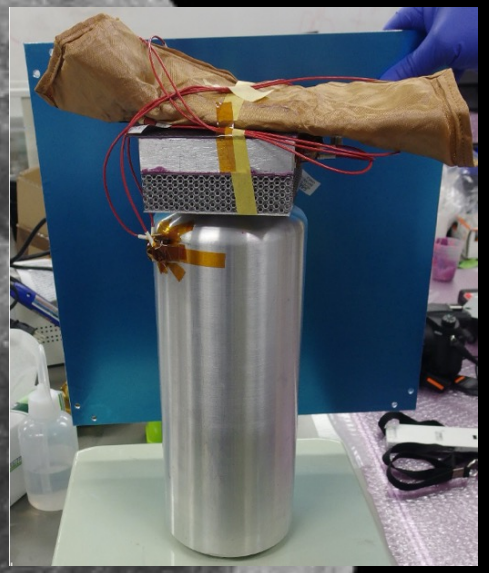
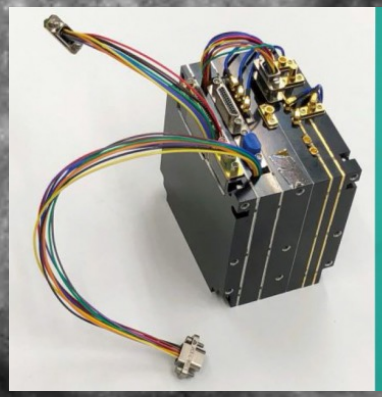
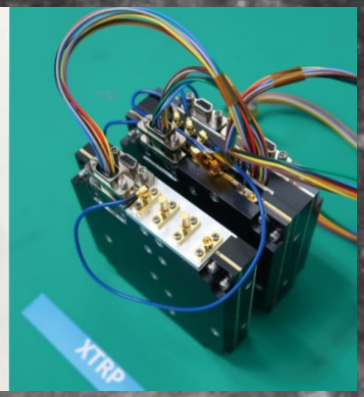
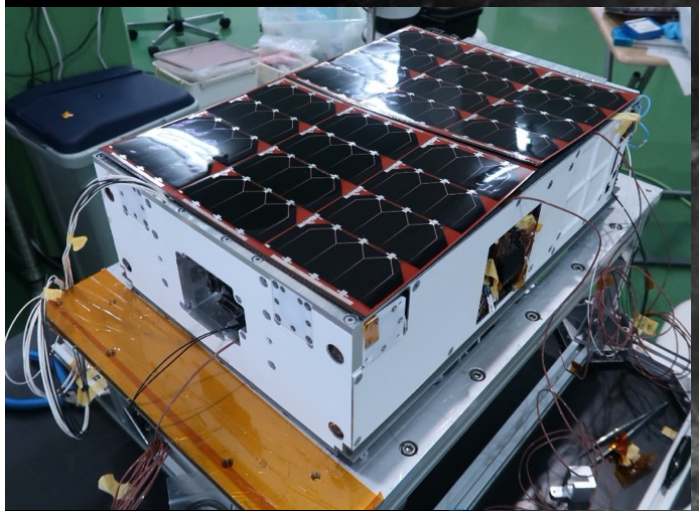
Let's receive the signal from the world's smallest Moon lander, OMOTENASHI

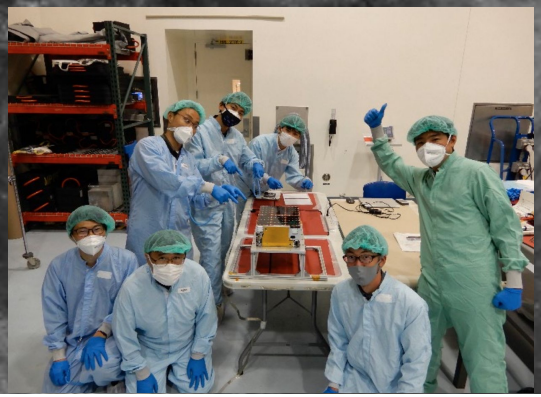
Wataru Torii (JAXA Ham Radio Club)



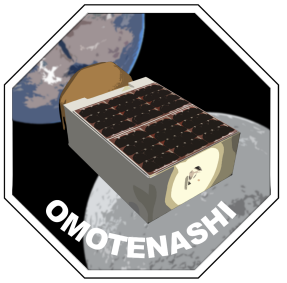








Wataru TORII



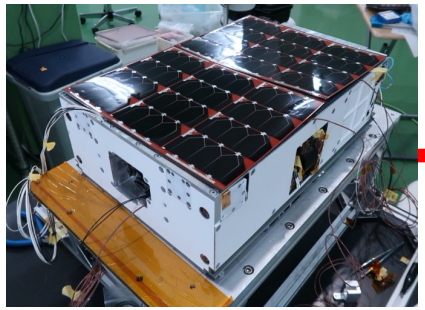
- R&D staff of ISAS/JAXA (Japan)
- Engage in the communication system: **OMOTENASHI**, EQUULEUS and others.
- President of JAXA Ham Radio Club
  (personal callsign is under application)

