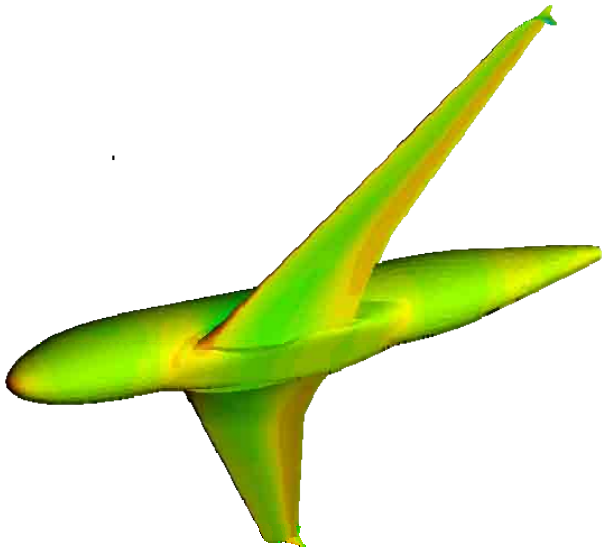
Overview of Polish Research Sector – Achievements and Capabilities

Jacek Rokicki
Department of Aerodynamics
Institute of Aeronautics and Applied Mechanics
Warsaw University of Technology

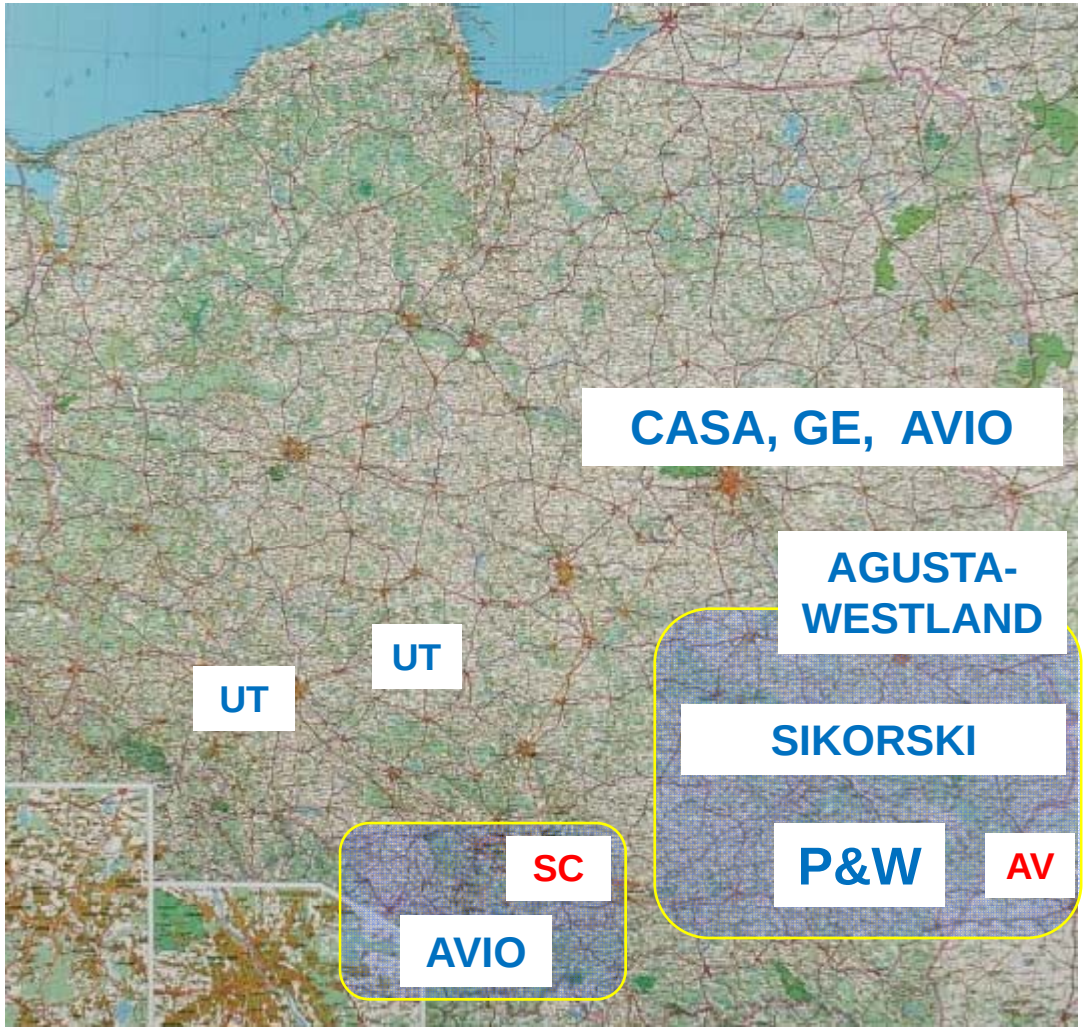
Polish Aeronautical Technology Platform
Head of the Group preparing
National Strategy for Research in Aviation



AGENDA

- Industry in Poland
- Research areas
- Assets and Challenges
- Strategic priorities

Aeronautic Industry in Poland



AV = Aviation Valley

SC = Silesian Cluster

Margański & Mysłowski

ZAKŁADY LOTNICZE Sp. z o.o.

Em 11 C "Orka"

AERO AT Sp. z o.o.

AT-3

Bogumił Bereś

B Biuro Projektowe

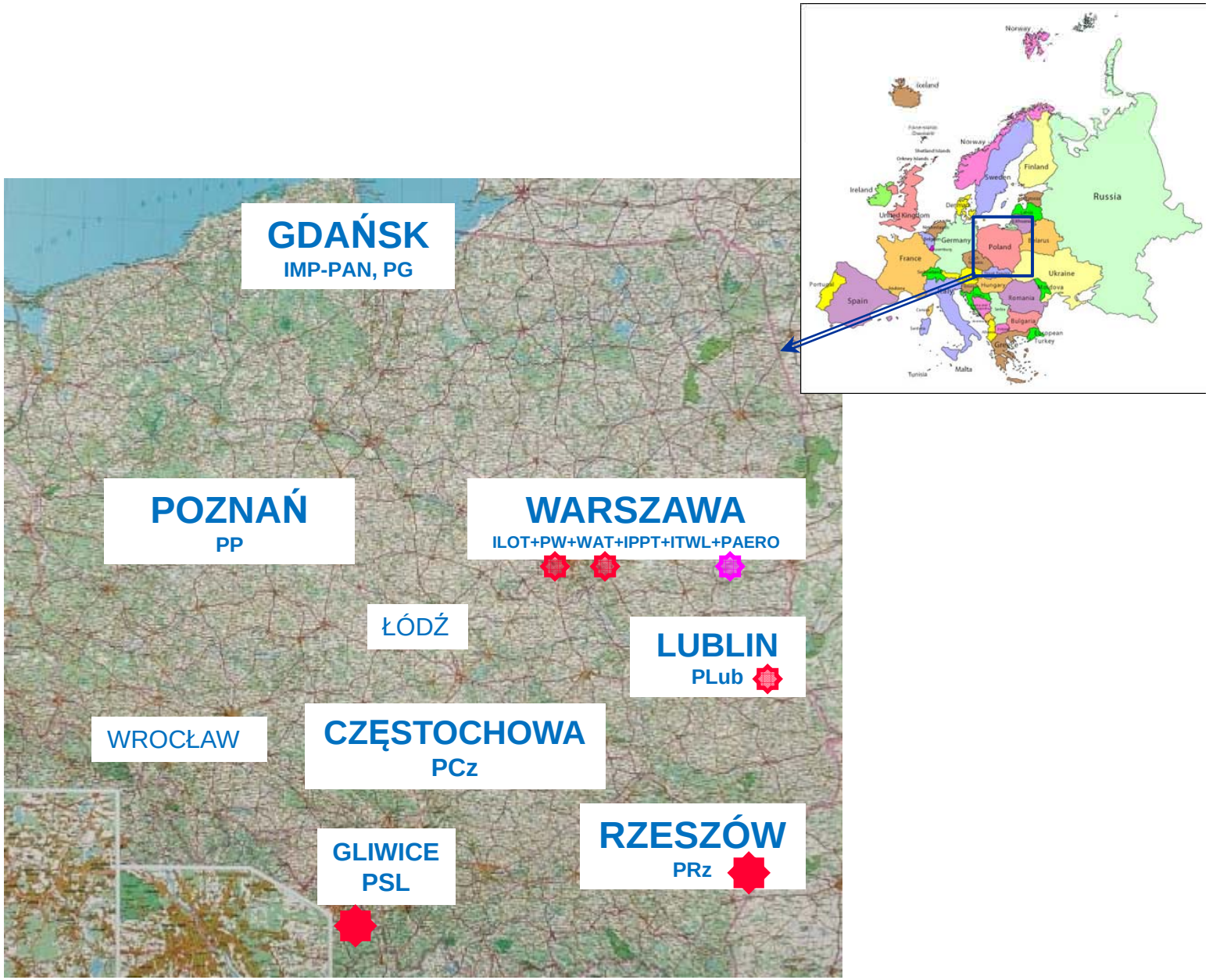
Diana 2

Metal-Master

Samonit

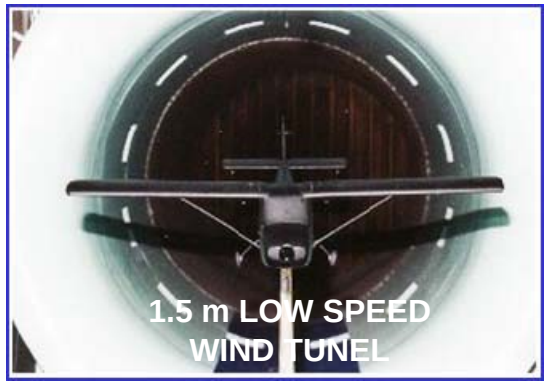
Research

- Main universities and research establishments
- Civilian institutions (without Military University of Technology, Airforce Institute of Technology)
- Flight physics, structures, materials, avionics, manufacturing
- Projects (eu)

