ILRS General Assembly
Grasse, France
September 27, 2007
16:30 – 18:00
Agenda

• Introductory Remarks	W. Gurtner
• Report from ILRS Governing Board Mtg (5 min)	W. Gurtner
• ILRS Status Report (15 Min)	M. Pearlman
• Session Summaries (5 min each/1-2 charts)	
1. Scientific and Analysis challenges for next decade	P.Exertier, C.Luceri
2. Improved data analysis procedures and corrections	E.Pavlis, F.Deleflie
3. Working together: station operations and data analysis groups	M.Torrence, G.Bianco
4. New related "laser ranging" space projects for the future	U.Schreiber, J.Degnan
5. Toward an Higher level of Automation for stations	W. Gurtner. J. McGarry
6. Counter performance and calibrations/Event Timers	G.Appleby, E.Pavlis
7. Kilohertz SLR and more	G.Kirchner, M.Wilkinson
8. Time transfer experiments	J.M.Torre, Y.Fumin
9. New & upgraded stations/collaborations for improving network	F.Pierron, L. Combrinck
10. Laser Reflector Array for Challenging orbits	T.Otsubo, J.Degnan
11. Technological Challenges with Data Format	R. Ricklefs, W. Seemueller

Agenda (continued)

- **Announcements**
  - **Plans for Future Laser Workshops** **M. Pearlman**
- **Discussions**
- **Closing Comments**

- **Rules:**
- **Charts from this session will be posted on the Website**
- **Time limits are firm. Presentations must be concise. Use only a few summary charts. Additional charts may be included on the session report on the website.**
- **Electronic copies of your charts must be given to Mike Pearlman at the time of the meeting**

Session 1 :
scientific and analysis challenges for next decades

Space Geodesy (SLR&LLR) : monitoring the changes that occur on Earth (and planets)

Oceanography : mean sea level rise, orbitography, CAL/VAL activites

Navigation&Positioning : contribution to GNSS, LAGEOS (eop+pos:ITRF), Time Transfer

Geodynamics : CHAMP, GRACE and GOCE missions; SLR contributes to GM, orbitography of LEO (altitude) and to the low degree (and their time variations) gravity field model

Going **from research to operational** : automation, systematic analysis, comparison with geophysical data and models, multi-technique approaches, international cooperation (GGOS, ...)

Session 1 :
scientific achievements for future

ITRF :

motion of the geocenter (SLR), and loading effects (VanDam) : data analysis NEED geophysical (e.g. GPS+OBP) models (and inversely)

scale factor: analysis of SLR and VLBI data. Now, 0.5ppb are explained but we still need to carefully investigate other error sources

Network : next generation of networks, better use of co-location (SLR&VLBI: 7) sites, for improved TRF parameters; we need scenario (simulations) for study the consequences of potential improvements and degradation

Celestial mechanics : importance of LLR data to improve solar system ephemeris; we need improved data quality and quantity (a better network?)

Fundamental physics : space geodesy and laser ranging to Lageos satellites and to the Moon are unique opportunity to measure phenomena relative to GRelativity; in addition to dedicated mission seach MicroSCOPE (2011)

Improved Data Analysis Procedures and Corrections

Session 2 Summary

Erricos C. Pavlis & Florent Deleflie

Contributions to Session 2

1. The temporary ILRS reference frame: SLRF2005
2. The site range biases of the worldwide SLR network
3. About one way to the exception of the systematic measurements errors in the processing of the biases SLR data
4. GRGS Team SLR Bias Data Base
5. Evaluating the effect of atmospheric gravity and annual gravity field variation on Lageos orbits
6. The Potential of Starlette and Ajisai for Station Positioning
7. Some ideas about the extension of the ILRS products in the near future

Session 3: Working together: station operations and data analysis groups

- Need for better inter- and intra-group communication
- Work to remove ambiguities between the various data quality assessments
- Move toward developing a comprehensive consolidated analysis report
- Recommendation: The Network and Engineering WG, the Analysis WG, and the Formats and Procedures WG form a task force to prepare, define, and install concrete procedures and processes

ILRS Workshop, Grasse

Transponder Session

Items identified

- Both optical communications and optical ranging are essential parts of current proposals such as the „Cosmic Vision“ program of ESA

- Optical altimetry has become very fashionable in interplanetray exploration due to the success of Mola (MLA, BELA, LOLA, ...)
- T2L2 also adds to the variety of advanced SLR applications

Action Items

- First real transponder applications are emerging (LRO)
- Missions of higher complexity are certainly coming
- Testbed operations are under way. Feedback from these are expected to go into future proposals

Automation Session

Full automation: all necessary functions controlled by computer (Gurtner).

1- Power-up, shut-down (laser, dome, computers, etc).

2- Security, safety, and emergency situation handling:
- external safety (A/C, human entering system),
- system safety monitoring and emergency handling.

3- Weather:
- information for data processing,
- precipitation and wind for system safety (for open domes),
- cloud sensor (to optimize ranging attempts) - if desired.

