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Nuclearization of a Tomographic Atom Probe and an electropolishing machine for neutron irradiated material studies at the nanometric scale in CEA/Paris-Saclay LECI hotlab facility

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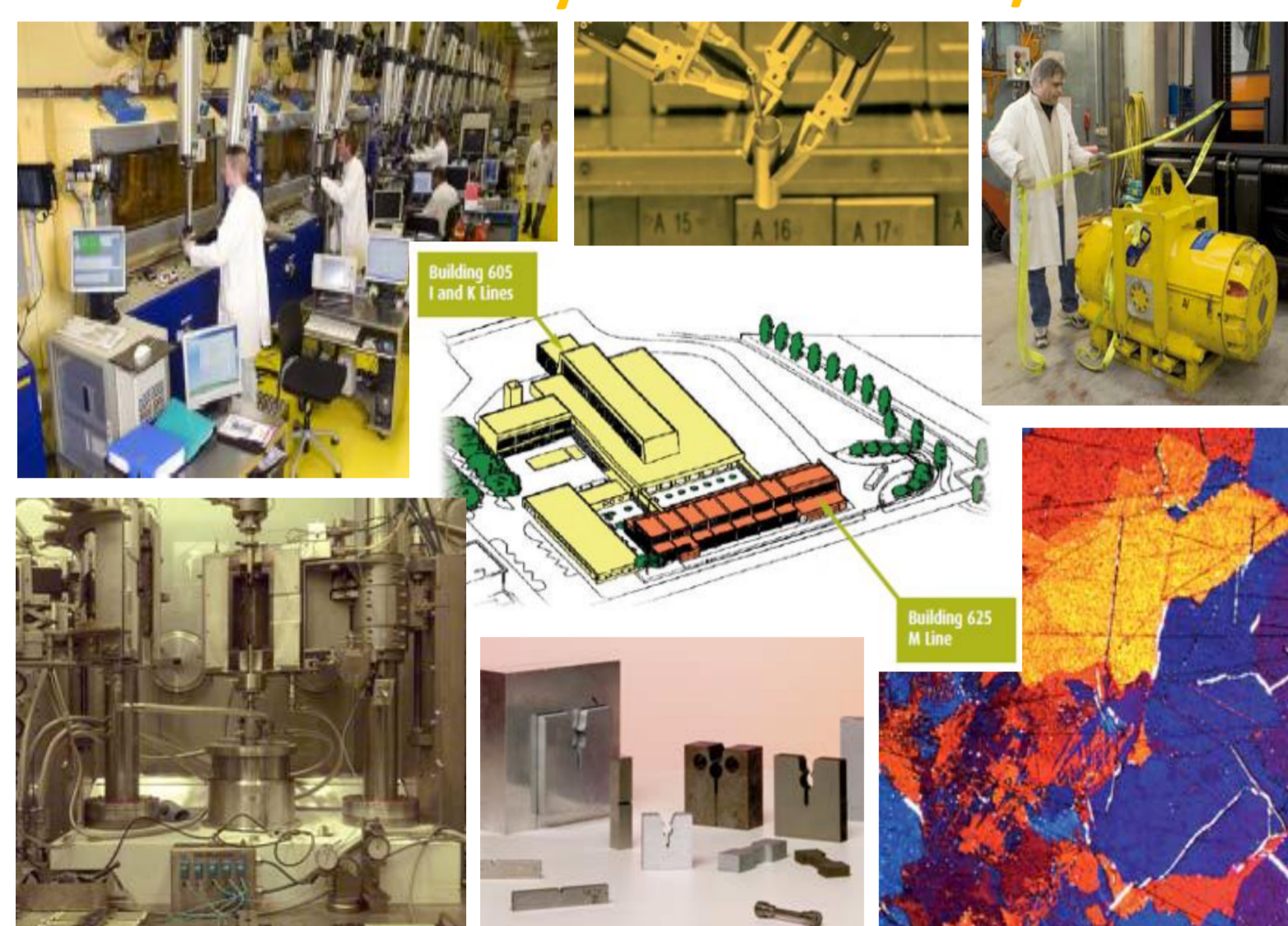
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An experimental platform for the analysis of neutron irradiated materials at the nanometric scale in LECI hotlab facility

