PAUL SCHERRER INSTITUT

PSI

Marco Streit :: NES / AHL

The PSI Hotlab – Who we are and what we do

Highlights @ NES Event 24.10.2017

Certified System SWISSTS ISO 9001

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 laboratory
- Approximately 70 to 100 people are using the lab regularly
- Owned by the Swiss confederation
- Operation (including personal) financed at about 65% by external money

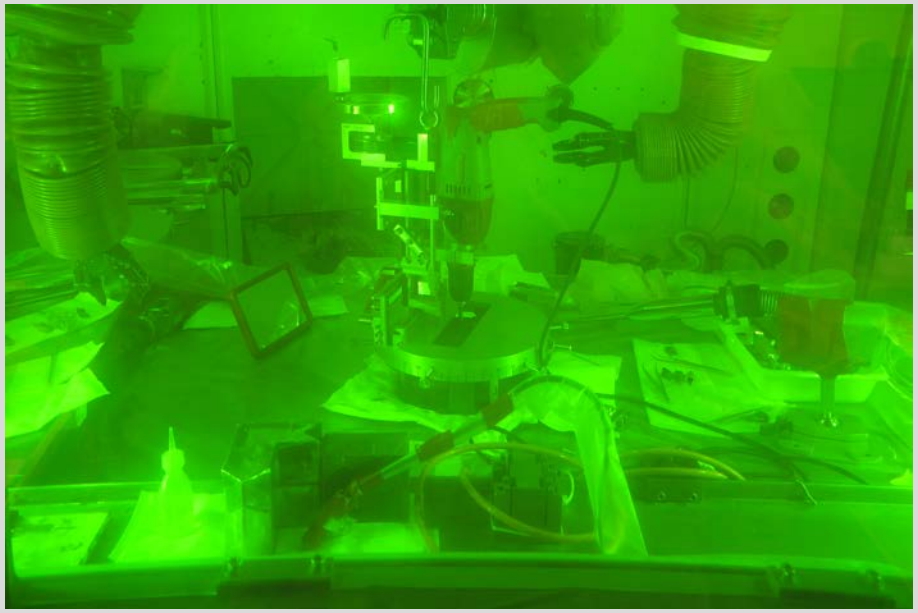
Who we are and what we do

- **Only Swiss laboratory** for the study of **highly radioactive materials**:
  - Post irradiation examination of irradiated fuel rods
  - Detailed characterization of nuclear fuel
  - Analysis of highly radioactive materials
- **Scientific services** for external partners such as:
  - Nuclear power plants
  - Producers of nuclear fuel
  - Regulators
  - Both national and international research groups
- Function of a **user laboratory** for PSI internal and external projects:
  - **LNM, LES, LRC** projects e.g.:
    - SINQ-Targets
    - STIP-Samples
- **Education & Training** of technical and scientific staff

PSI Hotlab - Infrastructure

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

Hot cell chain @ PSI Hotlab



Post irradiation examination:

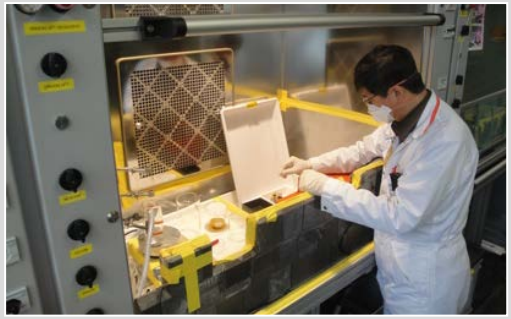
- Visual inspection
- Profilometry
- Eddy-Current
- Gammaspectroscopy
- FG-Analysis

Shielded hot cells @ PSI Hotlab

Lead and steel shielded cell with internal containment are mostly used for dedicated analysis tools:

- Hydrogen hot extraction box
- Dissolution box
- Optical microscopy box
- EPMA and SIMS box
- Laser ablation box
- **New FIB/SEM box**

