Session II: Technical Details and Demonstration Results

Technical development: Overview and approach
Prajwal Shiva Prakasha (DLR) and Thierry Lefebvre (ONERA)

Framework: Development & implementation of a collaborative framework for aviation impact assessment
Marko Alder et al. (DLR)

Use Case 1: Assessing advanced propulsion systems using the Impact Monitor Framework
Atif Riaz et al. (CU)

Use Case 2: Assessing continuous descent operations using the Impact Monitor Framework
Jordi Pons-Prats et al. (UPC)

Use Case 3: Assessing policies for the uptake of sustainable aviation fuels using the Impact Monitor Framework
Inge Mayeres et al. (TML)

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Use Case 1:

Assessing advanced propulsion systems using the Impact Monitor Framework

Utkarsh Gupta, Atif Riaz, Felix Brenner, Thierry Lefebvre, Patrick Ratei, Marko Adler, Prajwal Shiva Prakasha, Lukas Weber, Jordi Pons-Prats, Dionysios Markatos

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Content Overview

1. Introduction: Background and Motivation
2. Aim and Objectives
3. Advanced Airframe-Propulsion Design Framework
4. Use Case Demonstration
5. Summary and Conclusions

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Advanced propulsion Systems

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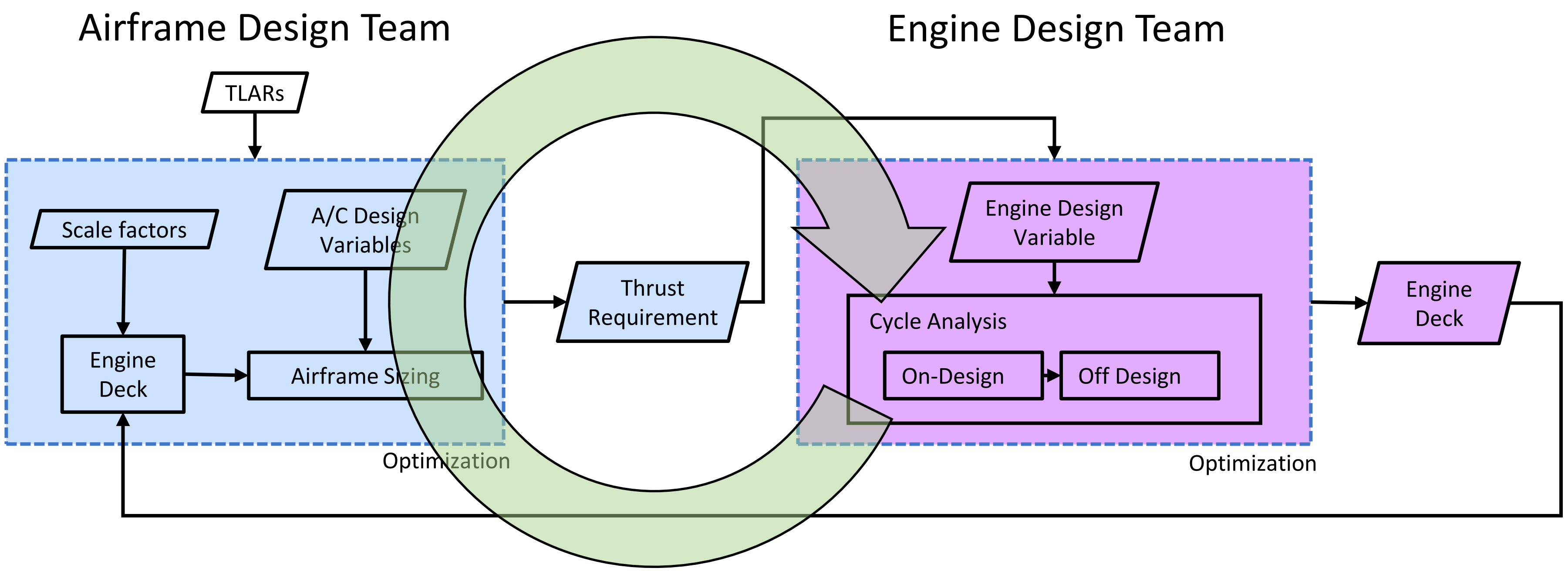
Research Problem (Challenges)

Existing airframe-engine matching process employs manual airframe-engine Design iterations

- Convergence Issue
- Suboptimal
- Change of requirements
- Design Conflicts



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Advanced propulsion Systems

Objective:

- Investigate the viability and competitiveness of future SAF fuelled aircraft concepts

Scenario:

- Design Mission + Long range mission + Payload Range analysis + Trajectory amendment for contrail avoidance

Aircraft and Engine Models:

- Single-Aisle (SMR), Wide-Body (LR)
- VHBR (9-10), UHBR 15+ with Gearbox, KER + SAF

Metrics:

- Fuel burn- mission level and segment ,
- Emissions- CO2, NOx, Contrails,
- Sustainability

Assumption:

- 0D steady-state thermodynamic performance simulation for propulsion systems
- Point-mass flight mechanics for aircraft 2D mission sizing
- Entry-into-Service of 2030-40 (No hydrogen fuel, but SAF percentage)

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Advanced Airframe-Propulsion Design Framework

