

DLR - German Aerospace Center

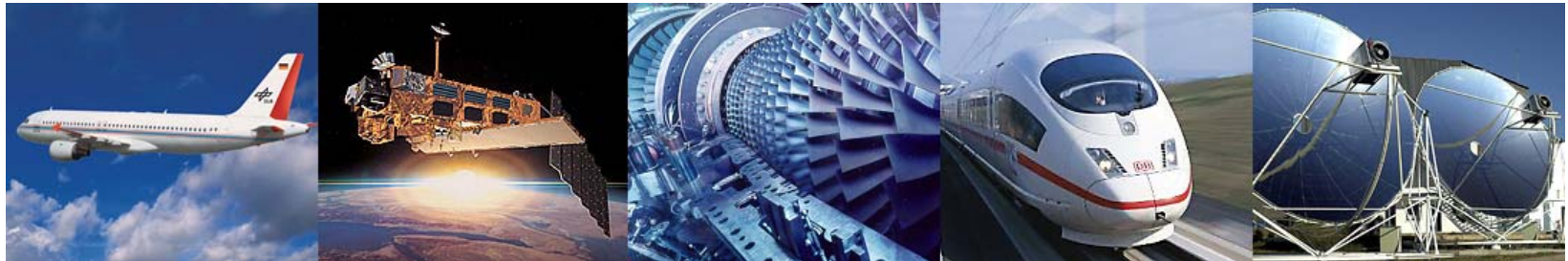
**DLR Research Projects,
a contribution to the Vision 2020**



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

DLR

German Aerospace Center



Research Institution
Space Agency
Project Management Agency

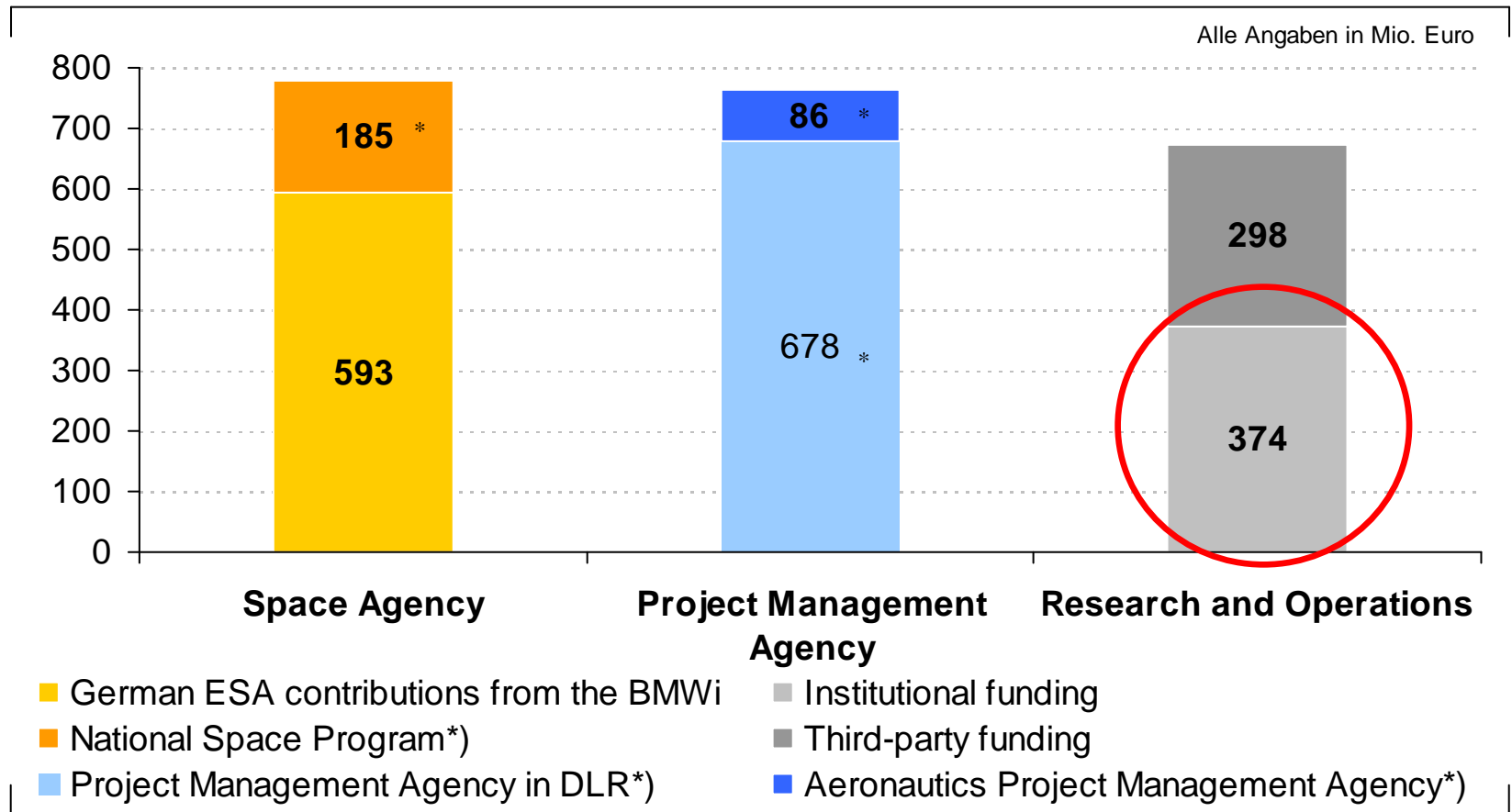
Key areas

- ✓ **Aeronautics**
- ✓ Space
- ✓ Space Agency
- ✓ Transport
- ✓ Energy
- ✓ Security

