



SILENCE(R)

SIGNIFICANTLY LOWER COMMUNITY EXPOSURE TO AIRCRAFT NOISE

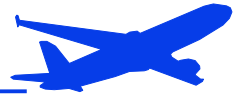
Halfway Towards Success

by Eugène Kors



Co-ordinator of the SILENCE(R) programme





Overview

SILENCE(R) Scope and Objectives

Selection of technologies

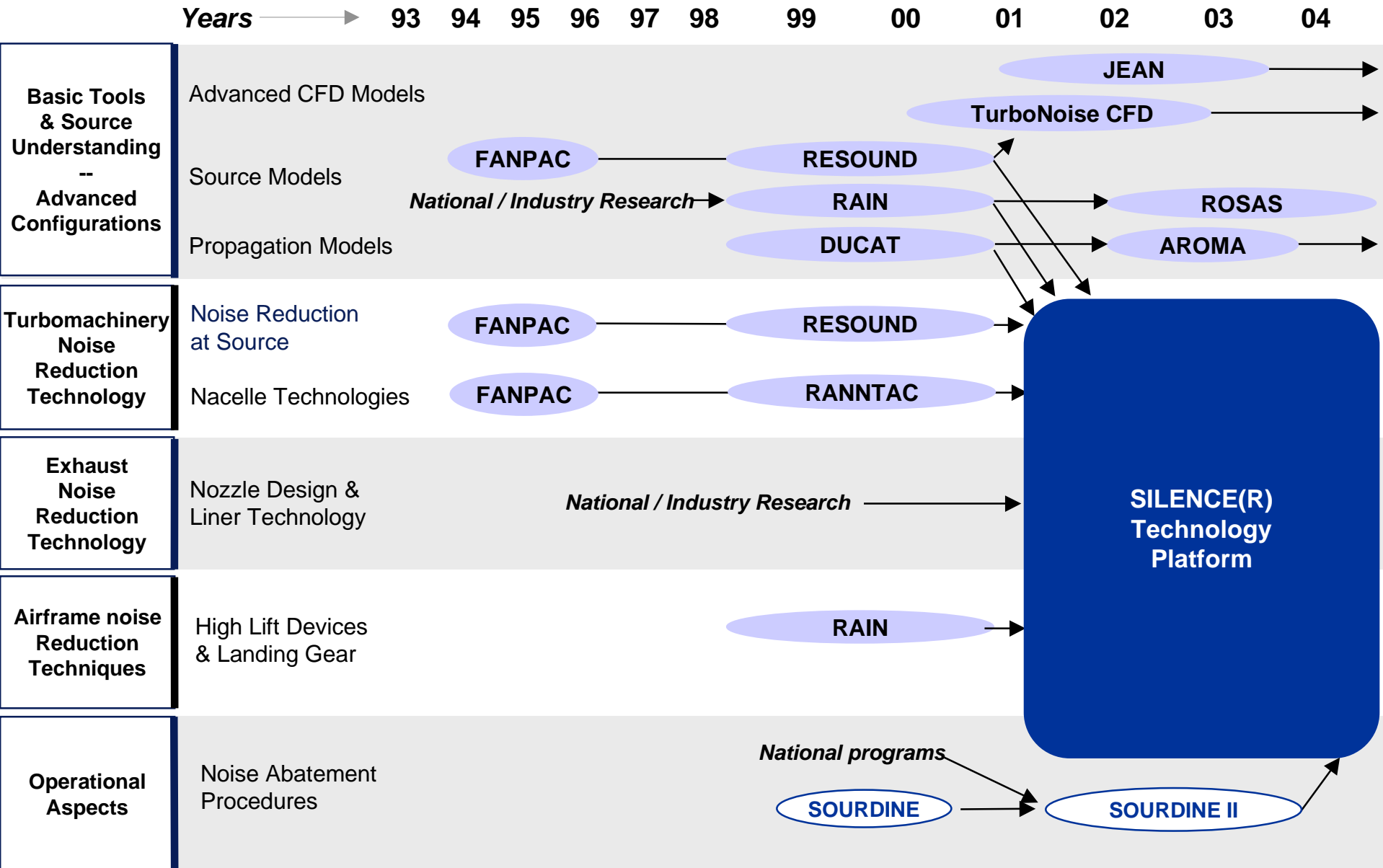
- Nacelle
- Engine
- Airframe

Full Scale Validation

Conclusion



X-Noise Projects Roadmap





SILENCE(R) Technology Platform

Project Coordinator : Snecma Moteurs

No. Of Partners : 51

Objectives :

- Validation of Individual Technologies
- Identification of applicability over the product range
- Cost/ Benefit Analysis

Project Duration : 4 years (Start April 2001)

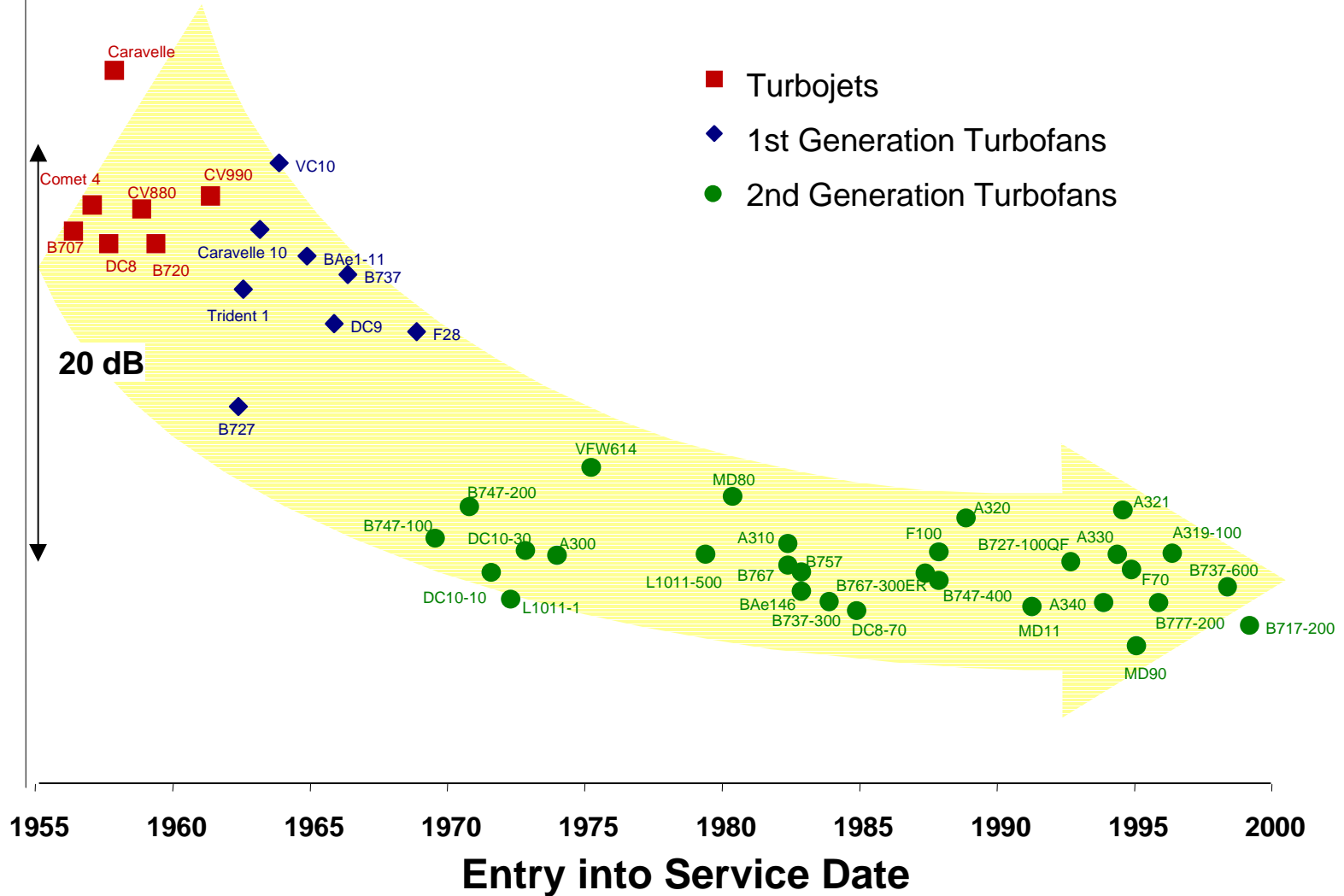
Total Budget: 111 MEuros (50% EC Support)

