ILRS Governing Board Meeting

18th International Workshop on Laser Ranging
Fujiyoshida, Japan

November 14, 2013
18:00-21:00

ILRS Governing Board Agenda

Sakura Room
November 14, 2013
18:00 – 21:00

1.	Opening Remarks	G. Appleby
2.	Status of the ILRS (15)	G. Appleby
3.	Working Group Reports (10each)	
	– Analysis	E. Pavlis/C. Luceri
	– Missions	G. Appleby/S. Wetzel
	– Data Formats and Procedures	H. Mueller/R. Ricklefs
	– Networks and Engineering	G. Kirchner/M. Wilkinson
	– Transponder	U. Schreiber/J. Degnan/J. McGarry
4.	EUROLAS Report (10)	P. Bianco/G. Kirchner
5.	Satellite Center Of Mass Task Force (2)	G. Appleby
6.	Update on GPS Retroreflector Arrays (5)	L. Thomas
7.	Laser Safety Issues (10 min)	D. McCormick
8.	GGOS Activities/Role of the ILRS (10 min)	M. Pearlman
9.	Election of GB Chair and WG Chairs	M. Pearlman
10.	Future Workshop Proposals (15 min)	M. Pearlman
11.	Other Business and Discussion	M. Pearlman

ILRS Governing Board 2013-2015

Director of the Central Bureau	Mike Pearlman (appointed)
Secretary of the Central Bureau	Carey Noll (appointed)
President of IAG Commission 1	Tonie Van Dam (appointed)
IERS Representative	Bob Schutz (appointed)
EUROLAS Network Representatives	Giuseppe Bianco, Georg Kirchner
NASA Network Representatives	David McCormick, Jan McGarry
WPLTN Network Representatives	Wu Bin, Toshi Otsubo
Data Center Representative	Horst Mueller
LLR Representatives	Juergen Mueller
Analysis Representatives	Cinzia Luceri, Erricos Pavlis
At-Large Representatives	Ulli Schreiber, Matt Wilkinson

Most Recent Chair — Graham Appleby

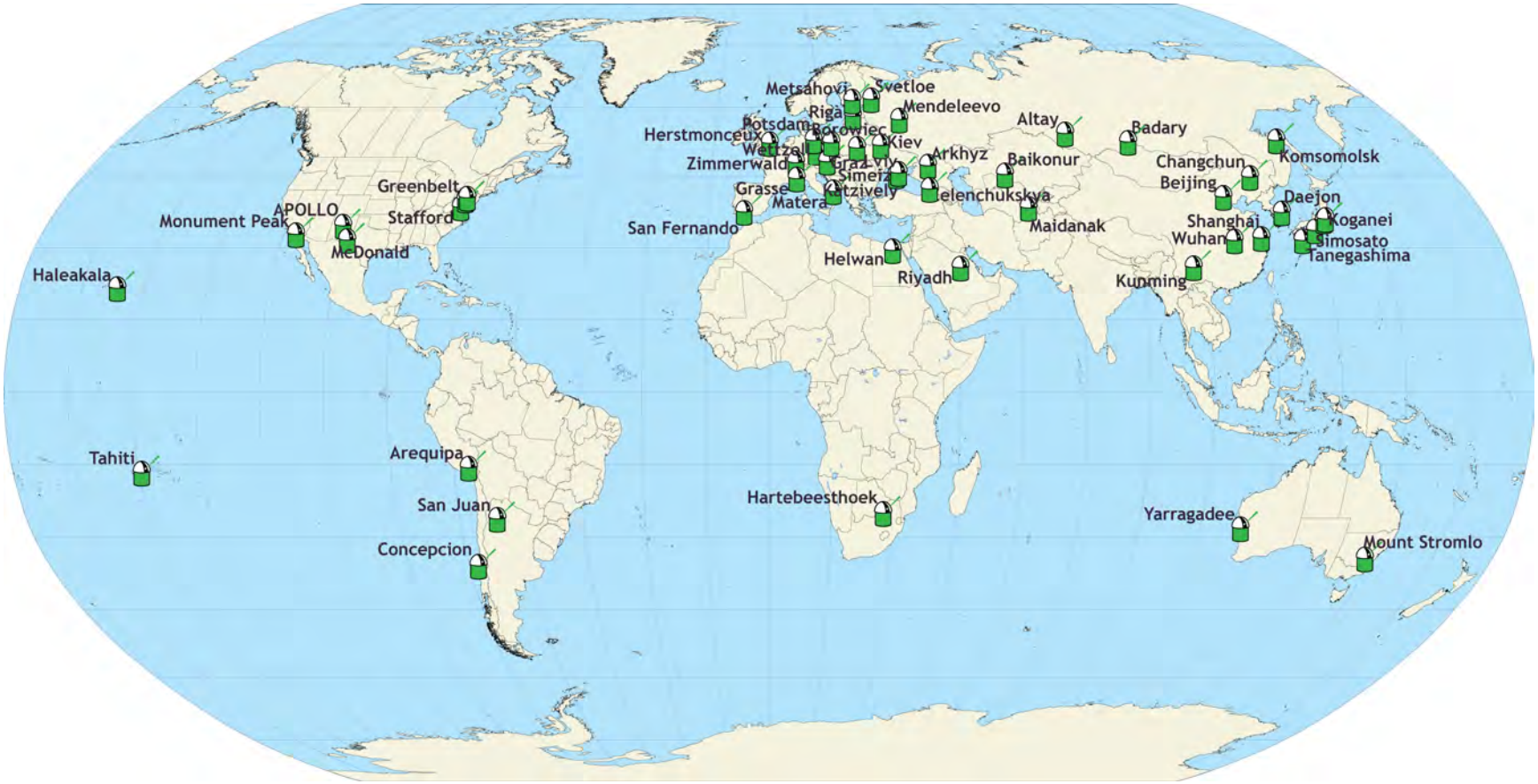
Retiring Members ILRS Governing Board 2012-13

- EUROLAS Network Representative — Francis Pierron
- WPLTN Network Representative — Hiroo Kunimori
- At-Large Representative — Graham Appleby (Chair 2010-2013)

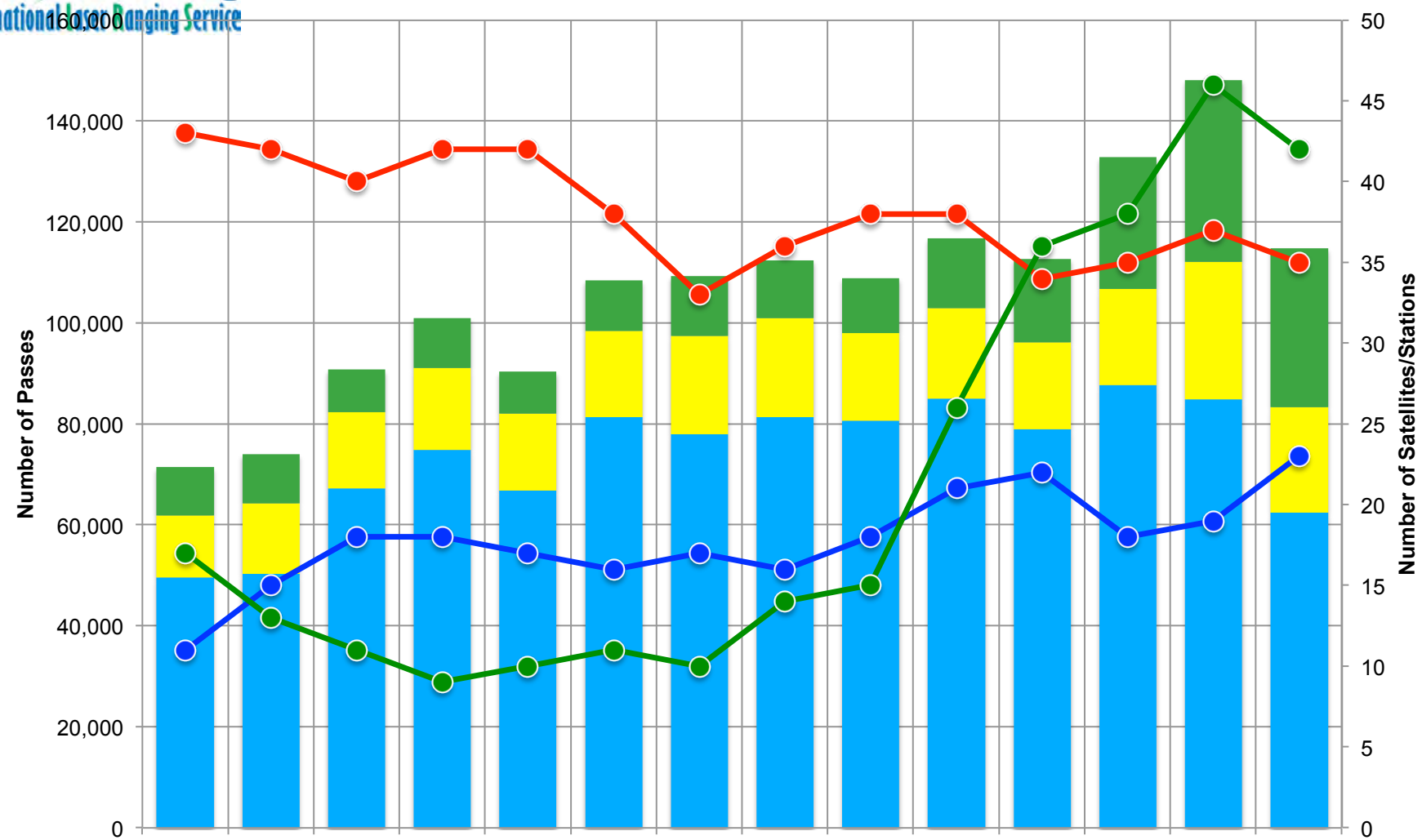
ILRS Working Groups 2011 - 2013

- Analysis
  - E. Pavlis/C. Luceri
- Missions
  - G. Appleby/S. Wetzel
- Data Formats and Procedures
  - H. Mueller/R. Ricklefs
- Networks and Engineering
  - G. Kirchner/M. Wilkinson
- Transponder
  - U. Schreiber/J. Degnan/J. McGarry

