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The Cluster Constellation Strategy for the Exploitation of the Magnetopause during the Second Mission Extension

D.Sieg
EDS c/o European Space Operations Centre, Darmstadt, Germany

Cluster is a multi point space plasma observatory with a complete set of dedicated instruments onboard the four satellites flying in an eccentric orbit around the Earth since the year 2000. It is the only mission in orbit providing four-point measurements in the Earth's magnetosphere. The spatial evaluation of the observations is influenced by the shape and the size of the constellation formed by the four satellites. Several formations have already been established during the mission. This has been also very demanding for the required flight dynamics operations especially during constellation changes which have been calculated with dedicated manoeuvre optimization software. The design of the constellations has always been a compromise between fuel consumption and orbital mechanics on one side and the wish to investigate different regions and small and large scale phenomena on the other side.

The paper will start with a summary of the original mission strategy where the best results were expected from regular tetrahedra at the region of interest. But orbital mechanics allows regular tetrahedra at the very most at two points within one orbital revolution and the formation is degrading to elongated tetrahedra at other parts of the orbit. To get optimal formations during the northern and southern cusp crossing in spring and the magnetotail in autumn, the constellation was changed twice per year and it was foreseen to alternate the scaling between a few 100 km and 10,000 km which would have cost a lot of fuel. To allow a continuation of the mission, measures were already taken before and during the first extension by postponing the 10,000 km constellation and performing only one constellation change per year. The formation was a compromise between cusp and tail crossing requirements.

The just starting second mission extension is now limited by a very tight fuel bud-

get and therefore it became necessary to develop a new constellation strategy. This strategy is described and an overview is given about the flight dynamics and scientific aspects which lead to the selection of the underlying target orbits. Then the paper focuses on the orbit evolution and especially on potential future constellations.
Concerning the orbit evolution it is shown how the inherent spatial configuration of the orbits will evolve and at which new regions the solar wind plasma can be investigated. One highlight will certainly be the crossing of the magnetopause close to the subsolar point.

Looking at the future constellations a lot of flexibility has been kept by putting two satellites in the same orbit. This allows changing between different multi-scale constellations with little fuel consuming phasing manoeuvres only. Around the magnetopause the first implementation of such a constellation is planned for spring 2007. Details about this and potential future constellations before the final re-entry of the spacecraft in 2010 are given.