

Development of fuel and heat management systems for liquid hydrogen powered aircraft

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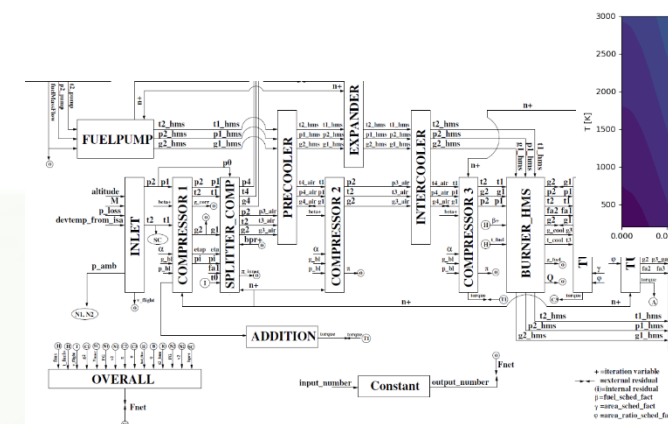
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This project has received funding from the EU Horizon 2020 research and innovation programme under GA n° 769241

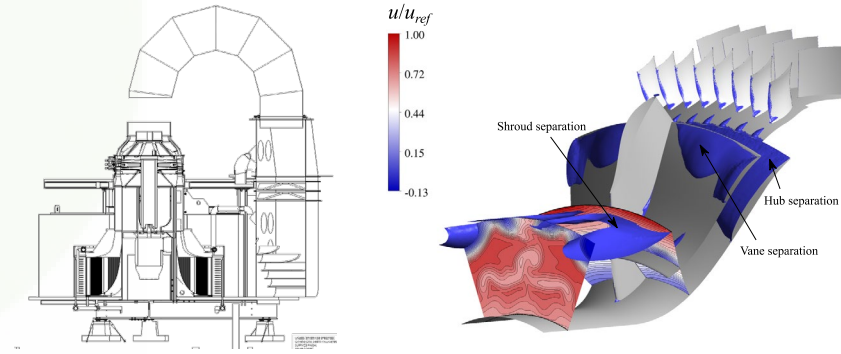
Phase 1: Conceptual Design

- System Model: Adaptation of components for cryogenic fuel simulation.
- Parametric Studies



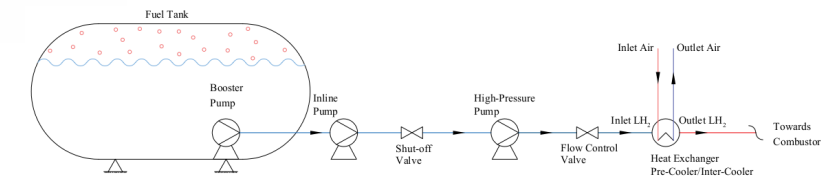
Phase 2: Preliminary design and validation

- Heat transfer, flow turning at representative conditions
- Core exhaust heat rejection
- Core flow cooling
- Low speed high Reynolds number annular test facilities



Phase 3: Heat Management System

- Final heat management system to be down-selected
- Optimize solutions applicable to the ENABLEH2 aircraft concepts
- TRL 2 achieved



Heat management potential

- High specific heat
- Cryogenic storage temperatures (22 K)
- From cryogenic to up to 800-1000 K about 14 MJ/kg can be recovered

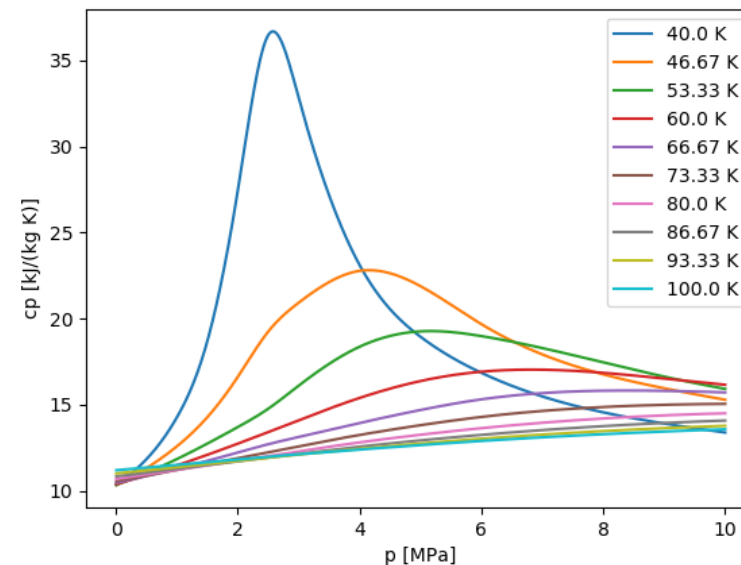


Fig: Hydrogen specific heat variation with pressure and temperature

Heat management potential

- Multiple options for heat recovery from the cycle exist
- Different designs can be explored
- Impact of tank and sub-system performances must be taken into consideration
- Engine performance, CFD and experimental work

