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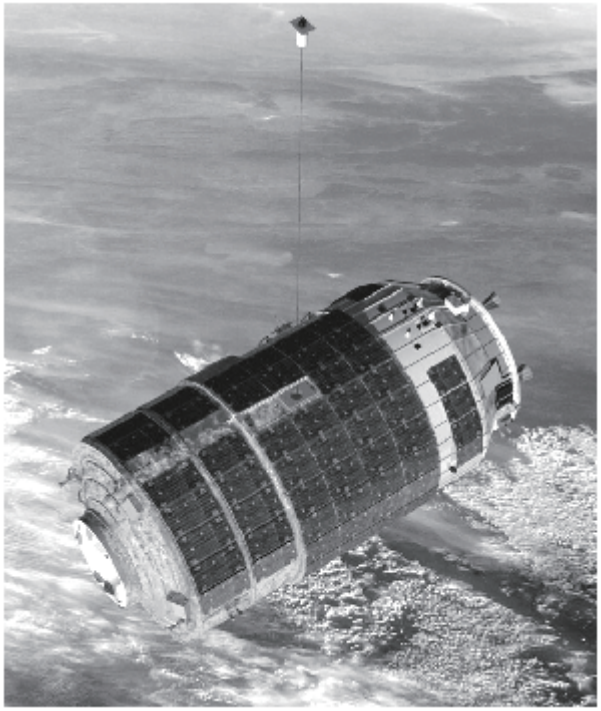
導電性テザー実証実験に向けた HTV 開発状況

HTV Development Status for ElectroDynamic Tether Experiments

○辻田大輔、葛西徹、中野英一郎、植松洋彦、河本聡美、大川恭志、井上浩一（JAXA）
○Daisuke Tsujita, Toru Kasai, Eiichiro Nakano, Hirohiko Uematsu, Satomi Kawamoto, Yasushi Ohkawa and Koichi Inoue (JAXA)

HTV(こうのとり)は, ISS へ物資を補給する宇宙機であり、2009 年から 2013 年にかけて HTV1~4 号機の 4 機連続ミッション成功を実現している実績を持つ。本実績に基づき、HTV4 号機より軌道上プラットフォームを整備して、機器開発ユーザーに軌道上実証機会を提供している。HTV6 号機では、デブリ除去技術の有力な候補である導電性テザー技術の実証実験を行う計画であるが、実験構成機器は 10 個に及ぶ為、軌道上プラットフォームの拡張が必須である。本発表では、実験に向けた軌道上プラットフォームの整備状況、及び、実験構成機器の搭載に向けた各種インタフェース試験状況を報告する。

The H-II Transfer Vehicle (HTV) is Japan's unmanned cargo transfer spacecraft that delivers cargo/supplies, and HTV1 through HTV4 completed the mission successfully. Based on the flight experiences, a on-orbit platform function is developed to provide the demonstration chance to users from HTV4. Currently, ElectroDynamic Tether (EDT) technique is planned to be demonstrated in HTV6, which is a promising candidate of debris removal device. The number of its instruments is as many as ten, and then the platform function has to be extended. The presentation shows its developement status, including the interface test plan and a part of results with experimental instruments.



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第6回スペースデブリワークショップ
2014.12.17～19
@JAXA調布

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1. Purpose

- The H-II Transfer Vehicle (HTV) is Japan's unmanned cargo transfer spacecraft that delivers cargo/supplies, and HTV1 through HTV4 completed the mission successfully.
- Based on the flight experiences, a on-orbit platform function is developed to provide the demonstration chance to users from HTV4.
- Currently, ElectroDynamic Tether (EDT) technique is planned to be demonstrated in HTV6, which is a promising candidate of debris removal device. The number of its instruments is as many as ten, and then the platform function has to be extended.
- The presentation shows its development status, including the interface test plan and a part of results with experimental instruments.

