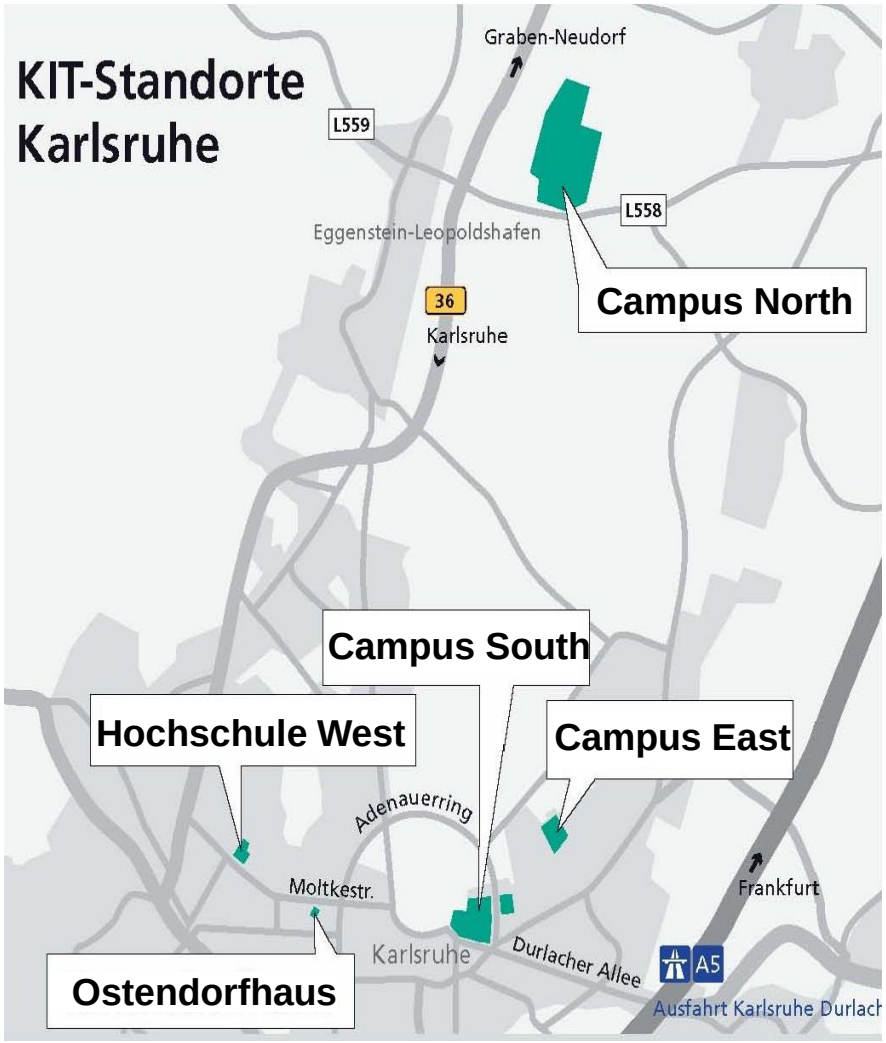
Karlsruhe Institute of Technology

ELINDER Launch Event,
Bratislava, 02/12/16

Regional Cluster in Decommissioning – a joint task

Th. Walter Tromm, Programme Nuclear Waste Management, Safety and Radiation Research

KIT – Locations and Figures



Karlsruher Institut für Technologie

Helmholtz - Mission		University - Mission	
12	Programs	11	Faculties
27	Institutes	130	Institutes
4.076	Employees	5.307	Employees
		23.836	Students

ca. 3200 Doctoral Students

378 Mio. €	**Budget**	**406 Mio. €**	**Budget**
29 Mio. €	State BW	183 Mio. €	State BW
236 Mio. €	Federal Rep.	0 Mio. €	Federal Rep.
113 Mio. €	Third Party	223 Mio. €	Third Party

KIT – Part of the Helmholtz Association

Helmholtz research centers

KIT	**Karlsruhe Institute of Technology**
DLR	German Aerospace Center
FZJ	Forschungszentrum Jülich
DESY	Deutsches Elektronen-Synchrotron
DKFZ	German Cancer Research Center
IPP	Max-Planck-Institute for Plasma Physics
HMGU	Helmholtz-Zentrum München
GSI	Helmholtz Center for Heavy Ion Research
HZB	Helmholtz-Zentrum Berlin für Materialien und Energie
AWI	Alfred-Wegener-Institute for Polar and Marine Research
HZDR	Helmholtz Center Dresden Rossendorf
UFZ	Helmholtz Center for Environmental Research
GKSS	Helmholtz-Zentrum Geesthacht – Center for Materials and Coastal Research
GFZ	Helmholtz-Zentrum Potsdam – German Research Center for Geosciences
MDC	Max-Delbrück-Center for Molecular Medicine
GEOMAR	Helmholtz Centre for Ocean Research Kiel
HZI	Helmholtz Center for Infection Research
DZNE	German Center for Neurodegenerative Diseases

Foundation of the Decommissioning Cluster, 02/2016

DHBW Karlsruhe

Universität Stuttgart

IKE and **MPA**
University of Stuttgart

Karlsruhe Institute of Technology

KIT Center for Decommissioning

JRC
EUROPEAN COMMISSION

Joint Research Center

PAUL SCHERRER INSTITUT
PSI

PSI Switzerland

Strategic objectives of the decommissioning cluster (1/2)

Coordination and bundling of activities:

- in research, teaching and training

Enhanced cooperation:

- with other universities, research centers, government agencies and industry, in Germany and in Europe.
- Cooperative support international initiatives to maintain competence (as Summer Schools in Decommissioning).
- Representation and tracking of trends in job development and the training capacity of the dismantling.

