

# 28th International Symposium on Shock Waves

Konstantinos Kontis (Ed.)

# 28th International Symposium on Shock Waves

Vol 1

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# Preface

The University of Manchester hosted the 28th International Symposium on Shock Waves between 17 and 22 July 2011. The University of Manchester was created by bringing together The Victoria University of Manchester (VUM) and UMIST, two of Britain's most distinguished universities, to create a powerful new force in British Higher Education. Manchester has a long tradition of excellence in Higher Education. UMIST can trace its roots back to 1824 and the formation of the Manchester Mechanics' Institute, whilst The Victoria University of Manchester was founded as Owen's College in 1851.

Among the twenty-six Nobel Prize winners associated with the University are Rutherford, W.L. Bragg, A.V. Hill, P.M.S. Blackett, L. Pauling, R. Robinson and A. Todd. In addition to Rutherford's work on nuclear theory and the splitting of the atom, the University of Manchester led the world in the development of digital computing (with Alan Turing) and radio-astronomy (with Bernard Lovell). Recent outstanding successes include the Millennium Technology award to Prof. Steve Furber in Computer Science and the Nobel Prize for Physics in 2010.

In the field of Fluid Mechanics, Osborne Reynolds, FRS, the first professor of engineering in England, spent his whole professional life at Manchester, during which (among his astonishingly wide-ranging contributions) he shaped the direction of turbulence research for the century which followed. In 1946, Sydney Goldstein was instrumental in establishing the Fluid Motion Laboratory linking mathematical analyses of fluid flows with appropriate experimental work. The Laboratory acquired a supersonic tunnel fitted with liners to provide flow Mach number of 1.96 and 3.0. In the late 1950s the Laboratory had acquired an experimental facility which was to prove highly productive over a number of years. This was the 31ft (9.4m) long, 1ft (0.305m) diameter shock tube, named the Mark II shock tube by the Department, which had been built originally at the Atomic Energy Research Establishment, Harwell.

Manchester is the academic, commercial and financial capital of the UK's largest economic region outside London. It has a population of 2.6 million people and is renowned world-wide as a leading trade centre. The region's universities are a source of world-class research and development, and form a 'Supercampus' which is the largest student campus in Europe. Located nearby are a number of UNESCO

designated World Heritage Sites, all relating to industrialisation. The success of modern Manchester is founded on scientific, industrial and social innovation; for historians, it is one of the world's key sites. Its early modern scientific connections date as far back as the 1600s, but it is from the late 1700s that Manchester establishes itself as a mercantile and industrial capital where sciences thrive. The key figures included John Dalton, the Quaker teacher who became famous for the atomic theory in chemistry; his friend William Henry (Henry's law); and his pupil James Prescott Joule, the brewer who established the mechanical equivalent of heat.

The University of Manchester has recognised the importance of running international conferences as a way of promoting international cooperation in the dissemination of research and building collaborations between scholars across the world. The International Symposia on Shock Waves are the definitive meetings of the scientific community devoted to the study and use of the shock-wave phenomena, of all kinds. Started in 1957, they take place every two years, at places close to centres of activity in the field. After 1971 and 1999 in London, it was an honour for us to host the Symposium again in the United Kingdom.

The call for abstract submission resulted in a total number of 486 abstracts. Each abstract was reviewed by two members of the ISSW28 Scientific Review Committee which consisted of 109 experts in the field of shock wave research. The final programme of the symposium contained 9 plenary lectures and 341 oral and poster contributions. The posters were presented in a dedicated session without overlapping oral presentations. The student papers competing for the International Shock Wave Institute (ISWI) Best Student Paper Award were also presented in dedicated sessions. The mission of ISWI, which was founded in 2005, is to promote international and interdisciplinary collaboration in all areas of shock wave research through the organization of conferences, awards and honours and to facilitate liaison with other organizations with similar interests and activities.

Three hundred and seventy eight participants, of which 82 were students, from 25 countries registered. The nations from which the participants originated were: United Kingdom (57), Japan (55), USA (40), China (34), Germany (30), Russia (30), France (29), India (18), Canada (15), Israel (12), Australia (10), Brazil (8), South Korea (6), The Netherlands (6), South Africa (5), Sweden (4), Singapore (4), Taiwan (4), Czech Republic (3), Nigeria (2), Mexico (2), Norway (2), Austria (1), Belarus (1), and Poland (1). In addition, 34 partners enrolled for the companions programme of ISSW28.

Following the opening ceremony, the symposium was started with the Paul Vieille Lecture, given by Prof. Kazuyoshi Takayama, Tohoku University, Japan, providing an exciting presentation on: 'Shock Wave Beyond'.

The ISWI Student Award, which was endowed with \$1,000 US each, was presented during the ISSW28 Dinner Banquet by Prof. Kazuyoshi Takayama and Prof KPG Reddy, President of the International Shock Wave Institute. The winners are:

- Raffaello Mariani, University of Manchester, United Kingdom for his presentation on: 'Head on Collisions of Compressible Vortex Loops on a Solid Wall' (together with K. Kontis) and
- Randall Paton, University of Witwatersrand, South Africa for his presentation on: 'Imploding Conical Shock Waves' (together with B. Skews)

The scientific programme was complemented by a number of social events. The reception on Monday evening was hosted by Professor Luke Georghiou, Vice-President Research and Innovation of the University of Manchester. On Wednesday, the excursion was to Chatsworth House, Derbyshire. On Thursday, the ISSW28 banquet was held in Runway Visitor Park at Manchester International Airport under the historic Concorde aircraft. British Airways received government approval for the production of the G-BOAC in December 1969. Concorde GBOAC (affectionately known as 'Alpha Charlie') became the second aircraft to join the Concorde fleet when she was delivered to British Airways on 13 February 1976. Two extra excursions for accompanying persons were organised to Quarry Bank Mill on Tuesday 19th July, and the Imperial War Museum North and the Lowry on Thursday 21st July.

During the meeting of the International Advisory Committee of ISSW28, the venue for ISSW29 which will be held in 2013, was selected. Five excellent proposals were presented to the IAC which shows that there is a continuing interest in ISSW. The 29<sup>th</sup> International Symposium on Shock Waves will be held in Madison, Wisconsin, USA and will be chaired by Professor Riccardo Bonazza of University of Wisconsin-Madison.

ISSW28 could not have been realised without the support of the University of Manchester, and this is gratefully acknowledged. Further, ISSW28 was generously sponsored by the European Office of Aerospace Research and Development (EOARD). The companies Vision Research, Specialised Imaging, Photron High Speed Cameras, CD-Adapco, TSI, LaVision, National Instruments and Photon Lines were the Symposium exhibitors.

On behalf of the Local Organizing Committee of ISSW28, I would like to thank all participants who came to Manchester to support the Symposium with their attendance and oral or poster contributions. I would like to express my gratitude to the members of the International Advisory Committee and Scientific Review Committee for their continuous support during the preparation and running of the conference. I would like to thank those colleagues who served as session chairpersons and who guaranteed an accurate performance of the parallel sessions.

The support of the ConferCare (STARS) team, the University of Manchester Aerospace Research Institute (UMARI), and members of staff of the School of Mechanical, Aerospace and Civil Engineering is also acknowledged. The dedication, enthusiasm and team spirit of my PhD students and post-docs (Aero-Physics Laboratory Group) was the basis of the realisation of ISSW28.

With all the resources and support at our disposal, I am confident that the 2011 International Symposium on Shock Waves in Manchester has made a significant contribution to the international development of our field.

Manchester  
July 2011

Professor Konstantinos Kontis  
Chairman of the 28th ISSW  
Chair in Aerodynamics and Shock Physics  
Deputy Director of UMARI

**The 28<sup>th</sup> International Symposium  
on Shock Waves  
Hosted by the University of Manchester  
Manchester, UK  
18<sup>th</sup>–22<sup>nd</sup> July 2011**

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Brian Launder	Alistair Revell	Vigor Yang
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## **Student Competition**

Alistair Revell

Sergey Utyuzhnikov

## **Poster Session**

Hossein Zare-Behtash

Daniel Bradford

# Conference Program

Date	Time	Session	Session Chair	Room
<b>Sunday, 17 July 2011</b>	1600	Registration Opens		Renold Concourse
	1900 - 2100	Welcome Drinks		Renold Concourse
<b>Monday, 18 July 2011</b>	0830 - 0850	Opening Ceremony		Renold C16
	0850 - 0930	Paul Vieille Memorial Lecture: Prof. K. Takayama	Prof. K. Kontis	Renold C16
	0940 - 1040	Hypersonic Flows I	Prof. S. Gai	Renold C2
		Propulsion I	Prof. B. E. Launder	Renold D7
		Shock Wave Propagation and Reflection I	Prof. I. Krassovskaya	Renold C16
		Multiphase Flows I	Prof. S. K. Lele	Renold C9
		Shock Waves in Rarefied Flows I	Prof. A. Sakurai	Renold F14
		Student Competition I	Prof. G. Jagadeesh	Renold E7
		1040 - 1100	Coffee / Tea	
	1100 - 1220	Hypersonic Flows II	Prof. T. Mizukaki	Renold C2
		Propulsion II	Prof. C. Mundt	Renold D7
		Shock Wave Propagation and Reflection II	Prof. I. Krassovskaya	Renold C16
		Multiphase Flows II	Prof. J. Yang	Renold C9
		Shock Waves in Rarefied Flows II	Prof. A. Sakurai	Renold F14
		Student Competition II	Prof. G. Jagadeesh	Renold E7
	1220 - 1330	Lunch		Barnes Wallis

<b>Date</b>	<b>Time</b>	<b>Session</b>	<b>Session Chair</b>	<b>Room</b>
<b>Monday, 18 July 2011</b>	1330 - 1410	Keynote Lecture 1: Prof. I. Krassovskaya	Prof. K. Takayama	Renold C16
	1420 - 1540	Blast Waves I	Prof. N. Apazidis	Renold F14
		Chemically Reacting Flows I	Prof. C. Needham	Renold D7
		Flow Visualisation I	Prof. H. Kleine	Renold C2
		Shock Wave Propagation and Reflection III	Prof. S. Kobayashi	Renold C16
		Multiphase Flows III	Prof. O. Igra	Renold C9
		Student Competition III	Prof. N. Qin	Renold E7
	1540 - 1600	Coffee / Tea		Renold Concourse
	1600 - 1720	Blast Waves II	Prof. N. Apazidis	Renold F14
		Chemically Reacting Flows II	Prof. C. Park	Renold D7
		Flow Visualisation II	Prof. H. Kleine	Renold C2
		Shock Wave Propagation and Reflection IV	Prof. S. Kobayashi	Renold C16
		Multiphase Flows IV	Prof. O. Igra	Renold C9
		Student Competition IV	Prof. N. Qin	Renold E7
	1900 - 2100	Reception		Sackville Entrance Hall

