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スペースデブリ観測とその運用

Space debris observation and operation

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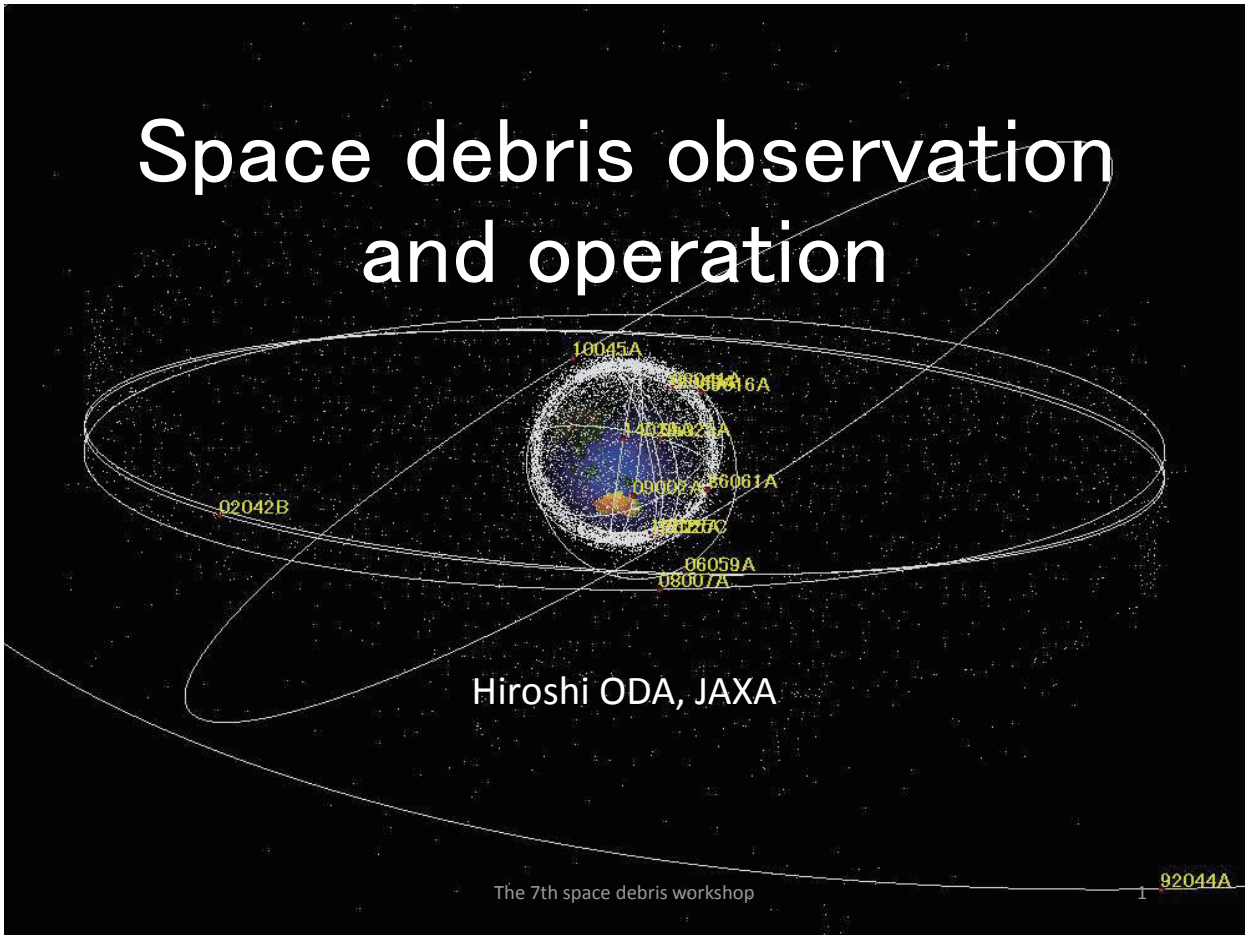
スペースデブリ(宇宙ゴミ)の数は増加しており、地球周辺宇宙空間における宇宙物体の衝突の危険性は高まっている。宇宙空間の安定的利用と持続的な発展のために宇宙状況把握(Space Situational Awareness: SSA)の推進が重要となっている。さらに、スペースデブリは世界規模の問題であり、国内外の外部組織との連携も重要である。
JAXA SSA システムはレーダー・光学望遠鏡からなる観測システムと軌道計算・接近解析、観測計画立案や軌道情報の維持管理等を実施する解析システムで構成され、軌道上物体の観測、接近解析、衝突回避支援、大型スペースデブリの大気圏再突入予測、未知物体の探索等を実施している。本講演では当該システムによるスペースデブリ観測とその運用方法について発表する。また、現行システムの問題点・課題とともに、次期システムの整備計画についても紹介する。

The growth in the number of space debris increases the risk of collision of man-made objects with space debris around the Earth. The development of Space Situational Awareness (SSA) has become important for the stable use and long-term sustainability of space activities. In addition, the cooperation with the other organizations is also important for the SSA because the space debris problem is a worldwide issue.
The JAXA SSA system consists of the radar observation facility (Kamisaibara SpaceGuard Center: KSGC), the optical telescope observation facility (Bisei SpaceGuard Center: BSGC), and the analysis system conducting the orbit determination and prediction, conjunction assessment and analysis, planning of observations, maintenance of the catalogue containing orbital information of objects, and so on. Using this system, we perform the observation of objects in orbits, conjunction assessment and analysis, collision avoidance maneuver planning for JAXA satellites, re-entry prediction of large size space debris, and detection of uncatalogued objects. In this paper, we present the space debris observation and operation using the JAXA SSA system. We also discuss the issue of the current JAXA SSA system and touch on the development plan of the next JAXA SSA system.