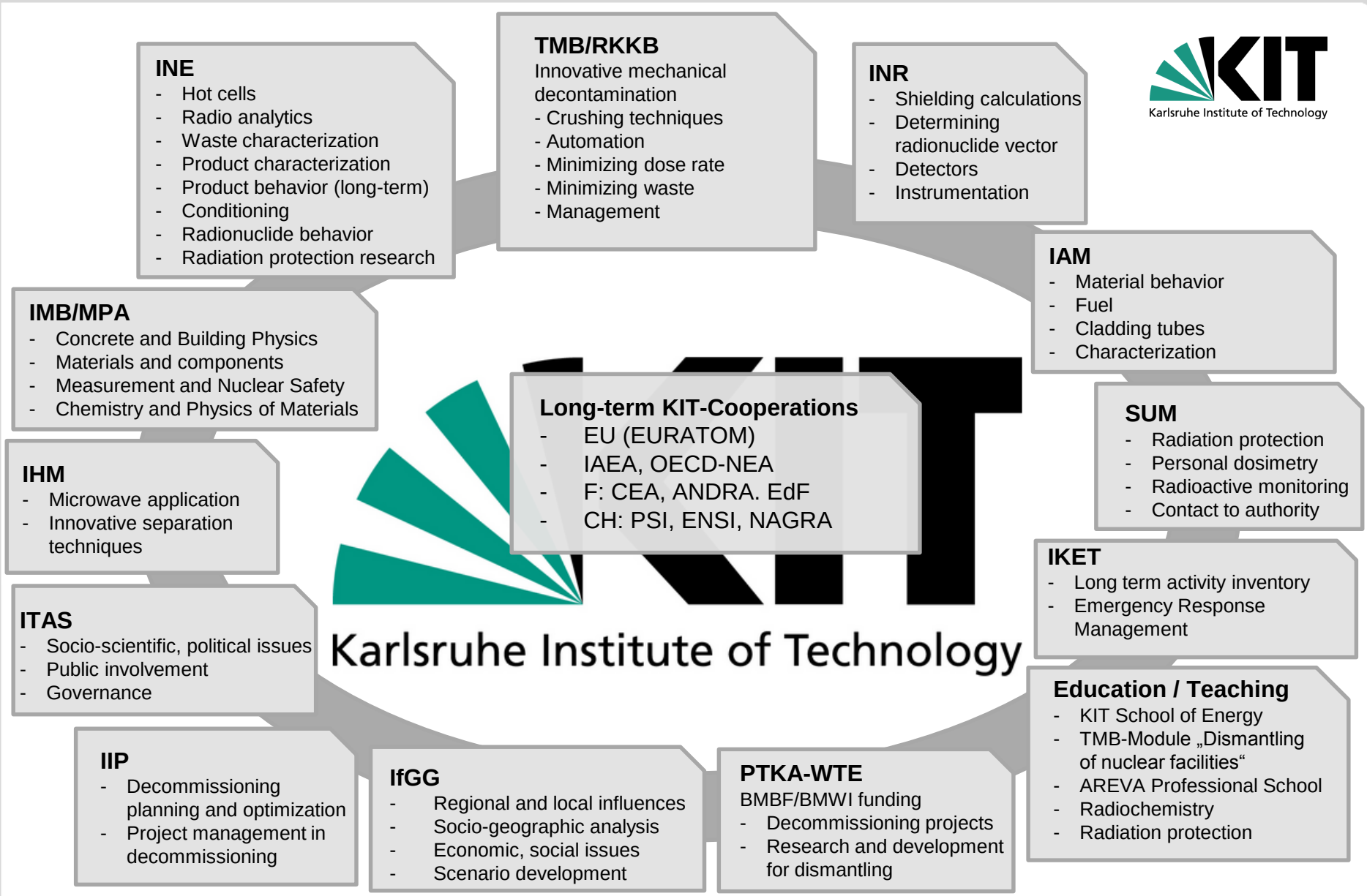
Strategic objectives of the decommissioning cluster (2/2)

- Acquiring external funding with industry and other organisations,
- Attracting grants for advanced courses, promotions and scholars
- Recruitment and training of qualified young scientists
- Publications in journals and newspapers
- Organize public events, such as trade fairs or open house days.
- Participation in the development of international standards in decommissioning

KIT Establishes Center for Decommissioning

Bundling the expertise for a safe dismantling of NPP in the scope of the German Energiewende; Innovative technologies – radiation protection – technology assessment

Press release, Nr. 020 | or, lg | 25.02.2015
http://www.kit.edu/kit/english/pi_2015_16383.php



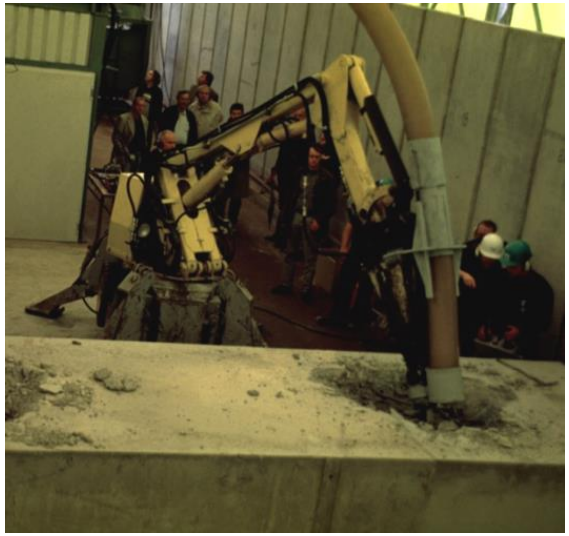
Competences within KIT Center for Decommissioning

Decommissioning Department at TMB

- First German Professorship in Decommissioning of Nuclear Facilities established in 2008
- Close cooperation with industry e.g. mock-Ups:

Prof. Dr. Sascha Gentes

Wire saw cutting of stainless steel brackets



Decommissioning of heavy concrete ceiling for research reactor KNK

Concrete crusher for waste processing and packaging

Minimisation of secondary waste

Universität Stuttgart

Karlsruhe Institute of Technology

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

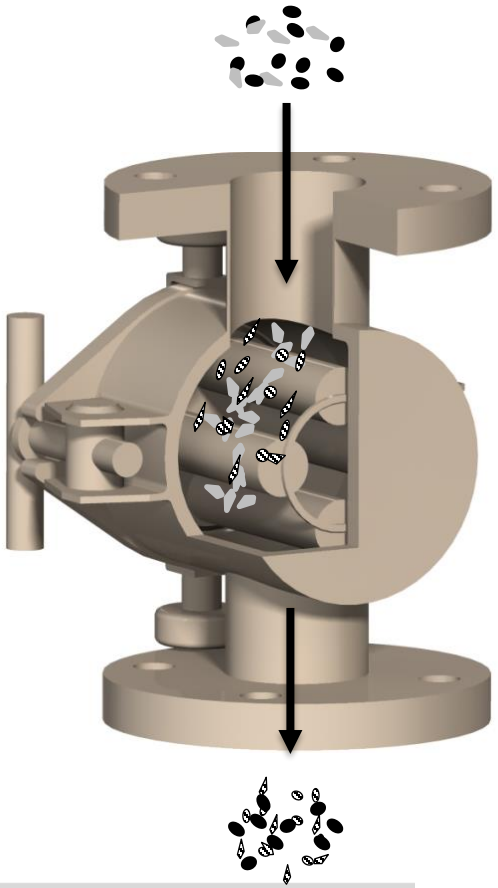
Cooperation between KIT and University Stuttgart

