

Research Strategy

- The Significance of Acoustic Research in Context of Climate Protection -

ICANA 2023

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Knowledge for Tomorrow

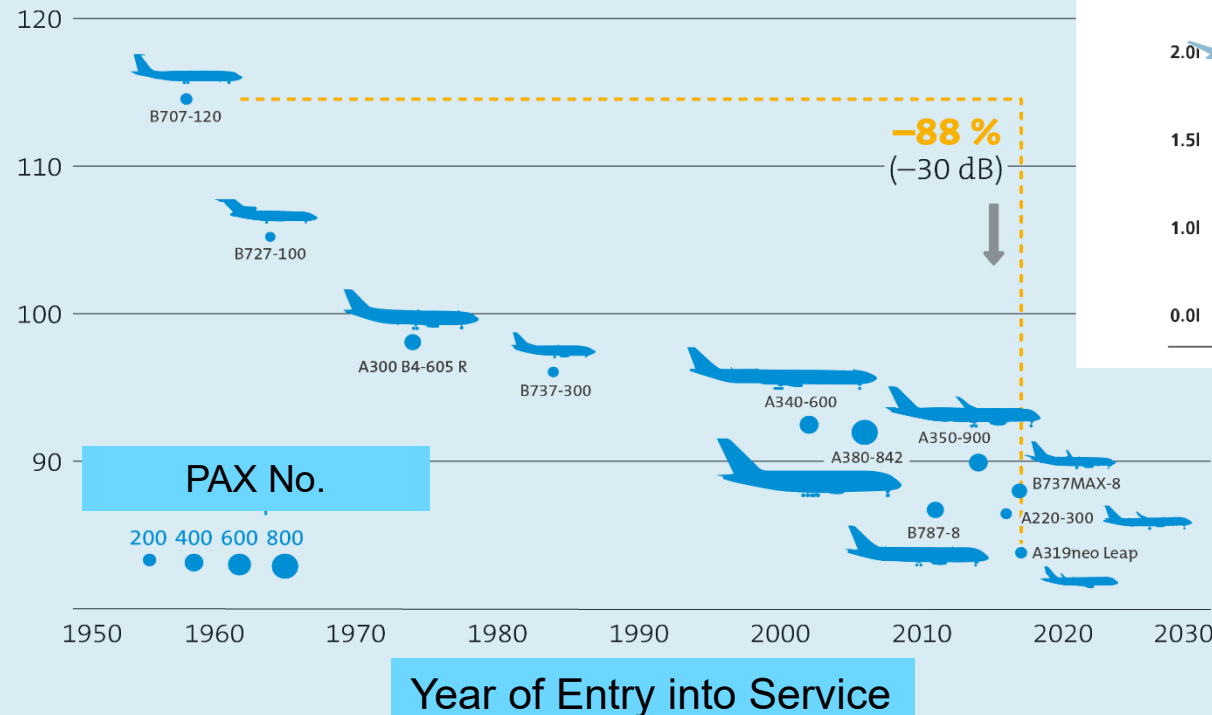


Have we achieved enough?

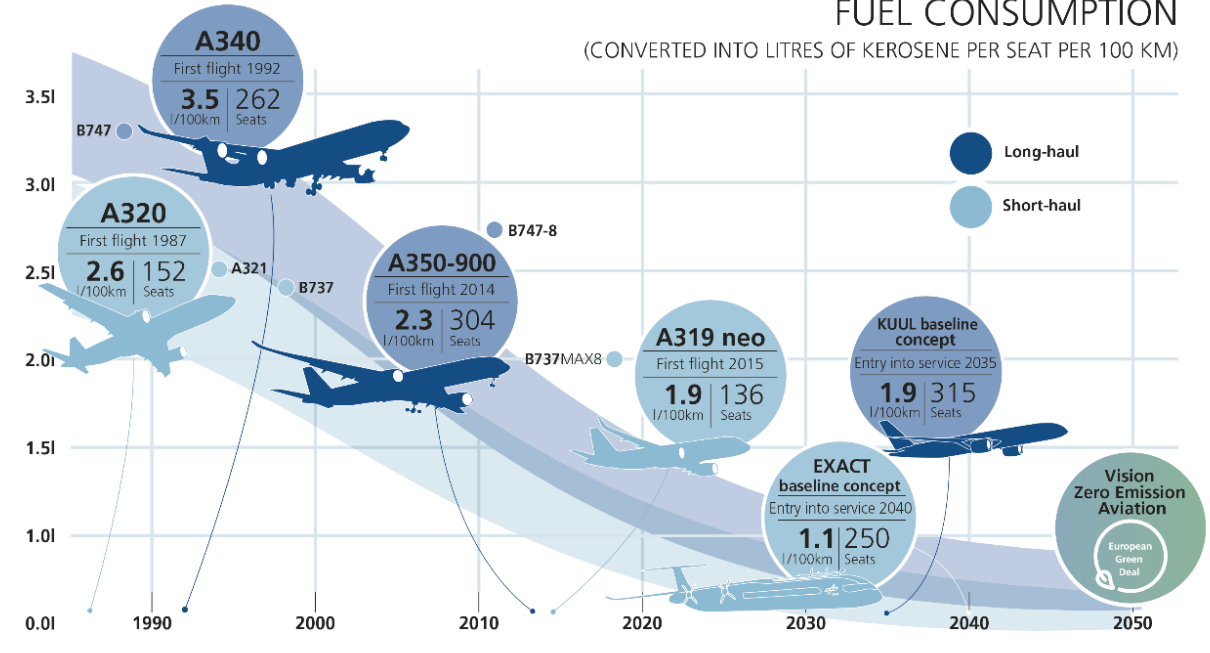


Source: DLR Aeronautics Strategy

Lateral Noise Level in EPNdB



FUEL CONSUMPTION (CONVERTED INTO LITRES OF KEROSENE PER SEAT PER 100 KM)

