Eighth General Assembly of the ILRS
October 11, 2002
Washington, D.C.

Presentation Material

Introductory Remarks

Science Coordinator Report

SCIENCE CHALLENGES FOR SLR

Steve Klosko
Raytheon/GSFC

Raytheon

MAJOR SCIENCE CONTRIBUTIONS

- Science Products
  - Global gravity models
  - Temporal gravity changes
  - Dynamic tides
  - Lunar science
  - Fundamental physics and tests of relativity
  - Earth scale: GM
  - ….
- Applications
  - GPS independent orbit/model assessment
  - Altimeter calibration
  - Precise orbit determination
  - Fail-safe precision tracking
  - ….

GEODETIC MONITORING OF EARTH

	Atmosphere	Hydrosphere/ Cryosphere	Crust	Earth Interior
Gravity Field	Temporal monitoring of mass redistribution throughout Earth system as form of remote sensing		Lithosphere strength, PGR, isostatic behavior	Mantle rheology, convection, core-mantle boundary
Tides	Thermal/gravity forces mass displacements	Ocean tides, ocean circulation, Earth/Moon system	Tidal loading and lithosphere strength	Inelasticity of solid Earth
Earth Rotation & Polar Motion	Atmospheric angular momentum, air-ocean coupling	Ocean momentum, bottom friction, ice sheet mass balance	Secular changes due to deglac-iation & long term processes	Core-mantle coupling/ reson-ance, ties to geomagnetism
Crustal Motions	Atmospheric loading	Ocean loading, non-tidal deformation	Strain in seismic zones, tectonics, subsidence, mountain building	Lithosphere-mantle coupling, crustal cooling
Topographic Mapping	Loading, baro-metric ocean response	Ocean circulation, ocean wind interaction	Gravity anom-alies, ice sheet loading	Small scale convection, mantle rheology

MAJOR CHALLENGES

- Complementing GPS activities
- Lowering operating costs
- Network densification
- Leveraging, adding value to nearly 40 year tracking history
- Obtaining increased funding for SLR/LLR-based science

Complementing GPS

NEW TECHNOLOGIES

- mm-level accuracy
- Fully automated low power systems
- Interplanetary tracking, laser transponders
- Dual, multi-frequency capabilities
- Laser altimetry

MM LEVEL SIGNALS

- Environmental Effects
  - ground water changes
  - frost heave
  - ocean loading
  - atmospheric loading
  - wind stress
  - thermal expansion/contraction

Network Reports

ILRS Eighth General Assembly

EUROLAS Report

Werner Gurtner

Washington D.C. October 11, 2002

EUROLAS Workshop

Detecting and eliminating errors in the EUROLAS network

March 2002, 11-13
Herstmonceux

→ **Report available on ILRS Web site**:

ILRS Home > Publications > Special Reports > EUROLAS Workshop

Summary

- Inter-comparison of performance of time interval counters
- Inter-comparison of station barometers
- Spreading best practice for operational conditions, procedures and monitoring of instruments
- Maximisation of data quality by post-pass checking at stations
- Encourage inter-station visits
- Encourage use of NRT display and TB service
- Need for accuracy in local site ties

CAGLIARI STATION

New Updates (because of breakdowns):

- ✓Telescope Encoders & Gears
- ✓Telescope Guide Hardware & Software
- ✓Dome Aperture System
- ✓Safety Provisions

Restarting Of The Observations: October 2002

(up to 6 Satellites/day, 5 days/week, LEO+Lageos+GLONASS)

Operating Difficulties:

- ✓Technical & Observations Staff too small:
  - 3 Researchers and
  - 4 unskilled Technicians,
  - involved part-time in SLR
- ✓Cut down on the Research Budget

EUROLAS/ILRS: New station

- Lviv in Ukraine
- 1 m Cassegrain Telescope
- T/R switch: Rotating mirror
- ND:YAG Laser, 150 ps, 130 mJ
- Low altitude and LAGEOS satellites
- No routine data submission yet

Sixth Framework Programme

- European Community for Research, Technological Development and Demonstration
- Instruments for funding:
  - "Integrated Projects"
  - "Networks of Excellence"
- Invitation to submit "Expressions of Interest" before June 7, 2002

EUROLAS CALNet

European Laser Ranging Precise Calibration and Orbit Evaluation Network

- Draft by
  - Wolfgang Schlüter, BKG, Wettzell
  - Werner Gurtner, AIUB, Zimmerwald
  - Karel Hamal, Prague
- Originally initiated by
  - Karel Hamal and Ivan Prochaska, Prague, shortly discussed in Nice, April 2002

Goal of EUROLAS CALNet

- Improve the European SLR capability
  - to establish a state-of-the-art calibration and orbit evaluation network
  - for all future Satellite Missions (GALILEO, ENVISAT, GOCE)
  - related to research in global change
  - with the underlying and vital need for a long-term consistent reference frame.

Contributions to FP6

- Support GALILEO
  - Independent evaluation of the satellite orbits
  - Support integration of GALILEO into existing reference frame
  - Combination with other geodetic techniques
- Support Earth Watch Projects satellites
  - Independent control and improved accuracy of satellite orbits
  - Failsafe backup means for orbit determination
  - Calibration test bed for the satellite altimeters.

New EUROLAS President:

Guiseppe Bianco, ASI, Matera

to replace

Werner Gurtner, AIUB, Berne

The WPLTN meeting_Report to General Assembly
11 October 2002

1. Matter of regret: Missing China and Russia delegates

WPLTN express the matter of regret for missing Chinese and Russia delegates by visa problem not only because we lost more than 2/3 people attendance of WPLTN network in the workshop but also we lost rare opportunity to exchange information for many solved-for problems through face-to-face communication in the week.

2. National Report Briefing

Australia: National Mapping Division of Geoscience Australia keeps running Yaragadee and Mt.Stromlo as the highest productivity and quality stations in ILRS network. EOS uses 10% of Mt.Stromlo time for research and development including such as LLR and debris observation using extremely high power laser.
Japan: See attached report.
China: See attached report
Saudi: Successful re-commission of SALRO data yield since 2001
(see attached report and figures by courtesy of KACST)
Russia: No report in this meeting
India: ISRO is trying to acquire station for associated space program

3. Overall Strategic issues

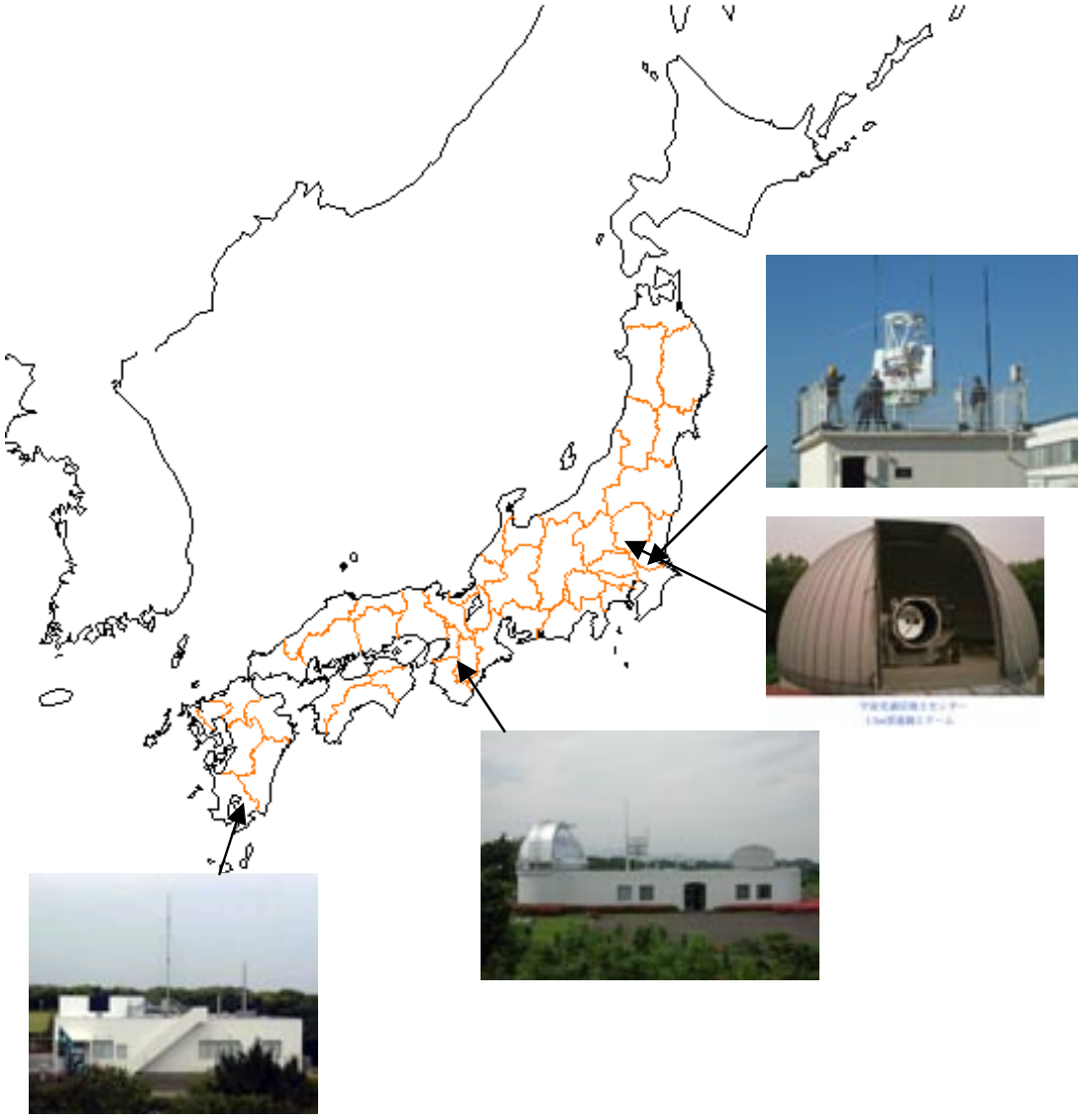
As shown statistics in CB report for last years, there has been more stations coming to high rank from data yield point of view. However, number of stations needs more effort for quality of their producing data. Each country (with no exception i.e., including Australia) has own funding problems to face on how to continue stations and operation, and how to upgrade the observation capability. Some of stations should be maintained/upgraded as core stations strategically in WPLTN region.

4. Other actions

To improve communication with CB for lack of information regarding sitelog etc.
New executives installed as attached sheet.

Japanese Network

CRL: Two stations Miura, Tateyama of four Keystone stations were dismantled in 2001. Laser and electronics of those stations are moved and integrated to Koganei 1.5m telescope for tracking campaign LRE and ADEOS2.
HOD (Hydrographic and Oceanographic Department of Japan Coast Guard): Simosato has been better routine observation than last few years. It will achieve in this month 15,000 passes since station built. HTLRS ceased its operation entirely in 2002.
NASDA: GUTS SLR system is in final integration phase waiting telescope to perform co-location test at GSFC



Report from China

1. Observations

Changchun, Shanghai, Beijing, and Kunming stations are operational, while Wuhan is doing some tests and will restart observing soon. The mobile system TROS has been in Wuhan for maintenance and rest, and is going to Urumqi for collocation with the VLBI system in the beginning of next year. Another mobile system CTLRS has been in Xian for upgrading of the control system and laser system, and is doing some testing satellite observations.

2. System upgrades

The Changchun station adopted the new computer control system as the Shanghai station had.
The Shanghai station has upgraded the system control and diagnosis software. The new observation house for SLR was started to build and will be completed in March 2003.
Shanghai station is developing a Raman laser in collaboration with K. Hamal and I. Prochazka of the Czech Technical University and J. Gaignebet of CERGA for the new SLR station.

3. Argentina system

The system is doing ground target ranging and is testing satellite tracking. It is shown that the mount and servo system are working well. It is expected to have satellite returns soon.

WPLTN Executive Meeting

Date:TBD (May-June, 2003), 3 days.
Venue: Shanghai Observatory, Shanghai, China
Participant: WPLTN Executive members
Topics: How to upgrade the observation capability of WPLTN stations

SALRO 2001 Report

The SALRO site at the Solar Village, Saudi Arabia. The Solar Village is some 45 km north west of Riyadh.

Photography date is July 9, 2002, whilst tracking the Etalon2 satellite after dusk.

The site has many shrubs and hedges, giving it the feel of an oasis in the desert.

The site is operated primarily during daylight and early evening hours.

Re-Commissioning in 2000

KACST let an O&M contract in mid 2000 with the aim of making SALRO work again, after it sat unused for some time. Several months were spent in 2000 making all equipment operational.

Spares from the defunct Orroral Observatory and CRL 1.5m SLR system were used in this effort, and thanks go to those organizations for their assistance.

By the end of 2000, SALRO was capable of successful SLR to satellites in all orbit categories, except the very lowest – limitations of the mechanical transmit/receive system which remains.

While the entire system received attention to varying degrees, it was the laser, receiver and pulse-handling electronics that required the most work. The acquisition software had previously been upgraded by EOS to deal with the Y2K problems.
The team consists of two KACST staff trainees and two expatriate engineers working under the O&M contract.

Operations Commence 1/1/2001

With all the gross problems cleared, use of the system commenced on a production basis. Operational procedures were developed in tandem with fine tuning of the system. Staff training assumed a higher priority. One observations shift operated all year.

2001 was a transitional year, commencing as “engineering” and ending by achieving compliance with all the ILRS guidelines.

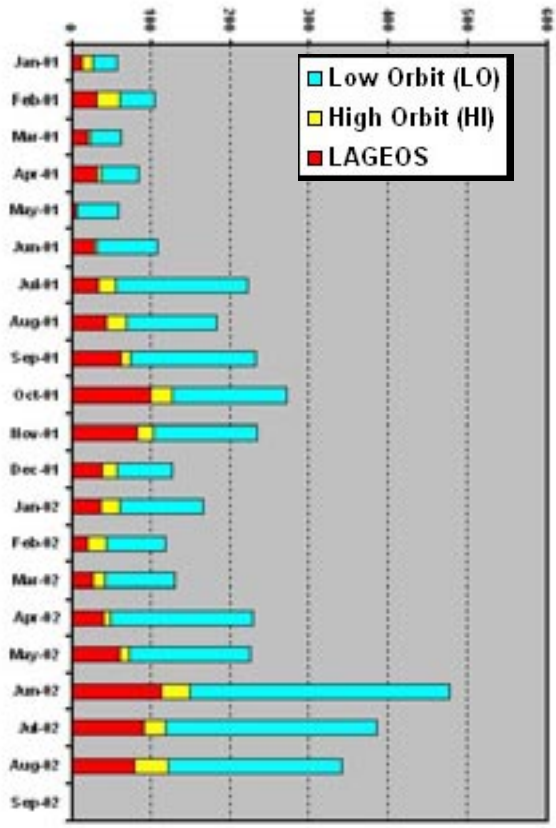
Some periods of downtime exceeding one week were required to overcome random failures, and implement major improvements such as the installation of a new compensated SPAD detector. The incidence of failures and unscheduled downtime is now minimized with the implementation of a preventative-maintenance program.

Winter: mid December to mid March. Cold, with very clear skies quite often. Occasional rain, some cloud periods lasting several days. Generally good SLR conditions day and night, routine daylight GPS acquisitions possible.

Autumn: October to mid December. Cooler, generally clear. Good SLR conditions day and night.

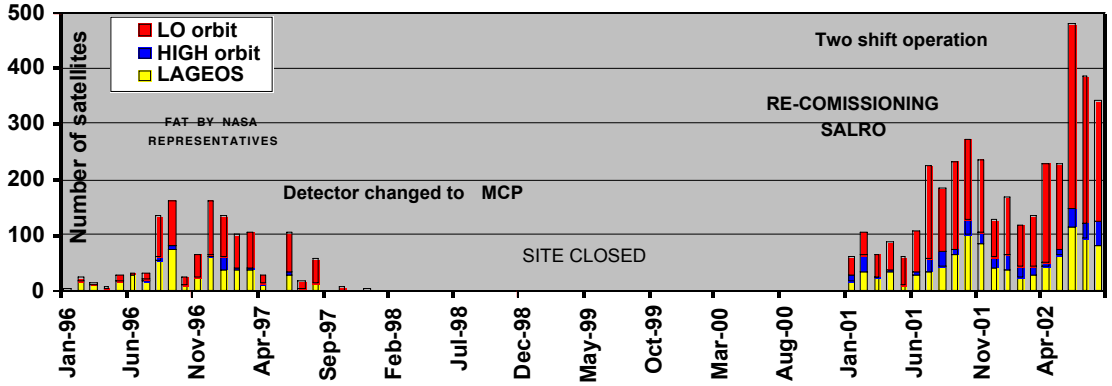
Summer: mid June through September. Generally clear, with varying degrees of sky haze at all times.
Day: high temperatures and directed sunlight on the telescope make SLR operations difficult.
Night: no problems, including occasional GPS acquisitions.

