The SCAPA LWFA Beamline

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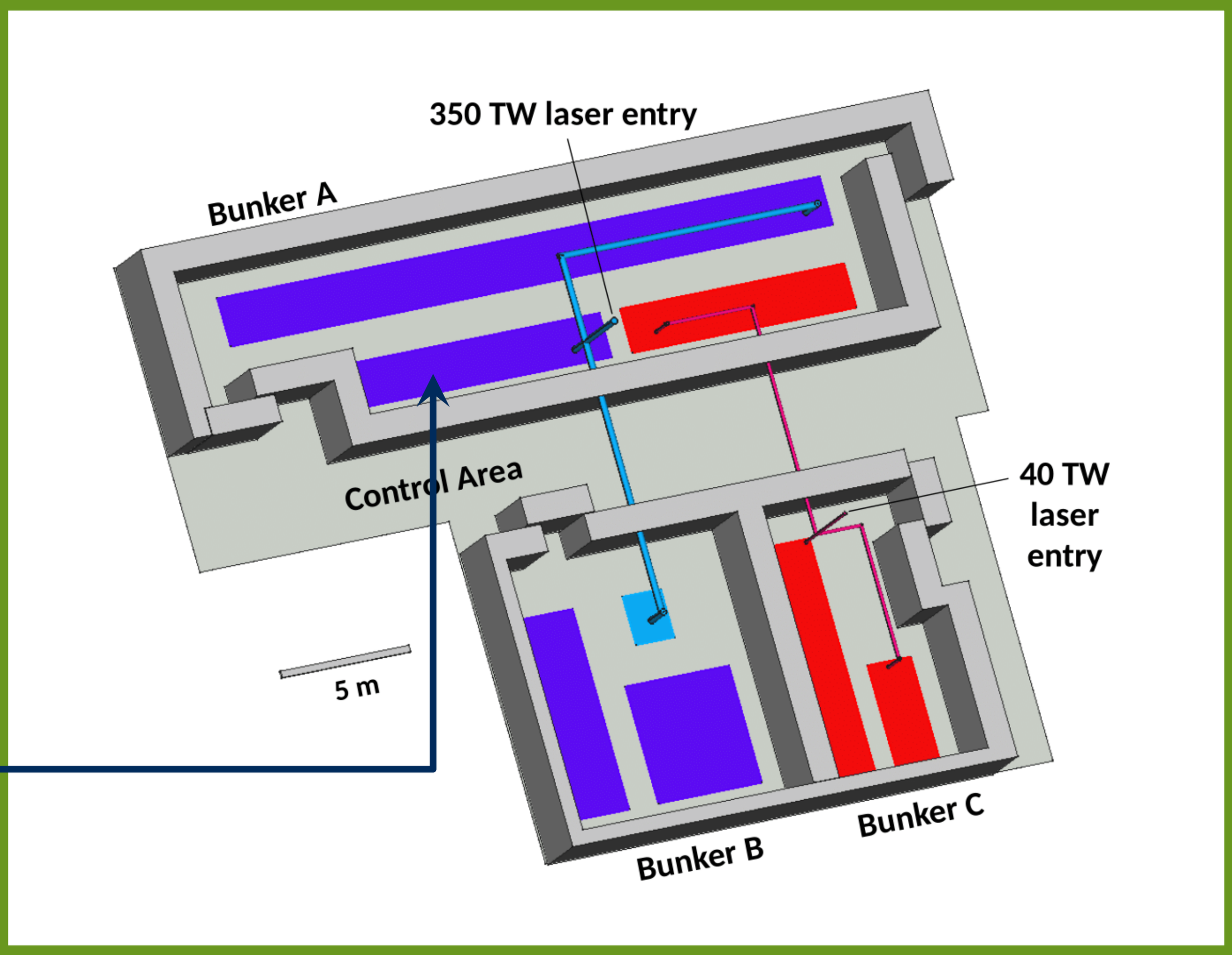
SCAPA

The Scottish Centre for the Application of Plasma-based Accelerators (SCAPA) [1], situated at the University of Strathclyde in Glasgow, UK, is coming online. It comprises three radiation shielded concrete bunkers housing a total of seven beamlines and interaction chambers, each driven by one of a pair of high power Ti:sapphire laser systems – a 350 TW and a 40 TW.



SCAPA layout showing beamlines driven by the 350 TW (blue) and the 40 TW (red) lasers.

