
NOVEMBER 30, 2007
RIGGS ALUMNI CENTER

# DLR Rotorcraft Research

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| 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|---|---|---|

# The roots – how it all began

- 1936-41: FW 61/FA 61 (2 vehicles)
  Prof. H. Focke (Engineer) and W. Just from Achgelis (Mathematician)


- 1936: Fl 185, 1938: Fl 265, Fl 282
  A. Flettner (later Chief Eng. at Kaman)
  Hohenemser, Sissingh, Bölkow
  First intermeshing rotor


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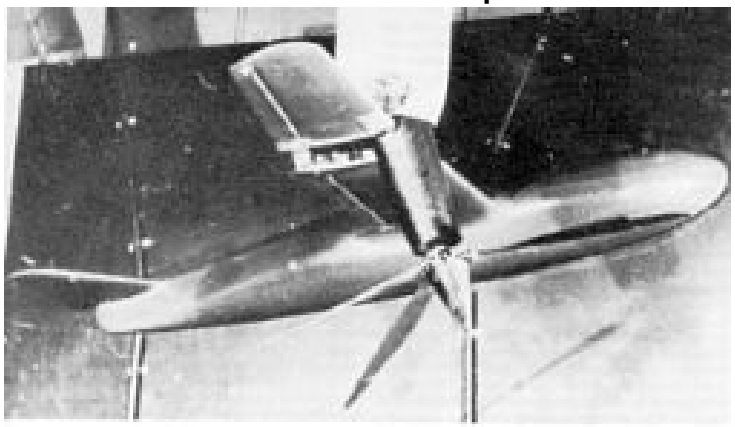
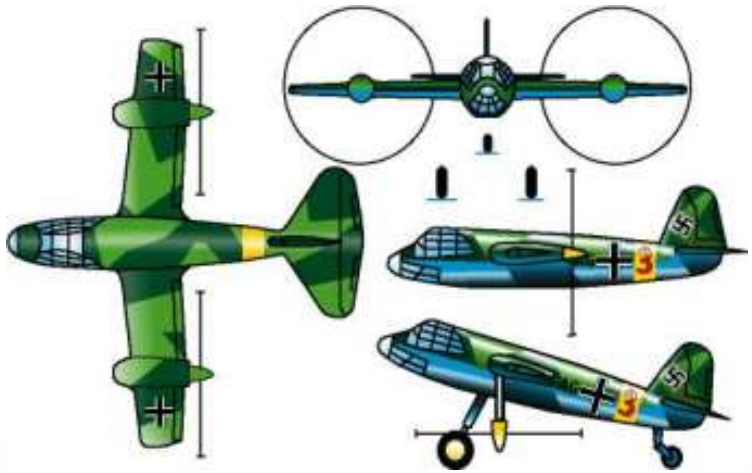
# The roots – how it all began

