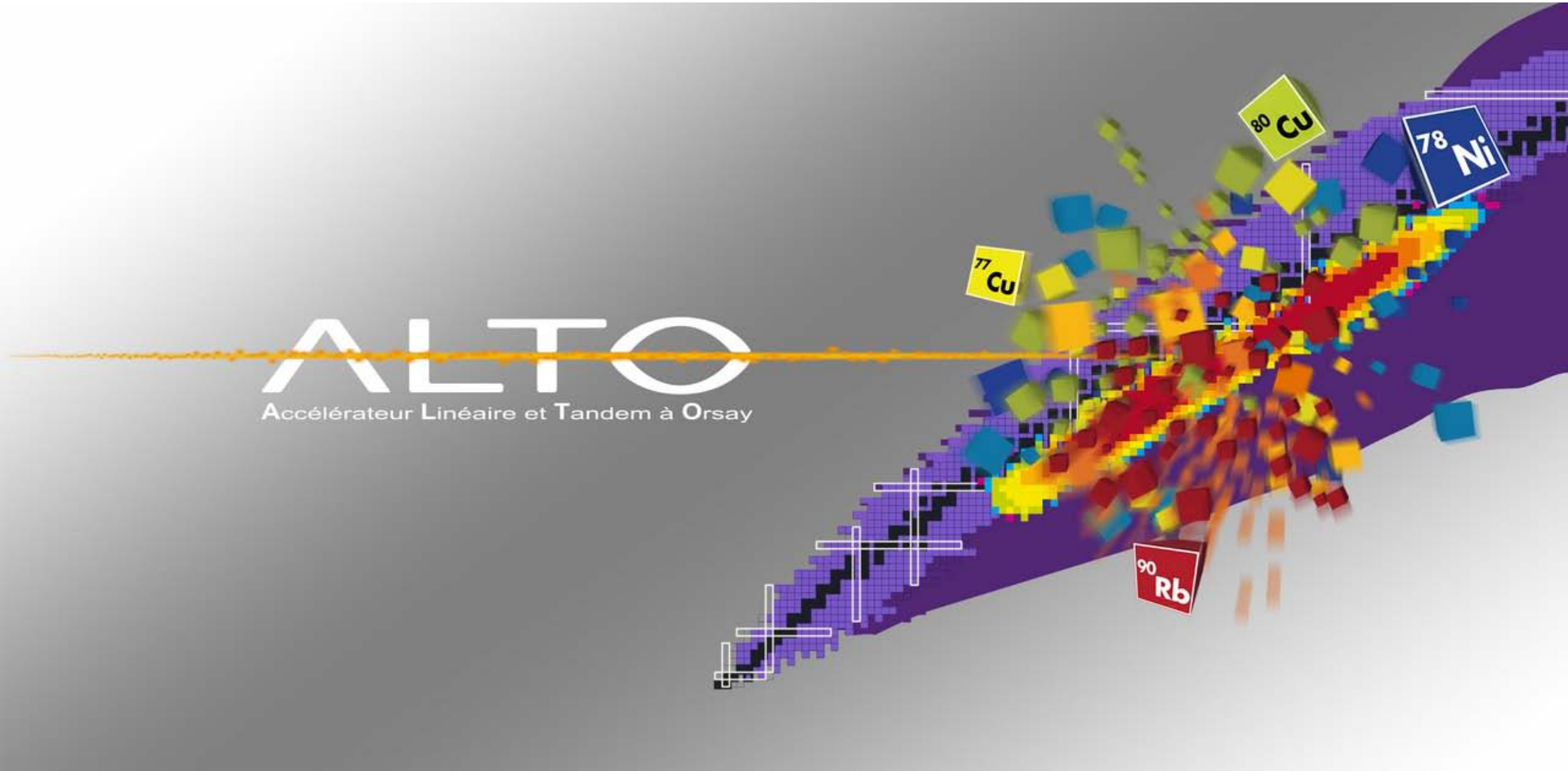
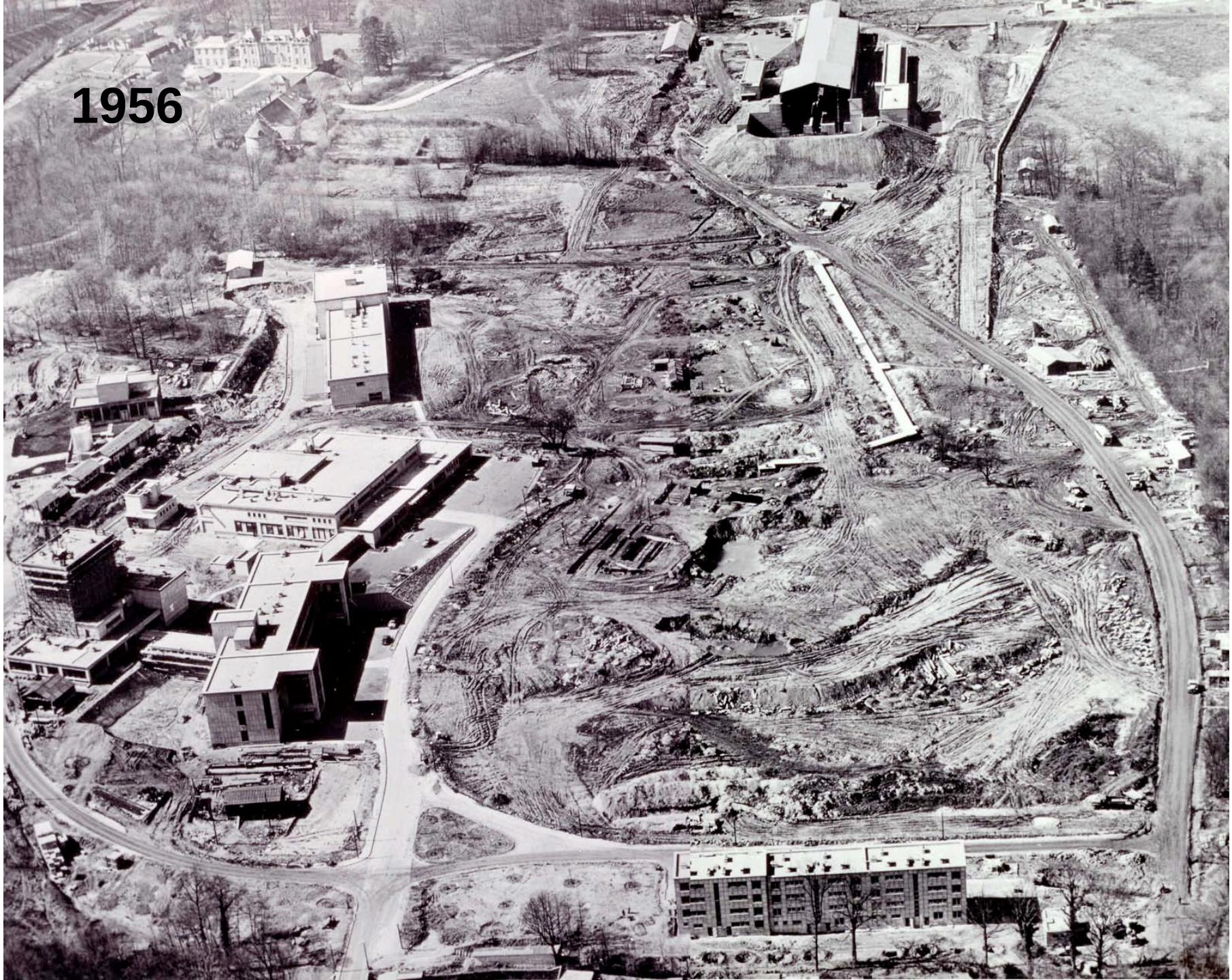
The ALTO facility

Fadi Ibrahim– IPN Orsay

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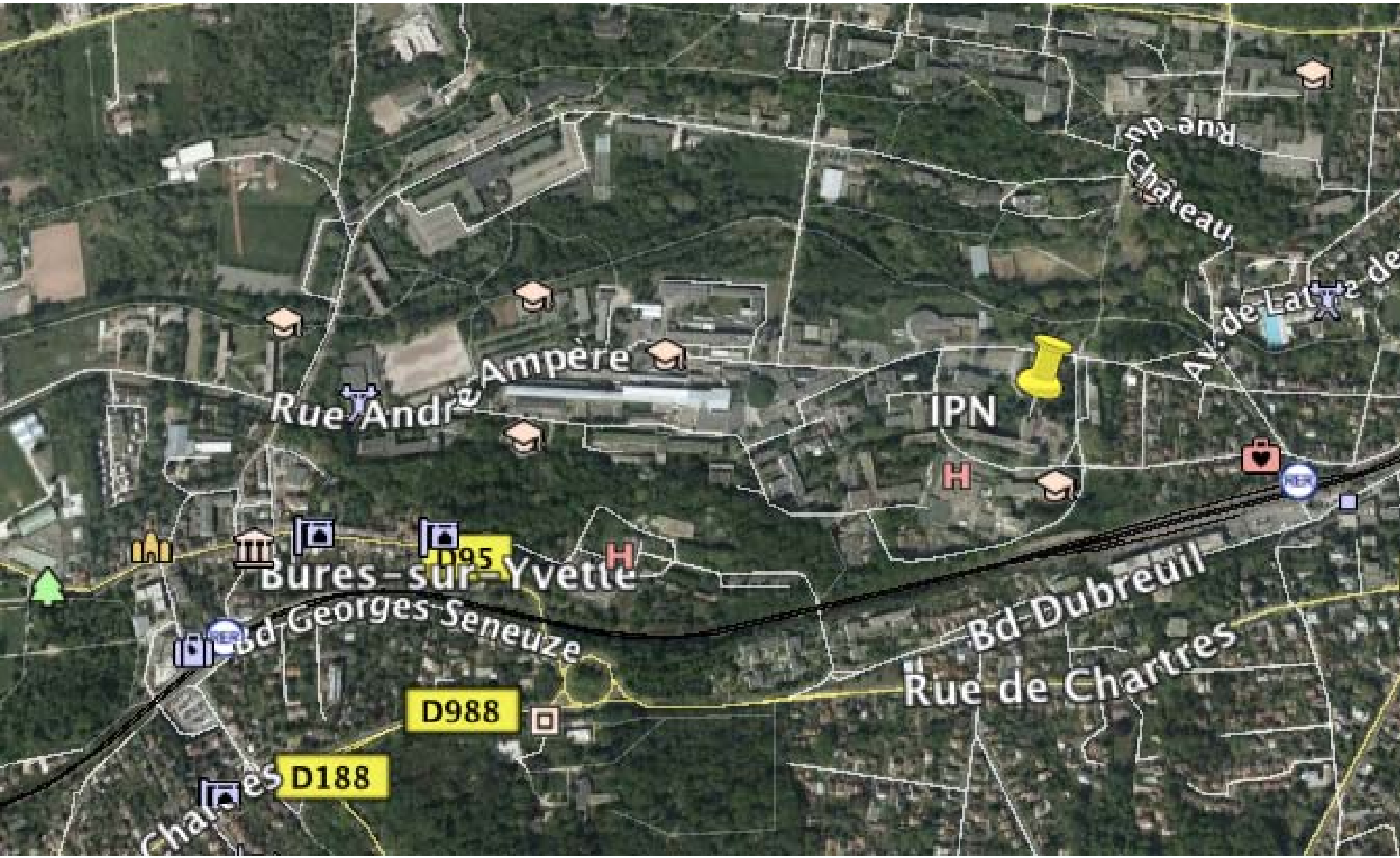
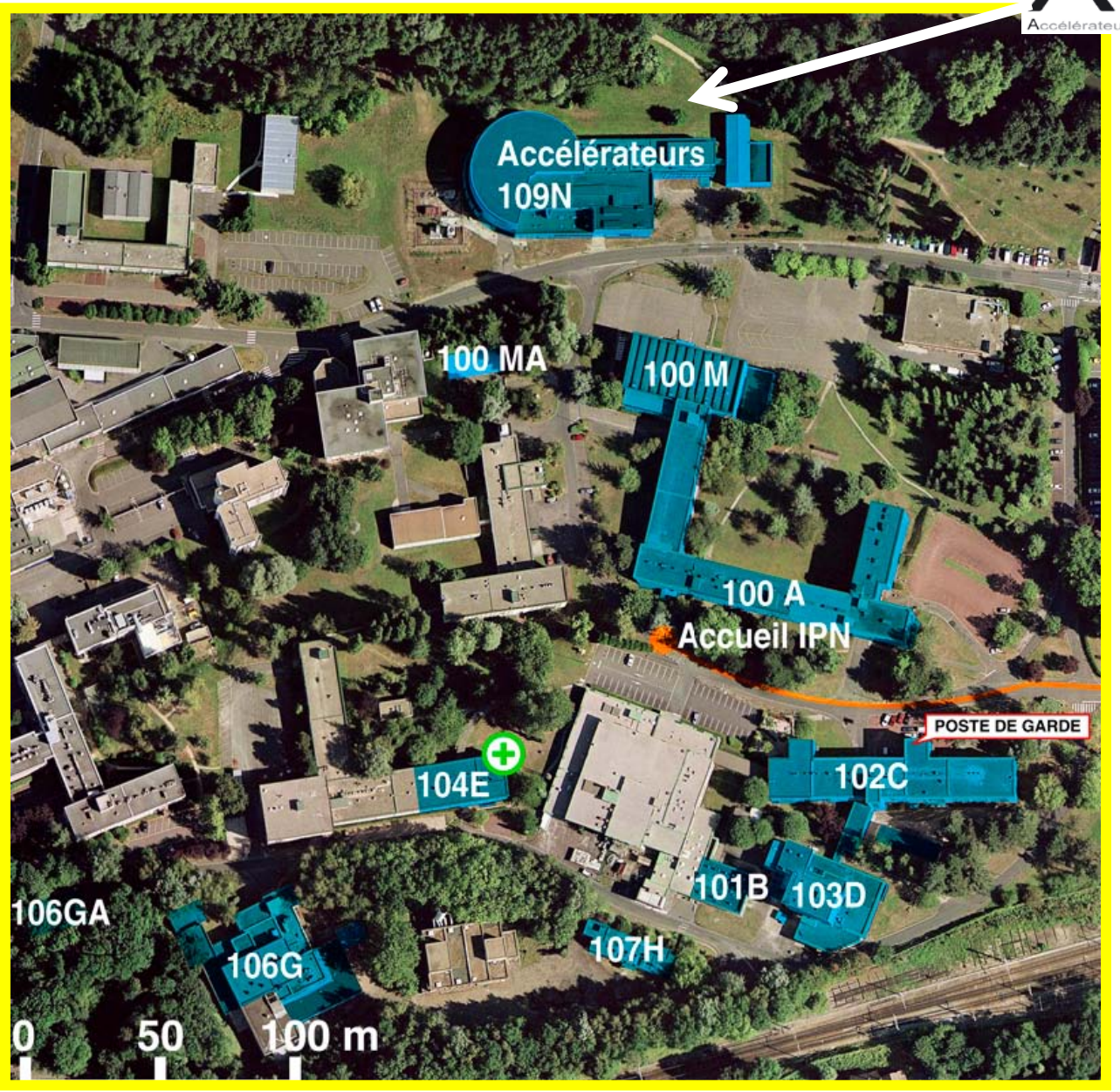
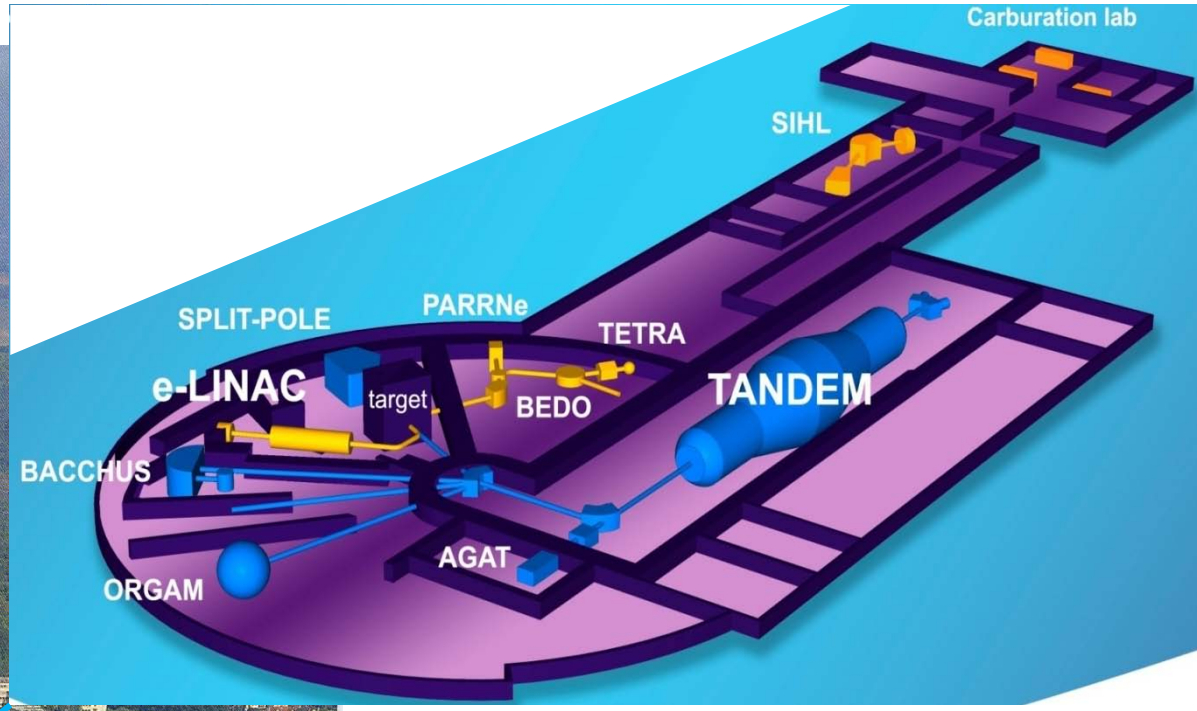
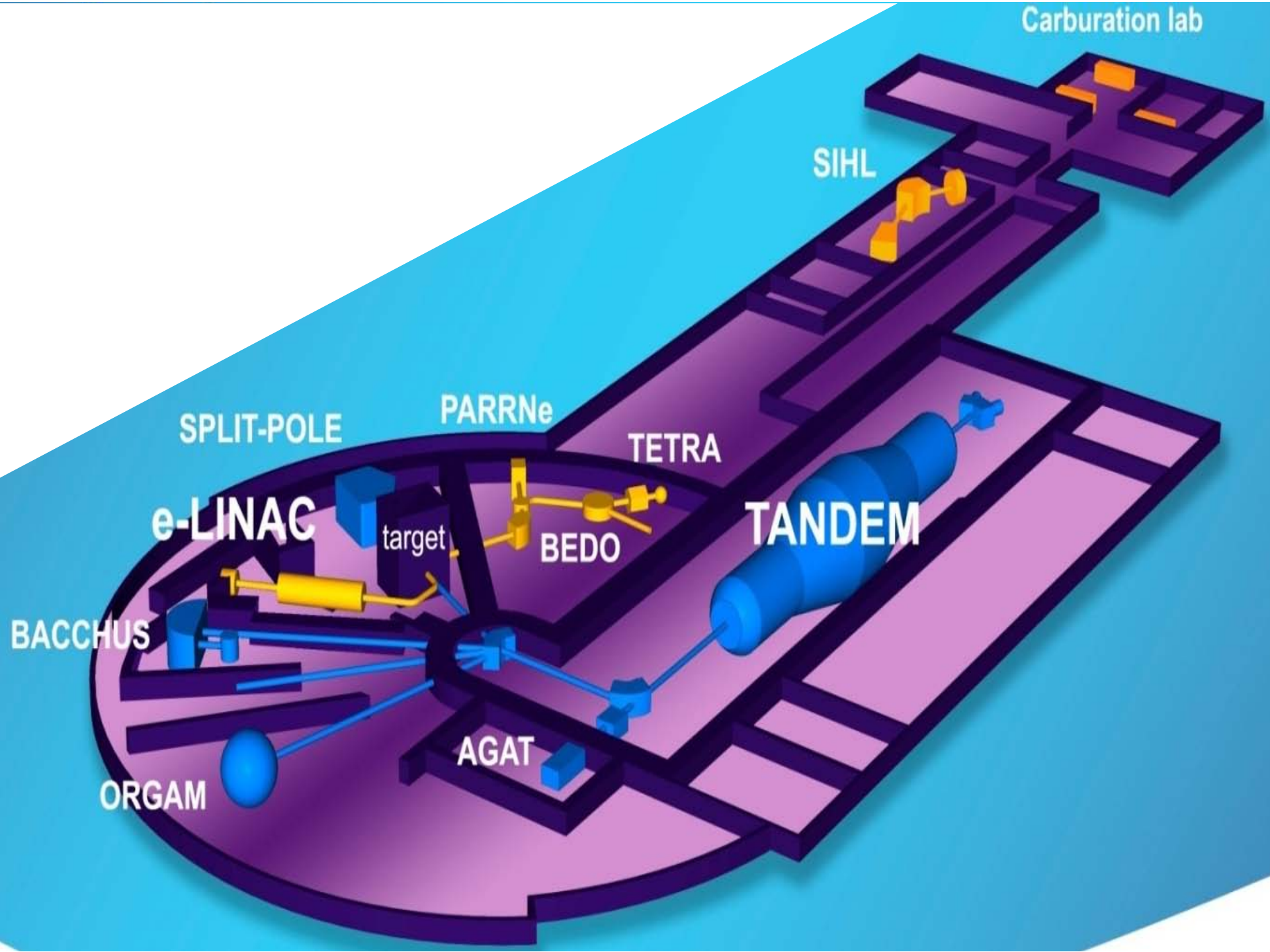

