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宇宙航空研究開発機構のスペースデブリ関連活動について

Overview of JAXA's Space Debris related Activities

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Space debris is a risk factor for all the countries and organizations who perform space activities. For example, multiple collision damages are possible for satellites with projected areas exceeding 10 m². Efforts are required for mission assurance against debris. The protection design for critical components of a spacecraft, adding functions to complete self-disposal actions, etc. are considered.

Almost all the debris experts in the world agree that the number of existing debris would continue to grow and the environment would go worse. Therefore, in addition to the mitigation efforts, more positive measures to remedy the environment should be globally discussed and implemented. In order to develop measures to remove debris, technology development is needed as well as international cooperation.

Considering the above mentioned situation, JAXA's debris related activities are introduced in this presentation.

スペースデブリは宇宙開発利用活動を行うすべての国、機関にとってリスクとなっており、ミッションの成功を保証するために努力が必要である。一例として、高度 1000km を周回する断面積 1m² の衛星には 1mm φ のデブリが3年で1回の頻度で衝突すると推定されており、当たり所が悪いと人工衛星の機能の一部を喪失することとなる。より大きいデブリが衝突すれば衛星自体の喪失、破砕に至る。

デブリは継続的に増加しており、その状況悪化の加速度を緩和するために、デブリ発生防止対策を徹底しなければならない。多くの対策は既に世界的に合意されているが、用済み後のシステムの除去や、落下時の地上安全の確保には更に徹底・配慮が必要な状況である。

軌道上物体同士の衝突は近年現実的な脅威となっており、現状のデブリ発生防止対策を超えて、分布密度の高い高度域から使用済み衛星・ロケットを相当数除去する活動が、近い将来必要になるという認識が共有されつつある。

この様な状況を踏まえ、宇宙航空研究開発機構における活動を概観する。

Biography - - - - -**ITO, Yasuyuki**

Place of birth: Osaka, Japan

Ms. and Bs. degree in Electrical Engineering at Kyoto University

1980 - 2003: National Space Development Agency (NASDA)

2003 - : JAXA

< R & D Career >

Earth Observation Instrumentation at R&D Directorate: Synthetic Aperture Radar, Microwave Radiometer

Conceptual study of ENVISAT/AMI at ESA/ESTEC as Research Fellow

Earth Observation Satellite Project : ADEOS-II, Aqua/AMSR-E

< Administration/Management Career >

Strategic Planning Dept., Human Resources Dept., Audit & Evaluation Office, Earth Obs. Science Team Management



Overview of JAXA's Space Debris related Activities

January 2013
5th Space Debris Workshop
at Chofu, Tokyo
Yasuyuki ITO, JAXA/ARD

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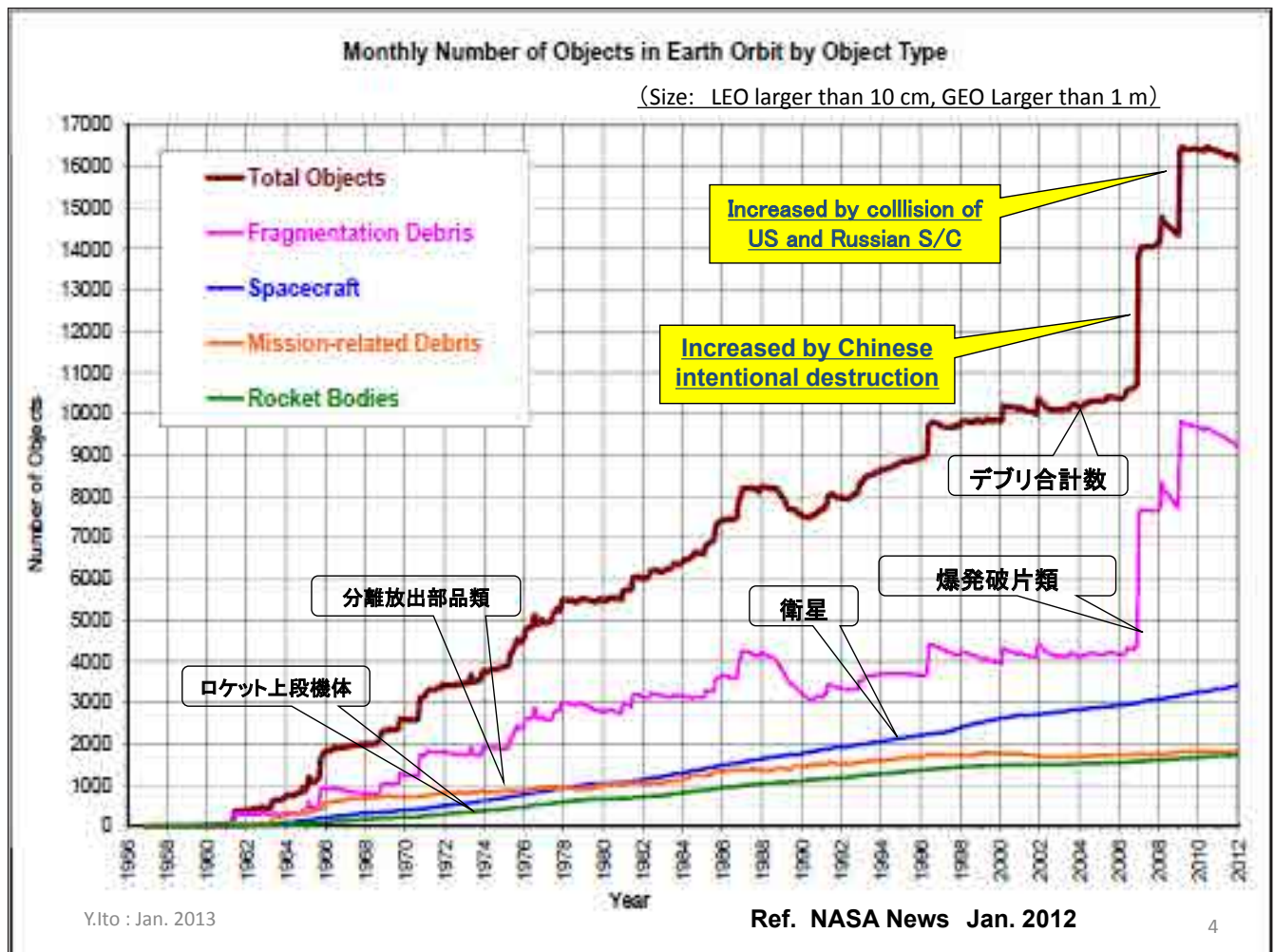
1. about Space Debris
2. about JAXA
3. Goals and Topics of Research and Development activities

