EXELIS

# Second SLR Campaign on Selected Global Navigation Satellites; Network Statistics

**Justine Woo**

**Date: June 30, 2015**

**Exelis Inc.**
**7855 Walker Drive**
**Greenbelt, Maryland 20770**

# Contents

**Section 1. Introduction ..... 1-1**

1.1 Data Statistics the Second GNSS Campaign, November 24, 2014 - February 28, 2015 ..... 1-1
1.2 Overview ..... 1-1
1.3 Definitions ..... 1-1

## List of Figures

Figure 1-1. Number of Normal Points by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-3
Figure 1-2. Number of Sectors by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-4
Figure 1-3. Number of Passes by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-5
Figure 1-4: Number of Sectors by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-7
Figure 1-5. Number of Sectors by Station (GLONASS Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-8
Figure 1-6. Number of Sectors by Station (Galileo Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-9
Figure 1-7. Number of Sectors by Station (Compass Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-10
Figure 1-8. Maximum and Average Number of NPT in 1 Pass by YARL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-12
Figure 1-9. Maximum and Average Number of NPT in 1 Pass by STL3 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-12
Figure 1-10. Maximum and Average Number of NPT in 1 Pass by CHAL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-13
Figure 1-11. Maximum and Average Number of NPT in 1 Pass by ALTL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-13
Figure 1-12. Maximum and Average Number of NPT in 1 Pass by KOML for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-14
Figure 1-13. Maximum and Average Number of NPT in 1 Pass by SHA2 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-14
Figure 1-14. Maximum and Average Number of NPT in 1 Pass by GRZL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-15
Figure 1-15. Maximum and Average Number of NPT in 1 Pass by HERL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-15

Figure 1-16. Maximum and Average Number of NPT in 1 Pass by MATM for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-16
Figure 1-17. Maximum and Average Number of NPT in 1 Pass by MONL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-16
Figure 1-18. Maximum and Average Number of NPT in 1 Pass by ZELL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-17
Figure 1-19. Maximum and Average Number of NPT in 1 Pass by GODL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-17
Figure 1-20: Maximum and Average Number of NPT in 1 Pass by ARKL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-18
Figure 1-21. Maximum and Average Number of NPT in 1 Pass by WETL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-18
Figure 1-22. Pass Segment Pie Charts by YARL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-20
Figure 1-23. Pass Segment Pie Charts by STL3 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-21
Figure 1-24. Pass Segment Pie Charts by CHAL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-22
Figure 1-25. Pass Segment Pie Charts by ALTL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-23
Figure 1-26. Pass Segment Pie Charts by KOML for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-24
Figure 1-27. Pass Segment Pie Charts by SHA2 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-25
Figure 1-28. Pass Segment Pie Charts by GRZL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-26
Figure 1-29. Pass Segment Pie Charts by HERL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-27
Figure 1-30. Pass Segment Pie Charts by MATM for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-28
Figure 1-31. Pass Segment Pie Charts by MONL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-29
Figure 1-32. Pass Segment Pie Charts by ZELL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-30
Figure 1-33. Pass Segment Pie Charts by GODL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-31
Figure 1-34. Pass Segment Pie Charts by ARKL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-32
Figure 1-35. Pass Segment Pie Charts by WETL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-33
Figure 1-36. YARL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-35
Figure 1-37. YARL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-36

Figure 1-38. STL3 Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-37
Figure 1-39. STL3 Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-38
Figure 1-40. CHAL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-39
Figure 1-41. CHAL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-40
Figure 1-42. ALTL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-41
Figure 1-43. ALTL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-42
Figure 1-44. KOML Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-43
Figure 1-45. KOML Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-44
Figure 1-46. SHA2 Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-45
Figure 1-47. CHAL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-46
Figure 1-48. GRZL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-47
Figure 1-49. GRZL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-48
Figure 1-50. HERL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-49
Figure 1-51. HERL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-50
Figure 1-52. MATM Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-51
Figure 1-53. MATM Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-52
Figure 1-54. MONL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-53
Figure 1-55. MONL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-54
Figure 1-56. ZELL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-55
Figure 1-57. ZELL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-56
Figure 1-58. GODL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-57
Figure 1-59. GODL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-58

Figure 1-60. ARKL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-59
Figure 1-61. ARKL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-60
Figure 1-62. WETL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-61
Figure 1-63. WETL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-62
Figure 1-64. Campaign and Non-Campaign GNSS Satellites Tracked for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-64
Figure 1-65. Percentage of Campaign and Non-Campaign GNSS Satellites Tracked for the Second GNSS Campaign; November 24, 2014 - ..... 1-65
Figure 1-66. Campaign and Non-Campaign GNSS Satellites NPT Counts for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-66
Figure 1-67. Percentage of Campaign and Non-Campaign GNSS Satellites NPT Counts for the Second GNSS Campaign; November 24, 2014 - February 28, 2015 ..... 1-67

# Section 1. Introduction

## 1.1 Data Statistics the Second GNSS Campaign, November 24, 2014 - February 28, 2015

Prepared for the ILRS Central Bureau

Date: June 8, 2015

Compiled by

Justine Woo

Exelis Inc., a wholly owned subsidiary of Harris Corporation

Greenbelt, MD

## 1.2 Overview

The Second GNSS Campaign took place November 24, 2014 to February 28, 2015. The satellites included in this analysis are from the campaign satellite list: 6 GLONASS satellites (GLONASS-123, GLONASS-125, GLONASS-129, GLONASS-130, GLONASS-131, and GLONASS-132), 4 Galileo satellites (Galileo-101, Galileo-102, Galileo-103, Galileo-104), and 1 Compass satellite (Compass-M3). At the end of this document, in Appendix A, an analysis including an additional 2 Compass satellites (Compass-I3 and Compass-I5) is shown. These two satellites were included in the original tracking list; however, their visibilities differ from the others and are not included in the main body of this document unless specified.

For the campaign, the stations were asked to obtain 3 segments (beginning, middle, and end) along each pass with 3 normal points in each segment for the campaign satellites. Stations were also asked to track during the daytime. None of these objectives were met in this campaign although some stations visibly performed better than others by these metrics. Issues the stations may have encountered include weather, changes in station shifts, and difficultly receiving returns during daytime tracking.

In addition, many stations tracked the full suite of satellites rather than just the ones specified for the campaign. It is unclear if this interfered with the campaign intent and reduced the number of pass segments received for the campaign satellites.

## 1.3 Definitions

Length of NP: 5 minutes or 1000 FR points

Definition of a Sector: The duration of each satellite's visibility is divided into 3-sectors (beginning, middle, and end)

Definition of a Pass: A pass is counted for each visibility where a station tracked the satellite

## 1.4 Some observations

1. GLONASS had the best representation in data yield, owing to the largest number of satellites in the campaign and evidently the priorities at the Russian stations; there was only one Compass satellite in the campaign.
2. Stations typically acquired 2 – 6 NP's per pass; in some extreme cases the number went as high as 15 – 20, and in one case 28.
3. The legacy stations at Yarragadee, Mt Stromlo, and Changchun acquired the largest NP, sector, and pass yield, but the several of the other stations acquired about 300 sectors during the campaign. We recognize that some stations have the advantage of good weather and several shifts of operation.

4. Several stations were able to track two and three sectors during some passes, in particular on GLONASS. A couple of the stations, Graz and Herstmonceux were able to get some three segment passes on Compass.
5. The most prevalent sector tracked was the middle sector of the pass, but there was considerable data in the beginning and end sectors.
6. Many of the stations got some daylight data, but the yield was considerably less than nighttime.

Conclusions:

1. We need more two and three sector event, particularly on the higher priority GLONASS satellites; it is more important to get two and three sectors of data on passes on these satellites than to track the lower priority GLONASS satellites.
2. We need more data in daylight, or at least around sunrise and sunset.

.

