



ILRS Governing Board Meeting

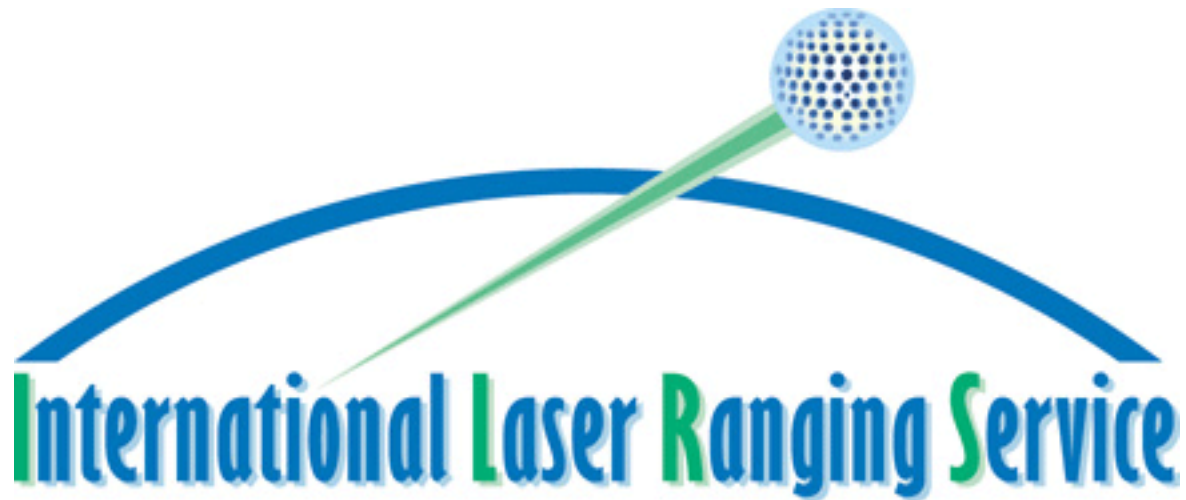
Agenda

Casa Cava

October 25, 2015

15:00-19:00

- | | | |
|--|------------------------|--------|
| • Opening Remarks | G. Bianco | 10 min |
| • Workshop Overview | C. Luceri | 5 min |
| • ILRS CB Report/ILRS Status | M. Pearlman/C. Noll | 15 min |
| • Working Group Reports | | |
| • Analysis | E. Pavlis/C. Luceri | 15 min |
| • Missions | T. Otsubo/S. Wetzel | 10 min |
| • Data Formats and Procedures | H. Mueller | 10 min |
| • Networks and Engineering | G. Kirchner | 10 min |
| • Transponder | U. Schreiber/J. Degnan | 10 min |
| • Space Debris Study Group | G. Kirchner | 10 min |
| • Data Q/C | T. Otsubo | 10 min |
| • Data Center Updates | C. Noll/H. Mueller | 10 min |
| • ILRS Terms of Reference and Election Process | M. Pearlman | 10 min |
| • GGOS Activities/Role of the ILRS | M. Pearlman | 10 min |
| • UN and GGOSIM | P. Opseth | 15 min |
| • Future Workshop Proposals | M. Pearlman | 5 min |
| • Other Business and Discussion | G. Bianco | |



ILRS Central Bureau Report

Mike Pearlman
Carey Noll
NASA GSFC

ILRS Governing Board Meeting
2015 ILRS Technical Workshop
October 25, 2015



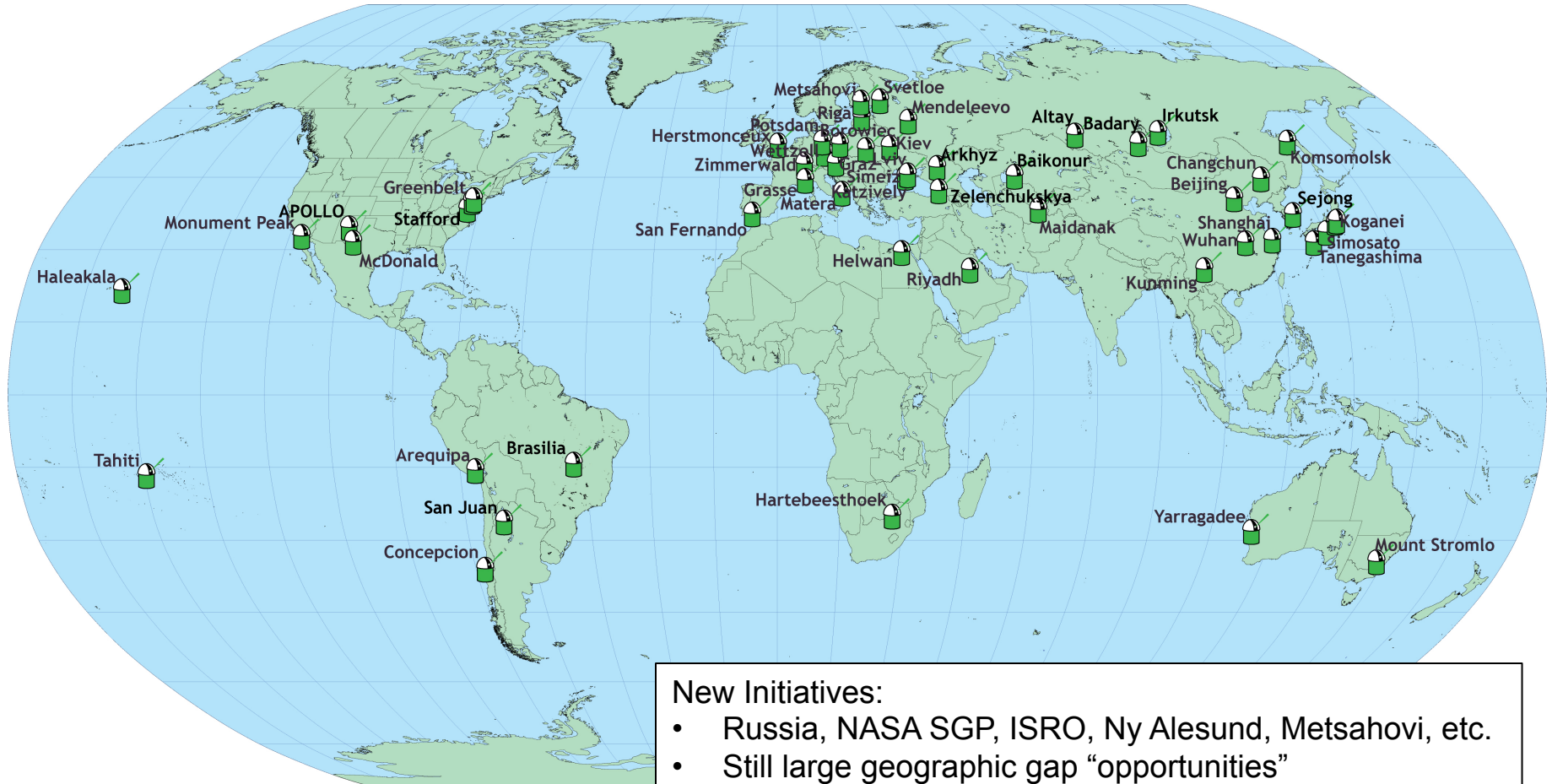
2015 ILRS Technical Workshop

October 26-30, 2015

- Schedule of working group meetings
 - Analysis Working Group (AWG): 24-Oct-2015 09:00-17:00
 - Missions Working Group (MWG): 26-Oct-2015 18:00-19:00
 - Transponder Working Group (TWG): 26-Oct-2015 19:00-20:00
 - Data Formats and Procedures Working Group (DFPWG): 27-Oct-2015 13:00-14:00
 - Networks and Engineering Working Group (NEWG): 27-Oct-2015 18:00-19:00
 - Space Debris Study Group (SDSG): 27-Oct-2015 19:00-20:00
- Working Groups should report on issues/findings during closing session on Friday, 30-Oct-2015
 - 1 slide/5 minutes



ILRS Network (2015)



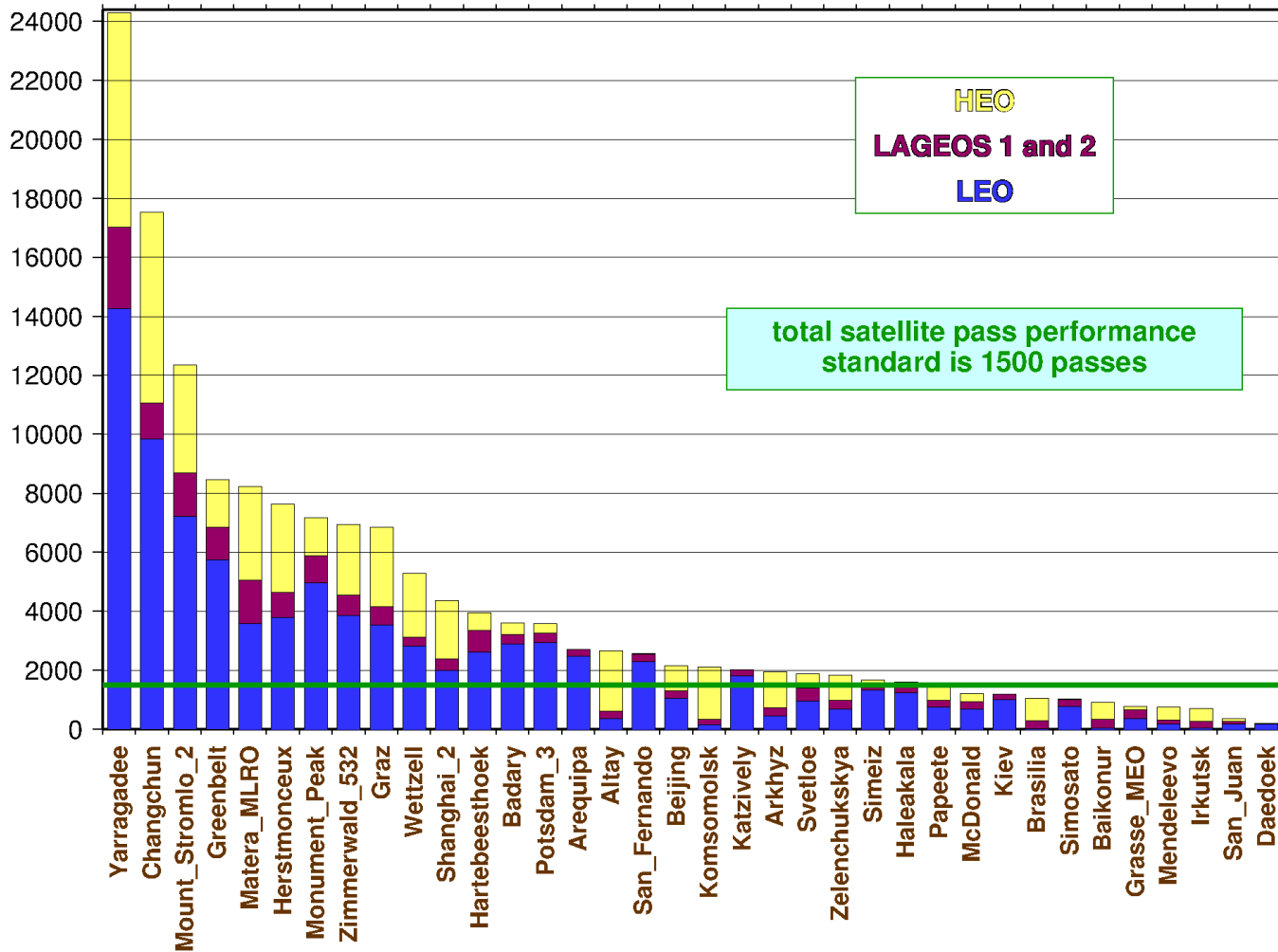
New Initiatives:

- Russia, NASA SGP, ISRO, Ny Alesund, Metsahovi, etc.
- Still large geographic gap “opportunities”
- Anachronistic mix of new and legacy technologies, but
- Expanded use of the newer technologies to move from legacy to new technology status



Station Performance (2015Q3)

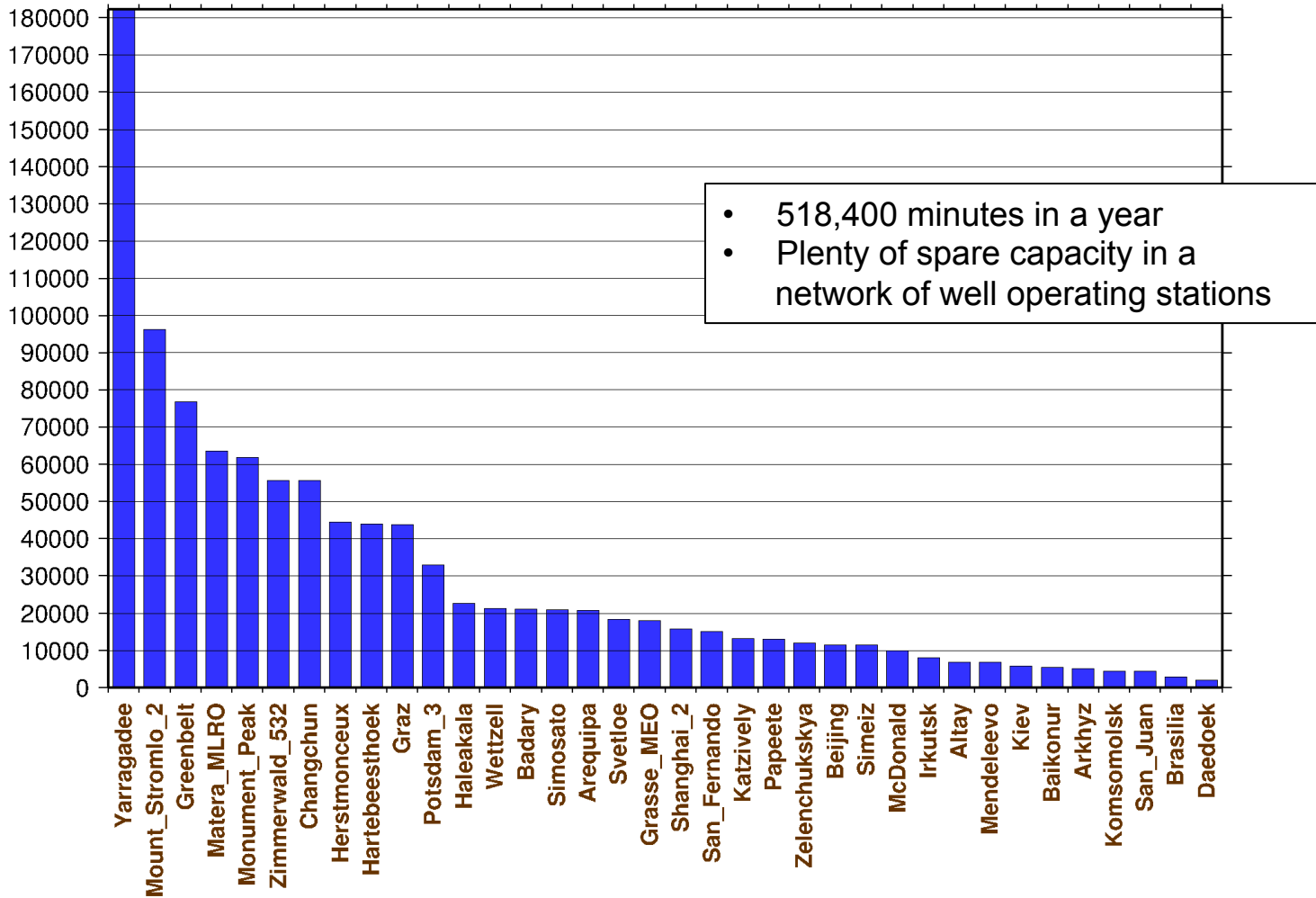
total passes
from October 1, 2014 through September 30, 2015