1. about Space Debris

- Basics updates
- “Clear and present danger”

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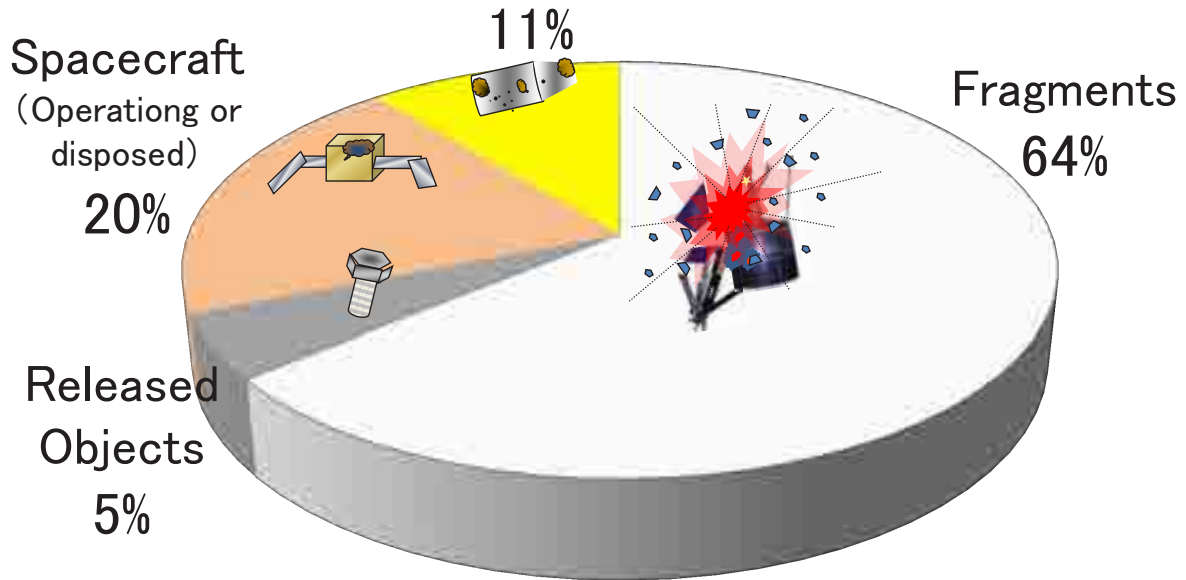
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Causes of Generation of Debris

(地上観測可能な物体について)

