RAeS Lecture / Hamburg Branch

The Clean Sky Programme

Preparing for the next generation of civil aircraft

Presented by
Dr Gareth Williams / Head of R&T Business Development & Partnerships

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Outline

- The aviation market
  - Growth
  - Innovation
- Clean Sky Programme
  - Technology Demonstration
  - New wings - Natural Laminar Flow
  - New engines – Contra Rotating Open Rotors

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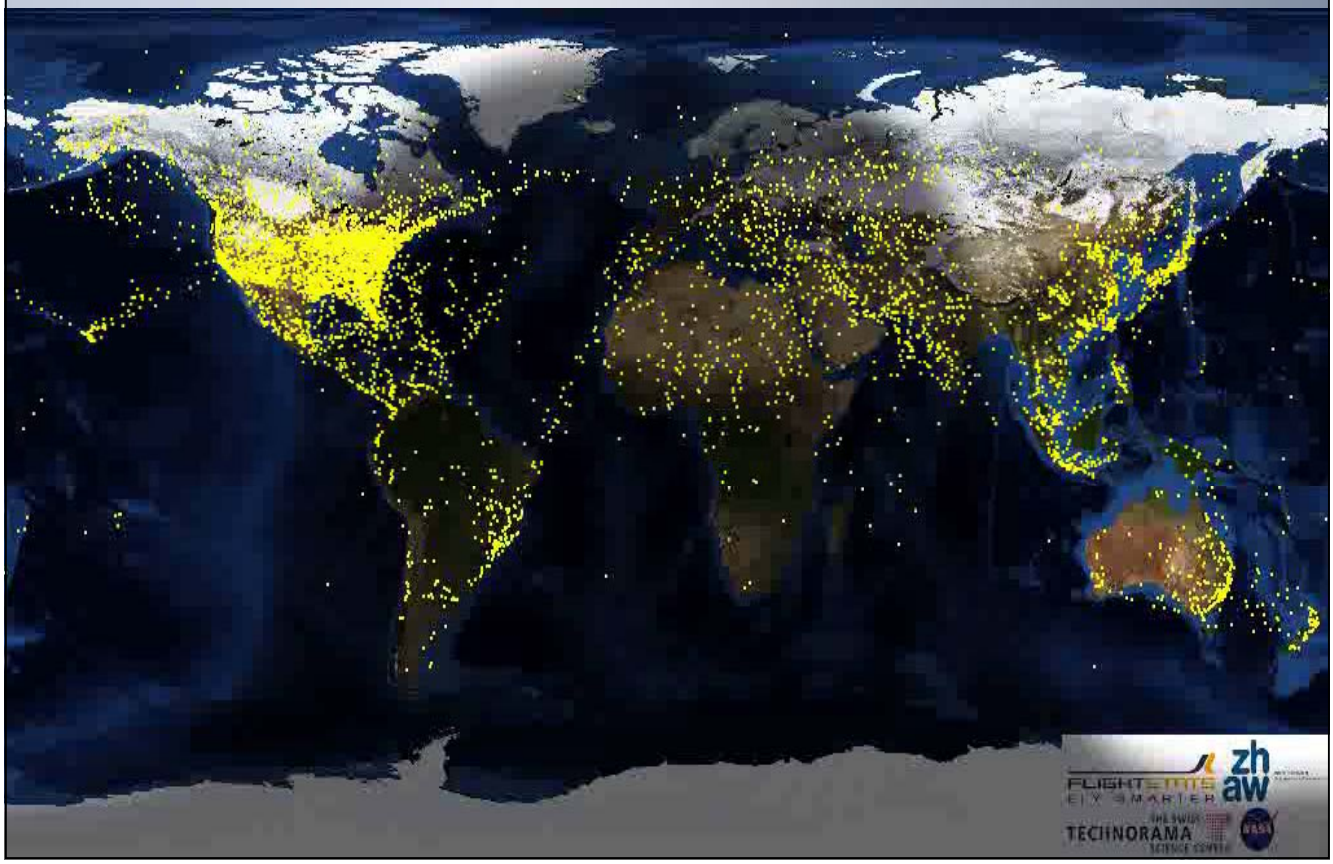
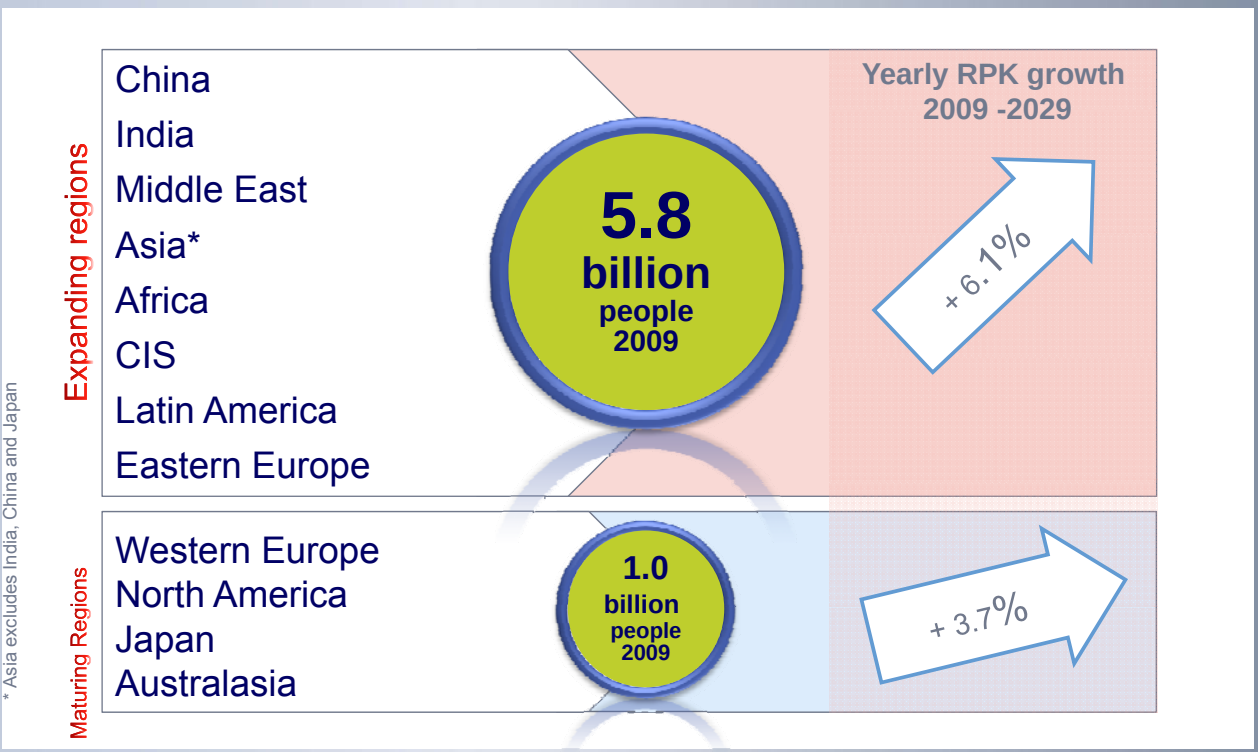
24 hrs of flights



