Japanese SLR Challenges

S. Nakamura, K. Akiyama, S. Kasho, A. Mori, H. Hashimoto (JAXA)
H. Kunimori (NICT)
T. Otsubo (Hitotsubashi Univ.)
M. Sato, S. Watanabe (Japan Coast Guard)

Review :Japan has 3 SLR stations and analytical basis.

SLR	Organization	Mission of organization
KOGC	NICT	Research for Optical communication
SISL	JCG	Marine cartography and geodesy
GMSL	JAXA	Satellite Operations

Each SLR station compensate each other.
For LEO : By cooperating, observable for each revolution
For GEO: simultaneous tracking

Hitotsubashi

KOGC

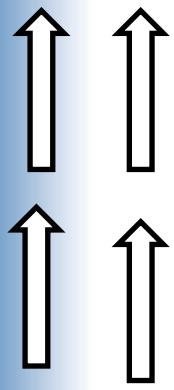
SISL

GMSL

Good Baseline for LEO
Sun synchronized sub-
Recurrent orbit

Hitotsubashi University

Outline of this presentation



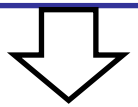
Topics and Future Plan of Each Organizations

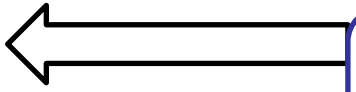
- JAXA
- NICT
- JCG
- HIT-Univ.

Collaborative Work
However, no so active

- ALOS Campaign
- AstroG LRA
- Earthquake
- AJISAI Spin

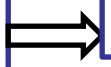
Award





18th WS on LR in Japan

Bind up 4 organization
&
Improved Relationship
&
Increase ability



new collaborative work in future

Topics and Future Plan

(1) Tanegashima (7358, JAXA)

- Tanegashima SLR station repair

  GMSL has operated for 11 years. Recently, once some trouble happened, it takes long time to fix because many parts are unavailable. JAXA is planning to repair SLR station. Conceptual design has finished. Now, due to lack of funding, repair plan is run in same place.

- QZS-2,3,… LRA

  Thanks to ILRS QZS-1 campaign, we could evaluated bias on QZS-1. Contribution from SLR data improved accuracy of QZS-1's orbit. Following through on QZS-1, JAXA is supporting QZS's LRA.

- New Science Mission

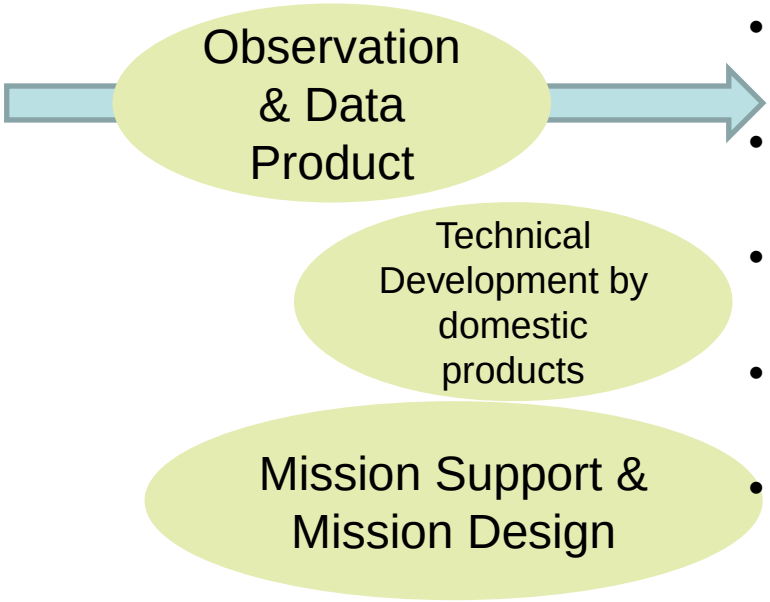
  JAXA is planning new mission, which observe sea surface height like a Jason mission. In this mission, GNSS and SLR play very important role to determine the precise orbit.

- Succession Planning

  According to JAXA's personnel reshuffle, it is big problem to make succession. Recently, young staffs who assigned flight dynamics team are taking charge SLR operation and analysis.

