100 YEARS
Aerospace Research in Germany

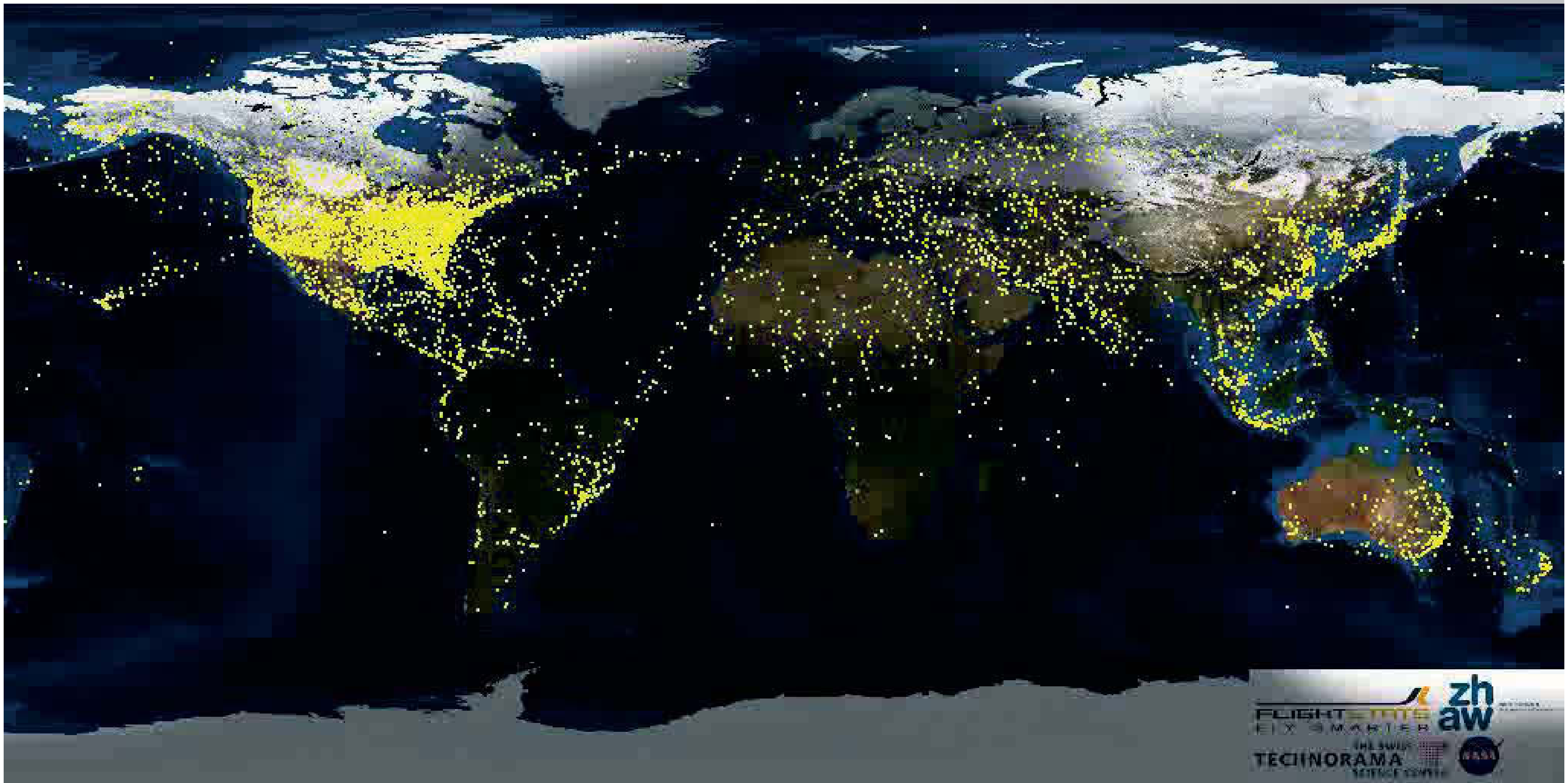
The Impact of the Air Transport System on Climate Change

