IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Small Launchers: Concepts and Operations (7)

Author: Mr. Arash Piran
SPACE WALKER Inc., Japan, arash.piran@space-walker.co.jp

Prof. Koichi Yonemoto
Tokyo University of Science, Japan, yonemoto@rs.tus.ac.jp
Dr. Takahiro Fujikawa
Tokyo University of Science, Japan, fujikawa.takahiro@rs.tus.ac.jp
Mr. Niklas Wendel
DLR (German Aerospace Center), Germany, Niklas.Wendel@dlr.de
Dr. Junnai Zhai
DLR (German Aerospace Center), Germany, Junnai.Zhai@dlr.de
Prof.Dr. Ali Gülhan
DLR (German Aerospace Center), Germany, ali.guelhan@dlr.de

COMPARISON OF WIND TUNNEL TEST RESULTS OF SUBORBITAL SPACEPLANE FUJIN WITH CFD ANALYSIS

Abstract

Computational Fluid Dynamics (CFD) analysis and wind tunnel testing had been conducted to evaluate the aerodynamic characteristics of the suborbital spaceplane, FuJin (Model X5) under development by the Tokyo University of Science (TUS) and the university's start-up SPACE WALKER Inc. The FuJin conducts scientific missions at the altitude of up to 120 km. With a 100 kg payload, FuJin lifts off vertically and lands horizontally on a runway autonomously through an integrated Navigation, Guidance and Control (NGC) system. CFD analysis was performed by TUS along the optimized flight trajectory to develop the aerodynamic database for the NGC design. The aerodynamic characteristics were evaluated in the clean configuration in terms of angle-of-attack and side slip angle, and aerodynamic control surface configurations with elevator deflections (symmetric elevon deflections), aileron deflections (asymmetric elevon deflections), body-flap deflections, and rudder deflections. Initially, CFD methods had been used to determine the preliminary vehicle aerodynamic properties. Within ongoing development activities subsonic and transonic wind tunnel tests were carried out at the Institute of Space and Astronautical Science (ISAS) of JAXA in Japan, and lower supersonic to hypersonic wind tunnel tests were conducted at the Supersonic and Hypersonic Technologies Department of DLR in Germany. The CFD analysis was in good agreement with the wind tunnel test results, with some open questions concerning coefficients of lateral motion. This paper demonstrates that a combined use of CFD and wind tunnel testing is an effective and reliable way to determine the aerodynamic characteristics of suborbital spaceplanes in flight regimes of essential aerodynamic relevance.