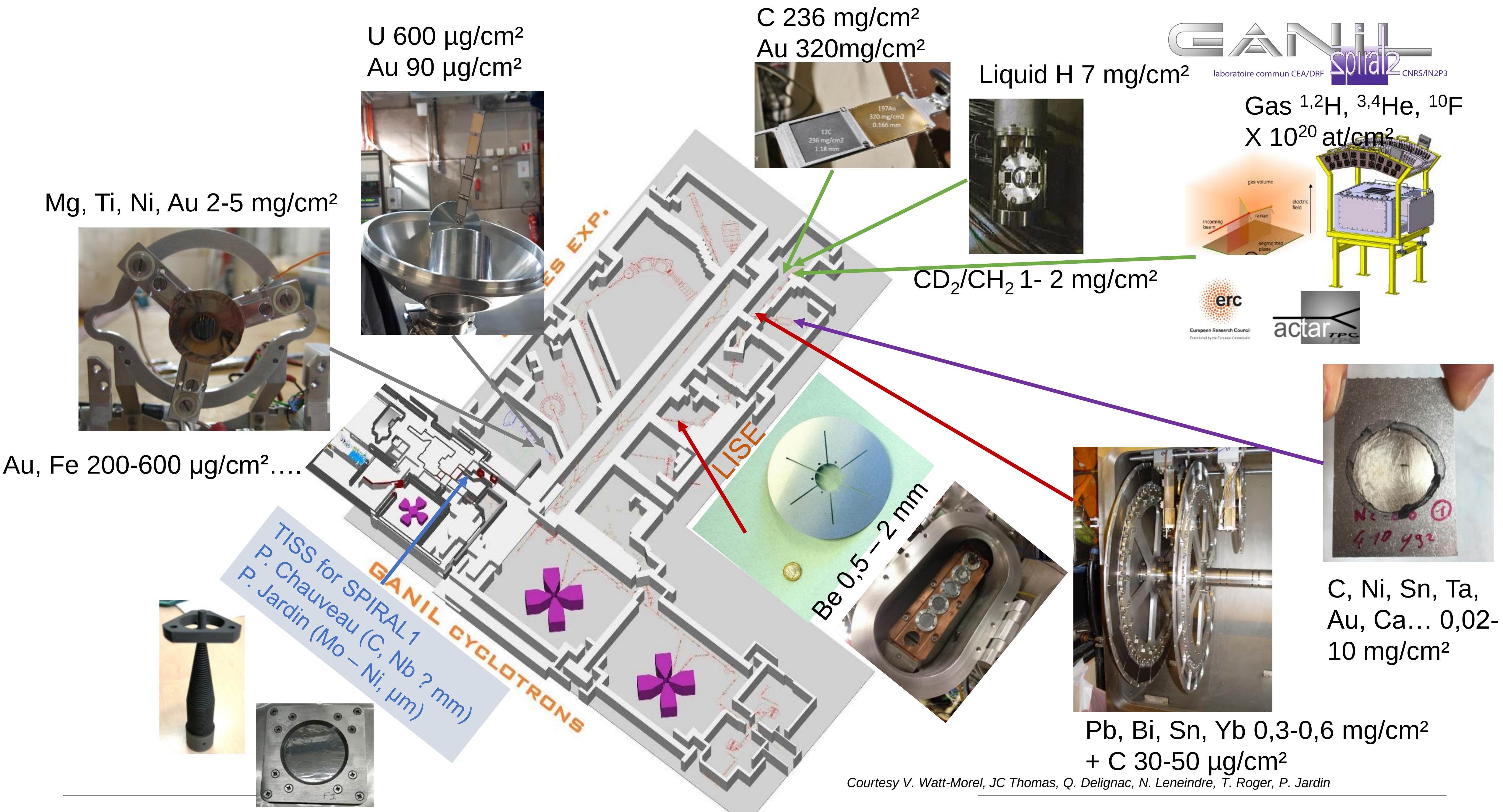
Target developments/target lab (incl. actinide targets)

Christelle Stodel, GANIL

Outline

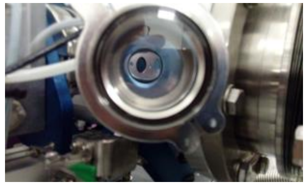
1. GANIL/SPIRAL2 Context & New challenges
2. GANIL Target Activities:
    a. Existing Target lab
    b. Updating target lab
    c. Investigation of external potentials
    d. Project « Target Lab »
3. Actinide Activities
    a. Requirements
    b. Project « Actinide Targets »
4. Collaborations
5. Conclusions

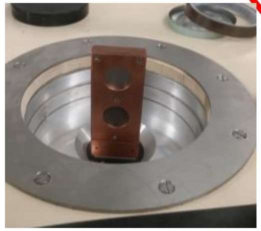
1. GANIL/SPIRAL2 Context & new challenges



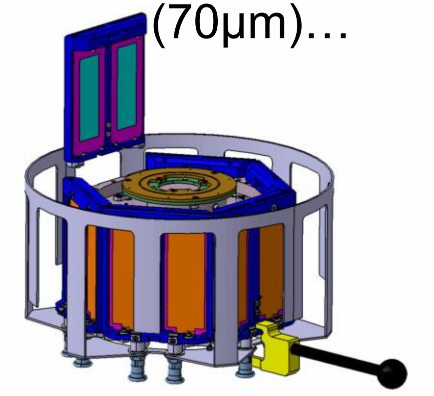
Courtesy V. Watt-Morel, JC Thomas, Q. Delignac, N. Leneindre, T. Roger, P. Jardin

- n + Ce, ^{A}Pb, ^{A}Sn, Ni, C : ~ cylinder of 4 cm diameter, weight = 250 g, thickness = 3 cm
- n + actinides

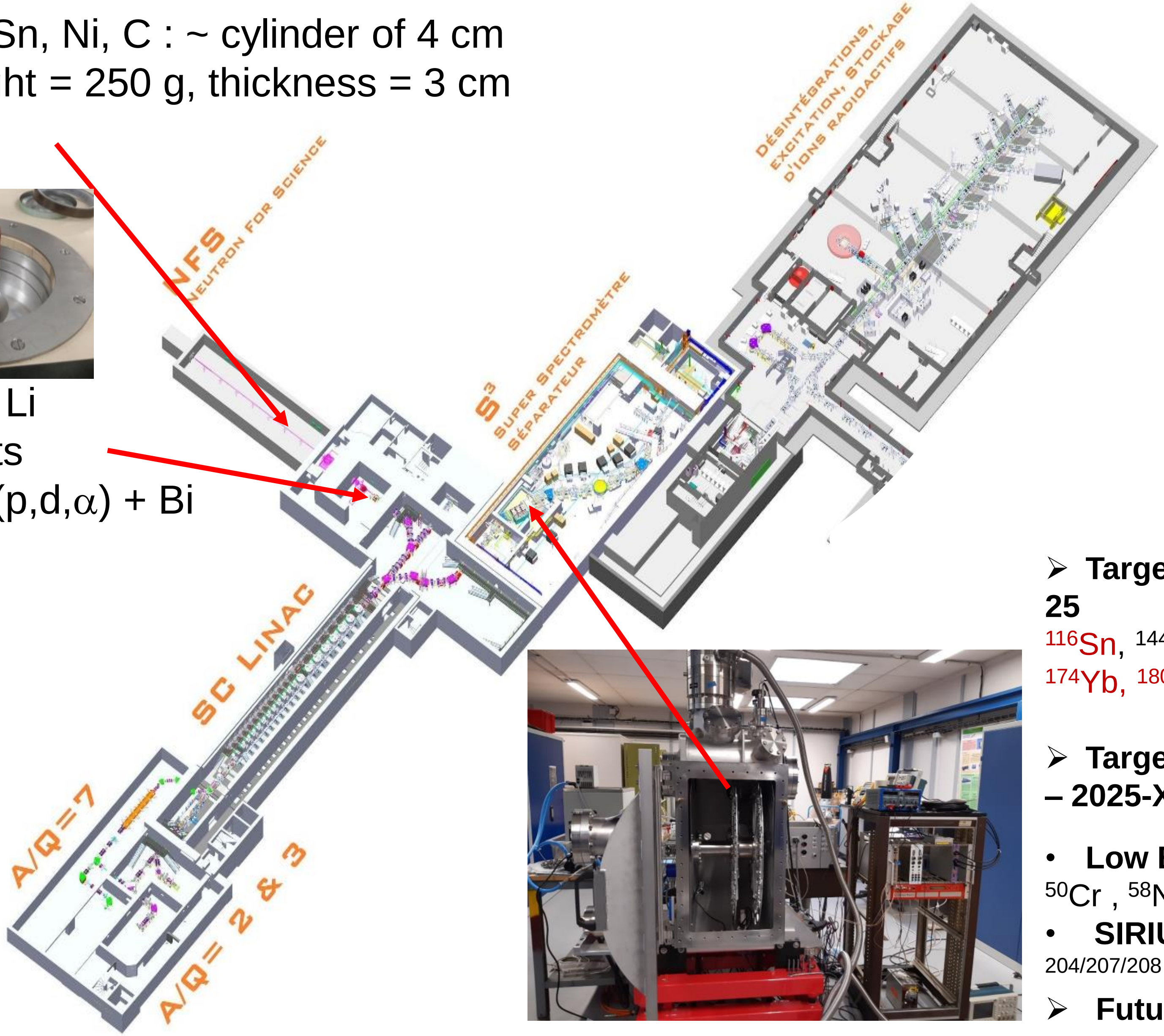




- Converters: Be, Li
- Activation targets
- Radioisotopes: (p,d,α) + Bi (70µm)…



REPARE system, M. Michel



➢ **Targets @ S^{3} for commissioning – 2024-25**
^{116}Sn, ^{144,148}Sm, $^{160, 164}$Dy, ^{60}Ni, ^{45}Sc, ^{170}Er, ^{174}Yb, ^{180}Hf, ^{160}Gd, ^{184,186}W & ^{181}Ta

➢ **Targets @ S^{3} for 1st day …. Experiments – 2025-XXX**

- **Low Energy Branch (0,5 – 1 mg/cm²)**
^{50}Cr , ^{58}Ni, ^{175}Lu, ^{180}Hf, ^{208}Pb, ^{238}U
- **SIRIUS – 300-500 µg/cm²**
$^{204/207/208}$Pb, ^{209}Bi, ^{238}U

➢ **Future**: Actinide targets

Courtesy J.C. Foy, M. Michel

Why a high - quality Target is needed ?