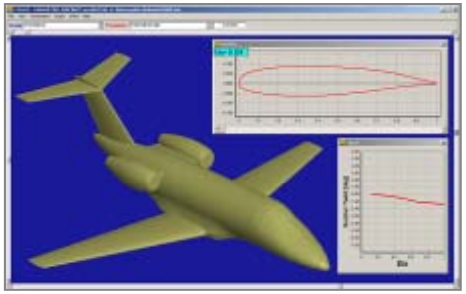

GDAŃSK
IMP-PAN, PG
POZNAŃ
PP
WARSZAWA
ILOT+PW+WAT+IPPT+ITWL+PAERO
ŁÓDŹ
LUBLIN
PLub
WROCŁAW
CZĘSTOCHOWA
PCz
GLIWICE
PSL
RZESZÓW
PRz
Large new research infrastructure

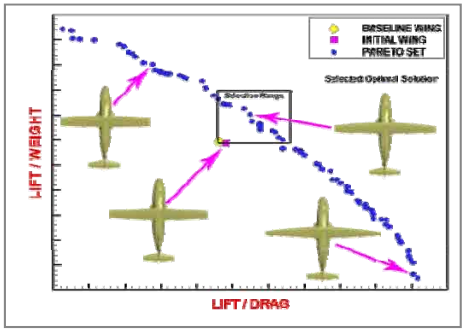
INSTITUTE OF AVIATION

LABORATORIES

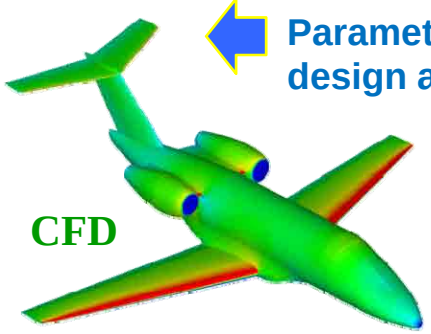


COMPUTATIONAL FLUID DYNAMICS

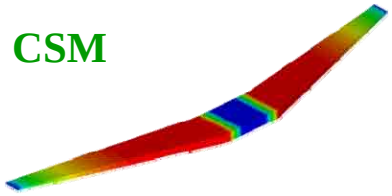




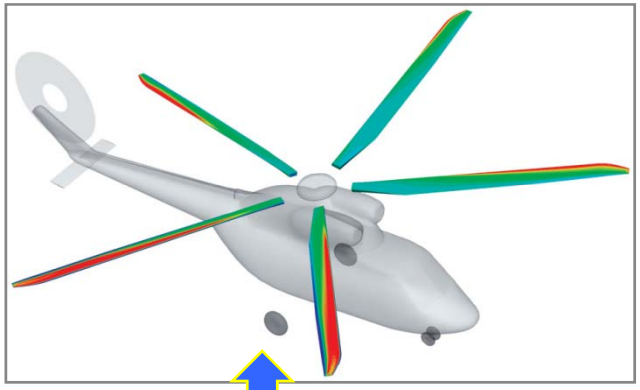
Parametric multidisciplinary design and optimisation



CFD

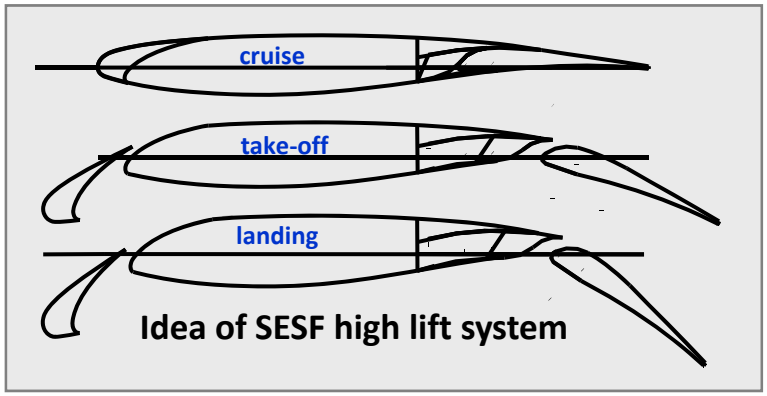


CSM



Flow field analysis

DESIGN



EASA Design Organisation Certificate

Certification Process

- ✓ paper documentation
- ✓ technical requirements
- ✓ technological documentation
- ✓ sheets of compliance
- ✓ operating documentation

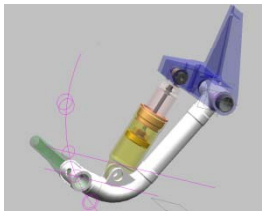
LABORATORIES

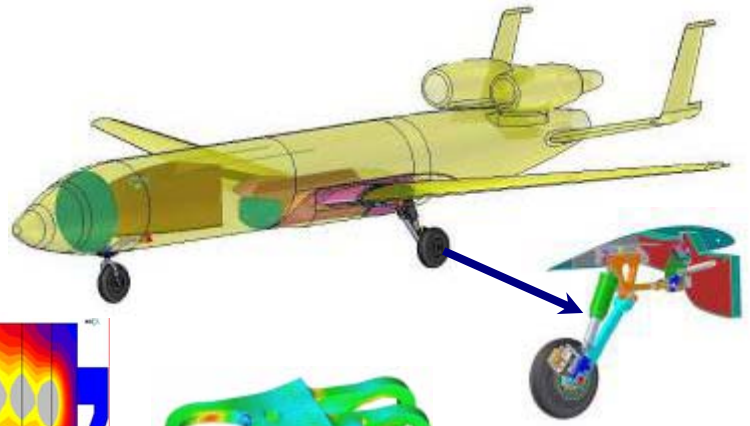
Full tests of aircraft's landing gears according to regulations: FAR, EASA, MIL (completed L/G and subassemblies).

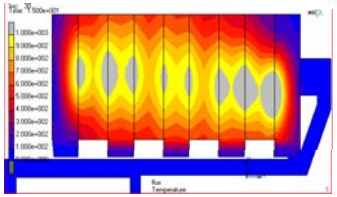
AB 131

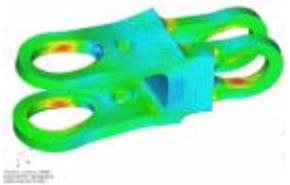
DESIGN AND TESTS

- ✓ Designing
- ✓ Stress analysis
- ✓ Loads analysis
- ✓ Fatigue analysis
- ✓ Thermal analysis









LABORATORIES

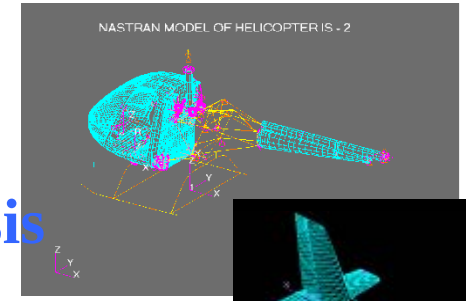
In the laboratory performed all the certification tests of composite aircraft I-23

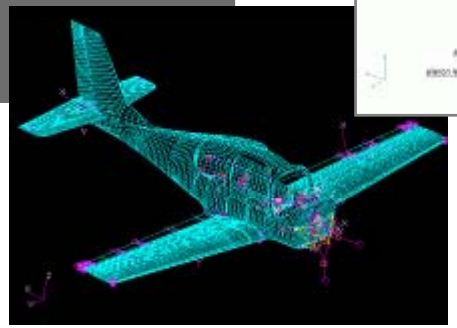

The static tests stand


The ground vibration tests stand

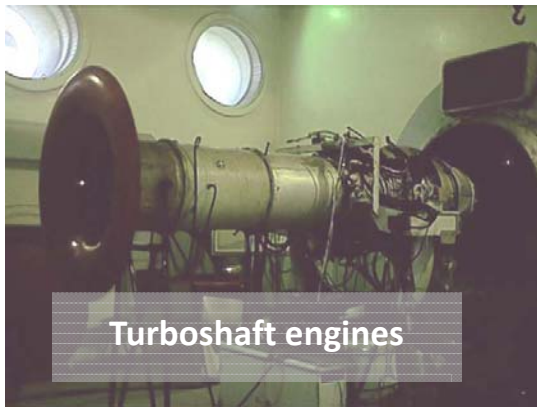
COMPUTATIOL STRUCTURE MECHANICS (CSM)

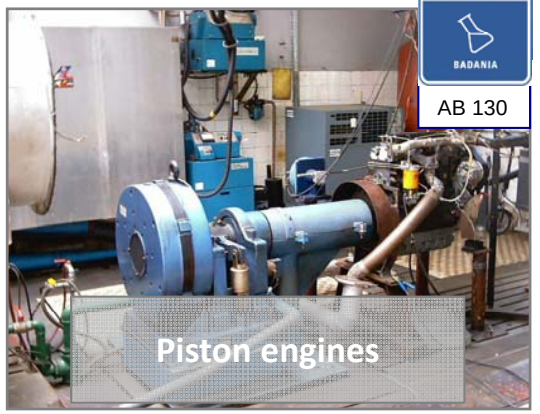
- ✓Design
- ✓Structure analysis
- ✓Aeroelastic analysis
- ✓Flatter analysis





LABORATORIES

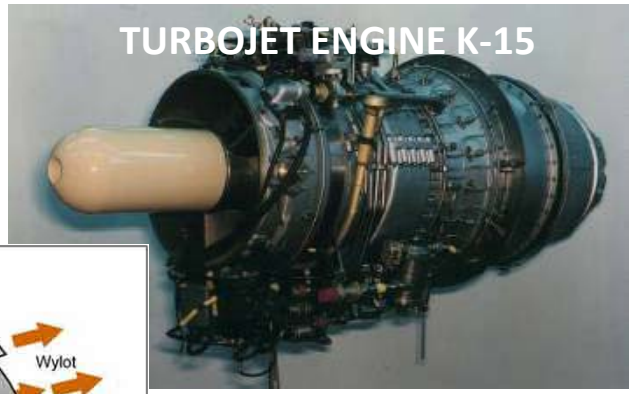


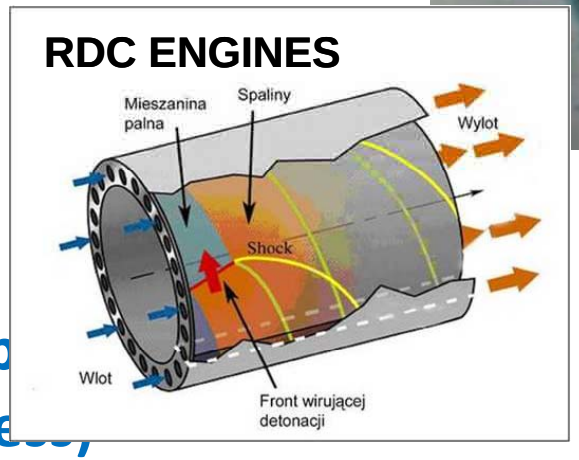


AB 130

RESEARCH

- ✓ Combustion process
- ✓ Emissions
- ✓ Bio fuels
- ✓ Long term tests
- ✓ Specialized test b
  (leak, leak tightne