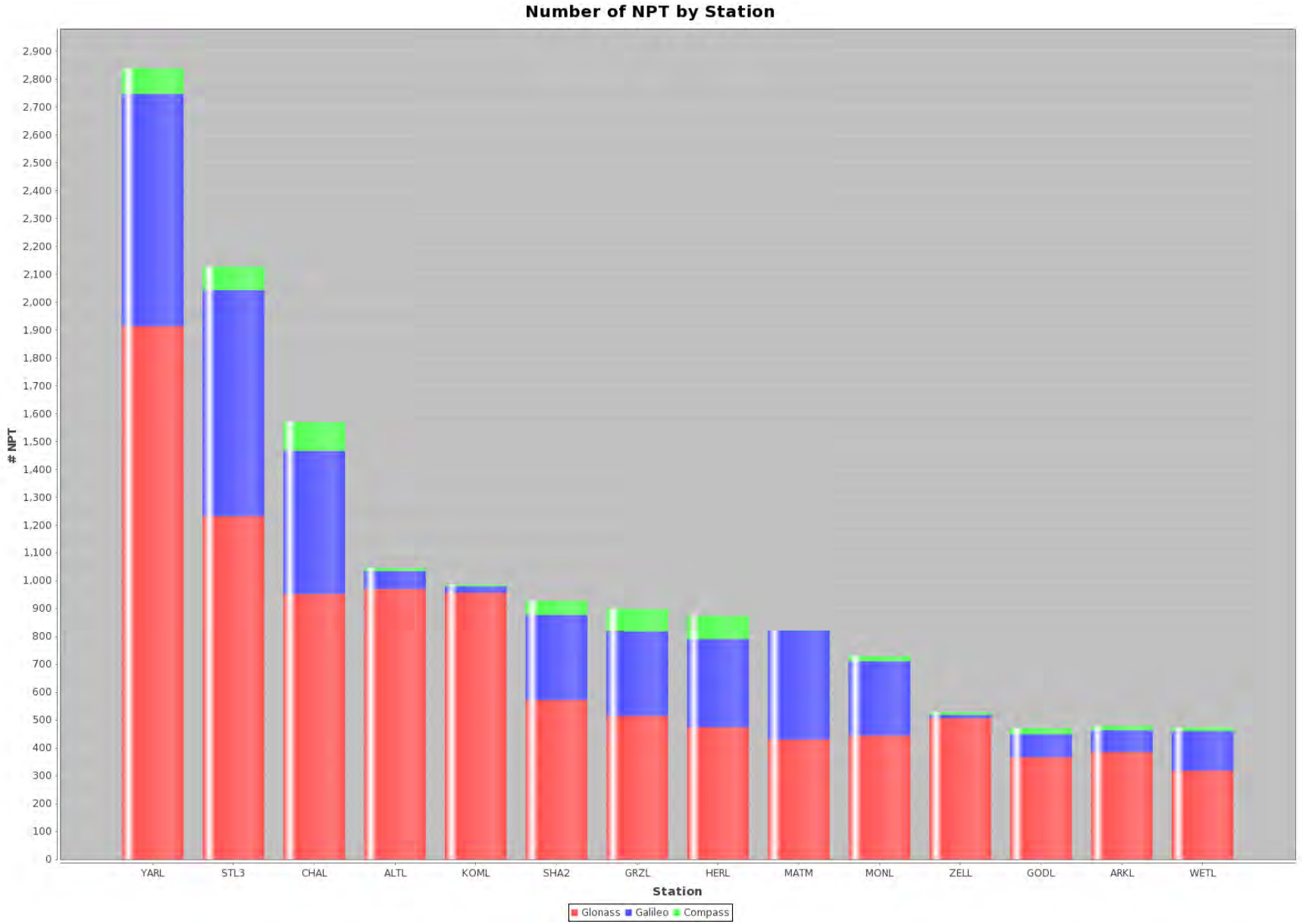



***Figure 1-1. Number of Normal Points by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

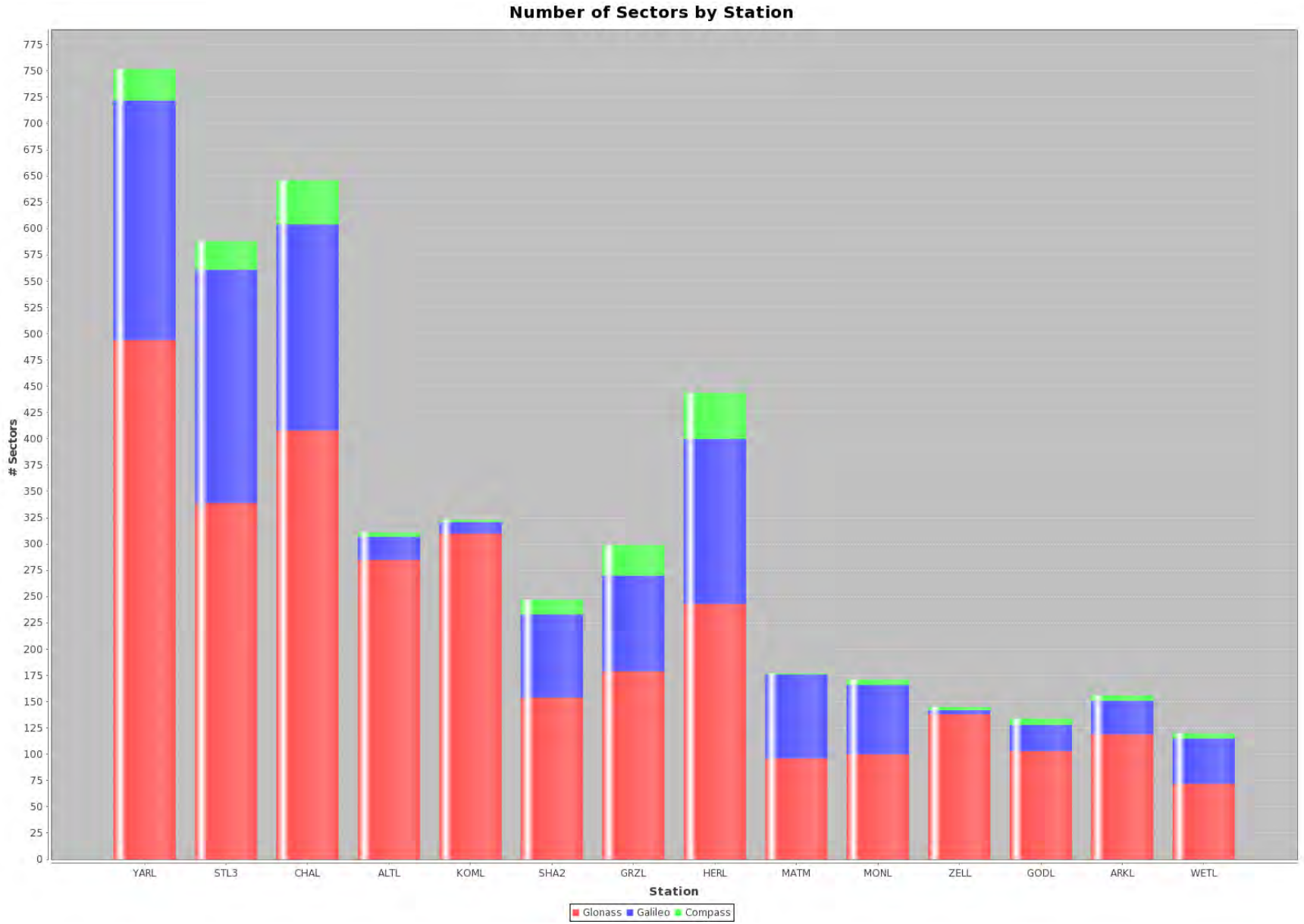



***Figure 1-2. Number of Sectors by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

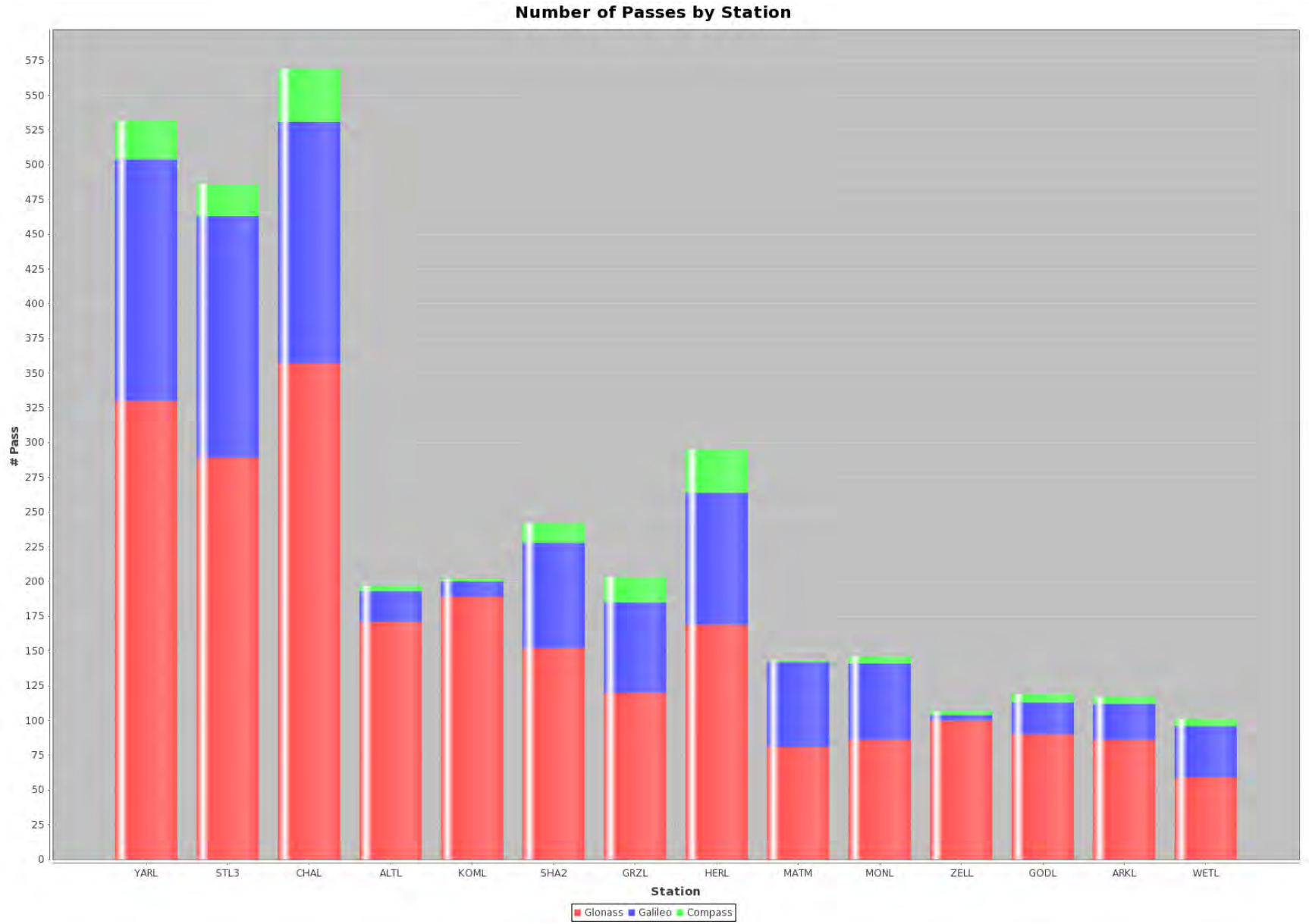



***Figure 1-3. Number of Passes by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

Figures 4, 5, 6, and 7 show the number of sectors where a satellite was tracked. Each visibility for a satellite is divided into three sectors (beginning, middle, and end). If a satellite is tracked less than 0.1*duration of the visibility or 30 minutes, whichever is less, after the track in a previous sector, the track is counted as part of the previous sector. For example, if a track is taken 5 minutes before the end of the beginning sector and a track is taken 5 minutes into the middle sector, it is counted as 1 bin rather than 2 if the visibility is longer than 100 minutes.

Figure 4 contains all the information in Figures 5, 6, and 7. Figure 5 shows the counts for the GLONASS constellation. Figure 6 shows the counts for the Galileo constellation. Figure 7 shows the counts for the Compass constellation.

The stations were asked to track all three segments per pass. However, as the charts below show, this was a rare occurrence for all the stations.

