

IAEA Activities in the Area of Partitioning and Transmutation

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IAEA

International Atomic Energy Agency

IAEA Activities

- Implemented in collaboration by IAEA's *Nuclear Power Technology Development* and *Nuclear Fuel Cycle and Materials* Sections
- Framework given by the *Technical Working Groups on Fast Reactors (TWG-FR)* and on *Nuclear Fuel Cycle Options (TWG-NFCO)*

Technical Working Group on Fast Reactors (TWG-FR)

- **TWG-FR working tool to**
 - **Promote exchange of information on national and multi-national fast reactor and hybrid systems programs (e.g., ADS)**
 - **Stimulate and facilitate collaborative research and development (CRPs)**
 - **Coordinate activities with other Agency projects (e.g., in Safety), and international organizations (EC and OECD/NEA)**

Membership of the TWG-FR

Belarus, Brazil, China, France, Germany, India, Italy, Japan, Kazakhstan, Republic of Korea, Russia, Switzerland, United Kingdom, and United States of America, as well as the EU (EC), and OECD/NEA
Observers: Belgium, Sweden

TWG-FR Annual Meetings

- **Last meeting hosted by China Institute of Atomic Energy in Beijing, 15 – 19 May 2006**
- **Next meeting will be hosted by Japan Atomic Energy Agency (JAEA), in Tsuruga/Kyoto, 14 – 18 May 2007**

Recent Accomplishments

- **Information exchange**

- **Theoretical and Experimental Studies of Heavy Liquid Metal (HLM) Thermal Hydraulics (IAEA-TECDOC-1520)**

- ✓ Summarizes the state-of-the-art of present Computational Fluid Dynamic (CFD) codes

- ✓ Reviews the current and planned experimental HLM programs

- ✓ Identifies needs for future R&D activities

- **IAEA/ICTP Workshop on *Technology and Applications of Accelerator Driven Systems*, Trieste, 17 – 28 October 2005**



Ongoing and Planned Activities

● Collaborative R&D

- **Coordinated Research Project (CRP) on *Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste***
 - ✓ Comparative assessment of the transient behaviour of advanced transmutation systems, both critical and sub-critical
 - ✓ Benchmarks studies on critical liquid metal, and gas cooled fast reactor, heavy liquid metal, and gas cooled ADS, critical and sub-critical molten salt concepts, and fusion-fission hybrid sub-critical systems
 - ✓ 17 institutions in 13 Member States, and the EC (JRC) participating
 - ✓ Results on molten salt benchmark presented at PHYSOR 2006
 - ✓ Ends 2006, final IAEA TECDOC expected end 2007