Growth per region



5.8 billion people will increasingly want to travel by air

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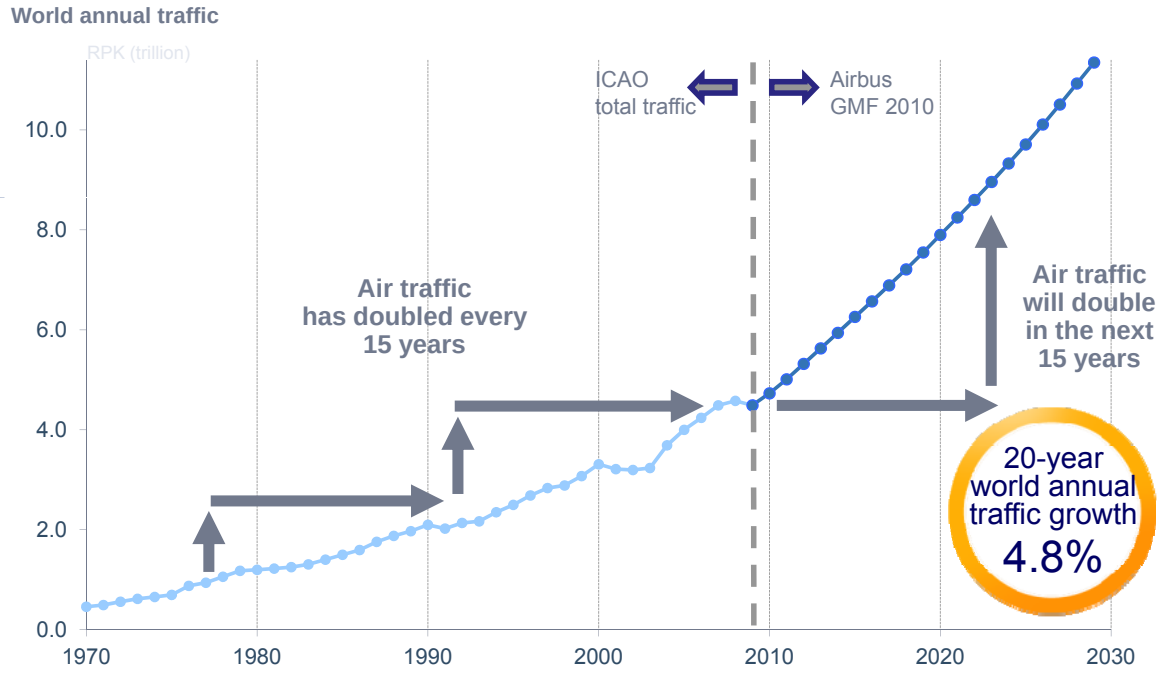
Long term fundamentals will lead to growth



Air traffic will double in the next 15 years

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20-year demand for over 27,347 new aircraft

20-year new deliveries of passenger and freighter aircraft

19,518 single-aisle aircraft

6,497 twin-aisle aircraft

1,332 very large aircraft

Passenger aircraft (≥ 100 seats) and freighter aircraft (> 10 tons)

Market value of > $3.9 trillion

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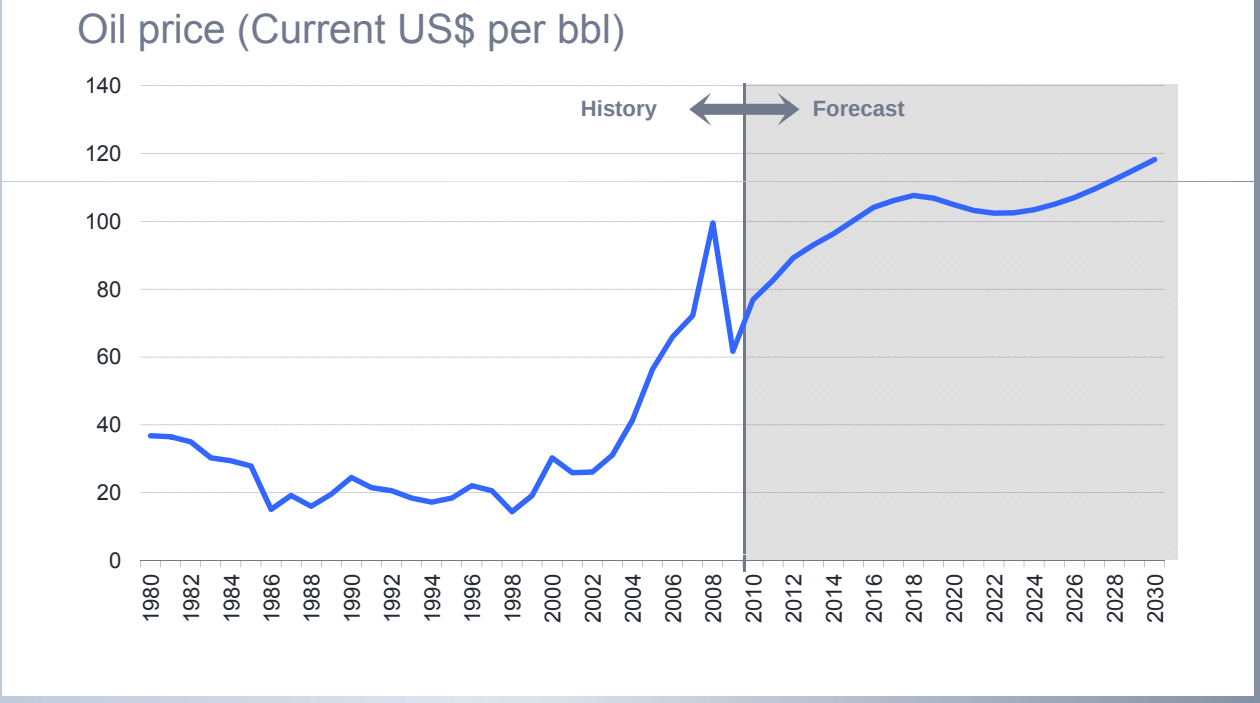
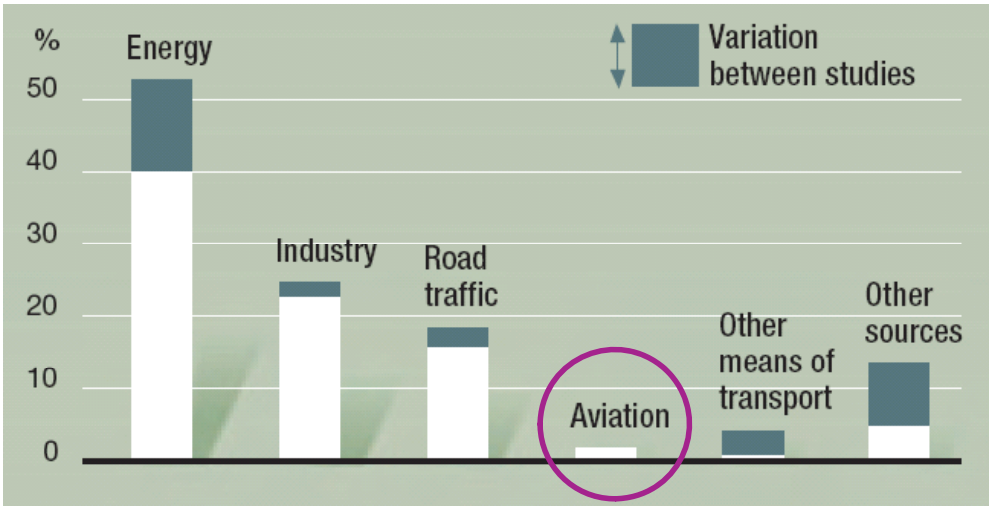
Oil price development



The oil price risk

The facts related to CO2

- Aviation contributes 8% of global GDP and supports 32 million jobs worldwide
- Aviation accounts for about 2% of total man-made CO_2 emissions



Economic powerhouse with moderate environmental impact

The continuiung challenge in aviation

Meeting an increasing demand for air transport

+

Minimising environmental footprint

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What drives aerospace innovation?

