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RPPR Final Report

as of 14-Apr-2020

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Proposal Number: 74137EGCF

Agreement Number: W911NF-19-1-0218

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Final Report for Period Beginning 18-Mar-2019 and Ending 17-Oct-2019

Title: 2019 Laser Diagnostics in Energy and Combustion Science Gordon Research Conference and Gordon Research Seminar

Begin Performance Period: 18-Mar-2019

End Performance Period: 17-Oct-2019

Report Term: 0-Other

Submitted By: Ph.D. Nancy Gray

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STEM Degrees: 0

STEM Participants: 86

Major Goals: The Laser Diagnostics in Energy and Combustion Science Gordon Research Conference will focus on the most recent scientific advances in optical diagnostics and their demonstrated or expected impact, in addition to diagnostic needs. Topics will include precise and accurate measurements of fluid motion and temperature, chemical composition, as well as transient and multi-phase phenomena under a wide range of conditions, including high pressure, and diagnostics relevant to combustion, catalysis and electrochemical energy conversion and storage. Emphasis will be placed on improving sensitivity, accuracy, precision, spatial resolution, and specificity as well as in exploring the cross-sectional importance of diagnostics in connecting various energy-related application fields. The properties and behavior of novel laser sources, detectors, and optical systems that lead to new diagnostic capabilities will also be included in the conference program. Invited speakers are encouraged to describe how their diagnostic development will have wide-ranging impact and to also address open questions to stimulate the research community to jointly address topics of high relevance to the entire field.

Accomplishments: Laser-based optical diagnostics provide critical insight into complex processes with high temporal and spatial resolution. They contribute to gains in fundamental understanding, provide validation data for modeling and simulation, and support the optimization of practical processes. A dramatic advancement of the diagnostics capabilities over the last decades has substantially contributed to improved performance of energy-related processes, including combustion – a technology that still provides the majority of the world's energy needs. Combustion represents an intricate interaction of chemical reaction, turbulent flow, and heat transfer with a wide variety of applications. Diagnostics strategies developed for combustion are also applicable to related technologies such as process engineering, energy storage, catalytic conversion, and materials processing. Interdisciplinary discussion opportunities for knowledge transfer and the related new challenges were an important part of this GRC. This conference focused on the most recent scientific advances in optical diagnostics and their impact. Topics included precise and accurate measurements of species transport and temperature, chemical composition, and transient and multi-phase phenomena in gaseous and liquid flows as well as at interfaces under a wide range of conditions, including high pressure and/or temperature. Emphasis was placed on improving sensitivity, precision, spatial resolution, and species specificity of laser diagnostics strategies. Novel laser sources, detectors, optical systems, and data analysis that lead to new diagnostics capabilities were also be discussed.

Although research into alternative sources of energy is essential and on the rise, combustion remains the prime source of power generation to the power grid and transportation. To reach the global demand of lower greenhouse emissions and higher energy conversion efficiencies, continuous development of combustion and energy-related processes is necessary. These efforts are greatly advanced by fundamental research. As alternative powertrains

RPPR Final Report

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and renewables become increasingly important, this year's Gordon Research Seminar (GRS) expanded the scope to the broader field of energy unlike previous years.

Nonintrusive, spatially and temporally resolved techniques in laser diagnostics are capable of investigating both combustion and related fields in fine detail to uncover fundamental insights into the underlying phenomena. In this context, laser optical techniques designed to measure temperature, pressure, major species concentrations and velocity are of great interest, as well as their applications in harsh and challenging environments. The scope of the GRS on Laser Diagnostics in Energy and Combustion Science was to capture the current trends and developments within the community and discuss the capabilities as well as limitations of recent progresses. The GRS provided a unique space for young researchers and scientists, such as graduate students and postdoctoral researchers, to share unpublished findings in a social and friendly setting. Participants presented their latest research endeavors in formal talks and poster sessions. The creative atmosphere promoted an active exchange of ideas, fruitful discussions and encourages networking among an international community of young scientists in laser diagnostics.

Training Opportunities: Speakers, discussion leaders, poster presenters and attendees simultaneously contributed to and benefited from the collective skills and experience shared throughout the conference. The funding provided by was invaluable to the success of the Conference.

Results Dissemination: According to the tradition and rules of Gordon Research Conference, no conference proceedings will be published to encourage participants to present unpublished, new data, which is a major strength of this conference format. Much emphasis was placed on the requirement for speakers and poster presenters to discuss their latest cutting-edge research, and to speculate on where new ideas can lead. This is not a conference for reviewing previous research, but rather to concentrate on novel, exciting, and often controversial advances for the near- and longer-terms. This is encouraged by the "off the record" policy of Gordon Research Conferences.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report



GORDON RESEARCH CONFERENCES

FINAL PROGRESS REPORT

Army Research Office

Laser Diagnostics in Energy and Combustion Science

Grant Number W911NF1910218

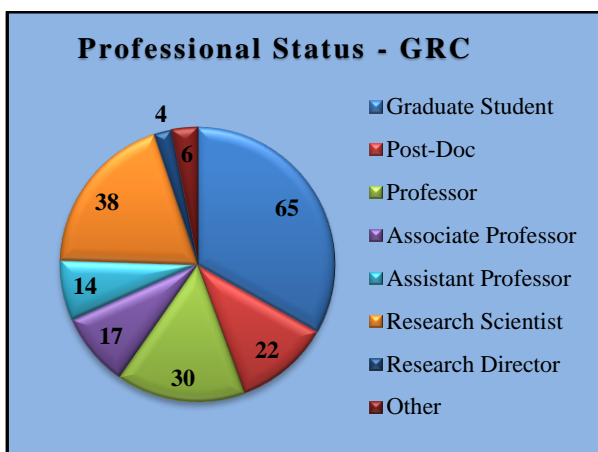
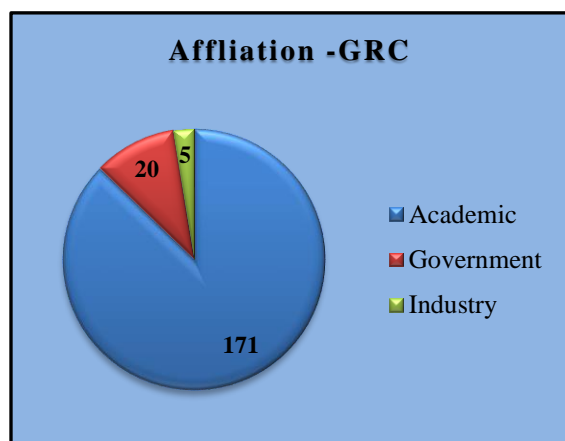
Operational Summary

The Gordon Research Conference (GRC) and Gordon Research Seminar (GRS) on Laser Diagnostics in Energy and Combustion Science were held at the Les Diablerets Conference Center in Les Diablerets, Switzerland June 23-28, 2019. The meeting covered a variety of scientific topics and the content presented was highly rated by participants.



