ILRS Governing Board Meeting

Austria Center Vienna
Splinter Meeting Room 5 Red Level
Monday, April 16, 2007
17:30 – 20:00

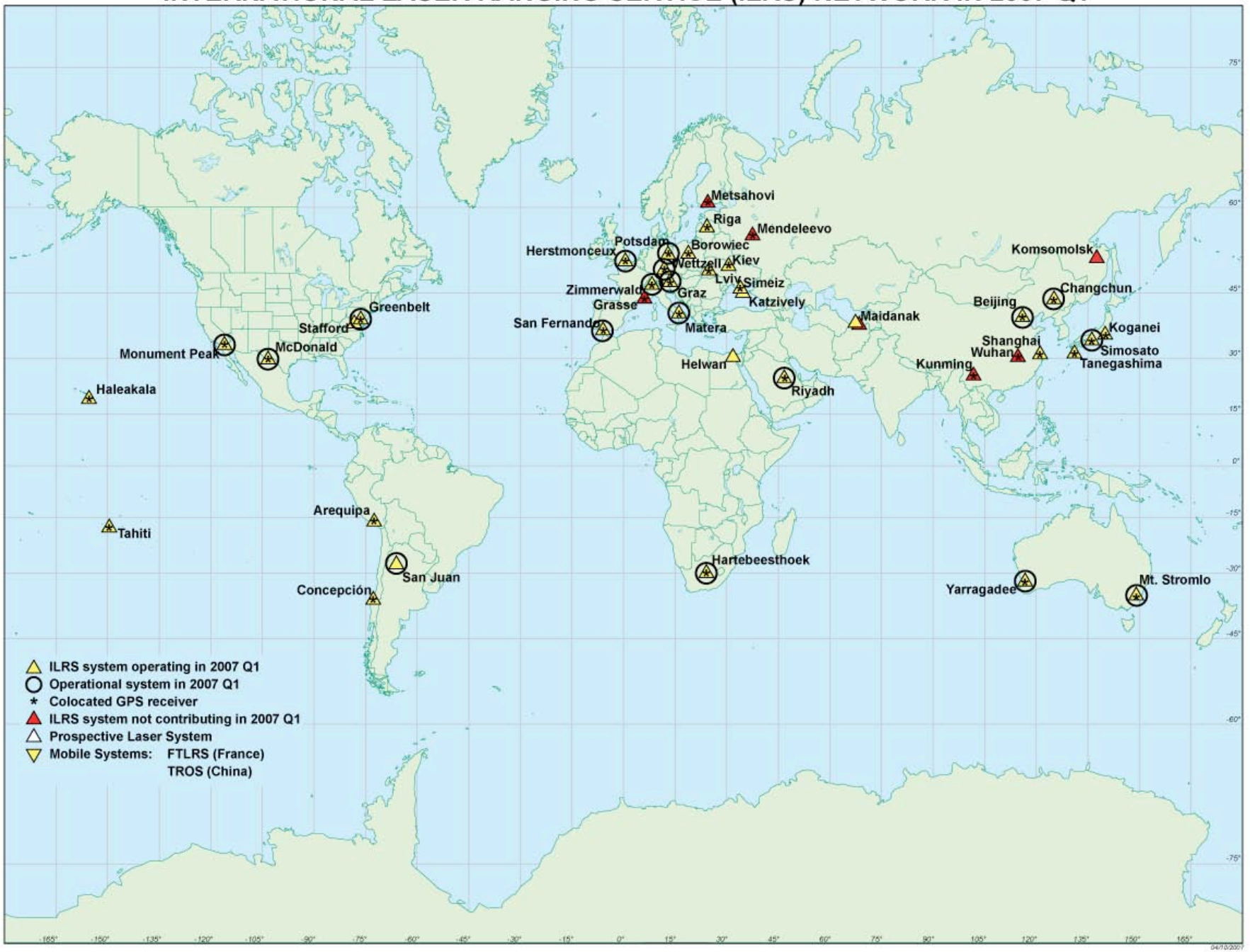
Agenda

• Opening Remarks (5 min.)	W. Gurtner
• ILRS Status/Action Items (15 min.)	M. Pearlman/C. Noll
• ITRF2005 Issues (5 min)	E. Pavlis/W. Gurtner
• Working Group Briefs and Recommendations (5-10 min each)	WG Chairs
✦ Analysis	E. Pavlis/C. Luceri
✦ Missions	G. Appleby
✦ Data Formats and Procedures	W. Seemueller
✦ Networks and Engineering	G. Kirchner
✦ Transponders	
• Galileo Support (5 min.)	W. Gurtner
• Site Ties Study Group (10 min.)	G. Bianco
• Laser Retroreflector Recommendation (10 min.)	M. Pearlman
• Stanford Counter Tests (5 min)	G. Appleby/G. Kirchner
• ILRS Letter of Support for Simosato (5 min.)	W. Gurtner/M. Pearlman
• Fall 2007 Workshop (5 min)	M. Pearlman
• GGOS Activities (5 min.)	M. Pearlman
• New Business	W. Gurtner/WG Chairs
• Other Business	W. Gurtner

