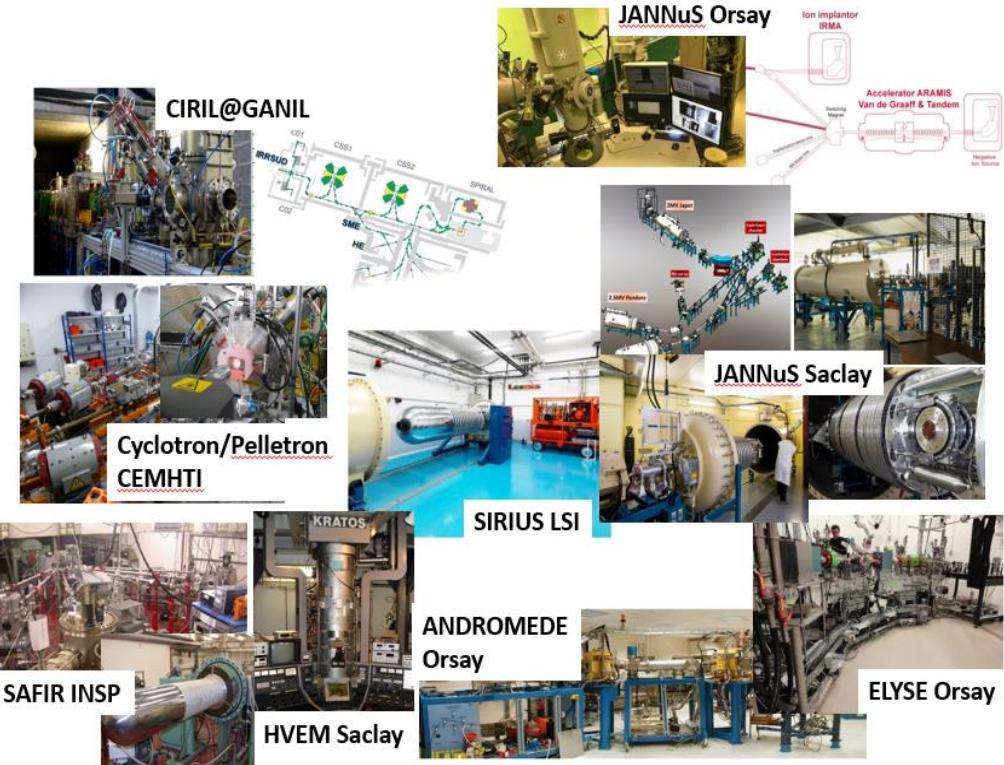


# EMIR&A

**French Network of Accelerators  
for Irradiation and Analysis of  
Molecules and Materials**

(<http://emir.in2p3.fr>)



Nathalie Moncoffre

Director of EMIR&A

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IP2I, Institute of Physics of 2 Infinities of Lyon  
France

# Presentation of EMIR&A



**EMIR&A partners:** supervised by the French host institutions (CNRS, Universities, CEA)

**EMIR = The federation of accelerators for the study of materials under irradiation created by the CNRS on January 1, 2014.**

**Research Federation (FR)** linked mainly to the Institute of Physics (INP) and also to the Institutes of Chemistry (INC) and Nuclear and Particle Physics (IN2P3)



## Research Infrastructure on the MESRI National Roadmap

Since its creation and until September 2019, EMIR was headed by Serge Bouffard, director of research CEA at CIMAP in Caen.

Since September 2019: Nathalie Moncoffre  
EMIR → EMIR&A (+ Ion beam Analysis, radiolysis)

# Recent evolution of the EMIR network → EMIR&A



## 2014 - 2019: 6 ion and electron irradiation platforms – 5 sites

- Research topics focused **on irradiation studies** in a wide range of materials  
**Fundamental research → Applications**

## In 2019: expand the EMIR scientific fields

- To further federate the scientific community of accelerators in France
- Irradiation effects in materials and molecules (including **radiolysis**)
- **Ion beam analysis**  
(in connection with the Ion Beam Analysis-Francophone network)
- New facilities

# EMIR Platforms



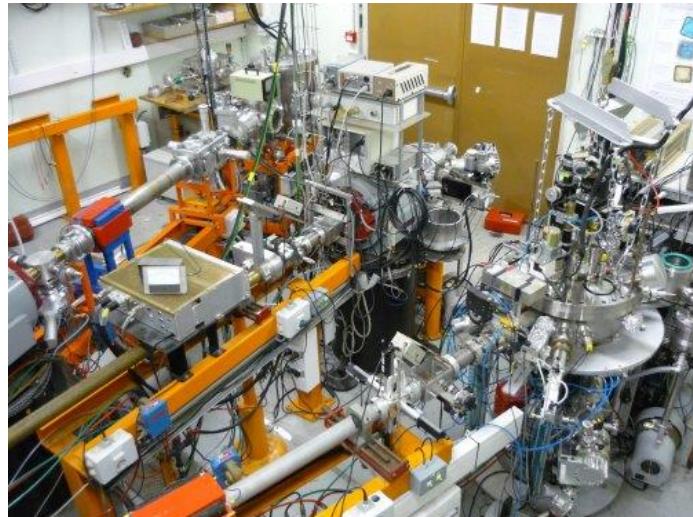
- CEMHTI - Orléans, UPR CNRS/INC, Université d'Orléans  
**45 MV Cyclotron**
- CIMAP -Caen, UMR CEA/DRF/IRAMIS, CNRS/INP, ENSICAEN, Univ. Caen-Normandie  
**SME, IRRSUD (talk C. Grygiel)**
- IJCLab - Orsay - UMR CNRS/IN2P3, Université Paris-Saclay  
**JANNuS - Orsay : IRMA 190 keV implantor, ARAMIS Tandem-VdG 2 MV**
- LSI - Palaiseau, UMR CEA/DRF/IRAMIS, CNRS/INP, École Polytechnique  
**SIRIUS, 2.5 MeV electron accelerator (talk A. Alessi)**
- CEA Saclay/DES/DMN  
**SRMP - JANNuS Saclay: EPIMETHEE, JAPET, PANDORE**  
**SRMA - HVTEM (electrons 1.2 MeV)**

**5 sites - 6 platforms  
10 accelerators**

# EMIR became EMIR&A



*Fédération nationale d'accélérateurs pour l'irradiation  
et l'Analyse des molécules et matériaux*



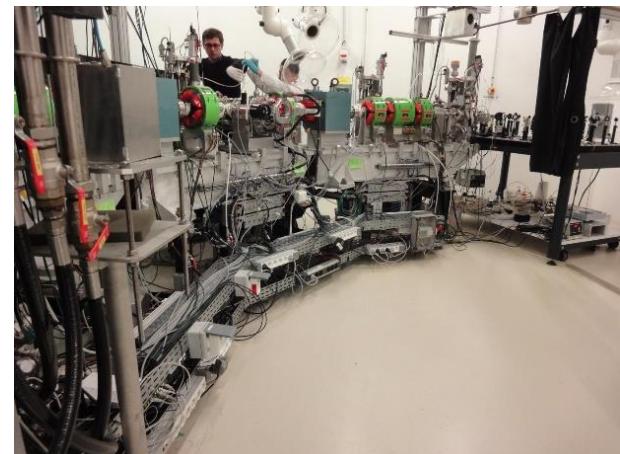
3 MV Pelletron CEMHTI, Orléans



SAFIR – 2.5 VdG, INSP, Paris

*Ion Beam Analysis  
techniques:  
RBS, NRA, ERDA,  
PIXE, MEIS*

ELYSE - ICP, Orsay  
9 MeV Electron accelerator, ps pulses  
Fundamental studies of ultra-fast chemical reactions  
Time-resolved radiolysis analysis  
with UV-Vis-NIR detection in liquids



## In 2020: ANDROMEDE (IJCLab, Orsay)

4 MV Pelletron

- Cluster beams
- Mass spectrometry analysis



## In 2021: Two other accelerators with new specificities

CEA – Saclay – DRF/IRAMIS/NIMBE

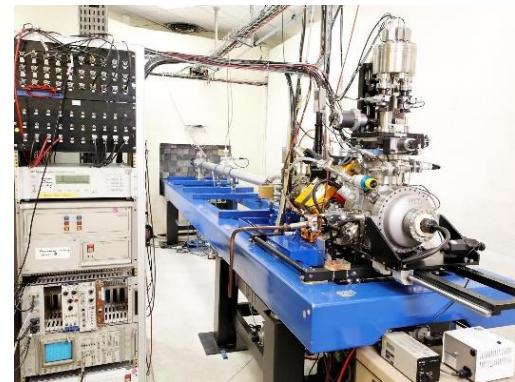
### *LEEL Nuclear microprobe*

3.75 MV Van de Graaff with 3 beam lines

Standard, radioactive samples, extracted beams

Typical microbeam:  $1.5 \times 1.5 \mu\text{m}^2 \rightarrow \mu\text{PIXE}, \mu\text{RBS}, \mu\text{NRA}, \mu\text{PIGE}$

2D/3D element mapping.