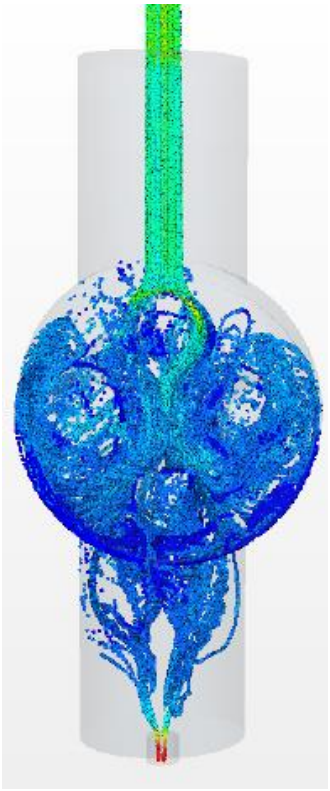
Objective:

- Minimisation of secondary waste (with contaminated swarfs and cutting technique) by magnetic separation

R&D tasks:

- Optimisation of the separation rate
- Experimental and numerical investigations

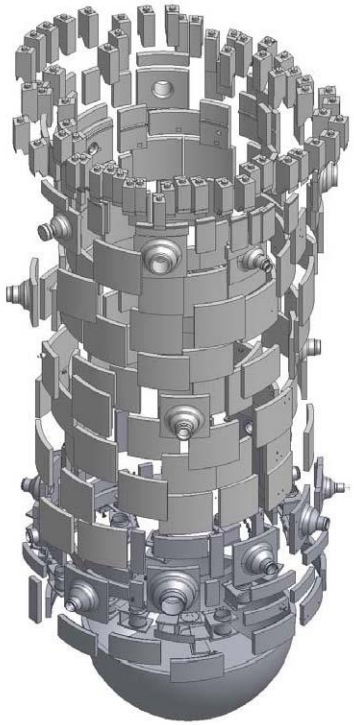




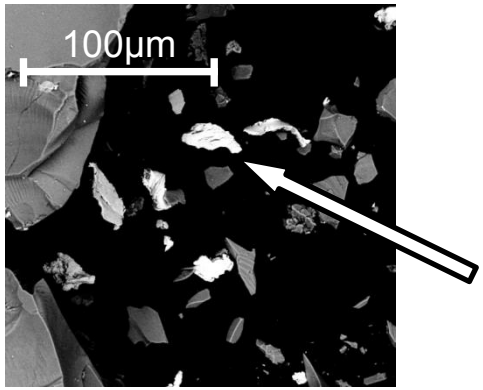
Bilder: M. Brandauer, KIT

Water abrasive cutting waste treatment

Source: ANT AG



Source: AREVA GmbH



Steel particle

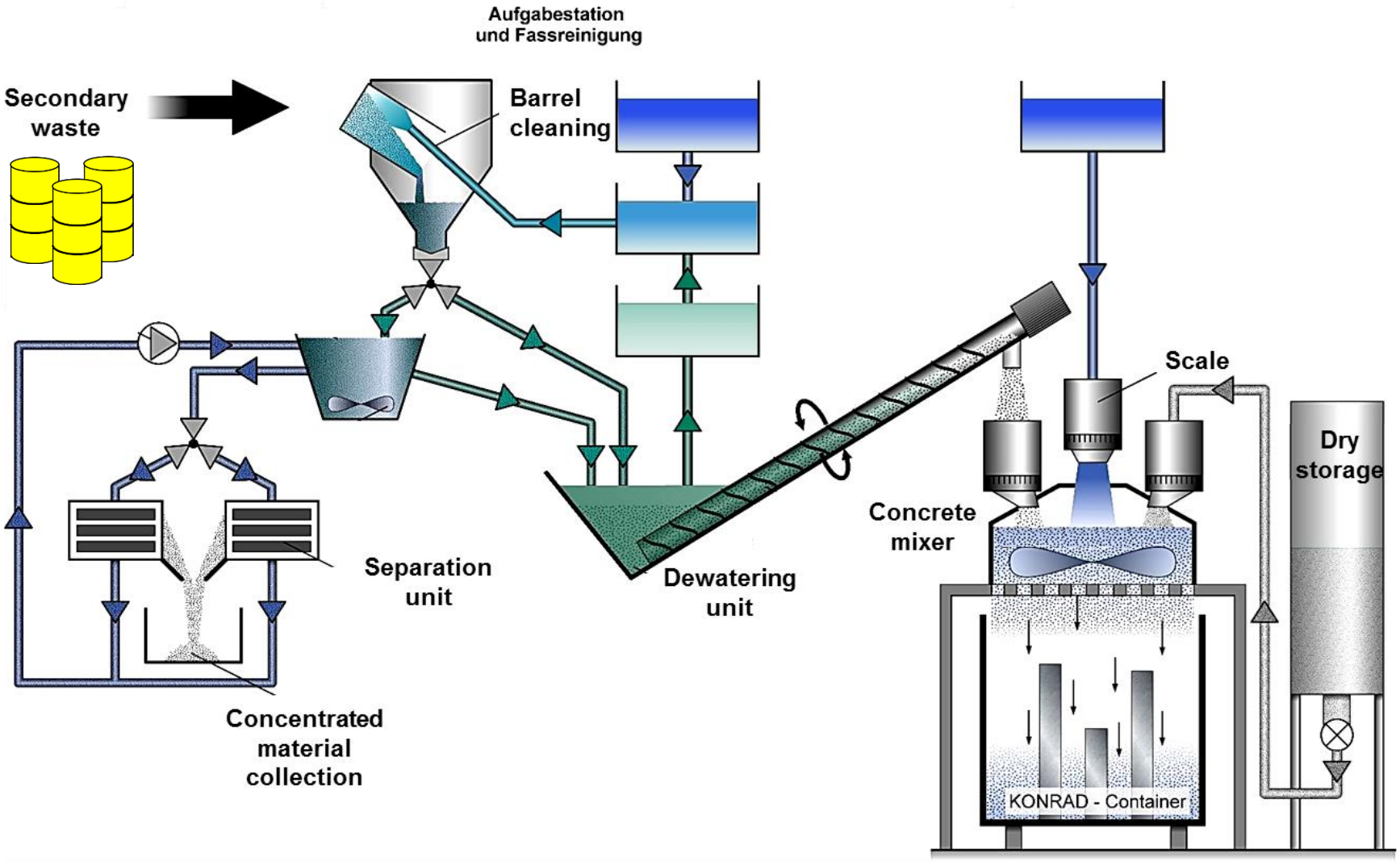
State of the art:

- **WASS method has successfully been applied**
- **Attachment to manipulator possible**
- **Large amounts of secondary waste**

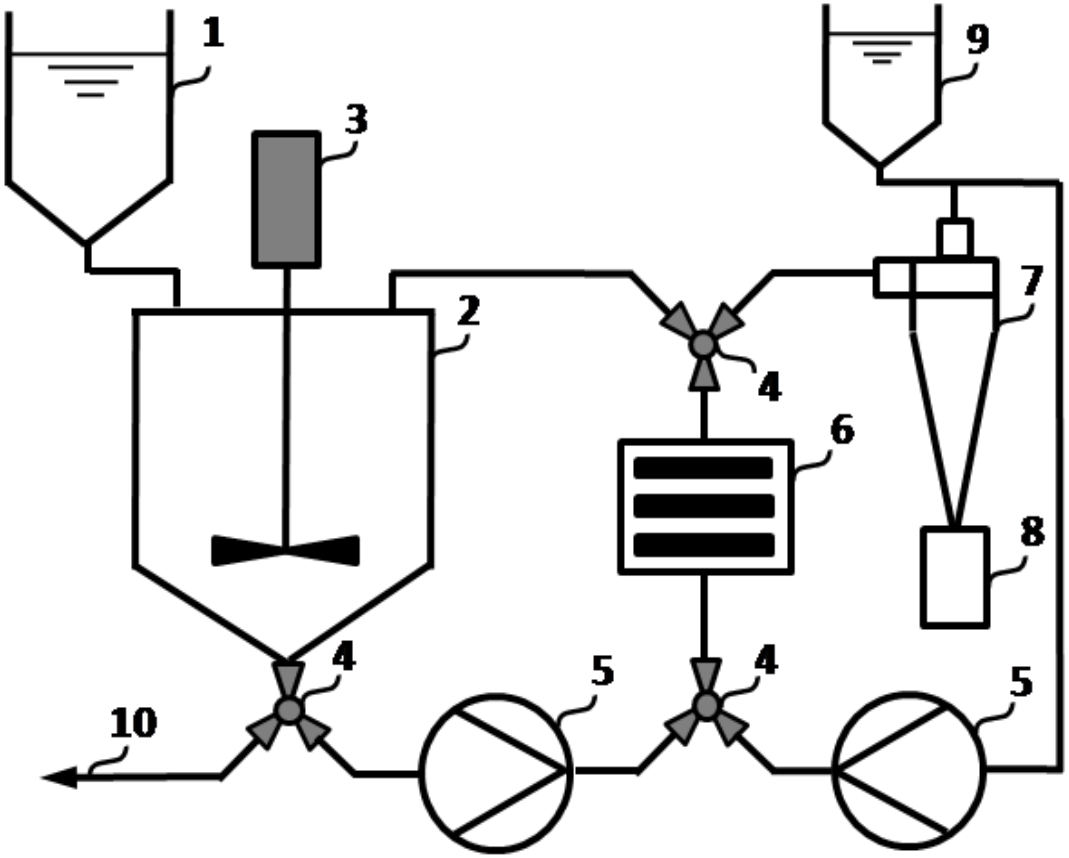
Research and Development

- **Reduction of secondary waste by physical separation**
- **Further processing by admixing in the backfill concrete of KONRAD containers**

Water abrasive cutting waste treatment



Process chain for prototype development



1 Feeding container

2 Slurry mixer

3 Drive gear

4 2/3-way ventile

5 Membrane pump

6 Magnet filter

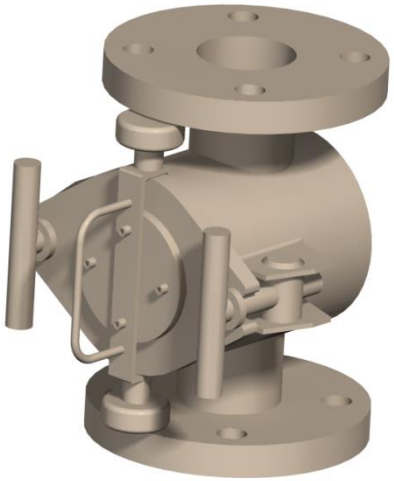
7 Sedimentation container

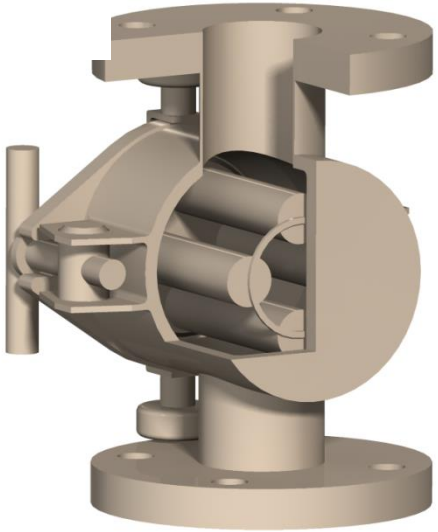
8 Reservoir

9 Fresh water container

10 Removal of filtered material

Prototype of the separation process



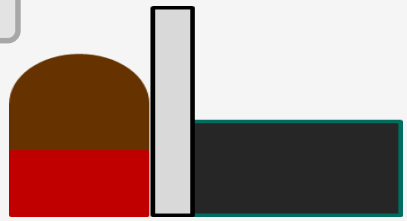


Institute for Neutron Physics and Reactor Technology (INR)

Virtual Reality Platform for optimized Decommissioning

3D Modeling Technology:

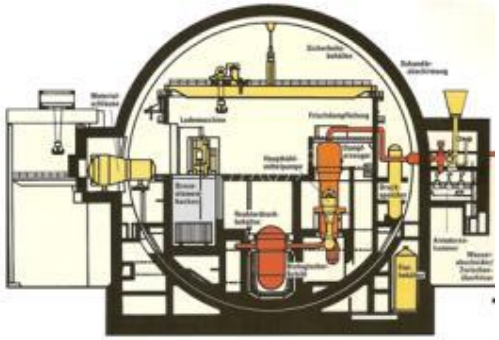
- 3D CAD Technology (MCAD)
- Laser scanner,
- 3D photogrametry



Virtual Reality Methods

- Virtual reality model e.g. i-models, VIRTOOLS, DELMIA, game-platforms, etc.
- Algorithms e.g. for virtual cutting

NPP CAD models from utility



Data Base

- **3D model data**
- **Equipment data**
- **Results data**

IT: Server, data bank

Activity inventory (AI) after 40 years of operation and 1 year of decay time
10.7x10 ^{17} Bq for a BWR (KRB-B)
1.9x10 ^{17} Bq for a PWR Type Biblis
Activated and contaminated components: distributor, tubes, arcs, edges and so on/ determining nuclides: Fe55, Co60, Ni63

3D Process Simulations

Radioation field

Radioactivity inventory

Spatial dose rate distributions

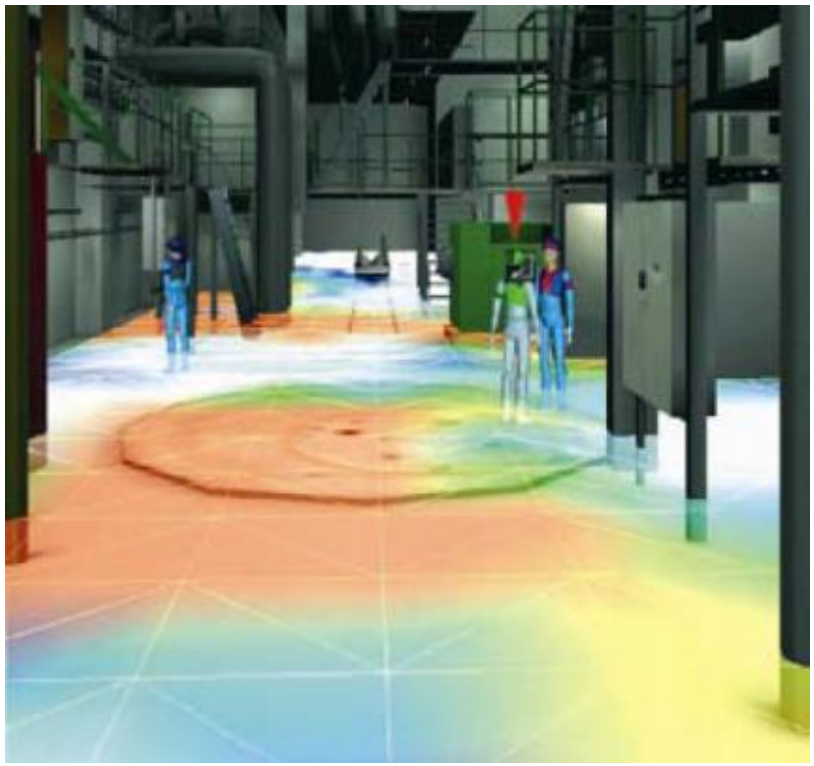
Spatial dose rate distributions

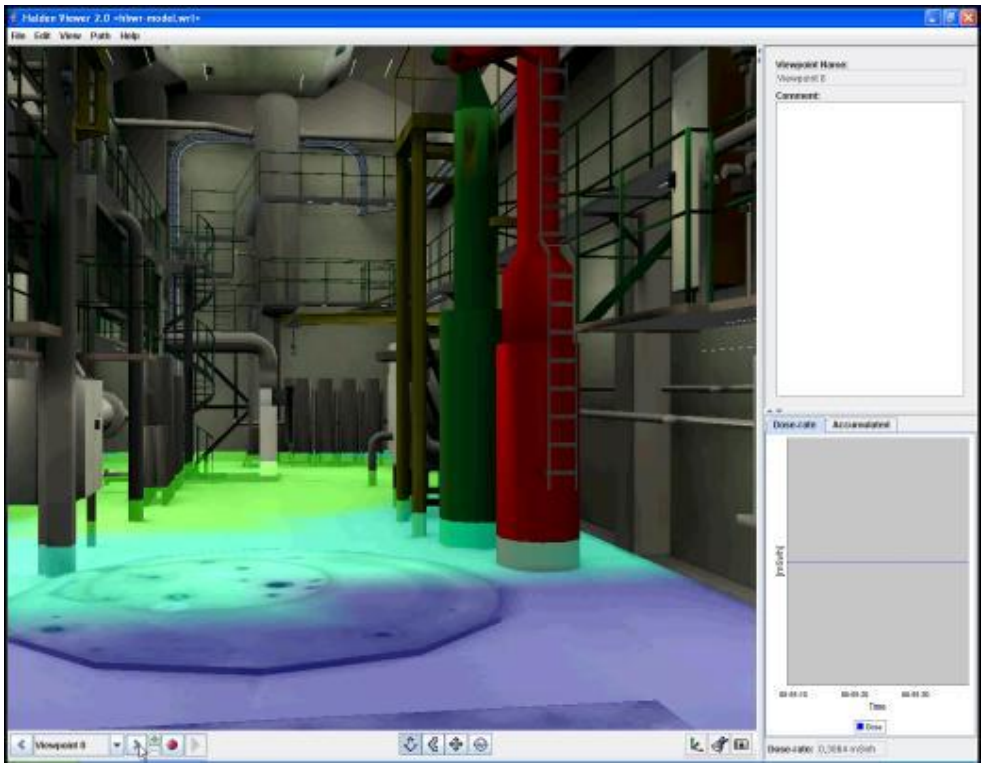
- Decontamination process
- Decommissioning process
- Dismantling simulation process

Optimize cutting process of pipes and equipments

Optimization of containers for waste storage (volume and weight)

Minimisation of radiation exposure of personnel





Calculation of radiation exposure by modern **Virtual Reality-Tools**:

- **VRDose** as a strong tool to visualise radiation fields (applied in **OECD Halden project)**
- Combined with **CAD-Geometries**
- Online-calculation of the **radiation exposure of personnel**

