

SFR systems R&D activities

Jean-Michel Ruggieri
Co-Chair of SFR-SSC

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System Integration & Assessment Project

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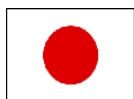
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France (CEA)



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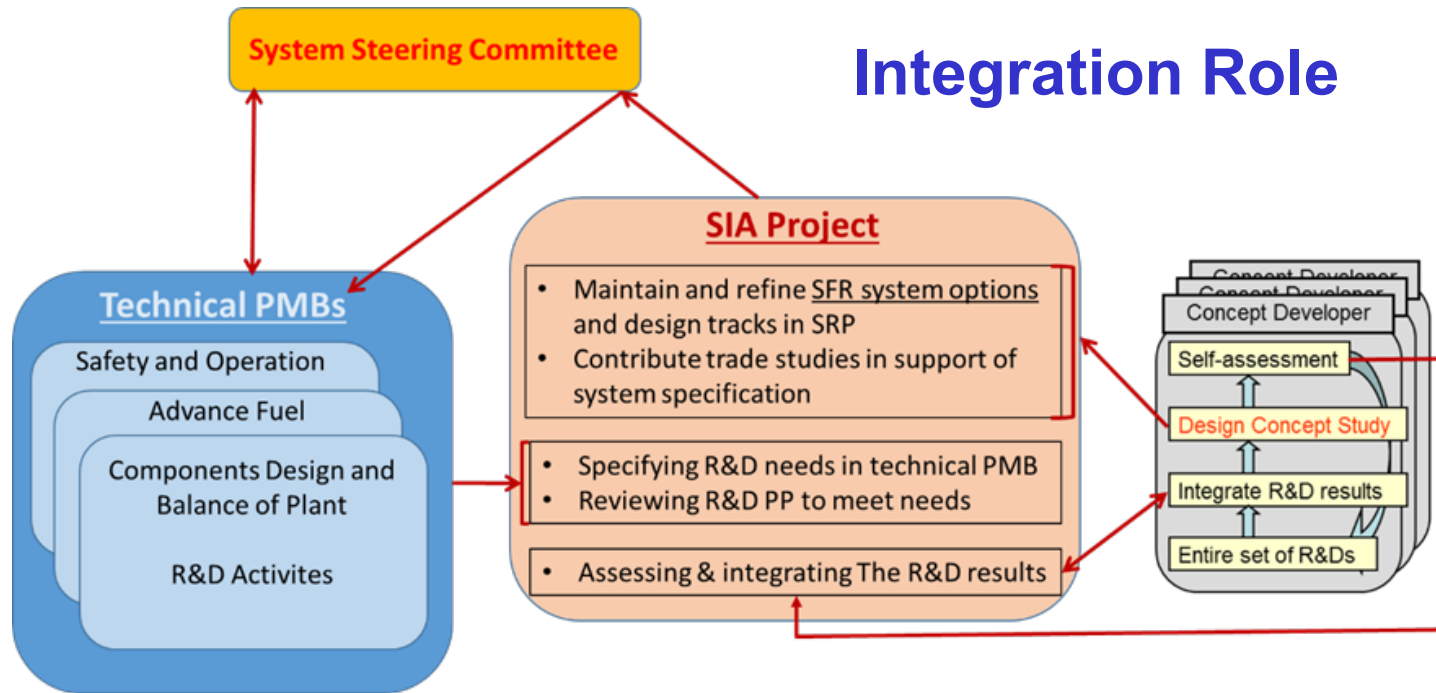
China (CIAE)



RF (Rosatom)

Project Objectives

- *Integration of the results of R&D Projects*
- *Performance of design and safety studies*
- *Assessment of the SFR System against the goals and criteria set out in the Gen IV Technology Roadmap*

