INSPIRE-ETN
INSPIRING PRESSURE GAIN COMBUSTION INTEGRATION RESEARCH, AND EDUCATION

DELIVERABLE D 7.4 PUBLIC DISSEMINATION: MID-PROGRAMME WORKSHOP, ICVDCW 2021

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DELIVERABLE LEADER:	Myles Bohon (TUB)
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Abstract :
The object of the deliverable is the description of the *IWDP-ICVDCW 2022*, the Joint Meeting of International Workshop on Detonation for Propulsion (IWDP) and International Constant Volume and Detonation Combustion Workshop (ICVDCW), held in Berlin (Germany) from 15th to 19th of August 2022

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GLOSSARY

Acronym	Description
ESR	Early-Stage Researcher
IWDP	International Workshop on Detonation Propulsion
ICVDCW	International Constant Volume and Detonation Combustion Workshop
TUB	Technische Universtaet Berlin
PGC	Pressure Gain Combustion
RDC	Rotating Detonation Combustor
CVC	Constant Volume Combustion

List of acronyms

1. INTRODUCTION

The Joint Meeting of the International Workshop on Detonation for Propulsion (IWDP) and International Constant Volume and Detonation Combustion Workshop (ICVDCW) was held in Berlin August 15-19, 2022. This was the first time these meetings were jointly held. Originally, IWDP was planned to be held in 2020 and ICVDCW in 2021, both in Berlin. However, due to the COVID-19 global pandemic, these meetings were postponed, and it was decided to hold a joint meeting of the two workshops due to their overlapping areas of interest. The choice to postpone and to merge the meetings was taken to maximize the in-presence representation of global participants. Indeed, the attendance was very satisfactory: scientists, engineers and students in the relevant fields participated and presented their research contributions in the workshop.
Date: August 15-19, 2022
Hosting Institution: Technische Universität Berlin

2. Description of the workshops

The International Workshop on Detonation for Propulsion (IWDP) has successfully brought together scientists worldwide to exchange cutting-edge technical achievements and new ideas in detonation applications for aerospace propulsion.
The International Constant Volume and Detonation Combustion Workshop (ICVDCW) has facilitated discourse in the development of fundamental and practical topics in the areas of constant volume combustion, detonations, and pressure gain combustion.
Due to the complications from the global pandemic, it was decided to align these two events into a combined meeting. This first joint meeting aimed to unite the parallel research objectives in a forum to facilitate the discourse and exchange of ideas in these topics through discussion sessions, as well as highlight the latest developments in the areas of detonations, constant volume combustion, and their applications.
This joint meeting covered several topics, relevant to the detonation, propulsion, constant volume combustion, and pressure gain combustion community and representative of the two composite workshops including:

- New findings in detonation, CVC, PGC, and/or DDT physics from experimental and theoretical studies.
- Analytical and computational methods of detonation or CV combustion processes.
- Progress in experimental or numerical modelling in combustion and propulsion systems, including rotating or pulsed detonation, CVC, pulsed jet, or other PGC or confined combustion devices.
- Development of diagnostic and/or analytical techniques relevant to high- speed or unsteady reacting flows.
- Combustor integration with turbomachinery and/or cooling systems
- New concepts in detonative or CVC propulsion from sub-component to system levels.

The meeting was divided into five days of discussions, presentations and social activities. Topical discussion sessions, forums, and moderated panels addressed important issues for the community, such as current and future technological and political concerns, ways and means of advancing the technology, encouraging the engagement of industry, improvement of standard practices, etc.