2011 INTERNATIONAL  
SYMPOSIUM ON  
SHOCK WAVES  
2011

<b>Date</b>	<b>Time</b>	<b>Session</b>	<b>Session Chair</b>	<b>Room</b>
<b>Tuesday, 19 July 2011</b>	0830 - 0910	Keynote Lecture 2: Prof. Y. M. Gupta	Prof. K. P. J. Reddy	Renold C16
	0920 - 1040	Detonation and Combustion I	Prof. K. Hayashi	Renold C16
		Shock Vortex Interactions I	Prof. F. Seiler	Renold C2
		Shock Boundary Layer Interactions I	Prof. J. Stollery	Renold C9
		Medical - Biological Applications I	Prof. H. Hosseini	Renold D7
		Student Competition V	Prof. L. Houas	Renold E7
	1040 - 1100	Coffee / Tea		Renold Concourse
	1100 - 1220	Detonation and Combustion II	Prof. K. Hayashi	Renold C16
		Shock Vortex Interactions II	Prof. F. Seiler	Renold C2
		Shock Boundary Layer Interactions II	Prof. J. Stollery	Renold C9
		Medical - Biological Applications II	Prof. H. Hosseini	Renold D7
		Student Competition VI	Prof. L. Houas	Renold E7
	1220 - 1330	Lunch		Barnes Wallis
	1330 - 1410	Keynote Lecture 3: Prof. K. Hayashi	Prof. R. Hanson	Renold C16
	1420 - 1540	Detonation and Combustion III	Prof. V. Golub	Renold C16
		Richtmyer-Meshkov I	Prof. R. Bonazza	Renold C9
		Diagnostics I	Prof. G. Settles	Renold D7
		Numerical Methods and Simulations I	Prof. T. Saito	Renold C2
		Student Competition VII	Prof. O. Sadot	Renold E7
	1540 - 1600	Coffee / Tea		Renold Concourse
	1600 - 1720	Facilities I	Prof. D. Buttsworth	Renold C2
		Richtmyer-Meshkov II	Prof. R. Bonazza	Renold C9
		Diagnostics II	Prof. G. Settles	Renold D7
		Shock Wave Phenomena and Applications I	Prof. D. Zeitoun	Renold C16
		Impact and Compaction I	Dr. J. Srulijes	Renold E7

<b>Date</b>	<b>Time</b>	<b>Session</b>	<b>Session Chair</b>	<b>Room</b>
<b>Wednesday, 20 July 2011</b>	0830 - 0910	Keynote Lecture 4: Prof. D. Buttsworth	Prof. H. G. Hornung	Renold C16
	0930 - 1700	Excursion		
<b>Thursday, 21 July 2011</b>	0830 - 0910	Keynote Lecture 5: Dr J. Steelant	Prof. J. L. Stollery	Renold C16
	0920 - 1040	Chemically Reacting Flows III	Prof. C. Park	Renold C2
		Detonation and Combustion IV	Prof. F. Lu	Renold C16
		Hypersonic Flows III	Prof. D. Mee	Renold C9
		Nozzle Flows I	Prof. A. Abe	Renold D7
		Shock Wave Phenomena and Applications II	Prof. M. Brouillette	Renold E7
	1040 - 1100	Coffee / Tea		Renold Concourse
	1100 - 1220	Facilities II	Prof. H. Olivier	Renold E7
		Detonation and Combustion V	Prof. M. Liberman	Renold C16
		Hypersonic Flows IV	Prof. D. Mee	Renold C9
		Nozzle Flows II	Prof. A. Abe	Renold D7
		Numerical Methods and Simulations II	Prof. T. Saito	Renold C2
	1220 - 1330	Lunch		Barnes Wallis
	1330 - 1410	Keynote Lecture 6: Prof. N. Qin	Prof. B. Skews	Renold C16
	1420 - 1540	Detonation and Combustion VI	Prof. M. Liberman	Renold C16
		Diagnostics III	Prof. T. Mizukaki	Renold D7
		Ignition I	Prof. N. Fedorova	Renold E7
		Richtmyer- Meshkov III	Prof. Z. Jiang	Renold C2
		Shock Wave Propagation and Reflection V	Prof. R. Morgan	Renold C9
	1540 - 1600	Coffee / Tea		Renold Concourse
1600 - 1720	Poster Session	Dr. N. Gongora-Orozco	Renold Concourse	
1830 - 2200	Banquet			

<b>Date</b>	<b>Time</b>	<b>Session</b>	<b>Session Chair</b>	<b>Room</b>
<b>Friday, 22 July 2011</b>	0830 - 0910	Keynote Lecture 7: Prof. S. K. Lele	Prof. E. Timofeev	Renold C16
	0920 - 1040	Special Session on Shock Wave Moderation I	Prof. A. Sasoh	Renold C2
		Detonation and Combustion VII	Prof. A. Hadjadj	Renold C16
		Flow Visualisation III	Dr. H. Sakaue	Renold D7
		Shock Wave Phenomena and Applications III	Prof. Z. Walenta	Renold E7
		Shock Wave Propagation and Reflections VI	Prof. M. Brouillette	Renold C9
	1040 - 1100	Coffee / Tea		Renold Concourse
	1100 - 1220	Special Session on Shock Wave Moderation II	Prof. A. Sasoh	Renold C2
		Detonation and Combustion VIII	Prof. A. Hadjadj	Renold C16
		Flow Visualisation IV	Dr. E. Schuelein	Renold D7
		Shock Wave Phenomena and Applications IV	Dr. S. Utyuzhnikov	Renold E7
		Shock Wave Propagation and Reflection VII	Prof. Z. Jiang	Renold C9
	1220 - 1330	Lunch		Barnes Wallis
	1330 - 1410	Keynote Lecture 8: Prof. E. Arunan	Prof. Z. Jiang	Renold C16
	1420 - 1520	Nozzle Flows III	Dr. E. Erdem	Renold D7
		Shock Boundary Layer Interactions III	Dr. H. Zare-Behtash	Renold C16
		Numerical Methods and Simulations III	Prof. K-S. Chang	Renold C2
		Multiphase Flows V	Prof. Z. Walenta	Renold C9
	1540 - 1550	Coffee / Tea		Renold Concourse
	1550 - 1700	Closing Ceremony		Renold C16



# Sunday, 17 July 2011

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Sunday, 17 July 2011

Renold Concourse

1600 hrs

**Registration Opens**

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Sunday, 17 July 2011

Renold Concourse

1900-2100

**Welcome Drinks**

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# Monday, 18 July 2011

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Monday, 18 July 2011

**Opening Ceremony**

0830-0850

**Prof. Konstantinos Kontis, Chairman of ISSW 28**

**Prof. Colin Bailey, Dean and Vice-President**

The University of Manchester, Faculty of EPS, School of MACE

Renold C16

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Monday, 18 July 2011

**Paul Vieille Memorial Lecture**

0850-0930

**Shock Wave Phenomena and Interactions**

**Prof. Kazuyoshi Takayama**

Tohoku University, Japan

**Session Chair:**

K. Kontis, University of Manchester UK

Renold C16

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## Monday, 18 July 2011 AM Session A

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### Monday, 18 July 2011

#### Hypersonic Flows I

Renold C2

<b>Session Chair:</b>	S. Gai, University of New South Wales, Australia		
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2431	2453	2744
<b>Paper title</b>	Experimental investigation of mechanical distortions to hypersonic boundary layers	On the stability of pitching motion of re-entry vehicle with the tilted toroidal ballute	Surrogate-based multi-objective aerothermodynamic design optimization of hypersonic spiked bodies
<b>Presenting author</b>	W. Flaherty, University of Illinois, USA	H. Otsu, Ryukoku University, Japan	N. Qin, University of Sheffield, UK

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### Monday, 18 July 2011

#### Propulsion I

Renold D7

<b>Session Chair:</b>	B. E. Launder, The University of Manchester, UK		
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2639	2645	2755
<b>Paper title</b>	A computational study of supersonic combustion relevant to air-breathing engines	On thermodynamic cycles for detonation engines	External and internal configurations of the 14-X hypersonic aerospace vehicle
<b>Presenting author</b>	E. Fedina, Swedish Defence Research Agency – FOI, Sweden	F. Lu, University of Texas at Arlington, USA	T. Marcos, Institute for Advanced Studies, Brazil

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**Monday, 18 July 2011**
**Shock Wave Propagation and Reflection I**

Renold C16

<b>Session Chair:</b>	I. Krassovskaya, Ioffe Institute, Russia		
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2496	2765	2456
<b>Paper title</b>	Shock wave reflection off convex cylindrical surfaces	Determination of the sonic point in unsteady shock reflection using various techniques based on numerical flowfield analysis	Consideration of von Neumann reflection and Mach reflection for strong shock waves
<b>Presenting author</b>	H. Kleine, University of New South Wales, Australia	A. Hakkaki-Fard, McGill University, Canada	S. Kobayashi, Saitama Institute of Technology, Japan

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**Monday, 18 July 2011**
**Multiphase Flows I**

Renold C9

<b>Session Chair:</b>	S. K. Lele, Stanford University, USA		
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2501	2504	2454
<b>Paper title</b>	Experimental study of scale effects on shock wave interaction with a granular layer	Supercavitation phenomenon during water exit and water entry of a fast slender body	Numerical investigation of processes accompanying energy release in water near the free surface
<b>Presenting author</b>	Y. Sakamura, Toyama Prefectural Technical University, Japan	H-H. Shi, Zhejiang Sci-Tech University, China	N. Petrov, Ioffe Physical Technical Institute RAS, Russia

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**Monday, 18 July 2011**
**Shock Waves in Rarefied Flows I**

Renold F14

<b>Session Chair:</b>	A. Sakurai, Tokyo Denki University, Japan		
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2441	2480	2514
<b>Paper title</b>	A DSMC-MD investigation of wall effects in a shock tube operating at high Knudsen numbers	Generation of shock wave by temperature change at wall	Numerical simulations of nonequilibrium and diffusive effects in spherical shock waves
<b>Presenting author</b>	U. Bhandarkar, Indian Institute of Technology, India	A. Sakurai, Tokyo Denki University, Japan	V. Riabov, River College, USA

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**Monday, 18 July 2011**
**Student Competition I**

Renold E7

<b>Session Chair:</b>	G. Jagadeesh, India Institute of Science, Banagalore, India			
<b>Time</b>	0940 hrs	1000 hrs	1020 hrs	1040
<b>Paper number</b>	2448	2414	2467	2723
<b>Paper title</b>	Hypersonic flow past spiked bodies	Head on collisions of compressible vortex loops on a solid wall. Effects of wall distance variation	Experimental study on inactivation of marine bacteria using electrodischarge shock waves	Micro-blast waves using detonation transmission tubing
<b>Presenting author</b>	R. Fernandes, Cranfield University, UK	R. Mariani, University of Manchester, UK	N. Tsujii, Kobe University, Japan	O. Isaac, Indian institute of Science, India

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**Monday, 18 July 2011**

Renold Concourse

1040-1100

**Coffee / Tea**


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## Monday, 18 July 2011 AM Session B

