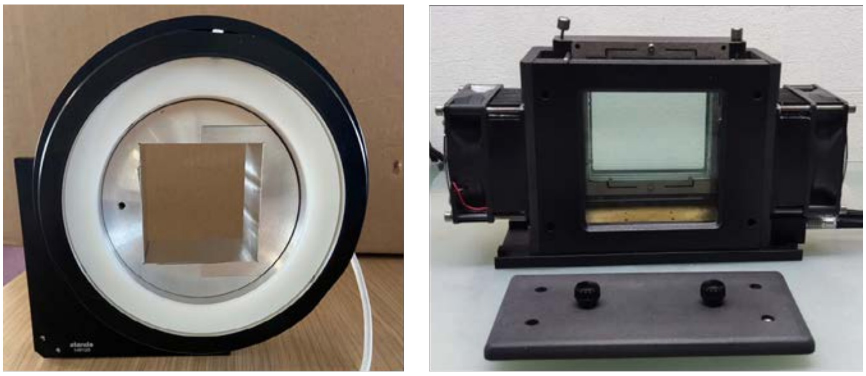
Laser Science and Development

Improved stability second harmonic conversion of a diode-pumped Yb:YAG laser at the 0.5 kW level

We report on the efficient and stable, type-I phase-matched second harmonic conversion of a nanosecond high-energy, diode-pumped, Yb:YAG laser. With a frequency-doubling crystal in an enclosed temperature controller with optical windows, 0.5% energy stability was achieved for approximately half an hour. This resulted in 48.9 J pulses at 10 Hz (489 W) and a conversion efficiency of 73.8%. These results are particularly important for stable and reliable operation of high-energy, frequency-doubled lasers.



(a) (b)

Figure 1: LBO crystal temperature-controllers (a) TC1 and (b) TC2, enclosed with optical windows (Applied Mezo Systems).

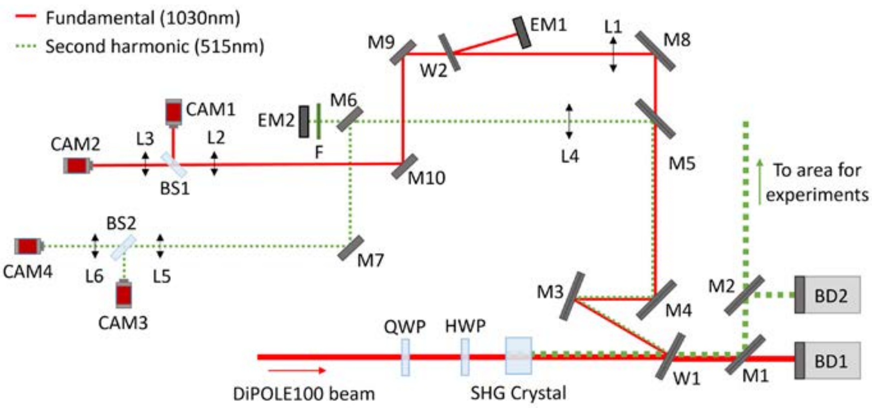
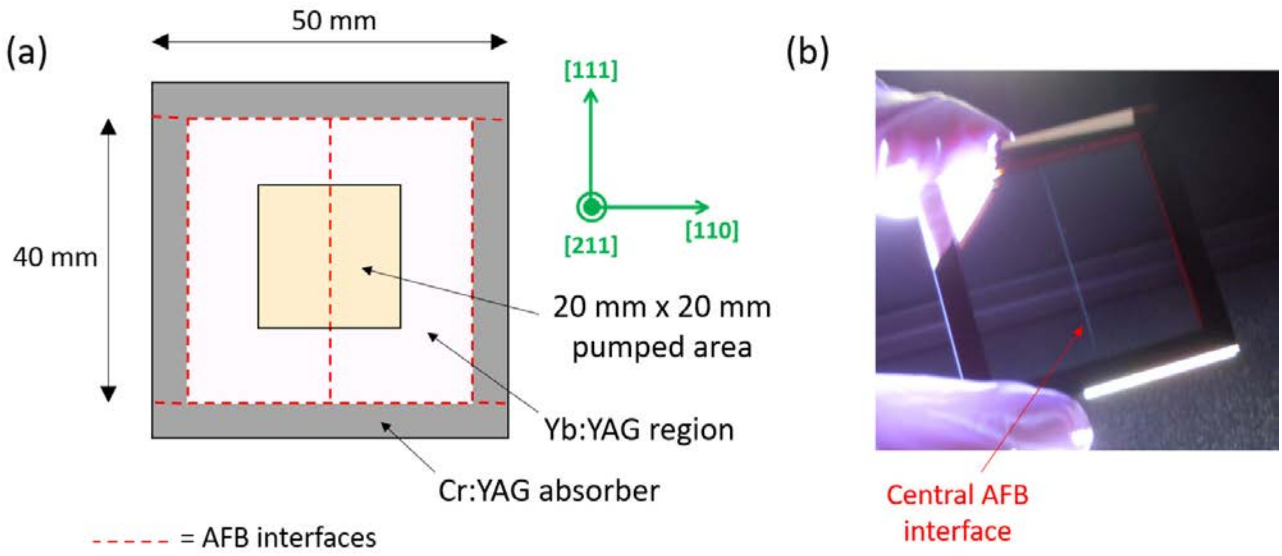


Figure 2: Schematic of the SHG experimental setup.

Authors: **D.L. Clarke**, P.J. Phillips, M. Divoky, J. Pilar, P. Navratil, M. Hanus, P. Severova, O. Denk, T. Paliesek, M. Smrz, P.D. Mason, T.J. Butcher, C.B. Edwards, J.L. Collier, T. Mocek

High energy, high pulse rate laser operation using crystalline adhesive-free bonded Yb:YAG slabs

We report on the successful amplification of 10 ns pulses to 10 J energy at 10 Hz in a DiPOLE laser amplifier using crystalline Yb:YAG/Cr:YAG composite slabs manufactured using adhesive-free bonding (AFB) technology. We demonstrate that bonded slabs are suitable for operation in high energy cryogenic laser amplifiers. We also report on frequency doubling of the beam amplified in the bonded slabs. When the pulse energy of the output infrared beam is set to 5 J, a pulse energy of 3.9 J is achieved in the green (corresponding to 78% conversion efficiency). Results demonstrate that AFB technology is suitable for producing large-sized gain material slabs and can overcome current limitations in the manufacture of large-aperture gain material pieces. We believe this work will facilitate energy scaling of high energy lasers where aperture scaling of optical elements is not achievable via conventional manufacturing techniques.



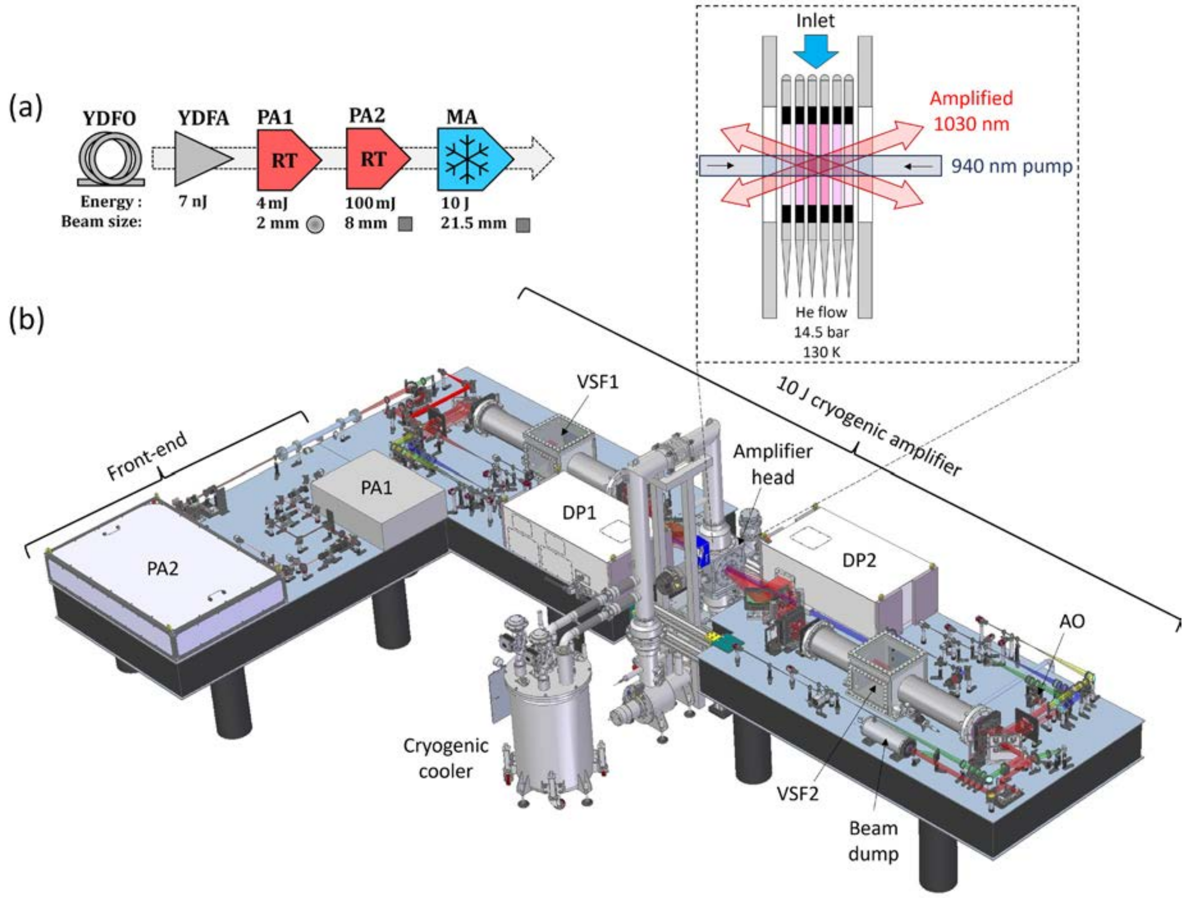
(a) Drawing showing composite slab geometry, position of AFB interfaces (red dotted lines) and area exposed to laser irradiation (yellow area). The green arrows indicate the crystal orientation.

(b) Photo of one of the bonded slabs under bright white light illumination. The bonding interface is visible at the centre of the slab.

Authors: M. De Vido ✉, P.J. Phillips, D. Meissner, S. Meissner, G. Quinn, S. Banerjee, M. Divoky, P.D. Mason

Demonstration of stable, long-term operation of a nanosecond pulsed DPSSL at 10 J, 100 Hz

We report on the stable, long-term operation of a diode-pumped solid-state laser (DPSSL) amplifying 15 ns pulses at 1029.5 nm wavelength to 10 J energy at 100 Hz pulse rate, corresponding to 1 kW average power, with 25.4% optical-to-optical efficiency. The laser was operated at this level for over 45 minutes (~3 x 10^5 shots) in two separate runs with a rms energy stability of 1%. The laser was also operated at 7 J, 100 Hz for four hours (1.44 x 10^6 shots) with a rms long-term energy stability of 1% and no need for user intervention. To the best of our knowledge, this is the first time that long-term reliable amplification of a kW-class high energy nanosecond pulsed DPSSL at 100 Hz has been demonstrated.



