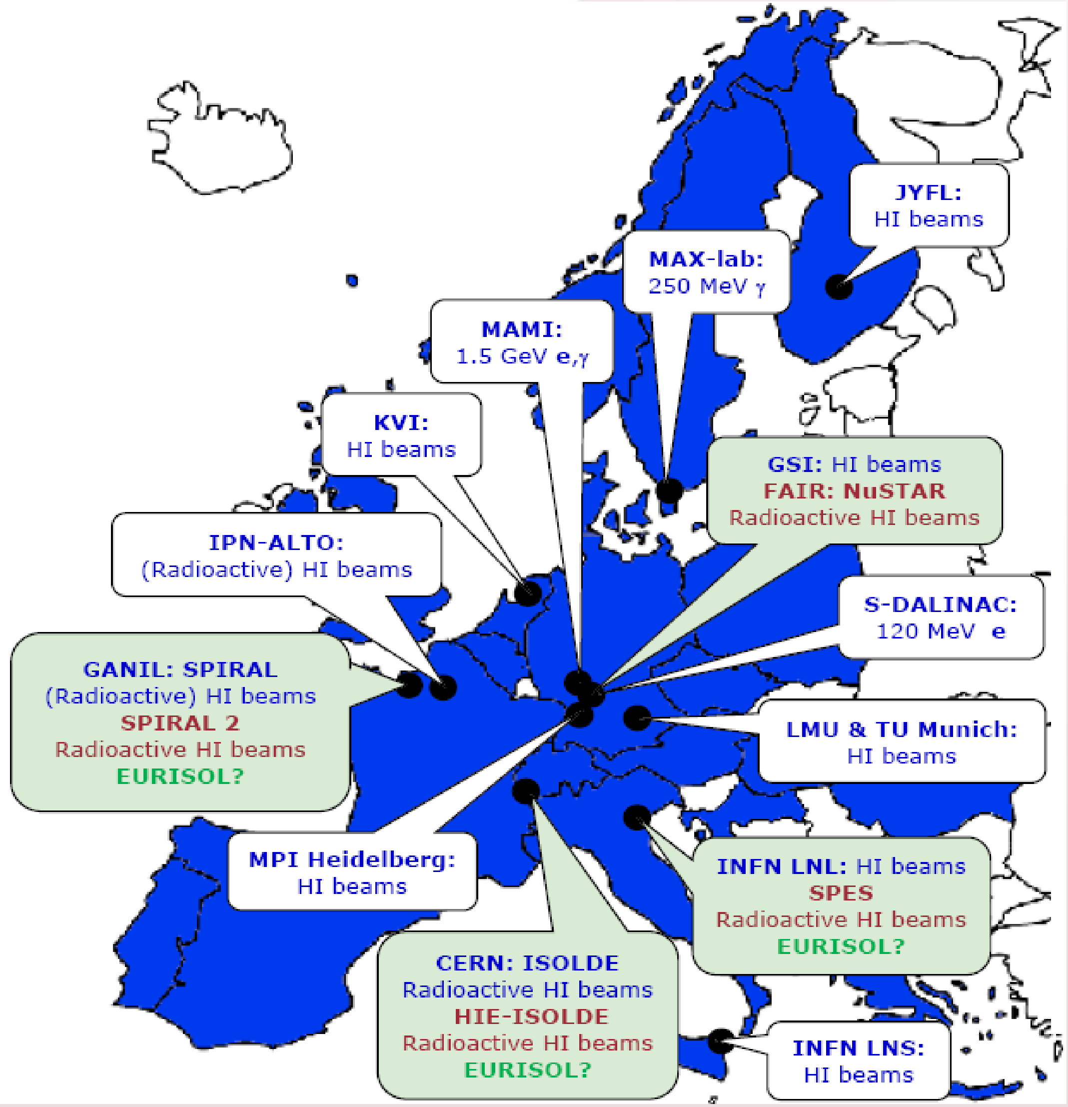
The ALTO Facility
Stable beams & RIBs

Maher CHEIKH MHAMED for the ALTO group

ALTO is recognized as Trans National Access facility in the framework of FP7



Maher CHEIKH MHAMED

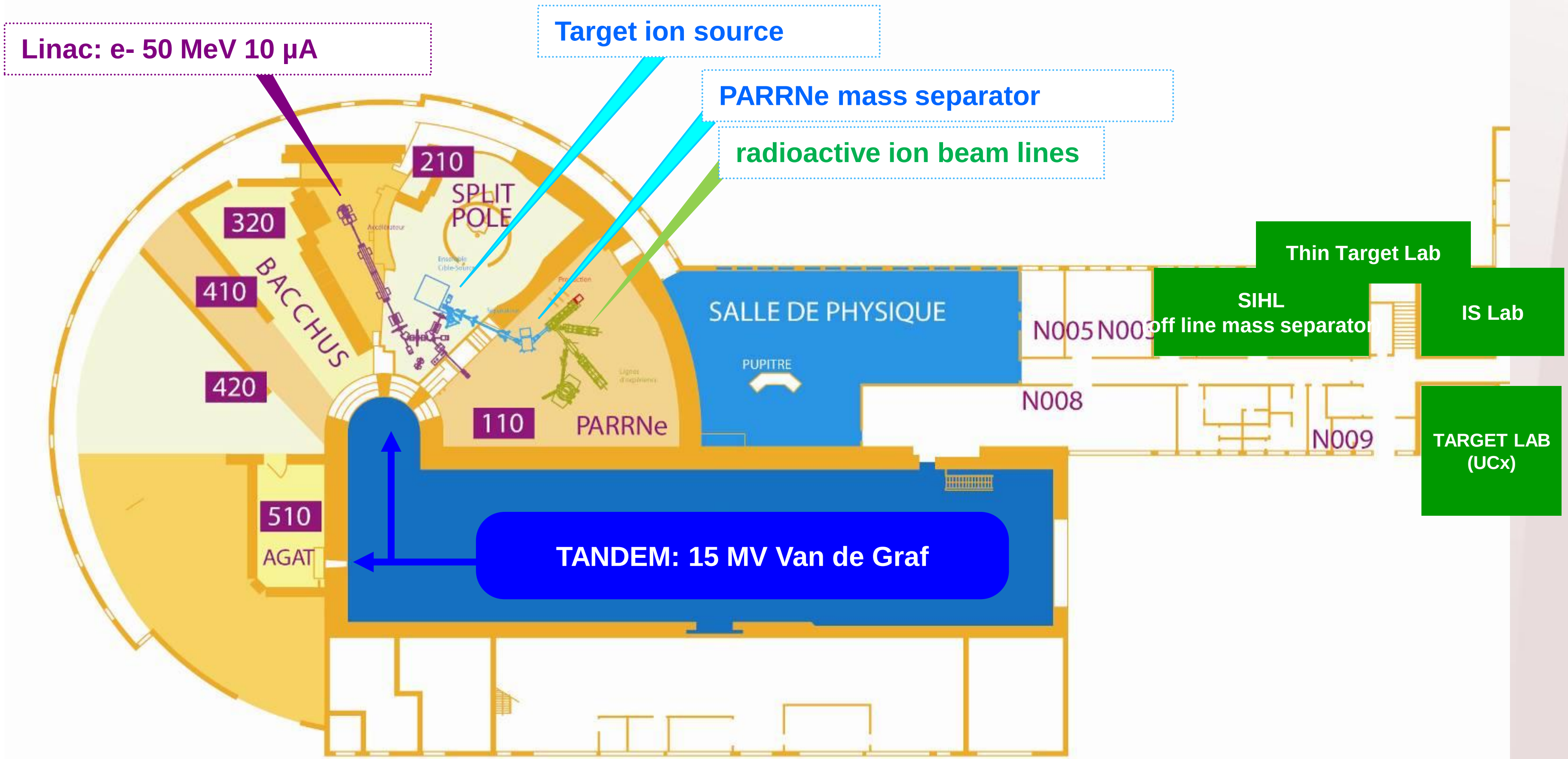
TNA FACILITY

AIMS

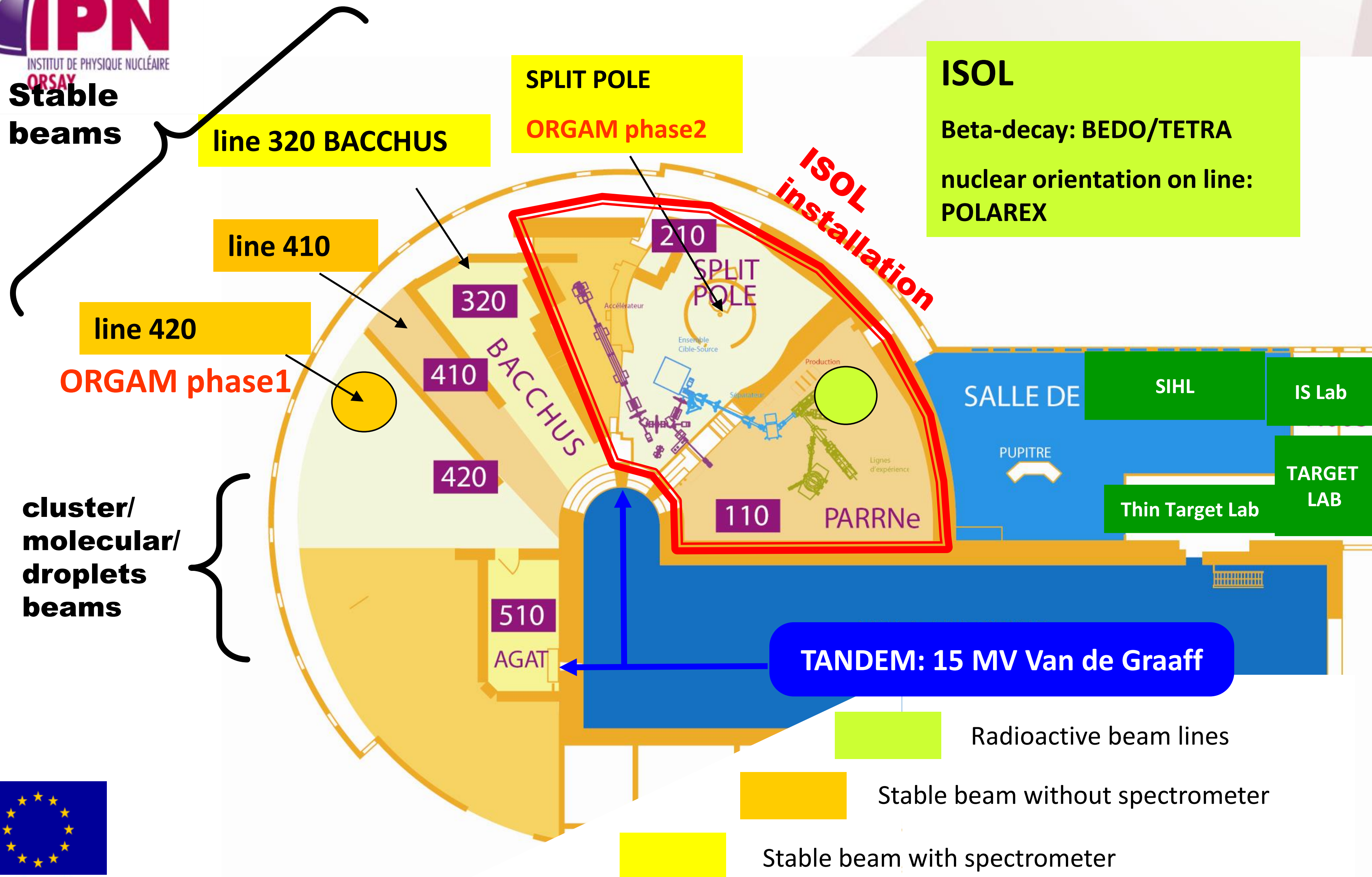
- **Providing both stable & radioactive ion beams with technical support to experiments**
- **Developing ion sources and thick actinide targets for the production of RIB**
- **Developing stable and radioactive thin targets for experiments**