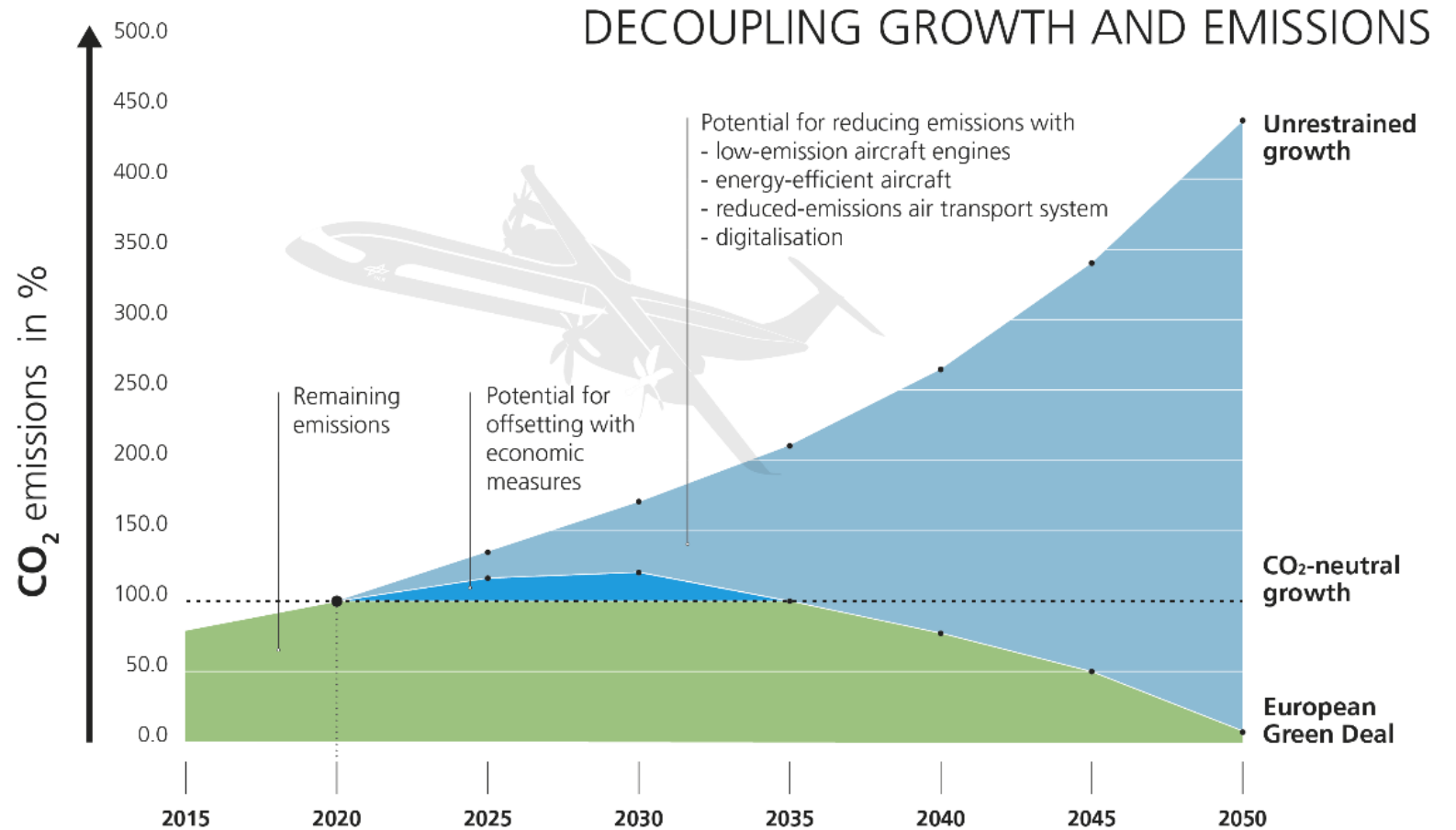


*Although significant reduction in aircraft noise and fuel burn
how to cope with air traffic growth?*

Source: BDL/ICAO Noise Certification Data Base

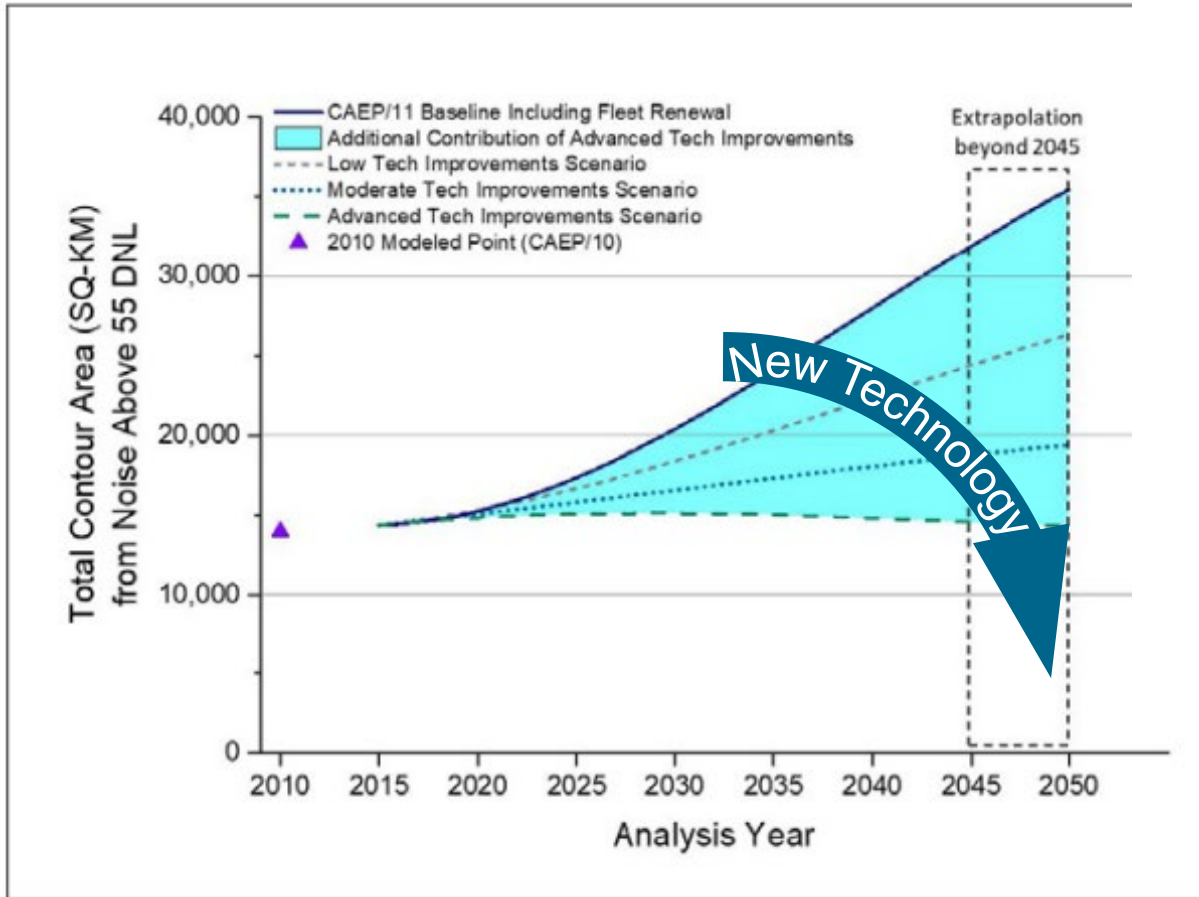
A Challenge

The Air Transport System as a whole has to be transformed



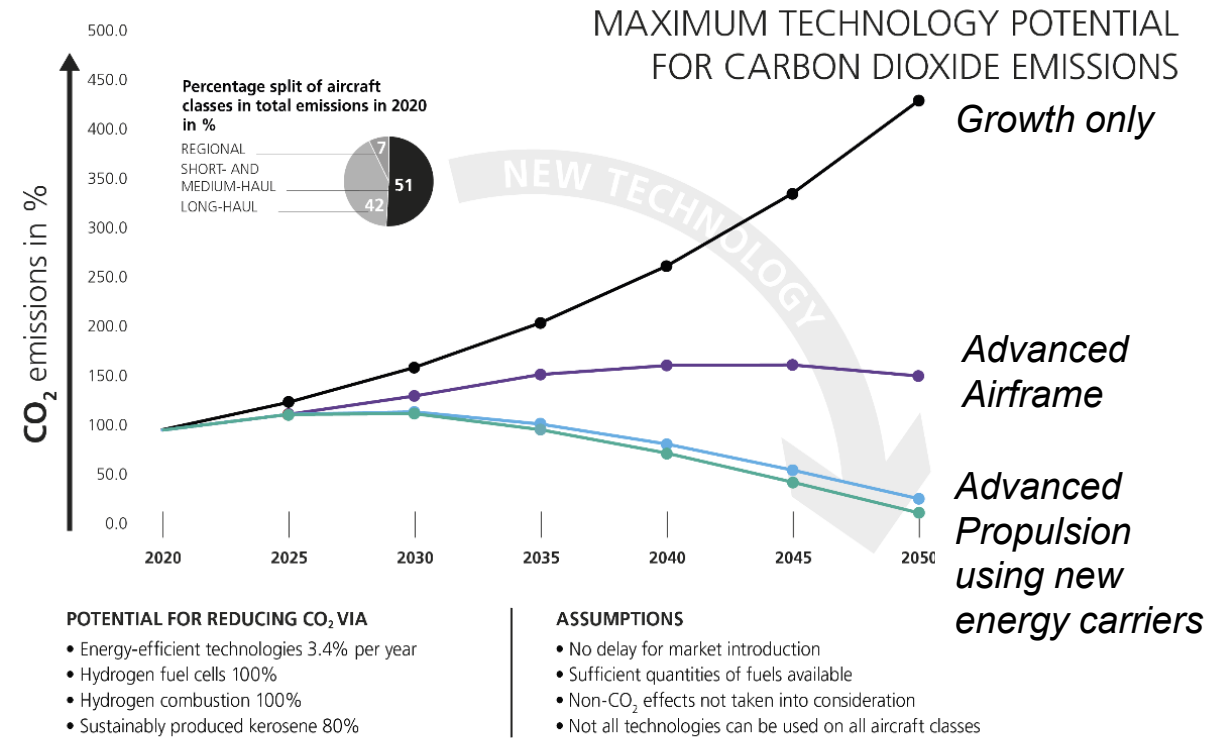
Striving for Both - Reduction of Chemical Emissions and Noise -