Station Performance (2015Q3)

minutes of data
from October 1, 2014 through September 30, 2015

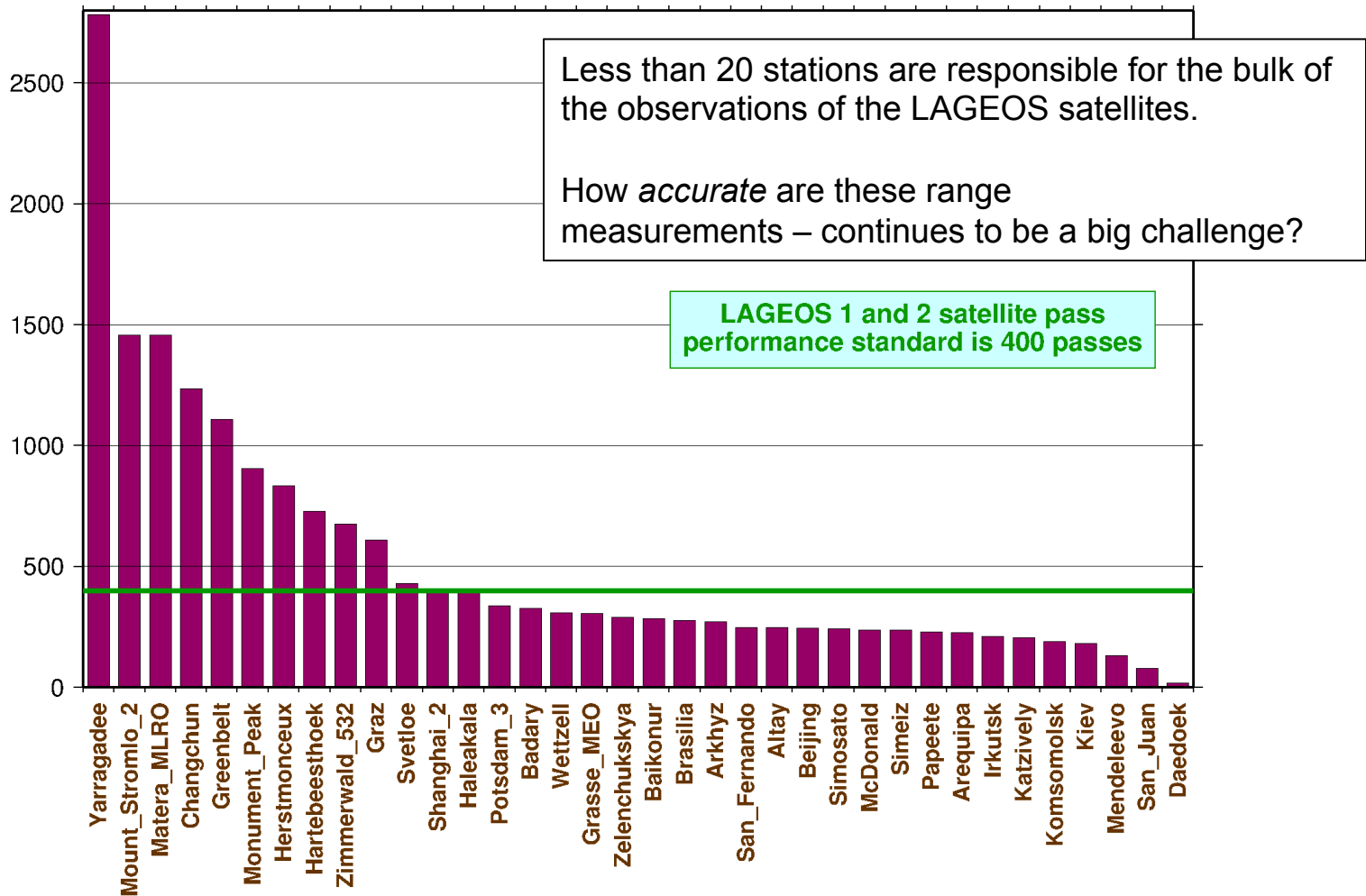


- 518,400 minutes in a year
- Plenty of spare capacity in a network of well operating stations



ILRS Network Productivity on LAGEOS-1 & -2 (Reference Frame) (2015Q3)

LAGEOS 1 and 2 passes
from October 1, 2014 through September 30, 2015





Network Developments

- NASA SGP finalizing deployment plans for core sites in Texas and Hawaii underway (Merkowitz)
- Activities in the Russian network:
 - New Russian SLR systems are operating in GNSS (mainly GLONASS) and LAGEOS; some passes on LEO satellites have been received over the past year
 - Russian station in Brasilia operational; continue working on deployment of an SLR systems in Cuba
 - Russian colleagues have discussions underway with Hartebeesthoek, Tahiti and several other locations
 - ILRS has had discussions with Russians on expanding the tracking role of the Brasilia station; we have established contact with Prof. Geovany Borges from the University of Brasilia regarding a working relationship



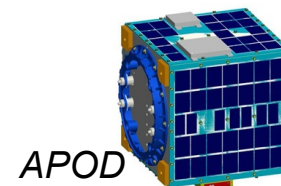
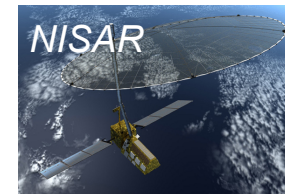
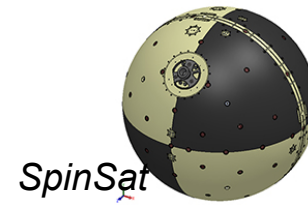
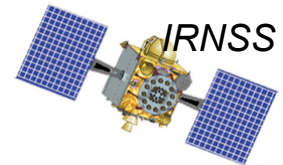
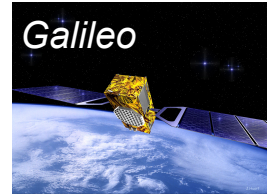
Network Status

- Number of systems are in testing:
 - AGGO (formerly TIGO) (BKG) moved to La Plata Observatory (core site)
 - SOS-W (BKG) at Wettzell (core site)
 - NAOC system at San Juan
 - KASI system at Sejong (core site)
 - Rebuilt system at Boroweic
- New SLR systems underway as part of core sites at Metsahovi, Ny Alesund, Yebes Spain, and several in China
- New stations at Mount Abu and Ponmundi in India online ~2016 (formal ILRS connection need to be made)
- Several sites are now working routinely at KHz rates
- Riyadh station is still off the air, a major disappointment because of the early success of the system and the unique location



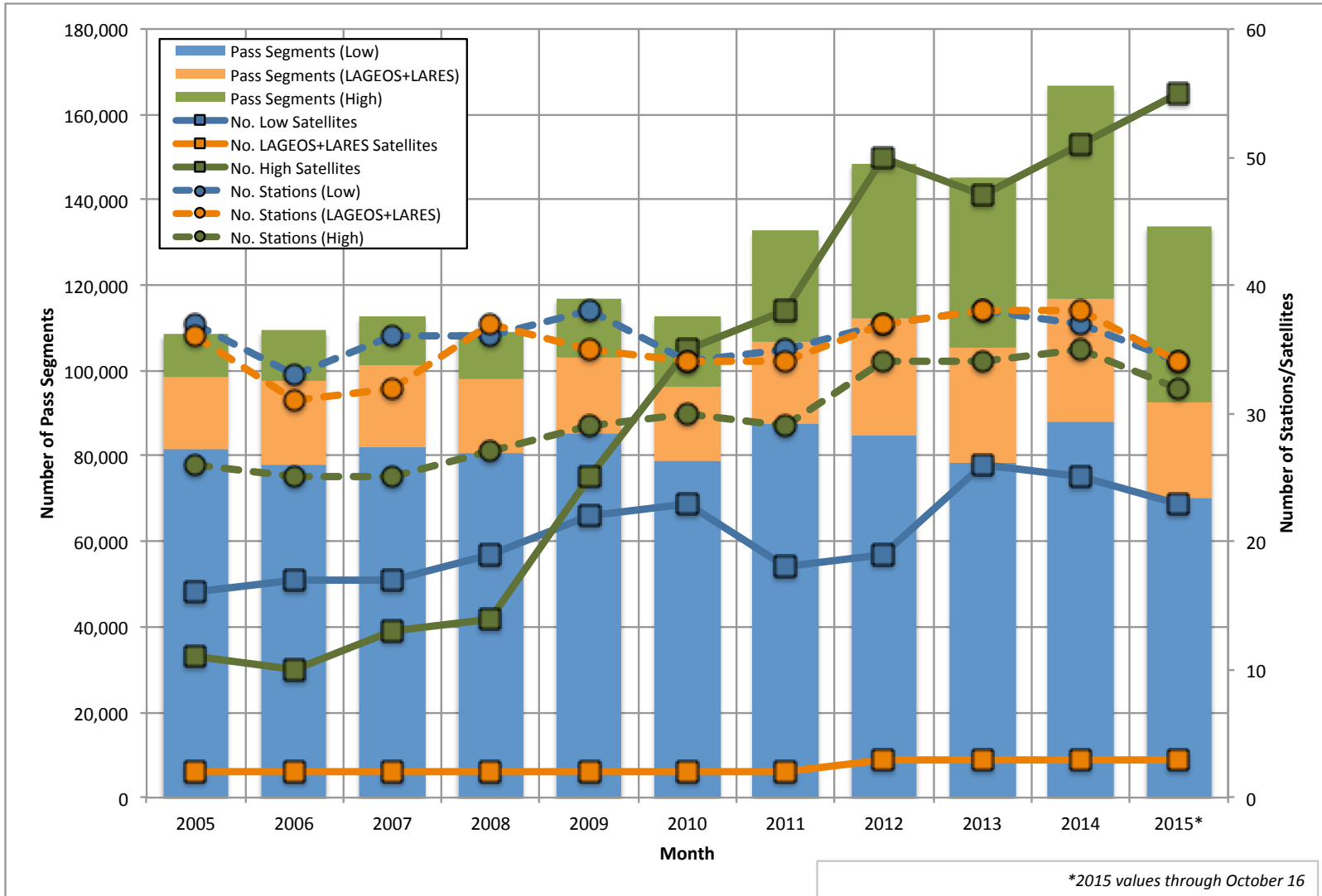
Mission Developments

- List of satellites on ILRS tracking roster continues to grow
 - Routinely tracked 81 satellites in 2015
- In last year, new satellites include:
 - Galileo-201, -202, -203, and -204; -205 and -206 recently added and special campaign starting November 01
 - IRNSS-1C and -1D
 - Two Beidou/Compass M class satellites
 - SpinSAT
- Future missions:
 - Jason-3 (2015; launch delayed due to launch vehicle issues)
 - Additional Beidou/Compass
 - PN constellation (China) (2015)
 - Sentinel-3A and -3B (2015)
 - HY-2C, SWOT, NISAR, COSMIC-2, and IceSAT-2



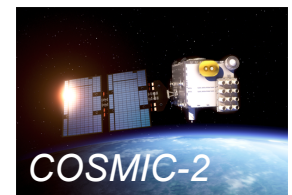


Yearly Pass Segment Totals (by satellite type)



Mission Issues

- LightSail-1 tracking unsuccessful (poor predictions and tracking opportunity very short)
- Payload vulnerability issue with Sentinel-3 satellites: must be resolved prior to approval for ILRS support (MWG)
- Technical issues also with COSMIC-2 MSR (MWG)
- Network has had little success tracking RadioAstron; orbital predictions may be the problem as well as possible issue with the design of the cube corners
- GPS-III satellites with retroreflectors now scheduled for launch beginning in 2019 (Merkowitz/Johnson)
- IRNSS-1A, -1B, -1C, -1D synchronous satellites supported for orbit QC; weak signal and limited visibility means yield is low and only from a few stations
- MSR to be reviewed by MWG for update; create a “mission log form”? (MWG)





Analysis Activities

- Preliminary ITRF received from IGN
 - Evaluation by ACs now underway (AWG)
- New products in development (AWG)
- ILRS special issue in the Journal of Geodesy in process (a few abstracts are still pending finalization) (AWG)



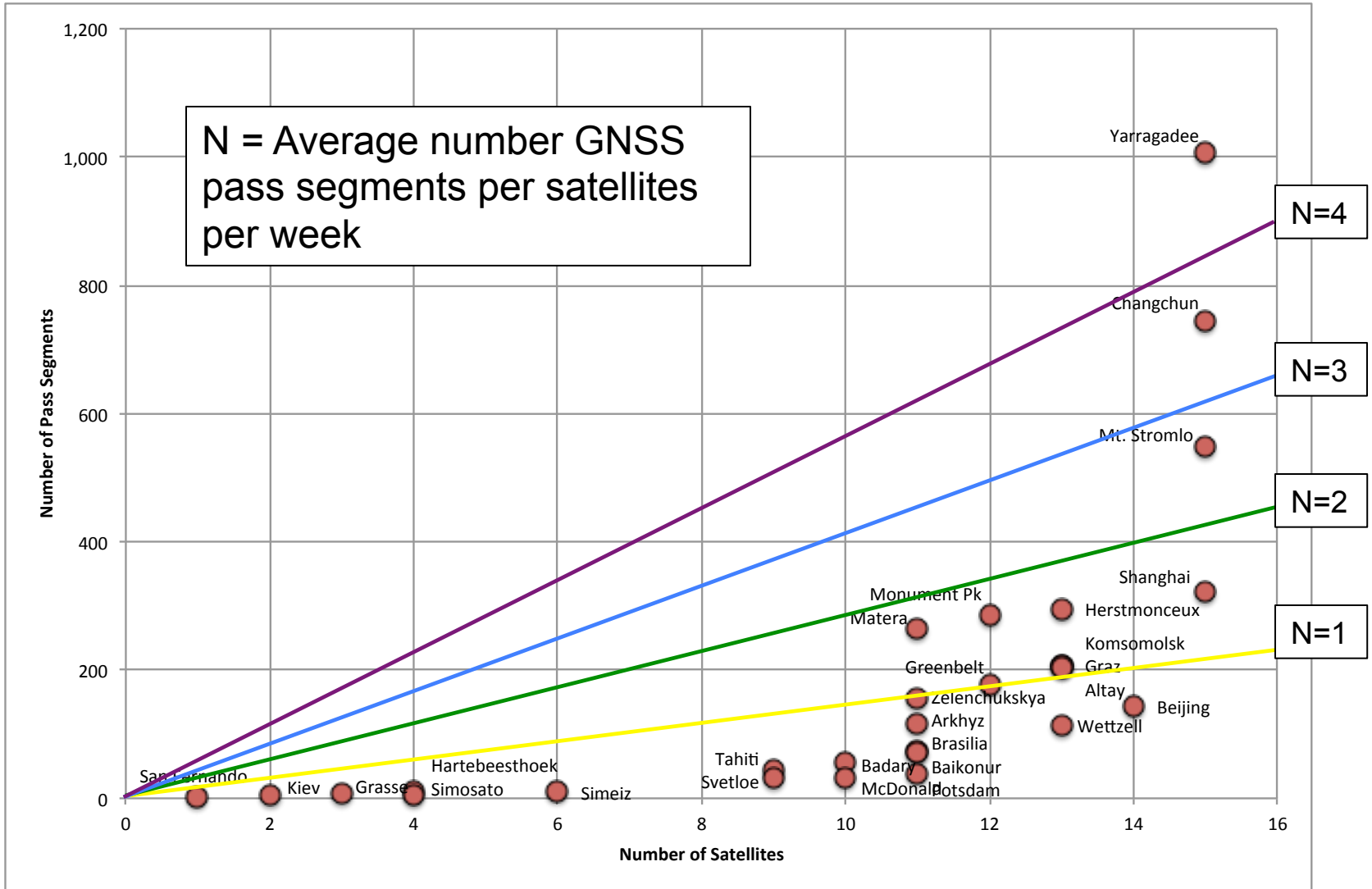
Operations Status and Issues

- Many stations had problems with leap second; poor weather may have saved others (NEWG)
- Leap second problem highlighted need for all stations to use EUROSTAT facility for real-time sharing of information
- Second GNSS campaign (22-Nov-2014 through 28-Feb-2015) conducted; detailed reports available on web
- Third GNSS campaign just completed (16-Oct-2015)
- Most high repetition rate systems using the 1000 point NPT recipe on GNSS satellites
- Stations doing better on reporting system configuration changes
- NEWG reviewing site log format for new/outdated information (NEWG)
- All active stations responded to questionnaire intended to update their station information files and in particular their future projection on GNSS tracking readiness