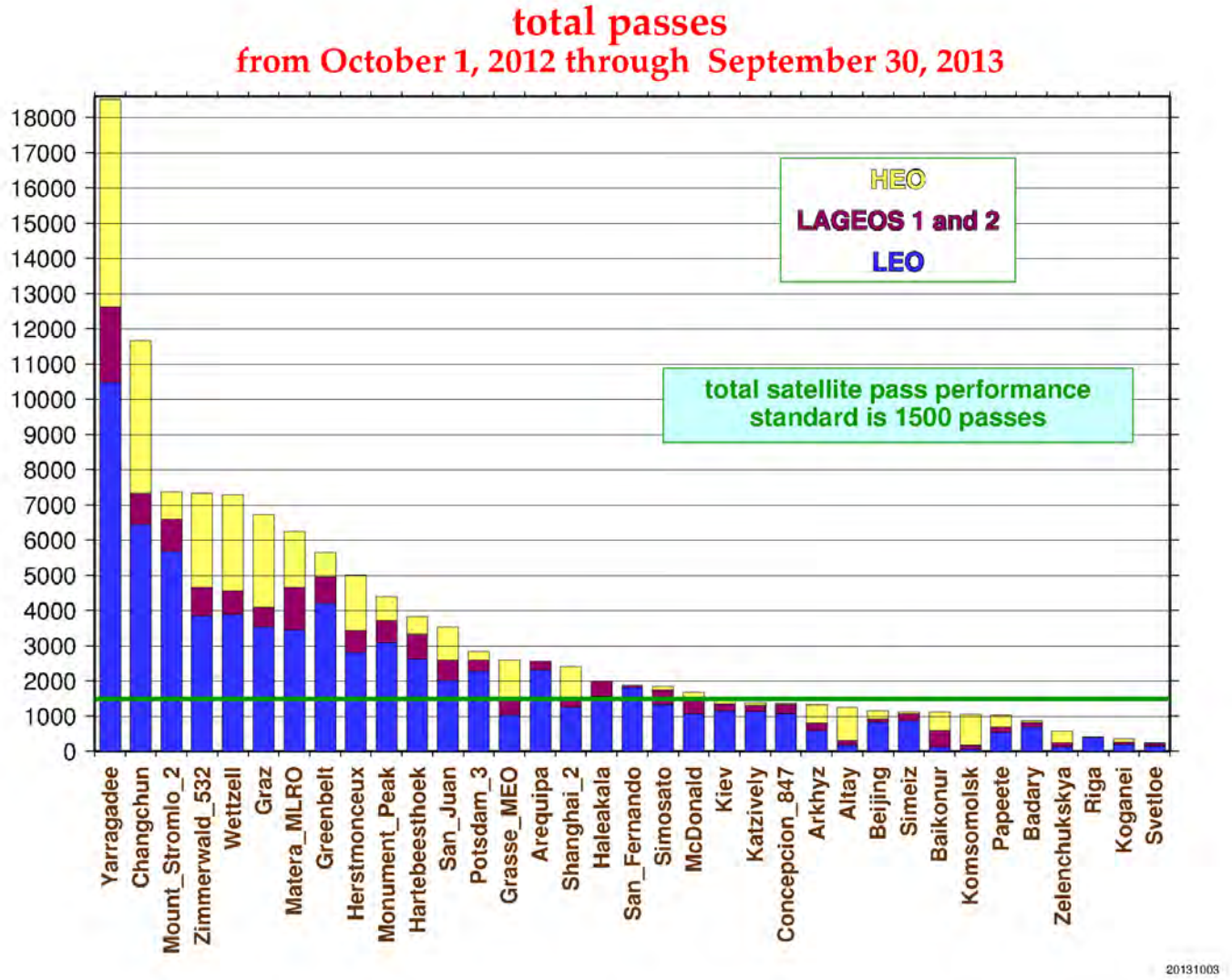
ILRS Network (2013)



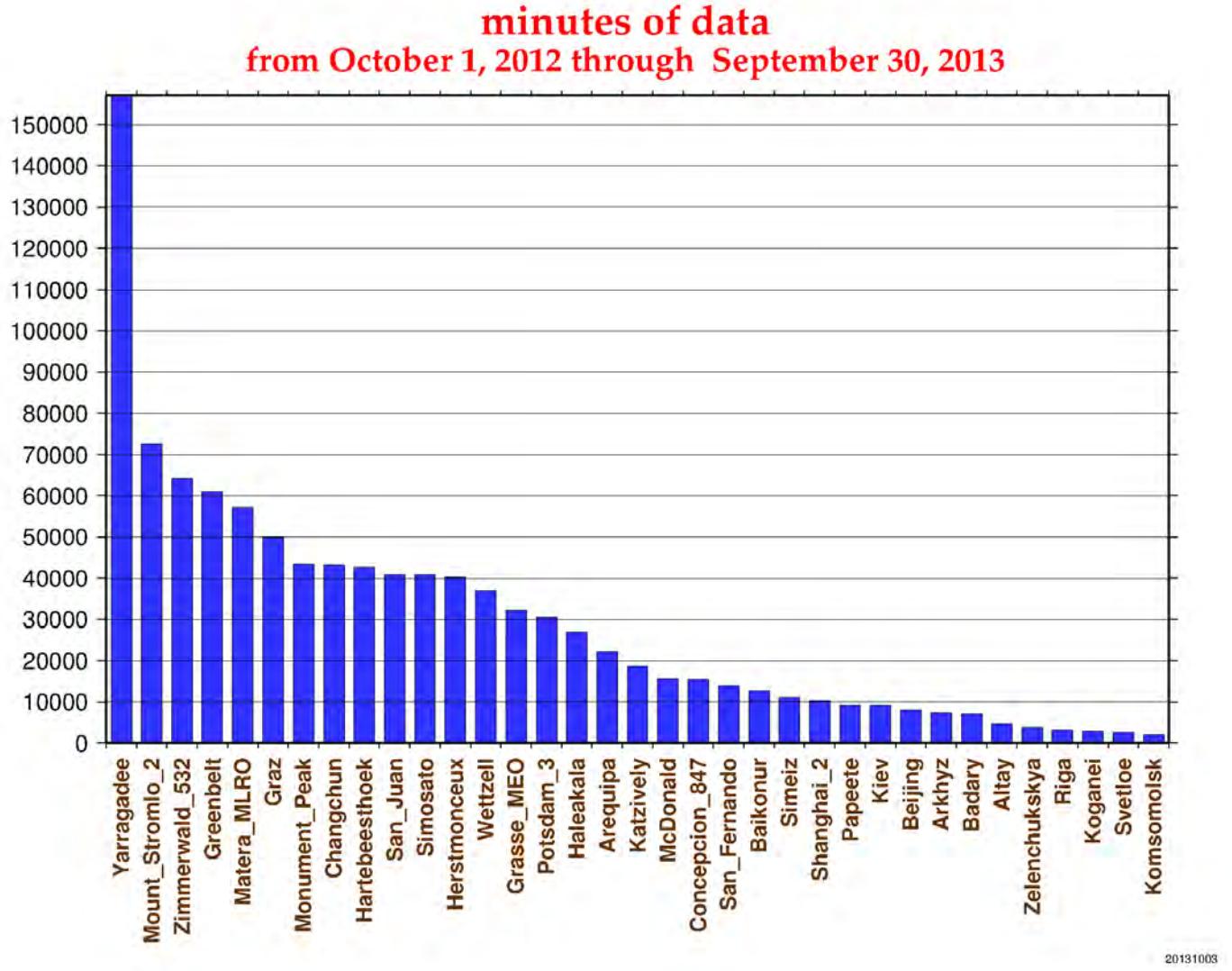
Annual Data Yield



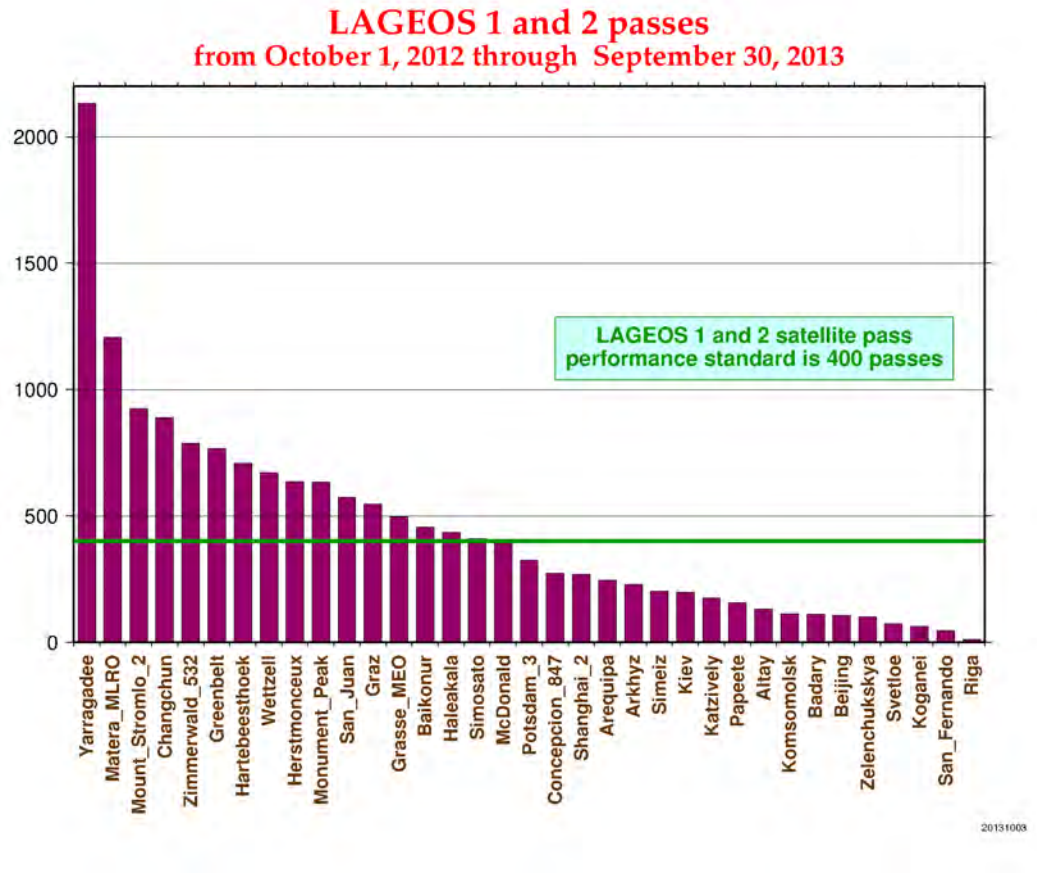
Station Performance (2014Q3)



Station Performance (2014Q3)



