Title

Production of beams of neutron-rich nuclei between Ca and Ni using the ion-guide technique

Permalink

https://escholarship.org/uc/item/634386jj

Authors

Perajarvi, K.
Cerny, J.
Hager, U.
et al.

Publication Date

2004-09-28

EPJ manuscript No.
(will be inserted by the editor)

Production of beams of neutron-rich nuclei between Ca and Ni using the ion-guide technique

K. Peräjärvi[1], J. Cerny[1], U. Hager[2], J. Hakala[2], J. Huikari[2], A. Jokinen[2], P. Karvonen[2], J. Kurpeta[3], D. Lee[1], I. Moore[2], H. Penttilä[2], A. Popov[4] and J. Äystö[2]

[1] Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
[2] Department of Physics, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland
[3] Division of Nuclear Spectroscopy, Institute of Experimental Physics, ul. Hoza 69, 00-681 Warsaw, Poland
[4] St. Petersburg Nuclear Physics Institute, Gatchina, 188350, Russia

Received: date / Revised version: date

Abstract.

Since several elements between Z=20-28 are refractory in their nature, their neutron-rich isotopes are rarely available as low energy Radioactive Ion Beams (RIB) in ordinary Isotope Separator On-Line facilities [1–4]. These low energy RIBs would be especially interesting to have available under conditions which allow high-resolution beta-decay spectroscopy, ion-trapping and laser-spectroscopy. As an example, availability of these beams would open a way for research which could produce interesting and important data on neutron-rich nuclei around the doubly magic ^{78}Ni. One way to overcome the intrinsic difficulty of producing these beams is to rely on the chemically unselective Ion Guide Isotope Separator On-Line (IGISOL) technique [5]. Quasi- and deep-inelastic reactions, such as ^{197}Au(^{65}Cu,X)Y, could be used to produce these nuclei in existing IGISOL facilities, but before they can be successfully incorporated into the IGISOL concept their kinematics must be well understood. Therefore the reaction kinematics part of this study was first performed at the Lawrence Berkeley National Laboratory using its 88" cyclotron and, based on those results, a specialized target chamber was built, see Fig. 1 [6].

The target chamber shown in Fig. 1 was recently tested on-line at the Jyväskylä IGISOL facility. Yields of mass-separated radioactive projectile-like species such as ^{62,63}Co are about 0.8 ions/s/pnA, corresponding to about 0.06 % of the total IGISOL efficiency for the products that hit the Ni-degrader, see Fig.1. (The current maximum 443 MeV ^{65}Cu beam intensity at Jyväskylä is about 20 pnA.) This total IGISOL efficiency is a product of two coupled loss factors, namely inadequate thermalization and the intrinsic IGISOL efficiency. In our now tested chamber, about 9 % of the Co recoils are thermalized in the flowing He gas (p_{He}=300 mbar) and about 0.7 % of them are converted into the mass-separated ion beams.

In the future, both of these physical/chemical conditions can be suppressed by introducing Ar as a buffer gas and by relying on selective laser re-ionization. This combination will produce isobarically pure beams and it will increase the existing yields by at least a factor of 100, making this overall approach to the study of neutron rich nuclei even more attractive. This work was supported by the Director, Office of Science, Nuclear Physics, U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

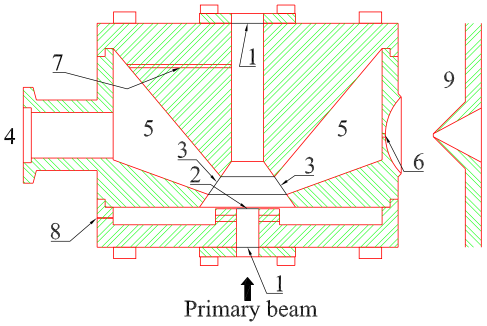

Fig. 1. Target chamber designed for use with quasi- and deep-inelastic reactions. The parts of the chamber are: 1) Havar-windows (1.8 mg/cm^2), 2) Au-target (3.0 mg/cm^2, diameter = 7 mm), 3) Conical Ni-window (9.0 mg/cm^2, angular acceptance from 40 to 70 degrees), 4) He-inlet, 5) Stopping volume, 6) Exit-hole (d = 1.2 mm), 7) Connecting channel (d = 1 mm), 8) Second exit-hole (d = 0.3 mm), 9) Skimmer electrode.

References

1. E. Runte et al., Nucl. Phys. **A399** (1983) 163.
2. E. Runte et al., Nucl. Phys. **A441** (1985) 237.
3. U. Bosch et al., Nucl. Phys. **A477** (1988) 89.
4. M. Hannawald et al., Phys. Rev. Lett. **82** (1999) 1391.
5. J. Äystö, Nucl. Phys. **A693** (2001) 477.
6. K. Peräjärvi et al., To be published.