

ROK's Nuclear Policies and R&D Programs



Ministry of Science, ICT and
Future Planning

Extra Slides

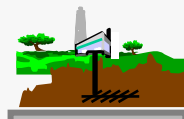
SFR-Pyroprocessing Development Plan

SFR(Sodium-cooled Fast Reactor) & Pyro-processing

Light Water Reactor

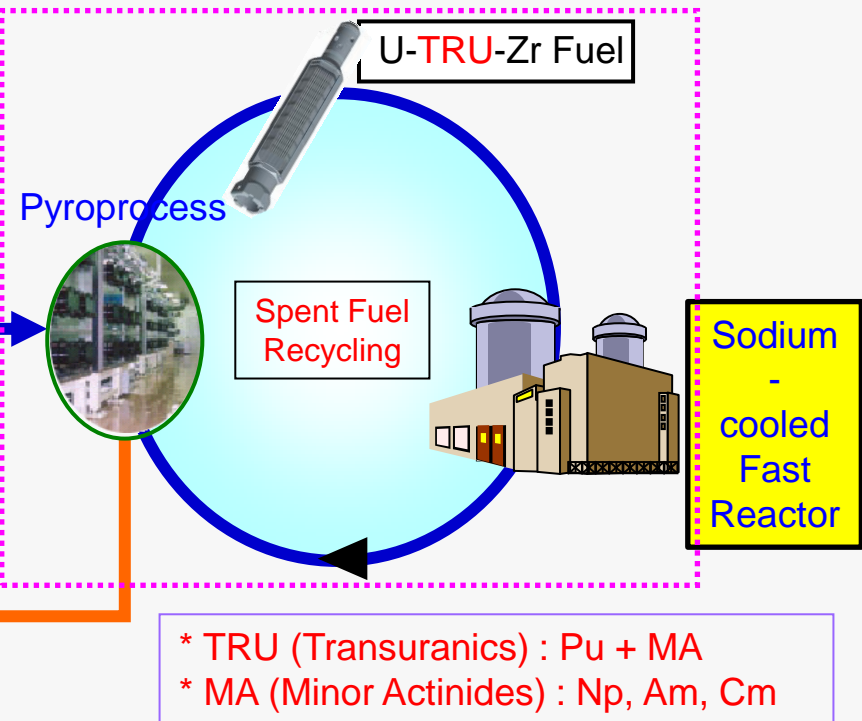


Spent Fuels



Disposal

High Level Waste



- KAEC(Korea Atomic Energy Commission) authorized the R&D action plan for the SFR and Pyro-processing to provide a consistent direction to long-term R&D activities for spent fuel management in December, 2008.
- The R&D action plan was revised in November 2011 in order to refine the plan and to consider the available budget for the R&D.

Sodium-cooled Fast Reactor Development

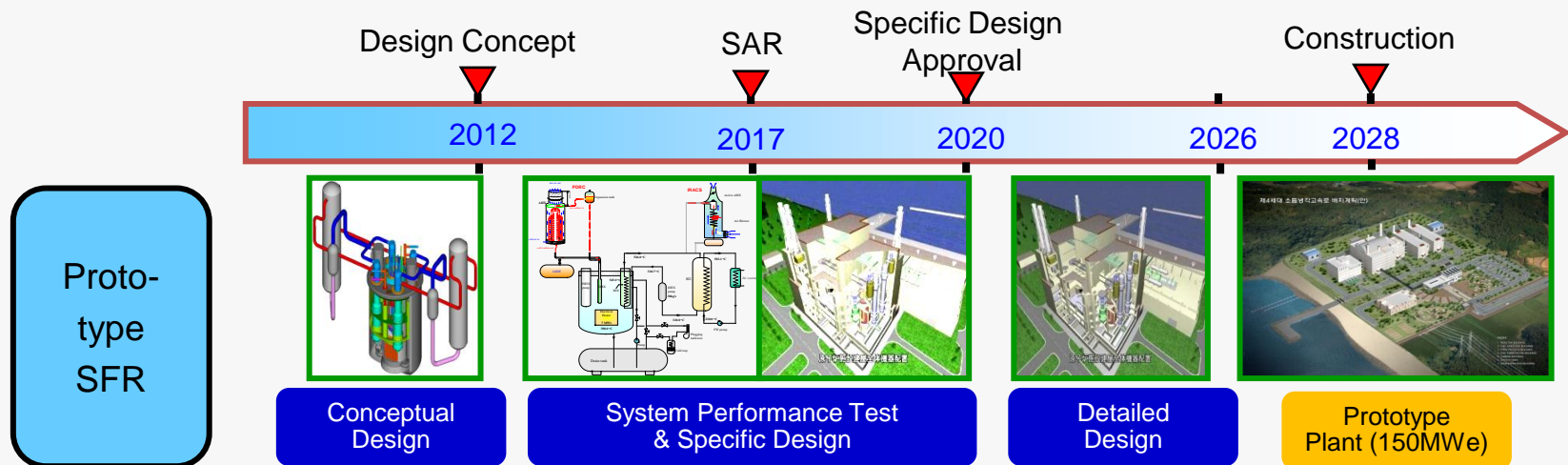
SFR provides a Technological Alternative for the Solution of Spent Fuel Management Problem

