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U-HARWARD

CS2-THT U-HARWARD PROJECT: SECOND DISSEMINATION EVENT

May 24, 2023

ONLINE WORKSHOP

Co-funded by the European Union

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U-HARWARD PROJECT

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Title of Proposal: **U**ltra **H**igh **A**spect **R**atio **W**ing **A**dvanced **R**esearch and **D**esigns

Proposal Acronym: U-HARWARD

In response to the topic JTI-**CS2**-2019-CFP10-**THT**-07

Starting date, May 1st, 2020; Duration 42 months

OBJECTIVE: **to facilitate** the development of Ultra-High aspect ratio wings for medium-large transport aircraft by the use of innovative aerodynamic and aero-servo-elastic designs in a **multi-fidelity multi-disciplinary optimal design approach**.

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AGENDA

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U-HARWARD Project Contributions

9:00 – 9:20 Introduction, project structure, methods, goals and status

9:20 – 9:40 Conceptual and preliminary design of high aspect ratio aircraft configurations: results and outlook

9:40 – 10:00 Aeroelastic issues related to high aspect ratio wing configurations and preliminary experimental results

10:00 – 10:20 High-Fidelity structural and aerodynamic evaluations of Strut Braced Wing configuration

10:20 – 10:40 Experimental and numerical aeroacoustics results of Strut-Braced Wing configuration

Coffee Break

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AGENDA

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RHEA Project Contributions

11:00 – 11:20 Conceptual design and sensitivity analysis for ultra-high aspect ratio wing aircraft

11:20 – 11:40 Bilevel MDO process applied to Strut Braced Wing configuration

11:40 – 12:00 A CFD-based local sensitivity study of the aerodynamic performance of Strut-Braced Wing aircraft

UPWING Project Contribution

12:00 – 12:20 The Clean Aviation UP WING project: objective, scope and partners

12:20 – 13:00 Open discussion and conclusions

ACKNOWLEDGEMENT

This project U-HARWARD has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 886552. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union.

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INTRODUCTION, PROJECT STRUCTURE, METHODS, GOALS AND STATUS

S.Ricci (POLIMI)

CONTRIBUTORS: ALL

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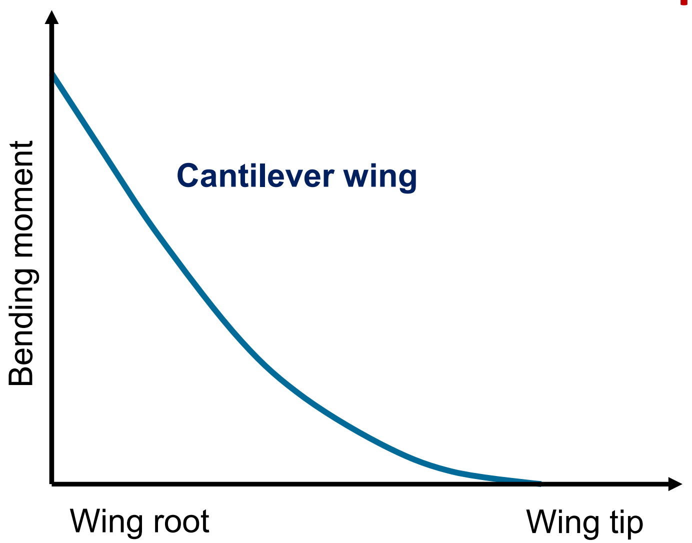
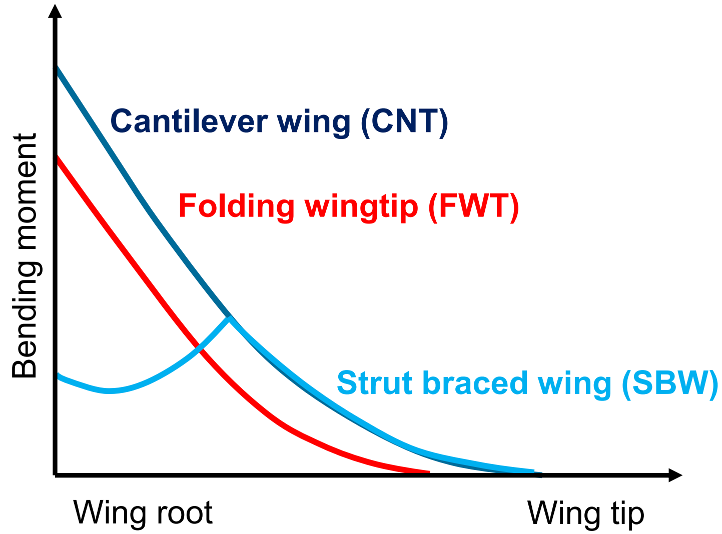
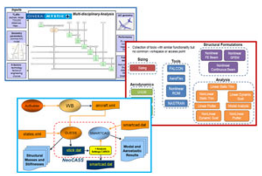
GOALS AND METHODS