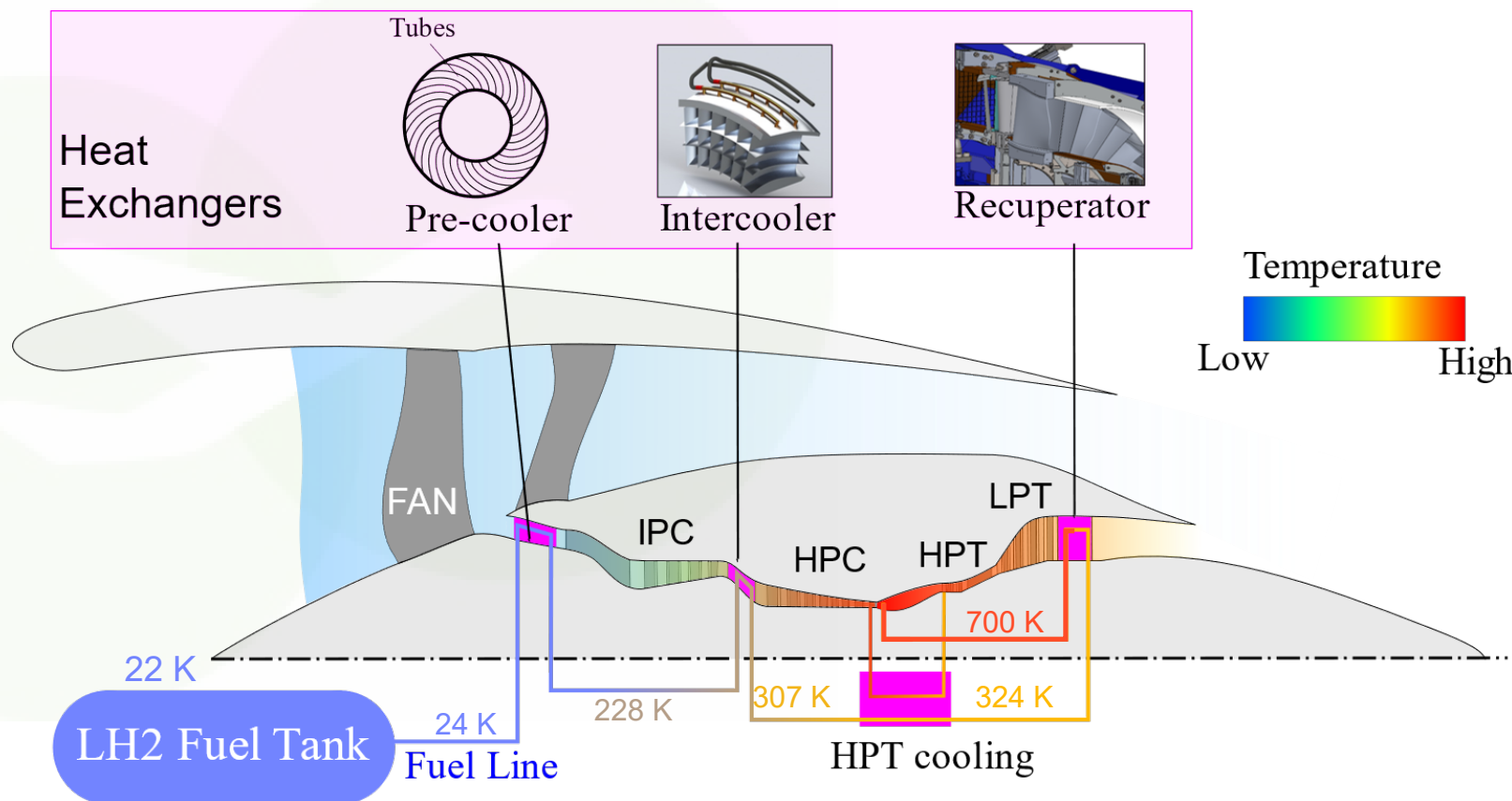


Fig: Cross-sectional meridional cut of a turbofan engine, including possible locations for core heat rejection to the hydrogen fuel



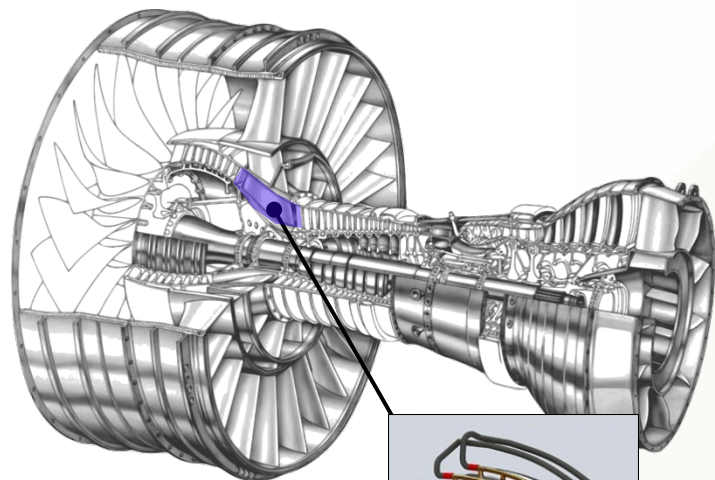
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Vane-integrated HEX