- By recycling spent fuel from LWRs, the amount of high-level radioactive waste, disposal space and management term can be reduced.

Objectives of a Prototype SFR Program

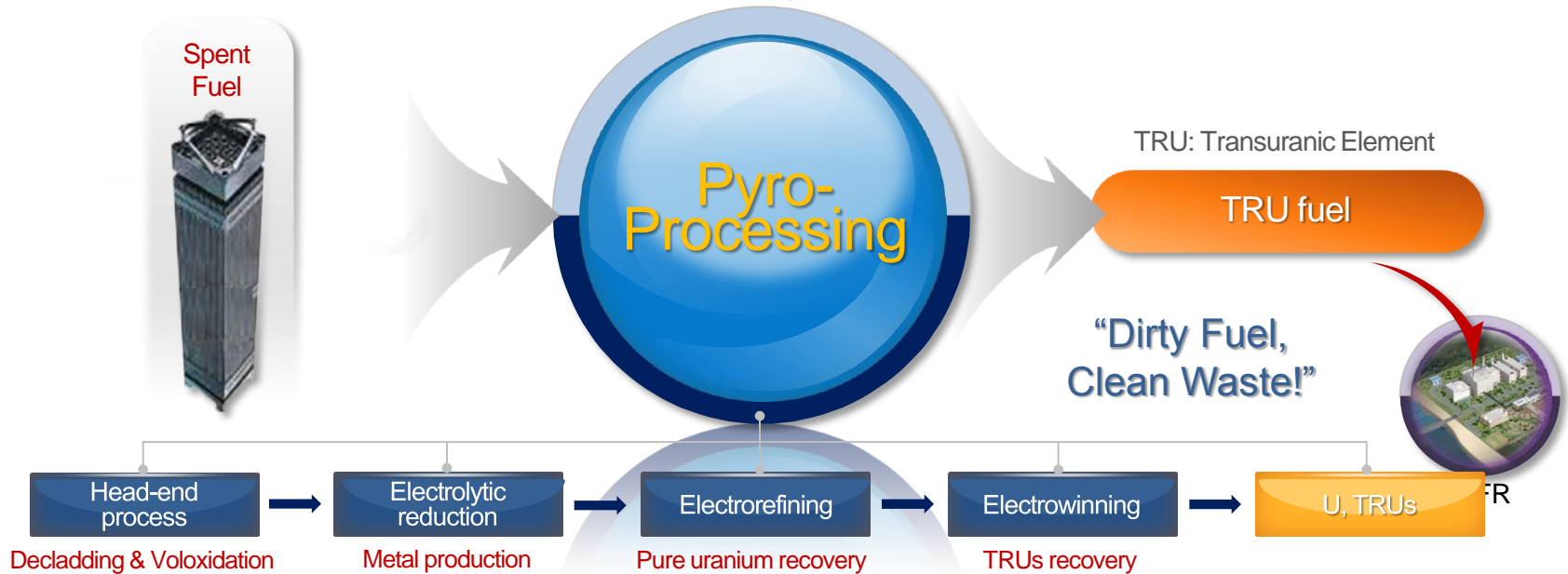
- Acquisition and demonstration of design, construction, and operation technologies
- Irradiation test of TRU fuels from spent LWR fuel

Milestones for a Prototype SFR Development



Pyroprocessing Technology Development

Pyroprocessing technology aims to recover U and TRUs from spent fuel for SFR fuels.