- **What is JAXA Ham Radio Club (JQ1ZVI)?**
  The Ham Radio club of JAXA members who are interested in amateur radio. We'll operate the UHF-band communication of OMOTENASHI, EME, LEV and etc.

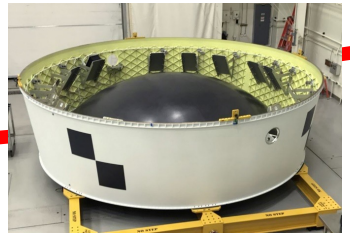
What is OMOTENASHI???

Outstanding MOon exploration TEchnologies
demonstrated by NAno Semi-Hard Impactor

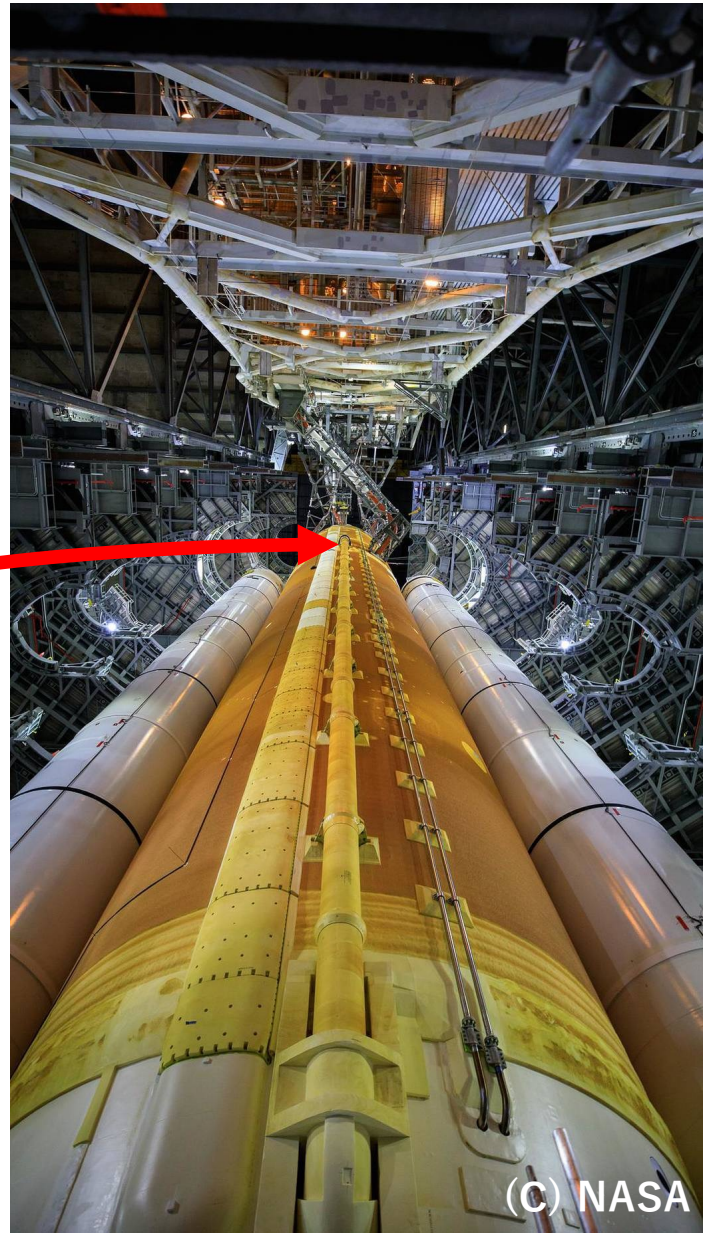
- The world's smallest Moon lander which is launched by the most powerful rocket SLS