Disposed Launch Vehicle

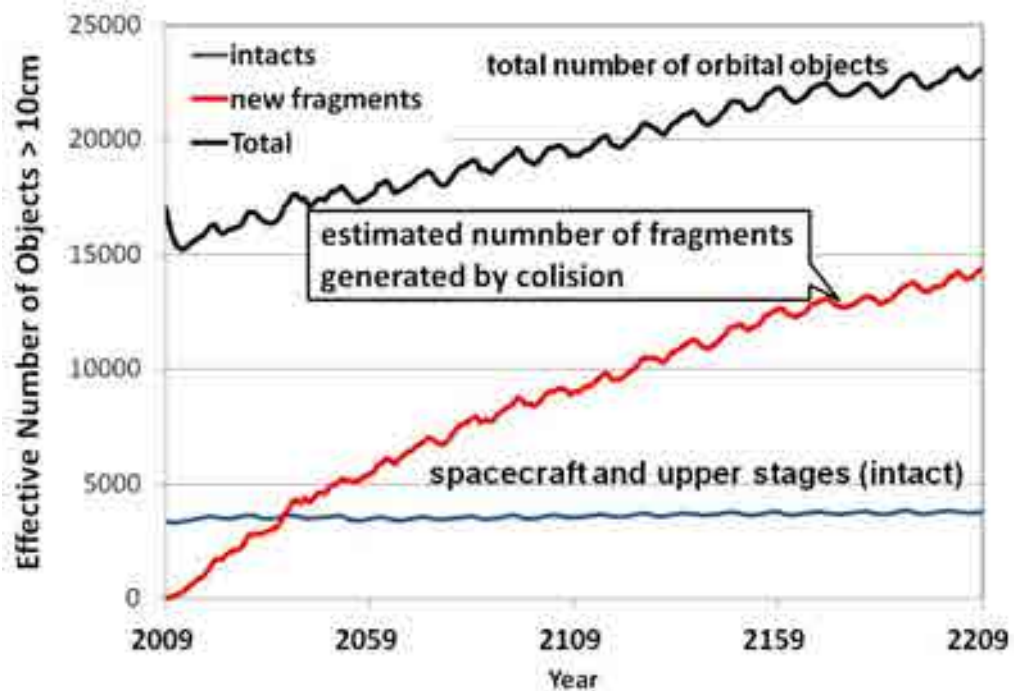


Ref. ESA Report to UN/COPUOS/STSC Feb. 2011

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Prediction of Number of Orbital Objects Increased by Collision

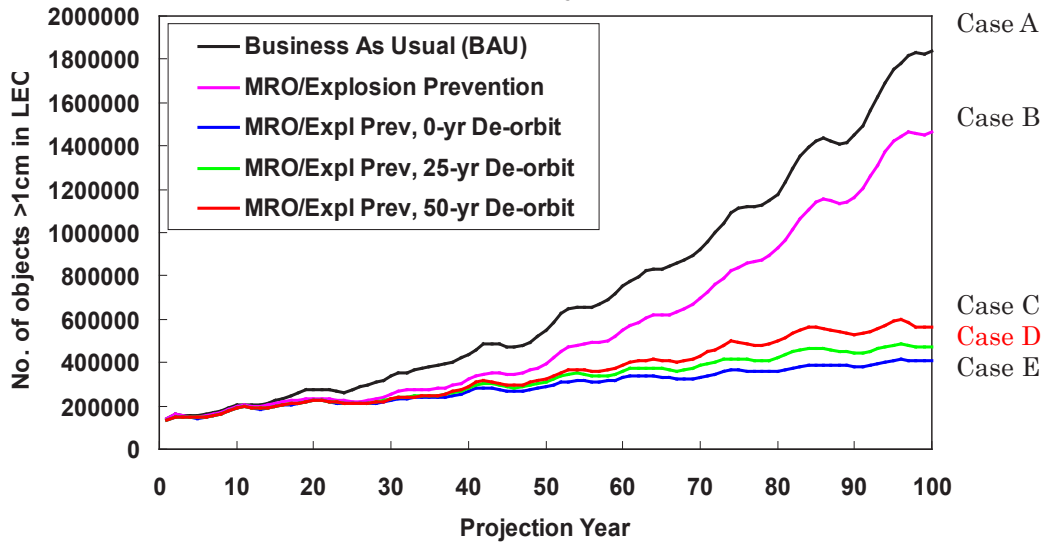


Average number of objects analyzed by Monte-Carlo simulation 60 cycles by the following condition;
 (1) number of explosion : no after 2009,
 (2) number of launching operation : number of launch events from 2001 to 2008 will be repeated.
 (3) compliance with 25-year-rule: 90% [Ref; Article by JAXA and Kyushu Univ.]

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Mitigation Measures and their effects

[Ref. End-of-life Disposal of Space Systems in the Low Earth Orbit Region, IADC/WG 2, 1 March 2002,]
>1cm Population Evolution
 EVOLVE Model Projections



- Case A:** Any mitigation measures will not be applied.
- Case B:** Any mission related objects (MRO) will not be released, and on orbital break-ups will be prevented.
- Case C:** Adding to case B, every objects will be removed within 50 years.
- Case D:** Adding to case B, every objects will be removed within 25 years.
- Case E:** Adding to case B, every objects will be removed at the mission termination.

