UCLA

Plasma Physics Seminar

Physics & Astronomy Building (PAB) Room 4-330

Via Zoom: https://ucla.zoom.us/j/92785449357?pwd=SVBTSko3bTdEUW03dzQwNks1Q2lKZz09

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11:30 AM Lunch will be served

Enabling Intelligent High-Repetition-Rate HED Experiments

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Abstract: Short-pulse (10's femtosecond - 10's picosecond), high-intensity (> 10^{18}W/cm^2) laser-solid interactions have been studied for decades due to the ability to create high-energy-density (HED) plasma conditions (P >1 Mbar) and to produce energetic particle and X-ray sources. This includes MeV electron and ion beams as well as keV-MeV energy X-rays. Today's premier laser-driven HED facilities such as Lawrence Livermore National Laboratory's National Ignition Facility (NIF, 192 beams delivering up to 2 MJ of laser energy) or the University of Rochester's Omega EP facility (~1 kJ in ~10 ps) can create extreme conditions but operate at shot-per-day or shot-per-hour hour rates. In contrast, facilities such as Colorado State University's Advanced Laser for Extreme Photonics (ALEPH) can deliver PW-class laser pulses (~30 J in 30 fs) at up to 3.3 Hz, providing an opportunity to perform experiments at 10^{21} W/cm^2 at massively increased frequency. As lasers facilities continue to grow and advance in repetition-rate capabilities (>shot per minute), there is an opportunity to drastically accelerate the study of laser-driven HED plasmas by several orders of magnitude compared to low-rep-rate facilities. The potential benefits of HRR experimentation include the ability to perform large multi-dimensional parameter scans, many repeat experiments for meaningful statistics, and the ability to deliver stable and reproducible sources of particles or X-rays that can be used for either probing or driving physics experiments.

Replacing human-guided experience and intuition will be necessary in simulations, driver control, and diagnostic analysis to enable utilization of these next-generation laser facilities to their full potential. Fortunately, advances in computational hardware and machine learning (ML) technologies provide a new path to operate experiments intelligently at multi-Hz rates and beyond. Examples include utilizing ensemble (many) simulations to construct physics-based surrogate models that can be used to guide experiments, replacing traditional film-based (or similar) plasma diagnostics for HRR compatibility, developing deep learning models to replace algorithmic diagnostic analysis for drastically increased speed, and utilizing transfer learning to retrain simulation-based surrogate models with experimental information.

There are many opportunities to develop these key enabling technologies that each face unique challenges, while the overall barrier is connecting all components so that they can eventually be orchestrated by a form of artificial intelligence. This seminar will outline the vision for HRR laser-driven experimentation and overview several areas of recent advancement that will ultimately enable the acceleration of scientific discovery by several orders of magnitude.