EUROPEAN PROJECT PARTICIPATION

- Innovative Aerodynamic High Lift Concepts - HELIX
- High Reynolds Number Tools and Techniques for Civil Transport Aircraft Design - HiReTT
- Technology Development for Aeroelastic Simulations on UnStrUctured GridS - TAURUS

- ADaptive LANDing Gears for Improved Impact Absorption – ADLAND
- Environmentally Friendly High Speed Aircraft - HISAC
- Cost-Effective Small Aircraft – CESAR
- European Personal Air Transport System – EPATS
- Safe autOmatic Flight back and lendIng of Aircraft – SOFIA
- Smart Maintenace of Aviation Hydraulic Fluid Using an On-board Monitoring and Recording System - SUPERSKYSENCE

- Guidelines for Cooperation between EU and LA in Aeronautics and Air Transport Research – CoopAIR
- Aeorcapture for Future space transportation – AEROFAST
- Green Adavnced Space Propulsion – GRASP
- Air Cargo Technology Roadmap - Cargo Map
- Multi-level Embedded Closed-Loop Control System for Fluidic Active Flow Control Actuation Applied in High-Lift and High-Speed Aircraft Operations ESTERA
- Radition –Shapes Thermal Protection Investigations for Hight Speed Earth Re-entry - RaSTas SpEaR
- Small Air Transport - Roadmap – SAT-Roadmap
- Efficient Systems And Propulsion For Small Aircraft – ESPOSA
- Basic wind tunnel investigation to explore the use of Active Flow Control technology for aerodynamic load control – STARLET

Projects & Partners

Lublin University of Technology

Faculty of Civil Engineering and Architecture
Department of Solid Mechanics
(prof. T.Sadowski)

FP7 – REGPOT – 2009-1, project No 245479

“Centre of excellence for modern composites applied in aerospace and surface transport”

- Project co-ordinator – T.Sadowski
- Centre of Excellence for Modern Composites Applied in Aerpospace and Surface Transport Infrastructure
- 11 EU partners
- Period: 1.04.2010 –
- 31.03.2013
- Activities: modelling and experimental testing of composite materials
- Funds: 2 560 000 EUR

aerospace – inteligent composites

surface transport infrastructure – asphalt degradation

Rzeszow University of Technology

Faculty of Mechnical Engineering and Aeronautics (FMEA)
Faculty of Electrical Engineering and Informatics (FEEI)
Faculty of Chemistry (FCh)
Faculty of Mathematics and Appllied Physics (FMAP)
Faculty of Civil and Environmental Engineering (FCEE)

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

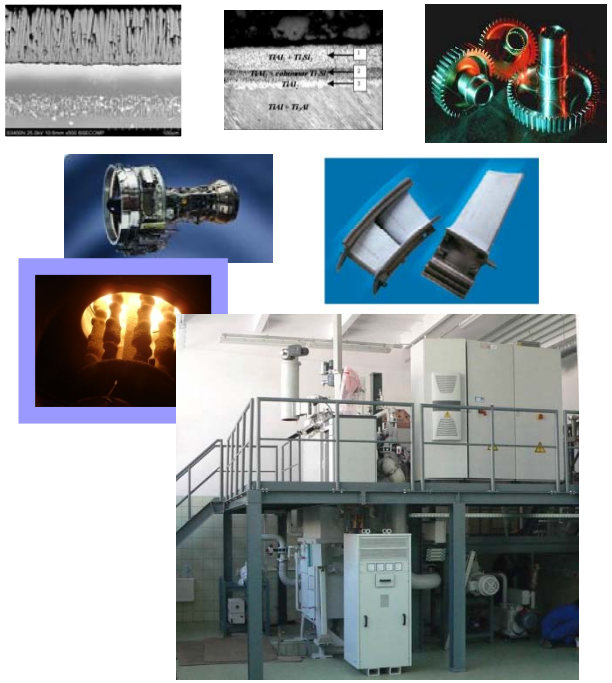
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FOUND

MODERN MATERIAL TECHNOLOGIES IN AEROSPACE INDUSTRY
2008 - 2013

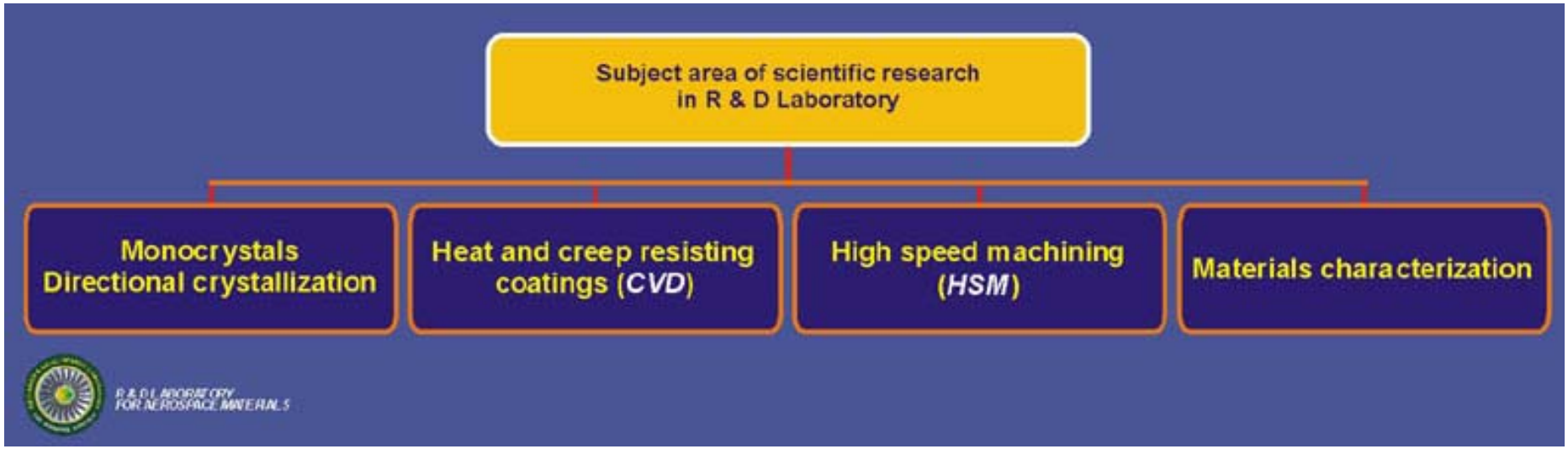
INDIVIDUAL KEY PROJECT (STRUCTURAL FUNDS)
OPERATIONAL PROGRAMME „INNOVATIVE ECONOMY”
Priority 1. **Research and development of modern technologies**
Measure 1.1. **Support of scientific research for the knowledge-based economic development**
Submeasure 1.1.2. **Strategic programmes of scientific research and development**

- *Scientific partners*
- Rzeszow University of Technology – coordinator
- Czestochowa University of Technology – partner
- Lublin University of Technology – partner
- Lodz University of Technology – partner
- Silesian University of Technology – partner
- Warsaw University of Technology – partner
- University of Rzeszow – partner
- Institute of Aviation – partner
- Institute of Fundamental Technological Research Polish Academy of Sciences – partner
- The Szewalski Institute of Fluid-flow Machinery Polish Academy of Scinces – partner
- Air Force Institute of Technology – partner
- *Industrial partners*
- Aviation Valley Association (currently 87 members) – partner

Materials Laboratory for aerospace industry



Aeronautics material testing lab – Poland



Silesian University of Technology (SUT)

Institute of Power Engineering and Turbomachinery

DREAM - Validation of radical engine architecture systems

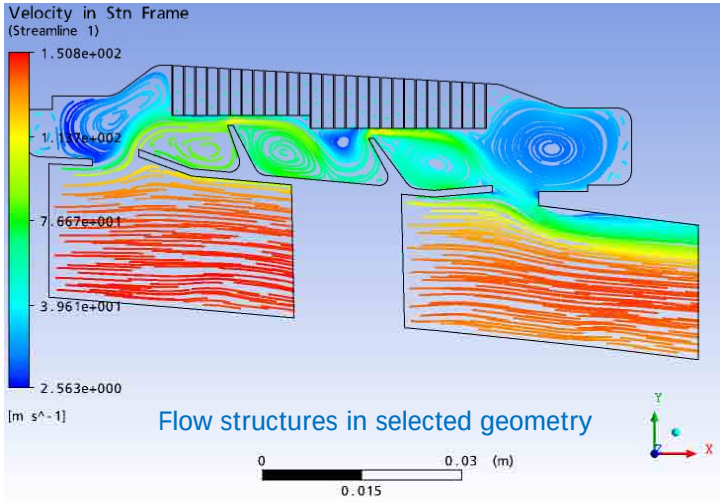
Validation of radical engine architecture systems

- The DREAM consortium, led by Rolls-Royce, is composed of 44 partners from 13 countries
- DREAM will advance technologies devoted to the development of aero engines incorporating contra-rotating open rotors with variable pitch blades, which are known to provide a significant fuel burn reduction, whilst maintaining acceptable noise levels.