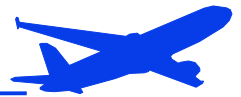




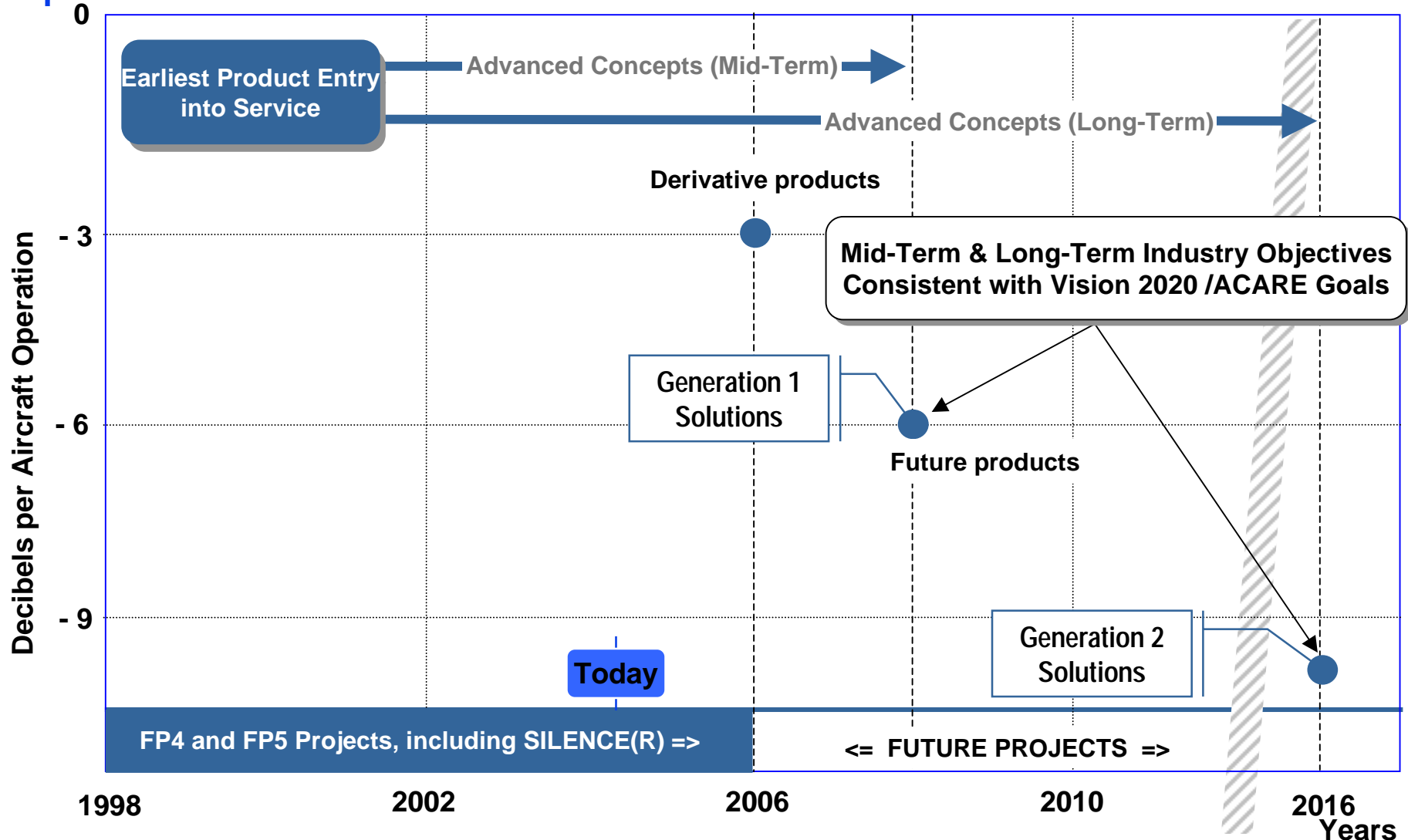
Progress in Noise Reduction

Sideline Take-off Noise Level
corrected for aircraft thrust





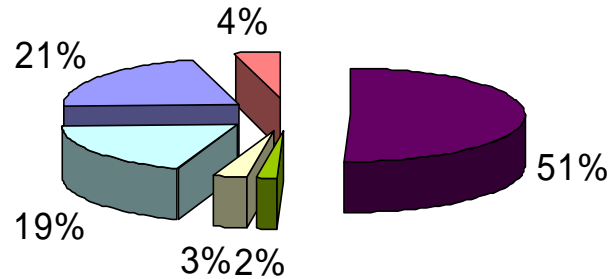
Research Initiative Noise Reduction Objectives



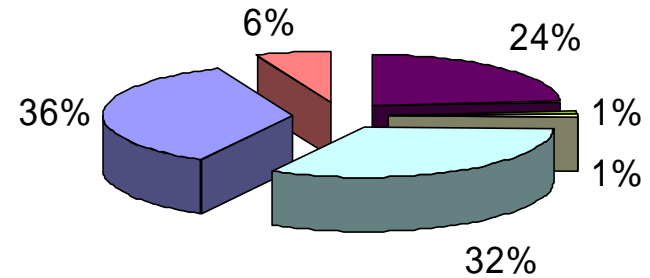


Current Aircraft Sensitivity to individual sources

Sideline

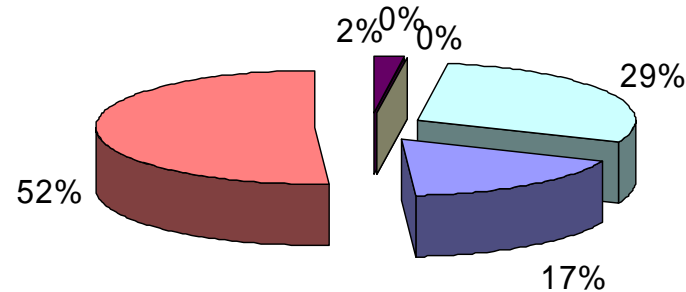
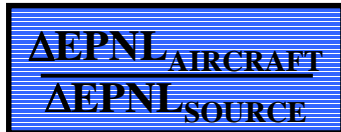


Flyover Cutback



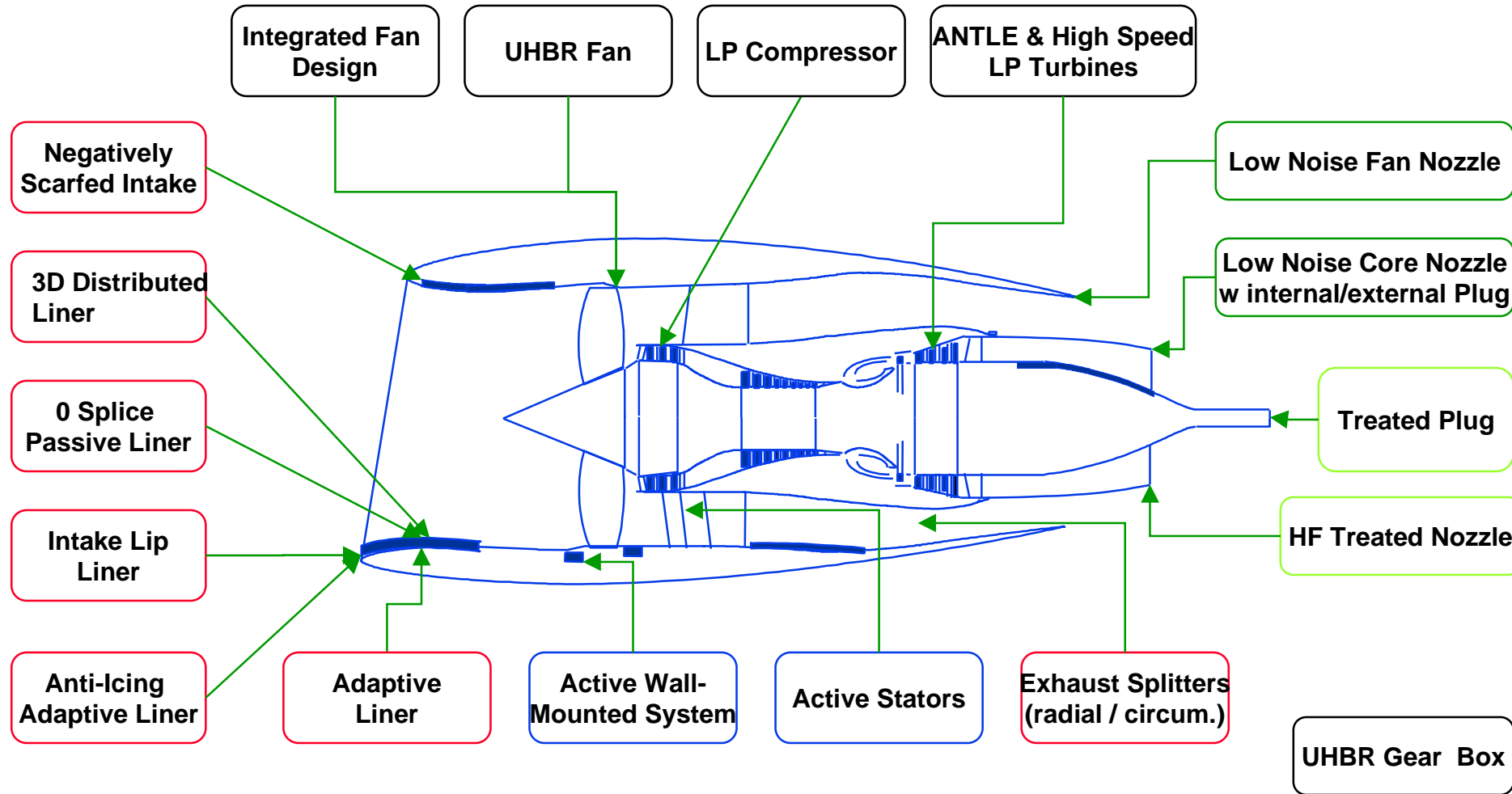
■ Jet ■ Turb ■ Comb ■ Fan fwd ■ Fan rwd ■ Airframe

