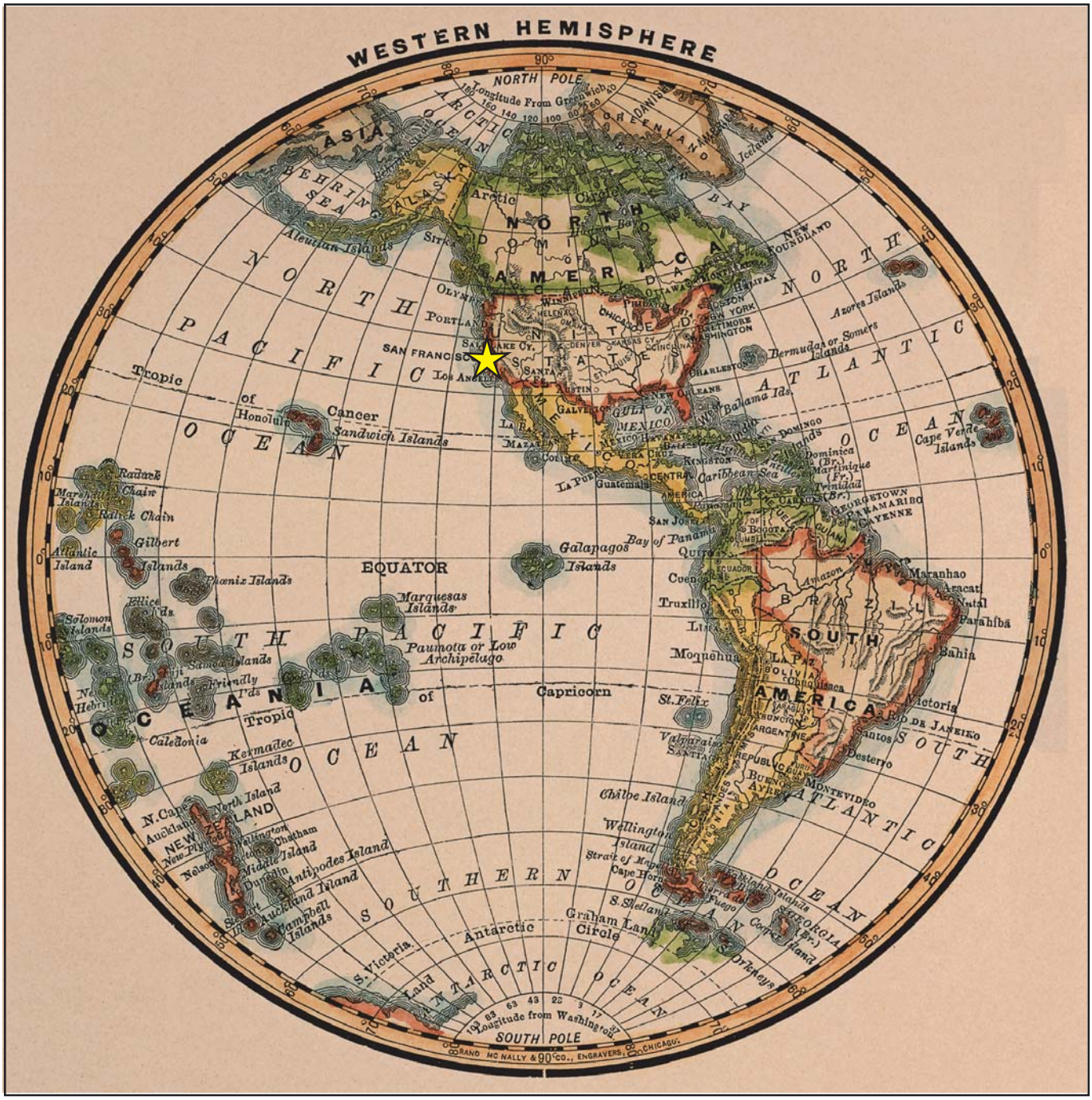
ILRS Governing Board Meeting



December 13, 2004

13:00 – 16:00

Chancellor Hotel
San Francisco, CA

ILRS Governing Board Meeting
December 13, 2004
13:00 – 16:00

Agenda

1.	Opening Remarks	W. Gurtner
2.	ILRS Status	M. Pearlman
3.	NASA SLR Status	J. McGarry
4.	Reports from Working Groups	WG Chairs
	Analysis	P. Shelus/G. Appleby
	Data Formats and Procedures	
	Missions	
	Networks and Engineering	
	Signal Processing	G. Appleby
5.	Tracking Restrictions (ICESat, ALOS)	W. Gurtner
6.	GGOS Activities	W. Gurtner/M. Pearlman
7.	ILRS Annual Report Series	C. Noll
8.	New Business	W. Gurtner/WG Chairs
9.	Other Business	W. Gurtner

ILRS Governing Board

Ex-Officio Members:

Director, Central Bureau:	Mike Pearlman
Secretary, Central Bureau:	Carey Noll
President of IAG Commission I:	Hermann Drewes

Members Appointed or Elected by Organizations:

EUROLAS Network Representatives:	Giuseppe Bianco
	Werner Gurtner (Chair)
NASA Network Representatives:	David Carter
	Jan McGarry
WPLTN Representatives:	Ben Greene
	Hiroo Kunimori
IERS Representative:	Bob Schutz

Members Elected by their International Peers:

Analysis Representatives:	Graham Appleby
	Ron Noomen
Data Center Representative:	Wolfgang Seemueller
LLR Representative:	Peter Shelus
At-Large Representatives:	Georg Kirchner
	Ulrich Schreiber

Former Members:

Francois Barlier (former At-Large Representative, 1998-2000)
Gerhard Beutler (former CSTG President, 1998-1999)
John Bosworth (former Director, ILRS Central Bureau, 1998-2001)
John Degnan (former Chairman and NASA Network Representative, 1998-2002)
Richard Eanes (former Analysis Center Representative, 1998-2000)
Yang Fumin (former WPLTN Network Representative, 1998-2002)
John Luck (former At-Large Representative, 1998-2002)
Wolfgang Schlueter (former EUROLAS Network Representative, 1998-2002)

ILRS Governing Board
Recent Actions and ILRS Developments

ILRS Administrative Issues:

- ILRS "recognition" in scientific publications:
  - SLRMail sent by ILRS CB (May 2004)
  - Messages on ILRS website (under Data & Products, ILRS Bibliography, Mission Support Form, AC Response Form)
  - Message on CDDIS (and EDC?) ftp sites (automatically appears on ftp connection to SLR directories)
- Governing Board elections completed in mid-October 2004 (See chart above)
- Selection of Working Group Chairs and Co-Chairs
  - Analysis - Ron Noomen/
  - Networks and Engineering - Georg Kirchner/
  - Data Formats and Procedures - Wolfgang Seemueller/
  - Missions -
  - Signal Processing (AH) - Graham Appleby/Toshi Otsubo
- TOR Modification
  - New IAG Structure
  - Reduce GA to one per year
  - GA election of IERS Alternate rather than appointing the Lunar Representative
- Exchange of notes with the RSA on "novel satellites" still in process
  - Awaiting a draft agreement from RSA
- Solicited updates to ILRS associates list via email in December 2004; updates on-going

Network Items:

- EUROLAS
  - Grasse SLR station (7835) to close in early 2005
  - FTLRS occupations in San Fernando and Brest in 2004
- WPLTN
  - New Mt. Stromlo station dedicated on April 1, 2004
    - Now submitting data
    - Awaiting AWG validation
  - GUTS system installed at Tanegashima, Japan; typhoon damage currently prevents tracking
  - GPS receiver at SALRO now part of IGS
  - GPS receiver in Changchun soon to be part of IGS
- NASA
  - Program being restructured to accommodate budget cut in FY04
  - Maui closed in June 2004
  - Arequipa closed in early 2004; operations to resume in 2005
  - Staff reduction at GSFC (MOBLAS-7)
  - SLR2000 has received first returns
- Station Qualification
  - Operational stations at Maui and Arequipa are lost; GSFC continues to qualify but at a reduced level.

Data Issues:

- Data reporting
  - All reports should issue quantity values in passes (not pass segments) and minutes of data (normal points times bin size)
    - Report Card is being updated
    - Some work still to be done at CDDIS here (two weekly reports currently issued; on-line forms)
- Data replacement
  - Data revisions (i.e., same header information, including start times) from the stations
    - Automatically replaced at the data center centers if received within 30 days
  - Data deletion at the data centers
    - Not a common problem
    - Concern about security issue
    - Prefer problem be described in SLRMail using appropriately documented message
    - Data removal from archive may be addressed to archive managers
- Data quality feedback to stations
  - Both operational data centers (HTSI and EDC) QC incoming data for integrity
    - Automated e-mails issued
    - Most data failing checks are withheld from data stream
  - Time bias QC automated procedure implemented at NSGF (P. Gibbs)
    - Automated e-mail messages issued to the stations
- CDDIS has modified SLR data archive structure to coincide with operation of new server (end of 2004); new archive intended to be more user friendly.