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### Monday, 18 July 2011

#### Hypersonic Flows II

Renold C2

**Session Chair:** T. Mizukaki, Tokai University, Japan

**Time** 1100 hrs 1120 hrs 1140 hrs 1200 hrs

**Paper number** 2521 2532 2568 2569

**Paper title** An investigation of base flow of a circular cylinder at hypersonic speeds    On the numerical solution method of the 2D Oswatitsch equations for hypersonic flow    Modelling the complete operation of a free-piston shock tunnel for a low enthalpy condition    Shock tube experiments on heat transfer at generic re-entry bodies

**Presenting author** S. Gai, University of New South Wales, Australia    V. Lorenz, University of the German Federal Forces, Germany    A. Dann, Loughborough University, UK    J. Srulijes, French-German Research Institute of Saint-Louis, France

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### Monday, 18 July 2011

#### Propulsion II

Renold D7

**Session Chair:** C. Mundt, Universität der Bundeswehr München, Germany

**Time** 1100 hrs 1120 hrs 1140 hrs 1200 hrs

**Paper number** 2761 2771 2633 2801

**Paper title** Particle-impact ignition measurements in a high-pressure oxygen shock tube    Limiting contractions for starting a Prandtl-Meyer-type scramjet intake with overboard spillage    High Mach number and total pressure flow conditions for scramjet testing    Interaction between combustion and shock wave in supersonic combustor

**Presenting author** M. Crofton, The Aerospace Corporation, USA    N. Moradian, McGill University, Canada    D. Gildfind, University of Queensland, Australia    L. Chen, Chinese Academy of Sciences, China

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**Monday, 18 July 2011**
**Shock Wave Propagation and Reflection II**

Renold C16

**Session Chair:** I. Krassovskaya, Ioffe Institute, Russia

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2457	2484	2486	2698
<b>Paper title</b>	Study of shock-wave mitigation through solid obstacles	Guderley reflection for higher Mach numbers in a standard shock tube	Wave processes in transonic airfoil flows	Effect of solution conductivity on shock wave pressure generated by multichannel electrical discharge in water
<b>Presenting author</b>	A. Chaudhuri, CORIA, France	A. Cachucho, Witwatersrand University, South Africa	J. Nies, RWTH Aachen University, Germany	V. Stelmashuk, Institute of Plasma Physics AS CR, Czech Republic

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**Monday, 18 July 2011**
**Multiphase Flows II**

Renold C9

**Session Chair:** J. Yang, University of Science and Technology of China, China

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2515	2528	2584	2601
<b>Paper title</b>	Explosive eruptions of volcanoes: hydrodynamic shock tubes as lab method of simulation	Investigation of bubble collapse and water jet induced by underwater explosion in a rectangular tube	Study of the interaction between a shock wave and a cloud of droplets	Motion of non-spherical particles following shock passage
<b>Presenting author</b>	V. Kedrinskiy, Lavrentyev Institute of Hydrodynamics, Russia	T. Koita, Tohoku University, Japan	A. Chauvin, Aix-Marseille Université, France	D. Murray, DSTL, UK

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**Monday, 18 July 2011**
**Shock Waves in Rarefied Flows II**

Renold F14

**Session Chair:** A. Sakurai, Tokyo Denki University, Japan

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2561	2566	2680	2679
<b>Paper title</b>	Numerical study of hypersonic rarefied flows about leading edges of small bluntness	High-energy molecular beam source using a non-diaphragm type small shock tube	Flow phenomena in microscale shock tubes	Propagating wave in binary gas mixture from boundary of variable temperature and velocity
<b>Presenting author</b>	G. Shoev, Khristianovich Institute of Theoretical and Applied Mechanics, Russia	Y. Yoshimoto, University of Tokyo, Japan	M. Brouillette, Université de Sherbrooke, Canada	K. Yoshimura, Mathematical Science and Information Technology Research Centre, Japan

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**Monday, 18 July 2011**
**Student Competition II**

Renold E7

**Session Chair:** G. Jagadeesh, India Institute of Science, Banagalore, India

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2549	2751	2575	2597
<b>Paper title</b>	Numerical simulation of a shock-accelerated multiphase fluid interface	Supersonic combustion flow visualization at hypersonic flow	Characteristics of shock wave propagating over particulate foam	Triple-shock-wave configurations: comparison of different thermodynamic models for diatomic gases
<b>Presenting author</b>	M. Anderson, Applied Research Associates, USA	T. Marcos, Institute for Advanced Studies, Brazil	M. Liverts, Ben Gurion University, Israel	P. Mostovykh, Baltic State Technical University, Russia

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**Monday, 18 July 2011**

Barnes Wallis

1220-1330

**Lunch**


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**Monday, 18 July 2011 PM Session A**

**Monday, 18 July 2011**

**Keynote Lecture 1**

Renold C16

1330-1410

**Reflection and Diffraction of Shock Waves and Shock Wave Configurations**

**Prof. Irina Krassovskaya**

Ioffe Institute, Russia

**Session Chair:** K. Takayama, Tohoku University, Japan

**Monday, 18 July 2011**

**Blast Waves I**

Renold F14

**Session Chair:** N. Apazidis, KTH, Sweden

	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2862	2498	2604	2524
<b>Paper title</b>	Numerical investigation of shock-wave load attenuation by barriers	Numerical analysis of weak-shock attenuation resulting from molecular vibrational relaxation	The influence of water saturation in soil on blast effect	Numerical investigations on muzzle flow under approaching real shooting conditions
<b>Presenting author</b>	S. Berger, Ben-Gurion University, Israel	K. Hatanaka, Muroran Institute of Technology, Japan	I. Kuchuk-Katalan, Plasan Sasa Ltd., Israel	X. Jiang, Nanjing University of Science and Technology, China

2011



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**Monday, 18 July 2011**
**Chemically Reacting Flows I**

Renold D7

**Session Chair:** C. Needham, Applied Research Associates, USA

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2722	2798	2825	2583
<b>Paper title</b>	Prediction of heatshield material performance in an arcjet	Experimental investigation of interaction of shock heated test gases with 7.25 $\mu$ m carbon fibres in a shock tube	A shock-tube with high-repetition time-of-flight mass spectrometry for the study of complex reaction systems	Reactions in H <sub>2</sub> +He+CH <sub>4</sub> in strong shock waves: a review
<b>Presenting author</b>	S. McDowell, DSTL, UK	V. Jayaram, Indian Institute of Science, India	M. Fikri, University of Duisburg-Essen, Germany	C. Park, Korea Advanced Institute of Science and Technology, Korea

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**Monday, 18 July 2011**
**Flow Visualisation I**

Renold C2

**Session Chair:** H. Kleine, University of New South Wales, Australia

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2495	2523	2614	2522
<b>Paper title</b>	Time-resolved Mach-Zehnder interferometry of shock waves	Study of normal shock behaviour near second throat	A temperature-cancellation method for motion-capturing PSP system and its application to a hypersonic wind tunnel	Surface pressure measurements on a supercritical airfoil employing pressure-sensitive paint
<b>Presenting author</b>	H. Kleine, University of New South Wales, Australia	A. Pateria, IIT-Madras, India	T. Okabe, University of Electro Communications, Japan	Q. Zhou, China Aerodynamics R&D Centre, China

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**Monday, 18 July 2011**
**Shock Wave Propagation and Reflection III**

Renold C16

**Session Chair:** S. Kobayashi, Saitama Institute of Technology, Japan

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2509	2661	2539	2622
<b>Paper title</b>	Analytical theory for planar shock focusing through perfect gas lens: high compression designs	Area change effects on shock wave propagation	Nonlinear analysis of stability of plane shock waves in media with arbitrary thermodynamic properties	Studies on shock wave attenuation in small tubes
<b>Presenting author</b>	M. Vandenboomgaerde, CEA/DAM, France	J. Dowse, University of the Witwatersrand, South Africa	A. Likhachev, Joint Institute for High Temperatures, Russia	J. Subburaj, Indian Institute of Science, India

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**Monday, 18 July 2011**
**Multiphase Flows III**

Renold C9

**Session Chair:** O. Igra, Ben Gurion University, Israel

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2692	2642	2653	2621
<b>Paper title</b>	The behaviors of a drop in ambient liquid under a sudden impact	Anti-diffusion interface sharpening technique for two-phase compressible flow simulations	Numerical simulation of a transonic gas-droplet two-phase flow over an airfoil with a droplet breakup model	Shocked fluid/fluid and fluid/solid interactions using a conservative level-set method
<b>Presenting author</b>	J. Yang, University of Science and Technology of China, China	K. K. So, Technical University of Munich, Germany	K-S. Chang, Korea Advanced Institute of Science and Technology, Korea	B. Obadia, Cranfield University, UK

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**Monday, 18 July 2011**
**Student Competition III**

Renold E7

**Session Chair:** N. Qin, University of Sheffield, UK

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2605	2466	2606	2677
<b>Paper title</b>	Numerical study on the evolution of the shock-accelerated interface: influence of the interfacial shape	Analytical estimation of microbubble motion exposed to discontinuous pressure change	Imploding conical shock waves	Micro-shock wave assisted bacterial transformation
<b>Presenting author</b>	M. Fan, University of Sciences and Technology of China, China	S. Fukuda, Kobe University, Japan	R. Paton, University of Witwatersrand, South Africa	D. P. Gnanadhas, Indian Institute of Science, India

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**Monday, 18 July 2011**

Renold Concourse

1540-1600

**Tea/Coffee**


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**ISSW 28**  
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 SHOCK WAVES  
 2011

## Monday, 18 July 2011 PM Session B

### Monday, 18 July 2011

#### Blast Waves II

Renold F14

**Session Chair:** N. Apazidis, KTH, Sweden

	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2641	2726	2759	2714
<b>Paper title</b>	Blast waves from cylindrical charges	High energy concentration by symmetric shock focusing	A novel experimental system for blast structure interaction research	Blast wave attenuation by dry aqueous foams
<b>Presenting author</b>	C. Knock, Cranfield University, UK	N. Apazidis, KTH, Sweden	O. Ram, Ben Gurion University, Israel	E. del Prete, CEA/DAM France

### Monday, 18 July 2011

#### Chemically Reacting Flows II

Renold D7

	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Session Chair:</b>	C. Park, Korea Advanced Institute of Science and Technology, Korea			
<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2513	2576	2590	2750
<b>Paper title</b>	Shock tube investigation of molecular oxygen dissociation at temperatures of 4000 to 10800 K	A numeric study of the effects of turbulent flow	Thermo-chemistry modelling in an open source DSMC code	Computations of radiation of high-temperature gases in shock layers
<b>Presenting author</b>	L. Ibragimova, Lomonosov Moscow State University, Russia	C. Needham, Applied Research Associates, USA	T. Scanlon, University of Strathclyde, UK	M-C. Druguet, Aix-Marseille Université, France

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**Monday, 18 July 2011**
**Flow Visualisation II**

