Contents

Foreword MHR Hutchinson	1
Overview of the Central Laser Facility M Dunne	2
High Power Laser Programme	
High Power Laser Programme – Short Pulse Plasma Physics	
Initial observations of the effect on the transverse acceleration of ions and production of neutrons from underdense plasma in controlled two pulse experiments with the Vulcan Petawatt laser L Willingale, S P D Mangles, P M Nilson, Z Najmudin, M S Wei, A G R Thomas, M C Kaluza, A E Dangor, K Krushelnick, K L Lancaster, R J Clarke, C Hernandez-Gomez, S J Hawkes, P A Norreys, S Karsch, J Schreiber, M Tatarakis	5
Forward acceleration of ions from underdense plasma interactions with the Vulcan Petawatt laser L Willingale, S P D Mangles, P M Nilson, Z Najmudin, M S Wei, A G R Thomas, M C Kaluza, A E Dangor, K Krushelnick, K L Lancaster, R J Clarke, S Karsch, J Schreiber, M Tatarakis	8
Experimental observations of blast wave formation driven by high-intensity laser interactions with underdense plasma P. M. Nilson, S. P. D. Mangles, L. Willingale, M. C. Kaluza, A. G. R. Thomas, M. Tatarakis, Z. Najmudin, R. G. Evans, A. E. Dangor, K. Krushelnick, R. J. Clarke, K. L. Lancaster, S. Karsch, J. Schreiber	11
Focusing of laser produced proton beams by using hemispherical targets S Kar, M Borghesi, L Romangnani, P K Patel, A J Mackinnon, R Snavely, M H Key, J A King, B Zhang, K U Akli, R R Freeman, R J Clarke, R Heathcote, D Neely	14
Charge dynamics following high-intensity laser propagation through gas jet targets S Kar, M Borghesi, L Romagnani, C A Cecchetti, R Jung, J Osterholtz, O Willi, J Fuchs, A Macchi, T V Liseykina, A Schiavi, M Galimberti, L A Gizzi, R Heathcote, D Neely	17
Spectral and angular characterisation of laser-produced proton beams from dosimetric measurements <i>E Breschi, M Galimberti, D Giulietti, L A Gizzi, M Borghesi, L Romagnani, S Kar, A Schiavi, O Willi</i>	21
Optimization and characterization of supersonic gas jet target for laser-plasma interaction studies R Jung, J Osterholz, O Willi, M Galimberti, L A Gizzi, M Borghesi, S Kar, C A Cecchetti, R Heathcote, D Neely	23
Measurements of electron beam patterns and divergence using transverse optical probing with optical, XUV and Cu Kα X-ray imaging K L Lancaster, J S Green, C D Murphy, R J Clark, S J Hawkes, C Hernandez-Gomez, P A Norreys, D S Hey, K U Akli, P Simpson, M Zepf, K Krushelnick, M H Key, R Snavely, H Habara, R Kodama, M Nakatsutsumi, T Yabuuchi, R R Freeman, R Stephens, C Stoeckl	25
Observation of annular electron beam transport in multi-TeraWatt laser-solid interactions J S Green, K L Lancaster, P A Norreys, M Tatarakis, M S Wei, A E Dangor, K Krushelnick, E L Clark, J R Davies, M Zepf	29
Acceleration, transport and dephasing of electrons in dense plasmas irradiated with Petawatt laser pulses J Osterholz, R Jung, K Löwenbrück, S Kiselev, A Pukhov, G Pretzler, O Willi, S Kar, M Borghesi, W Nazarov, S Karsch, R J Clark, D Neely	32
Integrated absorption-energy transport measurement from ultra-intense laser heating of atomic clusters A S Moore, E L Clark, R D Edwards, R T Eagleton, E T Gumbrell, P M Nilson, J Lazarus, R A Smith, R J Clarke	34