Operations:

- Predictions
  - Predictions Survey results are on the website (see chart)
  - Predominant center for each satellite
  - A few cases where mission-generated predictions are not widely used
- Low elevation tracking
  - Data from Grasse, Graz, and Zimmerwald
- Developing policy for restricted tracking missions (ICESat, ALOS) (see below)
- Dynamic Priorities
  - Two options on the table (see below)

Mission Items:

- Meteor-3M tracking very weak, but essential for SAGE (average of 7 passes/week in 2004)
- Tracking on GP-B going well (average of 21 passes/week in 2004)
- Tracking Support Request form for Galileo submitted by ESA is pending with MWG
- Contacted GPS-III regarding retroreflectors on board
- Latest Cryosat launch now Q2 of 2005

Reports:

- Proceedings from 2002 Washington laser ranging workshop (hardcopy and CD) issued in December 2003
- 2002 ILRS Annual Report posted on website in April 2004; hardcopy mailed in July
- Currently assembling combined 2003/2004 annual report (Report below)
- 14th International Workshop on Laser Ranging in San Fernando, Spain June 7-11, 2004
  - 99 papers (oral and poster) presented; 22 science and applications papers
  - Proceedings website established at ILRS (*http://cddisa.gsfc.nasa.gov/lw14*)
  - Approximately half the papers have been received
  - Due date for papers extended to January 14, 2005
  - Proceedings will be issued in both hardcopy and electronic media
- First, second, and third quarter 2004 ILRS station report cards issued by RITSS

Site Surveys:

- Site surveys conducted at Hartebeesthoek and Shanghai; survey planned for Beijing
- Analysis of survey data from Hartebeesthoek, Shanghai, Hawaii, Arequipa, and GSFC in process
- IERS has established a Collocation/Survey Working Group to coordinate ground survey activities for the IAG Space Geodesy activities (ILRS, IVS, IGS, and IDS)

Other Items:

- INDIGO now funded and will support some NASA participation in GGOS and IERS

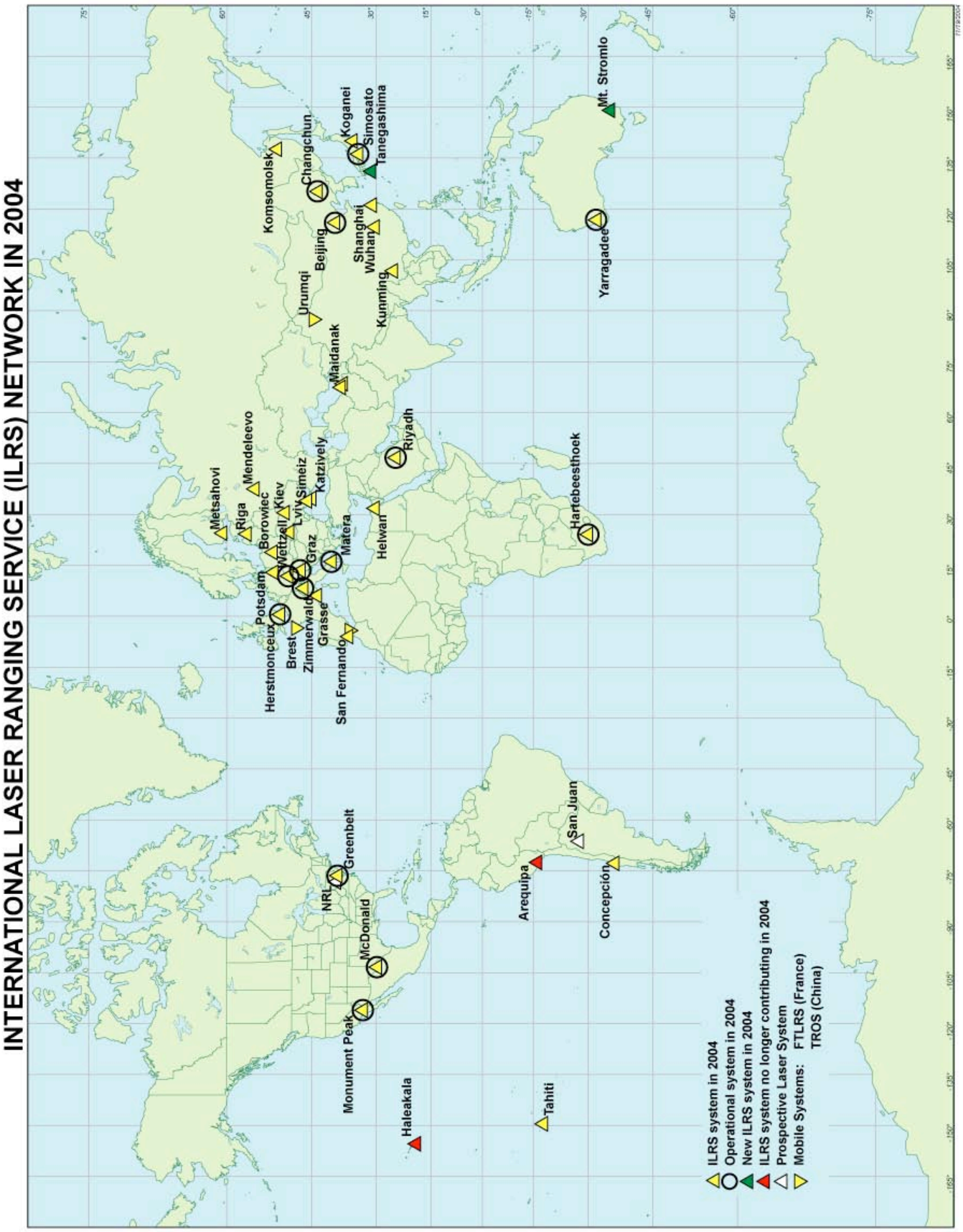
ILRS Satellite Tracking Priorities
December 2004

1. Priorities decrease with:
   a. increasing orbital altitude; and
   b. increasing orbital inclination (at a given altitude).
2. Priority of some satellites may then be increased to intensify support for:
   a. active missions (such as altimetry);
   b. special campaigns (such as IGLOS); or
   c. post-launch intensive tracking phases; and
3. Some slight reordering may be done to give higher priority missions with increased importance to the analysis community.

Priority	Mission	Sponsor	Altitude (km)	Inclination (degrees)	Comments
1	GP-B	NASA/Stanford U.	652	90	New mission
2	GRACE-A, -B	GFZ/JPL	485-500	89	Tandem mission
3	CHAMP	GFZ	429-474	87.3	
4	GFO-1	US Navy	790	108.0	Altimetry/no other tracking technique
5	Envisat	ESA	796	98.6	Tandem with ERS-2 tracking to commence 40 days after launch
6	ERS-2	ESA	800	98.6	Tandem with Envisat
7	Jason	NASA/CNES	1,350	66.0	Tandem with Topex
8	TOPEX/Poseidon	NASA/CNES	1,350	66.0	Tandem with Jason
9	Larets	IPIE	691	98.2	
10	Starlette	CNES	815-1,100	49.8	
11	Stella	CNES	815	98.6	
12	Meteor-3M	IPIE	1000	99.6	
13	Ajisai	NASDA	1,485	50	
14	LAGEOS-2	ASI/NASA	5625	52.6	
15	LAGEOS-1	NASA	5850	109.8	
16	Beacon-C	NASA	950-1300	41	Upgraded from campaign to ongoing mission (Jan-02)
17	Etalon-1	Russian Federation	19,100	65.3	Campaign extended to 01-Oct-02
18	Etalon-2	Russian Federation	19,100	65.2	Campaign extended to 01-Oct-02
19	GLONASS-89	Russian Federation	19,100	65	Replaced GLONASS-86 as of 20-Mar-03
20	GLONASS-87	Russian Federation	19,100	65	Replaced GLONASS-88 as of 20-Feb-02
21	GLONASS-84	Russian Federation	19,100	65	Replaced GLONASS-79 as of 22-Feb-01
22	GPS-35	US DoD	20,100	54.2	
23	GPS-36	US DoD	20,100	55.0	

Lunar Tracking Priorities

Priority	Retroreflector Array	Sponsor	Altitude (km)
1	Apollo 15	NASA	356,400
2	Apollo 11	NASA	356,400
3	Apollo 14	NASA	356,400
4	Luna 21	Russian Federation	356,400
5	Luna 17	Russian Federation	356,400


INTERNATIONAL LASER RANGING SERVICE (ILRS) NETWORK IN 2004
Komsomolsk
Changchun
Koganei
Simosato
Tanegashima
Mt. Stromlo
Beijing
Shanghai
Wuhan
Yarragadee
Urumqi
Kunming
Maidanak
Riyadh
Mendeleevo
Metsahovi
Riga
Borowiec
Kiev
Lviv
Simeiz
Katzively
Hartebeesthoek
Wettzell
Graz
Matera
Helwan
Potsdam
Herstmonceux
Brest
Zimmerwald
Grasse
San Fernando
Greenbelt
NRL
McDonald
Monument Peak
Haleakala
Arequipa
San Juan
Concepción
Tahiti
ILRS system in 2004
Operational system in 2004
New ILRS system in 2004
ILRS system no longer contributing in 2004
Prospective Laser System
Mobile Systems: FTLRS (France)
TROS (China)

Dynamic Priorities

Option 1

- Satellites placed in one of four priority categories;
- Stations should try to equalize the number of passes on each satellite over the course of a few days;
- The CB would provide a daily index (+1/-1) to raise/lower the priority within each category of priorities that need more/less attention. The indices will be based on a minimum number of passes that we anticipate every 2 -3 days;
- The priority table with the CB issued indices would be posted daily on the AIUB server, so it would be available when stations access their prediction updates.