6U CubeSat, 12.6kg



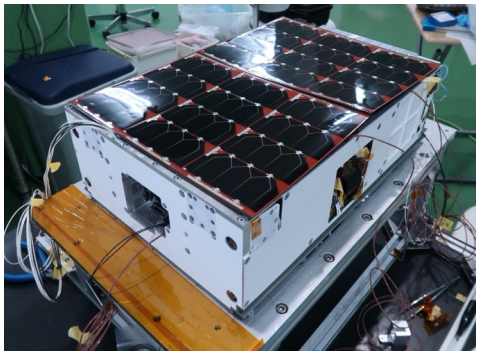
(C) NASA



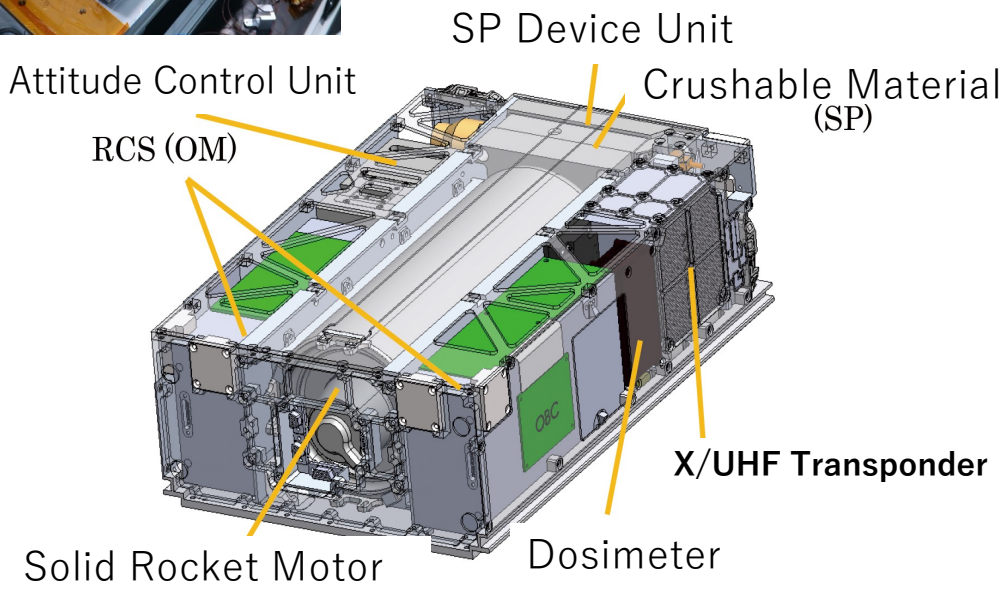
[Mission]

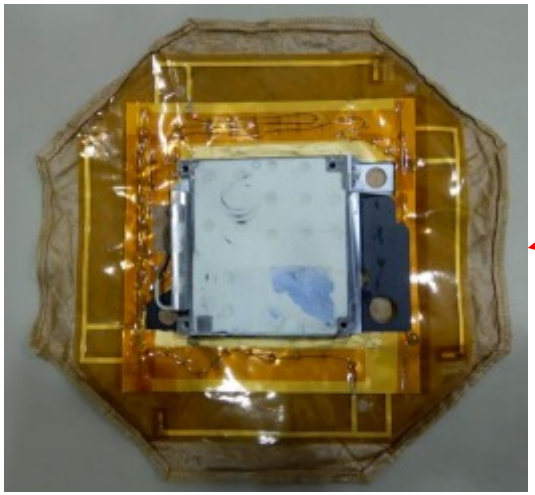
- Development & Verification of the world's smallest moon lander
- Environment measurement for manned exploration for the future

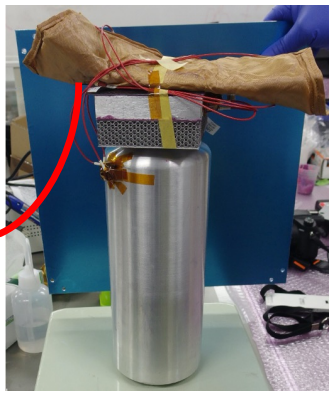
Structure



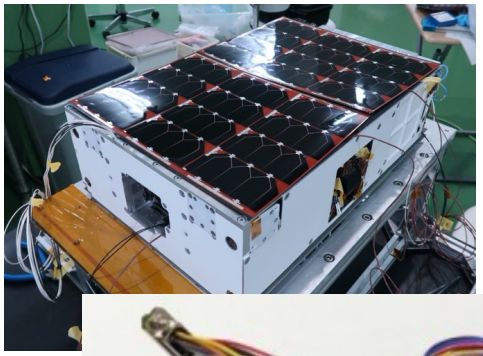
- Orbiting Module (OM): fly to the lunar impact orbit
- Surface Probe (SP) : the Moon lander
- Solid Rocket Motor (RM): deaccelerate SP







