Measurement of Spallation Residues using Inverse Kinematics at GSI

T. Enqvist[a,g], P. Armbruster[a], J. Benlliure[a,e], M. Bernas[c], A. Boudard[b], E. Casarejos[e], J.P. Dufour[d], S. Czajkowski[d], R. Legrain[b], S. Leray[b], B. Mustapha[c], M. Pravikoff[d], J. Pereira[e], F. Rejmund[a,c], K.-H. Schmidt[a], C. Stéphan[c], J. Taieb[a,c], L. Tassan-Got[c], C. Volant[b], W. Wlazło[b,f]

[a] *GSI, Planckstraße 1, D-64291 Darmstadt, Germany*
[b] *DAPNIA/SPhN CEA/Saclay, F-91191 Gif sur Yvette, France*
[c] *IPN Orsay, IN2P3, F-91406 Orsay, France*
[d] *CENBG, IN2P3, F-33175 Gradignan, France*
[e] *University of Santiago de Compostela, E-15706 Santiago de Compostela, Spain*
[f] *Jagellonian University, Institute of Physics, 30-059 Kraków, Poland*
[g] *University of Jyväskylä, Department of Physics, FIN-40351 Jyväskylä, Finland*

Former experimental techniques to study isotopic cross sections of primary residues from spallation reactions of high-energy protons with heavy nuclei were restricted to only a few nuclides. Mainly cumulative yields, resulting from beta decay of the primary reaction products, were determined.

Inverse-kinematic reactions by bombarding a liquid-hydrogen target with relativistic heavy ions give an access to all produced primary residues. The reaction products are identified in atomic number and in mass using a recoil separator. This technique is also capable of giving important information on the reaction kinematics and the velocities of the reaction products.

Spallation reactions have recently gained considerable interest due to their importance in technical applications. They can, for example, be used for the productions of neutrons in spallation sources, and they can act as an intense neutron source in accelerator-driven subcritical reactors, capable of incinerating nuclear waste and/or producing energy. In the next-generation radioactive-beam facilities, the projectile fragmentation at relativistic energies has been proposed as one of the major production methods. Reliable information on the production cross sections of individual isotopes in ISOL-type devices, widely-used method for radioactive-beam production, can also be obtained by inverse-kinematic experiments.

Nuclide production cross sections of primary residues and their kinetic energies have been experimentally measured at GSI in Darmstadt, Germany using the fragment separator FRS for systems ^{197}Au (0.8 AGeV) + p, ^{208}Pb (1 AGeV) + p,d and ^{238}U (1 AGeV) + p,d. For the first time, it was possible to study all nuclides produced by high-energy proton or deuteron induced reactions with heavy targets. Each mentioned reaction produces almost 1000 isotopes above 0.1 mbarn.

An extensive amount of experimentally measured data will be shown. The data are final for ^{197}Au and ^{208}Pb projectiles, and preliminary for ^{238}U reactions. Moreover, a brief comparison with currently used models will be shown.