Szodruch
DLR

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

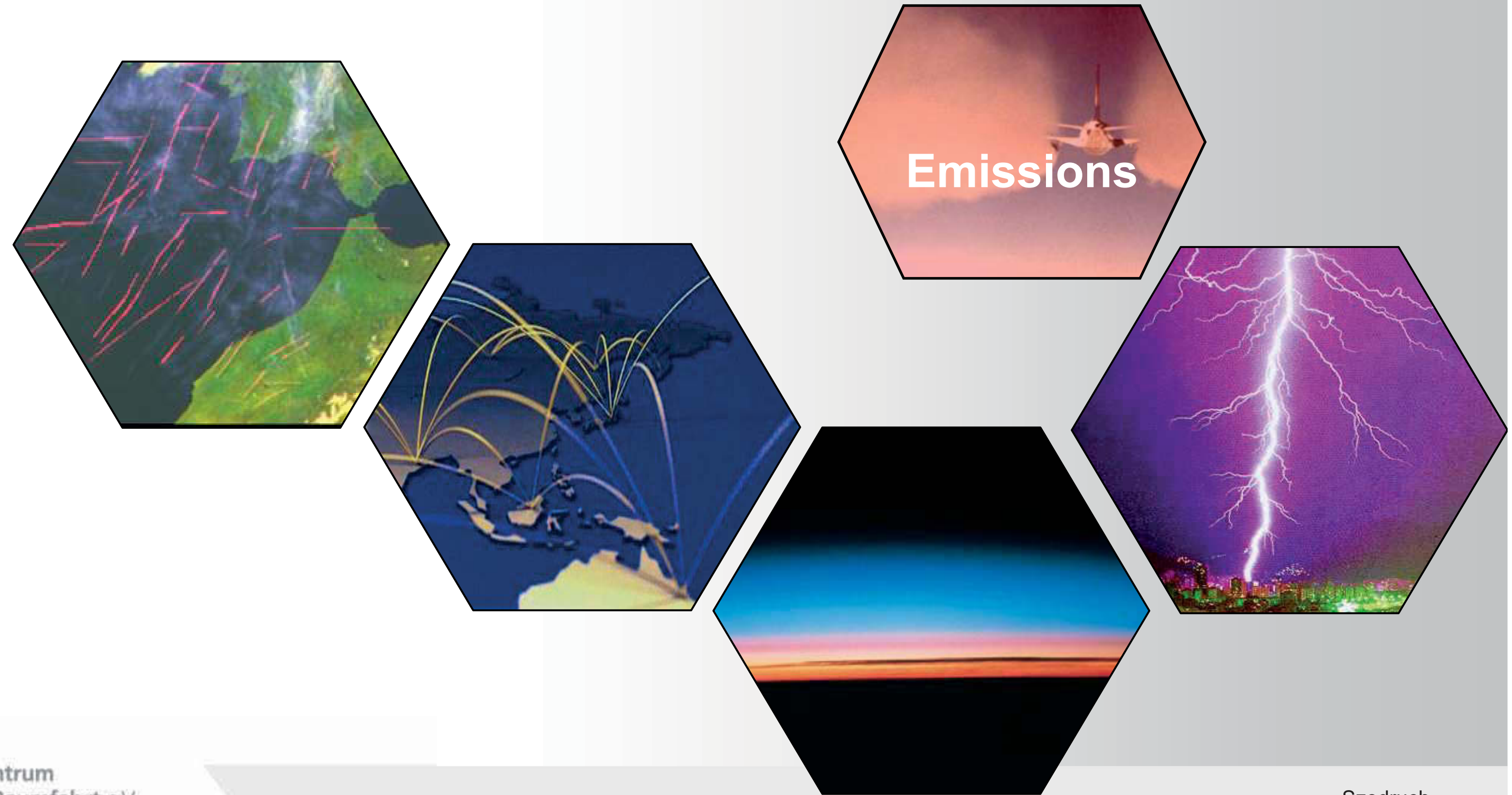
Deutsche Gesellschaft für Luft- und Raumfahrt Lilienthal-Oberth e.V.

The Air Transport System

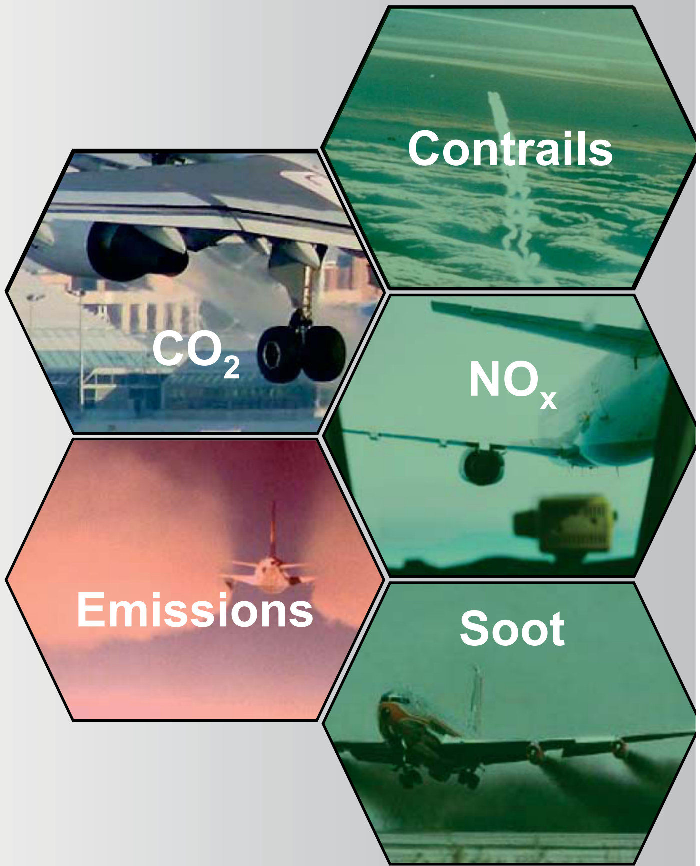


The degree of one's emotion varies inversely with one's knowledge of the facts -- the less you know the hotter you get."