Prepulse measurements from laser cluster interaction experiments on the Vulcan Petawatt laser <i>J Lazarus, P M Nilson, R A Smith, A S Moore, E L Clark, R T Eagleton, R D Edwards, E T Gumbrell, R J Clarke</i>	38
Electromagnetic pulse suppression in laser plasma interaction experiments on the Vulcan Petawatt laser <i>J Lazarus, P M Nilson, R A Smith, A S Moore, E L Clark, R T Eagleton, R D Edwards, E T Gumbrell, R J Clarke</i>	40
High Power Laser Programme - X-ray Laser and Long Pulse Plasma Physics	
X-ray scattering from laser-shock driven plasmas F Y Khattak, K A Thornton, D Riley, C D Gregory, N C Woolsey, M Notley, D Neely	43
Plasma dynamics and self-generated magnetic field distributions in multiple-beam produced plasmas P M $Nilson$, L $Willingale$, M C $Kaluza$, M S Wei , C $Kamberidis$, Z $Najmuudin$, W $Rozmus$, R G $Evans$, M G $Haines$, A E $Dangor$, K $Krushelnick$, R $Heathcote$, S $Bandyopadhyay$	46
High Power Laser Programme - Femtosecond Pulse Physics	
Measuring the dispersion of a recolliding electron wave packet E M L English, J Wood, W A Bryan, S L Stebbings, W R Newell, J McKenna, M Suresh, B Srigengan, I D Williams, I C E Turcu, J M Smith, K G Ertel, E J Divall, C J Hooker, A J Langley	49
Probing atomic ionization mechanisms in intense laser fields by calculating geometry and diffraction independent ionization probabilities <i>J Wood, E M L English, S L Stebbings, W A Bryan, W R Newell, J McKenna, M Suresh, B Srigengan, I D Williams, I C E Turcu, J M Smith, K G Ertel, E J Divall, C J Hooker, A J Langley</i>	51
Intense field dynamics of H ₂ and D ₂ with few-cycle laser pulses J McKenna, B Srigengan, I D Williams, J Wood, E M L English, W A Bryan, W R Newell, I C E Turcu	53
Ultrafast 3D photodissociation imaging (3D-PDI): initial observations of the interaction of 40fs laser pulses with a beam of ${\rm H_2}^+$ ions <i>W A Bryan, W R Newell, B Srigengan, I D Williams, I C E Turcu</i>	57
Atomic excitation during recollision-free ultrafast multi-electron tunnel ionization W A Bryan, E M L English, J Wood, S L Stebbings, W R Newell, J McKenna, M Suresh, B Srigengan, I D Williams, I C E Turcu, J M Smith, E J Divall, C J Hooker, A J Langley	59
Ultrafast laser-induced photodissociation dynamics of $\mathrm{H_2}^+$: measuring adiabatic avoided crossings W A B ryan, E M L E nglish, S L S tebbings, J W ood, W R N ewell, J M cKenna, M S uresh, B S rigengan, I D W illiams, I C E T urcu, J M S mith, K G E rtel, E J D ivall, C J H ooker, A J L angley	61
Enhanced He-α emission from smoked Ti targets irradiated with 400nm, 45fs laser pulses F Y Khattak, O A M B Percie du Sert, D Riley, M Edwards, P Mistry, G Tallents, P S Foster, R J Clarke, E J Divall, C J Hooker, A J Langley, D Neely, J M Smith, C Spindloe, M K Tolley	63
Efficient K-α and He-α emission from Ti foils irradiated with 400nm, 45fs laser pulses F Y Khattak, O A M B Percie du Sert, D Riley, M Edwards, P Mistry, G Tallents, P S Foster, R J Clarke, E J Divall, C J Hooker, A J Langley, D Neely, J M Smith, C Spindloe, M K Tolley	66
Laser-related effects on shock wave propagation C D Gregory, C Courtois, I M Hall, J Howe, N C Woolsey, D M Chambers	70
Study of high-field atomic effects in picosecond laser produced plasmas J Howe, C Courtois, C D Gregory, I M Hall, N C Woolsey, D M Chambers, E Förster, I Uschmann, O Renner	72
Electron beam pointing instability in a self-injected laser wakefield accelerator S P D Mangles, M C Kaluza, A G R Thomas, C D Murphy, Z Najmudin, A E Dangor, K Krushelnick, P. S. Fostor, C. I. Hookar, A. I. Langlay, F. I. Diyall, K. G. Fittel, J. M. Smith	75

