20th International Workshop on Laser Ranging

Organized and Sponsored by:

- **Helmholtz Centre Potsdam GFZ**

German Research Centre for Geosciences

- **International Laser Ranging Service**

October 10 -14, 2016
Potsdam, Germany

In memory of…

Bob Schutz/CSR
(1940-2015)

Suriya Tatevian/RAS
(1937-2015)

Bob Coates/NASA
(1922-2016)

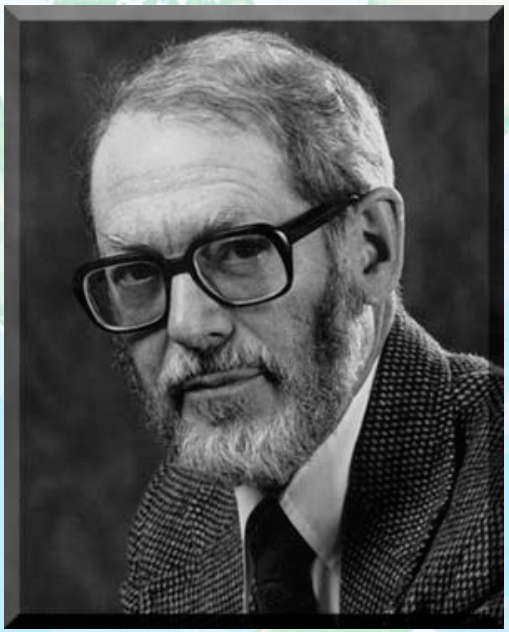
Carroll Alley/UMD
(1927-2016)

Our history

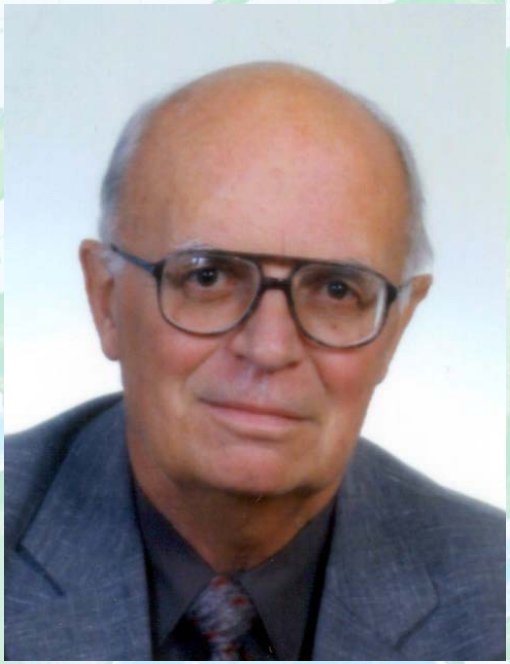
No.	Year	Location
1st	1973	Lagonissi, Greece
2nd	1975	Prague, Czech
3rd	1978	Lagonissi, Greece
4th	1981	Austin TX, USA
5th	1984	Herstmonceux, UK
6th	1986	Antibes, France
7th	1989	Matera, Italy
8th	1992	Annapolis MD, USA
9th	1994	Canberra, Australia
10th	1996	Shanghai, China
11th	1998	Deggendorf, Ger.

No.	Year	Location
12th	2000	Matera, Italy
13th	2002	Washington DC, USA
14th	2004	San Fernando, Spain
15th	2006	Canberra, Australia
16th	2008	Poznan, Poland
17th	2011	Bad Koetzing, Ger.
18th	2013	Fujiyoshida, Japan
19th	2014	Annapolis, MD
20th	2016	Potsdam, Germany
21st	2018	Canberra, Australia