Bertrand Russell



Climate Impact of Air Transport



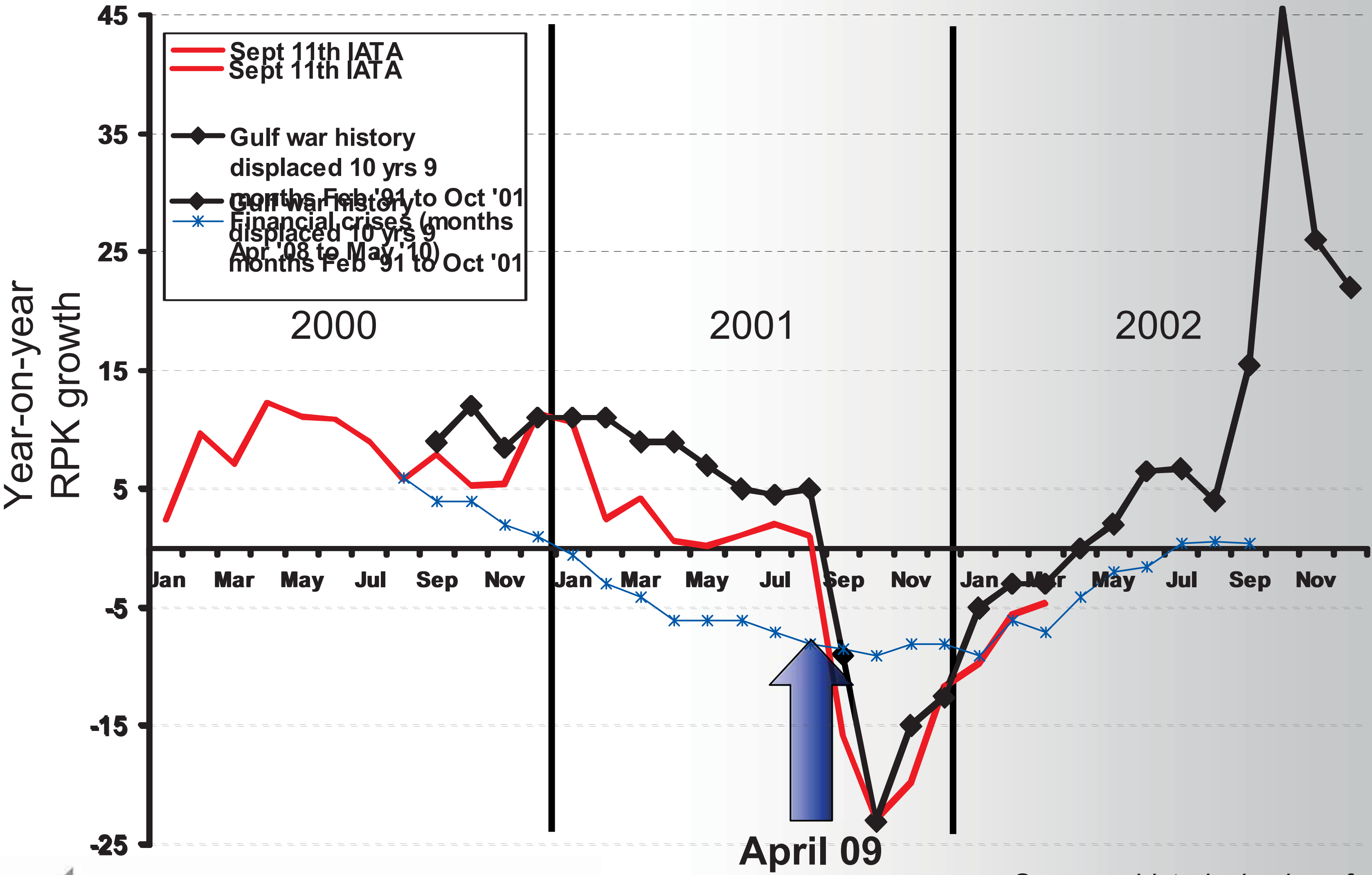
- CO_2 Emissions have the largest influence on our climate. For modest growth rates this applies also for air transport
- Global air transport emitts about 2 % of all fossile CO_2-emissions.
- Global air transport contributed with 1,6 W/m^2 to the Radiative Forcing (3 %).
- In consequence air transport of the 20th century is responsible for about 0,02 to 0,03°C global temperature increase.
- The largest uncertainty is related to the effect of contrails on the climate.
- However, contrails might be „easily“ reduced by changing altitude.

