

Status of the SPIRAL2-DESIR project

J.-C. Thomas, GANIL, on behalf of the DESIR project management and collaboration

- Project manager: Ch. Peaucelle, LPSC (09/14/2026)
- Scientific coordinator and spokesperson: B. Blank, LP2iB

GANIL Colloquium

September 24, 2026



Overview

- Scientific program
- Buildings and Infrastructure
- Transport beam lines
- Beam preparation and purification

Conclusion

Overview



Décroissance, Excitation et Stockage d'Ions Radioactifs

Decay, Excitation and Storage of (low energy) Radioactive Ions

Decay Spectroscopy

- Exotic decay modes
- High-precision β -decay studies
- TAS measurements

LASER Spectroscopy

- Charge radii
- Nuclear moments
- Spins

Ion trapping

- Mass measurement
- Fundamental interactions
- Trap-assisted spectroscopy

BESTIOL

LUMIERE

DETRAP

IN2P3 Master Projects



Décroissance, Excitation et Stockage d'Ions Radioactifs

Decay, Excitation and Storage of Radioactive Ions

Decay Spectroscopy

BESTIOL

LASER Spectroscopy

LUMIERE

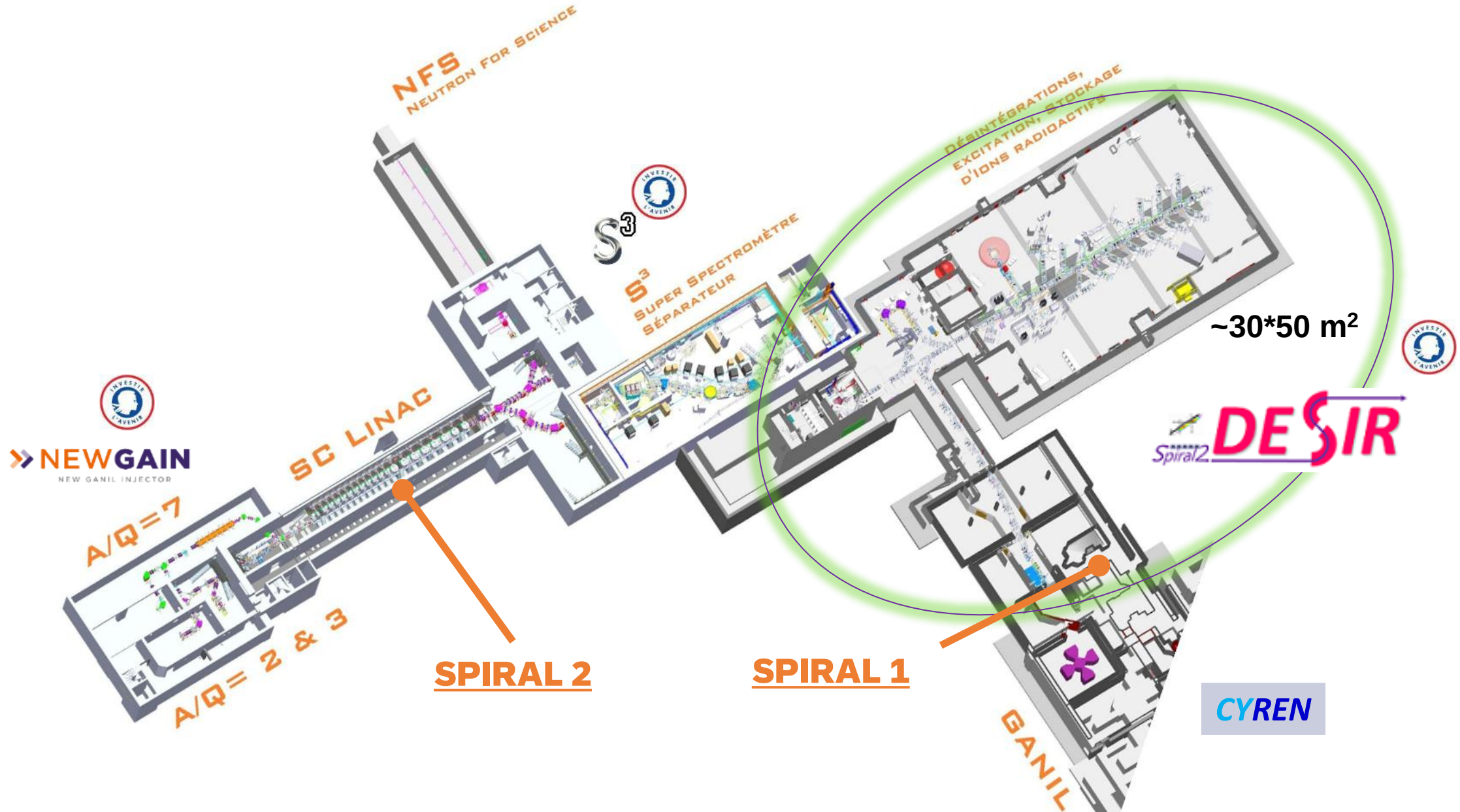
Ion trapping

DETRAP

A new GANIL users facility

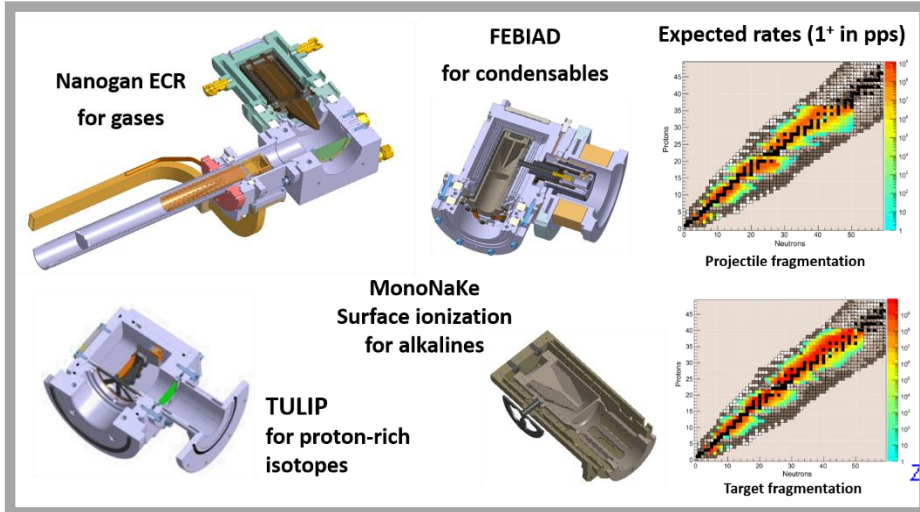
- To study the ***fundamental properties*** of atomic nuclei and underlying forces
- Using ***ultra-pure samples*** of radioactive ions manipulated at very low energy
- Taking advantage of the ***various RIBs*** production methods available at GANIL-SPIRAL2
- In complementarity to **S³(-LEB)** and other GANIL installations