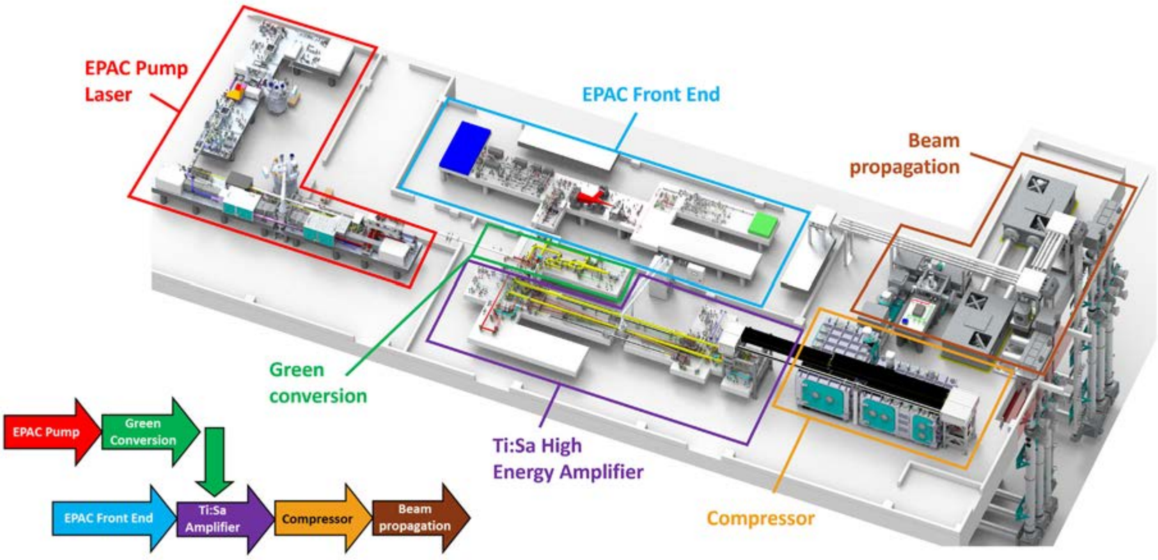
(a) Schematic of the DiPOLE-100Hz laser chain showing typical output performance after each stage: YDFO / YDFA = Yb-silica fiber oscillator / amplifier; PA = room-temperature pre-amplifier (1 = Yb:YAG regenerative, 2 = Yb:YAG multi-pass); MA = main cryogenic amplifier (Yb:YAG multi-slab). (b) 3D rendering of the DiPOLE 100 Hz system: DP = diode pump; VSF = vacuum spatial filter; AO = adaptive optic mirror. Inset: Schematic of main cryogenic amplifier head, showing pump and extraction geometry.

Reproduced from M. De Vido et al., "Demonstration of stable, long-term operation of a nanosecond pulsed DPSSL at 10 J, 100 Hz," Opt. Express 32, 11907-11915 (2024), published by Optica Publishing Group under the terms of the **CC-BY-4.0 license**.
doi: 10.1364/OE.521049

Authors: M. De Vido ✉, G. Quinn, D.L. Clarke, L. McHugh, P.D. Mason, J.L. Spear, J.M. Smith, M. Divoky, J, Pilar, O. Denk, T.J. Butcher, C.B. Edwards, T. Mocek, J.L. Collier

Progress on Laser Development at the Extreme Photonics Applications Centre

The Extreme Photonics Applications Centre (EPAC) is a new state-of-the-art laser facility being built at the Central Laser Facility (CLF) to study applications of laser-driven sources in industry, medicine, and security. The first laser system to be built in the facility is a petawatt laser delivering 30 J, 30 fs pulses at 10 Hz pulse rate that will be used to drive plasma accelerators. This petawatt laser will be housed on the second floor of a new dedicated building that was completed in April 2022.



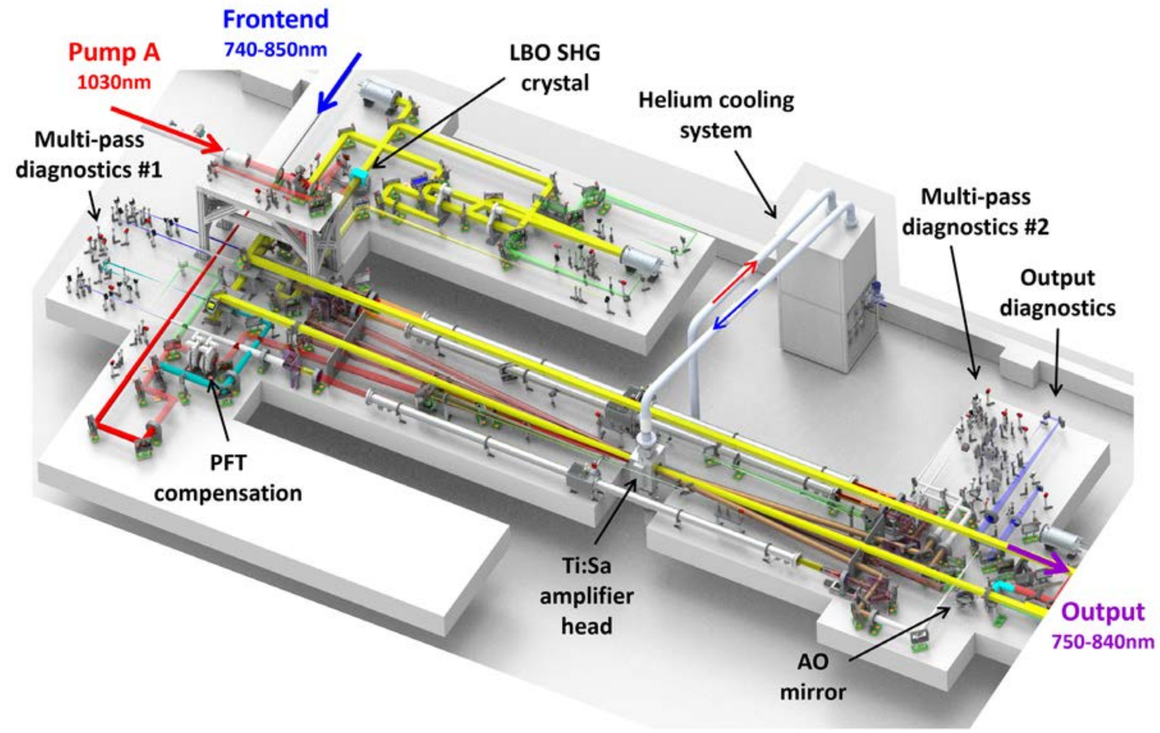
Layout and schematic of the EPAC 30 J, 30 fs, 10 Hz petawatt laser.

Presented at Conference on Lasers and Electro-Optics/Europe (CLEO/Europe 2023) and European Quantum Electronics Conference (EQEC 2023), Technical Digest Series (Optica Publishing Group, 2023), paper ca_8_2.
https://opg.optica.org/abstract.cfm?URI=CLEO_Europe-2023-ca_8_2

Authors: P.D. Mason, N.H. Stuart, P.J. Phillips, R. Heathcote, S. Buck, A. Wojtusiak, M. Galimberti, T. de Faria Pinto, S. Hawkes, S. Tomlinson, R. Pattathil, T.J. Butcher, C. Hernandez-Gomez, J.L. Collier

Design of a High Energy Ti:Sapphire Amplifier for the Extreme Photonics Applications Centre

This paper presents details of a high energy Ti:Sapphire amplifier, capable of delivering up to 50 J broadband pulses at 10 Hz for a state-of-the-art petawatt laser-driver at the Extreme Photonics Applications Centre (EPAC).



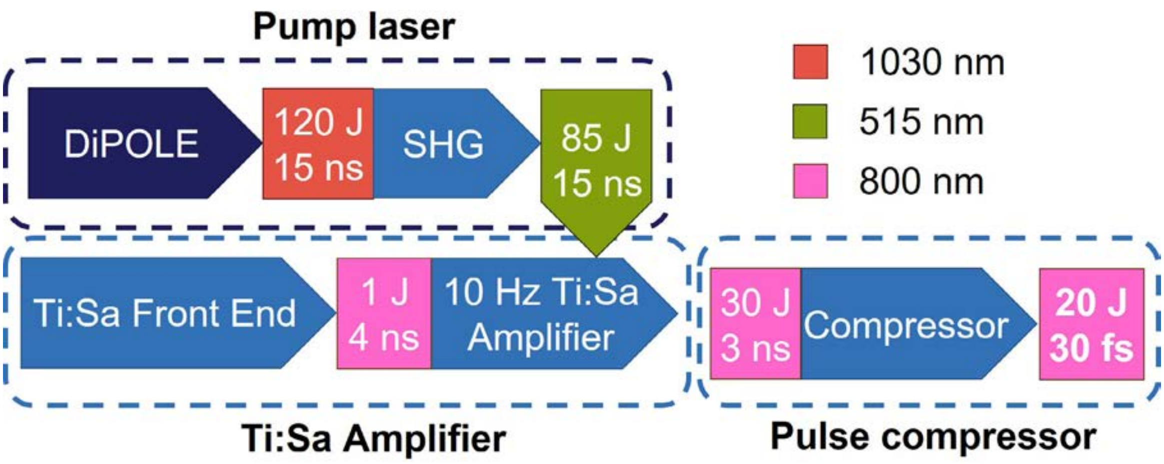
Layout of EPAC high energy Ti:Sa amplifier, highlighting key system components.

Presented at the 12th Advanced Lasers and Photon Sources Conference (ALPS2023), Japan, 18 - 21 April 2023

Authors: **P.D. Mason**, R. Heathcote, P.J. Phillips, T. de Faria Pinto, O. Chekhlov, Y. Tang, H. Schmitz, M. Harman, A. Wojtusiak, S. Hawkes, S. Tomlinson, T.J. Butcher, C. Hernandez-Gomes, J.L. Collier

Modelling the energetics of a potential new-look 10 Hz, 100 J class DiPOLE amplifier

This paper describes an investigation to identify possible modifications of the existing 100 J DiPOLE amplifier design, looking ahead to future systems with a particular focus on the second EPAC Pump Laser that will be used to pump a high energy Ti:Sa amplifier. Standard amplifier design rules are reviewed, and a 1D energetics model is used in tandem with previous experimental results to investigate the impact of relaxing previous design constraints.



