

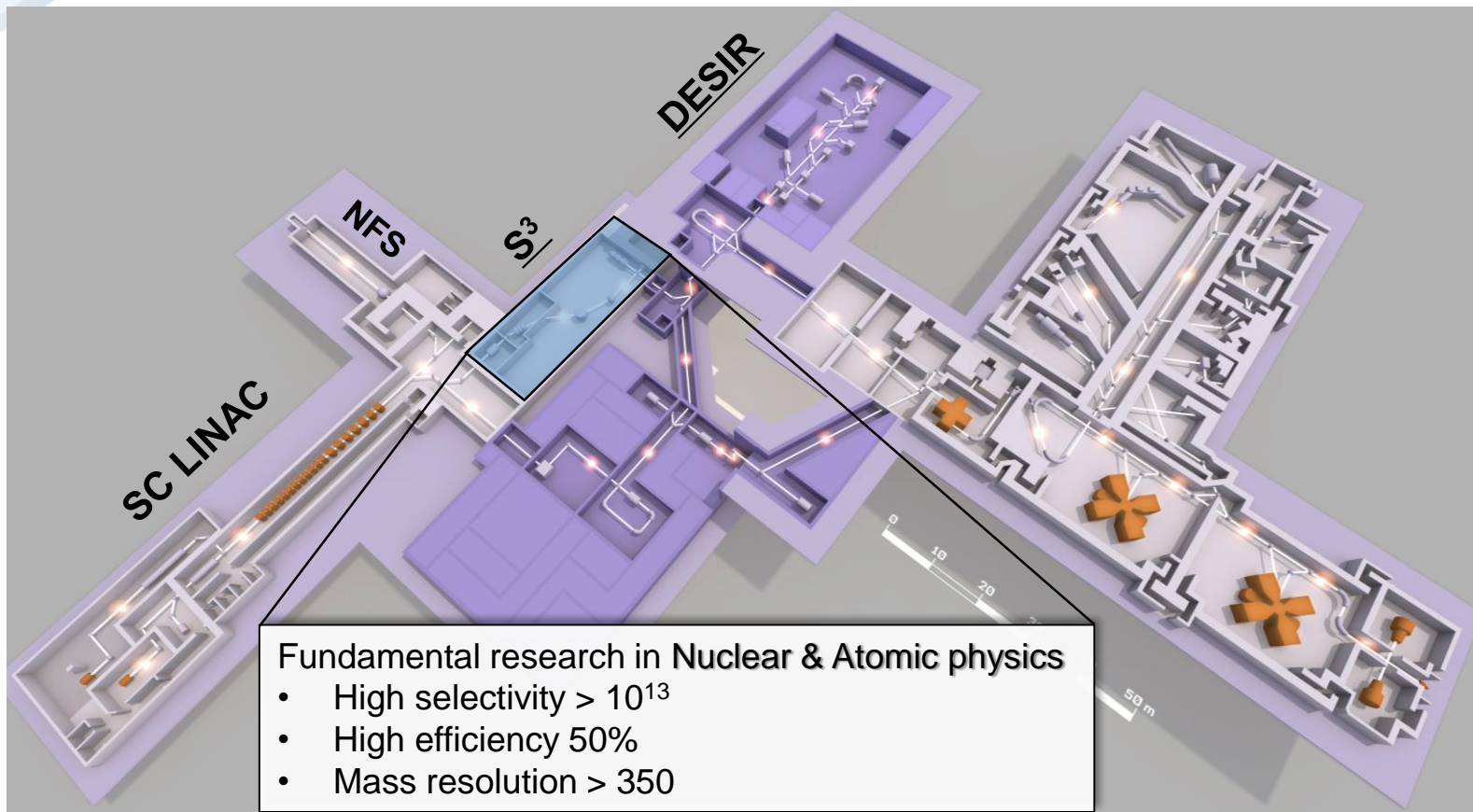
# Status of the $S^3$ and DESIR experimental installations

**Vladimir Manea**

IJCLab, Orsay, France  
GANIL, Caen, France

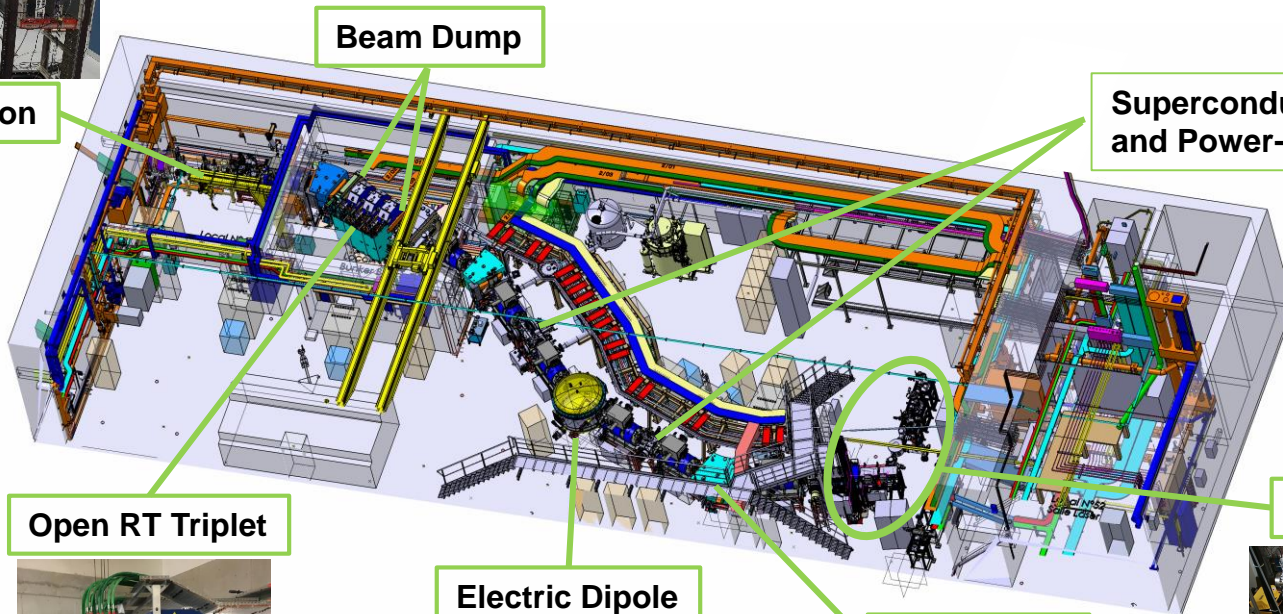
- ❑ SPIRAL2 facility and S<sup>3</sup> spectrometer
  - SIRIUS
  - S<sup>3</sup>-LEB
  
- ❑ DESIR
  - Updated layout and timeline
  - Status of the different experimental installations

Several detailed talks today and in the following days, as well as posters





- ❑ S<sup>3</sup> ready to start commissioning with beam mid-late 2023
- ❑ Day 1 experiments will begin as soon as commissioning is complete (>2024).



Target station

Beam Dump

Superconducting Multipole Triplets  
and Power-Supply Systems (x7)



S<sup>3</sup>-LEB

SIRIUS

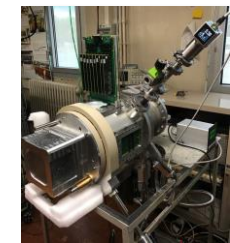
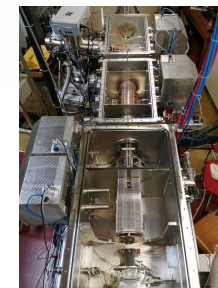
Open RT Triplet



Electric Dipole

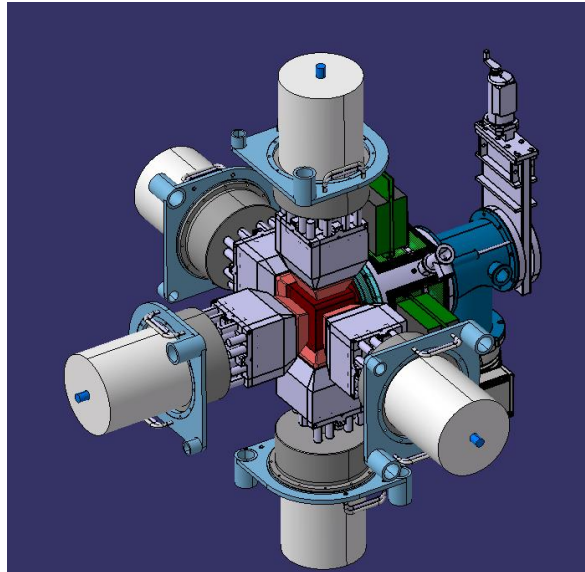


Dipoles (x3)



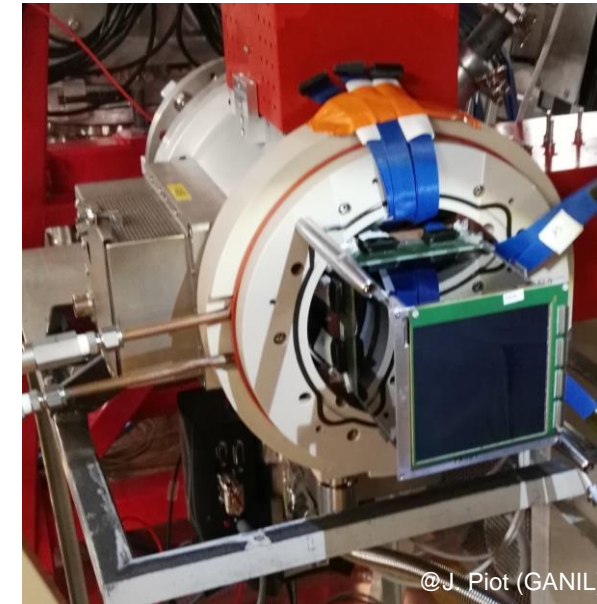
## Spectroscopy and Identification of Rare Isotopes Using S3

- ❑ Designed to study the structure of superheavy nuclei at the S<sup>3</sup> focal plane
- ❑ DSSD + tunnel detector + Ge clovers (+ tracker detector) in compact geometry



- ❑ SIRIUS installed at GANIL in March 2021
- ❑ DSSD and servitudes tested by June 2021
- ❑ Energy resolution of DSSD:
  - 20 keV FWHM for single strip
  - 24 keV FWHM for all strips