Passenger Appeal

- Comfort
- Additional Services
- Differentiation

Efficiency

- Direct Operating Costs
  - Fuel burn
  - Direct Maintenance Costs
- Dispatch Reliability
- Turn Round Time
- Simplicity

Environment Friendly

- Emissions
- Green Manufacturing
- Recycling

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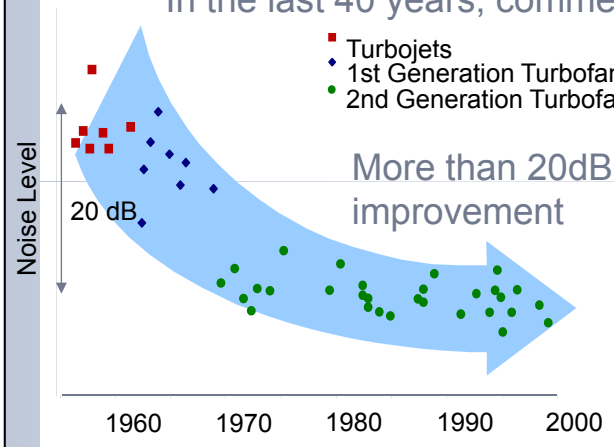
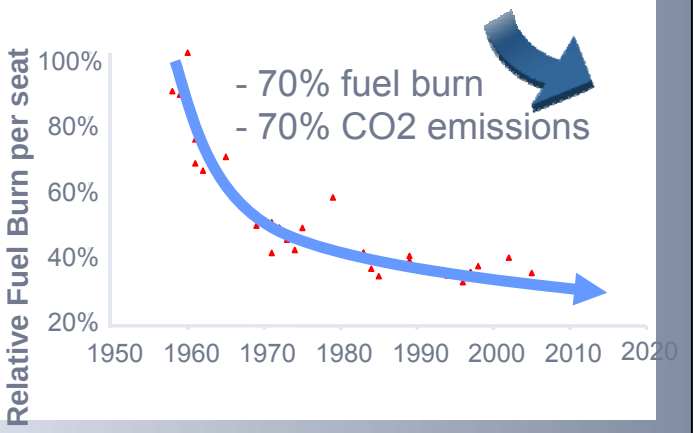
The achievements

In the last 40 years, commercial aviation industry has achieved:





Dramatic improvements due to technology

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Technology - an established driver for success

1990 **2000** **2010** ...

A320

Side-stick & Electronic Engine Controller

2nd generation digital auto flight system

A340

All-new advanced technology wing

CFRP bulkhead

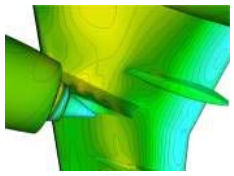
A380

CFRP centre wing box

Variable Frequency generator

A350

CFRP Fuselage



Aerodynamic Efficiency

The future is yet to be invented

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Clean Sky Programme

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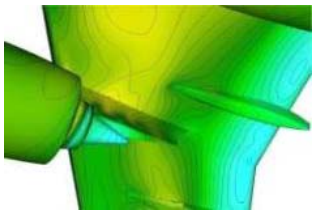
ACARE's ambitious targets

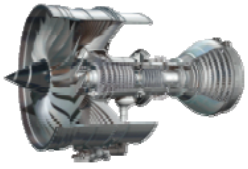
→ 50% cut in CO2 emissions

Aircraft manufacturers 20-25%



Integration

Engine manufacturers 15-20%



Operations 5-10%
Air Traffic Management

ACARE

ACARE: Advisory Council for Aeronautics Research & Innovation in Europe

ACARE targets drive innovation – technology + application

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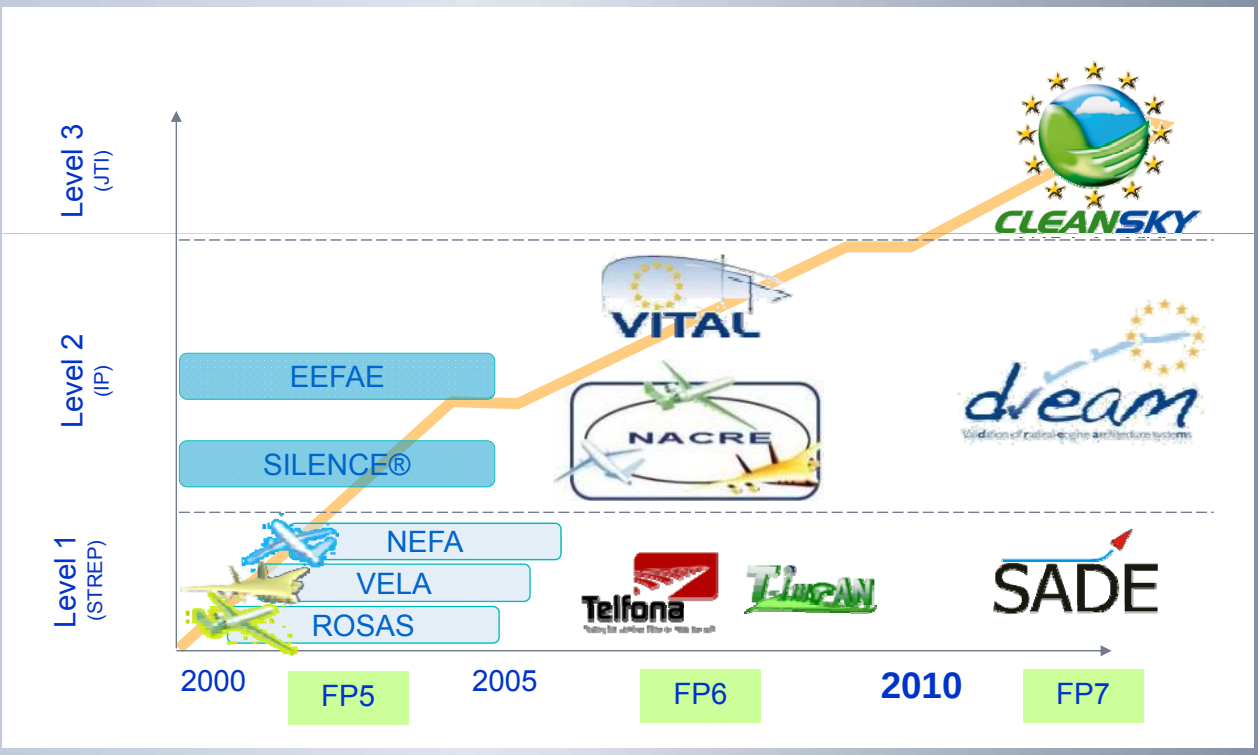
EU R&T Roadmap for New Aircraft Concepts



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Clean Sky - Overview

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Clean Sky -Partners

Total Investment = 1,600M€

"ITD-leaders"

Partners

- Airbus
- SAAB
- Dassault
- EADS-CASA
- Thales
- Liebherr
- Fraunhofer
- SAFRAN
- Rolls-Royce

