ACTIVE FLOW- LOADS & NOISE CONTROL ON NEXT GENERATION WING

OVERVIEW AND RESULTS AFTER 3rd PROJECT YEAR

AFLoNext
2ND GENERATION ACTIVE WING

ICAS 2016
Daejon, South Korea
September 2016
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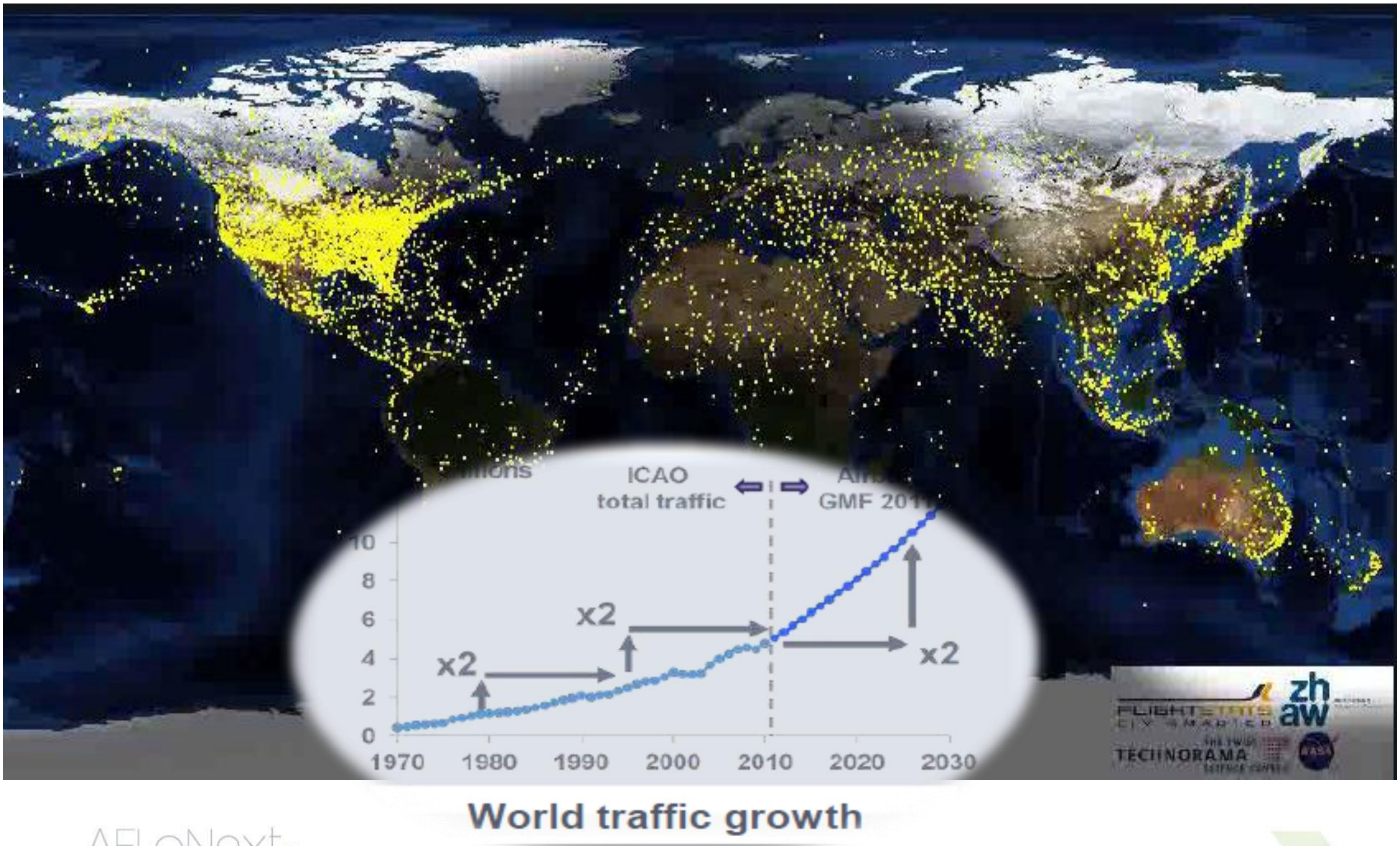
Introduction