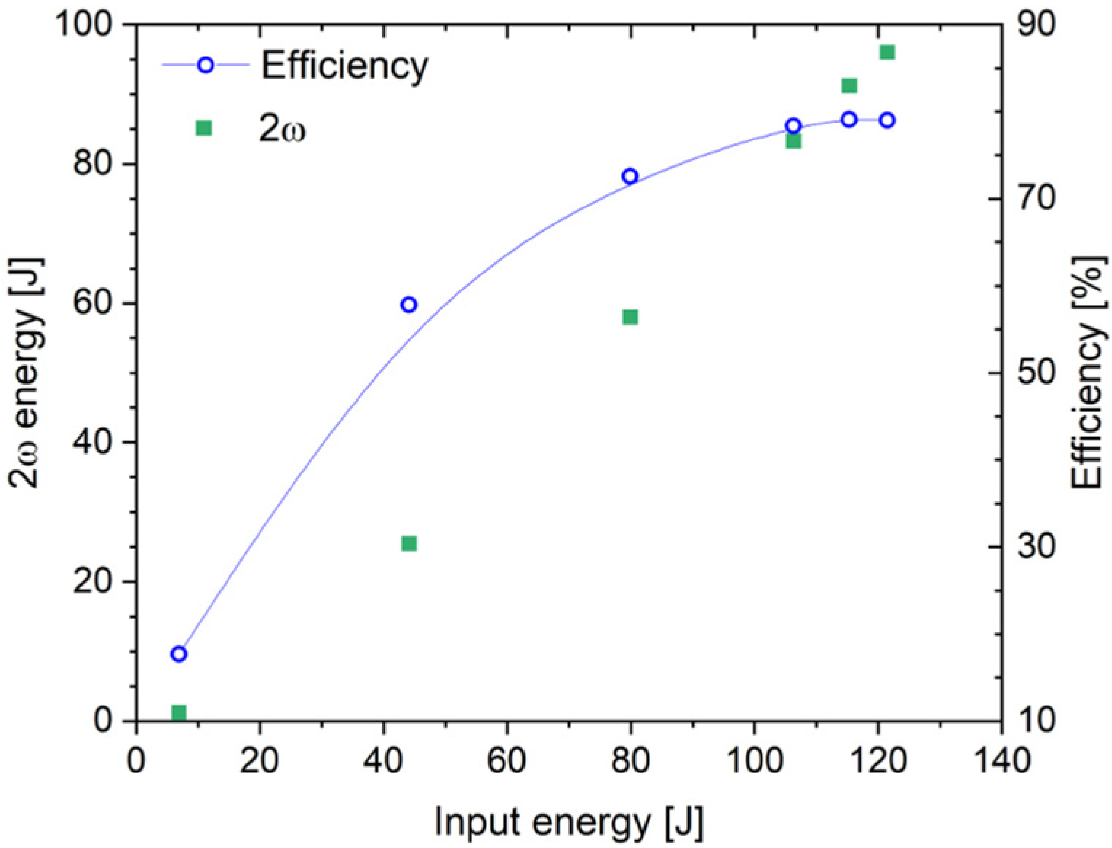
A simplified version of the 10 Hz Petawatt laser currently under construction in EPAC. A second DiPOLE100 system will be added in parallel to nearly double the available green pump energy and enable petawatt (30 J, 30 fs) operation.

Presented at Laser Congress 2023 (ASSL, LAC), Technical Digest Series (Optica Publishing Group, 2023), paper JM4A.5. doi: 10.1364/ASSL.2023.JM4A.5

Authors: **L. McHugh** ✉, P.D. Mason, P.J. Phillips, T.J. Butcher, C. Hernandez-Gomez

Kilowatt-class high-energy frequency conversion to 95 J at 10 Hz at 515 nm

We report on frequency doubling of high-energy, high repetition rate nanosecond pulses from a cryogenically gas cooled multi-slab ytterbium-doped yttrium aluminium garnet laser system, Bivoj/DiPOLE, using a type-I phase matched lithium triborate crystal. We achieved conversion to 515 nm with energy of 95 J at repetition rate of 10 Hz and conversion efficiency of 79%. High conversion efficiency was achieved due to successful depolarization compensation of the fundamental input beam.



Dependence of the second harmonic frequency output energy and conversion efficiency on the input energy during the energy ramp at the beginning of the experiment.

Authors: M. Divoky, P.J. Phillips, J. Pilar, M. Hanus, P. Navratil, O. Denk, T. Paliesek, P. Severova, **D. Clarke** ✉, M. Smrz, T.J. Butcher, C.B. Edwards, J.L. Collier, T. Mocek

Pathway for experiments for a DiPOLE D100-X 100 J amplifier synchronised to the European XFEL

A 100 J DiPOLE amplifier, with the capability to have arbitrary pulse shaping, has been successful installed at the European XFEL in Hamburg for High Energy Density Physics.

We have demonstrated 70 J at 1 Hz, which has been delivered to the target chamber for an experiment using frequency doubled energy at 60% efficiency. During the experimental period, the system was run for 24 hours over a period of seven days.

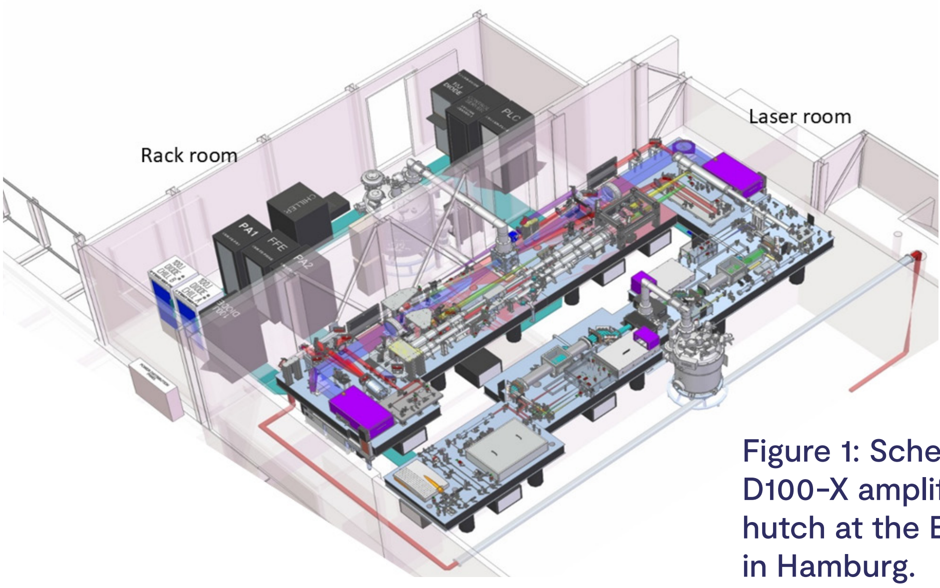


Figure 1: Schematic of the D100-X amplifier in the laser hutch at the European XFEL in Hamburg.

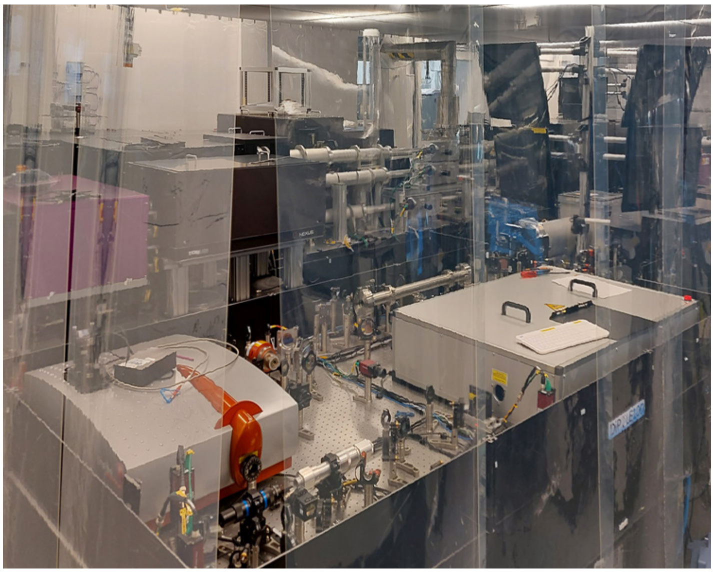


Figure 2: Image of the system installed in the Laser Hutch at the European XFEL.

Presented at Photonics West 2024: P.J. Phillips et al., "Pathway for experiments for a DiPOLE D100-X 100 J Amplifier synchronized to the European XFEL," Proc. SPIE PC12864, Solid State Lasers XXXIII: Technology and Devices, PC128640C (13 March 2024). doi: 10.1117/12.3005649.

Authors: P.J. Phillips, P.D. Mason, **J.L. Spear** ✉, J. Smith, S. Banerjee, A. Shepperd, T.J. Butcher, C.B. Edwards, R. Harding, E. Brambrink, T. Zata, S.D. Cafiso, M. Toncian, M. Masruri, H. Hoeppner, K. Knoefel, J-P. Shwinkendorf, T. Toncian, T. Cowan, C. Hernandez-Gomez, J.L. Collier

Overview of optical characterisation capabilities for assessing suitability of optics for high-energy, high repetition rate lasers

We present an overview of the optical characterisation capabilities available at the Central Laser Facility and describe how they are used to assess the suitability of optics and coatings for high-energy, high repetition rate laser.

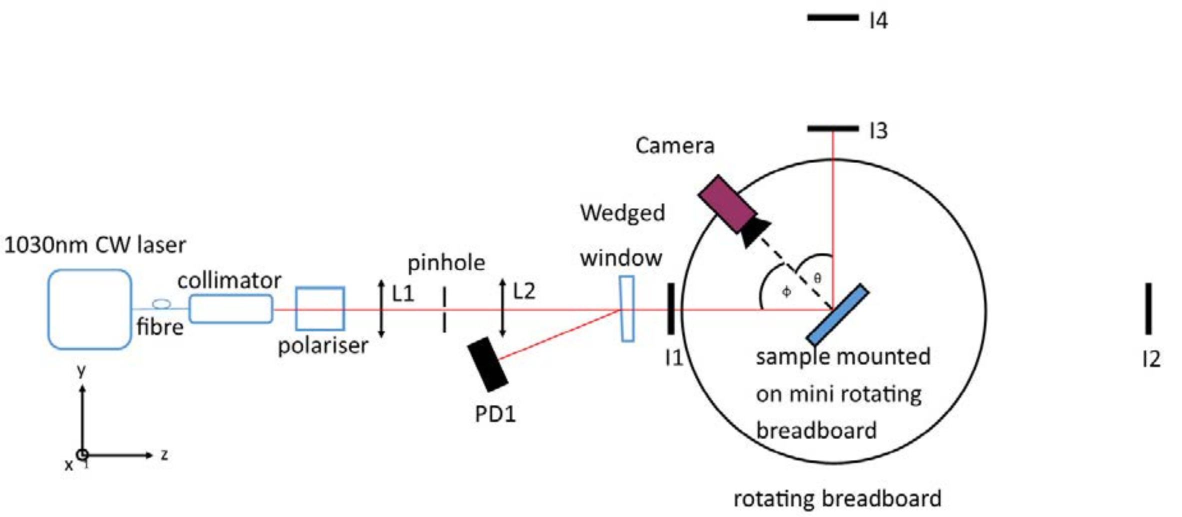


Figure 1: Layout of the setup used for measuring the transmittance and reflection of optical coatings over a range of angles.

