

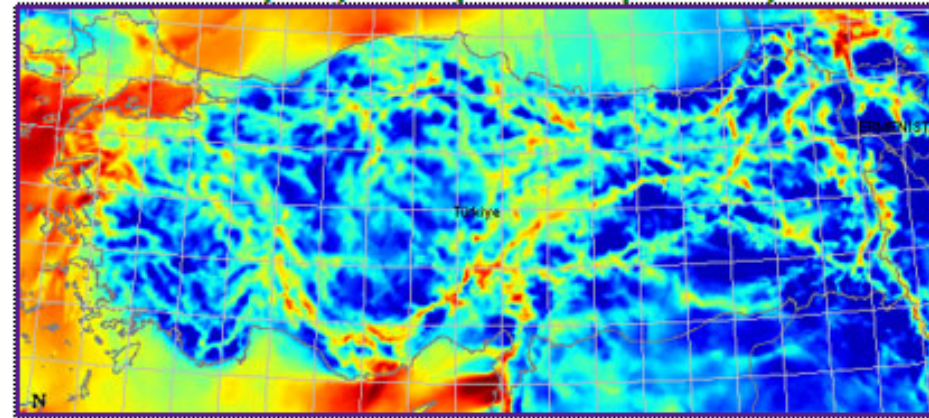
METU Center for Wind Energy **(METUWIND-RÜZGEM)**

Dr. Oğuz Uzol

Head, METUWIND
Associate Professor
Dept. of Aerospace Engineering, METU



WIND ENERGY UTILIZATION

Country	Total Installed Capacity (MW) (end of 2013)
China	91424
USA	61091
Germany	34250
Spain	22959
India	20150
UK	10531
Italy	8552
France	8254
Canada	7803
Turkey	3500 (~5% of total capacity)



Bozcaada Wind Farm

Source: GWEC 2013 and TWEA 2013 Reports

Planned Installed Capacity in Turkey: 2015  5000 MW
 2023  20000 MW (~20% of total capacity)

METUWIND

- ❑ Established in 2011.
- ❑ Collaborative effort of eight METU departments:
 - Aerospace, Mechanical, Electrical-Electronics, Materials and Civil Engineering as well as Department of Architecture, Department of City and Regional Planning and Department of Business Administration
- ❑ Initial funding through a five-year multi-million Euros project provided by the Ministry of Development of Turkey.
- ❑ Strong ties with
 - Wind Energy Industry in Turkey.
 - Turkish Wind Energy Association (TWEA)
 - Government organizations (Ministry of Energy, Ministry of Development, Ministry of Science, Industry and Technology, TUBITAK, TSE, etc).
 - EU organizations on wind energy research
 - Associate Member of EERA JP Wind
 - Full Member of EAWE
- ❑ Around 30 faculty members and currently around 20 MS/PhD students.