World traffic growth

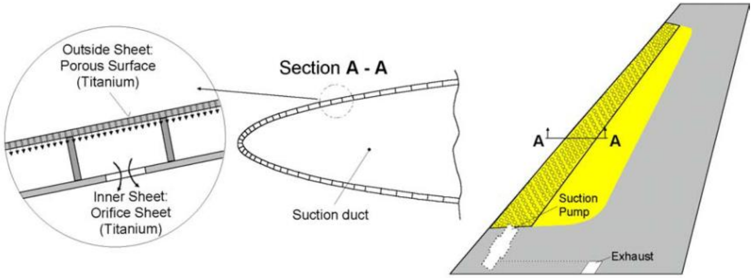
Introduction

- The worldwide traffic will significantly grow within the next decade.
- This makes it inevitable to reduce the ecological footprint of passenger aircrafts.
- AFLoNext tackles following lever arms towards more ecological aircrafts:
  → **laminarity** to reduce aircraft drag during cruise flight to reduce fuel burn .
  → **active flow control** on local applications to increase aerodynamic performance during take-off and landing and to allow installation of more efficient engines.
  → **passive noise control** technologies to reduce aircraft noise during take-off and landing.
  → **vibration mitigation & control** to allow design of optimized airframe components to reduce overall aircraft weight.

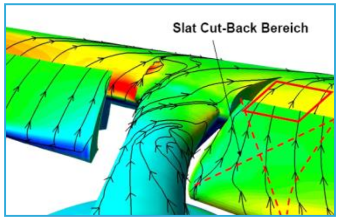
Objectives

To mature and demonstrate promising flow control technologies up to high maturity levels (TRL 4-5) to validate them later in a fully integrated large scale demonstrator approach such as in Clean Sky 2 (TRL 6 and higher).

