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Plateforme JANNuS-SCALP

Journée du LabEx P2IO

27 novembre 2020

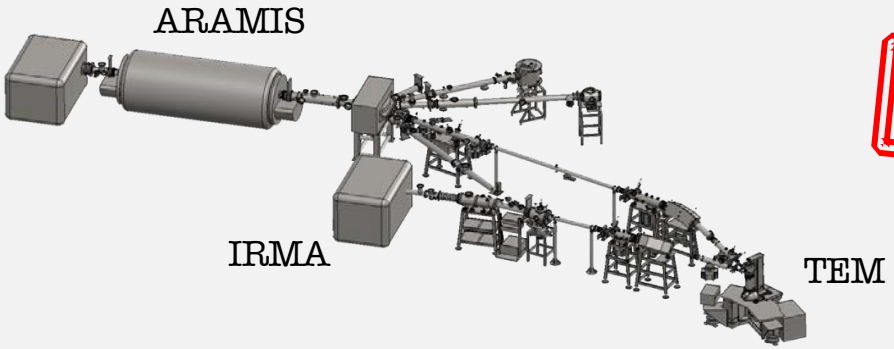
P2IO
Physique des 2 Infinis et des Origines

The JANNuS-SCALP platform

SCALP **S**ynthesis and **C**haracterization using ion **A**cce**L**erators for **P**luridisciplinary research

JANNuS-Orsay, Joint Accelerators for Nanosciences and Nuclear Simulation

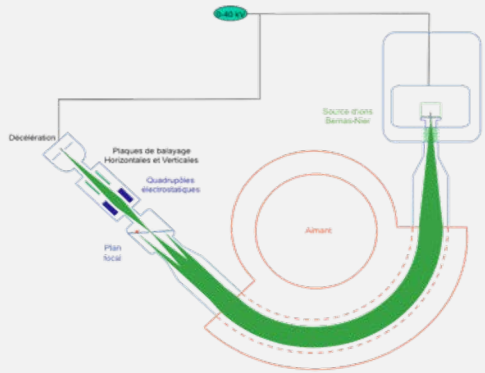
- 190 kV **IRMA** ion implanter, 2 MV **ARAMIS** Tandem-Van de Graaff accelerator, 200 kV **Transmission Electron Microscope** (TEM)
- Ion beam modification and ion beam analysis of materials
- *In situ* characterization techniques (single/dual ion beam)



