30 years of European Union Aviation Research Programme

Dr. Michael Kyriakopoulos

European Commission
DG Research & Innovation – H3 Aviation

EASN Open Workshop - Brussels – 12 April 2018

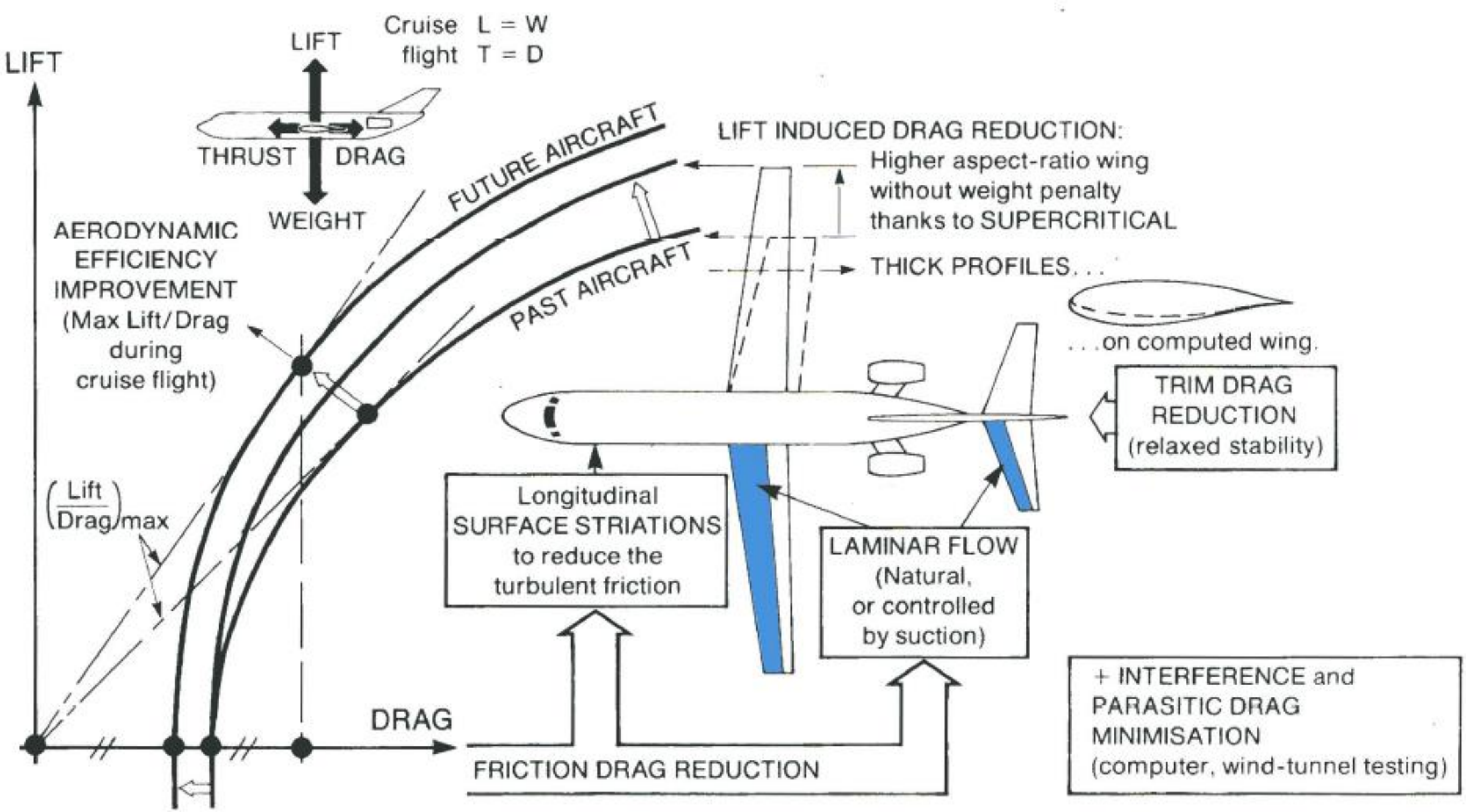
European Commission

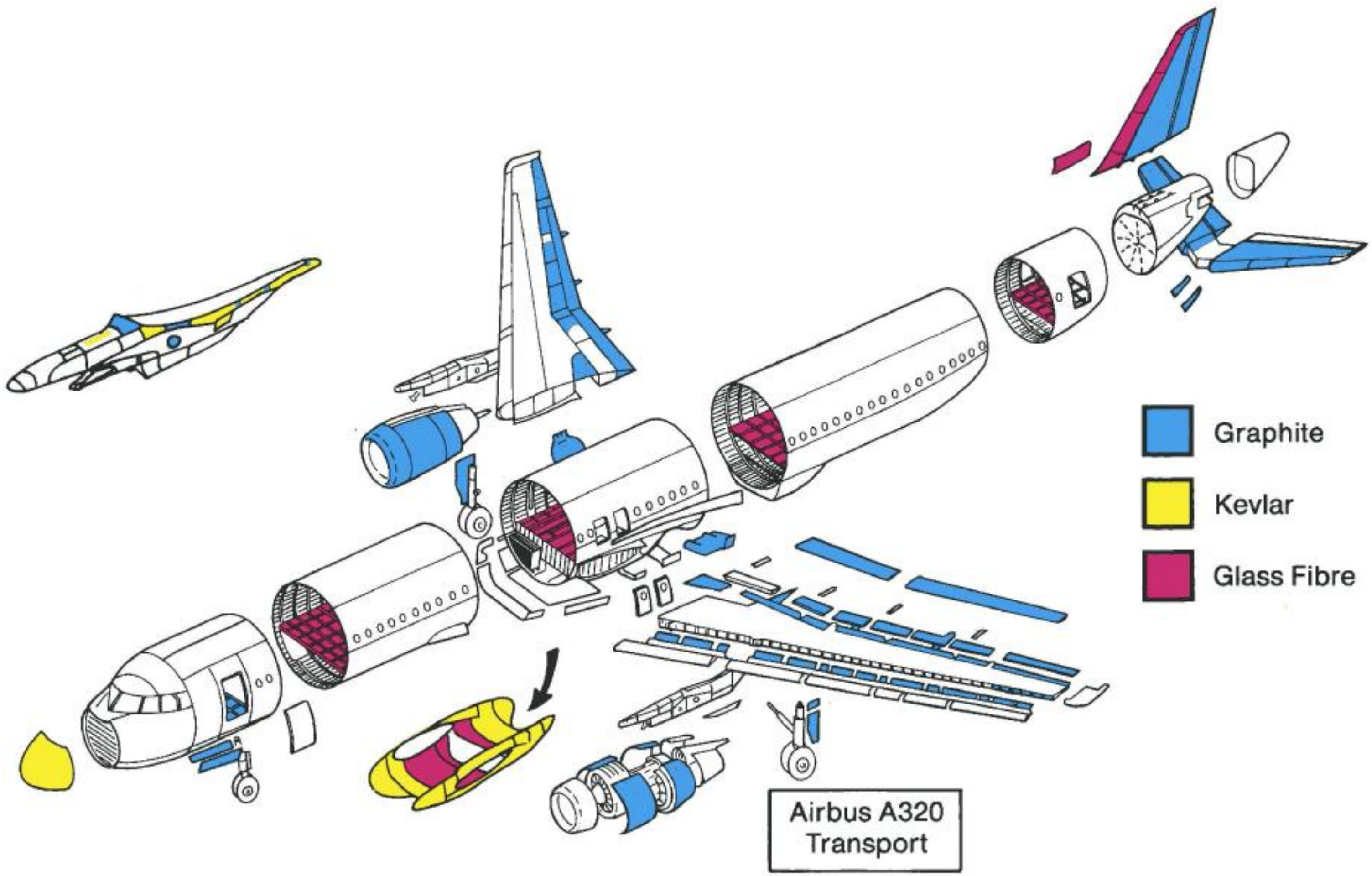
AERITALIA SPA
AEROSPATIALE SNI
AVIONS MARCEL DASSAULT — BREGUET AVIATION
BRITISH AEROSPACE PLC
CONSTRUCCIONES AERONAUTICAS SA
DORNIER GmbH
FOKKER AIRCRAFT BV
MESSERSCHMITT-BÖLKOW-BLOHM GmbH
SOCIETE ANONYME BELGE DE CONSTRUCTIONS AERONAUTIQUES,

conducted the Study under the terms of an EC contract (Ref. ECI-1539-B7210-B).

February 1987 – CEC, Commission of the European Community

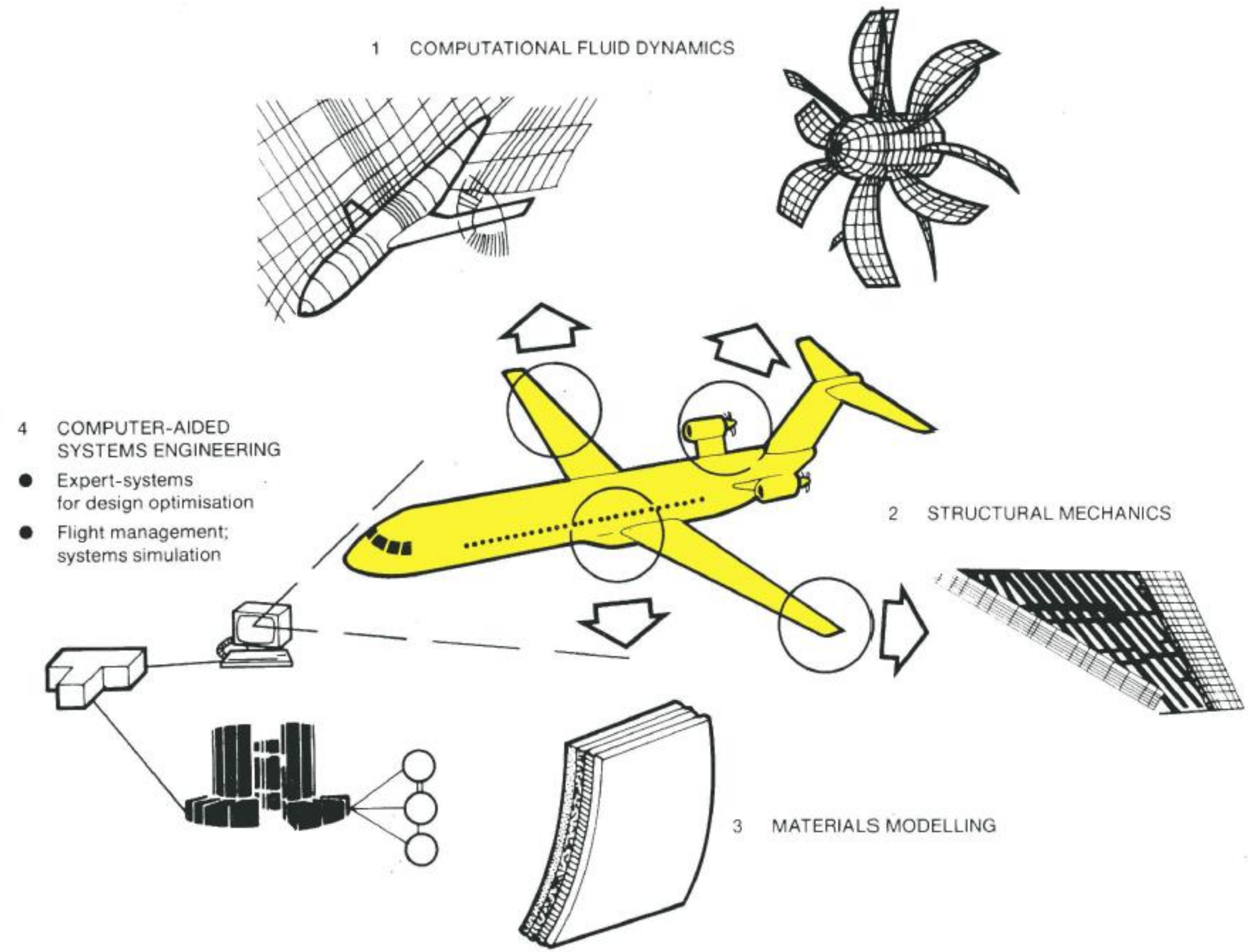
PROGRESS ON AERODYNAMICS



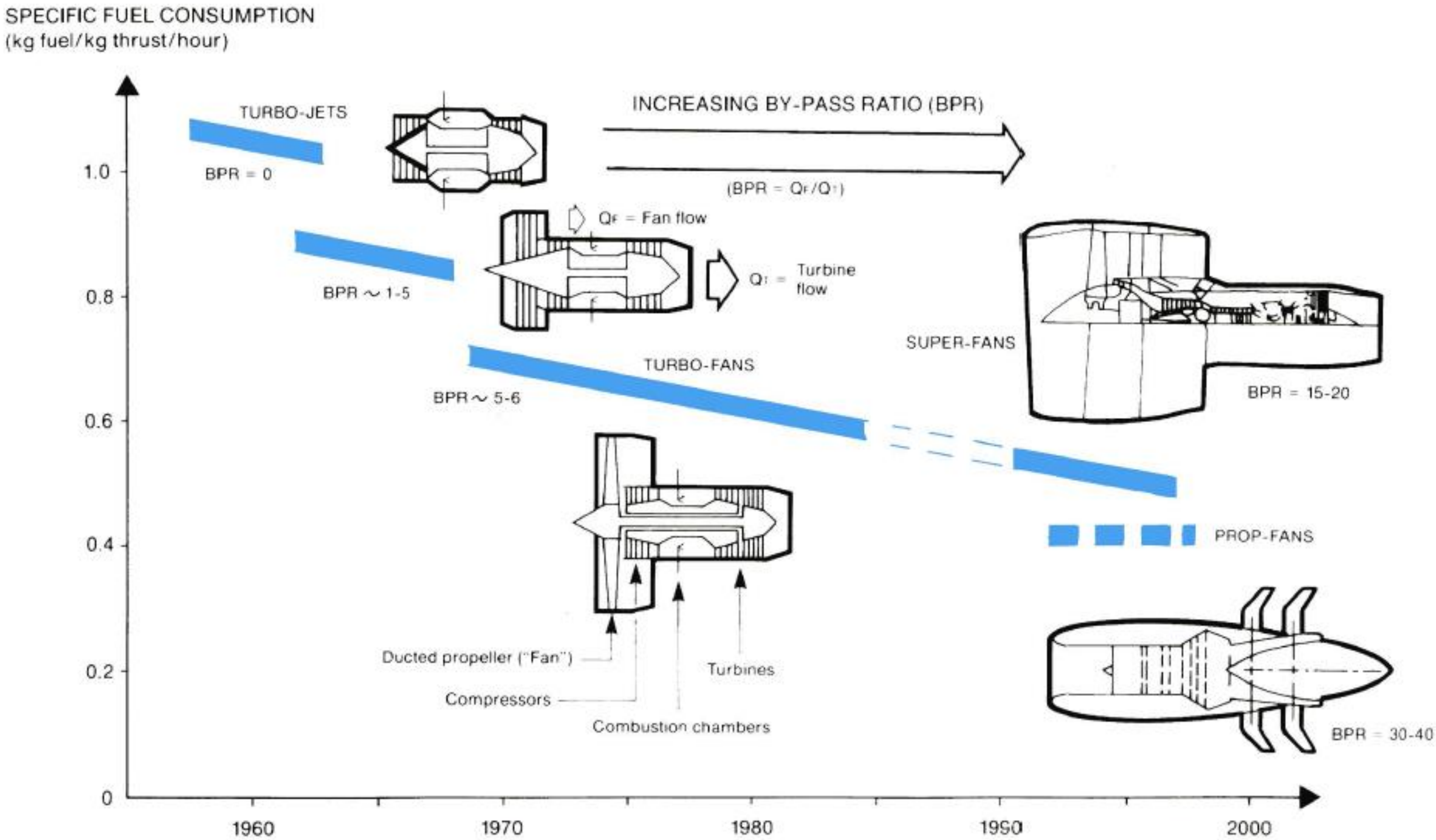


INCREASING APPLICATION OF COMPOSITES

FUTURE USE OF SUPER COMPUTERS



PROGRESS ON PROPULSION



European Commission

LEAD PROJECT	TITLE		COST (MECU) PILOT	/ MAIN
1	AEROTHERMODYNAMICS	AERO	15	45
2	LAMINAR FLOW	AERO	26	66
3	ADVANCED MATERIALS	MATER.	25	120
4	A/C NOISE	ACOUSTICS	23	62
5	FUTURE COMPUTING	COMP.	20	100
6	INTEGRATION OF SYST & EQUIP.	SYS + EQ	23	68
7	ALL-ELECTRIC A/C SYSTEMS	SYS + EQ	11	21 + 18
8	ADVANCED PROPELLERS	PROP	11	25 + ?
9	CAD/CAM/CIM	DESIGN & MAN.	15	100
			169	607

COMMUNITY R&TD in AERONAUTICS

- **Framework Programme 2 (1990-91)** — **66 MECU**
  - A "pilot phase" to stimulate European R&TD collaboration
- **Framework Programme 3 (1992-95)** — **130 MECU**
  - Continue work initiated in the "pilot phase" placing the emphasis on a Key Technical areas
- **Framework Programme 4 (1995-98)** — **400 MECU**
  - Improve industrial competitiveness with increasing emphasis on subjects of wide public interest (environment, safety and ATM)
- **Framework Programme 5 (1999-2002)** — **700 Mio €**
  - Industrial competitiveness and sustainable growth of air transportation
- **New Framework Programme (2002-2006)** — **1000 Mio €***
  - For Aeronautics and Space; achieving the ERA

