Artemis Operational Statistics

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During the reporting year April 2010 - April 2011 a total of 10 experiments were delivered in the Artemis facility, as shown in Table 1. At the user request some experiments were broken down into a series of slots, typically 2 weeks long. In total 28 experimental weeks were delivered to users. Seven weeks were allocated for vacuum beamline development and installation of the new preparation chamber on the materials science end-station. The few-cycle carrier-envelope-phase-locked beamline was also fully commissioned and used in an experiment. Seven weeks were allocated to laser services, including the installation of the second compressor on the Red Dragon laser. The overall availability of Artemis facility was 157% when including operations out of normal hours. Laser reliability was 88%.

Table 1. Artemis schedule 2010/11

Easter	05-Apr-10	11-Apr-10
Underwood	12-Apr-10	18-Apr-10
81003	19-Apr-10	25-Apr-10
Laser service (KML)	26-Apr-10	02-May-10
CEP/few-cycle commissioning	03-May-10	09-May-10
	10-May-10	16-May-10
Bryan (commissioning)	17-May-10	23-May-10
90003	24-May-10	30-May-10
	31-May-10	06-Jun-10
Greenwood	07-Jun-10	13-Jun-10
91000	14-Jun-10	20-Jun-10
	21-Jun-10	27-Jun-10
	28-Jun-10	04-Jul-10
	05-Jul-10	11-Jul-10
Engineering (Vacuum beamlines)	12-Jul-10	18-Jul-10
	19-Jul-10	25-Jul-10
	26-Jul-10	01-Aug-10
Petersen	02-Aug-10	08-Aug-10
92000	09-Aug-10	15-Aug-10
Building work	16-Aug-10	22-Aug-10
Laser service (KML)	23-Aug-10	29-Aug-10
AMO engineering	30-Aug-10	05-Sep-10
Marangos 91001	06-Sep-10	12-Sep-10
Laser service (TOPAS)	13-Sep-10	19-Sep-10
Cavalleri 90001	20-Sep-10	26-Sep-10
	27-Sep-10	03-Oct-10
AMO vacuum	04-Oct-10	10-Oct-10

	11-Oct-10	17-Oct-10
Marangos	18-Oct-10	24-Oct-10
91001	25-Oct-10	31-Oct-10
	01-Nov-10	07-Nov-10
Laser service (PI) and Devt.	08-Nov-10	14-Nov-10
Tallents 92004	15-Nov-10	21-Nov-10
Laser service (TOPAS)	22-Nov-10	28-Nov-10
Building work	29-Nov-10	05-Dec-10
Petersen	06-Dec-10	12-Dec-10
EU 92013	13-Dec-10	19-Dec-10
Engineering	20-Dec-10	26-Dec-10
Holidays	27-Dec-10	02-Jan-11
Laser service (PI) and Devt.	03-Jan-11	09-Jan-11
Petersen	10-Jan-11	16-Jan-11
92013	17-Jan-11	23-Jan-11
Prep-chamber installation	24-Jan-11	30-Jan-11
Wu	31-Jan-11	06-Feb-11
92009	07-Feb-11	13-Feb-11
Magnetic field commissioning	14-Feb-11	20-Feb-11
Wu 92009	21-Feb-11	27-Feb-11
End-stations move	28-Feb-11	06-Mar-11
Laser service (KML)	07-Mar-11	13-Mar-11
Wark 92003	14-Mar-11	20-Mar-11
Marangos 91001	21-Mar-11	27-Mar-11
AMO commissioning	28-Mar-11	03-Apr-11

	Availability in normal hours (%)	Overall Availability (%)	Reliability (%)
Underwood-81003	75	141	85
Bryan-90003	86	148	92
Greenwood	80	158	89
Petersen-92000	83	177	91
Marangos-91001	78	122	85
Cavalleri-90001	72	158	85
Tallents-92004	85	136	90
Petersen-92013	67	188	85
Wu-92009	92	204	96
Wark-92003	83	144	89
Average	80	157	89

Table 2. Artemis facility statistics 2010/11

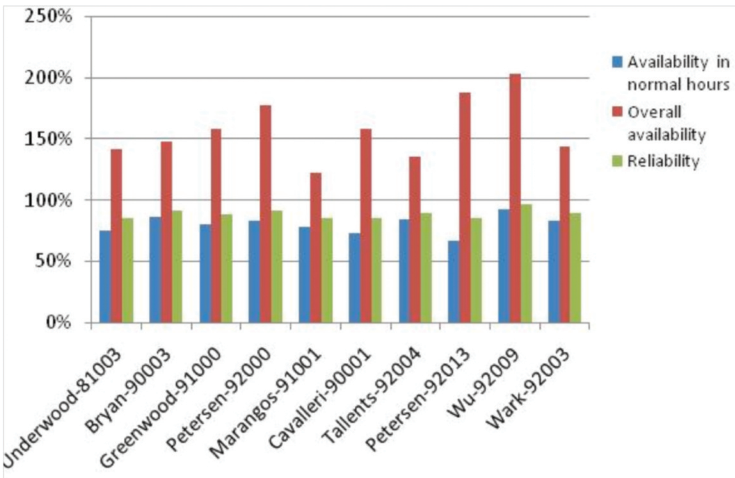

Figure 1. Artemis availability and reliability in 2010-11

Table 2 and Figure 1 are an experiment by experiment break down of the Artemis facility performance for the reporting year and show the availability and reliability. The number for availability during normal hours is lower because of the laser being ready for users at around 9:30 – 10am. During data acquisition, the laser system was run continuously (24 hour operation) for periods of up to 5 days. Overnight laser operation and shift work were introduced for some experiments at the request of the users.

Over the past year Artemis has provided many combinations of pump and probe pulses for experiments. These have included 800 nm pulses, few-cycle pulses, 1300nm and UV pulses from the Topas, and XUV pulses from the monochromatised beamline. Both the Materials Science and Atomic and Molecular Physics stations were used, and three visiting end-stations were also accommodated.