Home-made ion accelerators

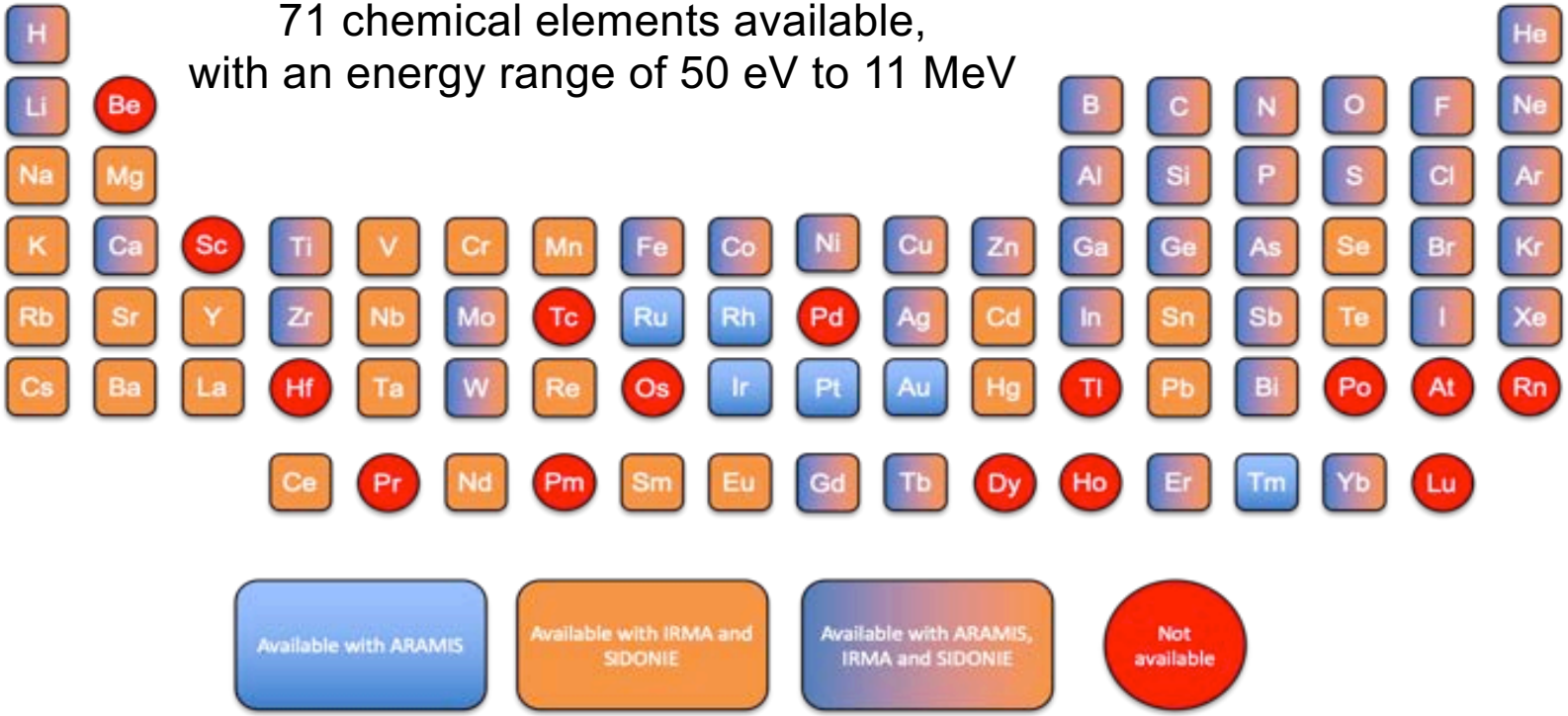
SIDONIE, a high purity isotope separator

