ISOL target and beam development

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We propose to make use of the variety and intensity of rare isotope beams with energies up to 150 MeV/A available at the NSCL/MSU for the R&D of ISOL type targets and to explore the feasibility of using the ISOL method for heavy charged-particle beams. The proposal includes the construction of a simple but complete ISOL front-end system with mass separator and counting station, to be installed on-line at one of the NSCL beam lines. This system and the tests performed with it are regarded to be the first step towards developing an ISOL front-end for RIA.

The choice of ISOL target materials and geometry determine the achievable yields of the rare isotopes. Monte Carlo simulations can give important guidance in target design, but the limitations of such calculations (for example, absence of target chemistry and difficulties in treating complicated target matrices such as coated fibers or composite materials) puts a premium on experimental measurements. The study of release efficiencies and delay times, which can be used to quantify the underlying processes of diffusion and effusion, is critical for the improvement of existing target systems, the testing of new target concepts, and the adaptation of these targets for RIA. At the NSCL, short-lived isotopes of practically any element can be implanted selectively and very locally into ISOL targets. Diffusion and effusion times can be studied with high precision under more realistic conditions. An example is the formation of molecular beams, which are a key to the production of ISOL beams not yet readily available. The formation of molecular beams can be investigated by implanting isotopes of the 'difficult' elements into appropriate target materials (examples are *C + TaO = Ta + *CO, *S + Sn = Sn*S, *Si + CeS = *SiS + Ce, *O + C = C*O, or *Al + F = *AlF). Similarly, undesired 'target chemistry' caused by material impurities and out-gassing can be studied.

An important feature of the employment of fast beams is the possibility of very fast iterations in the target development process. Only a minute quantity of a specific rare isotope (often short-lived) is implanted in the tests. Very low level of radioactivity and radiation will be observed after the implantation is stopped. The systems to be studied can practically immediately be dismantled for analysis. Irradiated targets and parts can be modified and reused.

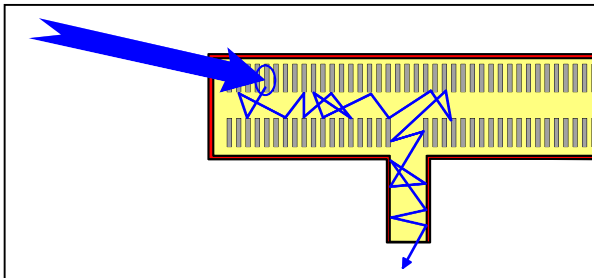

Fig. 1: Principle of ISOL target development with fast-fragment beams

It is envisioned that the ISOL systems will utilize the light-ion beams from the RIA accelerator. However, it will also be possible to deliver heavy charged particles to the ISOL target areas. We propose to investigate target/solid-catcher systems for use in "standard" ISOL-type target/ion source units. Compared to classical ISOL targets such systems can be expected to offer advantage in the production of very short-lived isotopes for some elements. Furthermore, the possibility to use heavy-ion beams in a parasitic mode during high-energy rare isotope production can be expected to enhance the overall productivity of RIA. Along the same line one could imagine catcher target systems being part of the beam dumps after the fragmentation targets. The proposed ISOL station and the NSCL beams will be ideally suited to study this option.

In addition to allowing research and development along the lines sketched above the NSCL ISOL station could serve as a test bench for the analysis and improvement of targets systems presently used at operational ISOL facilities in Europe and America or of prototypes suggested to be used at RIA. The results of studies with such a test facility will provide experimental verification of Monte Carlo simulations of simple target systems, while providing new and important data on the performance of more advanced target concepts. The NSCL ISOL station will allow testing of transfer lines and ion sources. Again, the use of specific short-lived rare isotopes will help to obtain reliable information on transport times and efficiencies.

A possible scenario for a target test station at the NSCL is shown if Fig. 2. In order to make target-changes easy and flexible it will be of benefit to keep target units or containers for material studies on ground potential and to place the frontend together with a simple mass separator and a counting station on a high voltage platform. To make best use of the implantation of fragment beams the platform should allow linear movement and rotation.

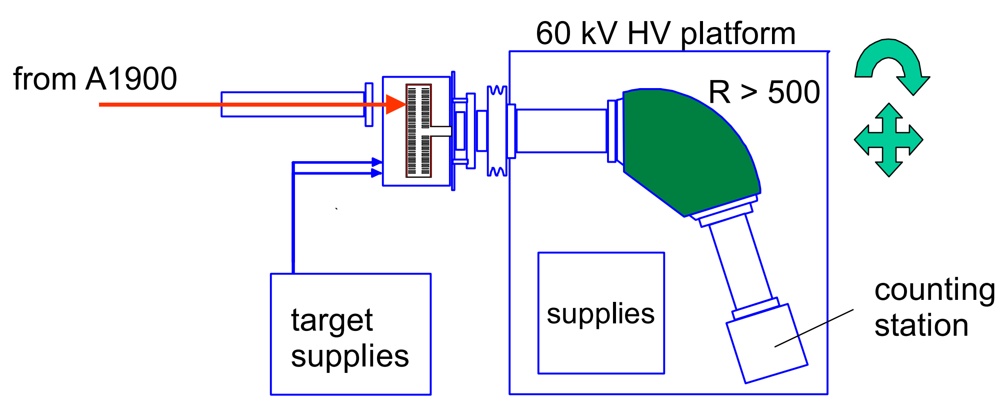

Fig. 2. Possible scenario for an ISOL target test station at the NSCL