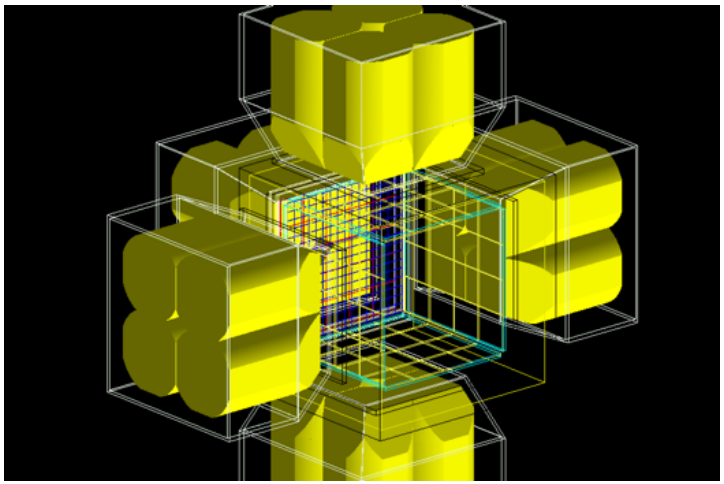


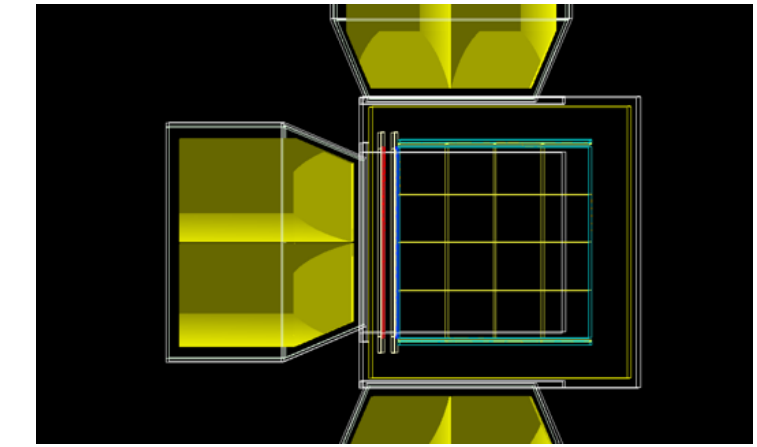
- Like TOF det. At SHIP (GSI)
- Few channels
- Limited size (80 mm wide)
- 90°/Thin
- fragile
- Design to put on a MW for large size (degraded spatial reso.)

