Artemis

Design of a waveplate to generate circularly polarised XUV radiation

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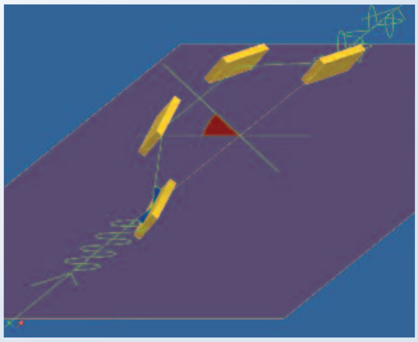
In the Artemis facility, soft XUV-radiation is generated in the energy region between 20 eV and 100 eV in order to perform time resolved photoemission experiments on condensed matter or gas phase targets. A fs laser beam is focused on a gas jet to generate linearly polarised high harmonics (HHG) of the fundamental beam. There is scientific interest in probing samples with circularly polarised XUV radiation. This article explains how to build a waveplate for XUV photon using four gold mirrors. Each mirror introduces a phase shift between s- and p- polarization and we present here a theoretical calculation to determine the different angles necessary to obtain a fully circularly polarised beam in the photon energy range 30 eV to 70 eV.



Laser beam pointing control system for driving the hollow-fibre few-cycle laser

51

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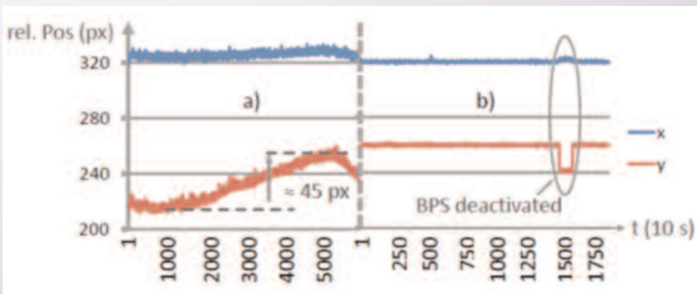
A hollow-fibre compressor is used at Artemis facility to shorten the pulse duration from the laser system from 30 fs to sub 10 fs laser pulses. The output signal of the hollow-fibre compressor, the pulse duration and beam profile, is very sensitive to its input signal. Hence it is necessary in order to achieve a stable output signal that a beam pointing stabilization system is inserted in the input beam to the fibre. Part of the beam focused into the fibre is coupled out through a leaky-mirror and is used as control. A camera is placed in the equivalent focal plane of the input into the hollow fibre. Therefore beam movements can be detected in this plane. A computer is now used to evaluate the image from the camera and stabilize the position of the beam by the feed-back control of a motorized mirror mount. The figure shows the beam pointing stability with and without beam-pointing- stabilization (BPS). Without PBS the deviation accounts to roughly 45 pixels which corresponds to 70 µm, over a time of approximately 12 hours. With BPS the deviation is negligible over 5 hours and 10 mins. After 4.16 hours, the beam pointing stabilization was deactivated for a short period of 15 minutes as evidence for a working stabilization system. A deviation appeared and was reduced back to zero when the PBS was re-activated.



Centroid position of the beam in x and y direction.
a) without beam stabilization
b) with beam stabilization.

In-line flat-field XUV spectrometer for the Artemis beamline 52

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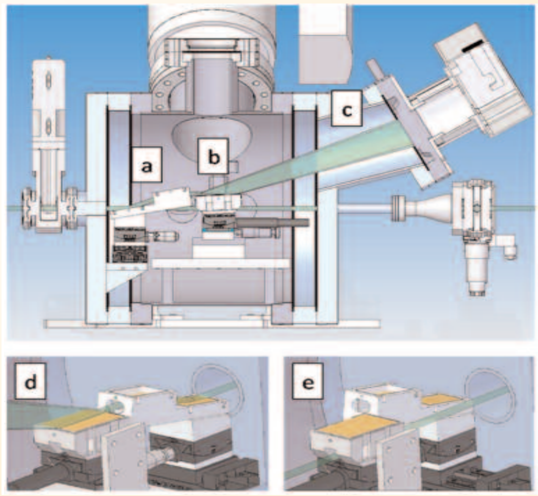
The Artemis facility has a monochromatic and a broadband XUV beamline where the XUV beams are generated by femtosecond-laser high harmonic generation (HHG) in a gas jet. The XUV spectrum, stretching between 10-100eV photon energy, is measured with Flat-field (FF) spectrometer in the broad-band beamline. We have modified the FF-spectrometer design such that the spectrum can be measured in-line by inserting and withdrawing an x-ray mirror during an experiment using the beamline.



Top: Engineering drawing of the FF-Chamber with:(a) Goniometer and x-ray mirror mount for liner shift of the beam; (b) Grating; (c) MCP and photomultiplier.

Bottom: (d)Option 1 - beam is guided up by the X-ray mirrors towards XUV spectrometer; (e) Option 2 - beam passes Flat-field spectrometer chamber towards the interaction chamber.

Modeling of the VMI spectrometer for the Artemis beam line 53

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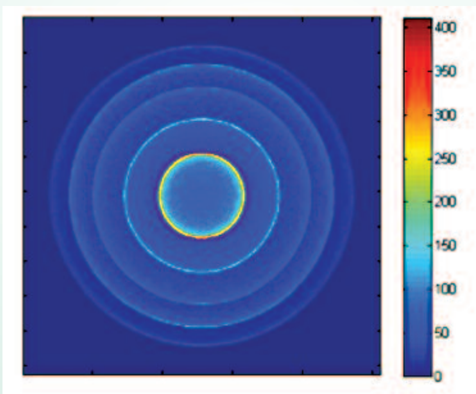
The recently commissioned AMO endstation at Artemis has been provided with a Velocity Map Imaging spectrometer designed to detect electrons with kinetic energies in the 0-200 eV range. In order to obtain an estimate of the energy resolution for different voltage settings and to determine the maximum kinetic energy detectable extensive simulations have been performed. After a brief introduction on the VMI technique and on the design features of the spectrometers the results of the simulations will be presented.



