"Back of a 'Cigarette' Packet Thruster Calculation"

yrrapt

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1 Orbital Manoeuvre Requirements

From Wikipedia the ΔV required from GTO (Geostationary Transfer Orbit) to GEO (GEostationary Orbit) is 1.6 $km \cdot s^{-1}$.

2 Busek Bit-3 Calculation

The Busek Bit-3 has a total ΔV of 2.5 $km \cdot s^{-1}$ so the manoeuvre is possible. However we need to calculate the time taken.

Using a spacecraft mass of 8 kg and the Bit-3's thrust of 1.25 mN, we can use Newton's classic equation to find the acceleration:

$$F = ma \Rightarrow a = \frac{F}{m} = \frac{1.25x10^{-3}\ [N]}{8\ [kg]} = 1.56x10^{-4}\ [m \cdot s^{-2}]$$

Then the total amount of time required firing the thruster is:

$$t = \frac{\Delta V}{a} = \frac{1600\ [m \cdot s^{-1}]}{1.56x10^{-4}\ [m \cdot s^{-2}]} = 1x10^{7}\ [s] = 7122\ [days]$$

To circularise the orbit the thruster must operate at apogee therefore the firing time is approximately half of the orbit. This doubles the time to reach stable GEO orbit to 14245 *days* or 39 *years*. Which is clearly not suitable for the mission.

3 Chemical Thruster

To achieve the mission objectives a higher thrust is required - which points towards a chemical based propulsion system. For example (but in no way limited to) the Tethers Unlimited HYDROS-C thruster provides 1.2 N of thrust.

This leads to an orbit raising time of $\approx$ 18 *days* which feasible is within the mission objectives.

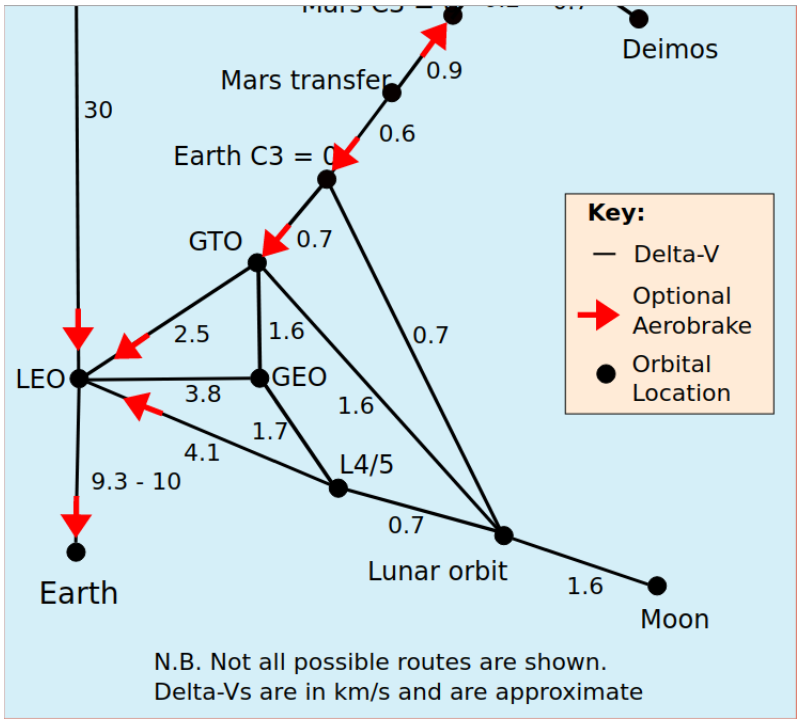

Figure 1: ΔV required for various orbit changes (from Wikipedia)