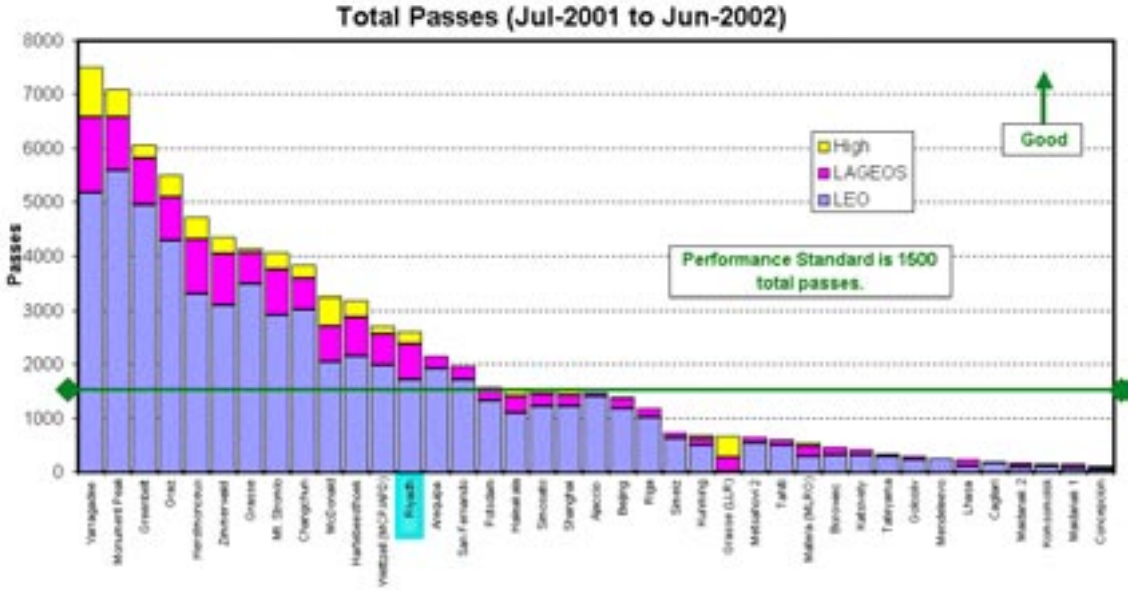
Spring: mid March to mid June: Difficult SLR conditions, day and night. Increasing daytime temperatures, very hazy at times, occasional cloud periods lasting several days – generally unsettled.

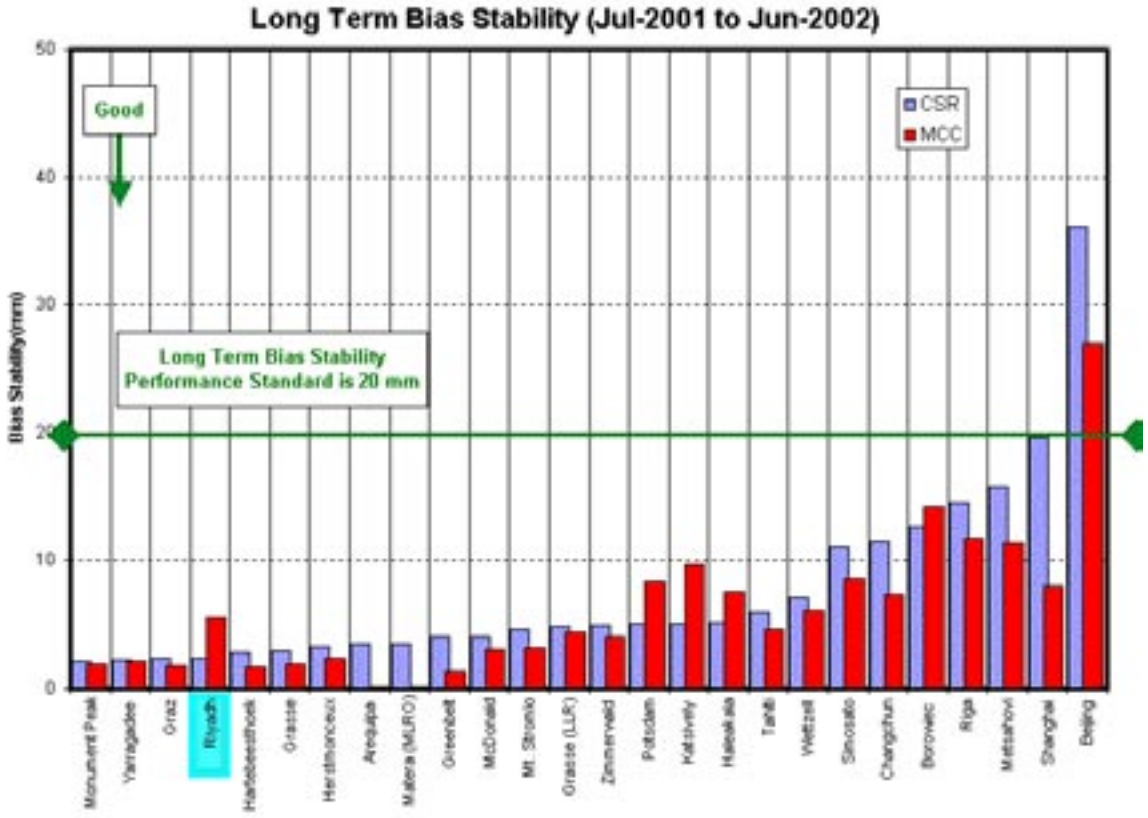


Plans
Boost productivity by expanding operations to cover 2 shifts 5 days per week.
Re-survey the site, work to remove any residual errors in adopted site coordinates.
Analyze and tune to eliminate systematic errors, range biases, etc.
Engineering improvements to the telescope (sun shields), AC/refrigeration systems, etc.
Site development to include analysis capability, GPS calibration etc.

SALRO PRODUCTIVITY PERFORMANCE 1996 TO PRESENT







Conclusions

KACST have a firm commitment to continue and develop SALRO operations, raising the profile of this science and its derivatives within the organization.

Environmental conditions allow useful operations all year round, with peak performance occurring in autumn and winter.

New Executives (Washington 2002 October 11)

Chairman	**Yang Fu Min**	**Shanghai Observatory, China**
Executive	**Wang Tanqiang**	**Beijing Observatory, China**
Executive	**Ramesh Govind**	**NMD/GA, Australia**
Secretary	**Ben Greene**	**EOS, Australia**
Executive	**Hiroo Kunimori**	**CRL, JAPAN**
Executive	**Mikio Sawabe**	**NASDA, JAPAN***
Executive	**Victor Shargorodsky**	**IPIE, Russia**
Executive	**Vladimir Vasilyev**	**IPIE, Russia**
Executive	**Abdallah M. Azzeer**	**KACST, Saudi Arabia ***
Executive	**Turki Al-Saud**	**KACST, Saudi Arabia**
Executive	**India: Elango K.Udayar**	**(ISRO)**

*** To be late approval or replacement in each organization.**

STATUS OF NASA NETWORK

- MOBLAS-4 & 7: Nominal Operations.
- MOBLAS-5 (Australia): Nominal Operations. Perform some single operator tracking which increased data volume.
- MOBLAS-6 (South Africa): Nominal Operations. Also performing single operator tracking.
- MOBLAS-8 (Tahiti): Training/Tracking Status. In the process of training the new crew member.

STATUS OF NASA NETWORK (Cont.)

- TLRS-3 (Arequipa): Nominal Operations.
- HOLLAS (Hawaii): Operational Status. Completed the telescope control system upgrade.
- MLRS (Texas): Nominal Operations.

The LLR Network

Peter J. Shelus

ILRS General Assembly

Washington, DC

October 11, 2002

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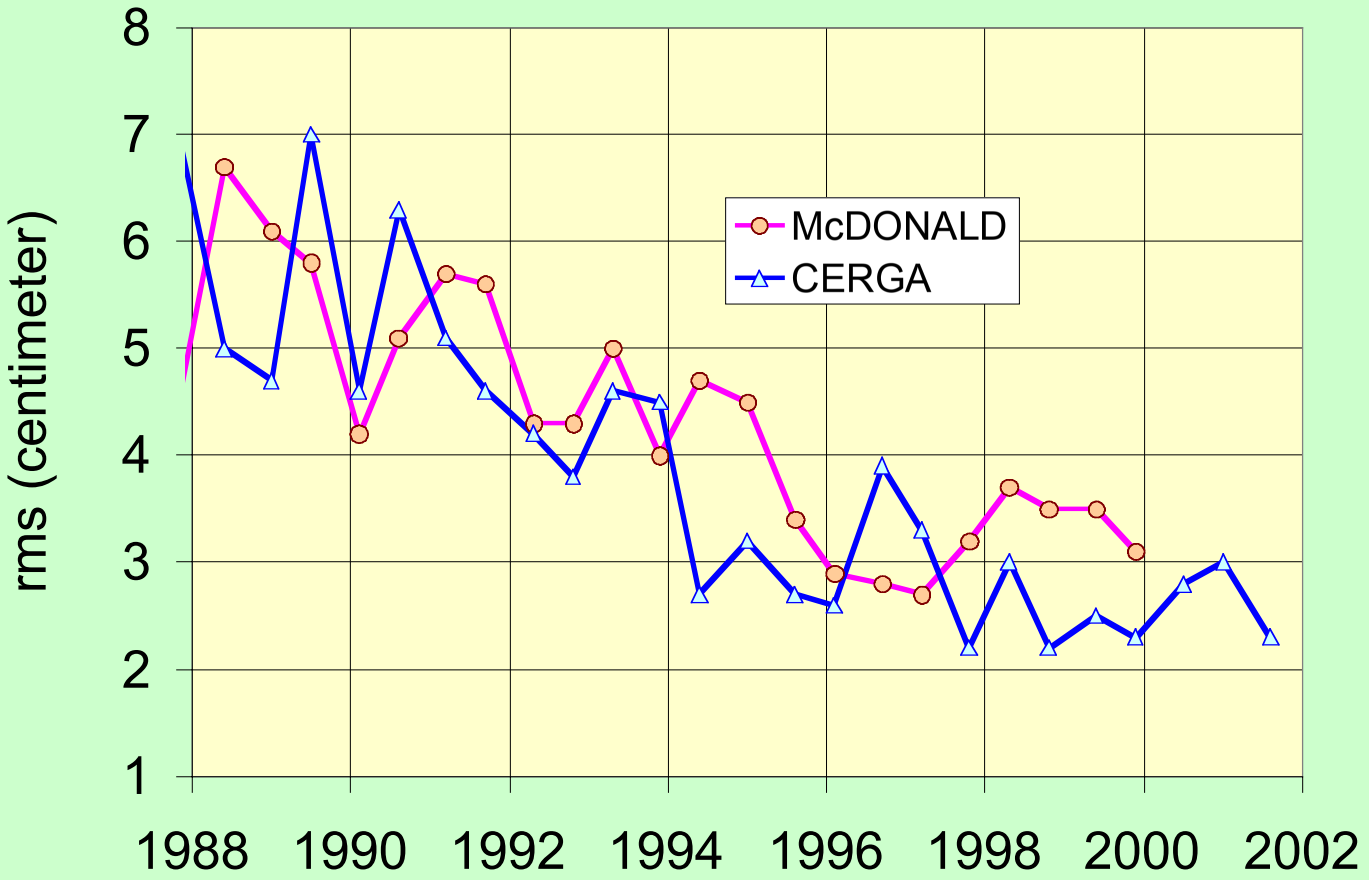
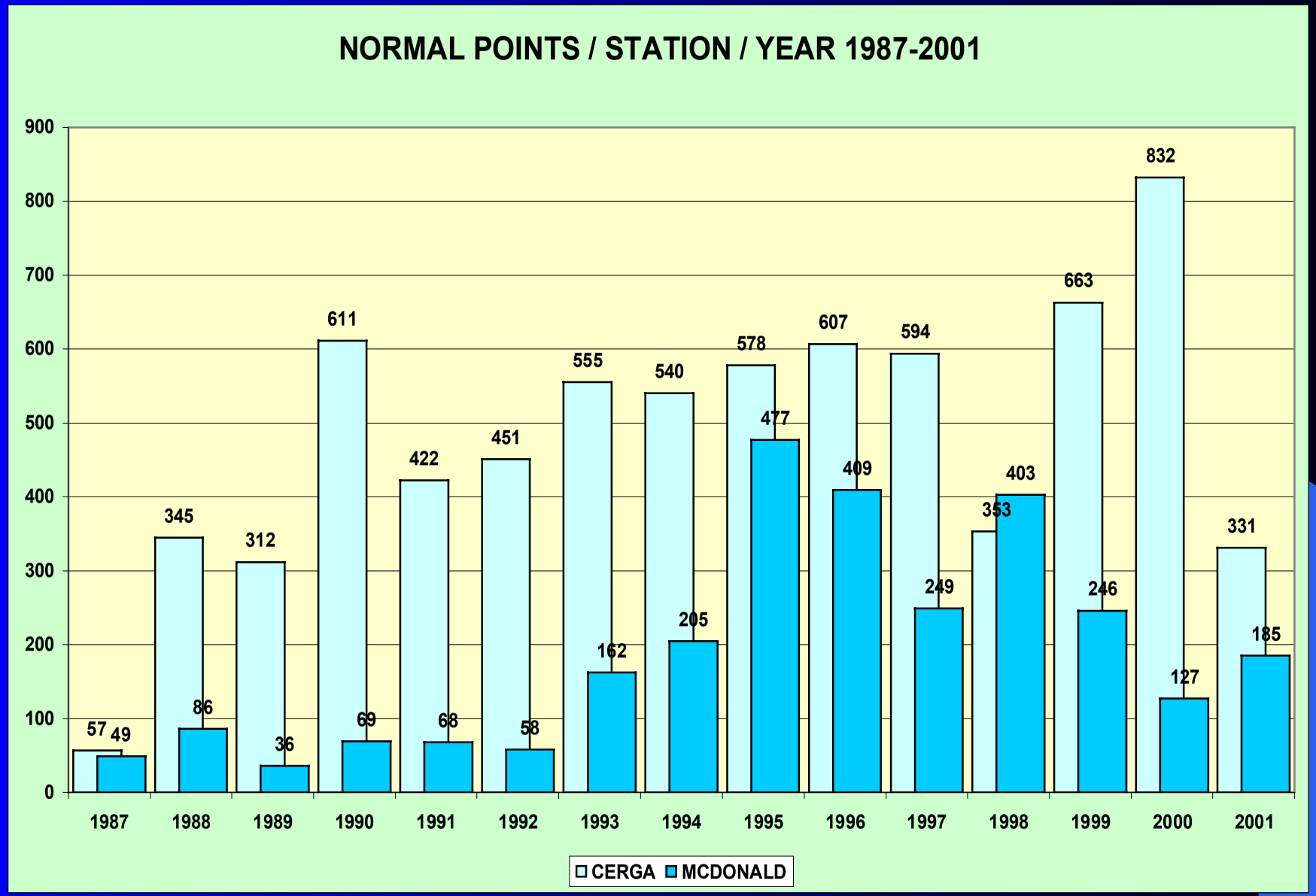
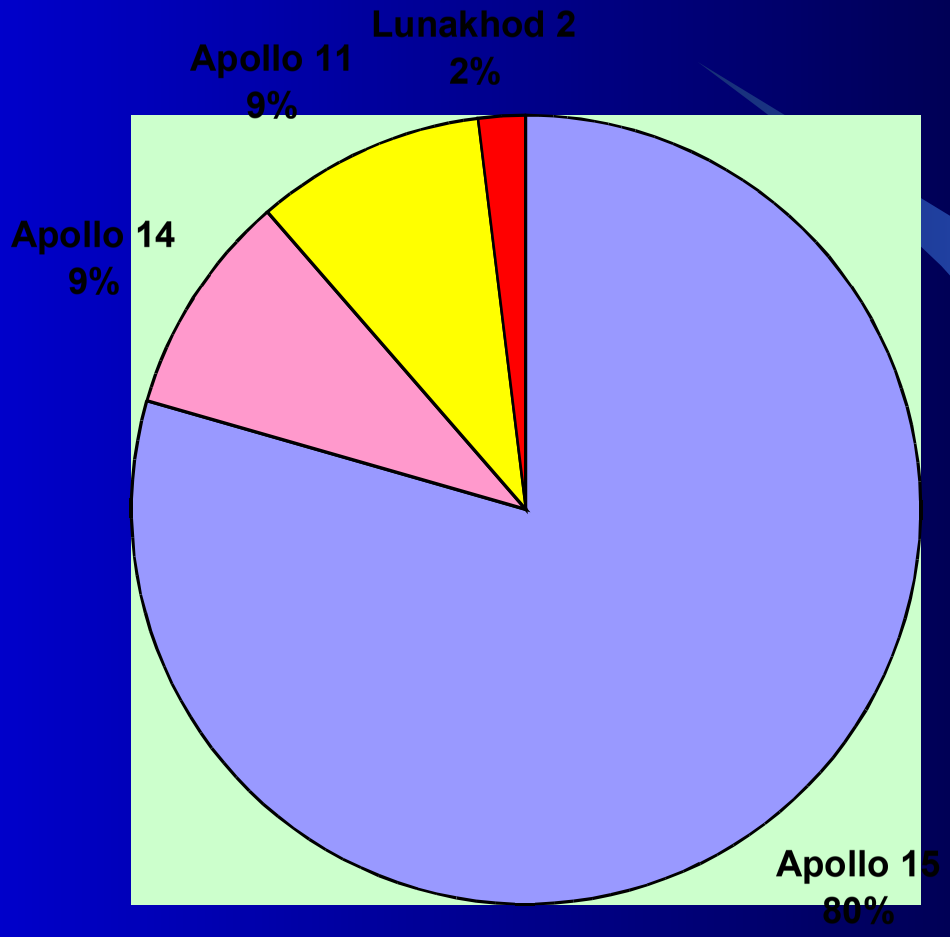
THE EVOLUTION OF THE QUALITY OF THE LLR OBSERVATIONS




NORMAL POINTS / STATION / YEAR 1987-2001
900
800
700
600
500
400
300
200
100
0
57
49
345
86
312
36
611
69
422
68
451
58
555
162
540
205
578
477
607
409
594
249
353
403
663
246
832
127
331
185
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
CERGA
MCDONALD

LLR OBSERVATIONS / REFLECTOR 1987-2001



Where we are

- Analysis in Paris & Pasadena
- Observing in Texas and at the Cote d'Azur
- 35 Years of Data
- Positive evolution of precision and accuracy

Where we are going

- Apache Point and APOLLO
- Mt. Stromlo in the “other” hemisphere
- MLRO in Italy ?
- Wettzell in Germany?

