

Curriculum Vitae

Dr.-Ing. Johannes Betz, M.A.
Postdoctoral Researcher in Autonomous Systems

710 Chestnut Street, Apt. 403, 19106 Philadelphia, Pennsylvania, USA

+01-215-433-8094

✉ joebetz@seas.upenn.edu

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Research interest

- Autonomous systems with focus on autonomous level 5 vehicles
- Path and behavioral planning for autonomous systems
- Advanced machine learning technologies
- Ethics in autonomous driving and artificial intelligence

Education

10/2016 – 05/2020	Master of Arts in Philosophy of Science and Technology Technical University of Munich, Munich, Germany Master thesis: “What is Mobility? Philosophical Perspectives”
11/2013 – 11/2019	Ph.D. in Automotive Technology Technical University of Munich, Munich, Germany Ph.D. thesis: “An evaluation of an intelligent fleet disposition for mixed vehicle fleets”; Advisor: Prof. Dr.-Ing. Markus Lienkamp
04/2012 - 11/2013	Master of Science in Automotive Engineering and Mechatronics University of Bayreuth, Bayreuth, Germany Master thesis: “Development of a RFID based service interface”
10/2008 - 04/2012	Bachelor of Engineering in Automotive Technology University of Applied Science Coburg, Coburg, Germany Bachelor thesis: “Development of a method for optimizing the sequence of a shift quality assessment in automotive transmission systems”
09/1999 - 06/2008	Higher education entrance qualification (A-Levels) Gymnasium Burgkunstadt, Burgkunstadt, Germany

Research and work experience

10/2020 – present	Postdoctoral researcher University of Pennsylvania, Philadelphia, USA Research group “mLab: Real-Time and Embedded Systems Lab”
11/2018 – 09/2020	Postdoctoral researcher Technical University of Munich, Institute of Automotive Technology Head of the research group “Intelligent Vehicle Systems”
02/2017 – 07/2017	Visiting researcher Lawrence Berkeley National Laboratory, Berkeley, USA Research group “Grid Integration Group”
11/2013 – 11/2018	Research associate Technical University of Munich, Institute of Automotive Technology Research group “Smart Mobility”
06/2012 - 10/2013	Research assistant University of Bayreuth, Fraunhofer Institute of Production Technology
10/2011 - 04/2012	Bachelor thesis: Porsche AG, Weissach, Germany Drivetrain development and transmission application

04/2009 - 10/2011 Research assistant
University of Applied Science Coburg, Institute of Automotive Technology

09/2010 - 03/2011 Internship: BMW AG, Dingolfing, Germany
Quality management in the overall vehicle development

Teaching experience

10/2020 - present University of Pennsylvania, Department of Electrical and Systems Engineering, Lecturer in "ESE 615 F1/10 Autonomous Racing Cars"

10/2018 - present Technical University of Munich, Institute of Automotive Technology
Lecturer in "Artificial Intelligence in Automotive Technology"

10/2018 - 10/2020 Technical University of Munich, Institute of Automotive Technology
Lecturer in "Vehicle Dynamics of Passenger Cars"

10/2015 - 10/2018 Technical University of Munich, Institute of Automotive Technology
Lecturer in "Electric Vehicles: Charging Technologies and Energy Grid"

10/2014 - 10/2020 Technical University of Munich, Institute of Automotive Technology
Lecturer in "Race Car Technologies"

03/2014 - 10/2018 Technical University of Munich, Institute of Automotive Technology
Lecturer in "CAN-Bus Technologies"

03/2014 - 10/2017 Technical University of Munich, Institute of Automotive Technology
Lecturer in "Power Electronics for Electric Vehicles"

11/2013 - present Thesis supervision: 19 bachelor theses, 25 term papers, 11 master theses

Publications and presentations

Peer-reviewed journal publications

Karle, P.; Geisslinger, M.; Betz, J.; Lienkamp, M.: „Scenario Understanding and Motion Prediction for Autonomous Vehicles – Review and Comparison“ in *Intelligent Transportation Systems Transactions, under Review*

Geisslinger, M.; Poszschler, F.; Betz, J.; Lütge, C.; Lienkamp, M.: “Autonomous Driving Ethics: From Trolley Problem to Ethics of Risk“ in *Philosophy & Technology*, under Review