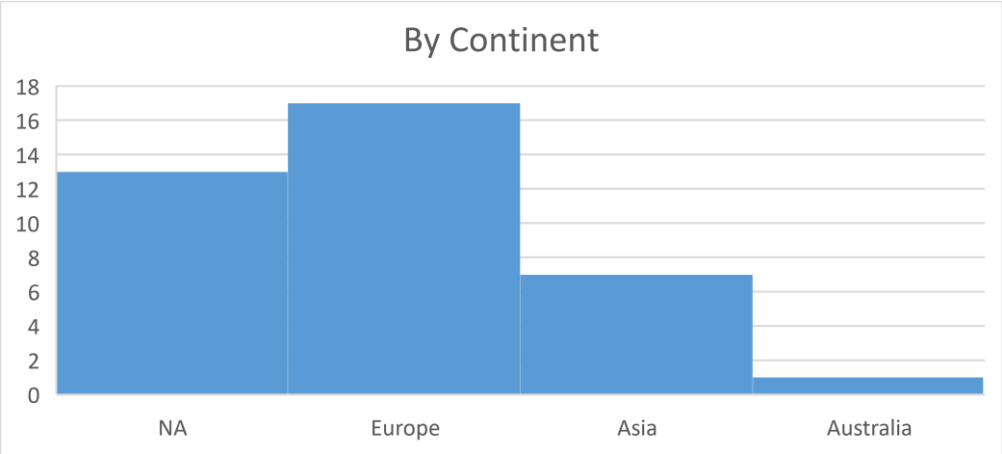
To facilitate the important aspects of networking, the meeting also featured a very active social and networking agenda, including:

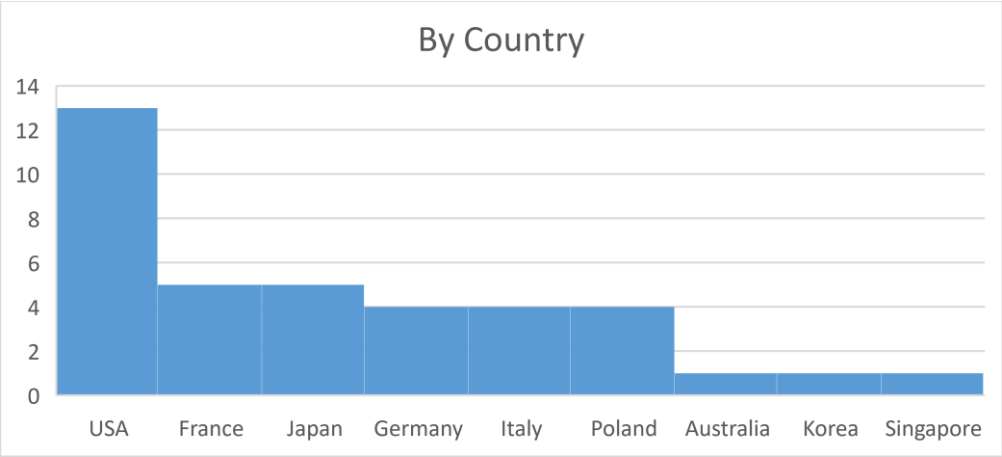
- Conference Banquet in Restaurant Nolle on 8/18/22
- Riverboat cruise along the river Spree on 8/17/22
- Social gathering in a Biergarten on 8/15/22
- Laboratory Tour of the TUB labs in the Chair of Experimental Fluidmechanics on 8/16/22
- Walking tour of Berlin on 8/19/22

Below are several statistics from the technical program of the conference:

- Duration: 5 days
- Total paper submissions: 53
- Withdrawals due to COVID and other travel restrictions: 15
- Total technical paper presentations: 38
- Total invited thematic presentations: 6
- Total session panels: 9
- Presentations by country: USA, France, Japan, Germany, Italy, Poland, Australia, Korea, Singapore (see distribution below)
- Total registered attendees: in excess of 75

All the 15 INSPIRE ESRs participated in this training event. Additionally, a "Young Scientists Best Paper" competition was held, with 11 poster submissions from INSPIRE ESRs. It is also worth mentioning that 2 ESRs held oral presentations and submitted short papers. Additionally, the Laboratory Tour on 8/16/22 was hosted and guided by the INSPIRE ESRs, allowing for significant interaction between ESRs and researchers in the PGC field.




