Section 3

Working Group Reports

SECTION 3 - WORKING GROUP REPORTS

3.1 Missions Working Group

Hiroo Kunimori, *Communications Research Laboratories*
Scott Wetzel, *Honeywell Technology Solutions, Inc.*

INTRODUCTION

The Missions Working Group (MWG) was formed at the first ILRS meeting in Deggendorf, Germany in September 1998. Since then, the MWG has been interacting regularly in the execution of its duties to coordinate new and existing tracking campaigns and missions with the ILRS operations community. The MWG meet formally twice in 2000 (see below). The MWG has conducted its business by phone and e-mail regarding new missions, tracking campaigns, satellite arrays, mission and related areas of analysis, engineering, network coordination, mission planning issues.

CHARTER

An SLR system can only track one satellite at a time. Over the past five years there has been a steady growth in the number of new satellites with many different tracking requirements requesting SLR support of the past 5 years. As this number has increased, the need has increased for an organized mechanism to review all requests for SLR support of future missions and campaigns and to ensure that the currently supported missions still require SLR tracking. This ILRS Missions Working Group is tasked to review the needs of current and future SLR missions and to make SLR tracking support and priority recommendations to the ILRS Central Bureau and Governing Board.

The Central Bureau refers Mission Support Request Forms submitted for new satellites to the MWG. The MWG reviews them for adequate scientific or engineering relevance and sufficient justification for laser tracking support. Additional requirements such as SLR temporal and spatial coverage, prediction services, data processing and community interest are reviewed. Special mission requirements such as time biases, drag functions, liberating functions, modes of calibration, accelerated data submissions, and organization of the data flow from the data centers to the mission analysis centers are reviewed for relevance and compliance with ILRS capabilities.

Whenever the normal procedures and formats are inadequate for proper support of a new mission, the MWG tries to work out possible solutions in cooperation with the Mission sponsor and the other Working Groups.

The MWG proposes to the ILRS Governing Board the acceptance or refusal of a new or modified mission, based on the documents submitted by the mission sponsor (including a mission plan and the current workload of the network). Prior to making a recommendation to the Board, the MWG consults with the Network and Engineering, Data Format, and Analysis Working Groups as necessary.

The MWG recommendation includes any changes in the current priority list required to accommodate the new missions

The full charter for the Missions working Group can be found at:

http://ilrs.gsfc.nasa.gov/missions_wg_charter.html

MEMBERSHIP

The members of the Missions Working Group are listed in Table 3.1-1.

Name	E-Mail	GB Member	Position
Hiroo Kunimori	kuni@crl.go.jp	Yes	Coordinator
David Carter	dlcarter@pop900.gsfc.nasa.gov	Yes	Deputy Coordinator
John Degnan	jjd@ltpmail.gsfc.nasa.gov	Yes	GB Appointee
Wolfgang Schluter	schlueter@wettzell.ifag.de	Yes	WG Interface
Scott Wetzel	scott.wetzel@honeywell-tsi.com	No	
Pippo Bianco	bianco@asi.it	No	
Vladimir Vassilvev	lavaser@orc.ru	No	
Ulrich Schreiber	schreiber@wettzell.ifag.de	No	
Julie Horvath	julie.horvath@honeywell-tsi.com	No	

Table 3.1-1. Missions Working Group Membership

ACTIVITIES

Two MWG working group meetings were held in 2000: the first was held in Nice, France during the EGS meetings in April 2000 and the second at the 12th International Workshop on Laser Ranging Instrumentation meetings in Matera, Italy in October 2000.

Reports for the meeting can be found at:

http://ilrs.gsfc.nasa.gov/ilrs_reports.html

WORK IN PROGRESS

The upcoming missions that have requested ILRS support are listed in Table 2.4-1.

The MWG continues to work in the following areas:

- more automated and user friendly Mission Support Request Form;
- Mission Support Plan Template to help satellite hosts in mission planning;
- procedure to periodically (1) review mission requirements and applicability of SLR to meeting these requirements and (2) require satellite owners or key science and technical contacts to justify continued SLR support.
- more systematic was of interleaving satellite passes and pass segments; and
- better trade-off between high-priority satellites and intensive campaigns.