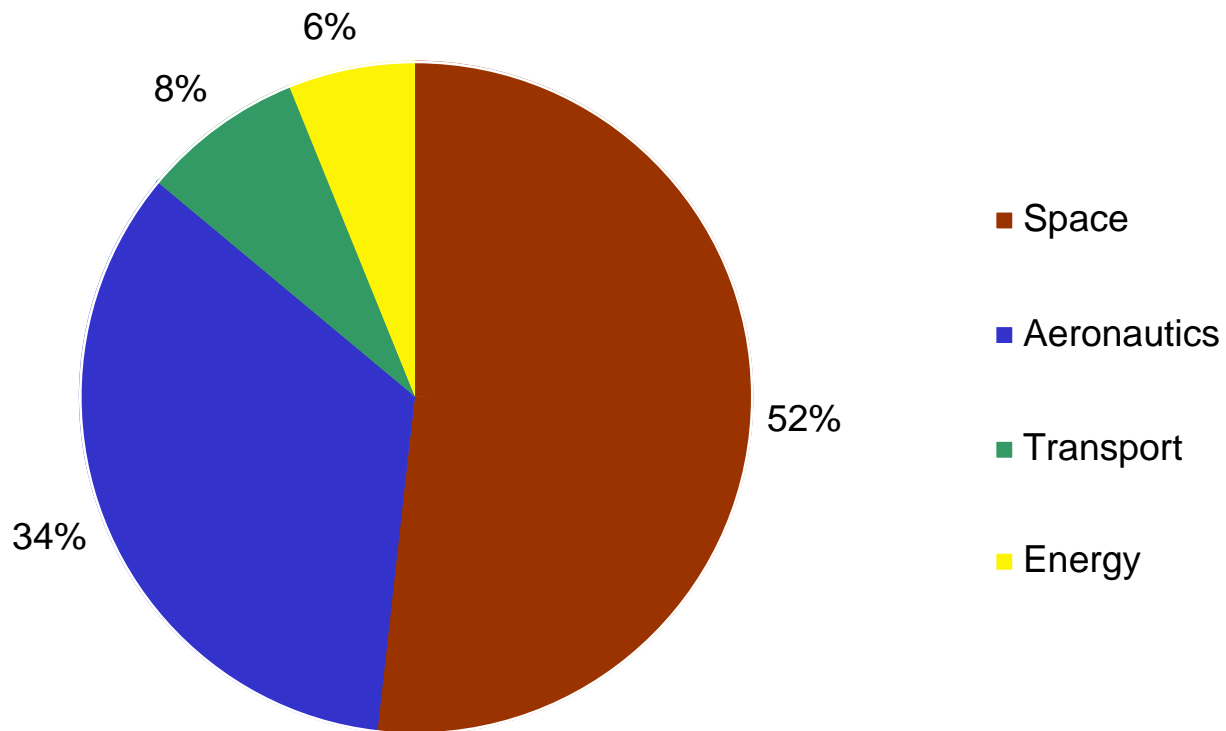


Financing of DLR and research funding 2010

2.114 Mio.€

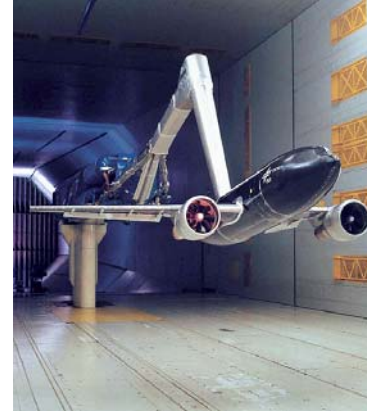


Percentage of overall income from research and operations



Large-scale facilities

- ✓ **Research aircraft and helicopter fleet,**
- ✓ **Windtunnels,**
- ✓ **Engine (rocket and aircraft) test rigs,**
- ✓ Solar furnace, solar fields,
- ✓ **Autoclaves,**
- ✓ Traffic tower.
- ✓ German Space Operations Center (GSOC),
- ✓ German Remote Sensing Data Center (DFD).



