SE²A – Sustainable and Energy-Efficient Aviation
ICA B1.6 Effective Design Methods and Design Exploration for Laminar Wings

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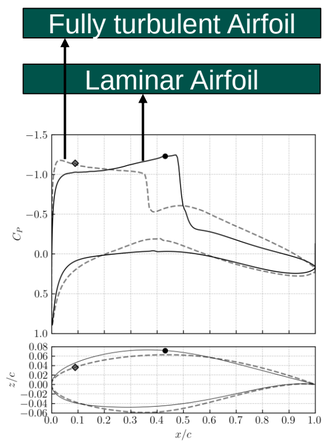
Current State of Research

- Laminarity yields significant fuel-saving potentials
  - Traditionally inverse design is used
  - Design highly sensitive to perturbations
- Research focused either on
  - Prediction of transition with different fidelities
  - Optimization under deterministic conditions
- Initial work taking UQ into account during design
  - „made-up“ distributions
  - Simplified assumptions

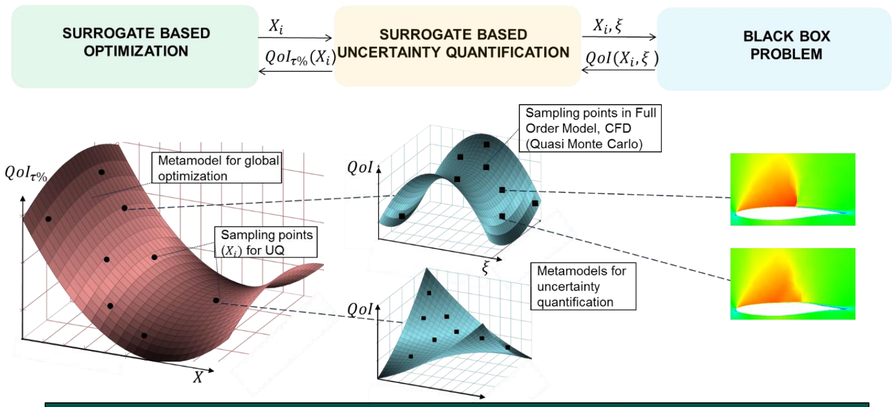


Research Objective

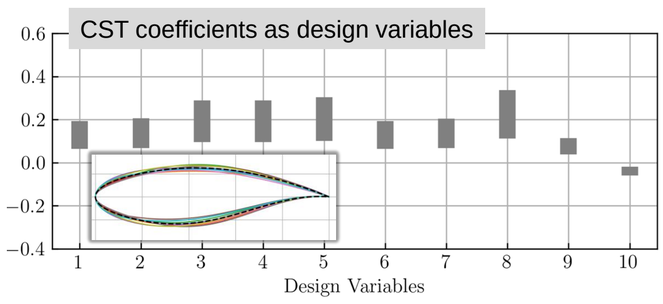
- Develop and apply methods for efficient and robust design of laminar wings

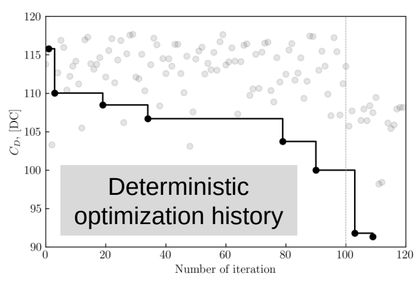
Methodical Approach

- Different methods and tools will be used and combined:
  - Aerodynamic solvers of different fidelity levels
  - Transition prediction
  - Surrogate modeling for efficient:
    - Optimization
    - Uncertainty Quantification

