Artemis Operational Statistics

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During the reporting year April 2011 - April 2012 a total of 7 experiments were delivered in the Artemis facility, as shown in Table 1. Artemis delivered 26 of its planned 28 operational weeks, despite a 10 week shut-down for repairs to the laser system. The extended shutdown was used to upgrade the laser interlock system by fully enclosing the Red Dragon and Topas lasers, adding centrally controlled sensors and improving the interlock software. This enables the laser to be kept warm on full power while other work can take place without the need for goggles. This has led to noticeable improvements in the long-term stability of the system, particularly in the OPA stages. Laser services, under service contracts, required 5 weeks. The PI pump lasers were serviced efficiently when their output dropped and the service visits took only five half days. Engineering work on end-stations and beamlines was allocated four weeks in addition to the eight weeks during the laser shut-down. Three weeks were allocated to re-commission the few cycle hollow-fibre laser compressor. The implementation of beam pointing stabilisation for the hollow-fibre pulse compressor has enabled short pulses to be delivered for full days of operation without manual intervention.

Table 1. Artemis schedule for FY 2011/2012

Underwood (Bromobenzene) 92010	04-Apr-11	08-Apr-11
	11-Apr-11	15-Apr-11
	18-Apr-11	22-Apr-11
Engineering and bank-holidays	25-Apr-11	29-Apr-11
Underwood 92010	02-May-11	06-May-11
Minns (HCNO) 92008	9-May-11	13-May-11
	16-May-11	20-May-11
Short pulse commissioning	23-May-11	27-Jun-11
	30-May-11	03-Jun-11
	06-Jun-11	10-Jun-11
Underwood (Bromobenzene) Extension 92010	13-Jun-11	17-Jun-11
	20-Jun-11	24-Jun-11
Minns (HCNO 92008	27-Jun-11	01-Jul-11
	04-Jul-11	08-Jul-11
Engineering Mat Sci Station	11-Jul-11	15-Jul-11
Laser service (KMLabs)	18-Jul-11	22-Jul-11
Petersen (TR-ARPES) 101007	25-Jul-11	29-Jul-11
	01-Aug-11	05-Aug-11
Greenwood (Biomolecules) 101000	08-Aug-10	12-Aug-10
	15-Aug-11	19-Aug-11
	22-Aug-11	26-Aug-11
	29-Aug-11	02-Sep-11
	05-Sep-11	09-Sep-11
Engineering (Mat Sci Sta)	12-Sep-11	16-Sep-11
Petersen (TR-ARPES) 101007	19-Sep-11	23-Sep-11
Downtime (laser-Verdi)	26-Sep-11	30-Sep-11
New laser interlocks Engineering End Stations (While Verdi laser repaired)	03-Oct-11	07-Oct-11
	10-Oct-11	14-Oct-11
	17-Oct-11	21-Oct-11
	24-Oct-11	28-Oct-11
	31-Oct-11	04-Nov-11
	07-Nov-11	11-Nov-11
	14-Nov-11	18-Nov-11
Verdi laser installation	21-Nov-11	25-Nov-11
Laser service (KMLabs)	28-Nov-11	02-Dec-11
Engineering AMO end-station	05-Dec-11	09-Dec-11
Von Haeften (Clusters) 101004	12-Dec-11	16-Dec-11
XUV beamline development	19-Dec-11	23-Dec-11
Holidays	26-Dec-11	30-Dec-11
Interlocks, Eng. End Sta., Laser service	02-Jan-12	06-Jan-12
	09-Jan-12	13-Jan-12
Eng AMO Station, Beamline tests	16-Jan-12	20-Jan-12
Von Haeften (Clusters) 101004	23-Jan-12	27-Jan-12
	30-Jan-12	03-Feb-12
	06-Feb-12	10-Feb-12
	13-Feb-12	17-Feb-12
TOPAS and beamline set-up	20-Feb-12	24-Feb-12
Laser service (KML)	27-Feb-12	02-Mar-12
TOPAS laser service (LC) and beamline set-up	05-Mar-12	09-Mar-12
Kaiser (TR-ARPES mid-IR) 111008EU	12-Mar-12	16-Mar-12
Torres (2-colour HHG) 111004EU	19-Mar-12	23-Mar-12
	26-Mar-12	30-Mar-12

The overall availability of the Artemis facility was 172% (up from 157% last year) when including operations out of normal hours. Laser reliability was 92% (up from 88% last year). The higher overall availability is due to improved laser stability which allowed users to take data over extended periods of time, with the laser running overnight. For example in the TR-ARPES experiments, which ran overnight routinely for data-taking, the beamlines used are the Red-Dragon laser driving the XUV beamline (probe pulse) and tuneable OPA (pump pulse) in the mid-IR. During data acquisition, the laser system was run continuously (24 hour operation) for periods of up to 5 days.

Table 2. Artemis facility statistics 2011/12

	Availability in normal hours (%)	Overall Availability (%)	Reliability (%)
Underwood-92010	87	135	91
Minns-92008	84	137	89
Petersen-101007	85	200	93
Greenwood-101000	84	150	90
VonHaeften-101004	73	188	87
Kaiser-111008	97	222	98
Torres-111004	87	175	93
Average	85	172	92

Table 2 and Figure 1 are an experiment-by-experiment breakdown 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 the laser is typically ready for users at around 9:30 – 10am instead of 9am. A number of late starts were also due to the servicing of the pump-lasers first thing in the morning, or due to emergency engineering work which is programmed early in the morning to minimise impact on users.