3.2 NETWORK AND ENGINEERING WORKING GROUP

Werner Gurtner, *Astronomical Institute at Berne*

MEMBER LIST

Name	E-Mail	GB Member	
Werner Gurtner	werner.gurtner@aiub.unibe.ch	yes	Coordinator
Graham Appleby	gapp@ite.ac.uk		
David Carter	dlcarter@pop900.gsfc.nasa.gov	yes	
John Degnan	jjd@ltpmail.gsfc.nasa.gov	yes	
Howard Donovan	howard.donovan@honeywell-tsi.com		
Van Husson	van.husson@honeywell-tsi.com		
Georg Kirchner	kirchner@flubpc04.tu-graz.ac.at		Deputy coord.
Rolf König	koenigr@dfd.dlr.de		
Hiroo Kunimori	kuni@crl.go.jp	yes	
John Luck	johnluck@auslig.gov.au	yes	
Mike Pearlman	mpearlman@cfa.harvard.edu	yes	
Ulrich Schreiber	schreiber@wettzell.ifag.de		
Wolfgang Schlüter	schlueter@wettzell.ifag.de	yes	
Fumin Yang	yangfm@center.shao.ac.cn	yes	
Tom Zagwodzki	thomas.w.zagwodzki@gsfc.nasa.gov		

Table 3.2-1. Networks and Engineering Working Group Membership.

WORKING GROUP MEETINGS

In the year 2000 the following two working group meetings were held:

- On April 26 in Nice, France during the XXV General Assembly of the European Geophysical Society
- On November 13 in Matera, Italy during the 12th International Workshop on Laser Ranging

The minutes of the working group meetings can be found on the ILRS web site at:

http://ilrs.gsfc.nasa.gov/networks_activities.html.

ACTIVITIES

In the summer months most of the ILRS laser stations submitted the new station logs to the Central Bureau. Members of the Central Bureau and the Networks and Engineering Working Group started to review the log files for consistency and completeness.

Procedures for Normal Point Data Submissions, taking into account possible backup procedures in case of severe communication problems with the data centers, have been discussed and partially tested during a planned outage of EDC.

The web-based satellite link budget calculations were updated by Stefan Riepl to include all satellites currently in the ILRS tracking list.

A new mail exploder for urgent mails to ILRS station operators has been proposed to the Central Bureau and established at CDDIS.

The requirements for a new prediction exploder have been discussed and proposed to the Central Bureau. The mail exploder should allow for an easier backup, it will remove the necessity for all prediction providers to maintain their own distribution list and it will help the stations to process the predictions automatically.

A small study group was formed to draft criteria for continued station participation and for the acceptance of new stations.

An on-line bibliography with engineering and analysis/scientific references has been established on the web-site by the Central Bureau. Members of the Networks and Engineering Working Group Working Group will support the Central Bureau to generate a “key word” dictionary for review by all Working Groups.

3.3 DATA FORMATS AND PROCEDURES WORKING GROUP

John Luck, *Australian Surveying and Land Information Group*

3.3.1 WORKING GROUP

Membership

Name	E-Mail	Responsibility
John Luck	johnluck@auslig.gov.au	Coordinator
Wolfgang Seemueller	seemueller@dgfi.badw-muenchen.de	Deputy Coordinator
Ron Noomen	ron.noomen@deos.tudelft.nl	GB Appointee
Van Husson	van.husson@honeywell-tsi.com dsgvsh@slral2.honeywell-tsi.com	CB Representative
Randall Ricklefs	rlr@astro.as.utexas.edu	LLR Representative; Leader, Prediction Formats SG (Lynx Team)
Graham Appleby	gapp@mail.nerc-monkswood.ac.uk	
Andrew Sinclair	atsinclair@aol.com	Emeritus
Roger Wood	rw@slrb.rgo.ac.uk	Leader, Rapid Predictions SG (Lion Team)
Roland Schmidt	rschmidt@gfz-potsdam.de	
Jan McGarry	Jan.McGarry@gsfc.nasa.gov	
Peter Shelus	pjs@astro.as.utexas.edu	
Werner Gurtner	werner.gurtner@aiub.unibe.ch	Networks & Engineering WG
Stefan Riepl	riepl@wettzell.ifag.de	Leader, Refraction SG (RSG)
Scott Wetzel	Scott.Wetzel@Honeywell-TSI.com	

Table 3.3.1-1. Data Formats and Procedures Working Group Membership.

