Seventh General Assembly of the ILRS
April 25, 2002
Nice, France

Presentation Material

Working Group Reports

Missions Working Group Report

ILRS Missions Working Group

Nice, France

April 23, 2002

Agenda/Summary

- MWG membership
- Past and Current Activity Since Last Meeting (September 2001 - Toulouse)
  - Campaign/Mission status
    - New Launches - Starshine 3, 2, Envisat, Grace, Meteor-3M, Jason
    - New Campaigns -Etalon -1, -2, BEC, LRE, Reflector
  - Mission/Satellite Data Base for Satellite Signature Study
- Continuing and Future Actions
  - Satellite identification/misidentification issue (getting better?)
  - Develop/implement procedure to track SLR mission requirements
  - Work with known satellite organizations to get Mission Request Forms and Support Plans completed and put on Web - ongoing
- Upcoming Missions
  - Within 2002
    - IceSat - 1
    - ADEOS-II
    - Gravity Probe B
  - Beyond 2002
    - Cryosat
    - Starshine 4/5
- Other Mission News
- Other Issues
- Appendix: Satellite Tracking Priority List

MWG Membership

COORDINATOR(Re-elected)

Hiroo Kunimori	CRL	Japan

Deputy Coordinator

David Carter	NASA	USA

New membership includes:

David L. Carter	NASA	USA	Wolfgang Schluter*	BKG	Germany

Retained membership include:

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 to be recruited for membership
- Change Mission Request Form to reflect satellite name in message Subject line
- New mailing list involving all working groups has been very successful. Current mailing list includes
  - Director of the Central Bureau
  - Secretary of Central Bureau,
  - Chairman of Governing Board
  - Coordinator of Each WG (AWG, NW&E, DF&P, and TIGER teams)

Past and Present Campaigns

Etalon-1, -2

- Campaign extended at Toulouse meeting until the end of March ‘02 - Extended until Nice for convenience
- Results provided by Ron Noomen showed that despite data volume increased by *2, EOP improvement was small
- Importance shifted to combined solution
- Action to Analysis Working Group to meet next week and give recommendations for continuation of campaign

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
- Kunimori proposes to keep LRE tracked on an “as available” basis
  - NASDA will provide TIRV routinely
  - 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

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, Monument Peak and Graz
  - Currently 28 systems tracking Reflector
- Success of campaign needs to be reviewed by IPIE
- Justification for continuation of campaign to be provided at these meetings

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 (9)
  - NRL provided high quality predictions to help support acquisition
  - Starshine-3 scheduled to de-orbit on approximately October 30, 2002

Starshine 2

- Starshine 2 deployed from STS-108 on December 16, 2001
  - No tracking attempted due to limitations of tracking Starshine 3
  - STARSHINE 2 2001-054B (#26996): is predicted to decay Apr 26, 2235Z
- Other Starshine(s) are being developed
- Starshine is important to drag research at NRL/NASA

Recent Launches / New Missions

Jason

- Jason was launched on Dec. 7, 2001 and placed in tandem orbit with TOPEX/ Poseidon (~1 minute separation, Jason leading)
- SLR attempted by several systems prior to operational commitment to confirm array performance
- SLR officially began on January 14, 2002
  - First operational Jason pass received by Yarragadee
  - Tracking leaders are Yarragadee, Graz….Good support from Monument Peak, Greenbelt, Zimmerwald & Wettzell
  - Currently 32 systems tracking Jason
- Tracking scenario as requested from Jason Team
  - Alternate successful full-pass tracking between Jason and TOPEX/Poseidon
  - Can pick up first minute of Jason pass when tracking TOPEX or last minute of TOPEX when tracking Jason
  - Several systems are experimenting with interleaving during each pass - being reviewed by Jason team
- Jason team to provide status at ILRS General Assembly

