THE GUINEVERE-PROJECT: THE FIRST ZERO-POWER FAST LEAD REACTOR COUPLED TO A 14 MEV NEUTRON GENERATOR (GENEPI)

Background

The GUINEVERE project is an European project in the framework of FP6 "IP-EUROTRANS". The IP-EUROTRANS project aims at addressing the main issues for ADS development in the framework of partitioning and transmutation for nuclear waste volume and radio toxicity reduction. The GUINEVERE-project is carried out in the context of domain 2 of IP-EUROTRANS, ECATS, devoted to specific experiments for the coupling of an accelerator, a target and a subcritical core. These experiments should provide an answer to the questions of on-line reactivity monitoring, sub-criticality determination and operational procedures (loading, start-up, shut-down, ..) in an ADS by 2009-2010.

During the definition of the experimental programme ECATS, it was judged that there was a strong need for a "European" managed experiment in the line of the FP5 MUSE-project. Reanalyzing the outcome of MUSE, two points were left open for significant improvement. To validate the methodology for reactivity monitoring, a **continuous beam** is needed, which was not present in the MUSE-project. In the definition of the MUSE-project, from the beginning a strong request was made for a **lead core** in order to have representative conditions of a lead-cooled ADS which was only partially answered by the MUSE-programme.

Therefore, there is a need for a lead fast critical facility connected to a continuous beam accelerator. Since such a programme/installation is not present at the European nor at the international level, SCK•CEN has proposed to use a modified VENUS critical facility located at its Mol-site and to couple it to a modified GENEPI deuteron accelerator (used in MUSE) working in current mode delivering 14 MeV neutrons by bombardment of deuterons on a tritium-target: the GUINEVERE-project (**G**enerator of **U**ninterrupted **I**ntense **NE**utrons at the lead **VE**nus **RE**actor). This proposal was formally accepted by the Governing Council of IP-Eurotrans in December 2006.

This project represents a close collaboration between SCK•CEN, CEA and CNRS. SCK•CEN is of course responsible for all the modifications at the VENUS facility to transform the water moderated facility into a fast lead core facility VENUS-F. CNRS modifies GENEPI to allow it to work in continuous mode: GENEPI-C. CEA provides the fuel and lead rodlets needed for the fuel assemblies.

Objectives

The aim of the GUINEVERE-project is to obtain a validated methodology for on-line reactivity monitoring for ADS by 2009-2010. In order to achieve this goal, the VENUS facility has to be adapted and a modified GENEPI-C accelerator has to be designed and constructed. During the years 2007 and 2008, the VENUS facility will be modified in order to allow the experimental programme to start in 2009.

Principal results

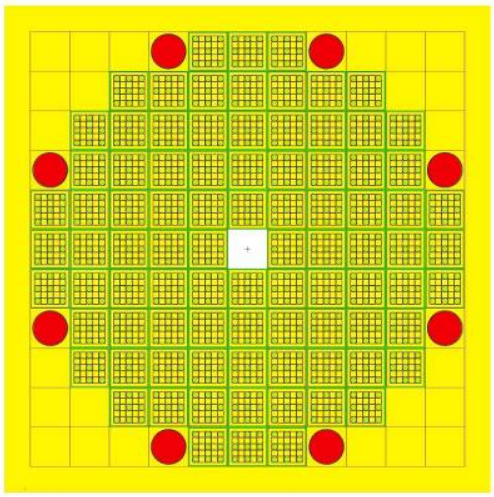
The execution of this project will consist of two types of modifications at the SCK•CEN site. First of all, the modifications which are connected to the installation of the new GENEPI-C accelerator, working in continuous and pulsed mode, at the VENUS critical facility and its coupling to the core. The second type of modifications is related to the adaptation of the VENUS critical facility to host a fast lead core, called VENUS-F.

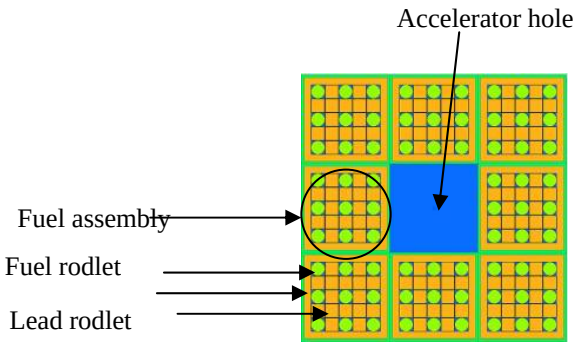
With regard to the "coupling" modifications, it was concluded after consultation with the European partners that a vertical penetration beam-line in the core would represent a significant added value to the project. To implement the vertical penetration option, the accelerator has to be put on top op the VENUS bunker in a technical room to be constructed. This means that civil engineering works are required to build a new technical area above the VENUS bunker. A first design of this new building and the possible coupling procedure was performed as can be seen from the figure below. The top level shown in the figure needs to be constructed.

To modify the water-moderated thermal reactor in a fast lead reactor, the following main items were identified:

- A new shut-down system based on shut-down rods (similar to the one used in the first years of the VENUS facility) will have to be installed;
- Construction of fuel assemblies with lead blocks and uranium fuel for the core and large lead blocks for the reflector. This will represent a total weight of about 30 t in the vessel;
- Analysis of the need of a supporting structure to reinforce the core vessel to carry the lead

A first lay-out of a core arrangement is given in the figure below on the left. This configuration consists of 88 fuel assemblies of about 60 cm active length. Each fuel assembly contains nine fuel elements with in between lead rodlets as can be seen from the figure below on the right. The core has a diameter of about 1m and has a radial, upper and lower reflector of about 30 to 40 cm of lead. There exists a central hole for the accelerator beam tube and the target material.





A preliminary safety report has already been prepared covering the key questions related to the GUINEVERE-project.

Future work

In the coming year 2008, the main focus will be on the finalisation of the drawings of the accelerator building and the internals of the core vessel. Meanwhile the existing internal parts of the VENUS reactor will be removed. Also, by the end of 2008 construction works will be started at the VENUS facility for the building of the accelerator level.

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Main reference

H. Aït Abderrahim, P. Baeten, B. Verboomen, A. Mueller, A. Billebaud, G. Granget, F. Mellier, *The GUINEVERE-project at the VENUS facility*, Conference proceedings "Utilisation and Reliability of High Power Proton Accelerators", Mol, Belgium, 6-9 May 2007