Hybrid laminar flow technology (HLFC)
for aircraft drag reduction

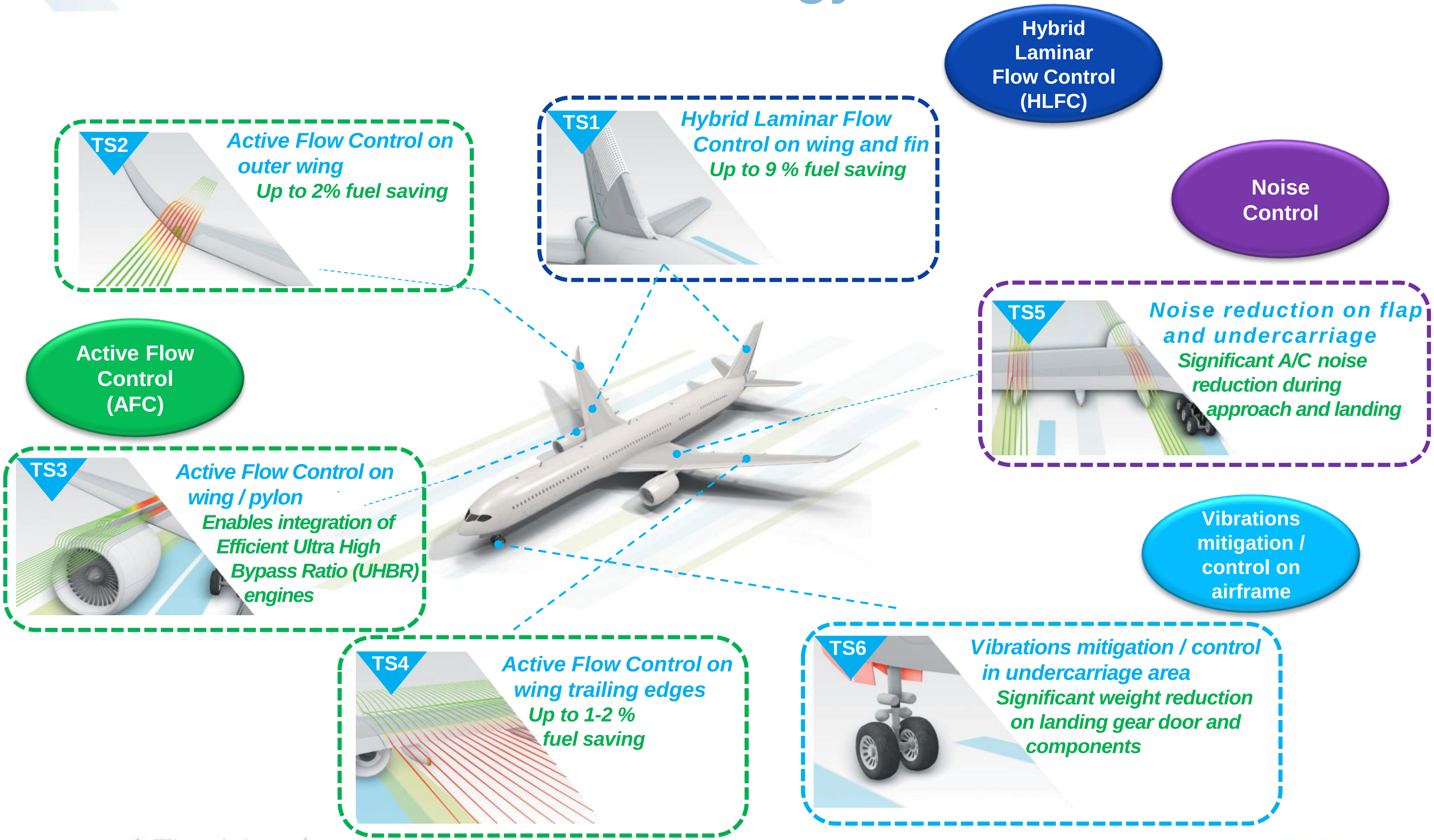


Active flow-control technologies
for local applications for performance increase and improved environmental compatibility



Passive vibration- and noise-control technologies
for local applications for performance increase and improved environmental compatibility

AFLoNext –
Overview of Technology Areas & Streams



Hybrid Laminar Flow Control (HLFC) / TS1

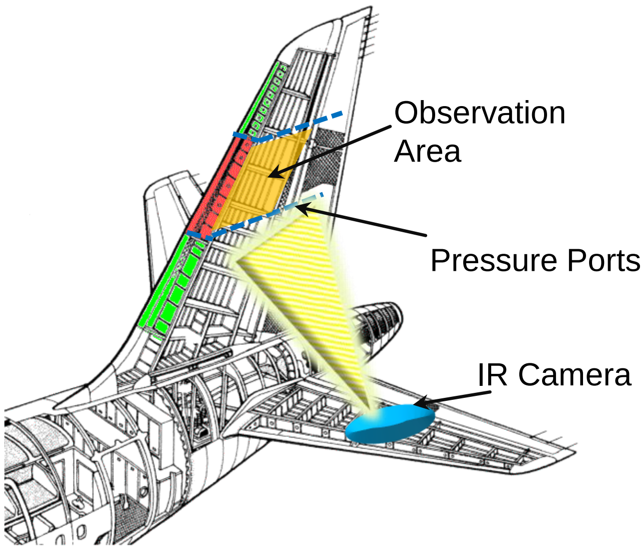
- Major Objectives & Achievements after 3rd Project Year -

Hybrid Laminar Flow Control (HLFC)

- **Flight Test demonstration of advanced HLFC technology on a Vertical Tail Plane (planned in Q2/2017).**
- **Ground based demonstration / Validation of HLFC integration on a wing leading edge.**

On HLFC VTP

- Aerodynamic design completed.
- FTI definition completed and frozen.
- PDR for HLFC leading edge has been passed– *CDR is imminent* - .
- Structural design of leading edge modifications almost finished.
- Manufacturing of new leading edge started – *first manufacturing demonstrators-*
- Design of suction system (active & passive) is complete, manufacturing has started.
- Route to permit to fly is agreed and fixed