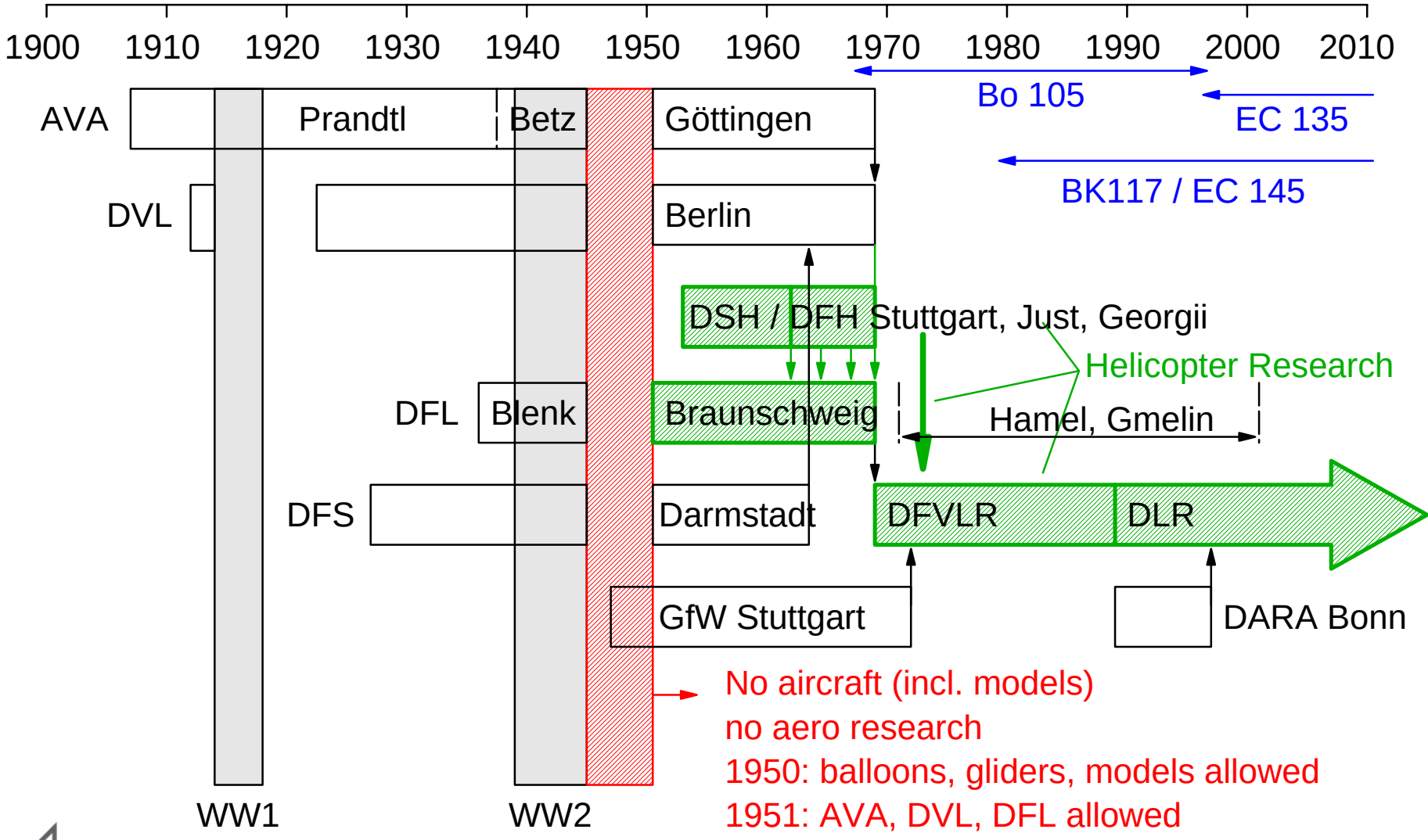
- 1939-45: FA 223 (40 vehicles)
  First crossing of the
  English Channel by helicopter


- 1943-44: FA 269 (wind tunnel test)
  First tilt rotor concept





# Consolidation of German Aerospace Research Est.



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# Evolution of Helicopter Research Establishments

- 1953: Foundation of the DSH (German Helicopter Research Institute) in Stuttgart, since 1957 called DFH (all VTOL concepts)

  Head: W. Just

  DSH alumni: Reichert, Richter, Sonneborn, Gmelin, Pfleiderer, Kindermann, Georgii, …

  Pre-development of wind tunnel test rig for R=2m Mach scale rotor models

- 1962: Integration into DFL

- 1969: Integration into DFVLR

- 1973: Move to DFVLR Braunschweig (B. Gmelin only)

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# Milestones of DFVLR / DLR Helicopter Research

- 1976: 1st wind tunnel model rotor test at VW, since 1979 in DNW
- 1977: US/German MoU in Helicopter Aeromechanics established
- 1978: 1st Bo105 research helicopter (still in operation, Kulites + strain gages)
- 1985: 1st helicopter in-flight simulator (Bo105, FbW/FbL, crashed 1995)
- 1985: 2nd rotor test rig for wind tunnel tests (MWM)
- 1998: Common DLR / ONERA Helicopter Research Program established
- 2002: 2nd helicopter in-flight simulator (EC135, FbL)

