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INNOVATIVE PASSIVE SYSTEM FOR RESIDUAL PRESSURE REDUCTION OF THE ARIANE 5 FAIRING AT SEPARATION FOR JAMES WEBB SPACE TELESCOPE (JWST)

Abstract

The James Webb Space Telescope (JWST) is a large, infrared space telescope operating at Lagrange point 2 developed by NASA, ESA, and CSA and launched by an Ariane 5 ECA rocket in December 2021.

In early 2019, the JWST program has identified the sensitivity of the folded solar shield to the pressure waves at fairing jettisoning. NASA and ESA decided to assess and attenuate this risk by reducing the residual pressure. NASA has selected and procured a sensitive sensor for residual pressure measurement in flight. Arianegroup and RUAG Space have been contracted by ESA to develop, qualify, and demonstrate during 3 demo flights an improved venting design for the Ariane 5 fairing to reduce the residual pressure at separation without perturbing the sensitive venting profile during atmospheric phase.

The initial project investigations have shown that the residual pressure was affected by two factors: 1: The 28 vent holes mechanisms start closing below 100 Pa pressure difference and therefore retain a certain amount of air, 2: The air trapped in the honeycomb structure volume of the satellites but also of the fairing itself keeps venting slowly and continuously in the payload volume after the atmospheric flight.

To maintain the vent-holes open, an innovative passive mechanism made of a COT pneumatic Piston, has been chosen and fixed in a 3D printed support above each of the 28 vent-holes mechanisms. During the atmospheric flight, each piston extends passively under the external pressure reduction. After atmospheric flight, the deployed Pistons maintain the vent-hole mechanisms in open position with their full venting performance independently of the vanishing pressure. The qualification of such passive mechanism has been a challenge with innovative solutions to demonstrate the structural and functional flight worthiness.

In addition to the improved venting, the air-source from fairing honeycomb has been attenuated by sealing all the panels edges. This has been validated by vacuum testing of panel samples with different seal patterns.

Passenger demonstrations on three Ariane flights have proven the effectiveness of the system: the residual pressure was attenuated at 32 Pa instead of 45 to 57 Pa for standard flights. Finally, the low volume of honeycomb in JWST was favourable and led to jettisoning the fairing at 24 Pa, with 50% margin to the required 36 Pa pressure.