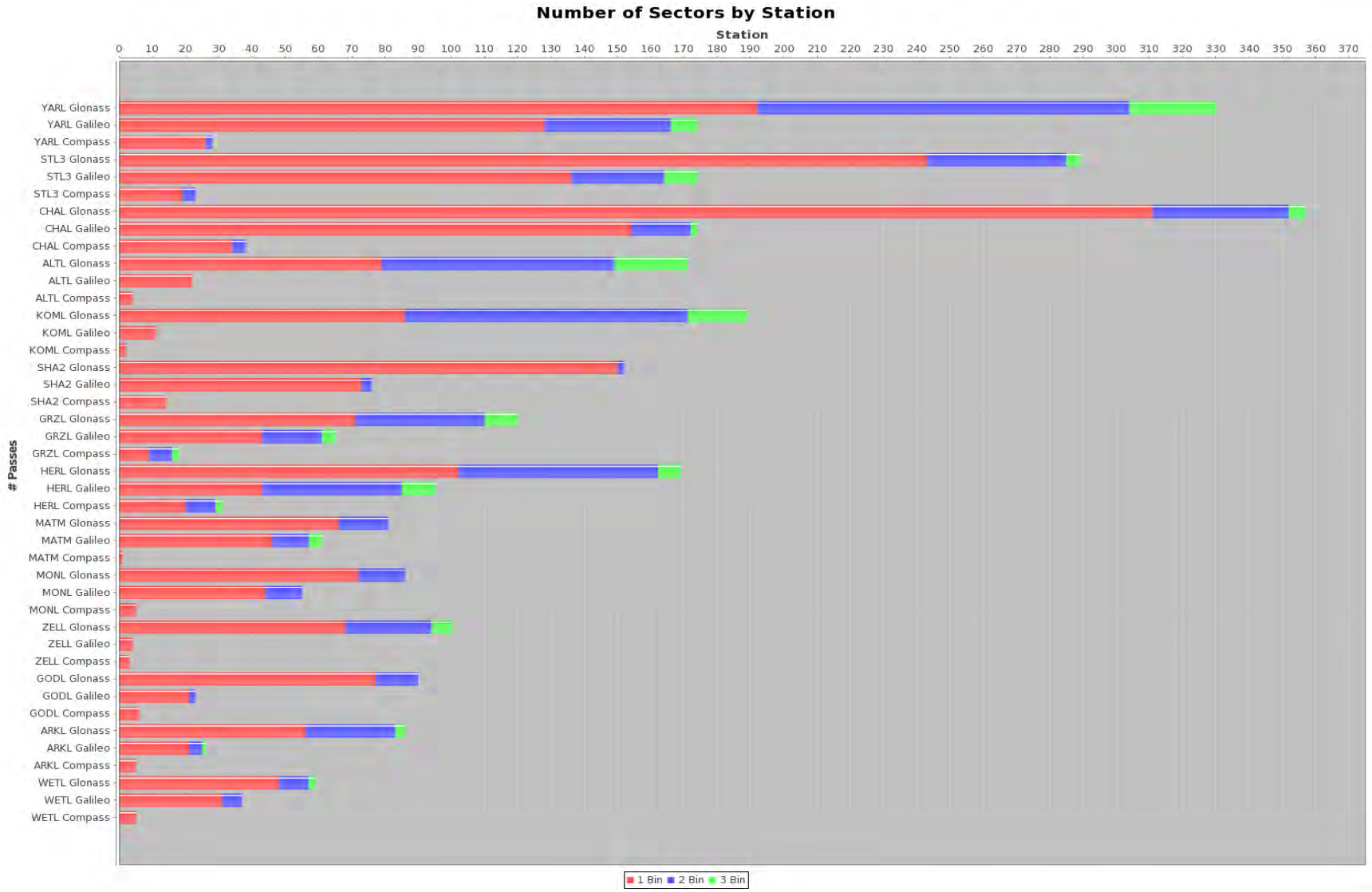



***Figure 1-4: Number of Sectors by Station for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

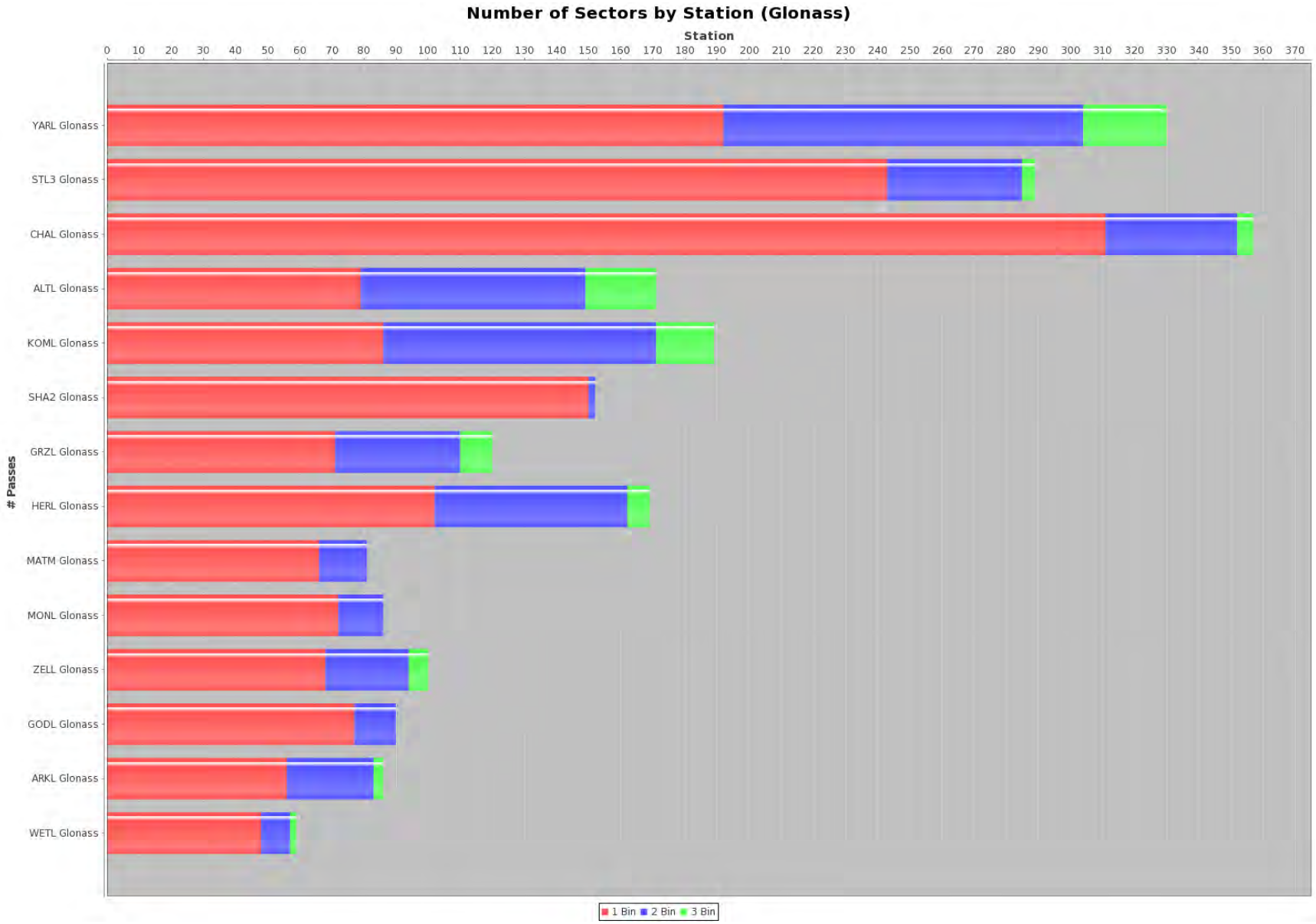



***Figure 1-5. Number of Sectors by Station (GLONASS Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

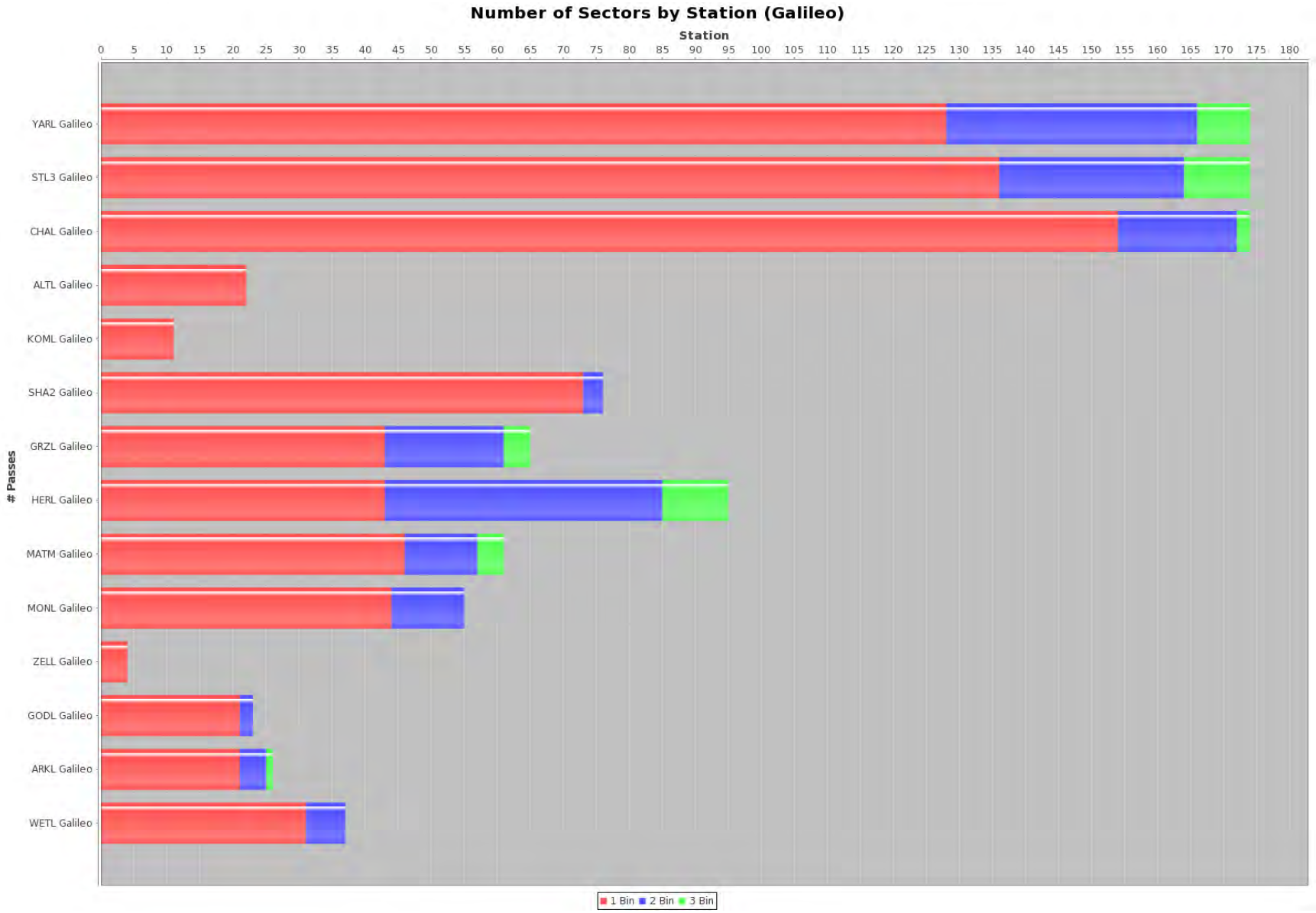



***Figure 1-6. Number of Sectors by Station (Galileo Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

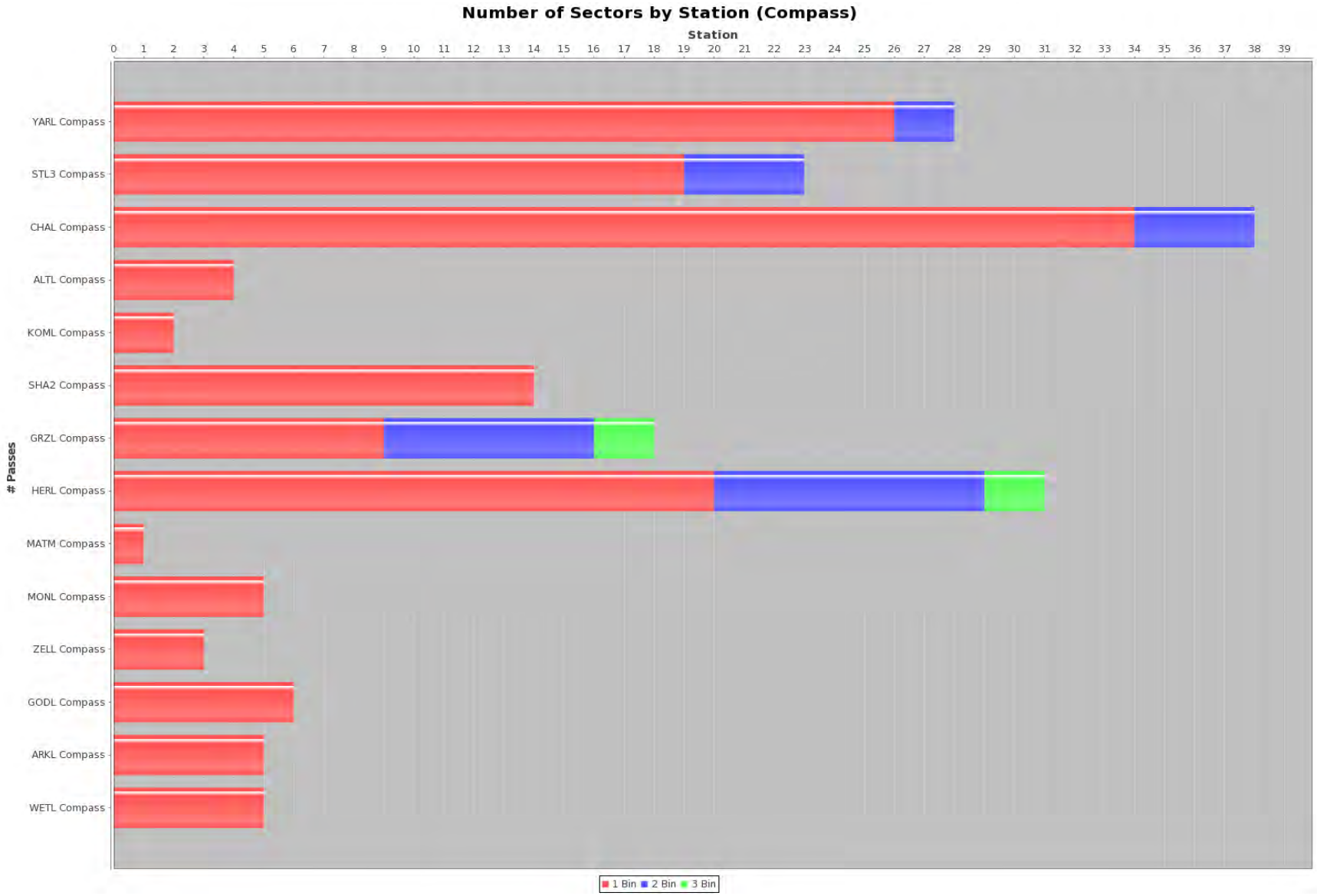



***Figure 1-7. Number of Sectors by Station (Compass Constellation) for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

Figures 8 – 21 are plots of the maximum and average number of normal points in 1 pass by station and satellite. The satellite SICs are along the x-axis and are grouped by constellation (Compassp-M3, Galileo-101, Galileo-102, Galileo-103, Galileo-104, GLONASS-123, GLONASS-125, GLONASS-129, GLONASS-130, GLONASS-131, and GLONASS-132).

The stations were asked to track 3 normal points per segment and to track 3 segments per pass; therefore 9 normal points per pass. Because the stations, for the most part, did not track 3 segments per pass, the display below was changed to show the number of normal points tracked per pass. The averages reached a maximum of 7 normal points per pass.

The averages tend to run relatively consistently although maximums can vary substantially. These charts can reveal some interesting clustering patterns based on satellites. The figure most that stands out the most is Figure 11; ALTL has a clear split between the number of normal points in each pass for the GLONASS satellites versus the other constellations because the maximum number of normal points in the other constellations are less than the number of normal points from the average GLONASS satellite. A similar cluster can be seen in Figure 12 for KOML and Figure 17 for ZELL.

