PAUL SCHERRER INSTITUT

PSI

Marco Streit :: NES / AHL

The PSI Hotlab

NES NE-Day@ PSI – 17.05.2021

swiss safety center ISO 9001 certified system

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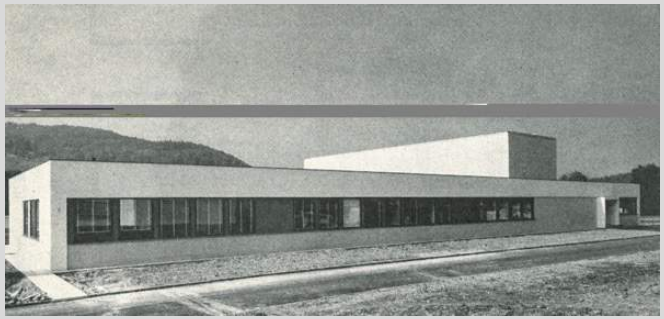
General introduction of the PSI Hotlab

swiss safety center ISO 9001 certified system

Facts & Figures of PSI Hotlab

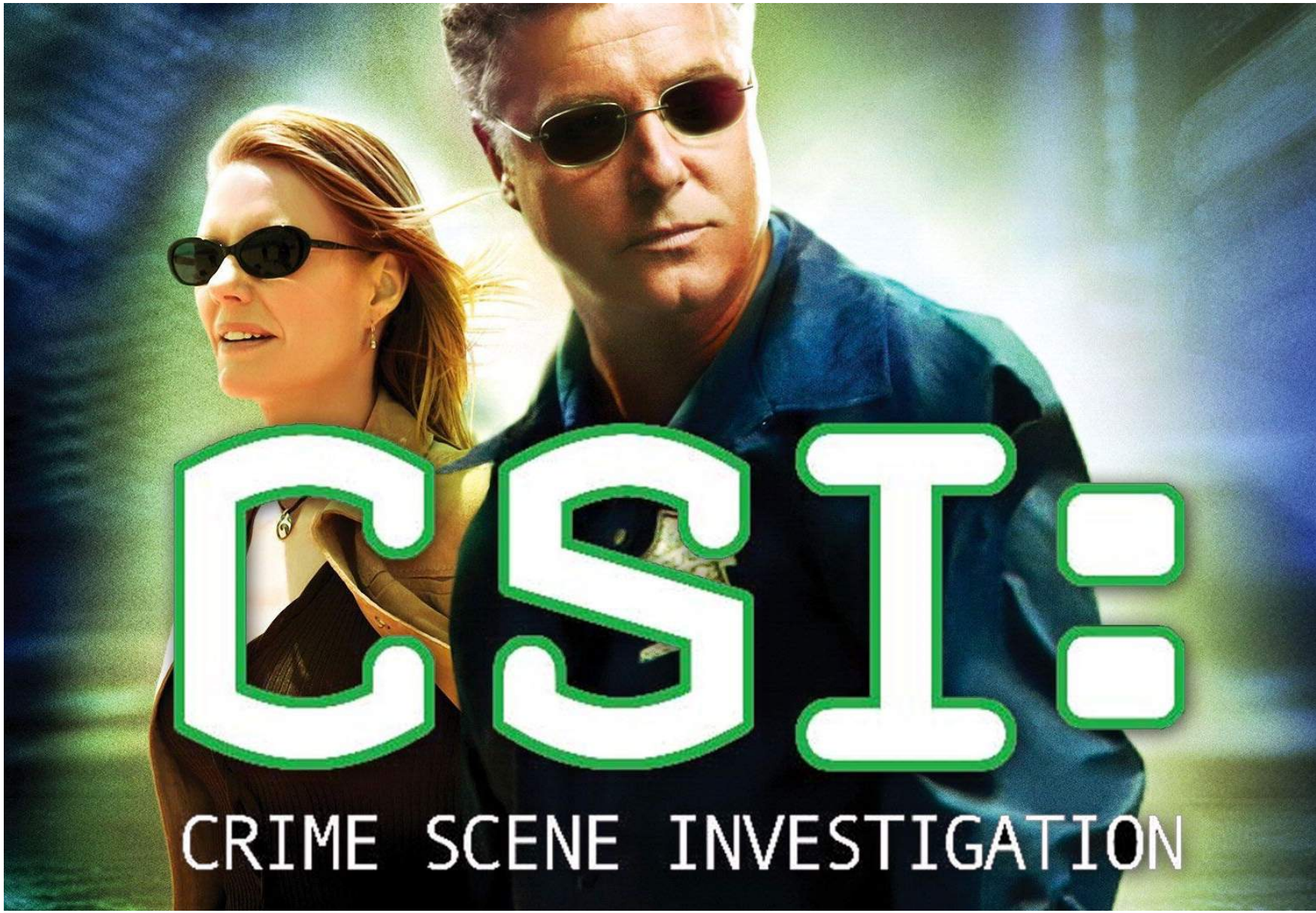
- Built 1961 – 1963 (11 Mio CHF)
- Continuously enlarged, extended and upgraded
- Operated by **AHL** / NES / PSI
- Approximately 32 people operate the infrastructure of the facility
- Approximately 70 to 100 people are using the facility regularly
- Owned by the Swiss confederation
- Operation (including personal) financed at about 65% by external money



Who we are and what we do …

- **Swiss Center of Competence** for handling & analysis of **highly radioactive materials**
- **Only Swiss laboratory** for the study of **highly radioactive materials**:
  - Post irradiation examination of **irradiated full length fuel rods**
  - Detailed characterization of nuclear fuel
  - Analysis of **highly radioactive materials** such as targets **from SINQ, CERN, ….**
- Function of a **user laboratory** for PSI internal und external Projects:
  - **LNM, LES, LRC, LRT** z.B.: SINQ-Targets, STIP-Samples, FP-swissnuclear
- **Scientific services** for external partners such as:
  - NPP, Nuclear Fuel Vendors, Regulators, Nagra, ….
  - Both national and international research groups
- **Technical support unit** for
  - PSI Large Research Facilities
  - PSI East Side (active waste water)
- **Education & Training** of technical and scientific staff
  - Nuclear Master
  - School for radiation protection

