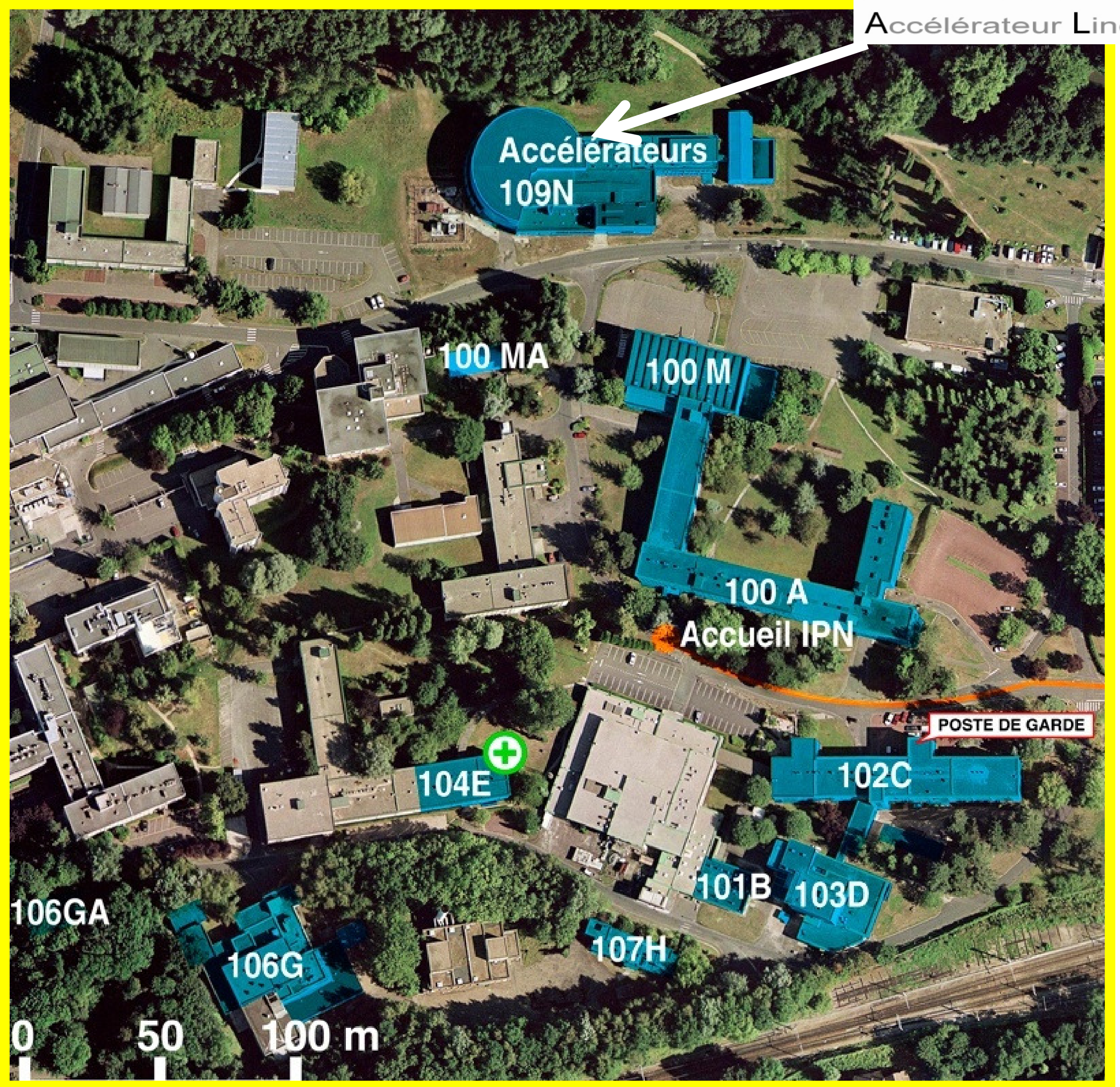
The ALTO facility
for the production of Rare Nuclei



ALTO

Accélérateur Linéaire et Tandem à Orsay

Linear

Accelerator

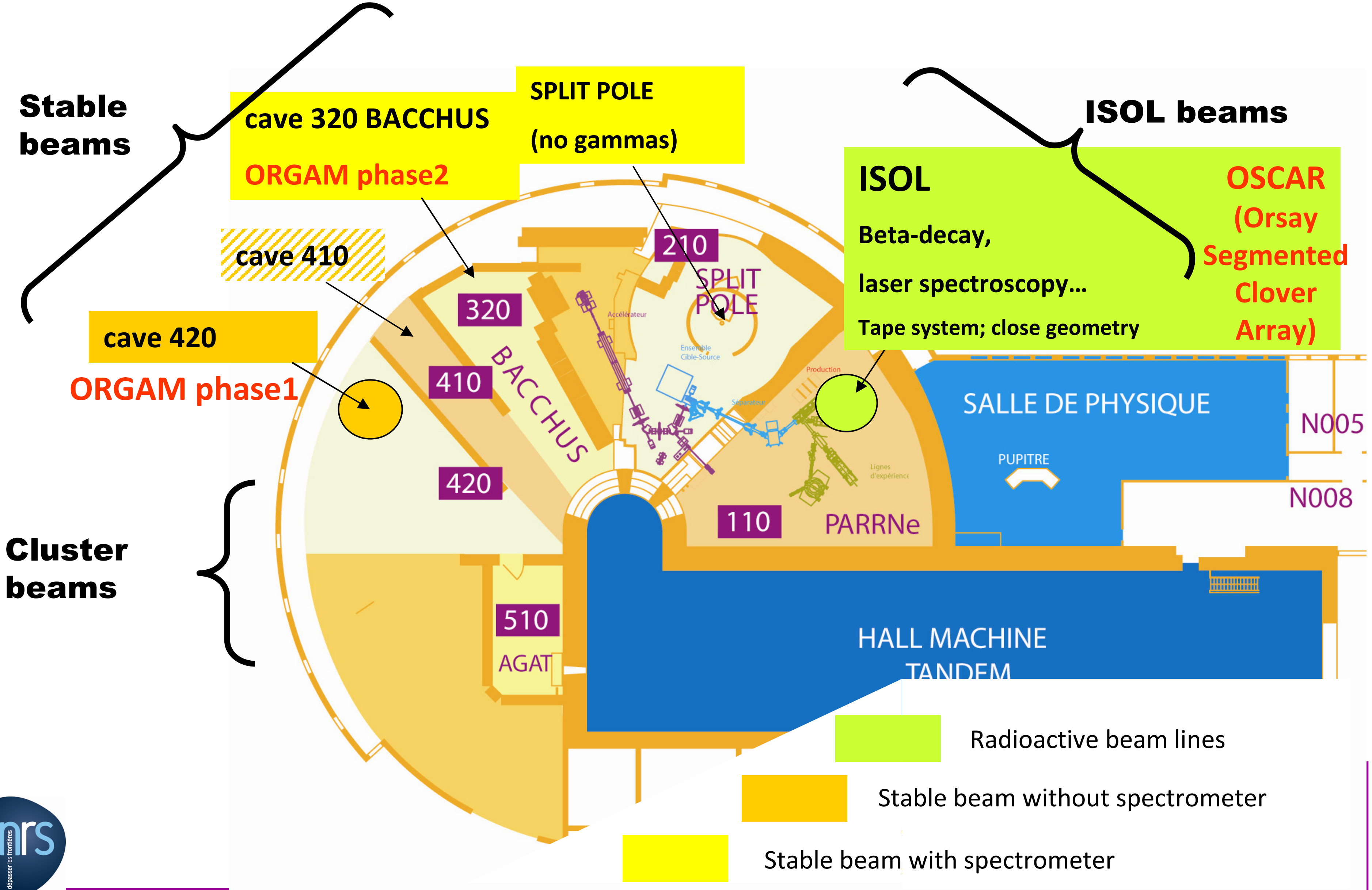
and

Tandem

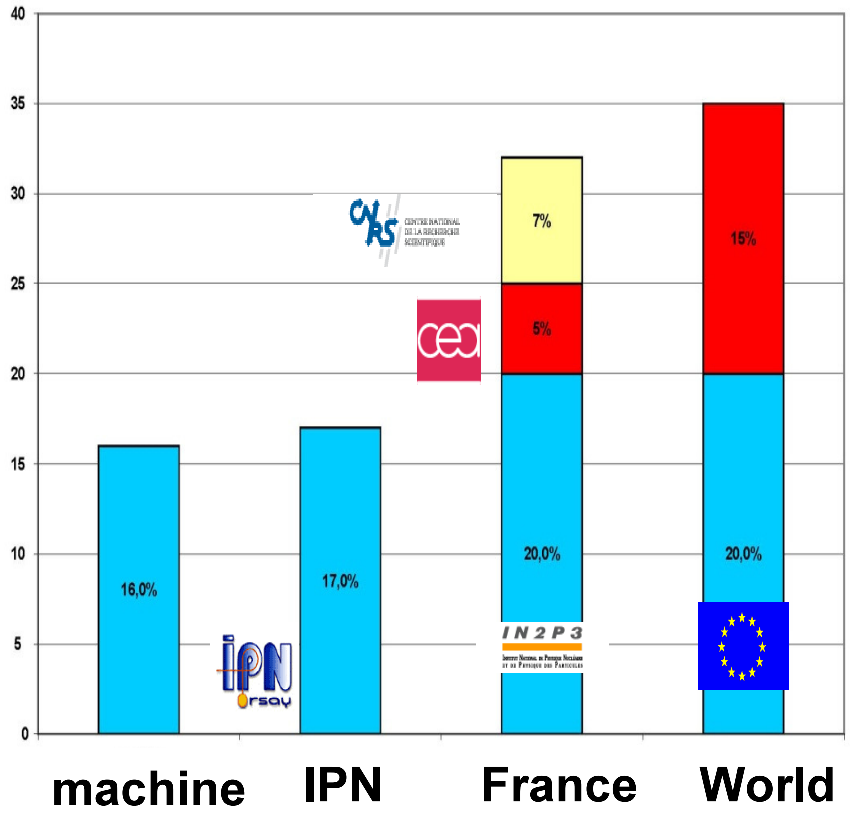
at Orsay

ALTO a hybrid facility

Accélérateur Linéaire et Tandem à Orsay



In2p3



The Tandem-ALTO facility is part of the IPN Orsay

4000 h per year

Possibility to run in the future Alto and Tandem simultaneously

28 engineers and technicians for Technical support

- -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

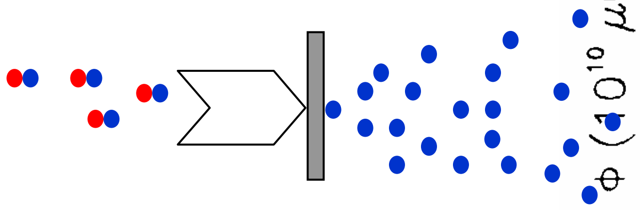
International Program Advisory Committee

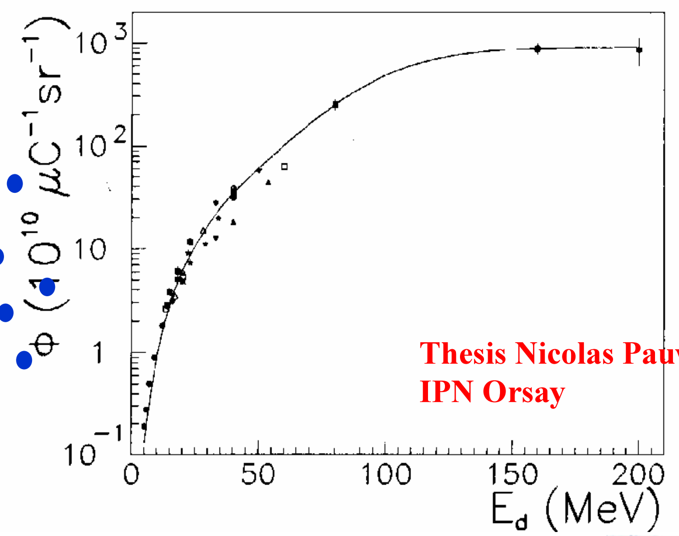
International Users Committee (2009)

Rooms available for experimentalists

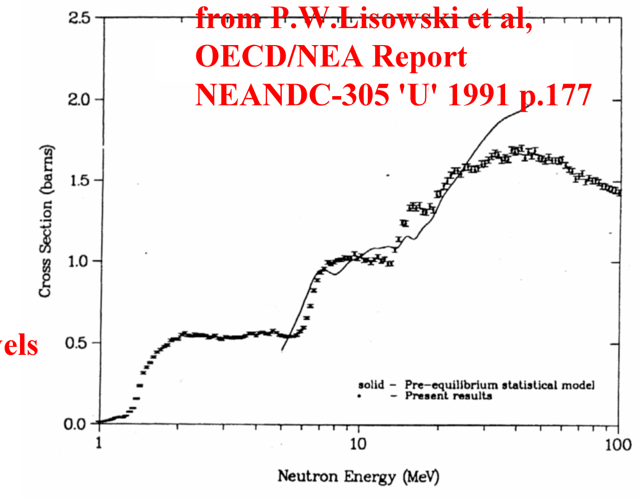
Production of Rare Nuclei at ALTO

Production of fission fragments
using fast neutrons



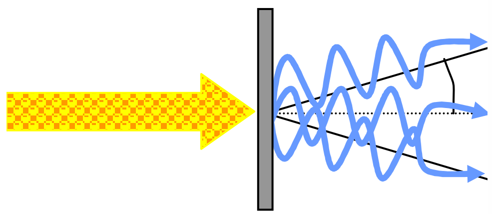


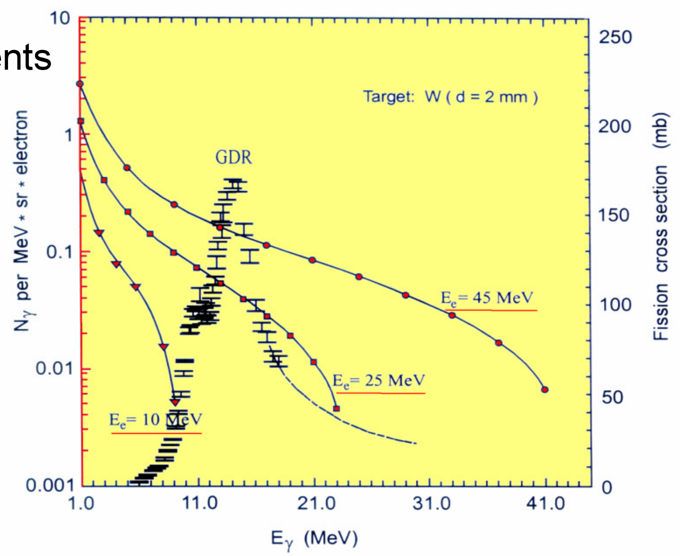
Thesis Nicolas Pauwels
IPN Orsay

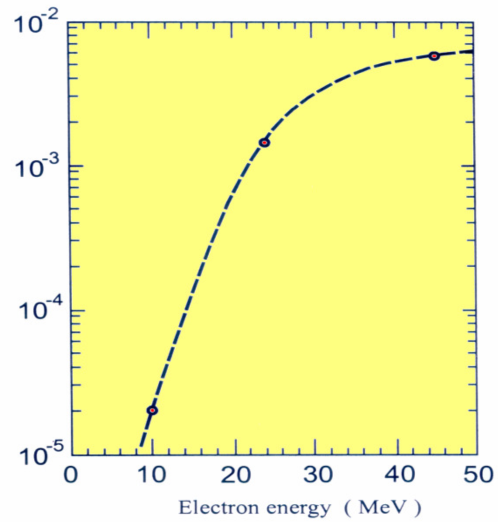


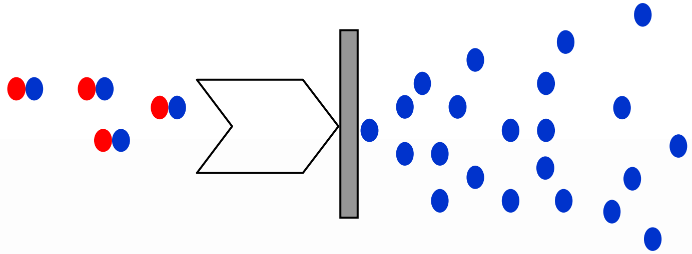
from P.W.Lisowski et al,
OECD/NEA Report
NEANDC-305 'U' 1991 p.177