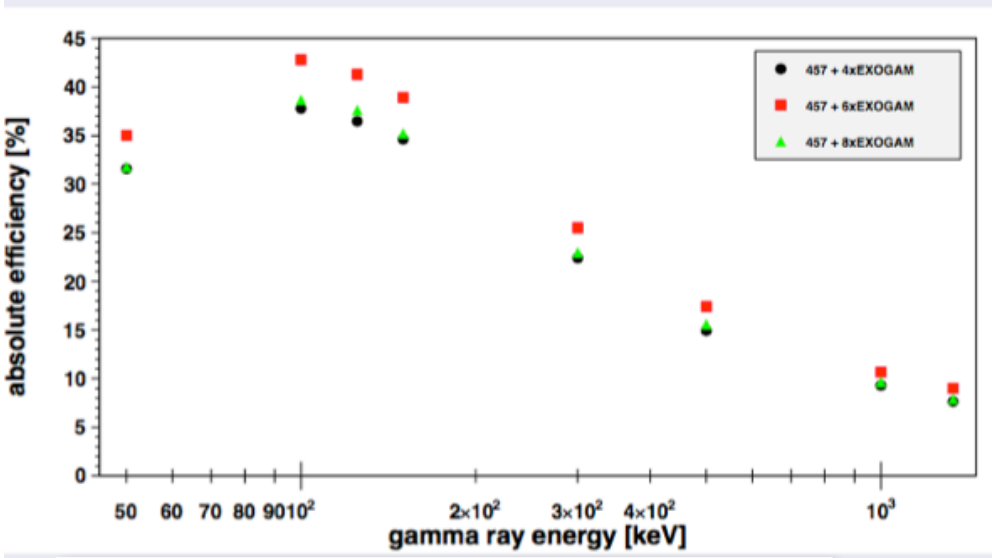
Courtesy of J. Pancin

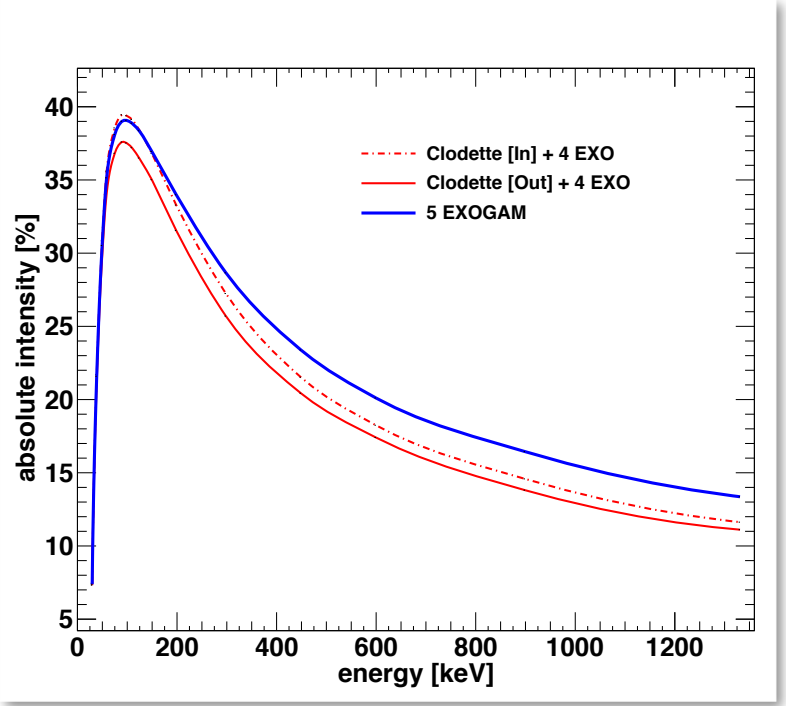
