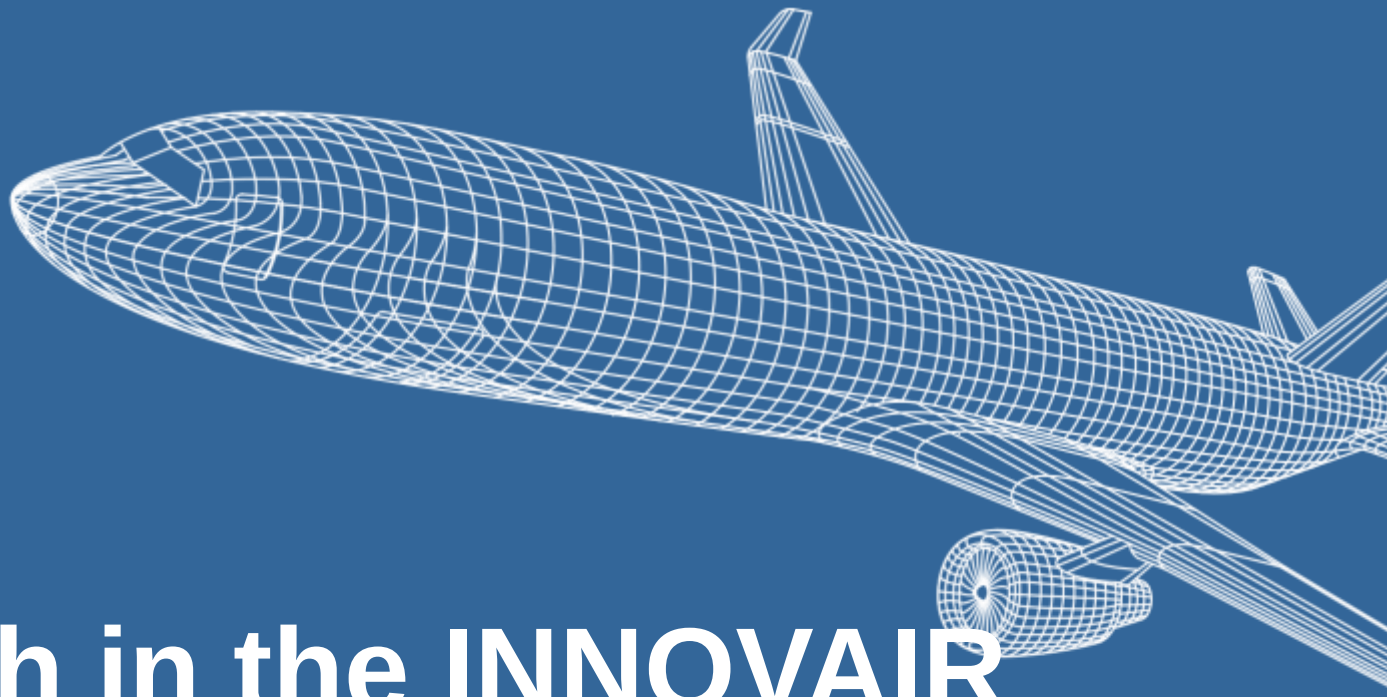

Research in the INNOVAIR turbomachinery cluster

Hans Mårtensson, 2016-10-12

Export Control

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Export Control

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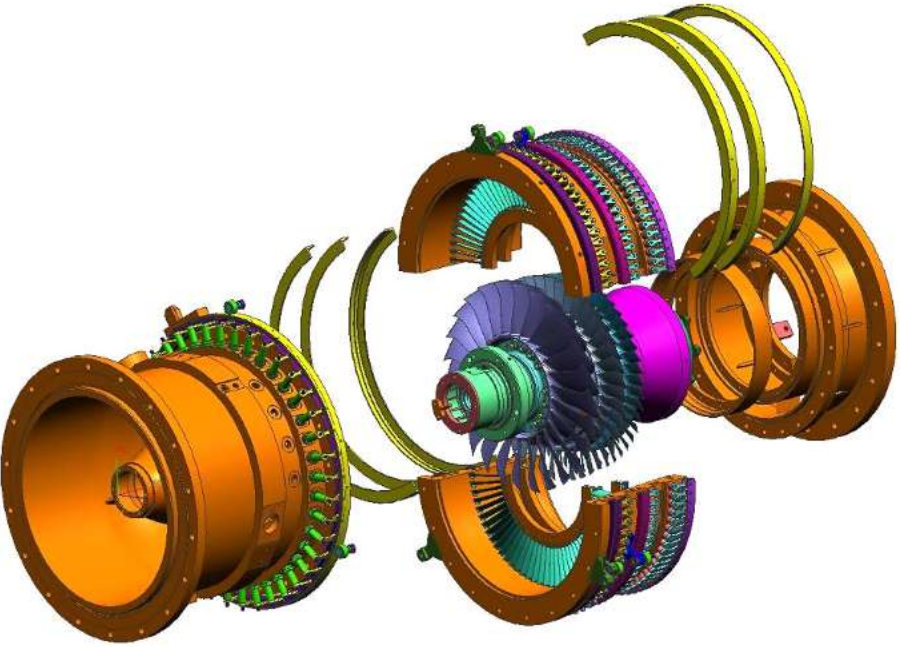
More power–less weight–close to physical limits



Tip speed 500 m/s
Supersonic flow

Designed and tested in the VITAL EU project
Power 5 MW (6500hp)
Diameter 400 mm
Flow 20 kg/s

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Aircraft Engines

A wide variety of operating conditions, and long service life

- Analysis methods with high confidence to support operations and customers
- Robustness in design/re-design/manufacturing
