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Multi-Electron Emission from Projectile Ionization of U28+Ions at Relativistic Velocities in Heavy-ion Storage Rings Letter of Intent (LOI) for Continuation Request for Proposal E117

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We propose to follow up on our previous study E117 of the dynamics of the projectile ionization for multi-electron heavy ions with near relativistic velocities
U28+ + A ⟶ U(28+n)+ + {A+*} + n e-(≈00-cusp)
by developing instrumentation for coincident detection of upcharged Uq+(29<q<45) inside the dipole following the jet target. This module is based on successful position sensitive solar cell particle detectors developed currently by B Jurado and J Glorius. This new detector inside the dipole then allows measuring coincidences between forward cusp electrons in the 00-electron spectrometer and the charge exchanged Uq+ projectiles. We will compare single and multiple forward electron continua originating from projectiles of relevance for accelerator technology, e.g. low charged U28+(...4f145s25p2).
The very strong and target Z dependent asymmetry of the electron loss to continuum (ELC) cusp which we found in our first non-coincident experiment with U28+ in the ESR, E117, clearly indicates that for these collision systems first order Born theories are not applicable; this entails potentially significant uncertainties in current predictions of beam lifetimes in future FAIR facilities. Therefore, we propose to expand the study of ELC cusp asymmetries by focussing on their dependence on the electron emission multiplicity. The coincidence techniques needed here is only now possible in the ESR as newly developed 2D PSD solar cell detector arrays have been successfully developed by Jurado and Glorius; this will enable identifying the upcharged projectiles after the collision on the inside of the magnetic dipole chamber following the target.

The differential cross sections (DCS) for electron emission with well-defined multiplicity distinguish one-electron processes from theoretically not yet understood multi-electron processes, which, however, are strongly contributing in the projectile ionization of U28+ .These DCS will present necessary benchmarks in the decidedly non-Born regime for generating dependable cross sections beyond first Born approximation for calculating beam lifetimes required for accelerator design and FAIR facilities. They will in particular permit, to our knowledge, the first and stringent tests for ab initio higher order theories in the strong perturbation regime, beyond the estimation of total cross sections given by current first order theories, which are applied far outside their range of validity.

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