The impact of early morning engineering will be minimised next year due to the new laser enclosure and new interlock system. Experiment 101004 had the lowest availability in normal hours, 73%. This was due to mainly infrastructure malfunctioning in the very cold winter (air-conditioning system freezing, external chiller problems) as well as two short services for the pump lasers. Despite this, the overall availability was 188% due to extended-hours data taking.

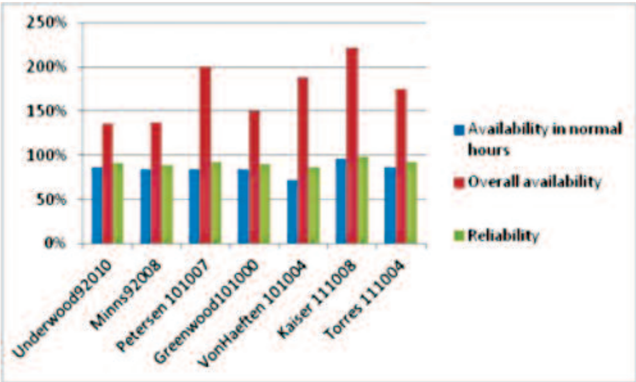

Figure 1. Artemis availability and reliability in 2011-12

The XUV beamlines and end-stations are an important part of the facility. Developments on Artemis over the past year are delivering operational improvements to the XUV experiments. Every experiment on the XUV beamlines requires the optimisation of the spatial and temporal overlap between the XUV and pump pulses. A new diagnostic has been implemented in the experimental chamber allowing us to visualise the position of both beams at the sample position. This diagnostic is now used on a daily basis during beam-time and saves a lot of time for the users as it is a very efficient way to optimise the experimental conditions for time-resolved measurements.

For the materials science experiments, a data analysis environment has been developed to analyse and check the time-resolved photoemission data during user beam-time. The time-dependent photoemission can be extracted from a data set for a given energy and momentum region. Fitting and FFT procedures are available to extract the relaxation time and the oscillation mode of the system studied, allowing daily analysis of the large datasets. The UHV vacuum in the main experimental chamber was improved, reaching 8.10-11 mbar and the sample preparation chamber was upgraded to include e-beam heating, sputtering and sample storage. This significantly increases the range of materials we can study.

The second Artemis XUV beamline, originally conceived as a broadband or attosecond beamline, has been further developed with the addition of an in-line flat-field spectrometer. This allows an easy switch from optimisation of XUV generation conditions to using the XUV in experiments.

Astra Operational Statistics

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During the reporting year, April 11 – April 12, a total of 5 complete experiments were delivered to the Astra-Gemini Target Area. In total 27 high power laser experimental weeks were delivered the Gemini Target Area. The delivered schedule is presented in figure 2.

The availability of the Gemini laser system (delivery to the Gemini Target Area) was 67% during normal working hours, rising to 153% 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 5 experiments conducted is presented in figure 1.

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 11/12 operating period frequent weekend operations were made available to users. Towards the completion of experiments, particularly during the Hooker experiment, continuous 24hr operations with users forming 2 operating shifts was also used. This mode of operating Gemini is reliant on the strength and numbers in the experimental user team.

During the reporting year a number of modifications to the Astra system were made. Astra amplifier 1 and amplifier 2 were completely reconfigured to include vacuum spatial filters and image relaying. Brewster windows were used on the vacuum pipes to prevent pre-pulse generation. The changes to the first 2 amplifier have had a significant improvement on the baseline contrast, as well as removing a number of discrete pre-pulse features (see annual report article by B Parry: Replacement of Astra Amplifiers One and Two for Enhanced Laser Contrast).

In order to improve the Gemini pulse compression and to clean the compressed pulse shape, a Fastlight Whizzler was installed on the Gemini North beam. This has removed the pulse side lobes and reduced the pulse duration. (See annual report article by O Chekhlov: Implementation of Pulse Measurements with Wizzler into Gemini Diagnostics).