By Country
14
12
10
8
6
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USA
France
Japan
Germany
Italy
Poland
Australia
Korea
Singapore

IWDP
ICVDCW
Berlin 2022

Joint Meeting of the

International Workshop on Detonation Propulsion

- and the -

International Constant Volume and Detonation Combustion Workshop

15-19 August 2022

Berlin, Germany

BASIC INFORMATION

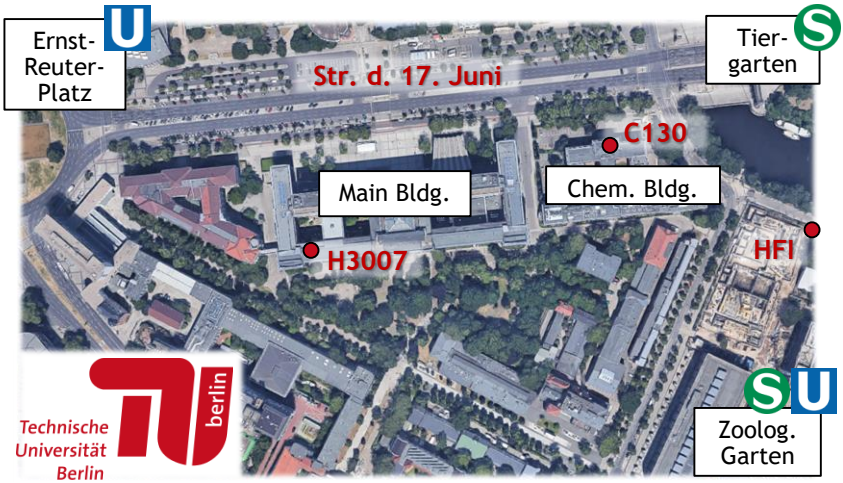
Conference venue

The event takes place on TU Berlin's main campus on Straße des 17. Juni between Ernst-Reuter-Platz and Tiergarten. All technical sessions are held in the Chemistry (C) building, in **lecture hall C130**. Lunch is offered in the Main (H) building, in **room H3007**. Students helpers and signs will guide you between locations.

The **registration desk** opens on Monday at 09:00, just outside room C130.

Locations and directions for all of the **social events** are included at the end of this program.

Campus map



Directions to C130

Directions to H3007

Emergency contacts for urgent matters

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Police 110	*Ambulance* 112

WELCOME TO BERLIN

At the heart of the German capital

Welcome to the TU campus at the very center of Berlin, the city of German reunification! We invite you to enjoy the capital's many sights and rich history, its diverse culture and exciting restaurant scene. The joint meeting of the International Workshop on Detonation Propulsion and the International Constant Volume and Detonation Combustion Workshop is hosted by TU Berlin's Chair of Fluid Dynamics. This university is among Germany's largest and most renowned public schools. Within this program you will find all the necessary information to help you navigate both the conference and the capital.

How to get around - special offer: 1 month/9€ ticket

Berlin offers an excellent public transportation system that will get you stress-free to wherever you need to go. At the moment, a discounted ticket is offered that allows you to use regional public transport not only in Berlin, but in **all of Germany**, for the whole month of **August**, for just **9€**.

Recommended: the BVG app

This app from Berlin's public transport company allows you to buy the 9€ ticket, check travel itineraries, and also study the complete map of train, metro, and bus lines.

BUS Tram

Download the app here:

PROGRAM AT A GLANCE

	15.08.2022	16.08.2022
9:00	Check in and Coffee Welcome	Historical remarks on the development of Detonative Propulsion *Piotr Wolanski*
9:30	Introductory comments and Welcome	Thematic Presentation - *Marc Bellenoue*
10:00	Thematic Presentation - *Chris Brophy*	Poster Session and Coffee Break
10:30	Technical Session: Pressure Gain Measurements Chair: Venkat Tangirala	
11:00		Technical Session: Heat Flux in PGC Devices Chair: Michal Kawalec
11:30		
12:00	Lunch	
12:30		Lunch
13:00		
13:30	Technical Session: RDE Propulsion Systems Chair: Eric Paulson	
14:00		Technical Session: Constant Volume Combustors Chair: Jeong-Yeol Choi
14:30		
15:00		Coffee break
15:30	Coffee break	Transfer to HFI
16:00	Technical Session: Turbine Integration Chair: Robert Fievisohn	Lab Tour
16:30		
17:00	Travel to Biergarten	
17:30	Social Gathering in Beer Garden	
18:00		
18:30		

