Background

The international Generation IV (GEN IV) initiative has once more highlighted that fast reactors are indispensable for a sustainable development of the Nuclear Energy. Europe has historically a large experience in the field of sodium-cooled fast reactors and recently has made a big effort in the development of the Lead-Bismuth Eutectic (LBE) technology for use in the sub-critical reactors, starting from the Russian technology for the submarine propulsion programme.

The evolution from the LBE technology towards the pure lead technology is a natural and logical way because lead is less expensive, less corrosive and of lesser radiological concern. Lead has chemical and neutronic characteristics which are unique for a safe fast reactor. Molten lead, namely, operates at low pressure and high temperature, is relatively inert to air and water.

Objectives

The ELSY consortium intends to design a Lead-cooled Fast Reactor (LFR) system that complies with all GEN IV goals and gives assurance of investment protection. The EC FP6-ELSY project aims to demonstrate that it is possible to design a competitive and safe fast critical reactor using simple engineered technical features. ELSY is a 36-months project (starting September 1, 2006) partially funded as a "Specific Targeted Research Project" entitled to the European Commission.

Europe is best suited to successfully work out this ambitious project, owing to

- the large experience in another liquid metal technology, namely sodium;
- the experience in the heavy metal technology acquired in the frame of Accelerator Driven Systems (ADS) with design, construction and operation of several Pb-Bi or pure Pb experimental loops and Pb-Bi irradiation capsule in existing MTRs;
- the ongoing ADS design and R&D activities performed within EURATOM FP6 IP EUROTRANS, in particular MYRRHA/XT-ADS and EFIT.

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Synergy with IP EUROTRANS will allow to achieve the best performance with minimum effort, while getting a major role in the LFR development in the frame of GEN IV. The Consortium is constituted by partners from:

- Industry (Ansaldo, Del Fungo Giera Energia, Empresarios Agrupados);
- Utilities (EDF);
- European Commission Joint Research Centre (JRC/IE-Petten);
- National research organisations (CESI, CNRS, ENEA, FZK, INR, NRG, UJV-REZ, PSI and SCK•CEN);
- Universities (AGH, CIRTEN and KTH);
- Some international partners, namely SNU (Korea) and KESRI (Korea) are also involved.

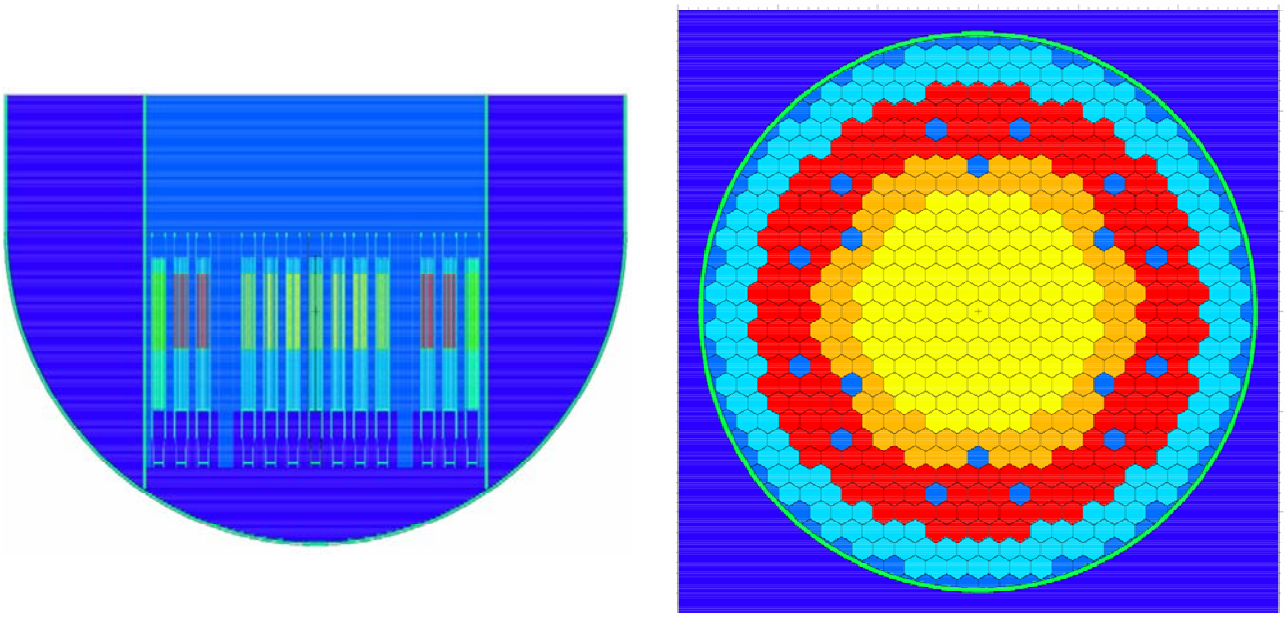
Due to the experience gained through the MYRRHA project, SCK•CEN is a major partner within the ELSY project and is responsible or involved in the following tasks:

- The definition of the core configuration parameters and the design of the fuel pin and of the hexagonal option of a fuel assembly;
- The reactor physics design of the MOX-based core and its performance assessment for a whole operation period (from the reactor start to the end of the fuel life), including static, kinetic parameters and various reactivity effect and coefficients;
- The assessment of Minor Actnide (MA) burning capability in such a system;
- The safety analysis of the ELSY reactor;
- The identification of the needed R&D support for ELSY.

Principal results

The definition of the ELSY core configuration and parameters has been achieved, and the preliminary designs of the fuel pin and of the fuel assembly have been delivered. A configuration of a 600-MW_e (1500 MW_{th}) core has been proposed for the ELSY performance assessment.

A detailed MCNP model has been successfully setup for the neutronics analysis of the ELSY core based on hexagonal fuel assemblies and MOX fuel. Reactor physics calculations have yielded a successful power peaks flattening using a 3 zone Pu-enrichment core loading pattern. The core performance assessment has been carried out at BOC (beginning of cycle) and after two effective full power years of operation. The preliminary simulation of a long-term behaviour of the critical fuel rods was also performed.



Neutronic MCNPX model of ELSY core

Future work

- Core design revision thanks to feedbacks from various teams.
- MA burning performance in ELSY-LFR.
- Thermal-hydraulics, thermo-mechanical and safety analysis.
- Set up a catalogue of the needed R&D.

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