Rue André Ampère
IPN
Av. de Latte de
Rue du Château
Bures-sur-Yvette
D95
Bd Georges Seneuze
Bd Dubreuil
Rue de Chartres
D988
D188
Chartres

ALTO
Accélérateur Linéaire et Tandem à Orsay

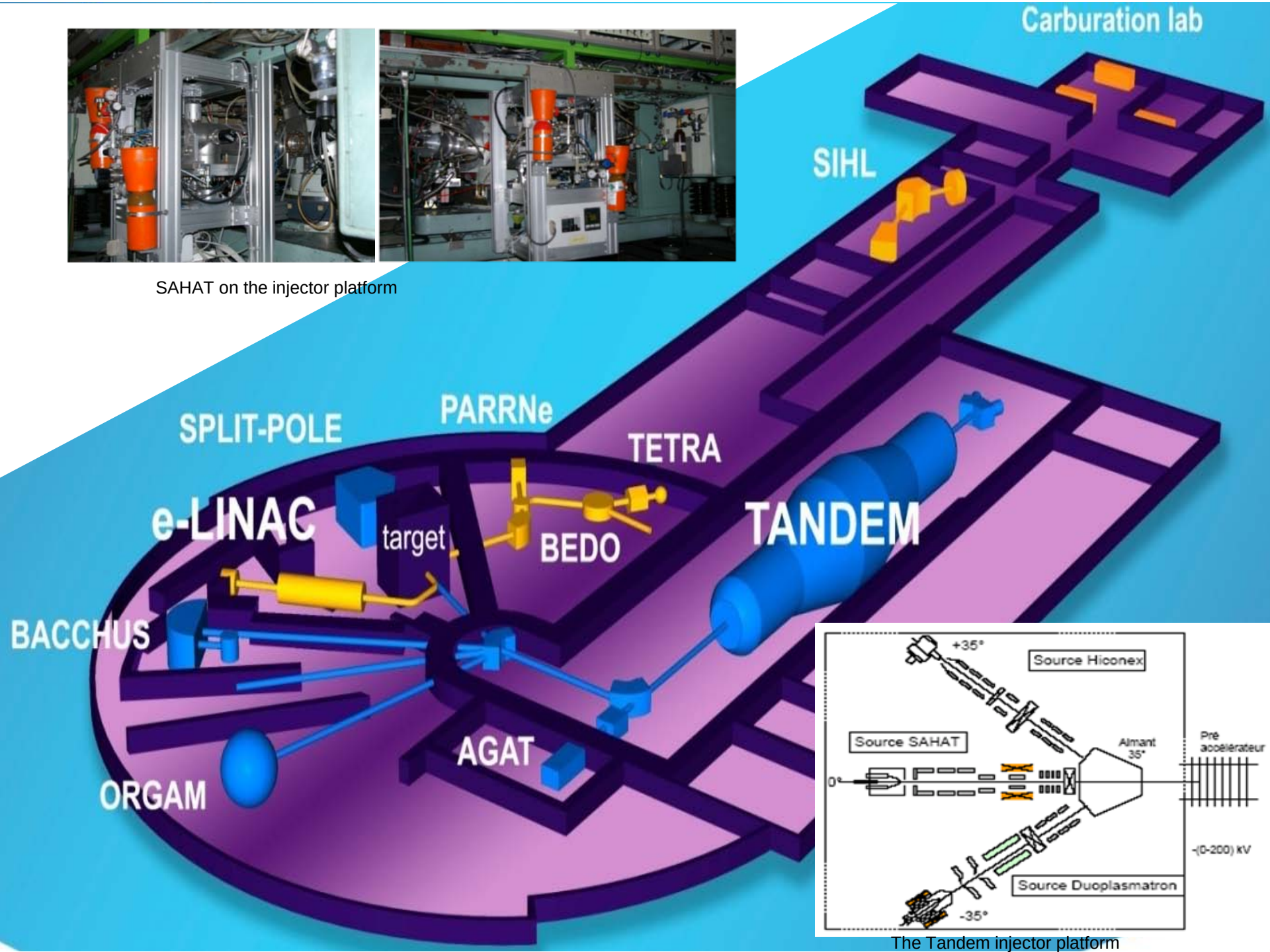




Tandem building
Institut de Physique Nucléaire
Campus of the Paris Sud University
Orsay (France)


Carburation lab
SIHL
PARRNe
SPLIT-POLE
TETRA
e-LINAC
target
BEDO
TANDEM
BACCHUS
AGAT
ORGAM

SAHAT on the injector platform



The Tandem injector platform

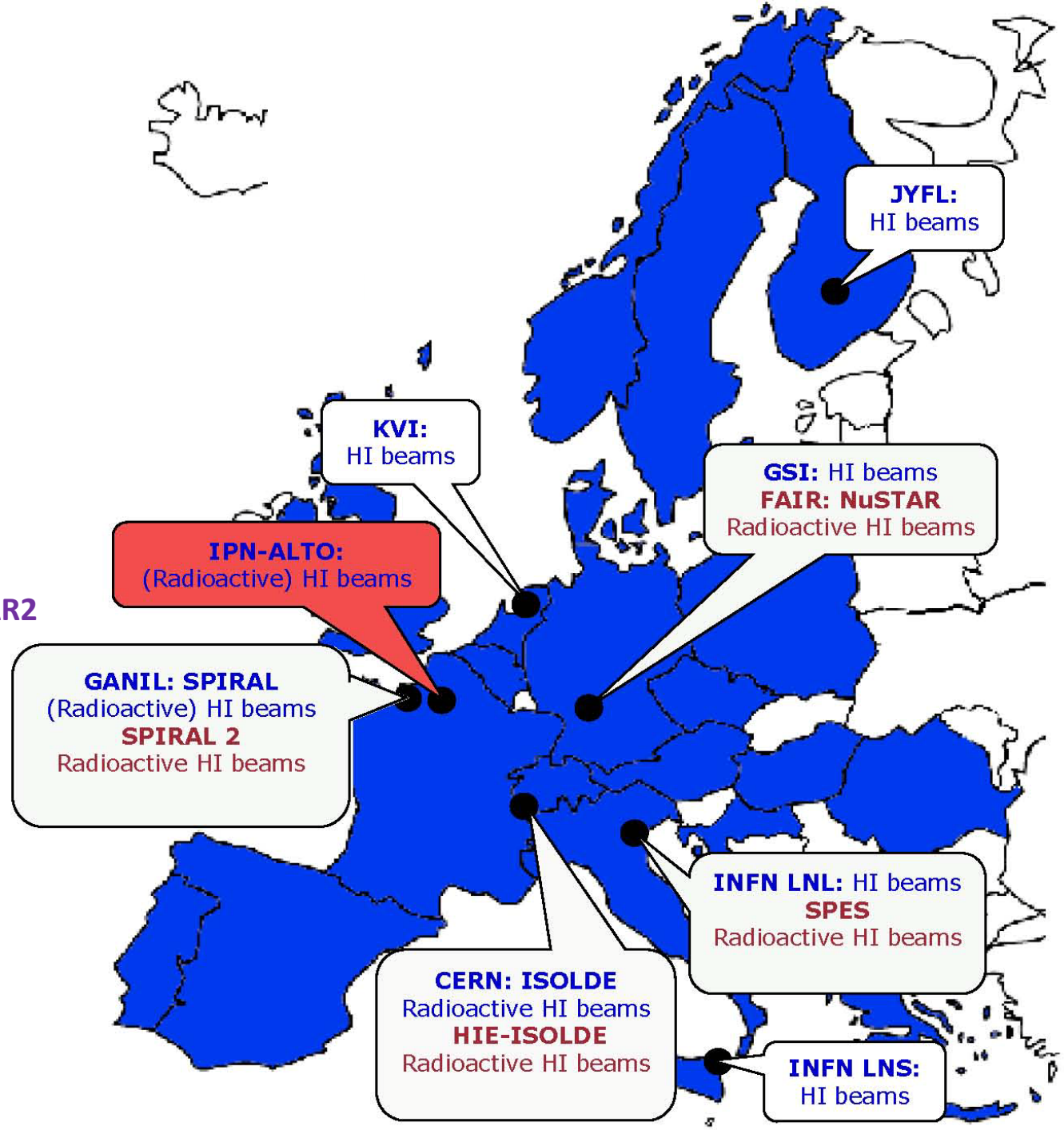
Carburation lab

Electron LINAC:
Optimal energy 50° MeV but possibility
To run 10-50 MeV (lower limit 10 MeV)
Intensity : 10 μA
Possibility to use the beam at energy between
3 and 5 MeV after the bunking system

