

# ILRS Governing Board Meeting



November 04, 2018  
17:00-19:00  
Canberra, Australia

## Agenda

- Opening Remarks M. Pearlman 5 min
- Summary of 2018 Governing Board Election C. Noll 5 min
- ILRS Governing Board Election Process C. Noll 15 min
- ILRS Report/ILRS Status and Current Topics M. Pearlman 20 min
- Standing Committee/Study Group/Board Briefs 5 min/each  
*Recent progress, important issues, summary of/plans for splinter meetings*
  - Analysis SC (+QCB) E. Pavlis/C. Luceri
  - Missions SC T. Otsubo
  - Data Formats and Procedures SC C. Schwatke/R. Ricklefs
  - Networks and Engineering SC M. Wilkinson/G. Kirchner
  - Transponder SC U. Schreiber/J. Degnan
  - Space Debris Study Group G. Kirchner
- GGOS Activities M. Pearlman 5 min
- DOI Discussion T. Otsubo 5 min
- Other Business M. Pearlman 10 min



# ILRS Governing Board Election Process

Carey Noll  
Michael Pearlman  
ILRS Central Bureau

21<sup>st</sup> International Workshop on Laser Ranging  
November 04, 2018  
Canberra, Australia

## Outline

- Election results
- Current process
- Recommendations
- Questions

# Governing board: 2018-2020



- Ex-officio/appointed positions:
  - Director of the Central Bureau – **Mike Pearlman**
  - Secretary of the Central Bureau – **Carey Noll**
  - Representative of IAG Commission 1 – **Urs Hugentobler**
  - IERS Representative – **Daniela Thaller**
- Elected positions:
  - EUROLAS Network Representatives – **Pippo Bianco, Georg Kirchner**
  - NASA Network Representatives – **Jan McGarry, Stephen Merkowitz**
  - WPLTN Representatives – **James Bennett, Zhang Zhongping**
  - Data Center Representative – **Christian Schwatke**
  - LLR Representative – **Jean-Marie Torre**
  - Analysis Representatives – **Cinzia Luceri, Erricos Pavlis**
  - At-Large Representatives – **Toshi Otsubo, Matt Wilkinson**
- Two additional members to be appointed by the Governing Board

# Elections: from ILRS Terms of Reference



- Call for Nominations and GB Elections conducted bi-annually by the Central Bureau using official email lists
- Board members serve two-year terms starting on January 1
- For lunar, data center and analysis representatives:
  - GB nominees must be associated with that ILRS component
  - Only ILRS associates officially participating in that component, as determined by the official email lists maintained by the CB, may participate in the election of their representatives
- Full ILRS membership can nominate and vote for At-Large representatives
- Election is by majority of votes received
- GB elects Chairperson from among its members for term of two years, renewable for one additional term (total of 4 years)

# Election process: 2018



1. Call for ILRS associates review of organization's membership ← June 2018
2. Call for appointed and network representatives: ← June 2018
  - Appointed: IERS (1), IAG Commission 1 (1)
  - Networks (conduct their own elections): NASA (2), WPLTN (2), EuroLAS (2)
3. Conduct elections for other positions: ← July/August 2018
  - Representatives for Lunar (1), Data Center (1), Analysis (2)
  - Nominations and voting limited to ILRS associates within these communities
4. Conduct elections for At-Large Representatives (2): ← September 2018
  - Voting on these positions from all ILRS associates
5. Following appointment/election of above 16 members: ← November 2018
  - Call for nominations for GB chairperson
  - Elect chairperson (at GB meeting)
  - Call for nominations of GB appointed members (2)
  - Conduct election of GB appointed members

# Election process: improvements



- Institute a more formal process, utilizing process similar to IGS, IDS
- Appoint election committee (chair+2)
- Start election process 6 months (minimum) prior to workshop and establish a clear schedule
- Conduct elections by "category" (lunar, analysis, data center, at-large)
- For each received nomination:
  - Confirm nomination with nominee
  - Request CV + statement from nominee
- Distribute (and then count) ballots through email from election committee
- Communicate results to nominees/elected/community
- CB can continue assist in election process

# Questions?





# ILRS Central Bureau Report

Michael Pearlman  
Carey Noll  
ILRS Central Bureau

ILRS Governing Board Meeting  
November 04, 2018  
Canberra, Australia

## Outline

- Infrastructure updates
- Network updates and station evaluation
- Mission updates, tracking campaigns, and mission support
- Issues and actions

# Recent developments



- Data analysis:
  - Improved procedures for evaluating station performance
    - Investigating error sources (e.g. satellite center of mass corrections)
    - Monitoring station by station biases over long periods of time using orbital solutions
  - Online tools for data examination by stations and analysts
- Infrastructure
  - New CRD and CPF formats
    - Increases transfer of information
    - Support for future missions and applications (e.g., ELT, space debris)
  - Web-based station site logs
    - Web procedures (web-based) for submitting/updating station site logs
    - More information on station configuration/status
  - Data screening/QC
    - More thorough QC procedures on incoming data
    - Harmonized process between EDC and NASA OCs
    - Better aligns QC parameters with the CRD V2 format