LECI hotlab facility located in CEA/Paris-Saclay



Hot laboratory mostly dedicated to mechanical and metallurgical characterization of neutron irradiated materials

Materials : steels, zirconium alloys, aluminum alloys, oxides, ODS, ceramics, graphites

Key actor in the development of an experimental platform for the analysis of neutron irradiated material at the nanometric scale

Creation of a nanoscale characterization platform composed of :

- New Tomographic Atom Probe*
- New glove box *
- New electropolishing machine for TAP samples preparation*
- New MEB/FIB*
- TEM

Nuclearization of the equipments to study neutron irradiated materials

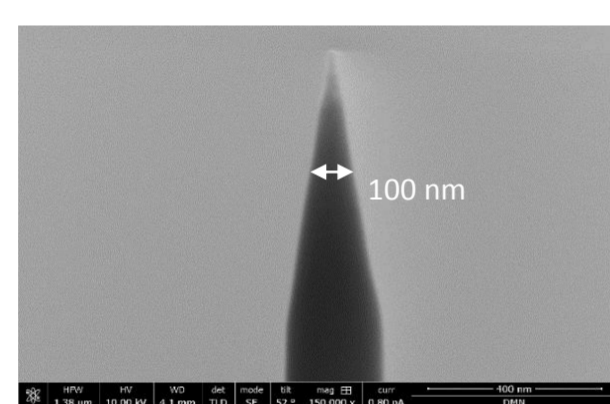
*Within the Equipement d'Excellence GENESIS and associated with laboratories (GPM Rouen and CIMAP)

Nuclearization of a Tomographic Atom Probe and an electropolishing machine for TAP samples preparation

Sample preparation equipments (nuclearization ongoing)

SEM-FIB

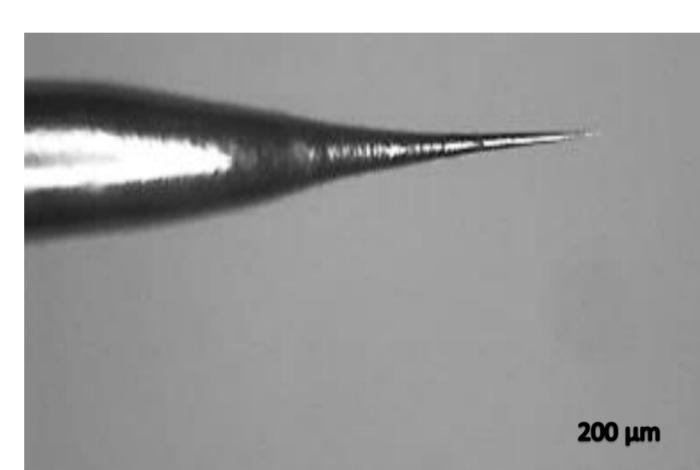
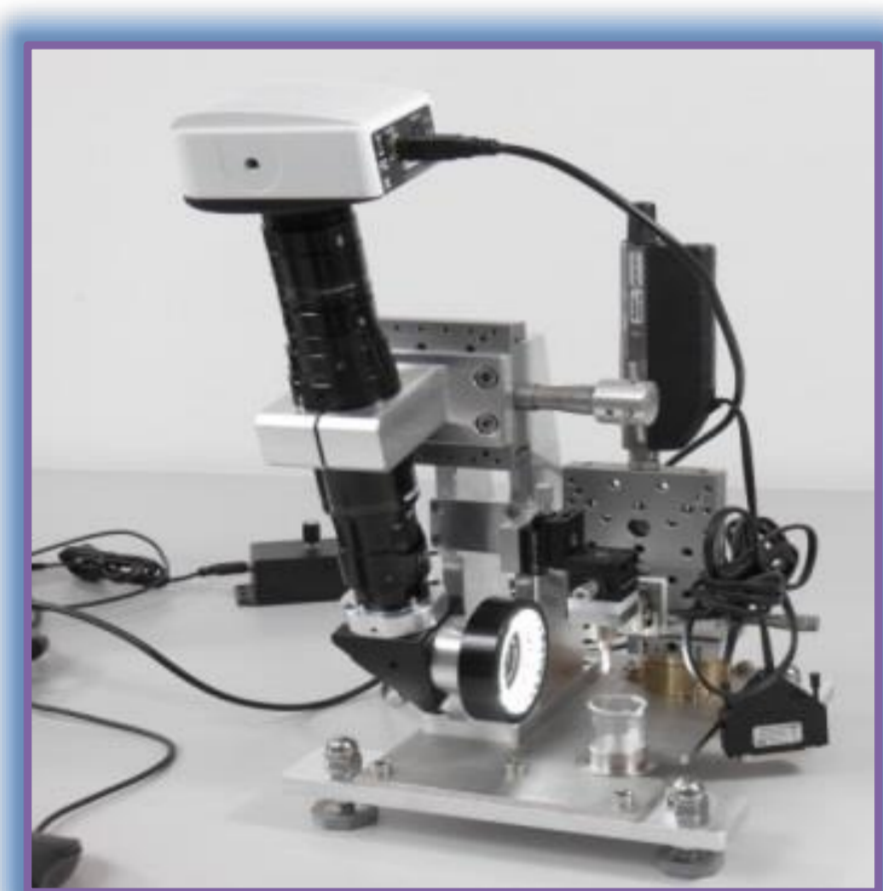
- Model ZEISS AURIGA 40
- Dedicated to the preparation of TAP and TEM samples
- Nuclear activity : 45 GBq [Hotlab 2015 and 2017]