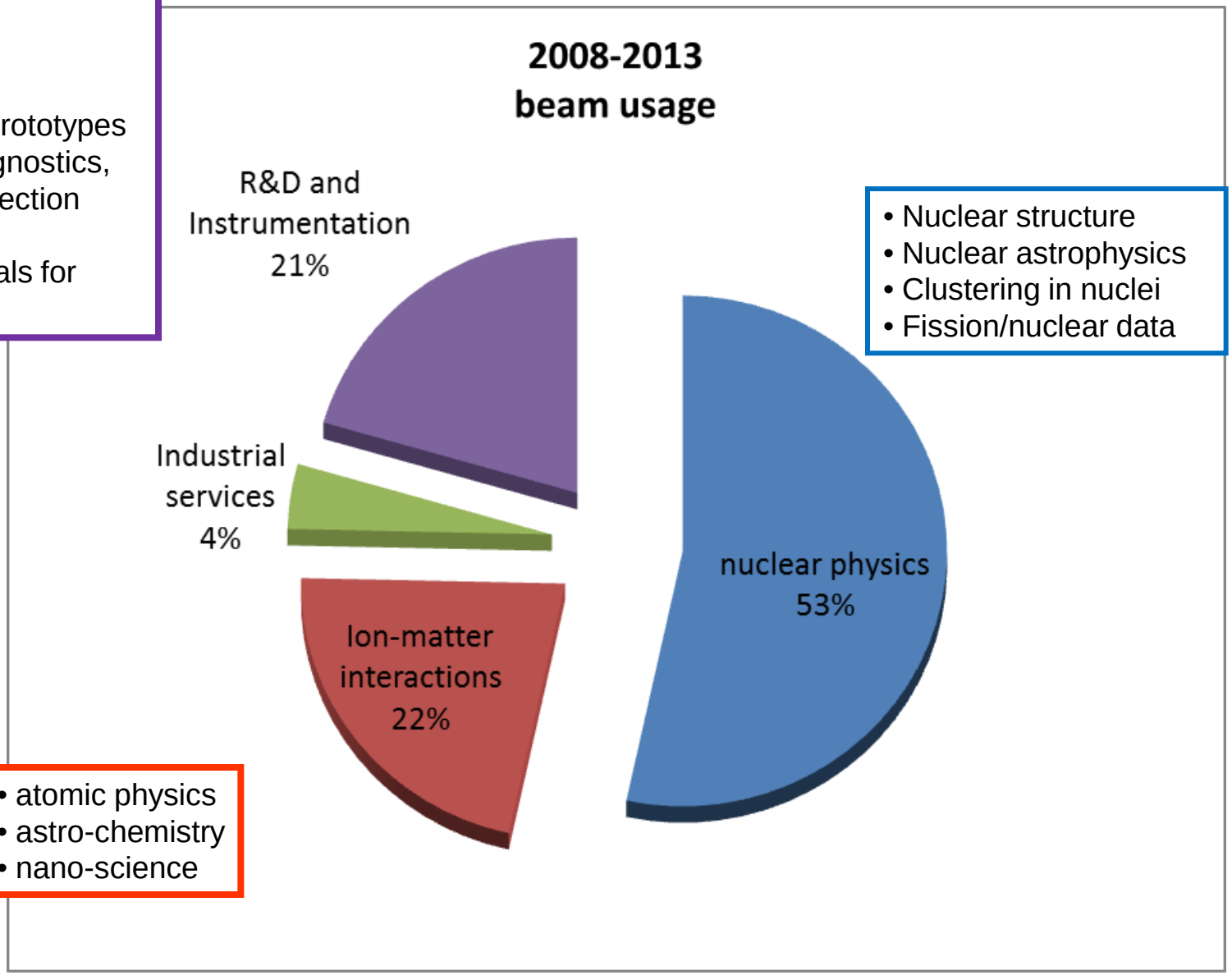
SEVENTH FRAMEWORK PROGRAMME

ENSAR

ALTO:
TNA within ENSAR
and
Candidate for TNA within ENSAR2

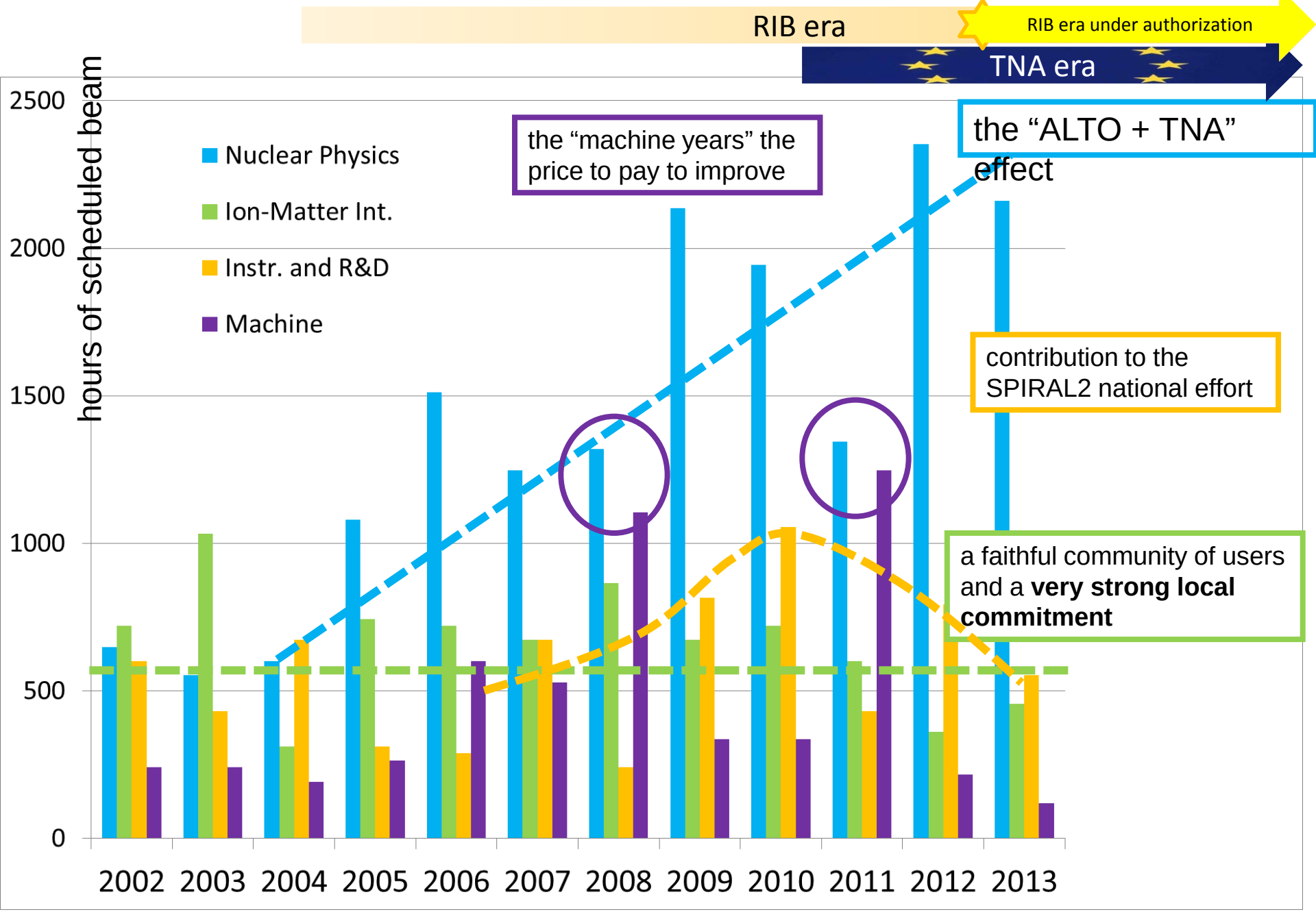


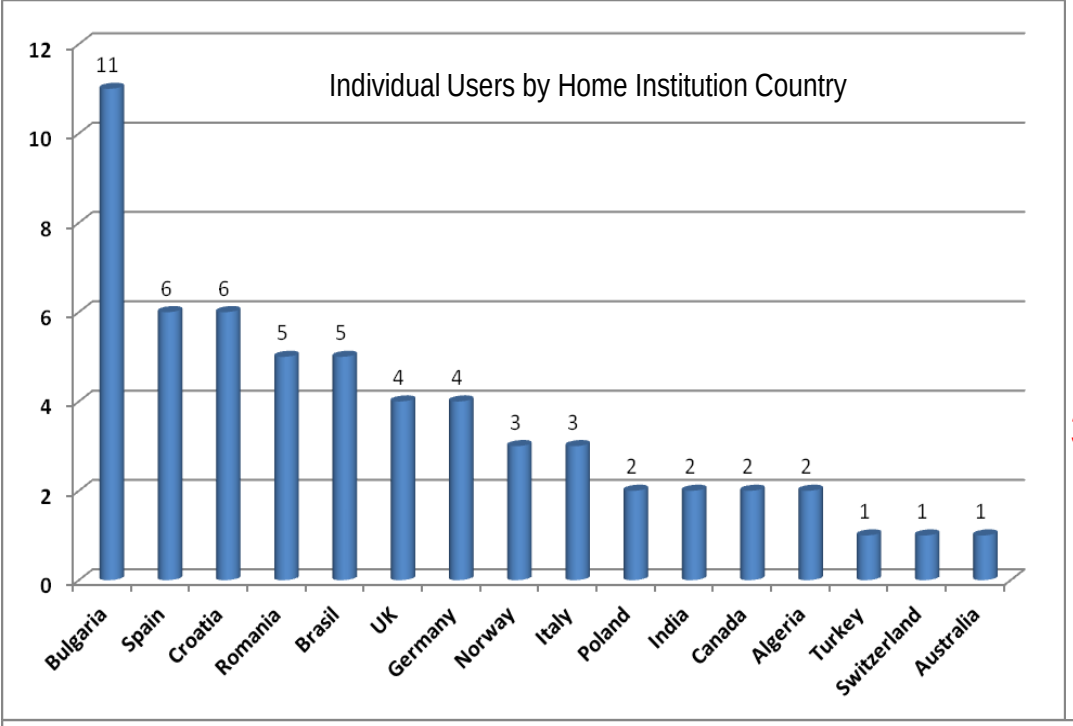
- EXL
- PARIS
- GASPARD
- SPIRAL2 (prototypes for beam diagnostics, radiation protection data etc)
- New materials for ISOL science

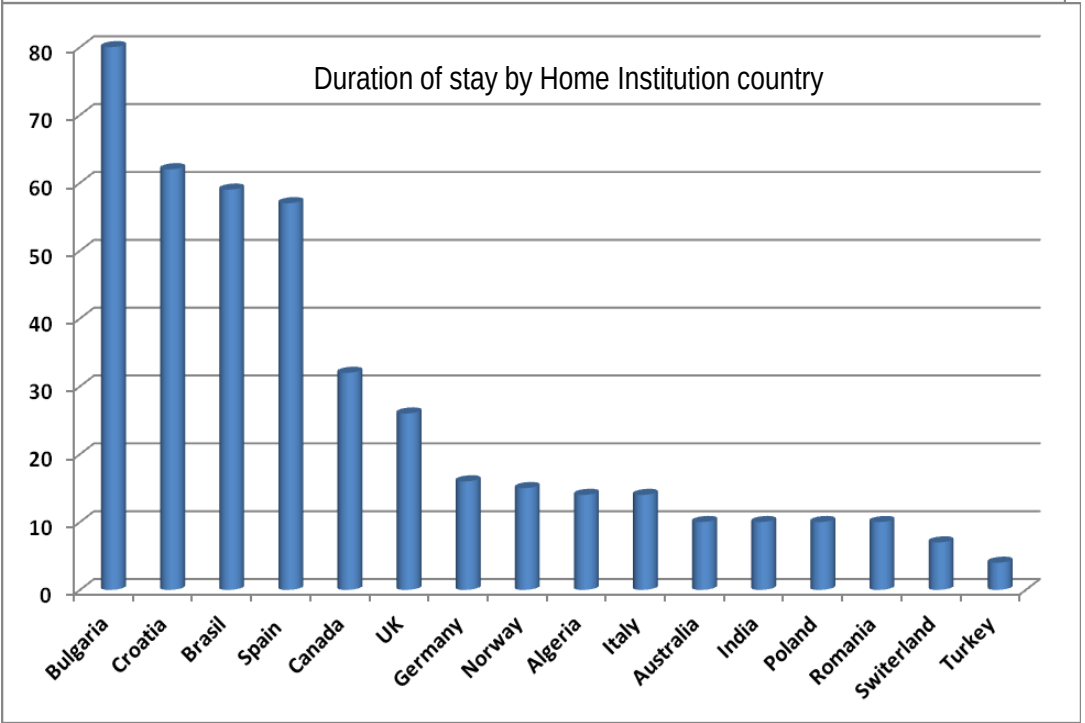


- Nuclear structure
- Nuclear astrophysics
- Clustering in nuclei
- Fission/nuclear data

- atomic physics
- astro-chemistry
- nano-science


RIB era
RIB era under authorization
TNA era
hours of scheduled beam
2500
2000
1500
1000
500
0
Nuclear Physics
Ion-Matter Int.
Instr. and R&D
Machine
the "machine years" the price to pay to improve
the "ALTO + TNA" effect
contribution to the SPIRAL2 national effort
a faithful community of users and a **very strong local commitment**
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013





Tandem+ISOL = 4000 h per year

Possibility to run in the future ISOL and Tandem simultaneously

28 engineers and technicians for Technical support

300 outside users (30 countries)/year

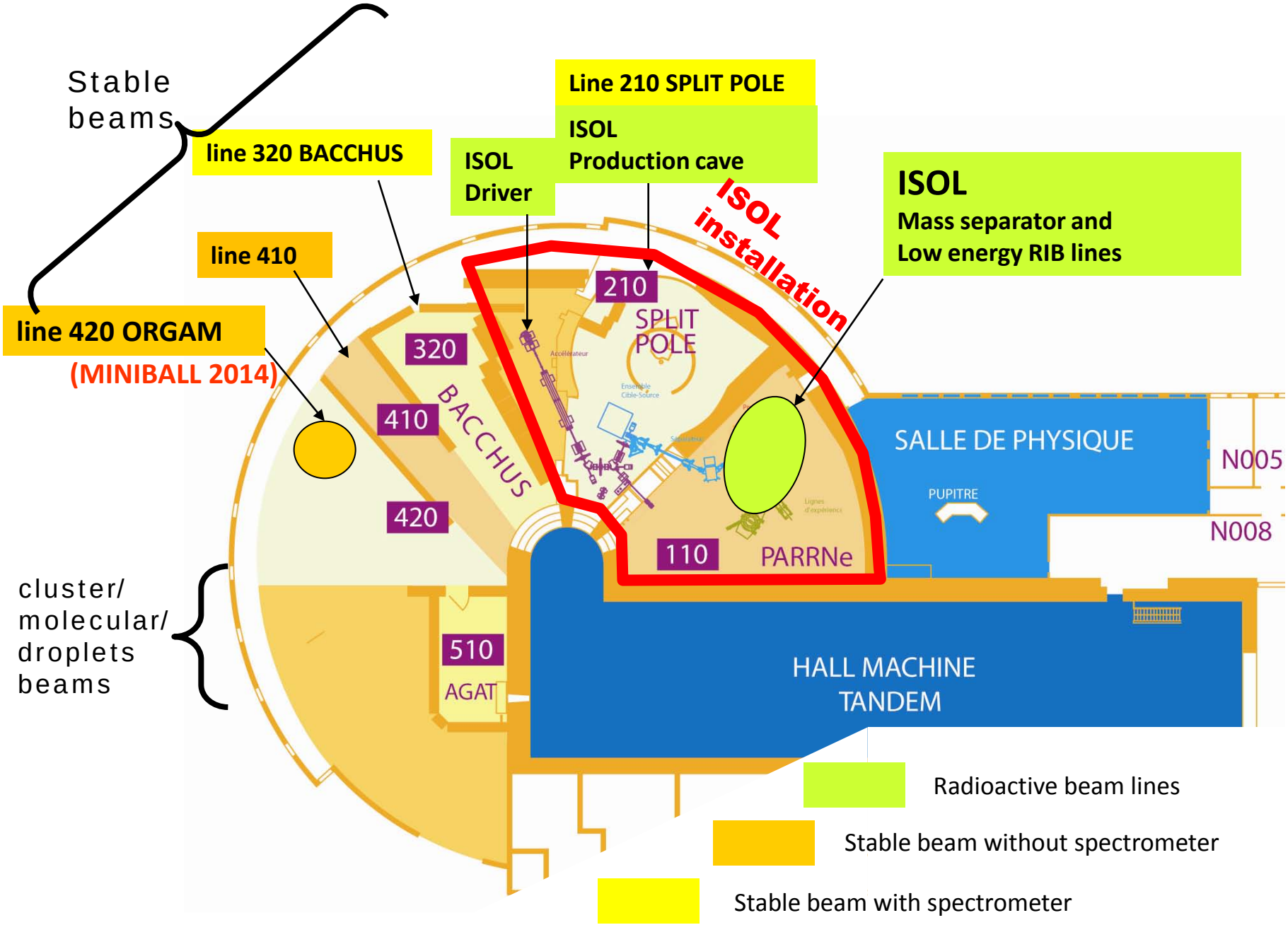
PAC: One/year

- R. F. CASTEN , Chair (Yale University)
- E. BALANZAT (CIMAP – Caen)
- D. BALABANSKI (Sofia – Bulgarie)
- S. GREVY (CENBG)
- E. KHAN (IPNO)
- W. KORTEN (SPhN-IRFU-CEA)
- B. RUBIO (IFIC Valencia)
- C. TRAUTMANN (GSI)
- A. TUMINO (LNS -Catania)
- J. C. THOMAS (GANIL)

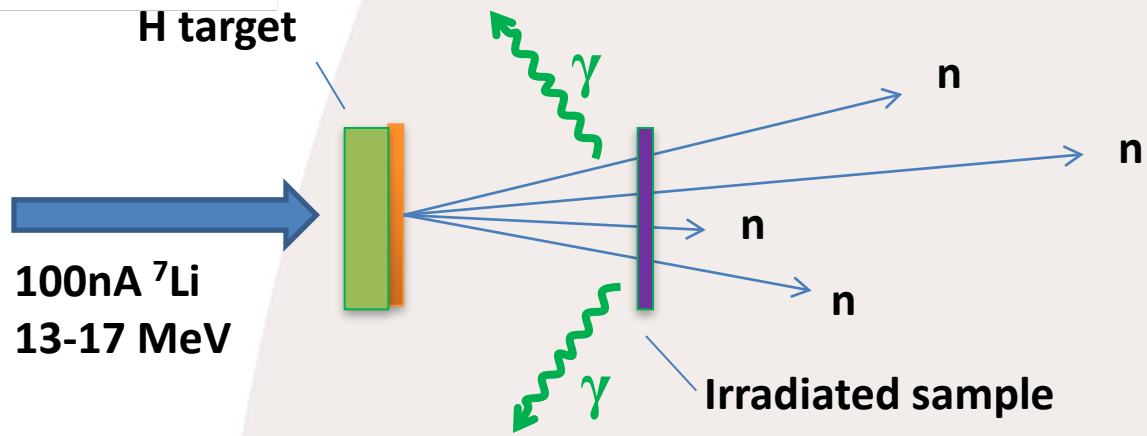
Chair of the User Commitee

- G. GEORGIEV, (CSNSM, France)