- ❑ Important milestones for end of 2021



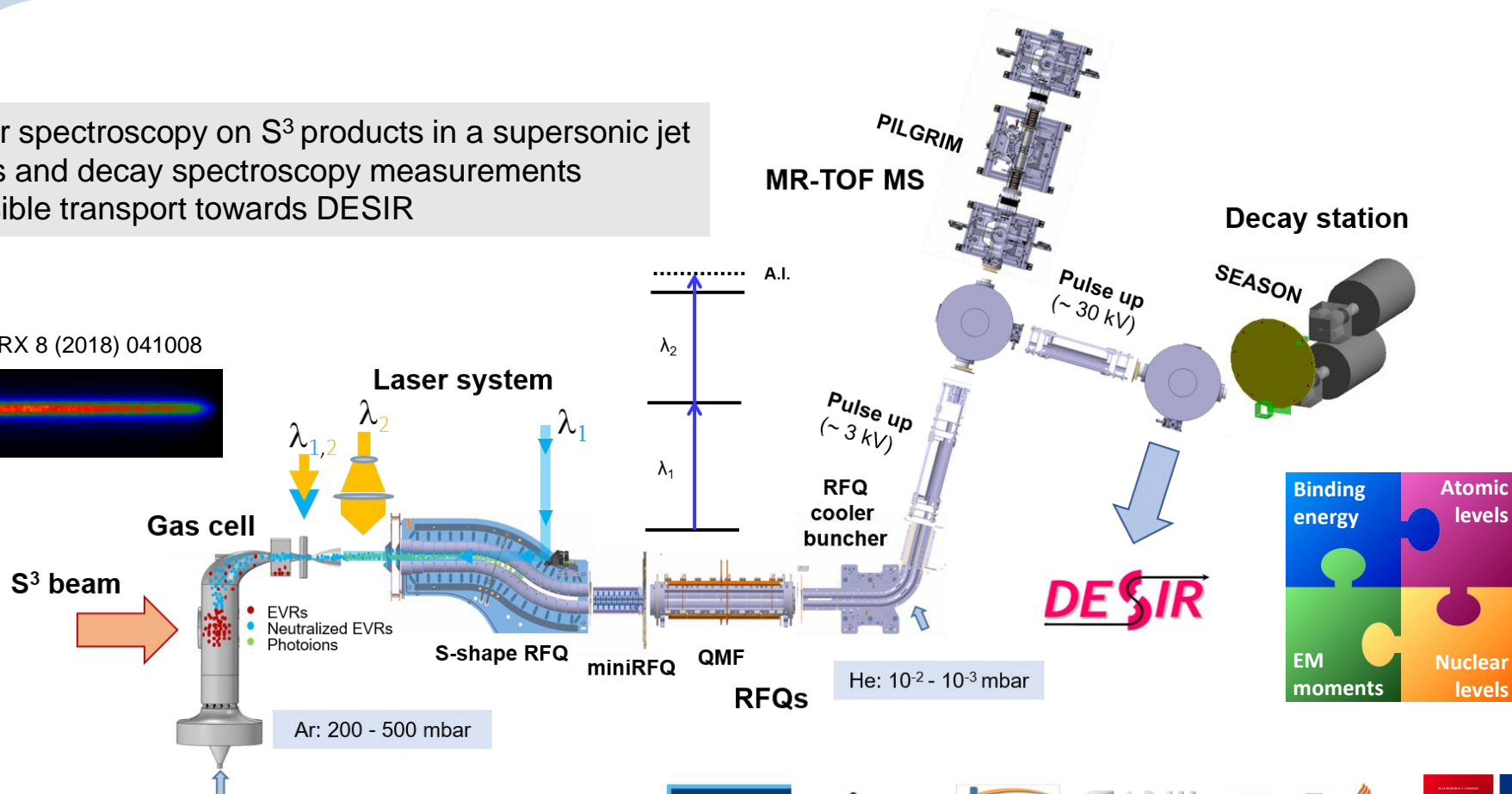
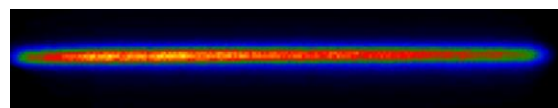
@J. Piot (GANIL)

Dedicated talks by Rikel Chakma and Zoé Favier today

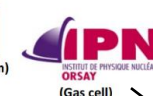
SIRIUS has been funded by the CPIER (Contrat Plan Etat Inter Régional) and by the European Union and Région Normandie through the FEDER grant SoSIRIUS.

- ❑ Laser spectroscopy on S<sup>3</sup> products in a supersonic jet
- ❑ Mass and decay spectroscopy measurements
- ❑ Possible transport towards DESIR

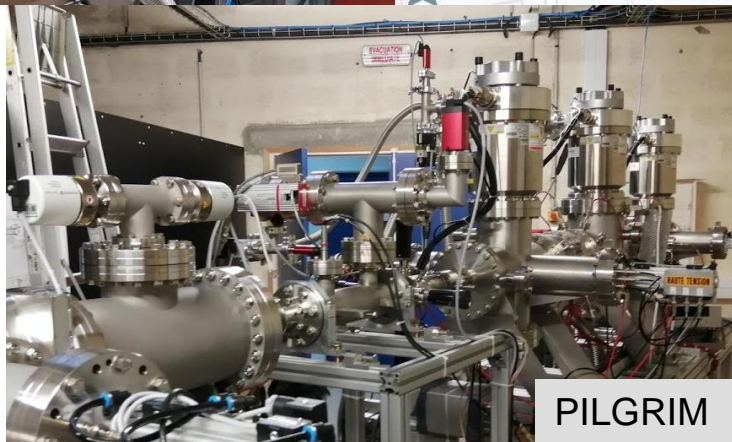
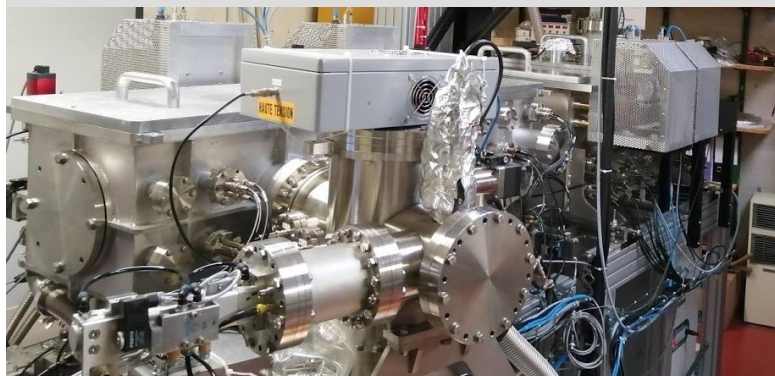
A. Zadornaya et al., PRX 8 (2018) 041008



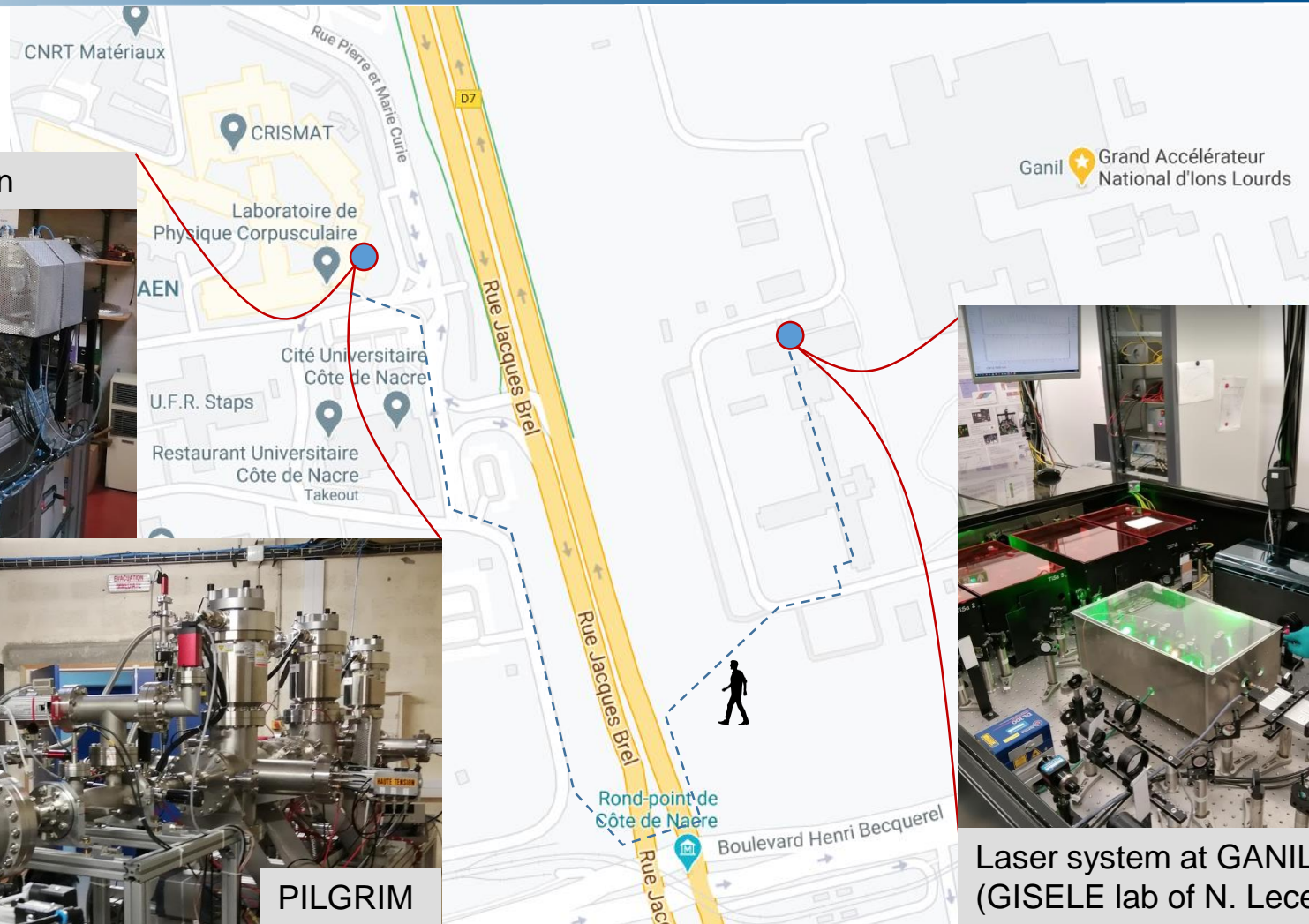
Talk by Iain Moore on scientific opportunities on Tuesday



## RFQs and MR-TOF MS at LPC Caen

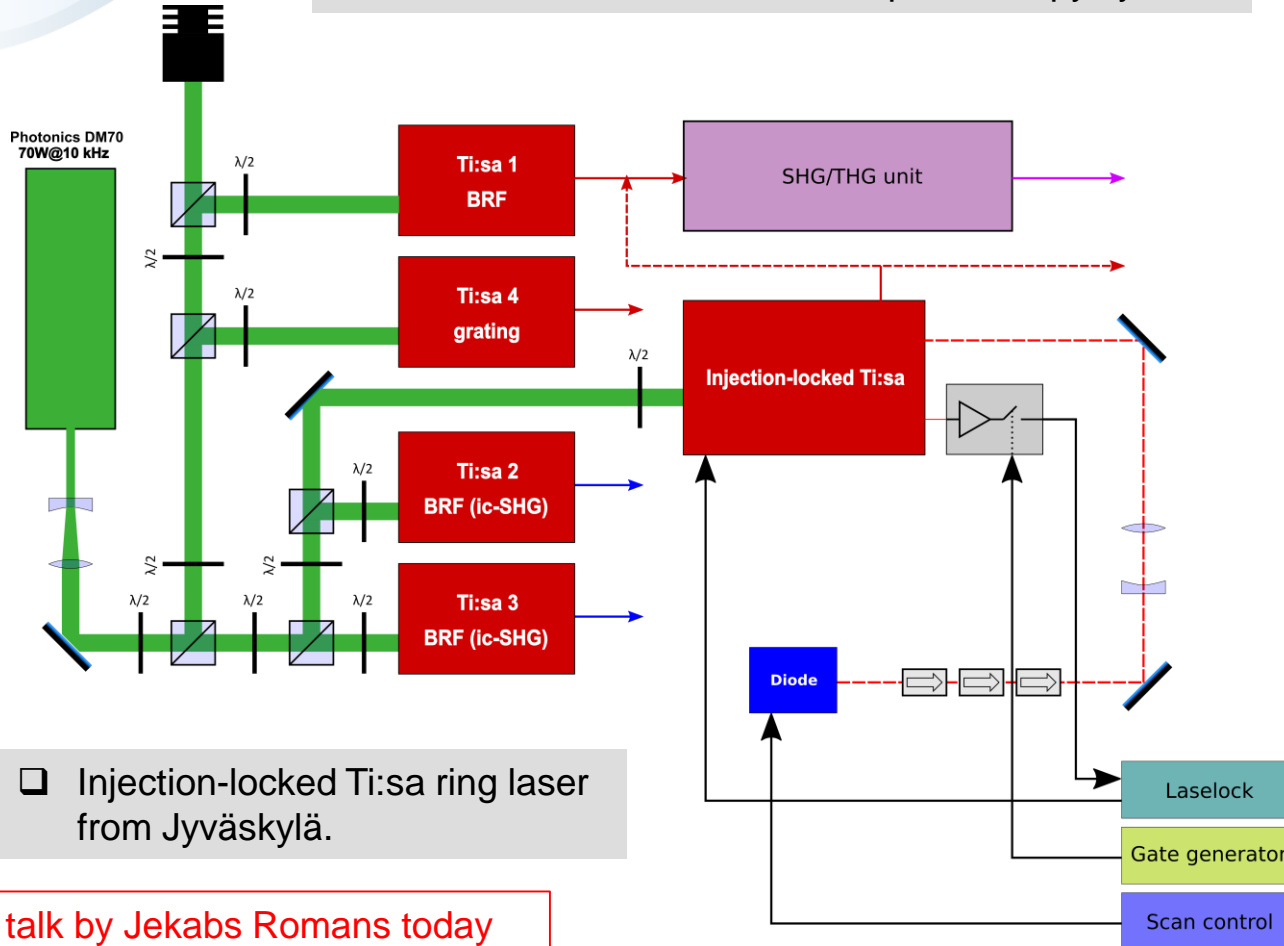


PILGRIM

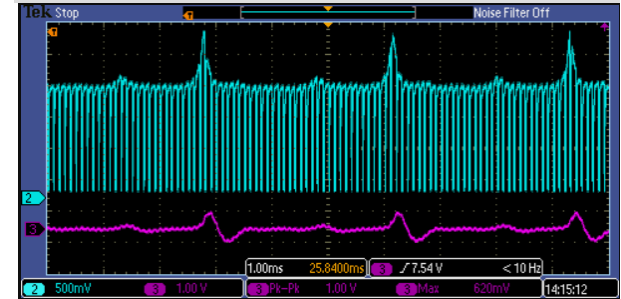


Laser system at GANIL  
(GISELE lab of N. Lecesne)

