AeroTherm: aerothermal management technologies for sustainable aviation

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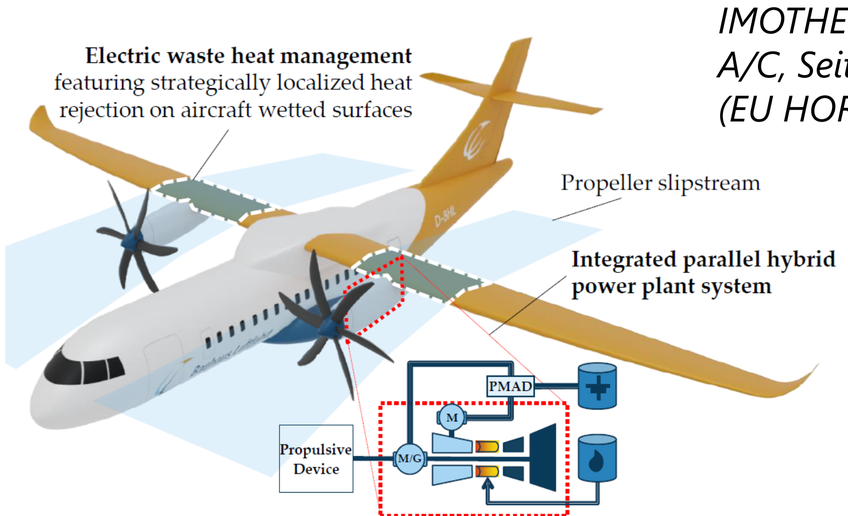
BACKGROUND

Sustainable aircraft concepts (e.g., fuel-cell powered and battery-powered ones) deal with large thermal loads, generated by the powertrain.

There is a strong ***need for an efficient rejection of excessive heat loads*** (options: ducted HX's, surface-embedded HX's, H_2 evaporators).



IMOTHEP REG-CON A/C, Seitz & Peter 2019 (EU HORIZON 2020)

Surface-embedded heat exchangers have a high potential for an efficient rejection of head loads:

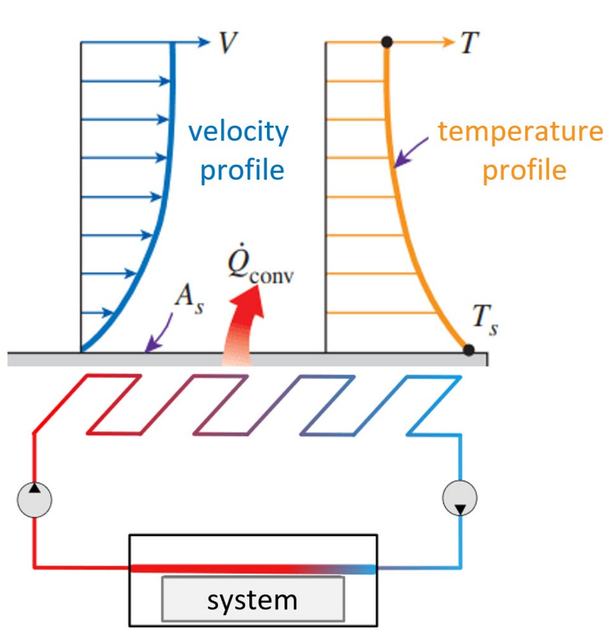
- No form drag due to grazing flow, but
- Complexity (integration) must outweigh improved aerodynamic performance.

OBJECTIVE(S)

AeroTherm aims to physically understand, model, and enhance the heat transfer capacity of skin-embedded heat exchangers, representative of ones required for regional aircraft.

A. Advance heat transfer capacity of external-air-side by exploring non-uniform heating layouts & surface textures.

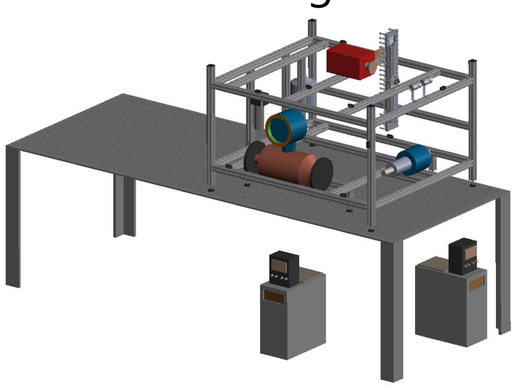
B. Advance heat transfer capacity of internal liquid-side by taking advantage of two-phase, internal flow boiling.

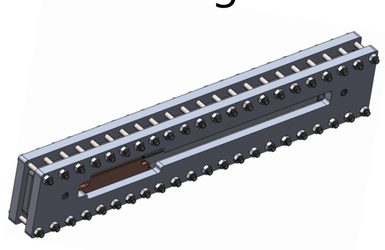


HOW?

Commence a flow boiling facility, and a heated-wall high-Reynolds-number grazing flow facility, enabling the exploration of parameter spaces, including surface textures, operating regimes and optimization of flow boiling heat transfer.

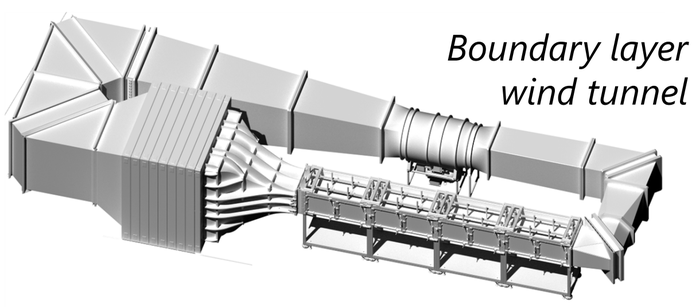
Line A: focusing on internal, flow boiling heat transfer



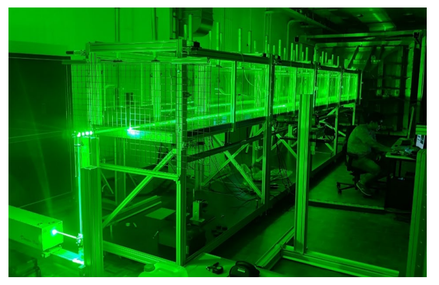


TULIP: Two phase Understanding and Liquid-vapour Interfacial Phenomena

Line B: focusing on external, forced thermal convection



Boundary layer wind tunnel



WHY?

Enhancing heat transfer allows for:

- Smaller scale heat sinks/more compact HX's
- System miniaturization (on liquid side) and smaller flow exposed area (on air side) → reduce system weight
- Higher TRL products and suitability for regional aircraft

RESULTS

- Being able to describe fundamental phase-change phenomena of flow boiling heat transfer over textured surfaces; being able to describe heat transfer properties of non-uniform heated/textured walls.
- Develop low-fidelity tools for supporting manufacturers with design studies at aircraft level.

Promising Research Knowledge Event | 21 November 2024

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