Mars Express – the end of the journey

When most of us are comfortably celebrating Christmas, most of the technicians and scientists responsible for the Mars Express project will be experiencing a very high pulse and with tense expectancy be following the orbiting phase for Mars Express and the landing phase for the Beagle lander. Europe's first visit to our neighbouring planet is a very large step forward for European space research. Success will definitely provide valuable knowledge about Mars as well as valuable experience for developing further interplanetary missions.

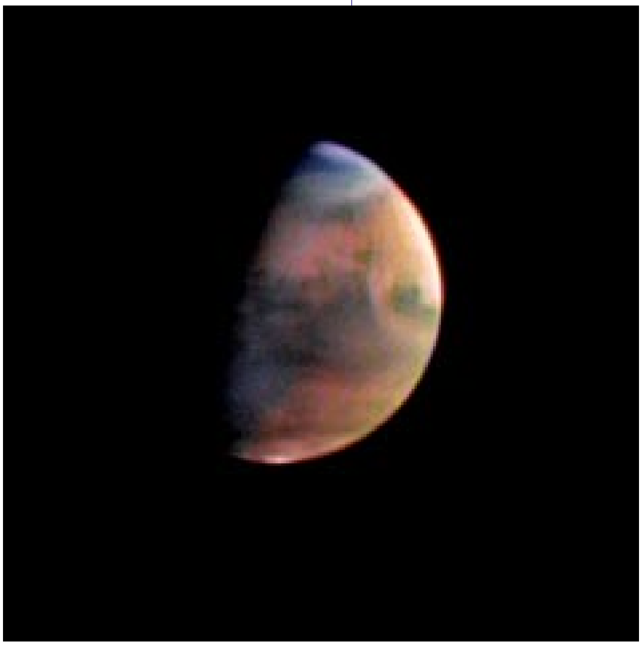
The lander, Beagle 2, is due to descend through the Martian atmosphere and touch-down on 25 December.

Mars Express is now within the gravitation field of the Red Planet and the next mission milestone comes on 19 December, when Mars Express will release Beagle 2. The orbiter spacecraft will send Beagle 2 spinning towards the planet on a precise trajectory.

Beagle has no propulsion system of its own, so it relies on correct aiming by the orbiter to find its way to the planned landing site, a flat basin in the low northern latitudes of Mars.

ESA engineers will then fire the orbiter's main engine in the early hours of 25 December to put Mars Express into orbit around Mars (called Mars Orbit Insertion, or MOI).

When Beagle 2 begins its descent, it will be slowed by friction with the Martian atmosphere. Closer to the surface, parachutes will deploy and large gas-filled bags will inflate to cushion the final touch-down. Beagle 2 should bounce to a halt on Martian soil early on Christmas morning. The first day on Mars is important for the lander because it has only a few hours to collect enough sunlight with its solar panels to recharge its battery.



Mars from 5.5 million km, taken 1 December.
Photo: ESA/Mars Express

ASPERA-3 on its way to Mars

Mars Express is closing in on Mars and will be placed in an orbit around the planet early Christmas morning.

On-board Mars Express is the Swedish instrument ASPERA-3, developed at the Swedish Institute of Space Physics (IRF) in Kiruna. After the six-month journey, ASPERA-3 together with six other instruments, will orbit Mars for at least 687 days. The instrument will deliver information about the interaction between the solar wind and the upper atmosphere of Mars.

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The ASPERA-3 experiment consists of sensors that detect particles (ions and neutrals). The direction of an incoming particle is registered, and for some of the sensors the particle's mass and velocity. There is an electron spectrometer, an ion mass analyzer, and two sensors that detect energetic neutral atoms (ENAs), the neutral particle imager (NPI) with higher angular resolution, but no energy resolution, and the neutral particle detector (NPD) with energy and mass resolution. No ENA imaging of Mars has been done in the past in the solar wind energy range. In fact, no such imaging has been done for any planet other than Earth. Thus, the first ENA images of the Mars-solar wind interaction region will be collected by ASPERA-3. Figure 1 shows a computer simulated ENA image of how the emissions could look like at Mars. For a more detailed description of the instrument, and the scientific questions that it addresses, see "Where did the water on Mars go?", Nordic Space Activities, Vol. 11, No. 1, 2003.