Air Transport System

A complex system with opposing interests of the various stakeholders

Crisis 2009

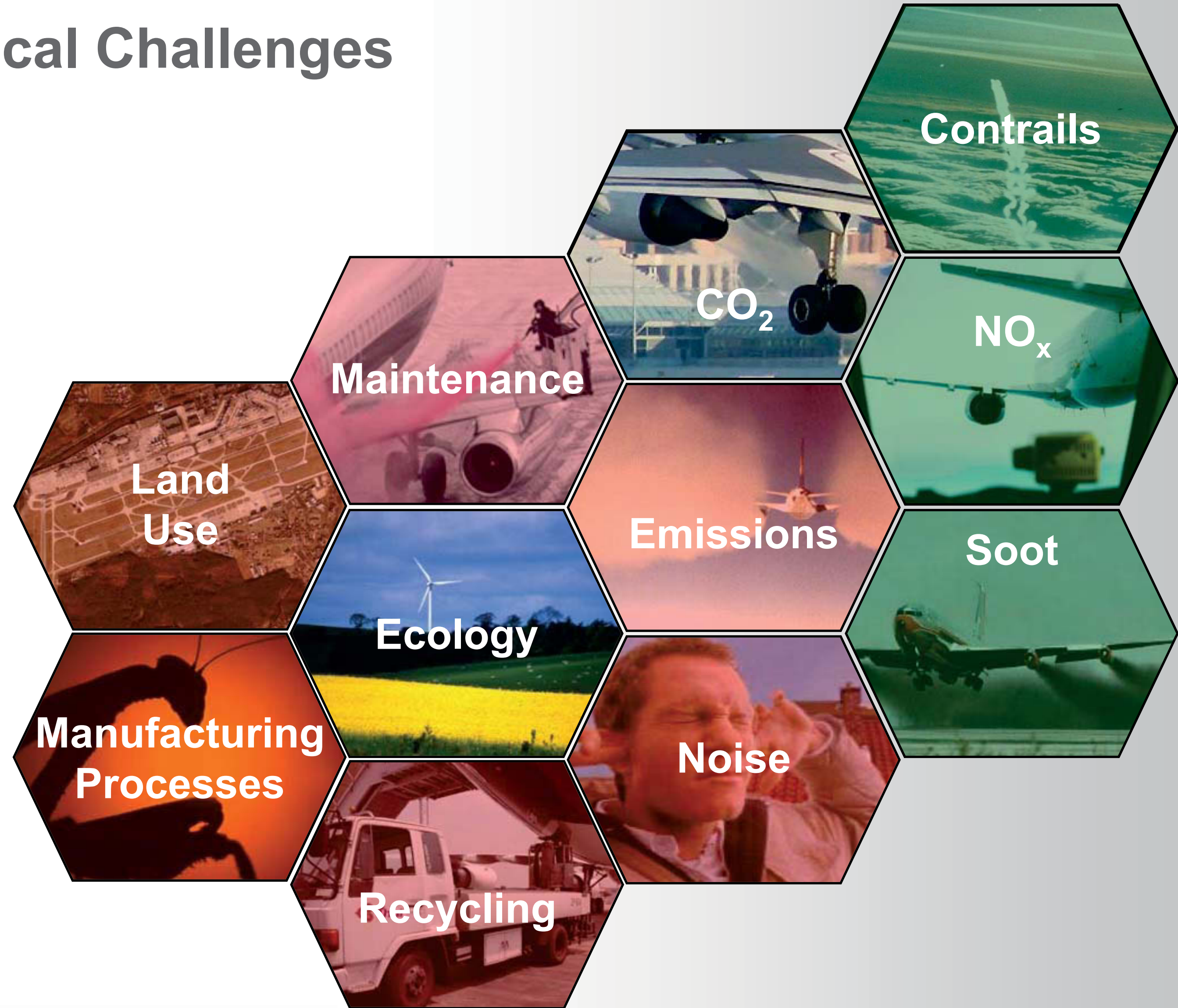
Traffic growth compared during different crises



Source : historical values from IATA

Opportunities

Ecological Challenges



Vision 2020

Challenges and Associated Goals

Group of Personalities

Quality and Affordability	*Reduced passenger airfares* *Increased passenger choice* *Modernized freight operations* *Reduced time to market by 50%*
The environment	*Reduction of CO2 by 50%* *Reduction of NOx by 80%* *Reduction of external noise by 50%* *Substantial progress towards 'Green MMD'*
Safety	*Reduction of accident rate by 80%* *Drastic reduction in human error and the consequences*
The Efficiency of the Air Transport System	*3X capacity increase* *99% of flights within 15 min of schedule* *Less than 15' min waiting time in the airport for short distance flights*
Security	*Airborne – terrorism prevention* *Airport – prevention of unauthorized access (persons or products)* *Air navigation - safe control of hijacked aircraft*