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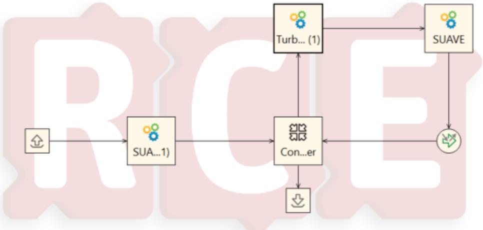
Collaborative Workflow/Framework



SAUVE (Aircraft Modelling)
@ USTUTT - Germany

DYNAMO (Trajectory Amendment for Contrail Avoidance)
@ UPC – Spain

Set of collaborative tools and environment
@ DLR, Germany

TurboMatch (Engine Modelling)
@ CU – United Kingdom

AECCI

(Aircraft Emissions and Contrails for Climate Impact)
@ ONERA - France

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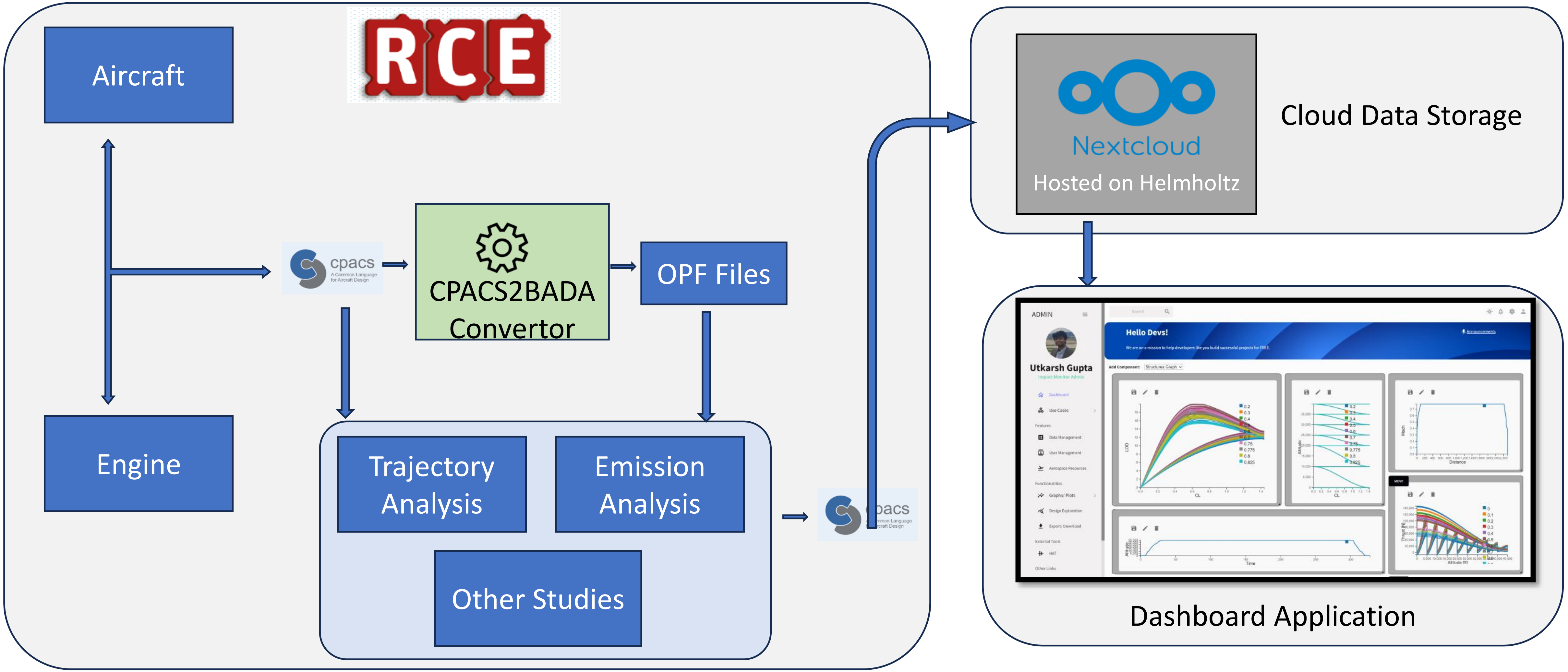
Collaborative Workflow/Framework



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Collaborative Workflow/Framework