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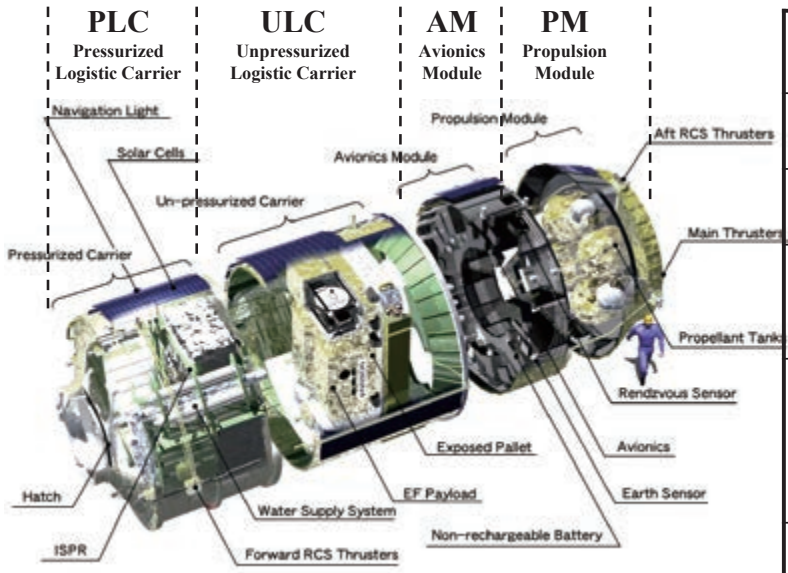
What's HTV?

- Logistic Supply and Waste Disposal Vehicle for the ISS
- Mission Summary of HTV
  - HTV-1: Sep. 11 to Nov. 2, 2009 (Demonstration Flight)
  - HTV-2: Jan. 22 to Mar. 30, 2011 (1st Operational Flight)
  - HTV-3: July. 21 to Sep. 14, 2012
  - HTV-4: Aug. 4, 2013 to Sep. 7, 2013
  - HTV-5 to -7: Planed in 2015 to 2017
- Almost yearly launch can be expected … Good mother spacecraft for demo mission!

Picture (C)NASA

2. HTV Overview –Configuration–



HTV Characteristics

Dimensions	Length: 9.2 m Diameter : 4.4 m
Total mass full loaded	16.5 ton
Launch Vehicle	H-IIB launch Vehicle
Target orbit	Altitude: 350km~460km Inclination: 51.6deg
Cargo capability	6 ton in total
Press.	Up to 5.2 ton
Un-press.	Up to 1.5 ton
Propulsion system	Four 500N main engine Twenty eight 120N RCS thrusters

2. HTV Overview –Operation–

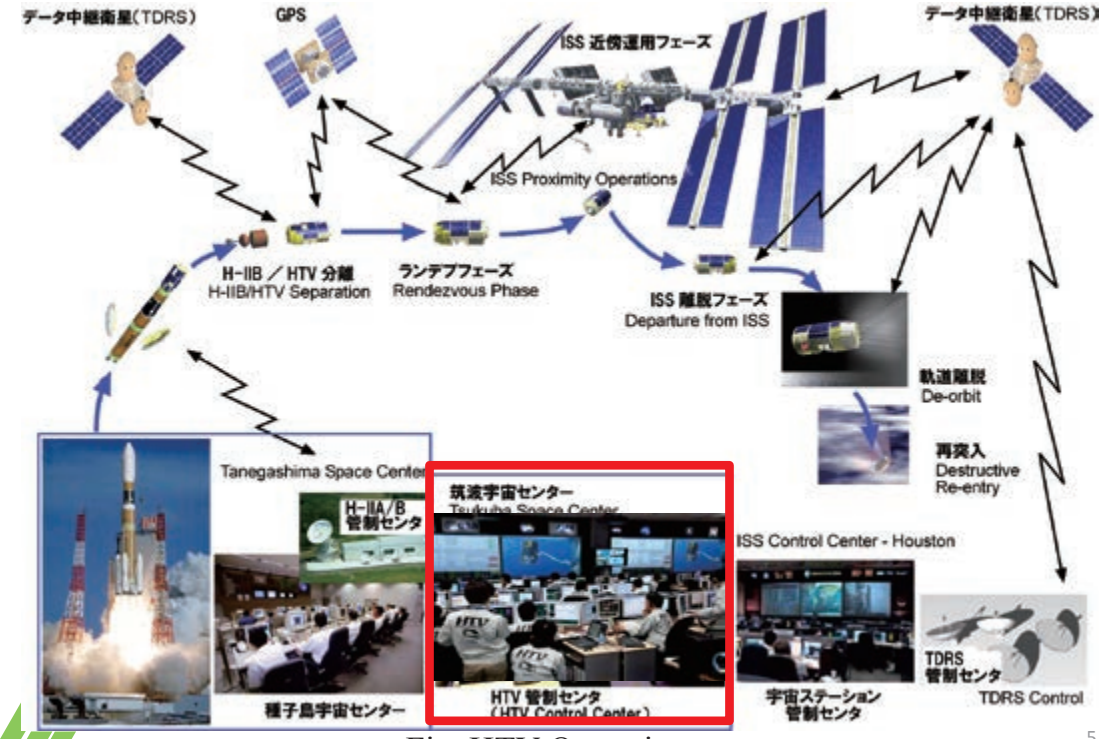
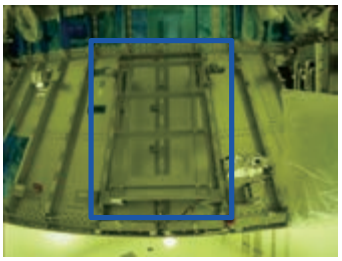