### *ALIENOR*

10 MeV electron accelerator, pulsed at the nanosecond.

- to study reactivities over longer times than ELYSE.
- time-resolved irradiation, irradiation under high pressure/high temperature conditions, high dose irradiation (maximum 10 MGy), low temperature irradiation,



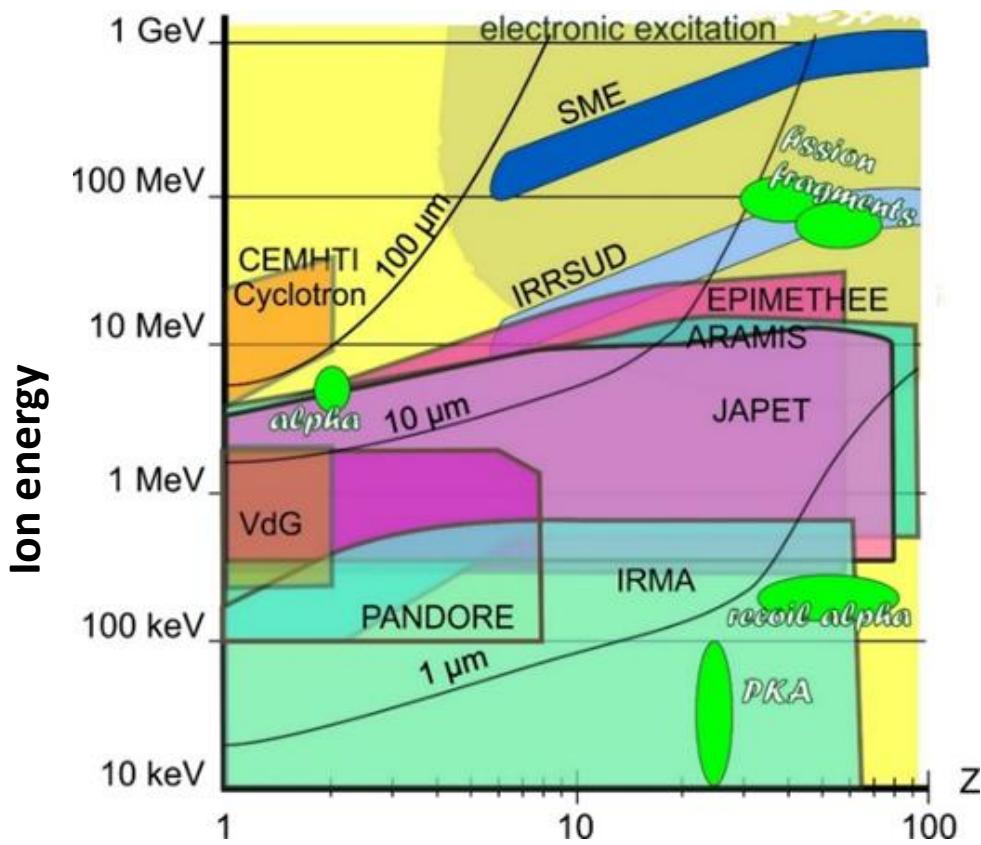
# EMIR&A platforms

- **Orléans**, CEMHTI -, UPR CNRS/INC, Université d'Orléans  
Cyclotron 45 MV, Pelletron 3 MV
- **Caen**, CIMAP -, UMR CEA/DRF/IRAMIS, CNRS/INP, ENSICAEN, Univ. Caen-Normandie  
SME, IRRSUD
- **Orsay** IJCLab - UMR CNRS/IN2P3, Université Paris-Saclay  
JANNuS –Orsay : IRMA 190 keV implantor, ARAMIS, Tandem-VdG 2 MV  
Andromède, 4 MV Pelletron  
ICP –Université Paris-Saclay  
ELYSE, 9 MeV electrons
- **Palaiseau**  
LSI - UMR CEA/DRF/IRAMIS, CNRS/INP, École Polytechnique  
SIRIUS 2.5 MeV electrons
- **CEA Saclay**  
JANNuS Saclay: EPIMETHEE, JAPET, PANDORE  
HVTEM 1.2 MeV electrons  
ALIENOR 10 MeV electrons  
LEEL Microbeam
- **Paris-Sorbonne Université, INSP**  
SAFIR, 2.5 MV VdG



# These platforms are highly complementary for irradiation and material analysis

**Irradiation:** These installations cover a very wide range Z - energy  
 $Z = 1 \rightarrow 92$  and 10 keV to GeV



***in situ* characterisation:** They offer original and high-performance online instrumentation:  
transmission electron microscopy, Raman spectroscopy, X-ray diffraction, optical spectroscopy, ion beam analysis techniques (Rutherford backscattering, nuclear reactions, ...).



*in situ* XRD diffractometer  
IRR SUD-GANIL

TEM Jannus-Orsay  
(© C. Baumier  
(IJCLab)

Platform	Accelerators	Beams	Irradiation set up	On line characterization
CEMHTI/CNRS-INC	Cyclotron	p, d, He 10-45 MeV	External beam/radiolysis LN2 1200°C	creep measurement <i>In situ</i> Raman
	Pelletron 3 MV	p, d, He, 0.5 - 3 MeV	5 axis goniometer 173 – 1300K	RBS, NRA, ERDA <i>In situ</i> Raman, resistivity
IJCLab/CNRS-IN2P3 JANNuS-Orsay	IRMA Implanter 190 kV	H – Bi 10 to 570 keV	Scanning device	<i>In situ</i> TEM, <i>in situ</i> RBS-C
	ARAMIS Tandem - VdG 2 MV	H- Bi 0.5 to 11 MeV	Scanning device LN2 – 1300K	<i>In situ</i> TEM, <i>in situ</i> RBS-C
	ANDROMEDE	H to Au Few 100 keV to few MeV	UHV	MeV NPS <i>in situ</i> (time of flight/multi-anode detector)
CIMAP –GANIL CNRS-INP	SME	C – U 4.5 to 13 MeV/A	8 – 1200K	XRD, IR, gas analysis
	IRRSUD	C – U 0.3 to 1 MeV/A	8 – 1200K	XRD, IR, iono-luminescence, gas analysis
SRMP/CEA JANNuS -Saclay	EPIMETHEE	H – Bi (source ECR) 0. 5 to 50 MeV	Triple beam chamber Scanning device 77 – 1100K	<i>In situ</i> Raman, gas analysis
	JAPET	H – Bi 0.5 to 18 MeV	Scanning device 77 – 1100K	<i>In situ</i> Raman
	PANDORE	H, D, He 0.5 to 2.5 MeV	Scanning device 77 – 1100K	<i>In situ</i> Raman, RBS, NRA, PIXE, ERDA
SRMA/CEA	HVTEM	Electrons 0.3 to 1.2 MeV	Heated sample holder (RT-1100K), SAT sample holder (RT-673K)	CCD camera for <i>in situ</i> TEM

Platform	Accelerators	Beams	Irradiation set up	On line characterization
NIMBE/CEA	ALIENOR	Electrons 10 MeV	Nanosecond pulsed beams	The environment of the sample can be instrumented (temperature, pressure) gas measurements
	LEEL Microprobe	3.75 VdG	Microbeams (1.5x1.5 $\mu\text{m}^2$ ), Radioactive samples, external beams	$\mu\text{PIXE}$ , $\mu\text{RBS}$ , $\mu\text{NRA}$ , $\mu\text{PIGE}$ , element mapping
LSI/CNRS-INP	SIRIUS	Electrons 0.15 to 2.5 MeV	Low T device (20K)	Conductivity, Hall effect, absorption, <i>in situ</i> photo and cathodo luminescence, EPR
INSP/CNRS-INP	SAFIR 2.5 MV VdG	P, d, He, C, N, O 100 keV to 2.5 MeV	Scanning device, goniometer, <i>in situ</i> thermal treatments	RBS, NRA, ERDA, MEIS
ICP/CNRS-INC	ELYSE	Electrons 3 to 9 MeV	Impulsions ps	UV, Vis, NIR spectro time resolved by probe-pump or streak camera

## EMIR&A

Set of accelerators and instrumentations made available to **users everywhere in the world**, after evaluation by an international scientific committee.

→ EMIR&A : <http://emir.in2p3.fr/>

- One call for proposal per year (mid-October)
- Pump priming possibility for Ion Beam Analysis proposals

## Aims at



- Structuring and bringing together the scientific community that studies condensed matter with accelerated ions and electrons
- Encouraging collaborations thanks to this pool of instruments and the associated scientific and technical expertise
- Animating the scientific community

**EMIRUM (EMIR&A user Meeting)**

# Scientific issues

## Fundamental research

### Solid state physics: Irradiation = A unique tool to understand solid properties

#### Intrinsic properties - defects

- Defect trapping, doping
- Role of defects on superconductivity/ferromagnetism
- Defect annealing
- Role of ballistic damage, electronic excitations, synergetic effects

Cryogenic system  
SIRIUS, LSI



### Irradiation: A unique tool to create controlled damage and understand the evolution of material microstructure and properties under irradiation

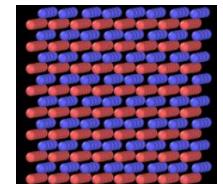
- Role of grain boundaries
- Chemical segregations
- Irradiation induced-processes (diffusion, corrosion, radiolysis)
- Modifications of use properties (mechanical, magnetic ...)