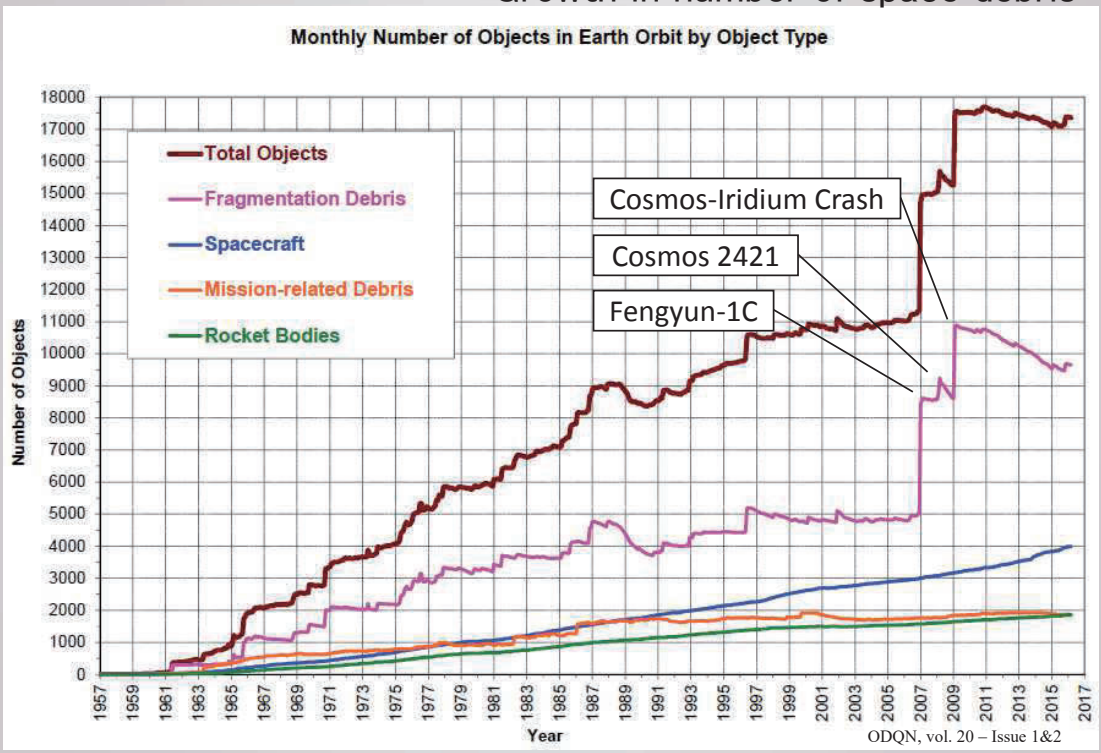


ABSTRACT

- The growth in the number of space debris
  - The risk of collision of man-made objects increases.
  - The development of Space Situational Awareness (SSA) has become important for the stable use and long-term sustainability of space activities.
  - In addition, the cooperation with the other organizations is also important for the SSA because the space debris problem is a worldwide issue.
- The JAXA SSA system consists of
  - the radar observation facility (Kamisaibara SpaceGuard Center: KSGC),
  - the optical telescope observation facility (Bisei SpaceGuard Center: BSGC)
  - the analysis system
- Using this system, we perform
  - observation of objects in orbits
  - conjunction assessment and analysis
  - collision avoidance maneuver planning for JAXA satellites
  - re-entry prediction of large size space debris
  - detection of uncatalogued objects.
- In this paper, we present the outline of the space debris observation and operation using the JAXA SSA system.
- We also discuss the issue of the current JAXA SSA system and touch on the development plan of the next JAXA SSA system.

