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Creating high energy density matter with intense laser driven proton beams[1]

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The interaction of a high-intensity short-pulse laser with a thin foil target can produce an intense highly directional beam of protons. The laser pulse produces a population of suprathermal electrons, which flood the target and set up an electrostatic sheath field at the rear surface. This highly transient field accelerates ions (predominantly protons) from a thin layer at the rear surface to multi-MeV energies on a timescale of just a few hundred femtoseconds. The properties of this proton beam make it an interesting candidate for application to the creation of high energy density matter. We describe experiments conducted on the 350J Titan Petawatt laser at the Lawrence Livermore National Laboratory and on the 500J Vulcan Petawatt laser at the Rutherford Appleton Laboratory to investigate the utility of laser driven proton beams for creating plasma conditions ranging from the warm dense matter regime of a few eV temperature at solid density, to the highly localized multi-keV hot spot temperatures necessary for proton fast ignition.

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