16th INTERNATIONAL CONFERENCE

HIGH SPEED MACHINING

DIGITALISATION IN FUTURE MACHINING

26 – 27/10 2021 **DARMSTADT | GERMANY**

PROGRAM

CONTENTS

WORD OF WELCOME

Chairmen of the 16th International Conference on High Speed Machining

Prof. Dr. -Ing. Eberhard Abele

Prof. Dr. -Ing. Matthias Weigold

Welcome to the 16th International Conference on High Speed Machining HSM 2021.

Since 1997, the conference is focused on machining technology, machine tool design and related topics. The HSM conference is carried out alternately in five different countries by the partners IK4 Tekniker & IDEKO (Spain), ENSAM Metz (France), RCMT – Research Center of Manufacturing Technology (Czech Republic), NUAA – Nanjing University of Aeronautics and Astronautics (China) and PTW Darmstadt (Germany).

The conference is sponsored by the International Academy for Production Engineering CIRP. For the first time PTW is organizing the conference in a "presence and online format" and hereby reacts to the prevailing pandemic situation. The annual conference offers international manufacturing experts from academia as well as from industry the opportunity to exchange views on current topics in the fields of machining technology, machine tool design and related topics. The main focus of this year's conference will be under the umbrella of "digitalization in future machining."

Digitization and networking are significantly shaping current research and development approaches in production. Data driven production creates completely new interaction possibilities with innovative concepts and approaches. Artificial intelligence

and machine learning algorithms still play a minor role in today's production. However, the research findings of recent years are promising and open a wide range of possibilities for manufacturing companies in monitoring, optimization or planning as well as control and automation of systems and processes. Due to the added efficiency and performance for the manufacturing industry by using AI, it is only a matter of time before it will be widely used.

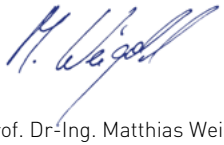
Within the conference we will see several new research approaches and ideas for further digitalization of production processes and self-optimizing machining systems in future machining. On the other hand, we will address the important topic of sustainable manufacturing and see new approaches on energy efficient and energy flexible machine tools and supply technology.

The goal is to gather and exchange knowledge and to stimulate the knowledge transfer between industry, universities and research centers. In addition to the presentations, we have a great evening planned for our guests as well as a guided tour through the PTW Laboratory and Learning Factories.

We would like to thank all authors and sponsors from industry for their contribution. We would also like to express our gratitude to the members of the international scientific committee for their time, effort, and constructive feedback, which ensures the quality of our conference. I wish you a fruitful and enjoyable conference!

Kind regards,

Prof. Dr.-Ing. Eberhard Abele



Prof. Dr.-Ing. Matthias Weigold

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Prof. M. Zäh | Germany
Dr. P. Zeman | Czech Republic

Scientific Keynote Speakers

Prof. Matthias Weigold | Germany
Prof. Dr. N. He | China
Dr. Matej Sulitka | Czech Republic

PARTNERS

The HSM 2021 is sponsored by the companies listed below. We would like to take this opportunity to thank the sponsors of HSM 2021 for their support and contribution to the conference.

pro-micron GmbH, Kaufbeuren

Alicona Imaging GmbH, Raaba

GMN Paul Müller Industrie GmbH & Co. KG, Nürnberg

Kern Microtechnik GmbH, Murnau

Big Data in Manufacturing GmbH, Hechingen

Software AG, Darmstadt

CONFERENCE OVERVIEW

Tuesday, 26th of October 2021

8:00 – 9:00	Arrival and Registration
9:00 – 17:10	Conference proceedings
17:45/18:15	Shuttle to event location
	Evening Event TEC-Lab

Wednesday, 27th of October 2021

8:30 – 9:00	Arrival 2nd day
9:00 – 17:00	Conference proceedings
18:00	Evening Event in traditional German Restaurant