50% of Total Budget

Associate Partners

- DLR
- ONERA
- INCAS
- NL-Cluster
- QinetiQ
- RUAG
- Aernnova

25% of Total Budget

Partner participation based on Call for Proposals *„CfP"*

25% of Total Budget

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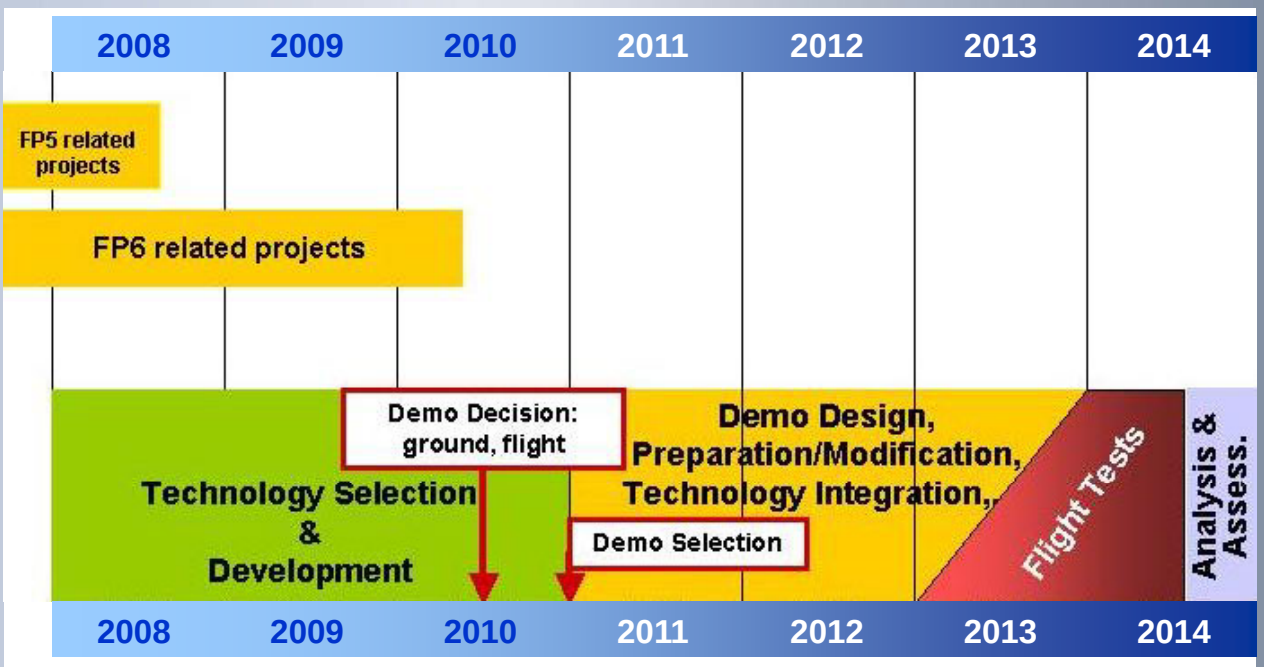
Clean Sky - Timeline



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SFWA-ITD – Objectives

Input connecting to:

"Sustainable and Green Engines" – ITD
CROR engine

"System for Green Operation" – ITD" **Novel Energy Management / Green Mission and trajectories**

Smart Wing Technologies

- **Technology Development**
- **Technology Integration**
- **Large Scale Flight Demonstration**

Innovative Powerplant Integration

- **Technology Integration**
- **Large Scale Flight Demonstration**

Output providing data to:

CleanSky Technology Evaluator **SFWA technologies for a Green Air Transport System**

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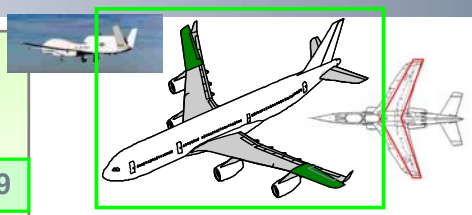
SFWA ITD Flight Demonstrator Options

1. High Speed Flight Demonstrator

Objective: **Large scale flight test of passive and active flow and loads control solutions on all new innovative wing concepts to validate low drag solutions at representative Mach and Reynolds Numbers.**

Option 1: UAV
Option 2: Alpha-Jet
Option 3: Airbus A340 with modified wing

Selected in April 2009



2. Low Speed Flight Demonstrator

Objective: **Validation flight testing of High Lift solution to support / enable the innovative wing low drag concepts with a full scale demonstrator.**

Option 1: Dassault Falcon
Option 2: Airbus A320

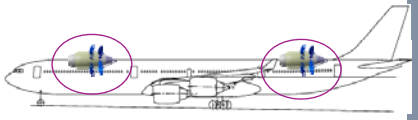
Decision in 2012

3. Innovative Engine Demonstrator Flying Testbed

Objective: **Demonstrate viability of full scale innovative engine concept in operational condition**

Options under investigation

Status: Preferred solution



4. Long Term Technology Flight Demonstrator

Objective: **Validation of durability and robustness of Smart Wing technologies in operational environment**

Option 1: In Service Transport Aircraft
Option 2: Airbus A300 "Beluga"
Option 2: Airbus A320

Selection(s) part of technology roadmap

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Natural Laminar Flow

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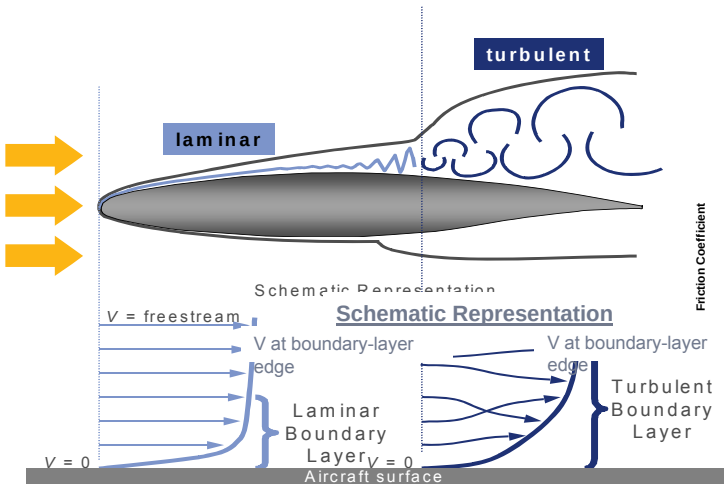
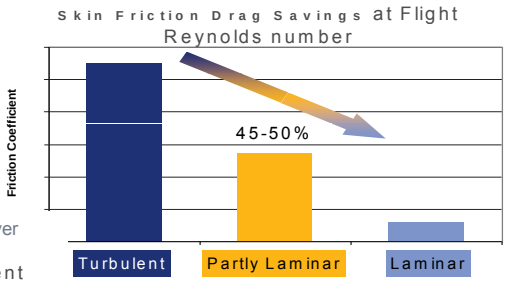
Aerodynamic drag reduction through laminar flow





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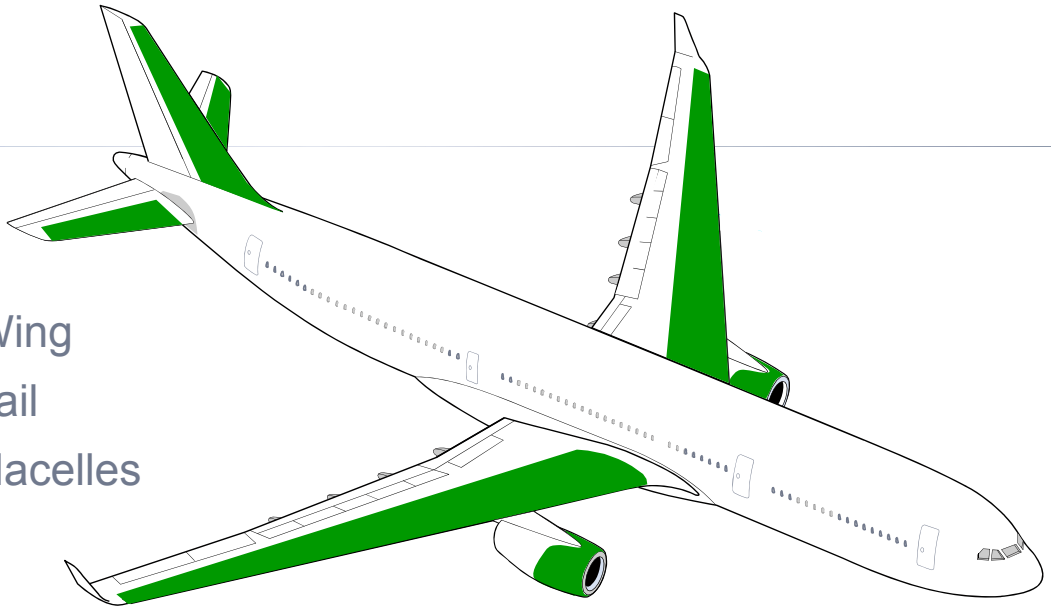
Aerodynamic drag reduction - potentials



- Wing
- Tail
- Nacelles

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Historic attempts at laminar flow

North American P-51 Mustang (1941)

- Wind tunnel tests better than real operations

.