Estimated Annual Collision of Small Sized Debris to a Operating Satellite (1m² cross section at 800km altitude orbit)

Debris SIZE	0.1~1mm	1~10mm	1~10cm	10cm over
Estimated Annual Collision (times)	100	0.01*	0.0001	0.00001

Measures for Mission Assurance

Protection

Orbit Maneuver



* NASA analysis shows 0.1

Ref. : Analysis using ESA tool "MASTER"

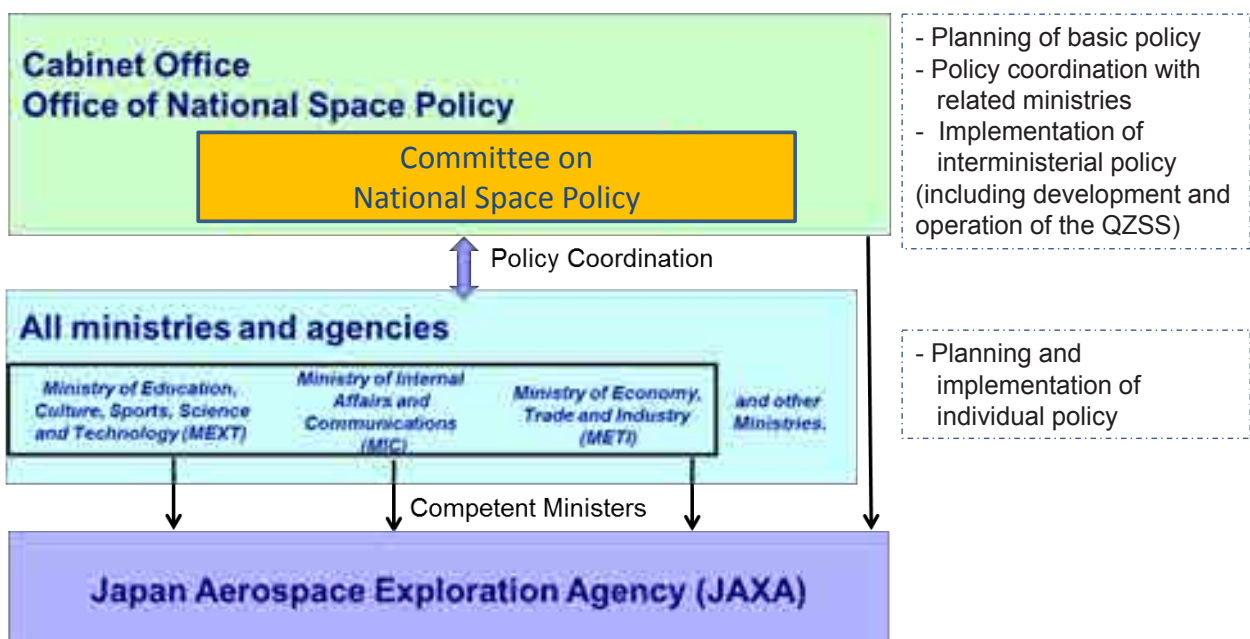
2. about JAXA

1. Japan's government organizational change
2. 9 years and half, next 5 years
3. Debris committee

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Organization chart (Space related ministries in Japan)



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Ref.: Presentation by Office of National Space Policy, CAO

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Office of National Space Policy, Cabinet Office ---The Headquarter for Japanese Space Policy---

The Office of National Space Policy shall

- Assist the Strategic Headquarters for Space Policy (Chaired by the Prime Minister / Constituted by all ministers of the Cabinet)
- Deal with the following issues by using the function of the Committee on National Space Policy
 - Formulate budget request policy and make follow-ups on each ministry's budget request to confirm their budget request is consistent with the policy
 - Revise the Basic Plan for Space Policy
- Develop and operate satellite systems for inter-ministerial use, including QZSS

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Ref.: Presentation by Office of National Space Policy, CAO

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Japan Aerospace Exploration Agency (JAXA) ---The core implementing agency to support the development and use of space by the entire government with technology---

The amendment of the law concerning Japan Aerospace Exploration Agency (JAXA law)

