

G1

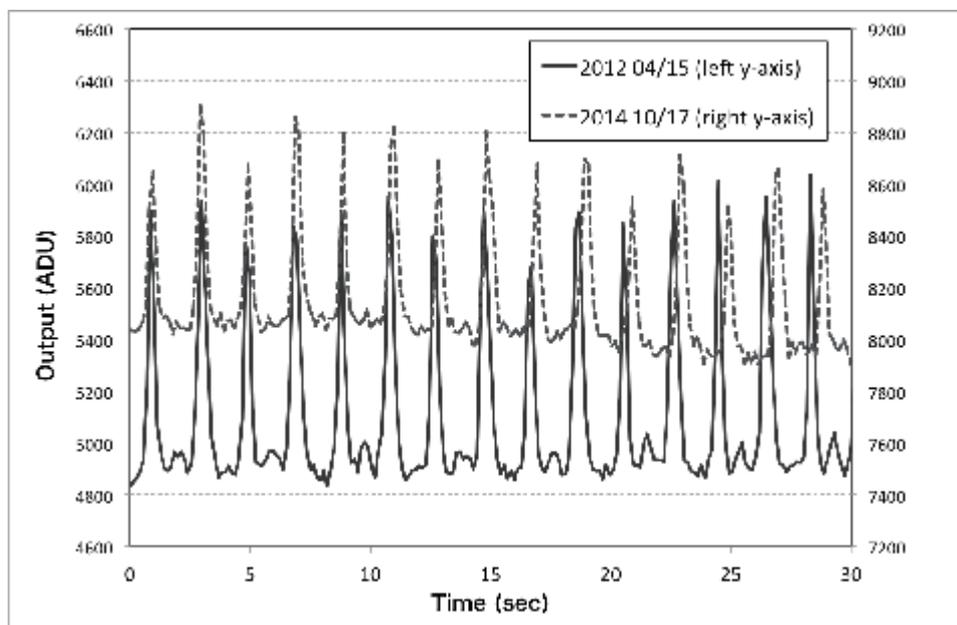
美星スペースガードセンターにおけるスペースデブリ 光学観測への取り組み

Status of the optical observations of space debris at the Bisei Spaceguard Center

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Nariyasu Hashimoto, and Noritsugu Takahashi (JSGA)

美星スペースガードセンターは日本スペースガード協会が旧科学技術庁に働きかけ、日本宇宙フォーラム、NASDA(現 JAXA)と協力して建設した世界初のスペースデブリと地球接近小惑星の専用観測施設である。ここでは2000年から3台の光学望遠鏡(1m, 50cm, 25cm)を用いたデブリの光学観測を実施している。主たる観測対象は静止軌道物体であるが、1mと50cmの望遠鏡は高速駆動が可能であり低軌道衛星などの高速移動物体を追尾する能力も有している。静止軌道物体の観測では0.2-0.3秒角(静止軌道上で約40m)の精度で位置測定が可能である。最近では研究観測も重視しており、独自の手法を用いてデブリの短時間光度変化の観測などを実施している。図は運用を終えたある衛星の秒スケールの光度変化を示すものであり、この2年間で回転もしくはタンブリングの状態が変化していることが確認できる。

Bisei Spaceguard Center was built as a facility for the purpose of the optical observations of space debris and near Earth asteroids. Since 2000, observations have been carried out with three telescopes (1 m, 50 cm and 25 cm). Although main targets are GEO objects, the telescopes have the tracking capability for high-speed moving objects at LEO. The accuracy of the positional measurement is about 0.2-0.3 arcsec, which corresponds to the distance of 40 m at GEO. We are also working on research observations of space debris in recently. For example, the figure shows a short-term light curve of a retired satellite. Two light curves were obtained in 2012 and 2014. It shows that the rotation or tumbling status has varied in these two years.