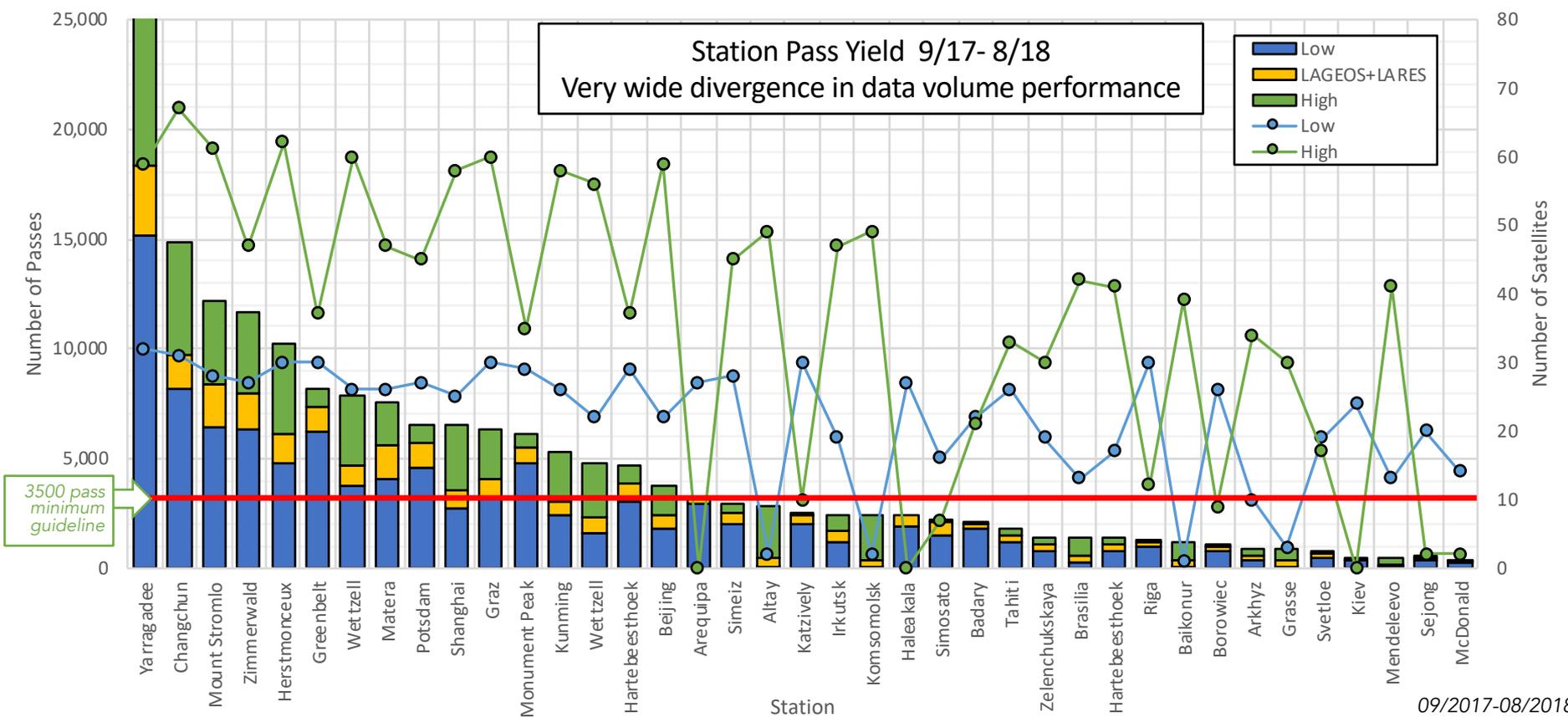
# Other recent developments



- Workshop proceedings websites
  - 2017 Technical Workshop in Riga:
    - Complete with links to abstracts, presentations, posters, and papers
    - Received papers for only 40% of presentations
  - 21<sup>st</sup> International Workshop on Laser Ranging in Canberra
    - Initial website created
    - Will link to PDFs of abstracts, presentations, posters, and papers as received
- Routine submission of all full-rate data to OCs and DCs for validation of procedures and operational issues; 32 out of 39 stations have complied with request
- Request to stations to incorporate additional resolution to their epoch recording precision of their data; little action
- NASA event timer installation required development of new procedures for special data evaluation of new system's configuration while data from operational configuration continues to flow;



# Station performance: passes

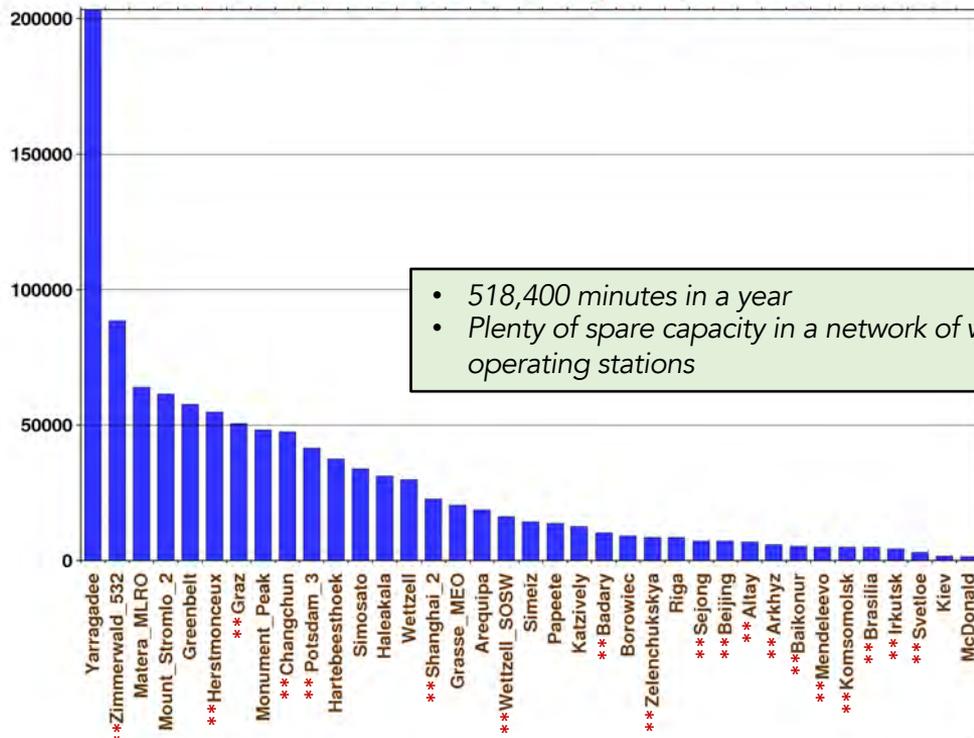


09/2017-08/2018

# Network performance (2 of 2)



Total Minutes of Data  
September 01, 2016 through August 31, 2017



- 518,400 minutes in a year
- Plenty of spare capacity in a network of well operating stations

From ILRS monthly report card; \*\* indicates high-repetition rate station

20170913

- Campaigns

- 2018 LARGE campaigns:

- First campaign: February 15 – May 15, 2018
- Second campaign: August 01 – October 31, 2018

*Designed to obtain improved temporal and spatial coverage by concentrating tracking on a subset of satellites from each of the GNSS constellations, GLONASS, Galileo, and Beidou/Compass.*

- Planned Etalon campaign:

- February-April 2019
- Possible dedicated campaigns to improve tracking on new missions

*Evaluate increase role of Etalon data in computation of ILRS products contributing to the ITRF.*

- Restricted tracking:

- Sentinel-3
- ICESat-2
- Others

*Developing mission-specific procedures for restricting SLR tracking of vulnerable satellites takes considerable time, coordination, and interaction between CB, mission, and stations.*