Approach





How to reach Objectives





How to reach Objectives

Scope of Airframe Noise Reduction Technologies



LANDING GEAR:

- Add-on Treatment
- Low Noise Design

HIGH LIFT DEVICES:

- Add-on Treatment
- Low Noise Design

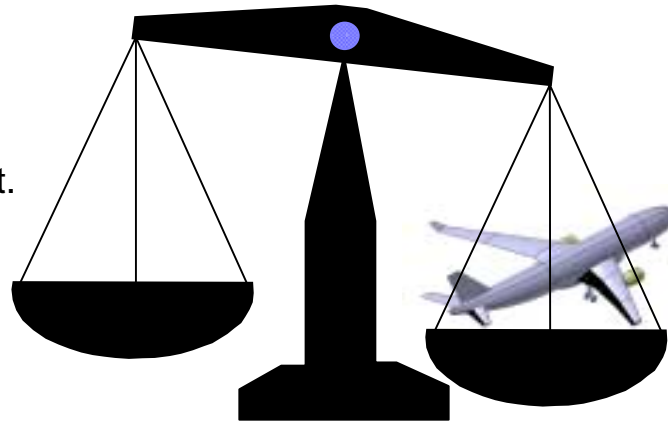


Technology Evaluation

- ✧ **SILENCE(R) first European noise program to introduce independent assessment of progress.**
- ✧ **Assessments during- and at end of program.**
- ✧ **Large matrix of aircraft - and engine combinations**

- **Noise**

- Single event
- Airport Impact.



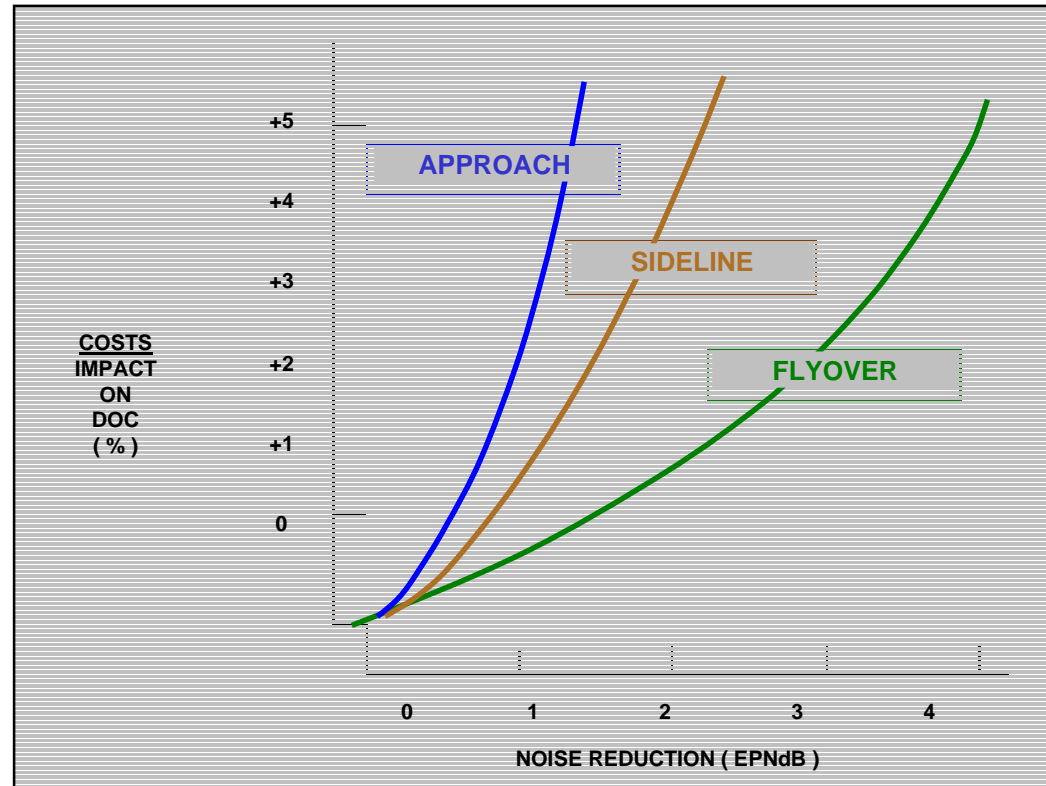
- **Economics**

- D.O.C.
- Weight
- Performance
- etc



Technology Evaluator - Cost / Benefit Evaluation

IMPACT OF FURTHER NOISE REDUCTION
USING AVAILABLE TECHNOLOGY (ICAO Study)



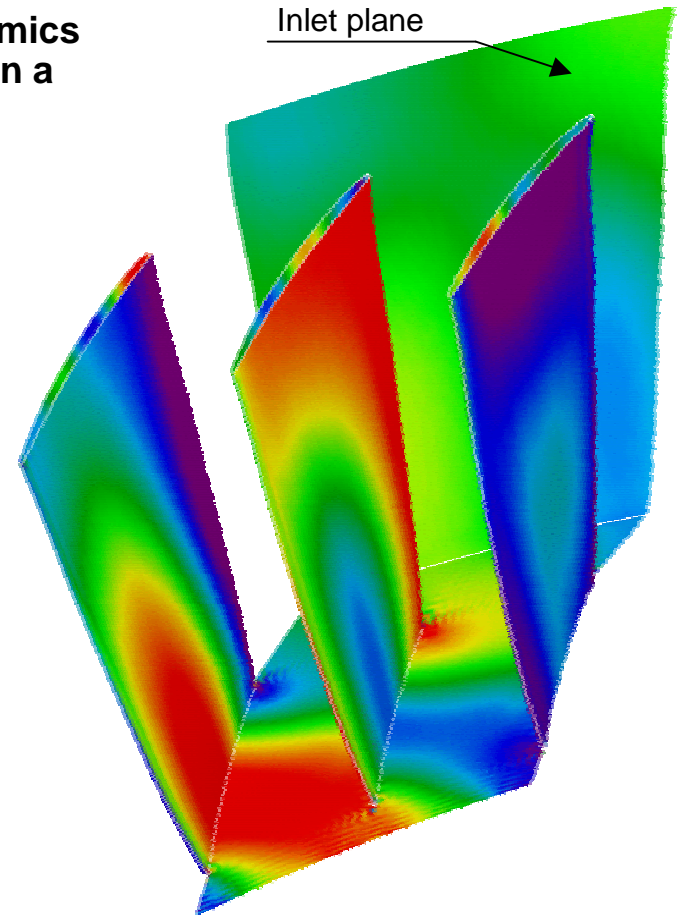
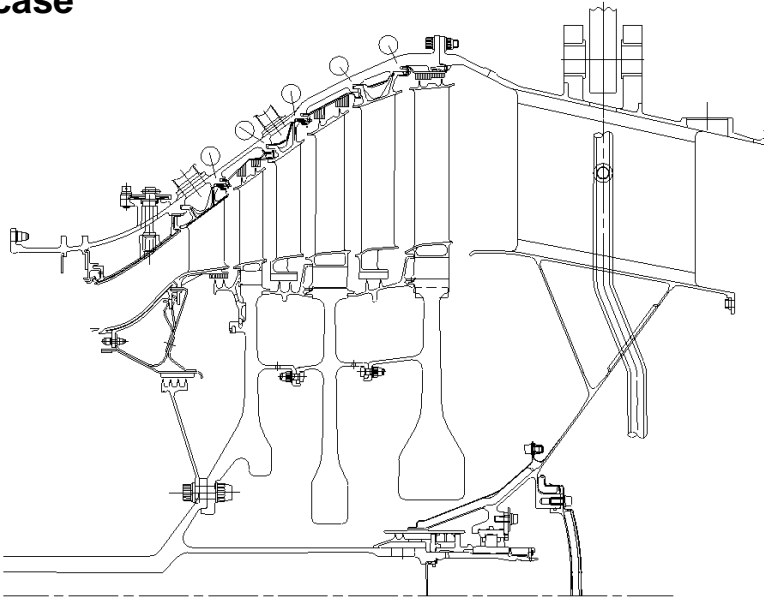
Reference Data - ANDES Study

