“Extreme Plasmas” 4 Major Opportunities

Challenge 1	Existing Research Capabilities	Gaps	Opportunities
Relativistic Beam Dissipation & Collisonless Shocks	2/3D PIC/Hybrid simulations; Ultra-intense Lasers; Accelerator Particle Beams; Strong (>MG) Pulse Magnets	High-contrast lasers; multi-kJ class PW lasers; lasers with wide spots & uniform wave-fronts; Diagnostics	Fully characterize Weibel-like instabilities using laser and particle beams; Create relativistic shocks with PW lasers; Design “simple” lab experiments to calibrate codes; Form international team to integrate simulations and experiments

4 Major Opportunities

Challenge 2	Existing Research Capabilities	Gaps	Opportunities
Reconnection and Turbulence Cascade in Relativistic Plasmas	2/3D PIC/Hybrid simulations with radiation damping; Ultra-intense Lasers; Accelerator Particle Beams; Strong Magnets	Multiple colliding PW lasers with longer duration and large spots; Diagnostics; Computer simulation capability: multi-scale physics	Create relativistic current sheets and turbulence using laser plasmas; Interface MHD and kinetic codes; Design “simple” lab experiments to calibrate codes

4 Major Opportunities

Challenge 3	Existing Research Capabilities	Gaps	Opportunities
Relativistic Jets	Multi-wavelength astronomical observations; Laser-created e +e- pair jets	Higher pair contents & density; Poynting flux dominated jets; diagnostics; Multi-scale physics in simulations;	Create magnetized relativistic jets with pulse-power and PW lasers; Interface MHD and kinetic codes; Calibrate codes with lab experiments

4 Major Opportunities

Challenge 4	Existing Research Capabilities	Gaps	Opportunities
Pair Plasmas and super-strong magnetic fields	Astronomical observations; laser and accelerator created pair plasmas; laser produced super-gigagauss fields	diagnostics of pairs and fields;plasma & radiation codes including pair & strong field processes; pair confinement and sustained pair production to create “thermal pair-equilibrium fire-balls”	Create strongly magnetized pair plasmas and thermal pair-equilibrium plasmas using multiple PW lasers with long durations; Study photon-bubble instability