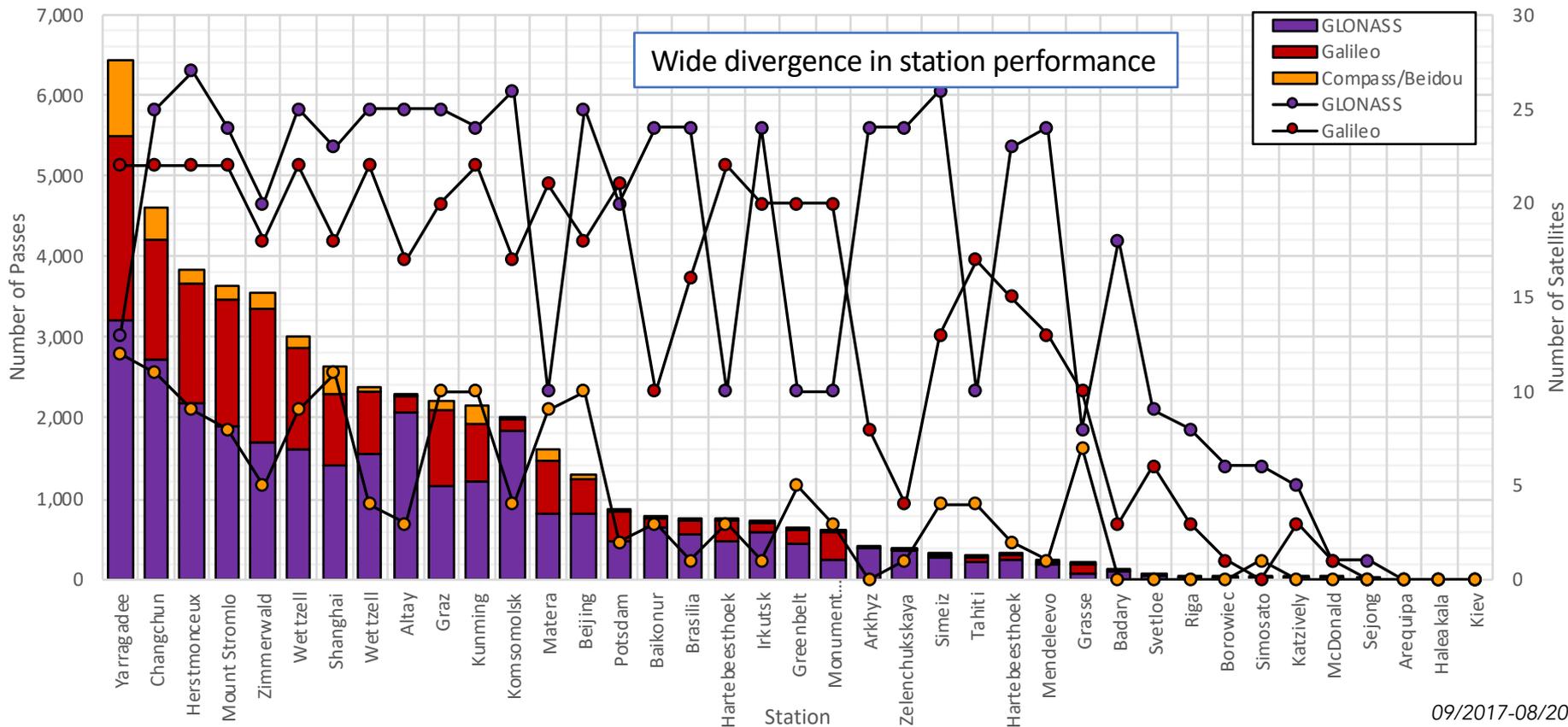
## Situation:

- ILRS sets priorities to balance requests and maximize the utility of the network
- List of satellites on ILRS tracking roster continues to grow
  - Network routinely tracked 100+ satellites in 2018 (too many)
  - Approved MSRs for 8 new missions thus far in 2018
- More requests for restricted tracking; significant preparation required
- Last minute requests for tracking support

## Activity:

- More discriminating about selection of new satellites to track
  - Developed guidelines for improved mission acceptance
- Avoid carrying satellites beyond their need by users
- Require missions to provide sufficient advance notice and MSRF
- Some changes to mission support requests

# Station performance: GNSS



09/2017-08/2018

- Conflicting Requests:
  - Concentrated tracking on a few satellites
  - A little data on everything
- LARGE campaign 1 (February 15-May 15) and 2 (August 01-October 31) trying different mixes of the two requirements
- Likely solution:
  - Constellations may select 4 – 8 satellites for high GNSS tracking with 3 segments of tracking requested per pass; change selections at agreed intervals
  - Some number of additional GNSS satellites in each constellation remain on the ILRS tracking list at lower priority, tracked non-interference basis with other requirements
- Discussions underway with the IGS and the ICG

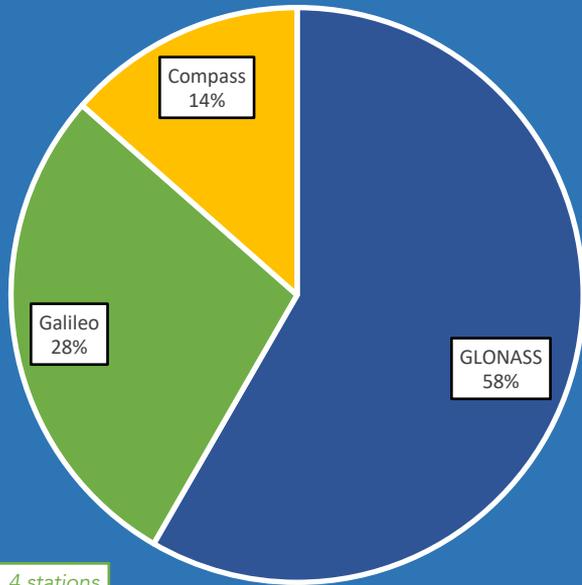
*Beidou laser retroreflector array  
(31.6 x 28 cm, planar, hexagonal array; 2.5 kg)  
(Chinese Academy of Sciences)*



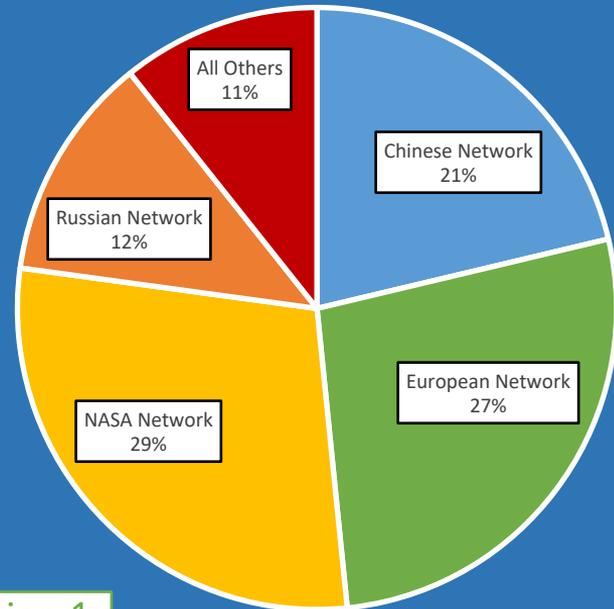
# Tracking by network and constellation



Station Tracking Totals by Constellation  
(passes)