ALTO general layout

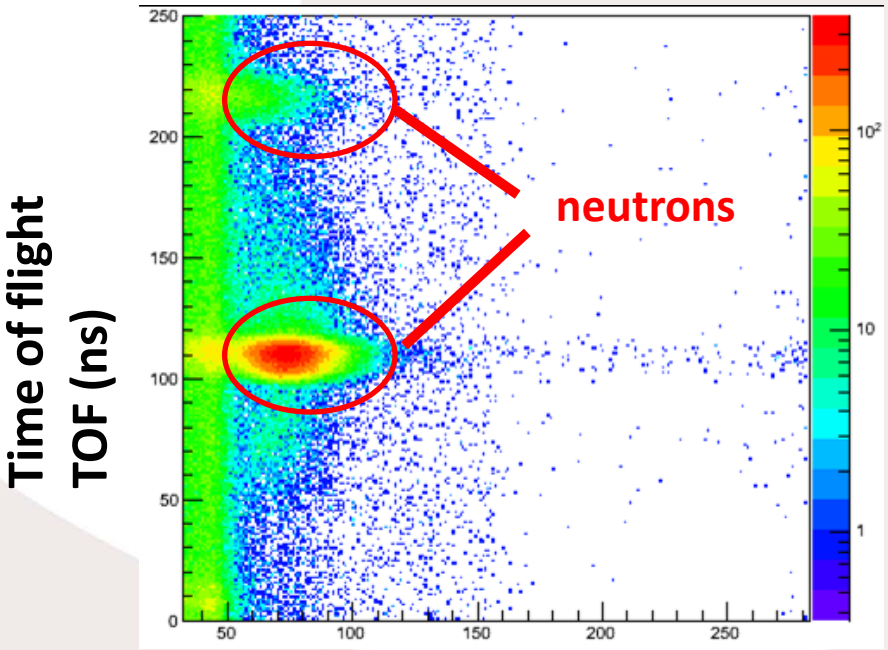


LICORNE 2013: COLLABORATION IPNO/IRMM

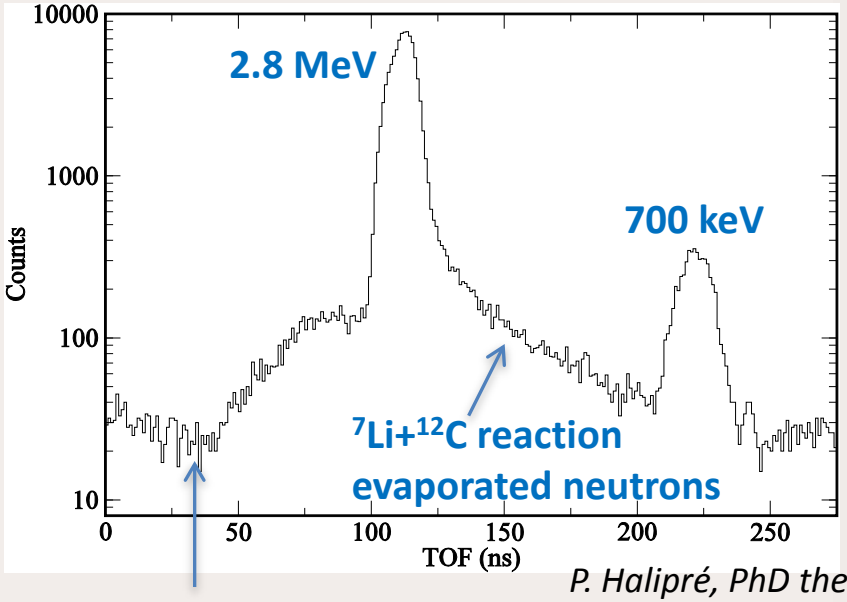


Focused intense source of mono-energetic neutrons:
10^7 n/s/steradian

E_n=0.5 – 4 MeV



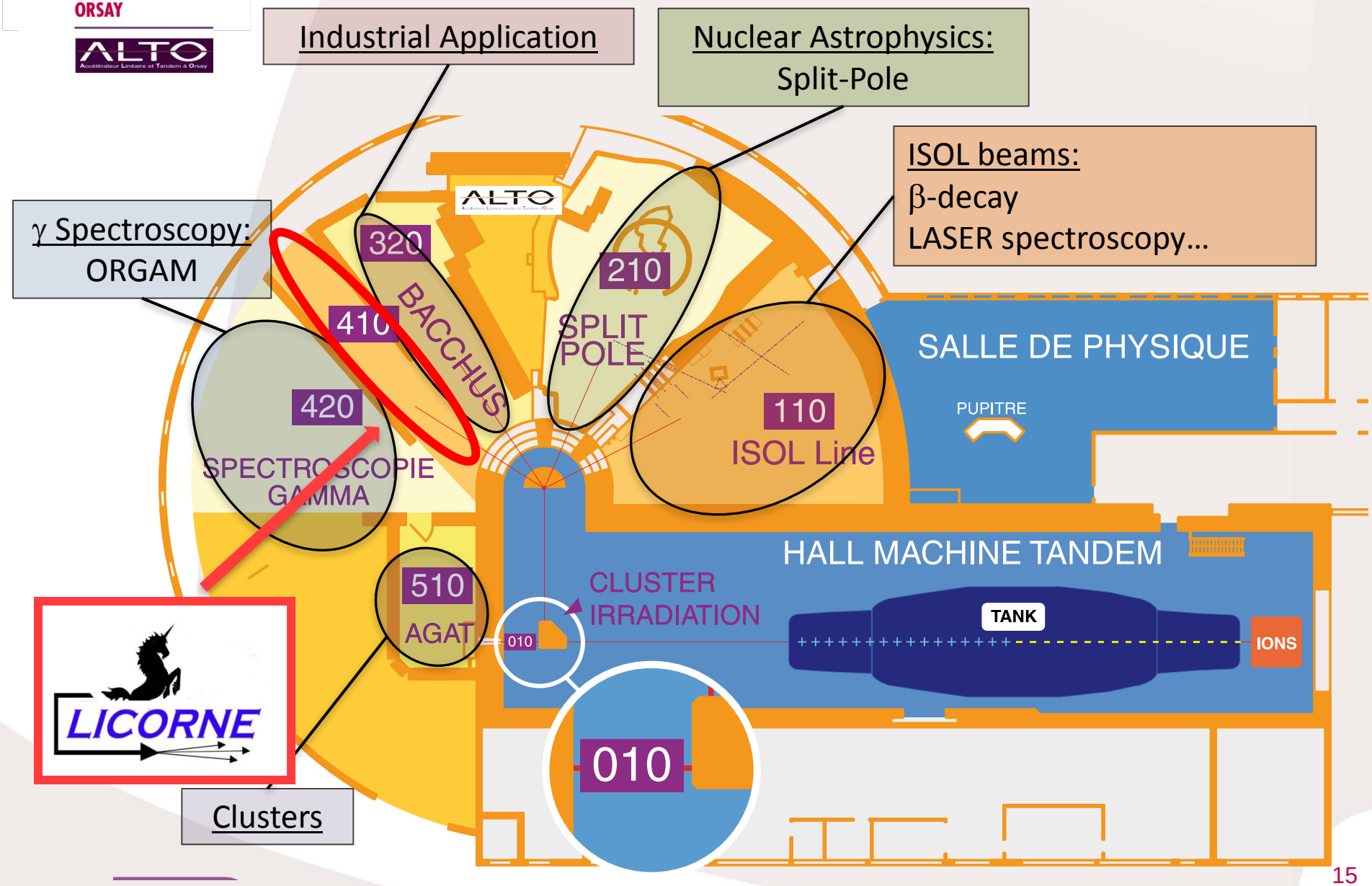
Pulse Shape Analysis (PSA)



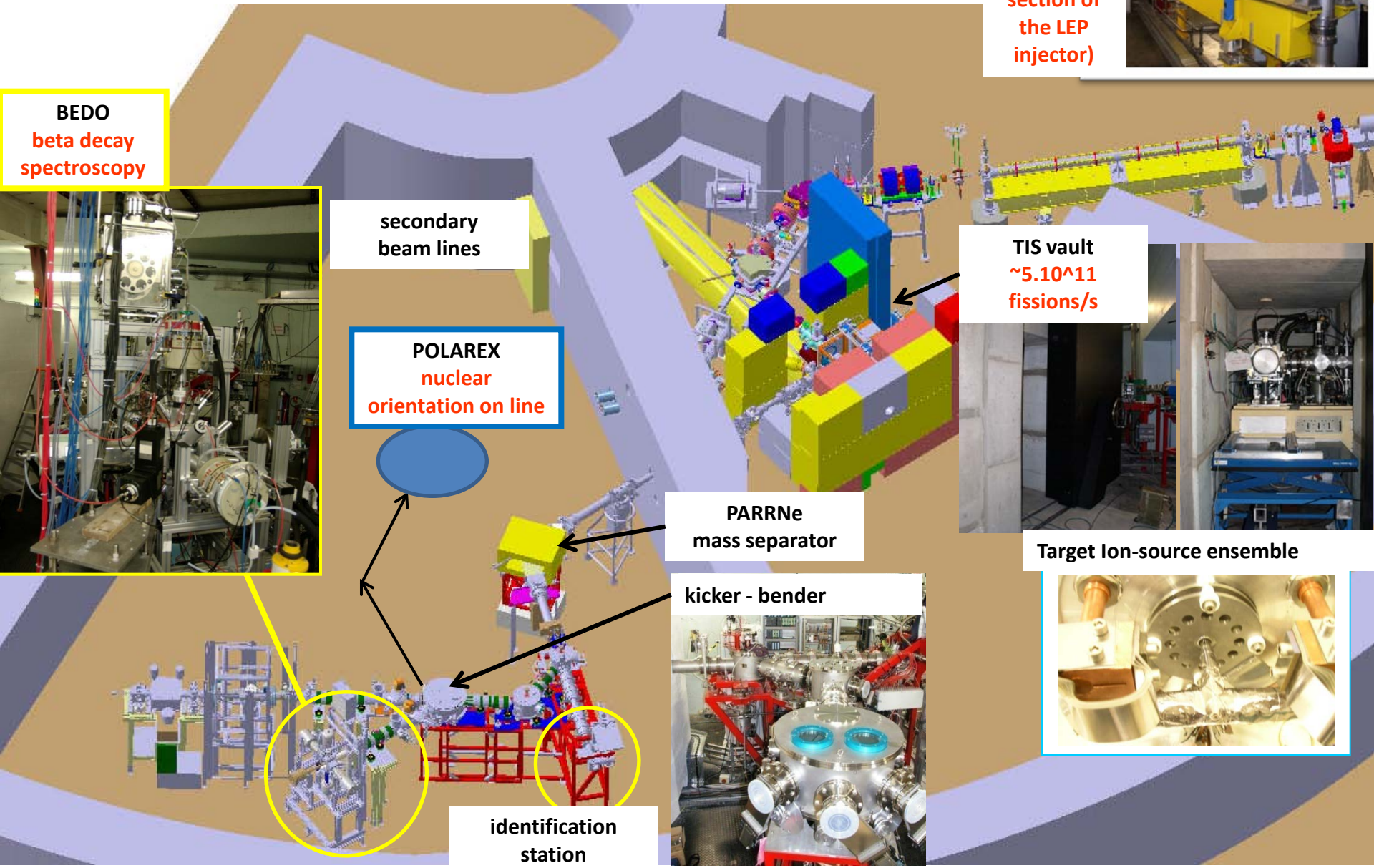
P. Halipré, PhD thesis

Uncorrelated room background

THE ALTO FACILITY BEAMS



The ISOL installation based on photo-fission: the first of its kind in the world

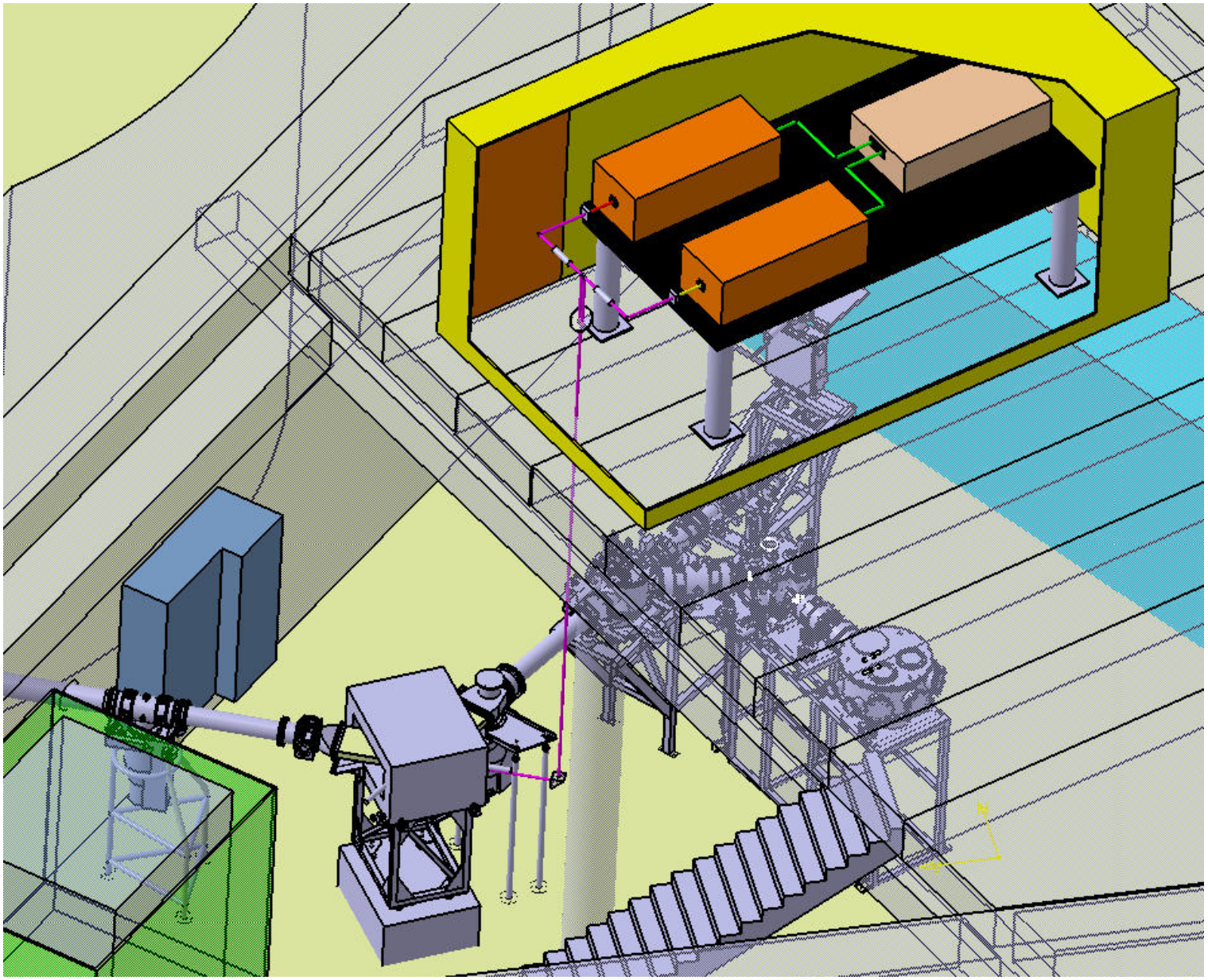


Laser ionized RIBs at ALTO

The ALTO laser ion source **RIALTO** (Resonant Ionization at ALTO)

Installation supervised by **S. Franchoo**
with the help of
R. Li, D. Yordanov (from 1/10/13**)**
with the collaboration of
ISOLDE:
V. Fedosseev, B. Marsh, T. Goodacre
Univ. Manchester:
K. Flanagan
Univ. Mainz:
T. Kron, K. Wendt

The on-line laser installation validated in 2011 with the production of Ga beams.
2012: Upgrade 2 new lasers (Radiant Dyes).
2013: Reference cell (in progress...)
Zn on line OK
2014 and beyond: suppression of surface ionized species using the LIST technique
+ development of requested beams:
Cu, Sn (ISOLDE scheme)
Ge, **Se** (difficult to very difficult)



Physics case

Observable	Experimental technique	Physics case
Energy level pattern	γ–spectroscopy following β-decay	Exploration of the valence space extending N-E to 78Ni
Nature of the em transitions	Electron conversion	
$\delta\langle r^2\rangle$	Laser spectroscopy	Evolution of the N=50 and N=82 shell effects far from stability
Static moments :Q, μ		
T1/2 of the excitation levels->dynamic moments :B(M1) (E2)	Fast timing	Onset of the collectivity and nature of the correlations
		Polarization effects
Pn P2n and T1/2 β	Neutron detection	Many purpose (including systematics)
g-factor and spin	Nuclear orientation	
γ emission	Total Absorption Spectrometer	Decay heat in reactors

Fullerene beams

The main goal is to understand the mechanisms of emission induced by a particle impact on solid surfaces.