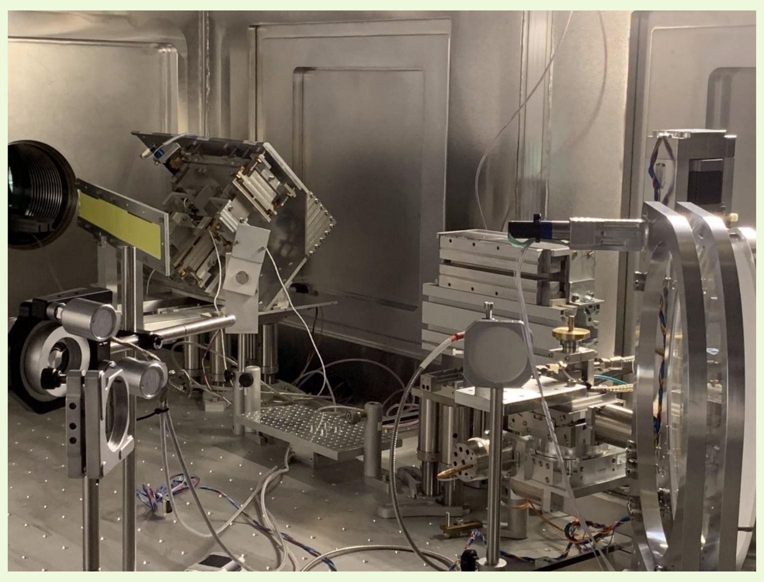
The A2 Beamline

Three beamlines at SCAPA are dedicated to laser wakefield acceleration. The resulting electron beams and high peak brightness EM radiation pulses will be used for applications in various scientific disciplines, medicine, industry and engineering.

An f/16 (2 m) or f/32 (4 m) off-axis parabolic mirror focuses the laser beam onto a gas target, which may be a supersonic jet, cell or capillary discharge tube.

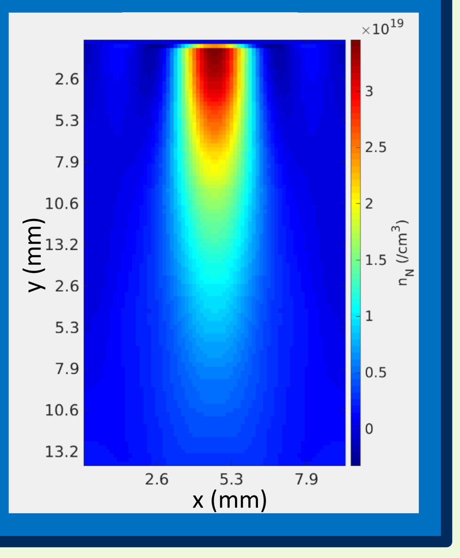
Numerous diagnostics are in place to monitor the laser-plasma interaction:

- Electron spectrometer with good resolution up to 1 GeV (soon to be upgraded)
- Kirkpatrick-Baez microscope for soft and hard X-ray focusing and imaging [2]
- Fibre-coupled VIS-NIR spectrometers, and more



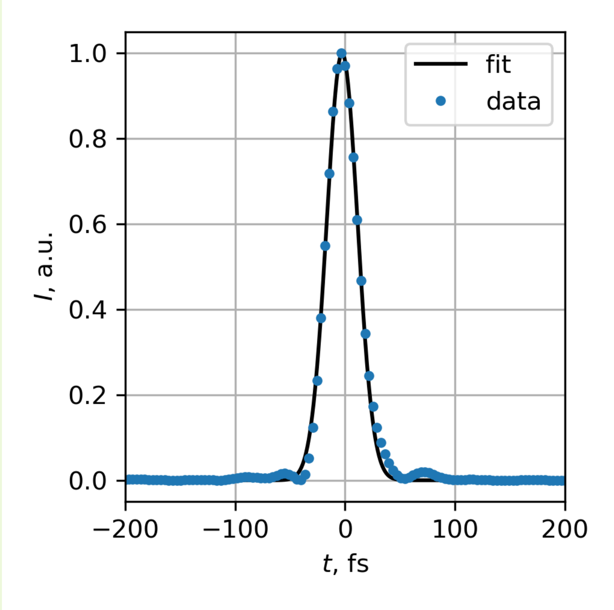
Target Metrology

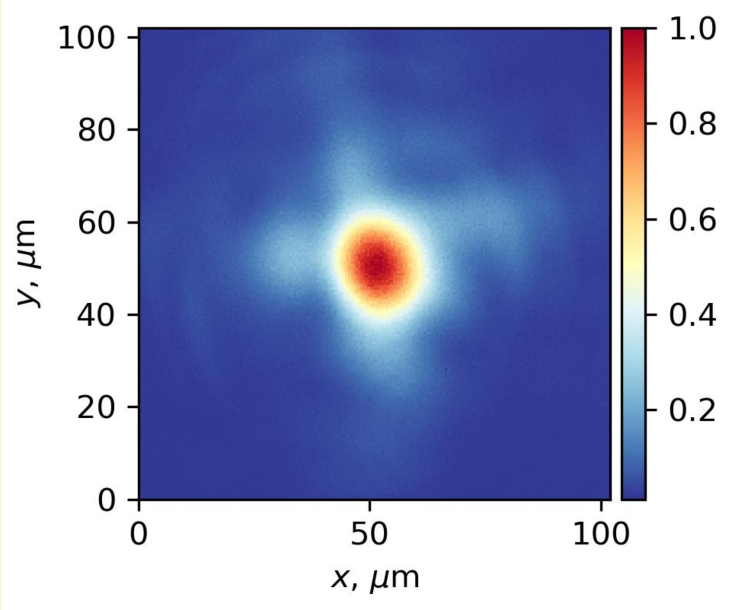
Target characterisation enables a thorough understanding of laser-plasma interactions and allows for accurate simulation. Wavefront sensor-based interferometry capabilities at SCAPA give quantitative information on gas nozzles and cells.