Tracking Totals by Network  
(Passes)



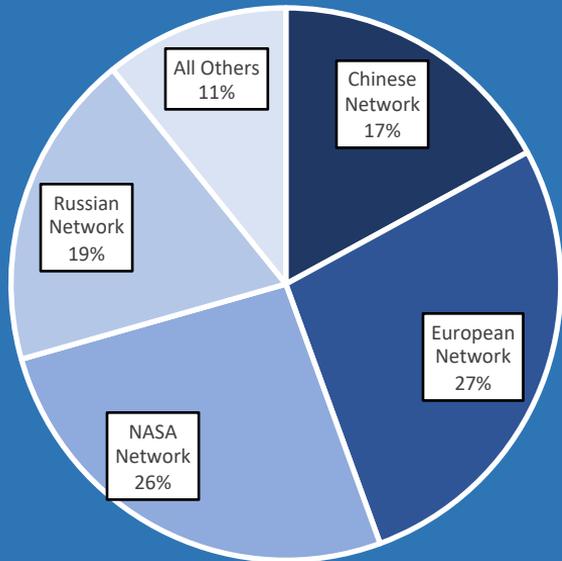
Chinese network: 4 stations  
EUROLAS network: 13 stations  
NASA network: 8 stations  
Russian network: 9 stations  
Other stations: 2 stations

LARGE 2018 campaign 1  
February-May 2018

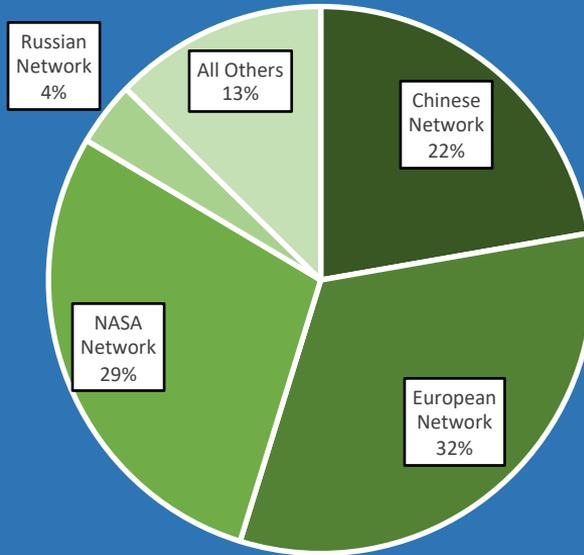
# Tracking by network and constellation



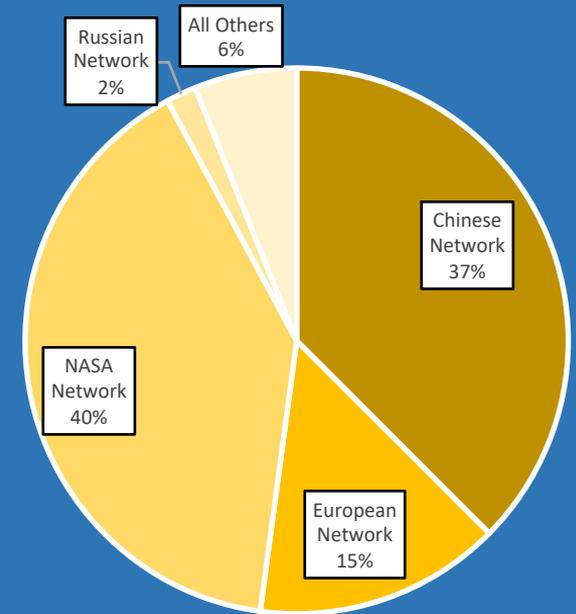
GLONASS Tracking Totals by Network (passes)



Galileo Tracking Totals by Network (passes)



Beidou/Compass Tracking Totals by Network (passes)



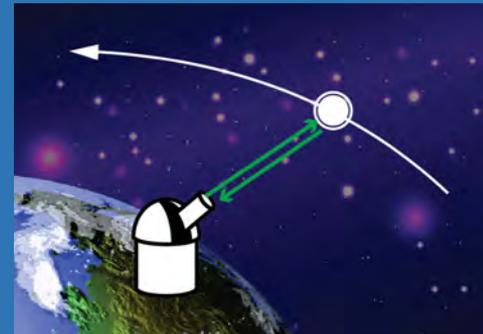
Chinese network: 4 stations  
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LARGE 2018 campaign 1  
 February-May 2018

# Issues & challenges



- Many geographic gaps, primarily in Latin America, Africa, and Oceania
- Mix of new and old technologies and levels of financial support
- Lack of standardization in system hardware and operations
- Local limitations: weather, personnel, budget, etc.



# Items for Special Attention



- Data biases
  - Station Systematics modeling (Erricos)
  - Incorporate modeling effects that we know
    - Satellite C/M modeling in process by Jose Rodrigues;
    - Atmospheric loading; other loading, etc.
- Number of target satellites continues to increase as new missions use SLR for orbit determination and other applications (100+ satellites)
  - More effective tracking strategies?
  - More selective on accepting new targets
  - Periodic community surveys to understand user requirements

# Items for Special Attention -2



- Understand why stations have poor performance; do we keep the poor stations in our operational network?
- Resolve station lack of compliance with the CRD data format and timing of data flow (even after having been informed many times);
- Need to better understand procedures at some of the stations;
  - Calibration, data screening, etc.
- Come to closure on the GNSS tracking strategy;



# ILRS ASC & QCB Activities

Erricos C. Pavlis and Cinzia Luceri

ILRS Analysis Coordinators

ILRS Governing Board Meeting

Mt. Stromlo, Canberra, Australia,

November 4, 2018

- New operational approach to handling error sources in our current modeling standards progressing. In summary:
  - Allowance for estimation of systematic errors simultaneously with all other parameters to eliminate the biases in station positions
  - Correction of the identified serious shortcomings in the current model for the target signature (also known as “CoM correction”) for certain types of ground systems. Correction of such errors can affect the SLR-VLBI scale difference at the 0.25 ppb level.
  - We will adopt the new CoM model now under development
  - We will do a complete reanalysis from 1983 that will provide ITRF2014-based “pos+eop” and orbital products for a seamless backwards-compatible set of operational products

## UAW recommendations for ILRS:

- Add LARES to the LAGEOS/LAGEOS-2 and Etalon series
- Add estimation/handling of station Range Biases
  - This is already agreed and implemented in special products
- Use updated CoM offsets (target signature corrections)
  - A preliminary model should be available by now(?)
- Add estimation/handling of Time Biases
  - Time biases are now modeled based on T2L2 results (to end of 2016, more for 2017 are expected by the end of the year?)
- Include applied  $R_B$  &  $T_B$  in SINEX file for next contribution to ITRF with their constraint information
  - The SINEX will contain the  $R_B$  &  $T_B$  values applied to each station and period

