

Investigation of engine noise installation effects on a business jet platform by numerical simulations and tests

Floriane REY – Dassault-Aviation

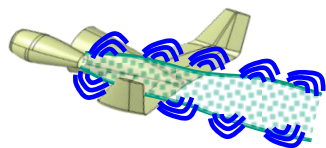


ACARE 2020 Objectives :

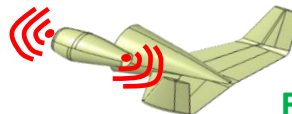
- CO2 emissions reduced by 50%
- NOx emissions reduced by 80%
- Minus 10 dB per certification point between 2000 and 2020

Main objective of the project : To bring to TRL5 the U-tail concept :

- To reduce noise by shielding engine from the ground and reflecting noise upward
- Negligible impact on the carbon footprint.



jet noise



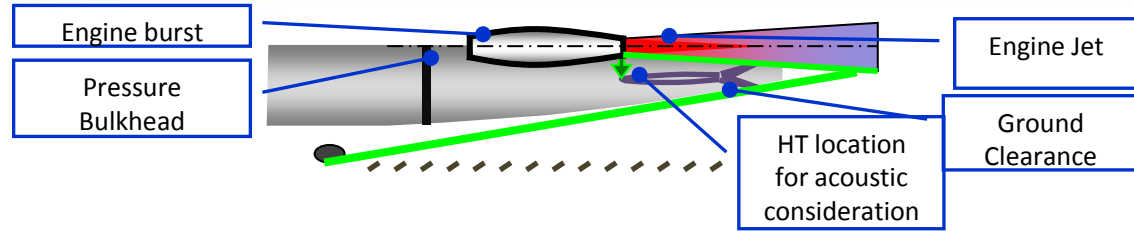
Fan noise

- ✓ **Concept and detailed design**
- ✓ **Wind tunnel test at DNW**
- ✓ **Full scale ground test at Istres**
- ✓ **Conclusion**

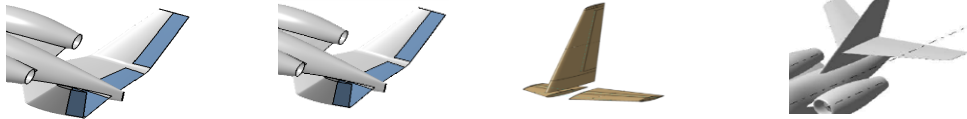


concept and detailed design

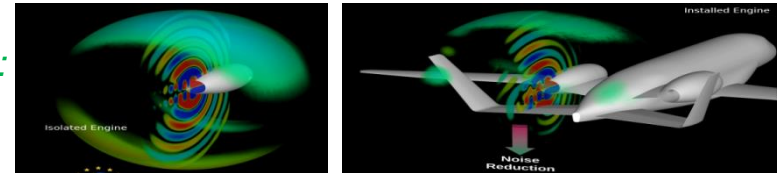
U tail designed for acoustic shielding capacity.



Review of the selection process for the aft-body : ranking of the candidate concept with penalties (drag and mass) take into account in the Overall Aircraft Design.



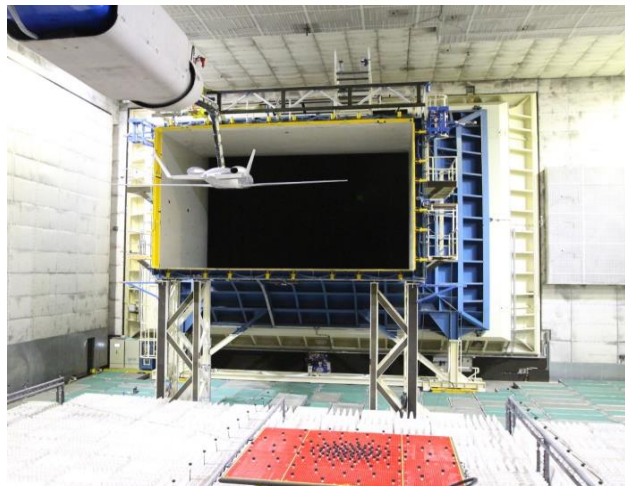
Acoustic shielding and aerodynamic validation: Simulation and testing



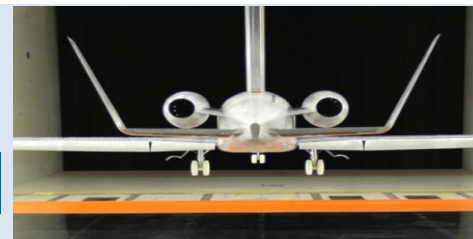
Structural design (loads and flutter):