Envisat-1

- Envisat-1 launched on March 1, 2002 and placed in tandem orbit with ERS-2 (~30 minute separation)
- SLR scheduled to begin at ~launch + 40 days, began on April 10, 2002
  - First Envisat pass received by Metsahovi and Riga (same times)
  - Tracking leaders are Metsahovi, Monument Peak and Herstmonceux
  - Currently 11 systems tracking Envisat-1
- Envisat-1 team to provide status at ILRS General Assembly

Recent Launches / New Missions (2)

GRACE

- GRACE A&B were launched on March 17, 2002 and placed in tandem orbit with each other (~30 secs separation)
- SLR required ASAP from separation from S/C
- Tracking scenario as requested from GRACE Team
  - Alternate successful full-pass tracking between GRACE A & B unless systems are able to quickly alternate between satellites
  - Several systems are experimenting with interleaving during each pass - being reviewed by GRACE team
- Tracking Summary- GRACE A
  - First GRACE A pass received by Yarragadee
  - Tracking leaders are Yarragadee, Herstmonceux
- Tracking Summary- GRACE B
  - First GRACE B pass received by Yarragadee
  - Tracking leaders are Yarragadee, Herstmonceux, and Monument Peak
- Currently there are many more GRACE A passes than GRACE B…What is the impact on GRACE and why is this happening??
- GRACE team to provide status at ILRS General Assembly

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
- Based on limited responses MWG endorses support Meteor-3M
  - new target testing
  - SLR only viable method for POD to support SAGE
- Governing Board Approval at ILRS GB meeting
- Tracking to begin ASAP

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
- Uchimura will 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 December 16, 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

GPB (Gravity Probe B)

- GPB is a NASA / Stanford University relativity mission
- GPB is scheduled for launch in October 2002
- Coordination efforts for ILRS on-going

Upcoming Missions
(beyond 2002)

Starshine 4/5

- NASA has firmly manifested our Starshine 4/5 dual-satellite experiment on the STS-114 Shuttle mission to the International Space Station in January of 2003.
- 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.

Other Mission News

Mission Status Changes

- BEC Mission Status Change
  - Campaign was revised to become a Mission (SLR Mail No. 0873 on January 3, 2002)
  - UTex/CSR requested Mission Status to strengthen long-term changes in gravity field
  - BEC retains same tracking priority level as during campaign
- WESTPAC SLR Support Suspended
  - SLR support was discontinued (SLR Mail No. 0877 on January 7, 2002)
  - ILRS community indicated WESTPAC was being used very little for research
  - Data set was very weak and difficult to acquire satellite
  - Satellite originators agreed to no immediate need for tracking data
- GLONASS satellite changes
  - At the request of the IGLOS-PP, the set of 3 GLONASS satellites to be tracked by SLR was changed to 84, 86 and 87. (SLR Mail No. 0900 on February 20, 2002)
  - Now all have the same type of (reduced sized) retroreflector arrays.
  - This limits some stations to night time tracking only resulting in loss of data

Missions to drop from list

- OICETS (NASDA) - Indefinitely postponed
- IRS-P5 (ISRO) - Lack of communication from ISRO
- SAC-C (CONAE) - No response from CONAE
- VCL (NASA) - Indefinitely postponed

Upcoming Missions

Satellite	Owner	Mission Type	Planned Launch Date	Mission Duration	Received Mission Request Form	Received ILRS GB Approval
Meteor-3M	ROSAVIACOSMOS	Solar Research / new array testing	December 10, 2001	3 years	Yes	Yes
IceSat (GLAS)	NASA	Ice sheet research	December 16, 2002	3-5 years	Yes	Yes
Gravity Probe B	NASA	Relativity research	October 30, 2002	1-2 years	Yes	Yes
ADEOS-II	NASDA	Altimeter calibration	November 2002	3 years	Yes	Yes
CryoSat	ESA	Earth Sensing	Apr/May 2004	3.5 years	Yes	Awaiting MWG Recommendation
ALOS	NASDA	Altimeter calibration	Jul/Aug. 2004	3 years	No	No
ETS-VIII	NASDA	Time transfer experiment	Jul./Aug. 2004	3 years	No	No