PROGRAM AT A GLANCE

	17.08.2022	18.08.2022	19.08.2022
9:00	Thematic Presentation - *Jiro Kasahara*	Thematic Presentation - *Akiko Matsuo*	
9:30	Technical Session: Injector Dynamics I Chair: Dmitry Davidenko	Technical Session: Detonations I Chair: Christian Mundt	Thematic Presentation - *Matt Fotia*
10:00			Technical Session: RDE Design Concepts Chair: Eric Bach
10:30	Coffee break	Coffee break	Coffee break
11:00	Technical Session: Injector Dynamics II Chair: Jiun-Ming Li	Technical Session: Detonations II Chair: Ratiba Zitoun	Technical Session: RDE Design Concepts (Continued) Chair: Eric Bach
11:30			
12:00	Lunch		
12:30		Lunch	Closing Remarks
13:00			Lunch
13:30	Transfer to Jannowitzbrücke		
14:00	Excursion - Sightseeing Boat Cruise on the River Spree	Technical Session: Linearized Combustors Chair: Myles Bohon	
14:30			
15:00			
15:30		Coffee break	
16:00		Planning Meeting	
16:30			
17:00			
17:30	Optional meetup in Zollpackhof Biergarten		
18:00			
18:30		Banquet	

MONDAY - 15.08.2022

9:00	Check in and Coffee Welcome
9:45	Introductory Comments
10:10	Thematic Presentation: *Current state of pressure gain measurement and achievement in PGC devices for propulsion and turbine integration* **Chris Brophy** (Naval Postgraduate School)
	Technical Session: *Pressure Gain Measurements* **Chair: Venkat Tangirala**
10:30	*Pressure gain problem on rotating detonation engine* **Koichi Hayashi** (Aoyama Gakuin University), Noboyuki Tsuboi, Kazuhiro Ishii
10:55	*EAP Methodology and Analysis* **Robert Fievisohn** (Air Force Research Laboratory)
11:20	*Comparison of total pressure measurements using EAP, Kiel probes, and Mach number corrected static pressure* **Eric Bach** (TU Berlin), Hongyi Wei, Christian Oliver Paschereit, Myles Bohon
11:45	Session Panel Discussion - Koichi Hayashi, Robert Fievisohn, Eric Bach
12:00	Lunch (in room H3007)
	Technical Session: *RDE Propulsion Systems* **Chair: Eric Paulson**
13:30	*Flight Experiment of Detonation Engine System By Using the Sounding Rocket S-520-31 and the Next Flight Experiment* **Jiro Kasahara** (Nagoya University), Koichi Matsuyama, Ken Matsuoka, Akira Kawasaki, Noboru Itouyama, Keisuke Goto, Kazuki Ishihara, Valentin Buyakofu, Tomoyuki Noda, Akiko Matsuo, Ikkoh Funaki, Hiroto Habu, Shinsuke Takeuchi, Satoshi Arakawa, Junichi Masuda, Kenji Maehara, Kazuhiko Yamada, Tatsuro Nakao, Daisuke Nakat, Masaharu Uchiumi
13:55	*Development of Continuously Rotating Detonation Liquid Rocket Engines* **Michał Kawalec** (Łukasiewicz - Institute of Aviation), Piotr Wolański

