

ENabling Optimized DISruptivE airframe-propulsion integration concepts

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Guidelines for the planning and execution of experimental campaigns distributed across multiple aeroacoustic wind tunnels

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DEC	Websites, patent fillings, videos, etc.	
ORDP	Open Research Data Pilot	
Dissemination Level		
PU	Public	X
CO	Confidential, only for members of the consortium (incl. Commission Services)	

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1 Introduction

This report provides guidelines for planning and executing aeroacoustic experimental campaigns across multiple wind tunnels. Based on lessons learned from the ENODISE project, these guidelines offer valuable insights for newcomers, young researchers, and industrial RTD managers in the field of aeroacoustics.

2 Guidelines for Experimental Campaigns

This section outlines basic guidelines that are organized into three critical phases: planning, execution, data management and analysis.

2.1 Planning Phase

During the planning phase, consider these key factors:

- Clearly define the research objective and carefully evaluate the necessity of conducting experiments across multiple wind tunnel facilities to achieve it;
- Carefully select appropriate aeroacoustic wind tunnel facilities for the study proposed;
- Coordinate equipment transport and setup across facilities to ensure consistency;
- Develop protocols for data collection and management across facilities;
- Develop a cross-validation strategy for comparing results between different facilities.

2.2 Execution Phase

During the execution of experiments:

- Document all procedures, observations, experimental conditions, equipment settings, and any anomalies;
- Regularly calibrate equipment;
- Execute quality control measures throughout the experimental campaign;
- Conduct preliminary data analysis to identify potential problems early on.

2.3 Data Management and Analysis

For adequate data management and analysis:

- Use a centralized data repository;
- Create a standardized format for data across all experiments;
- Keep a version control system for data and documentation to track any changes over time;
- Perform cross-validation analysis using experimental data from different facilities.

3 Lessons Learned and Recommendations

This section details the main lessons learned and provides recommendations for addressing the common challenges encountered during the ENODISE project.

3.1 Inflow Quality Control

- Configuration A (Fig. 1): It is easier to control and document turbulent boundary layer (TBL) characteristics using boundary layer tripping and fences.
- Configuration B (Fig. 2): Multiple propeller tests in different wind tunnels (TUD, ECL, NLR) revealed varying inflow properties at the propeller section.
- Configuration C (Fig. 3): Minimising the effect of ingested turbulence and/or recirculation is difficult. One promising approach is employing a porous floor with suction that can be adjusted for each propeller's downwash. Studying and documenting how room recirculation affects the experimental data is also essential, enabling cross-validation between the numerical and experimental results.

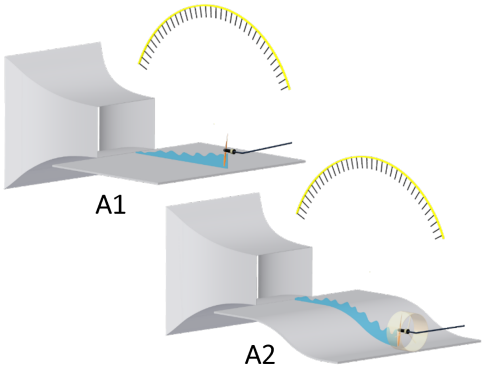


Figure 1: Configurations A

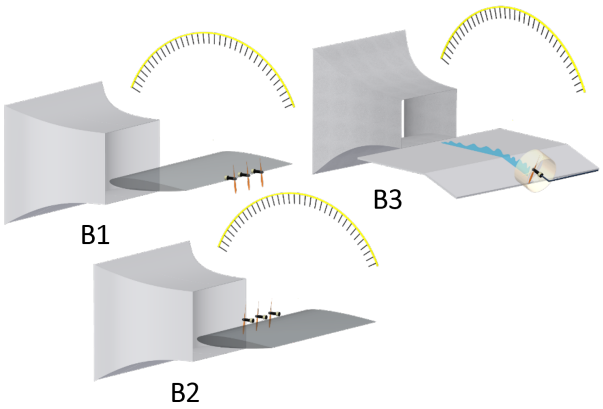


Figure 2: Configurations B

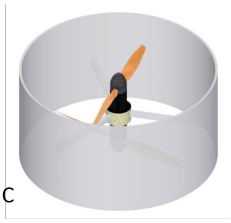


Figure 3: Configuration C

3.2 Experimental Setup Considerations

- Always have spare motors on hand, especially for experiments involving distributed propulsion systems.
- Cooling systems are crucial for motor longevity and accurate load cell measurements. Liquid cooling is recommended for future setups.
- Multi-sensor automated acquisition systems with shared sample clocks are worth the time and budget investments.
- Early characterization of the setup and ensuring result repeatability are essential for data reliability.

3.3 Cross-Facility Standardization

- Difficulties in avoiding discrepancies between configuration A mockups developed by different institutions (e.g., UBRI and UTWE) regarding temperature control and nacelle design.
- Test conditions and parameters should be more integrated across facilities.

3.4 Data Analysis and Comparison

To improve the reliability of wind tunnel comparisons:

- Treat secondary parameters (e.g., temperature) as inputs for a reduced-order model. This approach provides a systematic way to correct measurements for variations in these parameters, enabling more accurate comparisons.
- Identify parameters causing epistemic uncertainty and distinguish them from those associated with aleatoric uncertainty.

As a general and final observation, the ENODISE project revealed that despite appearing simple, low-TRL experiments often presented unexpected challenges and did not always deliver the expected high potential outputs.

4 Conclusion

These guidelines, derived from the ENODISE project, provide a framework for conducting succesful experimental campaigns across multiple aeroacoustic wind tunnels. By following these recommendations, researchers can improve the reliability and comparability of their results, contributing to advances in aeroacoustics and related fields.