46th STUDENT CONFERENCE (E2)
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BREAKING THE CANADIAN ALTITUDE RECORD: DEVELOPMENT OF A LOW-COST HYBRID SOUNDING ROCKET

Abstract

The University of Toronto Aerospace Team (UTAT) intends to break the Canadian amateur rocketry altitude record, flying a student built and designed rocket to over 15 km altitude. UTAT Rocketry is an organization focused on student-led research, contributing to the advancement of hybrid propulsion for efficient, low-cost, non-volatile rocket engines. Hybrid propellant rockets promise to deliver the simplicity of solid propellant rockets, while eliminating most of their inherent safety risks. Through UTAT Rocketry, nearly 40 students receive hands-on experience in this field, while developing cost-effective rocket technology. UTAT has a proven track record in rocketry, conducting multiple tests of its 3.5 kN thrust paraffin-N_2O hybrid rocket engine, with a successful flight in fall of 2017. The current focus for UTAT is Defiance, the hybrid rocket that aims to break the Canadian amateur rocketry altitude record. Defiance balances proven technology with new experimental designs such as its ablative fiberglass phenolic

composite nozzle. Recent developments include Quasar, a 7 kN thrust engine capable of imparting four times as much total impulse as the previously tested design. Defiance also possesses a 3U CubeSat volume dedicated to scientific research and public outreach payloads. Ongoing research within the team focuses on several novel branches of experimental and computational fluid dynamics (CFD). This includes the quantification of the non-isotropic vaporization of N_2O as it passes through an injector plate under autogenous (self) pressurization, and the refinement of Compressed Truncated Ideal Contour (CTIC) nozzle design techniques with both simulated and full-scale experimental validation. Furthermore, the program includes research into composite aerodynamic bodies, casing structures, hybrid fuel composition, injector geometry, and fuel grains. This all represents original student-led research, contributing to the advancement of knowledge in the field of hybrid propulsion. The ultimate goal of this endeavor is to help develop the technology required for the next-generation of Canadian sounding rocket and orbital micro-satellite launch vehicle applications, while training a new wave of aspiring aerospace students. Avionics and recovery hardware will be flight tested twice using a solid rocket test vehicle. This will culminate in the final launch for the record-breaker rocket, currently scheduled for Q4 2018.