DEEP SPACE PROJECTS IN JAPAN

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After 76 years of recurrent trip in the solar system Comet Halley will again approach the sun in the beginning of 1986. The Institute of Space and Astronautical Science —— formerly the Institute of Space and Aeronautical Science, University of Tokyo —— is planning in this big event to send its first interplanetary probe named Planet-A onto a heliocentrical orbit to take the images of the comet in vacuum ultra-violet region and to measure the solar wind plasma near the comet.
For this purpose the Institute is now developing an improved type of Mu-3S vehicle (M-3S II), which will be able to launch Planet-A spacecraft of 135 kg in weight into a flyby orbit near the comet after its perihelion passage. The Mu-3S II vehicle is a solid propellant rocket and the configuration is shown in Fig.1. Direct injection without parking orbit will be employed to save the weight of the attitude control system, and the firing of the spin-stabilized third stage and the kick stage are performed successively near the apogee of the second stage trajectory.

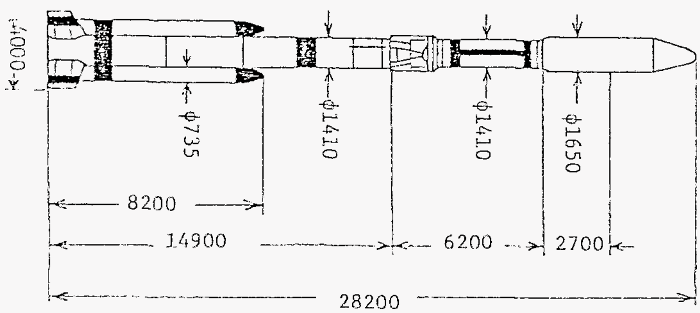

Fig.1 Configuration of Mu-3S II vehicle

Prior to the launching of Planet-A the Institute is planning to launch a test space-craft named MS-TS into a heliocentrical orbit by the use of the first flight of the Mu-3S II vehicle. Besides several instruments for measuring the launch environment two scientific instruments are planned to install in the MS-TS. Mechanical and electrical systems of the MS-T5 are designed to those of the Planet-A as similar as possible. The outlooks of these spacecrafts are shown in Fig.2.
The MS-TS and the Planet-A are tentatively planned to launch in January 1985 and in August 1985 respectively so as to realize the flyby to the comet nearly at the same time. The orbits planned are shown in Fig.3.
Scientific missions onboard the spacecrafts are as follows :

MS-TS Observation of the interplanetary magnetic field,
Observation of the interplanetary plasma waves,

Planet-A Imaging of the Comet Halley in vacuum UV region,
Observation of the solar wind near the cornet.

Telemetry, command arid ranging system of these two probes are designed at the S-Band frequencies allocated for the deep space mission.
Since in the encounter phase of two spacecraft.!; to the comet both will be on closed orbits, the