Characteristics

- Make it difficult to recover only high-purity plutonium (proliferation resistance)
- Minimization of Deep Geological Repository Space and HLW amount (environmental friendliness)
- Production of nuclear fuel materials for Gen-IV reactors, SFRs.(resource recycling)
- Creation of indigenous technology with comparative international superiority (technical self-reliance)

Key Tech. Development ('97 ~ '11)

Lab.-scale test

Engineering-scale Demo. ('12 ~ '16)

Eng.-scale test (PRIDE), Active Test(DFDF/ACPF)

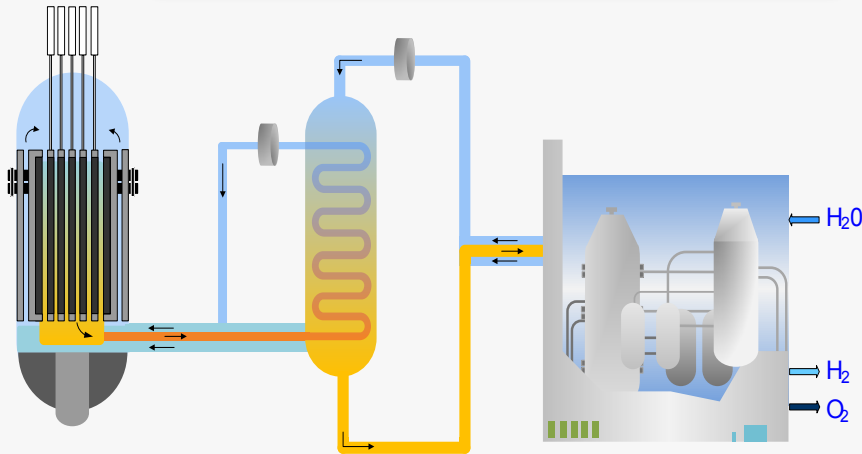
Scale-up & Design ('17 ~ '25)

VHTR and Nuclear Hydrogen Development

Clean, Safe Energy with
a Wide Range of Application

VHTR
Very High
Temperature
Reactor

- Highest Level of Nuclear Safety
- Wide Temperature Range of Heat Energy
- High Efficiency
- Substitution of Fossil Fuels



Advantages of VHTR for hydrogen production

- High efficiency (~50%) using thermochemical water splitting
- No GHG emission compared to LNG steam-methane reforming
- A clean and efficient manner reducing fossil fuel dependence