Source: ICAO



Total Aircraft Noise Contour Area above 55 dB DNL for 315 airports, 2010 to 2050

Source: DLR Aeronautics Strategy



Technology openness and a multidisciplinary approach in research is key

Shaping the Future of Aviation

DLR Green Deal Strategy / Fields of Action



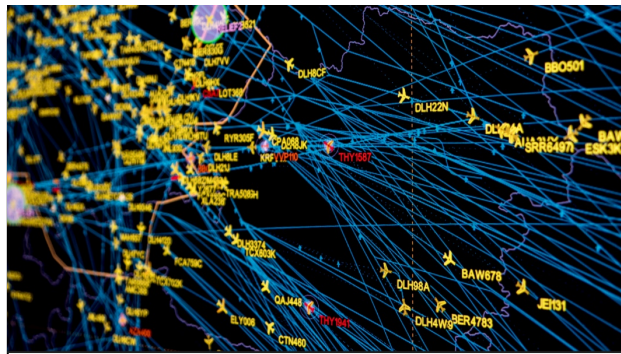
Low-Emission Propulsion

- Direct Combustion of Hydrogen
- Fuel Cell
- Battery
- SAF



Energy Efficient Aircraft

- New Configurations
- Weight reduction by Lightweight system design
- Minimizing energy consumption



Emission-Reduced Air Transport System

- Climate Optimized Routing
- Atmospheric Research
- Impact Assessment



Digitalisation

- Simulation-based Certification
- Digital Twin
- Digital Thread

Low Noise Aviation is inherent objective of DLR's Research Portfolio and part of the current coalition agreement of federal government

Low Noise Aircraft Design

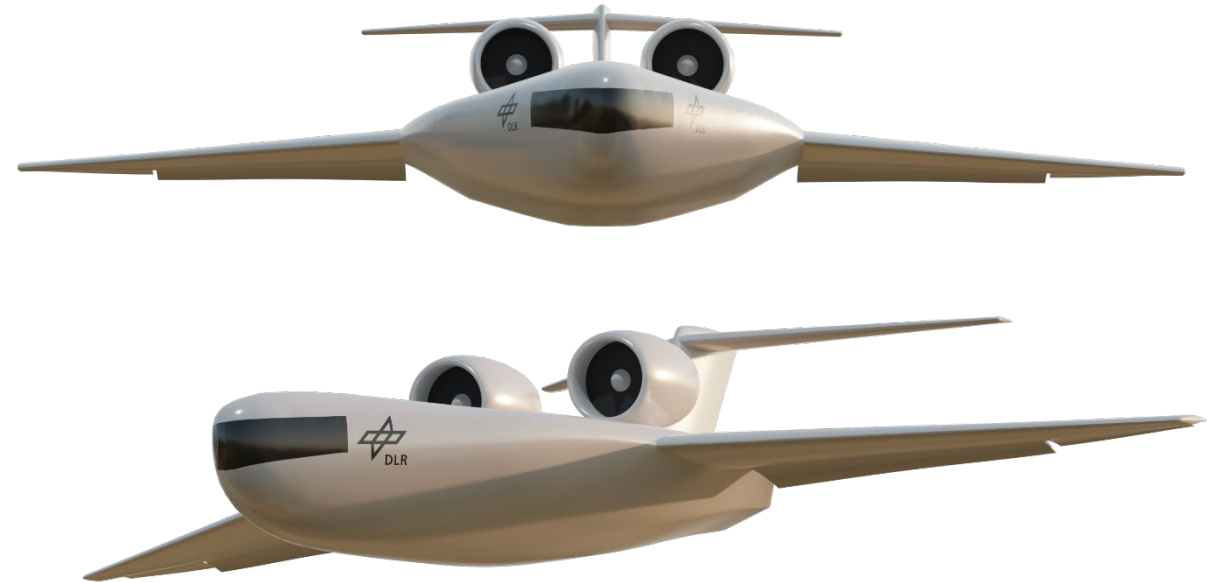


SIAM - SchallimmissionsArmes Mittelstreckenflugzeug (mid range a/c with low noise impact)



Silent by design

- Hybrid Wing Body (HWB) concept
- Extreme shielding of propulsion noise
- Slotless flap system, noise reduction technos
- Very silent UHBR GTF turbofan propulsors

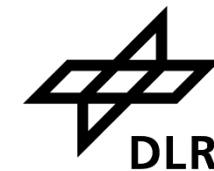


- **15dB/ 5dB/ 18dB*** reduction @ certification points w.r.t. **A320ceo (2000)**
- Close to visionary ACARE FlightPath 2050 noise objective!
(15dB reduction per op.)

*) EPNdB flyover/sideline/approach

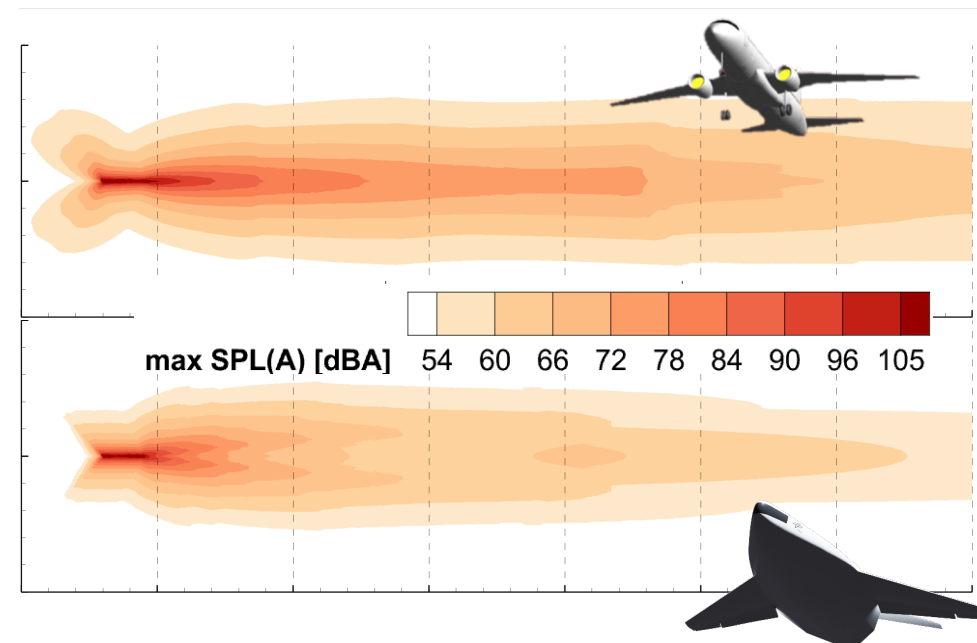
SIAM - SchallImmissionsArmes Mittelstreckenflugzeug

(mid range a/c with low noise impact)



HiFi design reveals

- Increased drag from propulsor integration
- Increased mass from T-tail (necessary for stability)
- Although most silent, too inefficient (even for further local optimisation)