MONDAY - 15.08.2022

14:20	*Research of Continuously Rotating Detonation for liquid fuels-air mixtures* Adam Bilar, Witold Perkowski, Michał Kawalec, **Piotr Wolański** (Łukasiewicz - Institute of Aviation)
14:45	*Influence of Ambient Backpressure on the Operability of an Ethylene/Air Rotating Detonation Engine* **Matt Fotia** (Air Force Research Laboratory), Andrew Knisely, Adam Holley, Chris Stevens, John Hoke
15:10	Session Panel Discussion - Jiro Kasahara, Michał Kawalec, Matt Fotia
15:25	Coffee Break
	Technical Session: *Turbine Integration* **Chair: Robert Fievisohn**
15:50	*Impact of the Inlet Conditions on the Starting of a Supersonic Turbine for RDE* **Noraiz Mushtaq** (Politecnico di Milano), Paolo Gaetani
16:15	*Transient Power and Loss Generation in Supersonic Turbines Downstream of Rotating Detonation Combustors* **Lukas Benjamin Inhestern** (TU Berlin), James Braun, Dieter Peitsch, Guillermo Paniagua
16:40	Session Panel Discussion – Noraiz Mushtaq, Lukas Inhestern
Close	**Social Event: Beer garden Café am Neuen See**

TUESDAY - 16.08.2022

9:00	*Historical remarks on the development of Detonative Propulsion* **Piotr Wolański** (Łukasiewicz - Institute of Aviation)
9:40	Thematic presentation: *State of the art of constant volume combustors and transient diagnostics* **Marc Bellenoue** (ISAE-ENSMA)
10:00	**Poster Session** and Coffee Break
	Technical Session: *Heat Flux in PGC Devices* **Chair: Michał Kawalec**
10:40	*A Review of Recent Advances in the Combustor and Blade Cooling Methods for Pressure Gain Combustors* **Abhishek Dubey** (University of Genova), Sreenath Purushothaman, Alessandro Sorce, Alberto Traverso
11:05	*Temperature and Heat Flux Measurements in a Thin-Walled RDE* **Christopher Stevens** (Innovative Scientific Solutions Inc.)
11:30	*Heat Flux Measurements of a Methane-Oxygen Rotating Detonation Rocket Engine* **Reza Aliakbari** (Royal Melbourne Institute of Technology), Quentin Michalski, Nicholas Mason-Smith, Maximilian Wenzel, Nathan Paull, Adrian Pudsey
11:55	Session Panel Discussion - Abhishek Dubey, Christopher Stevens, Reza Aliakbari
12:10	Lunch (in room H3007)

TUESDAY - 16.08.2022

	Technical Session: *Constant Volume Combustors* **Chair: Jeong-Yeol Choi**
13:40	The substantial gain of specific impulse obtained experimentally in a constant-volume combustor **Bastien Boust** (ISAE-ENSMA), Marc Bellenoue, Quentin Michalski
14:05	Development and Validation of a 0-D/1-D Model to Evaluate Pulsating Conditions from a Constant Volume Combustor **Panagiotis Gallis** (Politecnico di Torino), Daniela Misul, Simone Salvadori, Marc Bellenoue, Bastien Boust
14:30	Experimental determination of a transition to detonation criterion in a constant volume combustor Hugo Quintens, **Camille Strozzi** (ISAE-ENSMA - POITIERS UNIV. - CNRS), Marc Bellenoue
14:55	Session Panel Discussion - Bastien Boust, Panagiotis Gallis, Camille Strozzi
15:10	Coffee Break
15:35	Transfer to Hermann-Föttinger-Institut
15:45	**Lab tour** ○ Combustion labs ○ Wind tunnels ○ Water tunnels ○ Towing tank

WEDNESDAY - 17.08.2022

9:00	Thematic presentation: *The importance of the injector for transient reactant refill* **Jiro Kasahara** (Nagoya University)
	Technical Session: *Injector Dynamics I* **Chair: Dmitry Davidenko**
9:20	*Analysis of the Detonation Front Propagation in a Non-Premixed Rotating Detonation Combustor Operated with Hydrogen* Pier Carlo Nassini, **Antonio Andreini** (University of Florence), Myles Bohon
9:45	*Rotating Detonation Engine Wave Dynamics on Jet-in-Cross Flow Fuel Injection* Chris Brophy, **Alexis Thoeny** (Naval Postgraduate School)
10:10	*Numerical study of injectors patterns for a methane-oxygen rotating detonation engine* Davide Vimercati, **Christian Mundt** (Bundeswehr University Munich), Adrian Pudsey
10:35	Coffee Break
	Technical Session: *Injector Dynamics II* **Chair: Jiun-Ming Li**
10:55	*A modeling strategy for transitory injection simulation in Rotating Detonation Engines* Pierre Hellard, **Thomas Gaillard** (ONERA), Dmitry Davidenko
11:20	*Transitory injection simulation to study injector performance of an experimental Rotating Detonation Engine* **Pierre Hellard** (ONERA), Thomas Gaillard, Dmitry Davidenko
11:45	Session Panel Discussion - Antonio Andreini, Alexis Thoeny, Christian Mundt, Thomas Gaillard, Piere Hellard