Plan



Key Technology
Development

System Concept
&
Point Design

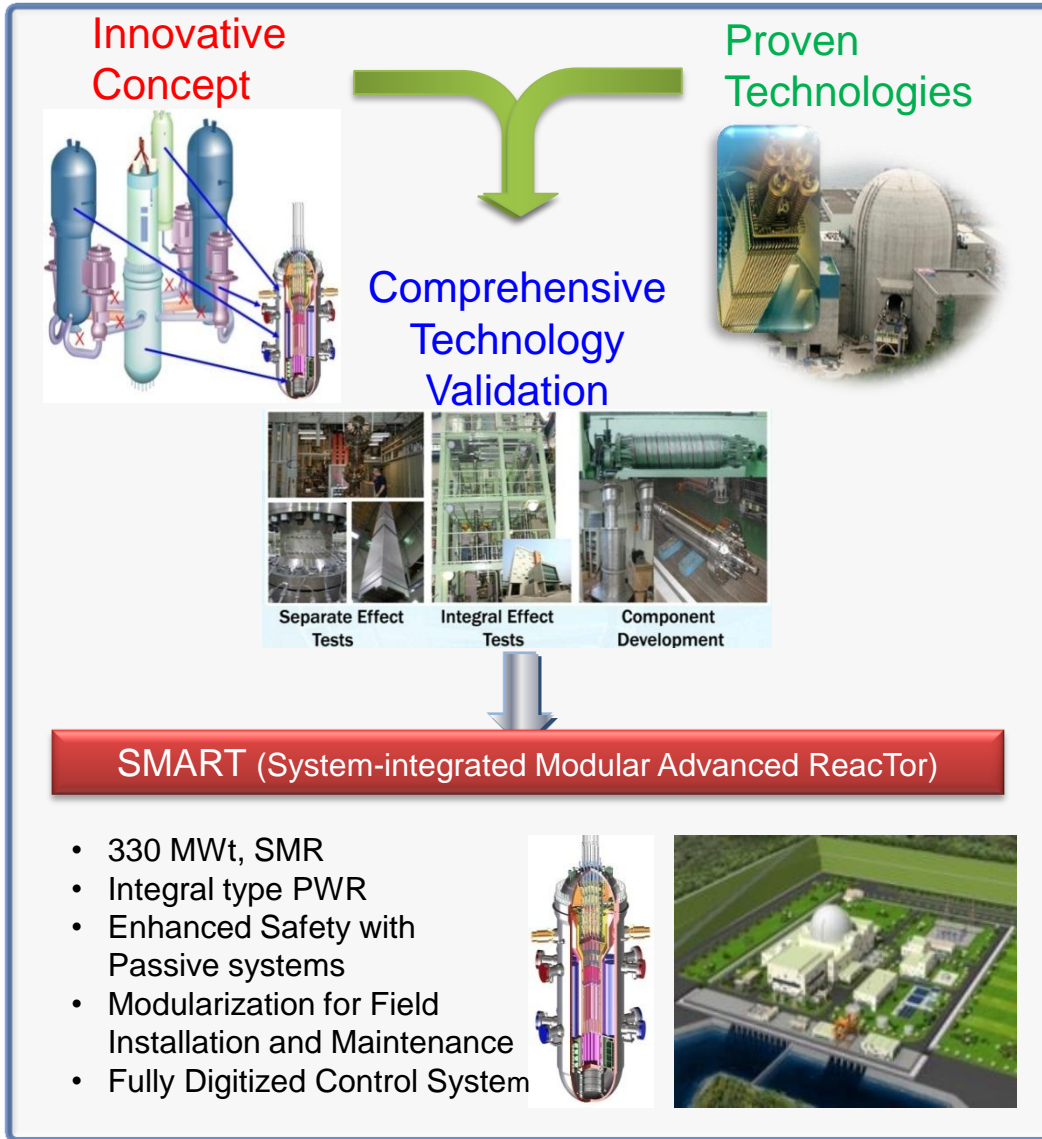
System Design
&
Construction

Demonstration
&
Operation

R & D

- Design and Analysis Code
- Helium Test Loop
- Material & Components
- TRISO Fuel
- Hydrogen Production Process

Small Reactors Development



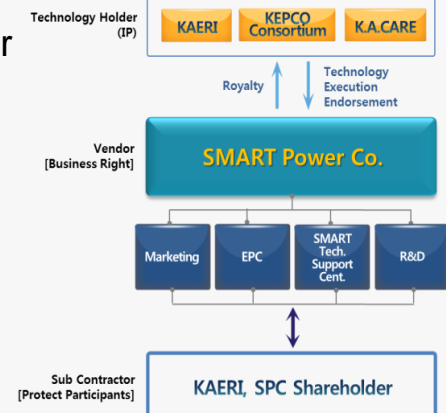
SMART Partnership



✘ Saudi Arabia and Korea signed MOU for SMART partnership (March 3, 2015)

SMART Power Co. (Joint Venture)

- Prime vendor company for SMART construction abroad



Research Reactor - HANARO



Ministry of Science, ICT and
Future Planning

KRR-1
(1962)



FOUNDATION

KRR-2
(1972)



GROWTH

HANARO (1995)



CHALLENGE



JRTR



KJRR

TRIGA Mark-II
(Pool Type)

250 KW

Education &
Training

RI Production
NAA

TRIGA Mark-III
(Pool Type)

2,000 KW

RI Production
NAA

Neutron Beam
Experiments

(Open-Tank In-Pool Type)

