

# ILRS Governing Board Meeting: 02 Dec 2020



## • [Reports]

- Welcome T Otsubo
- Next-term 2021-2022 ILRS GB members and Chair C Noll 5 min
- Report from IAG Executive Committee T Otsubo 5 min, from GGOS M Pearlman 5 min, from ILRS CB C Noll 10 min, and ILRS Virtual World Tour 2020 T Otsubo 5 min
- Standing Committee/Study Group Briefs 5 min/each = 40 min
  - Analysis SC E Pavlis/V Luceri
  - Missions SC S Merkwowitz
  - Data Formats and Procedures SC C Schwatke
  - Networks and Engineering SC M Wilkinson
  - Transponder SC J M Torre or U Schreiber
  - LLR Group J M Torre
  - Space Debris Study Group G Kirchner
  - QCB M Pearlman
- 22<sup>nd</sup> International Workshop on Laser ranging (Kunming) Zhang Z 5 min

## • [Discussions]

- Covid-19 impact and issues T Otsubo
- Selection of additional at-large GB members C Noll
- Some issues in network representative selection T Otsubo
- More? Next meeting?

**ILRS Governing Board Meeting  
December 02, 2020  
13:00 UTC via MS Teams**

**Attendees**

Graham Appleby, former GB Chair  
Sven Bauer, EUROLAS Network representative (2020-2022)  
James Bennett, WPLTN Network representative (2019-2022)  
Pippo Bianco, former GB Chair  
John Degnan, former GB Chair  
Evan Hoffman, NASA Network representative (2020-2022)  
Tang Kai, Kunming workshop representative  
Georg Kirchner, Space Debris Study Group chair (2019-2020)  
Rivers Lamb, ILRS CB Secretary (2021-2022)  
Cinzia Luceri, Analysis Center representative (2019-2022)  
Stephen Merkowitz, NASA Network representative (2019-2022)  
Carey Noll, ILRS CB Secretary (2019-2020)  
Toshimichi Otsubo, At Large representative, GB Chair (2019-2022)  
Erricos Pavlis, Analysis Center representative (2019-2022)  
Mike Pearlman, CB Director (2019-2022)  
Randall Ricklefs, Data Formats and Procedures Standing Committee co-chair  
José Rodríguez, EUROLAS Network representative (2020-2022)  
Ulrich Schreiber, Appointed At Large member (2019-2020)  
Christian Schwatke, Data Center representative (2019-2022)  
Krzysztof Sośnica, Appointed At Large member (2019-2020)  
Michael Steindorfer, Space Debris Study Group co-chair  
Daniela Thaller, IERS representative (2019-2022)  
Jean-Marie Torre, LLR representative (2019-2022)  
Matthew Wilkinson, At Large representative (2019-2022)  
Zhongping Zhang, WPLTN Network representative (2019-2022)

ILRS Governing Board Virtual meeting

14:58

Meeting controls: icons for participants, chat, hand raise, menu, video, microphone, screen share, and a red 'Leave' button.

 <p>Erricos C. Pavlis</p>	 <p>Georg Kirchner (Austria) (Gast)</p>	 <p>Ulrich Schreiber (Guest)</p>	 <p>Ricklefs, Randall L. (GSFC-61A.0)[Hexago...</p>	
 <p>Sven Bauer GFZ (Gast)</p>	 <p>Christian Schwatjke (Gast)</p>	 <p>Mike Pearlman (Guest)</p>	 <p>Krzysztof Sośnica</p>	 <p>Merkowitz, Stephen M. (GSF...</p>
 <p>Graham Appleby SGF Herstm...</p>	 <p>Jean-Marie Torre (Invité)</p>	 <p>Noll, Carey E. (GSFC-61A0)</p>	 <p>Toshimichi Otsubo (Hitotsubas...</p>	 <p>James Bennett</p>
 <p>Hoffman, Evan Derek (GSFC-...</p>	 <p>Daniela Thaller (Gast)</p>	 <p>Wilkinson, Matthew J.</p>	 <p>Lamb, Rivers C. (GSFC-5850)</p>	 <p>Tang Kai (来宾)</p>

Participant avatars and names in the bottom bar:

- +13
- RR
- GH
- TK (Tang Kai (来宾))
- SG (Sven Bauer GFZ ...)
- MP (Mike Pearlman (Guest))
- TO (Toshimichi Otsubo (Hitots...))

# ILRS Governing Board: 2021-2022



- Elected positions:
  - ◆ EUROLAS Network Representatives:  
**Sven Bauer, José Rodríguez**
  - ◆ NASA Network Representatives:  
**Evan Hoffman, 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 (Chair), Matt Wilkinson**
- Ex-officio/appointed positions:
  - ◆ Director of the Central Bureau:  
**Mike Pearlman**
  - ◆ Secretary of the Central Bureau:  
**Rivers Lamb**
  - ◆ Representative of IAG Commission 1:  
**Urs Hugentobler**
  - ◆ IERS Representative:  
**Daniela Thaller**
- Appointed by the Governing Board:
  - ◆ TBD (2)



# At-large appointments



- Need to nominate candidates for two At-Large appointed positions
- From the ILRS Terms of Reference, consider candidates that can
  - ◆ Help compensate for under-representation among the various components of the ILRS
  - ◆ Provide additional skills, organizational representation, geographic representation, or knowledge of use to the Board

# Standing committees/study groups



- Analysis SC
  - ◆ Erricos Pavlis
  - ◆ Cinzia Luceri
- Data Formats and Procedures SC
  - ◆ Christian Schwatke
  - ◆ Randy Ricklefs
- Missions SC
  - ◆ Stephen Merkowitz
  - ◆ Rob Sherwood
- Networks and Engineering SC
  - ◆ Matt Wilkinson
  - ◆ Clément Courde, You Zhao
- Transponder SC
  - ◆ Ulli Schreiber \*
  - ◆ Jean-Marie Torre
- Space Debris SG
  - ◆ Georg Kirchner \*
  - ◆ Daniel Kucharski \*



\* Denotes updates required/requested for 2021-2022 term

# **Short Report from IAG EC**

# IAG Executive Committee Meeting #3

- Held online (Zoom), 8 and 9 Oct 2020
- Compact format: collection of short reports and discussions
- Next meeting: Feb? Mar? 2021, online



# ILRS Status & Activities (Highlights Only)



- ILRS Stations have worked hard to keep their operations during the COVID-19-related restrictions.
- ILRS Analysis Standing Committee is:
  - finalizing the systematic error model to be used a priori during the REPRO phase for the generation of the ILRS contribution to the ITRF2020.
  - repeatedly reprocessing large periods of the data due to re-released (corrected) data or the correction of AC errors. However, the end product will be available within the expected deadline.
- LLR: New lunar missions to deposit very accurate reflectors on the Moon the next years. LLR Meeting is planned (2021?).
- New GB members (2021-2022) are being elected. U. Hugentobler agrees to serve as an ILRS GB member (IAG rep).
- Kunming 2020 and Arequipa 2021 workshops were postponed to 2021 and 2022 resp., but ILRS Virtual World Tour is being arranged (2-6 Nov 2020 →).



ILRS Virtual World Tour 2020  
November 02-06, 2020

[https://cddis.nasa.gov/ILRS\\_Virtual\\_World\\_Tour\\_2020/](https://cddis.nasa.gov/ILRS_Virtual_World_Tour_2020/)

# IAG EC Meeting #3: Summary

- All Joint WG, Joint SG were approved.
- IAG Website being renewed <https://www.iag-aig.org/>
- Global Geodetic Center of Excellence to be located in Bonn.
- J Geodesy
  - Geodesist Handbook to be published in November 2020
  - Impact Factor boosting: ~4.8
  - Too busy Editor-in-chief; maybe one additional position in the future
  - Self-citing rate 20+%. Should not exceed 25%; no IP would be given.
- IAG Scientific Assembly 2021
  - Almost all session proposals are ready.
  - Plan A = all in person, Plan B+ = all virtual, or Plan B = mixture
  - Final decision to be made in Feb or Mar 2021
- Re-arrangement of IAG Committees etc (every 20 years)
  - R Gross in charge of the plan
- IAG Travel Award
  - Oversea trips: USD1000 → EUR1500.



# **GGOS Report**

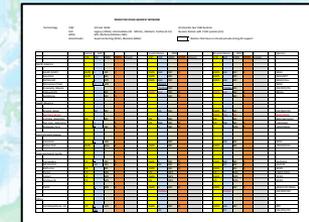
**Mike Pearlman  
Carey Noll**

**ILRS GB Virtual Meeting 2020**

**December 2, 2020**

- Former GGOS Coordinating Center Director Gunter Stangl passed away suddenly in 2018; new Director is Martin Sehnal from BEV
- GGOS Days meeting held October 5 – 7  
See: <https://cloud.ggos.org/index.php/s/nn4rb9jzn7FcMPL>
- New GGOS web site should be available to the public by year's end (Martin Sehnal – CO)  
See: <https://www.ggos.org>
- Finishing up the GGOS component of the IAG Geodests Handbook
- GGOS Japan is the first GGOS Affiliate; other possible candidates
- Working Group on DOI is active under the leadership of Krysten Elger
- Looking at outreach options: newsletters, articles, documentaries, etc
- Role of gravity field expanding

- Advocate for the expansion and upgrade of the space geodesy network for the maintenance and improvement of the reference frame and other GGOS priorities; encourage partnerships to build and upgrade ground stations;
- Organize a GGOS Affiliated Network of space Geodesy sites through a CfP;
- Provide the opportunity for representatives from the Services and the Standing Committees to meet and share progress and plans; discuss issues of common interest; meetings at EGU, AGU, GGOS Days, etc.;
- Scope the network for the Reference Frame;
- Maintain a Site Requirements Document;
- Monitor network status; projected network evolution based on input from current and expected future participants, estimate performance capability 5 and 10 years ahead;
- Talks and posters on the Bureau at EGU, AGU, JPGU-AGU, AOGS meetings, etc.;
- Letters/documentation to support stations, current/ new missions, and analysis centers;
- Interface with the UN Committee of Experts on Global Geospatial Information Management , Committee on Geodesy;