WEDNESDAY - 17.08.2022

12:00	Lunch (in room H3007)
13:45	Meet at the boat ramp at Jannowitzbrücke
14:00	**Excursion - Cruise on the river Spree**
18:00	**Optional meet up at Zollpackhof Beer garden**

THURSDAY - 18.08.2022

9:00	Thematic presentation: *State of the art for detonation science , with a focus toward detonation based power and propulsion devices* **Akiko Matsuo** (Keio University)
	Technical Session: *Detonations I* **Chair: Christian Mundt**
9:20	*NOx Production Patterns and Operational Effects in Rotating Detonation Engines Using a Simplified NOx Chemistry Mechanism* **Caleb Van Beck** (University of Michigan), Raman Venkat
9:45	*Nature of Deflagration to Detonation Transition* **Wolański Piotr** (Łukasiewicz - Institute of Aviation)
10:10	*Two-Dimensional Detailed Numerical Simulation on Ammonia/Hydrogen/Air Detonation: Effects of Hydrogen Concentration* Nobuyuki Tsuboi, Inoue Go, Ozawa Kohei, **A. Koichi Hayashi** (Aoyama Gakuin University)
10:35	Coffee Break
	Technical Session: *Detonations II* **Chair: Ratiba Zitoun**
10:55	*Numerical Investigation on the Effect of Ozone Sensitization in the Two-Dimensional Rotating Detonation Engine* Tanaka Raimu, **Akiko Matsuo** (Keio University), Eiji Shima, Hiroaki Watanabe, Akira Kawasaki, Ken Matsuoka, Jiro Kasahara
11:20	*Analysis of Detonation Structure in Liquid-Gas Detonation Systems* **Ral Bielawski** (University of Michigan), Supraj Prakash, Venkat Raman
11:45	*Breakup and Vaporization of Liquid Fuel Droplets by Detonation Waves* **Minwook Chang** (University of Maryland), Kenneth Yu

THURSDAY - 18.08.2022

12:10	Session Panel Discussion - Caleb Van Beck, Piotr Wolański, Koichi Hayashi, Akiko Matsuo, Ral Bielawski, Minwook Chang
12:25	Lunch (in room H3007)
	Technical Session: *Linearized Combustors* **Chair: Myles Bohon**
13:45	*Self-excited Wave Propagation in a Linear Detonation Combustor* **Michael Ullman** (University of Michigan), Supraj Prakash, Deborah Jackson, Venkat Raman, Carson Slabaugh, John Bennewitz
14:10	*Numerical Studies of Shuttling Transverse Combustion with C2H4-O2 Diluted by N2* Ruiqin Shan, Heng Kee Ngiam, **Jiun-Ming Li** (National University of Singapore), Chiang Juay Teo, Khoo Boo Cheong
14:35	*Flame acceleration and DDT of hydrogen-air mixtures at cryogenic temperatures* **Mike Kuznetsov** (Karlsruhe Institute of Technology), Andrey Denkevits, Andreas Friedrich, Anke Veser
15:00	Session Panel Discussion - Michael Ullman, Jiun-Ming Li
15:15	Coffee Break
15:45	**Planning Meeting**
18:30	Meet at Nolle restaurant
19:00	**Banquet**