- Design capabilities, in a complex product
- Innovation capabilities





Engine Structures



Engine Rotatives

Full Engine MRO & Support

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Turbomachinery Cluster

A mix of research organizations, people and projects working to improve the efficiency of turbomachines.

INNOVAIR Strategiskt Innovationsprogram Flyg

KTH Vetenskap och konst

Avancez 1826

VINNOVA

Siemens Industrial Turbomachinery

swerea swedish research

Lunds Universitet Lunds Tekniska Högskola

…. long term partnerships improving effectiveness of research

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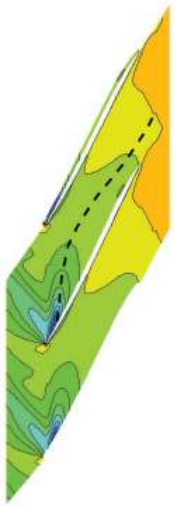
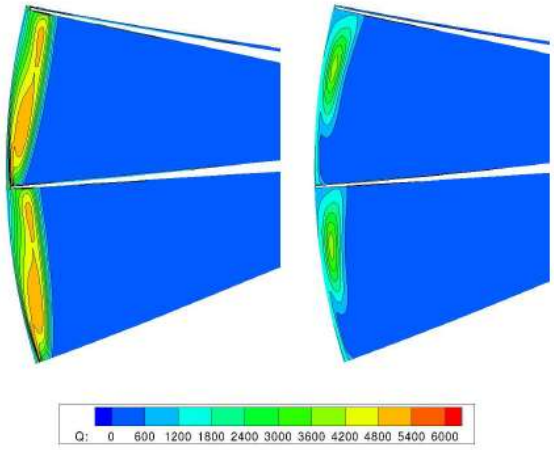
ROKS – Robust design of ccompressor blades