Support for experiments:
30 engineers and technicians,
5 physicists

Inside accelerator building (109)



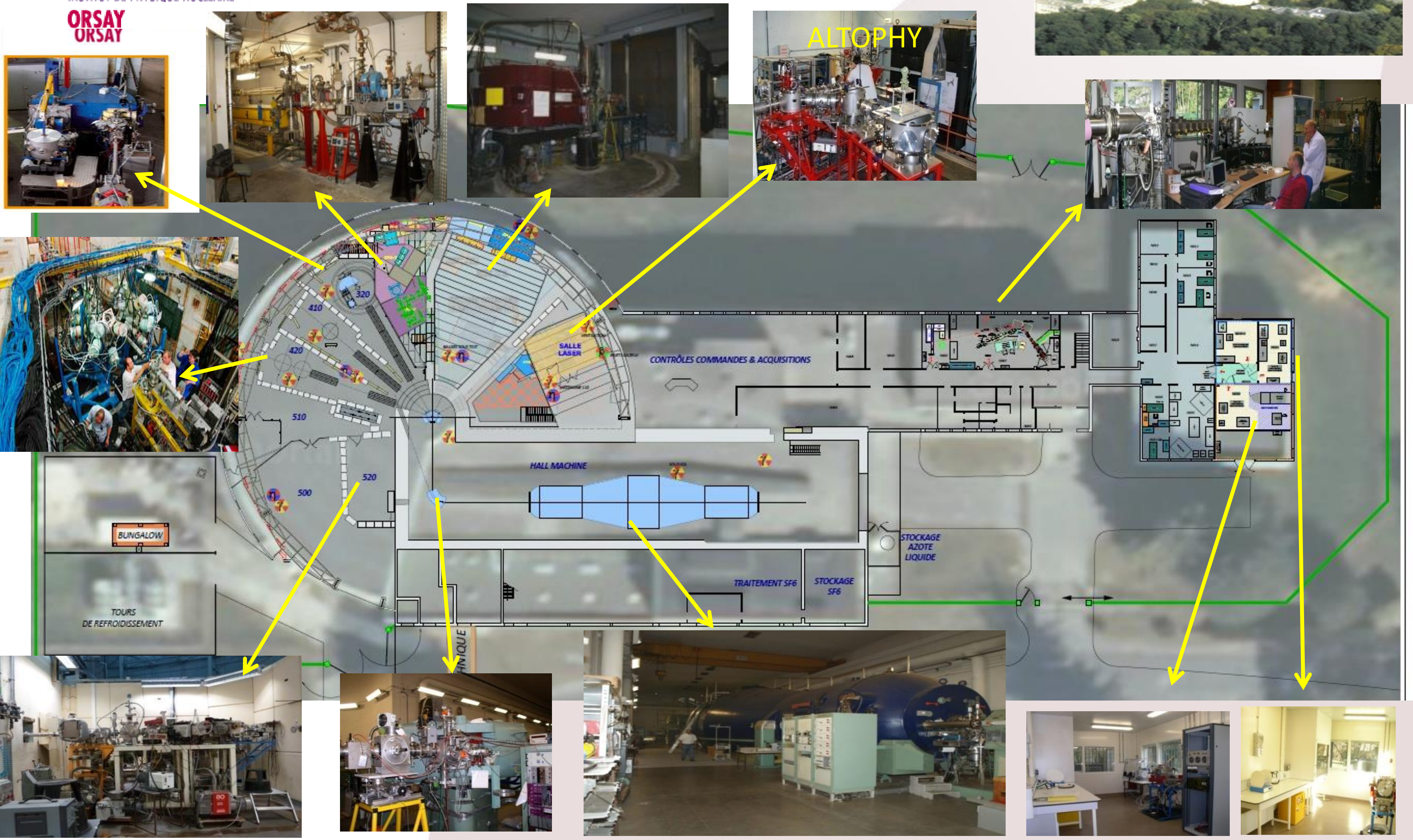
Tandem/ALTO general layout



A complex facility with many scientific equipment, 2 accelerators, 2 separators one off line and one on line, 2 spectrometers high-resolution, 8 beams line and a laboratory for the manufacturing of the uranium carbide targets UCx

ALTO

Accélérateur Linéaire et Tandem à Orsay



INSTITUT DE PHYSIQUE NUCLÉAIRE
ORSAY

Part 1
Stable beams - (Tandem) installation

ALTO
Accélérateur Linéaire auprès du Tandem d'Orsay

- ❑ **3 ion sources:**

-Duoplasmatron
-Sputter ion sources
-Liquid Metal Ion Source: Au_n

Bench for testing ion sources

- ❑ **6 beam lines:**

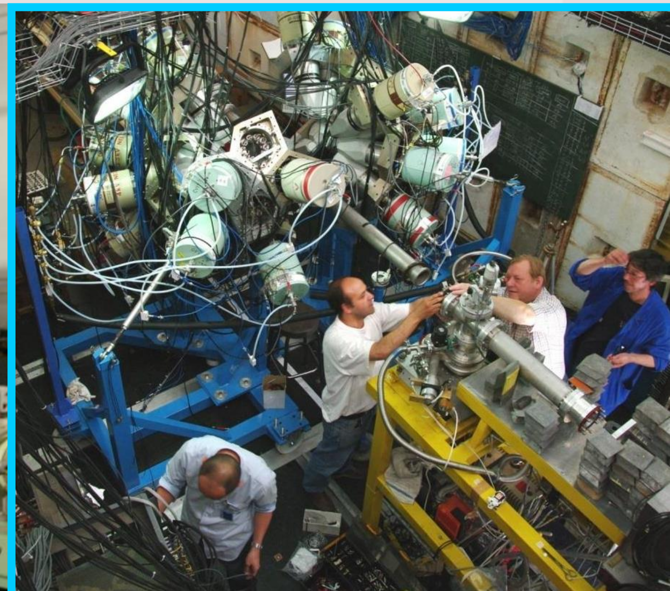
-Split-Pôle
-Bacchus
-ORGAM
-AGAT
-SIFAGA
-Free beam line 410

- ❑ **Acquisition room**

Range voltage: 0,5 to 14,8MV

75 beams can be tuned and delivered

- **from p to Au**
- **Cluster ions (Cn, CnHm)**



IPN INSTITUT DE PHYSIQUE NUCLÉAIRE ORSAY

ALTO Accélérateur Linéaire auprès du Tandem d'Orsay

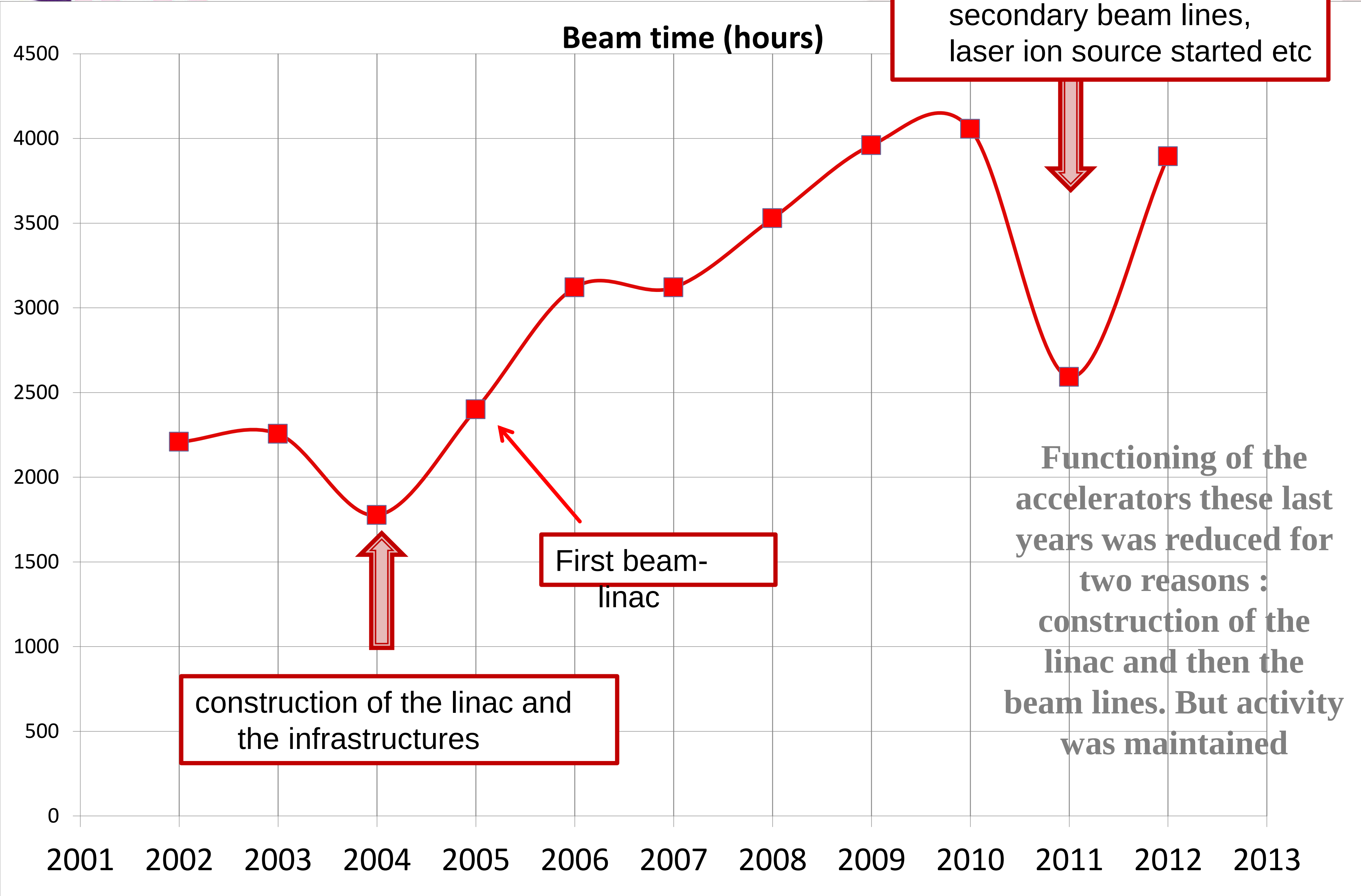
For the two accelerators: 33 weeks (4000 H)

- **Tandem 27 weeks**
- **Linac 6 weeks**
- **Produced Beams: p, D, ^{3}He, ^{4}He, ^{7}Li, ^{12}C, ^{13}C, ^{14}C, ^{24}Mg, ^{31}P, ^{32}S, ^{40}Ca, ^{48}Ca, ^{127}I, Cn, CnHm**
- **60% of heavy ions**
- **45% of pulsated beams**
- **Terminal voltage: over 10MV for 65% of time and 13,5-14,7 for 12% of the time.**

We compensated the time of the breakdowns by additional time, one working the weekend