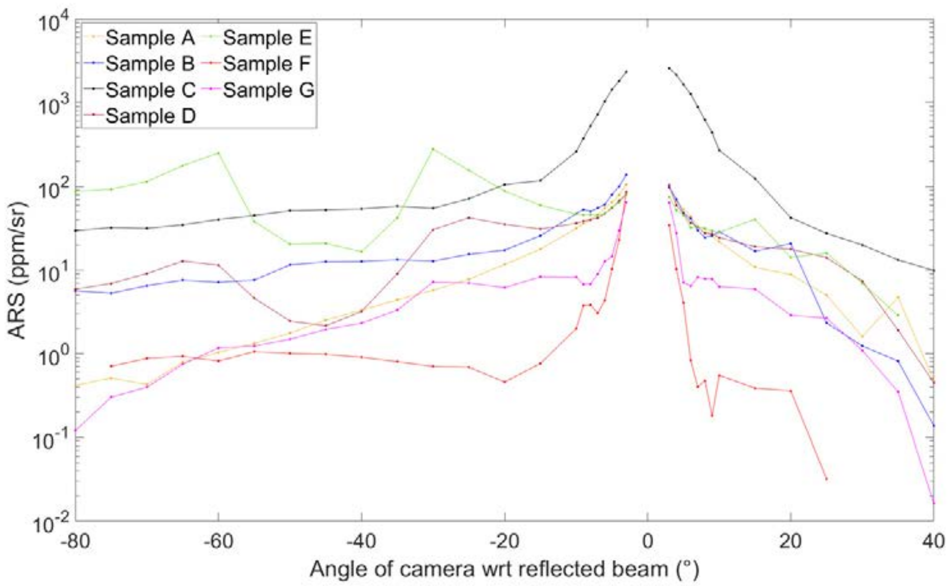


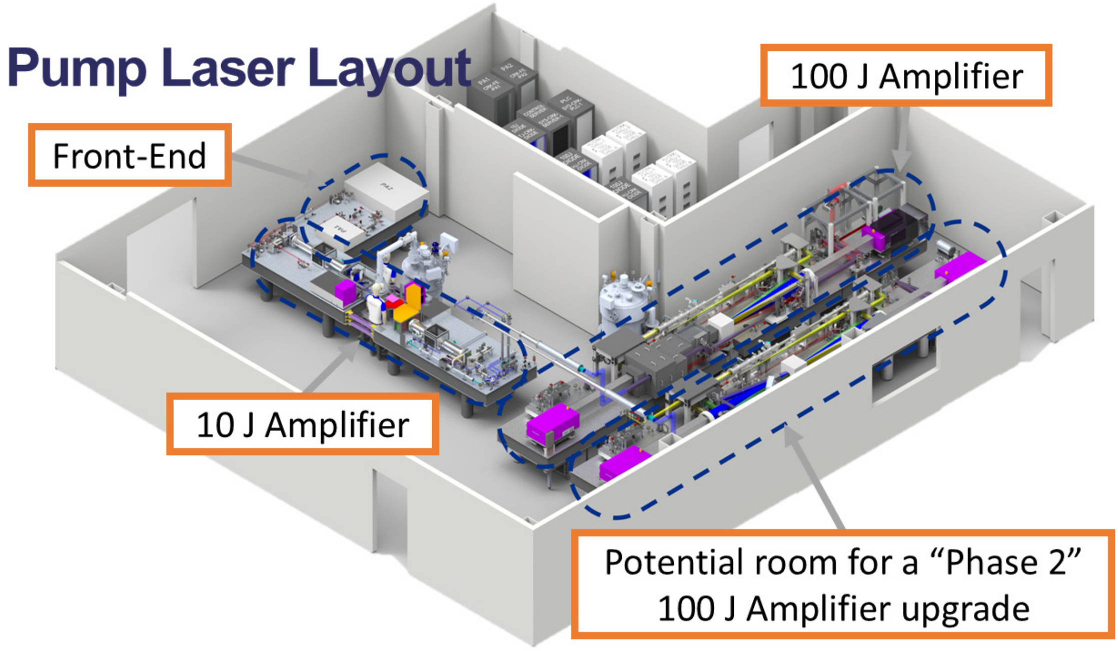
Figure 2: Experimental results of the angle-resolved scatter (ARS) from a number of HR mirror samples from different suppliers, with reflection optimised for 45°.

Presented at Laser Congress 2023 (ASSL, LAC), Technical Digest Series (Optica Publishing Group, 2023), paper JM4A.3. doi: 10.1364/ASSL.2023.JM4A.3.

Authors: **G. Quinn** ✉, D.L. Clarke, M. De Vido

Pump laser for the EPAC petawatt amplifier

The Extreme Photonics Applications Centre (EPAC) is a world-class research facility currently under development at the STFC Rutherford Appleton Laboratory in the United Kingdom. It will house a titanium-doped sapphire (Ti:Sa) amplifier, which will be capable of delivering petawatt-level pulses at an unprecedented repetition rate of 10 Hz. Such combination of high peak power and repetition rate will be achieved by pumping the Ti:Sa amplifier with a Diode-Pumped Solid State Laser (DPSSL) based on the Central Laser Facility's DiPOLE technology.



Schematic of the EPAC pump amplifier.

Presented at Photonics West 2024: A. Wojtusiak et al., "Pump laser for the EPAC petawatt amplifier," Proc. SPIE PC12864, Solid State Lasers XXXIII: Technology and Devices, PC128640D (13 March 2024). doi: 10.1117/12.3005639

Authors: **A. Wojtusiak**, P.J. Phillips, J. Smith, P.D. Mason, M. De Vido, T.J. Butcher, C. Hernandez-Gomez, J.L. Collier

Design of an electron energy spectrometer and energy selector for laser-plasma driven beams at EPAC

The Extreme Photonics Applications Centre (EPAC) is a new national facility currently under construction at the Rutherford Appleton Laboratory, UK. EPAC is designed to enable a wide variety of user experiments with a state-of-the-art petawatt-class laser system. It is anticipated that early experiments will include laser-plasma acceleration of electrons to energies ranging from 100 MeV to 5 GeV or higher, with later experiments using these electrons as a beam once stable generation is achieved. EPAC is designed to be flexible, allowing users to select the relevant central electron energy for their experiment. To achieve this goal, EPAC and the Accelerator Science and Technology Centre (ASTeC) at STFC Daresbury Laboratory have developed a beamline design to capture laser-plasma driven electrons with broad energy spread, measure their energy spectrum, perform selection of specific energies if necessary, and deliver these electrons to a user interaction point. We present here the conceptual design of the proposed spectrometer and energy selection system.

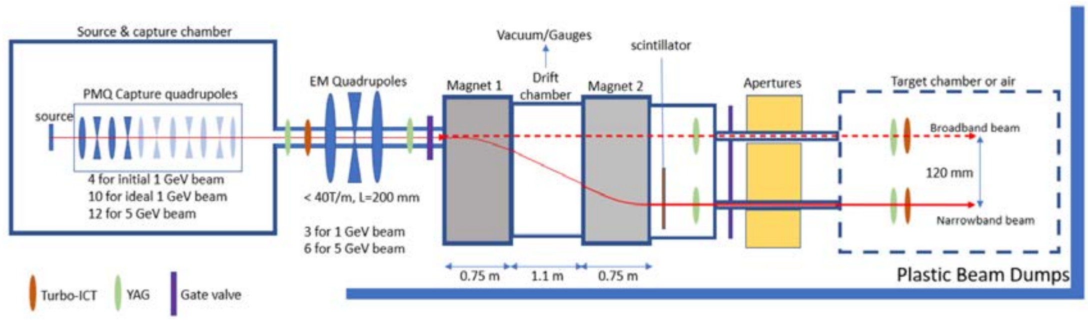


Figure 1: Overview of the basic layout of the proposed energy spectrometer chicane and energy selector, showing the spectrometer concept, energy selection, and proposed surrounding components. (Dimensions not to scale.)

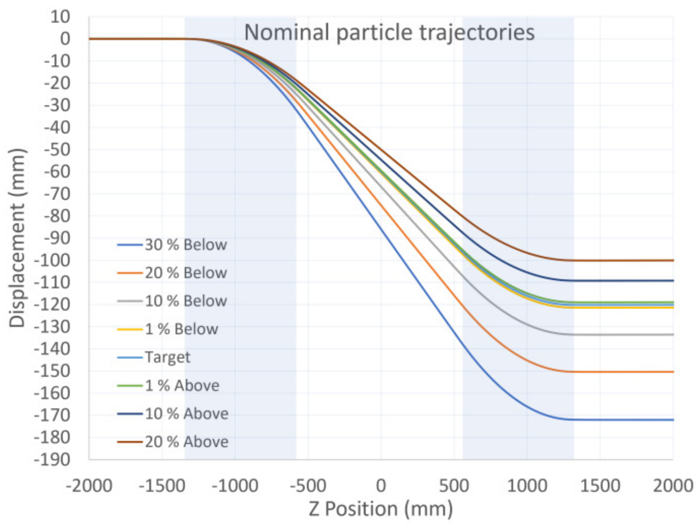


Figure 2: Simulated electron trajectories through the dipoles (shaded) showing the relation between electrons of the target energy and electrons of certain percentages above and below the target, assuming the field is chosen such that the central energy is displaced by 120 mm.

Reproduced from A.R. Bainbridge et al. Design of an electron energy spectrometer and energy selector for laser-plasma driven beams at EPAC, in Proc. 14th Int. Particle Accelerator Conf. (IPAC'23), paper THPL063, pp 4568-4571, under the terms of the **CC-BY-4.0 license**. doi: 10.18429/JACoW-IPAC2023-THPL063

Authors: A.R. Bainbridge ✉, J. Crone, J.K. Jones, B.D. Muratori, H.L. Owen, T.H. Pacey, B.J.A. Shepherd, D. Angal-Kalinin, D.R. Symes, N. Bourgeois

The EPAC electron transport beamline—physics considerations and design

The Extreme Photonics Applications Centre (EPAC) is a planned UK national facility, intended to use a 1 PW, 1 Hz laser system to drive laser-plasma acceleration with output energies ranging from 100 MeV up to at least 5 GeV. A design is presented in this paper for the capture and transport of the initially very divergent plasma-source electrons. We propose a unique, modular beam capture optics based on a FODO channel of Halbach permanent-magnet quadrupoles, which flexibly allows different-energy electron bunches to be captured and conditioned for experimental use. We show an engineering concept for the beamline that incorporates diagnostics and drive laser removal, and describe the effect of field errors and misalignments and their mitigation.

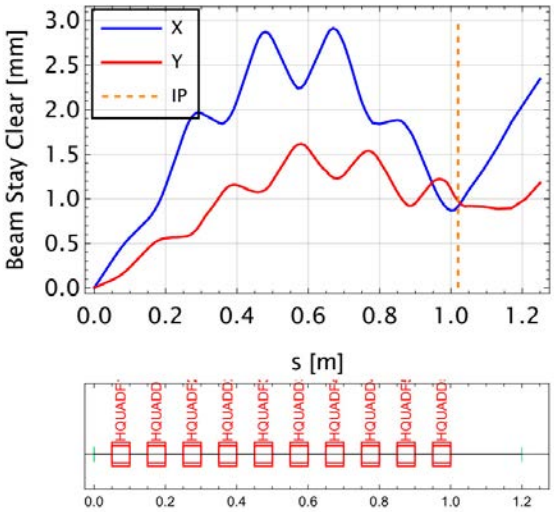


Figure 1: Beam stay clear as a function of distance in both planes for the 1 GeV permanent-magnet quadrupole (PMQ) array. IP position (orange) at ~1 m.

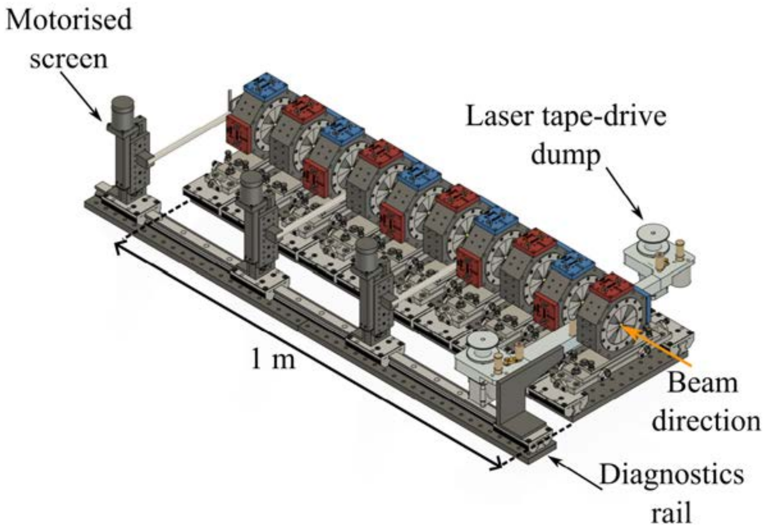


Figure 2: Engineering illustration of a 10 quadrupole capture array that may bring a 1 GeV electron bunch to a focus within around 1 m distance. Individual quadrupoles will be pre-aligned to around 50 µm relative accuracy (to the plasma source and to each other). One possible location for the tape drive beam dump is shown (between the first and second PMQs); also shown are the separately-mounted diagnostic screens and mounting mechanisms.

doi: 10.18429/JACoW-IPAC2023-TUPA105

Authors: B.D. Muratori ✉, A.R. Bainbridge, J. Crone, J.K. Jones, H.L. Owen, T.H. Pacey, D.R. Symes, N. Bourgeois

Upgrade to the Astra amplifier 3 optical pumping scheme

This report details an upgrade to the Gemini Astra amplifier 3 optical pumping scheme, which resulted in a doubling of the available pump energy from 3.5 J to 7 J and a smoother pump beam profile. This will be followed in the future by the installation of a larger-aperture Ti:Sa crystal, which will allow Astra amplifier 3 to double its output from 1 J to 2 J at 10 Hz.