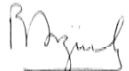


zhaw
FLIGHTTIME
EFLY SMARTER
THE SWISS
TECHINORAMA
SCIENCE CENTER



VISION 2020: Challenges and Associated Goals

Group of Personalities



Pedro Arguelles



John Lumsden



Manfred Bischoff



Denis Ranque



Philippe Busquin



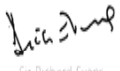
Soren Rasmussen



B.A.C. Droste



Paul Reutlinger



Sir Richard Evans



Sir Ralph Robins



Walter Kröll



Helena Terho



Jean-Luc Lagardère



Arne Wittlöv



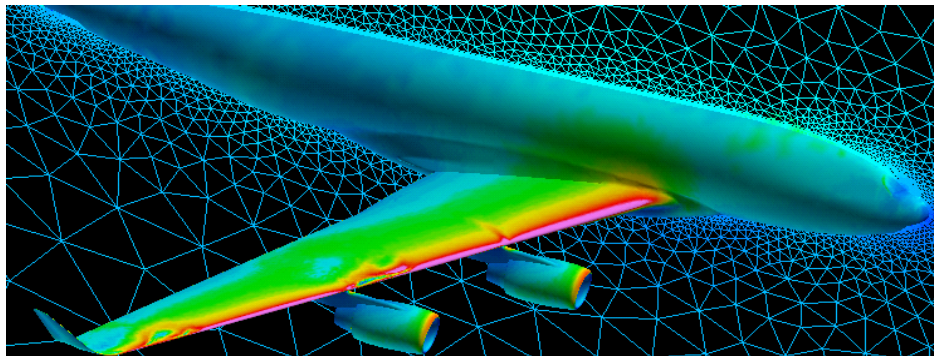
Alberto Lina

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



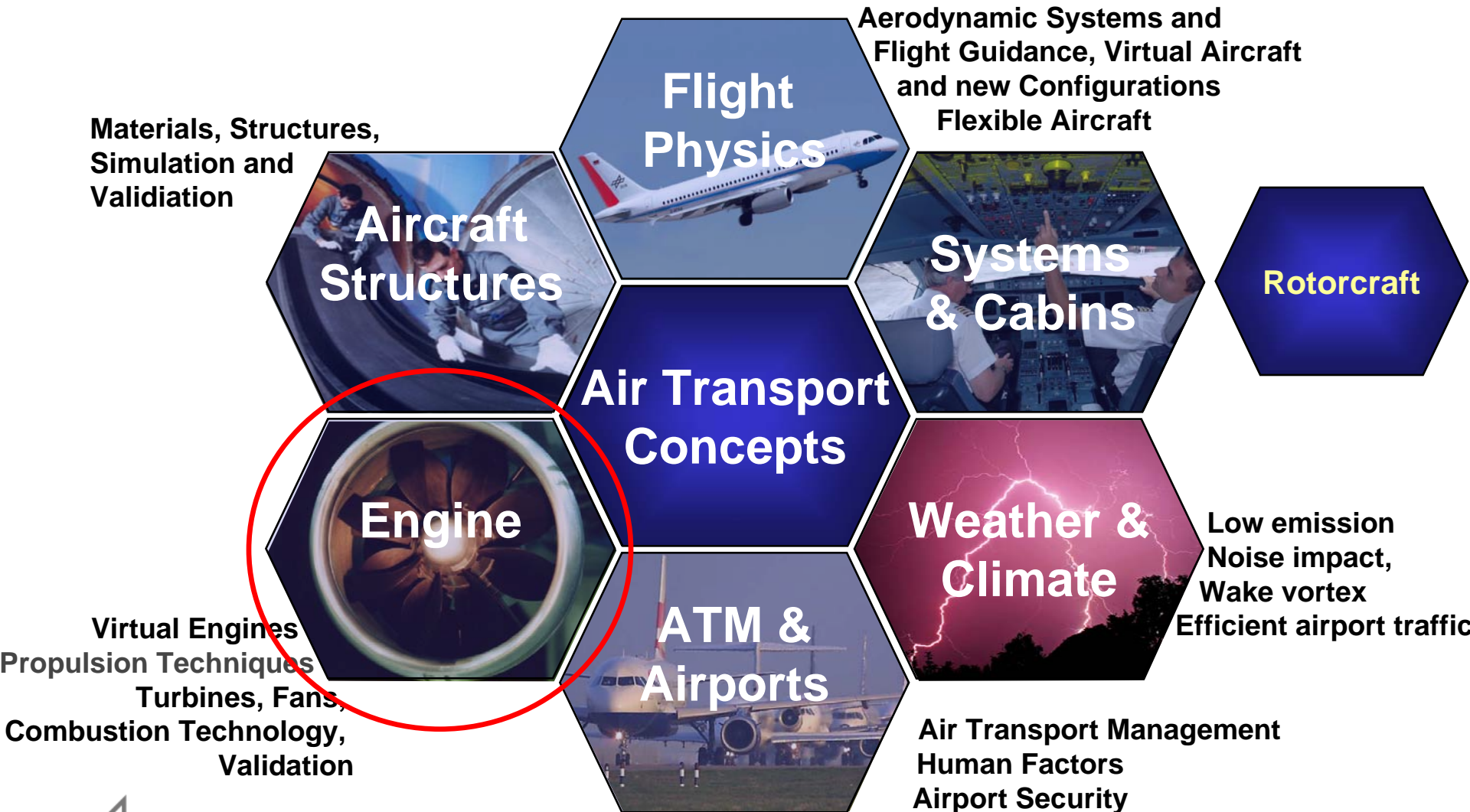
Aeronautics

Leading Partner for
