33rd ANNUAL CONFERENCE

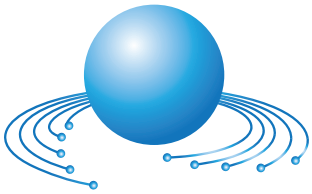
ILASS-Americas

Institute for Liquid Atomization and Spray Systems

2023 CONFERENCE BOOK

14-17 May 2023, Albuquerque, NM

33rd ANNUAL CONFERENCE



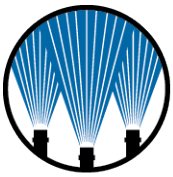
ILASS-Americas

Institute for Liquid Atomization and Spray Systems

TABLE OF CONTENTS

SPONSORS

ILASS-Americas is a non-profit organization committed to providing state-of-the-art spray information to our annual conference attendees and especially to our student attendees. Thanks to our sponsors, we are able to significantly reduce conference registration fees for students each year.



Spraying Systems Co.®
Experts in Spray Technology

begell
begell house, inc. publishers

ATOMIZATION AND SPRAYS

Parker

CONVERGE
CFD SOFTWARE

CATERPILLAR®

BOARD OF DIRECTORS

Chair

Scott E. Parrish
General Motors R&D and Planning

Vice-Chair

Malissa D. Lightfoot
Air Force Research Laboratory

Treasurer

Marcus Herrmann
Arizona State University

Secretary

Kyle M. Bade
Spraying Systems Co.

Member at Large

Michael Cloeter
Dow Chemical (retired)

Member at Large

Olivier Desjardins
Cornell University

Member at Large

Kuo-Cheng (Steven) Lin
Taitech, Inc.

Member at Large

Lyle Pickett
Sandia National Laboratories

Member at Large

Christopher F. Powell
Argonne National Laboratory

Member at Large

Chad Sipperley
Step 2 Consulting, Inc.

Member at Large

Mario Trujillo
University of Wisconsin-Madison

Past-Chair

Vincent G. McDonell
University of California

CONFERENCE ORGANIZERS

Local-Host and Organizer

Benjamin Halls
Sandia National Laboratory

Program Chair

Brandon Sforzo
Argonne National Laboratory

Awards Chair

Paul Vesely
Spraying Systems Co.

Exhibits Chair

Chad Sipperley
Step 2 Consulting, Inc.

Sponsorships Chair

Christopher F. Powell
Argonne National Laboratory

TECHNICAL COMMITTEE MEETING LEADERS

Technical Committee Meeting Liason

Kuo-Cheng (Steven) Lin
Taitech, Inc.

Physics of Atomization
Monday, May 15

Alan Kastengren
Argonne National Laboratory

James Michael
Iowa State University

Aerospace Propulsion
Monday, May 15

Brandon Sforzo
Argonne National Laboratory

Ethan Hanson
Advanced Atomization Technologies

Computation & Modeling
Tuesday, May 16

Mario Trujillo
University of Wisconsin-Madison

Xiaoyi Li
United Technologies Research Center

Industrial & Agricultural Sprays
Tuesday, May 16

Michael Cloeter
Dow Chemical (retired)

Andy Thistle
SPX Flow

Spray Measurements
Tuesday, May 16

Kyle M. Bade
Spraying Systems Co.

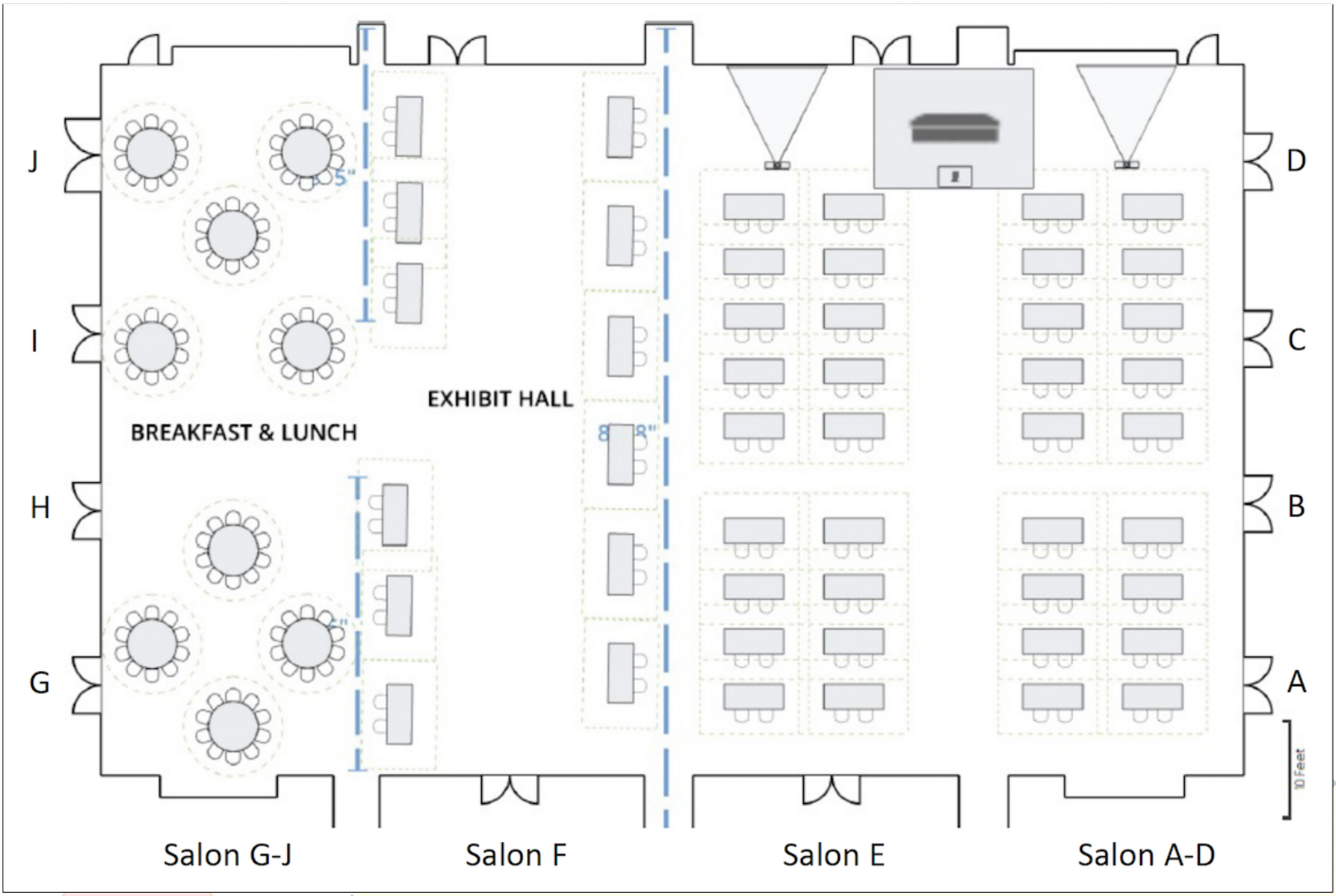
Benjamin Halls
Sandia National Laboratory

Diesel & Automotive
Tuesday, May 16

Lyle Pickett
Sandia National Laboratories

CONFERENCE MAPS

The ILASS-Americas 2023 conference will be held at the Marriott Albuquerque Hotel. Please see the map below which highlights the rooms which will be used for the conference.



CONFERENCE AND PROGRAM NOTES

These are some helpful notes for your time during ILASS-Americas 2023.

Registration takes place on Sunday, May 14 from 5-7pm in the Grand Ballroom Foyer.