(2) NICT

Hikari
SLR



Future Plan

- Synergy by Telecommunication and SLR.
- System development with λ=1.5 μm
- Developing Automated Operation technology
- Contribution to ELT mission, depending on NICT condition.
- Technical development, such as mission support, Selene-2, Hayabusa-2.

Past

1996 KSP 4 station,
ADEOS-RIS Experiment,
Join ILRS
2001 ADEOS-II
2006 ALOS
OICETS Optical Communication
2008 ETS-VIII
Technical development by domestic product
2010 QZS-1. T2L2, Selene-2, Hayabusa-21

Issues

- Market of SLR technology so small that it is difficult to find all round treating company.

(3) Simosato (7838, JCG)


Old telescope


New telescope

- Replacement of SLR system in 2007-2009

  In May 2007, the laser system broke down due to aging. We took this opportunity to replace the observation system in stages from 2007 to 2009 because other equipment was also aging. **All equipment except the mount of the telescope was replaced.**

- Achievement of 30,000 passes and 30th anniversary of SLR operation

  On September, 2011, the cumulative number of passes reached 30,000. Main observed satellites were LAGEOS-1, LAGEOS-2, Ajisai, Becon-C, Starlette.
  In March 2012, the SLR operation at Simosato commemorated its 30th anniversary.

- Coseismic displacement due to the 2011 Tohoku-oki Earthquake

  On March 11, 2011, a huge earthquake (M9.0) occurred off northeastern Japan. **Although Simosato is located about 800 km away from the epicenter, coseismic displacement of about 3 cm toward east-northeast was detected by SLR observation**.

- Introduction of calibration target in telescope

  We have used a calibration target on a steel tower, which is located about 1.5 from the observatory. To develop calibration accuracy, we are conside introduction of a calibration target mounted in the telescope. This will enable us calibrations while we conduct ranging measurements.

(4) Hitotsubashi Univ.

On-going development of analysis software “c5++”

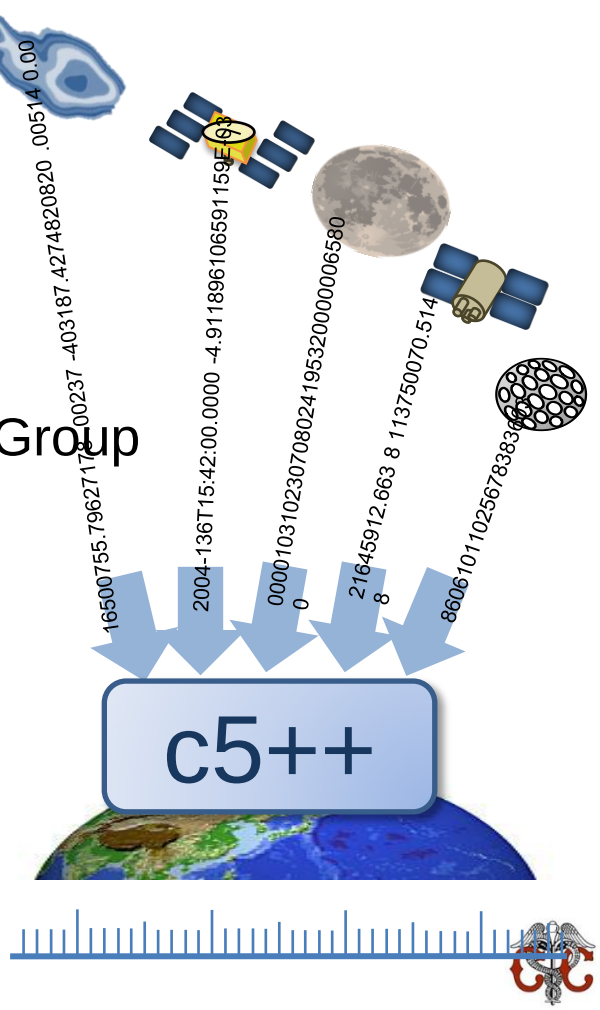
- Written in C++ (← was Java)
- Multi-technique combination at obs level
- Various application & Flexibility
- IERS Conv. 2010 & other latest models