** proposed*

European Commission
Research Directorate General

Aero-acoustic Research on EU Level

2nd Framework Programme:
HELINOISE
DACRO
SCIA
GEMINI I

3rd Framework Programme:
HELISHAPE
ECARP
SNAAP
GEMINI II

4th Framework Programme:
HELIFLOW
HELIFUSE
EROS, ROSAA
APIAN

New Perspectives in Aeronautics

Reducing Development Cost and Time to Market	Improving Efficiency	Improving Environmental Friendliness	Improving Capacity and Safety

Critical Technologies + Technology Integration and Validation

Horizontal Activities of the 5th F. P.

other international activities
GARTEUR
EUREKA

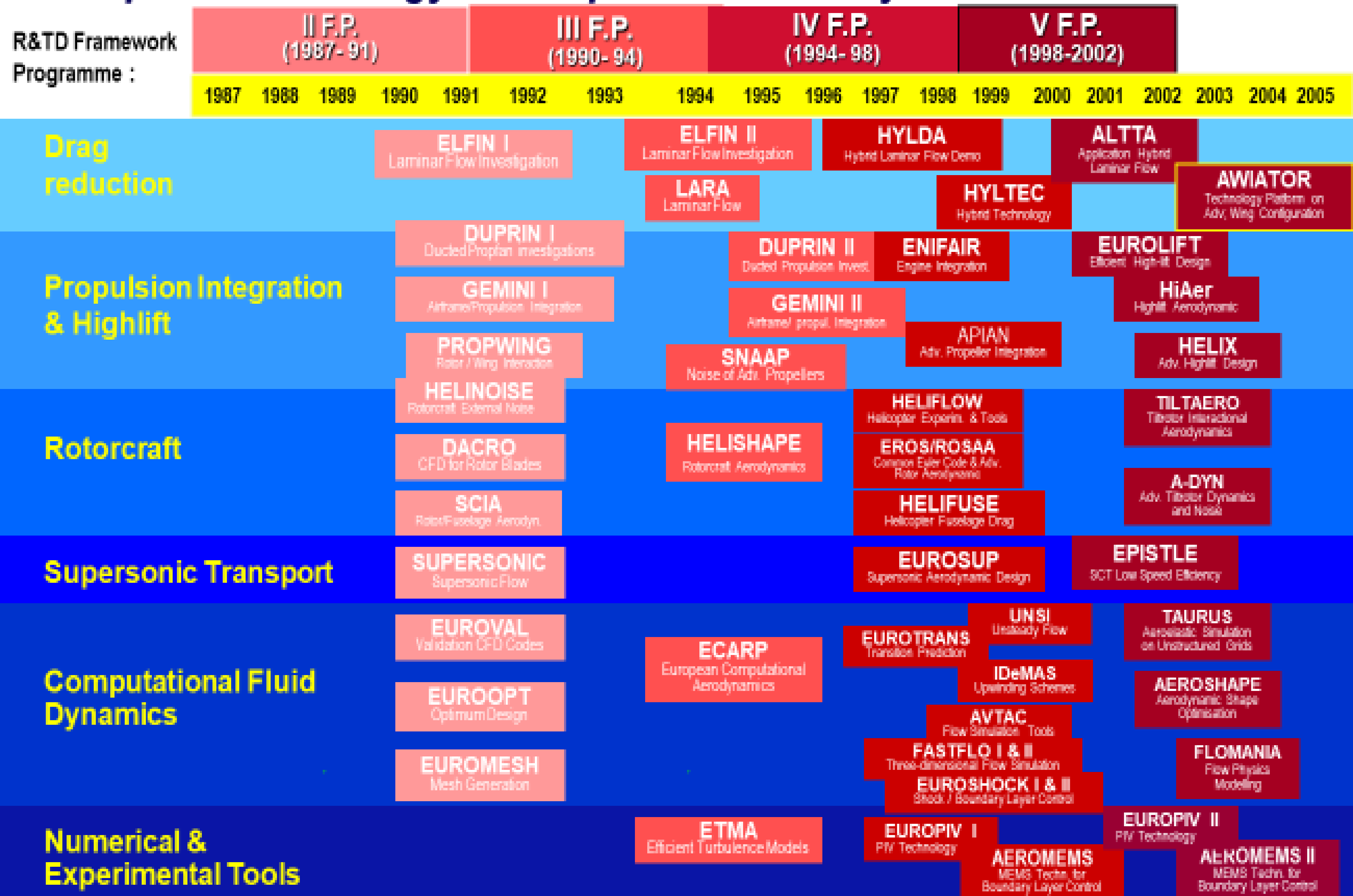
National R&TD Programmes of the Member States

International Co-operation

DG Research

European Commission

European Technology Development in Aerodynamics

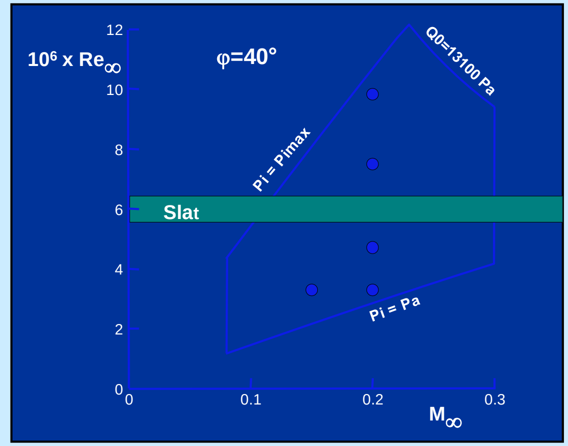


Transition Experiments on a Generic High Lift Configuration

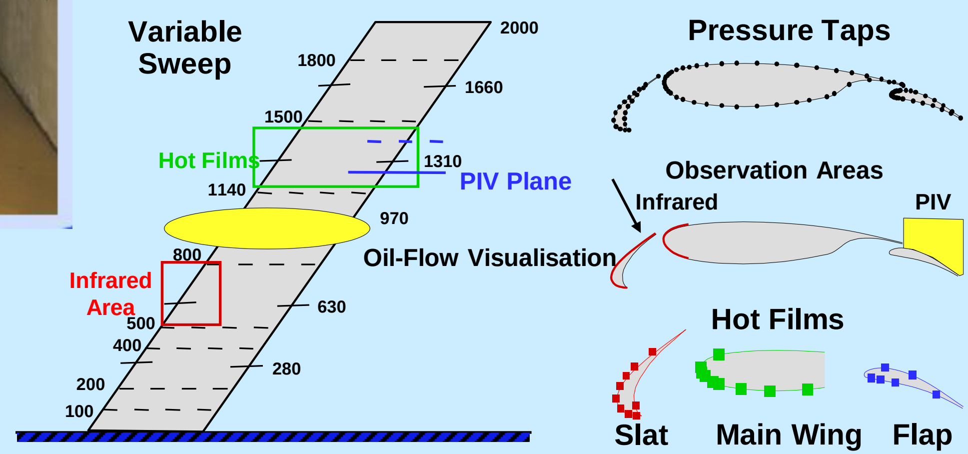
ONERA AFV Swept Wing Model in ONERA F1 Test Section

Source: Prof. P. Thiede, Airbus - D

Test Programme



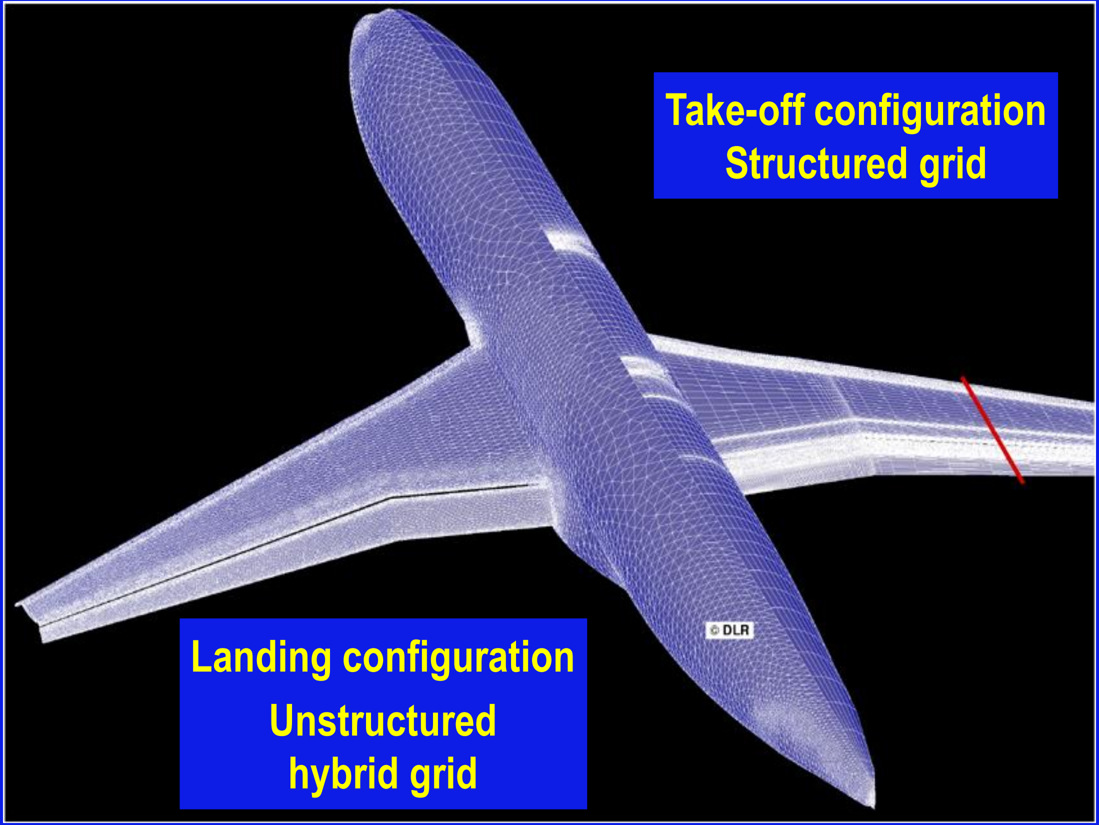
Model Equipment



European Commission
Research Directorate General

EUROLIFT
European High Lift Programme

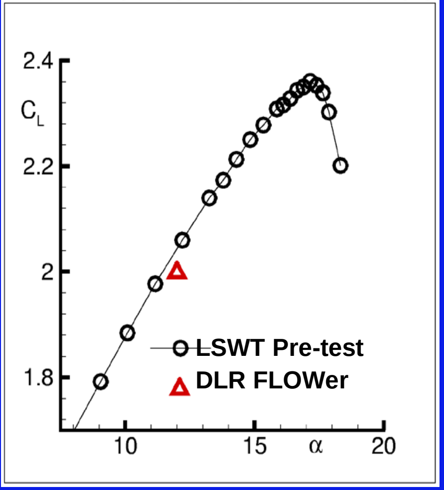
Pre-test RANS Computations of Take-Off & Landung Configurations



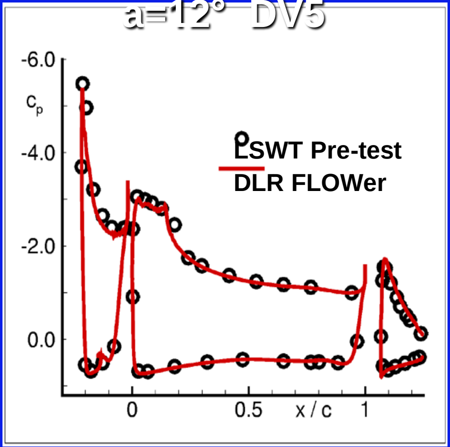
Surface grids of KH8Y configuration

Source: Prof. P. Thiede, Airbus - D

Take-off configuration
M¥=0.18 Re¥=1.4x106



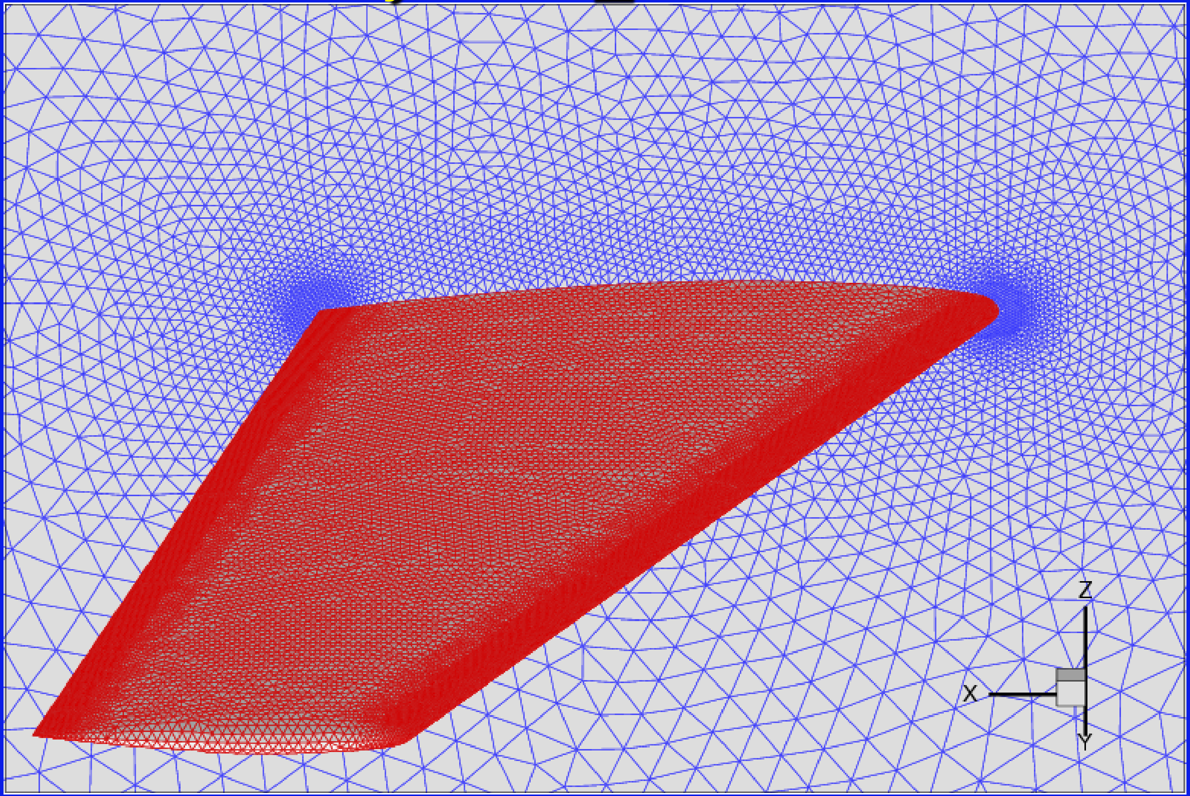
Pressure distribution
a=12° DV5

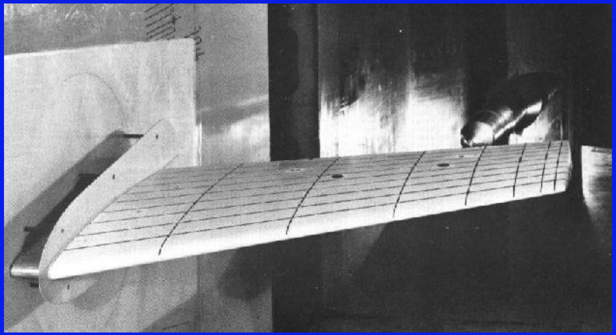


European Commission
Research Directorate General

IDeMAS

Industrial Demonstration of Advanced Algorithms for Aerodynamic Simulation on Unstructured Grids





Experiments:
Cp for 7 sections

ONERA M6 Wing

316 Knodes grid

Source: von Karman Institute, Brussels

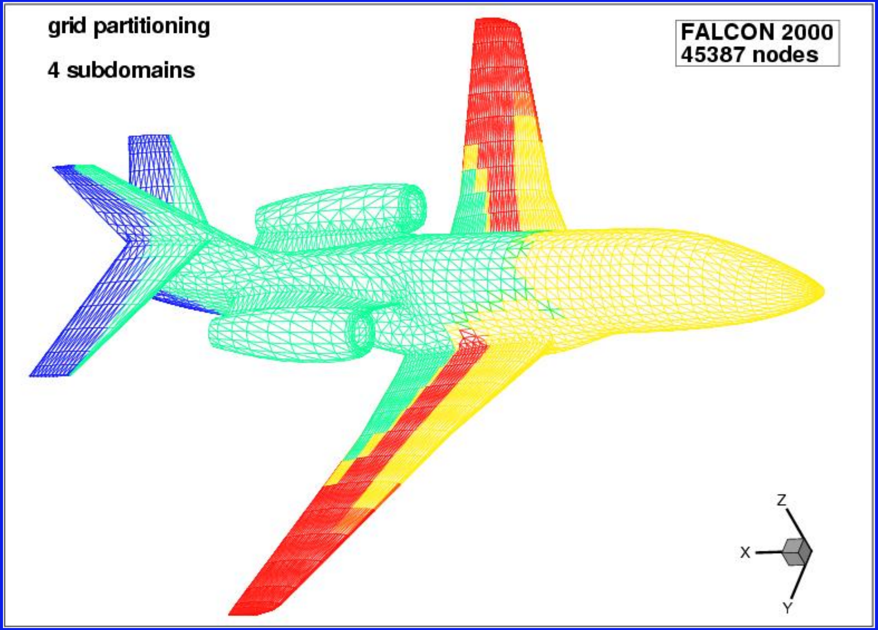
European Commission
Research Directorate General