- Isotopes and target production
- under renovation 2020-2021



Large diversity of ions available

71 chemical elements available,
with an energy range of 50 eV to 11 MeV



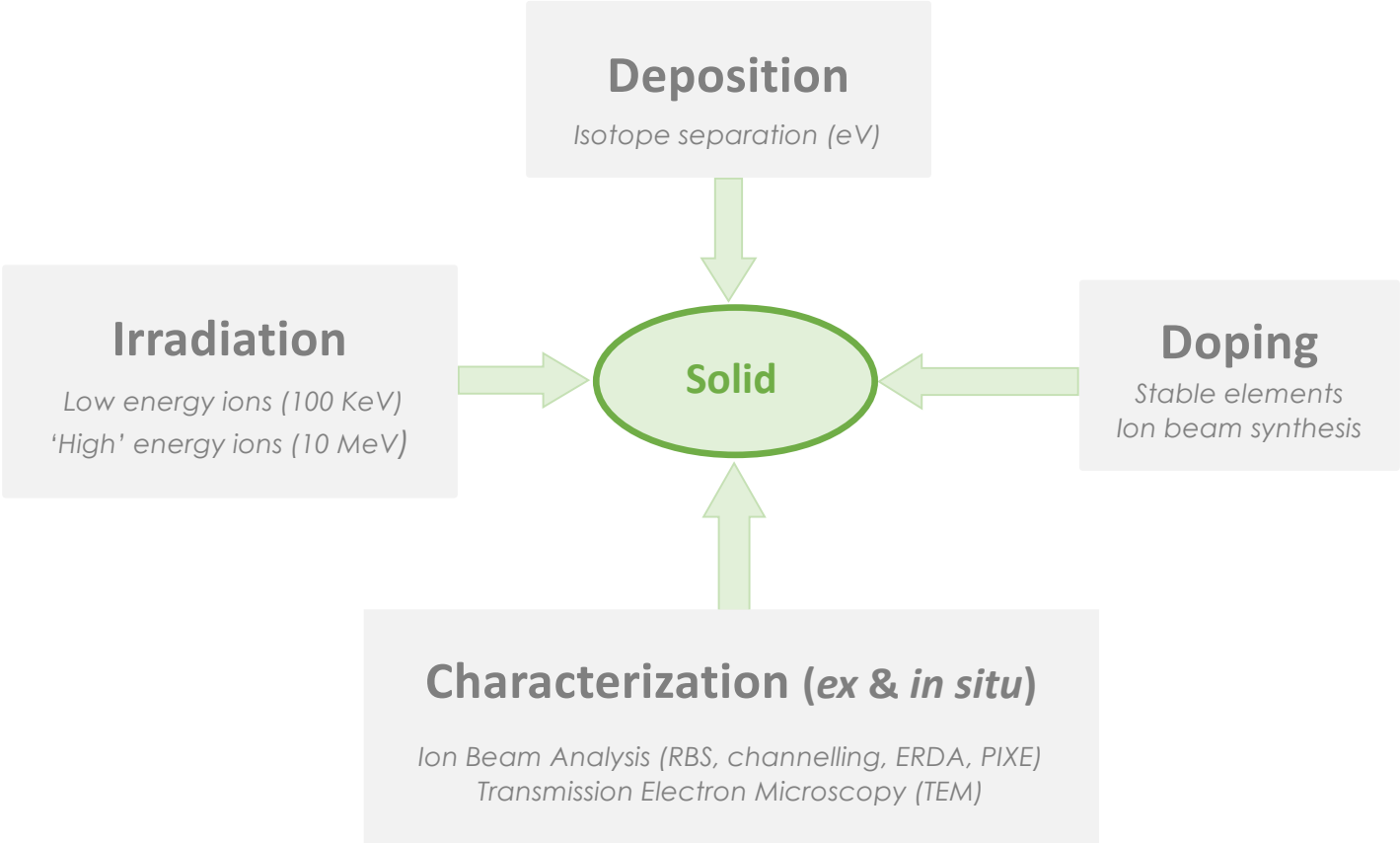
50 kV SIDONIE

190 kV IRMA

2 MV ARAMIS

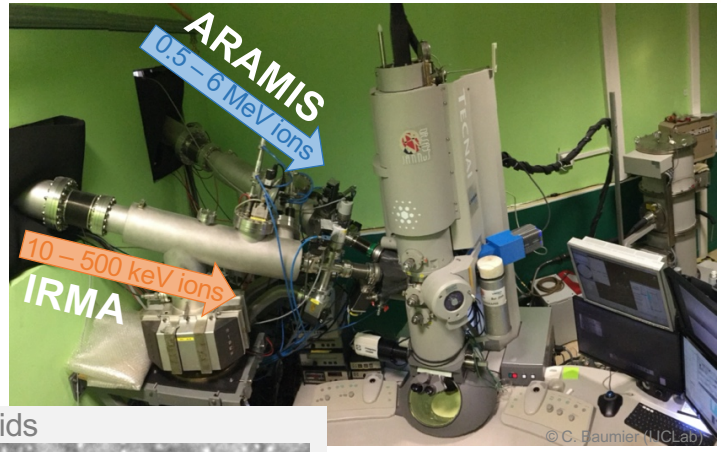
100 eV 1 keV 10 keV 100 keV 1 MeV 10 MeV

JANNuS-SCALP : ion beams for material science



Irradiation-induced defects, atomic diffusion, modification of physical and chemical properties of materials, …

A unique *in situ* dual ion beam Transmission Electron Microscope (TEM)



