



# ***Falcon***

## Foreseeing **the next generation** of Aircraft

D1.2 Data Management Plan  
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2	Julien FAVIER (AMU)	06/05/2024	Updated draft internally reviewed
3	All the partners	16/05/2024	Updated draft after contribution
4	Sophie Baudin, Julien Favier	19/06/2024	Final version

### List of acronyms

DMP	Data Management Plan
DPO	Data Protection Officer
EC	European Commission
EU	European Union
FSI	Fluid-Structure Interaction
GDPR	General Data Protection Regulation
KPIs	Key Performance Indicators
LBM	Lattice Boltzmann Methods
R&I	Research & Innovation
WP	Work Package

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## BACKGROUND: ABOUT THE FALCON PROJECT

The FALCON project is a Research and Innovation Action funded by the Horizon Europe – the Framework Programme for Research and Innovation (2021-2027) aiming to develop a hybrid approach combining both cutting-edge numerical and experimental methods to analyse Fluid-Structure Interaction (FSI), better predict and control the aircraft aerodynamic unsteady loads, thus improving the aeroelastic properties and sustainability of aerostructures and reducing the related aerodynamical noise. This will ultimately contribute to upscale the current design capabilities of the European aircraft industry while enhancing the digital transformation of the European supply chain.

The project is implemented by a European consortium with 8 world-class partners including: i) Internationally recognized research groups in fluid-structure interaction using numerical simulation (AMU, KIT) and experiments (DLR); ii) Major companies developing numerical simulation softwares for fluid dynamics (CS) and solid dynamics. (MSC); iii) An internationally renowned research center for high-performance computing (IT4I@VSB); a leading company in France for the funding obtention, communication and dissemination of EU projects (EURONOVIA) and iv) a major actor in the European aeronautical industry (AIRBUS).

To upscale the actual design capabilities of the aeronautics industry, FALCON addresses open key-problems involving FSI phenomena to reduce noise and improve sustainability, based on a conceptual methodology built on four pillars: MEASURE, SIMULATE, BOOST, OPTIMIZE.