A Welcome Reception will take place on Sunday, May 14 from 5-7pm in Salon F, followed by a **Reception Lecture** at 7-8pm in Salon A+E.

Breakfast (Continental) will be served every morning from approximately 7-8am in Salon F with seating available in Salon G-J. Exhibitor booths will be open during this time.

Lunch will be served on Monday and Tuesday in Salon F with seating available in Salon G-J. Lunch on Wednesday will be provided as a to-go box lunch.

The ILASS-Americas Annual Business Meeting will be held during lunch on Tuesday, May 16. All conference attendees are encouraged to attend.

Technical Committee Meetings will be held on Monday and Tuesday afternoons. Conference attendees are strongly encouraged to join the technical committee discussion(s) that match their interests. The meetings are open to all conference attendees.

The Atomization and Sprays Editorial Board Meeting will be held on Monday during lunch in the Sante Fe room (across from Salon G); this is closed meeting for editorial board members only.

Exhibitors' Displays are available each day from the start to the end of each day in Salon F.

Poster Session There is no poster *session* at the the 2023 conference, but posters may be on display.

Program changes will be announced every morning and noted on the schedule poster outside each presentation room as the need arises.

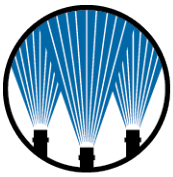
The Conference Banquet and Awards Ceremony will be held at the National Museum of Nuclear Science and History (601 Eubank Blvd SE, Albuquerque, NM 87123), on the evening of Tuesday May 16. Bussing will be provided and will leave promptly at 5:10pm.

Paper numbers are provided in the List-of-Papers (page 34) of this conference book, as well as in the Index of Authors (page 37).

Paper PDFs are provided for all registered conference attendees on a USB-drive that will be provided with your name badge and registration packet.

SPONSORS

ILASS-Americas is a non-profit organization committed to providing state-of-the-art spray information to our annual conference attendees and especially to our student attendees. Thanks to our sponsors, we are able to significantly reduce conference registration fees for students each year.



Spraying Systems Co.®
Experts in Spray Technology

begell
begell house, inc. publishers

ATOMIZATION AND SPRAYS

Parker

CONVERGE
CFD SOFTWARE

CATERPILLAR®

EXHIBITOR INFORMATION

The exhibitors at this year's conference offer an array of diagnostic instrumentation, services, software, and equipment and they look forward to discussions with the conference participants in the exhibitor showcase and break area. Specific details are outlined on the following pages with statements from each exhibitor.

The exhibitors at this year's conference are:

EXHIBITOR MAP

En'Urga Inc.

En'Urga Inc. is the industry leader in customized optical diagnostic equipment for the most challenging factory floor application. En'Urga Inc. has over 25 years of experience in optical diagnostics research, serving many Fortune 50 companies and Federal Government agencies. Our expertise in emission and absorption tomography in hostile environments enables the measurement and control of varied processes in a wide array of industries. We specialize in the research, design, development, calibration, and installation of instruments suitable for the measurement of temperatures, gas concentrations, emissivity, and particulate (liquid and powder) characteristics.

En'Urga Inc. has several products in its portfolio. The **SETscan** optical patternator obtains the distribution of droplets in sprays or particles in particulate-laden flows at a frequency of 10,000 Hz. The optical patternator is used for 100% quality audit of nozzles in a wide variety of industries ranging from aerospace to consumer products. Unlike laser sheet imaging patternators, the **SETscan** optical patternator provides quantitative information on various aspects of the spray such as spray angles, plume angles, % split in plumes, deviation, pitch, roll, and yaw angles. The **SETscan** patternator also provides the planar drop surface area density, the most useful quantity for ranking the performance of injectors for combustion and nozzles for spray drying. Custom units at 200 kHz are also available for studying transient sprays.

The **SPIvel v**elocimeter provides full planar axial and radial velocities from high-speed images obtained with any of the commercially available high-speed cameras.

The **PODscan** tomography system provides the tomographic mapping of drop sizes in sprays. In combination with the SPIvel velocimeter, the **PODscan** system can provide spatially resolved mass flux in spray in a matter of seconds.

All of En'Urga products can be leased or purchased from En'Urga Inc. En'Urga Inc. provides testing and consulting services for combustors, spray nozzles, heat sinks, and other engine-related components. We specialize in characterizing sprays (drop sizes, spray patterns, drop surface areas, velocities, mass fluxes, etc.) in ambient as well as high-pressure conditions. En'Urga Inc. has developed standardized test protocols for GDI injectors, urea dosers, consumer sprays, and paint sprays. These standardized test protocols ensure that the quality of the nozzle that is used in these applications conforms to the highest standards possible. At En'Urga Inc., customer service and innovation are our primary goals.

Contact info: 1201 Cumberland Avenue, Suite R, West Lafayette, IN 47906
Ph. (765) 497-3269; Email: info@enurga.com

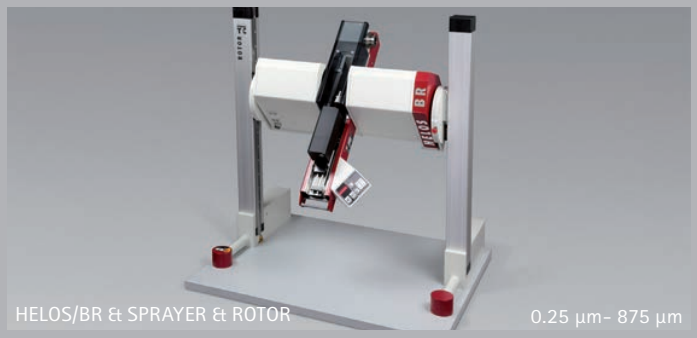
Particle Measurement | Laser Diffraction

Particle Size and Droplet Size Distribution

0.1 Microns to 8,750 Microns

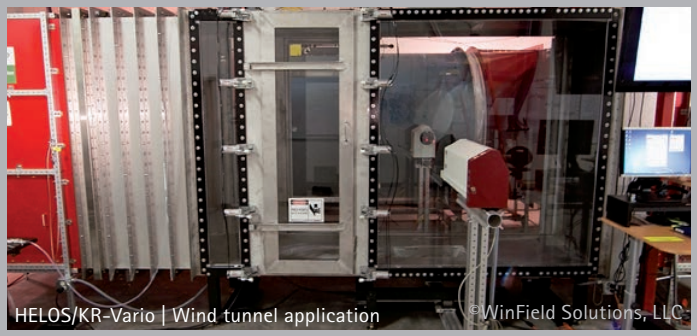
Sympatec Technology for Spray Particle Size and Droplet Distribution

HELOS/BR & SPRAYER 0.25 µm- 875 µm



HELOS/BR & SPRAYER & ROTOR 0.25 µm- 875 µm

HELOS/KR-Vario 0,1 µm - 8,750 µm



HELOS/KR-Vario | Wind tunnel application ©WinField Solutions, LLC

Sympatec develops, manufactures, sells, services and supports an innovative range of modular instruments for particle size and shape analysis in laboratory and process applications for customers worldwide. Typical applications comprise dry powders, granules, fibres, suspensions, emulsions, gels, sprays and inhalants – spanning a size range from 0.5 nm up to 34,000 µm.

Our instruments reliably supply highly precise and reproducible results in very short measuring times and with excellent system-to-system comparability. The open measuring zone of our laser sensors is most suitable for the analysis of extended sprays provide a wide variety from technical spray applications like agricultural sprays to pharmaceutical applications like nasal sprays.

FDA conforming characterization of spray dynamic due to description of formation phase, stable phase and dissipation phase methods guarantees conformity with the pharmaceutical product approval. A team of highly-qualified service employees provides support for Sympatec instruments worldwide, and can also perform preventive maintenance and assist in system qualification.

