National Aerospace University "KhAI"

Project ideas in engine related area

Kharkiv, Ukraine

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International S&T Projects manager

Who we are:

National Aerospace University «KhAI»

- 1930 - founded as Kharkov Aviation Institute
- 1998 - Aerospace University
- 2000 - National Aerospace University

National Aerospace University «KhAI»:

- 12000 students
- 160 postgraduates
- 700 teachers (400 Ph.D., 95 D.Sc.)
- 2000 employees
- 10 Schools
- 27 Specialities
- 45 departments
- terr. 25 hectars

International Activity:

About 900 students from 60 countries

EASN associate member

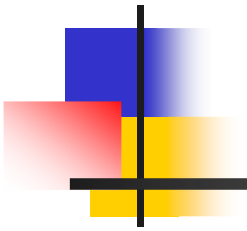
PEGASUS associate partner

Research collaboration

- United Kingdom
- Germany
- France
- Finland
- Austria
- Sweden
- United States
- Mexico
- South Korea
- China
- Japan

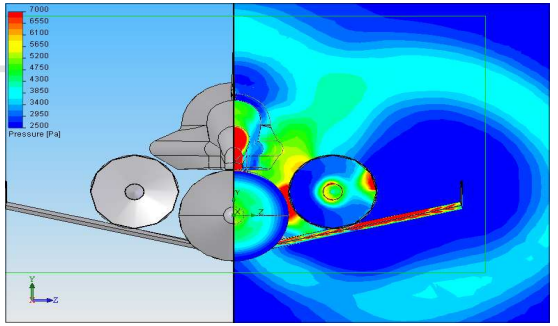
EU Research Projects:

- **FP6 – SENARIO** (Advanced Sensors and Novel Concepts for Intelligent and Reliable Processing in Bonded Repairs) – 11 members Consortium
- **FP6 – ALCAS** (Advanced Low Cost Aircraft Structures) – 61 members Consortium
- **FP7 - HPH.com** (Helicon Plasma Hydrazine Combined Micro Engine) – 15 members Consortium
- **FP7 – AERO-UKRAINE** (Support actions for further cooperation EU/Ukraine aeronautic communities)
- **FP7 – WASIS** (Composite fuselage section Wafer Design Approach for Safety Increasing in Worst Case Situations and Joints Minimizing) – Under negotiation



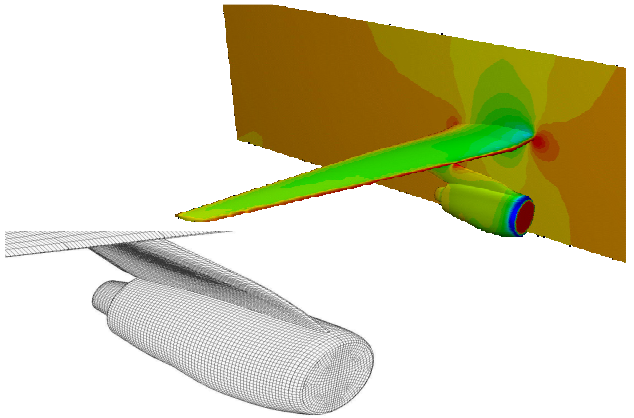
What we do?

Subsonic and supersonic aerodynamics



Unique aerodynamic complex

+ Simulation capabilities



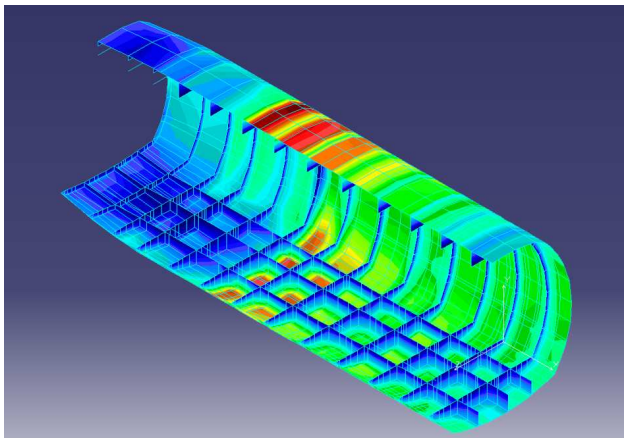
- ✓ 6 wind tunnels
- ✓ 1 to 4 Mach number range