Experimental studies of laser focusing conditions on electron acceleration in underdense plasma interactions A G R Thomas, C D Murphy, S P D Mangles, Z Najmudin, W Rozmus, A E Dangor, K Krushelnick, P S Foster, P A Norreys, E J Divall, C J Hooker, A J Langley, J M Smith, J L Collier, J G Gallacher, D A Jaroszynski	78
Photon acceleration by laser produced wakefields on Astra C D Murphy, R M G M Trines, J L Collier, E J Divall, P S Foster, C J Hooker, A J Langley, J M Smith, P A Norreys, R Bingham, A J W Reitsma, J G Gallacher, R Viskup, D A Jaroszynski, S P D Mangles, Z Najmudin, A G R Thomas, K Krushelnick	80
High Power Laser Programme - Theory and Computation	
Benchmark calculations for multiphoton ionization of He at a wavelength of 390 nm H W van der Hart, J S Parker, B J S Doherty, K T Taylor	83
Numerical studies of photon acceleration in laser wakefields R M G M Trines, C D Murphy, R Bingham, J T Mendonça, P A Norreys, A J W Reitsma	85
Scaling laws for laser-plasma interaction derived with photon kinetic theory A J W Reitsma, D A Jaroszynski, R M G M Trines, R L Bingham	87
Attosecond signatures in photodissociation by an intense Ti: Sapphire pulse JF McCann, L-Y Peng, I D Williams	90
Absorption of ultra-short laser pulses and particle transport in dense targets <i>M Sherlock, A R Bell, W Rozmus</i>	92
Modelling the interaction of CPA lasers with solid targets <i>R G Evans</i>	94
A new diagnostic for very high magnetic fields in expanding plasmas S Eliezer, J T Mendonça, R Bingham, P A Norreys	96
Effect of Landau quantization on the equations of state in dense plasmas with strong magnetic fields S Eliezer, P A Norreys, J T Mendonça, K L Lancaster	99
A coupled two-step plasma instability in Petawatt laser plasma interaction J T Mendonça, J R Davies, P A Norreys, R Bingham	102
The effect of target composition on proton acceleration A P L Robinson, A R Bell, R J Kingham	105
Aspects of electron acoustic wave physics in laser backscatter NJ Sircombe, TD Arber, R O Dendy	108
Lasers for Science Facility Programme	
Lasers for Science Facility Programme - Chemistry	
Photophysics of [Re(NCS)(CO) ₃ (α-Diimine)] complexes: character of the lowest excited state <i>A-M Blanco Rodriguez, S Záliš, A Vlček Jr, P Matousek, M Towrie</i>	115
TRIR studies of ruthenium-tin complexes A Gabrielsson, A Vlček Jr, P Matousek, M Towrie	117
How does the strength of the Fe-Solvent bond affect the formation of ¹ Fe(CO) ₄ (solvent) <i>A Cowan, P Portius, X-Z Sun, M W George, M Towrie, K L Ronayne</i>	119