Other Issues

Open Forum

- Dynamic Tracking Priorities
  - Shelus recommended that we continuously monitor all tracking and adjust tracking priorities to pick up on weak satellites
  - The MWG is taking up this issue - Wetzel
- Weak initial tracking support of new satellite
  - First several weeks of tracking of new satellites usually have same few stations supporting with others following later
  - This should not be happening during critical phase of mission
  - Causes are being investigated
- More information about Mission Support planning and implementation status on web
  - Greater detail to the mission summaries with respect to mission support activities will be posted on the web
- Spacecraft COM
  - MWG responsible for providing Signal Processing Group S/C COM models from satellite host
  - This needs to be done in the early stages of mission planning

Next Meeting

- Next ILRS Missions Working Group Meeting:
  - Meeting to occur at the Laser Ranging Workshop
  - Washington, DC, Hyatt Hotel
  - October 7-11, 2002

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	Stella	CNES	815	98.6	Geodetic / no other tracking technique available
9	Starlette	CNES	815-1,100	49.8	Geodetic / no other tracking technique available
10	REFLECTOR	IPIE	1,020	99.6	POD research for space debris detection
11	BeaconC	NASA	950-1300	41	Gravity Research / upgraded to ongoing mission (Jan 2002)
12	Ajisai	NASDA	1,485	50	Geodetic / no other tracking technique available
13	LAGEOS2	ASI/NASA	5625	52.6	Geodetic / no other tracking technique available
14	LAGEOS1	NASA	5850	109.8	Geodetic / no other tracking technique available
15	Etalon1	Russian Federation	19,100	65.3	Geodetic / no other tracking technique available
16	Etalon2	Russian Federation	19,100	65.2	Geodetic / no other tracking technique available
17	GLONASS80	Russian Federation	19,100	65	Positioning POD enhancement / replaced G70 as of 10/20/99
18	GLONASS78	Russian Federation	19,100	65	Positioning POD enhancement / replaced G72 as of 6/29/00
19	GLONASS84	Russian Federation	19,100	65	Positioning POD enhancement / replaced G79as of 2/22/01
20	GPS35	US DoD	20,100	54.2	Positioning POD enhancement
21	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
Meteor-3M	IPIE	1020	99.64	Retroreflector research / No other tracking technique available
LRE	NASDA	250-36000	28.5	HEO Characterization / Spin evolution vs. BK7 degradation

April 23, 2002

ILRS Network & Engineering Working Group Meeting
Wednesday, April 24, 2002, 14:00-16:00
Nice Acropolis Congress Centre, Room M 11

Agenda

- EUROLAS calibration workshop 11-13 March 2002 in Herstmonceux (W. Gurtner, G. Appleby)
- Signal processing working group: Short progress report (G. Appleby)
- Station log files (V. Husson)
- Cloud detection (J. Degnan)
- Near-realtime computation and distribution of time biases (W. Gurtner)
- Any other business

!
! Time biases at 19-Apr-2002 14:21 UT
!
! Satellite Total IRVset LstObs Passes SIC Drag
!   TB[ms]   [hhh:mm] used   [ms]
!

Satellite	Total TB[ms]	IRVset	LstObs [hhh:mm]	Passes used	SIC	Drag [ms]
Ajisai	-1	HON108	4:16	38	1500	0
Ajisai	4	NSD032	4:16	68	1500	0
Ajisai	1	RGO096	4:16	113	1500	0
BeaconC	3	HON108	1:52	20	0317	0
BeaconC	-1670	RGO041	1:52	65	0317	0
Champ	**-89**	GFZ375	0:00	**0**	8002	-89
ERS2	-16	GFZ400	3:47	8	6178	0
Envisat	**100**	ESO108	6:26	**20**	6179	0
GFO1	0	HON108	4:02	19	8501	0
GFO1	103	RGO101	4:02	62	8501	0
GraceA	-70	GFZ060	6:54	1	8003	-52
GraceB	**-144**	GFZ061	5:57	**3**	8004	**-48**