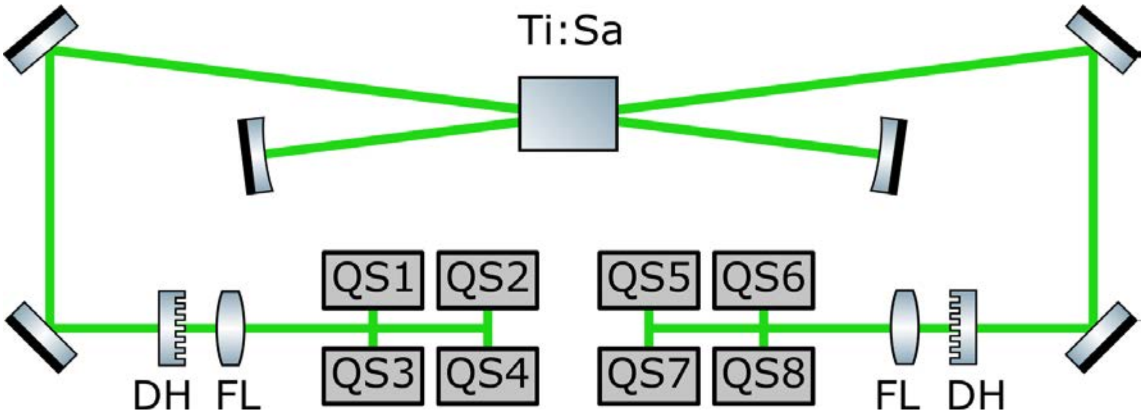


Figure 1: Astra amplifier 3 optical pumping layout. DH: diffractive homogeniser; FL: field lens.

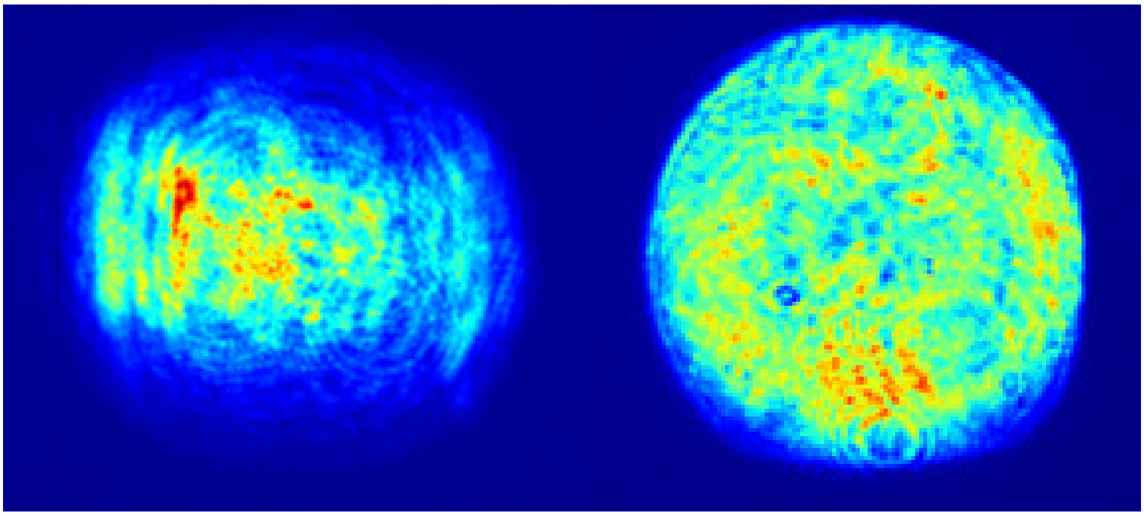


Figure 2: Left: Typical TA2 input near-field when pumped with Spectra Physics Quanta-Ray lasers. Right: Typical TA2 near-field when pumped with Lumibird Q-Smart HE 1500 lasers. Pulse energy of 1 J in both cases.

Authors: **T. de Faria Pinto**, O. Chekhlov, Y. Tang, S. Hawkes

Neutral gas interferometry in Gemini TA1

An important step to achieving stable, controlled laser wakefield acceleration is thorough design and characterisation of the gas targetry used. This is the remit of the EPAC gas target development programme, which includes fluid simulation, manufacturing and experimental testing of targets. An interferometry rig has been established in Gemini TA1 for experimental measurement of neutral gas density profiles generated by targets. An overview of the setup and the developments made in the last year are presented here.

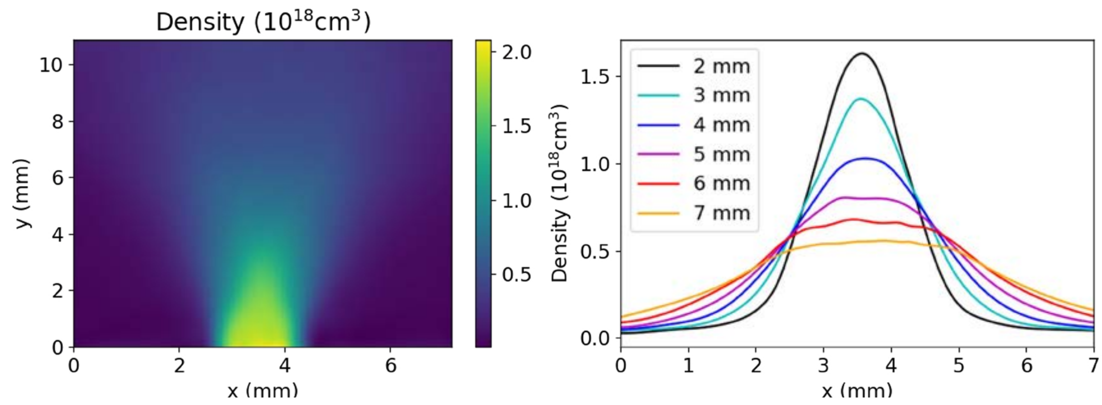


Figure 1: 2D density profile of the nozzle in the end-on geometry (left) and line outs at a number of heights above the nozzle (right).

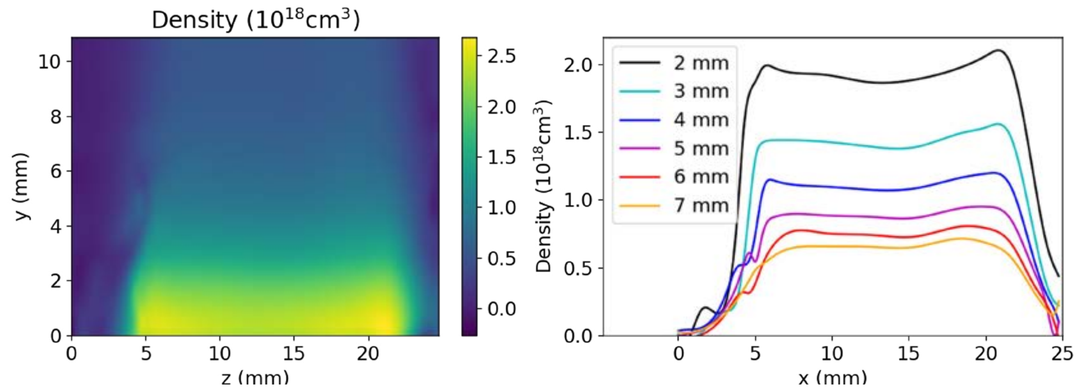


Figure 2: 2D density profile of the nozzle in the side-on geometry (left) and line outs at a number of heights above the nozzle (right).

Authors: **O. Finlay**, Z. Athawes-Phelps, D. Symes

Development of an optical probe for a laser wakefield accelerator in Gemini Target Area 2

A high repetition rate laser-wakefield accelerator will be established in Gemini TA2. This will allow for testing of optimisation, automation and stabilisation techniques that will be implemented at the Extreme Photonics Applications Centre (EPAC). This report details the commissioning of the optical probe that will allow us to monitor the plasma formed during accelerator operation.

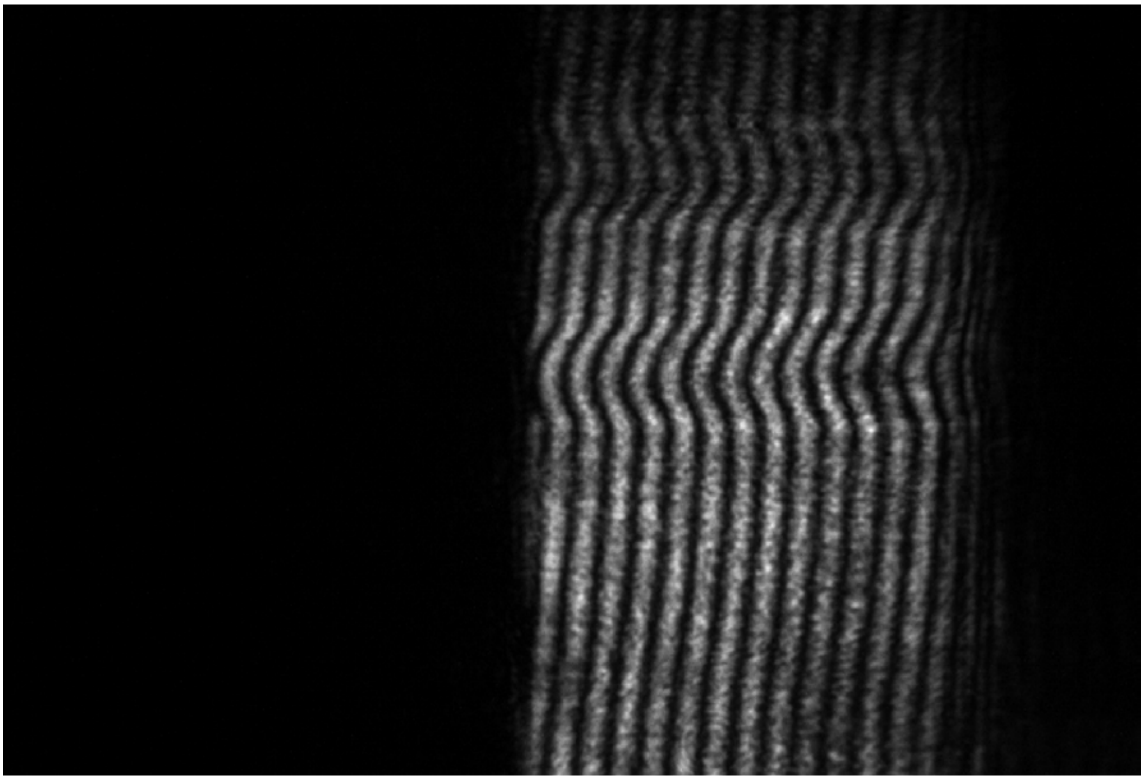


Figure 1: An interferometry image captured by the probe diagnostics showing a phase shift caused by the plasma during laser wakefield operation.