Exploration, Path planning and Control

Karlsruhe Institute of Technology

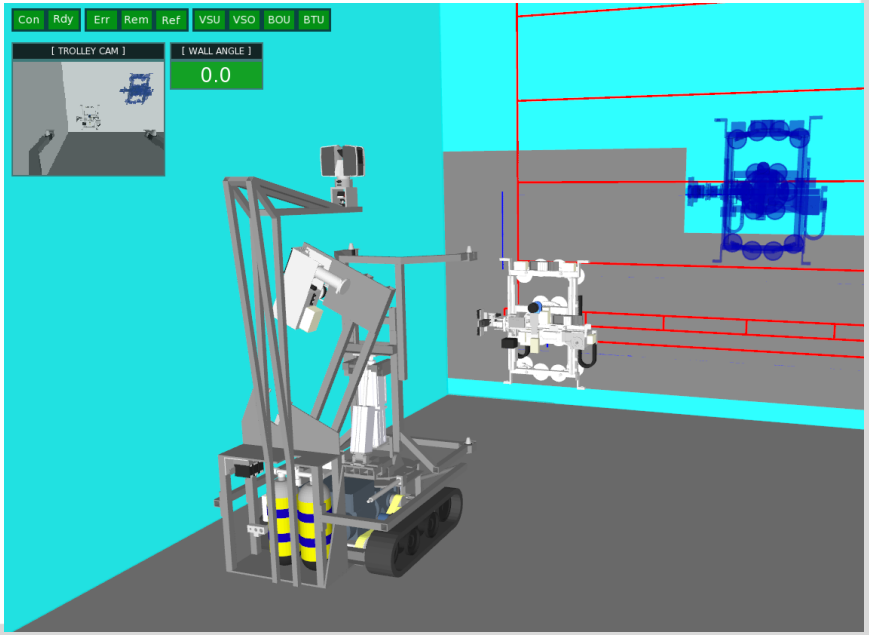
Environmental Model

FARO 3-D laser scanner (mid-res scan of 0.035° angular resolution → ~ 40 mio. points)

Co-operation partner: Institute for Anthropomatics and Robotics (IAR)

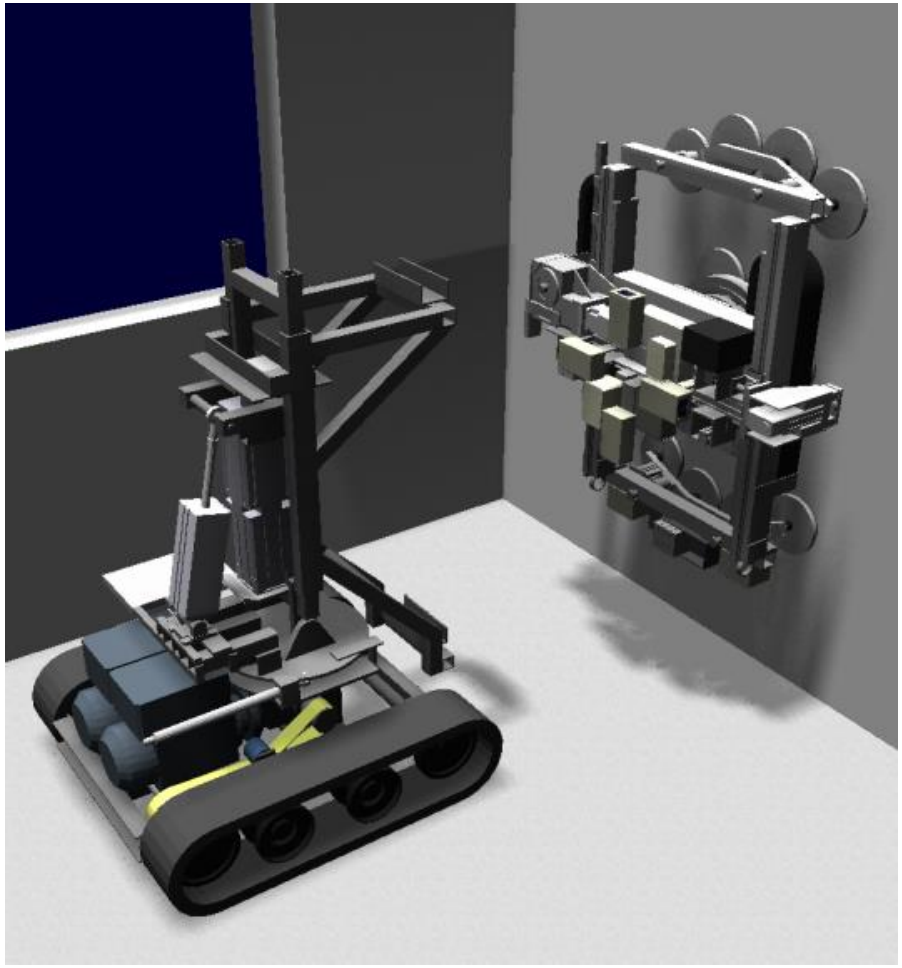
Control and Simulation

- Seamless alternation between actual system and simulation
- Predictive visualization and validation of path planning results
- Documentation and visualization of detector measurement results
- Sponsored by: (FKZ 02S8881)



Federal Ministry of Education and Research

Manipulator Operated Decontamination and Release Measurement of Surfaces



State of the art:

- **Mechanical decontamination methods causing contaminated dust**
- **No remote controlled systems for the decontamination of surfaces**

Research and Development

- **Development of a complete system for remote controlled decontamination of surfaces**
- **Prevention of contaminated dust**

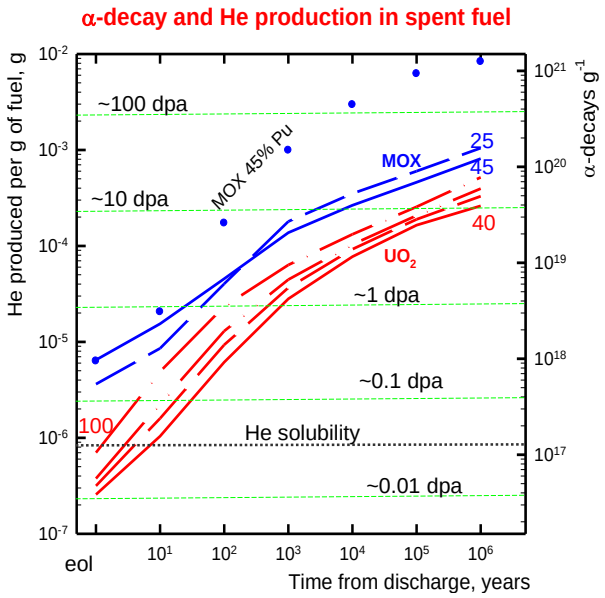
Spent fuel safety studies at JRC-Karlsruhe