In search of the proof …



Analytical Methods possible @ PSI Hotlab:

Non Destructive (NDT) and Destructive (DT) Analytical Methods

Visual inspection
- Cameras
- Macroscope / Microscope
- Laser Profilometer / 3D-Profilometer
- Optical systems, tasting system

Structure and crystallography
- Metallography / Ceramography
- Electron Microscope (SEM, *TEM*)
- Neutron radiography and diffraction
- X-Ray diffraction and absorption

Corrosion
- Eddy current
- Optical Microscope
- Electronic Microscope
- Impedance (basic studies of corrosion)

Structure and composition
- Metallography / Ceramography
- Electron Probe MicroAnalysis
- SIMS; ICPMS; TIMS
- X-Ray absorption
- Neutron absorption
- Chemical analysis

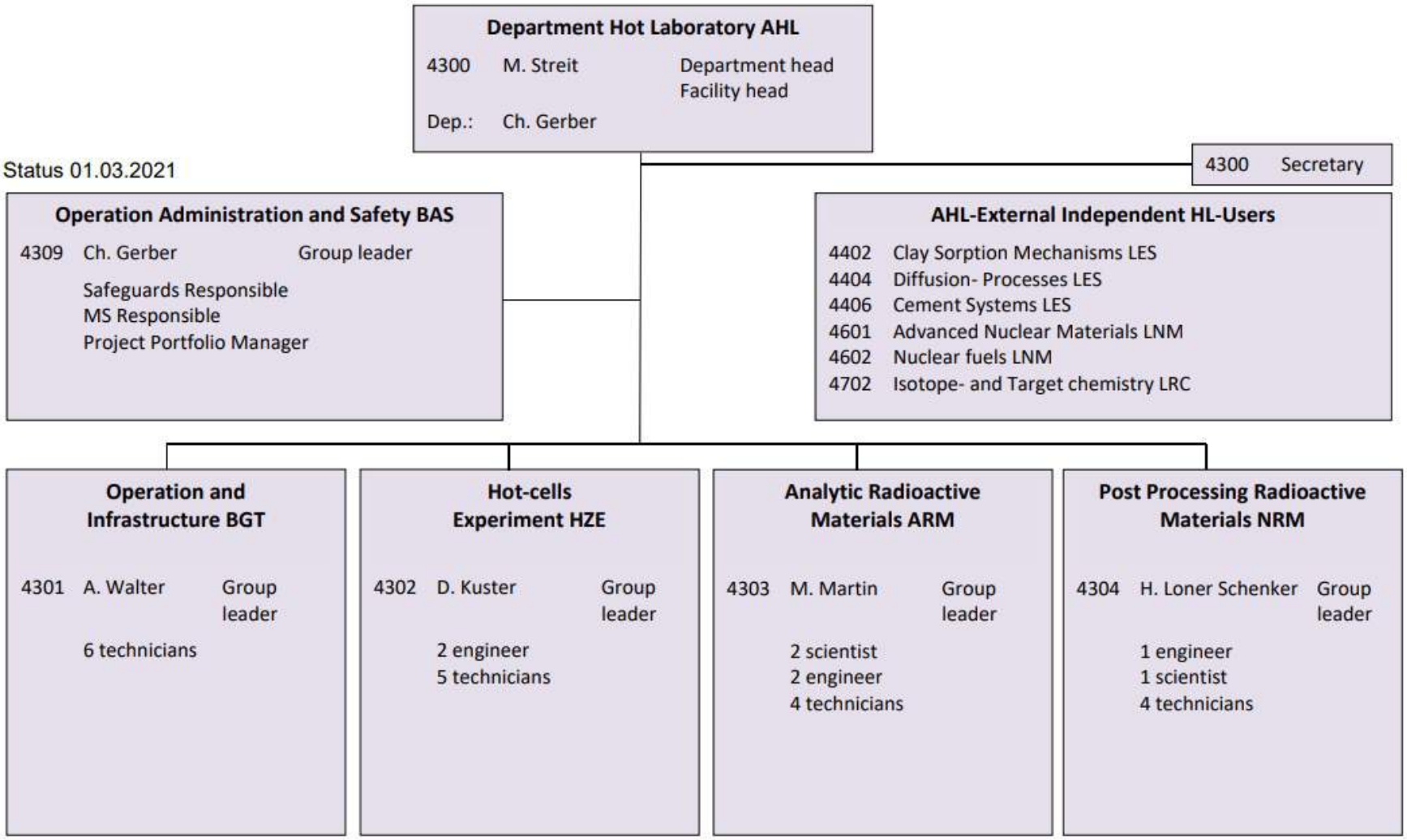
Mechanical Properties
- Deformation machines (Tensile, fatigue, creep)
- Burst test
- Indenter

Activity
- α, β, γ spectrometry

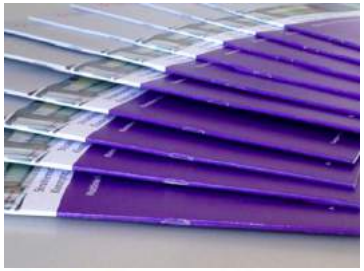
Thermal Properties
- Thermogravimetry
- Lightflash

Sample Preparation
- FIB & others to prepare samples for investigations @ PSI large facilities

The Organization of the Department Hotlab



Administration of the facility Hotlabor (BAS)