- Astrophysics: Cross-section of key isotopes for s-process determined with uncertainties of about 1%
- Standards database requested by the IAEA: cross-section data with uncertainties below 1%
- Fuel cycle, criticality safety studies of spent fuel storages and transportation: total and capture cross-sections requested with an uncertainty less 2%
- Thorium-Uranium fuel cycle: neutron-induced capture cross-section of ^{232}Th with an uncertainty better than 2%

P. Schillebeeckx et al., NIMA 613 (2010) 378-385

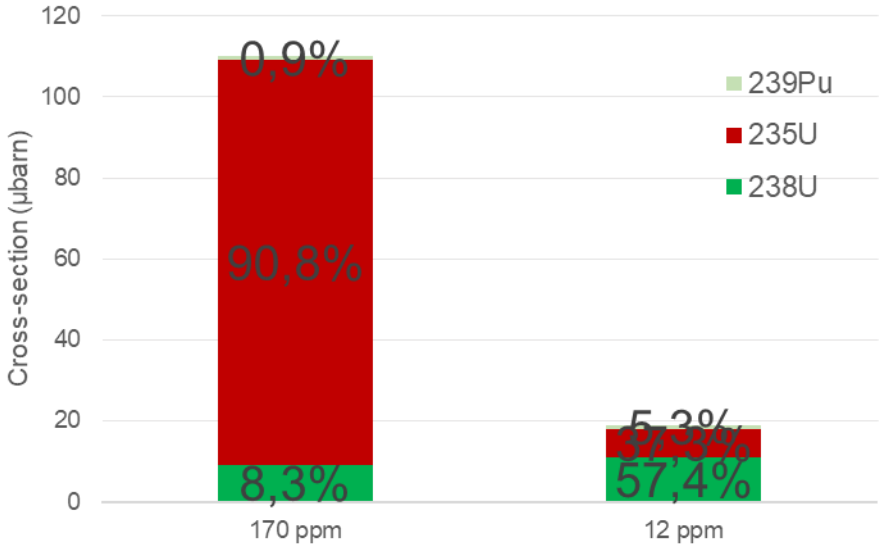
2 ^{238}U samples with 170 or 12 ppm ^{235}U

$$\sigma_f^{meas} = \sigma_f^{238U} + \alpha(\%) * \sigma_f^{235U} + \beta(\%) * \sigma_f^{239Pu}$$

587,6 (±2,6) µbarns 741,9 barns

$$^{238}U(n,\gamma)^{239}U \xrightarrow[t_{\frac{1}{2}} = 23.5\,\text{min}]{\beta^-} {}^{239}Np \xrightarrow[t_{\frac{1}{2}} = 2.355\,\text{day}]{\beta^-} {}^{239}Pu.$$

P. D'Hondt et al, Ann. Nucl. Energy vol 11 N°10 pp 485-488, 1984 "Measurement of the thermal-neutron induced fission cross-section of ^{238}U"



Why a high-quality Target is needed ?

Ex: Fusion-evaporation

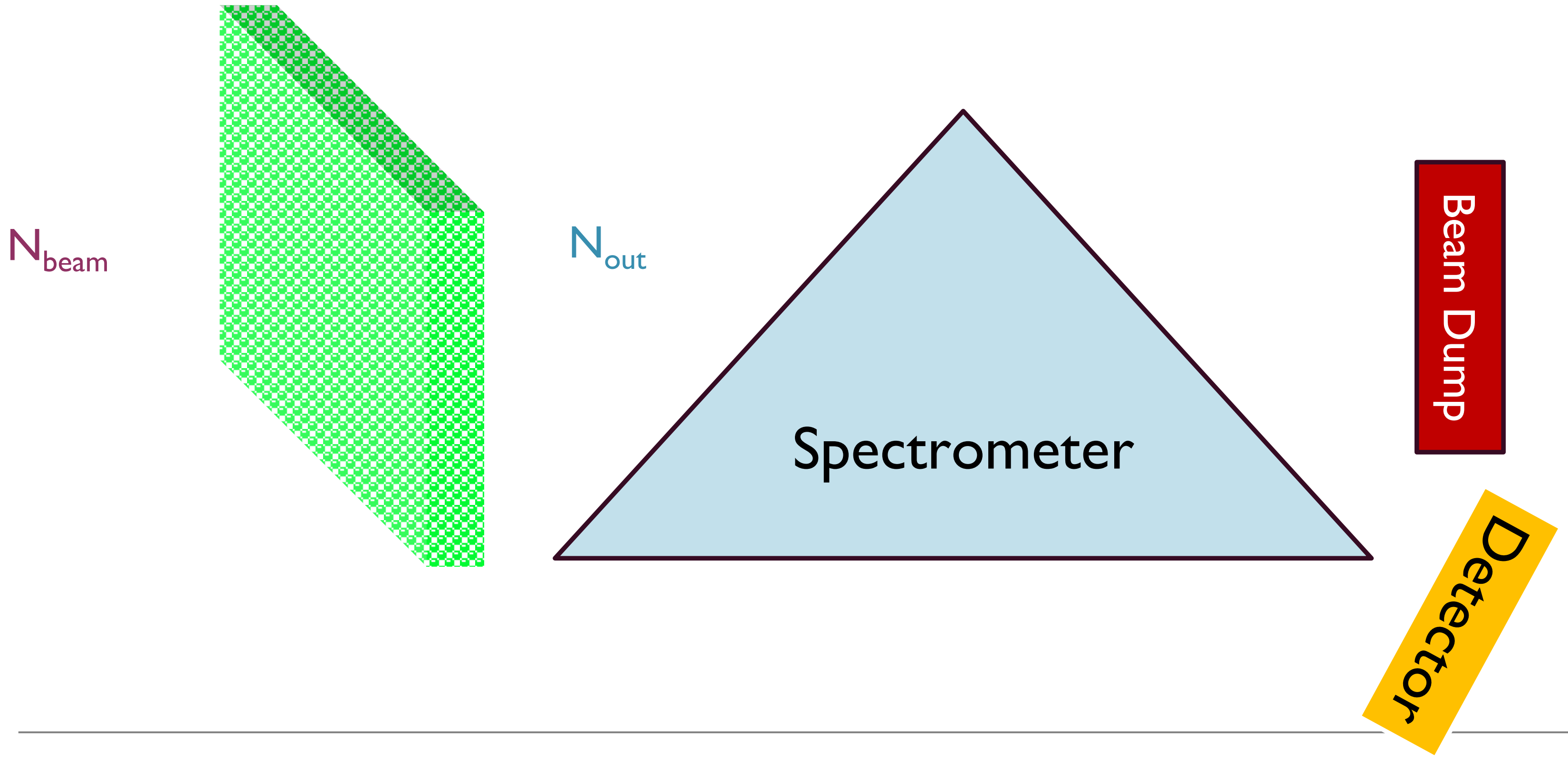
Thickness & homogeneity → ions Kinematics

→ Optimal tuning of the spectrometer :

transmission of desired residues

and control of unwanted particles

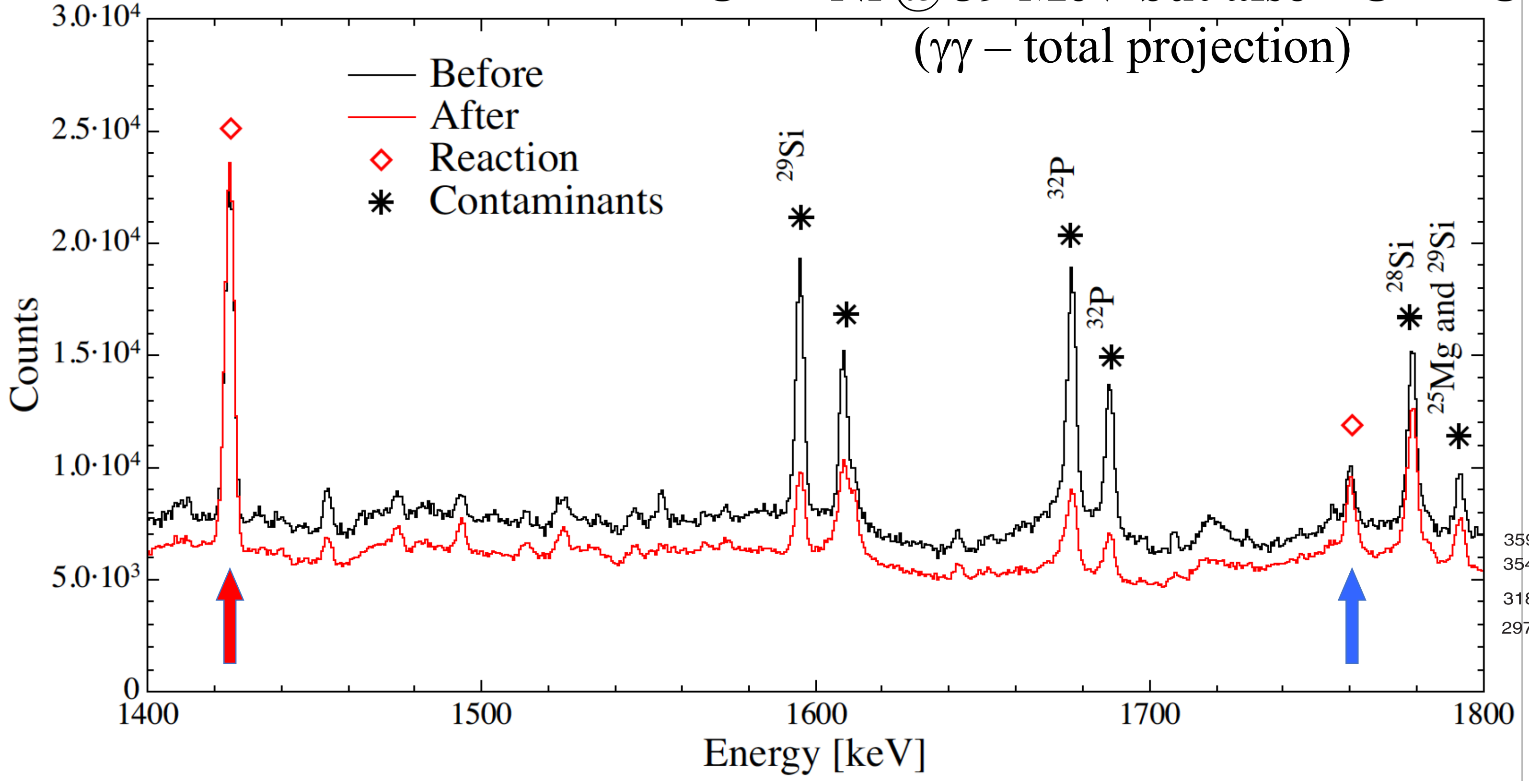
→ Accuracy (< 5%)



« Robust » - Long « lifetime »

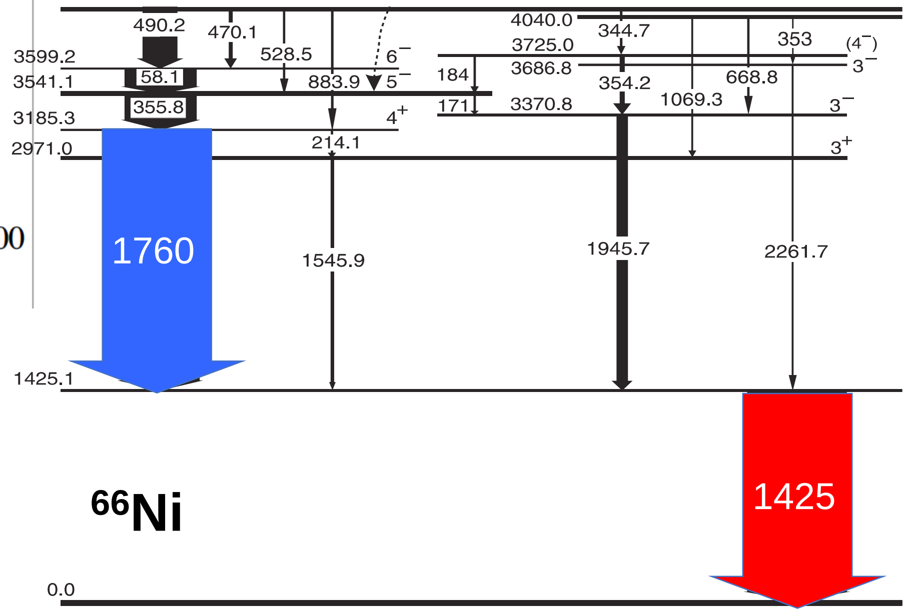
Why a high-quality Target is needed ?