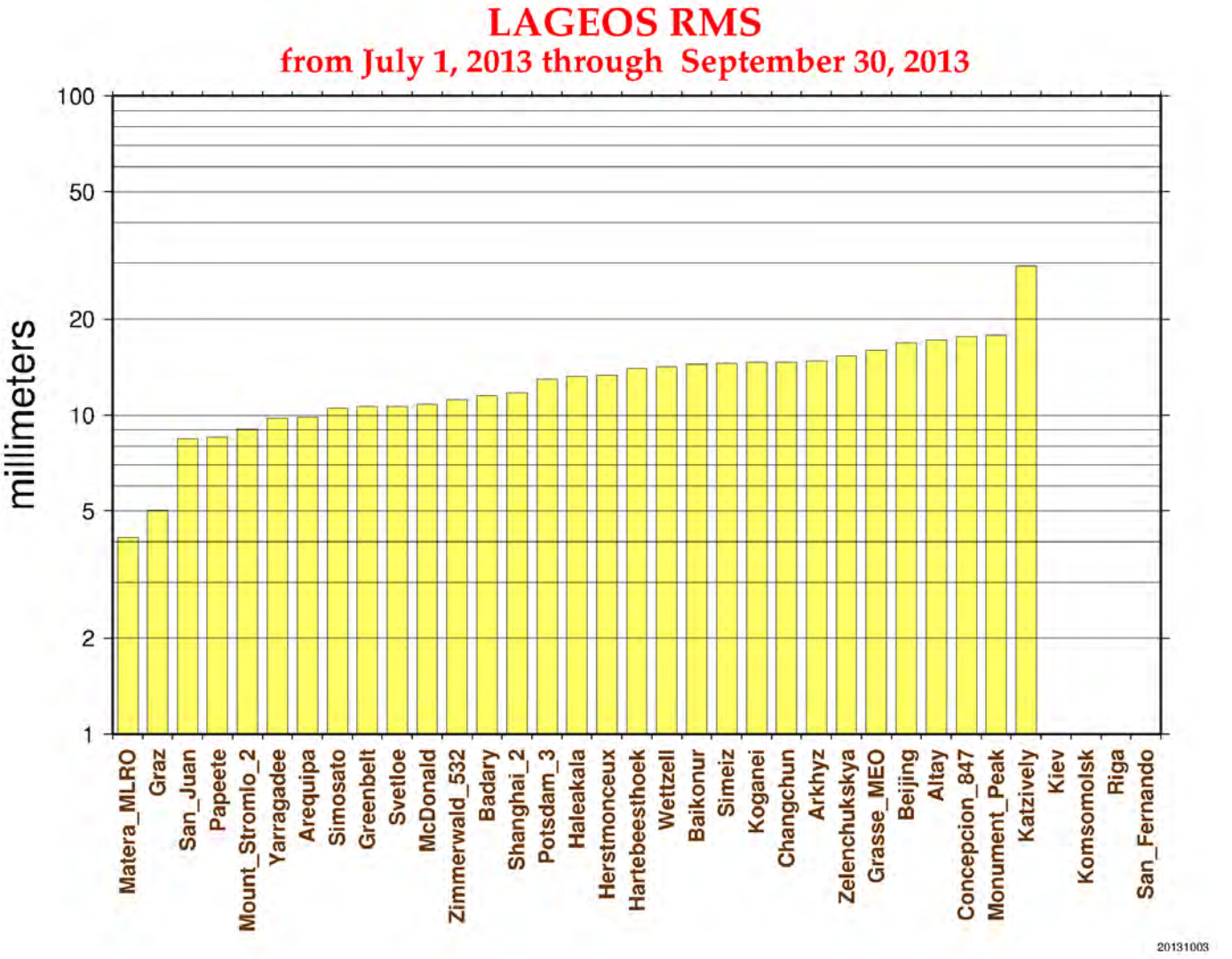
ILRS Network Productivity – reference frame



Less than 20 stations are responsible for the majority of the observations of the LAGEOS satellites.

How *accurate* are these range measurements – continues to be a big challenge?

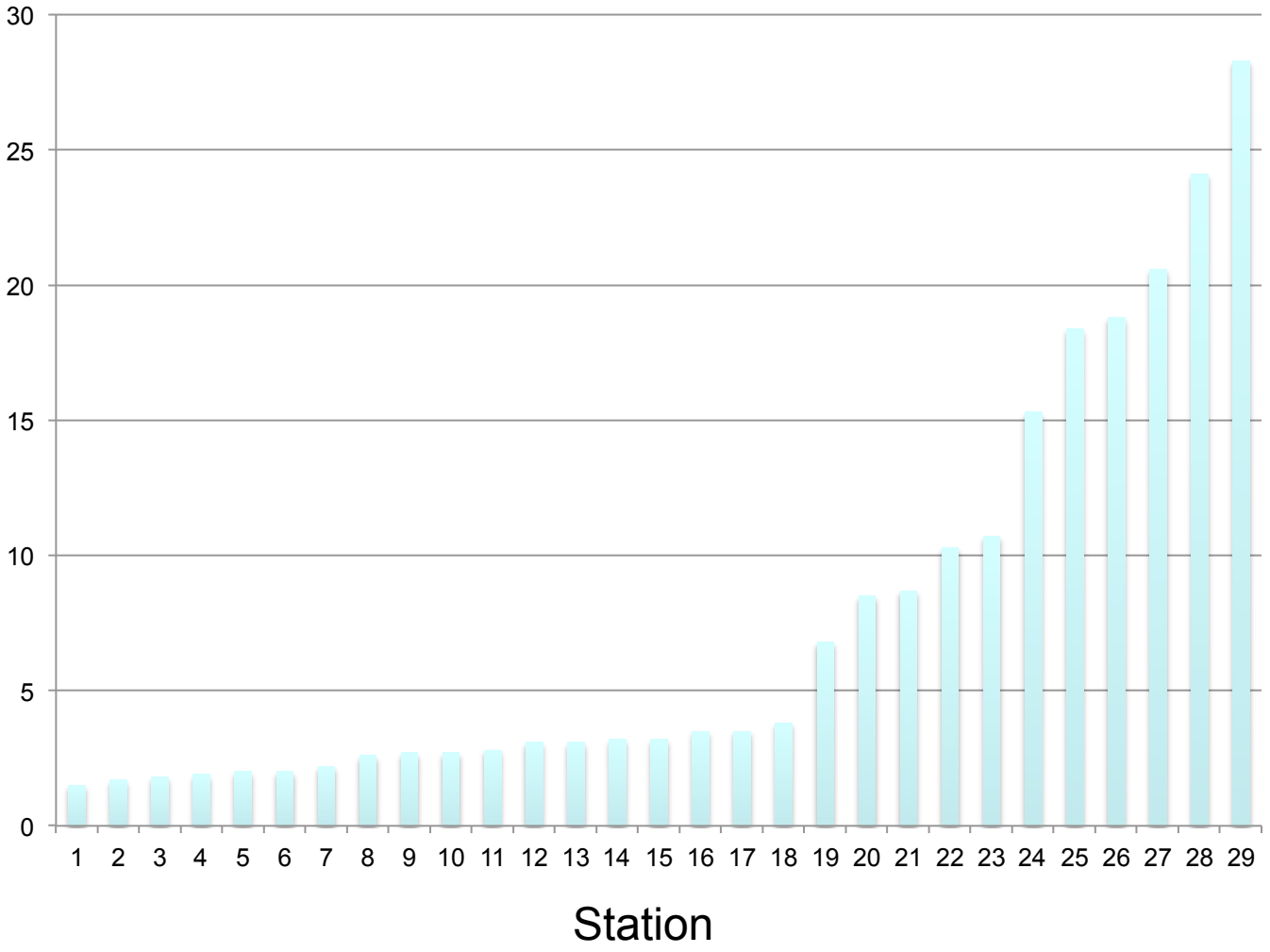
Station Performance (2014Q3) - single-shot precision



QC work leads to long-term *stability* estimates: via scatter about any long-term mean bias

Long-term stability of RB (mm)

2013 Q3, HitU



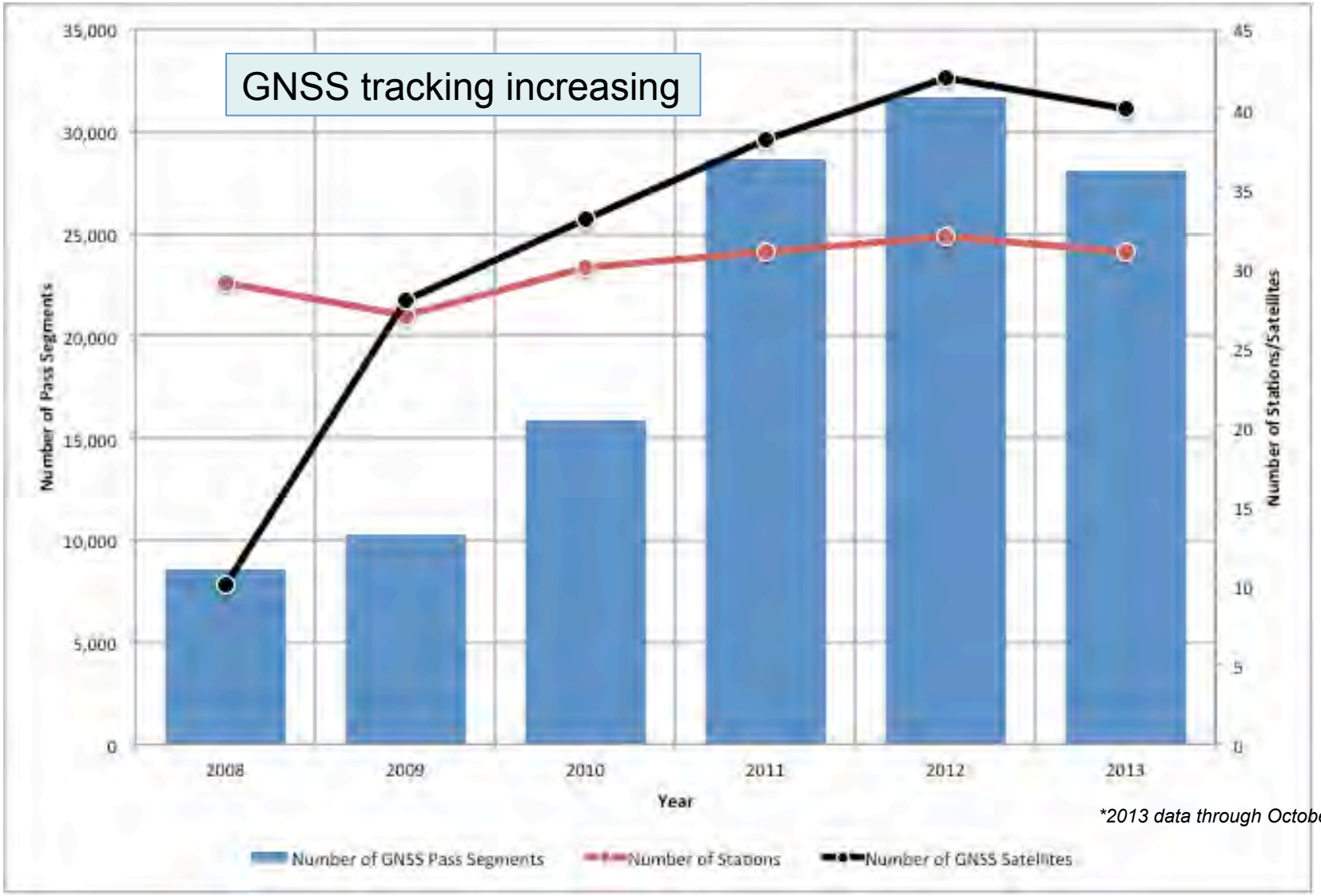
Limitations of QC

- The rapid QC procedures that are in routine operation are capable of detecting changes leading to bias at cm-level
- But this effort will *never* address the possibility that systematic range errors exist at the few to several mm level, and which were absorbed into station coordinates
- Detect and track-down hardware problem and/or remove RB by estimation during orbit and station coordinate determination
  - would appear to be only options.