PROGRAM OF 16TH INERNATIONAL CONFERENCE HIGH SPEED MACHINING, 26–27 OCTOBER 2021, DARMSTADT, GERMANY

Tuesday, 26th October				
8:00–9:00	Arrival and registration, darmstadtium			
9:00–9:30	Welcome and conference opening			M. Weigold
9:30–10:00	**Keynote speech** (Ferrum) How to understand spindles better – IIoT Ready with IO-Link		GMN Paul Müller Industrie GmbH & Co. KG	J. Falker
10:00–10:20	Coffee break			
10:20–11:00	**Session** (Ferrum) Digitalisation in future machining 1	**Session** (Europium) Cutting 1	**Session** (Helium) Hybrid manufacturing	
11:00–11:20	Short break			
11:20–12:20	**Session** (Ferrum) Digitalisation in future machining 1	**Session** (Europium) Cutting 1	**Session** (Helium) Hybrid manufacturing	
12:20–13:20	Lunch			
13:20–13:50	**Keynote speech** (Ferrum) Usecase examples for fully intergrated 100% workpiece quality control with spike		pro-micron GmbH	H. v. Zastrow
13:50–14:20	**Keynote speech** (Ferrum) Real-time quality assurance during the process through the use of AI		Big Data Manufacturing	V. Kreidler
14:20–14:40	Short break			
14:40–15:40	**Session** (Ferrum) Energy and sustainability 1	**Session** (Europium) Cutting 2	**Session** (Helium) Digitalisation in future machining 2	
15:40–16:00	Coffee break			
16:00–16:30	**Keynote speech** (Ferrum) Energy system planning opportunities for turnkey manufacturing solutions		ETA-Solutions GmbH	M. Beck
16:30–17:10	**Session** (Ferrum) Energy and sustainability 2	**Session** (Europium) Digitalisation in future machining 3		
17:45	1st Bus shuttle to Social Event, Main Entrance darmstadtium			
18:15	2nd Bus shuttle to Social Event, Main Entrance darmstadtium			
evening	Social Event TEC-Lab			

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Wednesday, 27th October				
8:30–9:00	Arrival 2nd day			
9:00–9:30	**Keynote speech** (Ferrum) Towards sustainability in mechanical machining under different lubri-cooling technologies		Nanjing University of Aeronautics and Astronautics	N. He
9:30–10:00	**Keynote speech** (Ferrum) Increasing performance and energy efficency of a machine tool through hydrostatic linear guideways with micrometer fluid film thickness		KERN Microtechnik GmbH	M. Fritz
10:00–10:20	Coffee break			
10:20–11:00	**Session** (Ferrum) Machine tool	**Session** (Europium) InterQ Project	**Session** (Helium) Cutting 3	
11:00–11:20	Short break			
11:20–12:20	**Session** (Ferrum) Machine tool	**Session** (Europium) InterQ Project	**Session** (Helium) Cutting 3	
12:20–13:20	Lunch			
13:20–13:50	**Keynote speech** (Ferrum) Energy efficiency beyond single-machine optimizations		Software AG	H. Schöning
13:50–14:20	**Keynote speech** (Ferrum) High-resolution surface texture measurements using a collaborative pick-and-place robot		Alicona	S. Bergmann
14:20–14:30	Short break			
14:30–15:30	**Session** (Ferrum) Cutting 4	**Session** (Europium) Digitalisation in future machining 4	**Session** (Helium) Cutting 5	
15:30–15:50	Coffee break			
15:50–16:20	**Keynote speech** (Ferrum) Digital twins for supporting the machining processes: recent development and future challenges			M. Sulitka
16:20–17:00	**Session** (Ferrum) Cutting 6	**Session** (Europium) Digitalisation in future machining 5		
18:00	Visit of a traditional German restaurant in Darmstadt.			

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	Tuesday, 26th October	
	ROOM FERRUM	
	Digitalisation in future machining 1 **Session Chair: M. Weigold**	
10:20–10:40	B165	**Using gamification on the shop floor for process optimization in machining production** Mario Dewald, Oliver Kohn, Yannick Dehorn, Hendrik Howaldt, Alexander Ebben, Nick Kratzke, Fred Janssen, Matthias Weigold
10:40–11:00	B104	**Rapid uncertainty quantification of the stability analysis using a probabilistic estimation of the process force parameters** Maximilian Busch, Benedikt Schmucker, Michael F. Zaeh
11:20–11:40	B105	**Demonstration of a new approach for measuring tools with the impingement sound of an air jet using machine learning** Hubert Würschinger, Daniel Gross, Manuel Stadler, Matthias Mühlbauer, Nico Hanenkamp
11:40–12:00	B156	**Damage evaluation in CFRP machining by digital image processing** Burcu Bilgic, Lutfi Taner Tunc
12:00–12:20	B141	**Burr formation at the interface during bi-material orthogonal cutting** Corentin Poissenot-Arrigoni, Guillaume Fromentin, Gérard Poulachon, Bertrand Marcon, Côme Legrand

