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Studying relativistic plasmas using the ReLaX laser at HED

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High-energy and high-intensity lasers are essential for pushing the boundaries of science. Their development has allowed leaps forward in basic research areas including laser-plasma interaction, high-energy density science, metrology, biology and medical technology. The HiBEF user consortium contributes and operates two high-peak-power optical lasers at the HED instrument of the European XFEL facility. These lasers will be used to generate transient extreme states of density and temperature to be probed by the X-Ray beam. This contribution introduces the ReLaX laser, a short-pulse high-intensity Ti:Sa laser system, and discusses its characteristics as available for user experiments. As the outcome of internal commissioning experiments, we will show unprecedented synchronization results for a 100 TW class laser and will validate the performance as laser-plasma driver with relativistic $I > 1020 \text{ W/cm}^2$ intensity on target by investigations of TNSA as laser-proton acceleration mechanism. Additionally, we have investigated the effect of EMP and laser generated secondary radiation and particle sources on several x-ray diagnostics, and have developed successful strategies to reduce their impacts. The commissioning of ReLaX is concluded by the successful run of the first user experiment "HED 2621: User community assisted commissioning of the UHI Laser at HED, impact of relativistic plasma environment on x-ray diagnostics". The main goal of 2621 was to validate SAXS, PCI and x-ray spectroscopy on a variety of targets covering a multitude of science cases such as, hole boring, relativistic transparency, fast electron transport along extended target, isochoric heating of buried targets, EOS determination by shocked targets, plasma instabilities in relativistic intensity regime.

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