Fathers of the Workshop



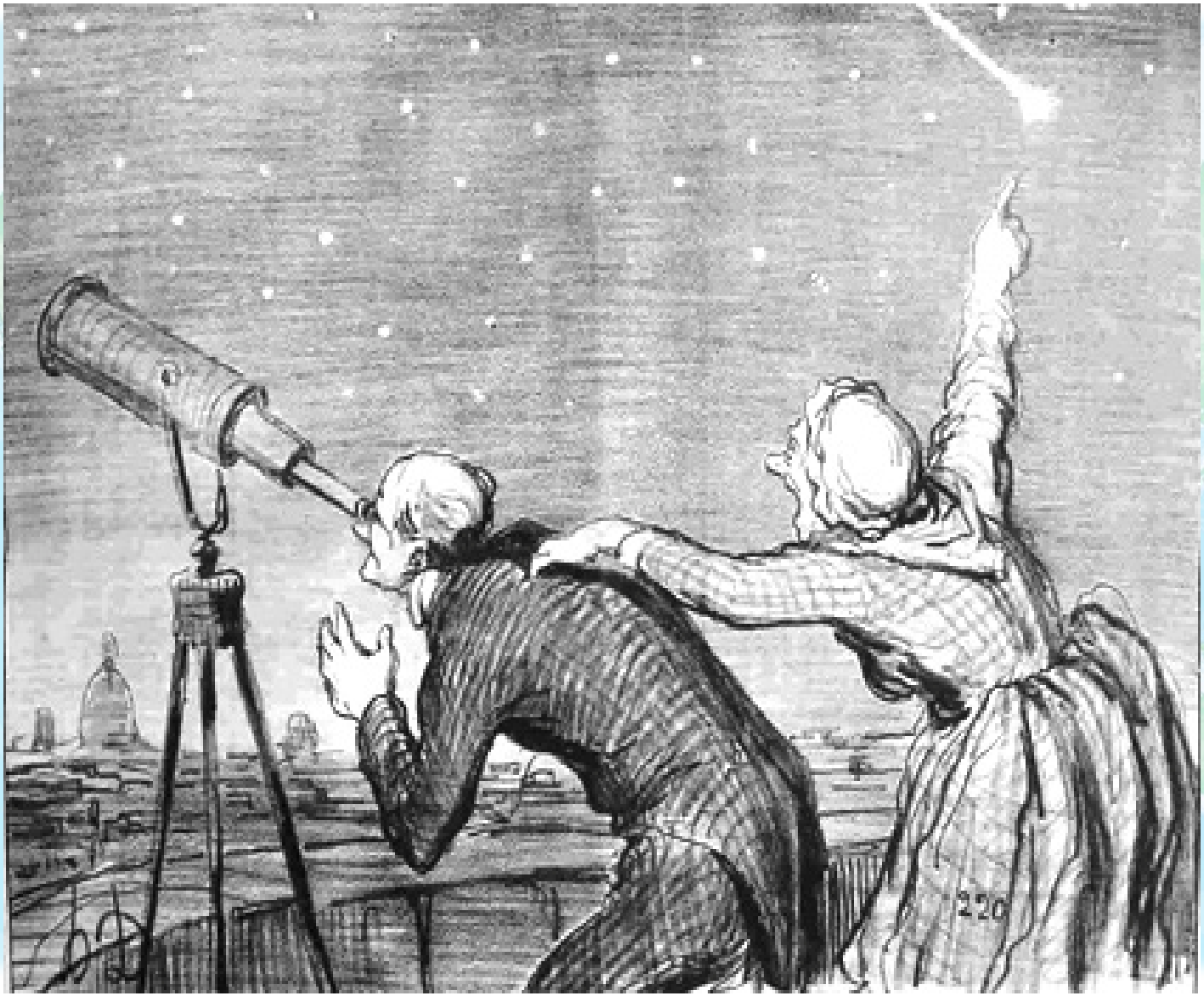
George C. Weiffenbach
1921 - 2003



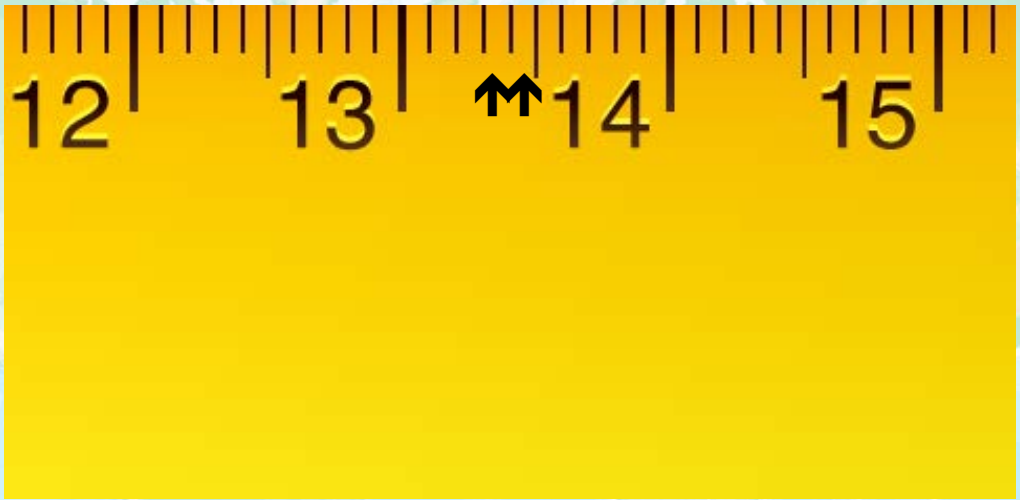
Karel Hamal
1932 – 2007

To provide an opportunity for engineers, practitioners, analysts and scientists to meet to exchange ideas, to compare technologies, to connect the measurements with the science, and to discuss the path forward.

Early View of Laser Ranging



And now – millimeters



Make the Workshop a Success

- Keep presentations short and allow discussion
- Participate in Station Clinics on Tuesday afternoon
- Visit the Poster Sessions: Addendum to the Oral Sessions, Missions, Stations, and General Topics
- Participate in the Standing Committee and Study Committee meetings
- Visit the Potsdam SLR Station
- All Workshop Sessions; Standing Committees and Study Committees should provide:
  - Short (5 min) and written (1 -2 chart) reports at the Summary Sessions on Friday morning and afternoon from: (Focus on things that are new/important and issues that we need to address)
- All oral presentations and posters should provide short written papers (5 pages max) for the proceedings
- Most of all – Meet, talk, exchange ideas with others and enjoy.

International Laser Ranging Service

Overview

Michael Pearlman
Carey Noll
ILRS Central Bureau

20th International Workshop on Laser Ranging
October 10 - 14, 2016
Potsdam, Germany

Current successes (1 of 2)

- Continue to coordinate, develop global standards/specifications and encourages international adherence to its conventions;