- PP for systematic error estimation will move to the next phase:
  - Reanalyzing of the data since 1993 will deliver starting error estimates to be adopted in the analysis of current/future data
- Preparations for the development of ITRF2020 are ongoing
- PP for low-degree harmonic estimation and the incorporation of LARES in the operational data product is next in line
- Finally, PP for observational-level modeling of loading corrections for stations and corresponding gravitational corrections in orbit (operational product) [ summer 2019 ??? ]

- The Quality Control Board (QCB) addresses laser ranging data quality issues via monthly telecons:
  - Data QC website with the results of current providers in SLRF2014 (3);
  - Web-based performance tools based on the inputs from the Station Report Card (Quarterly & Monthly) online
  - Online Engineering Forum Tool
  - Examining NP consistency vs FR data, methods employed by stations to form their NPs, etc.
- Updates to site log format complete, added information about station configuration and operation, site surveys, etc.
- Examining new strategies to “rate” station performance underscoring value to the users and science products
  - New online graphics site soon to be released



# Missions SC Meeting

John Curtin School of Medical Research, Canberra  
5.30 pm, 6 Nov 2018

Toshimichi Otsubo  
and  
Scott Wetzel



# Missions SC Meeting 2018 Agenda



**(1) Opening/Welcome**

**(2) Membership**

**(3) New ILRS website layout for GNSS LRAs**

**(4) MSC+NESC collaboration in ILRS NESC Forum**

**(5) Ongoing/Future Missions (5 min each)**

- ICESat-2 (Hoffman)

- Tiangong-2 (Zhang)

- GRACE-FO, QZS, RANGE, ELT, LightSail, S-NET, GPS-III and BLITS-M  
(presented in Session 3 & 6)

- Others (?)

**(6) New scheme for future mission approvals (discussion; with CB)**

**(7) Other issues?**

**(8) Closure**

# Data Formats and Procedures Standing Committee Status Report

Christian Schwatke<sup>1</sup>, Randy Ricklefs<sup>2</sup>

<sup>1</sup> *Deutsches Geodätisches Forschungsinstitut / Technische Universität München (DGFI-TUM)*

<sup>2</sup> *University of Texas / Center for Space Research (UT/CSR)*

*Canberra, Australia | 04 November 2018 | Governing Board Meeting,  
21st International Workshop on Laser Ranging*

# CRD and CPF (Version 2) - Current Status



*Recruited 4 - 5 stations, 1 prediction provider, and the ILRS ASC to perform pilot tests of the formats*

**June 2018** - New “v2” directories set up on CDDIS and EDC

**July 2018** - Released CPF v2 manual, sample code, and test data on CDDIS web site

*Three of the pilot stations reporting saw no problems integrating and testing CPF v2*

**September 2018** - Released CRD v2 manual, sample code, and test data on CDDIS web site  
- EDC-website provides an online tool for checking data with respect to the new CRD v2 and CPF v2 format

**October 2018** - MLRS analysis code incorporates CRD v2 code.

# CRD and CPF (Version 2) - Implementation Schedule



- December 2018** - One or two stations should be able to produce v2 CRD
- January 2019** - OCs, DCs should be able to handle v2 CPFs and CRDs
  - At least one prediction provider should be producing v2 CPFs
  - Some analysts should be able to process v2 CRD files
- December 2019** - Almost all stations should be able to use v2 CPFs  
(required for those tracking ELT)
- January 2020** - All prediction providers should be producing v2 CPFs
  - All analysts should be able to process v2 CRD files
- June 2020** - Almost all stations should be producing v2 CRDs

# Updated Site Log Procedure

- until August 2018** • Development of the new site log format (version 2)
- September 2018** • New site log format has been released
  - 18 fields were updated // 100 fields were added
  - Latest site logs have been converted
- October 2018** • “Site Log Manager” at the EDC-website has been released
- January 2019** • Review and updated of site logs by the stations  
*(Internal review and release of site logs in case of small format errors)*  
 → Also a task for the clinic session
- February 2019** • Switch to the operational review process by the ILRS CB

# Other ...

## **Station History Logs**

- Websites has been updated with respect to the updated user management
- Smaller software bugs have been fixed
- Status is fully operational
- 24 station history logs of 44 active stations are available

## **Software Study Group**

- Matt Wilkinson is about ready to release the normal points software
- Software has been tested with Herstmonceux data
- Request to other stations to test the software with their data as well

# DFPSC-Meeting



Wednesday, November 07, 2018, 17:00 – 18:30  
Seminar Room 1 at the JCSMR

## Agenda

- |  |   |
|--|---|
| 1. Introduction                                | <i>C. Schwatke</i>                            |
| 2. New CRD Format                              | <i>R. Ricklefs</i>                            |
| 3. New CPF Format                              | <i>R. Ricklefs</i>                            |
| 4. Implementation Plan for CPF and CRD Formats | <i>R. Ricklefs, K. Stevenson, C. Schwatke</i> |
| 5. Quality Assessment (CRD)                    | <i>K. Stevenson, C. Schwatke</i>              |
| 6. Station Logs                                | <i>C. Schwatke, R. Ricklefs</i>               |
| 7. Report of Study Group on Software           | <i>R. Ricklefs</i>                            |
| 8. Other Business                              | <i>All</i>                                    |
| 9. Next Meeting                                | <i>All</i>                                    |