#### Material modelling

Control of irradiation parameters (T, flux, dose)

Separate-effect studies → mechanistic studies

Theoretical approach  
Multiscale modelling



## Ion beam analysis

- Light element analysis (H, He, C, O)
- Isotopic tracing for corrosion studies,
- Diffusion mechanisms,
- ....

## Pulsed beams

- Radiolysis studies
- Rapid kinetics processes



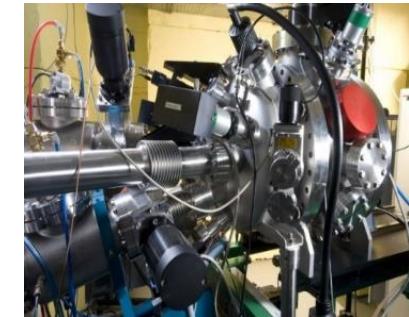
*Experimental hall© INSP  
2.5 MeV VdG*

-> Importance of *in situ* characterization tools  
-> For a given study:  
    Possibility to apply for complementary beams and instrumentations

# Applications

## Nuclear energy (fission, fusion)

- Material ageing: ions to simulate neutrons in all kinds of materials in the nuclear fuel cycle
- Damage effects in different energy domains ( $dE/dx$ )
- diffusion
- Corrosion
- ...



*Triple beam chamber  
Jannus Saclay*

## Electronics

- Implantation
- Smart-cut process



*Raman/Irradiation/HT  
CEMHTI*

## Radiative environment

- Robots for nuclear applications, satellites,
- Space applications



*Goniometric chamber  
SAFIR, INSP  
© INSP Emrick Briand*

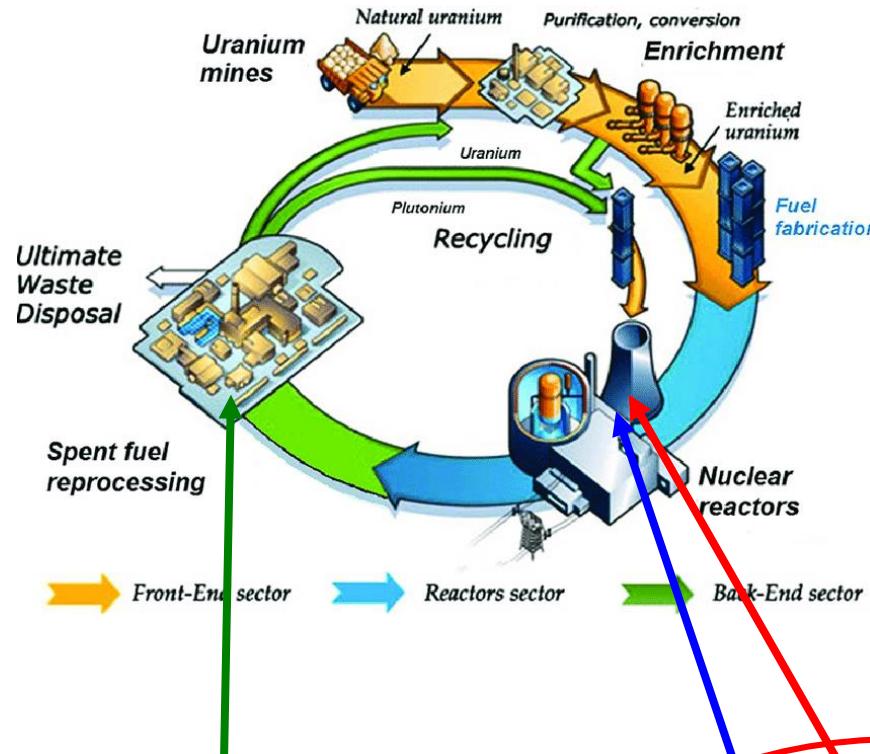
## Nanostructuration

- Trace formation , nanopores for functionalization ...

## Polymer reticulation

- Cables, claddings, ...

# In the field of materials for the nuclear fuel cycle



**Innovating materials:  
Conditioning materials**



EMIR&A : studies on all kind of materials

- Absorbers
- PWR Structural materials (claddings, structures, ...)
- Materials for fusion, GEN IV reactors, ...)
- Polymers
- Confining materials (glasses, transmutation, cementitious materials ,.....)

# Use of ions to simulate neutrons

not perfect but:

- Decouple parameters (energy deposition, temperature)
- Prevent from sample activation → facilitate post-irradiation analysis
- Couple experiments/modelling
- *in situ* experiments: cutting-edge sample characterization
- Simulate the presence of gas/ H, He + irradiation effects (dual, triple beams)
- Study of model materials
- Accelerate in reactor processes:

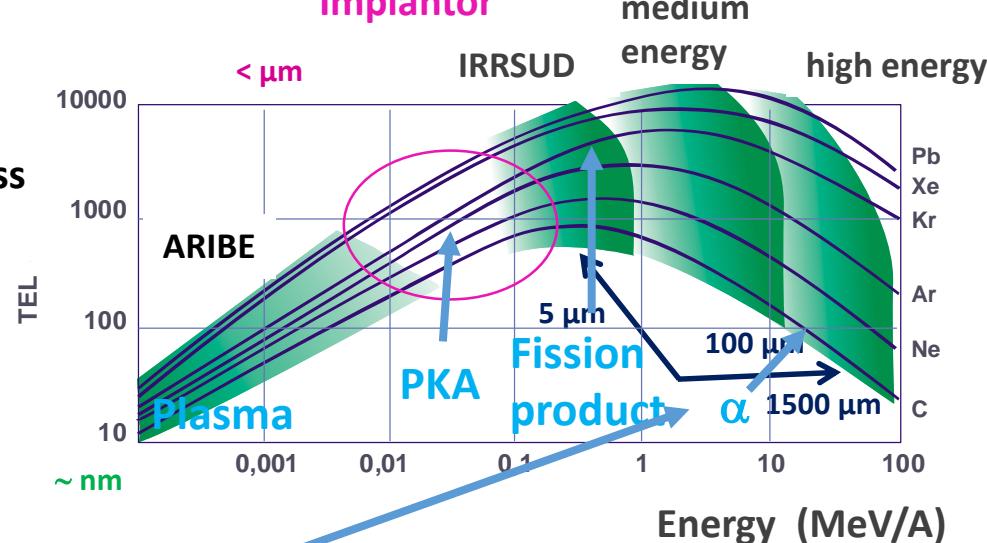
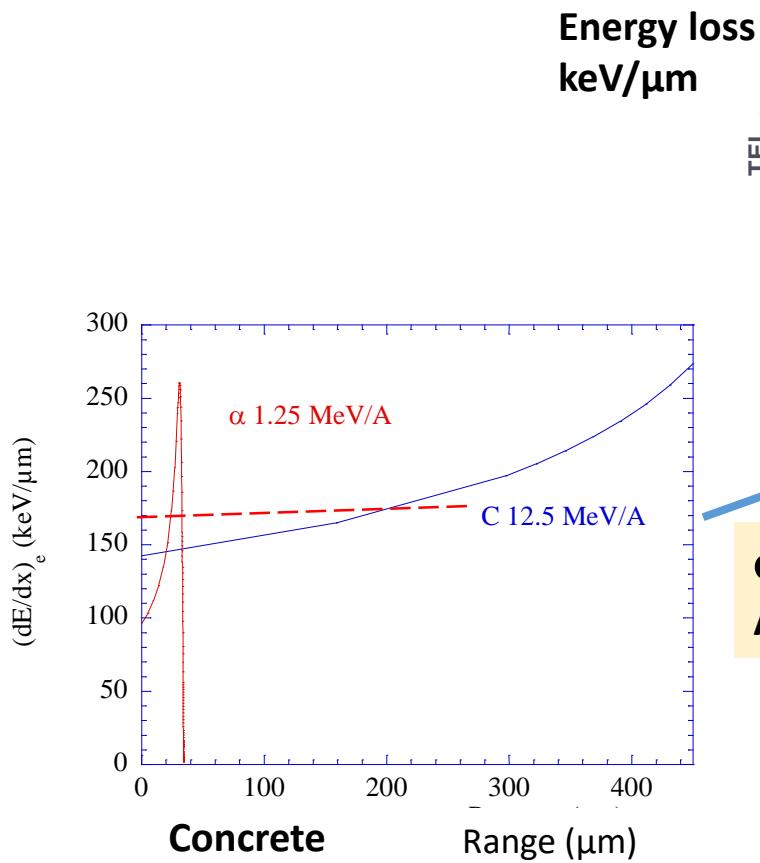
Like neutrons, ions create **dpa representative of material damaging**

	dpa/s	To reach 1 dpa	accessible dpa
<b>Helium 1 MeV</b>	$4 \cdot 10^{-6}$	3 days	2 dpa
<b>Krypton 1.2 MeV</b>	$3 \cdot 10^{-3}$	6 minutes	45 dpa
<b>Argon 600 keV</b>	$6.7 \cdot 10^{-2}$	20 seconds	200 dpa

Ions, depending on the type of interaction with matter allow simulating  $\alpha$ , FP, ...