30,000 KW

Cold Neutron Laboratory : 2009

Neutron Beam

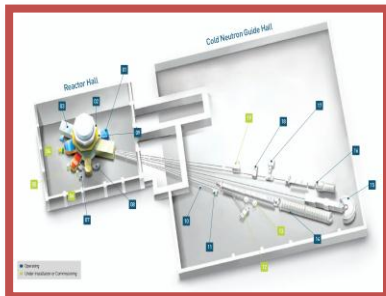
Fuel/Material Irradiation

RI Production / NAA

NTD

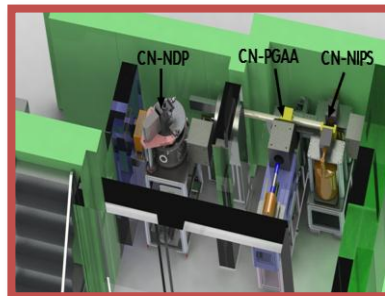
HANARO – R&D

Neutron Science



Thermal Neutron Instruments (7)
Cold Neutron Instruments (8)

Neutron Activation Analysis



Instrument NAA
Cold Neutron NAA (CONAS)

Neutron Irradiation

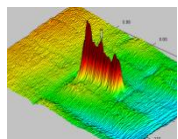


Vertical Irradiation Holes
Capsule / NTD

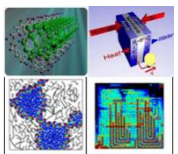
RI R&D



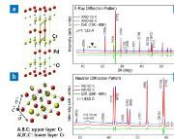
31 Hot Cell in 4 Bank



Nano-Structure Study



Hydrogen Storage & Fuel Cell



Magnetic & Crystal Structure



Residual Stress Instrument



Non-destructive Analysis (archeology, food, industrial materials etc.)



Depth profiling In thin film matter



Thermal-Cold Neutron Combined Study



Short Distance Neutrino Detection



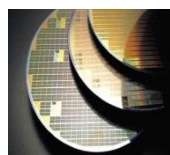
Fuel/Material Irradiation Test



Support of Future Nuclear System Development



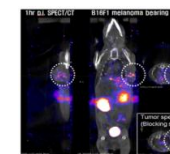
Neutron Transmutation Doping



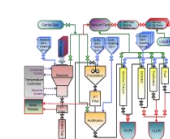
High-Tech Material Study



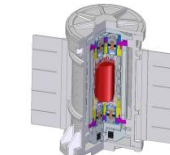
Medical & Industrial RI Production



Radio-pharmaceuticals for Therapy (Lu-177)



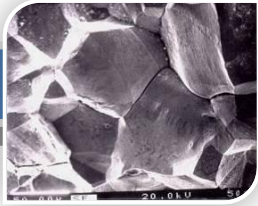
Fission Mo-99 Production Process



RTG for Space Exploration

Nuclear Safety R&D – Major Areas

Physical Integrity



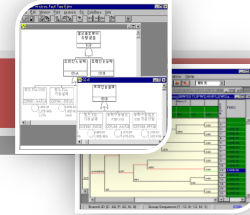
Reactor Cooling (Thermalhydraulics)



Severe Accident Management



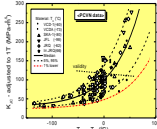
Risk Management



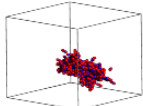
Environmental Protection



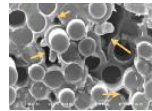
Materials Degradation Assessment of NPP Comp.



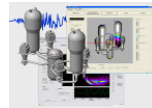
NDE Tech. & Computational Material Sci.



Advanced Materials Develop.



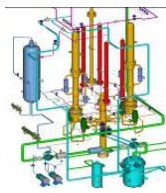
Integrity Monitoring & Diagnostics



Corrosion & Water Chem. Optimization



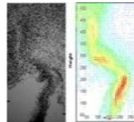
T/H Integral Effect Tests for Adv. PWRs (ATLAS, SMART-ITL)



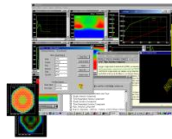
T/H Separate Effect Tests for Core, Systems & Components



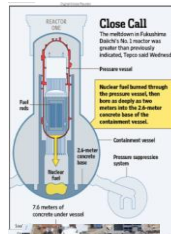
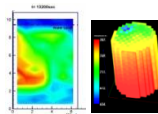
High-Resol. Experiment & Modeling



Adv. Safety Analysis Technology



Adv. Simul. of T/H Behavior & Multi-physics Behavior



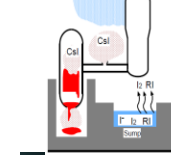
Interaction & Cooling of Molten Corium



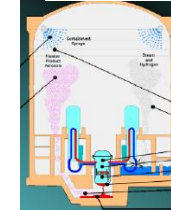
Containment Integrity under Severe Accidents