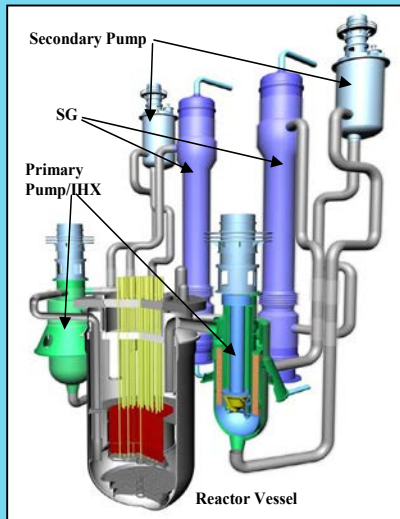


- **Identify** Generation-IV SFR Options
 - » General system options
 - » Specific design tracks
 - » Contributed trade studies
- Maintain comprehensive list of **R&D needs**
- **Review** Generation-IV SFR Technical Projects

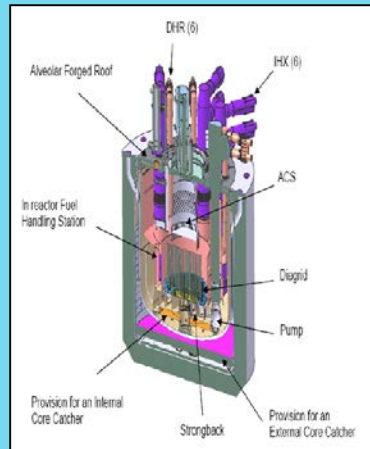
POOL

LOOP

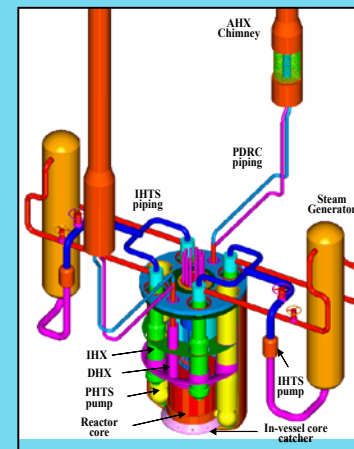
JSFR - JAEA



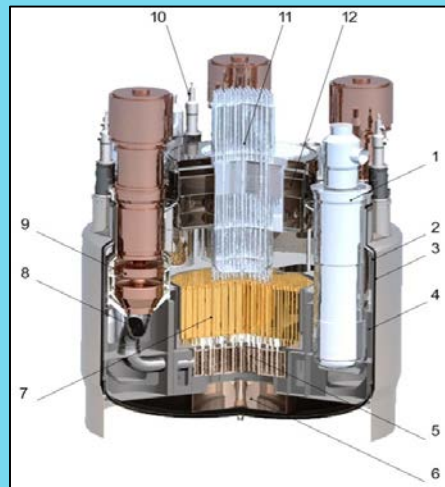
ESFR - Euratom



KALIMER - KAERI

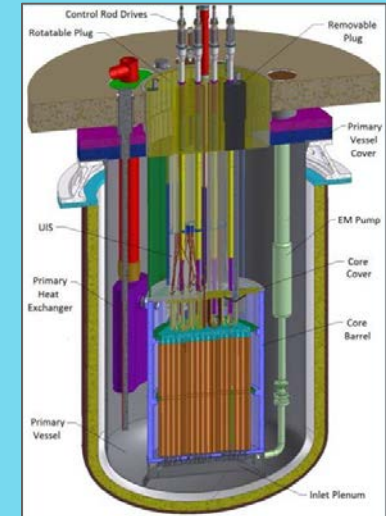


BN-1200 - ROSATOM



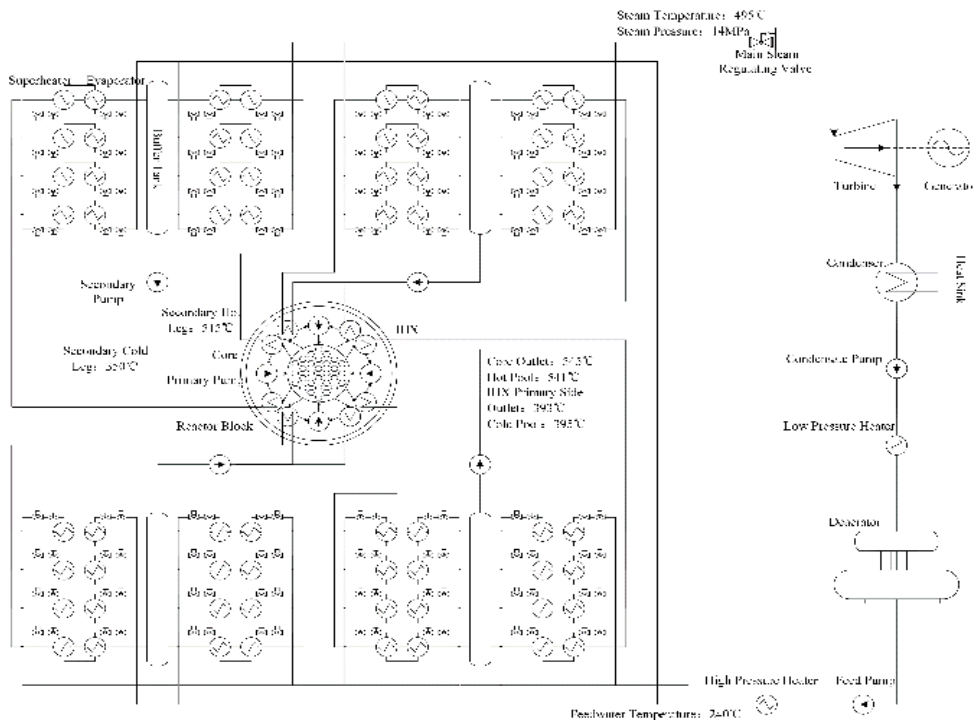
Small Modular

AFR-100 - USDOE



Concept under preparation for inclusion as Design Tracks

CFR-1200 (China): candidate for System Option #2



- CFR-1200 is a 1200MWe pool type sodium-cooled fast reactor.
- MOX fuel and ODS cladding material will be used based on the design goals.
- Passive features, including passive shutdown and passive heat removal, will both be considered for safety.
- For the power conversion system, some R&D of Super-CO₂ conversion will also be carried out in spite of water-steam conversion as the first choice.

Advanced Fuel Project

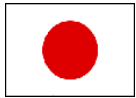
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China (CIAE)*



*RF *(Rosatom)*

* ROSATOM and CIAE joined the SFR AF Project from October 2015.

Project Objectives:

- *Selection of high burn-up MA bearing fuel(s), cladding and wrapper withstanding high neutron doses and temperatures.*
- *Candidates:*
 - *Driver fuels (Oxide, Metal, Nitride & Carbide)*
 - *Inert Matrix fuels & MA Bearing Blankets*
 - *Core materials: Ferritic/Martensitic & ODS steels*
- *Scopes :*
 - *Fabrication*
 - *Behavior under irradiation*