Structure



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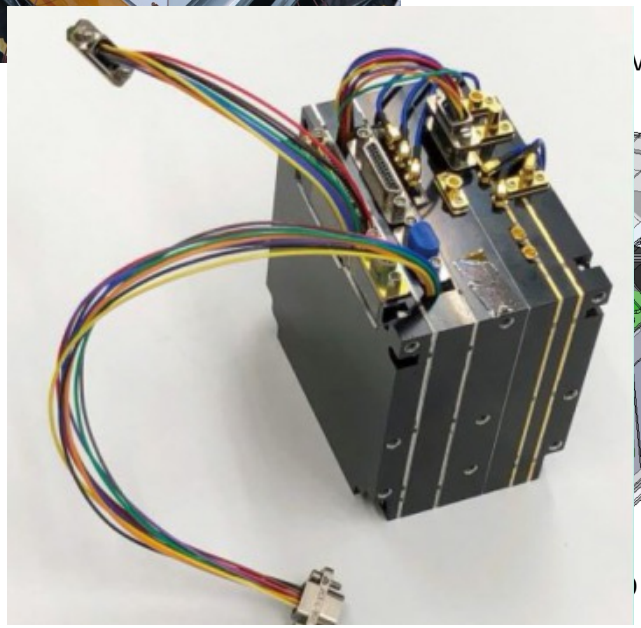
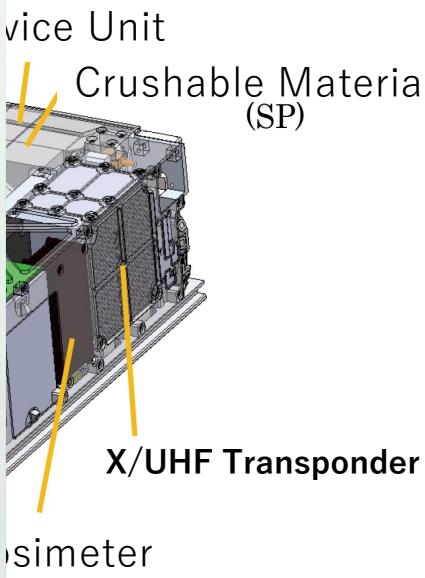