Sample simulated 512x512 VMI image with repeller voltage at 15 kV. The rings correspond to electrons with kinetic energies of 15,50,100,150 and 200 eV.

Improvements to the Artemis facility interlock system

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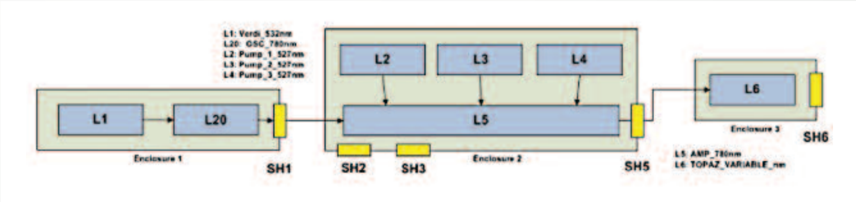
The Artemis laser system requires time to stabalise before the laser can be used. Prior to the interlock upgrade, the lab was rendered hazardous during this time. The new interlock system has enclosed a large portion of the laser system and overrides can be enabled from the control panel. The upgraded interlock system encloses the laser system and segregates it into 3 areas by the use of shutters. A portion of the enclosures are fixed and cannot be opened in normal operation. The remaining enclosures have access lids which are linked to the control system via magnetic switches and can be overridden by authorised persons.

Software changes have been made to future proof and simplify the task of displaying lasers on the Cerberus hazard screens. Multiple lasers can reside in a single enclosure. The propagation of different wavelength lasers into downstream enclosures is controlled via the shutters. The hazard screens then display the appropriate accumulation of hazards dependent upon which shutters are open.

The code separation between the PLC main program logic and the Cerberus logic is easily identifiable and thus more easily supported.

The upgrade to the Artemis interlock system has significantly improved the usability of the Artemis lab for engineering staff and users of the area. The lab can now be accessed without goggles while the laser is stabilising, providing a time saving as well as making the area as safe as possible for the users of the lab.



Lasers and Their Enclosures - Software Screen

Astra Gemini

An imaging system for accurate target positioning for fast focusing geometries

55

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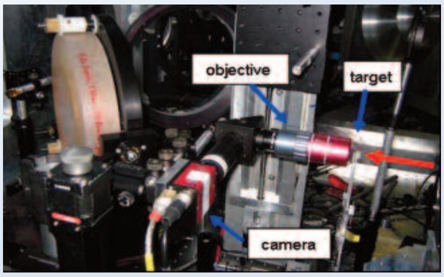
An F/0.87 on-axis parabolic mirror was fielded on a recent experiment on the Astra-Gemini laser to achieve higher laser intensities via a smaller focal spot.

Due to the very short, 1.7 µm, Rayleigh range of the F/0.87 optic a new alignment system was required. This was achieved using a camera with a high resolution long working distance objective. The camera is positioned to image the laser spot, the target is then brought into focus on the camera such that it is in the same plane as the laser focus. Once the target is in position the camera is driven out of the way for the laser shot. Illumination to image the target rear surface is provided by injecting light from an LED through the back of the camera objective.

The imaging system is able to achieve the required accuracy in alignment at the cost of a slower shot rate.



Alignment camera with objective en situ imaging a target. The red arrow indicates the direction of the laser off the F/0.87 parabola.

Implementation of pulse measurements with Wizzler into Gemini diagnostics

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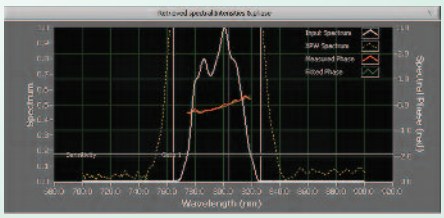
The Gemini laser has benefitted from a recent Dazzler upgrade and the acquisition of a Wizzler device. The commercially-available Wizzler measures the pulse parameters by comparing the test optical pulse with a reference pulse having flat spectral phase, using spectral interferometry. The reference pulse is collinearly generated from the input pulse by cross polarized wave generation (XPW). The combination of the higher resolution (HR-800/T3) Dazzler and pulse measuring Wizzler, which are easily linked together, has provided a fast-working tool for controlling and optimizing the spectral phase and duration of the compressed pulses. The application of the feedback phase file measured by the Wizzler aims to minimize the pulse duration after compression by modifying the spectral phase correction until a flat spectral phase of the optical pulse is achieved. The figure presented shows the modified spectral response of a transform limited short pulse achieved due to the feedback correction.



Measured spectral phase (red line), input spectrum (white line) and XPW spectrum (dashes) of Gemini pulse after correcting the phase.

Recommissioning of pulse compressor for Astra Target Area 2

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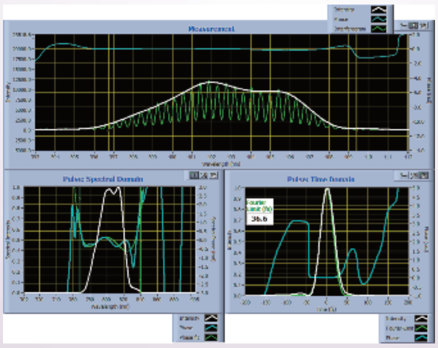
Astra Target Area 2 has recently been re-commissioned for operation and handed over for users' experiments. The vacuum control system and interlock system have been upgraded to the same standard as other experimental areas. The grating pulse compressor has been modified with a newly designed mount for the large grating, alignment of which is controlled by the standard CLF drive system software. Following alignment and optimisation of the compressor, the variation of spectral phase of the compressed pulse measured by LX-SPIDER was small enough to achieve near transform-limited pulses without applying a phase error file from the Dazzler.