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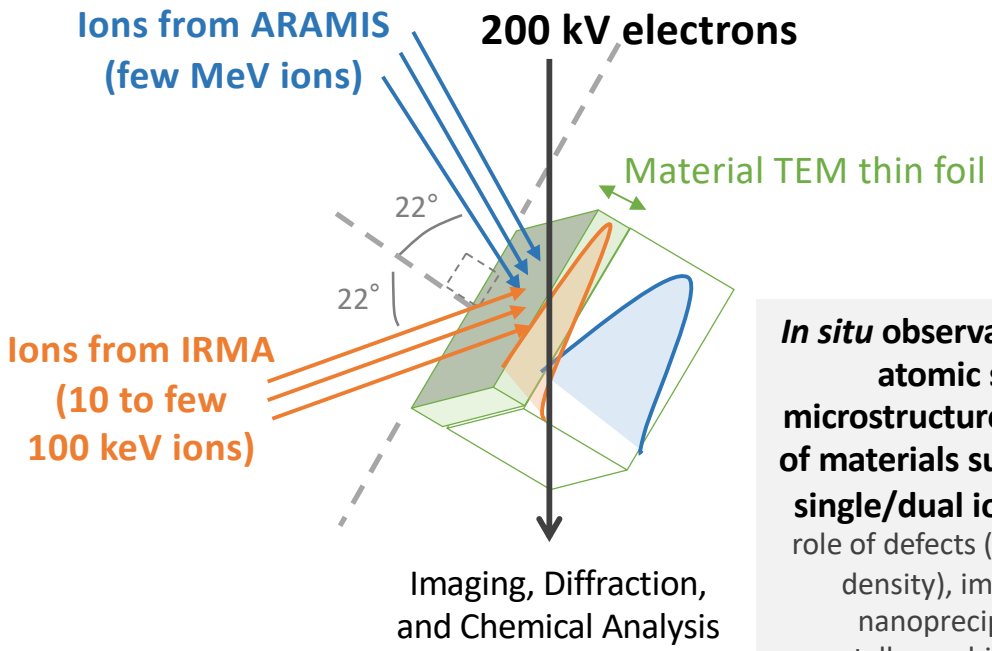
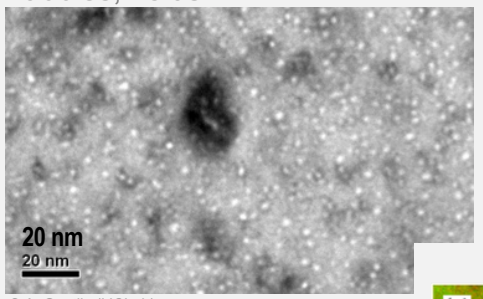


***In situ* observation of the atomic scale microstructure evolution of materials submitted to single/dual ion beams :**
role of defects (nature, size, density), impurities, nanoprecipitates, crystallographic structure, chemical composition….

Bubbles, voids



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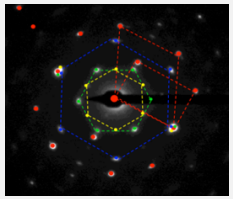
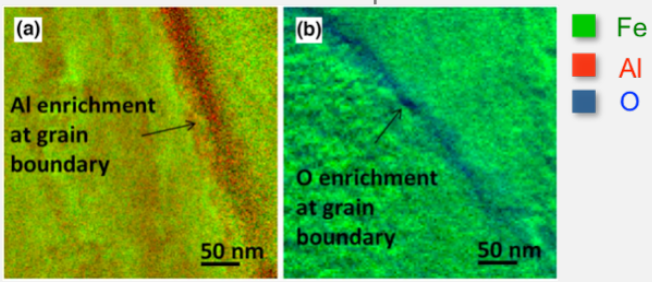
Crystallo-graphic structure