Renold C2

**Session Chair:** H. Kleine, University of New South Wales, Australia

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2724	2701	2716	2732
<b>Paper title</b>	Application of NPLS technique to hypersonic shock-wave and boundary layer interactions	Density field reconstructing in the supersonic wind tunnel using OCT technology	Experimental exploration of an underexpanded supersonic jet	Quantitative measurement and reconstruction of 3D density field by CGBOS (colored grid background oriented Schlieren) technique
<b>Presenting author</b>	M. Li, China Aerodynamics Research and development Center, China	G. Longde, CARDC, China	B. André, Ecole Centrale de Lyon, France	M. Ota, Chiba University, Japan

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**Monday, 18 July 2011**
**Shock Wave Propagation and Reflection IV**

Renold C16

**Session Chair:** S. Kobayashi, Saitama Institute of Technology, Japan

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2555	2577	2684	2551
<b>Paper title</b>	Supersonic patches in steady irregular reflection of weak shock waves	Shear layer evolution in shock wave diffraction	Shock detachment from curved surfaces	Shock and blast wave propagation through a porous barrier
<b>Presenting author</b>	G. Shoev, Khristianovich Institute of Theoretical and Applied Mechanics, Russia	B. Skews, University of Witwatersrand, South Africa	S. Mölder, McGill University, Canada	D. Epstein, ITAM SB RAS, Russia

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**Monday, 18 July 2011**

**Multiphase Flows IV**

Renold C9

**Session Chair:** O. Igra, Ben Gurion University, Israel

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2654	2699	2763	2791
<b>Paper title</b>	Numerical investigation of cavitation bubble dynamics near walls	Application of laser holography and PDPA technology in spray fuel particle field measurement	Dense particle cloud dispersion by a shock wave	Dynamic jet formation with mitigation materials
<b>Presenting author</b>	E. Lauer, TU München, Germany	Z. Long, CARDC, China	M. Kellenberger, Queen's University, Canada	C. Parrish, AWE, UK

**Monday, 18 July 2011**

**Student Competition IV**

Renold E7

**Session Chair:** N. Qin, University of Sheffield, UK

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2634	2618	2613	2610
<b>Paper title</b>	Free-piston driver optimisation for simulation of high Mach number scramjet flow conditions	Experimental investigations on the effect of dielectric barrier discharge on the hypersonic flow around a flat plate	On the evolution of spherical gas interface accelerated by planar shock wave	Experimental studies on mixing in supersonic ejector
<b>Presenting author</b>	D. Gildfind, University of Queensland, Australia	S. Rengarajan, Indian Institute of Science, India	Z. Zhai, University of Science and Technology of China, China	S. Rao, Indian Institute of Science, India

**Monday, 18 July 2011**

Sackville Entrance Hall

1900-2100

Reception

**Hosted by Prof. Luke Georghiou**

Vice-President Research and Innovation, The University of Manchester, UK

## Tuesday, 19 July 2011 AM Session A

Tuesday, 19 July 2011

Keynote Lecture 2

Renold C16

0830-0910

**Shock Induced Chemical Decomposition in Condensed Energetic Materials:  
(Molecular Mechanisms)**

**Prof. Yogendra M. Gupta**

Institute for Shock Physics, Washington State University, USA

**Session Chair:** K. P. J. Reddy, Indian Institute of Science, India

Tuesday, 19 July 2011

**Detonation and Combustion I**

Renold C16

**Session Chair:** K. Hayashi, Aoyama Gakuin University, Japan

Time	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2479	2442	2450	2438
<b>Paper title</b>	Interaction of laser pulse with liquid droplet	Expansion of the detonation products of a TATB based high explosive: Experimental characterization by Photon Doppler Velocimetry and high-speed digital shadowgraphy	Gas detonation simulation in the channel by instant heating of one Its flat end for the case of real chemical reaction	Front structure of detonation and the stability of detonation
<b>Presenting author</b>	K. Volkov, Kingston University, UK	A. Sollier, CEA, France	S. Kulikov, Institute of Problems of chemical Physics RAS, Russia	H-S. Dou, National University of Singapore, Singapore

**Tuesday, 19 July 2011**

**Shock Vortex Interactions I**

Renold C2

<b>Session Chair:</b>	F. Seiler, French-German Research Institute of Saint-Louis, France			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2624	2507	2591	2469
<b>Paper title</b>	Complex conservative difference schemes in modeling of instabilities and contact structures	Vortex induced Mach waves in supersonic jets	Numerical investigation of 2D/3D blade-vortex interactions	Shock wave in turbulent flow field
<b>Presenting author</b>	O. Azarova, Institution of Russian Academy of Sciences RAS, Russia	F. Seiler, French-German Research Institute of Saint-Louis, France	E. Yildirim, Imperial College London, UK	M. Tsukamoto, Tokyo Denki University, Japan

**Tuesday, 19 July 2011**

**Shock Boundary Layer Interactions I**

Renold C9

<b>Session Chair:</b>	J. L. Stollery, Cranfield University, UK			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2792	2510	2470	2729
<b>Paper title</b>	Boundary layer effects behind incident and reflected shock waves in a shock tube	Flow topology of symmetric crossing shock wave boundary layer interactions	PIV investigation of the 3D instantaneous flow organization behind a micro-ramp in a supersonic boundary layer	Effect of a counterflow plasma jet on aerodynamics characteristic of a blunted cone
<b>Presenting author</b>	R. Hanson, Stanford University, USA	A. Salin, Kingston University, UK	Z. Sun, Delft University of Technology, Netherlands	J. Li, China Aerodynamics Research & Nagoya University, Japan



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**Tuesday, 19 July 2011**
**Special Session – Medical / Biological Applications I Renold D7**
**Session Chair:** S. H. R. Hosseini, Kumamoto University, Japan

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2845	2849	2846	2627
<b>Paper title</b>	Applications of underwater shock wave research to therapeutic device developments	Focused tandem shock waves in water and their potential application in cancer treatment	High repetitive pulsed streamer discharges in water, their induced shock waves and medical applications	Improved shock wave-assisted bacteria transformation
<b>Presenting author</b>	K. Takayama, Tohoku University, Japan	P. Lukes, Institute of Plasma Physics AS CR, Czech Republic	S. H. R. Hosseini, Kumamoto University, Japan	A. Loske, Universidad Nacional Autonoma de Mexico, Mexico

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**Tuesday, 19 July 2011**
**Student Competition V**

Renold E7

**Session Chair:** L. Houas, IUSTI-CNRS Aix Marseille Université, France

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2752	2783	2652	2658
<b>Paper title</b>	Supersonic combustion experimental investigation at T2 hypersonic shock tunnel	Model experiment of Munroe jet formation using gelatine driven by a moderate speed impactor	Reflection transition of converging cylindrical shock wave segments	Development of blast-wave mediated vaccine delivery device
<b>Presenting author</b>	D. Pinto, Institute for Advanced Studies, Brazil	K. Suzuki, Nagoya University, Japan	B. Gray, University of Witwatersrand, South Africa	D. P. Gnanadhas, Indian Institute of Science, India

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**Tuesday, 19 July 2011**

Renold Concourse

1040-1100

**Coffee / Tea**


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## Tuesday, 19 July 2011 AM Session B

### Tuesday, 19 July 2011

#### Detonation and Combustion II

Renold C16

<b>Session Chair:</b>	K. Hayashi, Aoyama Gakuin University, Japan			
<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2500	2512	2581	2562
<b>Paper title</b>	Flame-acoustic interaction	Effects of vortical and entropic forcing on detonation dynamics	Deflagration-to-detonation transition in highly reactive combustible mixtures	Numerical simulations of afterburning during explosions
<b>Presenting author</b>	V. Golub, Joint Institute for High Temperatures RAS, Russia	F. Lu, University of Texas at Arlington, USA	M. Liberman, Uppsala University/Moscow State University, Russia	E. Fedina, Swedish Defence Research Agency – FOI, Sweden

### Tuesday, 19 July 2011

#### Shock Vortex Interactions II

Renold C2

<b>Session Chair:</b>	F. Seiler, French-German Research Institute of Saint-Louis, France			
<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2563	2787	2565	2710
<b>Paper title</b>	Post-shock pressure modulation through grid turbulence	Hypersonic interaction of a vortex wake with a bow shock wave	Aerodynamic vibrations caused by vortex ahead of hemisphere in supersonic flow	Bluntness effects in hypersonic flow over slender cones and wedges
<b>Presenting author</b>	A. Sasoh, Nagoya University, Japan	A. Shevchenko, ITAM SB RAS, Russia	T. Kawamura, Tokai University, Japan	S. Karl, Caltech, USA

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**Tuesday, 19 July 2011**
**Shock Wave Boundary Layer Interactions II**

Renold C9

**Session Chair:** J. L. Stollery, Cranfield University, UK

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2436	2552	2796	2693
<b>Paper title</b>	Numerical discovery and experimental validation of vortex ring generation by microramp vortex generator	Numerical simulation of conical and spherical shock interaction : hysteresis investigations	Simulation of a practical scramjet inlet using shock-unsteadiness model	Inviscid-viscous interactions of compressible convex corner flows
<b>Presenting author</b>	C. Liu, University of Texas at Arlington, USA	D. Zeitoun, Université de Provence, France	K. Sinha, Indian Institute of Technology Bombay, India	P. H. Chang, ASTRC, Taiwan

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**Tuesday, 19 July 2011**
**Special Session – Medical / Biological Applications II**

Renold D7

**Session Chair:** S. H. R. Hosseini, Kumamoto University, Japan

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2847		2669	2731
<b>Paper title</b>	Development of medical and biological applications by shock waves and bubbles		Light syringes based on the laser induced shock wave	Shock wave generation through constructive wave amplification
<b>Presenting author</b>	M. Tamagawa, Kyushu Institute of Technology, Japan		J. Yoh, Seoul National University, Korea	M. Brouillette, Université de Sherbrooke, Canada

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**Tuesday, 19 July 2011**

**Student Competition VI**

Renold E7

**Session Chair:** L. Houas, IUSTI-CNRS Aix Marseille Université, France

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2691	2756	2556	2713
<b>Paper title</b>	Starting characteristics of hypersonic inlets in shock tunnel	Polygonal shock waves: comparison between experiments and geometrical shock dynamics	Numerical simulation of shock wave entry and propagation in a microchannel	Three-dimensional simulation of bow shock instability using discontinuous Galerkin method
<b>Presenting author</b>	Z. Li, University of Science and Technology of China, China	M. Kjellander, KTH Mechanics, Sweden	G. Shoen, Khristianovich Institute of Theoretical and Applied Mechanics, Russia	Y. Sato, Tohoku University, Japan

**Tuesday, 19 July 2011**

Barnes Wallis

1220-1330

**Lunch**

ISSW 28  
28<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON SHOCK WAVES 2011

