Impact parameter sensitive study of inner shell atomic processes at the ESR*

A. Gumberidze[1], *C. Kozhuharov*[1], *R. Zhang*[1], *S. Trotsenko*[1,2], *H. F. Beyer*[1,2], *K.-H. Blumenhagen*[2,3], *C. Brandau*[1,4], *A. Bräuning-Demian*[1], *W. Chen*[1], *O. Forstner*[2,3], *B. Gao*[1], *T. Gassner*[1], *R. Grisenti*[1,5], *S. Hagmann*[1,5], *P.-M. Hillenbrand*[1], *P. Indelicato*[6], *A. Kumar*[7], *M. Lestinsky*[1], *Yu. A. Litvinov*[1], *N. Petridis*[1], *D. Schury*[1,4], *U. Spillmann*[1], *C. Trageser*[1,4], *M. Trassinelli*[8], *X. Tu*[1], *and Th. Stöhlker*[1,2,3]

[1]GSI Darmstadt, Germany; [2]Helmholtz Institute Jena, Germany; [3]Friedrich-Schiller-Universität Jena, Germany; [4]Justus-Liebig-Universität Giessen, Germany; [5]Goethe-Universität-Frankfurt, Germany; [6]ENS, CNRS, UPMC, Paris, France; [7]NPD, Bhabha Atomic Research Centre, Mumbai, India; [8]INSP, CNRS and UMPC, Paris, France

In this contribution, we present a further experiment from our program devoted to impact parameter sensitive studies of inner shell atomic processes for heavy atomic systems [1, 2] at the experimental storage ring (ESR). As compared to the previous measurement [3] whose conclusions were somewhat limited by the relatively poor statistics, in the current experiment we were able to clearly demonstrate the possibility of picking out the characteristic x-rays stemming from the close collisions only.

The experiment was performed with bare and He-like xenon ions (Xe^{54+}, Xe^{52+}) colliding with neutral xenon gas atoms, resulting in a symmetric collision system. This choice of the projectile charge states was made in order to compare the effect of a filled K-shell with the empty one. The final beam energy (for both charge states) was 50 MeV/u. This value of the beam energy was chosen as a compromise between the adiabaticity of the collision and the reasonable beam lifetime/intensity in the ESR after deceleration. Although the energy is not very low, one can still expect significant non-perturbative effects due to the heavy target. In order to obtain information concerning the impact parameter and, in particular to pick out close collisions which are especially important for observing quasi-molecular effects, the scattered projectile ions which had undergone close collisions with the target atoms were detected by a particle detector (plastic scintillator) mounted in a specially constructed movable pocket at ∼3.5 m downstream from the target. In the measurement position, the particle detector was covering the projectile scattering angles from ∼0.5 - 1.0° which, for the present collision system, corresponds to an impact parameter range of ∼35 - 70 fm. In addition to the detector for the scattered projectiles, the x-rays emitted from the interaction zone were observed by an array of detectors mounted at different angles with respect to the ion beam direction. Figure 1 (top part) shows a raw x-ray spectrum for the bare xenon ions recorded by a Ge(i) detector mounted at an observation angle of 35°. Transitions into the K-shell of H-like xenon due to the electron transfer from the target are clearly seen, together with the K-shell radiation of the target atom due to ionization of the corresponding shell. The inset displays the coincidence time spectrum between the x-rays (detected by the detector mounted at 35° observation angle) and the scattered projectiles. In addition, in the bottom part, we display the corresponding coincident x-ray spectrum containing only the x-rays detected in prompt coincidence with the scattered projectiles, i.e. stemming from the close collisions. One can clearly see a dramatic reduction of the projectile Kα radiation in the coincident spectrum. The data analysis is still in progress.

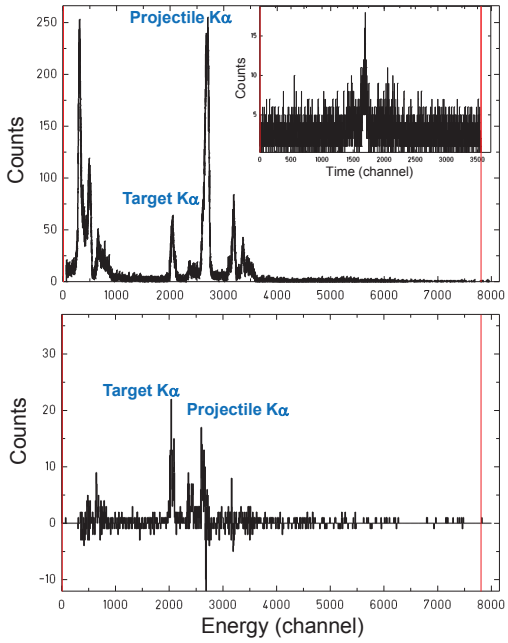

Figure 1: Preliminary results: (top) a singles x-ray spectrum for $Xe^{54+} \rightarrow Xe$ collisions at 50 MeV/u, recorded by the Ge(i) detector at 35° observation angle. (bottom) coincident x-ray spectrum containing only the x-rays detected in prompt coincidence with the scattered projectiles.

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References

[1] Dorin-Cezar Ionescu and Thomas Stöhlker Phys. Rev. A 67 (2003) 022705.

[2] F. Bosch, in W. Greiner (ed.) Quantum electrodynamics of strong fields, Plenum Press, New York, 1983, p. 155.

[3] A. Gumberidze et al., GSI Scientific Report 2011, GSI 2012-1, p. 367.