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Design and construction of a cold-gas attitude control system for a student microsatellite – part 2

Assembly, Integration and Verification

Due to the scarce time at hand and the costs, the decision was made to build a proto-flight model. After its first parts were manufactured, tests were performed in order to determine

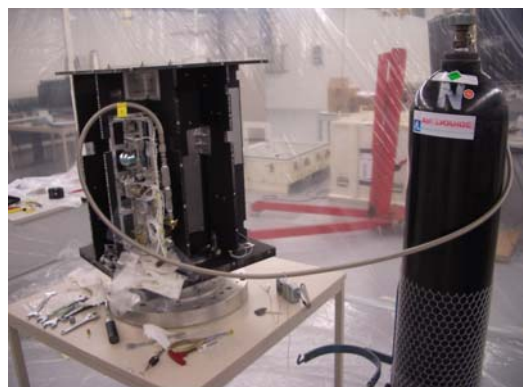
- the strength of the tank mounting and the PMS box,
- the quality of the sealing of the tubing system which contains a pressure up to 300 bar of gaseous nitrogen,
- the bending of the tubes without reducing their cross-sectional area,
- the feasibility of electron beam welding for the tubing and
- the tensile strength of the adhesive joint of the pipe mountings which connect the tubing to the structure.



Additionally, a 1:1 wood model of the satellite structure was built for integration testing and practising integration procedures. It largely helped to minimize the required integration time for our system.

Shortening the structure's presence in Stuttgart was indeed an important issue due to the tight time frame and the complex logistics involved: the structure was designed in Spain, manufactured in Dortmund, preassembled at ESTEC in Noordwijk and then shipped to Stuttgart where the PROPPAYLOAD system was integrated. After the PROP system was completely integrated, the satellite was transported to IABG in Munich for vibration testing, and finally brought to ESTEC where all the other teams started with the integration of their subsystems. In March, the assembled spacecraft is going to be shipped to the launch site in Plesetsk.

We did not integrate in the ESTEC clean rooms in order to decrease the time needed for integration and to simplify transport logistics. Instead we built our own clean tent made of polyethylene sheets.



After successful assembly and integration, some problems turned up during testing in Munich:

- tank heating during rapid fueling had to be counteracted by cooling with compressed air
- a pressure loss occurred overnight due to a creeping sealing ring
- because the washers primarily used for the tank mounting were too small, the inserts in the honeycomb structure were almost torn out during the shaker test
- it was very difficult to access the tubing in some parts of the integrated satellite, especially in the area where we had to fix the sealing of the tank-tubing adapter

Lessons learned

We have experienced that a good accessibility is indispensable for every part of the system in case it becomes necessary to repair or modify minor features. To avoid sealing problems, the tubing system should be designed in a way as to minimize the number of needed couplers, but using welded connections instead.

In order to reduce delays for other teams in this distributed international project, the ESEO design should allow a higher level of parallel integration than the Express design did, e.g. a design allowing for a separate parallel integration of a propulsion/structure module.

Outlook

Although SSETI is a student project which is realized in its members' spare time, one should always remember that SSETI Express is no complicated case study but a real space mission with real flying hardware. There will be a launch, currently scheduled for 2005/05/18 in Plesetsk with the Cosmos 3M. Thus, additionally to the design and manufacturing of the satellite, we have the privilege of participating in the exiting last phases of the Express project which consist of launching and operating a spacecraft. Nominal operation time is planned for 28 days but might as well be extended, a time we will use to accomplish our tests during the 8-minute intervals in which the spacecraft is in reach of the ground station at Aalborg university.

The final plan for these tests is currently being compiled. After the end of our operation time, the satellite will have a continued purpose, acting as a transponder for radio amateurs.

And even after that, SSETI will continue its work with ESEO and implement the lessons we have learned and will learn from Express.