$^{18}O + ^{64}Ni$ @ 39 MeV but also $^{18}O + ^{16}O$ (*)



Thermal treatment to remove oxygen with an Hydrogen Oven

(0 + H2 = H_2O)



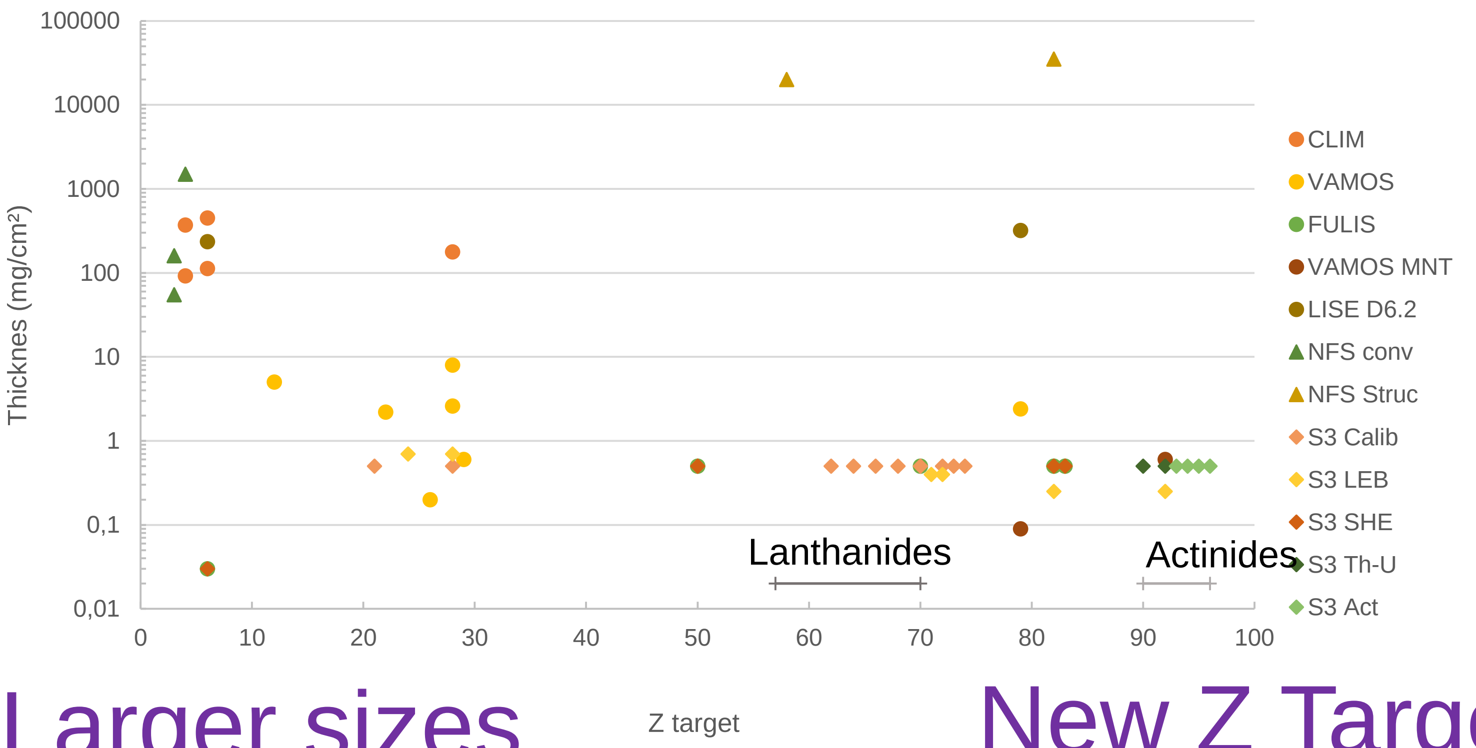
U.P.B. Sci. Bull., Series A, Vol. 80, Iss. 3, 2018 ISSN 1223-7027

IFIN-HH

HIGH GRADE DECONTAMINATION OF Ni TARGETS FOR SUB-BARRIER TRANSFER REACTIONS

Andreea MITU[1,2], Marius DUMITRU[3], Florian DUMITRACHE[3], Nicolae MARGINEAN[1], Rareş ŞUVĂILĂ[1], Cristina NIŢĂ[1], Maria DINESCU[3], Gheorghe CĂTA –DANIL[2]

New Challenges for targets



Commercial if not isotopic

To be made with specific technics

Larger sizes

Larger quantity

New Z Target

Higher quality

Successful experiment

= Accurate measurements + low background + safe conditions

→ Need of high quality targets with known properties at any time

2. GANIL Targets Activities

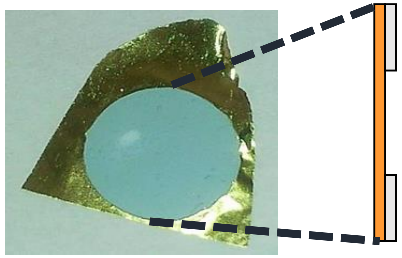
a. Existing Target lab
b. Updated Target Lab
c. investigation of external potentials
d. Project « Target Lab »

a. Thin Layer Laboratory at GANIL ~ 2000

G. Frémont: training and skills in target preparation using « physical methods »
& Recovery of material from the Strasbourg Target Laboratory in 2004

a. Existing lab & skills

Self-supporting



Mechanical Shaping

Tablet pressing

~20 mg/cm2 - > g/cm2

Rolling

0.5 mg/cm^2 - > g/cm^2

Press for pellets:

- Metallic powders before evaporation
- Mixture of powders (i.e. oxyde element + reductant) before evaporation
- Thick targets

A. Stolarz, Nucl. Instr. and Meth. A 397 (1997) 114-116.

2 Rolling mills

Manual for common metals

Motorized for fragile material to be worked under inert atmosphere in glove box

F.J. Karasek, Nucl. Sci. Eng. 17(3) (1963) 16-19.

a. Existing lab & skills

Deposition by evaporation

Resistive Heating of carbon

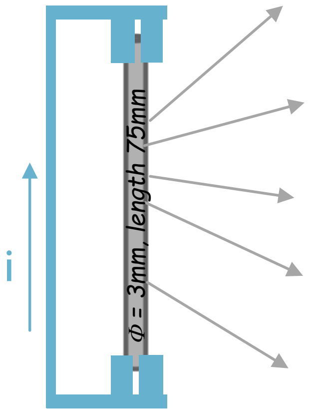
Heating of crucible or material

I-1/ **Evaporator for carbon sublimation**

Strippers or backings for material deposition.

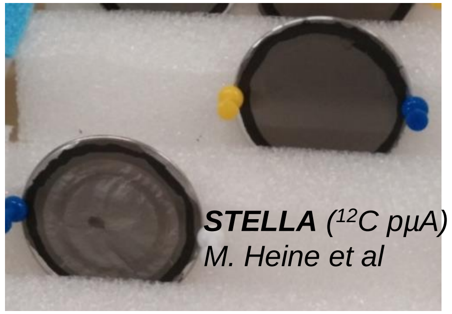
Thickness : 10 - 70µg/cm²

Surface : 20 X 20 cm



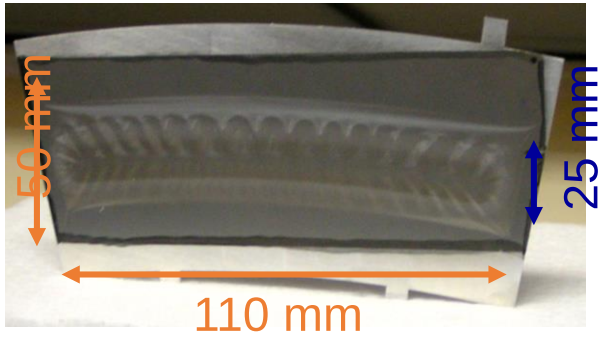
Tech I

P. Maier-Komor, NIM 102 (1972) 485-486
W. Thalheimer et al, Cryst. Res. Technol. 34 (1999) 175-179.



<u>One evaporation</u> =

- 8 glass plates : (100*140) mm², 35 µgr/cm2
- 16 C strippers or 24 C backing



a. Existing lab & skills

Deposition by evaporation

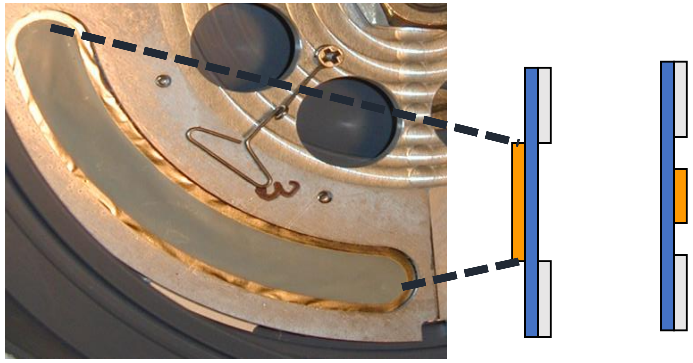
Resistive Heating of carbon

Resistive Heating of crucible

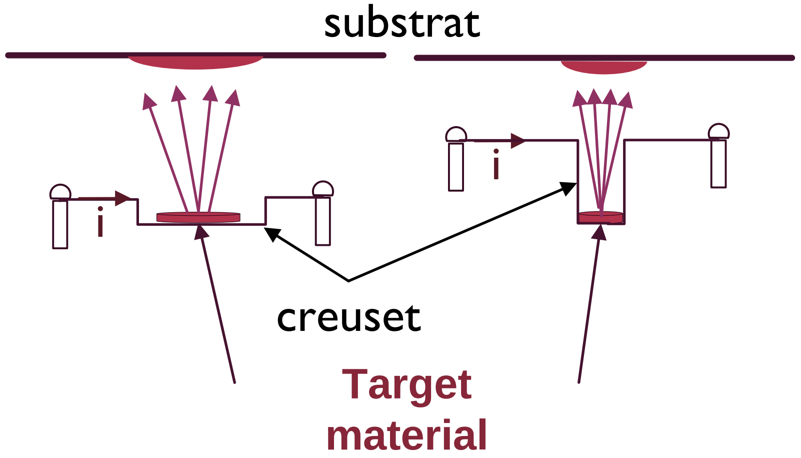
Electron heating of crucible

Electron heating of material

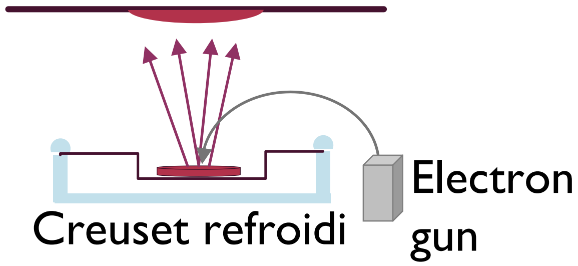
Thin layer deposited on substrate (backing)



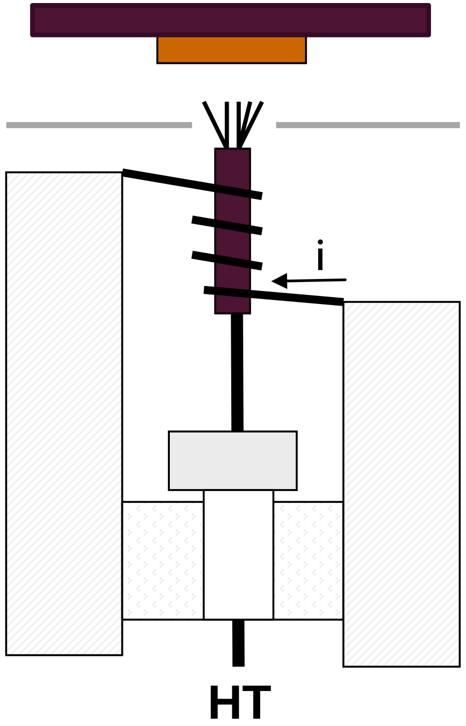
- **Backing must not interfere with the nuclear reaction used ⇒ Use high purity material**
- **Backing must not interact with the target material**



