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USING LINEAR ELECTROMAGNETIC ACCELERATION OF SATELLITE PAYLOADS FOR TARGETED ATMOSPHERIC INJECTION AND ORBITAL TRAJECTORY ADJUSTMENT

Abstract

An examination of the potential of using a Linear Electromagnetic Accelerator (LEA) for targeted atmospheric injection of satellite payloads and orbital adjustment. Multiple payload varieties both active and passive were examined, along with several different LEA designs. The targeted atmospheric injection of a satellite payload was found to be a workable application of a multi-stage LEA, whilst also acting as a solution for minor orbital trajectory adjustments.

Based on LEA test data, and simulating for a 1U cubesat in a 700km polar orbit, the maximum total Delta-V delivered exceeded 8.4m/s. In this configuration, the LEA, support electronics and total payload volume was 168 cm3 and weighed in at under 200g, whilst delivering 36 independent payloads. Due to the nature of polar orbits, a payload can be placed on an intercept trajectory to any location on Earth by accelerating it in the retrograde.

This ensures the expelled mass of the payload can most efficiently be harnessed by the host satellite to boost the orbit altitude, thereby improving the lifespan before reentry. For a 1U cubesat in a 700km orbit, this translates to an elliptical orbit of 700km by 732km. Deploying payloads in pairs at antipodal points results in a Hoffman-transfer style course adjustment, and results in a circular orbit of 720km altitude. Based on cubesat orbital decay models, this altitude adjustment could, if used early in the mission, allow the host satellite to increase mission duration by years.

Whilst the most effective payloads for orbital trajectory correction are passive magnetically- polarised slugs, several small active payloads were theorised for scientific data collection. One such payload designed was a temperature sensor which transmits its results a short distance over the FM spectrum, for retrieval by the host satellite or a ground station. Utilising single-chip electronics, the sensor is capable of broadcasting temperature readings until reentry with a power of 20dbm (100mw).

The ability to place a single-use sampling instrument with remote data monitoring ability anywhere within Earth's atmosphere has scientific value across a variety of research fields. With an emphasis on a low-cost cubesat as a host platform and single-use payloads, these combined technologies have the potential to improve accurate weather monitoring, and help further our understanding of climate change. LEAs are a compact and energy efficient method of payload injection, and offer a safe, reliable, low-cost all-electric alternative to hazardous combustible fuels and expensive plasma or ion thrusters.