Multi fidelity MDO

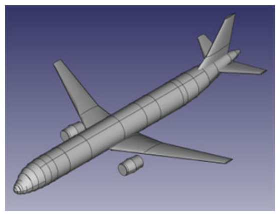


$$C_{Di} = \frac{C_L^2}{\pi A R e}$$

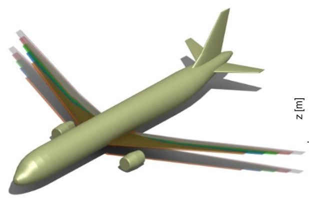




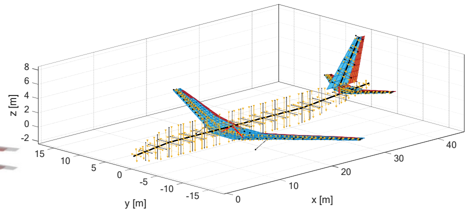
In-house design tools



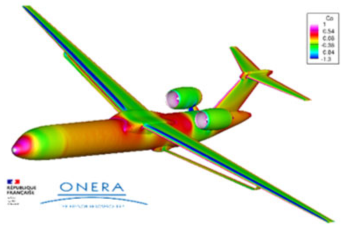
Reference Aircraft



HARW configurations



Low-fi aeroelastic models



hi-fi aero* models

Extended WT campaign

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CONSORTIUM

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Politecnico di Milano (as coordinator)	POLIMI (Italy)
IBK – Innovation GmbH & Co. KG	IBK (Germany)
University of Bristol	UoB (UK)
Office National d'Etudes et de Recherches Aerospatiales	ONERA (France)
Institut Superieur de l'Aeronautique et de l'Espace	ISAE (France)
Siemens Industry Software SAS	SIEMENS (France)

POLITECNICO MILANO 1863

University of BRISTOL

isae Institut Supérieur de l'Aéronautique et de l'Espace SUPAERO

Innovation IBK

ONERA THE FRENCH AEROSPACE LAB

SIEMENS

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WORK SHARING BY CONCEPTS

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Cantilever Wing (CNT)	**TEAM 1**	POLITECNICO MILANO 1863	Innovation IBK
Strut-Braced Wing (SBW)	**TEAM 2**	ONERA THE FRENCH AEROSPACE LAB	isae Institut Supérieur de l'Aéronautique et de l'Espace SUPAERO
Folding Wing Tip (FWT)	**TEAM 3**	University of BRISTOL	SIEMENS

