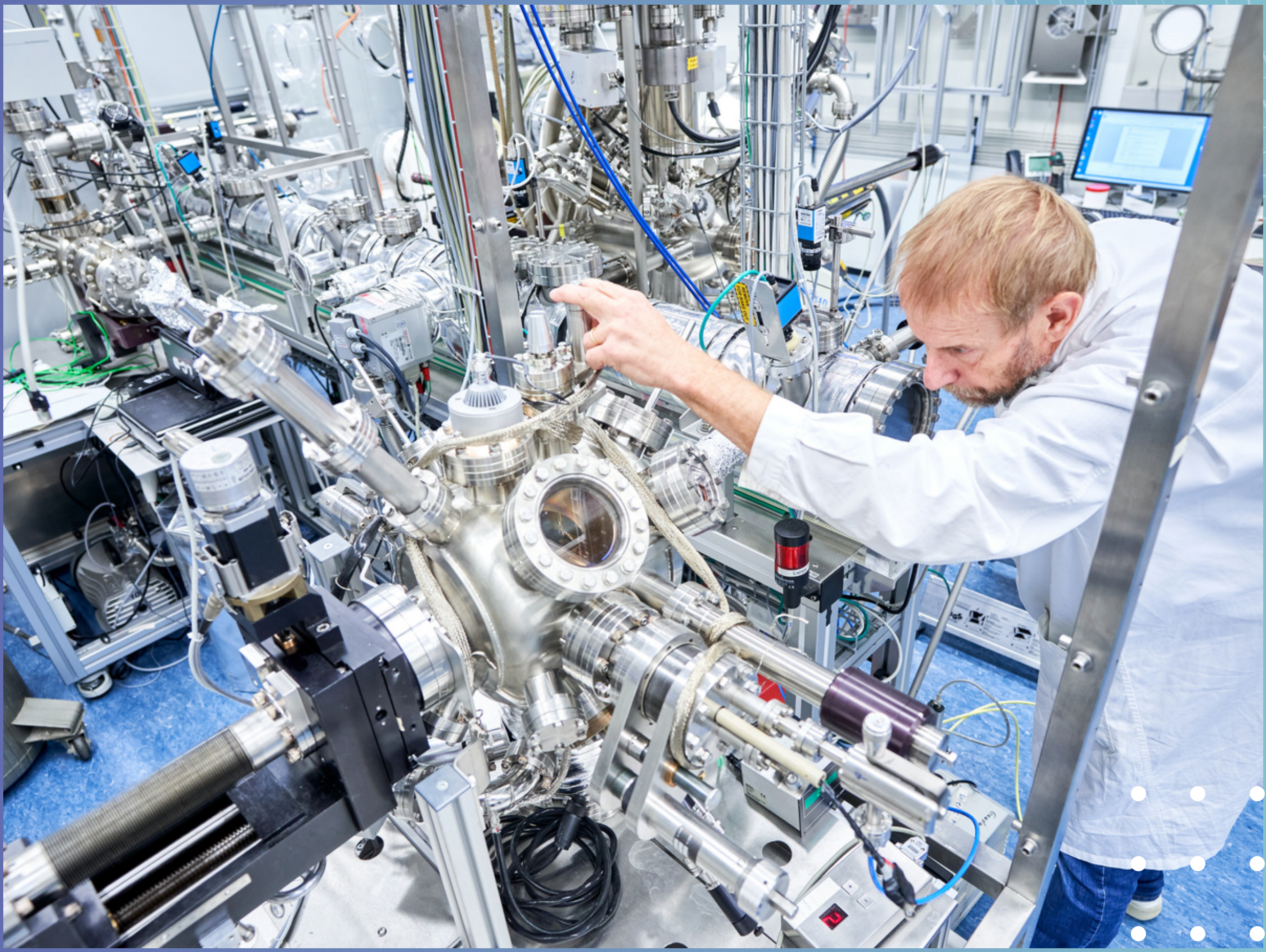
Call for Expression of Interest



Surface Science Laboratory Station Acquisition

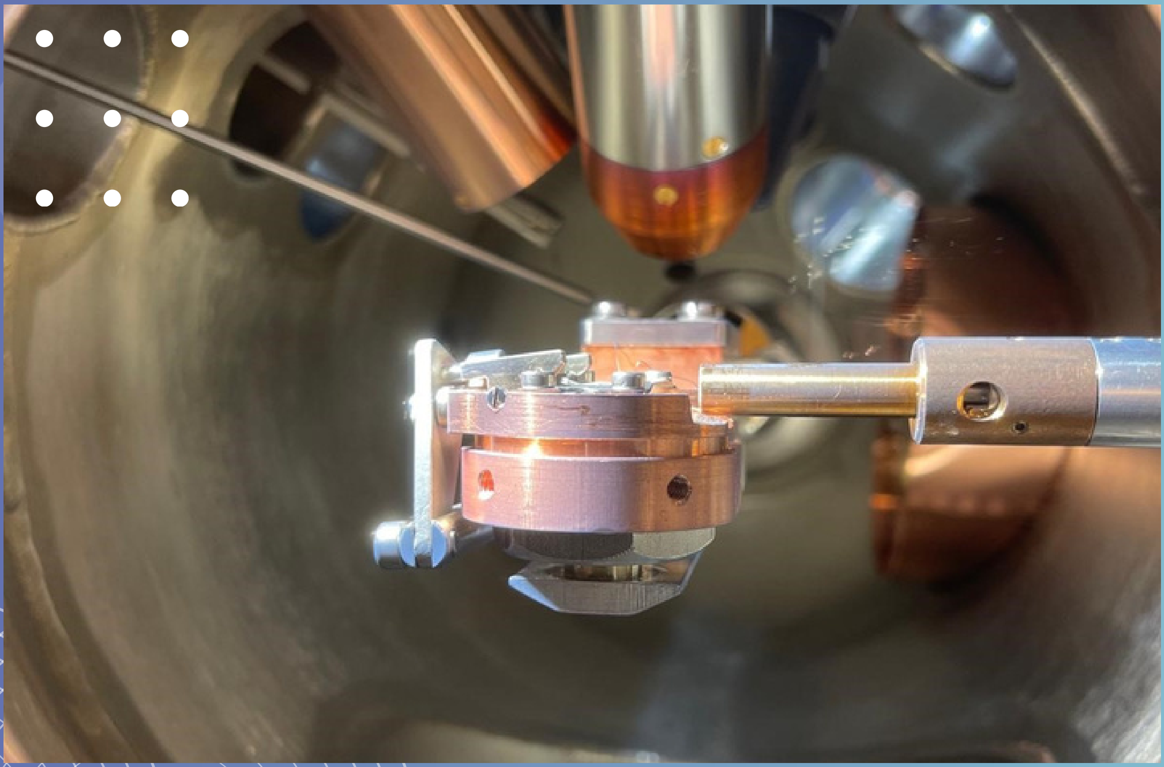
Joint
Research
Centre

About the SSLS

The Surface Science Laboratory Station (SSLS) comprises independent ultra-high vacuum (UHV) chambers connected to a 6-meter central transport tube chamber, designed with modularity to allow independent operation and customization of modules without disrupting other system functions.

This setup enables three main activities:

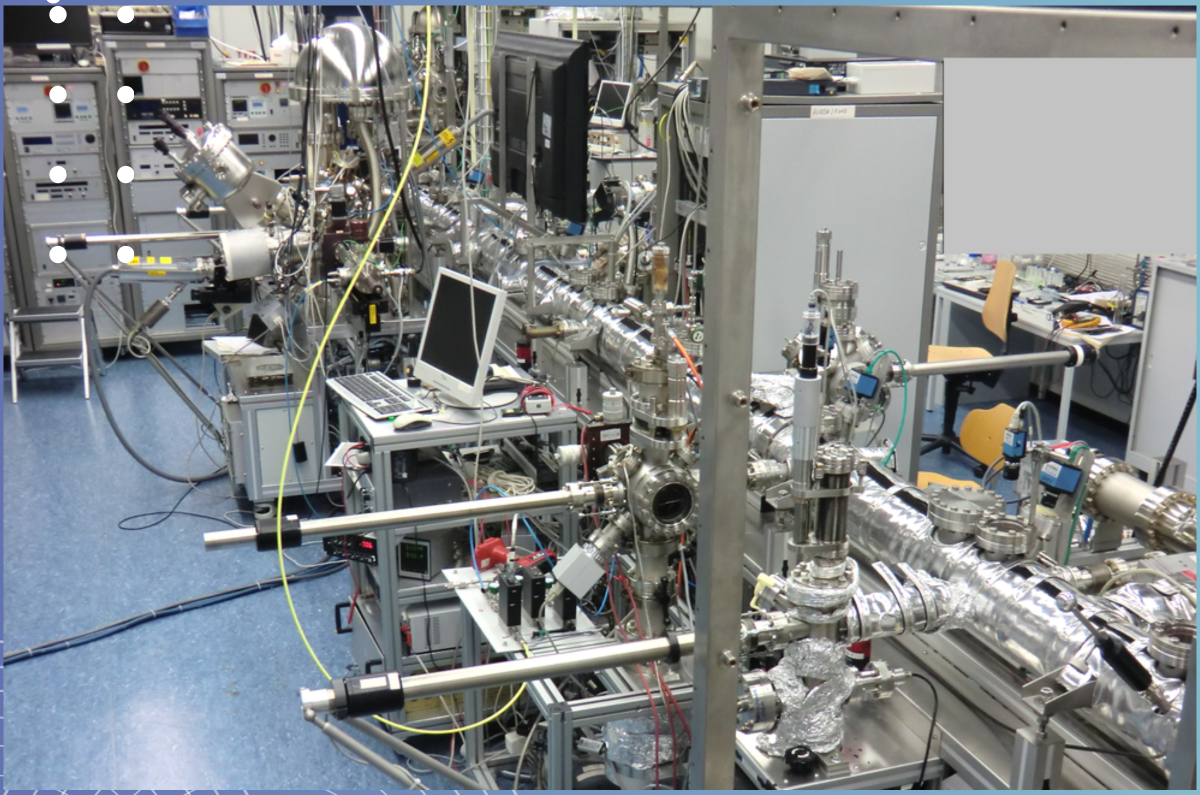
- Surface preparation (often as thin films).
- Surface reactions involving gas exposure, plasma exposure, and photo- or electrochemistry.
- Surface analysis techniques like XPS, UPS, BIS, REELS, HREELS, TPD, LEED, and KP.