## Tuesday, 19 July 2011 PM Session A

Tuesday, 19 July 2011

Keynote Lecture 3

Renold C16

1330-1410

**How Does Deflagration get Detonated in Gases? Recent Research  
Progress on DDT**

**Prof. Koichi Hayashi**

Aoyama Gakuin University, Japan

**Session Chair:** R. Hanson, Stanford University, USA

Tuesday, 19 July 2011

**Detonation and Combustion III**

Renold C16

**Session Chair:** V. Golub, Joint Institute for High Temperatures RAS, Russia

	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2527	2537	2595	2720
<b>Paper title</b>	Numerical simulation on detonation formation by shock/flame interaction	Experimental investigation of rupture rate on self-ignition of pressurized hydrogen release	Characterization of soot particles produced from the combustion of hydrocarbon fuels in a shock tube	The effect analysis of flow jam on two-meter direct-connection model
<b>Presenting author</b>	W. Chao, Zhejiang Sci-Tech University, China	V. Golub, Joint Institute for High Temperatures RAS, Russia	E. Petersen, Texas A & M University, USA	L. Xiangdong, China Aerodynamics Research and Development Center, China

2011

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**Tuesday, 19 July 2011**
**Richtmyer-Meshkov I**

Renold C9

**Session Chair:** R. Bonazza, University of Wisconsin – Madison, USA

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2433	2475	2675	2503
<b>Paper title</b>	Effects of initial conditions on mixing in Richtmyer-Meshkov turbulence experiments	Experimental study on a heavy-gas cylinder accelerated by cylindrical converging shock waves	Long time observation of the Richtmyer-Meshkov instability	Richtmyer-Meshkov instability at the interface of gas-oil-water three phases
<b>Presenting author</b>	K. Prestridge, Los Alamos National Laboratory, USA	T. Si, University of Science and Technology of China, China	C. Mariani, IUSTI-CNRS, Aix-Marseille Université, France	H-H. Shi, Zhejiang Sci-Tech University, China

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**Tuesday, 19 July 2011**
**Diagnostics I**

Renold D7

**Session Chair:** G. Settles, Penn State University, USA

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2462	2564	2435	2689
<b>Paper title</b>	Multi-species laser measurements of n-butanol pyrolysis behind reflected shock waves	Quantitative visualization of open-air explosions by using background-oriented Schlieren with natural background.	Cross-wavelet techniques for estimating uncertainty in propagating shocks and detonations	Measurement of vibrational/rotational temperatures of nitrogen behind strong shock wave generated at hypervelocities using CARS method
<b>Presenting author</b>	R. Hanson, Stanford University, USA	T. Mizukaki, Tokai University, Japan	F. Lu, University of Texas at Arlington, USA	H. B. Venigalla, Chiba University, Japan

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**Tuesday, 19 July 2011**

**Numerical Methods and Simulations I**

Renold C2

**Session Chair:** T. Saito, Muroran Institute of Technology, Japan

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2459		2526	2814
<b>Paper title</b>	Antiforce current bearing waves		Effects of turbulent inflow conditions on feedback-loop mechanisms in supersonic cavity flows	Prediction of transition onset location and investigation of its effects on shock bump control on a natural laminar flow aerofoil
<b>Presenting author</b>	M. Hemmati, Arkansas Tech University, USA		W. Li, University of Tokyo, Japan	F. Deng, University of Sheffield, UK

**Tuesday, 19 July 2011**

**Student Competition VII**

Renold E7

**Session Chair:** O. Sadot, , Ben Gurion University, Israel

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2753	2813	2773	2706
<b>Paper title</b>	OH emission diagnostics applied to study ignition of the supersonic combustion	Benchmarking a new, open-source direct simulation Monte Carlo (DSMC) code for hypersonic flows	Radiative heat transfer measurements in a nonreflected shock tube at low pressures	2D phenomena of shock wave propagation along a non-equilibrium thermal zone formed by surface discharge
<b>Presenting author</b>	R. Vilela, Institute for Advanced Studies, Brazil	A. Ahmad, University of Strathclyde, UK	C. Jacobs, University of Queensland, Australia	E. Koroteeva, Moscow State University, Russia

**Tuesday, 19 July 2011**

Renold Concourse

1540-1600

**Tea/Coffee**

## Tuesday, 19 July 2011 PM Session B

### Tuesday, 19 July 2011

#### Facilities I

Renold C2

<b>Session Chair:</b>	D. Buttsworth, University of Southern Queensland, Australia			
<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	3006	2553	2494	2754
<b>Paper title</b>	Manually operated piston driven mini shock tube	Propagation characteristics of the shock wave in small diameter tubes at atmospheric Initial driven pressure	Numerical study of the shock tunnel flow with a throat plug	Flow characterization of the T3 hypersonic shock tunnel
<b>Presenting author</b>	K. P. J. Reddy, Indian Institute of Science, India	S. Udagawa, Tokyo Metropolitan College of Industrial Technology, Japan	J. K. Lee, Korea Advanced Institute of Science and Technology, Korea	D. Pinto, Institute for Advanced Studies, Brazil

### Tuesday, 19 July 2011

#### Richtmyer-Meshkov II

Renold C9

<b>Session Chair:</b>	R. Bonazza, University of Wisconsin – Madison, USA			
<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2449	2745	2465	2617
<b>Paper title</b>	Numerical investigation of turbulence in re-shocked Richtmyer-Meshkov unstable curtain of dense gas	Experimental characterization of turbulence produced in a shock tube: a preliminary work for the study of the turbulent gaseous mixing induced by the Richtmyer-Meshkov instability	Experimental and numerical investigations of the inclined Air/SF6 interface instability under shock wave	Investigations on a gaseous interface accelerated by a converging shock wave
<b>Presenting author</b>	S. Shankar, Stanford University, USA	S. Jamme, ISAE, France	T. Wang, China Academy of Engineering Physics, China	X. Luo, University of Science and Technology of China, China



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**Tuesday, 19 July 2011**
**Diagnostics II**

Renold D7

**Session Chair:** G. Settles, Penn State University, USA

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2506	2646	2704	2749
<b>Paper title</b>	Extended shock-tunnel operation for free-flight aeroballistics testing	Surface flow visualization of a side-mounted NACA 0012 airfoil in a transonic Ludwieg tube	Photoemission measurements of soot temperature at pyrolysis of ethylene in the shock tube	Modern optical methods for determining the shock Hugoniot of transparent solids
<b>Presenting author</b>	F. Seiler, French-German Research institute of Saint-Louis, France	F. Lu, University of Texas at Arlington, USA	Y. Baranyshyn, Luikov Heat and Mass Transfer Institute, Belarus	G. Settles, Pennsylvania State University, USA

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**Tuesday, 19 July 2011**
**Shock Wave Phenomena and Applications I**

Renold C16

**Session Chair:** D. Zeitoun, Université de Provence, France

<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2795	2799	2673	2545
<b>Paper title</b>	Shock dynamics for cylindrical/spherical converging shocks in elastic-plastic solids	Study of the stability of $\text{Na}_{0.7}\text{CoO}_2$ thermoelectric materials under shock dynamic loading in a shock tube	Hybrid finite element/molecular dynamics simulations of shock-induced particle/wall collisions	Numerical analysis of interaction between moving shock wave and solid particle layer
<b>Presenting author</b>	A. López Ortega, California Institute of Technology, USA	V. Jayaram, Indian Institute of Science, India	M. Micci, Pennsylvania State University, USA	K. Doi, Nagoya University, Japan

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**Tuesday, 19 July 2011**

**Impact and Compaction I**

Renold E7

<b>Session Chair:</b>	J. Srulijes, French-German Research Institute of Saint-Louis, France			
<b>Time</b>	1600 hrs	1620 hrs	1640 hrs	1700 hrs
<b>Paper number</b>	2588	2728	2602	2502
<b>Paper title</b>	Multiscale modeling and simulation of shock-wave impact failure in hard and soft matter	Tunguska Impact: How far can we move up in our prediction of the past?	High-velocity impact characteristic of CFRP composite at low temperature	Propagation of luminous front at high-speed impact into sand layers
<b>Presenting author</b>	M. O. Steinhauser, Fraunhofer-Institute for High-Speed Dynamics, Ernst-Mach-Institut, Germany	C. Sandaldjian, University of Manchester, UK	A. Shimamoto, Saitama Institute of Technology, Japan	H. Yamamoto, Tohoku University, Japan

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## Wednesday, 20 July 2011

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Wednesday, 20 July 2011

Keynote Lecture 4

Renold C16

0830-0910

**Super-Orbital Re-Entry in Australia – Laboratory Measurement, Numerical Simulation and Flight Observation**

**Prof. David Buttsworth**

University of Southern Queensland, Australia

**Session Chair:** H. G. Hornung, Caltech, USA

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Wednesday, 20 July 2011

0930-1700

**Excursion**

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Chatsworth House is a stately home in Derbyshire, England that attracts over 300,000 visitors a year. The house has a history ranging from the mid 15<sup>th</sup> century up to modern day where it featured in the 2005 adaptation of *Pride and Prejudice* and the 2008 film *The Duchess*. The building housed Mary, Queen of Scots during her time in captivity.



The house itself contains a fascinating art collection including countless paintings, four royal thrones, a striking ancient Greek marble foot, and a titanium fan of a Rolls Royce jet engine.



Perhaps the most famous aspect of Chatsworth House is the fantastic gardens. The gardens total over 105 acres in size and contain a 200ft cascading waterfall and a vast hedge maze.