Overwhelming Drivers

- Push the envelope of technology
- Science
- Science
- Science

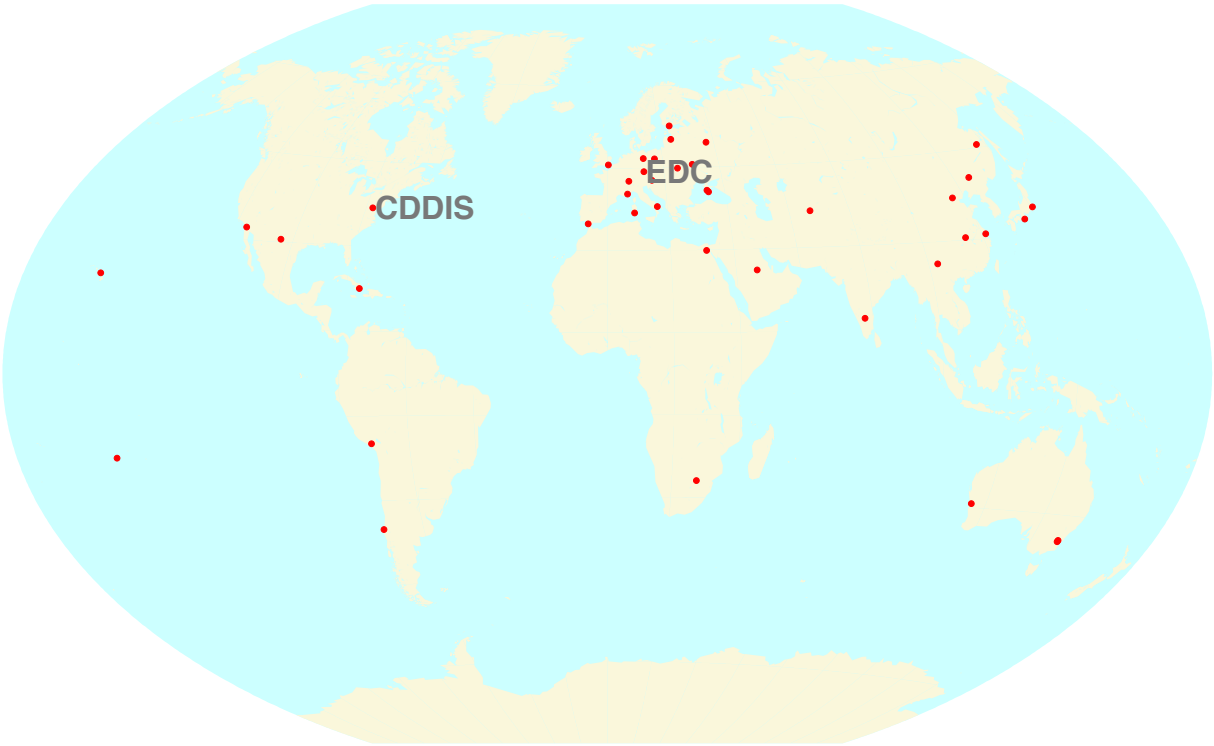
Conclusion

- The LLR network hangs on
- Blood, sweat and tears
- Unbridled tenacity

Data Center Report

ILRS Global Data Center Report / EDC

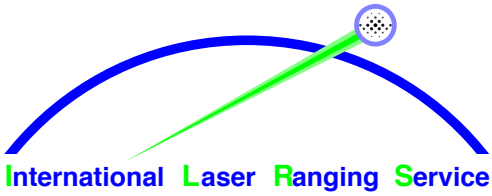
W. Seemüller



ILRS General Assembly, Washington D.C., October 11, 2002

DGFI

International Laser Ranging Service



ILRS Global Data Center Report / EDC

Wolfgang Seemüller

- Some remarks:
  - Backup procedures are installed at both global Data Centers (EDC replaced by Zimmerwald, CDDIS by EDC), EDC replacement is tested already, but CDDIS replacement not, no data at EDC ftp server from NASA stations (e.g. Sept. 13 to 15, power outage at CDDIS, no data since installation on Sep. 15, 2001)
  - Still old IRVs are distributed by the ILRS IRV exploder (e.g. September 13 to 15, 2002)
- New implementations
  - Two wavelength ONPs (separate files) are accepted, archived and distributed at both Global Data Centers (1 or 2 passes?)
  - New summary files at EDC, additionally the wavelength is given
  - New quality check for data format and integrity is installed at EDC (still missing: automatic information of the responsible SLR station)

International Laser Ranging Service

ILRS Global Data Center Report / EDC (continued)

- **New format of summary files**

Sat.No.	Stat.	For.	Date	Start	Dur.	No.	Wavl.	R.	File name
9306102	7840	onp	0210.03	68562	290	11	5320	0	ql_allsat_02100400
9306102	7835	onp	0210.03	68307	524	19	5324	0	ql_allsat_02100400
9502101	7810	onp	0208.22	77259	071	06	8460	0	ql_allsat_02082300
9502101	7810	onp	0208.22	77212	116	08	4230	0	ql_allsat_02082300
							^^^^^^^		

New! Laser wavelength & data release

- **New quality check for data format and integrity**

If an error is detected, an error file is written, e.g.:

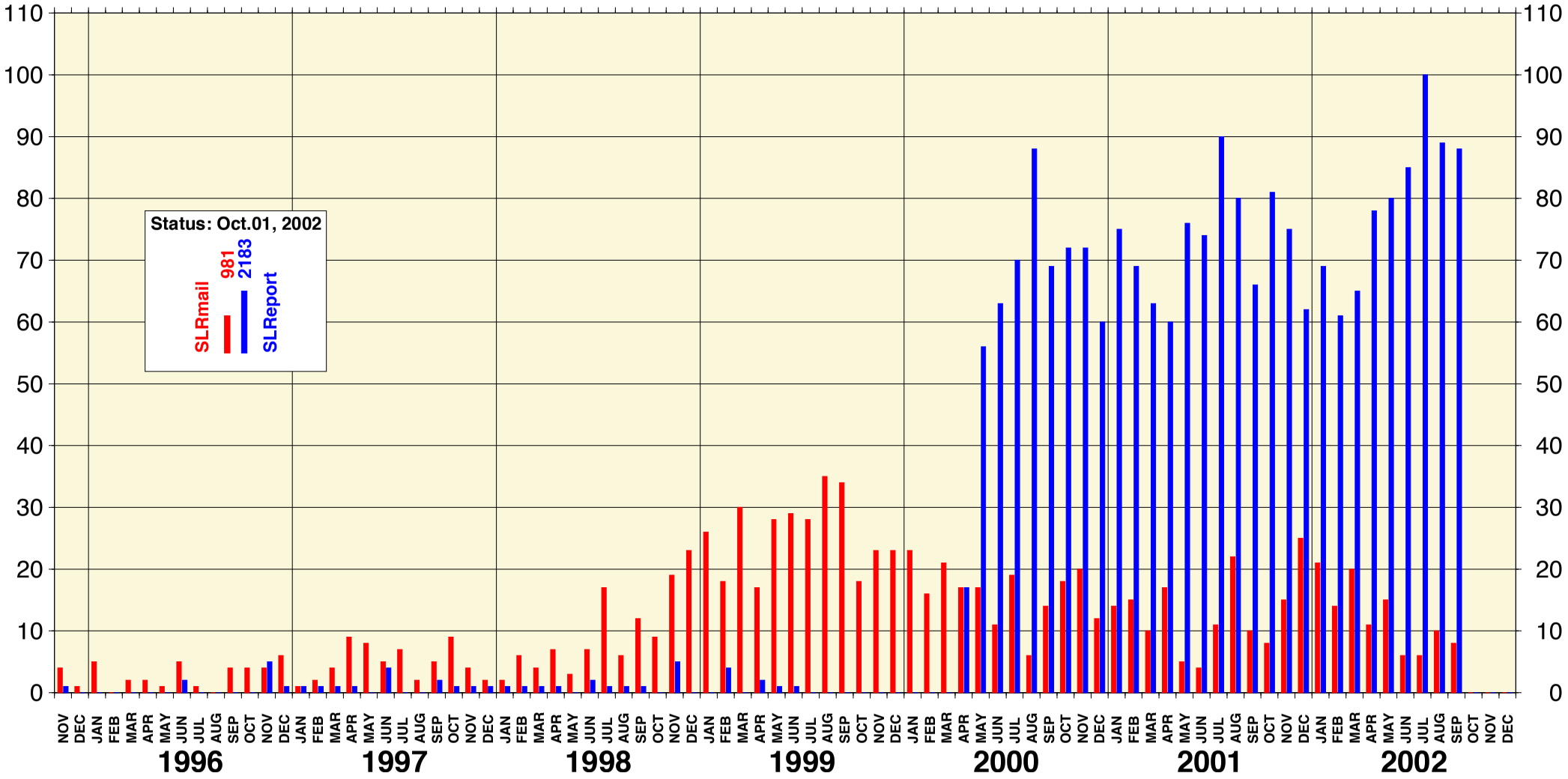
```
99999
950210102277784035015320001002630000000074345020070000 1 #spt hr ?
391568129997006842069054000007710261289007200450000000   . . x . . . x
391735494965006421851667000006710261289007200280000000   . . . . . x x
391877821513006122565434000006110261289007200340000000   . x . . x . .
```

with the following meanings:

```
#  the data record length is not 54
s  seconds of day is not < 86400
p  surface pressure out of the intervall < 600, 1100 > hPa
t  surface temperature out of the intervall < 200, 340 > K
h  humidity out of intervall < 0, 100 > %
r  release flag is changing in this pass
?  checksum not correct or not set to 00
```

DGFI

SLRmails and SLReports per month since Nov. 1995



Working Group Reports

Missions Working Group Report to GA

ILRS Missions Working Group

Washington, DC USA

October 11, 2002

Participants List MWG meeting Oct.7 ,2002

- Hiroo Kunimori (CRL)
- Scott Wetzel (HTSI)
- David Carter
- Ulrich Schreiber (TUM)
- Julie Hovath (HTSI)

Applogies:

- Wolfgang Schluter (BKG)
- John Degnan (NASA)
- Vladimir Vasiliev (IPIE)
- Giuseppe Bianco (ASI)

- Werner Gurtner (AIUB)
- Keitapu Maamaatuaiahutapu(UPF)
- Mike Pearlman(CFA)
- RON Nooman(DEOS)
- Ludwig Grunwaldt (GFZ)
- Frown Koidl (Graz)
- Graham Appleby(NERC)
- Peter.J.Shelus(UT/CSR)
- Paul Stevens (HTSI)
- Christoper Clarke (HTSI)
- Howard Donovan (HTSI)
- Andrew Nicholas (NRL)
- Mark Davis (HTSI)
- Chris Moore (EOS)
- Kazimirs Lapushka (RIGA)
- Matti Paunonen (FGI)
- Wolfgang Seemuller (DGFI)

23 people

Agenda/Summary

- **MWG membership**
- **Past and Current Activity Since Last Meeting (March 2002 - Nice, France)**
  - **Campaign/Mission Status**
    - **Etalon -1, -2** — **Update by Ron Noomen - Delft University**
    - **LRE** — **Update by Maki Maeda - NASDA**
    - **Reflector** — **Update by Natalia Parkhomenko - IPIE**
    - **Starshine-3** — **Update by Scott Wetzel - HTSI**
    - **Meteor-3M** — **Update by Natalia Parkhomenko - IPIE**
  - **Mission/Satellite Data Base for Satellite Signature Study/ COM information**
- **Continuing and Future Actions**
  - **Work with satellite organizations to get Mission Request Forms and Support Plans completed and put on Web - ongoing**
  - **Satellite Tracking Priority List**
- **Upcoming Missions**
  - **Within 2002**
    - **IceSat - 1** — **(December 2002) - Update by Peter Shelus - CSR**
    - **ADEOS-II** — **(December 2002) - Update by Maki Maeda - NASDA**
  - **Beyond 2002**
    - **Cryosat** — **(2004) - Update by Graham Applebey - NERC**
    - **ANDE** — **(Late 2003) - Introduction by Andrew Nicholas NRL**
    - **Gravity Probe B** — **(April 2003) - Update by Scott Wetzel - HTSI**
    - **NPOESS** — **(2013) - Update by Scott Wetzel - HTSI**
- **Other Mission News**
- **Other Issues**

New MWG Membership

COORDINATOR(Newly-elected)

David Carter	NASA	USA

Deputy Coordinator (Newly –elected)

Hiroo Kunimori	CRL	Japan

Mmembership includes:

David L. Carter	NASA	USA			
John Degnan	NASA	USA	Giuseppe Bianco	ASI	Italy
Vladimir Vasiliev	IPIE	Russia	Urlich Schreiber	TUM	Germany
Scott Wetzel	HTSI	USA	Julie Horvath	HTSI	USA

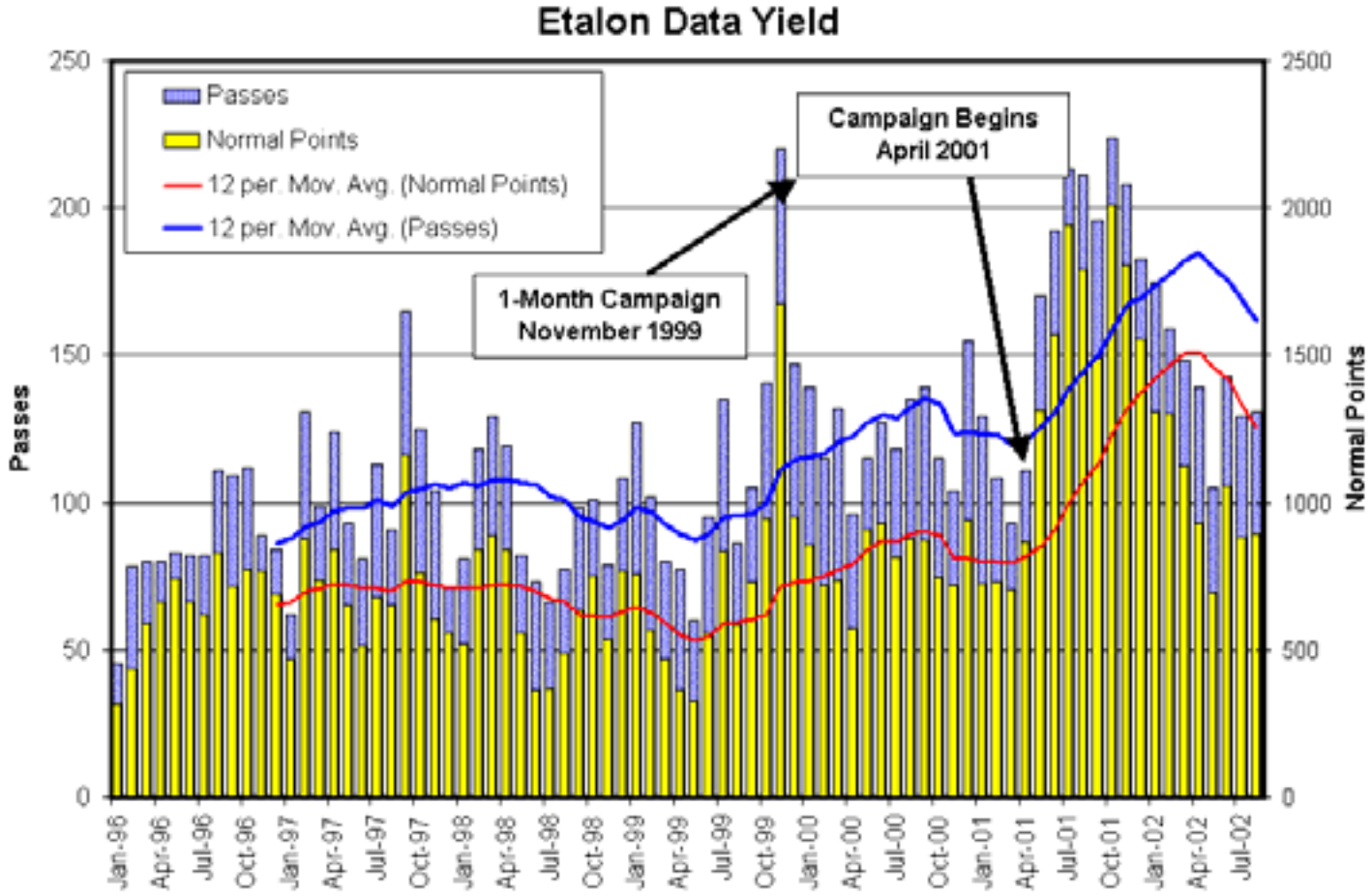
Membership action

- More active participation to be recruited for membership - keep trying
- Change Mission Request Form to reflect satellite name in message Subject line - no action

Past and Present Campaigns

Etalon-1, -2

- Campaign extended at Nice meeting until the end of March ‘03 -
- Ron Noomen to provide current status of campaign.