Mission Developments

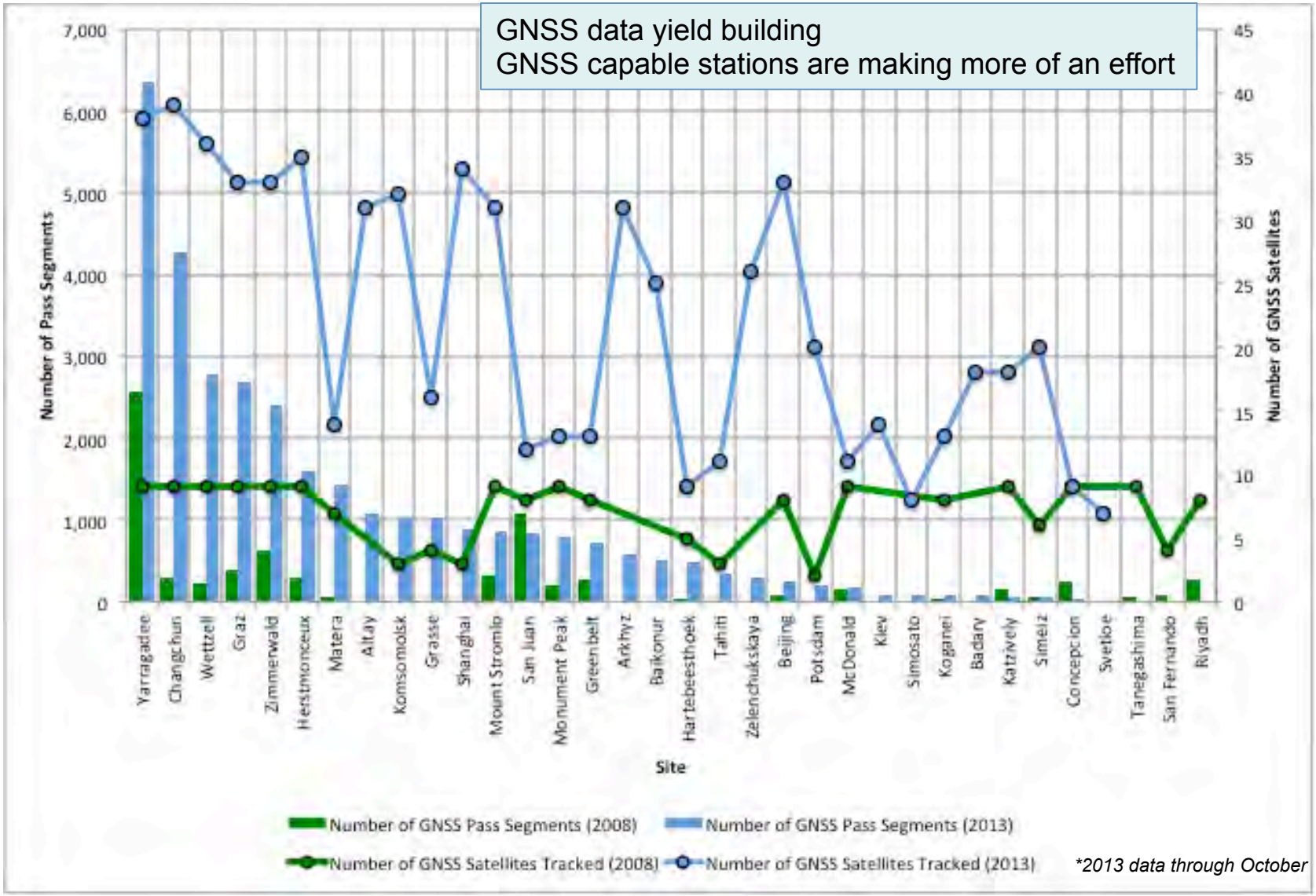
- Currently supporting 61 missions (includes 24 GLONASS satellites) and lunar tracking (4 reflectors)
- LRO-LR 3,527.6 hours of data since launch (as of 21-Oct-2013)
- Recent additions
  - KOMPSAT-5 (launch 23-Aug-2013)
  - IRNSS-1A (geosynchronous, launch 01-Jul-2013)
  - STSAT-2C (launch 30-Jan-2013)
    - Prediction quality affecting network ability to track
  - SARAL (launch 25-Feb-2013)
  - Envisat
    - System failure 08-Apr-2013
    - DLR/ESA requested continued tracking for space situational awareness
- Past missions
  - STPSat-2 for hollow cube studies (Apr-Oct 2013)
  - Jason-1 (ended Jul-2013)
- Upcoming missions
  - SWARM (ESA); 3 satellites; November 2013; prediction flow tested
  - Jason-3 (CNES); April 2015; MSR submitted and in review
  - Sentinel (ESA); 2 satellites; 2014
  - ANDE (NRL); 2014

Yearly GNSS Tracking



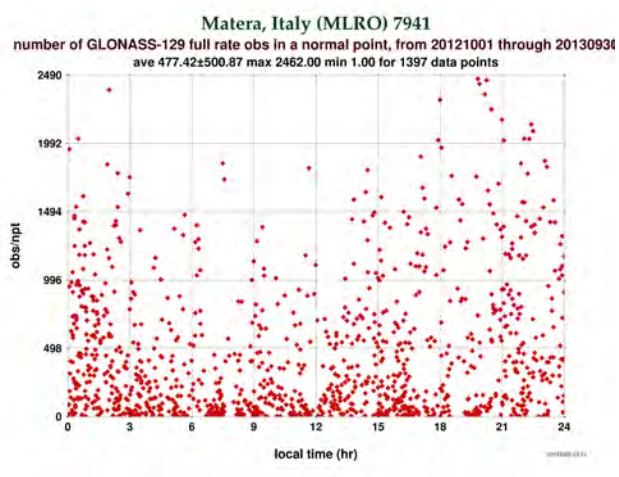
*2013 data through October

Station Tracking of GNSS (2008 and 2013)



GLONASS

- Some 13 ILRS stations are regularly, at some level, tracking up to all 24 vehicles
- Stations include: Changchung, Graz, Komsomolsk, Herstmonceux, Matera, Yarragadee, Zimmerwald
- Russian request for global support is under consideration
- Baseline is 2 NP per night-arc, 2 NP per day-arc, per stn, per vehicle
- Working to this baseline would be better, coordinated use of resources at the sites
- Maybe the ILRS six priorities distorts this
- Suggest setting all 24 with equal weight
- Also time transfer opportunities on GL113



Central Bureau Items

- New normal point population recipe devised and approved to take advantage of the high repetition systems
- New log files implemented for tracking station configuration changes
- Strengthen ILRS policies regarding station updates and quarantine of data following these updates
- All stations encouraged to submit full-rate data (including kHz) to be archived by the Data Centers
- Trying to strengthen the timely feedback and response procedures from the stations on maintenance, modification, and upgrades
- Adherence to processes for certification of new stations and requalification required for stations after upgrading or significant downtime
- Simplified algorithm to encourage stations to better distribute tracking efforts perhaps using the real-time web facility at AIUB needs to be developed
- ILRS 2009-2010 Report distributed May 2013

Meetings

- November 11-15, 2013: 18th International Workshop on Laser Ranging, Tokyo Japan
- December 09-13, 2013: Fall AGU, San Francisco CA, USA
- March 02-07, 2014: 8th IVS General Meeting, Shanghai China
- June 23-27, 2014: IGS 20th Anniversary Workshop, Pasadena CA, USA
- October 13-14, 2014: IAG Commission 1 Symposium 2014 on Reference Frame for Applications in Geoscience, Luxembourg
- October 27-31, 2014: ILRS Technical Workshop, Greenbelt MD, USA
- December 15-19, 2014: Fall AGU

ILRS Analysis Working Group Report to

ILRS Governing Board Meeting

Fujiyoshida-shi, Japan, November 14, 2013

Erricos C. Pavlis and Cinzia Luceri

Analysis Coordinators

ILRS AWG Activities

- 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
- Adopted the new CoM offset model for LAGEOS & ETALON (*site- and time-dependent with ~2 mm accuracy*) as of October 2013
- AWG participated in the ITRS/GGFC PP for testing atmospheric corrections at observation level using GGFC input data
  - IERS' WG on this subject held a splinter meeting at EGU 2013 and presented a compilation of the results of the PP
  - The ITRS decided NOT to include NT Atm. Loading corrections at observation level for ITRF2013

ILRS AWG Activities (cont.)

- Re-analysis for 1983 to present to begin once all model improvements have been tested and validated by all ACs
- Our contribution to the ITRS for the ITRF2013 development is expected in early 2014
- The AWG held its second Fall meeting at Fujiyoshida-shi, Japan, on Saturday, November 9, 2013, focusing primarily on the estimation and resolution of systematic errors in our past and future data
  - For ITRF2013, past data were examined and new list of systematic corrections is adopted for use in the re-analysis (to be finalized soon)
  - For future monitoring of systematics, a PP is planned once we are through the ITRF2013 development
  - Low degree harmonic estimation and incorporation of LARES into the operational official products is planned also after the ITRF2013 development work is done
- The last ILRS AWG all-day meeting was attended by a large group of ILRS associates and several engineers from the network stations

Operational Issues

- New Russian stations validated and accepted in 2013
  - Badari, Zelenchukskaya, and Svetloe
  - Data yield is still low, possibly due to weather(?)
  - Data are released to OC/DC with considerable delays
- Currently investigating the delayed availability of data which impacts the quality of the ILRS products on the last day of the analyzed arcs
- Stations undergoing repairs/upgrades are still not reporting these in time for the correct handling (quarantine) of their data and assignment of new SODs
- A new system at Daedeok, Korea is now undergoing validation for acceptance in the network
- Kunming data had serious preprocessing errors, now seem to be OK, thanks to close collaboration with Horst Müller/DGFI

Operational Issues

Stations validated after undergone upgrades and extended down time

System	Site	Upgrade start date	Upgrade end date	Remarks	Quarantine start date	Data release
McDonald	7080	21-Aug-2013	21-Aug-2013	Real-time controller system installation	21-Aug-2013	23-Oct-2013
Zimmerwald	7810	12-Dec-2012	15-Feb-2013	Laser repair (amplifier and chiller)	16-Feb-2013	21-Feb-2013
Haleakala	7119	17-Apr-2013	28-Apr-2013	Telescope motor casing assembly replacement	29-Apr-2013	15-Jun-2013
Riga	1884	11-Oct-2013		Optical system realignment; time and frequency standard upgrade	11-Oct-2013	
Wettzell	8834	21-Oct-2013		Installation of new laser	21-Oct-2013	