Wind tunnel test at DNW LLF wind tunnel

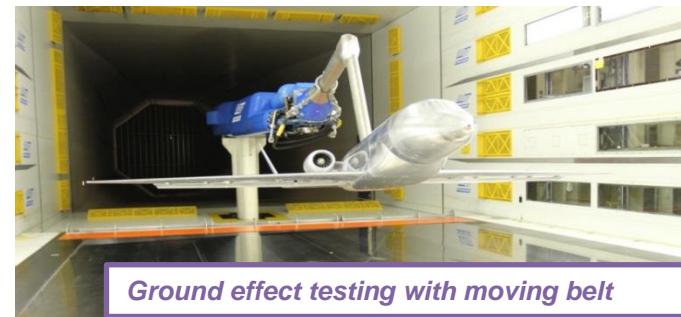
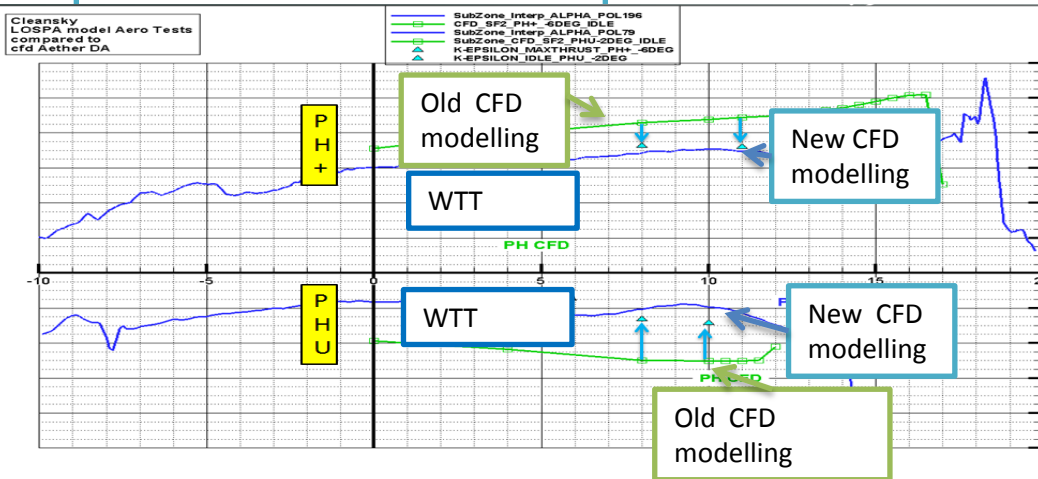


LSBJ AT DNW

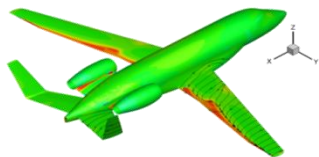
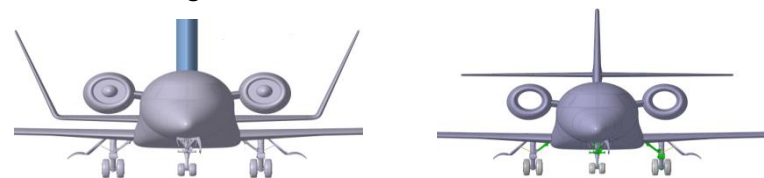


WTT at DNW: Aerodynamic test

Aerodynamic testing



Two main configurations tested: U tail and classic falcon tail:



New turbulence model for CFD computations leads to accurate comparison with test results