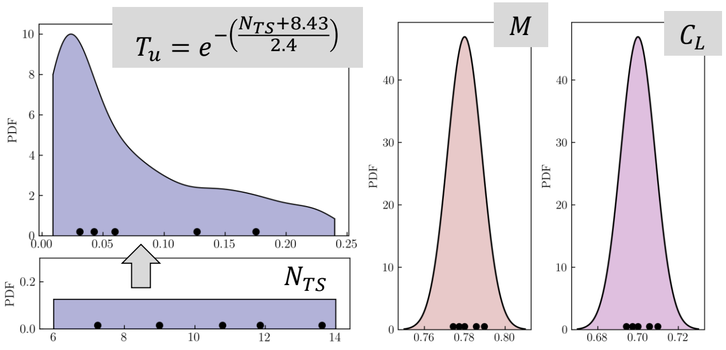


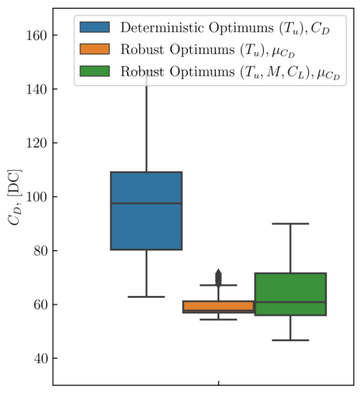
Interim Results

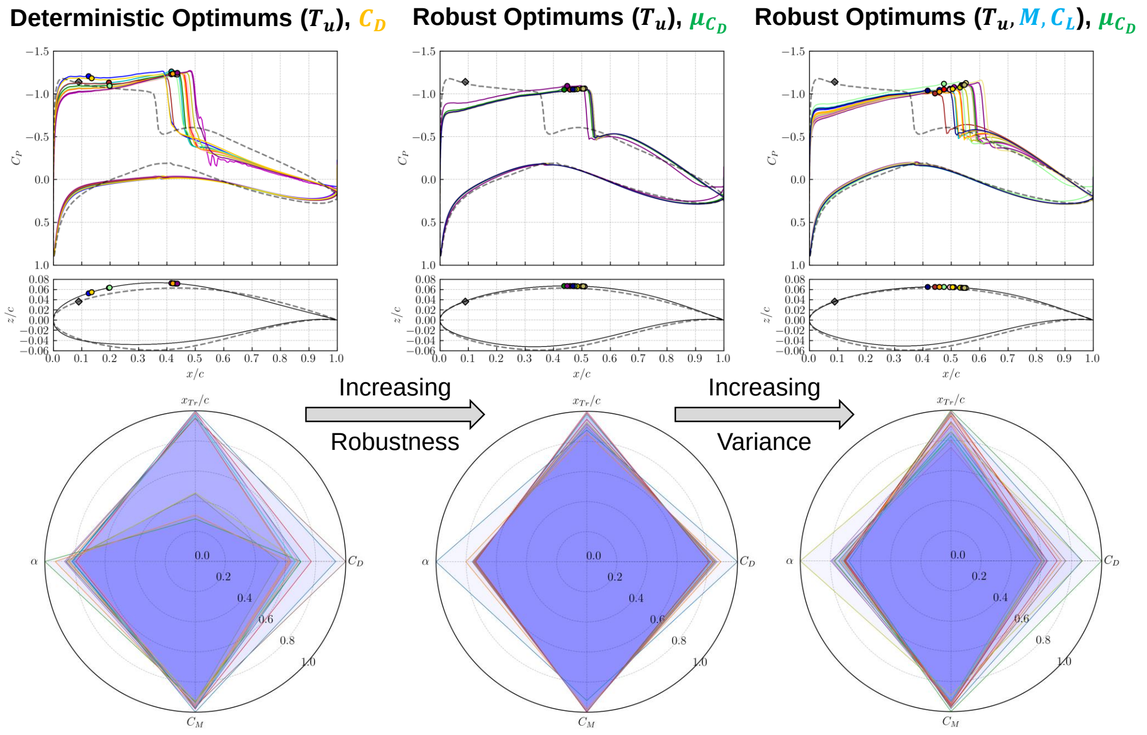




Transonic airfoil (RAE2822) optimization under environmental and operational uncertainties





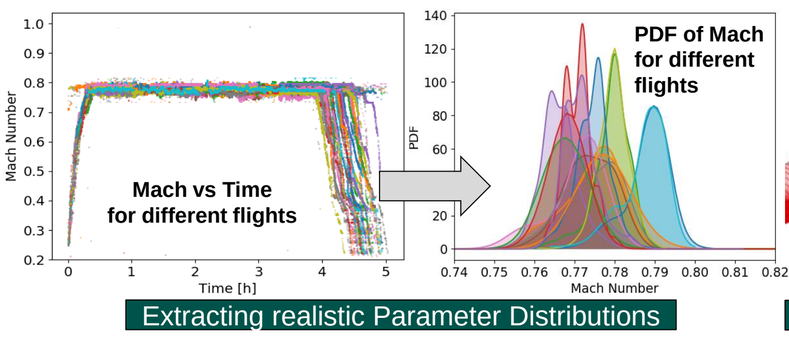


Interactions, cooperation and required Inputs

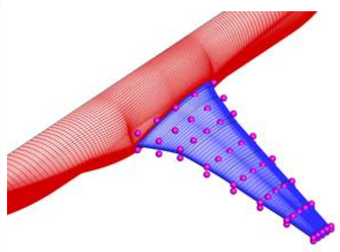
No.	Description	Connection
D1	Uncertainty Analysis of advanced swept-wing design with focus on transition location and sensitivities	To B1.8
D2	First version of γ-CAS model enhanced for 3D flows around wings	From B1.7
D3	Results from W/T#1: Transition position, velocity profiles, mode amplitudes, integral BL data, turbulence intensities above BL and uncertainties of quantities of interest for different HLFC settings	From B1.5
D4	Uncertain γ-CAS model input/operational quantities	From B1.7
D5	Reference suction surface properties characterized	From B1.8

Outlook and Challenges

- Devise multi-fidelity strategies for wing design to optimize for global minimum drag with feasible design parameterizations and constraints for natural as well as hybrid laminar flow control
- Rigorous assessment of various uncertainties and their influence
- Employ surrogate models to obtain an efficient design based on wing optimization under various uncertainties
- Integrate insights and models from other SE²A Cluster activities



Extracting realistic Parameter Distributions



Wing Parameterizations