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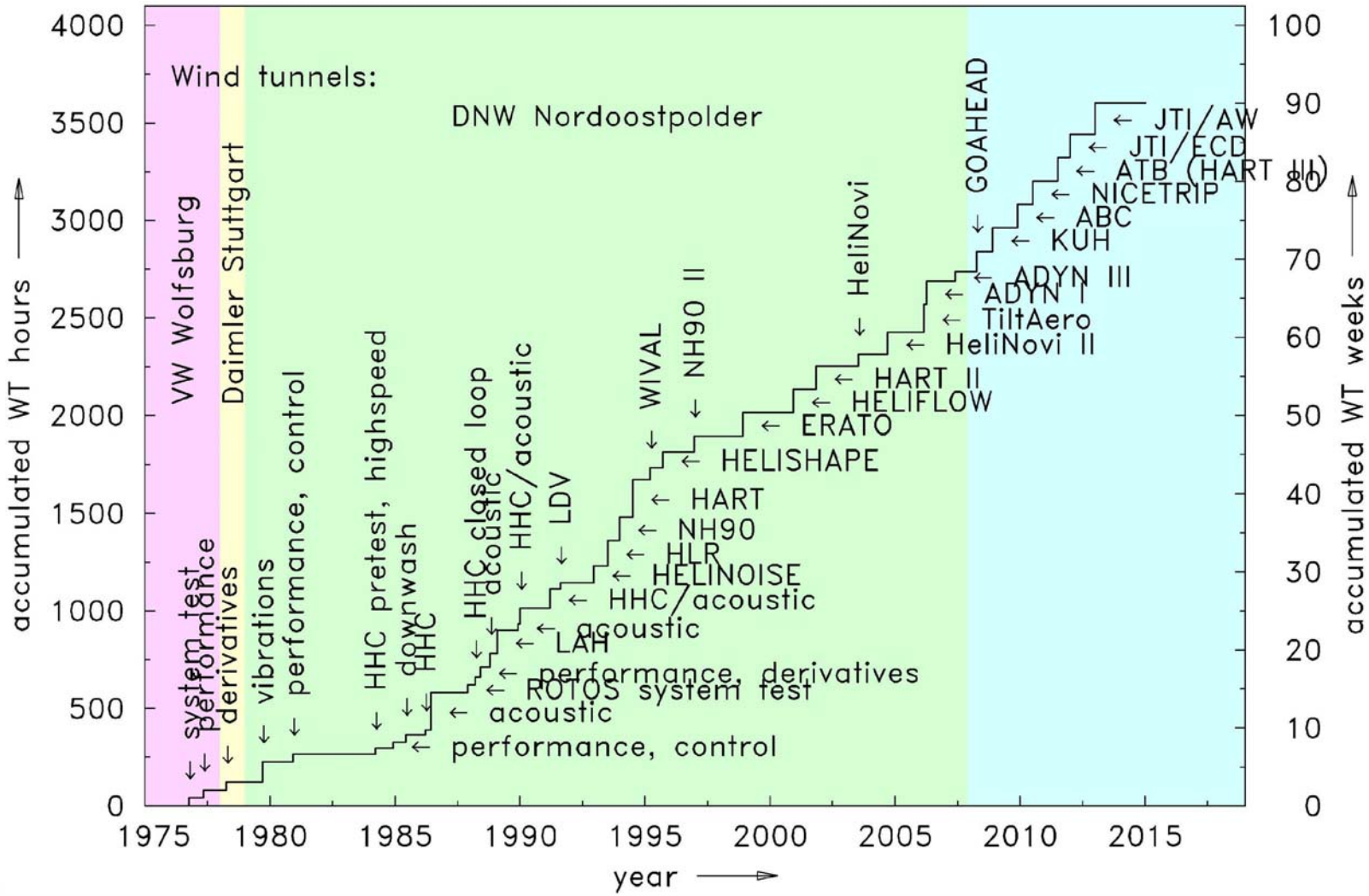
# DLR/ONERA Common Rotorcraft Research

- Established 1998 (J.J. Philippe / B. Gmelin)
- Permanent common management team (B. Demaret / K. Pahlke)
- Currently 8 research concepts (1 Responsable at DLR and ONERA)
  - 1 – The virtual Aerodynamic Rotorcraft (complete vehicle CFD)
  - 2 – The Quiet Rotorcraft (acoustics)
  - 3 – The Smart Rotorcraft (technologies for extended operations)
  - 4 – The Safe Rotorcraft (crashworhtiness)
  - 5 – The Comfortable Rotorcraft (vibration, internal noise)
  - 6 – The Active Rotorcraft (active rotor blade control)
  - 7 – The Advanced Rotorcraft (Tiltrotor, UAV)
  - 8 – The Specialized Military Rotorcraft (detectability, ONERA only)
- 2005 total budget: 20 M€ (≈10 M€ / organization)
- 2005 publications: 55 reports, 63 articles/papers, 2 PhD thesis

# DLR Institutes involved

- **Aerodynamics and Flow Technology, Braunschweig**
  CFD, acoustics, noise measurements
- **Aerodynamics and Flow Technology, Göttingen**
  Flow field measurements (S-PIV, V-PIV, BOSS)
- **Composite Structures and Adaptive Systems, Braunschweig**
  Active twist blade design
- **Flight Systems, Braunschweig**
  Helicopter and rotor simulation, flight test, wind tunnel test
- **Structures and Design, Stuttgart**
  Crashworthiness