Conference Participants

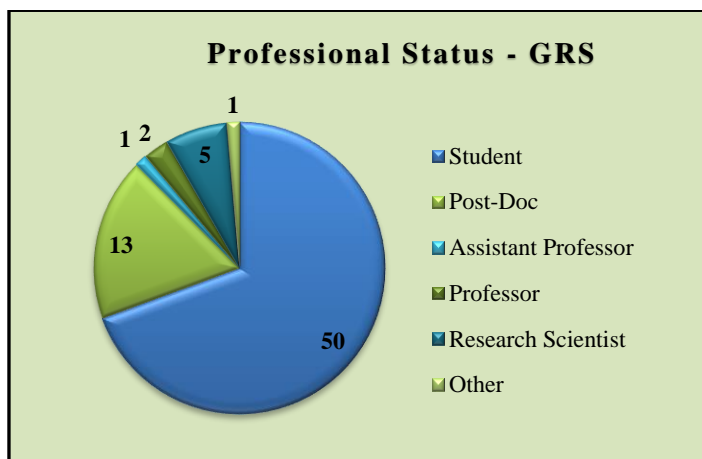
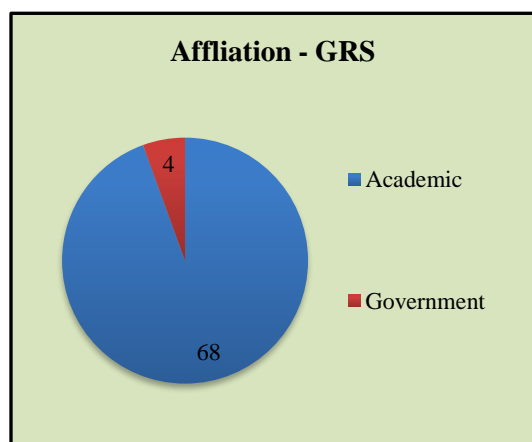
The Conference was well-attended with 196 participants. Scientists from academia represented 88% of the participants while attendees from government accounted for 10% and those from industry totaled 2%. The meeting also attracted a strong mix of young investigators and senior scientists. Students and post-docs accounted for 44% of all attendees. Approximately 14% of the participants at the 2019 meeting were women.



Gordon Research Seminars

Seminar Participants

The Seminar was well-attended with 72 participants. Scientists from academia represented 94% of the participants while attendees from government accounted for 6%. Students and post docs combined accounted for 88% of all attendees. Approximately 15% of the participants at the 2019 seminar were women.



Conference Program

Laser-based optical diagnostics provide critical insight into complex processes with high temporal and spatial resolution. They contribute to gains in fundamental understanding, provide validation data for modeling and simulation, and support the optimization of practical processes. A dramatic advancement of the diagnostics capabilities over the last decades has substantially contributed to improved performance of energy-related processes, including combustion – a technology that still provides the majority of the world's energy needs. Combustion represents an intricate interaction of chemical reaction, turbulent flow, and heat transfer with a wide variety of applications. Diagnostics strategies developed for combustion are also applicable to related technologies such as process engineering, energy storage, catalytic conversion, and materials processing. Interdisciplinary discussion opportunities for knowledge transfer and the related new challenges were an important part of this GRC. This conference focused on the most recent scientific advances in optical diagnostics and their impact. Topics included precise and accurate measurements of species transport and temperature, chemical composition, and transient and multi-phase phenomena in gaseous and liquid flows as well as at interfaces under a wide range of conditions, including high pressure and/or temperature. Emphasis was placed on improving sensitivity, precision, spatial resolution, and species specificity of laser diagnostics strategies. Novel laser sources, detectors, optical systems, and data analysis that lead to new diagnostics capabilities were also be discussed.

Although research into alternative sources of energy is essential and on the rise, combustion remains the prime source of power generation to the power grid and transportation. To reach the global demand of lower greenhouse emissions and higher energy conversion efficiencies, continuous development of combustion and energy-related processes is necessary. These efforts are greatly advanced by fundamental research. As alternative powertrains and renewables become increasingly important, this year's Gordon Research Seminar (GRS) expanded the scope to the broader field of energy unlike previous years.

Nonintrusive, spatially and temporally resolved techniques in laser diagnostics are capable of investigating both combustion and related fields in fine detail to uncover fundamental insights into the underlying phenomena. In this context, laser optical techniques designed to measure temperature, pressure, major species concentrations and velocity are of great interest, as well as their applications in harsh and challenging environments. The scope of the GRS on Laser Diagnostics in Energy and Combustion Science was to capture the current trends and developments within the community and discuss the capabilities as well as limitations of recent progresses. The GRS provided a unique space for young researchers and scientists, such as graduate students and postdoctoral researchers, to share unpublished findings in a social and friendly setting. Participants presented their latest research endeavors in formal talks and poster sessions. The creative atmosphere promoted an active exchange of ideas, fruitful discussions and encourages networking among an international community of young scientists in laser diagnostics

Conference Budget

Funding provided by ARO supported partial registration for 1 postdocs, 6 professors, 3 associate professors and 1 research scientists at the GRC and partial registration for 8 graduate students, and 2 postdocs at the GRS.

Conference Feedback

Participants had an opportunity to provide feedback at the end of the Conference. The feedback collected from the meeting was extremely positive. Evaluations included numerous positive remarks regarding the discussions around the poster sessions, variety of topics and the power hour. Evaluations from the GRS included positive comments regarding the mentorship component, speaker sessions and the poster presentations.

GRC would like to thank the Army Research Office for its continued support of the meetings. The contributions received have been critical to the success of the conferences and are having a measurable impact in advancing the frontiers of science worldwide.

