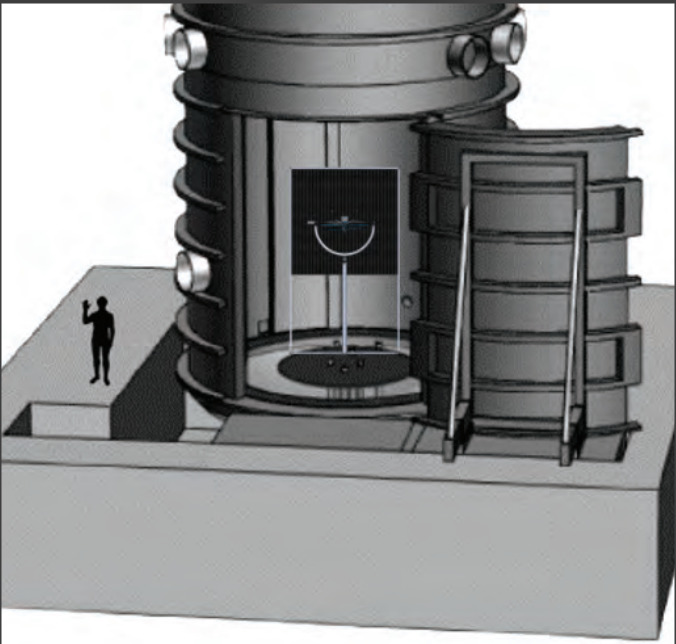
MARS FAWT

The first attempt at rotorcraft flight on another planet is set to take place Spring 2021 on Mars by the autonomous Ingenuity co-axial helicopter developed by NASA/JPL-Caltech. The atmosphere of Mars is composed mostly of CO_2 with a surface density~1% that of Earth's. To simulate flight conditions in the Martian environment, forward flight laboratory testing was ultimately conducted in a sealed 25' diameter low-pressure chamber with an integrated FAWT. Driven largely by time constraints, off the shelf components were required whenever possible. An extensive review and analysis of DC computer-cooling source fan unit performance in low-density environments was undertaken and determined that output velocity, in theory, would be independent of density. In sub-scale experimentation, results indicated that the fans operate less efficiently but can be driven to slightly higher than specified RPMs to give comparable velocity outputs in low-density environments. These results, along with array-to-rotor sizing experiments completed in CAST[1], justified the design and fabrication of a full-scale FAWT integrated into the Space Simulator chamber at JPL.

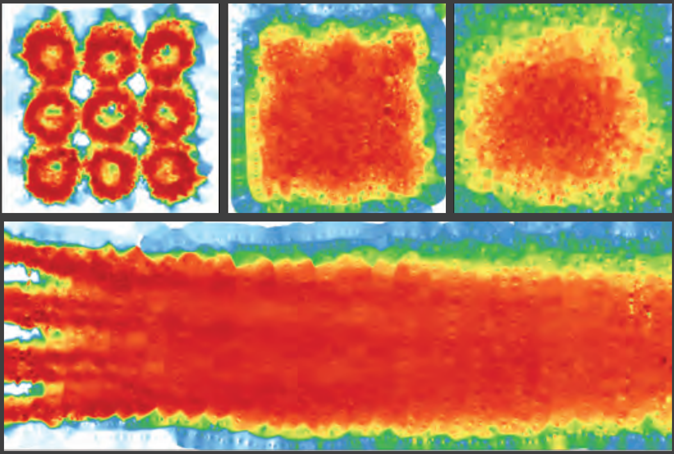
Rendering of Ingenuity deployed from the underbelly of the Perseverance rover, Mars 2020 mission


Photo credit: NASA/JPL-Caltech

[1] A sizing parameter for testing of rotors in FAWT implementations that depends on a ratio similar to advance ratio was posited and experimentally established by Marcel Veismann



Reduced mixing lengths allow for integration of FAWT into smaller environments that ordinarily could not accommodate wind tunnel testing. This is enabled by turbulence decay rates being determined by fan unit size, which can be orders of magnitude smaller in FAWT than in traditional builds. It is therefore possible to design large testing domains that achieve acceptable uniformity quickly downstream of flow generation, making FAWT leading candidates for projects where compactness is required.



Created by: Chris Dougherty