VELLA
{Virtual European Lead LAboratory}

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THE LEADER PROJECT

LEAD-COOLED EUROPEAN ADVANCED DEMONSTRATION REACTOR

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The **LEADER project** proposal has been recently accepted by the EC as one of the funded projects in the frame of the 7th Framework Program. The acronym of the project (Lead-cooled European Advanced DEmonstration Reactor) well describe the main goal of the activities. Following the indication of the Strategic Research Agenda and the European Industrial Initiative which envisage the 2012 has a key date for the decision of the alternative technology to Sodium Fast Reactor, the project aim is to provide support to Lead Cooled Fast Reactors and propose the development of a specific design for a demonstration facility to be finalised and built in the short term.

LEADER, coordinated by Ansaldo Nucleare, groups all European entities that have been already involved in previous projects related to Lead cooled systems design and developments such as: ELSY, IP-EUROTRANS, PDS-XADS etc.
The partners of the project are: ANSALDO, AGH, CEA, CIRTEN, DEL, EA, ENEA, FZK, INR, JRC, KTH, NRG,PSI, SCK•CEN, SRS, UJV, UNIBO.
As it can be easily noted all the major European Research Labs are involved in the activities with an important and wide contribution from the Italian partners.
The total amount of the budget is close to 6 M€ (EC contribution 50%).

The focus of the first part of activity will be the resolutions of the key issues emerged in the frame of the ELSY project to reach a new reference reactor configuration.
This updated reactor configuration of an industrial size LFR will be used to design a low cost and fully representative scaled down prototype of a suitable size.
The project foresee an important involvement of End-Users and Safety Authorities from the beginning of the design process to help the plant conception and to assure high safety standards. Education and Training activities are included in a specific work package where European Universities are directly involved with the aim to grow-up the future nuclear energy designers.
LEADER takes strongly into account the others already proposed or on-going EU projects. All projects dedicated to R&D and material developments, projects dedicated to the development of ADS systems for transmutation or related to the development of fast reactors (VELLA, CDT, CP-ESFR, GETMAT, FAIRFUELS, ACSEPT, EUFRAT, F-BRIDGE, ACSEPT, ACTINET-I3, THINS) have strong synergies with LEADER toward the development of a Lead cooled fast reactor system.

The objectives of the project, related to development of a LFR demonstrator, are to show:

- that the innovative design and technology achieves high safety standards
- the fuel cycle can be closed and Minor Actinides managed
- the non-proliferation resistance is enhanced,
- a high availability factor is reached
- the economic competitiveness target is reached.
- The design is compliant with GIF goals

Moreover the demonstrator shall confirm that the newly developed and adopted materials, both structural material and innovative fuel material, are able to sustain high fast neutron fluxes and high temperatures.

The proposed activities will be carried out in the period 2010-2012 with the aim to define a demonstration plant configuration as a starting point for the final design activities and the proceed to short term

realization.
The project Partners are convinced that fostering the European efforts towards a LFR demonstration/pilot plant realization is a milestone of the needed developments and will establish Europe as a leader in the field.

THINS

AN EUROPEAN LARGE COLLABORATIVE PROJECT FOR CROSS-CUTTING THERMAL-HYDRAULIC RESEARCH FOR INNOVATIVE NUCLEAR SYSTEMS

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Within the Work Programme 2009 for Nuclear Research and Training Activities of the 7th Euratom Framework Programme (FP7), thermal-hydraulics is recognized as a key topic for the development of innovating nuclear systems meeting sustainability criteria. Although the different advanced reactors concepts are characterized by different coolant fluids (gas, water, liquid metals and molten salt) many important thermal-hydraulic issues are common to most of the systems. A large consortium consisting of more than 20 institutes (research centers, universities and industries) from EU (9) and non-EU (2) countries has identified the main issues and defined a research program that has been proposed to the European 7th framework program as a large scale integrated research project called THINS (Thermal Hydraulic of Innovative Nuclear Systems).

The general objectives of THINS are the development and validation of new physical models, improvement and qualification of numerical engineering tools and their application to innovative nuclear systems. To this purpose existing experimental data will be taken into account and new experiments will be conducted where needed. The research activities will focus on a limited set of topics:

- Advanced reactor core thermal-hydraulics
- Single phase mixed convection
- Single phase turbulence
- Multiphase flow
- Numerical code coupling and qualification

The previous R&D programmes promoted by the European Commission for the conceptual development of advanced nuclear reactors and transmutation systems have allowed to identify the main T/H issues to be addressed primarily. In particular, concerning the Heavy Liquid Metal cooled systems, EUROTRANS (EUROpean research programme for TRANSmutation systems), ELSY (European Lead-Cooled System), and MEGAPIE (Megawatt Pilot Experiment) have been taken into account.