The 6th space debris workshop

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(Japan Spaceguard Association)

Contents

- ・ About the Japan Spaceguard Association
& the Bisei Spaceguard Center
- ・ Status of the space debris observations
 - Survey, follow-up (methods and examples)
 - Research
- ・ Future plans

Japan Spaceguard Association (JSGA)

- Non-profit organization established in 1996
- to protect the Earth's environment from a disastrous near-Earth object (NEO) collision by studying and observing
- Number of members: 400
activity: observations, research, and education about “spaceguard”

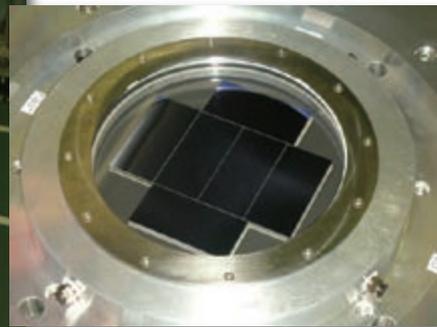
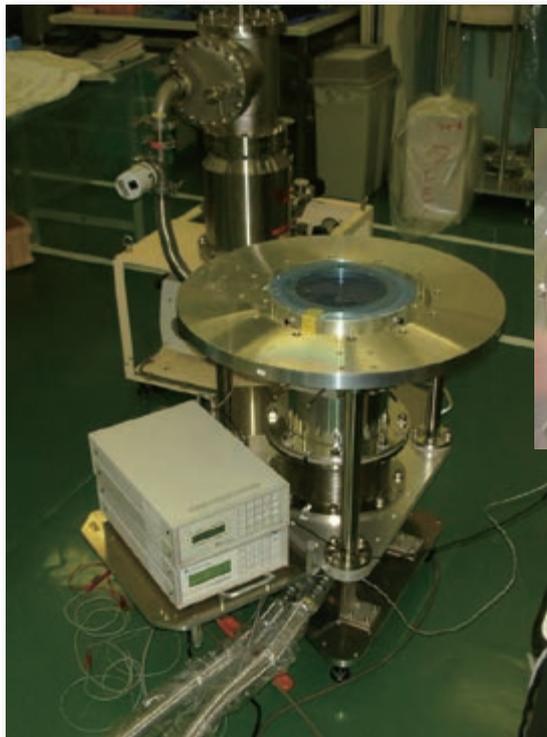
Bisei Spaceguard Center (BSGC)

- Built using a grant from the former Science and Technology Agency by the request from JSGA
- Construction began in 1998, with the cooperation of the Japan Space Forum, NASDA, and JSGA
- The first astronomical facility in the world, optimized for the observations of space debris and near Earth objects
- Constructed in 1999, 25cm and 50cm telescopes were installed and observations started from 2000
- 1m telescope and wide-field mosaic camera were installed in 2001

Bisei Spaceguard Center (BSGC)

- Building is administered by JSF
Funded by NASDA(JAXA)
Observations and research work by JSGA
- Discovery/followup/research observations of artificial objects
- Discovery/followup/research observations of near Earth objects
 - more than 1100 newly discovery (460 of “numbered asteroids”)
 - Follow up observations for more than 900 newly discovered near Earth objects





field of view $1.2^{\circ} \times 2.3^{\circ}$
maximum tracking speed $2.5^{\circ}/s$
limiting magnitude
18.7 (exp. of 2 min)
17.0 (exp. of 4 sec)



25cm telescope

- Deutch Equatorial
- Baker-Ritchey-Chrétien
focal length: 1250mm (F5)



50cm telescope

- Fork-mounted Equatorial
- Cassegrain
focal length: 1000mm (F2)
- Fields of view: $1.7^{\circ} \times 1.7^{\circ}$
- Maximum tracking speed $5^{\circ}/s$
- Limiting magnitude
17mag (2min)

Status of the space debris observations (organization)

- daily observation
 - …two JSGA members are in shift every night
(average 255 days over a year)