Huch, S.; Aybike, O.; Betz, J.; Lienkamp, M.: „Multi-Purpose End-to-End Self -Driving Architecture for Autonomous Platoons“ in *Applied Science*, under Review

Herrmann, T.; Wischnewski, A.; Hermansdorfer, L.; Betz, J.; Lienkamp, M.: „Real-Time Adaptive Velocity Optimization for Autonomous Electric Race Cars“ in *IEEE Transactions on Intelligent Vehicles*, *early access*, doi: 10.1109/TIV.2020.3047858

Heilmeier, A.; Thomaser, A.; Graf, M.; Betz, J.: “Virtual Strategy Engineer: Using Artificial Neural Networks for Making Race Strategy Decisions in Circuit Motorsport,” in *Applied Sciences*, vol. 10, no. 21, p. 7805, Nov. 2020, doi: 10.3390/app10217805

Heilmeier, A.; Graf, M.; Betz, J.; Lienkamp, M.: “Application of Monte Carlo Methods to Consider Probabilistic Effects in a Race Simulation for Circuit Motorsport,” in *Applied Sciences*, vol. 10, no. 12, p. 4229, Jun. 2020, doi: 10.3390/app10124229

Betz, J.; Heilmeier, A.; Wischnewski, A.; Stahl, T.; Lienkamp, M.: „Autonomous Driving – A Crash Explained in Detail“ in *Applied Sciences*, vol. 9, no. 23, p. 5126, Nov. 2019, doi: 10.3390/app9235126

Palafox, P.; Betz, J.; Nobis, F.; Riedl, K.; Lienkamp, M.: "Fusing Semantic Segmentation and Monocular Depth Estimation for Enabling Autonomous Driving in Roads Without Lane Lines" in *Sensors*, vol. 19, no. 14, p. 3224, 2019, doi: 10.3390/s19143224

Heilmeier, A.; Wischnewski, A.; Hermansdorfer, L.; Betz, J.; Lienkamp, M.; Lohmann, B.: "Minimum curvature trajectory planning and control for an autonomous race car" in *Vehicle System Dynamics*, vol. 58, no. 10, p. 1497–1527, Jun. 2019 doi: 10.1080/00423114.2019.1631455

Betz, J.; Lienkamp, M. "Approach for the development of a method for the integration of battery electric vehicles in commercial companies, including intelligent management systems" in *Automotive and Engine Technology - The International Journal of WKM*, vol. 1, no.1-4, p. 107-117, 2016, doi: 10.1007/s41104-016-0008-y

T. Tang, D. Soto-Setzke, C. Kohl, T. Köhn, J. Lohrer, and J. Betz, "EE-Architektur für mobile Dienste," *ATZ Extra*, vol. 19, no. 14, pp. 40–45, Oct. 2014, doi: 10.1365/s35778-014-1356-8.

Peer-reviewed conference publications

Hermansdorfer, L.; Trauth, R.; Betz, J.; Lienkamp, M.: „End-to-End Neural Network for Vehicle Dynamics Modeling" in *3rd IEEE Conference on Optimization and Modeling of Complex Systems*, Agadir, Morocco, December 2020, *In Press*

Wischnewski, A.; Betz, J.; Lohmann, B.: „Real-Time Learning of Non-Gaussian Uncertainty Models for Autonomous Racing" in *59th IEEE Conference on Decision and Control (CDC)*, Jeju Island, Republic of Korea, December 2020, *In Press*

Poszschler, F.; Geisslinger, M.; Betz, J.; Lütge, C.: "Risk management at the center of ethics: The applicability of traditional ethical theories" in *7th World Congress of the International Society of Business Economics and Ethics*, Bilbao, Spain, July 2020, *accepted*

Waclaw, A.; Gotzler, F.; Betz, J.: "Techno-Economic Analysis of State-of-the-Art Charging Infrastructure Concepts for Typical Commercial Battery Electric Vehicle Fleets" in *23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Sep. 2020, doi: 10.1109/itsc45102.2020.9294197

Stahl, T.; Betz, J.; Diermeyer, F.: "Online Verification Concept for Autonomous Vehicles--Illustrative Study for a Trajectory Planning Module" in *23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Sep. 2020, doi: 10.1109/ITSC45102.2020.9294703

Nobis, F.; Betz, J.; Lienkamp, M.: "Exploring the Capabilities and Limits of 3D Monocular Object Detection - A Study on Simulation and Real World Data" in *23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Sep. 2020, doi: 10.1109/ITSC45102.2020.9294625