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

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ETH zürich

EPFL

swissnuclear

IAEA
International Atomic Energy Agency

Kernkraftwerk Gösgen

swiss safety center

KKL
Kernkraftwerk Leibstadt
www.kkl.ch

suva

EPRI ELECTRIC POWER RESEARCH INSTITUTE

framatome

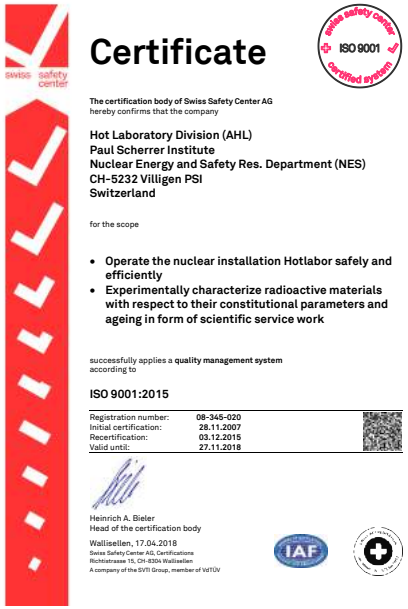
sck cen

NUCLEAR STATION COFRENTES

European Commission

GNF
Global Nuclear Fuel
A Joint Venture of GE, Toshiba, & Hitachi

Operation of the facility PSI Hotlab (BGT & NRM)



Certificate

ISO 9001

The certification body of Swiss Safety Center AG
hereby confirms that the company

Hot Laboratory Division (AHL)
Paul Scherrer Institute
Nuclear Energy and Safety Res. Department (NES)
CH-5232 Villigen PSI
Switzerland

for the scope

- Operate the nuclear installation Hotlabor safely and efficiently
- Experimentally characterize radioactive materials with respect to their constitutional parameters and ageing in form of scientific service work

successfully applies a quality management system
according to

ISO 9001:2015

Registration number:	08-345-020
Initial certification:	28.11.2007
Recertification:	03.12.2015
Valid until:	27.11.2018

Heinrich A. Bieler
Head of the certification body

Wallisellen, 17.04.2018

Swiss Safety Center AG, Certifications
Richtistrasse 15, CH-8304 Wallisellen
A company of the SVTI Group, member of VdTÜV

QMS: 9001:2015

ERT

Control room

Sewage treatment

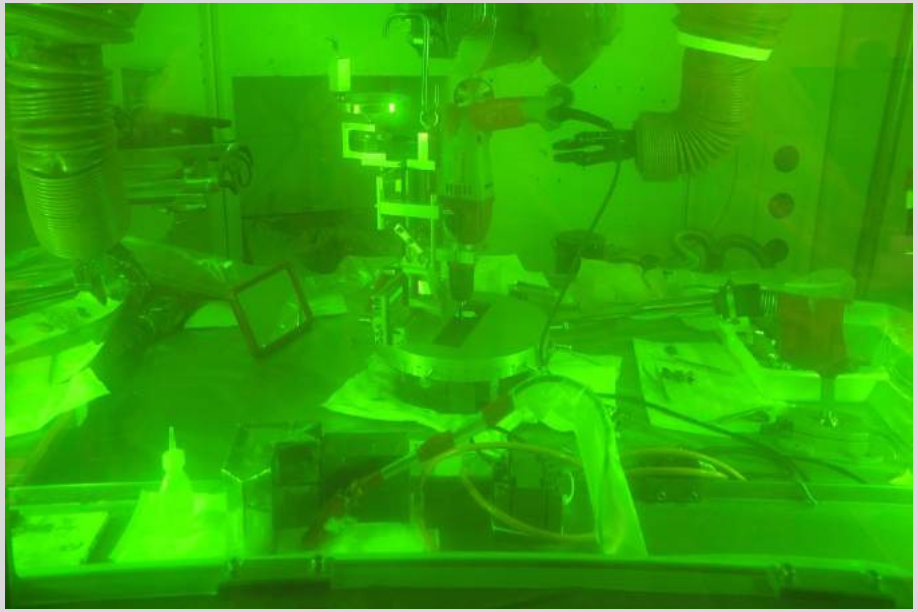
Ventilation system

Waste

PSI Hotlab - Infrastructure

- 31 Laboratories type A
- 6 concrete hot cells
- 12 lead or steel shielded cells
- 26 to 31 gloves boxes
- 30 radiochemistry fume hoods
- Different service area like:
    - a large lock,
    - wardrobes,
    - storage rooms, …

Hot cell chain @ PSI Hotlab (HZE)

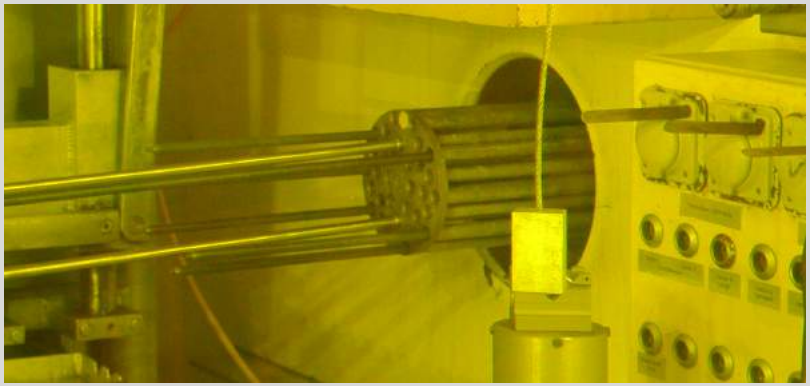


Post irradiation examination (PIE):

- Visual inspection
- Laser-Profilometry
- Eddy-Current
- Gamma spectroscopy
- Sample preparation
- Fission Gas (FG) Analysis
- **New 3D-Profilometry** (Keyence)

Sample preparation @ PSI Hotlab

Transportation @ PSI Hotlab



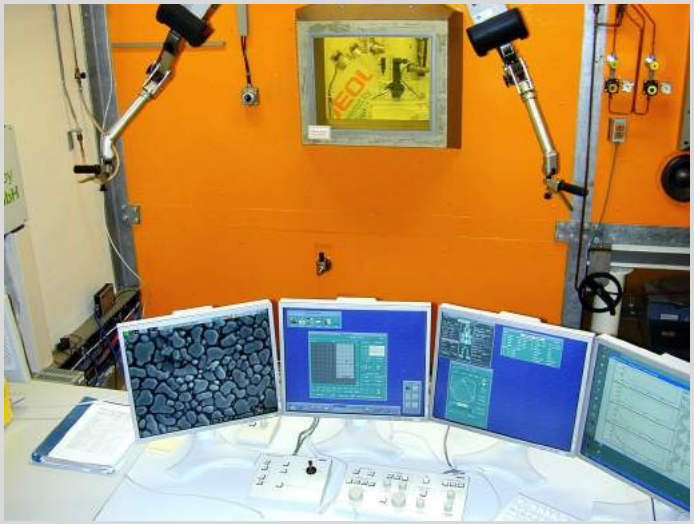
Movement of active material @ PSI Hotlab