Fig. HTV Operation

3. On-orbit platform

HTV has prepared a new platform from HTV4, where some existing spare electrical and communication channels are provided, and a special seat is developed to provide mounting position for some instruments.



Special Seat

Fig. Platform position

Table. Platform Interface

Item	Content
Electrical IF	50V power supply, On/Off commands, some analog telemetries
Mechanical IF	Mounting on the special seat
Thermal IF	Isolated thermally from the HTV structure
Mass	Less than approx. 5kg
Comm with Ground	Communication with HTV Operation Control System via HTV.

3. On-orbit platform

- An electrometer was installed on the platform in HTV4. It has the functionality of measuring the potential of HTV against space plasma in the range from -200V to +200V.
- The platform will be used by a similar instrument in HTV5.

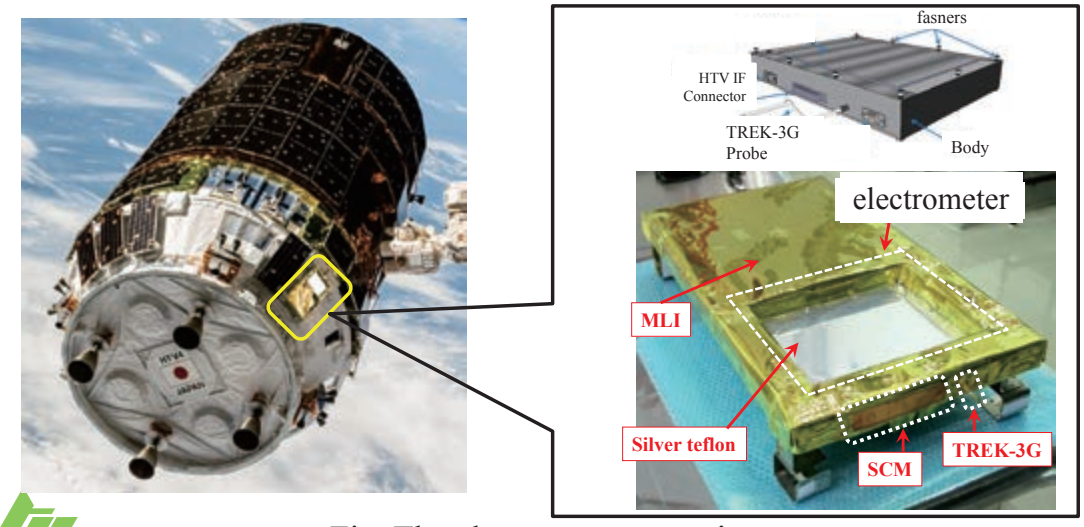


Fig. The electrometer overview

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4. ElectroDynamic Tether (EDT) experiments plan

[Candidate for HTV6]
As larger scale experiments, EDT experiments, are planned in the extended platform on HTV6.