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Historic attempts at laminar flow

HLFC "Laminar Fin" Airbus A320 demonstrator
(LaTeC, 3E, HYLDA, until 1998)

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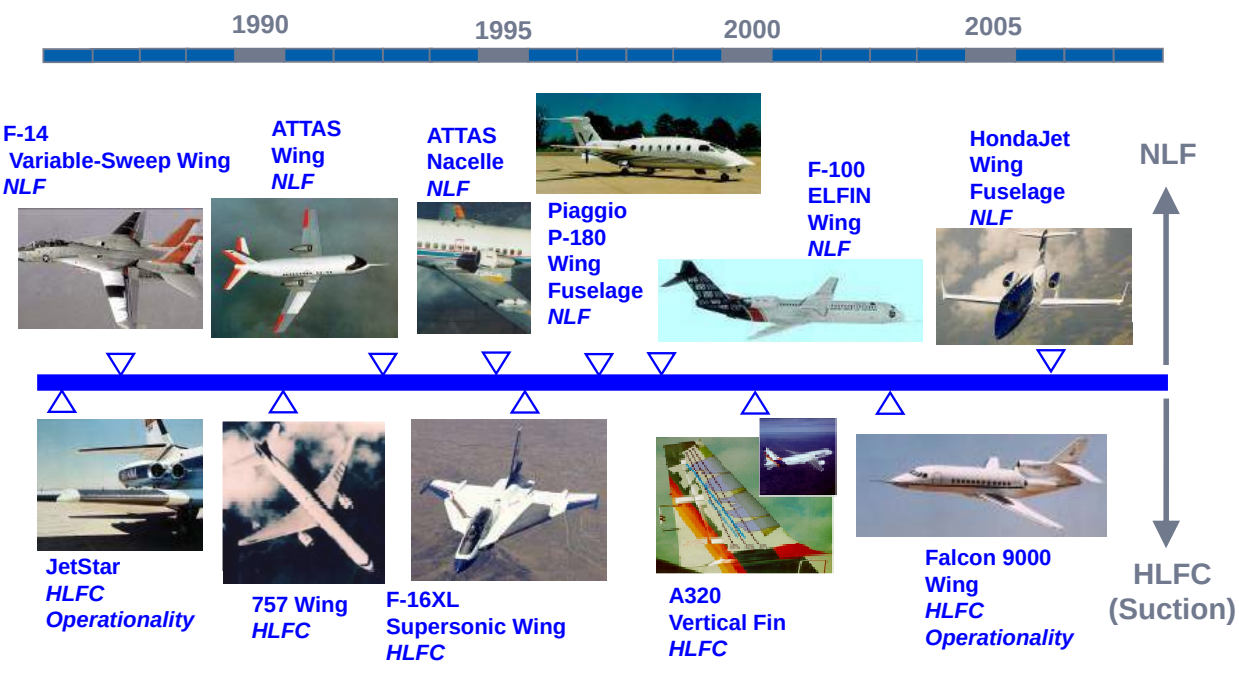
Laminar-Flow Flight Demonstrations 1985 – 2008



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BLADE

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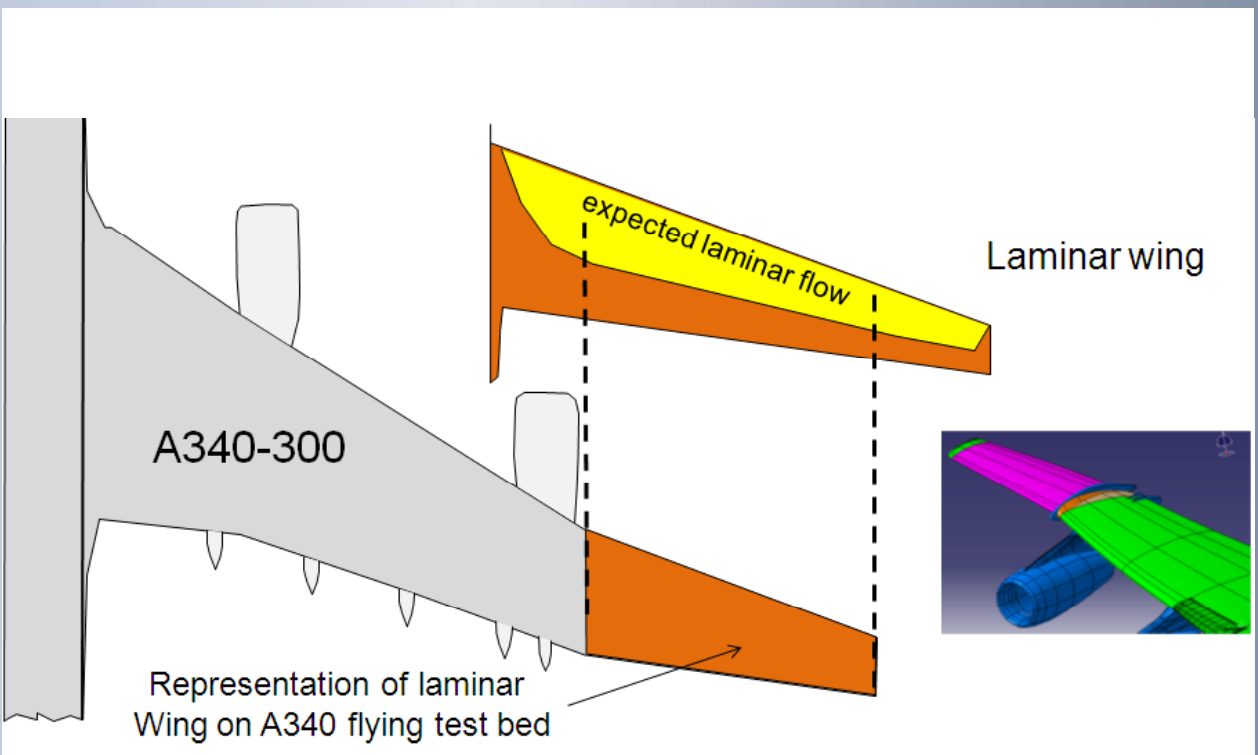
Demonstrate feasibility of a structure concept