4- Ranging operations:
- Scheduling, target selection, and searching

* - Good star calibration and/or nearby star for pointing correction and/or use of satellite tracking data to update mount model (Ricklefs):
  + predictions are now good enough that major error source to pointing is now mount model

* - Signal processing (Wilkinson):
  + critical for single photon systems
  + useful even in manned operations

* - Bias calculation and application (McGarry):
  + important for real-time tracking and for target re-acq.

5- Post processing.

Automation Session (cont)

Issues:

- Distributed processing which is being used in most of the systems today doing automation makes remote control and monitoring of the system easy but adds multitude of IT security headaches (Moore).

- In US at least, to operate unmanned, must be eye-safe. Prevents ranging to HEOs unmanned. Semi-autonomous may be best we can do.

Automation examples:

➢ Zimmerwald operates several hours per day fully automated.

➢ Mt. Stromlo has operated completely autonomous (unmanned) for periods during 2007.

➢ SLR2000 has many of the automation features but hasn't yet put it all together.

➢ Herstmonceux's automation features are to support the operator.

Session 6: Counter performance and calibration and upcoming event timers

Session Summary

• Laser ranging is inherently a linear process - in *principle* same precision to MOON as to GRACE;
- But, need linearity in time-of-flight counters/event timers to realise this.

- Reports from examinations of the performance of currently deployed event time/time-of-flight hardware (Stanfords) within the ILRS network;
    - finding errors in some existing counters equivalent to <=10mm range
    - *estimated* similar errors in other stations whose counters not measured
    - For TRF work 1976-date, AWG will apply only the measured corrections
- Stations encouraged urgently to examine linearity of their counters (Stanfords, HP, etc.)

Session Summary (2)

- Developments in the form of newly available and upcoming event timers;
  - Impressive performances of from a few ps up to sub-ps, including novel designs
- New calibration procedures;
  - impossible to overstate the value of accurate calibration
- Stressed importance of bringing together the existing estimates of CoM corrections, primarily for LAGEOS;
  - The ideal is an unambiguous table of values for each station/NP;
  - Task force with short report time formed to progress a solution

Grasse 2007: kHz Session Summary

Grasse 2007: kHz Session Summary

Increasing Number of Stations upgrading to kHz:

➢ Graz	2 kHz	Operational since 4 years
➢ NSGF	2 kHz	Operational
➢ Potsdam	2 kHz	Software in development
➢ Zimmerwald	0.1 kHz	Laser ordered, Software in progress
➢ SLR 2000	2 kHz	Tracking demonstrated
➢ TIGO	0.1 kHz	2-Color, operational
➢ SOS-W	1 kHz	2-Color; expected in mid 2008
➢ Metsahovi	2 kHz	Laser installed; needs telescope etc
➢ Matera	? kHz	Applying for money
➢ China	2 kHz	Up to 5 Stations planned
➢ FTLRS	0.1 kHz	Planned
➢ ???		

Grasse 2007: kHz Session Summary

It is clear that upgrading to kHz SLR has become easier now that a choice of lasers, range gate generators and event timers have been developed and are available.

Also we are gaining experience in using a number of operating systems, e.g. DOS, UNIX and Windows with LabView

Eyesafe operation and two colour SLR is possible at kHz

Grasse 2007: kHz Session Summary

The potential of kHz SLR for other applications was demonstrated in the session.

Atmospheric seeing using kHz SLR provides more information on a limiting factor in the SLR technique

kHz SLR is an effective and unexpected way of determining satellite spin rate, spin direction and axis.

Grasse 2007: kHz Session Summary

We recommend...

Stations moving kHz consider carefully the options they have in terms of hardware and software. Particularly to look at new developments.

Stations look at the experience of other stations in their progress and operation with kHz.

As with current studies in Potsdam (and previously in Herstmonceux) stations can request real kHz data to test their software during development.

Time Transfer Experiments

- Chinese Laser Time Transfer (LTT)
- French Time Transfer by Laser Link (T2L2)

Time Transfer Experiments

- Time Tranfer Validation
- Time Frequency Metrology:
  - Time scales constitution
  - Calibration of other comparison experiments
- Fundamental physics:
  - Experiments needs precise knowledge of time
- Space Navigation:
  - One way laser telemetry

New and upgraded stations/collaborations for improving network session conclusions

Chairs: Francis Pierron (OCA), Ludwig Combrinck (HartRAO)

- Four presentations from four countries, all presenting new developments or upgrades, all incorporate collaboration within the ILRS components
- Progress range from preliminary steps to capability demonstration and completed systems
- Challenges and issues remain
- Conclusion: Continued high level maintenance and development of instrumentation and network renewal (geometrically and instrumentally) continues within the ILRS and is driven by station and mission requirements as well as research priorities; inter-station collaboration plays a major role in successful ventures

Session 10:

Laser Reflector Array for Challenging Orbits

Chairs: Toshimichi Otsubo

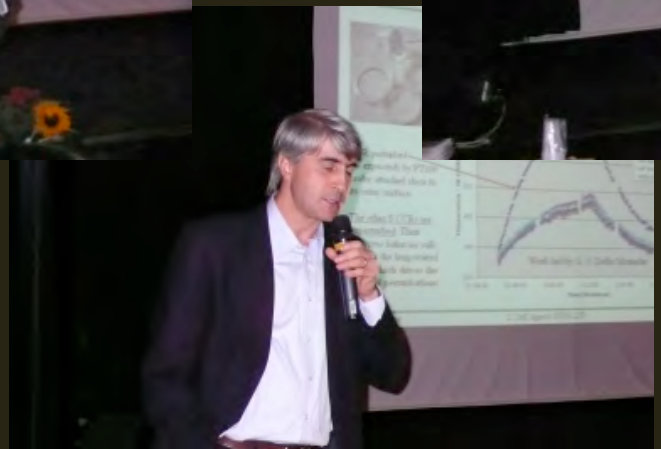
& John J Degnan





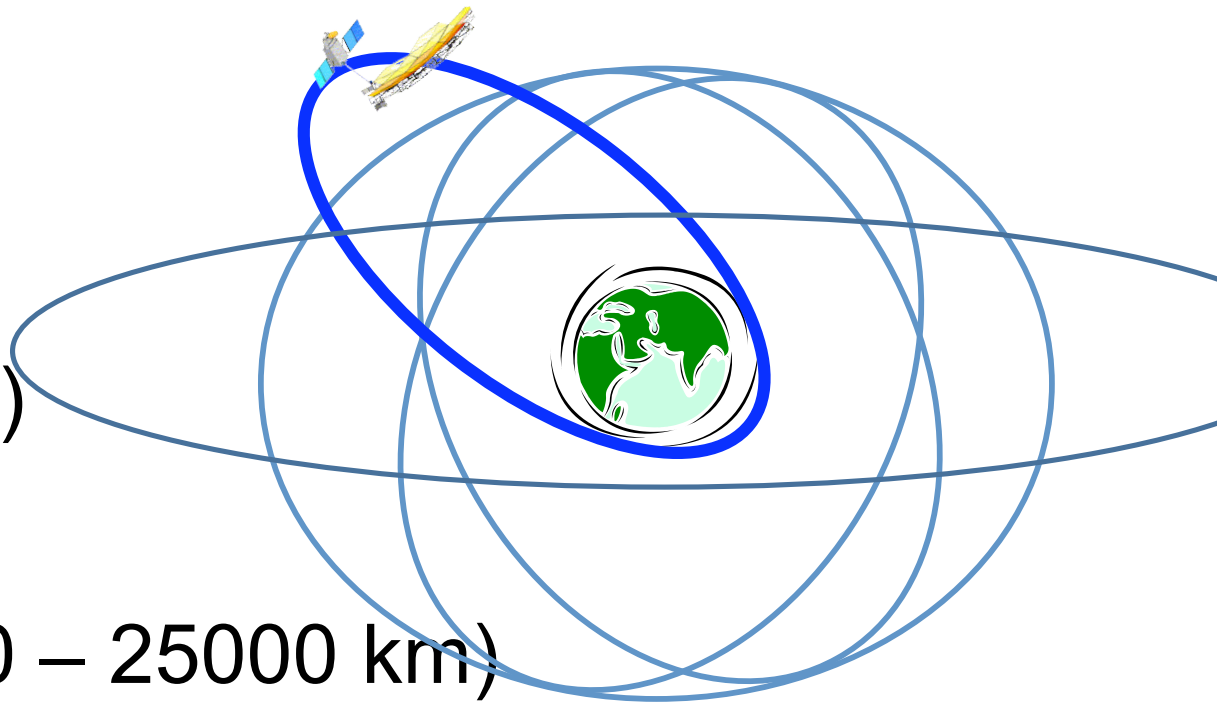







More targets in ‘Challenging’ Orbits!

- Around 20000 km
  - GPS Series III
  - Compass M1
- Geostationary
  - ETS-VIII
  - (QZS, Compass)
- Highly elliptic
  - ASTRO-G (1000 – 25000 km)



Long Distance, Large LRA?

- Size of array
  - Should be LARGE to get strong returns
  - Should be SMALL to reduce signature effects (& reduce the satellite weight)
- Choice of Retros
  - Prism (Coated / Uncoated) / Hollow
  - Size
  - Dihedral Angle
  - (More…)
- Measurement
  - Ranging to Compass & ETS-VIII very successful
  - SCF-Test (LNF): Useful for existing & future targets
  - Polarisation: 1-mm effect, detectable(?)

GPS
32 Retros,
24cm x 20cm

ETS-VIII
36 Retros,
30cm x 26cm

Session 11: Technological Challenges with Data Formats - 1

- Consolidated Prediction Format (CPF):
  - SLR: prediction errors seems to be minimal
  - LLR: in use at MLRS
  - Transponders: LRO predictions are reaching maturity, with great test results

Session 11: Technological Challenges with Data Formats - 2

- Consolidate laser Ranging Data format CRD)
  - Format is virtually complete
  - Pilot implementations are taking very different directions at 2 sites
  - CRD test data analysis shows little accuracy difference from old format
  - Parallel tests to start by end of year