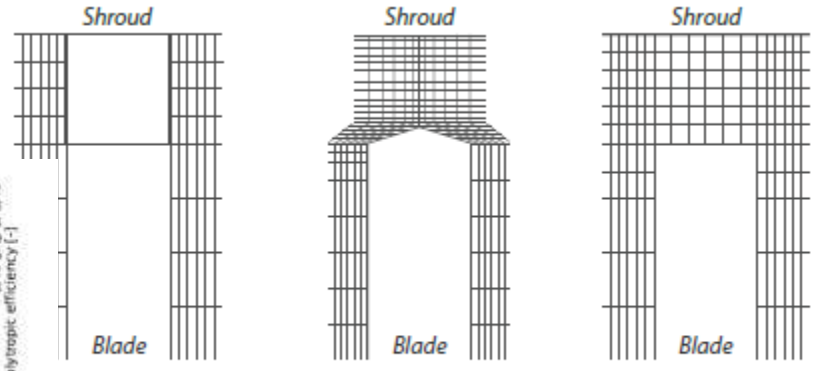
Chalmers and GKN

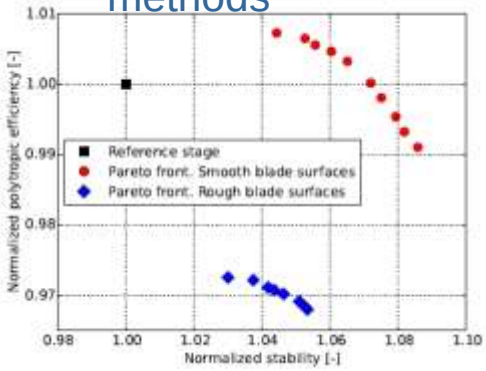
An essential goal of design is robustness

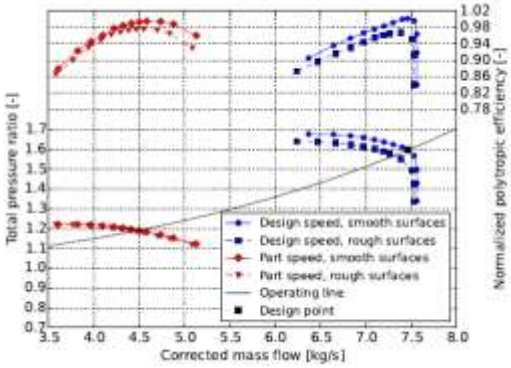
- Balancing efficiency and stablity
- Allowing for imperfections in geometry
  - Roughness
  - Clearances
- Understanding modelling variability
- Contributing efficient methods for shaping airfoils, using part industrial methods











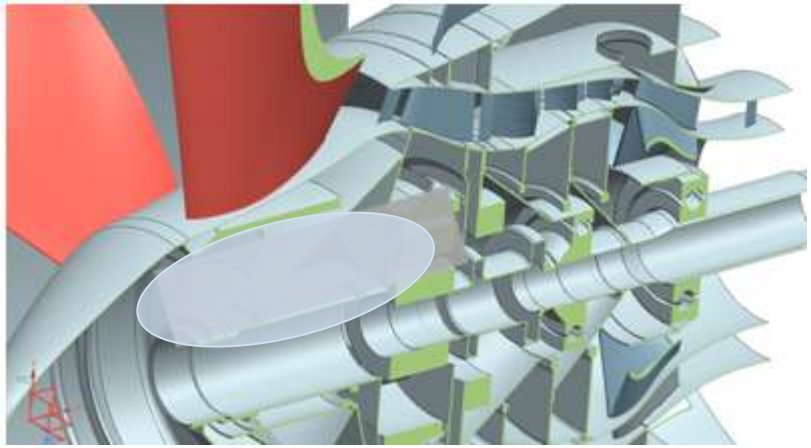
Lejon M., Andersson N., Eriksson L-E, Ellbrant L.,GT2015-43033
SIMULATION OF TIP-CLEARANCE EFFECTS IN A TRANSONIC COMPRESSOR