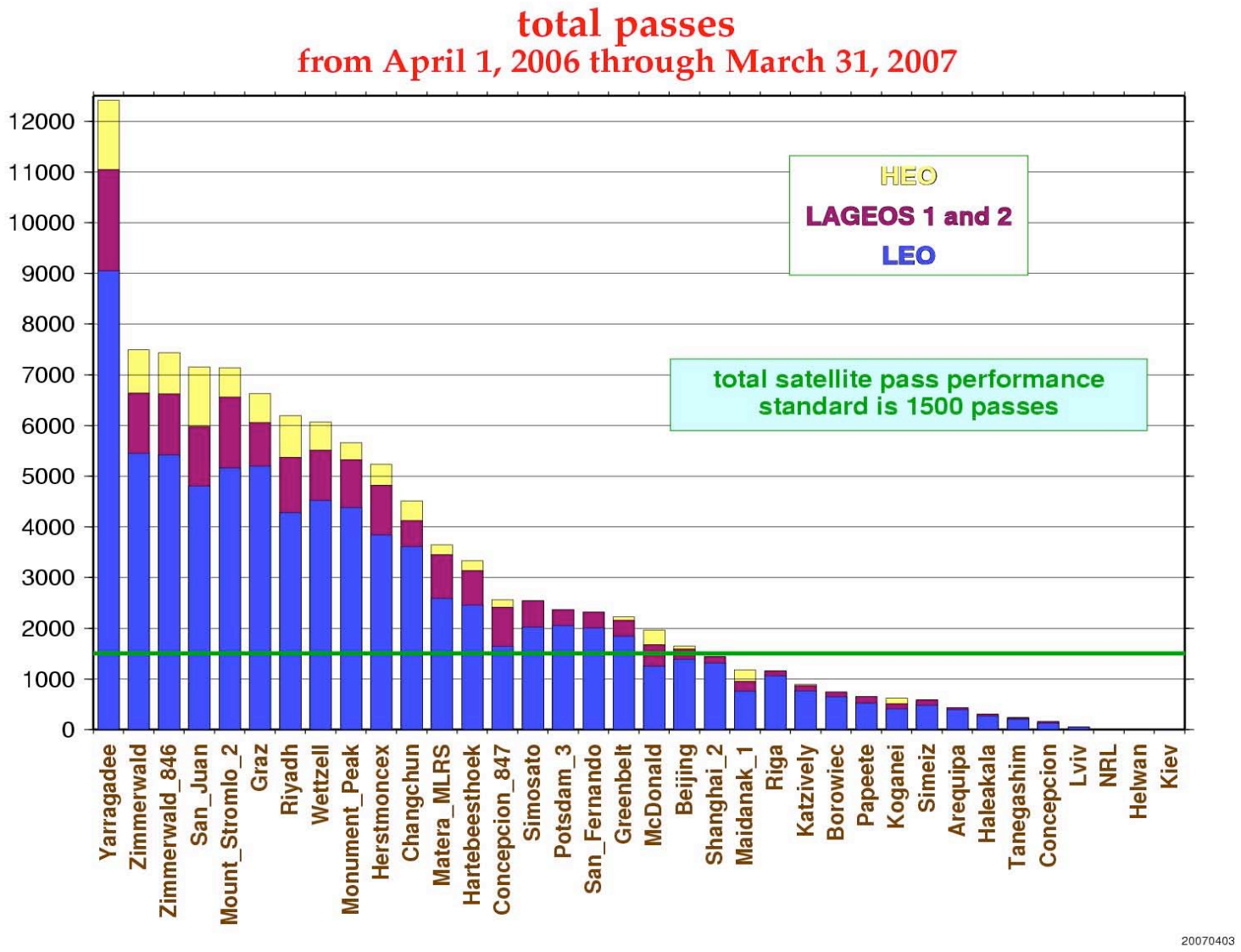
ILRS Update

ILRS Central Bureau
NASA GSFC, Greenbelt, MD USA
cb@cddis.gsfc.nasa.gov

INTERNATIONAL LASER RANGING SERVICE (ILRS) NETWORK IN 2007 Q1

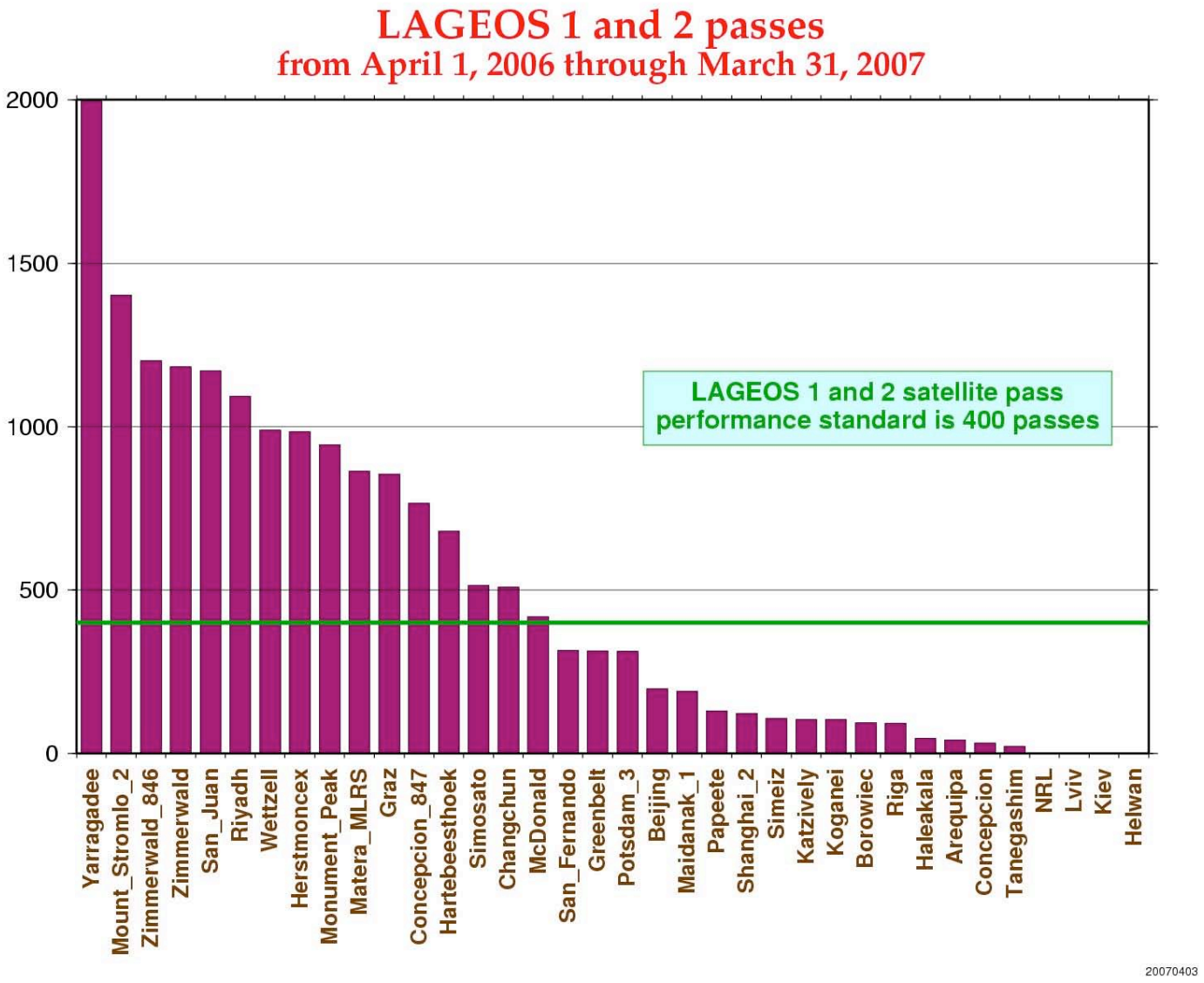


Station Performance
All Satellites (2007Q1)

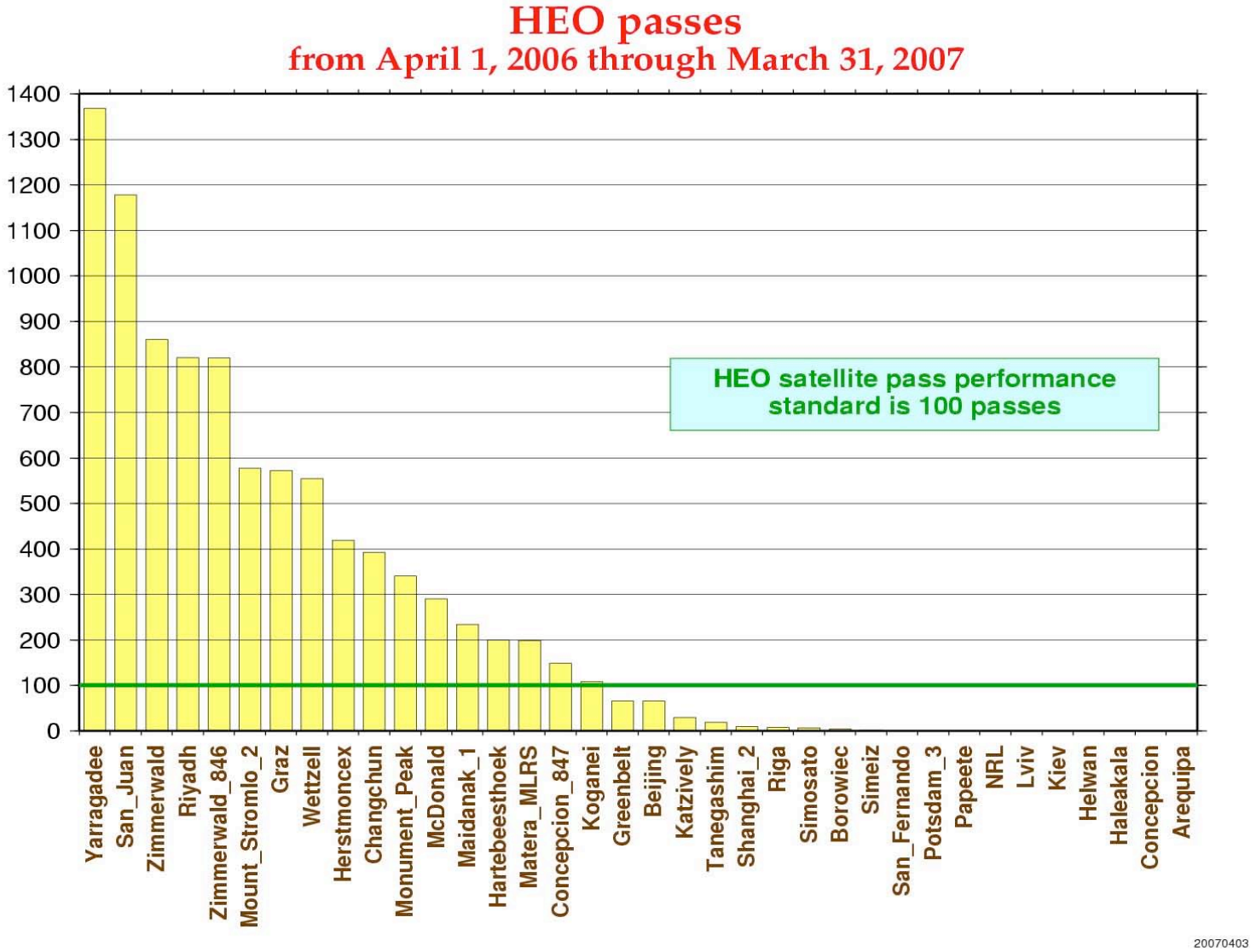


Station Performance

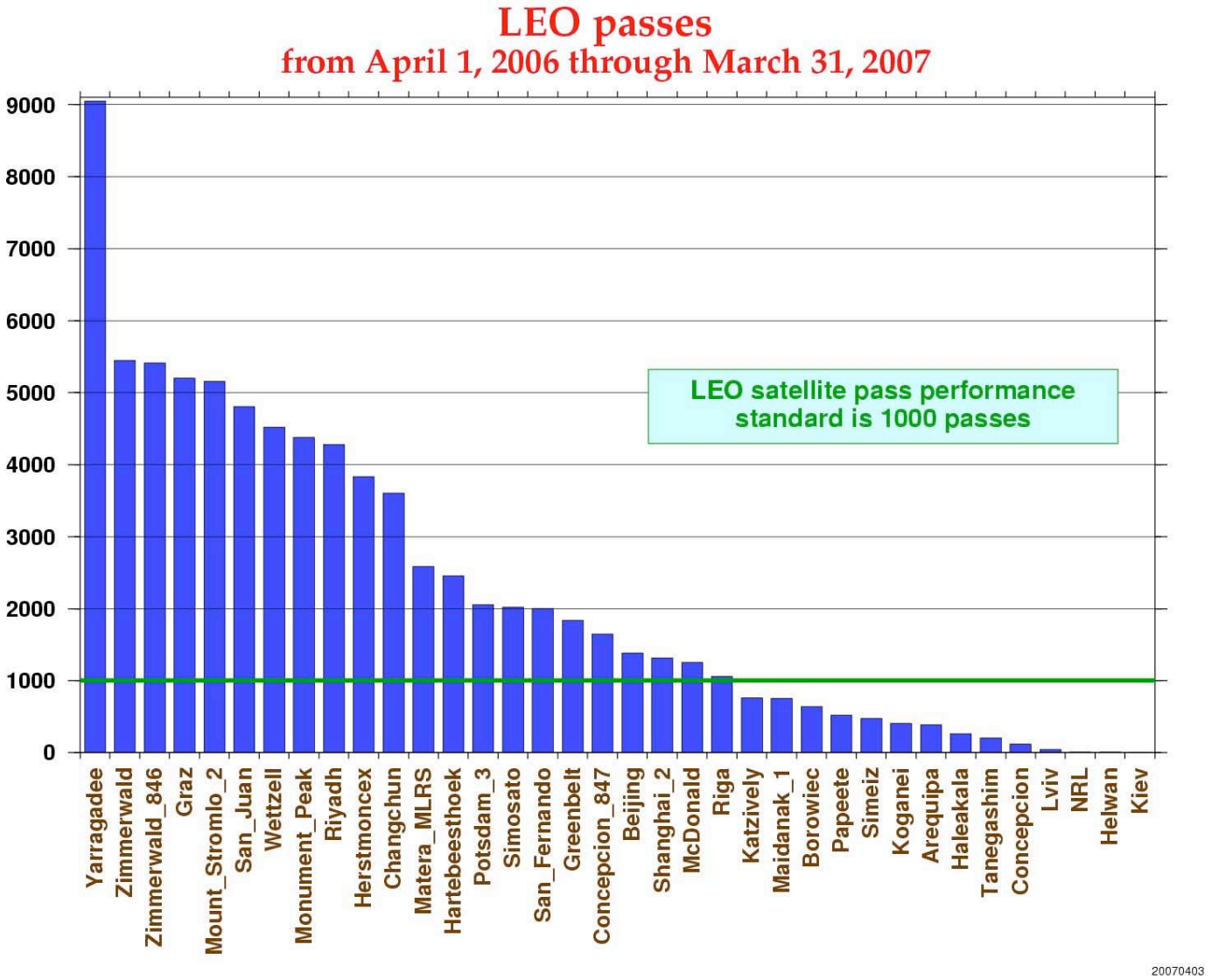
LAGEOS Satellites (2007Q1)