Research in National Aeronautical Industry



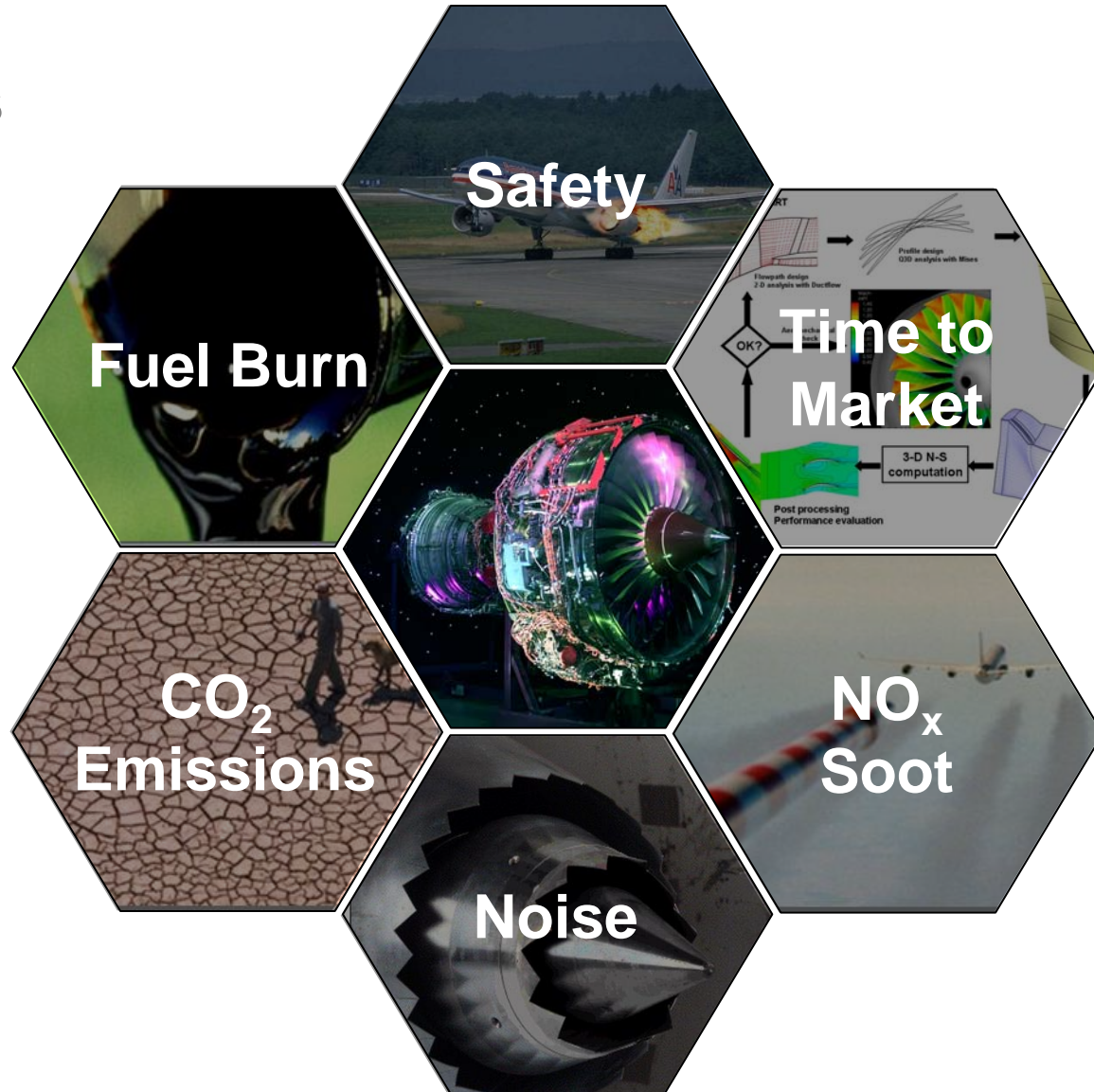
- Air Transport System Concepts and Assessment
- Energy and Cost Efficient Aircraft
- Efficient and low Emission Aero Engines
- Safe and Efficient Air Transport System
- The Future Helicopter

Main Areas of Aeronautics Research at the DLR



Sustainable Air Transport – DLR Engine Research 2010

Challenges



Sites and employees

6.200 employees working in 29 research institutes and scientific and technical facilities

- at 9 sites
- in 6 field offices (7 field offices of the Project Management Agency)

Offices in Brussels, Paris and Washington.

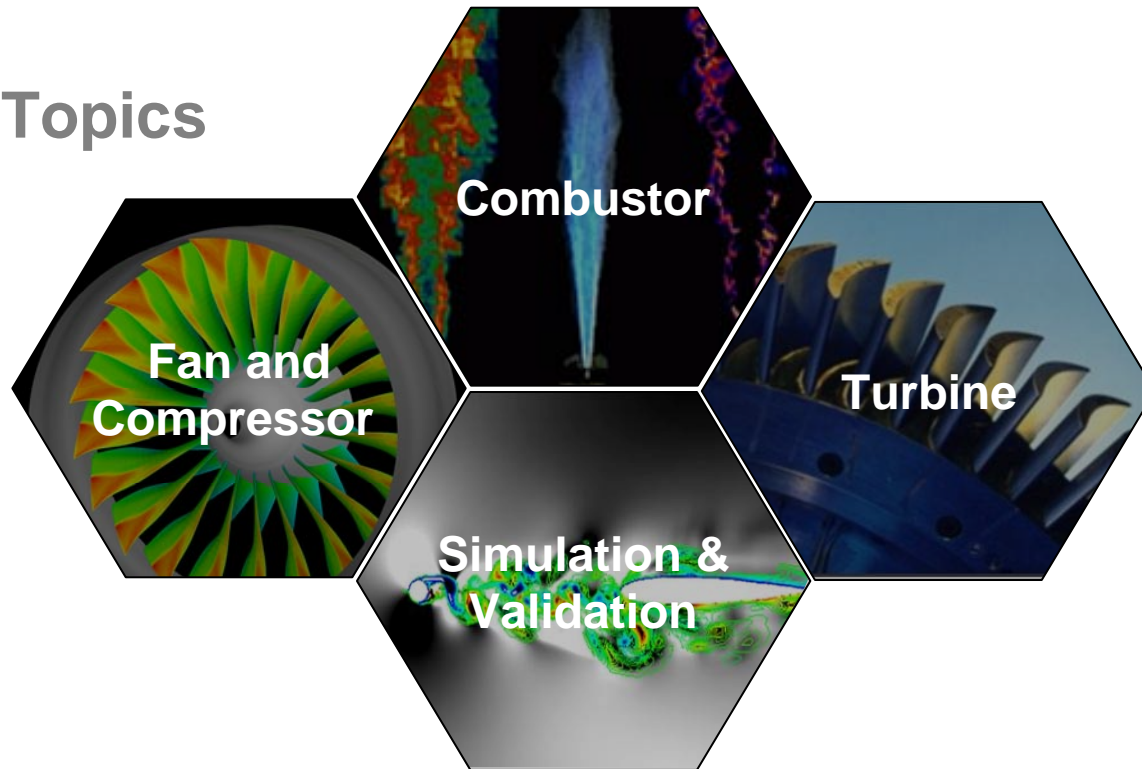
DLR participates in the:

- ◆ European Transsonic Wind Tunnel (ETW)
- ◆ German-Dutch Wind Tunnels (DNW)



Sustainable Air Transport – DLR Engine Research 2010

Research Topics





DLR Institute of Propulsion Technology, Cologne, Berlin, Goettingen

Cologne

- Combustor (BK), Dr. Christoph Hassa
- Combustion Test (BT), Dipl.-Ing. Christian Fleing
- Fan and Compressor (FV), Dr. Eberhard Nicke
- Numerical Methods (NM), Dr. Ing. Edmund Kügeler
- Engine (TW), Dr. Andreas Döpelheuer
- Engine Measurement Systems (TM), Dr. Christian Willert

Berlin

- Engine Acoustics (TA), Prof. Dr. Lars Enghardt

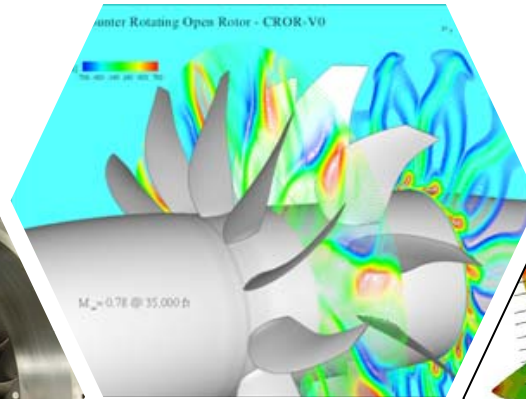
Goettingen

- Turbine (TU), Prof. Dr. Ingo Roehle

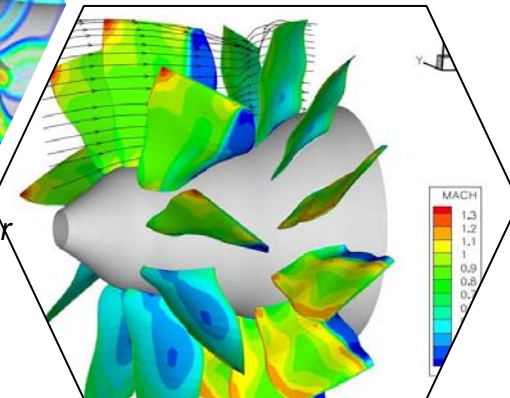
Fan and Compressor



UHBR Geared Fan



Counter Rotating Open Rotor



Counter Rotating Turbo Fan

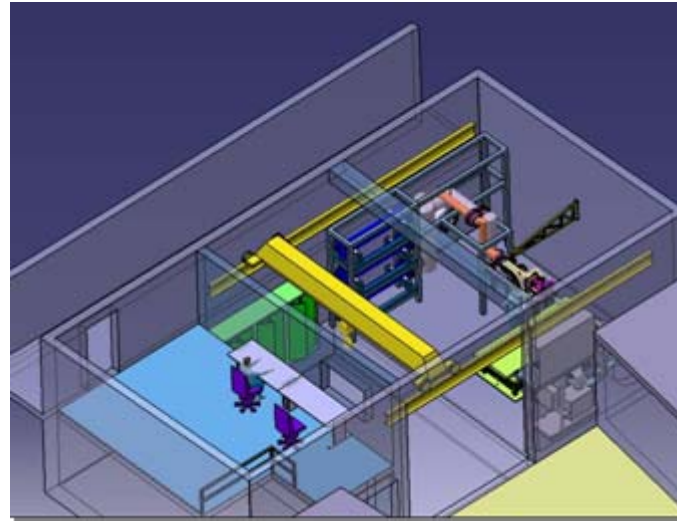
Recent Results

- Design & test of a **Ultra High Bypass Ratio (UHBR) Geared Fan** with Active Noise Control
- Automatic Optimization of Counter Rotating Open Rotor
- Loss Reduction in Compressor Cascades via Passive Flow Control

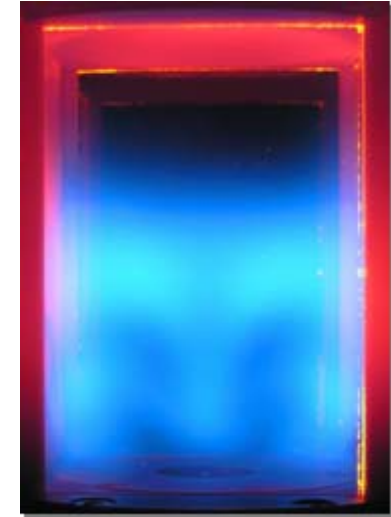
Short-Term Objectives

- Test of DLR-designed Counter Rotating Turbo Fan at CIAM
- Enhanced performance via Casing Treatment in 4-stage HP-Compressor
- Build-up & test of DLR-designed Light-Weight LP-Compressor

Combustor



New test bed for low emission combustor research



Lean burn combustor

Recent Results

- Upgrade of test infrastructure for low emission combustor research
- Characterization of advanced cooling concepts under realistic conditions
- Experimental investigations for the verification of combustor CFD