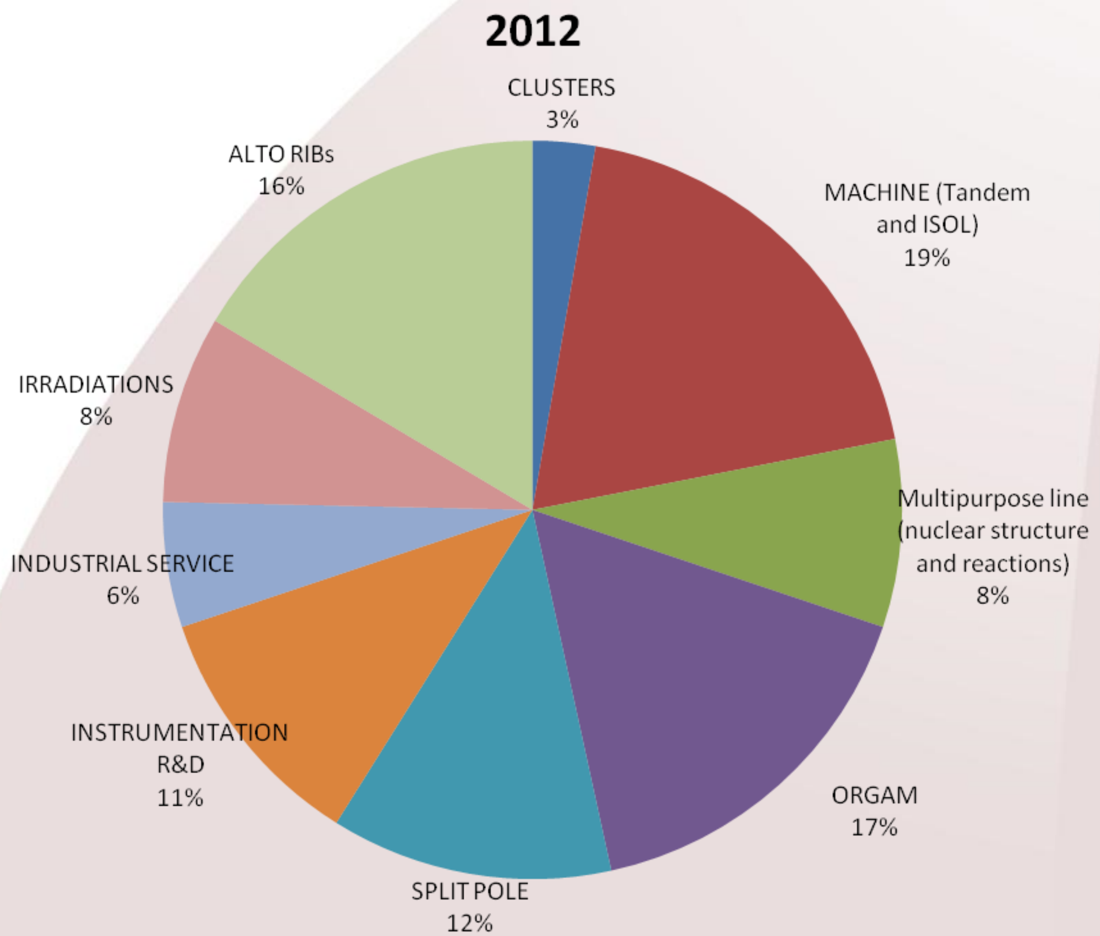
Tandem/ALTO beam schedule *Bilan*	
Time of scheduled and realized functioning (h) *Number of week*	*3624* *27*
Conditionning(h)	*240*
Tests ^{40}Ca , ^{48}Ca (h)	*120*
Time attributed)to the physics(h)	*3284*
Breakdowns (h)	*260*
Number of operators	*7*
Management of the breakdowns, additional Time (h)	*260*
Ion beam on Target (h) *%*	*3024* *100%*

Beam provided



Users

- ✓ **250 researchers from 26 foreign institutions and 15 national ones.**
- ✓ 33% Nuclear Physics/Astro-Physics
- ✓ 15% Clusters/Astro-Chemical
- ✓ 19% Instrumentation and other applications
- ✓ 13% Material irradiations
- ✓ 20% R&D improvement/development

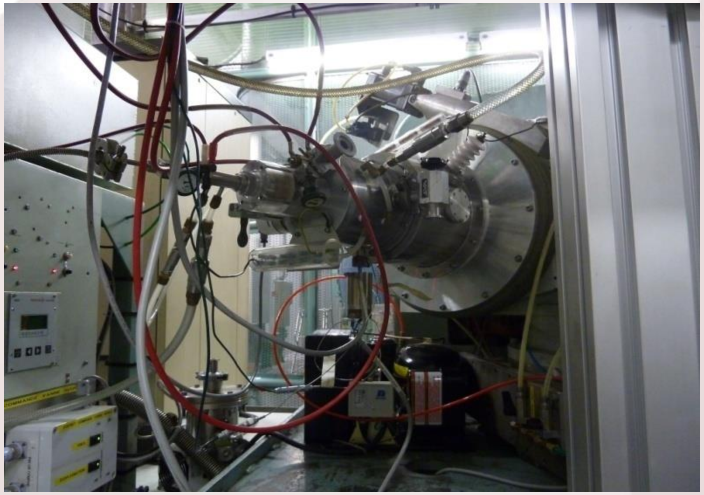


the topics of the experiments are very multi-field, with always a dominate for the nuclear physics

IPN INSTITUT DE PHYSIQUE NUCLÉAIRE ORSAY

ALTO Accélérateur Linéaire auprès du Tandem d'Orsay

Installation of new high intensity ion source for Clusters and ^{48}Ca



- Fullerene beams are produced by bombarding a target made of compressed fullerene with a 20 keV cesium beam
  - *Production of 10^7 C^{3+}_{60}/s at 48 MeV*
- Cs sputter ion source (type 860C) was tested off line in order to produce C_{60} ions and ^{48}Ca
  - The results showed that the new source produced 10 times more beam (^{12}C = 100 µA instead of 10 µA)
  - Next test with fullerene and ^{48}Ca targets underway (2014)

^{14}C Beam

Objective : intense beam of ^{14}C :

Previous experiments at Tandem with radioactive FeC paste :
initial activity = 25 mCi or 2.59 GBq
This experiment with a mixture of Carbon 14 and 12 in powder :
initial activity = 70 mCi or 7.25 GBq

Preparation of the target of ^{14}C in a gloves box :

Images of preliminary tests with only ^{12}C

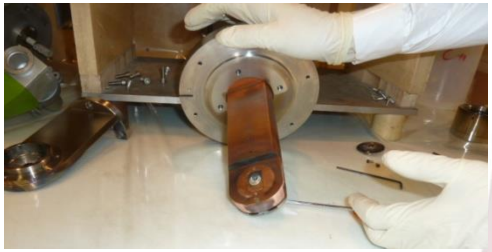
17 of ^{14}C + 53 of ^{12}C :
70 mg of carbon

Filling the target with a spatula

Pressing to compact the powder

^{14}C target

Assembly operation under extraction hood :

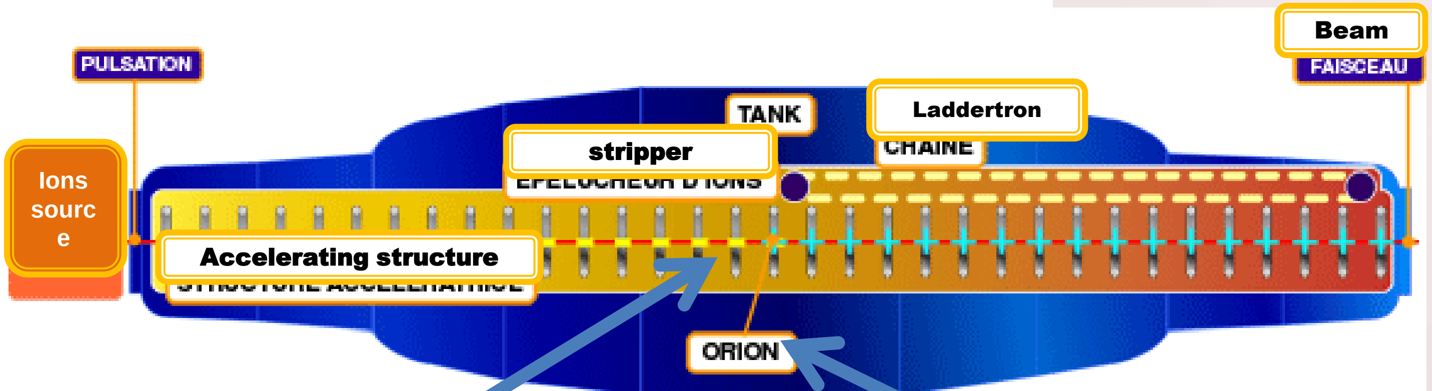


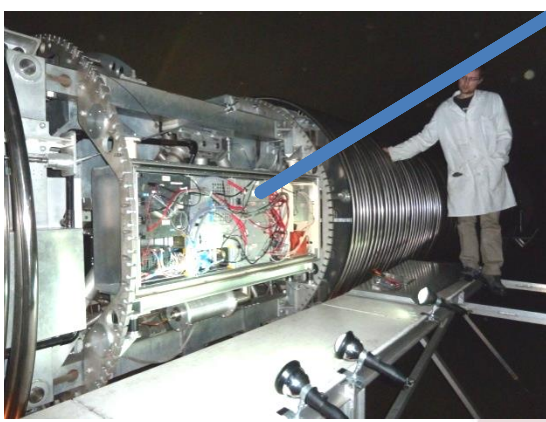
The ^{14}C target is placed in the source

New method to produce the targets of **^{14}C** , we obtained an analyzed current of 100nA. Multiplied by 3

INSTALLATION OF AN AUTOMATON SYSTEM IN THE TERMINAL OF THE TANDEM

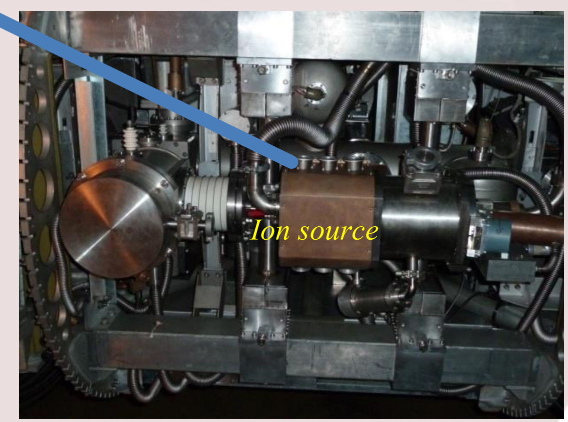
Development of a new C&C and to installation of an automaton inside the accelerator at the terminal 15MV. Support the pressure of SF6 and the Sparks - first successful test for the Tandem





The control and command system installed in the terminal

Orion: Beams of heavy gold cluster Produced by liquid metal ion source (LMIS)

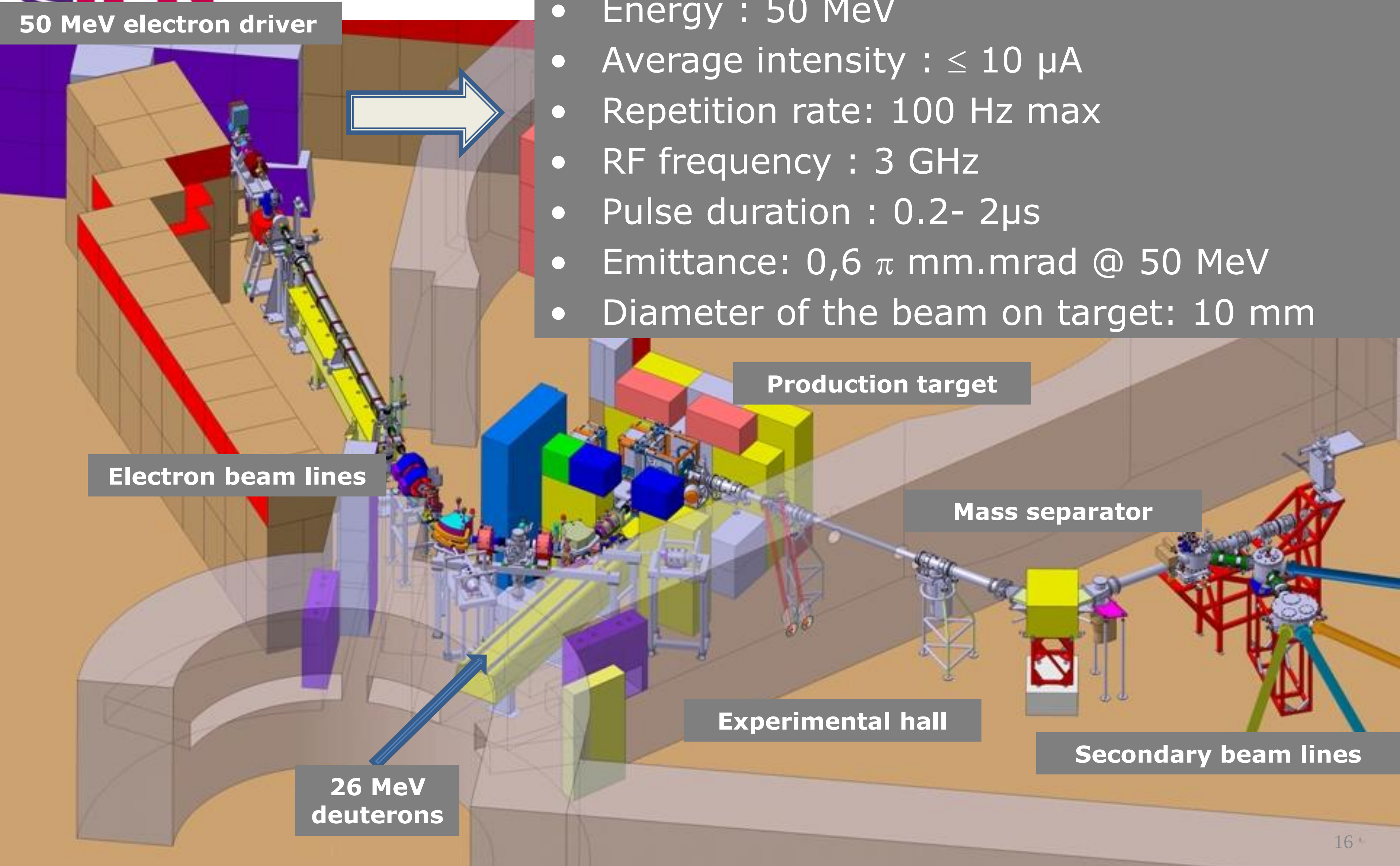


Seen through the bottom

Part 2
ISOL installation (RIBs)