Overview: DESIR@GANIL-SPIRAL2



SPIRAL1: Fragmentation Fusion-evaporation

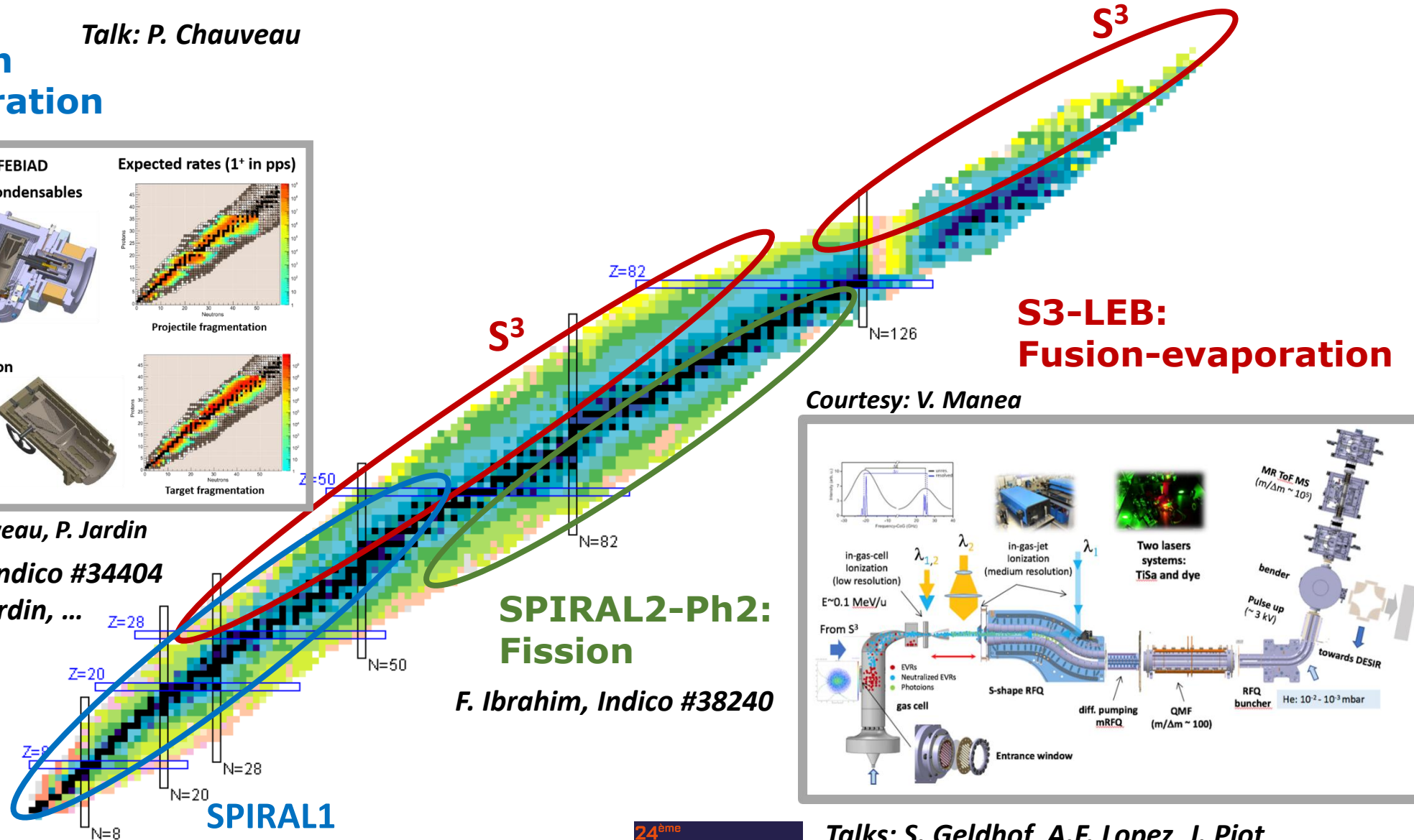
Talk: P. Chauveau



Courtesy: P. Delahaye, P. Chauveau, P. Jardin

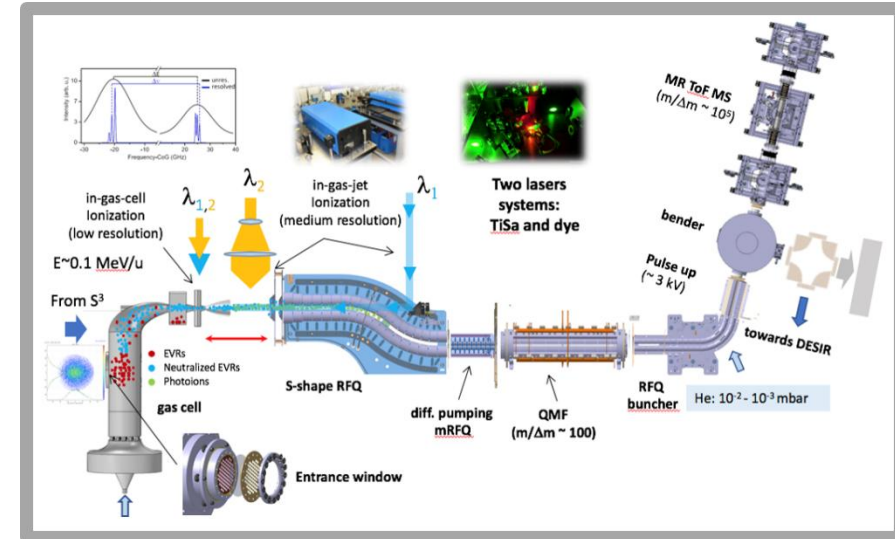
SPIRAL1 workshop 2025 – Indico #34404

B. Blank, P. Chauveau, P. Jardin, ...



F. Ibrahim, Indico #38240

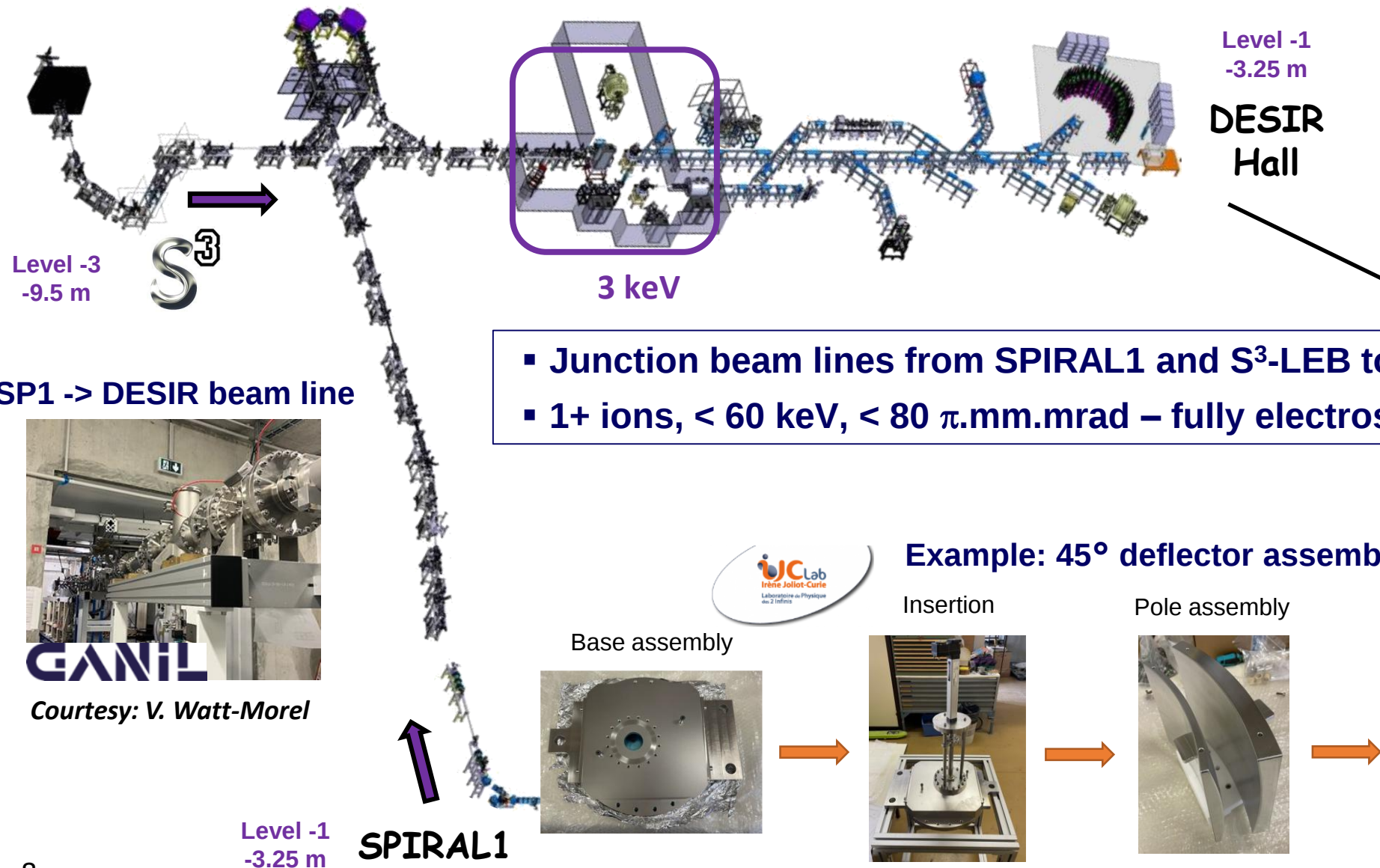
Courtesy: V. Manea



Talks: S. Geldhof, A.F. Lopez, J. Piot

Posters: S. Bara, M. Brun, S. Pineda, A. Vicente

Overview: Transport beam lines



- Junction beam lines from SPIRAL1 and S³-LEB to the DESIR Hall: ~100 m
- 1+ ions, < 60 keV, < 80 π .mm.mrad – fully electrostatic