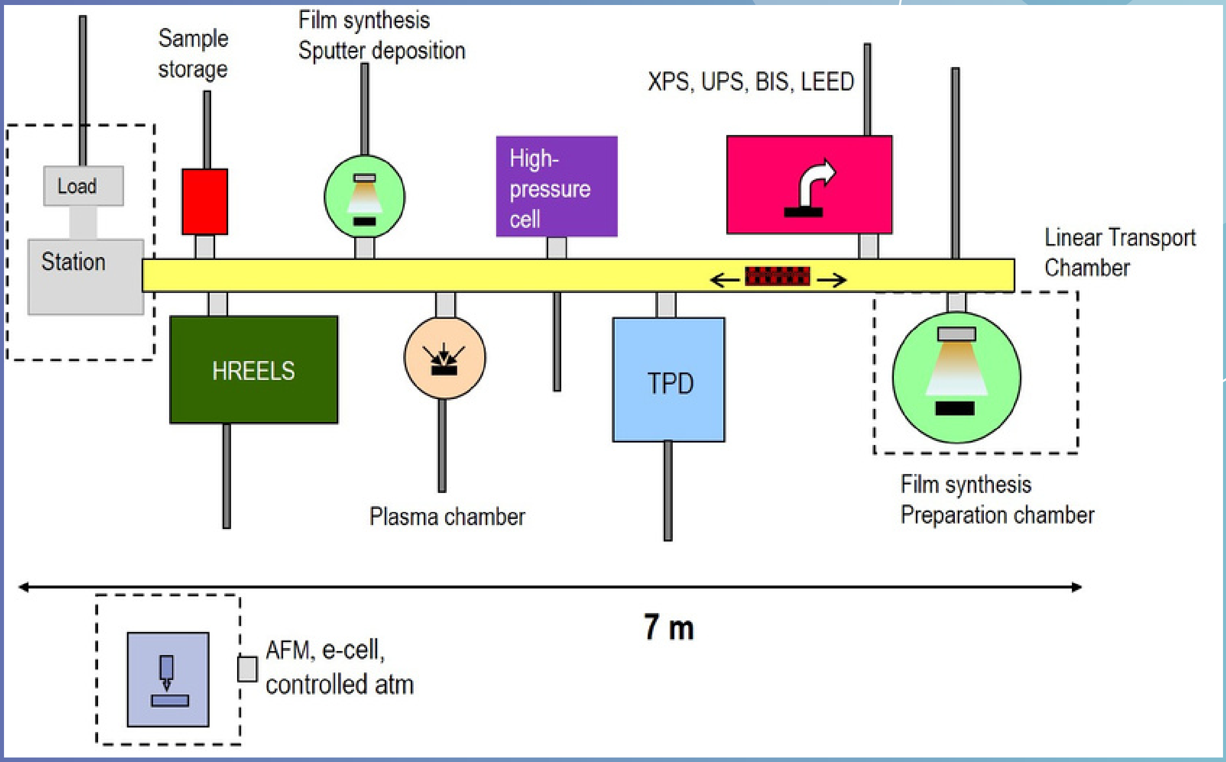


More In detail

The backbone of the SSLS is a long transport chamber (a tube of 6 m length) to which the vacuum chambers are attached. A transport wagon, carrying a maximum of 5 samples, moves inside the transport chamber to the various module positions.

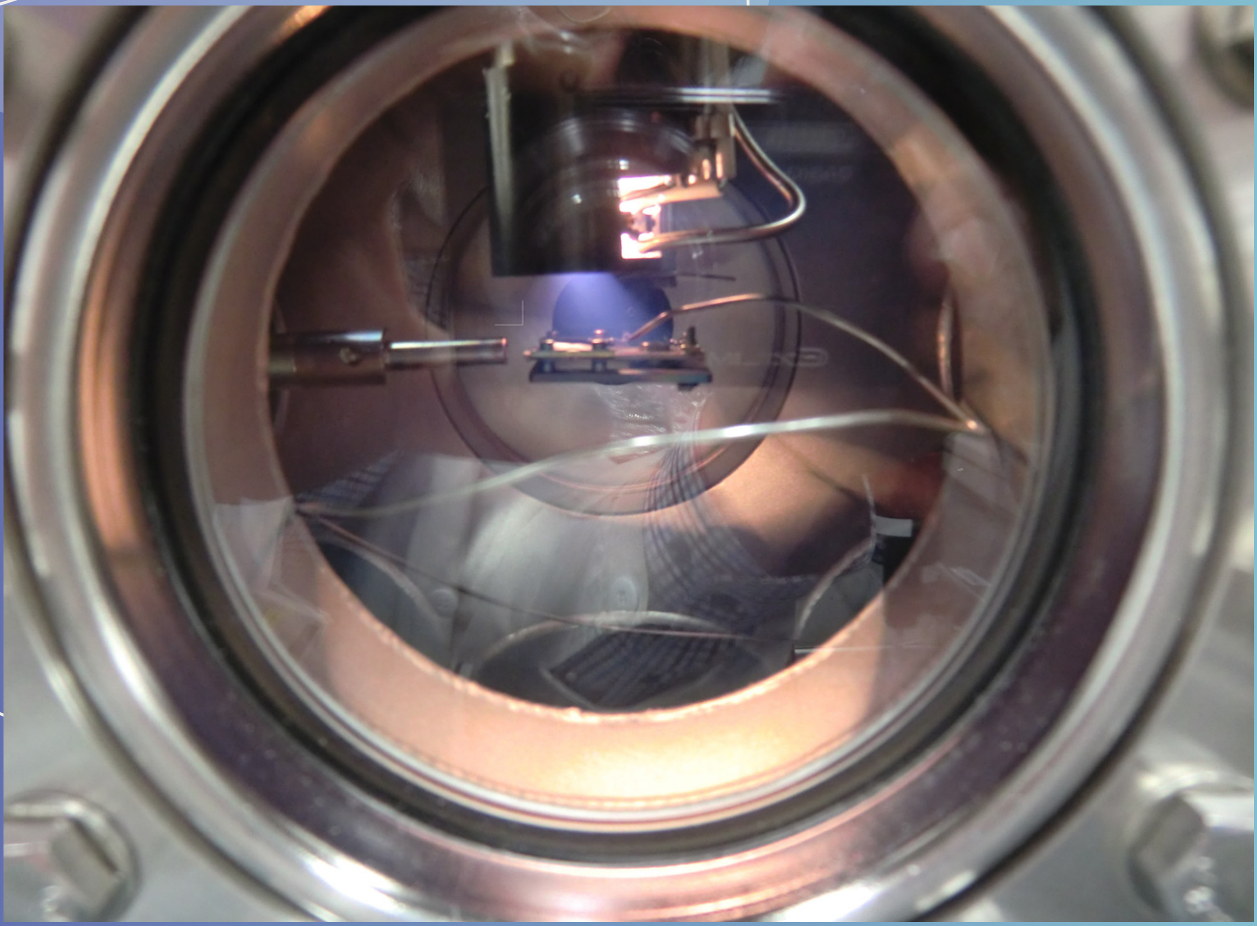
All chamber modules are independently pumped and can be separated from the backbone transport module. With its modular set-up the instrument has been optimized for ease of operation and flexibility. Different operators can work on their projects simultaneously. Also maintenance on a module can be carried without interfering with the others.