RIB production by photofission

- Energy : 50 MeV
- Average intensity : ≤ 10 µA
- Repetition rate: 100 Hz max
- RF frequency : 3 GHz
- Pulse duration : 0.2- 2µs
- Emittance: 0,6 π mm.mrad @ 50 MeV
- Diameter of the beam on target: 10 mm

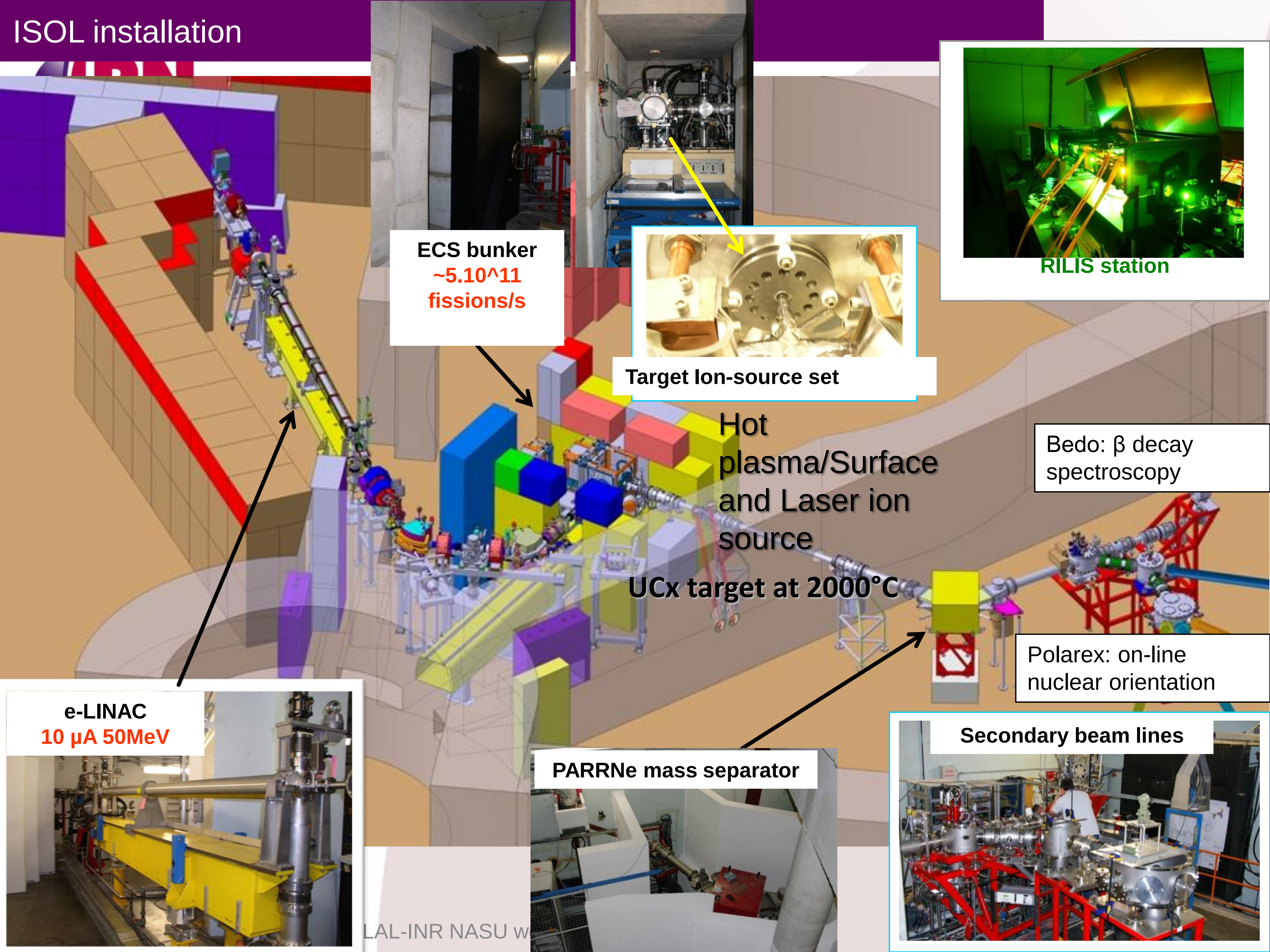


Good news of year 2012

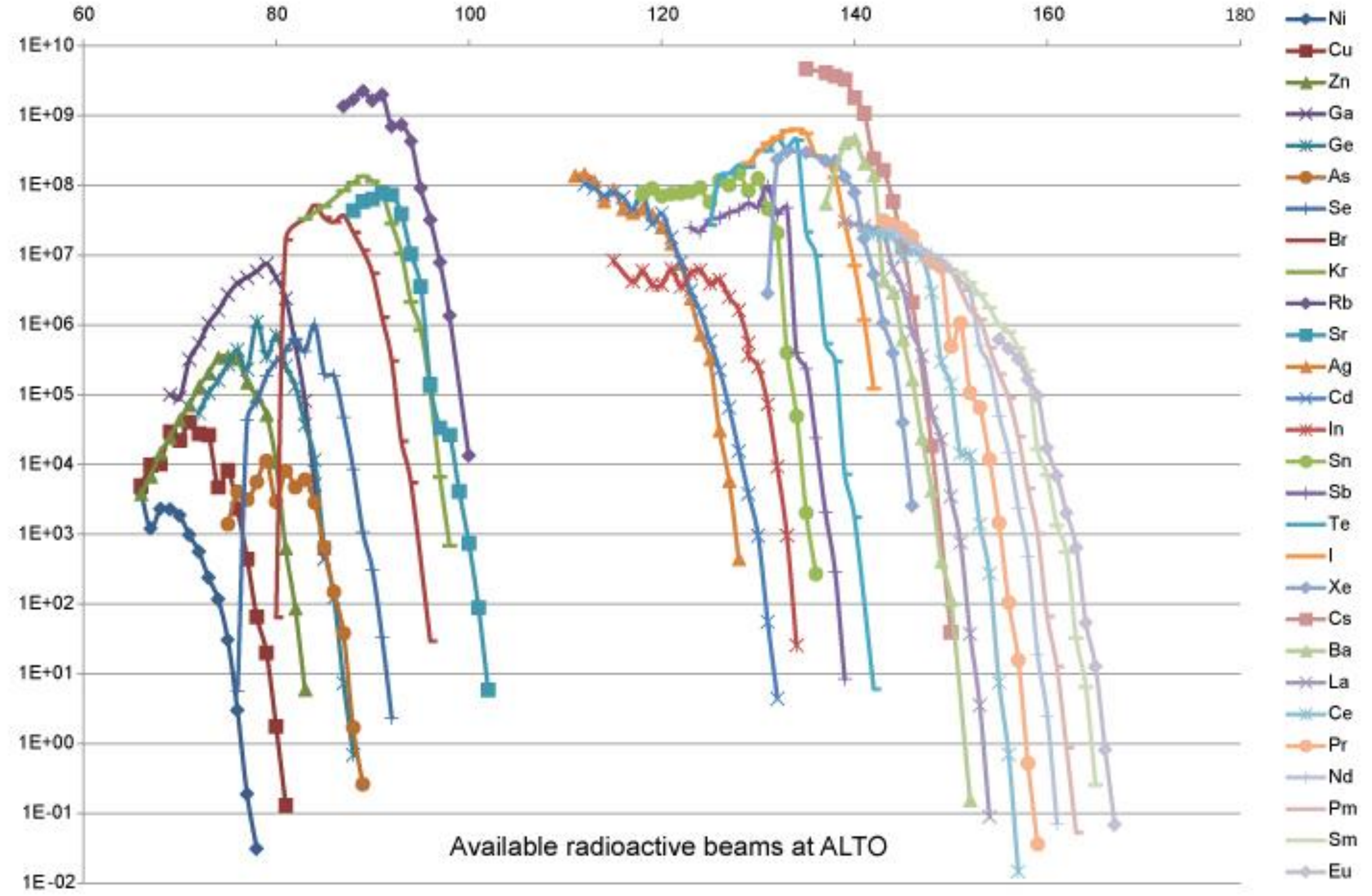
Green light from the safety authorities:

full authorization to run the ISOL facility at nominal primary electron beam intensity (10 µA, 50 MeV) – duration 5 years
no limitation in number of runs per year (to be confirmed)
⇒ access to non-IPN users is fully open

ISOL installation



The productions (with the most appropriate source)

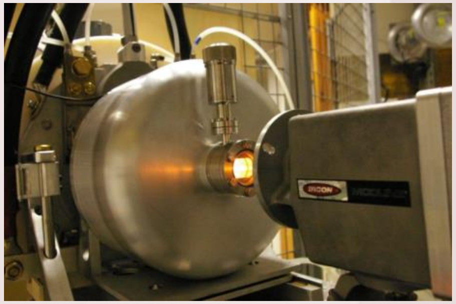


Efficient and reliable system for the next generation of ISOL facilities (≥10^{14} fissions/s)

High ε_i and longer running time/ strong irradiations

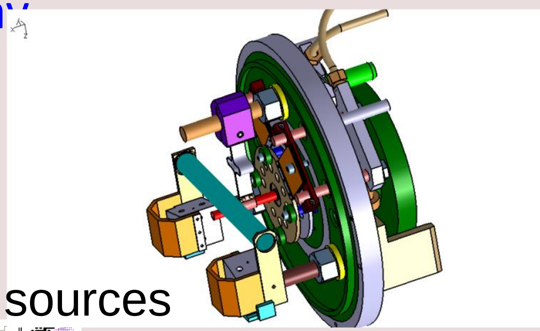
Hot plasma ion source

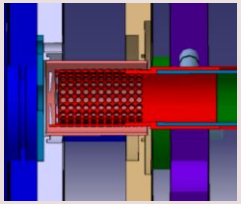
- Material operating at high T/Physicochemical interaction
- Study of the space charge compensation
- Design of an efficient extraction (60 kV)