FRIDAY - 19.08.2022

9:30	Thematic presentation: *State of the art of non-traditional RDE devices* **Matt Fotia** (Air Force Research Laboratory)
	Technical Session: *RDE Design Concepts* **Chair: Eric Bach**
9:50	*Analytical Methods for the Conceptual Design and Development of a Rotating Detonation Engine* **Venkat Tangirala** (CPEC Technologies LLC), Anthony Dean
10:15	*RDE is not necessarily circular* **Jeong-Yeol Choi** (Pusan National University)
10:40	Coffee Break
11:00	*Investigation into the Impact of Tapered Combustion Channels on the Operation of a Rotating Detonation Engine* Kaitlin Moosmann, Matthew Fotia, John Hoke, Adam Holley, Robert Fievisohn, **Christopher Stevens** (Innovative Scientific Solutions Inc.)
11:25	*Propagation of Gaseous Detonations in High Aspect Ratio Planar Curved Channels* RJ Hencel, **Matt Fotia** (Air Force Research Laboratory), John Hoke,
11:50	*Cycle Analysis of Simple Detonative Propulsion Systems* **Robert Fievisohn** (Air Force Research Laboratory)
12:15	Session Panel Discussion - Venkat Tangirala, Jeong-Yeol Choi, Christopher Stevens, Matt Fotia, Robert Fievisohn
12:30	**Closing Remarks**
12:40	Lunch (in room H3007)

SOCIAL PROGRAM

Monday night: Beer garden Café am Neuen See

Global dishes, Bavarian snacks & beer served in a rustic-chic space & a lake-view garden. Two drink tickets are included in the conference registration.

Address: Lichtensteinallee 2, 10787 Berlin

How to get there: Located inside Tiergarten park, it's an easy walk (10-15 min.) from either the TU campus, the victory column, or the Zoo train station. There are signs pointing towards "Neuer See" on all major paths.

Directions

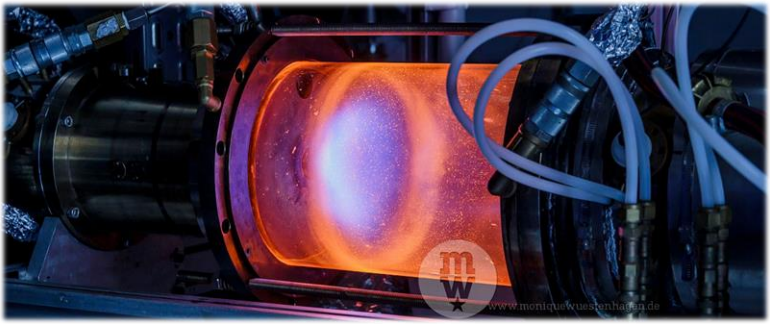
Tuesday afternoon: Tour of HFI laboratories

We present various experiments in operation at the Chair of Fluid dynamics: combustion labs (including PGC devices) as well as water & wind tunnels

Address: Müller-Breslau-Str. 8, 10623 Berlin

How to get there: An easy walk from the Chemistry Building (5 min.), HFI is located next to the Landwehr Canal, opposite of the "large pink tube".

Directions



SOCIAL PROGRAM

Wednesday afternoon: Excursion – Spree river cruise

Enjoy a 3-hour cruise to discover Berlin's most famous sights on the historic River Spree. Appetizers and two drink tickets are included.

Address: Anlegestelle Jannowitzbrücke, Rolandufer 4, 10179 Berlin

How to get there: From Jannowitzbrücke station, it's a 1 min. walk across the street and down a flight of stairs to the embarkation point.

Directions

Wednesday night: Optional meetup at Zollpackhof

Directions

Cozy beer garden on the Spree river bank, opposite of the Reichstag and the Federal Chancellery.

Address: Elisabeth-Abegg-Str. 1, 10557 Berlin

How to get there: Short walk (7 min.) from Hauptbahnhof or Bundestag stations, next to Moltke bridge.

Thursday night: Banquet at restaurant Nolle

Restaurant with an old-world vibe, an arched ceiling & a shady courtyard.

Address: Georgenstr. 203, 10117 Berlin

How to get there: Right around the corner from Friedrichstraße station.

RESTAURANT NOLLE

Directions