Deposit very high E densities (> 1 GeV U beam)

- create material modifications,
- Study phase changes
- Visualize nano-structures

Desorption of heavy masses organic molecules

- Production method bombardment of a target made of compressed molecules of C_{60} with a 20 keV Cs beam (1 mA)
- Used ion source sputtering type
- Multi-charged ions are detected by TOF method using a semiconductor detector
- C^{3+}_{60} Beam intensities reaching 10^7 ions/cm^2 over small surfaces (6-9 mm^2)
- E: 40-48 MeV (with a 12 MV voltage applied on the terminal)
- A stability over 8 hours is performed
- E spectrum: 30 MeV C^{+}_{60}, 40 MeV C^{3+}_{60} and 50 MeV C^{4+}_{60}

Fullerene beams

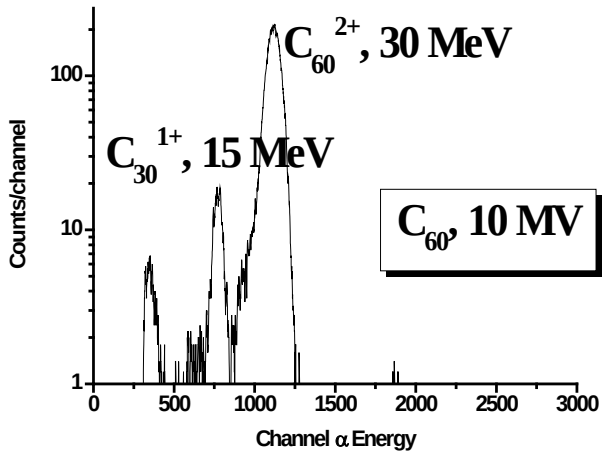


Figure 1 : energy spectrum of the selected ions such as 30 MeV C_{60}^{2+}

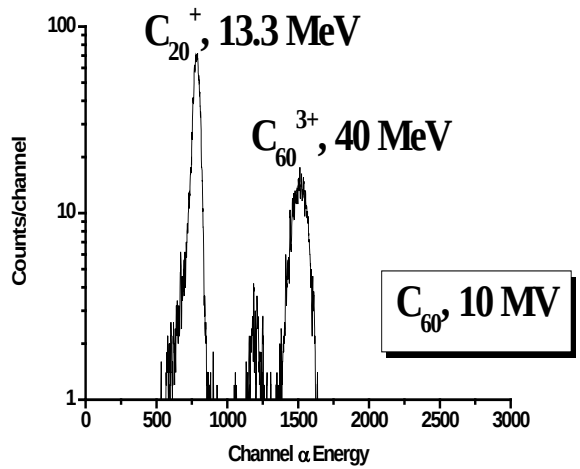


Figure 2 : energy spectrum of the selected ions such as 30 MeV C_{60}^{3+}

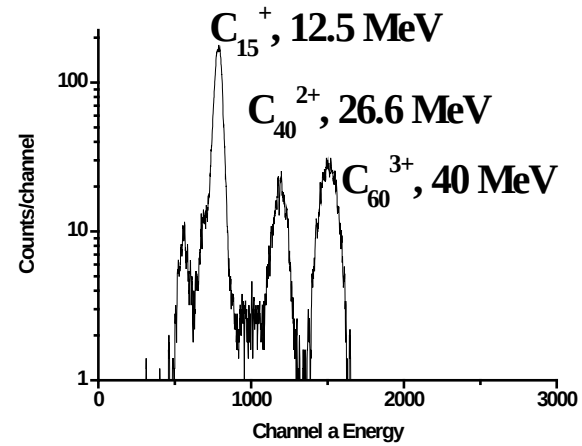


Figure 3 : energy spectrum of selected ions such as 30 MeV C_{60}^{3+} with a different tuning of the quadrupole lens

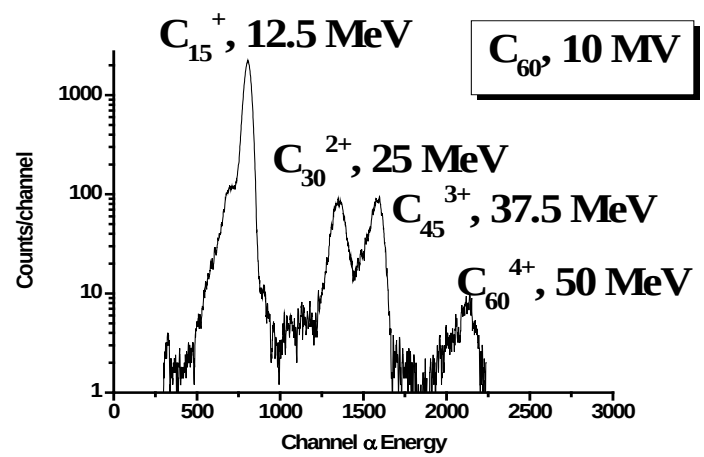
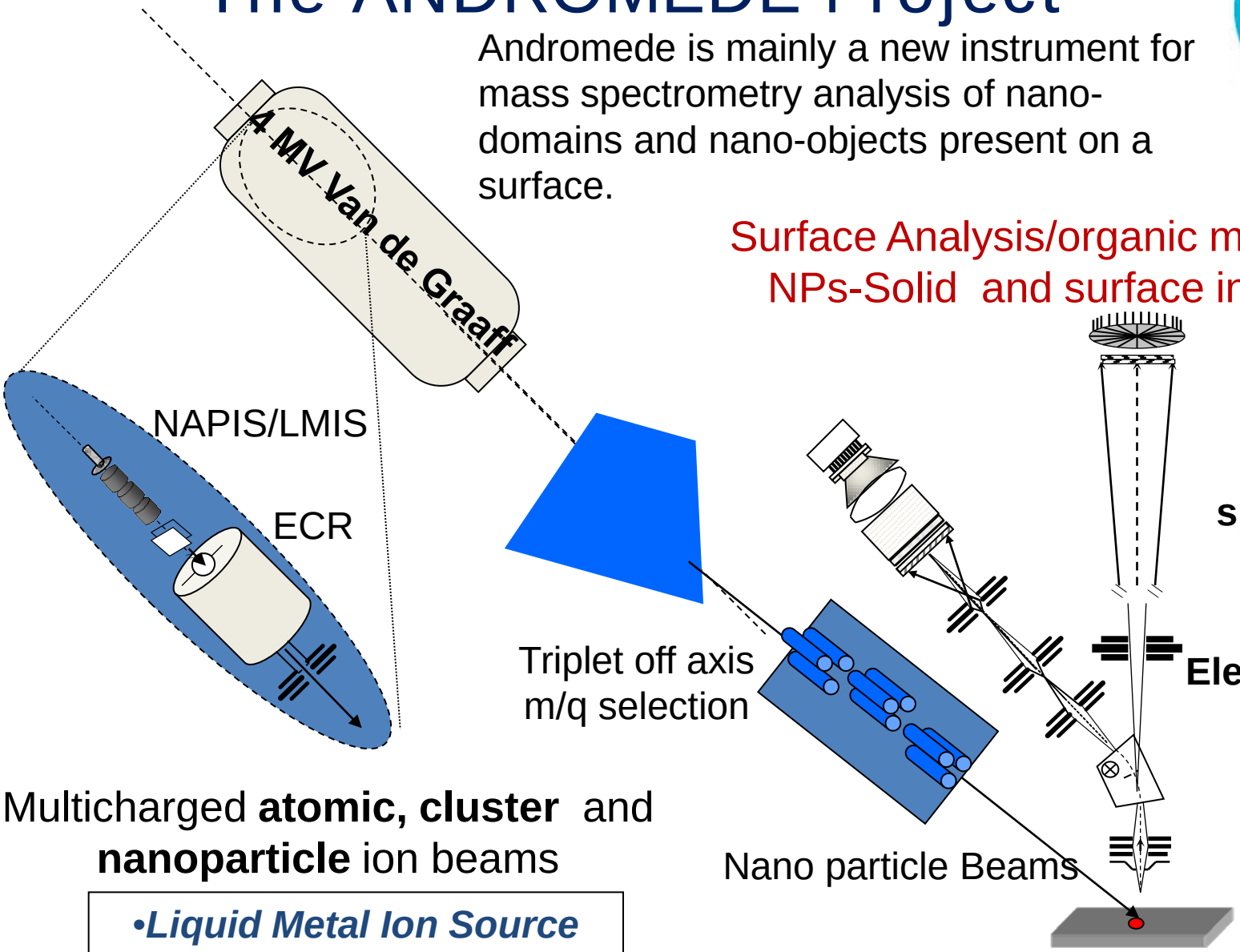


Figure 4 : energy spectrum of 50 MeV C_{60}^{4+}

The ANDROMEDE Project

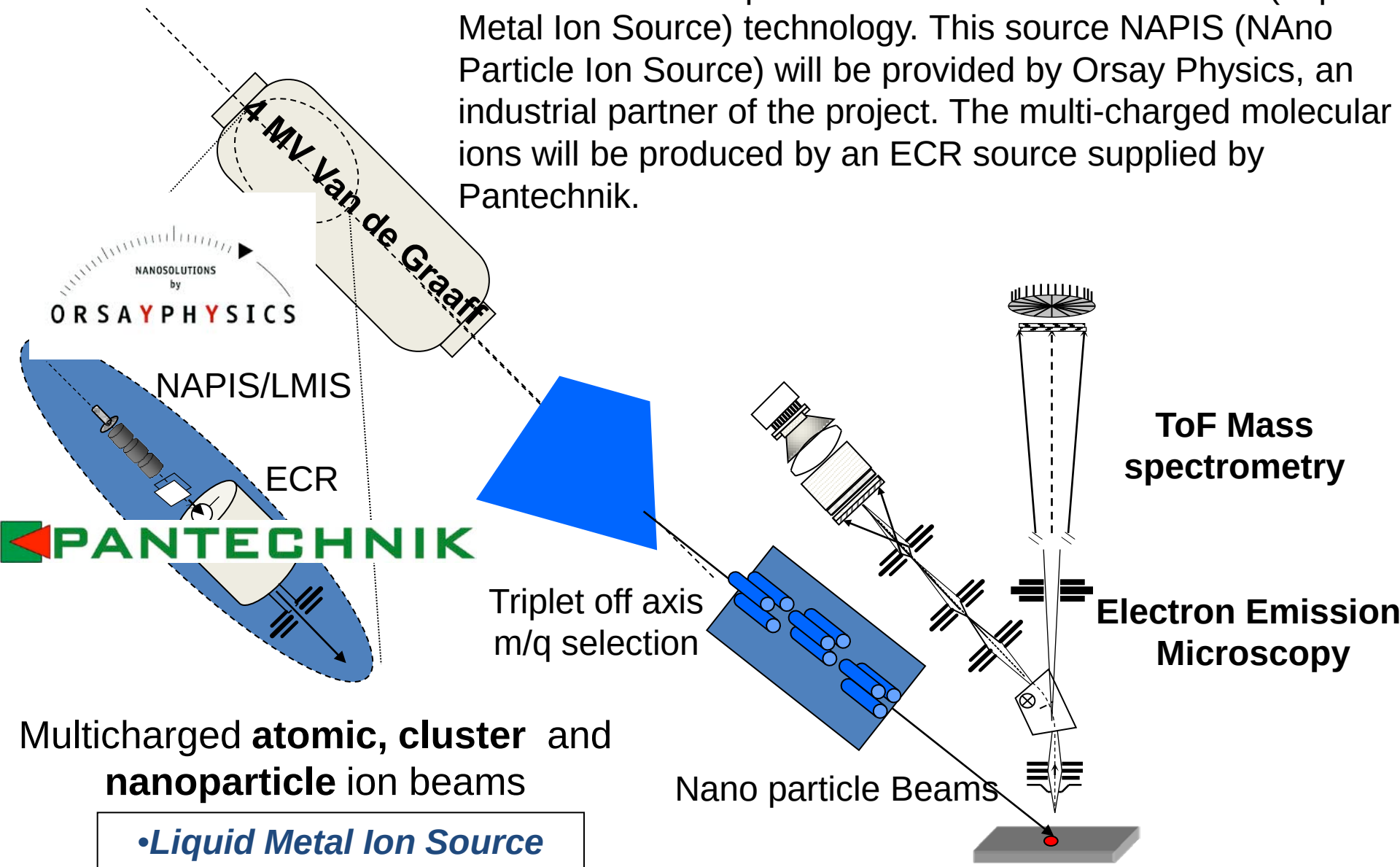
Andromede is mainly a new instrument for mass spectrometry analysis of nano-domains and nano-objects present on a surface.



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

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

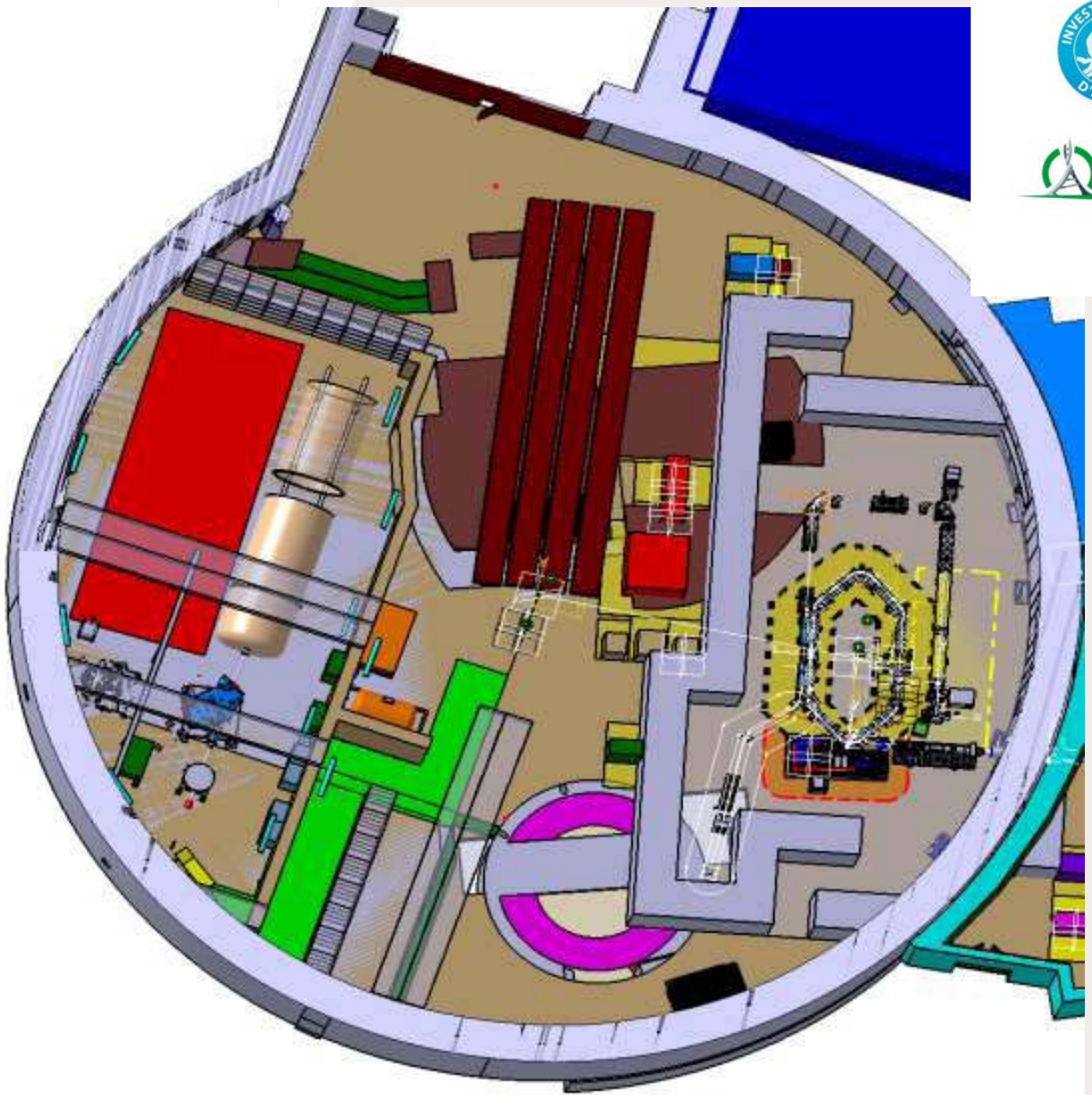
The ions will be produced by two ion source types. The clusters and nano-particles will come from the LMIS (Liquid Metal Ion Source) technology. This source NAPIS (NAno Particle Ion Source) will be provided by Orsay Physics, an industrial partner of the project. The multi-charged molecular ions will be produced by an ECR source supplied by Pantechnik.