# Networks and Engineering Standing Committee

Matthew Wilkinson, Georg Kirchner

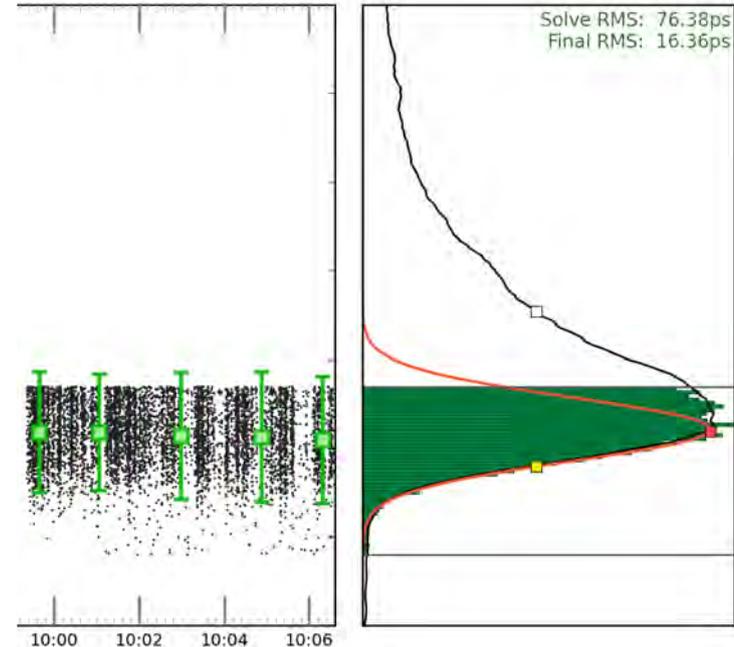
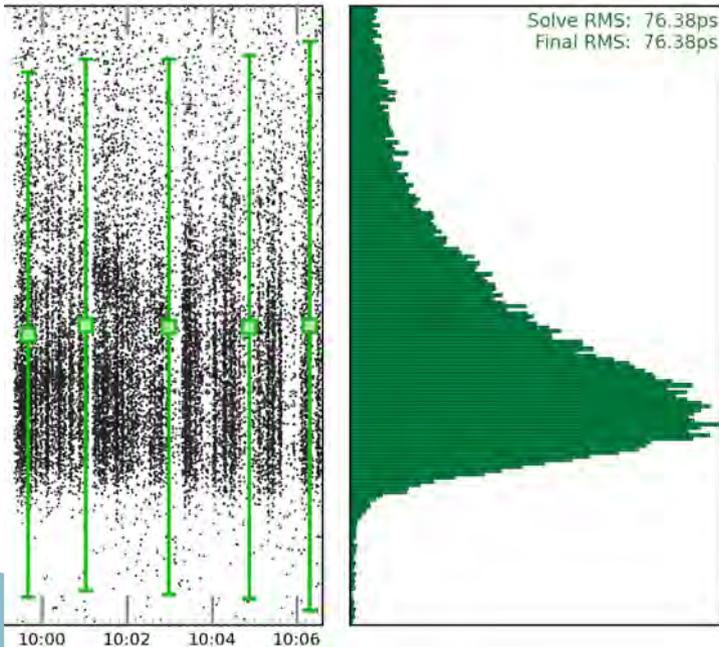
International Workshop on Laser Ranging  
Canberra, Australia 2018

# Agenda

- Preview of the QC tests for submitting CRD data to the ILRS Data Centres - *Katherine Stevenson*
- A discussion on how a normal point is formed
  - Is the current normal point method the only acceptable way to produce valid normal points?
  - Should stations be allowed to develop and implement alternative methods?
  - How should this be managed?
- A discussion on what to include as full-rate data?
  - Who is the user?
  - Should the full-rate data file only contain the ranges that went in to forming the normal point?
  - Should the full-rate data contain ALL ranges from the satellite?
- Update on the NESC online Forum

# Normal Point

- How a normal point is formed
  - Is the current normal point method the only acceptable way to produce valid normal points?
  - Should stations be allowed to develop and implement alternative methods?
  - How should this be managed?



## What to include as full rate data?

- Who is the user?
- Should the full-rate data file only contain the ranges that went in to forming the normal point?
  - Preserves link with normal point file
  - Vast majority of ranges are SLR returns
  - Could have scientific value?
- Should the full-rate data contain ALL ranges from the satellite?
  - Data available for other studies such as retro reflector modelling
  - Data can be re-processed in different ways if desired
  - May contain more noise and other non-SLR returns

# Space Debris Study Group / SDSG

## Canberra, Nov. 2018

Several SLR Stations are tracking SD actively / routinely:

- Borowiec, San Fernando, Graz, Wettzell, Stromlo (?) ...
- Several Chinese SLR stations
- Stations planning to install an additional SD laser: Matera, Yebes, ESA SLR (Teneriffe)

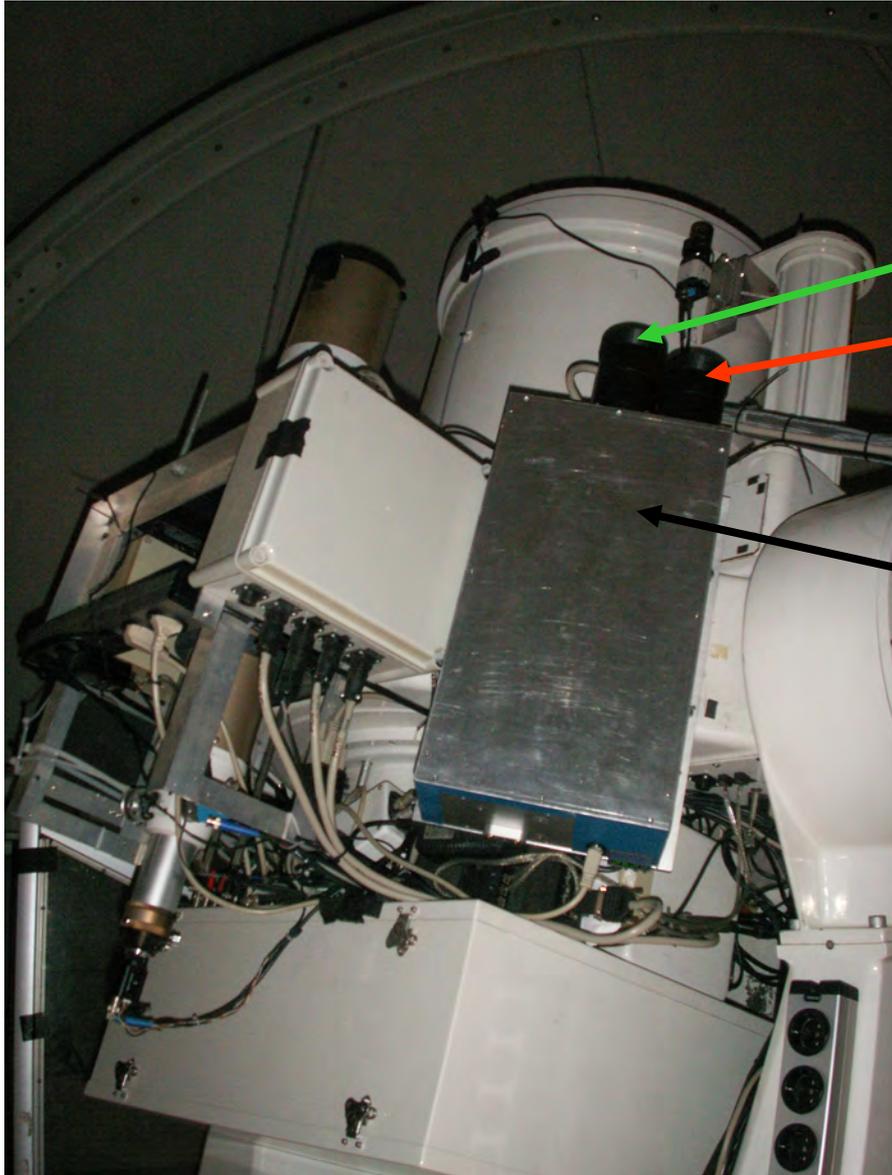
Bistatic Ranging to SD has been extended successfully to Graz – Potsdam

The Graz Debris Server is extensively used for all debris data exchange & storage issues: CPFs, NPs, FR, LCs ...