The different chambers are (explained by colors):

- **Transport chamber**
- Two-stage **Introduction chamber**
- **Storage chamber** (up to 150 samples can be stored under UHV)
- **Sputter deposition (SD)** chamber (for small sputter source materials: 10 g down to 0.1 g)
- **Plasma chamber** (film exposure to oxygen, hydrogen, nitrogen plasma).
- **Ambient pressure reaction chamber** equipped with illumination (simulation of sunlight)
- **TPD chamber** for Temperature Programmed Desorption experiments
- **Main Analysis chamber** for Photoemission (XPS/UPS), Low-Energy Electron Diffraction (LEED), Reflected Electron Energy Loss Spectroscopy (REELS), Bremsstrahlung Isochromate Spectroscopy (BIS) but also gas exposures (e.g. at 80K) and depth profiling by ion-sputtering
- **HREELS chamber** for High Resolution Electron Energy Loss Spectroscopy
- **Preparation chamber** (sputter deposition, evaporators, sample annealing, sputter cleaning)
- **AFM** module under protective atmosphere (glovebox, with sample introduction to the UHV system) (Optional)



1. Thin film deposition

Sputter source

In-house built DC triode-systems allowing to deposit films from a small target (0.1 g up to several g). The plasma is excited by electrons ejected from a hot cathode. Low pressures and subsequently good surface purity can be achieved. Up to three targets can be mounted, allowing to make alloys, compounds (UC. $U2C3$, ...), and multilayers. Reactive sputter deposition (in presence of oxygen, hydrogen, ...) allows making oxides, nitrides and hydrides. The source has been used for deposition of U, Th, Ce, Pd, Zr, Fe, Ag, etc.

Other commercial film deposition source are available and can be mounted:

- E-beam evaporators (single and triple crucible). Used for deposition of $UO2$ and $ThO2$.
- Filament evaporators. Used for deposition of Au and Pd nanoparticles.
- Effusion cell. Used for $ThF4$ deposition.
- Low/medium temperature evaporator. Used for deposition of Na, $ThF4$ and Te.

2. Surface reactions

Different surface reactions can be carried out under vacuum.