Ongoing and Planned Activities

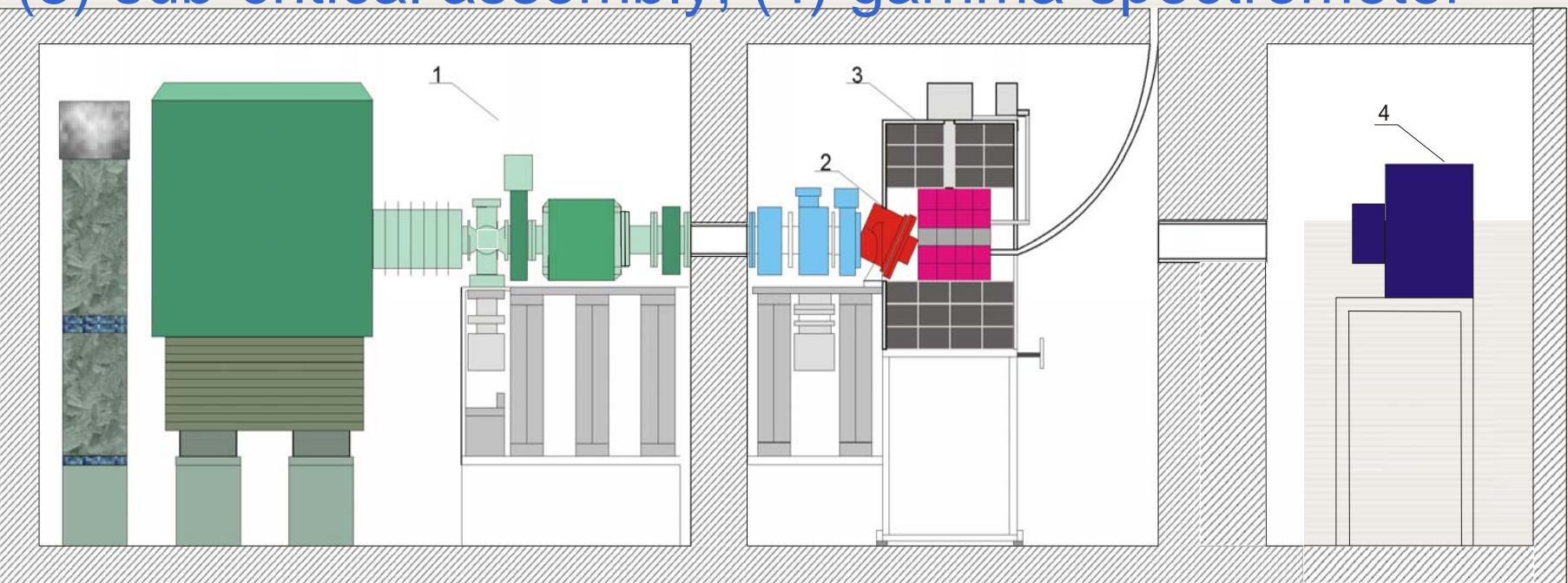
- **Coordinated Research Project (CRP) on *Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (ADS)***
 - ✓ Improve physics understanding of the coupling of external neutron sources with sub-critical cores
 - ✓ Experimental backing of analytical benchmarks
 - ✓ Participants will apply integrated calculation schemes to perform computational and experimental benchmark analyses
 - ✓ 27 institutions in 18 Member States and two international organizations participating
 - ✓ First stage benchmark problems: (i) YALINA-Booster; (ii) spallation target parametric studies with experimental validation; (iii) spallation source efficiency and energy dependence; (iv) analytical and numerical benchmarking of methods and codes for ADS kinetics; (v) ADS concepts; (vi) sub-critical experiments; (vii) photonuclear based transmutation benchmarks; (viii) ADS performance
 - ✓ CRP presented at PHYSOR 2006 (3 papers)
 - ✓ Ends 2009

Description of Experimental Benchmarks (1/5)

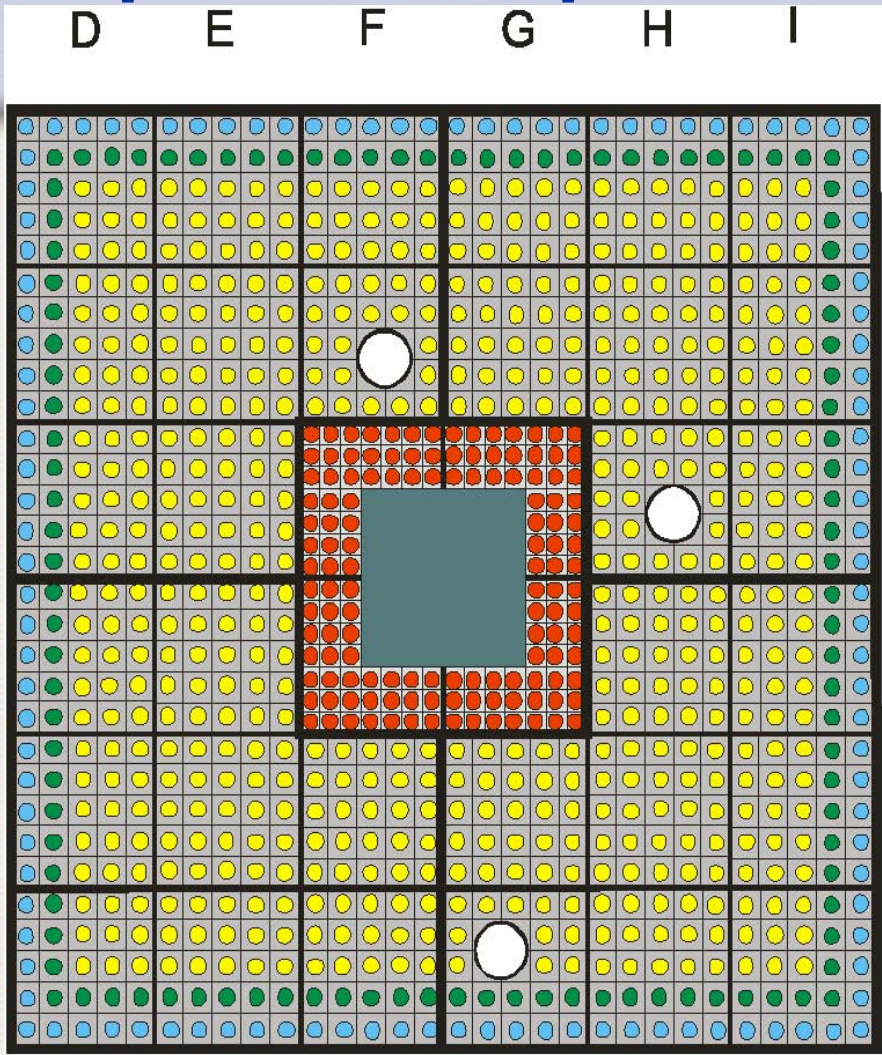
YALINA-Booster Facility (JIPNR, Minsk, Belarus)

