

Hi, this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Phobos-Grunt*.

Well, who could say no to doing a podcast on a space mission called *Phobos-Grunt*. The *Phobos-Grunt* mission is scheduled to launch in October 2009, but there's a more than 50% chance it will get delayed to 2011.

This is all about launch windows to Mars. Either *Phobos-Grunt* launches in October 2009 or it waits 26 months and launches in December 2011 – there are no in-between options. The recent history of launches to Mars reads like this: in 2007, the highly successful though now ice-entombed *Phoenix* mission launched; in 2005 the fabulous *Mars Reconnaissance Orbiter* launched; in 2003, there was Europe's *Mars Express* and its lander *Beagle 2*, which kind of crashed, and of course *Spirit* and *Opportunity* the Mars rovers; in 2001 *Mars Odyssey* was launched, a superb spacecraft still in operation, that is currently the prime relay site of signals from the Mars rovers.

This limited launch window relates to the fact that Mars takes 687 days, which is close to, though not quite twice the time that the Earth takes to orbit the Sun. This means there's only one opportunity, which happens when the planets are in just the right spots so that you can launch a spacecraft, give it a bit of a push up the Sun's gravity well into line with Mars orbit, just as Mars is passing that particular point in its orbit.

This opportunity will come up for a couple of months from October 2009 – and then 26 months after that – and so on. Try and get there outside the launch window you will have to chase the planet around its orbit – in which it moves at 24 kilometres a second.

Alternatively, you can try and fly in the direction opposite to its orbit around the Sun, but that means you lose all the 30 km a second momentum from the Earth's orbital velocity and waste yet more fuel slowing yourself down again when you do approach Mars. So, while it's technically possible to fly to Mars outside these launch windows you are going to have to burn an awful lot more fuel to do it. More fuel means more mass – and more mass needs more fuel – and yada, yada.

Anyway, what a great name. *Grunt* is apparently Russian for soil, because that's what it's going to do – bring some soil back, from Phobos. It's what rocket scientists call a sample-return mission.

And yep, it's Russian. Designed by NPO Lavochkin – which is a bit like NASA's JPL – and under Russia's equivalent of NASA being the Russian Federal Space Agency. The Russians first attempt at a Mars mission was way back in October 1960 – with start of the Marsnik program, but most of these missions failed on launch. Nonetheless, the Russians were the first to get probes to the surface of Mars, in 1971, but both of them crashed on the surface, leaving the Americans to make the first successful landing of a functioning probe, *Viking 1*, on the 20th of July 1976.

While flying to Mars is really difficult, the Russian's have had particularly poor luck with 18 out of 18 missions failing in one way or another – including two previous missions to Phobos.

Phobos 2 managed to enter Mars orbit in January 1989 – it returned nearly 40 photos, then... nah. But if *Phobos-Grunt* does succeed in a sample return from Mars – that would be quite something.

The first ever extra-terrestrial sample return mission was actually Apollo 11, but the first robotic one was the Russian's *Luna 16*. The first sample return from outside Earth's gravity well was NASA's *Genesis*, which collected particles from the solar wind – although these were somewhat contaminated when it crashed back to Earth in 2004 due to a parachute failure. Then there was *Stardust* which collected particles from the tail of Comet Wild 2 into chunks of Aerogel and returned, without crashing, in 2006.

Japan's *Hyabusa*, which failed to land on 25143 Itokawa, may have managed to collect a few dust grains swept up in the attempt – we'll find out after its scheduled return in June 2010 – when it will hopefully land by parachute at Woomera in Australia.

And that's about it. So a sample return from Phobos? Quite something.

After launch, *Phobos-Grunt* will take about 10 months before going into orbit around Mars, staying there for a few months to study the planet and its moons, before it lands on Phobos.

The spacecraft will remain on the surface, using a robotic arm to collect samples and undertake experiments, including heating a soil sample to check for water vapour. But after a year and a bit, a launch window back to Earth will come around and a small rocket-propelled canister will be launched from the top of *Phobos-Grunt* and returned to the Earth carrying soil samples and another very interesting package.

Well, when I say launched – Phobos' gravity is not strong, with an escape velocity of about 40kilometres an hour, so to protect the rest of the lander, the sample return canister will simply be spring-vaulted into space, the rocket only firing when it's well above the surface.

The other very interesting package is the Planetary Society's *Living Interplanetary Flight Experiment*, LIFE or Life. The LIFE package will contain ten types of organisms from the planet Earth, which will be launched along with *Phobos-Grunt* and then returned to Earth with the sample return canister after a 34 month round trip – allowing us to see just how well they cope with the extreme environment of space. The LIFE package includes an animal (the tiny segmented tardigrade, or water-bear), a plant (cress weed), a fungus (would you believe brewer's yeast), three prokaryotic organisms from the relatively new domain of Archaea – known for their extremophilic tendencies – and three other hardy prokaryotes from the more traditional domain of Bacteria.

The *Phobos-Grunt* spacecraft will be flying to Mars with yet another companion, the Chinese Mars probe *Yinghuo-1*. Yinghuo apparently means firefly, but rather than being a tribute to the TV series, it is a transliteration of the traditional Chinese word for Mars. *Yinghuo 1* will separate from *Phobos-Grunt* after the ten month journey to Mars and go into a different orbit to the Russian craft. Then, as well as fulfilling its own research agenda, *Yinghuo 1* will conduct occultation measures of Mars' ionosphere in collaboration with *Phobos-Grunt*. The idea is that one spacecraft will kind of ping the other just as it is about disappear around the edge of the

planet. Changes in that signal, just before the spacecraft disappears around the edge, will reveal valuable information about Mars upper atmosphere.

The joint *Phobus-Grunt* / *Yinghuo* launch, hopefully in October 2009, will take place from the historic Baikonur Cosmodrome in Kazakhstan – site of Yuri Gagarin's launch in 1961 and Valentina Tereshkova's launch in 1963.

There's a comprehensive *You-Tube* video of the whole *Phobus-Grunt* mission plan linked to this podcast at Cheap Astronomy, which will give you the general idea of the ambitious nature of the mission – even though it's narrated in Russian. And when you see the robotic arm dig into the soil of Phobus and hear the narrator say *Grunt* – I hope you'll be glad you listened to this podcast.

Many thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where currency depends on your frame of reference. No ads, no profit, just good science. Bye.