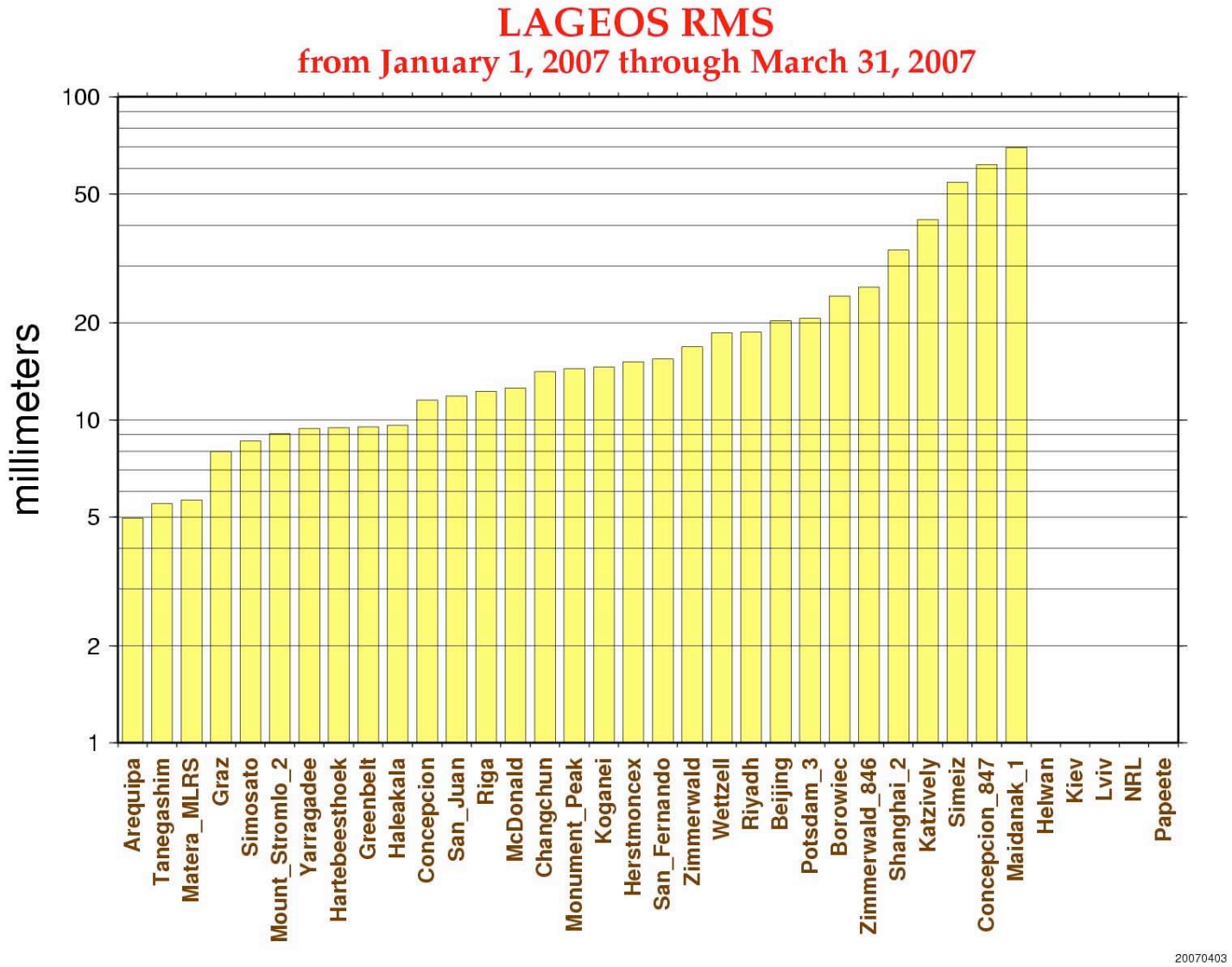
Station Performance
High Satellites (2007Q1)



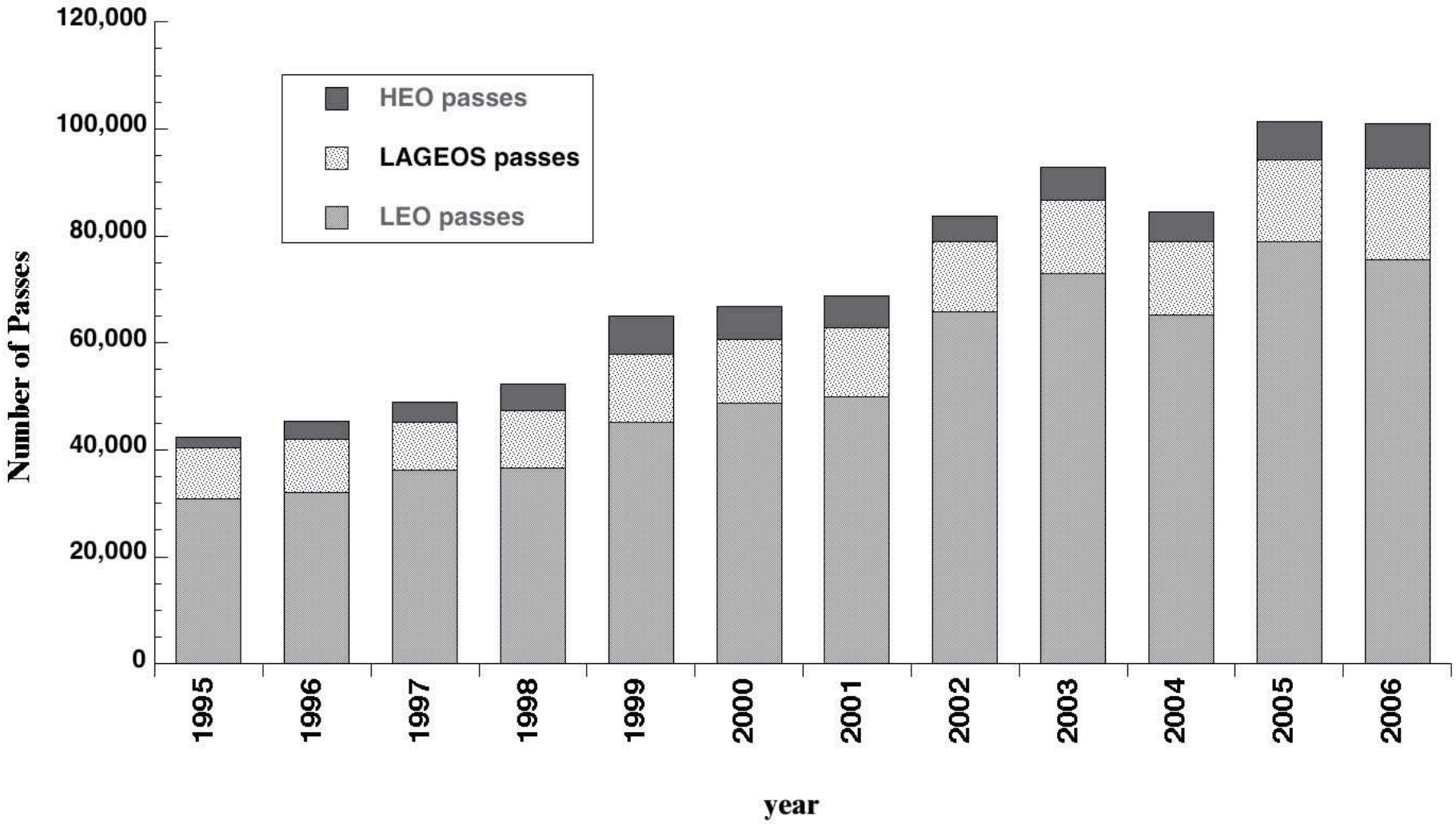
Station Performance
Low Satellites (2007Q1)



Station Performance
LAGEOS RMS (2007Q1)



Annual Data Yield



Network Operations

- ILRS Network Developments
  - 32 global stations providing tracking data regularly
  - Haleakala, HI station reactivated (November 2006)
  - Arequipa, Peru station reactivated (October 2006)
  - Highly productive San Juan, Argentina station, operational since March 2006 (Argentine/Chinese cooperation)
  - Simosato has GPS Receiver, but the station is in jeopardy
  - FTLRS going to Tasmania for a campaign in 2007
  - TROS going to Korea for a three month tracking campaign in 2007
- ILRS Operations
  - Restricted tracking operations implemented to protect optically vulnerable satellites (ICESat, ALOS, etc.)
  - Some holdouts remain on operational implementation of the CPF Prediction Format

Mission Developments

- Missions News
  - Supporting 26 missions and lunar tracking
  - New missions supported: GIOVE-A (Galileo), Atmospheric Neutral Density Experiment Risk Reduction (ANDE-RR), geosynchronous Engineering Test Satellite 8 (ETS-8)
  - Impressive tracking on ETS-8 by Yarragadee
  - ILRS GB approved support of TerraSAR-X, PROBA-2
- GNSS Retroreflector Activities
  - Dialog continues with relevant agencies on the importance of including reflectors on GPS-III satellites
  - Specification document for GNSS array created for Governing Board consideration
  - Study underway at GSFC on hollow cube technology in collaboration with a newly-established testing facility (LNF, Italy)

Analysis Activities

- ILRS official products (station coordinates and EOP) issued weekly
- Seven ILRS Analysis Centers (ASI, DGFI, BKG, GA, GFZ, NASA GSFC/JCET, and NERC) contribute to the official products
- Combination and Combination Back-up Centers at ASI and DGFI
- Analysis of early LAGEOS (1976-1993) data underway for ILRS product submission to the next reference frame
- POD product for geodetic satellites (initially) to be routinely available in mid-2007
- T. Otsubo moved from NICT to Hitotsubashi University
  - Will continue data analysis and reporting activities at HU
  - Applied for AAC status for HU; application accepted by AC coordinator
  - NICT plans to continue AAC activity