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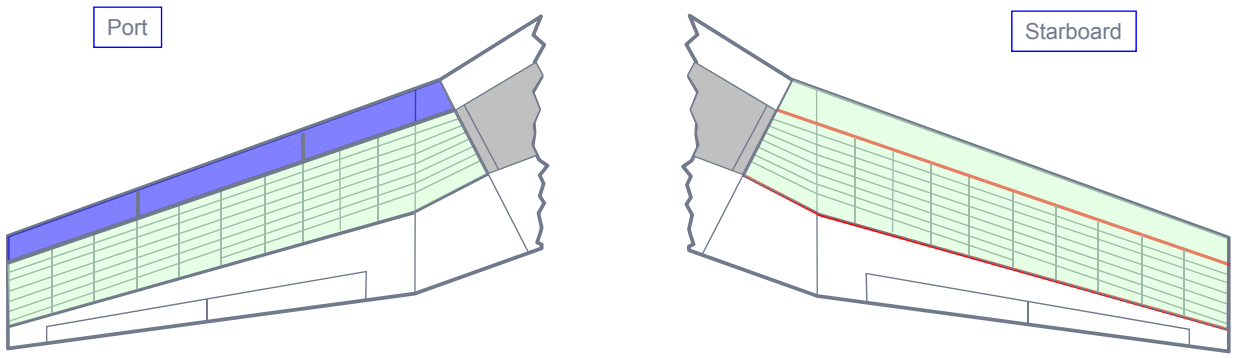
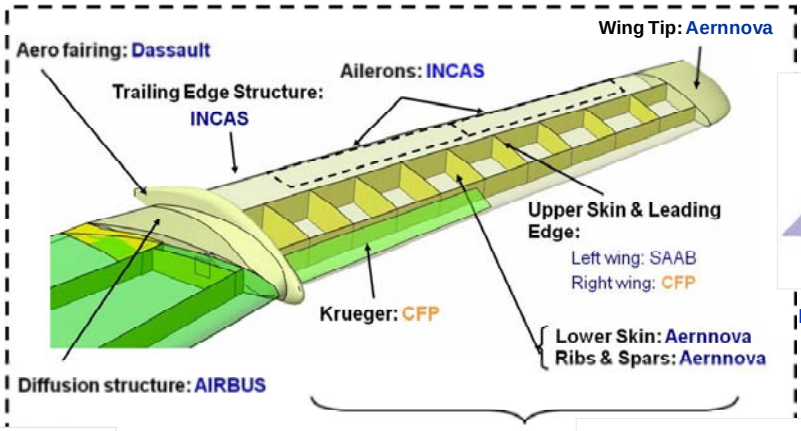
Smart Passive Laminar Flow Wing - Demonstrator

- New designs x 2
- Novel materials and structural concepts
- Ground demonstration – proof
- Flight test in operational conditions

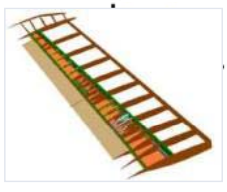


Full scale Laminar Wing FTB

SFWA – Partner Contributions



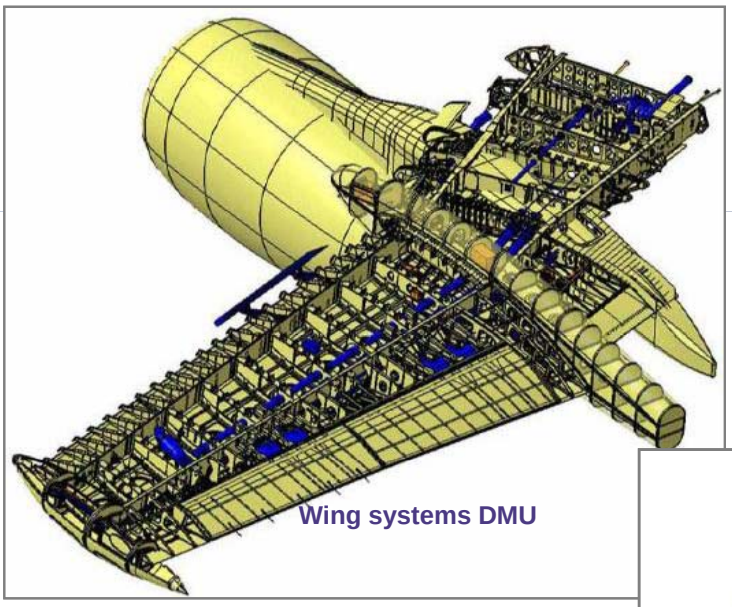
Integrated upper cover (SAAB)



Aileron structure (INCAS)

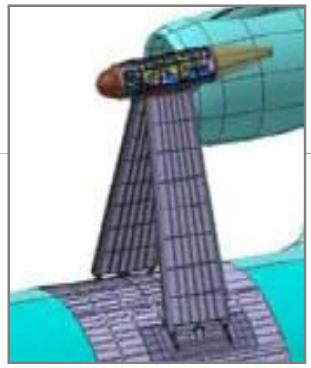
Integrated upper cover with structural concept (SAAB)

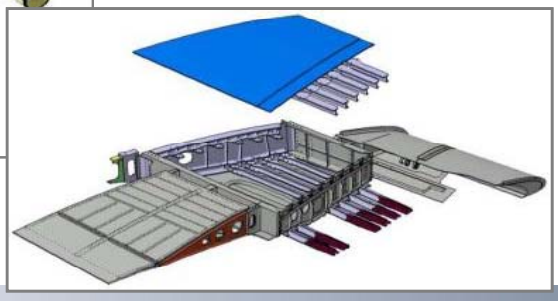
BLADE preparation



Wing systems DMU

Pod preliminary design

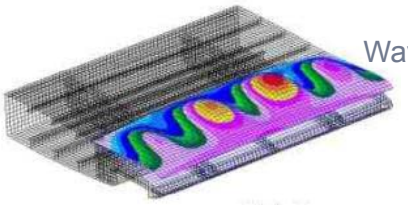




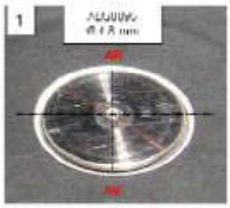
Diffusion element,
Rib 28 view with lifted top cover

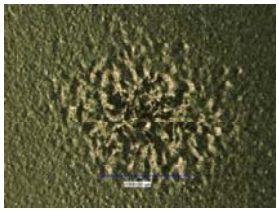
Surface quality

- High surface quality is essential:
  - No steps
  - No waviness
    - manufacturing or cruise
  - Avoid 3D disturbances
    - insects or fasteners
  - Leading edge roughness
    - manufacturing or operational