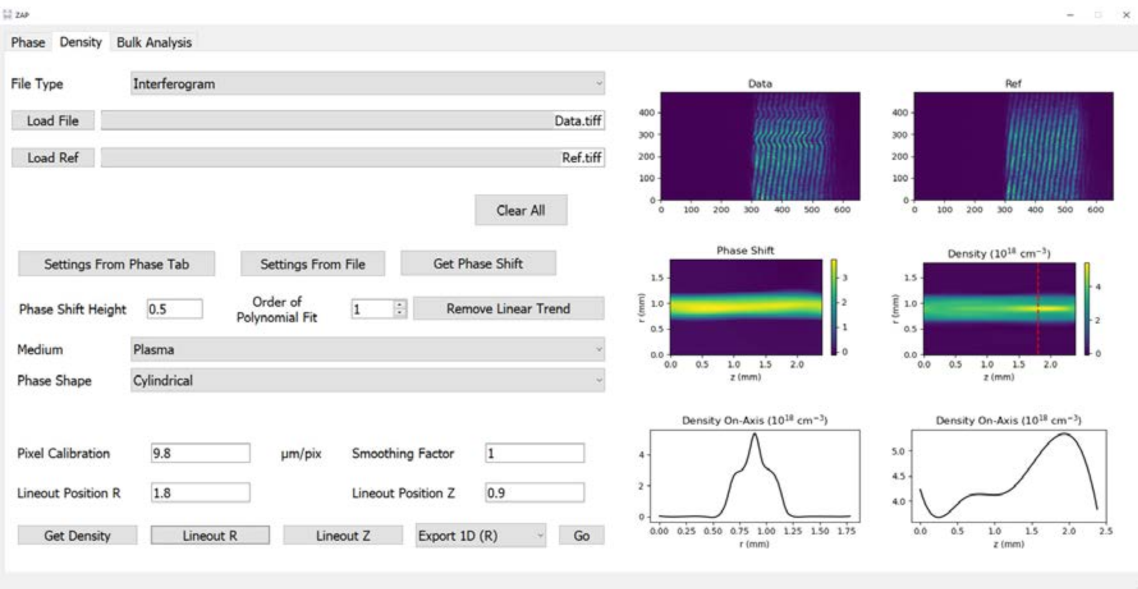


Figure 2: A screenshot of the phase and density retrieval software performing analysis on the data shown in Figure 1.

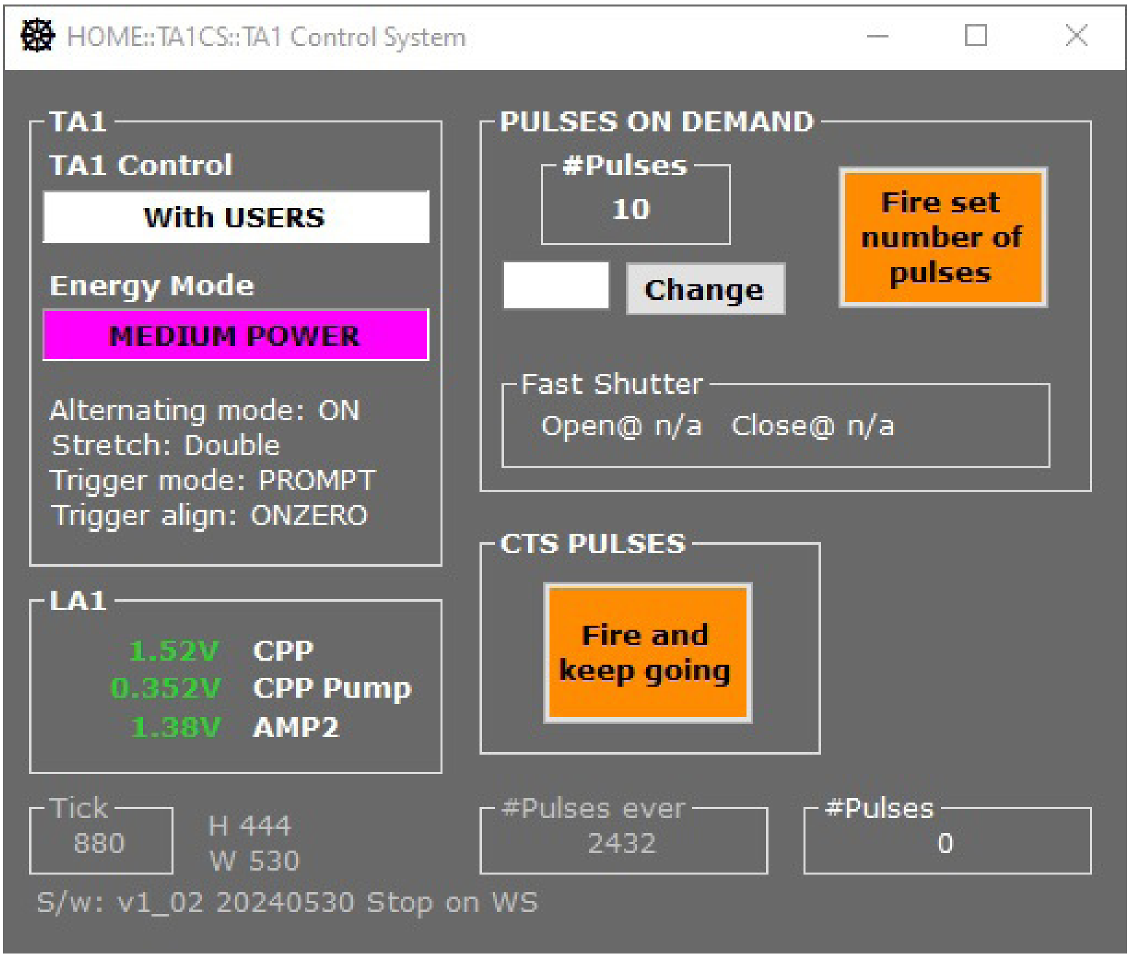
Authors: Z. Athawes-Phelps, T. Dzelzainis, K. Fedorov, **O. Finlay** ✉, D. Symes

Software developments in Gemini

Part of the commissioning process for the EPAC (Extreme Photonics Applications Centre) laser facility requires the development and testing of new laser diagnostics and characterisation of various optics to test their resilience to laser-induced damage. It is desirable to be able to do this with a laser operating at a repetition rate close to that of EPAC and as independently as possible from the rest of the facility so that long testing runs do not interfere with on-going experiments and other development work.

The original Astra laser Target Area, next to what is now Gemini TA2, was ideally suited for this purpose and so was brought back into service as TA1 (Target Area 1).

Various adjustments were made to the fabric of the room, including reopening the wall shutter between TA1 and the laser area, re-routing part of the beam through it, installing cabling for the laser network and updating the safety interlock system. A new TA1 Control System was also developed (see figure) and integrated with the existing main Gemini Control System.

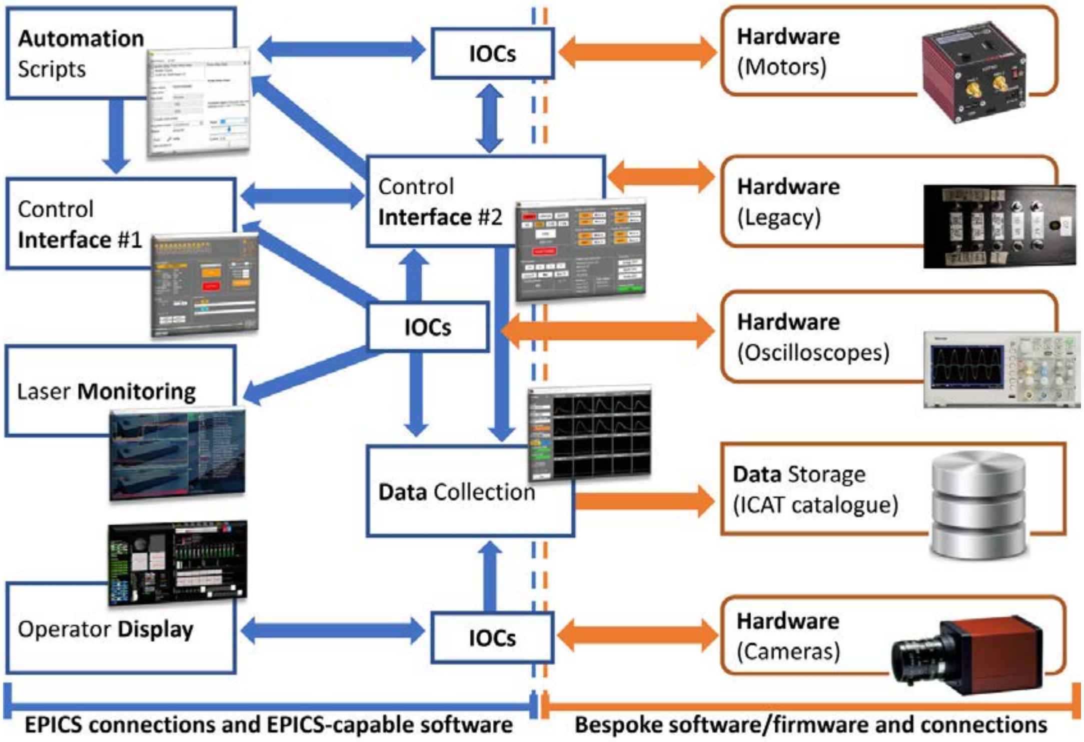


Screenshot of TA1 control system.

Authors: **V. Marshall**, N. Bourgeois

Control systems and data management for high-power laser facilities

The next generation of high-power lasers enables repetition of experiments at orders of magnitude higher frequency than what was possible using the prior generation. Facilities requiring human intervention between laser repetitions need to adapt in order to keep pace with the new laser technology. A distributed networked control system can enable laboratory-wide automation and feedback control loops. These higher-repetition-rate experiments will create enormous quantities of data. A consistent approach to managing data can increase data accessibility, reduce repetitive data-software development and mitigate poorly organized metadata. An opportunity arises to share knowledge of improvements to control and data infrastructure currently being undertaken. We compare platforms and approaches to state-of-the-art control systems and data management at high-power laser facilities, and we illustrate these topics with case studies from our community.



Architecture of the Gemini Control System. EPICS input/output controllers (IOCs) are software + hardware layers providing an abstraction between low-level device hardware and high-level control system software. Legacy hardware is connected into the system through a legacy interface, Control Interface #2. A differentiation is made between EPICS-interfacing components and connections (in blue) and bespoke components and connections (in orange). Clients for device data include human control interfaces, informational laboratory displays, automation software and archival data collectors.

Reproduced from S. Feister et al. (2023) ‘Control systems and data management for high-power laser facilities’, High Power Laser Science and Engineering, 11, p. e56, published by Cambridge University Press in association with Chinese Laser Press under the terms of the **CC-BY-4.0 license**. doi: 10.1017/hpl.2023.49

Authors: **S. Feister** ✉, K. Cassou, S.J.D. Dann, A. Döpp, P. Gauron, A.J. Gonsalves, A. Joglekar, V. Marshall, O. Neveu, H-.P. Schlenvoigt, M.J.V. Streeter, **C.A.J. Palmer** ✉

Super-resolution radial fluctuations microscopy for optimal resolution and fidelity

Fluorescence fluctuations super-resolution microscopy (FF-SRM) has emerged as a promising method for fast, low-cost and uncomplicated imaging of biological specimens beyond the diffraction limit. Amongst the FF-SRM techniques, super-resolution radial fluctuations (SRRF) microscopy is a popular technique, but is prone to artefacts, resulting in low fidelity, especially under conditions of high-density fluorophores.

