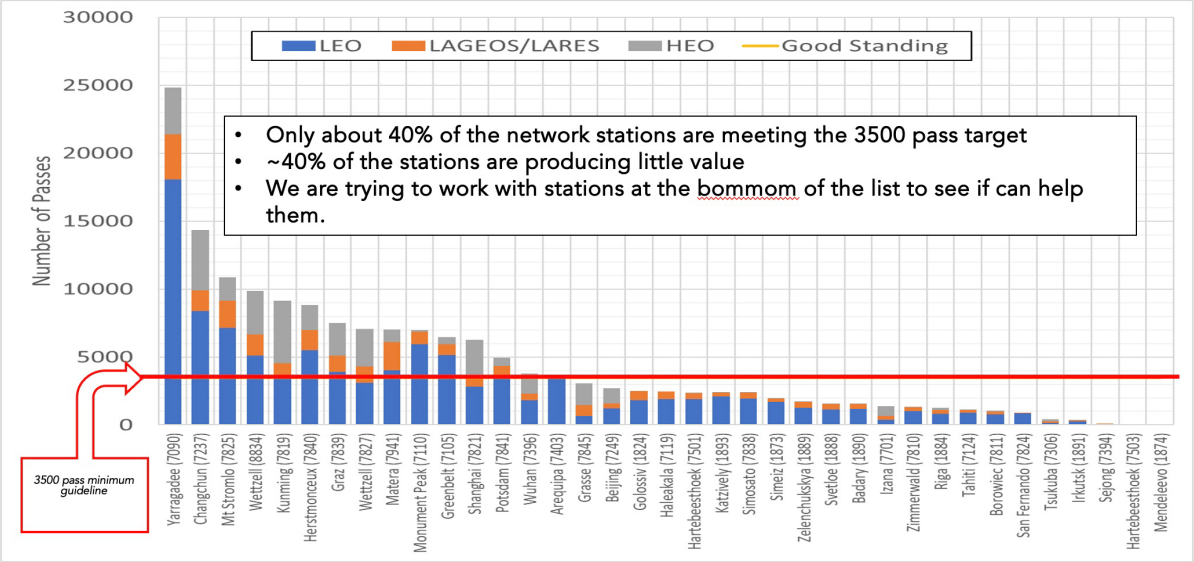
Stations Survey and Plans – Mike Pearlman:

Station Performance for 2023:
Station Performance for 2023 was used to decide which station to approach and try to understand issues that impacted their performance.



- We started a program with 10 stations at the bottom of the list, or stations whose data yield has fallen off; We also chose a few higher performing stations to broaden out the sample;
- We developed a questionnaire to ask stations some questions about their operations, data, procedures, their modes of failure, etc. to give us some basis for a dialogue with them; questions included are given on the next page;
- This first list of stations included Zelenchukskaya, Irkutsk, Mendeleevo, Svetloe, Badary, Moblas-6, Moblas-8, Borowiez, Metsahovi, Graz, Riga, and Simosato;
- We established a review team including Van Husson, Randall Carman, Matt Wilkinson, Clement Courde, You Zhao, Mike Pearlman, Alexandre Belli, Claudia Carabajal.

Our plan was to review the responses from the stations, and begin a dialog with them;
Much to our surprise, all except one station filled out and returned the questionnaire;
Our team has met, reviewed their answers, and are now preparing our responses back to the stations. In general, we think the stations were candid, but we will have to probe deeper to get more detail.

The questions asked included:

- Can your station track the full ILRS target list?
- Does your station track during day and night?
- How many days a week does your station operate?
- How many hours per day does your station operate?
- Are there additional tracking priorities beyond SLR?
- How could your station improve its tracking capability?
- Which targets are difficulty to acquire?

- Can you track GNSS in day-time and nigh-time conditions?
- Do you have lunar ranging capability?
- Does your station interleave satellites?
- Are there restrictions on SLR in azimuth and/or elevation?
- Do temperature changes impact target acquisition rates?
- What is currently limiting data volume?
- What would make a significant improvement in your station's tracking capability?
- Is your station fully supported?
- Is your station funded to observe continually?
- How often is the work of your station reviewed?
- How many full time and part time staff work at your station?
- Do staff have other duties to make them unavailable to observe?
- Is your tracking operational pattern likely to change soon?