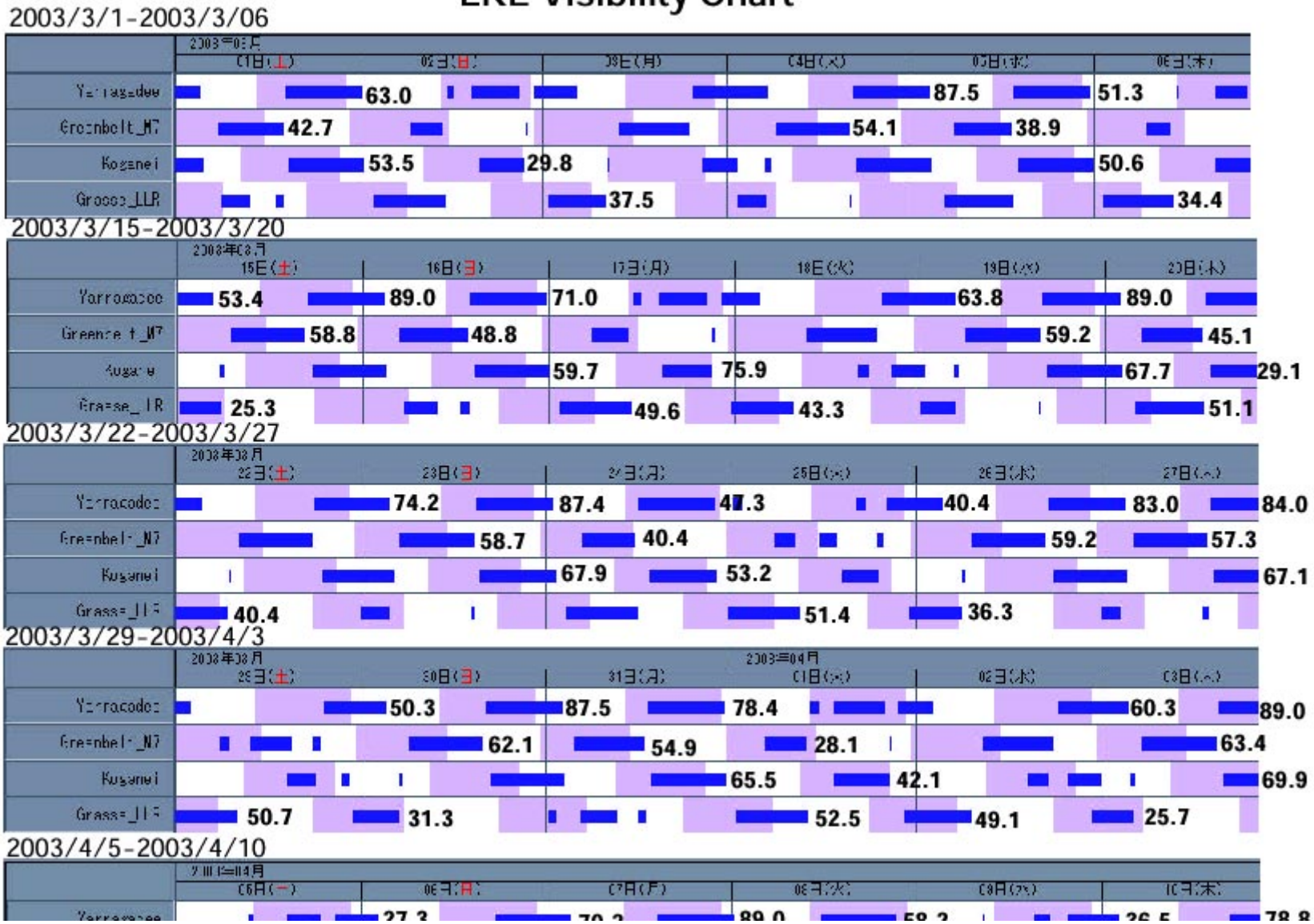


Past and Present Campaigns

- LRE
- Official campaign was 1 month in September 2001 and very difficult target to acquire due to 3 hour launch delay caused satellite to loose most of the terminator conditions for 3 months
- Grasse LLR station finally caught it in December 2001, then Yarragadee, then CRL
- No SLR tracking since March 28, 2002
- Kunimori proposes to keep LRE tracked on an "as available" basis
  - NASDA will provide TIRV routinely for CAMPAIGN period
  - LRE at bottom of priority list
- Lessons Learned
  - We were not ready for this campaign
  - We will work on better station pointing
  - We need cube specifications – Toshi

- **NASDA Proposed the SECOND campaign around March-April 2003.**
  - **Preparatory information will be circulated before approving campaign.**
    - **Night visibility for key station (Example followed in next page)**
    - **To produce good IRV prediction.**
    - **Signal strength information and experience from last campaign**

LRE Visibility Chart



Satellite Tracking Priority List

- Current tracking priority reflects ILRS tracking requirements
- At the Nice meeting Pete Shelus suggested dynamic tracking priorities with continuous monitoring of all satellites and systems and adjust tracking priorities to pick up on weak satellites.
- See papers in main conference WahingtonDC such as Bart Clarke's paper on "Intelligent Scheduler, Prioritize on the Fly" which will address many of these issues.
- **To maximize efficiency of interleaving satellite, stations wish to know criterion for each satellite from analysis point of view. (e.g. how much time/volume number of normal points in the pass, etc)**
- **There is no simple criterion from analysis, though should move to explore.**
- **There is suggestions that pilot program could be initiative in a environment e.g. in Eurolas realtime timebias serverc proposed**.

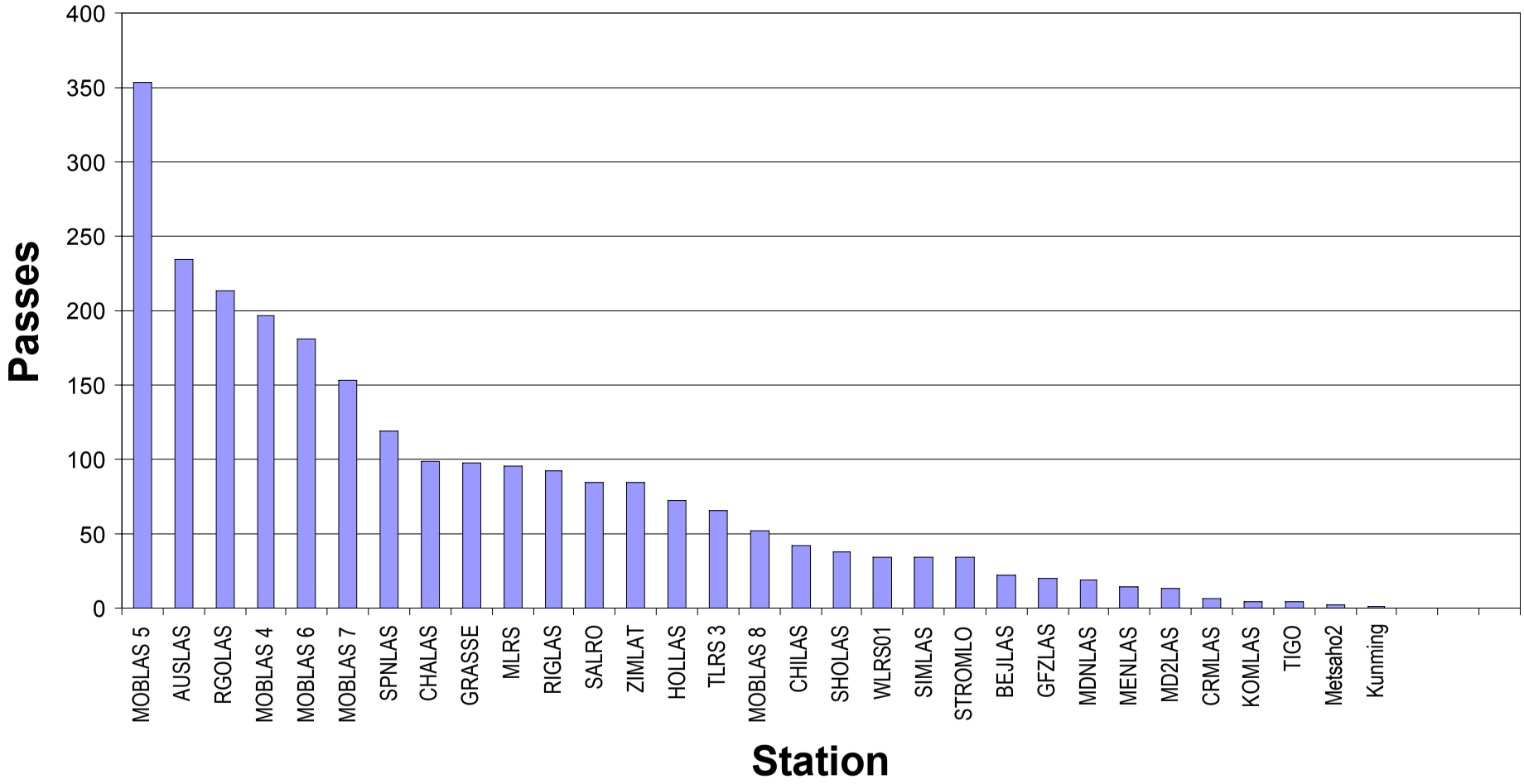
Past and Present Campaigns (2)

Reflector

- Reflector is a Russian satellite where SLR is used to support POD research for space debris detection
- Launched December 10, 2001
- Temporary emergency approval by the GB on December 20, 2001
- Campaign Duration was requested for 9 months
- SLR began on December 21, 2001
  - First operational Reflector pass received by Yarragadee
  - Tracking leaders are Yarragadee, Graz, RGO and Monument Peak
  - Currently 31 systems tracking Reflector
- Justification for continuation of campaign was provided and approval was given to continue campaign until August 2002 then extended until report at ILRS meeting
- IPIE requested Full-rate data supplied directly to them to study array response
  - Full-rate data was originally received from CDDIS for NASA only stations
  - Full-rate Study Group recommended direct full rate transmission from other systems to IPIE
  - IPIE noted that "Now we receive FR data from Herstmonseau, Mount Stromlo, San Fernando, and from some other stations".

Reflector Data Yield

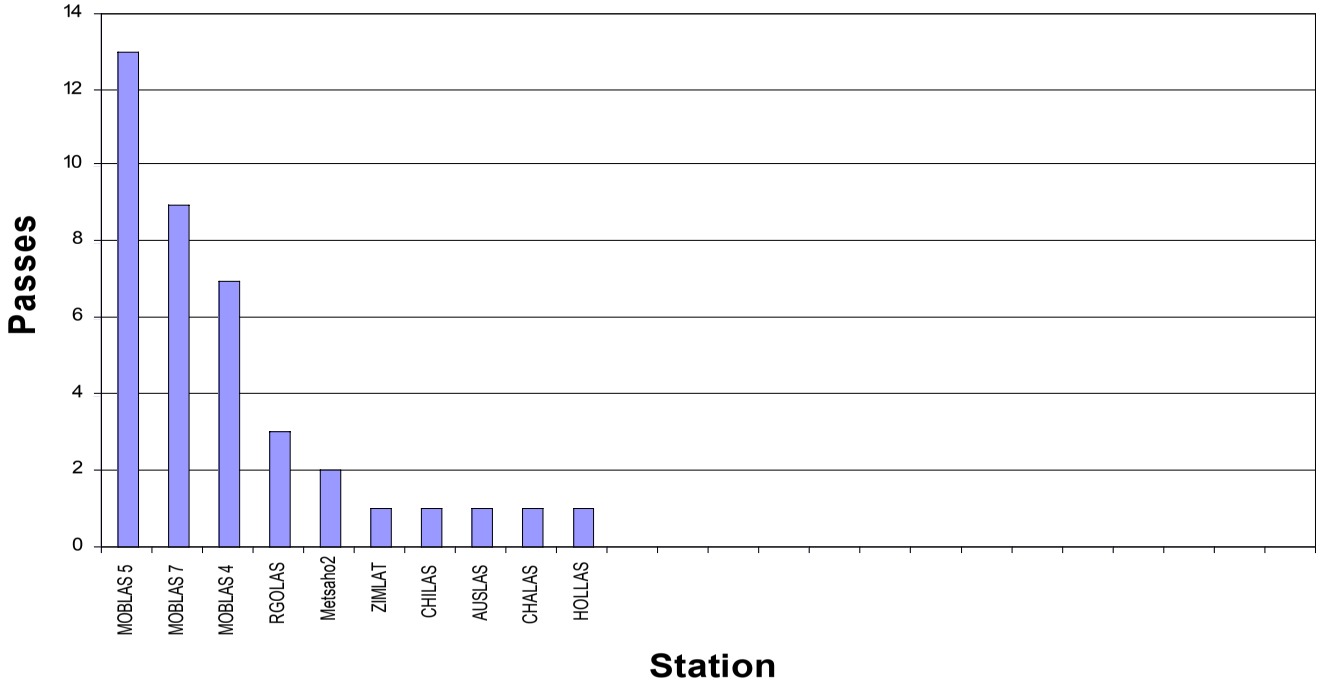
(12/21/01-10/03/02)



Past and Present Campaigns (3)

Starshine 3

- Starshine satellites were to be tracked by NASA stations and others if desired to determine utility of the retroreflectors
- Starshine 3 launched on September 30, 2001
  - First Starshine-3 pass received by Yarragadee on October 3, 2001
  - Tracking limited to NASA stations and anyone who wanted to try tracking (10)
  - NRL provided high quality predictions to help support acquisition but data availability was infrequent
  - Starshine-3 scheduled to de-orbit on approximately October 30, 2002



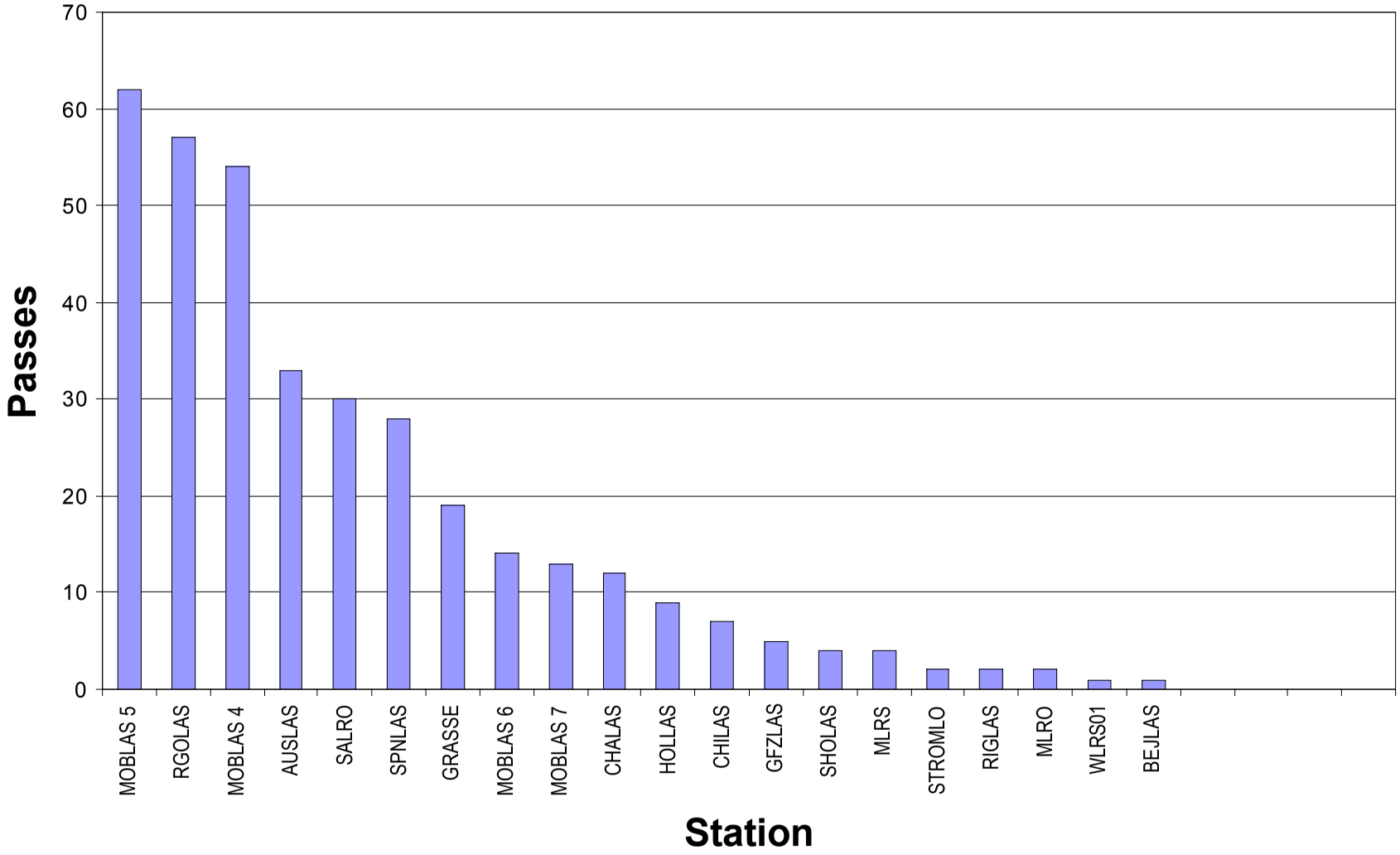
Recent Launches / New Missions (3)