[What is EDT]
An electrodynamic tether is a promising candidate of deorbit propulsion for future active debris removal systems because of its simplicity, high efficiency, easy attachment to debris, and no need of thrust vectoring. Since the electrodynamic tether utilizes Lorenz force by interaction between current on tether and the geomagnetic field to generate deorbiting force, the propulsion system needs neither propellant nor high electrical power in principle

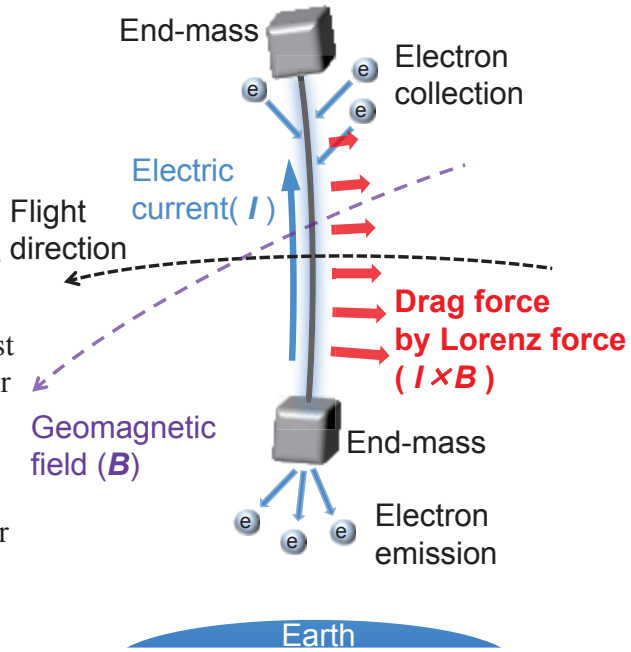

Fig. The EDT Principle

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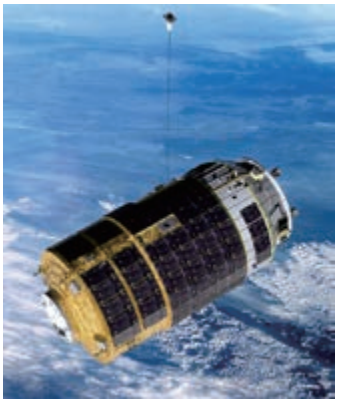
4. ElectroDynamic Tether (EDT) experiments plan

[Configuration]

The endmass is ejected from the HTV to deploy the tether whose length is approximately 700m. Tether current is driven 10mA at the maximum by using electron emitter on the HTV and the direction from nadir to zenith, so that Lorenz force applies on the opposite flight direction.



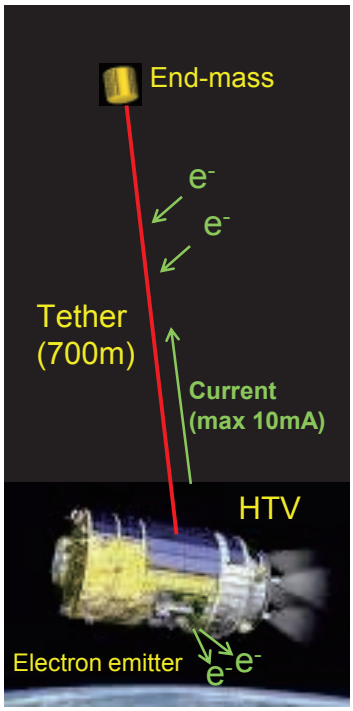


Fig. The Experiments configuration

4. ElectroDynamic Tether (EDT) experiments plan

[System block diagram]

The special characteristic of EDT on the HTV is that the endmass motion is monitored by HTV Rendezvous Sensor (RVS), which is used in approaching International Space Station (ISS). First concept said that GPS monitors the endmass position and transponder transmits the data to the HTV. In that case, the endmass needs batteries / solar array panels / power control unit for the GPS and transponder, at least, which indicates very complex system. However, HTV RVS solves the problem. Only the reflector is needed on the endmass, so that it greatly contributes to simplifying the system.