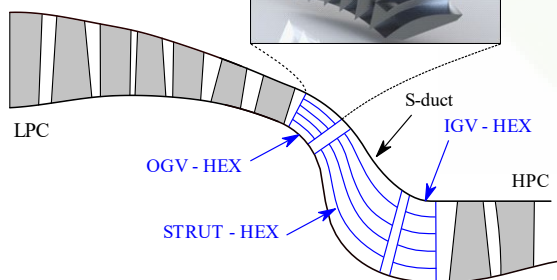
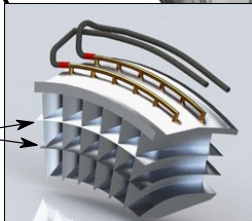


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- Compressor vane integrated HEX
- Enhanced radial turning
- Reduced Core size



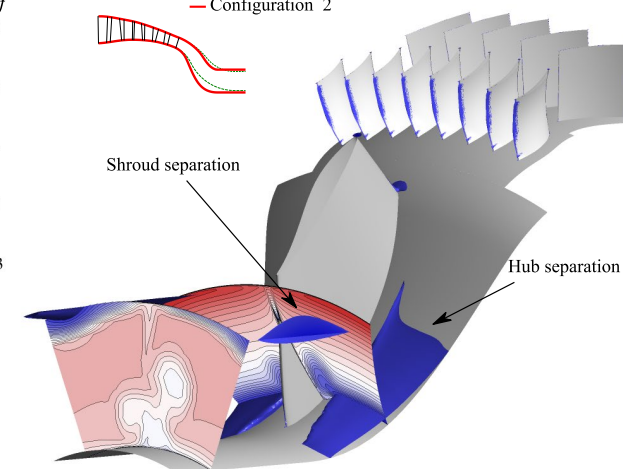
Splitter-vane



u/u_{ref}

1.00
0.72
0.44
0.15
-0.13

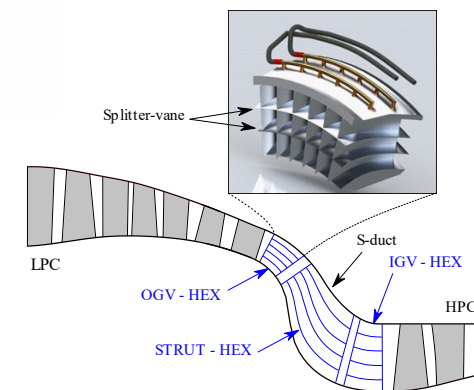
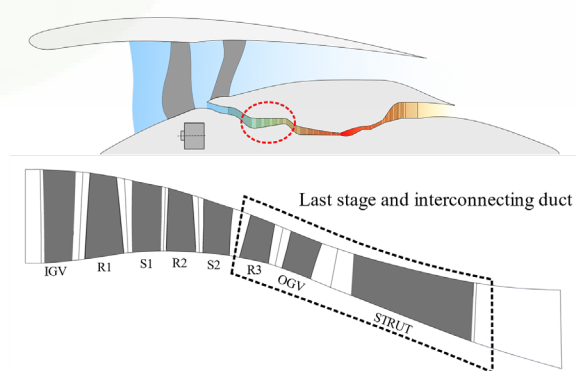
— Configuration 2



Conventional duct



New duct design



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First insight into the design