GERMANIUM DETECTOR

How many Ge are needed?
GEANT 4 simulation





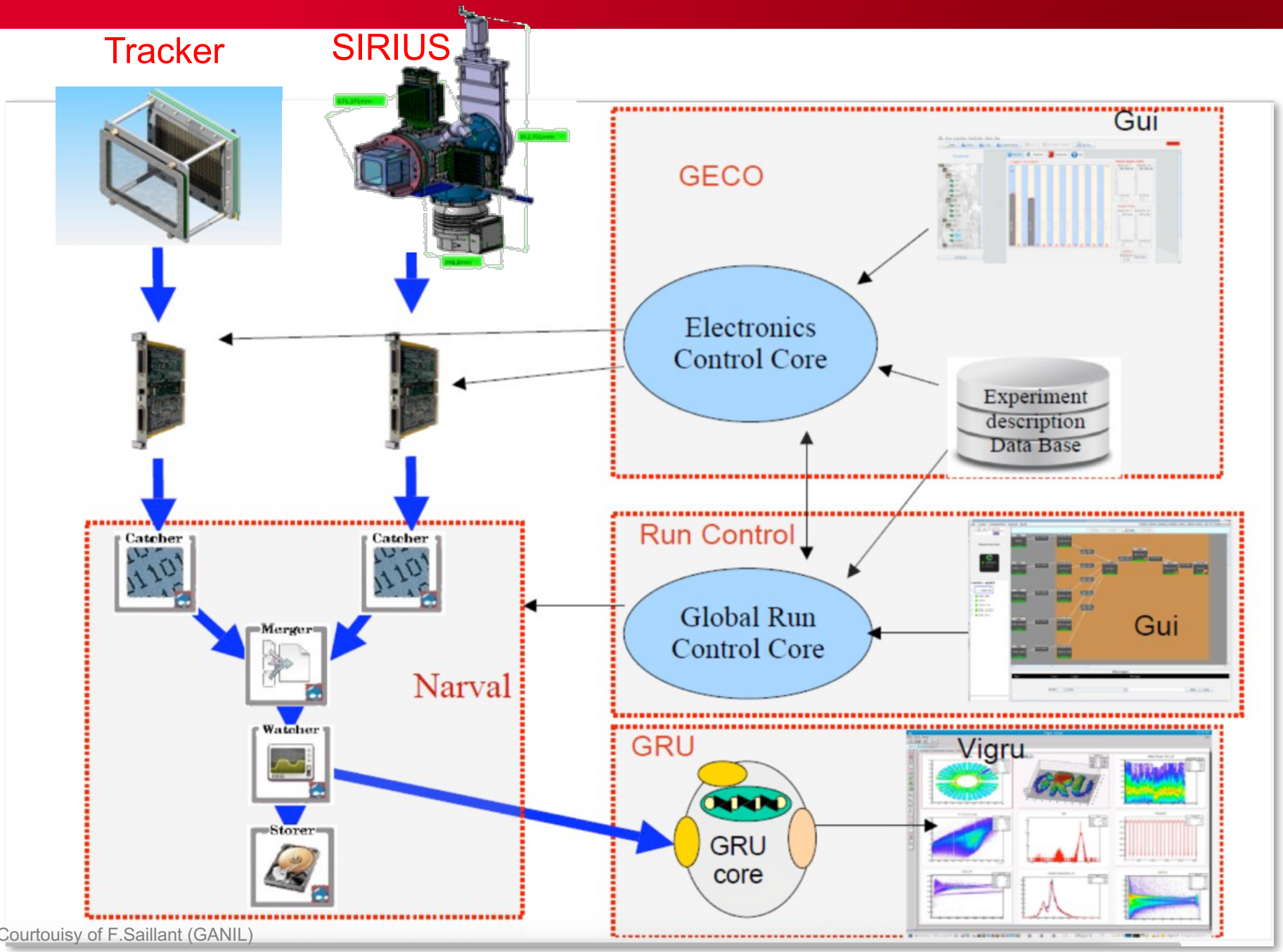