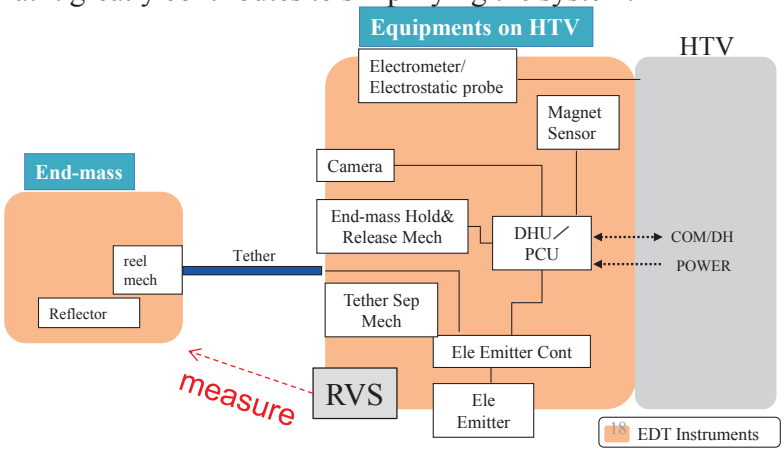


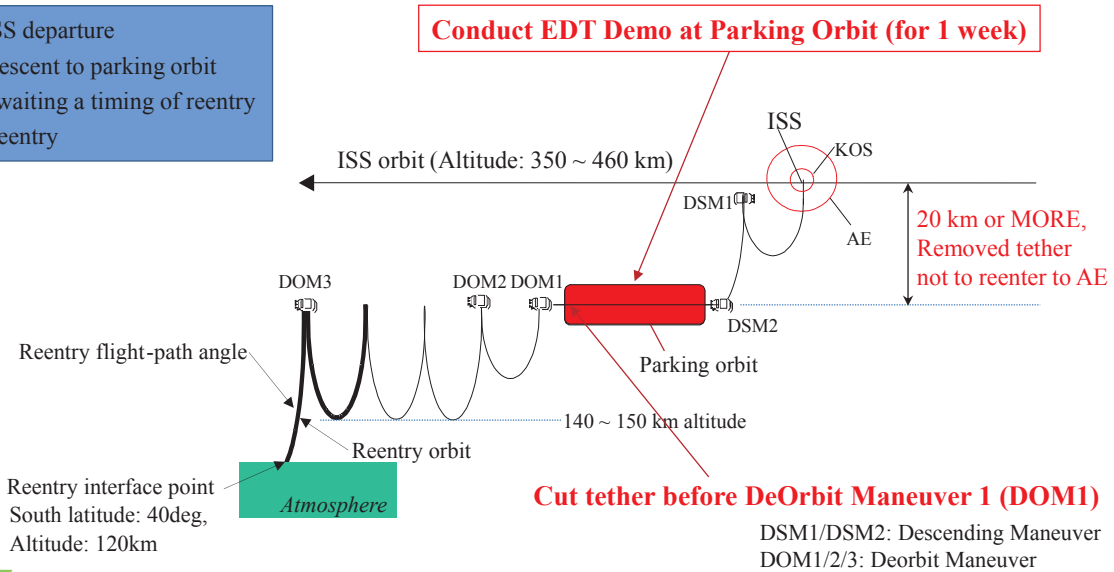
Fig. System block diagram

4. ElectroDynamic Tether (EDT) experiments plan

[Mission Profile]

The mission timing is planned for approximately 7 days from the end of integrated operation until re-entry, by prioritizing the HTV mission objective.