Production of fission fragments
by photo-fission



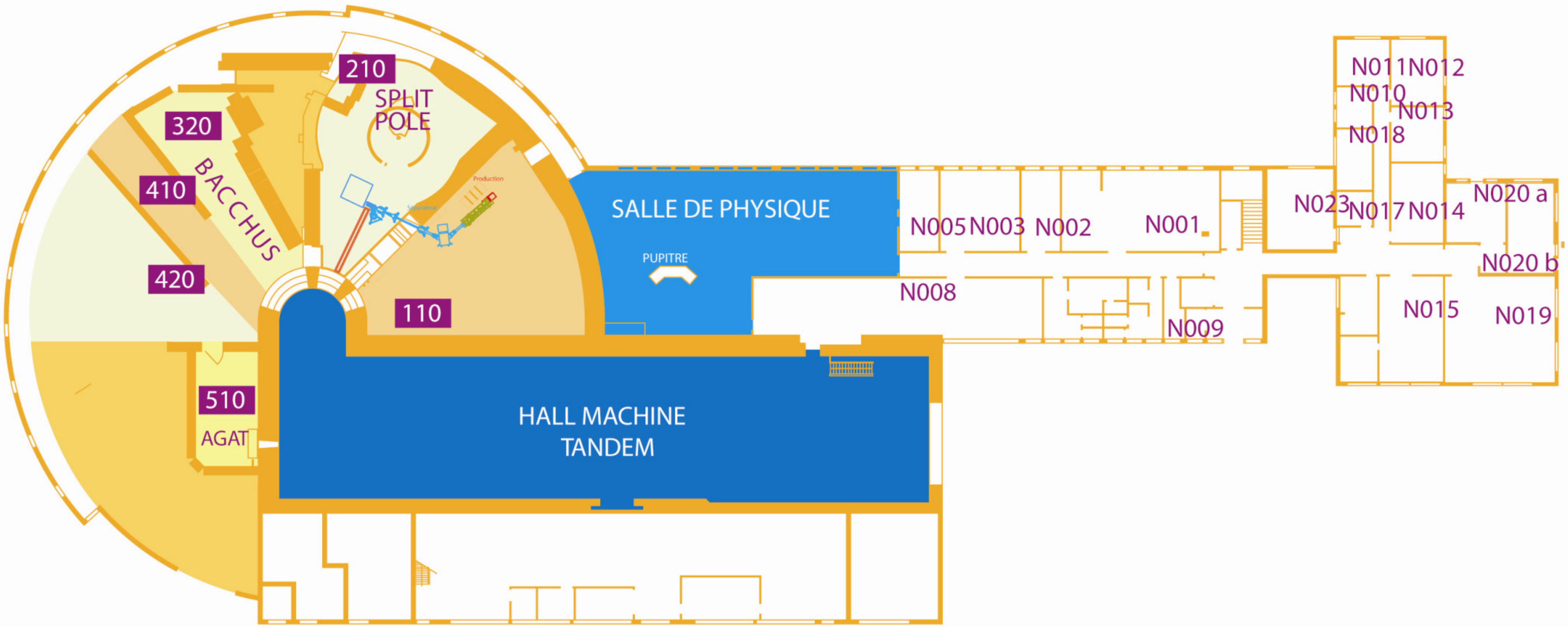


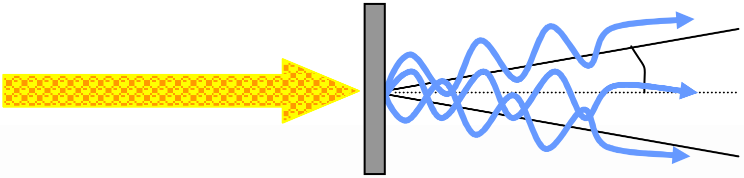




Deuteron beam from the tandem:
1µA, 26 MeV

10^9 fissions per second
$3\ 10^5$ ^{132}Sn after separation



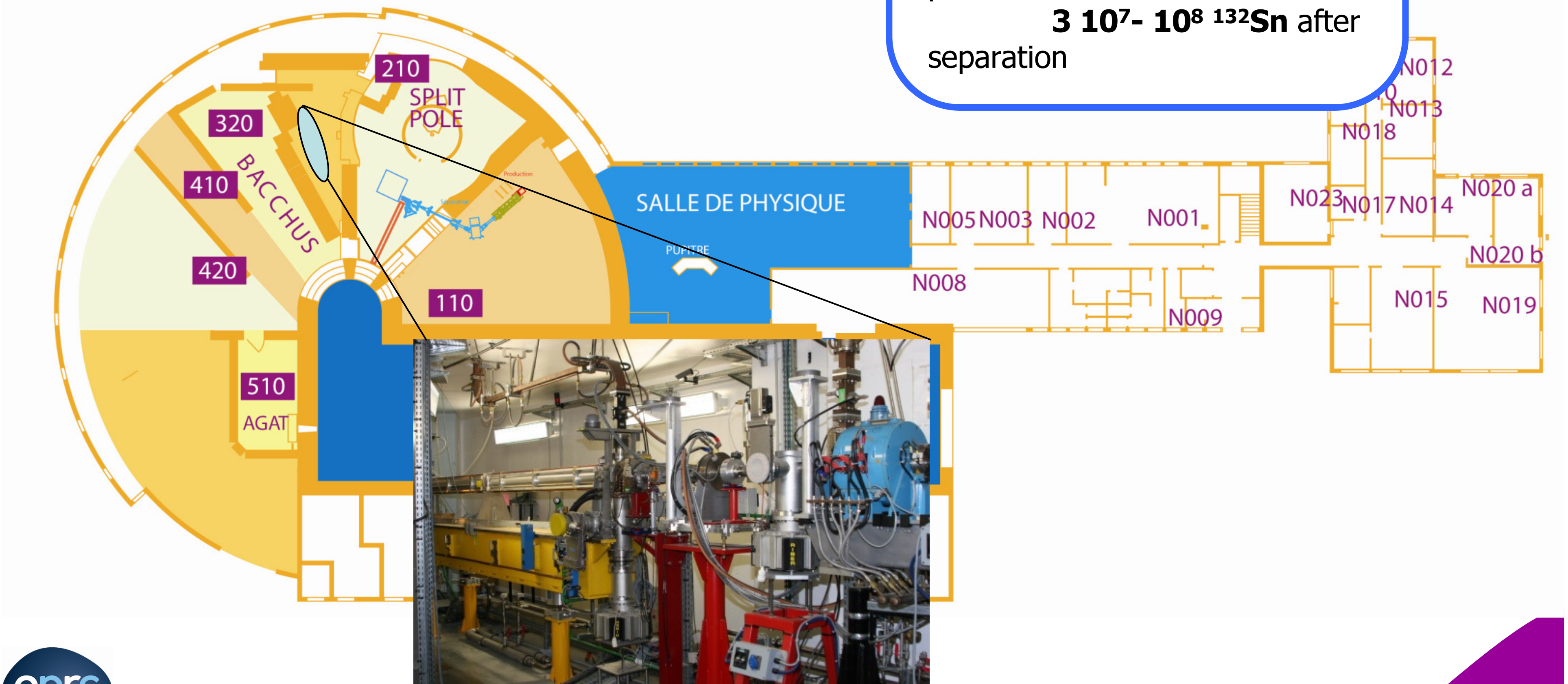


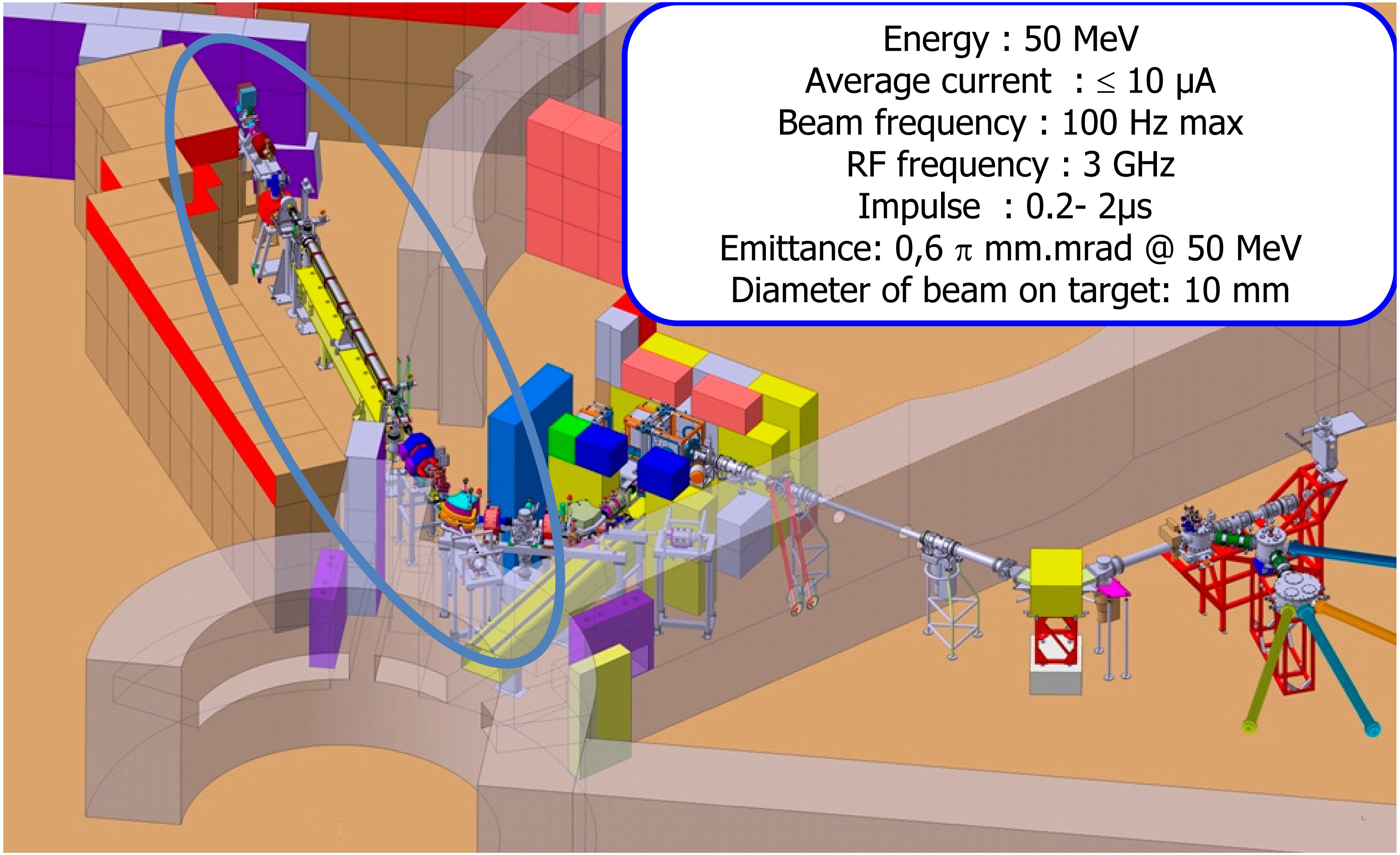
ALTO LINAC (formerly 1st section of the LEP injector) :
10μA, 50 MeV electrons

factor 100 in comparison with deuterons

10^{11}-4 10^{11} fissions per second

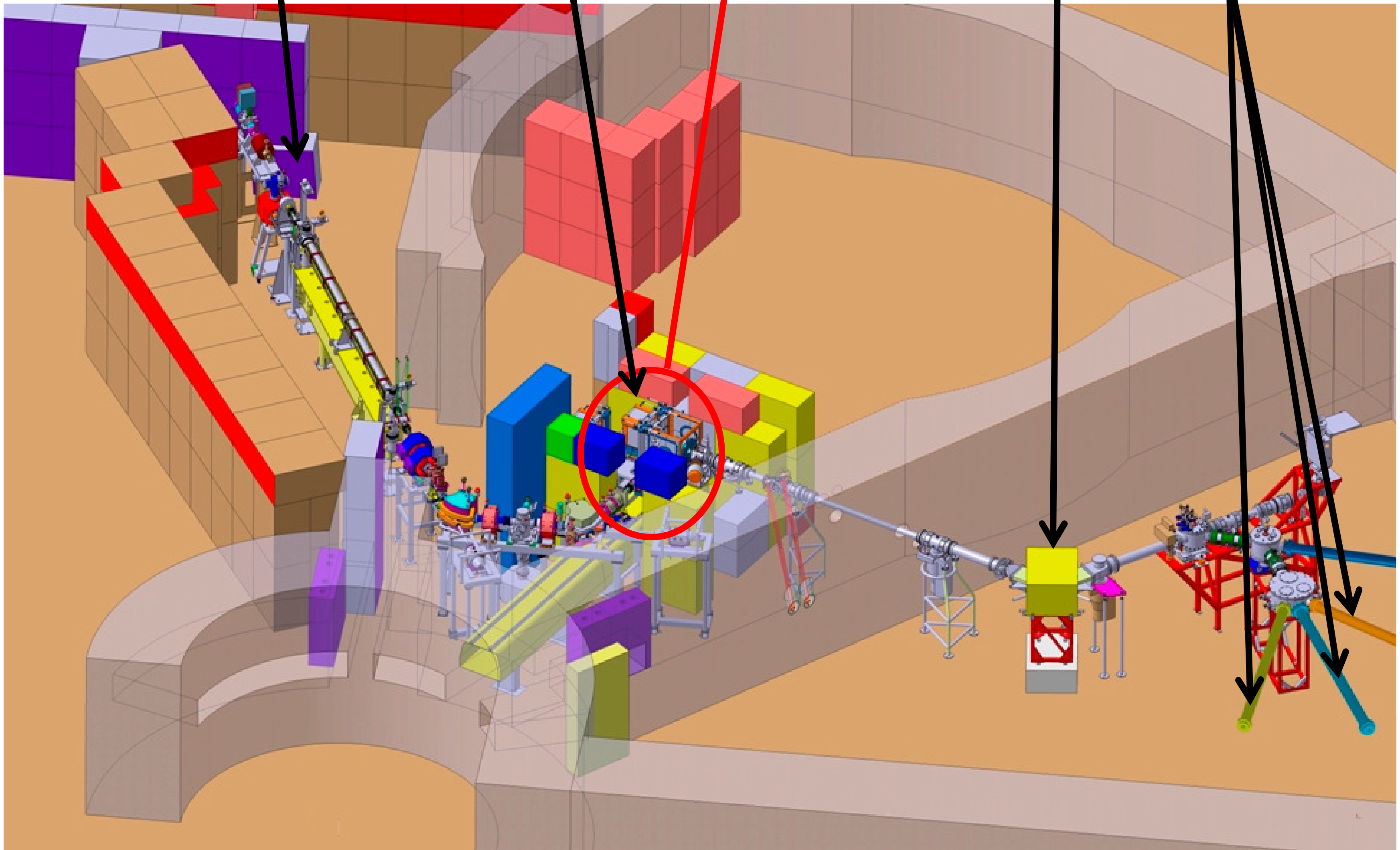
3 10^{7}- 10^{8} ^{132}Sn after separation