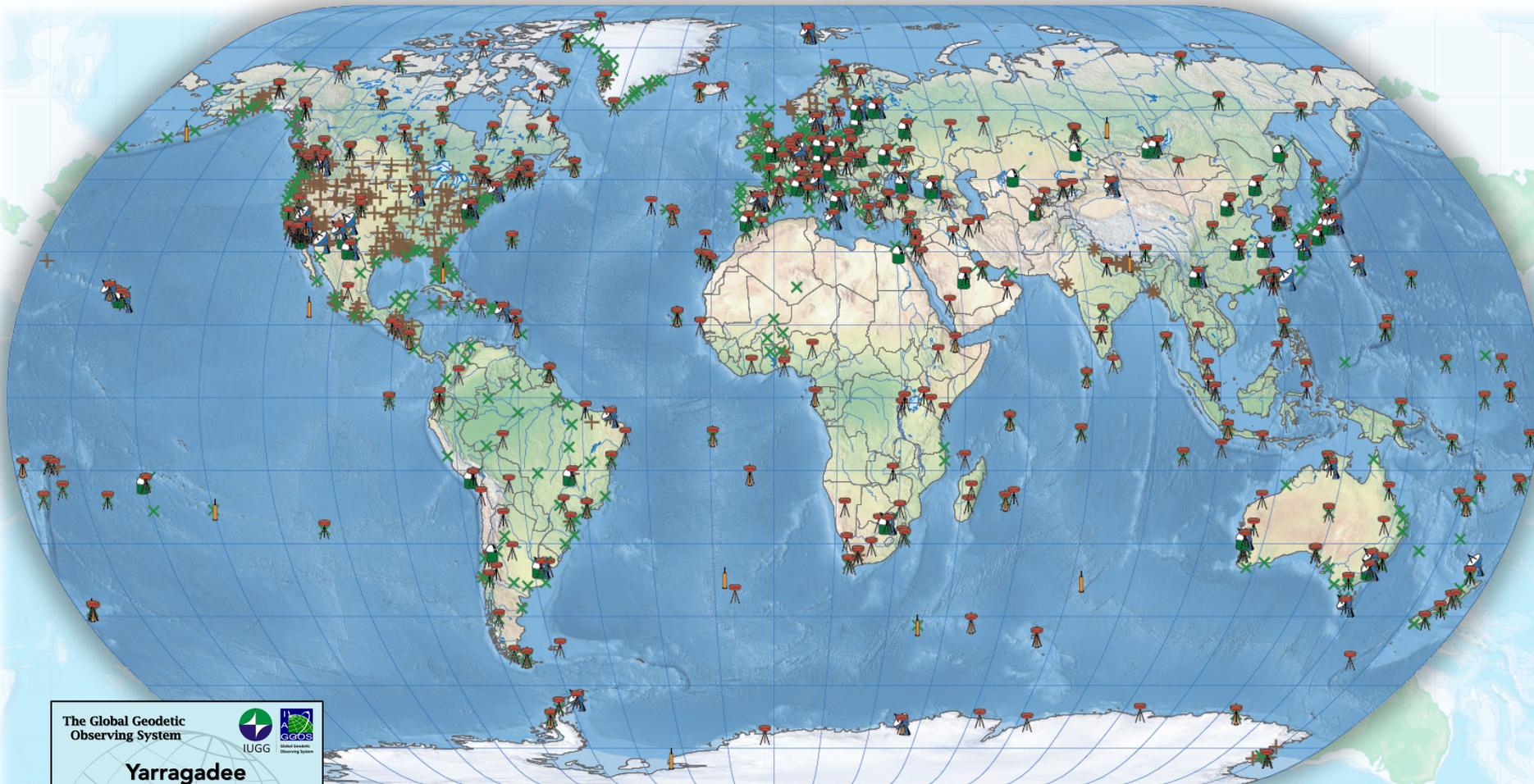
Category	Requirement	Priority	Status
Reference Frame	1.1.1.1	High	Met
	1.1.1.2	High	Met
	1.1.1.3	High	Met
	1.1.1.4	High	Met
	1.1.1.5	High	Met
	1.1.1.6	High	Met
	1.1.1.7	High	Met
	1.1.1.8	High	Met
	1.1.1.9	High	Met
	1.1.1.10	High	Met
Reference Frame	1.2.1.1	High	Met
	1.2.1.2	High	Met
	1.2.1.3	High	Met
	1.2.1.4	High	Met
	1.2.1.5	High	Met
	1.2.1.6	High	Met
	1.2.1.7	High	Met
	1.2.1.8	High	Met
	1.2.1.9	High	Met
	1.2.1.10	High	Met



# GGOS Affiliated Network



Global Geodetic  
Observing System



The Global Geodetic  
Observing System



**Yarragadee  
Geodetic Observatory**

is a member of the  
GGOS Space Geodesy Network



*Richard D. Stone*  
Executive Director  
Global Geodetic Observing System

*Michael R. Barlow*  
Global Geodesy Center  
GGOS Series of Networks and Observations

- Three big initiatives: NASA, BKG, and ROSCOSMOS
- Number of stations still need to "join the club"
- Continue to recruit station through the CFP

# BN&O Components



- Standing Committee on Performance Simulations and Architectural Trade-offs/PLATO (Daniela Thaller/Benjamin Mannel)  
Simulation studies and analyses to assess impact on reference frame products of: network configuration, system performance, technique and technology mix, co-location conditions, site ties, and network trade-off options
- Standing Committee on Data and Information (Nick Brown/Carey Noll)  
Metadata System development for a wide range of geodesy users including GGOS; near term strategy for data products (Carey Noll at GSFC) and a more comprehensive longer-term plan for an all-inclusive system
- Standing Committee on Missions (Roland Pail/CK Shum)  
Maintain lists of current and proposed satellites that contribute to GGOS Goals; advocate for new missions and project the benefit to GGOS
- IERS Working Group on Site Survey and Co-location (Ryan Hippenstiel)  
Ground survey and co-location issues including critical co-locations for the reference frame and gravity deformation of VLBI antennas



- Reports at scientific conferences;
- Components
  - Committee on Standards and Conventions
  - Committee on Earth Systems Modeling
  - WG toward consistent set of parameters for the definition of a new Geodetic Reference System
- Working with the UN GGRF WG "Data Sharing and Development of Geodetic Standards"
- Contributing to the re-writing of the IERS Conventions

# Focus Areas



- Unified Height System (Laura Sanchez)
  - Implementation of a Unified Height System/Height Reference Frame;
- Geohazards (John LaBrecque)
  - Development of international effort to use GNSS to implement Tsunami Warning System;
- Geodetic Space Weather (Michael Schmidt)
  - Understanding Magnetosphere – Ionosphere– Thermosphere interaction



# ILRS

# Central Bureau Report

Carey Noll  
Michael Pearlman  
ILRS Central Bureau

2020 ILRS Governing Board  
December 02, 2020

## Outline

- Recent developments
  - ◆ Network
  - ◆ Missions
  - ◆ Analysis
  - ◆ Operations
- QCB report
- Issues and challenges

# Recent news and highlights (1 of 2)



- ILRS network supported by 40 stations
- Network currently tracking over 110 missions
- Developing Memorandum of Understanding between ILRS/GGOS and ROSCOSMOS
- Regular meetings of the ILRS Quality Control Board (QCB) examining data quality issues in normal point data
- Most of the missions now providing predictions in CPF V2
- ILRS virtual poster submitted to 2020 Fall AGU meeting
- 2016-2019 ILRS report now published on ILRS website:
  - ◆ [https://ilrs.gsfc.nasa.gov/about/reports/annualrpts/ilrsreport\\_2016.html](https://ilrs.gsfc.nasa.gov/about/reports/annualrpts/ilrsreport_2016.html)



# Recent news and highlights (2 of 2)



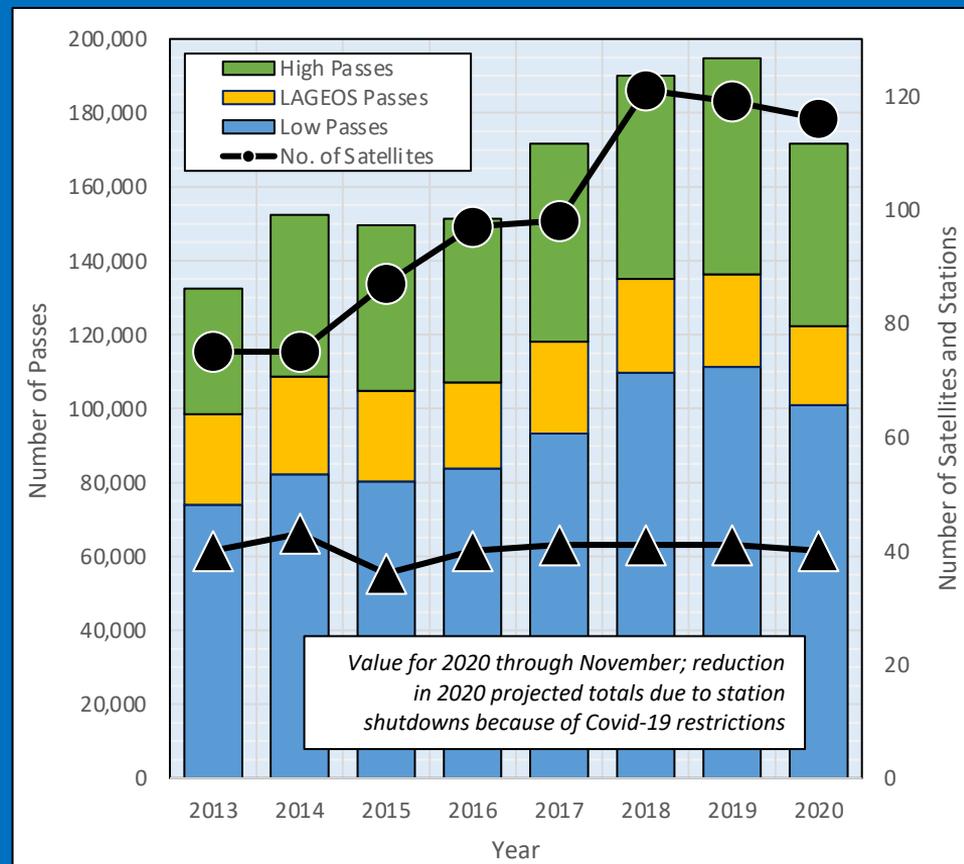
- Held very successful ILRS Virtual World Tour 2020
  - ◆ Virtual tours of five stations in five days
  - ◆ Updating website ([https://cddis.nasa.gov/ILRS\\_Virtual\\_World\\_Tour\\_2020](https://cddis.nasa.gov/ILRS_Virtual_World_Tour_2020)) with videos and additional material
- Future workshops postponed due to Covid-19:
  - ◆ 22<sup>nd</sup> International Workshop on Laser Ranging (Kunming, China in Fall 2021)
  - ◆ Next ILRS Technical Workshop (Arequipa, Peru in Fall 2022)
  - ◆ ILRS Standing Committees and Governing Board holding virtual meetings in 2020
- Material posted from 2019 ILRS Technical Workshop and first ILRS School
  - ◆ [https://cddis.nasa.gov/2019\\_Technical\\_Workshop/](https://cddis.nasa.gov/2019_Technical_Workshop/)