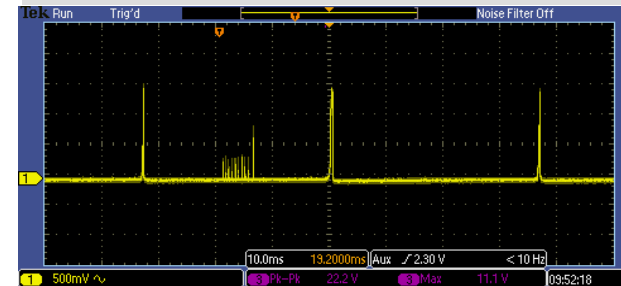
☐ Towards a narrowband laser spectroscopy system



Amplifier output



FPI image of cavity output

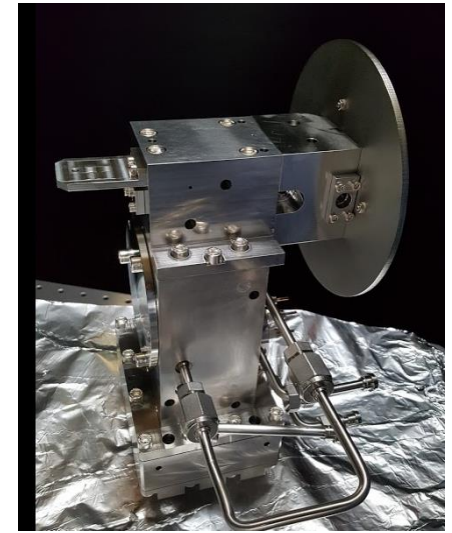
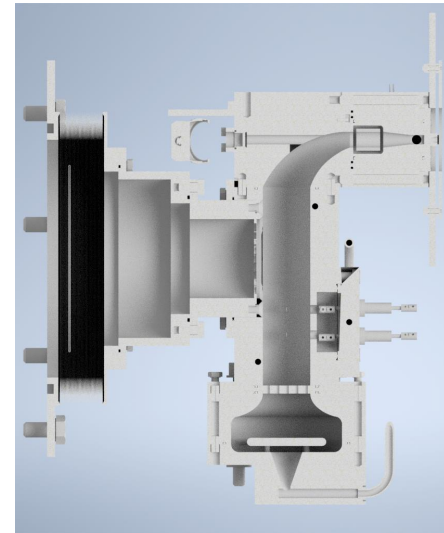
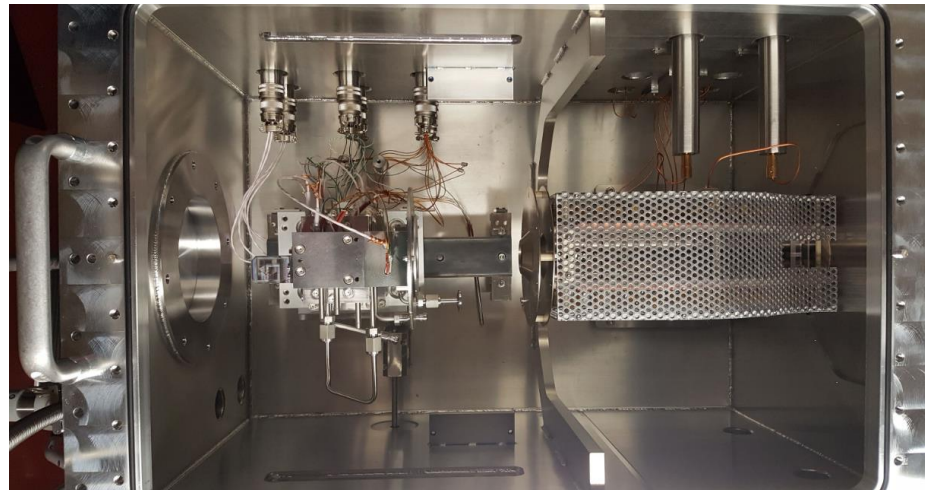


Dedicated talk by Jekabs Romans today

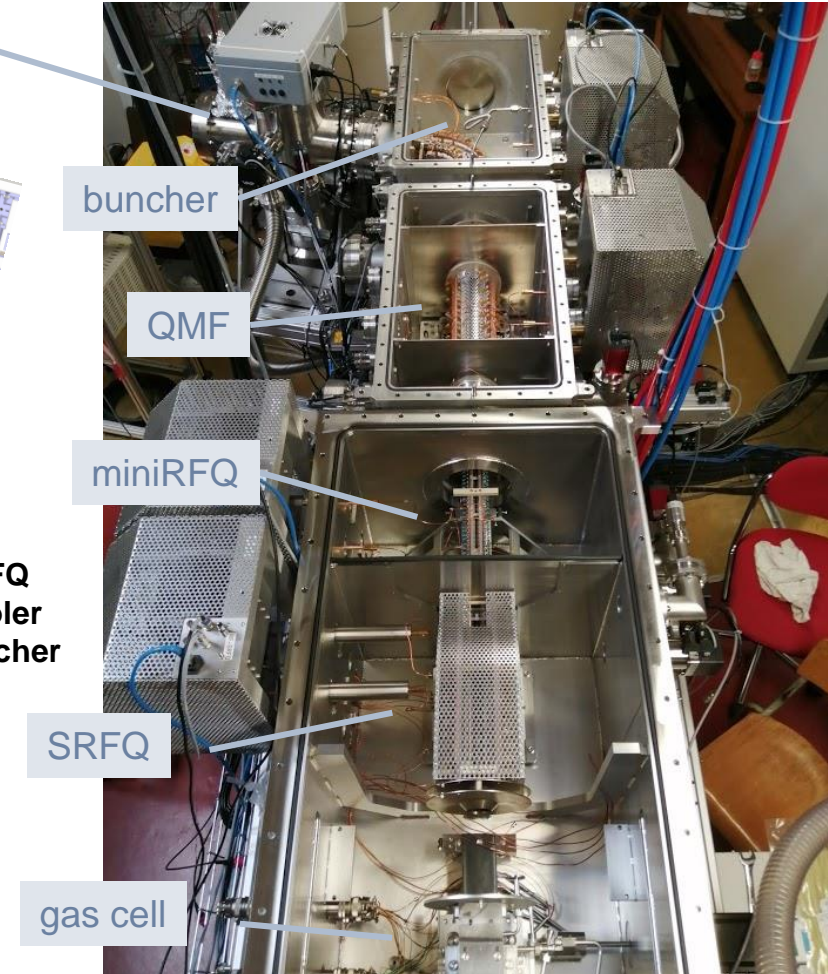
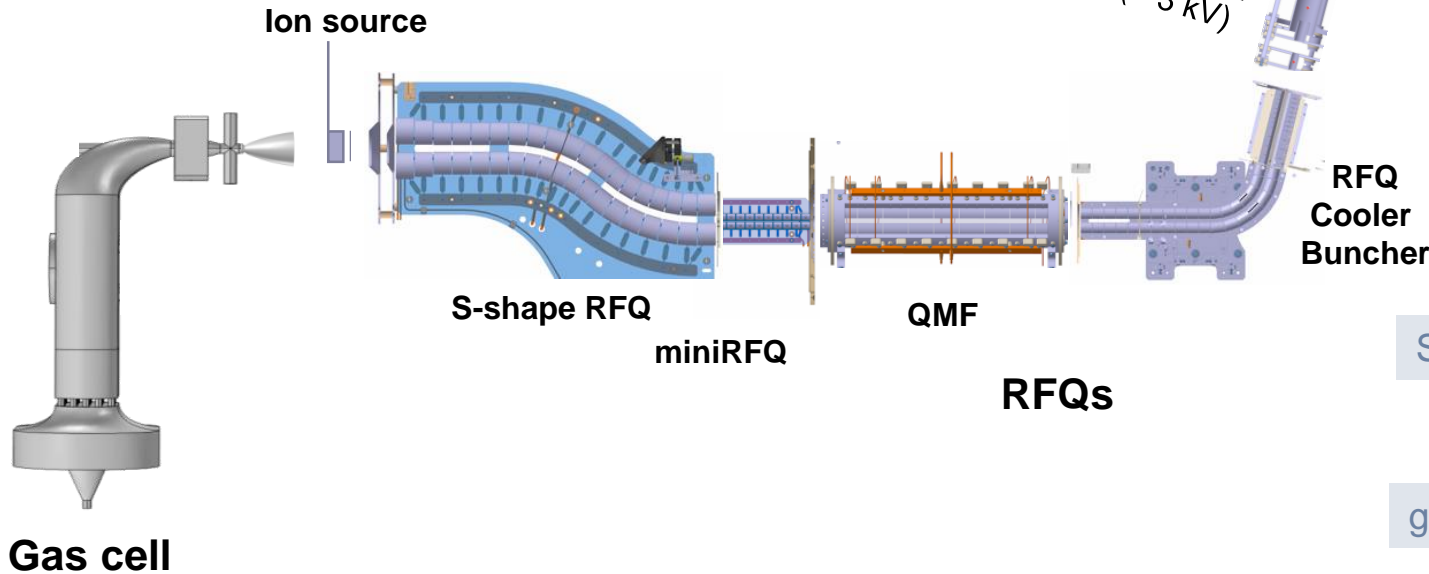




- Assembly and installation
- Connection to gas injection system
- Cabling of electrodes, filaments and baking system