Astra Operational Statistics

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During the reporting year, April 10 – April 11, a total of 3 complete experiments were delivered to the Astra-Gemini Target Area. In total 22 high power laser experimental weeks were delivered to the Gemini Target Area. In addition, 2 weeks of radiological commissioning was conducted. The delivered schedule is presented in figure 1.

The availability of the Gemini laser system (delivery to the Gemini Target Area) was 72% during normal working hours, rising to 131% with time made up from running out of normal working hours. The reliability of the Gemini laser was 82%. An individual breakdown of the availability and reliability for the 3 experiments conducted is presented in figure 2. The high levels of total availability were made possible by the unique operational model employed on Gemini, which involves running the laser late into the evening. In addition, during the 10/11 operating period frequent weekend operations were made available. Towards the completion of experiments continuous 24hr operations with users forming 2 operating shifts was also used.

		Gemini
05-Apr-10	11-Apr-10	
12-Apr-10	18-Apr-10	
19-Apr-10	25-Apr-10	
26-Apr-10	02-May-10	North beam commissioning
03-May-10	09-May-10	
10-May-10	16-May-10	
17-May-10	23-May-10	Set up
24-May-10	30-May-10	
31-May-10	06-Jun-10	
07-Jun-10	13-Jun-10	
14-Jun-10	20-Jun-10	
21-Jun-10	27-Jun-10	D Neely
28-Jun-10	04-Jul-10	91023
05-Jul-10	11-Jul-10	
12-Jul-10	18-Jul-10	
19-Jul-10	25-Jul-10	Set up
26-Jul-10	01-Aug-10	General Atomics
02-Aug-10	08-Aug-10	
09-Aug-10	15-Aug-10	
16-Aug-10	22-Aug-10	
23-Aug-10	29-Aug-10	Contrast enhancement
30-Aug-10	05-Sep-10	
06-Sep-10	12-Sep-10	
13-Sep-10	19-Sep-10	
20-Sep-10	26-Sep-10	Plasma mirror set up
27-Sep-10	03-Oct-10	
04-Oct-10	10-Oct-10	
11-Oct-10	17-Oct-10	M Zepf/B Dromey
18-Oct-10	24-Oct-10	91009/91015
25-Oct-10	31-Oct-10	
01-Nov-10	07-Nov-10	
08-Nov-10	14-Nov-10	System optimisation
15-Nov-10	21-Nov-10	
22-Nov-10	28-Nov-10	M Zepf/B Dromey
29-Nov-10	05-Dec-10	91009/91015
06-Dec-10	12-Dec-10	
13-Dec-10	19-Dec-10	Coseners meeting
20-Dec-10	26-Dec-10	Christmas
27-Dec-10	02-Jan-11	
03-Jan-11	09-Jan-11	
10-Jan-11	16-Jan-11	System optimisation
17-Jan-11	23-Jan-11	
24-Jan-11	30-Jan-11	
31-Jan-11	06-Feb-11	
07-Feb-11	13-Feb-11	M Zepf/B Dromey
14-Feb-11	20-Feb-11	91009/91015
21-Feb-11	27-Feb-11	
28-Feb-11	06-Mar-11	Radiological commissioning
07-Mar-11	13-Mar-11	
14-Mar-11	20-Mar-11	Set up
21-Mar-11	27-Mar-11	G Gregori
28-Mar-11	03-Apr-11	91008

Figure 1. Experiment by experiment breakdown of statistics

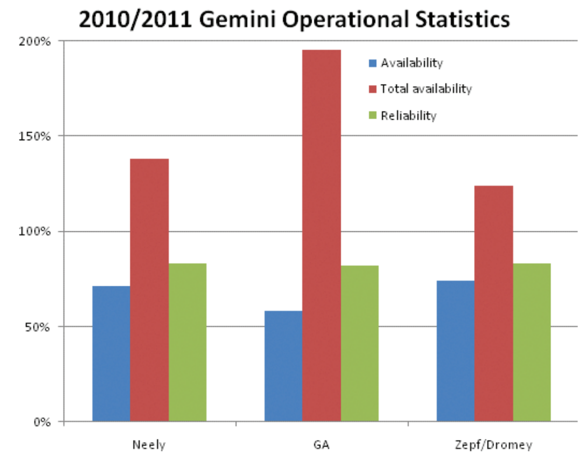

Figure 2. 2010/20011 Operational statistics

A major achievement during the 10/11 operating period was the full commissioning of the second Gemini beam. The North Gemini beam was brought up to near full specification, delivering energy at 25 J. The newly commissioned North beam was used in combination with the South beam for the first Gemini dual beam experiment during the David Neely experimental campaign. The North Gemini beam was also used in the first commercial access experiment conducted on Gemini, this was a weeks access by General Atomics.

A number of improvements to the Gemini contrast were made during the 10/11 operating period, with replacement of a number of optics including replacement of the pulse stretcher gratings. This work lead up to the commissioning and characterisation of the plasma mirror system in the Gemini Target Area. A number of weeks were dedicated to an investigation into the Gemini pulse front tilt and a new interferometric diagnostic was deployed on the Gemini system. Considerable improvements were made to the Gemini pulse front tilt.

Developments within the EPSRC Laser Loan Pool

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Introduction

Throughout 2010/11 the Laser Loan Pool continued to provide laser loans to the UK research community supporting 11 research groups.

Developments

This year two lasers retired from the facility these were the frequency-doubled argon-ion laser (CWL1) and a Nd:YAG pumped dye system (NSL5). These retirements made way for two new systems with a wide range of potential applications to support research in the fields of physics, chemistry and in particular the life-science interface. The two new systems are:

- Supercontinuum source with acousto-optic tunable filter.
- Tunable Ti:S oscillator and optical parametric oscillator (OPO) with dispersion correction.

Supercontinuum

This laser is a NKT SuperK G2 Extreme and is a quasi-cw single mode supercontinuum white light laser operating at 40 MHz. A spectrum of its output can be seen in Figure 1 and Figure 2 shows superimposed spectra of the AOTF output as it scans through the visible region. In addition to the supercontinuum output this laser is also equipped with a fibre delivering ca 100 mW from the pump source at 1064 nm. Full specifications of this system are given in Table 1. The first loan of this laser was to Prof Anita Jones at Edinburgh University to apply the combination of crystallography, computational chemistry, and high-pressure optical spectroscopy (both steady state and time-resolved methods) to understand the relationship between electronic structure and inter- and intra-molecular interactions.