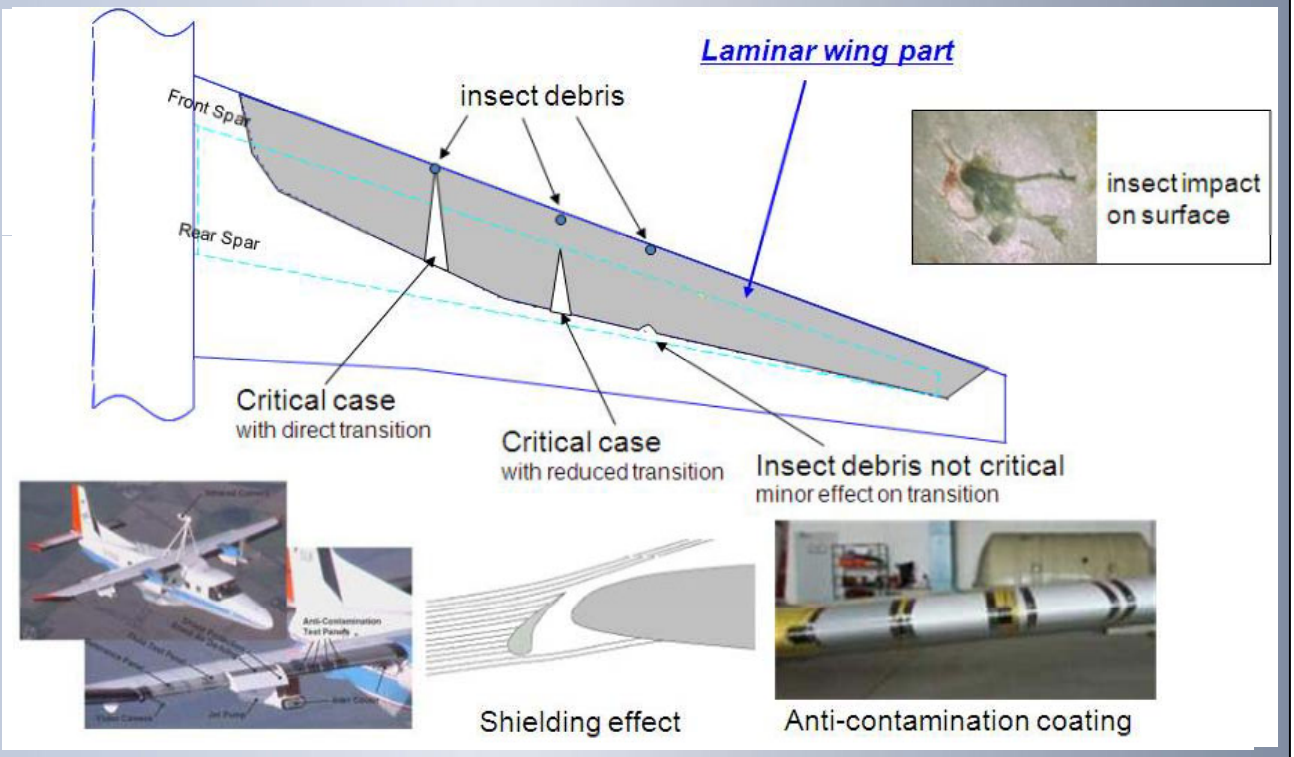
Waviness



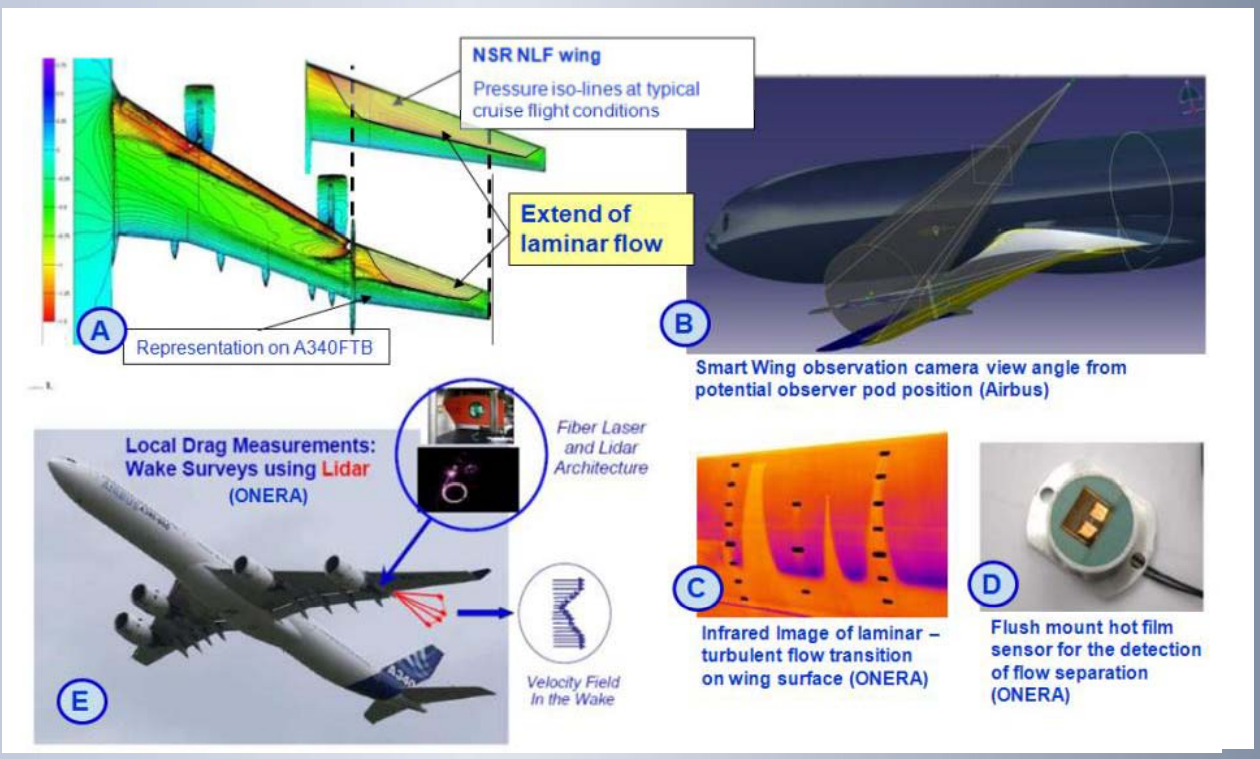


Erosion

Operational Challenges



SFWA Flight Test Instrumentation



BLADE – 2014/5

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Contra Rotating Open Rotor

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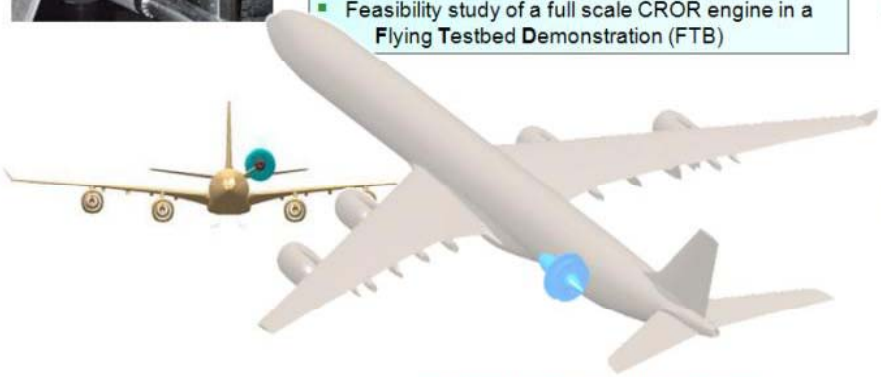
SFWA-ITD - CROR Engine Technology

CROR Aero -Acoustic experimental characterization

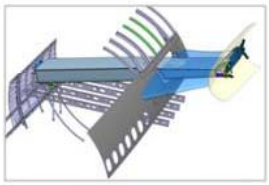
Innovative Power-Plant Integration

- Design of innovative CROR blades and pylon
- CROR installation effects: aero, noise, vibrations, handling qualities
- CROR propeller kinematics, study of fragment impact depending on size and propeller and fuselage materials
- Structural technologies for armour and shielding
- Feasibility study of a full scale CROR engine in a **F**lying **T**estbed **D**emonstration (FTB)

CROR design study: interference with HTP



Airbus A340-600 Flying Test Bed with CROR engine



CROR structural integration concept

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Pratt & Whitney Engine FTB

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CROR

General Electric GE36 UnDucted Fan (UDF)
- –Flight tested on B727-100 in August 1986
- –Flight tested on MD80 in April 1987

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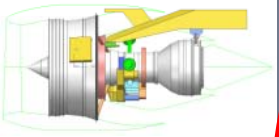
CROR demo FTB: PPS architecture vs. FTB vehicle

	Ducted Turbofan (GTF…)	Open rotor pusher	Open rotor puller	Open rotor "ducted"
Engine Architecture				
Potential FTB Vehicle	 A340-600 selected for GTF demo flight in 2008 ✓	 CROR Demo	 Or ? 	