Aramis  
Implantor



$\alpha$  can be simulated by 12.5 MeV/A C  
Advantage : much larger irradiated depths

**CiMap**

## JANNuS-Orsay, Joint Accelerators for Nanosciences and Nuclear Simulation

JANNuS-Orsay + 50 kV isotope separator SIDONIE (not mentioned hereafter) = JANNuS-SCALP platform at IJCLab



<https://www.ijclab.in2p3.fr>  
<http://jannus.in2p3.fr>

Home-made ion  
accelerators

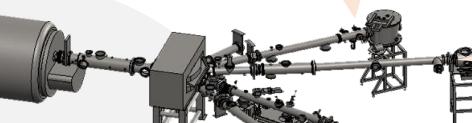


**ARAMIS** SINCE 1987  
2 MV Tandem – Van de Graaff

SNICS negative ion source:  
 $500 \text{ keV} < E < 11 \text{ MeV}$ ;  $10 \text{ nA} < i < 10 \mu\text{A}$   
 Penning source @ HV :  $i < 20 \mu\text{A}$   
 $200 \text{ keV} < \text{He} < 3.6 \text{ MeV}$ ;  $200 \text{ keV} < \text{H} < 1.8 \text{ MeV}$

E. Cottreau et al., NIMB 45 (1990) 293  
 H. Bernas et al., NIMB 62 (1992) 416

ARAMIS



**Ion Beam Analysis**  
 RBS, RBS/C, ERDA,  
 PIXE,  $\mu$ PIXE, PIGE

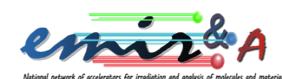


**Ion implantation / irradiation**  
 $\text{LN}_2 \rightarrow 1000^\circ\text{C}$

**IRMA** SINCE 1979  
**190 kV ion implanter**  
 $10 - 570 \text{ keV}$ , up to 20 mA

J. Chaumont et al., NIMB 198 (1981) 193

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



***in situ* RBS/C  
and ion impl.**  
 $\text{LN}_2 \rightarrow 600^\circ\text{C}$



TEM



**IN SITU DUAL ION BEAM TRANSMISSION  
ELECTRON MICROSCOPE**  
 SINCE 1980  
 UPDATED IN 1994, 2007

M.-O. Ruault et al., J. Mater. Res. 20 (2005) 1758  
 A. Gentils et al., NIMB 447 (2019) 107

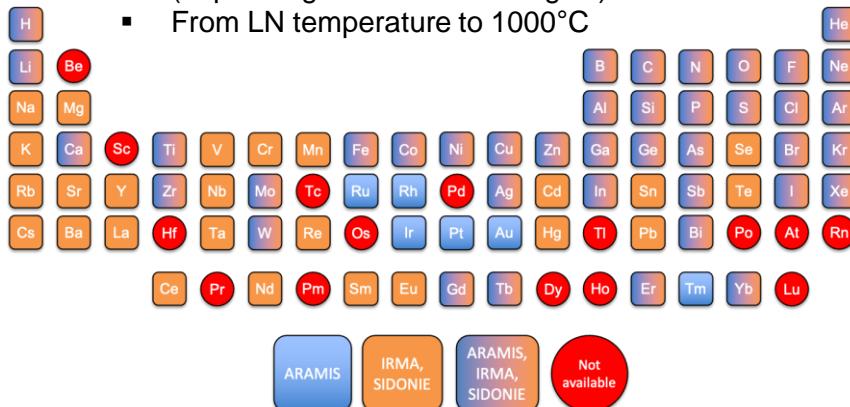
aurelie.gentils@ijclab.in2p3.fr

# A large diversity of ions and energies available, with *in situ* characterizations

71 chemical elements available, with an energy range of 100 eV to 11 MeV

Typical irradiation conditions:

- Rastered beam
- Average flux range  $1.10^{10} - 5.10^{11} \text{ cm}^{-2}.\text{s}^{-1}$  (depending on ions and energies)
- From LN temperature to 1000°C



50 kV SIDONIE

100 eV

1 keV

10 keV

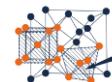
190 kV IRMA

100 keV

2 MV ARAMIS

1 MeV

10 MeV



Ion beams for material science

- Deposition, ion implantation and ion beam analysis, *in situ* characterization techniques of materials
- Various topics: nuclear energy, microelectronics, geology, physics for health, nuclear astrophysics, solar cells, space technology
- Various users : Internal (IN2P3), Academics, Industrials, Lab works, EU programs
- Access through EMIR&A annual call or quotation or collaboration

Contact: [aurelie.gentils@ijclab.in2p3.fr](mailto:aurelie.gentils@ijclab.in2p3.fr)

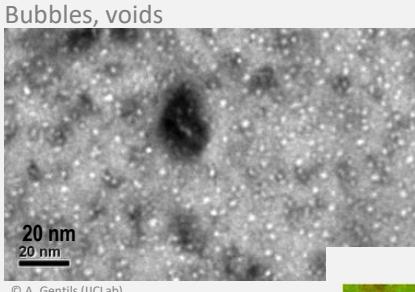
Operations manager: Dr Cyril Bachelet

Scientific leader: Dr Aurélie Gentils

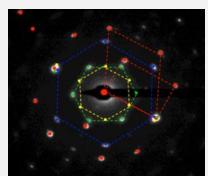
# A unique *in situ* dual ion beam Transmission Electron Microscope (TEM)



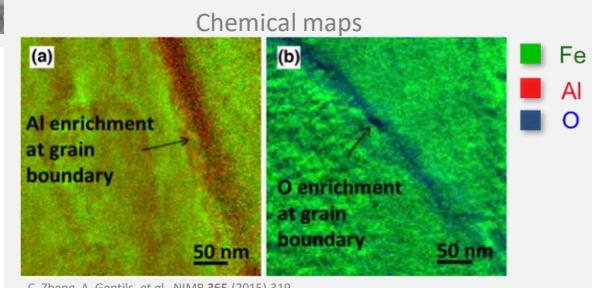
- ✓ Dynamical observation (above 100 keV N ions)
- ✓ Ion beam dosimetry inside TEM: continuous flux measurement
- ✓ Raster scanned ion beam(s)



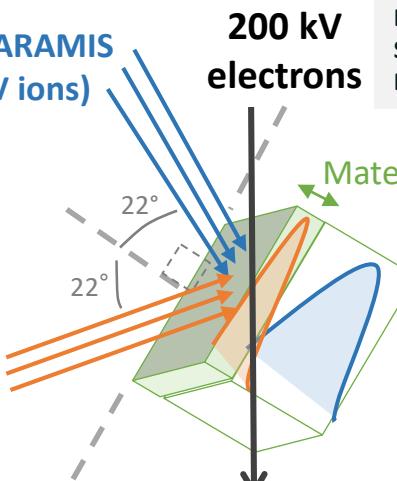
Crystallographic structure



Ions from IRMA  
(10 to few 100 keV ions)

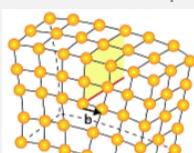


Ions from ARAMIS  
(few MeV ions)

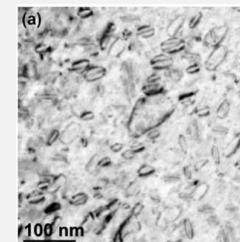


Imaging, Diffraction, and Chemical Analysis

Dislocations, dislocation loops



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



200 kV FEI Tecnai G<sup>2</sup> 20 TWIN  
Electron source: LaB<sub>6</sub> filament  
Spatial resolution: 0.27 nm  
Magnification range: x 70 – 700 000

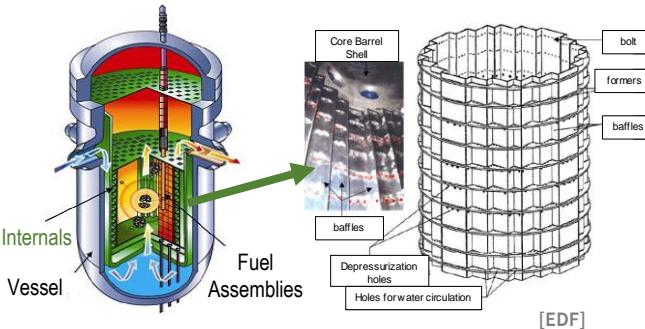
Techniques available:  
Conventional TEM  
Scanning TEM  
EDX, EELS, EFTEM, HAADF

**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....

# Ex: Synergetic effects: concomitant helium accumulation and damage creation

## Co-influence of helium and irradiation on the swelling of PWR vessel internal components (austenitic steels)

Pressurized Water Reactors :  
lifetime extension up to 60 years ?



