#24 - SERUM (SSETI Express RescUe Mission)

In 2005, the European Space Agency (ESA) launched SSETI Express, a spacecraft that is part of SSETI (Student Space Exploration Technology Initiative). The satellite aimed at taking pictures of Earth, deploying three picosats and, most importantly, educating students in space engineering. Only a couple of hours into its mission, SSETI Express unexpectedly shut down. A failure in its electrical circuit turned out to be the cause: a short circuit in the voltage regulating circuit prevented the solar panels from charging the batteries.

Mission Objective

In order to rescue SSETI Express, DSE group 24 has designed a SERUM (SSETI Express RescUe Mission) to cure SSETI Express. SERUM will strive to dock to SSETI Express and repair its electrical issue by either injecting power from its own batteries or cutting off the faulty part of the circuit. On top of that, SERUM will reduce the amount of space debris by deorbiting SSETI Express either at the end of its mission lifetime, or at any stage of the rescue mission if necessary.

System Design

In order to accomplish this mission, requirements (both stakeholder and mission) were analyzed which resulted in subsystem specific requirements. With these requirements in mind, the different subsystems were designed, by the means of research and trade-offs. The subsystems were designed in parallel, to accommodate changes and assure proper interface between all subsystems. This resulted in the final design. SERUM will be launched by a rideshare mission, with Falcon 9, and will then transfer to SSETI Express' orbit. It will use deployable solar panels and green monopropellant for its power and propulsion. When in close proximity of SSETI Express (less than 100 meters), SERUM will determine whether it is safe to approach SSETI Express. If not, SERUM will deorbit. Otherwise, a docking procedure will be initiated. First, the GNC subsystem will start an approach maneuver, followed by a grabbing operation performed by the payload. SERUM together with its robotic arm will match SSETI Express' rotation and insert an expansion mechanism in the deployment holes of the picosats (the T-pods); allowing accurate repositioning of SSETI Express with respect to SERUM. When this connection is established, a second, more sturdy connection to the non-functional satellite will be made: a zond will be inserted in a hole present on the bottom of SSETI Express clamping it, creating an enclosure around SSETI Express' bottom panel. Docking can be attempted several times. If docking is unsuccessful, SERUM will catch SSETI Express using a net and deorbit. After a successful docking procedure SERUM can start its attempt to repair SSETI Express: SERUM will inject power directly into SSETI Express using its power plug, to bypass the short circuit. Additionally, for backup SERUM will be equipped with an endoscopic arm and a wire tap connector to intercept the wires in a certain location; this way the faulty part of the circuit can be disconnected at will. SERUM will wait and check if SSETI Express revives. If this is not the case, they will deorbit. Otherwise, SSETI Express will continue its mission and SERUM will assure deorbiting at the end of its mission. This rescue mission will not only save SSETI Express, but has much bigger purpose: it will demonstrate in-orbit servicing. By repairing satellites and deorbiting them if they cannot be rescued, the amount of space debris can be reduced and a more sustainable approach with respect to satellite development can be taken.