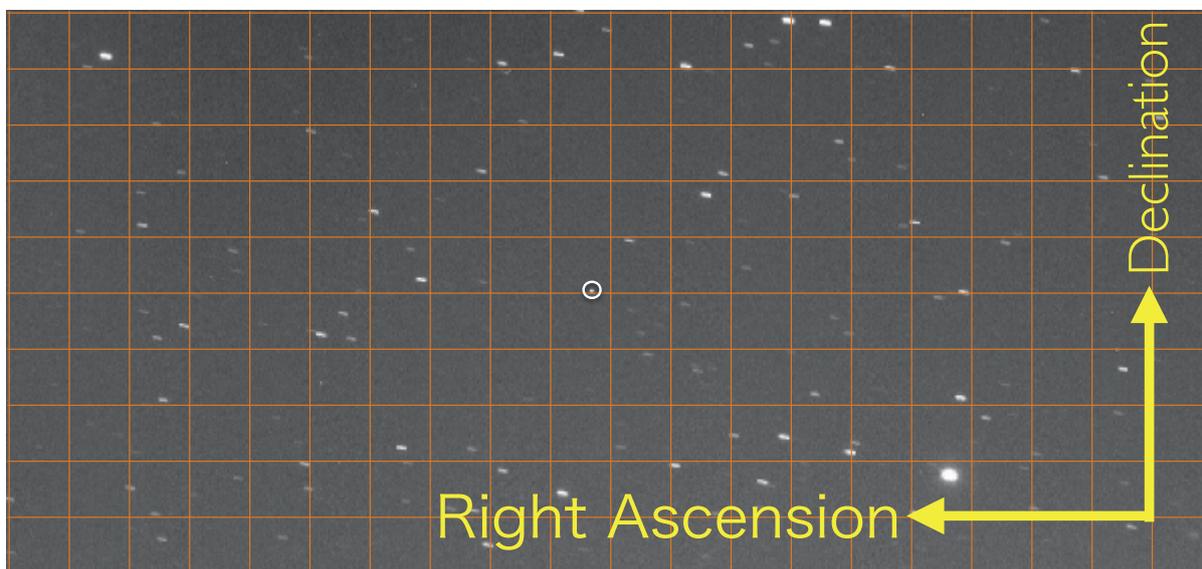
Status of the space debris observations (Survey and follow-up)

- Main target
 - …Space objects at the geosynchronous orbit
- Survey observations and followup observations by the request from user (JAXA)

Observation method (GEO object)



Observation method (GEO object)

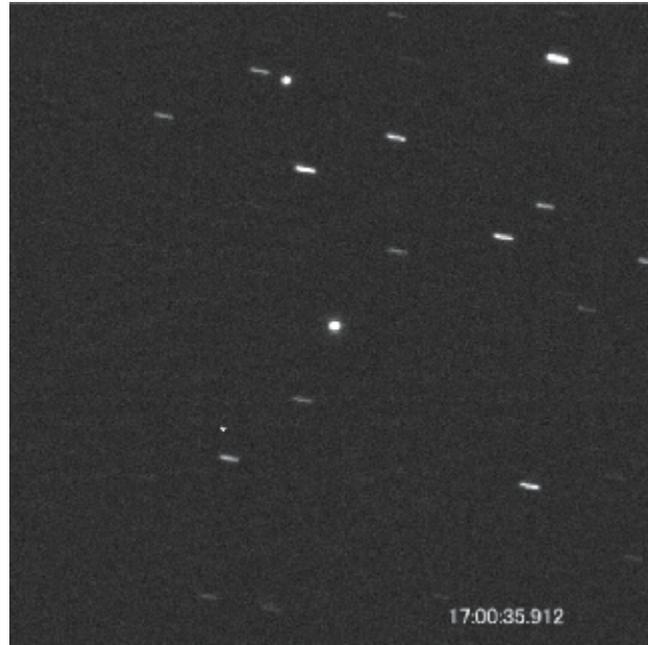


Status of the space debris observations (Survey and follow-up)

- Main target...Space objects at the geosynchronous orbit
- Survey observations and followup observations by the request from user (JAXA)