Other meetings will be held to wrap up the process, and decide if the Survey needs to be updated, and which stations need to be contacted next.

Station Quarantine Process:
José Rodríguez discussed the situation with stations that have the capability to range with two different wavelengths, and how the analysis is done to release the data from quarantine (like Tsukuba, Tenerife (Izaña) and Yebes). His opinion is that the stations should not be subject to pass quarantine separately for every wavelength. Stations want to be out of quarantine as soon as possible. If the station has the capability to range with two wavelengths, the ASC needs to characterize both. They need to accept data at whatever wavelength is provided.
San Fernando Station will also be coming back online soon.
This is a topic that will be discussed at length during the Kunming Workshop.
These discussions should also take place at the NEWG meetings.
Andreja mentioned that Yebes CoM tables state 2 values, one for each wavelength, for LAGEOS-1 (2.467 and 2.478). Wetzell does not indicate different values.

Action: There needs to be a group dedicated to resolve the appropriate procedure and updating the Quarantine Procedures as stated in the ILRS webpage, so they can be communicated to the Stations.

Stations/Mission Updates: • Contributions from Van Husson:
Simeiz (187) Epoch Errors
Simeiz (1873) data in September 2024 was exhibiting some large varying epoch errors because their station time was not being synched to UTC. Van raised the question of what's the best approach to document bad data. Is the best approach for all end users to document the period of bad data in the Data Handling File (DHF)? There was very little discussion on this topic and Van didn't get a response from the ASC either on this topic.

Geodetic System Performance Comparison: Yarragadee (7090) versus Mt Stromlo (7825)
This was a historical data volume comparison of geodetic satellite data from two high performing systems in Australia. One system, Mt Stromlo, is fully autonomous while the other

one, Yarragadee, is not. Yarragadee has for a number of years been the ILRS gold standard in terms of data yield (passes and normal points).

Yarragadee (7090) MINICO Results and the 2024 Local Survey
MINICO results can be impacted by systematic errors in the station. The operator who took the MINICO test can make a difference in minimizing certain systematic errors, like signal strength. Historical Yarragadee MINICO results since 2017 seem to indicate a net 5 to 6 mm change in the relative calibration distances to its three calibration piers. The RMS scatter of the MINICO results have increased in 2023 and 2024 for some unknown reason, but this could be an indicator in system performance degradation. It was also mentioned that Yarragadee single shot RMSs (satellite and calibration) have been trending upward since 2023 with currently no explanation (See ilrs.cddis.eosdis.nasa.gov/network/stations/active/perfPlots/YARL_Lageos_RMS_Monthly.html)

Retroactively applying the new survey results to the MINICO results in 2024 improved the daytime MINICO results but not the nighttime results.

Summary of Stations using the LE Filter
Two tables of the six systems that have implemented a Leading-Edge (LE) filter were presented showing:

1. the edit criteria being used (based on the site log) on the different geodetic satellites
2. the LAGEOS fullrate data filter approach and corresponding filter flags

These tables show a lack of standardization for the LE systems in the edit criterion and how the processing of fullrate data is handled. Jose at a previous QCB meeting discussed that perhaps all systems should provide their fullrate data based on a +/- 5 sigma edit and indicate with the filter flag which data was kept when forming normal points. This recommendation was never communicated to the stations.
Action: The QCB to develop a recommended approach for handling of fullrate data and then inform the stations.

LAGEOS and Calibration Single Shot RMSs from the LE Systems
LAGEOS RMS charts (pass-by-pass and monthly) from the ILRS website were presented from the six LE stations. There are some interesting trends in the RMS charts before and after the LE filter was implemented.