Tech-Evap 1: Resistive Heating of the crucible



Tech-Evap 2: Electron Heating of the material



Tech-Evap 3: Electronic bombardment of the crucible I_{fil} → e^- + dV → dP

a. Existing lab & skills

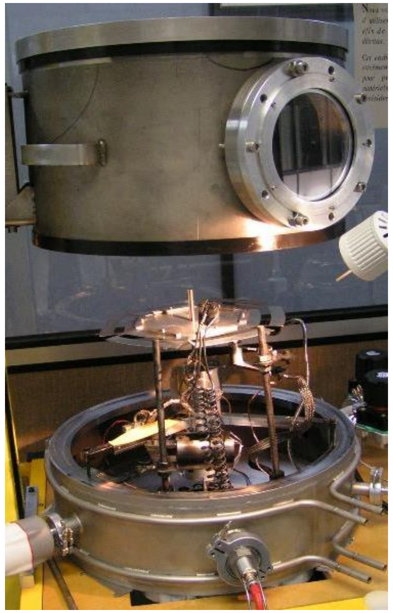
Deposition by evaporation

Resistive Heating of carbon

Resistive Heating of crucible

Electron heating of material

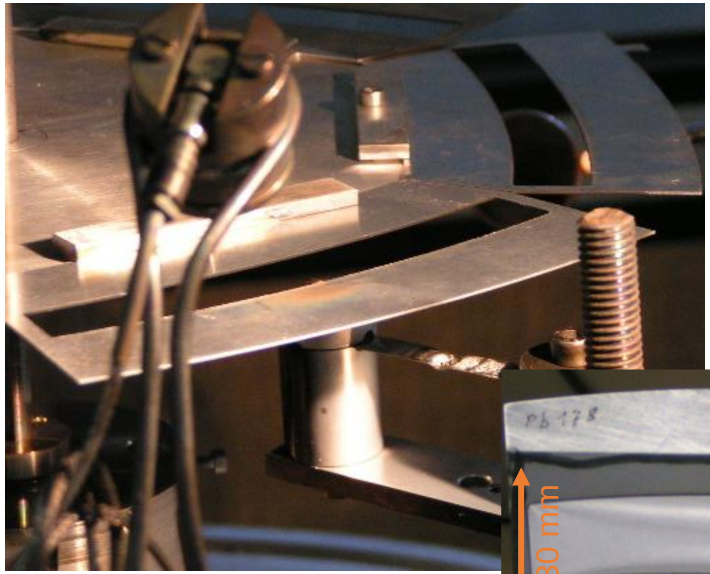
Electron heating of crucible

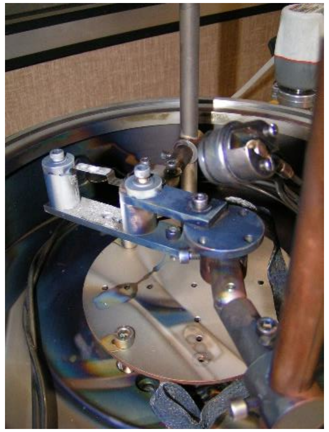


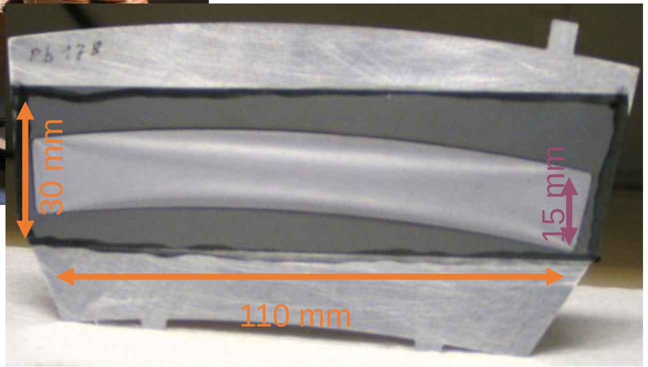
I.2.a / **Evaporator for metals, isotopes low melting point**

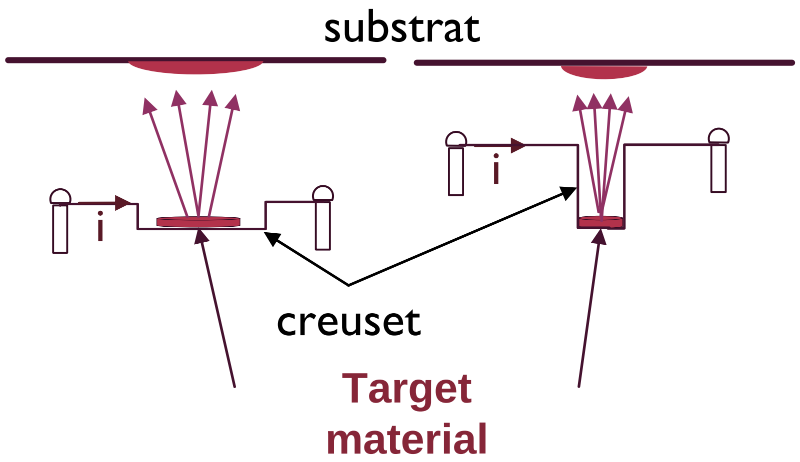
Yield= 23% for Bi/^{208}Pb

Optimizing distances crucible/backings, choice of crucible form & nature, temperature of backing....









Tech-Evap I: Resistive Heating of the crucible

H.A.F. Muggleton, Vacuum 37 (1987) 785-817.

a. Existing lab & skills

Deposition by evaporation

Resistive Heating of carbon

Resistive Heating of crucible

Electron heating of crucible

Electron heating of material

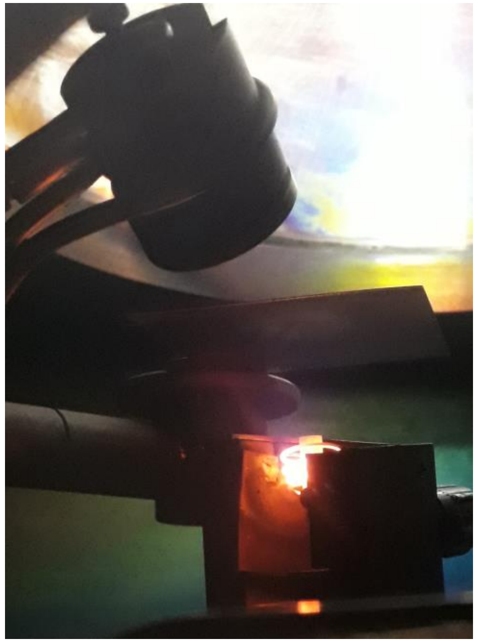
I.2.b / **Evaporator with electrostatic focused electrons (EFe-)**

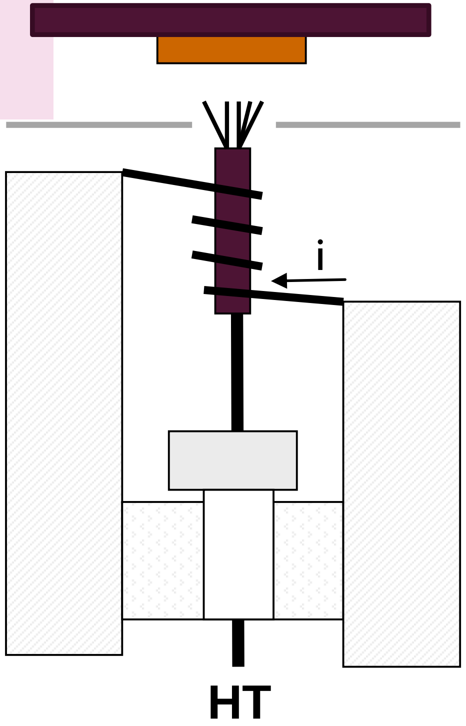
Thickness ~100s nm

High melting point materials,

oxides → reduction for metallic deposit

Efficient for low abundance isotopes





Tech-Evap 3: Electronic bombardment of the crucible I_{fil} → e^- + dV → dP

L. Westgaard et al, Nucl. Inst. Meth. 42 (1966) 77-81
A. Stolarz, *Journal of Radioanalytical and Nuclear Chemistry* vol. 299, pages 913–931 (2014)

a. Existing lab & skills

Deposition by evaporation

Resistive Heating of carbon

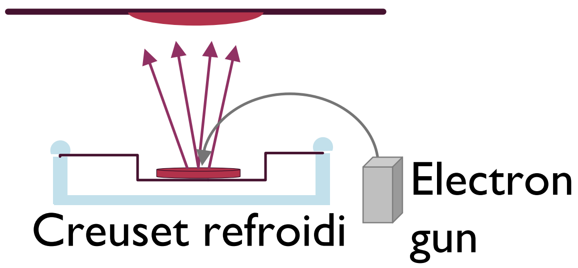
Resistive Heating of crucible

Electron heating of crucible

Electron heating of material

I.2.c / **Evaporator with electron gun (3 kW or 6 kW)**
Thickness > 1 µm
High melting point materials

Prevent chemistry reaction with crucible according to temperature



Tech-Evap 2: Electron Heating of the material

G.E. Thomas et al., Nucl. Instr. and Meth. A 303 (1991) 162-164.

a. Other applications, technics & skills

Deposition by evaporation

Evaporator large dimension
(diamètre 700 x1500)

Metallisation of thin foils for detectors
Non interactive emissive foils, Gold on
Drift chamber windows, Gold on
diamonds

Polymerisation

CD2/CH2 targets

Preparation of sensitive material

Molecular Plating

Preparation of osmium targets with carbon backing
Georges Fremont, Yvette Ngono-Ravache et al
AIP Conf. Proc. 1962, 030002-1–030002-4;
https://doi.org/10.1063/1.5035519

a. Other applications, technics & skills

Characterization

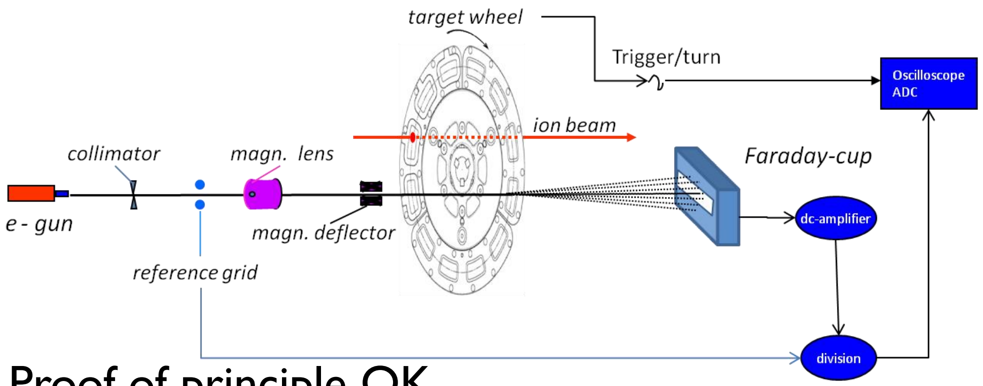
Areal density

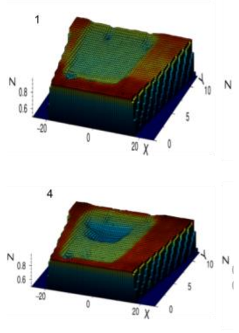
Weighting

Alpha energy loss

Homogeneity

electron transmission





Proof of principle OK

R. Mann, GSI, patent DE 10242962 A1-GSI, in prototype S3 station to be repaired

Commercial one on S3 stable station

Characterization

Composition, Surface

SEM, EDX, ….

