Diagnostics of laboratory plasmas with the high resolution XRS instrument at the EBIT-I facility: a critical tool for understanding spectral signatures of x-ray emitting astrophysical sources

F. S. Porter* P Beiersdorfer† G. V. Brown†
K. R. Boyce* H. Chen† R. L. Kelley*
C. A. Kilbourne* M. F. Gu‡ S. Kahn‡

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Abstract

The X-ray Spectrometer (XRS) instrument is a revolutionary non-dispersive spectrometer that was developed for the Suzake (Astro-E2) observatory. We have installed a flight spare XRS detector array in a laboratory cryostat and deployed it as a unique diagnostic spectrometer at the Electron Beam Ion Trap facility (EBIT I) at Lawrence Livermore National Laboratory. The XRS microcalorimeter is an x-ray detector that senses the heat deposited by the incident photon in a high Z absorber. It achieves a high energy resolution by operating below 0.1K and by carefully controlling the heat capacity and thermal conductance of each detector. The XRS/EBIT instrument has 32 pixels in a square geometry and achieves an energy resolution of 6 eV at 6 keV, with a bandpass from 0.1 to over 60keV. The instrument allows detailed studies of the x-ray line emission of laboratory plasmas. This provides critical diagnostics for x-ray emission models including absolute cross sections for L shell transitions, verification of thermal emission models of, for example, K shell Fe, and charge exchange interactions between a hot plasma and a cold target. These measurements are critical for guiding and verifying plasma codes used to interpret the high resolution spectra from the Chandra, XMM, and Suzaku observatories and will form the basis for the scientific interpretation of data from the Constellation-X observatory. We will discuss the current state of the instrument, near term significant upgrades, and some of our recent measurements. The authors wish to thank NASA's APRA program for funding this work.

*NASA/GSFC Greenbelt, MD
†Lawrence Livermore National Laboratory, Livermore, CA
‡Stanford University, Stanford, CA