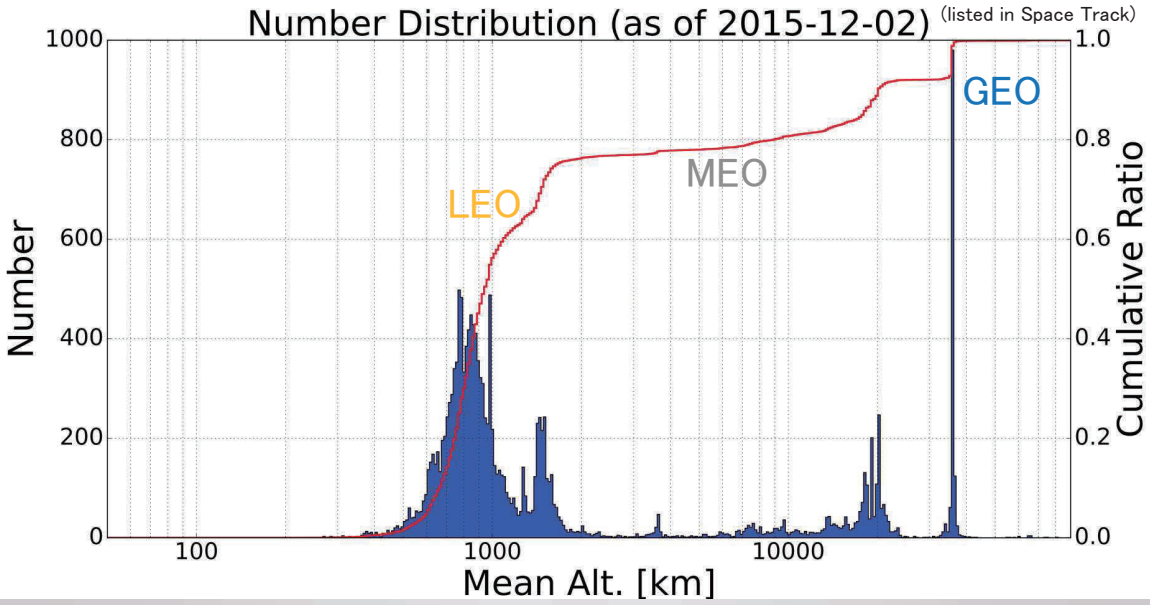
INTRODUCTION: Space debris problem

Growth in number of space debris



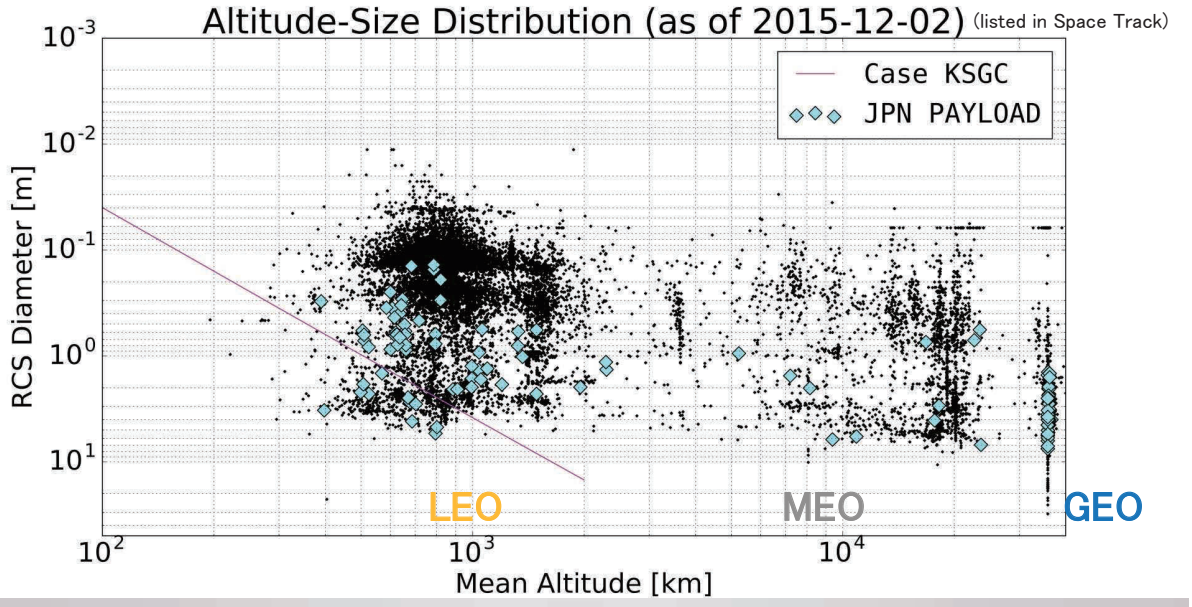
INTRODUCTION: Space debris problem