Hybrid Laminar Flow Control (HLFC) / TS1

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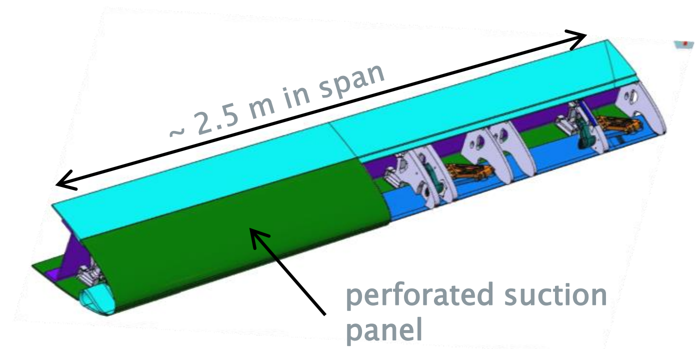
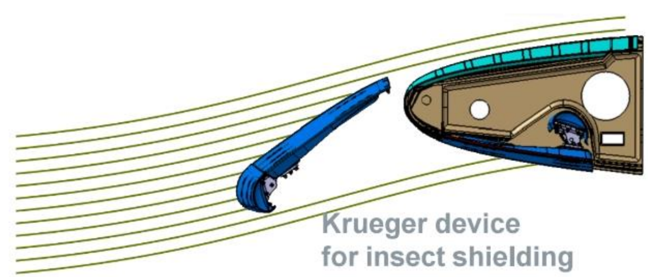
- Flight Test demonstration of advanced HLFC technology on a Vertical Tail Plane (planned in Q2/2017).
- **Ground based demonstration / Validation of HLFC integration on a wing leading edge.**

- **Aerodynamic design is finished (suction system & wing ice protection system).**
- **double curved & micro perforated skin concepts have been chosen (still to be matured).**
- **Krueger design has been finished.**
- **System architecture has been chosen.**
- **System design is finished.**
- **Manufacturing has started.**



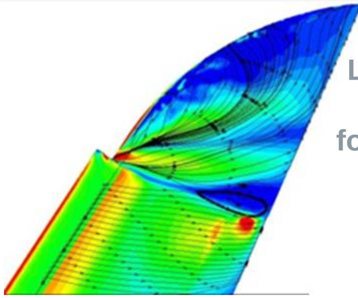


Active Flow Control (AFC) / TS2, TS3, TS4
- Major Objectives & Achievements after 2nd Project Year -

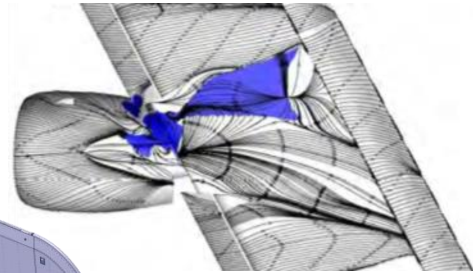
Active Flow Control (AFC)

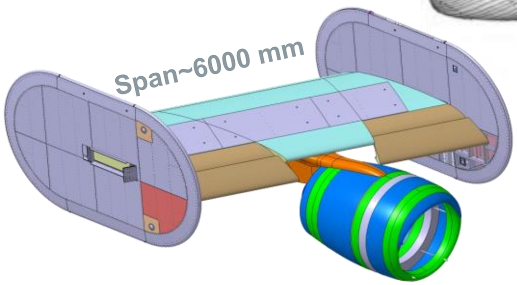
- **Experimental demonstration (large scale wind tunnel tests) of Active Flow Control technologies for local application on the wing (planned in Q1/2017).**
- **Definition and validation of realistic system integration and system architecture related to application on real Aircraft**

- **CFD studies for baseline & realistic configuration have been completed.**
- **Actuator type, size and location have been investigated.**
  → Promising investigations on PJA (Pulsed Jet A.)
  → investigations on SJA (Synthetic Jet. A.) show shortfalls in needed performance
- **Wind tunnel tests preparation are progressing well.**
- **System architecture design and integration progressing well on wind tunnel model and on outer wing.**

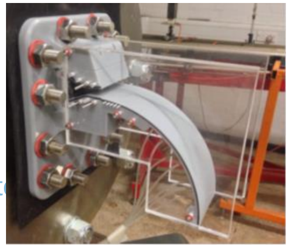


Local application on outer wing for more agressive wing tip design





Local application on pylon / wing junction for integration of close coupled nacelles



Noise Control / TS5

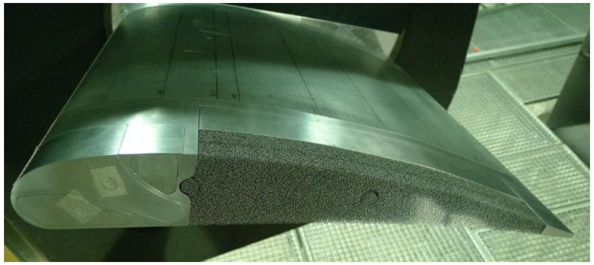
- Major Objectives & Achievements after 2nd Project Year -

Flight Test demonstration of passive noise control technologies on flaps and main landing gear (planned in Q2/2016 & Q2/2017).