TAP MEB-FIB sample dimension : $2 \mu\text{m} \times 2 \mu\text{m} \times 10 \mu\text{m}$

ELECTROPOLISHING MACHINE

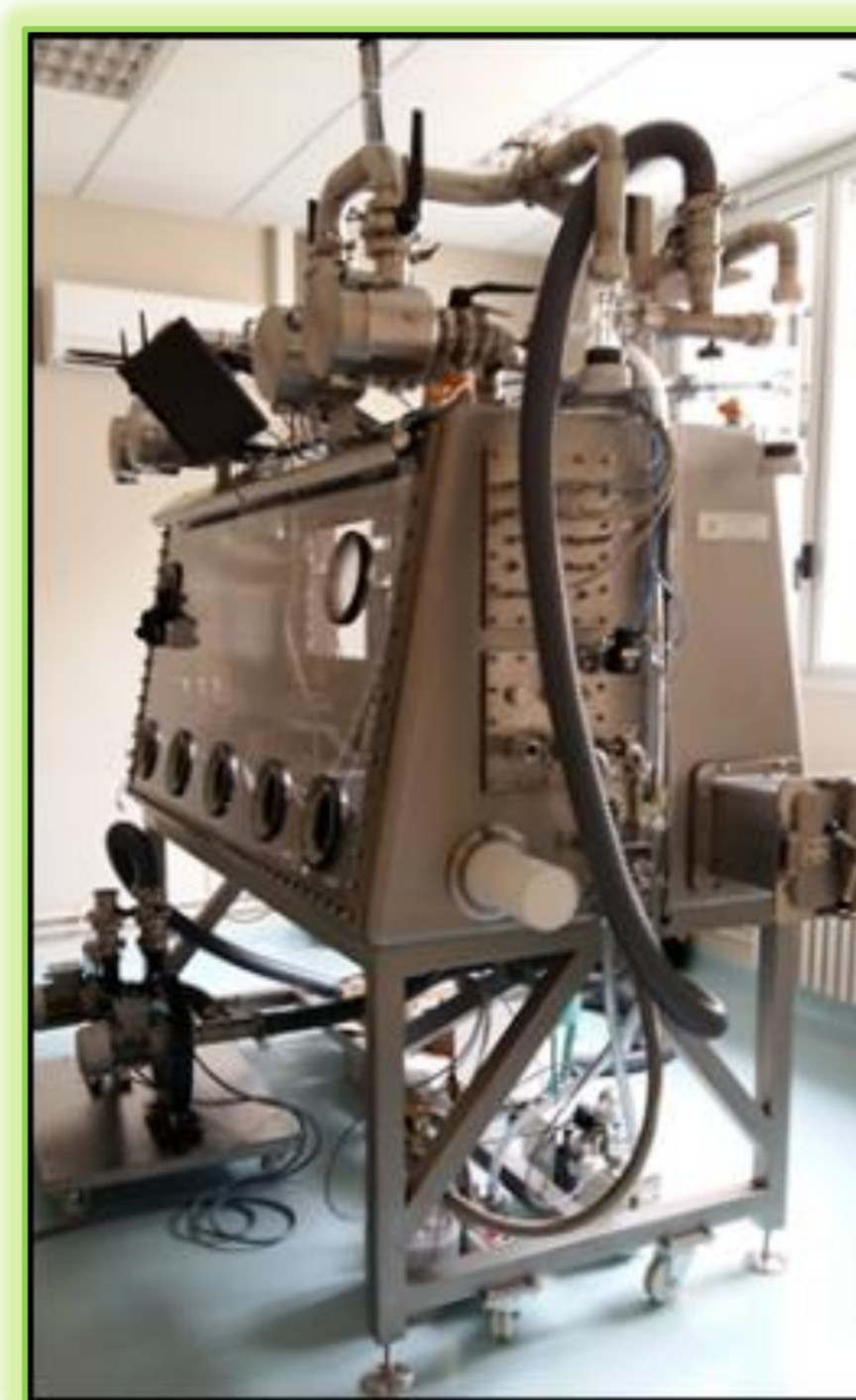
- Model CEA
- Dedicated to the preparation of TAP electropolished samples in a shielded glove box
- Nuclear activity : 60 MBq



Shielded glove box for the electropolishing machine

Electropolished TAP sample dimension : $0,3 \text{ mm} \times 0,3 \text{ mm} \times 15 \text{ mm}$

GLOVE BOX : preparation, storage and transfer of neutron irradiated samples



- Neutron irradiated sample storage
- Fine sample handling (optical microscope)
- Radiological protection measurements
- Sample cleaning (plasma cleaner)
- Leica vacuum system for the sample transfer between preparation equipment and TAP



Sample nano-characterization equipments

NUCLEARIZED TEM

- Model FEI tecnai G² 30
- Selection of region of interest in the aim of TAP analysis
- Nuclearized since 2009
- Max admissible dose rate : 2 mGy/h
- Max nuclear activity : 20 MBq equ. ⁶⁰Co