The compressed pulse parameters measured by LX-SPIDER: top plot -spectral interferogram of the second harmonics (green), bottom left- spectral phase dependence (blue), bottom right- pulse shape (white) and temporal phase (blue).

Achromatic beam diagnostic telescopes for Astra Gemini

58

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The original astronomical refracting telescopes used for diagnosing the output beams of Gemini have been replaced with all-reflective systems of higher optical quality. This has eliminated the chromatic error which significantly distorted the distribution of light in the focal spot, and prevented reliable measurements of the focal spot quality. A high-quality parabolic telescope mirror is used in combination with a full-aperture 90% beamsplitter to obtain unobstructed near- and far-field images of the beam at the output of the pulse compressor. The layout of the telescope is shown in Figure 1, and far-field images from the old and new systems are shown in Figures 2 & 3, demonstrating the improvement in image quality. An additional refinement is the introduction of a wide-angle far-field imaging capability, which makes it easy to recover the far-field image if the beam pointing changes, and greatly enhances the ease of alignment of the compressor optics.

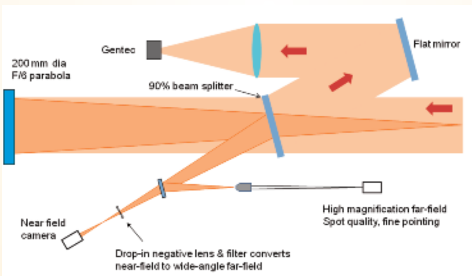

Figure 1.

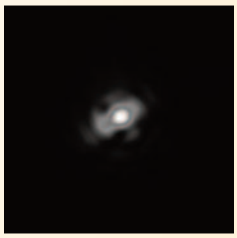

Figure 2.

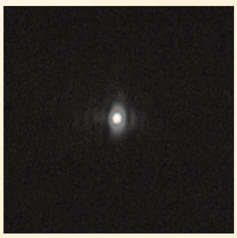

Figure 3.

Recent improvements in contrast on Astra Gemini

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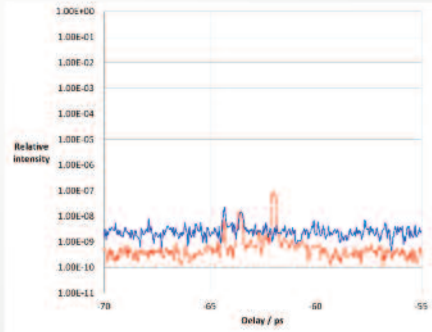
In the past year we have continued the campaign of replacing optics in the Astra laser system to eliminate post-pulses which can be converted into pre-pulses by the well-known nonlinear phase-coupling mechanism [1]. Windows with identical wedges were obtained by cookie-cutting from a single large wedged window, and were anti-reflection coated with high-quality narrow-band coatings. Installing these in the VSFs of Astra amplifier 3 eliminated one of the pre-pulses seen in previous contrast scans: the red trace was recorded before and the blue trace after the windows were replaced, and the -62 ps prepulse has disappeared. There are eight other ¼ inch windows in the laser: in the beam pipe between Astra and Gemini, and in the VSFs in the Gemini amplifiers. These are believed to be the source of the weaker prepulses between -63 and -65 ps in the trace.

[1].N.V. Didenko, A.V. Konyashchenko, A.P. Lutsenko, S.Yu. Tenyakov, Optics Express 16 (No 5), 3178-3190, March 2008



The effect of replacing plane-parallel windows with wedged windows in the amplifier 3 VSFs. Red trace: before replacement; blue trace: after replacement.

Development of an adaptive optic system for use in the Astra Gemini Target Area

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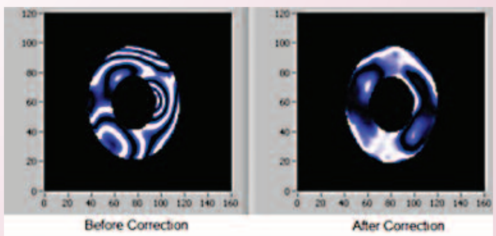
We have investigated the potential for a large-aperture deformable mirror to improve the focal intensity achieved with Astra Gemini. The deformable mirror itself has some distortion in its relaxed state, but our results show that it is capable of self-correction, so inserting the mirror in the beam does not make the aberrations worse. The main objective was to investigate whether the deformable mirror could be used to compensate the errors in a F/0.87 on-axis parabola and an additional thin optic with a hole used to send the beam to the parabola. The thin mirror was significantly distorted, and the wavefront sensor software required extensive modification to work with the annular beam reflected from it. The final result was partial correction of the system errors and an improvement of the initial Strehl ratio, but better correction of the wavefront errors will be needed to achieve the highest focused intensities.



The phase maps before and after correction when the thin mirror was in the beam. There is a π phase difference between regions of black separated by white.

Replacement of Astra amplifiers one and two for enhanced laser contrast

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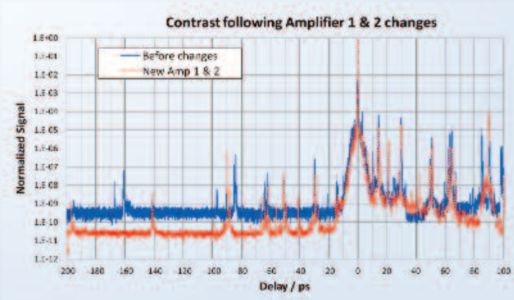
We report on the design and commissioning of upgraded replacements for the first two multi-pass amplifiers in the Astra laser chain. The new designs share common features intended to improve the laser contrast on ns and ps timescales, as well as improving the general performance and stability.

