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X-Ray Spectroscopy of Laser-Produced Al Plasma near the Target Surface in a Laser Ion Source

The spatially-resolved X-ray spectrum of laser-produced Al plasma near the target surface has been obtained in the energy range of 1.5-2.2 keV using a compact flat crystal spectrometer. The widely-used temperature and density diagnostics, the line ratios of $\text{Ly}\alpha/\text{He}\beta$ and $\text{IC}/\text{He}\alpha$, were measured and compared with the calculation results of a steady-state collisional-radiative model, so that the temperature and density profiles with a spatial resolution of 55 μm were obtained within 200 μm from the target plane. The plasma parameters derived from the spatially-integrated spectrum were used to calculate the ionization state distribution near the target surface with the steady-state model and the result was compared with the ion charge state distribution measured with an Electrostatic Ion Analyzer (EIA) at the distance of 4.2 m from the target surface. The validity of the steady-state model is discussed, as well as the difference between the calculated ion charge state distribution and that measured with the EIA.

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Email Address

luyt@impcas.ac.cn

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Presenter if not the submitter of this abstract

Primary author: LU, Yuting (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: Dr SHAO, Caojie (Institute of Modern Physics, Chinese Academy of Sciences); Mr ZHANG, Junjie (Institute of Modern Physics, Chinese Academy of Sciences); Mr AN, Longfei (Institute of Modern Physics, Chinese Academy of Sciences); SUN, Liangting (Institute of Modern Physics, Chinese Academy of Sciences); Dr ZHAO, Huanyu (Institute of Modern Physics, Chinese Academy of Sciences); Dr ZHAO, Hongwei (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: LU, Yuting (Institute of Modern Physics, Chinese Academy of Sciences)

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