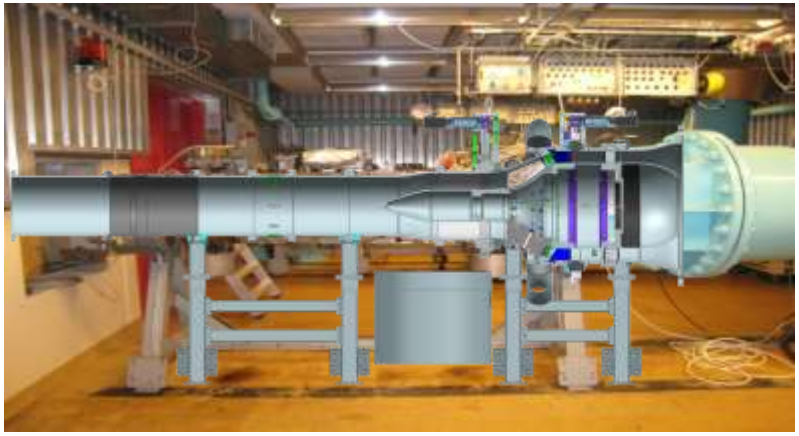
IDA – Integrated Duct Aerodynamics

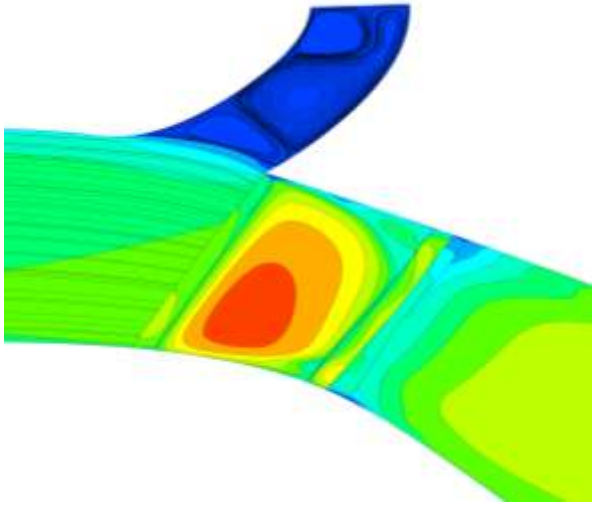
Chalmers and GKN

Drawing on results and collaborations from LEMCOTEC, targeting closer UK collaboration

- Increase the fidelity of CFD, exploiting and developing CFD capabilities at Chalmers
- Collaborate around unique experimental resources ing the UK
- Support the next generation IC frame development in Clean Sky 2.