**Positional accuracy for the GEO objects...0.2-0.3 arc sec
(約40m@36000km (GEO))**

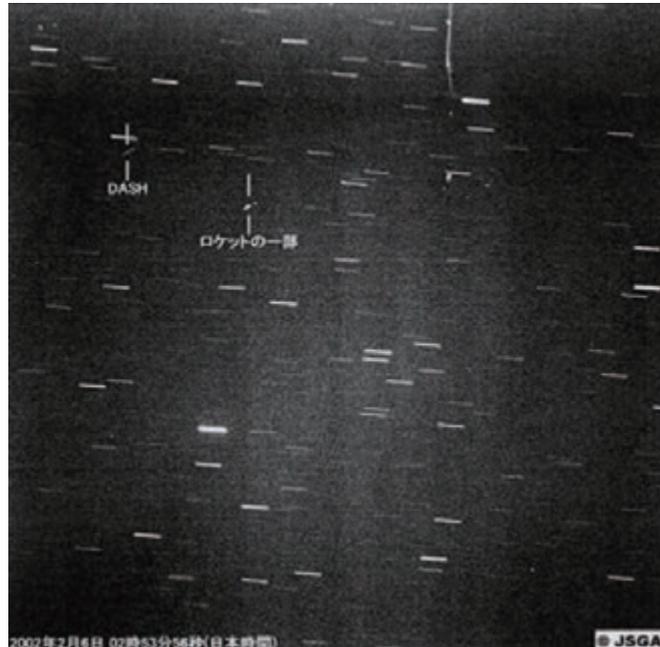
Example image (GEO)



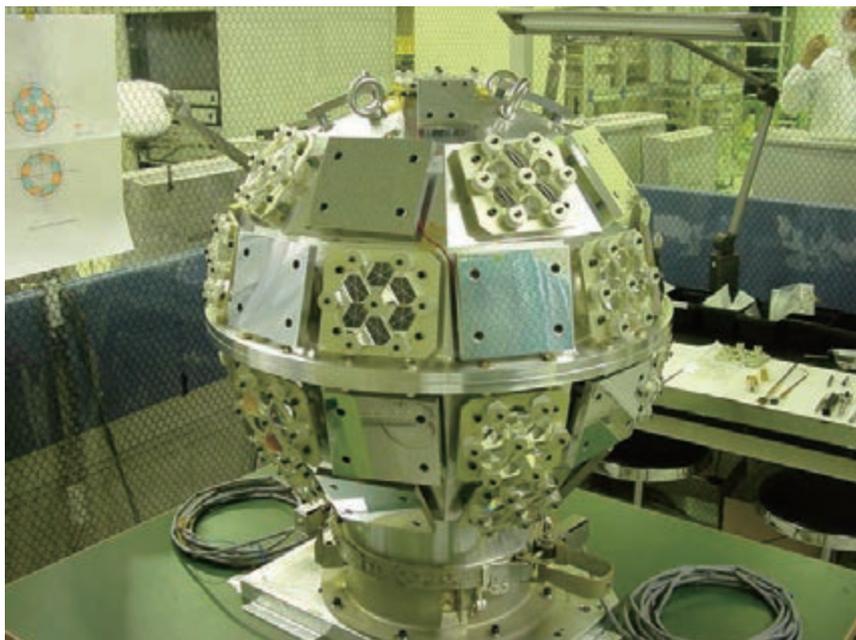
Example image (GEO)



Example (DASH & rocket body)

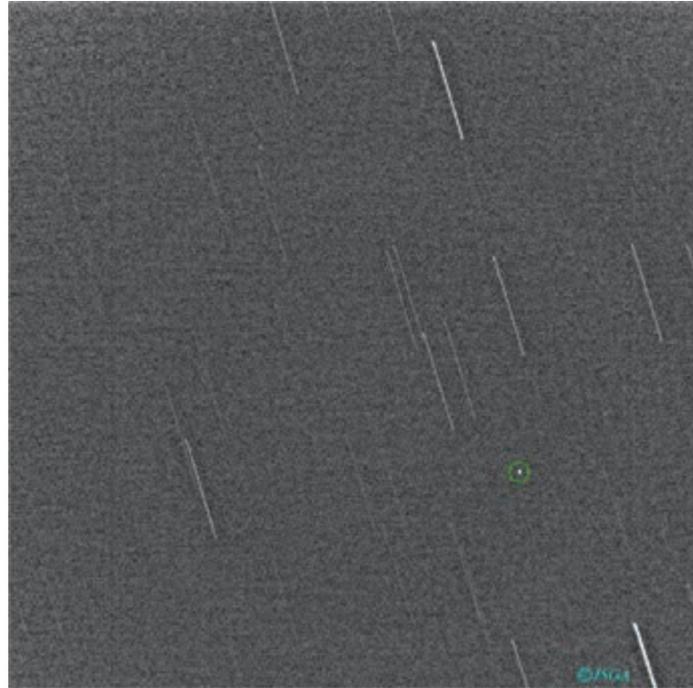


Example (Laser Reflecting Equipment: LRE)



from 「LRE Photo Gallery」 <http://god.tksc.jaxa.jp/lr/lre.html>

Example 99025AK (FENGYUN 1C debris)

