Paul Scherrer Institute: Swiss Spallation Neutron Source SINQ

General Information: http://www.psi.ch/sinq

SINQ key numbers user operation 2013
User operation started in **1998**

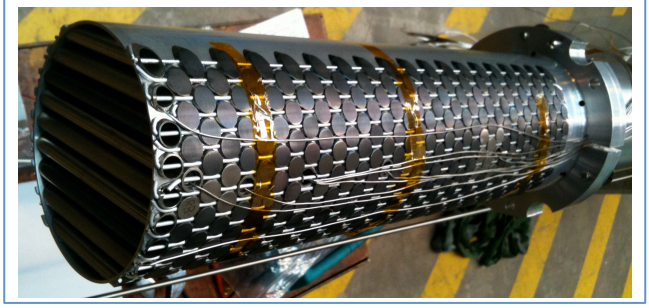
User Operation	2013
Visitors (badge requests)	870
Individual Users	486
Experimental days	1841
Number of Experiments	431
New Proposals	438
Number of Publications (in total)	125
High Impact Publications (≥ 7.1 (PRL))	10

High-Intensity Proton Accelerator HIPA

SINQ is driven by the **PSI proton accelerator HIPA** a 590 MeV, 2200 μA ring cyclotron.

This machine has been continuously upgraded and maintained since its first beam in 1974. With 1.4 MW beam power it is currently one of the most powerful proton accelerators worldwide.

SINQ Spallation Target



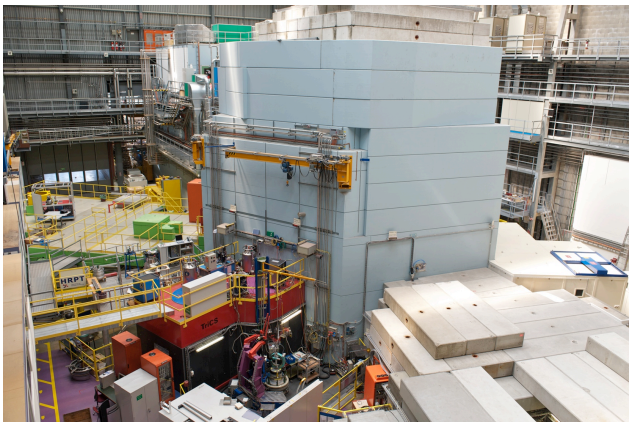
Neutron Scattering at SINQ

Neutron scattering and imaging are exquisitely sensitive and powerful experimental tools to obtain information on both the structure and the dynamics of condensed matter. A wide range of problems from fundamental solid state physics, chemistry, biology, medicine to environmental science are investigated with neutrons with increasing relevance for applied areas like energy and industry-driven research.

The **Swiss Spallation Neutron Source SINQ** is a continuous source - the first and only of its kind in the world - with a flux of about 10^{14} n/cm^2/s. Beside thermal neutrons, a cold moderator of liquid deuterium (cold source) slows neutrons down and shifts their spectrum to lower energies.

SINQ is an open access user facility. Interested groups can apply for beam time on the various instruments by using the SINQ peer review proposal system. The current us by Japanese groups is around 4%.