The issue of post-pulses generated in a CPA laser appearing as pre-pulses after compression is now well known. The new amplifier designs use wedged Ti:S crystals, spatial filtering between passes and Brewster windows on the VSFs to greatly reduce the generation of post-pulses. Angular dispersion introduced by the wedged crystal is cancelled by having an even number of passes in opposite orientations. The ns contrast resulting from scatter pre-pulses is improved by having passes with small angular separation travel through the crystal in different directions. Image relaying from the crystal position back onto itself improves the stability and beam quality.



Contrast trace showing improvements after the amplifier upgrades.

Lasers for Science Facility

Multiple probe spectroscopy

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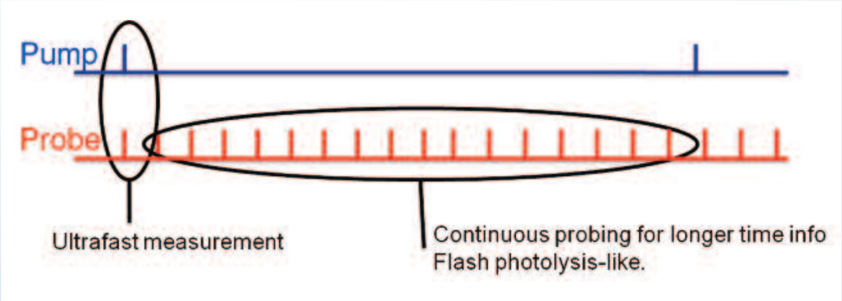
Development of time-resolved spectroscopy techniques within the Ultra facility have recently focussed on the ability to study sample changes across 10 orders of magnitude in time, from 100's of femtoseconds to milliseconds.

The new time-resolved multiple-probe spectroscopy facility combines ultrafast "pump-probe" measurements with flash photolysis-like high repetition rate probing. This allows a wide range of processes to be studied by non-linear spectroscopy techniques with high sensitivity on a single instrument. The development permits one to follow a chain of events from the early physics to the chemistry of large biological molecules and diffusion of molecules in solution.



Vulcan

A new short pulse diagnostics line for Vulcan Petawatt

63

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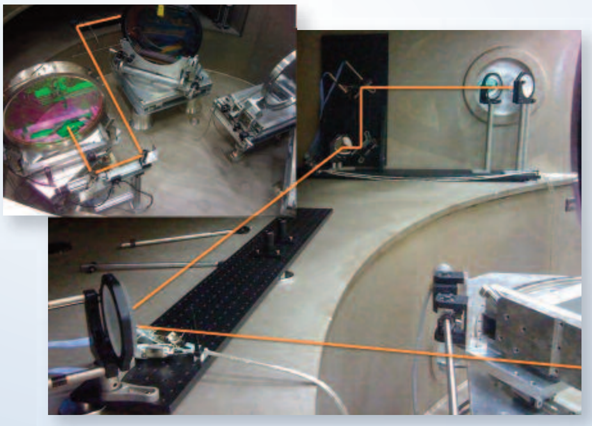
In this article we present the design and commissioning of the M2 diagnostics in TAP. The new M2 diagnostics beam line reduces the pulse degradation effects by reducing the B-integral. This is achieved by sampling a small portion of the beam via a hole in M2. This beam line is then split into a high and low energy channels and sent to a diagnostics suite outside the compressor chamber. The arsenal of diagnostics on this table include: near field (NF), far field (FF), spectrum, autocorrelation and Grenouille. The autocorrelator produces a reasonable results, 570fs. The spectrum is also good and does not exhibit any SPM.



Near field autocorrelator for high power lasers

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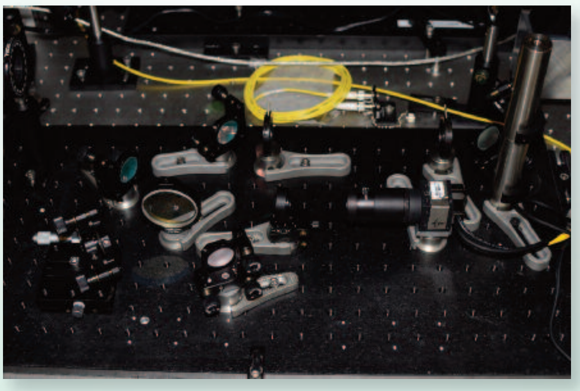
It is now the general consensus amongst some European high power laser facilities that short pulse diagnostics are unreliable. In general, post compression, short pulse diagnostics suffer from high B-integral, spectral dispersion, near field (NF) inhomogeneity and pointing stability. Here we present a simplified NF autocorrelator design for full energy shot diagnosis.

Preliminary results show autocorrelation traces in TAP of approximately 600 fs. The temporal window of this device is approximately 2.5 ps. The NF devices seem more stable than the uniaxial ACs, providing a measureable trace on nearly every shot.



Mixed glass rod chain optimisation

65

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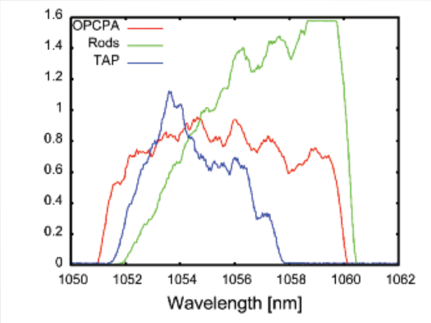
After some years of operation, the balance between the silicate and the phosphate amplifiers in the TAP beamline of the Vulcan laser has changed. The spectrum of the pulse is shifted in the red region, reducing drastically the gain into the disk amplifiers and affecting the final bandwidth and, as a consequence, the pulse duration and the peak power.

A series of tests were performed to characterize the amplifiers and a new balance between the two type of amplifiers was found. The silicate was modified replacing the 9mm silicate with a 9mm phosphate and changing the divergence of the beam into the 16mm silicate. After the optimization, the new layout was able to produce a pulse of 4.5nm of bandwidth during a full power shot in TAP.



