

WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN



Andreas Pautz, Bereichsleiter Nukleare Energie und Sicherheit (NES) :: Paul Scherrer Institut

NES präsentiert: Kompetenzen und Highlights

Paul Scherrer Institut, 18. Oktober 2016

NES präsentiert: Kompetenzen & Highlights

09:00	Begrüssung und Einführung	<i>A. Pautz</i>
09:20	Labor für Reaktorphysik und Systemverhalten	<i>H. Ferroukhi</i>
09:40	Labor für Thermohydraulik	<i>H.-M. Prasser</i>
10:00	<i>Kaffeepause</i>	
10:30	Hotlabor	<i>D. Gavillet</i>
10:50	Labor für Nukleare Materialien	<i>M. Pouchon</i>
11:10	Labor für Endlagersicherheit	<i>S. Churakov</i>
11:30	Labor für Energiesystem-Analysen	<i>S. Hirschberg</i>
11:50	Labor für Radiochemie	<i>A. Türler</i>
12:10	Schlussbetrachtungen und Verabschiedung	<i>A. Pautz</i>
12:30	Ende der Veranstaltung	

- NES Mission and Strategy, and Organization
- Projects and Partners of NES
- NES: Some Recent Activities

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NES Mission and Strategy

NES is the Swiss national center of competence for nuclear energy:

- NES research focuses on the **safety** of the existing nuclear power plants, **waste management** issues, and *decommissioning of nuclear installations*
- NES will continue to address **advanced and innovative nuclear system concepts**, in particular with respect to safe operation and waste minimization strategies
- NES strongly contributes to the **education** of nuclear engineers at the master, PhD, and PostDoc level and cooperates closely with **ETHZ** and **EPFL**
- NES recognizes the **multi-disciplinarity** of nuclear engineering and strives to build scientific links to the large-scale facilities at PSI, and across the whole ETH domain

Contribute to the evolution of the State-of-the-Art in science and technology for thermal and fast reactor systems

- NES acts as a **Technical Safety Organization (TSO)** for the Swiss Nuclear Regulator, ENSI, and is member of the European TSO Network ETSON
- NES has the Federal mandate of “Technology Monitoring” of Gen-III/Gen-IV reactor developments (*Membership GIF: Generation-IV International Forum*)

NES maintains the capability of handling and fostering investigations of radioactive materials in the Hot Laboratory (AHL)

- The AHL is one of the very few facilities of its kind in Europe, and provides PSI with a decisive advantage over other nuclear research institutions
- It remains mandatory to operate the AHL due to the industrial demand, e.g. PIE of spent fuel rods

NES Strategic Goals (II)

NES implements within LES the competence center for geochemistry of disposal systems and transport mechanisms of radionuclides

- LES contributes significantly to the Sectoral Plan (Stage 2/3)
- Re-orientation of the LES strategy towards remediation and decommissioning eventually needed

Strengthen the engagement in basic research, in particular at SLS and SINQ

Look for opportunities to apply NES expertise in sectors other than nuclear, and in its role as International Technical Safety Organization

Foster Nuclear Education by substantially contributing to the Swiss Nuclear Master Program and other programs (PSI / EPFL /ETHZ)

Contribute to effective decision-making on medium- to long-term technology strategies in energy supply and demand (LEA)

NES Mission: Maintaining Nuclear Competence



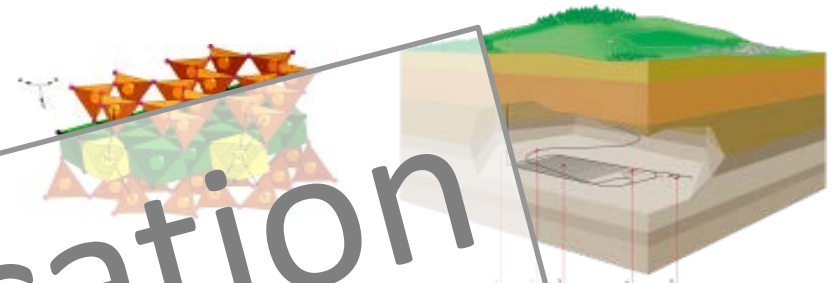
Safety

Education

Understanding relevant phenomena
Normal Operation ... Severe Accidents
Materials performance (barrier integrity)