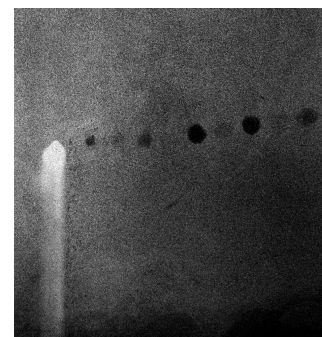
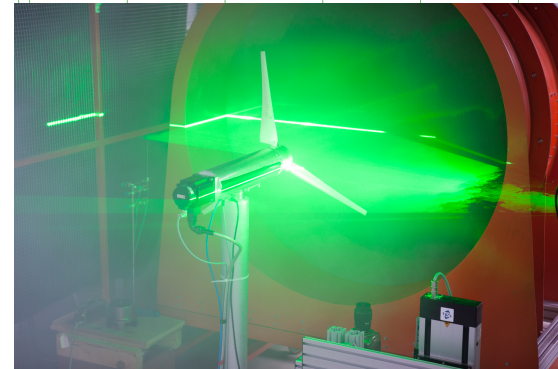
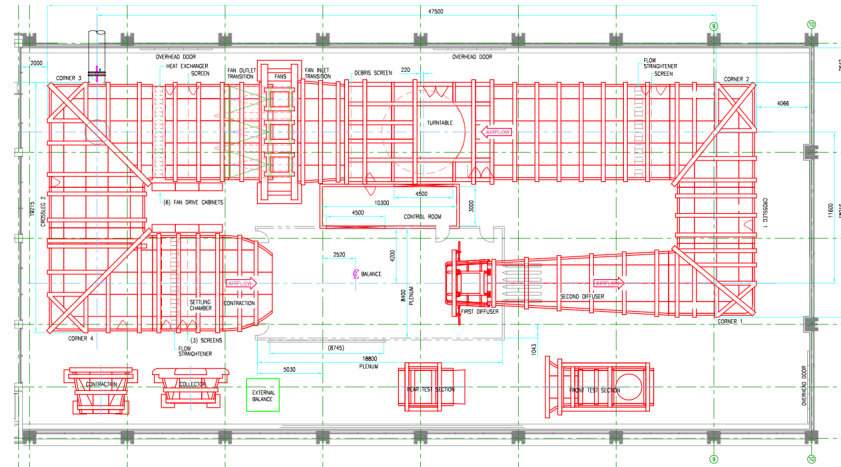
METUWIND Offices and Laboratory Buildings

METUWIND LABS

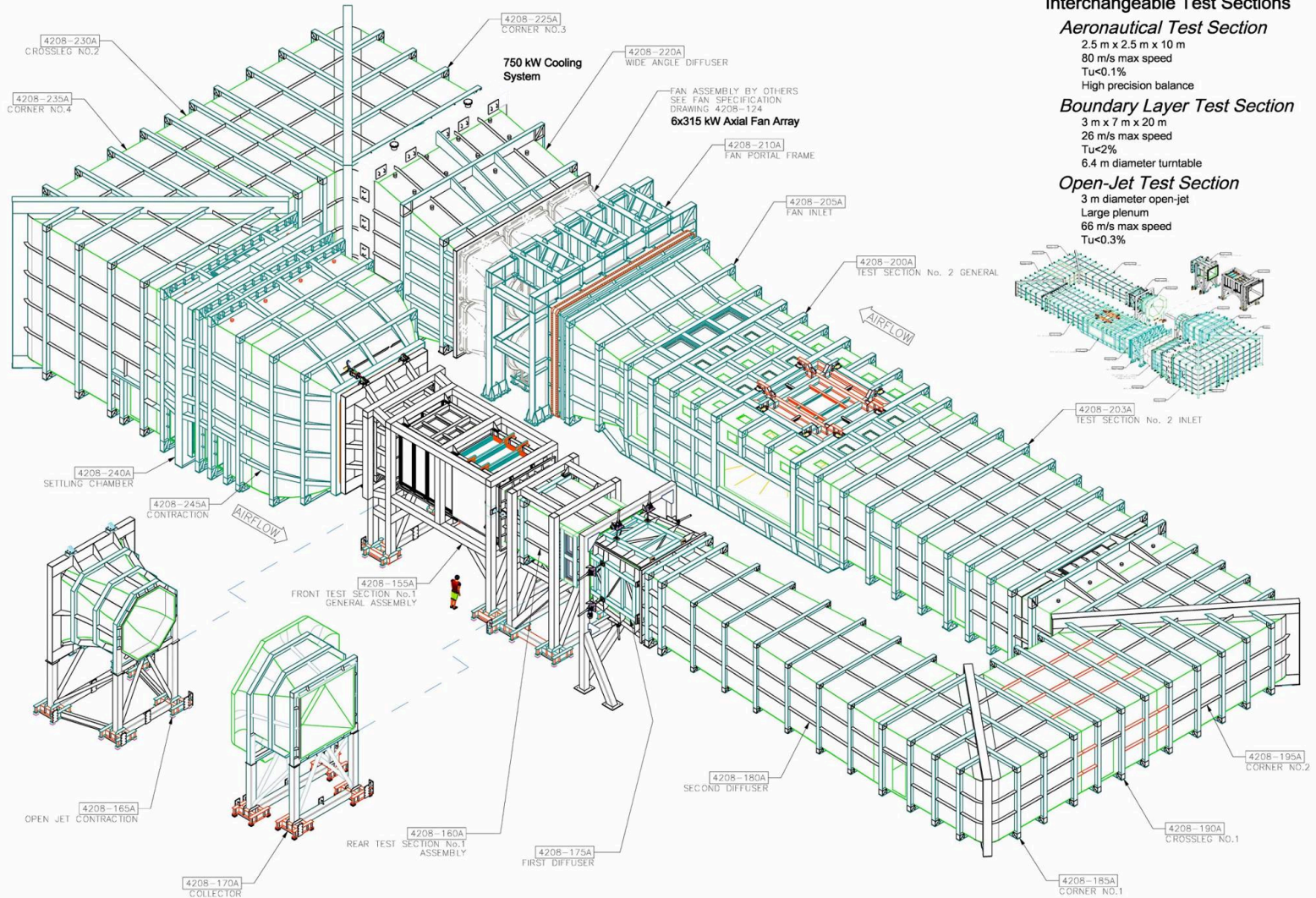
Four main laboratories various state-of-the-art measurement equipment and test facilities for wind energy related research:

◆ Aerodynamics Lab

- **Large Scale Wind Tunnel** (3 test sections: 2.5 m x 2.5 m x 10 m, 3 m x 7 m x 20 m, 3 m open-jet, max speed 80 m/s, 1.5 MW axial fan array)
- **Various smaller scale wind tunnels** (1m x 1m, 0.6m x 0.6m, etc).
- **State-of-the-art instrumentation** (Time-resolved stereoscopic PIV, pressure scanners, balances, CTA, etc)
- **In-house codes** (BEM, 3D unsteady free-wake with GPU/CPU parallel computation, Navier-Stokes Flow Solver)
- **Research projects** on tip vortex control using tip injection, boundary layer control using VGJs, aeroacoustic predictions, wake-rotor interactions, etc.







Interchangeable Test Sections

Aeronautical Test Section

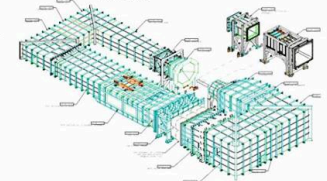
- 2.5 m x 2.5 m x 10 m
- 80 m/s max speed
- Tu<0.1%
- High precision balance

Boundary Layer Test Section

- 3 m x 7 m x 20 m
- 26 m/s max speed
- Tu<2%
- 6.4 m diameter turntable

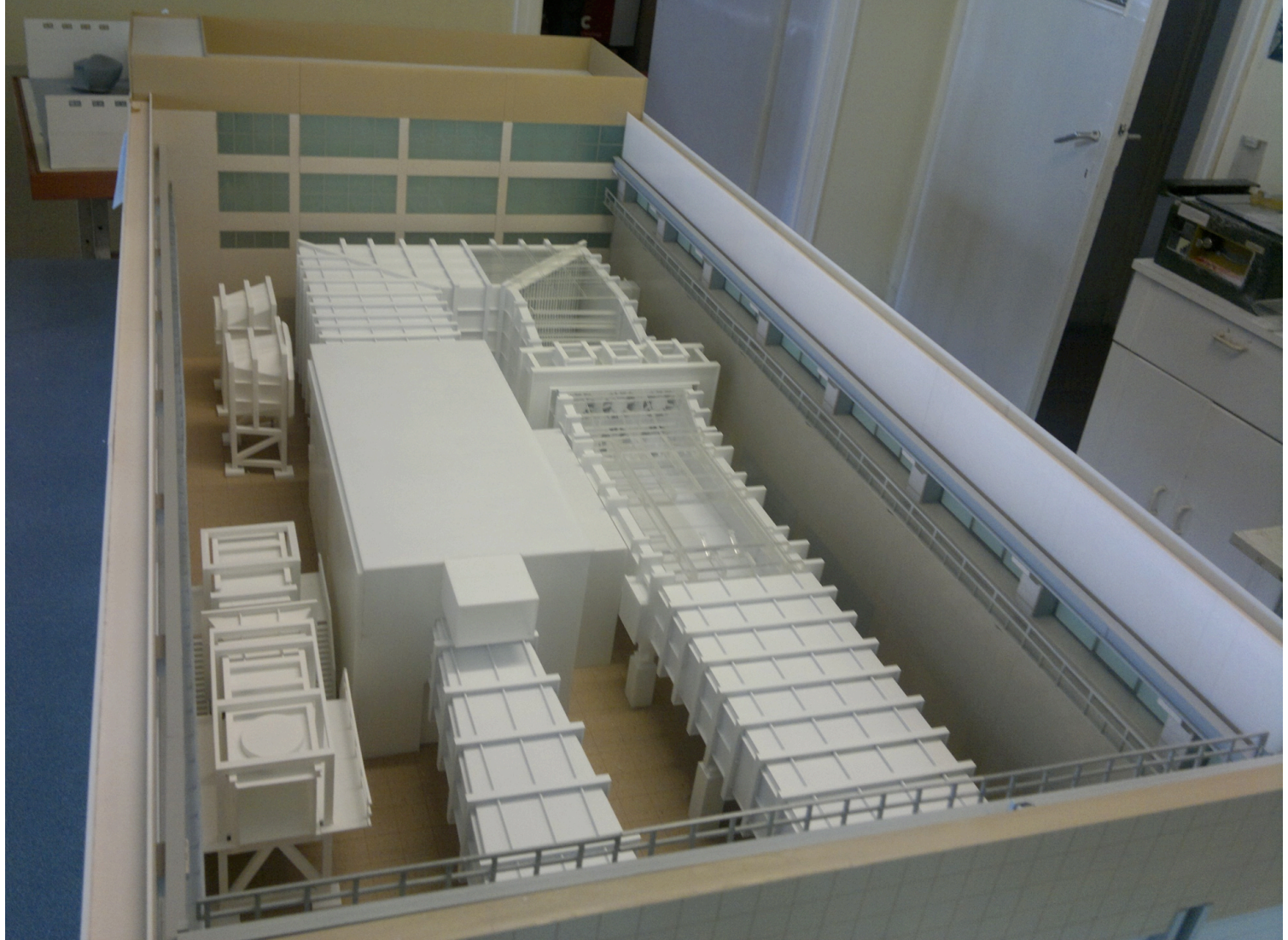
Open-Jet Test Section

- 3 m diameter open-jet
- Large plenum
- 66 m/s max speed
- Tu<0.3%



METUWIND Large Scale Multi-Purpose Wind Tunnel

Detail Design - April 2014

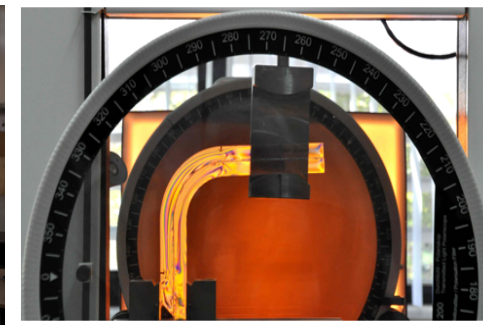
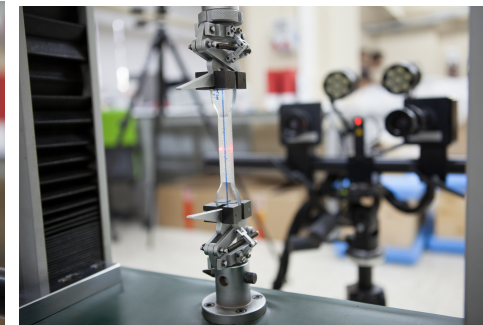