It was noted that Shanghai (7821) LE single shot RMSs on LAGEOS can be as low as 2 mm, which seems suspect. It was also noted that Shanghai calibration RMSs were higher than LAGEOS RMSs until October/November 2023. Post meeting based on their station's change history; the drop in Shanghai calibration RMSs was due to a new laser (5 kHz) and APD (100µm) detector being installed.

The DiGOS developed systems (Izaña [7701] and Tsukuba [7306]) LAGEOS single shot RMSs using the 20 mm LE filter are higher than the other 20 mm LE stations.

Yebes (YEBL 7817) Data Analysis

In the current site log, the only edit criteria mentioned is a 2.2 sigma filter. By analyzing the Yebes fullrate data using OrbitNP; it appears some form of LE filter is being applied to all four geodetic satellites. Also based on OrbitNP analysis, the FullRate (FR) filter flag used to indicate data and noise and excluded returns are not always correct.

There are a few cases where the corresponding FR observation that coincides with the NP time-of-flight's epoch is flagged as 'noise and excluded'. This violates the Herstmonceux NP algorithm. The NP epoch is always based on the 'accepted' FR observation who's epoch is closest to the mean of all accepted FR observation epochs within the normal point bin.
Based on analyzing Yebes LARES-2 RMSs, skew and peak minus mean statistics, it appears the type of LARES-2 filter being applied changed on 17-Jun-2024.

There a few Yebes's passes that exhibit bimodal distributions where there is a 60 to 90 mm separation between the two distributions. The distance between these two distributions may indicate a signal processing issue and not a satellite signature issue, but there was little discussion on this topic.

During the quarantine period most of the Yebes data was taken in the infra-red (1064 nm). The infra-red data including calibration data was more self-consistent than the data taken in green (532 nm).

The station needs to take the following **Actions**:

- Update their site log to indicate the correct data filter being applied
- Update the station's height
- Resolve the full rate filter flags issues

Message regarding system delays for Yebes and LAGEOS-2 - Husson, Van (PERATON)