Laser diffraction
The modular system concept of our proven HELOS laser diffraction sensors covers a wide range of dry and wet applications. Configurations for spray applications allow measurement of spray particle and spray droplet size distributions for more efficient product development of sprays and aerosols. It delivers valid and reproducible droplet size data from finest to coarse droplets.

Particle and droplet size characterisation within spray cones
Particles to be analysed as nebulae clouds of droplets or spray cones remain assigned to dry dispersion as long as air or gas is the continuous phase around the disperse systems. Together with the flexible SPRAYER adapter, the compact laser diffraction sensor HELOS/BR offers meaningful and reproducible analysis of the size distribution of droplets or solid particles in pump sprays, metered dose inhalers (MDI) and other pressurised sprays in the range from 0.25 µm to 875 µm. The adapter can be flexibly used for a wide range of different atomizer types and simulates the manual application of the relevant spray with a force or trajectory actuator.

HELOS/KR-Vario is the preferred model for application with extended particle clouds ranging from 0,1 µm to 8,750 µm. The open measuring zone, which can be varied in its width, supports the flexible adaptation of the optical measurement system to individual customer requirements in challenging technical applications in laboratories or pilot plants such as wind tunnels.

Sympatec Inc.
System | Partikel | Technik
1600, Reed Rd., Suite C
Pennington NJ 47455
USA
Phone +1 609 303 0066
Fax +1 609 303 0365
usa@sympatec.com
www.sympatec.com

Specialised Imaging manufactures and distributes Ultra High Speed Imaging Systems. We've been a leading manufacturer in the field for over 15 years made up of 20 or so seasoned scientists, engineers, and technicians devoted to ultra high speed imaging in concept design and manufacture. Our US office is a US veteran owned small business with offices in Temecula, California; Detroit, Michigan; and the Baltimore area. We offer sale, applications support and full line service of all products.

The Kirana Ultra High Speed Video Camera is capable of capturing 180 frames at 924 x 768 pixels per frame at all frame rates from 1,000 to 5 Million fps and exposure times down to 100 ns.

Our SIM Framing Cameras can capture up to 32 frames of 1360 x 1040 pixels @12 bits, at up to 1 Billion frames per second, with exposure times down to 3 ns.

We also offer a full line of single and double frame intensified cameras and standalone Image Intensifiers. We are also the North American representative for Optronis GmbH manufacturer of the OptoScope Streak Camera line.

We offer streak cameras with time resolution down to < 2 picoseconds, we also offer some of the largest format photocathodes at up to 35 mm long and time windows up to 40 mm long.

We are also the North American representative for Image Systems AB the developer of TEMA and TrackEye Motion Analysis Software which is the worlds most used automated motion tracking and analysis of video data for 2D, 3D, 6D and now DIC applications.

Specialised Imaging Inc,
40935 County Center Drive, Suite D
Temecula, CA 92591, USA
+1-951-296-6406

www.specialised-imaging.com

PHANTOM®

BROADEST RANGE OF HIGH-SPEED CAMERAS

FOR SCIENTIFIC RESEARCH & DEVELOPMENT

- Camera models from 1 to 9 Megapixel Resolution
- Up to 75 Gpx/Second throughput
- Flex4K and VEO4K for 4K up to 1000 fps
- TMX for ultrahigh-speed frame rates
- Workflow solutions to accommodate any environment

When it's too fast to see, and too important not to.®

PHANTOM®

PHANTOMHIGHSPEED.COM
+1.973.696.4500

VISION RESEARCH

AMETEK®

DANTEC DYNAMICS Turn Measurements into Knowledge

Scientists and Engineers in fluid dynamics and solid mechanics rely on measurements to make breakthroughs in applied research, technology development, and quality assurance.

Dantec Dynamics specializes in the development, manufacture and application support of measurement systems that acquire and analyze data of physical properties in fluids and in solid structures.

We deliver turnkey and customized solutions built on high-end laser optics, imaging, and sensor technologies. Our user-friendly software performs advanced data analysis and produces real-time results. Furthermore, we pride ourselves in providing our clients superior technical application support worldwide.

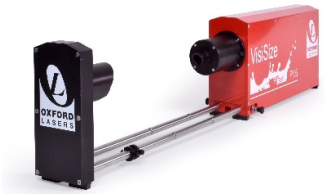
You gain accurate measurement results easily and quickly which help you accelerate the pace of discovery, innovation, quality control or NDT. Our distinct competence and experience in integrating measurement methods and technologies into the right solution for you, is unique.

Partnering with Dantec Dynamics helps you gain crucial knowledge from any test or measurement campaign.

Contact us at:

Dantec Dynamics, Inc.
750 Blue Point Road
Holtsville, NY 11742
United States
Phone / +1 631 654 1290
Fax / +1 631 654 1293
Email: USA@dantecdynamics.com
www.dantecdynamics.com

OXFORD LASERS IMAGING DIVISION



Visi*Size* P15 sizing system

Portable

Class I system

Visi*Size* N60 sizing system

Operate in Extreme Conditions

Fire*FLY laser*

Flexible, Robust

As one of the most successful spin offs from Oxford University in 1977, Today the company operates two divisions. Oxford Lasers have been at the forefront of laser technology for over 40 years.

Today, Oxford Lasers operate two divisions of the business, Imaging and Industrial and have locations in America, France and the UK.

Imaging Division

Oxford Lasers Imaging Division offer **Fire*FLY* & Fire*BIRD*** Short Pulsed Laser systems, Contract Services, System rental, R&D and technical support for: High speed imaging applications with Short Pulsed lasers illumination and software to offer complete imaging solutions.

Oxford Lasers experience within the field of spray characterisation, providing information on droplet size, droplet velocity and droplet shape. The **VisiSize** range: **P15** portable system to the N60 CLASS I lasers safe system, operate in all environments, to provide a range of capability to suit the different measurement challenges present in the field.

Industrial Division

Oxford Lasers Industrial Division offer the full spectrum of fully automated Laser Micro-Machining Tools from Compact Laser Micromachining Tools; perfect for R&D and Pilot Production, through to Ultrafast Laser Micromachining Tools; utilising the highest precision industrial laser technology.

The Industrial Division also offer Subcontract Laser Micromachining Services, capabilities include micro-drilling, milling, patterning, scribing and cutting in a vast array of materials from Metals to Glass and have covered over 10,000 niche applications across a variety of sectors.

Oxford Lasers Ltd.
8 Moorbrook Park
Didcot Oxfordshire
OX11 7HP
T: 01235 810088
F: 01235 810060
E: Oxford.ltd@oxfordlasers.com

Oxford Lasers Inc.
2 Shaker Road, Unit B104
Shirley MA 01464
USA
T: (978) 425-0755
F: (978)425 4487
E: oxford.inc@oxfordlasers.com

Energy Research Consultants (ERC) was founded in 1990 to address a demand for application of state-of-the-art experimental and numerical modeling tools to problems associated with transportation, propulsion, and energy generation and use. Projects which require fast and confidential answers via advanced research tools which are not otherwise readily available are conducted by experienced personnel using a fully equipped research laboratory. Both experimental and numerical studies are conducted for clients that are addressing mission oriented, time critical projects. In addition, customer on-site work can be accommodated.

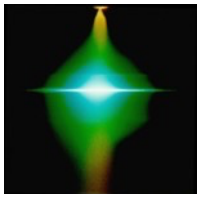
ERC has extensive experience with a wide variety of fluid dynamic, combustion, and spray system applications. In particular, ERC maintains expertise in the characterization of non-reacting and reacting flows such as those found in automotive combustion chambers and exhaust after-treatment systems, as well as those found in spray and gas fired gas turbine combustion systems and industrial processes. The expertise ranges from the basic science of liquid injection and sprays associated with a wide array of applications to study of complex practical configurations for atomization and spray formation, fuel/air mixing and combustion, swirl generation, and associated pollutant formation and operability performance and control.