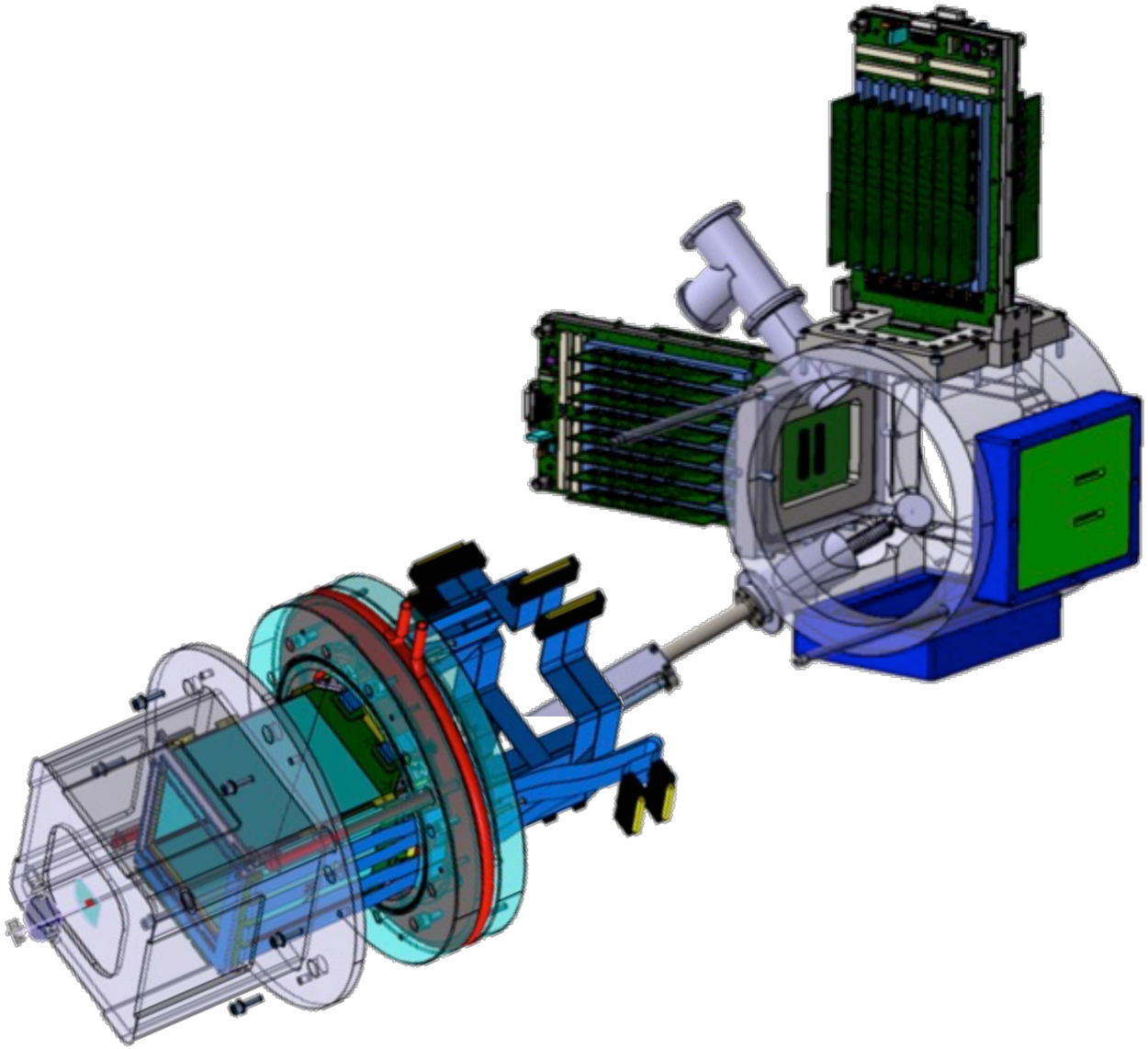
Realistic simulations
5 Exogam, DSSD, Veto, Tunnel and “chamber” with windows