Glove boxes & hoods @ PSI Hotlab



- Material treatment: Heat treatment
- Experiments: e.g. Investigation of diffusion & sorption processes
- Analysis: e.g. SC-ICP-MS, chemical analysis
- Further sample preparation for large facilities
- New MC-EBIS-ICP-MS

Typical projects @ PSI Hotlab (Department & Users)

Post irradiation examination of NPP fuel rods
- Material behavior
- Validation of new fuel elements
- Producing data for validation of models

Post irradiation examination of activated materials
- Material behavior after irradiation in accelerators/reactors
- Analytical examinations and modeling of behavior
- Sample preparation for investigation with PSI large facilities
- Chemical and radiochemical properties

Investigation for final disposal
- Diffusion processes
- Sorption processes

Radiochemistry
- Target production with radioactive isotopes

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Highlights @ the PSI Hotlab of the last year

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Highlights @ the PSI Hotlab (Department)

Infrastructure projects:

– Renovation of several Labs

– Movement of SC-ICP-MS & MeAWaT-Box to new Lab

– …

Development projects:

– Installation of new MC-ICP-MS

– Connecting **EBIS to MC-ICP-MS**

– Installation of New **FIB/SEM**

– **…**

Industrial projects:

– Return **shipping** of KKL fuel segments

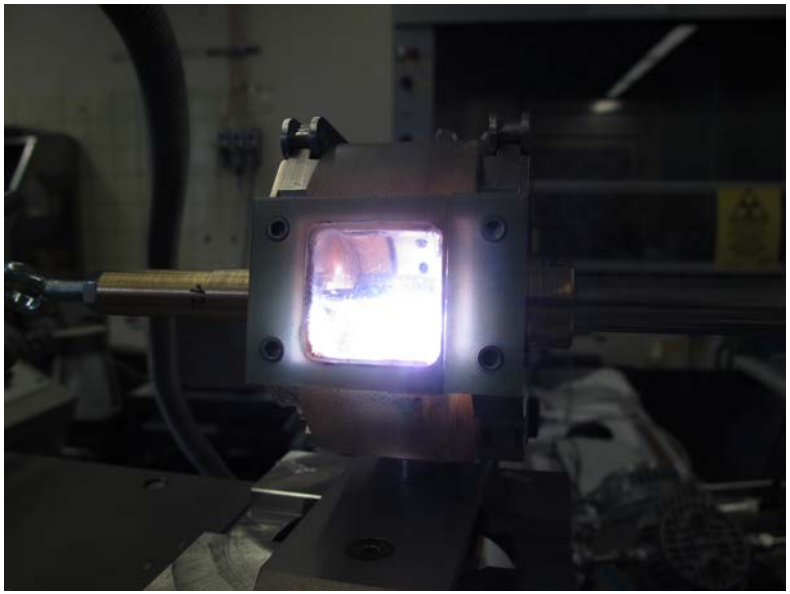
– Delivery of KKL fuel rods

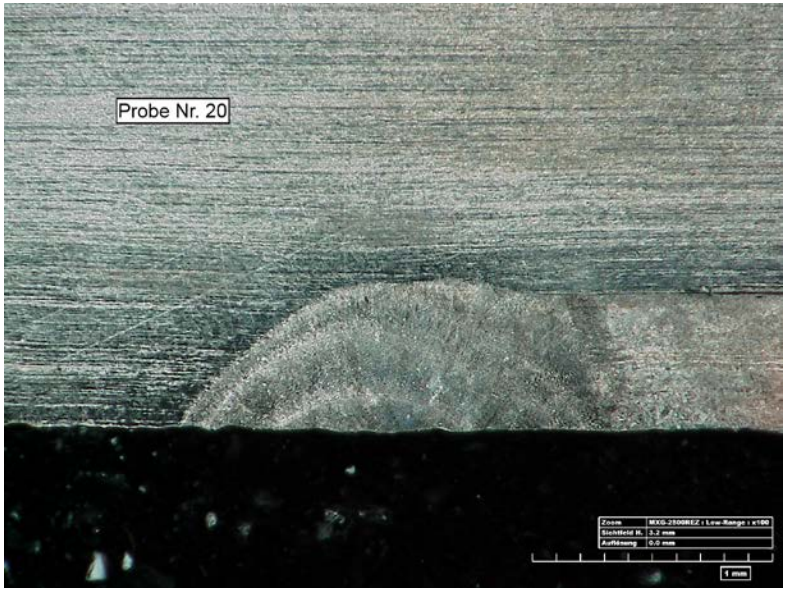
– …

Scientific projects:

– **Given by our users LNM, LES, LRC**

Shipment from and to KKL





- Preparation of material
- Licensing of arc welding
- Transport organization

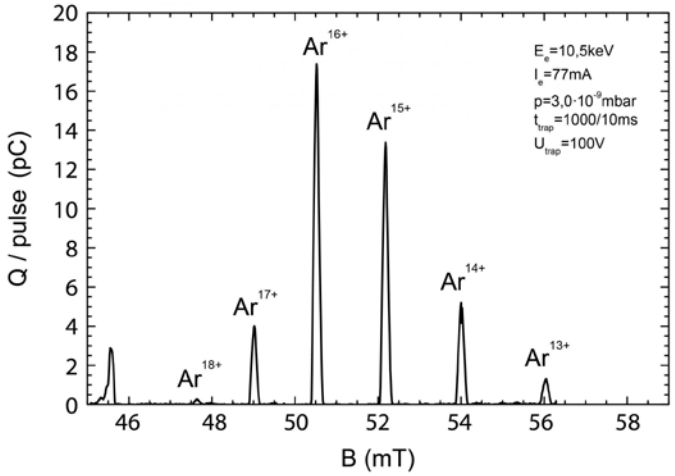
- -> Paperwork (needs time)

- Start of four different industrial projects together with KKL

Electron Ion Beam Source EBIS

- Existing EBIS @ Hotlab:
  - Able to produce ions of high charge states
  - Delivers beams of protons, alpha-particles, highly charged ion species, molecular fragments
  - Operation principle allows generation of pulsed ion beams as well as DC beams
  - Different injection methods

- EBIS is projected @ Hotlab:
  - for the production of multiple charged gas ions
  - to determine isotopic ratio of fission gas