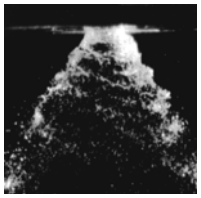
Specialized measurement services are offered to both commercial and government clients. Available spray diagnostics include Phase Doppler Interferometry, Laser Diffraction, Planar Liquid Laser Induced Fluorescence (PLIF with continuous and pulsed lasers with intensified CCD cameras), planar and global OH* LIF, optical patternation, particle image velocity, tunable diode laser spectroscopy, liquid film thickness measurements, and high speed visualization. ERC has extensive experience applying these methods to wide array of customer systems. Other capabilities include CFD modeling, test facility development, and test plan development and execution using statistically designed experimental methods.

In addition to measurement services, ERC has also developed standalone design tools (for example, Advanced Spray Injection Phenomena Simulator--ASIPS; Flame Response Sensitivity Tool—FRST) and image analysis tools (for example, Automated Feature Extraction and Analysis Tool—AFEAT). ERC has also developed other products such as a specialized imaging system for inspection inside high temperature environments and a turn-key reference burner for calibration of laser diagnostics. Gaseous and liquid fired burners are also available.

Contact Information:

Christopher Brown, Research Manager, Business Manager, Co-Owner
23342 South Pointe Drive, Suite E
Laguna Hills, CA 92653-1422
Tel: (949) 583-1197 x 101 Fax: (949) 583-1198
Email: Brown@ERC-Ltd.com Website: www.ERC-Ltd.com


Phase Doppler Interferometry


High Speed Video


Reacting Spray Visualization

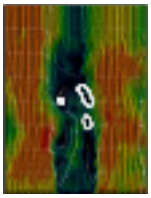

Particle Image Velocimetry

Figure 1 – Sample Data Sets (Many Other Measurements Are Available, Please Inquire).

470 Lakeside Drive, Unit C
Sunnyvale, CA 94085

Artium specializes in developing and manufacturing advanced particle characterization instruments for the spray community. We offer a broad range of instruments for measuring sprays, clouds, and aerosol droplets. Our **Phase Doppler Interferometry (PDI)** instruments are based on the light scattering interferometry principle which was **invented and developed by our scientists**. This technology has been developed and evaluated over the past few decades and is acknowledged as the most reliable and accurate means for characterizing spray and aerosol droplet dynamics. Our goal over the past 20 years has been to further refine the method and its implementation to insure greater measurement reliability and accuracy while making the instruments much easier to use. We have now introduced advanced particle imaging systems to allow easy and economic characterization of spray formation and drop size distributions. This method is also used for measuring aircraft icing sprays with mixed phase (liquid and ice) particles as well as large droplets that may be highly deformed. Other applications include spray drying particle characterizations wherein particulate in liquid and solid irregular-shaped particles exist.

System automation (US Patent 7,564,564) has been one of our key goals. We have introduced advanced methods and algorithms **(US Patent 7,788,067)** to minimize the possibility for user setup errors even for the most complex measurement tasks**.** Advanced modern electronics and computers coupled with **software utilizing innovative signal processing algorithms** and validation strategies have resulted in significantly improved instrument performance even under the most difficult measurement conditions.

Our **newly developed flight probes based on the phase Doppler method and multi-beam imaging (patents pending) have been designed for atmospheric cloud monitoring and aircraft icing research.** These instruments are also used for a broad range of spray applications. They have undergone significant testing in the field. Testing at the **U.S. Air Force Eglin Air Force Base McKinley Climatic Laboratory**, General Electric's aircraft engine icing facility, and in the **NASA Glenn Research Center Icing Research Tunnel (IRT)** proved our instruments are capable of making reliable and accurate measurements in these challenging environments.

Under **U.S. Army SBIR Ph II and NASA SBIR Phase I, II and III programs**, we have developed PDI and **High Speed Imaging** (**HSI**) systems for icing research. The probes have been successfully tested on a **UH60 Black Hawk Helicopter** under the U.S. Army's helicopter icing research program. The high speed imaging (HSI) probe characterizes non-spherical particles (deformed droplets, ice crystals, and mixed phase conditions). We have also developed a line of **TurnKey (TK)** systems, an integrated PDI probe suitable for in-spray use. Our instruments are also used for quality control for inkjet printing of large OLED displays. Artium's other products include the **Laser Doppler Velocimeter (LDV)** and **Laser Induced Incandescence (LII)** which is used for measuring soot (black carbon) emission from engine exhaust and in ambient air.

We are proud to announce our new **STTP Award** (2020) with the **US Air Force Test Center** for **Characterization of Simulated Weather and Turbine Exhaust** which will involve extensive use and development of both our **HSI** and **LII** instrumentation.

Contact Information: Dr. William Bachalo, President and CEO
Artium Technologies, Inc.
408-737-2364
Email: info@artium.com
Website www.artium.com

Revolutionizing high-speed camera technology
iX Cameras is a world-leading technology and product company specializing in the field of high-speed (slow motion) imaging. Based on proprietary innovative technologies, we design, build and sell cutting-edge ultra-fast cameras and software for a wide range of advanced scientific research applications. Our commitment to innovate and push the boundaries of high-speed video science is the reason we develop technically superior and easy-to-use products that our customers need to attain the highest scientific achievements and creativity. The innovation of our i-SPEED brand of cameras is backed by our world-class service and support teams, ensuring our customers' success.

Innovation built on our legacy
For over a decade, thousands of i-SPEED brand cameras were developed and sold by Olympus until the spinoff of the product development group in 2014. Today, the same heralded development team from Olympus, combined with new camera and software industry veterans, continues to design innovative state-of-the-art i-SPEED cameras under the iX Cameras name, always upholding the Olympus legacy of quality.

Products
i-SPEED 7 Series Cameras: Designed for engineering and research, i-SPEED 7 cameras provide the perfect balance of ultra-high resolution -- with higher pixel density for accuracy and the ability to zoom in to magnify detail -- with recording speeds that capture even the fastest transient events without any blur.

i-SPEED 5 Series Cameras: Designed with performance and environmental constraints in mind, the cameras are a new range of models from iX Cameras. The compact form factor of the 5 series contains plenty of power and memory for exceptional performance in both laboratory and field applications, all in a convenient package for ultimate functionality and portability. With an innovative sealed internal cooling system and sealed sensor, these are the first cameras in this class designed for use in harsh and demanding environments.

i-SPEED 2 Series Cameras: Bring portability and power to your application without exhausting your budget. The i-SPEED 2 features a beautiful 2.6 megapixel image sensor, optional extended battery and expandable video storage options.

Markets
Ballistics, Automotive testing, R&D testing, Production line monitoring and auditing, Biomechanics, Sports performance, Media and Cinematography

Offices
United States: 8 Cabot Road, Suite 1800, Woburn MA, 01801
United Kingdom: Bradley House, Locks Hill, Rochford, Essex SS4 1BB
China: No 399 Hangting Road, Oriental Hong Jing Garden ZhuQiao Town, Shanghai
India: J2-101, Swiss County, Thergaon, Pune-411033

nac IMAGE TECHNOLOGY

nacamericas@gmail.com (805) 584-8862

nac Image Technology is the most experienced name in high speed camera systems. Since 1958, nac's reputation for technical and digital innovation and comprehensive, integrated line-up of products have set industry standards for performance and reliability. nac cameras feature industry leading, clean, crisp image quality, combined with the fastest frame rates and unmatched light sensitivity.