Realtime Distribution of Time Biases

- NERC
  - Routine computation of time bias functions using recent SLR data
- Server program at Zimmerwald
  - collects the functions
  - distributes table of actual time biases (including drag function value) on request
- Client program at stations
  - requests, receives and displays/stores time bias table
  - EUROSTAT program or just TELNET
- Operator or user program at stations
  - Inserts current time bias into tracking program

Two-wavelength np data

```
ZIMMERWALD LASER STATION, SWITZERLAND 19-APR-02
QUICK LOOK DATA FILE

99999
930610202109781068014230000811310000000101571600150014 1
282153080562007101999297000012009165279306500770000066
282435080560006309370876000014609165279306500650000067
282764080561005648687931000011709165279306500210000071
283067080571005378514441000014609165279306500330000059

99999
930610202109781068018460000835940000000141071600160038 1
282150080559007111298748000013809165279306501740000070
282435080560006309369523000015709165279306501470000067
282756080560005660581151000014609165279306500730000061
283064080562005379376442000020809165279306500540000066
```

IRV files: Prediction center identification

First lines in each block:

```
IRVSHTSI    TUNED IRVS
GFZ_FITXYZ_950221_IRVS
GFZ_CONDOI_921001_IRVS
IRVS_ESOC_ENVISAT_ROUT
MCC_IRVS TUNED IRVS
IRV NSD Ajisai   0      1
GLO11630 GLO87          1
GLO11630 GLO87          4
COD11630 GPS35          1
COD11630 GPS35          4
NERCDY_LGA111           0
```

EUROLAS Workshop

Detecting and eliminating errors in the EUROLAS network

March 2002, 11-13
Herstmonceux

- Participants: 20 from 10 European stations
  1 from TU Prague
  2 from the ILRS CB

EUROLAS Workshop: General Principles

- Goal: 1 mm accuracy
  - Detection/reduction of systematic errors
  - Reduction of random errors
- Stations have primary responsibility for data integrity
  - Data screening/handling

EUROLAS Workshop: Detectors

- C-SPAD
  - Residual time walk could be determined if signal strength or return rate were known
  - Tune C-SPAD (pulse length dependent)
  - Check alignment
- PMT
  - Time walk determination (signal strength dependent)
  - Time walk omission (single photon level)

EUROLAS Workshop: Data reduction

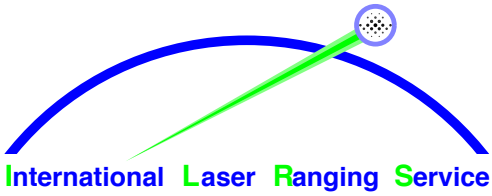
- Carefully check for noise
- Compute pass parameters: RMS, skew, kurtosis, compare with „standard“ values
- Compute return rates
- *Minimum number of returns for normal point*
  - Daytime: 6
  - At night: 3
- *Re-introduce full rate data archiving in MERIT II format*
- *Procedure for data withdrawal*
- Daily quality control by NERC

EUROLAS Workshop: Counters and timers

- Counter calibration/comparison relative to Herstmonceux counter.
- Measurements performed for some SR620 counters during the meeting
- Recommend to apply corrections to data
- NERC will analyse effect of corrections for test passes
- TU Prague: EU proposal for portable calibration standard (P-PET-based)

EUROLAS Workshop: Miscellaneous

- Encourage station personnel to visit each other
- Barometer calibration/comparison with Herstmonceux sensor on all European stations
- Recommendations for system monitoring
- Near-realtime status display: Encourage more stations to participate. Increase update rate
- Predictions: „Weak“ recommendation for sets to be used
- Instantaneous time bias computation by TCP/IP server program to be developed → Done