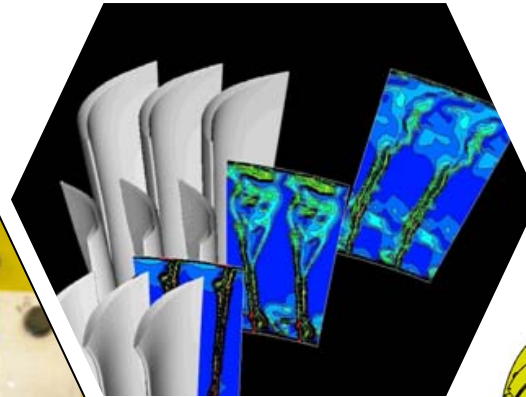
Short-Term Objectives

- Investigation on a real size piloted lean burner in a big single sector
- Simulation of deformation- and damage-behaviour of fiber reinforced ceramics
- Characterization of burner-flame/cooling-film interaction with a modular burner

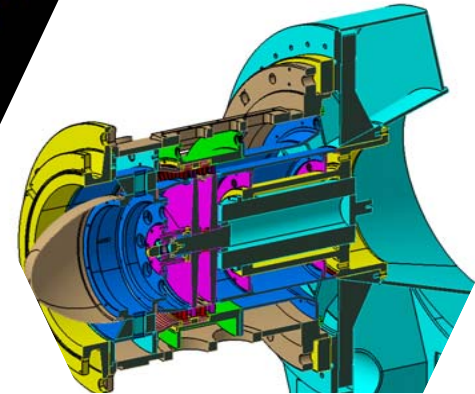
Turbine



HWSS-Turbine



LP-Turbine CFD



2-stage Turbine-Rig

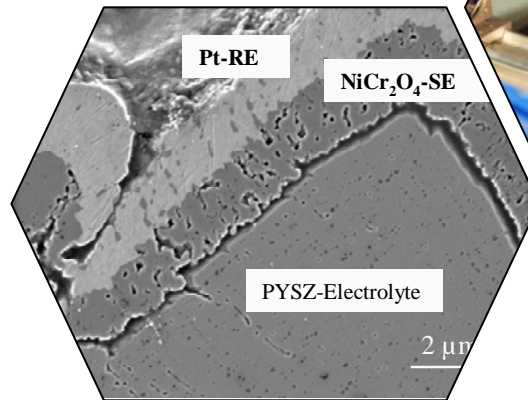
Recent Results

- Performance Measurements at a High Work load Single Stage Turbine (HWSS)
- Application of a Multimode Transition Model in LP-Turbine CFD-Simulation
- Flow Investigation in a Rotating Square-Sectioned Two-Pass Cooling System

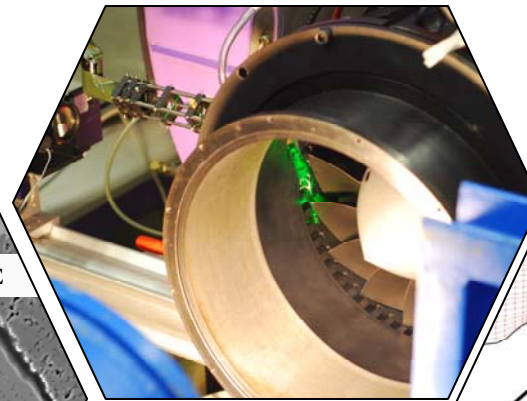
Short-Term Objectives

- Construction and manufacturing of a high-speed, 2-stage Turbine
- Minimization of cooling air through new coating and cooling technologies
- Low Engine Order Stage Tests for lifetime extension of rotorblades

