BEAM REJECTION CONSIDERATIONS OF THE RECOIL MASS SPECTROMETER

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The Recoil Mass Spectrometer (RMS) has superior beam rejection capabilities with moderately large solid angle, energy, and mass-to-charge ratio acceptances. The amount of rejection is dependent upon many things including vacuum pressure, target thickness, and reaction kinematics. Reaction kinematics is the dominant factor in most situations involving the RMS. A purely magnetic separator transmits ions which fall within the acceptances based on the equation

$$K = mass * energy/charge * *2$$

where the mass, energy, and charge values are given for the central ion trajectory. With the inclusion of electrostatic elements, a further condition based on energy and mass-to-charge ratio is produced. Clearly, many ions with different masses, energies, and/or charge states may be transmitted through some part of the spectrometer.

In recoil separator experiments, unreacted beam particles undergo stripping in the target foil resulting in a charge state distribution higher than that of the original beam. Those beam particles which do not fall within the K-acceptance of the device are dumped at area (1) in Fig. 1 for the RMS and area (2) for those devices which do not have a momentum separator before the mass separator. The resulting spray of ions from these beamdumps has a large distribution of energies and charge. The difference in location is significant since the many ion optic elements of the HRIBF RMS now conspire to stop the beam deposited at (1) from ever reaching the focal plane. If the beam particles are deposited at area (2), the separator will transmit some fraction of these ions to the focal plane and a large random background will result.

If the parameter K of the central ion and some beam particles are similar, the RMS, which has a ± 10 % K-acceptance, will transmit the ions though the device until they reach the magnetic dipole D3. This magnet selects the mass-to-charge ratio which is finally transmitted to the focal plane. The unwanted beam particles are directed into the anode of the electrostatic dipole which is marked with (3). With few magnetic elements in front of the focal plane, many beam particles will be transmitted to the focal plane. This effect is common to most separators, including the RMS. The fingers located inside of Q3, are intended to reduce this background by blocking these beam particles at the momentum focal plane. The assumption is that these particles still have a very narrow momentum distribution after passing through the target. Finger calibration is not yet completed.

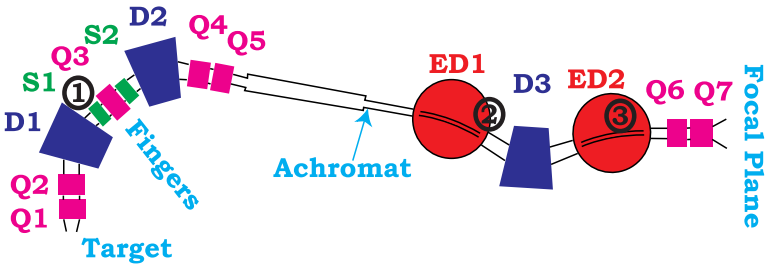

Figure 1: A schematic of the RMS. Areas (1) and (3) are the places where primary beam are usually deposited inside the RMS. Areas (2) and (3) are places where beam is deposited in similar mass spectrometers which do not have a momentum separator . The RMS achieves superior beam rejection by moving the first beamdump away from the final focal plane.

References

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