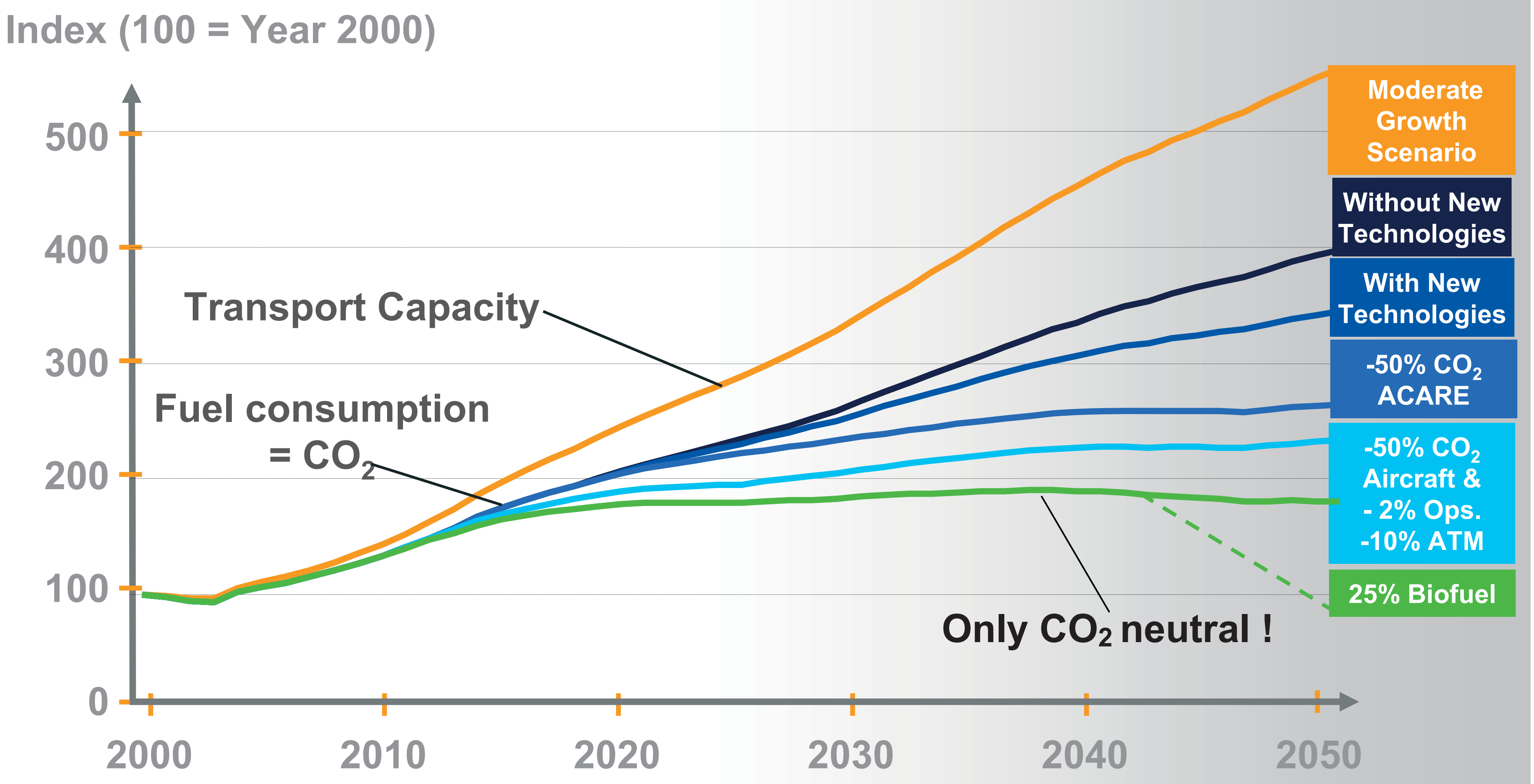
How much technology do we really need?

Prognoses

- Traffic Growth between 5% and 3,5%
- Load Factor
- Service Life
- PAX / Freight and Combi-Aircraft
- Blockfuel
- Average Seat Calculation
- Distance pro hour
- Flight-hours per Aircraft
- Considered Aircraft Types:
    - Classic and New Generation,

Technology Impact Fuel Burn

Technology Impact – Extrapolation 2000 - 2050



Technology Impact

"However beautiful the strategy, you should occasionally look at the results."

Winston Churchill

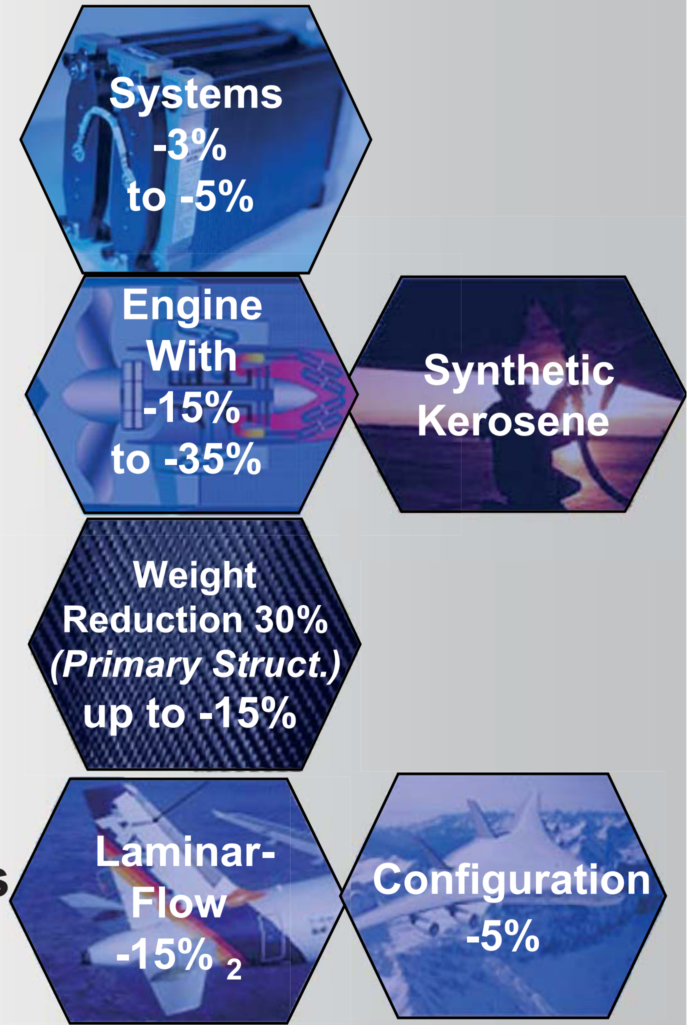
Aircraft Technologies for Fuel Burn Reduction