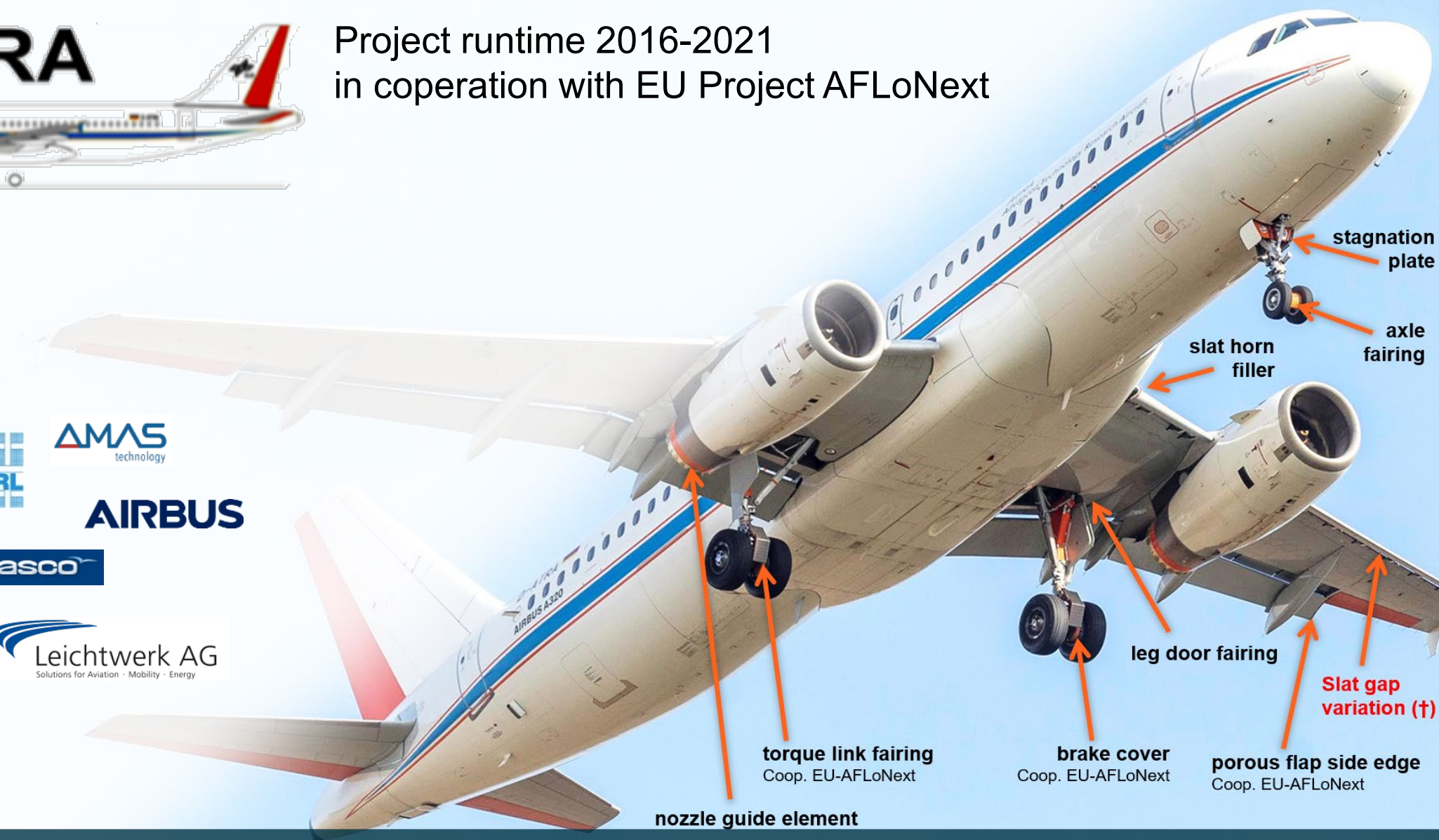
- SIAM shows massive potential of a/c design in terms of noise reduction
- Future research will focus on multi-objective optimisation (**noise vs. efficiency**)

Airframe Noise Research





Project runtime 2016-2021
in cooperation with EU Project AFLoNext



stagnation plate
axle fairing
slat horn filler
leg door fairing
Slat gap variation (\dagger)
porous flap side edge
Coop. EU-AFLoNext
brake cover
Coop. EU-AFLoNext
torque link fairing
Coop. EU-AFLoNext
nozzle guide element

LNATRA

- A DLR project to **demonstrate** the potential of **noise reduction technologies (NRT)** for current transport aircraft
- Implementation/test of known airframe+jet NRTs on real a/c

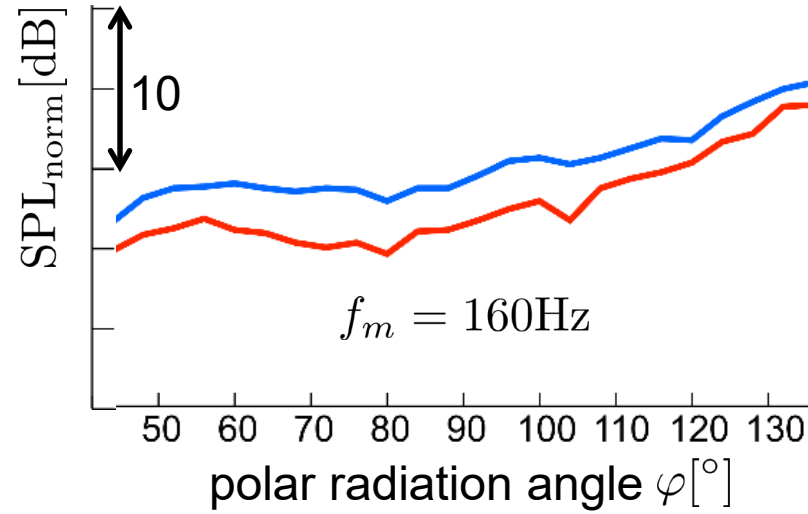
Jet Noise



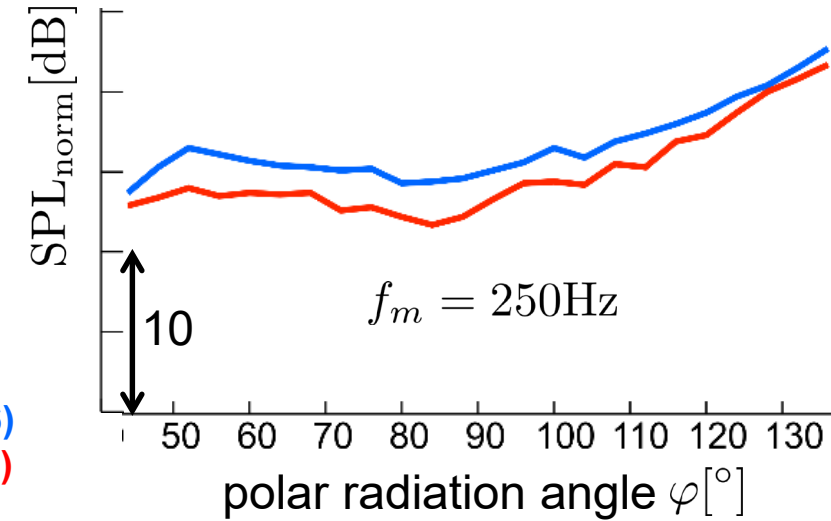
Nozzle modification



take-off – flaps 2: 22°/20° - gear up



standard nozzle (2016)
modified nozzle (2019)