Structural strength:

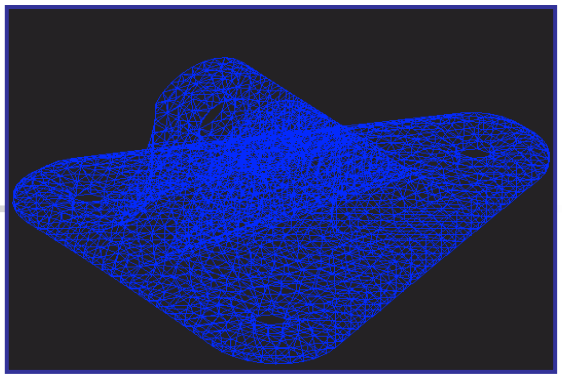
Static and fatigue test facilities

- Aircraft structures full-scale testing
- Static and fatigue materials characterisation
- Structures fatigue life-time prediction

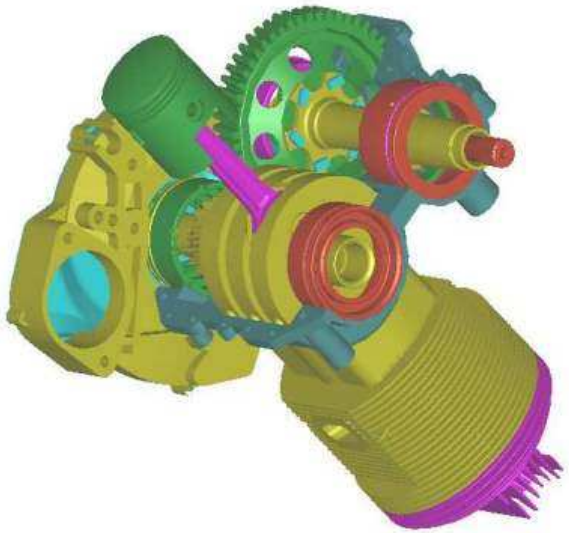
Certified:
- Aviation Regulations of Ukraine, part 23, sections C and D.
- Airworthiness Specifications JAR-VLA, sections C and D.

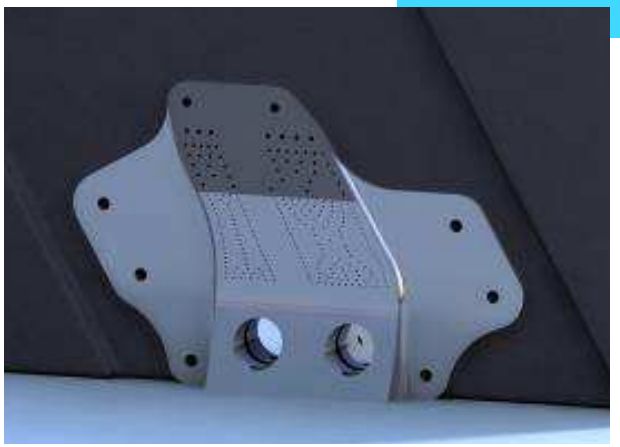


Design Centre:
CAD/CAM/CAE



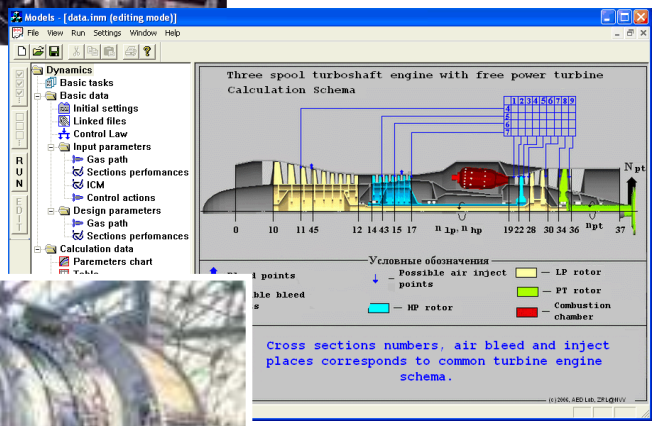
UNIGRAFIX, EUCLID, ANSYS, NASTRAN, COSMOS, SOLID WORKS, LS DYNA etc.
Design, 3D models, FEM