Systems

Engine

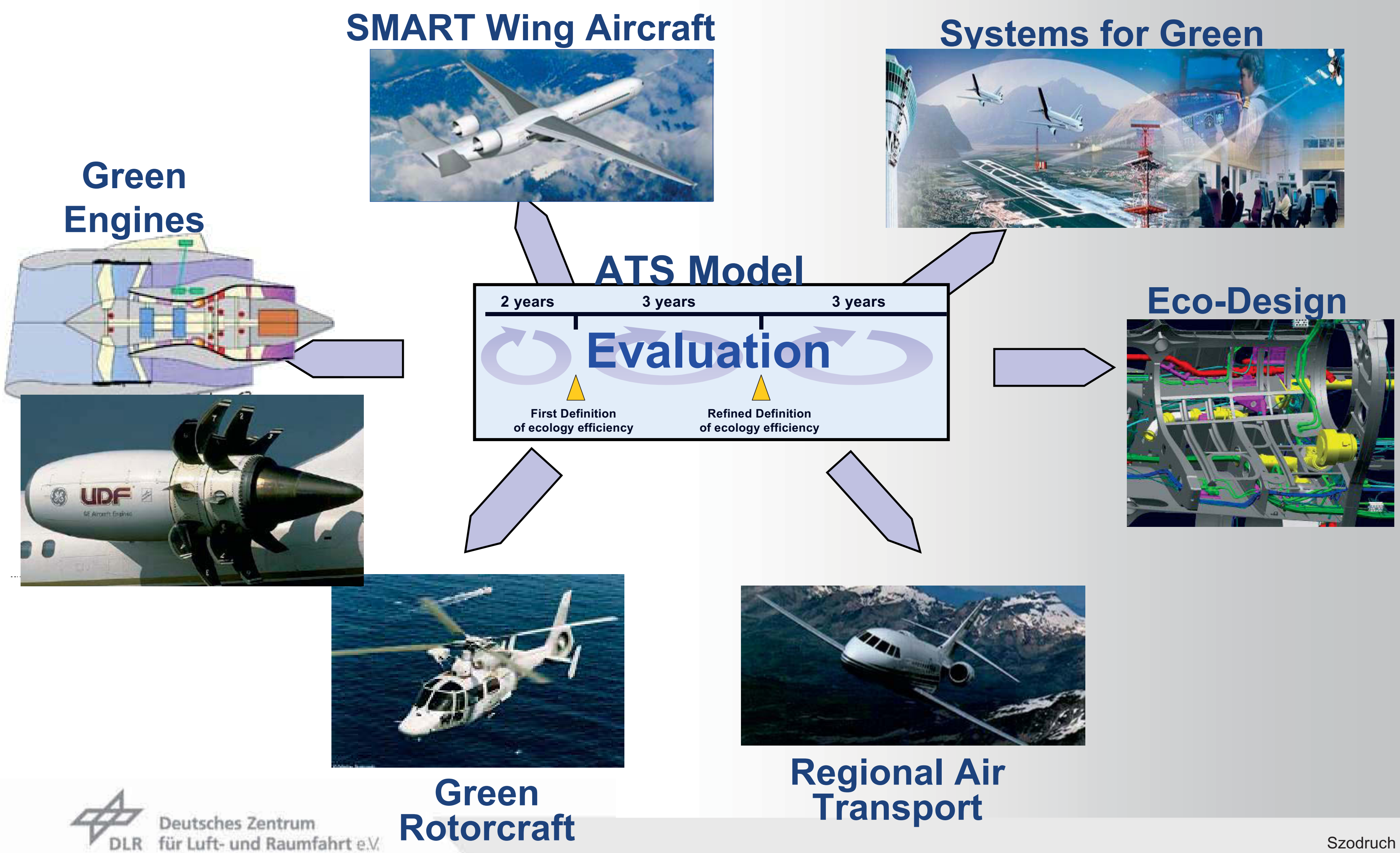
Structures

Aerodynamics



EU Technology Programmes

Joint Technology Initiative “Clean Sky”



Aircraft 2020

-20% Engine SFC

-20% Drag Reduction

-10% Empty Weight Reduction

+25% Wing Span (AR=9.81 → 14)

+7%	Wing Area 82 m²
+18.7%	Wing Weight
-27.4%	Required Thrust
-26.5%	Engine Weight
-8.2%	Landing Gear Weight
-8.7%	Take-Off Weight

-37% Fuel Burn

Regional = (70 PAX, 3000 km)

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Airneth

Operational Technologies for Fuel Burn Reduction

Flight Guidance

- SESAR
- 4 D Route Planning -3%
- „Free-Flight" -6%

Operation

- Efficiency. Airlines 10 Years -2%
- Formation-Flight -10%
- Air Refueling (Long Distance) -25%

EU Technology Programmes

Europe today

- 25.000 flights per day
- With 5.000 aircraft
- Over 650 sectors
- Between 100 large airports
- With 27 different Air Traffic Management Systems
- For a total ATM costs of 7 billion Euro per year
- Corresponding to 6% of the flight costs

