Investigations of two-step ISOL targets for the production of exotic ion beams

Igor Remec[1], Tony A. Gabriel[1], Mark W. Wendel[1],
Kenneth W. Childs[1], Reginald M. Ronningen[2], Georg Bollen[2]

[1]*Oak Ridge National Laboratory, Oak Ridge, P. O. Box 2008, TN 37831-6172, USA*
[2]*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824, USA*

Two-step isotope-separator-on-line (ISOL) targets are being studied as an attractive alternative for the direct ISOL targets for the next generation exotic beam facilities such as Rare Isotope Accelerator (RIA) and EURISOL [1, 2]. A two-step target consists of separate spallation (primary) region and fission (secondary) region. This separation reduces isobar contamination in the production of neutron-rich fission products and thermally decouples primary beam and fission region, which is important at high power beams when cooling of the target becomes problematic.

A two-step ISOL target considered here consists of a mercury or tungsten primary target and secondary target filled with UC (see Fig. 1). Three primary beams were investigated: 1-GeV protons, 622-MeV/u deuterons, and 777-MeV/u He-3 ions. The proton and deuterium beams were found to be about equivalent in terms of induced fission rates and heating rates in the target, while the He-3 beam, without optimizing the target geometry, was less favorable, producing about 15 % fewer fissions and about 50 % higher heating rates than the proton beam at the same beam power. The simulations were performed with the PHITS and MCNPX computer codes.

The heat transfer calculations indicate that for the 400 kW proton or deuteron beam power the primary target can be cooled with water flow. However, due to the relatively low thermal conductivity of UC_x [3] and the conditions required for the fast diffusion-effusion of the fission fragments, the cooling of the secondary target represents a challenge and may ultimately limit the maximum beam power.

This is a report on work in progress; further investigations will address yields of individual isotopes, detailed geometry of the secondary target, and related issues. This research is sponsored by the Laboratory Directed Research and Development Program of Oak Ridge National Laboratory (ORNL), managed by UT-Battelle, LLC for the U. S. Department of Energy under Contract No. DE-AC05-00OR22725.

The broader R&D effort on the RIA ISOL target area is carried out by a multi-institution collaboration involving Michigan State University, Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, and Los AlamLaboratory and is supported by DOE under contract number DE-FG02-04ER41322.

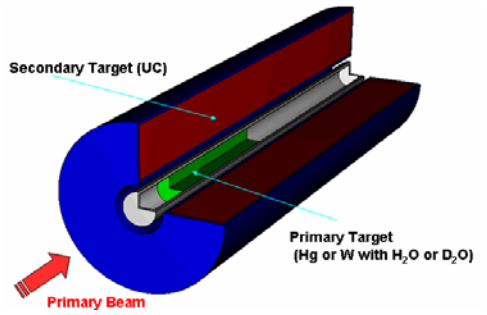

Figure 1: *Model of a 2-step ISOL target.*

[1] I. Remec et al., Particle and radiation simulations for the proposed rare isotope accelerator facility, Nucl. Instr. and Meth. A, In Press, (http://www.sciencedirect.com/science/article/B6TJM4/2/cd06dd29a70af16e1db1fbf92efc6df1);
[2] See for example: http://www.ganil.fr/eurisol/Final_Report/APPENDIX-C.pdf;
[3] John P. Greene, et al., Nucl. Instr. and Meth. B, 241 (2005), 986.