Spectra acquired during a full power shot in TAP.

Vulcan Target Area West commissioning

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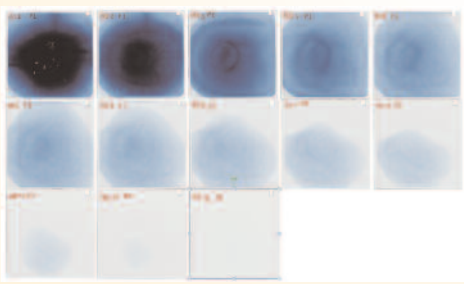
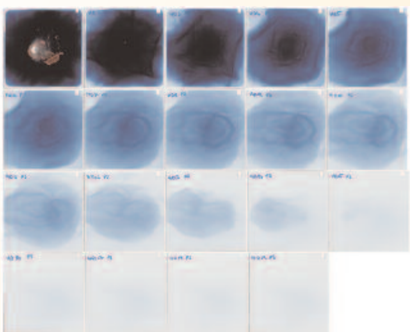
Target Area West has dual CPA short pulse facilities specified to deliver 1ps, 100J (beam 7) and a range of 1-10ps in up to 100 - 300J respectively (beam 8). The operations team has recently conducted a commissioning project to characterise, quantify and benchmark its capabilities. Presented here are the results of the campaign to measure beam quality, focal spot size and pulse length of the system, improving them where possible and necessary. These characteristics were also tested in combination via interaction of laser pulses on target. This gives knowledge about the intensity deliverable inferred from output peak proton signal and dosimetry measurements.

These aspects define the ability of this facility to deliver high intensity (>10^{18}W/cm^2) to target and have been pinpointed as desirable characteristics to quantify, benchmark and communicate to our research community.



25MeV proton peak energy measured with RCF HD810 from Beam 7 (95J, 1ps) interacting with 10μm gold foil.



28MeV proton peak energy measured with RCF HD810 from Beam 8 (240J, 12ps) interacting with 10μm gold foil. A further shot with 300J and a 20μm foil was also taken resulting in 35MeV peak result.

Refurbishment of Vulcan Target Area Petawatt

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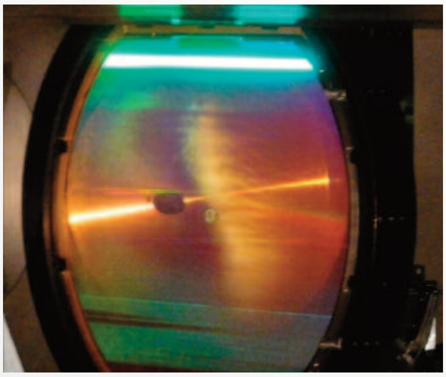
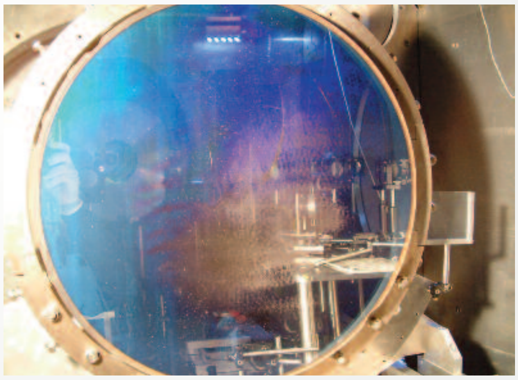
The Vulcan 1 PW Facility has delivered 2493 high energy shots to target since it was commissioned in 2002. The action of this high number of shots on the specialist large optics within the compressor has taken its toll. This has been to such an extent that the Facility has been running at reduced energy levels to try to prolong the operational lifetime of the optic coatings until a gap in the operational schedule of Vulcan could be opened up to facilitate the replacement of the pulse compression grating, the final turning/diagnostic mirror from the compressor and the focusing parabola on to target.



North gold compression grating as viewed from the South compressor tank. Clearly visible is the 'S' shaped burn in the gold grating surface.



Damage across half the beam area of the protective overcoat on the silver coated final focusing parabola.

Laser R&D

New CLF adaptive optics development lab

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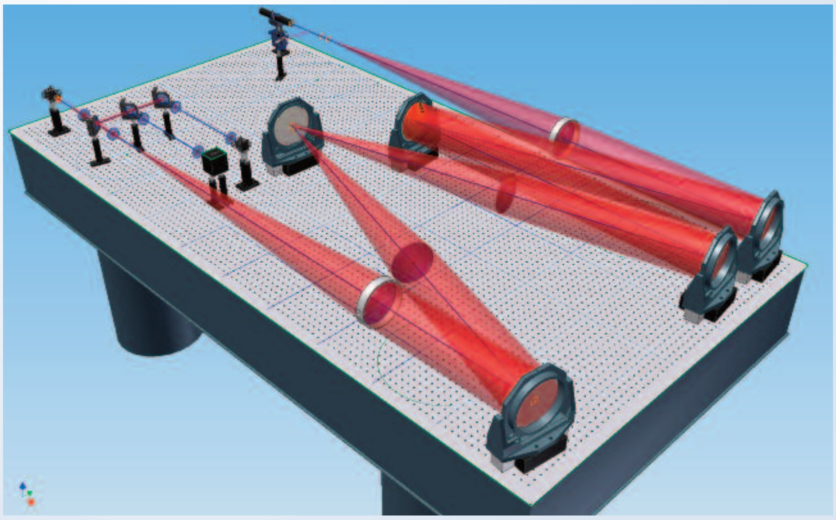
A dedicated lab has been established to support the CLF adaptive optics development program. The versatile optical layout features visible (635 nm) and infrared (808 nm) beams up to 150 mm diameter. The long propagation distance (>10 m) and optional spatial filter between the adaptive mirror and wavefront sensor emulate some of the features present in large high power lasers. In addition to a Shack-Hartmann wavefront sensor, the diagnostics include cameras for the near field and magnified focal spot image. Initial tests using the 150 mm diameter, gold coated Vulcan deformable mirrors with new commercial software have been successfully completed.

