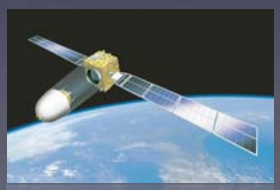
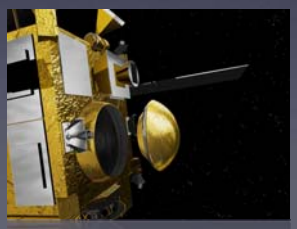
Japanese Entry / Reentry Capsules

- Past, Present, Future -

Tetsuya YAMADA, Yoshifumi INATANI
Nobuaki ISHII, Jun'ichiro KAWAGUCHI
Takashi ABE

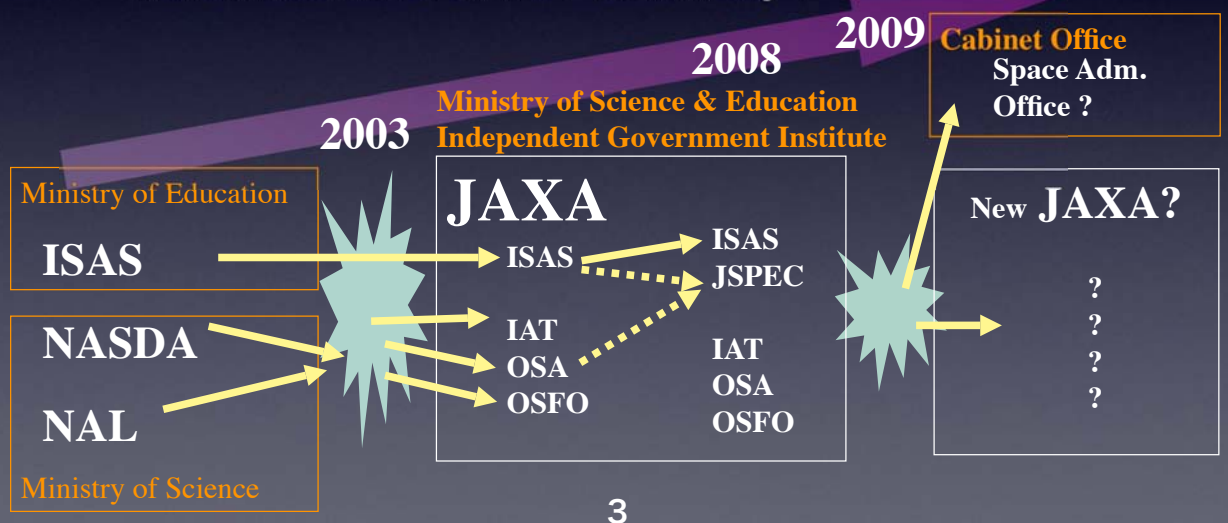



Contents of Presentation

- ✳Japanese Space Organization
- ✳Reentry Experiment Missions Overviews
- ✳USERS Reentry Capsule
- ✳Status of Hayabusa Mission and SRC
- ✳Future Plans;
  Marco-Polo, DASH-II, DASH-X

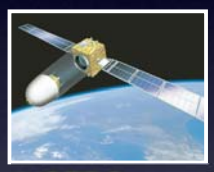
Japanese Organization

- JAXA came to birth (Oct. 2003)
- **Space Act 2008** approved in the Diet/Congress (June 2008)
  - permits to hold **Defensive Reconnaissance Satellites**
  - **Space Admin. Office** under **Cabinet** to be formed
  - **Reformation of JAXA definitely !**



Capsules for Planetary Exploration

EXPRESS
Launch : 95/1/15 ISAS



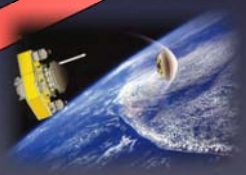
USERS
Reentry : 03/5/30

Venus Probe & Balloon
(2015?)

Solar Sail and
Juvian Entry

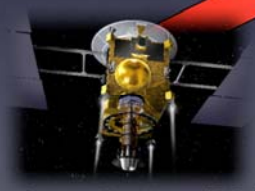
?

Manned
Capsule ??



DASH-II (2013 ?)