Meteor-3M

- Meteor-3M was launched on December 10, 2001 along with Reflector
- Meteor-3M is using an Optical Luneberg Lens for SLR tracking
- SLR originally limited by agreement to Greenbelt, Monument Peak, a Russian station near Moscow as a test only
  - the SAGE project was concerned about interference in their solar experiments
  - restricted tracking elevations
  - tracking in nighttime hours only
- At a meeting with the SAGE team in February it was disclosed that the GLONASS/GPS receiver on-board Meteor-3M was not function.
  - SLR had now become the only method for POD in support of SAGE - Radar tracking ends on April 30, 2002
- SAGE team requested to Meteor-3M group to support SLR -
  - No restrictions for elevation or daylight tracking
- On April 3rd a Mission Support Request Form was submitted for ILRS support of Meteor-3M
- Governing Board Approval at ILRS GB meeting

Meteor-3M Data Yield

(12/21/01-10/02/02)



Current Tracking priorities

Priority	Mission	Sponsor	Altitude (km)	Inclination (degrees)	Comments
1	GRACE A, B	GFZ/NASA	485-500	89	Gravity research (Two satellites tracked alternately)
2	CHAMP	GFZ	429-474	87.27	Gravity research
3	GFO-1	US Navy	790	108.0	Altimeter calibration / no other tracking technique available
4	Envisat-1	ESA	800	98.6	Altimeter calibration / DORIS backup
5	ERS-2	ESA	800	98.6	Altimeter calibration / PRARE backup
6	Jason	NASA/CNES	1,350	66.0	Altimeter / DORIS and GPS backup
7	TOPEX/Poseidon	NASA/CNES	1,350	66.0	Altimeter calibration / DORIS and GPS backup
8	Starlette	CNES	815-1,100	49.8	Geodetic / no other tracking technique available
9	Stella	CNES	815	98.6	Geodetic / no other tracking technique available
10	Meteor-3M	IPIE	1020	99.64	Retroreflector research / No other tracking technique available
11	BeaconC	NASA	950-1300	41	Gravity Research / upgraded to ongoing mission (Jan 2002)
12	REFLECTOR	IPIE	1,020	99.6	POD research for space debris detection
13	Ajisai	NASDA	1,485	50	Geodetic / no other tracking technique available
14	LAGEOS2	ASI/NASA	5625	52.6	Geodetic / no other tracking technique available
15	LAGEOS1	NASA	5850	109.8	Geodetic / no other tracking technique available
16	Etalon1	Russian Federation	19,100	65.3	Geodetic / no other tracking technique available
17	Etalon2	Russian Federation	19,100	65.2	Geodetic / no other tracking technique available
18	GLONASS86	Russian Federation	19,100	65	Positioning POD enhancement / replaced G70 as of 02/20/02
19	GLONASS87	Russian Federation	19,100	65	Positioning POD enhancement / replaced G72 as of 2/20/02
20	GLONASS84	Russian Federation	19,100	65	Positioning POD enhancement / replaced G79as of 2/22/01
21	GPS35	US DoD	20,100	54.2	Positioning POD enhancement
22	GPS36	US DoD	20,100	55.0	Positioning POD enhancement

Other Targets of Opportunity:

Starshine 3	US Cooperative	470	67	Drag research / no other tracking technique available
LRE	NASDA	250-36000	28.5	HEO Characterization / Spin evolution vs. BK7 degradation

October 11, 2002

Upcoming Missions

	Satellite	Owner	Mission Type	Planned Launch Date	Mission Duration	Received Mission Request Form	Received ILRS GB Approval
	IceSat (GLAS)	NASA	Ice sheet research	mid-December 2002	3-5 years	Yes	Yes
	ADEOS-II	NASDA	RemoteSensing CalibrationGPS	December 2002	3 years	Yes	Yes
	Gravity Probe B	NASA	Relativity research	April 2003	1-2 years	Yes	Yes
	ANDE	NRL	Drag research	Late 2003		No	No
	CryoSat	ESA	Earth Sensing	Apr/May 2004	3.5 years	Yes	Awaiting MWG Recommend ation
	IRS	ISRO	RemoteSensing CalibrationGPS			No	No
	ALOS	NASDA	RemoteSensing CalibrationGPS	2005	3 years	No	No
	ETS-VIII	NASDA	Time transfer /POD experiment	Q1 in 2005	3 years	No	No
	NPOESS	NOAA	Earth Sensing	2013	7 years	Yes	No

Upcoming Missions
(within 2002)

ADEOS-II (Advanced Earth Observing Satellite)

- ADEOS-II is an Earth Sensing mission hosted by NASDA
- ADEOS-II is currently scheduled to be launched in November 1-30, 2002
- SLR support required from L+39 days to support POD - GPS will be turned off during this period
- Issue with possible damage to GLI from SLR causing much problem with tracking
- Maki Maeda provided status on mission and to provide specifications and analysis for safety concerns for the GLI

ICESat (Ice, Cloud, and Land Elevation Satellite)

- ICESat is a NASA mission to measure the ice sheet mass, balance, cloud and aerosol heights, optical densities, vegetation and land topography hosted by NASA / CSR.
- ICESat is currently scheduled to be launched in mid December 2002
- Preparations for SLR support are ongoing at University of Texas, good coordination with ILRS
- HTSI to include GPS data in prediction generation
- Array confirmation only for L+30 days, then until L+6 months SLR is high priority
- Peter Shelus to provide status of mission
- Scott Wetzel to provide status of GPS supported predictions

Upcoming Missions
(beyond 2002)

GPB (Gravity Probe B)

- GPB is a NASA / Stanford University relativity mission
- GPB is scheduled for launch in April 2003
- Coordination efforts between ILRS and Mission on-going
  - GPB Orbit Determination and Orbit Trim Review held in June 2002

Atmospheric Neutral Drag Experiment (ANDE)

- ANDE is an NRL research satellite system as a means to calibrate atmospheric drag effects on low earth orbiting satellites.
- The program consists of two small spherical satellites
- Data about the position of the satellites can be used to calculate the drag on the satellite and the atmospheric density at that altitude.
- The data will also be used to answer questions about the impact of spacecraft composition and thermal characteristics when computing theoretical ballistic coefficients
- Andrew Nicholas from NRL to provide information on the ANDE mission

Upcoming Missions (2)
(beyond 2002)

Starshine 4/5

- Starshine 4/5 launch situation may be improving a bit.
  - Satellites were bumped from the STS-114 mission by an International Space Station control moment gyro.
  - Starshines 4 and 5 might not get to fly until 2005 or 2006, as a result of a budget-driven decrease in Space Shuttle launch rates to four per year
  - Limited number of shuttle flights may again be increased.
  - More to follow as known
- Starshine 4/5 will have mounted 1000 mirrors and 31 laser retroreflectors on its external shell.
- Starshine 4/5 Mission Plan
  - Release from Starshine 4, a 4 inch (10 cm) hollow aluminum sphere, instead, which will be Starshine 5.
  - This small subsatellite will be released shortly after Starshine 4 is deployed from Space Shuttle Atlantis
  - Both Starshines 4 and 5 will carry 31 laser retroreflectors on their surfaces
  - Starshine 5 will have no mirrors and will thus not be naked-eye visible, so tracking will dependent totally on ILRS and Space Command tracking for orbit determination of this satellite.
  - By comparing the orbital decay rates of Starshine 4 and 5, it will possible for us to determine the density of the earth's atmosphere more precisely than we've been able to do on previous missions.

Upcoming Missions (3)
(beyond 2002)

Cryosat

- Mission Request form received
- Working with MWG on approvals following Clarifications to form
- Graham Appleby from NERC to provide information on Cryosat

Upcoming Missions (4)
(beyond 2002)

The National Polar-orbiting Operational Environmental Satellite System (NPOESS)

- Mission Request form received in July
- Mission not scheduled until April 2013, however, early mission planning done to determine if they can use SLR.
- Increases the timeliness, accuracy, and cost-effectiveness of public warnings and forecasts of severe weather events; improved microwave imagery sounding products will improve prediction of ocean surface wind speed and direction
- Supports general aviation, agriculture, and maritime communities aimed at increasing U.S. productivity; improved early warnings will mitigate the devastating effects of floods through disaster planning and response
- Anticipated Launch: April 2013 Mission Duration: 7 years
- Orbital Parameters
- Altitude: 833 ± 17 km Inclination: 98.7 ± 0.05
- Eccentricity: 0.0011

Upcoming Missions (5)
(beyond 2002)

- NPOESS Tracking Requirements
  - Tracking Schedule: Monthly Spatial Coverage: 15 to 20 sites with high priority
  - Temporal Coverage: Continuous for 4 days per month
  - Data Accuracy: 2 cm
  - SLR will be employed at the start of the mission for initial calibration, and for periodic validations and correction. Calibration will be required approximately monthly.
  - SLR-based calibration, using high-elevation SLR to the GPS-derived NPOESS POD orbits, produces an independent measure of the radial accuracy and stability (drift) of the POD solutions. This technique removes the drift in the POD orbit (effectively the drift with respect to the frame including the tide gauges) from the altimeter-derived
  - SSH measurement drift for regions surrounding selected tide gauges. Tide gauges near SLR tracking sites and GPS stations minimize the effects of geographical variations in the radial orbit drift, thus allowing the altimeter measurement drift to be compared (and calibrated if necessary) with the corresponding value from the tide gauge data.

Other Mission News

Jason Maneuver issues

- Jason maneuver messages are not following proper formatting guidelines
- Currently working with Jason team to resolve maneuver format issues

IRS (India) mission status updated by K.Elango.

ILRS Eighth General Assembly

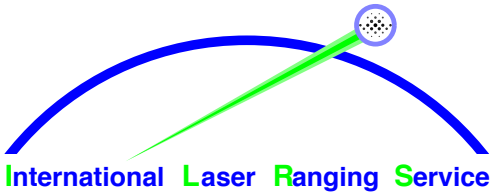
Network and Engineering Working Group

Werner Gurtner

Washington D.C. October 11, 2002

Network and Engineering Working Group

- Meeting on Monday, October 7, 2002
- Site log data base
  - available on the Web: Site log files, master Excel file
  - update procedures to be finalized
- Knowledge data base
  - Bibliography on the Web
    - Update important
    - Send references to the Central Bureau
  - To be supplemented by "hints and typs" for typical hardware
- Weekly analysis reports:
  - "Wish list" to be formulated by stations
- Dynamic priorities:
  - First discussions started
- Time bias server and real time status exchange
  - Stations urged to join, use, and give feedback
- NW&E WG Coordinator
  - New: Georg Kirchner



International Laser Ranging Service

Data Formats & Procedures Working Group

Agenda

Tuesday, October 08, 2002, 18:00-19:30
Washington D.C., USA
Breakout Room

1. Welcome and Introduction	**Wolfgang Seemüller**
2. Membership	**Wolfgang Seemüller**
3. Review of CB Activities	**Van Husson**
4. Refraction Study Group Report	**Stefan Riepl**
5. Prediction Format Study Group Report **(separate meeting: October 07, 21:00-22:30, Breakout Room)**	**Randy Ricklefs**
6. Two colour data submission and management	**Werner Gurtner**
7. Working Group Charter/WG Activities **What can our WG do to reach the 1 mm ranging accuracy?**	**Wolfgang Seemüller, all**
8. Management of prediction Exploder after break down	**Wolfgang Seemüller**
9. IRV Provider ID in IRV data set	**W. Gurtner, S. Riepl**
10. FR data format to accommodate calibration data, data flow and filename convention	**V. Husson, C. Noll, W. Gurtner, W. Seemüller**

International Laser Ranging Service

Data Formats & Procedures Working Group Report

Wolfgang Seemüller

- Two colour wavelength data submission and management installed
- New quality check for data format and data integrity now at both Global Data Centers
- Full-rate data format and archiving in progress (see below)
- IRV provider ID in IRV data set in new prediction format included
- Refraction Study Group - see Report by Stefan Riepl
- Prediction Format Study Group - see Report by Randy Ricklefs
- CB Activities

  Normal Point Data: - Sites need to ensure the release flag is updated
  - Improvement of data replacement procedures
  - Periodic comparison of data centers NP statistics

  Full Rate data: see below

  Site Logs: Sites need to keep their logs and local ties current

  Standard software packages: - NP generation (volunteers?)
  - Integration of satellite predictions (volunteers?)
  - EDC provide their software for format and data integrity check

  Multi-colour ranging NP data: EDC and CDDIS have modified their data handling procedures
- FR data meeting on Thursday noon, decisions:

  Three issues were discussed: Frequency of delivery, file name convention, and accomodation of the FR data format to calibration data.

  - The stations send a daily file for each satellite to the Global Data Centers, containing all passes starting the same day
  - File name convention: file naming as of CDDIS, but satellite names without dashes
  - Recommendation: the calibration data will not be archived. If needed the station should be contacted

  Implementation date: March 01, 2003
  A SLRmail with the details will be sent in November 2002

DGFI

Refraction Study Group Summary

13th International Workshop on Laser Ranging, Washington, USA,7-11 October 2002

- Currently available refraction models show differences at the millimeter level
- 2-colour lasere ranging is currently limited to about 1cm accuracy for remote sensing of refraction, i.e. inmature to tzest millimeter effects
- Arrangements have bee made to perform a comparison of
  - MARINI-MURRAY refraction model and
  - the recently introduced mapping function derived by MENDES in conjunction with the SAASTOMOINEN zenith path delay formula.

  An improvement in the modelling of the atmospheric delay should show up in better residual statistics at low elevations.
- Results are to be presented at the next analysis working group meeting in Nice, 2003.

Prediction Formats Study Group
"Lynx Team"

Commissioned by:
The ILRS Data Formats and Procedures Working Group
at Matera, November 2000

Presentation prepared by
R. Ricklefs
University of Texas at Austin
McDonald Observatory and Center for Space Research
(rlr@astro.as.utexas.edu)

Purpose

Recommend a single laser ranging prediction format to encompass

- Earth satellites
- Lunar laser retro-reflectors
- Laser transponders on or orbiting other solar system bodies
- Laser transponders in transit

Current Status

- Lunar and transponder feasibility studies are nearly complete. No "show stoppers" have been found.
- Interpolator tests are nearly complete. Need to insure that interpolator works with normalpoint generation.
- Preliminary format is ready for review
- Sample code is in early stages

Format Features

- Tabular (grid) format (interpolation, not integration)
- State vectors spaced as required (fixed or variable)
- True body-fixed coordinates
- Multiple header and ephemeris record types
- Special record types to handle features of particular target classes
- Records short enough for e-mail
- Allows for integration beyond last record of file
- Some free format records
- Removes need for drag messages

The Next Steps

- Distribute format widely within laser community for comment
- Develop sample code
- Conduct pilot projects using new format at several stations
- Refine format as needed
- Make plans for general implementation
- Seek ILRS Governing Board's approval for implementation

Pilot project “harmonization”

Goal

- ⇨ make QC results more consistent

Issues

- ⇨ ITRF2000
- ⇨ performance report card

Pilot project “benchmarking”

Characteristics

- ⇨ October 10 – November 7, 1999
- ⇨ LAGEOS-1
- ⇨ Produce identical integration and estimation results (*i.e.* detect software and data treatment errors and blunders)
- ⇨ A: direct integration
  B: estimation orbit
  C: estimation orbit, EOPs and station coordinates
  D: idem, no requirements on dynamic orbit model

Contributors

- ⇨ ASI, CRL, CSR, DGFI, GEOS, IAAK, JCET, NASDA, NERC

First results

- ⇨ Residuals diverge up to several m (“A”)
- ⇨ Mean residuals diverge several dm (“A”), several mm (“B”), 0.1 mm (“C”)
- ⇨ Orbits disagree up to several m (“A”), ~ 0.6 m (“B”), cm (“C”)
- ⇨ Refraction corrections consistent at 0.2 mm
- ⇨ Relativity corrections consistent at 0.1 mm

Future

- ⇨ refine description and re-analysis
- ⇨ develop reference solution
- ⇨ pass/fail benchmark test essential for other contributions

Pilot project “positioning + earth orientation”

Purposes

- ⇨ solutions for EOPs and station coordinates
- ⇨ 28-day intervals
- ⇨ “A”: 1999 (LAGEOS)
- ⇨ “B”: 2001-2002 (LAGEOS vs. Etalon; EOP vs. EOPdots)
- ⇨ official ILRS product

Customers

- ⇨ IERS Bulletin A
- ⇨ ITRF?
- ⇨ …

Contributors

- ⇨ ASI, BKG, CRL, CSR, DGFI, GEOS, GRGS, IAA, IAAK, JCET, NERC

Call for Participation

Products

- ⇨ daily x/y-pole, LOD for most recent days (-> IERS Bulletin A)
- ⇨ daily x/y-pole, LOD (28 days) + coordinates

2 Types of contributions solicited

- ⇨ data reduction
- ⇨ combination

Operational timeline

Timeline

- ⇨ October 31, 2002: disseminate CFP
- ⇨ December 15, 2002: “benchmarking “ criteria established
- ⇨ December 31, 2003: reactions “in”
- ⇨ January 15, 2002: data reduction contributors selected
- ⇨ January 15 – March 15, 2003: test period for candidate combination centers
- ⇨ April 2003: selection of prime and back-up combination centers
- ⇨ May 1, 2002: system fully operational

ILRS General Assembly
Friday October 11th 2002
Signal Processing ad-hoc WG

Graham Appleby

- Small working group with clear primary goal of computing system-dependent CoM values for spherical satellites;
- Come a long way since early detections of effect in single-photon data –latest results for LAGEOS, AJISAI and ETALON were presented in Target Signatures session of LW13;
- Informal meetings (at EGS, ILRS w/s) plus email correspondence, including valuable input from HTSI on NASA-system configuration;

Current/Future

- Working with HTSI colleagues to form an ILRS database of attitude algorithms for CoM corrections for the non-spherical satellites;
- recommend to the MWG that all future proposals for ILRS support include attitude algorithms as well as LRA CoM vectors;
- need to look now at potential mm-level effects in array corrections for the “small-cluster” arrays in current use (ERS, Jason, ENVISAT, GFO,…).
- New members always welcome.