MDO system formulation environments

Study 1: VHBR (9-10), UHBR 15+ with Gearbox, KER + SAF

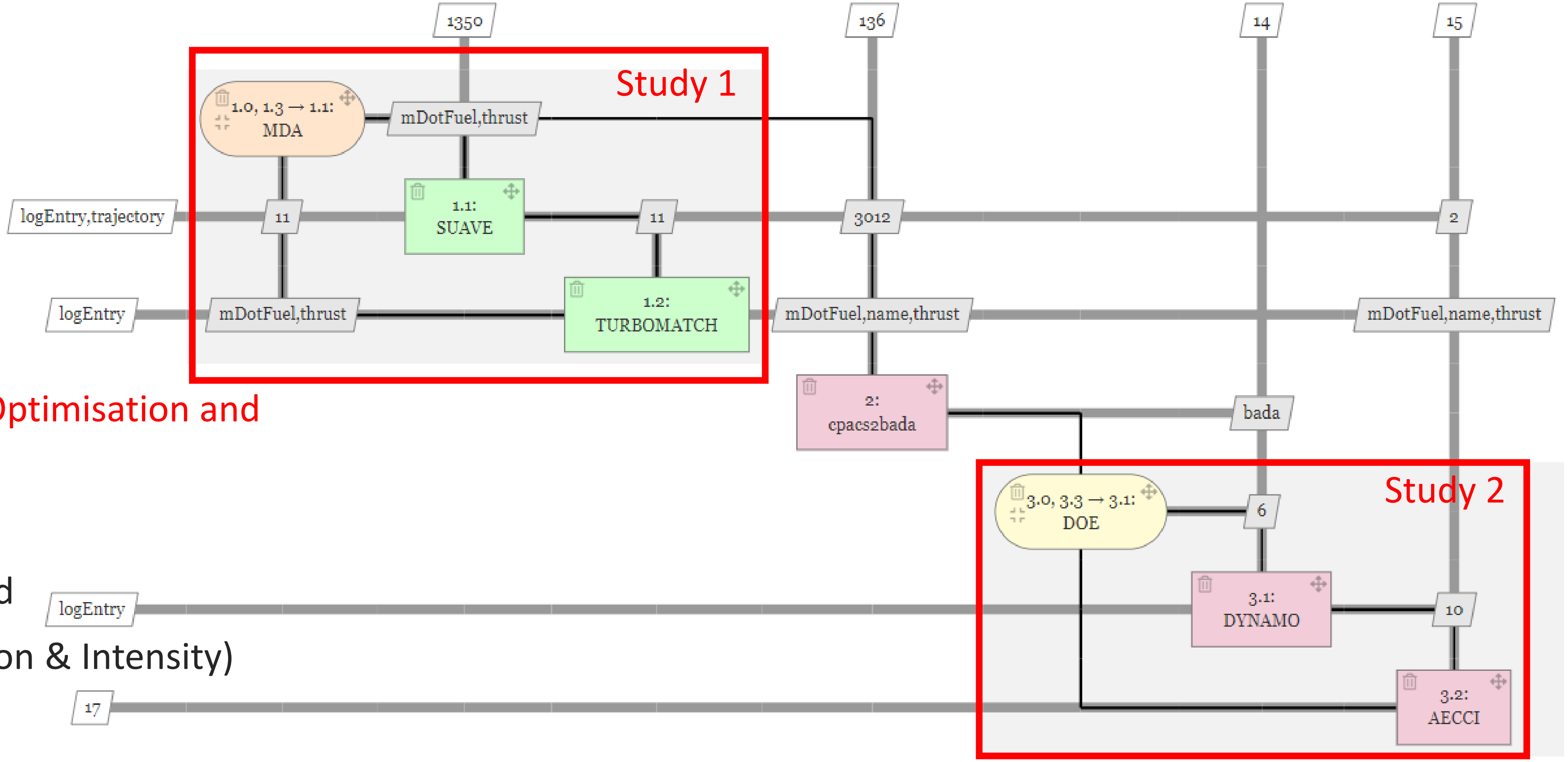
Design Variables:

- Aspect Ratio
- Wing Reference Area
- Gross weight
- Payload

Study 2: 4D Trajectory Optimisation and Emissions Analysis

Design Variables:

- Cruise Altitude & Speed
- Weather (Wind Direction & Intensity)
- Cost Index



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Use Case Results/Demonstration

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Study 1 Setup:

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Study 1: VHBR (9-10), UHBR 15+ with Gearbox, Kerosene + Sustainable Aviation Fuel, Conventional Airframe Configurations

Airframe Design Problem Formulation

Airframe Design Variables	Wing Area (m^2)	[120, 140]
	Aspect Ratio	[9, 12]
Top-Level Aircraft Requirements	Take-off Field Length (m)	$\leq$ 2000
	Time to Climb (min)	$\leq$ 25
	Range (nm)	$\geq$ 4000
	Block Fuel (lb)	Minimize
Thrust Requirements	End of Runway Thrust (lbf)	Calculated
	Top of Climb Thrust (lbf)	
	Mid-Cruise Thrust (lbf)	

Engine Design Problem Formulation

Engine Design Variables	Bypass Ratio	[9, 14]
	Fan Pressure Ratio	[1.6, 2.0]
	Low Compressor Pressure Ratio	[2.8, 3.2]
	High Compressor Pressure Ratio	[9, 15]
	Inlet Airflow Rate (kg/s)	[400, 600]
Performance Output	End of Runway Thrust (N)	Calculated
	Top of Climb Thrust (N)	
	Mid-Cruise Thrust (N)	
	Turbine Inlet Temperature (K)	$\leq$ 1750
	Specific Fuel Consumption ($kg/(N \cdot s)$)	Minimize
	Complete Engine Deck	Cpacs files

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Study 1: Advanced propulsion Systems Assessment

Study 1

Specification:

VHBR (9-10)