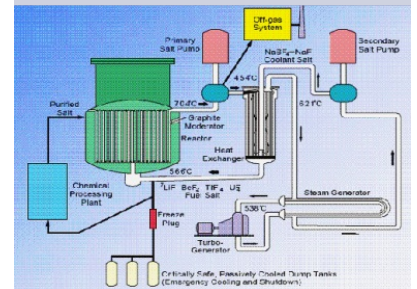
Waste Management

Multiscale reactive transport
of radio-isotopes
Safety of deep geological repository

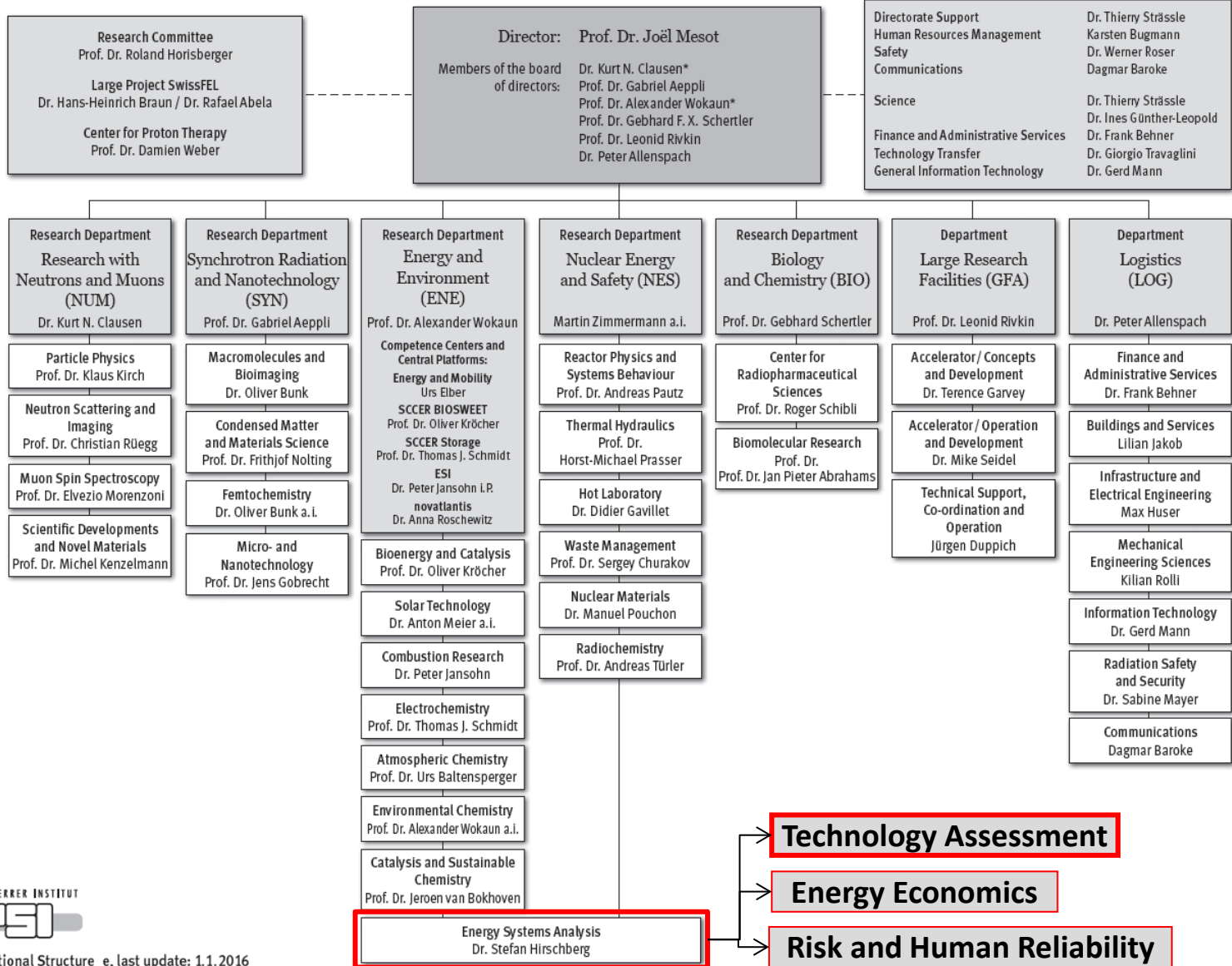


New Technologies

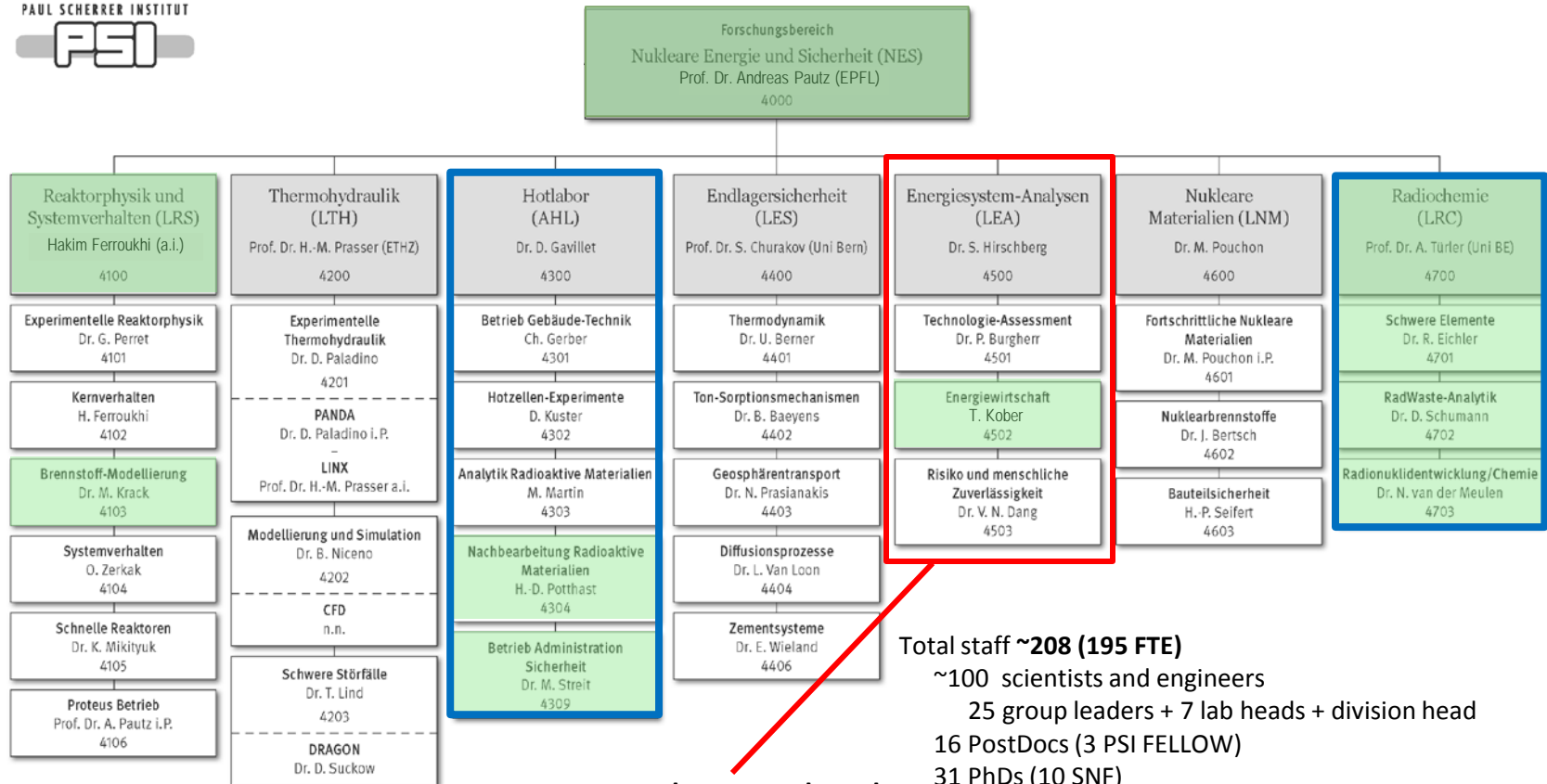
Reduced risk - Reduced waste



PSI Organization



NES Organization as of October 2016



Total staff ~208 (195 FTE)
 ~100 scientists and engineers
 25 group leaders + 7 lab heads + division head
 16 PostDocs (3 PSI FELLOW)
 31 PhDs (10 SNF)
 47 technical personnel (44.9 FTE)
 7 administrative personnel (6.1 FTE)