Campaigns and Mission Reports

C H A M P

Status SLR-Tracking CHAMP Mission

L. Grunwaldt, R. Schmidt, R. König, Ch. Reigber

GeoForschungsZentrum Potsdam (GFZ)
Division I: Kinematics and Dynamics of the Earth
Telegrafenberg
14473 Potsdam

CHAMP

Status

- CHAMP is more than 2 years in space. All systems are running smoothly. The scientific instruments - except the radial channel of the accelerometer - perform nominally. Scientific instruments are in science data collection mode.

- Based on the data from the onboard GPS receiver

  - a new class of the static long-wavelength gravity field has been computed (EIGEN models). With the data collected and future data sets the temporal variability of the long-wavelength part becomes detectable.

  - accurate globally distributed atmospheric profiles (temperature, humidity) are routinely generated to be assimilated in weather prediction models.

- Based on the data from the magnetometer instruments onboard CHAMP accurate and homogeneous maps of the Earth‘s magnetic field are generated.

CHAMP

GRIM1
Geoid Differences to Altimetry 5° x 5° Blocks
GRIM2
GRIM3
GRIM4-S4
GRIM5-S1
EIGEN
Geoid Mean Difference [m]
0
1
2
3
4
5
1970
1980
1990
2000
1974
1976
1981
1995
1999
2002
2001

CHAMP

Role of SLR Data

- GFZ orbit predictions are based on ephemeris from GPS navigation solution **and** the more accurate SLR data.
- Routinely used for the validation of the data of the onboard GPS receiver in POD.
- SLR data is valuable data for the quality control of gravity field recovery from CHAMP microwave tracking data.

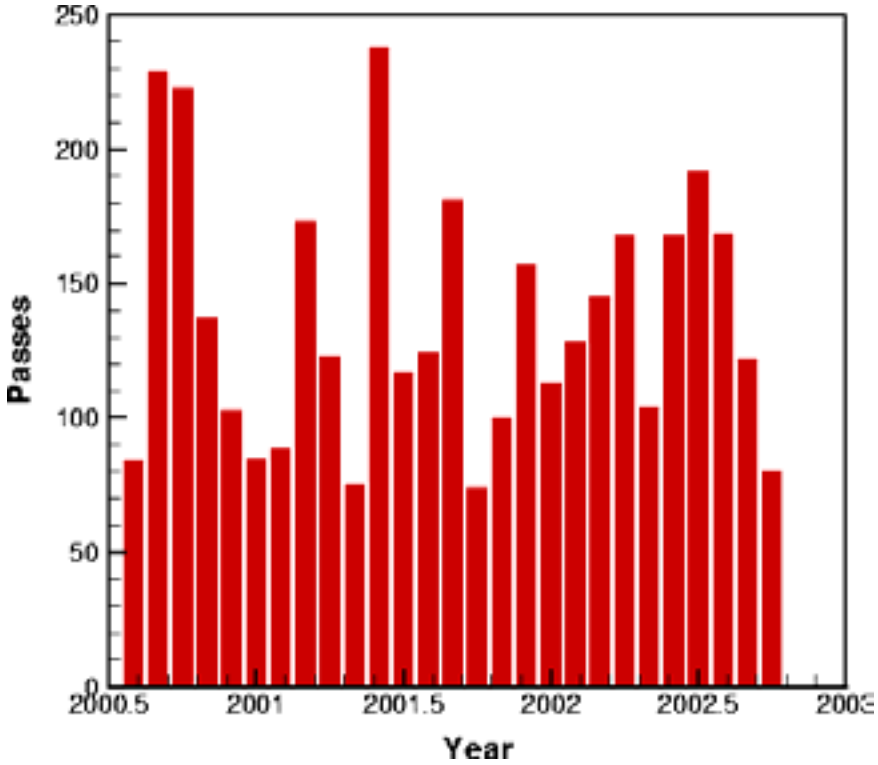
Example: orbital fit of SLR data for 26 14-h CHAMP arcs in May, 2002

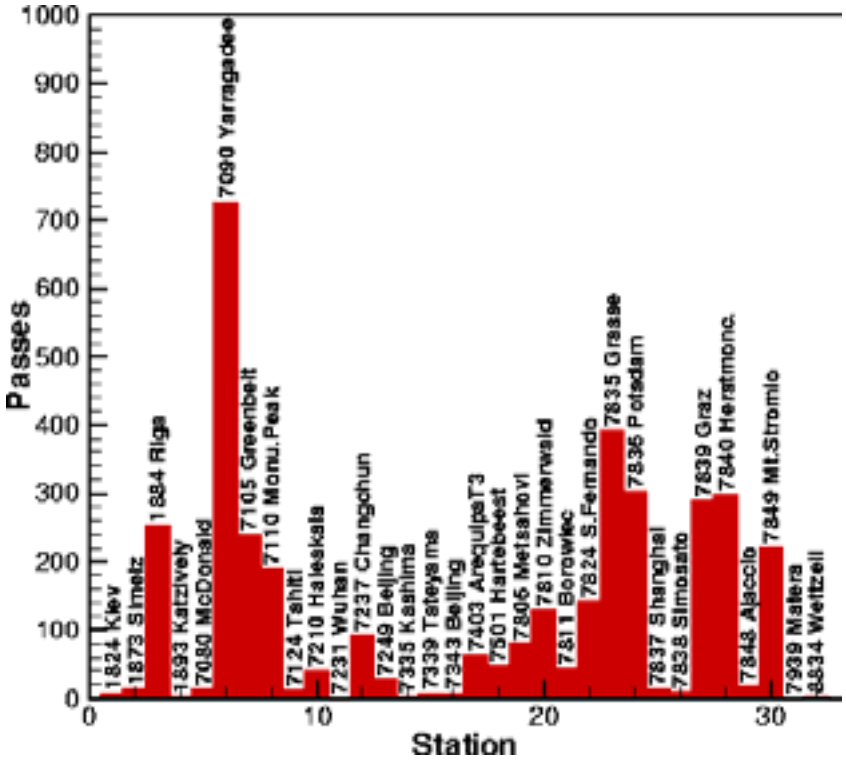
Model		SLR-RMS [cm]
GRIM5-C1.extended *)	(70 x 70)	8.6
EIGEN-2SP **)	(70 x 70)	8.2
EIGEN-2SP	(120 x 120)	7.4

*) GRIM5-C1.extended = GRIM5-C1 (GRIM5-S1 plus terrestr. data) + 2 months CHAMP data (comb. model)
**) EIGEN-2SP = preliminary, iterated version of the official EIGEN-1S model (satellite-only)

CHAMP

SLR-Tracking Jul. 2000 - Sept. 24, 2002





CHAMP

Summary

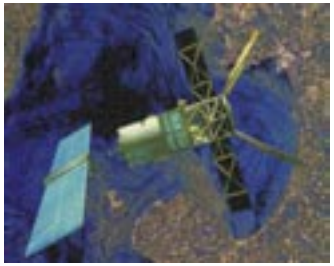
- Overall tracking statistics quite satisfactory for the CHAMP mission.
- Overall tracking statistics indicate adequate accuracy of GFZ orbit predictions.
- SLR data plays an important role:

  - for the generation of accurate orbit predictions,

  - for the continuous validation of the microwave tracking systems onboard the CHAMP satellite and

  - for the quality control of gravity field recovery.

= > continued intensive SLR support is requested

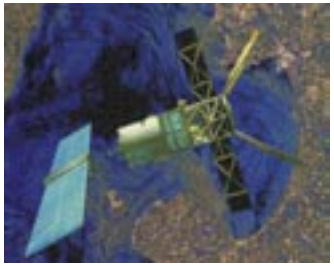


E R S - 2

Status SLR-Tracking ERS-2 Mission

L. Grunwaldt, F.-H. Massmann, Ch. Reigber

GeoForschungsZentrum Potsdam (GFZ)
Division I: Kinematics and Dynamics of the Earth
Telegrafenberg
14473 Potsdam



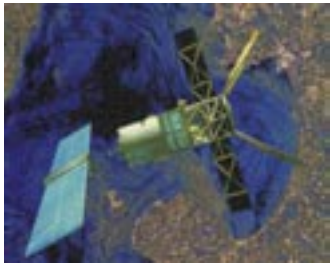
E R S - 2

Mission Status

- ERS-2 is now about 7.5 years in orbit.
- In general the satellite and the payload are in good condition.
- ESA plans to operate ERS-2 till mid of 2004.

Role of SLR

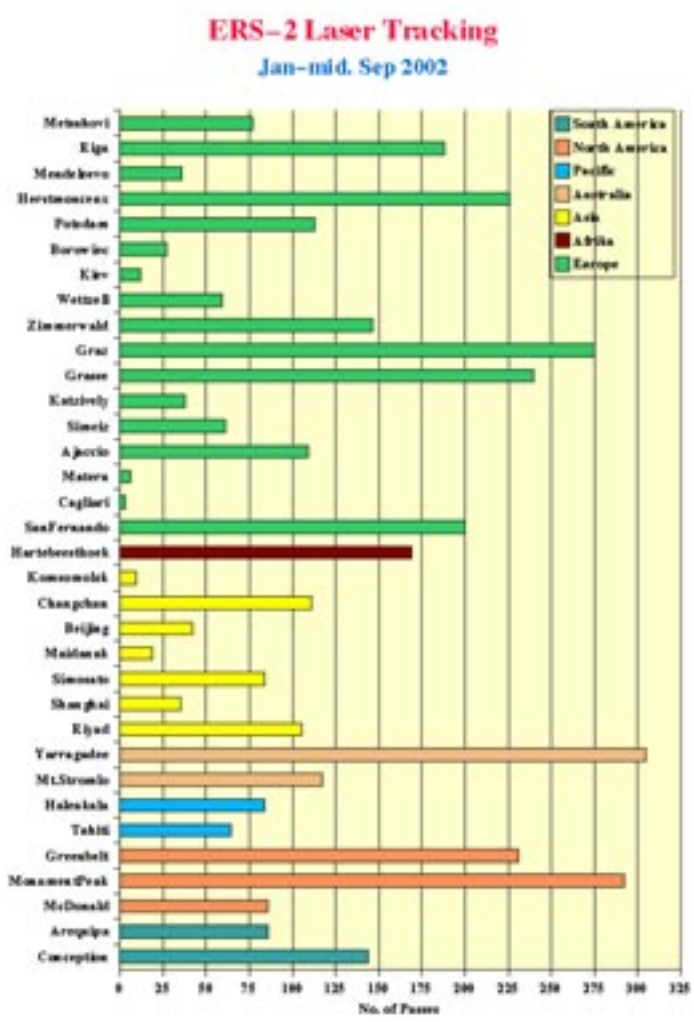
- SLR is the secondary tracking system, while PRARE is the primary one.
- The age of the PRARE ground equipment, a repair backlog of the manufacturer plus funding discussions give SLR an increasing importance.
- ERS-2 SLR tracking will be required until approximately mid 2004.

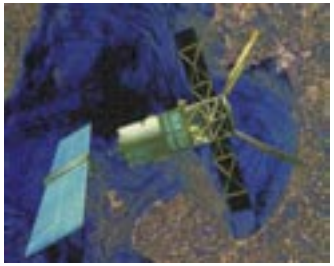


E R S - 2

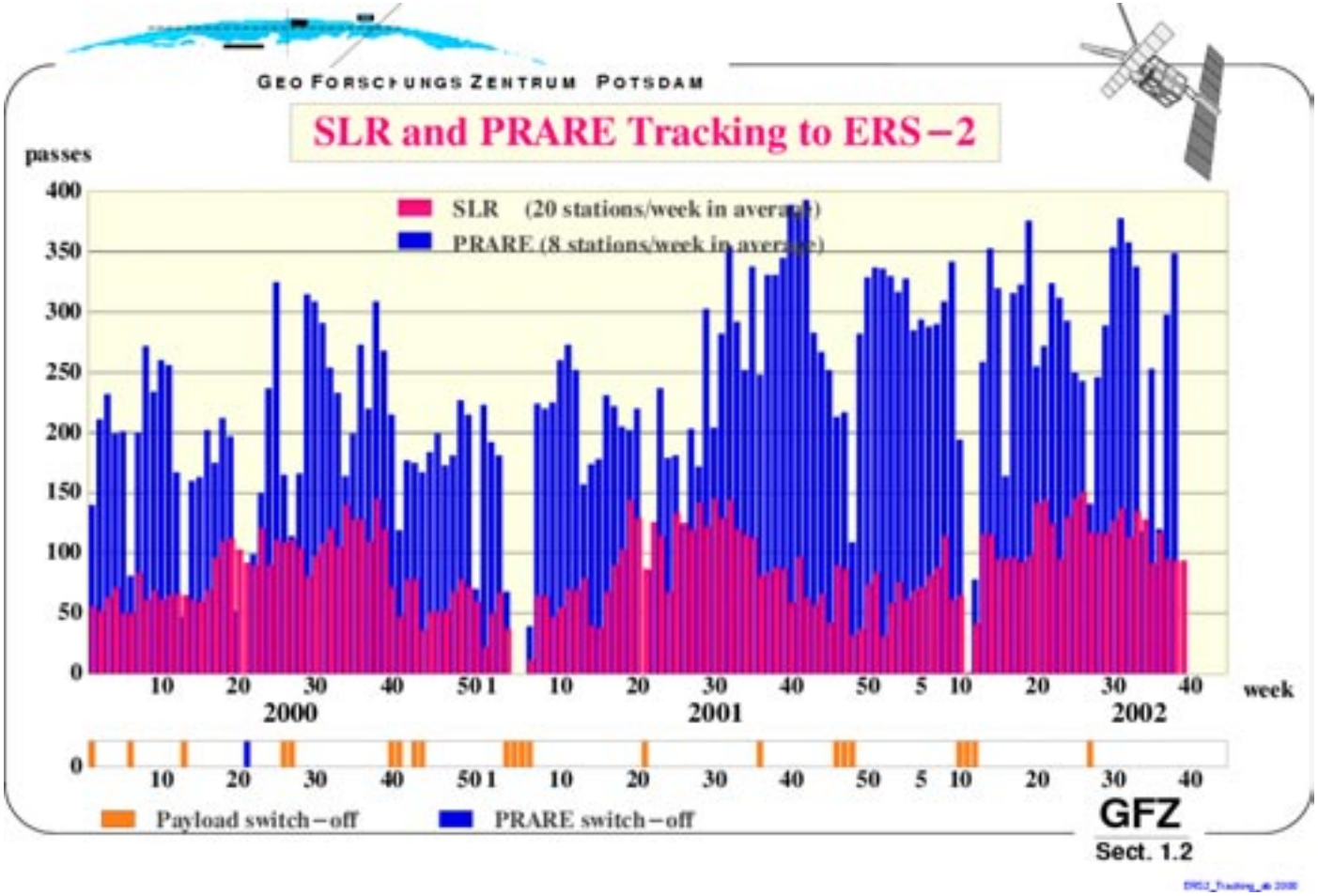
SLR Data Quantity and Quality

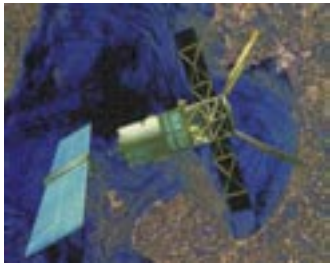
- In general the data amount (passes/day) is okay
- Contribution of stations very different
- The data quality is good