NGSLR Developments

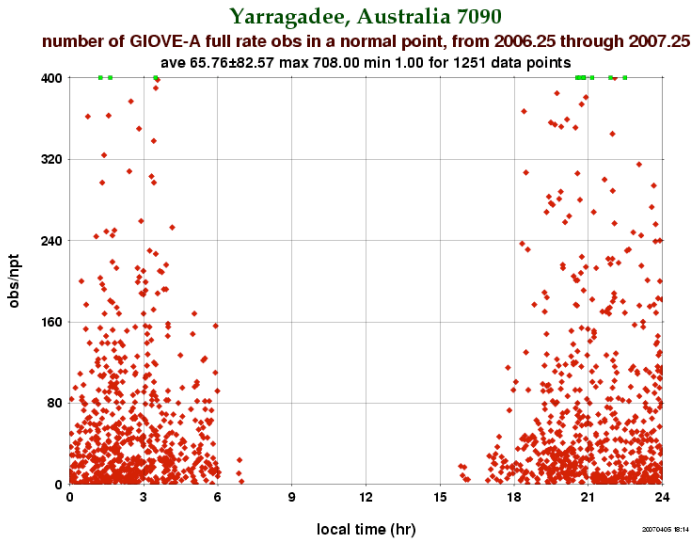
- NGSLR (Next Generation SLR, formerly SLR2000)
  - Schedule presented to NASA HQ has co-location of NGSLR with MOBLAS-7 in early summer 2008
  - NGSLR has tracked LAGEOS (several passes) with eyesafe laser
  - LRO-LR lasers have been delivered and are being characterized in lab
  - Radar for use with LRO-LR laser is being installed
  - Closed-loop tracking is the remaining NGSLR technical challenge to solve

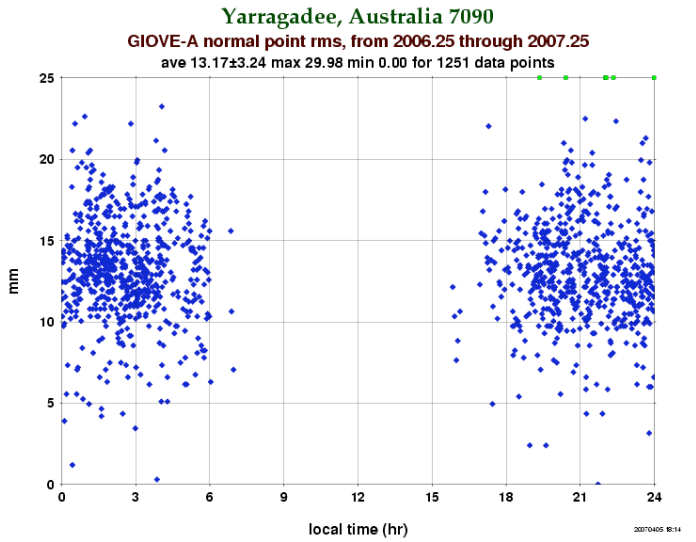
Technology Developments

- 2 KHz operations to be implemented soon at Herstmonceux station; Zimmerwald ordered 100 Hz laser in spring 2007
- Autonomous operations continue at Zimmerwald and Mt. Stromlo stations
- Eye-safe operations and auto tracking (self tracking) being demonstrated at GSFC with the Next Generation SLR (NGSLR, formerly SLR2000)
- Event timers with near-ps resolution now available; older ET biases calibrated at Herstmonceux and errors accounted for in new AC products
- Work continues on optical transponders for lunar and interplanetary ranging
  - LRO-LR

ILRS Web Site Developments

- Added new ILRS product description and links to on-line archive
- Developed retroreflector information form (required for new missions)
- Continue to update CoM pages (new values for GLONASS and Galileo)
- Developed additional ILRS station performance plots





Meetings and Reports

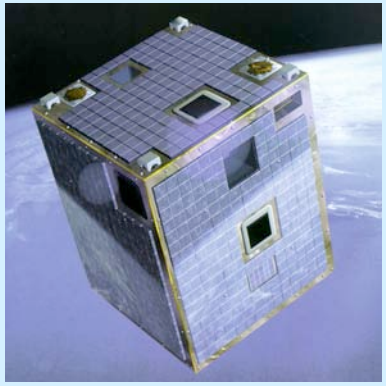
- Meetings
  - 15th International Workshop on Laser Ranging held in Canberra, October 2006
    - EOS is assembling report
  - Specialized ILRS workshop scheduled for Grasse on Sept. 25-28, 2007
    - *http://www.grasse-riviera.com/article.php3?id_rubrique=21*
    - No program organization to date
    - Analysis Working Group Meeting in Grasse on Sept. 24, 2007
  - "Unified Analysis Workshop" tentatively scheduled for Dec. 5-7, 2007 prior to the Fall AGU in San Francisco
- Reports
  - ILRS 2005-2006 Report in process; a few sections still missing
  - GSFC will edit and assemble report

ILRS Missions Working Group Report to Governing Board, 16th April 2007

Graham Appleby and Peter Shelus

- Current convenors installed at 15th LR Workshop in Canberra in October 2006.

- In early January 2007, PROBA-2 SLR Mission Support Request was submitted by the German Space Operations Center, Oberpfaffenhofen on behalf of ESA.



PROBEA-2

- Primary mission is Solar observation and plasma physics;
- also contains a strong technology demonstration element including in-flight validation of two new GPS receivers;
- a Sun-synchronous 780Km, 98 degree orbit;
- due for launch in December 2007.

PROBEA-2

- LRA is a compact cluster, identical to that placed on CryoSat.
- A detailed spec was submitted along with the mission request.
- Laser campaigns were requested in order to support precise orbit determination for cal/val exercise

- Opinions on whether ILRS should support the mission were solicited from Missions, Analysis and Networks WGs during Jan/Feb 2007.

PROBEA-2

- Questions were raised about whether ILRS should support ‘commercial’ mission (testing new GPS receivers)
- Also strongly suggested that the community should have access to the GPS data as part of the bargain.

- Not unanimous, but eventually consensus was that ILRS **should** support mission.

- Tracking was approved by GB on 16th Feb 2007.
- Launch expected late 2007.

Other missions

- The Microscope mission is no longer seeking ILRS support.
- Retroreflector information for TerraSAR-X has now been submitted - is on ILRS web
  - The mission was approved for ILRS support in December 2006;
  - Launch now expected in May 2007.

Recent Activities in Signal Processing WG

New Chair, New Members

T Otsubo named as a new chair at Canberra (who then left NICT in March and currently with Hitotsubashi Univ.).

3 new members, S Dell'Agnello, J J Degnan and M H Torrence joined the WG in January.

Ongoing work & To-do work

Design of LRA for highly elliptic orbits (ASTRO-G = future space VLBI mission by JAXA).

Precise model of response functions of spherical satellites using single-photon kHz data.

More

Chair will appear in France.

Next

WG meeting planned in conjunction with Grasse Workshop in Sep.

International Laser Ranging Service

GIOVE-A TRACKING

Werner Gurtner

Performance 2006

Site Name	Sta.	GP35	GP36	GL87	GL89	GL95	GIOA*	Total
Yarragadee	7090	125	110	200	196	196	78	905
San Juan	7406	81	83	96	126	138	57	623
Zimmerwald	7810	58	61	169	148	127	53	616
Monument Peak	7110	12	6	64	44	17	33	176
Graz	7839	24	50	97	81	79	33	364
Wettzell	8834	36	28	95	75	51	33	318
Mount Stromlo	7825	69	57	105	86	87	29	433
Herstmonceux	7840	26	38	59	59	46	28	256
Changchun	7237	15	2	75	54	68	28	242
Mcdonald	7080	31	30	23	40	28	25	177
Matera	7941	5	5	40	24	4	14	92
Riyadh	7832	117	121	89	99	96	11	533

* Note: GIOVE was tracked only the last eight months of the year.

Proposed Campaigns

- Max beta angle in 2007, from 8 to 28 June
- Eclipse season in September 2007, from 5 to 30 September
- Mid beta angle value 2007, from 18 October to 8 November
- Min beta angle 2007, from 5 to 25 December
- Mid beta angle value 2008, from 21 January to 10 February
- Eclipse season in March 2008, from 1 to 23 March

(Mail to the CB by Daniel Navarro-Reyes, ESA, April 11, 2007

Future Satellites

- GIOVE-B is under final integration and scheduled to be launched at the end of 2007
- ESA awarded a contract to SSTL for initial activities leading to the construction of GIOVE-A2 for ensuring mid-term availability of GIOVE mission
- The satellite shall be ready for launch on the second half of 2008, but the launch date will be decided depending upon GIOVE-A and GIOVE-B in-orbit performance.

Glonass Tracking

- Glonass 89: Stopped operation, set unhealthy
- Idea: Replace by one of the last series of December 2006
- Select satellite in third plane -> one satellite per orbital plane. Discussed with Russian MCC
- Problem: This satellite only tracked by one station (Javad receiver in Zimmerwald)
- Proposal: Stop tracking Glonass 89 immediately

Should the ILRS define a Performance Standard (or Recommendation) for Retroreflector Arrays in Space?

In particular, should we make a definition for “high satellites”?

- **Criteria:**
  - **“Effective cross section” should be sufficient to provide enough return signal strength to support mm level normal point accuracy by the ground stations.**

- **Timely: GPS-III, Galileo, Glonass**

PASS SEGMENTS for SEP-2005

Station	PAD	WAVE	GPS35	GPS36	GLONASS87	GLONASS89	GLONASS95	TOTAL
Maidanak	1864	5320			5	5	3	13
Simeiz	1873	5320			1	4		5
Riga	1884	5320		1				1
Mcdonald Observ	7080	5320	8	8	12	3	4	35
Yarragadee	7090	5320	44	2	66	35	51	198
Greenbelt	7105	5320	1		1	10	5	17
Monument Peak	7110	5320	18	11	15	15	22	81
Changchun	7237	5320				2	1	3
Tanegashima	7358	5320			2			2
Hartebeesthoek	7501	5320			17	41		58
Zimmerwald	7810	4230	9	16	17	19	16	77
Zimmerwald	7810	8460	7	13	16	20	15	71
Mt Stromlo	7825	5320	3		8	11	7	29
Riyadh	7832	5320	20	18	10	13		61
Graz	7839	5320	6	7	13	10	7	43
Herstmonceux	7840	5320		6	9	8	8	31
Wettzell	8834	5320	4	3	15	11	17	50
			120	85	207	207	156	775

Where do we stand?