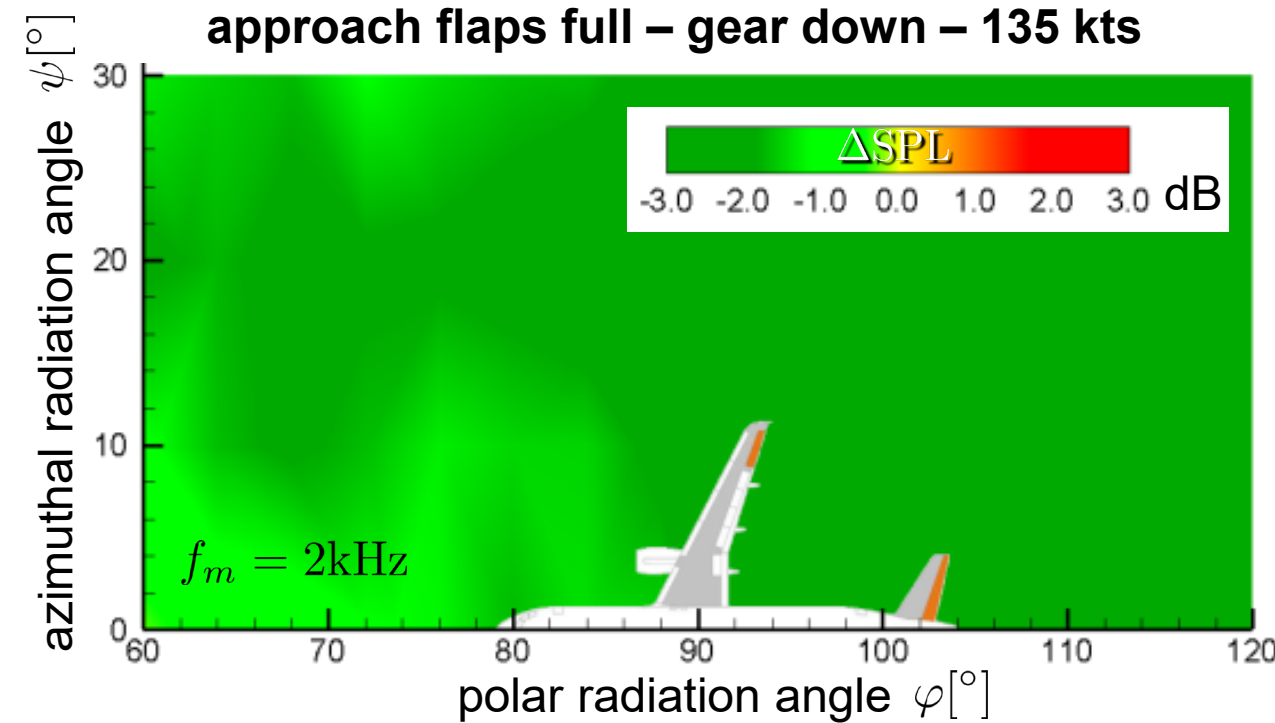


- Significant reduction at low frequencies, slight increase (1dB) high frequencies

Landing Gear Noise



Nose/Main LG modification

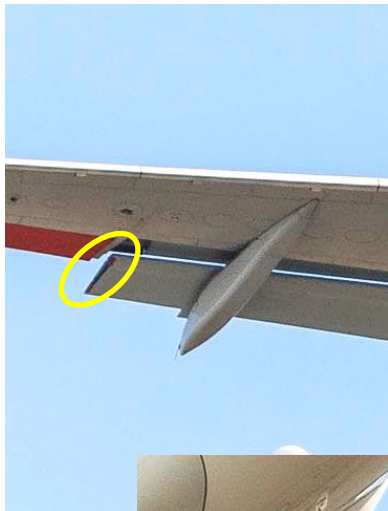


- Wide area broadband noise reduction ~ 2-3dB (single mics!)

