Cottbus UTC – Multidisciplinary Process Integration

Klaus Höschler, Bernd Beirow

https://www.b-tu.de/rolls-royce-utc/
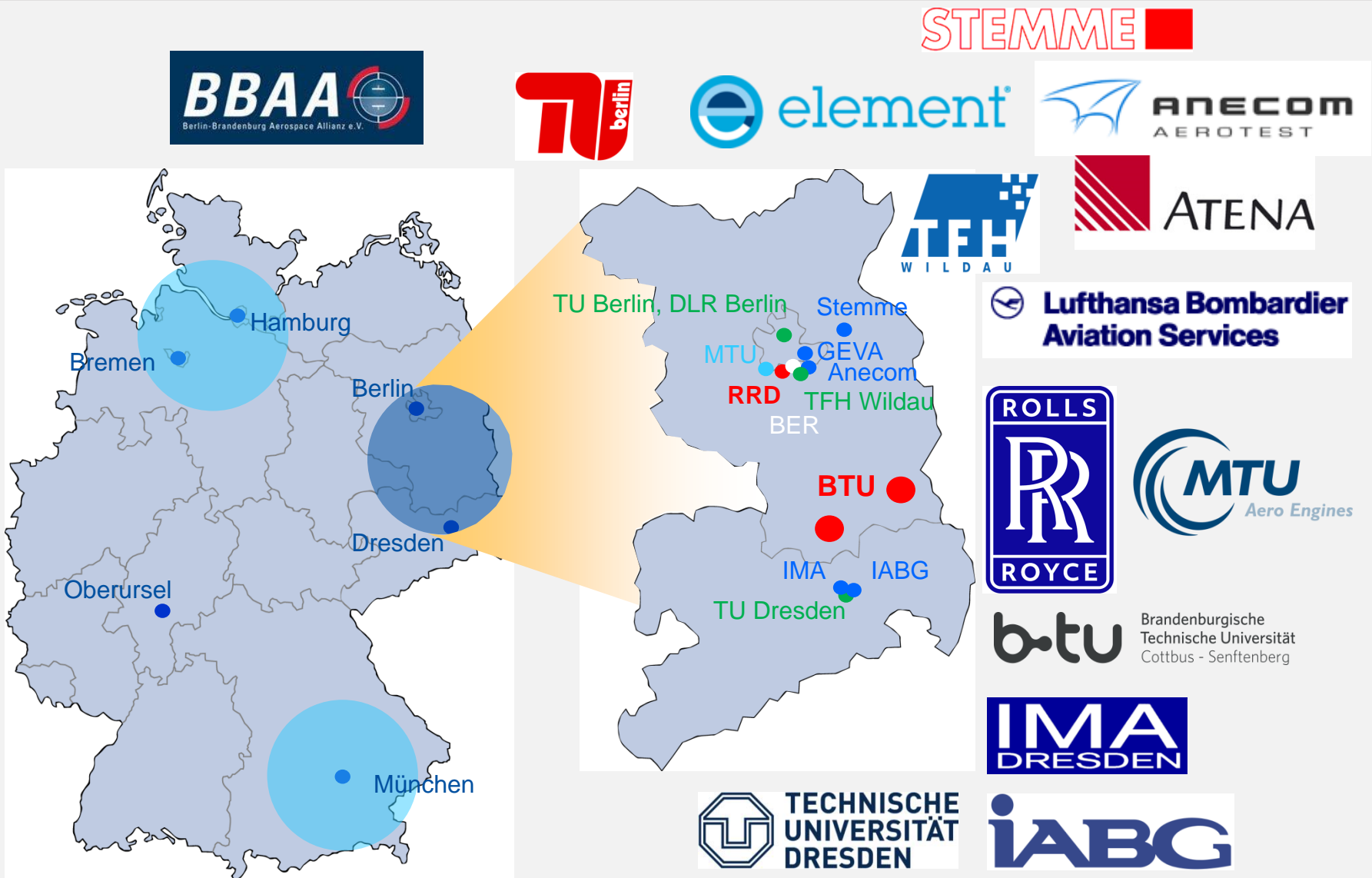
UTC Overview 2020

- Founded on **1st July 2013**, merger of BTU Cottbus and Hochschule Lausitz (university of applied science) in Senftenberg

- Three campuses: Cottbus as well as Cottbus-Sachsendorf and Senftenberg

- About **7.000** students, where **2.350** are coming from more than **100** different nations

- **180** professorships· **640** academic employees, where **303** are third party financed, **678** non-academic employees, **55** are third party financed (**status: 1st January 2020**)