- **“The best” stations**
  - **range to LAGEOS in both daytime and night-time;**
  - **range GLONASS at night with some success in daylight;**
  - **range to GIOVE-A at night**
- **A few stations range to GPS 35/36 at night;**

- **Some stations are upgrading hardware and operational procedures**
  - **So we should expect some improvement**

Relative Signal Strength Normalized to LAGEOS

(Effective Cross-Section (ECS) are estimated from the array and cornercube specifications)

Satellite	Average Range (in 10^3 km.)	Eff. Cross Section .(in 10^6 m^2)	R**4 (in 10^{16} m^2)	Relative Signal Strength normalized to LAGEOS
LAGEOS	6 – 8	7	0.24	1
GLONASS	19 – 21	76	13.3	0.1
GPS 35/36	20 – 22	19	16.0	0.02
GIOVE-A (Galileo)	24-26	45	31.0	0.025

What do we want on GPS III?

Based on:

- Experience with GLONASS;
- Anticipated improvements in the ground systems

It would be very helpful if we could gain another factor of five in ECS on GPS (100 million m^2)

Array Information

- **Arrays on GLONASS, GSP 35/36, and GIOVE-A (Galileo)**
  - **made by IPIE in Russia and are presumed to be identical;**
  - **cubes are back-surface aluminum coated; no dihedral angle.**
- **LAGEOS array;**
  - **cubes are uncoated; small vertex offset angle;**
  - **relies on total internal reflection (same as Apollo arrays)**

Options

- Solid cubes similar ETS-VIII satellite. Array areas and weight have been estimated by scaling from the cube size and number of cubes on ETS-VIII. The solid, back-coated cubes are assumed to be the same as those provided by IPIE for GPS, GLONASS, and GIOVE-A. The current GPS 35 and 36 arrays have 32 cubes with an array area of 463 sq cm and mass 1.28 kg.

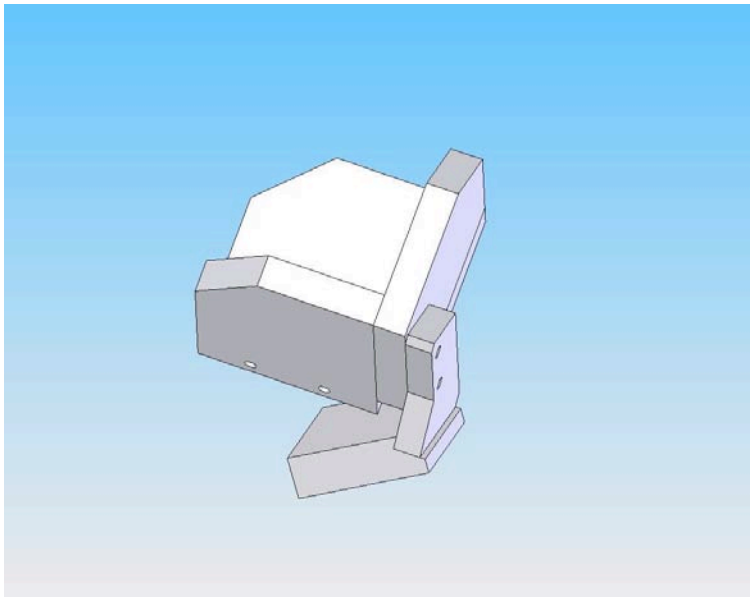
Array Options for Effective Cross Section of 100 million sq. meters.

Design	# of cubes	Diameter of cubes (inch)	Approx. Area of the array (sq cm)	Approx. Mass of the arrays (Kg)
Solid – uncoated (scaled ETS)	50	1.3	847	2.3
Solid – coated (scaled GPS)	160	1.06	2300	6.4
Hollow (calculation)	37	1.4	730	1.2

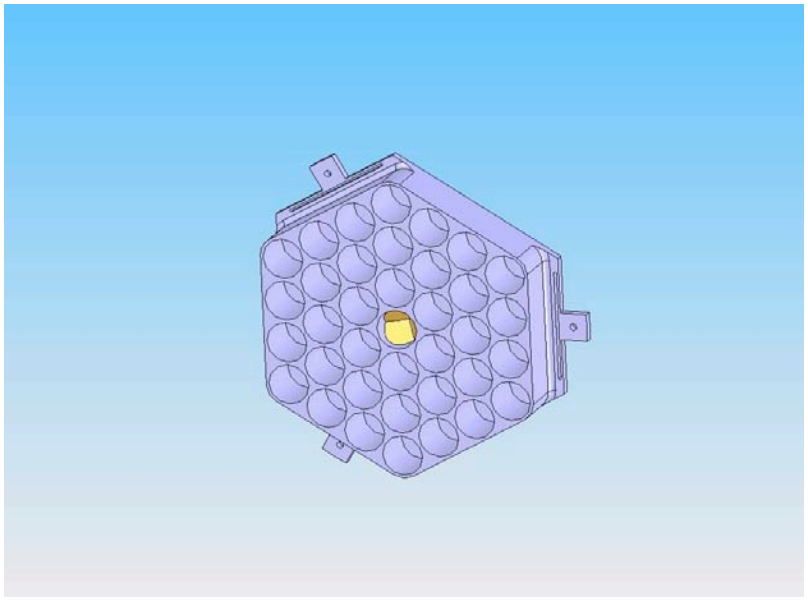
Current Activities

- Design and performance studies are currently underway at GSFC to determine the viability of a space qualified hollow cube (see figure 1). The area and weight for the hollow cube option is based on those studies. The hollow cubes would be purchased locally. If they are successful, the hollow cubes would take less space and offer a considerable savings in weight.
- The Laboratori Nazionali di Frascati (LNF) has the facilities to fully test corner cube arrays under space conditions. While they are testing their own arrays for the LARES satellite, they have offered to test some other configurations for other space missions. They will be in a position to perform these tests toward year's end.
- The Plan:
  - Complete the design and performance studies at GSFC
  - Test the spare GPS array to see if the present performance in GPS 35/36 is nominal;
  - Test the LAGEOS array sector as a means of normalizing these and all future array measurements;
  - Test a set of uncoated cubes to see if the anticipated improvement can be realized;
  - Procure and test the hollow cubes to see if their anticipated performance can be realized.

