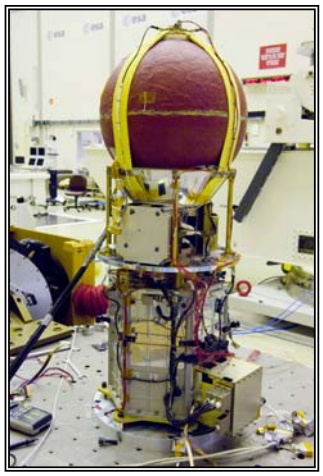
Launch of the Young Engineers' Satellite #2

On 25 September 2007, students from all over Europe will complete ESA's most ambitious space education project ever. Their challenge is a real-world space task: to return a capsule safely from space to Earth, without the use of any means of propulsion.

The experiment, YES2, is mounted on the tip of a much bigger Russian spacecraft, Foton-M3, which will be launched on 14 September 2007 from the Baikonur Cosmodrome in Kazakhstan.



Construction of YES2 at ESTEC

Background

Four years ago, after the successful launch of the Young Engineers' Satellite (YES) student satellite, a second YES project was approved by ESA.

The focus of this project was to provide European engineering and science students with the unique opportunity to gain real experience of spacecraft design and engineering development, thus preparing them for a career in the Space sector.

As well as being the first tether satellite mission of its kind, it also demonstrates the feasibility of the concept to safely de-orbit a payload at low-cost, without the need for any kind of propulsion.

Several records will be broken with the flight of this student experiment and some significant milestones have already been passed in the design and development of YES2.

After over five years of planning, design, development, construction and testing, the work of over 450 individual students have finally condensed into the completed YES2 student satellite, ready for flight.

Components

YES2 is the work of hundreds of university students from all over Europe. It has three components:

Fotino: a small 6 kg capsule containing scientific equipment and a parachute system. Fotino is encased in 3.5 cm of Alumina (specially processed Aluminum Oxide) coated with a silicon-based ablative material, which acts as a heat shield to protect the instrumentation inside as it returns to Earth. It can withstand up to 2000°C.

Mechanical data Acquisition Support System (MASS): a 6 kg carrier holding Fotino in place with four straps. These straps make up the MASS Fotino Decoupling system (MFD), which releases the Fotino capsule at the correct moment during the mission. MASS will burn up in the atmosphere on re-entry.

Foton LOcated YES2 Deployer (FLOYD): a 24 kg carrier bolted onto Foton-M3, which will eject Mass and Fotino towards Earth. Inside Floyd is a spool with 30 km of 0.5 mm thick Dyneema (polyethylene) tether, the end of which is connected with MASS.

Facts and Figures

- YES2 will become the longest ever man-made object in space which will be visible to the naked eye on Earth, when its 30 km long tether is successfully deployed.
- YES2 will demonstrate the 'space mail' concept for the first time. "Dropping" objects back to Earth from orbit using a tether may reduce the need to use retro-rockets for de-orbiting capsules from space stations.

Dimensions	1020 x 410 x 475 (maximum envelope)
Mass YES2	36 kg
Mass Subsystem FLOYD	22 kg
Mass Subsystem MASS	8 kg
Mass Subsystem FOTINO	6 kg
Operational duration	7 hours

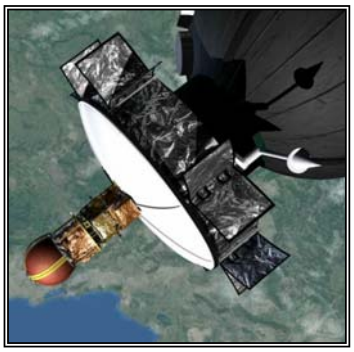
Schedule

- Installation and pre-flight preparations for YES2 and Foton-M3. This will include final functional and interface tests.
- Launch of Soyuz from Baikonur Cosmodrome, Kazakhstan, carrying YES2 on top of Foton-M3 (nominally on 14 September 2007).
- Deployment of the 30 km YES2 tether at the end of the 11 day Foton-M3 mission (nominally on 25 September 2007). Deployed tether illuminated by sunlight in the night sky from South America and Eastern Russia, so Telescope and camera observations will be possible.
- Release of the YES2 re-entry capsule, atmospheric re-entry and touchdown in a pre-determined target zone in Kazakhstan (nominally on 25 September 2007). Release after 2 hours from tether deployment, touchdown 30-40 minutes after release.