FEATURED PRODUCTS FOR ILASS 2021

World's First 100 GigaPixel/Sec Camera

MEMRECAM ACS-1 M60

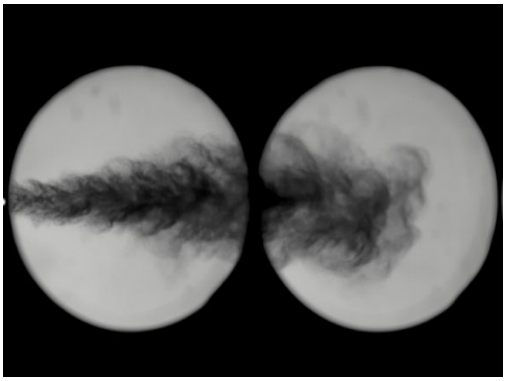
High Speed
1,280×896pixel@54,000fps
1,280×800pixel@60,000fps
1,280×448pixel@100,000fps

High Sensitivity
Color ISO25000
Mono ISO100000

Large Memory
Max. 256GB internal memory
Built-in SSD

High Speed Data Transfer
USB3.0B download
400% faster (vs Lan)

High End Affordable Compact High Speed Camera



MEMRECAM ACS-3

High Speed
1,280×896pixel@25,000fps
1MPix 30,000fps
0.4MPix 65,000fps

High Sensitivity
Mono ISO100000

Large Memory
Max64GB memory
Built-in SSD

Light weight/Compact
Dimension 128×128×206mm
Weight 4.5kg

OTHER KEY nac CAMERA FEATURES:

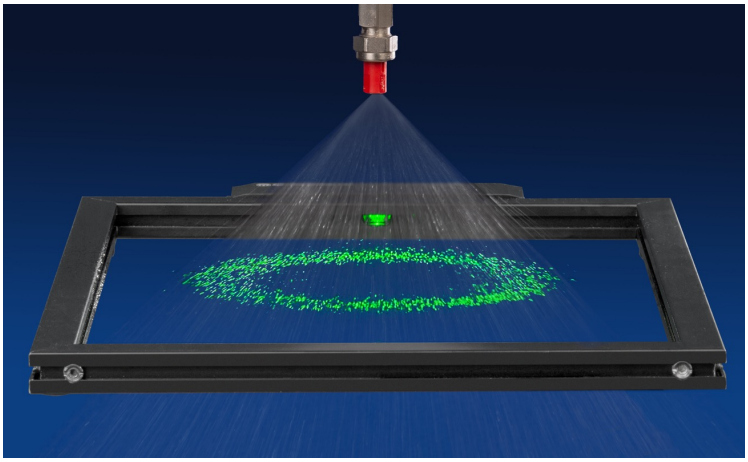
- Frame Straddling for PIV
- 190 nanosecond exposures
- Synced Laser Illumination
- Image Based Triggering
- Add-on image intensifiers (UV and Visible)
- Multiple Image Analysis Software Packages

nac Americas Inc.
193 Jefferson Ave, Suite 102
Salem, MA 01907

(805) 584-8862
nacamericas@gmail.com
www.nacinc.com

Spraying Systems Co.®
Experts in Spray Technology

Spraying Systems Co. is the world's leading manufacturer of spray **nozzles**. Every day, our local spray technology experts help customers optimize operations and create more sustainable manufacturing practices. With tens of thousands of standard products, we have the right nozzle for your application – and we ship most standard products in one day. If you need a special product or material, contact us! We develop hundreds of custom nozzles, injectors and headers every year. Our engineering and manufacturing resources can help solve your toughest spray technology challenges.



Spray Analysis and Research Services

The **Spray Analysis and Research Services** group at Spraying Systems Co. offers contract testing and modeling services to predict and validate spray performance. Understanding spray performance in operations such as gas cooling, spray drying and coating can help you increase production, reduce operating costs, enhance sustainability and reduce costs. At our state-of-the-art laboratories located in Chicago and around the world, we offer access to commercial and proprietary instrumentation to characterize spray drop size, velocity, surface impact, coverage and distribution, material rheology, and nearly any other parameter. To do this, we utilize Phase Doppler, Laser Diffraction, High Speed Video, CFD, and other methods which can be combined with support facilities such as wind tunnels, spray material heating, and conveyor motion. Contact us at Spray.Analysis@spray.com to learn more or to discuss a project with one of our engineers.

SPRAYSCAN®

The **SprayScan Suite** of products was developed after decades of laboratory testing for our many customers. The use of a wide range of commercial R&D instruments demonstrated but a strength, but a large overhead in cost and user expertise. The SprayScan systems are designed to be easy-to-use, fast to set up, and lower cost. These diagnostic devices are are able to characterize critical spray parameters such as: the flow rate, pressure, and temperature of the spray material (SprayScan mSM), 2D spray distribution (SprayScan mPT, shown above), spray impact, and drop size. Additionally, some of the SprayScan products are designed allow real-time monitoring of in-process sprays with very little user interaction and an online dashboard to view the current status (SprayScan mSM and SprayScan ePT). Please visit our website (below) or contact us at Spray.Analysis@spray.com to discuss how SprayScan may be able to help you in the lab, or in your process.

Detailed Program

Session Start Time			Sunday, May 14th, 2023
S	5:00 PM	MDT	**Registration Opens,** *Grand Ballroom Foyer* **Welcome Reception,** *Salon F*
S	7:00 PM	MDT	**Reception Lecture: "From the Nation's Nuclear Ordnance Engineering Lab to the Nation's National Security Engineering Lab"** **John Taylor (Sandia National Laboratories, retd.)** *Salon A & E*
S	8:00 PM	MDT	**Meeting Adjourn**

Session Start Time			Monday, May 15th, 2023	
M	7:00 AM	MDT	**Breakfast with the Exhibitors** *Salon F*	
M	8:00 AM	MDT	**Welcome and Opening Remarks** *Salon A & E*	
M	8:15 AM	MDT	**Keynote Lecture - Dan Guildenbecher (Sandia National Laboratories) "Aerodynamic Deformation and Breakup of Liquid Drops Due to the Flow Induced by a High-Mach Projectile"** *Salon A & E*	
M	9:15 AM	MDT	**Exhibitor Showcase** *Salon A & E*	
M	10:10 AM	MDT	**Break with the Exhibitors**	
M	10:30 AM	MDT	**Focus Session: High Speed** Session Chairs: Alan Kastengren & Ben Halls *Salon E*	**Spray Applications - Biomedical and Viral Transport** Session Chair: Jennifer O'Neil *Salon A*
M	10:30 AM	MDT	**9: Solubility Limit Mapping and the Effects of Injector Configuration on Spray Structures of Diesel with Dissolved Gas in High-Speed Crossflow** T. Tidball, K.-C. Lin, S. Hammack Taitech Inc, Air Force Research Laboratory	**16: Investigation of Insert Geometry Effect on Resulting Performance of a Jet Nebulizer** C. Wollschleger, L. Villasmil-Urdaneta, J. O'Neil Rochester Institute of Technology
M	10:50 AM	MDT	**54: Aero break-up of droplets in a ballistic wave system** M. Arienti, E. Wenzel, D. Guildenbecher, S. Beresh Sandia National Laboratories	**46: Secondary atomization of blood backspatter induced by muzzle gases** J. Michael, L. Imtiaz Kaya, K. Chen, A. Yarin Iowa State University, University of Illinois Chicago
M	11:10 AM	MDT	**62: Experimental Investigation of Water Droplets Interactions with Shock and Detonation Waves** S. Briggs, N. Berube, D. Dyson, M. Kinzel, S. Grace, S. Vasu University of Central Florida, Boston University	**56: Investigation of Jet Nebulizer Distance to Baffle on Resulting Performance** C. Wollschleger, L. Villasmil-Urdaneta, J. O'Neil Rochester Institute of Technology
M	11:30 AM	MDT	**39: High Weber Number Atomization from Droplet-Detonation Interactions** J. Burr, J. Bennewitz, A. Kastengren Air Force Research Laboratory, University of Alabama-Huntsville, Argonne National Laboratory	**35: Flat fan spray atomization of non-Newtonian fluids relevant to bloodspatter** L. Imtiaz Kaya, S. Bentil, J. Michael Iowa State University
M	11:50 AM	MDT	**Lunch** *Salon G*	**Atomization and Sprays Editorial Board Meeting** *Santa Fe*