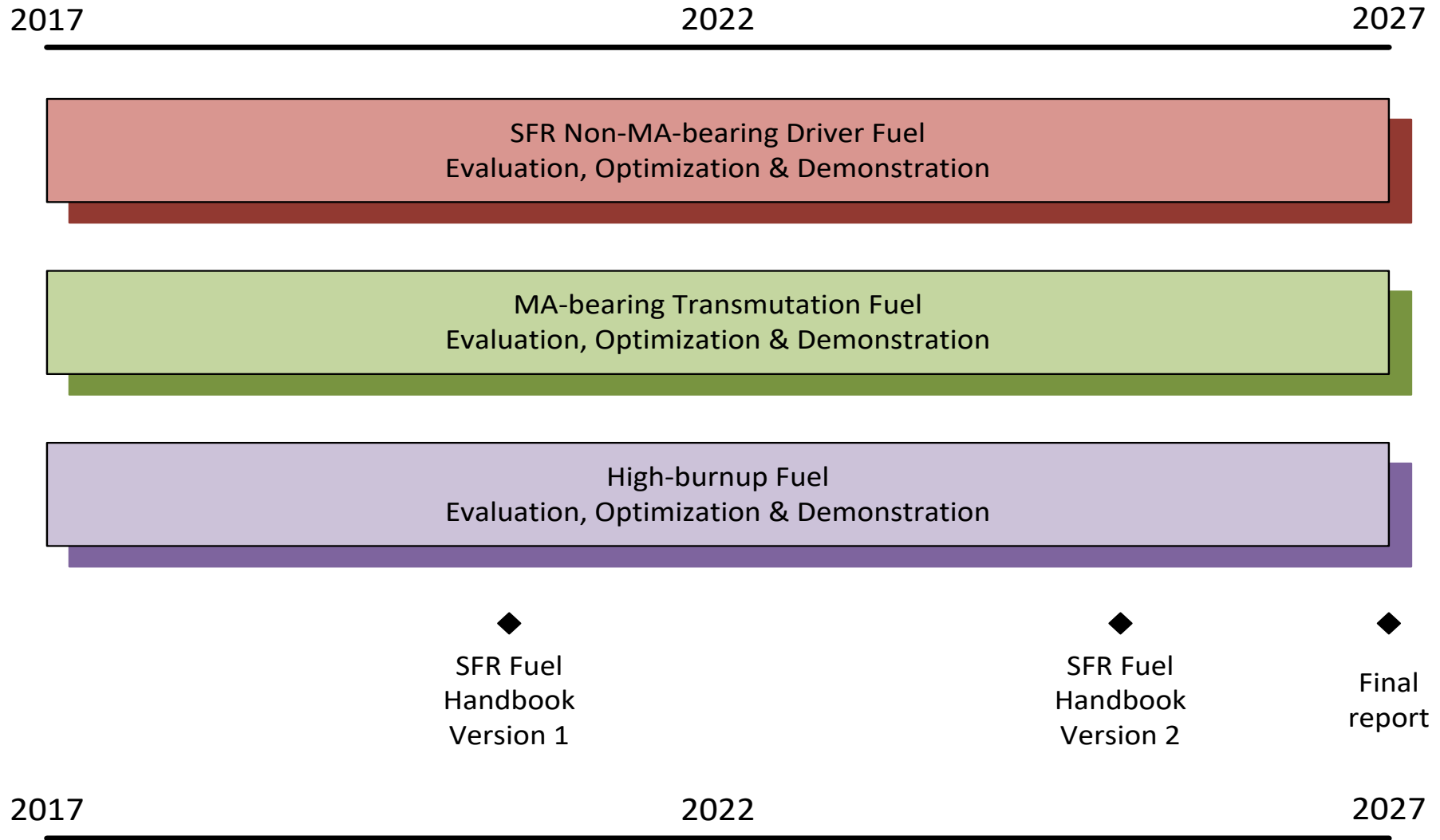
For actinide management, the topics are also still ongoing for innovative fuel development, new challenges till 2027 for following three items:

- ***SFR non MA-bearing Driver Fuel Evaluation, Optimization & Demonstration:***
 - *Update knowledge gaps on fuel performance and fabrication technologies*
 - *Experimental and analytical evaluation, including fabrication and irradiation tests for the demonstration of fabrication and adequate irradiation performance at assembly level*
 - *Candidates: Nitride, oxide and metal driver fuel.*

- ***MA-bearing Transmutation Fuel Evaluation, Optimization & Demonstration:***
 - *MA-bearing fuels as driver fuels and targets dedicated to transmutation in both homogeneous and heterogeneous ways of MA transmutation, to provide effective utilization and destruction of minor actinides in the SFR.*
 - *optimization and demonstration of fabrication and irradiation performance on fuel pin/bundle level for MA-bearing driver fuel.*
 - *Demonstration at fuel pin level is the long-term goal for MA-bearing transmutation targets.*

- ***High-burnup Fuel Evaluation, Optimization & Demonstration:***
 - *High-burnup fuel performance potential and safety performances characterization will be continued.*
 - *The scope is extended to irradiation testing and further development of core materials (cladding, wrapper) for high burnup fuels.*
 - *Optimization and demonstration of high burnup fuel performance is targeted at fuel pin level.*

Expected target schedule



Component Design & Balance Of Plant Project

CD&BOP Project

Members



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US (USDOE)



Korea (KAERI)



EURATOM (JRC)



Japan (JAEA)

* ROSATOM and CIAE are under negotiation of participation.