International Laser Ranging Service
Seventh General Assembly
Nice, France, April 25, 2002

Data Formats & Procedures Working Group Report

1. Review of CP Activities, Van Husson (only most important issues)
   - Backup for urgent mail exploder will be installed at EDC
   - Bias problems and occasional blunders:
     Procedure concerning archiving of retransmitted np data:
     The Data Centers archive retransmitted data additionally to the previous data
     (no data withdrawn, correct release number, creation of a file which gives information about these updated data)
   - Two colour data submission and management:
     submission of two files per pass for each wavelength
     (an e-mail will be sent by the CB about this procedure)
   - Archiving of full rate data:
     A request of the analysis working groups and the EUROLAS workshop in Herstmonceux to reinstall the archiving of FR data.
     A Study Group was built to define how to handle these data;
     members: Carey Noll, Werner Gurtner, Wolfgang Seemüller
     (no replacement of the np data, weekly/monthly files, file naming convention, etc.)

2. Future activity:
   Faster np data exchange between CDDIS/HTSI and EDC, i.e. every 15 min., for faster update of time bias functions of specific IRVs

3. Refraction Study Group Report, see report by Stefan Riepl

4. Prediction Format Study Group, see report by Randy Ricklefs

International Laser Ranging Service

ILRS Refraction Study Group Report

Stefan Riepl

(sent by e-mail from Concepcion)

1. **The new mapping function of E. Pavlis et. al. is derived for a laser wavelength of 532 nm only. According to the RSG charter it needs to be investigated for other wavelength.**

2. **A data set of the numerical weather prediction service (NWP) of Europe is under analysis for appliance in deriving horizontal refraction gradients. The results show pressure gradients of up to 0.08 mbar/km which need definitely to be considered for approaching mm accuracy at elevation angles > 15 degrees. The data set shows also a dependence of pressure gradients with respect to topography.**

3. **To generalize the application of horizontal gradients throughout the SLR network, each station manager should think about what can be done at the stations to improve the spatial resolution of meteorological data, either by using a meteorological network in the vicinity of the SLR station or a local GPS network.**

DGFI

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

- Preliminary format is available
- Lunar feasibility study was successfully completed
- Transponder requirements are solidifying