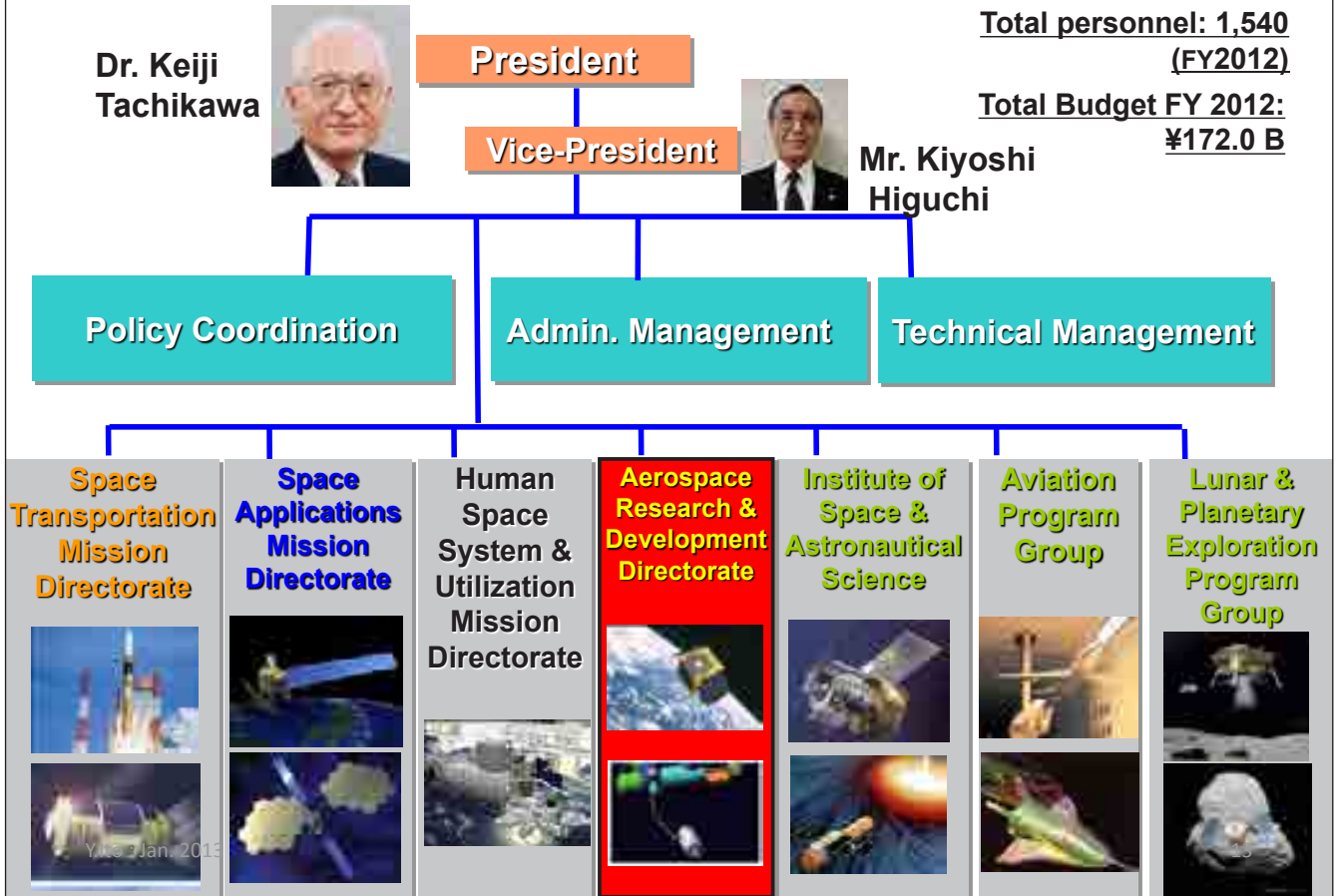
- Aligns description of the “peaceful purpose” in JAXA law with the Basic Space Law which is consistent with the Constitution
- Adds to JAXA's authority to assist and advise matters related to development, launch and operation of satellites in response to request from industry
- Any ministry could become competent ministers for individual projects when added by cabinet order. JAXA will develop satellites based on the needs of each ministry.

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Ref.: Presentation by Office of National Space Policy, CAO

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JAXA Organizational Structure



ISAS
NAL
NASDA

2003

1996 : NASDA first Debris Standard

1999 : Japan proposed a specific committee to UNCOPUOS for debris issue

2002 : IADC released the IADC Debris Mitigation Guidelines

2006 : JAXA Debris Committee

2007 : UN adopted the COPUOS Debris Mitigation Guidelines

2011 : ISO released "Debris Mitigation Requirements"

