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Opportunities and challenges with femtosecond XFEL imaging of matter at extremes

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The advent of x-ray free electron lasers (XFELs) has enabled us to peer into dynamic extreme conditions with unprecedented spatial and temporal resolution. Imaging with these sources has enabled movies of femtosecond to nanosecond dynamics in plasma, planetary and shock physics. Additionally, the high spatial and temporal coherence of XFELs can enable reconstruction of areal densities of the samples under dynamic loading conditions. However, the shot to shot noise introduced by the most common operating mode for XFELs, known as self amplification of spontaneous emission or SASE, make tradition areal density retrieval challenging. In this talk, we we review the state of the art in using XFEL pulses to image matter in extremes and highlight some of the challenges and progress towards single shot areal density reconstruction of samples undergoing laser shockwave interactions.

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