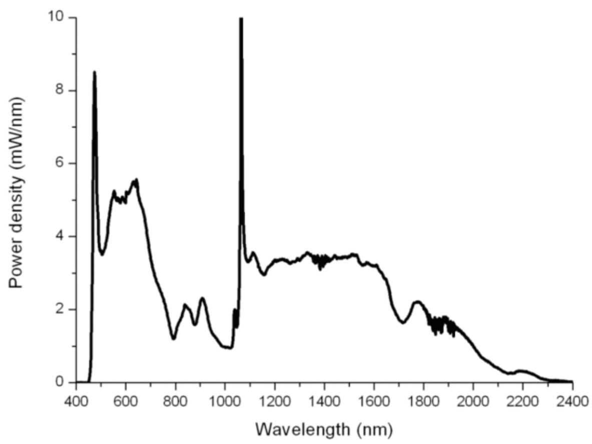

Figure 1: Spectral output of the supercontinuum laser.

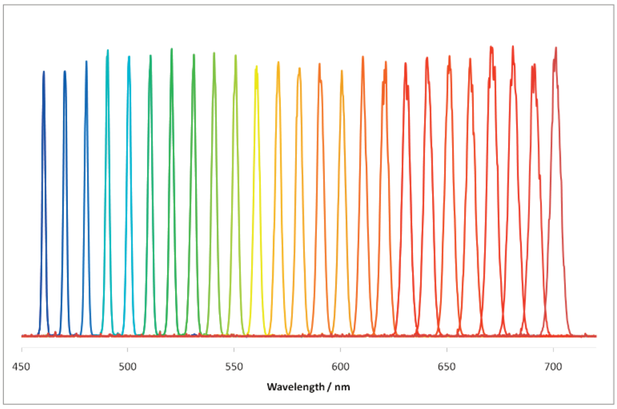

Figure 2: Spectral output of the supercontinuum laser.

Wavelength range	460-2400 nm
Total Average Power	> 2 W
Visible Spectral Density	2.4 mW/nm max, 0.8 mW/nm min 465-750 nm
NIR Spectral Density	2.0 mW/nm max, 0.3 mw/nm min 750-1100 nm
IR Spectral Density	1.2 mW/nm max, 0.3 mW/nm min 1100-2000 nm
Master Source Repetition Rate	40 MHz
Master Source Pulsewidth	5 ps
Output Termination	Achromatic collimator
Output polarization	Unpolarised
Beam Size	~1 mm @ VIS ~2 mm @ 1100nm ~3mm @ 2000nm

Table 1: Specifications of the Loan Pool's CWL1 supercontinuum laser system.

At present the system is being equipped with a pulse-picker option which will be available as of the next loan. This will provide on-the-fly variable repetition rate and will run at 40.0, 26.7, 20.0, 16.0, 13.3, 11.4, 10.0, 8.89, 8.00, 6.67, 5.71, 5.00, 4.44, 3.64, 3.20, 2.96, 2.76, 2.50, 2.35, 2.16 and 2.00 MHz.

Tunable Ti:S Oscillator & OPO

The second purchase is a Ti:S oscillator and OPO with dispersion control. This system is designed to be "turn-key" and as hands-free as possible, with the intention of being at the forefront of technology yet still being user friendly to those with less laser experience. The laser is suited to a wide range of research areas, but in particular coherent anti-Stokes Raman spectroscopy, multi-photon excitation microscopy and materials processing.

The full specifications of this system can be seen in Table 2 and the layout in Figure 3.

The first loan of this laser is to commence in the near future with Prof Stephen Faulkner at the University of Oxford to study energy up-conversion in bimetallic lanthanide complexes.

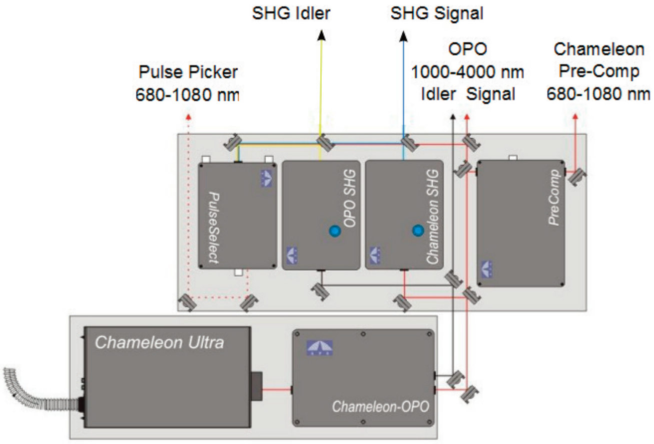

Figure 3: Optical layout of the UFL3 system.

TUNABLE OSCILLATOR	COHERENT CHAMELEON ULTRA II
Wavelength range	460-1080 nm
Total Average Power	> 2 W
Power	>2.8 W @ 800 nm (peak), >0.5 W @ 680 nm, >1.2 W @ 700 nm, >1.2 W @ 920 nm, >0.4 W @ 1020 nm, >0.16 W @ 1080 nm
Repetition Rate	80 MHz
Pulsewidth	*ca.* 140 fs
OPO	**COHERENT OPO COMPACT**
Wavelength range:	SIGNAL: 1000-1600 nm IDLER: 1750-4000 nm
Power:	SIGNAL: >440 mW @ 1100 nm IDLER: >200 mW @ 1750 nm
Second Harmonic Generation	
SHG of Signal	530-690 nm, >130 mW @ peak
SHG of oscillator	340-540 nm, *ca.* 1.6 W @ peak
Pulse-Picker	
Division ratio	1:20-1:5000 @ 680-1080 nm 1:2-1:260000 @ 500-1600 nm 1:2-1:260000 @ 340-540 nm
PreComp - GVD system	
Wavelength range	680-1080 nm
Precompensation range	0 to -23,000 fs^2

Table 2: Specifications of the Loan Pool's UFL3 tunable Ti:S oscillator & OPO laser system.