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

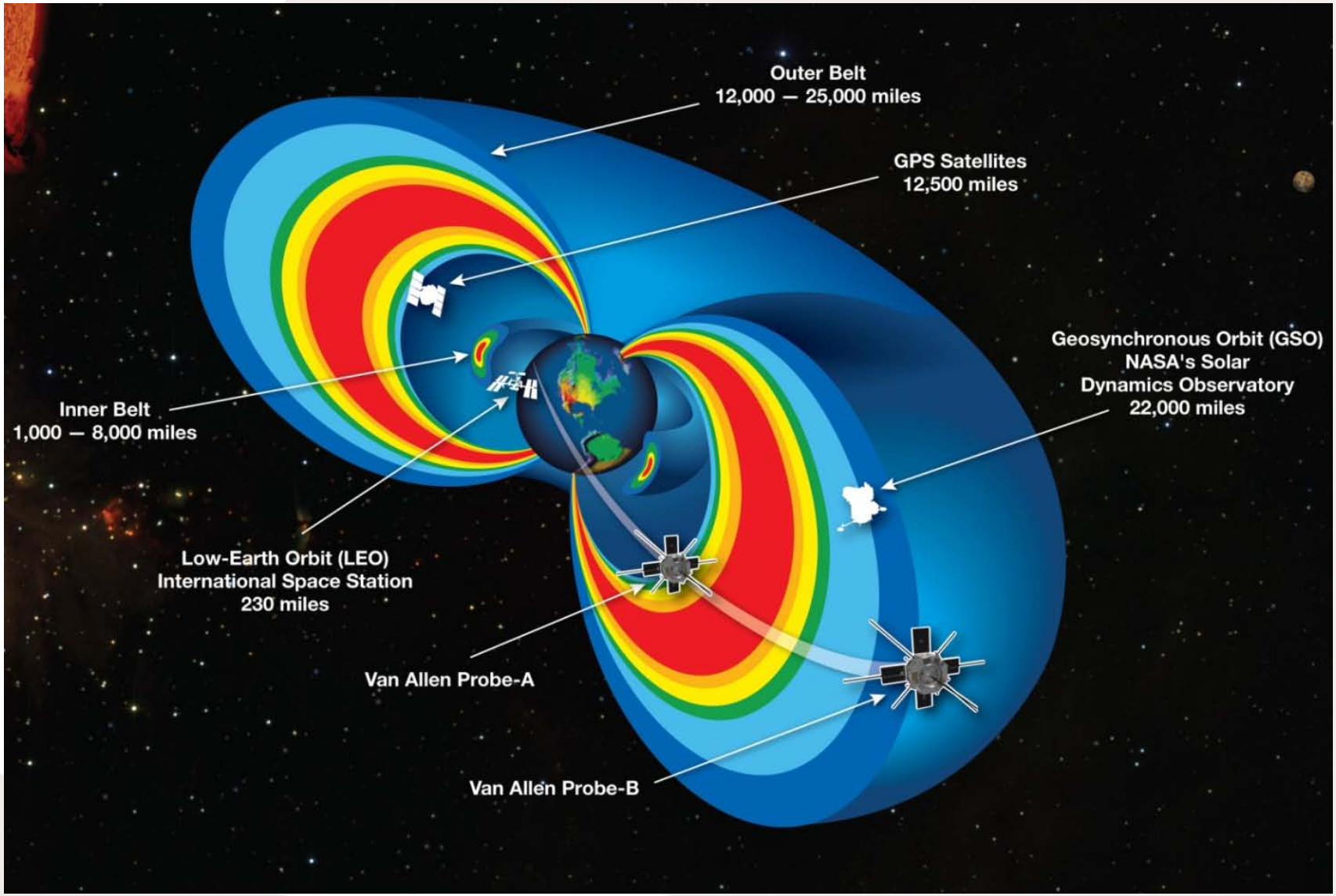
- ***Liquid Metal Ion Source***
- ***NAno-Particle Ion Source***
- ***ECR ion source***

THE PLURIDISCIPLINARY CENTER IN ORSAY

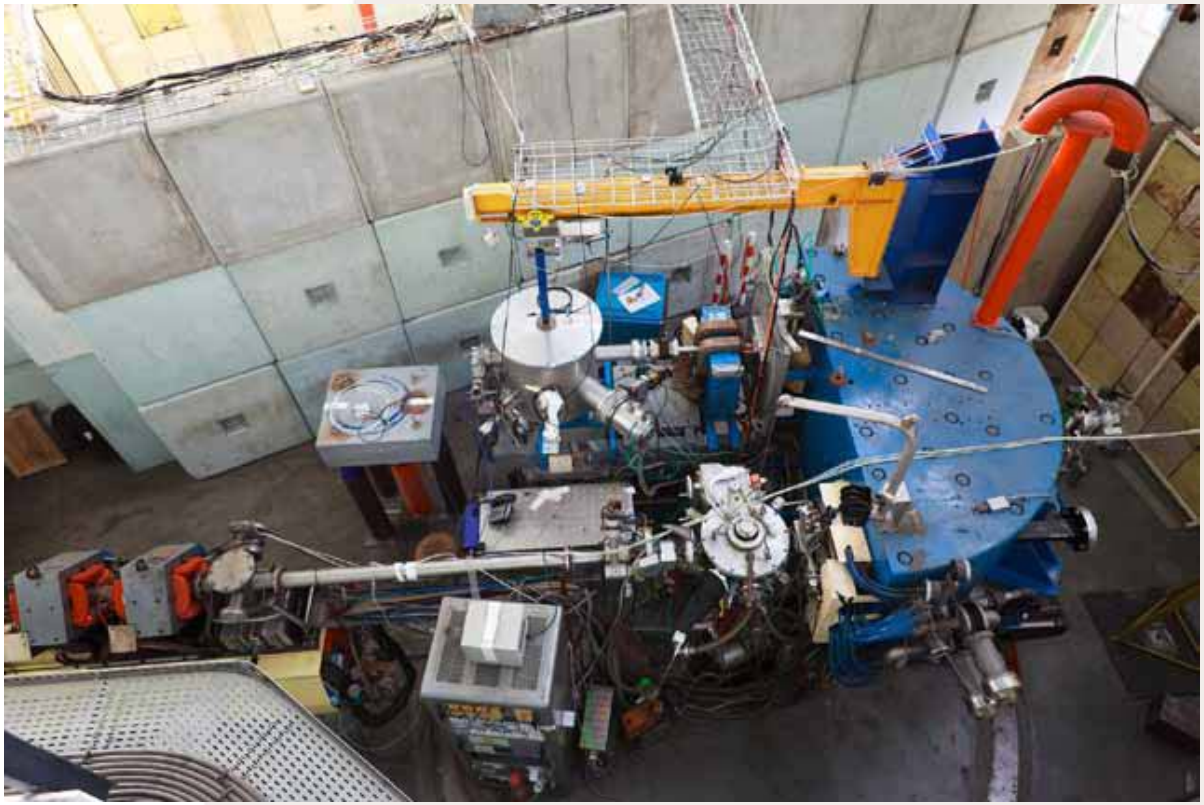


Application of these 2 facilities will cover large field of research:
Biochemistry
Toxicology
Medical research and imaging
Cancerology
Astrophysics
Material science

IRRADIATIONS: VAN ALLEN IRRADIATION BELT



LINE 320 AT ALTO



Line 320 devoted to irradiation of electronics

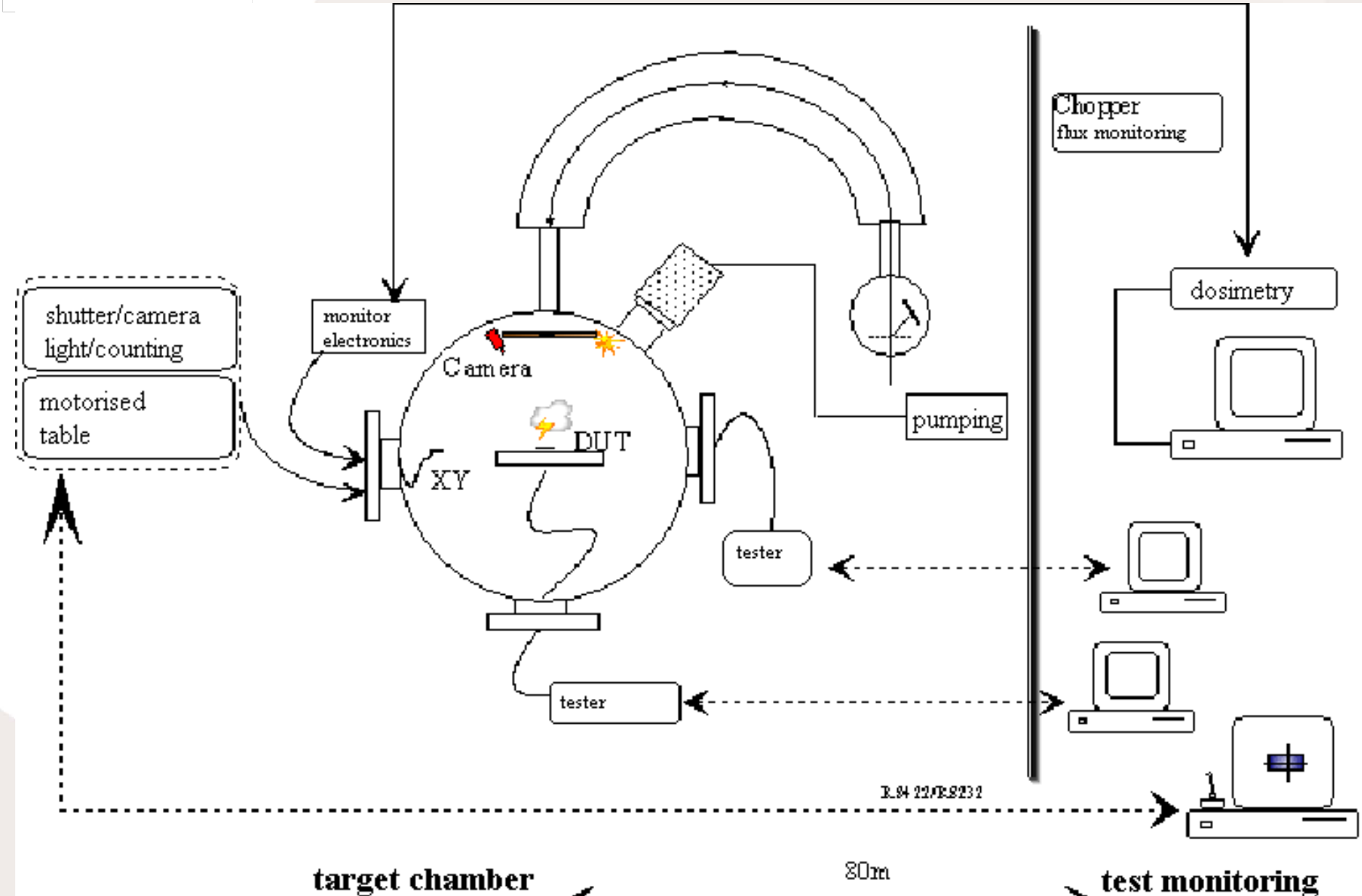
Development supported by CNES in 1989

Initial tests : October 1989

Managed by ONERA since 1992

commercial/governmental users : CNES, ONERA, TIMA, Hirex, TRAD, Thalès, ATMEL, Alcatel, ASTRIUM, ESA ....

LINE 320 AT ALTO



CHARACTERISTICS OF THE IRRADIATION STATION

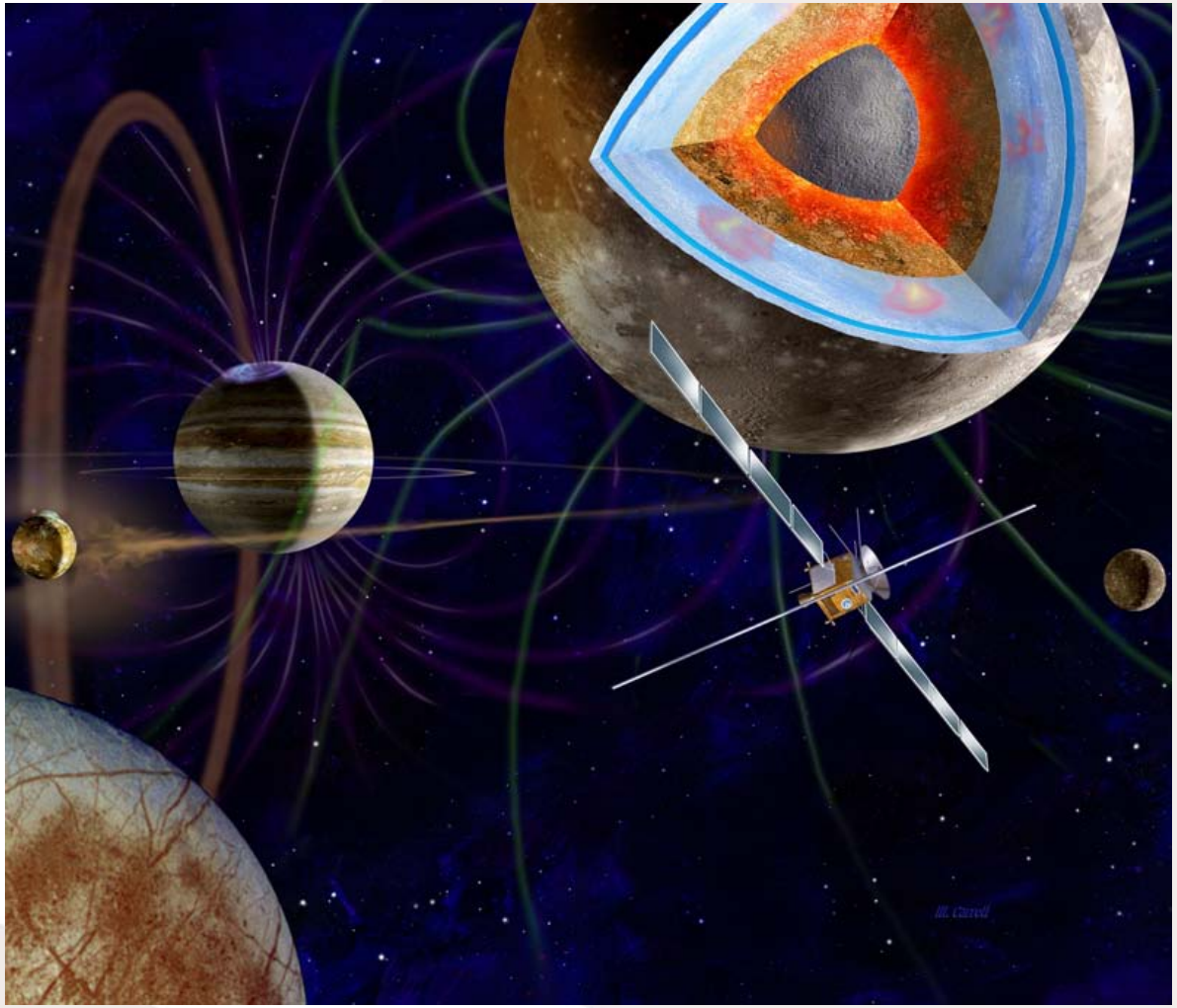
- Frame: no motorized Z-axis
- standard DN100 flanges : D-Sub connectors (25p x2, 37p x4), coaxials (x8)
- Beam spot : 1.7 x 2.3 cm^2
- Flux adjustment in real time by the user (chopper system)
  - Heavy ions : few tens – 1.E5 HI/cm^2.s
  - Protons : 1.E7-1.E9 p/cm^2.s (higher flux possible)
- Pumping/venting: few minutes
- Ion/E change (tuning and calibration) : <1/2h
- HI/p+ testing during the same irradiation campaign (incl. CPO)

STANDARD COCKTAIL

Ion species	Energy (MeV)	LET (MeV/mg.cm²)	Range (µm)
127 Iodine	325	62	30
79 Bromine	236	40	31
58 Nickel	182	29.9	29
43 Titane	160	21	31.7
35 Chlorine	199	11.8	60
19 Fluorine	120	4	93
12 Carbon	84	1.63	143