Crowed orbit/altitde

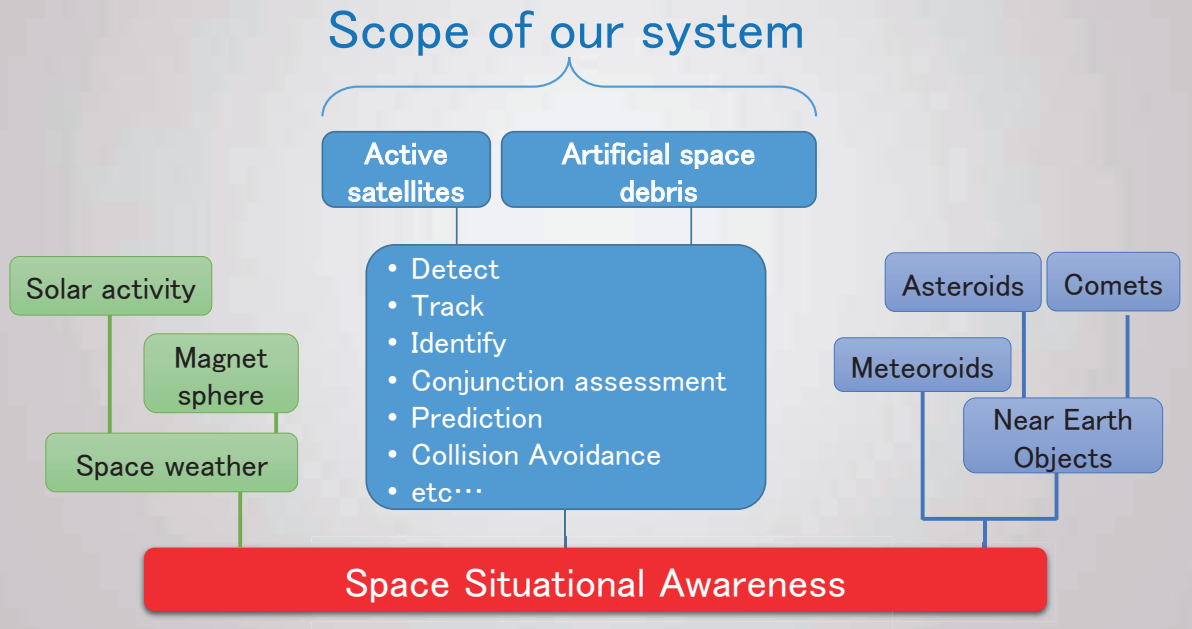


INTRODUCTION: Space debris problem

Crowed orbit/altitde

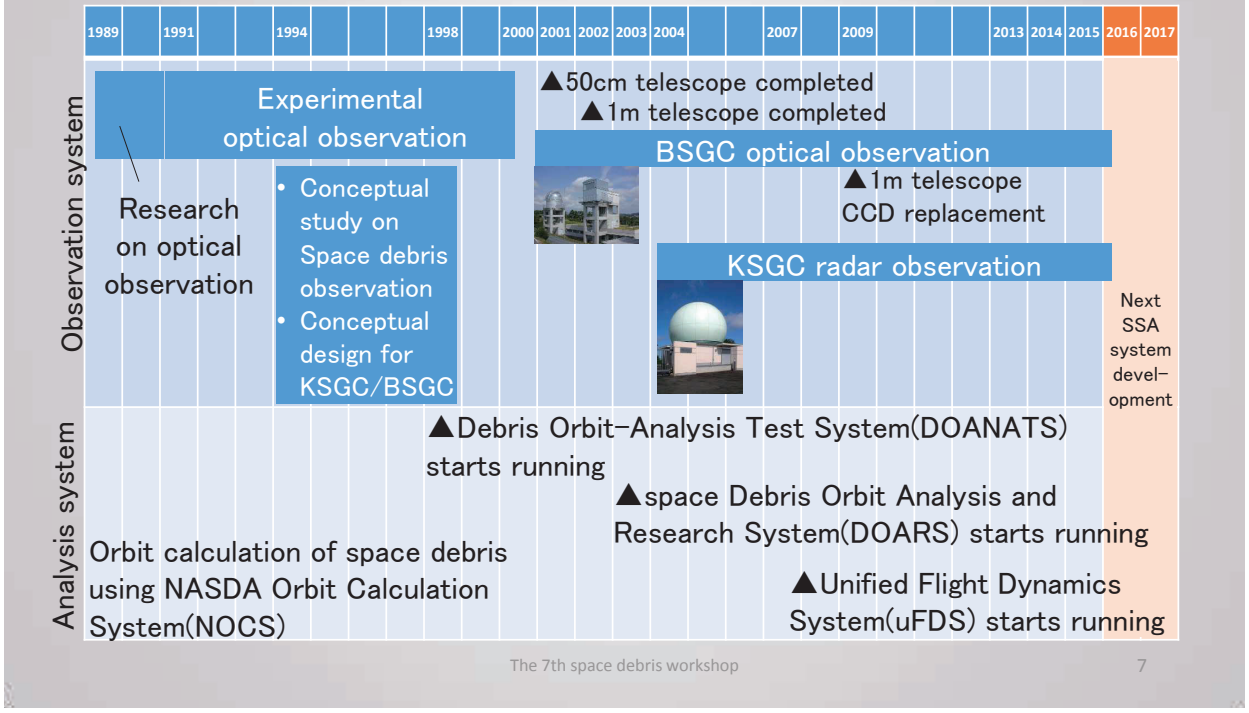


What is Space Situational Awareness?