UHBR 15+ with Gearbox

Kerosene & Sustainable Aviation Fuel

Conventional Airframe Configurations

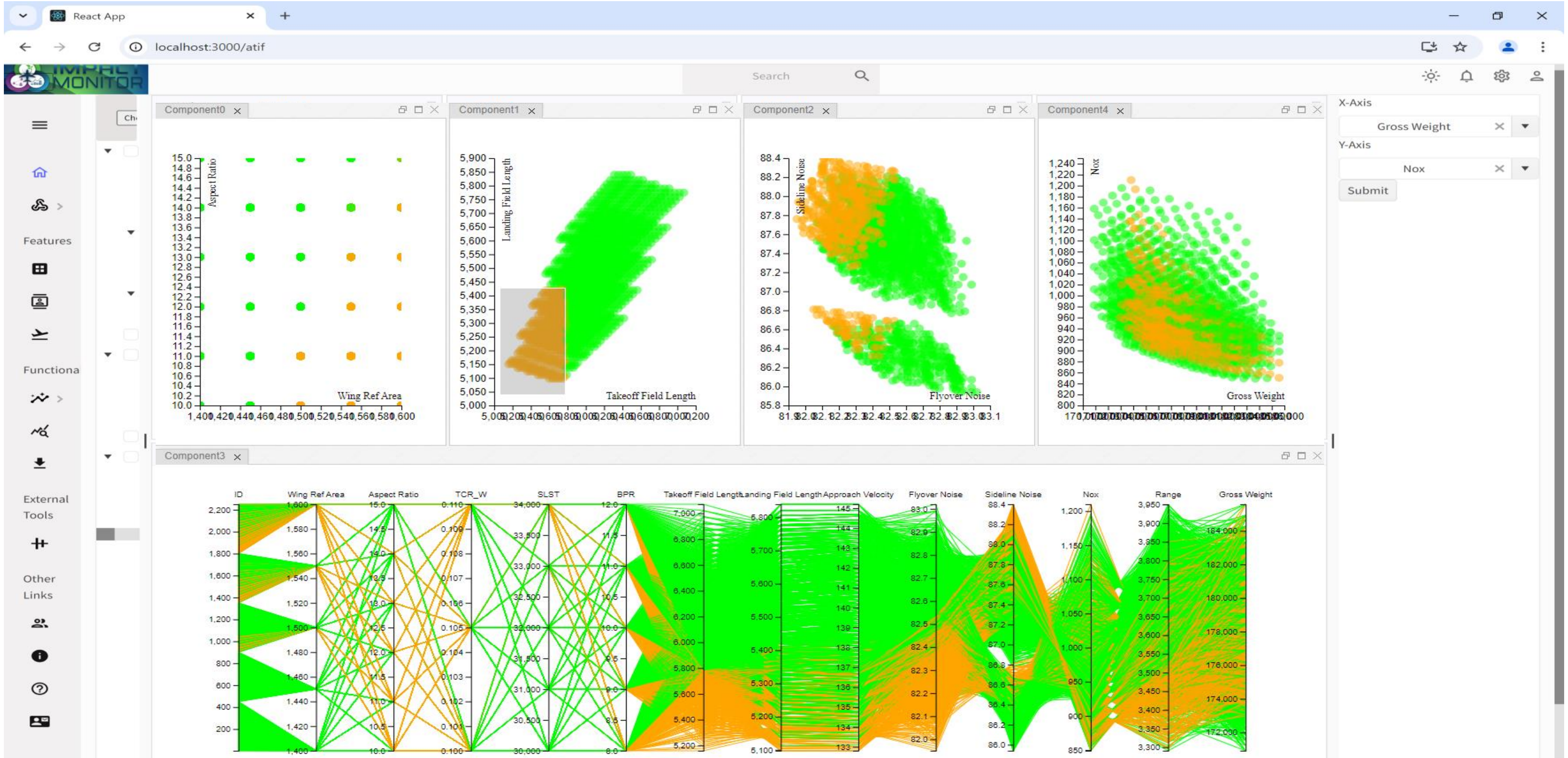
Results:

Multiple CPACS Files

Visual/Data Analytics

Design Space Exploration

What-if Analysis



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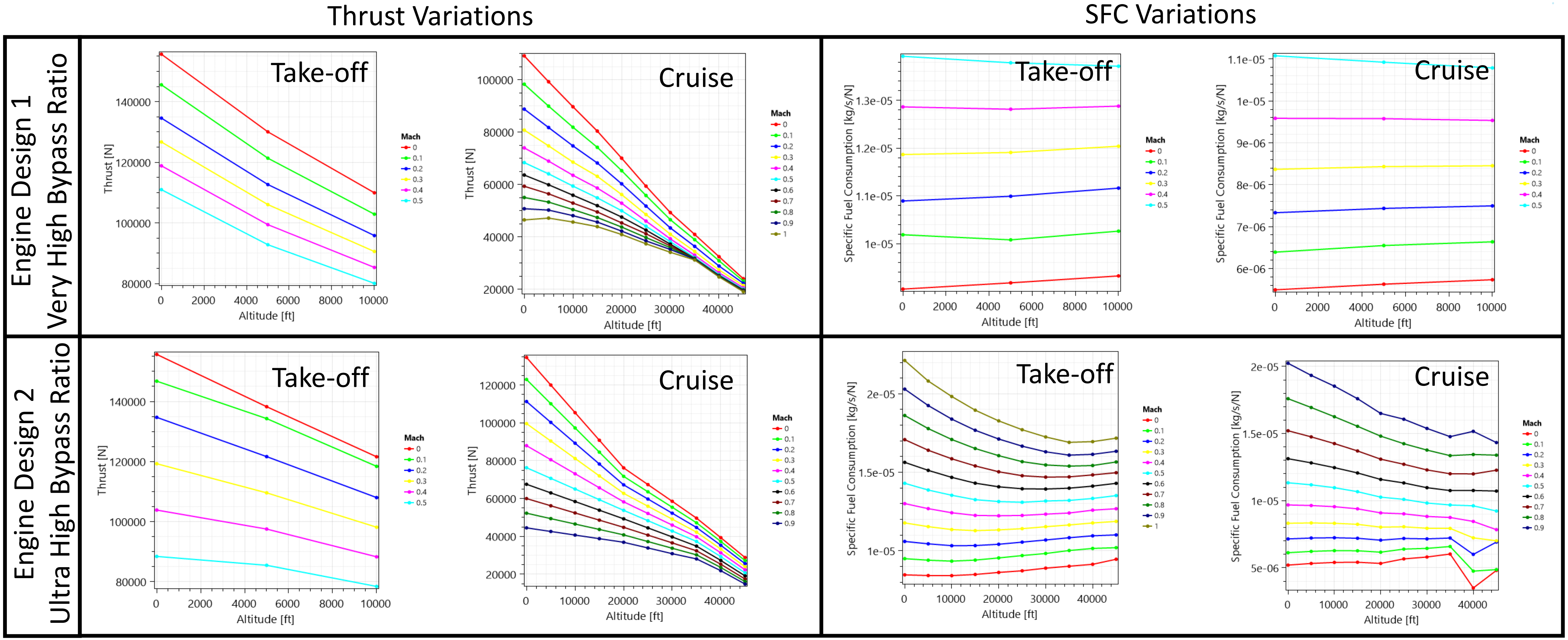
Study 1 – Engine Design Results



