

Electric Solar Wind Sail tether payloads onboard nanosatellites in low Earth orbit and in solar wind

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Electric Solar Wind Sail (E-sail) is a novel propulsion method, which uses long, conducting, electrically charged tethers to harness the momentum of solar wind protons in order to generate thrust. Plasma Brake, a spin-off of E-sail invention, is a technical solution with potential to effectively attack the growing space debris problem at low orbits. Attached to its host satellite, Plasma Brake will deploy one or multiple E-sail tethers, which will interact with ionospheric plasma, gradually decreasing the satellite's orbital speed and finally causing it to re-enter Earth's atmosphere. First samples of E-sail tether have flown onboard the ESTCube-1 and Aalto-1 nanosatellites. Here we introduce the instrumentation to be used in the next steps of E-sail small satellite tests.

ESTCube-2 and ESTCube-3 are two 3-unit CubeSats with quasi identical E-sail payloads, whose missions are to unreel and test E-sail tethers in low Earth orbit and in solar wind, respectively. Each satellite encases a single 300 meter long multifilament tether, manufactured at a facility under development at our institute, packed on a purpose-built reel. The payload also includes a stepper motor driven reel-out system and a high voltage source, used to charge the tether up to 10 kV potential with respect to ambient plasma environment. Electron guns are used to remove excess electrons, gathered by the tether when charged positively, in order to maintain the voltage. The entire payload has been miniaturized to fit into 0,5-1 CubeSat units.

Successful mission for each satellite would include a verified reel-out of the tether, coupled with quantitative measurement of the E-sail force, i.e. Coulomb drag, interacting between the tether and the surrounding plasma. If successful, ESTCube-3 would demonstrate the concept of using solar wind as source of momentum for a space craft, while ESTCube-2 will attempt to verify the usability of the Plasma Brake concept.