SINQ Target Block



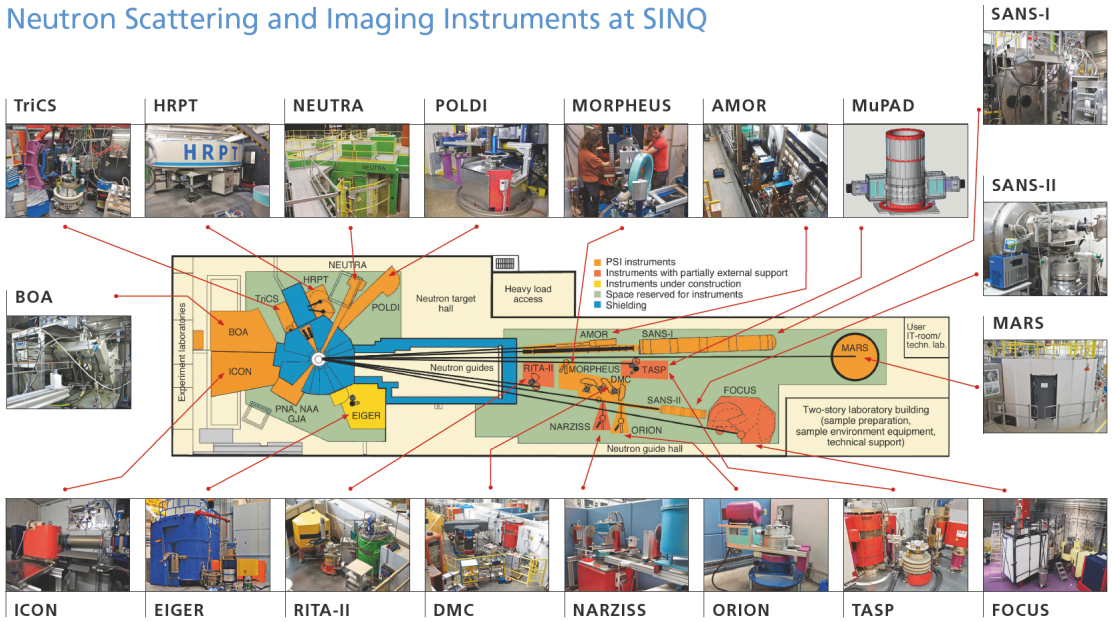
Spallation Neutron Source SINQ

The **SINQ target** is a so called Pb-cannelloni target. The present generation is an array of lead rods, enclosed in zircaloy tubes and cooled in cross flow by heavy water coolant.

In 2006 a liquid metal target with eutectic lead-bismut target material was tested successfully in the framework of the **MEGAPIE**-Project. The MEGAPIE target improved the neutron yield by about 80% relative to the beam current.

Swiss Spallation Neutron Source SINQ

Current Activities



Neutron Scattering and Imaging Instruments at SINQ

The Laboratory for Neutron Scattering and Imaging (LNS) operates a complete set of neutron scattering and imaging instruments at SINQ and conducts diverse research projects ranging from modern topics in condensed matter physics and materials science to pressing questions in energy research and health care.

The SINQ instrument suite includes powder and single crystal diffractometers (HRPT, DMC, TriCS) with a vital range of neutron wavelengths and efficient detector systems. Neutrons penetrate complex sample environment and have an extraordinary sensitivity to H atoms, which are properties that are of special importance for in-situ experiments on energy materials.

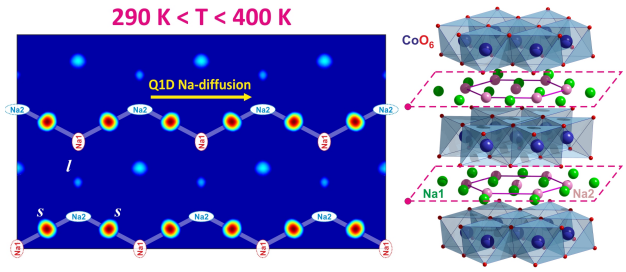
Small-angle neutron scattering (SANS-I and SANS-II) helps to determine the structures of soft matter systems like the active building blocks in photosynthesis and of polymers, such as those used as membranes in fuel cells.

Neutron spectroscopy (FOCUS) reveals the microscopic dynamics and provides essential information on diffusion processes in systems where atomic transport is important (batteries, H storage, water diffusion in clays for safe storage of nuclear waste).

Of particular relevance is neutron imaging (ICON, NEUTRA). It allow in-situ studies on working devices for example to understand the water management in fuel cells.

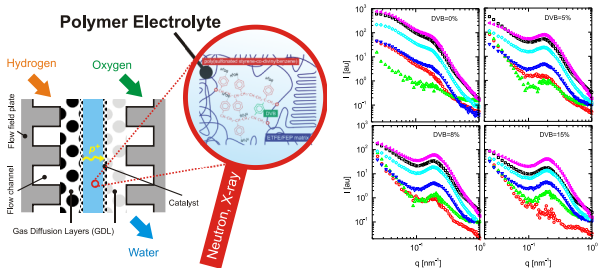
Highlights from Energy Research – Na batteries

Diffusion processes are studied by neutron diffraction in Na_xCoO_2, which is a potentially cheaper and more abundant alternative to battery materials containing Li.