SUT in DREAM – SP3, WP3.3

Task leader: Prof. Włodzimierz Wróblewski

- Geometrical configuration optimization of honeycomb top seal for flow rate reduction
- Characterization of flow structures and heat transfer for integrated top seal and cavity above the seal



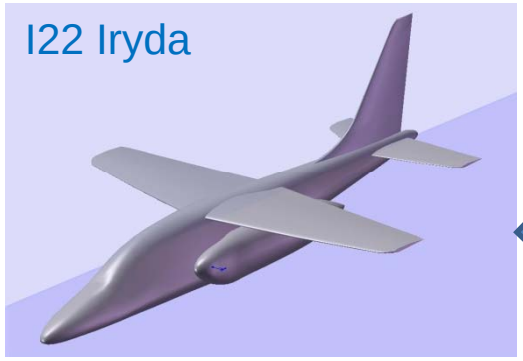
POZNAN UNIVERSITY of TECHNOLOGY

POLITECHNIKA POZNAŃSKA

Virtual Engineering Group
Flutter Laboratory

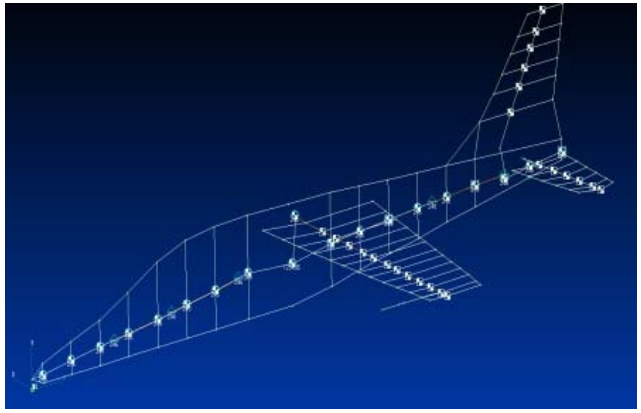
Aeroelastic Simulations

CAD model



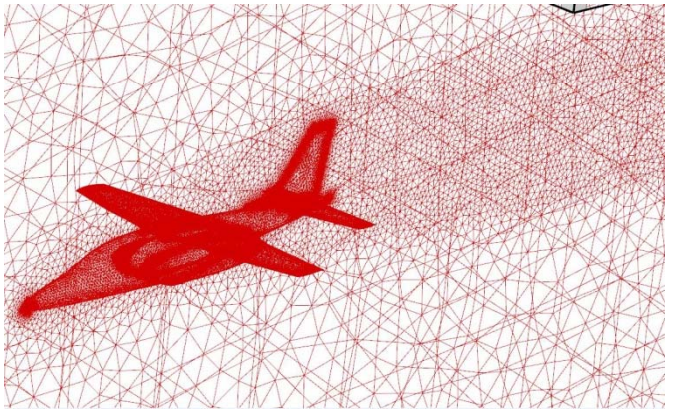
TAURUS, IDIHOM

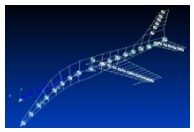
CSM model

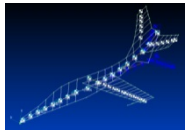


FSI

CFD model







Institute of Fluid Machinery

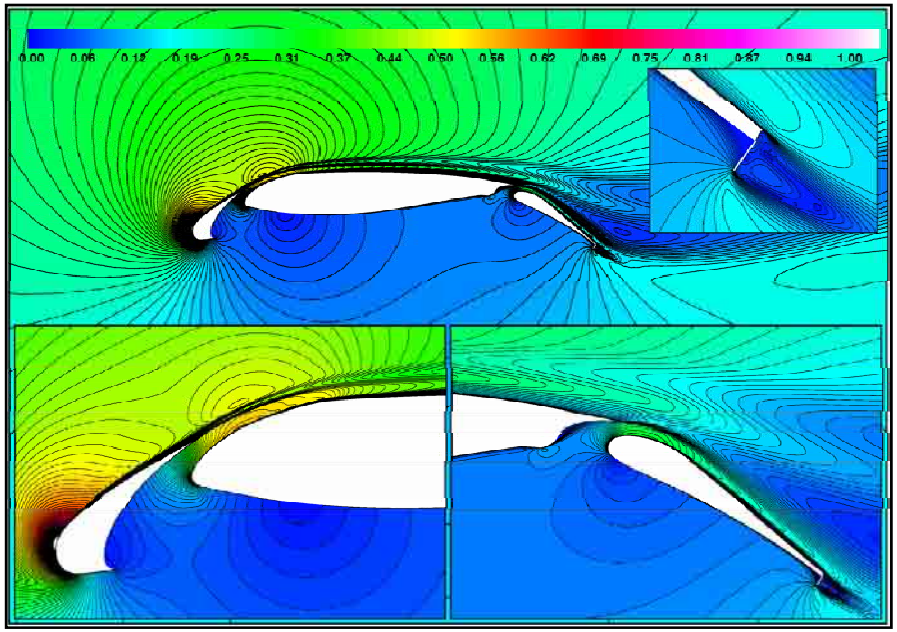
Instytut Maszyn Przepływowych
Polskiej Akademii Nauk, Gdańsk

IMP PAN
GDAŃSK
POWOŁANY W 1956

External flows

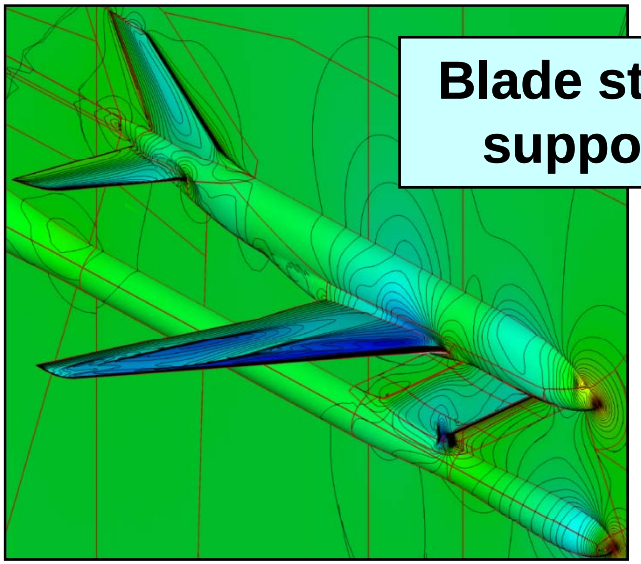
5th FP
HELIX (2001-2005)
Innovative Aerodynamic High-lift Concepts

subcontractor to
Institute of Aviation

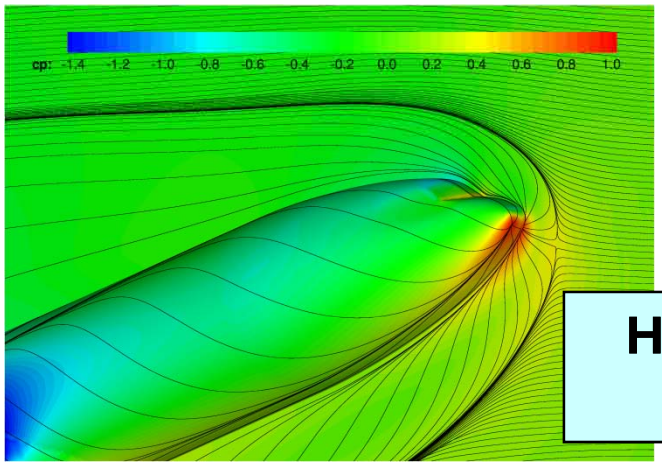


multielement airfoil with Lift Enhancing Tab

6th FP
FLIRET (2005-2008)
Flight Reynolds Number Testing



Blade sting support



Half span model

Coordination of EC project

Unsteady effects of shock induced separation

Objectives of UFAST:

*The **first objective*** of the UFAST project is to provide a comprehensive **experimental data base**

Experiments of "basic"interaction (WP-2)

and with flow "control devices" (WP-3) e.g. perforated walls, sublayer vortex generators, stream-wise vortex generators, synthetic jets, electro-hydrodynamic actuators EHD/MHD

*The **second objective*** - application of recent developments in numerical simulations:

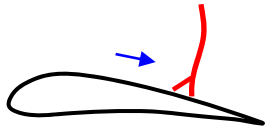
RANS/URANS (WP-4),

hybrid RANS-LES and LES (WP-5).

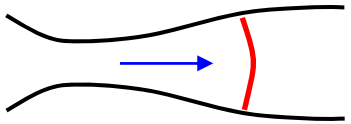
"best-practice guidelines"

*The **third objective***, **improvement in physical understanding** of unsteady effects in shock induced separation

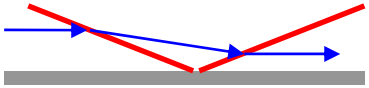
Interaction types considered in UFAST:



Transonic interaction



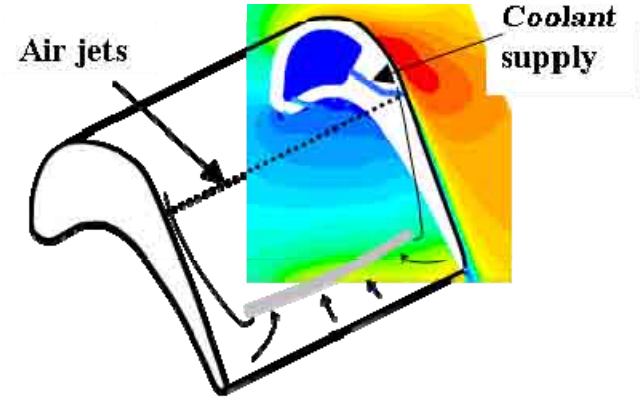
Nozzle flow

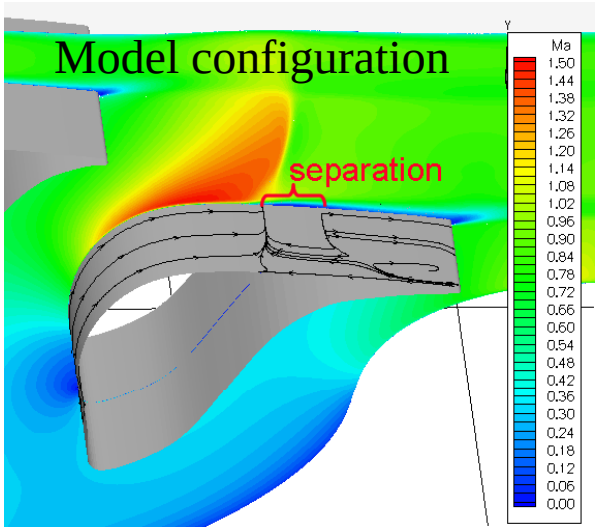


Oblique shock reflection

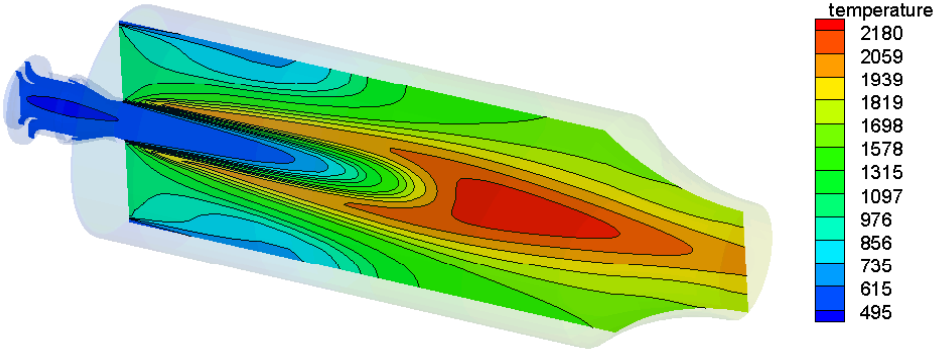
Internal flows

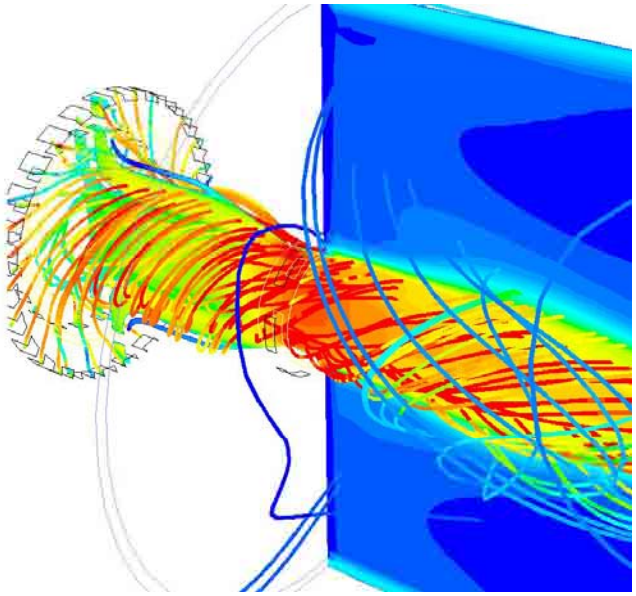
6th FP
AITEB-2 (2005-2009)
Aerothermal invstigation of turbine end walls and blades





6th FP
TLC (2005-2009)
Towards Lean Combustion





Structure Health monitoring

Gamesa Aeronáutica SOCIEDAD UNIPERSONAL ARTIMA

SIXTH FRAMEWORK PROGRAMME
AERONAUTICS AND SPACE

EC Grant FP6–2002–Aero–1 AERO–2002–1.3.2.1.A2; AERO–1.3, ARTIMA (*Aircraft Reliability Through Intelligent Materials Application*) duration: 2005–2008.

NATO OTAN — North Atlantic Treaty Organisation

NATO Grant – ref. CBP.EAP.CLG 98151 (*Preventing disasters from collapse of aircraft structures using vibration–based health monitoring*) duration: 2005–2007.

Structural Health Monitoring in Action

Type of instrument: Specific Support Actions (SSA)

Reference of Call: FP6–2002–Aero–2 (2006-2009).

Specific Programme: Integration and Strengthening the European Research Area. Priority Thematic Area 4: "Aeronautics and Space"

IMP Participation in 7th FP

Participation in existing projects

ERICKA – Engine representative internal cooling knowledge and application
GreenAir - PlasmAero - plasma technology
FACTOR – Full Aero-thermal Combustor – Turbine interaction Research

Participation to submitted proposals (5th call)

TFAST – Transition location effect on shock wave boundary layer interaction

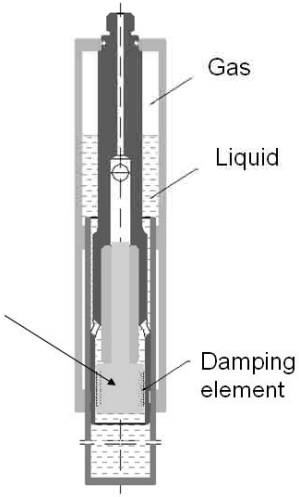
INSTITUTE OF FUNDAMENTAL TECHNOLOGICAL RESEARCH
Polish Academy of Sciences

Department of Intelligent Technologies
(Prof. Jan Holnicki-Szulc)

ADLAND – Adaptive landing gear for improved impact absorption

Piezo-actuated shock absorber and system for impact velocity recognition

Piezo-actuator



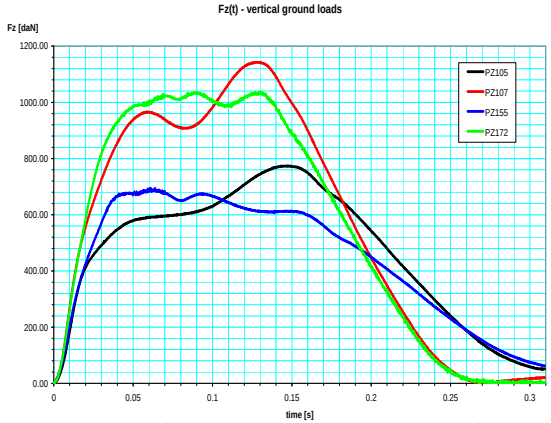
ADLAND

FP6-2002-Aero-1, 2003-2006

System for identification of the pre-touchdown sink speed

First technical application

Efficiency of the solution



Evolution of the vertical touch-down force in time domain.

Legend:

_____ high impact velocity, control off

_____ high impact velocity, control on

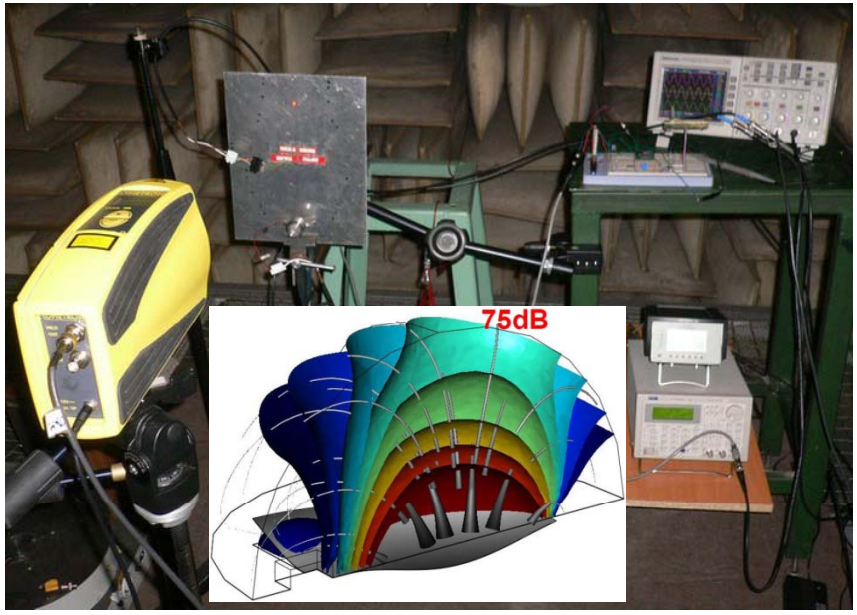
_____ low impact velocity, control off

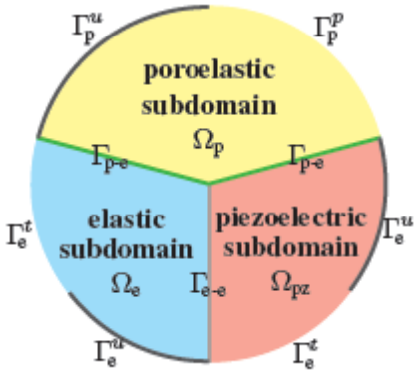
_____ low impact velocity, control on

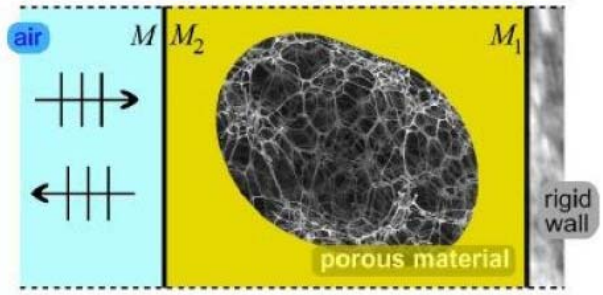
AEROCHINA2 – FP7 Project

Collaboration between Europe and China for the solution of multidisciplinary design problems in aeronautics

- **Techniques for noise reduction in aircraft cabin**: multiphysics modeling and experimentation
- **Adaptive vibroacoustics**: smart technologies and advanced composites



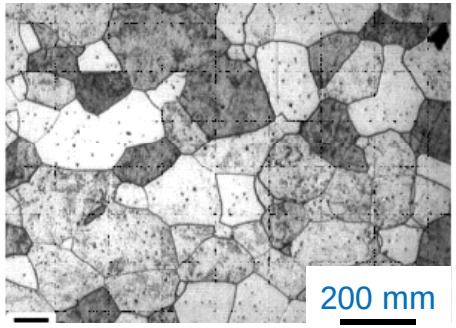




Warsaw University of Technology

Faculty of Materials Science and Engineering
Materials Design Division
(Prof. K.J. Kurzydlowski)

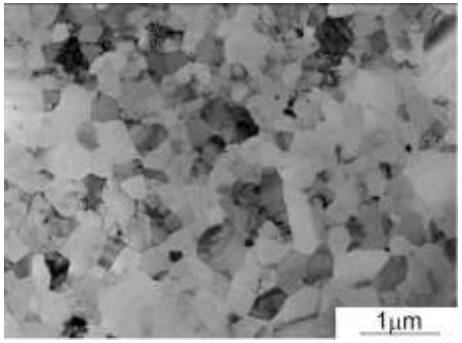
Lightweight structures ultra-high strength metals



Micro-crystalline

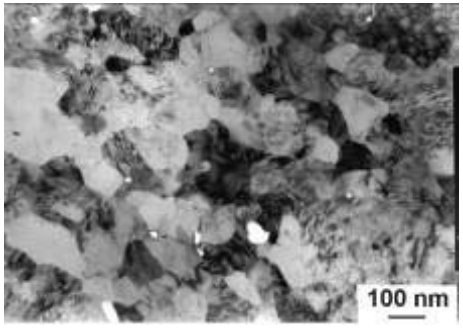
d > 1 mm

- at the Faculty methods of producing nanocrystalline alloys are developed
- such materials possess very high strength, frequently 2-3 times higher than conventional ones