Otsubo: Vice chair of Japanese GGOS Working Group

- Chair: Dr. Matsuzaka of GSI
- Established in May 2013
- Seeking international contributions

Young scientists welcome

- D Kucharski from Graz: 2009-2010
- K Matsuo from Kyoto: 2013



HITOTSUBASHI UNIVERSITY

Historical Background in Japan activities

- In 1982, Simosato SLR station started operation.
- In 1990, Koganei SLR station started operation.
- In 1986, AJISAI has launched

  → AJISAI consortium

  NASDA(JAXA), CRL(NICT), JCG, GSI made consortium to track AJISAI, sharing data, and have a discussion board.

  Every year, AJISAI meeting has been held.

27 years history

- Since 1998, CRL started distributed bias data via internet. In 2007, this work succeeded to Hitotsubashi Univ.
- In 2004, Tanegashima SLR station started operation, and JAXA started distributing TIRV (VPF) of AJISAI.
- In 2007-2009, Simosato SLR station system upgraded.
- In 2011, AJISAI consortium changed to Japan ILRS forum, which consist of JAXA, NICT, JCG, and Hitotsubashi Univ.

  Objective of discussion was widened to all topics related with SLR

  → Only 2013, this Japan ILRS forum is working as "18th WS LOC".

Output from Japan ILRS forum -- collaborative work --

Through 27 years, there are many output from collaboration.

- Around 2004, Independent Verification & Validation for software development (JAXA-NICT, NICT-JGC)

  same condition → compare results and middle output

  → improved accuracy and confidence themselves.

- ALOS Campaign

  ALOS has some restriction. JAXA demanded “Go/NoGo key operation”. In order to confirm operability, we performed rehearsal and dry run.

- Astro-G LRA baseline design

  Unfortunately, Astoro-G project has aborted. Long ellipse orbit beyond GPS orbit, but high accuracy orbit determination was required. We designed plate plus pyramid style LRA.

Output from Japan ILRS forum -- collaborative work --

- Before starting ETS-8 and QZS-1 campaign, accuracy of CPF was confirmed.

  Geostationary satellite ETS-8 and QZS-1 are farthest target without moon. Before starting ILRS campaign, we confirmed accuracy of CPF.

- Say hello to Space Debris; ALOS

  ALOS operation terminated in 2011. In 2012, at that time, ALOS is so-called space debris. JCG and JAXA tried to track ALOS again. Through this collaboration, we confirmed how to track space debris.