Category 1	Category 2	Category 3	Category 4
GRACE-A	GFO-1	Starlette	Etalon-1
GRACE-B	Envisat	Stella	Etalon-2
CHAMP	ERS-2	Beacon-C	GLONASS-89
	Jason	Ajisai	GLONASS-87
	TOPEX/Poseidon	LAGEOS-1	GLONASS-84
	Meteor-3M	LAGEOS-2	GPS-35
			GPS-36

Option 2

- Give stations a priority update key for each satellite to use within own capability (day, night, weather, etc.)
- Update relative to ILRS posted priorities
- Key could be based on recent tracking density and elapsed time since last pass
- Example
  - -2 = Do not track at all
  - -1 = Decrease priority
  - 0 = Neutral
  - +1 = Increase priority
  - +2 = Top priority
- Key calculated by CB or other center sub-daily and posted to AIUB real-time prediction service
- Numbers adjusted after we gain experience

ILRS Prediction Survey (July 2004)

Site	ID	AJI	BEC	CHA	GPB	GRA	ENV	ERS	ETA	GFO	GLO	GPS	ICE	JAS	LAG	LAR	MET	STA	STE	TOP	Drag?	Access
Golosiiv	1824																					
Lviv	1831	H	H		H		H	H		H				H	H			H	H	H	N/A	ftp
Maidanak 1	1863																					
Maidanak 2	1864																					
Komsomolsk	1868																					
Mendeleevo	1870																					
Simeiz	1873																					
Riga	1884	H	H	G	H	G	H	H		H				H	H	H	H	H	H	H	Yes	email
Katsively	1893																					
McDonald	7080	H	H	G	H	G	H	H	H	H	H	H	U	H	H	H	H	H	H	H	No	ftp
Yarragadee	7090	H	H	H	H	G	E	H	H	S	N	N		H	H	H	H	H	H	H	Yes	email/ftp
Greenbelt	7105	H	H	G	H	G	H	H	H	H	H	H	H	H	H	H	H	H	H	H	Yes	ftp
Monument Peak	7110	H	H	G	H	G	H	H	H	H	H	H	H	H	H	H	H	H	H	H	Yes	ftp
Tahiti	7124	H	H	G	H	G	H	H		H				H	H			H	H	H	Yes	ftp
Wuhan	7231																					
Changchun	7237	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	?	ftp
Beijing	7249	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	Yes	ftp
Koganei	7308																					
Arequipa	7403	H	H	G		G	H	H		H				H	H	H	H	H	H	H	Yes	ftp
Concepcion	7405	H	H	G	H	G	E	G	H	H	N	N		H	N	H	H	H	H	H	Yes	email
Hartebeesthoek	7501	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	Yes	ftp
Metsahovi2	7806	N	N	N	N	N	N	N		N				N	N	N	N	N	N	N	No	ftp
Zimmerwald	7810	H	H	G	H	G	E	G	H	S	C	C	U	H	H	H	H	H	H	H	Yes	email
Borowiec	7811	H	H	G		G	H	H		H				H	H	H		H	H	H	No	email
Kunming	7820																					
San Fernando	7824	H	H	H	H	H	H	H		H				H	H	H	H	H	H	H	No	email
Mt. Stromlo	7825	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	No	ftp
Helwan	7831	H	H	H	H	H	H	H		H				H	H	H	H	H	H	H	No	ftp
Riyadh	7832	H	H	H		G	H	H	H	H	H	H		H	H	H	H	H	H	H	Yes	ftp
Grasse	7835	H	H	G		G	H	H		H				H	H	H	H	H	H	H	No	email/ftp
Potsdam	7836	H	H	G	H	G	HN	HG	H	H	HN	H	H	H	H	H	H	H	H	H	Yes	ftp
Shanghai	7837																					
Simosato	7838	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	Yes	email
Graz	7839	HN	HN	GH	H	GH	EH	GH	HN	HNS	NH	NH		H	HN	HM	H	HN	HN	HN	Yes	ftp
Herstmonceux	7840	HNJ	HN	G	H	G	NEH	GH	HN	SNH	CH	CH		HN	HN	HMN	SMH	HN	HN	HN	Yes	email
Potsdam	7841	H	H	G	H	G	HN	HG	H	H	HN	H	H	H	H	H	H	H	H	H	Yes	ftp
Grasse (LLR)	7845	H	H	G		G	H	H		H	H	H		H	H	H	H	H	H	H	No	email/ftp
Matera	7941	H	H	G	H	G	H	H	H	H	H	H		H	H	H	H	H	H	H	No	ftp
Wettzell	8834	HN	H	G		G	H	G	HN	HN	HN	H		HN	HN	H	H	HN	HN	HN	Yes	ftp
FTLRS	--	H	H	G		G	H	H		H				H	H	H	H	H	H	H	No	email/ftp
TROS	--																					

Satellite abbreviations:		
	AJI	Ajisai
	BEC	BE-C
	CHA	CHAMP
	GPB	GP-B
	GRA	GRACE-A/B
	ENV	Envisat
	ERS	ERS-2
	ETA	Etalon-1/2
	GFO	GFO-1
	GLO	GLONASS
	GPS	GPS-35/36
	ICE	ICESat
	JAS	Jason-1
	LAG	LAGEOS-1/2
	LAR	Larets
	MET	Meteor-3M
	STA	Starlette
	STE	Stella
	TOP	TOPEX

Prediction Provider codes:		
	C	CODE-based
	E	ESOC
	G	GFZ
	H	HTSI
	J	JAXA
	M	MCC
	N	NGSF
	S	GSFC 926
	U	U. Texas/CSR

SLR Restricted Tracking

Meeting on SLR Restricted Tracking

ICESat

- Normally nadir pointing, with occasionally off-nadir excursions of 3 - 7 degrees;
- A 70-degree maximum elevation pointing restriction at the ground stations precludes illumination during nadir and the 3 - 7 degrees off nadir operations;
- CSR, now the only prediction provider, currently issues daily IRV's by email. Stations are instructed to range only if current day IRV's are issued;
- In the event that unusual operating conditions or emergencies place the satellite in jeopardy, CSR would not issue predictions;
- Tracking arranged through bi-lateral informal agreements with stations;
- Demonstration of tracking constraints by the station is required before approval is given

  CONCERN: off-nadir operations beyond 7 degrees, although not planned at this time, might jeopardize the satellite;

ALOS

- ALOS situation is even more complicated;
- ALOS has sensors that sweep side-to-side, normal to the satellite ground path, and sensors in the front and back of the satellite;
- Tracking segments will have to be scheduled during normal overflight to avoid vulnerable period that may occur several times during a pass;
- The ALOS project will issue IRV's and tracking schedules to stations that have acceptable safety procedures in place.

Plan for Tracking Vulnerable Satellites

- Station operating constraints offered by the ILRS
  - Hard station pointing constraints (e.g. don't exceed 70 degrees elevation);
  - Hard "Go - No Go" global key set by the mission which is accessed at regular intervals (e.g. 30 minutes) by the station via ftp;
  - Pass segment schedules issued by the mission to restrict tracking to non-vulnerable periods
- Documentation of the station procedures to implement the constraints
- Prescribed testing of station operating constraints on an alternative satellite.
- Documented approval for the station by the mission including waiver of any liability in case of damage to the satellite
- Periodic validation that the rules are being followed

Pass Segment Format

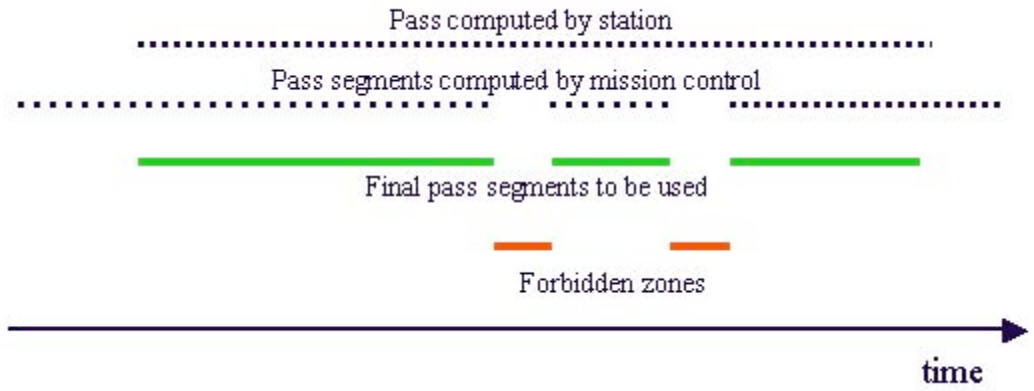
Example:

```
Satellite          :  GP-B
Generation Date    :  2004-07-23 19:07:00 [UTC]
Generated by       :  GP-B Mission Operations / Stanford University
Minimum Elevation  :  5 deg
-------------------------------------------------------------------
                  Start Date/Time      End Date/Time    MaxEl  Durtn
 ID     SAT            [UTC]              [UTC]         [deg]  [min]
---- ---------- ------------------- ------------------  ---   -----
1824 GP-B       2004-07-24 00:46:57 2004-07-24 00:53:51   80     6.9
1824 GP-B       2004-07-24 02:23:59 2004-07-24 02:28:26   10     4.4
1824 GP-B       2004-07-24 11:51:43 2004-07-24 11:55:45   27     4.0
1824 GP-B       2004-07-24 13:29:21 2004-07-24 13:33:19   27     4.0
-------------------------------------------------------------------
                  Start Date/Time      End Date/Time    MaxEl  Durtn
 ID     SAT            [UTC]              [UTC]         [deg]  [min]
---- ---------- ------------------- ------------------  ---   -----
7810 GP-B       2004-07-24 00:47:15 2004-07-24 00:52:53   13     5.6
7810 GP-B       2004-07-24 02:25:23 2004-07-24 02:32:23   67     7.0
7810 GP-B       2004-07-24 04:02:14 2004-07-24 04:05:52    7     3.6
7810 GP-B       2004-07-24 13:28:30 2004-07-24 13:32:27   27     3.9
```

A file may contain pass segments for more than one station, see the example. A station can easily extract its records from the pass segment list (e.g., using the UNIX grep utility).

The station will "fold" these pass segments onto the locally computed pass start and end times to generate the valid pass definition.