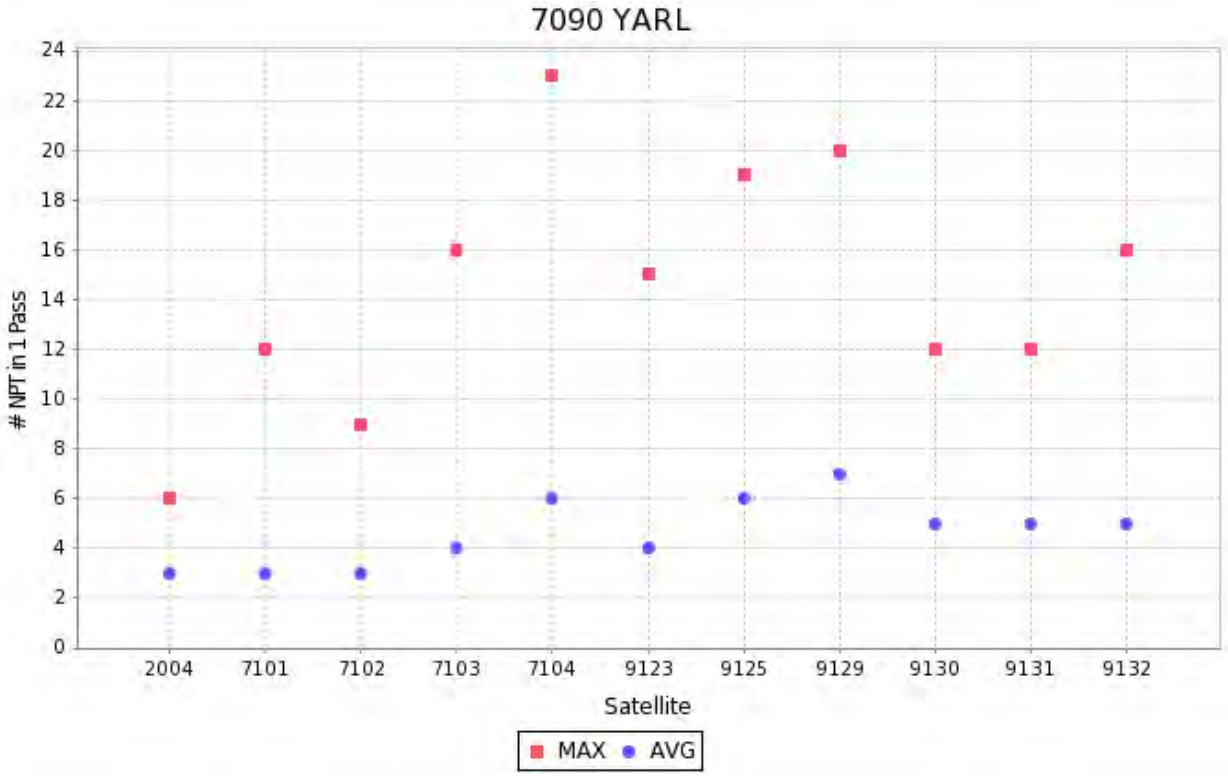



***Figure 1-8. Maximum and Average Number of NPT in 1 Pass by YARL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

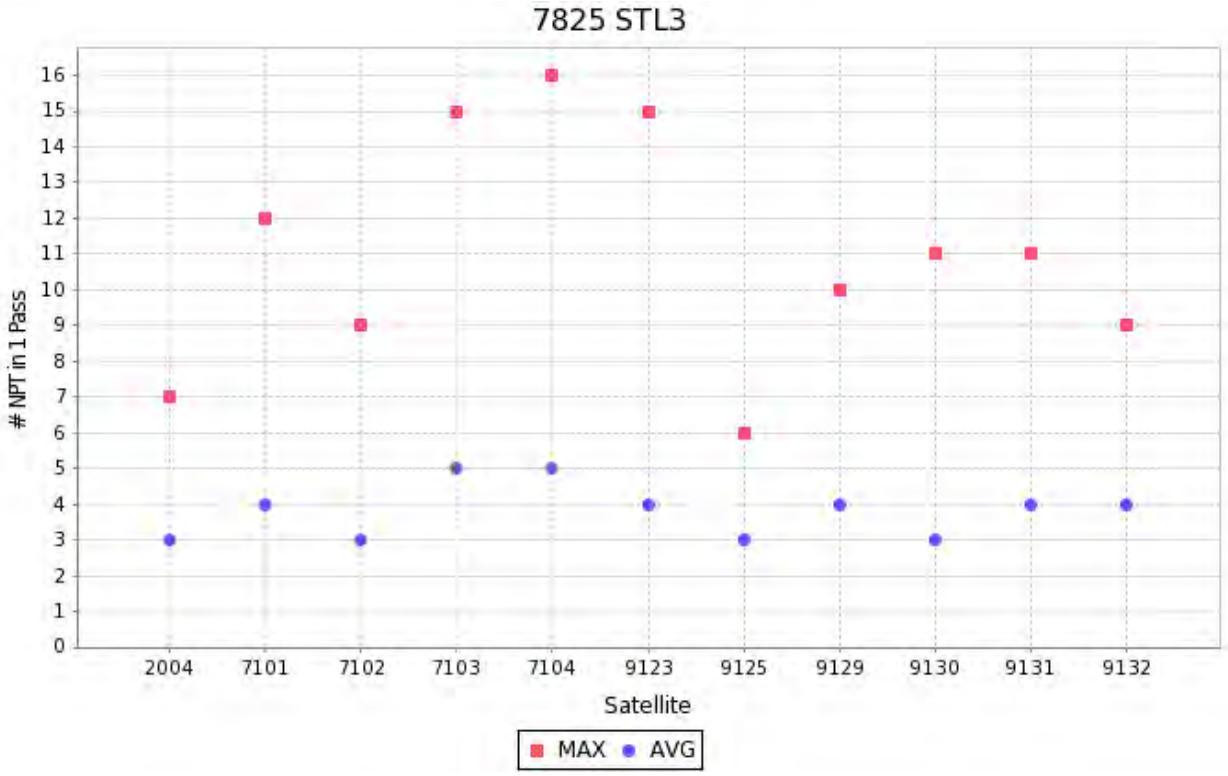



***Figure 1-9. Maximum and Average Number of NPT in 1 Pass by STL3 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

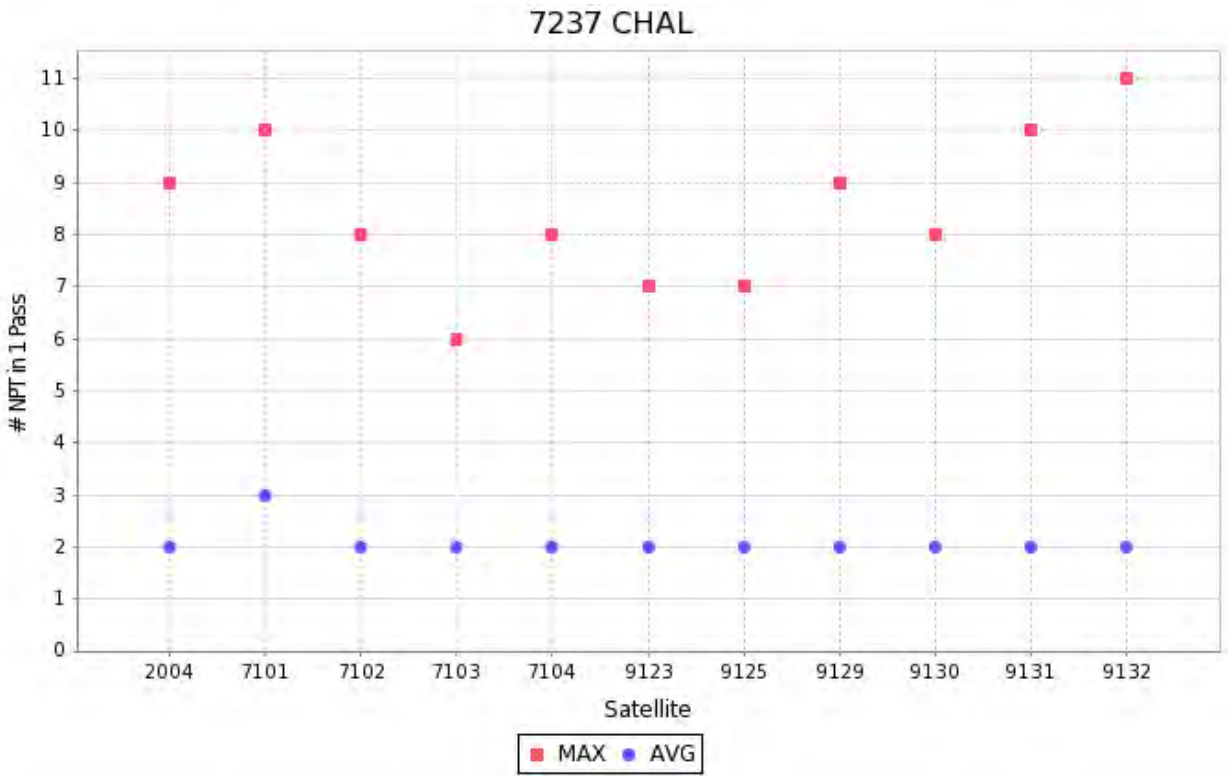



***Figure 1-10. Maximum and Average Number of NPT in 1 Pass by CHAL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

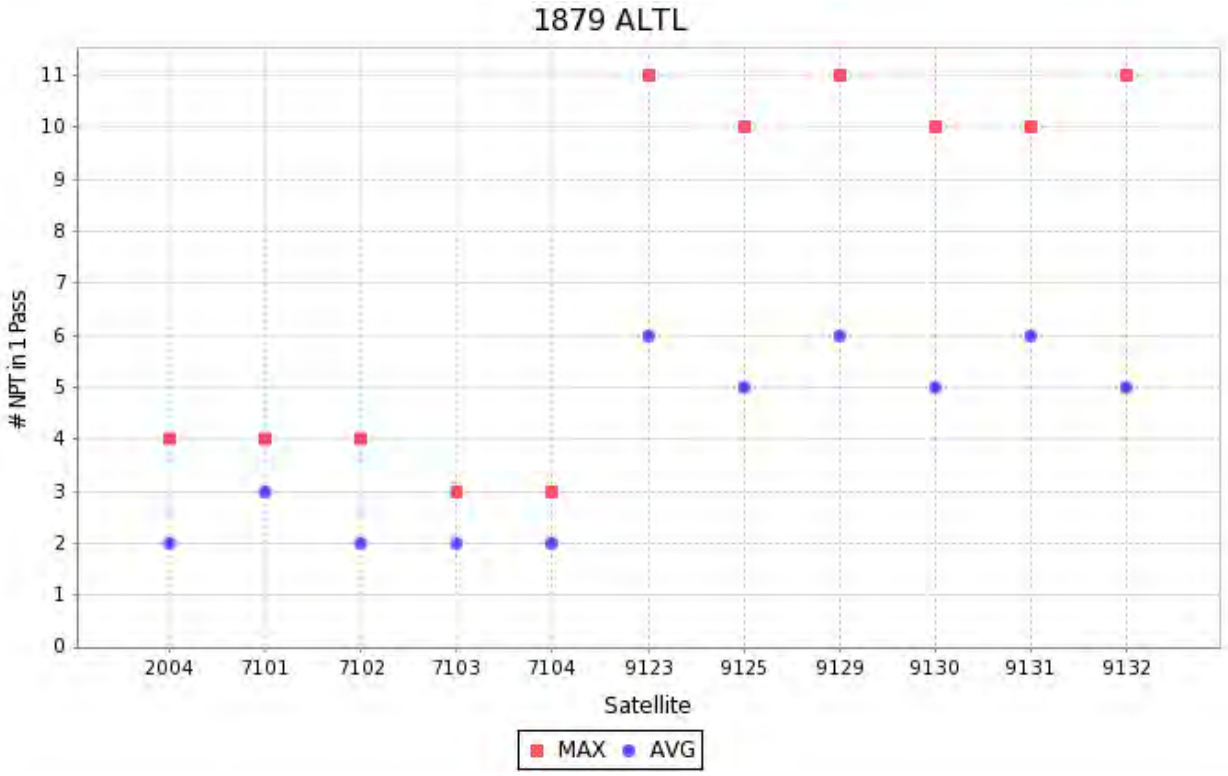



***Figure 1-11. Maximum and Average Number of NPT in 1 Pass by ALTL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

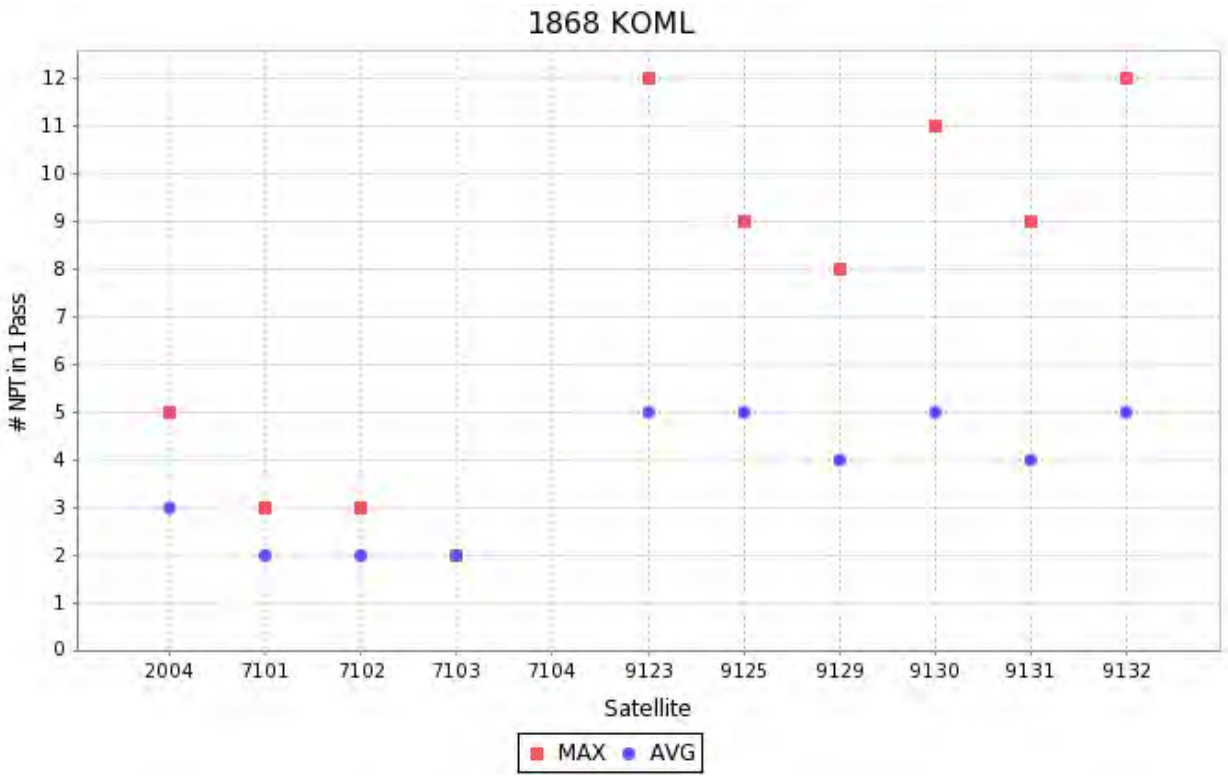



***Figure 1-12. Maximum and Average Number of NPT in 1 Pass by KOML for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

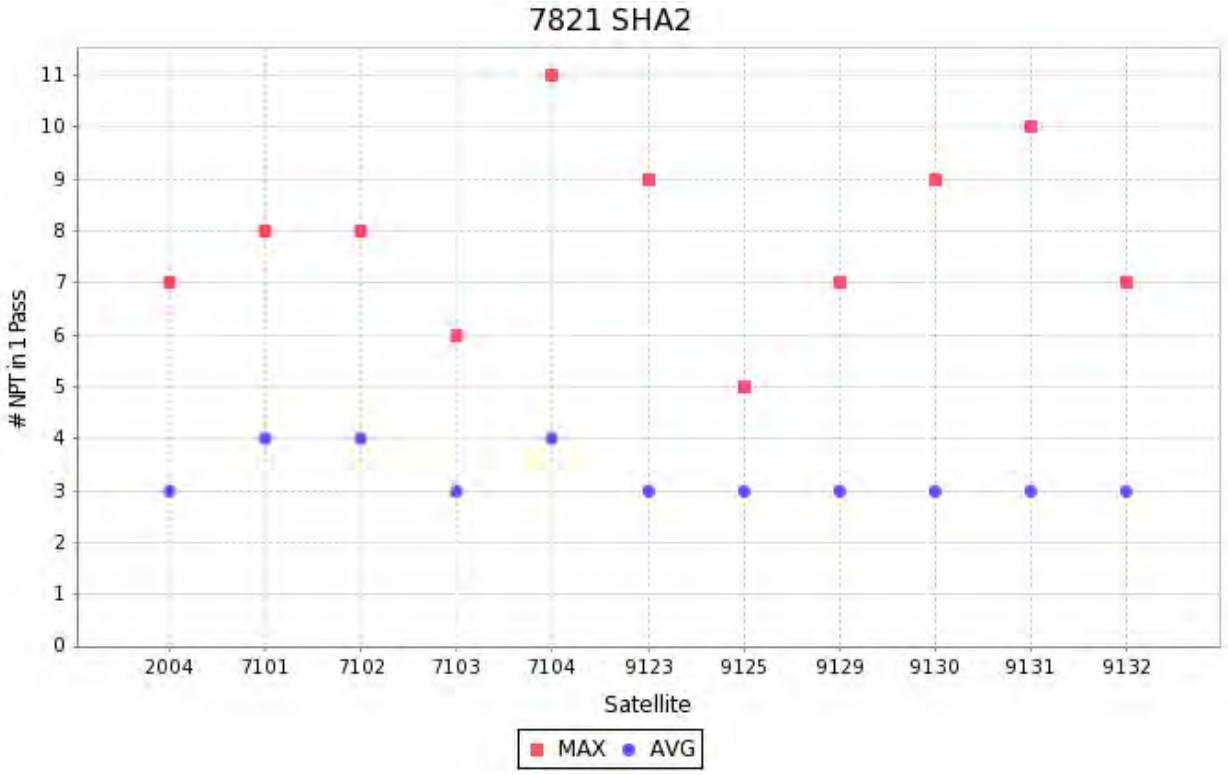



***Figure 1-13. Maximum and Average Number of NPT in 1 Pass by SHA2 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