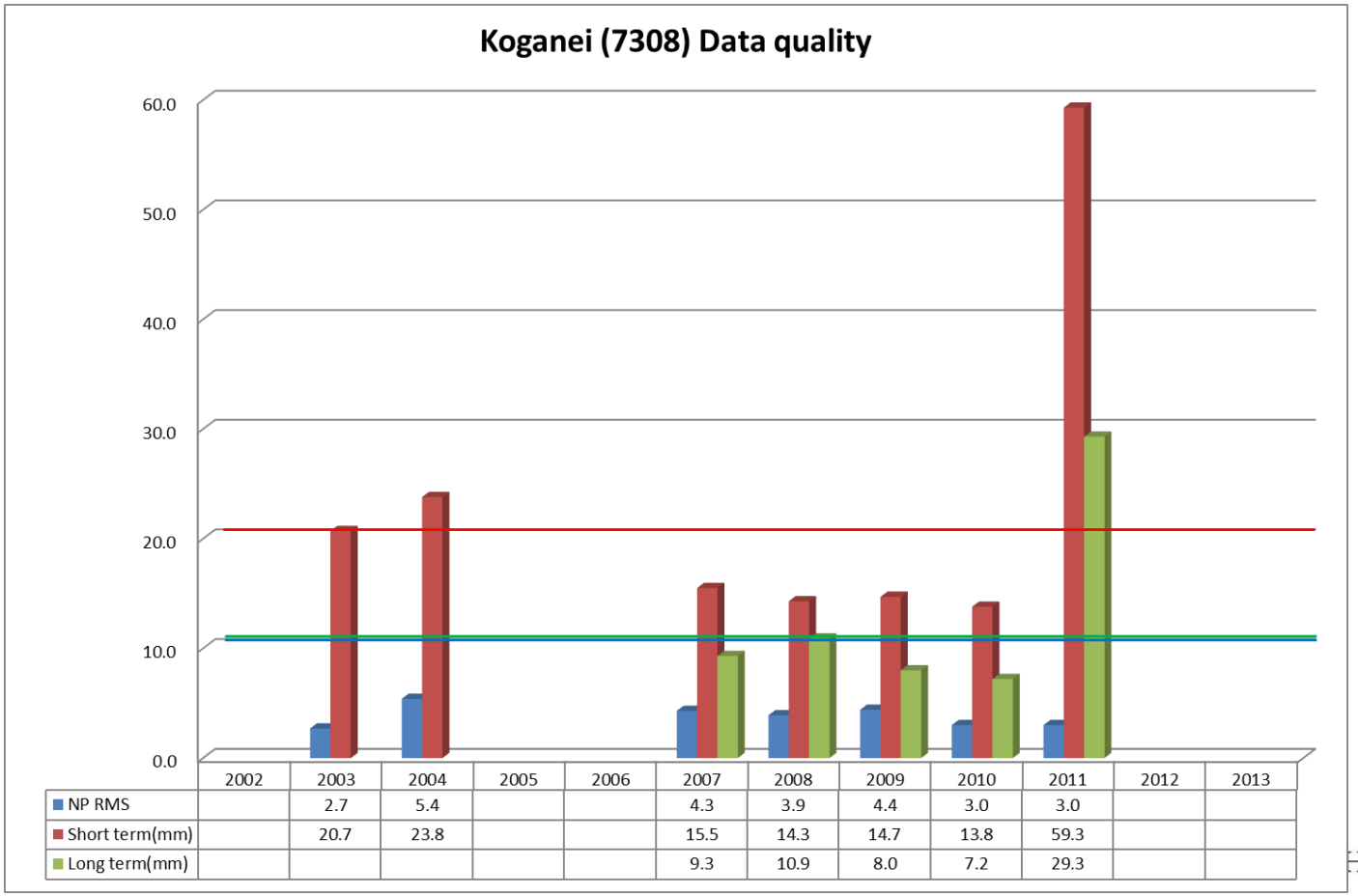
- Selene-2/LLR

  We studied LLR for lunar mission. Details were presented on 14th Lunar session.

Output from Japan ILRS forum -- collaborative work --

- 2011.3.11 Earthquake and recovery

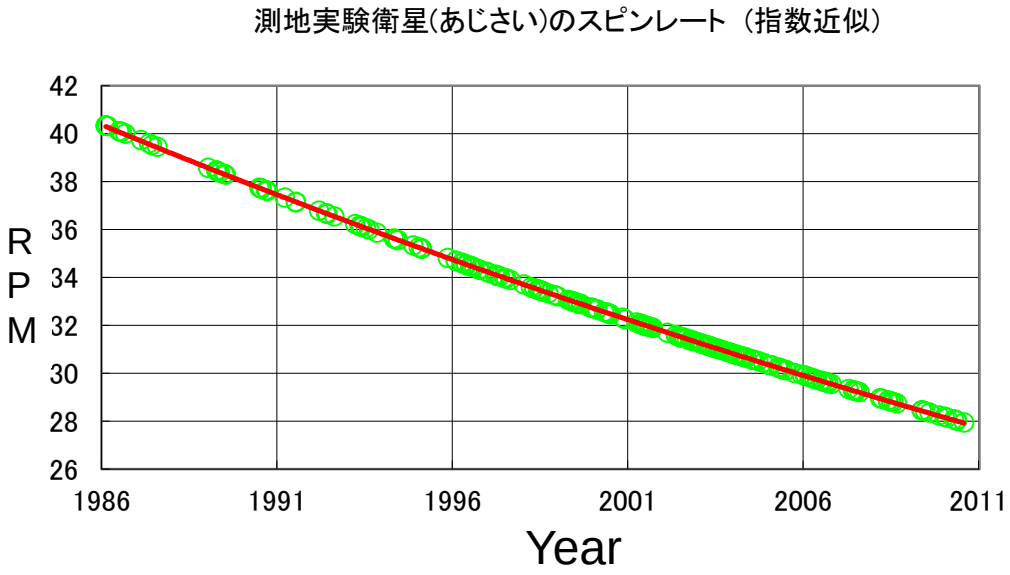
We communicated system damage and how to recover. After settling into daily operation, we communicate range bias and displacement of SLR station. HIT-U report helped very much.

