Development of cryogenic cooling system for low emission future aircrafts

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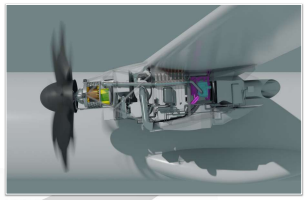
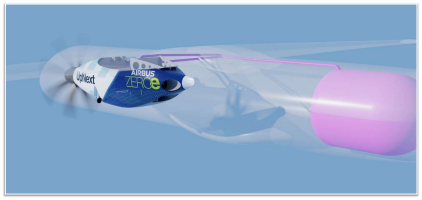
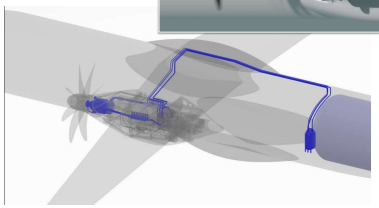
CRYOPROP (2024/2026)

- From building a **MW-class cryogenic powertrain** demonstrator to its integration in the regional aircraft







- Develop a Cryogenics & Superconducting supply chain for the key components in the powertrain
  - Superconductive motor + cryogenic Motor Control Unit
  - Hi Power Superconductive DC distribution
  - Propulsion Control System
  - Cryocooling system based on LH2 as primary cold source

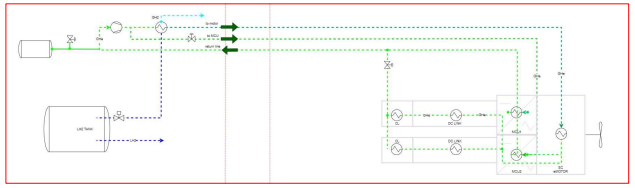
Cryocooling System Main objectives

- Operability of the electrical components of a 2 MW powertrain at the target working temperatures
  - Up to 4 kW at 40 K for superconductive motor
  - Up to 1 kW at 60 K for DC distribution lines
  - Up to 20 kW at 120 K for Motor Control Unit
- Optimization of the LH2 consumption for flight phase
  - steady state
  - Transients
  - Failure scenarios
- Optimization of weight , dimensions, space allocation at system and component level
- Increase maturity (TRL) at system and component level
- Assess operability and maintainability at aircraft level

Cryogenic cooling system First results

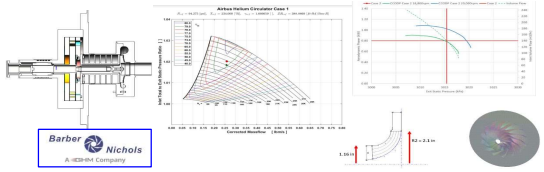
At system level

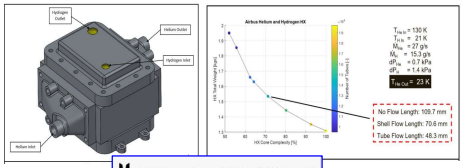
- Closed recirculation loop of GHe
  as secondary coolant
  @ 15 to 30 bara
- Architecture and system trades
  - Cooling system mass minimization
    220kg to 290 kg
    considering 14 m cryolines



  - Component operating temperature vs H2 consumption
    < 32 g/s at nominal power
    for motor temperature < 50K, DC cables < 60K , MCU <100K

At component level





Main learnings so far …

- Potential of an embeddable cooling system based on LH2 is confirmed
- Figures of Merit in terms of mass , efficiency and LH2 are compatible with AC requirements
- Technology to be matured, no showstoppers identified at system and component level

Future Challenges and next steps…

- Development of mature components with optimized figures of merit
  (valves, heat exchangers , cryofans, cryolines) taking into account aircraft constraints and qualification requirements.
- Manufacture and test a full representative cryogenic cooling loop Demonstrator in 2026

References

[1] L. Ybanez et al., "ASCEND: The first step towards cryogenic electric propulsion", Proc. IOP Conf. Ser.: Materials Sci. Eng., vol. 1241, 2022.
[2] L. Ybanez et al., "Cryogenic electric propulsion system: ASCEND main results and perspectives", Conference: MEA2024

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