Neutrons for Science (NFS) at SPIRAL-2

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A huge number of high energy neutrons (in the range between 1 and 40 MeV), produced in the carbon converter via C(d,xn) reaction, will be available at the SPIRAL-2 project at GANIL (Caen, France) aiming to produce neutron-rich fission fragments. The facility is expected to be operational by 2009. The main goal of this study is to provide quantitative estimates on the possibility of using a 40 MeV (5mA; 200kW) linear deuteron accelerator in a combination with the rotating target-converter, as initially projected at SPIRAL-2 for RIB production, for other purposes, namely, a) material irradiations very close to the target-converter and b) time-of-flight (ToF) measurements with a pulsed neutron beams. This work is also aimed to give a direct comparison a) with the ITER and IFMIF irradiation environment in terms of available neutron fluxes, energy spectra, material damage rates, useful irradiation volumes, etc., b) with the existing ToF facilities as GELINA at Geel and n-ToF at CERN in terms of available neutron beam characteristics (flux intensities, neutron energy range, neutron energy resolution, signal-to-noise ratio, etc.).

As long as material irradiations are concerned, we show that the SPIRAL2 facility would in principle be able to provide quite comparable neutron flux density, energy spectra and irradiation temperature conditions as ITER. On the other hand, in comparison with IFMIF, SPIRAL-2 would deliver neutron fluxes and damage rates by a factor of 10-20 lower. In addition, much smaller sample volumes (by a factor of 50) would be useful. Typical numbers for SPIRAL-2 are as follows: with neutron flux higher than $5\text{x}10^{13}$ n s^{-1} cm^{-2} and material damage rates greater than 3 dpa/fpy we obtain 10 cm^3 of a useful irradiation volume. It is important to emphasise that a variable temperature environment (between 500°C and 1000°C or higher) for irradiations would be possible at SPIRAL-2.

In the case of ToF measurements with a pulsed neutron beams, we conclude that a dedicated pulsed neutron beam facility can be easily built using the deuteron beam, and consequently neutrons produced at 0°, as delivered by SPIRAL-2. An integrated neutron flux greater by a factor of 100 -1000 (if compared to n-ToF at CERN) in the energy range from 5 to 40 MeV and with the energy measurement resolution of 1%, could be reached. In addition, this ToF facility in principle could function in parallel to the RIB production factory. However, additional investigations to define the neutron beam limits in terms of signal-to-noise ratio including safety radiation are necessary to determine the size of the experimental hall, the thickness and composition of the shielding walls, ToF channel geometry and materials, etc. This work is still in progress.

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