- Update of ILRS Terms of Reference approved by the IAG with some corrections; includes expansion of the GB to 18 members
- Network of tracking stations expanding and upgrading
  - New Russian overseas stations enhancing spatial and temporal coverage
  - NASA's Space Geodesy Project upgrading current stations and adding new stations to enhance global network
  - Other stations in process and in upgrading
- List of target satellites continues to expand as new missions utilize SLR for orbit determination and other applications;
- New ILRS pass performance standard adopted: 3500 passes/year
- New data Quality Control Board established to address laser ranging data quality issues; evaluation and diagnosis of systematic errors

Recent successes (2 of 2)

- Early use of optical receivers in space improve timing accuracy (T2L2, ACES) and as a step toward optical transponder for extended range
- Official orbital data product on LAGEOS and Etalon satellites now operational (ASC); other data product in the pipe line
- Implementation of ITRF2014 (SLRF2014) in ILRS operational products (ASC)
- Evaluation of the Systematic Error Monitoring Pilot Project and adoption of procedures for development of future operational products (ASC)
- Instituted new leap second procedure for stations (DFPSC)
- Updated Mission Support Request form to include more information (MSC)
- Created Networks and Engineering SC Forum to provide a facility to share ideas, questions, news, and advice (NESC)
- Participating in feasibility studies on tracking space debris targets (SDSG); Multi-static and multi-wavelength SLR to non-cooperative targets