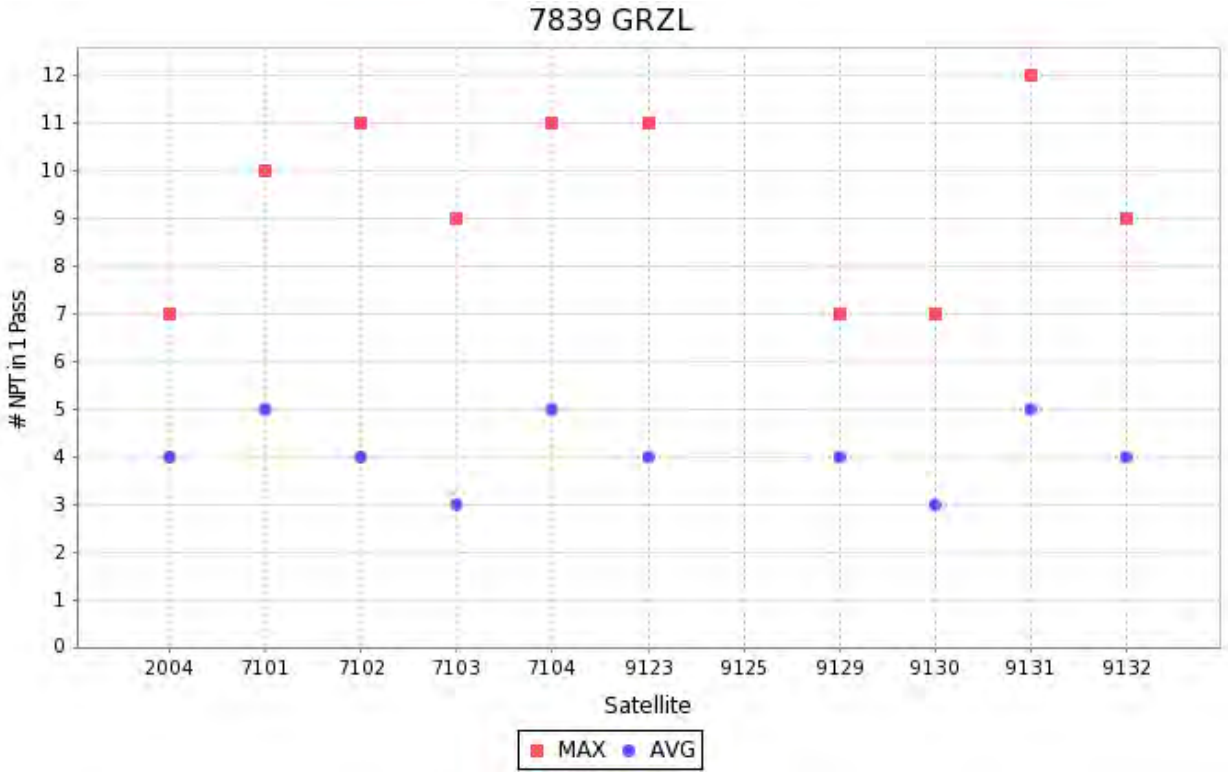



***Figure 1-14.*** *Maximum and Average Number of NPT in 1 Pass by GRZL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

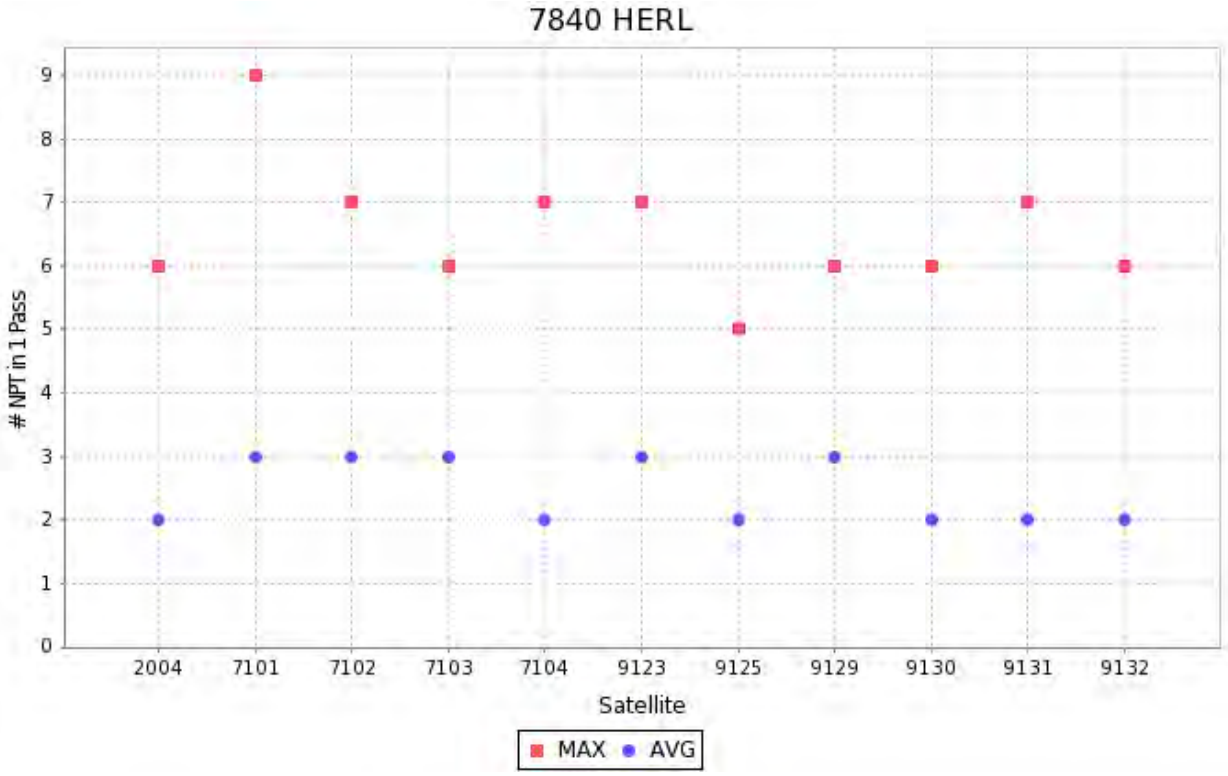



***Figure 1-15.*** *Maximum and Average Number of NPT in 1 Pass by HERL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

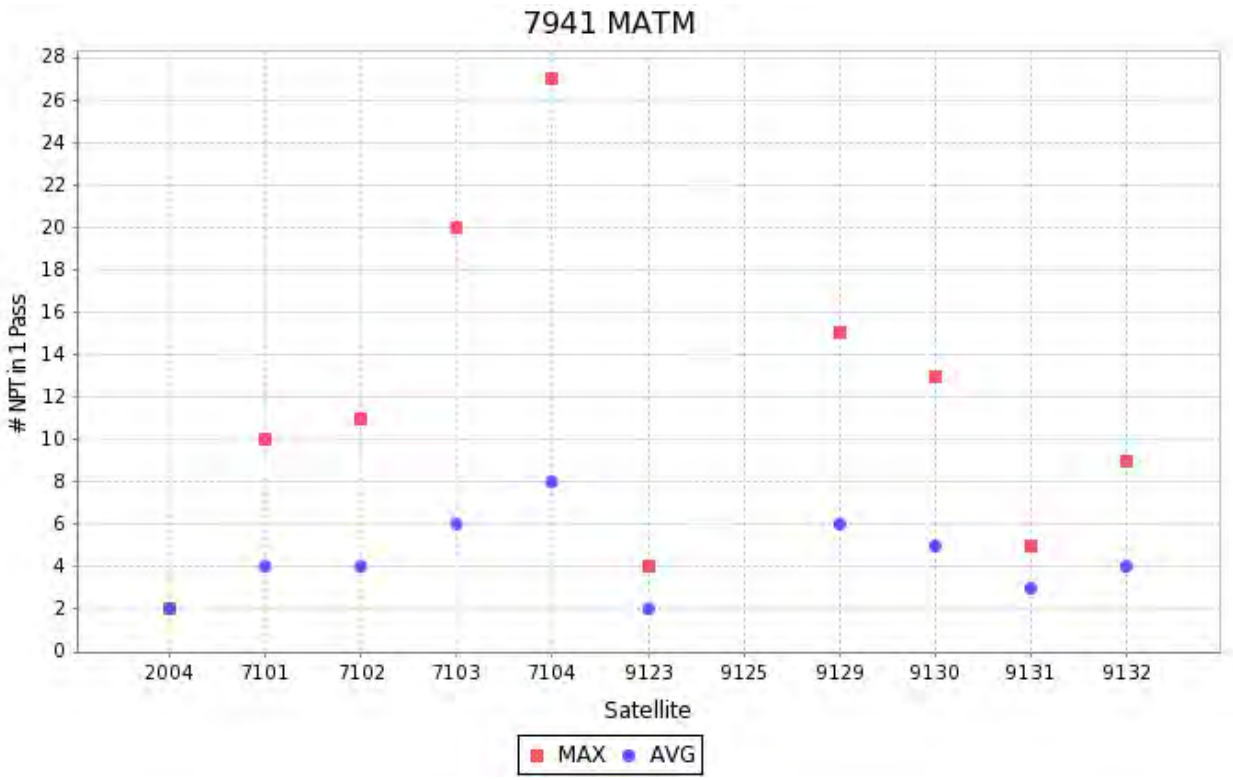



***Figure 1-16.*** *Maximum and Average Number of NPT in 1 Pass by MATM for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

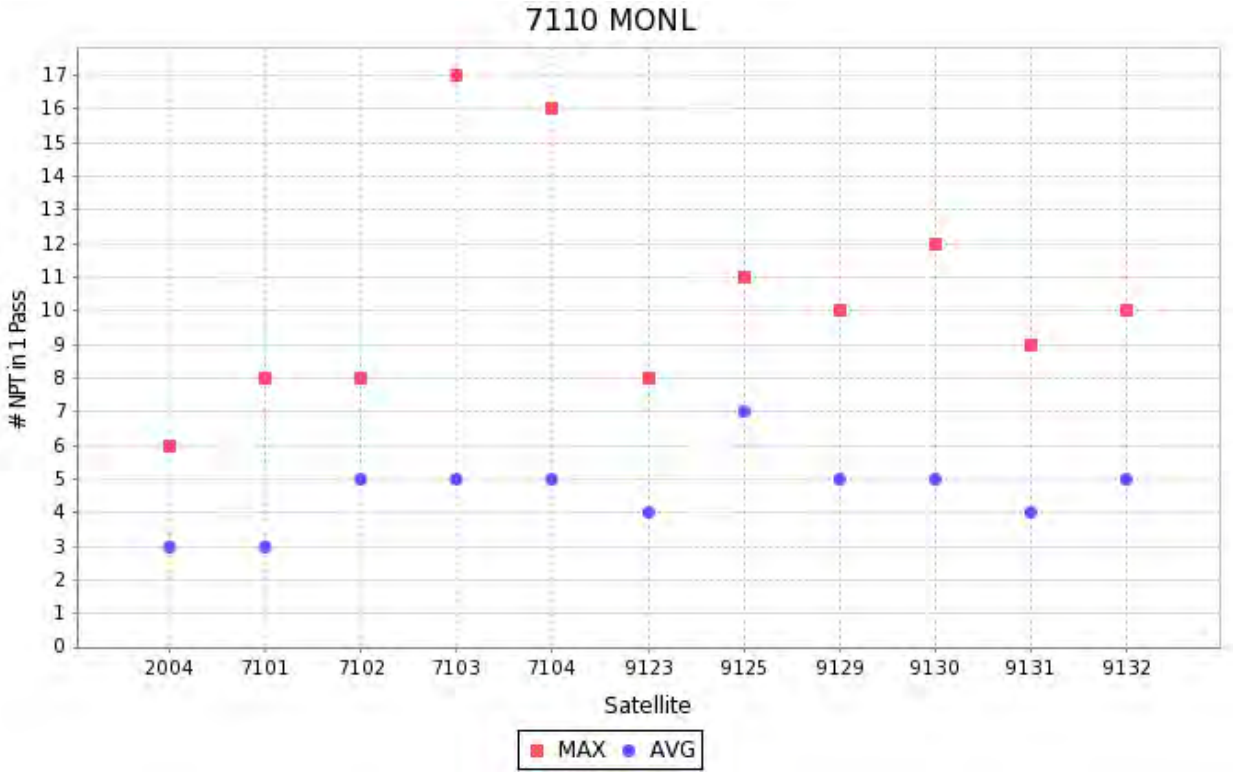



***Figure 1-17.*** *Maximum and Average Number of NPT in 1 Pass by MONL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