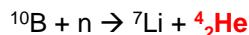
304 and 316 austenitic stainless steels constitute the core internals of PWR

- Irradiation : up to 120 dpa after 60 years
- Temperature 380°C
- Helium production: 10-15 appm He / dpa

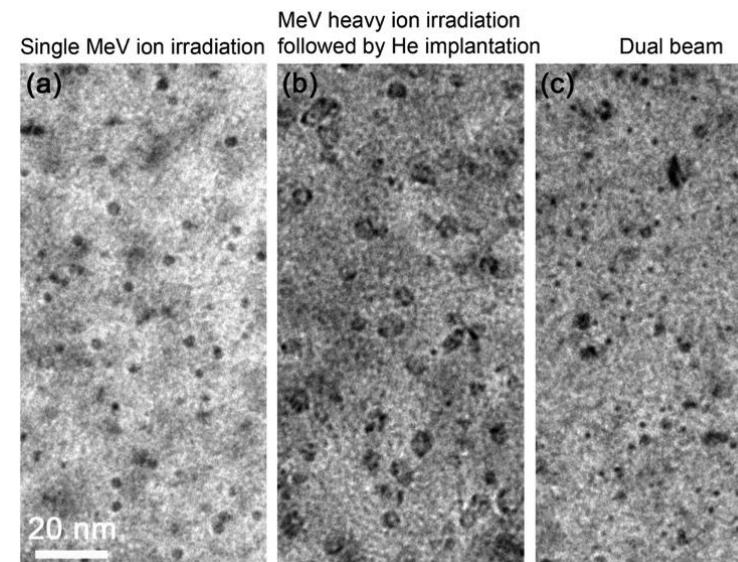
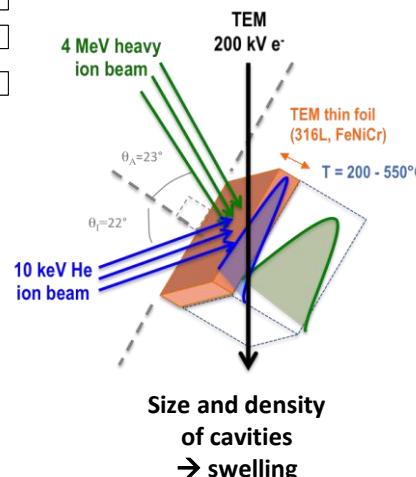
Production of helium from nickel (mainly):



Production of helium from boron:



Experimental simulation  
using two ion beams



Bright field Transmission Electron Microscopy images of cavities (black points)

S. Jublot-Leclerc, A. Gentils *et al*, Journal of Nuclear Materials 2017

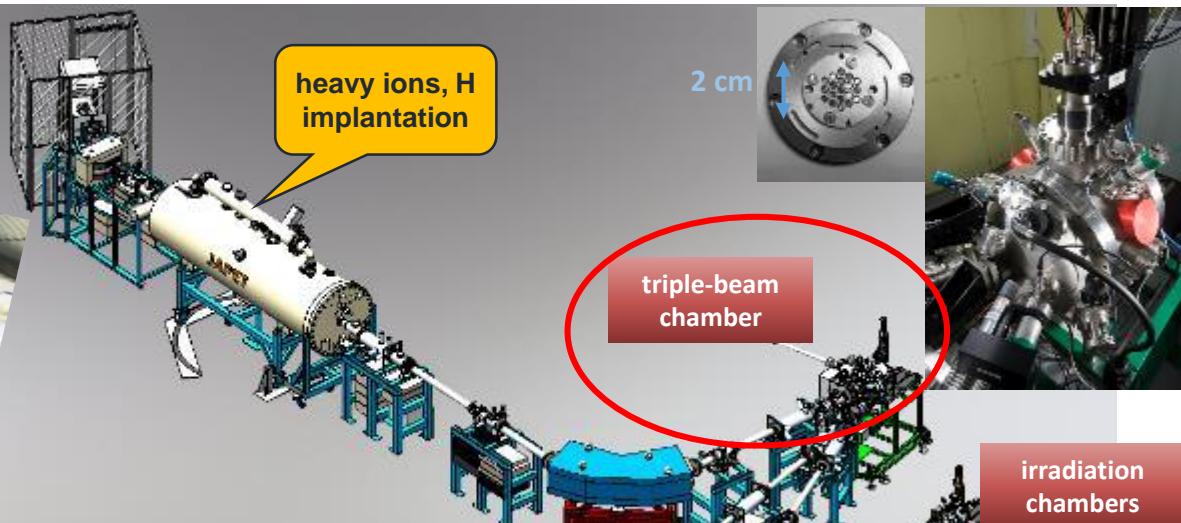
# Accelerator testing of nuclear materials – JANNuS-Saclay multiple ion beam irradiation facility