Stations in Validation

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* unreliable sites, sites in **quarantine** or with preliminary coordinates

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1831	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Lviv, Ukraine**
1873	--- mm	A 00:000:00000 00:000:00000 N	not stable	
1874	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Mendeleevo 2, Russia**
1879	--- mm	A 00:000:00000 00:000:00000 P	new station	
1884	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Riga, Latvia**
1887	--- mm	A 00:000:00000 00:000:00000 P	new station	
1888	--- mm	A 00:000:00000 00:000:00000 P	new station	
1889	--- mm	A 00:000:00000 00:000:00000 P	new station	
1890	--- mm	A 00:000:00000 00:000:00000 P	new station	
7358	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Tanegashima, Japan**
7359	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Daedeok, Korea**
7406	--- mm	A 00:000:00000 00:000:00000 N	not stable	
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**
7825	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Mt Stromlo, Australia**
7832	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Riyadh, Saudi Arabia**
8834	--- mm	A 00:000:00000 00:000:00000 Q	**quarantine**	**Wettzell, Germany**

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Publications & Meetings

- **IERS Annual Reports 2011 & 2012:**
- The AWG contributions were sent to IERS, 2011 is already published
- **ILRS Special Issue in the Journal of Geodesy:**
- Progressing now, awaiting three more abstracts before sending them to the editor for approval
  - Over 24 submissions, 3 abstracts pending finalization
  - Planning for a completed review process by early 2014
- **Future Meetings:**
  - The next Spring meeting of the AWG will take place in Vienna, around the time of the EGU 2014
  - The IERS is planning a “UAW” in Pasadena, CA, (tentative dates: June 27-28, 2014) following the IGS Workshop. Several ILRS associates will be required to represent the ILRS with presentations (more on this once we receive more information from IERS)

ILRS SI @ JofG

#	TITLE	Lead Author(s)
0	**Foreword**	**The Guest EB**
1	**The International Laser Ranging Service (ILRS): The First Decade and Beyond**	**Pearlman, Appleby, Noll, Pavlis, Torrence**
2	**Information Resources Supporting Scientific Research for the International Laser Ranging Service**	**Noll, Horvath, Ricklefs, Schwatke, Torrence**
3	*Past, Present and Future of the ILRS Global Tracking Network*	*Dunn, Torrence, Pearlman, Varghese and McCormick ???*
4	**Next Generation Satellite Laser Ranging Systems**	**Degnan, McGarry, Kirchner, Appleby, Prochazka, Jäggi, Moore, Artyukh, Samain, Schreiber**
5	**Geodetic satellites: a high accuracy positioning tool**	**Pearlman, Arnold, Davis, Barlier, Biancale, Vasiliev, Paolozzi. Ciufolini, Pavlis**
6	**Satellite Laser Ranging to Global Navigation Satellite Systems**	**Thaller, Dell'Agnello, Fumin, Govind, Nakamura, Noda, Springer**
7	**Lunar Laser Ranging – A Tool for General Relativity, Lunar Geophysics and Earth Science**	**J. Müller, Murphy, Schreiber, Shelus, Torre, Williams, Boggs**
8	**Interplanetary Ranging**	**Degnan, Schreiber, McGarry, Sun, Zagwodzki, Murphy, Samain, Turyshev**
9	**Target Signature Systematic Errors for Geodetic Satellites and Novel LR Array Design**	**Appleby, Otsubo, Arnold, Kirchner, Neubert, Grunwaldt, Vasilliev**
10	**Data Quality Control Service for the ILRS Tracking Network**	**Otsubo, H. Müller, Pavlis, Torrence, Thaller, Glotov, Xiaoya, Appleby**
11	**Systematic errors in SLR Data: Documentation and Discussion of their Sources**	**Luceri, H. Müller, Vei, Appleby and Pavlis**
12	**Operational and Definitive Products of the ILRS Analysis**	**Sciarretta, Luceri, Pavlis and Kelm**
13	*Monitoring Mass Redistribution in the Earth System with SLR*	*Pavlis, König, Ries, Deleflie, Cheng, H. Müller, ???*
14	*The ILRS Contribution to the International Terrestrial Reference Frame (ITRF)*	*Pavlis and the AWG ACs and CCs*

We also have EIGHT (9) "un-solicited" abstracts so far

1) **BOLD** indicates working title from author(s) for a submitted abstract
2) **RED** indicates lead author
3) *Non-bold entries in italics are still pending!!!*

MWG Meeting Activities

- Discussion of mission activities in the last year to include:
- New Missions:
  - Tracked: SARAL, GLONASS-131, IRNSS-1A, KOMPSat-5,
  - Not tracked: STSat-2C
  - Upcoming: SWAR
- Campaigns: Galileo 103, 104, QZSS, STPSat-2
- End of Mission: BLITS, Jason-1, GOCE
- Review of Mission Support Request process - any concerns or suggestions?
  - More information to be provided upfront for prediction providers so that they can be prepared to provide useful predictions in sufficient time before mission support begins
  - Provide a sample filled in MSRF for organizations not familiar with the process.
  - The MWG will review the MSRF and make additions / changes to the current form for improved MSRF submission from new missions

MWG Meeting Activities - Cont

- Issues and lessons-learned from recently-approved requests
  - Several missions have demonstrated issues with predictions just before and during mission operations
- Prediction sources
  - Work with prediction providers with greater lead time before mission support begins to establish a prediction process, provide test predictions in .CPF format, and demonstrate proficient prediction generation and delivery

Ulli Schreiber provided a discussion of the ELT mission:

ELT/ISS actions

- Safety on ISS – Ulli will circulate his draft of a protocol:
  - Involves on-site laser dynamic energy monitor with cut-out for energy above MPE
  - Divergence – forces a divergence appropriate to achieving MPE at satellite, with non-compliant auto cut-out
  - Likely to be station-specific solutions to these requirements – for MWG to vet and make recommendations
- Launch 2016
- Run for 18 months in campaign mode
- Any station would be valuable to demonstrate technique
- But most value if station is linked/contributes to national timescale

Report of the Data Formats & Procedures WG

Meeting: Tue. Nov. 12, 2013 19:00 – 20:30, 14 members/nonmembers present

- Need of a complete and actual ILRS email contact list
  - EDC will keep an email list which can be referenced from CDDIS
- New station logs: up to now only three stations have delivered new logs:
  - McDonald, Monument Peak and Potsdam
  - Core stations will receive an email to deliver an update in new format
  - Other station will ev. follow, dep. on result of first campaign
- CRD status:
  - Some stations still deliver data in old format. -> data will not longer be stored, but stations will be informed that these data will be dumped
  - Data in old format will be reformatted to CRD by EDC, indicating in comment and flag that these are reformatted data. Old format data will be kept but not in public directories, DGFI will validate reformatted data. Starting with NP data.
  - Some stations deliver system configuration upper/lower case mixed, should be unique
- Data Flow
  - EDC has a test implementation to validate data with CPF predictions
  - Proposal: stations should deliver np data to both operation centers, only the responsible center will react in case of data problems
  - EDC will provide a proposal of data handling to be discussed with CDDIS/ITT/Exelis

Fields in New Change History Log

- Site Occupation Designator (SOD)
- Year, Day of Year, Hour and Minutes when change became active
- Estimated Chance of Data Impact: 0=none,...,3=needs quarantine
- Subsystem number of changed component from site log (or 99 for those not in site log)
- Text – to the end of the line describing change so that station and analyst can locate and identify

New Normal Point Definition

1) Allows high rep-rate systems to move to a new target once they have "enough" data, even if in much shorter time than the normal point bin size.

2) Allows station to more effectively interleave passes, with the attendant increase in data yield

3) Mainly pertains to high (HEO) and the LAGEOS satellites, which have long normal point bins

4) Went into effect May 2012

5) Possibly implemented at 13+ stations

   Graz – real-time feedback, 1000 points/npt

   Herstmonceux – real-time feedback on precision

6) Chart on next page shows the number of stations with > 1000 returns/npt. There is much potential for better interleaving with the new npt definition

Procedure

A Normal Point is completed on Satellite 1 when either:

- About 1000 valid FR points have been taken, or
- NP precision (if computed and available in real-time) reaches 1 mm, or
- The SNPI has elapsed, whichever comes first;

If the Normal Point has been populated in less that the SNPI, move on to another satellite (e.g. Satellite 2);

If the full SNPI has been required to populate the normal point, ranging can continue on the current satellite or another satellite;

Do not return to Satellite 1 until the next SNPI has started.

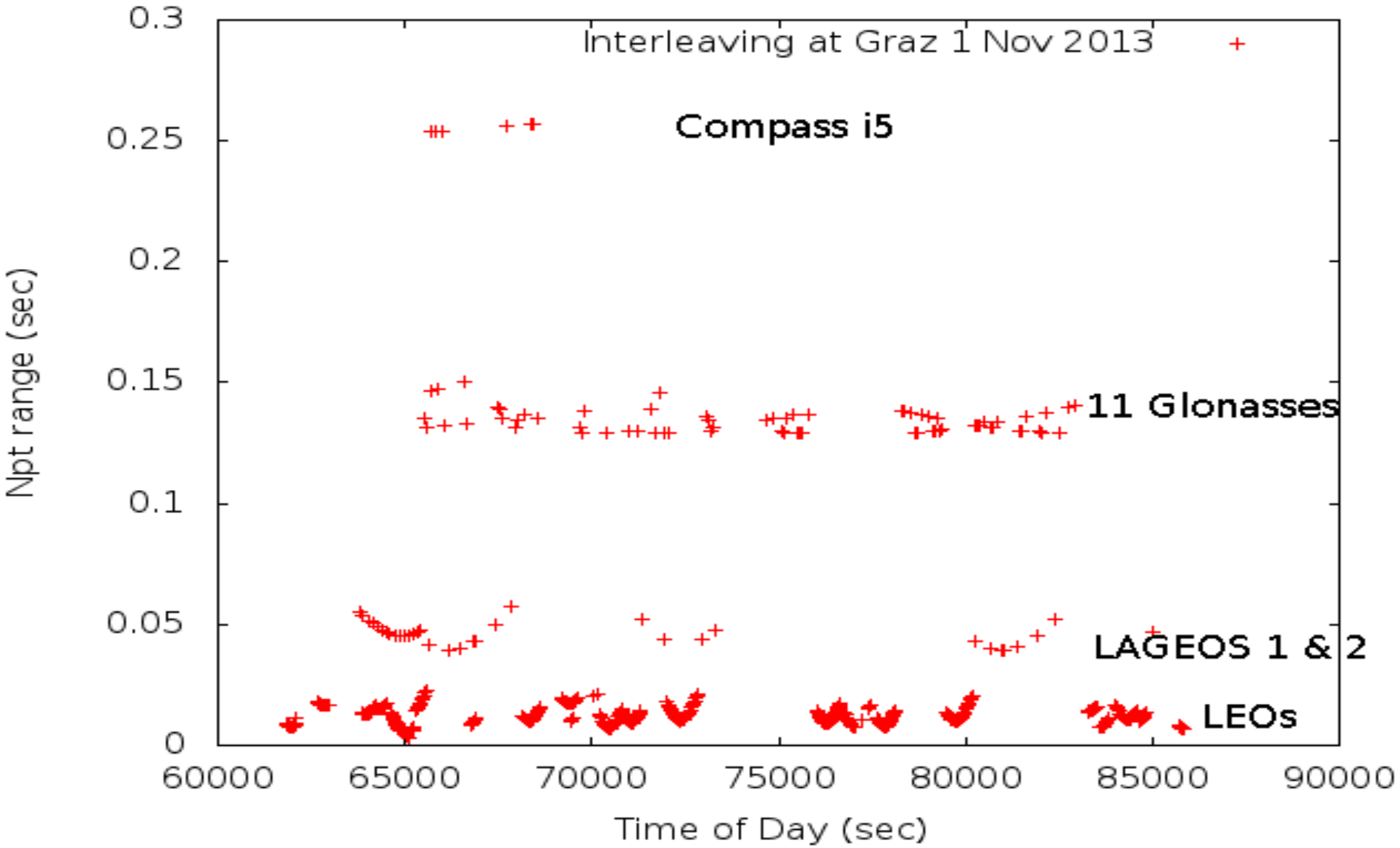
New Normal Point Definition
High Return NPs – Sept 2013