assess SF/wasteform ability to fulfil its expected function over long-term

(Extended) Storage

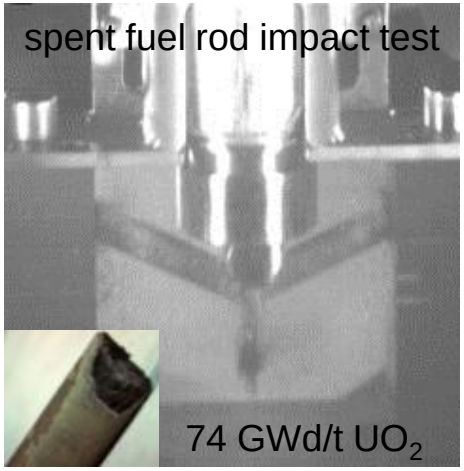
radionuclides **containment**, rod **retrievability** *(≥100 y?)*

SF evolution: decay damage and He accumulation effects



Accident conditions

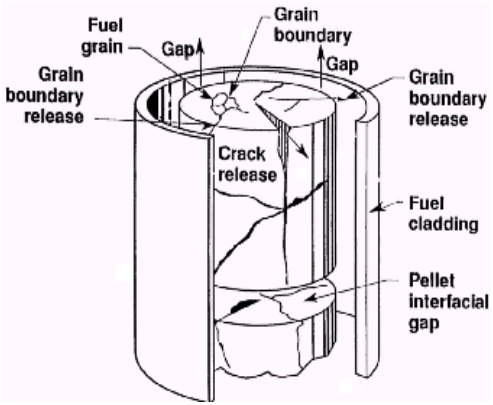
pools, handling, transport, storage, retrieval: mechanical load, impact resistance; corrosion, loss of cooling; damaged SF, debris properties



Geologic Repository

reduce uncertainties on release of long-lived radionuclides over an *open-ended disposal timescale*

radionuclides “Source Term”, “Instant Release”
matrix corrosion: environment and SF effects

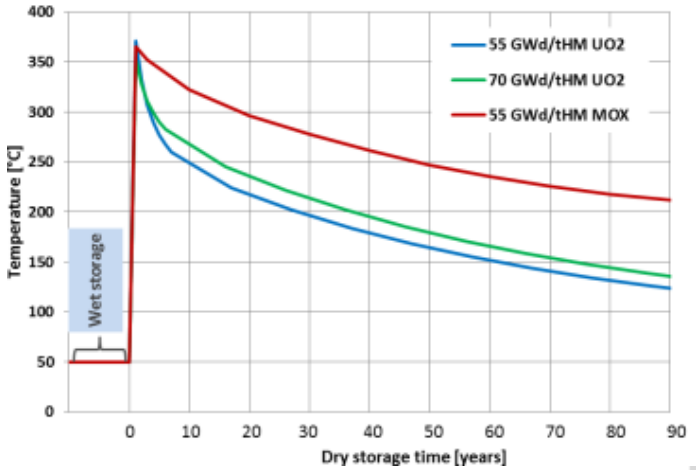


Convey experimental data into models and codes (predictions)

Joint Research Centre

Long term storage of fuel elements
Expertise due to QUENCH Team

Karlsruhe Institute of Technology

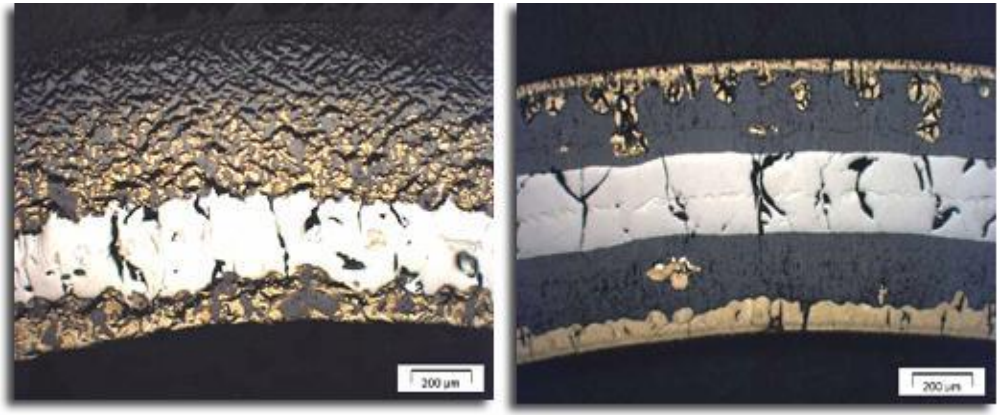


Topics:

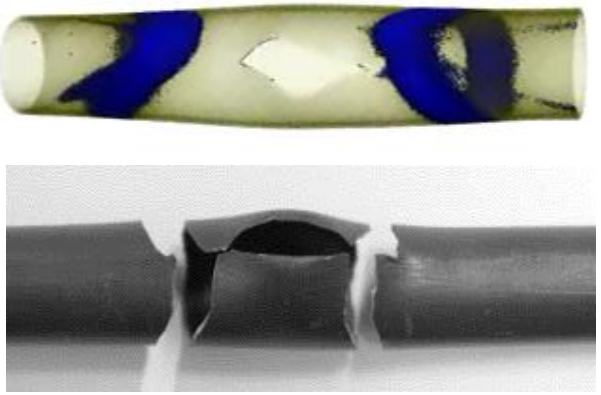
- Long term behaviour of fuel element materials in LWR
- Long term interim storage

Examples of Expertise:

- Analysis of oxidation of zirconium alloys in different atmospheres (steam, air, oxygen, nitrogen)
- Analysis of the behavior of new cladding tube alloys - developed to improve the long-term stability at high temperatures



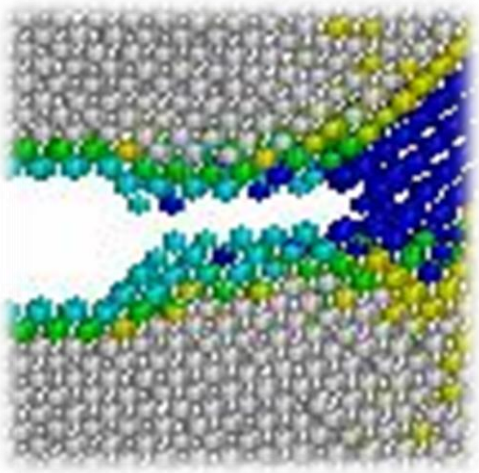
Formation of zirconium nitride ZrN (golden phase) by oxidation of zircaloy-4 in air (left) or by reaction of oxidized zircaloy-4 with nitrogen (right)