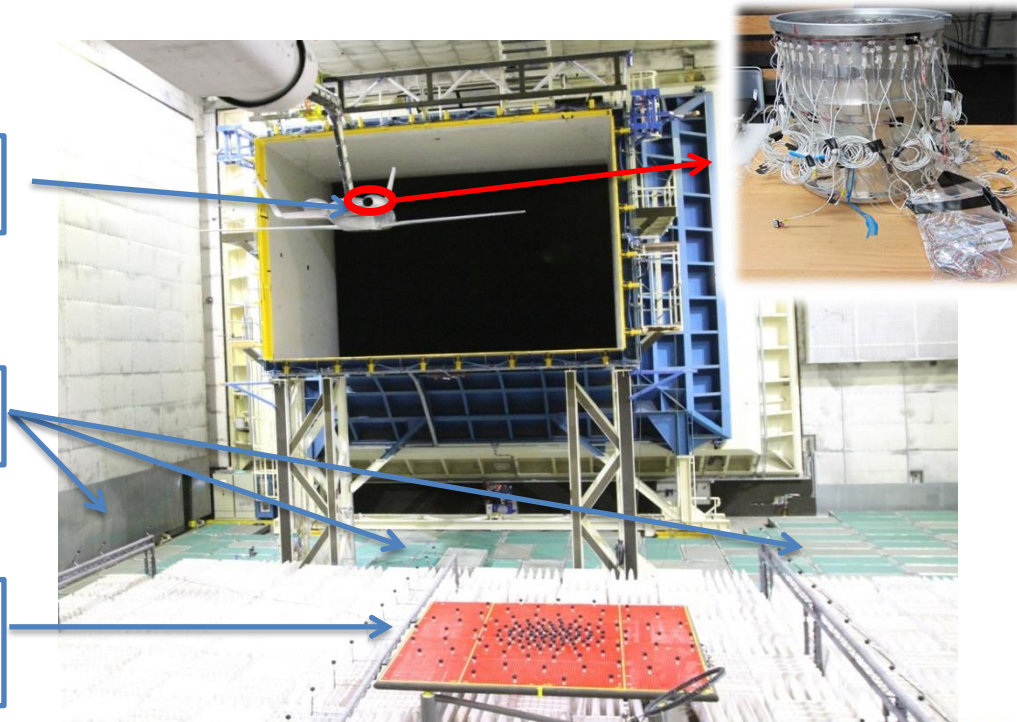
WTT at DNW: Acoustic test

Acoustic testing: U tail shielding and LSBJ airframe noise

Measurement of Modal content in the nacelle with TPS thanks to kulites.

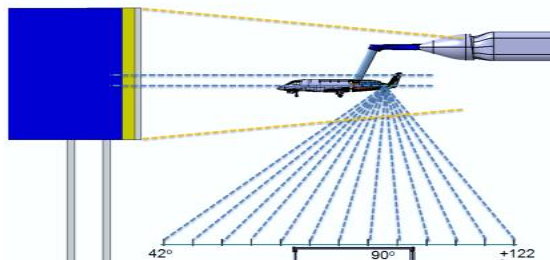
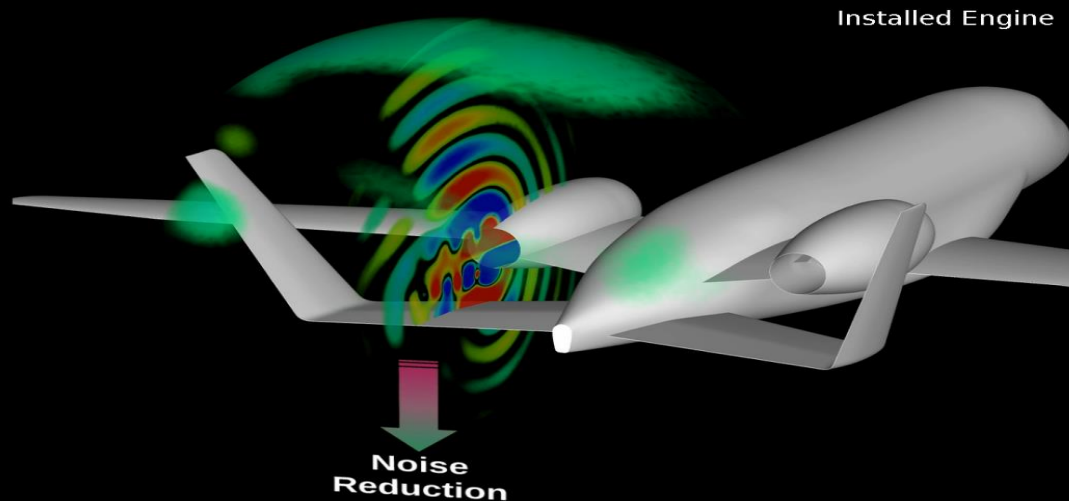
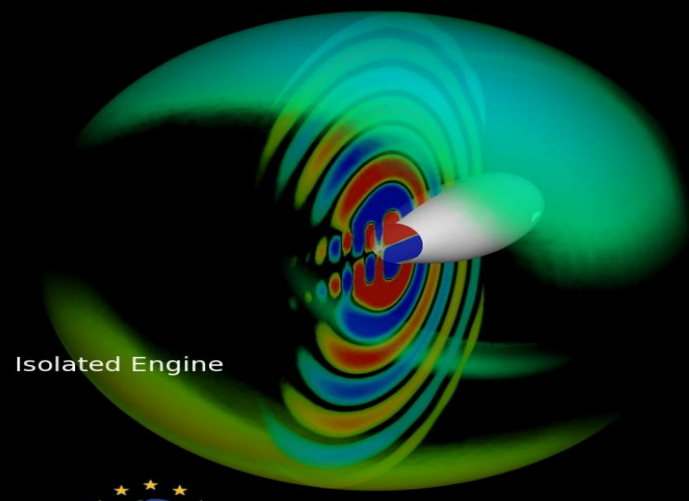
3 lines of 13 microphones for the far field noise