Minimization of Source Terms for Severe Accidents



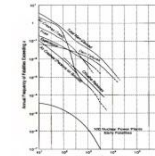
Severe Accident Analysis Codes



Risk Assess. for External Hazards



Risk Assess. for Multi-unit Sites



Risk-Informed Accident Management & Emergency Responses



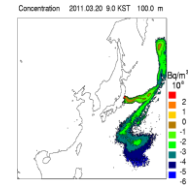
PSA Software Development incl. Human & Digital I&C Reliability



PSA Models for New Reactors (SFR, VHTR, SMART)



Radionuclide Dispersion & Dose Assess.



Environmental Monitoring Technology



Terrestrial Radioecology



Radiation Biology



Nuclear Safety R&D – Major Facilities

ATLAS



TH integral effect tests for accident conditions of APR1400, OPR1000 & APR+ at prototypic press & temp

- *OECD/NEA/CSNI ISP-50
- *OECD/NEA ATLAS Project

TROI



Steam explosion tests with prototypic reactor core materials of up to 30 kg

- *OECD-SERENA Project

VESTA



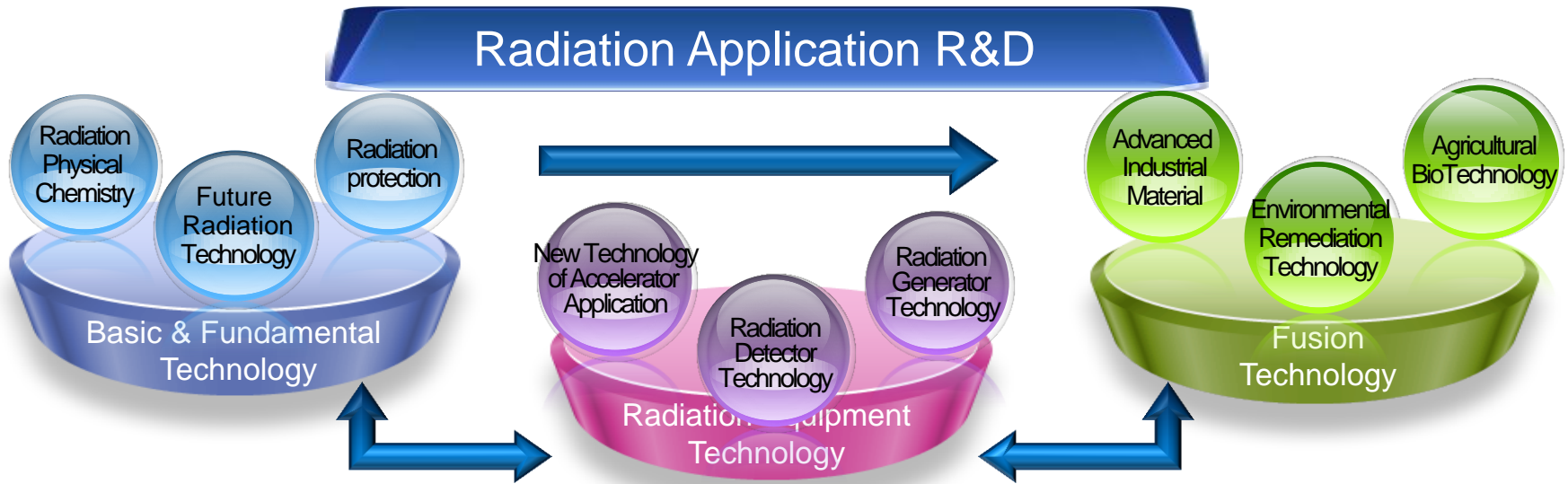
Test of corium behavior in a reactor cavity for up to 300 kg of prototypic corium

- * Fukushima Vessel Tests



Various Test Facilities for new design features of APR1400, APR+ & SMART

Radiation Technology



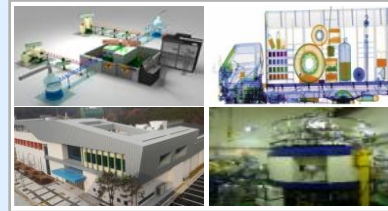
- Hydrogel for atopic dermatitis(Putto)
- High-strength wind turbine blade
- Construction of large-scale & multi-purpose demonstration center for electron beam processing