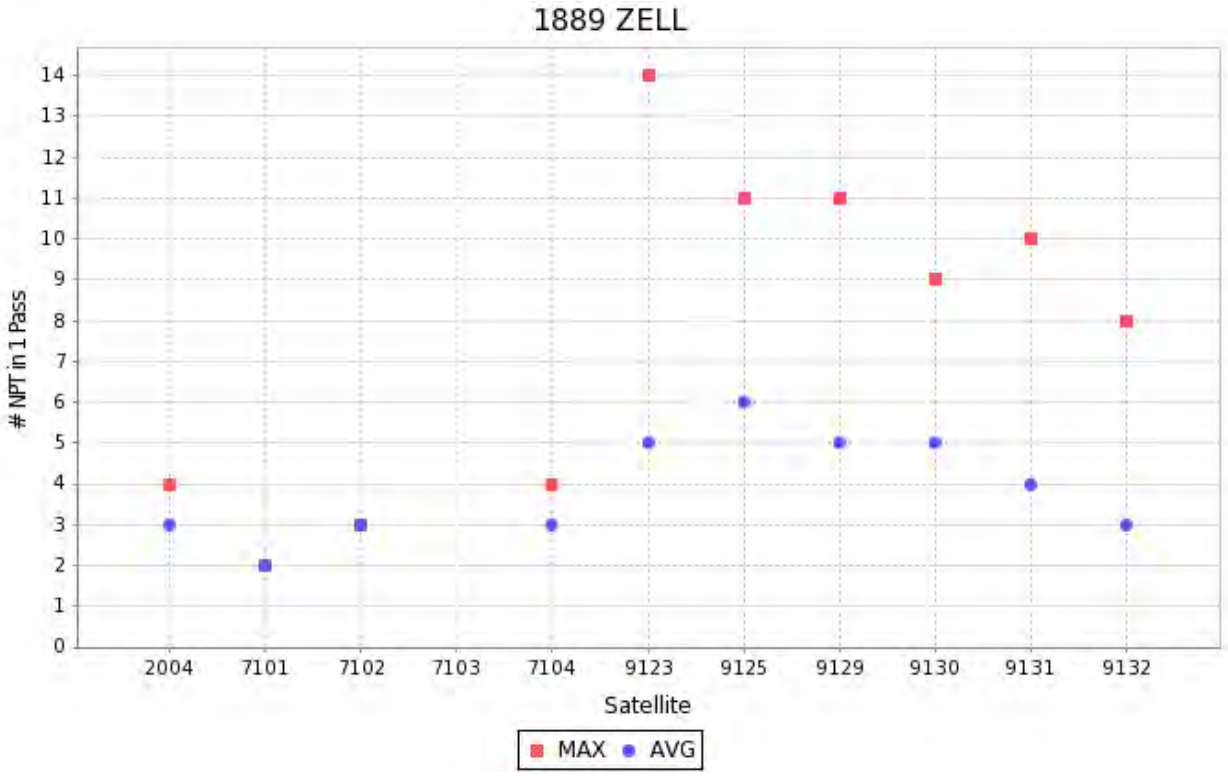



***Figure 1-18.*** *Maximum and Average Number of NPT in 1 Pass by ZELL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

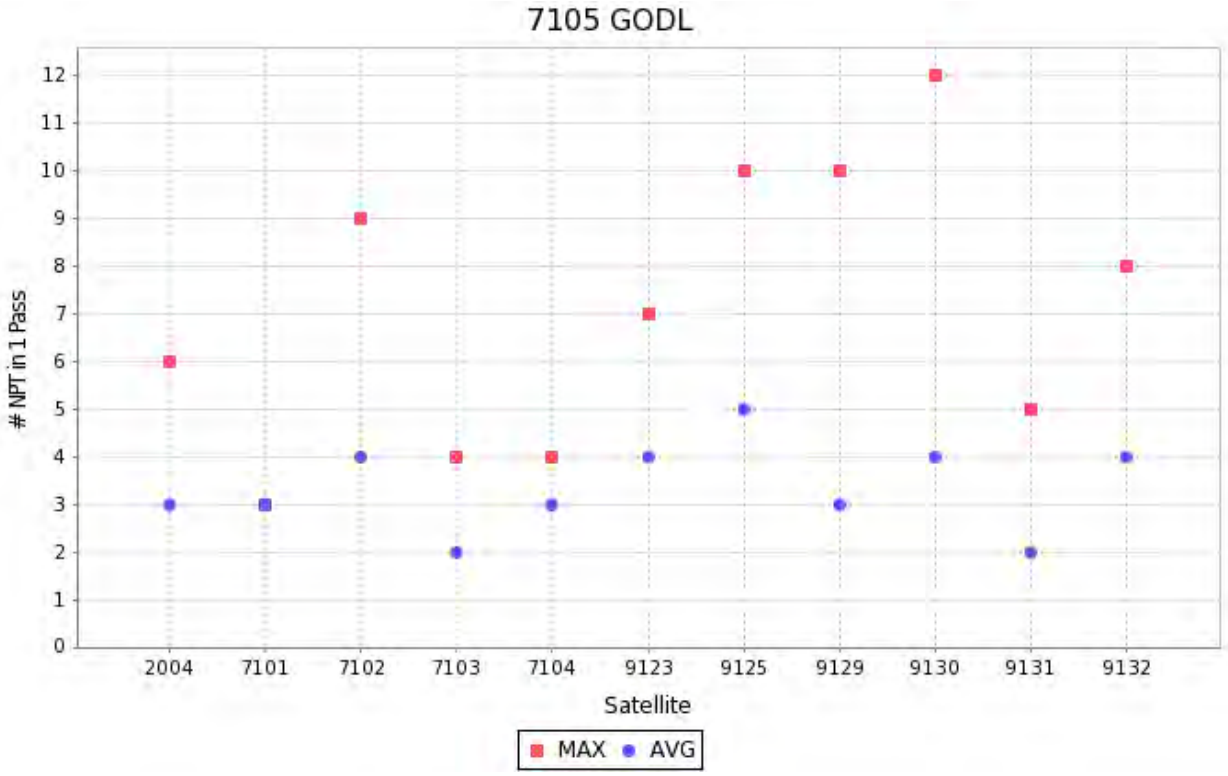
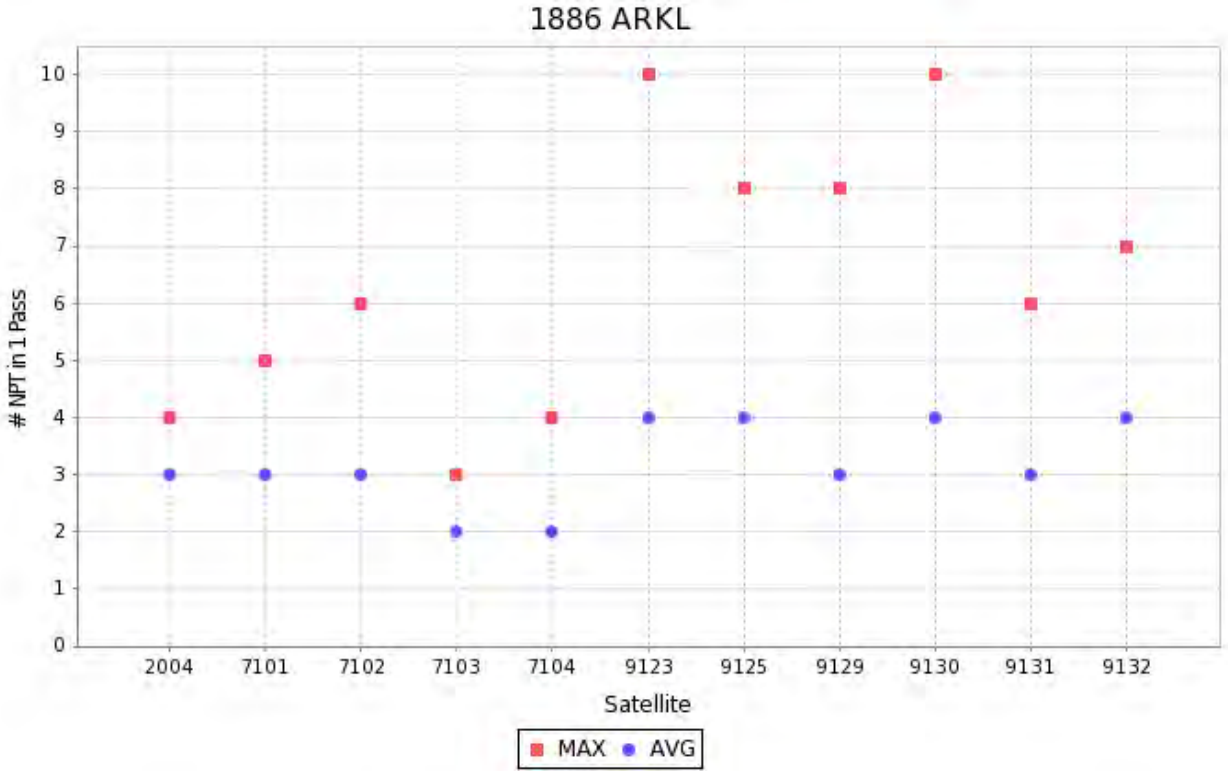



***Figure 1-19.*** *Maximum and Average Number of NPT in 1 Pass by GODL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

*Figure 1-20: Maximum and Average Number of NPT in 1 Pass by ARKL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*



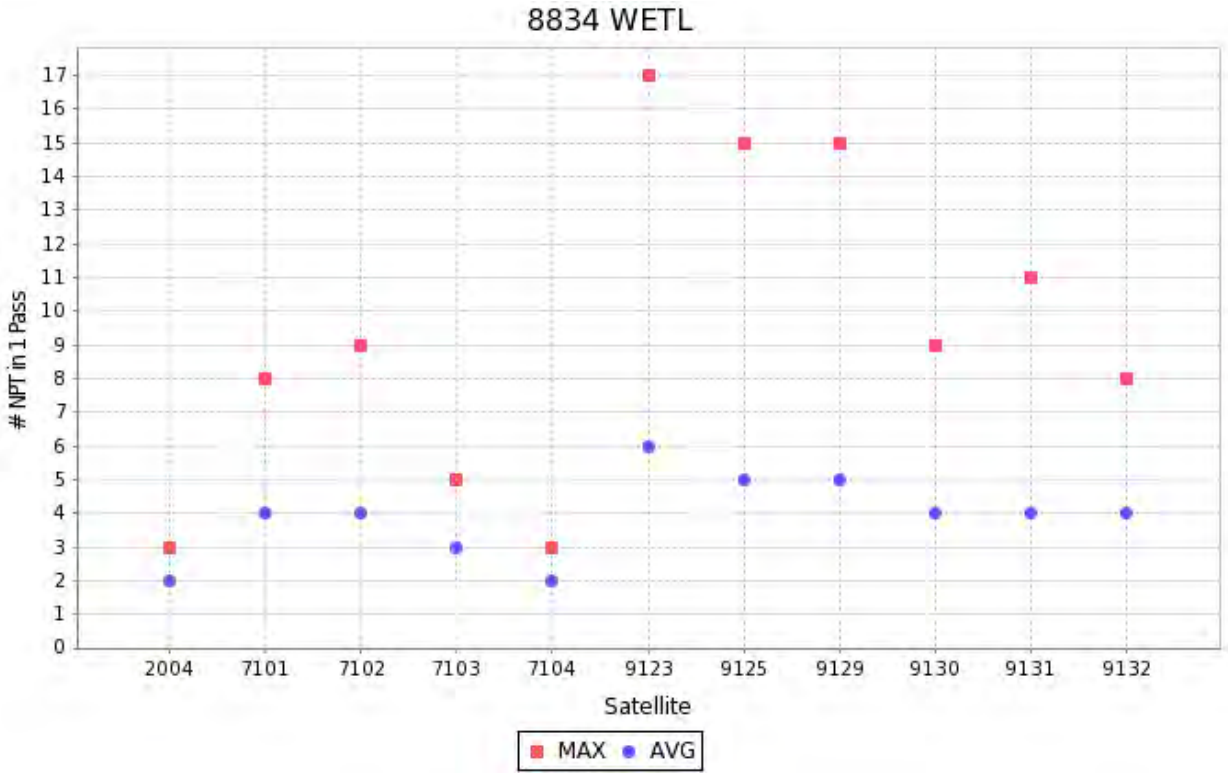




***Figure 1-21.*** *Maximum and Average Number of NPT in 1 Pass by WETL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

Figures 22 – 46 contain 3 pie charts per figure. The first set of charts for each station includes the number of passes that tracked in sectors by constellation and the values are equivalent to Figures 4 – 7. The pie charts show the number of counts per sector followed the percentage of passes in it. The second set of charts for each station includes the number of passes that tracked under each possible sector type. The abbreviations are as follows:

a. B = Beginning
b. M = Middle
c. E = End
d. BM = Beginning and Middle
e. BE = Beginning and End
f. ME = Middle and End
g. BME = Beginning, Middle, and End

These charts provide the best view into compliance in tracking at the beginning, middle, and end. They also provide insight into how stations may be tracking. For example, a majority of stations are tracking a satellite in the middle of the pass but may be faltering at the beginning or end. This can be cause by the fact that the station may be unable to track the satellite initially because it is already tracking another satellite. There additional factors that can affect tracking such as weather, station patterns, and difficulty with daytime tracking.

Some of the top performing stations by number of counts are outshined by other stations in this category. YARL (Figure 21) performs very well for GLONASS constellation. GRZL (Figure 33) and HERL (Figure 35) performed consistently well for all the constellations. This may be due in part to the fact that both HERL and GRZL have high repetition rate lasers.

| **Stations with Repetition Rates >=1000** | | | |
|---|---|---|---|
| Mon | Code | Location Name | Repetition Rate |
| 7821 | SHA2 | Shanghai, China | 1000 |
| 7827 | SOSW | Wettzell, Germany | 1000 |
| 7839 | GRZL | Graz, Austria | 2000 |
| 7840 | HERL | Herstmonceux, United Kingdom | 2000 |
| 7841 | POT3 | Potsdam, Germany | 2000 |
| 7237 | CHAL | Changchun, China | 10000 |
| 7249 | BEIL | Beijing, China | 1000 |

However, other stations with high repetition rate lasers did not necessarily track multiple segments. SHA2 has few passes where they tracked more than 1 segment per pass. About 10% of CHAL's passes contained more than 1 segment per pass. POT3 and BEIL are not within the top trackers for this campaign.