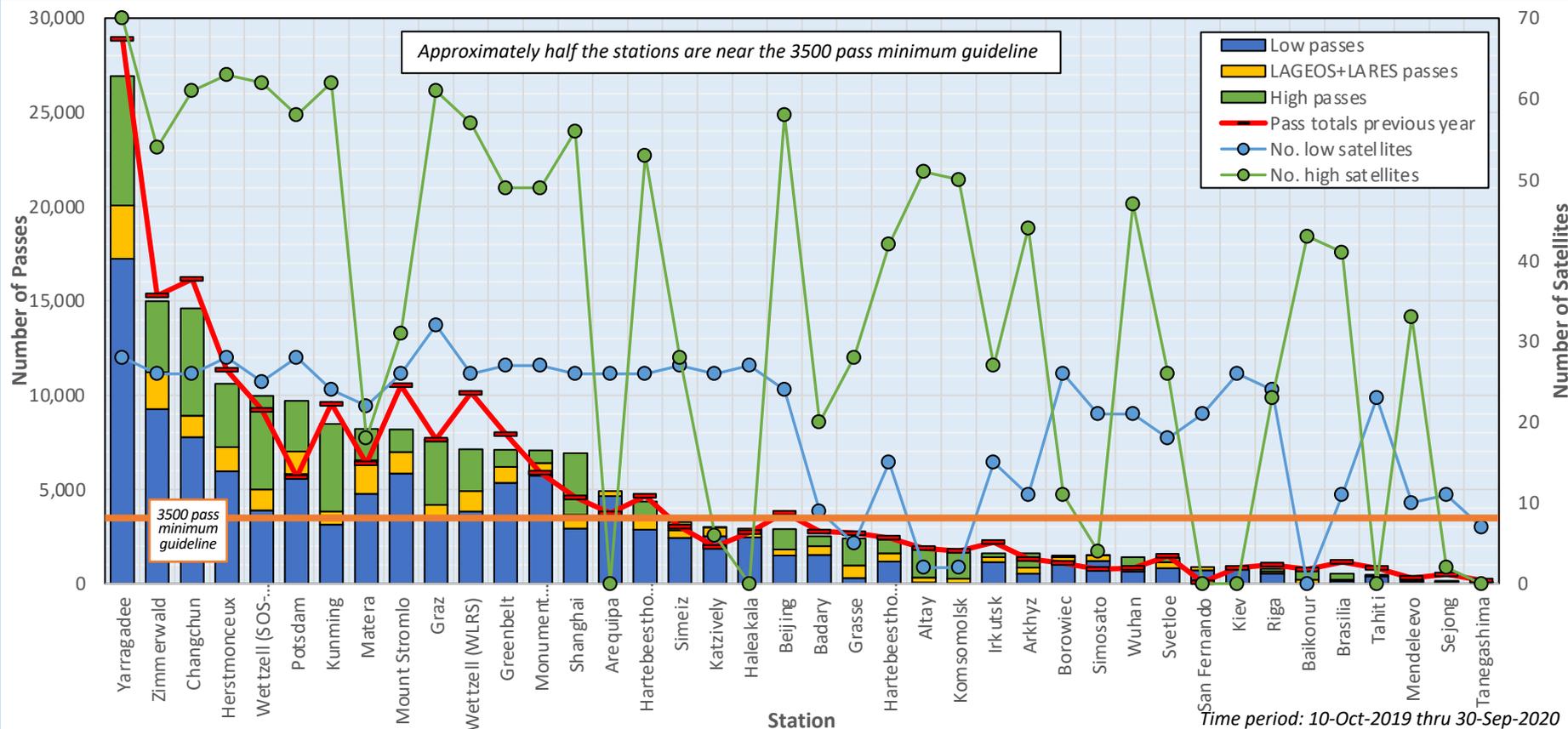


# Recent developments: network

- Forty stations are providing data on a routine basis; data from one station currently in quarantine for review
- Some station operations adversely affected by pandemic quarantine; projected yearly tracking value indicates total number of passes for 2020 will be lower than 2019 totals
- Less than half of the 40 stations in the network achieve the ILRS guideline of 3500 passes/year (see ILRS monthly report cards)
- Anticipating nearly a dozen new SLR stations in the next few years; spatial gaps still exist



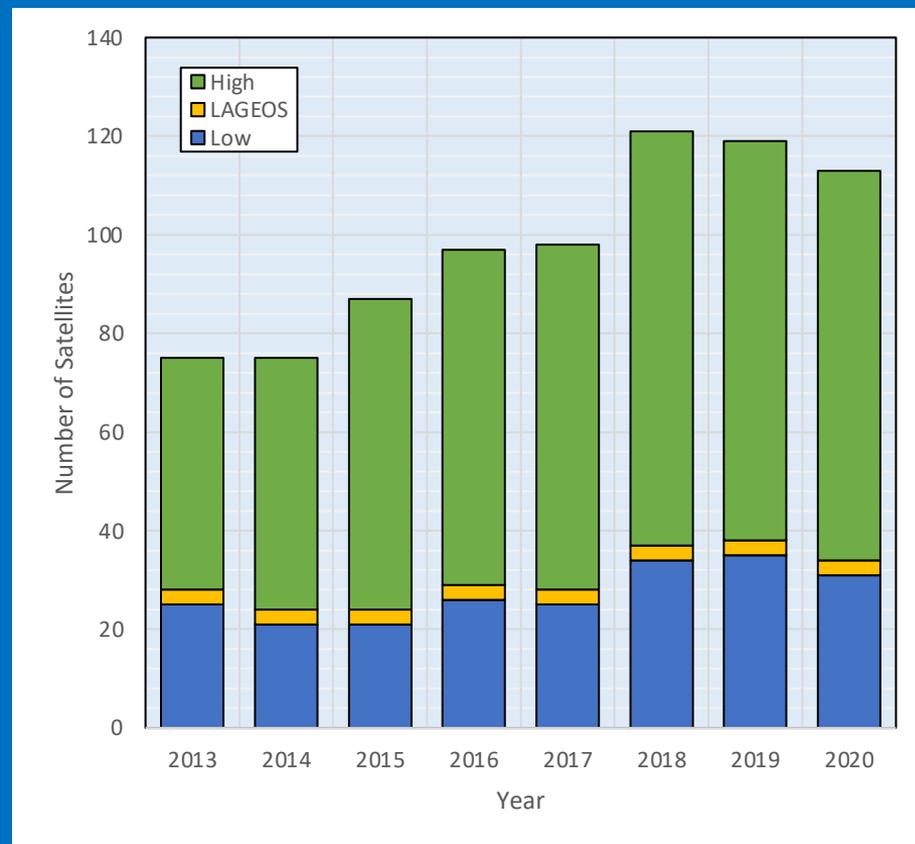
# Recent developments: network performance



# Recent developments: mission support



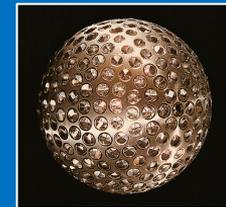
- Recent changes to the ILRS priority list:
  - ◆ Added HY-2C (altimetry mission)
  - ◆ Removed HY-2A
- Future missions requesting ILRS support:
  - ◆ Astrocast Precursor (2 cubesats/engineering testing)
  - ◆ Sentinel-6A/Jason-CSA (November 21, 2020)
  - ◆ LARES-2 (2020 Q4)
  - ◆ NXD-1/SLAG (2020 Q4)
  - ◆ ELSA-d (2021 Q1)
  - ◆ HY-2D (2021 Q1)
  - ◆ ICEYE (5 satellites, 2020 Q4)
  - ◆ Additional GNSS: BeiDou/Compass, Galileo, etc.
- Requests for restricted tracking, which is time consuming to implement



# Recent developments: analysis



- ILRS ACs preparing for the data re-analysis for ITRF2020
- Introducing LARES as a 5<sup>th</sup> target incorporated into ILRS products
- Investigating data yield improvement and use of GNSS tracking data to benefit ILRS EOP products
- ASC Pilot Projects
  - ◆ Systematic Error Monitoring Pilot Project completed
  - ◆ Low degree/low order gravity field terms ongoing
  - ◆ NT-Atmospheric loading (possibly other types of loading) applied at observation level
- Implementation of improved satellite Center of Gravity (CoG) values for geodetic satellites and new systematic error modeling have reduced the difference in scale between SLR and VLBI
- Increased data level on Etalon from a 3-month tracking campaign in 2019 resulted in improved EOP



# Recent developments: operations



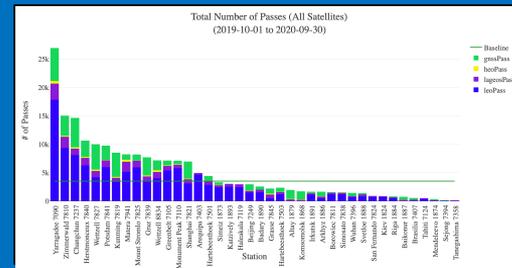
- ILRS infrastructure transitioning to version 2 of both Consolidated Range Data (CRD) and Consolidated Prediction Format (CPF)

- Updated versions will facilitate support of future missions and applications (e.g., ELT, space debris)
- Test files available from ILRS data centers
- Missions asked to provide files in CPF V2 by end of 2020
- Only 8 stations currently providing CRD V2 data

- New ILRS report card software developed and operational starting in 2020

- Study group currently developing new software to improve plotting of station performance and environmental parameters

- Help identify station systematics and errors more easily
- Help motivate stations to improve performance



- Role of the QCB: Examine issues that degrade data quality
- Recent Activities
  - ◆ Evaluation of “standardized” software and modeling;
  - ◆ Examine SLR data using a Weiner Filter approach (restoration technique for deconvolution);
  - ◆ Tests using a Weiner Filter to examine the statistics of SLR data;
  - ◆ Stations using different methods of NP computation;
  - ◆ Comparing alternative methods showed that results typically fell within a mm of a standard reference software;
  - ◆ Relaxing minimum FR content (6 day/3 night) criteria in NP’s tended to distort LAGEOS orbits; study underway now with LARES;
  - ◆ Studies of the influence of observed pulse shape on range quality; some double peaked structure may indicate resolution of satellite retro geometry;

- Recent Activities (continued)
  - ◆ Single photon data on the LAGEOS satellites tend to show that LAGEOS-2 is 2 mm smaller; more detailed information may be left behind by the NP process;
  - ◆ Number of operational issues revealed; (example – changing PMT voltage between calibration and ranging);
  - ◆ Value of the computed skew and kurtosis from the data in the light of corrections already included in the satellite center of mass corrections derived by Jose Rodriguez;
  - ◆ Big issue with stations not recording changes in the station history logs;
  - ◆ Increase stress on long and short stability rather than NP rms;
  - ◆ More information available on ILRS website at:  
<https://ilrs.gsfc.nasa.gov/science/qcb/qcbActivities/index.html>

# Issues and challenges



- Many geographic gaps still exist, primarily in Latin America, Africa, and Oceania
- Too many non-performing stations; less than half achieve ILRS minimal requirements
- Mix of new and old technologies and levels of financial support
- Lack of standardization in system hardware and operations
- Data quality issues (efforts underway to detect and reduce systematics)
- Number of target satellites continues to increase as new missions use SLR for orbit determination and other applications (100+ satellites); lots more coming
- Need to find less expensive implementation of this technique

# **Report from ILRS Virtual World Tour 2020**



# Organising team

- 2020 Kunming & 2021 Arequipa Workshops are postponed.
- Planning “ILRS Virtual World Tour 2020”
  - New style event, excluding what are expected in our annual workshops. Experimental event.
  - Organising team: **T Otsubo** (Chair), **E Hoffman** (MS Teams host), **M Wilkinson**, **D Thaller**, **R Carman**, **C Noll** (Web & Announcement) and **M Pearlman**. Five online meetings in July-October. Rehearsal sessions.
  - Destinations: **Graz** (Austria), **Zimmerwald** (Switzerland), **Simosato** (Japan), **Greenbelt** (USA) and **Yarragadee** (Australia)
- Importance of visiting and being visited
  - Seeing other systems, tracking operation, etc.
  - Meeting international colleagues and exchanging ideas.
  - And much more, such as traveling, language, culture, foods, and time difference!



SLR is fun!

## Program

### Monday, November 02:

12.30-13.00 UTC Opening Session

13.00-15.00 UTC Tour of [Graz, Austria](#)

### Tuesday, November 03:

13.00-15.00 UTC Tour of [Zimmerwald, Switzerland](#)

### Wednesday, November 04:

06.00-08.00 UTC Tour of [Simosato, Japan](#)

### Thursday, November 05:

17.00-19.00 UTC Tour of [Greenbelt MD, USA](#)

### Friday, November 06:

10.30-12.30 UTC Tour of [Yarragadee, Australia](#)

12.30-12.40 UTC Closing session

247 registered parties.  
90-130 parties attended per day.  
Mixture of pre-recorded video and live sessions.  
Lively discussions through chatbox.