Laser Pulse Optimisation

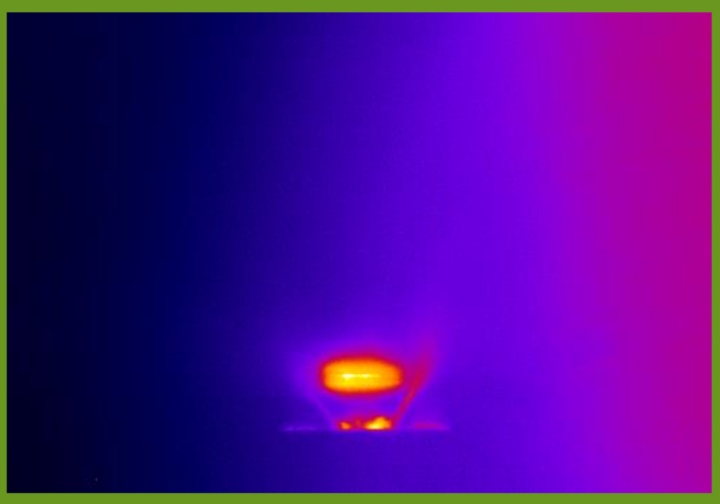
A near diffraction limited focal spot with a FWHM shape of 17×20 μm has been achieved with the use of an adaptive optic and wavefront sensor loop. 84% of the energy is within the 1/e^2 radius. Optimising compressor grating separation and spectral phase (with a Dazzler) results in a 33.0 fs FWHM pulse, as measured by a Wizzler.

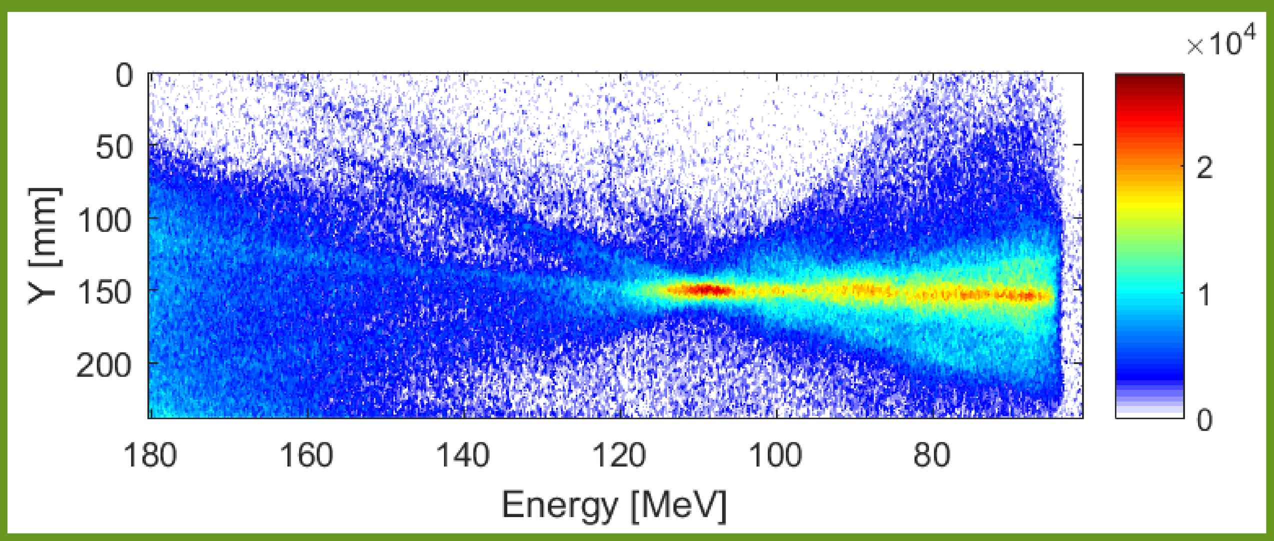




First Electrons

A 200 mm long NdFeB permanent magnetic dipole with B~0.93 T is currently used as an electron spectrometer. The dispersed electron beam is incident on a LANEX screen 1.2 m from the interaction point. A recent calibrated spectrum is shown below, obtained from a 2.8 J shot. To the right is a side view image of the plasma showing a clear self-focused channel within a broader plasma glow, which also illuminates the gas plume.





Upcoming Experiments

Scheduled experiments include:

- Laser-driven photonuclear production of ^{225}Ac, using a high energy electron beam (1 GeV) generated in a variable length gas cell, converted to γ photons in a tantalum target, which are then incident on a ^{232}Th target.
- Generation of attosecond duration electron bunches by plasma density profile shaping from multi-nozzle gas jets [3].
- X-ray source imaging and characterisation.
- Coherent terahertz radiation production [4].

Research and facilities funded by EPSRC*, SFC, Horizon 2020, SUPA and the University of Strathclyde.**
* EP/K011952/1, EP/J018171/1, EP/N028694/1, EP/J500094/1, EP/P020607/1, EP/R006202/1
** 654148 Laserlab-Europe, 653782 EuPRAXIA

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