(1) d-accelerator; (2) neutron producing Ti-d (or Ti-t) target

(3) sub-critical assembly; (4) gamma-spectrometer



Description of Experimental Benchmarks (2/5)



YALINA-Booster Facility
 XY-cross section (at
 Z=0) of the fast
 (“booster”) zone and the
 buffer zone

- Lead target
- Umet., 90% of U-235
- UO2, 36% of U-235
- Umet. (nat.)
- Boron carbide - B4C
- Experimental channels In fast zone



YALINA

Description of Experimental Benchmarks (3/5)

- **YALINA-Booster benchmark analyses**
 - Axial distributions of $^3\text{He}(n,p)$, $^{235}\text{U}(n,f)$, and $^{115}\text{In}(n,\gamma)$
 - Radial $^{115}\text{In}(n,\gamma)$ reaction rate distribution
 - $^{197}\text{Au}(n,\gamma)$ and $^{55}\text{Mn}(n,\gamma)$ reaction rates in mid-plane positions in the “booster” and in the thermal zone
 - Neutron spectrum
 - Neutron flux vs. time
 - Effective and source multiplication factors (k_{eff} and k_s), mean neutron generation time (Λ), and effective delayed neutron fraction (β_{eff})
 - Feasibility of sub-critical experiments using low-enriched uranium

Description of Experimental Benchmarks (4/5)

- **Spallation Source Efficiency and Energy Dependence (CERN experiments)**
 - **FEAT** (energy dependence, source efficiency)
 - **TARC** (neutron fluence, ^{99}Tc transmutation rates)
- **Spallation Target Characteristics**
 - **Thin** and **thick** target experiments performed at ITEP (Moscow)

Description of Experimental Benchmarks (5/5)

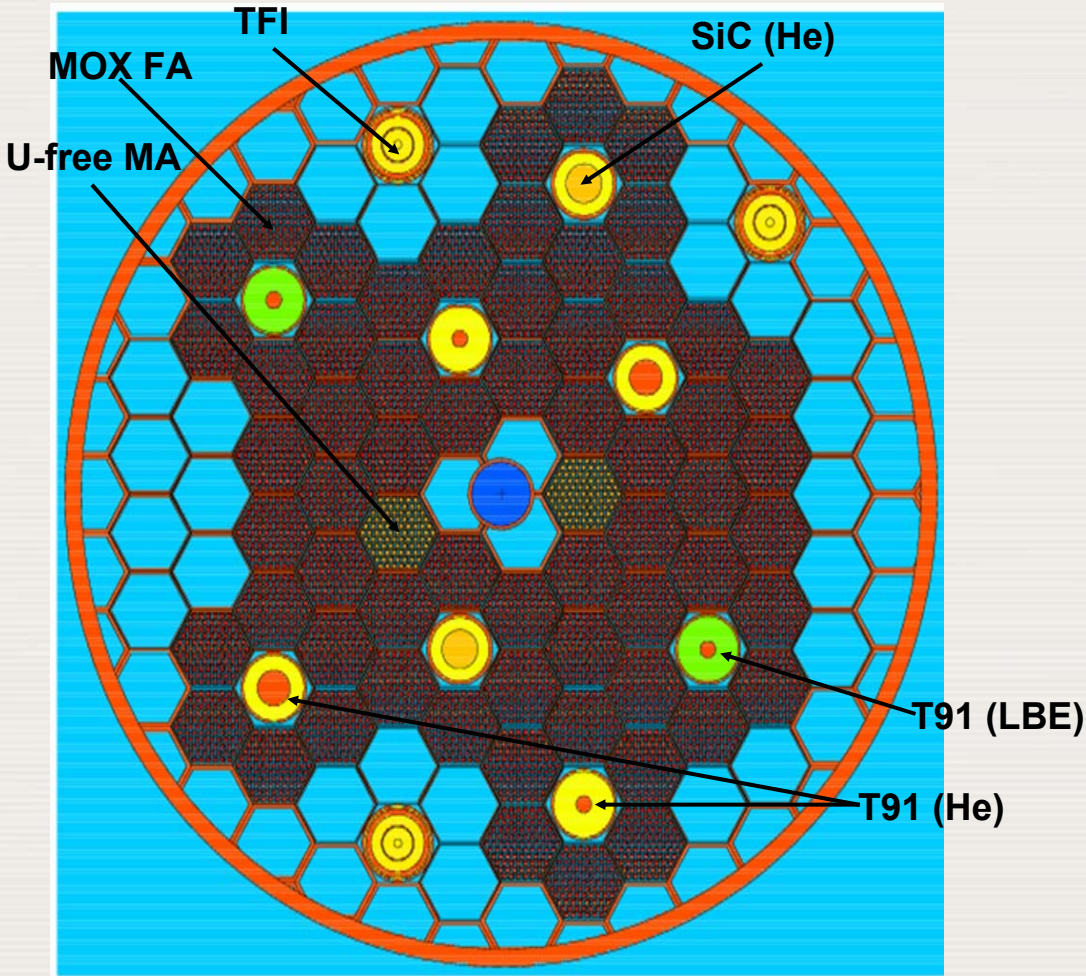
- **Sub-critical Experiments**
 - **Kyoto University's Critical Assembly (KUCA) benchmark**
 - **Planned coupling of a sub-critical configuration of the core of the Zero Power Facility IPEN-MB-01 at IPEN (São Paulo) with a compact neutron generator**
 - **Photonuclear based transmutation benchmark (neutron source facility planned at the Kharkov Institute for Theoretical Physics, Ukraine)**

