Overview of the Central Laser Facility

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The Central Laser Facility (CLF) is a world leading centre for research using lasers. This section provides a brief overview of the capabilities available to our international user community.

The CLF continues to offer its leading capabilities free at the point of access to our UK academic and industrial community, with significant scope for European and wider International involvement.

Vulcan

Vulcan is a highly versatile Nd:glass laser with three independent target areas that couple long and short pulse beams in a variety of flexible geometries. A maximum of 2.5 kJ can be delivered in its eight beams. Long-pulse temporal shaping is possible, with pulse durations from 100 ps to 20 ns, and a selection of focusing, beam smoothing and harmonic conversion options. Intensities up to 10^{21} Wcm^{-2} are available.

Work in the past year has included the replacement of the rod amplifier chain power supplies to remove a major risk to continued Vulcan operations.

TA-Petawatt is our highest intensity area, with a ~500 J/500 fs beam capable of being focused to 10^{21} W/cm^2. It offers the capability for beam splitting, combination with a ~100 J long pulse beamline, and various probe beam options.

TA-West has recently completed a substantial upgrade. It now offers dual CPA beams coupled to the long pulse beamlines. One beam operates at 80-100 J / 1 ps (10^{20} W/cm^2), and the second CPA beam operates either at 80-100 J / 1 ps, or at 500 J / 10 ps. An extended target chamber provides great versatility for pump/probe studies, including cylindrical implosion geometry systems.

TA-East offers long pulse capability along with short pulse probe beams – in a variety of highly flexible configurations.

Work continues on a very major upgrade – to 10 Petawatt peak power (300 J / 30 fs) capable of being focused to 10^{23} W/cm^2. This requires extension to the existing building, a new laser floor added above the target areas, and conversion of TA-East into a new area with enhanced radio-protection. The new beamline will be coupled to the existing PW beam, as well as into the new high intensity area coupled to the long pulse beams. Approval to proceed with the major build phase is anticipated in early 2010.

Astra Gemini

This Ti:Sapphire facility has been designed to offer 2 beams, each with a power of 0.5 PW and a repetition rate of one shot every 20 seconds. The facility will enable interaction studies up to 10^{22} Wcm^{-2}. F/20 and F/2 beam focusing options are available, along with a robotic solid target insertion system and a variety of "plasma mirror" configurations for high contrast pulse delivery. This facility fired its first user shots in January 2008 to a successful series of electron acceleration experiments. The second beam is now being commissioned, as are further improvements to the beam contrast, stability and facility flexibility.

Astra TA2

In addition to the existing 500 mJ, 40 fs pulse, this area has now been fitted with a pair of new probe beams. The first delivers 10 fs, 800 nm beam at 500 μJ, whilst the second is a tunable (450 – 1200 nm) TOPAS at 30 fs, 20 μJ. Both beams can be independently delayed up to 60 ns. There are highly flexible target irradiance options up to 10^{19} Wcm^{-2}, at contrast levels up to 10^{10}:1.

Artemis

Artemis offers ultra-short pulse capability in the Infrared and XUV spectral regions, along with a tunable probe source and end-stations offering optimised time resolution or energy resolution for atomic/molecular physics and surface science.

Artemis provides carrier envelope phase stabilised high power, <30 fs, 780 nm pulses with 14 mJ/pulse at 1 kHz or 3.5 mJ/pulse at 3 kHz. The output energy can be split into the following beam-lines:

i. 1 mJ can be further compressed to <10 fs, 0.5 mJ/pulse;

ii. 8 mJ can be used to pump an IR OPA system providing tuneable ~40 fs pulses in the spectral range of 1.18 μm - 15 μm with an output of up to 1.5 mJ/pulse.

iii. The remaining energy can be used as synchronized pump/probe pulses.

The end-stations are:

i. A high harmonic generation chamber with kHz gas-jet and XUV flat-field spectrometer (10-40 nm spectral region), together with a monochromator to select a single XUV harmonic in the spectral range 10 eV-100 eV.

ii. Materials science end-station with 2D hemispherical photo-electron analyser and <20 K five-axis cryo-manipulator.

iii. Gas-phase science end-station with a velocity-map imaging detector.