Example:



Draft
Agreement between ILRS Stations and Satellite Missions Regarding Issues of Liability for Spacecraft Damage due to Laser Ranging Operations

The is an agreement between the ABC Station (hereafter identified as "the Station") and the DEF Mission Sponsor (hereafter identified as "the Sponsor" for the tracking support of the XYZ Satellite (hereafter identified as "the Satellite").

The Station as an entity within the International Laser Ranging Services (ILRS) agrees to make its best effort to track the Satellite according to the ILRS agreement with the Sponsor. Data will be provided on a daily basis through the ILRS Data Centers. The Sponsor agrees to provide all predictions and scheduling information.

In consideration of the Satellite Laser Ranging (SLR) data provided by the Station on the Satellite, the Sponsor agrees not to make any claims against the Station or station contractors or subcontractors, or their respective employees for any satellite damage arising from these ranging activities, whether such damage is caused by negligence or otherwise, except in the case of willful misconduct.

Tracking of the Satellite by the station will commence only after the Sponsor has agreed that satellite safety programs being implemented at the Station are sufficient to protect the satellite.

Any insurance deemed necessary by the Sponsor, will be obtained by Sponsor at no cost to any of the ILRS entities including the stations.

The Sponsor and the Station shall consult promptly with each other on all issues involving interpretation or implementation of this agreement. Any matter that is not settled before implementation shall be referred to the appropriate Satellite program manager. The program manager will attempt to resolve all issues arising from the implementation of this agreement. If he or she is unable to resolve such issues, then the dispute will be referred to the agreement signatories, or their designated representative for joint resolution.

This agreement will go into effect upon the date of the final signature for a period commensurate with the agreed ILRS term of support for the Satellite. It may be amended by mutual agreement or terminated by one party providing written notice to the other party at least six months prior to the intended termination date or as funding constraints may dictate.

Date
Representative of the Mission Sponsor
Name, Title

Signature

Date
Representative of the Station
Name, Title

Signature

ILRS AWG Meeting
December 13, 2004
09:00 – 12:00

Agenda

1. Opening
2. Announcements
   - 2.1. IERS Conventions Advisory Board
   - 2.2. File structure ILRS products
3. Pilot Project "Positioning + Earth Orientation"
   - 3.1. Evaluation of combination results
   - 3.2. IERS PP/ ITRF2005 backwards: status
   - 3.3. Other products
   - 3.4. Other issues
4. Benchmark project: status
5. Miscellaneous
   - 5.1. SLR global coverage
   - 5.2. Analysis center categorization
   - 5.3. Procedure for assessing quality of new SLR system
6. Next meeting
7. Action items
8. Closure

ILRS Meetings

Recent Meetings

- April 22-23, 2004: ILRS AWG meeting
- June 7-11, 2004: 14th International Workshop on Laser Ranging in San Fernando, Spain
- June 7-11, 2004: Governing Board and WG meetings also held in San Fernando
- October 27-29, 2004: kHz SLR Meeting held in Graz, Austria

Upcoming Meetings

- December 13, 2004: Meeting with newly elected ILRS Governing Board at AGU
- December 13, 2004: ILRS AWG meeting at AGU
- April 25-29, 2005: ILRS meetings at EGU in Vienna, Austria
- October 3-7, 2005: ILRS Technical Workshop in Eastbourne (near Herstmonceux),
- October 16-20, 2006: 15th International Workshop on Laser Ranging in Canberra, Australia

Graz kHz SLR Meeting: Summary

- 27 to 29 October 2004 in Graz; about 40 participants;
- Demonstration of day / night kHz Ranging to GPS-36, LAGEOS-1, Stella, ...
- Main results, experiences in Graz, after 1 year of kHz SLR:
  - More than 1 Million returns from LAGEOS, Ajisai;
  - NPs with more than 100 k points for LAGEOS;
  - Increasing results from high orbit sats (GPS, GLONASS, ET...)
  - Single Retro Detection from the majority of tracked satellites ....
- Presentations / Discussions about:
  - kHz Lasers, Event Timers, Range Gate Generators etc.;
  - Computers, Software, post-processing for kHz SLR;
- All presentations available at: *http://khzslr.oeaw.ac.at/presentations.htm*
- Several SLR stations have started already to upgrade to kHz; others considering ...
- There is no reason, why to wait – increase your repetition rate ☺

ILRS Annual Report Series

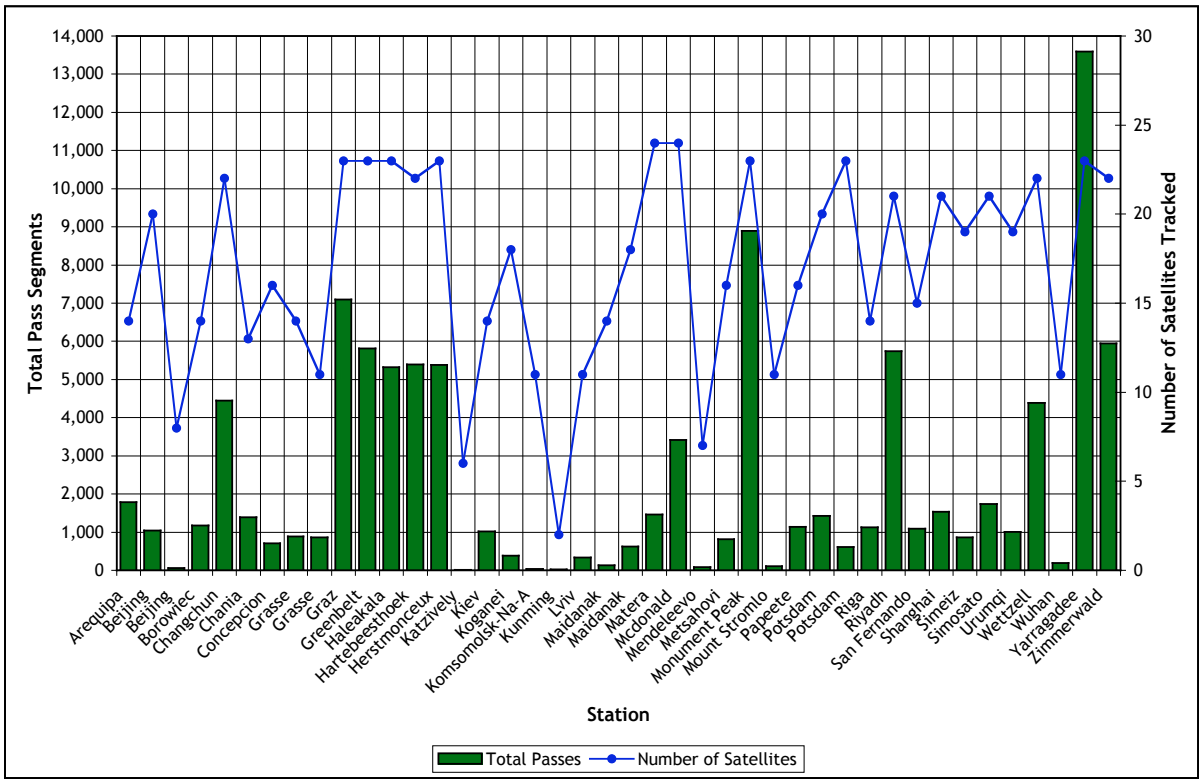
- 2002 ILRS Annual Report on web; hardcopy distributed in June
- A combined report for 2003 and 2004 will be created
- Call for input to this 2003/2004 ILRS Annual Report issued in August 2004
- Contributions were due to C. Noll by October 31, 2004; still receiving reports
- Now editing
- Plans:
  - Individual AC and AAC reports in Appendix A
  - Individual station reports in Appendix B
- Outline
  - Preface, Acknowledgements
  - Introduction to the 2003/2004 ILRS Annual Report
  - Chairperson's Remarks
  - Sections
    - 1 – ILRS Organizations (needs update)
    - 2 – ILRS Tracking Network
    - 3 – ILRS Missions and Campaigns
    - 4 – Infrastructure
    - 5 – Tracking Procedures and Data Flow
    - 6 – Emerging Technologies (not received yet)
    - 7 – Analysis Pilot Projects
    - 8 – Modeling (not received yet)
    - 9 – Science Coordination (not received yet)
    - 10 – Meetings and Reports
    - 11 – Bibliography (not received yet)
  - Appendices
    - A – AC and AAC Reports (20 out of 28 received thus far)
    - B – Station Reports (23 out of 40 received thus far)
    - C – ILRS Information (needs update)