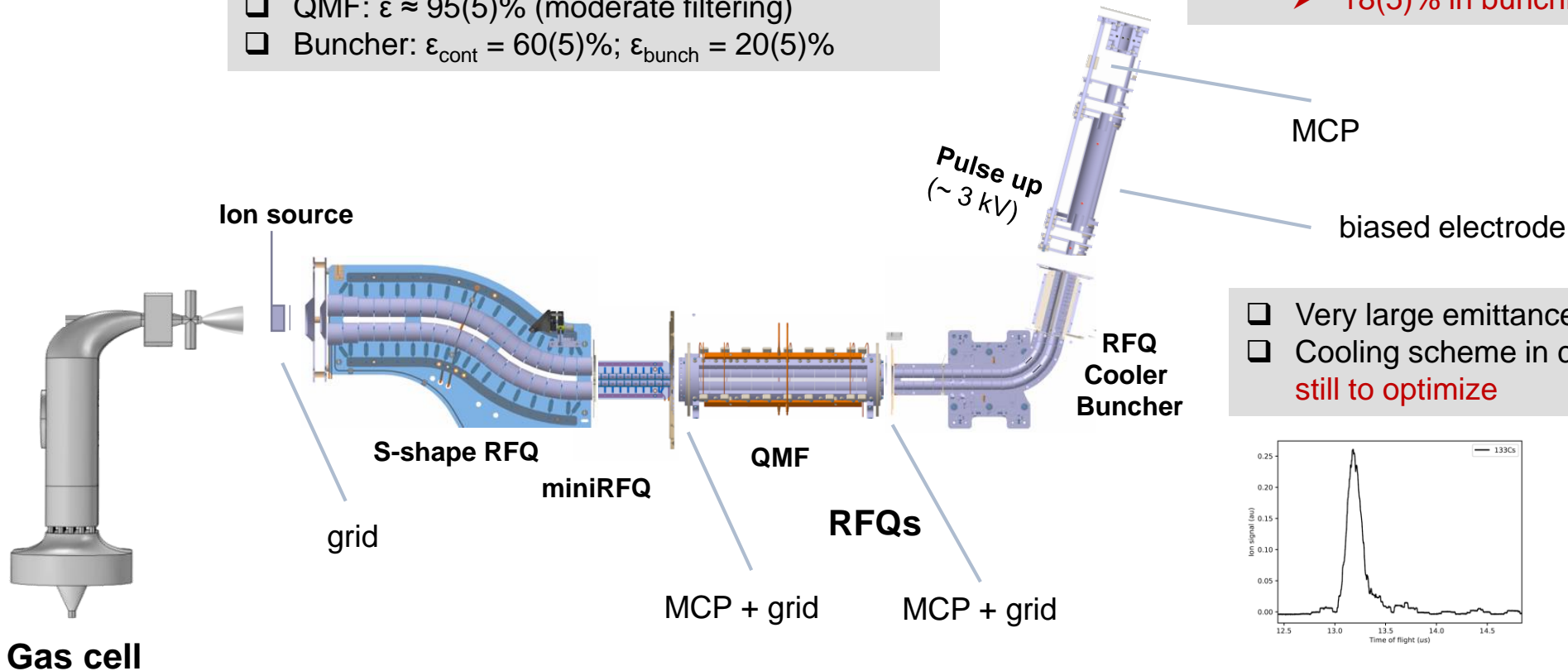


- Connection and alignment of all RFQs in 2020

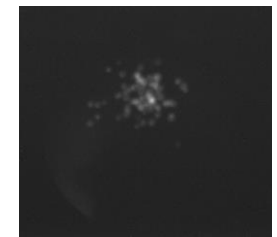
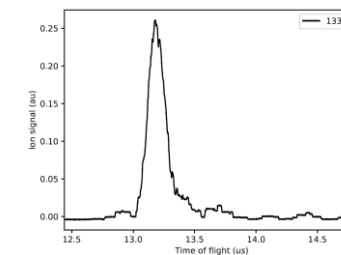


- S-RFQ + miniRFQ:  $\epsilon \approx 95(5)\%$
- QMF:  $\epsilon \approx 95(5)\%$  (moderate filtering)
- Buncher:  $\epsilon_{\text{cont}} = 60(5)\%$ ;  $\epsilon_{\text{bunch}} = 20(5)\%$

- Global efficiency with alkali source:
  - 55(5)% continuous
  - **18(5)% in bunching**



- Very large emittance source
- Cooling scheme in cooler-buncher **still to optimize**



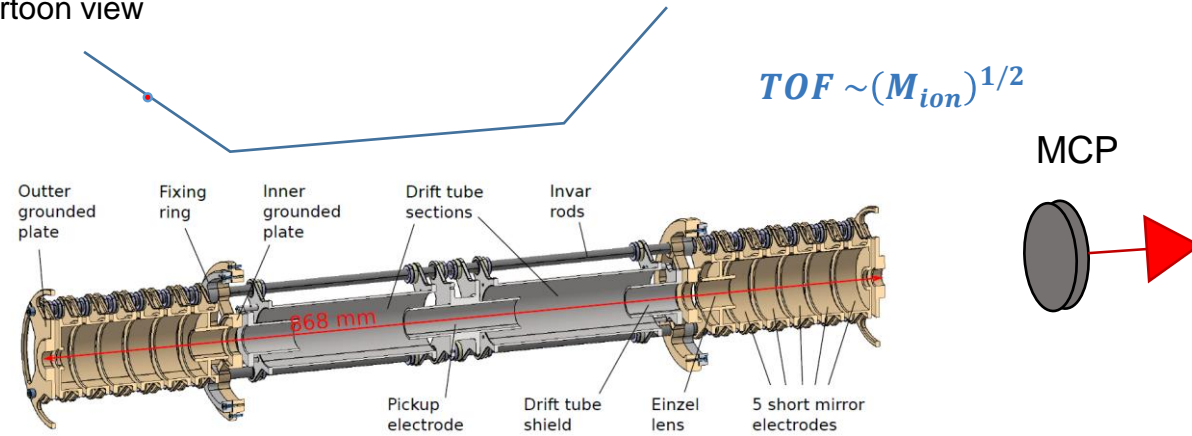
## Piège à Ions Lourds du GANIL pour la Résolution des Isobares en Masse



Pierre Delahaye, Pierre Chauveau,  
Blaise-Maël Retailleau and LPC Caen



Cartoon view



Pierre Chauveau, PhD thesis, Université de Caen Normandie (2016)  
Pierre Chauveau et al., Nucl. Instrum. Meth. B **376**, 211-215 (2016)

Multi-reflection time-of-flight mass spectrometer

- PILGRIM built in collaboration with the University of Greifswald.
- Design close to the one used at ISOLTRAP.
- Device fully operational.

## Piège à Ions Lourds du GANIL pour la Résolution des Isobares en Masse



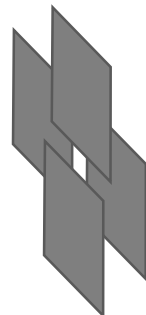
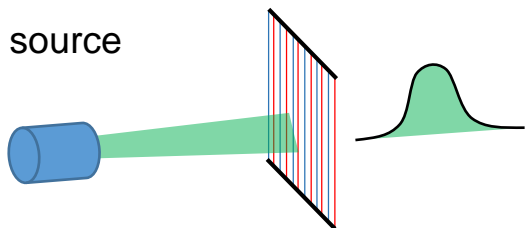
Pierre Delahaye, Pierre Chauveau,  
Blaise-Maël Retailleau and LPC Caen



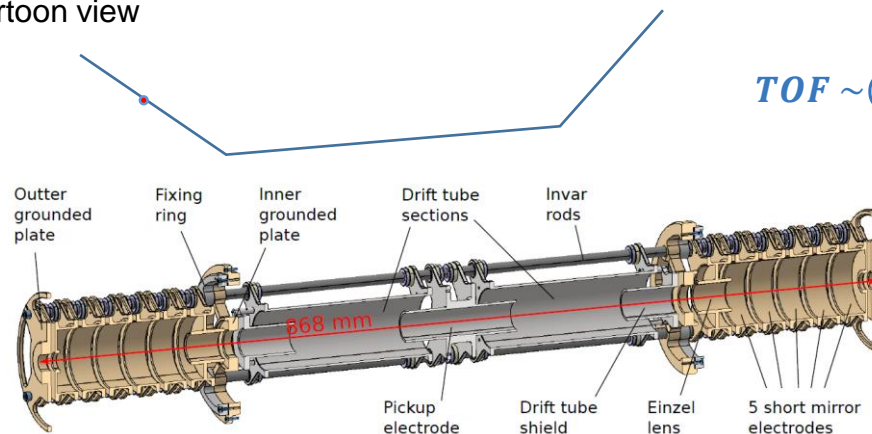
Bradbury-Nielsen  
beam gate

collimators

Ion source

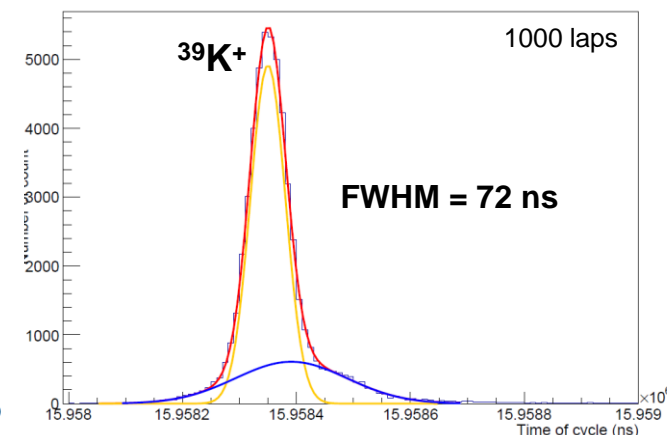
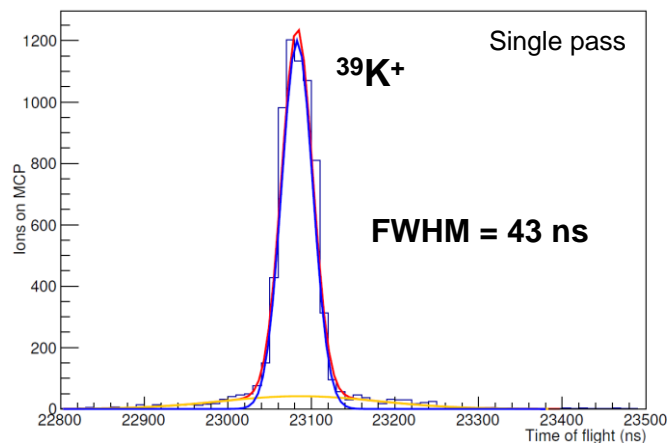
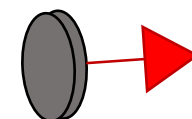


Cartoon view



$$TOF \sim (M_{ion})^{1/2}$$

MCP



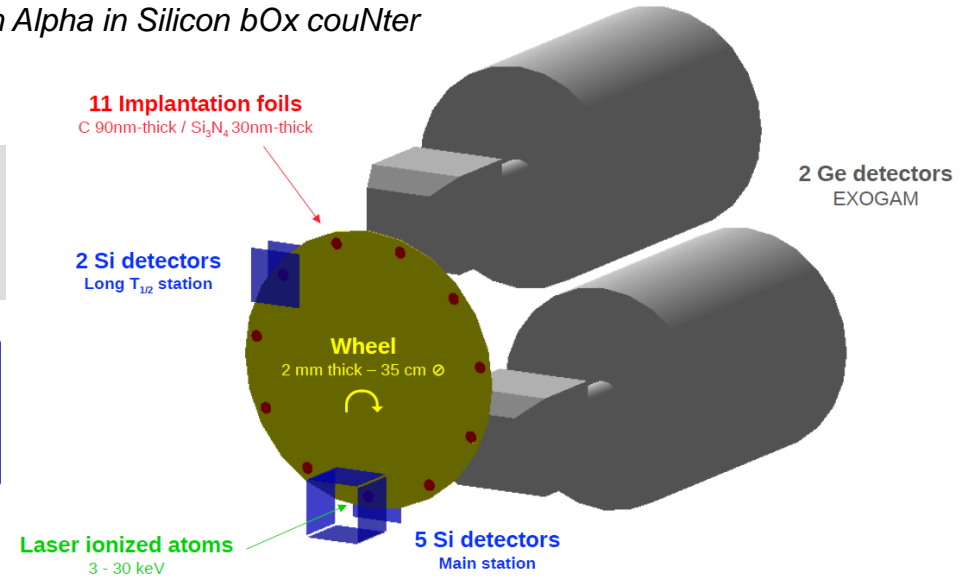
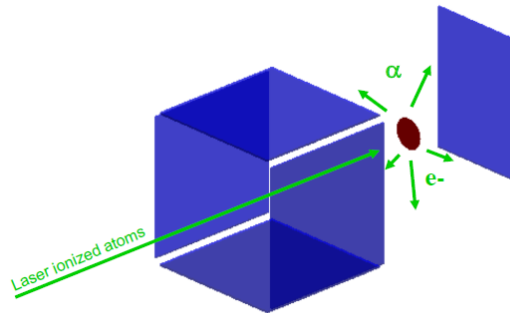
- Preliminary tests performed using alkali ion source and BNG to chop the beam.
- $R > 10^5$  and low  $10^{-7}$  mass accuracy
- Connection to buncher completed, pending injection tests.