- 140 microphones DNW array for the noise sources localization
- INCAS array



Clean Sky

WTT at DNW: Installation effect measurement

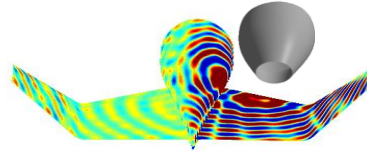


Measurement of isolated and installed engine on flyover microphones

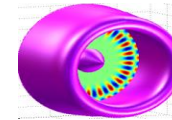


WTT at DNW: Installation effect simulation

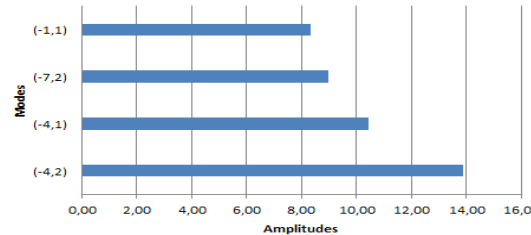
- ✓ Calculation of transposition Matrix between fan and far-field microphones, for installed and isolated TPS



- ✓ Application of this matrix on all propagative modes

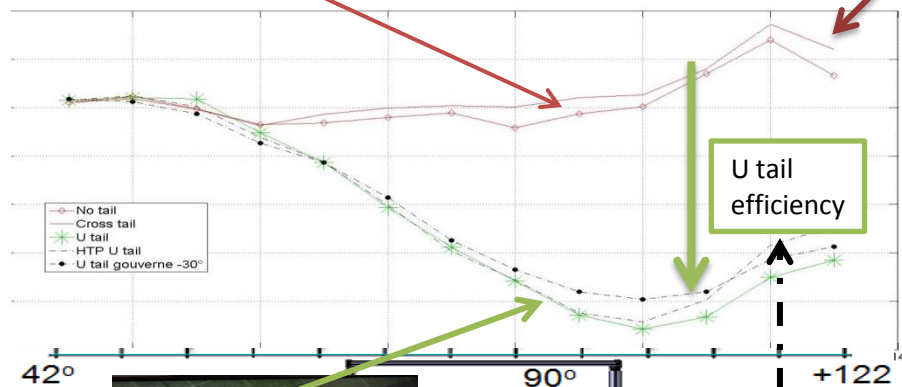
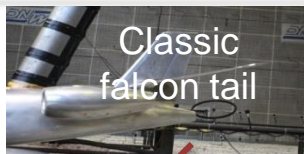


- ✓ ONERA post processing of kulites measurement: application of modal amplitude of propagating modes



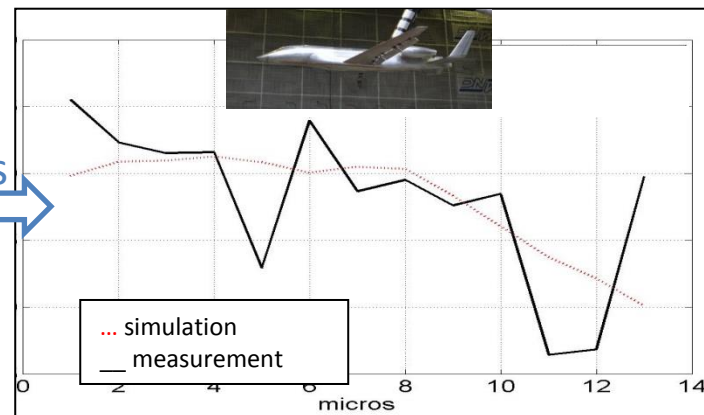
Installation effect = delta between isolated and installed configuration