More SLR stations are planning to install Single-Photon Counters for Light Curve recording (simultaneously with SLR)

Time Transfer via Laser Ranging to Space Debris Targets scheduled

# Graz has installed the SD laser head on the mount / telescope



2018: New Debris Laser in Graz (Innolas)

- 200 Hz / 3 ns / 2 wavelengths:

- 532 nm: 80 mJ / 16 W; or

- 1064 nm / 160 mJ (32 W)

- Temperature Stabilized Housing

- Water Cooled Laser Head

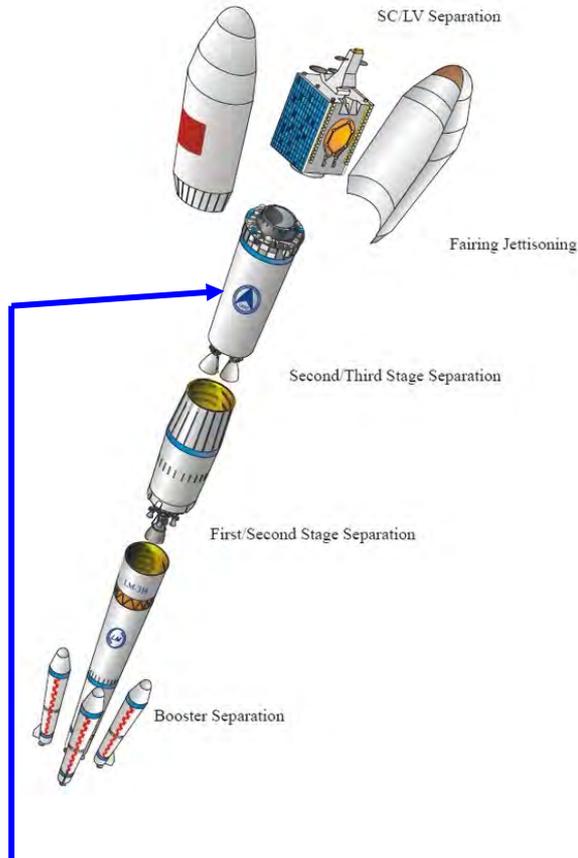
- Mounted on Graz telescope:

- No Coudé Path needed

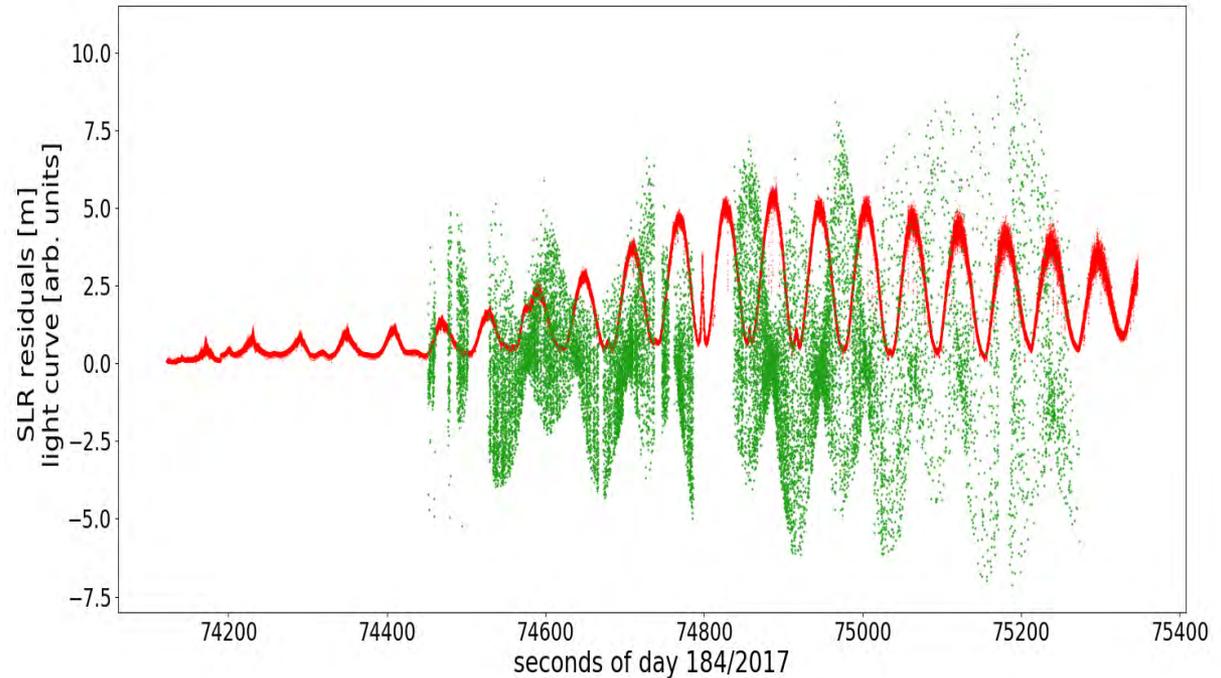
- Fixed alignment

- Used now for routine SD tracking

# Simultaneous SLR + LC analysis offers new details ...



CZ-3B R/B, Norad ID 38253  
3<sup>rd</sup> stage debris, Cyl 12 x 3 m;  
45 days before re-entering



