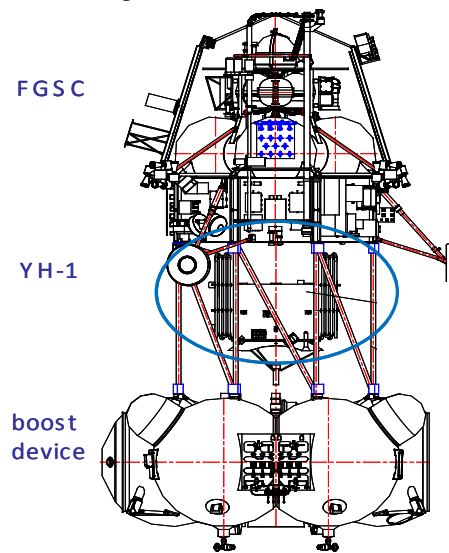


## Joint Yinghuo-1 and Phobos-Grunt VLBI Tracking for Martian Radio Science Experiments

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China and Russia are planning to launch a joint Mars mission in 2011, where the 1st Chinese Mars Probe, Yinghuo-1 will explore the space weather of the Mars and the deep space navigation techniques by means of free flying orbiter, the Russian mission Phobos-Grunt will land on the surface of Phobos and sample return back to the Earth. Both mission will transmit X band beacon signals with HGA to Earth, which give a unique chance for open-loop radio tracking. The same beam double differential one way phase and total phase counting have been developed to improve the celestial mechanical parameter of Mars and Phobos.



**Figure 1, Launching Package of YH-1 and FGSC**

**Introduction:** After successfully launching lunar orbiters Chang'E-1/2, A "Chinese-Russian collaborative Mission for Mars", Yinghuo-1 (YH-1) & Phobos-Grunt (FGSC), is planned in the government level, and the final agreement has been signed in 2007. The two probes will be launched together in November, 2011. Figure 1 shows the configuration of them. The joint Russian-Chinese Martian mission has been developed and promoted solidly.

After a successful joint launching, the spacecrafts YH-1 & FGSC will be sent to a transfer orbit flying to the Mars. After arriving the Martian system, they will be eject into an equatorial orbit of  $800 \times 80000 \text{ km}$ , with inclination of  $\sim 26^\circ$ . Then, they will be separated, FGSC will change its orbit to find change of landing on Phobos, and YH-1 will free-fly in this orbit for 1 year.

**Open Loop Tracking:** There is not a common PLL transponder used for tracking for YH-1. To solve the tracking and OD problem, an USO-based 1-way open loop concept will be used for the s/c. Different from the close-loop tracking methods in common deep space mission, the open-loop methods like DOR/DOD/DOP and 1-way Doppler, are developed and applied to determine the s/c orbit and position. The ground astronomical VLBI system will be used to receive the radio signal for S/C positioning and OD.

The two mission will send VLBI signal at 8424 and 8425 MHz, which can be used for SBI observation. Then, many possible scientific results are expected to be reached from the VLBI tracking of the joint mission. These objectives are estimated as:

- To define more exactly Sun system's parameters (Astronomical constant, orbital parameters of Mars and Phobos);
- To evaluate experimentally Phobos orbit life time, as well as rotation parameters of Phobos;
- To obtain mass distribution inside Phobos;
- To define more exactly the large asteroids masses from main belt;
- To define more exactly limits of variation of universal gravitational constant;

Using close-loop and open-loop tracking data, the long wavelength components of Martian gravity field will be estimated. The time variation of low frequency information can be observed to recovery the detail of mass transporting between polar areas.

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