IAF SPACE PROPULSION SYMPOSIUM (C4)
Joint Session between IAA and IAF for Small Satellite Propulsion Systems (8-B4.5A)

Author: Mr. Debdeep Roychowdhury
Technische Universität Berlin, Germany

Mr. Sascha Kapitola
Technische Universität Berlin, Germany
Mr. Fynn Bastian Boyer
Technische Universität Berlin, Germany
Mr. Alan Legenza
Technische Universität Berlin, Germany
Mr. José Manuel Diez
Technische Universität Berlin, Germany
Mr. Benjamin Palmer
Technische Universität Berlin, Germany
Mr. Felix Kübler
Technische Universität Berlin, Germany
Mr. Jens Freymuth
Technische Universität Berlin, Germany
Dr. Sebastian Grau
Technische Universität Berlin, Germany
Prof. Enrico Stoll
TU Berlin, Germany

LESSONS LEARNED FROM THE INITIAL OPERATIONS PHASE IN THE NANOFF CUBESAT FORMATION FLIGHT MISSION

Abstract

The NanoFF (Nanosatellites in Formation Flight) mission launched in December 2023 encompasses the development, deployment and operation of two 2U CubeSats designed for close formation flight, aiming to demonstrate advancements in small satellite formation flight technologies and Earth observation. Each CubeSat features a fully redundant satellite bus, a propulsion system, and a payload comprising a multispectral camera with four channels alongside three star trackers. This paper presents and discusses the activities and outcomes of the early operations phases, i.e., Launch and Early Operations Phase (LEOP) and commissioning. Particular emphasis is put on the deployment strategy, subsystem commissioning, initial orbit determination, thruster commissioning, drift reduction efforts, and the execution of a recovery maneuver to achieve close formation flight. The satellites were deployed into their intended partial helix orbit by the orbit transfer vehicle ION, developed and operated by the company D-Orbit. The use of the ION vehicle enabled a precise deployment, facilitating the immediate entry into a partial helix orbit, which is pivotal for reaching the mission goals. After separation, initial orbit determination was performed utilizing GNSS data to confirm proper orbit injection and assess the drift rate between the satellites. This step was crucial for adapting the mission timeline and implementing immediate corrective measures in the case of an unexpectedly high drift rate. In this paper, the commissioning of the satellite bus in orbit is reviewed, underlining the technical challenges encountered and the solutions applied to

maintain the desired satellite formation and orbit. The paper explores the challenges of commissioning of the attitude control system and thruster while simultaneously applying drift reduction strategies, which are vital for counteracting any initial discrepancies in the satellites' relative orbit. A key part of the operations phase was conducting a recovery maneuver aimed at realigning the CubeSats into their intended close formation following any deviations. This maneuver's planning, execution, and outcomes are detailed, showcasing the mission's capability to adjust and maintain formation within the challenging space environment. The insights garnered from the NanoFF mission's early operations phase highlight the technical feasibility and operational challenges of conducting complex formation flight missions with small satellites. The successful deployment, immediate orbit determination, and effective commissioning of subsystems for formation maintenance set a benchmark for future missions aiming to leverage small satellite formations for enhanced Earth observation capabilities and other applications.