Highlights from Energy Research – Electrolytes

Novel polymer electrolytes have high potential for future application in fuel cells. The structure-property relationships of radiation-grafted block copolymer is studied by small-angle scattering.



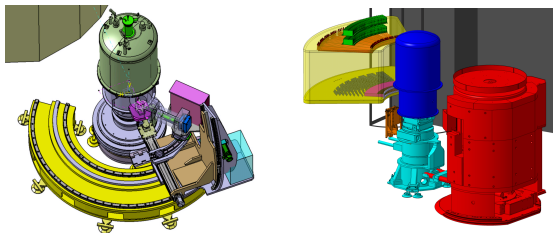
Swiss Spallation Neutron Source SINQ

Future Perspective

Upgrade of SINQ

New instruments at SINQ to be completed by the end of the decade include a **neutron microscopy** for high-resolution neutron imaging, a **diffractometer** giving access to unprecedentedly small sample volumes, a **spectrometer** for extreme condition studies e.g. of novel materials for spintronics applications, and a fully focusing **reflectometer** for in-situ studies of functional heterostructures.

SINQ was the first neutron source built based on **supermirror guides** for efficient neutron transport from the source to the instruments. This technology has evolved with signification contribution by Swiss industry. Advanced neutron optics allows more efficient transport and focusing on smaller sample volumes.



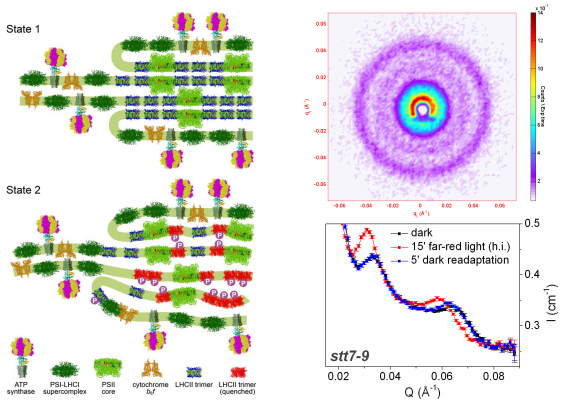
New Spallation Neutron Source ESS for Europe

Construction has started in Lund, Sweden, of a next generation neutron source for Europe. **The European Spallation Source ESS** will be a 5 MW source with 22 instruments, built as collaboration between 17 European partner countries, and will be operational by 2019. The PSI will be involved in the construction of 4 instruments at ESS, including a wide length scale diffractometer and an imaging instrument with 1 µm spatial resolution.

European Spallation Source ESS

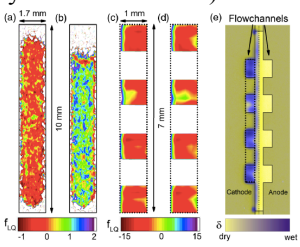
Energy Challenge – Understanding Photosynthesis

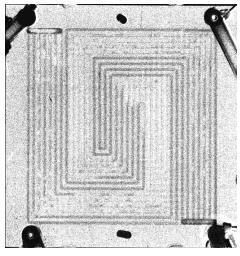
Understanding photosynthesis remains a great challenge. It is among the most complex and most efficient energy harvesting processes in nature. Small-angle neutron scattering allows in-situ and in-vivo studies of the structure of chloroplasts and its changes induced by light (G. Nagy *et al.*, Proc. Natl. Acad. Sci. 2014).



Energy Challenge – Optimizing Fuel Cells

Fuel cells are complex devices consisting of many components requiring material optimization and challenging operation control. For all of these optimization tasks neutron scattering and especially neutron imaging are essential for visualization of processes and for diagnostics. A technical challenge remains e.g. the water formed in the cells, its flow and aggregate state depending on the cell's operation temperature. In pioneering experiments using dual spectrum neutron imaging, for the first time the distribution of liquid water and ice was determined for future efficient sub-zero operation (J. Biesdorf *et al.*, Phys. Rev. Lett. 2014).





Contact and Proposal Deadlines

Laboratory for Neutron Scattering and Imaging

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Proposals: http://www.psi.ch/useroffice/