Time-resolved resonance Raman spectroscopy and isotopic substitution: probing the structure of charge-separated excited state in Pt(II) diimine (bis)thiolates J. A. Weinstein, M. Ya. Mel'nikov, P. Matousek, A. W. Parker, K. L. Ronayne, M. Towrie	121
Solvent-based switching of photophysical properties of polynuclear complexes T L Easun, M D Ward, W Z Alsindi, X-Z Sun, M W George	125
Early picosecond photophysical dynamics and vibrational energy relaxation in Ru(II)polypyridyl complexes C G Coates, K L Ronayne, C Brady, J J McGarvey, W Henry, W R Browne, J G Vos, P Matousek, M Towrie, S W Botchway, A W Parker	127
Atmospheric reactions of OH with unsaturated hydrocarbons P Cleary, M Baeza Romero, M Blitz, D Heard, M Pilling, P Seakins, L Wang	129
Growth and coagulation of aqueous aerosol droplets studied by cavity enhanced droplet spectroscopy J P Reid, L Mitchem, R J Hopkins, A D Ward	131
Probing aerosol dynamics by interfacing optical tweezing with cavity enhanced droplet spectroscopy <i>J P Reid, L Mitchem, R J Hopkins, A D Ward</i>	133
Reactions on atmospheric mineral aerosol M.D. King, F. N. Fisher, K. C. Thompson, A. D. Ward	135
Oxidation of organic films on atmospheric aerosol M D King, K C Thompson, A D Ward	137
Molecular interactions in complexes and nanodroplets A J Boatwright, A Musgrave, D Bergeron, R R Wright, A J Stace, T G Wright	139
Protonated neurotransmitters in the gas phase: a photochemical production method N A Macleod, J P Simons	141
The common core of <i>N</i> -linked glycans: rigidity through branching? <i>P Çarçabal, I Hünig, B Liu, R A Jockusch, L C Snoek, J P Simons</i>	143
Studies of UV stimulated luminescence from phosphors of commercial importance <i>R Withnall, J Silver, A L Lipman, S Zhang</i>	145
Photoluminescence of Y ₂ O ₂ S:REE and Gd ₂ O ₂ S:REE phosphors under 257 nm excitation <i>R Withnall, J Silver, G R Fern, A L Lipman, S Zhang, I Marian, E Barrett</i>	147
Lasers for Science Facility Programme - Biology	
Hyperluminescence from multiphoton excitation of serotonin complexed with β-cyclodextrin and imaged within mammalian cells <i>R H Bisby, S Dad, S W Botchway, A W Parker</i>	149
Characterisation of DNA damage induced by near infrared multi-photon absorption E. L. Leatherbarrow, J. V. Harper, P. O'Neill, S. W. Botchway, M. Dillingham, A. W. Parker	151
Protein kinase C interactions with caveolin determined in intact cells by resonance energy transfer-fluorescence lifetime imaging C D Stubbs, S W Botchway, A W Parker, S J Slater	155
Ultrafast dynamics of green fluorescent protein: evidence for excited state proton transfer and a rigid local chromophore environment <i>S R Meech, D Stoner-Ma, A A Jaye, P J Tonge, P Matousek, M Towrie</i>	158
A novel assessment of bone quality using time-resolved transcutaneous Raman spectroscopy ERC Draper, AE Goodship, MD Morris, NP Camacho, P Matousek, M Towrie, AW Parker	161
Solving the biological sample problem: Detection limits in small samples of 4-thio thymidine by resonance Raman spectroscopy C. Nevlon, H. Cross, I.P. Clark, S.M. Tayender, A. W. Parker	163

Probing the putative H-Channel of Cytochrome c oxidase from Paracoccus denitrificans using site-directed mutagenesis <i>S M Tavender, J Bennett, J Salje</i>	165
Kerr gated resonance raman spectroscopy in studies of lignin polymerization K. L. Larsen, S. Barsberg, K. L. Ronayne, A. W. Parker, P. Matousek, M. Towrie	168
Picosecond time resolved infrared absorption measurements reporting on the structural events in the photocycle of Green Fluorescent Protein <i>J J van Thor, G Zanetti, M Towrie, K L Ronayne</i>	170
Time-resolved isotope-edited IR spectroscopy – Detailed insight into the fast folding dynamics of α-helical peptides <i>M Volk, A Pozo Ramajo, S A Petty, A Starzyk, S M Decatur</i>	173
Peptide containing vesicles trapped with Raman tweezers – Vpu ₁₋₃₂ from HIV-1 W B Fischer, Y H Lam, A D Ward	175
Lasers for Science Facility Programme - Physics	
High resolution impedance and potential imaging S Krause, L Chen, W Moritz, S W Botchway, M Dillingham	177
Microphotoluminescence studies of single InGaN quantum dots R A Taylor, J W Robinson, J H Rice, J H Na, K H Lee, M J Holmes, R A Oliver, M J Kappers, C J Humphreys, Y Arakawa	179
Investigation of strain soliton formation and propagation N M Stanton, A J Kent	181
Adaptive optics for three-dimensional optical data storage and micromachining M J Booth, M Schwertner, T Wilson	183
Light-induced domain engineering in ferroelectrics C L Scones, C E Valdivia, J G Scott, S Mailis, R W Eason, D A Scrymgeour, V Gopalan, T Jungk, E Soergel, I P Clark	185
Laser Science and Development	
Laser Science and Development - Vulcan	
Operational damage to Petawatt gratings TB Winstone, P Brummitt, R J Clarke, C N Danson, A J Frackiewicz, S Hancock, S J Hawkes, C Hernandez-Gomez, D Neville	191
Pulse length optimization for the Petawatt performance of the Vulcan laser facility C Hernandez-Gomez, I O Musgrave, S J Hawkes, B Fell, T B Winstone, R J Clarke, C N Danson	192
Pump induced aberration characterization and compensation for the Vulcan Petawatt beam S J Hawkes, A Dunster, C Hernandez-Gomez, I O Musgrave	194
Nanosecond contrast measurements of the Vulcan Petawatt facility I O Musgrave, C Hernandez-Gomez, D Canny, R Heathcote, R J Clarke, J L Collier, S Bandyopadhyay	197
Picosecond contrast measurement of the Vulcan Petawatt facility C Hernandez-Gomez, D Canny, I O Musgrave, J L Collier	200
A dedicated beamline for the Petawatt facility T B Winstone, C Hernandez-Gomez, S Hancock, I O Musgrave	201
An ultra-fast electrical trigger for TAP using the OPCPA pre-amplifier W Shaikh, C Hernandez-Gomez, J Milnes	202
8.0 ns top hat pulse generation from Vulcan S J Hawkes, C Hernandez-Gomez, I O Musgrave	204