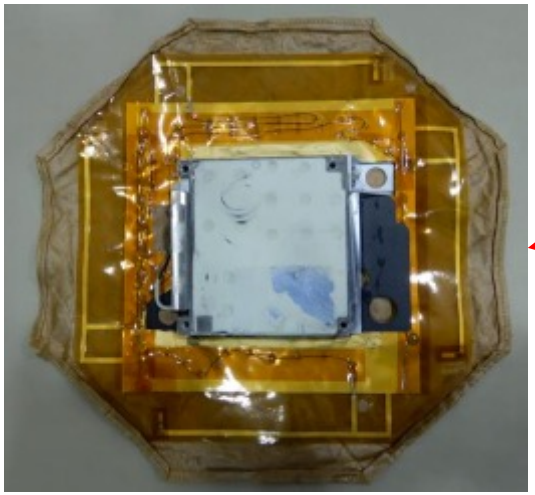
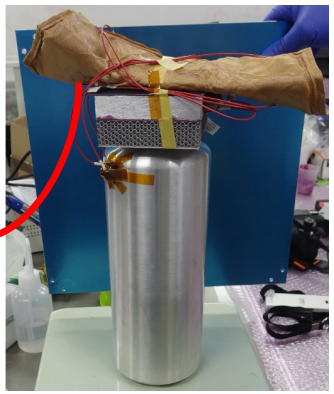
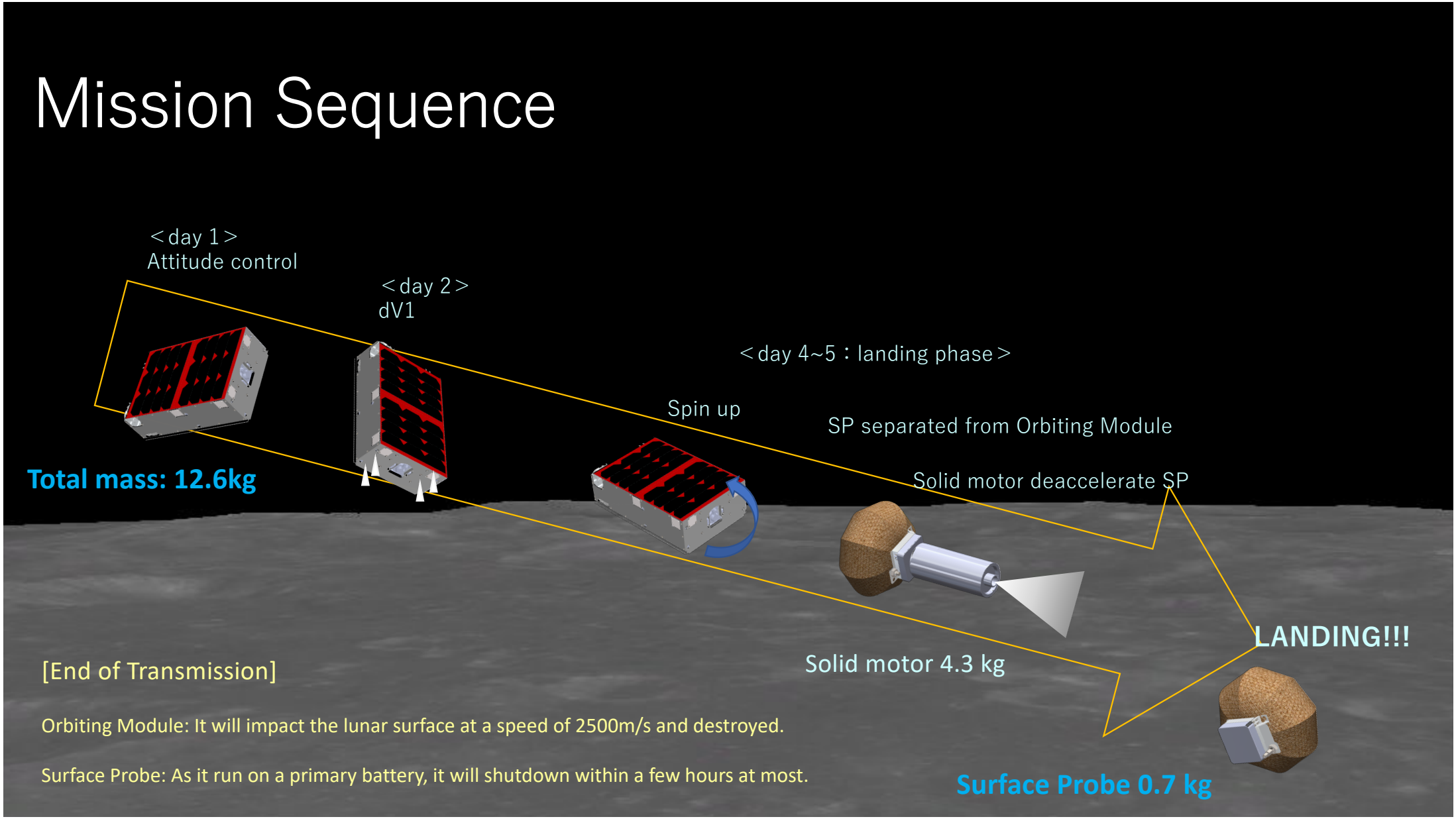