Description of Analytical Benchmarks (1/2)

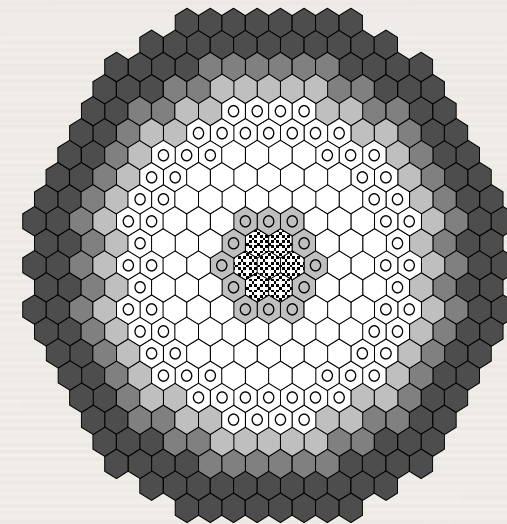
- **ADS Dynamics Problems**
 - **Exact analytical solutions**
 - **Highly accurate numerical solutions**
- **ADS Concepts**
 - **MYRRHA**
 - **JAEA ADS concept**








Description of Analytical Benchmarks (2/2)

MYRRHA (52 MW)



JAEA ADS Core Layout



-  Spallation target (7)
-  LBE buffer (12)
-  Inner core (66)
-  Outer core (66)
-  LBE reflector (48)
-  SUS shield (54)
-  B₄C shield (126)

Ongoing and Planned Activities

- **IAEA Workshop (School) on *Physics, Technology and Applications of Accelerator Driven Systems (ADS)*, in collaboration with ICTP, Trieste, planned for August/September 2007**
 - **Main objectives: formation and training**
 - **Lectures, tutorials, computer exercises**
 - **Participants mostly from Eastern Europe and Asia, but also participation from Africa, Western Europe, and South America**
 - **Syllabus: accelerator technology, nuclear data, ADS concepts (design), simulation methods, ADS safety, fuel cycle issues**
 - **More information soon available on <http://www.iaea.org/inis/aws/fnss/meetings/index.html#planned>**

Ongoing and Planned Activities

- **ADS Research and Development Database**
 - **ADS related R&D programs: experimental facilities (existing and planned) and programs, methods and data development, design studies, ...**
 - **Web based, operational**
<http://www-adsdb.iaea.org/index.cfm>
 - **Data collection started, contributions solicited**
 - ✓ Request login ID and PW from a.stanculescu@iaea.org
 - ✓ Data can then be provided on-line, intuitive interface

For more information, please visit
<http://www.iaea.org/inis/aws/fnss/>

Thank You !