STCC/JAXA's activities on the space debris problem

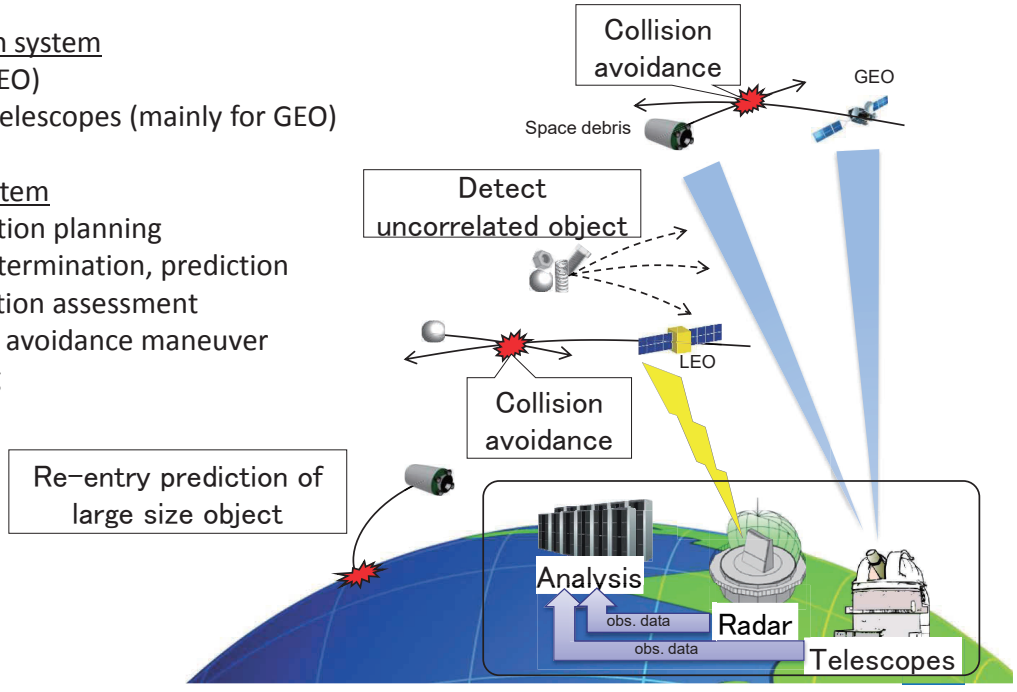
(Space Tracking and Communications Center)



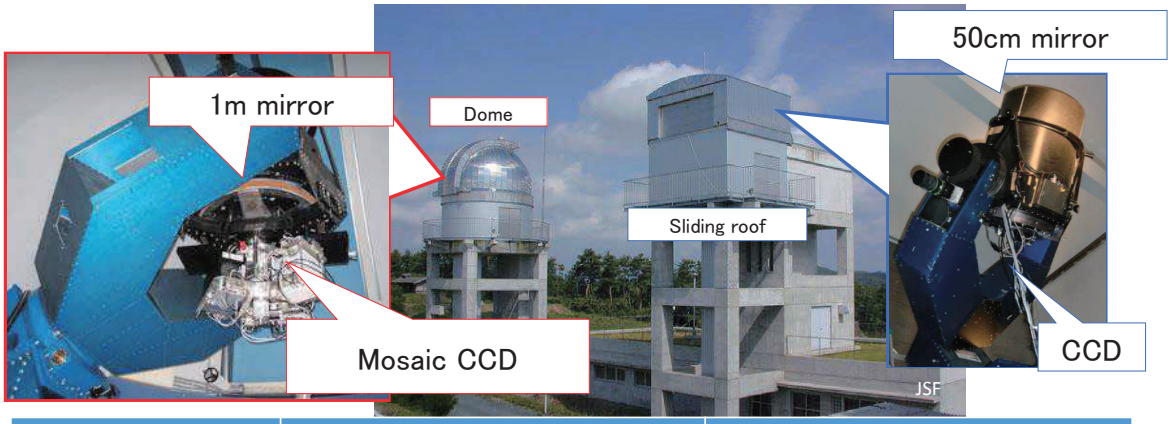
Overview of the current system

Observation system
- Radar (LEO)
- Optical telescopes (mainly for GEO)

Analysis system
- Observation planning
- Orbit determination, prediction
- Conjunction assessment
- Collision avoidance maneuver planning
- etc...

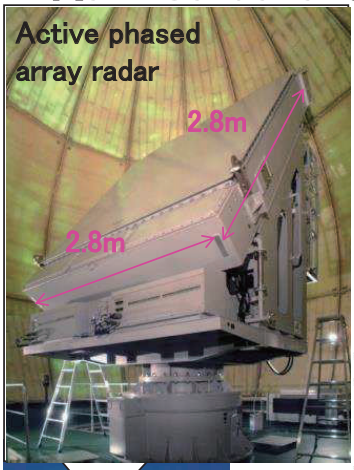


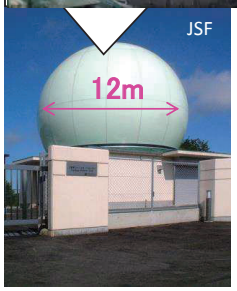
Optical observation facility: Bisei Space Guard Center(BSGC)