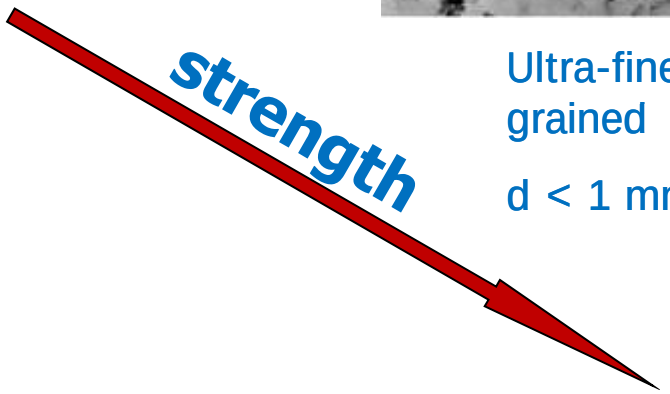
Ultra-fine grained

d < 1 mm

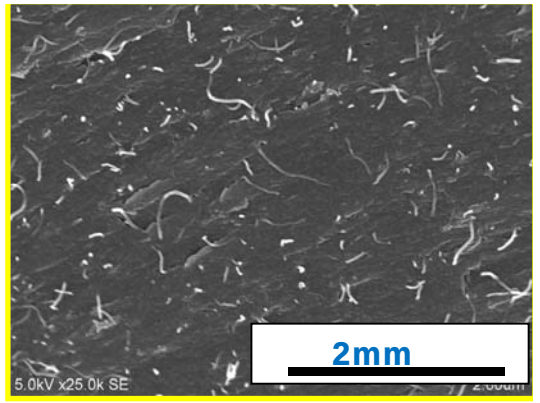


Nano-crystalline

d < 100 nm

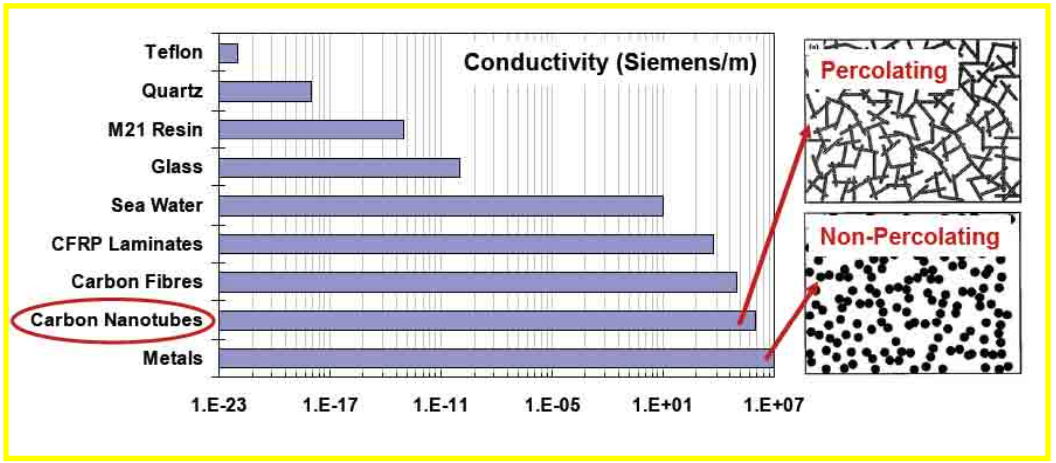


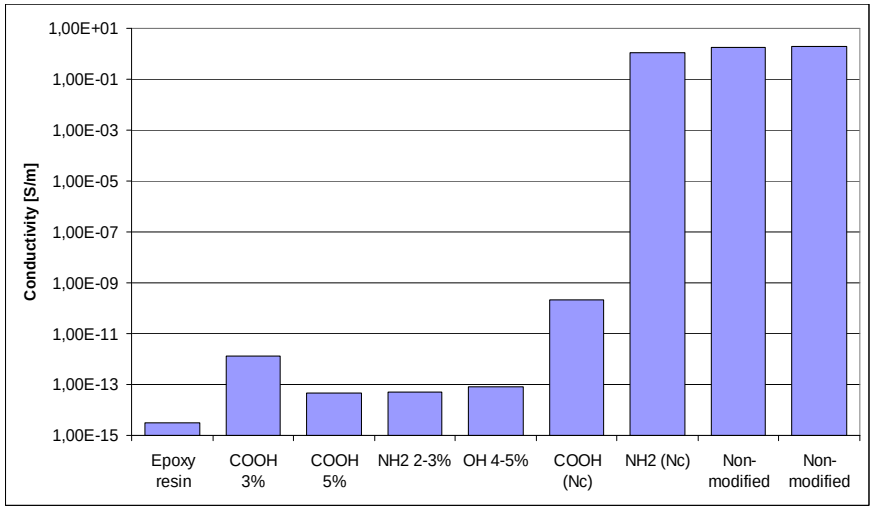
Lightweight structures
Nanocomposites

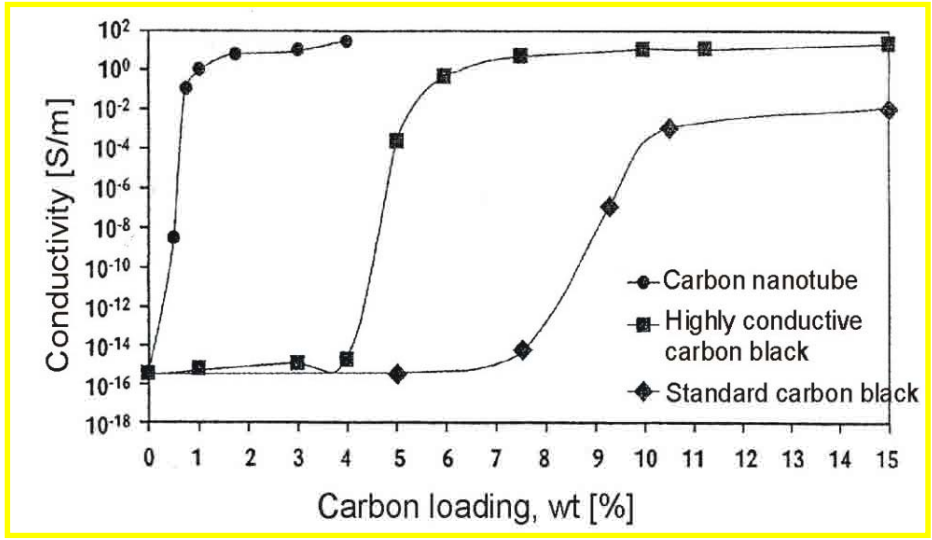


Technolofy of polymer matrix composites reinforced with CNTs has been developed:

- to improve conductivity of polymer composites
- to achieve high mechanical strength



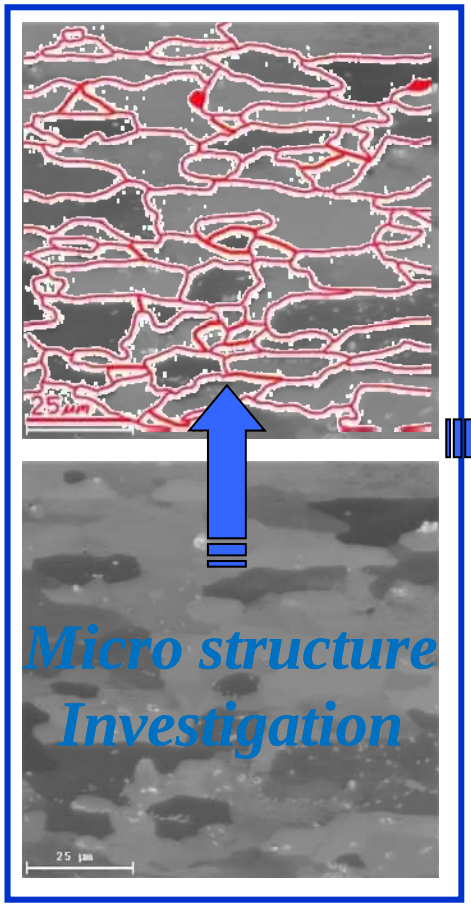


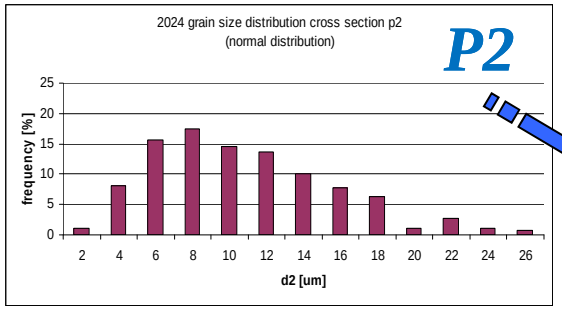


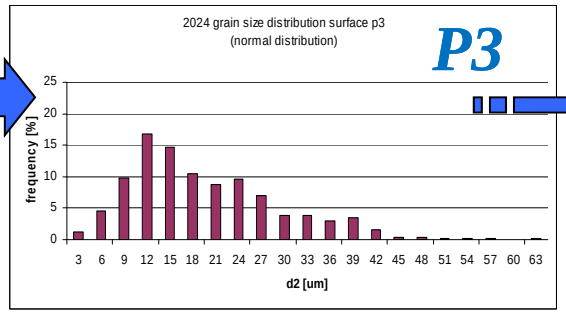
Corrosion resistance of AA2024

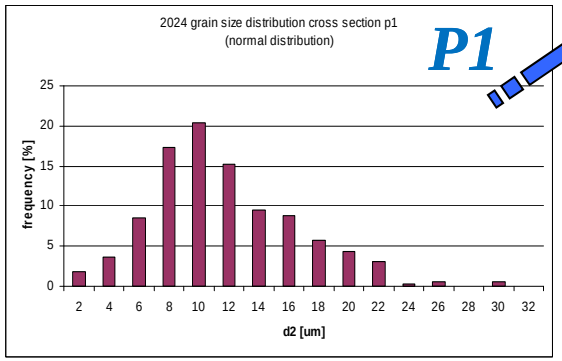
Representative model of the structure was created taking into account its various elements – the model has been used to model corossion of AA2024