- Reaction with molecular gases (O_2, H_2O, CO, ...) at low pressure. Also a high pressure chamber has been acquired, where reaction can be carried out up to 20 atms.
- Reaction with atomic gases (O, H, N) produced in an ECR (Electron Cyclotron Resonance) plasma.
- Reaction with O and H dissociated in a thermal cracker. It works are lower pressure than the ECR plasma but allows to do surface reactions while analysing (UPS).

Reactions with atomic gases give access to high reaction stages, which normally cannot be reached under low pressure conditions. UO_3 has been produced be exposing UO_2 to atomic oxygen. Exposure to water plasma allow simulating the radiolysis effect. Mixed plasmas (H_2O/H_2 and H_2O/O_2) where done as well.

3. Sample handling/treatment

Sample Introduction is done via a load-lock which can be floated to atmospheric pressure, then pumped down first to primary vacuum (about 2 mbar) by a roughing pump, then to high vacuum (about 1 10-7 mbar) via a turbo pump (which has not to be shut down during venting). A multiple sample holder allows mounting five sample simultaneously.

After reaching acceptable vacuum in the load-lock, samples are transferred to the transport wagon in the intermediate chamber (station) where they stay until reaching UHV final vacuum. The transport wagon has 5 sample mounting positions. The transport wagon is then transferred to the linear transport chamber.

A second load-lock has been developed and was foreseen to be placed in a glove box kept under protective atmosphere. The box is not an ordinary glove-box for radioprotection but can be filled with neutral or reductive gases. An AFM has been mounted in the glove-box and an electrochemistry setup (cyclic voltammetry was foreseen). The setup allows exchanging samples between the UHV environment and ambient pressure non oxidizing atmosphere, where electrochemistry and AFM can be done.

Surface Cleaning

Done by Ar ion sputtering. There are two setups. First a high intensity broad beam non-scanning ion gun is used. The sample is scanning under the ion beam using a computer controlled sample manipulator. Simultaneously the sample can be heated up to 1000°C. In a second setup, a focussed scanning ion gun allows scanning a fine beam over the sample surface. This setup is more meant for depth profiling study and it is now mounted on the XPS analysis chamber. This gun is differentially pumped, so the pressure in the chamber is low enough to do XPS simultaneously to ion bombardment.

4. Storage

Up to 150 samples can be stored under UHV.

5. Cooling/Heating and Temperature measurement

In different places samples can be heated or cooled depending on the applications

- Three e-beam heaters (preparation chamber, XPS analysis chamber and HREELS chamber) allow reaching 1000°C and cooling down to around -180 °C.
- Contact heaters PBN (TPD, SD chamber and ECR plasma chamber) allow reaching 600°C. They work under reactive gas environment, typically up to 10-5 mbar.
- An IR heater is used in the high pressure chamber to heat samples up to 300°C under ambient pressure.

6. Surface analysis

XPS: Monochromatized AlKa radiation with a micro-focus (150 W) with 0.1 to 1 mm spot. Monochromatized AlKa radiation, wide beam (400W).

UPS: High-intensity UV source (HeI, HeII and HeII*).

Electron Analyser: SPECS Phoibos 150 with multichannel detection (9 channeltrons). A Position Sensitive detector for angular resolved photoemission is available.

BIS: Using the X-ray monochromator in conjunction with a pulse counter. The sample is irradiated with electrons produced by a scanning electron gun using a LaB6 emitter.

Flooding gun

To compensate surface photocharging on insulating samples.

LEED

Surface crystallography on single crystals and epitaxially grown films.

REELS

Using the scanning electron gun as for BIS. The FWHM of the elastic beam is about 0.6 eV.

TPD

The surface temperature is scanned from -140°C to 600°C with a linear heating rate between 0.5 and 2 K/s. A differentially pumped high sensitivity mass-spec equipped with a Feulner cup allows separating the gases desorbed from the surface from the background pressure in the chamber.