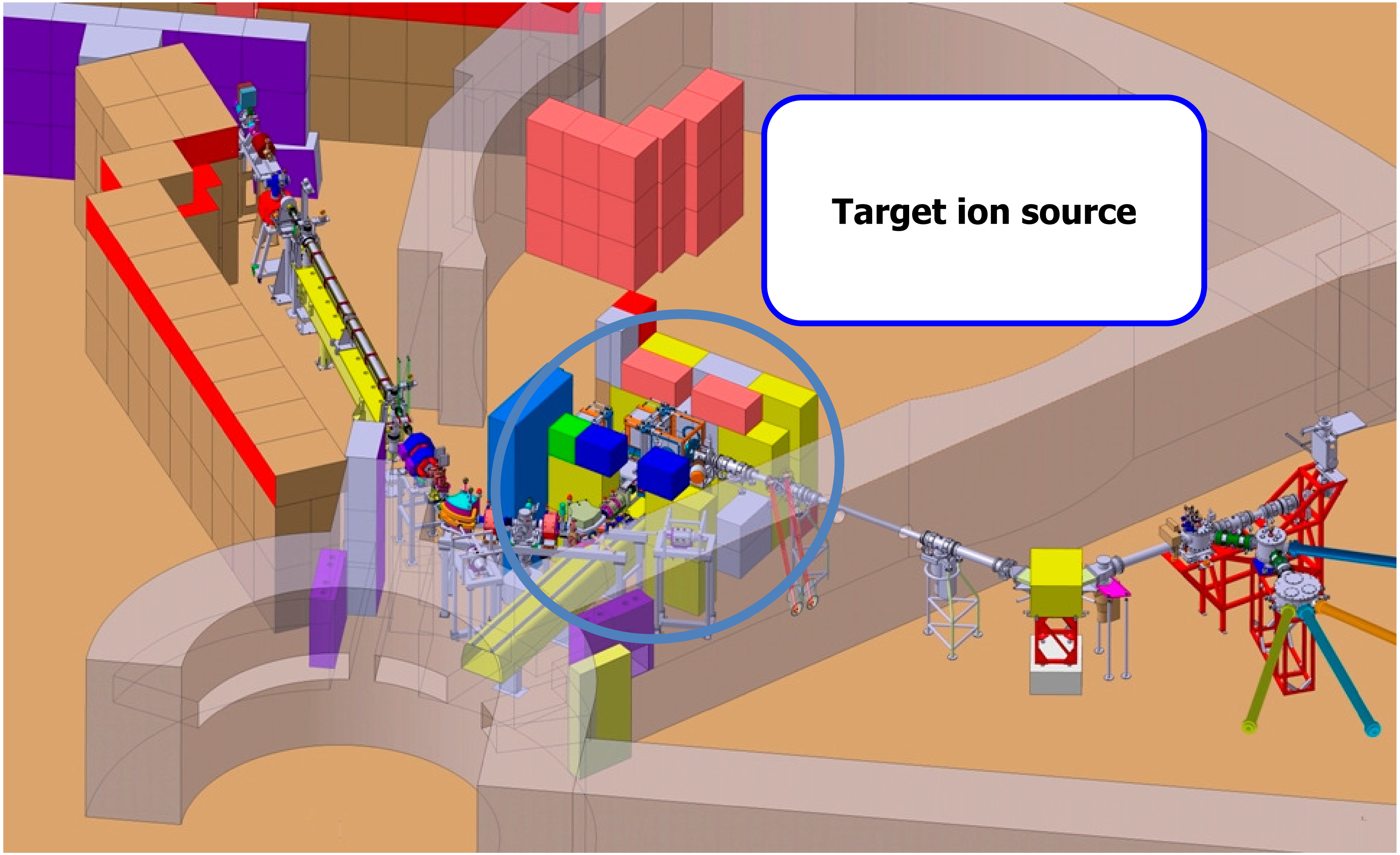




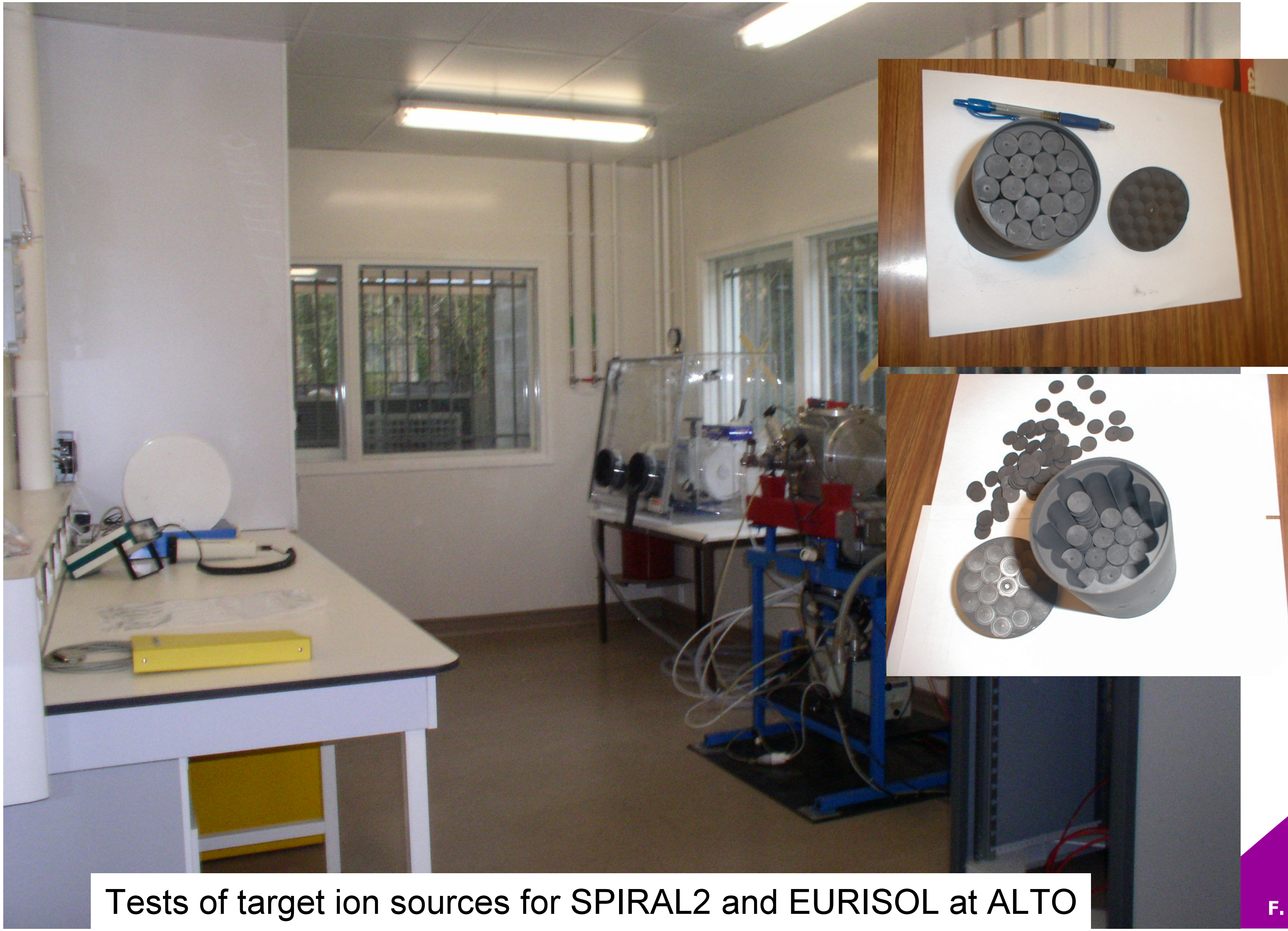
Energy : 50 MeV
Average current : ≤ 10 μA
Beam frequency : 100 Hz max
RF frequency : 3 GHz
Impulse : 0.2- 2μs
Emittance: 0,6 π mm.mrad @ 50 MeV
Diameter of beam on target: 10 mm

The ISOL installation




Target ion source

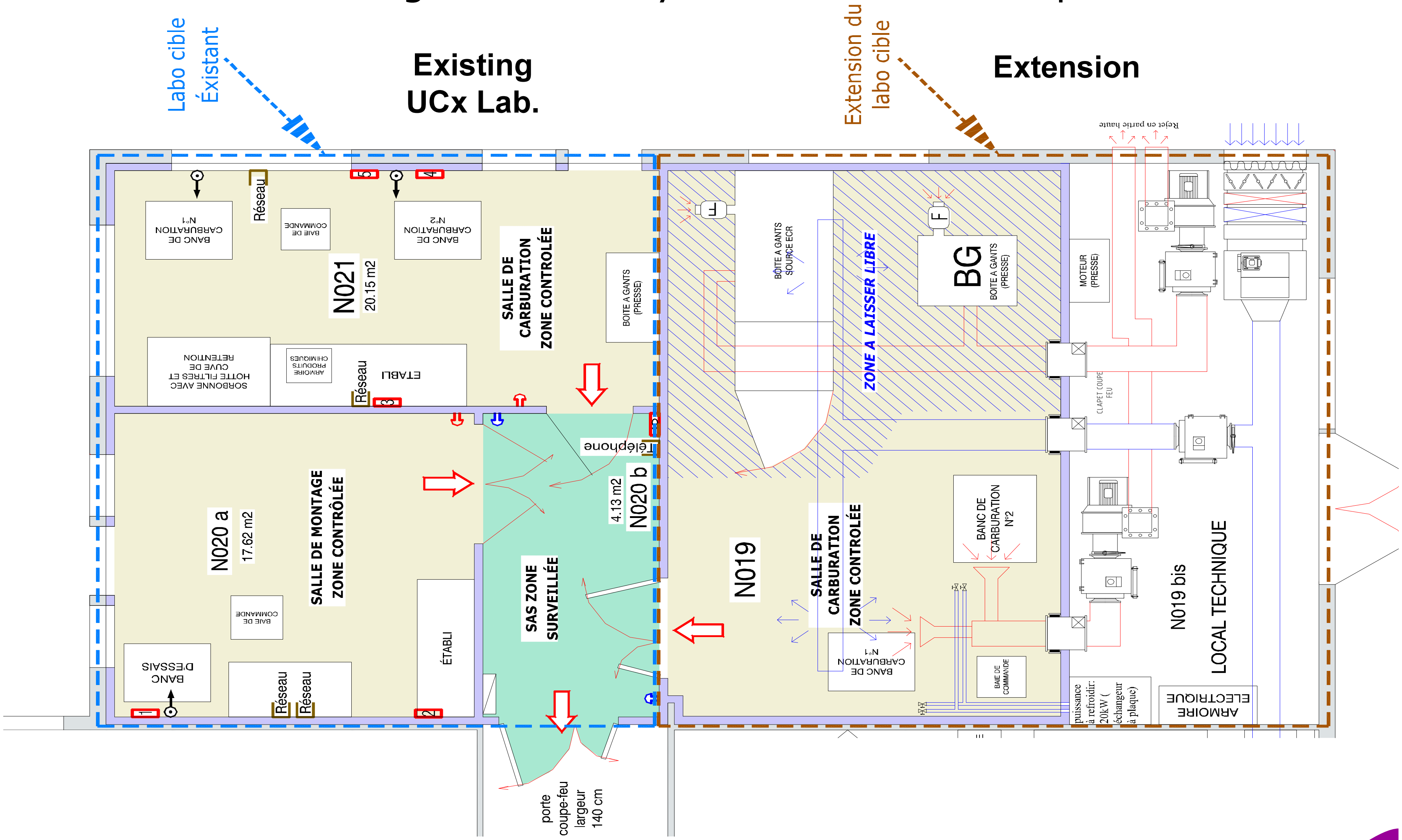
Carburation room



Tests of target ion sources for SPIRAL2 and EURISOL at ALTO

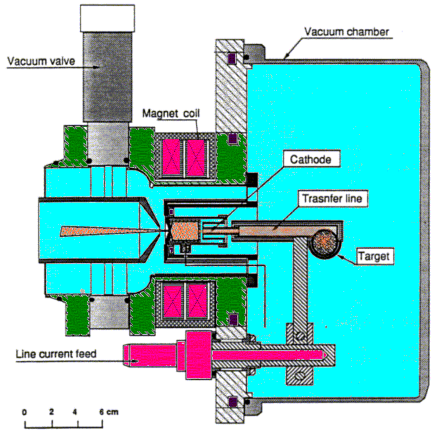
F. Ibrahim

Extension of the target laboratory: dimensioned for spiral2



Some ion sources currently used at ALTO

Febiad



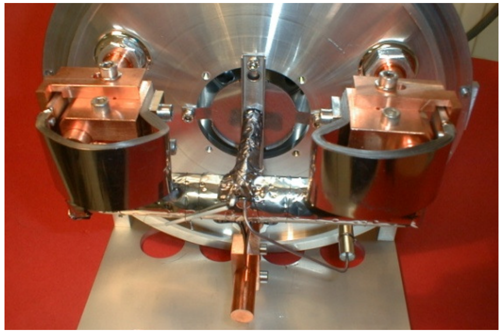
High temperature (1900 °C)

Compact: the target is part of the source high efficiency

well adapted for a large number of elements

No selectivity

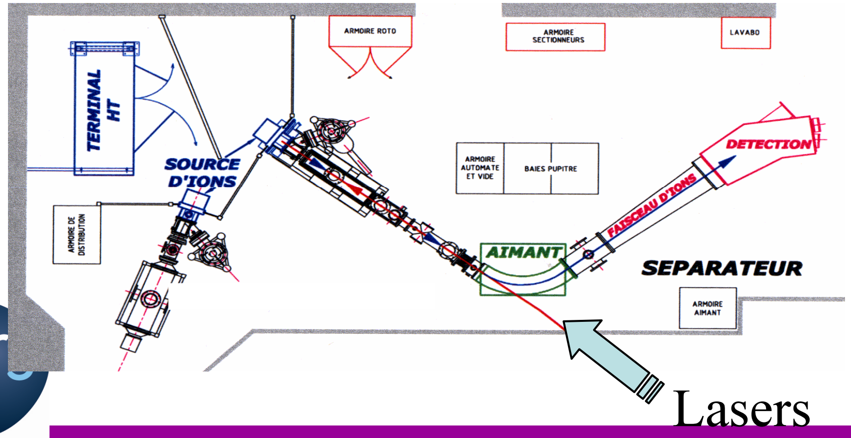
Surface ionization



Very high efficiency for alkaline

Dedicated to alkaline and Ga In

Laser source



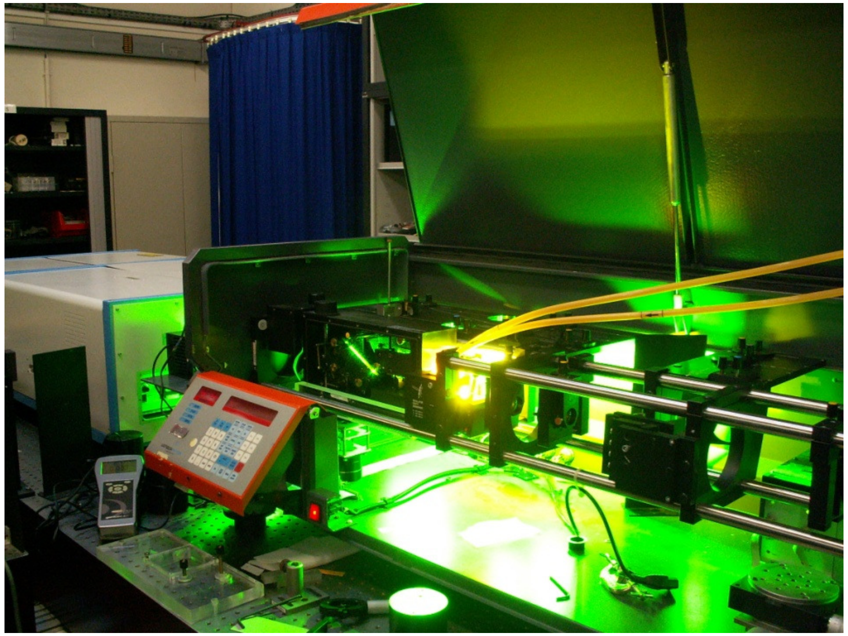
Very selective ion source

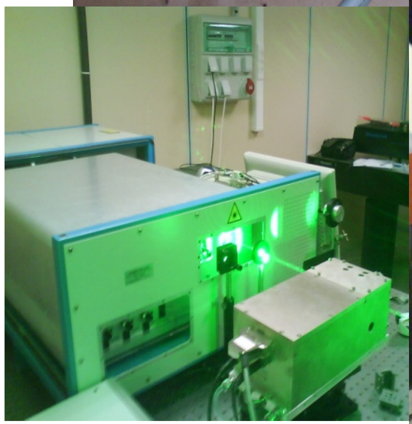
High efficiency depending on the rate frequency of the laser

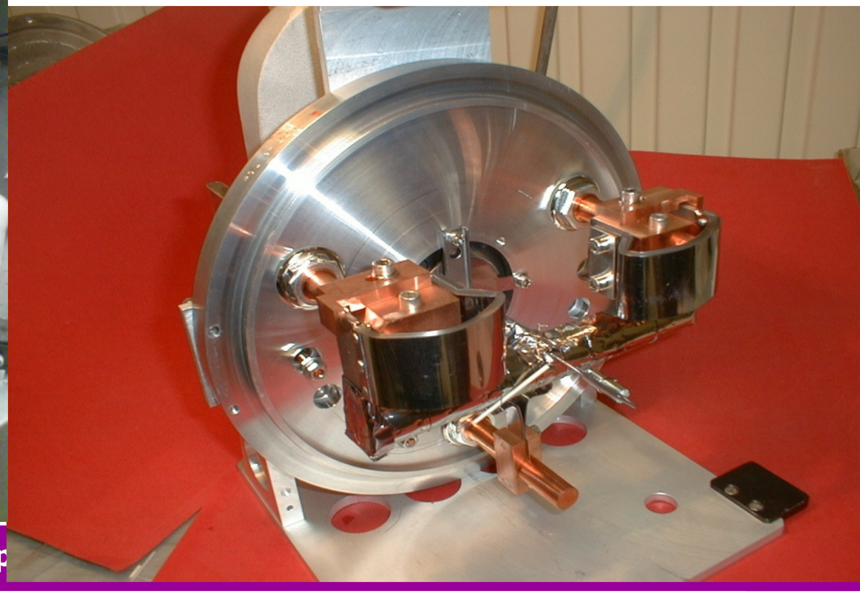
Large number of elements could be ionized