## Spectroscopy Electron Alpha in Silicon bOx couNter

- Design study of a windmill-type decay spectroscopy station
- Alphas, conversion electrons, gammas and fission fragments.
- Funded by the ANR

### 5 Si detectors (BB7 from Micron)

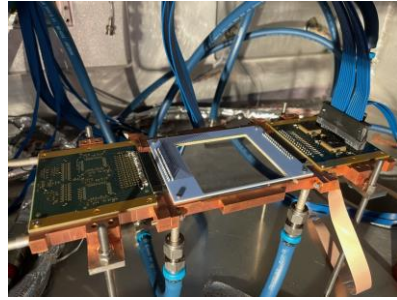
- ✓ Thickness: 1 mm
- ✓ Active area: 64 x 64 mm<sup>2</sup>
- ✓ Number of strips: 32 x 32
- ✓ Strip pitch: 2 mm



M. Vandebrouck, T. Goigoux  
and E. Rey-Herme



ANR  
AGENCE  
NATIONALE  
DE LA  
RECHERCHE

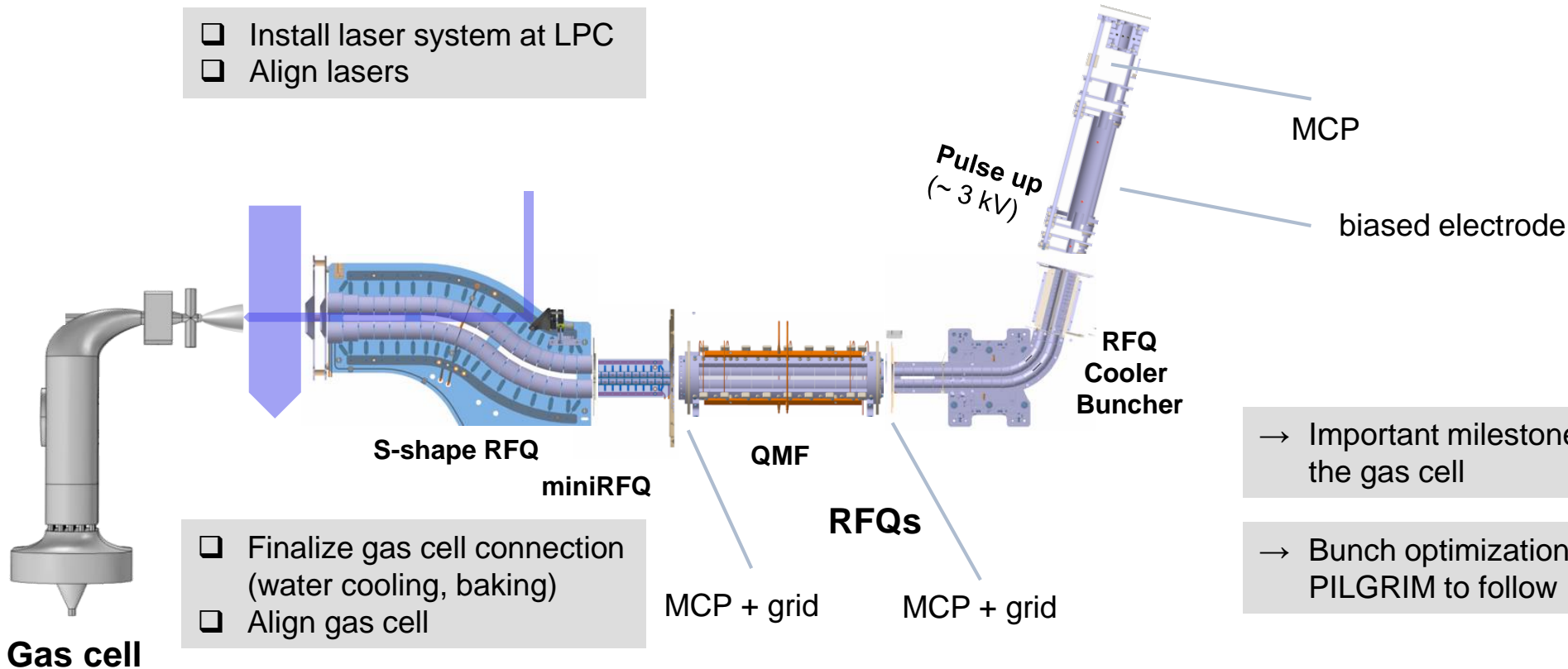


- Design almost complete, tests of Si detectors ongoing.

More details by Emmanuel Rey-Herme on Tuesday

✓ Laser safety installation completed and validated at LPC

- Install laser system at LPC
- Align lasers

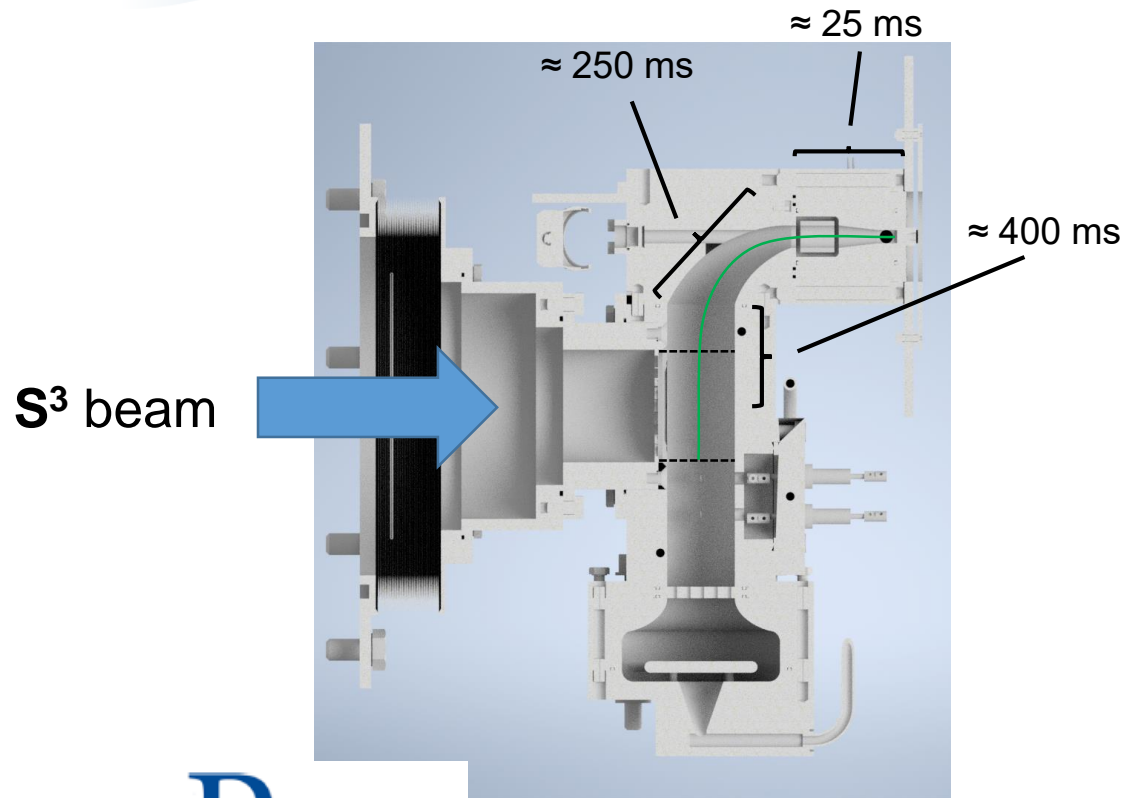


- Finalize gas cell connection (water cooling, baking)
- Align gas cell

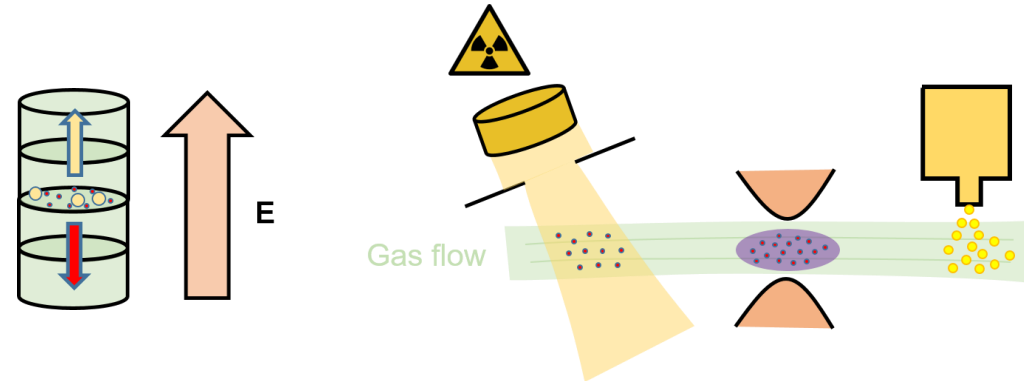
→ Important milestone: ionization in the gas cell

→ Bunch optimization and injection to PILGRIM to follow

## Fast Radioactive Ion Extraction and Neutralization Device for S<sup>3</sup>



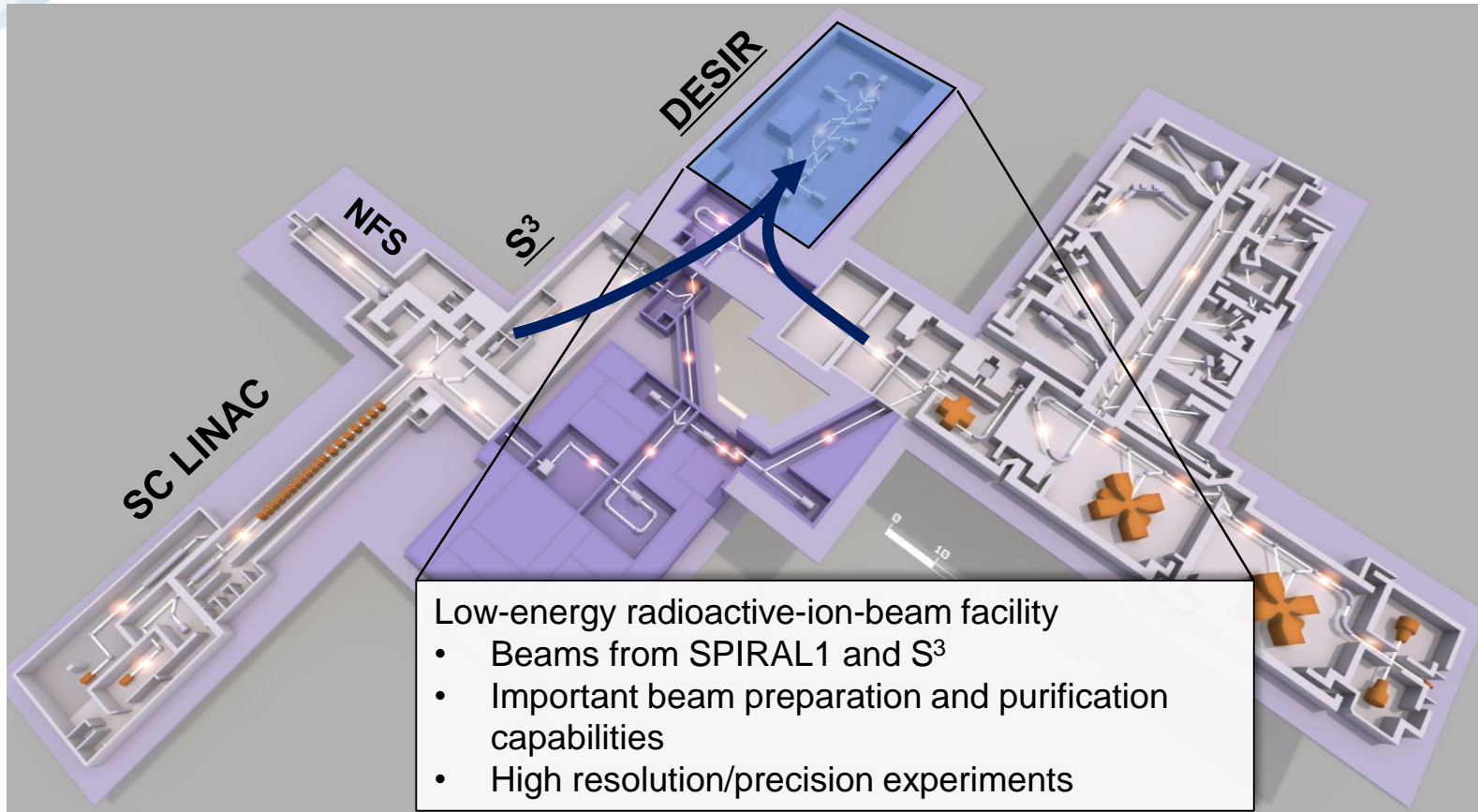
- Current version of the S<sup>3</sup>-LEB gas cell has a typical extraction time around 500 ms (enough for day-1 experiments).
- ANR Young Researcher funding obtained (coord. V. Manea).