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PROJECT STRUCTURE

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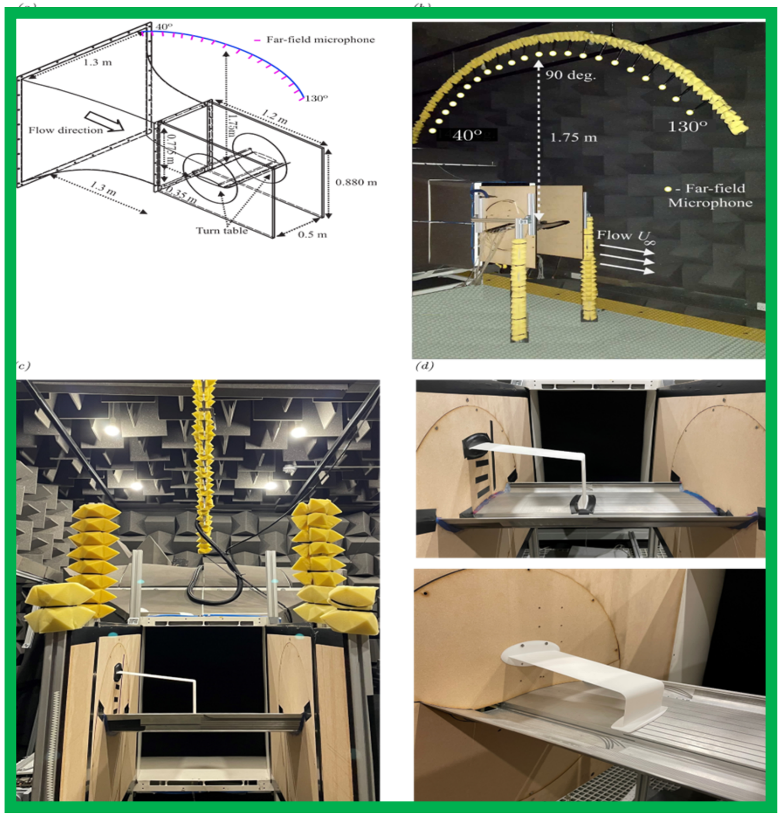
PROJECT COORDINATION AND MANAGEMENT

WP2 CONCEPTUAL DESIGN	WP3 HIFI DESIGN	WP4 EXPERIMENTAL VALIDATION	WP5 FINAL ASSESSMENT
▪ TOOLS VALIDATION ▪ REFERENCE AIRCRAFT ▪ HARW CONFIGURATIONS ▪ CNT, SBW, FWT ▪ FIRST ASSESSMENT	▪ AERODYNAMICS (SBW) ▪ AEROACOUSTICS (SBW) ▪ AEROELASTIC (FWT)	▪ AC1 (SBW) @ UNIVBRISTOL ▪ AE1 (SBW) @ POLIMI ▪ AA (SBW) @ POLIMI (7/23) ▪ AE2 (FWT) @ POLIMI (9/23)	▪ IMPACT ON BUSINESS AND EMISSIONS ▪ PROS AND CONS OF DIFFERENT CONFIGURAIONS ▪ TECHNOLOGICAL ROADMAP

COMMUNICATION, DISEMINATIONN AND EXPLOITATION

EXPERIMENTAL VALIDATION FINALIZED



Aeroacoustic SBW wing model AC1
Tested @ UNIVBRIS

Aeroelastic SBW wing model AE1
Tested @ POLIMI

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EXPERIMENTAL VALIDATION PLANNED