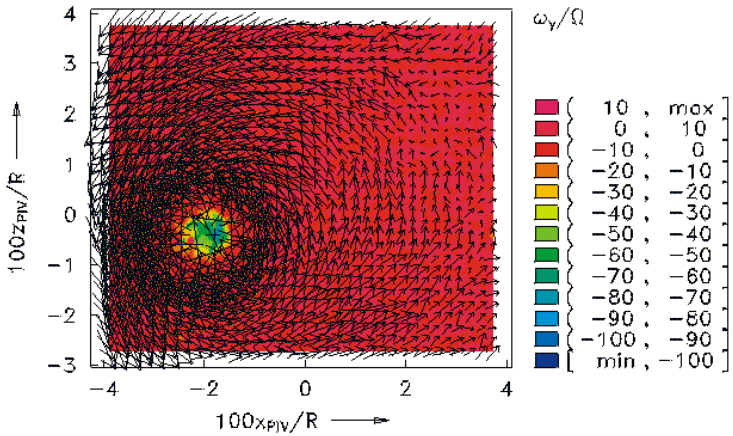
# Evolution of Rotorcraft Wind Tunnel Testing at DLR

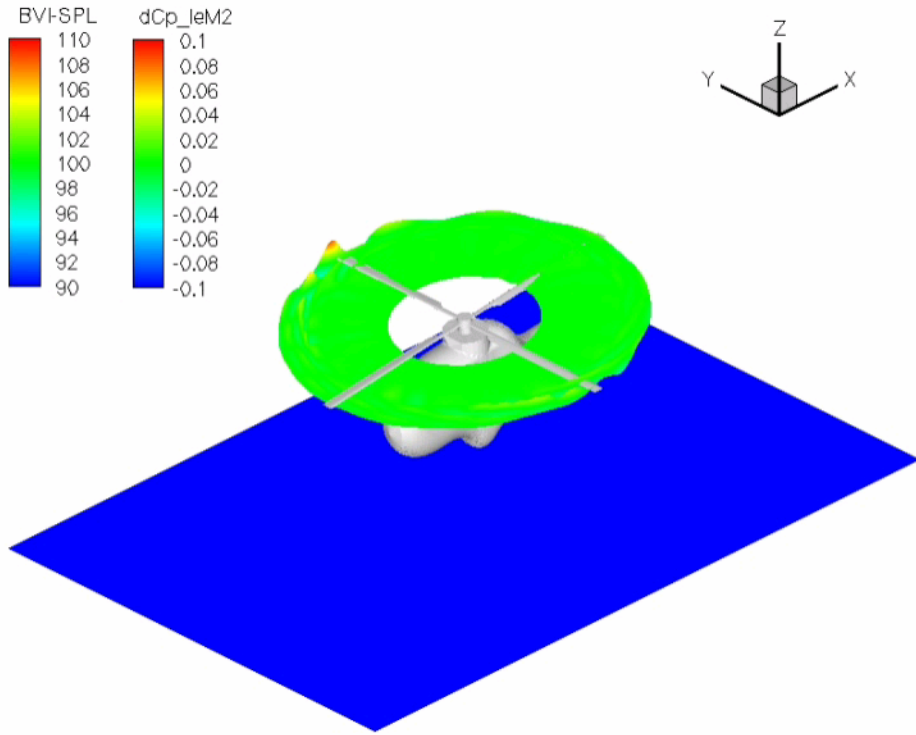


# HART: HHC Aeroacoustic Rotor Test
# DLR, ONERA, US Army, NASA, DNW

- 1994: HART I – acoustics, air loads
- 1996: AHS Gruppo Agusta Award

- 2001: HART II – wake, blade motion
- 2004: AHS Howard Hughes Award
- 2005: International workshop



