

MARS MINOR*. Daniel HERNANDEZ, Devil-Hop (11 Route des Bardis, 31320 REBIGUE, France - Danieljean.hernandez@orange.fr)

Introduction: The MARS MINOR project is related to a low cost mission to MARS. It will be studied with students of ISAE/Supaero (a French engineer well known school) from september.

Project and study description:

The MARS MINOR mission study started some weeks ago. It is a preliminary study of a Mars exploration mission that will be given to students in September as the project they will have to study in depth during their space specialized master (TAS Astro) year at ISAE/Supaero in Toulouse (France).

The preliminary ideas behind the project are:

- Launch with a small/cheap launcher: this implies that the satellite be weighing around 200 kg (mass at separation from launcher, i.e. including fuel)
- An orbiter to relay data transmissions from probes send to the Mars surface. This orbiter may also contribute to scientific measurements from the orbit (atmosphere, magnetism, gravity ...?)
- 2 or maximum 3 probes centered on study of the atmosphere
- 2 or maximum 3 probes soft landing on the Mars surface (surface, atmosphere and internal Mars structure)
- 2 or maximum 3 probes hard hitting the surface centered in measurement of the sub-surface

As a rough starting point, with in the order of 200 kg (or a bit more) at separation from the launcher and assuming in the order of 50 % of the mass i.e. 100 kg, for fuel, we may have a dry mass (orbiter + probes) of around 100 kg. This translates in 6 probes of in average 5 kg each plus 70 kg for the orbiter.

The orbiter will be carrying the probes during the trip from the Earth to Mars. It will also have to carry in the order of 100 kg of fuel. Considering the power supply and the telecommunication subsystem that will have to be oversized in comparison to Earth orbiting satellites, and also considering other characteristics of the project (possibly an heat-shield ...), it is somehow challenging but not unrealistic to do the mission respecting more or less the target of 200 kg "wet". We studied recently Earth orbiting satellites with 30-50 and 200 kg masses that will provide some reference elements for the "MARS MINOR" mission. Mars missions done up to now (Mars 98, Mars climate orbiter ...) will also be providing reference data.

For the launch we will study every possible low cost launcher complemented with an upper stage and also the feasibility of a launch as passenger on a GTO launch. Several transfer orbit (for instance via the Moon or Venus) will be considered in addition to conventional more or less direct orbit to Mars.

On arrival to Mars, aero-braking or aero-capture, together with propulsion control will be considered for changing the satellite orbit.

As regards the probes, past missions will of course be analyzed first to learn lessons and select the more appropriated solutions.

Several topics dimension the project:

- A first technology question is the technology for braking in the atmosphere then amortizing the final fall: shield, ballute, parachute, balloons, rotary wing ...
- A second technology topic is the power supply of the probes: non rechargeable battery will certainly be considered but may not be adapted to all probes. Then nuclear power sources and solar generator will be considered.
- A third question will be the telecommunication link from probes to orbiter and from orbiter to Earth.

The question of science will of course be essential. A preliminary list of possible science measurements / Instruments is:

- Seismometer: but given the small number of seisms on mars the big question will be, in addition of mass, the power for a sufficiently long time measurements
- Microphone
- Meteo package (Temperature, pressure, humidity, wind measurements)
- Spectrometer for soil and atmosphere analysis
- Laser for atmosphere content (gas and dust)
- Soil conductivity and Water detection in the sub-soil: cf. Deep space 2 probe
- Camera
- Gravity
- Magnetism
- Energetic particles
- ...

An inventory of instruments compatibles with the probes and orbiter will be done and a possible mix proposed.

The students of the TAS Astro specialized master for the coming school year are not yet known in may 2012. They will be known in September. They are in principle diplomed –and for some of them experienced- engineer or scientist from various specialty, various university/engineer schools and from various countries. For past years they proved being able to do excellent space system study. For instance, a constellation of small earth observation satellites has been studied in 2010-11 and 2011-12 years (project Peep-Hole) that has been presented in 6 international conferences (such as the IAA small E.O. satellite of Berlin or the IAC in Capetown in 2011).

We imagine that the mars Minor system will be studied for the 2012-13 and 2013-14 years: mission definition, feasibility and preliminary definition studies will be achieved.

Then, the results will be proposed for presentation in international conferences and will be presented to the specialized scientific community (Note: some such scientist will be partly associated in the course of the study). We hope the study will give elements for future agencies projects.

*Mars Minor: this name is provisional. It may be modified especially if it is already proprietary to someone.