M	12:50 PM	MDT	**Technical Committee Meeting** ***Physics of Atomization,*** *Salon A* ***Aerospace Propulsion,*** *Salon E*	
M	1:50 PM	MDT	**Focus Session: Sustainable Fuel Sprays** Session Chair: Angela Kimber *Salon E*	**Spray Characterization and Measurements I** Session Chairs: Safiullah & Daniel Dyson *Salon A*
M	1:50 PM	MDT	**24: Modeling and Simulation of Mixed Evaporation and Boiling: Application to Aviation Fuels at Lean Conditions** E. Wenzel, M. Arienti Sandia National Laboratories	**15: The Effect of Air-to-Liquid Ratio on Jet Nebulizer Performance** B. Beaudry, L. Villasmil-Urdaneta, J. O'Neil Rochester Institute of Technology
M	2:10 PM	MDT	**11: Modeling of Sustainable Aviation Fuels with Real-Fluid Equations of State** J. Poblador-Ibanez, L. Nocivelli Argonne National Laboratory	**1: Spray Drift due to Bag Breakup of Fan Sheet** K. Sallam, M. S. Raza Oklahoma State University
M	2:30 PM	MDT	**29: Applying motion-based detection algorithms to analyze x-ray phase contrast images of fluid spray** A. Karmarkar, C.-Y. Moon, A. Kastengren, C. Powell, B. Sforzo Argonne National Laboratory	**55: Effects of pressure and voltage on charge-to-mass ratio of an induction-charging electrostatic sprayer** S. Post, M. Jermy, A. Hewitt Embry Riddle Aeronautical University, University of Canterbury, University of Queensland
M	2:50 PM	MDT	**Break with the Exhibitors**	

M	**3:10 PM**	**MDT**	**Spray Applications - Aerospace** Session Chair: Vince McDonell *Salon E*	**Spray Applications - Industrial** Session Chair: Kyle Bade *Salon A*
M	**3:10 PM**	**MDT**	**5: Comparison of non-combusting spray fields in a model combustor using shadowgraphy** Y. Hicks, T. Capil, K. Tacina NASA Glenn Research Center	**36: Towards Improved Simulation of an Ar/He Plasma Spray of Metal Particles** A. Brown, A. Vackel, A. Cruz-Cabrera Sandia National Laboratories
M	**3:30 PM**	**MDT**	**60: Development of an aerospace spray characterization program and design of a non-proprietary gas turbine engine atomizer** B. Sforzo, A. Kimber, J. Moder Argonne National Laboratory, Woodward Inc, NASA Glenn Research Center	**69: Understanding breakup mechanisms in electrostatic rotary bell atomizers** V. Krisshna, B. Christensen, M. Owkes Montana State University
M	**3:50 PM**	**MDT**		**23: A computational study of non-Newtonian liquid atomization** J. Giliberto, O. Desjardins Cornell University
M	**4:10 PM**	**MDT**	**Meeting Adjourn**	

Session Start Time			Tuesday, May 16th, 2022	
T	7:00 AM	MDT	**Breakfast with the Exhibitors** *Salon F*	
T	8:00 AM	MDT	**Opening Remarks** *Salon A & E*	
T	8:15 AM	MDT	**Keynote Lecture - Marco Arienti (Sandia National Laboratories)** **"The Role of DNS in Multiphase Simulations"** *Salon A & E*	
T	9:15 AM	MDT	**Advances in Numerical Methods** Session Chairs: Xiaoyi Li & Olivier Dejardins *Salon E*	**Spray Applications - Automotive I** Session Chairs: Christopher Powell & Scott Parrish *Salon A*
T	9:15 AM	MDT	**10: An Improved Σ-Y Model for Diesel-Like Sprays** J. Poblador-Ibanez, L. Nocivelli, G. Magnotti, L. Anumolu, B. Sforzo Argonne National Laboratory, Convergent Science Inc.	**14: Development of a 3D Liquid Volume Fraction Imaging Apparatus for Hollow-Cone Sprays** M. Groendyk, A. Munnannur, J. Liu Cummins Emissions Solutions
T	9:35 AM	MDT	**18: A Dual Scale Approach to Modeling Sub-Filter Velocities due to Shear-Induced Instabilities** A. Goodrich, M. Herrmann Arizona State University	**50: Reacting spray characterization of diesel and light-distillate fuels for high injection pressure gasoline compression ignition applications** S. Jouzdani, H. Schmidt, T. Tzanetakis, J. Naber, A. Zhang Michigan Technological University, Aramco Research Center
T	9:55 AM	MDT	**19: A Dual Scale LES Model for Predicting Phase Change Velocities** A. Goodrich, M. Herrmann Arizona State University	**41: Characterization of plume-to-plume variations of Spray G** Z. Buen, L. White, M. Dhanji, L. Pickett Sandia National Laboratories
T	10:15 AM	MDT	**47: Near-Field Lagrangian Dispersion Model** M. A. Mason Jr., M. F. Trujillo University of Wisconsin-Madison	**40: A Study of Impinging Spray G on Transient Thermal Loading and Fuel Film Deposition** M. Dhanji, Z. Buen, L. White, L. Pickett, J. Manin Sandia National Laboratories
T	10:35 AM	MDT	**Break with the Exhibitors**	

T	10:50 AM	MDT	**Atomization & Spray Simulations I** Session Chairs: Marco Arienti & Lorenzo Nocivelli *Salon E*	**Spray Applications - Automotive II** Session Chair: Chi Young Moon *Salon A*
T	10:50 AM	MDT	**2: A Quantitative Analysis of Atomization Mechanisms from High-Fidelity Simulations** B. Christensen, M. Owkes Montana State University	**32: Application of high-speed imaging and infrared (IR) thermography in an optical electric motor** C. Idicheria, S. Parrish, R. Grover, X. Yang General Motors R&D
T	11:10 AM	MDT	**38: Large-scale instabilities in the breakup of liquid sheets** M. Ananth, M. Trujillo University of Wisconsin-Madison	**31: Experimental and Simulation Study of Optical Oil-Cooling Electrical Motor** X. Yang, C. Idicheria, R. Grover, S. Parrish General Motors R&D
T	11:30 AM	MDT	**48: Simulation and modeling of the deformation and breakup of evaporating drops** B. Boyd, T. Mahmood, Y. Ling University of Canterbury, Baylor University, University of South Carolina	**63: Conjugate Heat Transfer Modeling of Oil Jet Impingement Cooling on Corrugated Wire Surfaces** A. Waikar, D. Rowinski, A. Dahale Convergent Science Inc.
T	11:50 AM	MDT	**Lunch / ILASS-Americas Annual Business Meeting** *Salon G*	
T	12:50 PM	MDT	**Technical Committee Meetings** ***Computation & Modeling,*** *Salon E* ***Industrial & Agricultural Sprays,*** *Salon A*	
T	1:40 PM	MDT	**Break with Exhibitors**	

