New ion-guide for the production of beams of neutron-rich nuclei between Z = 20 - 28

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It has been shown for the first time that quasi- and deep-inelastic reactions can be successfully incorporated into the conventional Ion-Guide Isotope Separator On-Line (IGISOL) technique [1]. This is of particular interest for characterizing the decay properties of refractory elements and was applied to neutron rich nuclei between Z = 20 - 28. As a first step of this project, the kinematics of quasi- and deep-inelastic reactions, such as ^{197}Au(^{65}Cu,*X*)*Y*, were studied (see for example 2003 Annual Report). Based on these studies, a specialized IGISOL target chamber was designed and built, see Fig. 1.

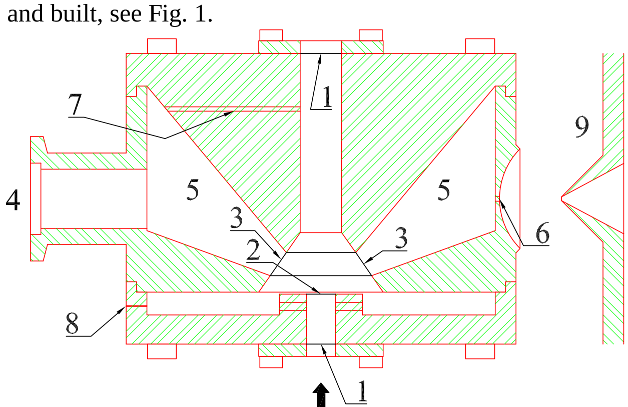

Fig. 1. Target chamber designed for use with quasi- and deep-inelastic reactions. The parts of the chamber are: 1) Havar-windows (1.8 mg/cm^2), 2) Au-target (3.0 mg/cm^2, diameter = 7 mm), 3) Conical Ni-window (9.0 mg/cm^2, angular acceptance from 40 to 70 degrees), 4) He-inlet, 5) Stopping volume, 6)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

This chamber was tested in on- and off-line conditions at the Jyväskylä IGISOL facility. The ^{197}Au(^{65}Cu,*X*)*Y* reaction was used in the on-line experiment. The 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-window, see Fig. 1. 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. This intrinsic efficiency is comparable to the one reported in [2] for the Heavy Ion-Guide Isotope Separator On-Line system (0.5 %). Figure 2 shows a part of the beta-gated gamma spectrum of A = 63. The 87 keV gamma-transition belonging to the beta-decay of ^{63}Co is clearly seen.

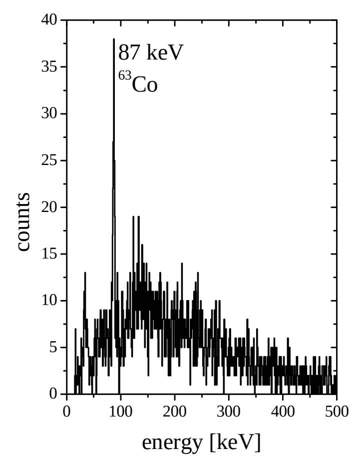

Fig. 2. Part of the beta-gated gamma spectrum at A = 63.

In the future, both of the discussed physical/chemical loss mechanisms can be suppressed by introducing Ar as 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 about a factor of 100, making this overall approach to the study of neutron-rich nuclei really attractive. For more information concerning this project see [3]. See also [4] for an operational gas catcher laser ion source.

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