IDeMAS

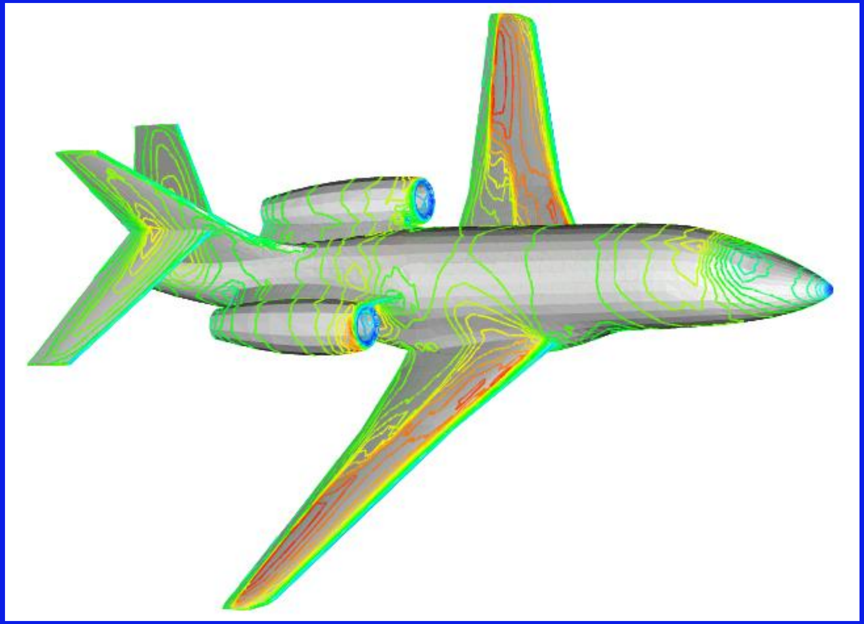
FALCON Aircraft $M_\infty = 0.85 \quad \alpha = 1.0^\circ$

MultiD upwind scheme

Grid (45.387 nodes)



Iso-Mach lines on surface



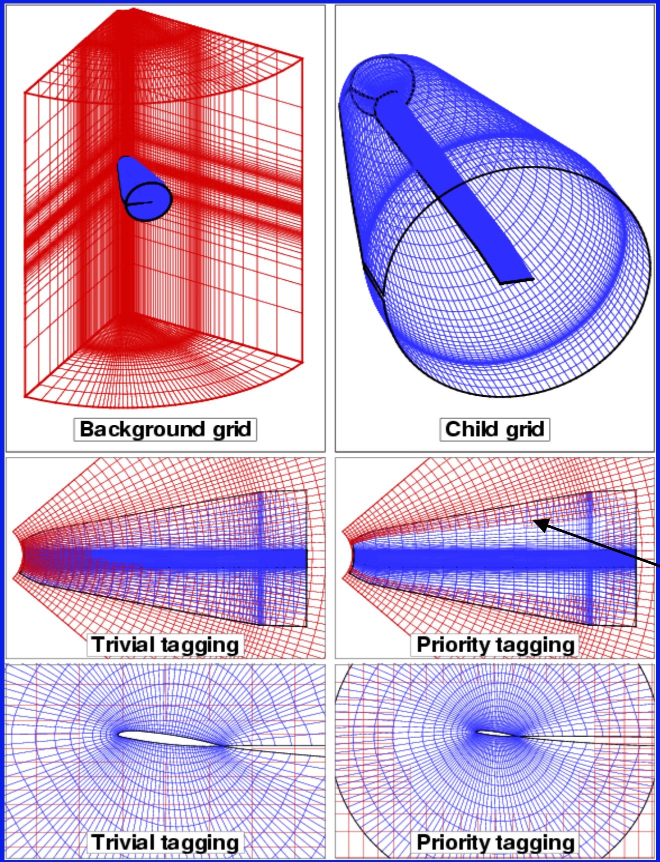
Source: von Karman Institute, Brussels

European Commission

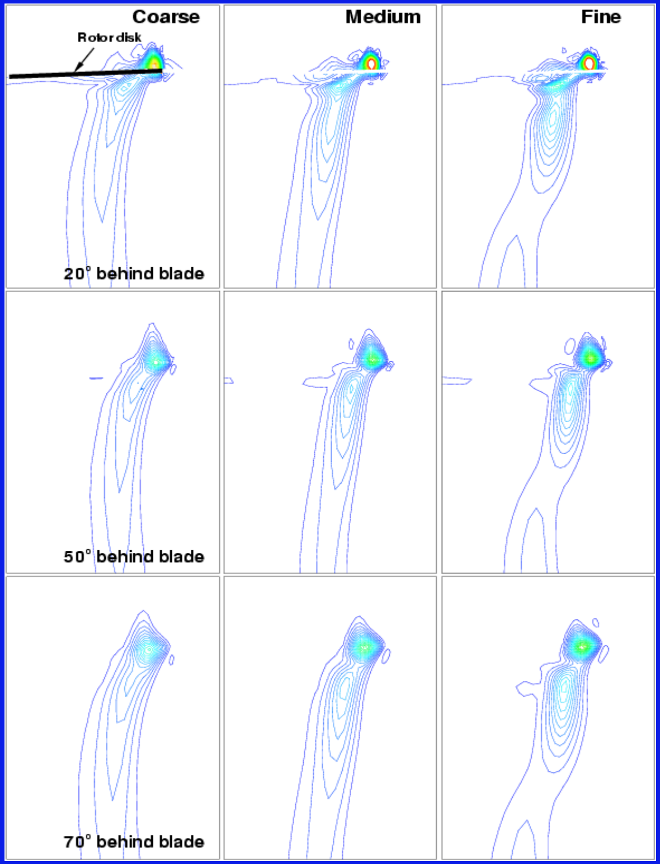
Research Directorate General

EROS - Euler Rotorcraft Software

Where is the wake ? - the dilemma



Vorticity field



Simulation of a Rotor in Hover

Solution is interpolated over the overlap region

Chimera grid

Chimera approach (overlapping of structured grids) simplifies grid generation and allows to put high quality grids in the areas where they are needed to resolve flow features
- near the blades; - following the wake

Grid resolution study

WAVENC

Wake Vortex Evolution and Wake Vortex Encounter

(Dec. 97 - Nov. 99)

Source: J. Thomas, Airbus

Goals:

- Improve physical understanding of wake vortex evolution
- Establish capabilities for flight simulation of wake vortex encounter

Work Content:

- Wind tunnel experiments
  - Catapult facility at ONERA Lille
  - DNW Large Low-speed Facility
- Numerical simulations
  - Wake vortex evolution and encounter

Consortium:

NLR(Coordinator), Aerospatiale, DASA Airbus, CERFACS, DLR, ONERA, IMFL, TsAGI, RED Scientific, Univ. Lisbon

Budget: 1.5 million Euro

Fifth Research Framework Programme

(1998 - 2002)

Key-Action 4: New Perspectives in Aeronautics

(Budget: 700 million €)

- ***Why ?***
  - to foster the Competitiveness of the European Aeronautics Industry
  - to enhance Safety and reduce the Environmental Impact,
  - to allow Sustainable Growth for Air Transport

- ***How ?***
  - develop critical technologies, for long term competitiveness
  - integrate and validate technologies, to ease their introduction

- ***Who ?***

  This key action involves in a joint effort:

  - Manufacturers, Suppliers (including SME's) and Operators
  - Regulatory Authorities
  - Research Organizations and Universities

GIFAS rewards Herbert Allgeier for his 'exceptional' contribution to the European aeronautic industry

The French group of aeronautical industries, GIFAS, has recognised the efforts of Herbert Allgeier in promoting the European aerospace industry during a special ceremony at the Paris Air Show at Le Bourget - the Cannes Festival of the aeronautics business.

On 18 June, GIFAS P...

The French group of aeronautical industries, GIFAS, has recognised the efforts of Herbert Allgeier in promoting the European aerospace industry during a special ceremony at the Paris Air Show at Le Bourget - the Cannes Festival of the aeronautics business.

On 18 June, GIFAS President Jean-Paul Bechat surprised Mr Allgeier, Director-General of the European Commission's Joint Research Centre, by presenting him with a one-off prize in recognition of his contribution to European research and technology policy.

Mr Allgeier, who is a keen pilot himself, has worked in the research field for the Commission since 1976. As well as his current position as Director-General of the JRC, he has overseen the work of the Commission's aeronautics task force and space coordination group.

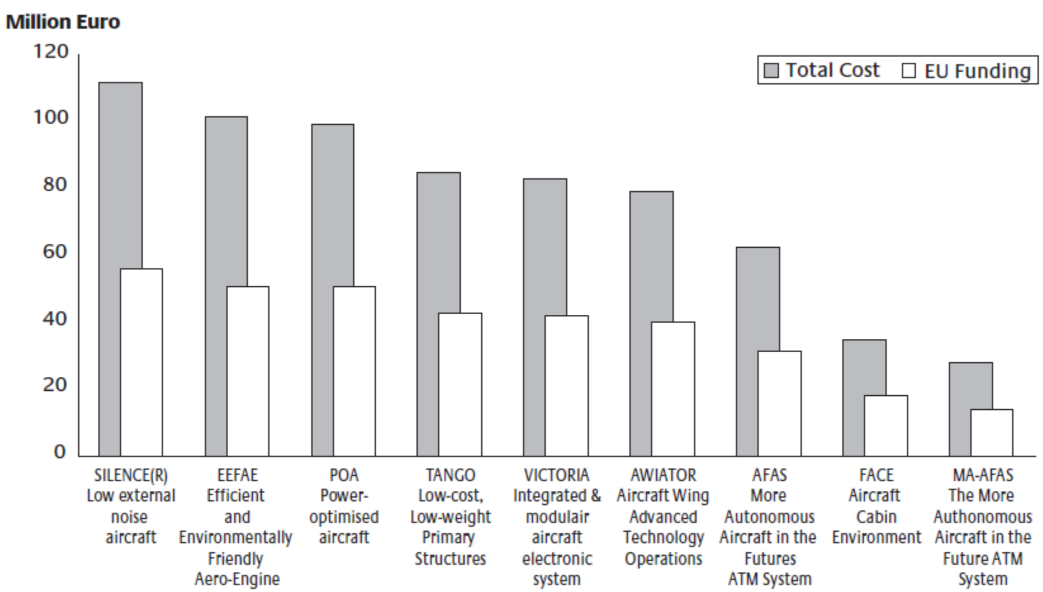
Confirmation of the Commission's support for his work is seen in the 700 million euro dedicated to encouraging competitive growth within the aeronautics industry under one Key Action of the Fifth Framework Programme (as opposed to 320 million euro for land transport and marine technologies).

European Commission

1. CRITICAL TECHNOLOGIES

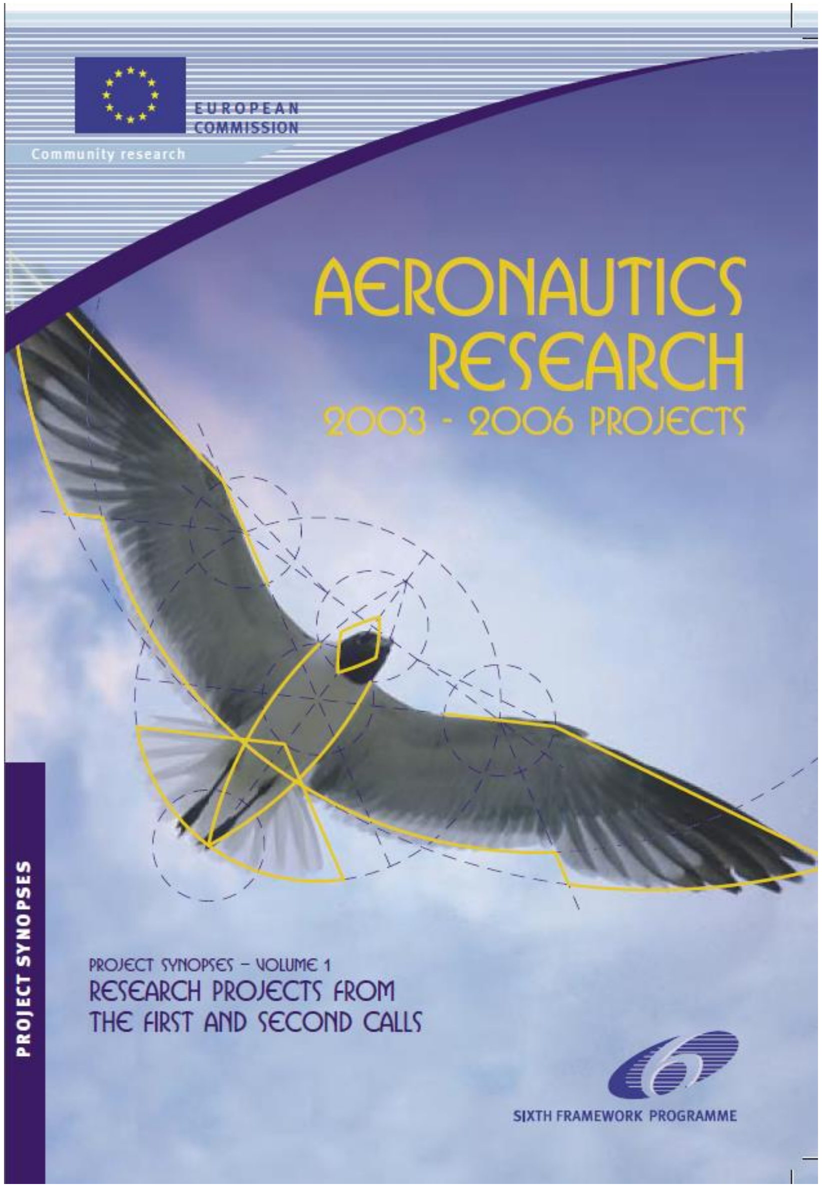
Aircraft Development Cost & Time to Market
Aircraft Efficiency
Environmental Friendliness
Operational Capabilities & Safety

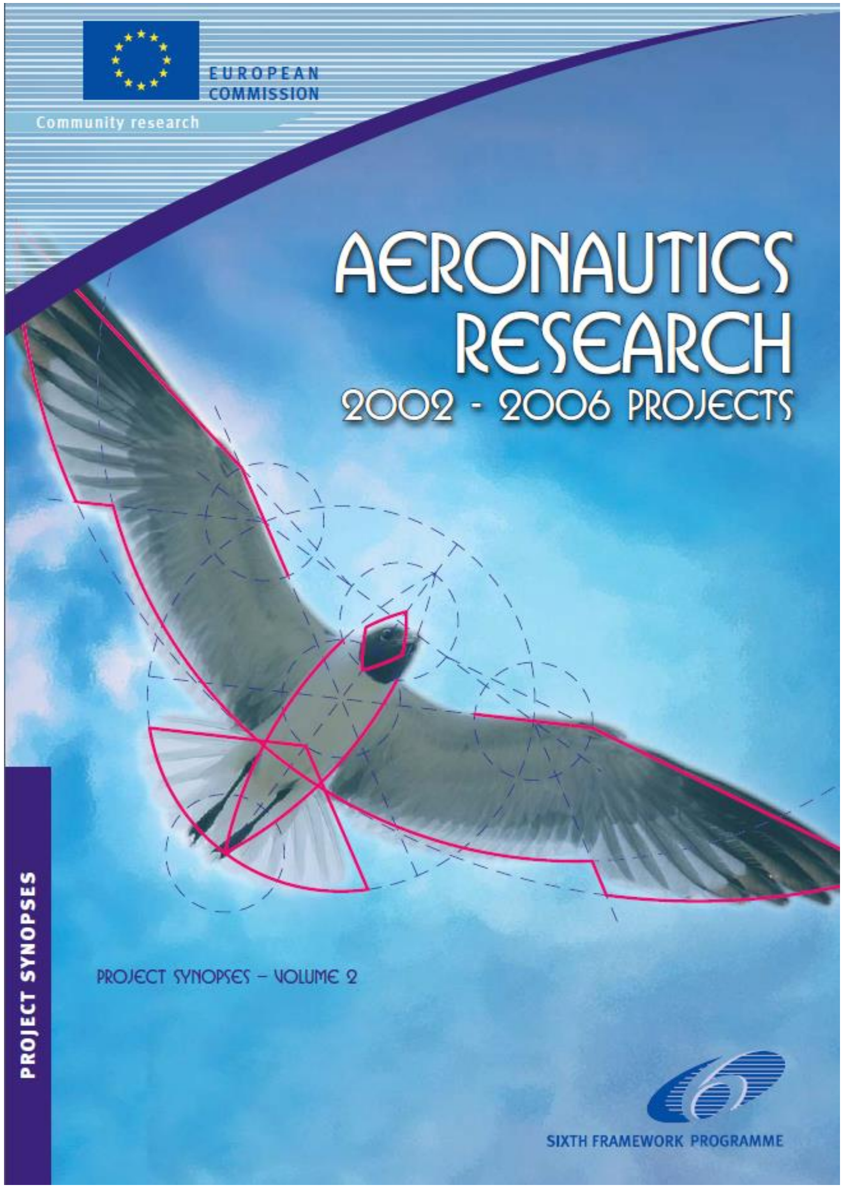
2. TECHNOLOGY PLATFORMS



Technology platforms – total costs and EU funding

European Commission





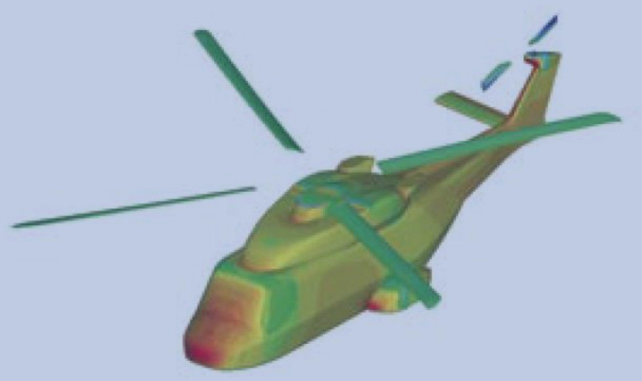
European Commission

DESIDER

Detached Eddy Simulation for Industrial Aerodynamics

GOAHEAD

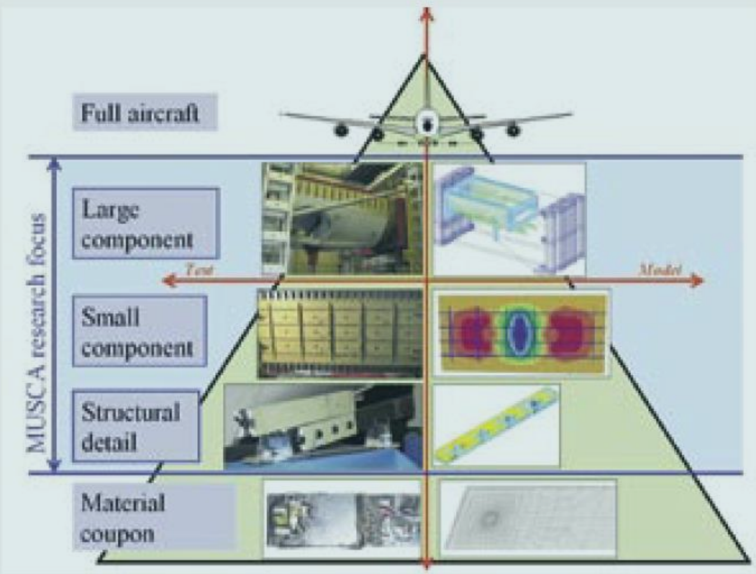
Generation of Advanced Helicopter Experimental Aerodynamic Database for CFD Code Validation



GOAHEAD aims to validate URANS CFD codes for complete modern transport helicopter configurations.