Working Group Meetings

Two formal Working Group meetings were held during 2000:

(1) On Tuesday 25 April in Nice, France;

(2) On Thursday 16 November in Matera, Italy.

A summary of activities is given at:

http://ilrs.gsfc.nasa.gov/data_activities2.html

Activities

Reports on the status and activities of Study Groups spawned by this Working Group are given below.

The format for Manoeuvres Notification Procedure was finally agreed at the Matera meeting, with options how to spell that word.

http://ilrs.gsfc.nasa.gov/manoeuver.html.

Not all mission control centers have adopted this format.

The format for the Site Information Logs was agreed at the Nice meeting, and handed over to Networks and Engineering Working Group for implementation which, in collaboration with the Central Bureau, they have done wonderfully well.

Data flows for predictions and normal point files were documented in a diagram at:

http://ilrs.gsfc.nasa.gov/data_flow.html

with an accompanying table of Operations Centres used by each station at:

http://ilrs.nasa.gov.au/np_data_flow.html .

3.3.2 Rapid LEO Predictions Study Group (Lion Team)

Roger Wood, *NERC*

A rapid LEO Prediction Study Group (Lion Team) was organized under the leadership of Roger Wood to recommend and test a means of improving predictions for the LEO satellites.

The Prediction Centres and Data Centres collaborated in generating and disseminating IRVs on a daily basis, and in some cases on a sub-daily basis. In support, the stations were asked to transmit their Normal Point data files as soon as possible after acquisition, which most are now doing within an hour or two. These schemes have become routine, resulting in considerably improved acquisition at the stations. Accordingly, the Lion Team was formally disbanded at the Matera meeting.

3.3.3 Refraction Study Group (RSG)

Stefan Riepl, *BKG*

This Refraction Study Group was formally set up and ratified by the Governing Board at the Nice meeting in April 2000.

Members: S.Riepl, M.Becker, F.K.Brunner, P.Ciddor, P.J.Dunn, R.Eanes, R.Govind, W.Gurtner, R.Haas, T.Herring, J.Luck, V.Mendes, R.Noomen, T.Otsubo, E.Pavlis, J.Rueger, H.J.Yan.

Charter: Considering that the current standard model developed by Marini and Murray for applying atmospheric propagation delay corrections to SLR observations is believed to be uncertain by up to 1cm in the zenith delay term, and considering that it is tuned to particular wavelengths which do not encompass all the wavelengths which might be used in practice:

- Assess the adequacy and accuracy of the Marini and Murray model for SLR at the 1mm level, for all elevations above 15 degrees and all wavelengths from 355 to 1570 nanometers and perhaps beyond.
- If necessary, define a new model and/or set of procedures which will satisfy these requirements, and verify it experimentally.
- Define optimum schemes for the collection and pre-processing of meteorological and any other necessary data to be used as input to the models/procedures, and assess the impact of the absence of any such data which may be difficult or expensive to collect.
- Prepare a formal recommendation to the ILRS, including a standard algorithm and set of recommended practices, for adoption by stations and analysis centres.

Activities: A special mailing list was set up, and a web page created to coordinate RSG activities.

http://www.wettzell.ifag.de/publ/rsg/rsg.html

which contains a bibliography and reports.

The conclusions presented at the Matera meeting were confined to wavelengths less that 1000nm, and included that the maximum error in the Marini and Murray model is 3 cm at 15 degrees elevation at 355nm. The mapping function derived by Gardner performed best of those tested, better than 4mm error at 15 degrees, and 2mm at 20 degrees, against ray-tracing. Future action items are:

- Experimental verification of the new mapping function.
- Modelling of anomalous dispersion for the wavelengths 850, 1064 and 1570nm.
- Inclusion of horizontal gradients.

The comprehensive Matera report prepared by Stefan Riepl is available at:

http://www.wettzell.ifag.de/publ/dfpreport/index.html

Several relevant papers were presented in the "Atmospheric Corrections and Multiwavelength Ranging" session of the 12th International Workshop on Laser Ranging in Matera.