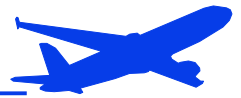


CFD analysis

✧ **High Speed Compressor : Computational Fluid Dynamics simulations to identify potentials of noise reduction in a High Speed LPC of an Aero Engine** →

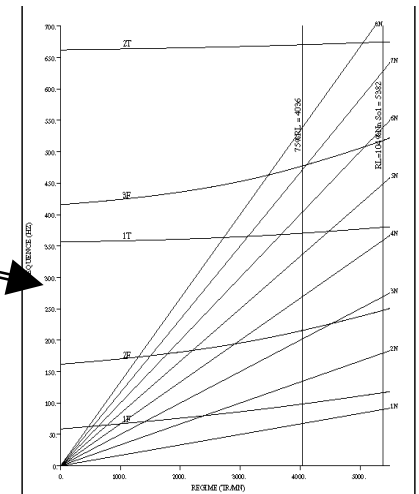
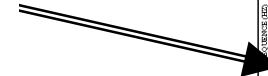
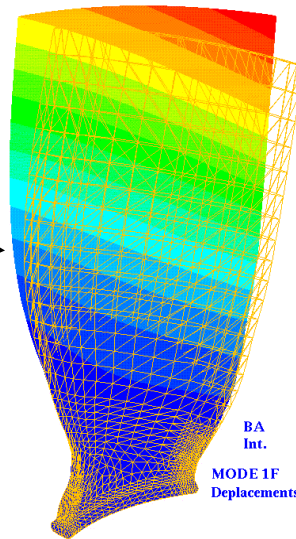
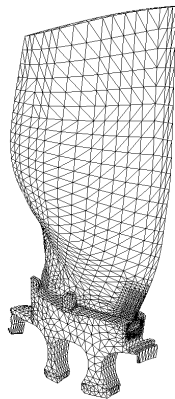
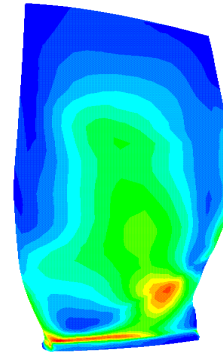
Three Stage Low-pressure Turbine Test case

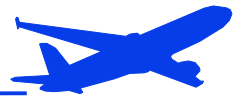




UHBR Fan

- ✧ Aerodynamic design
- ✧ Structural design
- ✧ Performance Verification





Development of Aeroacoustic test means

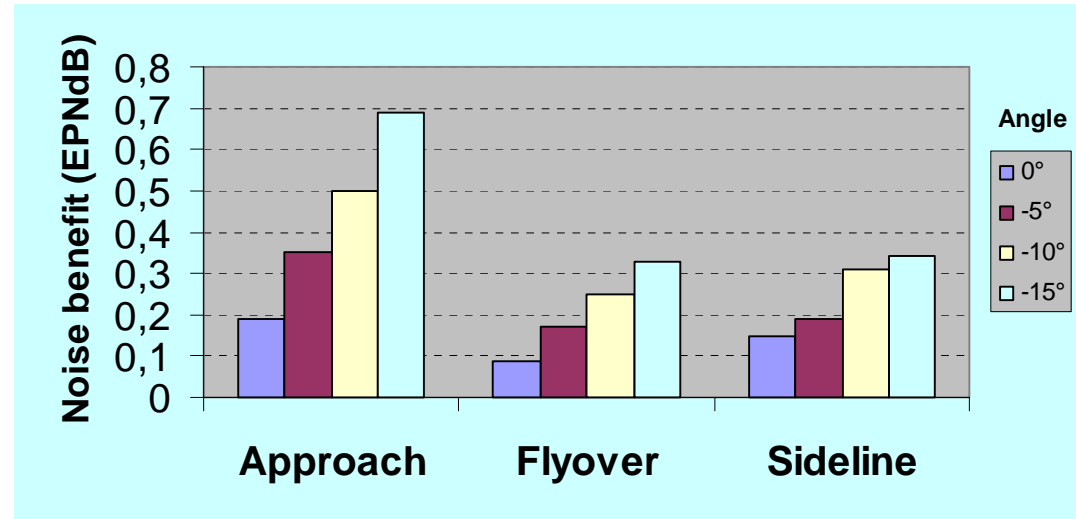
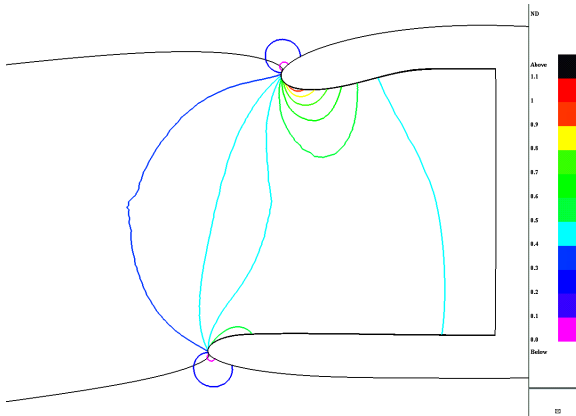


**Rotating mode
generator**

Aeroacoustic test in F1 (treated section)



Scarfed inlet



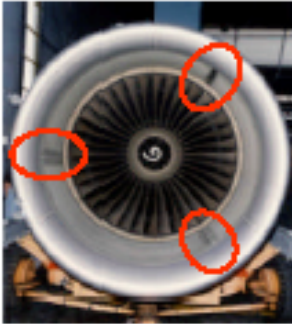
Scarf effect





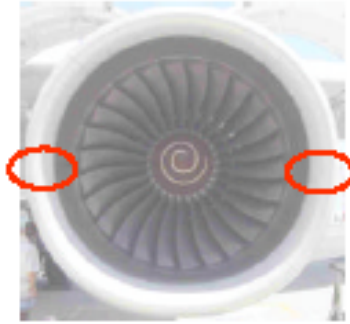
0-Splice liner

A320



3 Splices

A340-600



2 Splices

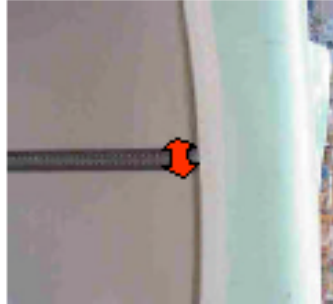
Future aircraft



0 Splice



Current design



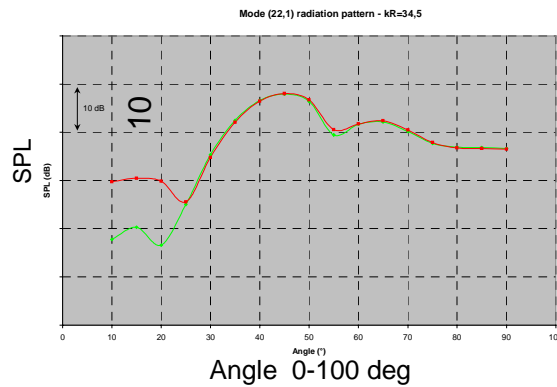
Increased acoustic area
Advanced SDOF Liner



New technology SDOF
0 Splice liner

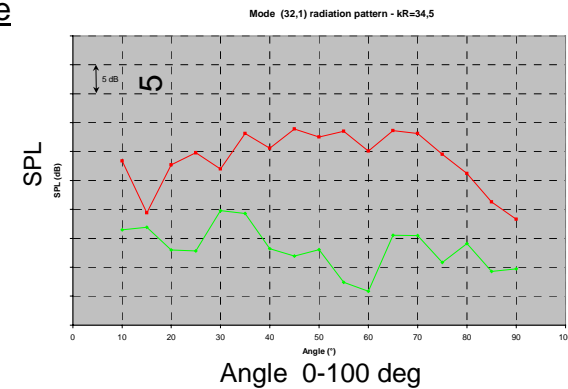


0-Splice Liner



Effect of splice distortion on the radiated noise field of well cut-on incident mode. Low effect on mode lobe. Little noise increase towards axis.