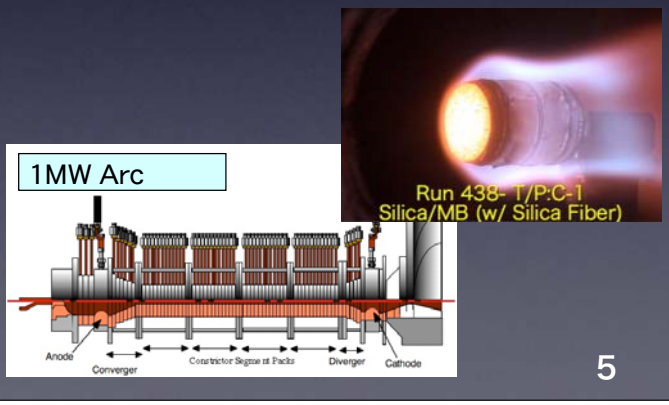
Marco-Polo
＝Hayabusa Mk-II(2018?)



Hayabusa Return (2010)
Hayabusa2 Launch (2014 ?)

EXPRESS Capsule

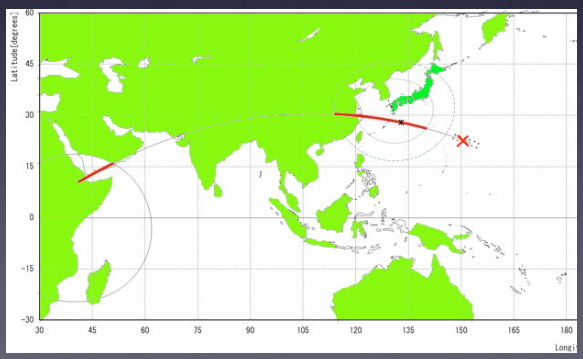
- ✳ German, Russia, Japanese Mission
- ✳ Launched on '95/1/15 by ISAS
- ✳ Due to the orbital insertion failure finally found in Africa in the end of the year.
- ✳ A lot of Experience in TPS, Heating Tests during the Ablator Development taken over by USERS and further



USERS Mission Overviews

- ✳ USERS System Launched on Sep. 10, 2002
- ✳ 8.5 month's On-Orbit μ-G Experiments (H450km x 450km : i=30.4°)
- ✳ Reentry on May 30, 2003.
  - REV splashed down on the sea in the east of Ogasawara Island
  - and successfully Recovered

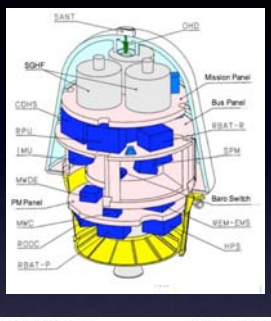
Size : ϕ1,475 × H 1,940 mm (REV1,320)
Weight : (REV+PM) 840 kg



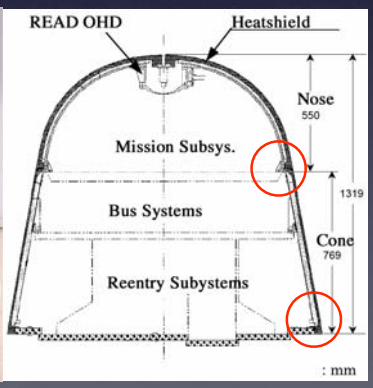
USERS REV (REentry Vehicle)

Size : φ1,475×H1,940(REV1,320)
Weight : (REV+PM) 840 kg

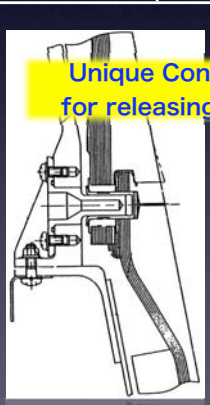
Totally Made in Japan Capsule



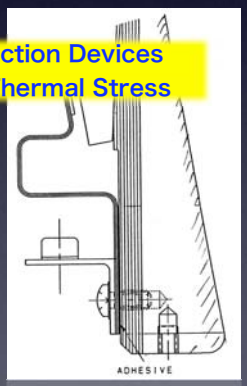
PM (Dry)		165.2 kg
REV	Instruments	437 kg
673.1 kg	TPS	236 kg
	(Ablator)	(124 kg)
	(Others)	(112 kg)



Unique Connection Devices for releasing Thermal Stress



Slide-Pin permits θ displacement



Skirt-bolt permits Radial, Axial

Asteroid Explorer Hayabusa

(MUSES-C)

May 9, 2003 : Launched by M-V-5
May 19, 2004 : Earth Swing-by toward Asteroid Itokawa
July/B-M, 2005
Sep/M, 2005 Itokawa Arrival
Nov, 205 Touchdown Operations