MUSCA

Multiscale Analysis of Large Aerostructures



SimSAC

Simulating Aircraft Stability and Control Characteristics for Use in Conceptual Design

	Nb	EC fund	Share of total fund
01) Flight Physics	9	46.1	4.6%
02) Aerostructures	18	125.7	12.7%
03) Propulsion	25	210.5	21.2%
04) Systems and Equip	19	95.4	9.6%
05) Avionics	10	127.5	12.8%
06) Design Tools	26	134.6	13.6%
07) Production	12	55.3	5.6%
08) Maintenance	11	35.8	3.6%
09) Flight ATM	5	10.6	1.1%
10) Airports	11	22.9	2.3%
11) Human Factors	4	15.7	1.6%
12) Noise	11	48.7	4.9%
Pioneering-Others	17	38.9	3.9%
CSA-Other	43	24.5	2.5%

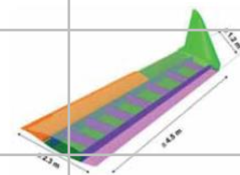
Sum	**221**	**992.1**	**MEur**

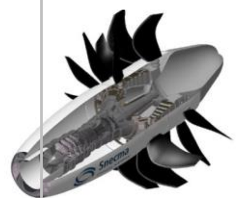
L1 ~150 projects, 500 MEur

- Flight Physics *Flow control, Computational methods, Morphing, Icing*
- Aerostructures *COMPOSITE, Ice accretion, health monitoring, resistance against blast*
- Propulsion *COMBUSTION, aerothermodynamics, materials, alternative fuels*
- Systems & Equipment *Detection of Turbulence, Ice, Electrical actuators, cabin comfort*
- Avionics *Single display, virtual reality, avionics for small aircraft*
- Design Tools *Computational and experimental techniques*
- Production *Flexible, fast, composites, new techniques*
- Maintenance *Health monitoring, non-destructive, composite repair*
- Noise *Reduction at the source (fan, jet, propeller, helicopter), psychoacoustic*
- Human Fact *Upset recovery, manual control, human centered cockpit, training*
- Airports *Airport turnaround time modelling, airport security*

L2 ~20 projects, 500 MEur

Flight Physics					***Flow Control AFLONEXT***
Aerostructures	***Composite Fuselage*** *MAAXIMUS*		***Structures*** *SARTISU*		
Propulsion	***Open rotor*** *DREAM*		***High OPR HP*** *LECOMTEC* ***General aviation*** *ESPOSA*	***Sub-Systems*** *E-BREAK*	***High OPR - LP*** *ENOVAL*
Systems & Equipment	***Electromagnetic environment*** *HIRF SE*		***Electrical actuators*** *ACTUATION 2015*		
Avionics	***Scalable*** *SCARLETT*	***All Weather*** *ALICIA* ***Communication*** *SANDRA*		***Crew Stress Reduction*** *ACROSS*	***Communication Extended Domain*** *ASHLEY*
Design Tools		***Behavioural digital aircraft*** *CRESCENDO*		***High Altitude Crystal*** *HAIC*	***Behav. digital aircraft: thermal*** *TOICA*
Production				***Low cost manufacturing*** *LOCOMACHS*	
Noise	***Noise*** *OPENAIR*				
	2007	2008	2011	2012	2013





Policy – Coordination 50 projects, 26 MEur, 2.7% budget)

International Cooperation

China, Canada, Japan, Latin America, Russia, Ukraine, South Africa, U.S.

Aerochina, Grain, Sunjet, Coopair-LA, Aero-Ukraine, CooperateUS

Education

Aeronautical School Labs - Curricula of Engineers - Promotion of Careers

Restarts, Educair, Fly-Higher, Promo-Air

SMEs

Support for SMEs and small entities to participate in FP7

Aeroportal
SME-Aeropower

East-West links

Beware - Ceares

Conferences - Dissemination

Aerodays - Turbomachinery - Air Transport - Harmonisation of Scientific Societies

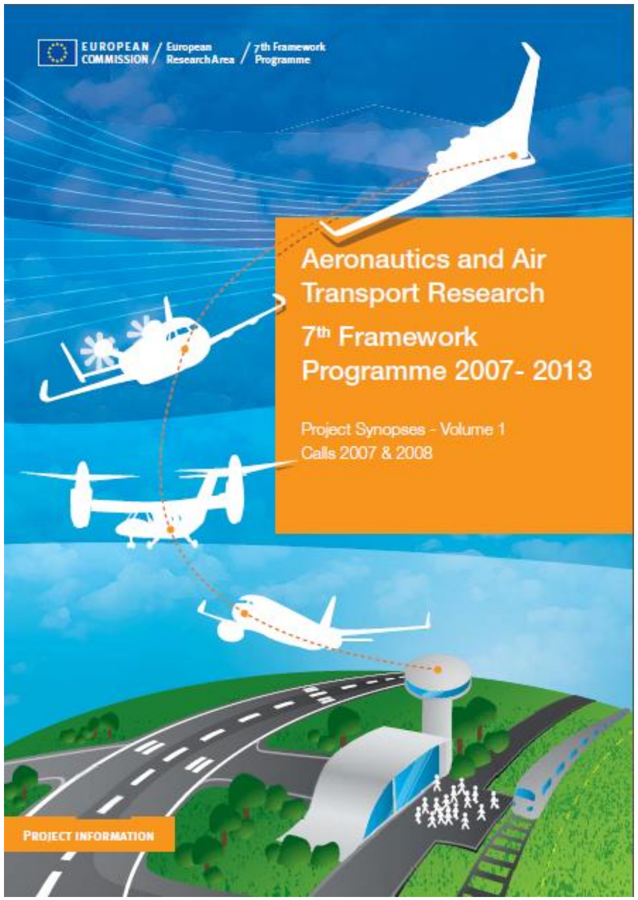
Aerodays, Euroturbo, E-CAero
Aeroplan

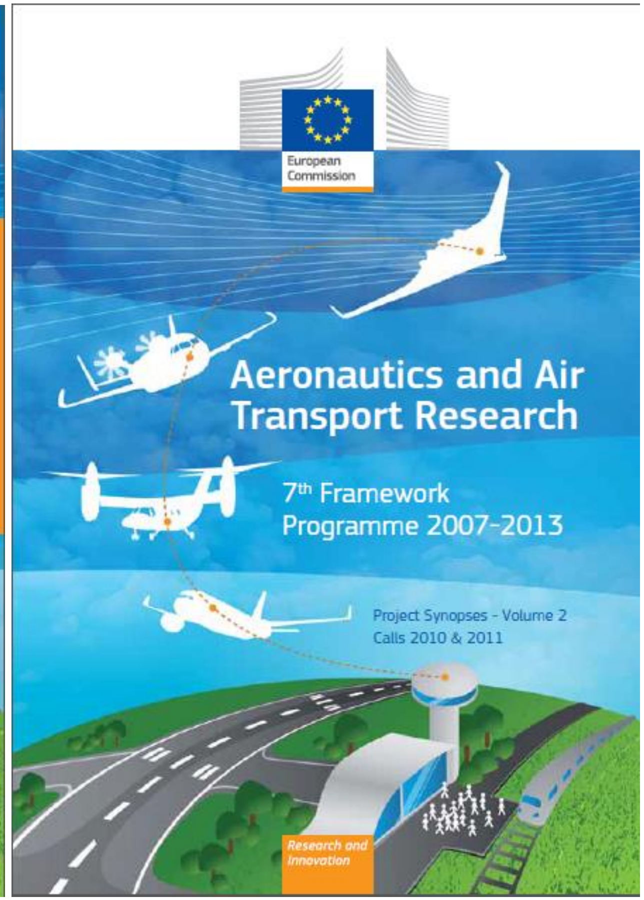
Coordination of Research

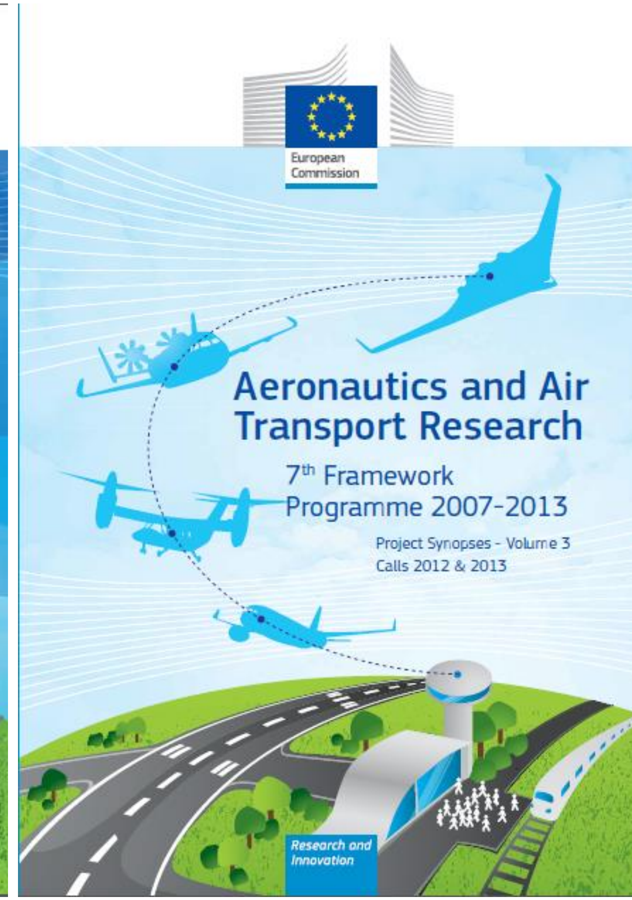
National - Noise - Environment - Time Efficiency - Safety& Security - Alternative Fuels