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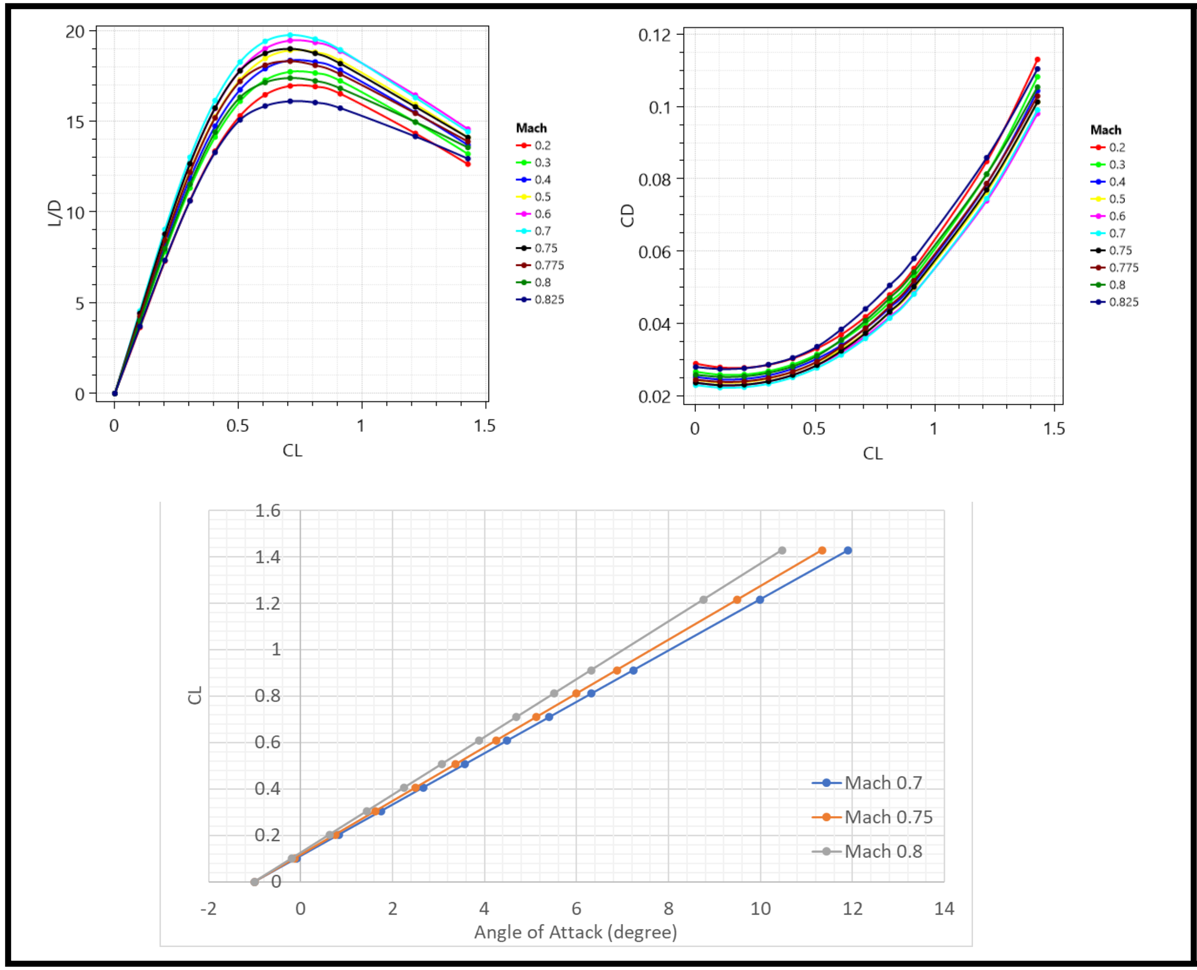
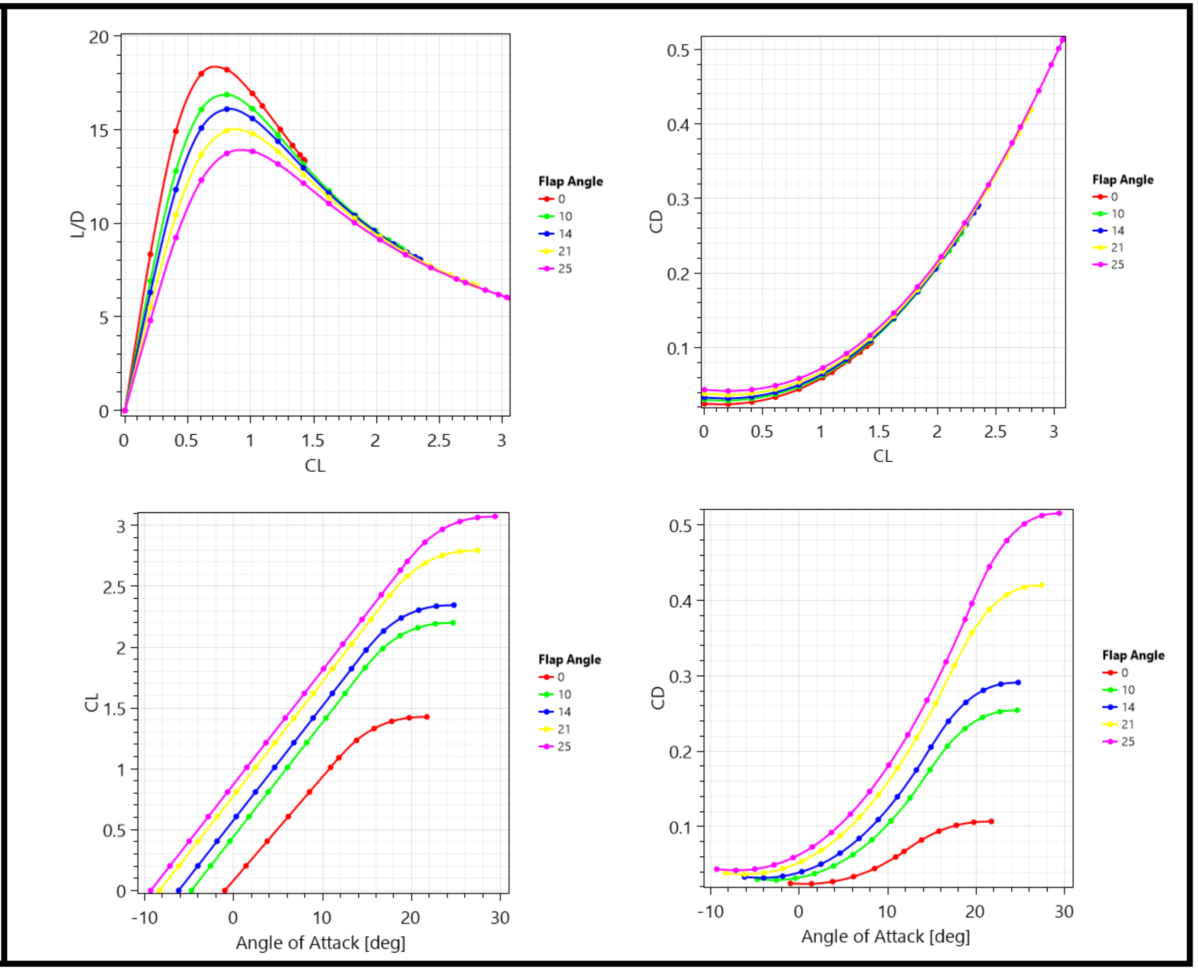
Study 1 – Airframe Design Results