A detailed history about Chatsworth House can be found at the following web address:  
[http://www.chatsworth.org/files/fom\\_history.pdf](http://www.chatsworth.org/files/fom_history.pdf)



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## Thursday, 21 July 2011 AM Session

**Thursday, 21 July 2011**

**Keynote Lecture 5**

Renold C16

0830-0910

**Pioneering in Hypersonic Transportation: Long Term Perspectives and Technological Challenges**

**Dr. Johan. Steelant**

ESTEC-ESA, The Netherlands

**Session Chair:** J. L. Stollery, Cranfield University, UK

**Thursday, 21 July 2011**

**Chemically Reacting Flows III**

Renold C2

**Session Chair:** C. Park, Korea Advanced Institute of Science and Technology, Korea

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
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<b>Paper number</b>	2760	2455	2708	2741
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<b>Paper title</b>	On the validity of the constant volume assumption in shock tube experiments	Influence of Electronic Excitation on the Transport Properties of Partially Ionized Atomic Gases	Hugoniot of a reactive metal powder mixture	Numerical simulation of thermal-chemical non-equilibrium and radiating hypersonic flow by using hybrid grid
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<b>Presenting author</b>	J. Melguizo-Gavilanes, University of Calgary, Canada	V. Istomin, Saint-Petersburg State University, Russia	C. Braithwaite, University of Cambridge, UK	Y. Wang, University of Sheffield, UK
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**Thursday, 21 July 2011**

**Detonation and Combustion IV**

Renold C16

**Session Chair:** F. Lu, University of Texas at Arlington, USA

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2518	2582	2560	2580
<b>Paper title</b>	Initial temperature effect on detonation initiation of JP-8-oxygen mixtures	Hydrogen-oxygen flame acceleration in channels of different widths with no-slip walls and the deflagration-to-detonation transition	Numerical study of gas detonation at the molecular kinetic level	Shock-flame interaction and deflagration-to-detonation transition in hydrogen/oxygen mixtures
<b>Presenting author</b>	C. S. Wen, National Cheng Kung University, Taiwan	M. Liberman, Uppsala University/ Moscow State University, Russia	Y. Bondar, Khristianovich Institute of Theoretical and Applied Mechanics, Russia	A. Kiverin, Joint Institute for High Temperatures, Russia

**Thursday, 21 July 2011**

**Hypersonic Flows III**

Renold C9

**Session Chair:** D. Mee, University of Queensland, Australia

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2517	2725	2767	2822
<b>Paper title</b>	Numerical studies of hypersonic binary gas-mixture flows near a sphere	On the validation of a hypersonic flow solver using measurements of shock detachment distance	Effect of gas injection on transition in hypervelocity boundary layers	Numerical simulation and experimental validation on shock oscillations of hypersonic vehicle's flowpath
<b>Presenting author</b>	V. Riabov, River College, USA	P. Jacobs, University of Queensland, Australia	J. Jewell, California Institute of Technology, USA	J. Liu, National University of Defence and Technology, China

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**Thursday, 21 July 2011**
**Nozzle Flows I**

Renold D7

<b>Session Chair:</b>	A. Abe, Kobe University, Japan		
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs
<b>Paper number</b>	2464	2477	2611
<b>Paper title</b>	Experimental investigation of asymmetric and unsteady flow separation in high Mach number planar nozzles	Influence of a normal slot boundary layer suction system onto a shock train	Asymmetric flow separation in de Laval nozzle
<b>Presenting author</b>	E. Shimshi, Ben Gurion University, Israel	A. Weiss, RWTH Aachen University, Germany	V. Golub, Joint Institute for High Temperatures RAS, Russia

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**Thursday, 21 July 2011**
**Shock Wave Phenomena and Applications II**

Renold E7

<b>Session Chair:</b>	M. Brouillette, Université de Sherbrooke, Canada			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2452	2785	2757	2786
<b>Paper title</b>	Density field measurements of a micro – explosion using BOS	Magnetic configuration effect on the interaction between the weakly ionized flow and the applied magnetic field	Starting flow through planar wedged nozzle: effect of nozzle asymmetry	Features of the impact of a solar wind shock wave on the Earth's bow shock in a strong interplanetary magnetic field
<b>Presenting author</b>	P. Suriyanarayana, CSIR National Aerospace Laboratories, India	M. Kawamura, University of Tokyo, Japan	Y. Shackak, Ben Gurion University, Israel	E. A. Pushkar, Moscow State Industrial University, Russia

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**Thursday, 21 July 2011**

Renold Concourse

1040-1100

**Coffee / Tea**

## Thursday, 21 July 2011 AM Session B

### Thursday, 21 July 2011

#### Facilities II

Renold E7

**Session Chair:** H. Olivier, RWTH Aachen University, Germany

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2667	2558	2463	2790
<b>Paper title</b>	Modeling of a detonation driven, linear electric generator facility	A new fast acting valve for diaphragmless shock tubes	A second-generation aerosol shock tube and its use in studying ignition delay times of large biodiesel surrogates	Demonstration of some concepts for developing long-test duration shock tunnels
<b>Presenting author</b>	F. Lu, University of Texas at Arlington, USA	H. Olivier, RWTH Aachen University, Germany	R. Hanson, Stanford University, USA	Z. Jiang, Institute of Mechanics at Chinese Academy of Sciences, China

### Thursday, 21 July 2011

#### Detonation and Combustion V

Renold C16

**Session Chair:** M. Liberman, Uppsala University/ Moscow State University, Russia

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2636	2764		2735
<b>Paper title</b>	Combined effects of a vortex flow and the Shchelkin spiral dimensions on characteristics of deflagration-to-detonation transition	Numerical study of detonation wave propagation in narrow channels		Flame propagation out from wide chamber into narrow channel of subcritical diameter and transition to detonation
<b>Presenting author</b>	K. Asato, Gifu University, Japan	A. Chinnayya, CORIA, France		V. Golub, Joint Institute for High Temperatures RAS, Russia



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**Thursday, 21 July 2011**
**Hypersonic Flows IV**

Renold C9

**Session Chair:** D. Mee, University of Queensland, Australia

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2832	2775	2817	2430
<b>Paper title</b>	Application of pressure- and temperature-sensitive paint in a hypersonic double ramp flow	Counterflow injection studies for hypersonic flow fields	Shock tunnel noise measurement with resonantly enhanced focused schlieren deflectometry	Separation length scaling in hypervelocity double-cone air flows

<b>Presenting author</b>	L. Yang, University of Manchester, UK	V. Kulkarni, Indian Institute of Technology, India	N. Parziale, Caltech, USA	A. Swantek, University of Illinois at Urbana-Champaign, USA
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**Thursday, 21 July 2011**
**Nozzle Flows II**

Renold D7

**Session Chair:** A. Abe, Kobe University, Japan

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2820	2819	2707	2609
<b>Paper title</b>	Effect of roughness in jets in Mach 5 cross flow	Flow visualization of supersonic free jet utilizing acetone LIF	2D numerical simulation of hydrogen injection into a channel with a cavity	Numerical investigation of over-expanded nozzle flows: Influence of internal shock waves

<b>Presenting author</b>	E. Erdem, University of Manchester, UK	K. Hatanka, Muroran Institute of Technology, Japan	I. Fedorchenko, ITAM SB RAS, Russia	A. Chpoun, LMEE, France
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**Thursday, 21 July 2011**

**Numerical Methods and Simulations II**

Renold C2

**Session Chair:** T. Saito, Muroran Institute of Technology, Japan

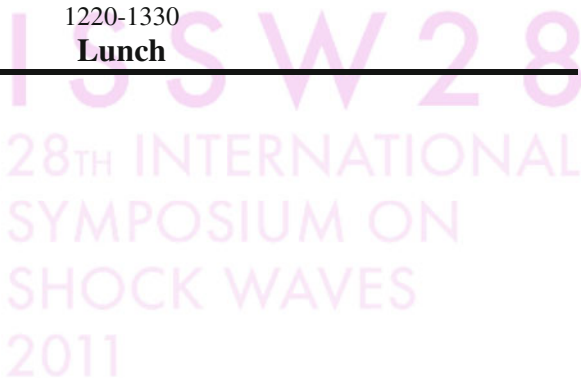
<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2600	2854	2648	2619
<b>Paper title</b>	Scale-separation for implicit large eddy simulation	An application of adaptive mesh refinement method for modeling of nonstationary hypersonic flows in the atmosphere	Numerical studies of high enthalpy flow over a rearward facing step with rounded corners	On the carbuncle origins from moving and stationary shocks
<b>Presenting author</b>	V. Tritscher, Technical University of Munich, Germany	A. Astanin, Tomsk State University, Russia	S. Gai, University of New South Wales, Australia	K. Kitamura, JAXA, Japan

**Thursday, 21 July 2011**

Barnes Wallis

1220-1330

**Lunch**



## Thursday, 21 July 2011 PM Session A

**Thursday, 21 July 2011**

**Keynote Lecture 6**

Renold C16

1330-1410

**Towards Substantial Drag Reduction for Transonic Wings Using  
Aerodynamic Optimisation with Shock Control through Reduced Wing Sweep**

**Prof. Ning Qin**

University of Sheffield, UK

**Session Chair:** B. Skews, University of Witwatersrand, South Africa

**Thursday, 21 July 2011**

**Detonation and Combustion VI**

Renold C16

**Session Chair:** M. Liberman, Uppsala University/ Moscow State University,

Russia

**Time** 1420 hrs      1440 hrs      1500 hrs      1520 hrs

**Paper number** 2686      2829      2766      2630

**Paper title**

Fast flame propagation and ignition process of DDT in the boundary layer of H <sub>2</sub> /O <sub>2</sub> mixture	Development of an ethanol/air reduced mechanism and its application to two-phase detonation	Detonation initiation by moving borders	Evolution of autocorrelation in detonation interaction with homogeneous, isotropic turbulence
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**Presenting author**

E. Dzieminska, Aoyama Gakuin University, Japan	A. K. Hayashi, Aoyama Gakuin University, Japan	V. Levin, Institute of Mechanics of the MSU, Russia	F. Lu, University of Texas at Arlington, USA
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**Thursday, 21 July 2011**
**Diagnostics III**

Renold D7

**Session Chair:** T. Mizukaki, Tokai University, Japan

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2789	2824		2592
<b>Paper title</b>	Radiometric temperature analysis of the Hayabusa reentry	Toluene laser-induced fluorescence (LIF) imaging of supersonic flow within a diverging duct		Experimental investigation of aerodynamic interference heat transfer around a protuberance on a flat plate subjected to hypersonic flow
<b>Presenting author</b>	T. Eichmann, University of Queensland, Australia	K. Mohri, University of Duisburg-Essen, Germany		C. Sudhiesh Kumar, Indian Institute of Science, India

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**Thursday, 21 July 2011**
**Ignition I**

Renold E7

**Session Chair:** N. Fedorova, ITAM SB RAS, Russia

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2594	2483	2596	2670
<b>Paper title</b>	Measurement of H <sub>2</sub> O <sub>2</sub> broadening parameters near 7.8 $\mu$ m with a shock tube	Laser-based ignition of the preheated supersonic hydrogen-air flow	Shock wave-induced ignition of normal-undecane (n-C <sub>11</sub> H <sub>24</sub> ) and comparison to other high-molecular-weight n-Alkanes	Ignition of aluminum in air via high power laser ablation
<b>Presenting author</b>	J. Mertens, Trinity College, USA	Y. Tunik, Lomonosov Moscow State University, Russia	E. Petersen, Texas A & M University, USA	C-H Kim., Seoul National University, Korea

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**Thursday, 21 July 2011**
**Richtmyer-Meshkov III**

Renold C2

**Session Chair:** Z. Jiang, Institute of Mechanics at Chinese Academy of Sciences, China

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2794	2736	2548	2696
<b>Paper title</b>	Experiments on the Richtmyer-Meshkov instability with an imposed, random initial perturbation	Effect of shock Mach number on Richtmyer-Meshkov instability in spherical geometry	Experimental shock-initiated combustion of a spherical density inhomogeneity	Numerical study of shock induced mixing in a cylindrical shell
<b>Presenting author</b>	J. Jacobs, University of Arizona, USA	A. Bhagatwala, Stanford University, USA	R. Bonazza, University of Wisconsin, USA	L. Wang, Institute of Applied Physics and Computational Mathematics, China

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**Thursday, 21 July 2011**
**Shock Wave Propagation and Reflection V**

