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New diagnostics development for pump-probe experiments

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Combination of pulsed power lasers and XFEL beams in pump-probe experiments allows deeply look inside into the behaviour of solid materials on the timescale of atomic motion probing ultrafast lattice-level dynamical phenomena and transient states appearing. To obtain high quality data it is necessary to provide monitoring of shock wave strength and stability of shock wave generation, as well as to diagnose initial structure of used targets and homogeneity of XFEL probe beam.

We proposed and tested different methods to control such parameters:

1) Indirect method[1], which allows to estimate the strength of the shock waves driven by pumping laser pulse and allows online monitoring of its reproducibility in each laser shot. This method is based on a shot-to-shot measurement of the x-ray emission from an ablated plasma by means of high resolution FSSR type spectrometer This method was tested in pump-probe experiments at SACLA XFEL facility, when Ti:Sa laser with energy of pulse of 1 J and pulse duration of 660 ps pumped different foils and produced shock waves with strength of ~ 130 GPa.
2) Single shot *in situ* method to control parameters of FEL probe beam parameters. This method based on combination of Fresnel diffraction analysis and micrometer resolution, large dynamic range LiF crystal detector (HR-FDA method). Method allows to evaluate the coherence degree, beam divergence and beam quality factor M^2 using a high spatial frequency imaging.
3) Single-shot transmission imaging method with a LiF detector for control initial quality of pump-probe targets and for observation of macro scale structure transformations in the target under shock wave propagation. This method utilizes diffraction and phase contrast enhancement in images of target material inhomogeneities.

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