Dr. Christof Schulz, GRC Chair
CENIDE, University of Duisburg-Essen

Dr. Terrence Meyer, GRC Vice Chair
Purdue University

Dr. Alfredo Tuesta, GRS Chair
Naval Research Laboratory

Dr. Florian Zentgraf, GRS Chair
Technische Universitaet Darmstadt

Dr. Nancy Ryan Gray
President and Chief Executive Officer
Gordon Research Conferences

Laser Diagnostics in Energy and Combustion Science

Gordon Research Conference

Exploiting and Developing Optical Diagnostics for Combustion and Related Energy Technologies

June 23 - 28, 2019

Chair Christof Schulz

Vice Chair Terrence R. Meyer

Conference Program

Sunday

4:00 pm - 8:00 pm Arrival and Check-in

6:00 pm - 7:00 pm Dinner

7:30 pm - 7:40 pm Introductory Comments by GRC Site Staff / Welcome from the GRC Chair

7:40 pm - 9:30 pm Keynote Session: Future Role of Combustion and Its Diagnostics Challenges

Discussion Leader: Terrence Meyer (Purdue University, USA)

7:40 pm - 7:50 pm Introduction by Discussion Leader

7:50 pm - 8:30 pm Katharina Kohse-Höinghaus (University of Bielefeld, Germany)

"Future of Combustion Research and Technology: What Are the Related Diagnostics Needs and Challenges?"

8:30 pm - 8:45 pm Discussion

8:45 pm - 8:55 pm Ali Hosseinnia (Lund University, Sweden)

"Simultaneous Temporally- and Spectrally-Resolved Raman Coherences with Single-Shot fs/ns Rotational CARS"

8:55 pm - 9:00 pm Discussion

9:00 pm - 9:10 pm Yi Mazumdar (Georgia Institute of Technology, USA)

"Shock-Wave Distortion Cancellation Using Ultra-High-Speed Phase-Conjugate Digital In-Line Holography"

9:10 pm - 9:15 pm Discussion

9:15 pm - 9:25 pm Hans Stauffer (Spectral Energies, LLC, USA)

"Broadband, Background-Free Single-Laser-Shot Absorption Using Time-Resolved Optically-Gated Absorption (TOGA)"

9:25 pm - 9:30 pm Discussion

Monday

7:30 am - 8:30 am Breakfast

9:00 am - 12:30 pm In Situ Diagnostics in IC Engines and Gas Turbines

Discussion Leader: Gilles Bruneaux (IFP Energies Nouvelles (IFPEN), France)

9:00 am - 9:10 am Introduction by Discussion Leader

9:10 am - 9:50 am Johan Hult (MAN Energy Solutions, Denmark)

"Optical Diagnostics for Addressing Development and Alternative Fuel Challenges Facing Marine Two-Stroke Diesel Engines"

9:50 am - 10:05 am Discussion

10:05 am - 10:35 am Coffee Break

10:35 am - 11:15 am Jacqueline O'Connor (Pennsylvania State University, USA)

"Understanding Three-Dimensional, Transient Behavior in Engines: Studies Inspired by Work in Diesel and Gas Turbine Engines"

11:15 am - 11:30 am Discussion

11:30 am - 12:10 pm Stefan Wigger (Daimler AG, Germany)

"Imaging Fuel Wall Wetting and Oil Dilution in Fired DISI Engine Operation"

12:10 pm - 12:30 pm Discussion

12:30 pm - 1:30 pm Group Photo / Lunch

1:30 pm - 4:30 pm Free Time

3:00 pm - 4:00 pm The GRC Power Hour™

The GRC Power Hour™ is designed to address challenges women face in science and issues of diversity and inclusion. The program supports the professional growth of all members of our communities by providing an open forum for discussion and mentoring.

Organizers: Simone Hochgreb (University of Cambridge, United Kingdom) and Jacqueline O'Connor (Pennsylvania State University, USA)

4:30 pm - 6:00 pm Poster Session

6:00 pm - 8:00 pm Aerosol Diagnostics

Discussion Leader: Hope Michelsen (Sandia National Laboratories, USA)

6:00 pm - 6:10 pm Introduction by Discussion Leader

6:10 pm - 6:50 pm Joel Corbin (National Research Council Canada, Canada)

"Laser-Based Quantification of Light-Absorbing Combustion-Generated Particles"

6:50 pm - 7:05 pm Discussion

7:05 pm - 7:45 pm Hai Wang (Stanford University, USA)

"Quantum Confinement in Flame Soot and Implications on Its Diagnostics"

7:45 pm - 8:00 pm Discussion

8:00 pm - 9:00 pm Dinner

Tuesday

7:30 am - 8:30 am Breakfast

9:00 am - 12:30 pm Diagnostics in Unconventional Reactive High-Temperature Processes

Discussion Leader: Stefan Will (LTT Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany)

9:00 am - 9:10 am Introduction by Discussion Leader

9:10 am - 9:50 am Stephen Tse (Rutgers University, USA)

"Laser-Based Spectroscopy in Gas-Phase Synthesis of Nanomaterials"

9:50 am - 10:05 am Discussion

10:05 am - 10:35 am Coffee Break

10:35 am - 11:15 am Philip Varghese (The University of Texas at Austin, USA)

"Diagnostics of Thermal Non-Equilibrium in High-Temperature Flows: High-Dispersion Spontaneous Raman Spectroscopy"

11:15 am - 11:30 am Discussion

11:30 am - 12:10 pm Graham Nathan (University of Adelaide, Australia)

"Laser Diagnostics in Solar Thermal Systems"

12:10 pm - 12:30 pm Discussion

12:30 pm - 1:30 pm Lunch

1:30 pm - 4:30 pm Free Time

4:30 pm - 6:00 pm Poster Session

6:00 pm - 8:00 pm Diagnostics in Batteries and Fuel Cells

Discussion Leader: Jürgen Wolfrum (Heidelberg University, Germany)

6:00 pm - 6:10 pm Introduction by Discussion Leader

6:10 pm - 6:50 pm Robert Kosteki (Lawrence Berkeley National Laboratory, USA)

"Laser-Based Optical Characterization of Electrical Energy Storage Systems"

6:50 pm - 7:05 pm Discussion

7:05 pm - 7:45 pm Jeffrey Owruksy (U.S. Naval Research Laboratory, USA)

"Operando Optical Studies of Solid Oxide Fuel Cells"

7:45 pm - 8:00 pm Discussion

8:00 pm - 9:00 pm Dinner

Wednesday

7:30 am - 8:30 am Breakfast

9:00 am - 12:30 pm Model-Based Diagnostics and Data Analysis

Discussion Leader: Frank Beyrau (Otto-von-Guericke-Universität Magdeburg, Germany)

9:00 am - 9:10 am Introduction by Discussion Leader

9:10 am - 9:50 am Christian Hasse (Technische Universität Darmstadt, Germany)

"Virtual Diagnostics: Insightful or Just Another Approach for Comparing Experiments and Simulation?"