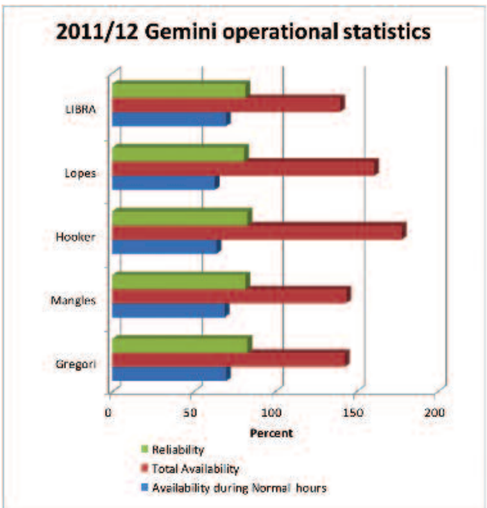

Figure 1. 2011/20012 operational statistics

		Gemini
04-Apr-11	10-Apr-11	
11-Apr-11	17-Apr-11	
18-Apr-11	24-Apr-11	G Gregori
25-Apr-11	01-May-11	91008
02-May-11	08-May-11	
09-May-11	15-May-11	
16-May-11	22-May-11	Laser maintenance
23-May-11	29-May-11	
30-May-11	05-Jun-11	
06-Jun-11	12-Jun-11	Set up
13-Jun-11	19-Jun-11	
20-Jun-11	26-Jun-11	
27-Jun-11	03-Jul-11	Mangles
04-Jul-11	10-Jul-11	102026
11-Jul-11	17-Jul-11	
18-Jul-11	24-Jul-11	Set up
25-Jul-11	31-Jul-11	
01-Aug-11	07-Aug-11	Hooker
08-Aug-11	14-Aug-11	102025
15-Aug-11	21-Aug-11	
22-Aug-11	28-Aug-11	Quantel Service
29-Aug-11	04-Sep-11	
05-Sep-11	11-Sep-11	
12-Sep-11	18-Sep-11	Amplifier 1 re-build
19-Sep-11	25-Sep-11	
26-Sep-11	02-Oct-11	
03-Oct-11	09-Oct-11	
10-Oct-11	16-Oct-11	System optimisation
17-Oct-11	23-Oct-11	
24-Oct-11	30-Oct-11	Hooker Extension
31-Oct-11	06-Nov-11	
07-Nov-11	13-Nov-11	Set up
14-Nov-11	20-Nov-11	
21-Nov-11	27-Nov-11	Lopes
28-Nov-11	04-Dec-11	112013
05-Dec-11	11-Dec-11	
12-Dec-11	18-Dec-11	
19-Dec-11	25-Dec-11	Christmas
26-Dec-11	01-Jan-12	
02-Jan-12	08-Jan-12	Whizzler installation
09-Jan-12	15-Jan-12	
16-Jan-12	22-Jan-12	Plasma mirror set up and contrast tests
23-Jan-12	29-Jan-12	
30-Jan-12	05-Feb-12	F1 Commisioning
06-Feb-12	12-Feb-12	
13-Feb-12	19-Feb-12	
20-Feb-12	26-Feb-12	Borghhesi
27-Feb-12	04-Mar-12	
05-Mar-12	11-Mar-12	
12-Mar-12	18-Mar-12	
19-Mar-12	25-Mar-12	Set up
26-Mar-12	01-Apr-12	Mayer-ter-vehn

Figure 2. 2011/20012 Delivered Gemini schedule

Developments within the EPSRC Laser Loan Pool

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Introduction

The EPSRC Laser Loan Pool continued to support the UK research community throughout 2011/2012 providing a total of 14 laser loans to 14 different research groups and producing at least 9 publications.

Developments

Last year's article reported on the purchase of two new systems one of which was a tuneable titanium:sapphire oscillator with optical parametric oscillator and dispersion control. This system, named UFL3, is now fully operation in the facility and has completed one loan with another in progress and a third to commence in August 2012. The first loan was to Prof Stephen Faulkner (Department of Chemistry, University of Oxford) to study energy up-conversion in bimetallic lanthanide complexes. This research programme has already produced one publication (Sørensen, Blackburn, Tropiano, & Faulkner, 2012) and another is in preparation.

The year has also seen the purchase of a new system described below which is due to arrive in the coming weeks.

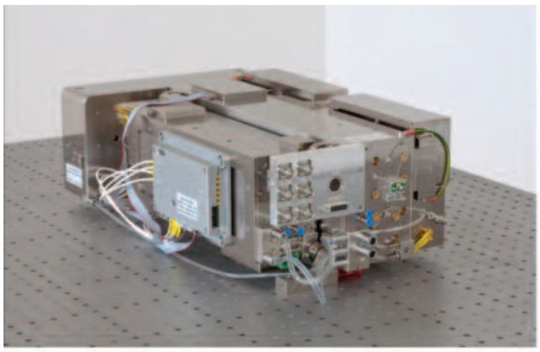
New Laser

The decision over which laser system to purchase was a difficult one to make. A laser system was wanted that would appeal to the engineering and machining communities but at the same time still retain appeal with the facilities core communities. Many machining systems are designed for one specific use and are beyond the budget of the facility. With the help of the Steering Committee the Light Conversion Pharos (compact, single-unit, Yb:KGW femtosecond laser system) with Orpheus optical parametric amplifier and Lyra second harmonic unit was chosen. This system offers a unique flexibility for many scientific applications including ranging from materials science through to spectroscopy. The system has a wide tuning range 315-2600 nm, (when coupled with OPA, pumped at 10 kHz) but its unique feature is its tuneable repetition rate (1-200 kHz) and tuneable pulse duration (200 fs to 10 ps).

The full specifications of this new Paros system, to be named UFL1, are given below.

LIGHT CONVERSION PHAROS	
Wavelength	1028 nm
Power	12 W
Pulse length	290 fs – 10 ps
Repetition Rate	Single pulse – 200 kHz
Polarization	Linear - horizontal
LIGHT CONVERSION ORPHEUS OPA	
Wavelength range	SIGNAL: 630-1020 nm IDLER: 1040-2600 nm
Energy	See Figure 2
Repetition Rate	10 kHz
LIGHT CONVERSION LYRA SHG	
Wavelength range	315-630 nm
Energy	See Figure 2

Table 1: Specifications of the Loan Pool's UFL1 Light Conversion system.



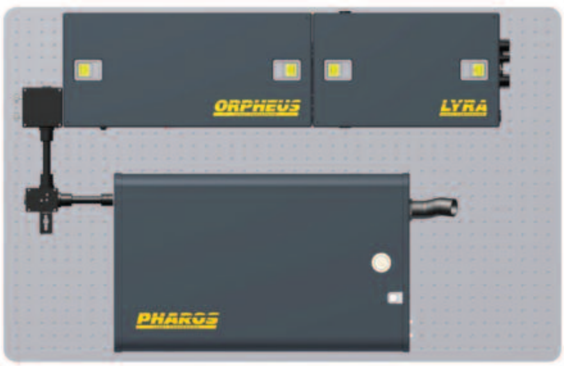


Figure 1: The inside of the Pharos laser head (top); layout of the UFL1 system as it will operate in the Loan Pool (bottom).