## Simultaneous debris laser ranging & light curve:

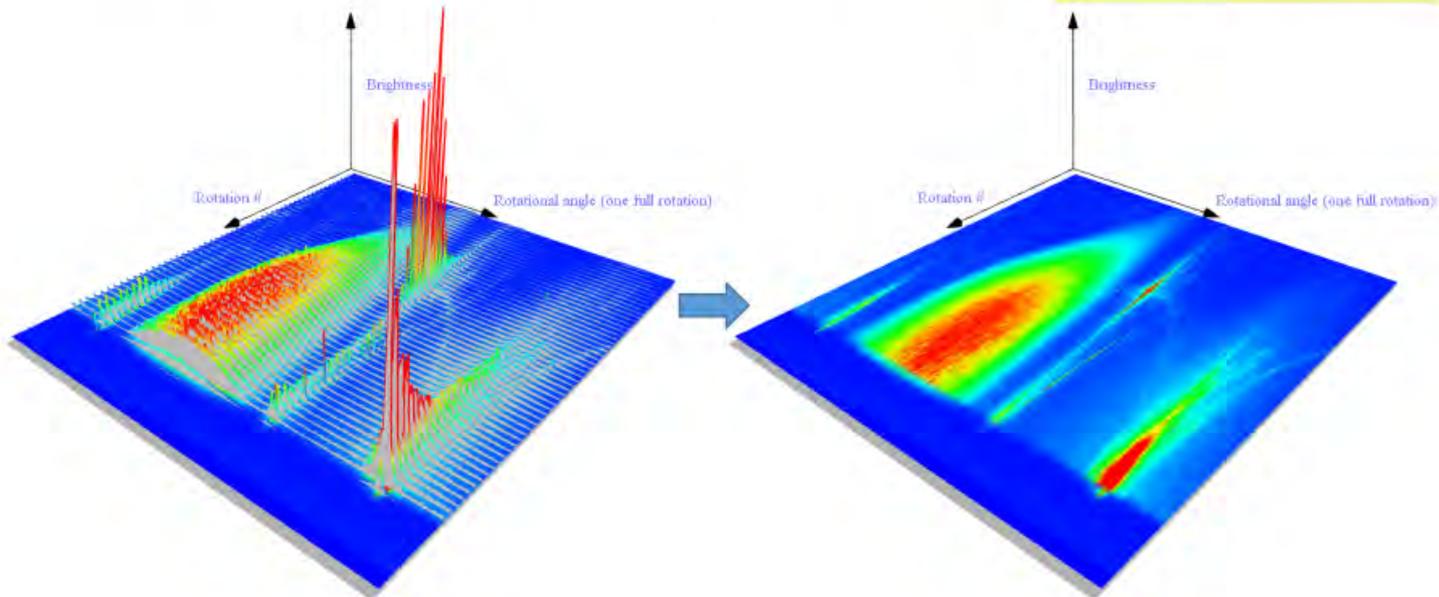
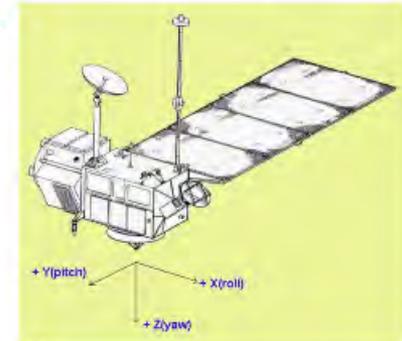
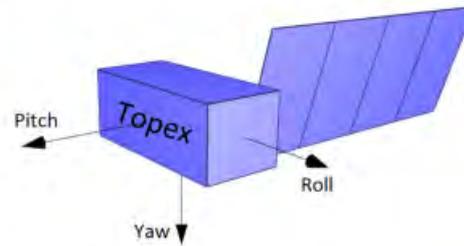
- Laser: 100 Hz, 3 ns, 20 W, 200 mJ
- LC: wavelength  $\neq$  532 nm; (532 is used by SPAD)
- x-axis: seconds of day 184 (2017-07-03)
- y-axis: SLR range residuals [m] (green)
- max. slant ranges  $\sim$ 3000 km
- LC (red): Scaled to fit within the SLR plot range

# A lot of detailed analysis concerning SD attitude motion is going on: e.g. TOPEX LIGHT CURVE ANALYSIS (Daniel Kucharski)



## Adding new techniques: SP light curves (Graz)

Topex light curve, 3D representation  
March 2016, sampling rate 100 Hz  
spin period 11.1 s, 57 rotations (10:33)



Space Debris Study Group will elect a new co-chair (Lutz Grunwaldt has retired last year)

... and SDSG will need a new chair (after end of 2019) 😊

# DOIs for Data Sets

## (for discussion)

- Digital Object Identifiers (DOIs) for publications
  - Widely used by publishers
    - More than 5000 publishers participate in DOI system
  - Unique identifier of publication
    - DOI is resolved into URL where the publication can be found (landing page)
    - Landing page contains abstract of publication, PDF, etc.
  - DOI system managed by International DOI Foundation (IDF)
- DOIs for data sets
  - Benefits to users
    - Easy access to data cited in journal article – just click on DOI
    - Improves traceability of published results – eliminates confusion about data used
    - Improves discoverability of data sets – enables wider distribution of data sets
  - Benefits to data providers
    - Providers can include information about data set on landing page (metadata)
    - Easily allows number of data publications to be tracked
    - Allows number of times data is used to be counted
    - Allows data providers to receive proper credit for their published data

# DOIs for Data Sets, cont.

## (for discussion)

- **Registration agency**
  - **Manages DOI to URL mapping**
    - Established by interested community (geodetic community)
    - Qualified by International DOI Foundation
  - **Develops registration server to share among data providers**
    - Registration agency assigns DOI prefix, data provider suffix: doi:prefix/suffix
- **Granularity of DOI assignment**
  - **One data set = one DOI**
    - Even if data set is updated
    - Example: IVS contribution to ITRF2014 (data set does not change)
    - Example: IGS Final combined EOPs (data set changes, but not file name)
- **Establish Working Group within BPS**
  - **Representatives of Services, data centers**
  - **Establish procedures for assigning DOIs to geodetic data sets**
    - Registration Agency
    - Standardized DOI naming convention
    - etc.

# Data DOI: Applicable to the ILRS?

## Data DOI: Advantages for ILRS

Direct access from papers. More users. Always up to date. Rewarded to all.

## ILRS Observation data

Current ILRS requirement: Citation (Pearlman, Degnan and Bosworth, ASR, 2002)

CDDIS has DOIs assigned for NP (hourly, daily, monthly) and FR.

→ Creation of ILRS DOIs & a new citation rule with it?

## ILRS Analysis products

Current: No rule?

→ Creation of ILRS DOIs? Ex. ICGEM, Japanese seafloor monitoring.

## Possible issues

Landing page

Granularity

Cost

# ILRS Governing Board Meeting



November 08, 2018  
17:00-19:00  
Canberra, Australia

## Agenda

- |   |             |            |
|---|-------------|------------|
| • Workshop Review   | M. Pearlman | 10 min     |
| • Review of Workshop Actions  | M. Pearlman | 10 min     |
| • Standing Committee/Study Group Actions<br><i>For the GB and/or CB</i> |             | 5 min/each |
| • Election of 2018-2020 Governing Board Chair                           | M. Pearlman | 10 min     |
| • Appointed Positions to ILRS Governing Board                           | M. Pearlman | 30 min     |
| • Other Business  | M. Pearlman | 10 min     |