Time-resolved spectroscopy for Z stellar opacity research

G. P. Loisel[1], J. E. Bailey[1], T. Nagayama[1], S. B. Hansen[1], G. S. Dunham[1], P. D. Gard[1], A. P. Colombo[1], A. D. Edens[1], R. Speas[1], Q. Looker[1], M. Kimmel[1], J. Stahoviak[1], J. L. Porter[1], E. C. Harding[1], G. A. Rochau[1], C. J. Fontes[2], C. Blancard[3], Ph. Cossé[3], G. Faussurier[3], F. Gilleron[3], J.-C. Pain[3], D. Aberg[4]

[1]Sandia National Laboratories, Albuquerque, New Mexico 87185, USA
[2]Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA
[3]CEA, DAM-DIF, Arpajon, F-91297, France
[4]Lawrence Livermore National Laboratory, Livermore, California 94550, USA

Time-resolved spectroscopy using a novel hCMOS Ultra-fast X-ray Imager (UXI) is transforming stellar interior opacity measurements at the Sandia Z facility. Calculated opacities disagree with measured opacities [Bailey et al. Nature (2015), Nagayama et al. PRL (2019)], which questions the accuracy of calculated opacities used for the solar interior. The novel time-resolved data help to resolve this dilemma in three unprecedented ways. First, time-resolved measurements of the backlighter history, sample evolution, together with calculated opacities at each time step allows us to assess how temporal integration have affected the published, film-based results. These tests show that the temporal integration cannot explain the reported discrepancy. Second, measurements of the sample temperature and density evolution refine our understanding of the Z opacity platform and enable improved experimental design. Third, Sandia's UXI technology enables measurements of iron opacities at multiple conditions from a single experiment. This not only increases the number of opacity measurements per experiment but also allows to study how opacity changes with conditions from a single experiment. In this presentation, I will summarize the results on sample evolution in Fe experiments as well as progress towards the first extraction of absolute *time-resolved* opacity and remaining challenges to obtain that goal.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

* E-mail: gploise@sandia.gov