1. ISS departure
2. Descent to parking orbit
3. Awaiting a timing of reentry
4. Reentry



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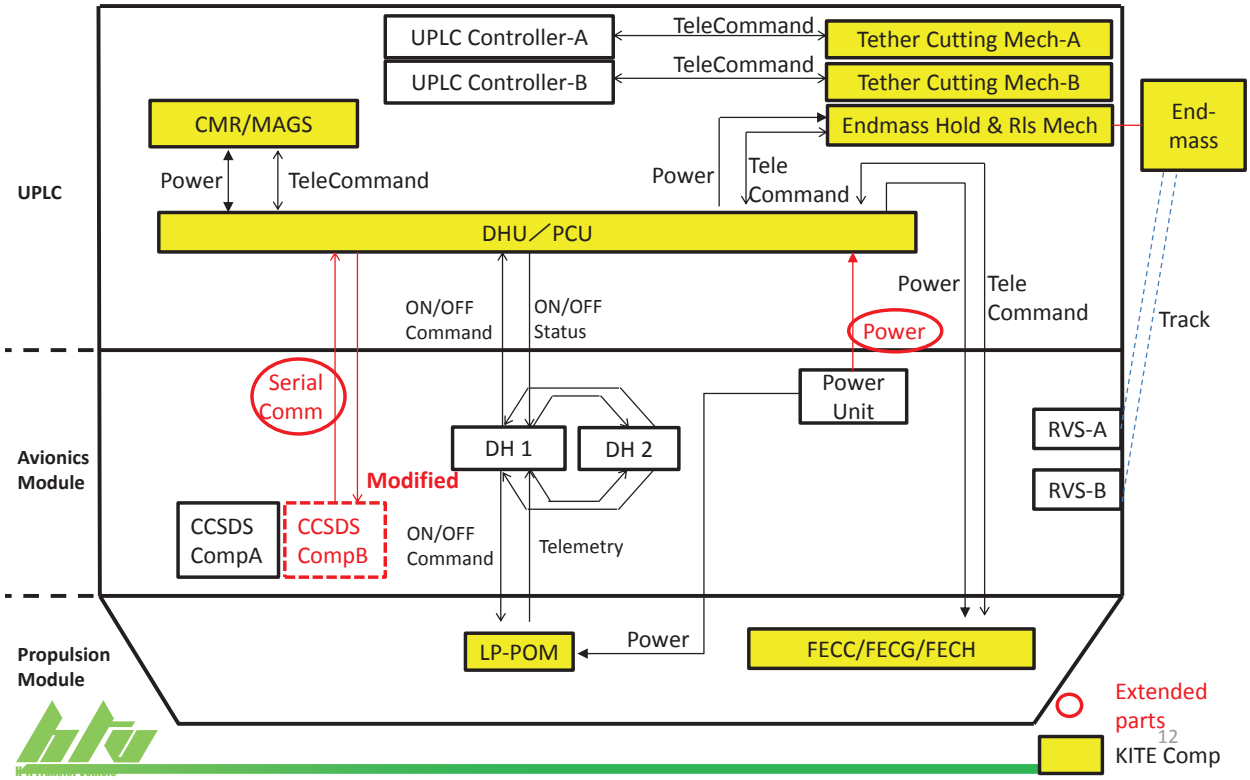
5. HTV development plan for the experiments



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5. HTV development plan for the experiments

UPLC provides the new installation area as the extended platform.