2 versus 0-splice

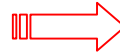


Effect of splice distortion on the radiated noise field of a near cut-off mode. Full disappearance of mode lobe. Large noise decrease at all angles.

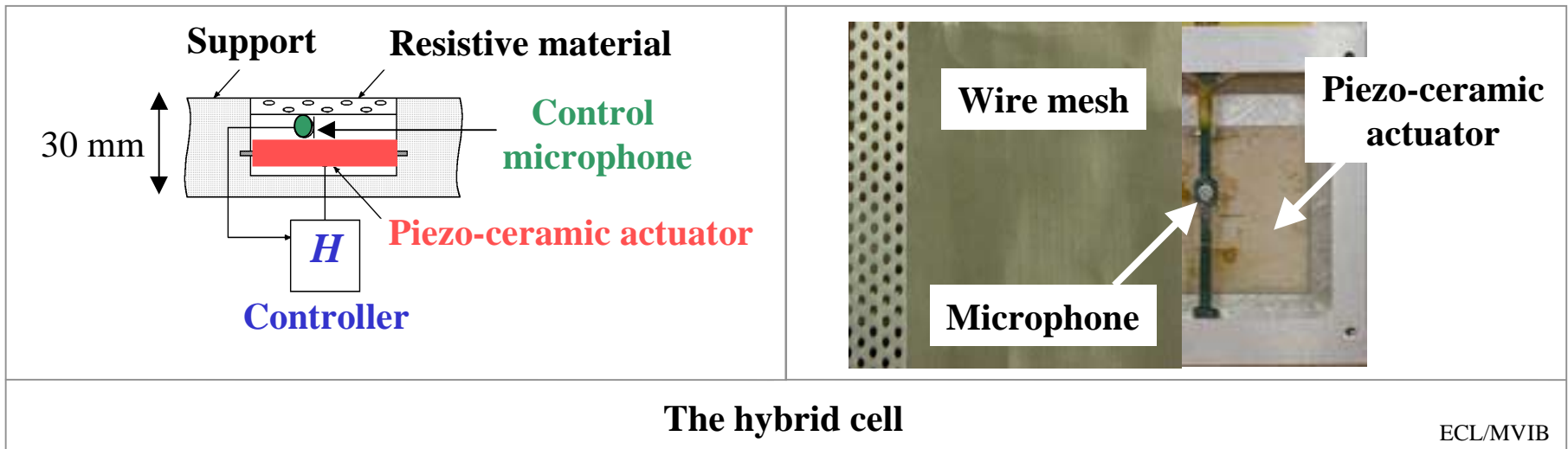


hybrid passive/active absorber

Principle: pressure minimization at the rear face of a porous material by active control



Broadband equivalent of a $\lambda/4$ absorber



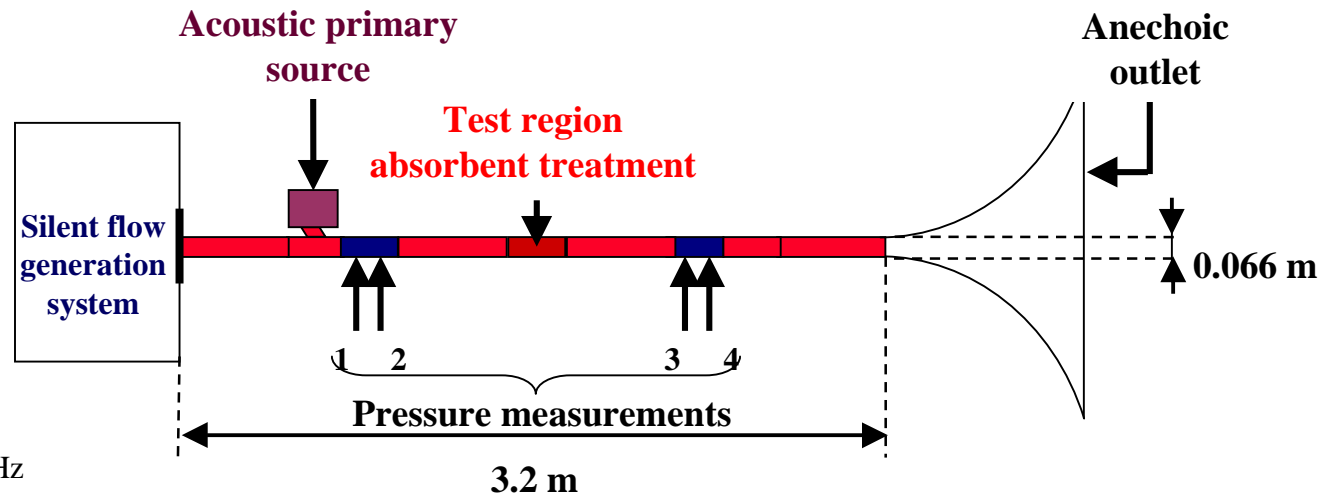


hybrid passive/active absorber

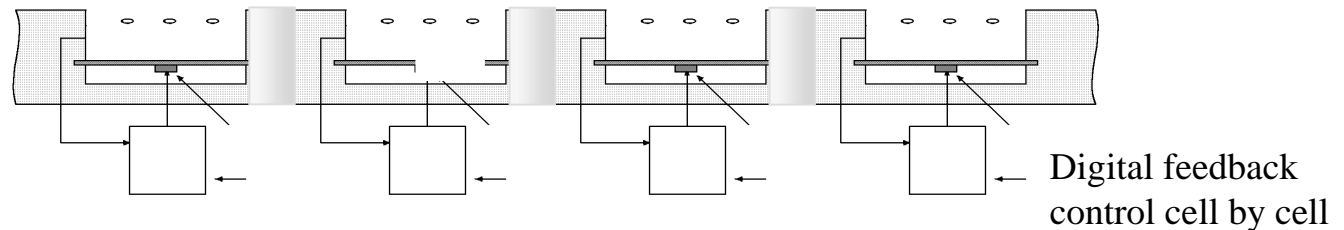
Test in flow duct

Transmission Loss (TL)
measurement

- for a 4 cell-absorber
- velocities : up to 50 m/s
- pure tones, frequency range [500-2500] Hz