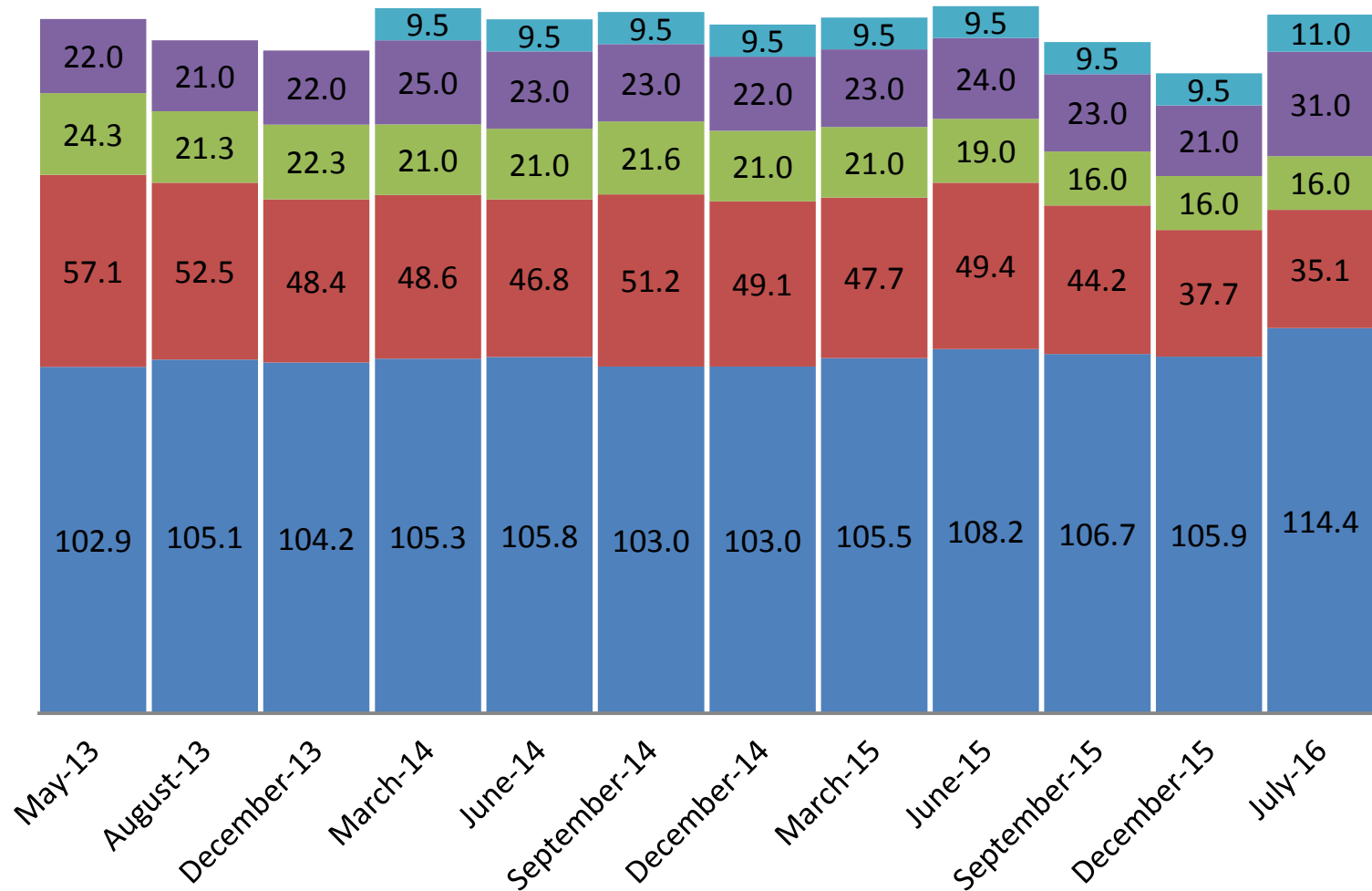
+ 4 PhDs from EPFL
 + 4 PhDs from ETHZ
 + 3 PhDs from Uni Bern

Laboratory shared with the «Energy and Environment» Division of PSI

Salaries 2016: 42.8% PSI «Erstmittel» / 57.2 % third-party funding

Development of NES Personnel (FTE)

■ Permanent ■ Non-Permanent ■ PostDocs ■ PhDs (PSI) ■ PhDs extern





NES Projects and Partners

- NES serves a wide range of clients, however, our most important national partners are:
 - **swissnuclear** (“Hotlaborbetrieb + Projektförderung/Kompetenzerhalt”)
 - **ENSI** (Reactor Safety Research + On-Calls)
 - **NAGRA** (Scientific Support for Sectoral Plan)
- Besides that, NES is involved in more than 20 **Euratom/Horizon 2020** projects, and participates in numerous OECD/NEA and IAEA activities
- NES has also been successful in acquiring competitive “Zweitmittel”, e.g. via the **Swiss National Science Foundation (SNF) and KTI**

