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AUXILIARY SENSOR PACKAGE (ASP) DESIGN FOR CHARACTERIZING AURORAL EMISSIONS WITH THE AERO AND VISTA CUBESATS

Abstract

The AERO-VISTA Auxiliary Sensor Package (ASP) is a secondary payload on two 6U spacecraft: AERO (Auroral Emissions Radio Observer) and VISTA (Vector Interferometry Space Technology using AERO). The AERO-VISTA spacecraft will use vector sensors (VS) and distributed element interferometry to measure HF (400 kHz - 5 MHz) radio propagation in the ionosphere near Earth's aurorae. AERO-VISTA will debut a novel instrument– the vector sensor payload– to meet scientific objectives and raise the instrument's Technology Readiness Level.

The primary scientific objective of the mission will be accomplished by the VS payloads. Additionally, each spacecraft will carry two ASP units as a secondary payload that will aid in mission operation and scientific analysis. ASP magnetometers will contextualize VS observations by measuring auroral currents, and an optical camera (Engineering Camera/ECam) will image the vector sensor antenna to

confirm successful antenna deployment. Additionally, the ECam can provide opportunistic contextual information in the visible band for auroral events with an intensity greater than 10 kRayleigh (kR). The ASP design is guided by three spacecraft Level 2 (L2) requirements which define the magnetometer measurement performance, camera measurement performance, and interfaces available to the ASP. Finally, as a secondary payload, the ASP is required to not harm the primary payload.

ASP mechanical, data, and power interfaces are made directly with the spacecraft bus independently of the VS. ASP instruments are supported by a custom PCB carrying a Raspberry Pi Zero, which contains all ASP software. The PCB provides housekeeping telemetry, power supplies, and IO electronics. An aluminum enclosure provides mechanical and thermal support and shields the VS payload from EMI/RFI generated within the ASP.

We achieve 100 nT magnetometer system precision and repeatability at 10 Hz with two HMC1053 magnetometers per ASP. Our custom analog amplification and mixed-signal circuit around this sensor achieves an instrument-intrinsic noise floor of 10 nT rms. Self-interference effects degrade the magnetometer's performance to 50 nT rms, though system-level performance is improved by the combination of readings from multiple magnetometers.

A Raspberry Pi Camera provides optical observations to confirm successful vector sensor deployment. A fisheye lense with a 195 degree Field of View (FOV) allows the two ASPs together to image the 4-meters long VS antenna. Radiometric sensitivity analysis and experimental estimation of usable FOV show that a 1 second integration time allows for detection of auroral red and green optical bands of 10 kR intensity.