Air-TN
X-Noise
Cater
Forum-AE
Optics

AAT – FP7 – Synopsis – 3 vol



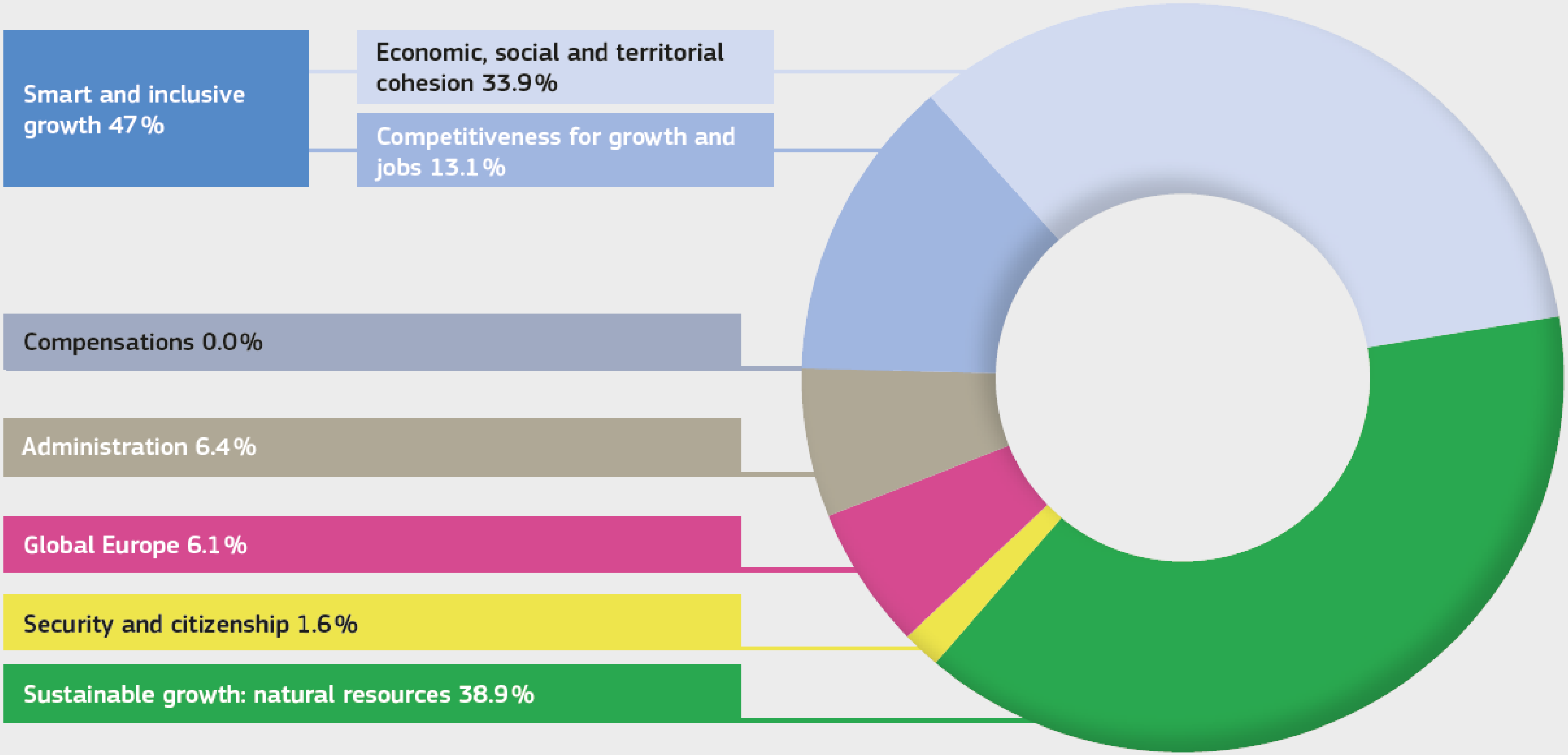




http://ec.europa.eu/research/transport/air/index_en.htm

EU Budget 2014-2020

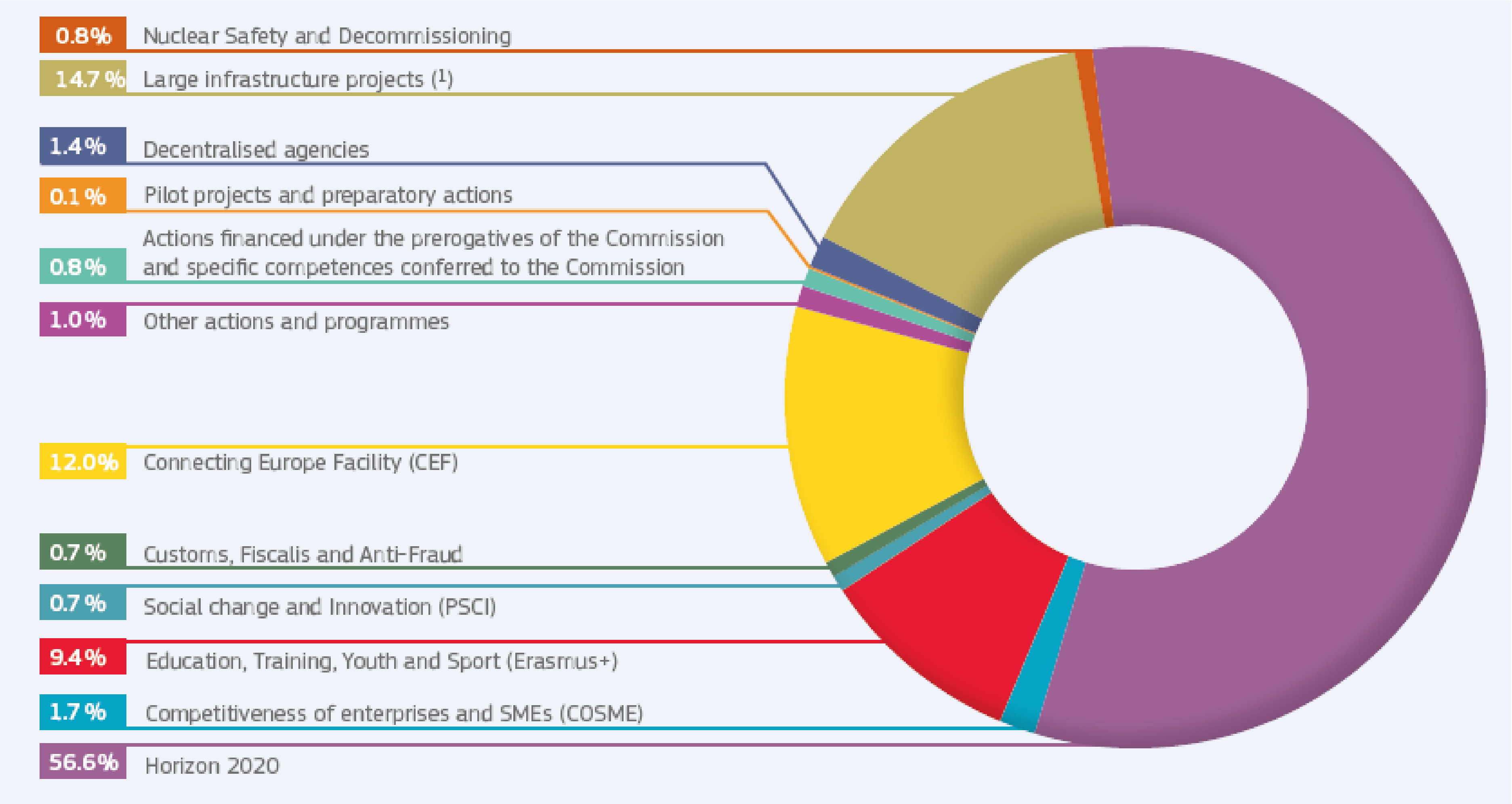
European Commission



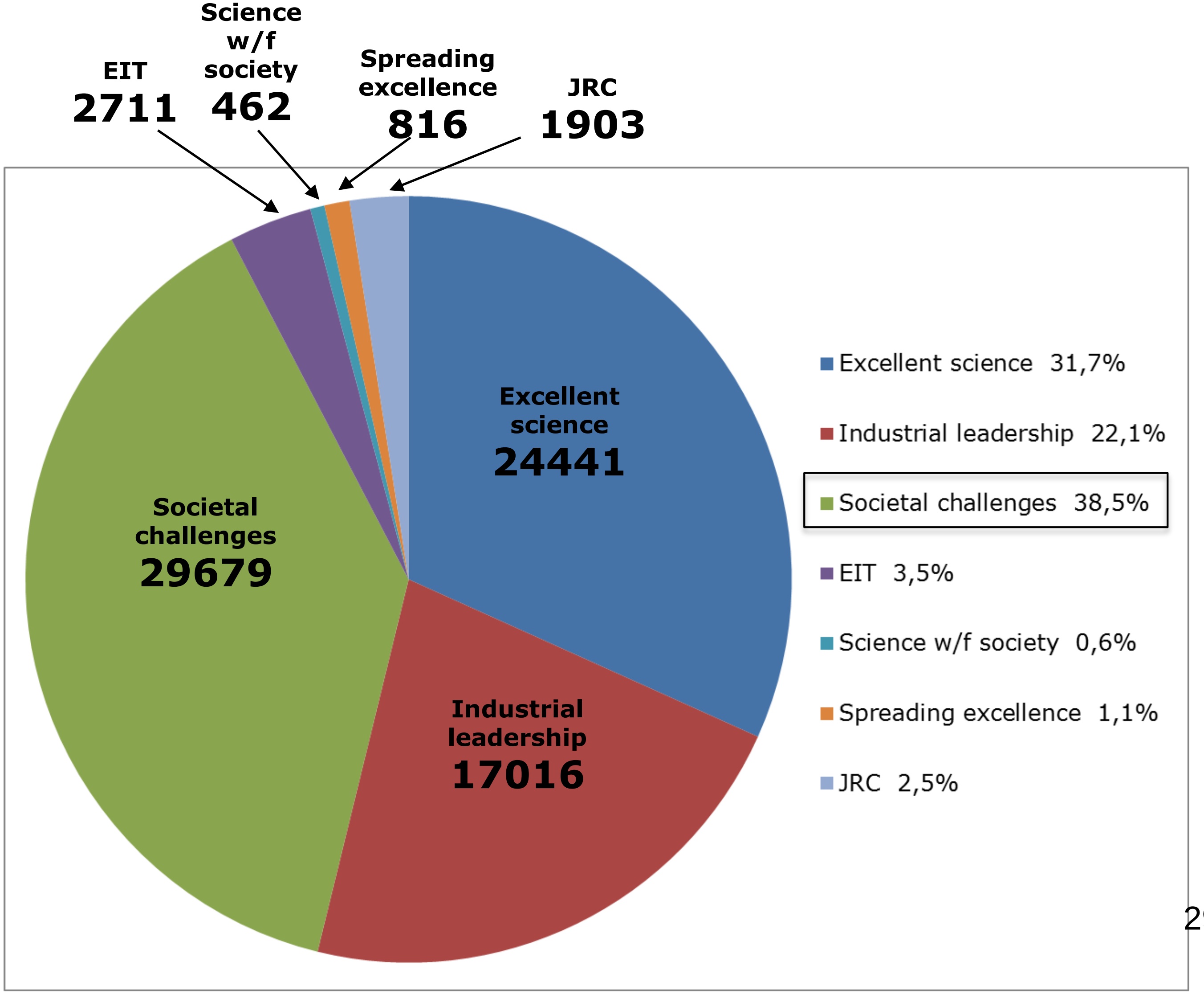
2015 EU budget: € 145.3 billion

= 1.02 % of gross national income

Competitiveness for growth and jobs

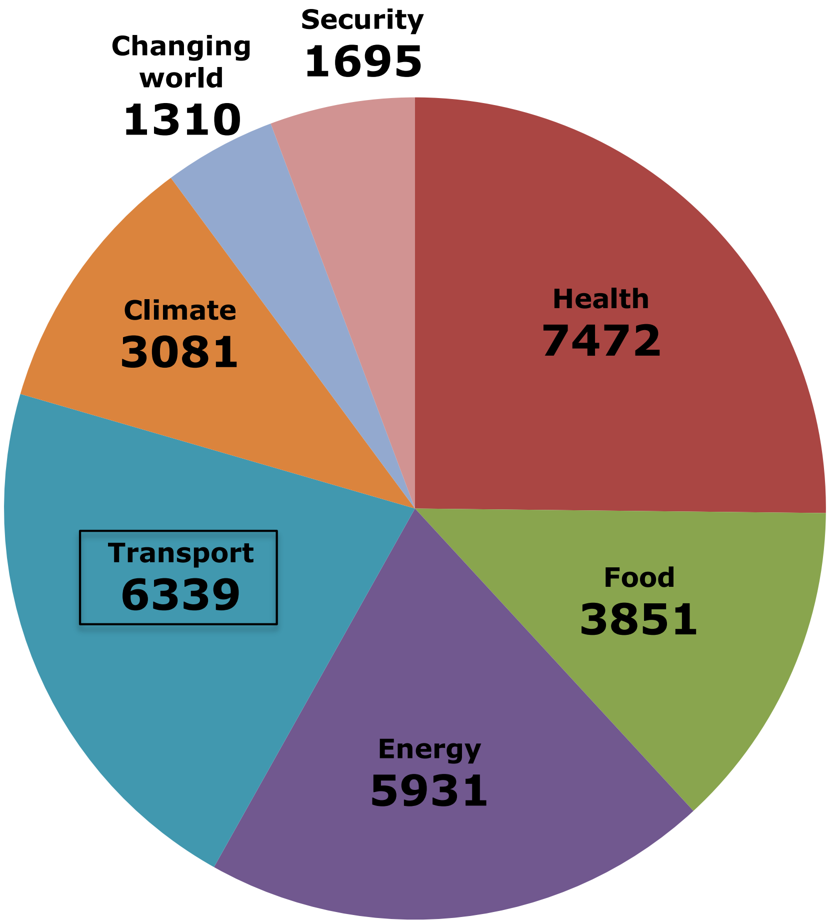


77 Billion euro over 2014-2020



Societal challenges

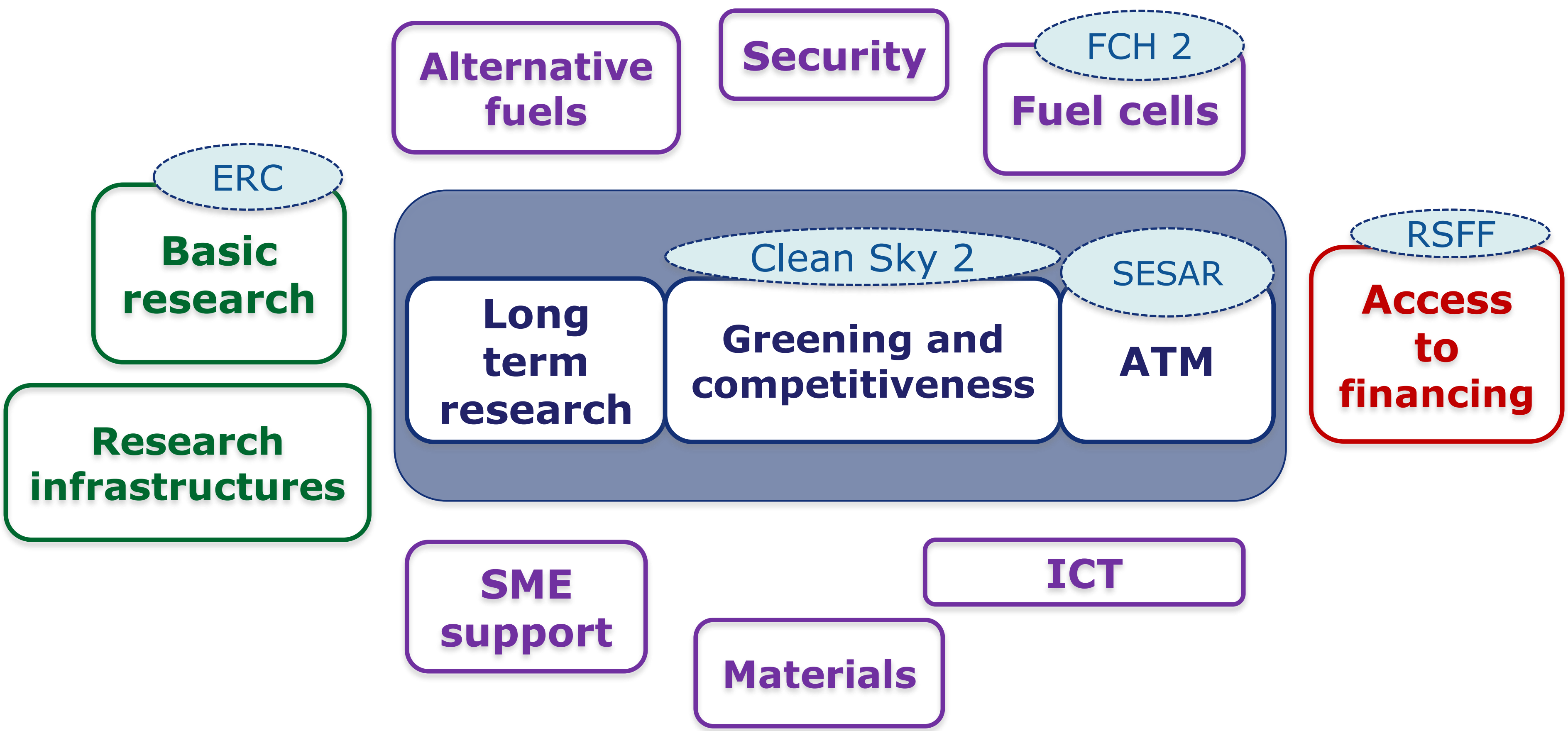
HORIZON 2020



% of H2020

- Health 9,7%
- Food 5%
- Energy 7,7%
- Transport 8,2%
- Climate 4%
- Changing world 1,7%
- Security 2,2%