Reconfiguration of the Vulcan pre-amplifiers S J Hawkes, C Hernandez-Gomez, D A Pepler	205
Testing of fiber based modulator systems for 'shaped' long pulse generation on Vulcan W Shaikh	206
Automatic alignment system testing for Vulcan A Dunster, D Canny, S J Hawkes, C Hernandez-Gomez	208
Laser Science and Development – Astra	
The Astra Gemini project – an overview JL Collier	210
Astra Gemini - building progress B E Wyborn, J M Henstridge, R E Cranston, D G Pyke	211
New front-end for the Astra Gemini project A J Langley, K G Ertel, E J Divall, J M Smith, C J Hooker, J L Collier	214
Amplifier design for the Astra Gemini project K G Ertel, C J Hooker, J L Collier	217
Compressor design for the Astra Gemini project O Chekhlov, S Hancock, C J Hooker, A J Langley, J L Collier	219
Interaction chamber design for the Astra Gemini project P S Foster, B Fell, A Brummitt, R J Clarke, B E Wyborn, D Neely	221
Contrast enhancement using gating techniques E J Divall, J L Collier, I N Ross	222
Ten-femtosecond laser pulse compression apparatus for Astra target areas I C E Turcu, E J Divall, P Bates, J M Smith, K G Ertel, J L Collier, J S Robinson, C A Howarth, J P Marangos, J W G Tisch, E M L English, J Wood, W A Bryan, W R Newell, J McKenna, B Srigengan, I D Williams	223
Laser Science and Development – Lasers for Science Facility	
SORS – A new approach to subsurface probing of diffusely scattering media <i>P Matousek, I P Clark, M Towrie, A W Parker, M D Morris, W F Finney, E R C Draper, A E Goodship, N Everall</i>	226
Femtosecond to microsecond time-resolved spectroscopy enabled using an actively Q-switched nanosecond microlasers coupled to the Ultrafast Facility lasers <i>M Towrie, P Matousek, A W Parker, K L Ronayne, A-M Blanco Rodriguez, A Vlček Jr., A Gabrielsson, K F Bowes, P R Raithby</i>	228
A time-resolved infrared vibrational spectroscopic study of the photo-dynamics of crystalline materials K L Ronayne, M Towrie, A W Parker, K F Bowes, P R Raithby	230
The control and data acquisition program for the LSF PIRATE laser CJ Reason, M Towrie	232
Towards a new ultrafast time resolved near-infrared facility using custom InGaAs arrays M Towrie, A W Parker, K L Ronayne, S Manolopoulos, S Martin, P Seller	234
Raman atomic force microscopy – further studies A W Parker, A D Ward, J Bennett, S W Botchway, M Towrie, I P Clark, P Matousek, R Devonshire, S Ward, W E Smith	237
Ultrahigh vacuum and surface science in the Central Laser Facility (CLF) E. Jamme, M.R.S. McCoustra, M.A. Chastars, J.P. Clark, A.W. Parkar,	239

LSF Operational Statistics

Publications

Author Index

E L Belcher, S M Tavender, M Towrie, A W Parker

Panel Membership and CLF Structure

261

265

277

281

Contents