The RSG requested stations able to do so to track to elevations down to 10 degrees, especially on LAGEOS, in order to gather data for testing the models.

3.3.4 Prediction Format Study Group (LYNX Team)

Randy Ricklefs, *University of Texas at Austin*

Initially motivated by the apparent incompatibility of lunar predictions with IRVs, a Prediction Format Study Group, under the leadership of Randall Ricklefs, was commissioned at the Matera meeting to recommend a single laser ranging prediction format to encompass Earth satellites including those in geostationary orbits, lunar retroreflectors, laser transponders on (or orbiting) other solar system bodies, and laser transponders in transit. Additional prediction challenges are presented by transponders, as well as by low earth orbiting satellites. In a sense, this SG carries on where the Lion Team left off.

By the end of 2000, a membership list had been drawn up, a draft charter prepared, and a list of specific problems identified.

3.4 ANALYSIS WORKING GROUP

Ron Noomen, *Delft University of Technology*
Peter Shelus *University of Texas*

INTRODUCTION

The International Laser Ranging Service (ILRS) was established in 1998. Its main tasks are to:

- coordinate the use of Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) instruments;
- coordinate the analyses of the observations obtained by these instruments, and provide for consistent and unambiguous results;
- provide various "standard" solutions as official ILRS combined product; and
- stimulate the use and interpretation of SLR/LLR analysis products and promote the laser ranging community.

In order to achieve these goals, a number of working groups have been formed, the Analysis Working Group (AWG) being one of them. The AWG focuses on the analysis aspects and science products generated from the laser range measurements.

CHARTER

The AWG is an element of the ILRS whose objectives are described in the charter found on the ILRS web page

http://ilrs.gsfc.nasa.gov/analysis_wg_charter.html.

In overview, these objectives are to:

1. provide internal quality control on results produced by slr data analyses;
2. ensure SLR results are compatible with results obtained using other techniques;
3. develop an official and combined ILRS data analysis strategy and analysis product(s);
4. provide feedback to the international network on specific laser system performance;
5. support ILRS in mission planning; and
6. establish and maintain a reference knowledge base for the analysis community.

SLR analyses make important contributions to the global geodetic and geophysical science communities by producing time-series of Earth Orientation Parameters (submitted to the International Earth Rotation Service (IERS)), well referenced station coordinates and their site velocities (included in the models of the International Terrestrial Reference Frame (ITRF), and in the generation of precise orbits and the accompanying improved modeling of the forces acting on SLR tracked satellites.

During the last decade, new satellite tracking techniques like GPS, DORIS, and GLONASS have significantly increased the number of technologies contributing to IERS/ITRF. This has necessitated a better coordination and definition of SLR-derived results. Working groups formed within each technology area are increasingly performing the combination of contributions received from their analysis groups. The goal is improved quality control on the individual contributions and of the resulting science products. This development is also reflected in the new structure of IERS, in which the institutes responsible for the various (operational) products (the so-called Product Centers) and the organizations providing parameter solutions (the Technique Centers) are clearly recognizable as having separate responsibilities. ILRS is one of the Technique Centers.

Satellite laser ranging provides an absolute and unambiguous scale for the determination of origin of a terrestrial reference frame. This strength was utilized in the generation of ITRF2000, which is a most recent implementation of the terrestrial reference frame. In ITRF 2000 the origin of the system is fully defined by the SLR solutions, and SLR and VLBI together define its absolute scale. The ILRS is focused on continuously improving the quality of SLR-derived science products. This includes those that are "unique" (like geocenter and absolute scale), and others where the role of the laser ranging has decreased due to the strength of other techniques. In addition, SLR has a very important role in the computation of high-quality orbits for altimetry and SAR satellites. For all of these applications, high quality observations and rigorous analysis approaches are crucial.

MEMBERS

As of March 31, 2001, the AWG currently consists of 19 members (cf. Table 3.4-1). The size of this group reflects the wide variety of laser targets and satellite missions (e.g. Moon, LEO and MEO satellites) being supported along with the large number of geophysical subjects that are being studied. It also reflects the worldwide distribution of institutes involved in the analysis of laser ranging data. Ron Noomen (DEOS, The Netherlands) is the Analysis Coordinator, and Pete Shelus (McDonald Observatory, Texas, USA) is the Deputy Analysis Coordinator.