Some stations have clear biases in how they're tracking; please see ALTL (Figure 27), KOML (Figure 29), ZELL (Figure 39).

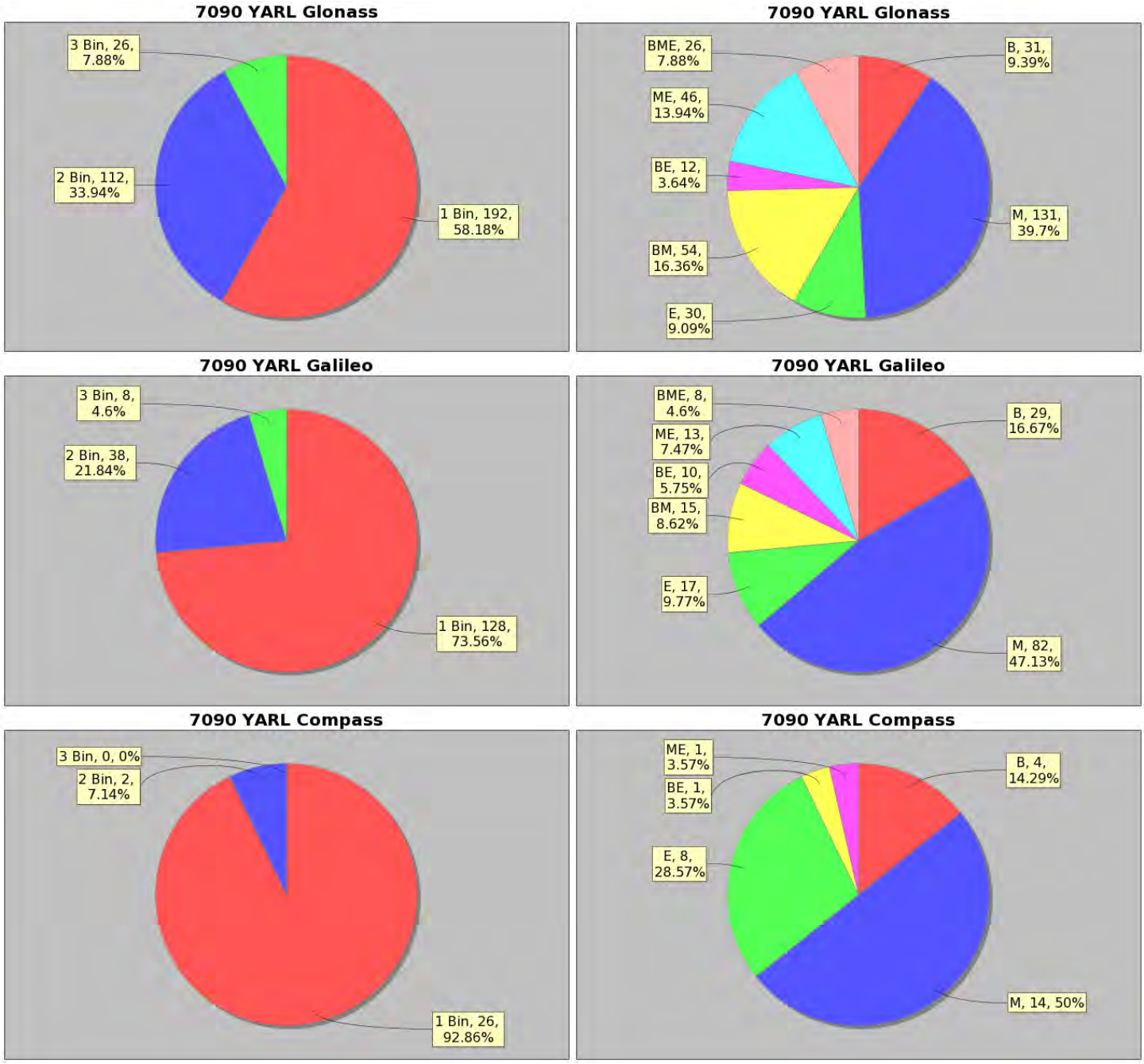



***Figure 1-22.*** *Pass Segment Pie Charts by YARL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

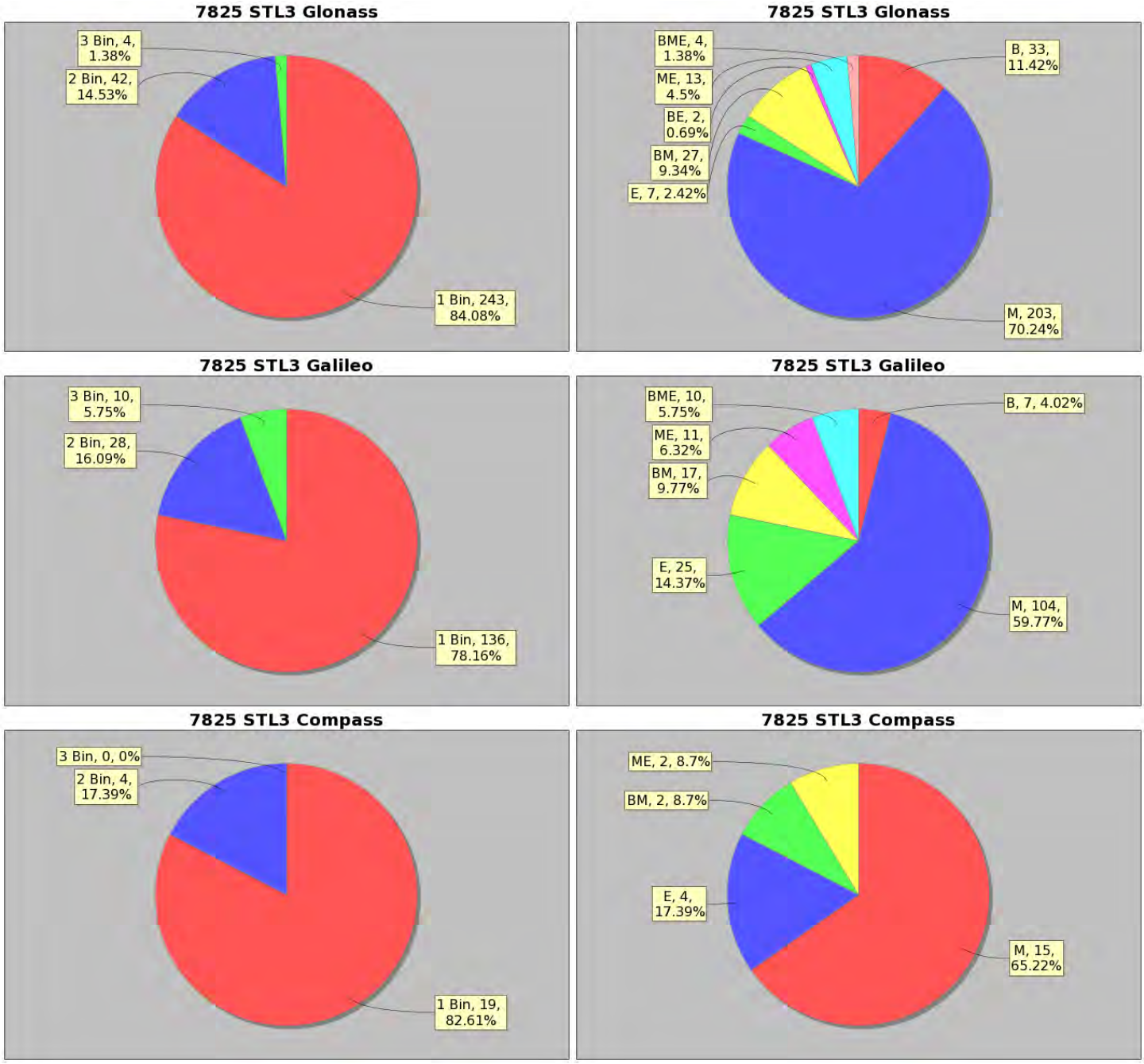



***Figure 1-23.*** *Pass Segment Pie Charts by STL3 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

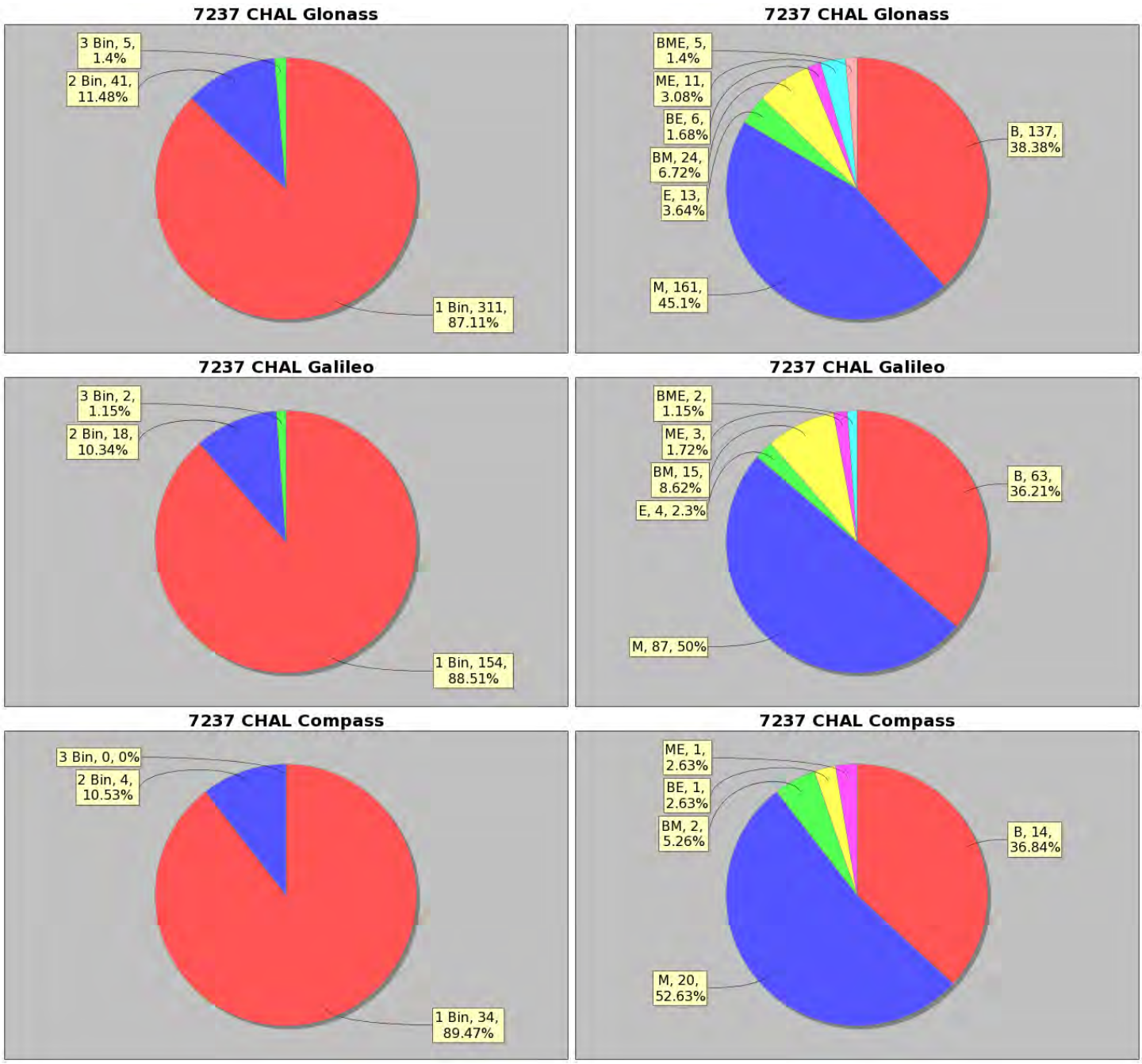



***Figure 1-24.*** *Pass Segment Pie Charts by CHAL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

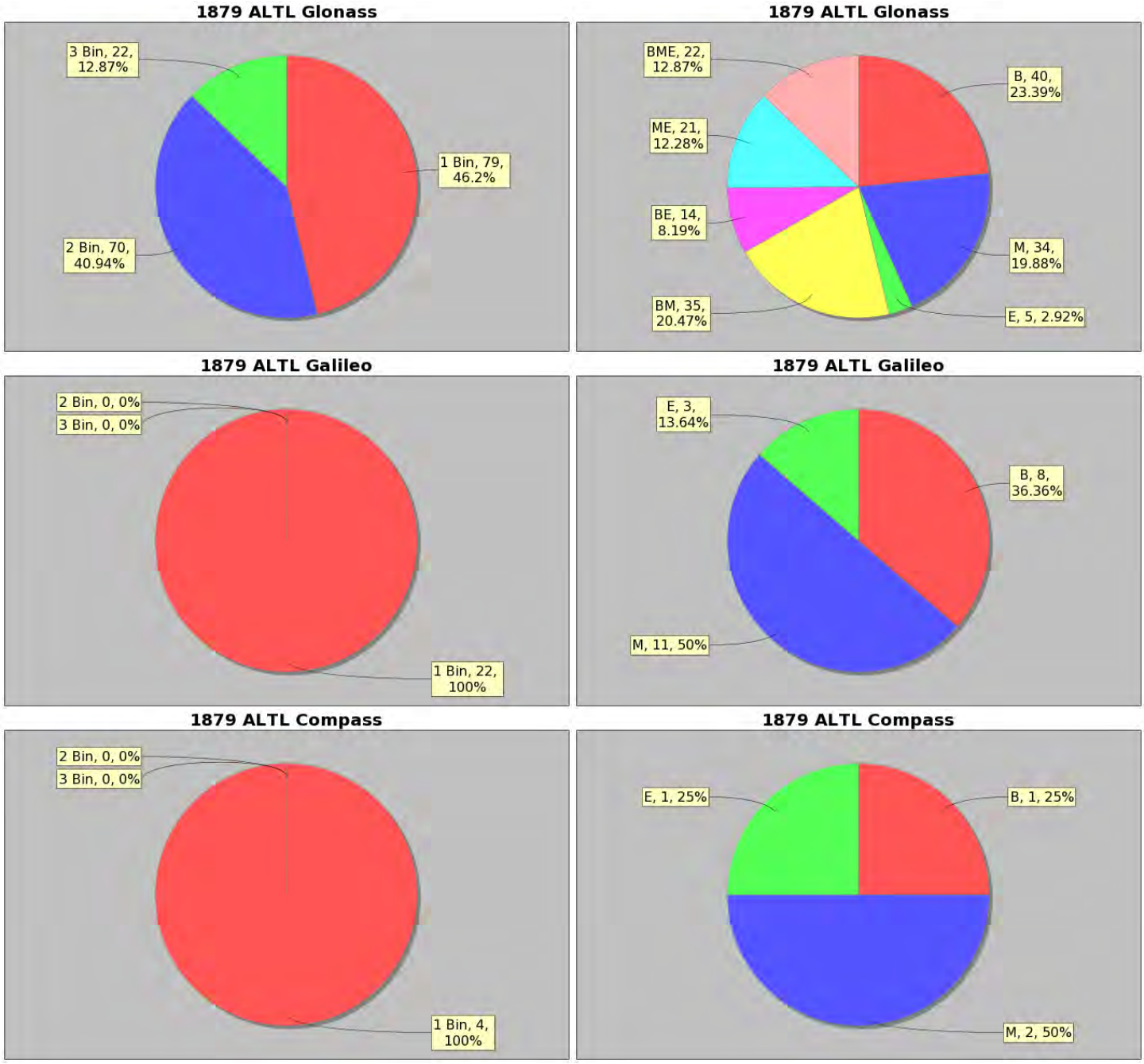