Campaign 2

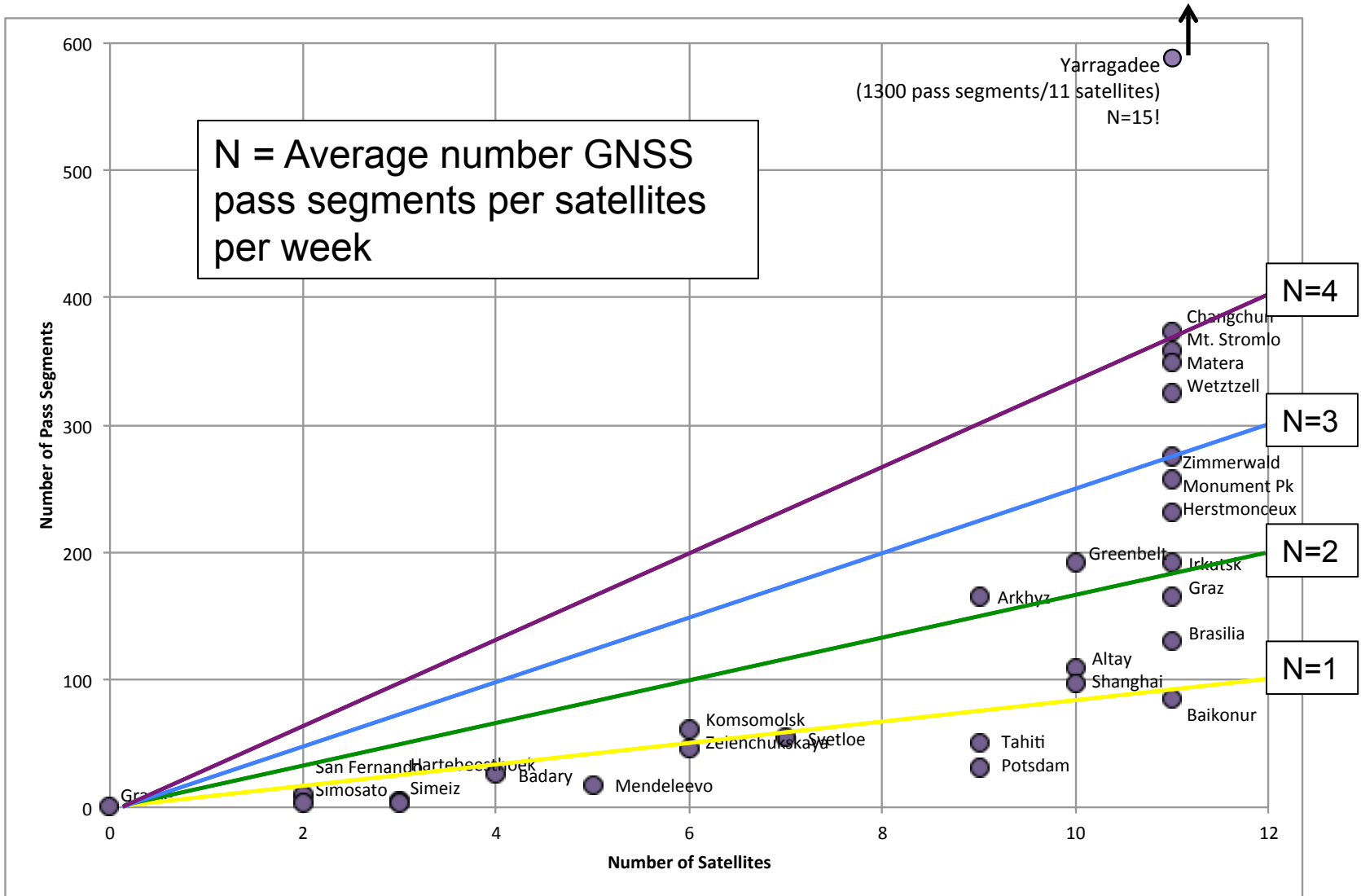
November 22, 2014 – February 28, 2015 (3 months/14 weeks/99 days)





Campaign 3

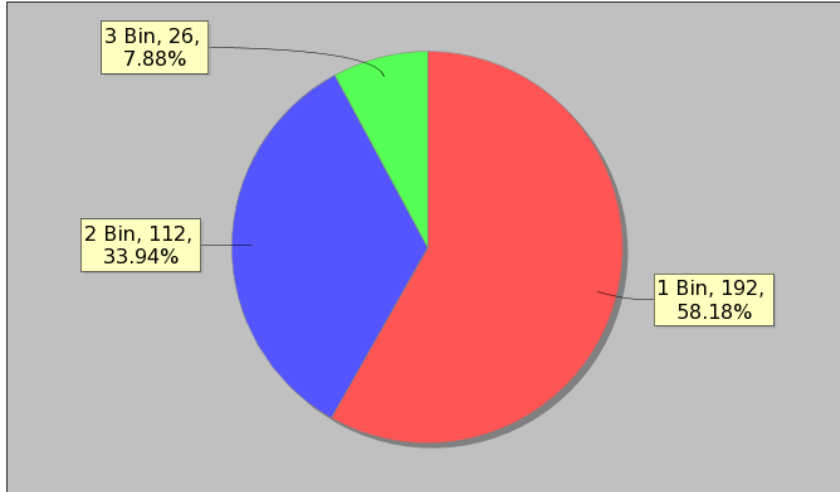
August 20 – October 16, 2015 (2 months/8 weeks/58 days)



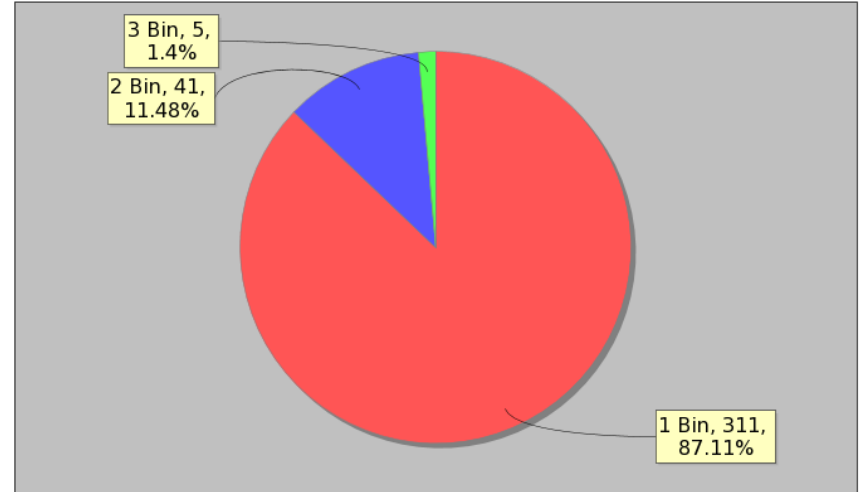


Campaign 2: Pass Distribution Analysis

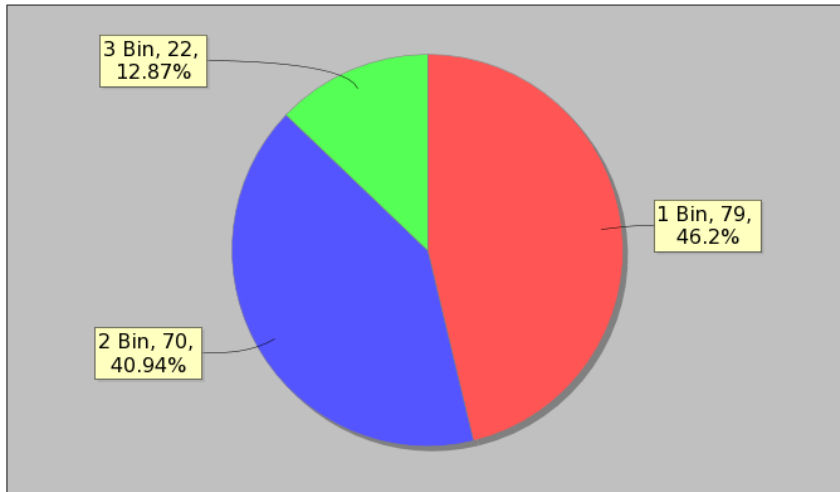
7090 YARL Glonass



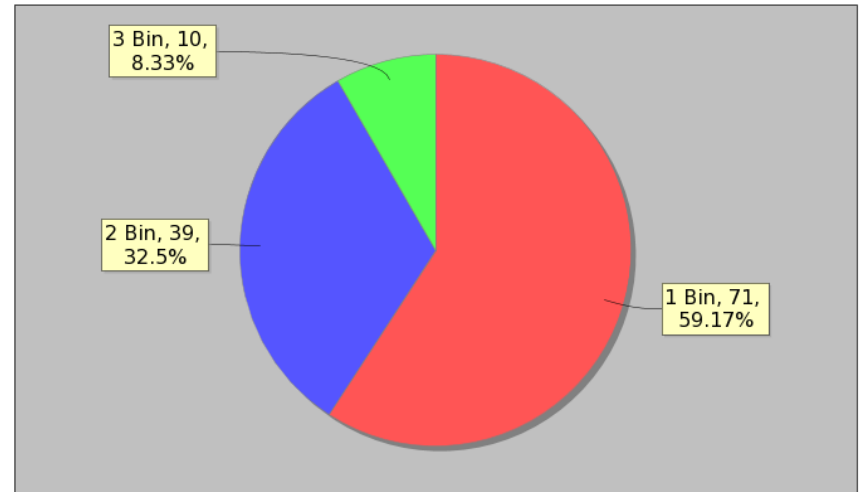
7237 CHAL Glonass



1879 ALTL Glonass



7839 GRZL Glonass



Percentage of the passes tracked that included one, two, and three segments for GLONASS.



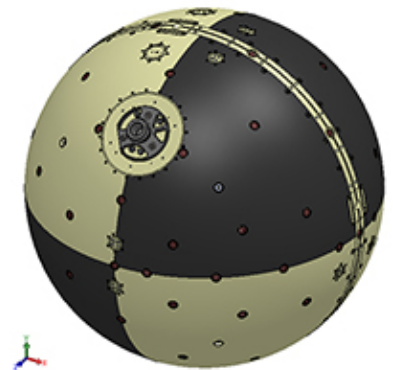
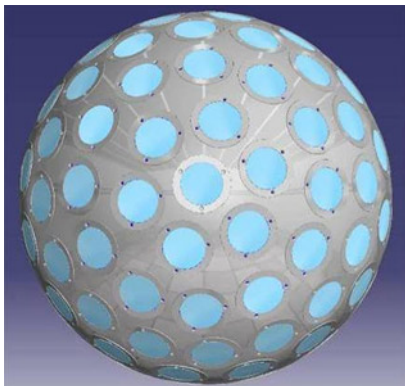
Operations Status and Issues (continued)

- Proposed procedure to measuring output beam divergence tested by several stations; results not yet analyzed (**NEWG**)
- Work continues on process to provide a dual path for data submission from the stations to both ODCs (EDC and NASA) to avoid data lapses and inconsistencies (**DFPWG**)
- Some stations now included tracking of space debris in their operations (**SDSG**)
 - Activities started with the Envisat and have expanded
 - ILRS has established a study group to better understand task, organization, and impact on the other network activities



Laser Retroreflector Array Modeling

- NASA Technical Memorandum on the LARES model awaits review
- NASA Technical Memorandum on Sentinel in publishing process
- Visibility model developed for SpinSAT
 - Verifying that tracking was possible even though the satellites was spinning
 - Mission did not inform the ILRS about the spinning at the beginning of mission support
- Report on a candidate array model for a satellite in high eccentricity orbit has been issued





General ILRS Issues/Concerns

- Filling the remaining geographic gaps will require many more partnerships and lots more resources
- System biases still plague us at some stations; proper calibration and testing equipment and procedures need to be designed and implemented at all stations
- Need more on-site tools for diagnostics and real-time performance assessment allowing systems to make real-time operational decisions
- Need more use of interactive communication on networks status to share experience and diagnostics
- The lack of a “central design” for a “next generation SLR” system raises the cost, creates some compatibility issues (although minor) in data applications, and above all, makes the availability of any spare parts an almost unique issue per site or sub-network of sites;
- Mix of legacy and modern technologies and lack of standards in hardware will have an effect the data for a long time



Meetings

- 2015 ILRS Technical Workshop, Matera Italy, October 26-30, 2015
- 2015 Fall AGU, San Francisco CA, December 14-18, 2015
- IGS Workshop "GNSS Futures", Sydney, NSW, Australia, February 15-19, 2016
- 9th International VLBI Service for Geodesy and Astrometry (IVS) General Meeting, Ekudeni in Muldersdrift, South Africa, March 13-19, 2016
- EGU General Assembly 2016, Vienna, Austria, April 17-22, 2016
- AOGS 13th Annual Meeting, Beijing, China, July 31-August 05, 2016
- GRACE Science Team Meeting, Potsdam Germany, October 05-07, 2016
- 20th International Workshop on Laser Ranging, Potsdam Germany, October 09-14, 2016
- Ocean Surface Topography Science Team (OSTST) Meeting, La Rochelle, France, November 01-04, 2016



ILRS Analysis Working Group Report

ILRS Governing Board Meeting

Matera, Italy,
October 25, 2015

Erricos C. Pavlis and Cinzia Luceri
Analysis Coordinators

ILRS system
Mobile Systems: FTLRS (France)
TROS (China)

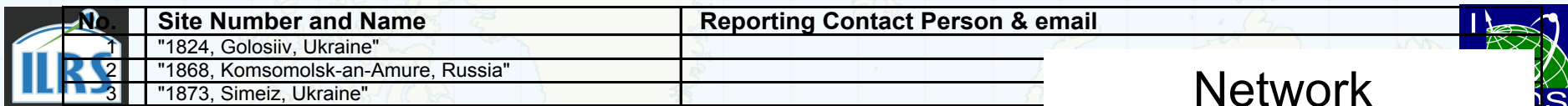
- Operational products (**daily & weekly**) delivered routinely and on time from the eight ACs:
 - **ASI** (AC & CC), BKG, DGFI, ESA, GFZ, GRGS, **JCET** (AC & CC), & NSGF
- All ILRS ACs committed to the evaluation of ITRF2014P
- To date, evaluation of ITRF2014P model is underway with only ~3 ACs providing input so far
- We are in discussions with ITRS/Zuheir on the selection and validation of “breaks” in the SLR sites’ series

ILRS system
Mobile Systems: FTLRS (France)
TROS (China)

- Finalization of the 4-sat orbital product (awaiting GRGS submission)
- Pilot Project (PP) for systematic error estimation (next)
- PP for low-degree harmonic estimation (will follow)
- Next will be the incorporation of LARES in the operational data product
- Finally, PP for observational-level modeling of loading corrections for stations and corresponding gravitational corrections in orbit (operational product)
- Benchmarking of new ACs as needed

- New & old stations validated & accepted in 2015 so far:
 - Irkutsk – for a second time after 90-day break
 - SOS Wetzell, in progress (system being worked on)
 - Borowiec, back after new laser installation
- AWG asks the CB to stress to stations that when undergoing repairs/upgrades, report their plans in time for the correct handling of their data (quarantine) and the assignment of new SODs if required
- AWG asks the GB to adopt our proposal to withhold data releases until robust station coordinates are available

- A network survey was completed with a very good response rate over the past summer/fall
- A well-thought set of questions was sent to all stations in the form of a Google spreadsheet in order to gauge their current state and their plans for the near and long-term, primarily for issues relevant to GNSS tracking ability and yield
- Of the 57 questionnaires we sent out, we received 48 responses and 8 of the 9 non-respondent sites are practically closed (only Riyadh is expected to reopen)
- Of the 16 questions posed, 7 are easily summarized (y/n), the remaining require some additional work or a one-by-one review by interested parties
- The results can be made available on the ILRS website (GB?)