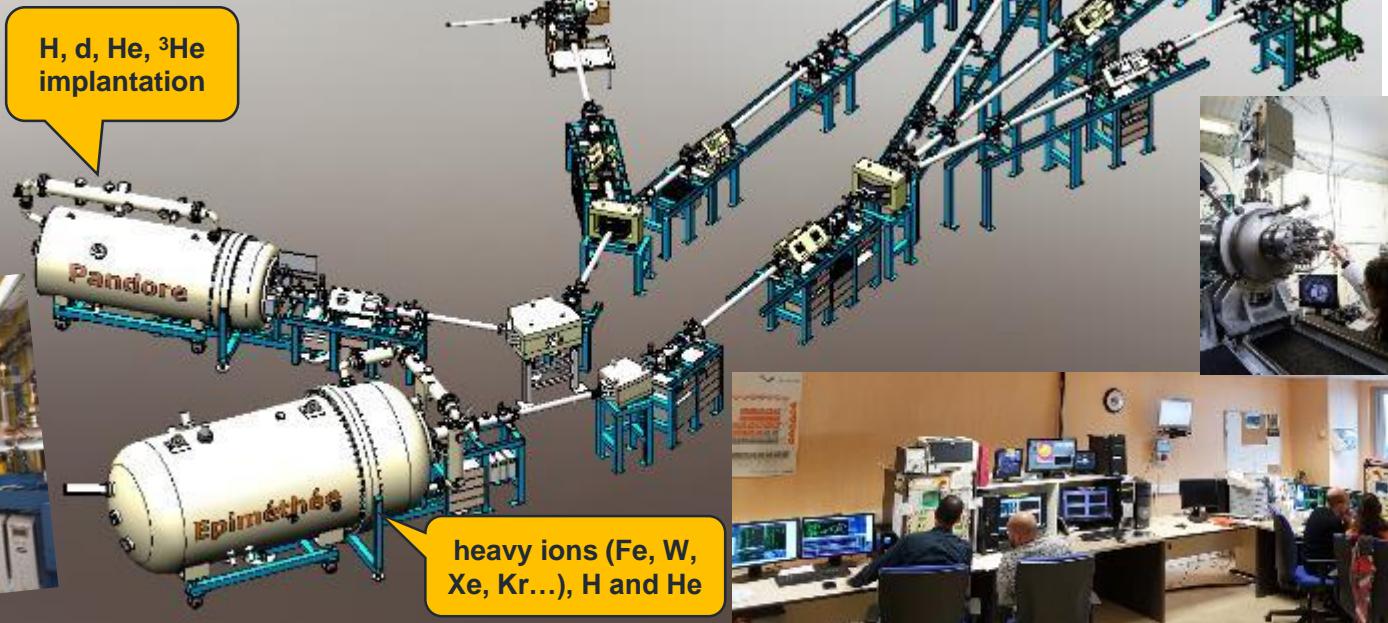
Celine.CABET@cea.fr



Japet, tandem 2MV

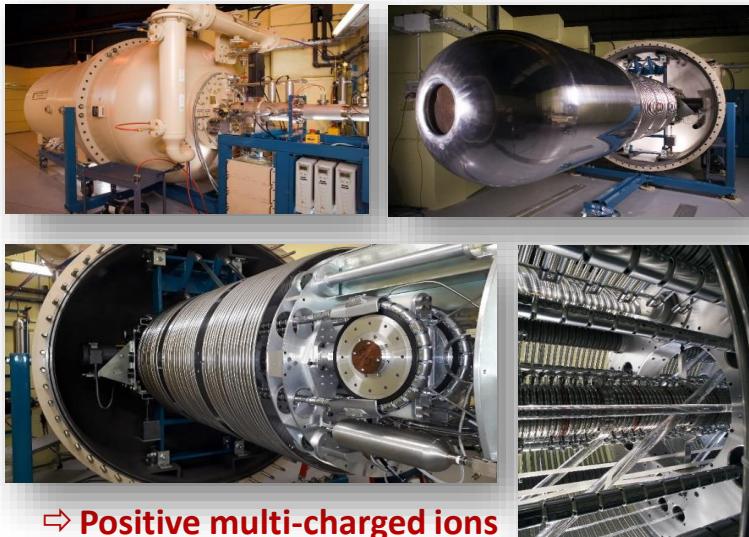


Pandore, 2.5MV



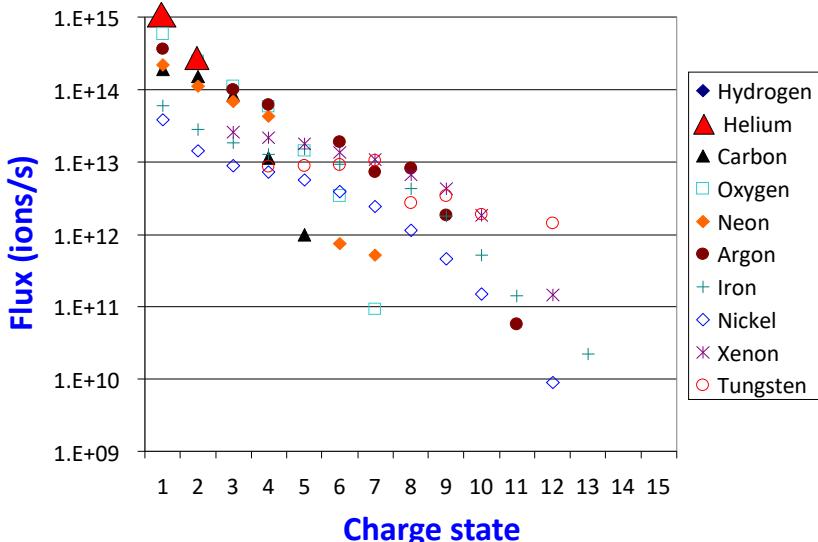
## JANNuS-Saclay: 3 MV Pelletron Épiméthée

- Accelerator: 3 MV Pelletron NEC (National Electrostatics Corp.) with a ECR (Electron Cyclotron Resonance) source from Pantechnik



- ⇒ Negative single-charged ions are converted into positive multi-charged ions through the stripper

→ provide highly damaging beams



Ballistic damage with Fe (~10 dpa/h)

### PANDORE 2.5 MV Pelletron with Radio Frequency source



⇒ Single-charged gasses: H, D, <sup>3</sup>He, <sup>4</sup>He

# Complementary sources for a variety of intermediate-energy ion-beams

Courtesy of S. Bouffard

**Epiméthée**

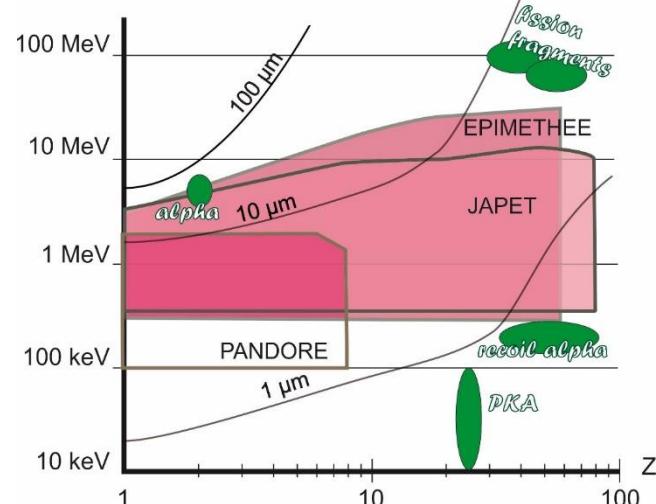
ECR (Electronic Resonance Cyclotron) from Pantechnik  
 ⇒ multicharged positive ions  
 $450 \text{ keV} < E < 40 \text{ MeV}$

**Japet**

Tandem + SNICS II (Source of Negative Ions by Cs Sputtering)  
 ⇒ negative ions ⇒ multicharged positive ions after stripping

**Pandore**

RF ⇒ monocharged positive ions (H, d, He)



H

Li Be

Na Mg

K Ca

Rb Sr

Cs Ba

Sc

Ti

V

Cr

Mn

Fe

Co

Ni

Cu

Zn

Ga

Ge

In

Sn

Sb

Te

I

Xe

Y

Zr

Nb

Mo

Tc

Ru

Rh

Pd

Ag

Cd

In

Sn

Sb

Te

I

Xe

Hf

Ta

W

Re

Os

Ir

Pt

Au

Hg

Tl

Pb

Bi

Po

At

Rn

He

F

Ne

Ar

Kr

Br

Epiméthée

Japet

Epiméthée /  
Japet

Epiméthée /  
Pandore

Epiméthée /  
Pandore / Japet

optimised

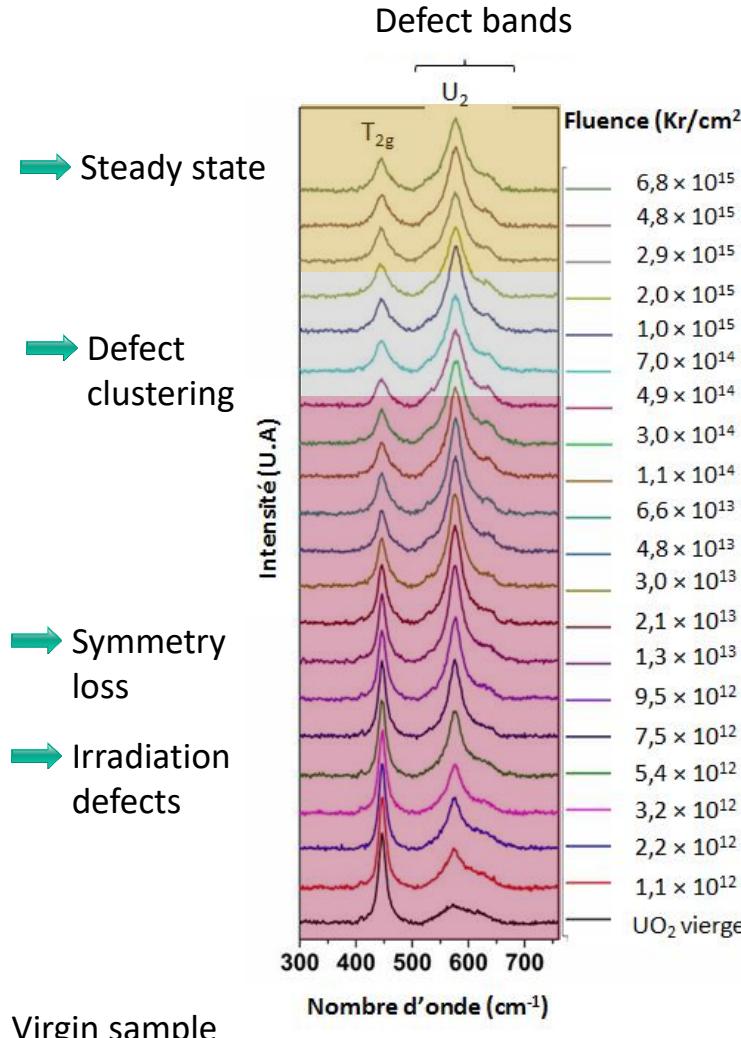
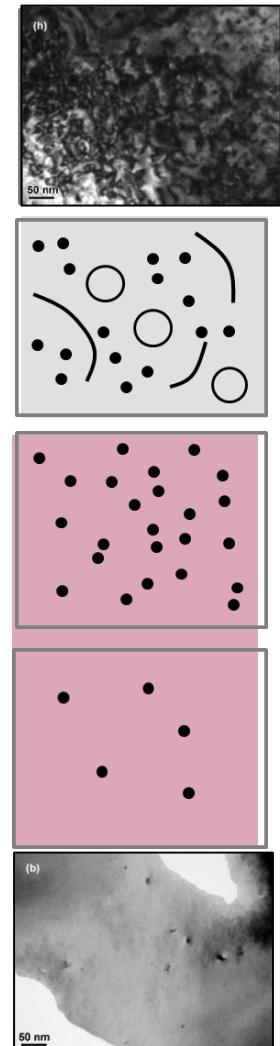
to be tested

un  
availa  
ble

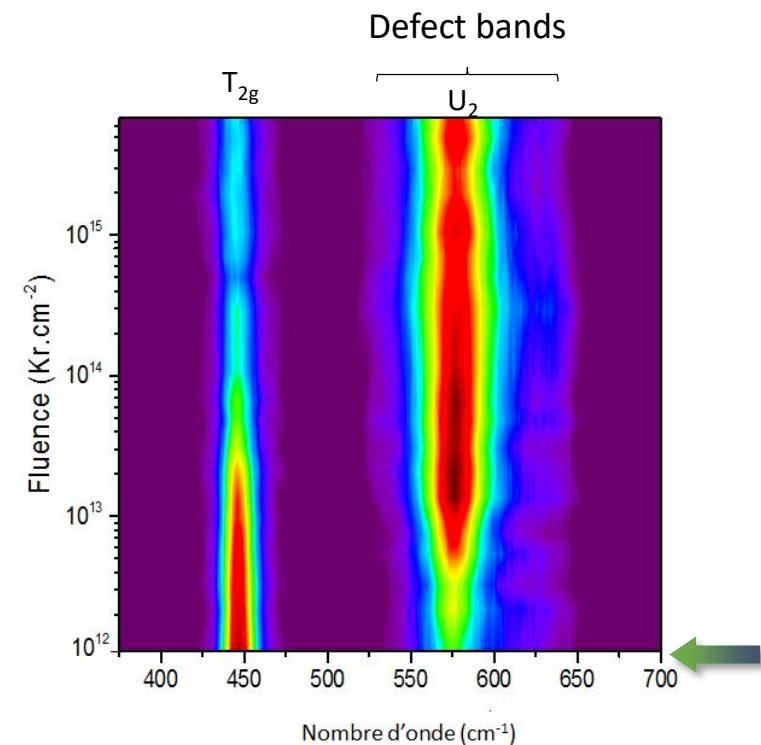
# Example of studies - in situ Raman spectroscopy