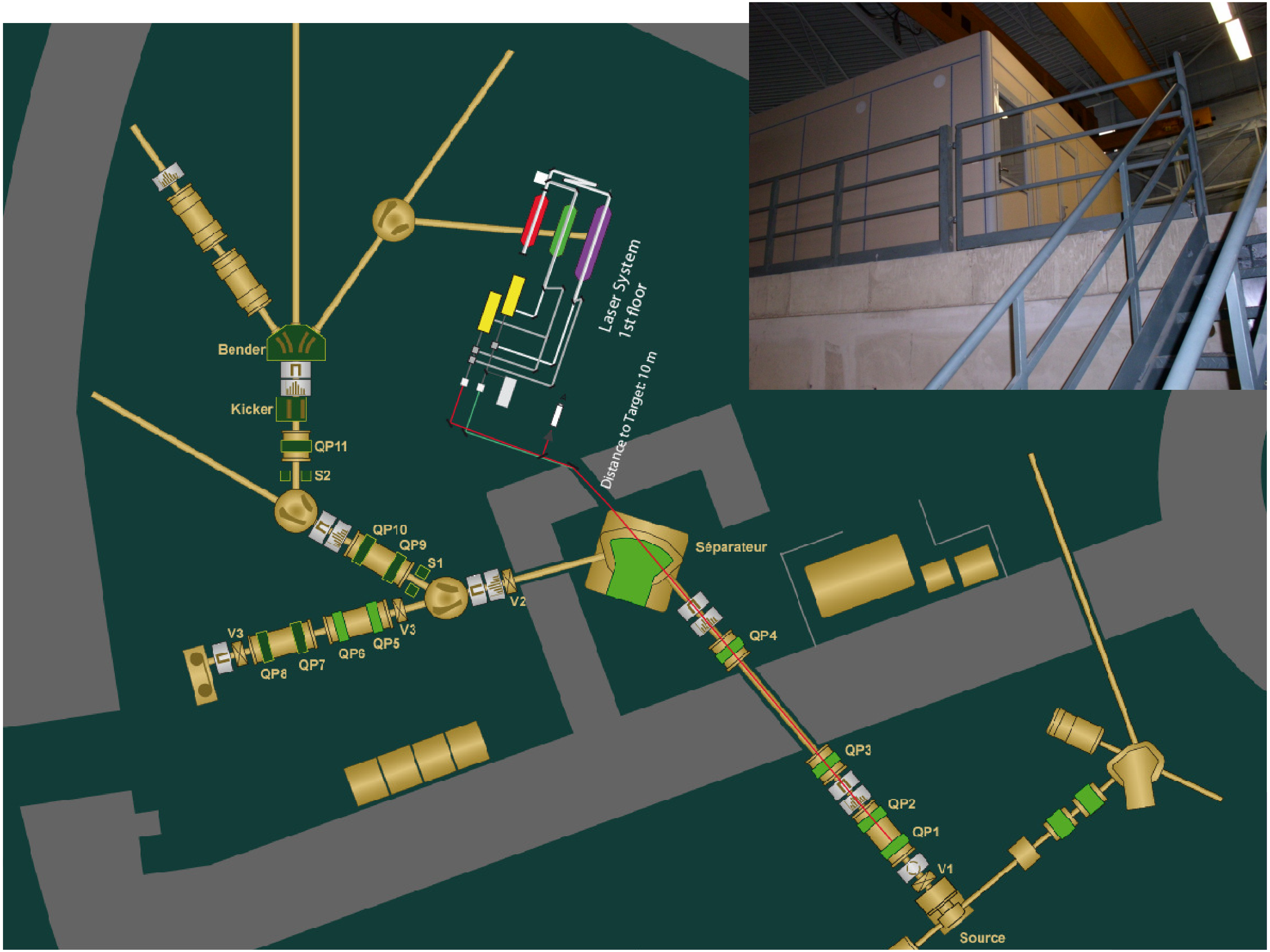
Contamination with surface ionization

On line laser ion source








Bender
Kicker
QP11
S2
Laser System
1st floor
Distance to Target: 10 m
QP10
QP9
S1
Séparateur
V2
V3
V3
QP5
QP6
QP7
QP8
QP4
QP3
QP2
QP1
V1
Source

Temporary authorization

DRIRE

DIRECTION RÉGIONALE DE L'INDUSTRIE,
DE LA RECHERCHE ET DE L'ENVIRONNEMENT
D'ILE-DE-FRANCE
10, RUE CRILLON
75194 PARIS CEDEX 04

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

AUTORITE DE SURETE NUCLEAIRE

DIVISION DE

DIRECTION GÉNÉRALE
DE LA SÛRETÉ NUCLÉAIRE
ET DE LA RADIOPROTECTION

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RÉPUBLIQUE FRANÇAISE

DEP-DSNR PARIS-1301-2006
Affaire suivie par : S. DOGNA
Tél : 01.44.59.47.76
Fax : 01.44.59.47.04
Mél : sylvain.dogna@asn.minefi.gouv.fr

Objet : Autorisation d'utiliser à des fins non médicales un accélérateu[r] des rayons X
Nouvelle autorisation

Référence : Formulaire daté du et dossier(s) correspondant(s)

P. J. : 1 notification d'autorisation

Référence à rappeler dans toute correspondance : T910611

Madame,

Comme suite à votre demande rappelée en référence et en applicatio[n] santé publique, je vous prie de trouver ci-joint la décision d'autori[sation] Ministre de la Santé et des Solidarités.

Cette autorisation expire le 01/07/2008 et est enregistrée sous le numé[ro] toute correspondance ultérieure).

J'attire votre attention sur le fait que cette autorisation vous a été acco[rdée] transférable ni annulable sans décision explicite du Ministre de la Sant[é]

Je vous prie d'agréer, Madame, l'assurance de ma considération distinguée.

Le Chef de la Division de la Sûreté Nucléaire et de la Radioprotection,

L. JACQUES

Copies : IRSN/UES, SD1-pôle Sources

IPN Orsay
Madame Dominique GUILLEMAUD-MULLER
IN2P3 Université paris sud
2, rue Georges Clémenceau
91406 ORSAY

www.ile-de-France.drire.gouv.fr

MINISTERE DE L'ECONOMIE, DES FINANCES ET DE L'INDUSTRIE
MINISTERE DE LA SANTE ET DES SOLIDARITES
MINISTERE DE L'ECOLOGIE ET DU DEVELOPPEMENT DURABLE

- ➔ ALTO tests carried out in accordance with the procedure notified by ASN
- ➔ Check the agreement between the measurements and the Fluka calculations
- ➔ irradiations in steps between 0.1 and 10µA
- ➔ for each test a report is submitted to the ASN for validation and authorization of the following test

Art. A2 – Références de l'autorisation et validité

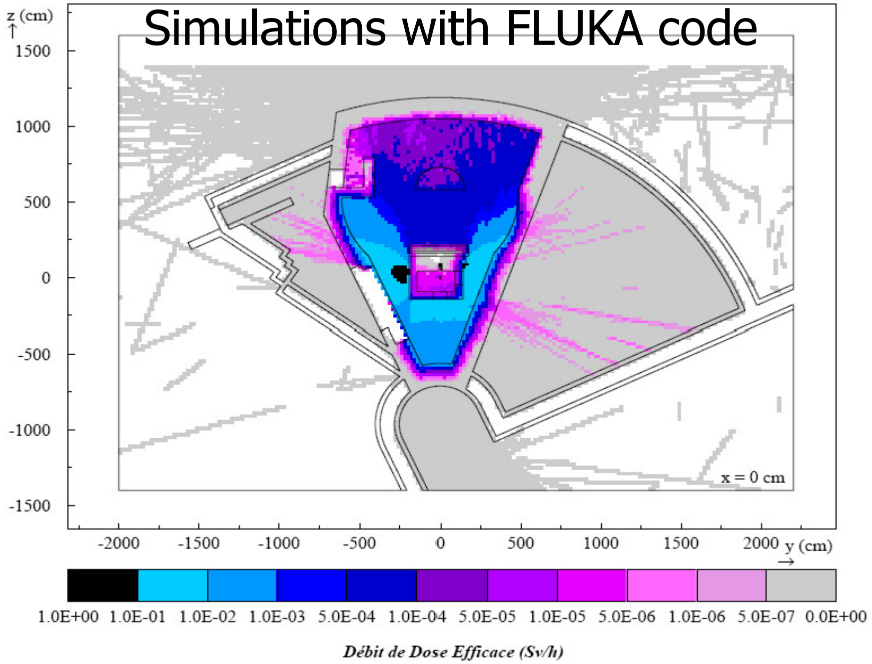
La présente autorisation est enregistrée sous le numéro T910611 et expire le 01/07/2008.

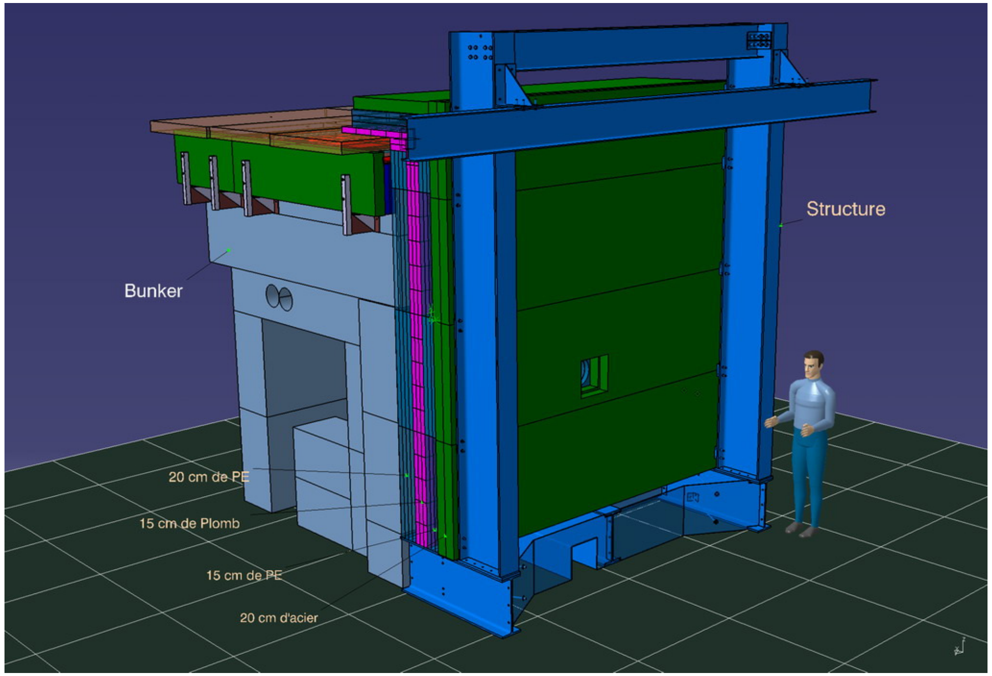
Son renouvellement doit être demandé six mois avant son expiration dans les conditions prévues par l'article R.1333-35 du code de la santé publique.

Concernant ALTO, cette autorisation ne permet que la phase de tests. Pour l'exploitation de l'accélérateur, un rapport de synthèse des essais de mise en service concernant l'accélérateur devra être transmis avec le dossier de renouvellement.

ALTO

Shielding of the target ion source





- Concrete Bunker :
  1 m thick for walls
  1.2 m for the roof
- Wrapped in a structure:
  Pb, steel and polyethylene (PE)
  0.70 m total thickness

Radioprotection measurements

Program :

2006

→100 nA

verify the Fluka code in the PARRNe configuration

2007

→ 500 nA

bunker configuration with only the concrete shielding

→ 1 μA

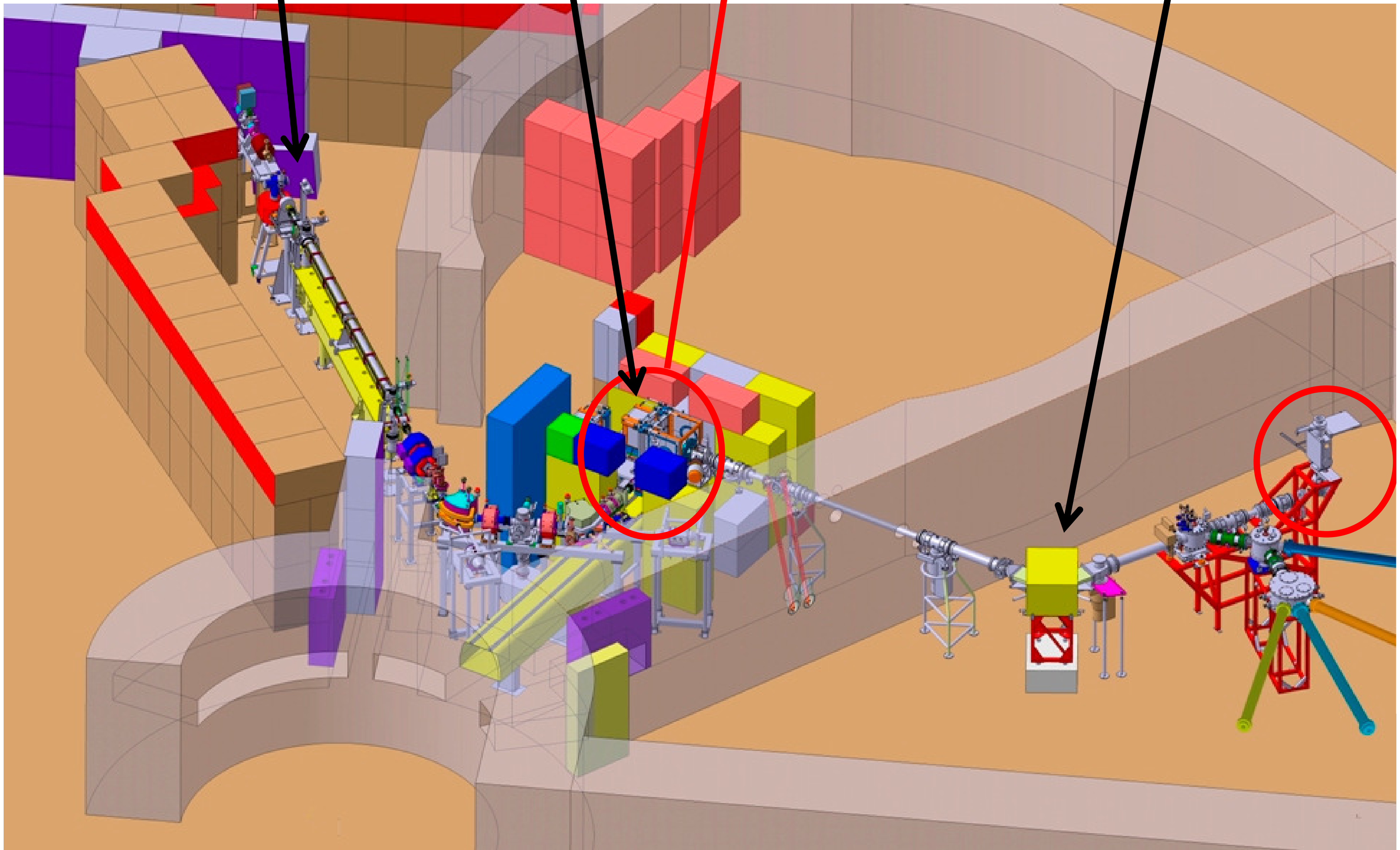
Bunker with the complete structure for the roof and concrete on the front

2008-2009

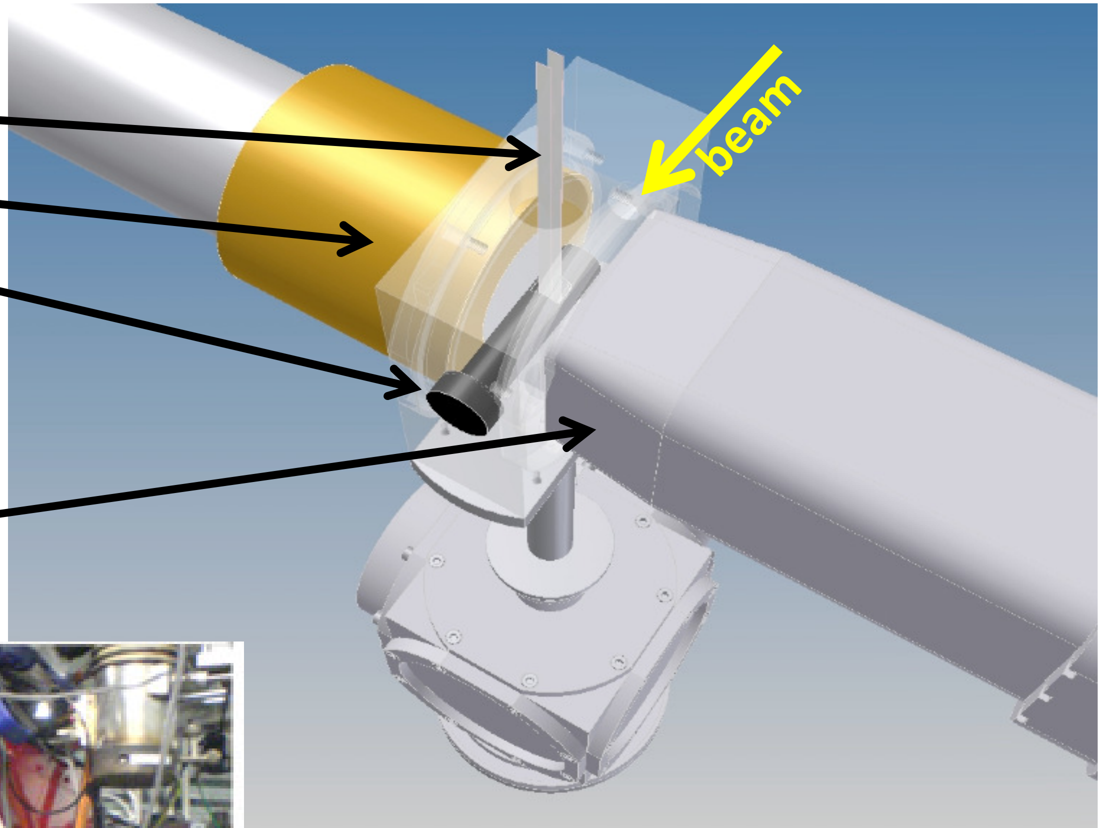
→ 5 μA and 10 μA (extraction with Febiad and surface IS)