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

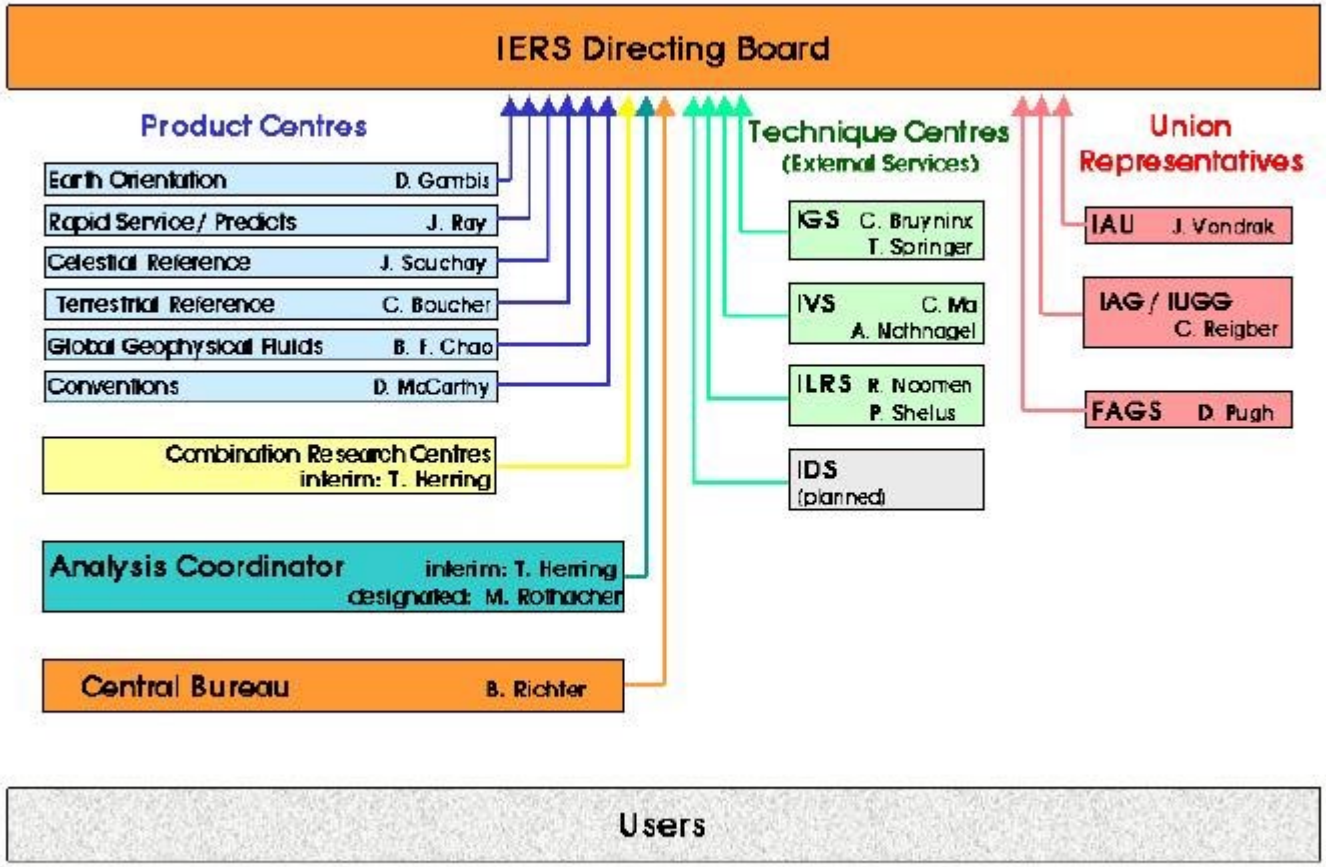
The Next Steps

- Perform simulations to finalize transponder prediction requirements
- Refine and document format
- Distribute format widely within laser community for comment
- Develop sample code, including interpolator
- Pilot projects to implement format at several stations
- Present results at Laser Workshop
- Further plans for implementation…

IERS related issues

- IERS organization
- IAG reorganization
- SINEX 2.0
- IERS workshop on IAU 2000 Resolutions
- IERS projects/products
  - Bulletin A
  -SINEX project
  - IGGOS project

New IERS


IERS Directing Board
Product Centres
Earth Orientation D. Gambis
Rapid Service / Predicts J. Ray
Celestial Reference J. Souchay
Terrestrial Reference C. Boucher
Global Geophysical Fluids B. F. Chao
Conventions D. McCarthy
Combination Research Centres
interim: T. Herring
Analysis Coordinator interim: T. Herring
designated: M. Rothacher
Central Bureau B. Richter
Technique Centres
(External Services)
IGS C. Bruyninx
T. Springer
IVS C. Ma
A. Nothnagel
ILRS R. Noomen
P. Shelus
IDS
(planned)
Union
Representatives
IAU J. Vondrak
IAG / IUGG
C. Reigber
FAGS D. Pugh
Users

IAG reorganization

IUGG

|

|

V

IAG

with:

Commisions (4) (reference frame, gravity field, …)