Station	SOD	Mean # of returns per NP	Median # of returns per NP	MAX # of returns per NP	# NP's with >=1000 returns	Total # of NPs	Percent of NP's with >= 1000 returns	Number of Passes with 1-1000 returns	Total Number of Passes (TP)	Percent of Passes with >=1000 returns	Max. Rep. Rate (Hz)
ALTL	18799401	1,743.18	1,600.00	4,572.00	87.00	289.00	30%	14	31	45%	300
ARKL	18869601	1,265.75	1,117.50	1,788.00	4.00	287.00	1%	3	49	6%	300
BAIL	18879701	1,492.46	1,303.50	3,103.00	28.00	901.00	3%	19	105	18%	300
CHAL	72371901	6,529.10	3,919.00	51,337.00	1,067.00	1,496.00	71%	194	223	87%	10000
CONL	74057904	1,356.45	1,239.50	2,189.00	44.00	876.00	5%	13	80	16%	100
GRZL	78393402	13,647.98	9,336.00	113,981.00	755.00	857.00	88%	76	77	99%	2000
HERL	78403501	4,570.26	3,075.50	22,600.00	554.00	1,164.00	48%	76	110	69%	2000
KOML	18685901	1,574.04	1,417.00	3,047.00	25.00	88.00	28%	10	16	63%	
MATM	79417701	1,023.56	1,023.00	1,070.00	9.00	2,116.00	0%	7	249	3%	10
POT3	78418701	2,793.18	2,125.00	10,397.00	308.00	1,056.00	29%	43	70	61%	2000
SHA2	78212801	3,861.12	2,740.50	15,630.00	166.00	257.00	65%	42	49	86%	1000
SVEL	18889801	1,028.00	1,028.00	1,028.00	1.00	83.00	1%	1	14	7%	300
ZIML	78106801	1,180.67	1,186.50	1,406.00	472.00	2,221.00	21%	73	165	44%	110

By Justin Woo, Excelis

- Many stations have a high enough return rate to implement the new npt definition

Recent Example of Interleaving Passes (Graz)

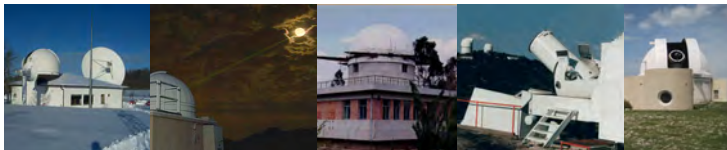




Network and Engineering WG Meeting -- Agenda

- Divergence measurement by stations – Ray Burris
- Feedback from Randy Ricklefs on tracking station changes
- Items for discussion
  - Laser-aircraft collision logging
  - Tracking Envisat
  - European Laser Time Transfer
  - Station range bias



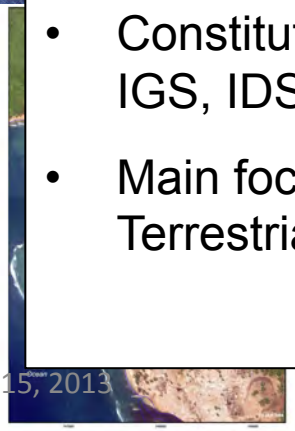


EUROLAS status

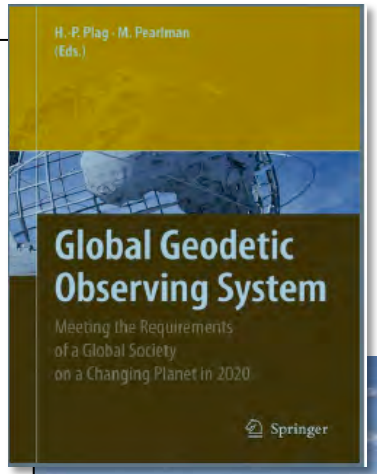
- **EUROLAS meeting** @IWLR18, 12 Nov: good attendance, keen interest
- **ToR obsolete**
  - Must be updated
  - Wider participation needed
  - EDC is currently the best Eurolas asset (thumbs up to Christian Schwatke)
- **European Network makes sense:**
  - To try to access EU (and ESA?) fundings
  - Density of stations allows interesting applications (multistatic space debris tracking, common view time transfer, schedule optimization)
- **New EUROLAS** should include all other components including data centers, analysts, and so on
- **Actions:**
  - Revision of ToR: first draft to be prepared by Appleby, Bianco, Kirchner, Mueller and then circulated within Eurolas for revision
  - Eurolas associates revised mailing list (Schwatke)
  - EUROLAS meeting?

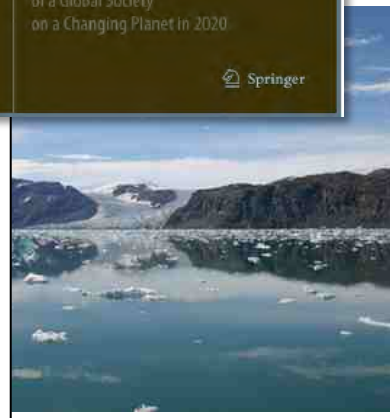
Global Geodetic Observing System

Global Geodetic Observing System (GGOS)



- Established by the IAG to integrate the three fundamental areas of geodesy (Earth's shape, gravity field, and rotation), to monitor geodetic parameters and their temporal variations in a global reference frame with a target relative accuracy of 10E-9 or better (See GGOS 2020)
- Provide products & services with the geodetic accuracy necessary to address important geophysical questions and societal needs, and to provide the robustness and continuity of service which will be required of this system in order to meet future needs and make intelligent decisions
- Constituted mainly from the Services (ILRS, IVS, IGS, IDS, and IERS)
- Main focus at the moment is the International Terrestrial Reference Frame





GGOS Site Requirements Document

(http://cddis.gsfc.nasa.gov/docs/GGOS_SiteReqDoc.pdf)

- Introduction and Justification
  - What is a Fundamental Station?
  - Why do we need the Reference Frame?
  - Why do we need a global network?
  - What is the current situation?
  - What do we need?
- Site Conditions
  - Global consideration for the location
  - Geology
  - Site area
  - Weather and sky conditions
  - Radio frequency and optical Interference
  - Horizon conditions
  - Air traffic and aircraft Protection
  - Communications
  - Land ownership
  - Local ground geodetic networks
  - Site Accessibility
  - Local infrastructure and accommodations
  - Electric power
  - Site security and safety
  - Local commitment

Global Geodetic Observing System (GGOS)

Site Requirements for GGOS Core Sites
(Revision 1a)

July 18, 2012

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Model Projecting Site Development and Performance for Simulations

Region/Class	Sites	Current Config. G	V	S	D	Gr	5 Year Projected Configuration G	V	S	D	Gr	10 Year Projected Configuration G	V	S	D	Gr	Partner/ Agency	Other Equipment	Ground Stability	Ease of Business	SLR: Production	SLR: Eq. Rating	SLR: Cloud Cover	SLR: Site Tie Closure (mm)	VLBI: Days/Year	VLBI: Data Rate	VLBI: RFI Conditions	VLBI: Site Tie Closure (mm)	Sponsor Commitment	Equipment Provider	Issues/Comments
North America																															
VLBI	Brewster	L	L				L	L				L	L				NRAO		3				3		6	1	1	3			VLBA
VLBI	Hancock		L					L					L				NRAO						2		6	1	1				VLBA
VLBI	Kitt Peak		L					L					L				NRAO						3		6	1	1				VLBA
VLBI	Los Alamos		L					L					L				NRAO						3		6	1	1				VLBA
VLBI	Mauna Kea	L	L				L	L				L	L				NRAO		2				3		6	2	1				VLBA
VLBI	North Liberty	L	L				L	L				L	L				NRAO		3				2		6	1	1	7			VLBA
VLBI	Pie Town	L	L				L	L				L	L				NRAO		1				2		6	2	1	4			VLBA
VLBI	St. Croix	L	L				L	L				L	L				NRAO						2	3	6	1	1	3			VLBA
Europe																															
Core	Wettzell, Germany	N	L	L		AS	N	N	N		AS	N	N	N			BKG		3	3	3	2	2	9	133	3	1	4,10	3		Historic Site
VLBI	Grasse, France	L		L			N		L		AS	N		L			GRGS		3	3	3	2	2	2,7					3		Historic Site
VLBI	Effelsberg, Germany		L					L					L				MPIR						1		2	3	1				
Core	Matera, Italy	N	L	L			N	L	L		A	N	N	N		A	ASI		3	3	3	2	2	6	52	0	0	10	3		Historic Site
Core Plan	Yebes, Spain	L	L			AS	N	N			AS	N	N	N		AS	IGN		2				2		35	3	1	7	3		
VLBI	Madrid, Spain	L	L				N	L				N	L				NASA						2		8			9			
VLBI Plan	Canary Islands						N	N				N	N				IGN						2				1		S		very cloudy Nov - June, other time can be very clear...depending on exact location
VLBI Plan	Azores						N	N				N	N				DRCTC		3				3				1		S		Mostly cloudy at the Terciera Island location. Need better location identifiaction
SLR (Core Plan)	Herstmonceux, GB	N		L		A	N		N		A	N	N	N		A	NERC		3	3	3	3	2	4					3		Historic Site
SLR	Graz, Austria	N		N			N		N			N		N			OEAW		3	3	3	3	2	6					3		Historic Site
SLR	Zimmerwald, Switzerl	N		N			N		N			N		N			AIUB		3	3	3	3	3	2,6					3		Historic Site
SLR	Potsdam, Germany	L		L			N		L			N		L			GFZ		3	3	2	2	2	7,22					3		Historic Site
SLR	San Fernando, Spain	L		L			N		L			N		L			ROA		3	3	2	2	3	21					3		Historic Site
SLR	Borowiec, Poland	L		L			N		L			N		L			SRC/PAS		3	3			2	3					2		Historic Site
VLBI (Core Plan)	Metsahovi, Finland	L	L			AS	N	N	N		AS	N	N	N		AS	FGI		3	3			2	12,62	10	3	1		3		
VLBI (Core Plan)	Ny Alesund, Norway	N	L				N		N			N	N	N			NMA		3	3			2		133	1	1		3		
VLBI	Medicina, Italy	L	L			S	N	L			S	N	N				IRA		2	3			2		24	3	0	4	3		
VLBI	Noto, Italy	L	L				N	L				N	N				IRA		3				2		12	3		7	2		
VLBI	Onsala, Sweden	L	L			AS	N	N			SA	N	N			AS	OSO		3	3			2		40	3	1	12	3		Historic Site
SLR VLBI	Simeiz, Ukraine	L	L	L			N	L	L			N	L	L			CRAO		3	3	2	1	2		12	1	1	8	3		
Middle East																															
SLR (Core Plan)	Riyadh, Saudi Arabia	L		L			N		N			N		N			KACST		3	1	1	1	3						2		

