As an extension of the work described previously [1], cross sections for projectile electron loss and target ionization were measured for 2.3 MeV/amu and 4.8 MeV/amu Ne\(^{2+,3+,4+}\) ions interacting with Ar and Xe gas targets. The idea behind this method is to extend the measurements for “low” charge state heavy projectiles to higher energies by reversing the roles of the projectile and the target, i.e., by studying fast light ion impact ionization of heavy neutral targets. Thus, in the reverse collision, electron loss from neutral Ar and Xe “projectiles” occurs when they impact Ne “target” ions. Cross sections for the collisions involving a neutral projectile and a neutral target can be extrapolated based on the measured projectile charge dependence.

This work consisted of two parts. First, absolute cross sections for electron loss from Ne\(^{2+,3+,4+}\) ions were measured. Then, ionization of the target (Ar or Xe) was detected in coincidence with the outgoing neon ions. In this part of the experiment, information about pure target ionization is obtained from coincidences with a projectile that has not changed its charge state, while information about simultaneous ionization of both collision partners is obtained from coincidences with projectiles which have lost 1,2,3, etc. electrons. Combining the measured yields with the absolute target density, the length of the target gas from which target ions are extracted, the extracted ion transmission and detection efficiencies, and the detection efficiencies for the projectile ions allows us to determine absolute cross sections.

Recoil ions produced in the gas cell were accelerated into a 15 cm long flight tube of a time-of-flight (TOF) spectrometer by an electric field directed perpendicular to the projectile ion beam. Two acceleration stages were used in order to provide space focusing. Upon reaching the end of the flight tube, the recoil ions were accelerated into a microchannel plate detector, 40 mm in diameter. Typically, the pressure inside the gas cell ranged between 2 and 4 mTorr and was maintained at a constant value by means of an automatic valve and a capacitance manometer. This pressure range was sufficiently low to effectively suppress double-collision events.

Signals from the recoil ion detector were used to start a time-to-amplitude converter (TAC), while delayed timing signals from the projectile ion detector were used to stop it. The TOF signals generated by the TAC were then digitized by a CAMAC analog-to-digital converter, along with the position signals derived from those generated by the projectile ion detector using a dual sum/inverter and position sensitive detector analyzer. The data were recorded event-by-event using a personal computer running customized data acquisition software.

Results for 4.8 MeV/amu Ne\(^{2+}\) - Ar collisions (shown in Fig. 1 below) indicate that collisions in which the projectile loses electrons are more efficient at removing large numbers of target electrons than collisions in which the projectile remains un-stripped (pure target ionization). Moreover, target and projectile ionization cross sections are found to be roughly identical. However, it should be noted that the target ionization cross section values presented here are preliminary, as the detection and transmission efficiencies are still under investigation. Based on the measurements with Ne\(^{2+}\), Ne\(^{3+}\), and Ne\(^{4+}\), it was...
found that with increasing projectile charge, target ionization cross sections increase while projectile electron loss cross sections decrease.

References