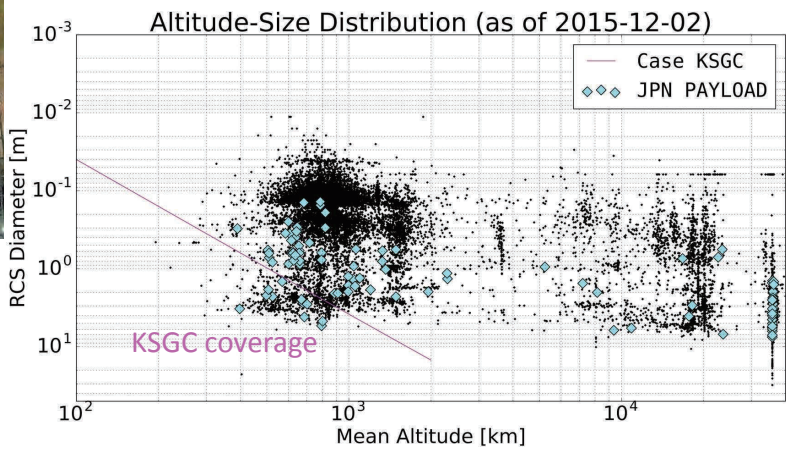


	1m telescope	50cm telescope
Limiting mag.	~18.5 for GEO observation (a few sec exposure time)	~16.5 GEO observation (a few sec exposure time)
Max tracking velocity	~2.5 deg/sec in [Ra, Dec]	~5 deg/sec in [Ra, Dec]
Mount	Fork	Fork
CCD	FOV: 2.4deg × 1.2deg 2K × 4K pixel x 4 chip	FOV: 1.7deg × 1.7deg 2K × 2K pixel

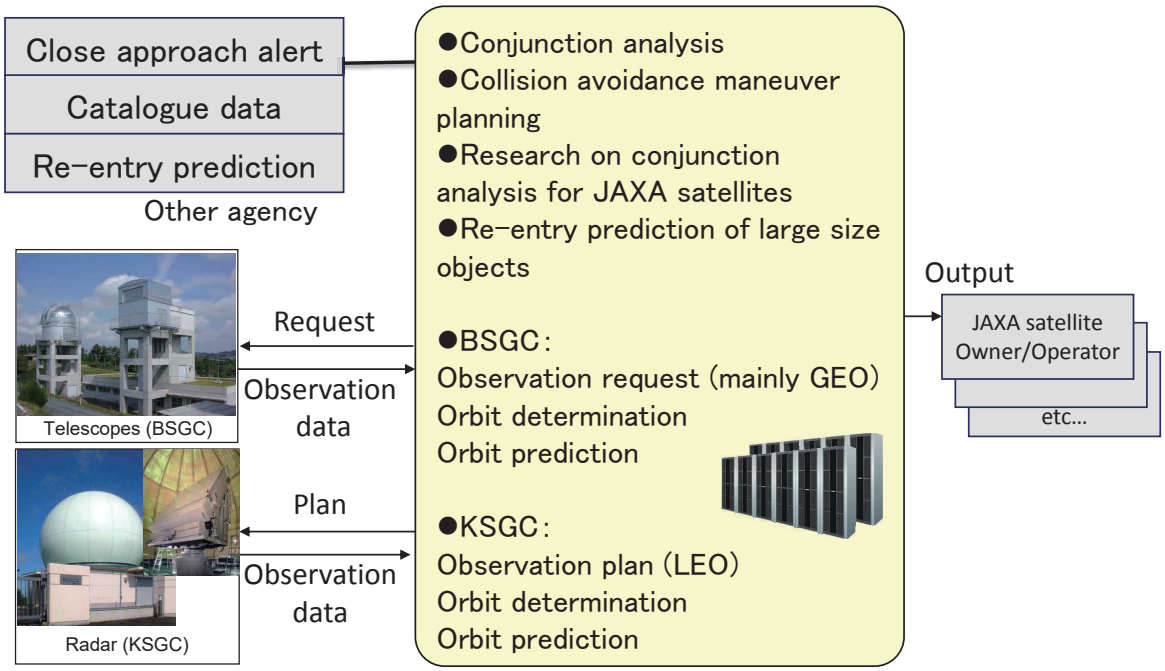
Radar observation facility: Kamisaibara Space Guard Center(KSGC)