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	Tuesday, 26th October	
	ROOM EUROPIUM	
	Cutting 1 **Session Chair: A. D'Acunto**	
10:20–10:40	B150 **Utilization of machine learning approaches for tool wear detection and prediction in the circular sawing process of metallic materials** Patrick Georgi, Sarah Eschelbacher, Hans-Christian Möhring	
10:40–11:00	B126 **Development of a methodology for the implementation of a smart drilling system for multimaterial aeronautical structures** Abdoulaye Affadine Haoua, Pierre-André Rey, Mehdi Cherif, Emmanuelle Abisset-Chavanne, Wadii Yousfi	
11:20–11:40	B109 **Local scale analysis of Ti-6Al-4V chip formation during orthogonal cutting using high-speed optical system** Haythem Zouabi, Madalina Calamaz, Olivier Cahuc, C.F. Ilvig, Vincent Wagner, Gilles Dessein	
11:40–12:00	B160 **Dynamic characterization of milling based on interrupted feed motion** Adam K Kiss, Daniel Bachrathy	
12:00–12:20	B101 **Characterization of metal workings fluids using tribological testing methods** Nicolai Ostrowicki, Julia Markert, Nico Hanenkamp	

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	Tuesday, 26th October	
	ROOM HELIUM	
	Hybrid manufacturing **Session Chair: E. Bosch**	
10:20–10:40	B138 **Fundamental investigations on the machinability of additively manufactured multi-materials** Tobias Kelliger, Daniel Schraknepper, Thomas Bergs	
10:40–11:00	B116 **Influence of LPBF process parameters on milling of a maraging tool steel** Manuela Neuenfeldt, Frederik Zanger, Volker Schulze	
11:20–11:40	B102 **Assessment of finish machining and mass finishing as postprocessing methods for PBF-LB/M -m-manufactured 316L** Christina Fuchs, Laura Kick, Ophelie Leprevost, Michael Zaeh	
11:40–12:00	B133 **Efficient wire based laser metal deposition for large aerostructural titanium parts** L. Uriarte, C. Soriano, I. Garmendia, D. Barrenetxea	
12:00–12:20	B140 **New generation cutting tools manufactured by SLM additive manufacturing technology** David Fernández Rodríguez, Alejandro Sandá Verde, I. Quintana, J.L. Inarrairaegi, Jon Urrutikoetxea Astigarraga, José Ignacio Aldecoa De Pedro	

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	Tuesday, 26th October	
	ROOM FERRUM	
	Energy and sustainability 1 **Session Chair: E. Abele**	
14:40–15:00	B162 **Tribological, heat transfer and machinability properties of newly developed hybrid lubri-coolant** Muhammad Jamil, Ning He, Aqib Mashood Khan, Wei Zhao	
15:00–15:20	B124 **Machine learning based identification of energy efficiency measures for machine tools using load profiles and machine specific meta data** Lars Petruschke, Ghada Elserafi, Borys Ioshchikhes, Matthias Weigold	
15:20–15:40	B130 **Investigation of lubricating oils from renewable resources for cryogenic minimum quantity lubrication** Trixi Meier, Daniel Gross, Nico Hanenkamp	

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	Tuesday, 26th October	
	ROOM EUROPIUM	
	Cutting 2 **Session Chair: A. D'Acunto**	
14:40–15:00	B154 **Semi-analytical period-doubling chatter analysis in thin wall milling** Markel Sanz-Calle, Jokin Muñoa, Alexander Iglesias, Luis Norberto López de Lacalle, Zoltan Dombovari	
15:00–15:20	B120 **Performance of different diamond cutting tools in face milling of cemented carbide** Andreas Nestler, Andreas Schubert	

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	Tuesday, 26th October	
	ROOM HELIUM	
	Digitalisation in future machining 2 **Session Chair: M. Dewald**	
14:40–15:00	B169 **Tool condition monitoring and tool defect detection for end mills based on high-frequency machine tool data** Alexander Fertig, Lukas Grau, Marius Altmannsberger, Matthias Weigold	
15:00–15:20	B106 **Instantaneous parameter identification for milling force models using Bayesian optimization** Benedikt Schmucker, Maximilian Busch, Thomas Semm, Michael F. Zaeh	
15:20–15:40	B119 **Experimental investigation of ultrasonic assisted helical milling of 2205 duplex stainless steel** Asmaa Wadee, Wael Khaireldin, Hassan El-Hofy	