Noise Control

- **Wind Tunnel tests at DLR-AWB & DNW-NWB facilities have been successfully conducted and their analysis showed high potential for noise reduction on real aircraft.**
- **Reference flight test successfully conducted.**
- **Selection of landing gear- and flap modifications are completed.**
  Flight test preparation has started.
  - Route to obtain permit to fly agreed.
  - design of flight test modifications for LG devices about to be completed (manufacturing started) ; inner flap with PFSE ready for installation.

wind tunnel model in open test section of DNW-NWB



Porous flap side edge (PFSE)

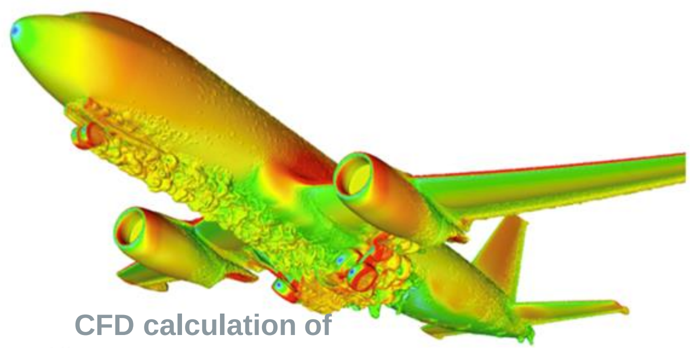
Vibrations mitigation / control on airframe / TS6

- Major Objectives & Achievements after 3rd Project Year -

Vibrations mitigation / control on airframe

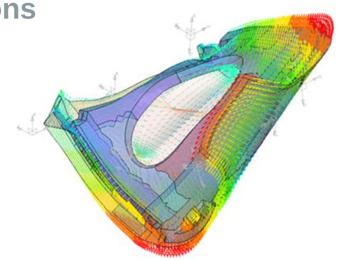
- **Development of prediction methods for vibration topics at the landing gear (structural and aerolastic coupled models).**
- **Design of passive devices to reduce vibration level at landing gear area.**
- **Flight Test validation of the numerical model (planned in Q2/2017).**

- **Numerical analysis of main landing gear door vibrations have been finalized.**
  → Sources of aerodynamic excitation have been identified thanks to coupling of CFD & FEA approach .
- **Aerodynamic and structural modification on landing gear are selected and designed.**
- **Manufacture of flight test modifications is ongoing.**
- **Analysis of Ground Vibration Test results have been completed.**
  → adaption of FEA models is ongoing.
- **Design and manufacture of monolithic NLG dooris progressing well.**
- **Flight test preparation is ongoing (FTI architecture is frozen)**



