

The ZEUS 3 PW laser user facility at the University of Michigan

Karl Krushelnick, Anatoly Maksimchuk, Yong Ma, Paul T. Campbell, John Nees, Brandon Russell, Qian Qian, Bixue Hou, Richard Anthony, Franko Bayer, Milos Burger, Nicholas Ernst, Rebecca Fitzgarrald, Galina Kalinchenko, Tanner Nutting, Gregg Sucha, Richard Van Camp, Lauren Weinberg, Grant Young, Qing Zhang, Carolyn Kuranz, Igor Jovanovic, Alexander G. R. Thomas, and Louise Willingale

University of Michigan, Ann Arbor, Michigan, United States

The Zettawatt Equivalent Ultrashort pulse laser System (ZEUS) at the University of Michigan is a user facility supported by the National Science Foundation. The name ZEUS refers to the collision of a petawatt laser pulse with a GeV energy electron beam, producing the equivalent of a “Zettawatt” power laser interaction (10^{21} Watts) in the rest frame of the electron beam. The facility aims to enable systematic exploration of non-linear quantum electrodynamics (QED) and radiation reaction. The laser will be capable of producing synchronized 2.5-PW and 0.5-PW pulses. The ZEUS target area has been designed to enable two collision geometries: one in which the 2.5-PW pulse drives laser-wakefield acceleration (LWFA) to generate high energy electron beams that collide with the 0.5-PW pulse, and another in which the 0.5-PW pulse drives LWFA and electrons collide with the 2.5-PW pulse focused to ultrahigh intensity. This presentation will describe the construction and operation of ZEUS as well as on-going preparations for zettawatt-equivalent experiments at ZEUS, including commissioning experiments, diagnostic design and laser-beam stabilization techniques.

The ZEUS facility construction and operation is supported by the National Science Foundation under award 1935950 and 2126181, as well as by the AFOSR grant number FA9550-22-1-0118 and the University of Michigan.