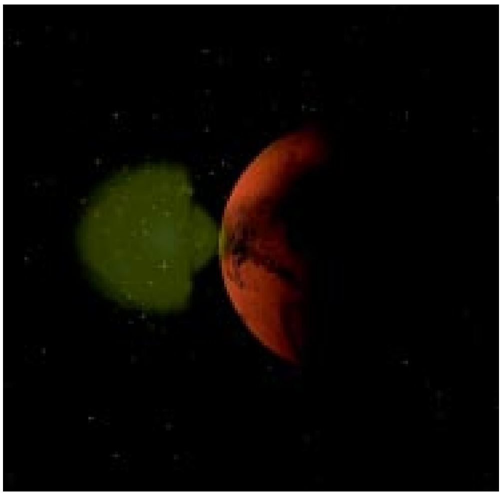

Figure 1. Computer simulation of an ENA image at Mars. In white-yellow are the emissions that an ENA imager would register. This is superimposed on an ordinary simulated image of Mars to show the geometry.

We turned on the instrument for the first time on June 25, more than three weeks after the June 2 Soyuz-Fregat launch from the Baikonur Cosmodrome. The long wait before first switch-on is due to out-gassing.

Since there are high voltages in the instrument, we had to wait until the gas density in the instrument was low enough to avoid arcing that could damage the instrument. Everything functioned as expected, and during the following weeks until July 25, the instrument was operated 16 times for sessions of a few hours each. During the sessions we verified that all parts of the instrument behaved as expected, as well as took measurements of the solar wind conditions that will be useful for comparisons to the measurements at Mars. In Figure 2 we can see an example of the measurements from this summer. It shows data from the ion mass analyzer.

In August we held a meeting in Kiruna with all of the participating research groups from Europe, USA and Japan.

The results of the initial tests were presented and discussed. This was also a planning meeting for Aspera-4, an instrument that is identical to Aspera-3, and will be launched on-board ESA's Venus Express mission in November 2005. It will be the first ENA imager to visit Venus, and having two identical instruments at Venus and Mars will provide us with a unique opportunity to compare the two planets' environments. This comparison may help answer questions about why the two planets have evolved so differently. It is also interesting to compare the two planets' evolution to that of Earth's.

Now we are waiting for the next time that ASPERA-3 is scheduled to be turned on, December 30, when Mars Express is orbiting the planet. This will be an exciting moment for all of us that have been working on the project for years.

Will everything work as planned? Will the observations be consistent with the predictions from our theoretical models and computer simulations? One thing is certain:

There will be surprises.

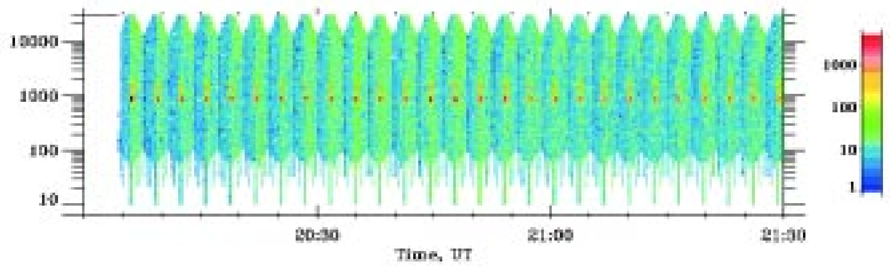

Figure 2. Measurements taken by the ASPERA-3 ion mass analyzer on July 10, 2003. Mars Express was in the solar wind at a distance of more than 8 million kilometers from Earth(more than 20 lunar distances). What is shown is the spectrum of solar wind ions. The brightest spot corresponds to protons, and the second spot is alpha particles. The colour scale shows counts. For each cycle, the instrument scans over different elevation angels.

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In 1997 he received a PhD in Numerical Analysis from Uppsala University. In 1993, he received a MSc in Mechanical Engineering from University of Houston and a MSc in Engineering Physics from Uppsala University.

Further readings.
http://www.irf.se
http://sci.esa.int/marsexpress/

The Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3)
for the Mars Express Mission,
S. Barabash et al.,
ESA Special Publication, SP-1240, 2002.