Dec. 2005 LOST
Feb. 2006 Resumed

Jan 19, 2007 Sampler Insertion, rid-close
Jan/B, 2007 Itokawa Departure
Oct 2007 ION engins complete 1st term in Return orbit
May, 2008 Max. Distance from Earth (E-S-H: 1+1.5 = 2.5 AU)
June/M, 2010 Earth Reentry

Asteroid Explore Hayabusa

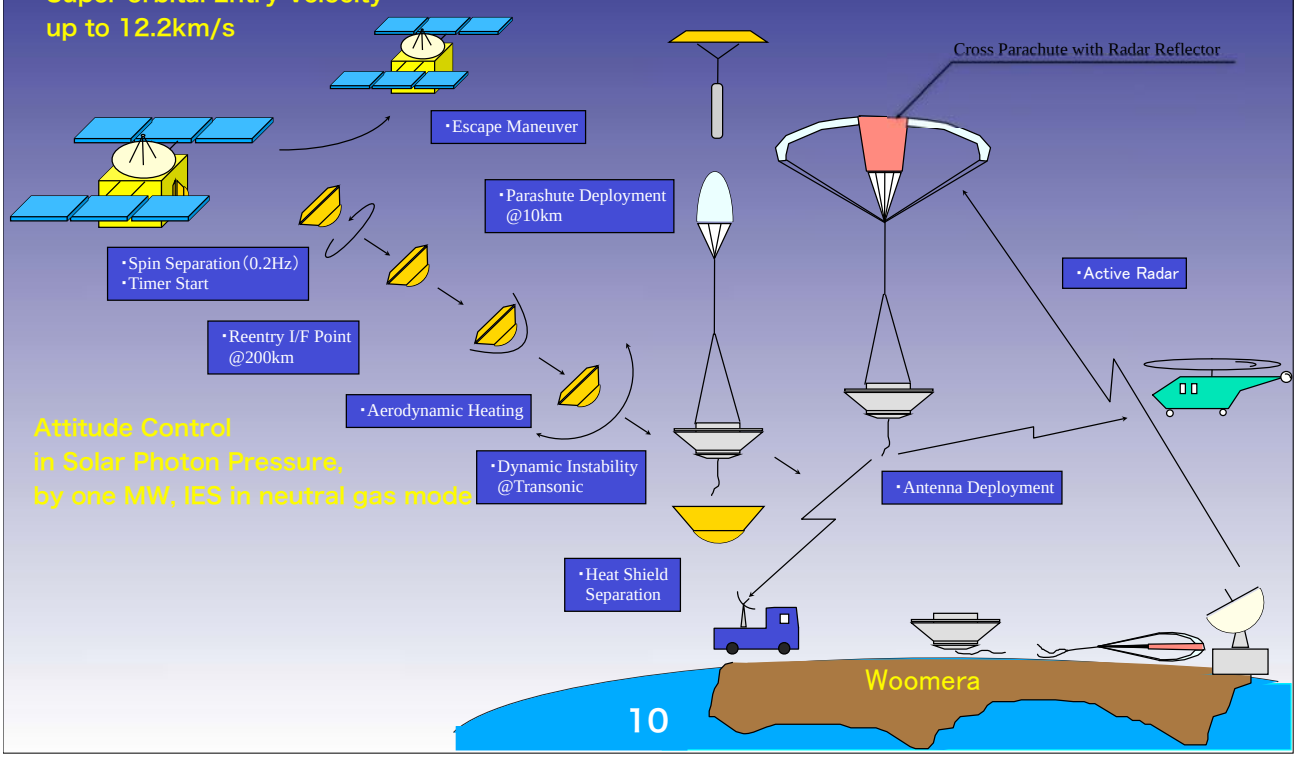
Return

Beginning of June, 2010

Jan 19, 2007 Sampler Insertion, rid-close
Jan/B, 2007 Itokawa Departure
Oct 2007 ION engins complete 1st term
in Return orbit
May, 2008 Max. Distance from Earth
(E-S-H: 1+1.5 = 2.5 AU)
June/M, 2010 Earth Reentry