ACTIVITIES IN 2000

The year 2000 has been significant for AWG activities. Workshops were held in January 2000 (Frankfurt, Germany), May 2000 (Delft, The Netherlands), November 2000 (Matera, Italy) and March 2001 (Nice, France). During these workshops, various topics were discussed the most important of which have been improved analysis products and formats.

Analysis and science products that can be generated with the laser ranging technique are abundant, but it was decided to initiate the coordination, combination, and quality control efforts addressing the generation of station positions and their motions, and observations of the Earth orientation parameters. In the future, other products (e.g. geocenter, temporal variations in the gravity field, ephemerides, lunar precession and nutation, etc.) may also be included.

When assessing station coordinates, many issues needed to be addressed when comparing results both across the SLR solutions and when applying these results in combination with other technologies. These include: data epoch, station velocity reference, optical centers vs. monuments, eccentricity vectors, site identification, impact of hardware replacements, and like issues with a focus on assuring that all groups are reporting their results within a well understood and consistent framework. When addressing Earth orientation observations, which consist of the x- and y-position of the pole and the UT1-UTC time difference or its derivative Length Of Day (LOD), discussions have been more fundamental. Issues discussed include the length of time to average over when reporting results (e.g. 1, 3 or 5 days). The question of representation of the third component (UT vs. LOD) has kept the AWG busy throughout the year 2000. Hopefully, a final concurrence will be reached at the next workshop in Toulouse, France (September 2001). At this meeting various representations for Earth rotation will be evaluated.

The format for providing science products is a second item that needed a number of meetings to come to a consensus. While the SINEX format has been accepted for this purpose, there are a number of different interpretations about various aspects of the format requiring clarification. The AWG has developed a slightly different description of the SINEX format, which is more explicit in its utilization while not conflicting with the original format. As an example, it has a strictly-defined description of the computation model in the COMMENTS field of the format whereas the original format had no such requirements.

As reported in the 1999 Annual Report, a number of pilot projects were initiated, each of them with the overall goal to improve the quality of SLR/LLR analysis results. These are discussed below:

Pilot project 1: Unification of fast-turnaround analysis results

A number of analysis institutes evaluate the SLR measurements on various satellites on a routine basis. They are summarized in Table 3.4-2. The frequency of these analyses ranges from daily to weekly. The results are distributed in a rather uncoordinated way, i.e. each analysis center produces its own report that is made available to the station and satellite managers and others. These results are offered without comparison to the results obtained by others. This pilot project aims to improve the interpretation of the "quality verdict" in these analysis results. This can be achieved by interpreting time-series of range and/or time biases, instead of producing absolute values. Furthermore, it is a goal that all of the individual analysis results will be merged into a single report, with a unique interpretation of the data problem(s) and their quality. The investigations done so far have clearly indicated that differences in station coordinates play a major role in the sensibly comparing results.

Pilot project 2: computation of station positions and EOPs

This project has so far received the most attention of the analysis community. The project deals with two of the fundamental analysis products of ILRS. In general, its objectives can be summarized as follows:

1. to test the communication between the various Analysis Centers and Data Centers with regard to transfer of solutions, use of and adherence to a data exchange format, meeting deadlines and adherence to the product definition;
2. to stimulate and encourage individual Analysis Centers to improve the quality of their analyses;
3. to explain and minimize the discrepancies between different analysis results obtained by individual Analysis Centers;
4. to develop an operational analysis procedure, including official ILRS products, with maximum quality while meeting time constraints; and
5. to promote the laser technique in general.

This project has seen a very significant development during year 2000. It started with an assessment of the analysis products produced from 28-days of LAGEOS-1 observations. In December 2000 this effort was expanded to encompass all of 1999 including both LAGEOS satellites. This project has also initiated thorough discussions on parameter representation, product format, analysis standards, cross center communication, deadlines, data screening, data weighting, parameter constraining and like issues. To give an idea of the impact of this project, during the most recent workshop (Nice, March 2001), 17 analysts representing 14 different analysis institutes presented results for comparison (Table 3.4-3).