Test bench



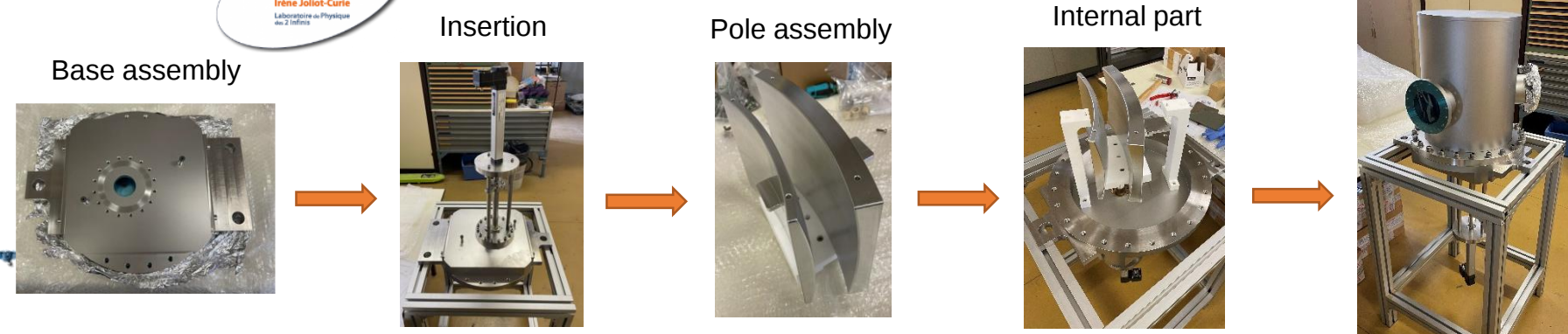
Courtesy: Ph. Alfaut, L. Daudin



Courtesy: V. Watt-Morel

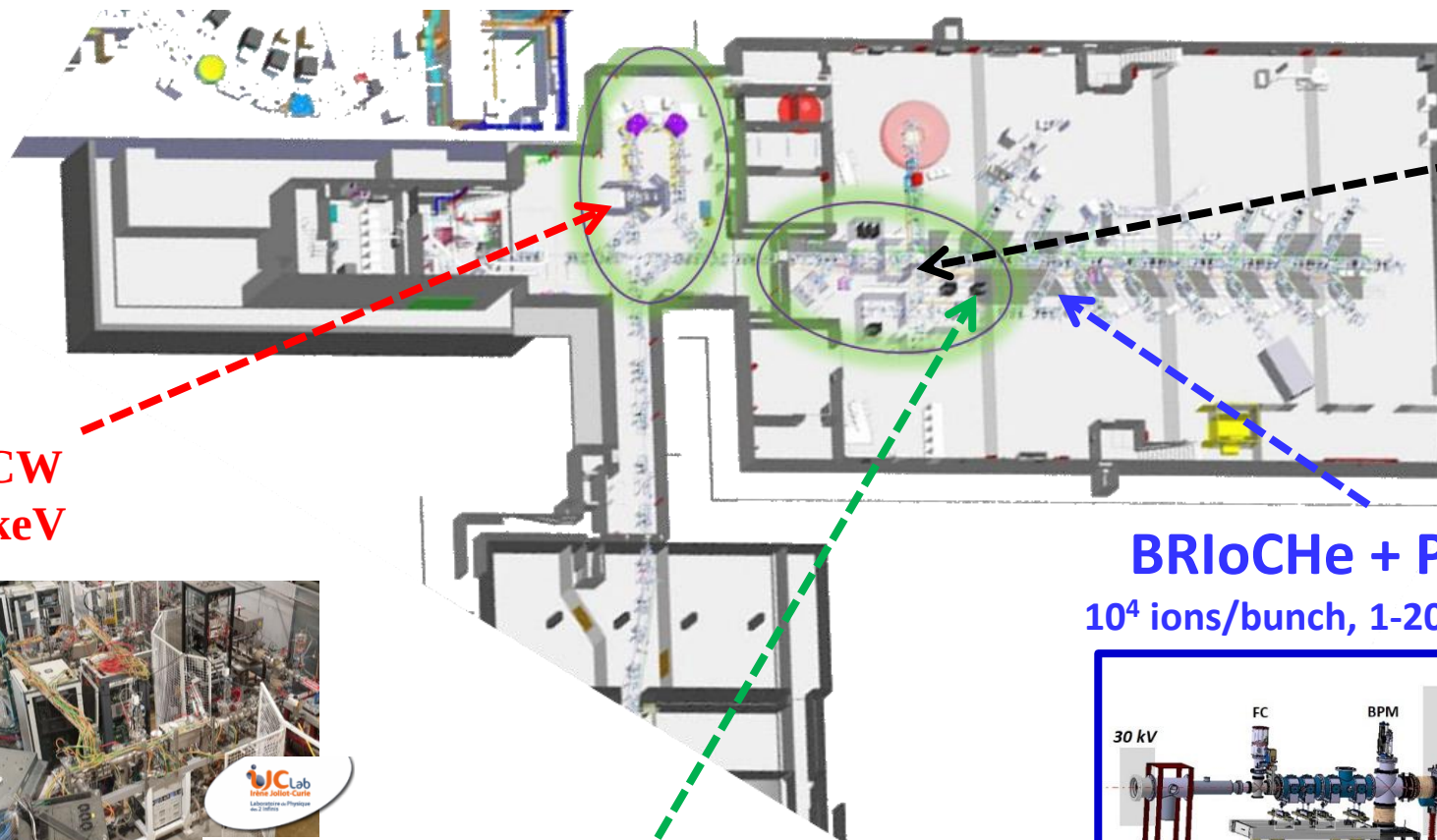


Example: 45° deflector assembly



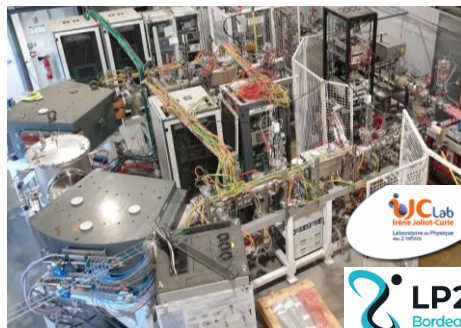
Courtesy: L. Perrot

Overview: Beam preparation and purification



RFQ + HRS

$M/\Delta M = 20,000$ - CW
 3π mm.mrad / 30keV



Commissioned at LP2iB

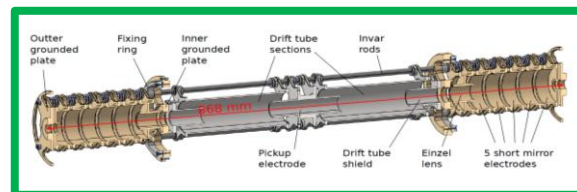


Commissioning
to start soon



TRAMWAY

10^4 ions/bunch, 100 Hz, $M/\Delta M = 10^5$



Studies



SID
Id. station

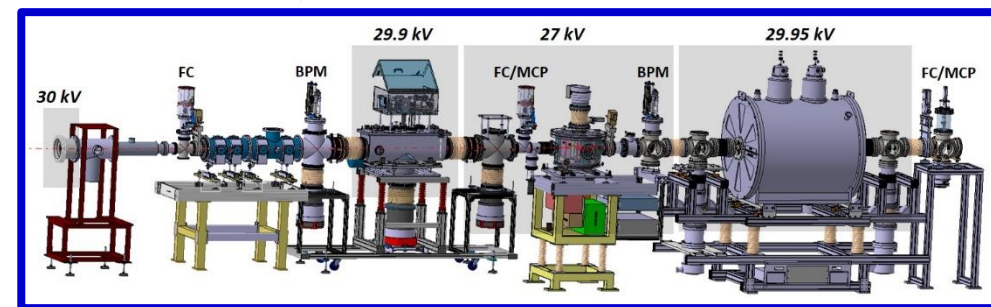


Refurbishment



BRIOCHE + PIPERADE

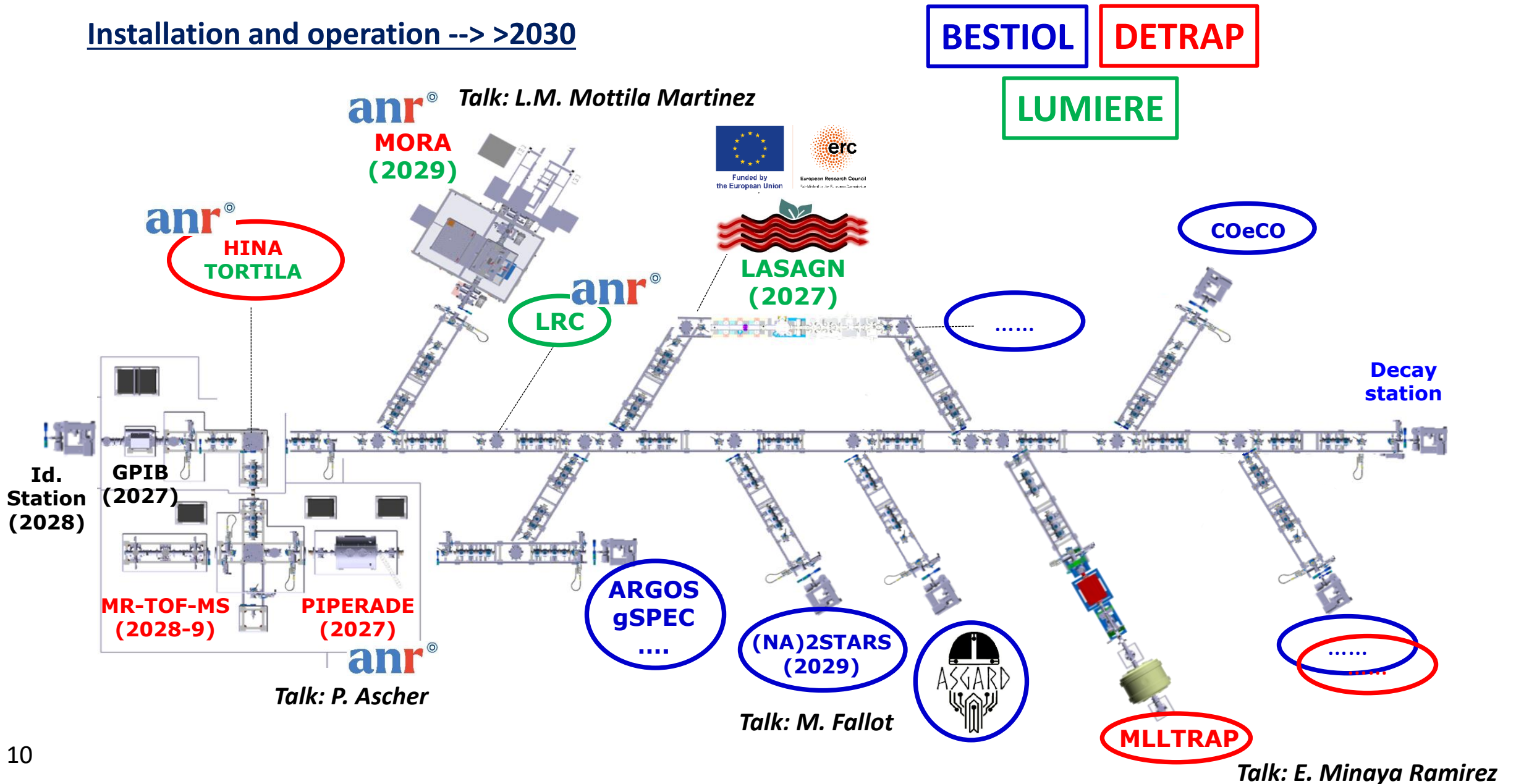
10^4 ions/bunch, 1-20 Hz, $M/\Delta M = 10^5$ (10^7)