Eighteen Responses covering 38 Sites have been submitted to the GGOS Call for Participation

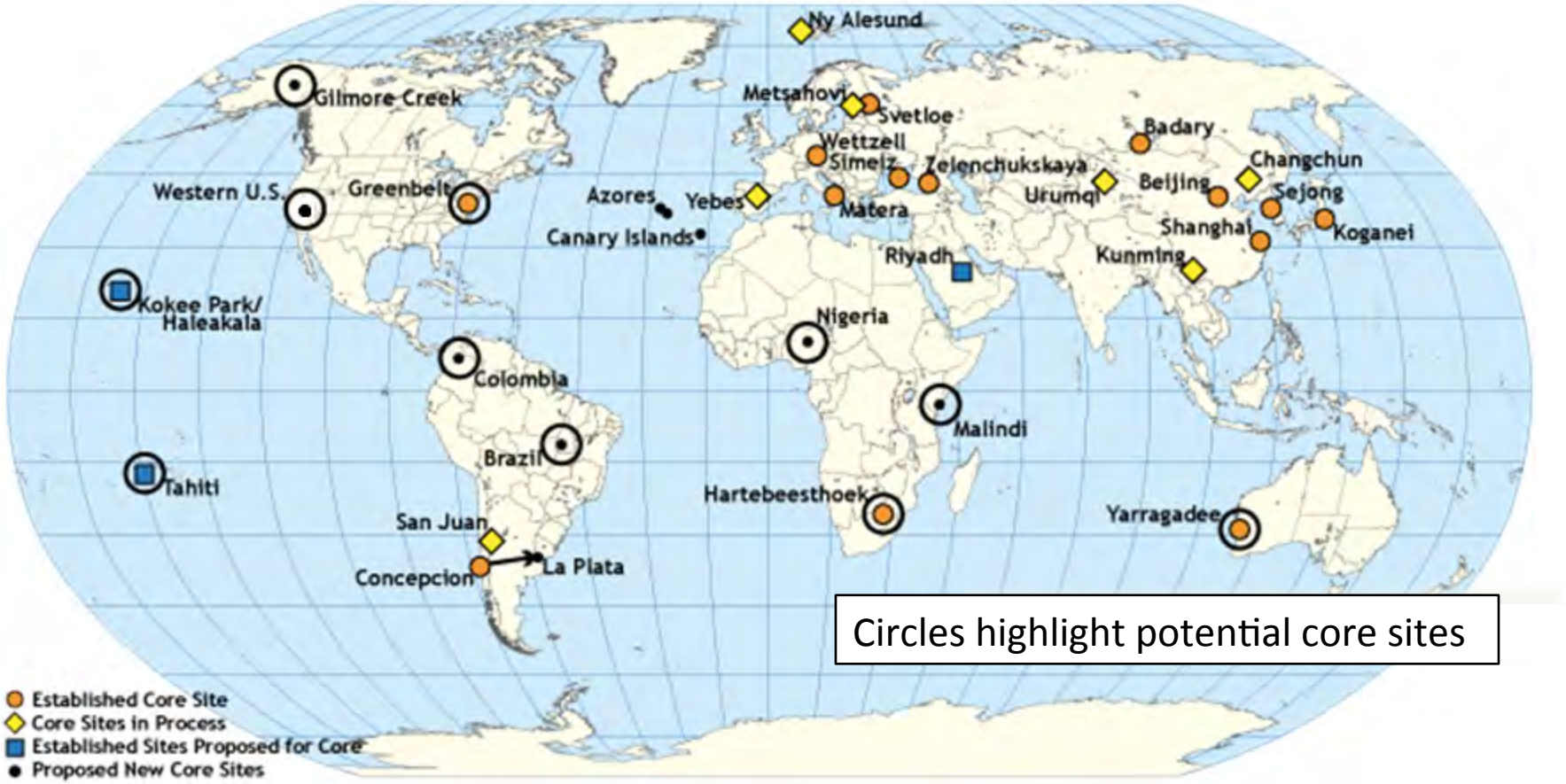
Agency (Country)	Sites
BKG/FESG (Germany)	Wettzell
NERC (UK)	Herstmonceux
IRA (Italy)	Medicina, Noto, Sardinia
OSO (Sweden)	Onsala
FGI (Finland)	Metsahovi
IGN Spain)	Yebes
SPC (Poland)	Borowiec
SHAO (China)	Shanghai, Beijing, Changchun, Wuhan, Kunming, Urumuqi, Sanyo, (San Juan)
GA (Australia)	Yarragadee, Mt. Stromlo, Katherine, Hobart
NASRDA (Nigeria)	Toto
NASA (US)	GSFC, Westford, Kokee Park, Monument Peak,Fortaleza, McDonald, Mt. Haleakala, Hartebeesthoek, Papeete, Arequipa
RIG (Czech Republic)	Pecny
NRF (South Africa)	Hartebeesthoek,
ASI (Italy)	Matera
KACST (Saudi Arabia)	Riyadh (SALRO)
NMA (Norway)	Ny Alesund
RAS (Russian Federation)	Svetloe, Zelenchukskaya, Badari
CNES	DORIS Network

Yellow denotes additions during the last year

Reality

- If we do achieve the full complement of core sites in the right places, it will take a long time;
- Even if we have sufficient resources, its very unlikely that we will find the full compliment of ideal sites; Some sites will have less than ideal conditions;
- Aside from core sites we will always need co-location sites (2 techniques or more) to help link the techniques and enhance global coverage
- We expect a mix of new technology and legacy sites for a long time (maybe forever)
- Data products will depend on this mix of sites and technology indefinitely

Current and Candidate Core Sites



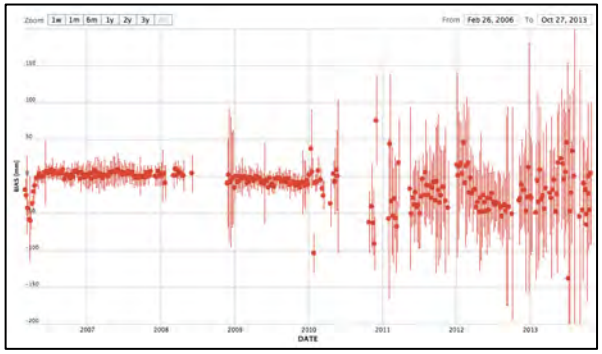
Given programmatic and technical constraints, the NASA SGP core sites (those either wholly owned or supported by NASA) required to cover gaps in the global site coverage are shown here (labeled “Proposed Core Sites”)

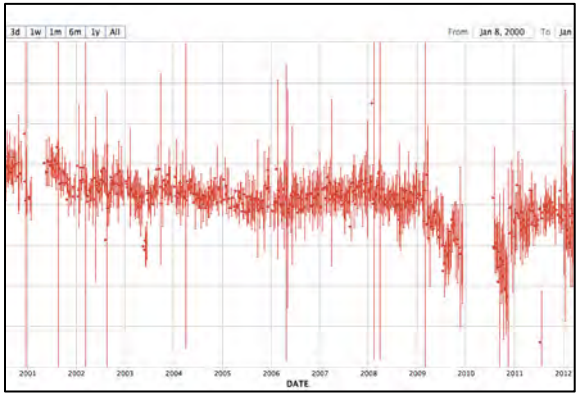
Current Situation

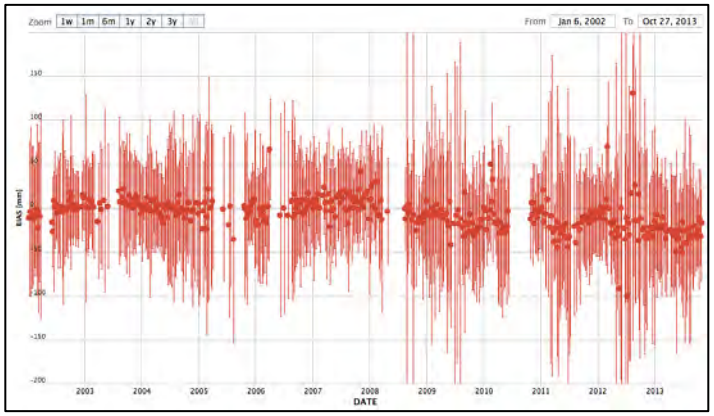
- Giant step improvements in the technology are being implemented;
- mm precision being demonstrated
- New groups/sites are joining the network;
- The analysis and modeling are improving
- But there are still major challenges to meeting the GGOS network requirement
  - Precision verses accuracy
  - Systematic errors
  - Site ties
  - More participants in good locations needed

System Biases and Degradation of System Performance

Examples of Unstable Performance







- System biases are corrupting our data products
- Some data and even some stations must be discarded
- Some are engineering and operational issues
- Some are lack of properly reporting systems changes

ILRS Feedback to the Network

- The ILRS has several AC/AAC groups that QC the data taken by stations within a day after the data were made available at the DCs
  - Results are summarized by CODE, and disseminated weekly, covering the past ten days
  - An ILRS "Global Report Card" is compiled every three months, in the near future it will be done on a monthly basis (now under testing)
- The ILRS implemented the "Rapid Service" email exploder which allows ACs that QC data to send directed emails to stations which demonstrate unexpected behavior, along with estimates of the error and suggestions
- The ILRS AWG maintains a web-based analysis product evaluation, including the continuously monitored systematic errors for each station since 1993
  - Stations are encouraged to query the site often and monitor how analysts see their system's performance
  - Stations should report any extraordinary events at the site or actions on the system, which may explain any of the seen performance deviations in the analysts' series