Aircraft engine research

Simulation and testing of gas-dynamic processes in gas-turbine engines.
Joint projects with KIMM (Korea)

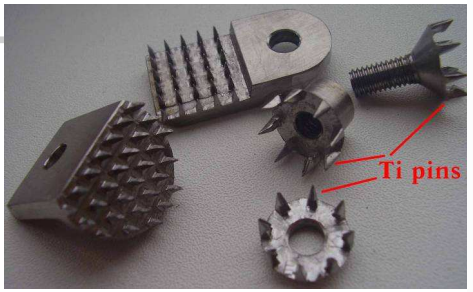


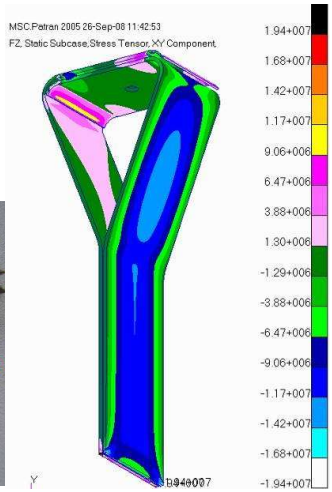
Real-time diagnostics of gas-turbine engines.
Commercial application by CCC (USA).

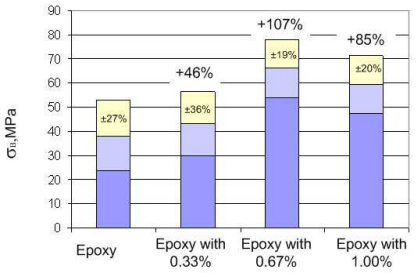
Engine control simulation software

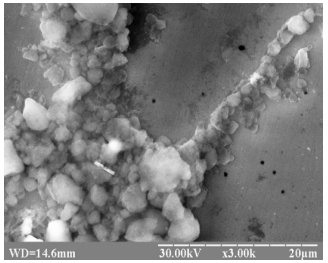
Material Science

- Advanced composites
  - Design methodology
  - Micro-level simulation
  - Innovative joints design
- Multi-layer coatings
  - Erosion-resistant
  - TBC
  - Hardening
- Nano-science
  - Nano-particles production
  - CFRP properties enhancement

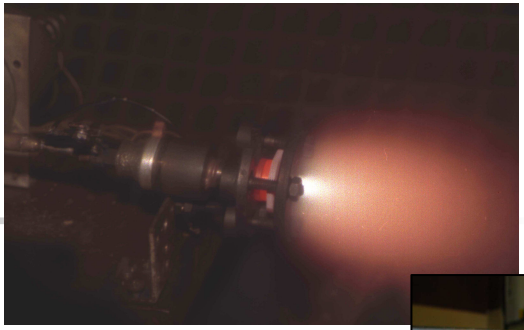


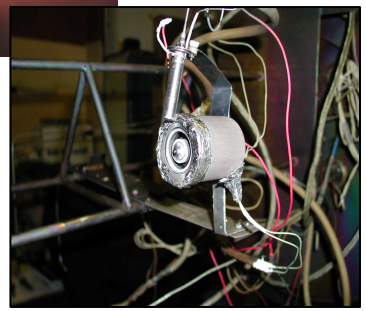






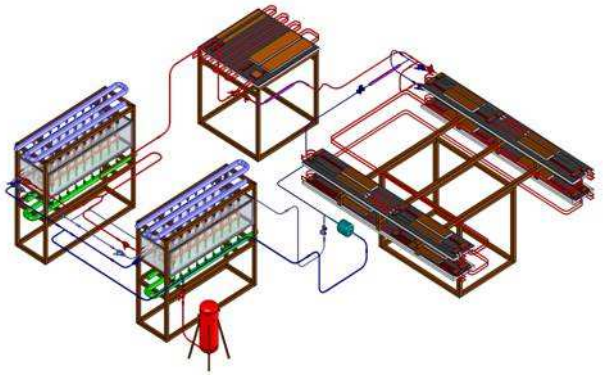
Space-related activities:





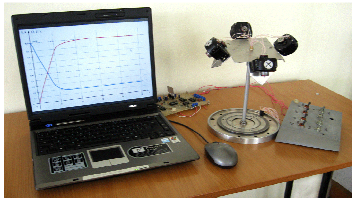
- Electric propulsion systems

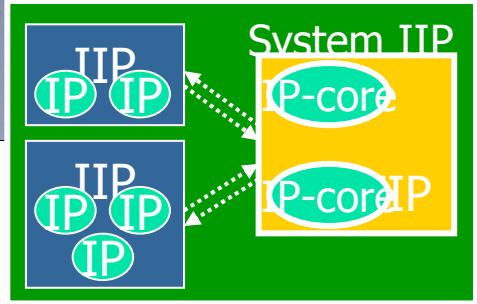
- Pre-launch satellite test system



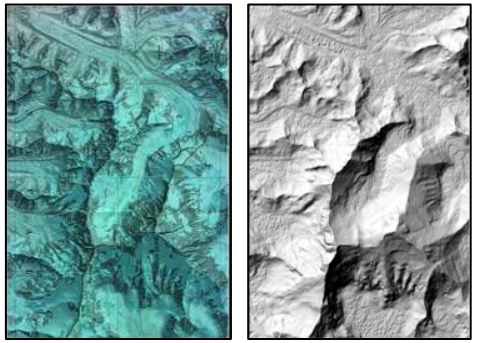
- Communication satellites thermal control system

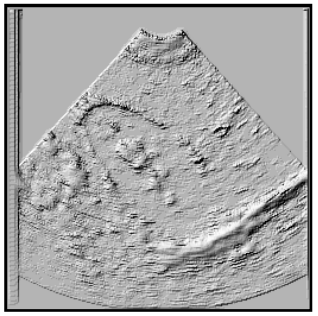
Various ICT applications:





- UAV Auto-pilot system
- Fault-tolerant embedded systems
- Remote sensing & advanced signal processing





Level 1 Project

“Pioneering Ideas” for Propulsion

Project Idea:

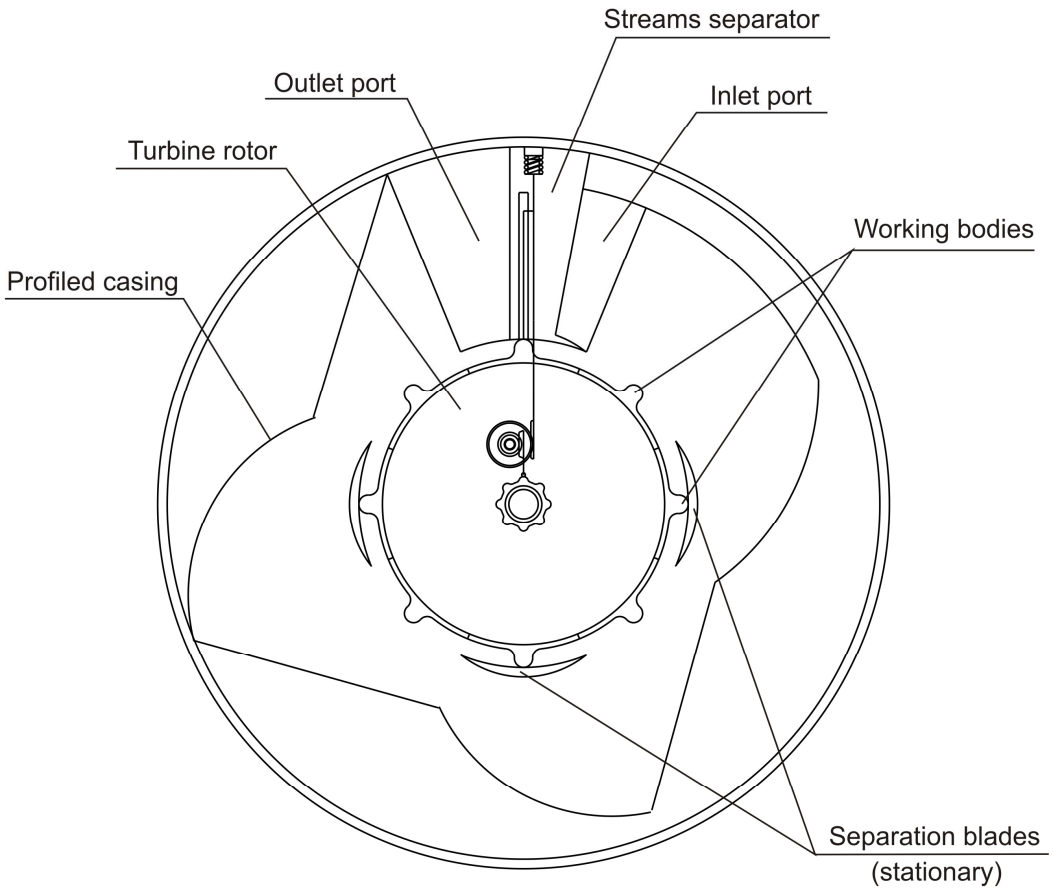
TDD

Tangential (non-bladed) turbine for rotorcraft direct-drive

Motivation:

- Gas turbine is high-tech product
- Blades are very expensive
- High speed rotation sometime is a disadvantage (helicopters)
- Gear boxes are heavy and expensive
- New type of low-speed engine can be a solution for helicopter direct-drive

Innovative approach:

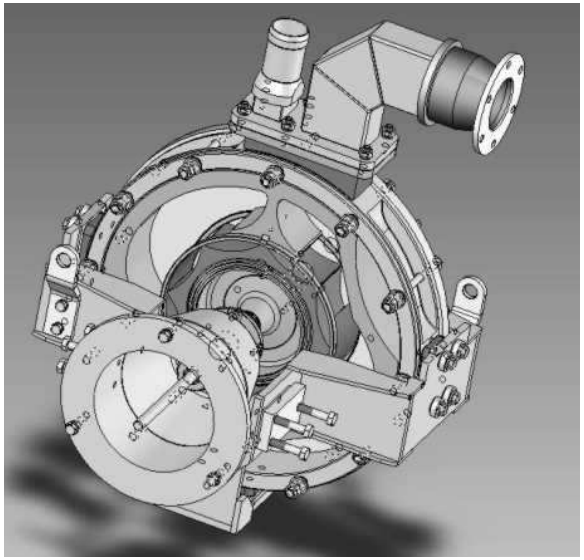


- Tangential turbine
- No moving blades
- Low speed – high moment
- No gearbox

Benefits and expected impact:

- Rotorcraft power plant weight decreasing 25-30%
- Lower fuel consumption => environmental impact
- Less sensitive to fuel quality => biofuel
- Wider application for low-speed drive

Up-to-date results:



Prototype design

"Cold" testbed

Tested parameters:

- Shaft frequency
- Total capacity
- Exhaust velocity
- Inlet/outlet pressure

It works!

Work Packages assumed:

- CFD study of non-stationary gas-dynamic processes in tangential turbine
- Combustion chamber geometry optimization
- Engineering model/prototype design, simulation, and manufacturing
- Simplified testbed for tangential turbine design and manufacturing
- Test program development and prototype basic performance testing
- Test results processing, comparison with conventional gas turbines.

Project Idea:

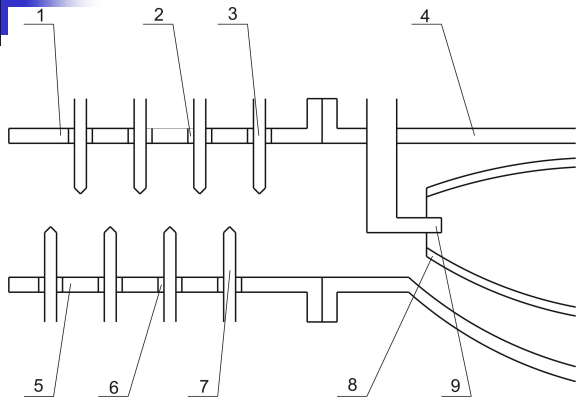
ELCO

ELectro-chemical COmbustion processes for new generation of gas-turbine engines

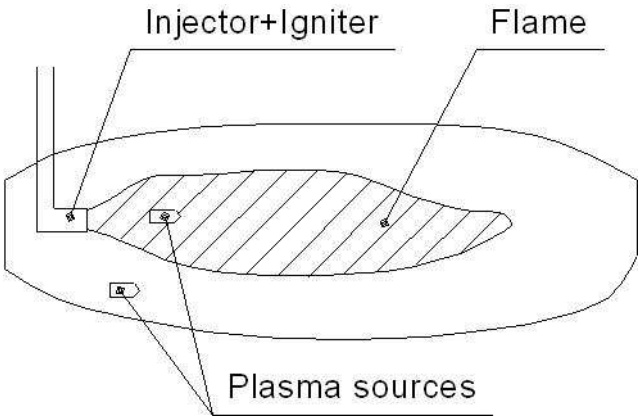
Motivation:

- Gas turbine engines are the main “driving force”
- Conventional combustion process is almost perfect => new approach needed
- Electro-chemical processes are the most promising
- Pre-ozonation, controlled local detonation, plasma source => combustion effectiveness increasing

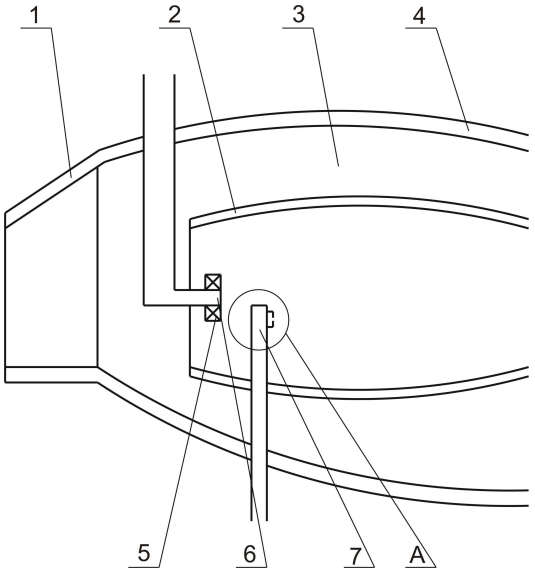
Approach:

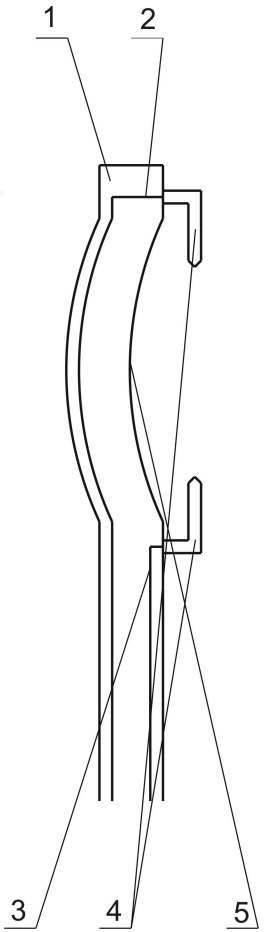


Pre-ozonation chamber



Combustion in presence of plasma





Detonation Discharger

To be studied:

- Methods for ozone generation and local detonation in combustion chamber generation and control
- Thermal, plasma, and detonation combustion processes optimal combination, ozone influence
- Electro-chemical processes influence on fuel combustion process efficiency increasing

Benefits:

- Combustion chamber dimensions decreasing
- Combustion intensity increasing
- Higher temperature, more power
- Fuel consumption decreasing
- Less CO, NOx

Work Packages assumed:

- Analytical and CFD simulation of electro-chemical combustion processes development
- Electro-chemical devices design and integration. Initial testing.
- Control system design and manufacturing
- Combustion chamber with embedded electrochemical unit design and manufacturing
- Comparative testing and efficiency assessment

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