Industrial new material
& Environment



- 'HemoHIM' to enhance immunity & for chemotherapy supplement
- Composition containing 'Hesperidin' to protect cells
- Special purpose foods(space, patient) using radiation

Biotechnology & RI



- Production of medical RI using 30MeV Cyclotron
- Manufacturing Nano particle using electron beam
- Security inspection technology using multi radiation sources

Radiation Equipment

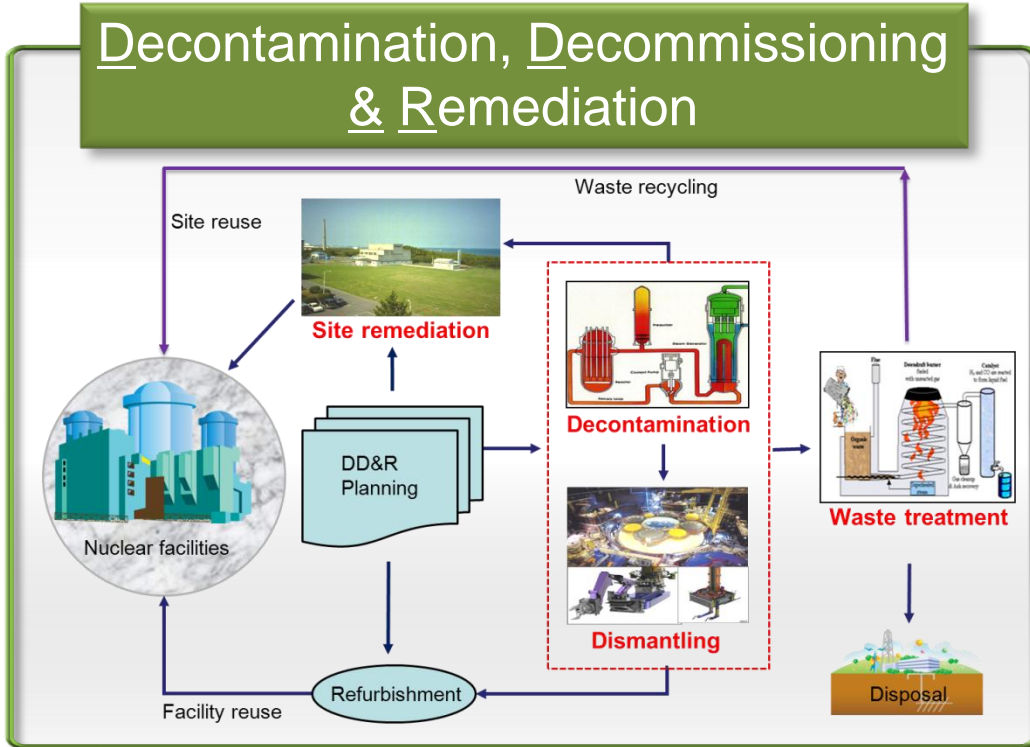


- Mutant new type varieties of chrysanthemum, dwarf Hibiscus and kenaf
- High functional new rice, soybean and blackberry variety ('Maple')

Radiation Breeding

DD&R Technology Development

Decontamination, Decommissioning & Remediation



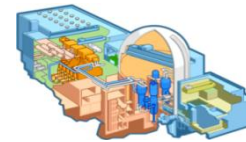
- National DD&R Plan (Nov. 2012, AEC)
 - Complete DD&R technology development by 2021
 - To prepare decommissioning of old NPPs in Korea
- KAERI's R&D Goal
 - Development of key DD&R technologies for NPP by 2016
 - Demonstration of Engineering Technology in DD&R system by 2021