International Laser Ranging Service

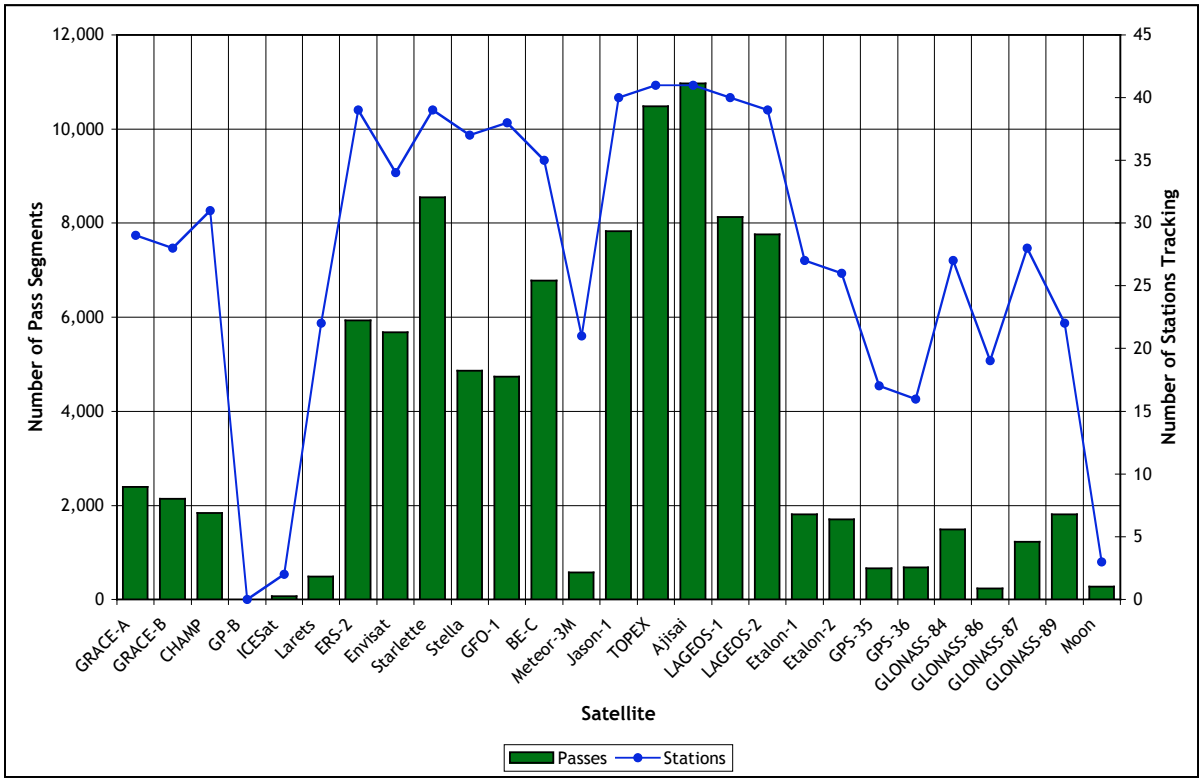
ILRS Quarterly Report Card (Table 1, 01/01-12/06/2004)

Site Information		Data Volume									Data Quality		
Column 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Location	Station Number	LEO pass Tot	LAGEOS pass Tot	High pass Tot	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Minutes of Tracking	Cal. RMS	Star. RMS	LAG RMS
Baseline		1000	400	100	1500								
Yarragadee	7090	8195	1240	1068	10503	150621	15086	9444	175151	44691	5.1	8.6	9.3
Riyadh	7832	4295	1129	710	6134	61456	10189	4150	75795	22199	8.5	10.5	13.9
Zimmerwald	7810	4566	984	562	6112	102430	19712	4566	126708	31869	17.1	18.1	21.2
Wettzell	8834	4326	908	428	5662	54581	6805	2400	63786	15894	3.8	10.3	16.8
Graz	7839	4086	704	377	5167	77644	8564	2790	88998	18574	2.0	3.5	7.3
Monument_P	7110	4009	708	242	4959	64894	5903	1747	72544	14059	6.3	12.7	13.1
Herstmonce	7840	3095	673	209	3977	47567	8278	935	56780	11314	7.8	13.0	16.2
Changchun	7237	3057	619	191	3867	39792	6484	948	47224	10153	10.5	12.6	13.9
Greenbelt	7105	2023	265	72	2360	40610	2717	570	43897	7281	10.6	14.0	12.0
Simosato	7838	1730	611	16	2357	35064	10659	121	45844	10053	12.3	15.6	18.3
San_Fernan	7824	1982	266		2248	28819	1406		30225	4232	9.6	11.2	20.9
Hartebeest	7501	1685	413	129	2227	24018	4279	1081	29378	7874	4.8	7.6	10.0
Beijing	7249	1576	427	145	2148	24075	4473	954	29502	7133	11.9	70.9	20.8
Matera	7941	1398	543	205	2146	21749	5438	1380	28567	8451	2.5	4.3	5.9
McDonald	7080	1229	371	163	1763	15945	3451	848	20244	5186	10.5	10.6	11.3
Shanghai	7837	1485	237	15	1737	21951	2274	111	24336	4127	9.4	16.1	24.3
Potsdam	7841	1155	244	14	1413	22887	3308	99	26294	4222	10.3	13.1	16.8
Riga	1884	1097	103		1200	20823	1129		21952	2465	7.7	15.2	14.1
Haleakala	7210	806	193	68	1067	12645	2186	437	15268	3493			
Mount_Stro	7825	610	256	80	946	7421	3370	429	11220	3750	3.4	7.1	8.8
Borowiec	7811	686	200		886	12180	2170		14350	2396	16.5	18.9	20.9
Maidanak	1864	482	253	133	868	6120	1695	589	8404	2847		50.9	54.4
Kiev	1824	748	55		803	7878	315		8193	1008	40.4	70.5	72.8
Grasse	7835	587	130		717	12947	1517		14464	2034	6.7	10.2	16.6
Simeiz	1873	532	151	33	716	4961	878	160	5999	1409			68.3
Papeete	7124	658	57		715	8454	348		8802	1263	5.9	8.1	6.8
Urumqi	7355	428	118	4	550	6034	1326	17	7377	1374			
Katzively	1893	397	104	5	506	6759	749	21	7529	1218	56.7		59.0
Concepcion	7405	319	43	6	368	4016	335	19	4370	863	8.2	20.1	89.2
Potsdam	7836	244	60		304	3929	587		4516	674			
Metsahovi	7806	260	28	1	289	4204	218	6	4428	519	10.3	13.7	14.5
Lviv	1831	223	53		276	3699	485		4184	747	17.6	53.0	39.3
Koganei	7308	103	97	39	239	1718	1213	243	3174	1416	6.4	9.9	12.6
Wuhan	7231	149	33		182	1936	233		2169	396	11.2	15.0	19.9
Helwan	7831	148			148	1477			1477	590	6.0	15.2	
Komsomolsk	1868	4	16		20	16	94		110	51			
Maidanak	1863	1	6		7	7	40		47	20			
Arequipa	7403	6			6	60			60	7			
Tanegashim	7358	1	2		3	17	16		33	12			