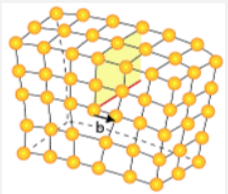


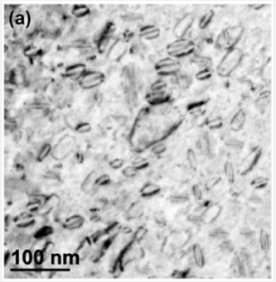
Chemical maps



C. Zheng, A. Gentils, *et al.*, NIMB **365** (2015) 319

Dislocations, dislocation loops





S. Jublot-Leclerc *et al.*, JNM **480** (2016) 436

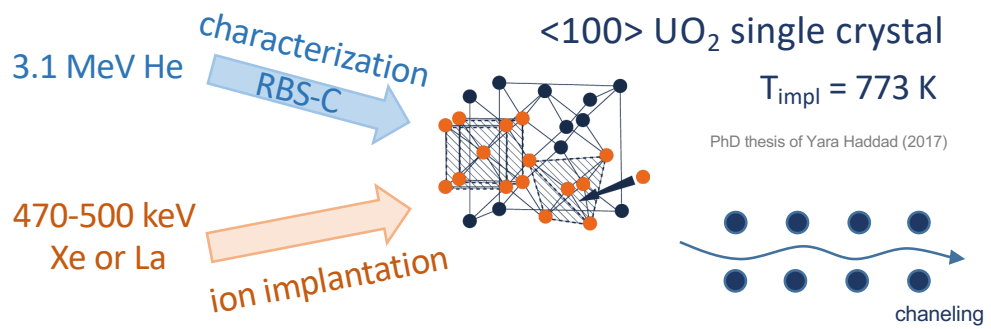
At a chosen T
LN_2 → 1000°C

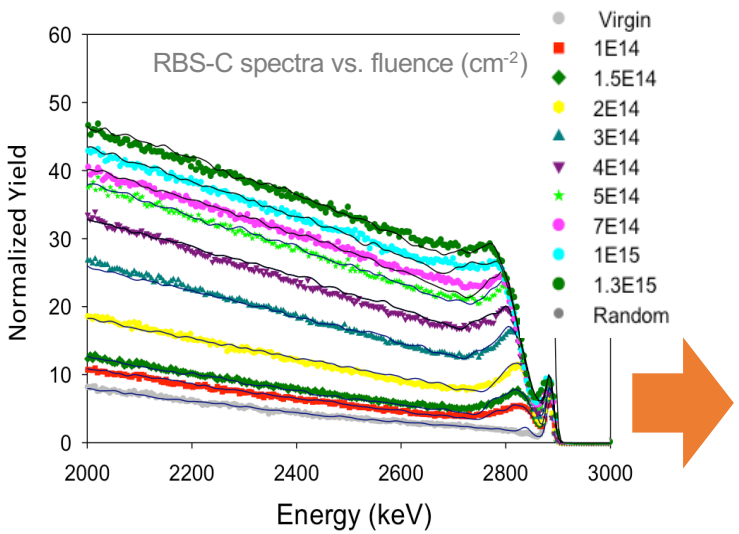
In situ Rutherford Backscattering Spectrometry in Channeling geometry (RBS-C)

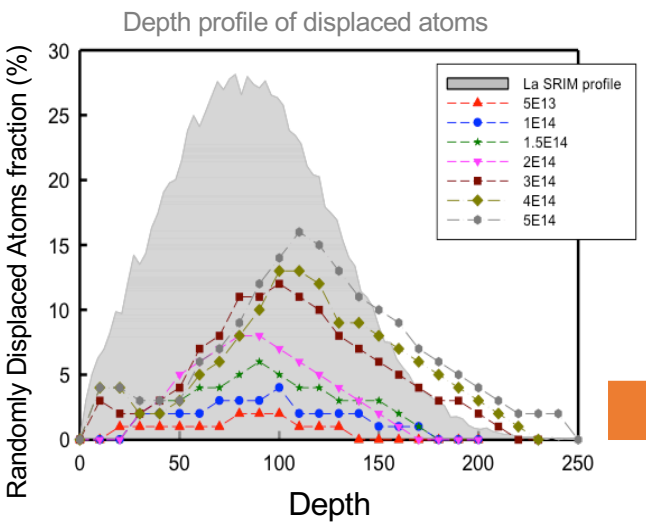
Matrix destabilisation under radiation : **experimental simulation of radiation by ion beams**

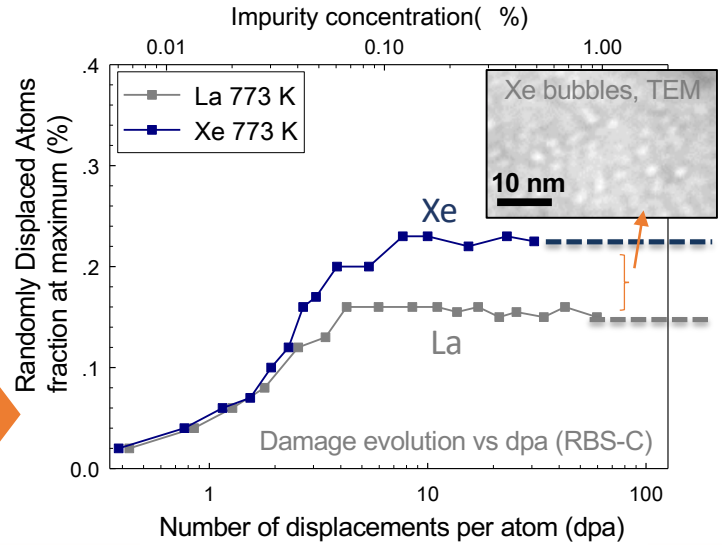
Legendary radiation stability of fluorite-structured oxides :
UO_2 single crystals as a model system