High Lift Noise



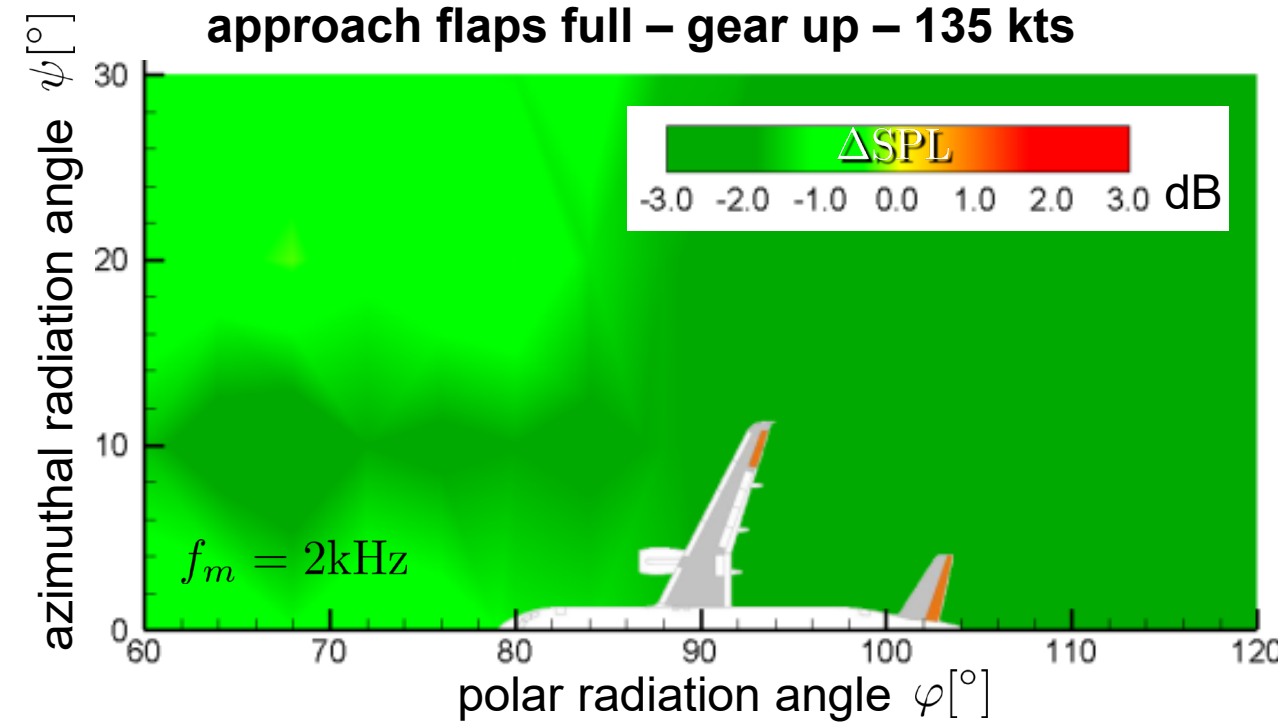
HLD side edge modification



aluminum foam



open cell urethane foam

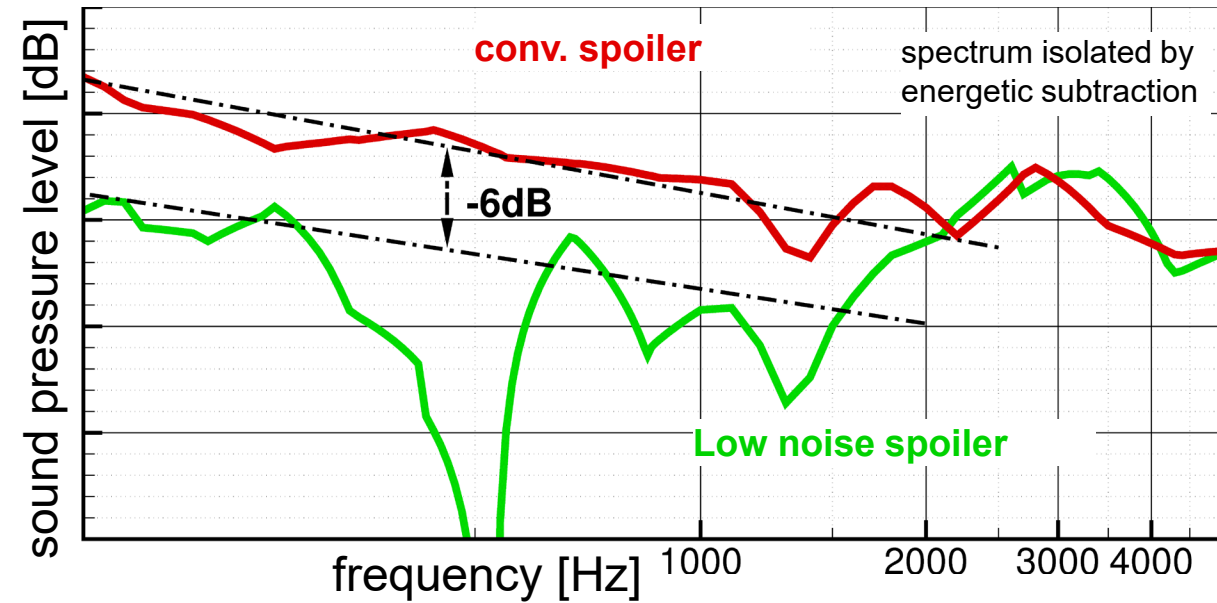
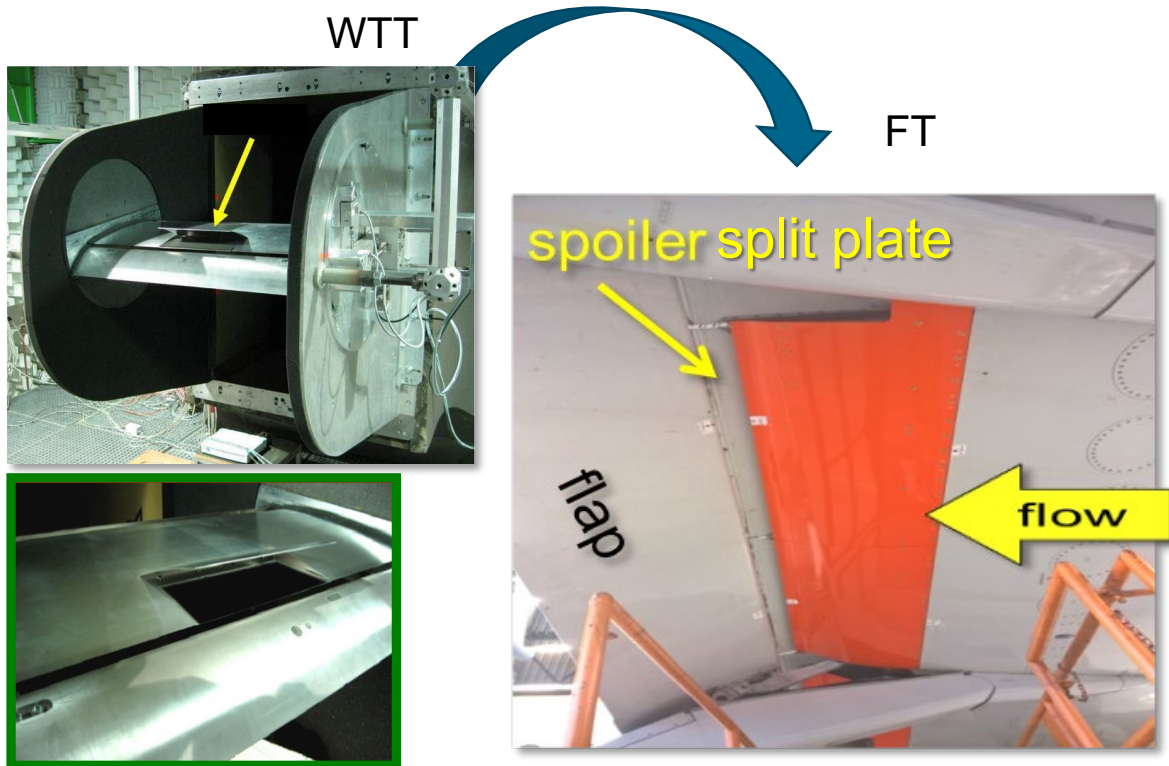


- Wide area broadband noise reduction ~ 2-3dB (single mics!)

Spoiler Noise

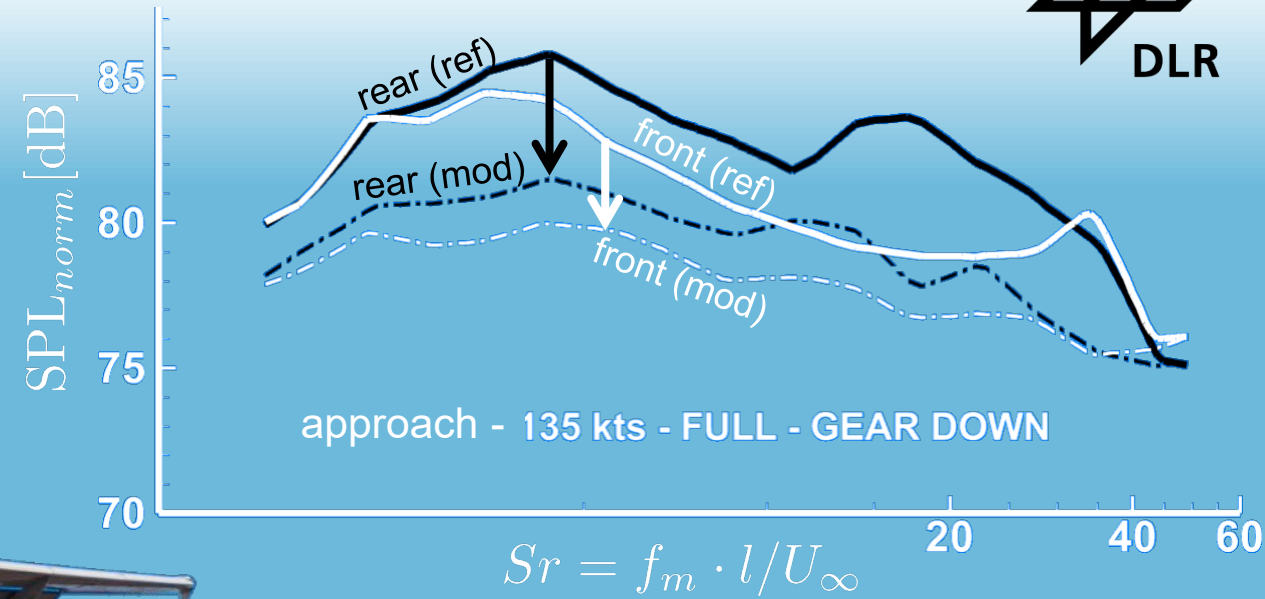
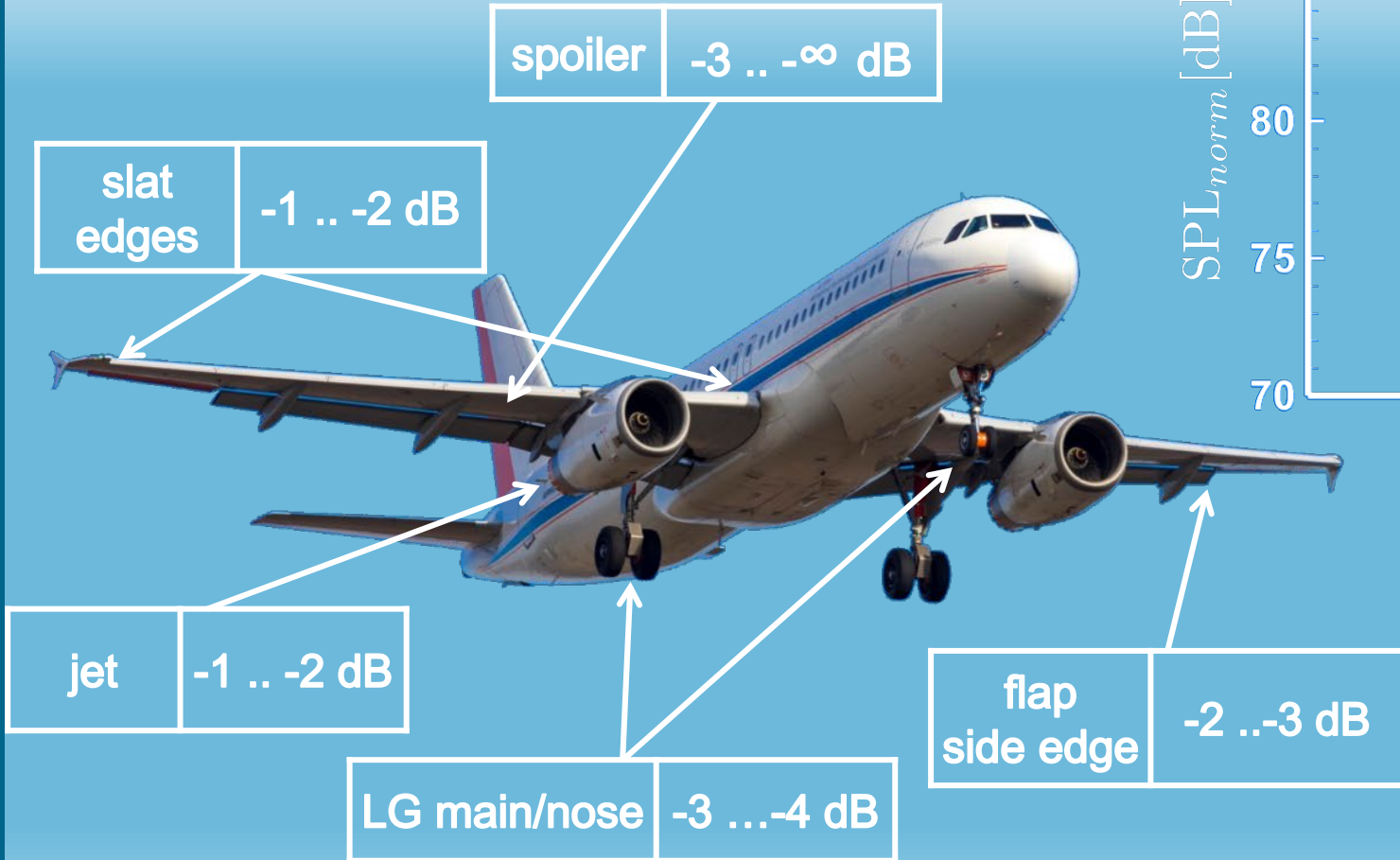