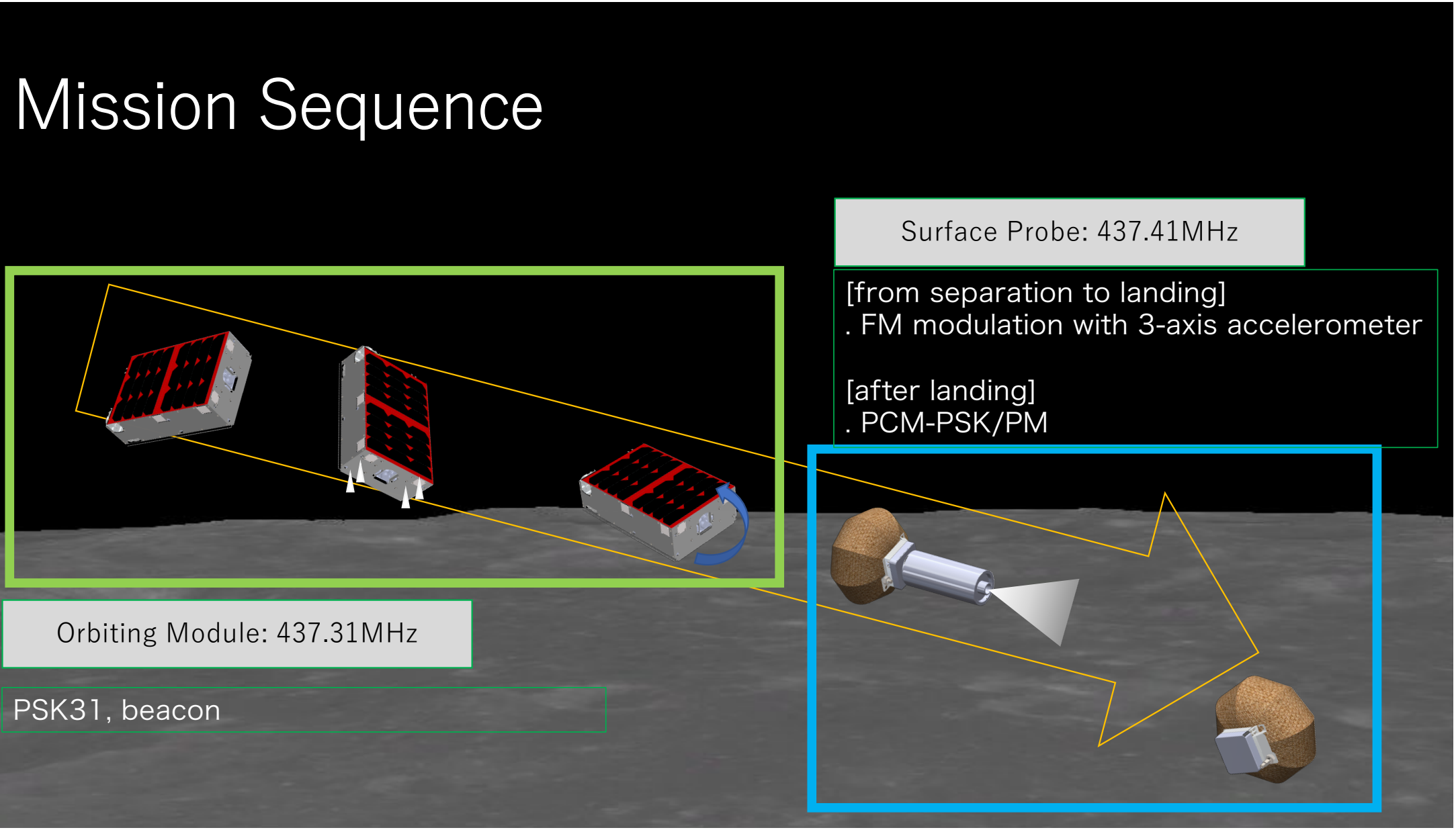




Mission Sequence



Mission Sequence



Surface Probe: 437.41MHz

[from separation to landing]
. FM modulation with 3-axis accelerometer

[after landing]
. PCM-PSK/PM

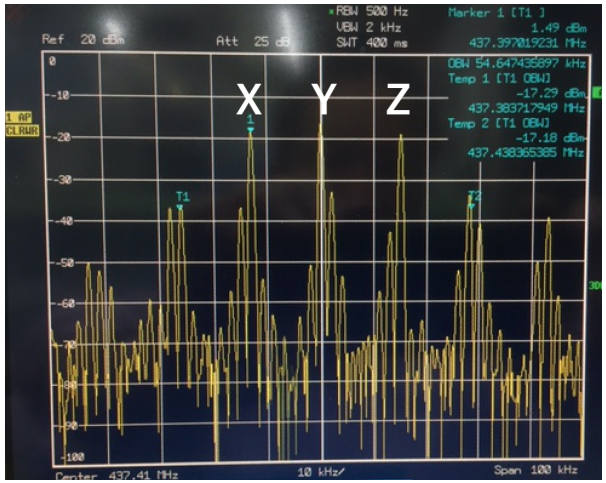
Orbiting Module: 437.31MHz

PSK31, beacon

FM Modulation Mode?

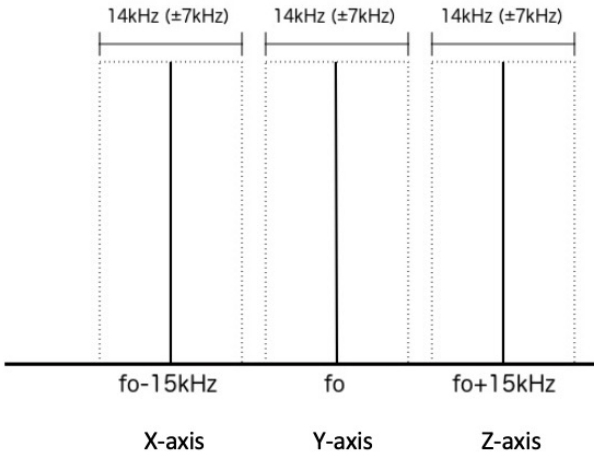
3 axis accelerometer
bandwidth：5~60kHz
Max shock：10,000G

X-axis
Y-axis
Z-axis
through LPF
UHF TRP



After SP is separated from OM, it run this mode about a few minutes.