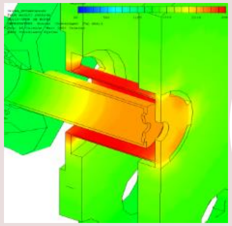


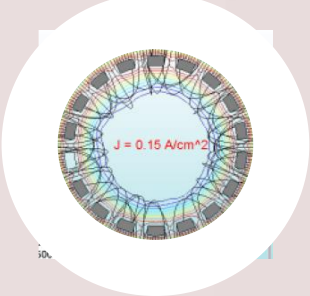
Radial configuration

- Cylindrical cathode (T >2500°)
- Insulating placed away
- No magnet







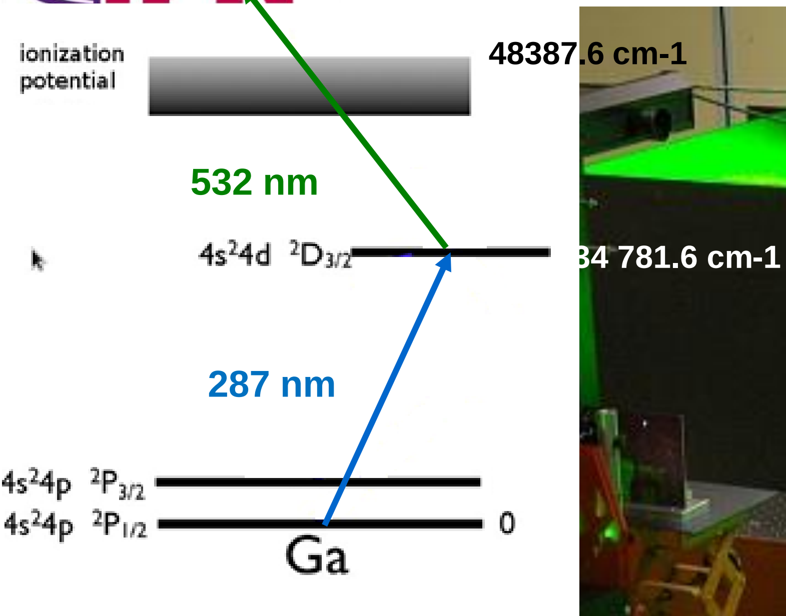


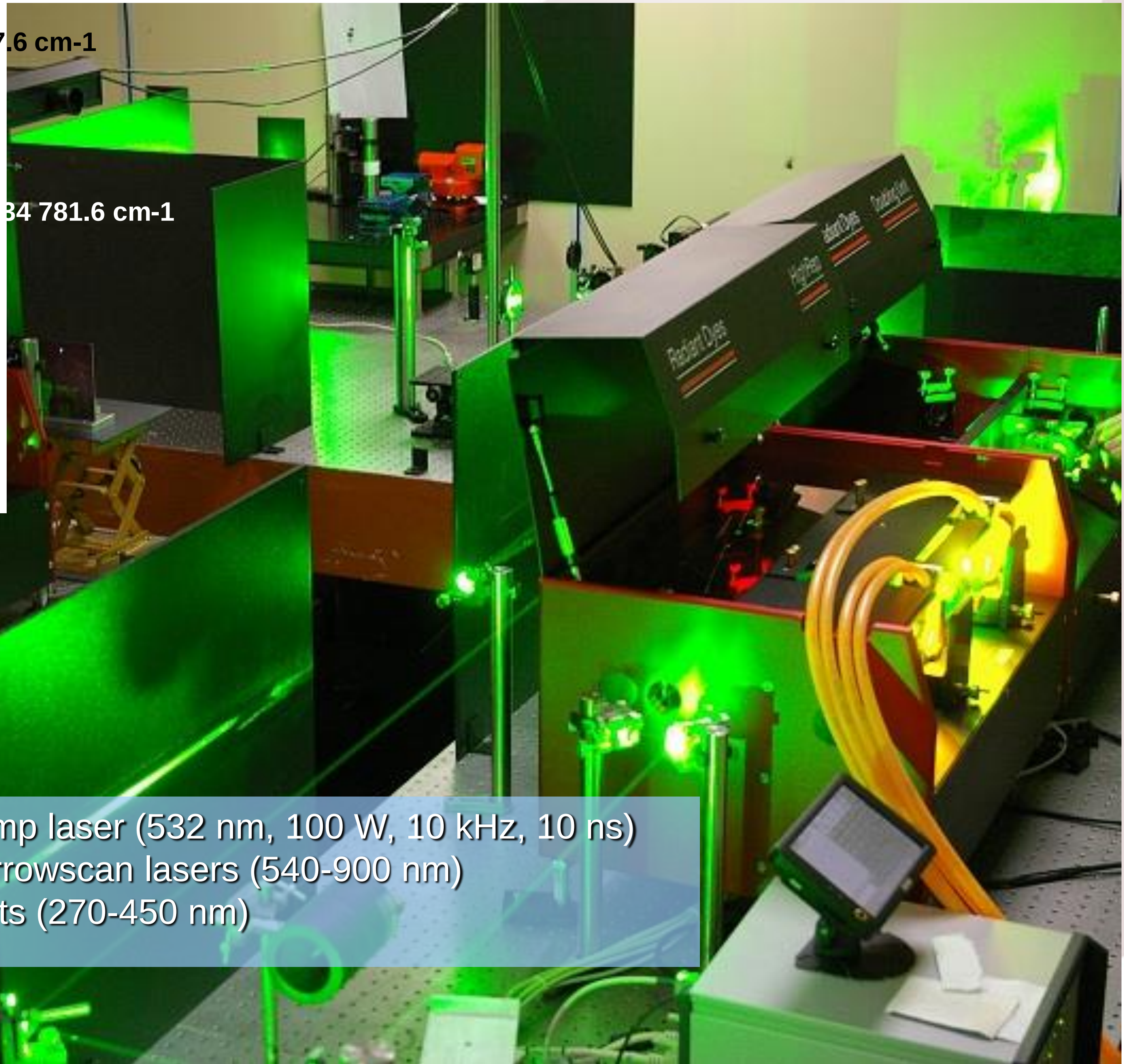
Simulations with Lorentz code and IDEAS

Status : Competetive effeciency

Comparing to the conventional ion sources

Alto laser ion source

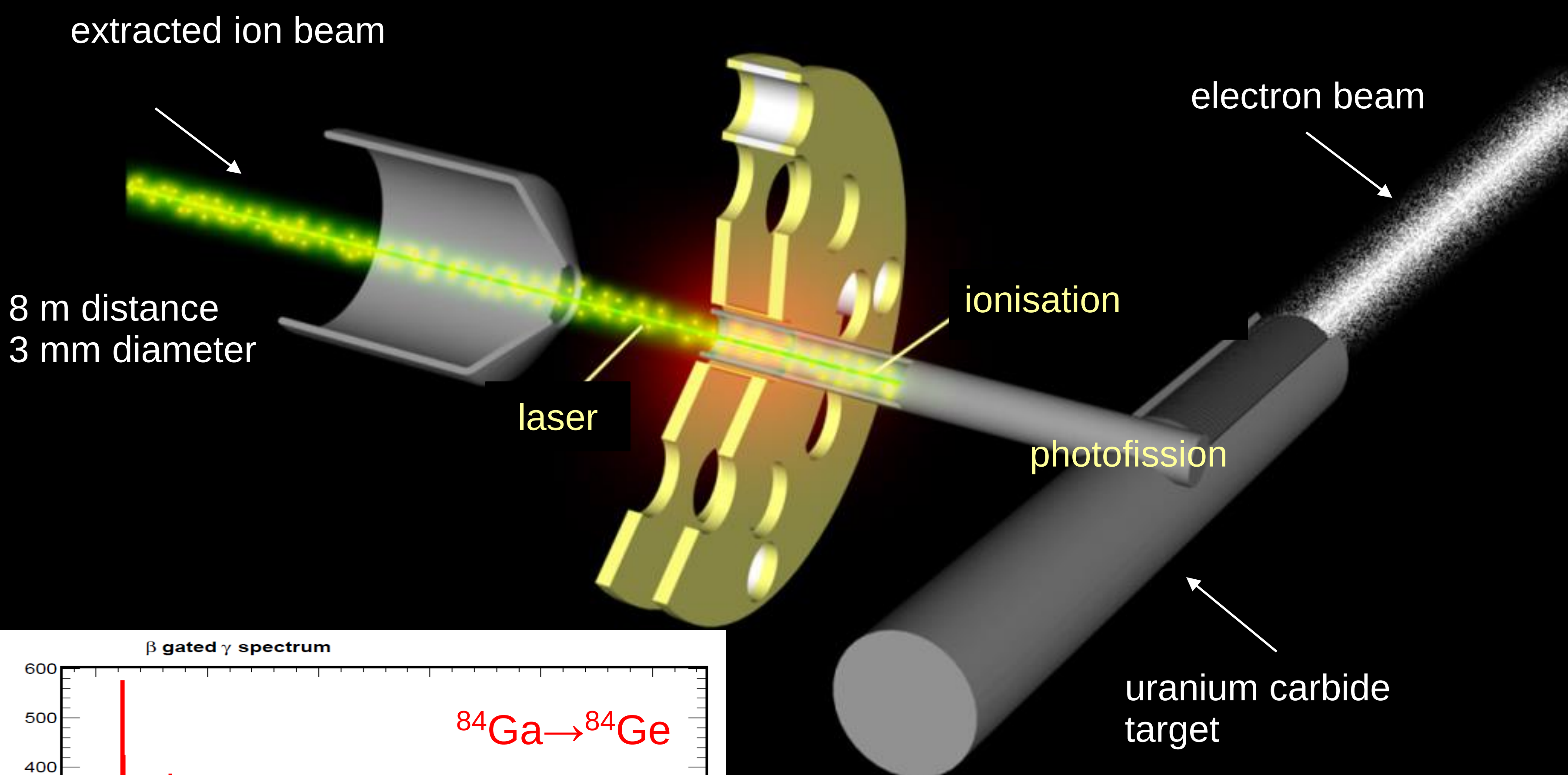


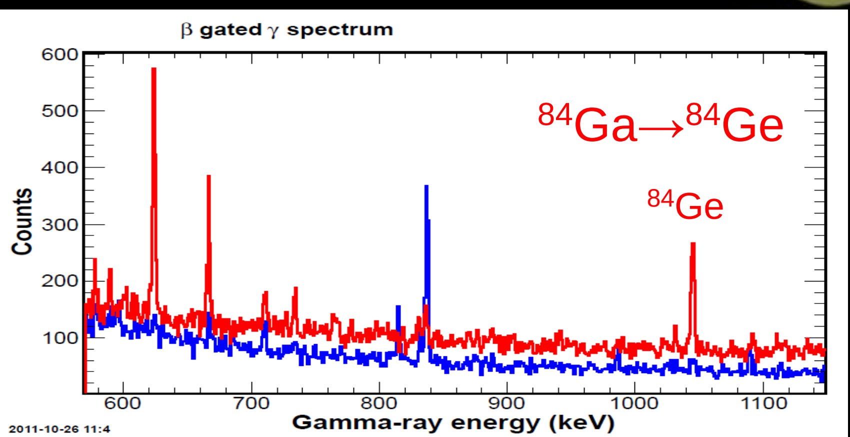


- ► Edgewave Nd:Yag pump laser (532 nm, 100 W, 10 kHz, 10 ns)
- ► Two Radiant Dyes Narrowscan lasers (540-900 nm)
- ► Two BBO doubling units (270-450 nm)

Alto Laser ion source at IPN Orsay : more selectivity …

Isolde-type ion source





laser ionisation ε~10% (10 μA)

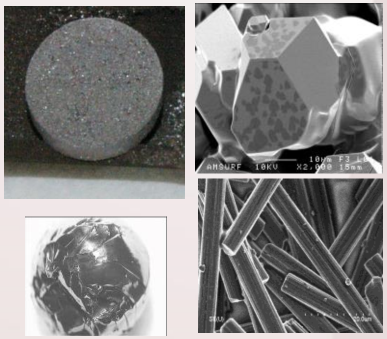
without laser:
surface ionisation ε~1% (1 μA)

(collaboration with Radiochemistry group)

Best release properties

Synthesis and densification of UCx materials

- Carbo-reduction of uranium oxide and oxalate
- arc melting (metallic U, C)
- Composites UCx-C (fibers, nanotubes)