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MOTSTRÖM- Drag reduction

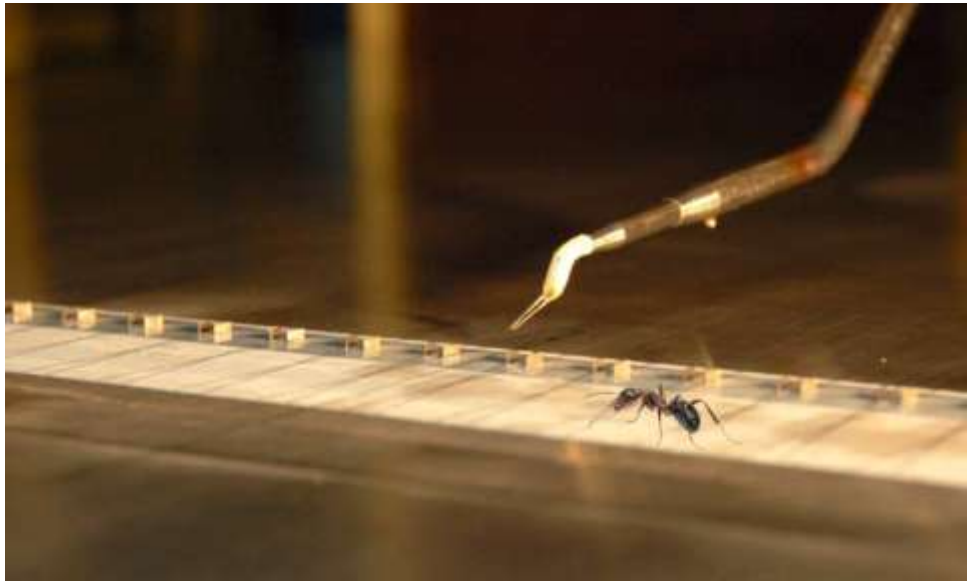
KTH, Chalmers and GKN

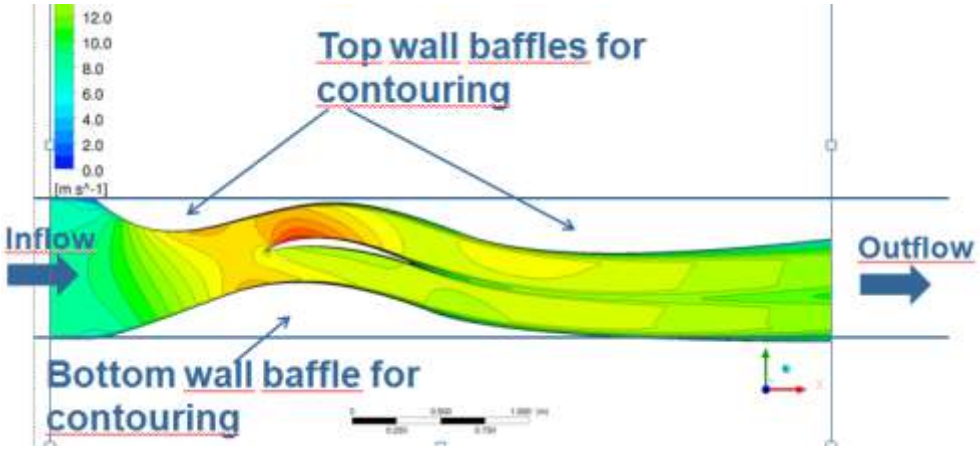
Drag reduction by control of transition

- Aerodesigns from GKN ensuring realistic component conditions

-Large scale low speed Controlled environment in KTH MWL tunnel for properly scaled OGV component 800 mm

- Full scale low speed turbine/OGV test at Chalmers entering rotor wakes in the transition scenario





Couples to other projects by modelling, and by giving possibility to understand technology effects

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Aeromechanics, TurboVib, ARIAS

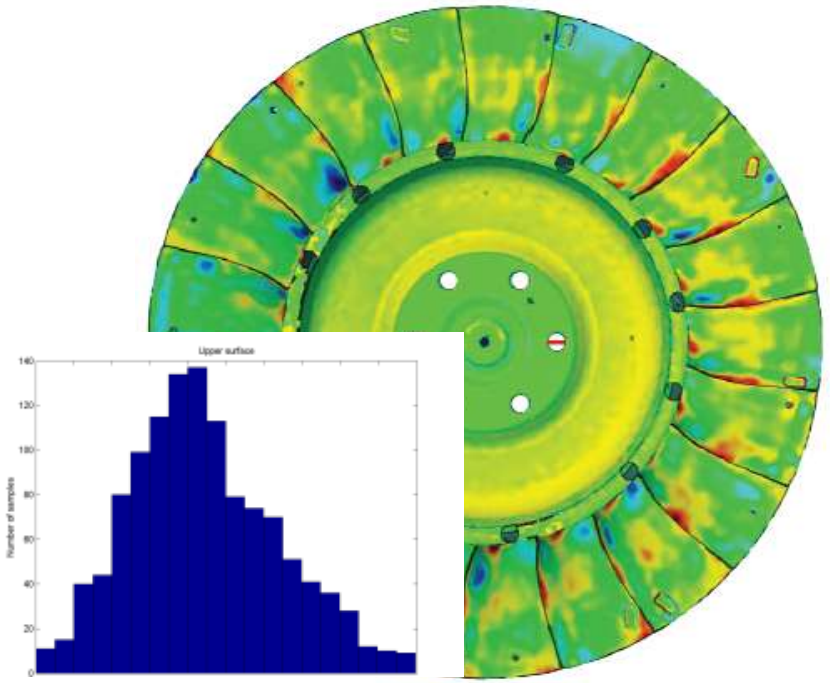
KTH and GKN

With a heritage from TurboPower, closely collaborating with with Siemens NFFP, FUTURE

-TUD, CTA test data along with detailed geometry direcly applicable to validation