Three carrier move independently between ±14kHz



Antenna Development

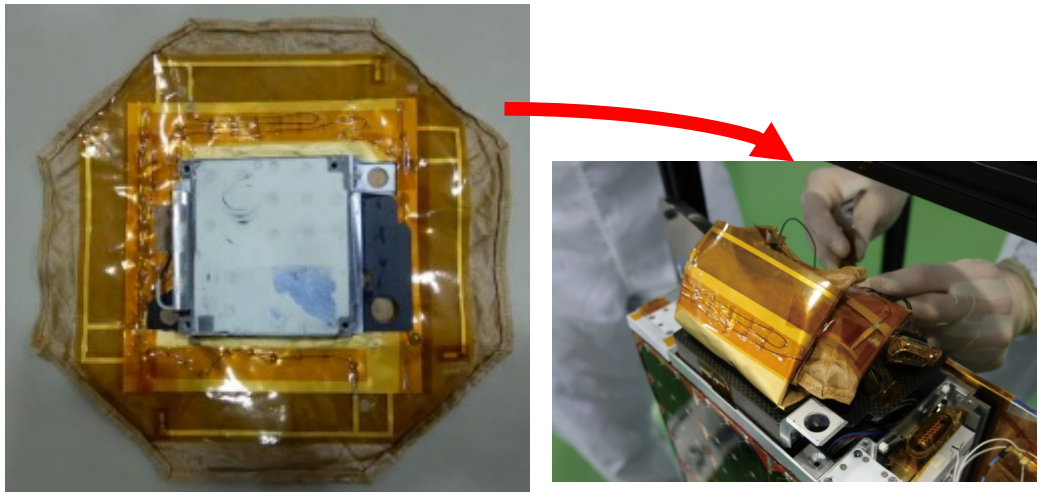
As it is ultra-small transponder, the maximum output power on UHF is 1W.

OM: SRR-antenna

- Meta-material antenna
- Max: -18dBi

SP: circular antenna (invert-F)

- Invert-F x 4elemets
- 1dBi (with cable loss)



Link Budget

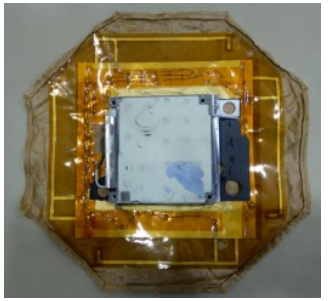
OM

		UHFANT-1		UHFANT-1	
type of wave		G1B		G2D	
item	unit	Downlink	remarks	ダウンリンク	備考
frequency	MHz	437.310		437.310	
output power of transmitter	dBm	30.0	1 W	30.0	1 W
transmitter feed-loss	dB	-1.0		-1.0	
transmitter antenna gain	dBi	-18.0	UHFANT-1	-18.0	UHFANT-1
EIRP	dBm	11.0		11.0	
transmit pointing loss	dB	0.0		0.0	
polarization loss	dB	-3.0		-3.0	
srant range	AU	0.002673833	100000 km	0.000668459	100000 km
free-space loss	dB	-185.3		-185.3	
atmosphere loss	dB	-0.3		0.0	
rain loss	dB	0.0	fine weather	0.0	fine weather
receiver pointing loss	dB	-1.0		-1.0	
receiver antenna gain	dBi	31.6		31.6	
receiver feed-loss	dB	0.0		0.0	
received signal power	dBm	-147.0		-146.6	
Tsys	K	120.0		120.0	
noise power density	dBm/Hz	-177.8		-177.8	
G/T	dB/K	9.8		9.8	
C/NO	dB・Hz	30.9		31.2	

		PSK31		CARRIER		TLM	
modulation index	rad	0.0		0.8		0.8	
modulation loss	dB	0.0		1.4	正弦波	5.7	正弦波
hardware loss	dB	1.0				1.0	
bitrate or bandwidth	dB・Hz	14.9	31.25 bps	10.0	2BL(Hz)= 10	15.1	32 bps
coding gain	dB	0				5.1	
required Eb/No or S/N	dB	9.6		13.5		9.6	1.0E-05 BER
required C/No	dB・Hz	25.5		24.9		26.2	
link margin	dB	5.3		6.2		5.0	

SP (FM Modulation)