SESA

-12%
Fuel Burn

GALILEO

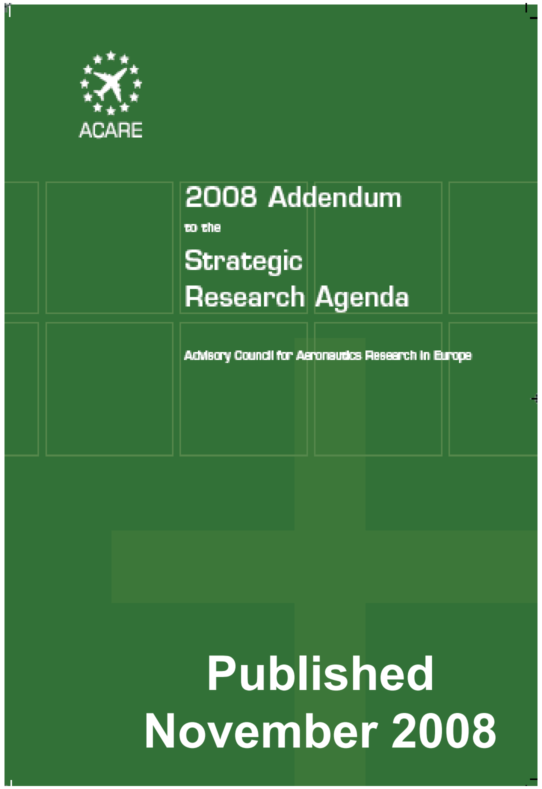
Complete Air Transport System Concept for 2020

DLR in 2013: -35%

Some typical technology issues:

- Engine concepts
- Low drag aerodynamics
- Light weight structures
- Low noise design and procedures
- Optimised high lift system
- City airport operation
- Climb performance
- Cruise operation
- Pilot assistance systems
- Short turn-around time
- Airport passenger flows
- Reduction of development time
- ………

SRA Addendum Recommendations



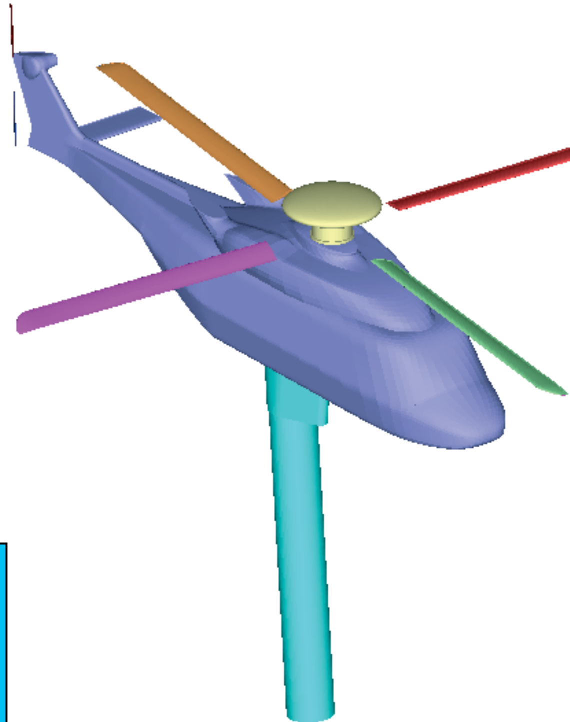
- Consider the role of rotorcraft

DLR / ONERA Research Programm

Aerodynamics
(CFD, Optimisation, WT Test, Flight Test for Performance Improvement)

Aeroacoustics
(Numerical Methods for Design, Low Noise Flight Procedures, WT and Flight Tests)

New concepts: *compounding*



Active Technologies
(active flaps, active twist) Flow Control (passive and active)

Flight Mechanics
(simulation tools, aircraft identification, flight mech models, handling qualities)

Tools for WT tests: *highly equipped rotors and blades, PIV, new measurement techniques*