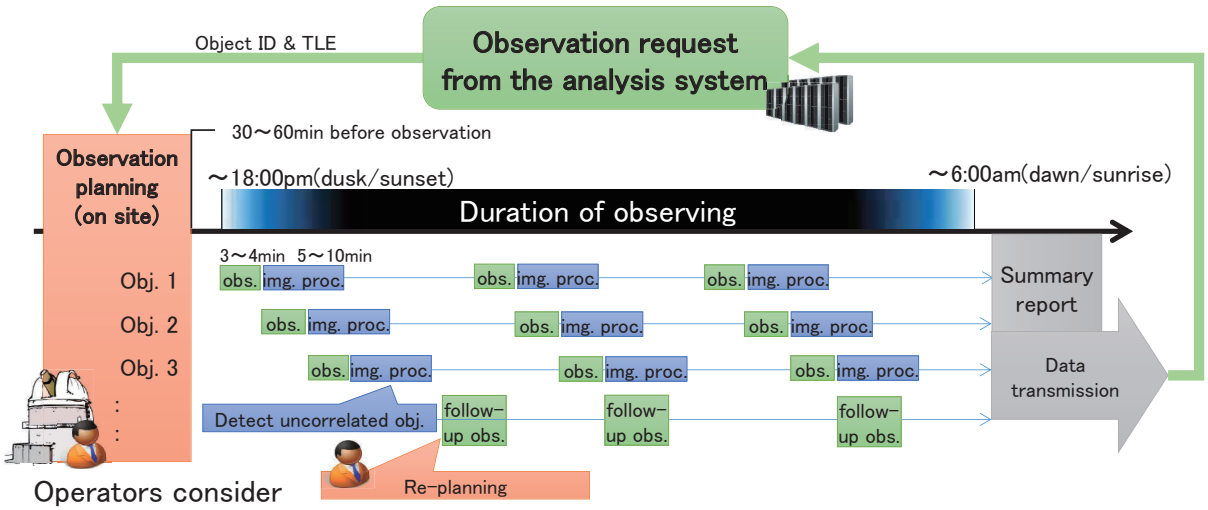




Analysis system:
space Debris Orbit Analysis and Research System(DOARS)
(+ something extra)



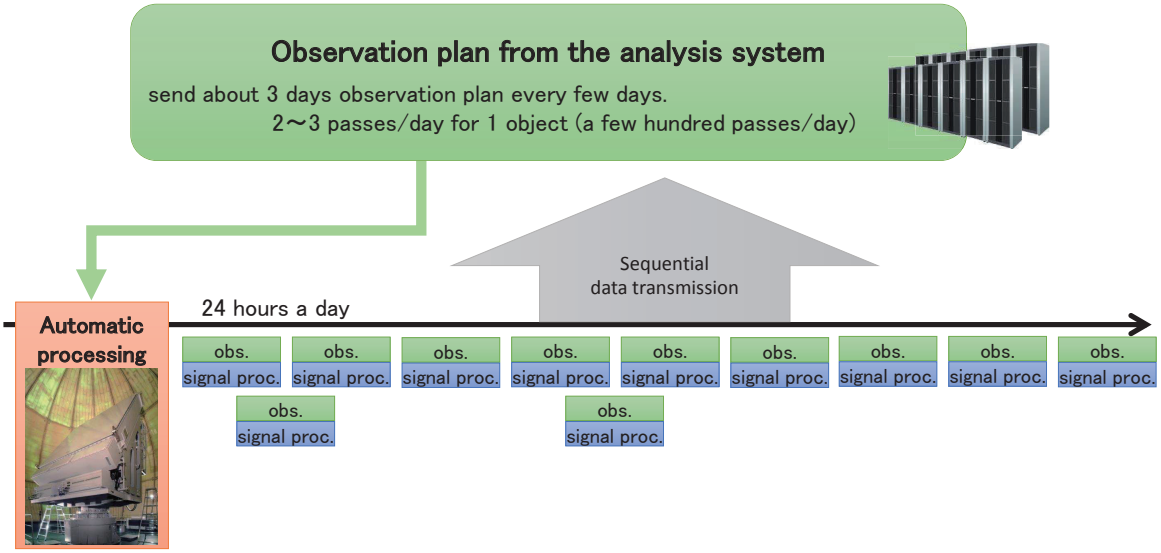
Operation flow: Optical observation



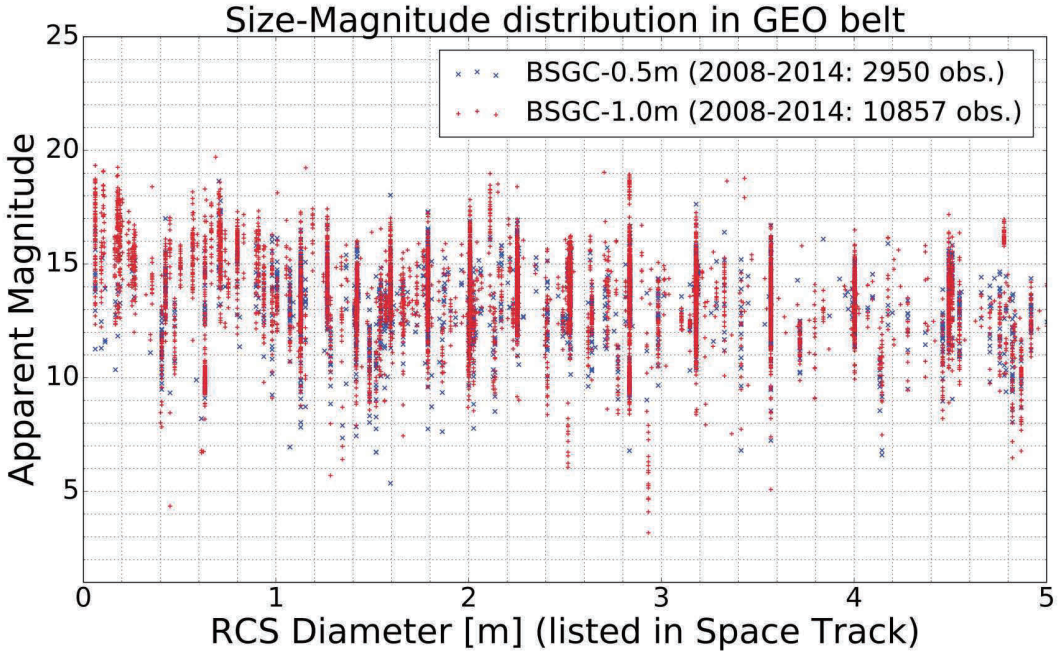
Operators consider
- ✓Order of priority
- ✓Visible pass
- ✓Accumulated number of data
- ✓Weather
- ✓etc…