A new design of double sided dielectric coated mirror has been devised, allowing the use of high damage threshold, high reflectivity coatings. The mirrors are currently being fabricated and tested, with the aim of characterising the system for installation in Astra-Gemini.



The optical layout of the new AO development lab.

Target Fabrication

Fabrication of mass produced microdot arrays for use as micro-targets on high-repetition rate experiments

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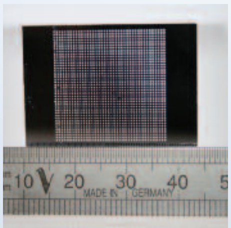
High Power Laser experiments to carry out fundamental research on subjects such as ion acceleration or condensed matter studies may require microdot targets of materials such as aluminium and iron. For example, when irradiating solid samples with the output of a free electron laser x-ray source the intensity distribution on target in such setups can span many orders of magnitude. As pulse shaping capabilities are not currently available in the X-ray regime one solution to this problem is to use dot targets which are smaller than the focused beam and thus spatially limit the range of intensities incident on the target.

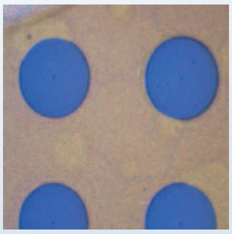
Typically these microdots are 3 to 5 microns in diameter with thicknesses up to a few microns, depending upon the material used. Furthermore, these dots need to be suspended by a minimal amount of low-Z support material and not simply mounted on the surface of a thick substrate. With the development of high repetition rate laser systems these microdots are shot in rapid succession (~1 min) and therefore the experiment requires a large number of such dots on a well defined grid to aid locating and rapidly stepping between dots during the experimental run.

Figures show (a) the micromachined silicon target mount with a 1600 target apertures, (b) an optical micrograph of four Fe dot targets on the mount and (c) scanning electron micrograph of a typical Fe dot target.

(a)



(b)



(c)

Thin-film measurements of multilayered foils using electron dispersive X-ray spectroscopy

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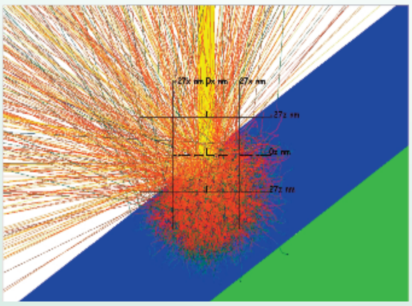
At its current state non-destructive thin-film measurements can be performed using SEM EDX spectroscopy for multilayered coatings or foils to within a limited accuracy for a total thickness up to around 2 microns depending on the materials.

Such coatings and foils have been used for phase plates, x-ray backlighters, optical coatings, filters, etc. What is essential is that the thickness of these deposited layers is known but in some cases traditional thickness measurements are not suitable or appropriate. A non-destructive method for making such measurements is described. EDX non-destructive measurements take advantage of the Bethe Range developed by Kanaya and Okayama and the principles of Energy Dispersive X-ray Spectroscopy in order to obtain thickness measurements for single or multiple layers. Simulation software was used to verify findings and can be used to examine in more detail the 3D nature of electron penetration.



Simulation of penetrating electron beam into an 88nm thick Al layer (blue) on a SiO2 substrate at 35°. The colour of the electron trails depicts their energy (yellow high).

A series of aluminium test runs of varying thickness were performed for simplicity to check against theoretical predictions before examining a dual-material dual-coating Caesium Iodide (CsI) / Tin Telluride (SnTe) / Glass substrate sample.

Experimental and theoretical results are in fairly good agreement and there are a number of areas available to greatly improve this technique.

High volume production of thin foil laser targets for use on next generation laser facilities

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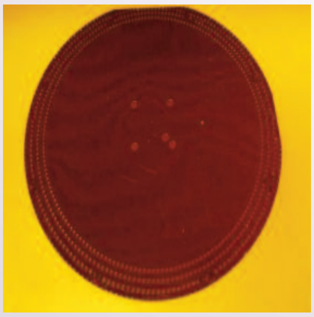
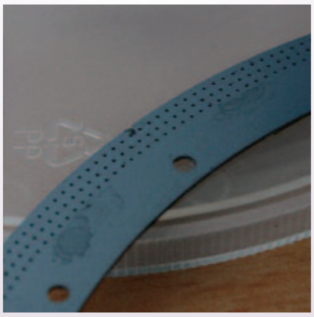
There is development across Europe and the wider international community of high power, high repetition rate laser systems such as the Astra Gemini laser at RAL, the ELI project, and eventually IFE facilities such as HiPER and LIFE. Established methods of target fabrication are less suited to meeting the high volume demand for high specification targets. This report looks at the Central Laser Facility development project to produce a 'Nano-positioning wheel' concept and to develop the target technologies required to deliver a reliable high production number stream of targets to this wheel.

A system has been designed at RAL to field targets that are produced around the outside of a 100 or 150mm diameter wafer. These targets are manufactured using conventional MEMS techniques integrated with established and well know target fabrication capabilities. Novel solutions for the combination of these two disciplines to deliver complex targets for high power lasers are discussed. The fabrication of a populated disk is described and the mounting onto a precision stage that has 6 axis controls (3 linear and 3 rotational stages) is detailed. Furthermore design changes and challenges that have arisen in the process are discussed.





Images of two types of wafer based targets.