Overview of NES Activities for ENSI

- **Deterministic Safety Analysis (LRS)**
 - R&D activities in DSA for the Swiss reactors
 - On-call activities of PSI for ENSI

- **Material Integrity (LNM)**
 - NORA-II: Impact of Early OLNC on Fuel Integrity
 - PROBAB: Effect of Plume Cooling in RPV PTS Analysis
 - PARENT (2012-16): NDT Test Bodies with SCC Cracks
 - SAFE-II SP-I: SCC Initiation in Alloy 182 Dissimilar Metal Welds

- **Severe Accidents (LTH)**
 - BSAF: Benchmark Study of the Accidents in Fukushima Daiichi Power Stations, Phase 2
 - MELCOR: Further development of air oxidation model and the effect of nitrogen on cladding degradation

- **Human Reliability and PSA (LEA)**
 - Project “Reliability of Operators in Emergency Situations (ROES)”

NES Project Portfolio: *swissnuclear*

- NES enjoys the financial support of **swissnuclear**: a new **framework contract** (*Rahmenvertrag*) for the *Sockelbeitrag Hotlabor*, and for the project funding have been signed very recently.
- The granted amount is **2.5 Mio. CHF/y** for the Hotlab operation (from 2016-2019), and on average **~2.3 Mio. CHF/y** for the project funding
- The **projects for 2016/2017** have been agreed upon with *swissnuclear*, and some have already started.
 - Overall, 18 project proposals were proposed to *swissnuclear*, of which 13 were approved

No.	Project Name	Principal Investigator	Labs
099	Investigation on the Chemical Speciation of C-14 from Activated Steel	E. Wieland	LES
100	VOID: Development of an experimental setup to reconstruct axial void profile through neutron noise measurements	G. Perret	LRS, EPFL
101	Source Term Mitigation During Severe Accidents – Phase 2	T. Lind	LTH
102	Long Term Analysis of Source Term from Severe Accidents	T. Lind	LTH
103	Hydrogen Uptake	S. Abolhassani	LNM
104	FAHRRAD – Fine Analysis of Hydrides Resolved by X-Ray Diffraction	M. Collet	LNM
105	Hydrides and Mechanics	J. Bertsch	LNM

No.	Project Name	Principal Investigator	Labs
106	Waste Treatment and Isotope Reclamation	D. Schumann	LRC, AHL
107	Cask Oriented Analyses for the Swiss Reactors with Quantification of Uncertainties in Activity, Decay Heat and Radiation Emission Sources	A. Vasiliev	LRS
108	QUASAR: Quantification of Uncertainty and Analysis of Sensitivity Applied to Reactors	M. Hursin	LRS
109	ATF@LWR: A Pilot Study on the Potential Benefits of SiC/SiC Cladding for Present-Day Light Water Reactors	O. Zerkak, J. Bertsch	LRS, LNM, AHL
110	Chemical Thermodynamic Aspects of LWR Pu and MA Burning in Fluoride Salt Fueled Fast MSR	S. Nichenko	LRS, AHL, LES
111	Plant Life Management PLiM: Thermo-Mechanical and Multiaxial Fatigue caused by Cyclic Thermal Shocks	M. Niffenegger	LNM

The Gen-IV International Forum (GIF)

- In August 2015, Switzerland signed the **ten-year extension of GIF Framework Agreement** for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems.
- In November 2015, Switzerland signed the Memorandum of Understanding and joined the **GIF Molten Salt Reactor Project**.
- Switzerland continues participation in the **GIF Very High Temperature Reactor** project (LNM)



Focus of NES: Molten Salt Reactor Safety

- **NES Division Project** on Gen-IV MSR (umbrella for several project).
- **Euratom Horizon2020 project SAMOFAR**
 - 1) Safety Assessment of Molten Salt Fast Reactors.
- **4 national project** fully or partly related to MSR:
 - 2) **SNF PhD**: Modular MSR Designing for Low Waste Production.
 - 3) **SNF PhD**: Nuclear Data Assimilation in Reactor Physics (Pu & Th).
 - 4) **Swiss Electricity Producers (VSE) & ETHZ** financed project:
Feasibility and plausibility of innovative reactor concepts (HTR & MSR).
 - 5) **swissnuclear** sponsored project:
Chemical thermodynamic aspects of LWR Pu and MA burning in MSR.
- 6 Master theses on MSR topics have been completed, 3 more are currently ongoing
- Due to its cross-cutting nature, the cooperation on MSR extends over several NES labs: **LRS^{1,2,3,4,5}**, **LTH^{1,4,5}**, **AHL^{1,5}**, **LEA^{1,4}**, **LES⁵**.


