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Cluster observations of the pitch angle distribution of plasma sheet electrons under active conditions

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Electrons with energies from several keV to several hundreds of keV, which typify the highly-dynamic, nightside plasma sheet, can be well characterised by combining observations from the PEACE and RAPID experiments on Cluster. We present results from a study that focuses on the pitch angle distributions of plasma sheet electrons during a series of quasi-periodic, intense energetic particle signatures in the magnetotail on 17/18 September 2003, as revealed by Cluster observations some 19 RE downtail, These features correspond to an extended interval of substorm activity, associated with the passage of a highly-geoeffective, high-speed solar wind stream. When Cluster is in or adjacent to the plasma sheet at substorm expansion phase onset, increased fluxes of energetic particles are observed near-simultaneous with the characteristic onset indicators - field dipolarization and particle injection at geosynchronous orbit. When the spacecraft are deeper in the lobe, energetic particles are detected by Cluster many minutes after substorm onset, as the spacecraft becoming engulfed in an expanding plasma sheet; subsequently, as the tail thins in the growth phase of the subsequent substorm the plasma sheet recedes such that the spacecraft return to the tenuous plasma of the lobe. We particularly concentrate on the variation of the pitch angle distribution of the plasma sheet electron population, derived from both PEACE and RAPID. In fact, the pitch angle distribution was particularly well resolved by the latter during this interval, due to its operation in a high-data rate mode. A consistent feature of the plasma sheet during these intense substorm conditions is its counter-streaming electron population, consistent with a recently closed field-line configuration at Cluster. However, at other times, the electron distribution is isotopic or even locally trapped (field-perpendicular). The pitch angle distribution of the plasma sheet electrons during such intense substorm

activity depends on the exact location of the observing spacecraft to the onset region.