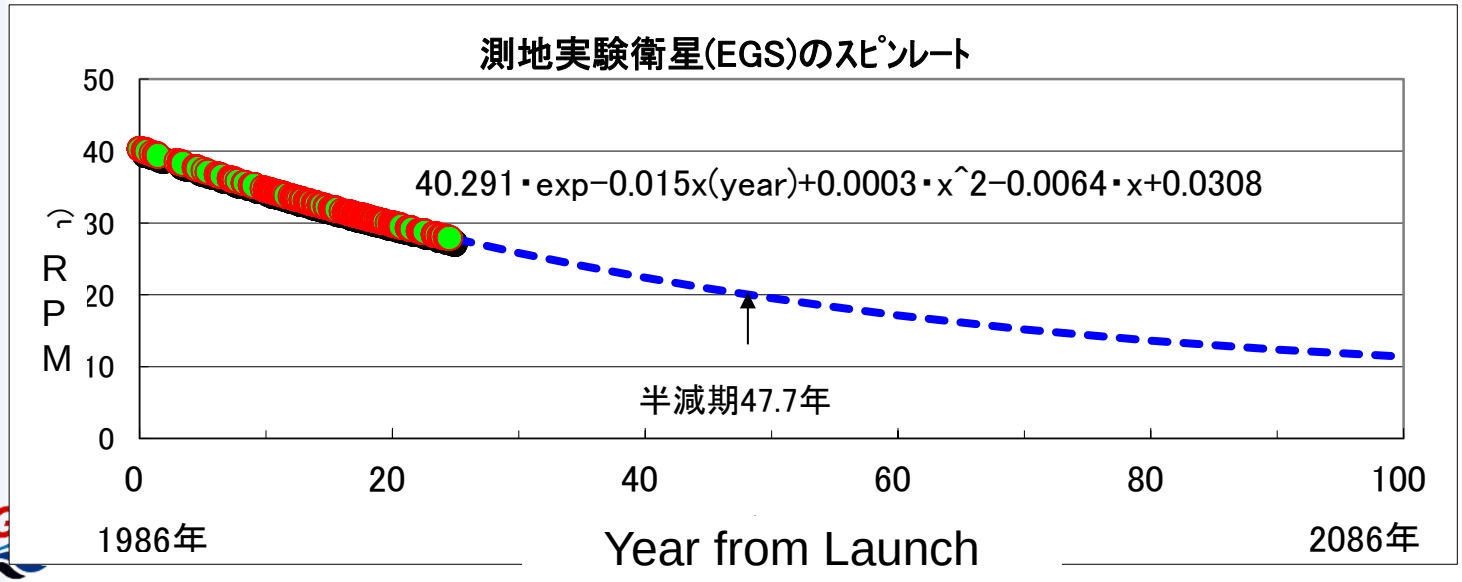


	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NP RMS		2.7	5.4			4.3	3.9	4.4	3.0	3.0		
Short term(mm)		20.7	23.8			15.5	14.3	14.7	13.8	59.3		
Long term(mm)						9.3	10.9	8.0	7.2	29.3		