T	2:00 PM	MDT	**Internal and Near Nozzle Behavior** Session Chairs: Lyle Pickett & Jordi Poblador Ibanez *Salon E*	**Spray Characterization and Measurements II** Session Chairs: Malissa Lightfoot & Ashwini Karmarkar *Salon A*
T	2:00 PM	MDT	**49: Numerical investigation of internal two-phase flows in flow-blurring atomizers** Y. Ling, L. Jiang University of South Carolina, Baylor University	**59: Understanding Droplet Breakup Mechanism for an Unsteady Oscillating Spray Nozzle** A. Hossain, M. Cloeter, J. Theuerkauf Dow Chemical
T	2:20 PM	MDT	**53: Internal mixing nozzle geometry impact on the spray process using steam as dispersing medium** U. Fritsching, M. R. Barbieri, L. Achelis University Bremen	**20: Film and Spray Characteristics of Water on an Airfoil Surface in High-Speed Flows** S. Safiullah, B. Esquivias , B. Hickey, V. McDonell University of California-Irvine
T	2:40 PM	MDT	**65: In-nozzle Multiphase Flow Patterns in Flash Boiling Atomization and Their Impacts on External Sprays** S. Wang, S. Qiu, Y. Zhang, D. Hung, X. Li, M. Xu Shanghai Jiao Tong University	**51: Using Holographic Imaging to Study Fuel Injection in High-Speed Flows** C. D. Scott, K. A. Sallam, K.-C. Lin, S. D. Hammack, C. D. Carter Oklahoma State University, Taitech, Inc., Air Force Research Laboratory
T	3:00 PM	MDT	**Technical Committee Meeting** ***Spray Measurements,*** *Salon E* ***Diesel & Automotive*** **,** *Salon A*	
	3:50 PM		**Break**	
T	5:10 PM	MDT	**Travel to banquet**	
T	5:30 PM	MDT	**Banquet and Awards Ceremony** *National Museum of Nuclear Science & History*	
T	9:00 PM	MDT	**Banquet Ends**	

Session Start Time			Wednesday, May 17th, 2023	
W	7:00 AM	MDT	**Breakfast with the Exhibitors** *Salon F*	
W	8:00 AM	MDT	**Opening Remarks** *Salon A & E*	
W	8:15 AM	MDT	**X-Ray Diagnostics** Session Chairs: Kuo-Cheng Lin & Jason Burr *Salon E*	**Droplet Phenomena** Session Chair: Meghnaa Dhanji & Austin Goodrich *Salon A*
W	8:15 AM	MDT	**7: X-ray Radiography Measurements of Spray Impingement on High-temperature Glow Plug Ignition Assistance Systems** C.-Y. Moon, A. Karmarkar, B. Sforzo, A. Kastengren, C. Powell, E. Mayhew, K. Kim, J. Temme, C.-B. Kweon Argonne National Laboratory, Army Research Laboratory	**12: Modeling spherical droplet evaporation using a shell based approach** A. Dahale Convergent Science Inc.
W	8:35 AM	MDT	**68: Two-Color X-ray Imaging for Material Differentiation in Multiphase Flows** R. La Foy, B. Halls Sandia National Laboratories	**21: On the Effects of Viscosity in Aerodynamic Droplet Breakup** I. Jackiw, N. Ashgriz Massachusetts Institute of Technology, University of Toronto
W	8:55 AM	MDT	**6: The Advanced Photon Source Upgrade and its Impact on Synchrotron Spray Research** A. Kastengren, K. Fezzaa, J. Ilavsky Argonne National Laboratory	**61: Characterizing size distributions for single drop impacts at high wall superheat** R. Werner, E. Mayhew, K. Kim, J. Michael Iowa State University, Army Research Laboratory
W	9:15 AM	MDT	**Break with the Exhibitors**	

W	9:30 AM	MDT	**Advances in Spray Diagnostics** Session Chair: Julien Manin *Salon E*	**Atomization & Spray Simulations II** Session Chairs: Mark Owkes & Ambarish Dahale *Salon A*
W	9:30 AM	MDT	**52: High-Speed Quantitative Imaging of Vapor and Liquid Phase Concentration Distributions in Evaporating Fuel Spray by Means of Two-Wavelength Laser Absorption Scattering Principle** S. C. Rat, S. Naito, E. Liu, Y. Ogata, M. Andersson, K. Nishida, S. Matsumura BSMRSTU University, University of Hiroshima, Chalmers University of Technology, nac Image Technology	**25: Simulating interfacial flows: a farewell to planes** F. Evrard, R. Chiodi, B. van Wachem, O. Desjardins Cornell University, Otto-von-Guericke-Universität Magdeburg, Los Alamos National Laboratory
W	9:50 AM	MDT	**64: Dense-field spray droplet size quantification of flashing boiling atomization using structured laser illumination planar imaging technique** Q. Shuyi, W. Shangning, Z. Yijia, L. Xuesong, H. David, X. Min Shanghai Jiao Tong University	**37: Improvements to a Dual-Scale Modeling Approach for Finite Weber Numbers** D. Kedelty, M. Herrmann Arizona State University
W	10:10 AM	MDT		**33: High-Fidelity Multi-Scale Simulation of Swirled Air-blast Atomization with Comparison against Experiments** L. Bruni, O. Desjardins Cornell University, University of Pisa
W	10:30 AM	MDT	**Boxed Lunch / Exhibitor Passport Drawing / Meeting Adjourn**	

KEYNOTE SPEAKERS

Monday Keynote

"Aerodynamic Deformation and Breakup of Liquid Drops Due to the Flow Induced by a High-Mach Projectile"

Daniel R. Guildenbecher

Principal Member of the Technical Staff
Sandia National Laboratories

Tuesday Keynote

"The Role of DNS in Multiphase Simulations"

Marco Arienti

Principal Member of the Technical Staff
Sandia National Laboratories

Paper Numbers, Titles, and Authors

1. Spray Drift due to Bag Breakup of Fan Sheet
   Khaled Sallam, Muhammad Saqib Raza

2. A Quantitative Analysis of Atomization Mechanisms from High-Fidelity Simulations
   Brendan Christensen, Mark Owkes

5. Comparison of non-combusting spray fields in a model combustor using shadowgraphy
   Yolanda Hicks, Tyler Capil, Kathleen Tacina

6. The Advanced Photon Source Upgrade and its Impact on Synchrotron Spray Research
   Alan Kastengren, Kamel Fezzaa, Jan Ilavsky

7. X-ray Radiography Measurements of Spray Impingement on High-temperature Glow Plug Ignition Assistance Systems
   Chi Young Moon, Ashwini Karmarkar, Brandon Sforzo, Alan Kastengren, Christopher Powell, Eric Mayhew, Kenneth Kim, Jacob Temme, Chol-Bum Kweon

9. Solubility Limit Mapping and the Effects of Injector Configuration on Spray Structures of Diesel with Dissolved Gas in High-Speed Crossflow
   Travis Tidball, Kuo-Cheng Lin, Stephen Hammack

10. An Improved Σ-Y Model for Diesel-Like Sprays
    Lorenzo Nocivelli, Gina Magnotti, Lakshman Anumolu, Brandon Sforzo

11. Modeling of Sustainable Aviation Fuels with Real-Fluid Equations of State
    Jordi Poblador-Ibanez, Lorenzo Nocivelli

12. Modeling spherical droplet evaporation using a shell based approach
    Ambarish Dahale

14. Development of a 3D Liquid Volume Fraction Imaging Apparatus for Hollow-Cone Sprays
    Michael Groendyk, Achuth Munnannur, Jerry Liu