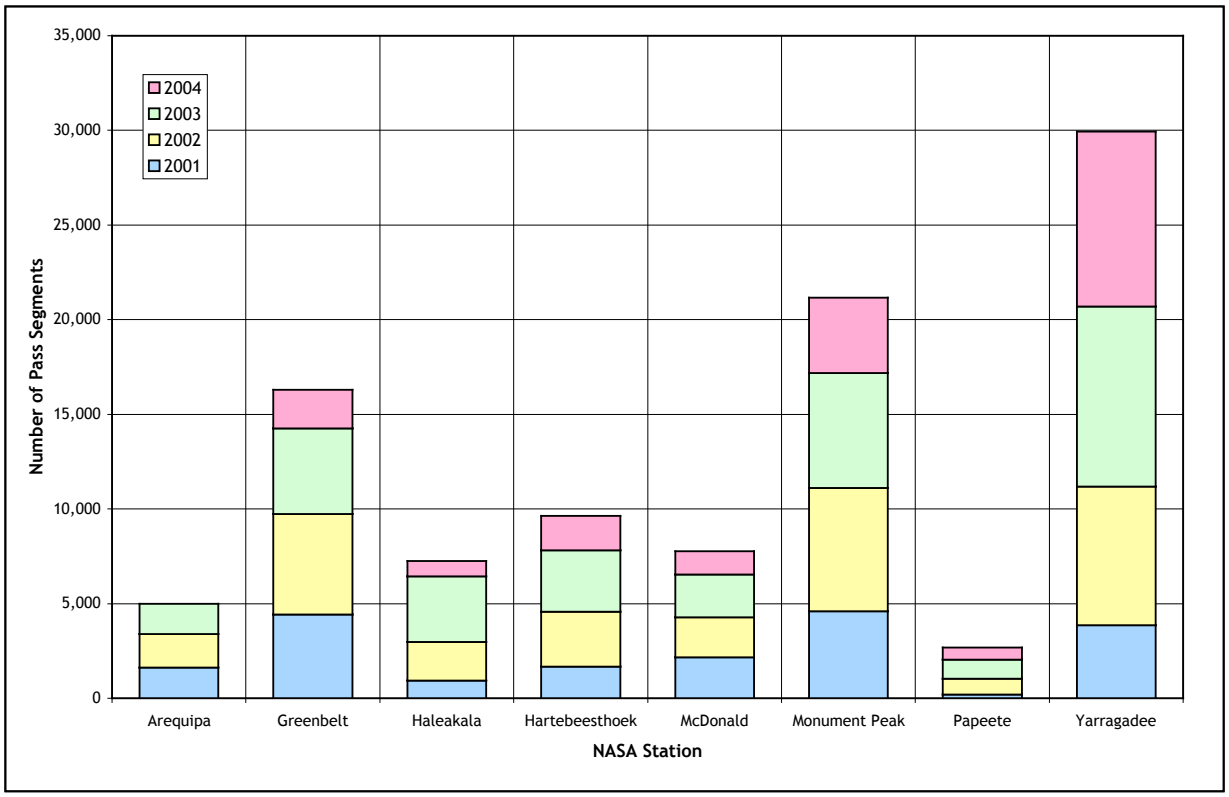
Total Pass Segments by Station in 2003



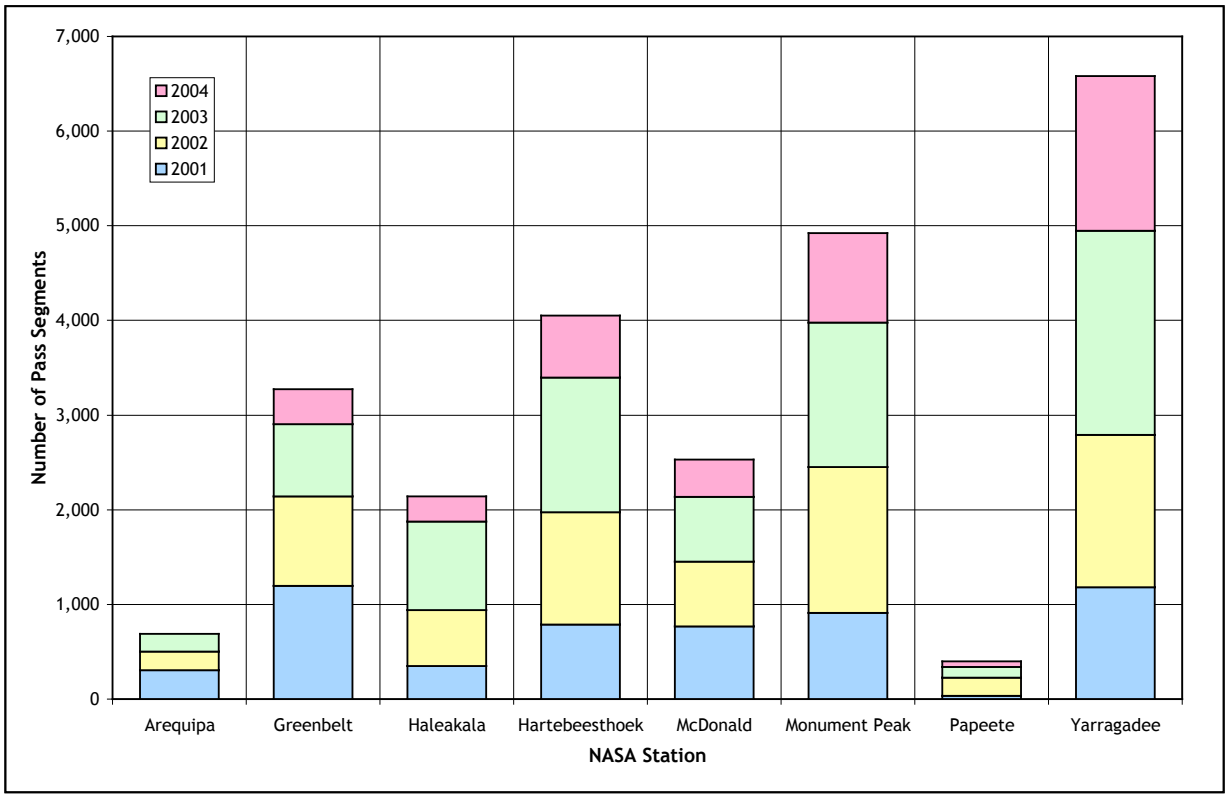
Total Pass Segments by Satellite in 2003



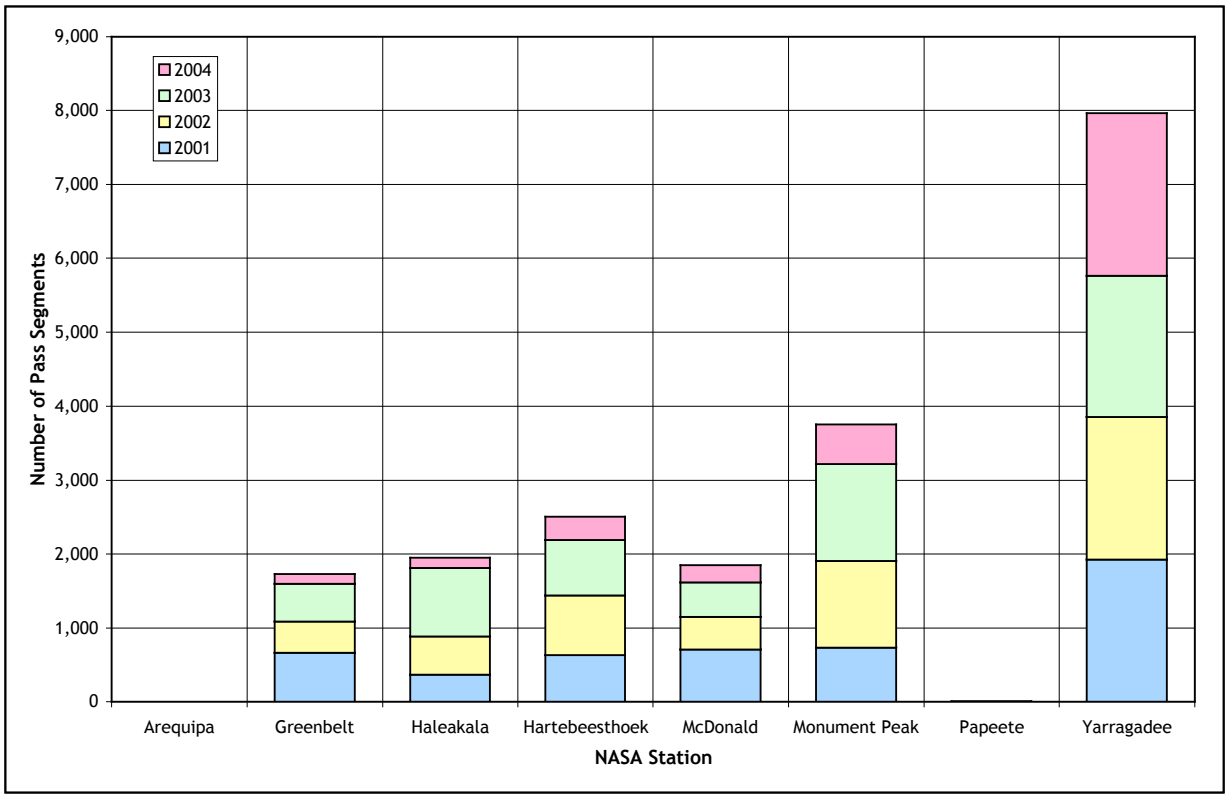
Total Low Satellite Pass Segments for NASA Network 2001-2004



Total LAGEOS Pass Segments for NASA Network 2001-2004



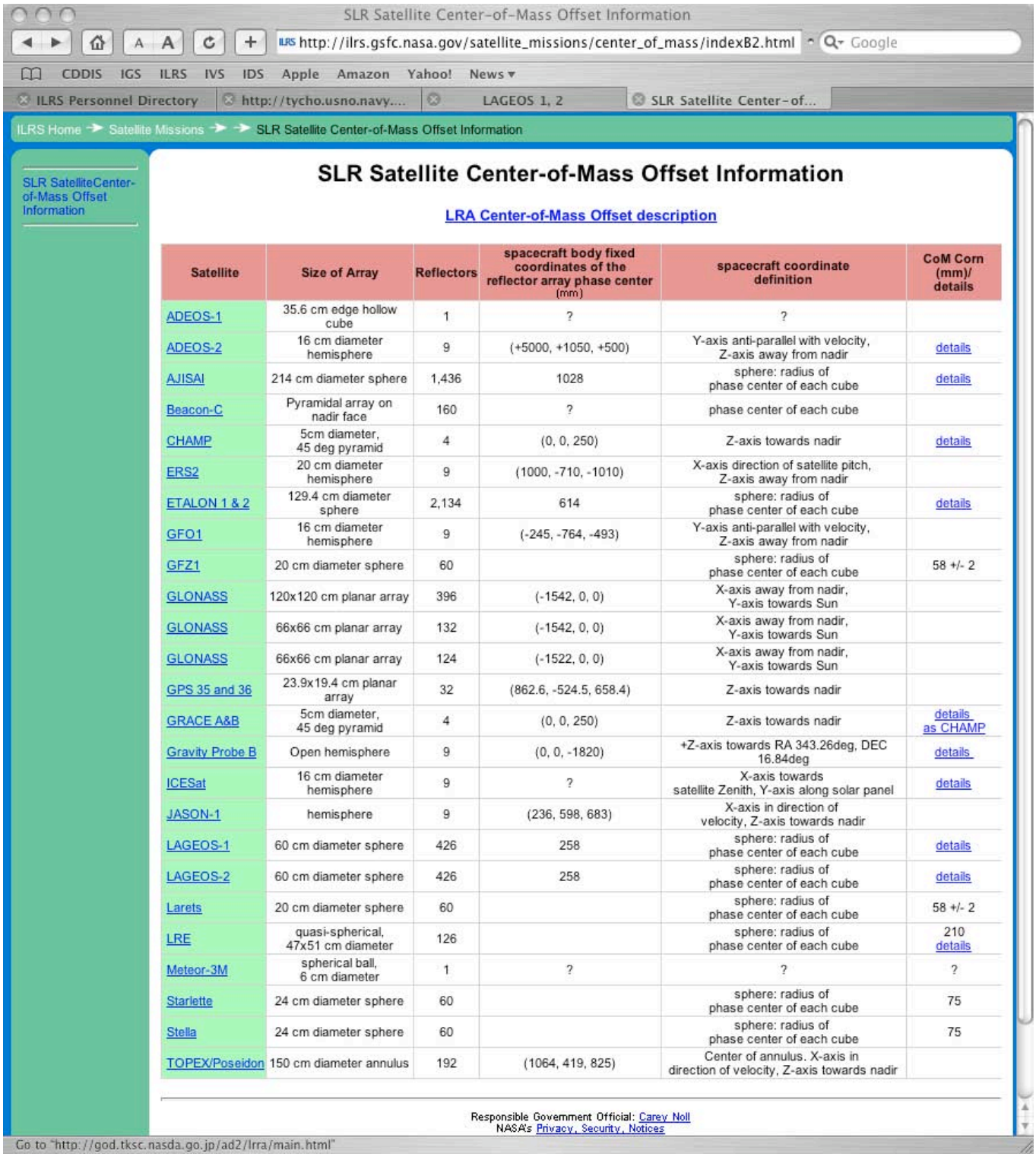
Total High Satellite Pass Segments for NASA Network 2001-2004



Low Elevation Tracking Statistics (2004)

		Number of Normal Point Observations At or Below 10 Degrees Elevation			
Site	Station	LAGEOS-1	LAGEOS-2	Etalon-1	Etalon-2
Borowiec	7811	20	3	0	0
Grasse	7845	12	4	0	0
Graz	7839	10		0	0
Shanghai	7837		12	0	0
Wettzell	8834	4		0	0

CoM Website "Front Page"



SLR Satellite Center-of-Mass Offset Information

http://ilrs.gsfc.nasda.go.jp/satellite_missions/center_of_mass/indexB2.html

CDDIS IGS ILRS IVS IDS Apple Amazon Yahoo! News

ILRS Personnel Directory | http://tycho.usno.navy.... | LAGEOS 1, 2 | SLR Satellite Center-of...