CIMAP, LPC, Crismat, Orsay….

b. New Challenges for targets → Updated Lab

Larger quantity

S3 Irradiation hypothesis/beam time :

- 3 to 6 months beam time per year
- Experiment 2/3 weeks : 1 isotope « experiment » + 1 isotope « calibration (= commissioning) »
- 1 target wheel (18 targets) irradiated within 5-7 days

→ 3 wheels/experiment + 2 wheels in spare (extreme case, some targets will certainly be reusable)

→ 500-1000 targets/year

Larger sizes

cm^2 → 10s cm^2

Bi @ 70 µm

Thick targets

New Z Target

Higher quality

b. Thin Layer Laboratory at GANIL Renovation project

laboratoire commun CEA/DRF CNRS/IN2P3

Targets for physics

300 – 500 µg/cm2:	^{64}Ni, ^{124}Sn, ^{24}Mg, ^{58,60,64}Ni, ^{208}Pb
1-2 mg/cm²:	^{64}Zn, ^{82}Se, ^{24}Mg, ^{208}Pb, ^{90}Zr
8 mg/cm²:	^{208}Pb / ^{90}Zr
30 µg/cm² :	C substrate & Qeq foils * 100s

…………………………

- **Large expertise in some physical deposition processes**
- **Evaporators aging and chambers for specific géometries**

Larger sizes | Larger quantity | New Z Target | Higher quality

b.1 / Metallic targets for physics cases, Bi for radioisotopes …..

→New evaporators : carbone (strippers, backings)
& metals

b. New Challenges for targets → Updated Lab

laboratoire commun CEA/DRF CNRS/IN2P3

Larger sizes Larger quantity **New Z Target** Higher quality

b.2 / Lanthanides

^{238}U

Actinides → part 3 of this talk

- **Targets @ S^3 for commissioning + calibration + S3 LEB**
- ^{116}Sn, $^{144,148}Sm$, $^{160,164}Dy$, ^{60}Ni, ^{45}Sc, ^{170}Er, ^{174}Yb, ^{180}Hf, ^{160}Gd, $^{184,186}W$ & ^{181}Ta
- Ex P-process @Lyon: $^{144,147,149,154}Sm$, $^{155,158}Gd$, $^{177,180}Hf$
- **Various Physics with ^{238}U targets**

→New evaporator with EFe- heating method & R&D

→New evaporator with sputtering method (^{238}U + monoisotopic materials, oxides, compounds…) & R&D

Project of collaboration with ORANO for ^{238}U targets

CIME https://www.orano.group/cime/fr

Physical Deposition

Resistance heating

- The method is very simple, robust

but

- limited to the materials of the low melting point (not higher then 1600 -1800 °C)
- and not alloying with the boat material.

E-gun

- The method is more complex, but extremely versatile.
- Can achieve temperatures in excess of 3000°C.
- Use evaporation cones or crucibles in a water cooled copper hearth.
- Typical emission voltage is 8-10 kV.

but

- Exposes substrates to secondary electron radiation.
- X-rays can also be generated by high voltage electron beam

Sputtering

- The method can be applied to the most of the materials except those which can degrade due to ionic bombardment
- This technology allows to release the deposited material at much lower temperature than evaporation.
- gives easy film thickness control via time, allows alloy deposition, no x-ray damage

but

- requires rather big surface of the sputtered material to avoid bombarding of the cathode material.
- There is as well big chance for the impurities incorporation due to low vacuum.

Courtesy A. Stolarz

b. New Challenges for targets → Updated Lab

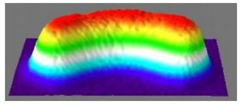
Larger sizes   Larger quantity   New Z Target   Higher quality

- ✓ *Destructive/non destructive*
- ✓ *Locally or over the surface*

thickness

α Energy loss
Precise analytical balance
Spectrophotometry
***Low geometry α-particle (LGA)**
***Radiographic Imaging (RI)**

G. Sibbens et al, J. Radioanal. Nucl. Chem. 299 (2014) 1093-1089
J. Heyse et al., J. Radioanal. Nucl. Chem. (2014)299:1055-1059



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D. Liebe et al, Nucl. Instr. Meth. A590 (2008) 145-150

surface morphology

Scanning Electron Microscpe (SEM)
AFM
X-ray diffractometer (XRD)
Optical microscope

surface roughness

TARGET

thickness uniformity

Rutherford Back Scattering (RBS)
Electron attenuation
PhotoElectron Spectroscopy (XPS)
Energy Dispersive X-Ray Spectroscopy (EDS)
Particle Induced X-ray Emission (PIXE)
Particle Induced γ-ray Emission (PIGE)

identification of impurities

Isotopic abundances

Thermal Ionization Mass Spectroscopy (TIMS)

S. Richter et al, Int. J. of Mass Spectrometry 229 (2003) 181-197
G. Sibbens et al, J Radioanal Nucl Chem (2014) 299:1093–1098

Neutron Activation Analysis (NAA)

D. Liebe et al, Nucl. Instr. Meth. A590 (2008) 145-150

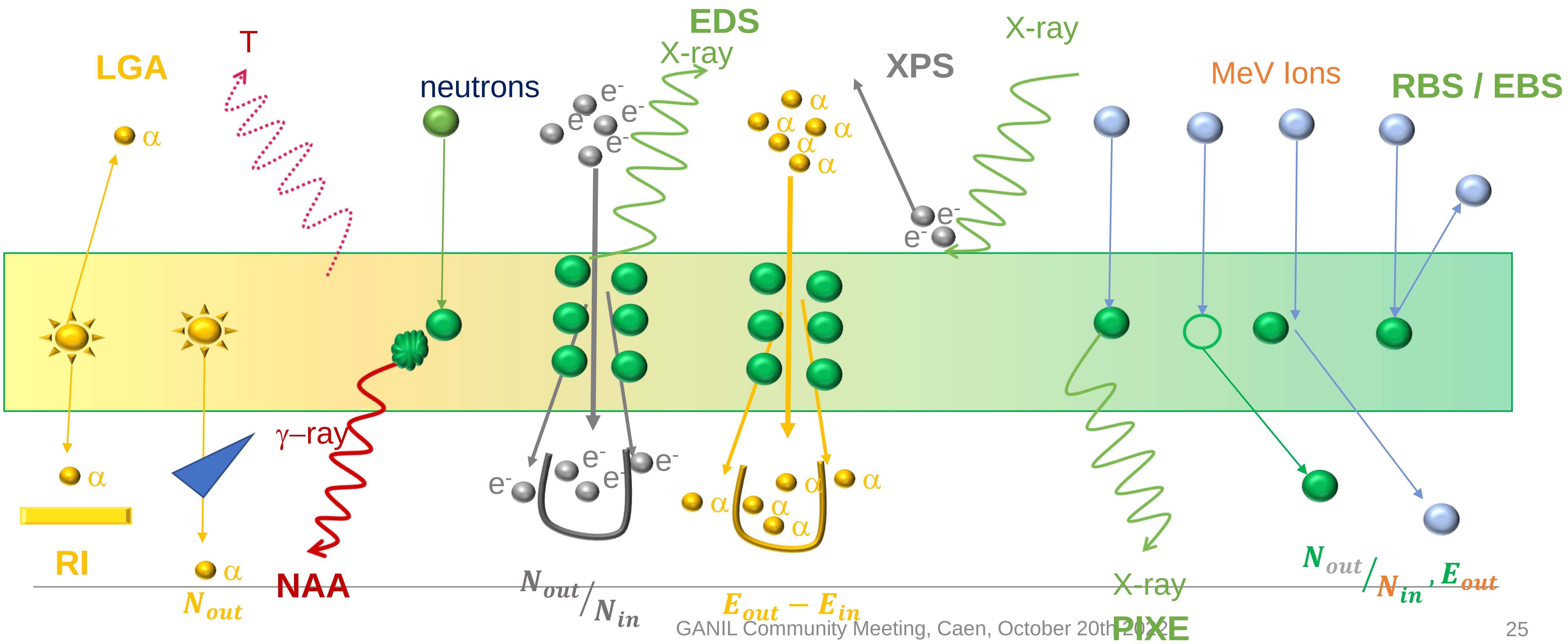
……

Echantillon de la solution lors de sa préparation

During irradiation

b. New Challenges for targets → Updated Lab

Larger sizes Larger quantity New Z Target Higher quality



b. New Challenges for targets → Updated Lab

Larger sizes | Larger quantity | New Z Target | **Higher quality**

Reliability, Reproductibility

→ Chemical composition of targets: XRF analyzer in the target lab

- → Optimization of parameters (I, V, time, powders…) for each targets for each common and new technic
- → Development of backings and understanding their impact on fabrication process and under irradiation
- → Characterization (homogeniety, contaminants…) of targets at each step of the fabrication process and systematic for its delivery
- → Evaluating performance under reallistic beam radiation
- → Feedback from experimenters
- → Understanding the involved physical, chemical, material processes

2. GANIL Target Activities:
2.c Investigation of external potentials (F. Perocheau*)

Larger sizes | Larger quantity | New Z Target | Higher quality

First Contacts with industries or CNRS laboratories, expertise in thin layer (optical & metallic treatments, sputtering technics)

→ Lab. Matériaux Avancés, Lyon (Ta)

→ HEF, Diamond Like Carbons-H (strippers, backings)
→ KERDRY (Sn, Ni, W)
→ PlasmaQuest (Ta, Ni)

d. 1st Conclusion – **Project « Target Lab »**

Larger sizes | Larger quantity | New Z Target | Higher quality

New equipment to be installed
& take in charge of each technic/evaporator
+
- ✓ R&D
- ✓ Targets management (from its fabrication to its use)

+ Manpower: GF, CDD, PD, + xxx ???
+ collaborations with experts

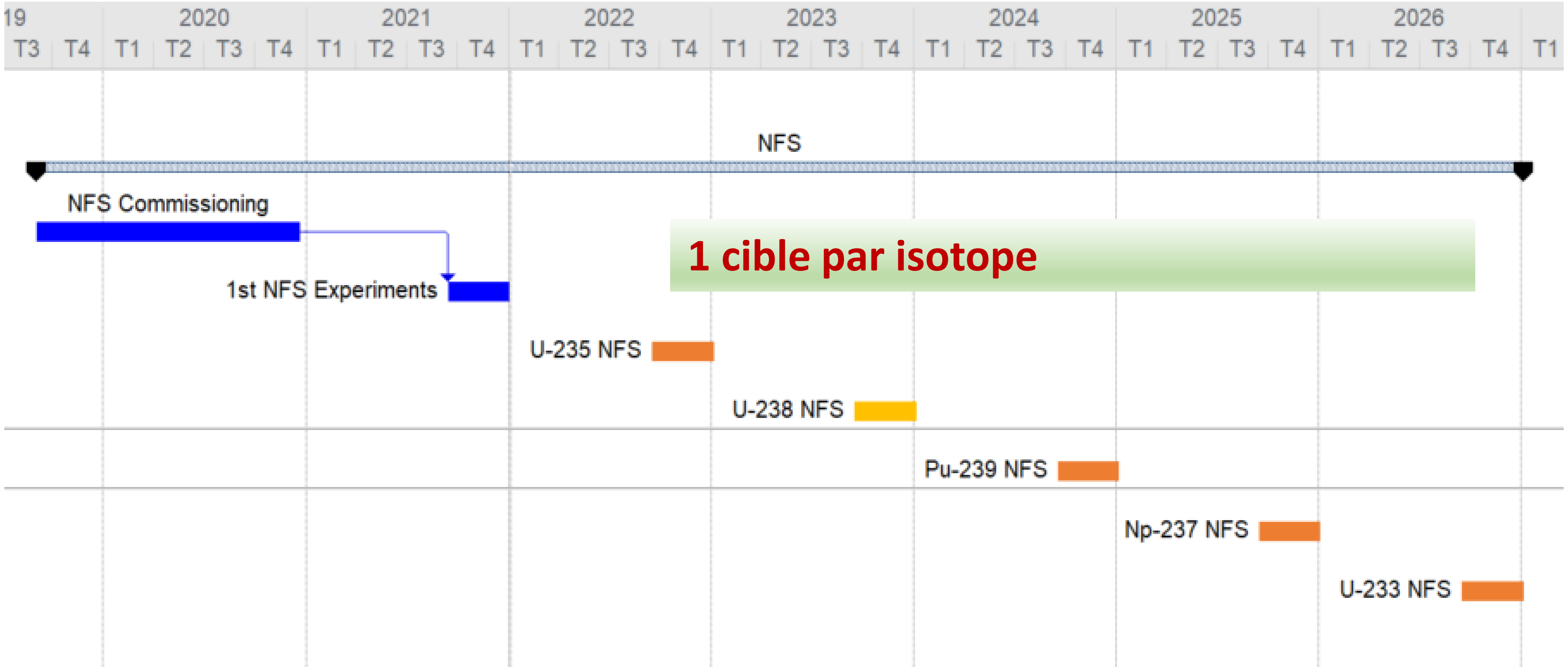
TARGET = multidisciplinary domain

3. Actinide Activities
a. Requirements
b. Project « Actinide Targets »

3. Actinide Activities a. Requirements

Cibles minces : surface utile de diamètre 30 mm,
épaiseur 150-200 µg/cm² (80 – 100 nm pour l'uranium)
sur support très fin : Ni de 250 nm ou plastique 220 nm