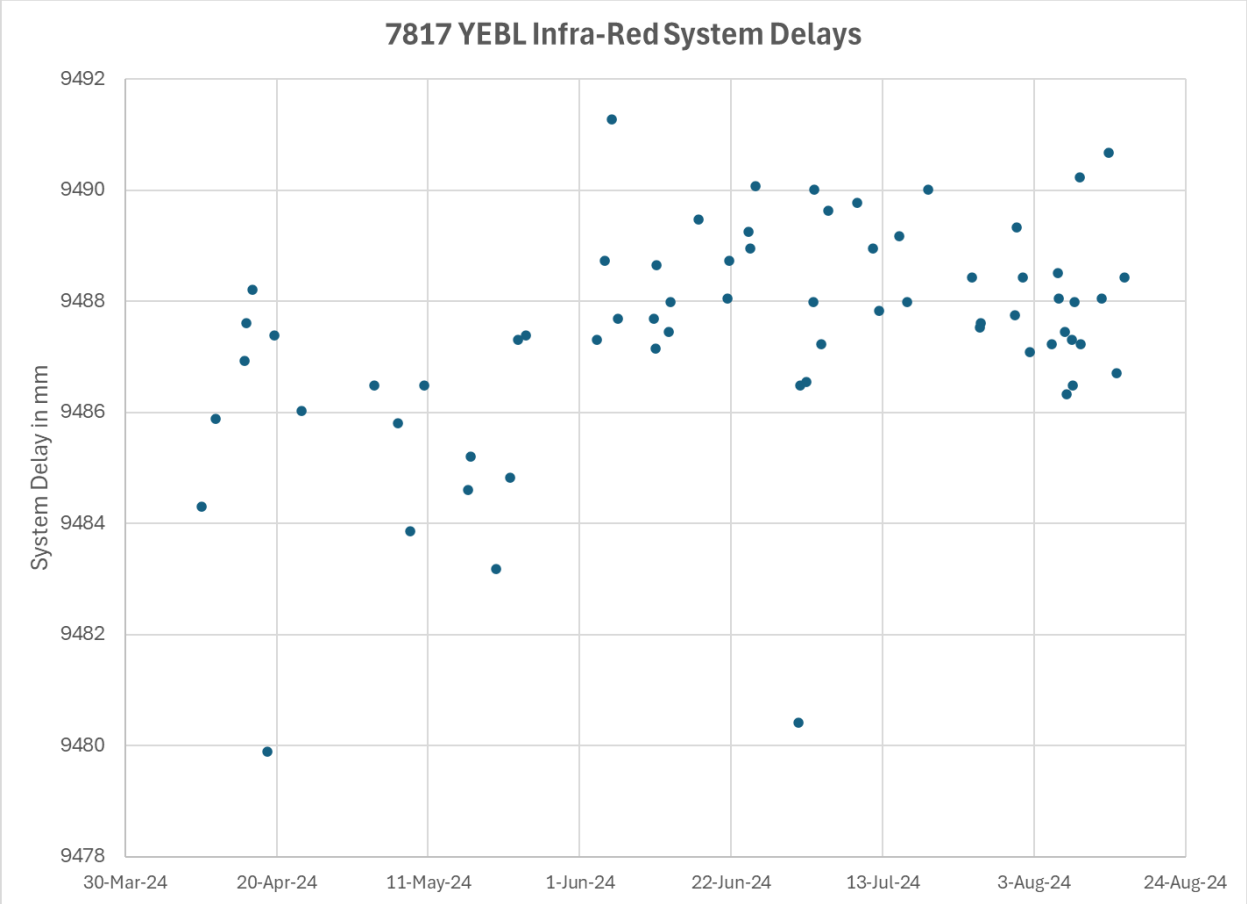
Thu 2024-10-03 18:02

To: Lemoine, Frank G. Cc: Magda Kuzmicz-Cieslak

"Fyi... Here is a plot of the electronic systems delays from LAGEOS-2. There is a change in delay after June 1. There could very well be a correlation between the bias and system delay which would indicate a calibration issue which we have seen in past systems including NASA systems. When we did collocation analysis back in the 1980's and 1990's, this was a test that we always performed. If there is a negative 1:1 correlation between range bias and system delay, points to a calibration problem. This implies the actual system delay is not really changing and there was a systematic error during the calibration.

This is probably a good test to add to the quarantine analysis (system delay versus range bias).

Regards, Van"



See also other materials related to the Quarantine data analysis for Yebes.

In general, there is concerns that stations are not clearly stating their criteria for using Leading Edge (LE) filter. The flag does not correctly indicate their method in the full rate data.
Stations should be asked to submit all full rate data properly flagged.
Van also expressed concern regarding Chinese stations doing LE, not always properly documented.

Claudia's Updates:
Missions:

- Received Missions SLR Tracking Reports from the first group of LEO missions contacted are under review by the review committee.
- ALOS-4 restricted tracking campaign to start mid-October, satellite checkout taking longer. The mission will inform us when they would like to start.
- Received MSRF from Hideki Yamada from JAXA, for "QPS-SAR" satellite on September 27, planning to launch in 2025. JAXA requested to have the opportunity to re-examine the contents of the request and resubmit to ILRS. MSC review on hold until updated version received.

Future Workshop Sites:

- The 24th International Workshop on Laser Ranging for 2026 will be hosted by the Argentinean CONICET and German BKG (AGGO), if approved during the Kunming, China Workshop. CONICET offers the venue in the center of Buenos Aires, the Argentine capital. More to come.

International Workshop on Laser Ranging – Kunming 2024
Celebrating 60 Years of SLR (1964-2024), Cooperation in the new era of ILRS

- The Yunnan Observatories and the International Laser Ranging Service (ILRS) announced that the 23rd International Workshop on Laser Ranging will be held in Kunming, China during 20-26 October 2024.
- Second announcement sent with change in venue. Workshop website online with the link below (recently updated): https://23rdworkshop.casconf.cn/
  KunmingLOC@outlook.com
- LOC POC:
  Yongzhang Yang
- Deadline for submissions 10/07/2024 [Abstracts and full presentations]