Crew Station: *active side sticks, pilot support, display symbology*

Safety: *crash modeling tools, composite behavior, new composites*

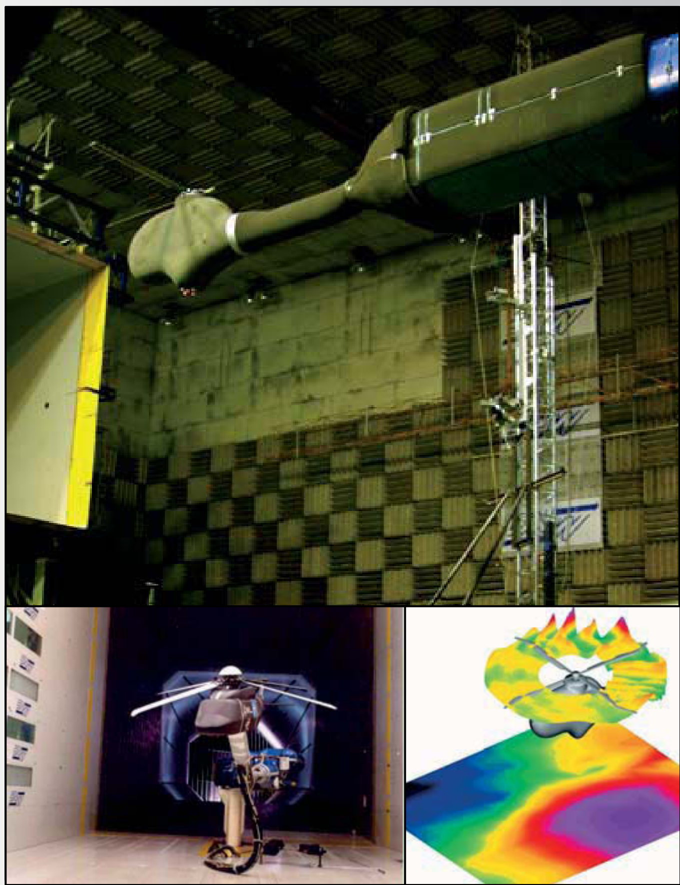
DLR Rotorcraft Research Facilities

EC 135 – Inflight Helicopter Simulator

Bo-105 Experimental Workhorse

ARTIS-Family (Micro, Midi, Maxi)

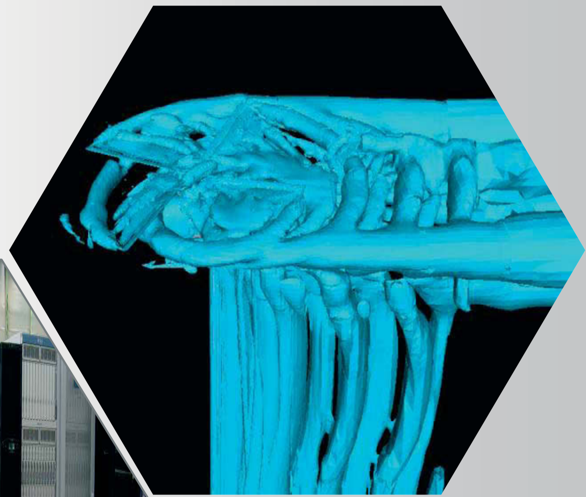
H/C Research Simulator (Planning Phase)

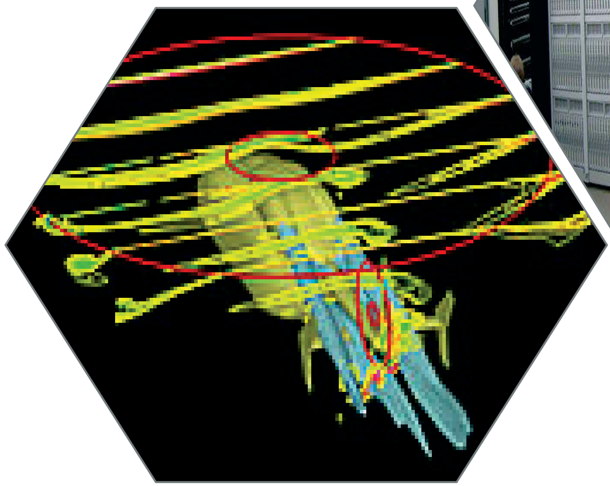


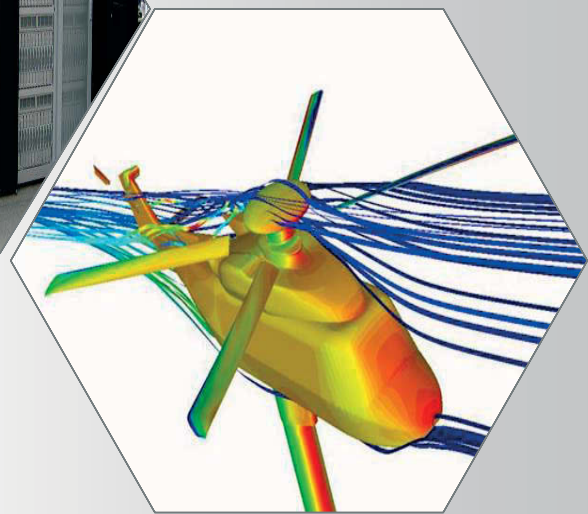
Rotor Test Facility for DNW-LLF

DLR advanced CFD methods

- Modelling of complete helicopter including BVI
- Reliable performance predictions
- Unsteady effects like dynamic stall







HELIxx

- All-weather Operations
- Noise
- Vibration
- Comfort
- Enhanced Vision
- Pilot Assistance
- Speed

HELIxx

Summary and Outlook

Vision 2020

The ACARE Vision goals for future air transport

- are very ambitious,
- but not sufficient in the long-term „green scenario“.
- They do not de-coupled traffic and fuel consumption
- and further related technologies are not readily available.

We need to foster creativity and innovation

- Focussed research activities required for critical issues
- Enabling technologies
- Infrastructure
- Pioneering research
- Education / Young Professionals

Can we afford …

……..not to wait for the technological window of opportunity?
……..to miss the economical window of opportunity?
…… not to develop a sustainable air transport system?
…… not to consider helicopter research?

“In light of the fact that humanity is not able to learn from past mistakes we can not afford to make mistakes in the future.” -

Ernst Ferstl

Thank you for listening

www.dlr.de

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