-Expensive tests with equipment not available in Sweden

- Aiming at continuation into H2020, with KTH

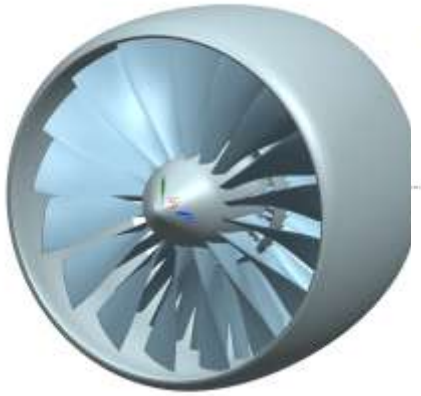


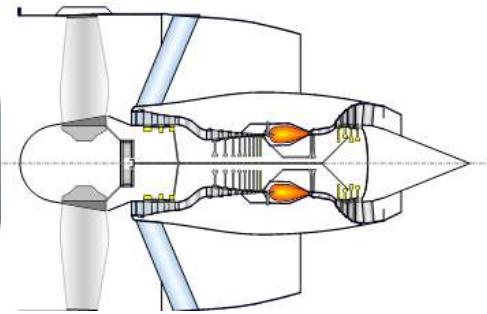
VINK – Virtuell INtegrerad Kompressor

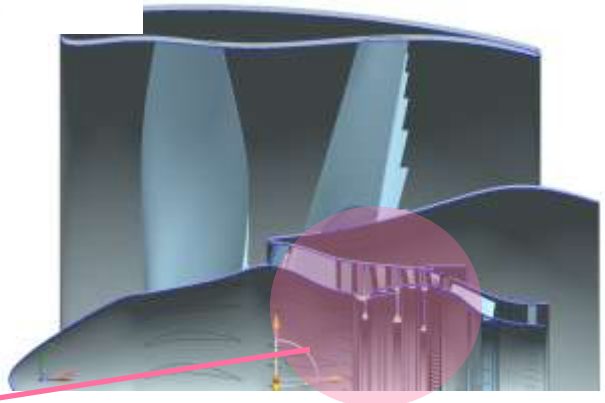
Heart of the cluster

The turbomachine is the best mechanical and aerodynamic design utilizing optimal material and manufacturing choices. Research improving one will affect the others.

- Provide a relevant context platform for all research disciplines, a notional engine framework less restricted by IP requirements
- We often learn context from work meetings, listening more than in regular presentations on what are already expert in
- Finding new research angles for publications







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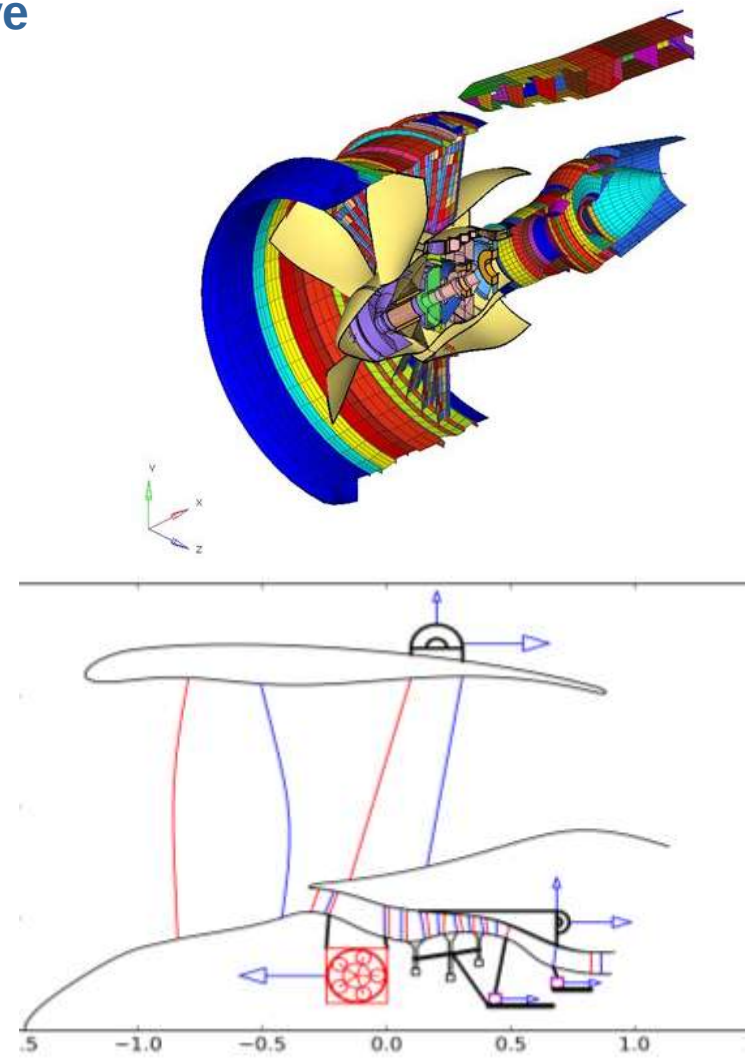
Turbomachinery Cluster / VINK