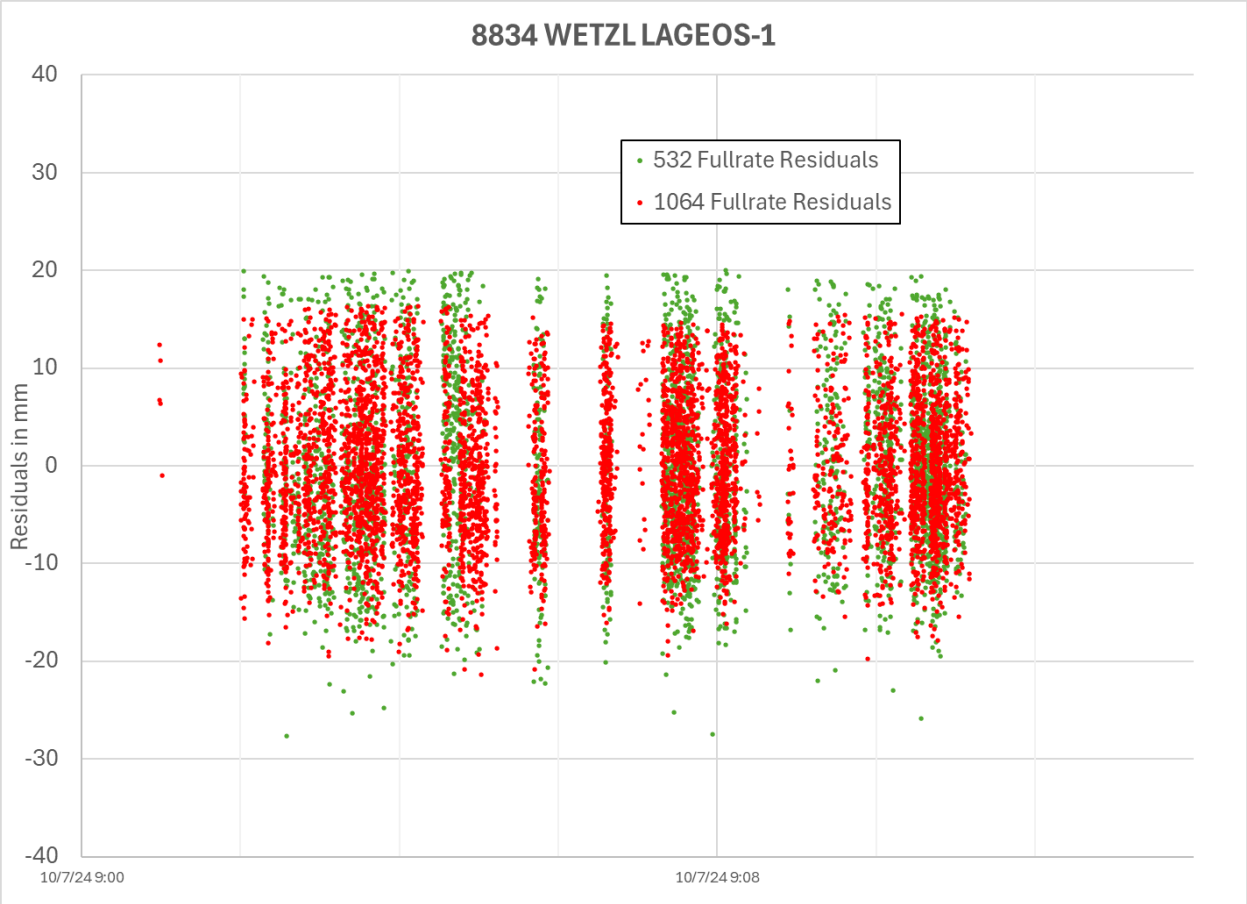
The status of the International Program Committee and Sessions Arrangement with potential Chairs was presented (See the slides). Detail Schedule was included, which also included ILRS Splinter Meetings. Guidelines for presenters were also communicated.

Other comments related to the quarantine procedure discussion:
Wettzell 8834 Two color OrbitNP LAGEOS-1 fullrate residuals Example (Message from October 15th, 2024)

The last QCB we discussed data quarantine procedures and two-color ranging capability of certain systems (e.g. Izana, Yebes, Tsukuba, Wettzell).