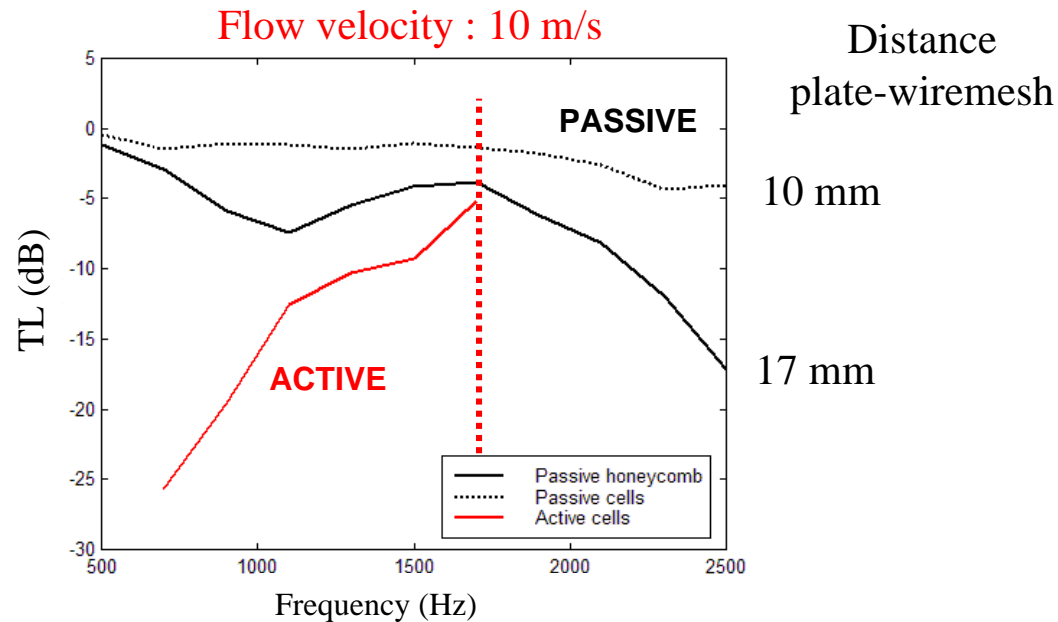


Extension of the liner surface





hybrid passive/active absorber



HYBRID FUNCTIONING : active at low frequencies, passive at high frequencies

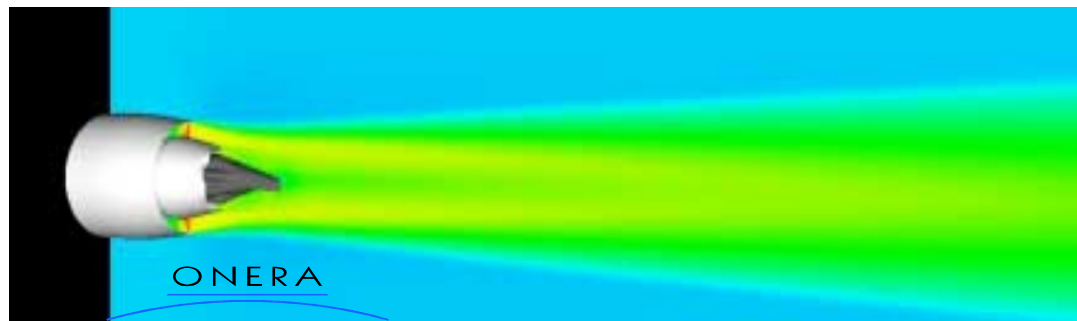
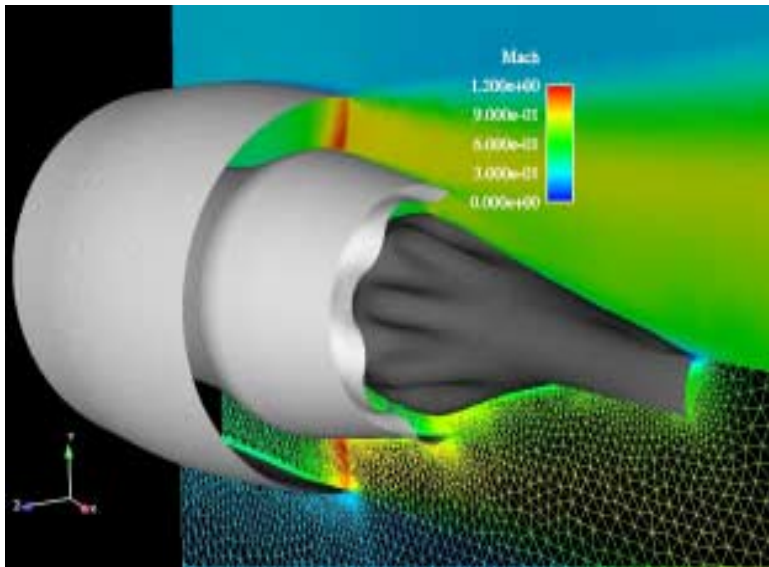
cut-off frequency : 1700 Hz

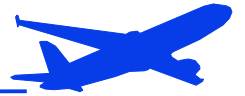


High attenuation levels over a large frequency range



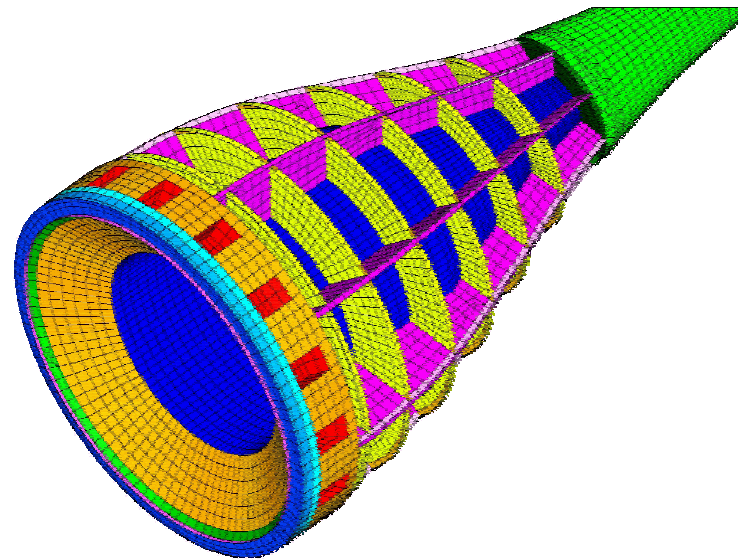
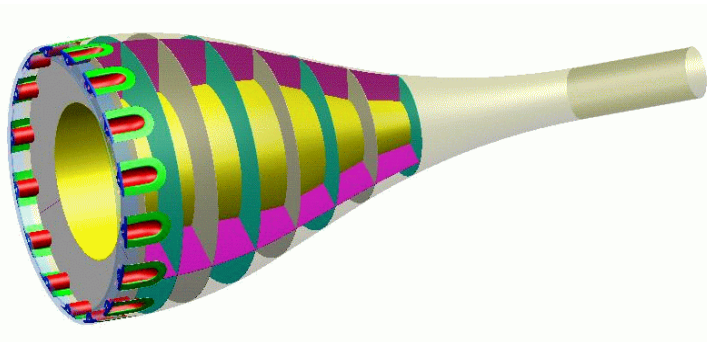
Exhaust Nozzle Treatement





Exhaust Plug Designs

- ✧ Multiple Light-weight designs
- ✧ Down-selection process for best performance





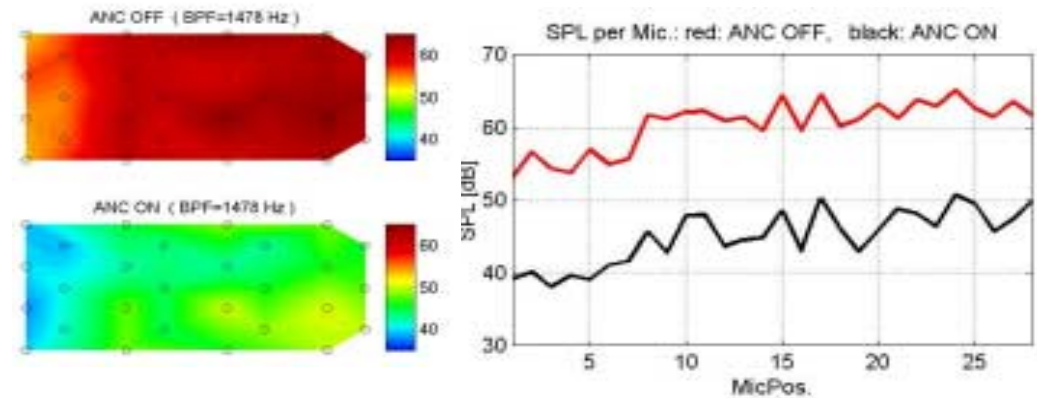
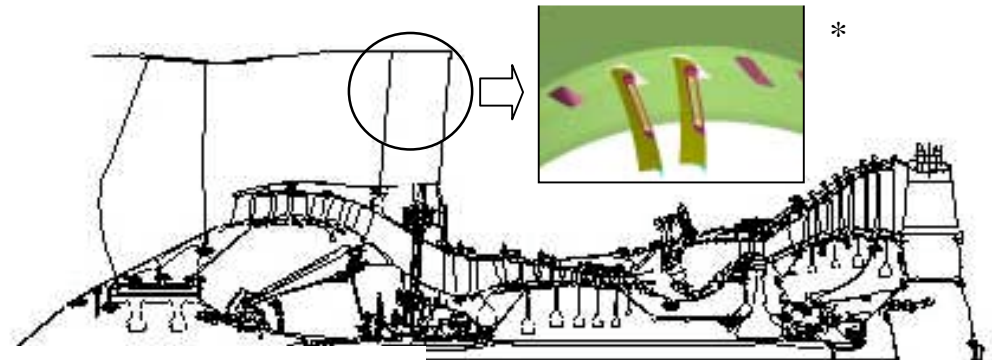
Active Stator Vane

Active Technologies applied to Low Frequency Fan Tones Reduction

✈ 10 dB noise reduction



Active Stator vane



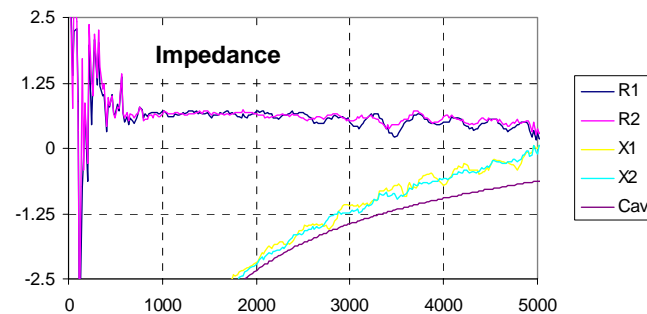
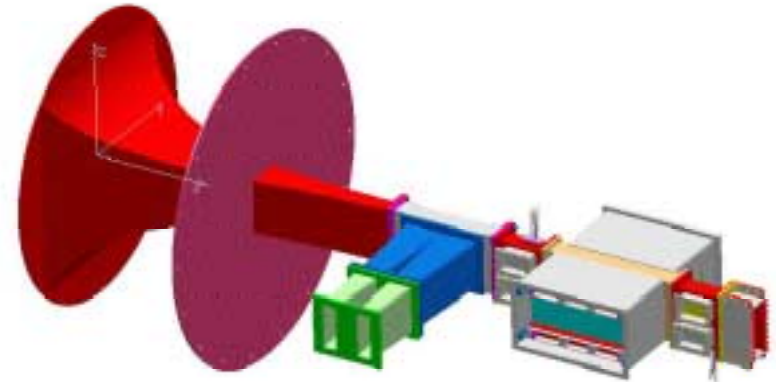
* Source Dornier