D. Doré



À compléter avec cibles épaisses et autres demandes d'isotopes

3. Actinide Activities a. Requirements

Super Separator Spectrometer

- Targets @ S3, > 2025 Experiments

Planning des expériences avec les isotopes (*1-4Act*) selon disponibilité cible** et contexte Scientifique international

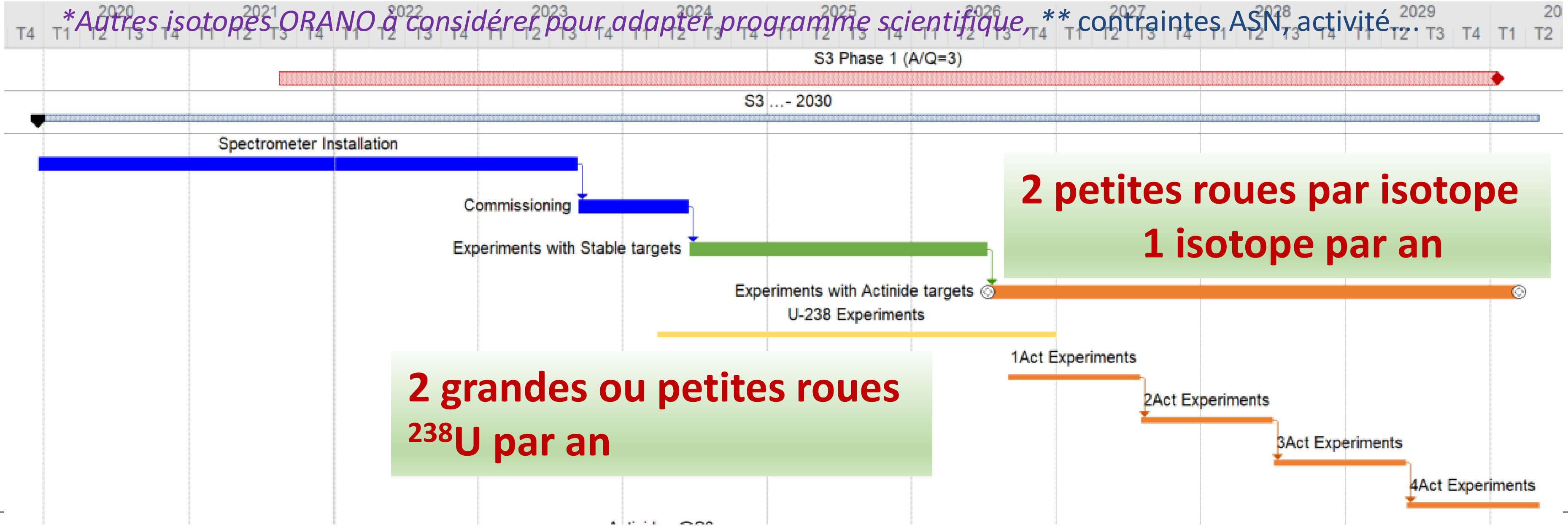
^{226}Ra*, ^{232}Th,^{238}U, ^{237}Np, ^{243}Am*, ^{248}Cm*, $^{239/242/244}$Pu*

0,3 - 0,5 mg/cm² ; 1 roue ≈ 12 cibles de ≈ 3 cm² ≈ 25 mg ≈ 10^2 –10^8 Bq < 1 GBq

^{238}U: 1 roue ≈ 18 cibles de ≈ 22 cm² ≈ 200 mg

Pureté isotopique ≈ 97% (ou <, importance de la connaitre pour activité totale autorisée et analyse des données)

Autres isotopes ORANO à considérer pour adapter programme scientifique, * contraintes ASN, activité….



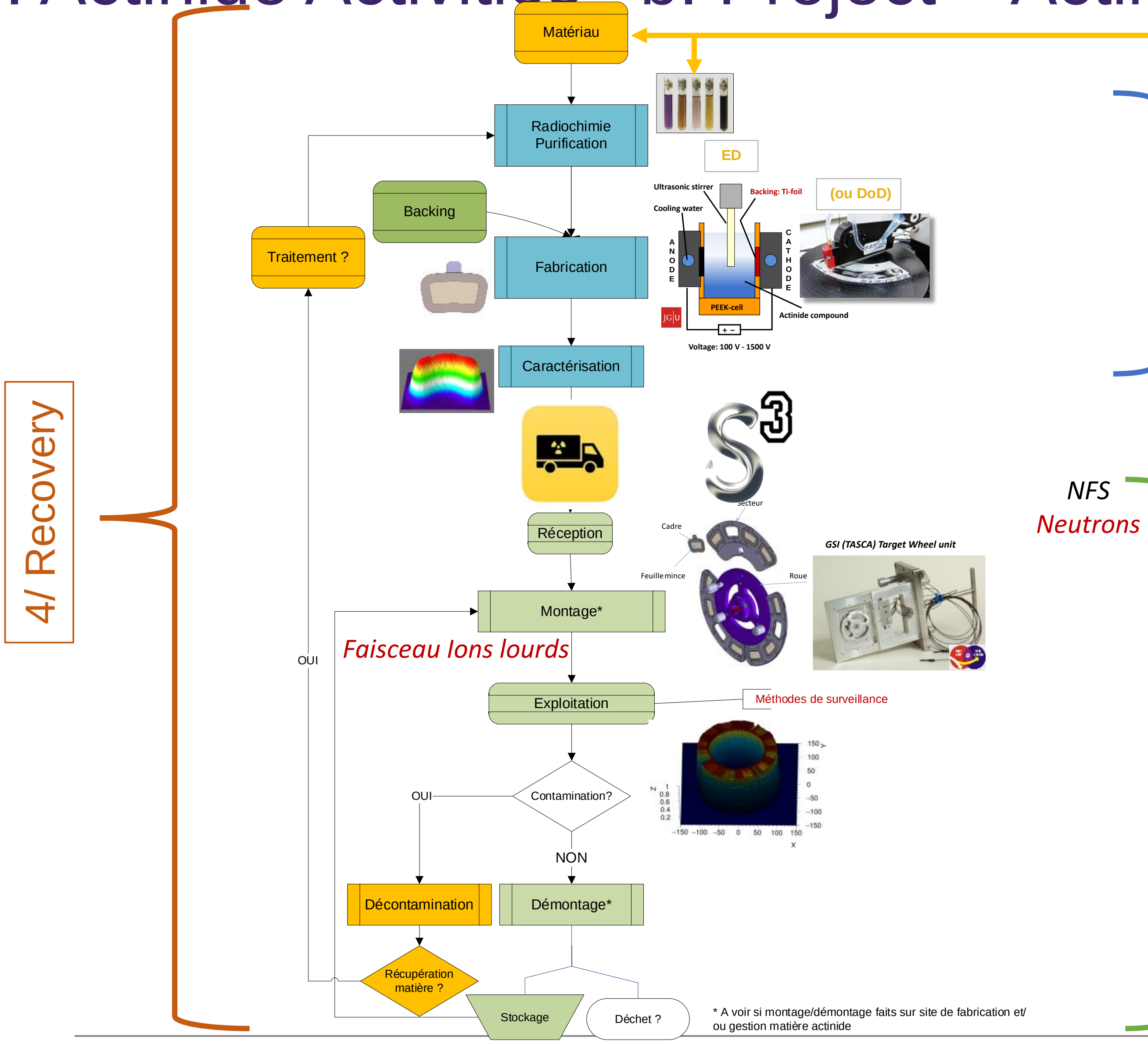
2 petites roues par isotope
1 isotope par an

2 grandes ou petites roues
^{238}U par an

3. Actinide Activities   b. Project « Actinide Targets »

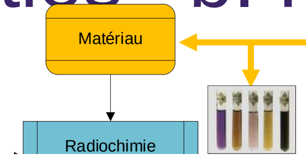
1/ ORNL, (Dubna), ORANO ?

2/ Specific Infrastructure, radiochemistry skills
R&D @ ORNL, Uni Mainz, PSI, JRC Geel
ORANO ?



3/ AEL Exploitation

3. Actinide Activities   b. Project « Actinide Targets »

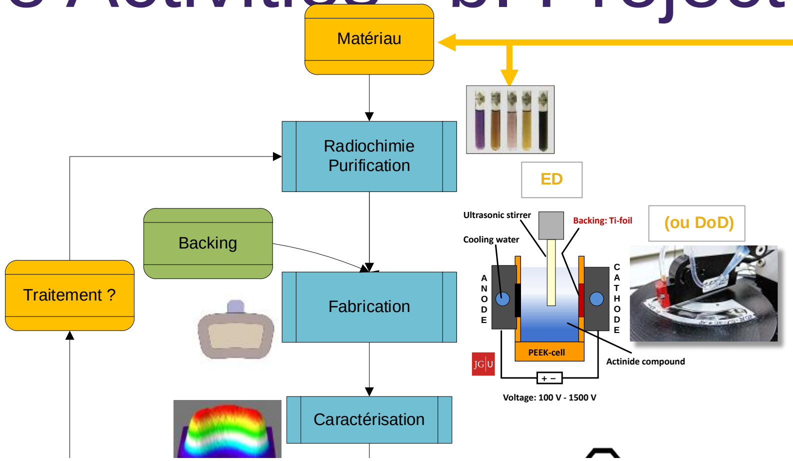


1/ ORNL, (Dubna): reactor
ORANO ? « wastes » ?

Available **Rare / Radioactive**

89	90	91	92	93	94	95	96	97	98	99	100
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm

3. Actinide Activities   b. Project « Actinide Targets »



1/ ORNL, (Dubna), ORANO ?

2/ Specific Infrastructure, radiochemistry skills
R&D @ ORNL, **Uni Mainz**, PSI, JRC Geel
Production @ ORANO* ?

