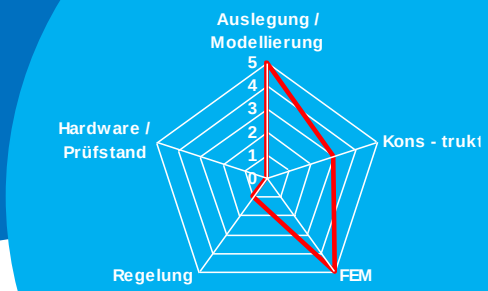
Universität Stuttgart
Institut für Elektrische Energiewandlung

FA/SA /MA



Preliminary Investigation of Inductive Electrically Excited Axial Flux Machines: Design, Analysis, and Performance Evaluation

Inductive Electrically Excited Synchronous Machines (iEESMs) are becoming an increasingly attractive alternative to Permanent Magnet Synchronous Machines (PMSMs) due to their potential to reduce reliance on rare earth materials and lower overall CO2 emissions. Axial Flux Machines (AFMs) offer several advantages over Radial Flux Machines (RFMs), such as higher power density and a more compact, modular design. These features make AFMs particularly well-suited for electric vehicle (EV) applications, where performance and space efficiency are critical.

As the automotive industry moves toward more sustainable solutions, the focus is shifting to Inductive Electrically Excited Axial Flux Machines (iEEAFMs), which eliminate the need for permanent magnets while maintaining the benefits of axial flux designs.

This thesis aims to size an iEEAFM based on an existing Permanent Magnet Axial Flux Machine (PMAFM) design. The research will also include the development of a 2D model, using either COMSOL or ANSYS Maxwell to analyze the machine's electromagnetic behavior. A parameter study will identify the key factors that influence performance. Finally, a comparison will be made between the PMAFM and the iEEAFM designs, focusing on power density and other performance metrics.

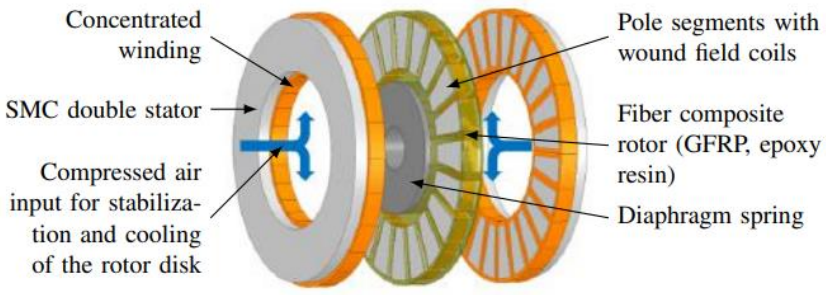


Fig. 1: Prototype of an EEAFM developed by TU Ilmenau [1].

[1]: P. Schwarz, A. Moeckel: "Development of an electrically excited axial flux machine with stabilized disk rotor". 2023

Working language:

→ Only **English**

Requirements for students:

→ Ability to work independently and a strong interest in the design of electrical machines
→ Basic knowledge of Finite Element Method (FEM)
→ Ideally, students should have attended the lectures Electrical Machines 1,2 and 3

Work packages:

- Literature review of existing iEE- and PM-AFM topologies
- Define base requirements based on existing PMAFM
- Initial analytical sizing and design decisions
- Establish geometry parameterization for the rotor
- Prepare scripts for automatic geometry creation
- Create a script for automatic extraction of performance parameters of the machine models
- Examine the differences between the initial iEEAFM model and the PMAFM, considering torque, torque ripple, losses and power density
- Sensitivity analysis for both iEE- and PMAFM with a final comparison
- Optimization for both iEE- and PMAFM with final comparison **(Optional)**

Ansprechpartner: Parisa Rezapour, Andreas Gneiting

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