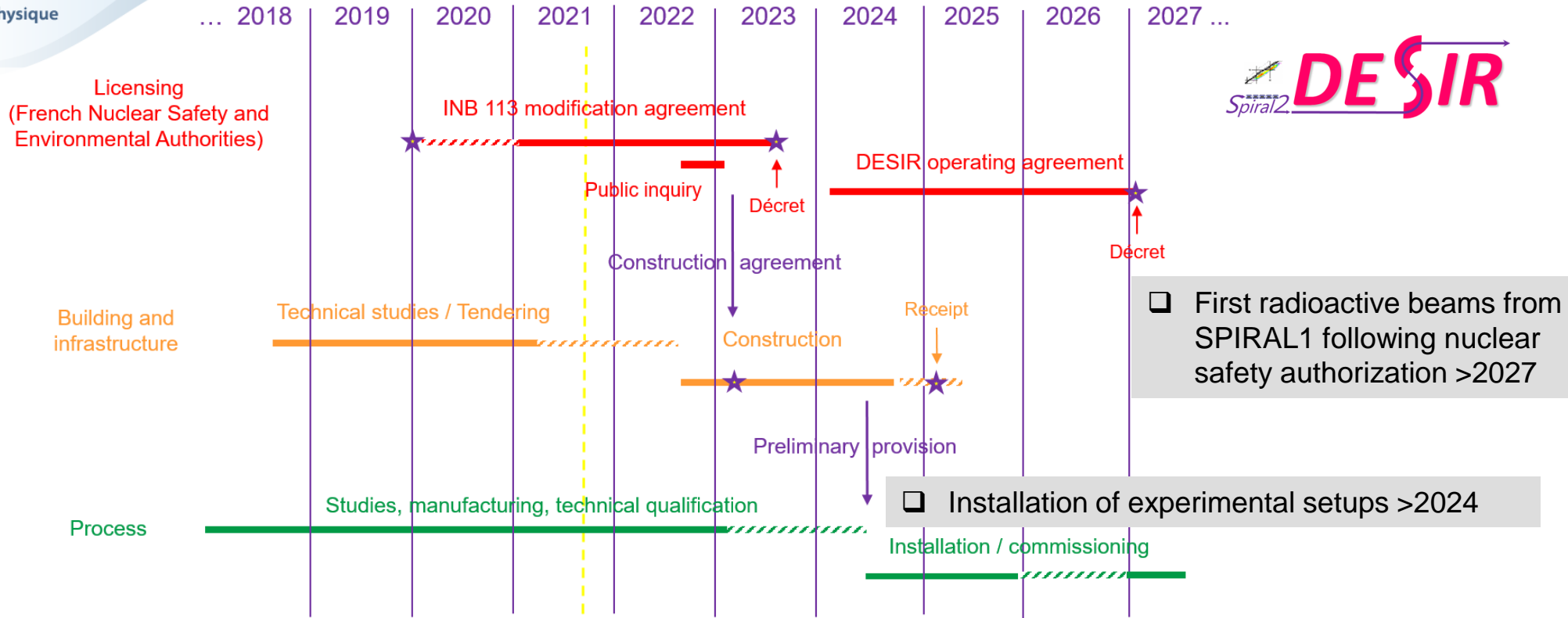


- ANR Young Researcher funding obtained (coord. V. Manea).
- Postdoc position will be opened



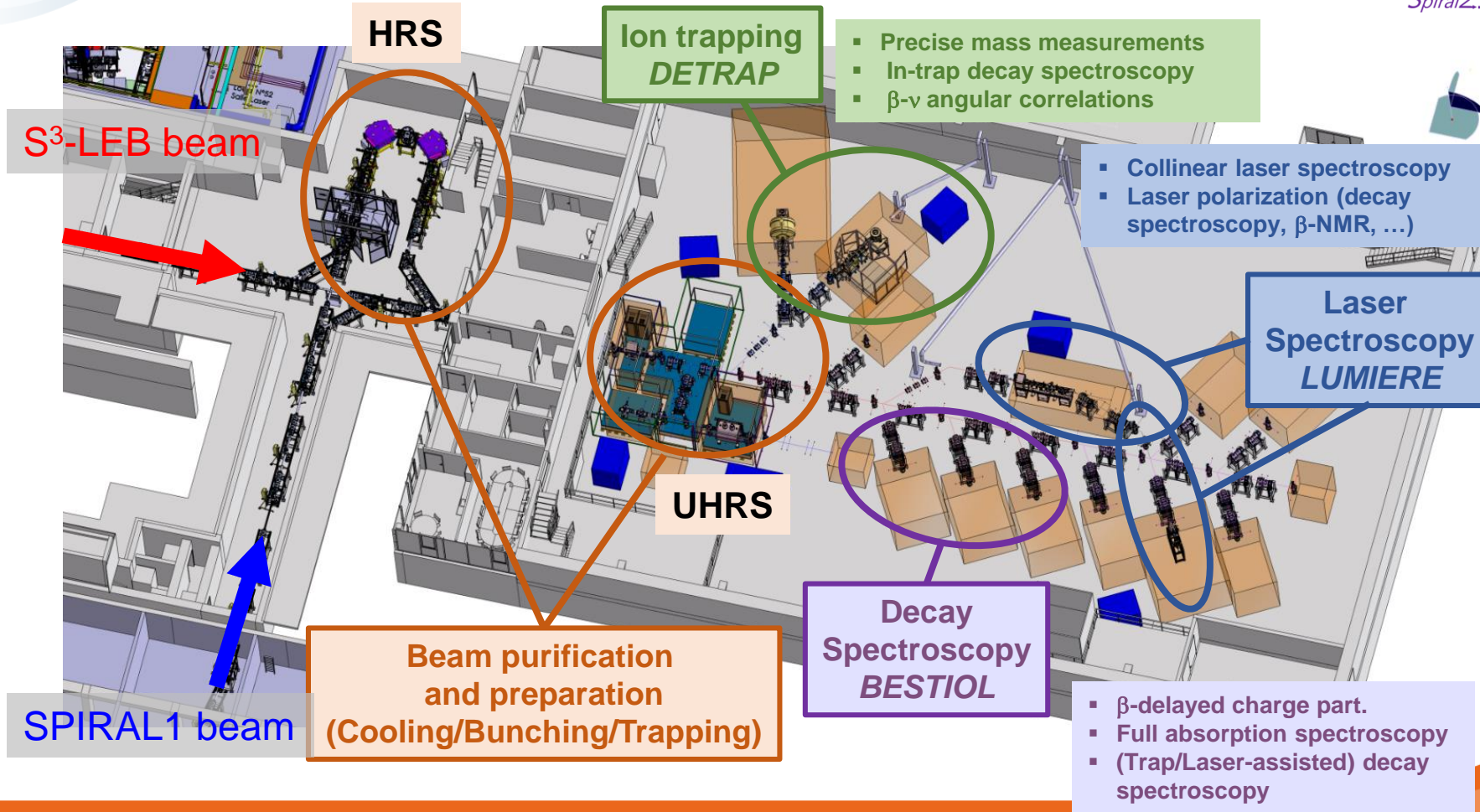
*Désintégration, excitation et stockage des ions radioactifs*

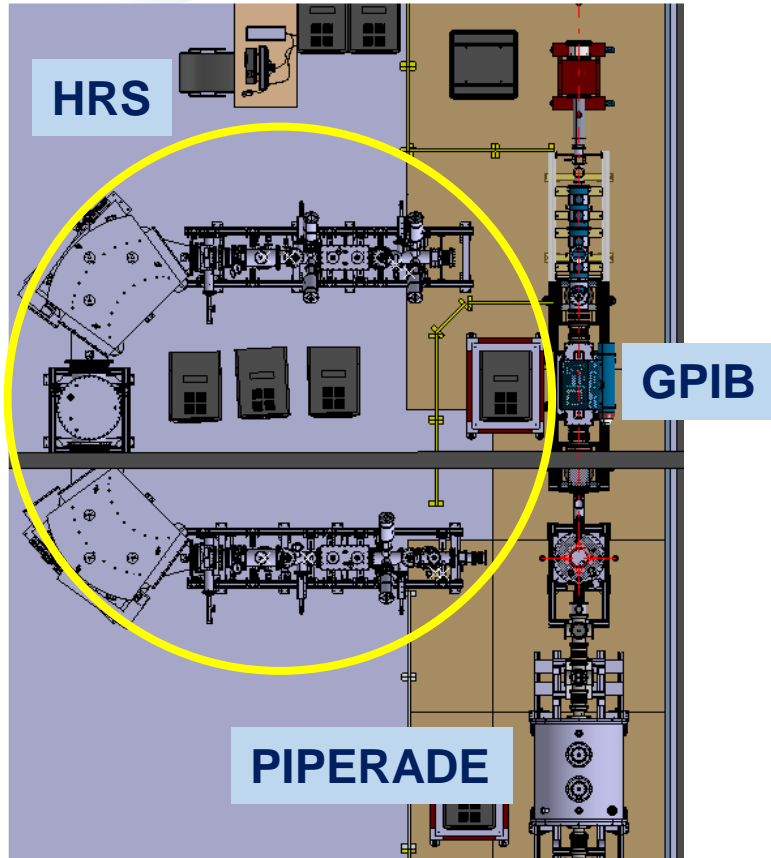




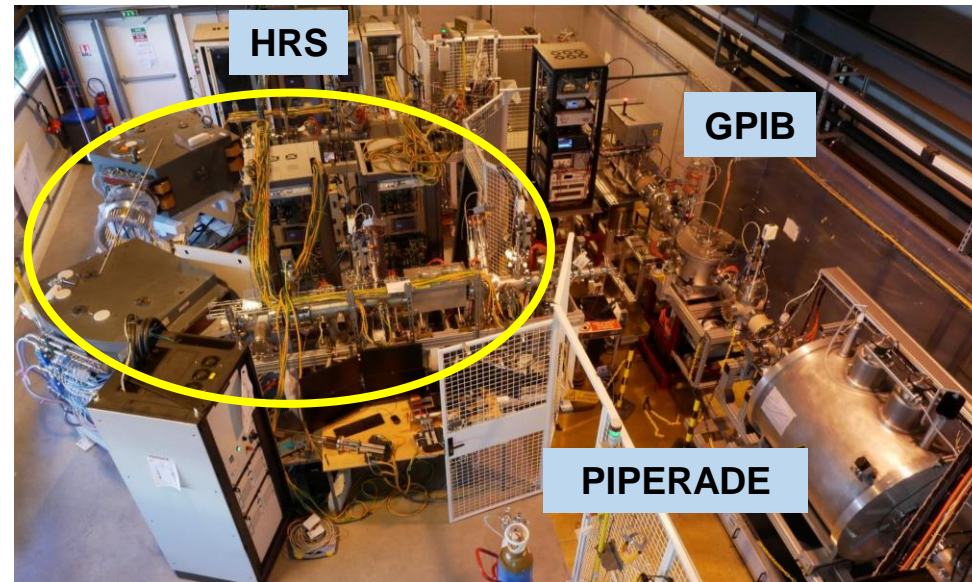
Dedicated talk by Franck Varenne in GANIL Users Session