# Active Twist Rotor
# DLR/ONERA, EU Programs Friendcopter & Green Sky

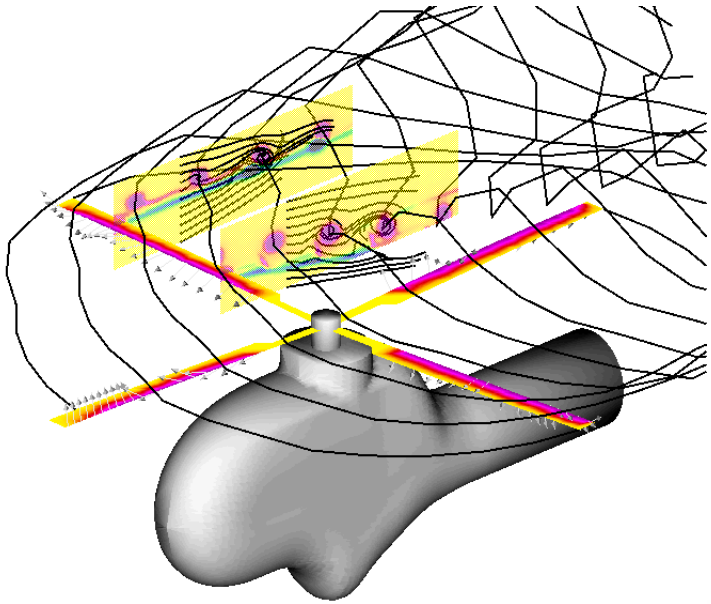
- 2005-2007:
- Design
- Whirl tower tests
- Performance evaluation

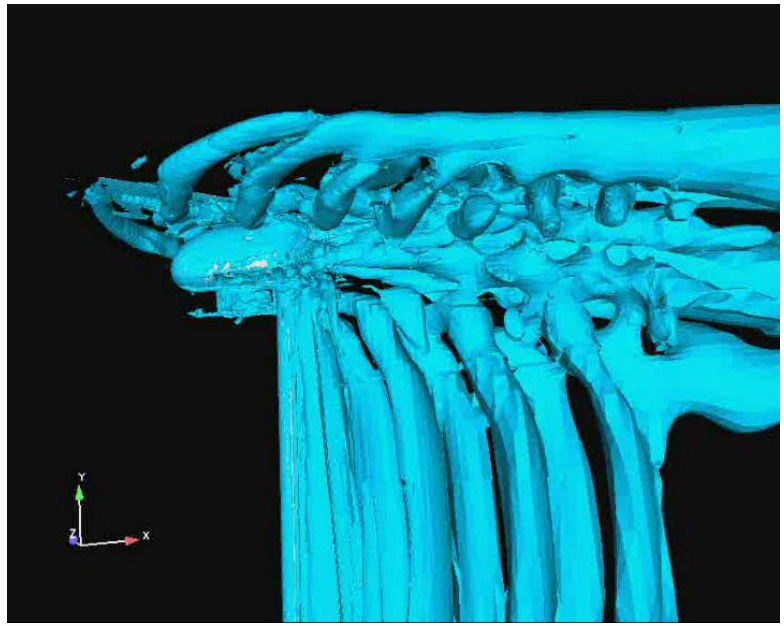
- 2008-2010:
- Manufacturing of WT rotor
- Laboratory tests

- 2011: DNW test (HART III)