Following the discussion during the Nice workshop, it was decided to add two new elements to this project: SLR data on the Etalon satellites (a request for a 6-month intensive tracking campaign was honored by the ILRS during the same week), and Earth rotation, now also including the time derivatives (which resolved the conflict between UT and LOD). These developments are aimed at improving the quality of the SLR/LLR EOP products. The results of various combinations of observations and parameters will be evaluated during the upcoming Toulouse workshop.

Pilot project 3: orbits

Although proposed and adopted by the AWG, orbital comparisons have largely been set for future efforts. When ongoing, this project will be instrumental in improving and understanding the quality of the individual orbit solutions, and is expected to stimulate improvement of their quality. This is a complex issue owing to the large number of force models needed to compute precise orbits.

Pilot project 4: software benchmarking

The fourth project is aimed at benchmarking the software packages that are in use at the various Analysis Centers. This pilot project will try to reproduce results (orbits, parameters) that are obtained at different institutes, and strive for a thorough understanding of their differences.

The overall intention of this project is to make sure that the various analysis/orbit determination software packages that are in use are free of errors.

OUTLOOK FOR 2001 AND BEYOND

During the year 2001, significant developments of the various pilot projects can be expected. The results seen so far for the first project are quite encouraging, and the "orbits" and "benchmarking" projects are in good starting positions. The second project, in particular, will be the focus of the current analysis activities. The outcome of the various test cases (choice of satellites, EOP parameterization) will set the stage for the next steps of the ILRS to fulfill its objectives.

Name	Institute/Country
Graham Appleby	NERC/United Kingdom
Richard Biancale	GRGS/France
Richard Eanes	CSR/USA
Ramesh Govind	AUSLIG/Australia
Van Husson	HTSI/USA
Rolf Koenig	GFZ/Germany
Hiroo Kunimori	CRL/Japan
Cinzia Luceri	ASI/Italy
Maria Mareyen	BKG/Germany
Vladimir Mitrikas	MCC/Russia
Horst Mueller	DGFI/Germany
Juergen Mueller	IAPG/Germany
Ron Noomen (coord.)	DEOS/Netherlands
Konstantin Nurutdinov	NCL/United Kingdom
Toshi Otsubo	CRL/Japan
Erricos Pavlis	JCET/USA
Bernd Richter	BKG/Germany
Remko Scharroo	DEOS/Netherlands
Pete Shelus (dept. coord.)	CSR/USA
Mark Torrence	NASA/USA
Robert Weber	Univ. Wien/Austria

Table 3.4-1. Analysis Working Group Members (status March 31, 2001).

Institute	Satellite							
	ERS-1 ERS-2	TOPEX/ Poseidon	Stella Starlette	AJISAJ	LAGEOS-1	LAGEOS-2	GPS-35 GPS-36	Etalon-1 Etalon-2
AIUB							X	
AUSLIG					X	X		
CRL			X	X	X	X		X
CERGA		X						
CSR					X	X		
DEOS					X	X		
GSFC		X						
MCC					X	X		
NERC	X			X	X	X		X
Shanghai					X	X		

Table 3.4-2. Overview of fast-turnaround SLR quality control analyses.

Institute	Station coordinates and EOPs	
	Computation	Comparison
ASI	yes	yes
AUSLIG	yes	no
BKG	yes	yes
CRL	yes	no
CSR	yes	yes
DGFI	yes	yes
GRGS	yes	no
GSFC/HTSI	no	yes
IAA	yes	no
JCET	yes	yes
NCL	no	yes
NERC	yes	no

Table 3.4-3. Contributors to the ILRS pilot project "positioning + earth orientation" (AWG Workshop Nice, March 2001).