In this paper, we developed a novel combinatory computational super-resolution microscopy method, namely VeSRRF, that demonstrated superior performance in SRRF microscopy. VeSRRF combined intensity and gradient variance reweighted radial fluctuations (VRRF) and enhanced-SRRF (eSRRF) algorithms, leveraging the enhanced resolution achieved through intensity and gradient variance analysis in VRRF and the improved fidelity obtained from the radial gradient convergence transform in eSRRF. Our method was validated using microtubules in mammalian cells as a standard biological model system. Our results demonstrated that VeSRRF consistently achieved the highest resolution and exceptional fidelity compared to those obtained from other algorithms in FF-SRM.

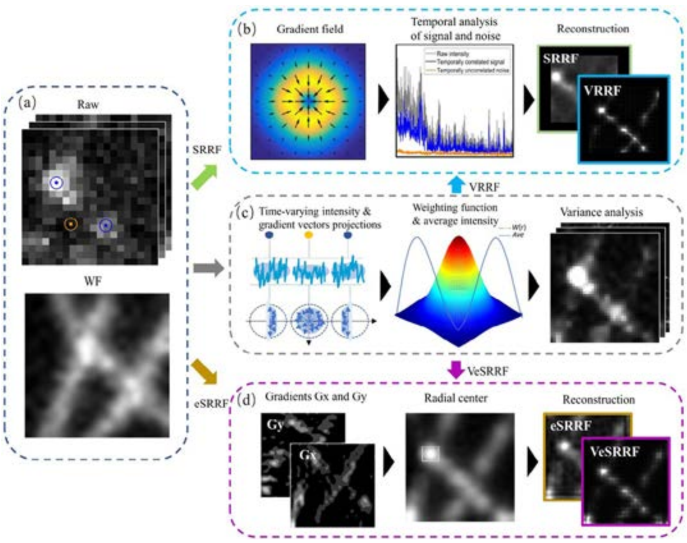


Figure 1: SRRF microscopy image reconstruction algorithm schematic. (a) Raw image sequence and wide-field image of microtubules. (b) SRRF reconstruction steps. (c) VRRF reconstruction steps. The reconstruction is then completed using the SRRF algorithm. (d) eSRRF reconstruction steps. The VeSRRF algorithm first processes the image sequence through VRRF, and then completes the image reconstruction using the eSRRF algorithm.

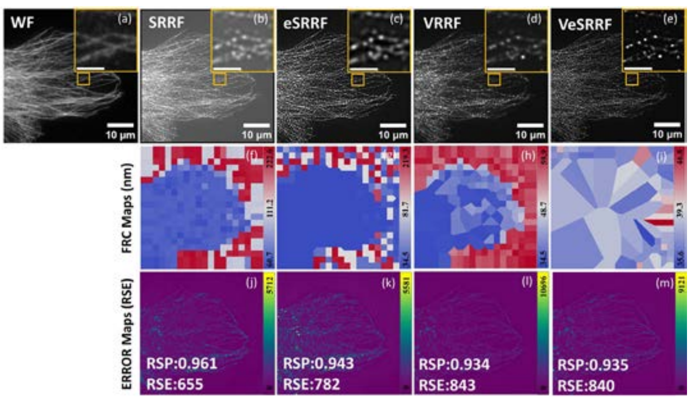


Figure 2: Comparison of the reconstructed images of Tubulin- AF488 in fixed COS7 cells. (a) Wide-field images. (b-e) Reconstructed images from the SRRF, eSRRF, VRRF, and VeSRRF algorithms. (f-i) Corresponding FRC maps. (j-m) Corresponding error maps. Scale bar in the enlarged image of the region indicated by the yellow border box: 2 μm.

Authors: Y. Li, L. Liu, S.K. Roberts, **L. Wang** ✉

Drift-free single molecule localization microscopy provides artefact-free super-resolution imaging

Single-molecule localization microscopy (SMLM) has the power to unravel intricate cellular structures and functions at the nanometre scale. However, the spatial resolution and image fidelity of SMLM may be hindered by the drift of samples during its long image acquisition. In this paper, we present SMLM based on innovative reinforced optical cage systems (ROCS) for proactively preventing sample drift. The ROCS features custom-designed optomechanical components and reinforced mechanical construction that uses tungsten steel rods to seamlessly connect and support optomechanical components holistically. We demonstrated that, owing to the implementation of ROCS, the sample drift was 29 nm over 30 minutes in SMLM, which has a negligible impact on the resolution. The ROCS offers a straightforward, inexpensive, open-source, and state-of-the-art solution that not only allows biomedical scientists to gain easy access to high-performance super-resolution microscopy, but also empowers the wider scientific community to achieve reliable precision instrumentation.

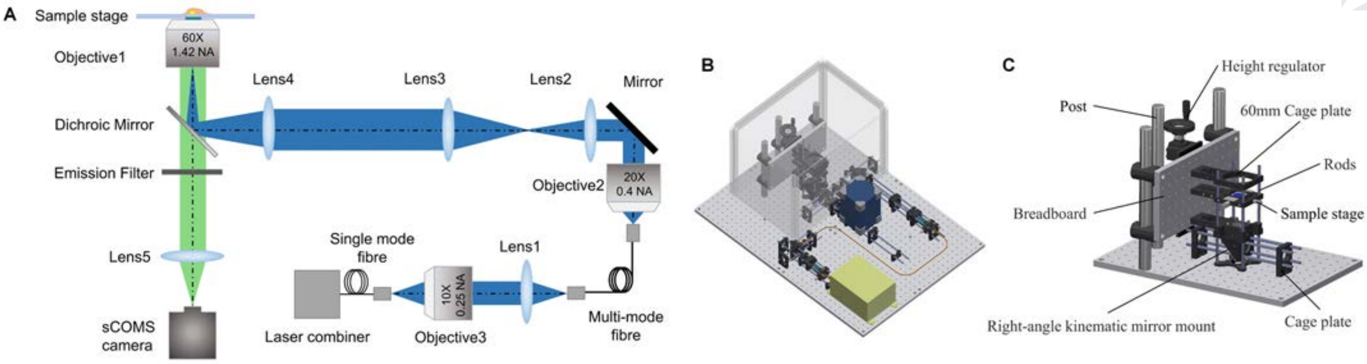


Figure 1 (above): (A) Schematic of the optical setup. (B) 3D CAD rendering of the microscope and (C) the sample stage sub-system.

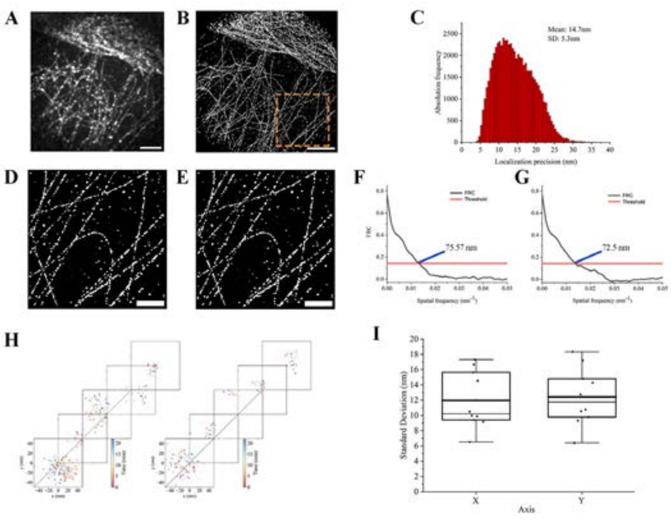


Figure 2 (left): (A) Wide-field image of Alexa Fluor 647-labelled microtubules in COS-7 cells. (B) Super-resolution STORM image of the microtubules. Scale bar: 5 µm. (C) Localization precision histogram of the STORM image. (D) Enlarged image of the region enclosed by the orange box in (B). (E) Drift-corrected STORM image following cross-correlation drift correction of (D). Scale bar: 2 µm. (F) FRC curve of the region shown in (D); resolution 75.57 nm at a correlation threshold of 0.143. (G) FRC curve of the region shown in (E); resolution 72.5 nm at a correlation threshold of 0.143. (H) Scatterplots of the drift from 10 AF647 molecules in the STORM image sequence. (I) Box plot of the standard deviations of the drift of the AF647 molecules along the x- and y-axes.

Authors: H. Qiu, M.C. Tang, S.K. Roberts, **L. Wang**

Characterisation of tape-drive targets using X-Ray Fluorescence Spectroscopy

Tape-drive targets are commonly used in high-repetition rate experiments, as they provide a simple but robust method of delivering 2.5D laser targets to the interaction point of the laser, while remaining as close to the focal spot position as possible. This removes the time-costly need to refocus the laser on each shot. The demand for these targets is increasing to support the future demands of the Extreme Photonics Applications Centre (EPAC) facility, which will be operational by 2027, and it is critical to know the parameters of these targets, including any coatings that are applied.

We have investigated X-Ray Fluorescence Spectroscopy as a method to measure the coating thickness on the tapes, and the use of machine learning models to predict the thickness of the coating on the tape from the XRF data.

Figure 1: Hitachi FT110A XRF machine.

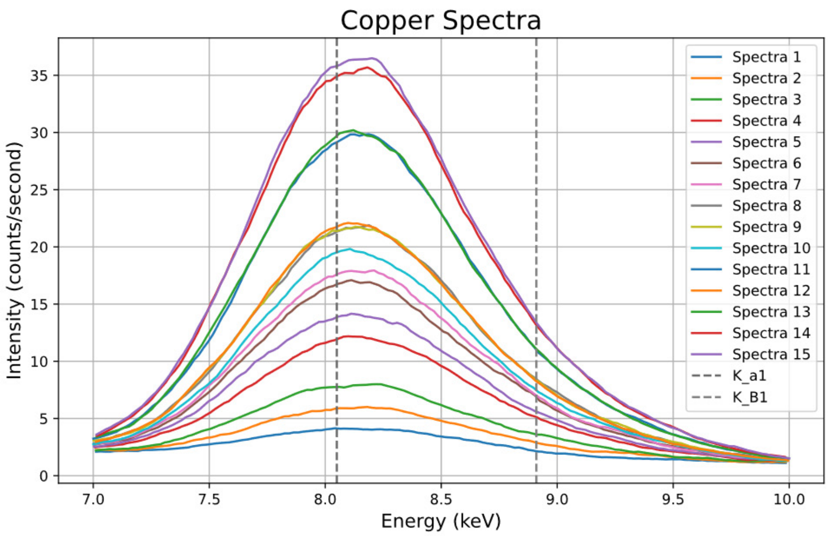


Figure 2: XRF spectra for copper samples.

Authors: **J. Fields** , P. Ariyathilaka, S. Astbury, M. Tolley, **C. Spindloe** , H. Edwards, R. Sarasola, G. Stenning, P. Hunyor

Development of experimental target platforms for Rayleigh-Taylor and jetting experiments at LLE

This report looks at the development of two examples of targets that Scitech Precision were tasked with delivering for high power laser experiments at The University of Rochester's Laboratory for Laser Energetics (LLE). LLE hosts the Omega laser facility and the Omega laser[1] where the following targets were fielded over a period of two years. Working closely with the Target Fabrication group in the Central Laser Facility (CLF) and the target fabrication team at the University of Michigan, Scitech Precision were able to bring together expanded capabilities and technologies to fabricate ever increasing complex targets and to characterise them in the high detail required to benchmark them for the experimental campaigns.