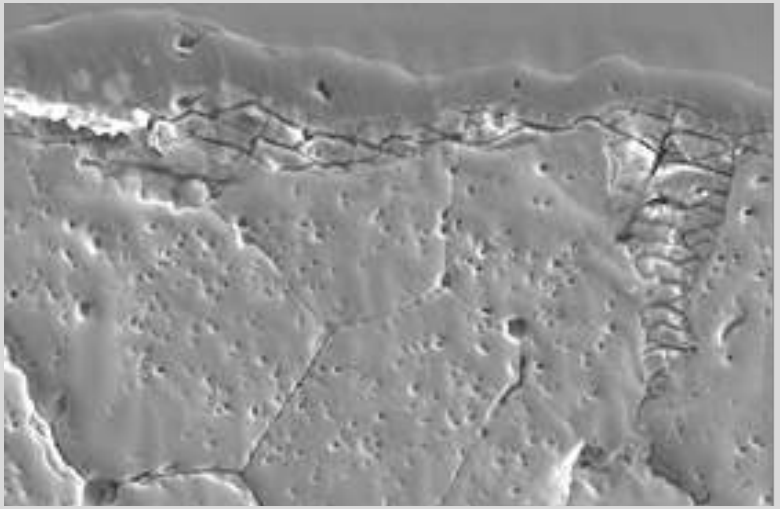
Shielded hot cells @ PSI Hotlab (ARM & HZE)

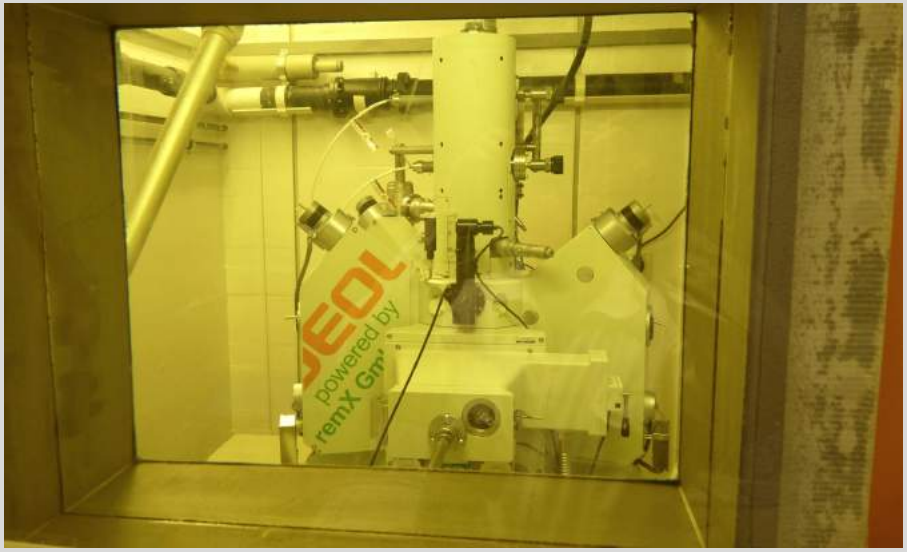
Lead and steel shielded cell for dedicated analytic tools:

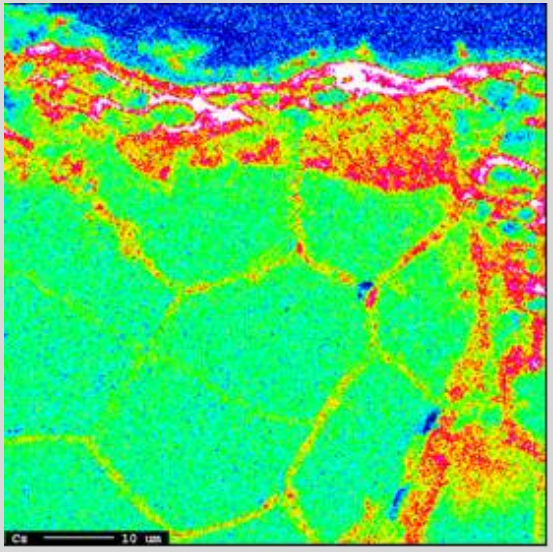
- Hydrogen hot extraction box
- Dissolution box
- Light Optical Microscope (LOM) box
- Electron Probe Micro Analyzer (EPMA) box
- Secondary Ion Mass Spectrum (SIMS) box
- Laser ablation (LA) box
- **New FIB/SEM box**

Analysis @ PSI Hotlab (e.g. EPMA)

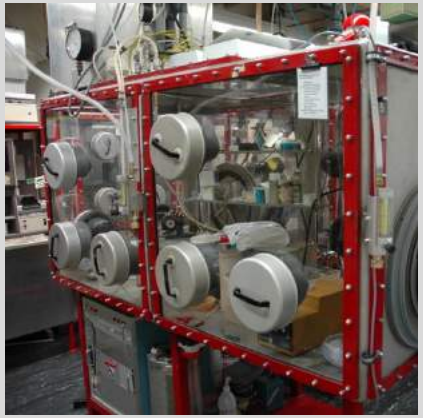




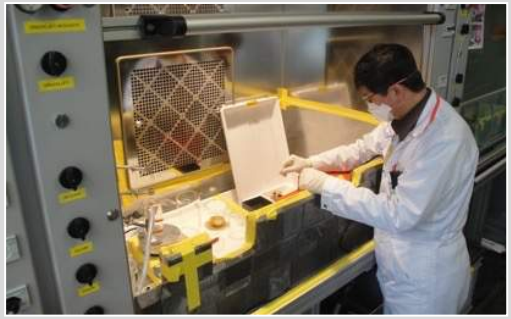




Glove boxes & hoods @ PSI Hotlab (ARM & Users)



