

Contents

	<i>Page</i>
Foreword	1
<i>A. M. Dunne</i>	
Overview of the Central Laser Facility	3
<i>A. M. Dunne</i>	
 High Power Laser Science	
1 Plasma Physics	
Observations of debris and shrapnel plumes from PW driven solid targets	7
<i>J. E. Andrew, R. D. Edwards, J. D. Fyrth, M. D. Gardner, A. J. Simons, K. Vaughan, R. J. Clarke, C. G. Allwork and H. Doyle</i>	
Measurement of laser ablation using X-ray laser transmission	12
<i>N. Booth, M. H. Edwards, Z. Zhai, G. J. Tallents, T. Dzelzainis, R. Ferrari, C. L. S. Lewis, G. Gregori, R. J. Clarke and D. Neely</i>	
Slowly varying electromagnetic structures in a laser-plasma channel	15
<i>A. Bigongiari, M. Borghesi, C. A. Cecchetti, S. Kar, L. Romagnani, R. Jung, J. Osterholtz, O. Willi, T. V. Liseikina, A. Macchi, M. Galimberti and R. Heathcote</i>	
Effects of front surface plasma expansion on proton acceleration driven by the Vulcan Petawatt laser	19
<i>D. C. Carroll, M. N. Quinn, X. H. Yuan, P. McKenna, O. Lundh, C.-G. Wahlström, F. Nürnberg, M. Roth, K. Markey, S. Kar, M. Zepf, S. Bandyopadhyay, D. Pepler, D. Neely, R. G. Evans, R. Jafer, R. Redaelli and D. Batani</i>	
Scaling cluster blast wave physics to high energies, relativistic intensities and ultra high mach numbers	23
<i>M. Hohenberger, J. Lazarus, R. E. Carley, H. W. Doyle, R. A. Smith, D. R. Symes, R. J. Clarke, M. M. Notley, A. S. Moore and E. T. Gumbrell</i>	
Guided transport of hot electrons in solid using magnetic field induced by resistivity gradient	28
<i>S. Kar, K. Markey, M. Zepf, A. P. L. Robinson, D. Neely, D. C. Carroll and P. McKenna</i>	
X-ray measurements of laser-solid interactions on the PW laser	31
<i>P. Koester, A. Giulietti, D. Giulietti, L. Labate, L. A. Gizzi, K. L. Lancaster, P. A. Norreys, J. S. Green, R. G. Evans, S. Baton, F. Perez, M. Koenig, J. Waugh, N. Woolsey, A. Morace, D. Batani and K. Akli</i>	
Temperature profiles derived from transverse optical shadowgraphy in ultra-intense laser plasma interactions	35
<i>K. L. Lancaster, J. S. Green, R. G. Evans, P. A. Norreys, R. Heathcote, C. Hernandez-Gomez, I. Musgrave, J. Pasley, J. Waugh, N. Woolsey, P. Koester, L. Gizzi, A. Morace, D. Batani, F. Perez, S. Baton and M. Koenig</i>	
Study of electron transport in nail-wire targets using the Vulcan Petawatt laser	38
<i>T. Ma, J. A. King, M. S. Wei, F. N. Beg, R. J. Mason, M. H. Key, A. G. MacPhee, S. P. Hatchett, A. J. Mackinnon, P. K. Patel, R. B. Stephens, K. U. Akli, R. R. Freeman, K. Highbarger, R. L. Weber, L. D. Van Woerkom, J. S. Green, K. L. Lancaster, J. Pasley, P. A. Norreys, P. Jamangi and W. Theobald</i>	
Divergence control of multi-MeV laser accelerated proton beams using curved foil targets	42
<i>K. Markey, S. Kar, P. Simpson, B. Dromey, M. Zepf, C. Bellei, S. Nagel, S. Kneip, Z. Najmudin, L. Willingale, J. S. Green, P. Norreys, R. J. Clarke, D. Neely, D. C. Carroll, P. McKenna, E. L. Clark and K. Krushelnick</i>	