Courtesy of A.Lopez Martens/Karl Hauschild

DATA ACQUISITION SYSTEM

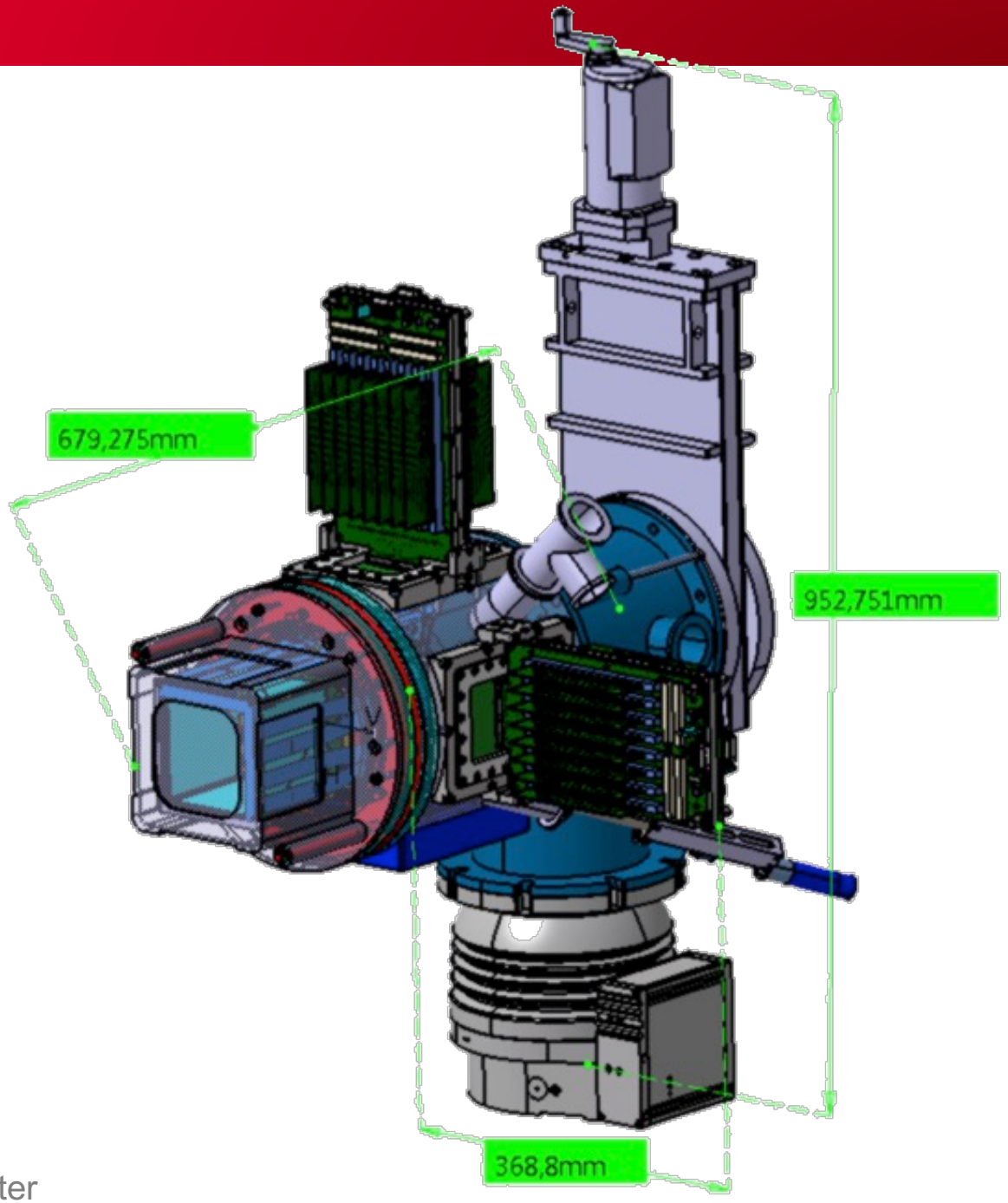


INFRASTRUCTURE



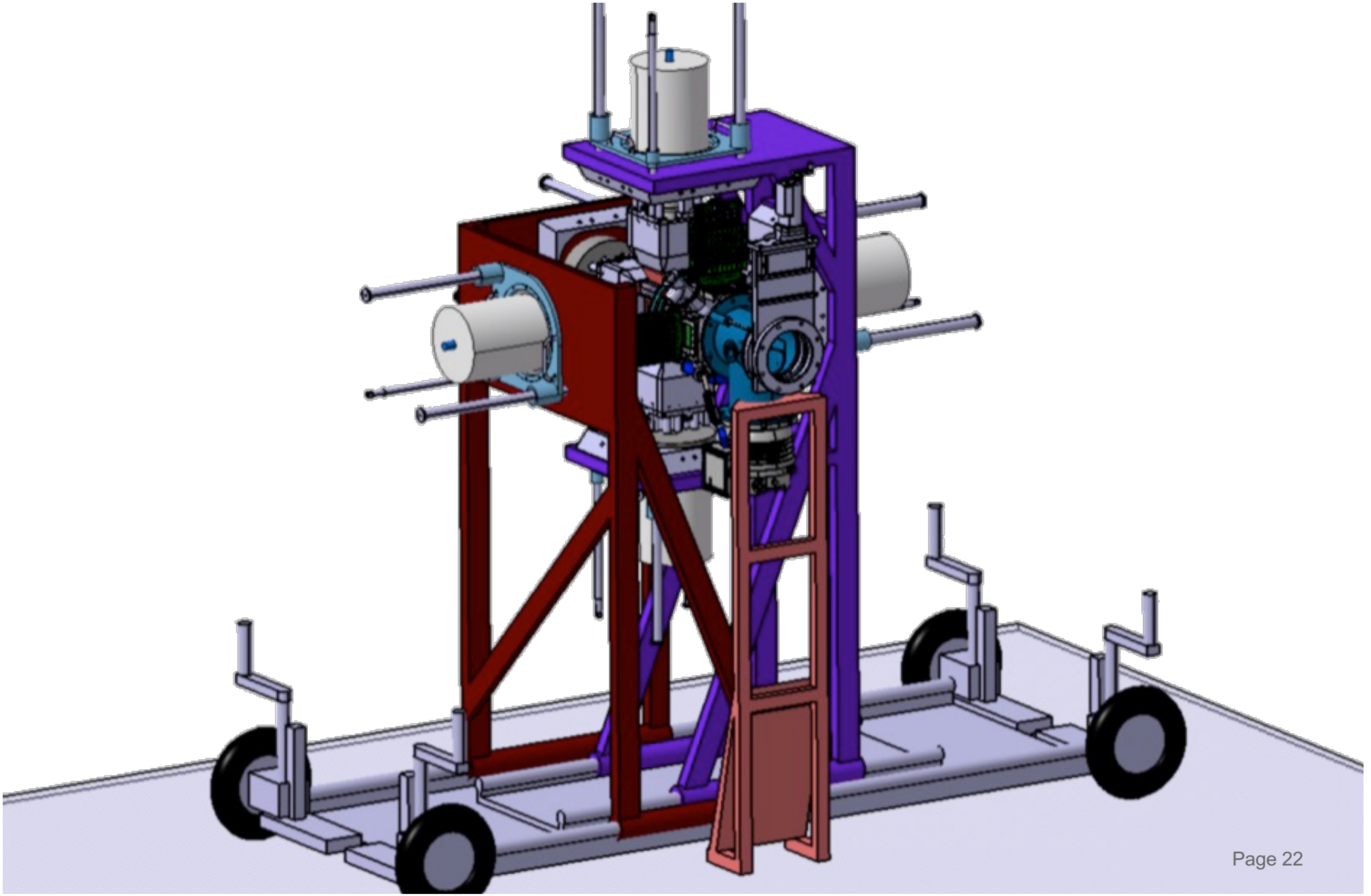
Courtesy of T. Goeltzenlichter

INFRASTRUCTURE



Courtesy of T. Goeltzenlichter

INFRASTRUCTURE



STATUS & TO DO

FEE & Detectors

❑DSSD Instrumentation

- ❑ DSSD Prototype validated and the final version DSSD already **DELIVERED**
- ❑ Mother boards and daughter boards **TESTED**
- ❑ Detector measurements FEE & Numexo2 **ONGOING**
- ❑ DSSD Firmware to be developed **ONGOING**
- ❑ Pulse shape analysis **: Q1 2017**
- ❑ Production early **2017 ONGOING.**
- ❑ System Ready in **Q3 2017.**

Tunnel Instrumentation

- ❑ First detector Prototype **VALIDATED PARTIALLY**
- ❑ FEE Mother board prototype **ONGOING**
- ❑ Readout data interface to be developed
- ❑ Final version for the FADC DAC **(STILL IN CAD SYSTEM)**
- ❑ Prototype in 2017.
- ❑ System Ready in early 2018.