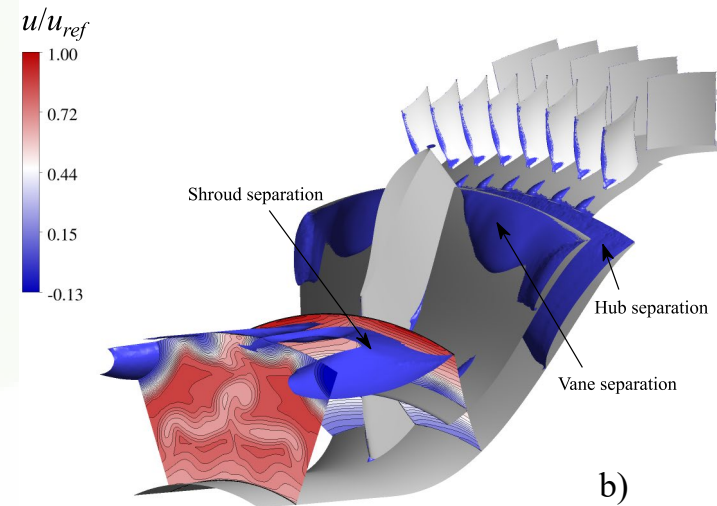
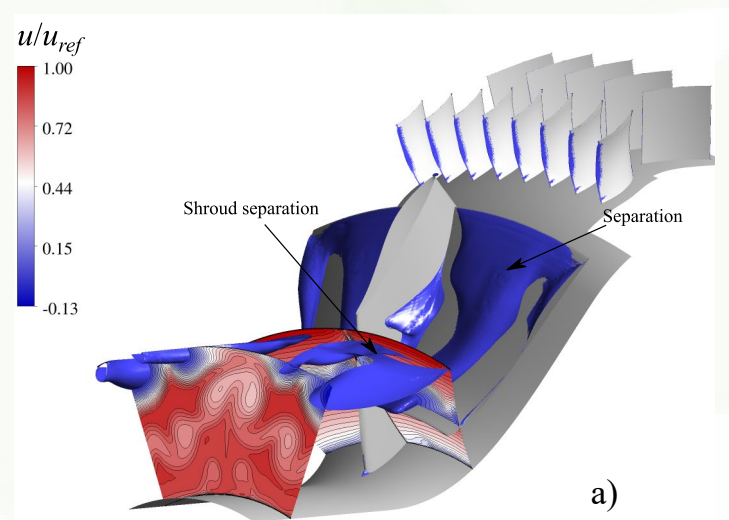
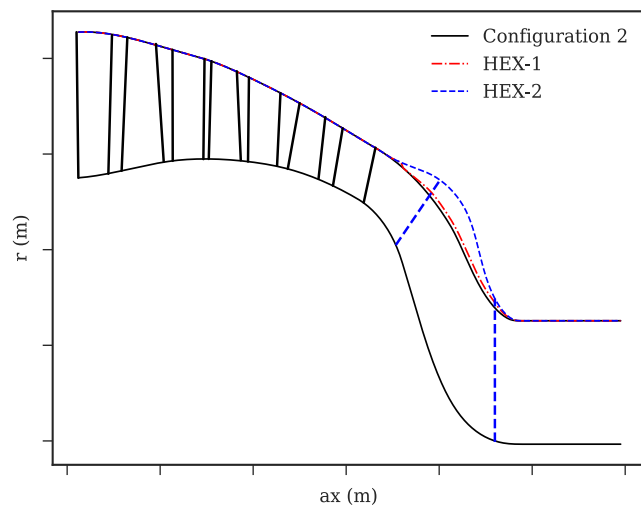
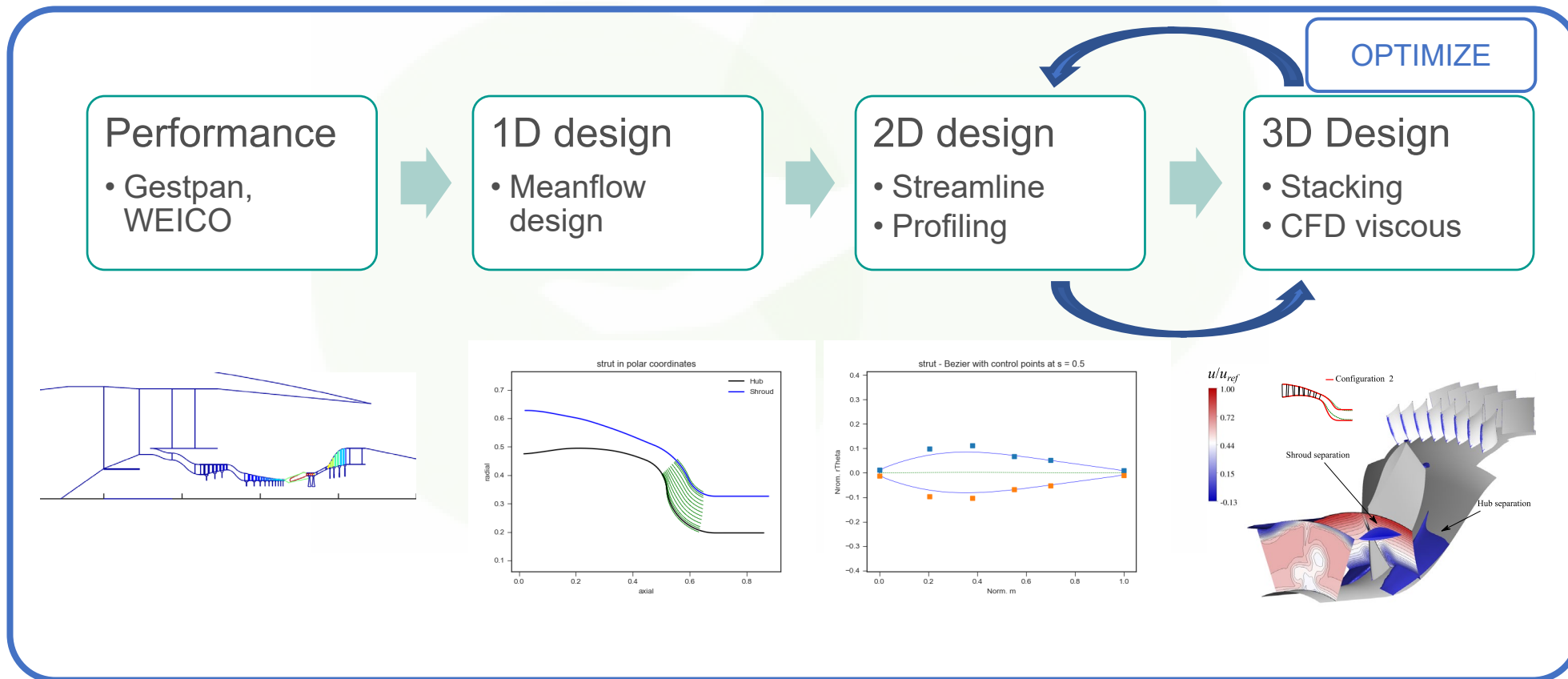