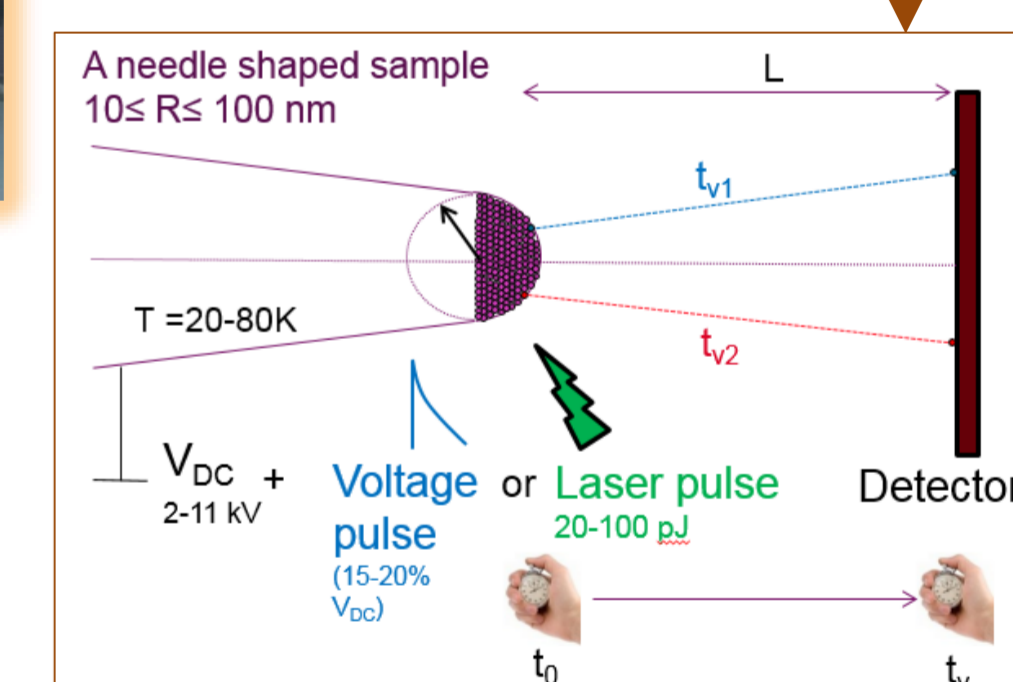


NUCLEARIZED TAP

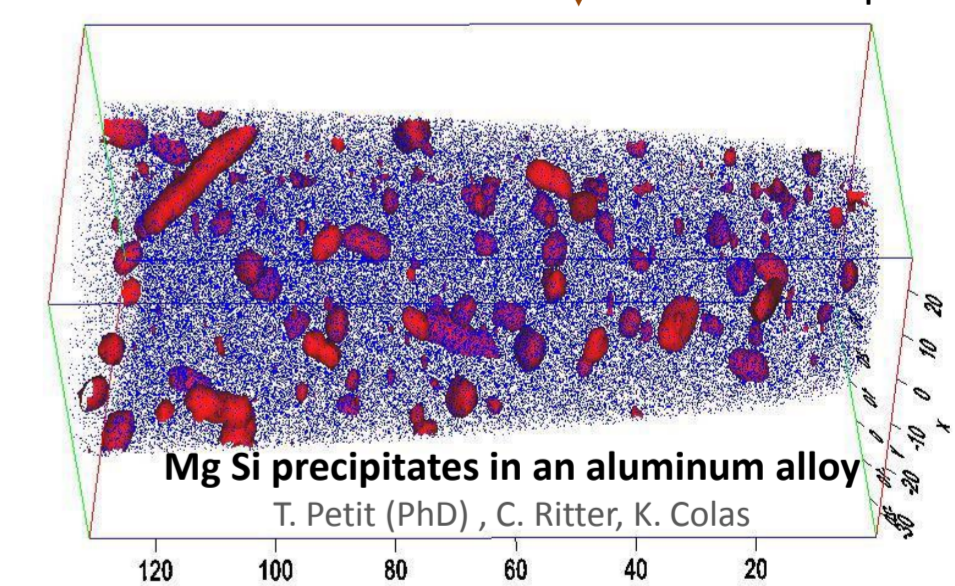


- TAP nuclearization : shielding of the detector, remote handling of vertical rod, vacuum transfer sample located on the TAP, cameras on the view ports
- Max admissible dose rate : 1,5 mGy/h at 5 cm
- Max nuclear activity : no limit for MEB/FIB samples, 20 MBq equ. ⁶⁰Co for electropolished samples

- Model CAMECA LEAP 4000X HR
- High resolution three dimensional microscope
- Dedicated to the characterization of defects at the atomic scale as clusters, segregation,...
- Field effect evaporation method of the atoms on the surface of the sample → nature and position of each atom of the sample



3D reconstruction of the sample



Nuclearization project : contribution of many actors during several years