Future

During this year the Loan Pool with be disposing of some of its older lasers to the user community and purchasing a number of new systems. A high power machining laser is being considered, providing enough user interest exists. Other potential purchases include a single-mode continuous-wave titanium sapphire laser for applications ranging from atom trapping and cooling to fluorescence spectroscopy and an IR narrow-linewidth OPO.

In order to aid the assessment of new purchases a user survey can be found on the Loan Pool web page: http://www.clf.rl.ac.uk/Facilities/Laser+Loan+Pool/14706.aspx

Acknowledgements

The Loan Pool wishes to thank the Loan Pool Steering Committee members for their time, advice and suggestions.

Lasers for Science Facility Operational Statistics

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RAL-based experiments

In the reporting period (April 2010 to March 2011), 21 different User groups performed a total of 24 experiments in the LSF laboratories at RAL. A total of 3005 hours laser time was delivered to the UK User community and European Users throughout the year, with 143 hours downtime. Biology/Bio-materials formed the majority of the applications, see figure 1.

A full breakdown of number of weeks applied for versus number of weeks scheduled is shown in figure 2 indicating an oversubscription ratio of 1.35:1. The RAL-Based schedule is shown in table 1. The average User satisfaction marks obtained from the scheduled Users are shown in figure 3, with an average satisfaction of 93% across the categories.

There were a total of 32 formal reviewed publications produced from the year's efforts, with the LSF programme supporting 4 students completing a PhD in the reporting year.

Loan Pool

Throughout 2010/11 the Laser Loan Pool continued to provide laser loans to the UK research community supporting 11 research groups and saw the publication of at least 9 articles in peer-reviewed journals including one in Nature by Prof J Simons of University of Oxford, "Sensing the anomeric effect in a solvent-free environment" (doi: 10.1038/nature09693).

This year saw the introduction of a number of new laser systems, namely an NKT supercontinuum source and a Coherent tuneable Ti:S and OPO with dispersion correction. These systems are virtually "turn-key" and have a wide range of potential applications to support research in the fields of physics, chemistry and in particular the life-science interface. Full details of these systems can be found in the Loan Pool development article also in this annual report.

The Loan Pool delivered 291 weeks of laser time in the reporting period with a ratio of weeks applied for vs. weeks scheduled of 1.33:1. Downtime was 37 weeks which was mainly due to a major UFL2 laser failure. Chemistry and Physics subject areas dominated the applications; the breakdown is shown in figure 4. The Loan Pool schedule is shown in table 2.

