Incorporation of an Ion Post Stripper at the NCSR Demokritos Tandem Accelerator within the APAPES Initiative*

E.-M. Asimakopoulou[1], I. Madesis[2,3], T. J.M. Zouros[2,3], T. J. Mertzimekis[1], A. Lagoyannis[3], M. Axiotis[3]

[1]Department of Physics, University of Athens, Zografou Campus, 15784, Athens, Greece.
[2]Department of Physics, University of Crete, P.O. Box 2208, 71003, Heraklion, Greece.
[3]Institute of Nuclear Physics, NCSR "Demokritos", P.O. Box 60228, 153.10 Aghia Paraskevi, Athens, Greece

Abstract

The APAPES research group focuses on atomic physics experimental research using accelerators, and works specifically on projectile electron spectroscopy. The experiments will be carried out at the TANDEM accelerator of the NCSR "Demokritos".

In view of the nature of the experiments that will be performed, it was considered necessary to incorporate a second stripping point along the beam line of the setup. Therefore a post-stripping unit will be constructed and placed in the beam line, with the purpose of allowing selection of either foil or gas stripping of the ion beam that will be used.

Together with the poststrippers, a charge state analysis code will be used to predict charge distribution after stripping and aid with optimal charge selection. Nikolaev-Dmitriev's [1], Sayer's [2] and other more recent formulas [3,4] particularly applicable to lighter Z-ions, such as Li to F (of primary interest to this project) will be used to derive the predictions.

Motivation

The research initiative APAPES is presently setting up a new experimental station at the 5.5 MV TANDEM of the National Research Center "Demokritos" with a dedicated beam line for atomic collisions physics research. The main purpose of the experiment is to perform high resolution studies of electrons emitted in highly charged ion-atom collisions and explore their excitation mechanisms as a function of collision energy.
Of particular interest are He-like ions, which will require the incorporation of a post-stripping unit into the existing beam line in order to enhance their production.

Experimental Setup

In a standard beam line as the propagation occurs there are two main stripping points:

- The 1st is in the Tandem Accelerator itself at the *tandem terminal* and of fundamental use in all Tandems,
- The 2nd takes place after acceleration by the Tandem, and typically placed between the analyzing and the switching magnets [Fig. 1].

Fig.1: Schematic of beam propagation

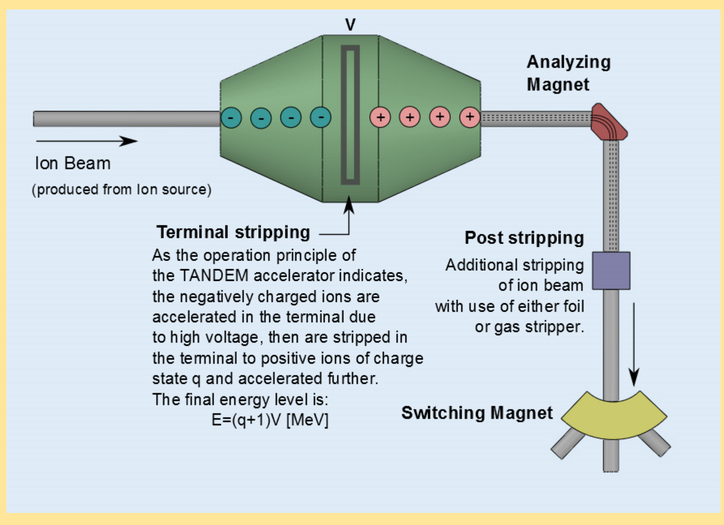
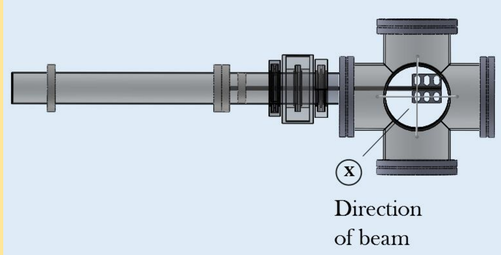


Fig.2: Representation of incorporated foil stripper



The post-stripping unit will be designed so as to support both a carbon foil stripper and/or a gas stripper.

Either one can be selected as needed while running the experiment. [Fig. 2].

Charge-State Analysis Code

A charge state analysis code is being developed for the calculation of the expected charge states intensities resulting from the final stripping. The program uses the semi-empirical formulas of Nikolaev-Dmitriev, Sayer and Betz along with the energy of the beam, its characteristics (Z, atomic mass) and incoming charge state.

These formulas are used to predict the mean charge parameter (q_{∞}) that will result from the interaction of the beam with the gas or foil stripper due to electron loss and capture effects that take place and the width parameter (b) of the equilibrium charge distributions, which can be represented by a Gaussian distribution.

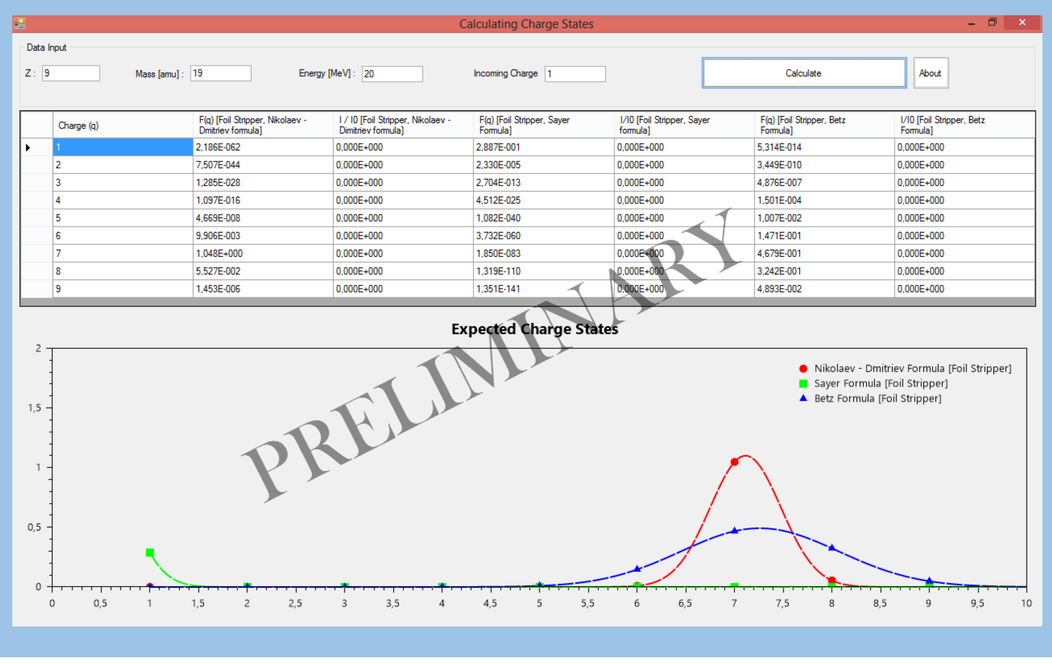
The mentioned formulas have different range of Z values at which their use is optimized [Table 1].

Table 1: Formulas used for calculating charge states present in the beam

Formulas	Stripping Medium	Z	MeV/A
Nikolaev - Dmitriev	Carbon	medium/high	few MeV/A
Sayer	Carbon or Gas	> 36	wide range
Betz	Carbon	medium/high	few MeV/A

A preliminary version of the analysis code for F is presented in [Fig. 4].

Fig.4: Preliminary program outline



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