3.5 SIGNAL PROCESSING *AD HOC* WORKING GROUP

Graham Appleby, *Natural Environmental Research Council*

OUTLINE

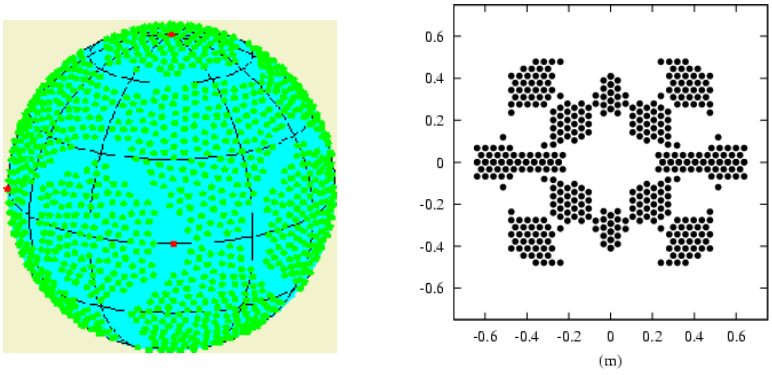
The Signal Processing Working Group (SPWG) continued working during the year on several aspects of its mission, to determine accurate center-of-mass (CoM) corrections that can be used by the global network of disparate SLR systems. Interest in the apparent radial bias between microwave-derived and SLR-derived orbits of the GLONASS and GPS satellites has prompted detailed investigations into retro-array effects for these satellites. Improved modeling of the impulse response functions for the principle spherical satellites LAGEOS, ETALON and AJISAI has been tested against single-photon data from several SPAD-based systems, and modeling for MCP systems is under consideration. It is clear that for LAGEOS the appropriate CoM correction varies from about 240mm for single photon systems up to at least the 'standard' 251mm for MCP systems employing leading-edge, half-maximum detection.

Most of the work has been carried out by Toshimichi Otsubo and Reinhart Neubert, with valuable comments from other members of the Working Group. An informal meeting of the group was held in conjunction with the International Laser Ranging Workshop in Matera in November 2000.

HIGHLIGHTS

a) Through the Missions Working Group, we have gained access to detailed specifications including detail of the mounting, degree of shadowing, etc of the reflector arrays on GLONASS and ETALON, an essential resource for CoM studies that hitherto was not generally available. For these two types of array we have derived from the specifications accurate coordinates and characteristics of each corner cube reflector. The following figure (Figure 3.5-1) show our derivations of the arrangement of the corner cubes on the two satellites. From this information Toshimichi Otsubo has determined accurate response functions, which we are now using to compare with range data. This work continues. All the data will be available on the SPWG Website, at

http://nercslr.nmt.ac.uk/sig/signature.html



ETALON Array GLONASS Array

Figure 3.5-1 Corner cube arrays.

b) Reinhart Neubert has computed from his analytical approach a table of CoM corrections for spherical satellites for a 10mm-precision system working at low return energy. He has also made available a set of useful algorithms related to this work. Links to his results are included in the SPWG website.

c) G. Appleby is looking at the problem of deriving CoM values for C-SPAD systems that work at higher-than-single-photon return levels. Data from Herstmonceux and Graz have been used to illustrate the effect. Modeling work continues.

d) Recommendations to the Networks and Engineering WG were made regarding the content of the Site Logs. We wanted stations to give more details about their working practices (return energy levels, post-processing techniques). These topics have now been added to the site log's list of questions, from which valuable information should be derived.

e) T. Otsubo and G. Appleby presented papers at the EGS in Nice in April 2000 on aspects of the array correction for GLONASS, and the impact on the observed bias between microwave orbits and laser range measurements. A paper by Otsubo *et al* has been accepted for publication in *Surveys in Geophysics*. Nine papers on target related issues were presented by the community in the Target Design, Signature and Biases Session of the 12th International Laser Ranging Workshop held in Matera, Italy in November 2000.

OUTSTANDING PROBLEMS

a) We have no model for the MCP systems; ideally we would use this to provide a check on our procedures, in comparison for example with the lab-measured CoM for LAGEOS.

b) We recommend that a procedure be set up, possibly by the Missions WG, to request from the mission managers all relevant information on cube locations, characteristics, etc. for all current and especially new missions. The Signal Processing Working Group's role would be to specify what is required to be made available to the community.

c) Another related role that we think we should consider taking on is to make sure that algorithms to some set standard be made available to enable an accurate determination of the instantaneous vector from the satellite CoM to the phase centre of the array for all non-spherical satellites**.** Good examples of such algorithms do exist for ERS, TOPEX/POSEIDON and CHAMP, but the set should be completed and made available via the ILRS web pages. This is particularly important for the stream of new missions about to be launched, and should be available prior to launch.