FOCAL – X-RAY SPECTROSCOPY FOR QED IN STRONG FIELDS *

H.F. Beyer[1], D. Banaś[2], K.-H. Blumenhagen[1], F. Bosch[1], C. Brandau[1], W. Chen[1], Chr. Dimopoulou[1], E. Förster[3,8], T. Gaßner[1], A. Gumberidze[4], S. Hagmann[1,5], R. Heß[4], P.-M. Hillenbrand[1], P. Indelicato[6], P. Jagodzinski[2], T. Kämpfer[8], Chr. Kozhuharov[1], M. Lestinsky[1], D. Liesen[1], Yu.A. Litvinov[1], R. Loetzsch[8], B. Manil[7], R. Märtin[8], F. Nolden[1], N. Petridis[4,5], M.S. Sanjari[1], K.S. Schulze[8], M. Schwemlein[1], A. Simionovici[10], U. Spillmann[1], M. Steck[1], Th. Stöhlker[1,8,c], C.I. Szabo[6], M. Trassinelli[10], S. Trotsenko[8], I. Uschmann[3,8], G. Weber[8], O. Wehrhan[3,8], N. Winckler[1], D. Winters[1], N. Winters[1], and E. Ziegler[11]

[1]GSI Helmholtzzentrum, Darmstadt, Germany; [2]Institute of Physics, Swietokrzyska Academy, Kielce, Poland; [3]Inst. für Optik und Quantenelektronik, F. Schiller-Universität, Jena, Germany; [4]Extreme Matter Institute, EMMI, GSI Helmholtzzentrum, Darmstadt, Germany; [5]Institut für Kernphysik, Goethe-Universität, Frankfurt am Main, Germany; [6]Lab. Kastler Brossel, Université P. et M. Curie, Paris, France; [7]Laboratoire de Physique des Lasers (LPL) UMR 7538 CNRS - Université Paris 13, Villetaneuse, France; [8]Helmholtz-Institut Jena, Jena, Germany; [9]LGIT, Observatoire des Sciences de l'Univers de Grenoble, Grenoble, France; [10]Institut des Nanosciences de Paris, Université Pierre et Marie Curie-Paris 6 and CNRS-UMR 7588, Paris, France; [11]ESRF, Grenoble, France

The goal of the present experiment is to access the quantum-electrodynamic (QED) contributions to the 1s binding energy in a heavy one-electron system in order to provide an accurate comparison with the most advanced QED calculations taking into account also two-photon exchange.

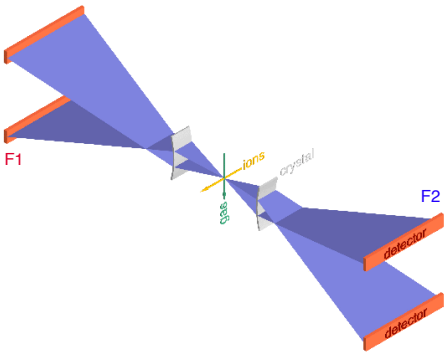

Figure 1: The Bi-FOCAL crystal-spectrometer arrangement at the ESR gas jet.

For this purpose the twin crystal-spectrometer assembly, Bi-FOCAL, operated in the FOcusing Compensated Asymmetric Laue geometry has been arranged for accurate x-ray spectroscopy at the ESR gas jet as schematically depicted in figure 1 [1]. Each spectrometer was equipped with one 2D position-sensitive Ge strip detector, F1 and F2. In May 2012, a major production run (E039) was conducted and the Lyman-α transitions of hydrogen-like Au^{78+} were measured in high resolution via spectroscopy of the corresponding x rays located near 63 keV in the laboratory system. Bare gold ions were stored in the ESR at a velocity corresponding to $\beta \approx 0.47$ and the x rays were measured in coincidence with ions undergoing single-electron capture in the argon gas target and being deflected into a particle detector by the bending magnet dowstream the gas jet. It could be demonstrated that the newly developed crystal optics in concert with the position sensitive detector can cope with the low count-rate situation encountered. Background could be effectively reduced, by proper shielding facilitated by the existence of a polychromatic focus and by making use of the time and energy resolving capabilities of our detectors.

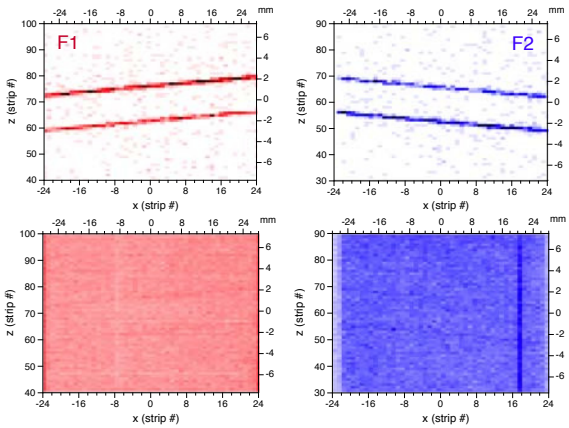

Figure 2: Lyman-α doublet of Au^{78+} recorded with the two 2D Ge strip detectors: *Bottom* – without, *top* – with energy and time discrimination in effect.

Figure 2 shows two-dimensional images of the Lyman-$\alpha_{1,2}$ doublet of hydrogen like Au^{78+} impressively revealing the low background when energy and time discrimination is in effect. The slanted lines observed are consonant with the underlying x-ray-optical design. This way spectral resolving power can be retained also for fast moving sources. Coming in pairs the x-ray optics provide Doppler cancellation capabilities. Data analysis is still in progress.

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