- Material treatment, Heat treatment
- Experiments from user groups:
  e.g. diffusion & sorption processes, corrosion loop
- Numerous analytic tools:
  e.g. Single-Collector-ICP-MS, chemical analysis
- Sample preparation for large facilities
- **New MC-EBIS-ICP-MS**
  (Multi Collector - Electron Beam Ion Source -
  Inductively Coupled Plasma - Mass Spectrometry)



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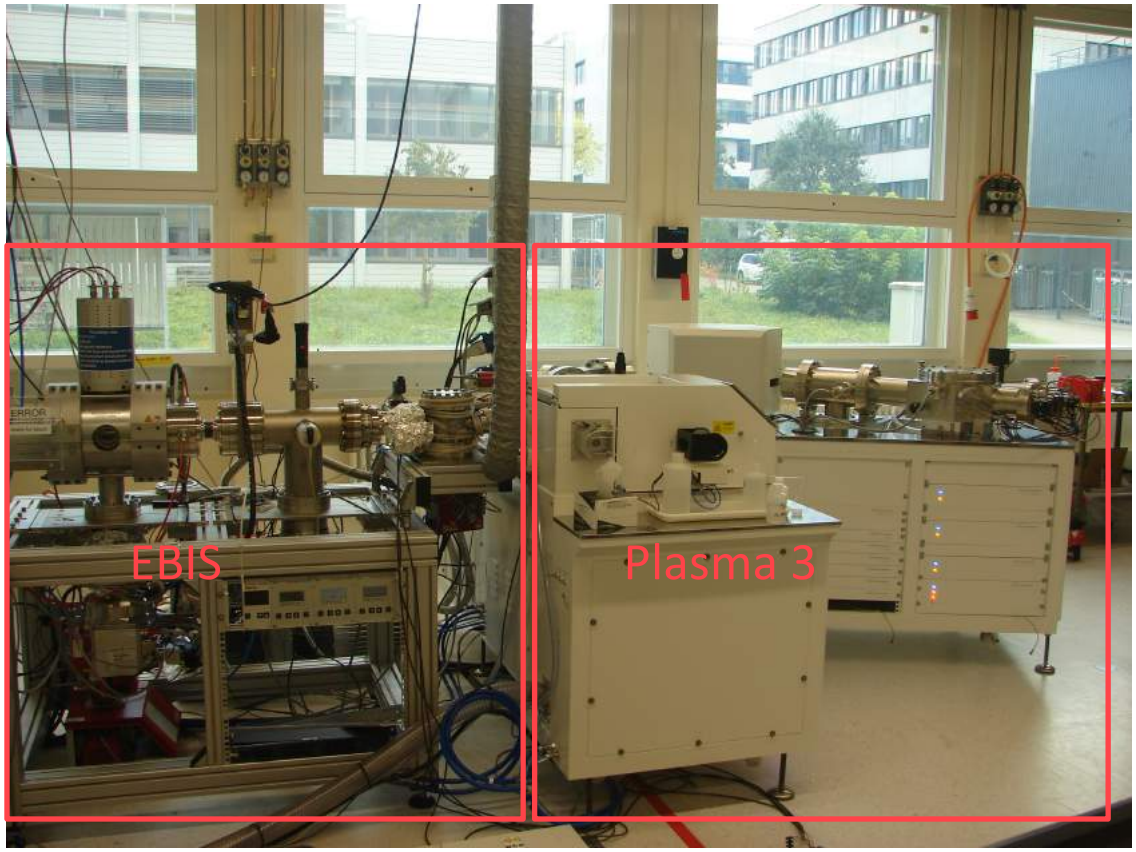
Highlight @ Hotlab

swiss safety center ISO 9001 certified system

MC-EBIS-ICP-MS (2017/2018)

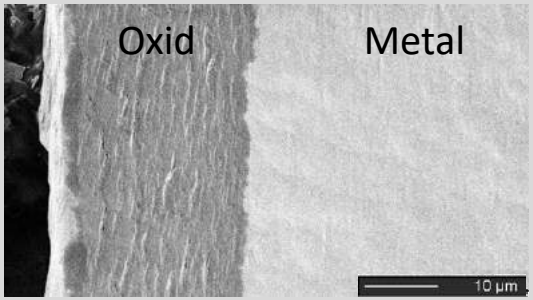
- For radioactive use a fume hood is projected (not yet implemented)
- Application is determination of high precession isotope ratios
  e.g. U-235/U-238 0.009% rsd; Nd-143/Nd-144 0.0006 % rsd
- **Coupling of EBIS and Plasma 3 is an in-house development**
- Determination of isotopic ratio of fission gas is envisaged