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	Tuesday, 26th October	
	ROOM FERRUM	
	Energy and sustainability 2 **Session Chair: E. Abele**	
16:30–16:50	B114 **A deep learning approach to electric load forecasting of machine tools** Bastian Dietrich, Jessica Walther, Yurui Chen, Matthias Weigold	
16:50–17:10	B131 **Comparison of sprayability and solubility of bio-based lubricants with liquid carbon dioxide** Trixi Meier, Daniel Gross, Nico Hanenkamp	

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	Tuesday, 26th October	
	ROOM EUROPIUM	
	Digitalisation in future machining 3 **Session Chair: M. Dewald**	
16:30–16:50	B111 **Production of individualised multi-material components using a robot-based process chain** M. Albergt, M. David, M. Droß, A.-K. Reichler, H.-W. Hoffmeister, K. Dröder	
16:50–17:10	B112 **Robot-Based Surface Finishing of Forming Dies Concerning Different Path Strategies** Stephan Bay, Paul Bossong, Matthias Weigold	

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	Wednesday, 27th October	
	ROOM FERRUM	
	Machine tool **Session Chair: F. Geßner**	
10:20–10:40	B171 **Method for safe experimental testing of machine tool usable spindle power** Petr Kolar, Miroslav Janotab, Jiri Sveda, Tomas Kozlok	
10:40–11:00	B142 **Chatter detection based on a contact sensor in milling operations** David Hajdu, Daniel Bachrathy	
11:20–11:40	B159 **Static stiffness analysis of an electronicaly preloaded rack and pinion feed drive system** Oier Franco, Xavier Beudaert, Kaan Erkorkmaz, Jokin Munoa	
11:40–12:00	B107 **Experimental study on tilting stiffness of oil hydrostatic shallow recess thrust bearings** Fabian Tripkewitz, Matthias Fritz, Matthias Weigold	
12:00–12:20	B147 **Frictional force modeling of a machine tool feed drive telescopic cover** Jan Ferkl, Lukáš Novotný, Štěpán Fiala, Petr Kolář, Michal Rytíř	

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	Wednesday, 27th October	
	ROOM EUROPIUM	
	InterQ Project **Session Chair: J. Muñoa**	
10:20–10:40	B134 **Framework for coupled digital twins in digital machining** Denys Plakotnik, Alexandru Curutiu, Arkadii Zhulavskyi, Xavier Beudaert, Jokin Munoa, Marc Stautner	
10:40–11:00	B135 **Fingerprint: Machine tool condition monitoring approach for zero defect manufacturing** Mikel Armendia, Jon San Sebastian, Diego Gonzalez, Bruno Santamaria, J. A. Gonzalez, R. González-Velázquez, K. Lopez de Calle	
11:20–11:40	B168 **Polygonal errors in thin-walled medium-size casings due to lap-flanges and iso-grid milling** Naiara Ortega, Guillermo González-Marín, Soraya Plaza, Felipe Marín, Luís Norberto López de Lacalle	
11:40–12:00	B158 **Identification of the origin of surface topography inaccuracies by means of process monitoring** Monica Gil, Xavier Beudaert, Jokin Muñoa, Jose Antonio Sánchez	

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	Wednesday, 27th October	
	ROOM HELIUM	
	Cutting 3 **Session Chair: L. Petruschke**	
10:20–10:40	A105	**Influence of micro-holes on rake face of the carbide insert on machining performance** Anthony Xavior, P. Jeyapandiarajan, P. Sasidharan, Arnaud Duchosal
10:40–11:00	B173	**Performance evaluation of (AlCrN) PVD coated CBN inserts on machining of Inconel 718** Anthony Xavior, P. Jeyapandiarajan, Arivazhagan Anbalagan
11:20–11:40	B100	**Cryogenic milling of metastable austenitic stainless steel AISI 347** Kevin Gutzeit, Stephan Basten, Benjamin Kirsch, Jan C. Aurich
11:40–12:00	B117	**Experimental analysis of the etching process for validation of non-conventional slot machining in aero engine component manufacturing** Carolin Baier, Matthias Weigold
12:00–12:20	B123	**Numerical methods for the simulation of segmental chips and experimental validation in machining of Ti-6Al-4V** Hans-Christian Möhring, Christian Menze, Tim Reeber, Robert Wegert, Felix Erhart