Summary

Situation

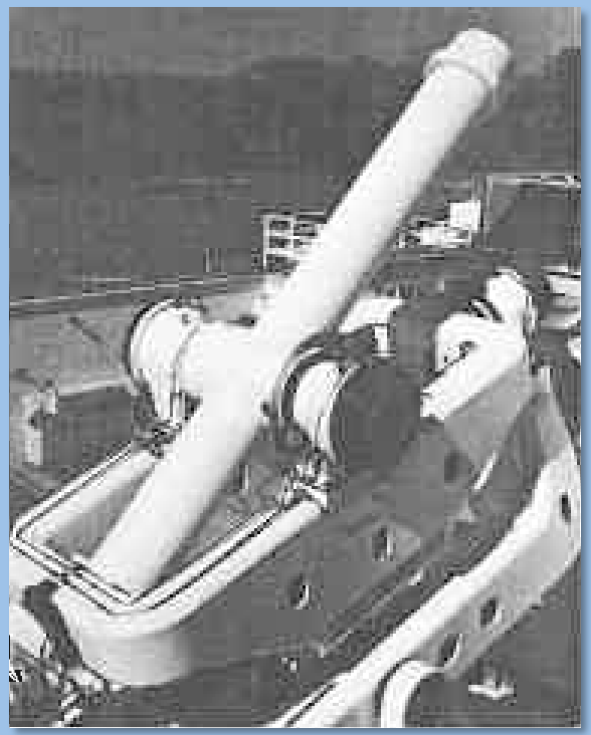
- Significant loss of data due to biases and malfunctions
- Mix of expertise, technologies, and depth of QC at the stations - maybe even depth of interest?
- Analysis Centers provide feedback to the stations – is it in the best form?
- Station responses sluggish and in some cases non-existent

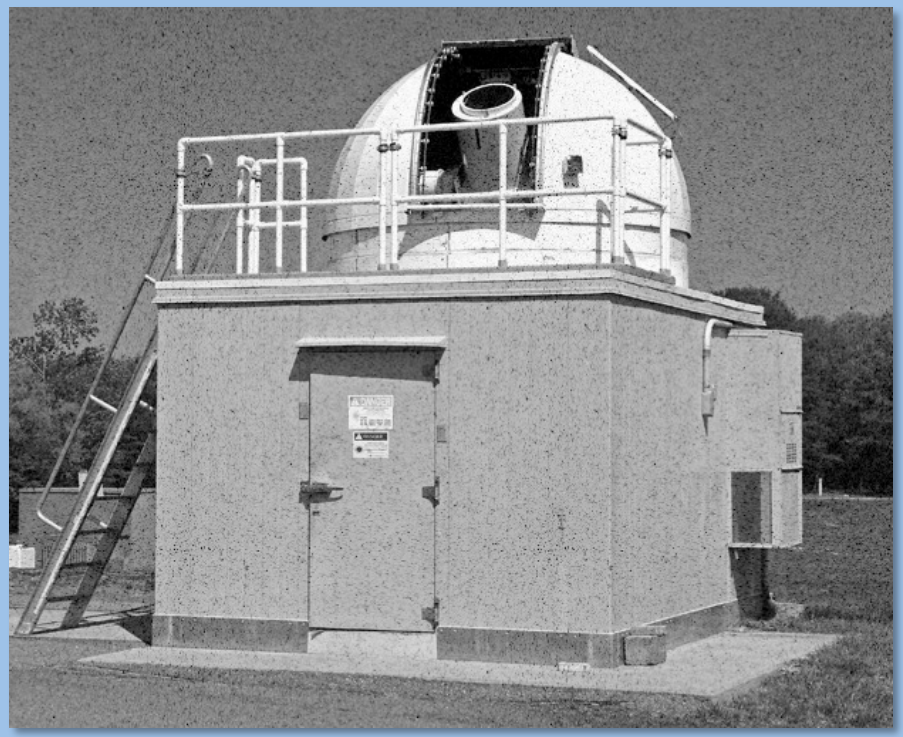
Actions;

- Update/Verify the station mailing lists
- Reiterate the issue clearly on a station by station basis and highlight the QC information on the website
- Direction to the stations on timely responses
- Identify senior level contact for each of the regional networks
- Identify minimum QC procedures for the stations (N&E WG)
- Consider a workshop/clinic for stations, analyst, engineers, etc. to help educate the stations and help improve procedures

2014 ILRS Technical Workshop

"Celebrating 50 Years of SLR: Remembering the Past and Planning for the Future"

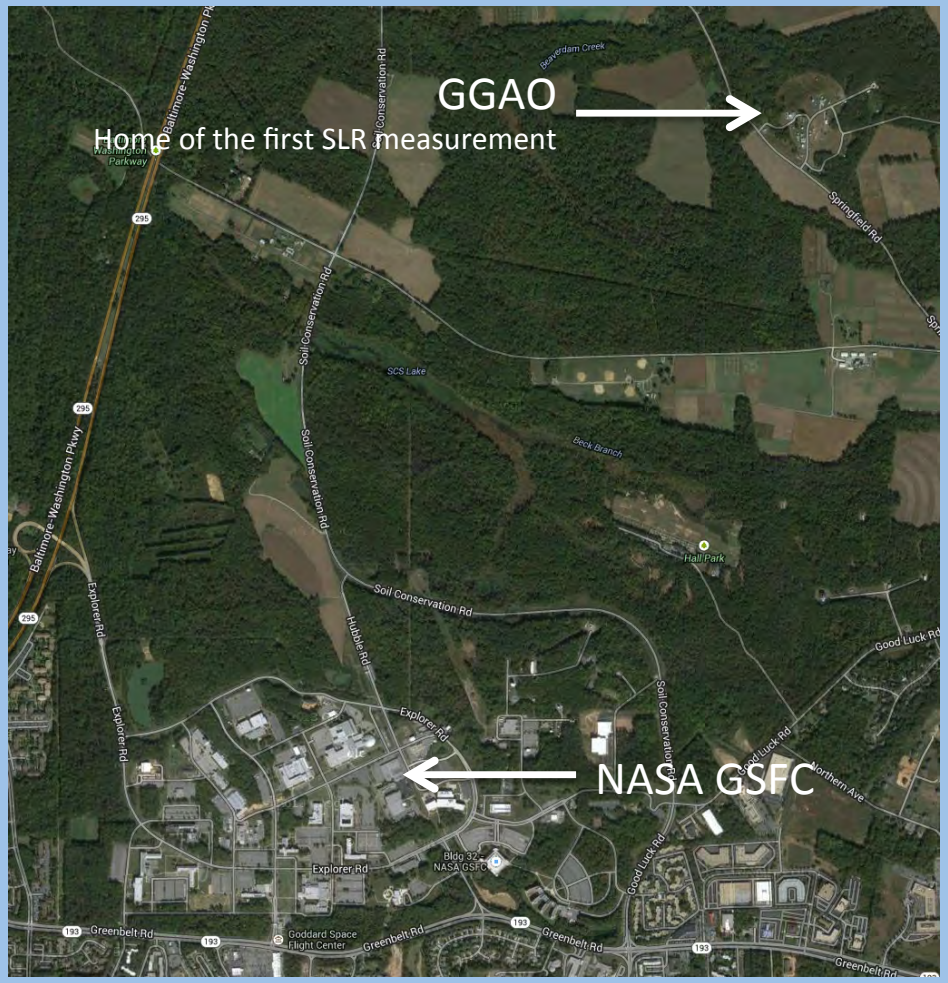




2014 ILRS Technical Workshop

(or 19th International Workshop on Laser Ranging?)

- NASA Goddard Space Flight Center, Greenbelt MD, USA
- October 27-31, 2014
- Theme for this workshop, "Celebrating 50 Years of SLR: Remembering the Past and Planning for the Future”
- First SLR measurement was made at NASA GSFC on October 31, 1964
- October 2014 marks the 50th anniversary of this event
- Solicit speakers from these first days of SLR to share their experiences



2014 ILRS Technical Workshop
Possible Topics

- In the GGOS era:
  - How can SLR better integrate with GNSS, VLBI, DORIS, and other systems to create a co-located, core sites?
  - What factors influence site selection and geographic distribution?
  - What are the interactions between these systems that can affect the measurement accuracy and system operations?
  - How can we characterize and mitigate RFI issues?
  - How can we characterize and measure ties between co-located instruments?
  - What scheduling interactions are possible to maximize efficiencies and data yield?

Resolution from the Eighteenth International Workshop on Laser Ranging

Resolution from the Eighteenth International Workshop on Laser Ranging

- Recognizing:
  - The increasing importance of SLR to the improvement of GNSS performance;
  - The necessity of the SLR technique to the improvement of time, frequency, and ephemeris data products from GNSS;
  - The significant contribution of GGOS to the development of GNSS measurement accuracy through co-location with SLR and other measurement techniques; and
  - The enhancement in station performance that we expect from the next generation SLR systems
  - The availability of full satellite characteristics
- The Participants of the 18th International Workshop on Laser Ranging recommend that:
  - The ILRS develop a GNSS tracking strategy and on the basis of it to implement a mission, based on the example of the fully loaded GLONASS system, and use it to all GNSS satellites equipped with retroreflector arrays;
  - Multi-constellation GNSS receivers(Glonass, GPS, Compass, etc) be co-located at all ILRS stations to improve measurement performance of GNSS and to support GGOS development;
  - All SLR stations will participate in GGOS project.

Goal requested for Glonass Satellites

Each participating station should make its best effort to provide two passes per day, one in day-time and one in night-time for the whole GLONASS constellation; each pass should have 2 NP (1000 fr or 5 minutes), spaced widely apart in the orbit.

Such multi-constellation GNSS receivers could be offered by

Precision Systems and Instruments JSC for all interested ILRS stations.

Resolution from the Eighteenth International Workshop on Laser Ranging

The participants of the Eighteenth International Workshop on Laser Ranging express their

- **appreciation for the funding support from the**
  - **National Institute of Information and Communication Technology (NICT)**
  - **Society for Promotion of Space Science (SPSS)**
  - **Geodetic Society of Japan, and**
  - **Support Center for Advanced Telecommunications Technology Research (SCAT)**
- **gratitude for the academic support from the**
  - **Geodetic Society of Japan**
  - **Japan Society for Aeronautical and Space Sciences**
  - **Science Council of Japan**
- **Overwhelming gratefulness to the**
  - **Local Organizing Committee**
  - **Program Committee; and**
  - **All of those who worked on the event;**

for making the Workshop a very successful and enjoyable event.