Infrastructure

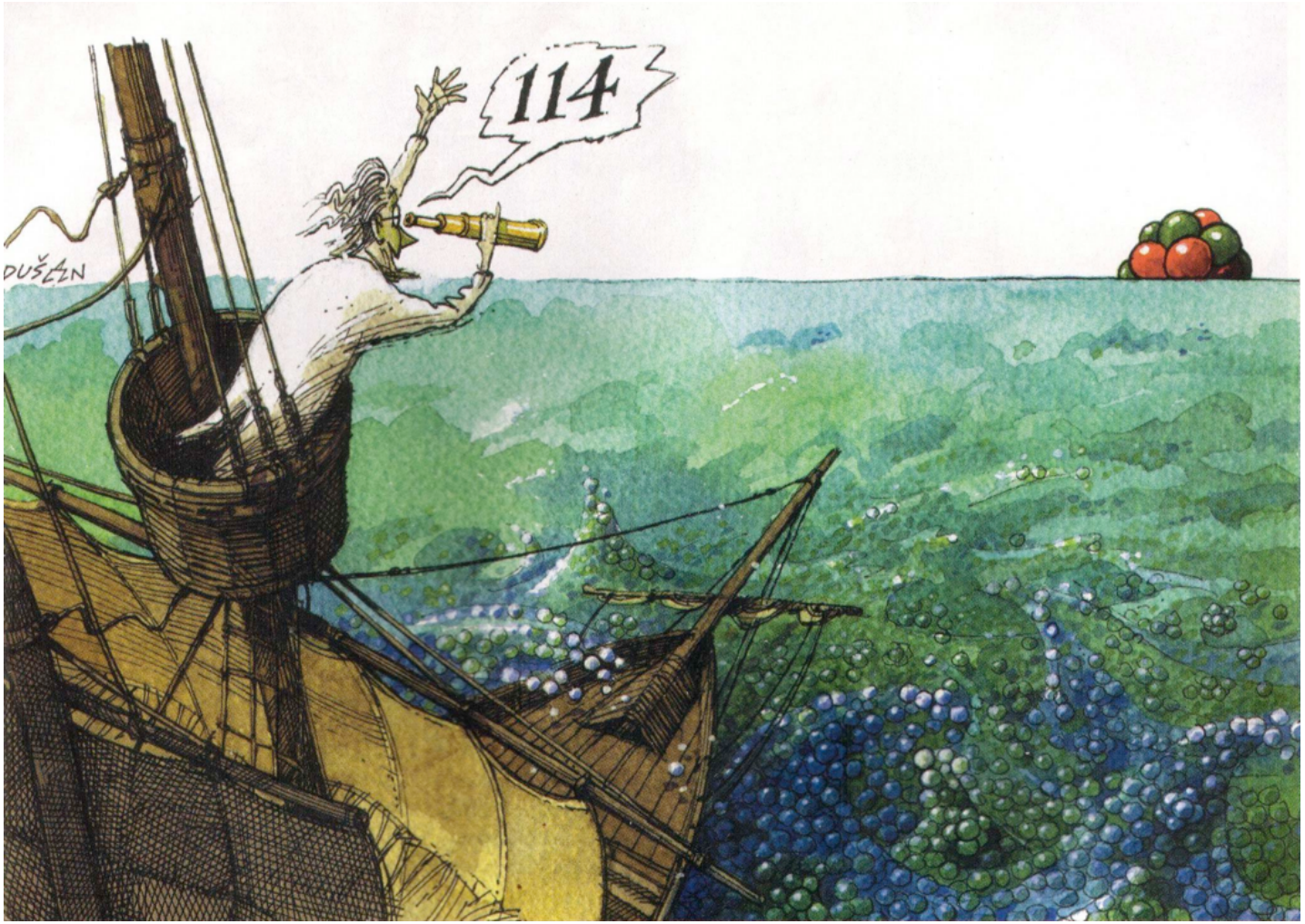
- ❑ Mechanical design :validated
- ❑ Production Q2 2017

Daq

- ❑ Traces of DSSD and TUNNEL will be recorded
- ❑ Online and off line analysis need to be written

END

Bon voyage to SUPERHEAVY Island



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