Source: http://www.dreebit-ibt.com/

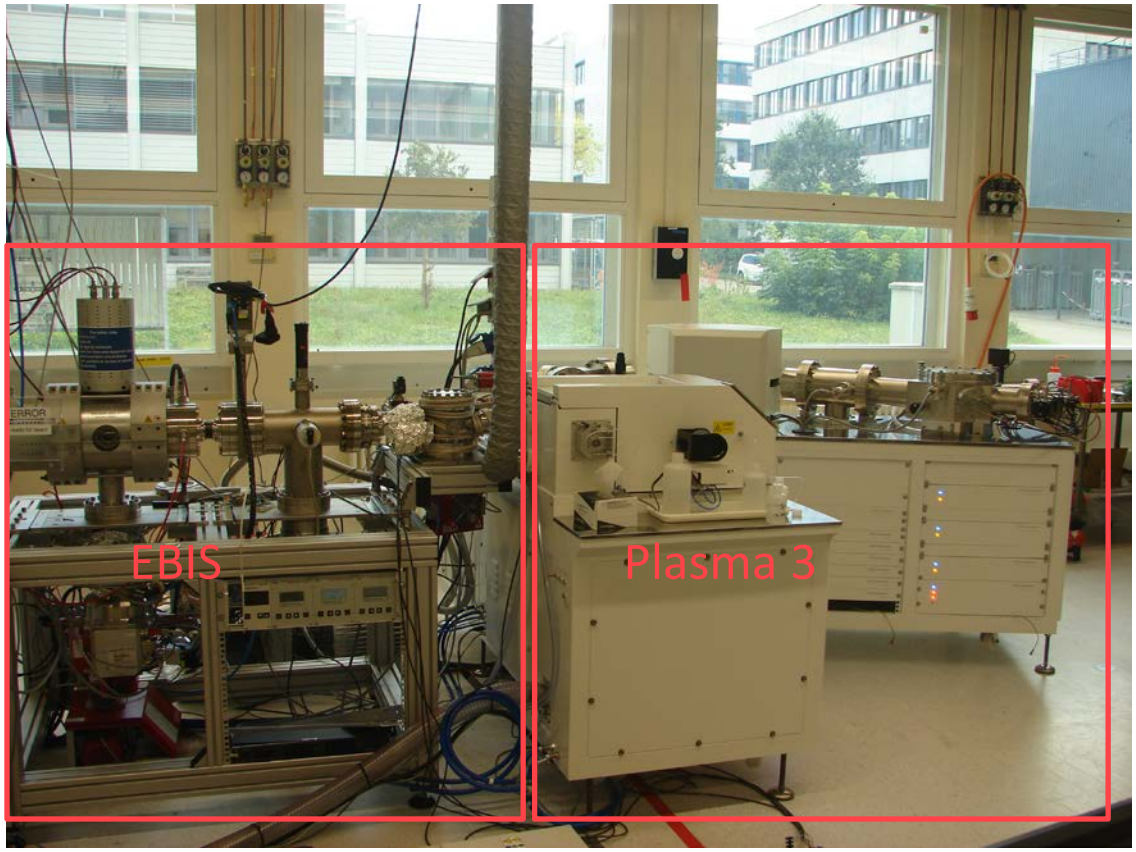
Key Features of the MC-ICP-MS, plasma 3

- Double focusing high precision isotopic measurement mass spectrometer
- Enhanced sensitivity Interface as standard
- Innovative torch box design allowing easy connection of a wide range of sample introduction devices
- EATO – Enhanced Abundance Transfer Optics (patent pending)
- Robust third generation RF generator with “Frequency Tuning”
- Fully dry pumped configuration
- 16 large dynamic range Faraday detectors, with switchable resistor amplifiers
- Up to six ion-counting detectors (with SEM / Daly)
- High resolution and pseudo high resolution capabilities
- Variable zoom optics allow for instantaneous switching between isotopic systems during analysis