– Structure analysis

- Purity Density
- Porosity Morphology of the grains and pores

– On line measurement of the release parameters

γ spectroscopy

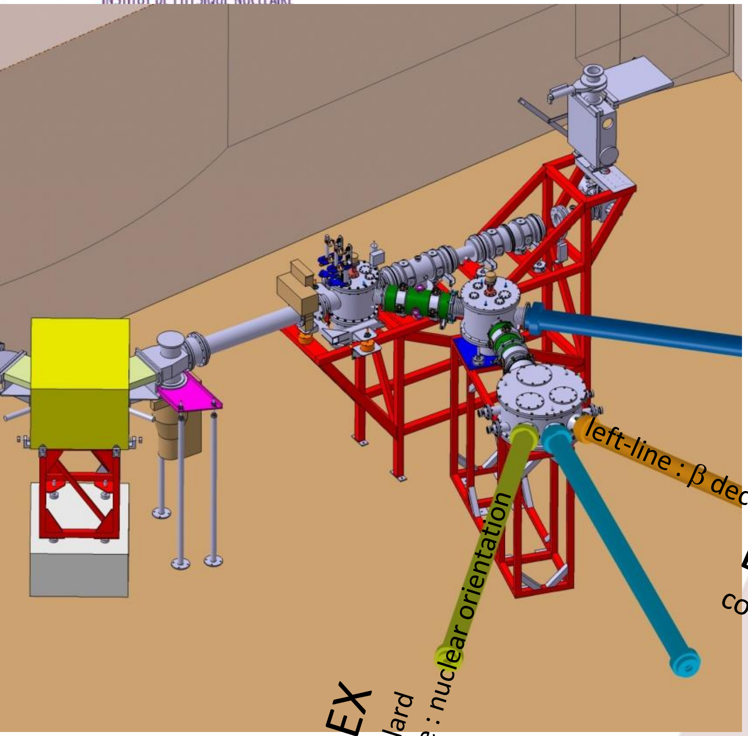
effusion-diffusion process

Waste reprocessing

- Study of the stabilisation of UCx by chemical dissolution
- Controlled oxidation process of the UCx material

Part 3
detection systems and instrumentation

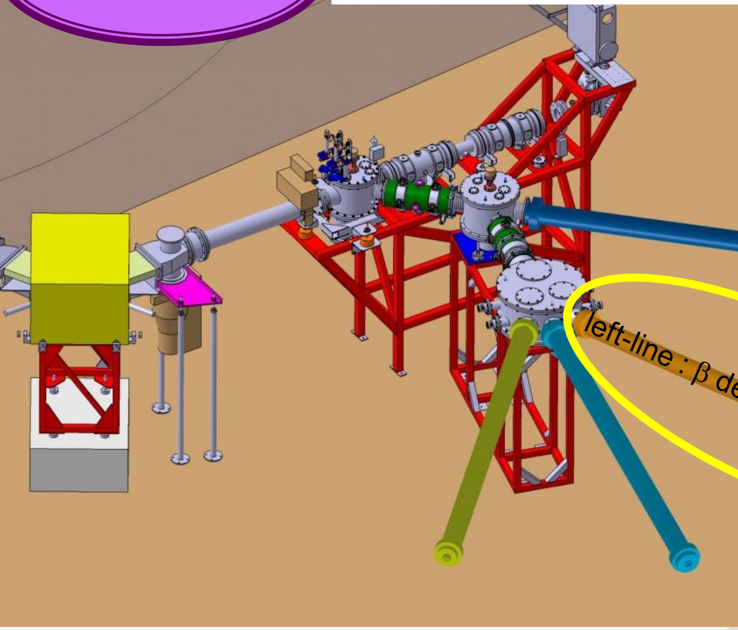
Instruments for radioactive beams



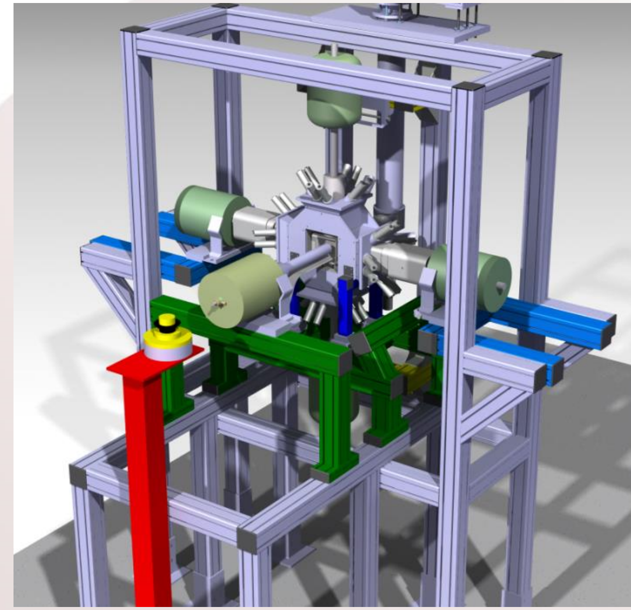
Equipment of the secondary beam lines : beta decay spectroscopy

BEDO

BEta Decay studies at Orsay



left-line : β decay spectroscopy

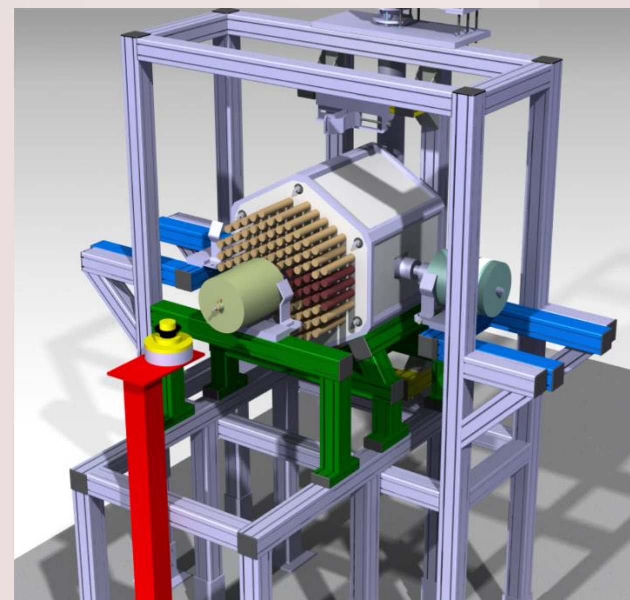


gamma spectroscopy following β-decay

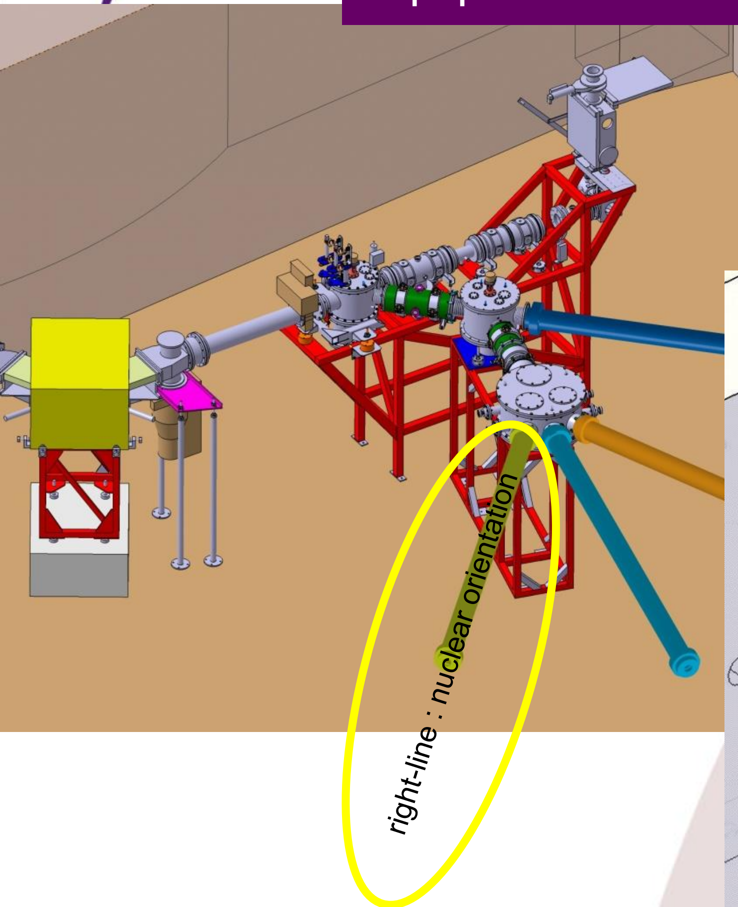
fast-timing

detection of β-delayed neutrons + gammas

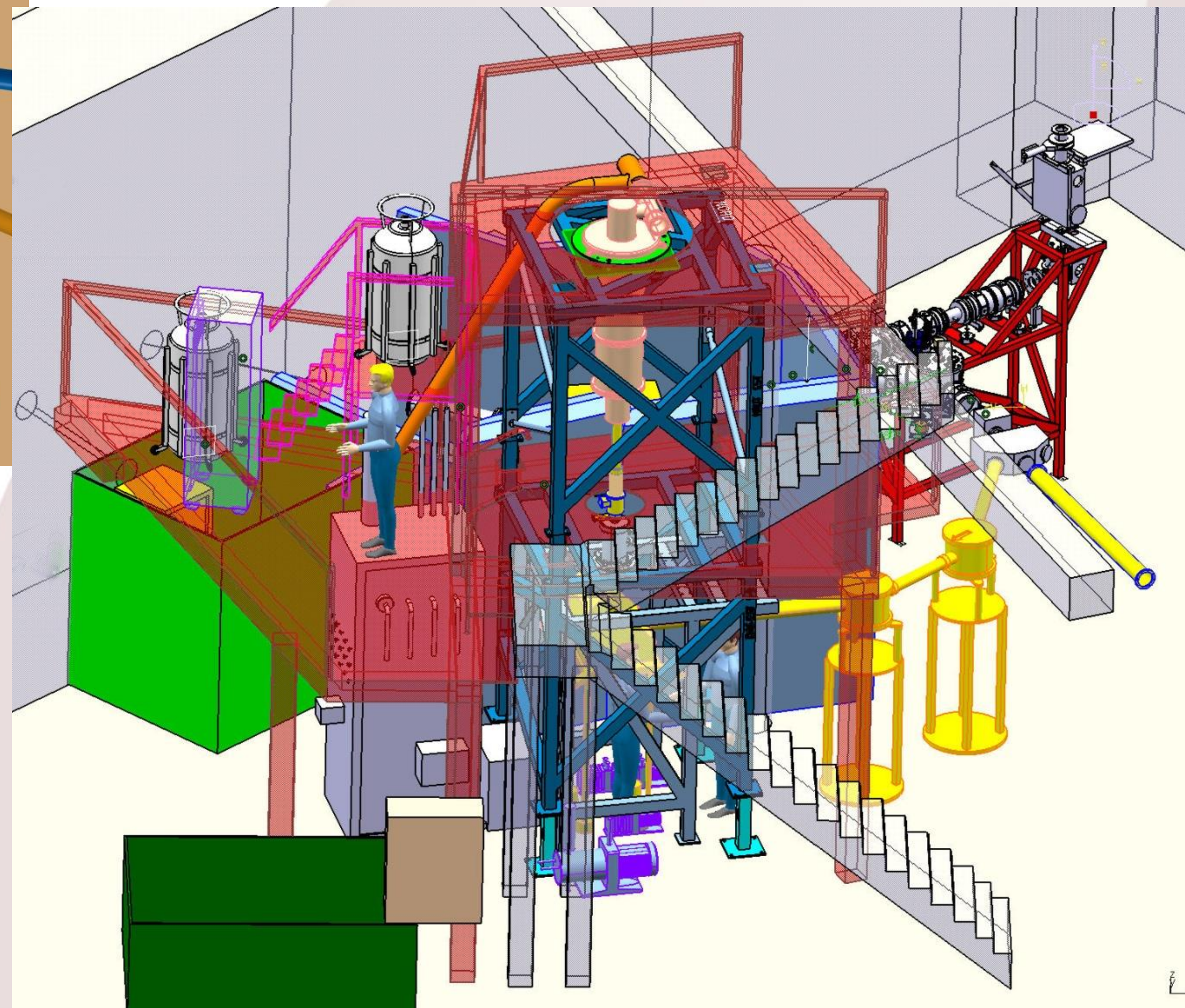
3He neutron detector (Dubna-Orsay collaboration)



