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Permanent Magnet ECR Ion Source and LEBT Dipole for Single-Ended Heavy Ion ToF-ERDA Facility

We present the status of the ion source and low energy beam transport prototyping activities for a single-ended heavy ion time-of-flight elastic recoil detection analysis (ToF-ERDA) equipment for depth profiling of light elements. The environmentally friendly concept is based on a permanent magnet ECR ion source and dipole magnet on a 500 kV platform without SF_6 insulation, producing high charge state noble gas ion beams, e.g. 3-6 MeV argon. We report experimentally measured argon beam currents achieved with the CUBE-ECRIS permanent magnet minimum-B quadrupole ion source [1, 2], demonstrating ion fluxes of Ar^{6+}-Ar^{12+} in excess of 1-10 particle nA required for the low energy ToF-ERDA application. It is shown that the CUBE-ECRIS can produce over 1 particle nA krypton and xenon beams up to charge states Kr^{19+} and Xe^{24+}, which opens the door to extending the ToF-ERDA application to depth profiling of thin films containing heavier elements. Methods, such as increased microwave power and improved low energy beam transport, to reach higher charge states and final beam energies of these noble gas ions are outlined. Furthermore, we present the design, construction and validating field measurements of an adjustable-field permanent magnet 90 degree dipole prototype [3], completing the front-end of the envisioned ToF-ERDA facility. Finally, the status of the dipole magnet's integration into the CUBE-ECRIS test stand at the JYFL accelerator laboratory is described.
[1] T. Kalvas, O. Tarvainen, V. Toivanen, H. Koivisto, J. Instrum. 15, P06016 (2020).
[2] T. Kalvas et al, Plasma Sources Sci. Technol. 31 12LT02, (2022).
[3] O. Tarvainen et al, Nucl Instrum Methods Phys Res B 538, (2023), pp. 110-114.

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