Application of a linear TOF mass spectrometer for the investigation of impact ionization

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Abstract. Impact physics plays an important role in a variety of field such as investigation of matter at extreme pressures and temperature, shock waves in solid bodies or planetology and cosmic dust research. The processes of interest are the generation of impact plasma, neutrals, secondary ejecta, and electromagnetic (EM) radiation.
To relate the measured valued resulting from in hypervelocity impact experiments with the impact parameters (speed, mass, composition) for individual particles a comprehensive set of experiment is needed with well known experimental conditions[1].

The characteristics of the impact plasma[2], such as the velocity distribution of the ions and the ion appearance in the mass spectra, can be analyzed with a linear TOF mass spectrometer. Here, the combination of velocity and angular distributions of the ions results in a broadening of the mass lines[3], determining their shapes. To study the distribution of the ion velocities alone, we developed an optimized narrow aperture mass spectrometer (Fig.1). The simple set up and the almost homogenous fields allow to calculate the flight times due to the known response function of the instrument. The measured mass line profile can be inverted for the distribution of initial velocity and subsequently the initial kinetic energies of the ions as shown in Fig.1.
This allows to investigate the thermodynamical properties of the ions leading to a deeper understanding of impact ionization and the behavior of matter under extreme conditions[4].

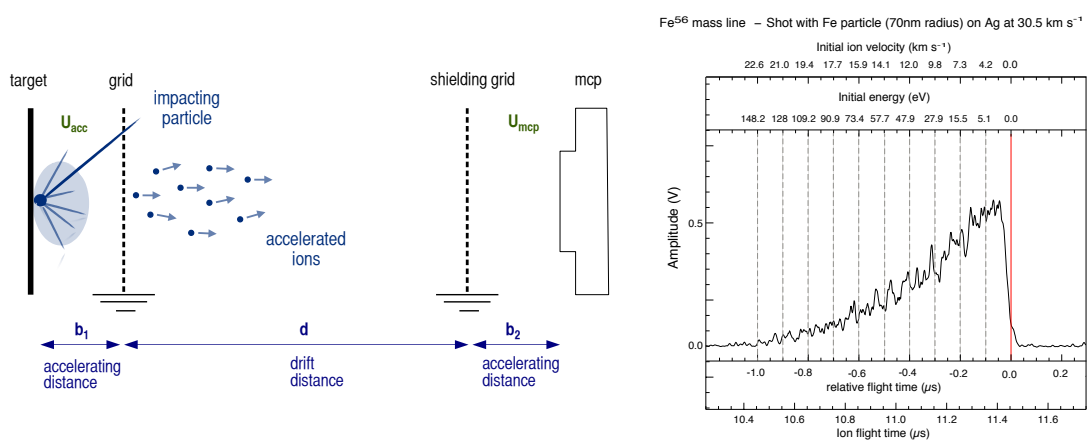

Fig. 1 (left) Schematic of the TOF mass spectrometer . (right) Shape of the ^{56}Fe mass line (Fe on Ag at of 30.5km s^{-1}).

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