Recent news

- LAGEOS anniversary celebration
  - 40 years: launch May 04, 1976
- Ajisai anniversary
  - 30 years: launch August 13, 1986
- 19th International Workshop on Laser Ranging
  - Sponsored by NASA, SAO, and ILRS in Annapolis MD, October 2014
  - “Celebrating 50 Years of SLR: Remembering the Past and Planning for the Future”
  - Introduction of station clinic sessions
- 2015 Technical Workshop
  - Sponsored by ASI in Matera Italy, October 2015
  - “Network Performance and Future Expectations for ILRS Support of GNSS, Time Transfer and Space Debris Tracking”

ILRS network

In spite of the progress, we still have large geographic gaps

Network developments (1 of 3)

- New systems operational in 2016:
  - SOS-W (BKG) at Wettzell (core site)
  - KASI system at Sejong (core site)
  - Rebuilt systems in Boroweiz and Riga
- Activities in the Russian network:
  - Primary objective GLONASS and LAGEOS, expanding to other GNSS and LEO
  - New station in Hartebeesthoek now in process; planned for late 2016
  - Plans underway for a station at Ensenada, Mexico
  - Discussions underway with CNES for station in Tahiti
  - Other sites being examined
- Activities in the NASA SGP
  - Working deployment plans for core sites in Texas and Hawaii (2018 – 19 timeframe); other sites being explored
  - NMA working with NASA on deployment of SLR system to Ny-Ålesund Core Site (~2019)

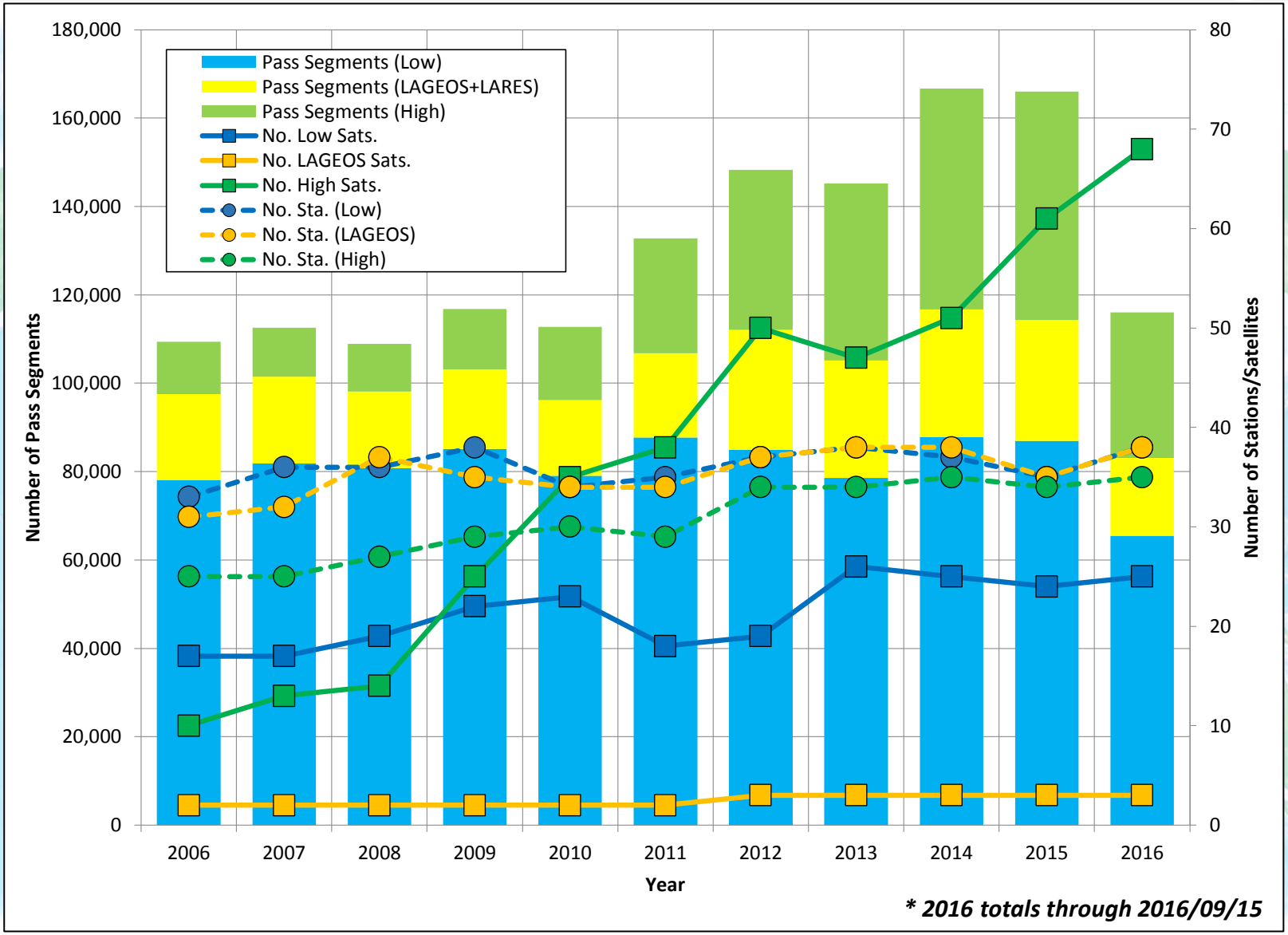
Network status (2 of 3)