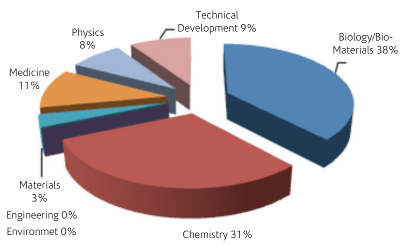

Figure 1. RAL-based bids by subject group

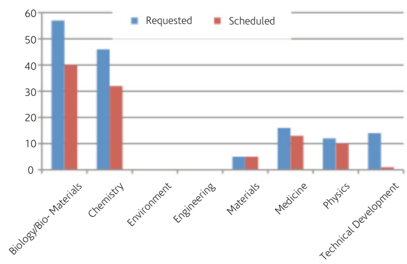

Figure 2. RAL-based experiments by subject

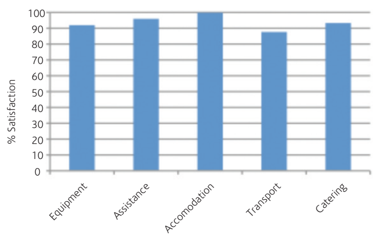

Figure 3. RAL-based average User satisfaction scores

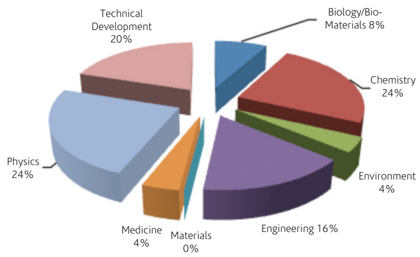

Figure 4. Loan Pool bids by subject group

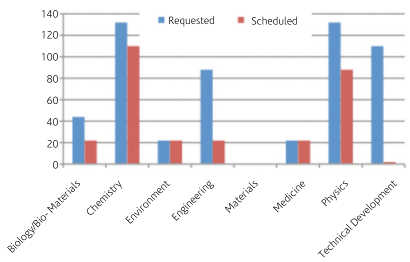

Figure 5. Loan Pool experiments by subject

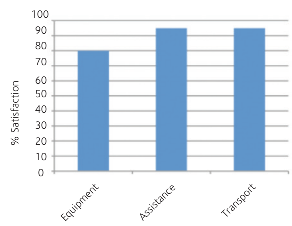

Figure 6. Loan Pool average User satisfaction scores

Table 1. Lasers for Science Facility RAL-based Schedule 2010/11

	Date	Functional Biosystems Imaging	Molecular Structural Dynamics	Cross Department Research
2010	5 Apr	**Relocation to Research Complex R92**	**MAINTENANCE**	
	12 Apr		**A VLCEK** (Queen Mary University of London) **101020** Ultrafast Electron Transfer and Localization	
	19 Apr			**J HILLER ST/F001746/1** I22 Optical trap
	26 Apr		**LSF USER MEETING**	**Currell/Botchway DLS-MT1517** Radiobiological enhancement
	3 May		**P RAITHBY** (University of Bath) **101028** A Solid-state Investigation of the Excited-State Structures Dimeric Mo and W Carboxylates	**A WAGNER DLS-NT1926** Optical mounting of protein crystals
	10 May			**Relocation to Research Complex R92**
	17 May		**A ORR-EWING** (University of Bristol) **101006** Dynamics of Chemical and Photochemical Reactions in Solution	
	24 May			
	31 May			
	7 Jun		**MAINTENANCE**	
	14 Jun	**M MARTIN-FERNANDEZ** (STFC) **101026** Supra-molecular rules in signalling networks: A single molecule comparative study in cells and tissues	**D HEYES** (University of Manchester) **101,007** Novel approaches for studying the role of protein dynamics	
	21 Jun		**S MEECH** (University of East Anglia) **101,005** Protein Photosensors - Photodynamics in Blue Light using FAD (BLUF) Proteins	**A WARD** (STFC) **101021** Target Delivery using Optical Levitation (II)
	28 Jun	C STUBBS (STFC) **101032** Interactions of mTOR signalling		
	5 Jul	P O'NEILL (University of Oxford) 101014 Dynamics of genomic DNA damage repair proteins		
	12 Jul	S J QUINN (University College Dublin) **101002**	**D HEYES** (University of Manchester) **101,007**	
	19 Jul	**J R DILWORTH** (University of Oxford) **101025** The use of one and two photon fluorescence emission lifetimes	**MAINTENANCE**	**A WARD** (STFC) **101021** Target Delivery using Optical Levitation (II)
	26 Jul	C HAWES (Oxford Brookes University) **101003** The plant secretoryome	**N HUNT**(University of Strathclyde) **101004** Dynamics and Reactivity of the FeFe[Hydrogenase] Enzyme System via State-of-the-Art Ultrafast Multidimensional Spectroscopy	
	2 Aug	**M MARTIN-FERNANDEZ** (STFC) **101026**		
	9 Aug			
	16 Aug			
	23 Aug	R BISBY (Salford University) **101013** 2-P stilbene activation	**P PORTIUS** (University of Sheffield) **101033**	
	30 Aug	**MAINTENANCE**	**P RAITHBY** (University of Bath) **101,028**	
	6 Sep	C STUBBS (STFC) **101032** Interactions of mTOR signalling	**Relocation to Research Complex R92**	
	13 Sep	C HAWES (Oxford Brookes University) 101003 The plant secretoryome		
	20 Sep	**DILWORTH** (University of Oxford) **101025**		
	27 Sep	**M MARTIN-FERNANDEZ** (STFC) **101026**		

<table>
<tr><th></th><th>Date</th><th>Functional Biosystems Imaging</th><th>Molecular Structural Dynamics</th><th>Cross Department Research</th></tr>
<tr><td rowspan="13">2010</td><td>4 Oct</td><td>M MARTIN-FERNANDEZ (STFC)
101026</td><td rowspan="8">Relocation to Research Complex R92</td><td></td></tr>
<tr><td>11 Oct</td><td>• P O NEILL (Oxford University)
101014 Dynamics of genomic DNA damage repair proteins</td><td></td></tr>
<tr><td>18 Oct</td><td>ZA WILSON (University of Nottingham)
101023 Plant protein interactions</td><td rowspan="3">M KING (RHUL/ISIS)
91,017 Night-time oxidation of tracer species in atmospheric rainwater</td></tr>
<tr><td>25 Oct</td><td rowspan="2">• JW HAYCOCK (Sheffield University)
101031 Time-resolved emisison imaging microscopy with long-lived Pt(II) complexes</td></tr>
<tr><td>1 Nov</td></tr>
<tr><td>8 Nov</td><td>ZA WILSON (University of Nottingham)
101023 Plant protein interactions</td><td></td></tr>
<tr><td>15 Nov</td><td rowspan="2">• R BISBY (Salford University)
101013 2-P stilbene activation</td><td></td></tr>
<tr><td>22 Nov</td><td></td></tr>
<tr><td>29 Nov</td><td rowspan="2">• A ALEXANDER (University of Edinburgh)
101016 Laser scattering Microscopy</td><td>M GEORGE (University of Nottingham)
101034 The Role of Nonstatistical Dynamics in the Chemistry of Reactive Intermediates</td><td></td></tr>
<tr><td>6 Dec</td><td rowspan="2">P PORTIUS (University of Sheffield)
101033</td><td></td></tr>
<tr><td>13 Dec</td><td>M MARTIN-FERNANDEZ (STFC)
101026</td><td>M WATSON (Bristol)
MSF/NERC Sandpit Access
PROVISIONAL</td></tr>
<tr><td>20 Dec</td><td>• C STUBBS (STFC)
101032 Interactions of mTOR signalling</td><td>MAINTENANCE</td><td></td></tr>
<tr><td>27 Dec</td><td colspan="3">CHRISTMAS 2010</td></tr>
<tr><td rowspan="13">2011</td><td>3 Jan</td><td rowspan="2">• S J QUINN (University College Dublin)
1091003</td><td>MAINTENANCE</td><td></td></tr>
<tr><td>10 Jan</td><td rowspan="2">A J ORR-EWING (University of Bristol)
101006 Dynamics of Chemical and Photochemical Reactions in Solution</td><td></td></tr>
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101026</td><td></td></tr>
<tr><td>24 Jan</td><td>• P O NEILL (Oxford University)
101014 Dynamics of genomic DNA damage repair proteins</td><td rowspan="2">S R MEECH (University of East Anglia)
101005 Protein Photosensors</td><td rowspan="2">M WATSON (Bristol)
MSF/NERC Sandpit Access
PROVISIONAL</td></tr>
<tr><td>31 Jan</td><td rowspan="2">M MARTIN-FERNANDEZ (STFC)
101026</td></tr>
<tr><td>7 Feb</td><td>MAINTENANCE</td><td></td></tr>
<tr><td>14 Feb</td><td>• C STUBBS (STFC)
101032 Interactions of mTOR signalling</td><td rowspan="3">N T HUNT (University of Strathclyde)
101004 Dynamics and Reactivity of the FeFe[Hydrogenase] Enzyme System</td><td>A WARD (STFC)
101021 Target Delivery using Optical Levitation (II)</td></tr>
<tr><td>21 Feb</td><td>• S J QUINN (University College Dublin)
1091003</td><td></td></tr>
<tr><td>28 Feb</td><td rowspan="2">• C HAWES (Oxford Brookes University)
101003 The plant secretoryome</td><td></td></tr>
<tr><td>7 Mar</td><td>J M KELLY (University of Dublin)
1091001 Study of naphthalimides and their nucleotide complexes</td><td></td></tr>
<tr><td>14 Mar</td><td>MAINTENANCE</td><td>S J QUINN (University College Dublin)
1091004</td><td rowspan="3">A WARD (STFC)
101021 Target Delivery using Optical Levitation (II)</td></tr>
<tr><td>21 Mar</td><td>RB FREEDMAN (University of Warwick)
101019 Protein disulphide-isomerase</td><td>MAINTENANCE</td></tr>
<tr><td>28 Mar</td><td>DILWORTH (University of Oxford)
101025</td><td>S J QUINN (University College Dublin)
1091004</td></tr>
</table>