Hollow Cube Array



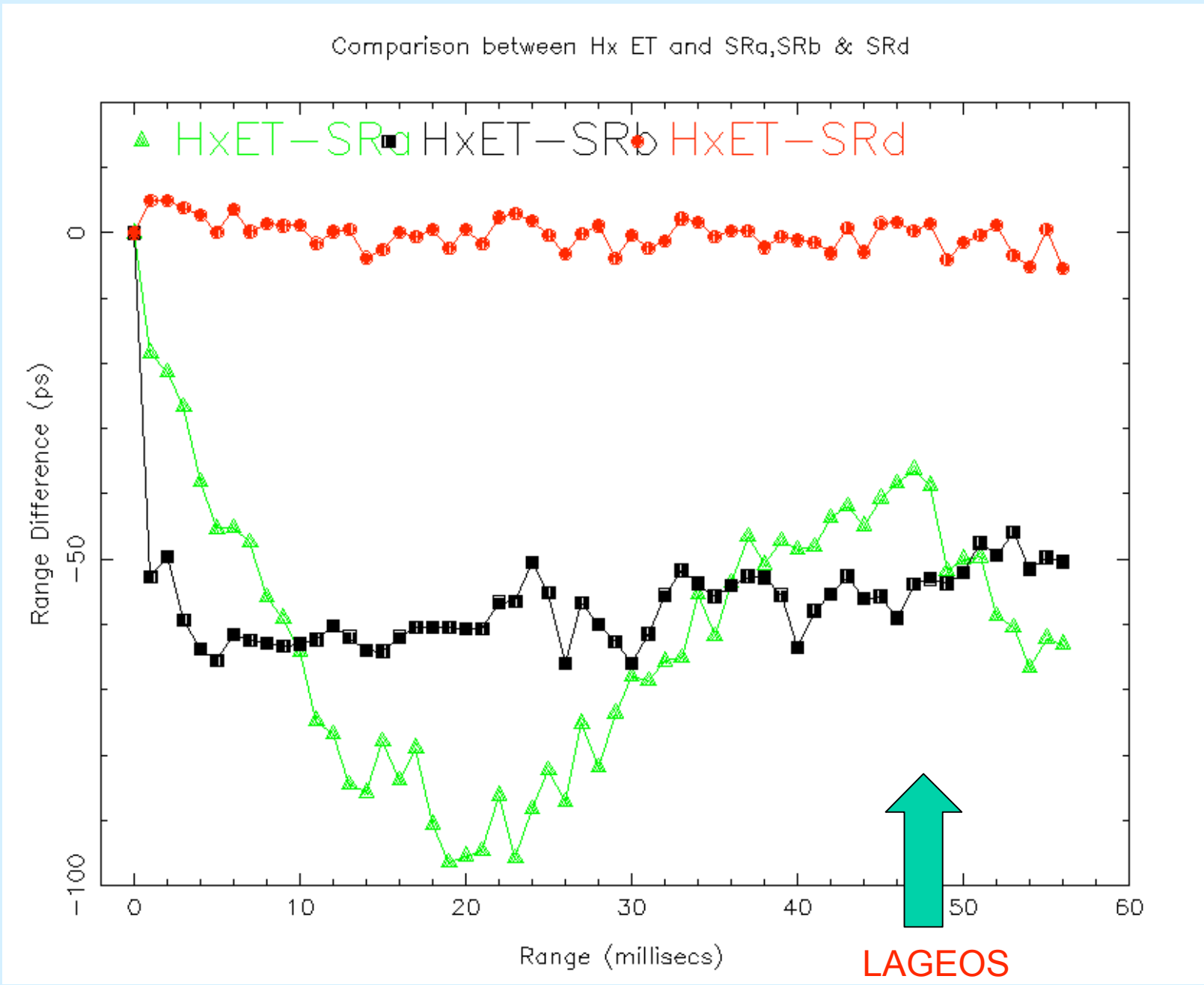
Single hollow cube

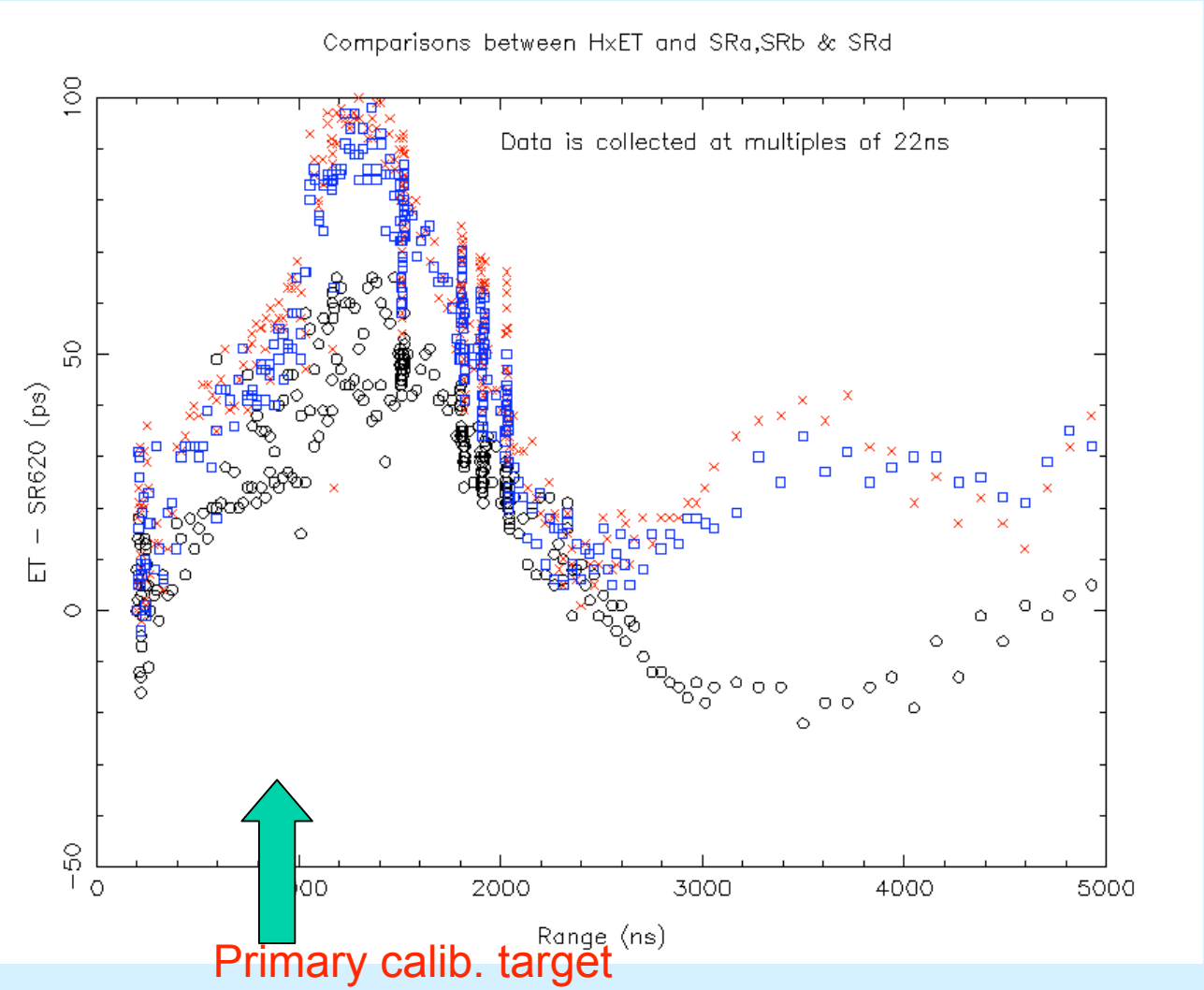


Hollow cube array configuration

Tests on counter linearity

- Work was started by a careful examination of *Stanford* (SR) counters in use at Herstmonceux, UK, relative to a high-spec, ps-level event timer.
- Studied effects at LAGEOS and at local calibration target distances.
- Moved on to estimate effects in ILRS network:
  - Relative to a ‘perfect’ time-of-flight counter, what are the characteristics of the SR counters in common use over the last 15+ years?


Comparison between Hx ET and SRa,SRb & SRd
HxET−SRa
HxET−SRb
HxET−SRd
Range Difference (ps)
0
−50
−100
0
10
20
30
40
50
60
Range (millisecs)
LAGEOS

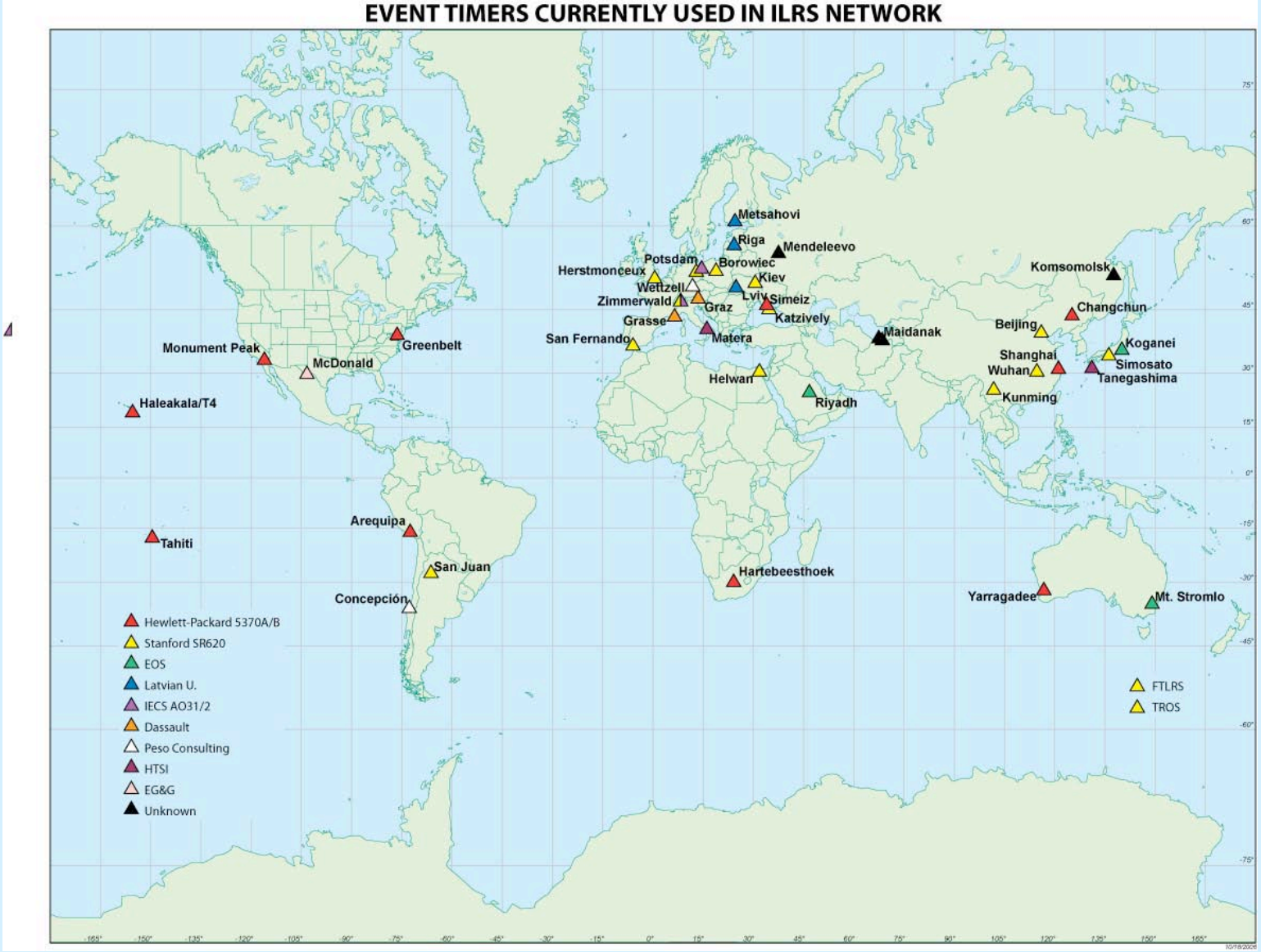


Test runs between HET and the Stanfords at 0-5000ns range (calibration boards' distances);
Behaviour very similar to spec;
Errors up to 100ps, with some systematic detailed structure

Summary of effect on range measurements at Herstmonceux (1992-2006)

- The non-linearity of the Stanfords:
- imparts an average of ~7±2mm error onto the observed calibration range;
- Value is dependent on the target range and on the particular Stanford;
- At distance of LAGEOS, range error is between zero and ~8±2mm;
- **So total range error was up to 15mm**
- **Currently error is ~zero, with new event timer**

Effect present in other ILRS stations?



Effect present in other ILRS stations?

- At this stage, we confine our investigation to Stanford counters;
  - Our limited experience with *e.g*. HP timers suggests they do not have problem – used by NASA network
- We have made ‘worst case’ estimates of calibration error and total range error at LAGEOS for all ‘Stanford stations’
- Largest error is ~20mm, frequent error 10mm
- Uncertainty in these **estimates** is ~5mm

Worse-case error estimates (mm)

Station		ID	Calibration error	LAGEOS error	Total error
BEIL	Beijing	7249	12	10	22
BORL	Borowiecz	7811	9	0 meas	9
BREF	Brest	7604	10	10	20
GLSV	Kiev	1824	6	10	16
HELW	Helwan	7831	0	10	10
HERL	Herstmonceux	7840	8 meas	0 meas	8
KTZL	Katzively, Ukraine	1893	0	10	10
KUNL	Kunming, China	7820	9	10	19
POT3	Potsdam	7841	0	10	10
POTL	Potsdam	7836	0	5 meas	10
SFEL	San Fernando	7824	0	8 meas	8
SISL	Simosato, Japan	7838	-1	10	9
SJUL	San Juan	7406	0	10	10
WUHL	Wuhan	7231	0	10	10
ZIML	Zimmerwald	7810	3	8 meas	11
Closed sites					
GRSL	Grasse	7835	1	10	11

meas = measured on particular Stanford counter

Summary/outlook

- We emphasize that:
- These stations are a subset of the full ILRS network, but do include some core sites;
- The counters can be calibrated (ongoing) and past data reprocessed;
  - SGF have started this work, by inviting EUROLAS stations to send their counters to Hx – Potsdam so far; need to consider counter loans to speed progress.
- Several of the stations have already upgraded to higher-quality counters.