	Page
Electron acceleration from the interaction of Vulcan 100TW laser with Au foils and its dependence on laser polarisation	45
S. R. Nagel, C. Bellei, S. Kneip, S. P. D. Mangles, C. Palmer, L. Willingale, A. E. Dangor, Z. Najmudin, R. J. Clarke, R. Heathcote, B. Dromey, S. Kar, K. Markey, P. Simpson, M. Zepf, M. Kaluza, A. Sävert, A. Henig and J. Schreiber	
RCF imaging spectroscopy of laser-accelerated proton beams at Vulcan Petawatt	49
F. Nürnberg, M. Schollmeier, K. Harres, M. Roth, D. C. Carroll, M. N. Quinn, P. McKenna, O. Lundh, C.-G. Wahlström, K. Markey, S. Kar, M. Zepf, S. Bandyopadhyay, D. Pepler, D. Neely, R. Redaelli, R. Jafer and D. Batani	
Proton energy spectra from ultra-intense laser interactions with film targets of varying thicknesses	52
C. Palmer, C. Bellei, A. E. Dangor, S. Kneip, S. P. D. Mangles, S. R. Nagel, Z. Najmudin, L. Willingale, R. J. Clarke, R. Heathcote, A. Henig, J. Schreiber, M. C. Kaluza and A. Sävert	
Ultrafast field dynamics following high-intensity laser interactions with metallic wires	56
K. Quinn, L. Romagnani, P. A. Wilson, B. Ramakrishna, M. Borghesi, M. M. Notley, R. J. Clarke, L. Lancia, J. Fuchs, A. Pipahl, O. Willi and R. G. Evans	
Spatial intensity mapping of Petawatt laser focus into fast electron transport	60
M. N. Quinn, D. C. Carroll, X. H. Yuan, P. McKenna, K. Markey, S. Kar, M. Zepf, M. Günther, K. Harres, F. Nürnberg, M. Roth, K. L. Lancaster and D. Neely	
Divergence control with two laser pulses – results of first experiment	63
R. H. H. Scott, K. L. Lancaster, J. S. Green, A. P. L. Robinson, M. Sherlock, P. A. Norreys, M. G. Haines, S. Kar, M. Zepf, J. King, T. Ma, T. Yabuuchi, F. N. Beg, M. H. Key, P. Nilson, R. B. Stephens, M. Nakatsutsumi, T. Tanimoto, R. Kodama, K. A. Tanaka, K. Takeda, H. Azechi, J. Valente and J. R. Davies	
Relativistic electron transport and beam filamentation in foams	66
P. A. Wilson, M. Borghesi, L. Romagnani, K. Quinn, B. Ramakrishna, A. Pipahl, O. Willi, L. Lancia, J. Fuchs, R. G. Evans, W. Nazarov, R. J. Clarke and M. M. Notley	
2 Femtosecond Pulse Physics	
Quantum engineering in molecules using intense Ti:Sapphire lasers	71
T. Birkeland, C. R. Calvert, R. B. King, I. D. Williams and J. F. McCann	
Beam quality and conversion efficiencies of harmonics generated from overdense plasma	73
D. Adams, B. Dromey, S. Kar, K. Markey, M. Zepf, R. Hörlein, Y. Nomura, S. G. Rykovanov, G. Tsakiris, D. Neely, P. S. Foster and M. Streeter	
Evidence for plasma polarization shift of Ti He-α line in high density laser produced plasma	76
F. Y. Khattak, D. Riley and F. Rosmej	
Steps towards vibrational control of D₂⁺	82
R. B. King, C. R. Calvert, J. D. Alexander, T. Birkeland, J. F. McCann, I. D. Williams, G. R. A. J. Nemeth, W. A. Bryan, W. R. Newell, E. L. Springate, C. A. Froud, S. J. Hawkes, K. G. Ertel, O. Chekhlov, C. J. Hooker, I. C. E Turcu, A. J. Langley and J. L. Collier	
Design of a sub 100-femtosecond X-ray streak camera	85
Bin Li, P. P. Rajeev, B. Dobson, M. M. Notley, D. Neely, G. Gregori, A. Cavalleri, P. Lau, J. Lynn, M. Benetou, L. Pickworth, F. H. Read and P. Jaanmagi	
Modeling proton probing of femtosecond laser propagation through underdense plasma	90
B. Ramakrishna, S. Kar, M. Borghesi and A. Schiavi	

	<i>Page</i>
Electron emission from atomic clusters irradiated with 10 fs laser pulses	93

Y. C. El-Taha, R. Carley, D. Darios, J. W. G. Tisch, R. A. Smith, J. P. Marangos, E. L. Springate, C. A. Froud, S. Bonora, D. Symes, F. Rajgara and D. Mathur

Mapping molecular orbitals from high harmonic generation	96
---	-----------

R. Torres, T. Siegel, Y. El-Taha, S. Baker, J. W. G. Tisch, J. P. Marangos, I. Procino, J. G. Underwood, C. Altucci, R. Velotta, C. A. Froud, E. L. Springate and I. C. E. Turcu

