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A first integrated CERN-ISOLDE spallation source operated at 2000℃ with GW instantaneous beam power for isotope production

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Neutron-rich fission fragments are readily available at CERN-ISOLDE. However, if produced by direct irradiation (1.4GeV - 2μA pulsed protons) of a uranium carbide (UCx) target, the desired isotopes come with very high isobaric neutron-deficient fission fragments. Instead, irradiating a W spallation source, the neutrons produced irradiate the target producing high purity neutron-rich fission fragments. However, scattered protons from the W hit the target producing impurities, and a small solid angle intercepting the target causes a reduced beam intensity.

A converter design optimization has been proposed before and a simplified version has been tested[1], where in both current and tested prototype designs, the converter is positioned just below the target. A solution where the converter is positioned inside of the target is, for the first time, being studied in a collaboration with SCK-CEN and TRIUMF. This solution presents the advantage of using the full solid angle of the emitted neutrons, and have the highest possible neutron flux by being in close proximity with the UCx target. However, challenges arise from the coupling of the converter and heating of the target, nominally operated at 2000℃ or higher. A much larger target oven/heat screens are as well needed as well as chemical stability of the full assembly at 2000℃. Furthermore, from the pulsed proton beam, up to 700W (2.8kW - 1.2GW instantaneous power) are deposited in the target, while submitting the W to severe thermo-mechanical stresses. Since the W converter sits inside of the target oven, it acts as an internal heat source which needs to be compensated to avoid target degradation and promote isotope release. This concept will be designed to accommodate also the ISOLDE upgrade to 2GeV - 6μA.

[1] A. Gottberg, et al., NIMB 336 (2014) 143–148.

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