- ✓ Constraints:
  - ➢ limited availability
  - ➢ high specific activity
  - ➢ backing: material, thickness, roughness
  - ➢ high chemical purity
  - ➢ large surface/numerous
  - ➢ fragile for transportation
  - ➢ little expertise in the world

- ✓ Methods:
  - ➢ high yield
  - ➢ reliability/reproducibility
  - ➢ control of dimensions and thickness

R&D on MP mecanism and kinetic,
MP parameters (U, I, solvent…),
Nature & thickness of backings
Innovative technics

- ➢ Electro-precipitation
- ➢ Drop-on-Demand
- ➢ intermetallic targets

K. Eberhardt, et al, AIP Conference Proceedings, vol. 1962, p. 030009, 2018
J. Runke et al., J. Radioanal. Nucl. Chem. 299 (2014) 1081–1084

R. Haas et al, Nuclear Instruments and Methods A, vol. 874, pp. 43-49, 2017

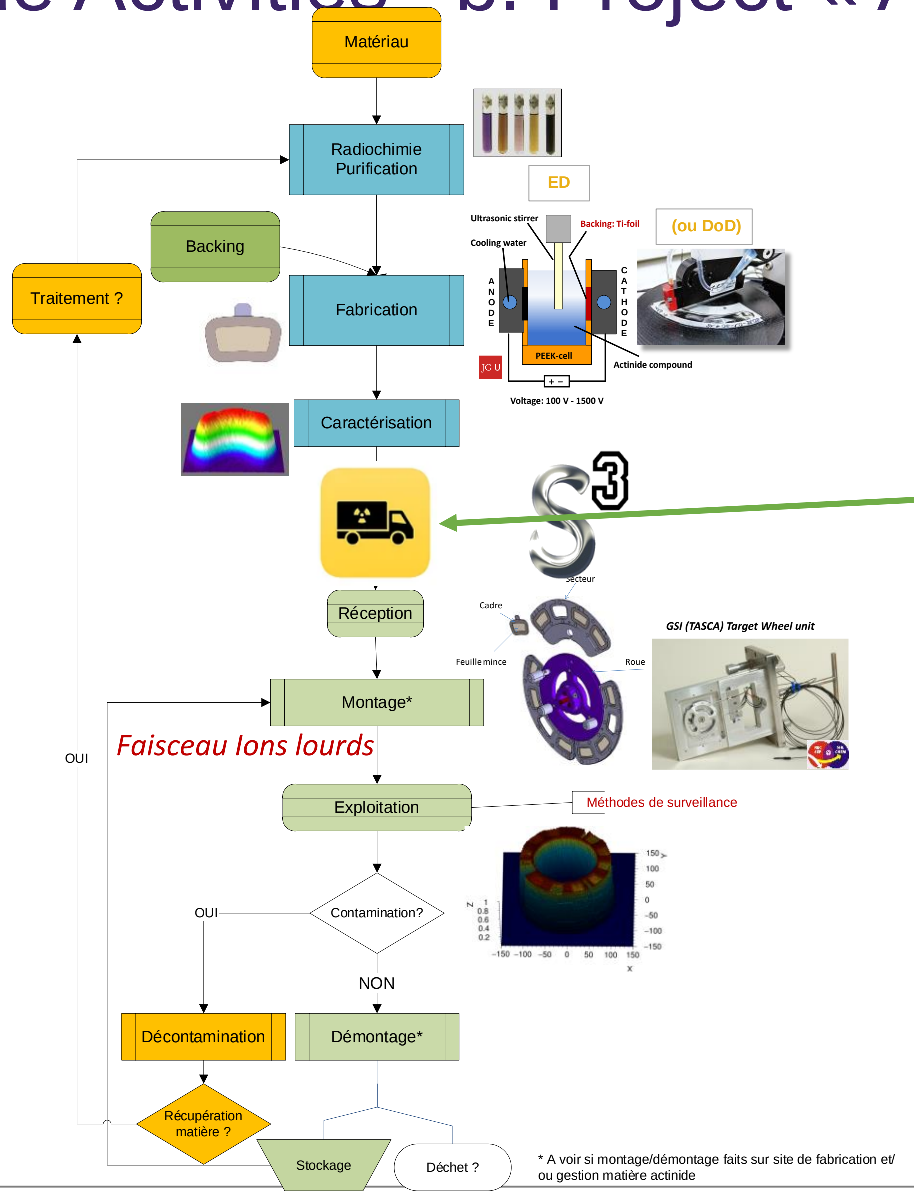
I. Usoltsev et al, Nucl. Instr.Meth. B 318, pp. 297-305, 2014

- ✓ Complementary developments:
  - ➢ backings (material + thickness)*
  - ➢ characterization techniques

**B. Lommel et al., Nucl. Instrum. Methods A 590 (2008) 141-144*

*CIME https://www.orano.group/cime/fr
*LEA https://www.orano.group/lea/fr

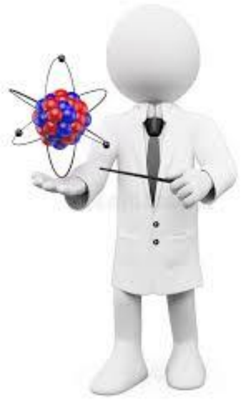
3. Actinide Activities   b. Project « Actinide Targets »



✓ GAGE Project for NFS

Authorized targets at NFS

- stables
- radioactives
- actinides (uniquement dans salle 33 ⇔ Neutrons)
  - cibles encapsulées
  - cibles minces de faible activité
  - cibles minces de forte activité (EDMS-I035121)



Liste des actinides autorisées RGE :

^{233}U, ^{235}U, ^{237}Np, ^{239}Pu, ^{241}Am, ^{242m}Am, ^{245}Cm, ^{234}U, ^{236}U, ^{240}Pu, ^{242}Pu, ^{244}Pu, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{231}Pa, ^{241}Pu, ^{249}Cf, ^{251}Cf

Caractéristiques:
Mince 150 µg/cm2 ⇔ pour que les fragments sortent
Irradiée par des neutrons ⇔ pas de dépôt d'énergie

Risques:
- contamination en cas de chute
- irradiation selon activité

∞ **Confinement obligatoire**

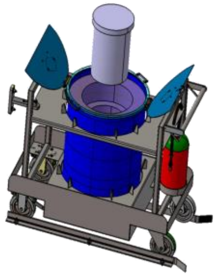
Courtesy E. Dessay

Highly active thin targets at NFS

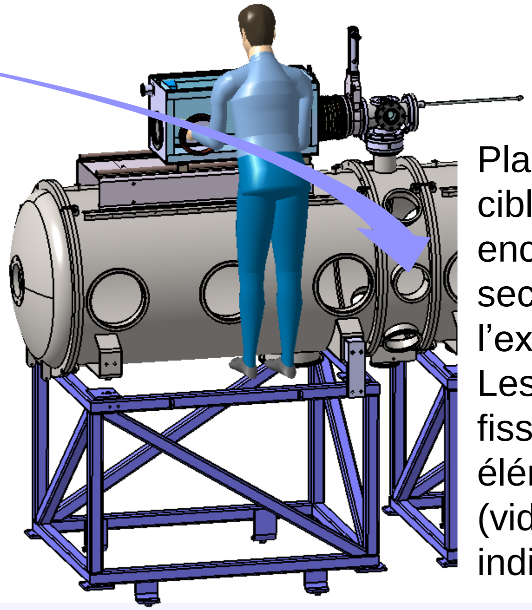
Objectif pour la physique :

Réaliser des expériences avec des cibles minces radioactives (≈100µg/cm^2)

Arrivée au GANIL de la cible dans un emballage adapté à son activité



Préparation de la cible et transport vers la salle 33



Placement de la cible dans une enceinte sous vide secondaire pour l'expérience.
Les fragments de fission sont des éléments lourds (vide secondaire indispensable)

Projet BAGE@NFS

Créer un dispositif expérimental de type BaG pour le transfert de cibles minces d'actinides de forte activité compatible avec les détecteurs utilisables dans la salle 33 de NFS

Courtesy E. Dessay

Activité « actinides »

Réceptionner, préparer, transporter et installer les cibles d'actinides

Actinide « EIP » at NFS

laboratoire commun CEA/DRF CNRS/IN2P3	RÈGLES GÉNÉRALES D'EXPLOITATION INB 113 - CHAPITRE Annexes : Liste des EIP de l'INB 113	SSR-220-D Niv. 2 — Page 34/47
PROCESSUS DE RATTACHEMENT : Gérer la sécurité nucléaire (PS02)		

ANNEXE N°6

6 EIP n°6: Systèmes de confinement des cibles d'actinides (hors faisceau)

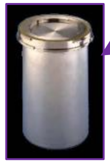
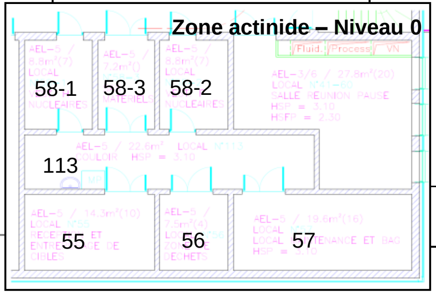
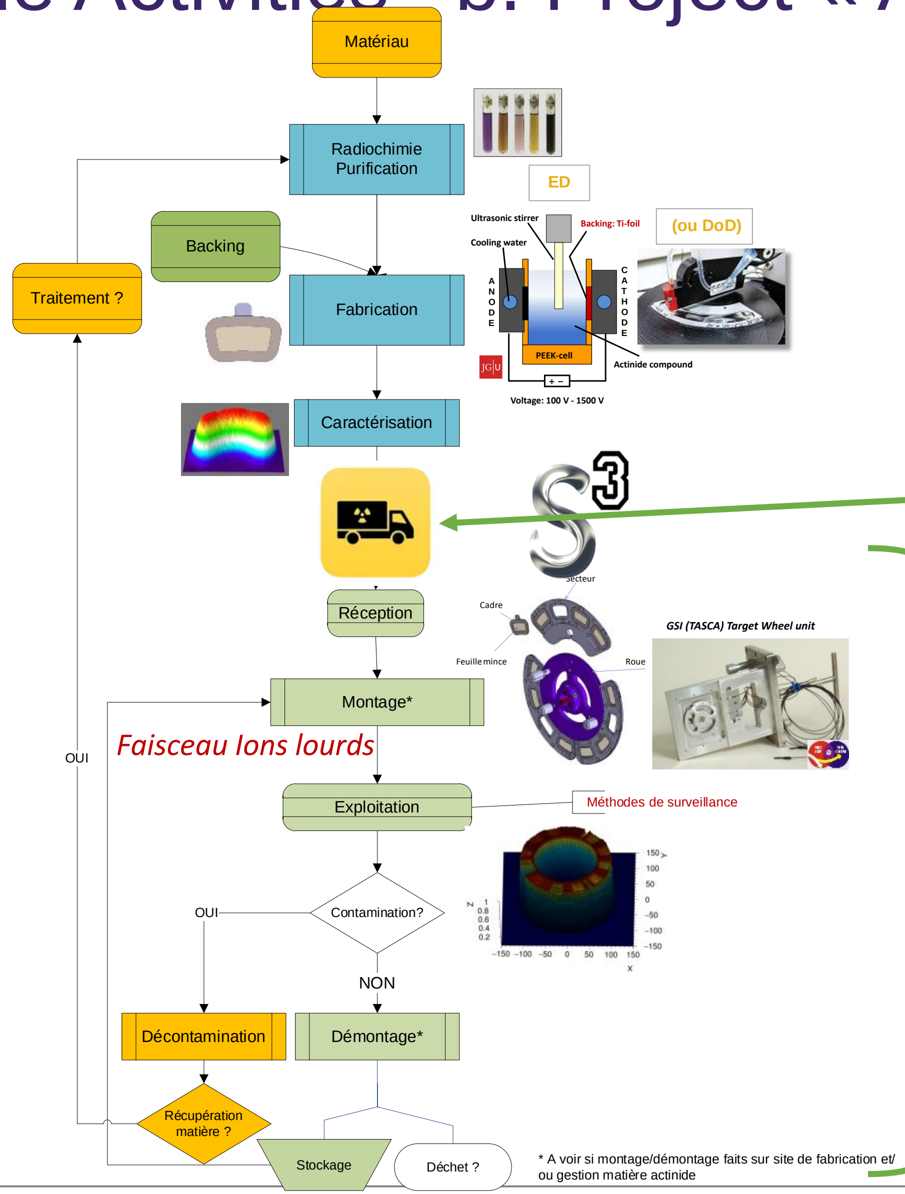
EIP n°6	Composition
 	EIP n°6a : Dispositif expérimental NFS de type « BàG »
	EIP n°6b : BàG (× 2) cibles actinides (local 057)
	EIP n°6c : Conteneur DPTE
Systèmes de confinement des cibles d'actinides (hors faisceau)	EIP n°6d : Systèmes de transfert (chariot de transfert et mousse absorbante du chariot de transfert)
 	EIP n°6e : Capsule de conditionnement des cibles épaisses d'actinides 
	EIP n°6f : Armoire d'entreposage des cibles d'actinides