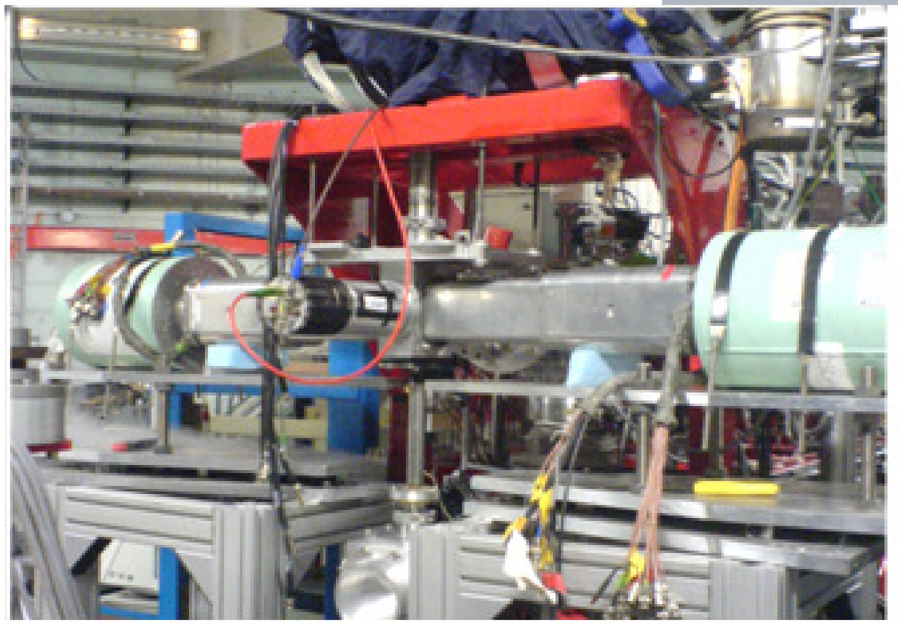
final configuration of the bunker

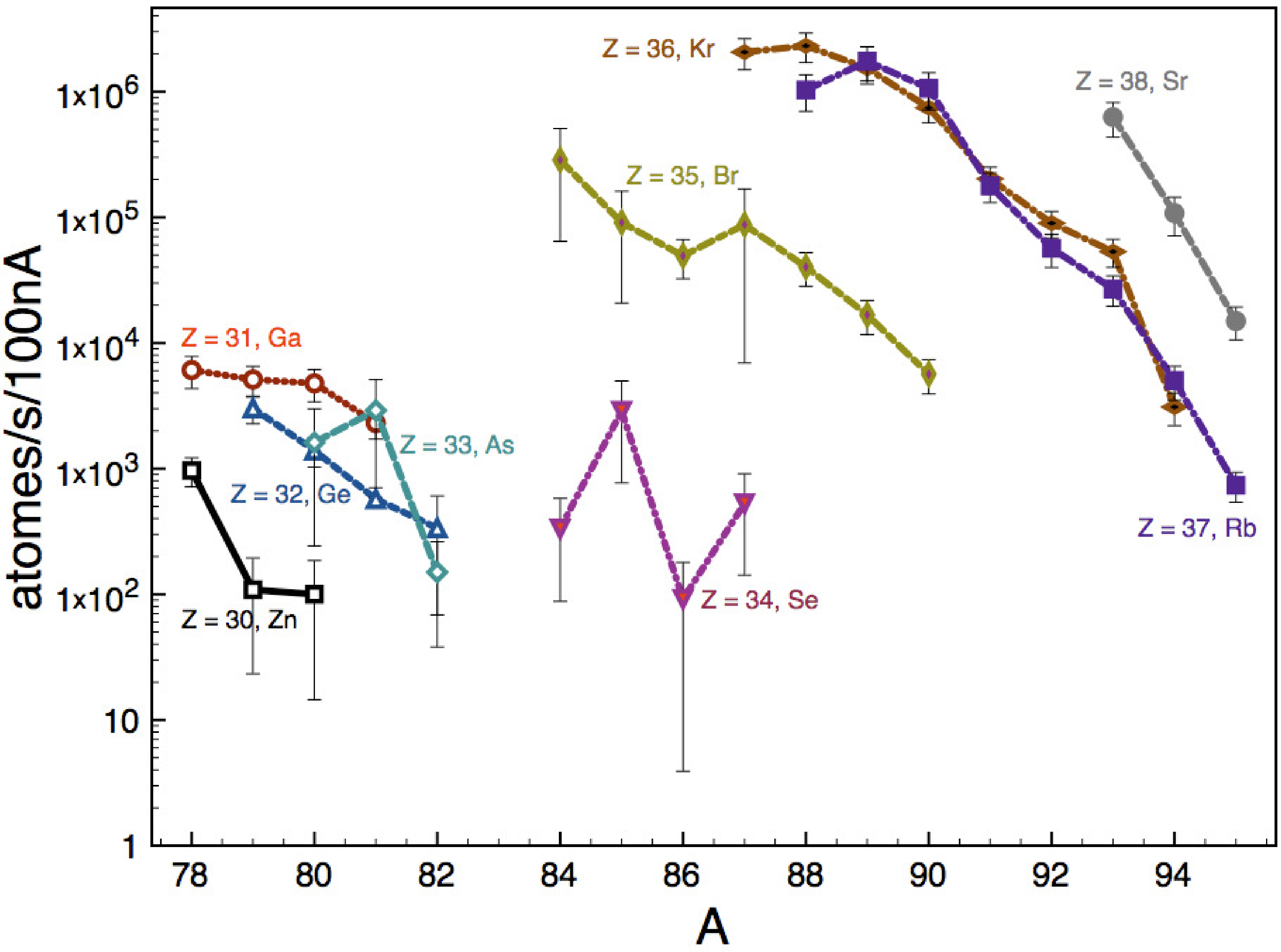
July 2006 test: Running conditions

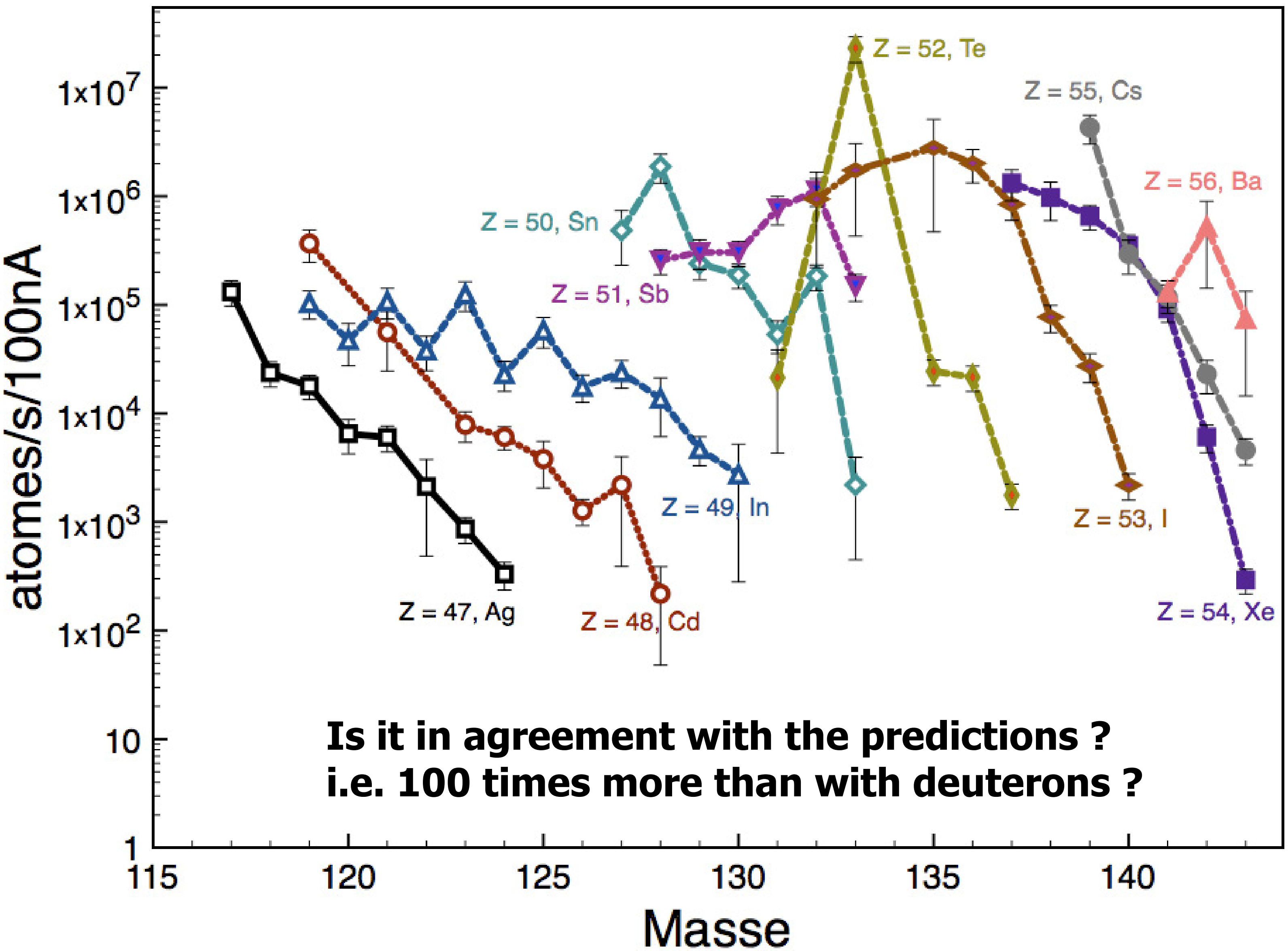


Detection setup





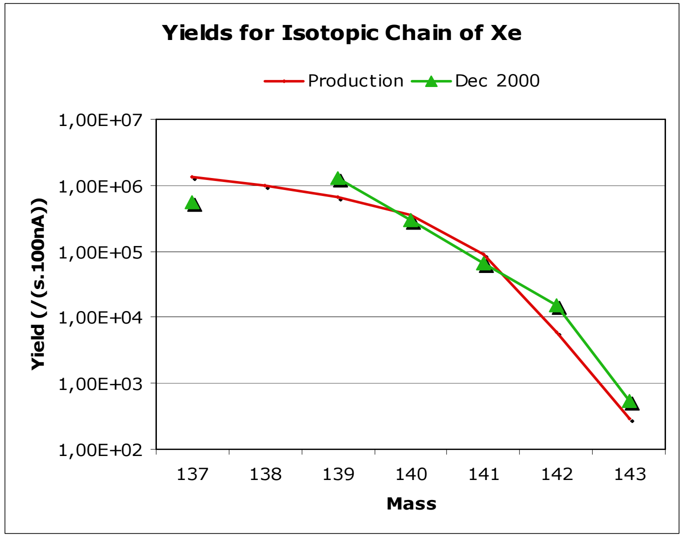

atomes/s/100nA
A
Z = 36, Kr
Z = 38, Sr
Z = 35, Br
Z = 31, Ga
Z = 33, As
Z = 32, Ge
Z = 30, Zn
Z = 34, Se
Z = 37, Rb
1x10^6
1x10^5
1x10^4
1x10^3
1x10^2
10
1
78
80
82
84
86
88
90
92
94

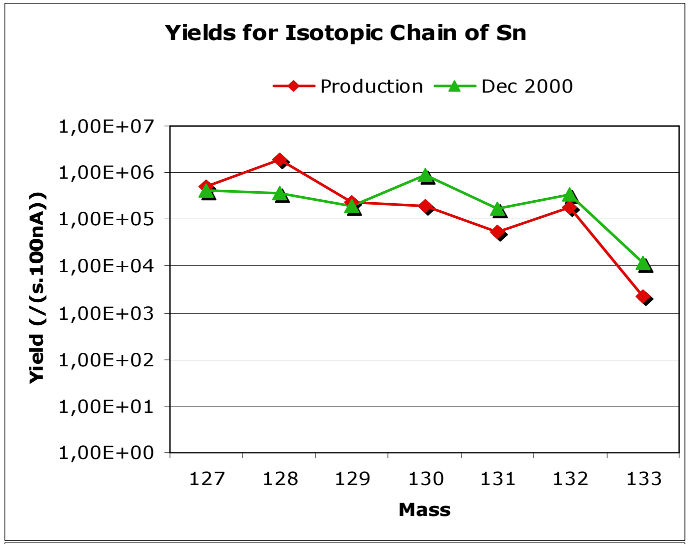


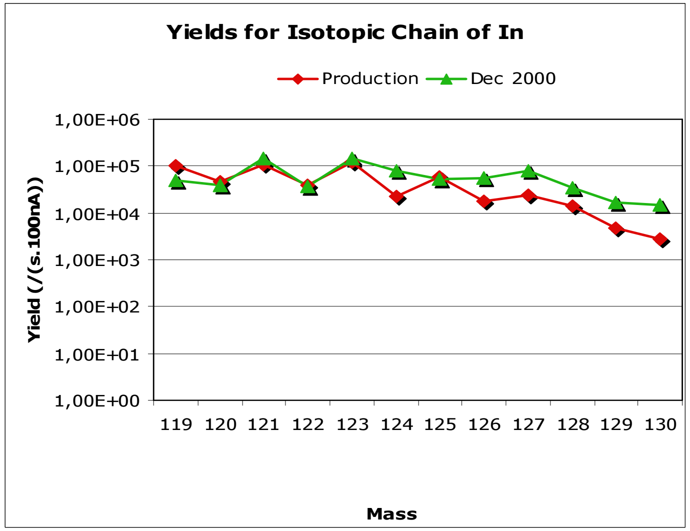
Is it in agreement with the predictions ?
i.e. 100 times more than with deuterons ?