Network Questionnaire Status – 2015.10.15

No	Site Number and Name	Reporting Contact Person & email
1	"1824, Golosiiv, Ukraine"	
2	"1868, Komsomolsk-an-Amure, Russia"	
3	"1873, Simeiz, Ukraine"	
4	"1874, Mendeleevo 2, Russia"	"Igor Ignatenko Iglg@vniiftri.ru"
5	"1879, Altay, Russia"	parknataliya@yandex.ru
6	"1884, Riga, Latvia"	"Kalvis Salmis, kalvis.salmis@lu.lv"
7	"1886, Arkhyz, Russia"	
8	"1887, Baikonur, Kazakhstan"	
9	"1888, Svetloe, Russia"	
10	"1889, Zelenchukskya, Russia"	
11	"1890, Badary, Russia"	
12	"1891, Irkutsk, Russia"	"Igor Ignatenko Iglg@vniiftri.ru"
13	"1893, Katzively, Ukraine"	"Andriy Makeyev, clogao@rambler.ru"
14	"7045, Apache Point, New Mexico"	
15	"7080, McDonald Observatory, Texas"	
16	"7090, Yarragadee, Australia"	"Randall Carman, Randall.Carman@ga.gov.au"
17	"7105, Greenbelt, Maryland"	
18	"7110, Monument Peak, CA"	Ron Sebeny
19	"7119, Haleakala, Hawaii"	
20	"7124, French Polynesia"	
21	"7237, Changchun, China"	
22	"7249, Beijing, China"	
23	"7308, Koganei, Japan (NICT)"	"Hiroo Kunimori, National Institute of Information and Communications Technology (NICT)"
24	"7328, Koganei, Japan"	"Hiroo Kunimori, National Institute of Information and Communications Technology (NICT)"
25	"7358, Tanegashima, Japan"	
26	"7359, Daedeok, Republic of Korea"	
27	"7394, Sejong, Republic of Korea"	
28	"7403, Arequipa, Peru"	
29	"7406, San Juan, Argentina"	"Liu Weidong, wdliu@bao.ac.cn"
30	"7407, Brasilia, Brazil"	
31	"7501, Hartebeesthoek, South Africa"	
32	"7806, Metsahovi, Finland"	"Arttu Raja-Halli, arttu.raja-halli@nls.fi; Jyri Naranen, jyri.naranen@nls.fi"
33	"7810, Zimmerwald, Switzerland"	"Martin Ploner, martin.ploner@aiub.unibe.ch"
34	"7811, Borowiec, Poland"	
35	"7820, 7820, Kunming, China"	"Li Zhulian, lzhl@ynao.ac.cn"
36	"7821, Shanghai, China"	"Zhang Zhongping, zzp@shao.ac.cn"
37	"7824, San Fernando, Spain"	
38	"7825, Mt Stromlo, Australia"	
39	"7827, Wettzell, Germany"	
40	"7831, Helwan, Egypt"	"Prof. Dr. Makram Ibrahim, Makikh@yahoo.com"
41	"7838, Simosato, Japan"	
42	"7839, Graz, Austria"	
43	"7840, Herstmonceux, UK"	
44	"7841, Potsdam, Germany"	"Ludwig Grunwaldt, grun@gfz-potsdam.de"
45	"7845, Grasse, France (LLR)"	
46	"7865, Stafford, Virginia"	Jake Griffiths
47	"7941, Matera, Italy (MLRO)"	Giuseppi Bianco
48	"8834, Wettzell, Germany (WLRS)"	

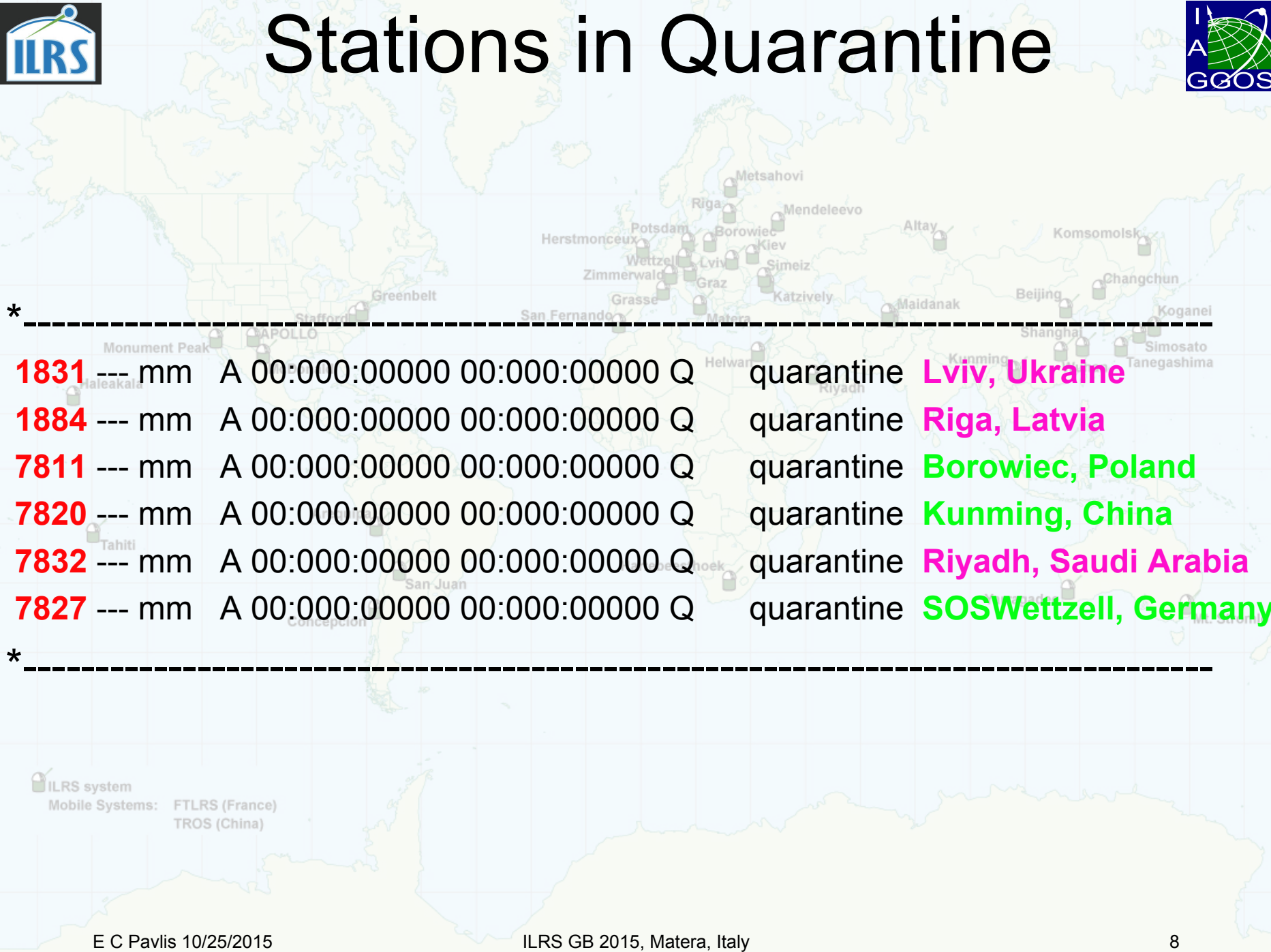


Network Questionnaire Status – 2015.10.15: 48 of 57

Sites that did NOT respond yet are in RED

Monument	Name
1824	Golosiiv, Ukraine
1831	Lviv, Ukraine NO TRACKING since 2010
1863	Maidanak 2, Uzbekistan NO TRACKING since 2004
1864	Maidanak 1, Uzbekistan NO TRACKING since 2009
1868	Komsomolsk-na-Amure, Russia
1870	Mendeleev 1, Russia SITE CLOSED???
1873	Simeiz, Ukraine
1874	Mendeleev 2, Russia
1879	Altay, Russia
1884	Riga, Latvia
1886	Arkhyz, Russia
1887	Baikonur, Kazakhstan
1888	Svetloe, Russia
1889	Zelenchujskya, Russia
1890	Badary, Russia
1891	Irkutsk, Russia
1893	Katzively, Ukraine
7040	Wrightwood, California NO SLR TRACKING
7045	Apache Point, NM
7080	McDonald Observatory, Texas
7090	Yarragadee, Australia
7105	Greenbelt, Maryland
7110	Monument Peak, California
7119	Haleakala, Hawaii
7124	Tahiti, French Polynesia
7231	Wuhan, China NO TRACKING since 2006
7237	Changchun, China
7249	Beijing, China

Monument	Name
7308	Koganei, Japan(CRL)
7328	Koganei, Japan
7358	Tanegashima, Japan
7359	Daedeok, Republic of Korea SITE CLOSED
7394	Sejong, Republic of Korea
7403	Arequipa, Peru
7405	Concepcion, Chile SITE CLOSED
7406	San Juan, Argentina
7407	Brasilia, Brazil
7501	Hartebeesthoek, South Africa
7806	Metsahovi, Finland
7810	Zimmerwald, Switzerland
7811	Borowiec, Poland
7820	Kunming, China
7821	Shanghai, China
7822	Tahiti* FTLRS OCCUPATION
7824	San Fernando, Spain
7825	Mt Stromlo, Australia
7827	Wettzell, Germany
7831	Helwan, Egypt
7832	Riyadh, Saudi Arabia NO TRACKING since 2011
7838	Simosato, Japan
7839	Graz, Austria
7840	Herstmonceux, United Kingdom
7841	Potsdam, Germany
7845	Grasse, France (LLR)
7865	Stafford, Virginia
7941	Matera, Italy (MLRO)
8834	Wettzell, Germany (WLRS)



* -----

1831	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	Lviv, Ukraine
1884	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	Riga, Latvia
7811	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	Borowiec, Poland
7820	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	Kunming, China
7832	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	Riyadh, Saudi Arabia
7827	---	mm	A	00:000:00000	00:000:00000	Q	quarantine	SOWWetzell, Germany

* -----

ILRS system
 Mobile Systems: FTLRS (France)
 TROS (China)

- **IERS Annual Report 2014 (ILRS contribution):**
 - It was submitted by February 23, 2015, no further news from IERS
- **ILRS Special Issue in the Journal of Geodesy:**
- Progressing now, awaiting three more abstracts before sending them to the editor for approval
 - Originally over 24 submissions, 3 abstracts pending finalization
 - Need to revive this and update the contributions to reflect recent events
- **Future Meetings:**
 - The next Spring meeting of the AWG will likely take place in Vienna, during the week of EGU 2016



Missions WG Report

@ ILRS GB Meeting
25 Oct 2015

Toshimichi Otsubo
and
Scott Wetzel



Agenda (for 26 Oct 2015)



(1) Opening/Welcome

New Members: A Boni, A Sokolov and Zhang Z

(2) Recently approved missions, (3) Future missions (5 min each)

PN-1A, B, C & D (Zhang Z): approved on 28 Apr 2015, more info required

Compass (Zhang Z)

NISAR (?)

LightSail-A/B (S Chait; read by T Otsubo)

COSMIC-2 (J Weiss)

SC Lomonosov (A Sokolov)

(4) Mission Support Request (MSR) Form: Revision Plan

(5) Others?

(6) Closure

(1) MWG Members



- Graham Appleby/NERC Space Geodesy Facility
- Giuseppe Bianco/Agenzia Spaziale Italiana (ASI)
- **(new)** Alessandro Boni/Istituto Nazionale di Fisica Nucleare
- John J. Degnan/Sigma Space Corporation
- Julie E. Horvath/HTSI/SLR
- Georg Kirchner/Space Res. Inst., Austrian Acad. of Sci.
- Hiroo Kunimori/NICT
- John Mck. Luck/.
- David McCormick/NASA GSFC
- Jan F. McGarry/NASA GSFC
- Carey E. Noll/NASA GSFC
- Ron Noomen/Delft University of Technology
- **(chair)** Toshimichi Otsubo/Hitotsubashi University
- Erricos C. Pavlis/GEST/UMBC
- Michael R. Pearlman/Harvard-Smithsonian Center for Astrophysics.
- Ulrich Schreiber/BKG/Geodaetisches Observatorium Wettzell
- Peter J. Shelus/University of Texas at Austin/CSR
- **(new)** Andrey Sokolov/SRI for Precision Instrument Engineering
- Vladimir P. Vasiliev/SRI for Precision Instrument Engineering
- **(cochair)** Scott L. Wetzel/HTSI/SLR
- **(new)** Zhongping Zhang/Shanghai Data Center

(2)-1 COSMIC-2



2015-10-02 MSR submitted to ILRS CB → Distributed to MWG

2015-10-09 MWG not accept the MSR as it is → ILRS CB

2015-10-14 ILRS CB (Pearlman) replies after rewording etc

2016-Q4? Launch

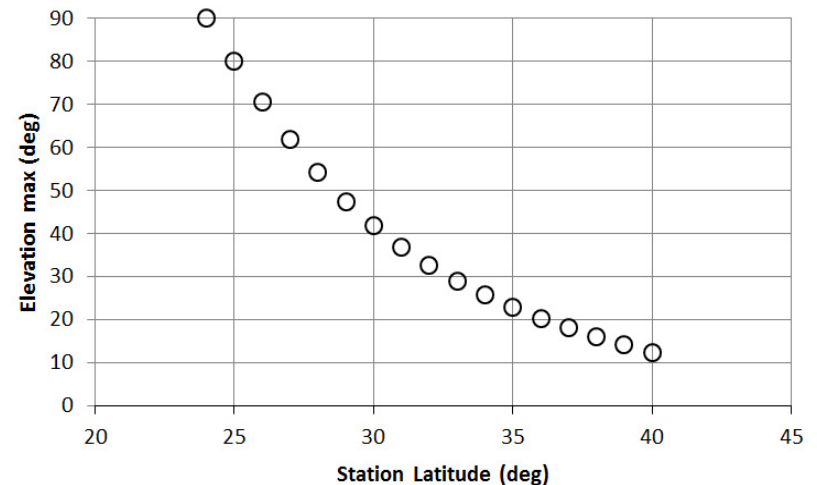
Issues:

[1] Low inclination (24 deg) & planar (single-retro?) array

Only low-latitude sites (30S to 30N? 35S to 35N?) can see them

[2] Closely flying 6 satellites

[3] Incomplete MSRF



(2)-2 Sentinel-3A



2014-10-28 ESA (Féménias) presentation at ILRS MWG Meeting (read by Appleby)

2015-03-23 MSR submitted to ILRS CB

2015-06-09 → MWG (Chairs only)

where pending issues (damaging a detector) remains

2015-06-11 ILRS CB (Pearlman) requests the clarification of damage cases

2015-10-10 ILRS CB (Lemoine) sends a reminder

2015-10-14 ESA replies: 85 deg elevation limit

2015-12? Launch

Shall we ask them to revise the MSRF, then shall we proceed?

(3) Follow-on/series missions



Current protocol: Once ABC-1 got approved, ABC-2, 3, ... do not need to submit a MSR and are automatically (?) approved.

Question: Is it OK for ILRS?

Why:

The new satellite(s) may

- carry a (very) different retroreflector array.
(← Array info should be stored on the ILRS website.)
- have a huge impact to ILRS tracking resources.
- require a different style of ILRS support.

Solutions:

To be discussed with ILRS GB+CB.

Request a subset/update of the MSRF? Too much for MWG?

(4) MSR Form



- **Revision plan being prepared.**

Easy to fill in & easy to read.

Eliminate ambiguous questions.

↵

Array type:↵

Spherical Hemispherical Planar else (specify: _____)

↵

Attach a diagram or photograph of the satellite that shows the position of the LRA, at the end of the document.↵

Attached ↵

↵

Attach a diagram or photograph of the whole LRA at the end of this document.↵

Attached Same as above, Not attached (acceptable only for an SLR-only satellite) ↵

↵

Array manufacturer:↵

- **To-Dos**

(Soon) Distribute our revision draft to the MWG members.