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	Wednesday, 27th October	
	ROOM FERRUM	
	Cutting 4 **Session Chair: W. Kirsten**	
14:30–14:50	B115 **Modelling of process forces for complex multiaxial turning processes** Berend Denkena, Alexander Krödel, Lars Ellersiek, Felix Zender	
14:50–15:10	B132 **Influence of contour radius and fiber orientation on heat accumulation during machining of unidirectional CFRP** Jan Mehnen, Wolfgang Hintze, Lars Köttner	
15:10–15:30	B163 **Multi-phase simulation of the liquid coolant flow around rotating cutting tool** Lukáš Topinka, Michael Bräunig, Joachim Regel, Matthias Putz, Martin Dix	

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	Wednesday, 27th October	
	ROOM EUROPIUM	
	Digitalisation in future machining 4 **Session Chair: P. Kolar**	
14:30–14:50	B152 **CAD-Based path planning for line laser scanning of curved surface** Wei Guo, Zhengcai Zhao, Yucan Fu	
14:50–15:10	B108 **Control strategies for a gantry stage equipped with flexible joints using frequency response methods** Patrick Pöhlmann, Marcel Merx, Jens Müller, Steffen Ihlenfeldt	
15:10–15:30	B155 **dPart – A digital twin framework for the machining domain** Philipp Ganser,Tommy Venek, Viktor Rudel, Thomas Bergs	

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	Wednesday, 26th October	
	ROOM HELIUM	
	Cutting 5 **Session Chair: M. Sulitka**	
14:30–14:50	B129	**Simulation on microstructure evolution of machined surface of titanium by laser-assisted machining** Binbin Xu, Jun Zhang, H.X. Guo, X. Liu, Wanhua Zhao
14:50–15:10	A108	**Effects of constitutive model parameters on finite element simulation process for hard milling of AISI H13 steel** Song Zhang, Binxun Li, Jianfeng Zhang, Jia Man
15:10–15:30	B136	**Parametric study of an empirical material behavior law in orthogonal cutting simulations of TI6AL4V alloy** Preshit Limje, Madalina Calamaz, Dominique Coupard, Mehdi Cherif

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	Wednesday, 27th October	
	ROOM FERRUM	
	Cutting 6 **Session Chair: W. Kirsten**	
16:20–16:40	B166 **The impact of key temperature measuring points on thermal error compensation model transfer between milling centers of the same product line** Michal Straka, Martin Mareš, Otakar Horejš	
16:40–17:00	B121 **Machine data-based prediction of blisk blade geometry characteristics** Alexander Ernst, Matthias Weigold	

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	Wednesday, 27th October	
	ROOM EUROPIUM	
	Digitalisation in future machining 5 **Session Chair: M. Weigold**	
16:20–16:40	B153 **Development of a measuring and control unit for an intelligent adjustment of process parameters in sawing** Florian Schreiner, Benjamin Thorenz, Julian Schmidt, Markus Friedrich, Frank Döpper	
16:40–17:00	B113 **Depths of cut identification in 3-axis milling using cutting force spectrum** Lorenzo Morelli, Niccol Grossi, Antonio Scippa, Gianni Campatelli	

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CONFERENCE LOCATIONS

darmstadtium
Schlossgraben 1
64283 Darmstadt

Entry underground garage:
Alexanderstraße or Schlossgarage/
Karolinenplatz (follow the signs to Tiefgarage darmstadtium)
Entrance height: 1,95 m | opening hours: 24/7

Parking fees:
60 Min.: 2,20 €
max. daily fee: 15,00 €
(please ask for a reduced parking ticket at our reception desk)

Internet connection inside darmstadtium
Wifi: HSM2021
Password: HighSpeed

Institut für Produktionsmanagement,
Technologie und Werkzeugmaschinen (PTW)
Otto-Berndt-Straße 2
64287 Darmstadt

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DARMSTADT

The City Darmstadt is located in the middle of Hessen. Since 1997 the old residence town has been entitled "City of Science" and since then has been combining culture and modernity increasingly.

Traces of the past as the residential city of the Hessian landgraves can be found today, for example, the residential palace located in the city center. Since July 2021, the Mathildenhöhe in Darmstadt has been a UNESCO World Heritage Site. Surrounded by a park landscape, the Mathildenhöhe invites you to stroll and relax.

A lively research landscape with a high degree of innovation combines history with the present and still stands for excellent and relevant science in teaching and research, among others with the Technical University. Darmstadt is the only German city after which a chemical element – Darmstadtium – is named.

A tip for city walker is the traditional dish Handkäs mit Musik (Hardcheese with music), Rippchen mit Kraut (ribs with sauerkraut) and Äppelwoi (apple wine). Also a stop at one of the three breweries should not be missed while visiting Darmstadt. Cheers and a good time in Hesse.