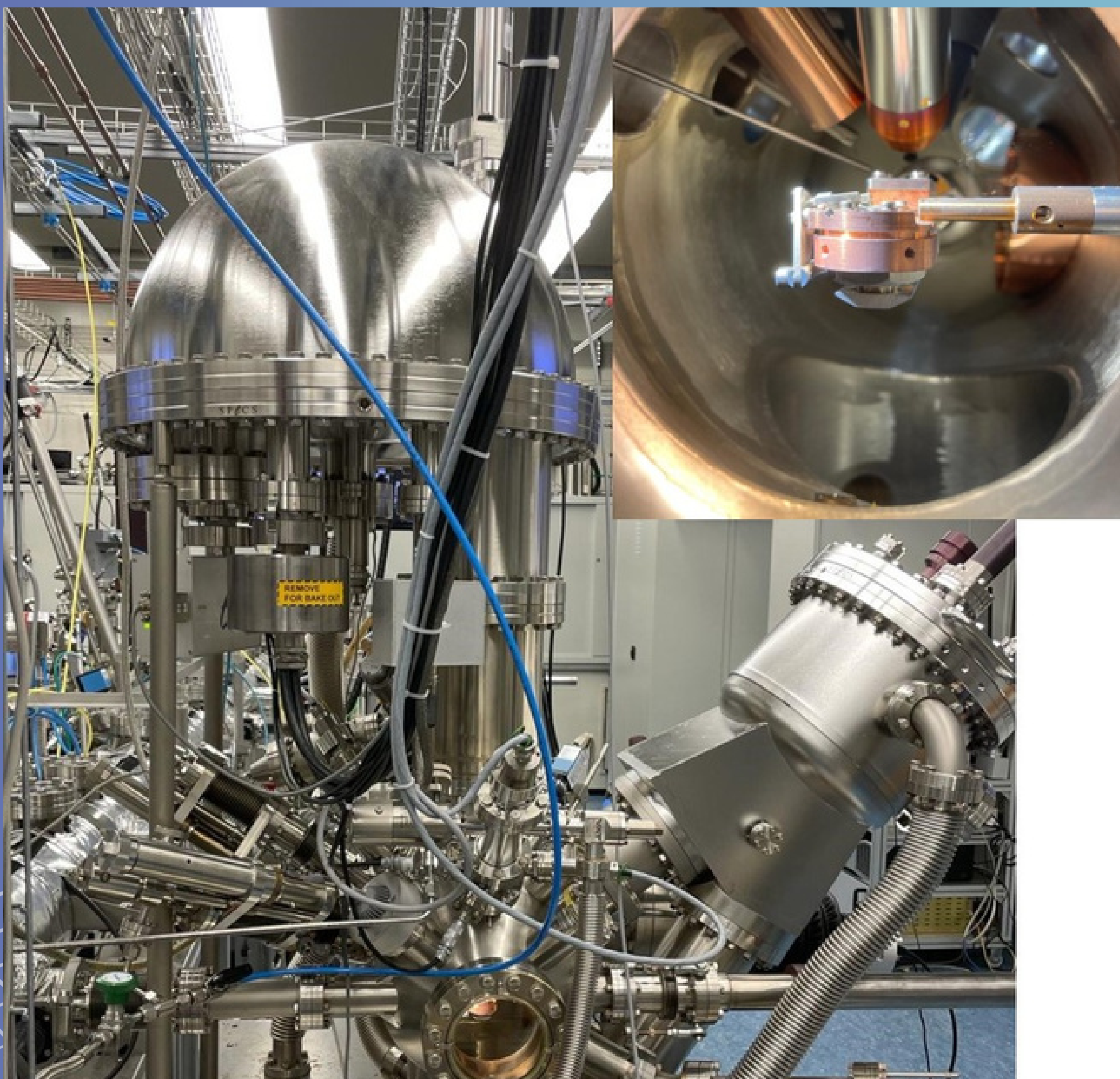
HREELS

A single channel HREELS (Ibach setup, reaching about 2 meV resolution). The sample holder can be cooled down to around -180 °C and heated up to 600°C.

Requirements

01 The institution or university receiving the SSLS must possess a valid nuclear license for handling natural uranium and thorium.