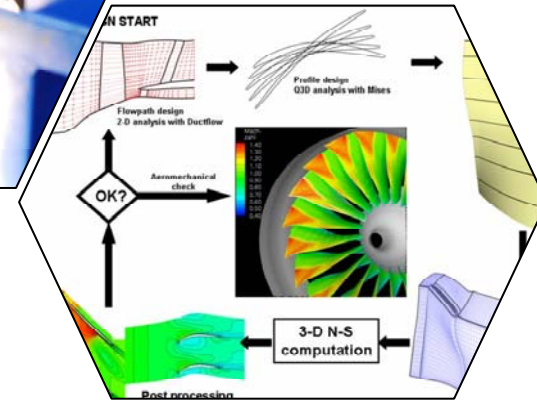
Simulation and Validation



Design-integrated NOx-Sensor



Stereo-PIV Application



Automatic Optimisation

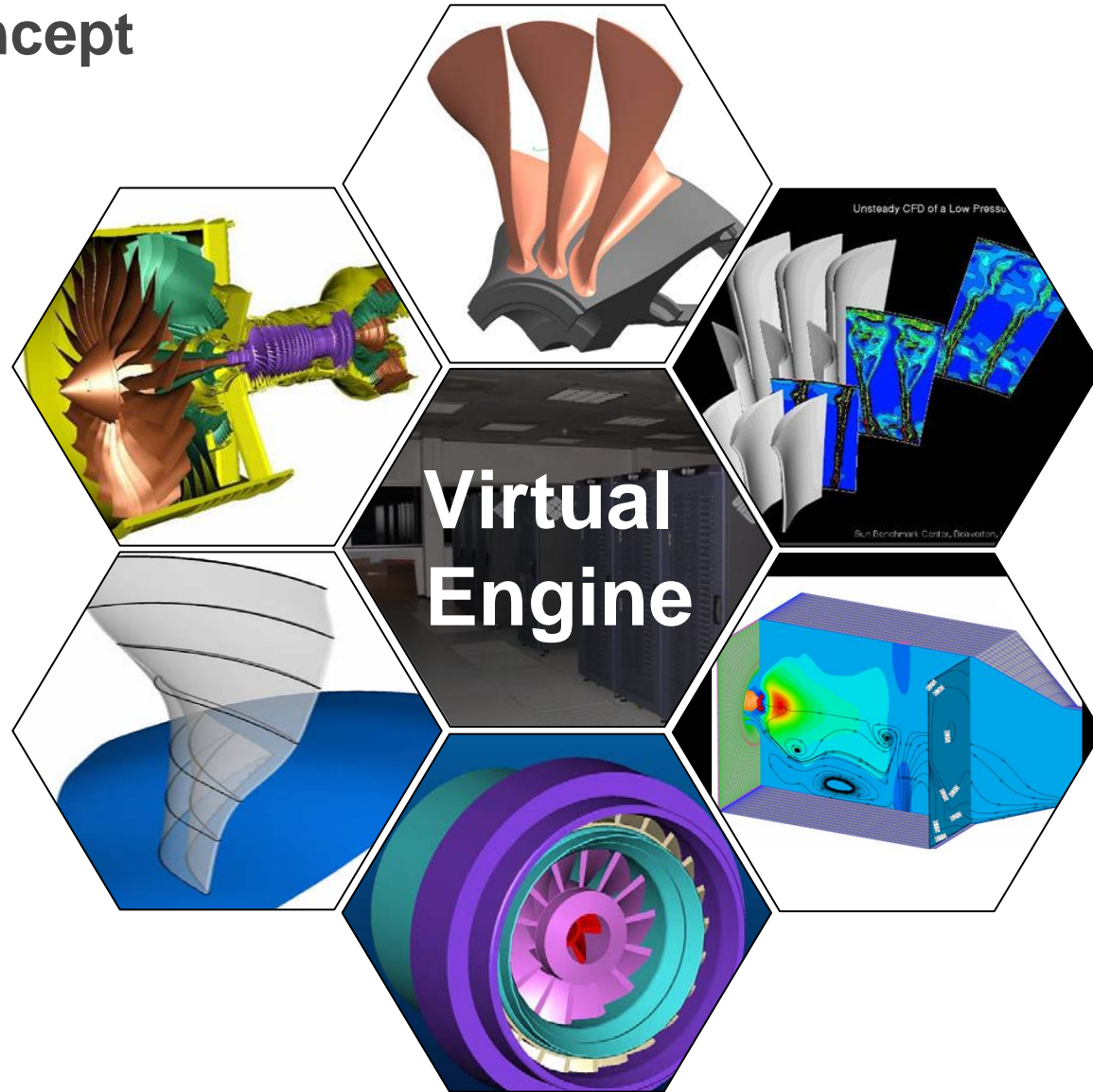
Recent Results

- Development and manufacturing of planar design-integrated NOx-Sensors
- Stereo-PIV and CFD-Investigation of Casing Treatment in transsonic compressor
- Development of a linearised CFD-solver for efficient aeroelasticity analysis

Short-Term Objectives

- Automatic Numerical Optimization of complete engine-components
- Numerical Simulation of the phase-transition in alternative fuels
- Multidisciplinary Pre-Dimensioning-Tool for aero-engines