2012 : (Japan's New Law)
< 5th Debris Workshop >

1995 : NASA first Debris Standard

1999 ~ 2007 : CNES first Debris Standard

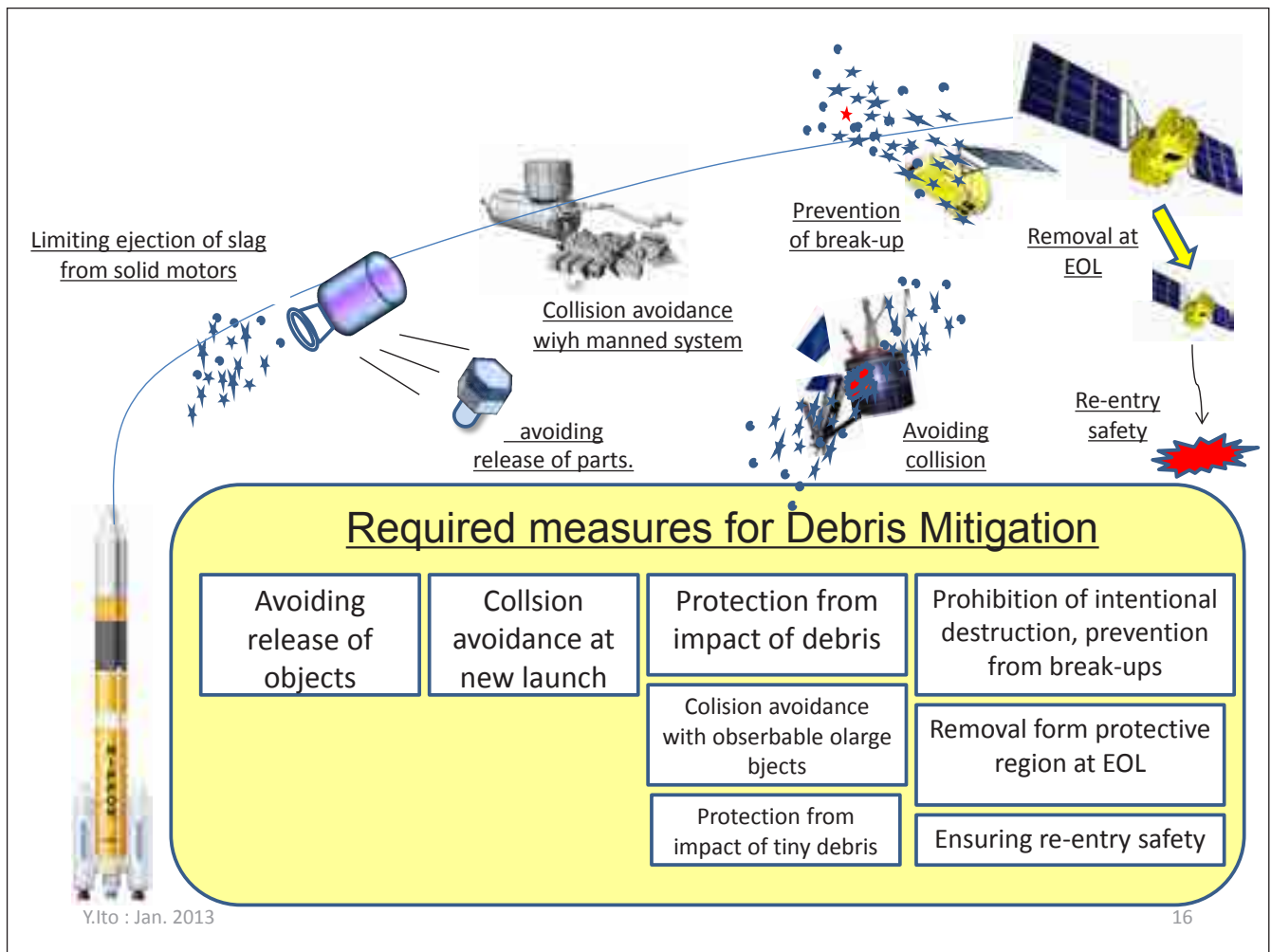
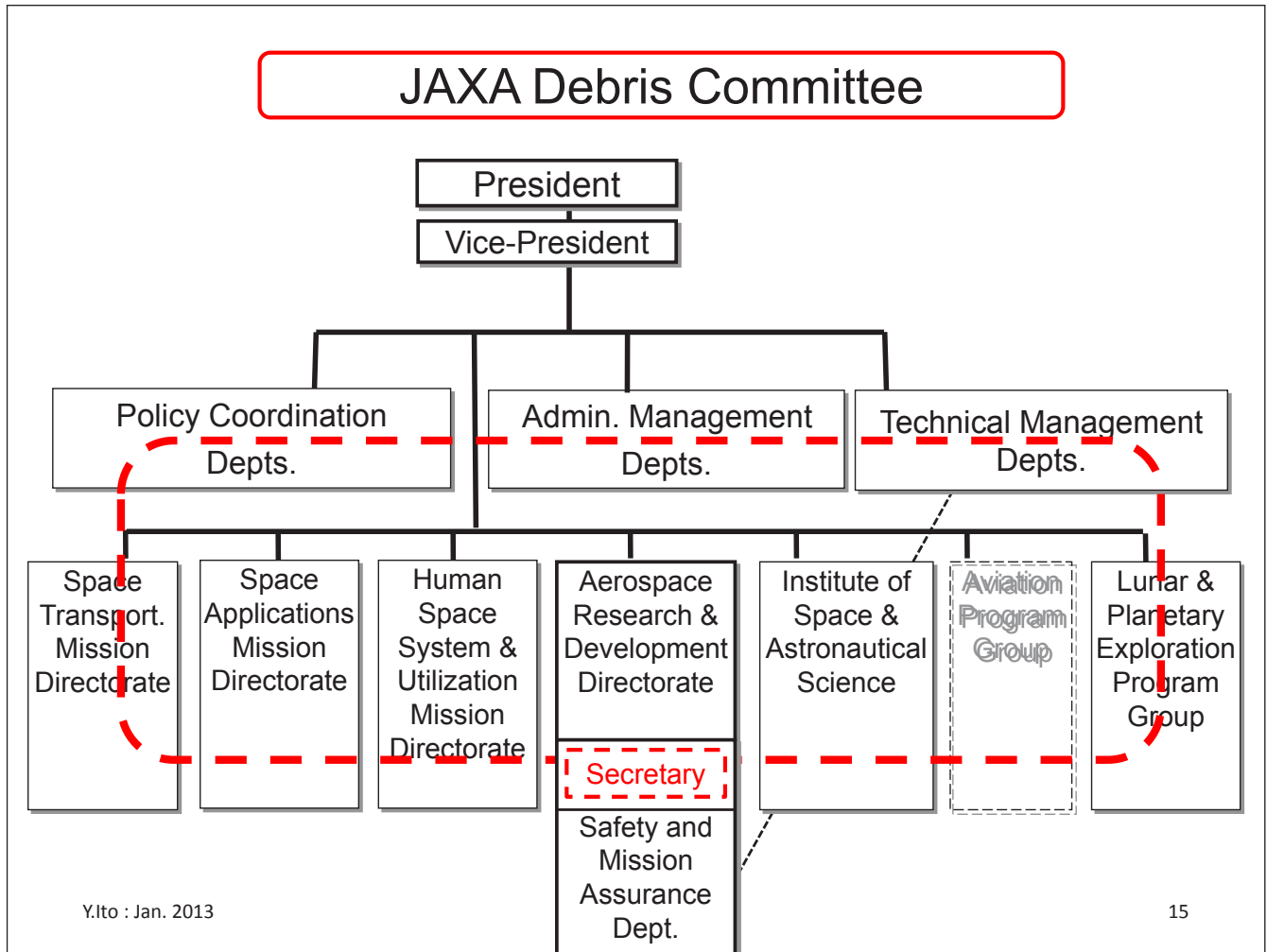
European Code of Conduct