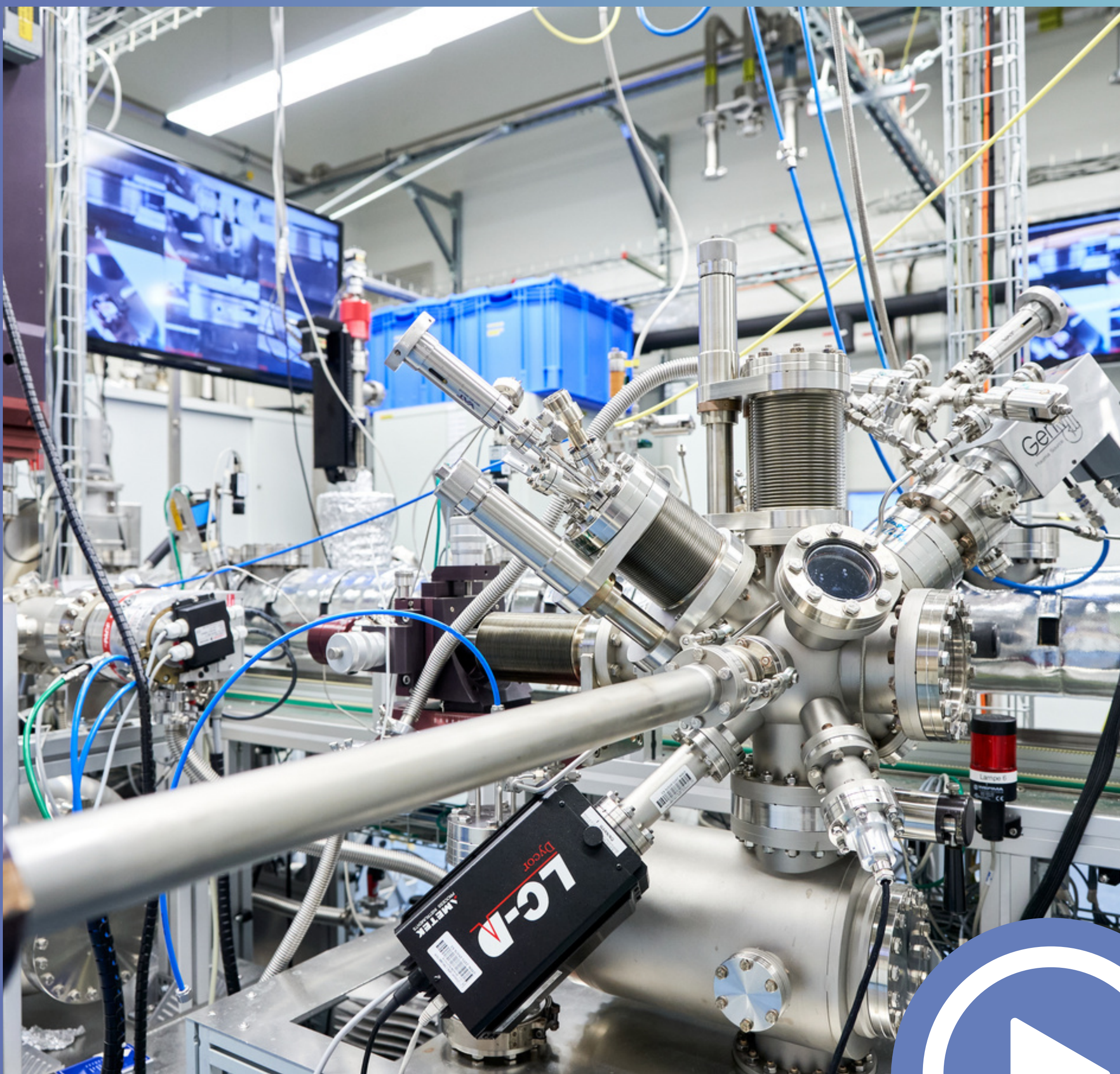
02 A suitable installation location meeting the necessary specifications and demonstrated experience in Surface Science



How to apply

For further details, please go to the official Call for Expression of Interest by clicking in the eTendering platform

CLICK HERE



Do you want to see the SSLS in action? Play me to watch our video!