## AP2-1-INV

# Superconducting motors for aircraft propulsion: the Advanced Superconducting Motor Experimental Demonstrator project

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The European Union-funded ASuMED project started in May 2017 with the purpose of demonstrating the benefits of a new, fully superconducting motor for reaching the targets established by the FLIGHT2050 plan. The project aims at a motor power density of 20 kW/kg using a high-temperature superconducting (HTS) stator. The rotor will use HTS stacks operating like permanent magnets. A highly efficient cryostat for the motor combined with an integrated cryogenic cooling system and associated power converter will be used. This presentation will provide a general overview of the prototype that is currently being built and tested soon.
The motor design was decided by using an analytical calculation tool for multicriterial optimization and by following the specifications provided by Rolls Royce. The stator integrates the cryogenic cooling circuit into the superconducting winding system while using less than 10% of the stator space for the complete cooling supply system. The winding structure is also the flux generator for magnetizing the superconducting rotor.
The AC losses in the stator were evaluated with aptly developed numerical models which incorporate the angular field dependence of the critical current of the superconducting tapes, derived from measurements with fields up to 6 T.
Advanced numerical modeling was used to calculate the magnetization of the tape stacks of the rotor, optimize their design, and study the effects of cross-field demagnetization on the trapped field.
For the inverters, a “Dual-Two-Level” topology, consisting of two classical Two-Level inverters placed on each ends of the windings, was chosen. For such a topology, all ends of the motor windings need to be open and therefore are not connected in the standard star configuration.
The rotor cryostat design is particularly challenging because of the cryogenic operating temperatures, the cooling requirements and the rotating parts, which include a rotary seal. A number of alternatives based on different heat transfer mechanisms were analysed, showing that a forced convection based system using gaseous helium is the optimal solution for the rotor cryostat.
Airborne cryocooler systems were investigated, and their mass was found to be compatible with an airborne application thanks to the use of light heat exchangers and an optimized cycle.

Keywords: Superconducting motors, Aircraft propulsion, HTS coated conductors, AC losses