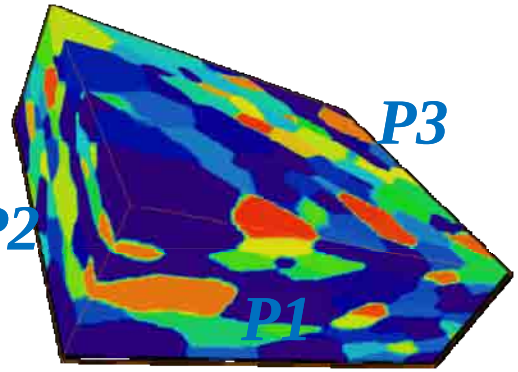
SICOM FP6 Project



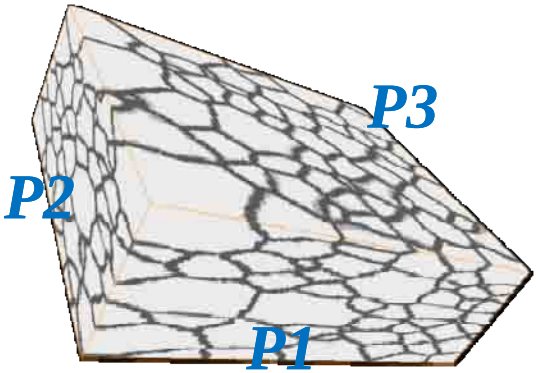








Map of grains orientation



Map of grain boundaries

Warsaw University of Technology

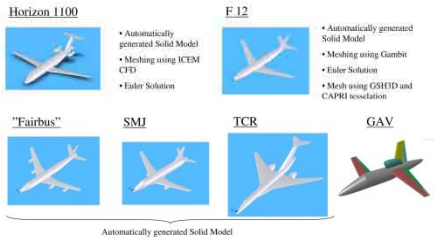
Faculty of Power and Aerionautical Engineering
Institute of Aeronautics and Applied Mechanics

prof. Zdobyslaw Goraj (Aircraft Design)
prof. Janusz Narkiewicz (Systems)
prof. Jacek Rokicki (Aerodynamics)

Warszawa, 22 czerwca 2009

EU PROJECTS

NACRE = "**N**ew **A**ircraft **C**oncepts **RE**search"



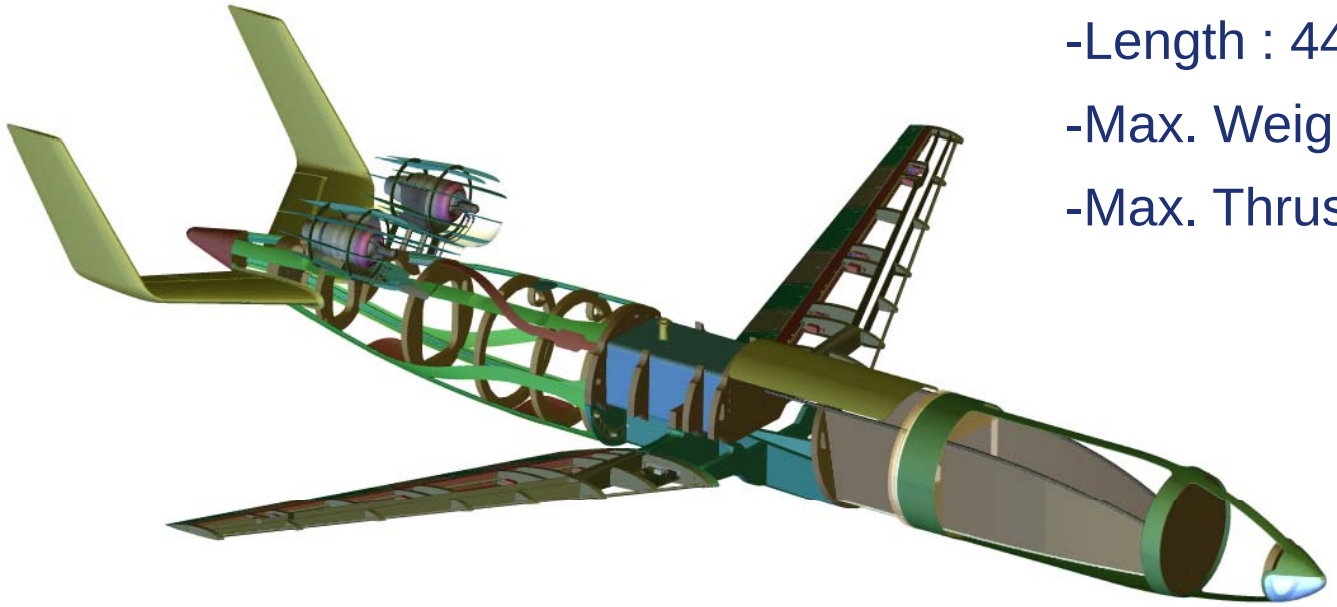
SimSAC: *Simulating Aircraft Stability and Control Characteristics for Use in Conceptual Design*

Unmanned light patrol aircraft

SAMONIT

IEP Design (T 1.4.2)

- Preliminary Design and Detailed design :
  - Modular Flying Platform Airframe



Main characteristics

-Span : 4160 mm

-Length : 4445 mm

-Max. Weight : 100 kg

-Max. Thrust : 400 N

Sizing is based on:

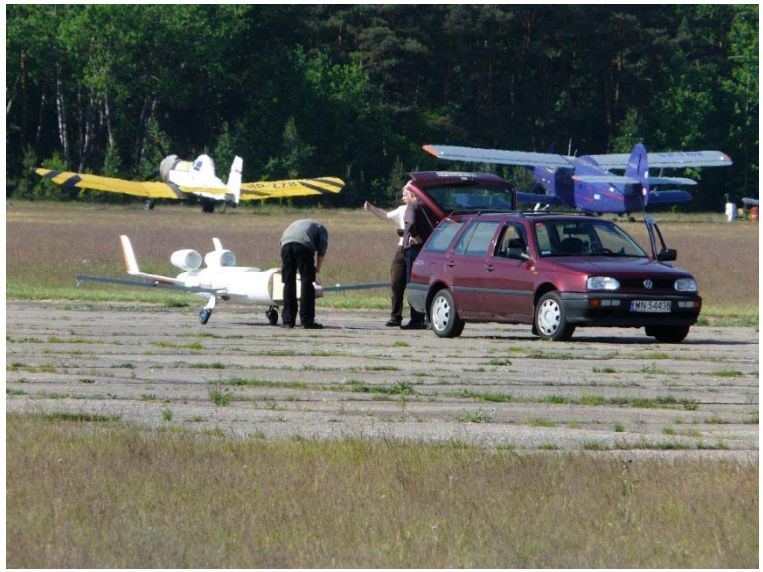
-Froude Similarity

-Operational aspects

-Available engines

  - Modular Flying Platform Systems (FMCS, Autopilot)
  - Ground Segment

Taxi tests, Bemowo, May 2009



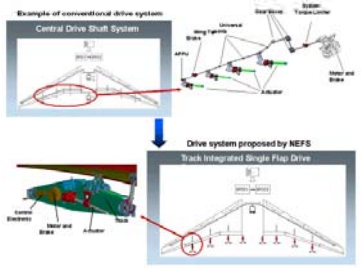
EU 7 FP going

TALOS

Transportable Autonomous Patrol for Land Border Surveillance System

design and implement the UGV navigation system

EU 6 FP going



NEFS

New Track integrated Electrical Single Flap Drive System

develop a comprehensive model of an aircraft (DLR) with integrated model of differential flap system (WUT) to evaluate the functions and performance of an aircraft with differential flap system (DFS)

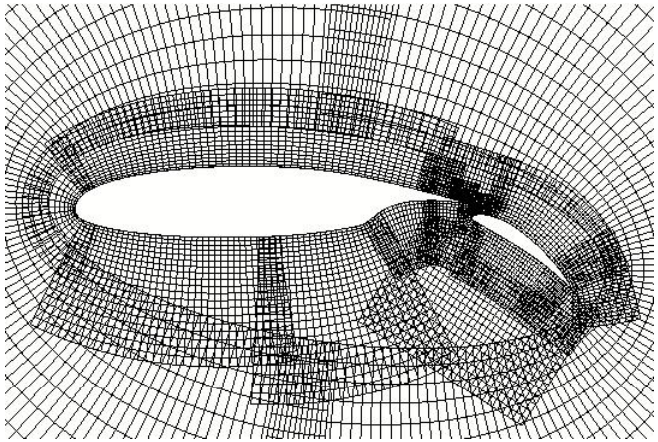
NICE TRIP

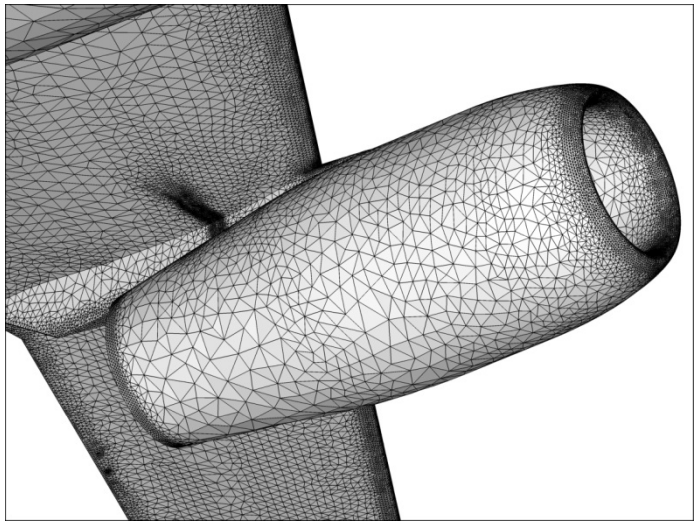
Novel Innovative Competitive Effective Tilt Rotor Integrated Project

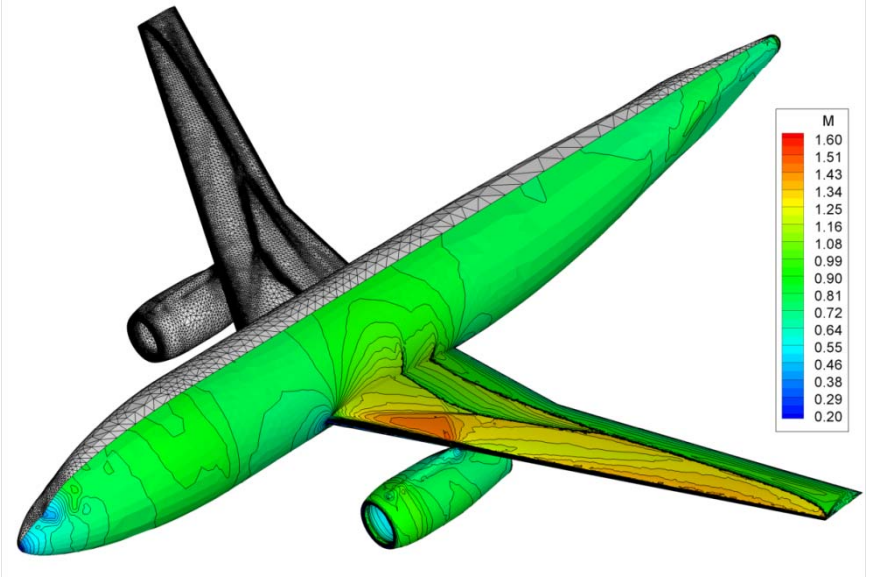
definition of an operational concept of use of the tilt rotor in the European ATM system and definition of an operational scenario for civil tilt rotor applications; tilt-rotor flight control system modeling and simulation (Flightlab and Simulink)

