The constraints for MIC7

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1) Spacecraft envelope size is less than 1.0 m x 1.0 m x 1.0 m size with mass less than 100 kg （multiple satellites are acceptable within the envelope area）.

2) The launcher delivers the spacecraft into Earth escape trajectory with a relative velocity to the Earth (hyperbolic-excess velocity) greater than 0 km/s. The relation between C3 (square of the excess velocity) and the deliverable spacecraft mass is shown in Figure. 1.

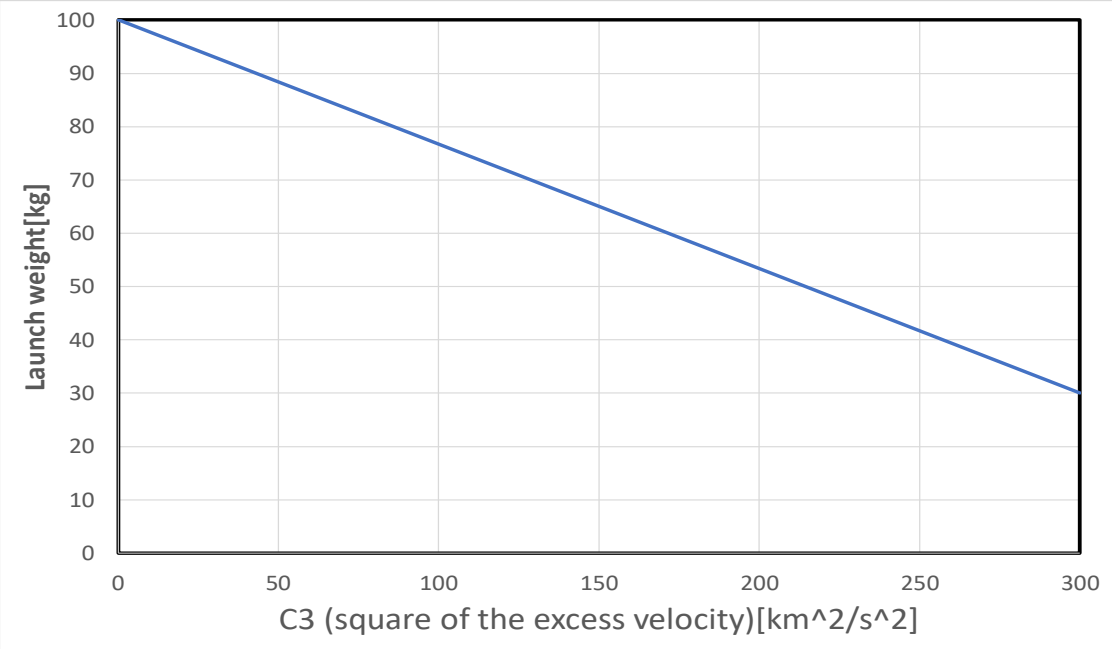

Figure 1　C3 vs. Launch Weight

3) It is possible to use the same transponder onboard of PROCYON, the first deep space micro-spacecraft developed by the University of Tokyo and JAXA. Its communication system is primarily comprised of XTRP (transponder) and XSSPA (power amplifier). The total required power and output RF power of the communication system is roughly 50 W and 15W respectively. The relationships between the distance and bit rate can be calculated from the link-equation assuming a certain ground station performance and spacecraft antenna size, modulation and BER (Bit Error Rate), etc.

4) You can assume usage of earth ground stations for deep space missions like DSN (Deep Space Network), for which the detailed specifications are obtained from the reference of JPL DESCANSO Book Series (see below).

> *Theodore D. Moyer, Formulation for Observed and Computed Values of Deep Space Network Data Types for Navigation, Volume 2. JPL Deep Space Communications and Navigation Series (DESCANSO Book Series), Jon Hamkins, Editor-in-Chief,*
> *https://descanso.jpl.nasa.gov/monograph/series2/Descanso2_all.pdf*

You need to assume the position of the spacecraft by RARR (Range and Range Rate), the accuracy of the position estimation, and the direction determination.
For your reference, here are the actual values observed in PROCYON. Please use it if necessary.

The accuracy of the position estimation: <300km(3σ) for the distance of 0.1au
The direction determination: <10micro-radian

It should be noted that the accuracy could have been better if the spacecraft could have been stabilized, maneuvered less, or used Delta Differential One-way Range (DDOR). For further details, please read the paper below.

> *N.Ozaki, et al., Flyby Navigation and Guidance Experiment for Interplanetary Micro-Spacecraft PROCYON, 55th Annual Conference of the Society of Instrument and Control Engineers of Japan (SICE), 2016,*
> *https://ieeexplore.ieee.org/document/7749238*

5) You can assume a continuous period of 8 hours for spacecraft operation every day.

6) The lifetime is a free parameter, but you should consider the effect of radiation for the proposed lifetime.

7) The proposed launch window should be some time before 2030.