METUWIND LABS

◆ Structures and Materials Labs

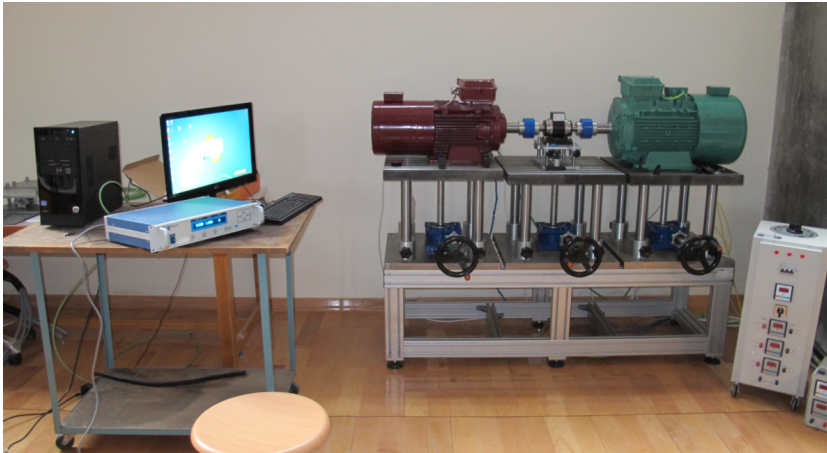
- Composite Materials Lab
 - Composite material characterization (DMA, DSC, TGA, UV-VIS, etc)
 - Composites manufacturing
- Structural Mechanics, Materials and Dynamics Labs
 - **Coupon tests:** Tension-compression, tension-torsion (10 kN, 100 kN, 250 kN static and fatigue)
 - **Optical measurement capability:** Laser Vibrometer, DIC, High-speed cameras (up to 1 M fps)
 - **Full-scale tests:** Blade static, dynamic and fatigue test facilities up to 10 m blade length.
 - **Software:** A variety of finite element analysis, structural optimization, composite design and fatigue analysis software



METUWIND LABS

◆ Electromechanics Lab

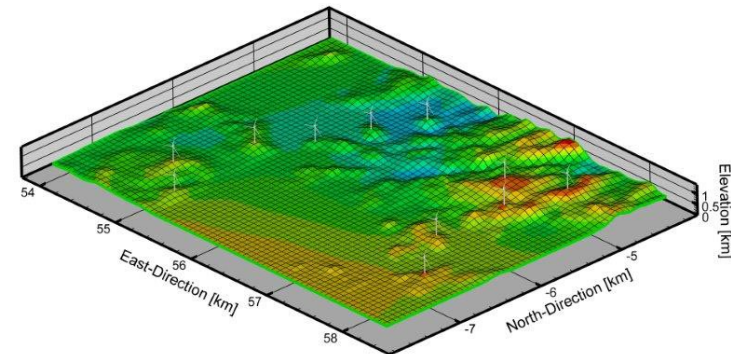
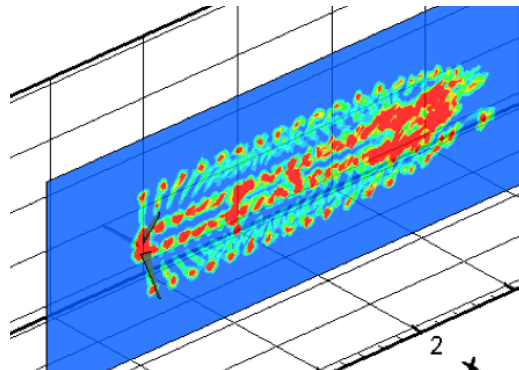
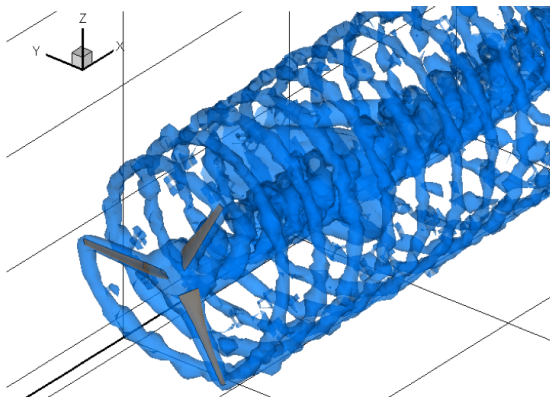
- A 10 kW hardware in the loop wind turbine emulator-generator test bed with appropriate data collection equipment
 - Testing of new generator concepts (energy yield, efficiency etc.) under realistic conditions
 - Testing of customer generator, gearbox and electronic equipment under adverse conditions (grid faults or other operating conditions)
 - Testing of turbine-generator controller combinations for assessment of their suitability (energy yield or otherwise) for a particular wind regime
 - Control strategy development
 - Identification of action needed under fault conditions to avoid harm to the system or grid connected customers or to the grid