ILRS Home → Satellite Missions → → SLR Satellite Center-of-Mass Offset Information

SLR SatelliteCenter-of-Mass Offset Information

SLR Satellite Center-of-Mass Offset Information

LRA Center-of-Mass Offset description

Satellite	Size of Array	Reflectors	spacecraft body fixed coordinates of the reflector array phase center (mm)	spacecraft coordinate definition	CoM Corn (mm)/ details
ADEOS-1	35.6 cm edge hollow cube	1	?	?	
ADEOS-2	16 cm diameter hemisphere	9	(+5000, +1050, +500)	Y-axis anti-parallel with velocity, Z-axis away from nadir	details
AJISAI	214 cm diameter sphere	1,436	1028	sphere: radius of phase center of each cube	details
Beacon-C	Pyramidal array on nadir face	160	?	phase center of each cube	
CHAMP	5cm diameter, 45 deg pyramid	4	(0, 0, 250)	Z-axis towards nadir	details
ERS2	20 cm diameter hemisphere	9	(1000, -710, -1010)	X-axis direction of satellite pitch, Z-axis away from nadir	
ETALON 1 & 2	129.4 cm diameter sphere	2,134	614	sphere: radius of phase center of each cube	details
GFO1	16 cm diameter hemisphere	9	(-245, -764, -493)	Y-axis anti-parallel with velocity, Z-axis away from nadir	
GFZ1	20 cm diameter sphere	60		sphere: radius of phase center of each cube	58 +/- 2
GLONASS	120x120 cm planar array	396	(-1542, 0, 0)	X-axis away from nadir, Y-axis towards Sun	
GLONASS	66x66 cm planar array	132	(-1542, 0, 0)	X-axis away from nadir, Y-axis towards Sun	
GLONASS	66x66 cm planar array	124	(-1522, 0, 0)	X-axis away from nadir, Y-axis towards Sun	
GPS 35 and 36	23.9x19.4 cm planar array	32	(862.6, -524.5, 658.4)	Z-axis towards nadir	
GRACE A&B	5cm diameter, 45 deg pyramid	4	(0, 0, 250)	Z-axis towards nadir	details as CHAMP
Gravity Probe B	Open hemisphere	9	(0, 0, -1820)	+Z-axis towards RA 343.26deg, DEC 16.84deg	details
ICESat	16 cm diameter hemisphere	9	?	X-axis towards satellite Zenith, Y-axis along solar panel	details
JASON-1	hemisphere	9	(236, 598, 683)	X-axis in direction of velocity, Z-axis towards nadir	
LAGEOS-1	60 cm diameter sphere	426	258	sphere: radius of phase center of each cube	details
LAGEOS-2	60 cm diameter sphere	426	258	sphere: radius of phase center of each cube	details
Larets	20 cm diameter sphere	60		sphere: radius of phase center of each cube	58 +/- 2
LRE	quasi-spherical, 47x51 cm diameter	126		sphere: radius of phase center of each cube	210 details
Meteor-3M	spherical ball, 6 cm diameter	1	?	?	?
Starlette	24 cm diameter sphere	60		sphere: radius of phase center of each cube	75
Stella	24 cm diameter sphere	60		sphere: radius of phase center of each cube	75
TOPEX/Poseidon	150 cm diameter annulus	192	(1064, 419, 825)	Center of annulus. X-axis in direction of velocity, Z-axis towards nadir	

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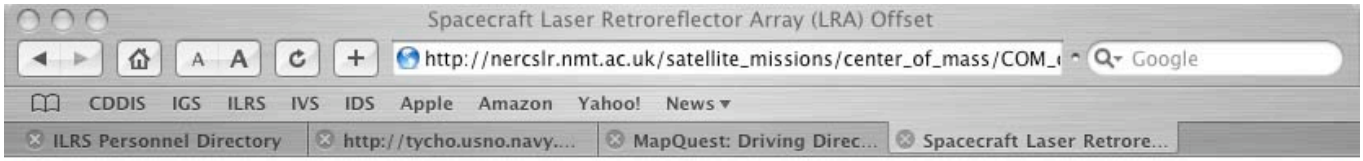
Go to "http://god.tksc.nasda.go.jp/ad2/lrra/main.html"

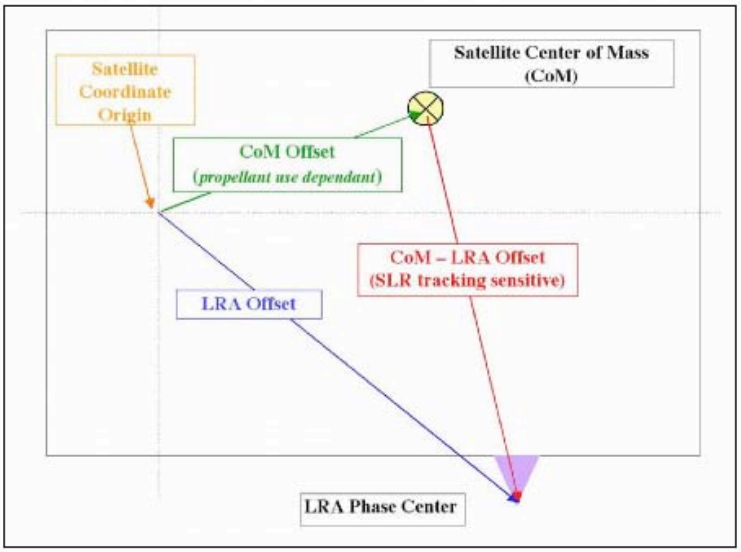
CoM Website Concept Page

In order to refer SLR range observations to the centres of mass of satellites, detailed information is required on the characteristics and locations of the phase centres of the reflector arrays. The draft web pages shown here give an overview of the collected information that is presently available. For the spherical satellites the phase centre locations are given as radial distances from the centres of the spacecraft; for the active satellites, the phase centres of the array are given, where known, as 3D locations in body-fixed coordinate frames. In addition, for the major geodetic satellites, results are included on variation of centres of mass correction with tracking system characteristics.
In order to simplify the maintenance of the data source, it is recommended that spacecraft agencies be required to furnish array location and characteristic information when applying for ILRS tracking support.



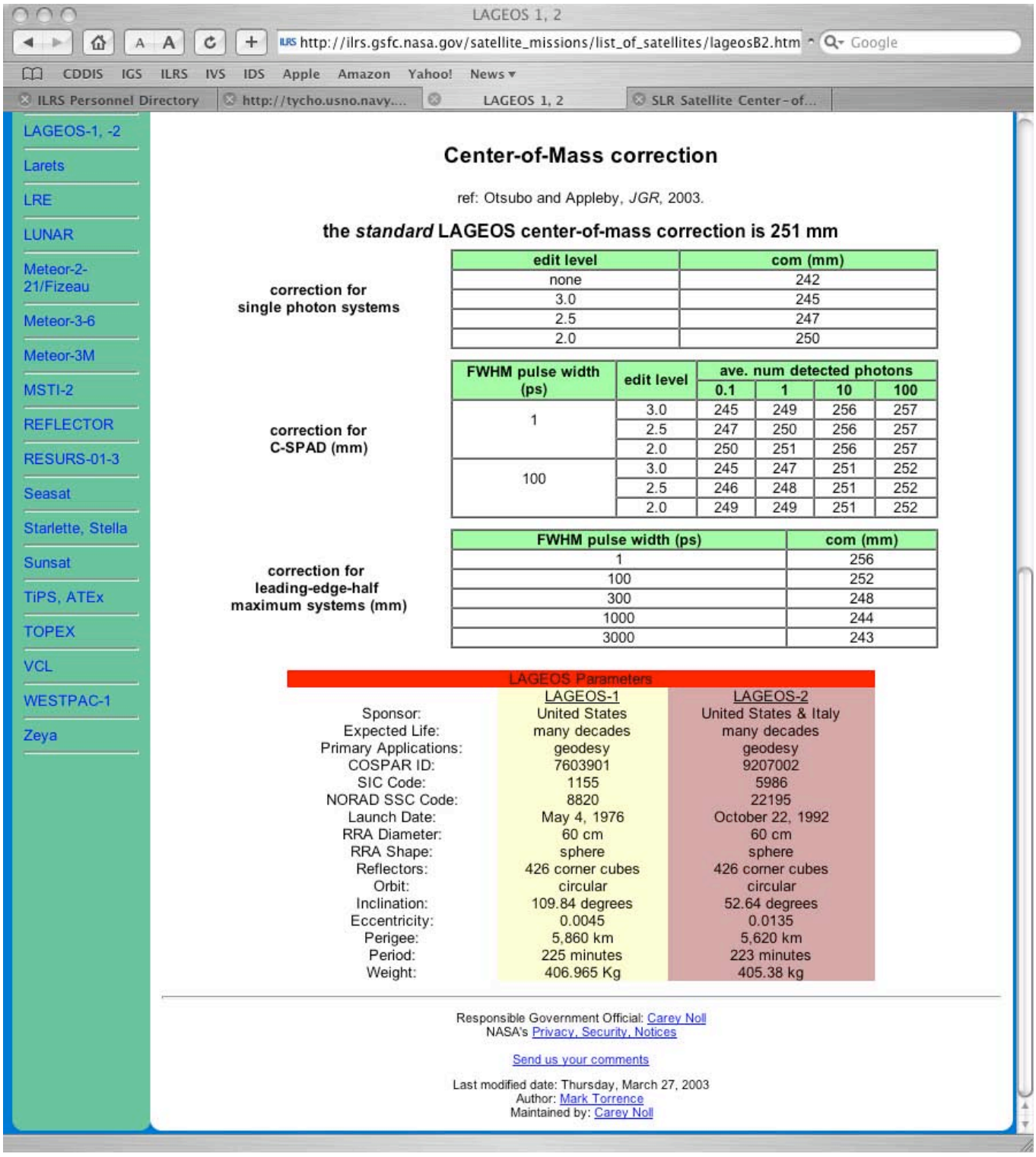
Spacecraft Laser Retroreflector Array (LRA) Offset: "Satellite Center of Mass Measurement Correction"

To accurately know the SLR center-of-mass offset measurement correction for each satellite, several pieces of information are necessary.