Tableau 31 : Composition de l'EIP n°6



Courtesy E. Dessay

3. Actinide Activities   b. Project « Actinide Targets »



✓ GAGE Project for NFS

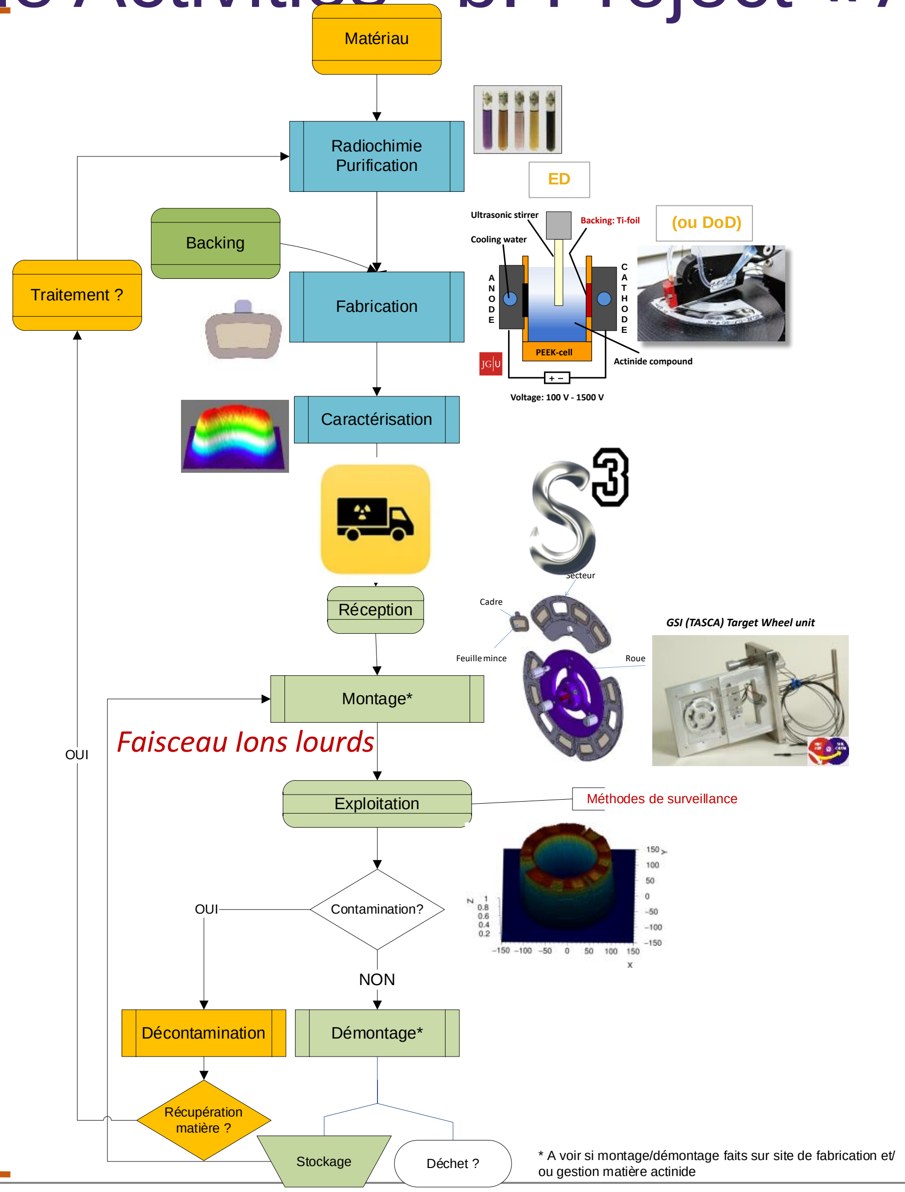
3/ AEL Exploitation

- ✓ **Design, fabrication of S3 actinide station**
- ✓ **Instrumentation for control of targets during irradiation and after**
- ✓ **Process of mounting, dismounting**
- ✓ **Art 26**

TASCA model or not ?
French expertise @ ORANO ?

3. Actinide Activities   b. Project « Actinide Targets »

4/ Recovery



- ✓ **Processes**
  - ✓ **dismounting**
  - ✓ **Decontamination**
  - ✓ **Waste & targets management**
  - ✓ **Recovery of material**

Radiochemistry skills

French expertise @ ORANO ?

4. Collaborations

Collaborations

+ Catania, JYFL

- ✓ CIMAP: MEB, EDS,… - damage process, Thermal Spike model ….
- ✓ GSI: training & some « small » targets
- ✓ INTDS network: Training, « recipes/tricks », share of knowledge/know-how
- ✓ ORNL: material supply + actinides
- ✓ Uni Mainz (Actinide), proposal for studying performance of MP targets under realistic beam
- ✓ IPHC, backings developments
- ✓ ORANO, under discussion, 1st step with ^{238}U

		Year 1												Year 2												Year 3												Year 4											
Task	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP2	Access to Research Infrastructures for Nuclear Physics																																																
2.5	Service Improvements			MS13									MS15						MS12 MS14												MS16						D2.5												
	Post Doc	GANIL (45k€)												LNS ? (31k€)												LNL ? (31 k€)																							

MS13: Production of a report to define the state of the art in the field (targets for NP) and collect request from the community

C2) Targets

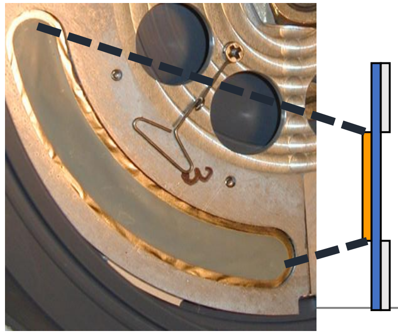
Participants:
LNL-LNS (coordination)
GANIL
IPHC Strasbourg
IJCLab Orsay
CEA Saclay
GSI
INFN Turin
SLCJ Warsaw
HH-IFIN

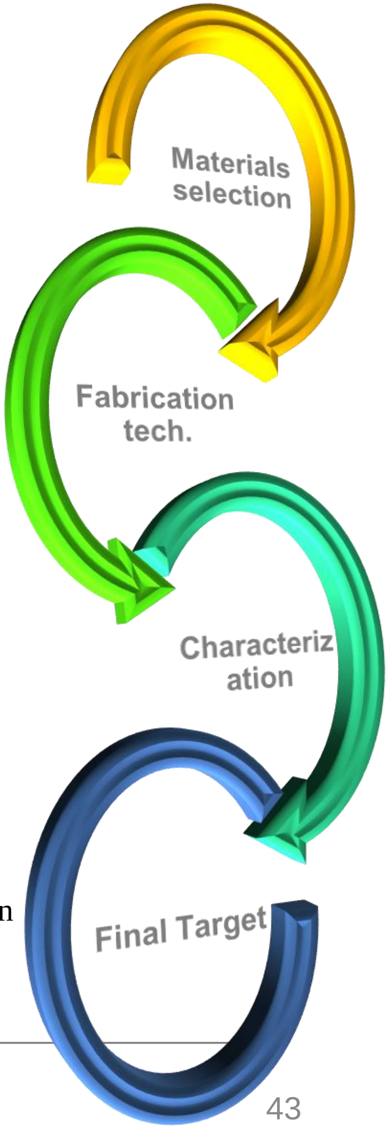
Associated partners:
LIP
PSI Switzerland
Daresbury Lab. UK.

Beneficiary short name	Installation (facility name)	Person - months	Monthly personnel costs	Personnel costs	Travel and subsistence	Contact person
INFN	LNS	12,00	2583,3333	**31 000,00**	8 300,00	Manuela Cavallero
INFN	LNL	12,00	2583,3333	**31 000,00**	8 300,00	Juan Esposito
INFN	TURIN			**0,00**	9 500,00	Federico Pinna
GSI	GSI			**0,00**	9 500,00	Bettina Lommel (B. Kindler)*
GANIL	**GANIL**	**12,00**	**3750**	**45 000,00**	**5 400,00**	**CS**
UNIWARSAW	SLCJ			**0,00**	9 500,00	Anna Stolarz*
CNRS	IJCLab			**0,00**	9 500,00	Aurelie Gentils**
CNRS	IPHC-Strasbourg			**0,00**	9 500,00	Benoit Gall
CEA	Saclay			**0,00**	4 000,00	Barbara Sulignano
IFIN-HH	TANDEM			**0,00**	9 500,00	Nicoleta Florea*
Associated Partner						
LIP	P. Teubig*		*Targets Laboratory Infrastructure (INTDS)			
PSI	D. Schumann*		** Characterization (JANNUS-Scalp)			
Daresbury	P. Morrall*					

Specific activities

- **Study of existing and novel materials**
- **Improvement of current and development of novel fabrication techniques**
- **Characterization procedures**
- **Sharing of knowledge.**





The goal of the subtask is to **gather, at a European level, the community of "nuclear target makers"** having specific expertise in the field of target **manufacturing and characterization**, **both for nuclear and applied physics purposes**. Different research areas and applications, indeed, require **high quality targets**, ranging from fundamental physics (nuclear reaction studies, nuclear data measurements, etc.), passing through specific targets for strippers and neutron converters, up to the development of (usually) isotope-enriched targets for high quality standard medical radioisotope production. Target preparation is often a crucial step on the path towards the achievements of nuclear physics experimental results, or specific final nuclear "products".

Outcome:

Database, publicly available, containing the information about the preparation and the characteristics of available targets and those newly developed in various laboratories within this subtask. The first version of the database will be ready after the first year of the project and will be continuously updated during the duration of the project

- 1 year Postdoctoral Researcher in Nuclear Targets within EURO-LABS project at GANIL
- + 1 application within Winning Normandy
- Master 2 internship 2023, « GEANT4 simulation of the interaction of a 15-30-*kV*-electron gun with thin nuclear physics Target »

5. conclusions

Conclusions – Take Home

→ Improve the capability of GANIL to make target (manpower & equipment)

→ “target” infrastructure = Project

new equipment soon to cover the highest demand and new requests

Room for improvements in the quality of targets

R&D on fabrication, characterization pre-/during-/post-irradiation unavoidable

Time consuming, specific know-hows → complementary skills

When you plan an experiment:

1/ Define the properties of your future target: What is needed - absolutely necessary - for a successful measurement? What (material or chemical composition) is excluded?

element/isotope / thickness / dimensions / supported or not, if yes what can be considered as support / purity /chemical form (pure / compound)

2 / Discuss your plans with the target maker: Target preparation people can do sometimes more for you than you believe. However, sometimes they can do less than you wish…

It is always a question of communication and of raising the relevant problems at a very early

Conclusions – Take Home

→ Improve the capability of GANIL to make target (manpower & equipment)
→ "target" infrastructure = Project

→ Settle collaboration with other target makers (GSI, Uni Mainz, ORANO, ….)

→ Secure the supply chain for rare elements – to be analysed for targets

→ Actinide target development → Full project

- Liquid, Gas, cryogenic Targets
- Stations

Thanks for your attention