MeV Neutral atom beam generation

S. Ter-Avetisyan\textsuperscript{1,2}, Abicht\textsuperscript{3}, M. Borghesi\textsuperscript{4}, R. Prasad\textsuperscript{4}, G. Priebe\textsuperscript{3}, J. Braenzel\textsuperscript{3}, A. Andreev\textsuperscript{3}, P.V. Nickles\textsuperscript{3}, M. Schnürer\textsuperscript{3}, S. Jequier\textsuperscript{5}, and V. Tikhonchuk\textsuperscript{5}

\textsuperscript{1}Center for Relativistic Laser Science, Institute for Basic Science (IBS), Gwangju, Korea
\textsuperscript{2}Department of Physics and Photon Science, GIST, Gwangju, Korea
\textsuperscript{3}Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Berlin, Germany
\textsuperscript{4}School of Mathematics and Physics, The Queen’s University of Belfast, UK
\textsuperscript{5}Centre Lasers Intenses et Applications, University Bordeaux, CEA, CNRS, France

Nowadays the role of neutral atoms has increased substantially due to their essential in the fusion experiments for additional heating of the plasma based on the injection of powerful beams of neutral atoms into pre-heated plasma. The way to generate powerful neutral beams of fast atoms is to produce large amounts of positive and negative ions, then to accelerate them and finally to neutralise the beam. However, the efficiency is very low.

In the present paper we are demonstrating the efficient production of neutral atom beams from MeV positive ions in the electron capture and loss processes, where the energy and momentum of the particle is preserved. Efficient generation of neutral hydrogen, carbon and oxygen atom beams have been demonstrated. The process is rather general and different neutral atom beams can be generated.

We will discuss the physical aspects of the phenomena and open problems. Comprehensive analyses of the experimental findings indicate a substantial difference between the existing data of the energy dependant cross sections of these processes and our measurements. However, the process has high conversion efficiency. At the moment we do not have clear explanation for that, but it suggests that the processes are more complex than the considered single electron capture and loss: for example, contribution of multiple electron capture or loss processes, the shell effects in the electronic structure of the projectile ion and/or target atoms may influence the probabilities of electron capture and loss in subsequent collisions.

Substantial work would be required for sophisticated model analyses in order to better understand the dynamics involved in the electron transfer processes. Until such a model is available, the present experiments open a possibility for measuring the cross sections of electron capture and loss processes to benchmark future theories.