WTT at DNW: Acoustic results



Directivity :broadband noise 100Hz-60KHz

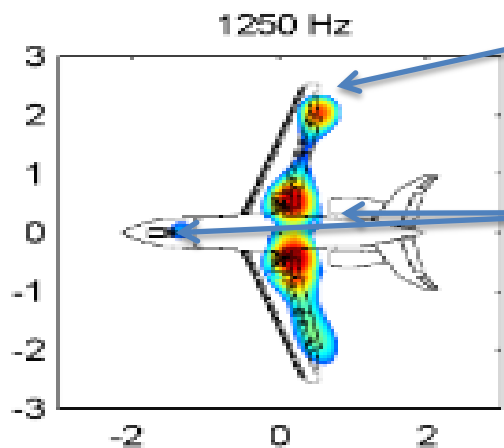
Deltas



Airframe nose campaign



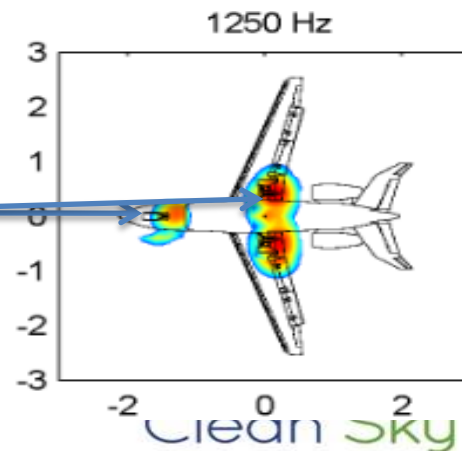
Landing configuration



highlift

Main and auxiliary
landing gears

Landing gear only



Full Scale Aft Body Ground Test

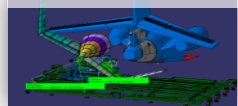


SHIELD



SHIELD: Ground Test objectives

Design



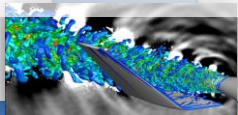
Manufacturing



Testing



Simulation tools



Complementary to LSBJ at DNW WT testing, this test was investigating several fields involved in U-Tail aircraft architecture:

Far field acoustic shielding capacity of U-tail

- Validate shielding prediction methodologies with **real engine noise sources** → scale 1
- Assess the expected noise shielding levels and consequently confirm the **acoustic benefits of the innovative aft-body configuration**

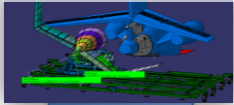
Thermal and acoustic fatigue

- Assess **impact of the proximity of the engine jet** (temperature, vibration) **on the structure** (metallic or composite) with respect to acoustic fatigue issues



SHIELD: Fatigue and thermal measurements

Design



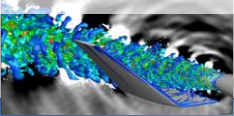
Manufacturing



Testing

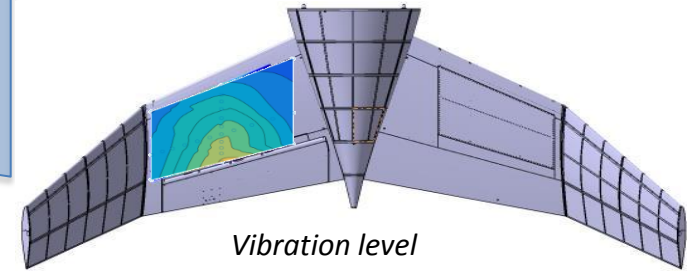
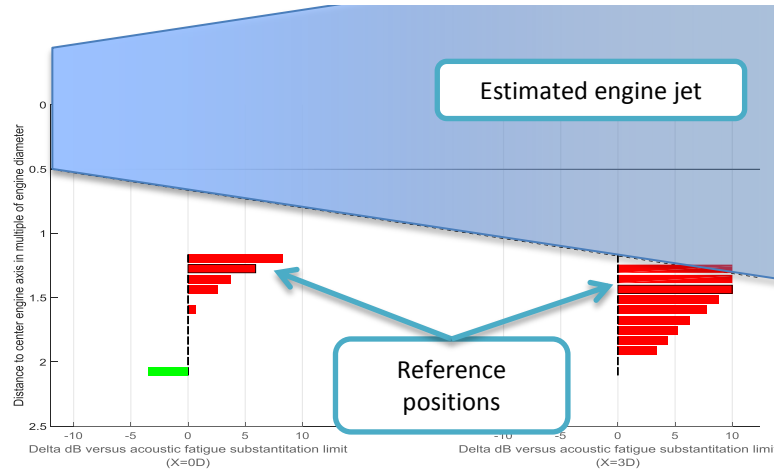