Herrmann, T.; Passigato, F.; Betz, J.; Lienkamp, M.: "Minimum Race-Time Planning-Strategy for an Autonomous Electric Racecar" in *23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Sep. 2020, doi: 10.1109/ITSC45102.2020.9294681

Stahl, T.; Betz, J.: ""An Open-Source Scenario Architect for Autonomous Vehicles," in *the 2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, Sep. 2020, doi: 10.1109/ever48776.2020.9243029

F. Nobis, O. Papanikolaou, J. Betz, and M. Lienkamp, "Persistent Map Saving for Visual Localization for Autonomous Vehicles: An ORB-SLAM 2 Extension," in *the 2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, 2020, doi: 10.1109/ever48776.2020.9243094

Riedl, K.; Huber, S.; Böhmer, M.; Kreibich, J.; Betz, J.: ""Importance of Contextual Information for the Detection of Road Damages," in *the 2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, 2020, doi: 10.1109/ever48776.2020.9242954

Hermansdorfer, L.; Betz, J.; Lienkamp, M.: "Benchmarking of a software stack for autonomous racing against a professional human race driver," in the *2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, 2020, doi: 10.1109/ever48776.2020.9242926

Nobis, F.; Geisslinger, M.; Weber, M.; Betz, J.; Lienkamp, M.: "Learning-based Radar and Camera Sensor Fusion Architecture for Object Detection," in *2019 Sensor Data Fusion: Trends, Solutions, Applications (SDF)*, doi: 10.1109/SDF.2019.8916629

Betz, J.; Wischnewski, A.; Heilmeier, A.; Nobis, F.; Stahl, T.; Hermansdorfer, L.; Herrmann, T.; Lienkamp, M.: "A Software Architecture for the Dynamic Path Planning of an Autonomous Racecar at the Limits of Handling" in *2019 IEEE International Conference on Connected Vehicles and Expo (ICCVE 2019)*, doi: 10.1109/ICCVE45908.2019.8965238

Wischnewski, A.; Betz, J.; Lohmann, B.: "A Model-Free Algorithm to Safely Approach the Handling Limit of an Autonomous Racecar" in *2019 IEEE International Conference on Connected Vehicles and Expo (ICCVE 2019)*, doi: 10.1109/ICCVE45908.2019.8965218

Herrmann, T.; Christ, F.; Betz, J.; Lienkamp, M.: "Energy Management Strategy for an Autonomous Electric Racecar using Optimal Control" in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, 2019, doi: 10.1109/ITSC.2019.8917154

Hermansdorfer, L.; Betz, J.; Lienkamp, M.: "A Concept for Estimation and Prediction of the Tire-Road Friction Potential for an Autonomous Racecar" in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, 2019, doi: 10.1109/ITSC.2019.8917024

Stahl, T.; Wischnewski, A.; Betz, J.; Lienkamp, M.: "Multilayer Graph-Based Trajectory Planning for Race Vehicles in Dynamic Scenarios" in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, 2019, doi: 10.1109/ITSC.2019.8917032

Wischnewski, A.; Stahl, T.; Betz, J.; Lohmann, B.: "Vehicle Dynamics State Estimation and Localization for High Performance Race Cars" in *IFAC-PapersOnLine*, vol. 52, no. 8, p. 154–161, 2019, doi: 10.1016/j.ifacol.2019.08.064

Riedl, K.; Kurscheid, S.; Noll, A.; Betz, J.; Lienkamp, M.; "Road Network Coverage Models for Cloud-based Automotive Applications: A Case Study in the City of Munich" in *IEEE Intelligent Vehicles Symposium (IV'19)*, 2019, doi: 10.1109/IVS.2019.8814020

Waclaw, A.; Betz, J.; Lienkamp, M.: "Techno-Economic Assessment of Implementing Holistic Electromobility Solutions to Commercial Companies" in *14th International Conference on Ecological Vehicles and Renewable Energies (EVER2019)*, 2019, doi: 10.1109/EVER.2019.8813533

Heilmeier, A.; Geißlinger, M.; Betz, J.: "A Quasi-Steady-State Lap Time Simulation for Electrified Race Cars" in *14th International Conference on Ecological Vehicles and Renewable Energies (EVER2019)*, 2019, doi: 10.1109/EVER.2019.8813646