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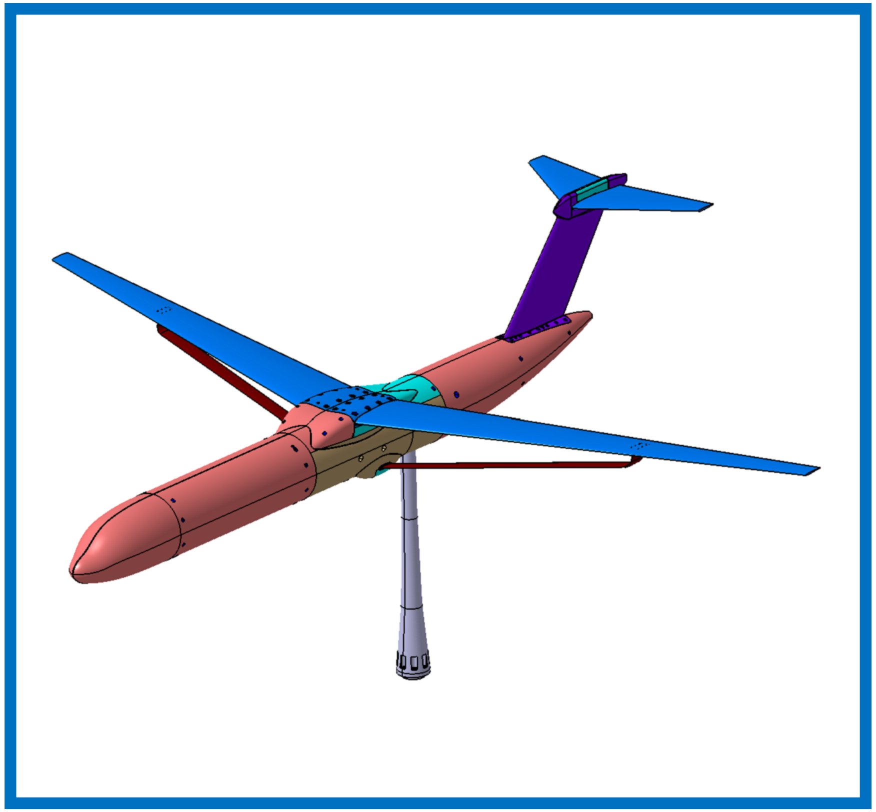
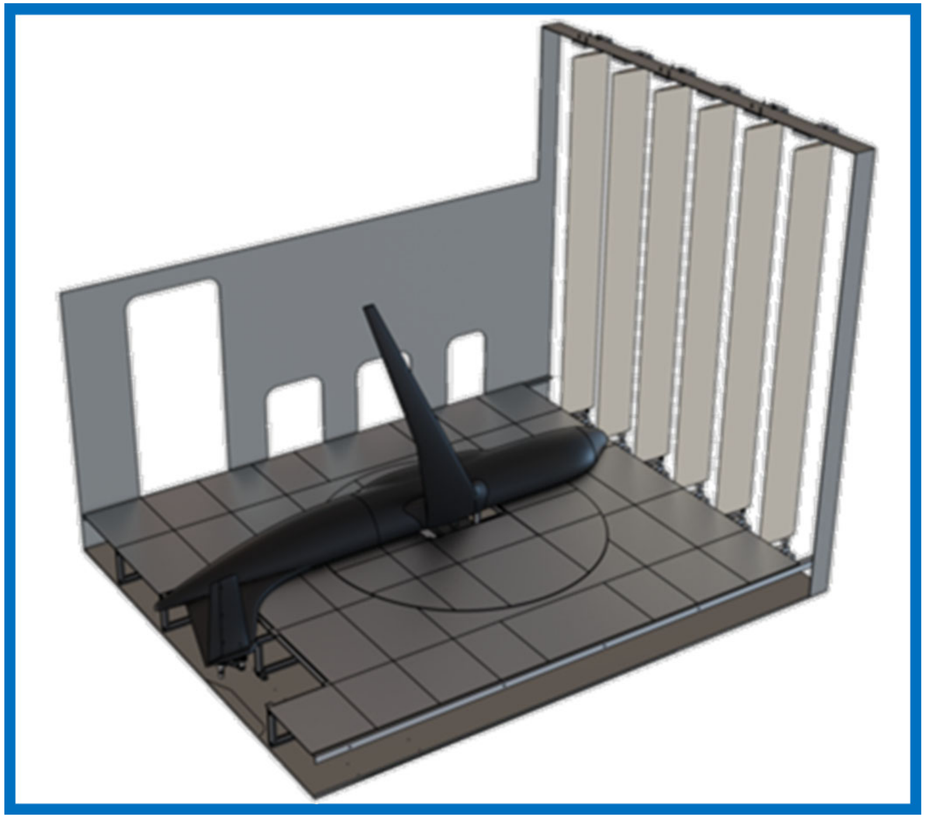