Design for production of thin film solid hydrogen targets

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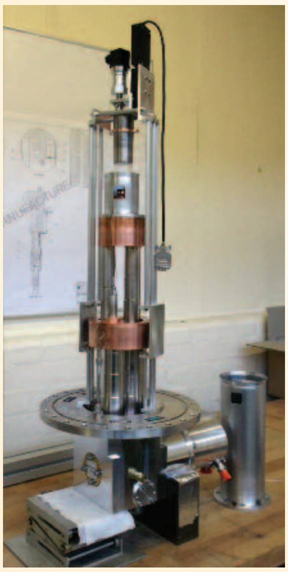

There is interest in accessing new physical mechanisms for the acceleration of ions using high energy lasers, one of which is Light Sail Radiation Pressure Acceleration (LSRPA). LSRPA requires a solid thin film target and the material with the lowest solid density is hydrogen.

CLF is currently developing a cryogenic system to produce solid hydrogen targets using a condensation method. The desired target parameters are 2-5mm diameter and 50 micron thickness. The target and cryogenic system will be situated in a vacuum of $1x10^{-6}$mbar within a target chamber required for laser operations.

The properties of hydrogen and its phase behavior define what cooling and control methods are required for the design of the cryogenic targetry system. The design of the system needs to control the temperature and pressure of the hydrogen such that it is kept between the critical and triple point.

A 4K Pulse Tube Cryocooler is utilised to cool the target end. A target mount is fixed to the end of the pulse tube to hold the target foils and provide a suitable location for heaters and temperature sensors. The whole system is in a vacuum chamber, so a local removable gas boundary is used to contain a small volume of gas around the foil during target production. A pressure sensor is fitted to the local boundary. The hydrogen gas is fed into the local gas boundary vessel through a path of stainless steel capillary tubes through a heat exchanger, which is connected to the first stage of the pulse tube. Radiation shields, consisting of an Aluminium former and Multi-Layer Insulation (MLI) have been installed around the system to limit the heat load on the target end from room radiation.

DiPOLE & HiPER

First light from the DiPOLE project 73

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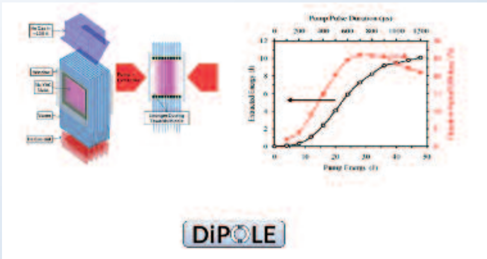
We report the first results of the DiPOLE amplifier system, a concept developed at the Central Laser Facility (CLF) based on a diode-pumped, gas cooled, cryogenic multi-slab Yb:YAG amplifier. The system performance was characterised over a temperature range from 88 K to 175 K. A maximum small-signal single-pass longitudinal gain of 11.0 was measured at 88 K. When amplifying ns-pulses, recorded output energies were 10.1 J at 1 Hz in a 4-pass extraction geometry and 6.4 J at 10 Hz in a 3-pass setup, corresponding to optical-to-optical conversion efficiencies of 21 % and 16 %, respectively. To our knowledge, this represents the highest pulse energy so far obtained from a cryo-cooled Yb-laser and the highest efficiency from a multi-J DPSSL system. Additionally, we describe the current status of the relay imaging multi-pass extraction architecture, capable of supporting up to nine passes required for achieving even higher optical-to-optical efficiencies by enabling operations at higher coolent temperatures with reduced gain and ASE loss. Furthermore, we discuss in brief the future plans for an upgrade of DiPOLE to 100J output at 10Hz, which will enable us to realize a PW-class, multi-Hz laser facility building on the existing Astra-Gemini system.



Two beam spatial and temporal coherent phasing with femtosecond pulses 74

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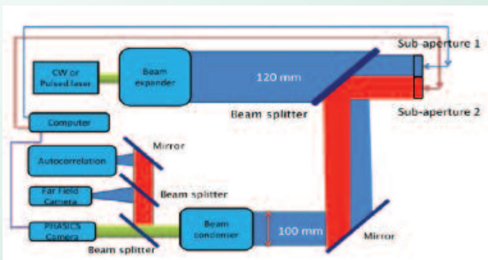
High average powered lasers are attractive owing to their potential for enabling a diverse range of experiments. The power extractable from current laser systems is limited by the size and damage threshold of the amplifying medium or other optical components. Other important additional factors limiting the scale of amplifiers for repetitive systems are ASE, laser material growth, thermal effects and depolarization. An alternative scheme of achieving high power is to combine several beams into a monolithic beam, which immediately reduces the requirements for the amplifier to a more modest level. We have developed a test bed to investigate a method for spatial recombining and temporal overlap. We have a Ti:Sapphire laser which can produce pulses of ~200 fs , ~5 nJ of energy per pulse and has a wavelength tuning range of 950-1080 nm at 80 MHz. In these experiments the laser is used in the femtosecond mode at a centre wavelength of 1030 nm. We will describe an experiment in which two pulses are generated from the same laser and then split into two subapertures of 50 mm square and then they are combined using a unique wavefront sensor in the spatial domain and then also in the temporal domain showing full beam coherence.



Instrumentation, Engineering and Plasma Diagnostics

Proton film packs for multi-shot experiments

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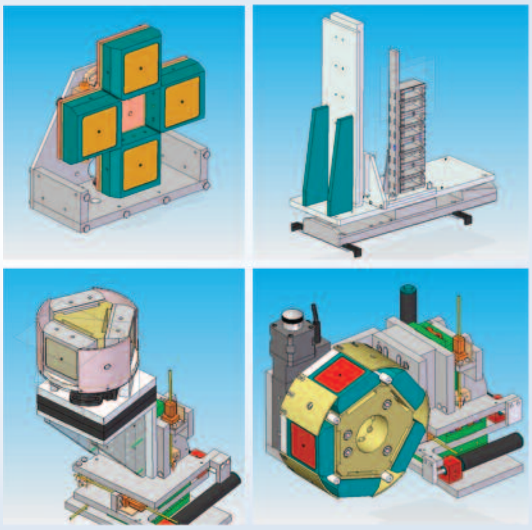
The CLF has been expanding the range of diagnostic designs for proton film stacks. The 4 designs now available provide flexibility for different experimental types, use of multiple diagnostics as well as providing multi-shot uses.