- **Role of the elastic collisions** (‘*nuclear stopping force*’) ?
  → Irradiation : ballistic contribution
- **Role of the incorporated atoms** (*fission products*) ?
  → Doping with La (soluble) or Xe (insoluble) : chemical contribution



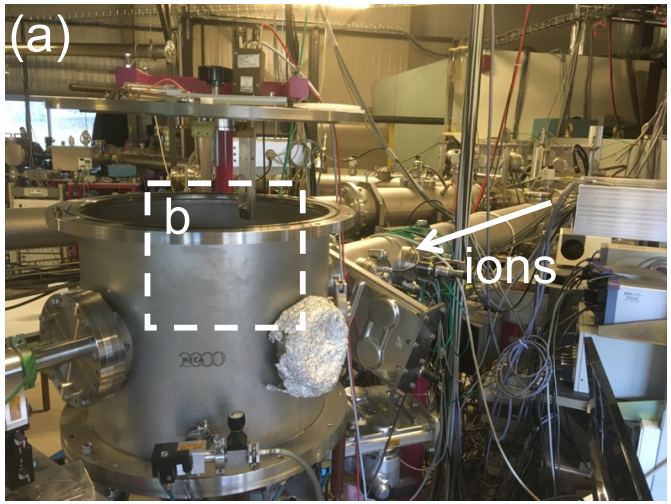


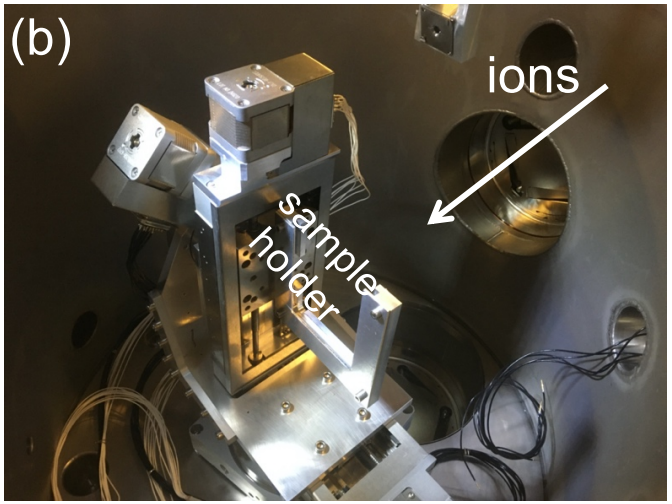


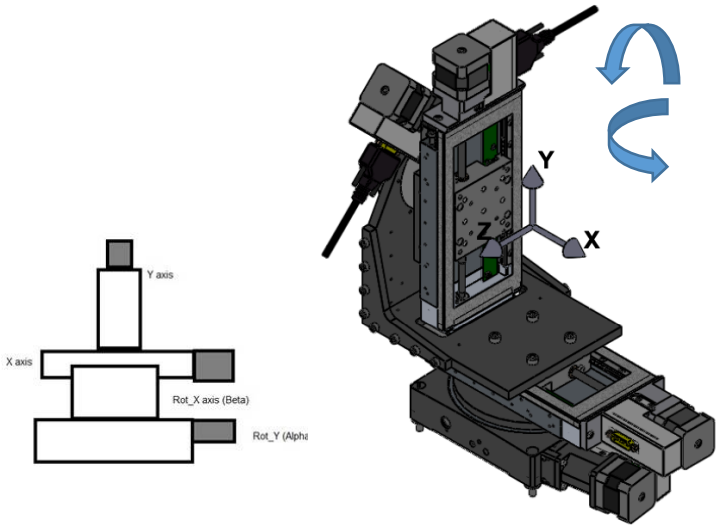


Nouveau goniomètre pour l'analyse par faisceaux d'ions

- ✓ **Travaux pratiques** Masters Université Paris-Saclay : *Utilisation de la canalisation d'ions légers à la mesure de l'endommagement des matériaux d'intérêt pour les applications liées à l'énergie nucléaire*
- ✓ **Spectrométrie de rétrodiffusion Rutherford en géométrie de canalisation** (RBS-C): caractérisation de l'endommagement de matériaux, localisation d'impuretés, cristallographie par faisceaux d'ions, …