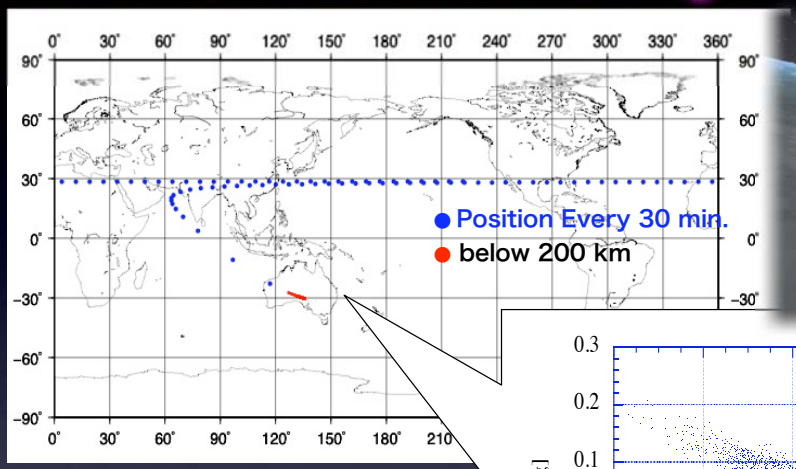
SRC Reentry Sequence

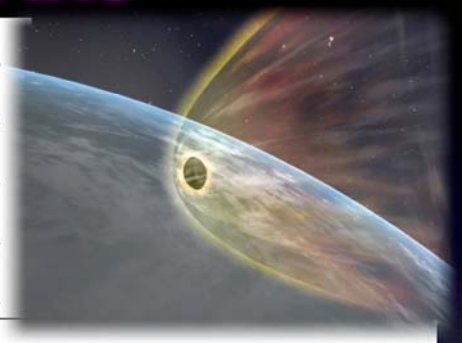
Super-orbital Entry Velocity
up to 12.2km/s