9:50 am - 10:05 am Discussion

10:05 am - 10:35 am Coffee Break

10:35 am - 11:15 am Kyle Daun (University of Waterloo, Canada)

"Probabilistic Data Analysis in Laser-Based Diagnostics"

11:15 am - 11:30 am Discussion

11:30 am - 11:45 am Jan Menser (University of Duisburg-Essen, Germany)

"Flame Tomography Based on Multi-Simultaneous Measurements and Best Practice on Assessing Volumetric Reconstruction"

11:45 am - 11:50 am Discussion

11:50 am - 12:05 pm Amanda Makowiecki (University of Colorado Boulder, USA)

"Cepstral Analysis for Baseline-Free Spectroscopy from Any Absorption Spectrometer"

12:05 pm - 12:10 pm Discussion

12:10 pm - 12:25 pm Simone Hochgreb (University of Cambridge, United Kingdom)

"Using Modelling and PIV-LII to Understand Droplet Combustion in Laminar Flames"

12:25 pm - 12:30 pm Discussion

12:30 pm - 1:30 pm Lunch

1:30 pm - 4:30 pm Free Time

4:30 pm - 6:00 pm Poster Session

6:00 pm - 8:00 pm Diagnostics on and Near Catalytic Surfaces

Discussion Leader: Andreas Dreizler (Technische Universität Darmstadt, Germany)

6:00 pm - 6:10 pm Introduction by Discussion Leader

6:10 pm - 6:50 pm Johan Zetterberg (Lund University, Sweden)

"Operando Gas Imaging of Catalytic Processes"

6:50 pm - 7:05 pm Discussion

7:05 pm - 7:45 pm Günther Rupprechter (Technische Universität Wien, Austria)

"Operando Spectroscopy and Microscopy of Catalytically Active Surfaces"

7:45 pm - 8:00 pm Discussion

8:00 pm - 9:00 pm Dinner

Thursday

7:30 am - 8:30 am Breakfast

8:30 am - 9:00 am Business Meeting

Nominations for the Next Vice Chair; Fill in Conference Evaluation Forms; Discuss Future Site and Scheduling Preferences; Election of the Next Vice Chair

9:00 am - 12:30 pm Ultra Fast and Sensitive Diagnostics and Their Applicability in Industry

Discussion Leader: Mark Linne (University of Edinburgh, United Kingdom)

9:00 am - 9:10 am Introduction by Discussion Leader

9:10 am - 9:50 am Thomas Berg (LaVision GmbH, Germany)

"Making Laser Diagnostics Applicable in Industry"

9:50 am - 10:05 am Discussion

10:05 am - 10:35 am Coffee Break

10:35 am - 11:15 am Peter Fjodorow (University of Duisburg-Essen, Germany)

"Intracavity Absorption Spectroscopy: Ultrasensitive Diagnostics in Harsh Environments"

11:15 am - 11:30 am Discussion

11:30 am - 12:10 pm Megan Paciaroni (Fort Lewis College, USA)

"Ultrafast Diagnostics in Challenging Environments"

12:10 pm - 12:30 pm Discussion

12:30 pm - 1:30 pm Lunch

1:30 pm - 4:30 pm Free Time

4:30 pm - 6:00 pm Poster Session

6:00 pm - 8:00 pm Temperature Imaging Diagnostics

Discussion Leader: Sebastian Kaiser (University of Duisburg-Essen, Germany)

6:00 pm - 6:10 pm Introduction by Discussion Leader

6:10 pm - 6:50 pm Grazia Lamanna (University of Stuttgart, Germany)

"Temperature Measurements in High-Pressure, High-Enthalpy Flows with LITA"

6:50 pm - 7:05 pm Discussion

7:05 pm - 7:45 pm Christopher Abram (Otto von Guericke University Magdeburg, Germany)

"Phosphor Thermometry: Advanced Methods, Applications in Fluids, and Synthesis and Characterization of New Phosphors"

7:45 pm - 8:00 pm Discussion

8:00 pm - 9:00 pm Dinner

Friday

7:30 am - 8:30 am Breakfast

9:00 am Departure

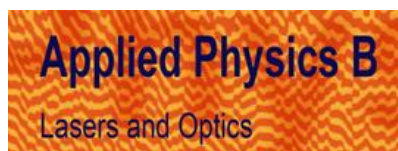
Contributors



Gordon Research
Conferences
Frontiers of Science



Carl Storm
Underrepresented
Minority Fellowship
Program



NORTHROP GRUMMAN

Cutting Edge Optonics



Radiant Dyes Laser



**Spectral
Energies**



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Laser Diagnostics in Energy and Combustion Science
Gordon Research Seminar
Exploiting and Developing Optical Diagnostics for Combustion and Related Energy Technologies
June 22 - 23, 2019
Chairs Alfredo D. Tuesta and Florian Zentgraf

Conference Program

Saturday

- 1:30 pm - 4:30 pm Arrival and Check-in
- 3:00 pm - 3:15 pm Introductory Comments by GRC Site Staff / Welcome from the GRS Chair
- 3:15 pm - 4:00 pm Keynote Session: Evolution of Laser Diagnostics over the Years, and What Is Next?
Discussion Leader: David Feng (Princeton University, USA)
- 3:15 pm - 3:45 pm Mark Linne (University of Edinburgh, United Kingdom)
"Evolution of Laser Diagnostics over the Years, and What Is Next?"
- 3:45 pm - 4:00 pm Discussion
- 4:00 pm - 5:30 pm Poster Session
- 5:30 pm - 7:30 pm Diagnostics of Sooty Environments and Application of Advanced Diagnostics
Discussion Leader: Kevin Dieter (Hochschule Darmstadt, Germany)
- 5:30 pm - 5:35 pm Introduction by Discussion Leader
- 5:35 pm - 5:50 pm Niklas Jüngst (University of Duisburg-Essen, Germany)
"Imaging of Evaporating Fuel Films in Combustion, Soot Precursors, and Soot by Laser
Induced Fluorescence and Incandescence"
- 5:50 pm - 5:55 pm Discussion
- 5:55 pm - 6:10 pm Sandra Török (Lund University, Sweden)
"Laser Induced Incandescence for Maturity Investigations of Soot"
- 6:10 pm - 6:15 pm Discussion
- 6:15 pm - 6:30 pm Max Greifenstein (TU Darmstadt, Germany)
"Investigating Spatio-Temporal Coherences of Temperature in the Exhaust of a Single Sector
Gas Turbine Combustor"
- 6:30 pm - 6:35 pm Discussion
- 6:35 pm - 6:50 pm Caroline Winters (Sandia National Laboratories, USA)
"Interrogation of Burst-Mode Laser-Induced Plasma in Overexpanded Jets via Advanced
Spectroscopic and Imaging Diagnostics"
- 6:50 pm - 6:55 pm Discussion
- 6:55 pm - 7:10 pm Garrett Marshall (Vanderbilt University, USA)
"Quantitative O-Atom Profiles in Tubular Flames Quench Corrected with Raman Data"
- 7:10 pm - 7:15 pm Discussion
- 7:15 pm - 7:30 pm General Discussion
- 8:00 pm - 9:00 pm Dinner