Commissioning

Overview: Experimental equipment

Installation and operation --> >2030



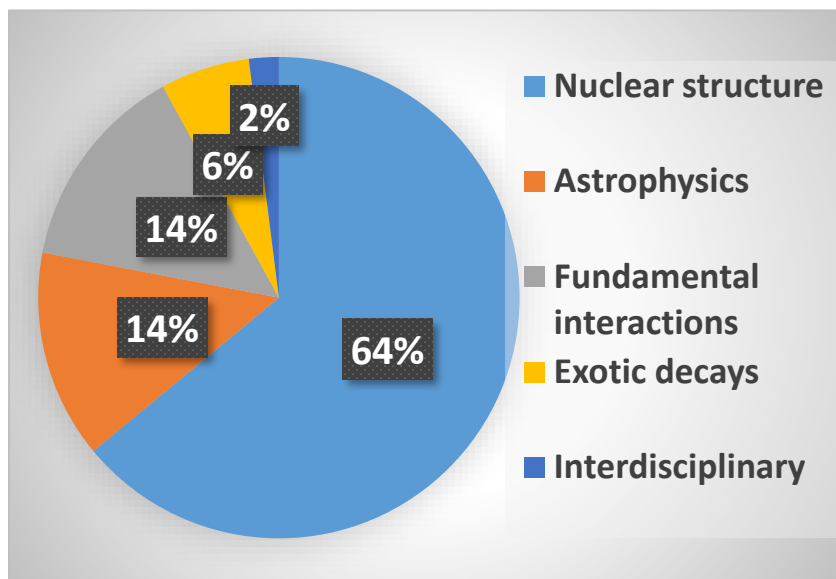
Scientific program

- **Preparation of DESIR physics case**
 - Workshop DESIR: Spring 2024: 100 participants, 22 institutes (15 from foreign countries)
 - Workshop LUMIERE: July 2024
 - Workshop BESTIOL: Dec.
 - Workshop DETRAP: May 2025
- **Brainstorming (IN2P3): Impact of high-precision measurements on BSM physics at DESIR, July 2026**
- **Letters of intent**
 - DESIR LOI workshop: March 2026, > 50 LOIs
 - > Working group to analyze the feasibility (RIBs), propose RIB developments and experiment priorities
 - Forming of collaborations to submit detailed written LOIs
 - > DESIR collaboration Committee
- **Proposals $\geq$ 2027**
- **Equipment commissioning**
 - Some stable and radioactive beam without going through proposals and PAC
- **Routine operation $\geq$ 2030**

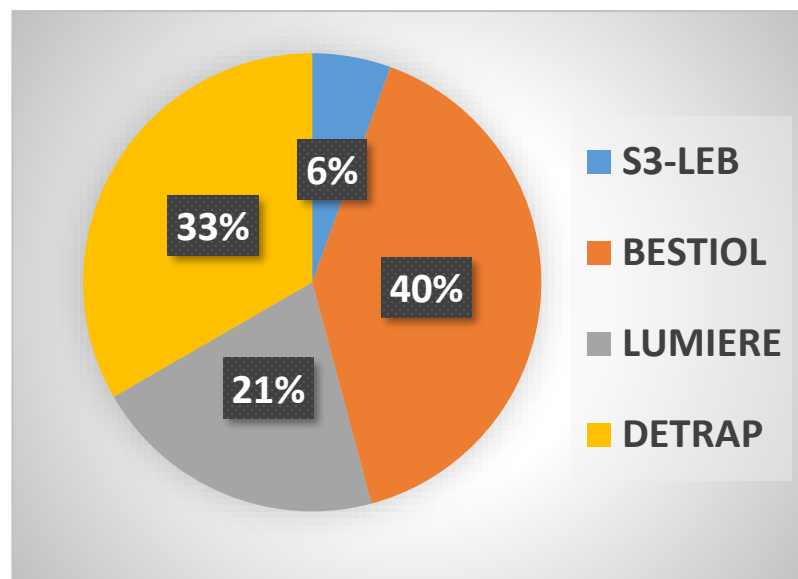
Overview

- 50 Lols, ~2000 UTs, ~300 isotopes from ^6He to ^{263}Sg , from 0.01 to 10^7 pps
- 90% from French labs (46% IJCLab)
- Mainly n-deficient (production sites)
- Using different technics to probe the same region (e.g. around ^{100}Sn)
- Combining different setups, e.g. PIPERADE + Decay spectroscopy
- Combining $\text{S}^3\text{-LEB}$ and DESIR studies
- Using beams expected from either $\text{S}^3\text{-LEB}$ (29 Lol) or SPIRAL1 (50 Lol) (overlap)
-> But feasibility to be checked

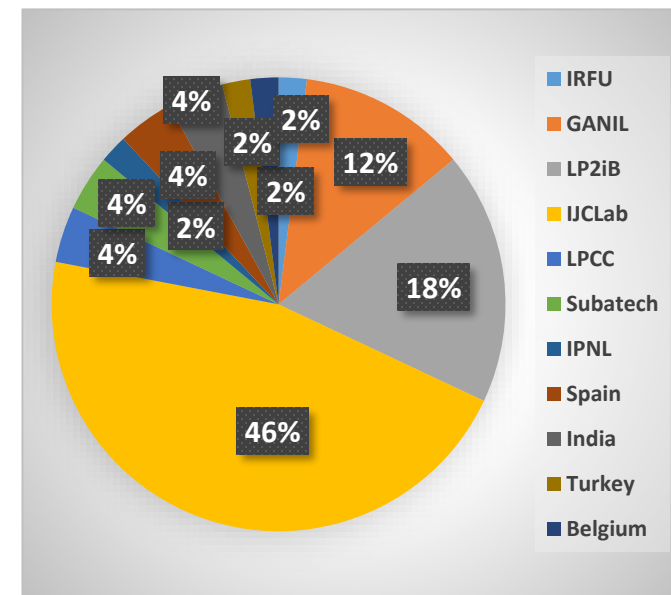
Physics cases



Setups/Techniques



Labs

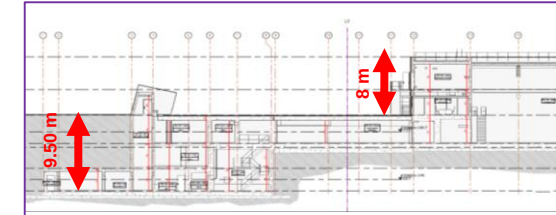
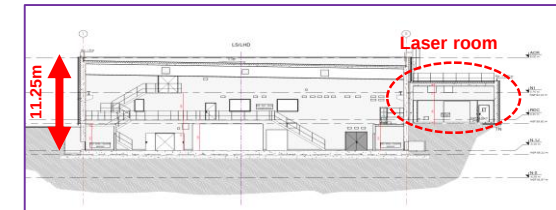
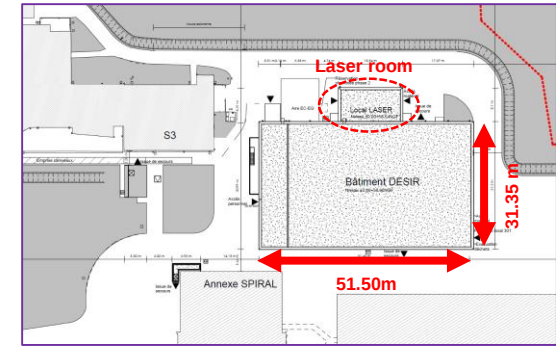


Buildings and Infrastructure

Buildings and infrastructure



- Building delivery: 11/2025
- Building operation (internal licence): 11/2026
- Facility operation (safety licence request)
 - About to be submitted
 - Expected green light: 10/2028?