Investigation of Jet Collimation using Astra	99
---	-----------

J. N. Waugh, C. D. Gregory, L. A. Wilson, B. Loupias, E. Brambrink, M. Koenig, Y. Sakawa, Y. Kuramitsu, H. Takabe, R. Kodama and N. C. Woolsey

3 Theory and Computation

Coherent X-rays from relativistic plasmas	103
--	------------

T. Bæva

Spiral magnetic fields and density cavities generated by hot electron streaming	107
--	------------

A. R. Bell

Electrostatic wave-breaking in thermal plasmas	110
---	------------

D. A. Burton and A. Noble

Multielectron atoms in ultra-short light fields: a time-dependent R-matrix approach	113
--	------------

M. A. Lysaght, P. G. Burke and H. W. van der Hart

The effects of contaminant ion species on thermonuclear ignition and burn in high density DT fuel	116
--	------------

J. Pasley

Scaling relations for recombination following tunnelling ionisation	119
--	------------

G. J. Pert

Transport in the presence of inverse bremsstrahlung and magnetic fields	123
--	------------

C. P. Ridgers, A. G. R. Thomas, A. P. L. Robinson, J. Bissel and R. J. Kingham

Collimation and guiding of fast electrons in laser-solid interactions	126
--	------------

A. P. L. Robinson, M. Sherlock, P. A. Norreys, R. J. Kingham, C. P. Ridgers, M. Zepf and S. Kar

Vlasov simulations of intense (10^{19} Wcm$^{-2}$) laser interactions with overdense plasma of varying scale-length	129
--	------------

M. Sherlock and W. Rozmus

Vlasov-Maxwell modelling of beam-plasma instabilities in two dimensions	131
--	------------

N. J. Sircombe, R. Bingham and T. D. Arber

Vlasov-Fokker-Planck modelling of magnetic field generation by anisotropic pressure in laser-plasma interactions	135
---	------------

A. G. R. Thomas, R. J. Kingham and C. P. Ridgers

Numerical simulations of photon acceleration occurring during the modulation of a long laser pulse in plasma	138
---	------------

R. M. G. Trines, C. Murphy, P. A. Norreys, R. Bingham, J. T. Mendonça and L. O. Silva

Inner-shell processes in two-photon ionization of Ne⁺	142
---	------------

L. Hamonou and H. W. van der Hart

Page

Lasers for Science Facility (LSF) Programme

4 Biology

The potential of UVRR for characterizing the structure, conformation and stability of biopharmaceutical protein formulations	147
<i>S. E. J. Bell, I. A. Larmour, T. Arvinte, M. A. H. Capelle, E. Patois, F. Mulinacci and C. Palais</i>	
Hydroxyl radical formation and detection from multi-photon-ionization of tryptophan in the presence of hydrogen peroxide	150
<i>R. H. Bisby, S. W. Botchway, A. G. Crisostomo and A. W. Parker</i>	
Analysis of prostate and bladder cells using Raman tweezers	153
<i>T. J. Harvey, C. Hughes, E. Correia Faria, R. D. Snook, P. Gardner, A. D. Ward, N. W. Clarke and M. D. Brown</i>	
Photodynamics in light sensing proteins: a time resolved infra-red study of the BLUF (blue light sensing protein using FAD) domain of AppA	155
<i>A. Stelling, P. J. Tonge, M. Kondo, S. R. Meech, I. P. Clark, K. L. Ronayne and A. Bachter</i>	
Contribution of DNA repair pathways following multi-photon irradiation of cycling and G1-arrested mammalian cells	158
<i>P. Reynolds, J. V. Harper, S. W. Botchway, A. W. Parker and P. O'Neill</i>	
Fluorescence quenching of 2-aminopurine as identifying transient species formed in DNA	162
<i>K. C. Thompson, S. J. O. Hardman, K. L. Ronayne, I. Clark, M. Towrie and A. W. Parker</i>	
Deriving molecular information from photoselection experiments of the green fluorescent protein using intense femtosecond pulses	164
<i>J. J. van Thor, K. L. Ronayne, M. Towrie and J. T. Sage</i>	
UV resonance Raman spectroscopy reveals details of the "random coil" state of polypeptides	169
<i>R. Whynes, M. Volk, S. M. Tavender and M. Towrie</i>	