## Graz Tour

### Schedule

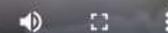
	Sub-session	Topic	Presenter	Pre-recorded/Real time	Duration (min)	Elapsed time (min)
1	1.1	Introduction of Graz city		<a href="#">Pre-recorded</a> 01:38 200MB	10 810MB	10
	1.2	Drive to Observatory		<a href="#">Pre-recorded</a> 00:30 114MB		
	1.3	Welcome to Observatory	Georg Kirchner	<a href="#">Pre-recorded</a> 00:54 63MB		
	1.4	Bird's-eye view of Observatory		<a href="#">Pre-recorded</a> 01:07 121MB		
	1.5	Telescope and dome	Georg Kirchner	<a href="#">Pre-recorded</a> 02:44 200MB		
	1.6	Laser room	Franz Koidl	<a href="#">Pre-recorded</a> 02:30 235MB		
	Break for discussions			<a href="#">Real time</a> 05:10 105MB	5	15
2	2.1	Observation	Georg Kirchner/Christian Graf	<a href="#">Pre-recorded</a> / <a href="#">Real time</a> 08:16 535MB	12 1.0GB	27
	2.2	Calibration	Peiyuan Wang	<a href="#">Pre-recorded</a> 03:55 218MB		
	Break for discussions			<a href="#">Real time</a> 09:03 223MB	9	36
3	3.1	MHz SLR at day and night time	Peiyuan Wang	<a href="#">Pre-recorded</a> 06:00 19MB	12 96MB	48
	3.2	Introduction of "piggyback" laser and detection package	Georg Kirchner	<a href="#">Real time</a> 05:14 34MB		
	3.3	Machining	Reinhard Stieninger	<a href="#">Pre-recorded</a> 00:33 50MB		
	Break for discussions			<a href="#">Real time</a> 11:53 223MB	12	60
4	4.1	SP-DART	Peiyuan Wang	<a href="#">Pre-recorded</a> 02:03 5MB	18 170MB	78
	4.2	Recent development	Michael Steindorfer	<a href="#">Pre-recorded</a> 13:56 45MB		
	4.3	Time lapse of SLR Graz		<a href="#">Pre-recorded</a> 01:19 67MB		
	Final discussion and close			<a href="#">Real time</a> 25:45 357MB	26	104



**KIRCHNER GEORG**

FLR GRAZ

▶ 0:35 / 2:44



# Group photo (1 of 4) (Tuesday, 3 Nov 2020, captured by C Noll)<sup>13</sup>

ILRS Virtual World Tour 2020: Tour of Zimmerwald, Switzerland

03:06:02

Recording has started. This meeting is being recorded. By joining, you are giving consent for this meeting to be recorded. [Privacy\\_policy](#) Dismiss

Jorge Roberto Del Pino Boytel

Clement Courde

Toshimichi Otsubo

Arnold, Daniel (AIUB)

Gøril Margrethe Breivik

Johann Eckl

Lyubka Pashova (NIGGG-BAS...)

Vida Eszter

Андрій Білінський

MOBLAS 5

Graham Appleby SGF Herstm...

Rolf Dach (AIUB) (Gast)

Blazej, Josef

Carabajal, Claudia C. (GSFC-6...)

Mateusz Drożdżewski UPWr (...)

Brockmann Elmar SWISSTOPO

Rosario Etchegoyen (IGN-Ar) ...

Liliane Biskupek (Inst. for Ge...

Ayelén Acosta (Invitado)

Emiliano Cordelli (ESA) (Guest)

Adolfo GM - Yebes Observat...

Kalvis Salmiņš

+95 GM TS DT TO



# ILRS Virtual World Tour **2021!**

- 2020: Very positive responses from participants.
  - A number of stations showed interests in hosting.
- 2021 Plan
  - Stations to be picked after collecting responses
  - Possibly more than stations
  - Schedule
    - December 2020: Finish the website.
    - Early 2021: Call for opportunity for VWT2021. Form a new organising team.
    - (Kunming 2021 workshop to be decided. If it happens, the VWT might be in a shorter style. )
    - Month TBD 2021: VWT2021



# ILRS ASC Activities

Erricos C. Pavlis and Cinzia Luceri

ILRS Analysis Coordinators

ILRS Governing Board Virtual Meeting

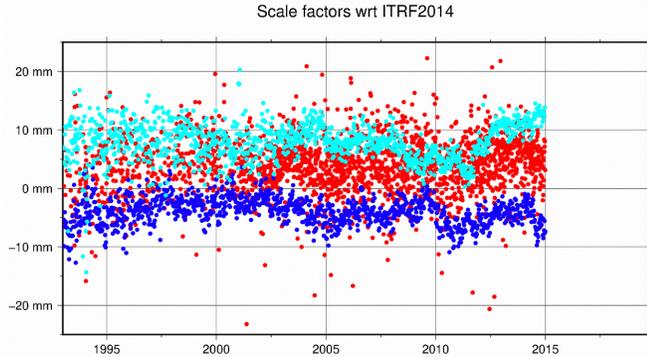
December 2, 2020

- Working on the development of the ITRF2020 contribution (02/2021)
- New Data Handling file compiled from SSEM PP results (12/2020)
- Timing Biases (mostly T2L2-based) added to new Data Handling file
- The new model for the target signature correction by NSGF, already adopted by the ASC for the SSEM PP, made a big difference in SSEM
- The next contribution to ITRF weekly SINEX files will include the applied  $R_B$  &  $T_B$  with their statistics in each SINEX file along with the applied CoG offsets specific to stations tracking that week.

# ILRS ASC - Analysis Activities - 2



## SLR Scale in ITRF2014 Systematically Different



In 2015 ILRS launched a multi-year effort to address and resolve the SLR scale issue: Station Systematic Error Modeling Pilot Project (SSEM PP).

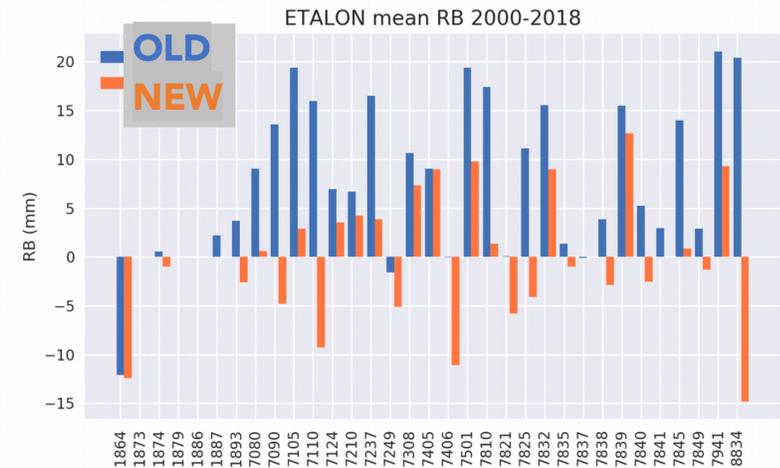
••• VLBI contribution to ITRF2014 + 4.4 + 0.11 (t - 2010) mm  
••• SLR contribution to ITRF2014 - 4.4 - 0.08 (t - 2010) mm  
••• DORIS contribution to ITRF2014 + 7.2 - 0.11 (t - 2010) mm

} VLBI - SLR = 8.8 mm  $\approx$  1.375 ppb

Credits: ITRS Center, ILRS ASC Meeting, Oct. 1<sup>st</sup>, 2019, Observatoire de Paris

## Improved Target Signature Corrections

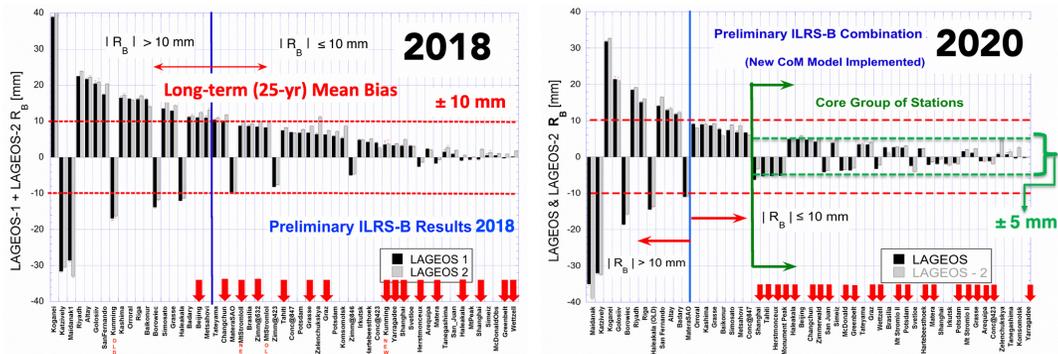
- These errors introduce a direct scale "bias"
- Most stations had inadequate modeling even at cm-level, e.g. for the Etalon satellites
- A non-random distribution in the network, resulted in significant distortion of the scale



Credits: José Rodríguez & Graham Appleby, NERC 2018

## New modeling vastly improved the solution:

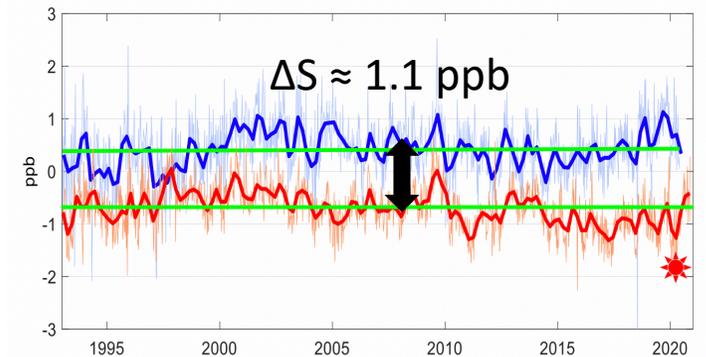
- Long-term mean biases were halved for Core stations
- Biases were more randomly distributed about zero



12/02/2020

## Revised SLR scale as a result of the SSEM PP 2020 reanalysis:

- Upper curve:
  - SLR scale from SSEM
  - Mean: **+0.4 ppb**
- Lower curve:
  - SLR scale in ITRF2014
  - Mean: **-0.7 ppb**
- Mean difference:
  - $SLR_{NEW} - OLD \approx 1.10$  ppb
  - $VLBI - SLR \approx 0.28 \pm 0.10$  ppb



★ ITRF2014 SLR series extended beyond 2014 using the weekly ILRS ASC product.



---

# Missions Standing Committee Brief

Stephen Merkowitz

December 2, 2020

- ◆ Robert Sherwood was appointed MSC Co-Chair
- ◆ Reviewed mission support requests and recommended:
  - BLITS-M
  - LARES-2
  - Sentinel-6A/Jason-CSA
  - HY-2C
  - NXD-1-SLAG
  - ELSA-d
- ◆ Under review
  - ICEYE
- ◆ Upcoming
  - ALOS-4 (2022)

- ◆ The committee found that there is no need at this time to develop new/formal criteria for evaluating mission requests from commercial and non-science missions.
- ◆ The committee agreed it would be useful for the MSC to periodically follow-up with missions to update their tracking needs and assess the value of continued ILRS support.
- ◆ The committee recommends that the ILRS include reports from all active missions in future “annual” reports.
- ◆ Kazuhiro Yoshikawa (JAXA) presented an update on the ALOS-4 mission. The committee recommended the mission work closely with the MSC on determining the best approach for implementing the restricted tracking for this mission.