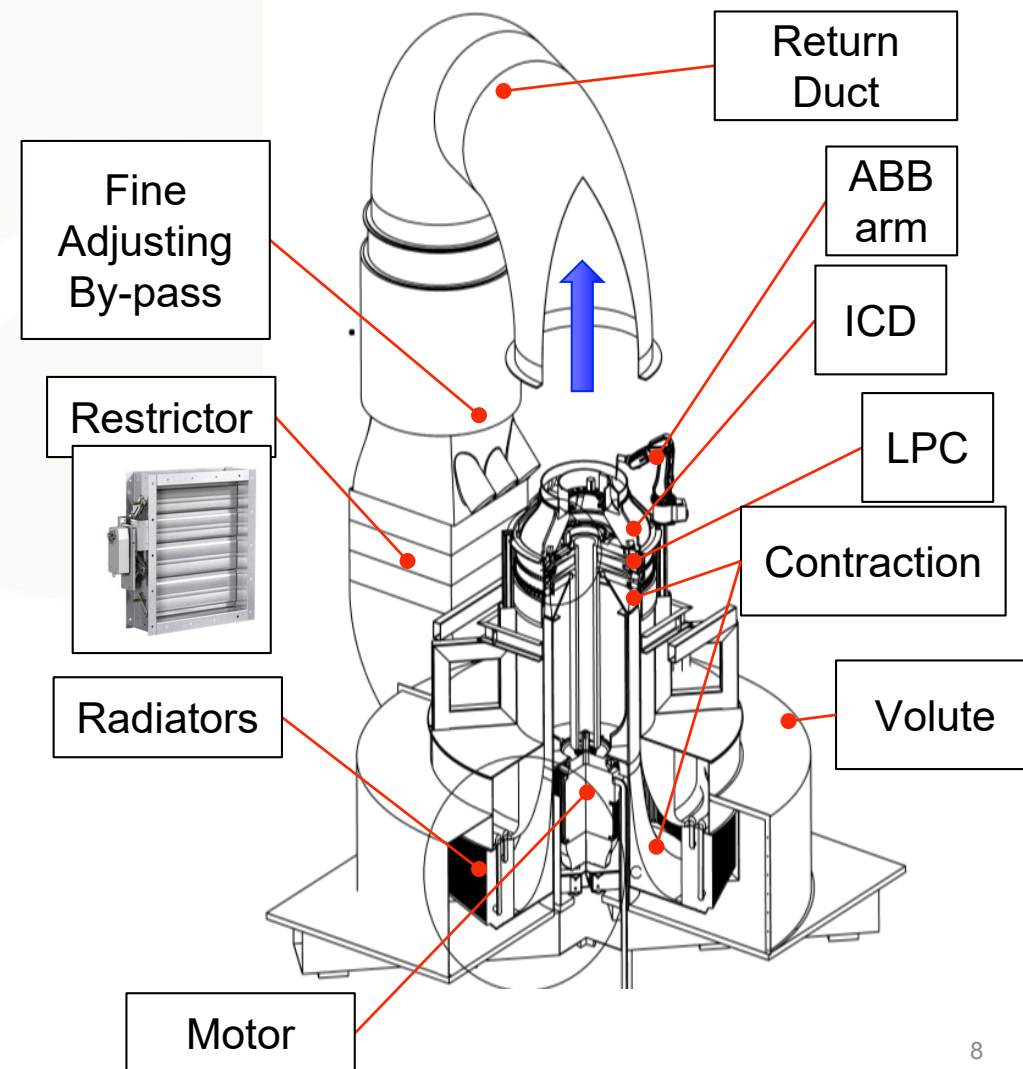
FIG: Normalized axial velocity computed for the HEX-1 (a) and HEX-2 (b) duct design. The Iso-surface shows regions of flow separation.

Design tools



Compressor rig

- 2.5 stages, low-speed
- Vane integrated cooling system
- Calibration
 - Heat transfer
 - Transition





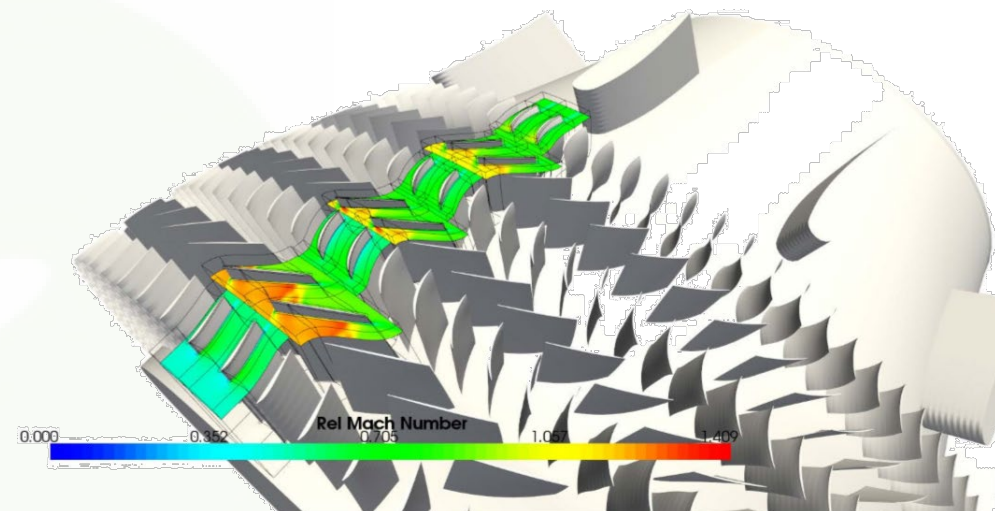
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Compressor rig