I was always curious about Wettzell 8834 two color ranging. Were the two colors interleaved relatively quickly or were the two colors 'quasi simultaneous'. Below are OrbitNP LAGEOS-1 fullrate residuals from October 7, 2024. It appears the data from the two colors is 'quasi simultaneous'.

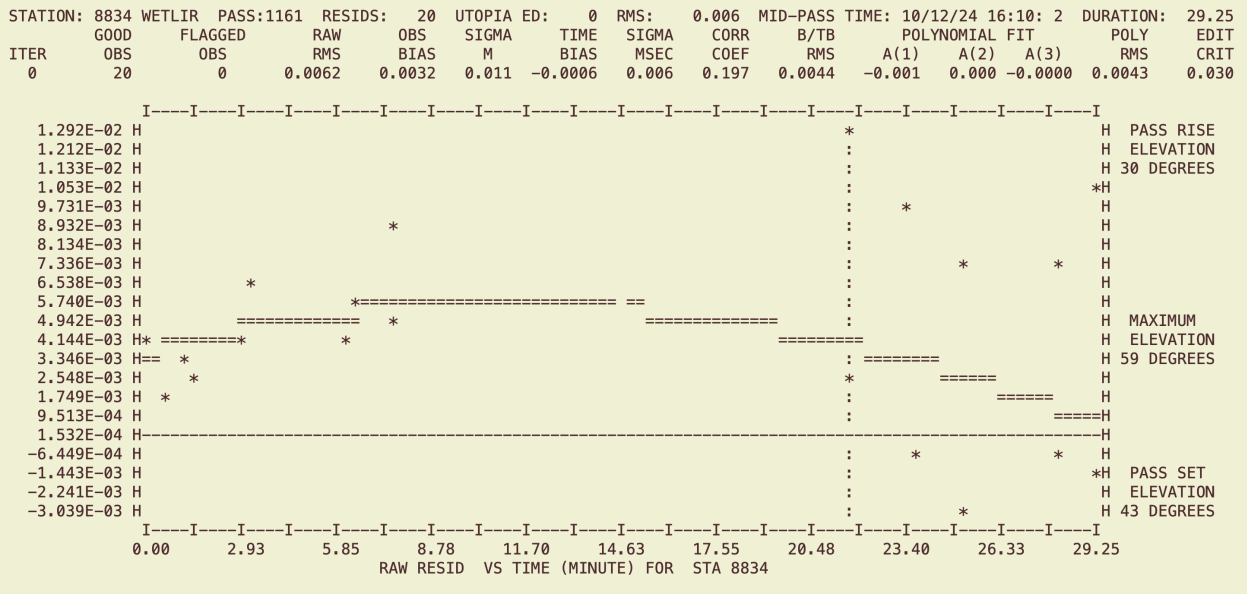
Regards, Van



Van Husson, Peraton.
NASA SLR Operations Center
NASA Space Exploration Network Services and Evolution (SENSE)

Response from John C. Ries:

I am able to 'cheat' and plot green and infra-red on the same plot. In this plot, there are 10 green and 10 infra-red.



In some cases, the NPTs line up exactly, while others, at the beginning, not so much. I infer that the shots are more or less at the same time, but the resulting NPTs might end up with a different epoch depending on how many shots were acquired.

Thanks,
JR

Mathis Blossfeld comment (10/16):