Get an approval from the MWG & GB.

New version placed on the ILRS web.

Data Formats & Procedures Working Group

GB Meeting Matera 2015

Dual pass for data submission

- Present procedures work fine
- quality checks are nearly identical at both operation centers
- Dual pass seems critical, no progress in the last months
 - Contact to stations is still not easy (no response on emails)
 - Closer cooperation between operations centers needed
- Suggestion: leave it as it is (skip dual submission)

Leap Second 2015

- At least 4 reminders went out from the ILRS to prediction providers, stations, and analysts for the June 30 leap second
- CPF leap second procedures were followed by 7 of the prediction providers (Good!)
- 2 providers stopped prediction files just before leap second and started new files after leap second (OK)
- The rest (8 providers) ignored the CPF leap second procedures (Not good)
- One provider had serious times biases from a few days before to a few days after leap second. Being investigated.

Leap Second 2015 - II

- Stations used backup providers and applied time biases as needed
- Two large tracking networks reported that they had no problems
- No problems reported by analysts (unlike 2012)
- Weather and crew off-time limited some stations
- For whatever reason, data output was down significantly from July 1-3

Leap Second 2015 Conclusions

- Prediction providers **MUST PAY ATTENTION** to the leap second procedures. They must:
 - Follow the CPF leap second procedures and test the results
- Stations **ARE ALSO RESPONSIBLE**. They must:
 - Follow the CPF leap second procedures, test the results, and
 - Be able to apply appropriate time biases for providers whose predictions do not include the flag (The ILRS may help in the future by sending a list of those providers a day or two before the leap second.)
- Maybe next time, everything will come together :-)

Technical Laser Ranging Workshop Matera 2015

NEWG - Meeting Network & Engineering Working Group

Matt Wilkinson / Georg Kirchner

Matt / Head of NEWG / is unable to attend; any news about baby ???

- Laser Beam Divergence measurements
 - NERC has published the procedure/ it is on ILRS web site
 - NERC: Measurements completed; Graz: Only previous measurements;
 - No other SLR station has done it (yet);
 - Intention: At least a few main stations should do it ...

- Site Log: NERC will show responses to the update questions

- Safety: Many stations are using ADS-B data now; Wettzell contribution

- Range Biases: Special session scheduled

TWG Report

The terms of reference were adjusted to reflect the current state of the art of technology following a discussion and vote in Annapolis. In general we observe a reduction in activities, such as the Earth - Mars 1-way transponder experiment, the messenger flyby 2-way transponder experiment or the asynchronous ground to ground transponder experiment using a satellite as a passive reflector. We observe that numerous new satellites and a reduction of resources make new projects difficult for stations. NASA efforts appear to have reduced too. For example the planned time transfer between Wettzell and Greenbelt via LRO simply did not happen. ESA is not actively talking to us either in general areas of overlap between various potentially suitable missions and ILRS. This may have to do with the fact that the visibility of the tracking network of the ILRS is low AND probably because of suspected competition between different Engineering groups within the respective communities. Currently there are only two general technical activities under way in the transponder working group, which are Time Transfer using satellites and Time Transfer by reflecting off from items of Space Debris.

On the station level there is right now little room left for such activities either, due to the lack of staff, increasing observation load and station resource assignment (are we required to do this?). Laser "in sky safety issues" (felt or real) adds to the problems. What is the status of the current activities?

Preparations for the European Laser Time Transfer (ELT) are rather slow, because of pending decisions on laser safety requirements within the safety teams at NASA and ESA. A document with required laser safety features was updated and circulated among the laser safety boards. Talk is under way for Mob7, Mob5, NRL, NERC, Graz, Wettzell and Borowiec to get

prepared for the mission. An application for the Missions WG requesting tracking support is awaiting submission awaiting clearance from ESA and NASA.

Space Debris is an emerging research area. ILRS is a natural partner because of the existing station network and experience. While the general subject of space debris tracking is covered in a dedicated study group, a small subsection of this activity concerns the transponder WG, which is the time transfer by asynchronous laser observations of debris items between Graz and Wettzell. An experiment aims at independent simultaneous ranging of space Debris in Graz and Wettzell, while simultaneously also detecting laser shots from Graz in Wettzell and vice versa. Results to be reported when they are available.

Technical Laser Ranging Workshop Matera 2015

SDSG - Space Debris Study Group

Georg Kirchner

What has been done ...

- TLE to CPF conversion program / contributed by Daniel Kucharski
 - Distributed to all interested SLR stations
 - Used by several stations; some others developed their own
 - Some SLR stations track old ILRS targets / experimentally

- Debris ftp server for CPFs and data has been installed at IWF Graz
 - CPFs for selected targets (Glonass-41/44/62/64, Topex; Envisat)
 - Stores FR / NP data of these satellites
 - Used for improved CPFs, spin determination etc.

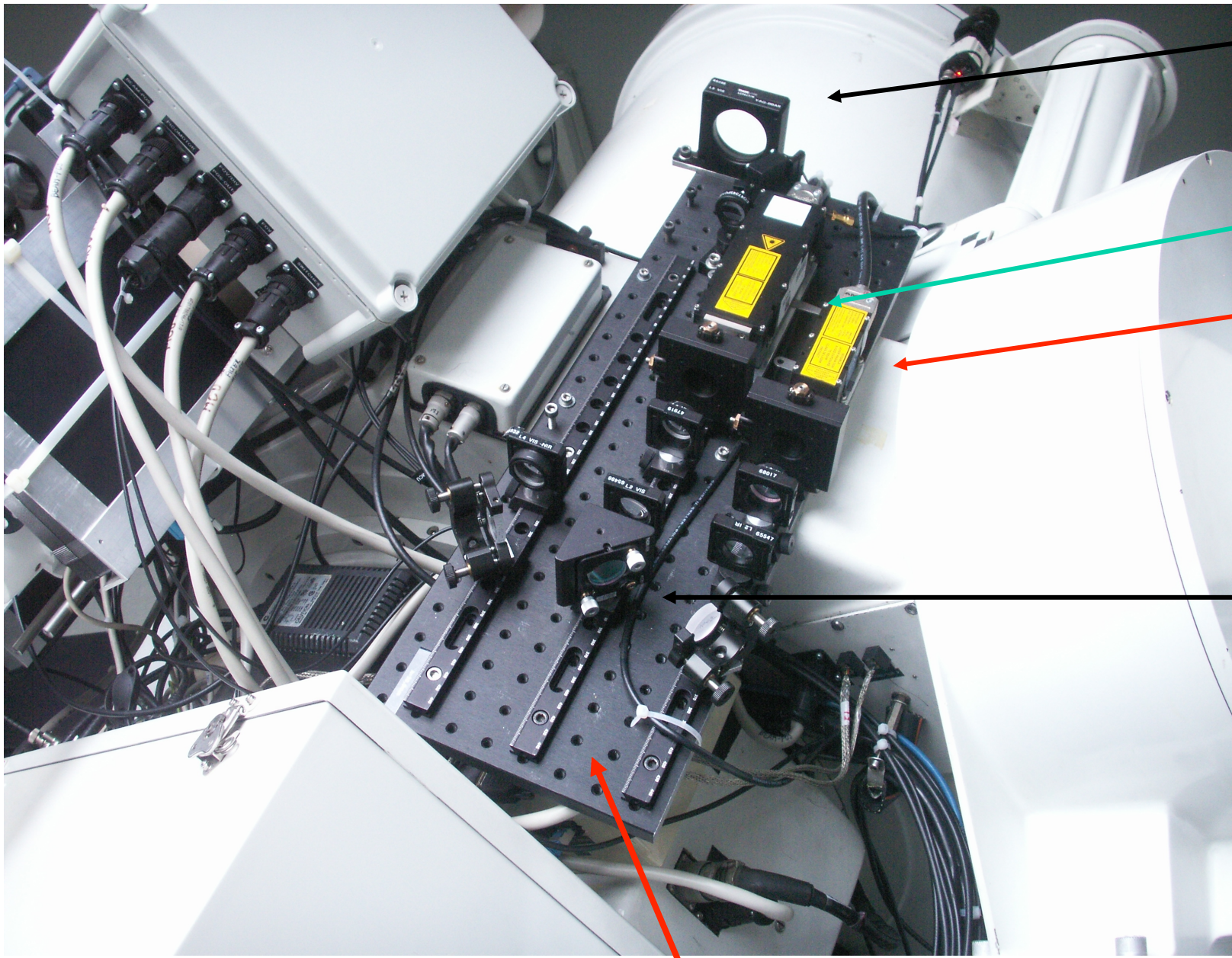
- A small Topex campaign has been started, several stations participate
 - Goal: e.g. 1 (full) pass day, or at least 1 or 2 passes / week
 - Will allow full spin parameter determination

What has been done ...

- Several stations are ranging to/preparing for Debris Laser Ranging
 - Changchun is actively ranging to space debris;
 - Graz, Shanghai, ??? are ready to do... (experiments scheduled)
 - Wettzell has installed a 350 mJ@1064 nm / 20 Hz / 3 ns laser: Ready
 - Borowiec, Metsahövi, San Fernando, Grasse, ??? are planning ...
- Graz - Wettzell: Bi-static SLR in both directions & both wavelengths scheduled
- Attitude motion determination programs
 - Graz determines spin periods of > 40 defunct Glonass satellites
 - Graz determines spin parameters of ENVISAT, TOPEX, Compass-G2 and > 10 others
 - Other SLR stations now are joining for TOPEX (we need e.g. Southern stations)
 - Graz has developed Single-Photon Counters for Light Curves / Spin Determination

What has been done ...

- Single-Photon DART (Detection, Alignment & Reference Tool): Tests started:
 - Graz developed a small 10 kg transmitter (2 kHz / < 1 ns / 15 μ J / 532/1064 nm)
 - Attached to any satellite tracking telescope with SP receiver: Reference
 - Useful for several applications:
 - Graz data as reference (e.g. 3% return quote with 15 μ J / Galileo)
 - Allows comparison with other SLR stations (receive channel check)
 - Alignment / Setup tests on astronomy telescope: Bi-static DLR
 - Adding a 15 μ J / ps / kHz laser head: Pico-DART => Small SLR station for ranging up to GNSS targets



Output Lens

2 μ Laser:

532 nm

1064 nm

Dichroic

SP DART mounted on GRAZ telescope



Data QC Issues

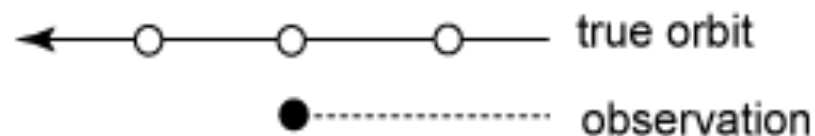
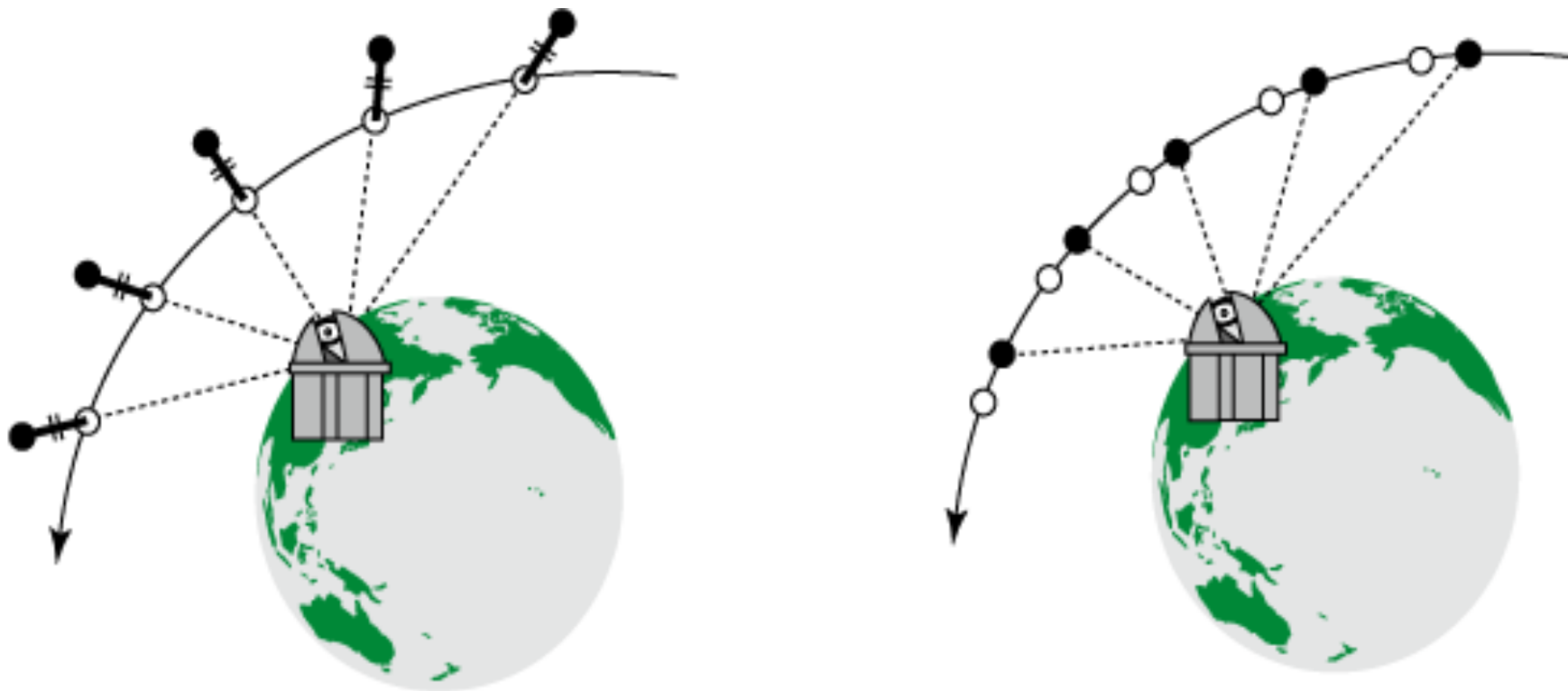
@ ILRS GB Meeting

25 Oct 2015

Toshimichi Otsubo

Hitotsubashi University

Pass-by-pass Range Bias and Time Bias



7838 = SIMOSATO

# sat	site	date	time	dur	rb	mm	err	tb	us	err	prec	bad	total
LAG2	7838	2015/10/02	13:25	49	-6	(5)	11.1	(2.9)	3	0	/	20	
AJI1	7838	2015/10/02	14:31	10	-30	(10)	7.5	(4.0)	4	0	/	22	
LARS	7838	2015/10/05	00:25	4	-3	(12)	11.0	(5.3)	3	0	/	11	
AJI1	7838	2015/10/06	12:54	7	19	(12)	-10.5	(6.1)	5	0	/	15	

⋮
⋮

Quick QC

Quick feedback to the stations

Range bias and time bias per pass derived from post-fit residuals.

12 incidents reported via RapidServiceMail (operated at DGFI) during the last 1 year. 9 from HITU & 3 from DGFI.

1 false alarm sent from HITU to Wettzell: time bias mapped by Zimmerwald's.

Soon to use ITRF2014. Discontinuity expected.