15. The Effect of Air-to-Liquid Ratio on Jet Nebulizer Performance
    Ben Beaudry, Larry Villasmil-Urdaneta, Jennifer O'Neil

16. Investigation of Insert Geometry Effect on Resulting Performance of a Jet Nebulizer
    Christopher Wollschleger, Larry Villasmil-Urdaneta, Jennifer O'Neil

18. A Dual Scale Approach to Modeling Sub-Filter Velocities due to Shear-Induced Instabilities
    Austin Goodrich, Marcus Herrmann

19. A Dual Scale LES Model for Predicting Phase Change Velocities
    Austin Goodrich, Marcus Herrmann

20. Film and Spray Characteristics of Water on an Airfoil Surface in High-Speed Flows
    Safiullah Safiullah, Brandon Esquivias, Brandon Hickey, Vince McDonell

21. On the Effects of Viscosity in Aerodynamic Droplet Breakup
    Isaac Jackiw, Nasser Ashgriz

23. A computational study of non-Newtonian liquid atomization
Joseph Giliberto, Olivier Desjardins

24. Modeling and Simulation of Mixed Evaporation and Boiling: Application to Aviation Fuels at Lean Conditions
Everett Wenzel, Marco Arienti

25. Simulating interfacial flows: a farewell to planes
Fabien Evrard, Robert Chiodi, Berend van Wachem, Olivier Desjardins

29. Applying motion-based detection algorithms to analyze x-ray phase contrast images of fluid spray
Ashwini Karmarkar, Chi Young Moon, Alan Kastengren, Christopher Powell, Brandon Sforzo

31. Experimental and Simulation Study of Optical Oil-Cooling Electrical Motor
Xiaofeng Yang, Cherian Idicheria, Ronald Grover, Scott Parrish

32. Application of high-speed imaging and infrared (IR) thermography in an optical electric motor
Cherian Idicheria, Scott Parrish, Ronald Grover, Xiaofeng Yang

33. High-Fidelity Multi-Scale Simulation of Swirled Air-blast Atomization with Comparison against Experiments
Lorenzo Bruni, Olivier Desjardins

35. Flat fan spray atomization of non-Newtonian fluids relevant to bloodspatter
Labiba Imtiaz Kaya, Sarah Bentil, James Michael

36. Towards Improved Simulation of an Ar/He Plasma Spray of Metal Particles
Alexander Brown, Andrew Vackel, Alvaro Cruz-Cabrera

37. Improvements to a Dual-Scale Modeling Approach for Finite Weber Numbers
Dominic Kedelty, Marcus Herrmann

38. Large-scale instabilities in the breakup of liquid sheets
Mohan Ananth, Mario F. Trujillo

39. High Weber Number Atomization from Droplet-Detonation Interactions
Jason Burr, John Bennewitz, Alan Kastengren

40. A Study of Impinging Spray G on Transient Thermal Loading and Fuel Film Deposition
Meghnaa Dhanji, Zachary Buen, Logan White, Lyle Pickett, Julien Manin

41. Characterization of plume-to-plume variations of Spray G
Zachary Buen, Logan White, Meghnaa Dhanji, Lyle Pickett

46. Secondary atomization of blood backspatter induced by muzzle gases
James Michael, Labiba Imtiaz Kaya, Kailin Chen, Alexander Yarin

47. Near-Field Lagrangian Dispersion Model
Michael A. Mason, Jr., Mario F. Trujillo

48. Simulation and modeling of the deformation and breakup of evaporating drops
Bradley Boyd, Taofiqhasan Mahmood, Yue Ling

49. Numerical investigation of internal two-phase flows in flow-blurring atomizers
Yue Ling, Lulin Jiang

50. Reacting spray characterization of diesel and light-distillate fuels for high injection pressure gasoline compression ignition applications
Shirin Jouzdani, Henry Schmidt, Tom Tzanetakis, Jeffrey Naber, Anqi Zhang

51. Using Holographic Imaging to Study Fuel Injection in High-Speed Flows
Chris D. Scott, Khaled A. Sallam, Kuo-Cheng Lin, Stephen D. Hammack, Campbell D. Carter

52. High-Speed Quantitative Imaging of Vapor and Liquid Phase Concentration Distributions in Evaporating Fuel Spray by Means of Two-Wavelength Laser Absorption Scattering Principle
Samir Chandra Rat, Shinichiro Naito, Erwei Liu, Yoichi Ogata, Mats Andersson, Keiya Nishida, Satoshi Matsumura

53. Internal mixing nozzle geometry impact on the spray process using steam as dispersing medium
Udo Fritsching, Matheus Rover Barbieri, Lydia Achelis

54. Aero break-up of droplets in a ballistic wave system
Marco Arienti, Everett Wenzel, Dan Guildenbecher, Steven Beresh

55. Effects of pressure and voltage on charge-to-mass ratio of an induction-charging electrostatic sprayer
Scott Post, Mark Jermy, Andrew Hewitt

56. Investigation of Jet Nebulizer Distance to Baffle on Resulting Performance
Christopher Wollschleger, Larry Villasmil-Urdaneta, Jennifer O'Neil

59. Understanding Droplet Breakup Mechanism for an Unsteady Oscillating Spray Nozzle
Arif Hossain, Mike Cloeter, Jorg Theuerkauf

60. Development of an aerospace spray characterization program and design of a non-proprietary gas turbine engine atomizer
Brandon Sforzo, Angela Kimber, Jeffrey Moder

61. Characterizing size distributions for single drop impacts at high wall superheat
Ryan Werner, Eric Mayhew, Kenneth Kim, James Michael

62. Experimental Investigation of Water Droplets Interactions with Shock and Detonation Waves
Sydney Briggs, Nicolas Berube, Daniel Dyson, Michael Kinzel, Sheryl Grace, Subith Vasu

63. Conjugate Heat Transfer Modeling of Oil Jet Impingement Cooling on Corrugated Wire Surfaces
Ameya Waikar, David Rowinski, Ambarish Dahale

64. Dense-field spray droplet size quantification of flashing boiling atomization using structured laser illumination planar imaging technique
Shuyi Qiu, Shangning Wang, Yijia Zhang, Xuesong Li, David Hung, Min Xu

65. In-nozzle Multiphase Flow Patterns in Flash Boiling Atomization and Their Impacts on External Sprays
Shangning Wang, Shuyi Qiu, Yijia Zhang, David Hung, Xuesong Li, Min Xu

68. Two-Color X-ray Imaging for Material Differentiation in Multiphase Flows
Roderick La Foy, Benjamin Halls

69. Investigating atomization of a non-Newtonian paint in a rotary bell atomizer
Venkata Krisshna, Brendan Christensen, Mark Owkes

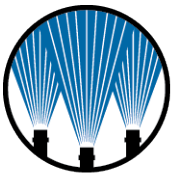
INDEX OF AUTHORS

All authors are listed here with the paper number & page number of their paper listing in this Book where the paper title and authors are provided. Authors are listed in alphabetical order with a reference to their paper in the format: *(Paper Number)Page Number*.

All papers are provided in PDF form on the USB-drive provided to all registered conference attendees.

SPONSORS

ILASS-Americas is a non-profit organization committed to providing state-of-the-art spray information to our annual conference attendees and especially to our student attendees. Thanks to our sponsors, we are able to significantly reduce conference registration fees for students each year.



Spraying Systems Co.®
Experts in Spray Technology

begell
begell house, inc. publishers

ATOMIZATION AND SPRAYS

Parker

CONVERGE
CFD SOFTWARE

CATERPILLAR®