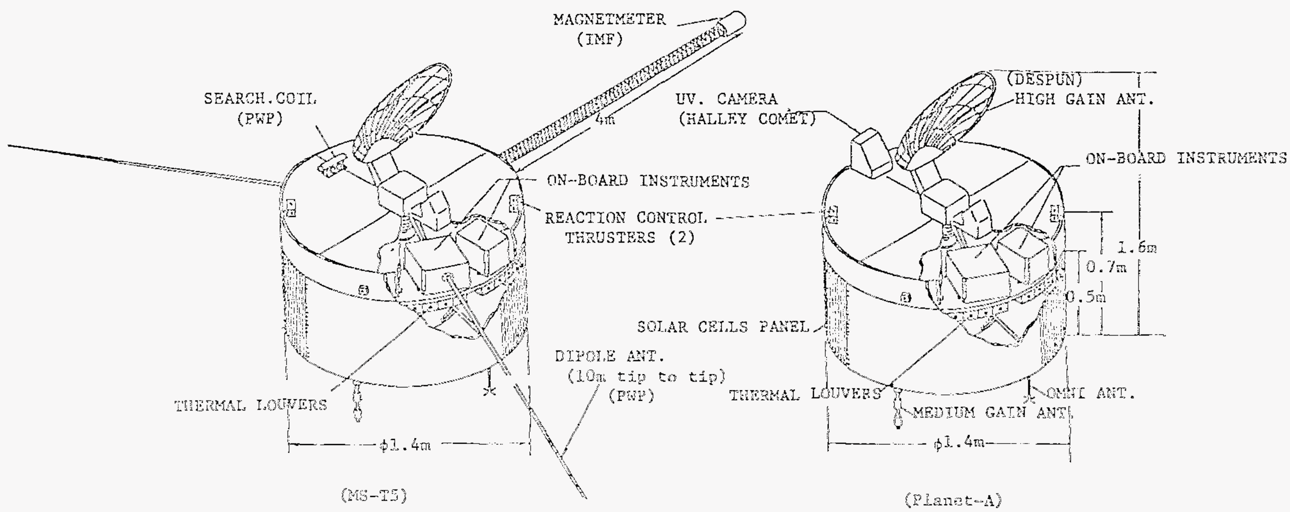

Fig.2 Configurations of MS-T5 and Planet-A

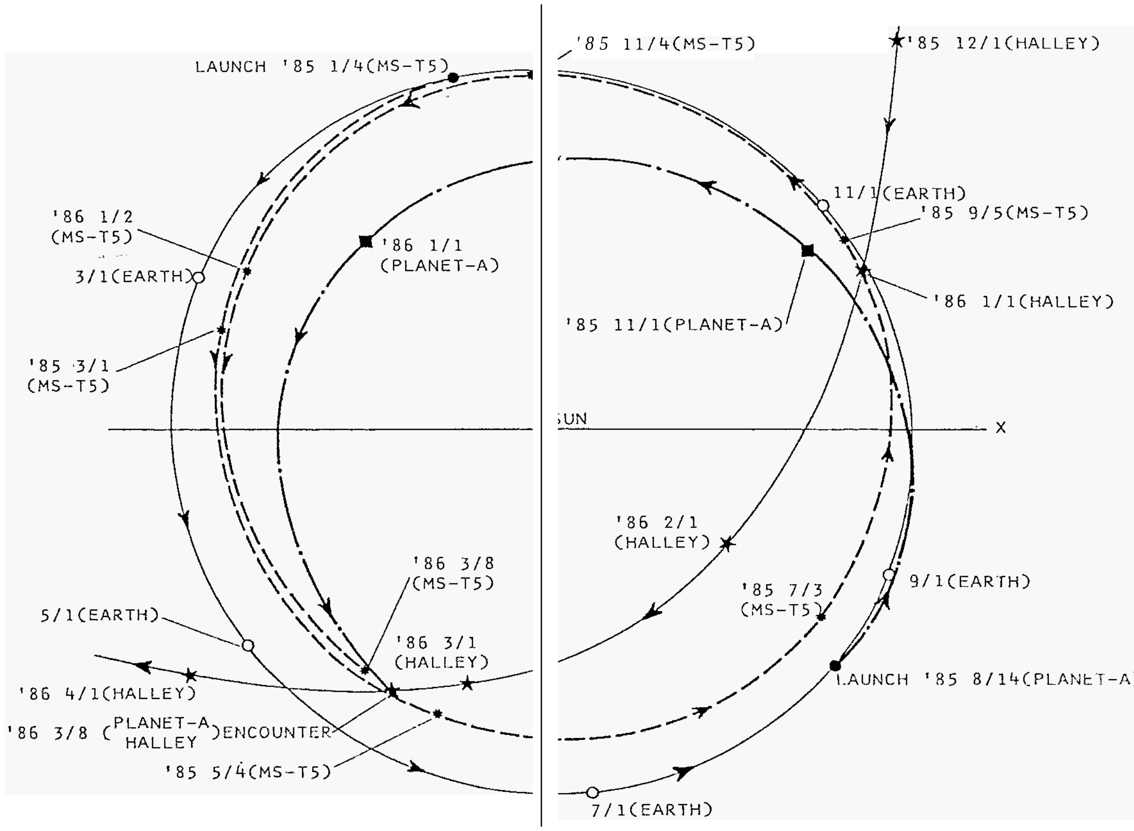

Fig.3 Orbits planned for MS-T5 and Planet-A

S-Band frequencies for the spacecrafts would like to be different from each other in order to make the tracking and the data acquisition. The exact paints of the frequencies would be determined in the near future by an international negotiation. The outline of the communication system for MS-T5 and Planet-A is as follows :

1) Telemetry System

a) Frequency : S Band
b) Coding : Convolutionally Encoded PCM (R=1/2, k=7, Q=8)
c) Data Rate : 2,048 bps without coding, 64 bps with coding
d) Modulation : PCM/PSK/PM (Square Wave) 1.0 rad
e) Subcarrier Frequency : 8,194 Hz
f) Transponder Power : 5 W

2) Command System

a) Frequency : S Band
b) Modulation : PCM(PN)/PSK/PM (Square Wave)
c) Sit Rate : 16 bps with 512 Hz Subcarrier
d) Transmitter Power (Up Link) : 40 kW

3) Ranging System

a) System : Turn-Around (PN Code)
b) Subcarrier Frequency : 100 kHz (Square Wave)
c) Code Component : 20
d) Standard Frequency : Cs Clock

4) Onboard Antenna

a) High Gain Antenna : Offset parabolic antenna, 80 cmϕ
b) Gain : 23 dBi,
Polarization : Right hand circular
Half power beam width : 10"
b) Medium Gain Antenna : 3 element colinear broadside array,
Polarization : Linear
Gain : 5 dBi
c) Low Gain Antenna : 'Turnstile antenna
Polarization : Right hand circular
Gain : o dBi

