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Calibration of a neutral particle beam source with the novel Absolute Beam Monitor

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The energetic neutral atom detection instrument IMAP-Lo is part of the scientific payload of the upcoming Interstellar Mapping and Acceleration Probe (IMAP) mission by NASA and is designed to analyse interstellar neutral and heliospheric Energetic Neutral Atom fluxes and their composition for energies from 1000 eV down to 10 eV. IMAP is dedicated to extend our knowledge of the local interstellar medium (LISM) and its interaction with the solar magnetic field and the heliosphere. Most importantly, H, He, O and Ne ENAs will be analysed.

Calibration and testing of IMAP-Lo is planned in MEFISTO, a unique laboratory test facility for ion and neutral particle instruments at the University of Bern, which can provide the required neutral atom beams. In MEFISTO we have a microwave-induced plasma ion source for beam energies up to 100 keV/q. The ion beam can be converted to a neutral beam in the energy range 10 eV – 3 keV with a removable ion beam neutralizer with decelerating the ion beam first and subsequent neutralisation via surface reflection. It comes with an estimated beam energy reduction of 15 % and energy-dependent transmission. The neutral beam flux into the test chamber therefore depends on the ion beam energy, intensity and species. To improve the calibration process for ENA space instruments such as IMAP-Lo, it is important to measure the neutral beam flux and energy in the test facility.

The Absolute Beam Monitor (ABM) is a novel laboratory device developed for absolute neutral particle flux measurements and energy determination of neutral atom beams. The ABM takes advantage of secondary electron emission during surface scattering of incident neutral atoms off a highly polished tungsten plate. The effective rate of neutrals is inferred from detecting secondary electrons and reflected atoms in two electron multipliers as well as its coincidence signal rate. Time difference of the two signals yields the neutrals energy. To date, the ABM is the only device to measure absolute fluxes of neutral atoms in this energy range.

Measurements of the neutral beam source in MEFISTO have been performed for several species using the ABM to determine the relation between the effective neutral atom flux and the primary ion beam current at the charge conversion surface, as well as the neutral beam energy, for ion energies from 1000 eV down to 10 eV.