Sunday

- 7:30 am - 8:30 am Breakfast
- 9:00 am - 11:00 am Development of Diagnostic Techniques and Novel Applications
Discussion Leader: Maria Ruchkina (Lund University, Sweden)
- 9:00 am - 9:05 am Introduction by Discussion Leader

9:05 am - 9:20 am Francesca De Domenico (University of Cambridge, United Kingdom)
"Tracer-Free Laser Induced Grating Spectroscopy at 100 KHz"

9:20 am - 9:25 am Discussion

9:25 am - 9:40 am Pengji Ding (Lund University, Sweden)
"Backward Lasing Technique for Combustion Diagnostics"

9:40 am - 9:45 am Discussion

9:45 am - 10:00 am Mohammad Khaled Shakfa (King Abdullah University of Science and Technology (KAUST), Saudi Arabia)
"Widely Tunable Mid-Infrared Difference-Frequency-Generation Source for Combustion Diagnostics"

10:00 am - 10:05 am Discussion

10:05 am - 10:20 am Hao Tang (King Abdullah University of Science and Technology (KAUST), Saudi Arabia)
"Multiple Species, 2D Raman/Rayleigh Scattering Imaging and Application to Diffusion Flames"

10:20 am - 10:25 am Discussion

10:25 am - 10:40 am Amanda Makowiecki (University of Colorado Boulder, USA)
"Baseline Free Quantitative Absorption Spectroscopy"

10:40 am - 10:45 am Discussion

10:45 am - 11:00 am General Discussion

11:00 am - 12:30 pm Poster Session
Coffee will be served in the poster area from 11:00 am - 11:30 am

12:30 pm - 1:30 pm Lunch

1:30 pm - 2:30 pm Mentorship Component: Setting Yourself Apart in a Scientific Career
Discussion Leader: David Escofet-Martin (University of Edinburgh, United Kingdom)

1:30 pm - 1:35 pm Introduction by Discussion Leader

1:35 pm - 2:25 pm Panel Discussion
Setting Yourself Apart in a Scientific Career
Khadijeh Mohri (University of Duisburg-Essen, Germany)
Hope Michelsen (Sandia National Laboratories, USA)
Brian Peterson (University of Edinburgh, United Kingdom)
Mark Linne (University of Edinburgh, United Kingdom)

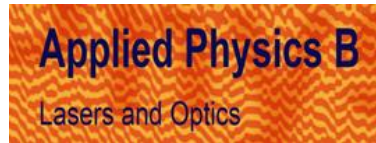
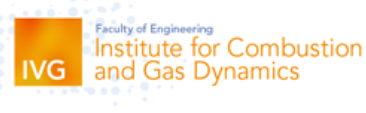
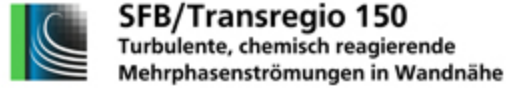
2:25 pm - 2:30 pm Closing Remarks

2:30 pm - 3:00 pm Evaluation Period
Fill in GRS Evaluation Forms

3:00 pm Seminar Concludes

Contributors



The logo for THORLABS, featuring the word "THORLABS" in a bold, red, sans-serif font.The logo for Applied Physics B, featuring the text "Applied Physics B" in a bold, black, sans-serif font, with "Lasers and Optics" in a smaller, black, sans-serif font below it. The background is a textured orange and yellow pattern.The logo for CENIDE, featuring two overlapping orange circles to the left of the text "CENIDE" in a bold, black, sans-serif font. Below "CENIDE" is the text "CENTER FOR NANOINTEGRATION" and "DUISBURG-ESSEN" in a smaller, black, sans-serif font.The logo for NORTHROP GRUMMAN, featuring the text "NORTHROP GRUMMAN" in a bold, blue, sans-serif font, with a blue swoosh line below it. Below the swoosh is the text "Cutting Edge Optronics" in a smaller, blue, sans-serif font.The logo for IVG, featuring the text "IVG" in a bold, orange, sans-serif font, with "Faculty of Engineering" in a smaller, black, sans-serif font above it. To the right is the text "Institute for Combustion and Gas Dynamics" in a smaller, orange, sans-serif font.The logo for LAVISION, featuring a stylized blue and red "V" inside a blue circle, with the text "LAVISION" in a bold, blue, sans-serif font below it. Below "LAVISION" is the text "FOCUS ON IMAGING" in a smaller, blue, sans-serif font.The logo for edgewave, featuring the text "edgewave" in a blue, sans-serif font, with a horizontal line above the "e" and "d" and another horizontal line below the "e" and "d".The logo for SFB/Transregio 150, featuring a green and blue square icon to the left of the text "SFB/Transregio 150" in a bold, black, sans-serif font. Below this is the text "Turbulente, chemisch reagierende Mehrphasenströmungen in Wandnähe" in a smaller, black, sans-serif font.