Laser rooms



RFQ1P + HRS room



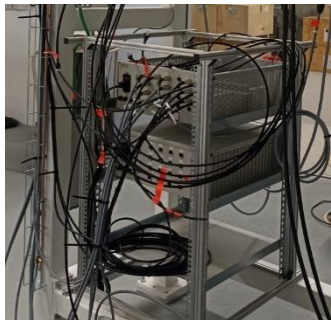
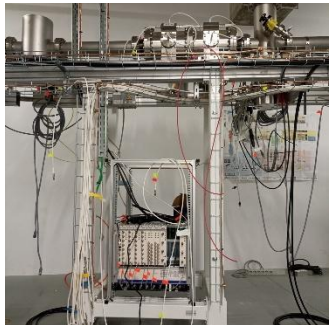
Experimental hall

Transport beam lines

Transport beam lines: Prototype section

Validation of:

- Assembly protocols
- Vacuum tests
- Cabling principles
- Supplies integration
- Diagnostics insertion
- PLCs
- Interlocks
- Beam tuning software



SPIRAL1 -> ----- (~20 m) -----> DESIR

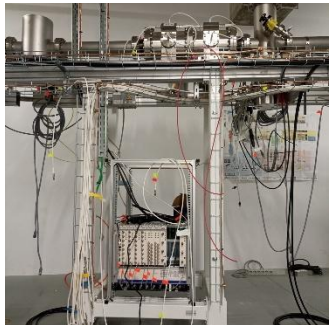


*L. Daudin, K. Lacombe, LP2iB
V. Watt-Morel, GANIL*

Transport beam lines: Prototype section

Validation of:

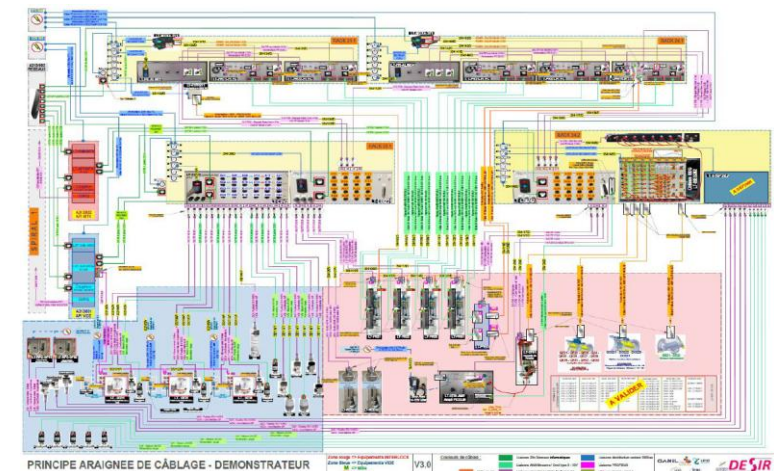
- Assembly protocols ✓
- Vacuum tests ✓
- Cabling principles ✓
- Supplies integration ✓
- Diagnostics insertion ✓
- PLCs
- Interlocks
- Beam tuning software



SPIRAL1 -> ----- (~20 m) -----> DESIR



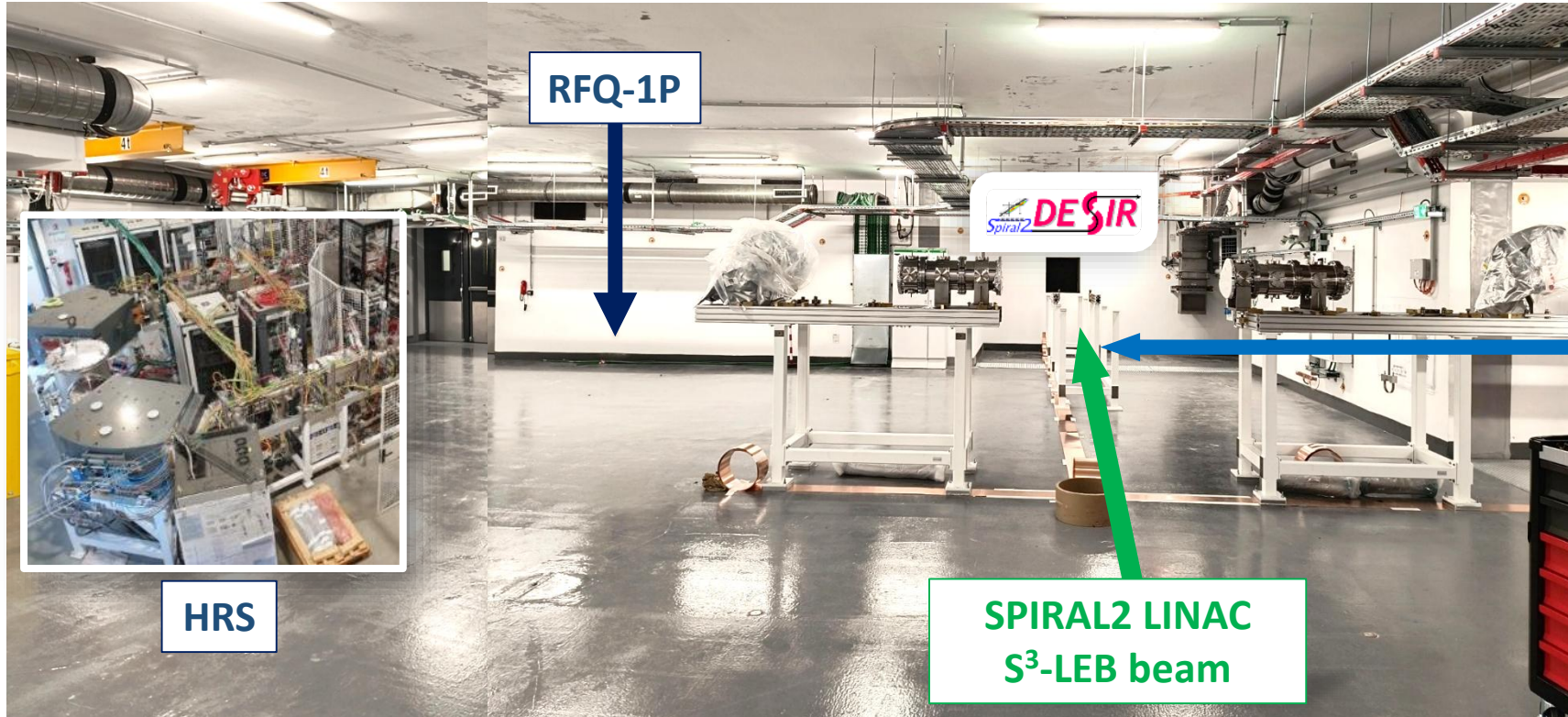
Still a lot to do: e.g., cabling



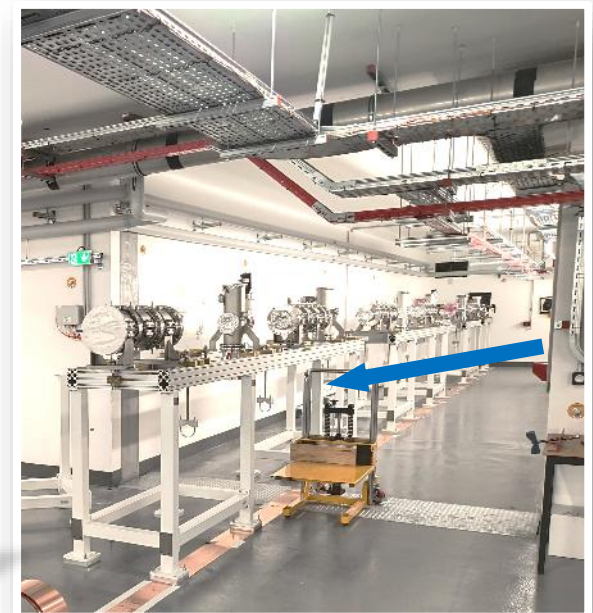
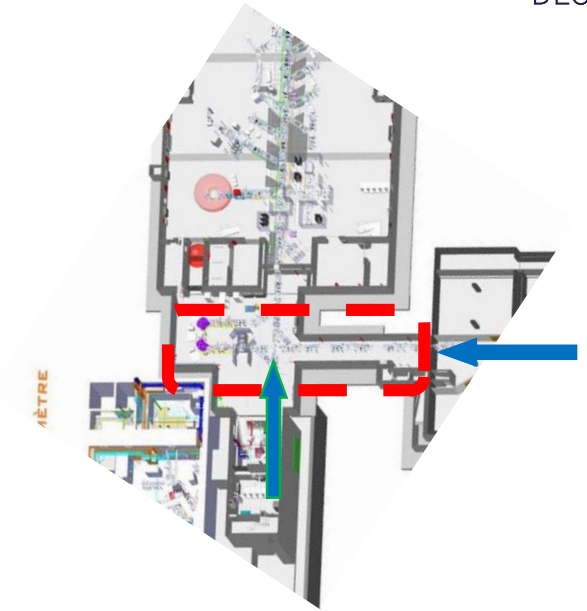
-> offline commissioning in 2027

Transport beam lines: Junction tunnels

- Installation of the beam line equipment (mechanics/optics): Early 2026 ---->
- Call for tender for the cabling and piping: October 2026