Betz, J.; Wischnewski, A.; Heilmeier, A.; Nobis, F.; Stahl, T.; Hermansdorfer, L.; Lienkamp, M.: "A Software Architecture for an Autonomous Racecar" in *IEEE 89th Vehicular Technology Conference (VTC2019-Spring)*, 2019, doi: 10.1109/VTCSpring.2019.8746367

Stahl, T.; Wischnewski, A.; Betz, J.; Lienkamp, M.: "ROS-based localization of a race vehicle at high-speed using LIDAR" in *E3S Web of Conferences*, vol. 95, p. 4002, 2019, doi: 10.1051/e3sconf/20199504002

Nobis, F.; Betz, J.; Hermansdorfer, L.; Lienkamp, M.: "Autonomous Racing: A Comparison of SLAM Algorithms for Large Scale Outdoor Environments" in *Proceedings of the 2019 3rd International Conference on Virtual and Augmented Reality Simulations - ICVARS '19*, 2019, doi: 10.1145/3332305.3332319

Betz, J.; Wischnewski, A.; Heilmeier, A.; Nobis, F.; Stahl, T.; Hermansdorfer, L.; Lohmann, B.; Lienkamp, M.; „What can we learn from autonomous level 5 Motorsport?“ in *Proceedings, Springer Fachmedien Wiesbaden*, 2018, p. 123–146. doi: 10.1007/978-3-658-22050-1_12

Wittmann, M.; Lohrer, J.; Betz, J.; Jäger, B.; Ott, M.; Klöppel, M.; Hann, M.; Lienkamp, M.; „A Holistic Framework for Acquisition, Processing and Evaluation of Vehicle Fleet Test Data“ in *IEEE International Conference on Intelligent Transportation Systems (ITSC 17)*, 2017, doi: 10.1109/ITSC.2017.8317637

Betz, J.; Walther, L.; Lienkamp, M.; „Analysis of the Charging Infrastructure for Battery Electric Vehicles in Commercial Companies“ in *IEEE Intelligent Vehicle Symposium (IV 17)*, 2017, doi: 10.1109/IVS.2017.7995945

Betz, J.; Hann, M.; Jäger, B.; Lienkamp, M.; „Evaluation of the Potential of Integrating Battery Electric Vehicles into Commercial Companies on the Basis of Fleet Test Data“ in *IEEE 85th Vehicular Technology Conference (VTC Spring)*, 2017, doi: 10.1109/VTCSpring.2017.8108289

Betz, J.; Prottung, S.; Lienkamp, M.; „An evaluation of the car-free city potential for the city of Munich regarding mobility data“ in *2017 Twelfth International Conference on Ecological Vehicles and Renewable Energies (EVER)*, 2017. doi: 10.1109/EVER.2017.7935875

Betz, J.; Scholz, T.; Lienkamp, M.; „Evaluation of the Potential of Integrating Battery Electric Vehicles into the Energy Structure of a Commercial Company“ in *IEEE International Conference on Smart Energy Grid Engineering (SEGE 16)*, 2016, doi: 10.1109/SEGE.2016.7589541

Betz, J.; Werner, D.; Lienkamp, M.; „Fleet disposition modeling to maximize utilization of battery electric vehicles in companies with on-site energy generation“ in *Transportation Research Procedia*, vol. 19, pp. 241-257, 2016, doi: 10.1016/j.trpro.2016.12.084

Other publications

Jäger, B.; Schawohl, R.; Christl, W.; Bachmann, F.; Hann, M.; Betz, J.; Frank, C.; Lienkamp, M.; „VEM-Virtuelle Elektromobilität im Taxi- und Gewerbeverkehr München“ Final report for the BMWi-funded project ICT for Electric Mobility II, 2016, doi: 10.2314/GBV:871992922

Hann, M.; Jäger, B.; Betz, J.; Frank, C.; Christl, W.; „Virtuelle Elektromobilität im Taxi- und Gewerbeverkehr München-Teilvorhaben der Handwerkskammer für München und Oberbayern (HWK)“, Final report of the Subproject Electric vehicles in commercial companies for the BMWi-funded project ICT for Electric Mobility II, 2016, doi: 10.2314/GBV:871992922