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Laser Diagnostics in Energy and Combustion Science GRC Registration List

Name	Organization	Participation
Abram, Christopher	Otto von Guericke University Magdeburg	Speaker
Alzuabi, Mohammad	University of Michigan	Poster Presenter
An, Qiang	National Research Council Canada	Attendee
Arndt, Christoph M	German Aerospace Center (DLR)	Poster Presenter
Asif, Muhammad	University of Duisburg Essen, Germany	Poster Presenter
Attal-Tretout, Brigitte	ONERA	Attendee
Ayers, Zachary M	Purdue University	Poster Presenter
Baranowski, Thomas	Universität Duisburg-Essen /IVG	Poster Presenter
Barviau, Benoit	CORIA	Attendee
Bauer, Florian	Lehrstuhl für Technische Thermodynamik	Poster Presenter
Bengtsson, Per-Erik	Lund University	Poster Presenter
Berg, Thomas	LaVision GmbH	Speaker
Berrocal, Edouard	Lund University	Poster Presenter
Beuting, Matthias	Institute for Combustion and Gas Dynamics - Reactive Fluids, University of Duisburg-Essen	Poster Presenter
Beyrau, Frank	Otto-von-Guericke-Universität Magdeburg	Discussion Leader
Biondo, Luigi	TU Darmstadt - Reactive Flows and Diagnostics	Poster Presenter
Black, John D	University of Strathclyde	Poster Presenter
Boehm, Benjamin	TU Darmstadt	Poster Presenter
Bollmann, Jonas	Lehrstuhl für Technische Thermodynamik FAU Erlangen-Nürnberg	Poster Presenter
Bood, Joakim	Lund University	Poster Presenter
Bouvier, Maxime	CORIA UMR 6614	Poster Presenter
Brackmann, Christian	Lund University	Poster Presenter
Bruneaux, Gilles	IFP Energies Nouvelles (IFPEN)	Discussion Leader
Burns, Iain S	University of Strathclyde	Poster Presenter
Butz, David	Technische Universität Darmstadt	Poster Presenter
Carpenter, Chad D	Vanderbilt University / NASA Glenn	Poster Presenter
Chen, Jun	University of Shanghai for Science and Technology	Poster Presenter
Cheskis, Sergey	School of Chemistry, Tel Aviv University	Poster Presenter
Corbin, Joel C	National Research Council Canada	SpeakerCruz-
Cabrera, Alvaro A	Sandia National Laboratories	Poster Presenter
Cutler, Andrew D	George Washington University	Poster Presenter
Daily, John W	University of Colorado	Poster Presenter
Dam, Nico	Technical University of Eindhoven	Poster Presenter
Danehy, Paul M	NASA Langley Research Center	Poster Presenter
Daun, Kyle J	University of Waterloo	Speaker
De Domenico, Francesca	University of Cambridge	Poster Presenter
De Iuliis, Silvana	CNR - ICMATE	Poster Presenter
deChamplain, Alain	Universite Laval	Poster Presenter
Denisov, Alexey	University of Applied Sciences and Arts Northwestern Switzerland	Poster Presenter
Derafshzan, Saeed	Lund University	Poster Presenter
Desgroux, Pascale	PC2A - Université de Lille	Poster Presenter
Dieter, Kevin Marc	University of Applied Sciences Darmstadt	Poster Presenter

Ding, Pengji	Lund University	Poster Presenter
Doddema, Robin	Eindhoven University of Technology	Poster Presenter
Doll, Ulrich	Paul Scherrer Institute (PSI)	Poster Presenter
Dreier, Thomas	University Duisburg-Essen	Poster Presenter
Dreizler, Andreas	Technische Universität Darmstadt	Discussion Leader
Ebi, Dominik	Paul Scherrer Institut	Poster Presenter
Eigenmann, Florian A	IRsweep	Poster Presenter
El Moussawi, Abbas	IVG – RF, University of Duisburg Essen	Attendee
Endres, Torsten	University of Duisburg-Essen, IVG	Poster Presenter
Escofet-Martin, David	University of Edinburgh	Poster Presenter
Fach, Christian	Technische Universität Darmstadt	Poster Presenter
Fahringer, Timothy W	National Institute of Aerospace / NASA Langley Research Center	Poster Presenter
Fan, Qingshuang	Division of Combustion Physics, Lund University	Poster Presenter
Feng, David	Princeton University	Poster Presenter
Fikri, Mustapha	IVG, University of Duisburg-Essen	Attendee
Fisher, Jordan	Purdue University	Poster Presenter
Fjodorow, Peter	University of Duisburg-Essen	Speaker
Flores-Brito, Wendy	University of New Mexico	Poster Presenter
Fond, Benoit	Otto-von-Guericke Universität Magdeburg	Poster Presenter
Foo, Kae Ken	University Lille, Faculty of Science and Technology	Poster Presenter
Gerakis, Alexandros	Texas A&M University	Poster Presenter
Geyer, Dirk	HDA Darmstadt	Poster Presenter
Goldenstein, Christopher S	Purdue University	Poster Presenter
Gomez Gomez, Mateo	Purdue University	Poster Presenter
Grauer, Samuel J	Georgia Institute of Technology	Poster Presenter
Greifenstein, Max	TU Darmstadt	Poster Presenter
Grib, Stephen W	Air Force Research Laboratory	Poster Presenter
Guiberti, Thibault F	KAUST Saudi Arabia	Poster Presenter
Halls, Benjamin R	Sandia National Laboratories	Poster Presenter
Hasse, Christian	Technische Universität Darmstadt	Speaker
Hayakawa, Akihiro	Institute of Fluid Science, Tohoku University	Poster Presenter
He, Yong	Zhejiang University	Attendee
He, Dong	Universität Duisburg-Essen Institute for Combustion and Gasdynamics - Reactive fluids	Poster Presenter
Heinze, Johannes H.	German Aerospace Center (Dlr)	Poster Presenter
Henrion, Lucca	University of Michigan	Poster Presenter
Hertle, Ellen	FAU Erlangen-Nuernberg	Poster Presenter
Hessels, Conrad	Eindhoven University of Technology	Poster Presenter
Higuchi, Yasuhiro	Institute of Fluid Science, Tohoku University	Poster Presenter
Hochgreb, Simone	University of Cambridge	Speaker
Hoelzer, Jonas I	University of Siegen, Engineering Thermodynamics	Poster Presenter
Hoffmeister, Kathryn N. G.	Sandia National Laboratories	Poster Presenter
Hoghooghi, Nazanin	University of Colorado, Boulder	Poster Presenter
Homan, Tess	Eindhoven University of Technology	Attendee
Hosseinnia, Ali	Lund University	Speaker
Hot, Dina	Lund University	Poster Presenter
Hult, Johan F	MAN Energy Solutions	Speaker