5 Chemistry

Vibrational emission from electronic quenching	173
<i>S. Gowrie and G. Hancock</i>	
Two photon LIF measurements of CO	176
<i>U. Bhayaraju, S. Hochgreb and Dr. R. Barlow</i>	
The isolation of porphyrins in the gas phase using pulsed-laser desorption	179
<i>J. M. Beames and A. J. Hudson</i>	
Temperature dependence of hydrogen-bonding dynamics via ultrafast 2D-IR spectroscopy	182
<i>A. I. Stewart, N. T. Hunt, I. P. Clark, M. Towrie and A. W. Parker</i>	
Oxidation of HULIS in atmospheric aerosols	185
<i>M. D. King, O. R. Hunt, A. D. Ward and C. Pfarrang</i>	
Hydrogen bonding vs. dispersive interactions: Carbohydrate-p-Cresol complexes	188
<i>E. C. Stanca-Kaposta, Z. Su, P. Hurtado, D. Gamblin, B. Davis and J. P. Simons</i>	

	Page
Application of resonance Raman spectroscopy for a direct characterisation of the nature of the frontier orbitals in Pt(II) diimine acetylide complexes <i>R. D. Bennett, N. M. Shavaleev, I. V. Sazanovich and J. A. Weinstein</i>	192
6 Physics	
Fundamental and applied studies of hyper-Raman scattering <i>T. J. Dines, I. P. Clark, P. Matousek, M. Towrie and K. L. Ronayne</i>	195
UV laser direct writing of ferroelectric domain inverted structures in single crystal lithium niobate <i>S. Mailis, A. C. Muir, C. L. Sones, R. W. Eason, T. Jungk, A. Hoffmann and E. Soergel</i>	197
Enhancement of signal in transmission Raman spectroscopy of turbid media <i>N.A. Macleod and P. Matousek</i>	200
Non-invasive detection of concealed liquid and powder explosives using spatially offset Raman spectroscopy <i>C. Eliasson, N. A. Macleod and P. Matousek</i>	203
Terahertz frequency scattering and plasmonic probe studies <i>G. P. Swift, D. Dai, J. R. Fletcher and J. M. Chamberlain</i>	207

7 Laser Science and Development

Astra

Space charge effects in the Axis-Photonique PX-1 X-ray streak camera <i>M. H. Edwards, N. Booth, Z. Zhai, G. J. Tallents, T. Dzelzainis, R. Ferrari, C. L. S. Lewis, P. Foster, M. Streeter and D. Neely</i>	213
Managing metadata for Astra Gemini <i>V. A. Marshall and E. J. Divall</i>	216
Laser performance data analysis tool <i>E. J. Divall</i>	220
Gemini diagnostics <i>E. J. Divall</i>	223
Gemini control system <i>E. J. Divall</i>	226
eCLF project progress <i>E. J. Divall, K. Hayrapetyan, A. Kidd, D. Neely, M. Notley, M. Gleaves, L. Lerusse, V. Marshall, L. Sastry, A. Pakhira and S. Nagella</i>	229
Commissioning the south beam of Astra Gemini <i>C. J. Hooker, S. Blake, O. Chekhlov, R. J. Clarke, J. L. Collier, E. J. Divall, K. Ertel, P. S. Foster, S. J. Hawkes, P. Holligan, B. Landowski, W. J. Lester, D. Neely, B. Parry, R. Pattathil, M. Streeter and B. E. Wyborn</i>	232
eScience-CLF data acquisition system <i>K. Hayrapetyan</i>	236