Retirements

In April 2012 the Loan Pool called for applications for retiring laser systems. As ever free lasers proved popular and many applications were received all of which were reviewed by the Facility Application Panel. Nd:YAG pumped dye lasers will soon be awarded to the following researchers:

- Dr Justin Benesch, Department of Chemistry, University of Oxford
- Prof Robin Perutz, Department of Chemistry, University of York
- Dr Otto Muskens, School of Physics and Astronomy, University of Southampton

The frequency-doubled argon ion laser will soon be awarded to Dr Martin Volk, Department of Chemistry and Surface Science Research Centre, University of Liverpool.

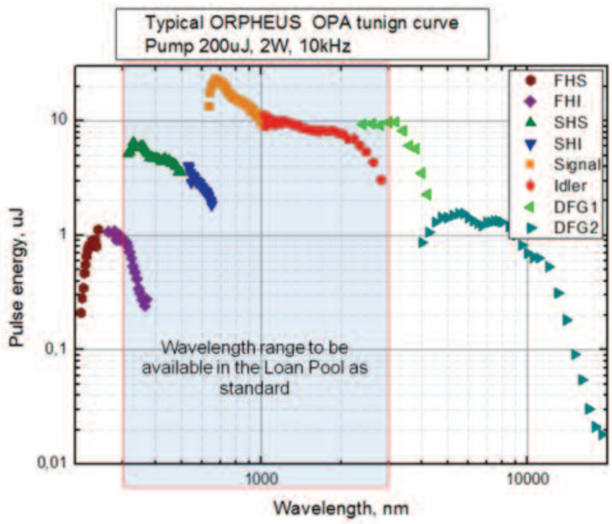


Figure 2: Plot of energy versus wavelength for the Pharos/Orpheus and all its harmonic options. This shows the very wide tuning range achievable with this system. The 1028 nm (Pharos output) signal (orange squares), idler (red circles) and the second harmonic of both the signal (dark green triangles) and the idler (blue triangles) will be available on the Loan Pool system.

Future

The first loan of the Light Conversion system will commence in Autumn 2012 the applications for this have yet to be reviewed. Potential future purchases include a single-mode continuous-wave titanium sapphire laser for applications ranging from atom trapping and cooling to fluorescence spectroscopy. A narrow-linewidth IR OPO was desired but the man

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.

References

Sørensen, T. J., Blackburn, O. a., Tropiano, M., & Faulkner, S. (2012). Direct two-photon excitation of Sm3+, Eu3+, Tb3+, Tb.DOTA-, and Tb.propargylDO3A in solution.

Chemical Physics Letters, 541, 16-20. Elsevier B.V. doi:10.1016/j.cplett.2012.05.053

Lasers for Science Facility Operational Statistics

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RAL-based experiments

In the reporting period (April 2011 to March 2012), 29 different User groups performed a total of 42 experiments in the LSF laboratories at RAL. A total of 4444 hours laser time was delivered to the UK User community and European Users throughout the year, with 75 hours downtime. Biology and Bio-materials formed the majority of the applications, see figure 1.

A full breakdown of the number of weeks applied for versus the number of weeks scheduled is shown in figure 2 indicating an oversubscription ratio of 1.46:1. 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 91% across the categories.

There were a total of 36 formal reviewed publications produced from the year's efforts, with the LSF programme supporting 3 students completing a PhD in the reporting year.

Loan Pool

Throughout 2011/12 the Laser Loan Pool continued to provide laser loans to the UK research community supporting 14 research groups and saw the publication of at least 9 articles in peer-reviewed journals.

The year saw the introduction of one new laser system (tuneable titanium-sapphire oscillator with dispersion control) and the purchase of a second system (Light Conversion Pharos Orpheus) soon to be delivered. This latter system is designed for engineering applications and has excellent control over many of its parameters permitting its use in a wide range of applications.

The Loan Pool delivered 319 weeks of laser time in the reporting period with a ratio of weeks applied for vs. weeks scheduled of 1.86:1. Downtime was 12 %. Physics and chemistry subject areas dominated the applications; the breakdown is shown in figure 4. The Loan Pool schedule is shown in table 2.