- Accurate 3-dimensional knowledge of each of the vectors in the diagram above from pre-launch measurements as documented in the Interface Control Documents (ICD).
- Accurate characterization of the corner-cube response for all incident geometries and wavelengths.
- Accurate characterization of the detector response for all operating conditions.
- Accurate knowledge of the satellite attitude in its orbit.

CoM Website Details (LAGEOS)



LAGEOS 1, 2

http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/lageosB2.htm

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ILRS Personnel Directory | http://tycho.usno.navy.... | LAGEOS 1, 2 | SLR Satellite Center-of...

- LAGEOS-1, -2
- Larets
- LRE
- LUNAR
- Meteor-2-21/Fizeau
- Meteor-3-6
- Meteor-3M
- MSTI-2
- REFLECTOR
- RESURS-01-3
- Seasat
- Starlette, Stella
- Sunsat
- TiPS, ATEx
- TOPEX
- VCL
- WESTPAC-1
- Zeya

Center-of-Mass correction

ref: Otsubo and Appleby, *JGR*, 2003.

the *standard* LAGEOS center-of-mass correction is 251 mm

correction for single photon systems

edit level	com (mm)
none	242
3.0	245
2.5	247
2.0	250

correction for C-SPAD (mm)

FWHM pulse width (ps)	edit level	ave. num detected photons			
		0.1	1	10	100
1	3.0	245	249	256	257
	2.5	247	250	256	257
	2.0	250	251	256	257
100	3.0	245	247	251	252
	2.5	246	248	251	252
	2.0	249	249	251	252

correction for leading-edge-half maximum systems (mm)

FWHM pulse width (ps)	com (mm)
1	256
100	252
300	248
1000	244
3000	243

LAGEOS Parameters

	LAGEOS-1	LAGEOS-2
Sponsor:	United States	United States & Italy
Expected Life:	many decades	many decades
Primary Applications:	geodesy	geodesy
COSPAR ID:	7603901	9207002
SIC Code:	1155	5986
NORAD SSC Code:	8820	22195
Launch Date:	May 4, 1976	October 22, 1992
RRA Diameter:	60 cm	60 cm
RRA Shape:	sphere	sphere
Reflectors:	426 corner cubes	426 corner cubes
Orbit:	circular	circular
Inclination:	109.84 degrees	52.64 degrees
Eccentricity:	0.0045	0.0135
Perigee:	5,860 km	5,620 km
Period:	225 minutes	223 minutes
Weight:	406.965 Kg	405.38 kg

Responsible Government Official: Carey Noll
NASA's Privacy, Security, Notices

Send us your comments

Last modified date: Thursday, March 27, 2003
Author: Mark Torrence
Maintained by: Carey Noll

Validation of Mt. Stromlo Data (J. Ries/CSR)

Mt. Stromlo SLR Data Performance

Data from Lageos-1/-2 from May 28 through Nov 30

	No. Passes	No. Obs	Mean Bias (mm)	Mean Time Bias (μsec)	Precision (mm)
LAGEOS-1	142*	1654	-4 ± 1	-0.8 ± 0.5	4
LAGEOS-2	122*	1556	-3 ± 1	2.6 ± 0.6	4

* 9 (8) passes edited for Lageos-1(Lageos-2) due to less than 2 points or other reasons

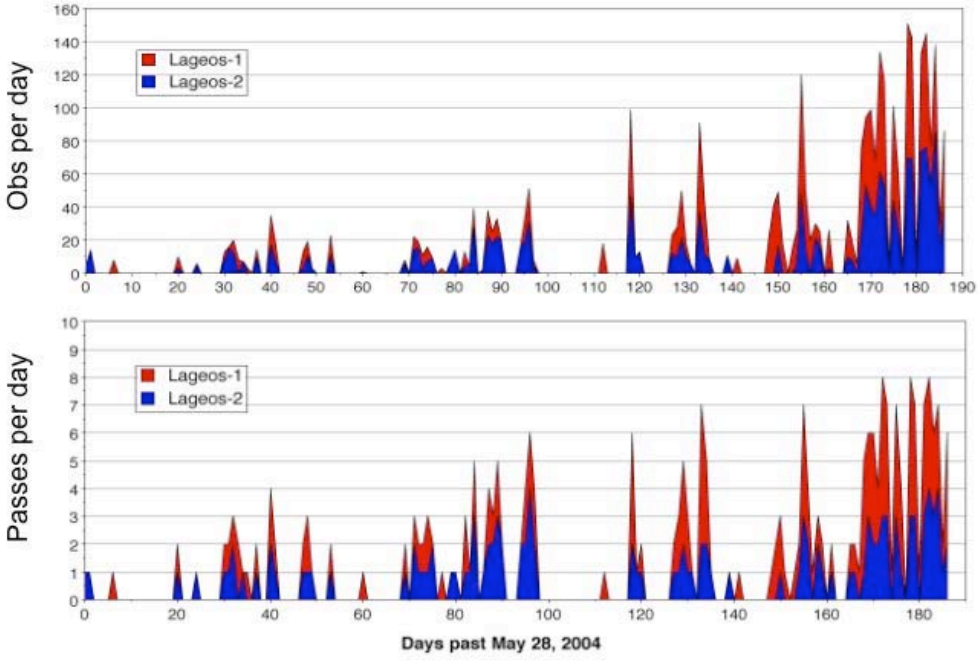
Of passes with 9 or more points, 69.4% of passes have 3 mm precision or better for Lageos-1 and 70.3% for Lageos-2

Coordinates based on Geoscience Australia local tie survey (adjustment did not seem to be necessary; adjustment with 147 passes indicated only cm-level change)

STROML7849 -4467063.648 2683034.480 -3667007.371
STROML7825 -4467064.309 2683034.884 -3667007.917

Tie: 7849 50119S001 - 7825 50119S003 = -0.6611 0.4035 -0.5466

Tracking Performance



Proposed CDDIS Directory Structure

New Server *cddis.gsfc.nasa.gov*

```
/pub/slr/data/
            /npt/SATNAME/YEAR/SATNAME.YYMMDD        Daily combined normal point data file by satellite
                             /SATNAME.YYMM          Monthly normal point data file
                             /sum/SATNAME_sum.YYMM
                                                    Monthly normal point summary file
                 /allsat/YEAR/nasa_allsat.YYMMDD    Daily HTSI file includes normal point data from NASA stations
                                                    only for all satellites
                             /edc_allsat.YYMMDD     Daily EDC file includes normal point data from EUROLAS
                                                    stations only for all satellites
                             /allsat.YYMMDD         Daily combined normal point data file for all satellites
                             /allsatH.YYMMDD        Hourly combined normal point data file for all satellites
                             /allsat.YYMM           Monthly normal point data file for all satellites
                             /sum/allsat_sum.YYMM   Monthly normal point summary file

            /fr/SATNAME/YEAR/SATNAME_V.YYMM.Z       Monthly full-rate data file
                             /sum/SATNAME_V_sum.YYMM.Z
                                                    Monthly full-rate summary file
                        /daily/SSSS/SSSS_YYMMDD_V.SATNAME.Z
                                                    Daily full-rate data file
                        /npt/YYYY/SATNAME_V_npt.YYMM.Z
                                                    Monthly file of normal points created from full-rate
                                 /sum/SATNAME_V_npt_sum.YYMM.Z
                                                    Monthly summary file of normal points created from full-rate

            /llrnpt/YEAR/llr_npt.YYMM.Z             Monthly LLR normal points, prior to 1999
            /llrnpt/YEAR/sum/llr_npt_sum.YYMM.Z     Monthly LLR normal point summary, prior to 1999

/pub/slr/products
                 /pos+eop/YYMMDD/CENTER.pos+eop.YYMMDD.v#.snx.Z
                                                    Station and EOP solution ending on YYMMDD
                               /CENTER.pos+eop.YYMMDD.v#.sum.Z
                                                    Summary file for solution ending on YYMMDD
                               /CENTER.eop.YYMMDD.v#.snx.Z
                                                    EOP (wrt ITRF2000) solution ending on YYMMDD
```

KEY:				
	SATNAME	satellite name (agreed to list)	DD	2-digit day
	YEAR	4-digit year	H	1-digit hour of day
	YY	2-digit year	V	version number
	MM	2-digit month	SSSS	4-digit station number
	#	1-digit version number	CENTER	AC code (ilrsa=primary, ilrsb=backup)

- New CDDIS server *cddis.gsfc.nasa.gov* should be operational by EOY 2004
- Directory structures for GNSS, laser, and VLBI data have changed
- CDDIS, ILRS, and supporting websites will be moved to new server at that time