Technische Universität Braunschweig | Institut für Strömungsmechanik
Hermann-Blenk-Str. 37 | 38108 Braunschweig | Deutschland

PhD research position

"Aerostructural Wing and Fuselage Optimization for Hydrogen-based Aircraft "

Department of Mechanical Engineering,
Technische Univesitat Braunschweig, Germany

Background

Currently, aviation is undergoing a large shift towards more sustainable, eco-friendly, and efficient aviation to meet the International Air Transport Association (IATA) ambitious targets to mitigate CO2 emissions by 50% from air transport until 2050.

Hydrogen technologies have emerged as a potential energy source represent a long-term option as a fuel for aviation. Beyond the purely technological issues, a holistic assessment requires looking at the integration of hydrogen into the aircraft design towards hydrogen-powered aircraft.

The development of the necessary systems to store and distribute hydrogen fuel on the aircraft for flight is a mandatory step toward such a system. Since liquid hydrogen cannot be reasonably stored in the wings due to its volume, pressure, and the insulation required, new solutions must be introduced to integrate liquid hydrogen tanks into the fuselage. This opens up possibilities with regard to the design of the wing and the fuselage. The space in the wing reserved previously for the fuel can now be used for optimizing the structural load paths for high aspect ratio wings incorporating natural laminar flow (NLF) or hybrid laminar flow control HLFC technologies for drag reduction.

The shape of conventional transport aircraft is tube-and-wing configuration (CTW), which remains up to today. For Hydrogen aircraft type (liquid H2 aircraft), it is most likely that the length and width of the fuselage will both increase to accommodate the integral LH2 tanks. The fuselage can generate up to 50% of total profile drag (parasitic drag) for all-turbulent aircraft in cruise conditions. However, it is estimated that the contribution of the turbulent fuselage to airplane profile drag increases to more than 70% if the extended laminar regions on the wings and the tail surfaces are obtained.

Expected research focus

Within a large research consortium, TU Braunschweig embarks on research on the aero-structural design of hydrogen aircraft. The main objectives of this research proposal are:

1) to develop the tools to optimize the wing design from the aerodynamic and structural aspects. On the aerodynamic side, the focus is on drag reduction, especially through maintaining laminar flow on the wing using Hybrid Laminar Flow Control (HLFC) or Natural Laminar Flow (NLF) approaches. On the structural side, various aspects for more accurate weight prediction for highly flexible wings are investigated in more depth, such as evaluation of suitable designs and inclusion of secondary structures such as control surfaces in the weight consideration based on physics-based methods.

2) to optimize the tube-and-wing configuration (CTW) aircraft with accommodation for integral hydrogen tanks in synergy with minimum drag fuselage shape that satisfies the design constraints and requirements. Genetic algorithm-based optimization coupled to three-dimensional aerodynamic panel solver with BL solver and transition prediction using Granville criteria will be utilized for hydrogen mid/long-range aircraft fuselage design. This task addresses the conceptual design of the fuselage for H2 aircraft. The fuselage has a number of features specific to the class and mission of the aircraft configuration.

General qualifications:

Applicants must hold (or graduating soon) a Master's degree from a from a recognized university or institution in Aerospace Engineering or Mechanical Engineering or Applied Physics or related disciplines or a related field; Applicants are expected to have very good academic achievements as well a strong background in Science, Technology, Engineering, and Mathematics (STEM) areas. Independent, curiosity-driven work attitude; excellent communication skills in English (written and spoken). International exposure and participation in competitive research projects are beneficial.

Specific qualifications

Applicants are expected to have

- Experience in running numerical simulations using commercial or in-house codes.
- A solid foundation in fluid dynamics especially transitional flows from laminar to turbulence and flow instability analysis.
- A solid foundation in structural analysis and design for aerospace engineering.
- Background in computational fluid dynamics and numerical methods and finite element method
- Very good programming skills in one or more of the program languages (C, C++, Fortran, Python)
- Familiar with turbulence and transition flow modeling, optimization methods are advantages

Benefits

We are offering excellent working conditions in a highly international and interdisciplinary research environment. Salary and working hours are in accordance with the funding guidelines of the TU Braunschweig for Phd researchers. Working hours are fulltime; salary is according to E13 TV-L. Furthermore, we offer opportunities regarding work life balance as well as health promotion services. The PhD position is limited to three years. The expected starting date is *January 1st, 2022*.

About the employer

At TU Braunschweig we appreciate a team-oriented and communicative style of work. Gender Equality is an important factor for us. The TU Braunschweig is committed to increasing the number of women in STEM areas; therefore, we explicitly encourage women to apply. Applications from international Master students of all nations are very welcomed.

Application Process

Applications have to consist of a cover letter (statement of purpose, including your motivation), your idea of methodical and contextual contribution to the project (length about one page), full CV, academic certificates and transcripts (Bachelor and Master degrees), and other supporting certificates. Please send a complete written application in English as a single PDF file to:

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Dr. Camli Badrya: TU Braunschweig, Institute of Fluid Mechanics
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Email: c.badrya@tu-braunschweig.de

Dr. Matthias Haupt: m.haupt@tu-braunschweig.de
Please add your affiliation

The deadline for submitting applications is September 25th, earlier applications are welcome to be submitted.
The expected starting date is 1/1/2022

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As part of the Lower Saxony Research Center for Aviation (NFL) our work is based on the following

Mission statement

We are a leading aerospace research center in Germany, providing top level research and education. We create leading innovations in aerospace.

Scientific excellence and professionalism guide us in all that we do. Our research helps satisfy society's need for mobility – both today and in the future. We focus on environmental sustainability, safety, and efficiency.

We direct the results of our research toward industry, science, and society. Our education is aimed at highly qualified engineers who are enthusiastic about aerospace.

Joining together the broad areas of expertise from the TU Braunschweig and the German Aerospace Center gives us a particular appeal, along with international visibility.

Together we have all the skills needed to create technical innovations for aircraft and air transportation. These we develop with a holistic view toward of the system.

We offer the complete spectrum, from basic research to application-based technical development and testing. The results keep our education and training on the cutting edge.

The Campus Research Airport is building on an 80-year tradition of aeronautical research and flight testing in Braunschweig. We have an infrastructure that is unique internationally, with research aircraft, wind tunnels, simulators, and test facilities. Award-winning scientists and motivated students ensure top-level research.