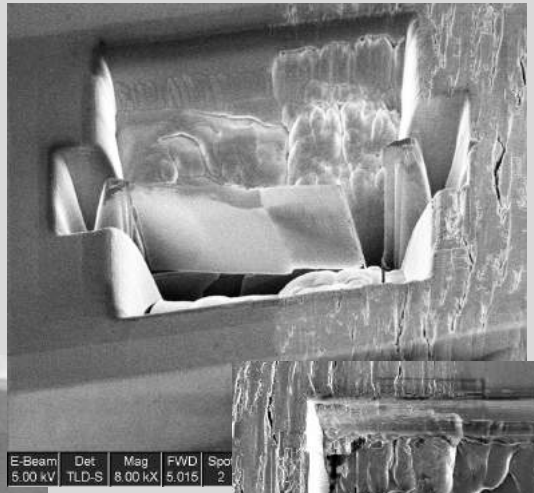


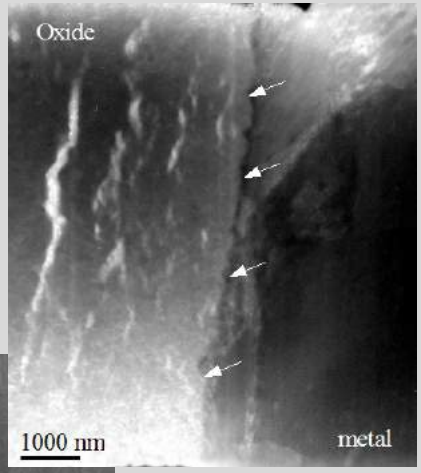
New possibilities with FIB @ PSI Hotlab

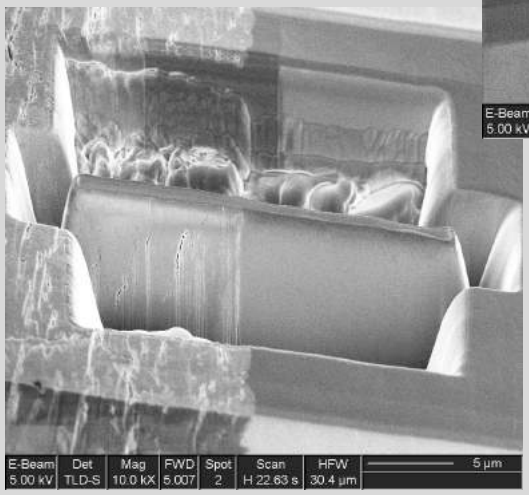
- **Zeiss Crossbeam XB 540**
  - Gemini II FE column
  - 4 detectors for imaging
  - Large Chamber
  - Capella ion gun
  - Gas injection system
  - Plasma cleaner
  - Micromanipulator
- **EDAX TEAM Pegasus 3D analysis system**
  - “Octane Super” SDD
  - “TEXS WDS” spectrometer
  - “DigiView 5” EBSD-Camera
- **Joint Investment with LNM enables:**
  - Up to date analytics:
    Scanning Electron Microscope (SEM)
  - New combined analytics
    - Energy Dispersive Spectrometer (EDS)
    - Wavelength Dispersive Spectrometer (WDS)
    - Electron BackScatter Diffraction (EBSD)
  - Use of PSI beamlines (micro samples by FIB)

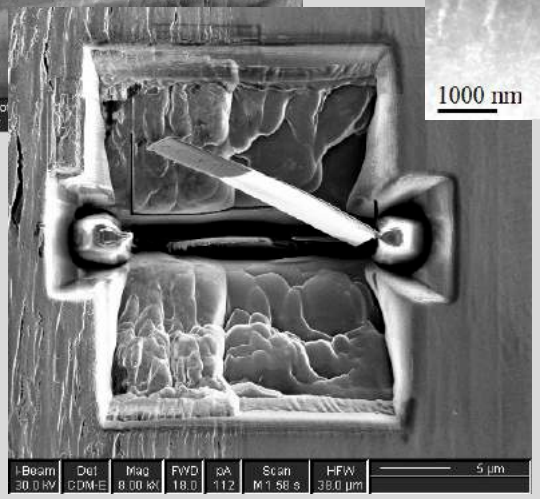
Example FIB – Specimen preparation for TEM









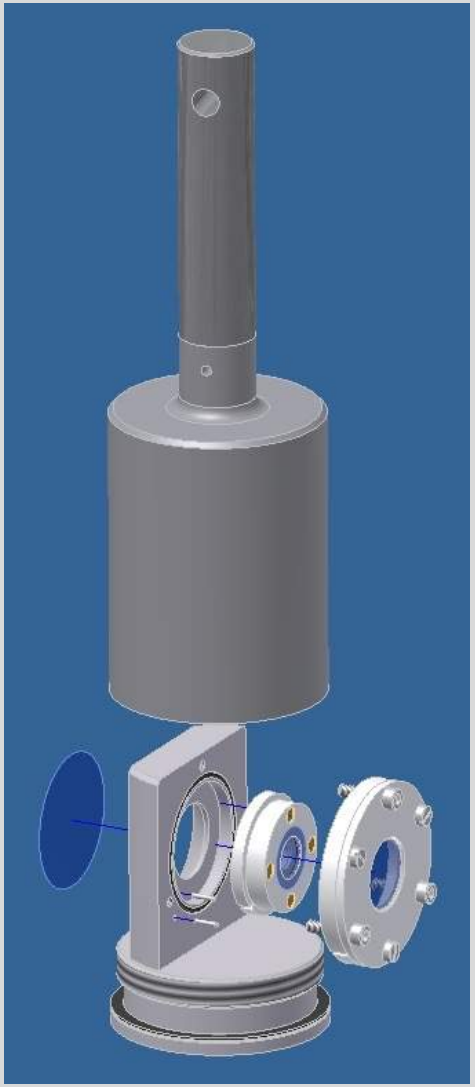


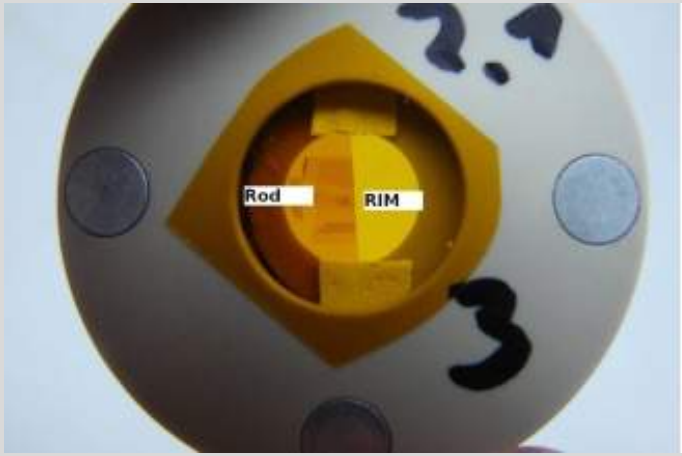
Preparation of a specimen at a metal-oxide interface

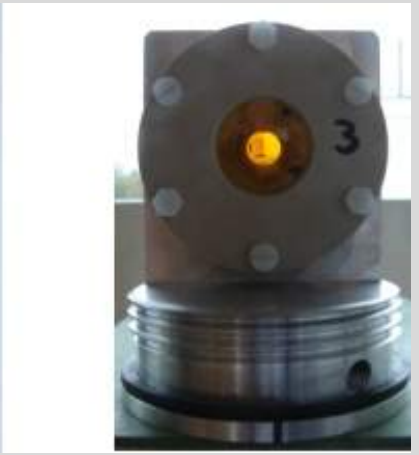
FIB prepared TEM Sample (thickness: 16.5 µm)

