Development of laser-solid plasma accelerators for industrial imaging and nuclear inspection applications

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Laser-accelerated electrons with relativistic energies and mega-Amp current injected into solid targets can generate bright, energetic, point-like photon and particle sources. High-energy beams of x-rays, ions and neutrons that are generated as a result are of particular interest for industrial applications as the laser-accelerator concept has several major competitive advantages, namely that it can generate x-rays from a micro-scale point source for high resolution projection radiography and can operate in multi-modal delivery generating, in parallel, beams of electrons, neutrons, positrons and even muons for complimentary inspection techniques. This makes a laser-accelerator a versatile source, capable of imaging and inspecting a wide range of samples and materials that are of interest to many high value sectors – from medium density alloys for aerospace through to large dense objects such as nuclear waste barrels.

Recent results in the development of x-ray, ion and neutron beams for these specific applications will be discussed. Advanced targetry for generating micro x-ray sources and cryotargets for new acceleration dynamics in deuterium beams will be presented. A new 3-year STFC-funded Innovation Partnership Scheme project that started in October 2016 will also be introduced. The collaboration will demonstrate and develop laser-driven x-ray and neutron beams for nuclear waste inspection in partnership with Sellafield Ltd, the UK's nuclear waste decommissioning authority.

With the recent delivery of the CLF's 100 J, 10 Hz DiPOLE100 laser system and the development of LLNL's 10 Hz HAPLS system, utilising these beams for industrial applications is now within reach. This step-change in high-energy laser technology is vital for realising laser accelerators for important and high impact applications and for transferring the technology from laboratory to commercial exploitation.