Development of Aeroacoustic test means

✈ Hot Stream Liner Test Facility

- Rig specifications:
 - Mach 0.4
 - Temperature 550 °C
 - SPL 140 dB
 - Insertion loss and in-situ acoustic impedance measurements in the frequency range between 0.5 and 5 kHz
- 23 Liner Configurations Tested



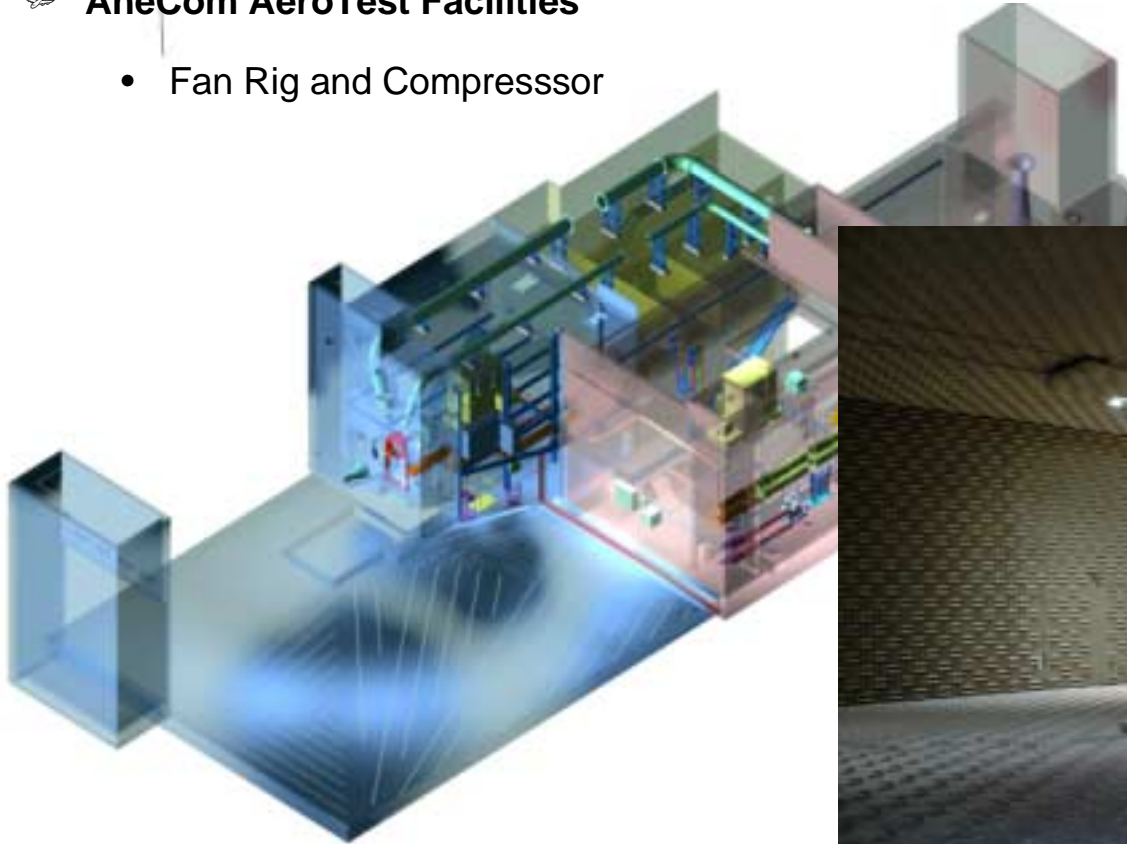
Perforate type of liner, broadband random noise excitation,
 $T = 500^{\circ}\text{C}$, $M = 0.325$