E R S - 2


GEO FORSCHUNGS ZENTRUM POTSDAM
SLR and PRARE Tracking to ERS−2
passes
SLR (20 stations/week in average)
PRARE (8 stations/week in average)
400
350
300
250
200
150
100
50
0
10 20 30 40 50 1 10 20 30 40 50 5 10 20 30 40
week
2000
2001
2002
Payload switch−off
PRARE switch−off
GFZ
Sect. 1.2



E R S - 2

Achieved Results

Based on SLR and PRARE tracking data predicted and precision orbits have been generated, which are used for

- **Geolocation of SAR data**
- **Antenna steering**
- **Mission planning**
- **Interferometric SAR processing (DEM, deformation analysis)**
- **Sea surface monitoring**
- **Ice mass monitoring**
- **High resolution gravity modelling from radar altimeter data**

ERS-2 SLR and PRARE data are also incorporated in recent gravity models (GRIM-5, TEG3p)

Status SLR Tracking GRACE Mission

L. Grunwaldt, R. Schmidt, R. König, Ch. Reigber

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14473 Potsdam

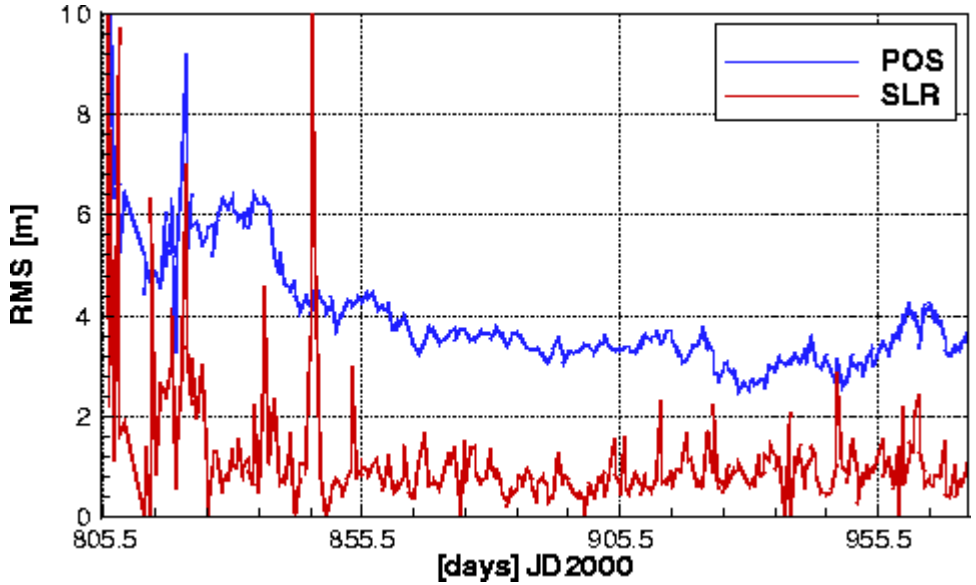
Status

- The twin GRACE satellites are 6 months in space. The mission is in commissioning phase in transition to calibration/validation phase.
- All sensors and instruments - except the intertial measurement unit on GRACE-1 - are operating in the science data collection mode.
- All scientific instruments (accelerometers, star cameras, GPS receivers, K-Band-Ranging system, Laser Ranging Reflector) are performing nominally.
- The Science Data System teams at JPL, UT-CSR and GFZ have generated first gravity fields based on GPS, accelerometer and K-Band-Ranging data showing significant improvements of gravity field modelling derived from satellite-only data.
- At GFZ the generation of standard GRACE orbit predictions based on GPS navigation solution and SLR data is operational in automatic mode (2 predicts/day).

Role of SLR data

- At GFZ precise orbit predictions are generated from GPS navigation solution and SLR data.

  Example: Orbital fit of positions from GPS navigation solution and SLR data of orbit determination for the generation of orbit predictions of GRACE-A.



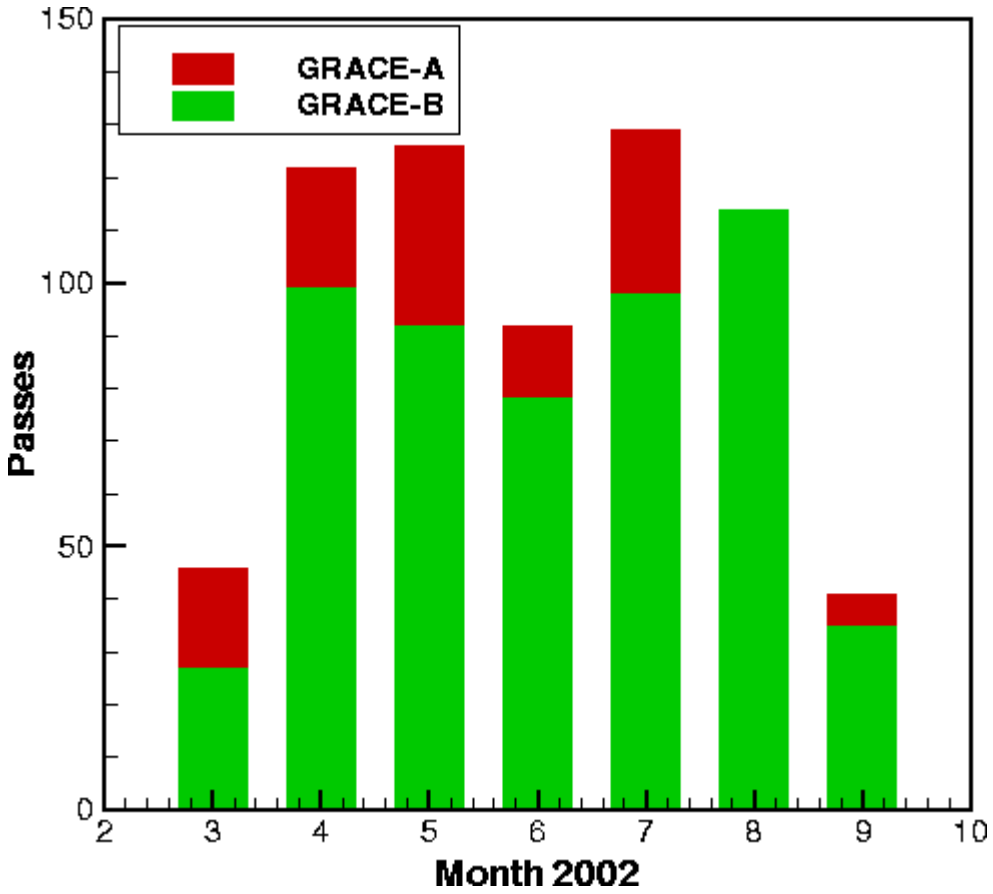
Role of SLR data

- At GFZ highly down-weighted SLR data is used in POD for gravity field recovery based on high-low satellite-to-satellite tracking (SST) using GPS and low-low SST using K-Band-Ranging data for validation of the microwave tracking systems.

  Example: 6 x 1.5-day arcs for GRACE-A&B in April/May after (before) first gravity field recovery (SLR data not included)

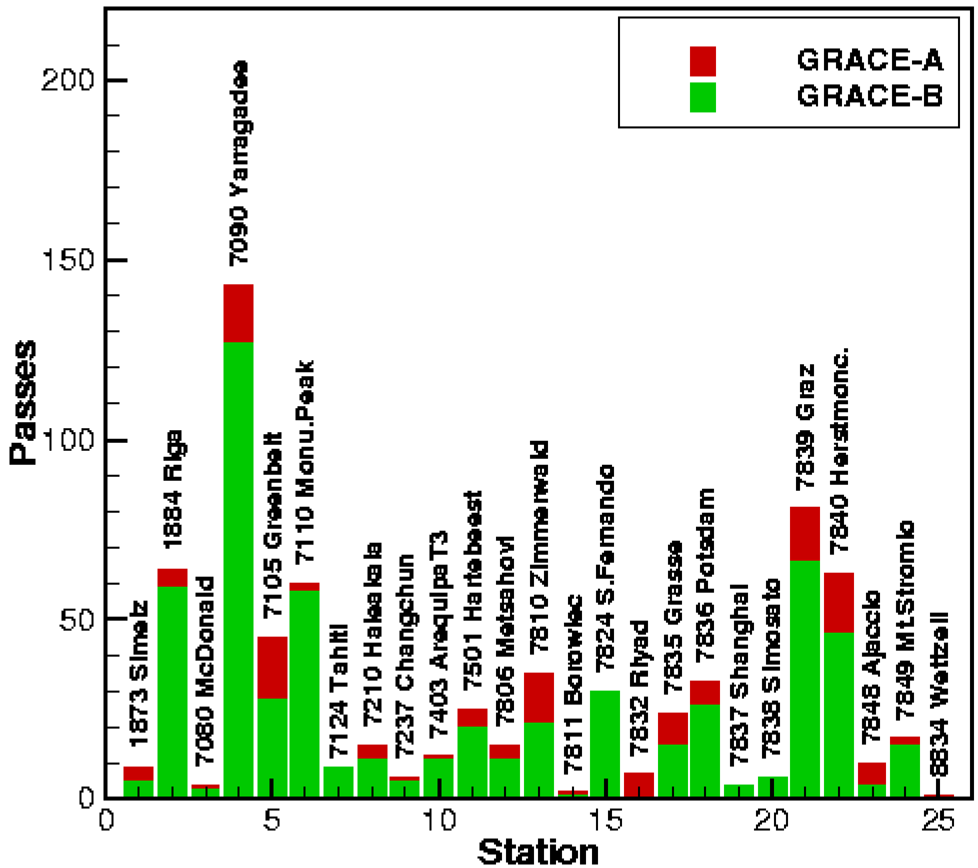
		RMS	
		after	before
SLR (σ = 50 m)	[cm]	7.6	16.4

GRACE SLR-Tracking Mar.- Sep. 24, 2002



- Total 1285 passes (GRACE-A: 704, GRACE-B: 581).
- Good amount of data per month and per satellite (as of Apr. 2002 in general more than 100 pass/month)
- Until Aug. 2002 stronger tracking of GRACE-A.
- First time balanced tracking in Aug. 2002.

GRACE SLR-Tracking Mar.- Sep. 24, 2002



- Total 25 ILRS stations.
- Overvall summary statistics show unbalanced tracking per station for the two GRACE-satellites, however as of Aug. 2002 statistic show balanced tracking for the majority of the stations.

Summary

- Overall tracking statistics quite satisfactory for the GRACE mission. Since Aug. 2002 number of observations for individual spacecrafts is getting balanced.
- Overall tracking statistics indicate adequate accuracy of GFZ orbit predictions.
- SLR data plays an important role:

  - for the generation of accurate orbit predictions,

  - for the calibration/validation of the microwave tracking systems onboard the GRACE satellites and

  - for the quality control of gravity field recovery.

= > continued intensive SLR support is requested

Etalon campaign

Purpose

- ⇨ Improvement EOP solutions
- ⇨ Improvement GM
- ⇨ Improvement station characterization

Time-span

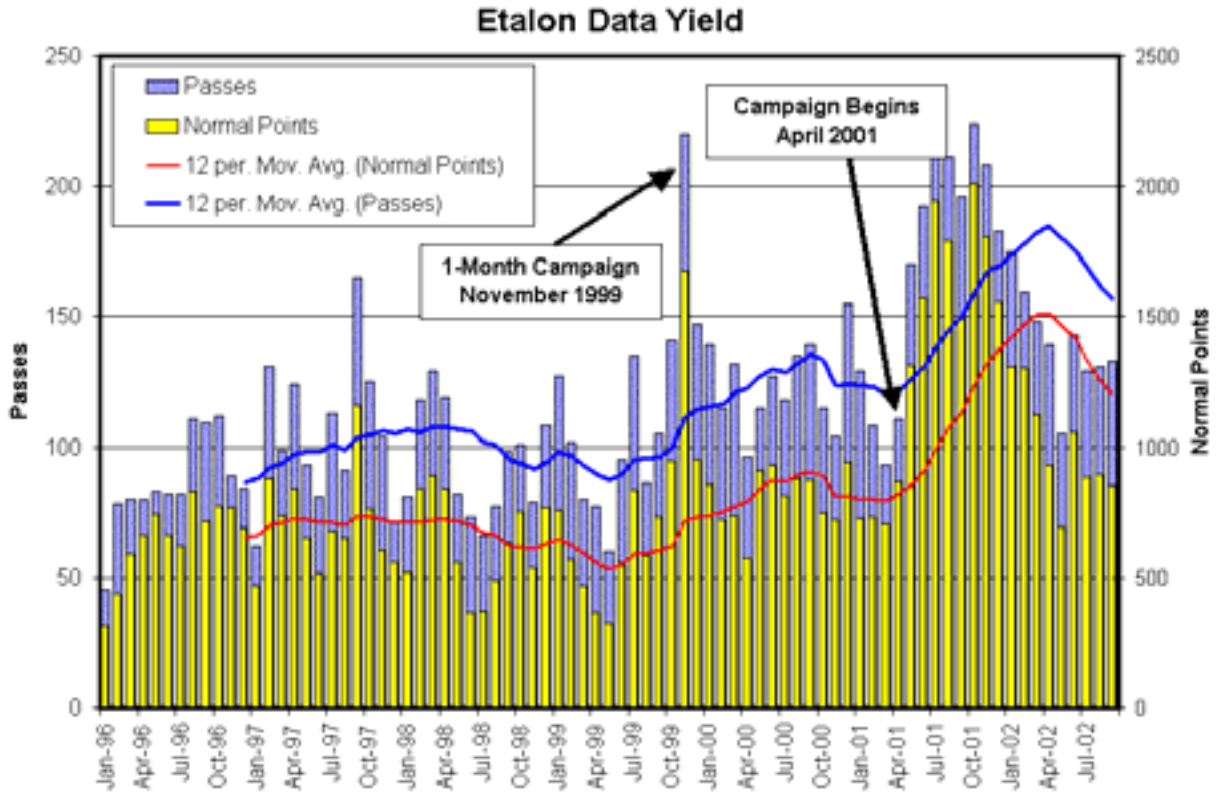
- ⇨ April 2001 – April 2002
- ⇨ May 2002 – October 2002

Observations

Results (JCET)

	LAGEOS	LAGEOS + Etalon
rms x-pole [mas]	0.525	0.488
rms y-pole [mas]	0.504	0.506
rms LOD [ms]	0.162	0.099

October 2002 =>


Etalon Data Yield
Passes
Normal Points
12 per. Mov. Avg. (Normal Points)
12 per. Mov. Avg. (Passes)
Campaign Begins
April 2001
1-Month Campaign
November 1999
Passes
Normal Points
250
200
150
100
50
0
2500
2000
1500
1000
500
0
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02

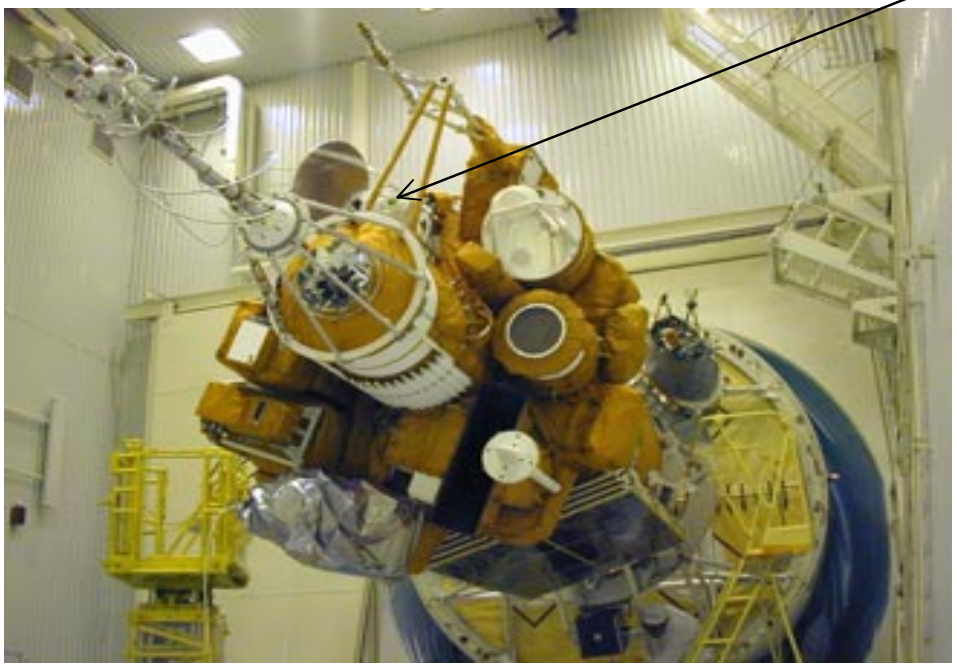
SLR Performance on TOPEX/Poseidon, Jason-1 and GRACE

