

IAF SPACE PROPULSION SYMPOSIUM (C4)
Solid and Hybrid Propulsion (1) (3)

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RAVEN: RESULTS AND INSIGHTS FROM THE FIRST TEST CAMPAIGN OF A HYBRID ROCKET ENGINE

Abstract

RAVEN, Rocketry and Aerospace Vehicle Engineering in Norrbotten, is the first student rocket project at Luleå University of Technology, Kiruna Space Campus, Sweden. Initiated in early 2020, RAVEN's mission is to design, build, and launch a hybrid propellant rocket from scratch. The objective is to achieve a thrust of 1kN with a burn time of 6 seconds, using paraffin with 2% carbon black as fuel and nitrous oxide as an oxidizer. The project aims to provide valuable hands-on experience and lay a foundation for future student-led and research-oriented rocket projects at LTU. In 2021 and 2022, the preliminary rocket design and test plan, including the construction of a test bench, were presented, respectively. Since then, the proposed design has been adjusted for RAVEN's application, leading to the construction of a small-scale engine, URSA-1, and a versatile mobile test bench. This bench is designed to accommodate rocket motors of varying sizes, ensuring its applicability for future iterations of the RAVEN rocket. An advancement is the elaboration of a piping system, which has been engineered to safely operate high pressure nitrous oxide and nitrogen. The electronics system of the test bench was developed to control the test procedure and parameters and facilitate data acquisition through a variety of sensors. This enables the comparison of test results and an analysis and understanding of the engine's performance. To date, three igniter tests have been successfully conducted, with plans for additional tests including cold flow and hot flow tests in the spring of 2024. To ensure the safety of testing procedures and the eventual engine operation, a thorough risk analysis was conducted to identify potential safety concerns. This analysis led to the development and iterative improvement of procedures, refined through multiple dry runs and reviews. These thorough preparations and the completion of systems ensure that RAVEN is well-prepared for the upcoming test phase. The procedures, along with the engine and test bench design, were presented at the test readiness review. Following integration of feedback from the review board, the engine is primed for testing across multiple parameters, including chamber pressure, plume temperature, thrust, and injector characteristics, with outcomes to be detailed subsequently. Additionally, the design phase for the flight-ready engine, incorporating the oxidizer tank, has commenced, paving the way for a future launch. This paper will present the results and lessons learned from the first test campaign.