High Speed Drag Polar



Low Speed Drag Polar



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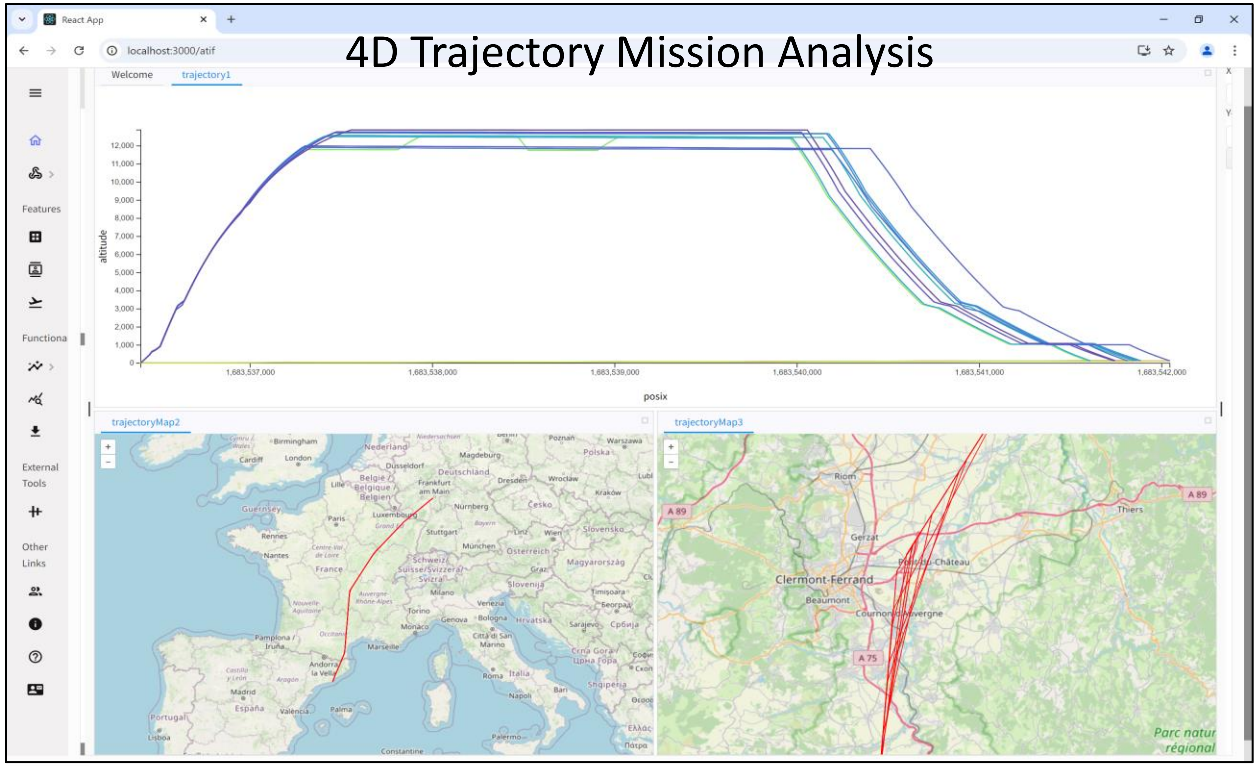
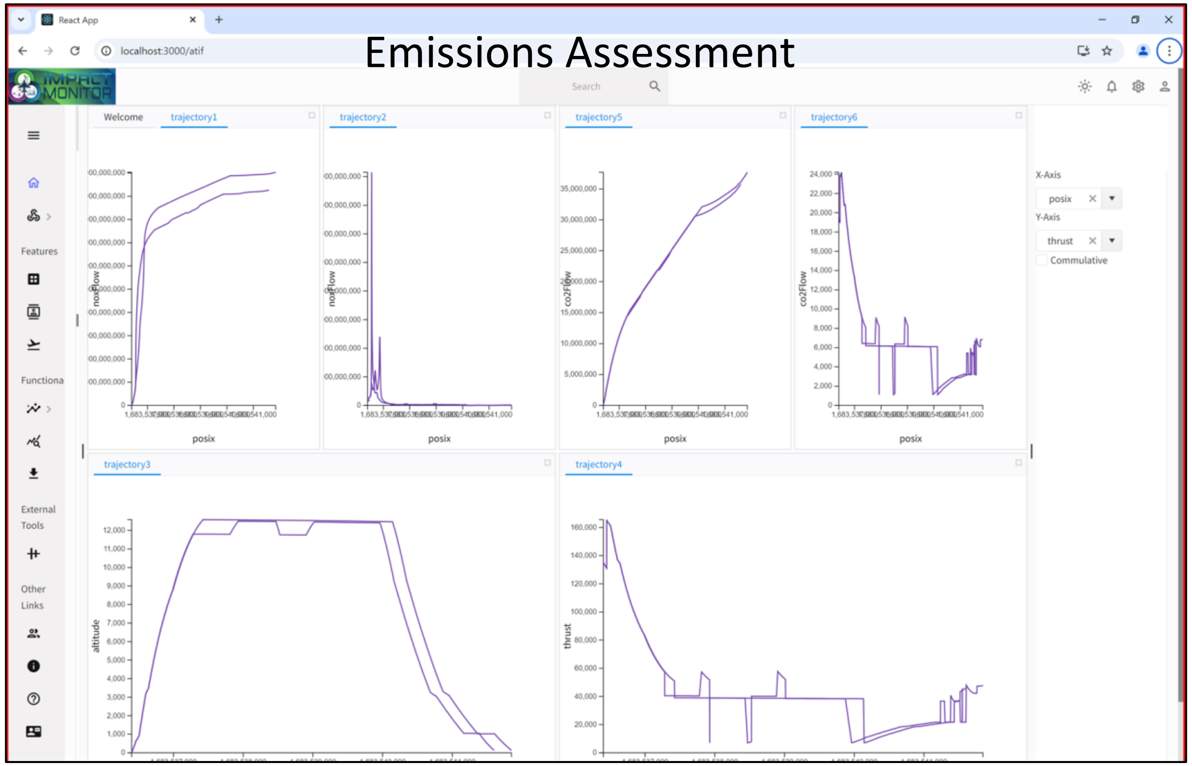
Study 2 – 4D Trajectory & Emissions Analysis