ILRS Data Format & Procedure Standing  
Committee (DF&P SC) and Software Re-use  
Study Group (SRSG)  
2020 Report

Randy Ricklefs  
The University of Texas at Austin  
Christian Schwatke  
DGFI-TUM

# Executive Summary

- All station site logs have been updated to version 2
- CPF v2 predictions for all satellites are expected by Jan 1, 2021 when v2 will be the official standard. All but a handful are currently available.
- CRD v2 is being produced by only 8 stations, but there will be a push for stations to expedite implementation and complete the conversion by the end of 2021
- The Herstmonceux open source normal point program has been extensively tested and appears to produce normal points as good or better than the official station normal points. Testing of statistical products and exceptions continue and will result in a new version accessible via the ILRS web site.

# Site Logs

- All ILRS SLR station site logs have been upgraded to version 2
- The EDC Station Log tool has been updated and works well

# CPF v2 Update

- 1) More and more predictions providers are supplying CPF v2 files in preparation for the conversion to CPF v2 as the official ILRS prediction format on January 1, 2021. It is expected that at least one provider for every satellite will be supplying predictions by the end of the year, and hopefully all the current providers will have v2 CPFs available by then. The only satellites not currently available in v2 are IRNSS, QZS, SARAL, and on eof the restricted satellites.
- 2) This has not been without issues. Some providers either didn't understand the format or didn't continue providing CPF v1 files after starting to provide CPF v2 files. Those involved were contacted as soon as the issue was detected.
- 3) Prediction providers are being asked to continue supplying CPF v1 through most of 2021. It would be preferable to end the CPF v1 supply earlier than the end of 2021, so I will be asking the stations periodically next year whether CPF v1 is still needed.

# CRD v2 Update

- 1) There are still only eight stations producing CRD v2 files: Grasse, Graz, Golosiiv, Herstmonceux, Mt. Stromlo, Shanghai, Simiez, and Zimmerwald, with seven of those providing data regularly. Stations will be contacted early next year about expediting the implementation, so that as of early April 2021, the Analysis Standing Committee can start vetting as many stations as possible. The goal is to complete conversion by the end of 2021.
- 2) While the CRD Configuration Records (C1-C7) are listed as "recommended" in the CRD format document, they should be included unless there is some insurmountable obstacle. They provide valuable information to analysts to help identify the source of station performance changes. Of course, it is critical to keep these records (as well as station change history logs and site logs) up-to-date and to reflect the configuration of the past.

# Sample Code and Webpage

- 1) There are bug-fix versions of the CPF and CRD sample software available on the ILRS web site. The changes are not major, but those who use the sample code should check on their impact. These involve `read_crd,c`, `write_crdf.f`, and `cpf_chk.c`.
- 2) The web pages on the ILRS web site describing the CPF and CRD v2 formats have been updated to make them easier to read, and to remove outdated information.

# Testing the Herstmonceux Open Source Normal Point Program

- The Herstmonceux normal point software was created as reference code for those testing or updating existing normal point software.
- By use of a large data set, it was hoped to show that the Herstmonceux normal point software produces demonstrably acceptable results.
- Use the test to quantify the performance of the Hx software vs stations' software
- Use the tests to highlight errors or issues with the Hx software
- Use the software is helping to critique stations' software and procedures

# Testing of Herstmonceux Open Source Normal Point Program

- Software was written by Matt Wilkinson in Python and provided on the ILRS web site provided a basis for testing
- Several corrections and modifications were made to the program, including testing of a python version of the ILRS DISTRIB software
- The program was used by Ricklefs at UT to generate normal points for all LAGEOS 1 and LARES passes from all stations for January 2020 using full rate data from the CDDIS.
- Pass by pass comparison showed that  $\frac{3}{4}$  of the LAGEOS 1 and  $\frac{2}{3}$  of the LARES normal point ranges agreed to 1 mm. The differences for the rest were larger, mainly due to filtering differences.
- Differences seen through orbit fitting and analysis done by J. Ries at UT were small for most stations, and the RMS was generally the same or better with the new software
- Other tests at Herstmonceux explained differences in certain stations' normal points

# Testing of Herstmonceux Open Source Normal Point Program - II

- Results have been presented to the ILRS Quality Control Board (ILRS QCB)
- The results prompted discussion and testing of the effect of normal points containing only 1-5 returns
- More testing with the DISTRIB function continue
- Changes are being integrated at Herstmonceux
- A new version of the software will be available through the ILRS website when the testing and integration are complete

# Transponder SC Report

Ulrich Schreiber, Jean-Marie Torre

# Hayabusa 2 Transponder Experiment

- Hayabusa 2 was launched in 2014
- It went for a rendezvous with the C-class asteroid 162173 Ryugu (1999 JU3) in order to extract material



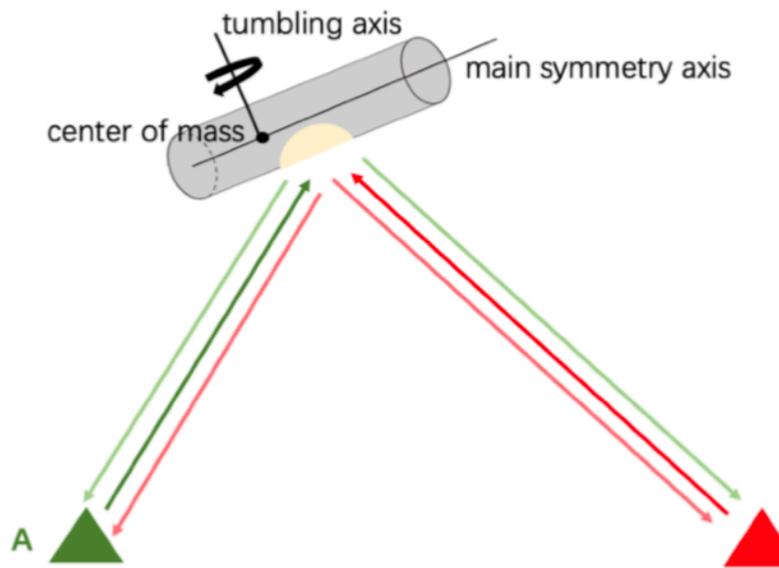
- The probe carries a lidar system
- Transponder operations have been attempted on the way out and are now scheduled for the return (Stromlo returns were detected on the probe, but no returns)
- The challenge is the low repetition rate of the laser of 0.5 Hz and the large uncertainty for the space probe internal delay.
- Mt. Stromlo, Koganei, Grasse and Wettzell are preparing for this event
- One way ranging distance is 20 - 80 Mio km
- Timeframe: Dec. 9 - 23, 2020

# Challenging Einstein on the ISS: ACES takes a step ahead

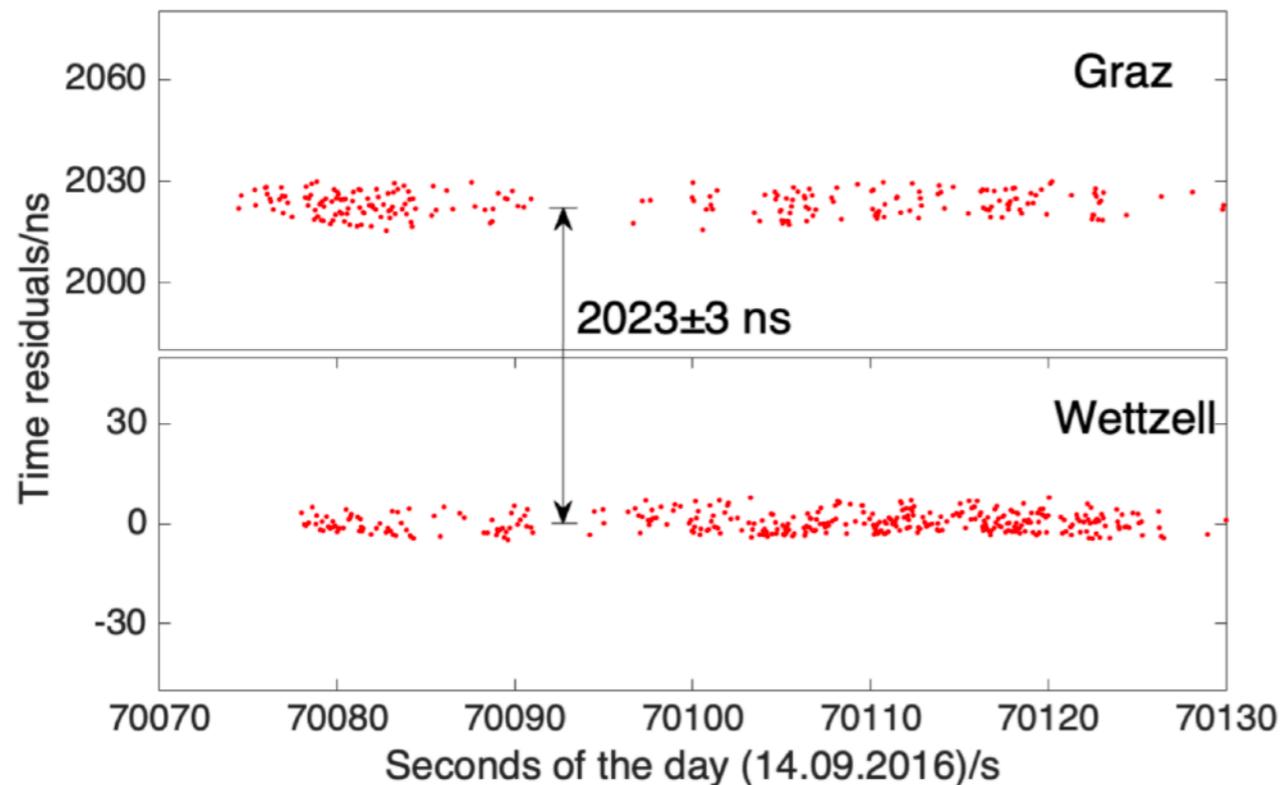
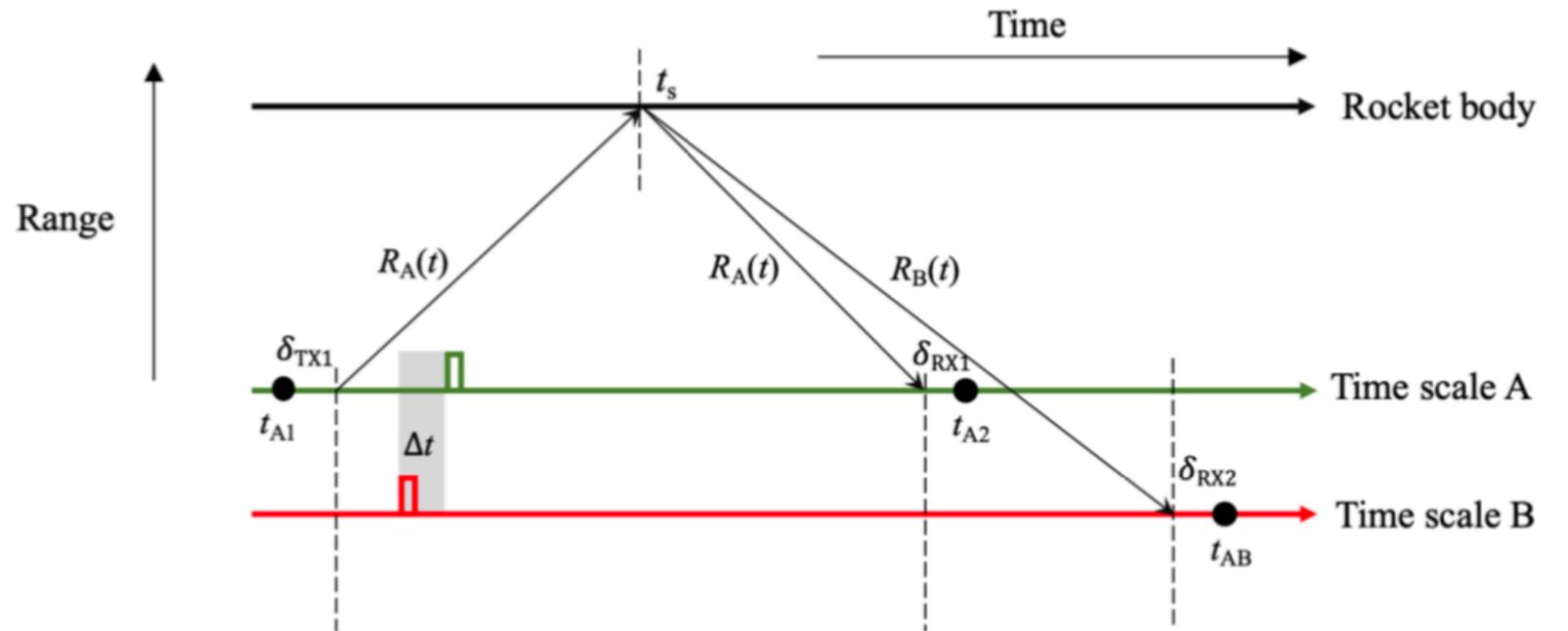