S. Abolhassani and al. Journal of Microscopy, July 2006, pp. 73-82

Sample prep. for large facilities @ PSI Hotlab







Sample holder for SLS:

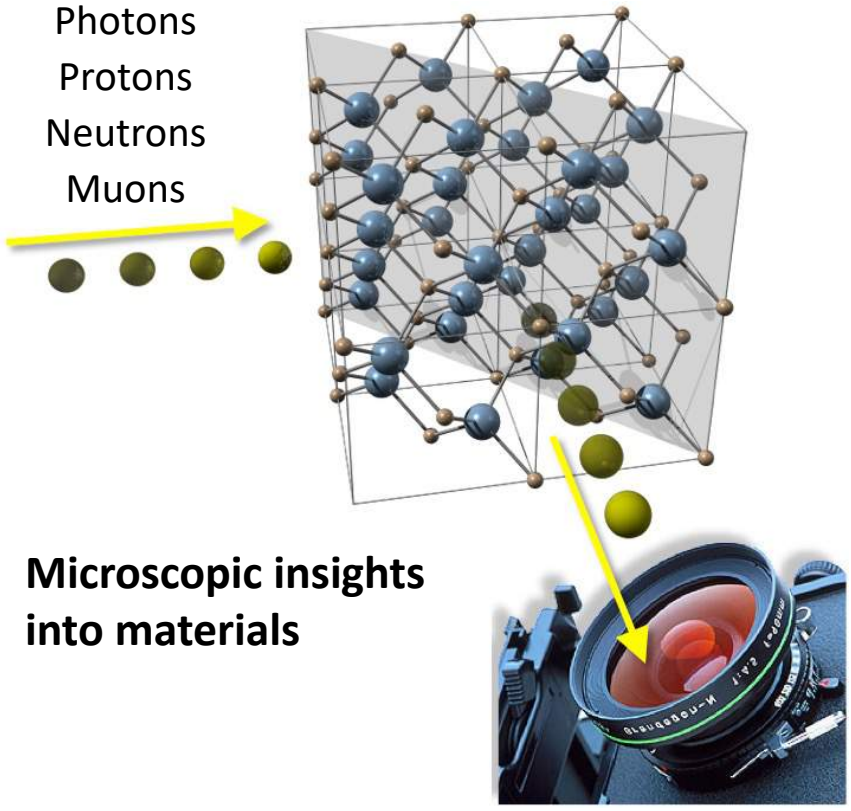
Home design of a simple specimen holder system
for the analysis of radioactive materials (including fuel)
at the Swiss Light Source (SLS)
(Approved by the safety authorities / BAG)

Large research facilities @ PSI

Research at large facilities

Synchrotron light source SLS
Proton Accelerator
Neutron source SINQ
Muon source SμS