DD&R tech. for research reactor and uranium conversion plant



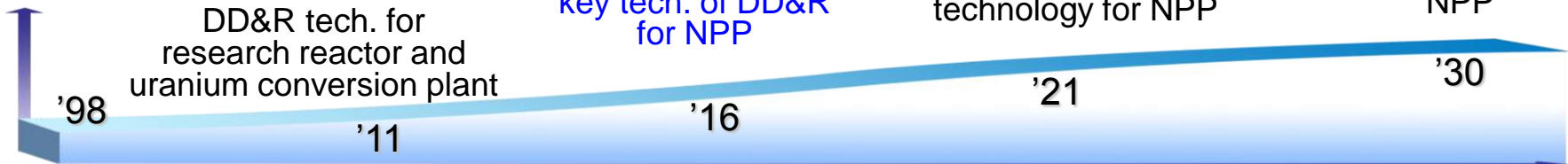
key tech. of DD&R for NPP



Demonstration of DD&R technology for NPP



Commercialization of DD&R tech. for NPP

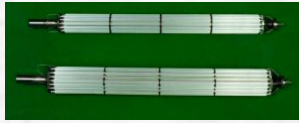


Nuclear Fuels Development

LWR & SMR Fuel



Research Reactor Fuel



Rod-type Fuel for HANARO




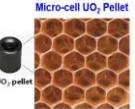
Plate-type Fuel for Kijang reactor

SFR Fuel




VHTR Fuel






Micro-cell UO₂ Pellet

Accident Tolerant Fuel (ATF) Pellet




3D laser coating technology


Accident Tolerant Fuel (ATF) Cladding




ATF Irradiation Test in the Halden Reactor



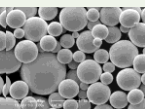
SMART Fuel Assembly TH Test



SMART Fuel Structural Integrity Test



Centrifugal Atomizer for Powder Production



Atomized U₃Si Powder



HANARO Fuel Manufacturing Facility



HANARO Fuel Storage


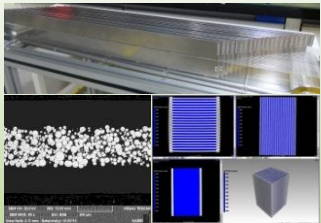



Plate-type Fuel Fabrication Facility



U-Mo Fuel Plate/Assembly



LTAs for ATR Irradiation Test




Metal Fuel Slug Fabrication




Metal Fuel Cladding, Duct & Parts



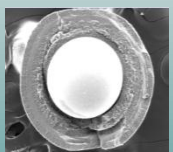
Metal Fuel Performance Evaluation



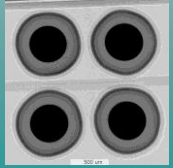
UO₂ Kernel fabrication



UO₂ Kernel



TRISO-Coated Fuel



X-ray Test

Nuclear Materials Technology

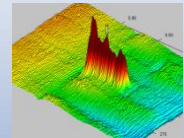
Materials Safety



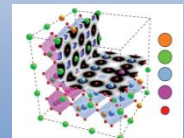
Structural Integrity Evaluation of RPV Materials



Corrosion Evaluation of Nuclear Materials



Non-Destructive Evaluation of Degradation

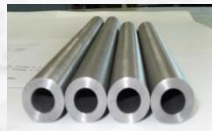


Modeling & Simulation of Material Damage

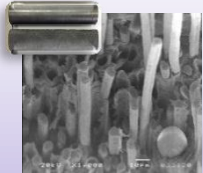


Mitigation and Water Chemistry

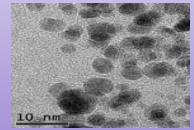
Advanced Materials



Development of ODS (ARROS)



Development of Ceramics & Composites

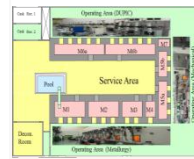


Development of Nano-Materials

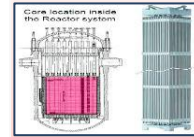


Development of Fusion Materials (ARAA)

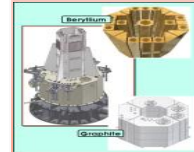
PIE Technology



Irradiated Materials



Irradiated Fuel



Research Reactor Materials & Fuel



Development of Advanced PIE Technologies

Radwaste Tech.



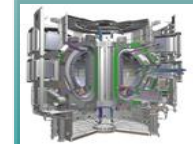
Treatment of Solid Radwaste



Treatment of Liquid Radwaste



Development of JRTR RTF



ITER Radwaste Treatment System

RPV : Reactor Pressure Vessel, ODS : Oxide Dispersion Strengthened Alloy