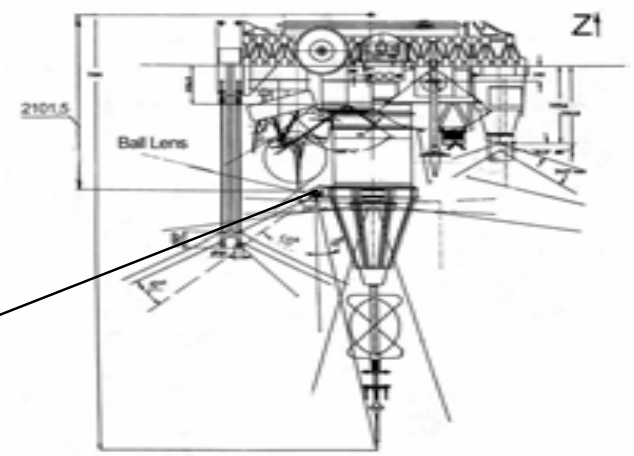
- Tracking of T/P and Jason-1 averaging more that 16 passes of good data per day (15/day was mission goal)
  - Coverage is good in spite of close proximity of T/P and Jason-1
  - Jason-1 LRA design supports higher precision SLR
    - Jason-1: 18 mm fit RMS, 4 mm precision, -2 mm bias (248 day average)
    - T/P: 24 mm fit RMS, 7 mm precision, -2 mm bias (200 day average)
  - SLR remains a critical component of altimeter satellite POD, for both accurate orbit centering and accuracy assessment
- GRACE-A and GRACE-B tracked 3-4 times per day on average
  - 6-7 cm SLR RMS consistent with expected orbit error using GRACE gravity model
    - Adequate for post-fit orbit quality assessments most days
  - ~6 cm Z-bias apparent in center-of-mass offset correction being investigated

Meteor 3M / SAGE III Mission Overview

The ILRS is providing accurate orbit data to mitigate the failure of an on-board GPS/GLONASS receiver

This data is required for accurate SAGE III scientific results





IPIE (Russia) Experimental Reflector

Reflectors: 1 (glass ball)

Orbit: Sun synchronous (near polar)

Inclination: 99.64

Eccentricity: 0.0024

Perigee: 1,012km

Period: 105 minutes

ILRS support has been outstanding

Operational support began May 7 2002

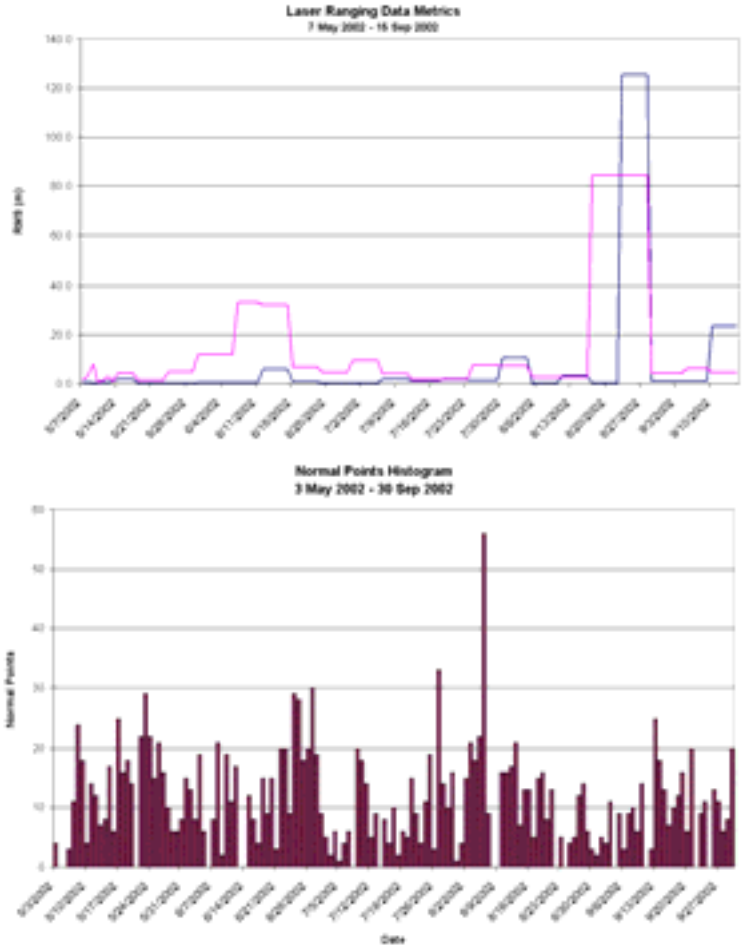
Statistics through 9/23/2002:

21 participating ILRS stations

254 Laser Tracking Sessions

Leading Stations:

- *Herstmonceux – 46 sessions*
- *Yarragadee – 45 sessions*
- *Monument Peak – 30 sessions*
- *Graz – 28 sessions*
- *San Fernando – 23 sessions*
- *Schelkovo* – 65 sessions*



* Schelkovo (Russia) measurements were not submitted to ILRS but were used for orbit determination

Data Processing

Operations Data Processing Center: MCC-M (Korolev, Russia)

- Daily orbit determination
- 24 – hour orbit prediction
- Preparation of IRV sets
- Distribution of IRVS to participating stations (email)

Definitive Orbit Processing Center: NASA GSFC

- ILRS data Processed on weekly basis
- 7-day arcs
- Typical orbit accuracy < 4 meters

Conclusion

Please continue to regularly track Meteor 3M

Thanks!

Upcoming Missions

ADEOS-II Mission Status

Maki MAEDA

Flight Dynamics Group
Office of Satellite Technology, Research and Applications
Satellite Mission Operations Department
National Space Development Agency of Japan

ILRS Meeting, 7-11 October 2002/ Washington D.C.

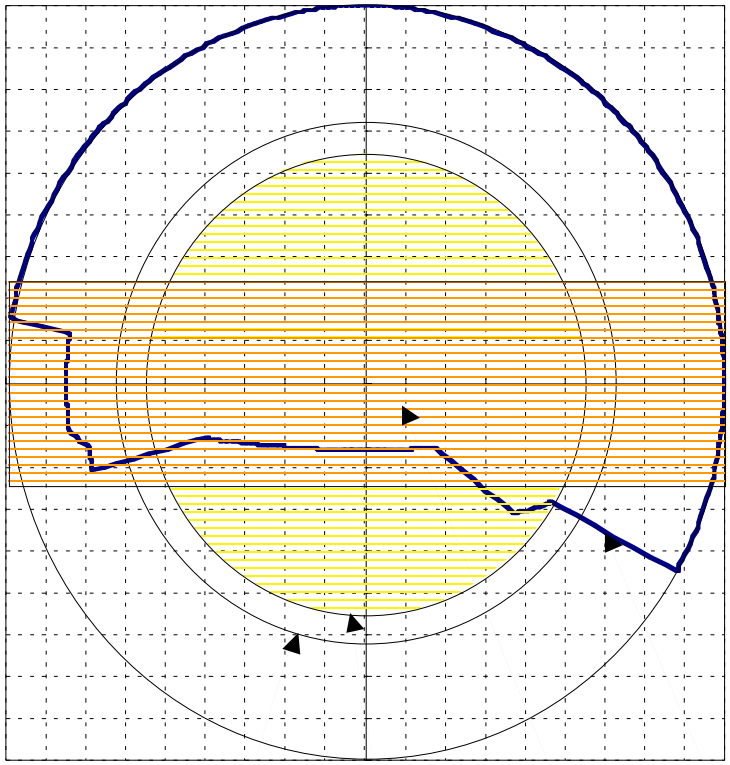
NASDA-ILRS-0007

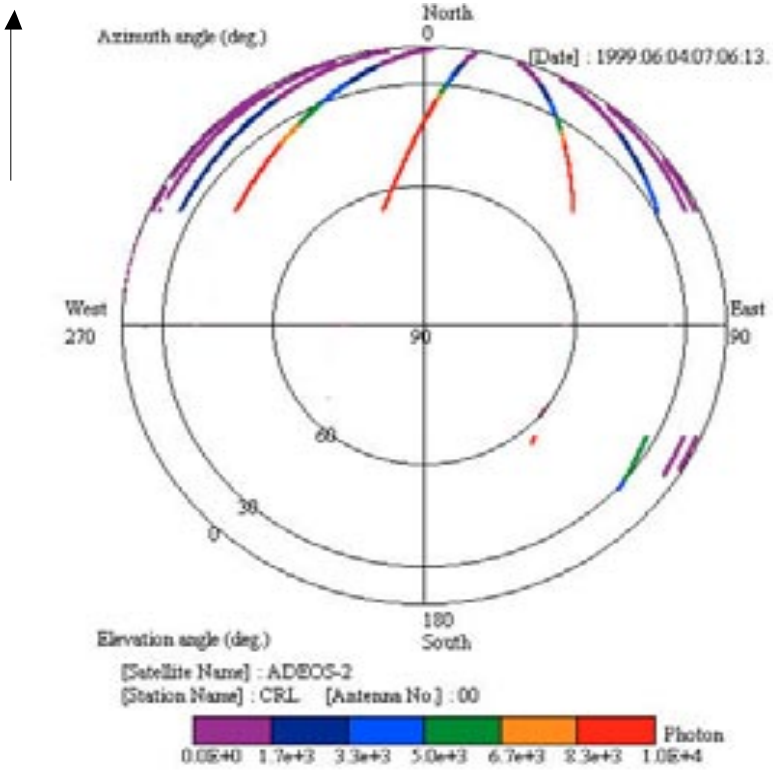
NASDA

The Latest Information of ADEOS-II

- *Launch vehicle : H-IIA*
- *Launch site : Tanegashima (Southern Island of Japan)*
- *Launch Window : 10th Dec 2002 to 31th Dec 2002*
- *Launch time : 01H31m – 01H47m(UT) [16min]*

The Restriction area in the ADEOS-II tracking





ADEOS-II SLR tracking campaign

?¢Nominal 10th.Dec.2002
L/O

Progress days	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Satellite's event	?£PDL…….etc.																	?£GPSR ON																									?£GLI ON
				ƒ ∅/#2																																							
Orbit maneuvers			?¡	?¡			?¡			?¡						?¡			?¡			?¡			?¡			?¡															
			ƒ ∅/#1				ƒ ∅/#3			ƒ ∅/#4						ƒ ∅/#5			ƒ ∅/#6			ƒ ∅/#7			ƒ ∅/#8			ƒ ∅/#9															
																																											Prohibit SLR
SLR																																										
Orbit determination		?£				?£			?£				?£	?£	?£	?£			?£			?£			?£			?£			?£	?£	?£	?£	?£	?£	?£	?£	?£	?£	?£	?£	?£
TIRV		?£				?£			?£			?£							?£			?£			?£			?£			?£	?£	?£	?£	?£	?£	?£	?£	?£	?£			
Maneuvers Info.		?£				?£			?£			?£							?£			?£			?£			?£															
Experiment in GUT	Precise orbit determination using SLR																		Precise orbit determination using GPS and SLR																								
																		Evaluation of orbit determination technique using GPS with SLR																								

NASDA

ADEOS-II SLR tracking plan during Launch Phase

Y-4day		TIRV of nominal orbit
Y+0day		
L+0	01:31(UT)	Lift off
	L+988sec	separation of ADEOS-II
	L+1855sec	separation of Fedsat
	L+1960sec	separation of WEOS
	L+2070sec	separation of μ-LabSat
L+3.5H	05:00(UT)	1st distribution of TIRVs
L+7.3H	8:50(UT)	2nd distribution of TIRVs
Y+1day		
	10:00(UT)	TIRVs with the prediction of 1st maneuver
Y+2day		1st orbit maneuver
	:	

ADEOS-II SLR tracking plan

NASDA proposed and accepted the following operation plan (Last ILRS meeting at Nice)

Launch Phase:

40 days tracking campaign after launch

(GLI is under safety mode avoiding any signal through its aperture.)

Routine Phase:

After launch phase, GLI will starts its observation and switch over to the routine operation through the mission check out.

All station must be suspended laser ranging to the ADEOS-II from this phase, and also NASDA will interrupt deliver IRV set to the station at once.

If we need more SLR data in routine phase, we request to the specified station as an partial campaign.

ADEOS-II SLR tracking plan during Routine Phase

When NASDA request partial campaign to the specified station…

1. NASDA will inform to the station directory (via e-mail) about the partial campaign one month before the planned schedule.
2. NASDA will send TIRVs to the station directory via e-mail.
3. Also with the TIRVs, NASDA will send the availability schedule of laser transmission to the ADEOS-II. Stations can transmit laser only this period.
4. Stations send the QLNP to NASDA via e-mail or CDDIS/EDC server.
5. Again, NASDA will send TIRVs and tracking schedule.

ADEOS-II SLR tracking plan during Routine Phase

Station mail format (sample:TBD)

STATION : NASDA-GUTS
FROM : 2003/02/10 TO : 2003/02/17
MANEUVER TIME : 2003/02/10 21:56:43 – 21:58:22 (UTC)

No.	START TIME	STOP TIME	LENGTH	START Az/El	Max El Az/El	END Az/El	Passes after maneuver
1.	2003/02/10 01:43:44	2003/02/10 01:51:11	(00:06:27)	243.3/20.0	120.6/59.3	101.8/40.5	
2.	2003/02/10 03:10:31	2003/02/10 03:19:27	(00:08:56)	56.4 /20.0	98.1/73.2	68.5/22.8	
3.	2003/02/11 01:41:09	2003/02/10 01:49:16	(00:08:07)	122.7 /20.0	275.3/63.8	243.3/43.0	*****
4.	2003/02/11 03:12:22	2003/02/10 03:17:33	(00:05:11)	156.2 /20.0	229.1/42.5	256.1/33.5	*****
:	:	:	:	:	:	:	

NASDA will deliver the information about the schedule of LASER transmission to ADEOS-II like this. Stations permitted to SLR out of this period.

PRESENTATION TO THE ILRS WORKING GROUP

13TH INTERNATIONAL WORKSHOP ON LASER RANGING

OCTOBER 11, 2002
WASHINGTON D.C.

❑

BY

K. ELANGO

ISRO TELEMETRY, TRACKING AND COMMAND NETWORK (ISTRAC)
INDIAN SPACE RESEARCH ORGANISATION (ISRO)
BANGALORE
INDIA

- **ISRO HAS LONG EXPERIENCE IN OPERATING THE FIRST GENERATION LASER SYSTEM AT KAVALUR, INDIA FOR MORE THAN A DECADE**

- **ISRO CAN REVIVE SLR PROGRAM IN INDIA AND BECOME PART OF THE GLOBAL SLR NETWORK**

- **ESTABLISHING SLR STATION AT BANGALORE WILL FULFILL THE LONG STANDING GAP IN THE SLR NETWORK AT THE INDIAN SUB-CONTINENT**

- **NECESSARY SITE SELECTION CRITERIA WAS CARRIED OUT AND NASA TEAM VISITED AND APPROVED THE SITE FOR LOCATING A SLR STATION AT BANGALORE**

- **A DETAILED SITE SELECTION CRITERIA REPORT WAS MADE FOR LOCATING SLR AT BANGALORE**

- **ISRO IS ALREADY PROVIDING TTC SUPPORT TO MULTIPLE REMOTE SENSING SATELLITES USING ITS GROUND STATIONS WITHIN AND OUTSIDE INDIA**

- **NECESSARY INFRASTRUCTURE, EXPERTISE IN HARDWARE, SOFTWARE, ROUND THE CLOCK OPERATION, ORBIT DETERMINATION ETC. ARE AVAILABLE IN ISRO**

- **ISRO HAS OPERATIONAL EXPERIENCE IN ORBIT DETERMINATION/POD FOR MORE THAN TWO DECADES**

- **ISRO IS ALSO OPERATING A PRARE STATION AND A P-CODE GPS RECEIVER AT THE SAME CAMPUS, BANGALORE**

- **BANGALORE CAN BE ELEVATED AS ONE OF THE FUNDAMENTAL REFERENCE STATIONS FOR SPACE GEODESY BY LOCATING A SLR STATION**

- **BANGALORE SITE IS ALREADY IN THE INTERNATIONAL SPACE GEODESY NETWORK (SITE NUMBER 7725)**

- **ISRO HAS PROPOSAL TO CONDUCT INTERNATIONAL WORKSHOP ON SPACE GEODESY TO BRING THE EXPERTS ON A COMMON PLATFORM**

- **ISRO HAS PLANS TO FOSTER SPACE GEODESY IN INDIA BY ESTABLISHING A SPACE GEODESY CENTRE. TOWARDS THIS, A GEODESY DIVISION IS ESTABLISHED RECENTLY**

- **TO GET ACCURATE GROUND IMAGERIES FROM REMOTE SENSING SATELLITES, ISRO HAS PROPOSED TO PUT RETROREFLECTORS TO ITS FUTURE IRS MISSIONS**

- **A DETAILED INTERNAL DESIGN REPORT IS MADE IN THIS RESPECT.**

- **SATNAV PROGRAM (INDIAN WAAS) IS JUST EMERGING OUT IN INDIA WITH BANGALORE AS THE CONTROL CENTRE**

Other Business

ILRS Annual Report Series

- 2001 ILRS Annual Report nearly finished
- Call for input to 2002 ILRS Annual Report to be issued after first of the year
- Plans:
  - Much shorter report (less than 20 pages total)
  - One page per section (additional for AWG report)
  - No individual center reports
  - Working group chairs, network coordinators, etc. generate summaries
- Final report could be used for ILRS input to the CSTG annual report