Talk by Iain Moore on scientific opportunities on Tuesday



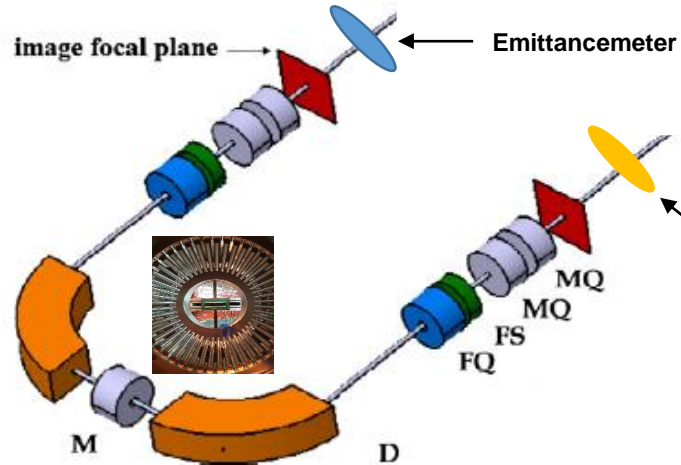
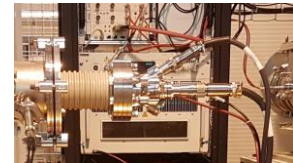


- ❑ High Resolution Separator (HRS), General Purpose Ion Buncher (GPIB) and PIPERADE Penning-trap system are installed at CENBG.
- ❑ Tests with beam of all components are ongoing.



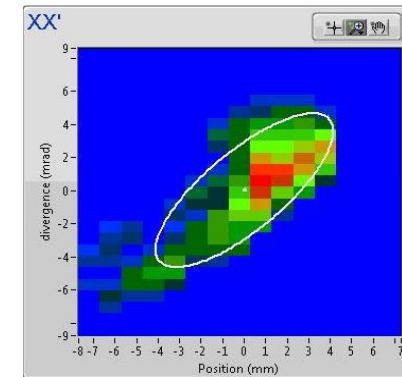
Dedicated talk by Antoine de Roubin on Tuesday

Commissioning by Julien Michaud
   
 (post-doc CENBG)

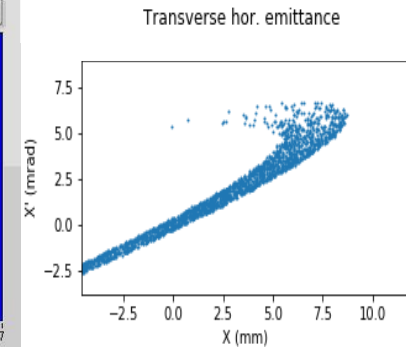


- ❑ High-resolution ( $R > 20000$ ) purifier of DESIR beams.
- ❑ Ongoing tests:
  - Emittance measurements
  - Improvement of resolution

- ❑ Preliminary results:
  - Good agreement between measured and simulated emittance
  - $R \approx 12000$  for  $^{133}\text{Cs}$  at 15 keV



Measured emittance



Simulated emittance

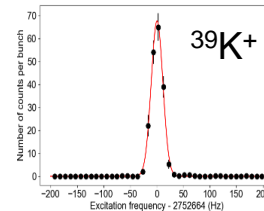
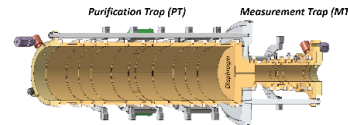
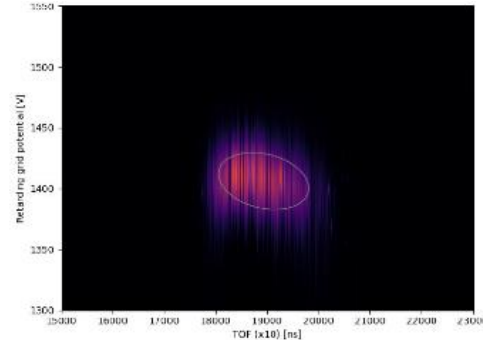
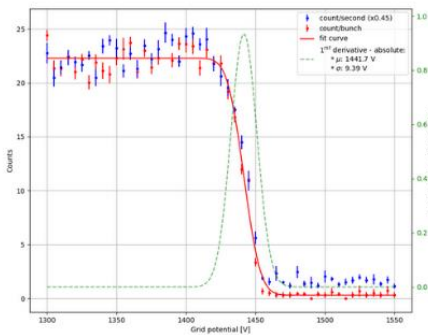
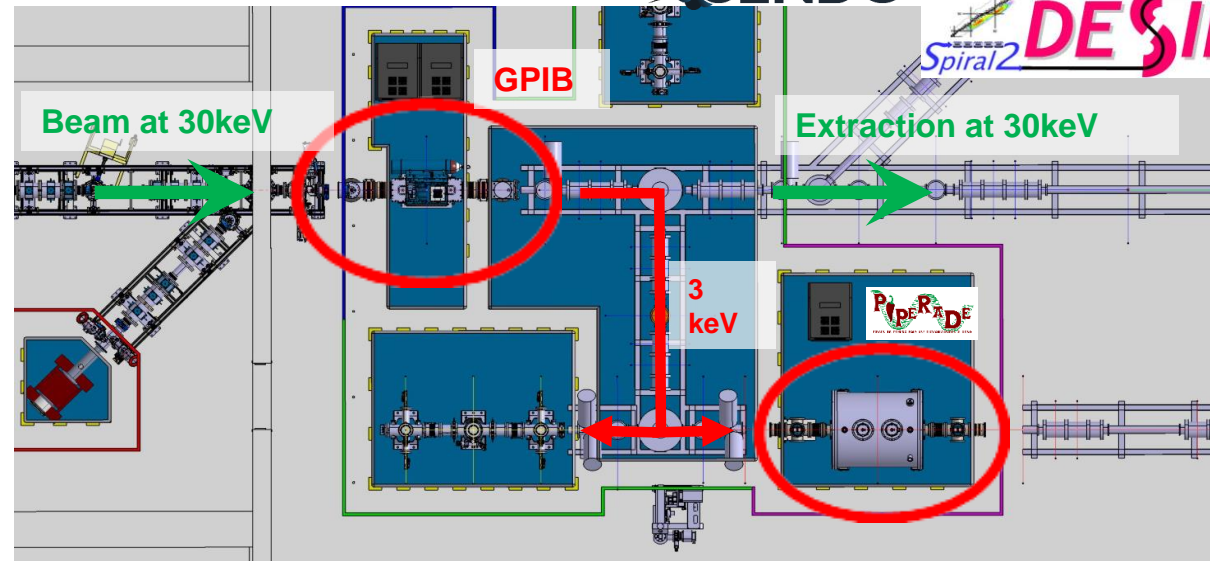
Poster by Julien Michaud

Plège de Penning pour des ions RAdioactifs à DESir



- ❑ GPIB achievements:
  - Transmission in CW/bunch modes
  - Energy dispersion measurements
- ❑ Ongoing/foreseen tests:
  - Emittance measurements

Commissioning by Audric Husson  
(post-doc CENBG)

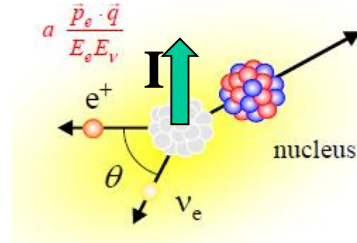
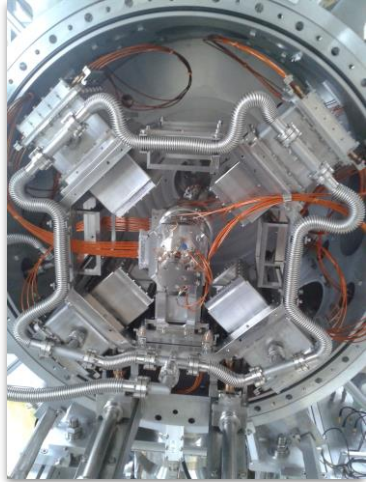


- ❑ PIPERADE achievements:
  - Trapping in both Penning traps
  - First resonances in preparation trap

Dedicated talk by Antoine de Roubin on Tuesday and poster by Mathieu Flayol

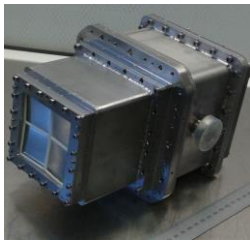
*Matter's Origin from the Radio Activity of trapped and oriented ions*

- Beta-decay correlation studies with spin-polarized nuclei:



$$D \frac{\langle \vec{J} \rangle}{J} \cdot \left( \frac{\vec{p}_e}{E_e} \times \frac{\vec{p}_\nu}{E_\nu} \right)$$

- Setup constructed and ion transport tested with an off-line source at LPC
- Setup will move to Jyväskylä for first experiments with  $^{23}\text{Mg}$  (end 2021)