Fall 2007 Laser Workshop

- September 25-28, 2007 in Grasse, France
- First “brief” circular already issued
- Workshop – Some introductory talks and lots of discussion
- Each WG must provide at least two topics and lead at least one session
- Analysis WG meeting on September 24

Global Geodetic Observing System (GGOS)

- GGOS 2020 document (Justification and Background) being developed for presentation to IAG in July
- Geodetic Requirements
  - Reference Frame Requirement – 1 mm stability over 10 years
  - Ground Networks include co-located SLR, VLBI, GNSS, DORIS, Gravity Field, etc
- Activities of the GGOS WG on Networks and Communications
  - Posting of network information on the GGOS website
  - Simulations to scope size and distribution of the GGOS network to support of Reference Frame and POD
  - Examining Options for accurate ground survey monitoring at co-located stations
  - WG Meeting at Technical University on Wednesday evening at 18:00 in Seminar Room 124 (CB0308).

	15TH INTERNATIONAL WORKSHOP ON LASER RANGING			
	Canberra, Australia October 16 to 20, 2006			
			STATUS at 12 April 2007	
Session Name	**Author**	**Title of Paper**	**Received by Editor**	**MISSING**
MONDAY				
Science Products: Steve Klosko, Gerhard Beutler	J Andres, R Noomen -- INVITED	Enhanced modelling of the non-gravitational forces acting on LAGEOS		**With Steve Klosko?**
Science Products	C Urschl, G Beutler, W Gurtner, U Hugentobler,S Schaer -- INVITED	Calibrating GNSS orbts with SLR tracking data	Yes	
Science Products	F Deleflie, S Melachroinos, F Perosanz, O Laurain, P Exertier	GIOVE-A and GPS-35 satellite orbits: analysis of dynamical properties based on SLR-only tracking data		**Missing**
Science Products	R Govind	Orbit Determination and Analysis for GIOVE-A using Satellite Laser Ranging Data		**Missing**
Science Products	C Urschl, G Beutler, W Gurtner, U Hugentobler, M Ploner	Orbit Determination for GIOVE-A using SLR tracking data	Yes	
Science Products	Lambeck, Kurt -- INVITED	Satellite Laser Ranging in the National (Australian) Collaborative Research Infrastructure Proposal for Geospatial R&D		**Missing**
Science Products	F Lemoine, S Klosko, C Cox, T Johnson -- INVITED	Time-variable gravity from SLR and DORIS tracking		**Missing**
Science Products	W Peltier -- INVITED	Global Glacial Isostatic Adjustment: Target Fields for Space Geodesy		**Missing**
Science Products	E Pavlis, I Ciufolini, R Konig	Recent Results from SLR Experiments in Fundamental Physics		**Missing**
Science Products	F Delefilie	A "web service" to compare geodetic time series		**Missing**
Science Products	D Coulot, Ph. Berio, A Pollet	Least-square mean effect: application to the analysis of SLR time series		**Missing**
Science Products	H Mueller, D Angermann, M Kruegel	Some Aspects Concerning the SLR Part of ITRF2005	Yes	
Science Products	R Govind	Determination of the Temporal variations of the Earth's Centre of Mass from Multi-Year Satellite Laser Ranging Data		**Missing**

Science Products	D Gambis, R Biancale	Contribution of Satellite & Lunar Laser Ranging to Earth Orientation monitoring		**Missing**
Science Products	Z Altamimi -- INVITED	Station Positioning and the ITRF		**Missing**
Science Products	R Koenig, H Mueller	Station Coordinates, Earth Rotation Parameters and Low Degree Harmonics from SLR within GGOS-D		**Missing**
Science Products	D Coulot, Ph. Berio, O Laurain, D Feraudy, P Exertier	An original approach to compute Satellite Laser Ranging biases		**Missing**
Science Products	D Coulot, Ph. Berio, O Laurain, D Feraudy, P Exertier, F Deleflie	Analysis of 13 Years (1993-2005) of Satellite Laser Ranging data on the two LAGEOS satellites for Terrestrial Reference Frames and Earth Orientation Parameters		**Missing**
TUESDAY				
Network Performance and Results: Cinzia Luceri, Mark Torrence	Ron Noomen	the SLR network from a QC perspective	Yes	
Network Performance and Results	G. Bianco	The ILRS Standard Products: a quality assessment	Yes	
Network Performance and Results	Toshi Otsbuo	Systematic range bias 2005-06,	Yes	
Network Performance and Results	Phillip Gibbs	A reassessment of laser ranging accuracy at SGF Herstmonceux, UK,	Yes	
Network Performance and Results	Erriocs Pavlis	The Global SLR Network and the origin and scale of the TRF in the GGOS era,		**Missing**
Network Performance and Results	Francis Pierron	Ftlrs Ajaccio campaigns: operations and positioning analysis over 2002 and 2005 campaigns	Yes	
Network Performance and Results	Erricos Pavlis	SLR-based evaluation and validation studies of candidate ITRF2005 products,		**Missing**
Network Performance and Results	Ramesh Govind	An Optimised Global SLR Network for Terrestrial Reference Frame Definition,		**Missing**

Network Performance and Results	Luck, J.	Performance of Southern Hemisphere Stations	Yes	
Network Performance and Results	Peter Shelus	Response of the network to new satellites		**Missing**
Network Performance and Results	Mark Torrence	Assessment of SLR Network Performance:	Yes	
Network Performance and Results	John Luck	WPLTN Performance.:	Yes	
Network Performance and Results	Carey Noll	ARCHIVING AND INFRASTRUCTURE SUPPORT AT THE ILRS DATA CENTERS,	?	**With Cinzia Luceri and Mark Torrence?**
Network Performance and Results	John Luck	MINICO Calibration paper,	Withdrawn	**N/A**
Network Performance and Results	Chris Moore	A Summary of Observations of Giove A, taken from Mt Stromlo SLR Station,	Yes	
Lasers and Detectors: John Degnan	I Prochazka, K Hamal, L Kral	Photon Counting Module for Laser Time Transfer Space Project	Un-zippable	**Please Re-send**
Lasers and Detectors	N Andreev, E Grishin, O Kulagin, A Sergeev, M Valley	Picosecond lasers with Raman frequency and pulsewidth conversion for range finding		**Missing**
Lasers and Detectors	Gao, Y. et al.	Advanced Solid State Laser System for Space Tracking		**Missing**
Altimetry: Frank Lemoine	J Degnan, D Wells, R Machan, E Leventhal, D Lawrence, Y Zheng	Second-Generation, Scanning, 3D Imaging Lidars Based on Photon-Counting	Yes	
Altimetry	H Michaelis, T Spohn, J Oberst, N Thomas, K Seiferlin, U Christensen, M Hilchenbach, U Schrieber	The BELA - The first European Planetary Laser Altimeter: Conceptional Design and Technical Studies	Yes	
Altimetry	P Jirousek, I Prochazka, K Hamal, M Fedyszynova	Timing System for the Laser Altimeter for Planetary Exploration Technology Demonstrator	Yes	
Altimetry	T Varghese, R Burnham	A Compact Low Power Altimetry Laser for Lunar Applications		**Missing**
	Ray Burris	Lasercomm at Sea - Trident Warrior 06		**Missing**
Kilohertz Systems: Georg Kirchner, Graham Appleby	K Hamal, I Prochazka, Y Fumin	Portable Pico Event Timer and SLR Control (P-PET-C) System	Yes	

Kilohertz Systems	P Gibbs, C Potter, R Sherwood, M Wilkinson, D Benham, V Smith	Some Early Results of Kilohertz Laser Ranging at Herstmonceux	Yes	
Kilohertz Systems	J Degnan & D Caplan	Performance of Liquid Crystal Optical Gate for Suppressing Laser Backscatter in Monostatic Kilohertz SLR System	Yes	
Kilohertz Systems	J McGarry, T Zagwodzki	SLR2000: The path toward completion	Yes	
Kilohertz Systems	Kirchner, G., Kucharski, D., Cristea, E., Hausleitner, W.	Spin Parameters of GP-B and AJISAI with Kilohertz SLR Data	Yes (split into 2 papers)	
Kilohertz Systems	D Kucharski, G Kirchner	LAGEOS-1 spin determination, using comparisons between Graz kHz SLR data and simulations	Yes	
Kilohertz Systems	Kirchner, G., Kucharski, D., Koidl, F., Weingrill, J.	Measuring Atmospheric Seeing with KHz SLR	Yes	
WEDNESDAY				
Timing Systems: Yang Fumin	X Dong, C Fan, Y Zhao, X Han	A032-ET Experimental Test on Changchun SLR	Yes	
Timing Systems	Y Artyukh, V Bespal'ko, K Lapushka, A Rybakov	Event Timing System for Riga SLR Station	Yes	
Timing Systems	Y Artyukh, E Boole, V Vedin	Instrumentation for Creating KHz SLR Timing Systems	Yes	
Timing Systems	E Samain, J Tore, D Albanese, Ph. Guillemot, F Para, J Paris, I Petitbon	OCA Event Timer	Yes	
Timing Systems	V Bespalko, E Boole, V Vedin	The Model A032-ET of Riga Event Timers	Yes	
Timing Systems	Y Zhang, P Huang, R Zhu	Upgrading of Integration of Time to Digit Converter on a Single FPGA	Yes	
Timing Systems	D McClure, C Steggerda, S Wetzel	High-Speed Enhancement to HTSI Event Timer Systems		**Missing**
Multiple Wavelength Refraction: Erricos Pavlis	H Mueller	Analysis of Multi-Wavelength SLR Tracking Data Using Precise Orbits	Yes	
Multiple Wavelength Refraction	G Hulley, E Pavlis	Improvement of Current Refraction Modeling in Satellite Laser Ranging (SLR) by Ray Tracing through Meterological Data	Yes	
Multiple Wavelength Refraction	W Gurtner	Two-color calibration of the Zimmerwald SLR System	Yes	

