Abstract Submitted
for the DPP19 Meeting of
The American Physical Society

Experimental Studies of High-Mach-Number Magnetized Collisionless Shocks in Laboratory Plasmas DEREK SCHAEFFER, Princeton University, WILLIAM FOX, AMITAVA BHATTACHARJEE, PPPL, Princeton University, JACKSON MATTEUCCI, Princeton University, GENNADY FIKSEL, U. Michigan, Ann Arbor, CHIKANG LI, Massachusetts Institute of Technology, KAI GERMASCHEWSKI, U. New Hampshire, Durham, DANIEL BARNAK, RUSSELL FOLLETT, DAN HABERBERGER, SUXING HU, Laboratory for Laser Energetics — We review experiments undertaken on the Omega laser facility that study high-Mach-number magnetized collisionless shocks through the interaction of a laser-driven piston plasma and ambient plasma in an external magnetic field. Through time-resolved, 2-D refractive imaging and proton radiography we observe the formation of shocks with an Alfvénic Mach number $M_A \sim 15$ that occur over ion kinetic length scales. Additional measurements with optical Thomson scattering directly demonstrate the shock formation process through the evolution of the piston and ambient ion velocity distributions and their coupling through electric and magnetic fields. We also show particle-in-cell simulations constrained by experimental data that further detail how laser-driven piston plasmas generate magnetized shocks in laboratory plasmas. The results provide key features of the structure of piston-driven shocks and several criteria by which to determine when shocks have formed under laboratory conditions. The development of this experimental platform opens the way for controlled laboratory investigations of high-Mach-number collisionless shocks, including mechanisms of shock heating and particle acceleration.

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Date submitted: 24 Jun 2019 Electronic form version 1.4