Lasers for Science Facility (LSF)

The LSF operates a suite of state-of-the-art table top laser systems, giving users access to highly tunable (VUV to IR) and variable pulse width (ns to fs) laser radiation. The extremely versatile lasers are applied to a wide range of scientific and industrial applications across chemistry, physics, biology, medical and material sciences.

The LSF clusters into two areas: molecular structural dynamics, and functional bio-systems imaging. Each is centred around a highly capable array of laser systems.

In the dynamics area, a new laser system, ULTRA, jointly funded by BBSRC and STFC has now been commissioned. This offers a state-of-the-art high power 10 kilohertz fsec / psec regenerative amplifier system combined with OPAs to generate pulses for a range of unique pump and probe spectroscopy techniques. It provides spectral coverage from 200-12000 nm and temporal resolution down to 50 fs. This is used in the investigations of fast photodynamic processes in solids, solutions and gases.

The Ultrafast Spectroscopy lab offers 1 kHz operation for both IR and Raman spectroscopy studies. Its time resolved resonance Raman (TR^3) capability enables highly fluorescent samples to be studied using a 4ps optical Kerr shutter in combination with a fully tunable kHz femtosecond synchronised pump-probe capability. The same laser source also drives the high brightness PIRATE facility (Picosecond InfraRed Absorption and Transient Excitation) giving two independently tunable beams across the mid infrared region of the spectrum for pump / probe experiments.

In the imaging area, the Octopus cluster provides access to a broad range of capabilities from single-molecule imaging, confocal microscopy and spectroscopy, along with bio-preparation laboratories and associated tools. In addition, a "laser tweezers" laboratory is available to study Raman spectra and pico-Newton forces between particles in solution (such as living cells and aerosol droplets) for bioscience and environmental research.

Over the course of the next year, these capabilities will be pulled together within the Research Complex at Harwell, which completed construction in late 2009. This will provide a combined capability for their exploitation alongside the Diamond Light Source and ISIS.

Laser Loan Pool

Commercial laser systems are available from the EPSRC Laser Loan Pool for periods of up to 6 months at the user's home laboratory. A wide range of ancillary and diagnostic equipment is also available to support user experiments.

Engineering services

Mechanical, electrical and computing support is provided for the operation of the laser facilities at the CLF, for the experimental programmes on these facilities and for the CLF's research and development activities. Access to mechanical and electrical CAD tools and workshop facilities enable a rapid response to be provided to users.

Theory and modelling

The CLF will support any scheduled experiment throughout the design, analysis and interpretation phases. We offer multi-dimensional fluid, PIC, hybrid and Vlasov-Fokker-Planck modelling capabilities and access to large scale computing resources.

Target preparation

A high quality target fabrication facility is operated within the CLF. This area has been significantly extended recently, offering separated characterisation, assembly, and coating areas, plus office space. It is equipped with a wide range of target production and characterisation equipment, including evaporation and sputter coating plants, interference microscopes, SEM, AFM, surface profiling and a plasma etch facility. Many targets are produced in collaboration with STFC micromachining and lithographic services. A rapid turnaround service responds quickly to the developing demands for targets, essential for maintaining the scientific productivity of the programme.

Commercial access to target preparation capabilities is available for supply to other laboratories via the spin-out company Scitech Precision Ltd.

Access to facilities

Calls for access are made twice annually, with applications peer reviewed by external Facility Access Panels. For information please visit http://www.clf.stfc.ac.uk/Access/Index.htm or contact me at the above email address.

The CLF operates "free at the point of access", available to any UK academic or industrial group engaged in open scientific research, subject to external peer review. European collaboration is fully open for the high power lasers, whilst European and International collaborations are also encouraged across the entire CLF suite for significant fractions of the available time.

Dedicated access to CLF facilities is awarded to European researchers under the auspices of the LaserLab-Europe initiative (www.laserlab-europe.net) funded by the European Commission.

Hiring of the facilities and access to CLF expertise is also available on a commercial basis for proprietary or urgent industrial research and development.

Please see our website for more details on all aspects of the CLF.