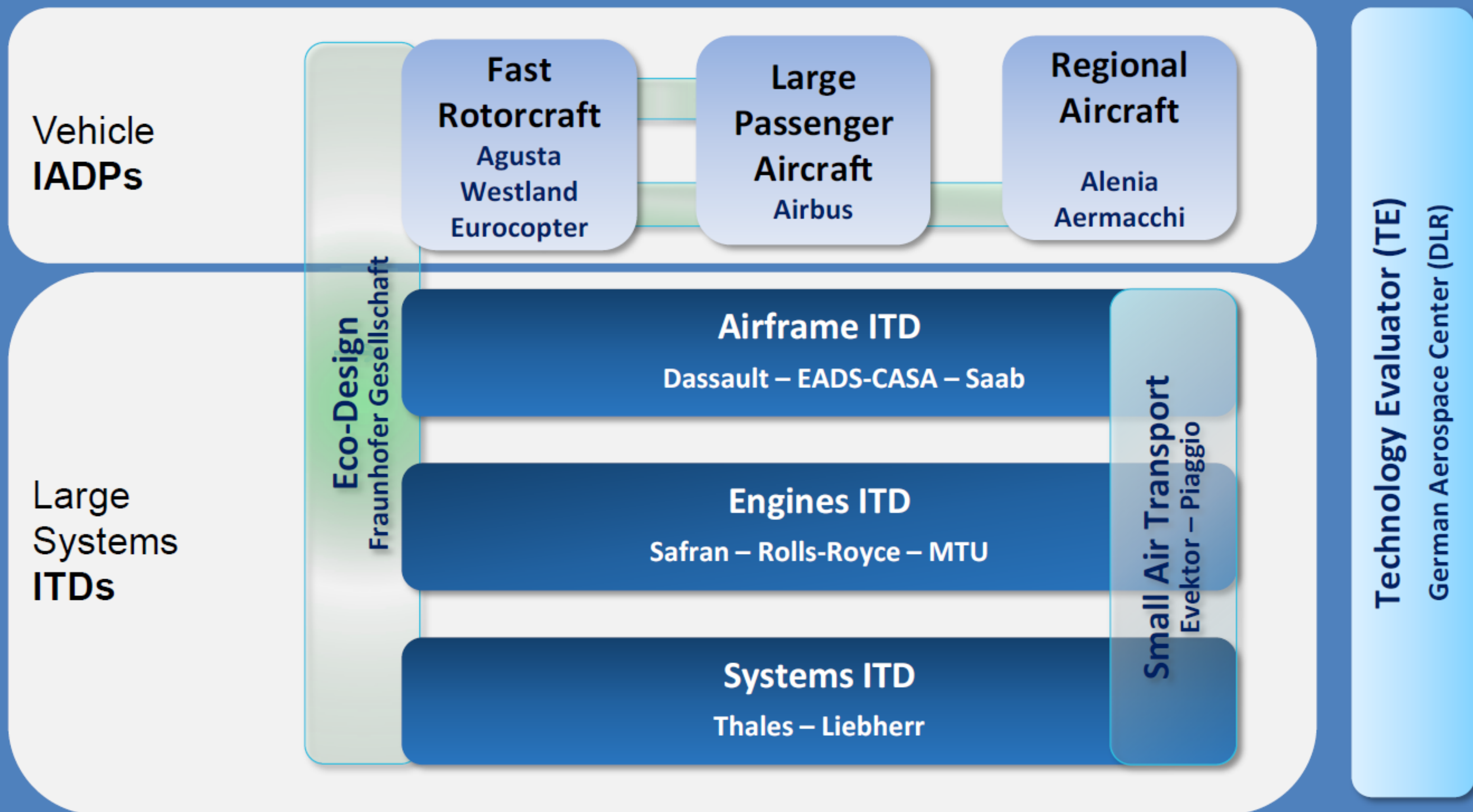
Aviation Research in H2020



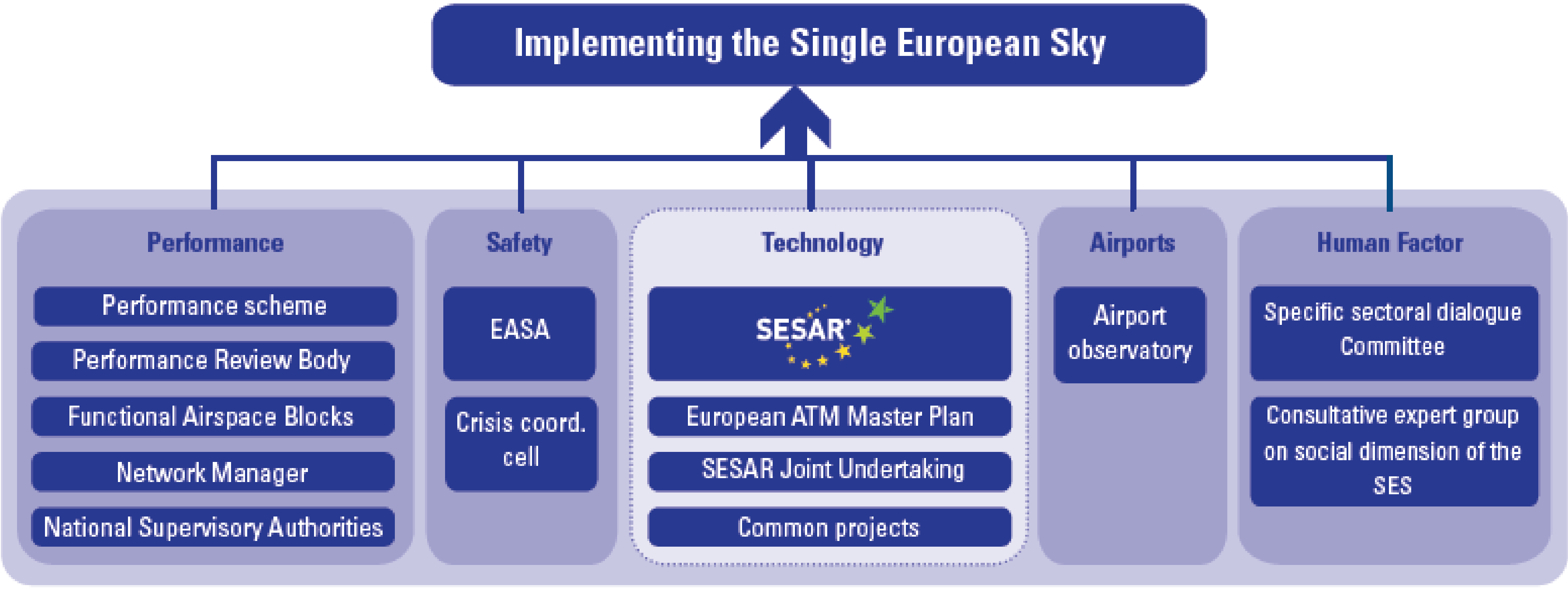
European Commission

HORIZON 2020

Clean Sky 2

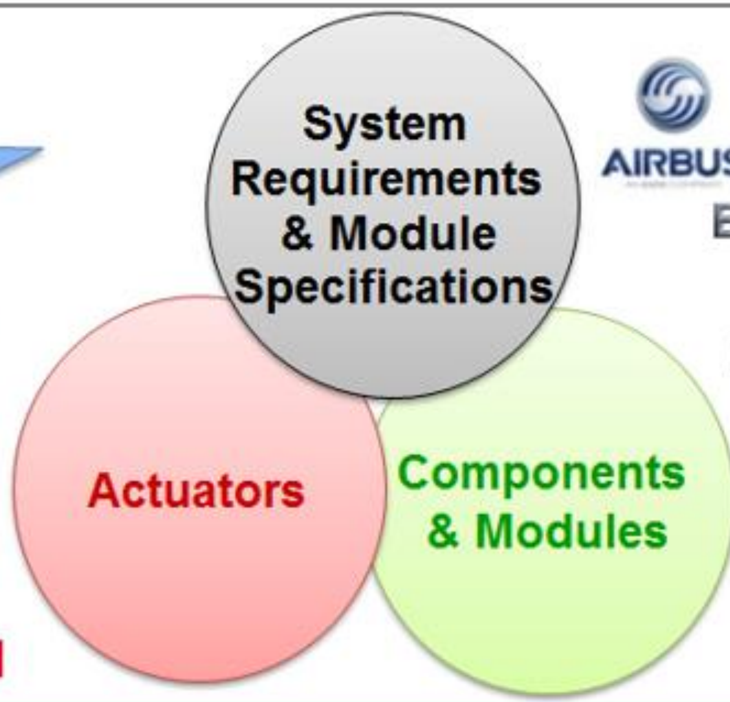


Clean Sky – (2008-2016) – 1.6 billion (800 mil from FP7, industry in kind)
Clean Sky 2 – (2014-2024) - 4 billion (1755 mil from H2020, industry in kind)



SESAR 1 (2008-2016) – 2.1 billion (FP7+TEN, Eurocontrol, Industry)
SESAR 2020 (2016-2024) – 1.6 billion (H2020, Eurocontrol, Industry)

54 partners within 12 countries
Budget = 35 M€ over 54 months



UTC Aerospace Systems
LIEBHERR
SAFRAN Messier-Bugatti-Dowty
SAFRAN Sagem
BAE SYSTEMS

AIRBUS
AleniaAeronautica
PIAGGIO AERO
EADS

EADS-IW
SAFRAN Hispano-Suiza
ECEPS
THALES
AEM
PIHER
MEGGiTT
SENER
SAGENTIA
Harmonic Drive AG
Microsemi
SKF
tecnalia
UMBRAGROUP

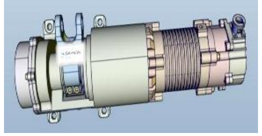
Support organisations for

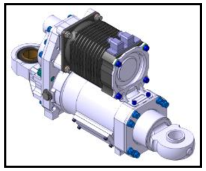
Tools and Models	Management of EU R&D projects	Qualification, Standardisation	Test rigs
Newcastle University, INSA, MTA SZTAKI, IFST, DLR, The University of Nottingham, ONERA	ARTTIC	cen, NLR, DIN	C·E·R·T·I·A, CLEMESSY

Modular actuators' topology trade and selection

- **Primary flight controls**

Rotary modular topology

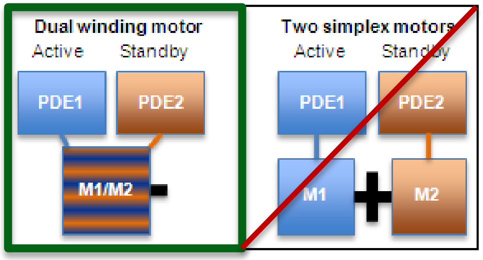


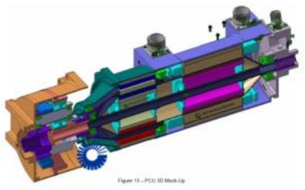


Linear "gear drive" topology

- **High lift system & Trimmable horizontal stabilizer**

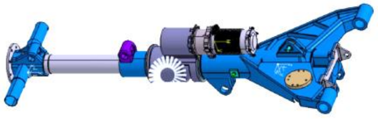
Dual winding motor topology





- **Landing gear systems**

Rotary modular topology



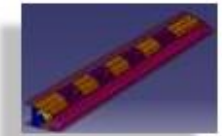
Linear "gear drive" topology

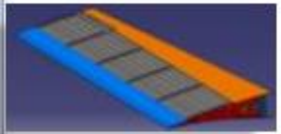
European Commission

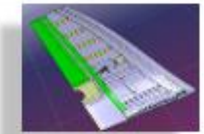
Smart Intelligent Aircraft Structures

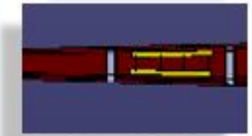
SARISTU

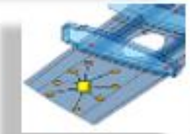
51 million total – 32.5 million EU contribution

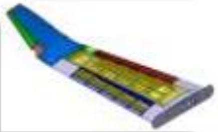

AS01 – Enhanced Adaptive Droop Nose


AS02 – Adaptive Structural Tailoring of a Trailing Edge


AS03 – Wingtip Active Trailing Edge

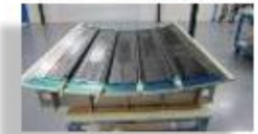

AS04 – Fibre Optic based monitoring system


AS05 – Wing damage detection employing guided waves

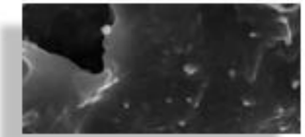

IS 12 – Wing Integration


WP 200 – Overall Consortium Management

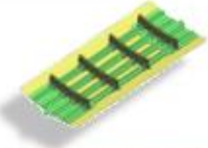

AS06 – Door Surround Structure damage detection and assessment


AS07 – Multi-site damage assessment for CFRP


AS08 – Sensitive Coatings for impact detection


AS09 – Enhancement of primary structure robustness


AS10 – Improvement of the electrical isotropy of CFRP


IS 13 – Fuselage Integration


WP190 - Dissemination

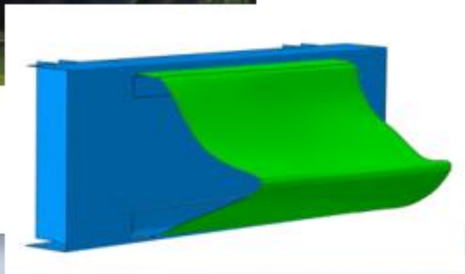
European Commission

SARISTU

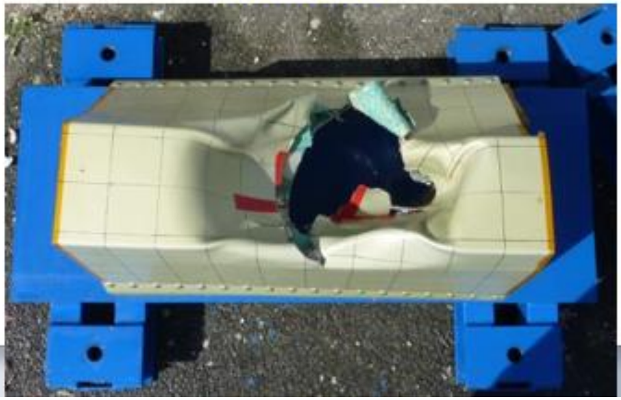
AS01: Bird Strike Test on EADN including Bird Splitter

AS01: Bird Strike Test on EADN kinematic area

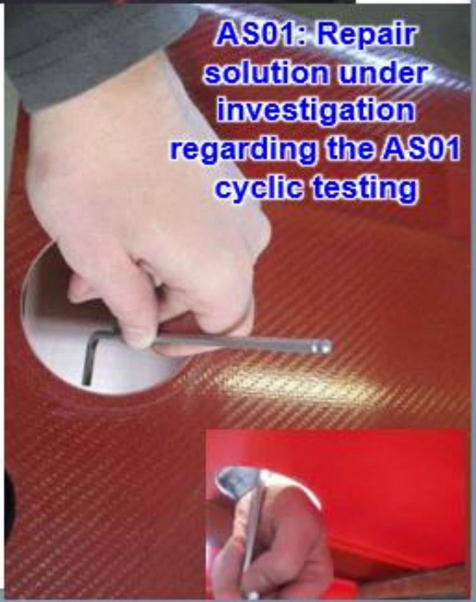
AS01: Calibration Bird Strike Test on Bird Splitter: Good alignment between experiment & prediction



AS01: Calibration Bird Strike Test on Bird absorption structure: Large difference to prediction

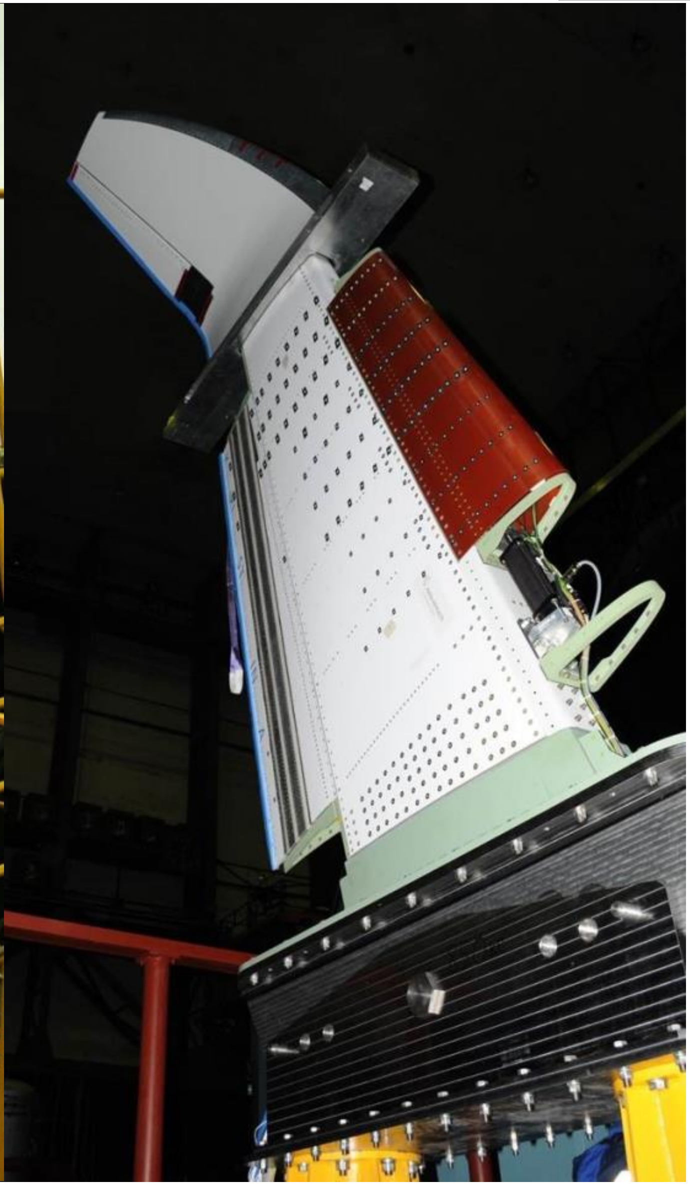


AS01: Repair solution under investigation regarding the AS01 cyclic testing



European Commission

SARISTU



IS12 Ground Test Demonstrator build status 25.06.2015. Please note the acoustic sensors and cables.

European Commission

Thermal Overall Integrated Concept Aircraft

SEVENTH FRAMEWORK PROGRAMME

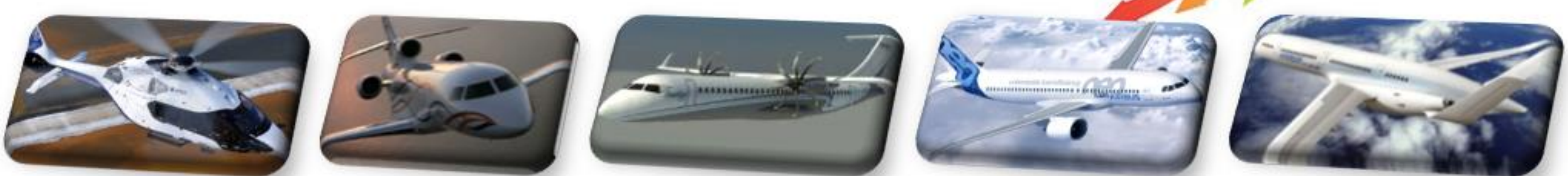
3 years

26.5M€

32 Partners

Project Drivers

- ❑ Develop solutions in **an integrated project**
- ❑ Work on plateaus for **representative aircraft baselines**
- ❑ Deliver collaborative **thermal trade-off** capabilities at TRL4



TOICA High Level Objectives

Thermal Overall Integrated Concept Aircraft

➔ Improve methodologies and processes for aircraft design.

1 - COLLABORATE ALONG THE PROCESS

Develop **customised collaborative and simulation capabilities** improving the generation, the management, and the maturity of the **B**ehavioural **D**igital **A**ircraft (BDA) dataset

2 - OPTIMISE THERMAL BEHAVIORS

Develop **new concepts for improved thermal load management** for aircraft components, systems or equipment, which will integrate innovative cooling technologies and products

3 - VALIDATE

Assess and validate the developed capabilities and technology concepts against different common reference aircraft targeting both "**EIS 2020 and EIS 2030+** Thermal Concept Aircraft"

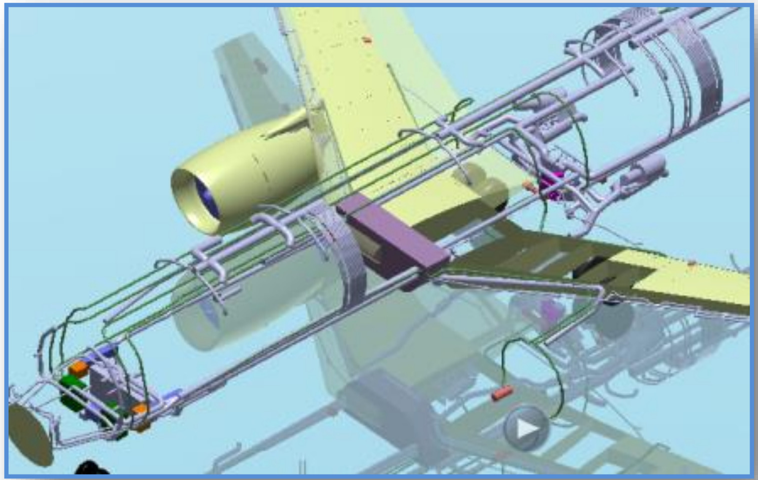
4 - ENABLE INNOVATION

Optimise aircraft design by **enabling highly dynamic allocation and association between requirements, functions and product elements** (Super integration) for product innovations

Plateau Objectives

Thermal Overall Integrated Concept Aircraft

Next Generation of Short Range (NSR)



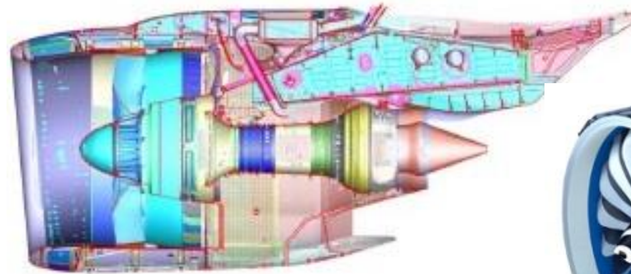
The NSR baseline focused on More Electrical Architectures as relevant solutions to the market demand. The objectives were to:

- **De-risk installation in regards to increasing thermal heat dissipation and ventilation needs**
- **Develop capabilities enabling more integrated architectures**
- **De-risk integration of innovative cooling technologies in early design phase with Partners' support**
- **Enable Overall Thermal Aircraft assessment for trade-offs and comparisons of 'thermal' concepts**

Plateau Objectives






New Engine Options (Neo)