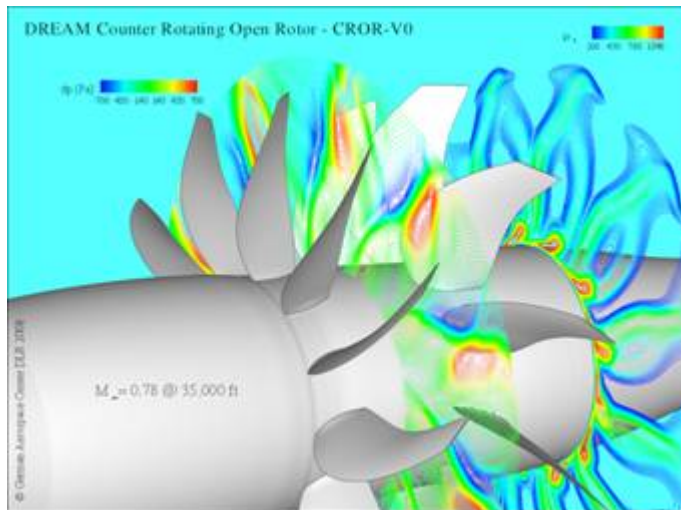
Key Concept



FP-7 Project DREAM

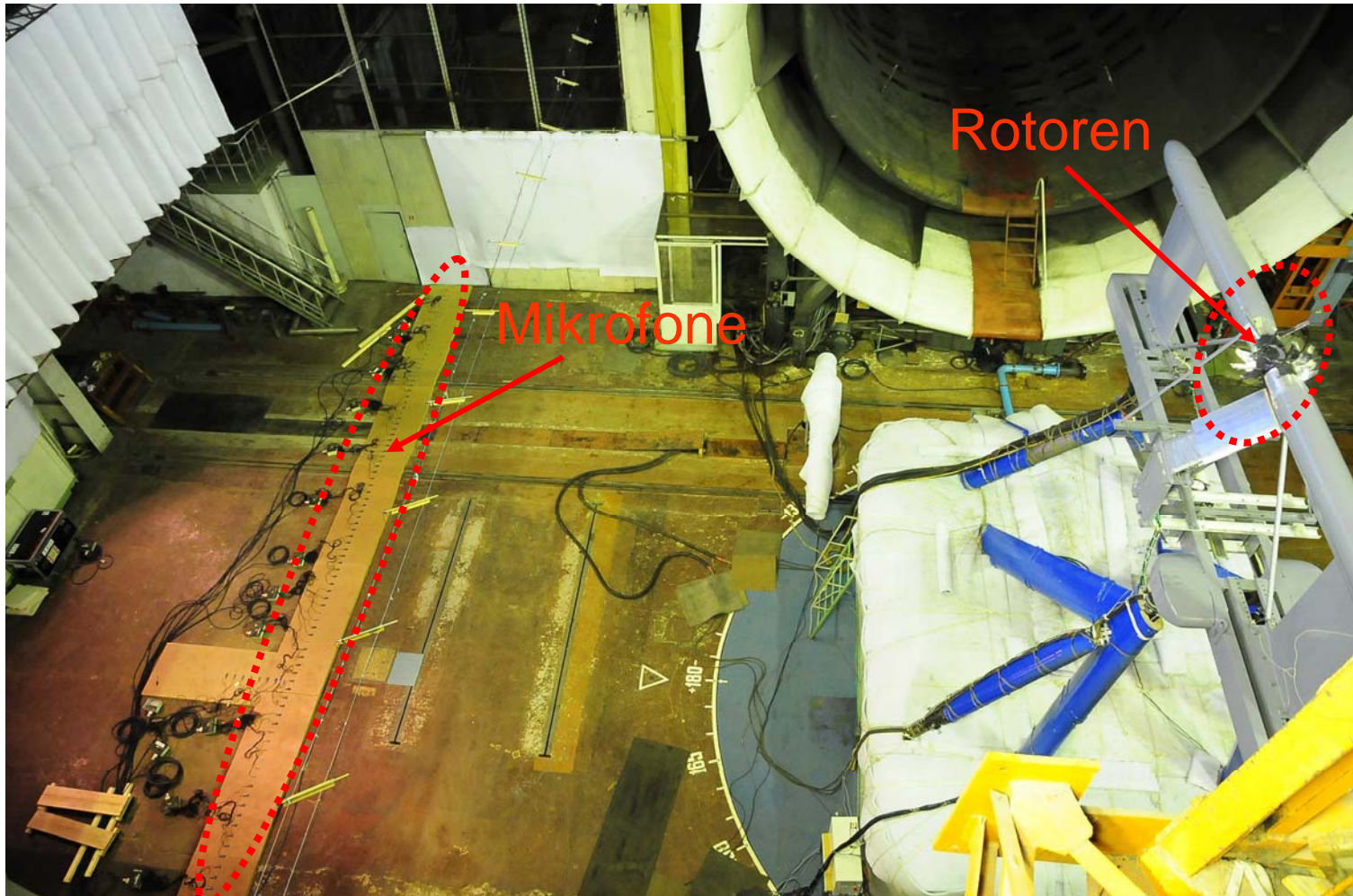
Validation of Radical Engine Architecture Systems

- Consortium leader is RR, SNECMA, DLR and TsAGI are partners (44 c. members from 13 countries),
- Main goal is the development of an open rotor contra rotating fan configuration to reduce the fuel consumption,
- Problem: increased noise emission,
- Main instrument: TRACE (Turbo machinery Research Aerodynamic Computational Environment),



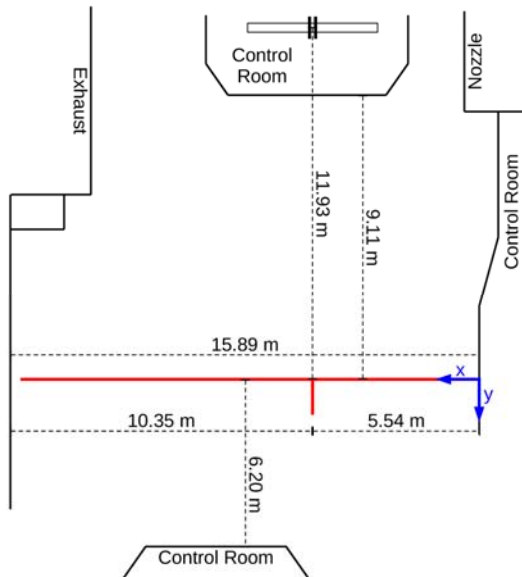
SNECMA open rotor geometry to be improved by using simulations (TRACE Simulation)
To be validated by experiments

Wind tunnel T104 at TsAGI, acoustic measurements

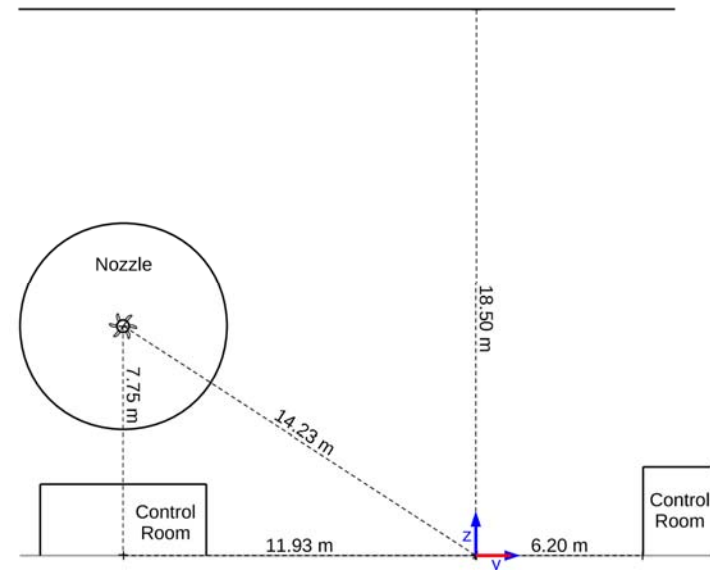


DLR Microphone Array Setup

- line array with 104 microphones, constant spacing 15 cm
- 8 additional microphones in y-direction for correlation analysis and beamforming
- measured emission angles: 70-125° (without shear layer correction)
- additional signals: shaft speed trigger signals of both rotors



xy-plane



yz-plane



Contacts in DLR

Programme direction for engines

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International cooperation

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End of Presentation