Visualization & Combination/Comparison

NERC, JCET, ASI: Web Tools

AIUB: Combined RB Report (← DGFI, MCC, HITU, SAO, JCET)

ILRS CB: Global Performance Card



http://geo.science.hit-u.ac.jp/slr/bias

geo.science.hit-u.ac.jp



JAS2	7845	2015/10/07	21:16	18	-27	(5)	7.9	(1.1)	4	0 / 69	12	872.0	285.6				
JAS2	7845	2015/10/09	05:38	5	-48	(13)	5.0	(5.8)	9	0 / 18	9	874.0	282.1				
#																	
#	7941 = MATERA																
#	sat	site	date	time	dur	rb	mm	error	tb	us	error	prec	bad	total	rms	pres	temp
LAG1	7941	2015/10/03	08:51	0	-8	(0)	-----	.-	(-----	.-)	0	0 / 2	4	966.6	293.2		
GA01	7941	2015/10/03	09:03	111	4	(2)	24.8	(28.7)	1	0 / 11	5	966.5	293.9				
STRL	7941	2015/10/03	10:16	7	-6	(6)	8.0	(1.2)	2	0 / 12	2	966.4	294.3				
ETA1	7941	2015/10/03	12:12	18	-16	(11)	-----	.-	(-----	.-)	4	0 / 5	10	965.5	295.1		
LAG2	7941	2015/10/03	15:07	19	9	(9)	-5.7	(4.9)	1	0 / 11	5	965.2	293.4				
LAG1	7941	2015/10/03	15:29	8	7	(2)	-9.3	(1.1)	0	0 / 4	4	965.2	293.3				
STRL	7941	2015/10/04	08:47	5	-14	(4)	-0.5	(1.3)	2	0 / 13	2	966.4	294.3				
LAG1	7941	2015/10/04	10:27	19	-7	(3)	3.3	(3.1)	2	0 / 8	4	966.2	295.4				
STRL	7941	2015/10/04	10:37	0	-26	(1)	-----	.-	(-----	.-)	0	0 / 2	3	966.2	295.6		
STEL	7941	2015/10/04	11:57	0	3	(6)	-----	.-	(-----	.-)	3	0 / 3	3	965.3	296.8		
LAG1	7941	2015/10/04	14:10	0	-----	(-----	-----	.-	(-----	.-)	-----	0 / 1	5	964.5	296.2		
GA01	7941	2015/10/04	16:03	4	2	(4)	-----	.-	(-----	.-)	1	0 / 2	4	964.2	294.3		
LAG2	7941	2015/10/04	16:47	51	7	(2)	2.3	(1.2)	1	0 / 12	4	964.4	292.9				
LARS	7941	2015/10/04	17:11	11	3	(2)	-0.0	(0.5)	5	0 / 19	3	964.5	291.8				
SARL	7941	2015/10/04	17:29	5	-17	(6)	3.7	(1.0)	1	0 / 12	2	964.4	291.6				
LAG1	7941	2015/10/04	17:43	9	-19	(25)	14.3	(12.7)	1	0 / 6	4	964.4	291.2				
GL18	7941	2015/10/04	18:17	67	7	(4)	-32.9	(18.8)	1	0 / 10	8	964.5	292.3				
AJI1	7941	2015/10/04	18:22	10	1	(1)	-8.1	(0.5)	1	0 / 23	8	964.4	292.1				
JAS2	7941	2015/10/04	20:15	4	-1	(3)	8.5	(1.8)	1	0 / 21	2	964.6	291.3				
AJI1	7941	2015/10/04	20:24	10	-1	(5)	-0.3	(1.5)	3	0 / 21	8	964.5	291.5				
LAG2	7941	2015/10/04	21:01	19	16	(5)	5.0	(3.5)	1	0 / 10	5	964.5	290.7				
AJI1	7941	2015/10/04	22:26	11	18	(5)	6.9	(1.6)	3	0 / 24	8	963.8	290.9				
ETA1	7941	2015/10/04	23:53	2	-29	(16)	-----	.-	(-----	.-)	2	0 / 2	13	963.2	290.5		
LAG2	7941	2015/10/05	15:01	28	7	(2)	-2.8	(1.6)	2	0 / 11	4	959.6	294.6				
LAG2	7941	2015/10/05	19:09	41	5	(1)	1.1	(0.8)	0	0 / 21	4	959.7	291.2				
JAS2	7941	2015/10/05	20:41	3	13	(13)	0.7	(3.3)	1	0 / 14	2	959.5	291.6				
ETA1	7941	2015/10/05	21:24	2	-31	(12)	-----	.-	(-----	.-)	2	0 / 2	10	959.5	291.5		
LAG2	7941	2015/10/05	23:07	10	42	(24)	17.1	(12.1)	1	0 / 6	5	959.0	291.0				
AJI1	7941	2015/10/06	01:47	0	37	(6)	-----	.-	(-----	.-)	1	0 / 2	8	957.5	290.4		

JAS2 7810 2015/07/04 00:37 11 -4 (3) 0.1 (0.9) 2 0 / 23 7 921.6 297.5 54 17979

STEL

AJI1

JAS2

STEL

LARS STRL 8834 2015/07/03 10:58 6 -14 (14) -1.6 (4.4) 4 0 / 10 13 955.5 302.8 40 1

LAG2 LARS 8834 2015/07/03 11:12 3 -3 (11) -1.4 (7.8) 3 0 / 8 11 955.5 302.8 40 1

AJI1 STEL 8834 2015/07/03 11:23 5 3 (8) -0.9 (2.3) 3 0 / 13 12 955.4 302.6 40 1

LARS STRL 8834 2015/07/03 12:52 2 -18 (8) ----- (----) 2 0 / 6 10 955.0 303.1 41 1

LAG2 STEL 8834 2015/07/03 13:06 1 14 (20) ----- (----) 4 0 / 4 13 954.9 304.2 40 1

LAG1 STRL 8834 2015/07/03 14:41 3 50 (31) -13.1 (6.5) 2 0 / 7 11 954.3 305.3 38 1

LARS STRL 8834 2015/07/03 16:29 2 6 (16) ----- (----) 4 0 / 6 13 953.7 304.5 39 1

STRL JAS2 8834 2015/07/03 16:56 2 390 (12) ----- (----) 3 0 / 7 11 953.7 303.8 41 1

LAG1 JAS2 8834 2015/07/03 18:50 3 -40 (29) 111.9 (9.5) 4 0 / 8 11 954.5 301.3 45 1

STEL GAO2 8834 2015/07/03 19:24 17 -60 (3) ----- (----) 1 0 / 5 23 954.7 300.5 46 1

STRL GAO4 8834 2015/07/03 19:48 33 23 (7) ----- (----) 2 0 / 8 17 954.8 300.1 47 1

STRL AJI1 8834 2015/07/03 20:26 4 14 (11) 72.2 (6.6) 3 0 / 9 26 954.7 299.7 47 1

LAG1 GAO3 8834 2015/07/03 22:03 18 33 (2) ----- (----) 0 0 / 5 16 954.5 298.8 49 1

STRL AJI1 8834 2015/07/03 22:26 9 -24 (12) 84.2 (3.5) 5 0 / 18 36 954.6 298.6 51 1

JAS2 JAS2 8834 2015/07/03 22:49 1 304 (6) ----- (----) 1 0 / 4 10 954.6 297.9 53 1

GL29 LARS 8834 2015/07/04 00:12 0 49 (16) ----- (----) 5 0 / 3 7 954.5 297.1 57 1

AJI1 AJI1 8834 2015/07/04 00:28 6 -9 (13) 92.2 (4.7) 4 0 / 12 31 954.4 297.8 55 1

JAS2 STEL 8834 2015/07/04 01:13 5 -30 (12) 106.9 (2.8) 4 0 / 11 10 954.0 296.7 63 1

AJI1 LARS 8834 2015/07/04 02:05 1 -58 (12) ----- (----) 3 0 / 5 12 953.7 296.1 65 1

LAG2 AJI1 8834 2015/07/04 02:29 7 41 (8) 89.3 (2.5) 2 0 / 11 32 953.5 295.9 65 1

JAS2 JAS2 8834 2015/07/04 02:41 1 199 (1) ----- (----) 0 0 / 4 11 953.6 295.9 65 1

LAG1 STEL 8834 2015/07/04 02:55 1 181 (61) ----- (----) 87 0 / 3 13 953.6 295.5 66 1

AJI1 AJI1 8834 2015/07/04 04:32 5 46 (18) 74.5 (11.3) 7 0 / 13 35 953.5 296.4 66 1

LAG2 8834 2015/07/04 04:43 21 -15 (8) 66.4 (7.6) 2 0 / 8 17 953.4 296.6 66 1

sat LARS 8834 2015/07/04 08:07 7 -3 (8) 12.6 (3.8) 3 0 / 12 11 953.4 302.4 46 1

AJI1 LAG2 8834 2015/07/04 08:41 29 11 (6) 66.8 (4.3) 2 0 / 11 15 953.2 302.7 44 1

JAS2 LARS 8834 2015/07/04 10:07 7 17 (8) 7.1 (2.6) 3 0 / 16 11 953.0 304.4 40 1

JAS2 STRL 8834 2015/07/04 11:17 7 -13 (9) 22.0 (2.3) 3 0 / 13 12 952.7 305.6 36 1

JAS2 STEL 8834 2015/07/04 12:40 1 244 (20) ----- (----) 5 0 / 5 12 952.2 304.3 39 1

STRL 8834 2015/07/04 13:11 2 163 (23) ----- (----) 8 0 / 6 10 952.1 304.5 40 1

sat STRL 8834 2015/07/04 16:49 2 120 (23) ----- (----) 6 0 / 6 11 951.0 304.5 39 1

AJI1 JAS2 8834 2015/07/04 17:12 6 -41 (8) 31.5 (2.3) 3 0 / 13 10 951.1 304.4 39 1

AJI1 JAS2 8834 2015/07/04 19:14 2 76 (15) ----- (----) 3 0 / 5 13 951.1 302.1 43 1

AJI1 AJI1 8834 2015/07/04 19:37 0 -155 (69) ----- (----) 17 0 / 3 38 951.3 301.3 45 1

LAG1 8834 2015/07/04 19:43 4 5 (3) ----- (----) 1 0 / 4 12 951.3 301.3 45 1

GL29 8834 2015/07/04 20:58 22 -6 (3) ----- (----) 1 0 / 6 25 951.1 299.2 54 1

AJI1 8834 2015/07/04 21:22 8 22 (11) 85.2 (8.8) 4 0 / 13 24 951.1 298.5 53 1

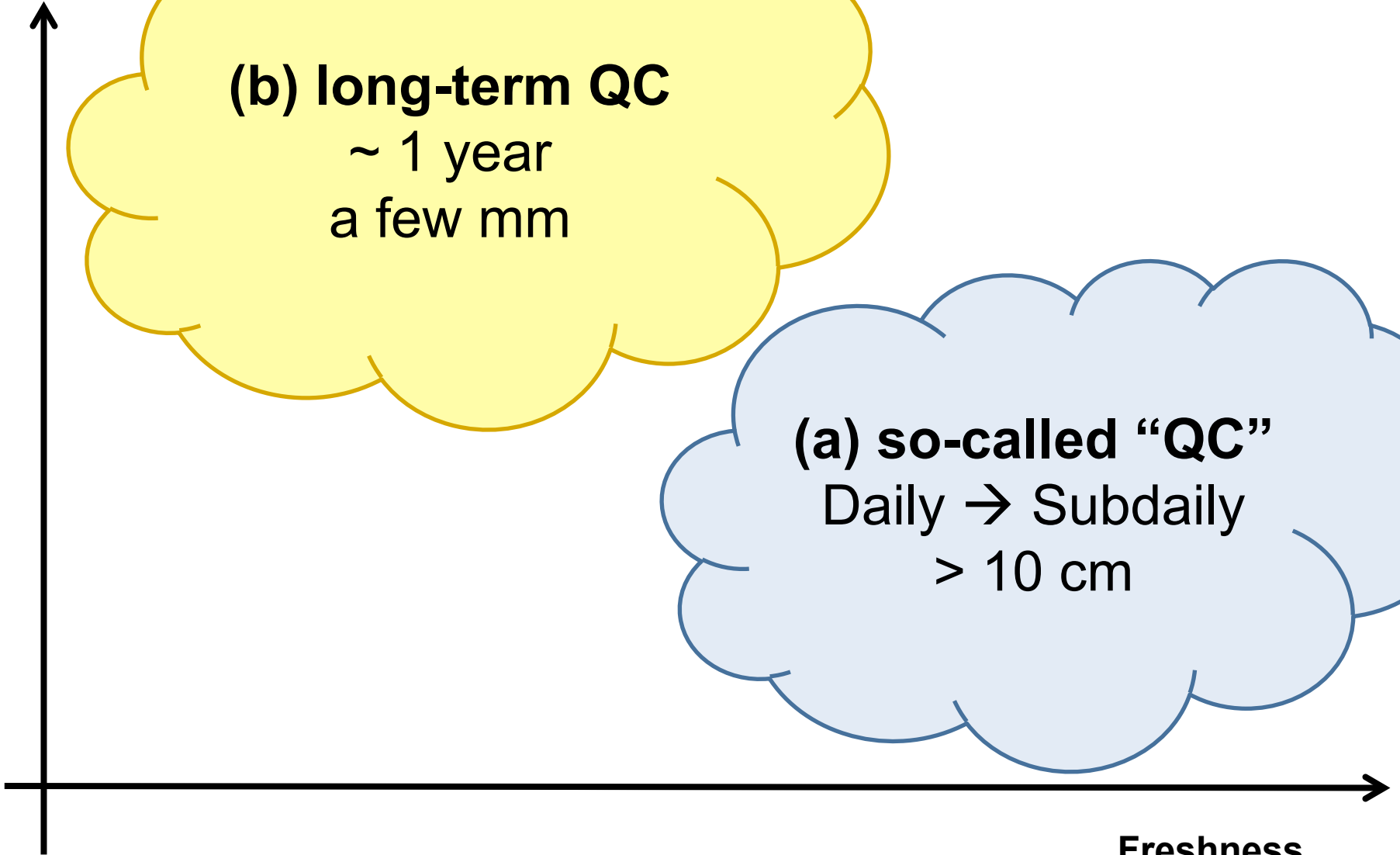
Quick QC and “Slow” QC

Quality
/ Sensitivity

(b) long-term QC
~ 1 year
a few mm

(a) so-called “QC”
Daily → Subdaily
> 10 cm

Freshness



“Slow” QC (@ HIT-U): Key parameters

Test #1:
Single-shot returns per NP bin

Test #2:
Single-shot RMS in a NP bin

Test #3:
System delay (calibration)

Test #4:
Time to the nearest
calibration

Test #5:
Range rate

Test #6:
Month

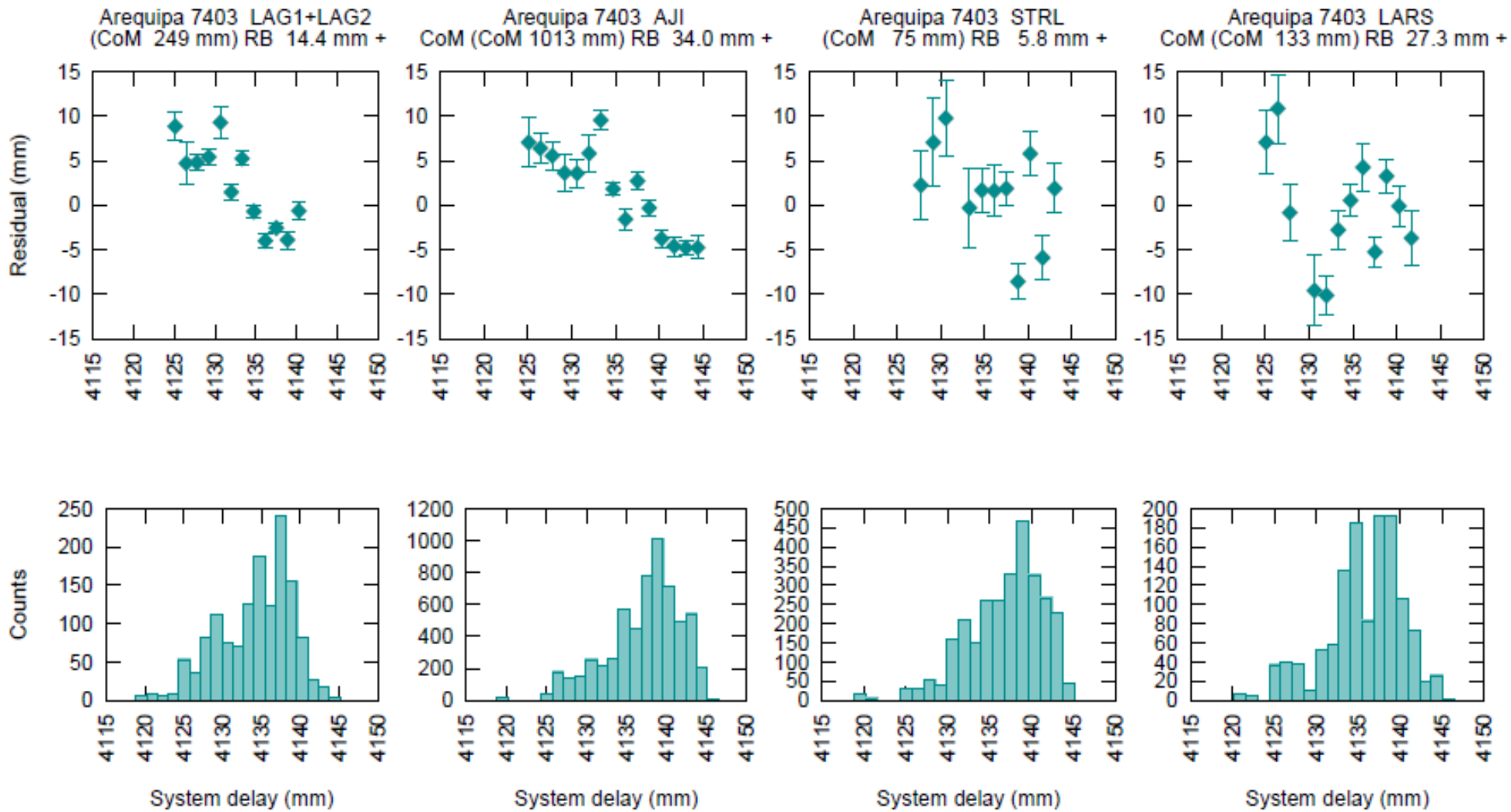
NEW!!