Renold C9

**Session Chair:** R. Morgan, University of Queensland, Australia

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2578	2659	2497	2616
<b>Paper title</b>	Shock reflection off combined surfaces	Standing shock formation in non-reflected shock tube	Aerodynamic ground effect for transonic projectiles	A simple scheme for calculating distortion of compression wave propagating through a tunnel with slab tracks
<b>Presenting author</b>	B. Skews, University of Witwatersrand, South Africa	R. Morgan, University of Queensland, Australia	H. Kleine, University of New South Wales, Australia	T. Miyachi, Railway Technical Research Institute, Japan

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**Thursday, 21 July 2011**

Renold Concourse

1540-1600  
**Tea/Coffee**

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## Thursday, 21 July 2011 PM Session B

Thursday, 21 July 2011

1600-1720

### Poster Session

**Session Chair:** N. Gongora-Orozco, The University of Manchester, Renold Concourse UK

#### Blast Waves

2505	A numerical and experimental study on charge geometries	M. G. Omang	Norwegian Defence Estates Agency	Norway
2572	Pressure propagation and attenuation phenomena of underwater shock wave in visco-elastic fluid	F. Ishiguro	Aichi Institute of Technology	Japan
2632	Structure of the blast wave front	K. Sergey	Institute of Atmospheric Physics, RAS	Russia
2482	Stability of detonative combustion of hydrogen-air supersonic flow in convergent-divergent nozzle	Y. Tunik	SRI for Mechanics of Lomonosov Moscow State University	Russia
2487	Thermal decomposition of 2-bromoethanol: single-pulse shock tube experiments, modelling DFT and TSt calculations	H. Chakravarty	Indian Institute of Science	India
2649	Shock-tube studies on the reactions of o-, m-, and p-xylenes with O(3P) atoms	K. Takahashi	Sophia University	Japan
2650	Shock tube study for pyrolysis and oxidation of ethylene oxide	T. Koike	National Defense Academy Japan	Japan
2538	Influence of static temperature on H <sub>2</sub> /Air detonation initiation and evolution	Z. Lin	NUDT	China
2540	Self-ignition of pressurized hydrogen in perforated channels	V. Golub	Joint Institute for High Temperatures, RAS	Russia
2585	Formation of detonation wave of condensation in acetylene	A. Emelianov	Joint Institute for High Temperatures, RAS	Russia

2711	Experimental study of SiC ablations in air plasma freejets	M. Funatsu	Gunma University	Japan
2719	Enhancement of thermal properties for platinum thin film heat transfer gauges with nanofluids	R. Kumar	Indian Institute of Technology Guwahati	India
2485	Hybrid LES/RANS of supersonic compressible mixing layer with droplets evaporation	J. Zhou	National Univ. of Defense Technology	China
2635	Pressure measurement using MEMS based sensors array over a backward facing step in IISc hypersonic shock tunnel	S. N. Ram	Indian Institute of Science	India
2571	Ablation testing of carbon fiber reinforced carbon composite in CO <sub>2</sub> arc plasma flow	T. Ito	Aichi Institute of Technology	Japan
2629	Numerical study of air-He shock tube for hypersonic researches	C-Y. Wen	National Cheng Kung University	Taiwan
2660	Measurement of heat transfer rates around the aerodynamic cavities on a flat plate at hypersonic Mach number.	S. Jobin Philip	Indian Institute Of Science	India
2705	Experimental investigation of the effect of a thermal bump on hypersonic flow	R. Sriram	Indian Institute of Science	India
2776	Simple conjugate heat transfer analysis for hypersonic flows	V. Kulkarni	Indian Institute of Technology Guwahati	India
2623	Oxidation of 3-carene at high temperatures	N. Sharath	Indian Institute of Science	India
2734	Supersonic body streamline in plasma at presence of electric and magnetic fields	S. Ponyaev	Ioffe Physico-Technical Institute, RAS	Russia
2657	Development of blast-wave mediated vaccine delivery device	D. P. Gnanadhas	Indian Institute of Science	India
2694	Development of blast-wave assisted particle delivery system	S. G. Rakesh	Amrita School of Engineering, Amrita Vishwa Vidyapeetham	India
2852	On the effect of a shock wave on a micro-organism	L. Houas	IUSTI-CNRS Aix Marseille Université	France

2432	Simulation of sphere's motion induced by shock waves	O. Igra	Ben Gurion University, Israel	Israel
2828	Experimental investigation of liquid jet into supersonic cross-flow	H. Gu	Institute of Mechanics, C A S,China	China
2481	An Investigation of pressure boundary conditions for the simulation of a micro-nozzle using DSMC method	B. Puranik	Indian Institute of Technology Bombay, India	India
2493	Numerical and experimental studies of fluidic thrust vectoring	L. Li	Muroran Institute of Technology	Japan
2550	Sound generating mechanism in the supersonic mixing layer	Z. Chen	Nanjing University of Science & Technology	China
276	Numerical investigation of nitrogen condensation in nozzles	L Lin	University of Science and Technology of China	China
2533	Integrated LES and NPLS studies of HYLTE nozzle flowfield with supersonic angled injection	Y. Shao	National University of Defence Technology	China
2492	A comparison of higher-order extensions to approximate Riemann solvers	M. Ray	Indian Institute of Technology Bombay	India
2534	Numerical investigation of supersonic combustion using flamelet modeling	Z. Fan	College of Aerospace and Material Engineering	China
2589	The compatible algorithms in radiation hydrodynamics for hohlraum physics simulation	H. Yong	Institute of Applied Physics and Computational Mathematics	China
2644	Development of a numerical approach to deal with fluid-structure interactions in solid propellant rocket motors	J. Devesvre	IUSTI	France
2808	Flow visualisation of scramjet inlet-isolator in Mach 5 using pressure sensitive paint	A. Che Idris	The University of Manchester	UK
2802	Experimental studies of shock diffraction	M. K. Quinn	The University of Manchester	UK
2490	Shock wave diffraction on convex curved walls	A. Muritala	Obafemi Awolowo University ILE-IFE	Nigeria



3007	Unsteady shock wave interactions with 2-D geometries	K. H. Lo	The University of Manchester	UK
2546	Numerical study of stability of converging shock waves in a hard-sphere fluid	A. Konyukhov	Joint Institute for High Temperatures, RAS	Russia
2625	Influence dispersion and cross flow on structure of shock wave	E. Prozorova	St. Petersburg State University	Russia
2678	Effect of an impinging shockwave on a partially opened door	L. Biamino	IUSTI Aix Marseille University	France
2681	Numerical study on the mechanism of the entrainment of a rectangular solid body by a shock wave	Y. Sakamura	Toyama Prefectural University	Japan
2683	Free standing conical shock	S. Mölder	McGill University	Canada
2638	Flow establishment around a shock holder in a shock tube	C. Park	Korea Advanced Institute of Science and Technology	Korea
2676	Boltzmann-Hermite expansion approach to shock structure problem for binary gas mixture	S. Kuwabara	Nagoya University	Japan
2655	Shock wave-boundary layer interactions inside the supersonic inlet at on/off design conditions	H. J. Lee	LIG Nex1, Co., Ltd.	Korea
2697	An investigation on the near-wall behaviors of hypersonic inlet flow	J. Yang	University of Science and Technology of China	China
2774	Numerical investigation of three-dimensional shock/boundary-layer interaction in a hypersonic inlet	K. Sinha	Indian Institute of Technology Bombay	India

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**Thursday, 21 July 2011**

1830-2200

**Banquet**

**Guest Speaker: Dr. John Ackroyd**

The Invention of the Aeroplane Near Scarborough at the Time of Trafalgar

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The ISSW 28 banquet will be held in Runway Visitor Park at Manchester International Airport under the historic **Concorde** aircraft.

British Airways received government approval for the production of the G-BOAC in December 1969. **Concorde G-BOAC** (affectionately known as ‘Alpha Charlie’) became the second aircraft to join the Concorde fleet when she was delivered to British Airways on 13 February 1976.

Although G-BOAC was the second **Concorde** to be delivered, she is considered to be the flagship of the fleet as she carries the registration plate BOAC - which were the initials of British Airways' forerunner, British Overseas Airways Corporation, which merged with BEA (British European Airways) to form British Airways.



### **Concorde Facts**

- A specification for the Anglo-French Mach 2.2 airliner was published in October 1962
- Concorde 001 made her maiden flight on 2 March 1969. Concorde 002 took to the air for the first time one month later on 9 April 1969
- Concorde entered commercial service on 21 January 1976. British Airways opened up a London to Bahrain service with G-BOAA and Air France launched a Paris to Rio service via Dakar with F-BVFA
- The airline's second Concorde G-BOAC - which is now in retirement at Manchester Airport's Runway Visitors Park - was delivered one month later on 13 February 1976
- Concorde could accelerate from 0-225 mph in 30 seconds. She could travel faster than the earth rotates.
- More than 2.5 million people travelled on Concorde since she started commercial passenger services in 1976
- The first flight to New York was on 22 November 1977
- On 11 August 1999 two British Airways Concorde's flew in a supersonic formation to chase the total eclipse of the sun

## Friday, 22 July 2011 AM Session

**Friday, 22 July 2011**

**Keynote Lecture 7**

Renold C16

0830-0910

**Numerical Experiments on Shock-Turbulence Interaction**

**Prof. S. K. Lele**

Stanford University, USA

**Session Chair:** E. Timofeev, McGill University, Canada

**Friday, 22 July 2011**

**Special Session on Shock Wave Moderation I**

Renold C2

<b>Session Chair:</b>	A. Sasoh, Nagoya University, Japan			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2478	2730	2816	2838
<b>Paper title</b>	Improvement of supersonic aerodynamic performance using repetitive laser energy depositions	The control of supersonic flow past bodies by upstream energy deposition in toroidal-type regions	Experimental studies on micro-ramps at Mach 5	Effect of dielectric barrier discharge plasma in supersonic flow
<b>Presenting author</b>	A. Sasoh, Nagoya University, Japan	R. Georgievskiy, Institute of Mechanics, Russia	R. Saad, University of Manchester, UK	S. Pal, Indian Institute of Science, India

SHOCK WAVES  
2011

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**Friday, 22 July 2011**
**Detonation and Combustion VII**

Renold C16

**Session Chair:** A. Hadjadj, CORIA INSA de Rouen, France

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2768	2784	2805	2806
<b>Paper title</b>	Detonation in supersonic flows in channels with obstacles	Application of gas detonation for a needleless device development	Stability of planar ZND detonation waves for three-step chain-branching kinetics	A theoretical approach to one-dimensional detonation instability
<b>Presenting author</b>	I. S. Manuylovich, Institute of Mechanics of the MSU, Russia	V. Golub, Joint Institute for High Temperatures of RAS, Russia	L. Bauwens, University of Calgary, Canada	C. Wang, Institute of Mechanics of Chinese Academy of Sciences, China

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**Friday, 22 July 2011**
**Flow Visualisation III**

