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PRISMA: DLR experiment on autonomous satellite formation flight begins

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Tango imaged by Mango

The primary objective of the Swedish satellite mission PRISMA is to demonstrate autonomous onboard control of satellite formation flying and close approach to other spacecraft. The German Aerospace Centre's (Deutsches Zentrum für Luft- und Raumfahrt; DLR) involvement in the project includes an innovative real-time navigation system that uses GPS measurements to present continuous, ultra-precise data on positions of the satellites and their relative separation. The first DLR experiment began on 29 September 2010, after the first project phase was completed. The primary feature is the commencement of autonomous formation flight.

"Autonomous formation flight will enable new scientific missions and autonomous rendezvous operations in the future. Rendezvous operations are a major prerequisite for orbital inspection and servicing missions," explains Professor Felix Huber, Director of DLR Space Operations and Astronaut Training.

Expertise sourced from Oberpfaffenhofen

The two satellites, named Mango and Tango, were launched on 15 June 2010 and were initially mated together. After successful separation, they orbited Earth following closely linked paths, moving further apart and closer together. This gives the team of researchers the world's first system for testing different processes in autonomous formation flight and satellite rendezvous. The project uses a number of different measurement systems and a propulsion system that controls the path of the larger satellite Mango in relation to its smaller partner, Tango.

The GPS receiver used in the navigation system, developed by DLR's German Space Operations Center in Oberpfaffenhofen (GSOC), is barely the size of a credit card. GSOC also developed one of the Guidance, Navigation and Control Systems. Data from the Tango GPS receiver is sent to the main

satellite, Mango. By comparing them with the GPS data from the receiver on Mango, the distance between the satellites can be determined to within 10 centimetres, in real time. Mango can use this information to control its path in relation to Tango with absolute precision, and autonomously follow a pre-set flight path.

As part of its ground segment role for the PRISMA mission, GSOC is responsible for precise orbit determination. This has an accuracy in the centimetre range, a prerequisite for setting and checking the other measurement systems.

PRISMA – a twin-pack around Earth

Mango and Tango in the space simulator

The PRISMA mission was designed and implemented by the Swedish Space Corporation, SSC, which was responsible for developing and building the satellites, and is currently overseeing the project operation. Along with DLR, the French space agency, CNES, and the Danish Technical University are involved in the mission as international partners, with their formation flight sensor and approach navigation camera system.

The partners will test a number of different formation flight and rendezvous concepts using PRISMA over the next few weeks and months. When the first experiment is completed and evaluated, DLR will carry out further technology experiments in satellite guidance, navigation and control. The autonomous formation flight processes developed excel in their particularly high level of safety and minimal fuel consumption. Future radar satellites or missions to measure Earth's gravity field are just two examples of endeavours that could benefit from this work.

A further important step in the PRISMA mission will be when GSOC takes over operational control in spring 2011. Then, DLR will be engaged in key operations for both space and ground segments. A long-term objective of this involvement is to prepare and test rendezvous and docking manoeuvres that will be required for on-orbit servicing missions or, more generally, in space robotics.

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