Services: IGS, IVS, ILRS, IERS, PSMSL, …

Projects

Communication & Outreach

Inter-commision committees

- Overlap?
- New organization IAG approved by IERS DB

AWG activities

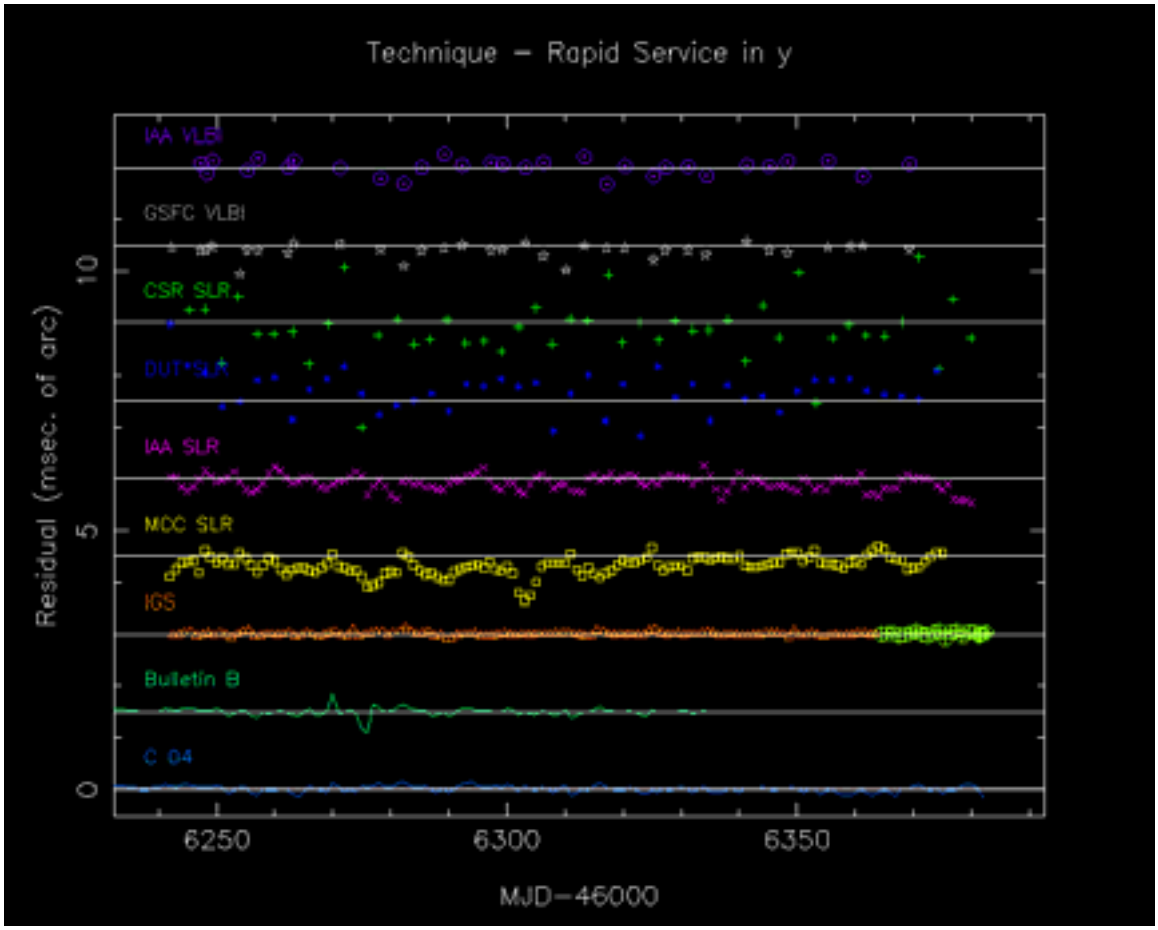
Pilot projects:

- Benchmarking
  Van Husson & Maria Mareyen
  Blunders, software inconsistencies
  Orbit comparisons

- Harmonization
  Van Husson
  Unify analysis results (i.e. biases)
  Continuous development

- Orbits
  Richard Eanes
  Product: satellite ephemerides
  Planning stage

- Positioning + earth orientation
  Ron Noomen


Technique – Rapid Service in y
IAA VLBI
GSFC VLBI
CSR SLR
DUT*SLR
IAA SLR
MCC SLR
IGS
Bulletin B
C 04
Residual (msec. of arc)
0
5
10
6250
6300
6350
MJD−46000

ILRS “public relations”

- “POD with SLR: setting the standard”
  Noomen
  Surveys in Geophysics, 22, p. 473-480, 2001

- ILRS contribution to IGGOS
  Noomen, Appleby and Shelus
  AGU Spring Meeting

ILRS General Assembly

April 25th 2002, Nice, France

Signal Processing Ad-hoc WG, G. Appleby and T. Otsubo.