Spoiler modification



- Massive reduction for frequencies 500-2000Hz, largest effect laterally
- Enables steep approaches w/o excess source noise

Low Noise ATRA - Synopsis -



- ✓ Broadband reduction 3 – 4 dB for standard approaches
- ✓ Spoiler noise eliminated
- ✓ 1 – 2 dB reduction at departure

Up to **5dB reduction** at approach (including slat modification)

Acoustic Methods and Tools

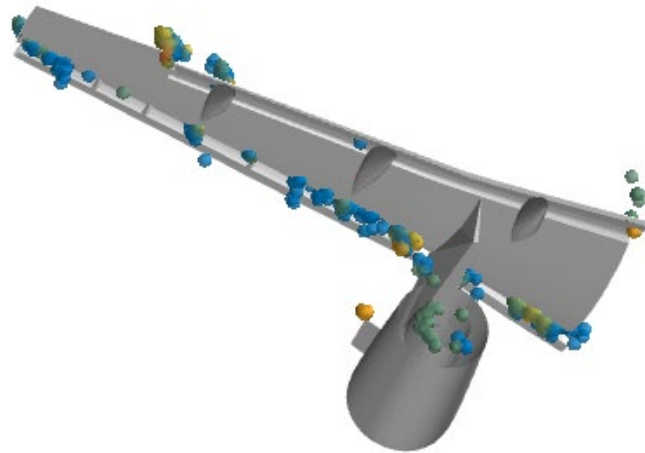


Microphone-Array Measurements in Wind Tunnels

- Analysis of New Aircraft Configurations in ETW -

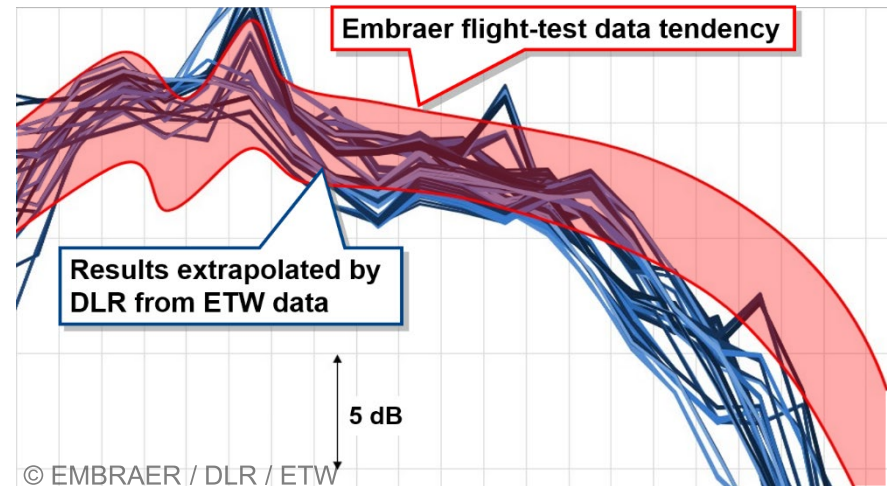
- Project partners: DLR, ETW, EMBRAER
- Enable piggy-back measurements (aerodynamics, aeroacoustics)
- Measurements at real-flight Reynolds number (pressurized and cryogenic)

Localization of noise sources

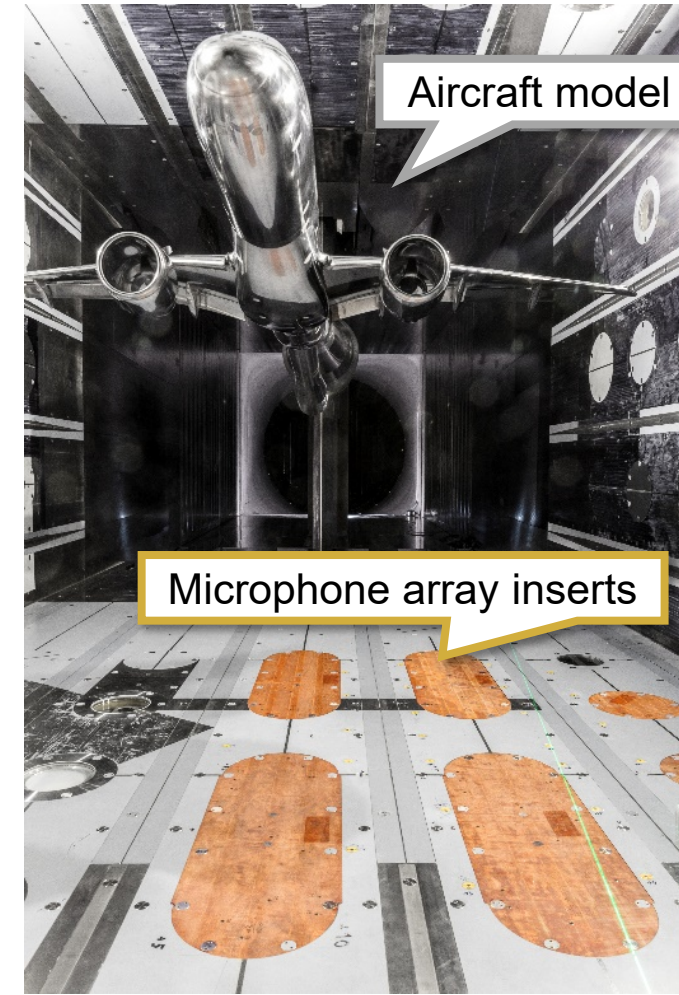


- Dominant airframe noise sources on the aircraft model (color coded frequency)
- Landing configuration

Comparison to flight-tests



- Good agreement with flight test data of the real aircraft

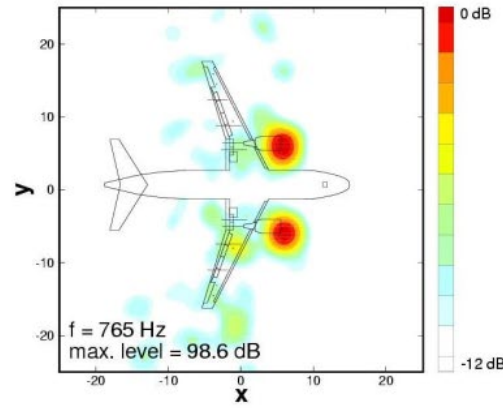


Fly-Over Microphone Array - Sample Results -

- Global
 - Doppler-corrected Frequency Spectra
 - Source Maps
- For each Source Region:
 - Spectra
 - Total Level