Equipment of the secondary beam lines : on line nuclear orientation



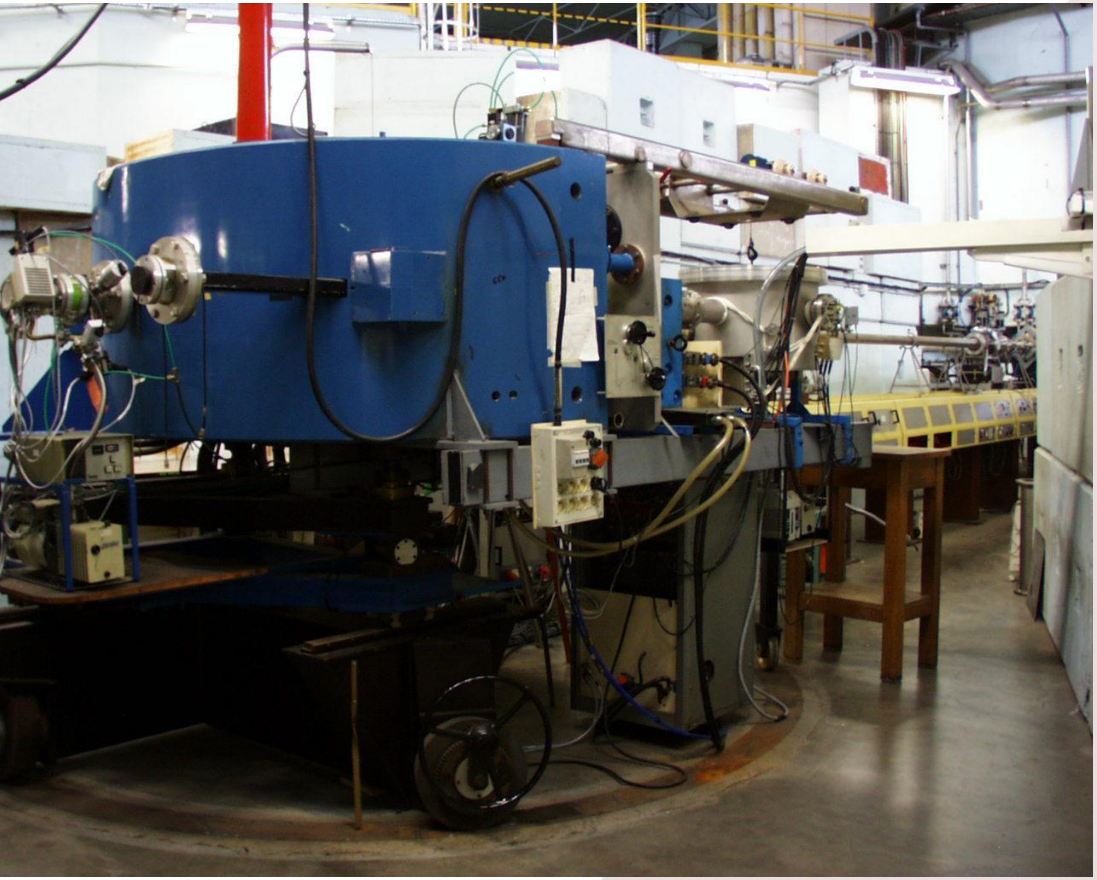
POLAREX project (C. Gaulard et al.)

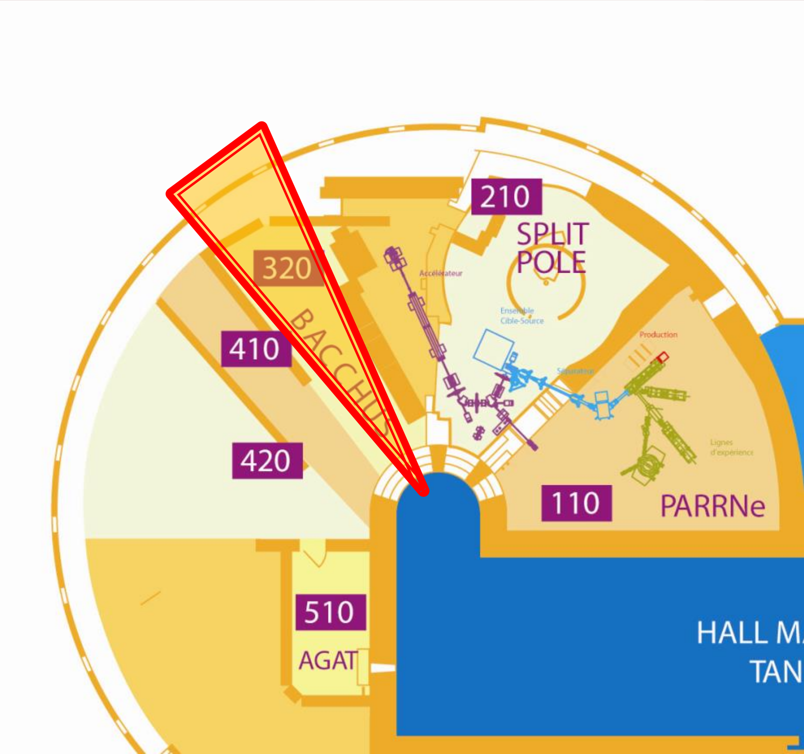


* study of the nuclear magnetic moments and spins of exotic nuclei

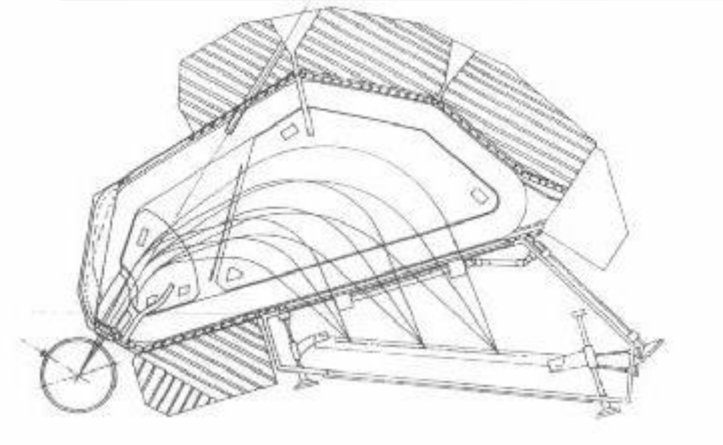
* observe the decay of a spin-oriented ensemble of nuclei

Could be used for nuclear physics but fully devoted to industrial applications and irradiations (ex : see Planck proposal this year)



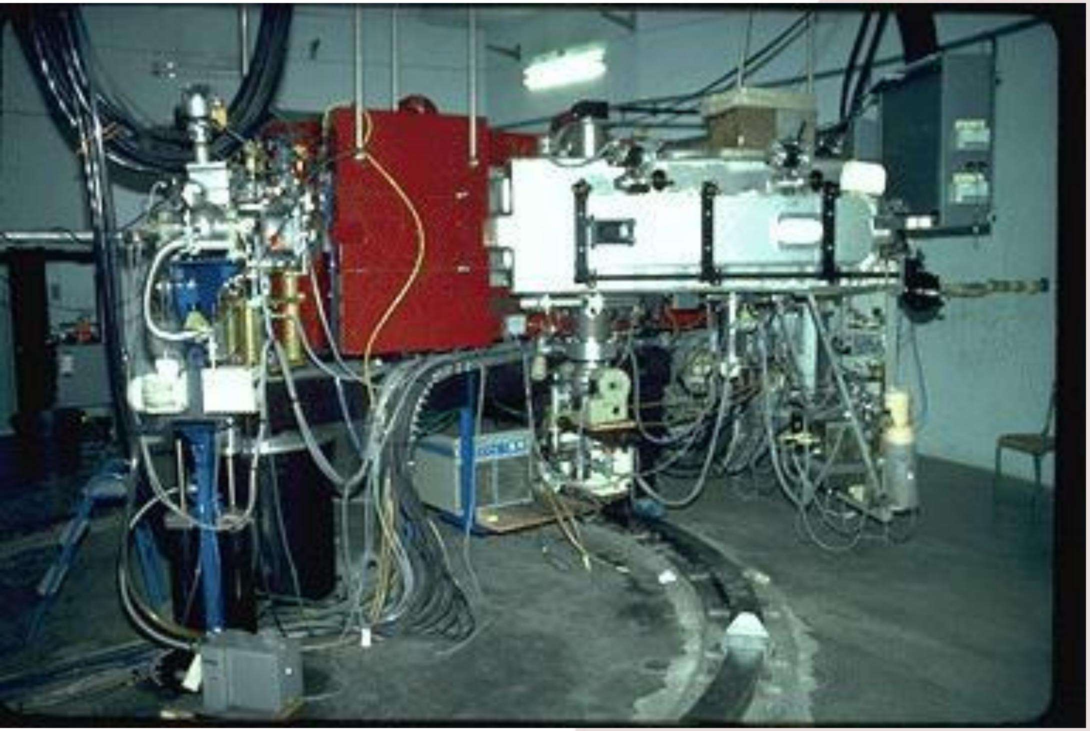


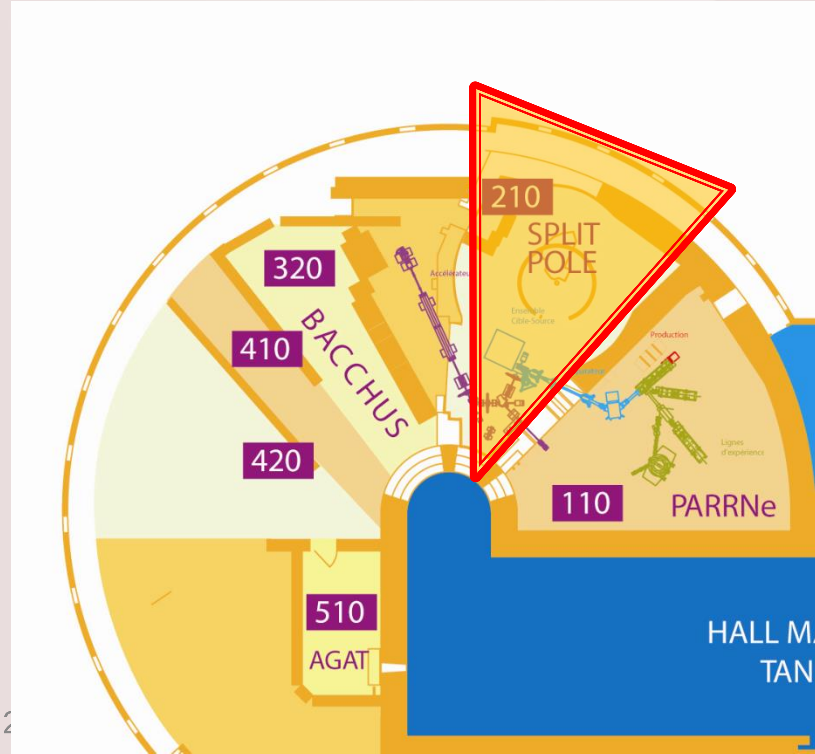
Split-Pole spectrometer



maximum magnetic rigidity : 1.65 Tm
maximum solid Angle : 4 msr
energy resolution E/ΔE~2000

focal plane detectors :
proportional counter : energy loss ΔE + localization
plastic : residual energy E
(+ time of flight if pulsed beam)