Test #7:
Day of week

NEW!!

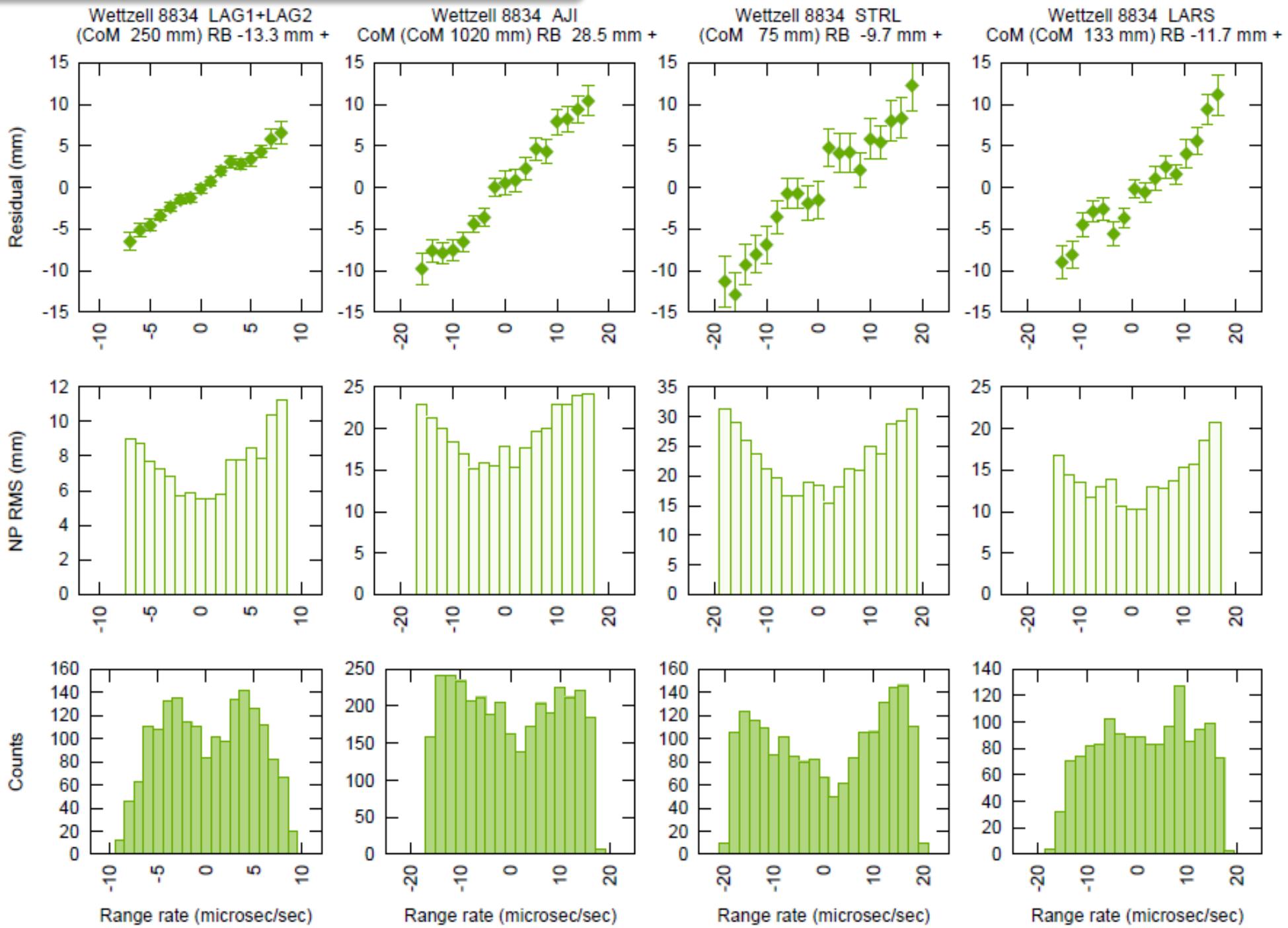
Test #8:
Local time

#3: System delay



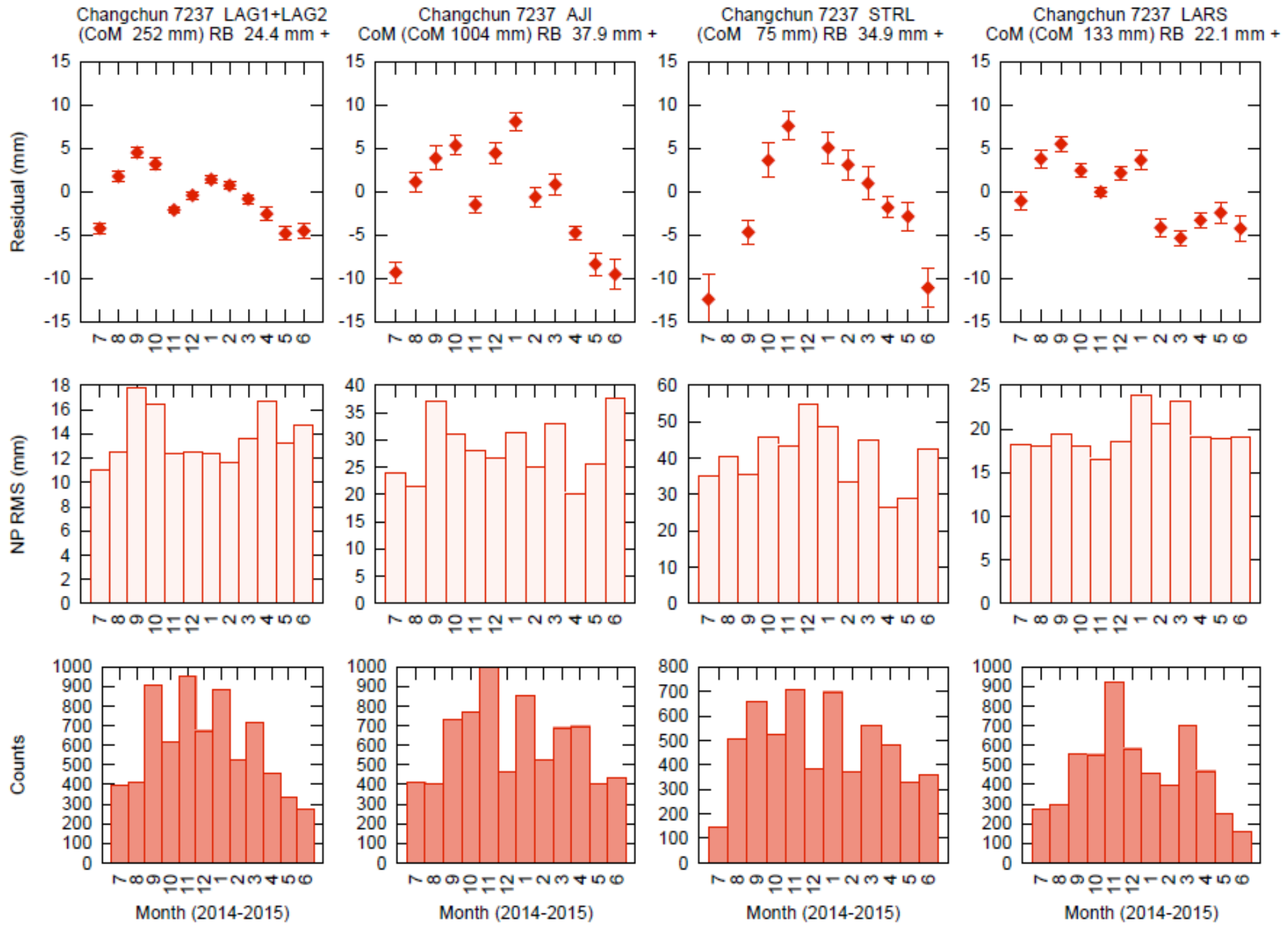
Negative 1:1 trend → Calibration variation unreal?

#5: Range rate



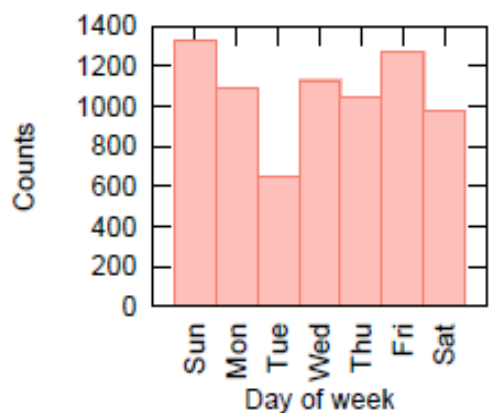
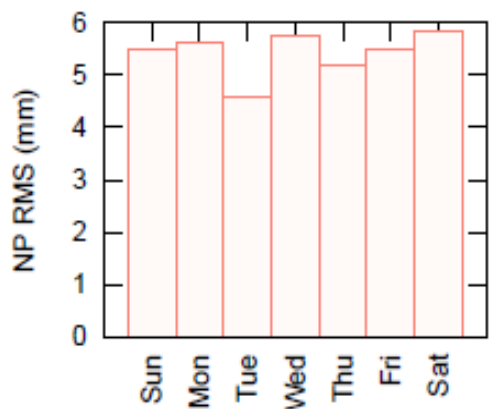
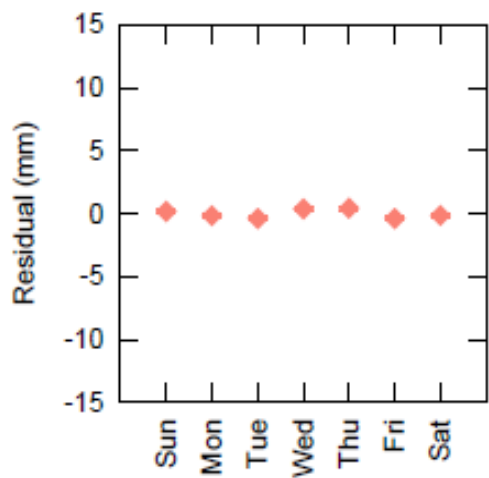
→ Time bias suspected.

#6: Month

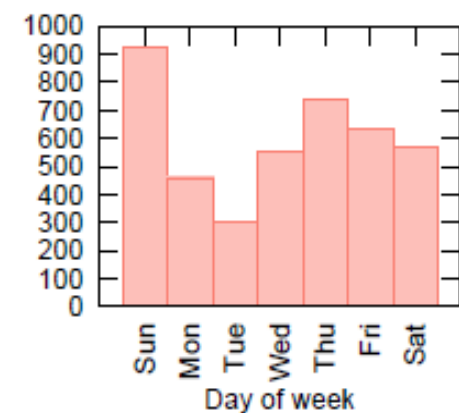
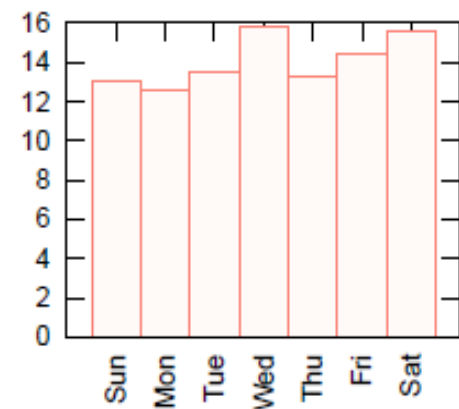
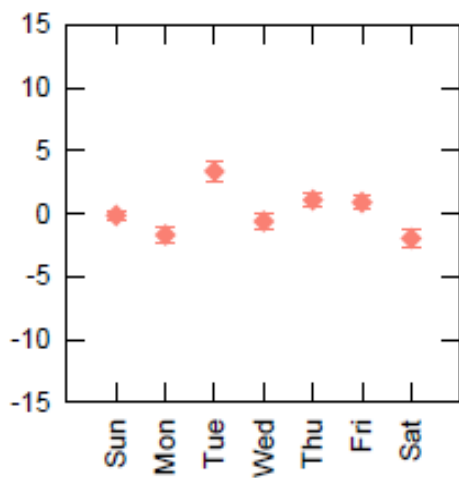


#7: Day of week

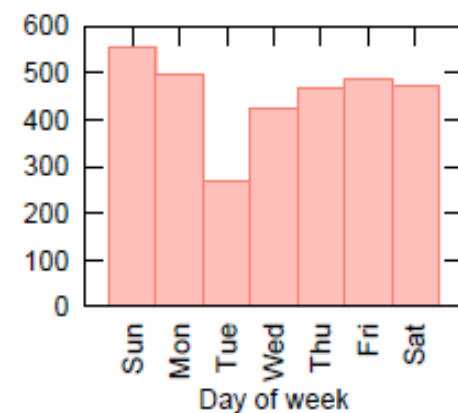
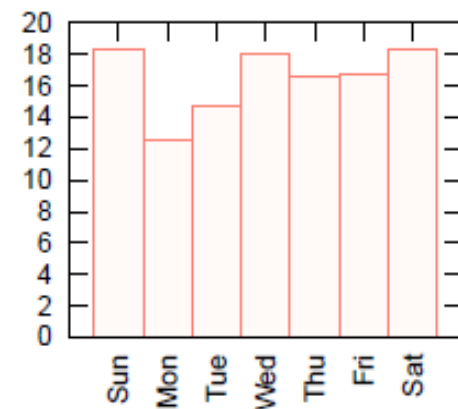
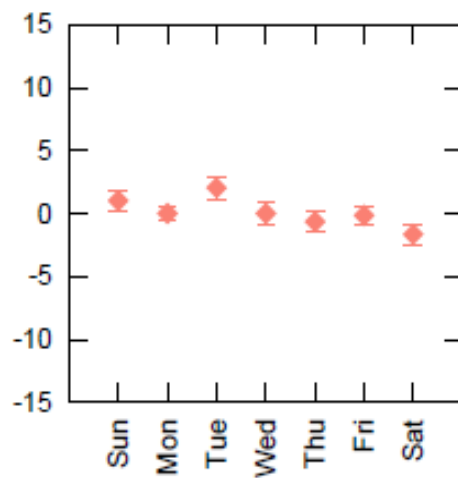
Zimmerwald 7810 LAG1+LAG2
(CoM 249 mm) RB 6.8 mm +