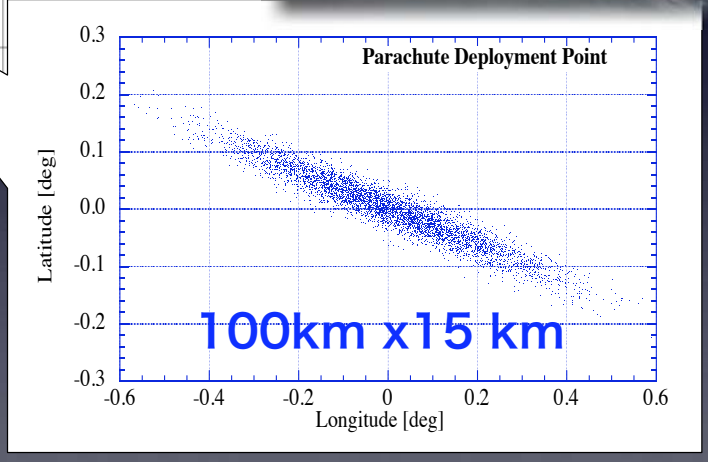


Attitude Control
in Solar Photon Pressure,
by one MW, IES in neutral gas mode

SRC Ground Footprint



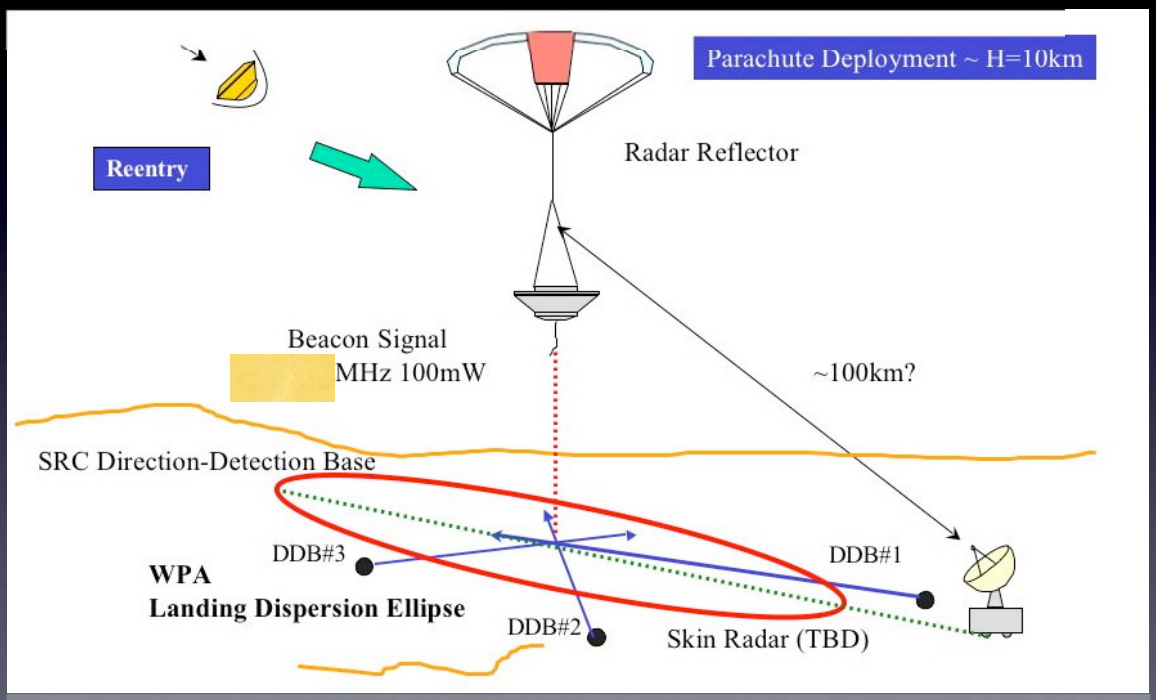




5000Case Monte-Carlo Analysis

Dispersions of
- Atmos. Density/Wind
- Cd Errors
- Orbital Errors

Direction Finding of SRC



WPA Site-Survey Trip

May 30 - June 5, 2005
- Pre-discussion on Landing Center, ROP
- Site Survey Trip for DFS

Marco-Polo (Hayabusa Mk-II)

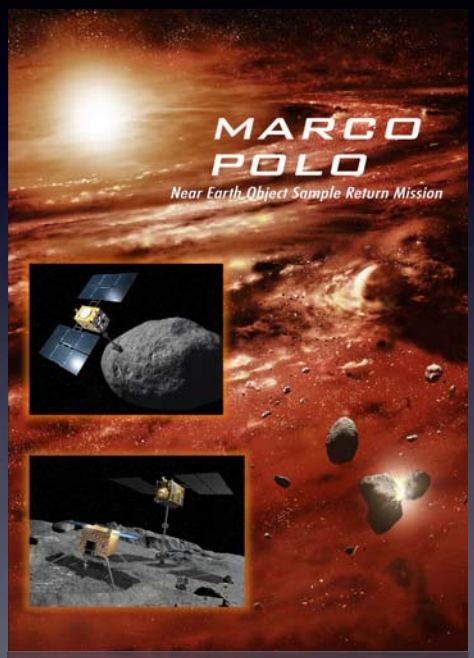
Series NEO Exploration Projects

Haya-2 (to be launched in 2014?)

- Sampling by Haybusa's original method
- Target : C-type Asteroid (Haya : S-type)
- Minimum Development Policy

Haya-MK-II (Marco-Polo)

- Collabo. with Europe applied to CV2008
- Sample Return of Extinct Core of Comets
- 14.2 km/s Entry
  requires innovative TPS



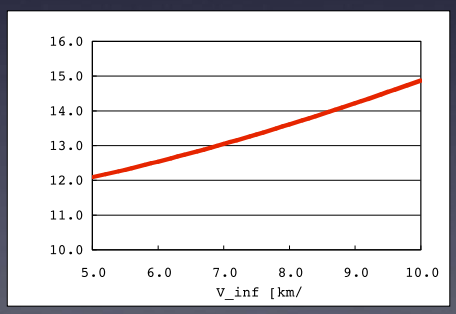
The joint European-Japanese mission MARCO POLO to a Near Earth Object Sample Return has been proposed in response to the ESA CV call for M class missions and has been selected by ESA for a joint assessment study with JAXA.

Marco-Polo (Hayabusa Mk-II)

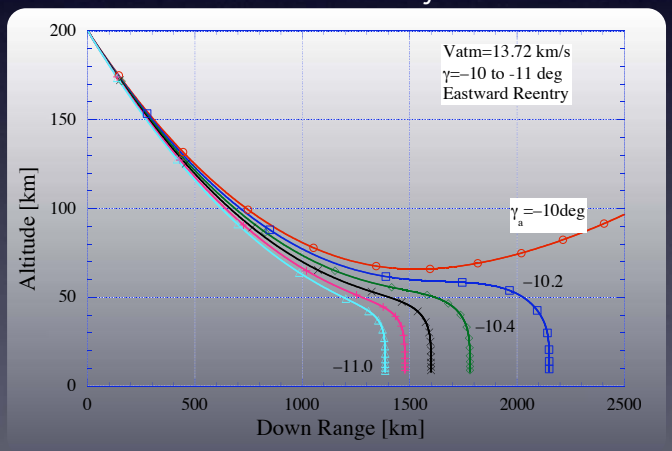
Marco-Polo SRC :