Source: http://www.cameca.com/

New MC-ICP-MS (Plasma 3) coupled with EBIS

- 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



FIB/SEM Hotcell as large as necessary & as small as possible

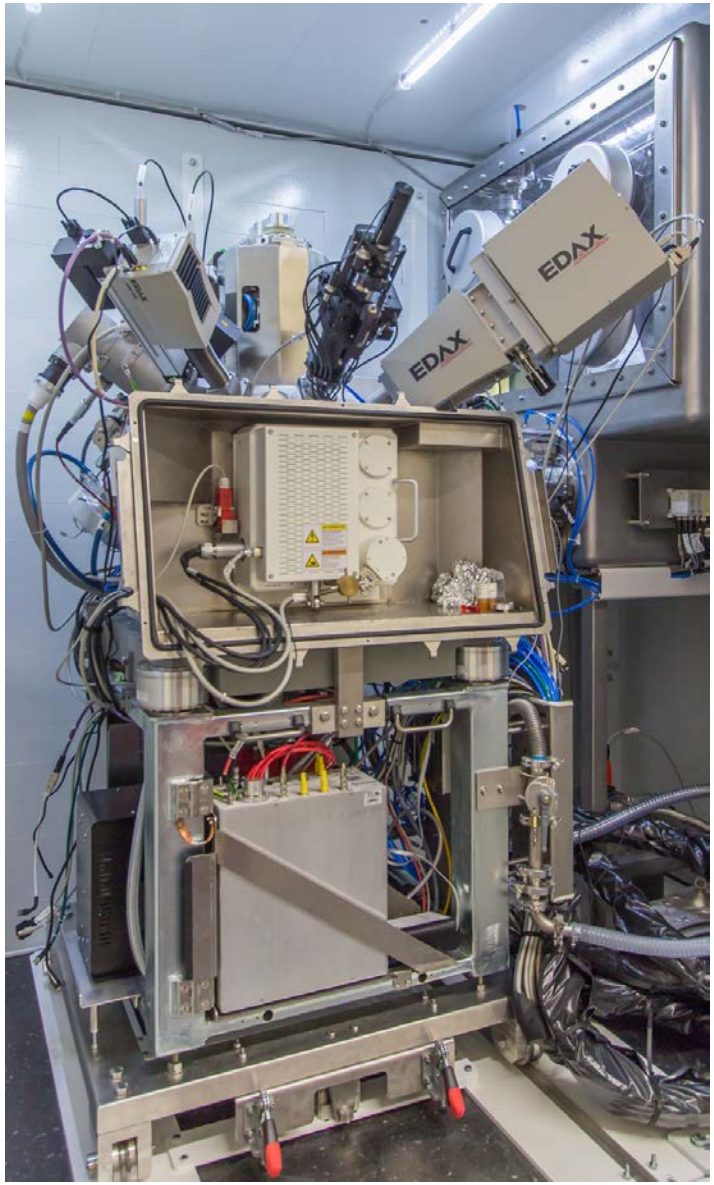
New possibilities with FIB @ PSI Hotlab

Zeiss Crossbeam XB 540

- Gemini II FE column
- 4 detectors for imaging
- Large Chamber
- Capella ion gun
- Gas injection system
- Plasma cleaner
- Micromanipulator

