Experimental investigation of Weibel-filament growth in the nonlinear regime

Mario J.-E. MANUEL[1], Channing M. HUNTINGTON[2], Frederico FIUZA[3], Gianluca GREGORI[4], Drew P. HIGGINSON[2], Jaehong PARK[5], Brad POLLOCK[2], Bruce A. REMINGTON[2], Hans RINDERKNECHT[2], James S. ROSS[2], Dimitri RYUTOV[2], Youichi SAKAWA[6], Hong SIO[7], Anatoly SPITKOVSKY[5], George SWADLING[2], Hideaki TAKABE[6], Scott WILKS[2], Alex B. ZYLSTRA[8], Hye-Sook PARK[2]

1) General Atomics, USA (San Diego, CA)
E-mail: manuelm@fusion.gat.com
2) Lawrence Livermore National Laboratory, USA
3) Stanford Linear Accelerator Laboratory, USA
4) Oxford University, UK
5) Princeton University, USA
6) Osaka University, Japan
7) Massachusetts Institute of Technology, USA
8) Los Alamos National Laboratory, USA

The Weibel instability is presently the leading mechanism proposed to amplify magnetic fields necessary to form ‘collisionless’ shocks in weakly magnetized astrophysical systems, including young supernova remnants and gamma-ray bursts. These systems rely on the presence of strong self-generated magnetic fields to mediate shock formation since the typical collisional mean-free-path is much larger than the system size. In recent years, experiments at the Omega Laser Facility [1] and the NIF [2] seek to form a purely collisionless shock in the laboratory using counter-propagating plasma flows. The work presented here investigates the development of the Weibel instability in the highly nonlinear regime through experimental variation of the plasma parameters using different ion species and separation distances. Proton imaging is used to visualize magnetic fields amplified by the Weibel instability in these systems, as shown in Figure 1. Our goal is to better understand, through experiment and computation, the underlying physical mechanism that may allow the formation of collisionless shocks in astrophysical objects. Recent experimental and computational results will be presented and discussed.

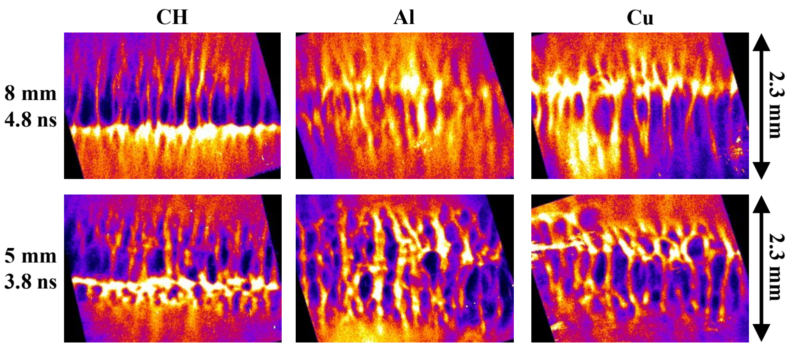

Figure 1: Proton images of Weibel-generated magnetic fields, illustrating the development of nonlinear behavior at smaller separation distances for plastic (CH), aluminum (Al), and copper (Cu) foils.

References

[1] C. M. Huntington *et al.*, Nat. Phys. **11**, 173 (2015)
[2] J. S. Ross *et al.*, PRL **accepted** (2017)