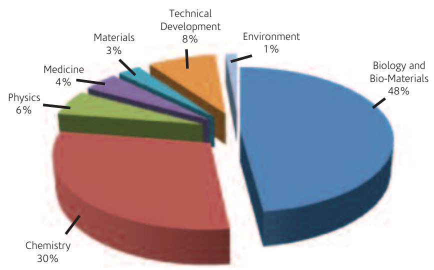

Figure 1. RAL-based bids by subject group

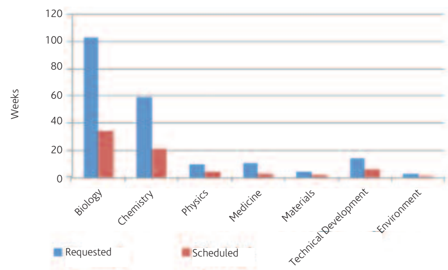

Figure 2. RAL-based experiments by subject

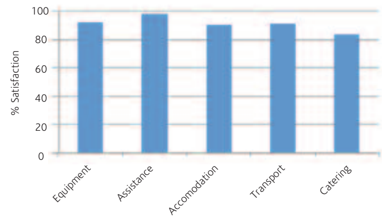

Figure 3. RAL-based average User satisfaction scores

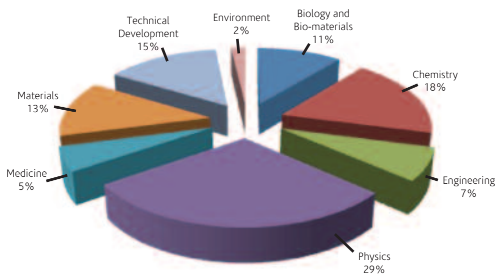

Figure 4. Loan Pool bids by subject group

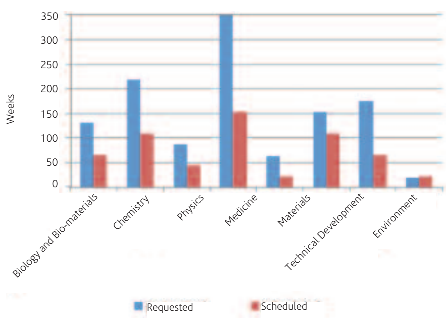

Figure 5. Loan Pool experiments by subject

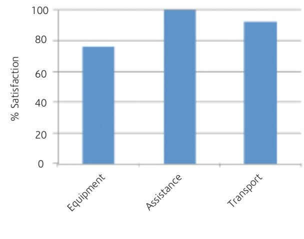

Figure 6. Loan Pool average User satisfaction scores

Table 1. Lasers for Science Facility RAL-based Schedule 2011-12 Part 1

	Date	Functional Biosystems Imaging	Molecular Structural Dynamics	Cross Department Research
2011	4 Apr	**C STUBBS** (STFC) **1110007**	**D HEYES** (University of Manchester) **1110005**	
	11 Apr	**M MARTIN-FERNANDEZ** (STFC) **1110023**	**P KUKURA** (University of Oxford) **1110012**	
	18 Apr	**MAINTENANCE**		
	25 Apr	**M MARTIN-FERNANDEZ** (STFC) **1110023**	**MAINTENANCE**	
	2 May		**P KUKURA** (University of Oxford) **1110012**	
	9 May	**J R DILWORTH** (University of Oxford) **1110011**		
	16 May	**P O'NEILL** (University of Oxford) **1110003**	**N HUNT** (University of Strathclyde) **1110000**	
	23 May	**M MARTIN-FERNANDEZ** (STFC) **1110023**		**F CURRELL** (QUB) **MT6571**
	30 May	**C STUBBS** (STFC) **1110007**		
	6 Jun	**C HAWES** (Oxford Brookes University) **1110001**		**C PFRANG** (Uni. of Reading) **SM6883**
	13 Jun		**P PORTIUS** (University of Sheffield) **1110021**	**S CARR** (RCaH) **1110020**
	20 Jun	**J R DILWORTH** (University of Oxford) **1110011**		
	27 Jun	**R BISBY** (Salford University) **1110009**	**MAINTENANCE**	**C PFRANG** (Uni. of Reading) **SM6883**
	4 Jul	**P O'NEILL** (University of Oxford) **1110003**	**S MEECH** (University of East Anglia) **1110025**	
	11 Jul	**M MARTIN-FERNANDEZ** (STFC) **1110023**		**C PFRANG** (Uni. of Reading) **SM6883**
	18 Jul	**P MATOUSEK** (STFC) **1110006**		**A ALEXANDER** (Uni. of Edinburgh) **1110015**
	25 Jul	**C HAWES** (Oxford Brookes University) **1110001**	**D HEYES** (University of Manchester) **1110005**	
	1 Aug	**R BISBY** (Salford University) **1110009**	**MAINTENANCE**	
	8 Aug		**Y GUN'KO** (University of Dublin) **1110017**	
	15 Aug	**MAINTENANCE**	**A ORR-EWING** (University of Bristol) **1110002**	
	22 Aug	**M MARTIN-FERNANDEZ** (STFC) **1110023**		
	29 Aug	**MAINTENANCE**		
	5 Sep		**MAINTENANCE**	**A ALEXANDER** (Uni. of Edinburgh) **1110015**
	12 Sep	**M MARTIN-FERNANDEZ** (STFC) **1110023**	**D HEYES** (University of Manchester) **1110005**	
	19 Sep	**P O'NEILL** (University of Oxford) **1110003**	**P RAITHBY** (University of Bath) **1110014**	**RB FREEDMAN** (Uni. of Warwick) **101019**
	26 Sep	**P MATOUSEK** (STFC) **1110006**		**F CURRELL** (QUB) **MT6571**