- ACES is scheduled for Launch on Space X in the 2nd half of 2021
- Restricted target: Wettzell obtained (laser safety) clearance recently
- The Transponder SC is propagating the requirements to particular stations - exquisite timing is required
- Missions SC has to expect the tracking request shortly: (we are currently collecting a signature from ESA)
- In order to save weight and power, the complexity of the time transfer is on the ground station
- Most notable is the requirement for the control of the laser fire epoch and to record the start epoch with ps- resolution

**Chance for the community to compare MWL and SLR ranging**



## optical time transfer by diffuse reflection



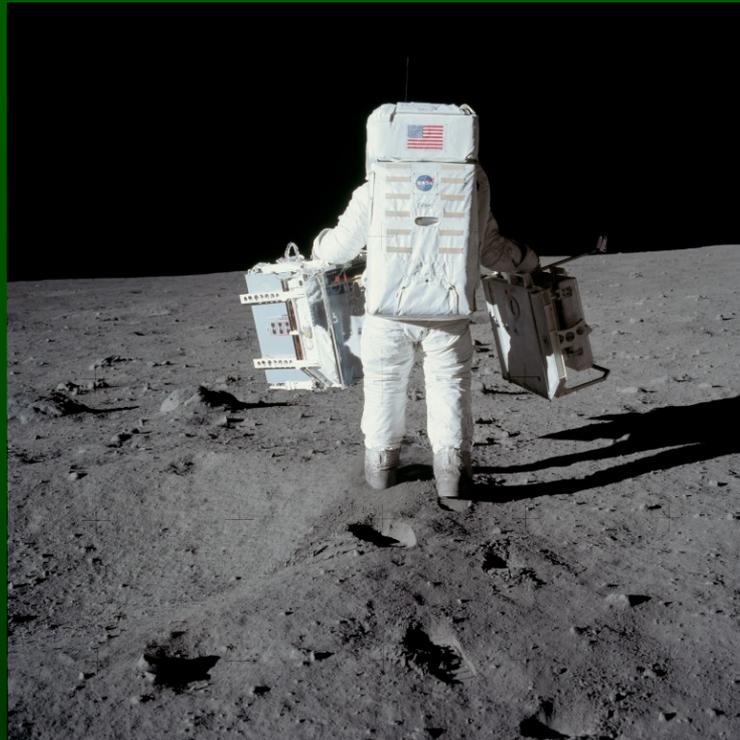
- highly dynamic problem
- we require the orbit and the target motion
- On the first attempt the two clocks could be sync'ed with 3 ns rms
- Monostatic experiments suggest that it may go well below 1 ns.

# ILRS Governing Board

## LLR Report

*Jean-Marie Torre*, Université de Nice Sophia-Antipolis, Observatoire de la Côte d'Azur, Géoazur,  
2130 route de l'Observatoire, 06460 Caussols, France.

*Ulrich Schreiber*, Technical University Munchen, Geodetic Observatory, Wettzell, Germany.

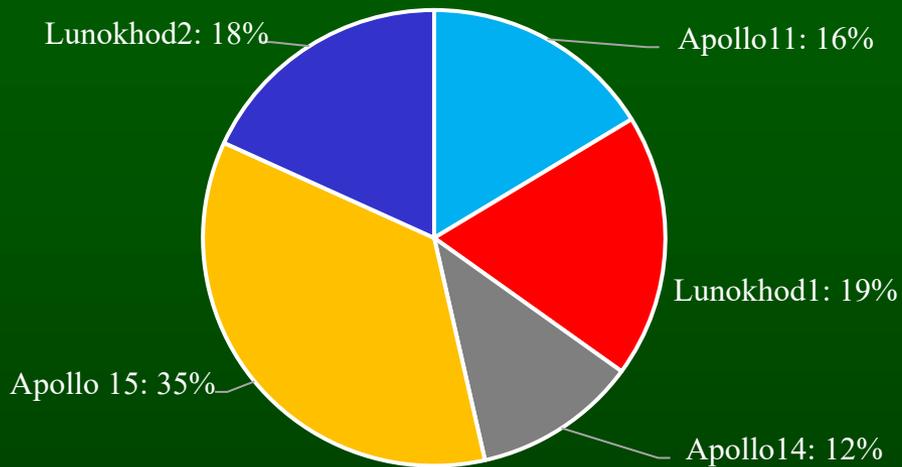


# Lunar Laser Ranging Network

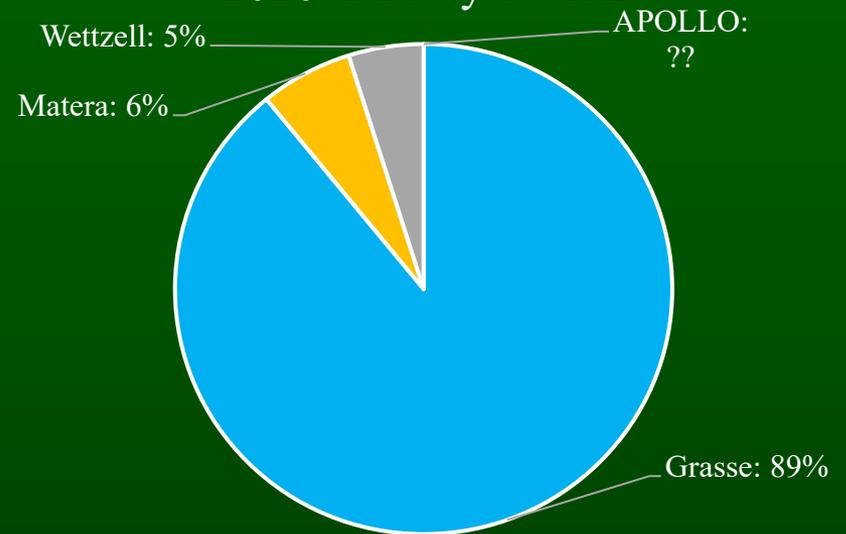
- **APOLLO**, (USA): no recent news, but the station could stop in February if no one wants to take Tom's place.
- **Grasse**, (France): no change.
- **Matera**, (Italy): they analyzed the problem of Luna17 which has never been observed by MLRO. The problem was related to the original MLRO software. For 2021 they expect a  $\approx 70\%$  increase in the number of returns. An optimization of the FOV is programmed.
- **Wettzell**, (Germany): no LLR observations after July, because the system is under refurbishment. Come back on shortly.
- **Kunming**, (China): no news.
- **Altay Optical-Laser**, (Russia): no news.

# Results: 2020 - November 2020

2020: NPs by reflector



2020: NPs by station



# Analysis Centers

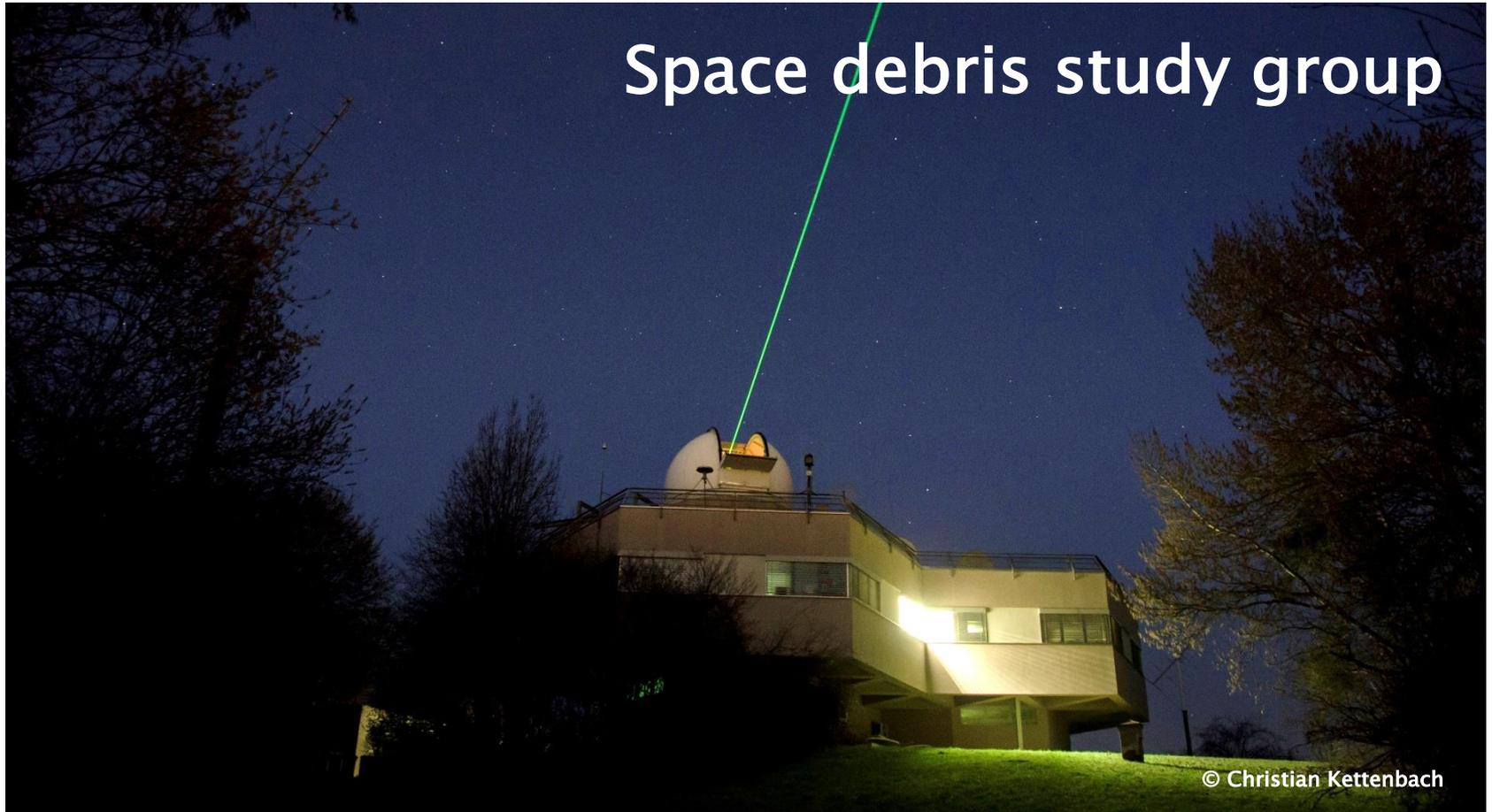
- **Institute of Applied Astronomy Russian Academy of Sciences (IAARAS), Saint Petersburg (Russia):** Dmitry Pavlov stopped working on the LLR.