Use of Aeroacoustic test means

AneCom AeroTest Facilities

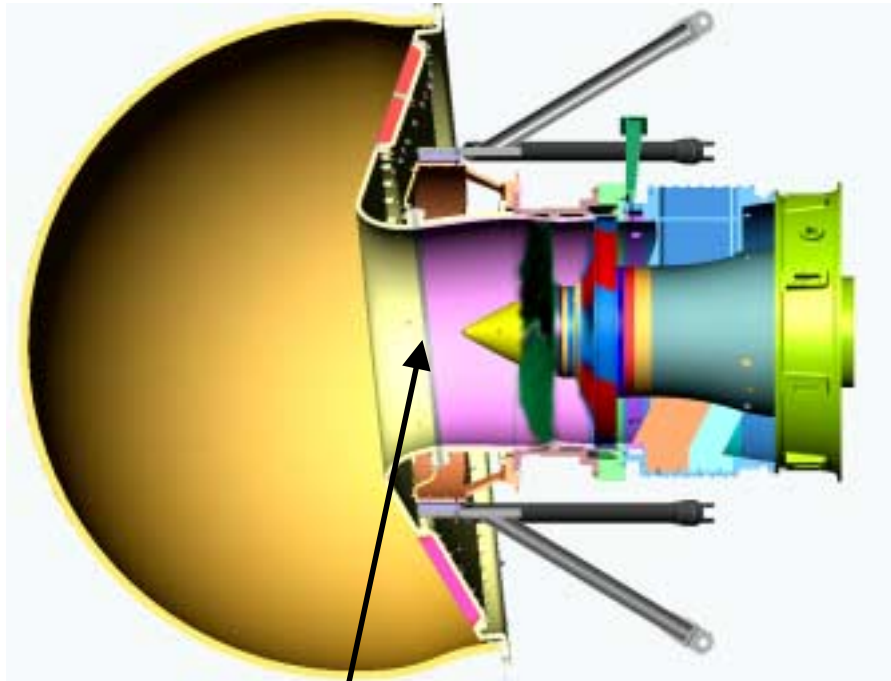
- Fan Rig and Compressor



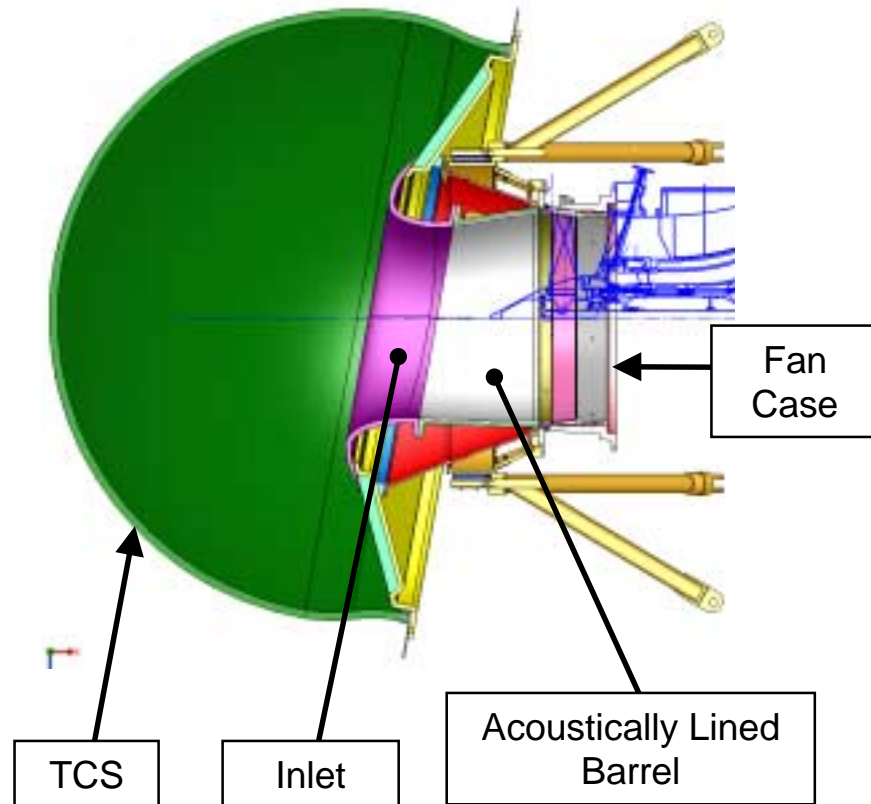
Troubadix Test Cell – Aug 03



Large scale tests on Fan rig



Forward Mode Detection Ring



TCS

Inlet

Acoustically Lined Barrel

Fan Case





Large scale tests on Fan rig



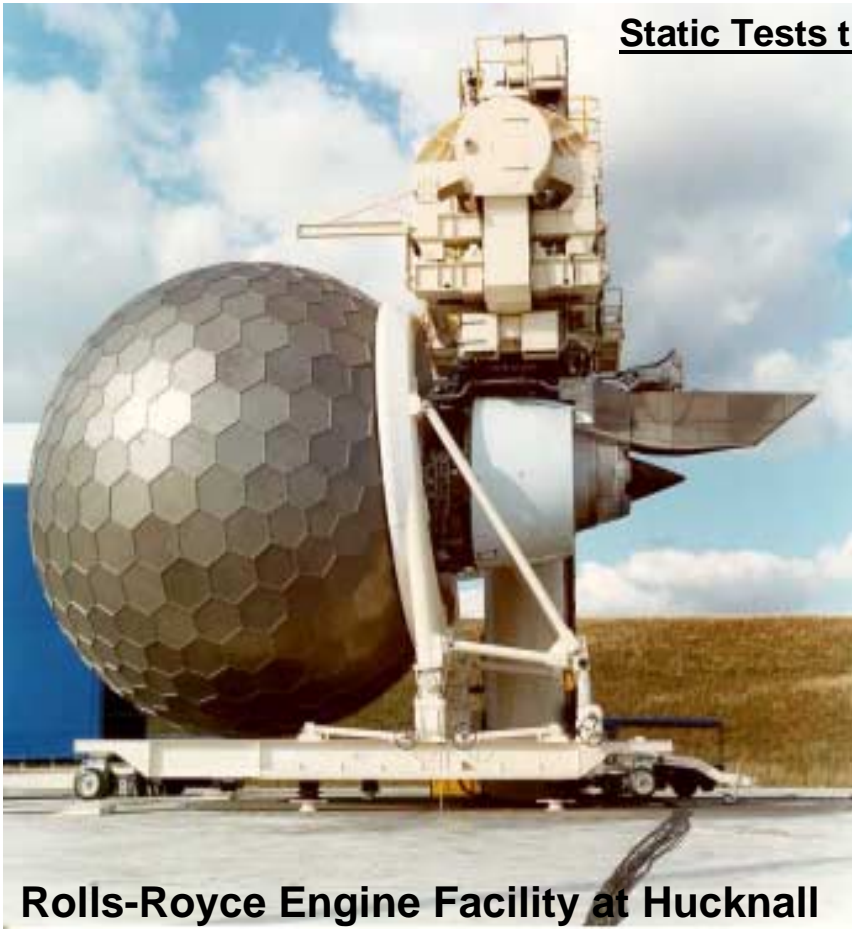
Flare

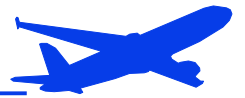




Full Scale Validation Tests

Static Tests trough 2003-2005





Full Scale Validation Tests

✈ **Flight Tests trough 2003- 2004**





AIRFRAME NOISE REDUCTION ACTIVITY

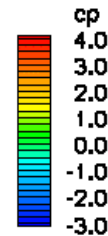
- ✧ **Airframe noise is an important contributor to approach noise level**
- ✧ **Major sources are landing gear and high lift devices**
- ✧ **Identification of noise sources ranking and development of low noise technologies in previous FP4 EC project RAIN 1998-2001**
- ✧ **SILENCER objectives relative to airframe noise:**
 - Further development of low noise technologies
 - Study of interaction noise
 - Full scale demonstration of noise reduction



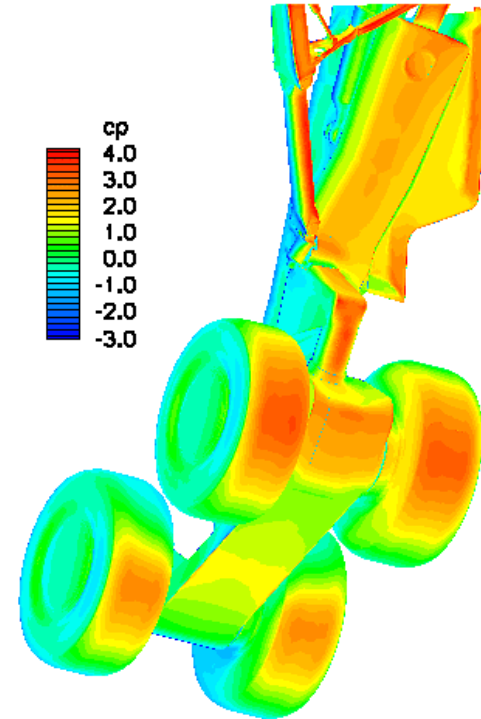
Landing gear noise reduction

✈ Optimisation of landing gear fairing de
using CFD computation

New NLG design



Surface pressure
distribution C_p



✈ Development of Low noise landing
gear design





✈ Study of gear / gear interaction noise



A340 Centre & Main LG model in Airbus UK wind tunnel



A340 LG model in DLR AWB wind tunnel



Study of LG wake / flap interaction noise

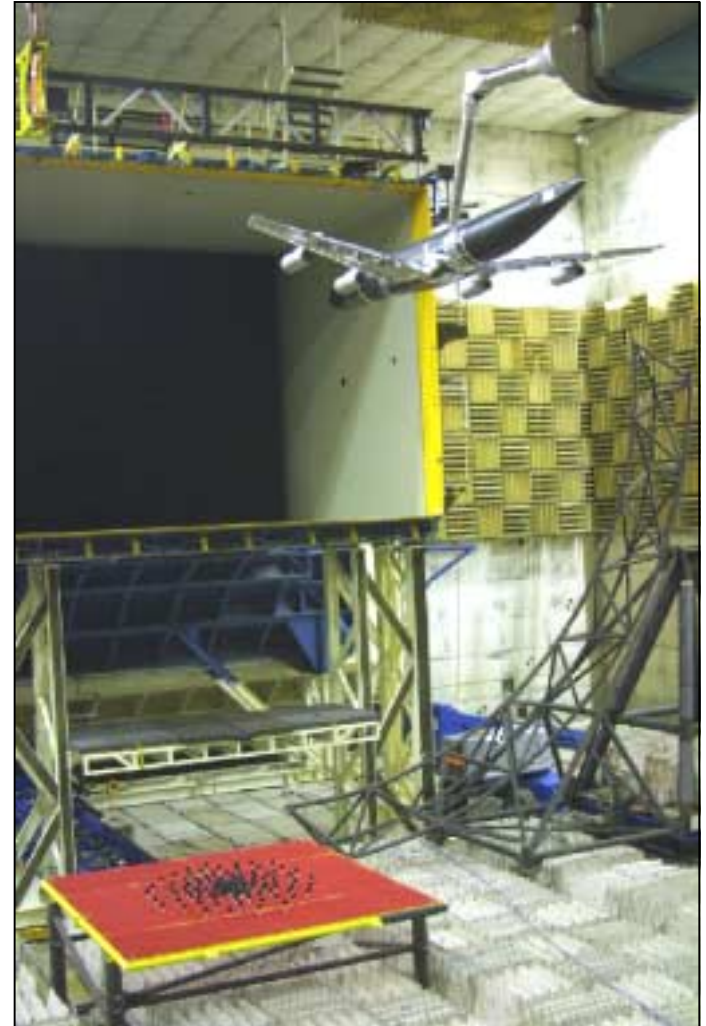




High lift devices noise reduction

✧ Development of low noise HLD design

- A340 model test in DNW wind tunnel open & closed test sections in 2002





Full scale demonstration tests

- ✈ **A340 flight test in 2003 including LG fairings & wing add-on treatments**



- ✈ **A340 full scale low noise MLG & NLG mock up tests in DNW planned in mid 2004**



Conclusion

- ✧ **After SILENCE(R) start ambitious -10 dB Noise Targets have been set for 2020 (ACARE).**
- ✧ **SILENCE(R) Objectives match ACARE time schedule**
- ✧ **SILENCE(R) Achievements on nacelle, engine and airframe noise reduction will match ACARE time schedule.**
- ✧ **Continued investment required to fully achieve 2020 objectives through the Balanced Approach:**
 - Source Noise reduction
 - Noise abatement procedures
 - Land-use Management