What does the notional engine framework give

- Boundary conditions traded across the project,
- Conditions for advanced material dependent on temperatures and loads
- Improved structural solutions,for weight but also control of gaps and clearances
- Robustness to environmental , operational or manufacturing variation
- Integration of new functionality



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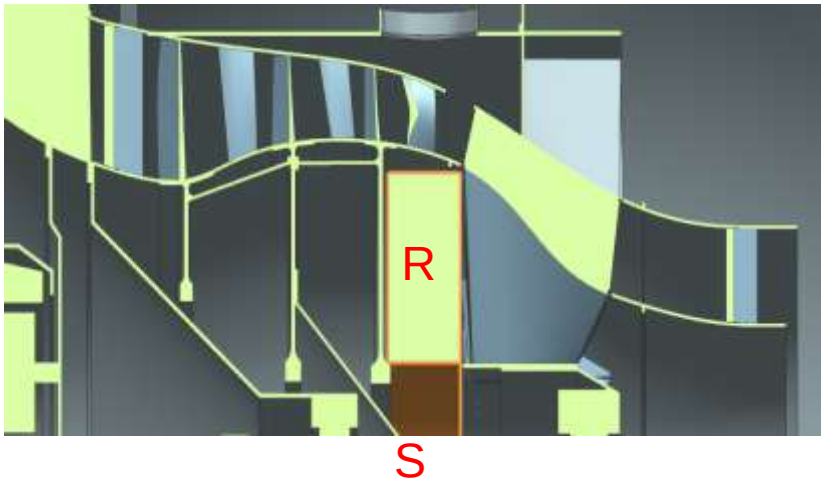
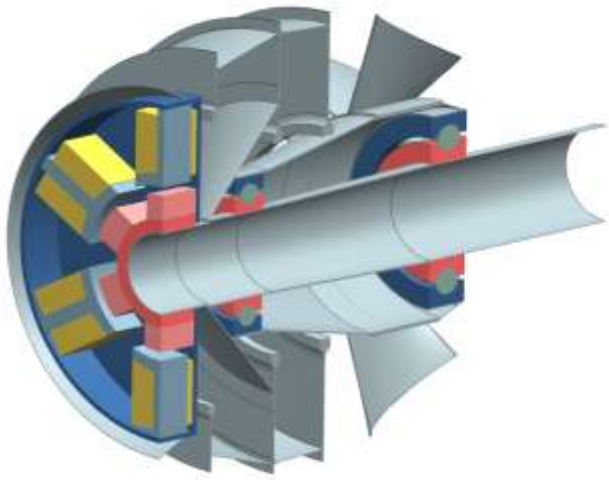
Innovative evolution – example



