PETASCALE SIMULATION OF HIGH-ENERGY-DENSITY (HED) PLASMAS

Research Challenge
The key research questions are: Can plasma-based acceleration be the basis of new compact accelerators for use at the energy frontier, in medicine, in probing materials, and in novel light sources? Can laser–plasma interactions be controlled or even harnessed in inertial fusion energy-relevant plasmas? What are the collective processes responsible for the formation of shocks in collisionless plasmas? Are collisionless shocks in plasmas responsible for the most energetic particles in the universe?

Methods & Codes
The UCLA Plasma Simulation Group and its collaborators at IST in Portugal maintain a large number of PIC codes, including OSIRIS, QuickPIC, and UPIC. These codes are all developed locally, share many of the same algorithms and data structures, and have been optimized for heterogeneous leadership-class supercomputers such as Blue Waters.

Results & Impact
In the past 12 months, the results of these petascale simulations have appeared in high-impact journals such as Physics of Plasmas and Physical Review Accelerators and Beams.

Why Blue Waters
The system has continued to provide a very stable high-performance platform for the study of kinetic effects in high-energy-density plasmas. This stability has allowed the team to perform a large number of petascale simulations that will help experimentalists produce brighter X-ray sources using X-FEL (using LWFAs) and produce higher-yield targets in inertial fusion experiments.