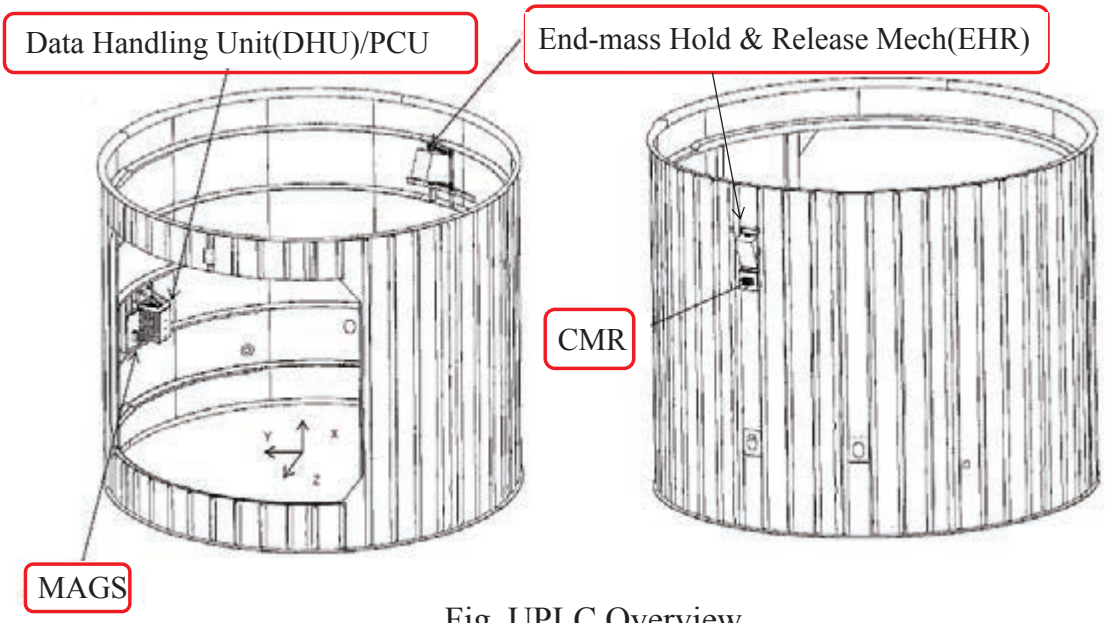

Fig. UPLC Overview

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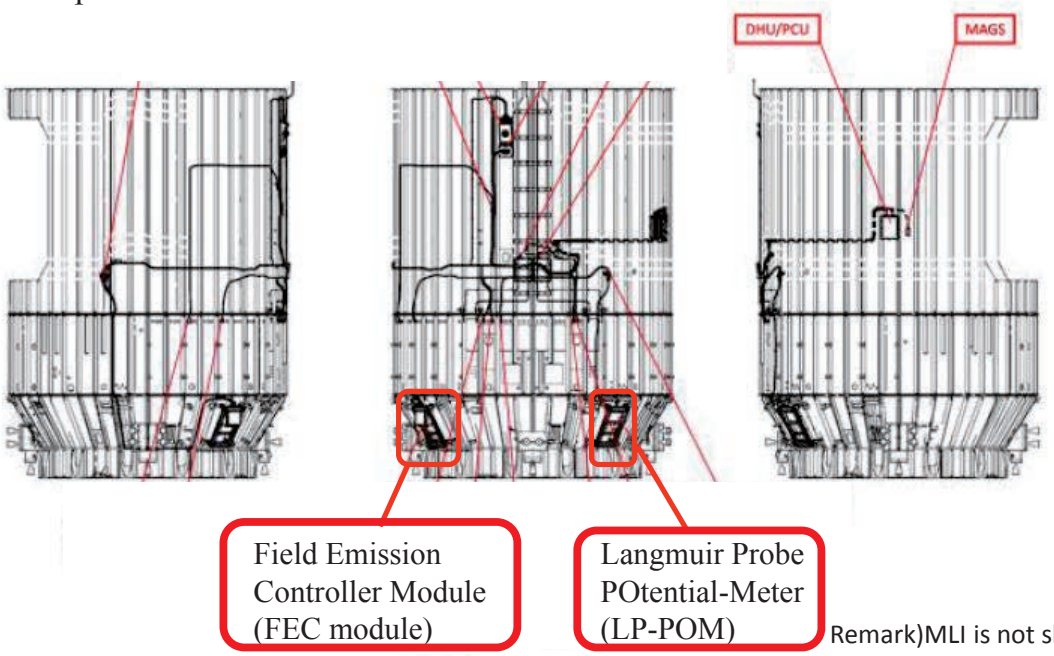
5. HTV development plan for the experiments

PM provides a additional installation area as the extended platform, such as FEC module position.