Project Objectives: Research & Development on:

- *In-Service Inspection*
- *Repair*
- *Leak Before Break (LBB) Assessment*
- *Supercritical CO₂ Brayton Cycle Energy Conversion*
- *Steam Generators*

- **Advanced Energy Conversion System:**
 - *Testing of small-scale compact diffusion-bonded heat exchangers,*
 - *Testing of small-scale S-CO₂ compressors,*
 - *Sodium-CO₂ interactions,*
 - *CO₂ corrosion of various austenitic and ferritic steels,*
 - *Analyses of SFRs incorporating S-CO₂ Brayton cycles,*
 - *Plant dynamic analyses for SFRs with S-CO₂ cycles,*
 - *Sodium plugging of sodium-to-CO₂ heat exchanger sodium channels*
- **Steam Generators:**
 - *The development of steam generators including investigations of sodium-water reactions and development of advanced inspection technologies for a Rankine-type steam generator.*
- **For sodium leakage and interactions:**
 - *Development of leak before break (LBB) assessment procedures*
 - *instrumentation to detect sodium leakage,*
 - *Consequence analysis (sodium fire and aerosols) and mitigation approaches.*
 - *The creep-fatigue crack initiation and growth behavior in ferritic martensitic steels*
 - *Development in the field of sodium leakage detection is also an objective, with improvement of time response and limitation of false alarms.*
 - *Better knowledge of sodium fire in order to limit its consequences and design the well appropriate mitigation systems.*

- ***In-Service Inspection & Repair (ISIR) technology:***
 - ***Development of various innovative inspection technologies:***
 - » ***transducers development and testing,***
 - » ***waveguide development and testing,***
 - » ***sodium wetting behavior,***
 - » ***EC flowmeter for fuel assembly outlet flow measurement,***
 - » ***CIVA code applications,***
 - » ***under sodium viewing techniques development***
 - ***PHÉNIX, JOYO, MONJU development of technology for component repair under sodium***

- ***Sodium operation technology and new sodium testing facilities:***
 - ***sharing and/or development of data on sodium:***
 - » ***drainability,***
 - » ***wetting,***
 - » ***plugging,***
 - » ***purification,***
 - » ***stresses during freezing and remelting,***
 - ***share the information of the existing and/or new sodium testing facilities:***
 - » ***AtheNa,***
 - » ***STELLA-2,***
 - » ***METL facilities,***
 - » ***...***

Safety & Operation Project

S&O Project

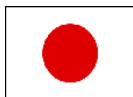
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Project Objectives

- *Analyses and experiments that support safety approaches and validate specific safety features*
- *Development and validation of computational tools useful for such studies*
- *Acquisition of reactor operation technology, as determined largely from experience and testing in operating SFR plants*

12 technical topics of interest based on the past deliverables:

- 1 - Core**
- 2 - DHR, natural circulation**
- 3 - Severe Accidents, sodium boiling, fuel degradation, core catcher**
- 4 - External events**
- 5 - Shutdown systems**
- 6 - Containment and source term**
- 7 - Benchmarking, code V&V**
- 8 - PRA**
- 9 - Sodium / water / concrete interactions**
- 10 - (ISIR)**
- 11 - Safety and Design (passive/inherent safety)**
- 12 - Safety Analysis (design-basis modeling)**

Addressed under three work packages:

- WP SO 1 – Methods, models and codes**
- WP SO 2 – Experimental programs and operational experiences**
- WP SO 3 – Studies of innovative design and safety systems**

In addition, Project Plan points out potential topics for common project interest:

- ***Natural circulation in sodium systems (first priority):***
 - *Design issues: thermal stratification, flow redistribution or reversal, freezing, thermal stress;*
 - *Evaluation methods: PIRT, model selection, plant-scale validation, uncertainty quantification;*
 - *Fundamental models: heat capacity, pressure loss, and property correlations; experimental measurement techniques.*
- ***Reactivity control system options:***
 - *Hydraulic, fusible devices, Curie-point, GEMs, ARC, etc.*
- ***Ex-vessel cooling system options:***
 - *RVACS (air NC), forced oil convection, modeling approaches, etc.*
- ***Sodium boiling experience:***
 - *Timing and location, stability, codes and methods, experiments.*

Thank you for your kind attention!