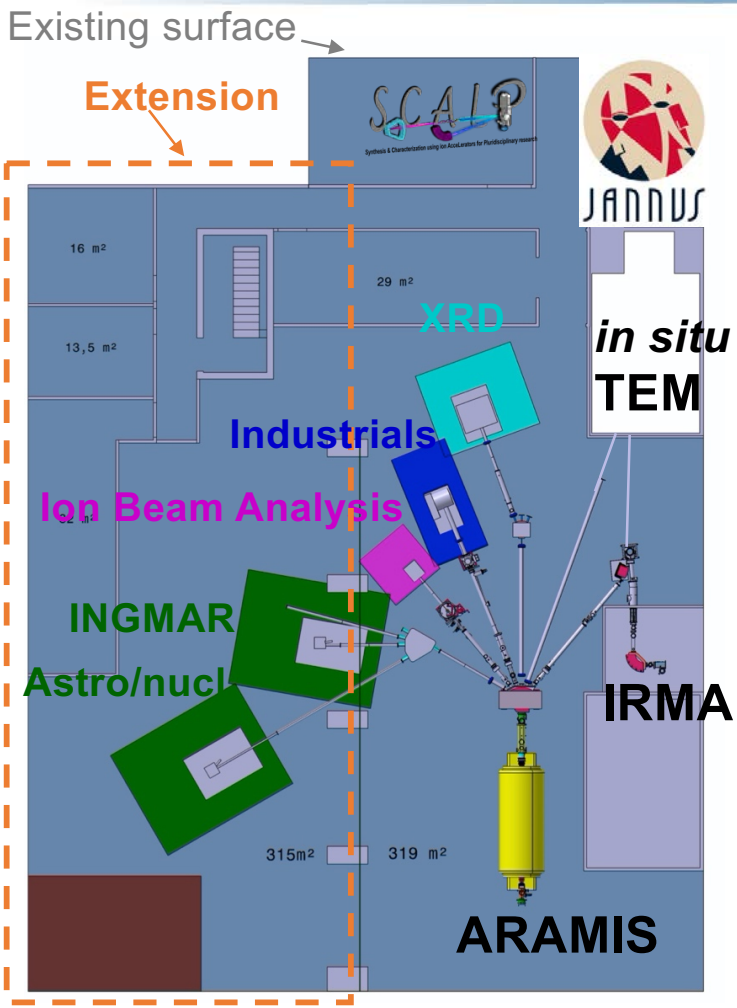




Financé en 2015 par LabEx P2IO
(AAP formation, F. Garrido, 25 k€) et
Master Nuclear Energy (10 k€)

Grande précision angulaire
- ✓ 2 rotations angulaires
- ✓ 2 translations

JANNuS-Orsay experimental hall extension



- ✓ **New ion beam lines on ARAMIS**
  - *In situ* X-Ray Diffraction line (SIXPAC project)
  - γ analysis line (astro/nucl. physics)
  - Infra-Red *in situ* Spectrometry (INGMAR setup)
  - …
- ✓ **Practical work** with dedicated beam time and data analysis room (Masters Université Paris-Saclay)
- ✓ **Industrials - Valorisation**

CPER P2IO Vallée

Start January 2021
Duration 12 months

JANNuS-SCALP, a facility open to external users

- Various themes: nuclear energy, microelectronics, geology, physics for health, nuclear astrophysics, solar cells, space technology
- Various users : Internal, Academics, Industrials, Lab works, EU programs

- GIS JANNuS (*Scientific Interest Group*) with JANNuS-Saclay facility (triple ion beam @ CEA, DES/ISAS/DMN/SRMP)
- Founding member of EMIR&A, French Accelerators federation for Irradiation and Analysis of Materials and Molecules

Web sites
http://www.csnsm.in2p3.fr/scalp
http://jannus.in2p3.fr
http://emir.in2p3.fr

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