

## Foreword

### Prof. Dr. Horst Geckeis

*Director of the Institute for Nuclear Waste Disposal*

2016 was another very important and successful year for the Institute for Nuclear Waste Disposal. INE completed the second year of the third Program oriented funding period (POF III) of the Helmholtz research program NUSAFE (Nuclear Waste Management, Safety and Radiation Research) and succeeded in passing significant milestones defined in the POF III research proposal. Research activities are strongly embedded into national and international collaborative projects and range from applied technology development e.g. for high-level radioactive waste vitrification and decommissioning of nuclear facilities to very fundamental science topics partly applying state-of-the-art spectroscopic techniques and theoretical approaches e.g. concerning the nature of actinide lanthanide binding to N-donor ligands and radionuclide behavior in cementitious systems. Research activities outside the nuclear topic related e.g. to the successful development of new monitoring approaches related to the minimization of induced seismicity in geothermal systems. INE-scientists are involved in teaching activities and the organization of international workshops and conferences on various topics related to our research. Numerous publications in peer-reviewed international journals and presentations at international conferences document their visibility.

**Radionuclide speciation** - As a major milestone in instrumentation development, in 2016 the new CAT-ACT hard X-ray beamline for CATalysis and ACTinide research at ANKA became fully operational. After finishing the installation of beamline optic and infrastructure in 2015, the ACT experimental station of the new ANKA CAT-ACT wiggler beamline – jointly operated by KIT institutes ITCP/IKFT for CATalysis research and INE for ACTinide and radionuclide science – became fully operational towards the end of 2016. The new lab offers high flux synchrotron based speciation methods with monochromatic X-rays in a wide energy range encompassing the actinide M-edges and K-edges of the early lanthanide elements. The ACT station is equipped and licensed to handle radionuclide containing samples including highly radioactive waste forms with activities up to one million times the exemption limit inside a flexible containment concept. The multi crystal Johann-type high resolution X-ray emission spectrometer (HRXES) originally commissioned at the INE-Beamline has been transferred to the ACT station as core experimental infrastructure. As first of its kind this instrument allows advanced X-ray absorption and emission studies of solid and liquid radioactive sample systems (including in situ measurements) in the tender X-ray region with all beam paths enclosed by a gas-tight Helium environment.

**Radiochemistry** - KIT-INE has investigated the interaction of plutonium with Isosaccharinic acid within a research collaboration with Amphos21 (Spain), for the Swedish Waste Management Organization SKB. Isosaccharinic acid (ISA) is the main degradation product of cellulose materials which can be present in large amounts in low to intermediate level waste repositories. The studies target hyperalkaline pH conditions characteristic for a cementitious near field environment and redox neutral up to strongly reducing conditions. The results indicate that the trivalent and tetravalent plutonium oxidation states are relevant in both the aqueous and solid phase depending upon redox conditions. Systematic solubility studies performed with Pu in the presence of ISA show that the impact of ISA on Pu solubility is significantly lower than indicated by previous scoping experiments reported in literature. Based upon these studies, chemical models and thermodynamic data are derived, to be included in thermodynamic database projects.

**Vitrification technology** - The German-Chinese VPC (Vitrification Plant China) project has been established in November 2009 with the objective to construct an HLLW vitrification plant in the Sichuan province of China on the basis of the process technology developed by KIT-INE. From German side the project is executed by an industry consortium (STEAG Energy Services, WAK GmbH, Kraftanlagen Heidelberg GmbH) with KIT-INE as nominated subcontractor responsible for design of the core process technique and key components like the waste glass melter and for input of process-chemical and glass-chemical knowhow and expertise. This research topic has been completed in 2016 very successfully and respective activities are faded out.

**DAEF** - KIT-INE is founding member of the “Deutsche Arbeitsgemeinschaft für Endlagerforschung (DAEF)”. As a major event, the second international conference on “Key Topics in Deep Geological Disposal – Challenges of a Site Selection Process: Society – Procedures – Safety”, was organized in 2016 with INE being part of the local organizing team. The conference provided detailed information on the results of the work of the German commission on nuclear waste disposal (“Kommission Lagerung hoch radioaktiver Abfallstoffe”) related to the design of a site selection process in Germany. In this respect, 2016 was a crucial year related to the provision of a basis for the siting process for a repository for heat generating radioactive waste in Germany: The commission has

set the framework and the criteria for the site selection process and the BGE (“Bundesgesellschaft für Endlagerung”), has been founded as the new implementing organization. The DAEF conference has covered all related topical issues and provided focused and dynamic presentations and discussions on research in different science disciplines including natural sciences, engineering, and social sciences relevant to the further development of nuclear waste disposal projects in Germany and internationally..

Finally, I would like to express my gratitude to our numerous partners, visitors and collaborators. Last, but not least, I extend a sincere thank you to the entire staff of INE for their dedication in both scientific activities and in administrative and technical support.