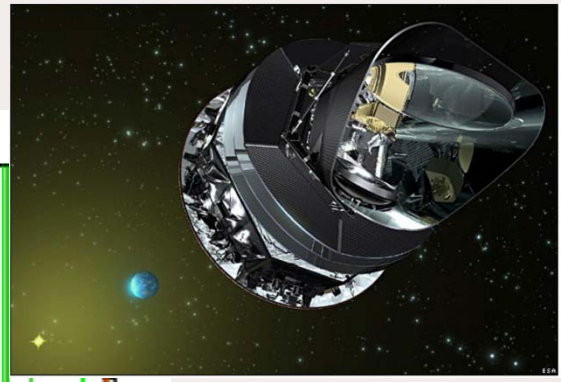
+ protons 1-20MeV (mono-energetic beam)

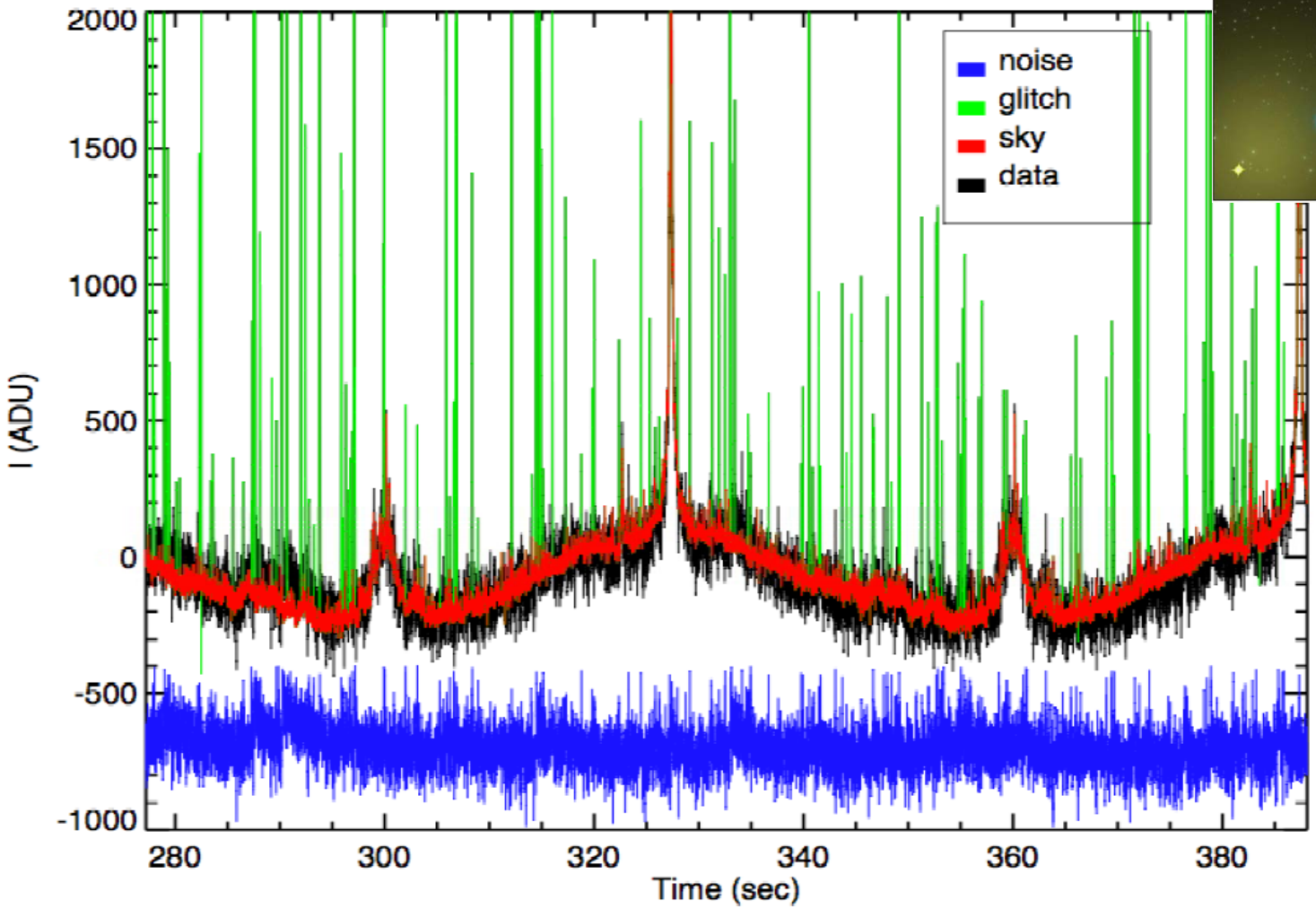
JUICE - A NEW MISSION TO EXPLORE JUPITER AND ITS MOONS



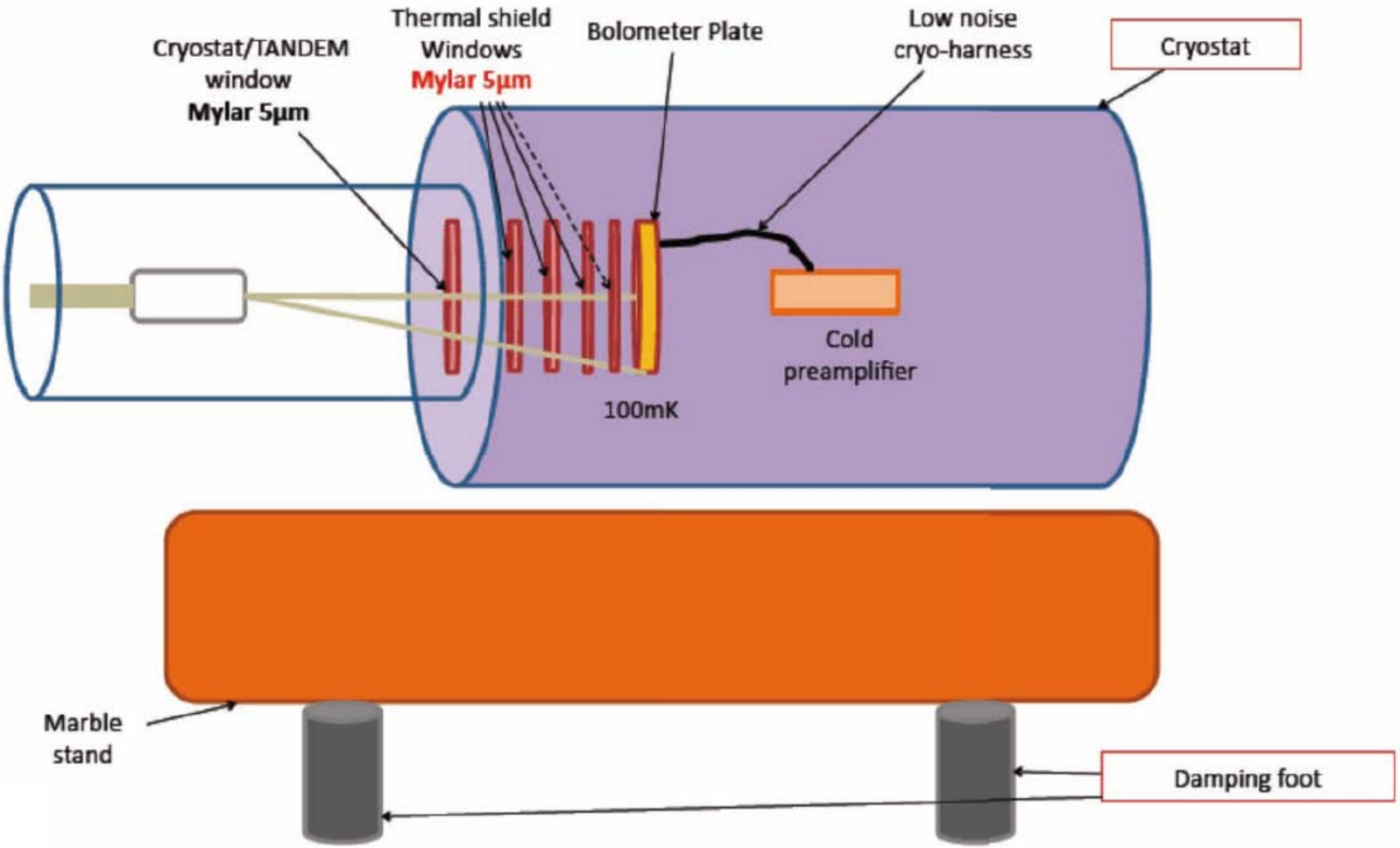
Van allen radiation belt much stronger
Many electrons from 0 to 50 MeV
Irradiation at ALTO 10-50 MeV

PLANCK: GLITCHES IMPACT





SET UP FOR PLANCK EXPERIMENT AT ALTO



- Energy of the beam used : up to 23 MeV
- Proton rate : down to few proton/s

ISOTEC

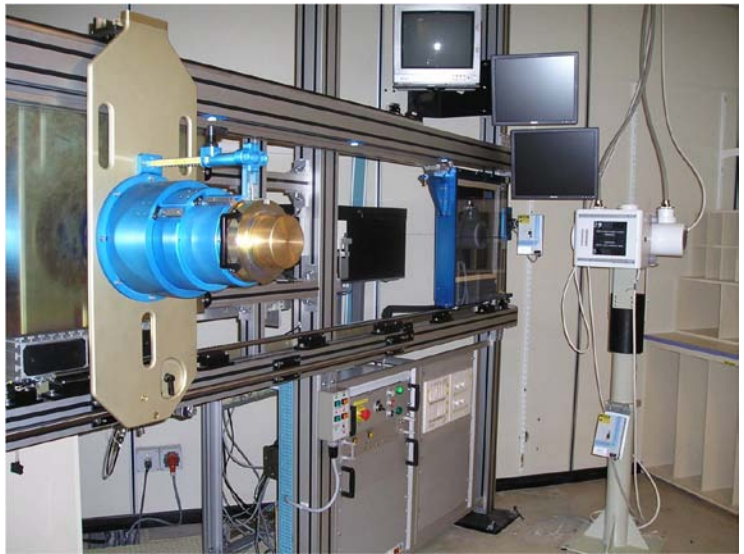
Study of the production rate and identification of radioisotopes produced on various targets

Participation to this thematic through the study of nuclear reactions of interest and also through the development of the associated instrumentation would help the development (improve) of knowledge on this subject.

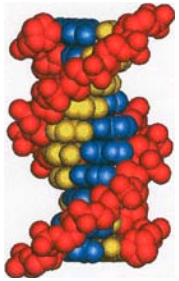
- Proposal motivated by the work that has been developed on ^{99m}Tc and ^{99}Mo for which data were needed
  - Optimization of the production using neutron converter
  - study a new class of radio-isotopes emerging for the application to medicine
  - applied to other isotopes and optimize the production versus the beam energy and the nature of targets

CPO collaboration

For the treatment of much localized tumors, the Proton Therapy Center CPO at the Institut Curie has been equipped with the first rotating-arm beam guide in France. The IPN installed its **fixed proton beam lines**, the first stage in delivering the beam to the patient for the treatment of ocular and intracranial tumors.



ALTO



Applications for research and industry:

- Biochemistry in ionizing radiation
- Irradiation of protein in the solid state Studies
- Study of biological systems (molecules DNA) under parallel radiations (X-rays and electron beams)

Industrial applications

Electronic components under irradiation (electrons)

“other beams other targets”
at ALTO

R&D (TRIUMF-IPN MOU) = photo-production of 8Li in ISOL conditions

8Li photo-photoproduction collaboration at ALTO
P. Bricault, M. Lebois, *TRIUMF, Vancouver, Canada*
F. Ibrahim, D. Verney, S. Essabaa, E. Cottereau, Ch. Lau, M. Cheikh Mahmed and the source group *IPN, IN2P3/CNRS, Orsay, France*

alkali
=>surface
ionization

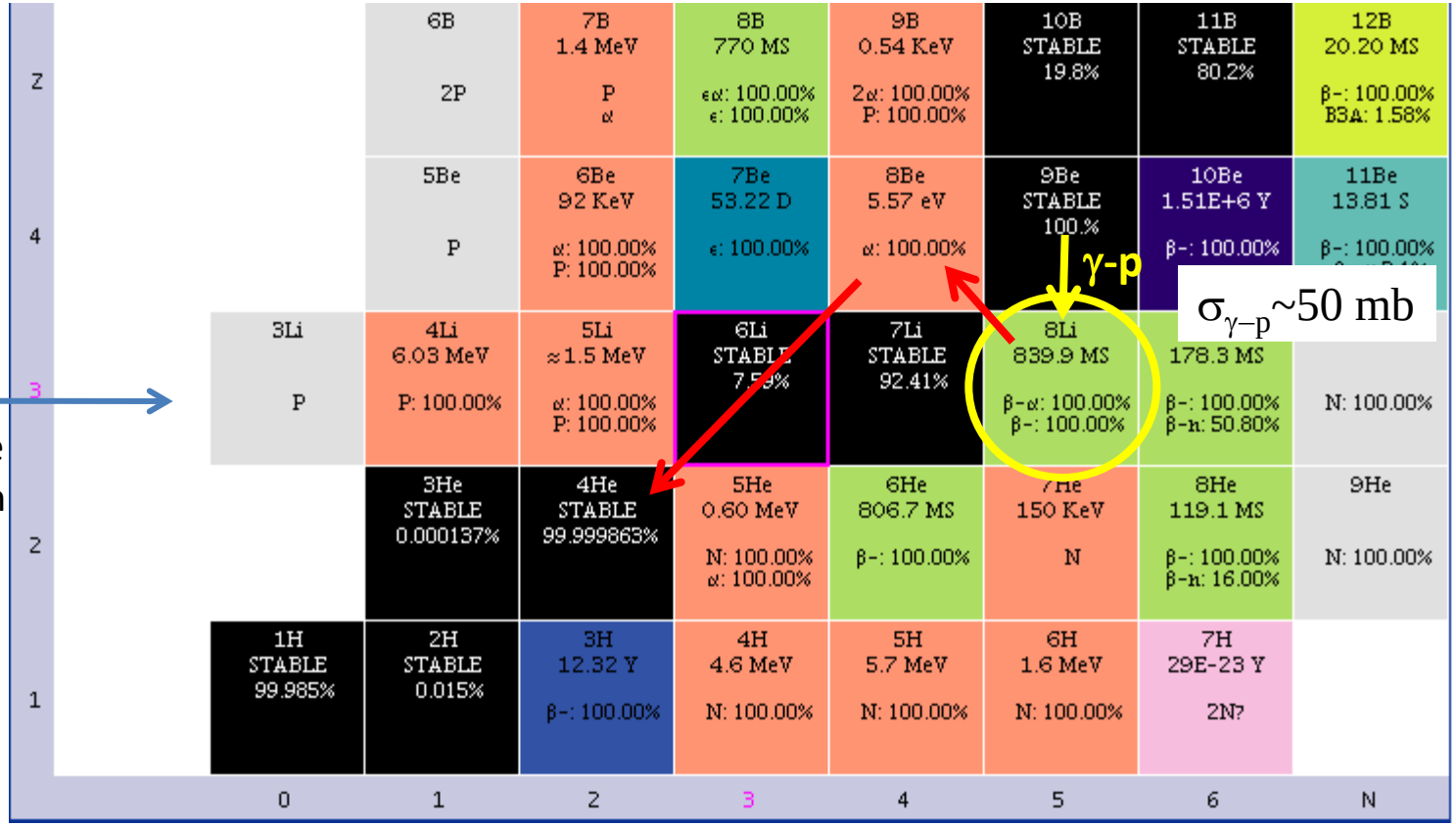
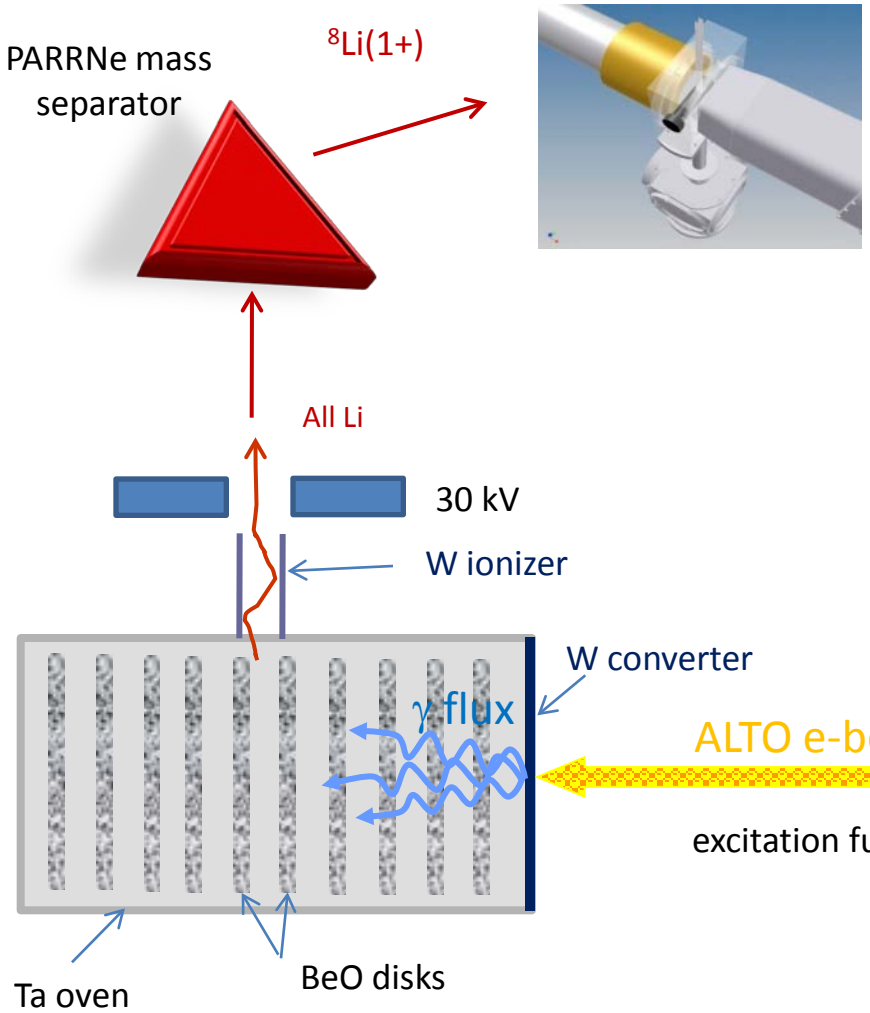