YES2 ready to be launched

Objectives

The objectives of the YES2 Student Satellite are as follows:



YES2 in orbit attached to Foton

- Demonstrate the 'Space Mail' concept for the first time, by returning a capsule with payload safely to Earth using a tether-assisted de-orbiting manoeuvre instead of a conventional retro-rocket propulsion system.
- Demonstrate the deployment and control of a 30 km long tether.
- Demonstrate the soft-landing of a small lightweight re-entry capsule in a pre-determined location.
- Obtain new scientific measurements of the tether dynamics and physical environment of the capsule during its atmospheric re-entry.

Here comes the science…

The purpose of the tether is to reduce the orbital energy of the capsule without the use of a retro-rocket, as is normally done. Thanks to the vacuum of space and the force of gravity, when two orbiting objects are in a pendulum swing, the larger craft (Foton-M3) is given energy. Because of it's larger size, the craft is only accelerated by a tiny amount, while the same swing takes far more energy *away* from the small YES2 capsule at the other end of the pendulum.

Artists impression of YES2 re-entry

The reduced orbital energy results in a lower perigee of the orbit of the released Fotino capsule, so low that its orbit crosses the Earth's surface. The friction of the atmosphere will slow down the capsule to allow a soft-landing. This only works if the orbit is low (280 km for Foton-M3) and the tether long enough (30 km for YES2) to generate a perigee of less than the radius of the Earth, in a single pendulum swing.

How does it work in practice?

Just before activation of YES2, the Foton-M3 mother craft reorients itself so that the experiment is pointing towards the Earth.

- Three strong springs accelerate MASS/Fotino, towards Earth at a speed of 2 m/sec, while the attached tether is unwound like a fishing line. As gravity becomes stronger, the capsule is gently pulled down long after the initial energy has been lost due to friction.

- The unwinding speed controls the motion of the capsule. When this speed is high, the orbital angular velocity increases, and MASS/Fotino swing in the direction of flight. If the unwinding speed is low, then Earth's gravity becomes the dominating factor and the capsule stays close to the "local vertical". A friction brake on the tether provides control of unwinding speed and hence the tether motion, according to a reference profile.

- Three and a half kilometres of tether unwind in 90 minutes and MASS/Fotino swing forward then back to vertical, as the friction brake slows down the tether release. When the 3.5 km of tether have been pulled out of FLOYD, the brake blocks the release completely for a few minutes in order to allow precision targeting of the landing location.

- The brake is released again and Fotino/Mass rapidly moves towards the Earth. With the lower orbit, the angular velocity of Fotino/MASS increases, moving ahead of Foton by about 40 degrees. After an hour, 30 km of tether is unwound and the release in blocked.

The YES2 parachute opens for a soft landing

- Foton-M3 and YES2 are now a 30 km pendulum in space. At release speed zero, the gravity gradient forces the pendulum to swing back against the direction of flight.

- When it is nearly in the local vertical, Fotino is released from MASS and then the tether is cut at FLOYD. Both are slowed down enough for a direct path from space to Earth, plunging towards the atmosphere for re-entry.

- Thirty kilometres of sun-lit tether is the longest object ever deployed in space and will be visible from Earth. It will rapidly burn up in the atmosphere together with MASS.

- Fotino follows a course toward the Kazakh steppe. Diving into the atmosphere, it loses energy as heat, protected by a heat shield tested to withstand 2000°C.

- A small parachute opens at five kilometres when the air pressure is high enough. The touchdown will be gentle—some 15 m/sec.

Media

For image Galleries and video please go to Multimedia at www.esa.int/yes2.

Contact

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