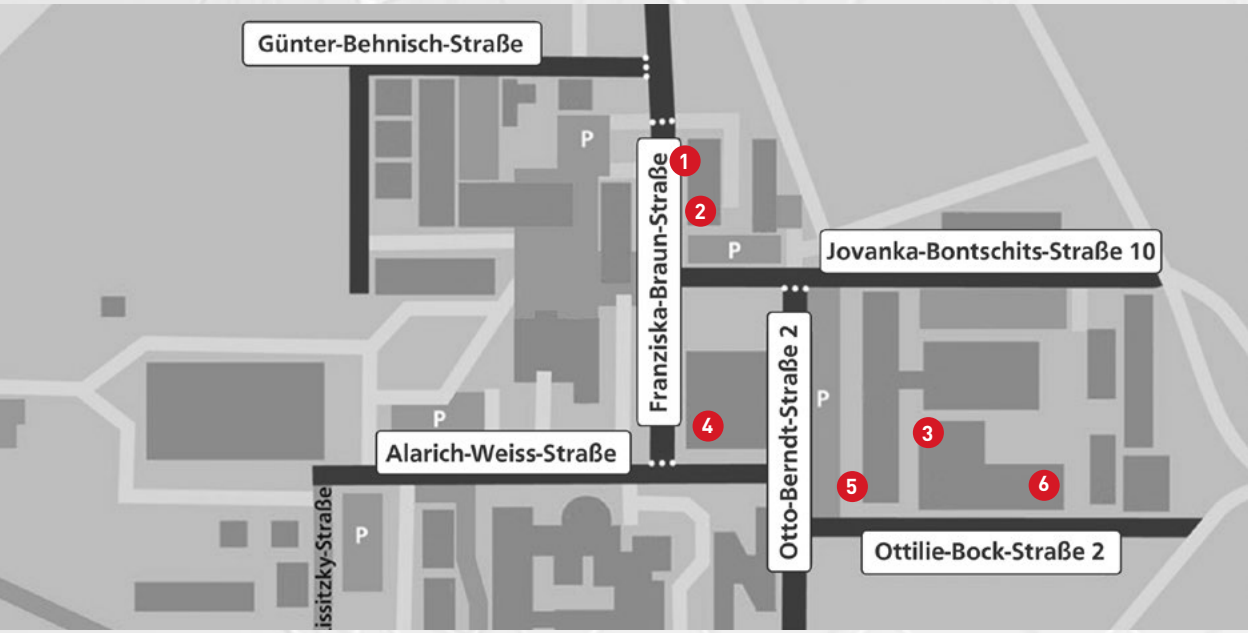
SOCIAL EVENT

BUS SHUTTLE TO TEC-LAB

Departure darmstadtium main entrance

17:45

18:15



EVENING EVENT LOCATION

1/ Arrival Shuttle Bus
2/ ETA-Fabrik guidance: 18:00 + 18:30
3/ TEC-Lab / social event location
4/ Public stop (Line K & KU, every 10 min.)
5/ Departure Bus Shuttle to darmstadtium: from 21:00 every 30 minutes; last departure 23:00
6/ Parking space – barrier-code-word: "HSM Conference" (GPS: Ottilie-Bock-Strasse)

TRAVEL INFO

CITY MAP

stadtatlas.darmstadt.de/

LOCATION EVENING EVENT 2ND DAY

Grohe Brauhaus
Nieder-Ramstädterstr. 3
64283 Darmstadt

TOURIST INFORMATION

www.darmstadt-tourismus.de/en/index.html

CURRENCY, CREDIT CARDS

The currency unit is Euro (EUR).

EC-Cards and international credit cards are accepted at most of hotels, restaurants and shops.

PUBLIC TRANSPORTATION

Tickets should be purchased in advance (e.g. at metro and bus stations). The tickets should be validated (on board or at the entrance gates), and kept, since one must provide them if requested by inspectors on board or at the exit gates.

Take the Line K or KU from the conference center darmstadtium to the ETA-Fabrik and the TEC-Lab.

You can find public city transport routes, ticket prices and timetables on **https://www.rmv.de/c/de/rmv-vor-ort/staedte/darmstadt**.

USEFUL PHONE NUMBERS

Emergency numbers (110 and 112 can be dialed without a coin or a card):

Ambulance: 112
Police: 110
Policestation Südhessen: +49 6151 969-06
Fire Brigade: 112
Emergency Medical Service: +49 116117
HSM Hotline: +49 6151 82297-14
(9:00–16:00 h)

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