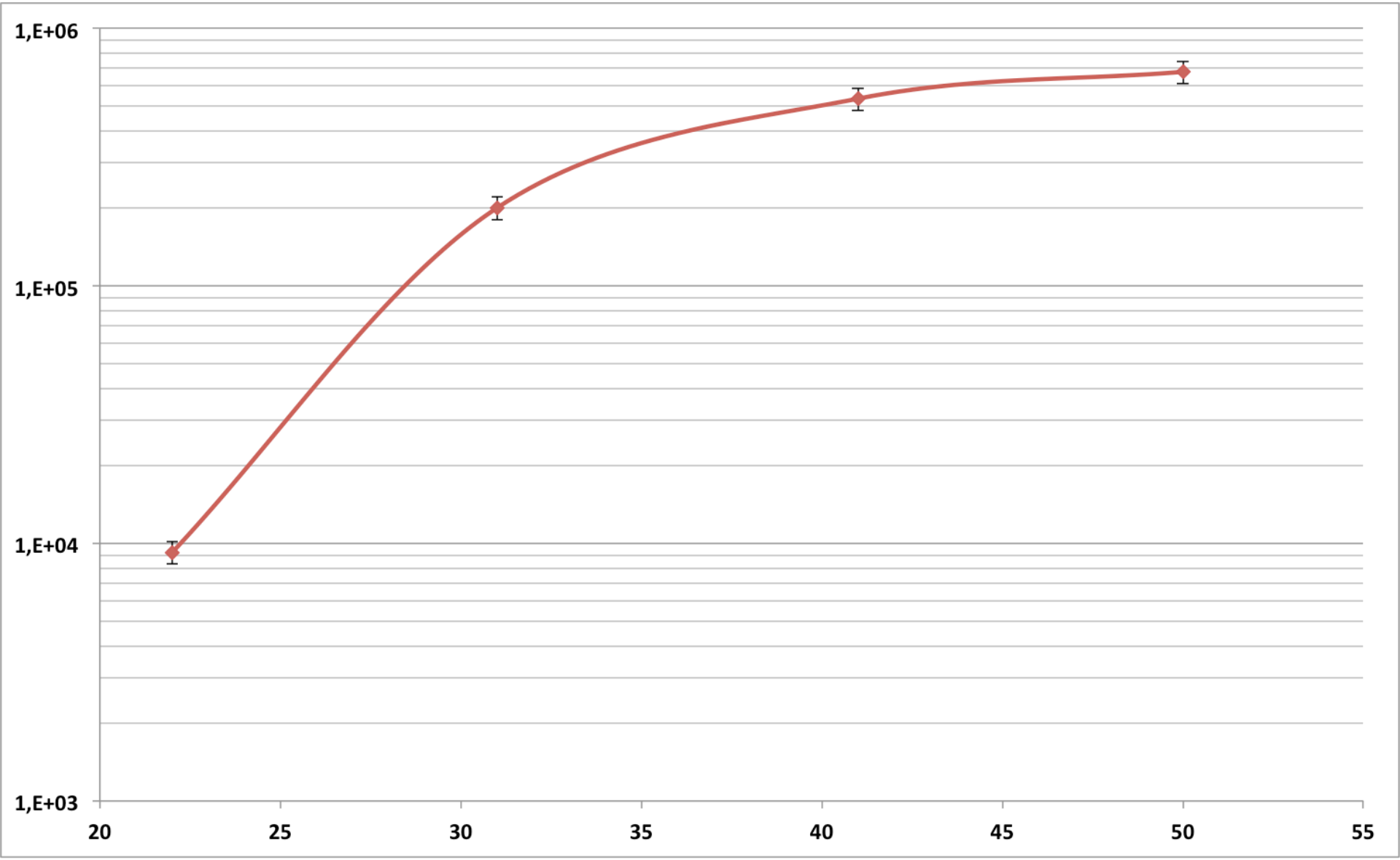
photo-production of ^{8}Li at ALTO : experimental setup

Surface ionization

ECS bunker

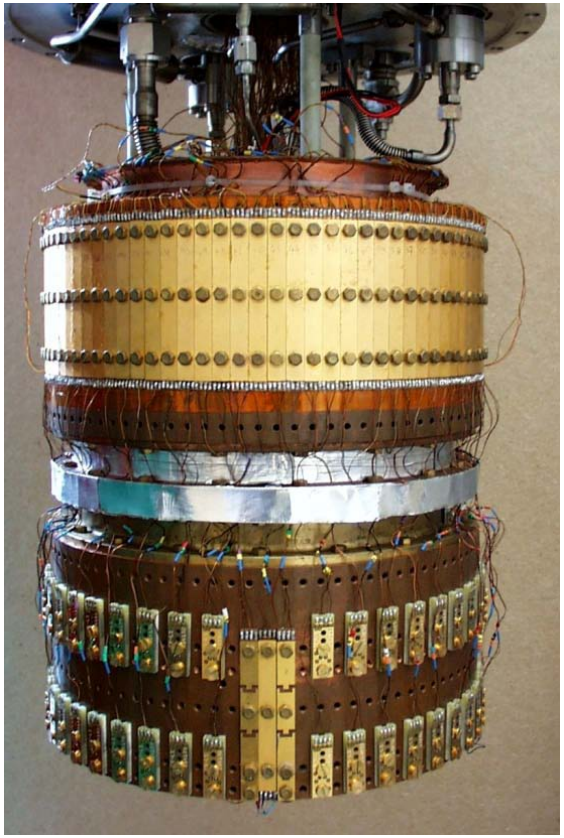


Photoproduction of ^{8}Li: the results



Cryogenic systems
Thermometer calibration facility

- Temperature range **[1.6K,300K]**
- Accuracy of ± 5 mK from 1.6 K to 4.2 K and about 1 % for higher temperatures
- The calibration system capacity: 94 thermometers
- **6000** thermometers have been calibrated for LHC and **290** for Spiral2



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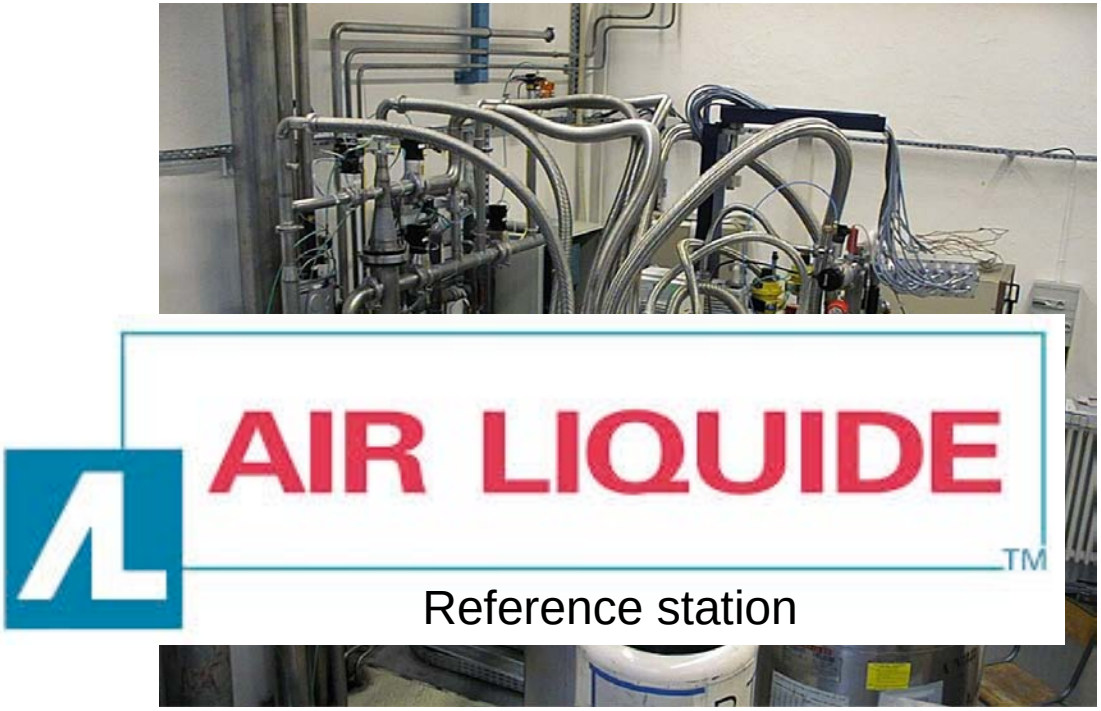
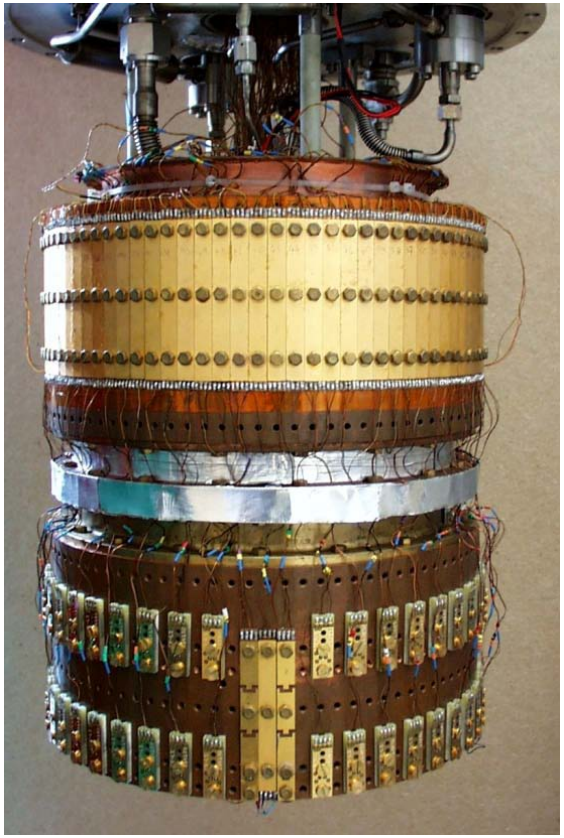
- The calibration system capacity: 94 thermometers
- **6000** thermometers have been calibrated for LHC and **290** for Spiral2

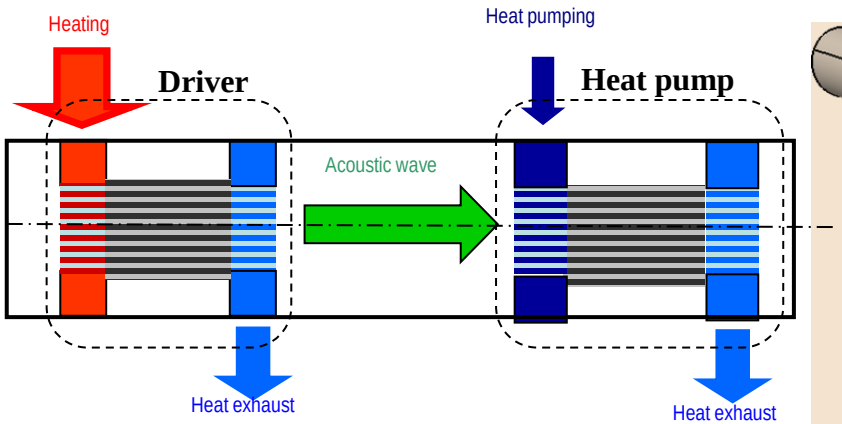


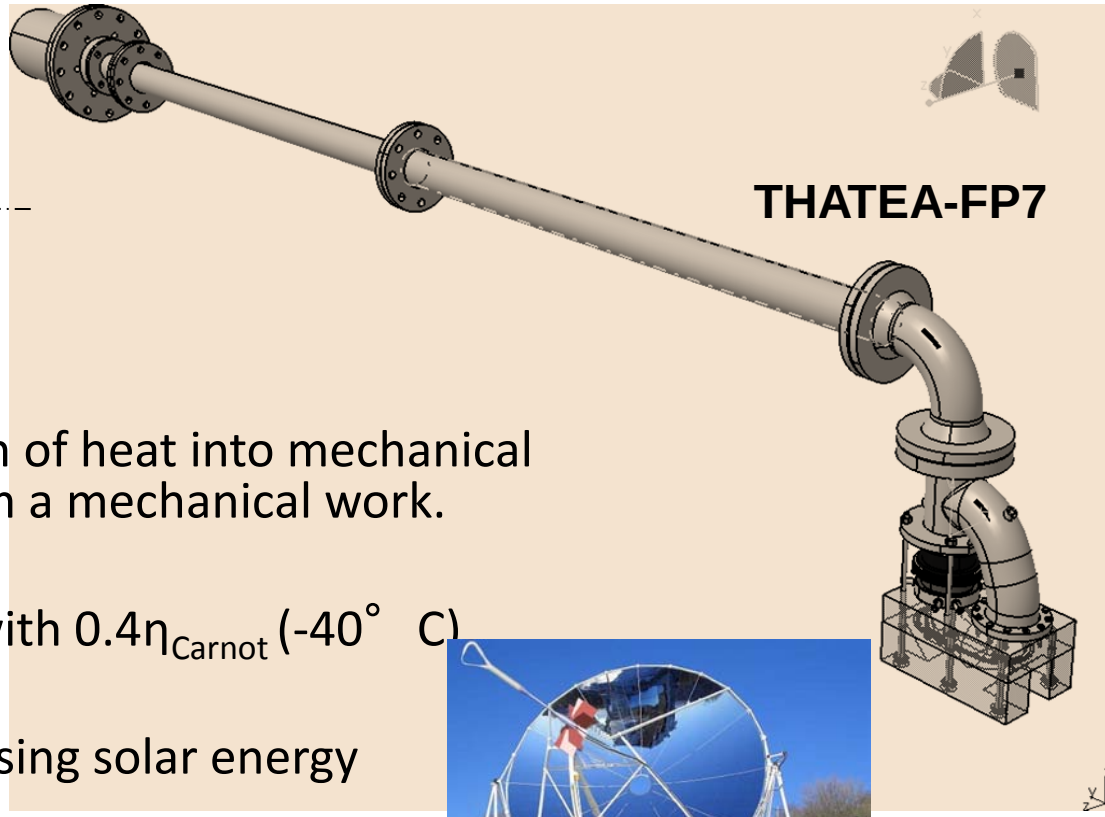


R&D on cryogenic systems

Refrigerator based on the thermoacoustic technology

Interaction between in a porous medium and a gas subjected to an acoustic standing wave





- Optimization of the conversion of heat into mechanical work or the heat transfer from a mechanical work.
- Development of refrigerator with $0.4\eta_{Carnot}$ (-40° C)
- Development of refrigerator using solar energy

ANR-TACSOL

Technology transfert: ACS

- Startup company ACS was established on 2009 in order to enhance the skills and knowledge acquired by the laboratory in the preparation and testing of particle accelerators using the cold elements and technologies widely based on the use equipment platform Laboratory, to provide engineering services to clients in the field of particle accelerators.

ACCELERATORS AND CRYOGENIC SYSTEMS

The ALTO facility

Fadi Ibrahim– IPN Orsay

Thank you for your attention