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A Hot Plasma Composition Analyzer (HPCA) for the SMART/Magnetospheric Multiscale Mission

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Accurate ($\sim$1%) measurement of all relevant ion species (H^+, He^{++}, He^+ and O^+) in the regions around sites of magnetic reconnection, i.e., the dayside magnetopause and the magnetotail, is a particularly difficult task. The Hot Plasma Composition Analyzer (HPCA) described here is designed to investigate reconnection as part of NASA's Magnetospheric Multiscale Mission (MMS). The HPCA combines an electrostatic energy analyzer (ESA) with a time-of-flight mass analyzer (TOF). In order to obtain the exceptionally high dynamic range ($> 10^6$) needed for studies of space plasmas we have introduced a novel radio-frequency mass filter into the ESA. The TOF section uses the carbon foil technique combined with positional detection in order to correct for path-length variations and improve mass resolution. In this paper we discuss design methods including optimization techniques, and present test data from a fully operational prototype unit. Although designed for MMS, the HPCA also has wide applicability to other areas in magnetospheric physics.