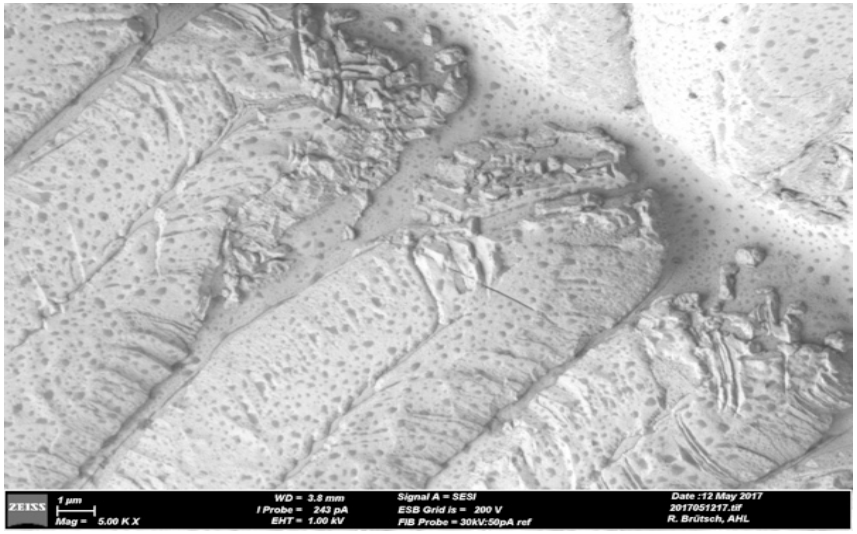
EDAX TEAM Pegasus 3D analysis system

- “Octane Super” SDD
- “TEXS WDS” spectrometer
- “DigiView 5” EBSD-Camera



Timeline FIB @ PSI Hotlab

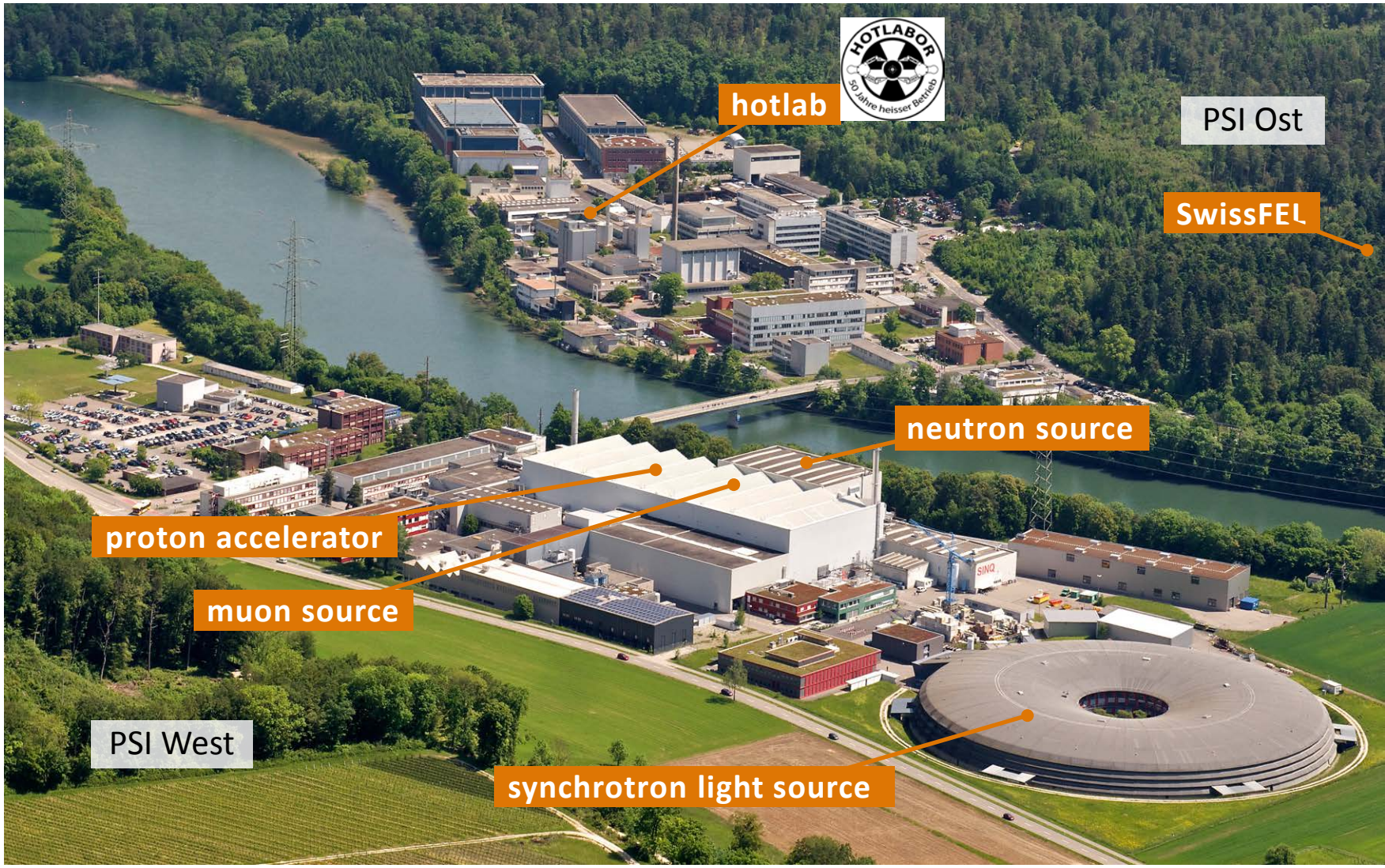
- ✓ 2010 decision to replace old SEM with a shielded SEM/FIB
- ✓ 2015 Order placed
- ✓ 2016 Offside construction
- ✓ Dec 2016 Delivery to PSI
- ✓ Feb2017 Construction of shielding
- ✓ Mai 2017 Installation (1st SEM Picture)
- ✓ Sep 2017 installation & last modifications finished
- o Oct 2017 start-up & training & testing
- o 1st Q 2018 inactive operation
- o 2nd Q 2018 low-active materials
- o 3rd Q 2018 high-active materials