Table 2. Loan Pool Schedule 2010/11

	Date	NSL1	NSL2	NSL3	NSL4	NSL5	UFL1	UFL2	CWL1	Date
		YAG/Dye Powerlite + Sirah + SHG + DFG	YAG/Dye Powerlite + Sirah + SHG + MAD	YAG/ Mid-band OPO + SHG	YAG/Dye Powerlite + Sirah + SHG	YAG/Dye Spectra Pro + Sirah + SHG	Coherent Verdi/Mira + SHG +THG	Coherent Libra OPerA Ultrafast Amp + OPA	Frequency Doubled Argon Ion	
2010	Apr 05	**RITCHIE** (Oxford) Measurement of fragment polarization from photolysis of vibrationally state prepared molecules **92,000**		**RUDDOCK** (Strathclyde) **92,001**	**BLITZ** (Leeds) Generation and photo-dissociation of the HO_3 radical **92,003**	**HIPPLER** (Sheffield) High-resolution stimulated Raman spectroscopy with photo-acoustic detection (PARS) **92,002**	**CLAEYSSENS** (Sheffield) 2-photon 3D structuring of photo-curable	**WU** (York) **91,007**	**VOLK** (Liverpool) **91,024**	Apr 05
	Apr 12		**SIMONS** (Oxford) Structural motifs in hydrated polysaccharide and antifreeze glycoprotein building blocks **101,011**							Apr 12
	Apr 19									Apr 19
	Apr 26									Apr 26
	May 03								**Purchase, delivery & testing of new system**	May 03
	May 10							**WU** (York) Femtosecond imaging of optically-induced magnetisation reversal dynamics at finely tuned temperatures **101,022**		May 10
	May 17			**BIRTILL** (Institute of Cancer Research) Multi-wavelength Optoacoustic imaging for determination of oxygen level in the blood **101,029**			**SHEN** (Liverpool) Generation of high-power terahertz radiation using laser induced micro-plasma **101,024**			May 17
	May 24									May 24
	May 31									May 31
	Jun 07									Jun 07
	Jun 14									Jun 14
	Jun 21									Jun 21
	Jun 28									Jun 28
	Jul 05									Jul 05
	Jul 12									Jul 12
	Jul 19	**BUSH** (Oxford) Isolating Membrane Protein Complexes: Gas-Phase Photo-activation for Facile Micelle Release **101,017**								Jul 19
	Jul 26									Jul 26
	Aug 02									Aug 02
	Aug 09									Aug 09
	Aug 16					**HIPPLER** (Sheffield) High-resolution stimulated Raman spectroscopy with photo-acoustic detection (PARS) **92,002**				Aug 16
	Aug 23									Aug 23
	Aug 30									Aug 30
	Sep 06									Sep 06
	Sep 13									Sep 13
	Sep 20									Sep 20
	Sep 27									Sep 27
	Oct 04									Oct 04
	Oct 11									Oct 11
	Oct 18									Oct 18
	Oct 25									Oct 25
	Nov 01									Nov 01
	Nov 08									Nov 08

2010	Nov 15									Nov 15
	Nov 22									Nov 22
	Nov 29									Nov 29
	Dec 06									Dec 06
	Dec 13									Dec 13
	Dec 20									Dec 20
	Dec 27									Dec 27
2011	Jan 03	**BUSH** (Oxford) 101,017					**MUSKENS** (Southampton) Ultrafast manipulation of photon localization and molecular beams 1,051,001			Jan 03
	Jan 10			**BIRTILL** (Institute of Cancer Research) 101,029				**CALVERT** (Queens University Belfast) Ultrafast Dynamics in Organic and Biological Molecules 1,011,000		Jan 10
	Jan 17		**SIMONS** (Oxford) 101,011			**HIPPLER** (Sheffield) 92,002				Jan 17
	Jan 24									Jan 24
	Jan 31									Jan 31
	Feb 07									Feb 07
	Feb 14									Feb 14
	Feb 21									Feb 21
	Feb 28									Feb 28
	Mar 07									Mar 07
	Mar 14									Mar 14
	Mar 21									Mar 21
	Mar 28									Mar 28

Target Fabrication Operational Statistics

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RAL Experiments

A total of two Astra Gemini and eight Vulcan experiments were supported by Target Fabrication in the reporting period April 2010 to April 2011. All these experiments were 'solid target' experiments. Target Fabrication provided a total of 41 weeks of experimental support for Vulcan and 17 weeks for Astra Gemini on solid target experiments. The report does not include the extensive amount of filter and pinhole support provided from Target Fabrication for some gas jet experiments or target support provided to experiments on Artemis for which two experiments were supported.

1) Target Numbers

For the reporting year, the total target numbers produced are shown in Table 1. The table is broken down into separate experiments and gives data on total target numbers produced and the subset consisting of high specification complex 3D targets that have been produced. High specification 3D targets are defined as targets that have taken significant highly skilled microassembly or micromachining to be produced over and above standard target manufacture. The total number of targets for use at RAL produced by the group in 2010-2011 was 1532 compared to 1,424 in 2009-2010[1]. During 2010-2011, the number of high specification targets produced was 256, accounting for 17% of the total targets made. This is lower than the figure of 27% for 2009-2010[1] and 29% for 2008-2009[2]. This can be accounted for by the higher number of experiential weeks supported in Astra Gemini which required slab targets for multiple shots rather than a high volume of complex 3D targets. However, as the experimental campaign on Astra Gemini ramps up the number of complex targets required is expected to increase significantly to numbers higher than previously seen.