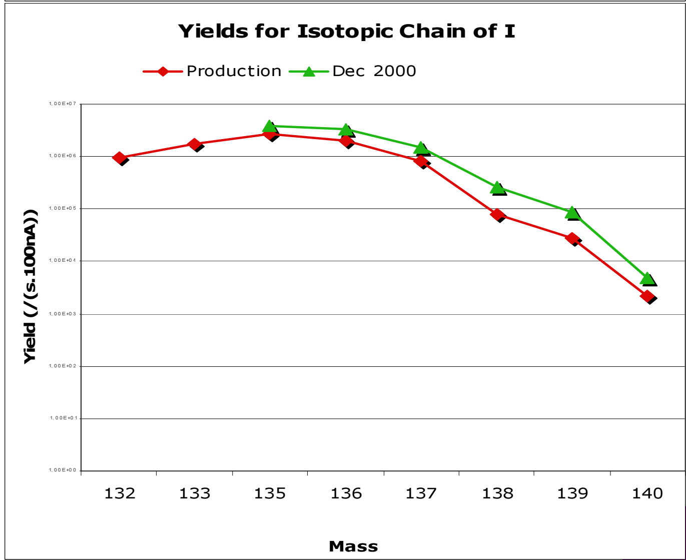
Yields of Xe, Sn, In and I beams

Comparaison of the yields by photofission and by neutrons
(100 nA electrons@50 MeV ≡ 1 μA deutons@26 MeV-PARRNe)





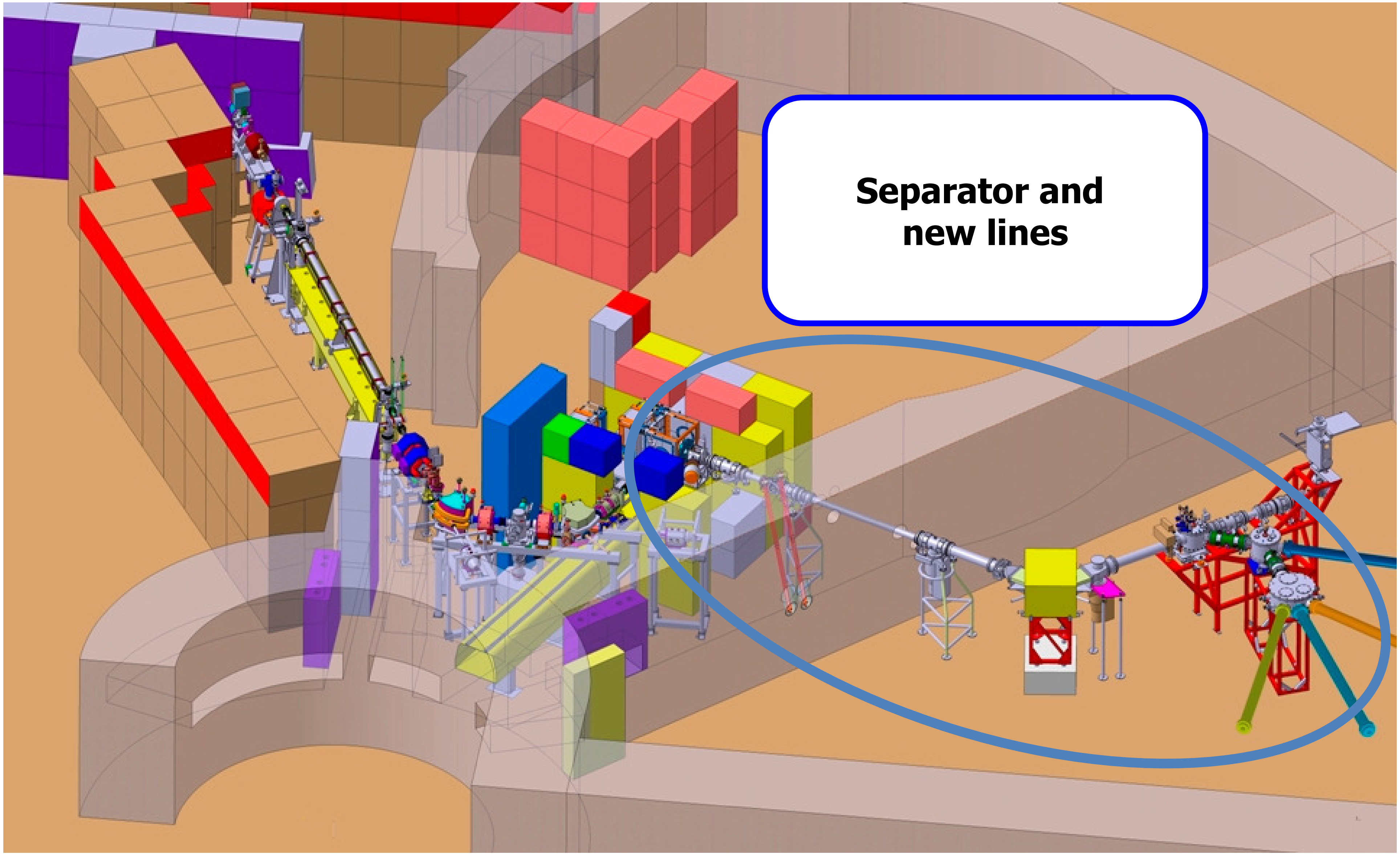




Physics case

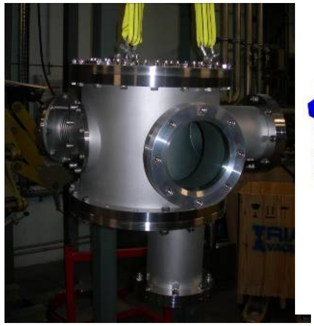
Observable	Experimental technique	Physics case
Energy level pattern	γ–spectroscopy following β-decay	Exploration of the valence space extending N-E to 78Ni
Nature of the em transitions	Electron conversion	
$\delta<r^2>$	Laser spectroscopy	Evolution of the N=50 and N=82 shell effects far from stability
Static moments :Q, μ		Onset of the collectivity and nature of the correlations
T1/2 of the excitation levels->dynamic moments :B(M1) (E2)	Fast timing	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