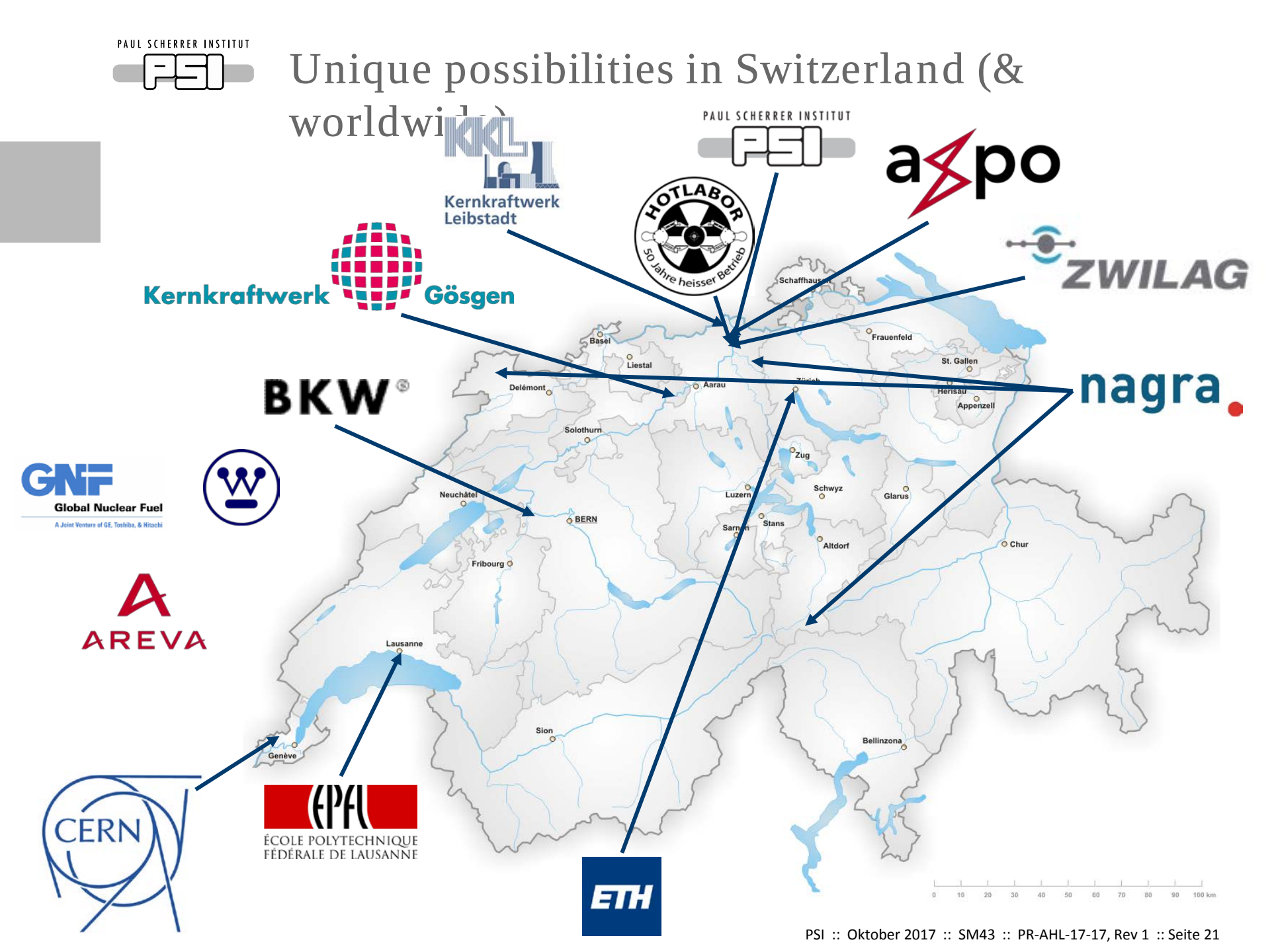
The PSI Hotlab ...

- 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

Unique possibilities at PSI



Unique possibilities in Switzerland (& worldwide)



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PSI Hotlab – Your Partner for Radioactive Materials Examinations

Thanks to ...

- AHL
- LNM
- LES
- LRC
- NES
- ASI
- SIZ
- NFO
- RBE
- AIT
- AIB
- AIE
- ...
- PSI
- ...