Experiment	Targets Produced	High Specification Targets
May 2010 TAP	145	48
June 2010 TAW	137	16
August 2010 TAP	169	16
September 2010 TAW	186	3
October 2010 TAP	320	52
January 2011 TAW	101	38
February 2011 TAP	211	22
February 2011 GTA	174	50
March 2011 TAW	21	0
March 2011 GTA	68	11
TOTAL	1532	256

Table 1: Target production summary for 2010-2011.

2) Target Types

The high specification targets can be separated into 6 main types as shown in Table 2 and Figure 1. Most notably, 53 multilayered microsquare targets were delivered to the July 2009 TAP experiment and 95 thin wire targets were delivered to the January 2010 TAW experiment requiring extensive highly skilled microassembly.

Target Type	Targets Produced
High Surface Finish Foils	45
Precision Fabricated Limited Mass Target	24
Ultra-thin Foils	85
Multilayered foils (>3 layers)	37
Thin 3D Microstructures	17
Precision Machined Structured Foils	39
Other	9

Table 2: High Specification Target Delivery Summary.

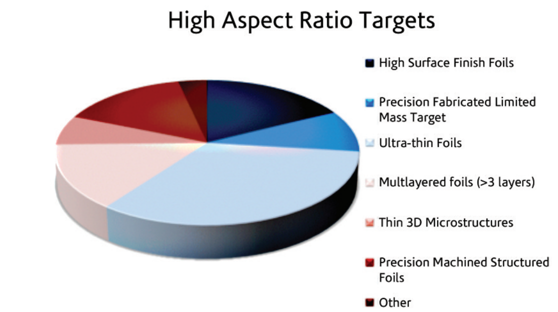

Figure 1: High Specification Target Delivery Summary.

3) Experimental Response

It is seen as a significant strength of Target Fabrication to be rapidly responsive to experimental results and conditions by working collaboratively with experimental groups. The Target Fabrication group responds to experimental changes during a run and often implements a number of modifications or redesigns to the original requests. The number of modifications and variations usually fluctuates widely across a year and is dependent on the type of experiment and also on experimental conditions such as diagnostic and laser performance. On average, during experiments in the reporting period, 34% of the targets that were shot were modified or redesigned from the planned target specifications. This is similar to the figures for recent years, which were 30% in 2008-2009[2] and 32% in 2007-2008[3]. However it is somewhat lower than the figure for 2009-2010 which was 42%. Figure 2 shows the proportion of targets that were redesigned or modified during the experiments supported in 2010-2011.

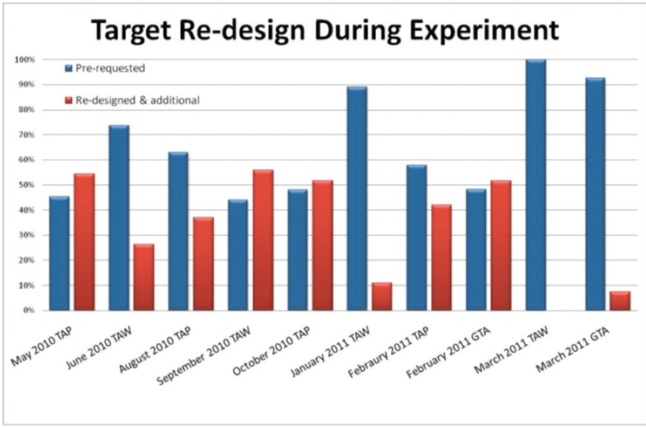

Figure 2: The percentage of pre-requested targets compared to redesigned targets fabricated throughout the year for each experiment.

The redesign of targets during experiments means that there are often a number of targets that have been fabricated but that are not shot by the end of experimental campaigns. As shown in Figure 3, an average of 23% of targets manufactured for each experiment were either unissued contingency targets (having been made in preparation for the experiment but not required due to changes) or targets that were returned un-shot.
This is a dramatic reduction from previous years. In 2009-2010, 39% of targets that were fabricated were either returned un-shot to Target Fabrication or were unused and the figures for 2008-2009[2] and 2007-2008[3] were 35% and 36% respectively.
This reduction can be accounted for by the implementation of the ISO9001 Quality Management System which has allowed the Target Fabrication Group to plan experimental delivery of targets in a more structured way, has improved the quality of targets and has allowed user groups to plan their shot lists with the confidence that targets will be delivered with less need for contingency targets that are made prior to an experiment. To elaborate on this, for an experiment that requires many multilayered coatings, materials must be prepared in advance of an experiment as the coating processes required can take several months, whereas some other target types can be manufactured on much shorter timescales. However, this reduction has not led to less flexibility (as seen in figure 2) as the percentage of re-designed and additional targets is in line with the figure for 2008-2009[2] and 2007-2008[3].

It is worth noting that any unissued or returned targets are carefully sorted and high aspect ratio targets are stored under closely controlled conditions for potential use on future experiments. Where possible, all spare target components and mounts are also stored for future use. The variety of mounts and components held in stock by the Target Fabrication Group contribute to their ability to adapt target designs quickly in response to experimental changes.

External Contracts

Scitech Precision Ltd, (a spinout company from CLF Target Fabrication) also supplied microtargets, specialist coatings and consultancy to a number of external contracts. In the year 2010-2011 a total of seventeen contracts were completed for coatings, characterisation and also full target design and assembly. These contracts were delivered to external facilities in countries including France, Germany, Italy, China and the US.

Summary

Target Fabrication has supported ten internal and seventeen external experimental groups in the last year as well as providing an increasing amount of characterisation services and acting as a knowledge base for Target Fabrication activities throughout Europe. There was an increase in the number of targets delivered to experiments compared to 2009-2010 with one additional experiment running compared to the previous period.