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- Version VINK (National Collaboration; GKN, KTH, Chalmers, LTH, Swerea)
- Geared turbofan, 70klb thrust
- Replicate similitudes: Re , ϕ (flow coef.), ψ (stage loading), hub-to-tip ratio, de - *Haller* number



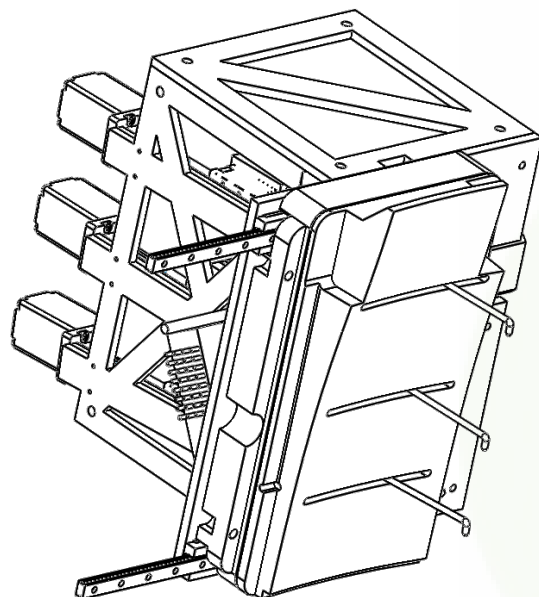


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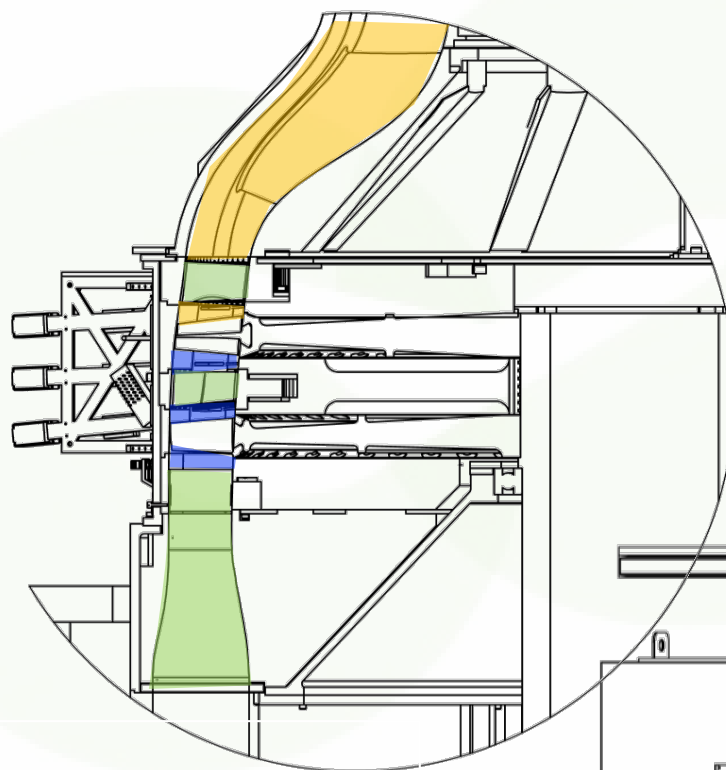
Instrumental Overview