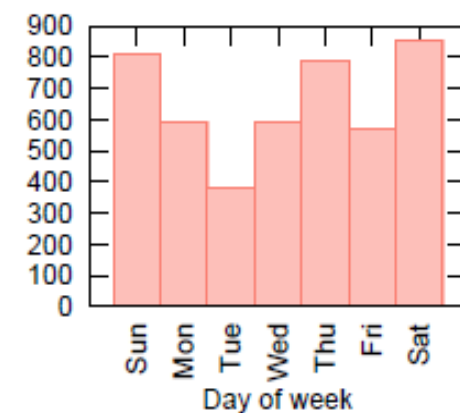
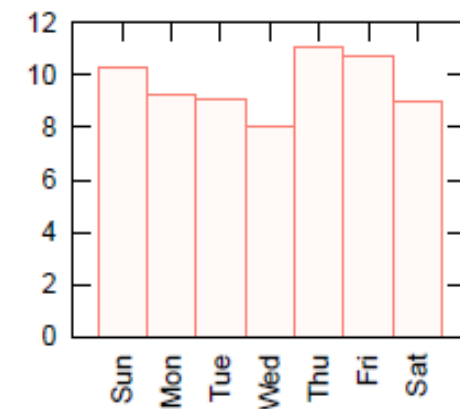
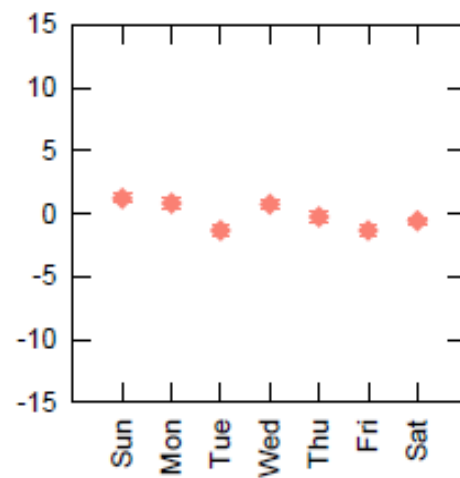
Zimmerwald 7810 AJI
CoM (CoM 999 mm) RB 29.4 mm +



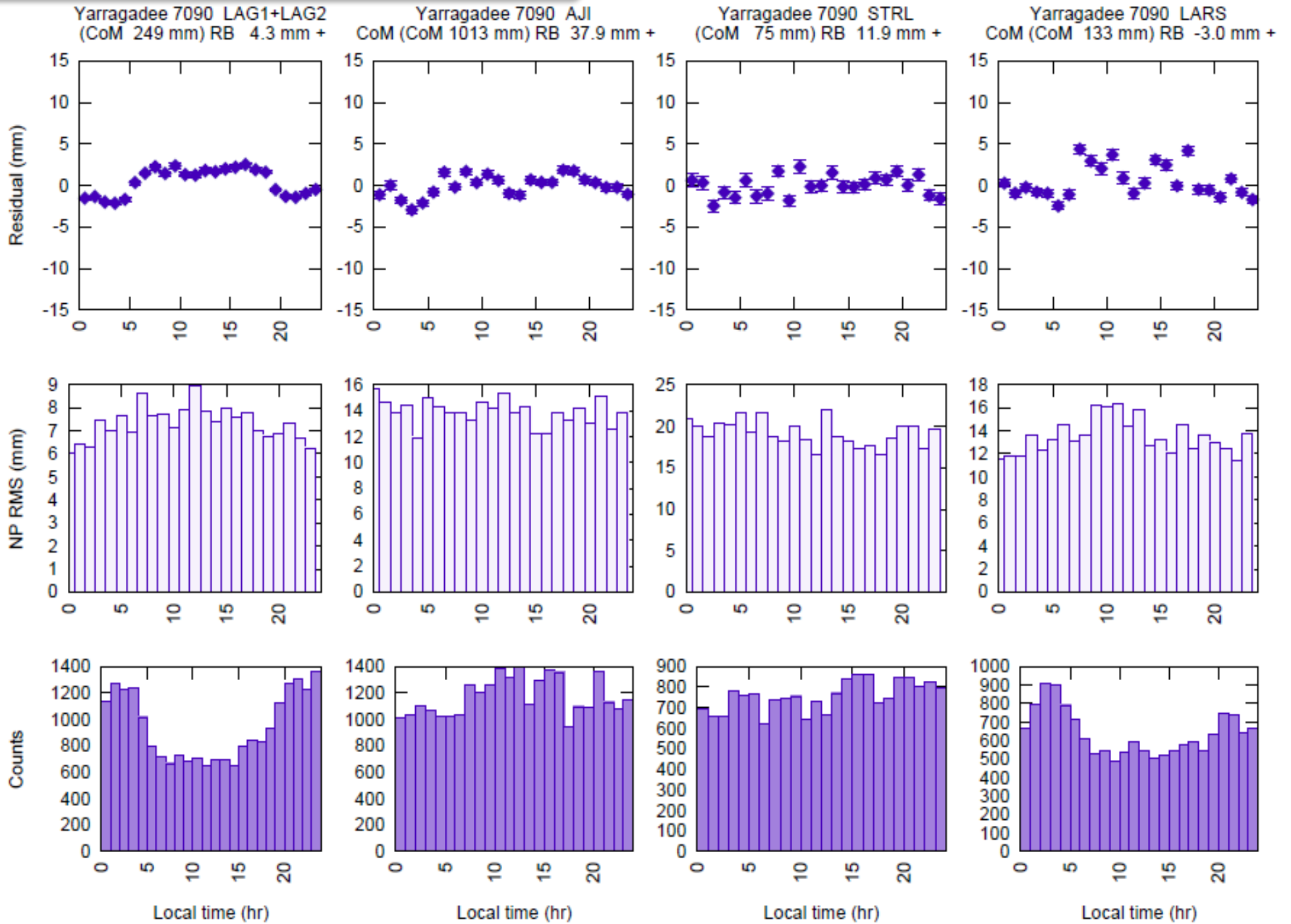
Zimmerwald 7810 STRL
(CoM 75 mm) RB 15.0 mm +



Zimmerwald 7810 LARS
CoM (CoM 133 mm) RB 14.3 mm +



#8: Local time



→ Day/night bias?

More at the Thursday session



ILRS Terms of Reference and Next GB Election

Mike Pearlman

Carey Noll

NASA GSFC

ILRS Governing Board Meeting

2015 ILRS Technical Workshop

October 25, 2015



Terms of Reference

- 1.0 INTRODUCTION
 - 1.1 Charter and Affiliations
 - 1.2 Services
 - 1.3 Amendments to the ILRS Terms of Reference
- 2.0 PERMANENT COMPONENTS OF THE ILRS
 - 2.1 Tracking Stations and Subnetworks
 - 2.2 Operations Centers
 - 2.3 Data Centers
 - 2.3.1 Regional Data Centers
 - 2.3.2 Global Data Centers
 - 2.4 Analysis Centers
 - 2.4.1 Analysis Centers
 - 2.4.2 Associate Analysis Centers
 - 2.4.3 Lunar Analysis Centers
 - 2.5 Central Bureau
- 3.0 GOVERNING BOARD
 - 3.1 Roles and Responsibilities
 - 3.2 Membership
 - 3.3 Nomination and Election of Members
 - 3.4 Election and Role of Chairperson
 - 3.5 Frequency of Governing Board Meetings and ILRS General Assemblies
 - 3.6 Rights and Privileges of GB Members
 - 3.7 Analysis and Lunar Coordinators
 - 3.8 Working Groups
- 4.0 DEFINITIONS
 - 4.1 ILRS Associate Members
 - 4.2 ILRS Correspondents



Updating the ToR

- It is time to review and update the ILRS Terms of Reference
- Several areas need review (election process, meetings of the GB and general assembly)
- Add reference to Transponders Working Group
- Need to add involvement in GGOS, e.g.:
 - ILRS will operate in concert with GGOS
 - ILRS will be a member of the GGOS-affiliated network
- Proposed process:
 - Subcommittee of the ILRS GB will create a draft revision
 - Circulate revision to GB by end of 11/2015
 - Comments due back from GB by 12/31/2015
- Coordinate changes with IAG following review and adoption within ILRS GB



Next ILRS Governing Board Election

- According to the Terms of Reference, the GB election takes place in conjunction with the International Workshop on Laser Ranging
- We are now out of sync with this schedule (19th workshop held last year, 20th workshop to be held in 2016)
- Propose hold election prior to end of 2015:
 - Ask for appointed members (2 EuroLAS, 2 NASA, 2 WPLTN, 1 IERS) by 11/15/2015
 - Solicit nominations for elected members (2 analysis, 1 data center, 1 lunar) by 11/30/2015
 - Hold elections for these members by 12/15/2015
 - Solicit nominations for at-large members (2) by 12/31/2015
 - Hold elections for at large members by 01/15/2016
 - Board in place by 01/15/2016 for 2016-2017 time frame



Kartverket

Status in the ongoing UN-GGIM process forming a roadmap for Geodesy

Chair GIAC



19th ILRS conference - Anapolis, USA

- UN-GGIM committee of experts was preparing a resolution for adoption in the UN ECOSOC for further referral to UN General assembly





UN-General Assembly hall, 26th February 2015



Global survey - conclusion

A joint international governanc effort is needed in order to meet the objectives of the GGRF resolution



From the GGRF Terms of reference

To develop a roadmap for a collaborative *global geodetic observation network and the associated infrastructure, with sustainable funding and investment*, as well as strategic partnerships between mapping, space and other interested agencies

A huge potential for geodesy and the SLR community

Will influence the future

- The choices made by the GGRF WG now will influence the future work of IAG and GGOS - both as organisations and the development of the services/products
- What the roadmap includes will get priority both nationally and internationally

Please contact the WG chairs if you would like to contribute

The chairs:

Gary Johnston, Geosciences Australia

Anne Jørgensen, Norwegian Mapping Authority

Contribution needed now!

Roadmap timeline:

- Final roadmap adopted at the UN-GGIM 6th session in early August 2016
- Roadmap draft be sent out for comments January and April 2015
- WG to combine feedback and produce cohesive document
- Road map deadline in May 2016

The contributing techniques to GGRF



GGRF WG liasons (ToR)

The Working Group will liaise with other international groups that have an interest in the GGRF, including:

- The International Association of Geodesy (IAG) Global Geodetic Observing System (GGOS), and the IAG services (IERS, IGS, *ILRS*, IVS, IDS, BIPM etc.).
- The Office for Outer Space Affairs as the executive secretariat of the International Committee on Global Navigation Satellite Systems (ICG).
- The International Federation of Surveyors (FIG).
- The Group on Earth Observations (GEO) and the Global Earth Observing System of Systems (GEOSS).
- The Committee on Earth Observation Satellites (CEOS).

GIAC - ongoing work

- Supporting the UN-GGIM process
- Conduct a benefit analysis which show the value The Global Geodetic Reference Frame contributes to society

Please contact me if your organization would like to contribute

Questions

- Does ILRS have a plan for how to contribute to the sustainability and development of the GGRF?
- Has ILRS thought about how to utilize the UN-GGIM GGRF roadmap to ensure the necessary future SLR contribution to the GGRF?



Kartverket

Status on the construction of a GGOS core site in Ny-Ålesund

Director Geodetic Institute, Norwegian Mapping Authority



Status

- The fundament is in place
- We are looking into contractual matters with NASA
- Trying to build competence
- Operational from 2019?

















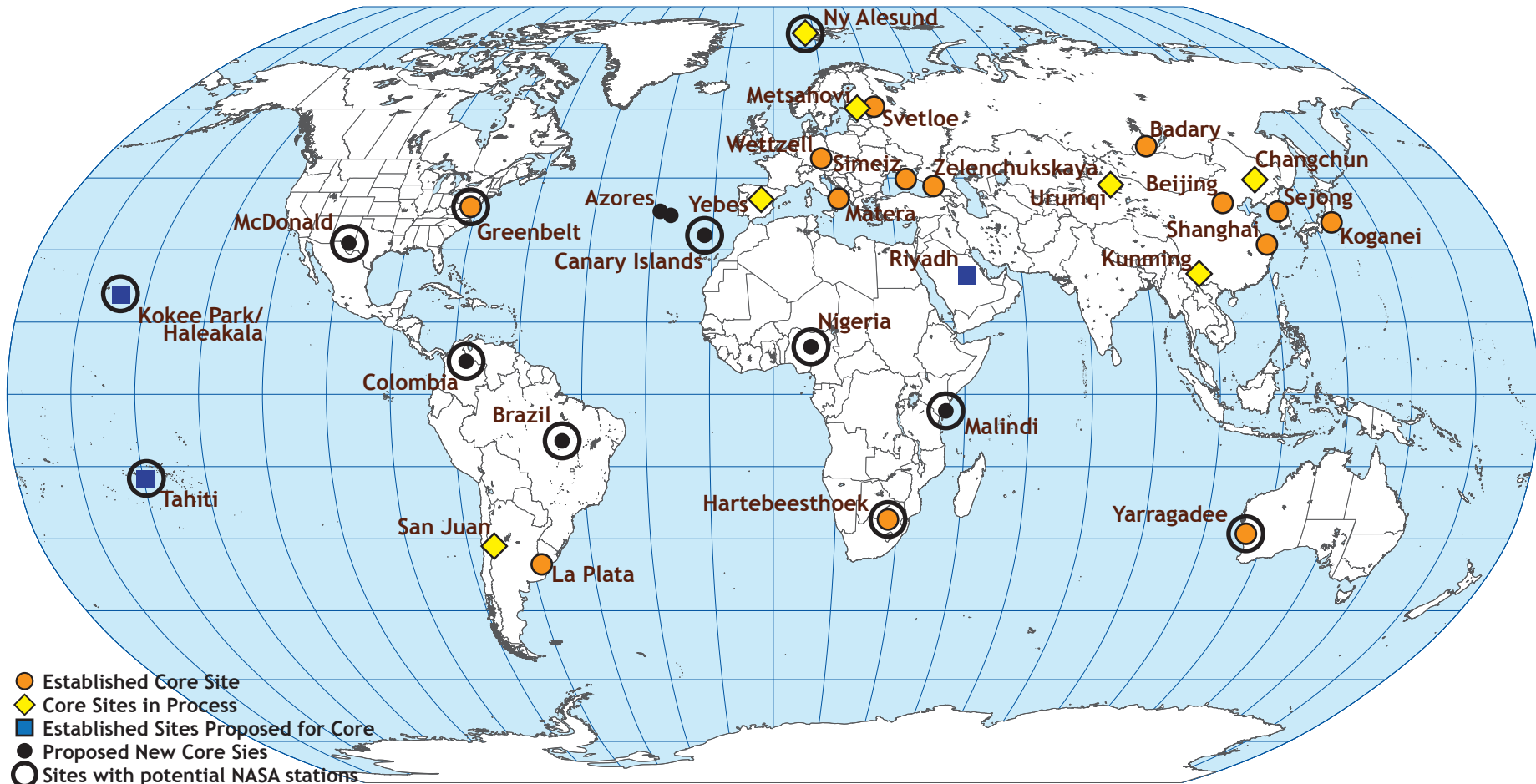
54
5
SP
T4 16/9 T4 16/9
T3 15/9 T3 17/9







To succeed with an improved geodetic reference frame there is a need for fully automated standardized SLR equipment.



- Established Core Site
- ◆ Core Sites in Process
- Established Sites Proposed for Core
- Proposed New Core Sites
- Sites with potential NASA stations



Future Workshops

Mike Pearlman

Carey Noll

NASA GSFC

ILRS Governing Board Meeting

2015 ILRS Technical Workshop

October 25, 2015



Next International Workshops on Laser Ranging

- 20th International Workshop on Laser Ranging to be held at GFZ, Potsdam Germany, October 9-14, 2016
- Need candidates to host 21st workshop
 - One informal proposal submitted from consortium of organizations in Australia (B. Greene)
 - SLRmail sent to solicit interested parties
 - Will issue a follow-up email shortly to request proposals by 11/30/2015
- Need location and theme for 2017 ILRS Technical Workshop