Aerodynamic SBW full model AA
To Be Tested @ POLIMI



Aeroelastic FWT half model AE2
To Be Tested @ POLIMI

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OVERALL STATUS

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POLITECNICO MILANO 1863

IBK Innovation

University of BRISTOL

ONERA THE FRENCH AEROSPACE LAB

isae Institut Supérieur de l'Aéronautique et de l'Espace SUPAERO

SIEMENS

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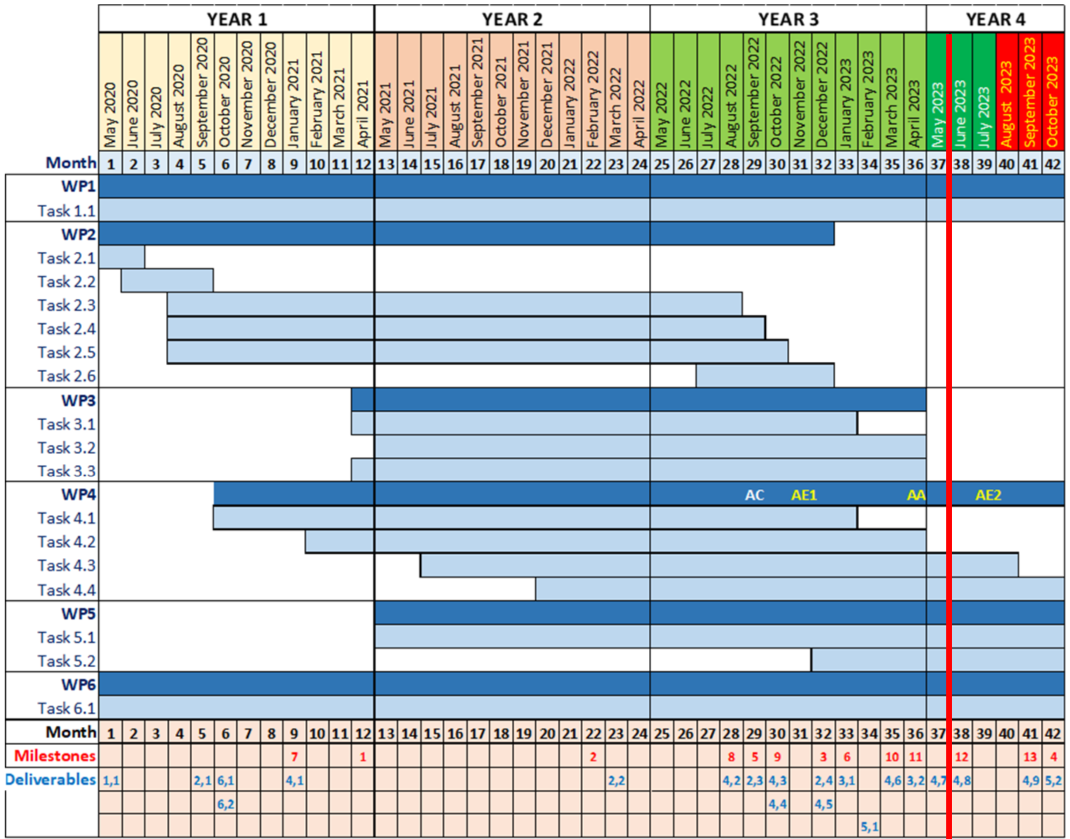

AC = AeroAcoustic Test @ UoB (M29)
AE1 = Aeroelastic Test (flutter identification) @ POLIMI (M31)
AA = Aerodynamic Test (HQ) @ POLIMI (M36)
AE2 = Aeroelastic Test (Gust Response) @ POLIMI (M39)

PROJECT TIME

M37

We are here

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PRELIMINARY ASESSMENTS

- A first, intermediate assessment, on the basis of WP2 results allowed to quantify the **potential advantages of different configurations**. For what concerns the cantilever wing the **maximum expected aspect ratio** achievable of AR=14-15 is identified as the best compromise between the weight penalty and the emissions reduction. In the case of Strut-braced configuration The optimal configuration able to minimize the block fuel is characterized by AR=19. Finally, the folding wingtip appears as a **promising technology**, applicable to different configurations, once resolved the open issues related to system reliability and certification aspects (Presentation 2).
- In case of both SBW and FWT configurations some **aeroelastic issues still remain**, that require combined numerical and experimental investigations, and allow for a relevant margin of dedicated trade-off studies (Presentation 3).
- The potential aerodynamic benefits of SBW configuration have been **refined and confirmed** by a comprehensive high fidelity analyses campaign done in WP3 (Presentation 4).
- The aeroacoustics experimental campaign, validated by accurate hifi results, shows that the presence of the strut **does not increase** the noise impact in SBW configuration (Presentation 5).

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THANK FOR YOUR ATTENTION!

ANY QUESTIONS?

Visit our online stand at
https://cleansky.virtualfair.be/

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