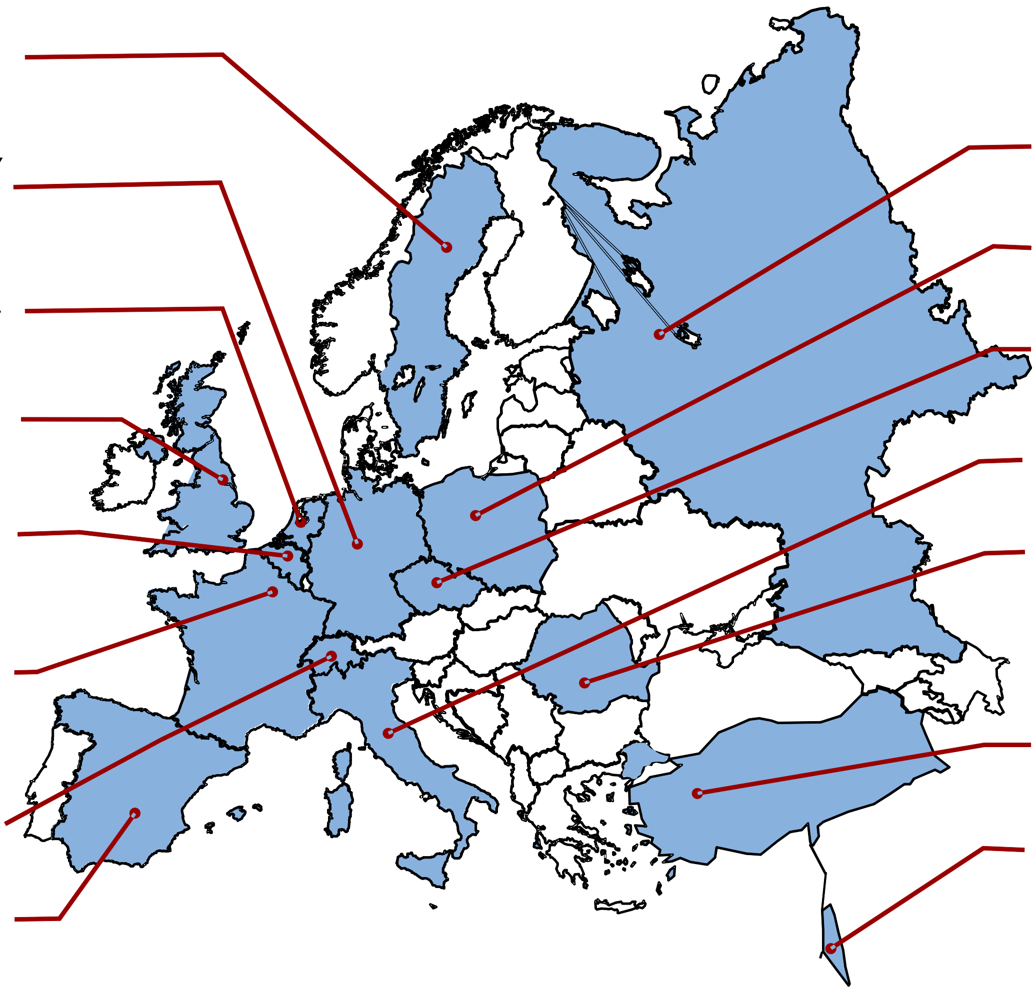
CFD calculation of wake interactions

Ground vibration test at DLR



FEA model of main landing gear door

The European Footprint of the Consortium



Sweden
FOI, KTH

Germany
A-D, A-DS, AGI,DLR, FRAUN
IBK, INVENT, TUHH

Netherlands
ACQ, FOKK, NLR

United Kingdom
A-U, ARA, BAE, CITY,
AGI, GKN, UOM

Belgium
ASCO, COEX, SONA

France
A-F, CERF, DASS, LUP,
MBD, ONE, SLCA

Switzerland
CFSE

Spain
A-E, AERN

Russia
TSAGI

Poland
PW

Czech Republic
VZLU

Italy
CIRA

Romania
INCAS

Turkey
TAI

Israel
IAI, TAU

AFLoNext Statistics

40 Partners in 15 countries

Approx. **37 M€** total cost
20.5 M€ proposed funding
23.6 M€ effective funding

Project top level ranked and assessed as “excellent”

Project duration: **5 years** (2013-2018)

Project start: **1st of June 2013**

Conclusion

- The consortium collaborates very well by providing world-class capabilities to AFLoNext. A strong team spirit and the will to deliver results is permanently present.
- The project is well on track after 3rd year of operation, however a one year project extension was requested due to re-schedule of the F/T

- In the oncoming 4th year the project will face challenges such as:
  → Preparation of flight test campaigns in-time
  (Delivery of hardware and get the permit to fly).
  → Prepare large wind tunnel tests and ground-based demonstrations.

- In summary, AFLoNext will deliver technologies, which will meet customers needs to reduce to overall ecological footprint of future aircrafts.

- The next logical step will be the handover of the most promising flow control technologies to research programs like CleanSky2 in order to further mature them to make this technologies available for serial aircraft within the next decade.

Thank you for your attention

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AIRBUS

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