Januskevicius, Regimantas	Ekspla	Attendee
Jüngst, Niklas	University of Duisburg-Essen	Poster Presenter
Kaiser, Sebastian A	University of Duisburg-Essen	Discussion Leader
Kearney, Sean P	Sandia National Laboratories	Poster Presenter
Kelesidis, Georgios A	ETH Zurich	Poster Presenter
Kholghy, M. Reza	Swiss Federal Institute of Technology	Poster Presenter
Kiefer, Johannes	University of Bremen	Poster Presenter
Kim, Haisol	Lund University	Poster Presenter
Koehler, Markus	DLR - German Aerospace Center	Poster Presenter
Kohse-Höinghaus, K	University of Bielefeld	Speaker
Kostecki, Robert	Lawrence Berkeley National Laboratory	Speaker
Krishna, Yedhu	King Abdullah University of Science and Technology	Poster Presenter
Kulatilaka, Waruna D	Texas A&M University	Poster Presenter
Labus, Markus	Lehrstuhl für Technische Thermodynamik (LTT) Friedrich-Alexander Universität Erlangen-Nürnberg (FAU)	Poster
PresenterLamanna, Grazia	University of Stuttgart	Speaker
Lamoureux, Nathalie S	Pc2a UMR8522 CNRS/Lille	Poster Presenter
Lauriola, Daniel K	Purdue University	Poster Presenter
Le, Thi Kim Cuong	Division of Combustion Physics, Lund University	Poster Presenter
Li, Shen	Lund University	Attendee
Li, Tao	Technische Universität Darmstadt	Poster Presenter
Li, Chiping	Air Force Office of Scientific Research	Attendee
Linne, Mark A	University of Edinburgh	Discussion Leader
Liu, Xin	Lund University	Poster Presenter
Liu, Yingzu	Zhejiang University	Poster Presenter
Loparo, Zachary E	University of Central Florida	Poster Presenter
Lubnow, Marc	Universitaet Duisburg Essen	Poster Presenter
Maes, Noud	Eindhoven University of Technology	Poster Presenter
Magnotti, Gaetano	King Abdullah University of Science and Technology	Poster Presenter
Makowiecki, Amanda S.	University of Colorado Boulder	Speaker
Marshall, Garrett J	Vanderbilt University	Poster Presenter
Mathews, Garrett C	Purdue University	Poster Presenter
Mazumdar, Yi Chen	Georgia Institute of Technology	Speaker
Mazur, Marek	Norwegian University of Science and Technology	Attendee
Mecker, Nils T	The University of Edinburgh	Poster Presenter
Meier, Wolfgang	German Aerospace Center DLR	Poster Presenter
Menser, Jan	University of Duisburg-Essen	Speaker
Meyer, Terrence R	Purdue University	Vice Chair
Mhanna, Mhanna	King Abdullah University of Science and Technology (KAUST)	Poster Presenter
Michelsen, Hope A	Sandia National Laboratories	Discussion Leader
Miller, John H	George Washington University	Poster Presenter
Mulvihill, Clayton	Texas A&M University	Poster Presenter
Musikhin, Stanislav	University of Duisburg-Essen	Poster Presenter
Naduvil Mannazhi, Manu	Lund University	Poster Presenter
Nathan, Graham J.	University of Adelaide	Speaker
Norooz Oliaee, Jalal	National Research Council Canada	Poster Presenter
O'Connor, Jacqueline	Pennsylvania State University	Speaker

Otti, Precious	University of Strathclyde	Poster Presenter
Owrutsky, Jeffrey C	U.S. Naval Research Laboratory	Speaker
Paciaroni, Megan E	Fort Lewis College	Speaker
Peterson, Brian R	University of Edinburgh	Poster Presenter
Pfaff, Sebastian	Lund University	Poster Presenter
Preusche, Andreas	TU-Darmstadt	Poster Presenter
Rahinov, Igor	The Open University of Israel	Poster Presenter
Ren, Yihua	RWTH Aachen University	Poster Presenter
Renfro, Michael	University of Kentucky	Poster Presenter
Richardson, Daniel R	Sandia National Laboratory	Poster Presenter
Richter, Mattias	Lund University	Attendee
Rieker, Gregory B	University of Colorado Boulder	Poster Presenter
Ruchkina, Maria	Lund University	Poster Presenter
Rupprechter, Günther	Technische Universität Wien	Speaker
Sahlberg, Anna-Lena	Lund University	Poster Presenter
Sanchez-Gonzalez, Rodrigo	St. Olaf College	Poster Presenter
Santagata, Rosa	ONERA	Poster Presenter
Schrman, Michael	ONERA	Poster Presenter
Schmidt, Marius	TU Darmstadt	Poster Presenter
Schorr, Juergen	Daimler AG	Poster Presenter
Schulz, Christof	CENIDE, University of Duisburg-Essen	Chair
Schwind, Rachel A	University of Michigan, Department of Mechanical Engineering	Poster Presenter
Seeger, Thomas	University of Siegen	Poster Presenter
Shah, Priyav	University of Oxford	Poster Presenter
Shahbaz, Muhammad A	Institute for Combustion and Gas dynamics, University of Duisburg-Essen.	Poster Presenter
Shakfa, Mohammad Khaled	King Abdullah University of Science and Technology (KAUST)	Poster Presenter
Sharma, Priybrat	King Abdullah Institute of Science and Technology	Attendee
Shimura, Masayasu	Tokyo Institute of Technology	Poster Presenter
Slipchenko, Mikhail N	Spectral Energies, LLC	Poster Presenter
Smallwood, Greg	National Research Council Canada	Attendee
Smyser, Michael E	Purdue University	Poster Presenter
Stauffer, Hans U	Spectral Energies, LLC	Speaker
Steinberg, Adam M	Georgia Institute of Technology	Poster Presenter
Su, Mingxu	University of Shanghai for Science and Technology	Poster Presenter
Sylvain, Legros	CORIA	Poster Presenter
Tancin, Ryan J	Purdue University	Poster Presenter
Tang, Hao	King Abdullah University of Science and Technology (KAUST)	Poster Presenter
Török, Sandra	Lund University	Poster Presenter
Trabold, Johannes L	FG Reactive Flows and Diagnostics	Poster Presenter
Tse, Stephen	Rutgers University	Speaker
Tuesta, Alfredo D	Naval Research Laboratory	Poster Presenter
Unterberger, Andreas	University of Duisburg-Essen	Poster Presenter
Varghese, Philip L	The University of Texas at Austin	Speaker
Vasu, Subith	University of Central Florida	Poster Presenter
Vena, Patrizio C	National Research Council Canada	Attendee
Vilmart, Gautier	ONERA/DPHY/SLM	Poster Presenter