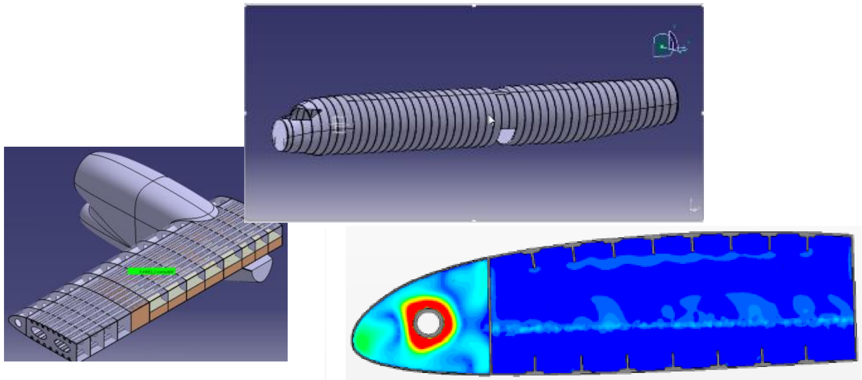
Derivative A/C programs require architects to manage the changes due to New Engine Options (NEO) efficiently. The aim of Neo Baseline was to:

- **Demonstrate capacity to integrate more efficient engines (-15% Fuel consumption) that are also hotter**
- **Explore architectural alternatives to meet the new conditions arising from a higher-bypass ratio (10-15) causing an increase of thermal loads affecting:**
  - Ventilated equipment in core engine compartment
  - Pylon structure and integrated systems
  - Engine components

Plateau Objectives

Thermal Overall Integrated Concept Aircraft

Next Turboprop Regional Aircraft



The objectives were to optimise global aircraft thermal architecture through

- **A/C thermal management**
  - Definition of environmental parameters for composite structures design
  - Optimisation of global airplane conductance
  - Input analyses for flammability assessment for wing fuel tanks
- **System level trade-offs**
  - Optimisation of airplane zoning concurrently with E/E system requirements
  - Assessment of new configurations using fuel as heat sink
- **System level performance optimisation by minimising engine bleed off-take**

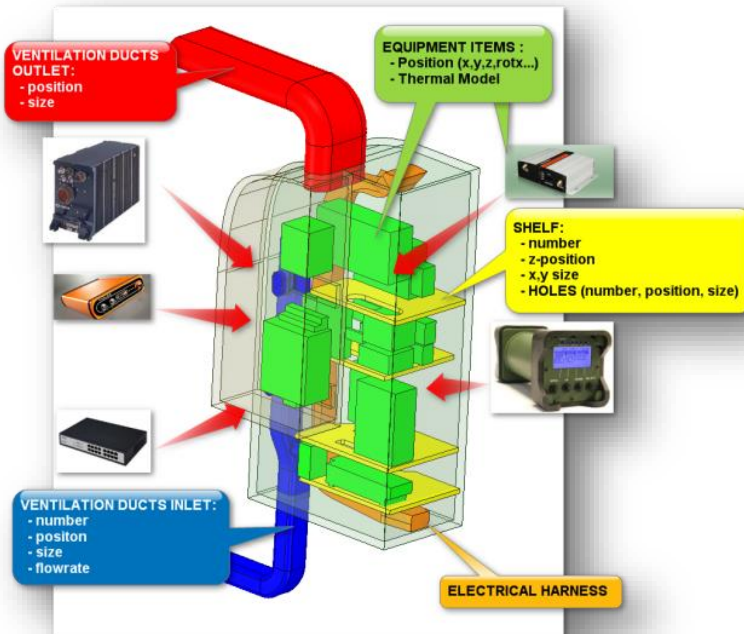
Plateau Objectives

Thermal Overall Integrated Concept Aircraft

AI-H worked out more robust integration of new avionic systems (more functions, more heat, less space, flight domain extension…) in order to

- **Reduce development lead time, weight and cooling needs**
- **Explore more designs to improve the thermal design**
- **Improve collaboration design for stronger equipment reliability**
- **Validate integration of new modular avionics combining new cooling technologies**

Next Evolution Of Helicopters

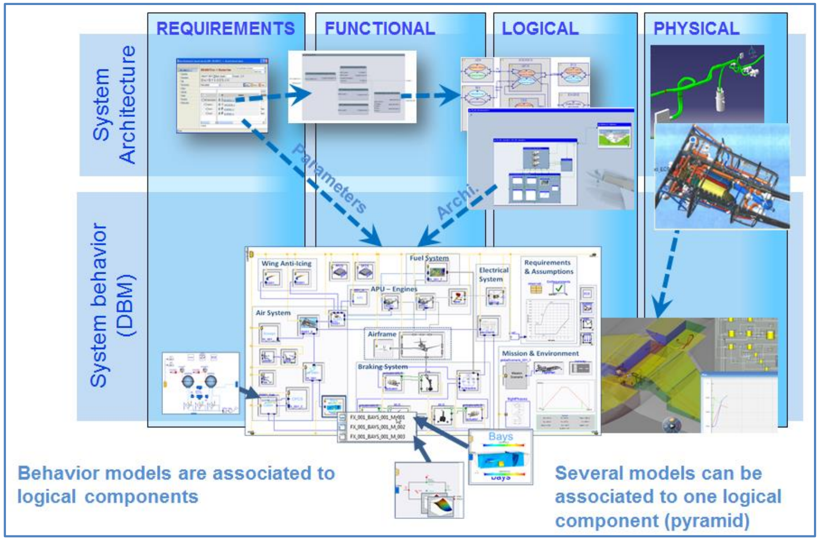


Plateau Objectives

The DASSAV objectives were to:

- **Perform trade-off studies on alternative architectures involving partners**
  - **Manage complex hierarchy of interoperable models**
  - **Evaluate design robustness with respect to risks and uncertainties**
  - **Use exploration techniques considering model fidelity variability**
- **Improve the design process of complex systems**
- **Develop interactive capabilities for decision making**

Next Business Jet



Trade-off components in TOICA

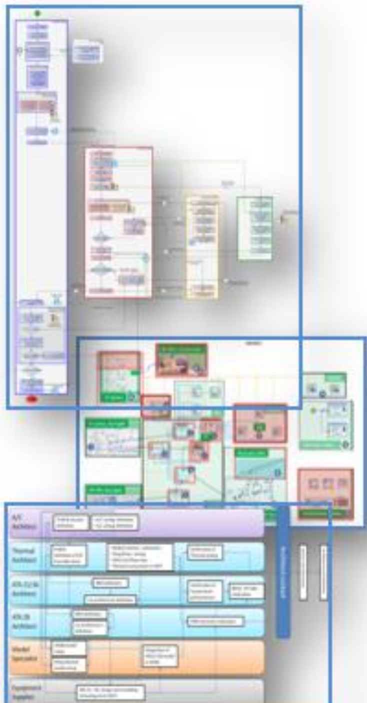
Thermal Overall Integrated Concept Aircraft

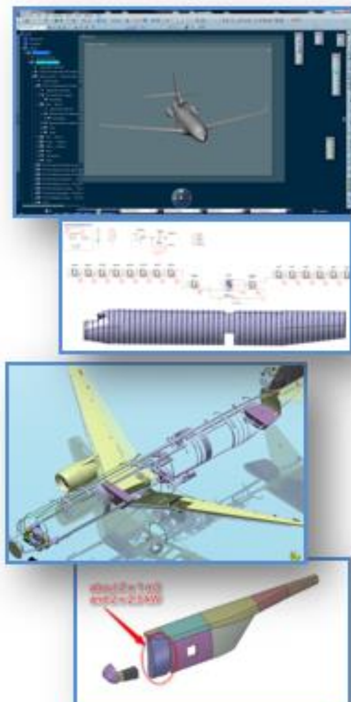
PROCESS

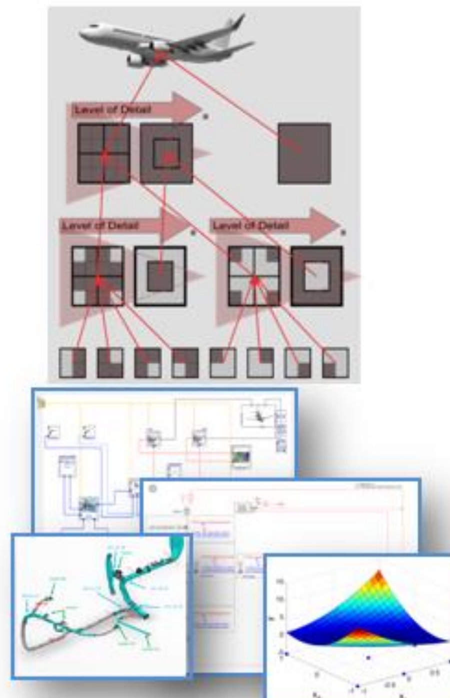
AIRCRAFT DEFINITION

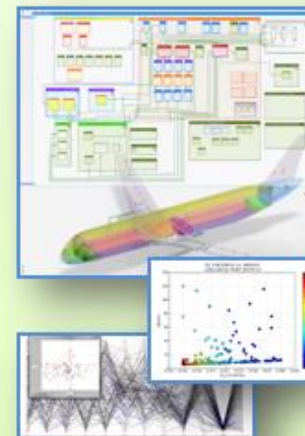
PYRAMID OF MODELS

DRIVERS for CONCEPT SELECTION









Weight
Speci. Fuel Cons.
Reliability
Maintainability
RC / NRC
Schedule
Lead-Time
...

Keep Flexible process
Run from End-to-End

Automate/Parametrise definitions
Links to MBSE Platforms

Adapt complexity
Assemble fastly
Balance accuracy vs uncertainties

DRIVERS for TRADE-OFF SET-UP

The DisPURSAL Project

Bauhaus Luftfahrt
Neue Wege.

>> EC granted approval for a distributed propulsion project

- > Distributed Propulsion and Ultra-high By-Pass Rotor Study at Aircraft Level
- > Framework 7 project, Level-0, Feb 2013 until Jan 2015
- > Coordinated by Bauhaus Luftfahrt e.V., involves partners from the CIAM (Russia), ONERA (France) and Airbus Group Innovations (Germany)
- > Industrial Advisory Board comprises Airbus Group (Germany), MTU Aero Engines (Germany), DLR (Germany) and ONERA (France)

>> *Propulsive Fuselage Concept (PFC)*

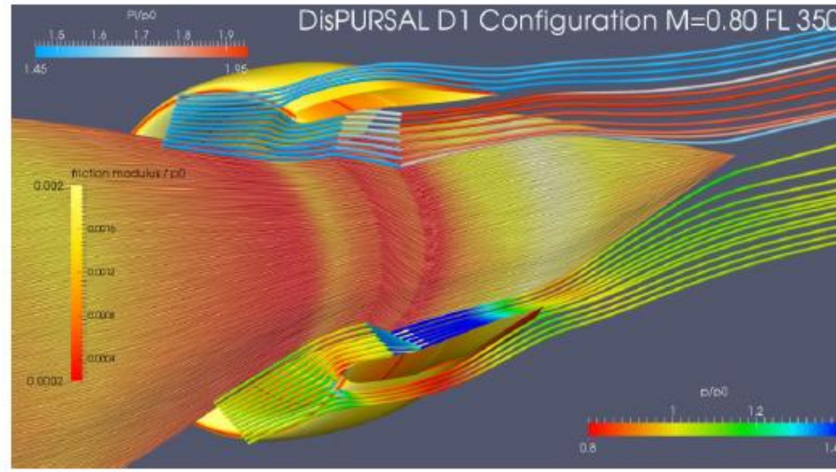
>> *Distributed Multiple-Fans Concept (DMFC)*

Bauhaus Luftfahrt Neue Wege. ЦИАМ AIRBUS GROUP INNOVATIONS ONERA THE FRENCH AEROSPACE LAB

DLR AIRBUS GROUP MTU Aero Engines

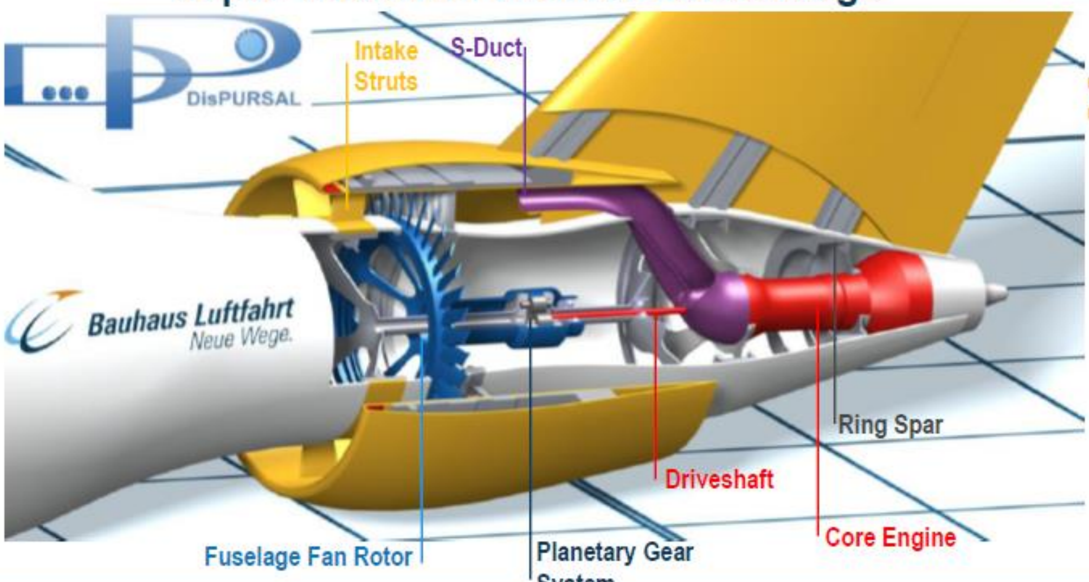
PFC – Aero-Airframe Numerical Analysis and Power-Train Design

Bauhaus Luftfahrt
Neue Wege.



>> Aero-Airframe Analysis

- > Sensitivity studies conducted w.r.t. aerodynamic/engine operating conditions, and engine fan diameter
- > Shroud design needs to be performed with great attention, i.e. avoid local super-velocities and nozzle blockage



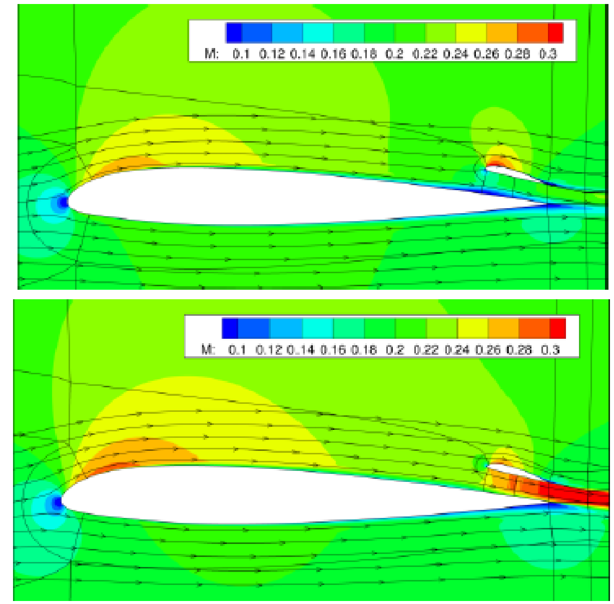
> Power Supply & Transmission

- > Single rotating Fuselage Fan device
- > Shrouded for noise and tail-scrape
- > Powered via LP-spool and planetary reduction gear system
- > Core intake supplied by eccentrical swan-neck duct aft of FF rotor plane

DMFC – Aero-Airframe Numerical Analysis and Power-Train Design

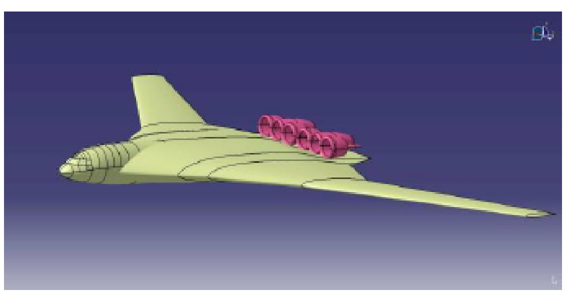
>> Aero-Airframe Analysis

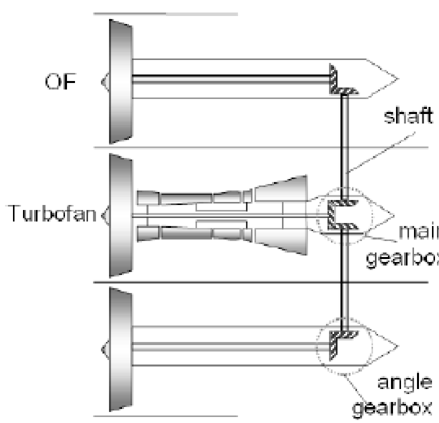
- > Appropriate aircraft body contouring and alignment of nacelle tilt is at a premium in avoiding super-velocities
- > Increase in FPR has a significant impact on local Mach, thereby, lift and boundary layer thickness



>> Power Supply & Transmission

- > Core driven by 2 fans on either side
- > Relative positioning between core/fans chosen to minimize axial loading
- > Mechanical gearing losses are 2%; heat generation requires dedicated thermal regulation and control system





European Commission

Safety

✈ MISSA (FP7-2007-212088)

MISSA focused on Modelling, Analysis and Optimization and delivered capabilities at the 3 Aircraft Systems Development Levels,

