

# An Efficient Maglev Counter-rotating Rim Driven Fan Usable In Future Civil Aviation.

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## Abstract

Rim-driven fan systems are an acclaimed technology in the modern ship industry. Yet their use in aviation is inexistent. The goal of decarbonized aviation initiated with the development of more electric aircraft paves the way for introducing new propulsion concepts that shift the engineer's attention from the use of traditional combustion-centric engines to distributed electrical ones, which can not only optimize the aerodynamics of a blended-wing aircraft but also its carbon footprint, thanks to the power of (hydrogen) fuel cells. The gain in performance of both counter-rotating propellers and ducted fans is well known but reminds us of the efficiency loss either at the propeller blade tips or at the shaft hub to which the propellers joint. Therefore, we try to overcome these limitations by blending the idea of counter-rotating fans driven by rims with the efficiency of magnetic levitation. The goal is to demonstrate the viability of this new concept not only for a distributed powertrain but also for a centralized one. Besides the design of an efficient Halbach arrangement for a fine Eddy current exploitation, we will optimize the aerodynamics of the fan system using FEM and CFD simulations. The advantage of such a concept resides in its inherently fail-safe characteristic due to the absence of attrition among parts. Furthermore, this powertrain concept shall be more cost-effective than the traditional one due to its reduced maintenance costs owing to the reduced number of moving parts and required lubricants.

The paper deals with the physical concept of a rim-driven fan thruster suitable for aviation applications in a distributed or centralized arrangement setting. A modular approach is presented, which allows for replicating multiple counter-rotating arrangements and more suitable higher-pressure ratios and exhaust airspeeds for the modern civil aviation industry. Besides designing a Permanent Magnet Synchronous Motor model based on a Halbach array concept as a peripheral active fan inducer that provides both levitation and propulsion, the paper shows that a stable electromagnetic torque is achievable within optimal geometrical and operation constraints. The Aerodynamic analysis is performed in COMSOL. The geometry is simulated using the Finite Element Method. An optimal modulation of the time-varying electromagnetic field is performed in MATLAB.

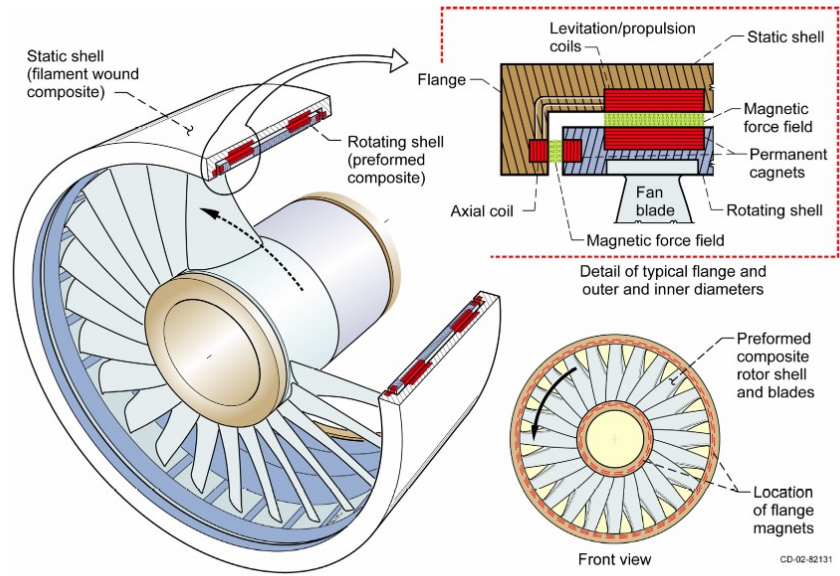
## Reference

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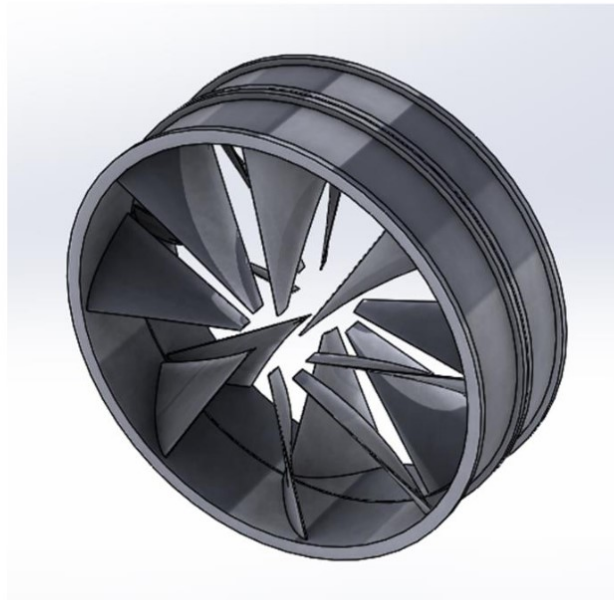
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## Figures used in the abstract



**Figure 1 :** Figure 1: A general concept of a levitated rim-driven Fan.



**Figure 2 :** Figure 2: An isometric view of a rim-driven Fan.