Overview – what's been achieved:

GLONASS, GPS –

- We have acquired details of precise location and characteristics of each CCR, thanks to Missions WG;
- Attitude-dependent impulse functions computed for GLONASS and tested against single-photon range data;
- Demonstration that large (20-40mm) ambiguity exists in CoM correction for high-energy systems
- Through work of MWG, now have available accurate geometry of the 3 types of LRA on the GLONASS satellites and have concluded that:
    - The apparent radial bias in the GLONASS orbits was caused by a combination of incorrect information on location of LRA *plus* the 'large array' effect;
    - The radial bias (~50mm) of the GPS orbits persists - re-visit the current values of the locations of the GPS LRAs?

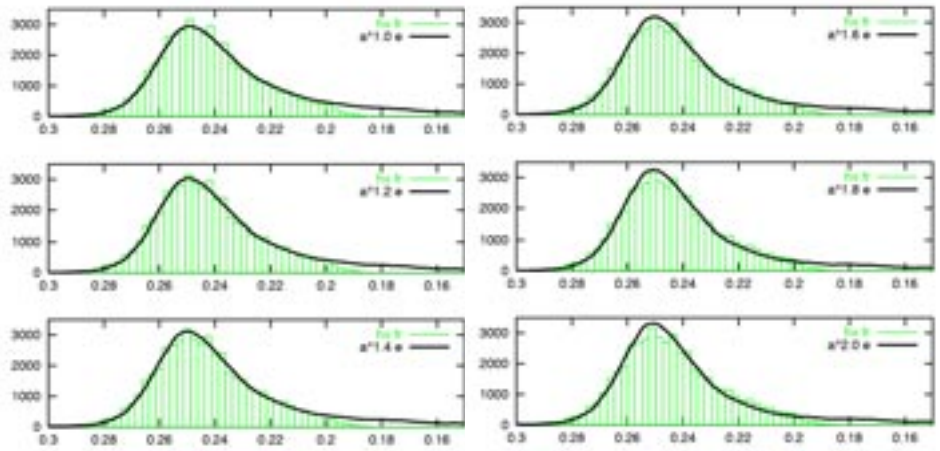
LAGEOS, ETALON and AJISAI –

- We know the precise location and characteristics of each CCR;
- Impulse response functions have been computed, where the reflection intensity is modelled as a function of effective reflection area, CCR reflectivity and diffraction effects;
- Tested against single-photon range data; crucial to this stage is to understand the particular power law applicable to each satellite. The fit of the models to Herstmonceux single photon data can be used as a powerful indicator of this, as shown in the results for LAGEOS over a range of power-law models:

Model vs Obs [1]

model: the (a priori) models convolved with the transmon system response
obs Single-photon (Herstmonceux) full-rate residuals
=> Fit: estimate x-shift and y-scale

LAGEOS



Further:

- We have demonstrated that the use of system-dependent CoM values are crucial for mm-level accuracy (e.g. the use of CSPAD at single- and multi-photon levels can influence appropriate CoM corrections by up to 5mm);

- Discussions are underway with Honeywell colleagues on details of the NASA systems' CFD/MCP combinations, with a view to deriving appropriate CoM values for this important group of systems.

- It is likely that estimates of CoM values, or ranges of values, for the broad classes of systems (Single-photon, multi-photon with C-SPAD, multi-photon with MCP/CFD) for LAGEOS, AJISAI and ETALON will be available by the next ILRS GA.