- **6 faculties**

    Faculty 1 - Mathematics, Computer Science, Information Technology, Physics, Medical Technology
    Faculty 2 - Environmental Sciences and Process Engineering, Biotechnology, Chemistry
    Faculty 3 - Mechanical, Electrical and Industrial Engineering
    Faculty 4 - Health Science, Social Work, Music Education
    Faculty 5 - Economic Science, Jurisprudence, Social Science
    Faculty 6 - Architecture, Civil Engineering and Urban Planning

Brief History

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Multidisciplinary Process Integration

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University of Technology
Cottbus - Senftenberg

- 2001: Beginning of joint research Rolls-Royce - BTU

- 2002: Cooperation agreement signed

- 2003: Establishment of the unique study course 'Aero Engine Technology' in Germany (Rolls-Royce, MTU Aero Engines, DLR)

- 2005: Grand opening of UTC as first UTC in Germany (11 April 2005, first UTC Director: Arnold Kühhorn)

- 2007: Honorary professorship 'Jet engine thermodynamics' to Roland Fiola, Rolls-Royce

- 2016: Honorary doctorate to Uli Wenger, Rolls-Royce

- 2016: 10 years UTC anniversary celebration (21 November 2016)

- since 2019: UTC director Klaus Höschler

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Aero Engine Design (FTD), K. Höschler   hoeschle@b-tu.de

Structural Mechanics and Vehicle Vibrations (SMF)
B. Beirow (acting)   beirow@b-tu.de

Engineering Mechanics and Vehicle Dynamics (TMF)
D. Bestle   bestle@b-tu.de

Automation Technology, U. Berger   ulrich.berger@b-tu.de

Media Technology (MT), C. Hentschel   christian.hentschel@b-tu.de

Database and Information Systems (DBIS), I. Schmitt   schmitt@b-tu.de

Power Electronics and Propulsion Systems

G. Möhlenkamp   Georg.Moehlenkamp@b-tu.de

Metallurgy and Materials Technology (MWT), S. Weiß   sabine.weiss@b-tu.de

Control Systems and Network Control Technology
J. Schiffer   schiffer@b-tu.de

Design and Manufacturing, M. Bambach   bambach@b-tu.de

Research Focus of Members

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Aero Engine Design (Höschler)

- Automation of design engineering and analysis methods, concept studies
- Mechanical concepts for aero engine installation and integration
- Multi-functional system integration

Structural Mechanics and Vehicle Vibrations (Beirow, acting)

- Aeroelastics, blade and blisk vibration
- Mistuning: measurement, modelling and simulation
- Structural and topology optimisation, WEM and component modelling

Engineering Mechanics and Vehicle Dynamics (Bestle)

- Artificial Intelligence (AI)-aided multidisciplinary multicriteria optimisation considering mechanical, structural dynamic, and aerodynamic aspects
- Robust design of aero engines
- Modelling, parameter identification, and virtual prototyping of mechatronic systems
- Linear and non-linear vibration

Automation Technology (Berger)

- AI-based assistance systems for aero engine assembling and quality management
- Human-robot collaboration in aviation industry
- Augmented Reality (AR) and Virtual Reality (VR) based learning and training methods
- Multimodal machine networking for real time data processing.

Media Technology (Hentschel)

- Virtual and augmented reality systems
- Classic and AI-based image processing
- Visualisation of large geometries and transient simulation in VR
- VR-AR collaboration
- Multi-sensor data fusion and processing

Database and Information Systems (Schmitt)

- Knowledge representation and modelling
- Data analysis and pattern recognition
- Quantum logic

Power Electronics and Propulsion Systems (Möhlenkamp)

- Hybrid electric propulsion systems

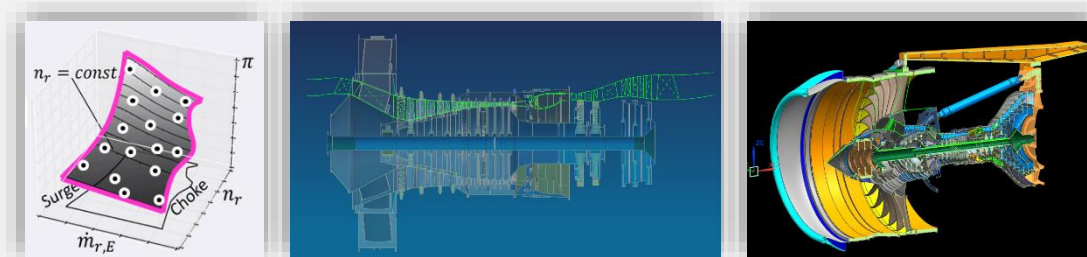## Metallurgy and Materials Technology (Weiß)