Mitigation of EMP effects for imaging specularly reflected light on Vulcan-PW

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The interaction of intense laser pulses with solid targets produces a multitude of radiation. This is an extremely harsh environment for sensitive electronic equipment to operate in. Over the course of an experiment both data and time are commonly lost due to such equipment being “knocked out” during a shot. Simple techniques to avoid these effects help improve diagnostic reliability and shot-to-shot repetition rates.

In this report we introduce a simple technique to increase standoff distance and flexibility of position for some optical diagnostics by using a combination of a high magnification telephoto lens and an optical fibre bundle. The result is to reduce, significantly, the prominence of EMP effects over the course of a given experiment.

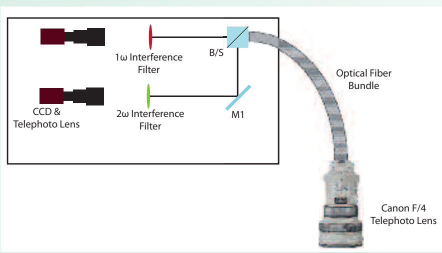

Figure.1: Schematic of diagnostic arrangement. High magnification lens and fibre optic bundle provide standoff distance from interaction and enables access for multiple output channels.

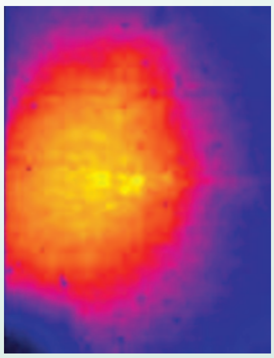

Figure.2: Example image of specularly reflect light taken with fiber bundle arrangement.

Modified Thomson parabola design for high energy, multispecies ion source

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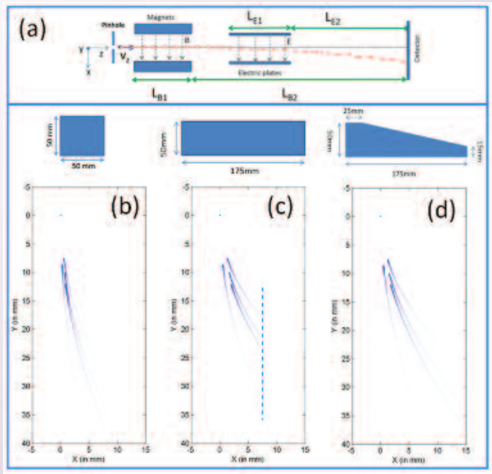
With the growing need for compact, high-resolution ion spectrometer for characterisation of 10s MeV/nucleon ions produced by high power laser plasma interactions, we have studied a potential modification to the standard Thompson parabola spectrometer [figure (a)] currently used in experiments. We have proposed to use extended, trapezoidally shaped electric plates [figure (b)], which will provide, not only better trace separation for high energy ions, but also will retain the lower energy part of the spectrum. While longer plates [figure (c)] provide a more effective charge state separation at the high energy end of the spectra as compared to shorter plates with a commensurately higher electric field strength, the trapezoidal shape also allows the low energy ions to reach the detector, avoiding clipping of this component by the plates.



(a) Schematic diagram of a Thomson Parabola Spectrometer; (b),(c),(d): Comparison between the Thompson parabola traces for several ion species (protons, C6+, C5+ and C4+ from left to right respectively) obtained using different electric plate designs – (b) 50 mm x 50 mm rectangular plates, (c) 50 mm x 175 mm rectangular plates and (d) 50 mm x 175 mm trapezoidal plate as shown on top of the simulated images. All other parameters were kept same in all cases, viz. E=1x10^6 V/m, B=0.5T, L_{B1}=50mm, L_{B2}=235 mm. The species separation is significantly improved by using longer electric plates at same potential. However, the low energy ions are clipped by the rectangular plate, as shown by the dotted line in (c). The trapezoidal plate allows the low energy ions to pass over the top of the plate, while keeping the same trace separation for high energy ions obtained in (c).

Cryogenic pump induced vibration in the TAP interaction chamber

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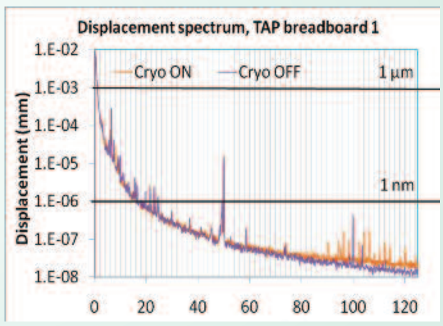
The SHI Marathon CP-16 Cryogenic vacuum pump has been installed on both the TAP and Gemini Interaction Chambers. It has consistently delivered an improvement in vacuum levels by one decade instantly. Cryogenic vacuum pumps are a source of vibration and this has impacted experiments in Gemini. Due to the problems on Gemini an investigation was instigated to determine the effect on TAP and improve our knowledge of good chamber design. This report details the use of a number of analysis techniques to determine whether the Cryogenic pump could be directly connected to the TAP interaction chamber without impeding experiments.

Analysis suggests that the design of the TAP interaction chamber is more appropriate than the Gemini chamber for use with a cryogenic pump. The figure shows a trace with both the cryogenic pump on and off and the displacement induced is insignificant. For full details of the analysis carried out please see the full report.



0-125Hz displacement spectrum at breadboard 1.