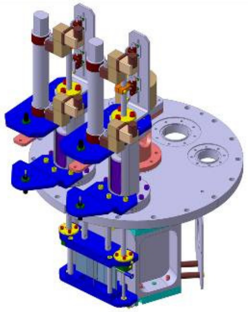
In2p3


Separator and
new lines

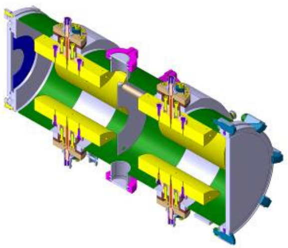
Deflection of the beam and new lines

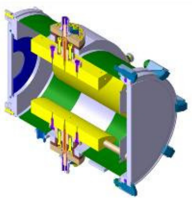
deflector 45°&60°

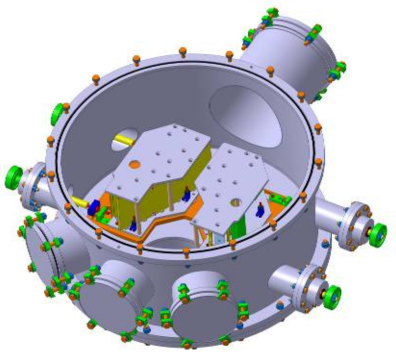




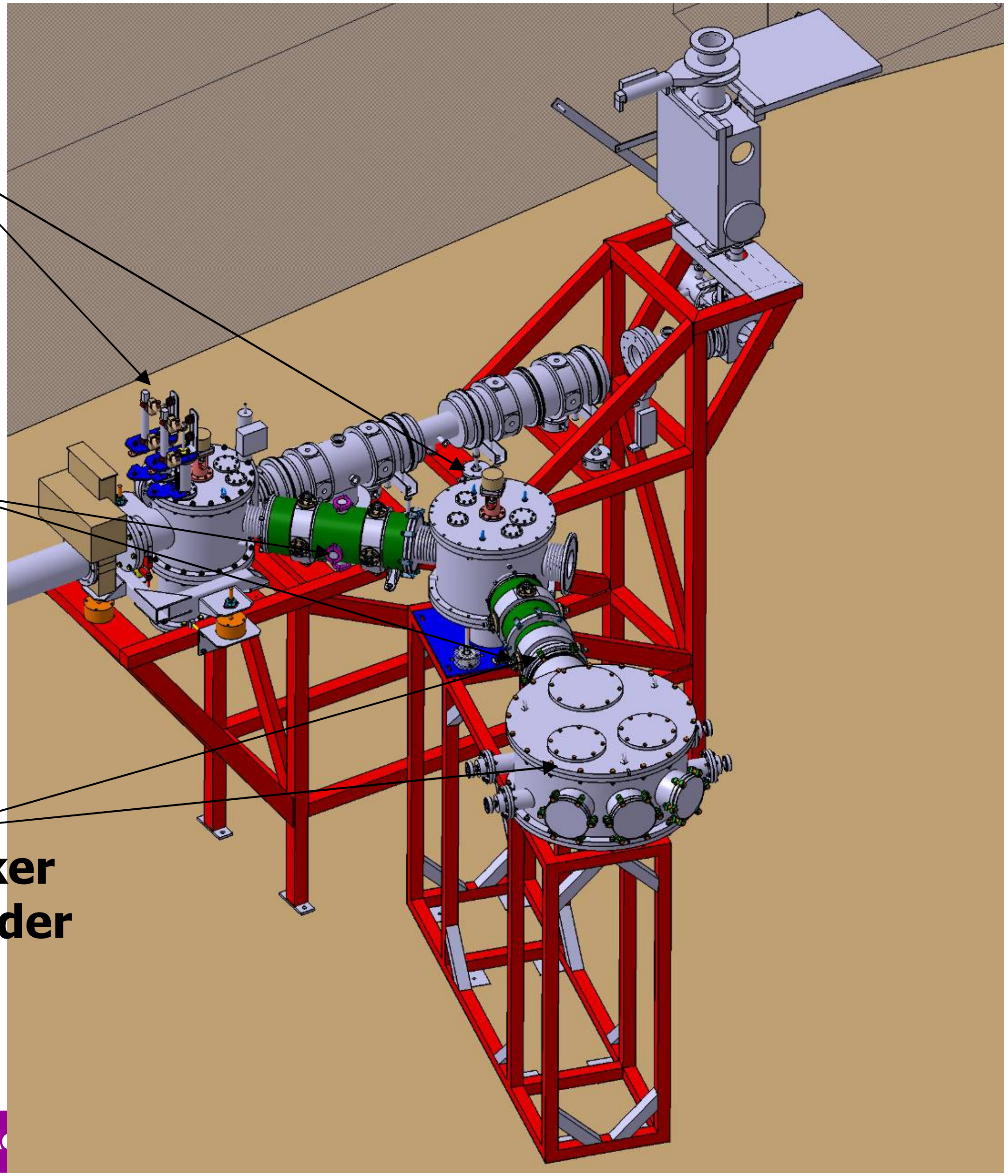
Electrostatic QP

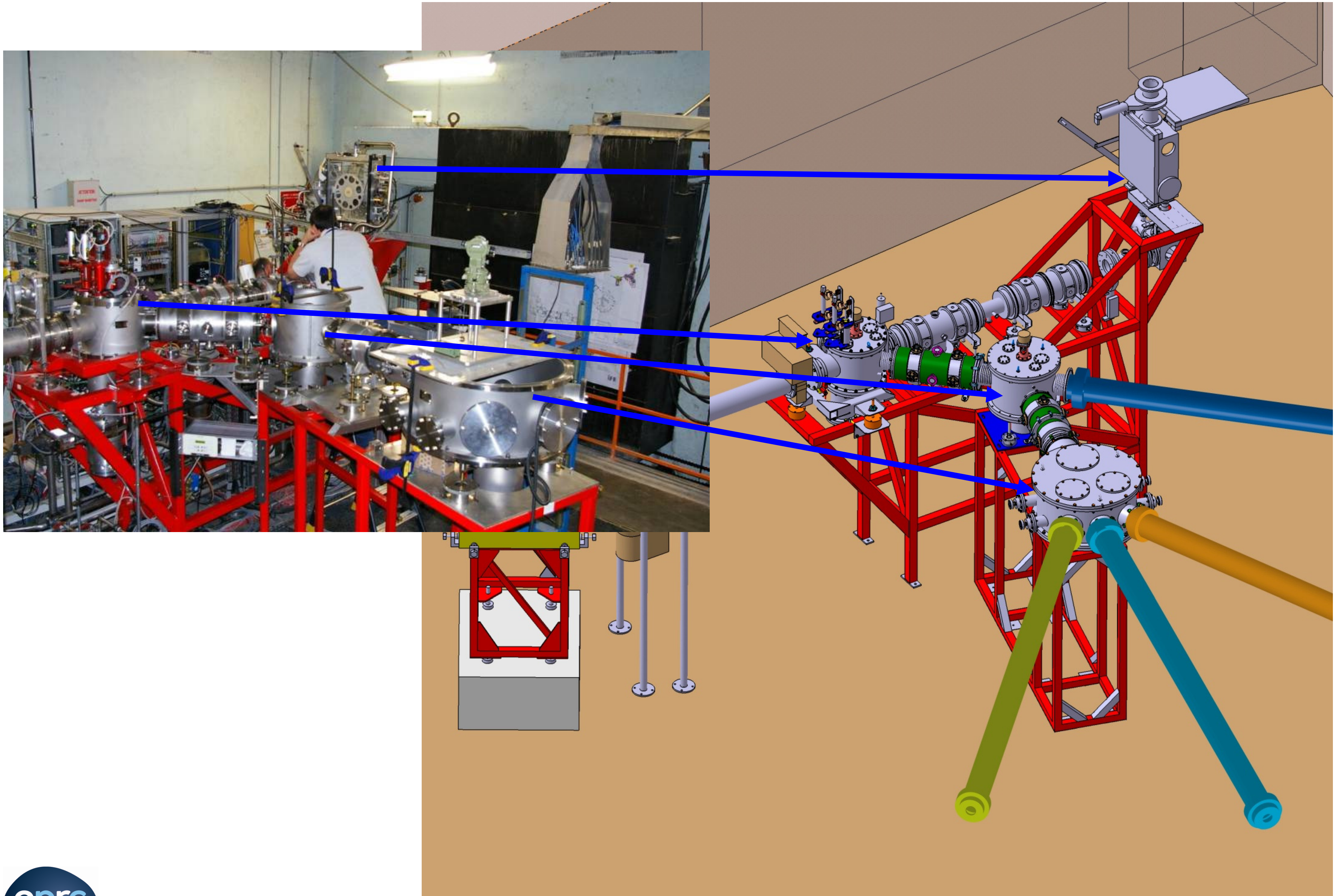


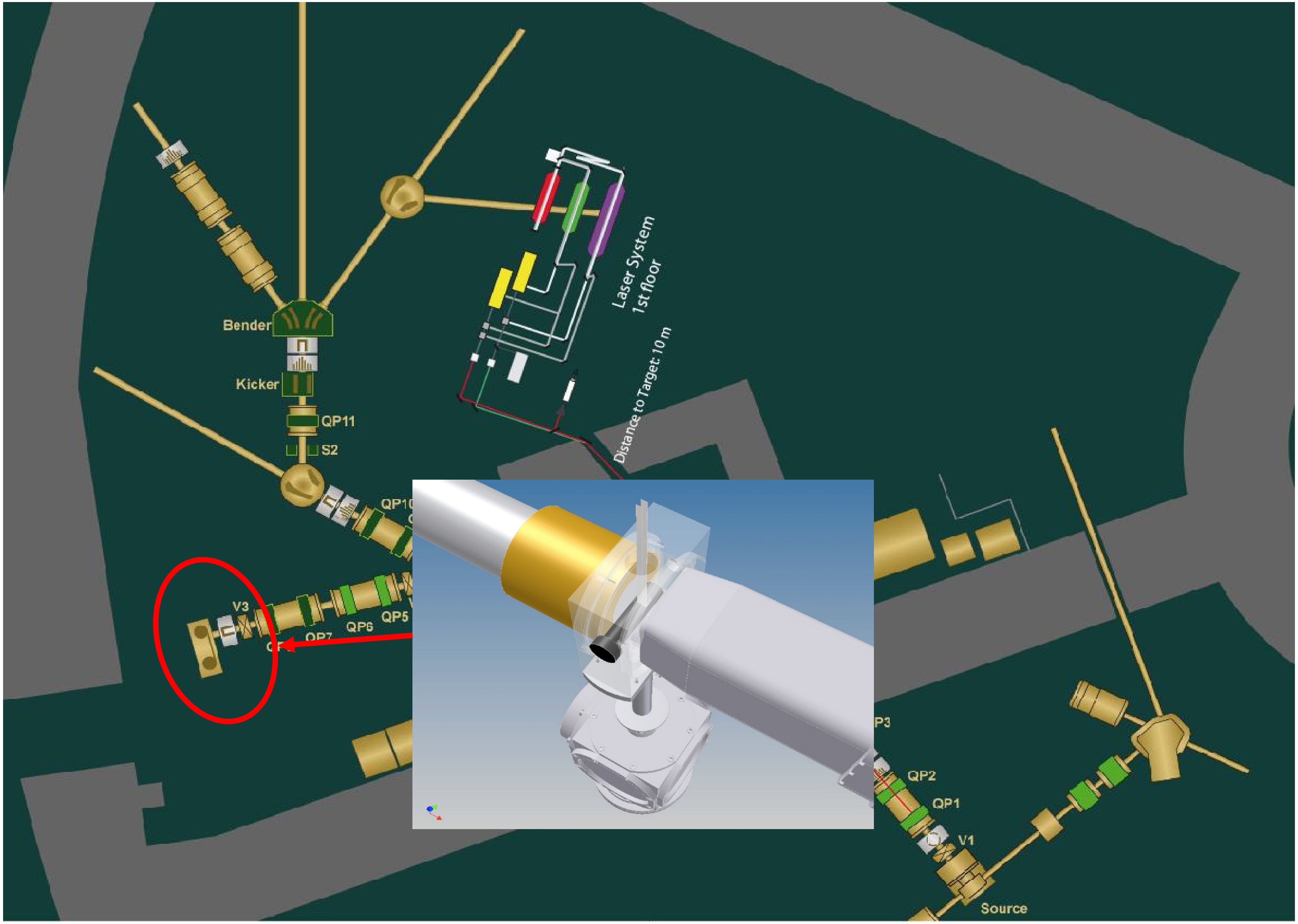




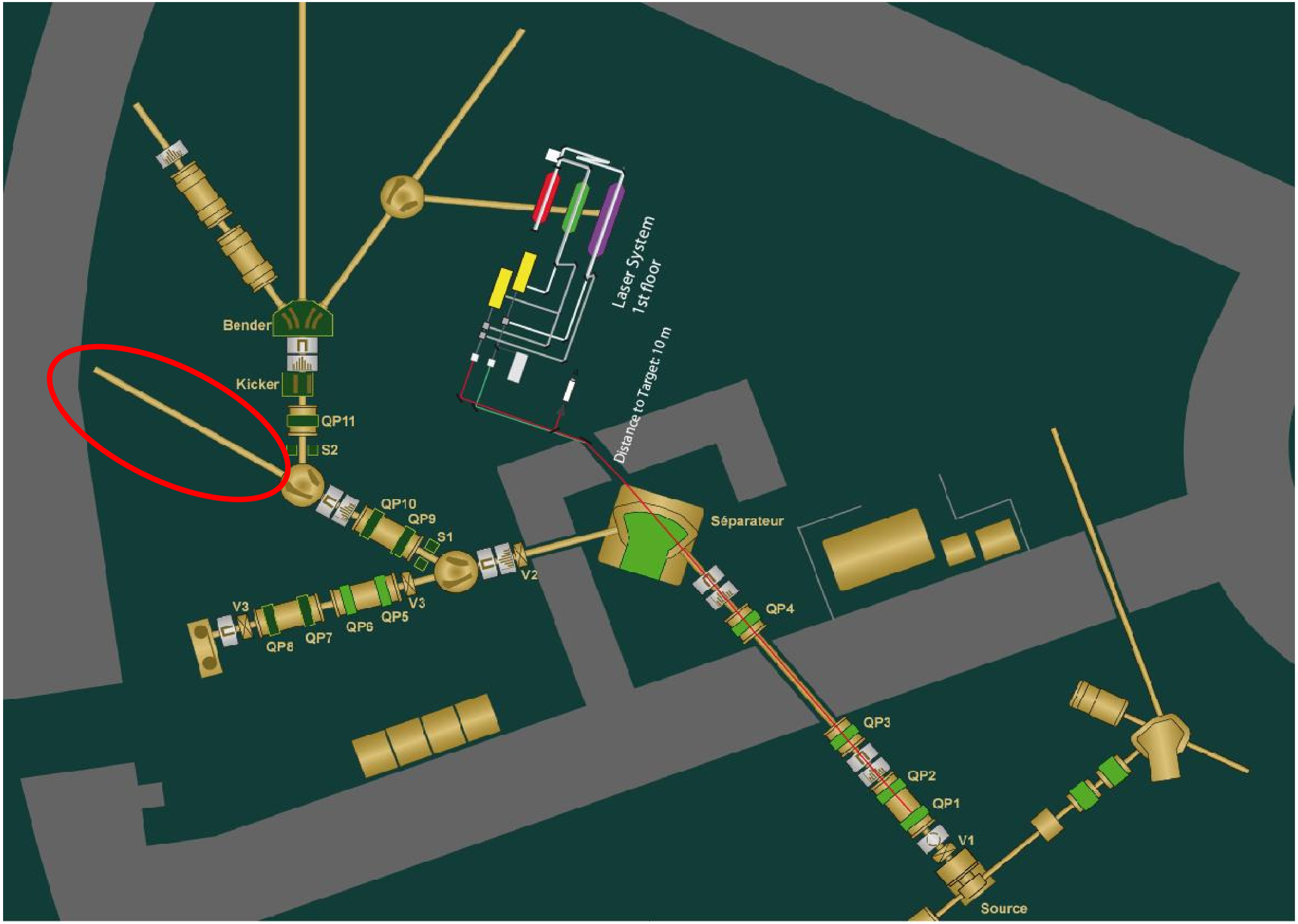
Kicker bender



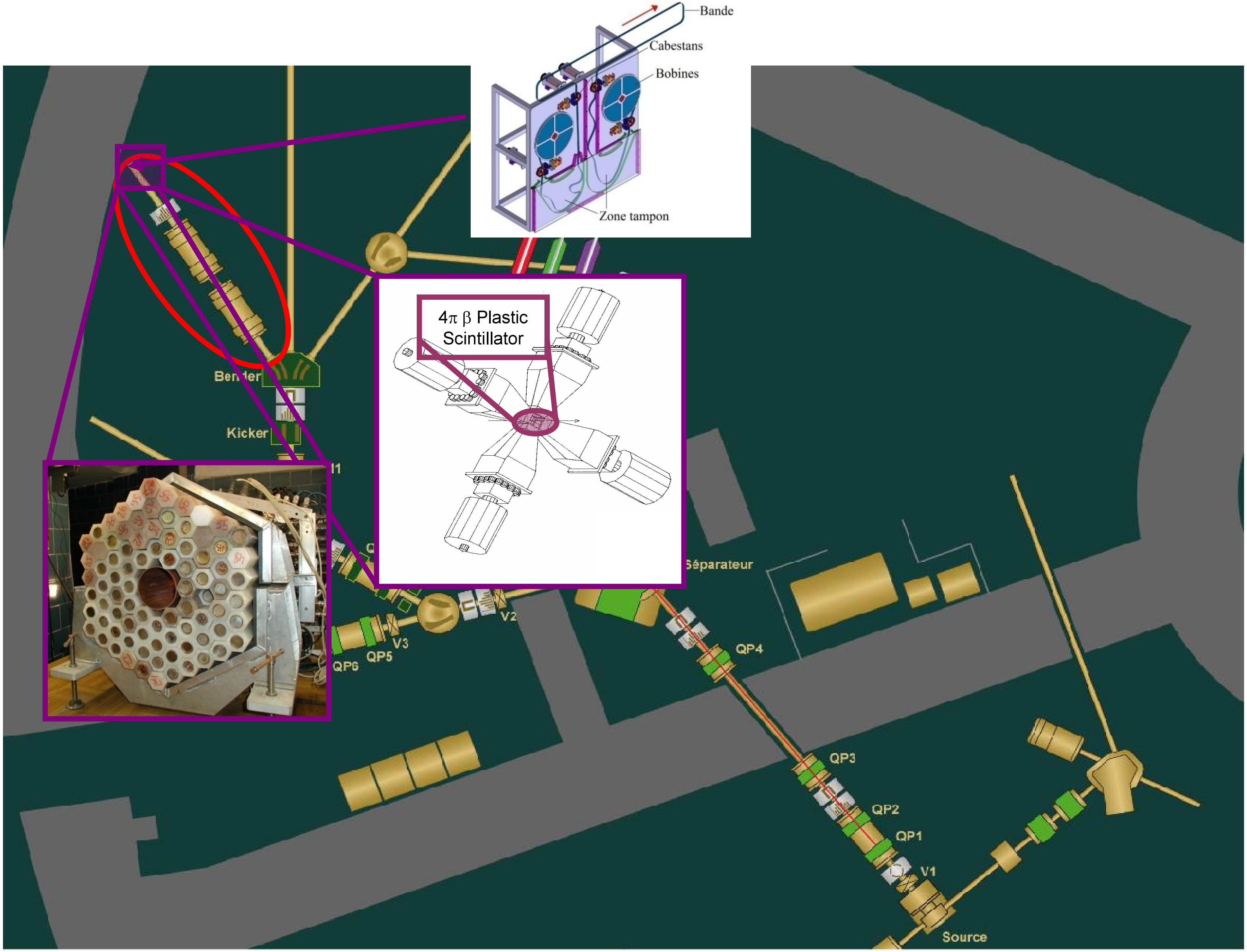


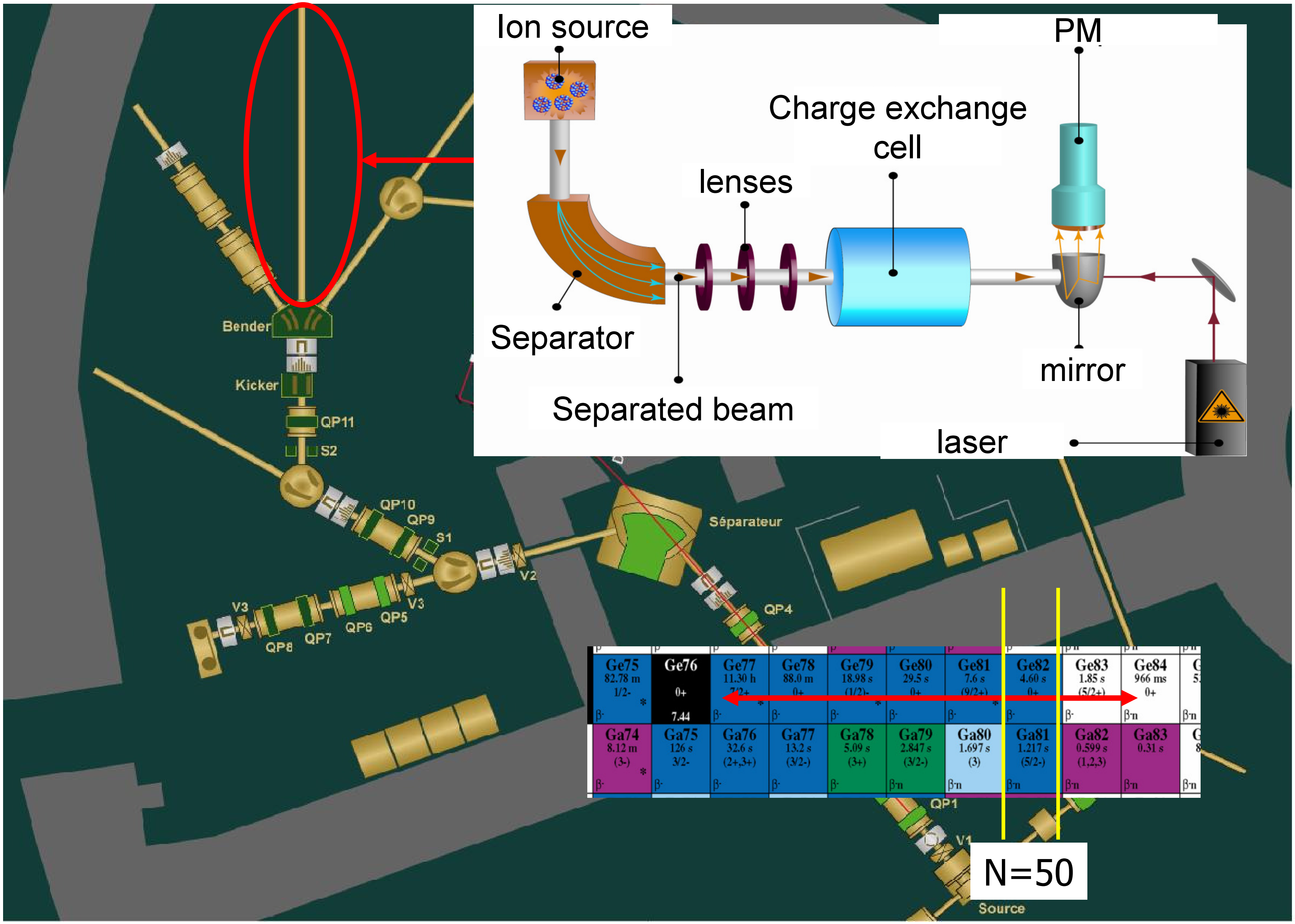


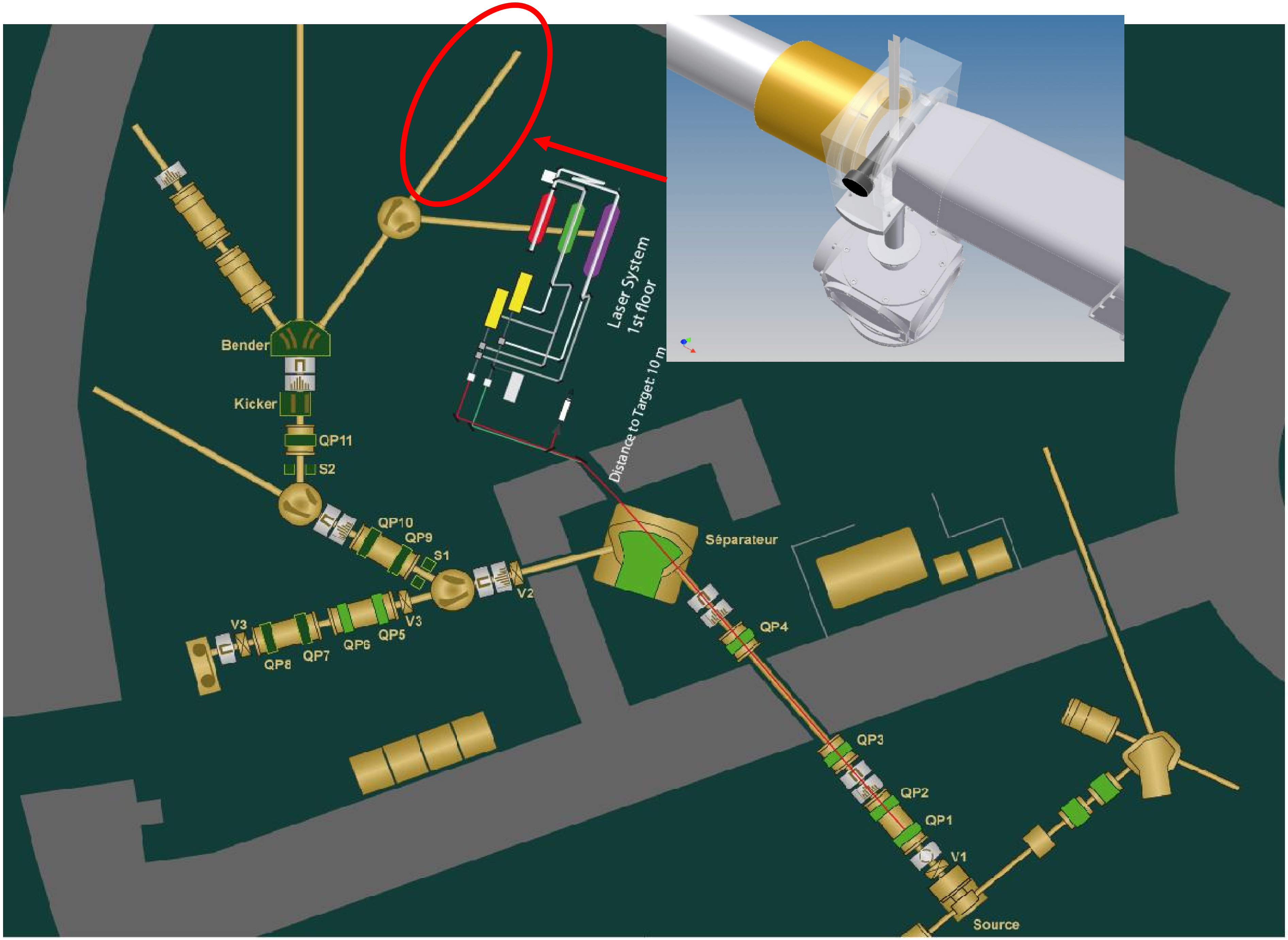
Bender
Kicker
QP11
S2
Laser System
1st floor
Distance to Target: 10 m
V3
QP7
QP6
QP5
QP2
QP1
V1
Source