Table 1(cont). Lasers for Science Facility RAL-based Schedule 2011-12 Part 2

	Date	Functional Biosystems Imaging	Molecular Structure and Dynamics	Cross Department Research
2011	3 Oct	**J WEINSTEIN** (Uni. Of Sheffield) **1110024**	MAINTENANCE	
	10 Oct		**A W PARKER** (STFC) **1120009**	
	17 Oct	MAINTENANCE		
	24 Oct	See Cross Department Research	**R BISBY** (University of Salford) **1120013**	**N KAD** (Univ of Essex) **1110016**
	31 Oct	MAINTENANCE	**M W GEORGE** (University of Nottingham) **1120023**	
	7 Nov	See Cross Dept. Research / MAINTENANCE	**P R RAITHBY** (University of Bath) **1120016**	**N KAD** (Univ of Essex) **1110016**
	14 Nov	**S I PASCU** (University of Bath) **1120010**	**CARPENTER** (University of Cardiff) **1120007**	
	21 Nov	**M MARTIN-FERNANDEZ** (STFC) **1120021**		
	28 Nov		**S HAYES** (University of Cypus) **1191001** **(EU Access)**	
	5 Dec	**C HAWES** (Brookes University) **1120012**		
	12 Dec		MAINTENANCE	**M KING** (Royal Holloway) **1120015**
	19 Dec	**M MARTIN-FERNANDEZ** (STFC) **1120021**	**P PORTIUS** (University of Sheffield) **1120019**	
	26 Dec	CHRISTMAS HOLIDAYS		
2012	2 Jan	See Cross Department Research	MAINTENANCE	**N KAD** (Univ of Essex) **1110016**
	9 Jan		**N HUNT** (University of Strathclyde) **1120001**	
	16 Jan	**R BISBY** (University of Salford) **1120011**		**M WATSON** (Bristol) **EPSRC/NERC SPICE Programme**
	23 Jan			
	30 Jan	**S I PASCU** (University of Bath) **1120010**	**M W GEORGE** (University of Nottingham) **1120023**	
	6 Feb	**P O'NEILL** (University of Oxford) **1120002**	**P R RAITHBY** (University of Bath) **1120016**	
	13 Feb	See Cross Department Research	**ORR-EWING** (University of Bristol) **1120000**	**F CURRELL** (QUB) **MT6571 (DLS)**
	20 Feb	**M MARTIN-FERNANDEZ** (STFC) **1120021**		**M KING** (Royal Holloway) **1120015**
	27 Feb	**S QUINN** (University College Dublin) **1192000**		See Functional Biosystems Imaging
	5 Mar		MAINTENANCE	
	12 Mar	**C HAWES** (Brookes University) **1120012**	**S R MEECH** (University of East Anglia) **1120004**	
	19 Mar	**M MARTIN-FERNANDEZ** (STFC) **1120021**		**CARTMELL** (RCaH) **1120022**
	26 Mar	**J WEINSTEIN** (Uni. Of Sheffield) **1120017**	**D HEYES** (University of Manchester) **1120003**	
	2 Apr			**M WATSON** (Bristol) **EPSRC/NERC SPICE Programme**

Table 2 Loan Pool Schedule 2011-12 Part 1

	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	
	Mar 21									Mar 21
	Mar 28									Mar 28
	Apr 04								Installation of new system	Apr 04
	Apr 11									Apr 11
	Apr 18									Apr 18
	Apr 25									Apr 25
	May 02									May 02
	May 09	**HUANG** (Sheffield) Optical switching for microfluidic sorting of microbes **1,151,002**								May 09
	May 16									May 16
	May 23									May 23
	May 30									May 30
	Jun 06									Jun 06
	Jun 13									Jun 13
	Jun 20									Jun 20
	Jun 27									Jun 27
	Jul 04									Jul 04
2011	Jul 11									Jul 11
	Jul 18					**Delivery and Installation of new UFL3 system**				Jul 18
	Jul 25			**VERLET** (Durham) Electronic spectroscopy and structure of gas-phase anions **1,151,004**					**JONES** (Edinburgh) Piezo-chromism: Putting the squeeze on photophysics **1,151,005**	Jul 25
	Aug 01						**CLAEYSSENS** (Sheffield) Scaffolds for nerve repair **1,151,000**	**WU** (York) Dynamic spin injection at Fe/GaAs interfaces **1,151,003**		Aug 01
	Aug 08				**WAGEN-AARS** (York) Enabling plasma medicine by unravelling the physics of plasma jets **1,151,009**					Aug 08
	Aug 15		**FLANAGAN** (Manchester / CERN) Feasibility study of Collinear Ion Resonant Ionization Spectroscopy **1,151,012**							Aug 15
	Aug 22									Aug 22
	Aug 29					**FAULKNER** (Oxford) Energy up-conversion in bimetallic lanthanide complexes **1,151,007**				Aug 29
	Sep 05									Sep 05
	Sep 12									Sep 12
	Sep 19									Sep 19
	Sep 26									Sep 26
	Oct 3									Oct 3
	Oct 10									Oct 10
	Oct 17									Oct 17
	Oct 24									Oct 24

Table 2(cont) Loan Pool Schedule 2011-12 Part 2

	Oct 31									Oct 31
	Nov 07									
	Nov 14									Nov 14
	Nov 21									Nov 21
	Nov 28									Nov 28
	Dec 05									Dec 05
	Dec 12									Dec 12
	Dec 19									Dec 19
	Dec 26									Dec 26
	Jan 02	**ROBINSON** (Oxford) Fast gas-phase photo-activation of protein assemblies: Application to membrane proteins and metallo-proteins **1,152,001**								Jan 02
	Jan 09			**KEMP** (Strathclyde) Wavelength dependence of the Raman gain in synthetic diamond **1,152,000**			**FREY** (S'hampton) Using second harmonic microscopy to assess solid form quality and growth **1,120,018**			Jan 09
	Jan 23							**BRYAN** (Swansea) Ultrafast electron diffraction and photo-electron spectro-scopy **1,152,004**	**UNALLOCATED**	Jan 23
	Jan 30									Jan 30
	Feb 06									Feb 06
	Feb 13									Feb 13
	Feb 20		**LAWRENCE** (Lincoln) Using Schlieren imaging to develop an in-line debris removal system for laser micro-machining **1,152,002**			**CATALUNA** (Dundee) New degrees of freedom for terahertz generation from quantum-dot materials **1,152,005**				Feb 20
2012	Feb 27				**WAGEN-AARS** (York) Enabling plasma medicine by unravelling the physics of plasma jets **12,150,001**					Feb 27
	Mar 05									Mar 05
	Mar 12									Mar 12
	Mar 19									Mar 19
	Mar 26									Mar 26
	Apr 02									Apr 02