- Activities in the Chinese Network
  - San Juan being repaired and upgraded; should be operational in 2017 with Khz ranging
  - Wuhan being repaired and upgraded, should be operational in 2017
  - Shanghai has a 10KHz system and a newly implemented Super-Conducting Nanowire Single Photon Detector (SNSPD): the SNSPD also in use at Kunming;
  - One meter aperture telescope under development at Wuhan; plans to deploy a one of these systems in Xinjian Province in NW China
- Current systems being upgraded or moved:
  - BKG AGGO (formerly TIGO in Concepcion) being setup in La Plata Observatory (core site)

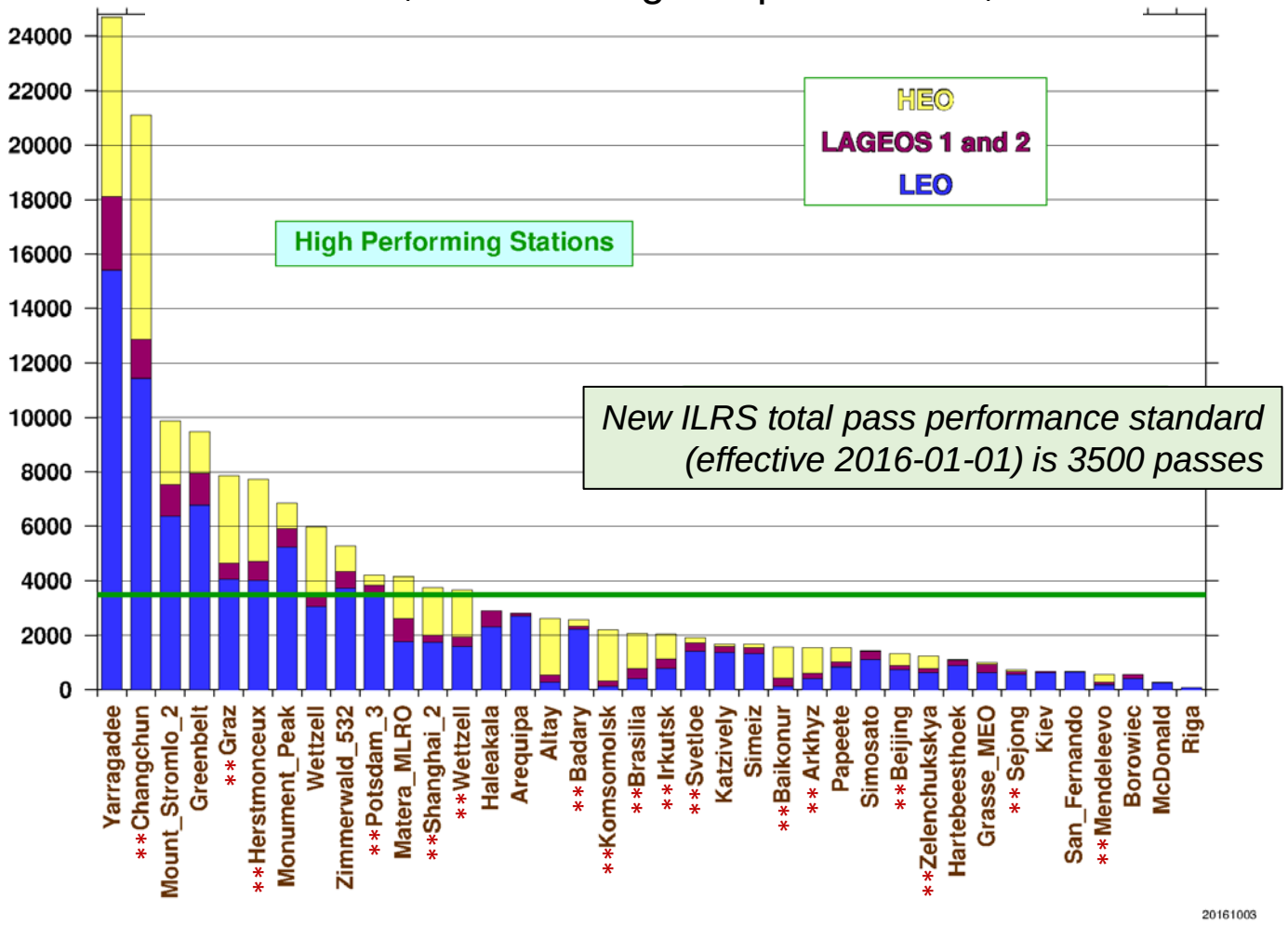
Network status (3 of 3)

- New SLR systems underway:
  - Metsahovi (Core Site)
  - Yebes (Core Site)
  - Mt Abu and Ponmundi in India (2016 – 17); formal ILRS connection need to be made
- Several sites are now working routinely at kHz rates; others planned:
  - Current: Herstmonceux, Sejong, Wettzell (SOS-W), Changchun, Beijing, Shanghai, Potsdam, Graz
  - Future: SGSLR (McDonald, Ny Ålesund, Hawaii, …), others?
- Riyadh station not operational;

Yearly pass segment totals (by satellite type)