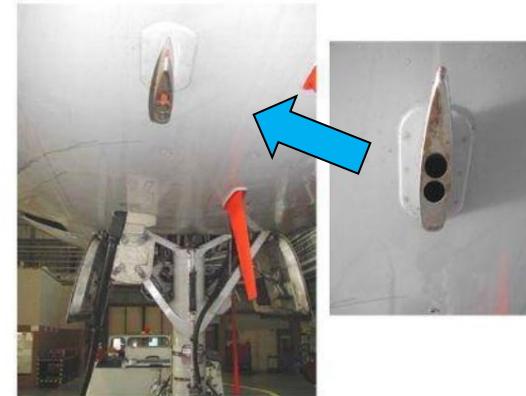
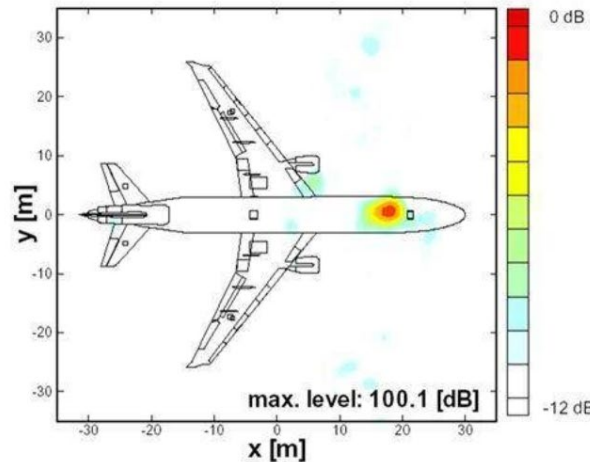


247 microphone multi-arm spiral array



Modification of CFM56-5A nacelle suppresses 800 Hz tone

Original vents and geometric modification



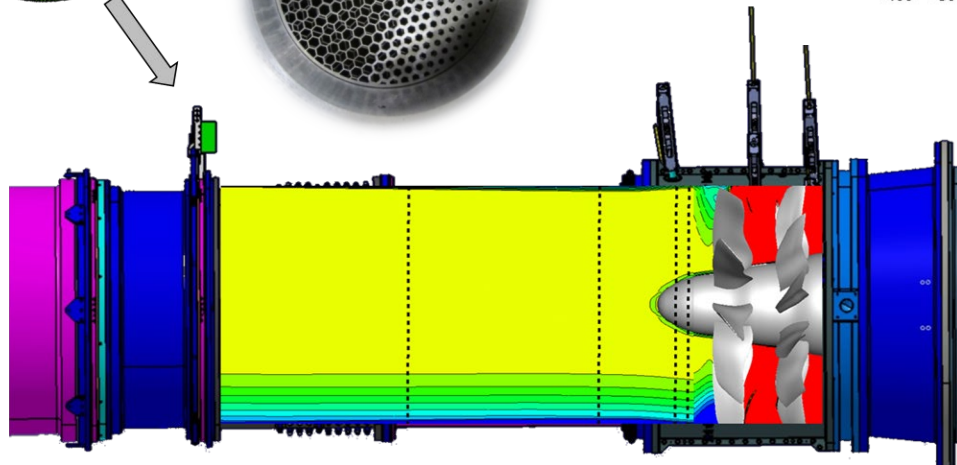
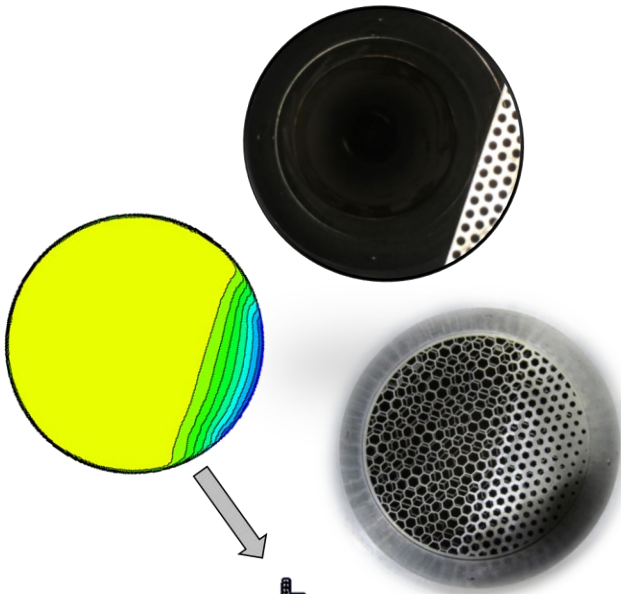
Cavity noise generated at the drain mast of the MD-11 in the 790 Hz one-third-octave band

Drain mast with its two cavities

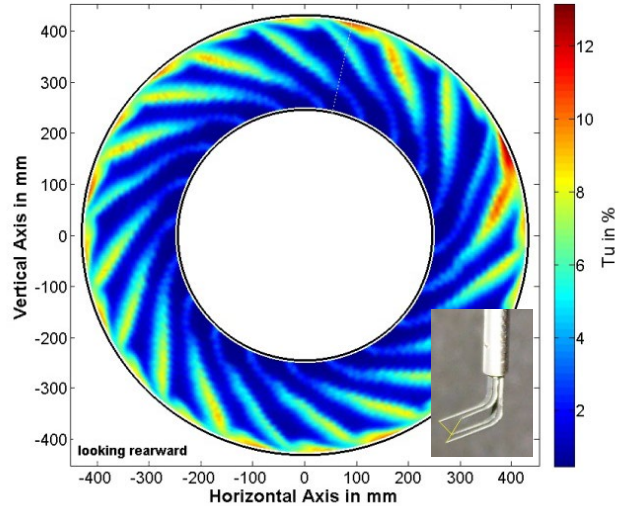
Experimental Means to study Fan Noise caused by Inflow Disturbances



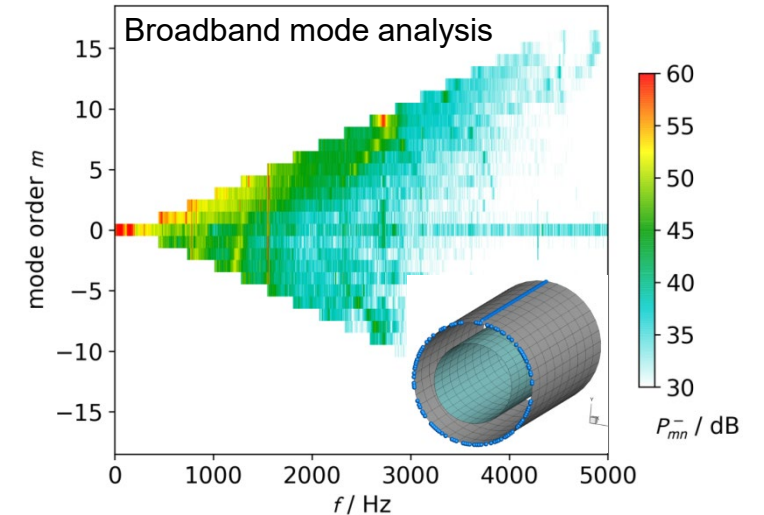
Techniques to generate different inflow disturbance patterns



High-resolution aerodynamic measurements



High-resolution acoustic measurements



- Separation of different noise source mechanisms
- Identification of noise generating parameters by means of correlation techniques
- Noise reduction technologies, e.g. flow control techniques

DLR's „Fachausschuss für Fluglärm“



Expert group and advisory body regarding DLR's acoustic research activities and capabilities



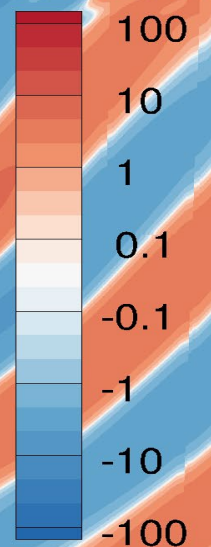
Disciplines

- Airframe Noise and Low Noise Aircraft Design
- Aircraft Noise Sources
- Aircraft Noise Determination and Quantification
- Low Noise Aircraft Operation
- Aircraft Noise Impact

Experts

- Prof. Jan Delfs
- Prof. Lars Enhardt
- Dr. Rainer Schmid, Dr. Lothar Bertsch
- Dr. Fethi Abdelmoula, Dr. Bernd Korn
- Dr. Susanne Bartels

Pressure (Pa)



Thank You!