## ► Irradiation of $\text{UO}_2$ with 4 MeV Kr at $-160^\circ\text{C}$

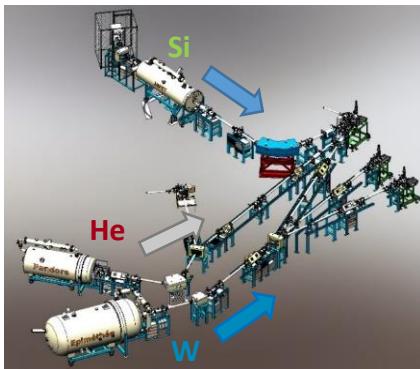
C. Onofri et al., NIMB 374 (2016) 51



Microstructure and damage evolution with increasing fluence



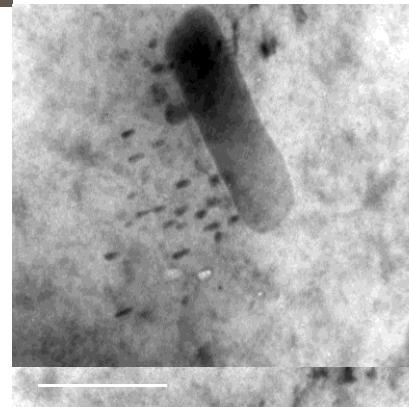
► Triple beam irradiation for studying the long term microstructure development of RJH (Jules Horowitz Reactor) in-core plate Al-alloy



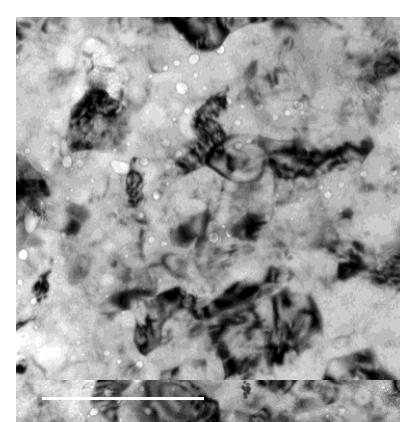
**Japet:** Si beam implantation mimicking the transmutation of Al into Si

**Pandore:** Helium implantation for reproducing He production by fast neutrons

**Epiméthée:** 20 MeV W beam for high dpa rate



*Si rich precipitate*



*He-stabilized cavities*

V. Garric et al., Mater. Sci Eng 753 (2019) 253-261

## ➤ He behaviour in $\text{UO}_2 \rightarrow$ He analysis by NRA

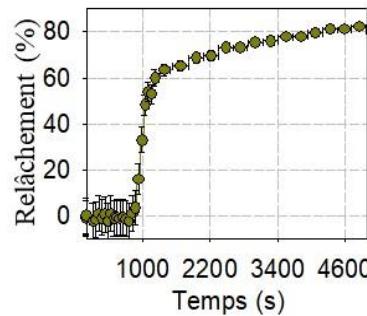


Implanted (Simulate  ${}^4\text{He}$ )

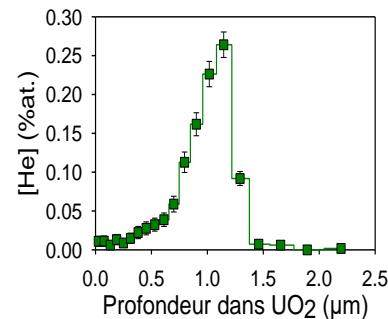
He profiles and release in  $\text{UO}_2$   
As function of time and temperature

↓ *in situ measurement*

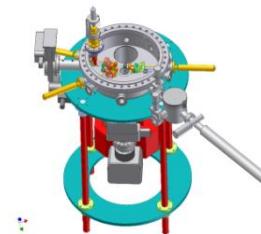
He desorption ( $t, T$ )



He profiles 1D (Z)

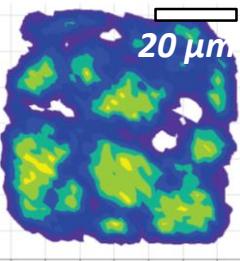


CEMHTI  
DIADDHEM device  
-150 – 1400°C



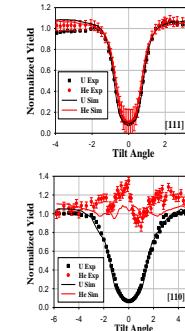
↓ *ex situ measurement*

He mapping (X,Y)



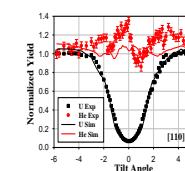
Locating He in the structure

Implantation RT



Axis [111]

Axis [110]



Octahedral site

T. Belhabib, Journal of Nuclear Materials 467 (2015) 1-8

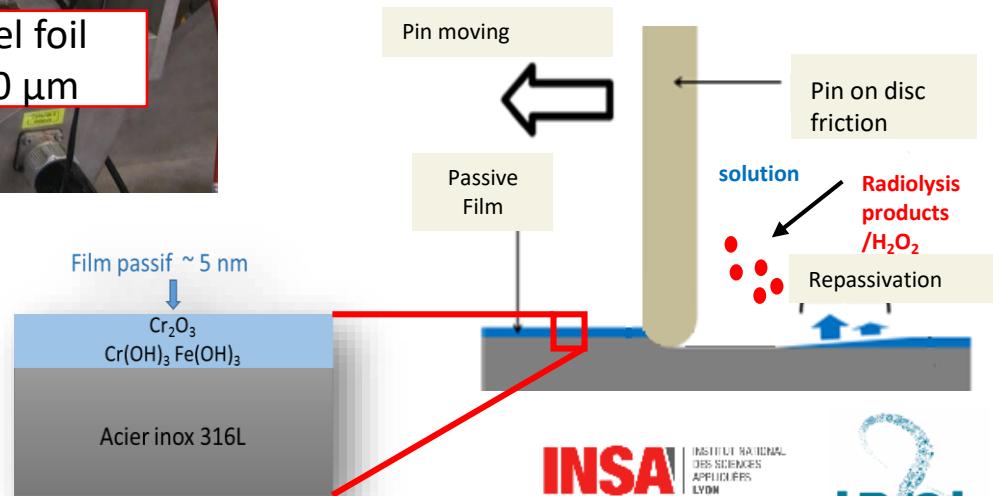
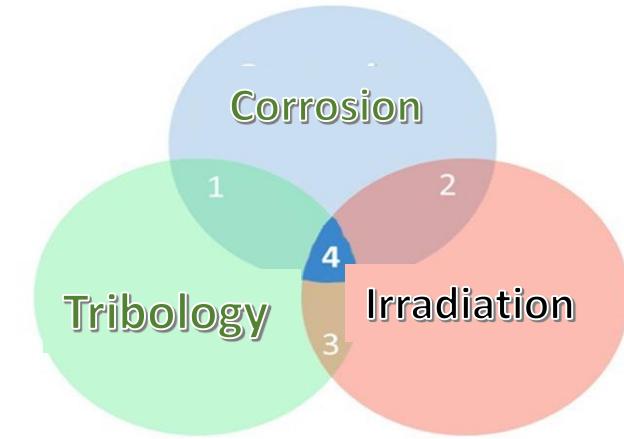
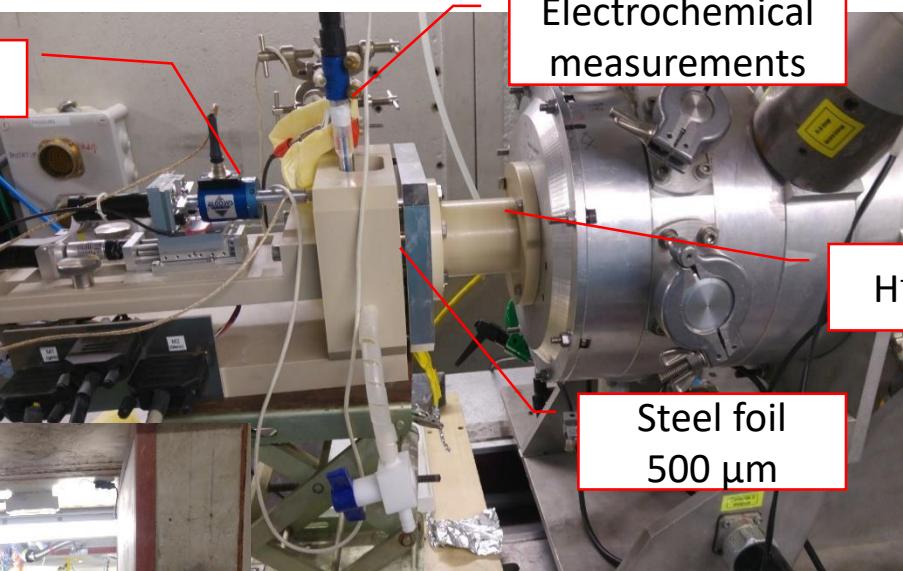
G.Martin et al., Nucl. Instr. Meth. Phys. Res. B 268 (2010) 2133-2137