# Numerical Tools

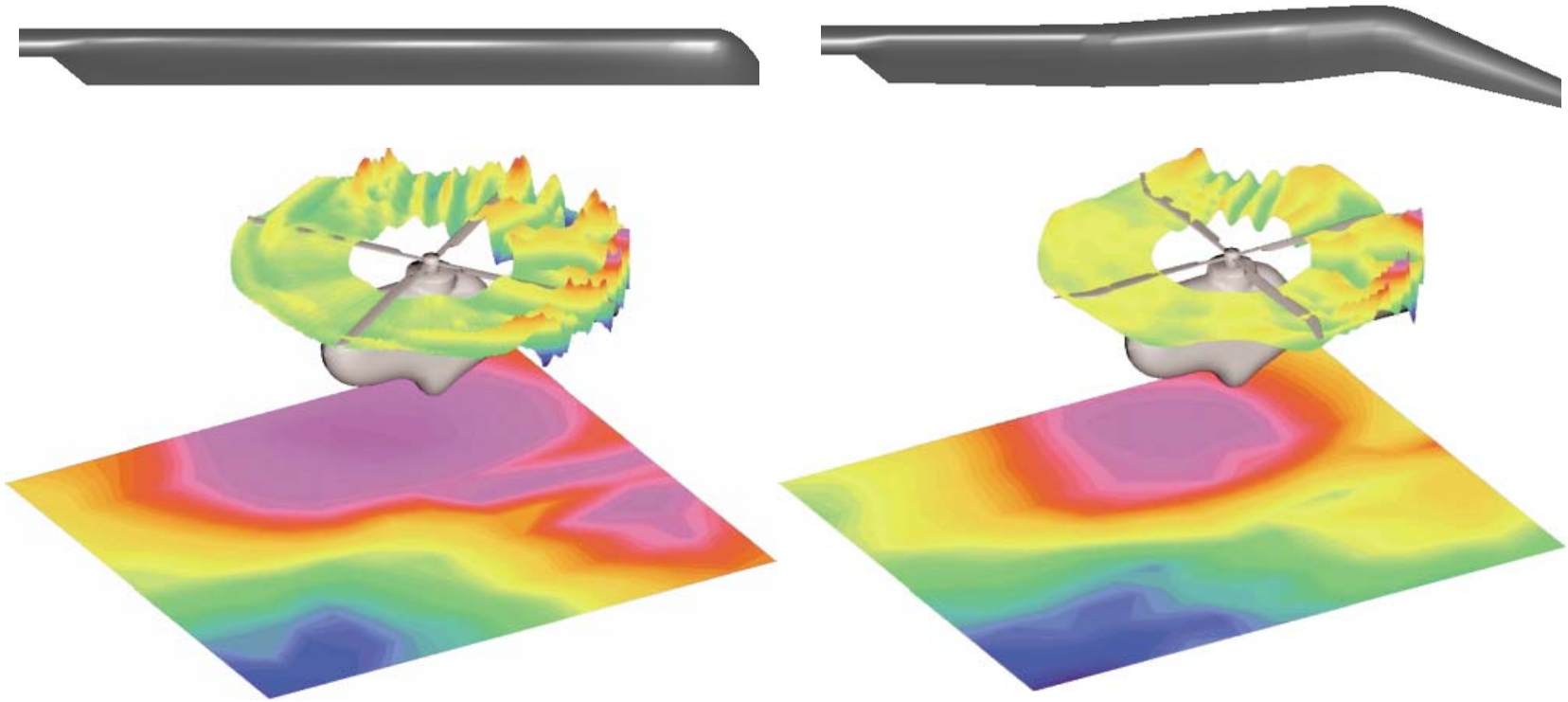
- HOST – Eurocopter code for vehicle simulation
- S4 – DLR's high resolution rotor code
- Flower – DLR's structured grid CFD
- TAU – DLR's unstructured grid CFD





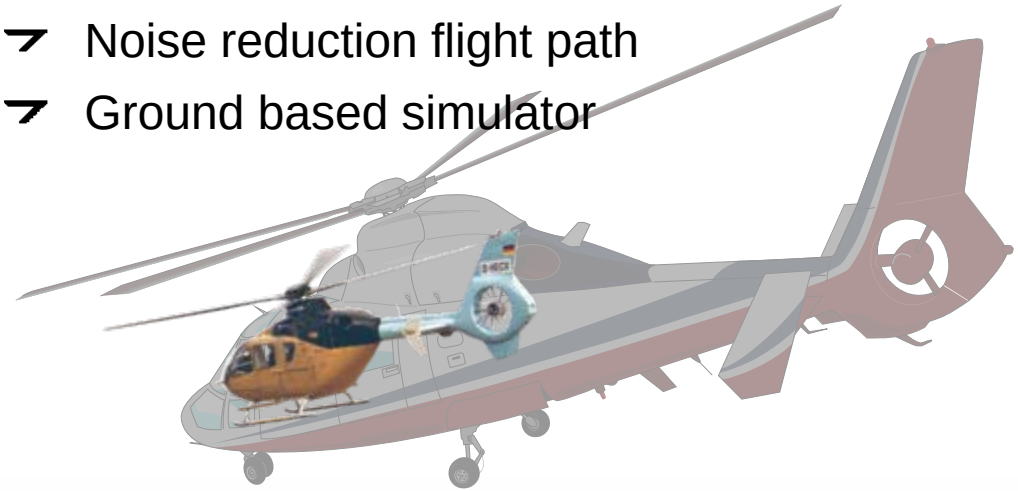
# Rotor Aeroacoustic Optimization
# DLR/ONERA ERATO Program 1992-1998

Numerically optimized, WT tested, Worldwide patented



# Flight Testing

- System identification
- MFCS
- In-flight simulation
- HQ investigations
- Slung load stabilization
- All-weather capabilities
- Noise reduction flight path
- Ground based simulator



# Slung Load Stabilization

- Development of a Flight Director
- Flight tests with CH53 of German Army (military bridge segments)
- Flights tests with DLR's BO105
- Stabilization via modified synthetic horizon

# Thank you!

Congratulations to 25 years of excellence in rotorcraft research!

The best wishes for the future to the

## Alfred Gessow Rotorcraft Center


at the Department of Aerospace Engineering
of the University of Maryland!