“Hi Van and John,
since I was not able to participate in the last QCB meeting I cannot contribute much to your dsicussison or the topic you are discussing. Anyway, I can confirm that Wettzell (WLRS, 8834) frequenly measures with 2 wavelengths. Please see the analysis plot below: 1 --> 1064nm, 0 --> 532 nm
Anything specific you are interested?”

```
                                                                                                          Elevation  28.1 : 59.6 deg
"0": Pass  15 14201S018 A01 8834  532.00 nm   RMS/WRMS/Median  0.83E+00  0.83E+00  0.86E+00 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
"1": Pass  17 14201S018 A01 8834 1064.00 nm   RMS/WRMS/Median  0.34E+00  0.34E+00 -0.84E-01 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
1/1225     6.45562550 SLR                               1        :                                        :    -0.45    0.872  7    470  D      D       S
1/1227     6.45587199 SLR                                        :    0                                   :     0.23    0.872  7    257  D      D       S
1/1228     6.45653598 SLR                                        : 0                                      :     0.09    0.872  7    257  D      D       S
1/1226     6.45656972 SLR                                1       :                                        :    -0.42    0.872  7    470  D      D       S
1/1229     6.46157649 SLR                                      1 :                                        :    -0.08    0.872  7    889  D      D       S
1/1234     6.46165640 SLR                                        :                0                       :     0.86    0.872  7    616  D      D       S
1/1230     6.46257030 SLR                                        :   1                                    :     0.21    0.872  7    889  D      D       S
1/1235     6.46259604 SLR                                        :              0                         :     0.74    0.872  7    616  D      D       S
1/1236     6.46437743 SLR                                        :                0                       :     0.86    0.872  7    616  D      D       S
1/1231     6.46439732 SLR                                        :      1                                 :     0.35    0.872  7    889  D      D       S
1/1232     6.46547608 SLR                                        :          1                             :     0.55    0.872  7    889  D      D       S
1/1237     6.46550132 SLR                                        :                        0               :     1.27    0.872  7    616  D      D       S
1/1233     6.46640791 SLR                                        :           1                            :     0.60    0.872  7    889  D      D       S
1/1238     6.46641644 SLR                                        :                     0                  :     1.09    0.872  7    616  D      D       S
1/1239     6.47676321 SLR                                        :   1                                    :     0.19    0.872  7    506  D      D       S
1/1240     6.47793910 SLR                                     1  :                                        :    -0.15    0.872  7    506  D      D       S
1/1241     6.47937101 SLR                                      1 :                                        :    -0.12    0.872  7    506  D      D       S
1/1242     6.48040287 SLR                                     1  :                                        :    -0.16    0.872  7    506  D      D       S
                                                                                                          Azimuth    31.0 : -130.7
                                                                                                          Elevation  32.3 : 77.7 deg
"0": Pass  16 14201S018 A01 8834  532.00 nm   RMS/WRMS/Median  0.23E+00  0.23E+00  0.22E+00 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
"1": Pass  18 14201S018 A01 8834 1064.00 nm   RMS/WRMS/Median  0.31E+00  0.31E+00  0.22E-01 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
1/1256     6.60204377 SLR                                1       :                                        :    -0.42    0.872  7    673  A      D       S
1/1257     6.60301270 SLR                                   1    :                                        :    -0.25    0.872  7    673  A      D       S
1/1265     6.60402029 SLR                                     0  :                                        :    -0.15    0.872  7     23  A      D       S
1/1258     6.60421169 SLR                                       1:                                        :    -0.07    0.872  7    673  A      D       S
1/1266     6.60578206 SLR                                       0:                                        :    -0.03    0.872  7     23  A      D       S
1/1259     6.60578970 SLR                                        :1                                       :     0.05    0.872  7    673  A      D       S
1/1267     6.60693632 SLR                                        :   0                                    :     0.22    0.872  7     23  A      D       S
1/1260     6.60694071 SLR                                        :1                                       :     0.03    0.872  7    673  A      D       S
1/1261     6.60836285 SLR                                        1                                        :     0.01    0.872  7    673  A      D       S
1/1268     6.60843214 SLR                                        :     0                                  :     0.32    0.872  7     23  A      D       S
1/1269     6.60915881 SLR                                        :     0                                  :     0.28    0.872  7     23  A      D       S
1/1270     6.62008010 SLR                                        :       1                                :     0.41    0.872  7    114  D      D       S
1/1271     6.62042542 SLR                                        :           1                            :     0.58    0.872  7    114  D      D       S
                                                                                                          Azimuth    44.4 : -50.6
                                                                                                          Elevation  29.9 : 46.8 deg
"0": Pass  17 14201S018 A01 8834  532.00 nm   RMS/WRMS/Median  0.67E+00  0.67E+00  0.60E+00 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
"1": Pass  19 14201S018 A01 8834 1064.00 nm   RMS/WRMS/Median  0.41E+00  0.41E+00  0.29E+00 cm   RB  0.00000E+00 m    TB  0.00000E+00 sec  --  0.00000E+00 ----
1/1293     6.74346896 SLR                                      0 :                                        :    -0.11    0.872  7    256  A      D       S
1/1295     6.74348794 SLR                                        :  1                                     :     0.16    0.872  7    537  A      D       S
1/1296     6.74447770 SLR                                        :        1                               :     0.45    0.872  7    537  A      D       S
1/1294     6.74450572 SLR                                        :     0                                  :     0.30    0.872  7    256  A      D       S
1/1315     6.75020176 SLR                                        :        1                               :     0.43    0.872  7     29  A      D       S
1/1320     6.75020808 SLR                                        :         0                              :     0.49    0.872  7     13  A      D       S
1/1316     6.75131710 SLR                                        :        1                               :     0.45    0.872  7     29  A      D       S
1/1321     6.75140287 SLR                                        :              0                         :     0.75    0.872  7     13  A      D       S
1/1317     6.75312950 SLR                                        :            1                           :     0.66    0.872  7     29  A      D       S
1/1322     6.75317808 SLR                                        :                    0                   :     1.06    0.872  7     13  A      D       S
```