Output from Japan ILRS forum - collaborative work --

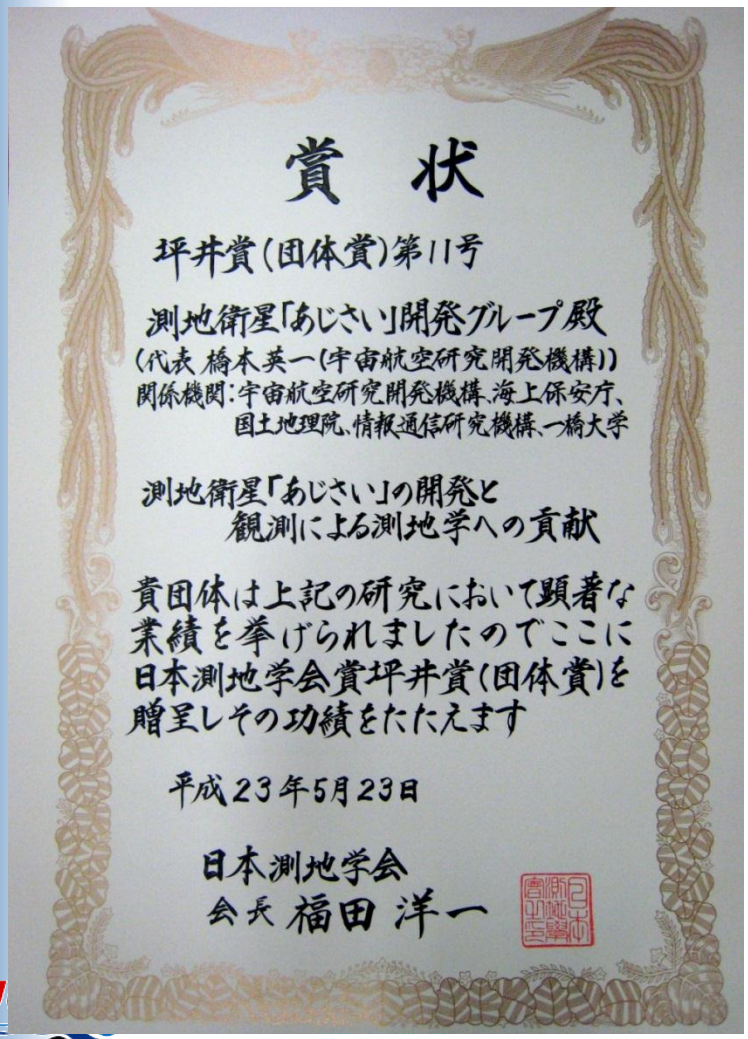
- **AJISAI spin rate by Optical Observation**





Output from Japan ILRS forum - collaborative work --

Commonly recognized the worth of development & operation of AJISAI through 25 years, JAXA, JCG, GSI, NICT, and Hitotsubashi Univ. have received “Tuboi award” from Geodetic Society of Japan in May 2011



賞　状

坪井賞（団体賞）第11号

測地衛星「あじさい」開発グループ殿
（代表 橋本 英一（宇宙航空研究開発機構））
関係機関：宇宙航空研究開発機構、海上保安庁、
国土地理院、情報通信研究機構、一橋大学

測地衛星「あじさい」の開発と
観測による測地学への貢献

貴団体は上記の研究において顕著な
業績を挙げられましたのでここに
日本測地学会賞坪井賞（団体賞）を
贈呈しその功績をたたえます

平成23年5月23日

日本測地学会
会長 福田 洋一

Japan ILRS forum

Now, we regretted what needs to be regretted.

Though we made some collaborative works, we could not gather without event.

(1) Difference of Purpose

JAXA : Space development and Satellite operation

NICT : Optical communication

JGC : Geodesy and Marine mapping

HIT-U : Analysis

(2) In JAXA and JGC, personnel reshuffle happen.

→ Relationship has to re-build from Greeting.

(3) Japan ILRS forum has met once in a year.

Therefore, our collaboration is not so active.

→ These condition has changed now through 18 LW.

Conclusion

In Japanese proverbial saying,

"United you stand. Divides you fall."

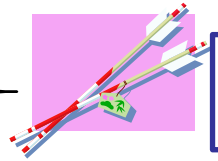
JAXA

NICT

JCG

Hitotsubashi Univ.

Independently working → "Divides you fall"



Wonderful Opportunity=18LW

18 LW bound up 4 organization.
We could take down fences among us.
→ "United we stand"
We gained confidence to work together.

We firmly believe that Japanese organizations will evolve with ILRS.
We can execute responsibility in ILRS ongoingly.

Anyway, we are proud to have a 18th workshop in Japan.
We conclude 18th WS with expressing our special thanks for your kind contribution.
See you next workshop & Symposium! Thank you!