Target Fabrication Operational Statistics

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RAL Experiments

A total of three Astra Gemini and five Vulcan experiments were supported by Target Fabrication in the reporting period April 2011 to March 2012. For solid target experiments the Target Fabrication Group provided a total of 29 weeks of experimental support for Vulcan and 17 weeks for Astra Gemini. However, this report does not include the extensive amount of filter and pinhole support provided from Target Fabrication for gas jet experiments and also does not include support for other areas of the CLF such as Artemis and the LSF. The total number of weeks of target support dropped from 58 for last reporting year to 46 for this reporting year due to a Vulcan shutdown and a number of gas jet experiments in this period.

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 the total target numbers produced and the subset consisting of high specification complex 3D targets that have been produced. High specification 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 2011-2012 was 1080 compared to 1532 in 2010-2011[1] and 1424 in 2009-2010[2]. During 2011-2012 the number of high specification targets produced was 355, accounting for 33% of the total targets produced. This is higher than the figure of 17% 2010-2011 and 27% for 2009-2010. This can be largely accounted for by 137 mass limited targets in TAP 11/11 and 104 complex 3D targets in TAW 01/12.

Experiment	Targets Produced	High Specification Targets
June 2011 GTA	30	2
September 2011 TAW	153	79
November 2011 TAP	164	137
November 2011 TAW	124	104
January 2012 TAP	171	0
January 2012 GTA	124	4
March 2012 GTA	63	0
March 2012 TAP	251	29
TOTAL	1080	355

Table 1.

2) Target Types

The targets can be separated into 7 main types as shown in Table 2 and Figure 1. It is worth noting that, although single target foils were manufactured for Gemini, these targets were mounted onto an array of numerous single target positions. The Gemini set up takes multiple shots on each array with up to 25 shots available per single target array. One array foil accounts for one mass produced foil in Table 2 below, and 167 mass produced foils give a total of over 4000 possible shots.

Target Type	Targets Produced
Mass Produced Foils	167
Ultra-Thin Foil	202
Foils	271
Multilayered foils (>2 layers)	109
Mass limited	141
Wire Targets	85
3D Micro-structures	105

Table 2.

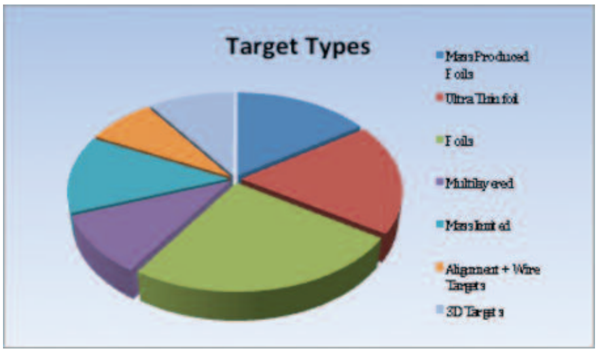

Figure 1: Target Delivery Summary.

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 user groups. The Target Fabrication group responds to experimental changes during a run and often implements a number of modifications or redesigns to the original target 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, 30% 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 34% in 2010-2011[2] and 32% in 2007-2008[3]. However it is somewhat lower than the figure for 2009-2010 which was 42%.

4) Adapting to Demand

The Target Fabrication Group endeavors to be adaptable to the changing demands of the user community as experiments develop because each experiment that is carried out often has widely varying target demands (e.g. even the targets required for Gemini 01/12 and 02/12 on similar array mounts were with completely different materials with hugely varying thickness ranges) the group is required to be constantly developing its capabilities. There is a clear trend that thin foil targets have sharply increased in demand over the past two years due to the increased development on the Gemini facility. The Target Fabrication group has adapted its capabilities to be able to deliver targets as high rep rate arrays while still developing 3D targets that will become more prevalent as Gemini experiments become more complex. The trends can be seen in Figure 2 where in 2009-2012 the thin foil target numbers have increased dramatically. However after an initial fall in 2009-2011 the number of 3D target has started to increase again pointing towards the increasing complexity of the experiments that are being carried out on the facility.

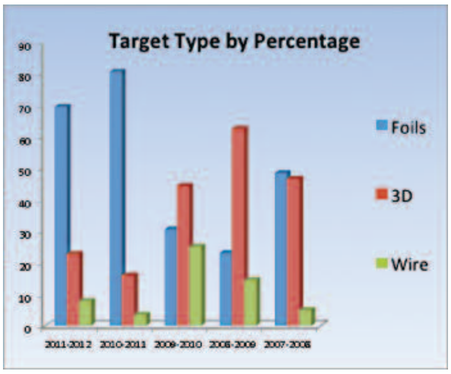

Figure 2: Target type produced by percentage of total targets made each year.