Table 1. History Log Voids by Station (2024.09.27)

Station Location	CDP #	Time Gap(s)*				Last entry
Kiev	1824	000120-080302	080402-110515			141410
Komsomolsk	1868	NO DATA				
Simeiz	1873	NO DATA				
Mendeleevo	1874	NO DATA				
Altay	1879	NO DATA				
Riga	1884					240803
Arkhyz	1886	NO DATA				
Baikonur	1887	NO DATA				
Svetloe	1888	NO DATA				
Zelenchukskaya	1889	NO DATA				
Badary	1890	NO DATA				
Irkutsk	1891	NO DATA				
Katzively	1893	NO DATA				
Yarragadee	7090					240530
Greenbelt	7105					240418
Monument_Peak	7110					240904
Haleakala	7119					240304
Tahiti	7124	020825-080414	130321-191022			230520
Changchun	7237	950101-970802	020714-051002	180410-210106		240417
Beijing	7249	881101-940301	940301-981116	981116-211013		230425
Tsukuba	7306					240919
Sejong	7394	NO DATA				
Wuhan	7396	NO DATA				
Arequipa	7403	920718-951023	951023-981130	981130-010523		200629
San Juan, Argentina	7406	NO DATA				
Brasilia	7407	NO DATA				
Hartebeesthoek_HARL	7501	020409-081105				240710
Hartebeesthoek_HRTL	7503	NO DATA				
Izana	7701					230406
Zimmerwald_532	7810	030905-060203	080715-100901			240821
Borowiec	7811	030329-071227	080205-131218			211005
Kunming	7819					240306
Shanghai_2	7821	140222-170315	170720-190811			231113
San_Fernando	7824	900703-930222	971216-010124	090302-110601	180801-210518	231121
Mount_Stromlo_2	7825					210901
Wettzell_SOSW	7827	140501-160511	160511-190528	200424-230607		240119
Simosato	7838	900701-950810	950810-991007	991019-040701	080401-181212	211209
Graz	7839	150504-190311				240926
Herstmonceux	7840					230427
Potsdam_3	7841	040906-081026	081026-110501	170303-200303		240305
Grasse_MEO	7845	010601-200818				240517
Matera_MLRO	7941	140902-171204	171206-210629			240612
Wettzell	8834	980720-001012	001012-090324	090324-131021	170407-190604	240605

* Assuming at least 2 year data gap

Status 2024.10.03

Next QCB Meeting: January 27th, 2025, 09:00-11:00 AM EDT (14:00 UTC)