Weight 158 kg

Power 155 kW

U@T/O= 312 m/s

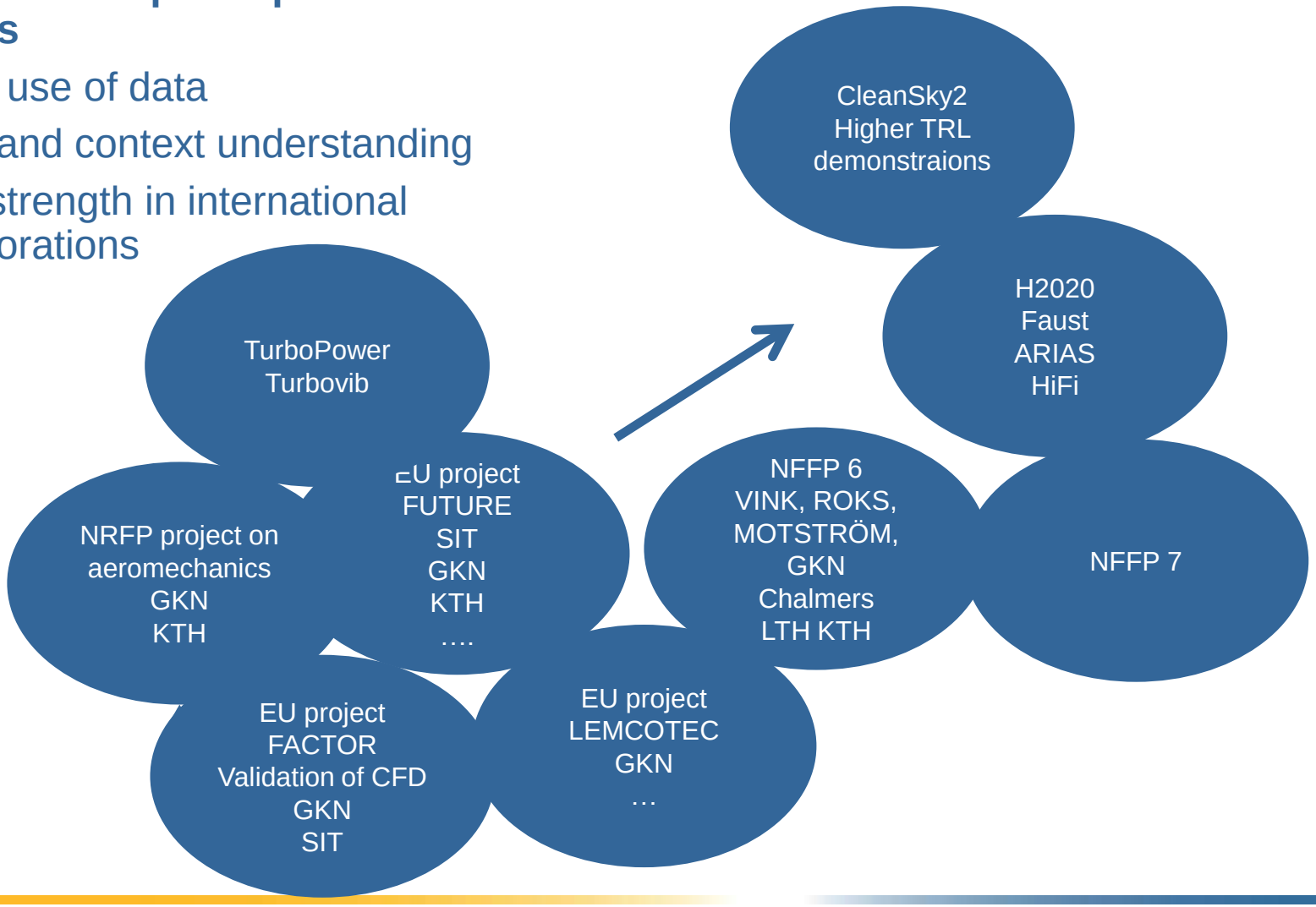


Challenges:
Electric engineering
Cooling, Heat transfer/ heat management
Integration

A bigger research puzzle

Swedish research participation in EU projects

- Direct use of data
- Skills and context understanding
- Gain strength in international collaborations



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