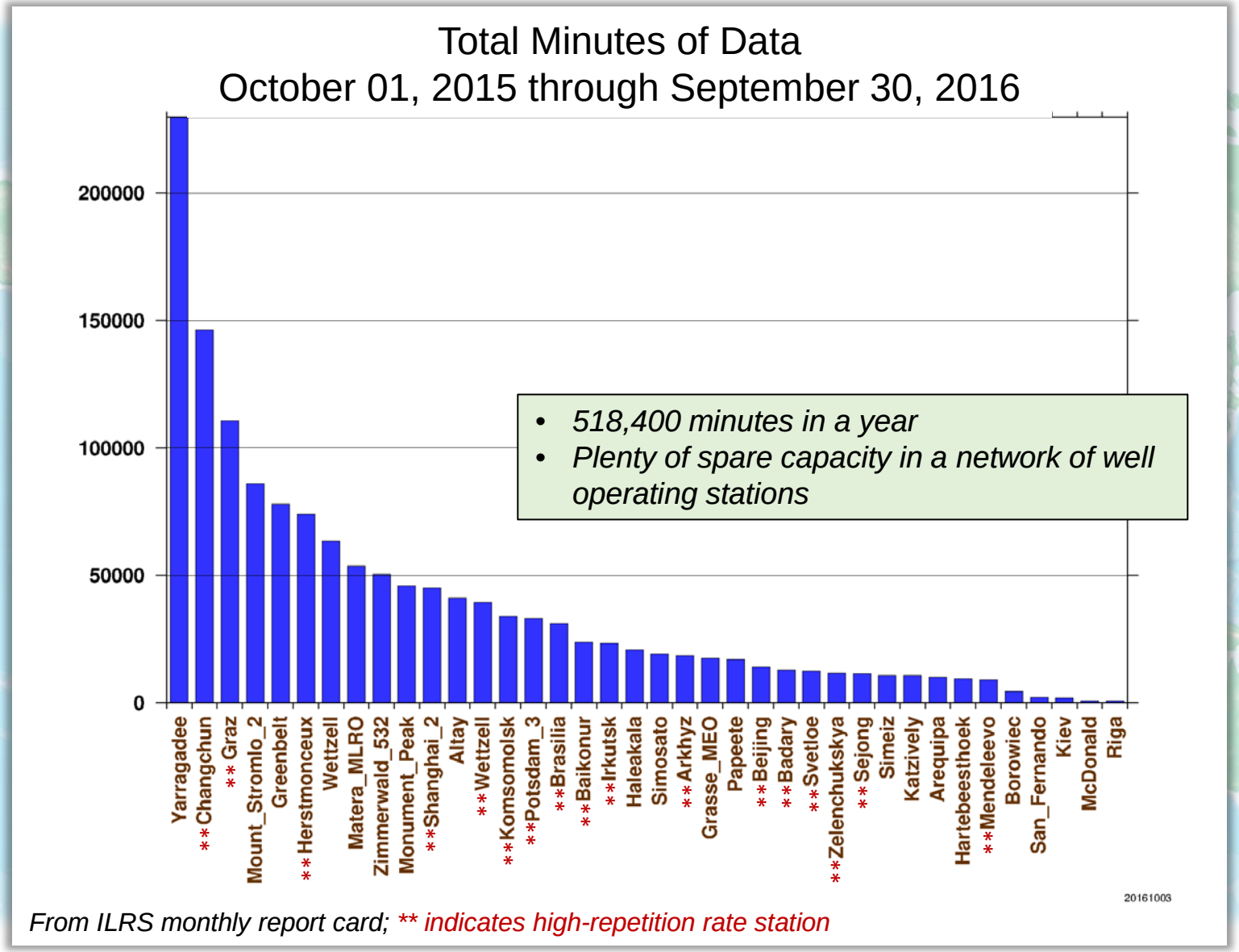


Network performance (1 of 2)



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

Network performance (2 of 2)



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

Issues & challenges

- Filling gaps in network global coverage; many geographic gaps still exist primarily in Latin America and Africa
- Implementing new systems and upgrades to overcome the present mix of new and old technologies; trying to get more standardization in system hardware and operations
- Addressing SLR data bias issues as the ILRS strives for mm accuracy
- Supporting the increasing list of targets (90+), many now at GNSS and synchronous altitudes; are we momentarily saturated?
  - Need to implement more effective tracking strategies
  - Be more selective in the targets
- Understanding who are our users and are we satisfying their needs
- Supporting new missions in order to contribute to a broader range of scientific and operational applications
- Exploring more efficient retroreflector arrays designs for GNSS and geodynamics satellites