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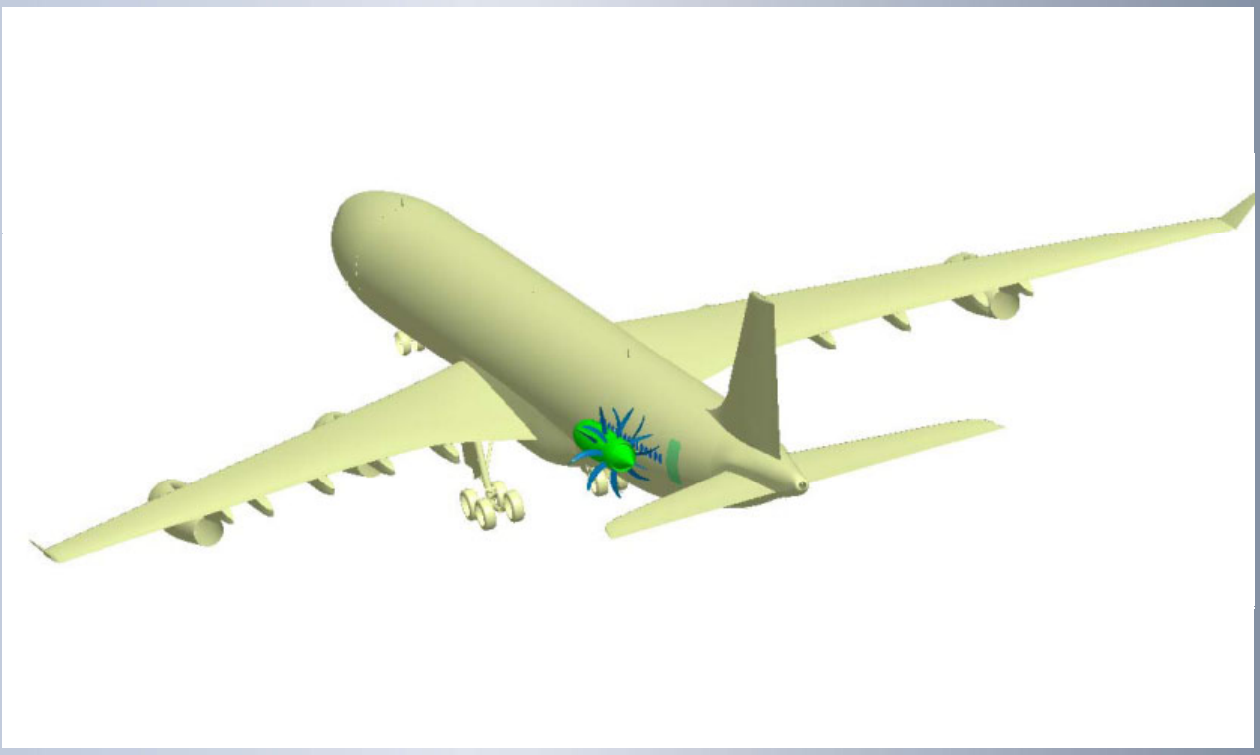
CROR FTB – A340-600



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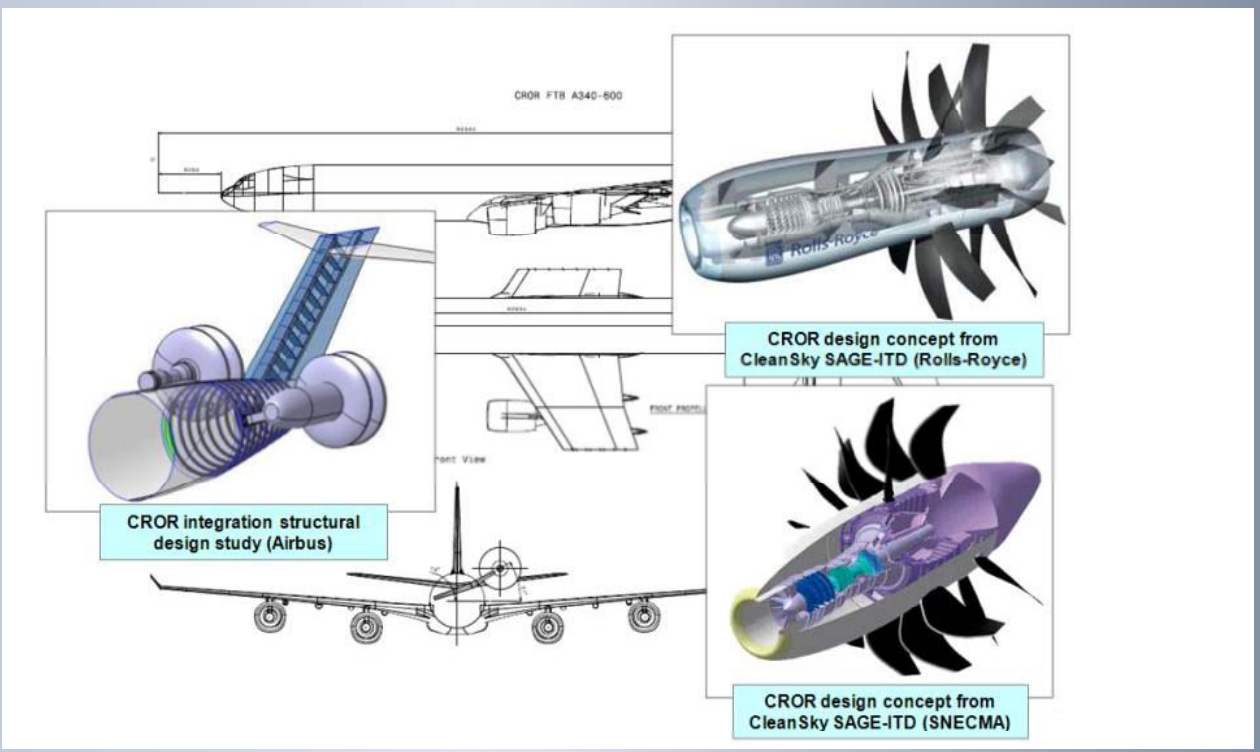
CROR engine integration concepts



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SFWA-ITD – Objectives

Input connecting to:

"Sustainable and Green Engines" – ITD **CROR engine**

"System for Green Operation" – ITD" **Novel Energy Management / Green Mission and trajectories**

Smart Wing Technologies

- **Technology Development**
- **Technology Integration**
- **Large Scale Flight Demonstration**

Innovative Powerplant Integration

- **Technology Integration**
- **Large Scale Flight Demonstration**

Output providing data to:

CleanSky Technology Evaluator **SFWA technologies for a Green Air Transport System**

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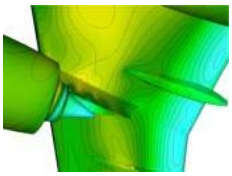
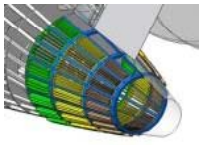
Conclusion: Airbus as architect and integrator

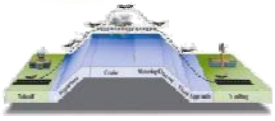
Smart Wing Technologies



Innovative Power Plant

Systems for green operations





Configuration / Integration

Innovative Structures

Cabin innovations for the passenger

Full deployment of individual benefits through smart integration

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Airbus priority R&T in CleanSky

CLEANSKY

is of major programme for Airbus R&T

to fulfil on the ambitious targets of ACARE

- *by developing an all new smart low drag wing*
- *by integration of innovative power plants*
- *through large, representative flight test demonstration*
- *engaging a wide range of partners from all over Europe*

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End

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