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Easy accessible

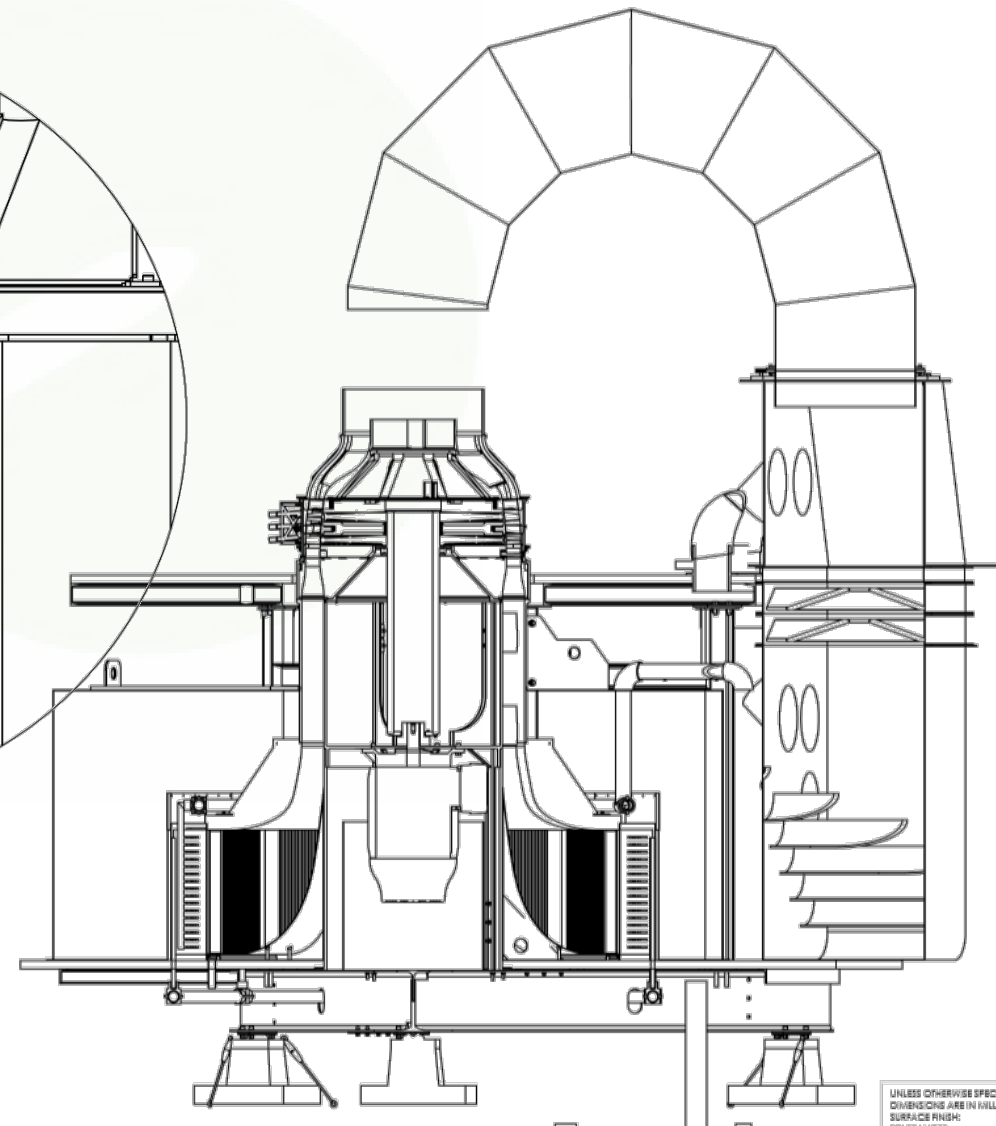


360°

Static mount

- Pressure taps
- Prandtl tube/rakes etc

Sector Access



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
100 80 100 100



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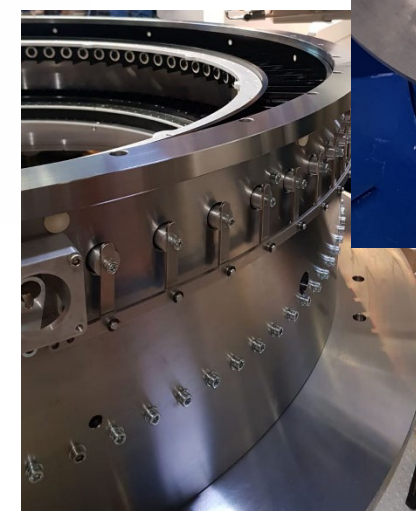
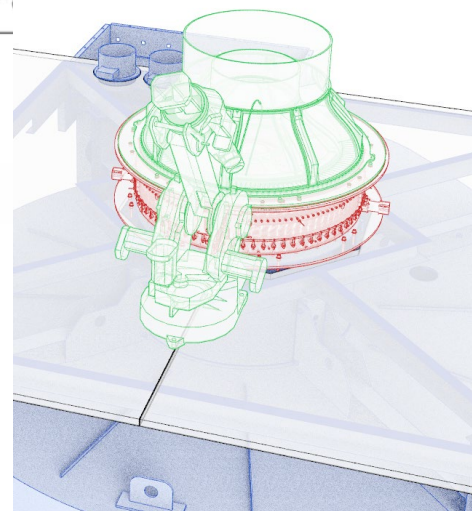
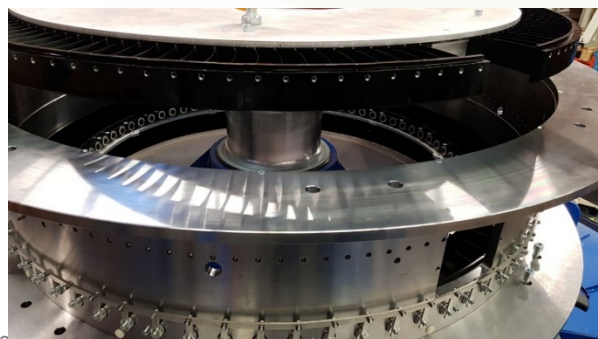
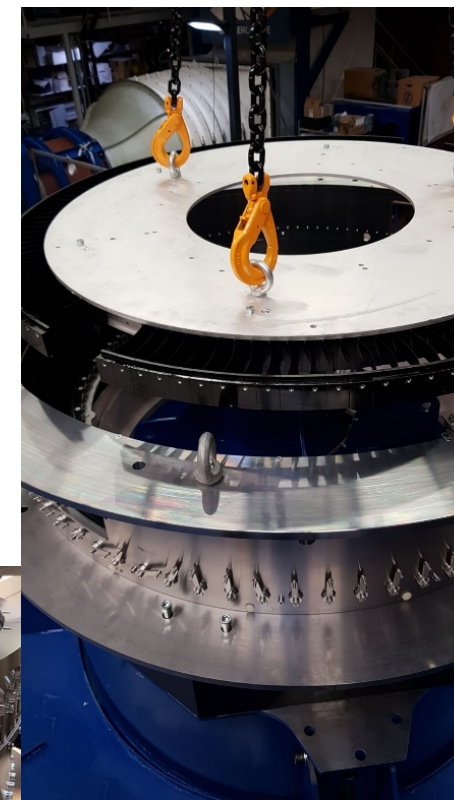
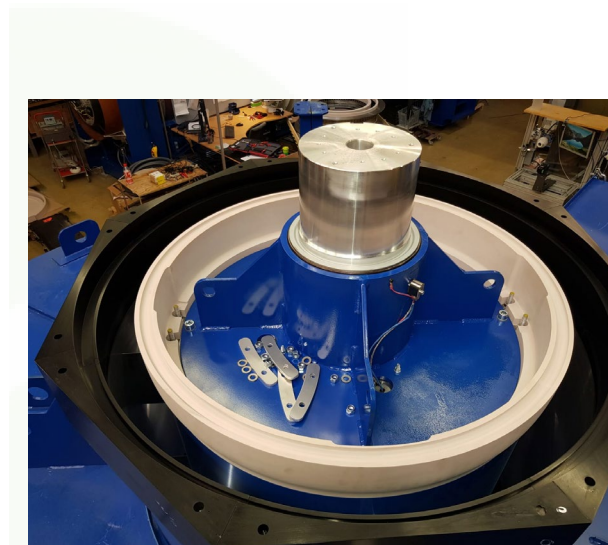
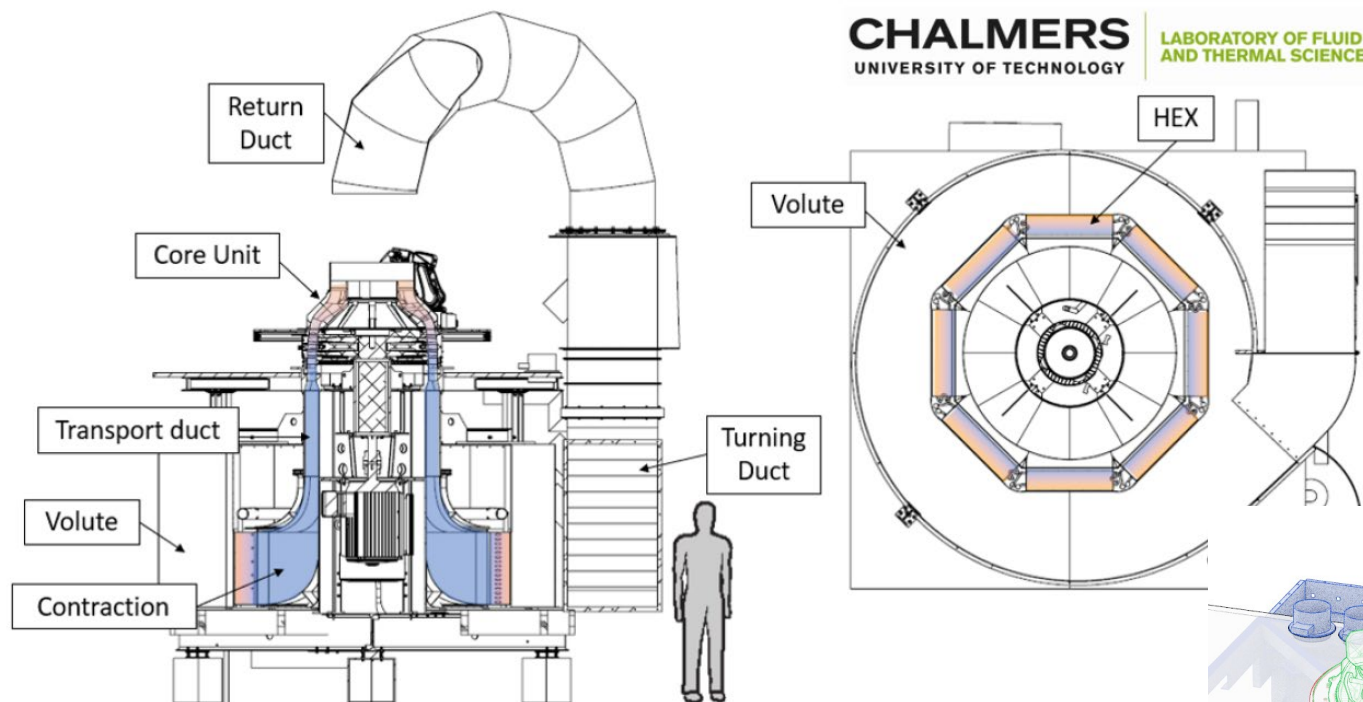


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Teaser



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Future steps



- Validation data
- Preliminary design of vane integrated HEX
- Test design in the new facility
- Optimize the design
- Develop and optimize fuel and heat management systems applicable to different ENABLEH2 aircraft concept





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Thank you!

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London
South Bank
University



Heathrow



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