Simulation tools



Identification of the environment

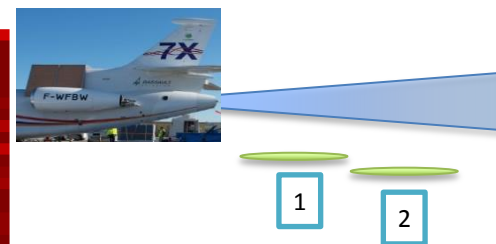
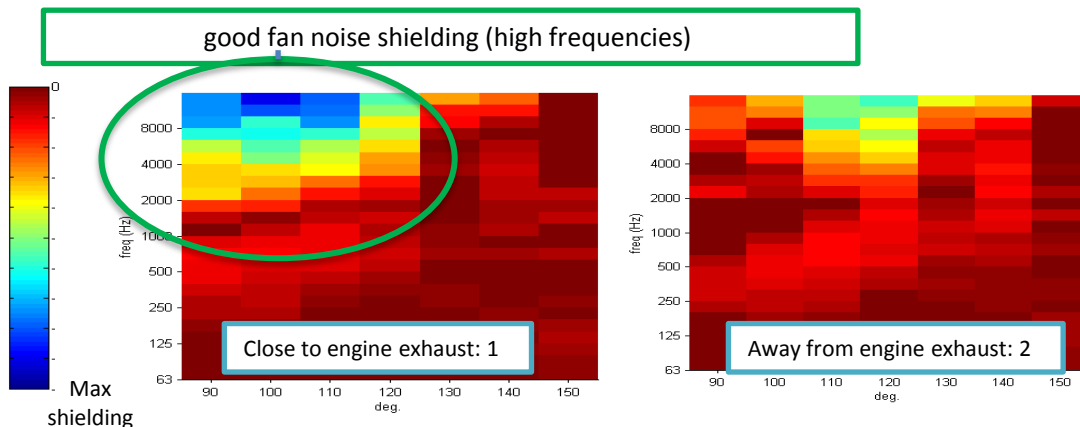
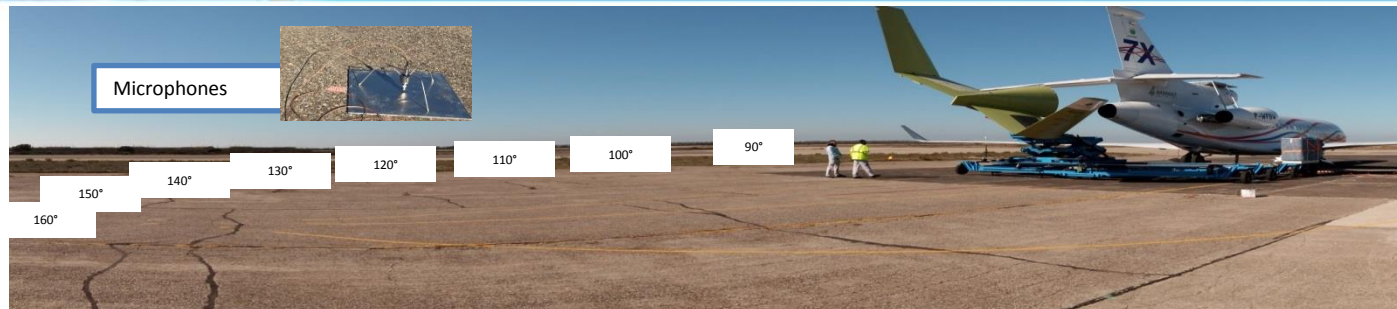
- Successful measurements of the influence of relative position (X and Z) on vibration level
- Impact on panel sizing to be analyzed



Vibration level
Reference position $X=0D$

- The different positions are not temperature limited

SHIELD: Acoustic shielding measurements



Ground test verifies the importance of U tail position regarding engine exhaust on noise shielding.



Conclusion

In the framework of Cleansky/SFWA program, ARA, Airbus Group, Avioane Craiova, Dassault-Aviation, DNW, FOKKER, FUTURE, INCAS, NLR, ONERA, RUAG, studied **the integration of innovative turbofans to business jet aircraft.**

Detailed design, acoustic and aerodynamic performances, structural design, and impact on global aircraft architecture have been evaluated.

This project permitted to improve simulation tools for aerodynamic (turbulence model) and acoustic (modal content simulation and measurement post processing) thanks to comparison with high quality test results.

U tail shielding capacity has been proven during those studies, leading the concept to TRL 4/5