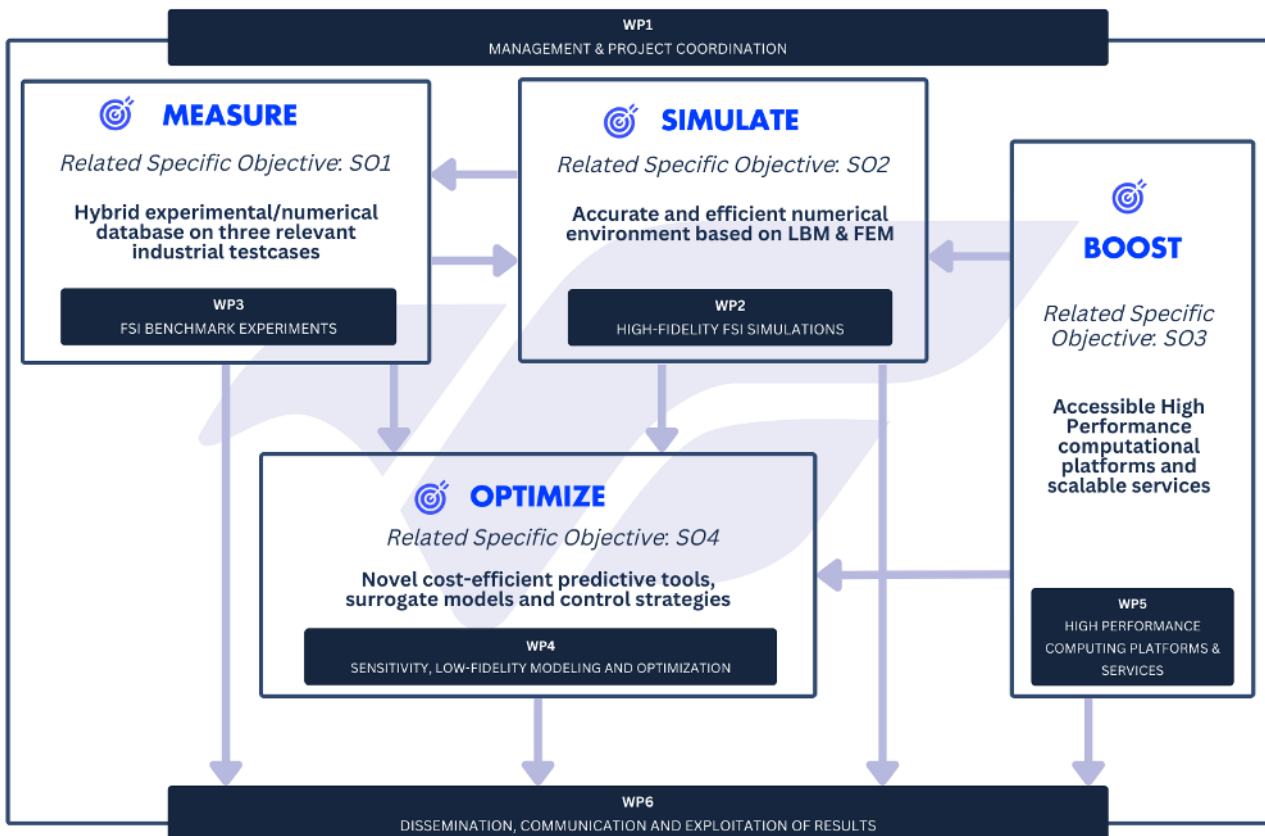


Figure 1: FALCON conceptual approach

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## EXECUTIVE SUMMARY

This document is a deliverable of the FALCON Project, funded under the European Union's Horizon Europe research and innovation programme under the grant agreement No 101138305.

This deliverable is the first version of the Data Management Plan as part of Work Package 1 on Project Management and Coordination.

The aim of this deliverable is to define how project data is managed, both during and after the project: from the creation or compilation of data to its sharing and archiving. The project coordinator is responsible for producing the DMP.

The DMP is a evolutive document that must be revised regularly during the duration of the project. It describes all the data generated or collected during the project, at each stage of the data life cycle.

This document helps to plan the management of the data and anticipate the necessary steps to be taken, facilitating the re-use of the data and reinforcing confidence in the quality of the data.

# Research Outputs

## Hybrid FSI database

The numerical and experimental results produced in FALCON will be compiled to construct a worldwide reference database capturing essential numerical and experimental challenges for FSI in aeronautics, with detailed local and global physical quantities for the fluid, aeroacoustics, and dynamics of structures.

This database will contain:

1. the three industrial test cases (TC1, TC2 and TC3), carefully selected in close interaction with AIRBUS strategies. These three test cases cover a large range of modeling technical needs and were chosen for i) their relevance to the aviation industry (as they are also associated to secondary target applications); ii) the availability of existing data or knowledge on them; iii) the challenges they pose for high-fidelity and low-fidelity modelling and experimentation; and iv) the potential impact on aircraft mass, and related emissions (CO<sub>2</sub> and noise).

[The Partners involved are as follows:

-AMU, CS, KIT for the numerical results for fluid (velocity and pressure fields, aerodynamical coefficients)

-MSC and IT4I for the numerical results for structures (displacements fields, deformations, stresses),

-CS, MSC, AMU, AIRBUS KIT, IT4I for the numerical results on acoustics fields for the three test cases obtained by the following solvers: LaBS-MSC Nastran (CS-MSC- AMU), OpenLB-ESPRESSO coupling code and description (KIT-IT4I@VSB), and 3D monolithic LBM-FSI GPU-parallelized solver (KIT);

-DLR for the measured quantities for flow, turbulence, aeroacoustics and vibrational data and appropriate post-processing.]

2. existing data on the F16 high-lift wing model, a highly representative and state-of-the-art FNG wing for AIRBUS, and a central high-lift geometry of the BANC research effort, associated to a huge aerodynamic and aeroacoustics database. [partners involved: DLR, AIRBUS]

The database will be ‘as open as possible, and as closed as necessary’, following the FAIR principles of open science principles, with the ambition to provide a broadly spread validation test case in the research community for flexible airframe structures, which will accelerate further use in an industrial context.

This database will be used to train efficiently surrogate models such as Neural Networks, polynomial chaos expansion or Gaussian process regression, with the objective of studying sensibility and optimize aerodynamics/aeroacoustics properties of airframe structures. [partners involved : AMU, KIT]

## Numerical codes

Following the same open science principles (“as open as possible, and as closed as necessary”) the FALCON project will provide to the community opensource numerical frameworks, while specific licensed softwares will remain within the project consortium:

1. The numerical FSI suite OpenLB-ESPRESSO will be distributed freely together with a description of the coupling methods (KIT-IT4I@VSB) after publication in scientific journals. [partners involved: KIT,IT4I]

2. The 3D monolithic FSI solver based on LBM and GPU-parallelized will be provided freely, after having published the algorithms in scientific journals [partners involved: KIT, AMU]

3. The numerical FSI suite LaBS-MSC Nastran will not be open (according to the terms of partners CS and MSC) and the IP will be kept inside the partners involved, as detailed in the consortium agreement [partners involved: CS, MSC, AMU]

# 1. Data summary

FALCON will provide a first-of-a-kind combined experimental-numerical data during its lifetime. Thus, original scientific and technical data will be issued from the technical Work Packages (WP2 to WP5). Some of this data will be created by a group of partners as a result of collaborative work, while other data will be created individually by a specific partner. The datasets planned to be generated within the different WPs are listed below:

-WP2: Numerical results for fluid (velocity and pressure fields, aerodynamical coefficients) and structure (displacements fields, deformations, stresses), acoustics fields for the three test cases obtained by the following solvers: LaBS-MSC Nastran (CS-MSC-AMU), OpenLB-ESPRESO coupling code and description (KIT-IT4I@VSB), and 3D monolithic LBM-FSI GPU-parallelized solver (KIT);

Codes: open-source C++ code of ESPRESO structural solver with newly implemented methods with description (IT4I@VSB), open source C++ code library OpenLB with monolithic solver with description (PDF) (KIT), scientific publication about the different solvers : LaBS-MSC Nastran (CS-MSC-AMU), OpenLB-ESPRESO coupling code and description (KIT-IT4I@VSB), and 3D monolithic LBM-FSI GPU-parallelized solver (KIT);

-WP3: Measured quantities for flow, turbulence, aeroacoustics and vibrational data and appropriate post-processing. Scientific publication of the generated database and further improved state-of-the-art optical measurement techniques.

-WP4: Hybrid database with description and metadata (STLs, VTKs, PDFs, XML, XLSX, CSV)

Codes: C++ code of sensitivity and optimization solvers, C++ codes of surrogate models, scientific publications;

-WP5: Opensource code of the convertor of CFD simulation results into volumetric representation (IT4I@VSB) with report, data for cinematic visualization (IT4I@VSB).

Codes: just-in-time visualization code with report (KIT), open-source code of the convertor of CFD simulation results into volumetric representation (IT4I@VSB) with report, data for cinematic visualization (IT4I@VSB).

## 2. FAIR Data

### 2.1 Findable

(meta)data are assigned a globally unique and persistent identifier (DOI) issued for each published record and the version numbers are automatically provided by Zenodo for each new upload of the same entry,

Also we can spread the maximum on newsletter, website etc., but only when the results are published. Make the hybrid database widely available, once results are published.

### 2.2 Accessible

The consortium agreed to store the data and publications generated by the project in the Zenodo repository, where a project community will be created. This will ensure the long-term availability of data, even after the end of the project.



Data are described with enriched metadata: Zenodo's metadata is compliant with DataCite's Metadata Schema minimum and recommended terms, with a few additional enrichments, Experimental data generated in the framework of WP3 within the project will be made available as a general benchmark for FSI validation purposes for interested external partners in due time. Coping proved and tested procedures from other renowned benchmark activities (such as the Category 6 problem of the Workshops on Benchmark Problems for Airframe Noise Computations (BANC)), geometries and validation data will be provided to dedicated project external researches upon formal request to a WP3 person responsible. The shared validation data will comprise pre-selected and evaluated data points, but not the bare data set of measured unsteady aerodynamic and aeroacoustics data. An overview of the complete data set will be documented in freely accessible documentation. The complete amount of measured data of the order of 10TB and more will be secured for 12 years on DLR internal secure storage location so that access can be ensured for this time frame at least. Open source codes : we will provide a link to the place where they are.

## 2.3 Interoperable

(meta)data of each record is indexed and searchable directly in Zenodo's search engine immediately after publication. FALCON research data uploaded on Zenodo, except for data uploaded under closed, embargoed, or restricted access, will be open access under a CC-BY, CC0 or equivalent license.

## 2.4 Re-use

Keywords will be provided for each dataset to optimize data re-usability and facilitate data discovery FALCON research data uploaded on Zenodo, except for data uploaded under closed, embargoed, or restricted access, will be open access under a CC-BY, CC0 or equivalent license. Open source codes will be published under Gnu General Public License V.2 (GPL2) in case of OpenLB or similar licenses.

# 3. Allocation of resources

There are currently no expected costs to manage and preserve data: thanks to Zenodo we will upload data for free with a limited size of up to 50 GB per record. The data will be stored indefinitely (minimum 5 years). Each partner is committed through its own human resources to respect the prescriptions set out by the DMP. While overall data management and curation will be the responsibility of the AMU coordination team, each WP Leader will be responsible for the supervision, quality and management of data within their WP, including data verification before uploading in the repository.

# 4. Data security

To ensure maximum data security, research data will be only stored and processed on partners' internal servers and institutional workstations, that are protected in accordance with state-of-the-art security measures provided by the responsible IT units. Sensitive data will be encrypted and protected by secured password before it is transferred between partners. Personal data will be anonymized, with

particular attention to data on sexual orientation, religious beliefs and ethnic origin, which are considered highly sensitive in some EU countries. The project coordinator will provide consent forms with appropriate guidelines.

## 5. Ethical aspects

In accordance with national regulations, FALCON partners will apply for ethical approval from national ethical review boards or agencies for data collections, which will also concern the sharing of research data and the storing of any gathered data. Where applicable, participating institutions will appoint a Data Protection Officer (DPO) to ensure that GDPR rules are properly understood and applied.