Invitation to MSR workshop at PSI

- The upcoming **23rd GIF MSR PSSC** meeting will be hosted by PSI on **23-24 January 2017**.
- We plan, as a newcomer, to organize on **24 January - Tuesday** afternoon, a **public MSR workshop** presenting the key national programs and the foreseen project and motivation of Switzerland.
- Preliminary confirmed speakers:
 - Dr. Xu – China
 - Dr. Holcomb – USA
 - Dr. Ignatiev – Russia
 - Prof. Kloosterman – EU
 - Prof. Pautz – Switzerland
 - Prof. Edwards – Australia

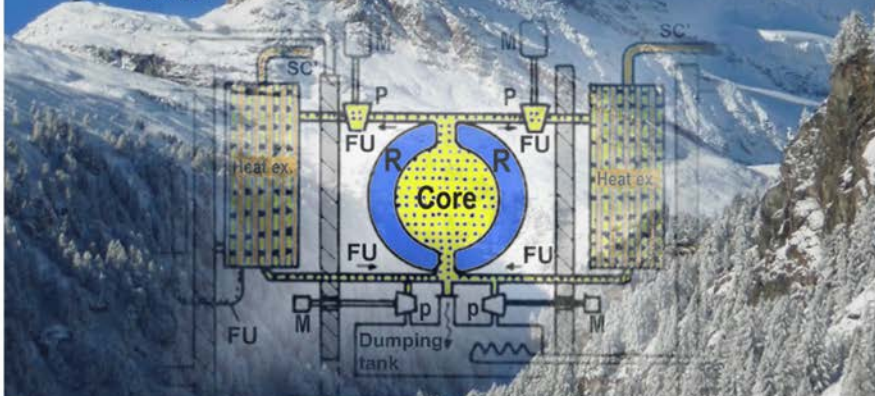
Molten Salt Reactor Workshop at PSI

Designs, Diversity, Safety, Sustainability
PSI Auditorium, 24. January 2017, afternoon

In November 2015 Switzerland joined the GIF MSR activities and the upcoming 23rd GIF MSR PSSC meeting will be hosted by Paul Scherrer Institute, the Swiss implementing agent. At this occasion an MSR workshop dedicated to the national projects of the GIF MSR partners will be held. It will include the country programs of China, EU, France, Russia, USA, and the motivation and foreseen project of Australia and Switzerland.



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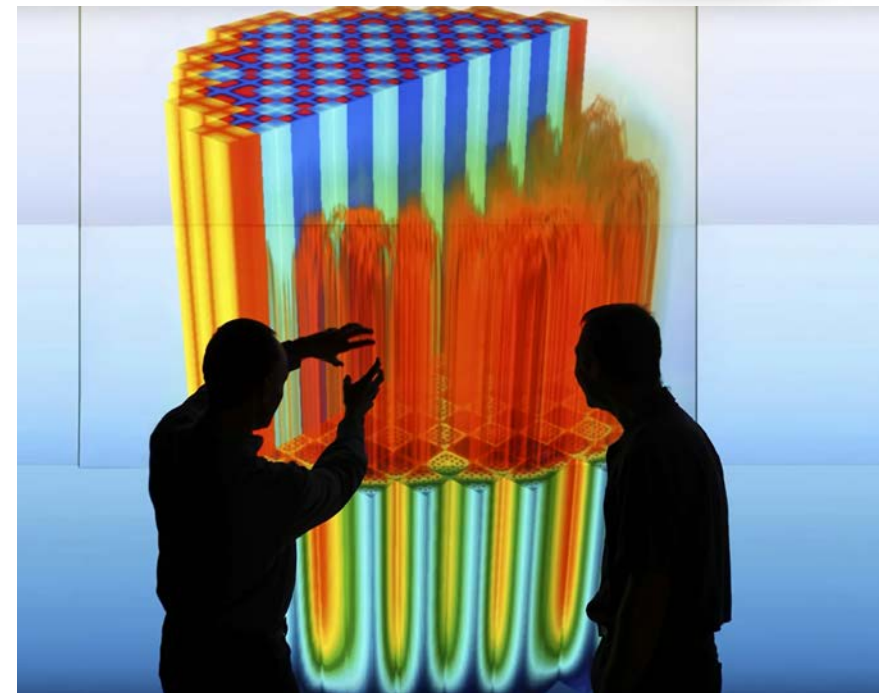
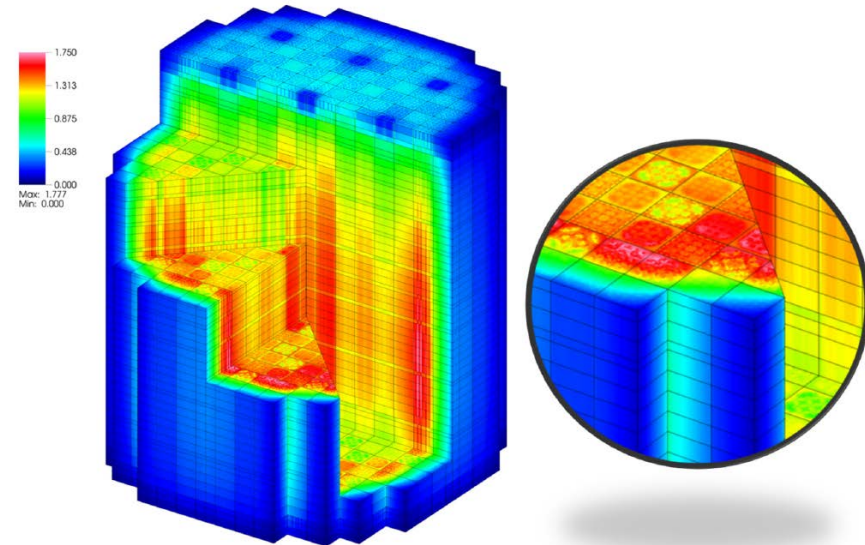