5) Waste Reduction

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 10% 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 2010-2011 23% of targets that were fabricated were either returned un-shot to Target Fabrication or were unused and the figures for 2009-2010[2] and 2008-2009[3] were 43% and 34% respectively.
This reduction can be accounted for by the continued 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 and has improved the quality of targets. Additionally the new planning process enables long term delivery projects to be managed effectively. However the improvements have not led to less flexibility as shown by the percentage of re-designed and additional targets which is in line with the figures for 2008-2009[2] and 2007-2008[3].

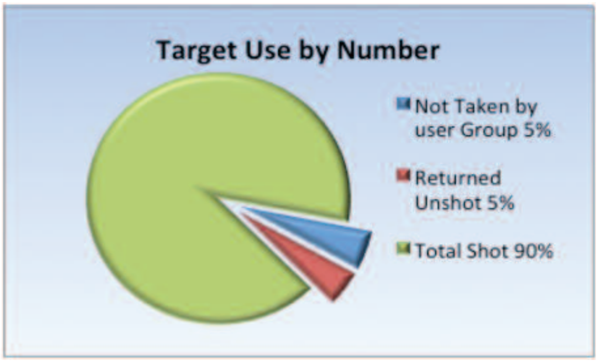

Figure 3: The average proportion of targets shot, returned and unused during solid target experiments in 2011-2012

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 fifteen 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 eight internal and fifteen other UK and international 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 a decrease in the number of targets delivered to experiments compared to 2010-2011 with two less solid target experiments running compared to the previous period.

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Vulcan Operational Statistics

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Introduction

Vulcan has completed an active experimental year, with 41 full experimental weeks allocated to target areas TAW and TAP between April 2011 and March 2012. This figure is down on previous years due to Vulcan being inaccessible to users between April and September 2011 in order to enable the Petawatt Target Area to be "re-lifed".

PERIOD	TAW	TAP
2011		
12 Sep – 23 Oct	P McKenna *Fast electron transport in diamond: Elucidating the role of solid state structure* (114, 10, 91.2%) (66.9%, 125.4%)	
1 Nov – 6 Nov	K M Spohr *Production and decay of radioactive 26-Al in laser induced plasma, pump priming an astrophysical laboratory* (46, 1, 97.8%) (73.9%, 149.8%)	
7 Nov – 15 Dec		N Booth *Multi MegaGauss magnetic field measurements in ultra-relativistic plasmas* (86, 6, 93.0%) (70.0%, 95.5%)
14 Nov – 22 Jan	G Gregori *X-rat Thomson scattering on molten carbon heated by laser accelerated protons* (91, 11, 87.9%) (76.0%, 103.3%)	
2012		
9 Jan – 19 Feb		Z Najmudin *Diagnosing plasma surfaces driven by radiation pressure* (82, 8, 90.2%) (68.3%, 91.9%)
23 Jan – 12 Feb	D Riley *Microscopic structure of warm dense iron* (81, 6, 92.6%) (71.4%, 98.2%)	
27 Feb – 9 Apr	D A Jaroszynski *An experimental study of amplification of high power laser pulses in plasma in the Raman and Compton regimes* (20, 1, 95.0%) (89.0%, 132.6%)	M Borghesi *Light sail acceleration with intense sub-ps pulses (a LIBRA consortium proposal)* (121, 9, 92.6%) (76.3%, 119.8%)

Table 1. Experimental schedule for the period April 2011 – March 2012

(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 641. Table 2 shows how this figure compares with recent years. 54 shots failed to meet user requirements. The overall shot success rate to target for the year is 92%, compared to 91%, 90%, 85% and 89% in the previous four years. Figure 1 shows the reliability of the Vulcan laser to all target areas over the past five years.

	No of shots	Failed shots	Reliability
07 - 08	977	98	90%
08 - 09	646	61	91%
09 – 10	445	65	85%
10 – 11	764	87	89%
11 - 12	641	54	92%

Table 2: Target type produced by percentage of total targets made each year.

The shot reliability to TAW has improved slightly compared with 2009-2010 at 91%, which is particularly encouraging as this follows the rod amplifier upgrade[1]. The improvement in front end contrast has led to an improvement in the reliability of the OPCPA Vulcan Petawatt system - the shot reliability to TAP is around 92% - 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 (although this year pulsed power issues have been significant - 14% of failures). 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

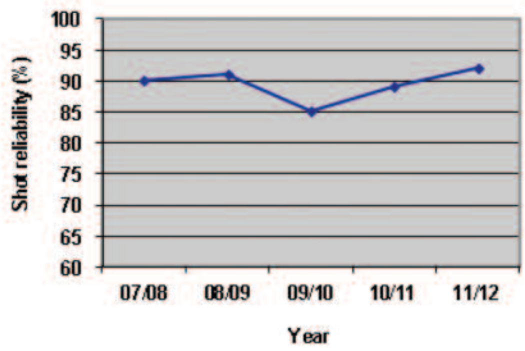

Figure 1. All areas shot reliability for each year 2007-8 to 2011-12

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 74.2% of the time during contracted hours and 111.2% overall. These figures compare with 77.8% and 103.6% in 2010-2011 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.

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LASERS FOR SCIENCE FACILITY

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HIGH POWER LASER FACILITY – ASTRA-GEMINI & VULCAN

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Panel membership and CLF structure

Lasers for Science Facility Access Panel 2011/12

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Dr A. Randewich (January 2012)
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CENTRAL LASER FACILITY STRUCTURE 2011/12