Wagner, Steven	Technical University of Darmstadt	Poster Presenter
Wang, Hai	Stanford University	Speaker
Wang, Zhihua	Zhejiang University	Poster Presenter
Weng, Wubin	Lund Univeristy	Poster Presenter
Wigger, Stefan	Daimler AG	Speaker
Will, Stefan	LTT Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg	Discussion Leader
Willman, Christopher	University of Oxford	Poster Presenter
Winters, Caroline	Sandia National Laboratories	Poster Presenter
Wolfrum, Jürgen M.	Heidelberg University	Discussion Leader
Yang, Huinan	University of Shanghai for Science and Technology	Poster Presenter
Yang, Chaobo	King Abdullah University of Science and Technology	Poster Presenter
Zentgraf, Florian	Technische Universitaet Darmstadt	Poster Presenter
Zetterberg, Johan	Lund University	Speaker
Zhang, Yiyang	Tsinghua University	Poster Presenter
Zhao, Ming	University of Duisburg-Essen	Poster Presenter
Zhou, Lei	Harbin Institute of Technology, Shenzhen	Poster Presenter
196 Attendees		

Laser Diagnostics in Energy and Combustion Science GRS Registration List

Name	Organization	Participation
Alzuabi, Mohammad	University of Michigan	Poster Presenter
Arndt, Christoph M	German Aerospace Center (DLR)	Poster Presenter
Asif, Muhammad	University of Duisburg Essen, Germany	Poster Presenter
Ayers, Zachary M	Purdue University	Poster Presenter
Baranowski, Thomas	Universität Duisburg-Essen /IVG	Poster Presenter
Biondo, Luigi	TU Darmstadt - Reactive Flows and Diagnostics	Poster Presenter
Bollmann, Jonas	Lehrstuhl für Technische Thermodynamik FAU Erlangen-Nürnberg	Poster Presenter
Butz, David	Technische Universität Darmstadt	Poster Presenter
Carpenter, Chad D	Vanderbilt University / NASA Glenn	Poster Presenter
De Domenico, Francesca	University of Cambridge	Speaker
Derafshzan, Saeed	Lund University	Poster Presenter
Dieter, Kevin Marc	University of Applied Sciences Darmstadt	Discussion Leader
Ding, Pengji	Lund University	Speaker
Doddema, Robin	Eindhoven University of Technology	Poster Presenter
Doll, Ulrich	Paul Scherrer Institute (PSI)	Poster Presenter
Escofet-Martin, David	University of Edinburgh	Discussion Leader
Fach, Christian	Technische Universität Darmstadt	Poster Presenter
Fan, Qingshuang	Division of Combustion Physics, Lund University	Poster Presenter
Feng, David	Princeton University	Discussion Leader
Fisher, Jordan	Purdue University	Poster Presenter
Gomez Gomez, Mateo	Purdue University	Poster Presenter
Grauer, Samuel J	Georgia Institute of Technology	Poster Presenter
Greifenstein, Max	TU Darmstadt	Speaker
He, Dong	Universität Duisburg-Essen Institute for Combustion and Gasdynamics - Reactive fluids	Poster Presenter
Henrion, Lucca	University of Michigan	Poster Presenter
Hessels, Conrad	Eindhoven University of Technology	Poster Presenter
Hoghooghi, Nazanin	University of Colorado, Boulder	Poster Presenter
Hosseinnia, Ali	Lund University	Poster Presenter
Hot, Dina	Lund University	Poster Presenter
Jüngst, Niklas	University of Duisburg-Essen	Speaker
Kelesidis, Georgios A	ETH Zurich	Poster Presenter
Kholghy, M. Reza	Swiss Federal Institute of Technology	Poster Presenter
Kim, Haisol	Lund University	Poster Presenter
Krishna, Yedhu	King Abdullah University of Science and Technology	Poster Presenter
Lauriola, Daniel K	Purdue University	Poster Presenter
Le, Thi Kim Cuong	Division of Combustion Physics, Lund University	Poster Presenter
Li, Tao	Technische Universität Darmstadt	Poster Presenter
Linne, Mark A	University of Edinburgh	Speaker
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Loparo, Zachary E	University of Central Florida	Poster Presenter
Maes, Noud	Eindhoven University of Technology	Poster Presenter
Makowiecki, Amanda S.	University of Colorado Boulder	Speaker
Marshall, Garrett J	Vanderbilt University	Speaker

Mathews, Garrett C	Purdue University	Poster Presenter
Mecker, Nils T	The University of Edinburgh	Poster Presenter
Mhanna, Mhanna	King Abdullah University of Science and Technology	Poster Presenter
Michelsen, Hope A	Sandia National Laboratories	Speaker
Musikhin, Stanislav	University of Duisburg-Essen	Poster Presenter
Naduvil Mannazhi, Manu	Lund University	Poster Presenter
Norooz Oliiae, Jalal	National Research Council Canada	Poster Presenter
Otti, Precious	University of Strathclyde	Poster Presenter
Peterson, Brian R	University of Edinburgh	Speaker
Pfaff, Sebastian	Lund University	Poster Presenter
Preusche, Andreas	TU-Darmstadt	Poster Presenter
Ren, Yihua	RWTH Aachen University	Poster Presenter
Ruchkina, Maria	Lund University	Discussion Leader
Sahlberg, Anna-Lena	Lund University	Poster Presenter
Schmidt, Marius	TU Darmstadt	Poster Presenter
Schulz, Christof	CENIDE, University of Duisburg-Essen	Attendee
Shah, Priyav	University of Oxford	Poster Presenter
Shahbaz, Muhammad A	Institute for Combustion and Gas dynamics, University of Duisburg-Essen.	Poster Presenter
Shakfa, Mohammad Khaled	King Abdullah University of Science and Technology	Speaker
Sharma, Priybrat	King Abdullah Institute of Science and Technology	Attendee
Smyser, Michael E	Purdue University	Poster Presenter
Tang, Hao	King Abdullah University of Science and Technology	Speaker
Török, Sandra	Lund University	Speaker
Trabold, Johannes L	FG Reactive Flows and Diagnostics	Poster Presenter
Tuesta, Alfredo D	Naval Research Laboratory	Chair
Winters, Caroline	Sandia National Laboratories	Speaker
Yang, Chaobo	King Abdullah University of Science and Technology	Poster Presenter
Zentgraf, Florian	Technische Universität Darmstadt	Chair
Zhao, Ming	University of Duisburg-Essen	Poster Presenter

72 Attendees