NES: Some Recent Activities

Establishing a New Laboratory in NES

The PSI directorate has decided to bundle **all PSI activities on scientific modelling and computing** in a single lab:

- It recognizes the **importance of computer simulation and modelling** as a third branch of endeavor besides experiment and theory
- Several other large research labs have implemented **similar units and/or initiatives**, e.g.
 - **Oak Ridge (ORNL):**
<http://www.csm.ornl.gov/newsite/>
- It was decided to launch this new laboratory **within NES**, since NES is the PSI division with the strongest computational focus
- A new professorship on Multiscale Materials Modelling is to be established at ETH Zurich, as joint position with a PSI laboratory lead



Establishing a New Laboratory at PSI

This new laboratory should cover at least the following areas:

- **Condensed Matter Theory** - (including Analytical modeling)
- **Materials Science** - hard materials, microstructure and microstructural evolution, nuclear materials and structural integrity
- **Computational Fluid Dynamics (CFD)**
- **High-Fidelity Radiation Modeling** - shielding, activation, neutron/photon transport
- **Complex System Simulation:** Reactor simulation, Target simulation/design, «multi-physics» coupling
- **Computational soft matter and biology** - Molecular modeling and simulation of the dynamic properties of biological soft matter.

New Format of the NES PhD Day

- On May 9, 2016, the 8th NES PhD day took place at Auditorium West
- The work of 22 PhD students was judged by a 12-member jury¹ in a closed poster session
- From 22 poster contributions, 8 (two 1st year, two 2nd year, four 3rd/4th year), were selected for oral presentations in the afternoon
- From those, four winners were selected (one 1st year, one 2nd year, two 3rd/4th year)
- The proud winners are:
 - 1st year: Benoit Soubelet (LTH)
 - 2nd year: Anne-Laurene Panadero (LRS)
 - 3rd/4th year: Nicol Grilli (LNM)
 - 3rd/4th year: Nadine Chiera (LRC)



New Format of the NES Colloquium

Upcoming NES Colloquia

Date	Time	Room	Speaker	Title
Wed 12 Oct 2016	11:00 - 12:00	Auditorium	D. Schumann	Exotic radionuclides: what are they good for?
Tue 8 Nov 2016	11:00 - 12:00	Auditorium	E. Chiaveri (CERN/n_TOF)	n_TOF (Neutron Time of Flight) at CERN: a bright future for neutrons
Wed 23 Nov 2016	11:00 - 12:00	OSGA/EG06	W. Schenler	Global price regional variations in current reactor technology: what are the contributing factors?
Tue 13 Dec 2016	11:00 - 12:00	OSGA/EG06	N. Kivel	Characterization and analysis of radioactive materials with mass spectroscopy