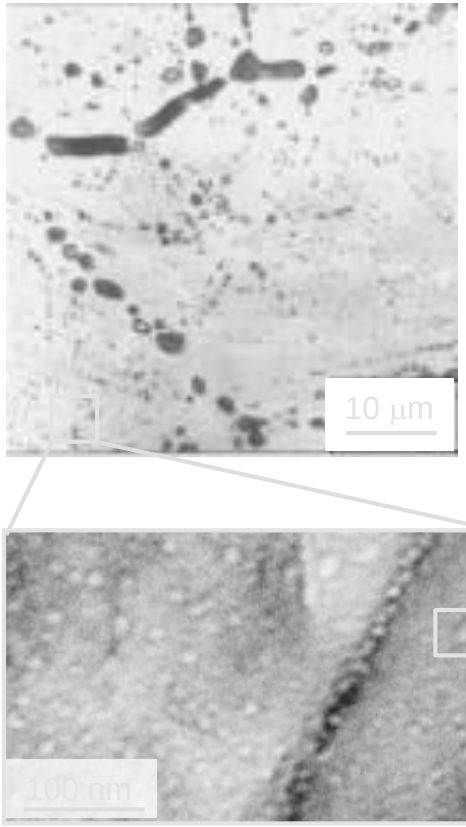
Neutron tomography and break behaviour

Expertise: Material Behaviour under Irradiation

Atomistic simulation of fractures



Irradiation induced porositiy formation



Hot cells

Transport- and Storage Casks

Analysis and Assessment of relevant safety goals

- Material- and fabrication quality
- Structural integrity
- Tightness

Source: GNS, TÜV Symposium / 26.11.2015 / Markus Röder, Lutz Oelschläger, Dr. Matthias Heck

Objectives:

- Transport and storage handling
- Incidental scenarios

R&D tasks:

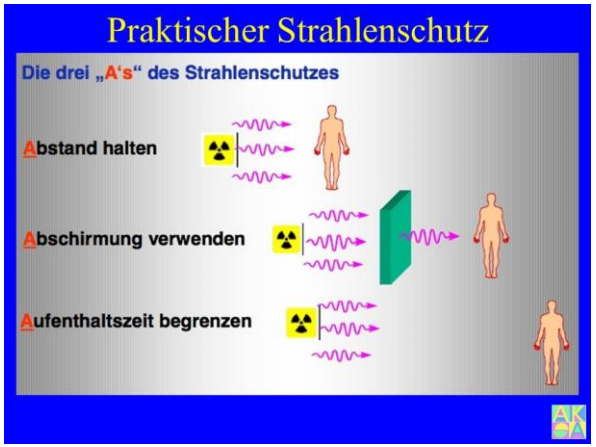
- Analysis of dynamic impacts on storage casks and fuel element structures
- Long-term behaviour of storage cask materials

University Study: Industrial Safety

Courses in:

- Occupational safety
- Operational safety
- Radiation Protection
- Environmental technology
- Nuclear energy


Source: bbb-umwelt.com




Source: Kernenergie.ch

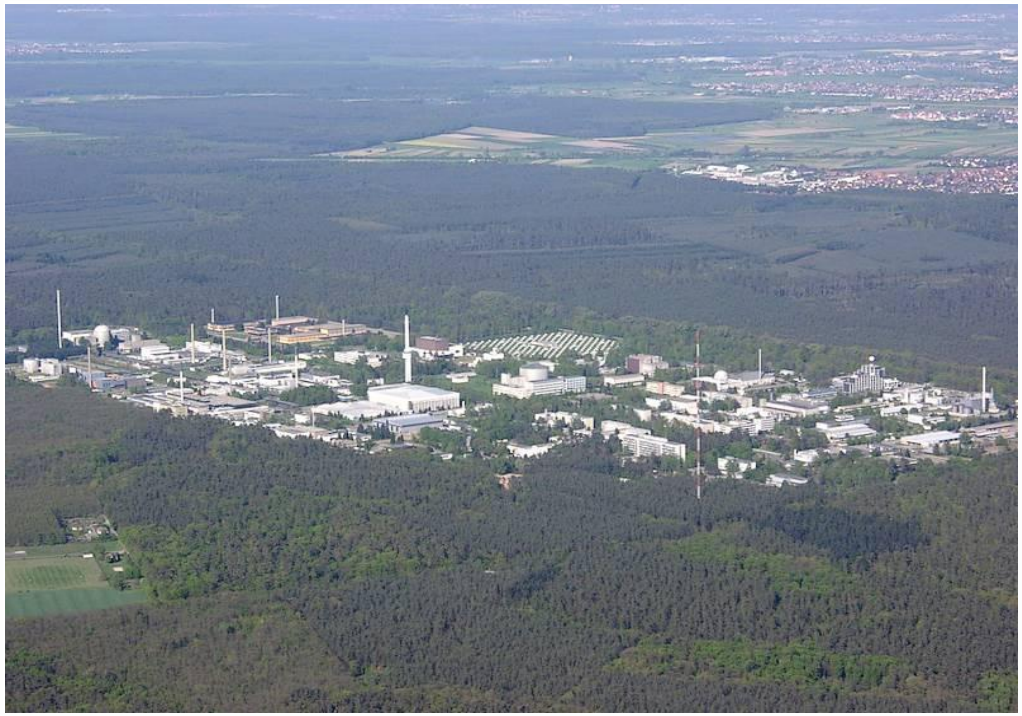
Excellent opportunity for specialised study of decommissioning of nuclear facilities

Certificate: Bachelor of Science (B.Sc.)

Conclusion and Outlook

- Strong demand and necessity to build-up and enhance competencies for decommissioning and waste management of nuclear facilities
  - In Germany, but as well for whole Europe
- Unique competencies are combined in the various institutions of the decommissioning cluster
- Bundling and focusing of the know-how will lead to an added value not only for Germany, but for Europe
- In the long-term, education and training of scientists and engineers is of crucial importance

Thank you very much for your attention!



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