- Metal-ceramics based wear-, corrosion- and high temperature-protection
- Protective coatings against erosion, erosion testing
- Micro structure characterisation and design, damage analysis

Control Systems and Network Control Technology (Schiffer)

- Modelling, controlling, and monitoring of complex technical systems
- Power and energy management of electric systems
- Robust control strategies for electric propulsion

Deployment 2019

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- Supported detailed Finite Element (FE) modelling to understand component movements

- Universal Data Format based parametric geometry library and tools

- Automatic Compressor Map calculation developed using 3D Computational Fluid Dynamics (CFD)

- Delivered system identification from vibration measurements capability to understand mistuning and aerodynamic damping pattern

- Improvements to the Fan/Compressor Gas Path Design System

- Workflow for optimising gearwheel tooth base shapes based on 2D FE-models built up

- Process to quantify manufacturing uncertainties of turbine blades by means of geometry measurements

- Graphical User Interface to create FE input files for bird impact simulation

- Procedure for determining impact factors on Engine Preliminary Design System (EPDS) results developed and in consequence for ranking of EPDS parameters

- Integration of Unity3D in Dahlewitz-CAVE for immersive post-processing of transient simulations

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- Doctoral theses finished: 7

- Recruitment at Rolls-Royce: 2

- 10 papers

- 6 master/bachelor thesis with Rolls-Royce themes

- 1 award (Rolls-Royce innovation award gold)

- 18 projects in process

- Rolls-Royce project team members: 30

- Projects with Rolls-Royce total sum: 7,2 M€

- therefrom 5 M€ 100% funded by the Brandenburg Ministry

- and 2 M€ 50% funded by other funding authorities

- 2,43 M€ per year

- Postdocs transfer to Rolls-Royce (since 2006): 25

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- Start VIT VI and LuFo 6 call 1 projects / define LuFo 6 call 2 projects to be started in 2021

- Prepare **hybrid electric research centre** with BTU in leading function for cooperation with Rolls-Royce and other institutes (research/rapid prototyping/manufacturing with Industry 4.0 standards)

- Support enhancement of hybrid electric demonstrator

- Artificial Intelligence (AI) activities for the turbine blade design

- AI-based component detection in Computer-Aided Design (CAD) environment

- Joint supervision of master theses (subject: aeroelastics, partner: Imperial College London)

Awarded Publications (at all times)

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Rey Villazon, J. M., Berthold, M., Kühhorn, A.
Adaptive Flow Field Thermal Modeling Techniques for Turbine Rotor-Stator Cavities
Paper GT2013-94845, Proceedings of ASME Turbo Expo 2013, June 3-7, San Antonio, Texas, USA
Rolls-Royce Innovation Award 2013

Figaschewsky, F., Kühhorn, A.
Analysis of Mistuned Blade Vibrations Based on Normally Distributed Blade Individual Natural Frequencies
Proceedings of ASME Turbo Expo 2015, GT2015-43121, 13-19 June 2015, Montréal, Canada
Rolls-Royce Innovation Award 2015

Figaschewsky, F., Kühhorn, A., F., Beirow, B., Giersch, T., Schrape, S.
Experimental Analysis of Mistuned Forced Response in an Axial High Pressure Compressor Rig With Focus on Tyler-Sofrin Modes,
Proceedings of ISABE 2017, ISABE-2017-22614, Manchester, 2017.
Rolls-Royce Innovation Award 2017

Kober, M., Kühhorn, A.
Stable implicit time-integration of flexible rotating structures - explanation for instabilities and concepts for avoidance. *Applied Mathematical Modelling, Volume 60, August 2018, Pages 235-243.*
Rolls-Royce Innovation Award 2018 (1st place)

Figaschewsky, F., Hanschke, B., Kühhorn, A.
Efficient Generation of Engine Representative Tip Timing Data Based on a Reduced Order Model for Bladed Rotors. *Proceedings of ASME Turbo Expo 2018, GT2018-76342, June 11-15, 2018, Lillestrom (Oslo), Norway.*
Rolls-Royce Innovation Award 2018 (2nd place)

Figaschewsky, F., Kühhorn, A., Beirow, B., Giersch, T., Schrape, S., Nipkau, J.
An inverse approach to identify tuned aerodynamic damping, system frequencies and mistuning – Part 3: Application to engine data.
Proceedings of ASME Turbo Expo 2019, GT2019-91337, June 15-21, 2019, Phoenix, AZ, USA.
Rolls-Royce Innovation Award 2019