Courtesy: C. Berteloite, GANIL

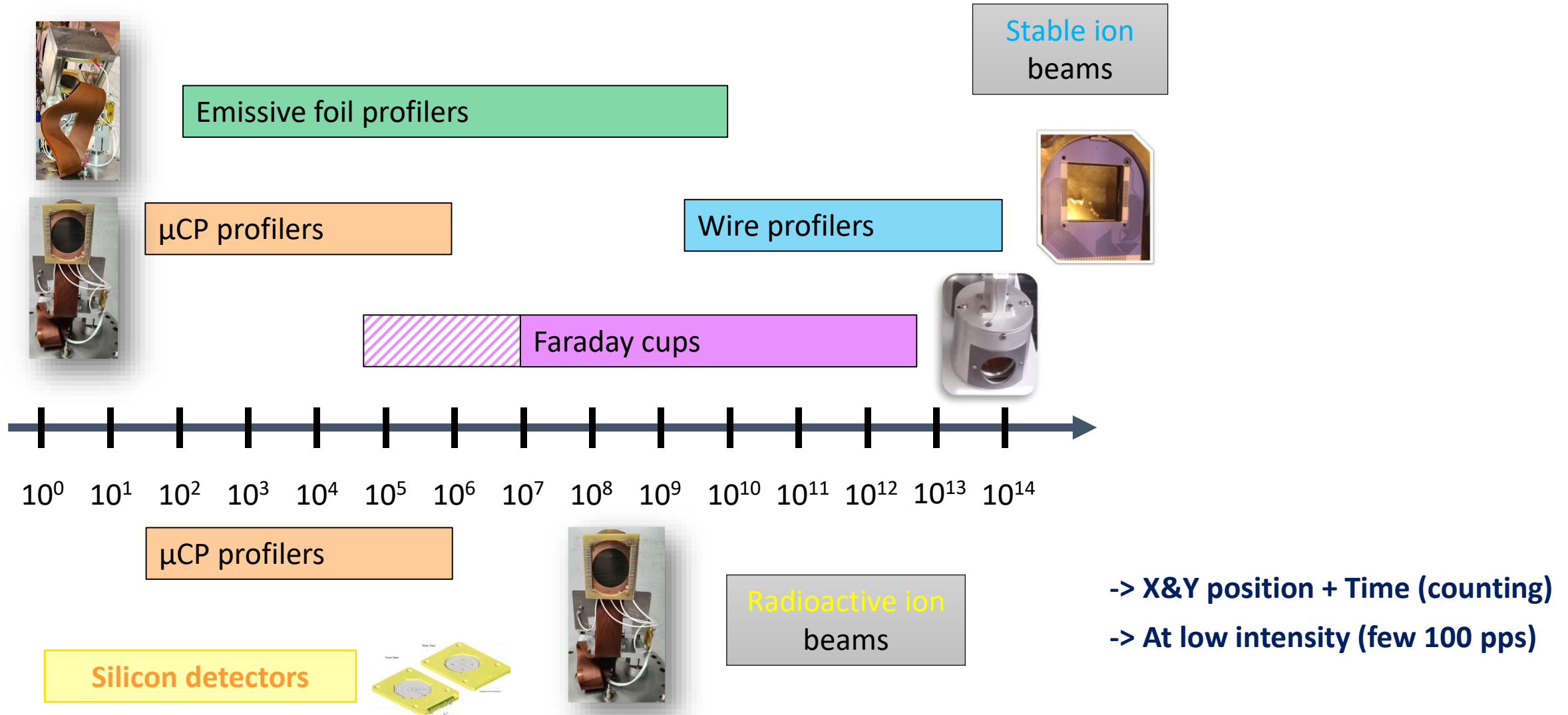


GANIL Cyclotrons
Spiral 1 beam

Transport beam lines: Diagnostics

C. Berteloite, GANIL

- For 10-30 keV stable beam tuning
- For (low-intensity) (bunched) 3 keV RIBs



- Undergoing development: μ CP + homemade delay-line position readout - *R. Revenko, GANIL*
 - To be further investigated: stable/radioactive discrimination capabilities - *C. Berteloite, H. Guérin, GANIL*
 - Specific needs for RIB manipulation at 3 keV: MagneToF, μ CP, μ CF
- > Synergies with S3-LEB: low energy bunched beams

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Dead-end development



Beam preparation and purification

Beam preparation:

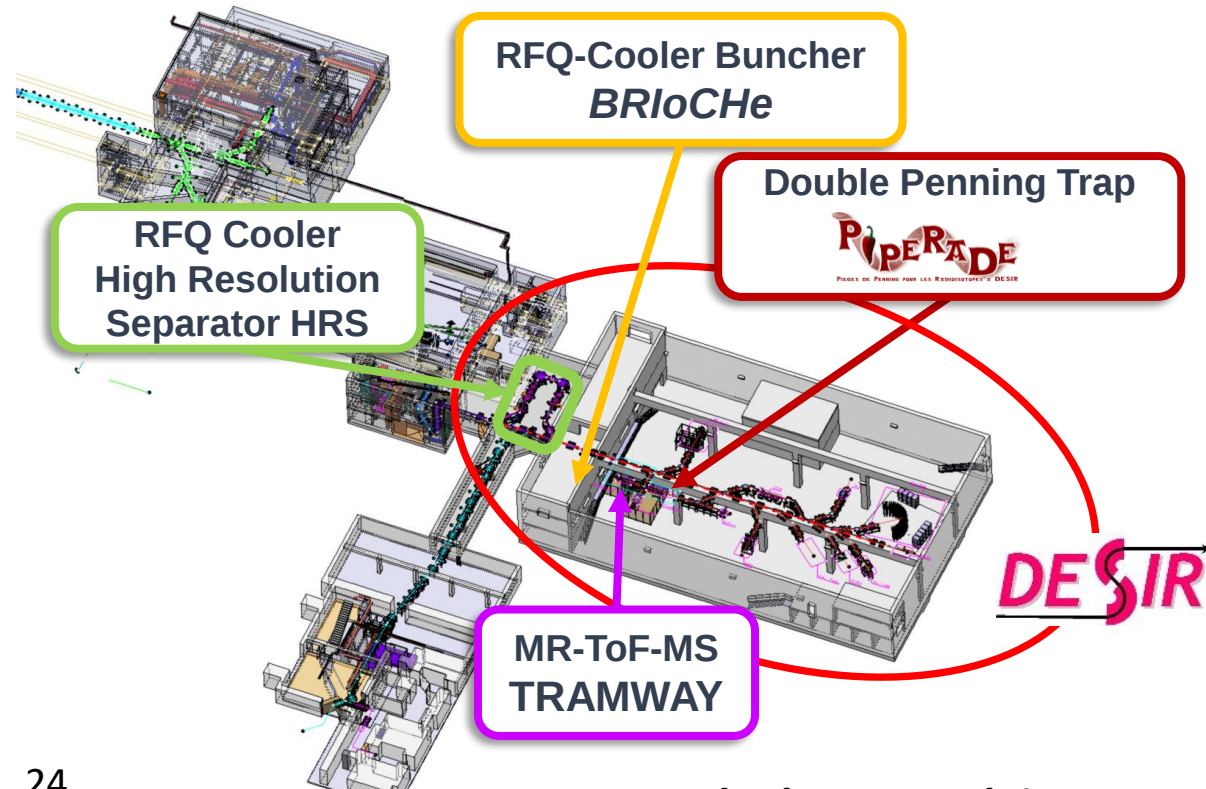
GPIB

- Cooling and bunching

MR-ToF

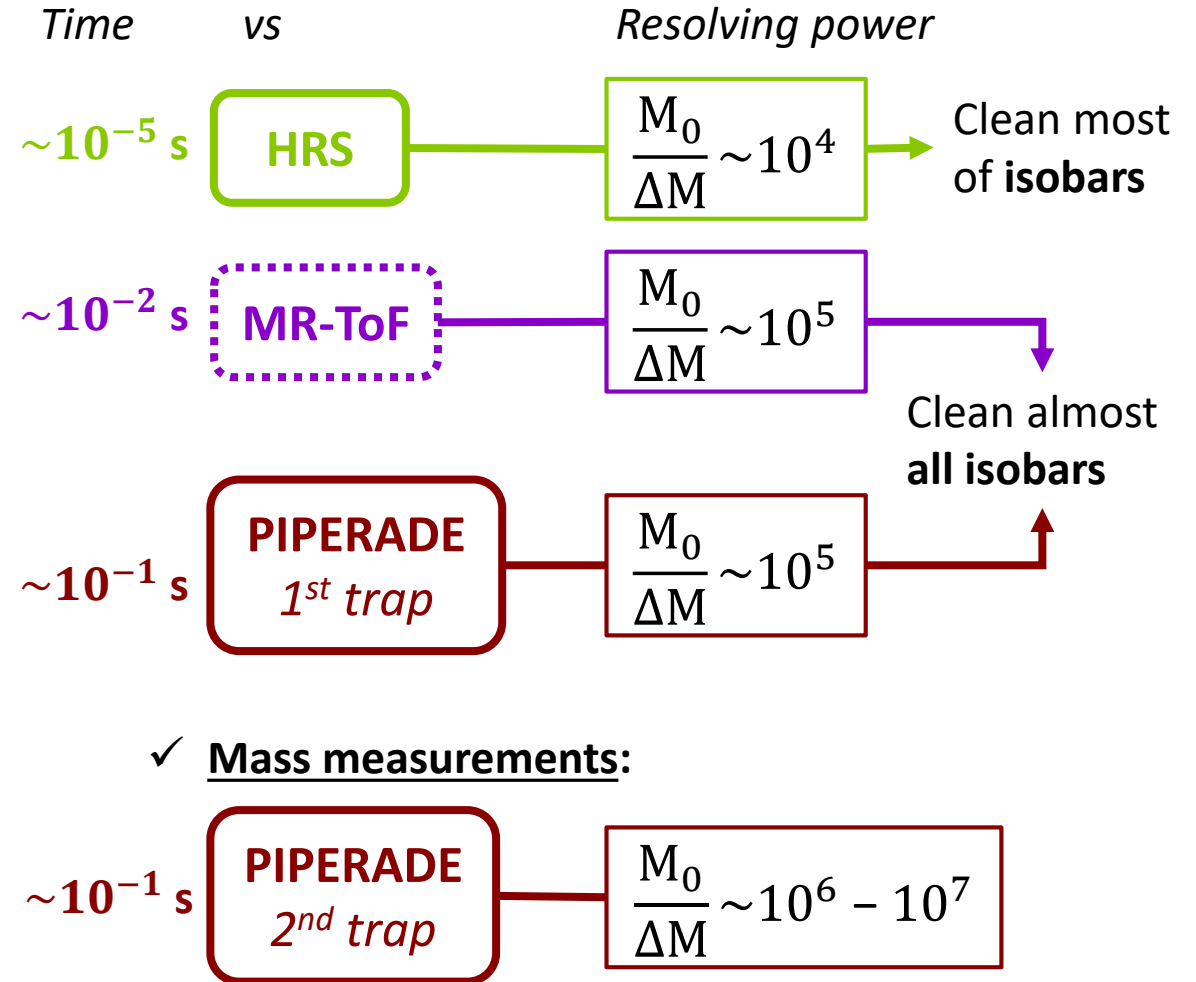
- Accumulation trap

PIPERADE



Courtesy: B. Blank, C. Berteloite

Mass separation/beam purification:



Clean isomeric states separated by a few 10 keV

Mass precision: $10^{-8} - 10^{-9}$ **Trap-assisted spectroscopy**

Beam preparation and purification: RFQ cooler

Based on the SHIRAC RFQ studied within SPIRAL2-Phase 2 and an upgraded version for SPES

R. Boussaid et al., JINST 9 (2014) P07009

- Construction and tests at LPC Caen
 - technical commissioning: end-2026
 - offline commissioning: early 2027
 - > transfer to GANIL: mid-2027

Material: J.-F. Cam, LPC Caen



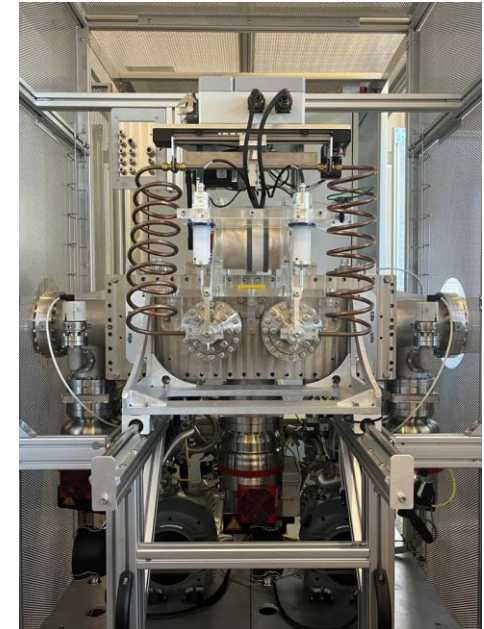
Quadrupole



RFQ1P test bench at LPC Caen (w/o the HV cage)

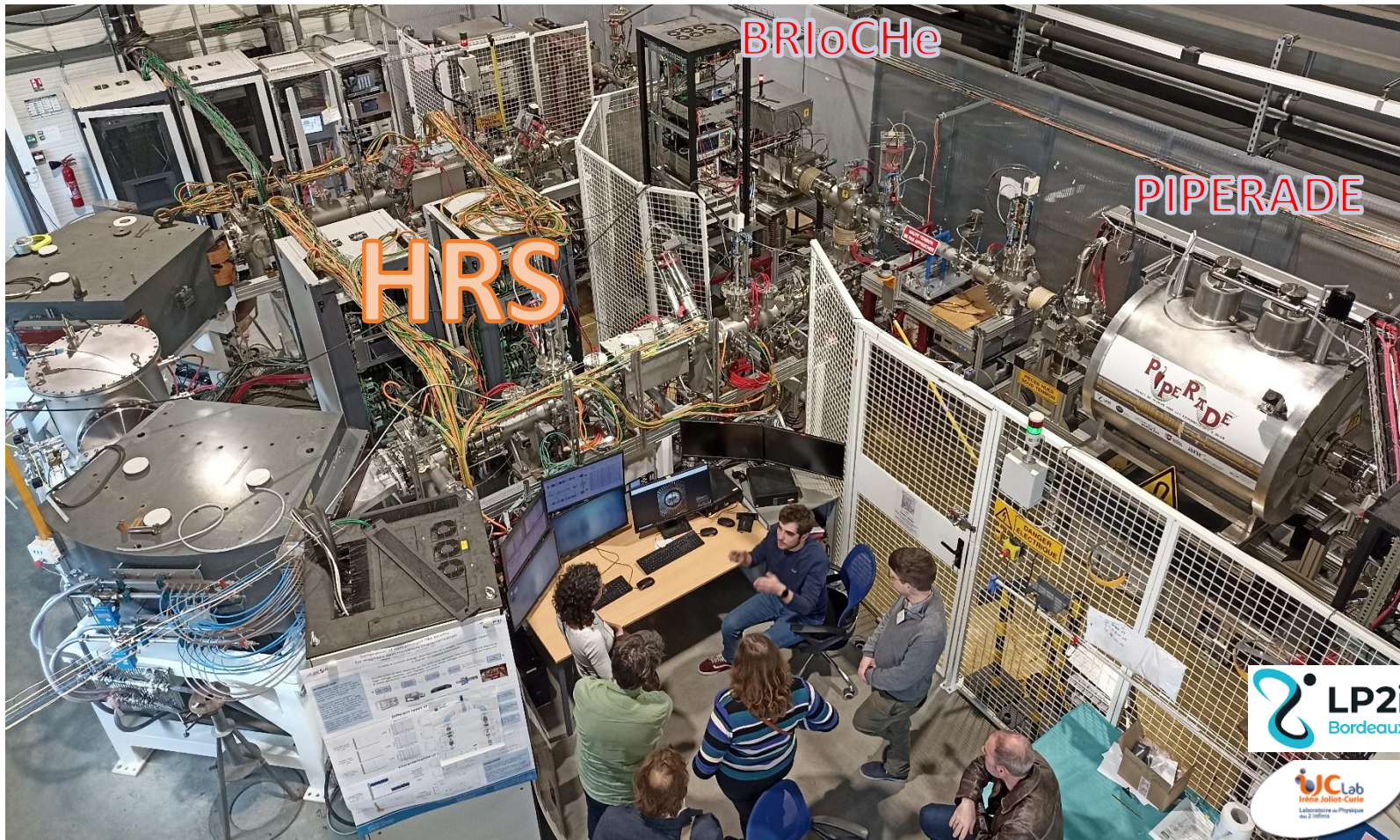


HV cage



RF circuit

- *Fully commissioned at LP2iB - J. Michaud, A. Balana, B. Blank, L. Daudin*
-> transfer to GANIL: end-2026



J. Michaud et al., NIM B 541, 161 (2023)

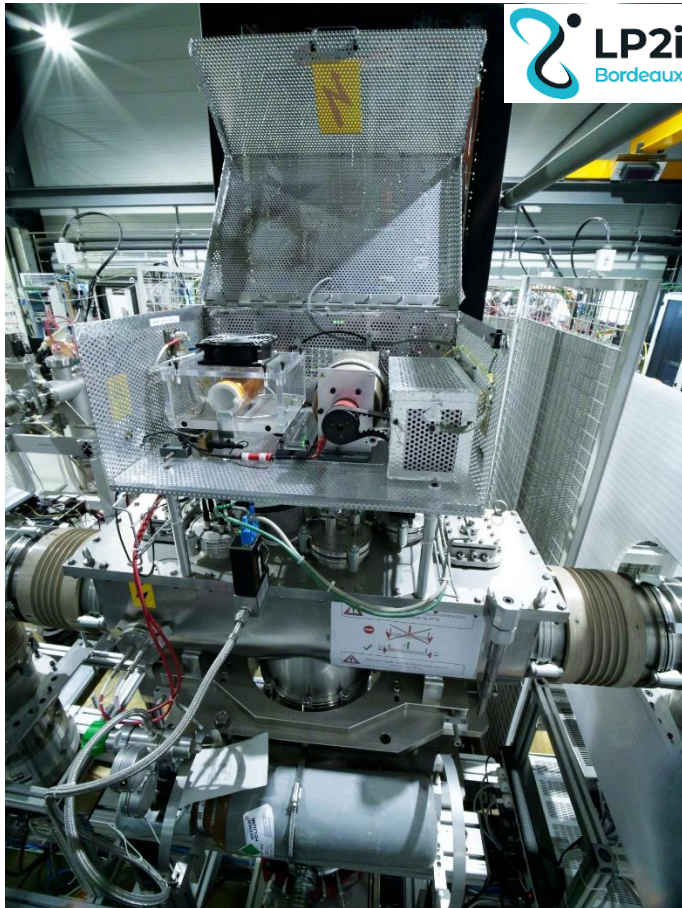
T. Kurtukian Nieto et al., NIM B 317, 283 (2013)