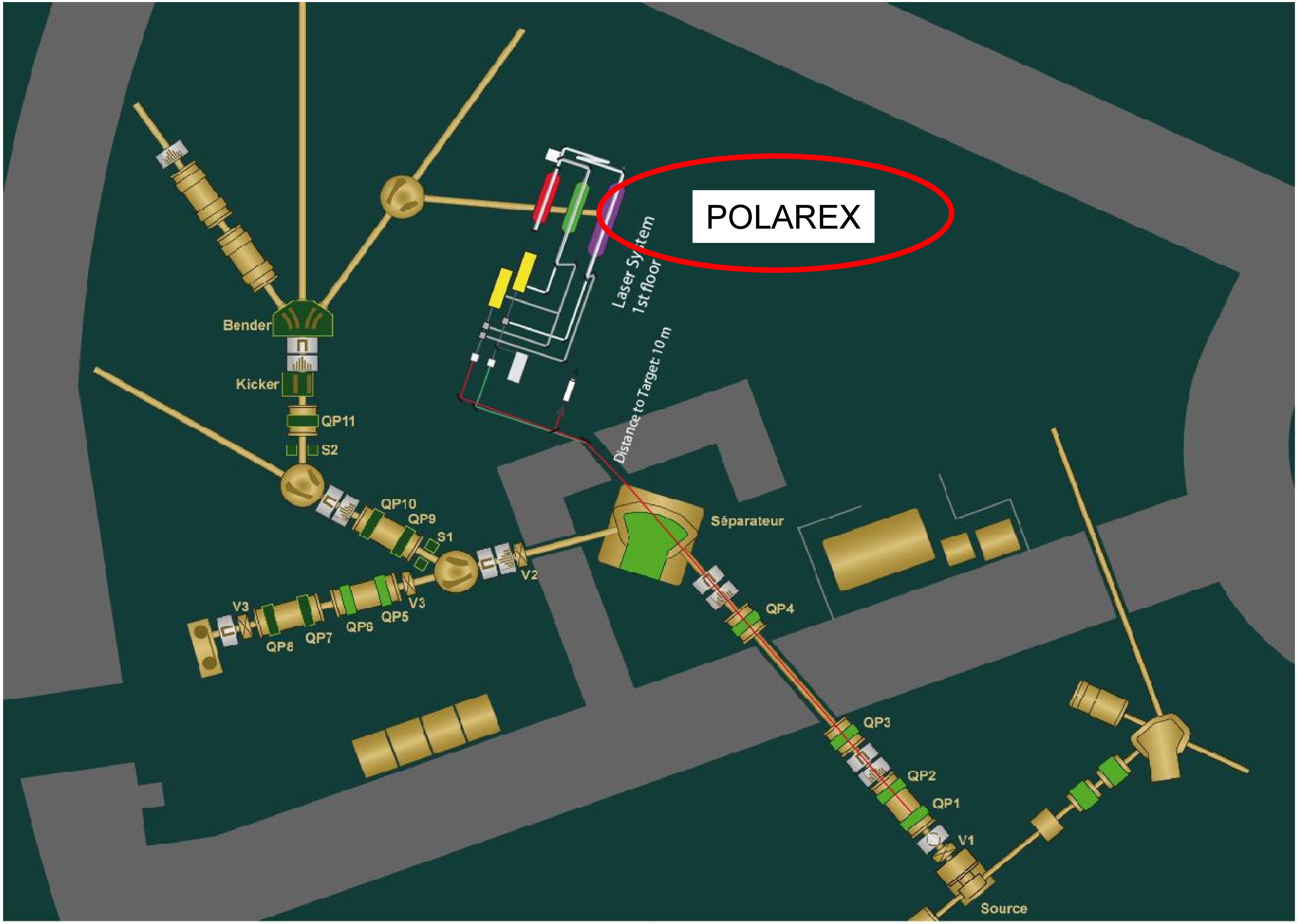
Bender
Kicker
QP11
S2
QP10
QP9
S1
V2
V3
QP8
QP7
QP6
QP5
V3
Laser System
1st floor
Distance to Target: 10 m
Séparateur
QP4
QP3
QP2
QP1
V1
Source

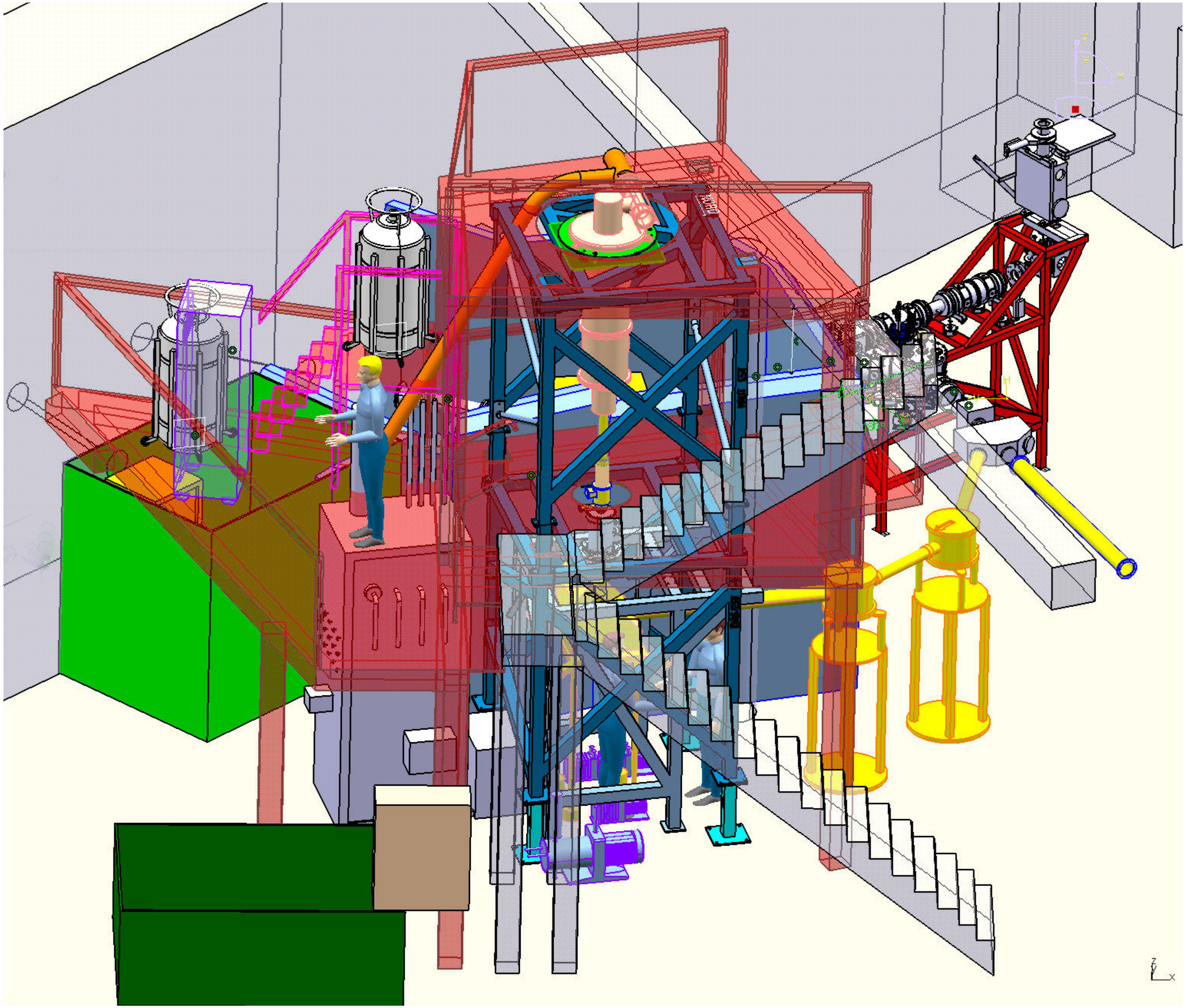

Bande
Cabestans
Bobines
Zone tampon
4π β Plastic Scintillator
Kicker
Séparateur
QP6
QP5
V3
V2
QP4
QP3
QP2
QP1
V1
Source


Ion source
PM
Charge exchange cell
lenses
Separator
Separated beam
mirror
laser
Bender
Kicker
QP11
S2
QP10
QP9
S1
V2
V3
QP5
QP6
QP7
QP8
Séparateur
QP4
QP1
V1
Source
Ge75 82.78 m 1/2-
Ge76 0+ 7.44
Ge77 11.30 h
Ge78 88.0 m 0+
Ge79 18.98 s (1/2)-
Ge80 29.5 s 0+
Ge81 7.6 s (9/2+)
Ge82 4.60 s 0+
Ge83 1.85 s (5/2+)
Ge84 966 ms 0+
Ga74 8.12 m (3-)
Ga75 126 s 3/2-
Ga76 32.6 s (2+,3+)
Ga77 13.2 s (3/2-)
Ga78 5.09 s (3+)
Ga79 2.847 s (3/2-)
Ga80 1.697 s (3)
Ga81 1.217 s (5/2-)
Ga82 0.599 s (1,2,3)
Ga83 0.31 s
N=50



Bender
Kicker
QP11
S2
QP10
QP9
S1
V2
V3
QP8
QP7
QP6
QP5
V3
Laser System
1st floor
Distance to Target: 10 m
Séparateur
QP4
QP3
QP2
QP1
V1
Source


POLAREX
Laser System
1st floor
Distance to Target: 10 m
Bender
Kicker
QP11
S2
QP10
QP9
S1
V2
V3
QP8
QP7
QP6
QP5
Séparateur
QP4
QP3
QP2
QP1
V1
Source

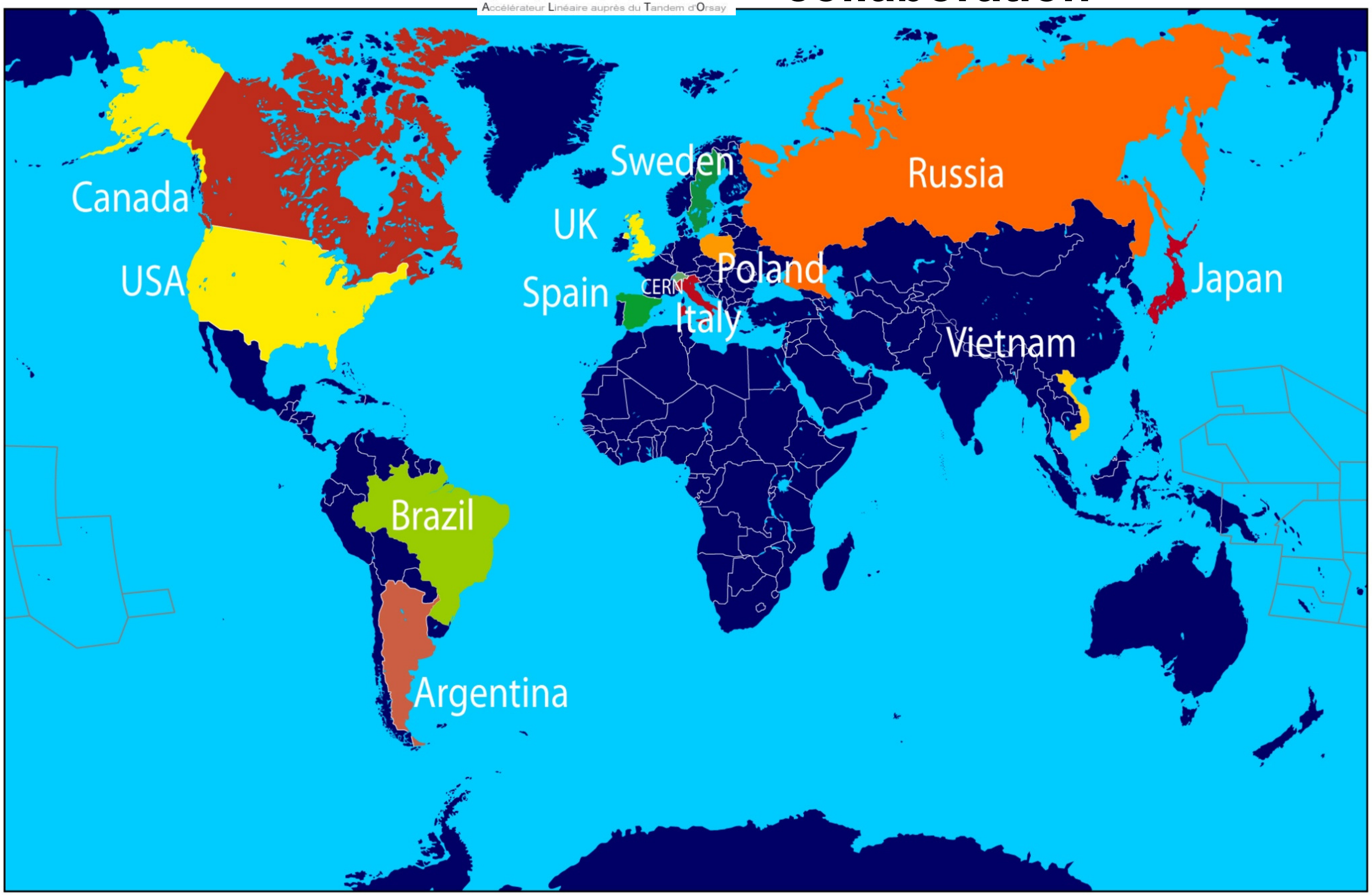


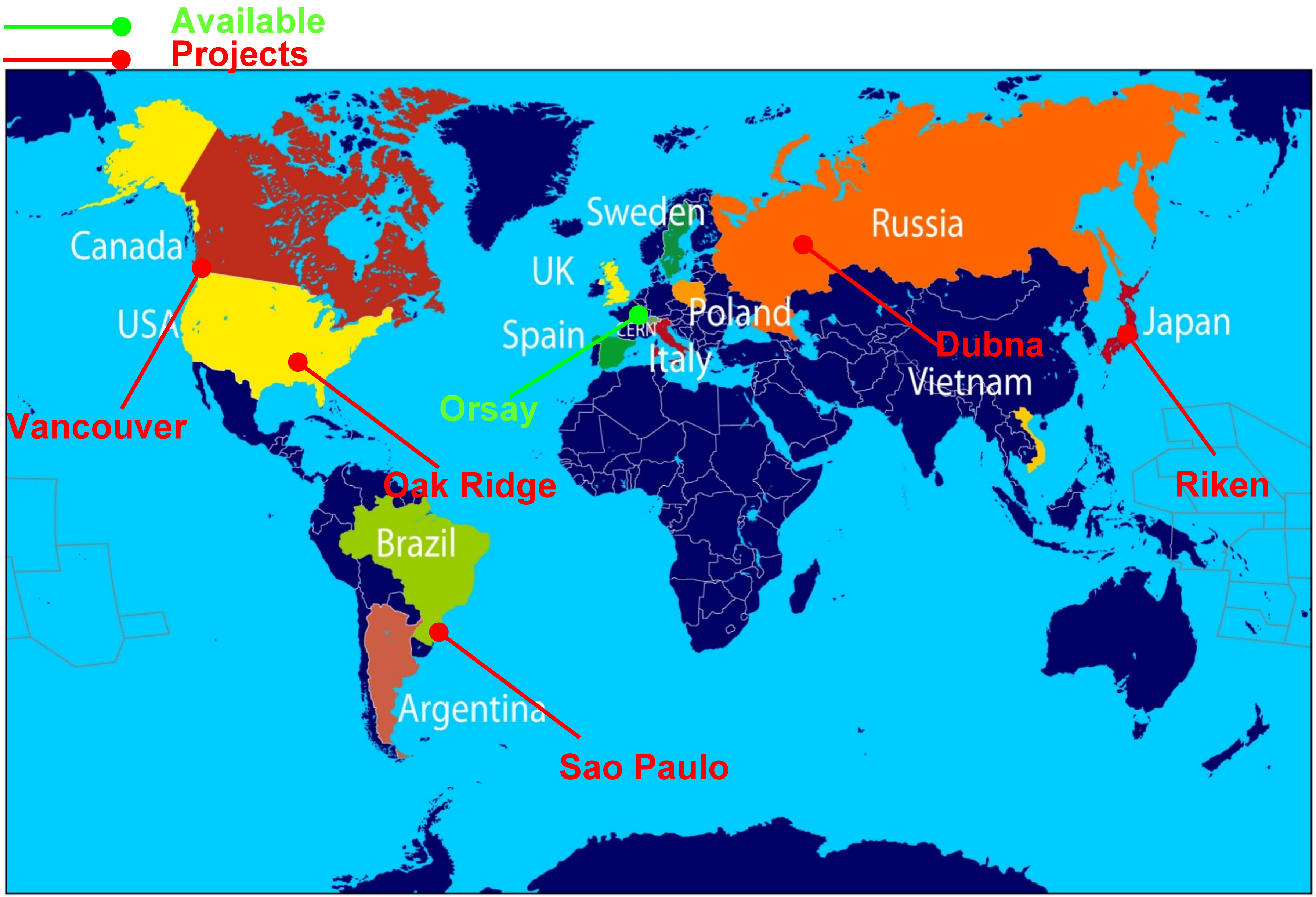
Collaborations : R&D and instrumentation

GANIL/ SPIRAL2 : Target ion sources
CSNSM : POLAREX
ISOLDE CERN : Target ion sources
TRIUMF VANCOUVER CANADA : Target ion sources + Li beams
ARGONNE USA : High density uranium targets
DUBNA RUSSIA : neutron detection
WARSAW POLAND : separator
STUDSVIK SWEDEN :fast timing installation
SURREY UK : decay heat reactors
VALANCIA SPAIN : total absorbsion spectrometer
SAO PAULO BRAZIL : Target ion sources
BUENOS AIRES ARGENTINA : fast timing
RIKEN JAPAN : Target ion sources

ALTO collaboration

Accélérateur Linéaire auprès du Tandem d'Orsay




Available
Projects
Canada
USA
Vancouver
Oak Ridge
Brazil
Argentina
Sao Paulo
Sweden
UK
Spain
CERN
Italy
Poland
Orsay
Russia
Dubna
Vietnam
Japan
Riken