Study 2

Specification: Cruise Altitude & Speed, Weather (Wind Direction & Intensity), Cost Index

Results: 16 4D Trajectories (CPACS Files), Lift/Drag Coefficients, Thrust/SFC, Emissions (CO_2, NOX, SOX, H20, HC, Contrails)





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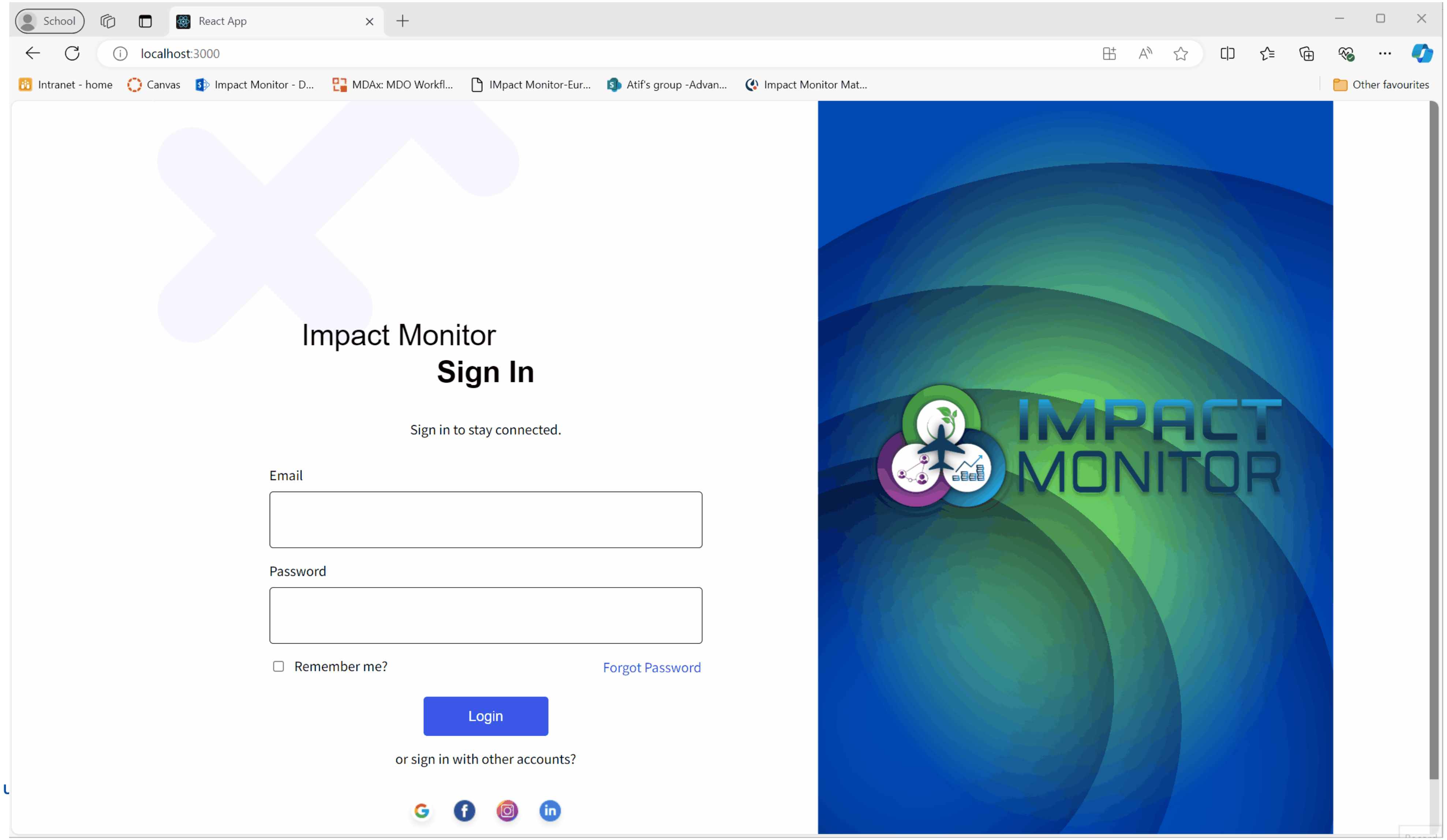
Demo



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Summary & Conclusions

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Benefits and Conclusions

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Enhanced Efficiency and Productivity

- Streamlined workflows
- Improved data sharing
- Real-time collaboration

Innovation and Knowledge Sharing

- Cross-functional collaboration
- Knowledge transfer
- Accelerated research and development

Improved Decision-Making

- Comprehensive analysis
- Scenario planning
- Risk mitigation

Improved Regulatory Compliance

- Centralized data management
- Enhanced traceability
- Reduced risk of non-compliance

Cost Reduction

- Resource optimization
- Reduced development time
- Improved collaboration

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EU Project