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Investigation of tenuous plasma environment using Active Spacecraft Potential Control (ASPOC) on Magnetospheric Multiscale (MMS) Mission

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The NASA's Magnetospheric Multiscale (MMS) Mission is planned to be launched on March 12, 2015. The scientific objectives of the MMS mission are to explore and understand the fundamental plasma physics processes of magnetic reconnection, particle acceleration and turbulence in the Earth's magnetosphere. The region of scientific interest of MMS is in a tenuous plasma environment where the positive spacecraft potential reaches an equilibrium at several tens of Volts. An Active Spacecraft Potential Control (ASPOC) instrument neutralizes the spacecraft potential by releasing positive charge produced by indium ion emitters. ASPOC thereby reduces the potential in order to improve the electric field and low-energy particle measurement. The method has been successfully applied on other spacecraft such as Cluster and Double Star. Two ASPOC units are present on each of the MMS spacecraft. Each unit contains four ion emitters, whereby one emitter per instrument is operated at a time. ASPOC for MMS includes new developments in the design of the emitters and the electronics enabling lower spacecraft potentials, higher reliability, and a more uniform potential structure in the spacecraft's sheath compared to previous missions. Model calculations confirm the findings from previous applications that the plasma measurements will not be affected by the beam's space charge.

A perfectly stable spacecraft potential precludes the utilization of the spacecraft as a plasma probe, which is a conventional technique used to estimate ambient plasma density from the spacecraft potential. The small residual variations of the potential controlled by ASPOC, however, still allow to determine ambient plasma density by comparing two closely separated spacecraft and thereby reconstructing the uncontrolled potential variation from the controlled potential. Regular intercalibration of controlled and uncontrolled potentials is expected to increase the reliability of this new method.