# First Lunar Laser Ranging Meeting

- In this year we had planned and organized a novel type of community meeting in order to reorganize the LLR activities more coherently and close the loop between the observation and the analysis side. While a lot of different groups have their stakes in LLR, there is no common agenda and the goals differ a lot from one group to the other. In order to find more synergy and common interest, this meeting should also recognize and redistribute some of the responsibilities. Due to the COVID-19 threat, the meeting was put on hold and we expect to host it at the earliest convenience, hopefully in 2021. Due to the organizational and partly controversial matters to handle, it is definitively not suitable for a virtual meeting.
- <https://llr2020.sciencesconf.org/>

# GOVERNING BOARD

## Space debris study group



© Christian Kettenbach

Michael Steindorfer, Daniel Kucharski, Georg Kirchner  
Institut für Weltraumforschung, Österreichische Akademie der Wissenschaften

$$C = \frac{F_{\text{star}}}{F_{\text{sky}}} \approx \frac{1}{A_{\text{star}}} 10^{\frac{m_{\text{sky}} - m_{\text{star}}}{2.5}} \approx \frac{1}{\Theta_a^2 \pi} 10^{\frac{m_{\text{sky}} - m_{\text{star}}}{2.5}}$$

# DAYLIGHT SDLR

## Visual detection of stars/satellites during daytime -> !! It's all about contrast !!

1) Airy disc -> telescope aperture

2) Magnitude difference: sky vs. star

3) Camera: FoV/pixel = Airy disc

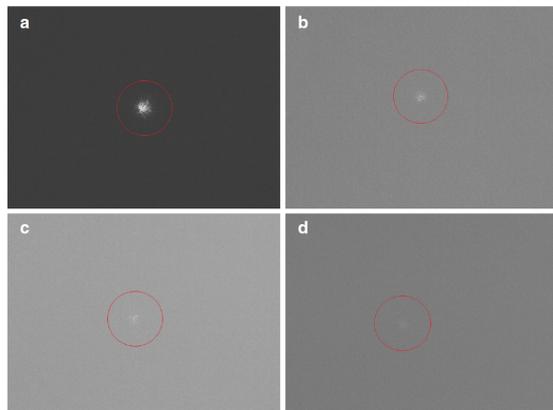
4) Seeing: Exposure time low enough to freeze seeing (a few milliseconds -> CMOS)

- Speckles: individual images of star according to seeing bubbles
- Exposure time low enough: each image Airy limited, no effect on contrast

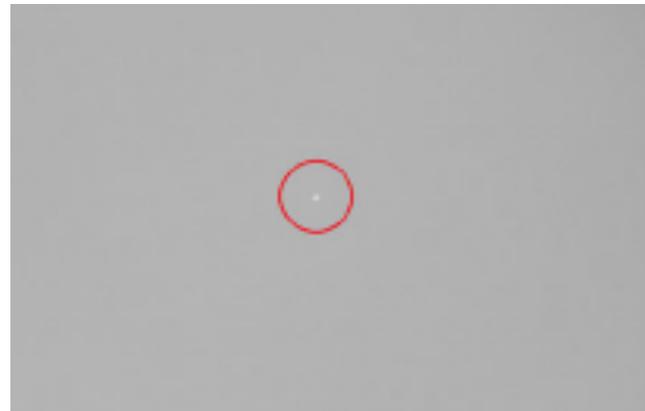
Undersampling	Oversampling
object < FOV/pixel	object > FOV/pixel
↓↓ contrast ↓↓	↓↓ magnitude limit ↓↓

Stars, ASI 120

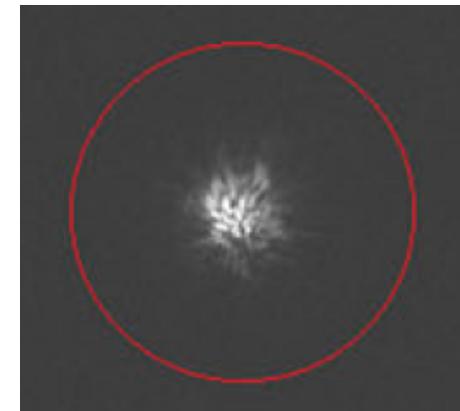
a)  $m = 0.15$ , b)  $m = 3.00$ , c)  $m = 6.95$ , d)  $m = 8.25$



Space debris, ASI 1600 (crop)  
Rocket body SL-12 R/B



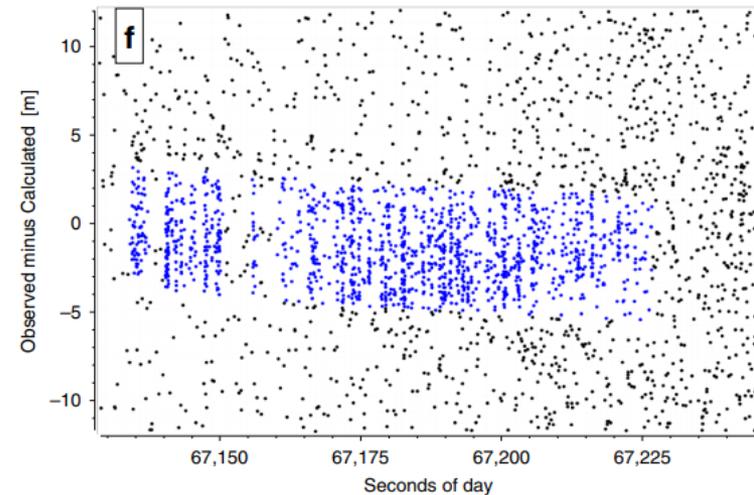
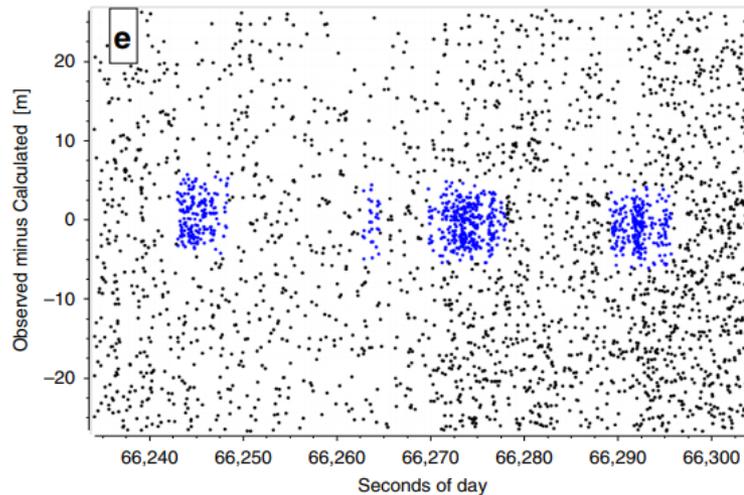
Speckles of star  
millisecond exposure



# DAYLIGHT SDLR

## Four successful daylight space debris laser ranging passes

- Maximum sun elevation of four passes:  $39^\circ$
- Automatic detection of space debris objects -> correction of time and range bias
- Centering targets in field of view -> reduced search area on sky
- Examples: Two different SL16 rocket bodies (NORAD: 23705, 20511)

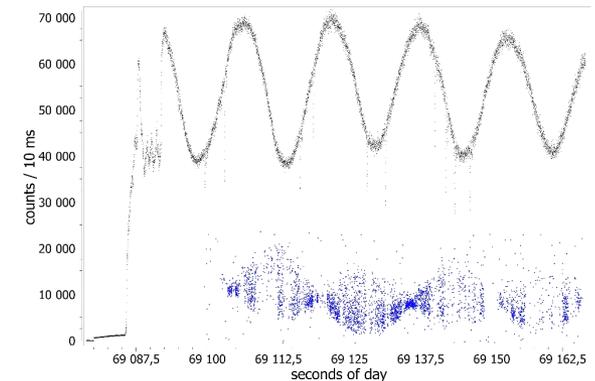
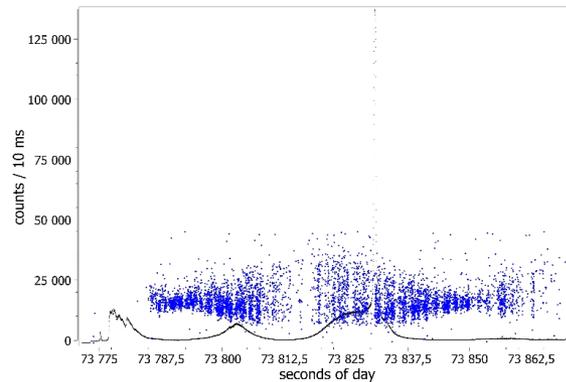
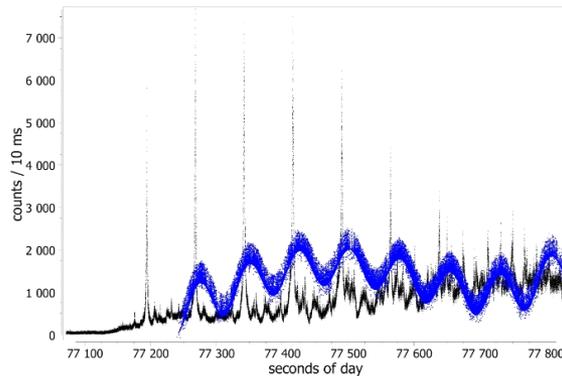


- Paper in Nature Communications -> increased public awareness of space debris related topics

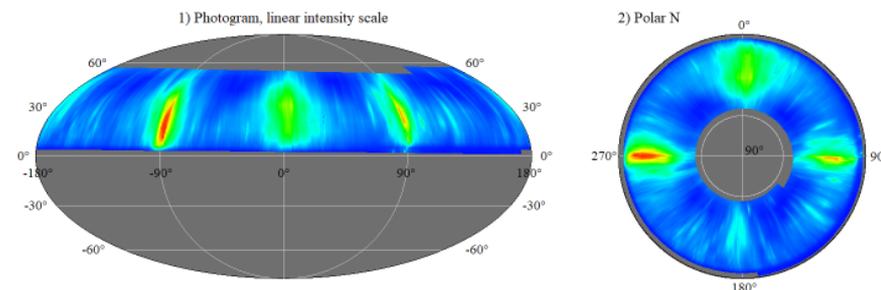


# SPIN-UP OF JASON 2

- Jason 2: observed tumbling since approx. May 2020
- Spin period: day 139/2020 + 147/2020 + 148/2020 --> approx. 71s / 83s / 87s
- Below: SLR + single photon light curve (simultaneous, superimposed)
- Left: Jason 2; Center: H2A debris (NORAD 38346); Right: SL16 R/B (NORAD 25407)