European-Japanese Collaboration Capsule

Vinf : ～ 9 km/s
V0, entry : ～ 14.2 km/s
FlightPathAngle : 11 deg ～



Ballistic Entry



Flight Environment and Ablator

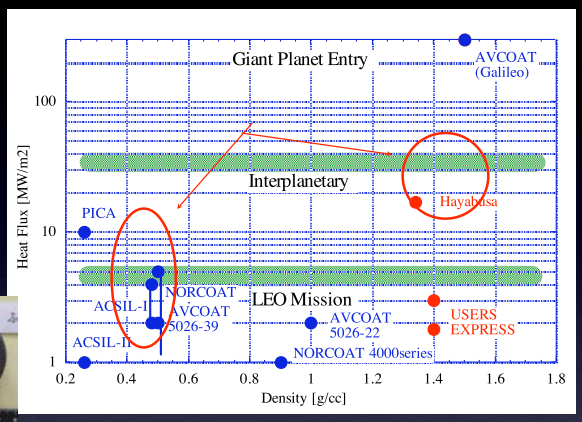
TPS Development Started

utlizing Hayabusa TPS Heritage

・低表面損耗,高加熱率対応の前面アブレータ

・超軽量,断熱性に優れた背面アブレータ

現在,試作→加熱試験評価→改良と1サイクル／2ヶ月で進行中.



	DASH-II	Hayabusa	Marco-Polo (Haya Mk−II)
Entry Speed (Inertia) [km/s]	10.2	12.06	14.2
Flight Path Angle (Geodetic)	-19	–13.4	– 11
Max. Heat Flux [MW/m^2] (Conv./Rad.)	15 (14 + 0.8)	16 (13 + 3)	22 (15 +7)
Heat Input (Conv/Rad) MJ/m^2	195 (190 + 5)	260 (240+20)	***600*** (500+100)
Max. Deceleration [G]	90	60	30

DASH-II

Demonstrator of Atmospheric entry System with Hyper velocity

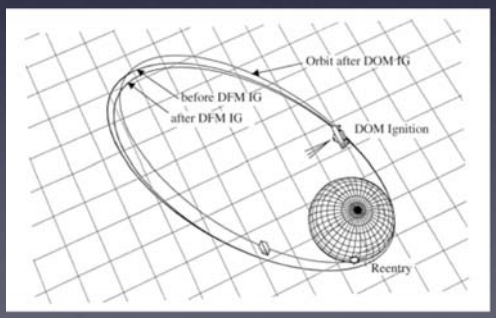
Atmospheric Reentry Flight Demonstrator for Future Space Exploration (manned/unmanned)

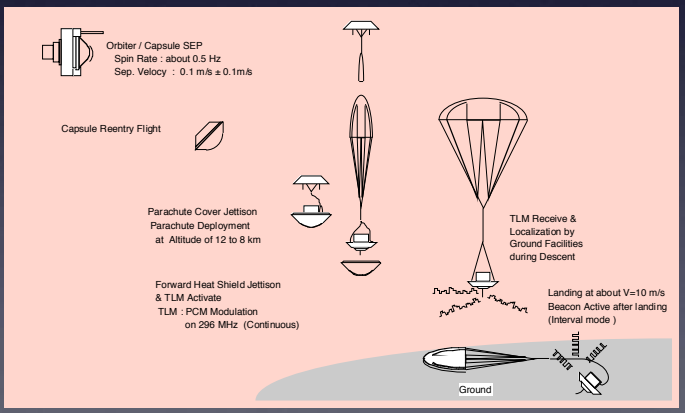
Small Reentry System from GTO(90～150kg)

・Flight Environment Advanced Diagnostics

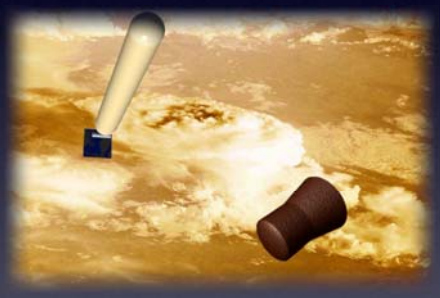
・Flight Verification of Newly-built TPS

・Flight Verification of Descent System





Planetary Entry Probes



Venus Probe & Balloon
(2015?)

Solar Sail and
Juvian Entry

Summary

- Introduced Institutes in JAXA associated with Development Fields
- Hayabusa SRC Returns in Beginning of June, 2010.
- As a preceding Research for Marco-Polo DASH-II (piggy-back sat. of ASTRO-G) is now in prephase-A Study.