Past NES Colloquia

Date	Time	Room	Speaker	Topic
Wed 14 Sep 2016	11:00 - 12:00	OSGA/EG06	J. Krepel	Molten Salt Reactor: sustainable and safe reactor for the future?
Wed 24 Aug 2016	11:00 - 12:00	OSGA/EG06	Dr. G. Perret (LRS)	Example of a not too technical presentation: The sound of neutrons
Fri 15 Jul 2016	11:00 - 12:00	OSGA/EG06	Dr. D. Gavillet	AHL: Hot Laboratory Department
Tue 12 Jul 2016	11:00 - 12:00	OSGA/EG06	Prof. R. Hayano (University / CERN)	Fukushima Accident – Five years on
Wed 15 Jun 2016	11:00 - 12:00	OSGA/EG06	Prof. A. Pautz (LRS)	LRS: Overview, examples of recent highlights and outlook
Tue 17 May 2016	11:00 - 12:00	OSGA/EG06	Dr. S. Hirschberg (LEA)	LEA: Overview, examples of recent highlights and outlook
Mon 11 Apr 2016	11:00 - 12:00	OSGA/EG06	Prof. S. Churakov (LES)	LES: Overview, examples of recent highlights and outlook
Wed 30 Mar 2016	11:00 - 12:00	OSGA/EG06	Dr. M.A. Pouchon (LNM)	LNM: Overview, examples of recent highlights and outlook
Fri 12 Feb 2016	11:00 - 12:00	OSGA/EG06	Prof. M. Prasser (LTH)	LTH - Thermal Hydraulic Fundamentals of the Prevention and Mitigation of Severe Nuclear Accidents
Tue 19 Jan 2016	11:00 - 12:00	OSGA/EG06	Prof. A. Türler (LRC)	LRC: Overview, examples of recent highlights and outlook

<https://www.psi.ch/nas/events>

Nuclear Energy and Safety (NES)

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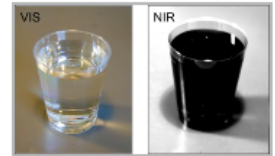
Scientific Highlights NES

2016

28. September 2016

Infrared imaging sheds new light on the condensation/evaporation process

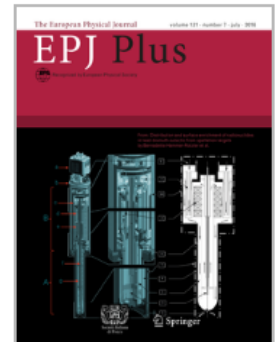
Researchers at PSI (NES/LTH) have brought modern infrared technologies into their large thermal-hydraulic facility, called **LINX**, to obtain insights into condensation/evaporation process occurring under thermodynamic conditions resembling those of a nuclear power plant containment during a severe accident scenario. In such a scenario, condensation is of prime importance to control the thermodynamic state of the containment, which affects the pressure history, the overall gas (steam, hydrogen) and fission product distribution within the containment. Better understanding of these phenomena under accident conditions is essential to properly predict the containment evolution.



14. September 2016

Post Irradiation Examination of MEGAPIE shows how radiochemical analytics helps looking inside a high-power liquid metal spallation target

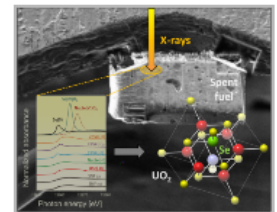
PSI radiochemists now finished the radiochemical analysis of the residue nuclei production in the Lead-Bismuth Eutectic (LBE) of the MEGAPIE target. Twenty – more than expected – relevant – radionuclides could be identified and quantified. Comparisons with theoretical predictions show a good agreement in most cases, but also considerable discrepancies for some selected radionuclides. Moreover, the scientists learned that noble elements like Gold, Silver, Mercury or Rhodium are homogeneously distributed in the bulk LBE, while others, sensitive to reduction/oxidation (Lanthanides, Iodine, Chlorine) tend to accumulate at exposed positions like vessel walls and free surfaces. These results will help to improve models and codes for predictions and, thus, will improve the safety of existing and future facilities.



26. August 2016

The chemical state of ⁷⁹Se in spent nuclear fuel

An interdisciplinary study conducted at different PSI laboratories (LES, AHL, LRS, SYN) in collaboration with Studsvik AB (Sweden) demonstrates that selenium originating from fission in light water reactors is tightly bound in the crystal lattice of UO₂. This finding has positive consequences for the safety assessment of high-level radioactive waste repository planned in Switzerland, as it implies (contrary to previous assumptions) that the safety-relevant radionuclide ⁷⁹Se will be released at extremely low rates during aqueous corrosion of the waste in a deep-seated repository.



<https://www.psi.ch/nep/scientific-highlights>

Questions ?