Computational Fluid Dynamics

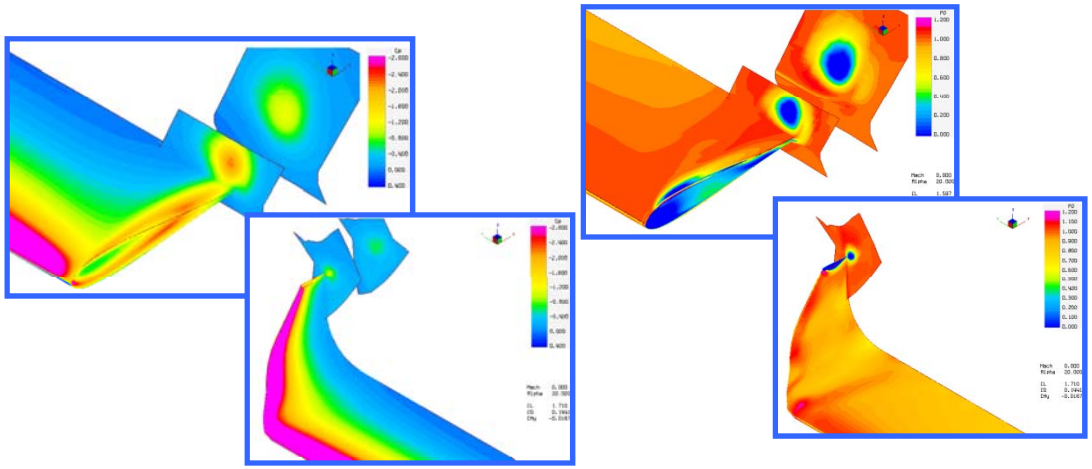
- Chimera meshes for helicopter simulations (cooperation with Prof. Barakos, LIV)
- Adaptive mesh generation (ADIGMA, IDIHOM)
- Design and optimisation for aeronautic configurations (NACRE) – genetic algorithms and adjoint equation approach (FLOWHEAD)
- Laminar wings and morphing

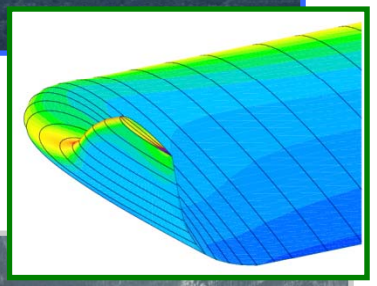






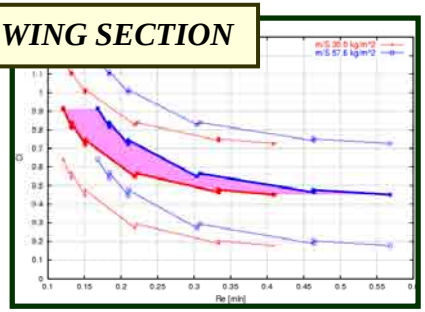
Fixed Wing Aerodynamics

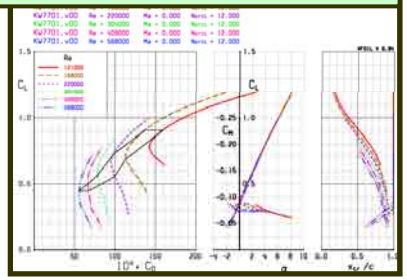




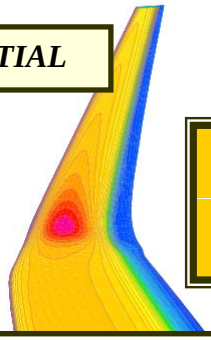
OPTIMIZED AIRFOIL FOR WING STATION

REQUIREMENTS FOR WING SECTION

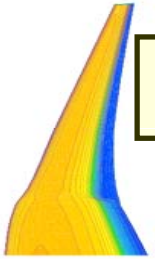




INITIAL



→ 3D - DESIGN PROCESS →



REQUIRED = DESIGNED

European Projects

IDIHOM

2010-2012

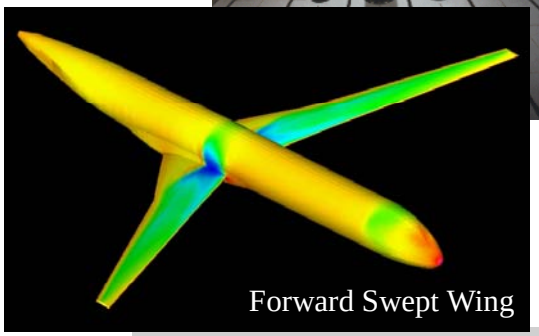
Industrialisation of High-Order Methods – A Top-Down Approach

HiReTT

1999-2003

ADIGMA

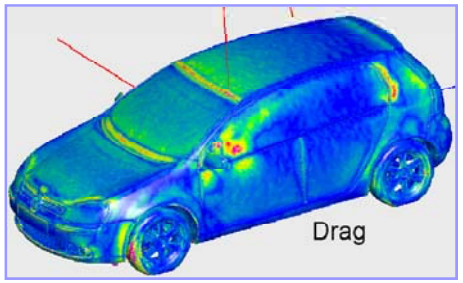
2006-2009



M-DAW

NACRE

2005-2009



FLOWHEAD

2008-2011

Fluid **O**ptimisation **W**orkflows for
Highly **E**ffective **A**utomotive **D**evelopment Processes

New Research Infrastructure

STRUCTURAL FUNDS PROJECT POIG 2.2

Military University of Technology
Warsaw University of Technology

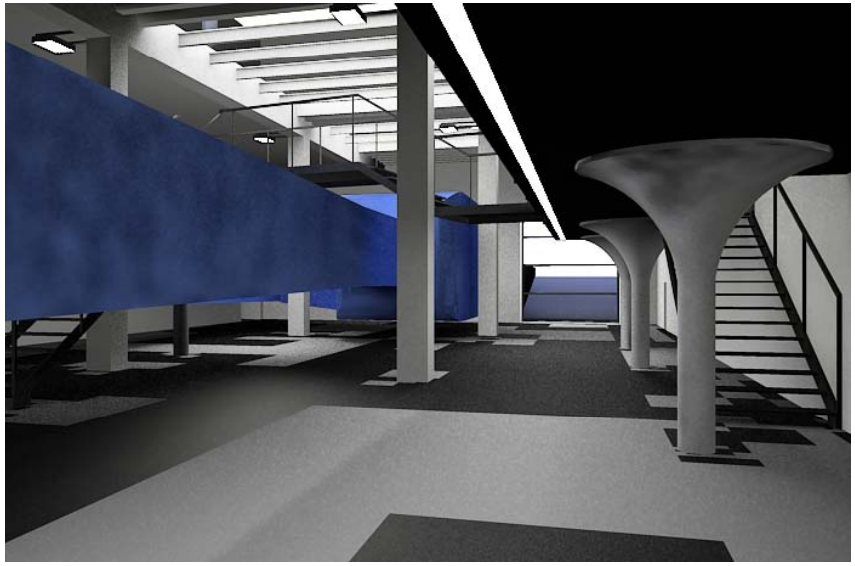
Experimental Infrastructure for Aero-Engine Research

2 Labs (8 mln Euro – 2010-2014):

- Laboratory of Turbine Aerodynamics and Combustion (LATiS) PW: ZA-ITLiMS + ZSL-ITC
- Laboratory of Aircraft Engines (LBNL) WAT.

Consortium

1. POLONIA AERO Sp. z o.o.
2. Warsaw University of Technology
3. Military University of Technology



Cold Flow Turbine Laboratory „Polonia Aero”

Cold Flow Turbine Laboratory „Polonia Aero”

- Cost: approx. 50 mln euro
- EU structural funds

Potential and Priorities

ASSETS

- Tradition of 80 years education and research in Aeronautics (~150 Aeronautic engineers per year)
- Diversified research
  - Aerodynamics (CFD, Control, Shock-BL)
  - Structures (Landing gears, High lift systems)
  - Aircraft Design (UAV, Small aircraft, Helicopters)
  - Materials (Composites)
  - Air Traffic Management
- New research infrastructure
- Presence of the Global Industry
- Active SME sector

CHALLENGES

- Insufficient links of the Polish Research Community with the Global Industries in Poland and in Europe
- Insufficient participation in EU programmes (esp. CLEANSKY and SESAR)
- Inadequate harmonisation of different funding strategies (e.g., FP & Cohesion)
- Lack of EU Vision towards Central/Eastern Europe

Research priorities

- Unmanned Aerial Systems
- Integrated Small & Medium Aircraft Transport Mode
- New Materials and Manufacturing Technologies for Aeronautics (esp. for new Engines)
- Simulation, Optimisation & Design tools and methods
- Upstream technologies (Passive and active flow control, morphing, health monitoring, ...)

THANK YOU

Priorities for EU presidency

- GROWTH via INNOVATION (budget priorities)
- Sustainable and integrated ERA ... fully using the intellectual capital of **all** European countries and regions
- Simpler and more harmonised Framework Programme ... consistent with ... Cohesion Policy (esp. accessibility for SMEs)
- Coherent and Integrated transportation system that will boost EU's economic development
- Greater competitiveness of the services needed to operate EU airports (Airport package)
- Effective use of resources

Polish perspective for future

- Aviation as „enabler of prosperity and wealth creation for the Member States and their periphereal regions” (FP 2050)
- More emphasis on aviation system as a whole („efficient and seamless travel service”)
- Shift of interest also towards smaller aviation transport modes (UAS, small, regional) <- EPATS, ESPOSA, SAT-ROADMAP
- Maintaining and extending industrial leadership („whole innovation process from basic research to demonstrators”)
- Safer and greener aviation