Beam preparation and purification: BRloCHe

Based on the ISCOOL design, ISOLDE

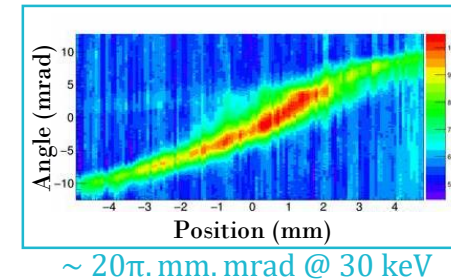
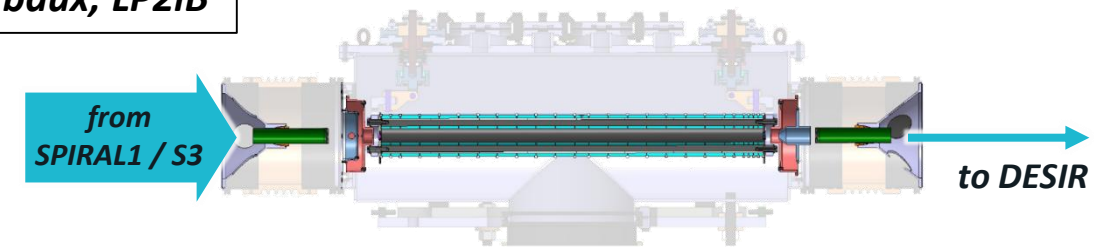
Material: M. Gerbaux, LP2iB

- Routinely (**24/7**) used together with PIPERADE since 2019
-> transfer to GANIL: 2027

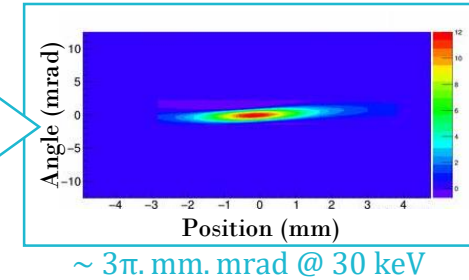


- Operable either in...
 - Continuous mode (cooler only)
 - Bunched beam mode (up to $\sim 10^8$ ions/bunch)

- Transmission (with alkali):
 - Cooler only: up to 90%
 - Bunching: 40 to 100% (depending on bunch size, cycle duration, requested energy or time spread...)
- Typical performances
 - $\sim 1 \mu\text{s}$ -long bunches; 100-200 Hz
 - < 10 eV energy dispersion
- Bunching can be set to favour either a lower energy dispersion or a shorter duration
 - Shortest bunch so far [work in progress]: 140 ns FWHM
 - Smallest energy dispersion measured so far [work in progress]: 4 eV FWHM



Buffer-gas
cooling



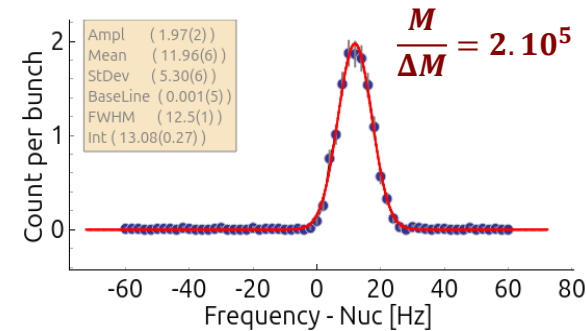
Beam preparation and purification: PIPERADE

Designed and machined at MPIK Heidelberg

Material: P. Ascher, LP2iB -> Talk tomorrow morning

- Offline commissioning at LP2iB
-> transfer to GANIL: 2027

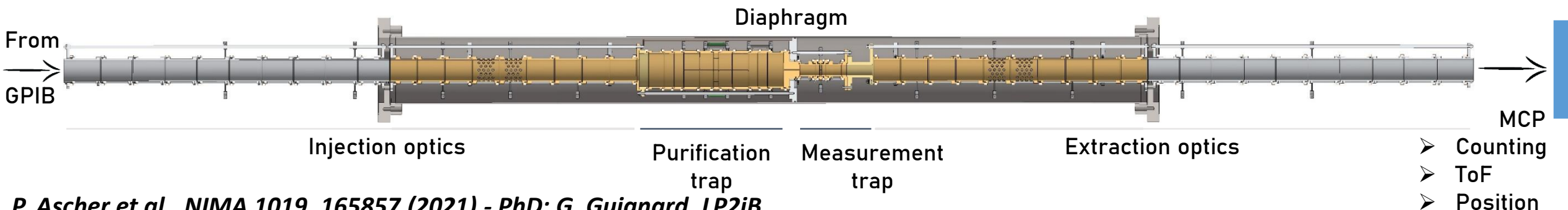
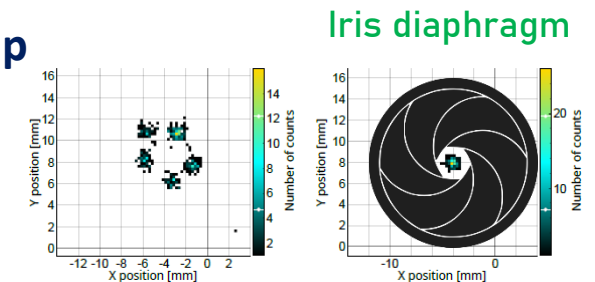
- Mass measurements → ToF-ICR and PI-ICR operational
- Beam purification
 - Buffer gas cooling in the first trap



anr[®]
PEPPER
(04/2027 - 4y)

- Phase cleaning in the second trap

$M/\Delta M$ of 10^7 in ~500 ms
(→ 10^6 in 50 ms)



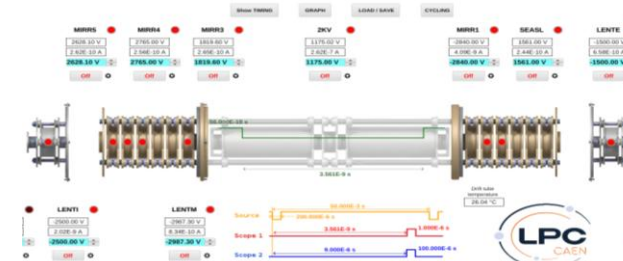
Beam preparation and purification: TRAMWAY

Based on the PILGRIM (S^3 -LEB) MR-ToF-MS

Material: L. Canete, GANIL

- Development at LPC Caen: 2027-2028
-> Operation at DESIR: 2029

- PhD: K. Ronxin, GANIL (10/26)
- Post Doc: M. Benhatchi, GANIL (12/26)



TRAMWAY objectives

- Provide a fast separation of isobaric contaminants (+ PIPERADE)
- Measure masses of very short-lived nuclides (cycle time ~ 10 ms)

-> Currently the fastest mass spectrometry technique able to achieve resolving powers exceeding 10^5

Capitalizing on PILGRIM upgrades

- Active and passive tension stabilizations
- Optimization of the bunch formation
- Integration of new FAST COMTEC TDC (12.5Gsps, MCS8A)
- Installation of a Si Detector on an actuator
- Using neural networks (NN) to reconstruct precisely the ToF distribution for high number of ions per bunch

CaeSAR



Conclusion

❖ Timeline of the project

- Building delivery -> Building operation: end 2026
- Transport beam line to the DESIR hall: 2028
- Installation and commissioning of beam preparation and purification equipment: 2027-29
- Consolidated LOIs, then proposals
- Commissioning experiments with the first setups: 2029

❖ Critical points

- Stable ion source for experimental equipment commissioning
- 1st laser room operation
- *Upgrade of the maximal B_ρ value of SPIRAL1 RIBs*
- Transfer of technical developments to the GANIL staff

❖ Positive aspects

- Lol Wks: strong interest in the possibilities, although relying on RIB developments (S³-LEB + SPIRAL1)
- ANR*6 + 1 ERC grants ((ACCLAIM-)MORA, HINA, PIPERADE and LASAGN)



Thanks for your attention

and to the contributors to the presentation

C. Berteloite, L. Canete, V. Watt-Morel, GANIL

P. Ascher, B. Blank, L. Daudin, M. Gerbaux, K. Lacombe, LP2iB

J.-F. Cam, LPC Caen

L. Perrot, IJCLab