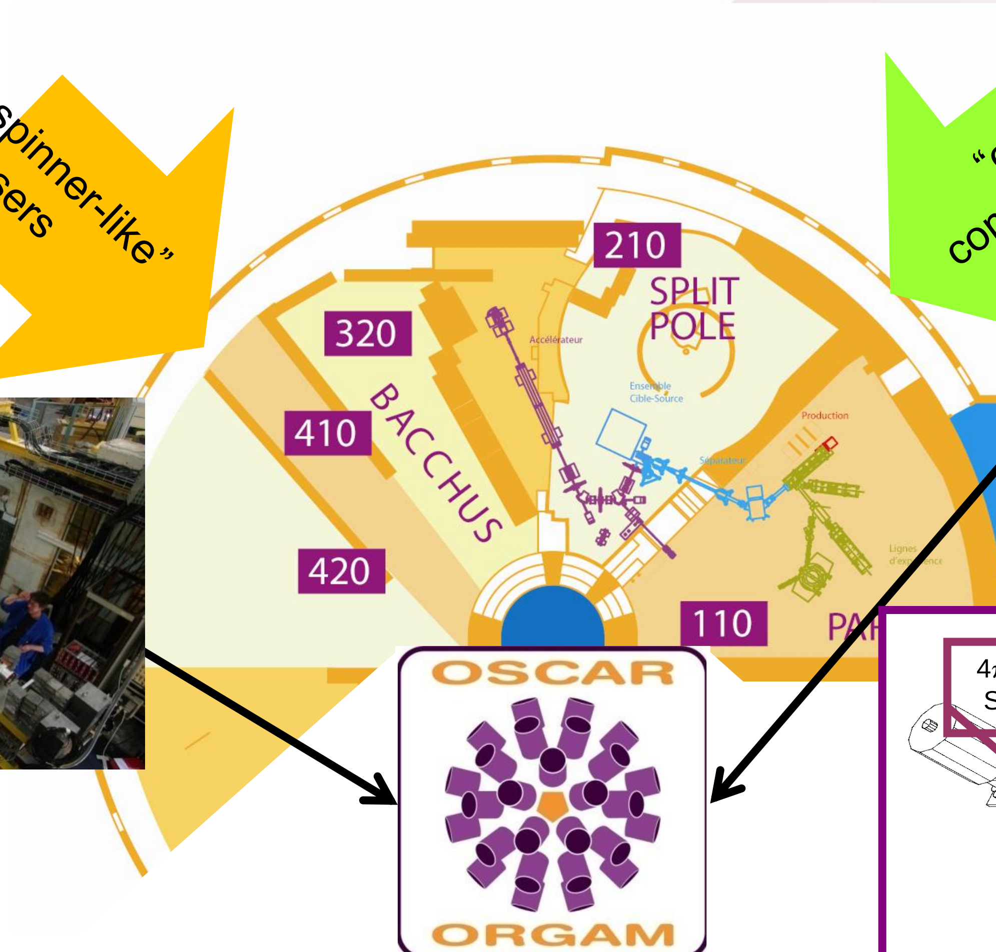


instruments : Ge arrays

“stable beam/high spinner-like” community of users

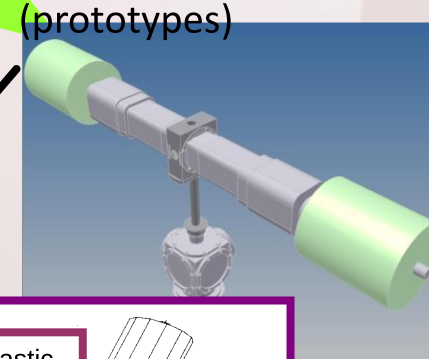
“exotic-like” community of users

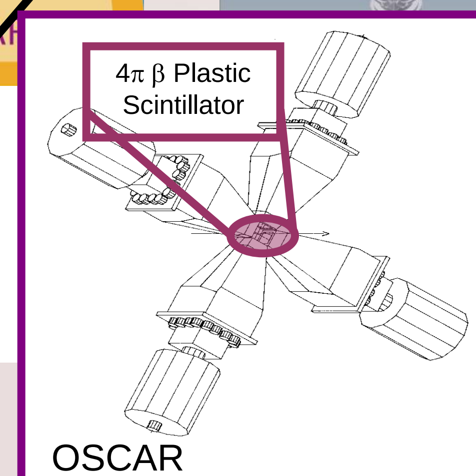
ORGAM (ORsay GAMma array)



OSCAR (Orsay Segmented Clover Array)

4 small EXOGAM clover (prototypes)





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Tests of embarked instruments and irradiations of components

ALTO
Accélérateur Linéaire auprès du Tandem d'Orsay

Program JUICE

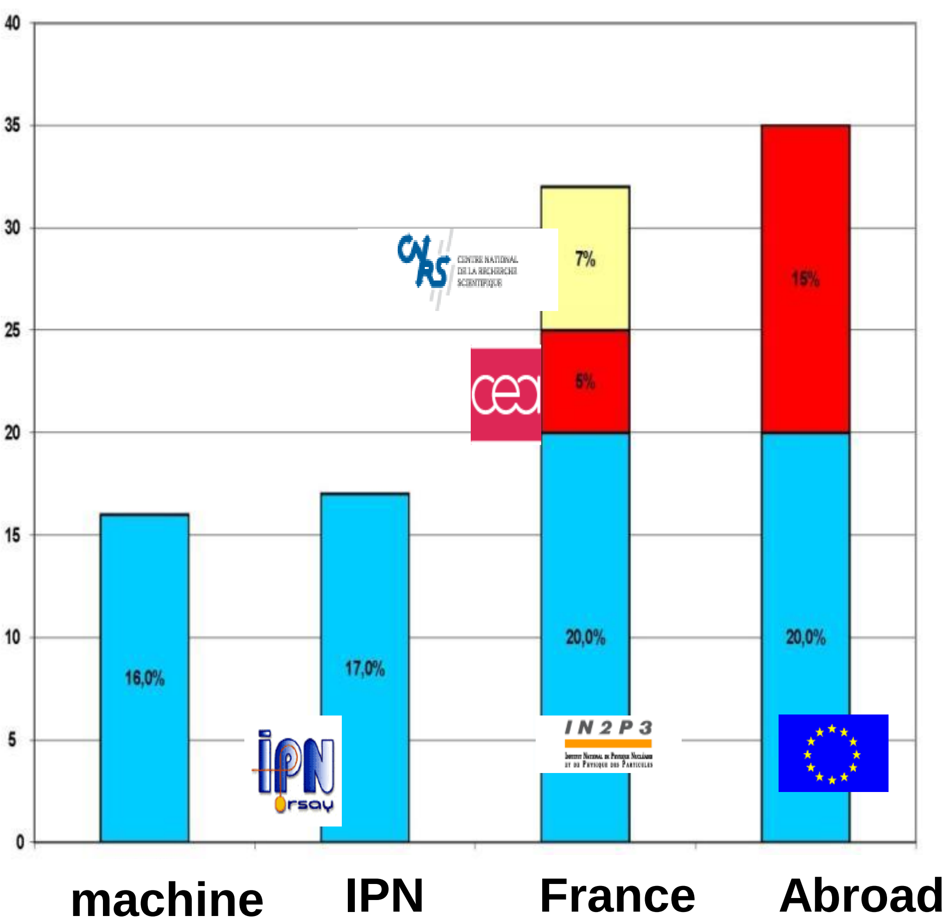
For the impact study of radiations on Schottky diode manufactured with the LPN or by UMS for space program JUICE of the ESA (mission of class L). The LERMA is responsible for the delivery of several circuits using of the Schottky diode for the submillimeter instrument heterodyne receiver SWI which will observe Jupiter starting from 2030 (launching 2022).

Beam line dedicated to the industrial ones

Satellite Planck

Irriadiation of embarked measuring instruments :
HFI : detectors bolometric, multiple cooling systems, and electronics with weak noise

Our community of users



400 researchers from

26 foreign institutions and 15 national ones

for nuclear physics and applied physics.

-Nuclear structure of exotic nuclei
-Cluster in nuclei
-Nuclear astrophysics
-Nuclear waste
-Nuclear physics for energy and environment
-Atomic physics: cluster atoms collisions
-Nanotechnology (cluster atoms)
-Instrumentation

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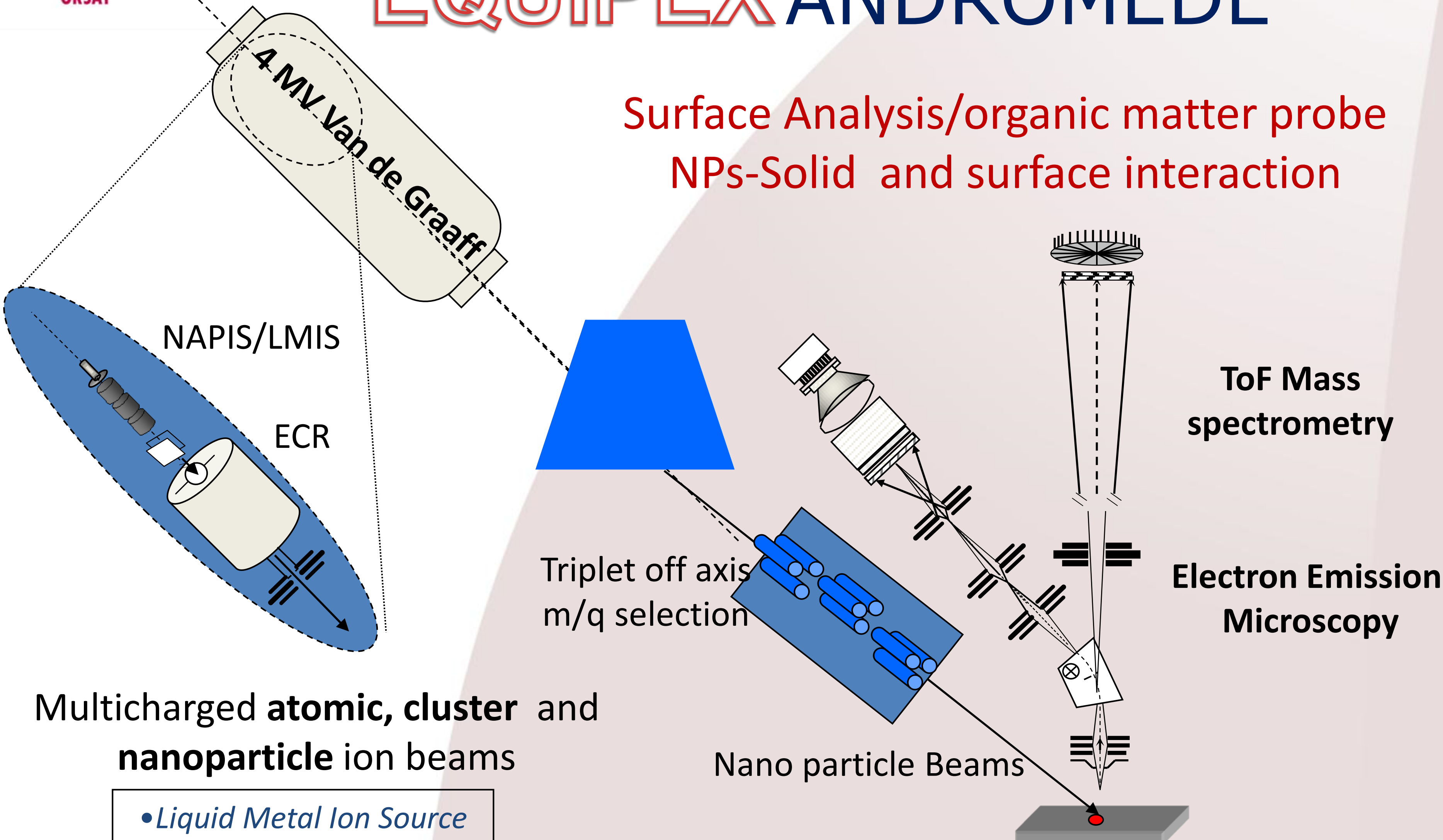
ORSAY

EQUIPEX ANDROMEDE

Surface Analysis/organic matter probe
NPs-Solid and surface interaction



Multicharged **atomic, cluster** and **nanoparticle** ion beams

- *Liquid Metal Ion Source*
- *NAno-Particle Ion Source*
- *ECR ion source*

Thanks for your attention …