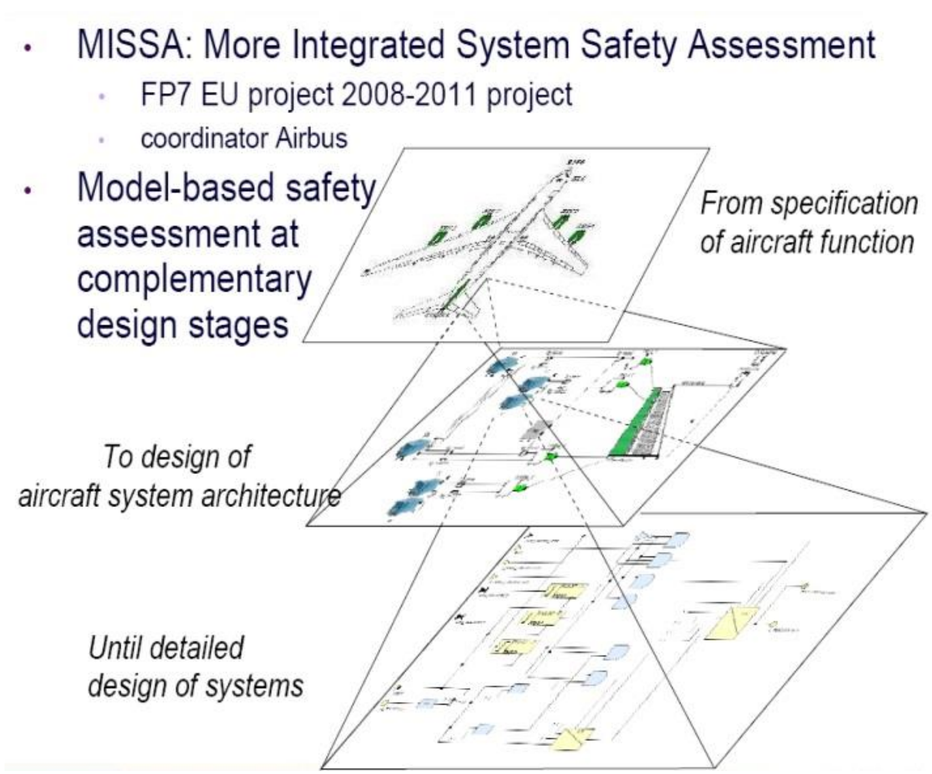
- Aircraft level

- Systems Architecture level

- Systems Implementation level

as well as across the levels to consider transverse themes such

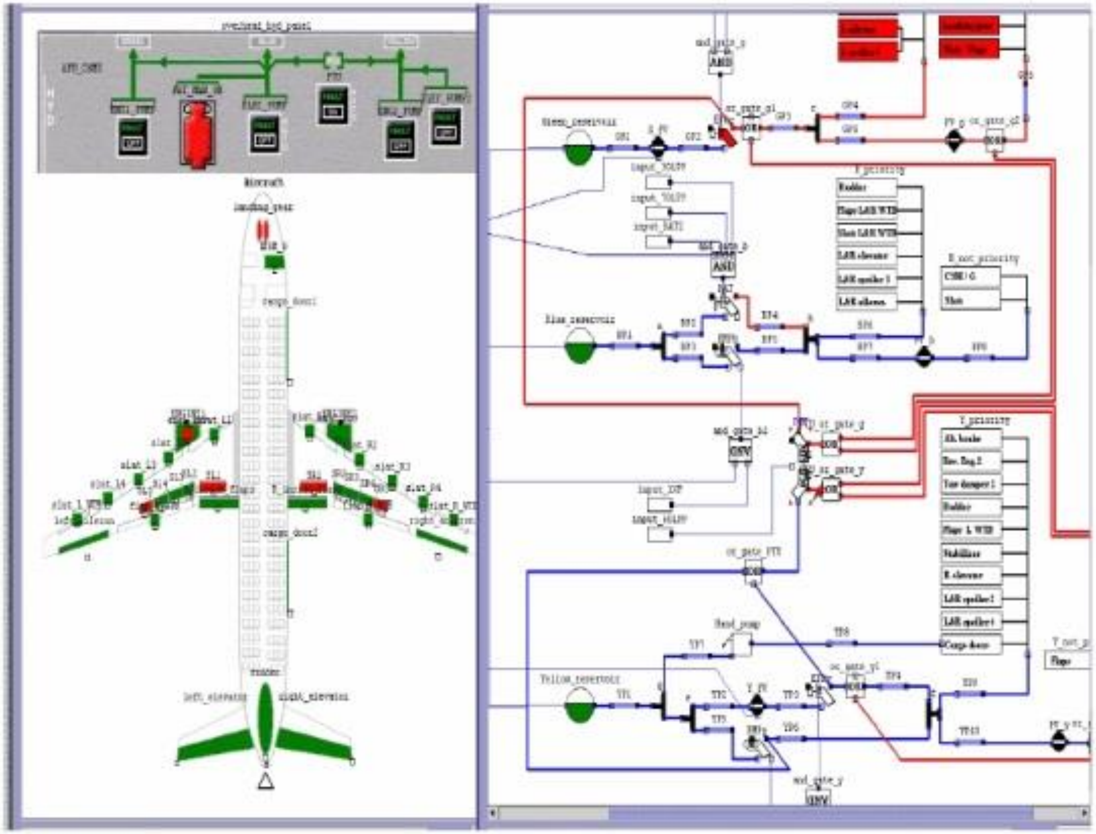
- **Evidence Synthesis**
- **Safety Argumentation and**
- **Change Control**



European Commission

Example: AltaRica model of A320 like hydraulic system made with OCAS (Dassault tool)

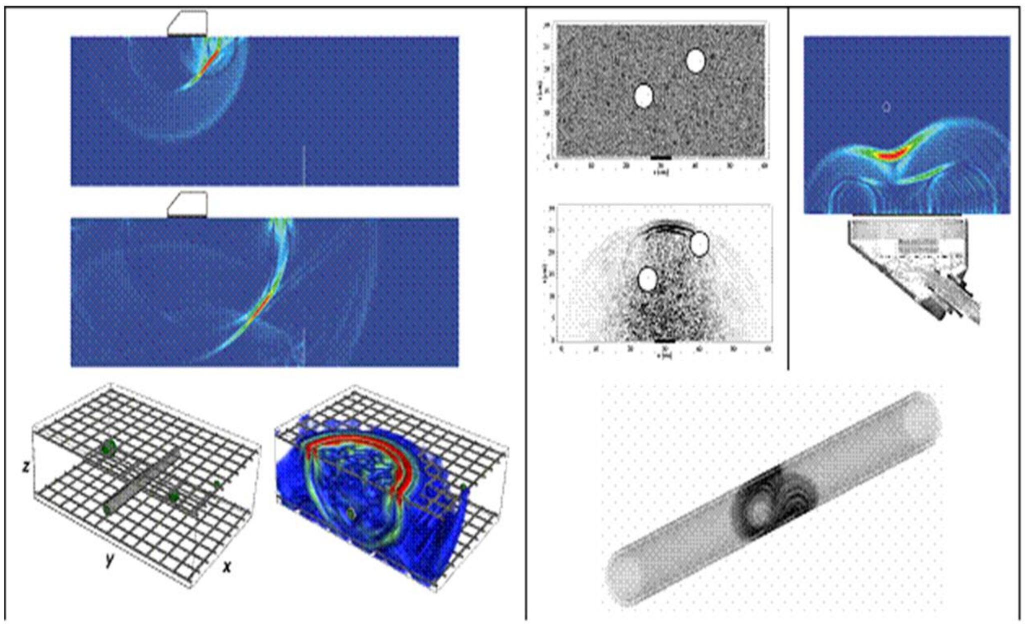
- Graphical view of the model: very useful for interactive simulation

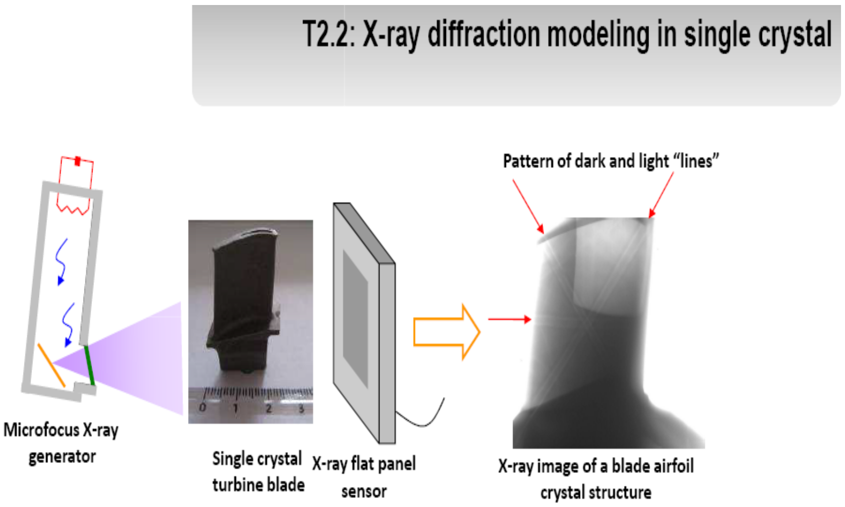


ONERA
THE FRENCH AEROSPACE LAB

✈ PICASSO (FP7-AAT-2007-RTD-1)

- increase the accuracy, and reduce the cost of, a Probability of Detection campaign with NDT simulation techniques
- improve damage tolerance requirements with higher knowledge and accuracy on NDT inspection PODs

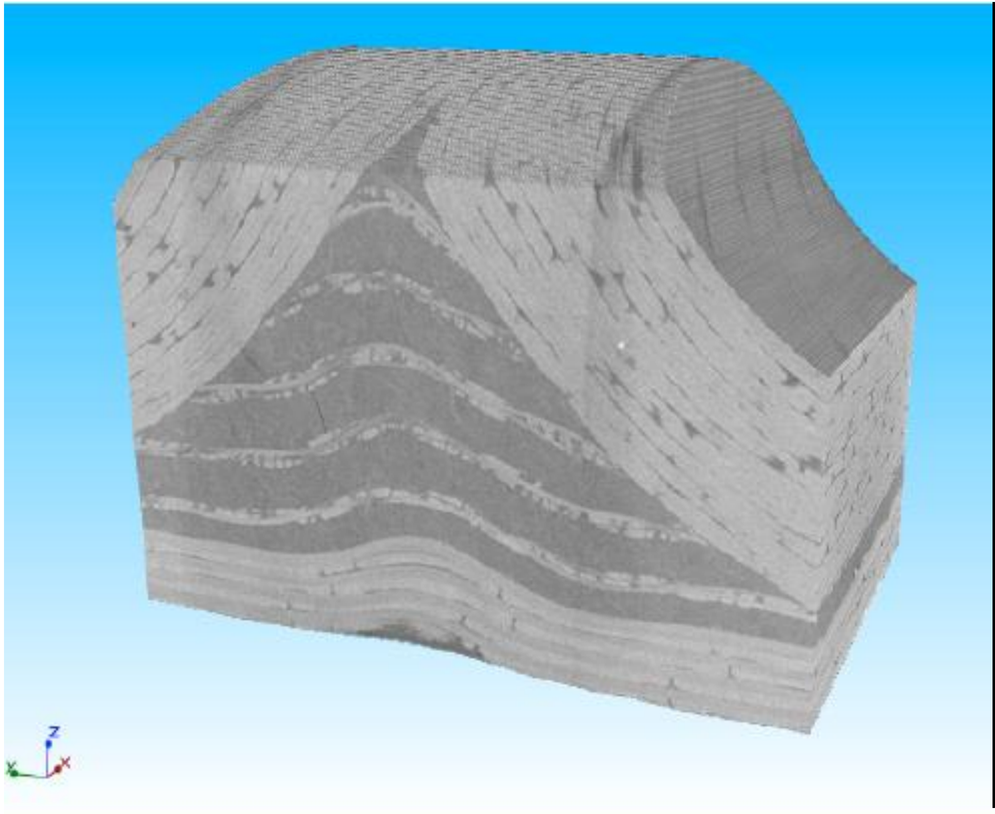


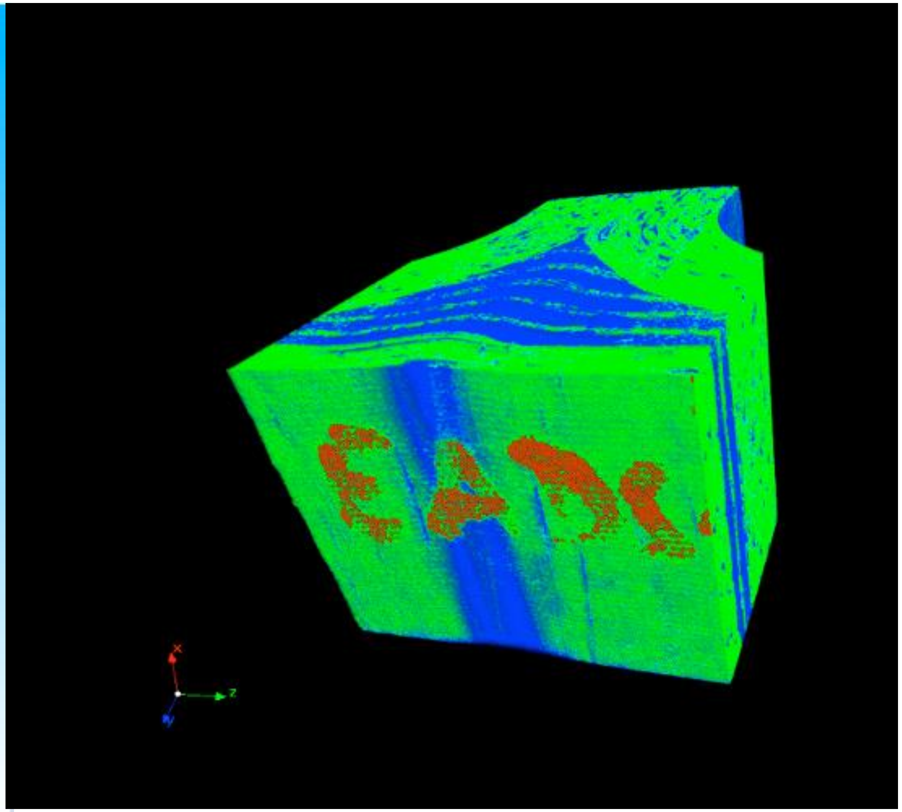


Examples of various elastic wave propagation problems calculated by the numerical EFIT code.

✈ QUICOM (FP7-AAT-2012-314562)

develops further 3D X-ray computed tomography (XCT) non-destructive characterization of small high volume CFRP parts, composite metallic parts, complex and large CFRP parts.





- **New Challenges in Aviation Safety Regulations & Certification Process**

→ Design, Manufacturing and Supply Chain are evolving rapidly
→ More Integrated Multifunctional Structures & Systems
→ Virtual Certification
→ Aircraft Software
→ UAS
→ Security threats
→ Counterfeit products

→ …. and many more highlighted in SRIA vol. 2

"Moving towards performance based regulation,
based upon agreed safety performance in combination with
risk based approach to standardization,

... significant improvements in the way safety risks are controlled"

→ Analysis of existing regulations and certification processes
→ Definition and evaluation of innovative certification approaches
→ Framework Safety Performance Indicators

July 2001

European Aeronautic Science Network
E A S N

- **Background:**

- Universities play an important role in the qualification of future engineers and in the performance of basic research for aeronautics
- Aeronautics industry and research establishments are
in their co-operation.
- On the university level the organisation and co-operatic
improved, their participation in European aeronautics a
often on a case to case basis

- **Motivation:**

- Develop co-operation structures that will improve the p
universities as the third major sector in the aeronautics
activities in Europe,
- Creation of a European aeronautics science network

European Aeronautic Science Network
E A S N

EASN Network

- ***Network Partners:***
  - Cranfield University, College of Aeronautics (Co-ordinator)
  - Technische Universität Munich, Institut für Luft- und Raumfahrt
  - ENSMA Ecole Nationale Supérieure de Mécanique et d´Aérotechnique
  - Chalmers University of Technology, Gothemburg
  - University of Patras / Greece
  - Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)

- ***Duration:*** *3 years*
- ***Start:*** *1st September 2001*
- ***Budget:*** *521.385 €*

European Commission
Research Directorate General

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FLOMANIA – A European Initiative on Flow Physics Modelling

Results of the European-Union funded project, 2002 – 2004

Werner Haase, Bertrand Aupoix, Ulf Bunge, Dieter Schwamborn

European Commission
Research Directorate General

TRANSAERO

NOTES ON NUMERICAL FLUID MECHANICS AND MULTIDISCIPLINARY DESIGN · VOLUME 79

TRANSAERO – A European Initiative on Transient Aerodynamics for Railway System Optimisation

Burkhard Schulte-Werning
Rémi Grégoire · Antonio Malfatti
Gerd Matschke (Eds.)

Community Research
in Railway Technology

Comission of the European Communities
Directorate General XII
Science, Research and Development

Notes on Numerical Fluid Mechanics

Volume 42

EUROVAL – An European Initiative on Validation of CFD Codes

Edited by Werner Haase
Frans Bradsma
Eberhard Elsholz
Michael Leschziner
Dieter Schwamborn

Report
on Community Research

Piet Christof Wölcken
Michael Papadopoulos *Editors*

Smart Intelligent Aircraft Structures (SARISTU)

Proceedings of the Final Project Conference

SARISTU

Springer

European Commission
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NOTES ON NUMERICAL FLUID MECHANICS AND MULTIDISCIPLINARY DESIGN · VOLUME 103

DESider – A European Effort on Hybrid RANS-LES Modelling

Results of the European-Union Funded Project, 2004–2007

ADIGMA – A European Initiative on the Development of Adaptive Higher-Order Variational Methods for Aerospace Applications

Results of a collaborative research project funded by the European Union, 2006–2009

Norbert Kroll Heribert Bieler
Herman Deconinck Vincent Couaillier
Harmen van der Ven
Kaare Sørensen (Editors)

On behalf of the H3 team, thank you for your attention

http://ec.europa.eu/transport/research/index_en.htm

http://ec.europa.eu/research/horizon2020