- Daniel Kucharski et al.: Quanta photogrammetry (Jason 2)
- Unique „fingerprint“ at current attitude (phase vector projection: inertial -> body fixed)

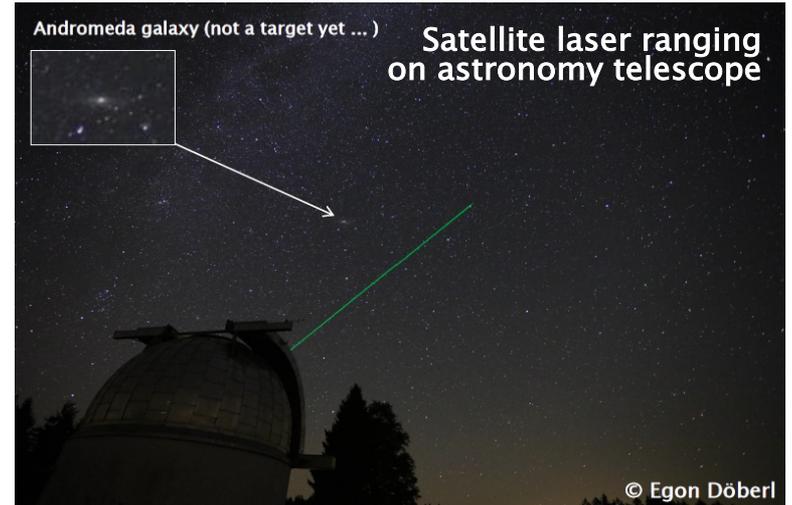
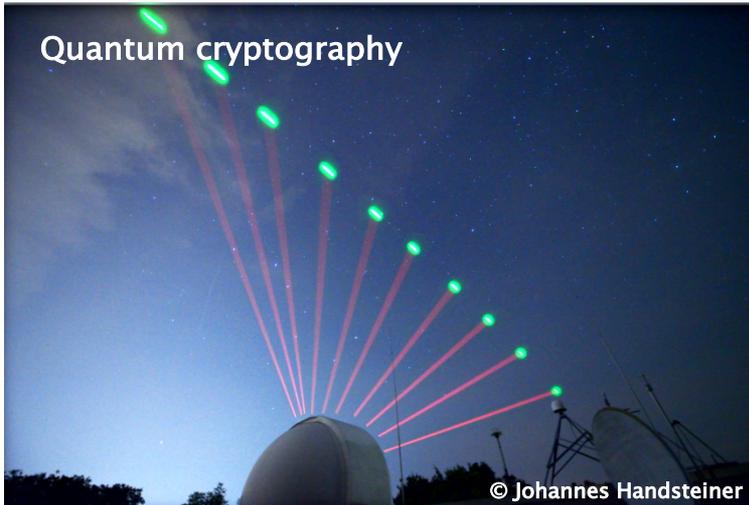


## SDSG ACTIVITIES

- **Tumbling Motion Project**
  - Screening campaign (spin status: different objects // various orbital regimes)
  - Attitude determination methods (Epoch, Amplitude, Quanta fotogr.)
  - Data fusion (Single photon + optical light curves + SLR + SDLR + Imaging Radar)
  - iOTA software (Tumbling Motion and attitude prediction)
  
- **ESA Expert Center**
  - Coordination / tasking / data acquisition / campaigns of multiple sensors
  - Quality control: data calibration / validation (mono- and multistatic, optical)
  - Data formatting
  - Campaigns with Potsdam / Borowiec / AIUB

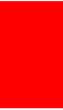


! THANK YOU !



# Progress of preparing for 22th SLR workshop

Zhang Zhongping, Li Yuqiang



# Outline

1. General arrangement of 22nd International Workshop
2. Accommodation: Empark Grand Kunming Hotel

# General arrangement of 22nd International Workshop

1. Date: 2<sup>rd</sup>-6<sup>th</sup>, November, 2020
2. Hotel : Empark Grand Kunming Hotel (Five-star and four-star)



The workshop date has been postponed  
and the hotel did not change.

1. Date: 25<sup>th</sup>-30<sup>th</sup>, October, 2021
2. Hotel: Empark Grand Kunming Hotel (Five-star and four-star)

# Empark Grand Kunming Hotel

Founded by Huang Ru-Lun - the famous industrialist and patriotic Philippine-Chinese, Century Golden Resources Group is an international comprehensive trans-industry group. All the staff of the hotels is comply with the "intelligence services, hard work," business philosophy, to warm and thoughtful service, has won high praise at home and abroad guests.



# room photoes



North tower standard room



South tower standard room

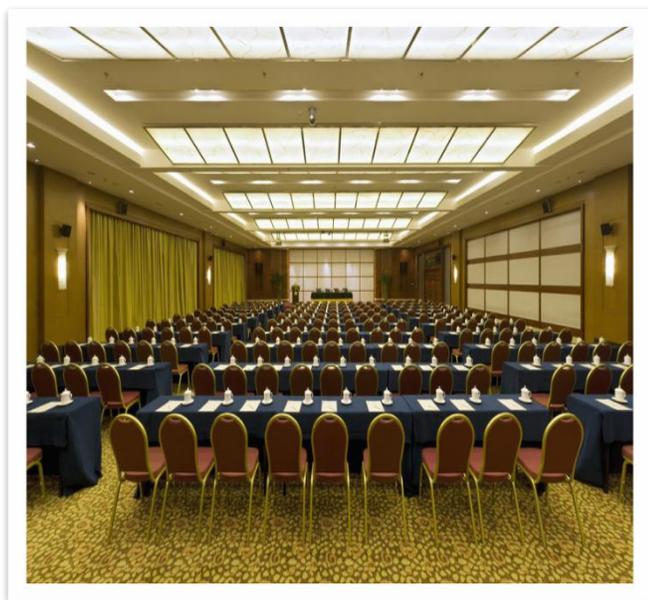


South tower superior room



South tower deluxe room

# meeting room photoes



Beginning of this year, we have established a website for the workshop, including registration, abstract submission, hotel book and other helps/questions.

# 22nd International Workshop on Laser Ranging

November 02-06, 2020, Kunming, China

[Home](#) [Organizing Committee](#) [Programme](#) [Registration](#) [Abstract Submission](#) [Book Hotel](#) [Payment](#) [Help/Question](#)

- Home
- Welcome
- Sign In
- Organizing Committee
- Important Dates
- Programme
- Session List & Chairs
- Invitation & Visa
- Venue & Accommodation
- About Kunming
- Tours Information
- About Us
- Contact Us



### News

[1st Announcement](#)

**Notice**

### Date & Location

~~November 02-06, 2020~~ **Postponed to 2021**

Yunnan Observatories, Chinese Academy of Sciences  
Kunming, China

[About Us](#)  
[Contact Us](#)

### Important Deadlines

Deadline for Submission of Abstract : ~~September 15, 2020~~ **Postponed to 2021**

Deadline for early bird Registration : ~~October 15, 2020~~ **Postponed to 2021**

Deadline for Hotel Registration : ~~October 15, 2020~~ **Postponed to 2021**

### Sponsors

~~November 02-06, 2020~~ **Postponed to 2021**

International Laser Ranging Service  
Yunnan Observatories, Chinese Academy of Sciences

# completed things

	2020	2021
1st Announcement	The organizers are open for ideas and suggestions.	The organizers are open for ideas and suggestions.
Conference Agenda	under progress	under progress
Session List	scheduled	scheduled?
Deadline for Submission of Abstract	Sep. 15th	Maybe Sept. 10th
Deadline for early bird Registration	Oct. 15th	Maybe Oct.5th
Deadline for Hotel Registration	Oct. 15th	Maybe Oct. 5th

Though the workshop is postponed to next year, we have arranged some important matters this year.

We have formed  
committees and  
local committees.

## Committees

### International Program Committee: ( in alphabetical order by last name )

Yaoheng Xiong, Yunnan Observatories, CAS, China (chair)

Toshimichi Otsubo, Hitotsubashi University, Japan (co-chair)

Zhongping Zhang, Shanghai Data Center, China (co-chair)

Sven Bauer, Helmholtz Centre Potsdam/GFZ, Germany

Daniel Hampf, DLR, Germany

Evan Hoffman, NASA, USA

Georg Kirchner, Space Res. Inst., Austrian Acad. of Sci., Austria

Yuqiang Li, Yunnan Observatories, CAS, China

Chengzhi Liu, Changchun Observatory, NAO, China

Cinzia Luceri, e-GEOS S.p.A, ASI/CGS Matera, Italy

Stephen Merkowitz, NASA, USA

Erricos Pavlis, NASA JCET/UMBC, USA

Michael Pearlman, CfA, USA

Ivan Prochazka, Technical University of Prague, Czechia

Tomasz Suchodolski, Space Research Centre of PAS, Poland

Matt Wilkinson, NERC Space Geodesy Facility, UK

You Zhao, National Astronomical Observatories, CAS, China

### Local Organizing Committee: ( in alphabetical order by last name )

Yuqiang Li, Yunnan Observatories, CAS, China (chair)

Chunmei Zhao, Chinese Academy of Surveying and Mapping, China (co-chair)

Xue Dong, Changchun Observatory, NAO, China

Honglin Fu, Yunnan Observatories, CAS, China

Xingwei Han, Changchun Observatory, NAO, China

Lijuan He, Yunnan Observatories, CAS, China

Rongwang Li, Yunnan Observatories, CAS, China

Zhulian Li, Yunnan Observatories, CAS, China

Xiaoyu Pi, Yunnan Observatories, CAS, China

Xiaoli Su, Yunnan Observatories, CAS, China

Zhibo Wu, Shanghai Observatory, CAS, China

Dongsheng Zhai, Yunnan Observatories, CAS, China

Haitao Zhang, Yunnan Observatories, CAS, China

Jie Zhang, Innovation Academy for Precision Measurement Science and Technology, CAS, China

Yu Zhou, Yunnan Observatories, CAS, China

# Session list scheduled

## **Session List and Chairs**

scheduled

- 1. Welcome and introduction**
- 2. Scientific Achievement, Application and Requirement**
- 3. Satellite Missions and Retroreflector Arrays**
- 4. Station Stability and Systematic Errors**
- 5. Advanced Technologies, Software and Automation**
- 6. Network Operations and Station Upgrades**
- 7. Lunar Laser Ranging and Deep Space Missions**
- 8. SLR beyond Geodesy (Debris ranging, Transponders and Time Transfer etc.)**
- 9. Summary (including Next Workshop)**
- 10. Clinics**

- Despite the date of 22th workshop is postponed to the second half year of 2021, but there still exists the uncertainty because of the influence of COVID in 2021.
- It is better that we may decide whether the workshop can be hold up or not in June next year, according to the disease condition over world.
- We can also discuss the possibility of the online workshop.
- We hope the disease disappear from the earth as soon as possible and see all of you in beautiful Kunming city in 2021.

Thanks

# **Impact of COVID-19**

# COVID-19

- Some ILRS colleagues infected.
- Cancellation/postponement of events. More virtual meetings.
- Short-time closure/reduction at observatories/institutes. Delay in development.
- Observation: Huge drop of data yield avoided. 10-15% less than the past few years.

- SLR: most affected among geodetic techniques.