[1]**lle.rochester.edu**

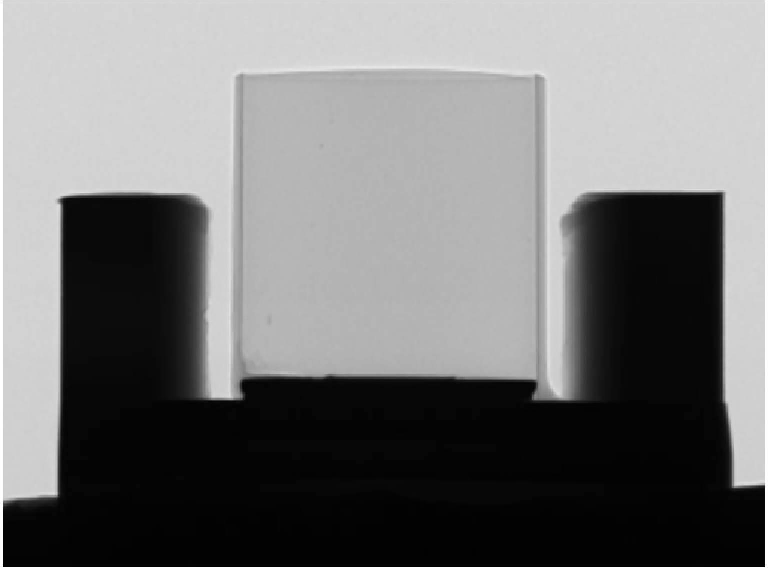


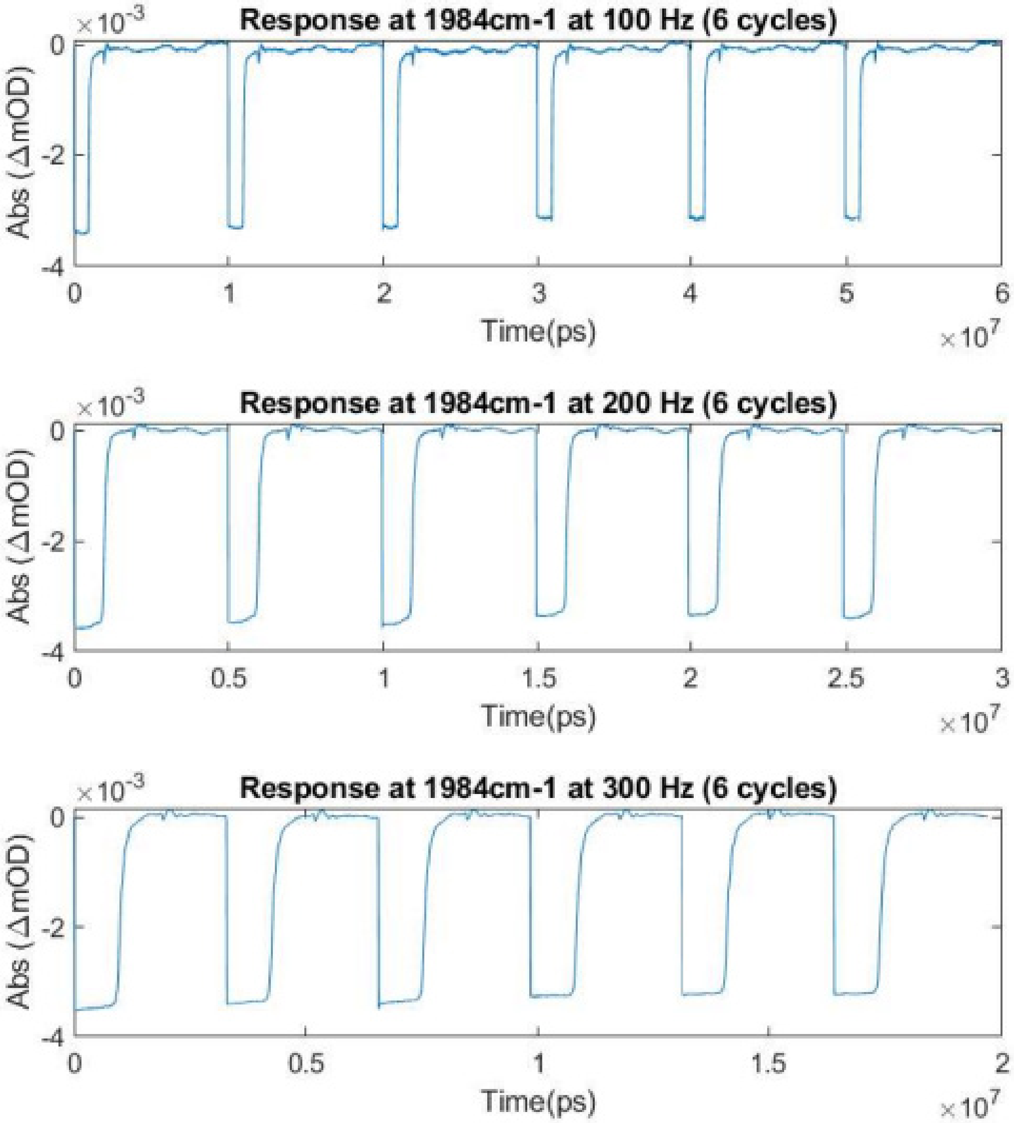
Figure 1: X-ray radiography showing the foam quality of a completed target.

Figure 2: Optical image of the complete target

Authors: **J. Robinson** ✉, C. Spindloe, S. Klein, J. Schnell, S. Irving, D. Wyatt, C. Dobson, M. Harrs, P. Ariyathilaka, P.M. Nilson

A stop-flow sample delivery system for TRMPS experiments

Developing new sample delivery solutions, to keep up with the new technologies in time-resolved spectroscopy, is an essential part of enabling the spreading and ease of use of such technologies to the academic community. Since time-resolved spectroscopy averages many samples to improve the signal-to-noise in the data, there is a need for systems that can advance the sample in a controlled manner during analysis. We are presenting improvements on a stop-flow sample system, which uses custom designed electronics and microvalves attached to a microfluid channel to move liquid samples in a step-like manner. This allows the synchronisation of the sample movement to a laser trigger, leading to a system that is easy to use and reliable.



Transient IR response at three valve opening frequencies, showing the signal dropping, in line with excitation by the pump pulse and creation of the water adduct, and staying at around -3mOD until the valves are open, where the signal recovers to zero, showing the full replacement of the sample. This behaviour is seen to be consistent across different frequencies.

Authors: S. Dragomir, P. Malakar

Multi-amplifier laser system for time-resolved spectroscopy at HiLUX-Ultra

HiLUX is a UKRI Infrastructure Fund project, to deliver the next generation of ultrafast laser spectroscopy facilities. The facility will provide a range of capabilities in ultrafast XUV – IR spectroscopy, photoelectron and photoion spectroscopy, and non-linear spectroscopies. The facilities will be accessible to academia and industry in the UK and internationally.

We present an outline of the HiLUX-Ultra laser system, currently under construction. It will supply a broad range of multi-kilohertz, femtosecond to picosecond pulsed laser outputs, in a multiamplifier format, enabling pump-probe spectroscopy measurements across femtoseconds to seconds timescales.

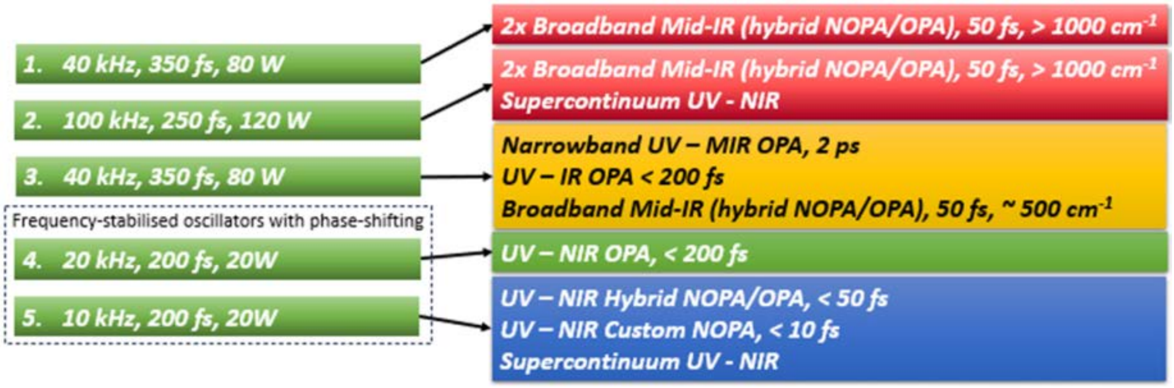


Figure 1: Schematic of the HiLUX-Ultra laser system.

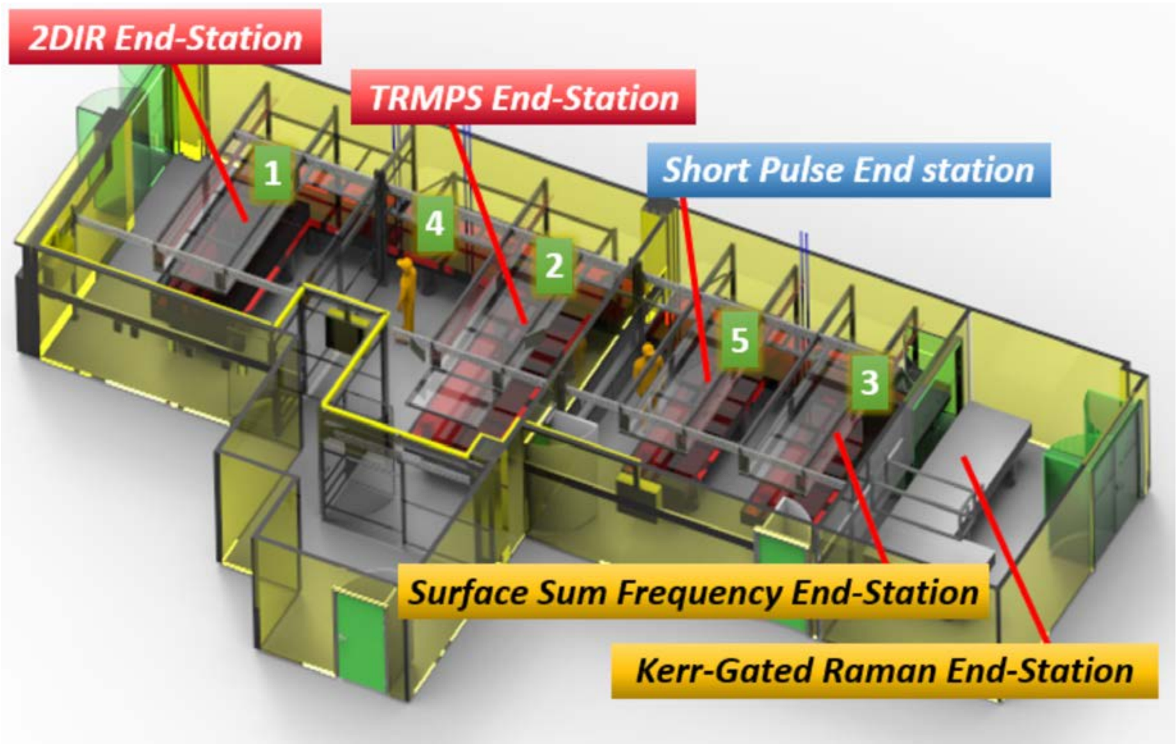


Figure 2: The HiLUX-Ultra laser laboratory, under construction. End-stations are labelled with the associated laser systems.

Authors: P.M. Donaldson, P. Malakar, I.V. Sazanovich, M. Towrie, **G.M. Greetham**