	<i>Page</i>
Artemis: a sub 10-fs XUV source for ultrafast time-resolved science	240
<i>C. A. Froud, A. J. Langley, E. Springate, I. C. E. Turcu, J. Underwood, D. S. Wolff, A. Cavalleri, S. S. Dhesi, S. Bonora, F. Frassetto, L. Poletto and P. Villoresi</i>	
A report on the commissioning of the Gemini experimental target area	243
<i>M. J. V. Streeter, P. Foster, C. Hooker, J. Collier, D. Neely, E. Divall, S. Hawkes, K. Ertel, O. Chekhlov, D. Symes, B. Parry, R. Clarke, B. Wyborn, S. Blake, S. Hancock, A. Langley, W. Lester, D. Neville, P. Rice, R. Bickerton, P. Holligan, J. Suarez-Merchen, P. Brummit, B. Landowski, R. Heathcote, S. & P. P. Rajeev, S. Kneip, S. Nagel, S. Mangles and Z. Najmudin</i>	
Advanced optical probing capabilities in Astra TA2	246
<i>D. R. Symes, E. J. Divall, P. S. Foster, M. J. V. Streeter, P. P. Rajeev, D. Neely, J. L. Collier, J. S. Robinson, F. Frank and J. W. G. Tisch</i>	
Lasers for Science Facility	
ULTRA laser system: a new dual-output 10 kHz Ti:Sapphire amplifier with UV–IR generation for time-resolved spectroscopy	249
<i>G. M. Greetham, P. Matousek, D. A. Robinson, R. C. Farrow, P. S. Codd, Z. J. Xin, M. W. George, A. W. Parker and M. Towrie</i>	
Vibrational emission from electronic quenching	251
<i>S. Gowrie and Prof. G. Hancock</i>	
Non-invasive detection of cocaine in rum using displaced Raman spectroscopy	254
<i>C. Eliasson, N. A. Macleod and P. Matousek</i>	
Rapid non-invasive quantitative assessment of pharmaceutical capsules using transmission Raman spectroscopy	256
<i>C. Eliasson, N. A. Macleod, P. Matousek, L. C. Jayes, F. C. Clarke, S. V. Hammond and M. R. Smith</i>	
Vulcan	
An overview of the Target Area West short pulse upgrade	260
<i>C. Hernandez-Gomez, S. Blake, C. Burton, R. Clarke, J. Collier, B. Costello, V. Dubrosky, A. Frackiewicz, M. Galimberti, S. Hancock, S. Hawkes, R. Heathcote, A. Kidd, I. Musgrave, D. Nealy, M. N. Notley, B. Parry, D. Pepler, W. Shaik, T. B. Winstone and B. Wyborn</i>	
TAW Pulse stretcher upgrade	263
<i>C. S. Burton, I. O. Musgrave, W. Shaikh, M. Galimberti and C. Hernandez-Gomez</i>	
Self lasing effect on proton beam production in Target Area West	265
<i>M. Galimberti, J. S. Green, R. Heathcote, C. Hernandez-Gomez, A. K. Kidd, K. L. Lancaster, I. O. Musgrave and W. Shaikh</i>	
A novel optical parametric chirped pulse amplification source as seed for a 10PW laser	268
<i>Y. Tang, I. N. Ross, C. Hernandez-Gomez, I. Musgrave, O. V. Chekhlov, P. Matousek, J. L. Collier and G. H. C. New</i>	
Development of the Joule level amplification stage for the Phase 1 of the Vulcan 10 PW OPCPA project	271
<i>A. Lyachev, O. Chekhlov, J. L. Collier, S. Hancock, P. Holligan, C. Hernandez-Gomez, P. Matousek, I. Musgrave, I. N. Ross, Y. Tang and M. Divoky</i>	
Spider diagnostics technique for Vulcan 10 PW OPCPA project	273
<i>M. Divoky and C. Hernandez-Gomez</i>	

	Page
Laser R&D and Instrumentation	
Setup of a commercial digital SLR, large area, triggerable CCD camera for optical laser-plasma diagnostics	276
<i>L. Labate, A. Barbini, L. A. Gizzi, L. M. R. Gartside and D. Neely</i>	
Development of VISAR at CLF	279
<i>S. Bandyopadhyay and R. J. Clarke</i>	
Damage testing of reflective coatings in Astra TA2	281
<i>M. J. V. Streeter, P. S. Foster, T. Winstone, B. Parry and P. P. Rajeev</i>	
New image capture system for high rep-rate image acquisition in the CLF high power experimental areas	284
<i>M. J. V. Streeter</i>	
Target Fabrication	
The production of micron scale square mass limited high power laser targets	286
<i>D. Wyatt and C. Spindloe</i>	
Production of embedded metallic microdots for study of fast electron collimation in high power laser experiments	288
<i>H. F. Lowe, C. Spindloe, B. Landowski, A. Robinson, P. Norreys, S. Kar and M. Zepf</i>	
Advanced X-ray collimator micro-fabrication for warm dense matter studies	291
<i>C. Spindloe, M. Tolley, D. Neely, D. Riley, G. Gregori and J. J. Spencer</i>	
8 Appendices	
Schedules and Operational Statistics	
Astra operational statistics 07/08	297
<i>S. Hawkes</i>	
LSF operational statistics	299
<i>A. W. Parker</i>	
Vulcan operational statistics	303
<i>A. Kidd and T. Winstone</i>	
Target fabrication operational statistics	306
<i>H. F. Lowe, C. Spindloe and M. Tolley</i>	
Publications	309
Panel Membership and CLF Structure	315
Author Index	319