Basic operation
- •6～8 images for 1 dataset: 3～4min
- •Image-processing: 5～10min
- •3 datasets for 1 GEO object

Operation flow: Radar observation

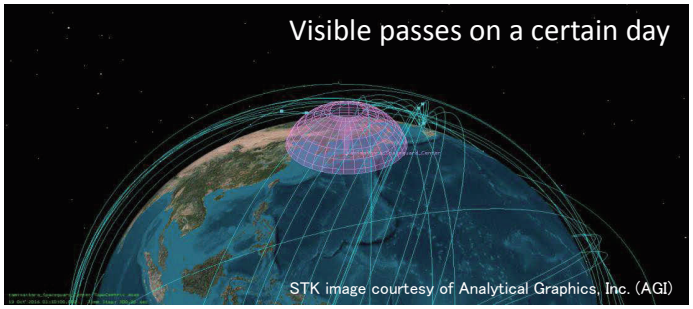


Optical observation results

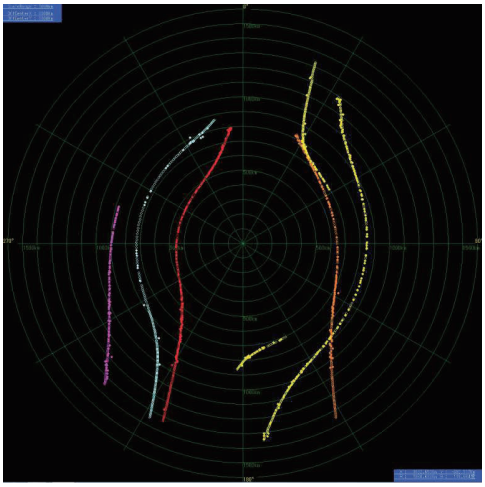


Radar observation results

Visible passes on a certain day



Sample capture of the detected signal indicator at a certain moment

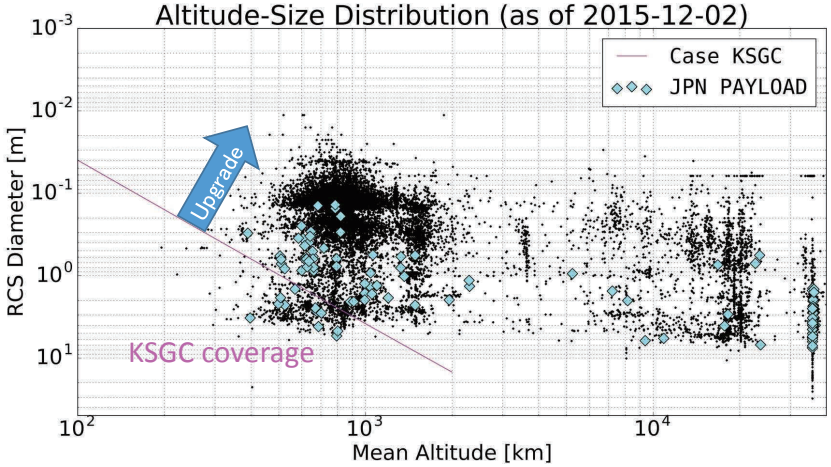


Problem with our current system

Capability of BSGC optical telescope system is enough for our current mission. But, aging…

Refurbishment

Upgrade
Tracking velocity for LEO tracking



Capability of the KSGC radar system is not enough for our SSA purpose.

Upgrade

Note: Use of the current radar will be banned by the revision of relevant law.

Upgrade the analysis system to match the capability of new observation system and SSA purpose

Summary

- We perform
  - observation of objects in orbit using BSGC telescopes and KSGC radar
  - conjunction assessment and analysis
  - collision avoidance maneuver planning for JAXA satellites
  - re-entry prediction of large size space debris
  - detection of uncatalogued objects.
- We plan to develop the next JAXA SSA system.
  - Refurbishment of the BSGC telescope
  - Upgrade of the KSGC radar
  - Upgrade of the analysis system