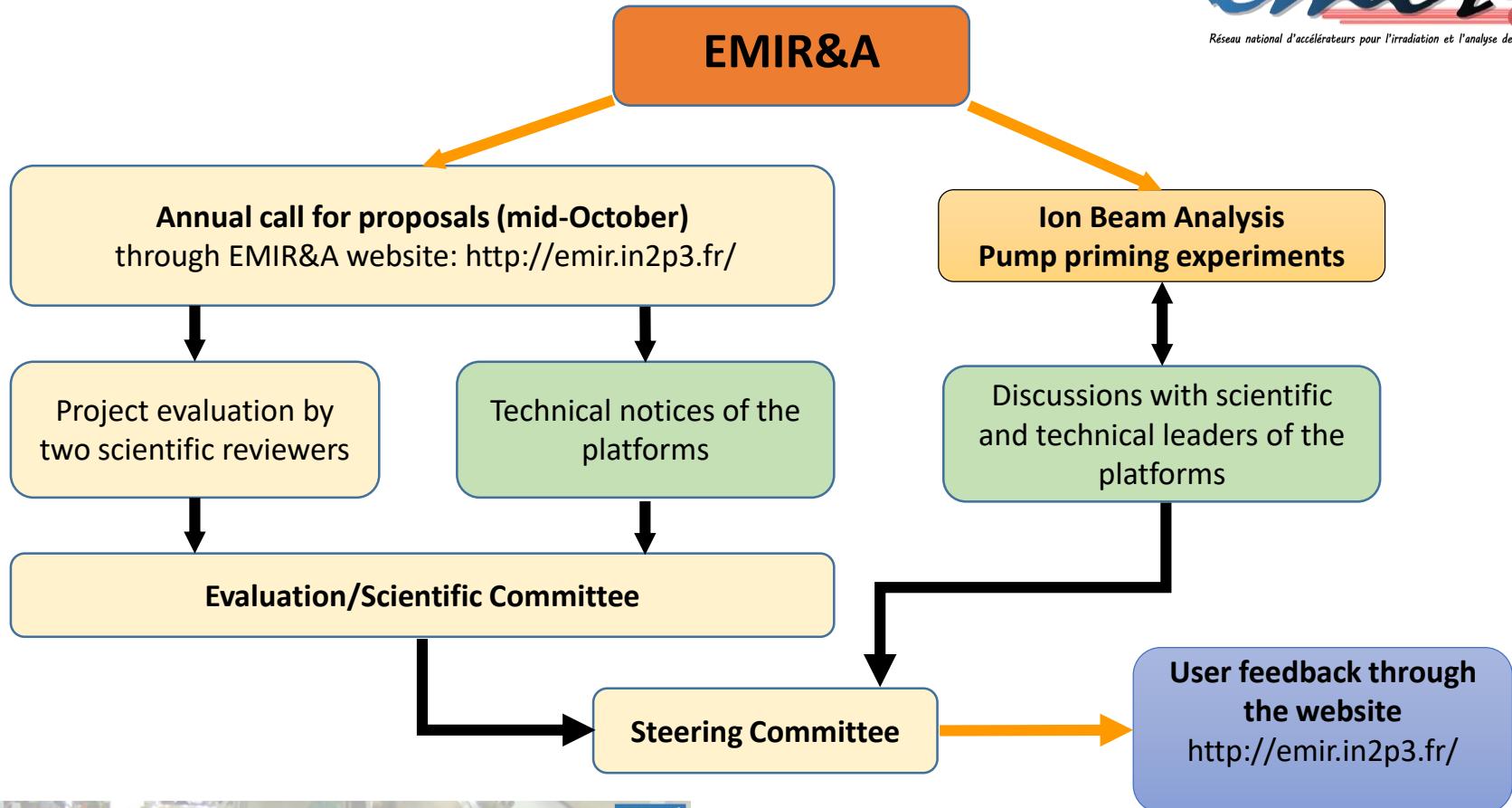
marie-france.barthe@cnrs-orleans.fr

## ➤ Study of the radiolysis effects at the interface stainless steel/solution

Original irradiation device - **16 MeV protons**

→ **Tribocorrosion under irradiation**





<http://emir.in2p3.fr/>

## When applying ...

### **Local contact(s) of the platform**

The feasibility of the experiment, the relevance of using a specific equipment of the EMIR&A network, the number of days, ...

**Complete the online form** which will be reviewed by reviewers and then the international scientific committee

## After the experiment has been carried out ...

**Submit back, online, a brief report:** summary of the results obtained and any difficulties encountered.

**For any publication or presentation** related to experiments carried out *via* EMIR&A

Acknowledge support from the EMIR&A French network (FR CNRS 3618) - specify the platform

# Organization

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Nathalie Moncoffre (IP2I Lyon)

### Deputy Director

Marie-France Barthe (CEMHTI Orléans)

### Deputy Director

Clara Grygiel(CIMAP, Caen)

## Coordinator

Cédric Baumier, IJCLab, Orsay

### Webmaster

Sébastien Grégoire, IJCLab, Orsay

<http://emir.in2p3.fr/>

## Platforms - Accelerators

**CEMHTI** - Orléans, UPR CNRS, Université d'Orléans, M. F. Barthe, T. Sauvage

- **45 MV Cyclotron, 3 MV Pelletron**

**CIMAP** - Caen, UMR CEA/DRF/IRAMIS, CNRS, ENSICAEN, Univ. Caen-Normandie I. Monnet, J. Rangama  
• **SME, IRRSUD**

**IJCLab** - Orsay - UMR CNRS, Université Paris-Saclay

- **JANNuS - Orsay : IRMA 190 keV implanter, ARAMIS, Tandem-VdG 2 MV** C. Bachelet, A. Gentils
- **Andromède, 4 MV Pelletron**, I. Ribaud

**ICP** – Orsay, CNRS et Université Paris-Saclay, S. Denisov, J. P. Larbre

- **ELYSE, Accélérateur d'électrons 9 MeV**

**LSI** - Palaiseau, UMR CEA/DRF/IRAMIS, CNRS/INP, École Polytechnique

- **SIRIUS, Accélérateur d'électrons 2,5 MeV**, A. Alessi, M. Raynaud

**NIMBE** CNRS et CEA Saclay

- **ALIENOR Accélérateur d'électrons** S. Le Caë, **Microsonde LEEL** H. Khodja

**SRMP** - CEA Saclay, C. Cabet

- **JANNuS Saclay : EPIMETHEE, JAPET, PANDORE**

**SRMA** - CEA Saclay, O. Tissot

- **HVTEM (électrons 1,2 MeV)**

**INSP** – CNRS et Paris-Sorbonne Université, E. Briand, I. Vickridge

- **SAFIR, Accélérateur VdG 2,5 MV**

## Steering committee

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- Platform leaders :

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- Céline Cabet (CEA SRMP Saclay)
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- Michèle Raynaud, Antonino Alessi, LSI, (Palaiseau)
- Thierry Sauvage, CEMHTI, (Orléans)
- Isabelle Ribaud, (IJCLab, Orsay)
- Olivier Tissot, (CEA SRMA, Saclay)
- Ian Vickridge, Emrick Briand, (INSP, Paris)
- Sergey Denisov, Jean Philippe Larbre, (ICP, Orsay)

## Evaluation Committee/Scientific Committee

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## EMIR&A in a nutshell

- Provide the scientific community with unique online irradiation facilities and instrumentation : original, complementary
- Federate the French scientific community around accelerators for the study of materials and molecules
- Attract new users: from other scientific communities, from the international community

# Acknowledgement

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Clara Grygiel (CIMAP, Caen , F)

Isabelle Monnet (CIMAP, Caen, F)

All my colleagues from EMIR&A platforms



# Thank you for listening!