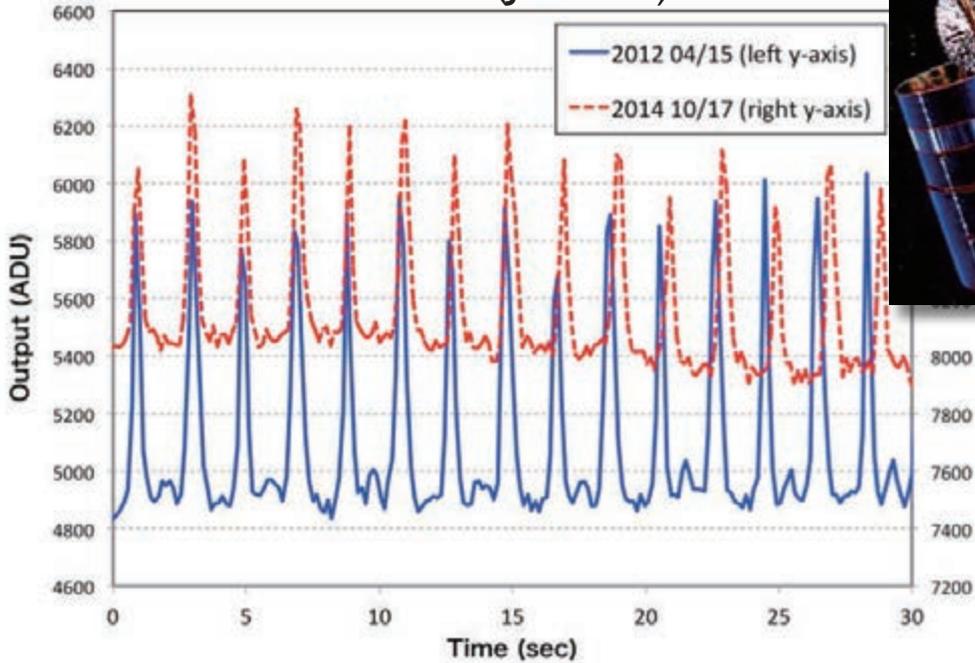


Status of the space debris observations (Research)

- Luminosity vs Phase angle with the Sun
 - Test observations of Low-Earth orbit objects
 - Estimation of shape or motion form its light curve
 - Short-period light curve by the application of TDI mode
- etc., ...

Example : research observation

90001B (JCSAT-2)



Future plans

- Discovery and followup for smaller debris
→larger telescope
- More efficiently
→wide field
- For LEO object
→light weight, fast tracking

日本スペースガード協会
次期スペースガード望遠鏡が地球をまもる
 地球接近小惑星とスペースデブリを監視

口径3m級スペースガード望遠鏡構想

ロシア・チリ・トピノスカ
 隕石の衝突による被害
 地域は、半径50km

直径17mの隕石が都市に
 衝突したら大災害になる。

小惑星衝突情報センター

●望遠鏡仕様

- 光学系
- 口径：3.5m
- 焦点距離：3.5m (F1)
- 光学タイプ：カセグレン光学系
- 視野角：2°×2°
- 3軸の望遠鏡を1台で全天を監視

●光路図

●3つのスペースガード望遠鏡

日本宇宙航空研究開発機構（JAXA）が主導し、ロシア・チリ・トピノスカにスペースガード望遠鏡を設置。

●マウント：経緯台

Plan of 3m-class wide-field and light-weight telescope for space debris and near Earth object



Summary

- ・ Bisei Spaceguard Center
 - ★ **The first facility for the observations of space debris and near Earth objects**
- ・ Status of the space debris observations
 - Survey and follow-up observations
 - ★ **GEO objects**
(positional accuracy~40m@36000km)
 - Research
 - ★ **Light curve of space debris, etc.,**
- ・ Future plans
 - ★ **3 m-class telescope**