Remark)MLI is not shown

Fig. HTV development plan overview

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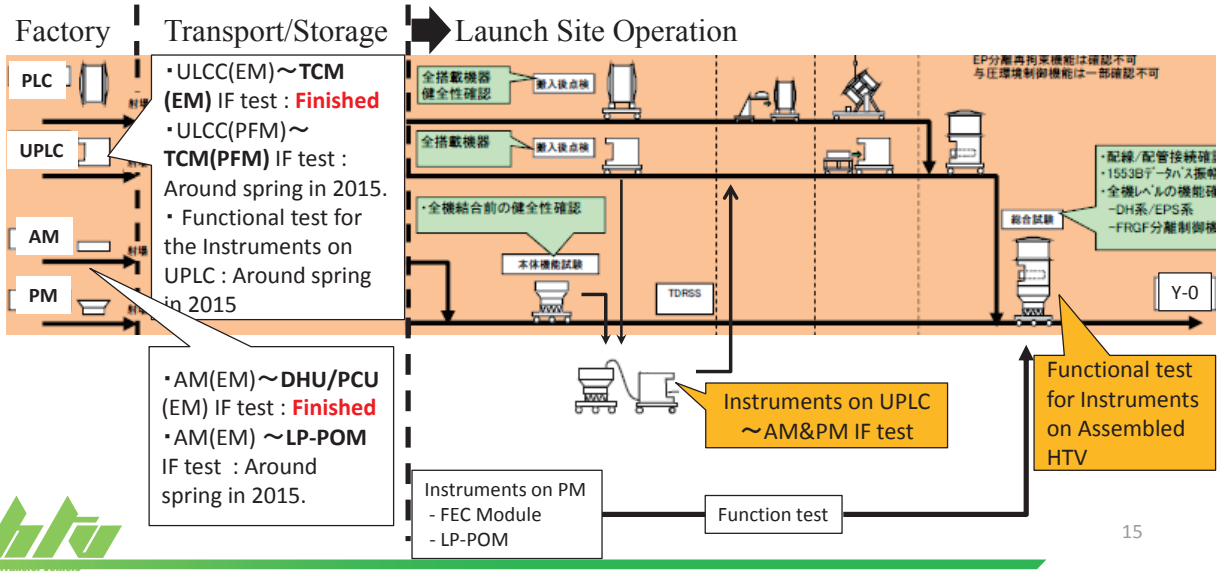
5. HTV development plan for the experiments

・Basically, End to End tests are planned between EDT experiments instruments and HTV until the launch.
・The below figure shows the HTV test plan for installing the instruments.
・The instruments interfaced directly to HTV are planned to have IF test before shipping to the launch site.



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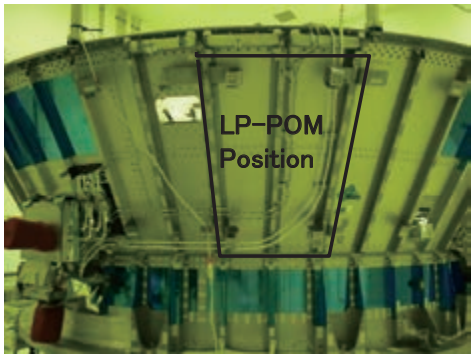
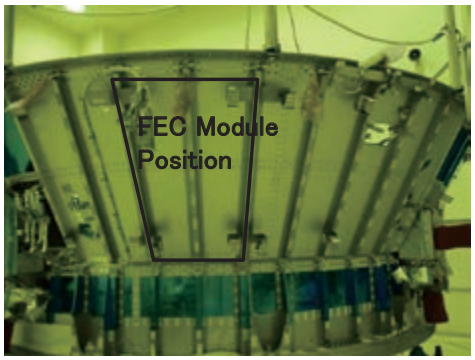
5. HTV development plan for the experiments

HTV6 UPLC picture





HTV6 PM pictures

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6. Summary

- The presentation shows HTV development status for ElectroDynamic Tether Experiments.
  - The extended platform on HTV is being manufactured for EDT experiments.
  - Some interface tests has been done and are planned.
- We would like to execute the plan steadily and provide the flight chance and, finally contribute solving the space debris problem.