METUWIND LABS

◆ High Performance Computing Lab

- 512 core
- 2.3 GHz processors
- 2 Tb total memory (4 Gb/core)
- 16 Tb storage and backup system
- 512 core GPU on server
- Active research on CFD based RANS/DES unsteady flow solutions on high resolution, terrain fitted unstructured grids coupled with a mesoscale atmospheric flow solver such as MM5 or WRF.
- Parallel GPU/CPU free-wake, RANS, LES computations.



METUWIND FOCUS AREAS

□ Main research focus areas are:

- Aerodynamic and structural design optimization
- Wake interactions
- Active/Passive flow control
- Wind farm design and optimization
- Topographical analysis and micrositeing
- Energy storage
- Adaptive control techniques
- Mechanics of composite materials and material characterization
- Damage mechanics
- Structural optimization
- Structural dynamics and aeroelasticity
- Innovative manufacturing techniques for composite blades
- Architectural and regional integration
- Public acceptance issues

METUWIND HIGHLIGHTS

- ❑ Associate Member of European Energy Research Alliance Joint Programme Wind (EERA JPWind)
- ❑ Full member of European Academy of Wind Energy (EAWE)
- ❑ National and international projects on:
 - Wind potential assessment and micrositing – offshore and onshore
 - Wind turbine rotor/wake aerodynamics and flow control
 - Delamination and failure in composite wind turbine blades
 - Bending twisting coupling of composite turbine blades
 - Wind turbine aeroacoustics
 - Wind turbine icing
 - Low-cost off-shore floating platforms
 - Hardware-in-the-loop Wind-Electric Energy Conversion Tests
 - Integration of Research Infrastructures in Wind Energy in Europe (Large Scale Wind Tunnel and Electromechanics Lab)
- ❑ Part of several submitted EU H2020 proposals. In consortium of other H2020 proposals that are currently in preparation.
- ❑ Contract work for the industry (wind loads, wind potential assessment, wind turbine aerodynamics, material characterization, mechanical tests, etc.)



METUWIND ORGANIZATION AND MANAGEMENT TEAM

Yönetim Kurulu
(ODTÜ Öğr. Üyeleri)



Yrd. Doç Dr. Zeynep Kalaylıoğlu
RÜZGEM Müd. Yrd.



Doç. Dr. Oğuz Uzol
RÜZGEM Müdürü

Danışma Kurulu
(Sanayi, Kamu, STK, Üniversite
Temsilcileri)



Prof. Dr. Altan Kayran
RÜZGEM Müd. Yrd.

Lab Coordinators

**Aerodinamik
Labi**



Doç Dr. Oğuz Uzol

**Kompozit Malzeme
Labi**



Prof. Dr. Altan Kayran

**Yapısal Mekanik ve
Malzeme Labı**



Doç. Dr. Demirhan
Çöker

**Yapısal
Dinamik Labı**



Doç. Dr. Melin Şahin

**Yüksek Başarımlı
Hesaplama Labı**



Prof. Dr. Ismail Hakkı
Tuncer

**Elektromekanik
Labi**



Prof. Dr. Bülent Ertan

Administrative Personnel



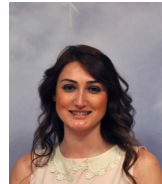
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Başar Kütükoğlu



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Yashar Ostovan



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