MULTISCALE MODELLING FOR HIGH ENERGY DENSITY PHYSICS EXPERIMENTS ON ORION

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The Orion laser at AWE couples high energy long-pulse lasers with high intensity short pulses, allowing material to be compressed hydrodynamically to several times solid density and heated isochorically. This experimental capability has been demonstrated as a platform for conducting High Energy Density Physics (HEDP) material properties experiments[1]. A clear understanding of the physics in HEDP experiments at this scale, combined with a robust, flexible and predictive modelling capability can be viewed as an important step on the road to more complex experimental platforms and ICF schemes which rely on high power lasers to achieve ignition.

These experiments present a significant modelling challenge, the system is characterised by hydrodynamic effects over nanoseconds, driven by long-pulse lasers or the pre-pulse of the petawatt beams, and fast electron generation, transport, and heating effects over picoseconds, driven by short pulse high intensity lasers. We describe the approach taken at AWE[2]; to integrate a number of codes which capture the detailed physics for each spatial and temporal scale. The basis of this approach is a suite of three codes: the PIC code EPOCH; the Monte-Carlo hybrid code THOR; and the radiation hydrodynamics code CORVUS. Simulations of the heating of buried aluminium microdot targets are detailed and compared with experimental results. The impact of laser contrast and frequency, as well as the implications of relying on 2D modelling and the challenges of 3D modelling, are discussed.

The tools summarised here are more advanced than has been available in the past at AWE, and we show that this sophistication is required to model full scale Orion experiments self-consistently. Future work will focus on: improving the robustness of the suite; performance enhancements in key areas; post processing capability; full 3D modelling in the longer term; and most importantly, the application of the model to upcoming Orion campaigns.

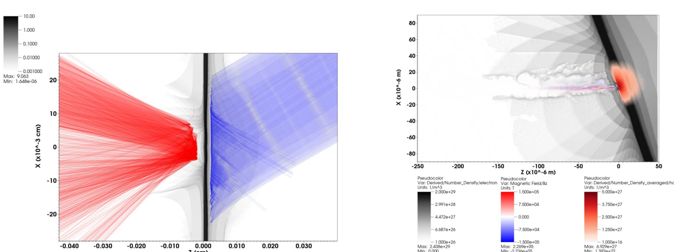

Figure 1: Laser ray-trace and background density (left) from CORVUS for the short-pulse pre-pulse (red) and long pulse compression beams (blue) at the point when the main short pulse enters the system. EPOCH modelling of the main pulse LPI (right) shows the channel formation in the pre-plasma, and the divergent hot electron population generated when the pulse reaches the dense target.

[1] D J Hoarty *et al.* HEDP, 9, 661 (2013)
[2] N J Sircombe, S J Hughes and M G Ramsay. New Journal of Physics, 15, 025025, (2013)