Multiple Wavelength Refraction	K Hamal, I Prochazka, J Blazej, Y Fumin, H jingfu, Z Zhongping	Multi Color Satellite Laser Ranging	Yes	
Telescopes, Stations & Upgrades: Craig Smith	F Pierron, E Samain, J Torre	Grasse laser stations in evolutions to future, technological developments in progress	Yes	
Telescopes, Stations & Upgrades	V Burmistrov, V Vasiliev, N Parkhomenko, V Shargorodsky	New Russian Systems for SLR, Angular Measurements and Photometry	Yes	
Telescopes, Stations & Upgrades	H Donovan, D McCollums, J Horvath, M Heinick, A Mann, D Patterson, T Oldham	TLRS-3 Return to Operations		**Missing**
Telescopes, Stations & Upgrades	Lim, et al	Korean Plans for SLR System Development		**Missing**
Telescopes, Stations & Upgrades	Z Li, X Zheng, Y Yong	Study on Servo-Control System of Astronomical Telescopes	Yes	
Telescopes, Stations & Upgrades	V Burmistrov, A Fedotov, N Parkhomenko, V Pasinkov, V Shargorodsky	Russian Laser Tracking Network	Yes	
Telescopes, Stations & Upgrades	H Donovan, M Blount, D McCollums, C Foreman, M Heinick, S Wetzell	TLRS-4 Deployment to Maui, Hawaii		**Missing**
Telescopes, Stations & Upgrades	Y Han, E Actis, T Wang, W Liu, R Podesta, F Qu	A New SLR System of NAOC Running in San Juan of Argentina	Yes	
Telescopes, Stations & Upgrades	Y Zhao, C Fan, X Han, C Liu, J Shi, Z Zhang, B Shao, H Zhang	System Improvement and GIOVE-A Observation of Changchun SLR	Yes	
Advanced Concepts; Time Transfer: Hiroo Kunimori	Y Fumin, H Peicheng, C Wanzhen, Z Zhongping, W Yuanming, G Fang, Z Guangnan, L Ying, I Prochazka, K Hamal	Progress on Laser Time Transfer Project	Yes (.pdf only ?)	
Advanced Concepts; Time Transfer	E Samain, Ph Guillemot, D Albanese, Ph. Berio, F Delefie, F Para, J Paris, I Petitbon, J Torre, P Vrancken, J Weick	T2L2 - Time Transfer by Laser Link	Yes	
Advanced Concepts; Time Transfer	T Otsubo, H Kunimori, T Gotoh	New application of kHz laser ranging: time transfer via Ajisai	Yes	
Advanced Concepts; Time Transfer	Kunimori, H., Okawa, M., Watanabe, H., Yasuda, Y	Satellite Tracking Demonstration on Ground Using 100mm Aperture Optical Antenna for Space Laser Communication	Yes	

Advanced Concepts; Time Transfer	D Carter	The NASA Satellite Laser Ranging Network: Current Status and Future Plans		**Missing**
Advanced Concepts; Time Transfer	T Otsubo, T Kubo-oka	Possibility of laser ranging support for the next-generation space VLBI mission, ASTRO-G	Yes	
Advanced Concepts; Time Transfer	D Lewova, M Nemec, I Prochazka, K Haamal, G Kirchner, F Koidl, D Kucharski, Y Fumin	Electron Multiplying CCD Camera Performance Tests	Yes - Abstract only	**Please send paper**
Advanced Concepts; Time Transfer	G Appleby, R Jones, C Potter, P Gibbs	LIDAR experiments at the Space Geodesy Facility, Herstmonceux, UK	Yes	
Advanced Concepts; Time Transfer	M Abele, L Osipova	Possibility of the Near Earth Objects Distance Measurement with Laser Ranging Device	Yes	
THURSDAY				
Transponders: Ulrich Schreiber	G Neumann, J Cavanaugh, B Coyle, J McGarry, D Smith, X Sun, T Zagwodski, M Zuber	Laser Ranging at Interplanetary Distances		**Missing**
Transponders	J Degnan	Simulating Interplanetary Transponder and Laser Communications Experiments via Dual Station Ranging to SLR Satellites	Yes	
Transponders	J McGarry, T Zagwodzki, P Dabney, Peter Dunn, J Cheek	Laser Ranging at Planetary Distances from SLR2000	Yes	
Transponders	D Smith, M Zuber, M Torrence, J McGarry, M Pearlman	Laser Ranging to the Lunar Reconnaissance Orbiter (LRO)	Yes	
Uncooperative Targets: Craig Smith	Y Fumin, C Wanzhen, Z Zhongping,C Juping, W Yuanming, I Prochazka, K Hamal	Experimental Laser Ranging System for Space Debris at Shanghai	Yes	
Uncooperative Targets	M Nemec, I Prochazka, K Hamal, G Kirchner, F Koidl, W Voller	Simultaneous Optical and Laser Space Objects Tracking	Yes	
Software & Automation: Werner Gurtner, Jan McGarry	Moore, C.	A Comparison of Performance Statistics for Manual and Automated Operations at Mt. Stromlo	Yes	

Software & Automation	M Pearson	EOS Software Systems for Satellite Laser Ranging and General Astronomical Observatory Applications	Yes	
Software & Automation	P Wang, T Guo, X Li, Y Han, W Liu, T Wang, F Qu, Y Tan, T Zou	Electro-Control System of San Juan SLR Station	Yes	
Software & Automation	L Xin, G Tangyong, A Tong, W Peiyuan, T Yechun, X Jiening, Z Yunyao D Ruilin	Integrated Upgrades of Control System for TROS	Yes	
Software & Automation	W Gurtner, M Ploner	CCD and SLR dual-use of the Zimmerwald tracking system	Yes	
Software & Automation	J Degnan, G Jodor & H Bourges	Adaptation of a Commercial Beam Expander for Automated Transmitter Beam Size and Divergence Control in the SLR-2000 System	Yes	
Software & Automation	Li, Q., Qu, F., Wei, Z	Obtaining the High-resolution Epoch with the FPGA Technology	Yes	
Software & Automation	M Pierron	New FTLRS software tools for tuning observations schedule and remote control	Yes	
Software & Automation	M Heiner, N Brandl, U Schreiber	Recursive Filter Algorithm for Noise Reduction in SLR	Yes	
Software & Automation	C Moore	The Impact and Resolution of Collision Bands on Tracking Targets at Various Ranges	Yes	
Software & Automation	K Salminsh	Web Application for the Engineering Data Files Processing	Yes	
Software & Automation	R Ricklefs	Consolidated Laser Prediction and Data Formats: Supporting New Technology	Yes	
FRIDAY				
LLR Systems: Tom Murphy	T Murphy	APOLLO springs to life: one-millimeter LLR	Yes	
Targets & Return Signal Strength: Tom Murphy	D Arnold	Retroreflector studies	Yes	
Targets & Return Signal Strength	G Delle Monache	The INFN-LNF Space Climatic Facility for the LARES mission and the ETRUSCO project	Yes	
Targets & Return Signal Strength	T Murphy	Absolute Calibration of LLR Signal: A Peek at Reflector Health	Yes	

Targets & Return Signal Strength	J Mck.Luck, C Moore	Experimental Return Strengths from Optus-B and GPS	Yes	
Targets & Return Signal Strength	V Shargorodsky, V Vasiliev, M Belov, I Gashkin, N Parkhomenko	Spherical glass SLR target Microsatellite	Yes	
Overflow: Mike Pearlman	A Dmytrotsa, O Minin, D Neyachenko	Current Status of Simeiz-1873 station	Yes	
Overflow	K Martynyuk-Lototsky, J Blahodyr, A Bilinskiy, O Lohvynenko	Overview and performance of the Ukrainian SLR station "Lviv-1831"		**Missing**
Overflow	J Horvath, M Blount, C Clarke, H Donovan, C Foreman, M Heinick, A Mann, D Patterson, D McCollums T Oldham S Wetzel	Results of the TLRS-4/Moblas-7 Intercomparison Test		**Missing**
Overflow	N Kudo, S Nakamura, R Nakamura, S Katagiri	Using SLR, the GPS accuracy verification experiment of ALOS	Yes	
Overflow	Hyung Chul Lim, Jong Uk Park, Yong Ki Kim, Young Su Son, Sang Hyun Lee, Jun Ho Lee, Hyung Ki Cha	Korean Plan for SLR System Development		**Missing**
Overflow	Y Zhao, X Han, C Fan, T Dai	Fulfillment of SLR daylight tracking of Changchun station	Yes	
Overflow	V Glotov, S Revnivykh, V Mitrikas	GLONASS Status Update and MCC activity in GLONASS Program		**Missing**

POSTERS & MISCELLANEOUS

Timing Systems	J.Kolbl, P.Sperber, G.Kirchner, F.Koidl	Low-Noise Frequency Synthesis for High Accuracy Picosecond Satellite Laser Ranging Timing Systems	Yes (but poster only)
Opening Session: Ben Greene	W.Gurtner	Welcome Note	Yes
Session Summaries 1-page manuscripts	T.Murphy	Lunar Laser Ranging Session Summa	Yes
	M.Pearlman	Overflow Session Summary	Yes
	T.Murphy	Targets and Return Signal Strength Session Summary	Yes

Session Summaries PPT present'ns as .PDF files		
Science Products	S.Klosko, G.Beutler	**Need 1-page .doc**
Network Performance and Results	C.Luceri, M.Torrence	**Need 1-page .doc**
Lasers and Detectors	J.Degnan	**Need 1-page .doc**

Altimetry	F.Lemoine	**Need 1-page .doc**
KiloHertz Systems	G.Kirchner, G.Appleby	**Need 1-page .doc**
Timing Systems	Y.Fumin	**Need 1-page .doc**
Multiple Wavelength, Refraction	E.Pavlis	**Need 1-page .doc**
Telescopes, Stations & Upgrades	C.Smith	**Need 1-page .doc**
Advanced Concepts / Time Transfer	H.Kunimori	**Need 1-page .doc**
Transponders	U.Schreiber	**Need 1-page .doc**
Uncooperative Targets	C.Smith	**Need 1-page .doc**
Software & Automation	W.Gurtner, J.McGarry	**Need 1-page .doc**