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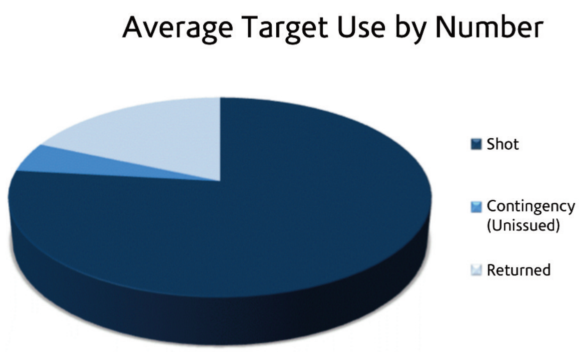

Figure 3: The average proportion of targets shot, returned and unused during solid target experiments on Vulcan in 2010-2011.

Vulcan Operational Statistics

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Introduction

Vulcan has completed an active experimental year, with 44 full experimental weeks allocated to target areas TAW and TAP between April 2010 and March 2011. This figure is down on previous years due to single area operations being adopted in January 2010 to enable front end tests to be undertaken.

PERIOD	TAW	TAP
26 Apr – 20 Jun		P McKenna Magnetic collimation of fast electron transport in "thick" solid targets (122, 38, 68.9%) (39.1%, 109.5%)
28 Jun – 8 Aug	N Woolsey Diffusive shock acceleration (107, 15, 86.0%) (86.4%, 108.3%)	
30 Aug – 19 Sep (TAW) 16 Aug – 26 Sep (TAP)	D Riley X-ray scatter from shock compressed ions (74, 10, 86.5%) (87.8%, 110.8%)	P Norreys Source characterisation for electron and proton beams for fast ignition (114, 8, 93.0%) (73.0%, 96.8%)
11 Oct – 21 Nov		Z Najmudin Uses of ultra-thin targets for ion acceleration at ultrahigh intensity (83, 4, 94.0%) (79.2%, 100.1%)
22 Nov – 12 Dec		M Borghesi Investigation of radiation pressure effects during laser-driven ion acceleration from thin foils (95, 4, 95.8%) (82.1%, 119.9%)
2011		
10 Jan – 30 Jan	J Pasley Radiation hydrodynamics studies with an ultra-high power short pulse laser (43, 2, 95.3%) (87.1%, 109.5%)	
7 Feb – 20 Mar		N Woolsey Constraining fast electron fundamental parameters with hollow atom measurements (95, 6, 93.7%) (78.1%, 105.6%)
21 Mar – 29 Mar	R Deas DSTL (31, 0, 100.0%) (87.5%, 112.2%)	

Table 1. Experimental schedule for the period April 2010 – March 2011

(Total shots fired, failed shots, reliability)
(Availability normal, additional hours)

Table 1 shows the operational schedule for the year, and illustrates the shot rate statistics for each experiment. Numbers in parentheses indicate the total number of full energy laser shots delivered to target, followed by the number of these that failed and the percentage of successful shots. The second set of numbers are the availability of the laser to target areas during normal operating hours and including outside hours operations. The total number of full disc amplifier shots that have been fired to target this year is 764. This figure compares favourably with recent years (Table 2). 87 shots failed to meet user requirements. The overall shot success rate to target for the year is 89%, compared to 85%, 91%, 90%, 85% in the previous four years. Figure 1 shows the reliability of the Vulcan laser to all target areas over the past five years.

The shot reliability to TAW has remained roughly constant compared with 2009-2010 at 89%, which is particularly encouraging as this follows the rod amplifier upgrade [Ref. 1]. Front end contrast improvement has led to an improvement in the reliability of the OPCPA front end system - the shot reliability to TAP is around 89% - an increase from 80% in 2009-10. Analysis of the failure modes reveals that, as in recent years, the two overriding causes of failed shots are alignment and front end related issues. It is difficult to distinguish these two causes and we are in the process of commissioning further diagnostics on the rod amplifier chain (energy monitors and beam profiling after each amplifier).

There is a requirement which was originally instigated for the EPSRC FAA that the laser system be available, during the four week periods of experimental data collection, from 09:00 to 17:00 hours, Monday to Thursday, and from 09:00 to 16:00 hours on Fridays (a total of 156 hours over the four week experimental period). The laser has not always met the startup target of 9:00 am but it has been common practice to operate the laser well beyond the standard contracted finish time on several days during the week. In addition, the introduction of early start times on some experiments continues to lead to improvements in availability.

On average, Vulcan has been available for each experiment to target areas for 77.8% of the time during contracted hours and 103.6% overall. These figures compare with 76.4% and 105.6% in 2009-2010 to all target areas. The time that the laser is unavailable to users is primarily the time taken for beam alignment at the start of the day.

Reference

1. A K Kidd et al, "Vulcan rod amplifier upgrade", CLF Annual Report 2009-2010.

	No of shots	Failed shots	Reliability
06 - 07	1043	149	85%
07 - 08	977	98	90%
08 - 09	646	61	91%
09 – 10	445	65	85%
10 – 11	764	87	89%

Table 2. Shot totals and proportion of failed shots for the past five years

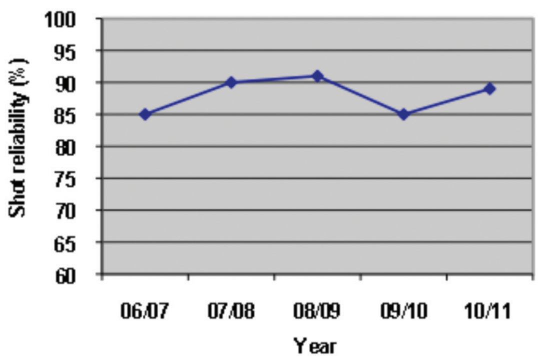

Figure 1. All areas shot reliability for each year 2006-7 to 2010-11

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Skopalová, E; El-Taha, YC; Zaïr , A; Hohenberger, M; Springate, E; Tisch, JWG; Smith, RA; Marangos, JP
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Panel membership and CLF structure

Laser for Science Facility Access Panel 2010/11

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Astra Artemis Facility Access Panel 2010/11

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CENTRAL LASER FACILITY STRUCTURE 2010/11