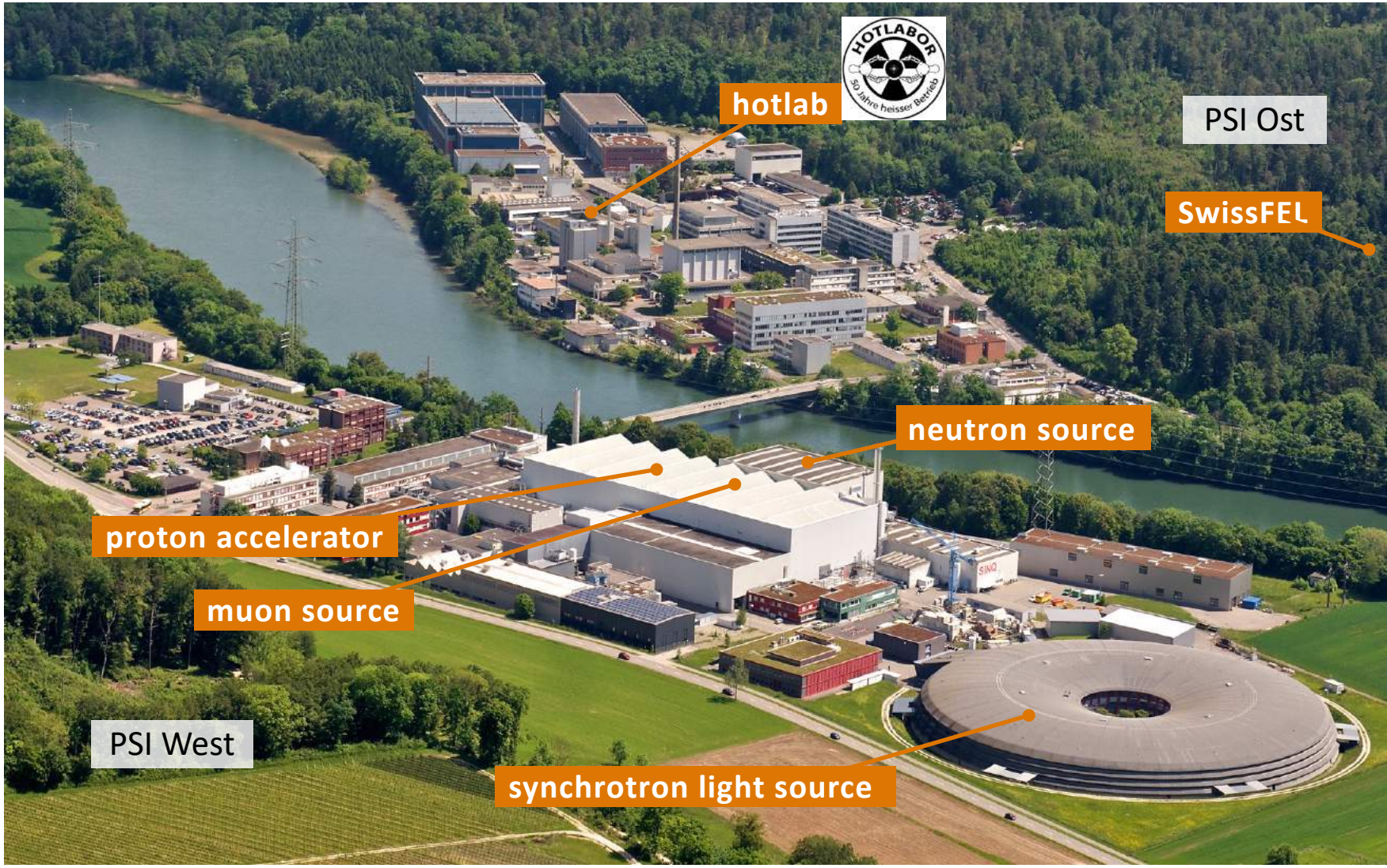
Photons
Protons
Neutrons
Muons



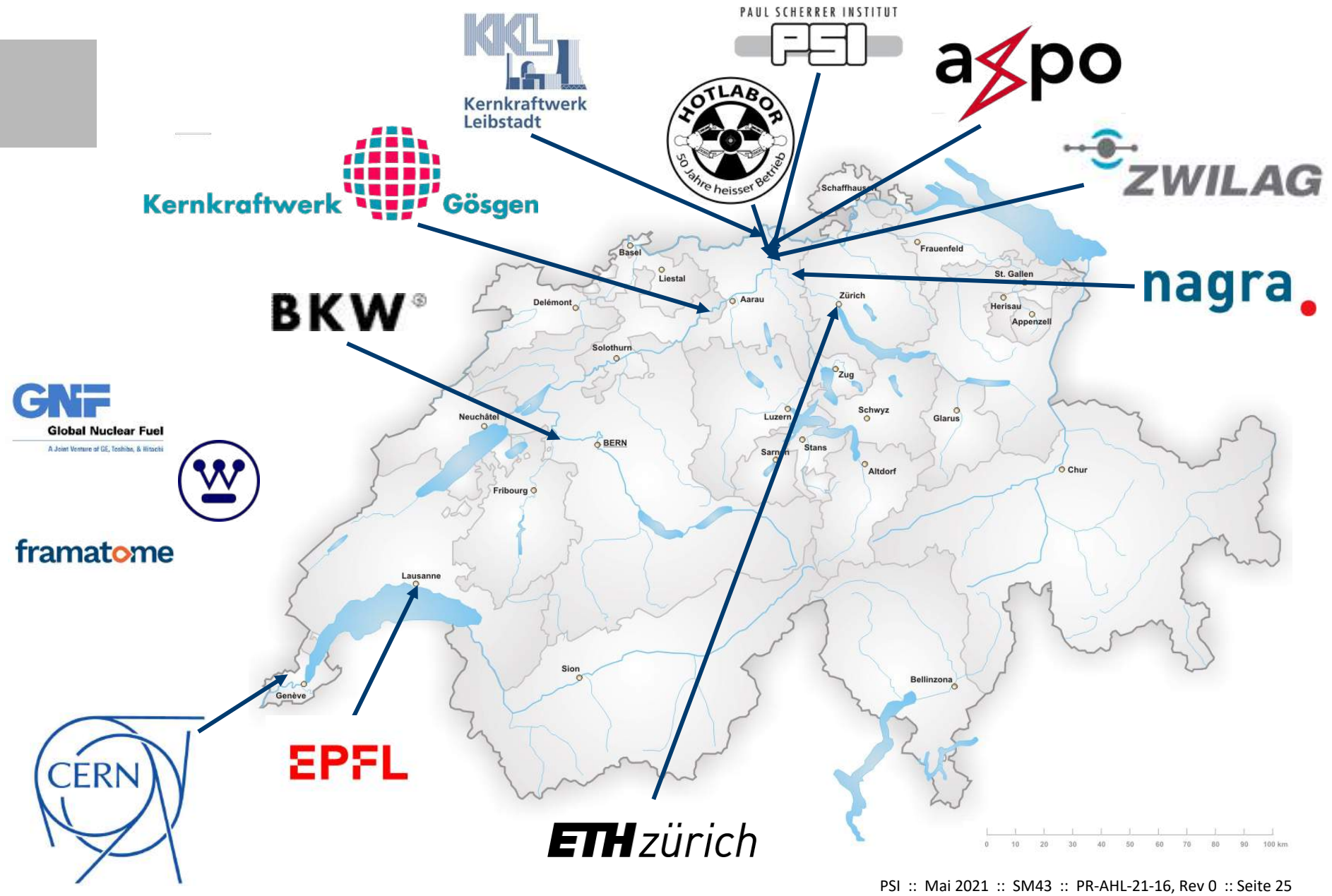
Microscopic insights into materials

Unique possibilities @ PSI

← Basel Germany ↑ Aarau/Bern ↓ Zürich →



Unique possibilities in Switzerland (& worldwide)



The PSI Hotlab …

- is the **Swiss laboratory** for the study of **highly radioactive materials**
- **delivers scientific services** for external partners
- is a **user laboratory** for PSI internal and external projects
- houses **PSI experts** on nuclear materials, waste disposal and radiochemistry
- is equipped with a **large number of up to date analytical tools** for fuel rod and materials investigations
- Enables the use of **PSI large beamline facilities** with high radioactive material by sample preparation

Possible Projects @ AHL

- Due to Corona-Pandemic no lab related projects are planned

- Possible are paperwork projects:
  - Processing of the **events in the hot laboratory** before 2005:
    digitalization and entering in Management-Database
  - **Risk-Analysis of Hotlab** operation:
    Assessing the risk portfolio of Hotlab and updating the Database
  - **Incident analysis**:
    Further developing of existing calculation tool
  - **Testing** of updated **sample and criticality database**:
    Performing the required test for updating the database
  - **Update of the statistical evaluation** of the management information system:
    Updating of existing programmed reports

- For all these projects good knowledge of German necessary

- If interested: contact: Marco.Streit@psi.ch

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PSI Hotlab – Your Partner for Radioactive Materials Examinations

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