Renold D7

**Session Chair:** H. Sakaue, JAXA, Japan

<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2434	2615	2530	2703
<b>Paper title</b>	Visualizing the supersonic flow around a microvortex generator	Development of polymer-ceramic pressure-sensitive paint and its application to supersonic flow field	Fine structures of supersonic laminar flow over a backward facing step	The manufacture of high-speed shoot system of adjustable frame
<b>Presenting author</b>	F. Lu, University of Texas at Arlington, USA	T. Hayashi, Tokyo University of Science, Japan	Z. Chen, National University of Defence Technology, China	Y. Furong, CARDC, China

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**Friday, 22 July 2011**
**Shock Wave Phenomena and Applications III**

Renold E7

<b>Session Chair:</b>	Z. Walenta, Institute of Fundamental Technology Research, Poland			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2888	2804	2812	2468
<b>Paper title</b>	Fracture evaluation using shock-induced borehole waves	Structure of shock waves in dense media	3D MHD description and animation of the process of collision of a solar wind shock with the Earth's bow shock	High-speed opening operation of diaphragmless shock wave generator
<b>Presenting author</b>	H. Fan, Delft University of Technology, Netherlands	Z. Walenta, Institute of Fundamental Technology Research, Poland	E. A. Pushkar, Moscow State Industrial University, Russia	A. Miyachi, Kobe University, Japan

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**Friday, 22 July 2011**
**Shock Wave Propagation and Reflection VI**

Renold C9

<b>Session Chair:</b>	M. Brouillette, Université de Sherbrooke, Canada			
<b>Time</b>	0920 hrs	0940 hrs	1000 hrs	1020 hrs
<b>Paper number</b>	2740	2709	2737	2685
<b>Paper title</b>	On hyperbolic shock wave	Sonic line and stand-off distance on re-entry capsule shapes	Numerical and experimental investigation of the effect of bypass mass flow due to small gaps in a transonic channel flow	A study on the unsteady aerodynamics of projectiles in overtaking blast flowfields
<b>Presenting author</b>	S. Mölder, McGill University, Canada	H. G. Hornung, Caltech, USA	M. Giglmaier, Technische Universität München, Germany	<del>C. Muthukumar, Indian Institute of Space Science and Technology, India</del>

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**Friday, 22 July 2011**

Renold Concourse

1040-1100

**Coffee / Tea**


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## Friday, 22 July 2011 AM Session B

### Friday, 22 July 2011

#### Special Session on Shock Wave Moderation II

Renold C2

**Session Chair:** A. Sasoh, Nagoya University, Japan

	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2843	2844	2840	2841
<b>Paper title</b>	Steady energy deposition at Mach 5 for drag reduction	Interaction of a shock wave with a contact discontinuity for local heat release in a flow	Two modes of shock interaction with zone of pulse volume discharges in the channel	Mach 5 bow shock control by a nanosecond pulse surface dielectric barrier discharge
<b>Presenting author</b>	E. Erdem, University of Manchester, UK	V. Zudov, Russian Academy of Sciences, Russia	J. Jin, Lomonosov Moscow State University, Russia	I. Adamovich, Ohio State University, USA

### Friday, 22 July 2011

#### Detonation and Combustion VIII

Renold C16

**Session Chair:** A. Hadjadj, CORIA INSA de Rouen, France

	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2823	2887	2690	2520
<b>Paper title</b>	Experimental and numerical investigation of CH* and OH* chemiluminescence in acetylene combustion behind reflected shock waves	Simulations of non-ideal detonation wave propagation and Its experimental validation	Effect of wave flow structure on combustion at high speeds	Similarity solutions for reactive shock hydrodynamics
<b>Presenting author</b>	M. Bozkurt, University of Duisburg-Essen, Germany	X. Zhang, Chinese Academy of Engineering Physics, China	M. Goldfeld, ITAM SB RAS, Russia	R. Arora, IIT Roorkee, India

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**Friday, 22 July 2011**
**Flow Visualisation IV**

Renold D7

**Session Chair:** E. Schuelein, DLR, Germany

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2663	2777	2738	2909
<b>Paper title</b>	Potential of localized flow heating for wave drag reduction	Quantitative visualization of high speed flow through optical tomography	Application of two sections focusing Schlieren technique on the supersonic combustion wind tunnel	Flow visualization of discontinuities and instabilities in supersonic flow

<b>Presenting author</b>	E. Schuelein, German Aerospace Centre, Germany	G. Hedge, Indian Institute of Science, India	A-M. Xie, China Aerodynamics Research and Development Center, China	Y. Shihe, National University of Defense Technology, China
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**Friday, 22 July 2011**
**Shock Wave Phenomena and Applications IV**

Renold E7

**Session Chair:** S. Utyuzhnikov, The University of Manchester, UK

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2807	2842	2788	2811
<b>Paper title</b>	Structure of the plume emitted during laser ablation of materials	Interaction between laser induced plasma and boundary layer over a flat plate in hypersonic flow	Shock wave boundary layer interaction from reflecting detonations	Laser driven burning and detonation waves in silica-based optical fibers

<b>Presenting author</b>	Z. Walenta, Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland	L. Yang, The University of Manchester, UK	J. Damazo, California Institute of Technology, USA	V. P. Efremov, Joint Institute for High Temperatures RAS, Russia
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**Friday, 22 July 2011**

**Shock Wave Propagation and Reflection VII**

Renold C9

**Session Chair:** Z. Jiang, Institute of Mechanics at Chinese Academy of Sciences, China

<b>Time</b>	1100 hrs	1120 hrs	1140 hrs	1200 hrs
<b>Paper number</b>	2762	2758	2665	2747
<b>Paper title</b>	Computational study of the interaction of a planar shock wave with a cylinder/sphere: The reflected wave velocity	Experimental and numerical investigation of shock wave interaction with rigid obstacles	Analytical and numerical study of three shock configurations with negative reflection angle	Simulations of reflected shock bifurcation in a square channel
<b>Presenting author</b>	Y. Kivity, Ben-Gurion University, Israel	E. Glazer, Ben-Gurion University, Israel	L. Gvozdeva, Joint Institute for High Temperature RAS, Russia	J. Austin, University of Illinois, USA

**Friday, 22 July 2011**

Barnes Wallis

1220-1330

**Lunch**

13 SW 28  
28<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON SHOCK WAVES 2011



## Friday, 22 July 2011 PM Session A

**Friday, 22 July 2011**

**Keynote Lecture 8**

Renold C16

1330-1410

**Getting Fundamental Molecular Properties from Shock Tubes**

**Prof. E. Arunan**

Indian Institute of Science, Bangalore, India

**Session Chair:** Z. Jiang, Institute of Mechanics at Chinese Academy of Sciences, China

**Friday, 22 July 2011**

**Nozzle Flows III**

Renold D7

**Session Chair:** E. Erdem, University of Manchester, UK

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2476	2743	2781	2671
<b>Paper title</b>	Experimental investigation of shock train turbulence	Pseudo-shock system structure in rectangular Laval nozzles with gaps	Thrust shock vector control of an axisymmetric C-D Nozzle via transverse gas injection	Fluid-structure interaction for a flexible overexpanded rocket nozzle using the aeroelastic stability model
<b>Presenting author</b>	A. Grzona, RWTH Aachen University, Germany	T. Gawehn, DLR German Aerospace Center, Germany	V. Zmijanovic, ICARE-CNRS / CNES, France	N. Bekka, Université d'Evry, France

2011

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**Friday, 22 July 2011**
**Shock Wave Boundary Layer Interactions III**

Renold C16

**Session Chair:** H. Zare-Behtash, University of Manchester, UK

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2780	2688	2446	2620
<b>Paper title</b>	A non-linear eddy-viscosity view of shock wave/boundary layer interaction flow simulation	Step configuration influence on structure of supersonic reacting flows in channels with sudden expansion	Shock-wave boundary-layer interaction control on a compression corner using mechanical vortex generators	Transitional shock-wave/boundary-layer interaction behind a roughness element
<b>Presenting author</b>	Y. You, DLR German Aerospace Center, Germany	N. Fedorova, ITAM SB RAS, Russia	C. Manisankar, NAL Bangalore, India	N. de Tullio, University of Southampton, UK

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**Friday, 22 July 2011**
**Numerical Methods and Simulations III**

Renold C2

**Session Chair:** K-S. Chang, Korea Advanced Institute of Science and Technology, Korea

<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2815	2770	2460	2499
<b>Paper title</b>	An investigation into solver strategies for the modelling of compressible turbulent flow	Application of a new hybrid explicit-implicit flow solver to 1D unsteady flows with shock waves	Numerical simulation of initial shock- and detonation-wave development in shock-tube configurations	Computations of flow field around an object decelerating from supersonic to subsonic velocity
<b>Presenting author</b>	I. Asproulis, University of Manchester, UK	E. Timofeev, McGill University, Canada	P. Ess, DLR German Aerospace Center, Germany	T. Saito, Muroran Institute of Technology, Japan

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**Friday, 22 July 2011**
**Multiphase Flows V**

Renold C9

<b>Session Chair:</b>	Z. Walenta, Institute of Fundamental Technology Research, Poland			
<b>Time</b>	1420 hrs	1440 hrs	1500 hrs	1520 hrs
<b>Paper number</b>	2674	2889	2715	2826
<b>Paper title</b>	Time resolved measurements of shock induced cavitation bubbles in various liquids: A novel method of optical measurement	Direct numerical simulations of supersonic interfacial flows	Secondary atomization on two-phase shock wave structure	Interaction of a planar shock wave with a dense field of particles
<b>Presenting author</b>	W. Garen, Hochschule Emden/Leer-University of Applied Sciences, Germany	C. H. Chang, University of California, USA	E. del Prete, CEA DAM, France	J. Wagner, Sandia National Laboratories, USA

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**Friday, 22 July 2011**

Renold Concourse

1540-1550

**Coffee / Tea**


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**Friday, 22 July 2011**

Renold C16

1550-1700

**Closing Ceremony**

**Guest Speaker: Dr. Sameer Savani, ADS Group LTD**  
**Strategic Overview of UK Aerospace**

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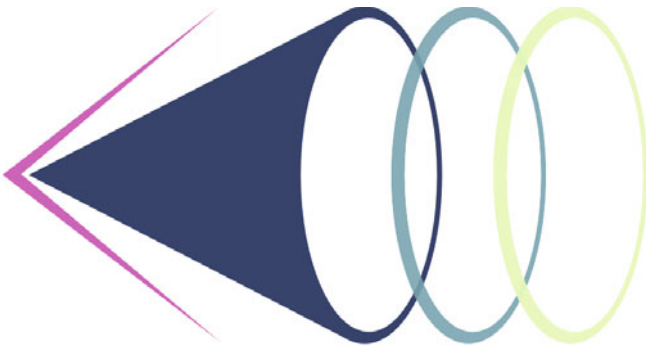
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# Aero-Physics Laboratory

**The University of Manchester  
Aero-Physics Laboratory**

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