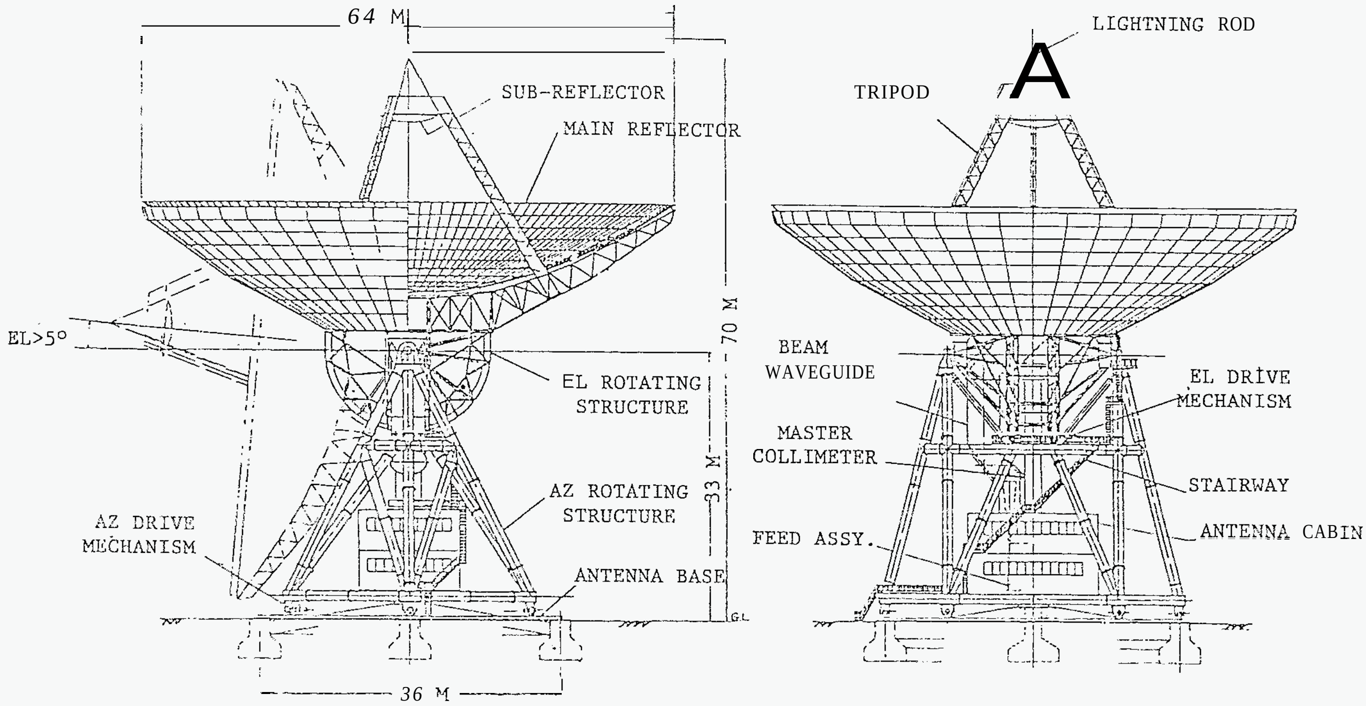

Fig.4 Configuration of the Ground Antenna for Deep Space

In order to support this mission construction of a deep space station (DSS) including a big parabolic antenna is planned at a site located about 150 km away from Tokyo to the north-west. Configuration of the antenna under design is shown in Fig.4. The feed system is designed supposing the simultaneous use of both S-Band and X-Band in the future. Major performance of the ground antenna is shown in Table 1. The schedule for developing MS-T5 and Planet-A is shown in Fig.5.

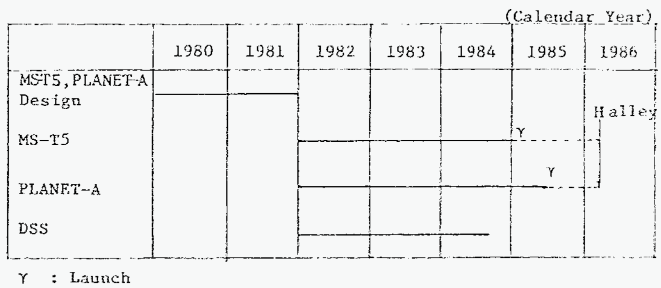

Fig.5 Schedule for Developing MS-T5 and Planet-A

Table 1 Major Performance of Ground Antenna

1. Antenna Type	: Beam waveguide feed cassegrain antenna
2. Antenna Diameter	: 64 m (Nominal)
3. Antenna Mount	: Azimuth/elevation mounted wheel on track type
4. Antenna Drive	: Dual motor anti-backrush drive
5. Steering	: Azimuth 90° ± 185° Elevation 5° ~ 92°
6. Surface Tolerance	: Better than 2 mm rms
7. Frequency Band	: Transmit S-band/X-band Receive S-band/X-band
8. Antenna Gain Excluding Feed Loss	: More than 61.9 dB at 2.115 GHz More than 71.2 dB at 8.425 GHz
9. Antenna Efficiency	: 77 % (S-band) 42 % (X-band)
10. Noise Temperature Excluding Feed Loss	: Less than 6 K at EL=90° Less than 14 K at EL=20°
11. Wide Angle Directivity	: Better than CCIR Recommendation
12. Polarization	: Circular (TX/RX same sense)
13. Power Handling	: 40 KW (S-band) 10 KW (X-band)
14. Tracking	: Program
15. Maximum Drive Speed	: 0.5 deg/sec
16. Tracking Accuracy	: 0.002° deg rms
17. Survival Wind	: 65 m/sec