Most of the research activities within THINS are of fundamental interest for the T/H of HLM systems:

- Thermal exchange in fuel assemblies
- Mixing and stratification in a large pool
- System dynamics
- Low Prandtl number turbulence
- Free surface flow
- Interaction of heavy liquid metal and water

The development and validation of numerical tools capable to simulate these phenomenologies will be based on a reliable and representative data base including existing and new experimental data. In this regard, new experiments to be conducted in existing facilities of different countries such as CIRCE and LIFUS5 (ENEA, Italy), Tall (KTH, Sweden), Kalla (FZK, Germany) as well as in a new large-scale pool facility (SCK-CEN, Belgium) will be essential to meet the overall objectives of the project. It is worth to mention the important contribution given by the VELLA initiative in developing the basis for such a synergic approach.

THE HELIM*NET* PROJECT

HEAVY LIQUID METAL NETWORK

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The Sustainable Nuclear Technology Platform (SNE-TP) has identified, among the six systems considered in the Generation IV International Forum, three concepts of fast neutron spectrum reactors and has prepared a Strategic Research Agenda (SRA) to implement these goals, taking into account the following criteria and milestones:

- innovations for new generation of Sodium Fast Reactor (SFR);
- selection of an alternative fast reactor type between 2010 and 2012;
- assessment of Accelerator Driven Systems (ADS) as dedicated facility for transmutation at industrial scale and merits of an experimental ADS in the 2020s and/or as multipurpose fast spectrum facility to supplement the Jules Horowitz Reactor and above prototypes or experimental reactors for tests of new structural materials and fuels.

The **realization of an LFR prototype** of the industrial plant at the horizon of 2030 is a potential option within the SNE-TP. The implementation of a LFR needs a strong R&D effort that includes:

- system design and component development;
- materials qualification and lead technology development;
- innovative fuels and fuel cycle.

Several of these activities have been already launched in Europe and an essential part will be the design of a small-scale European Technology Pilot Plant (ETPP) with a power of 50-100. These activities are e.g. preliminary design supported by R&D to guide design choices, followed by a detailed design phase that includes a consistent experimental program which takes into account safety and pre-licensing items. Innovative design solutions might be pre-tested at component level at representative scale and all experimental programs should include physical models, code development and validation.

With respect to the **development of ADS systems**, the SRA points out the potentialities of an Experimental Accelerator Driven System (XT-ADS) with a power of 50-100 MWth.

The design and development of ADS systems for transmutation of long-lived waste has been pursued within the European Commission Framework Programme since FP5. Within the FP5 project PDS-XADS conceptual designs of three different ADS machines have been developed and these results have been used to define the objectives of the FP6 IP-EUROTRANS that foresees the advanced design of an Experimental

Transmutation Accelerator Driven System namely MYRRHA/XT-ADS and the conceptual design of a European Facility for Industrial Transmutation (EFIT). The design activities on the experimental ADS are continued within the FP7 project CDT (Central Design Team). As in the case of the LFR development, needed R&D efforts have been identified such as system and plant design, material qualification and fuel development and qualification. Commonalities among LFR and ADS are that both systems use Heavy Liquid Metal (HLM), both system are developed to address the fuel cycle in terms of waste minimization and Lead Bismuth Eutectic alloy (LBE) as coolant.

Moreover, some commonalities between LFR and SFR can be identified as well. These can be deduced from the fact that both liquid metal systems would need e.g. dedicated ISI&R strategies, technological and operational approaches typical of liquid metal systems, even if the technological solutions might be of different type. In addition, both LFR and SFR would have similar mission in terms of sustainability, therefore within the area of fuel development some common aspects could be addressed.

Finally, the high power neutron spallation target development, has been envisaged as an investigation area relevant for the ADS, as well for other applications as structure studies of materials, scientific purposes in the biological and medical area, etc. Therefore, common approaches to develop high power neutron spallation target for ADS and other applications can be identified.

Accordingly, a coordinated action has been proposed, in the framework of FP7 –theme Fission -2009: " Other activities in support to the implementation of the SRA of SNE TP". The CSA-CA HeLiM*Net* (Heavy Liquid Metals Network), has the aim to carefully identify the details of the commonalities among the abovementioned systems and to facilitate the experience exchange, to enhance the knowledge transfer and to promote the integration of R&D effort. An additional relevant item, which is also objective of the project, is to foster the integration between design and R&D teams to promote effective design choices and support technological development.

The detailed objectives of HeLiM*Net* are, then:

- ✓ the **creation of a large and effective network** for the diffusion of information on the liquid metal technologies with special emphasis on HLM. The goal will be achieved by exploiting the features of the new information technologies (e.g. creation of virtual space for debates, focus groups and information exchanges) as well as the traditional tools as workshops, seminars, topical days etc.
- ✓ the **understanding and the coordination of procedures** through the development of guidelines, protocols and standards with particular attention to the harmonisation of operational procedures in order to ensure the quality and comparability of the experimental data obtained in different laboratories.
- ✓ **the appraisal of the liquid metal technology research area,** through the analysis of approaches and activities in different areas of investigation (fission (LFR, ADS, SFR), neutron spallation targets and fusion), the identification of possible cooperation, the definition of existing gaps and possible future R&D activities to cover these gaps.