**Phoswich detector**

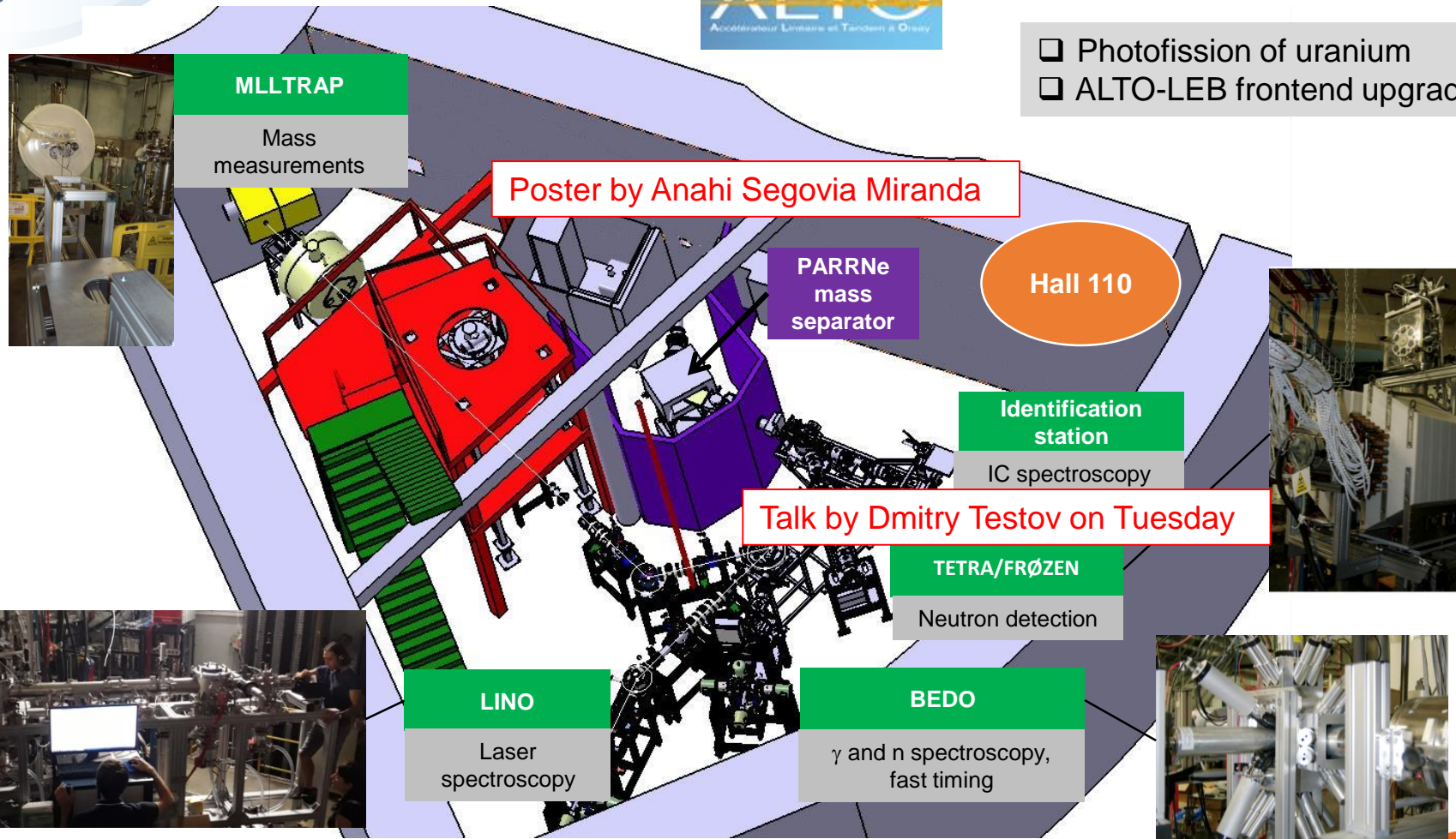


**Beam line @ LPC Caen**

Friday morning session

Dedicated talk by Sacha Daumas-Tschopp on Friday and poster by Nishu Goyal





- Photofission of uranium
- ALTO-LEB frontend upgrade: FRISAL project.

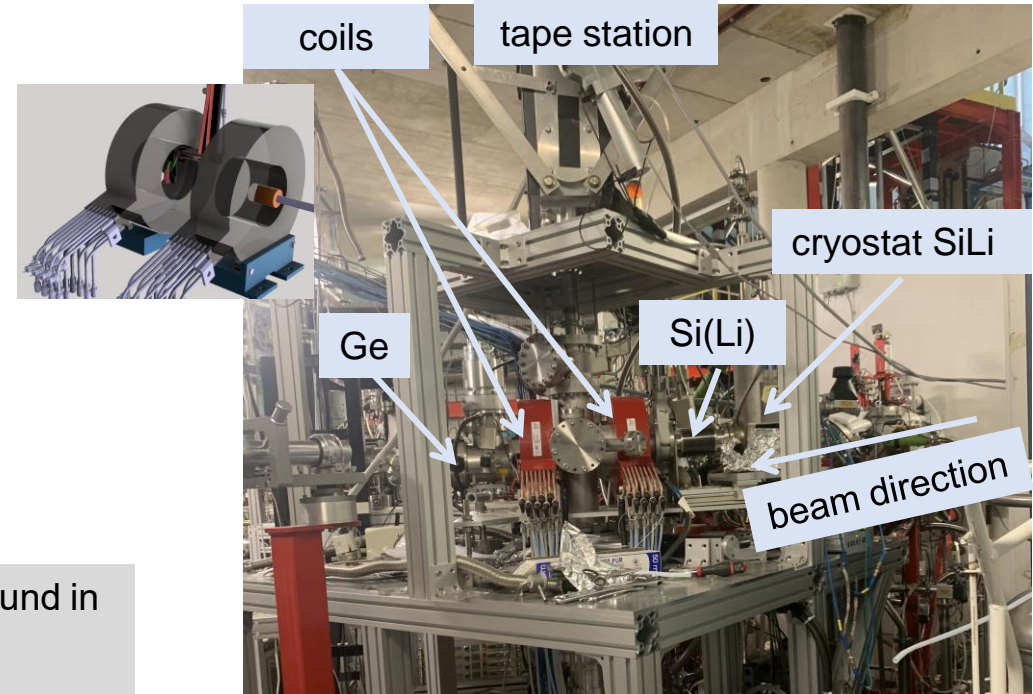
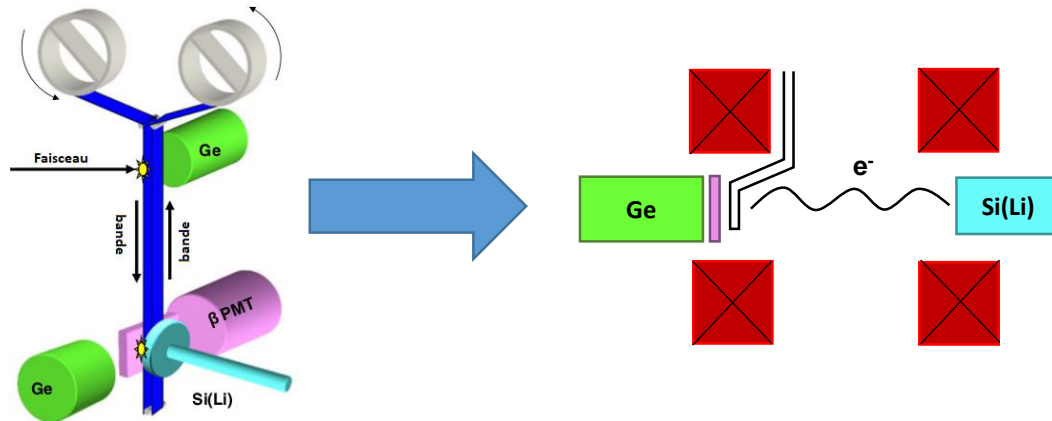


**PARIS@BEDO**



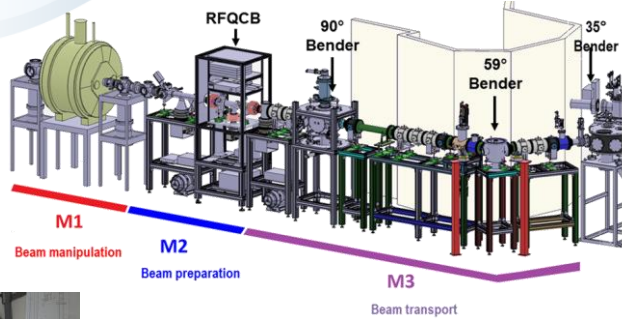


*CO*nvergent *e*lectron *C*haser in *O*rsay



- Electron transporter spectrometer → reduce gamma background in conversion electron spectra.
- Setup built, off-line tests ongoing.
- Gallium experiment scheduled.

PhD thesis of G. Tocabens + postdoc C. Delafosse



Accelerator physics pole

BIMP team

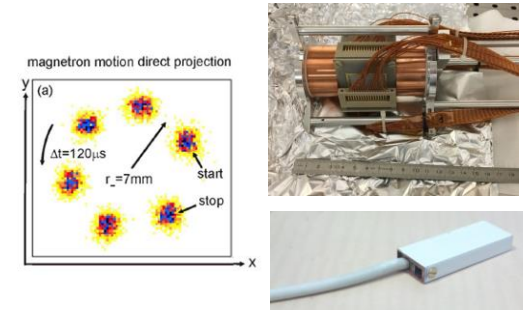
IN2P3 Master project :  
DETRAP (DESIR)

Section M1 and M2 are being built.  
Section M3 is almost done.

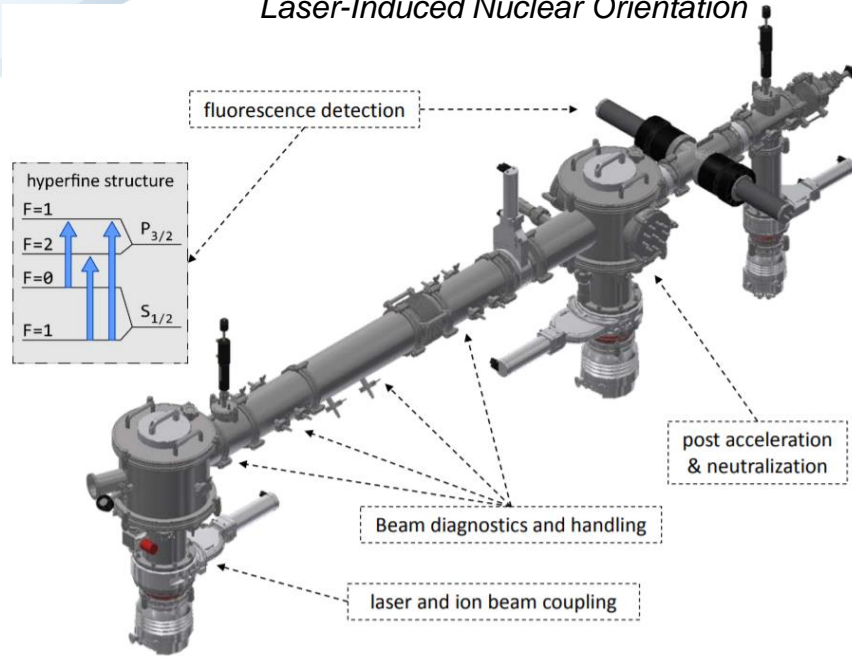


High precision mass measurements → nuclear structure studies & nuclear astrophysics

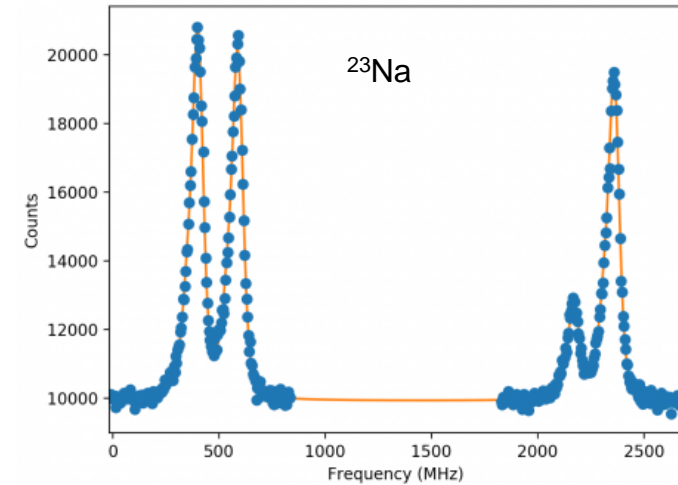
- ❑ Study of neutron-rich silver isotopes @ ALTO
  - thesis Elodie Morin 2019-2022
- ❑ Collaboration with SHIPTRAP to study superheavy elements at GSI
  - IN2P3/CEA-DRF – GSI collaboration
- ❑ In-trap alpha spectroscopy, phase imaging and in-situ magnetic probes (with Caylar)



## Laser-Induced Nuclear Orientation



- LINO installation completed at ALTO.
- First test experiment with stable  $^{23}\text{Na}$  in 2019.



- New Millennia eV, 532 nm pump laser bought to replace the old Ar-ion laser.
- Setup ready for on-line experiments.

- Building the S<sup>3</sup> and DESIR experimental facilities is a complex and demanding task.
- Many new developments are ongoing.
- Important milestones are being announced for the next one-two years.
- Stay tuned for more details on the SPIRAL2 experimental installations and scientific opportunities (Iain Moore).

Thanks to the S<sup>3</sup>-LEB collaboration and to all the colleagues who have provided slides and information for the talk:

Pauline Ascher, Rikel Chakma, Sacha Daumas-Tschopp, Zoé Favier, Nishu Goyal, Mathieu Lebois, Julien Michaud, Enrique Minaya-Ramirez, Iain Moore, Julien Piot, Antoine de Roubin, Hervé Savajols, Jean-Charles Thomas, Franck Varenne, Marine Vandebrouck, Deyan Yordanov.