Talks and presentations

Traffic21/Mobility21 UTC Deployment Partner Consortium Symposium, November 2020

Title: „F1/10 Autonomous Racing: Community, Course & Competitions

Fahrzeug- und Motortechnisches Seminar TU Darmstadt, June 2019

Title: „Roborace – Autonomous Level 5 Motorsport“

Werner-Heisenberg-Gymnasium Garching, Mai 2019

Title: „Autonomes Fahren – Forschung und Lehre“

Munich Science Days 2018, November 2018, [video available online](#)

Title: „Autonomes Fahren und die neuen Arbeitswelten – das Beispiel Roborace“

NVIDIA GTC Conference 2018 in Munich, October 2018, [video available online](#)

Title: Betz, J.; Balcombe, B.: „Roborace: A Case Study in Collaboration“

VDI-Dienstagsvortrag Hochschule München, April 2018

Title: „Was können wir vom Motorsport mit autonomen Level-5 Fahrzeugen lernen?“

7th E-Motive Expertenforum München, June 2015, doi: 10.13140/RG.2.2.30235.46887
“Visio.M – Leichtfahrzeugkonzept für die urbane Elektromobilität

Honors and awards

11/2019	IEEE ICCVE 2019 Best Student Paper Finalist, Graz, Austria
11/2019	PhD graduation with distinction (summa cum laude)
10/2019	Roborace Season Alpha: 1 st Place at Roborace Event 5
07/2019	IFAC IAV 2019 Young Author Award, Gdansk, Poland
11/2018	Selected for German-Japan Young Professional Exchange Program 2018
05/2018	Roborace: Winner of the “Human vs. Machine” Challenge
09/2017	Nvidia GPU Grant: Sponsoring of one “Titan Xp” GPU
04/2012	3 rd best graduate in Bachelor of Engineering at FH Coburg

Service to academic community

Membership of committees

2020 - present	<i>Associate Editor</i> , SAE International Journal of Connected and Automated Vehicles
2020 - present	<i>Program Committee</i> , IEEE International Conference on Ecological Vehicles and Renewable Energies

Review activities

MDPI Sustainability Journal
MDPI Sensors Journal
MDPI Energies Journal
MDPI Applied Sciences Journal
Journal of Field Robotics
International Journal of Vehicle Mechanics and Mobility
SAE International Journal of Connected and Automated Vehicles
IEEE Conference on Intelligent Transportation Systems
IEEE International Conference on Robotics and Automation
IEEE Intelligent Vehicles Symposium
IEEE International Conference on Ecological Vehicles and Renewable Energies
IEEE Vehicular Technology Conference
International Scientific Conference on Mobility and Transport
International Munich Chassis Symposium

University Service and organization of scientific meetings

12/2020	ESE PhD Committee member at University of Pennsylvania
07/2019	Organization of the “Roadshow: Autonomous Driving” at TUM
04/2018-10/2020	Organization of the doctoral seminar “Autonomous Driving” at TUM
04/2018-10/2020	Organization of the doctoral seminar “Ai in Mechanical Engineering” at TUM

Open-source projects

F1TENTH Courses: An openEDX course for autonomous driving; courses.f1tenth.org
F1TENTH autonomous Racing Project, f1tenth.org
A vehicle dynamics simulation for autonomous vehicles; [available on Github](#)
A graph based local trajectory planner for dynamic environments, [available on Github](#)
A library with functions for trajectory planning for autonomous vehicles, [available on Github](#)
A scenario architect for autonomous driving benchmarks, [available on Github](#)
A neural network for object detection with camera and radar, [available on Github](#)

ORB-SLAM2 map saving extentsion, [available on Github](#)

An optimization algorithm for the creation of a global, optimal raceline, [available on Github](#)

A path and velocity controller for an autonomous racecar, [available on Github](#)

A quasi-static laptime simulation, [available on Github](#)

Competences

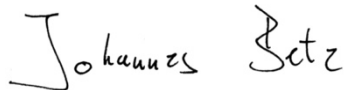
Computer skills Programming: Python, Matlab/Simulink, C/C++, CUDA
 Development: GitLab, git, SVN, Continuous Integration
 AI-Frameworks: Tensorflow, Keras, TensorRT
 Operating systems: Windows, Linux, MacOS
 Engineering software: Solid Works, Vector CANape, PCB Layout Editors
 Other: Microsoft-Office (Word, Power-Point, Excel), Latex

Language German: Native
 English: Full Professional working proficiency

Extracurricular activities

Travel, soccer, triathlon

Philadelphia, 1/24/21



Johannes Betz