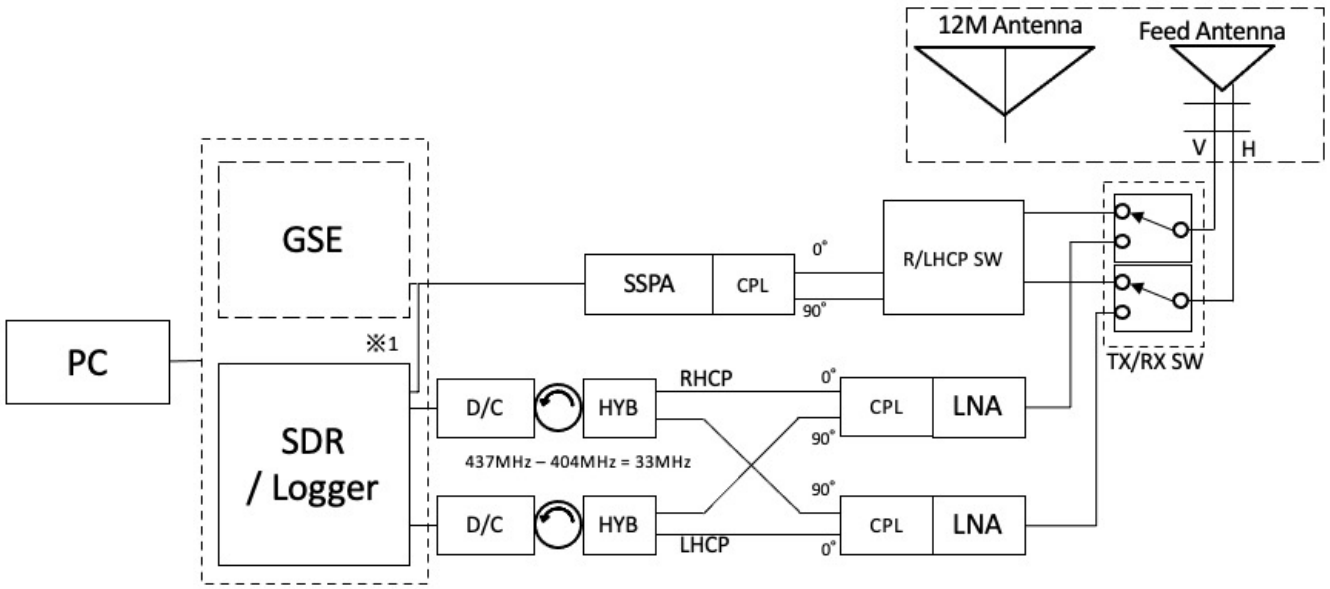
		UHFANT-2	
type of wave		G3X	
item	unit	Downlink	remarks
frequency	MHz	437.410	
output power of transmitter	dBm	20.0	0.1 W
transmitter feed-loss	dB	0.0	
transmitter antenna gain	dBi	-4.0	UHFANT-2
EIRP	dBm	16.0	
transmit pointing loss	dB	0.0	
polarization loss	dB	-3.0	
srant range	AU	0.002673835	400000 km
free-space loss	dB	-197.3	
atmosphere loss	dB	-0.3	
rain loss	dB	0.0	fine weather
receiver pointing loss	dB	-1.0	
receiver antenna gain	dBi	31.6	
receiver feed-loss	dB	0.0	
received signal power	dBm	-154.0	
Tsys	K	120.0	
noise power density	dBm/Hz	-177.8	
G/T	dB/K	9.8	
C/NO	dB・Hz	23.8	

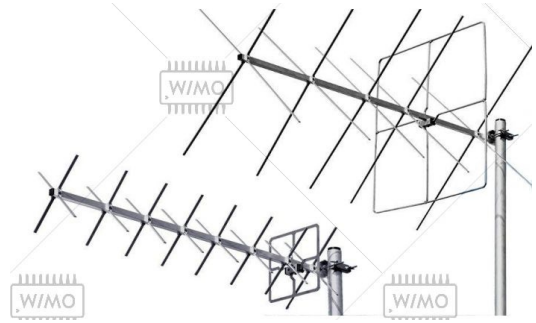


Circular or V/H

Ground Station

- JHRC & Wakayama EME prepared the earth station

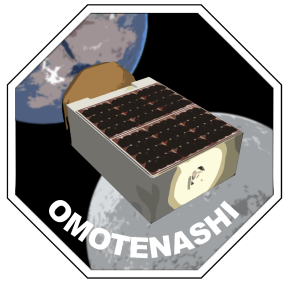




We don’t know visible area …

- JHRC (Wakayama, Japan)
- The blank area is so many!
  (Australia, USA etc…)

- We announced via ARRL newsletter and get responses some Ham Stations.



Thank you for listening!

JHRC HP:
https://www.isas.jaxa.jp/home/omotenashi/JHRCweb/jhrc.html

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twitter: @OMOTENASHI_JAXA