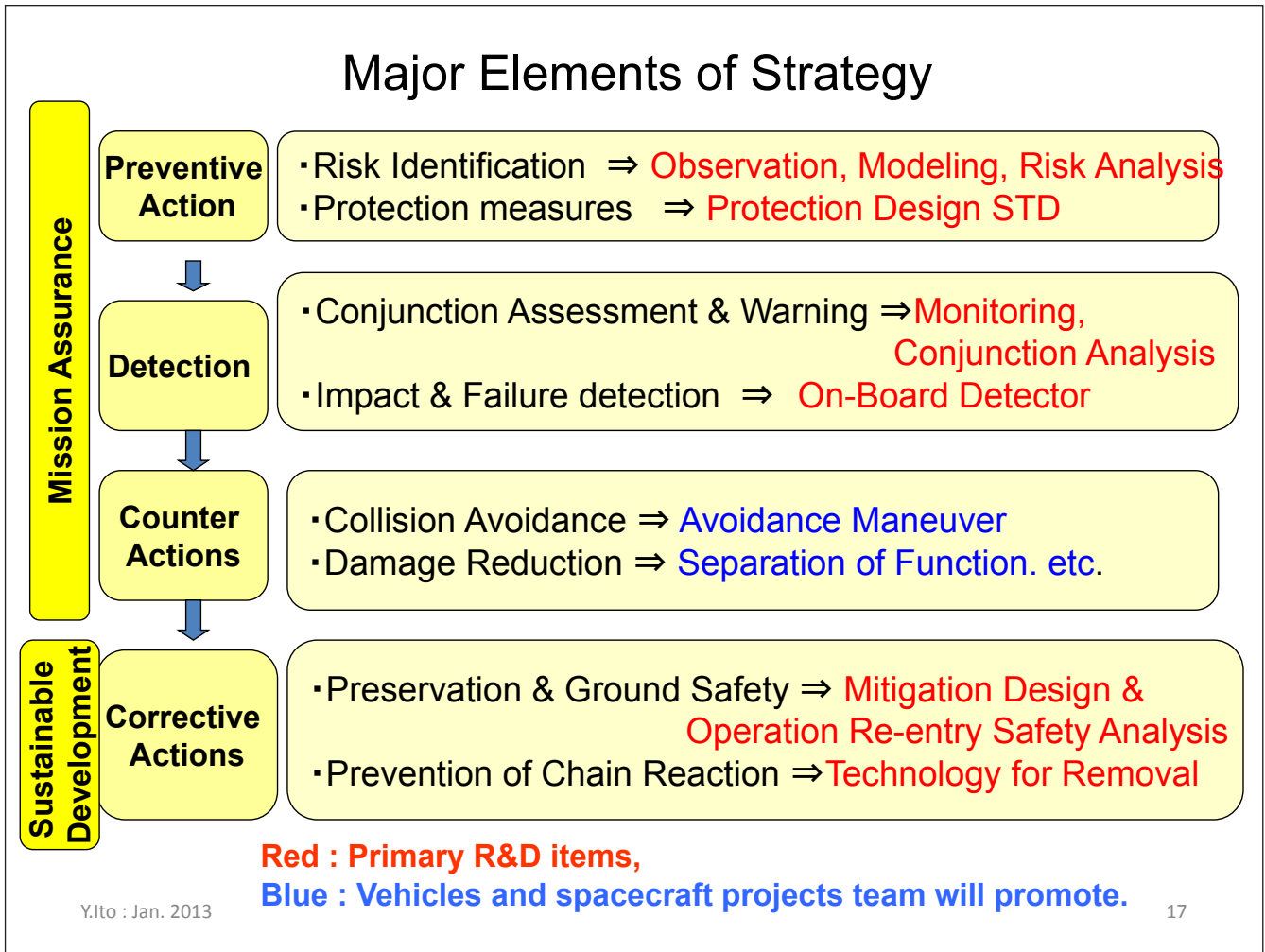
JAXA First
Mid-Term

JAXA Secnd
Mid-Term

JAXA Third
Mid-Term

History of JAXA and World Debris Activities





3. Research and Development activities

1. Observation technology
2. Modeling
3. Protection design
4. Ground safety
5. Active removal

Mission Assurance: Ground Observation

Goals in next 5-year-plan

1. Objects smaller than 10 – 20 cm in GEO can be observed.
2. Conjunction with debris can be assessed by domestic facilities in sufficient precisions to support avoidance maneuver.



Image of the automatic debris detection tool

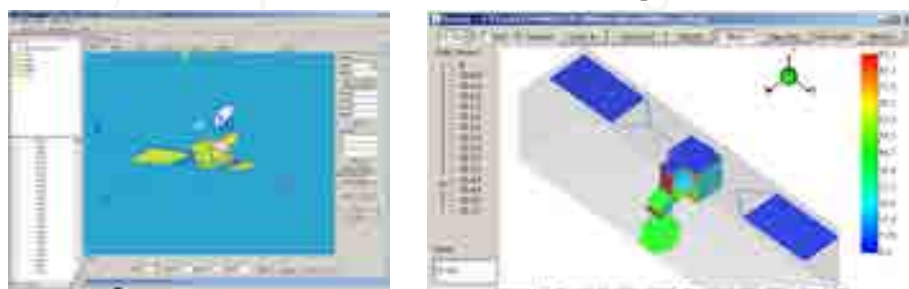
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Mission Assurance: Modeling

Goals in Modeling

1. Future debris population can be prospected, and adequate policy can be implemented in advance.
2. Collision risk management will be conducted by analyzing the impact probability, damage estimation, and protection design.



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JAXA debris collision risk analysis tool, TURANDOT

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Mission Assurance: Protection Design

Goals in next 5-year-plan

1. Establishment of a Protection Design Standard

- It enables adequate design depending on the mission characteristics.



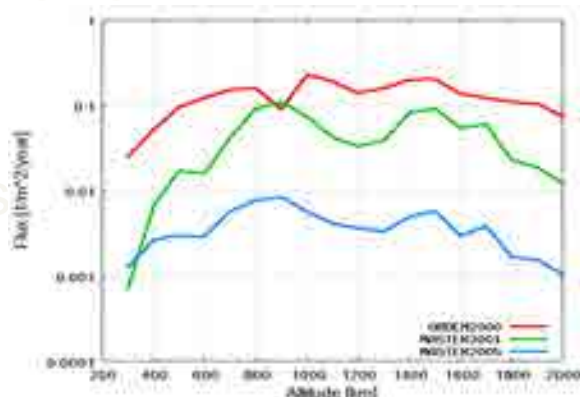
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Mission Assurance: Debris Detector

Goals in Debris Detector

1. The debris detector will be launched to confirm orbital debris distribution.
 1. The debris larger than 100 μ m will be detected with its size
 2. The data will contribute to the world debris models.



Disagreement in MASTER and ORDEM

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Ground Safety

Goals in Ground Safety after deorbit

1. More reliable re-entry risk analysis can be done with improved database (material properties, human distribution, etc.)
2. Risky devices that survive re-entry will be minimized.



Titanium casing of the STAR-48B solid rocket motor found in northeastern Argentina.

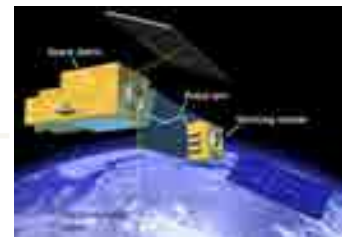
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Preservation and improvement of the environment

Goals in Active Debris Removal

1. First step: Key technology demonstration such as electrodynamic tether (EDT) as economical deorbit devices.
2. Final Step: large intact debris such as rocket upper stages will be removed by international project.



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Summary

- “Clear and present danger”
- Japan’s organization change
- JAXA Debris Committee
- R & D for the future
 - Mission Assurance
 - Debris detector in orbit
 - Preservation of environment and Ground safety
 - Improvement of environment
 - Active debris removal mission study