***Figure 1-25.*** *Pass Segment Pie Charts by ALTL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

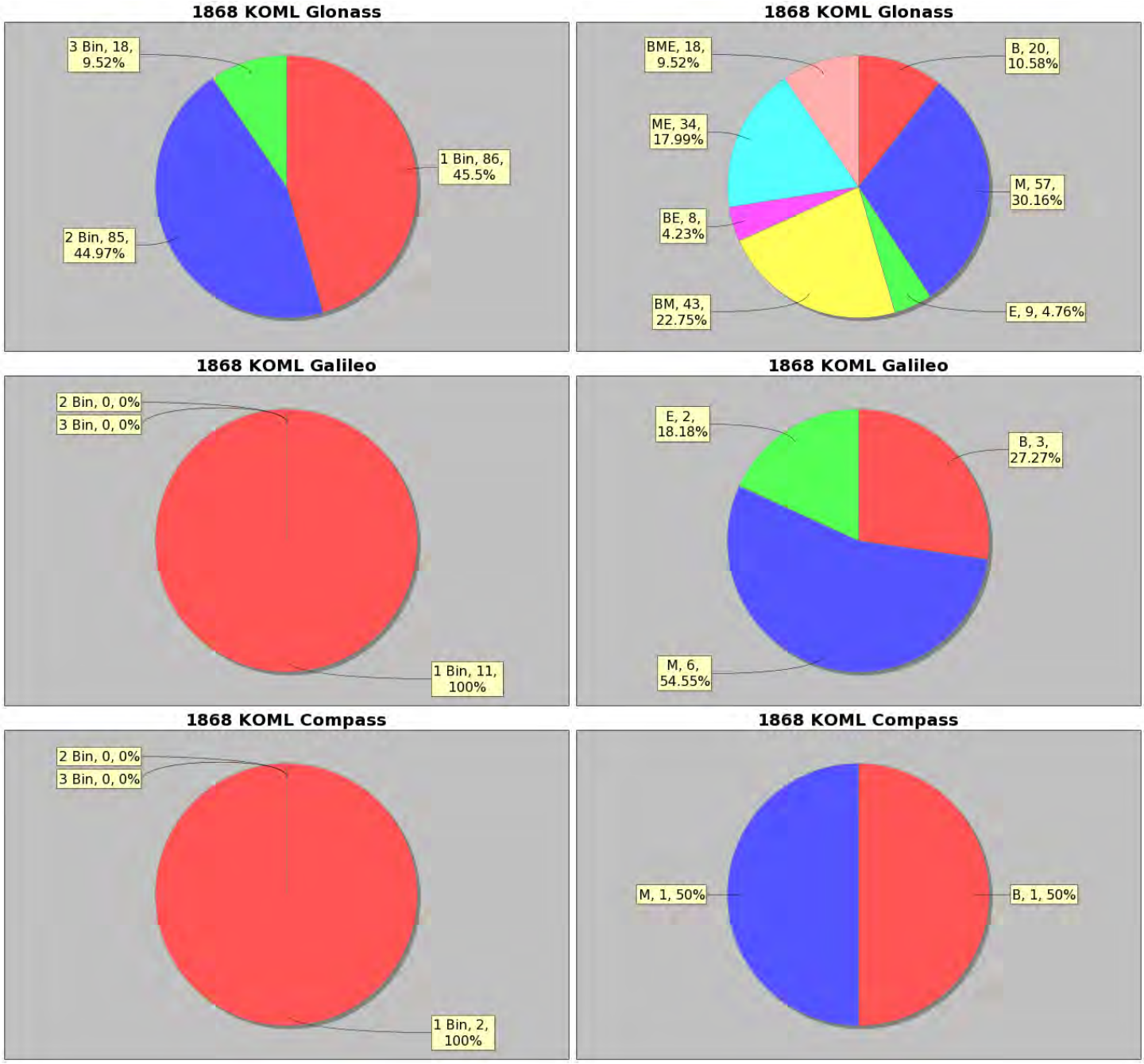



***Figure 1-26.*** *Pass Segment Pie Charts by KOML for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

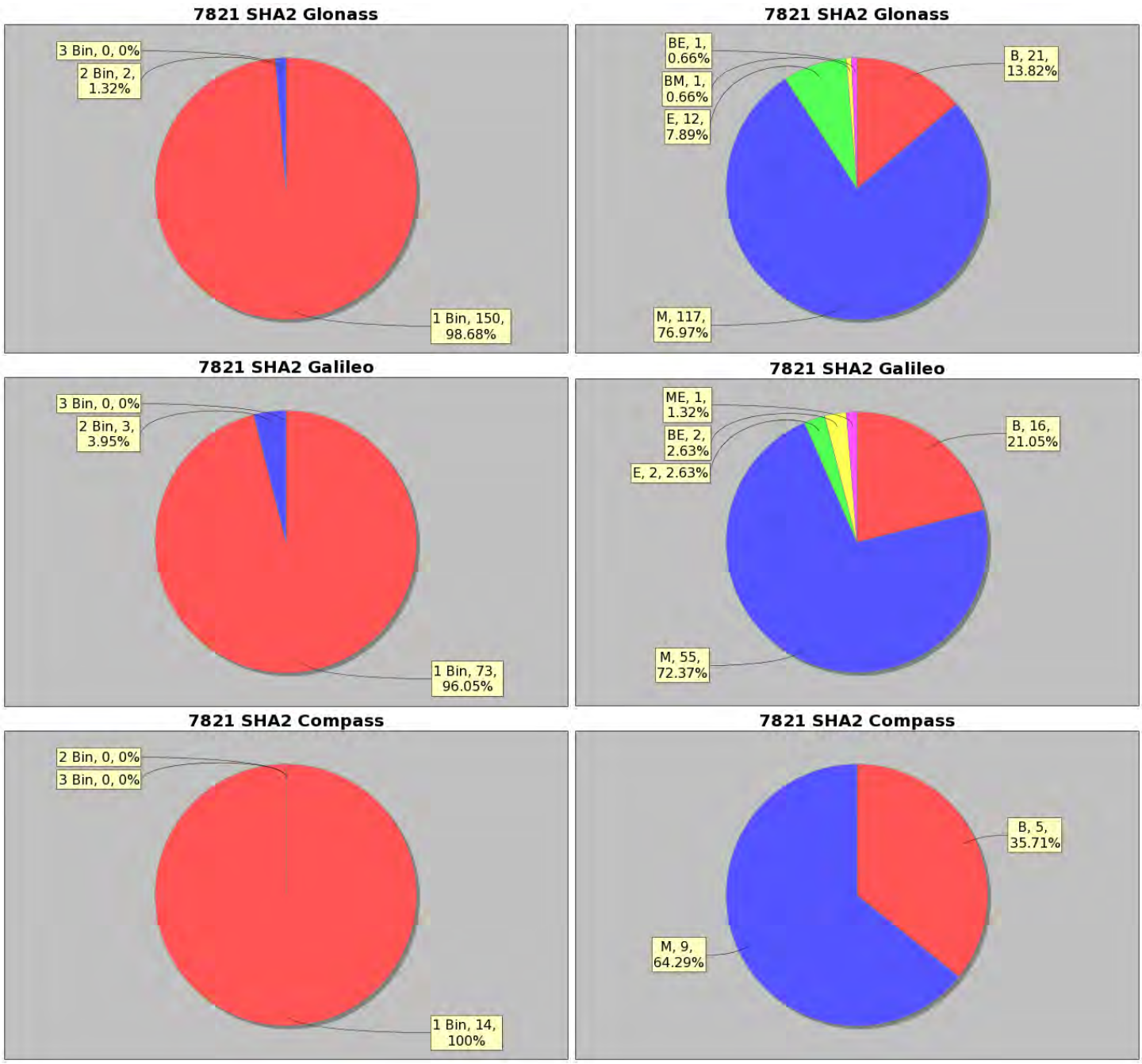



***Figure 1-27.*** *Pass Segment Pie Charts by SHA2 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

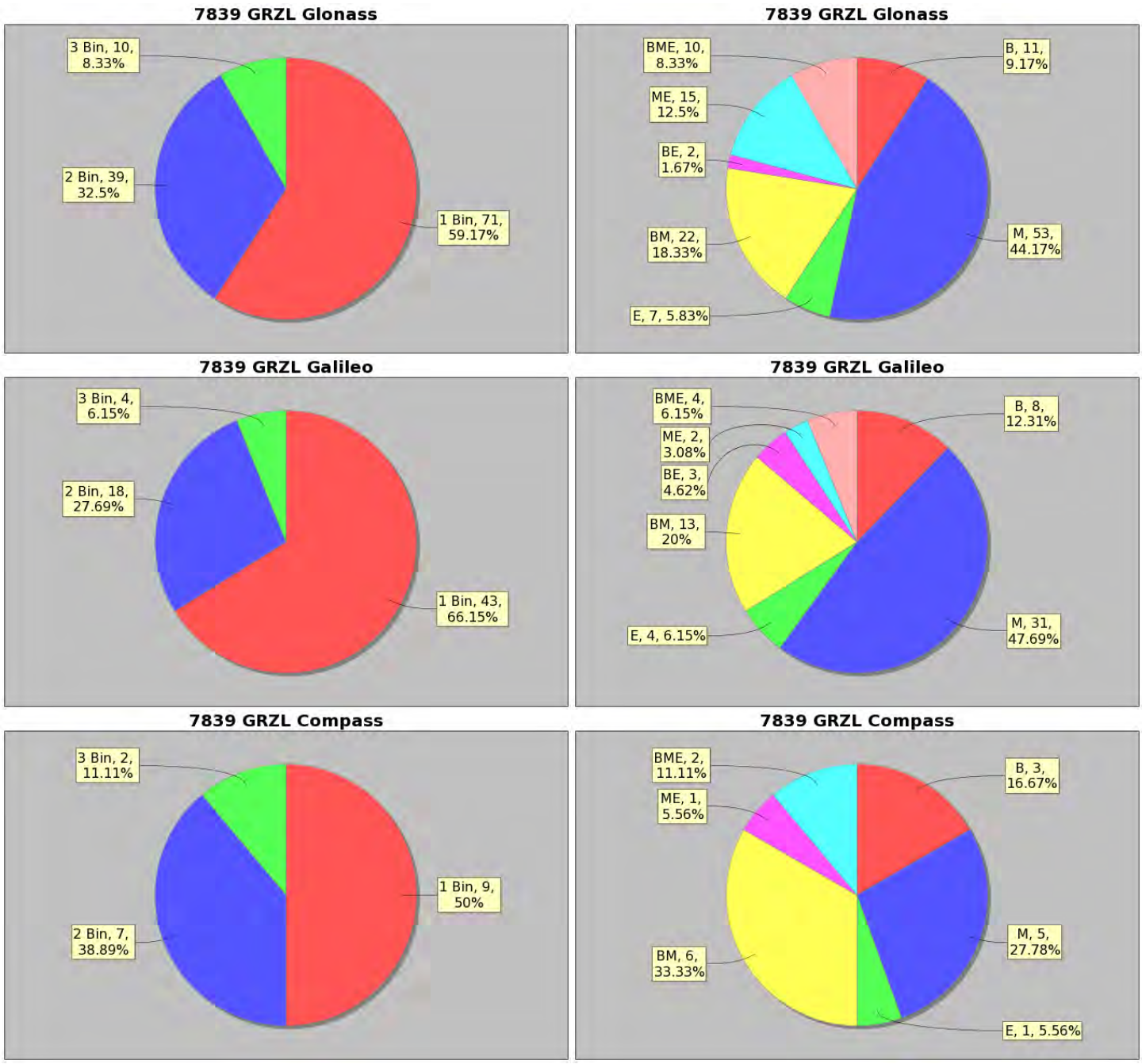



***Figure 1-28.*** *Pass Segment Pie Charts by GRZL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

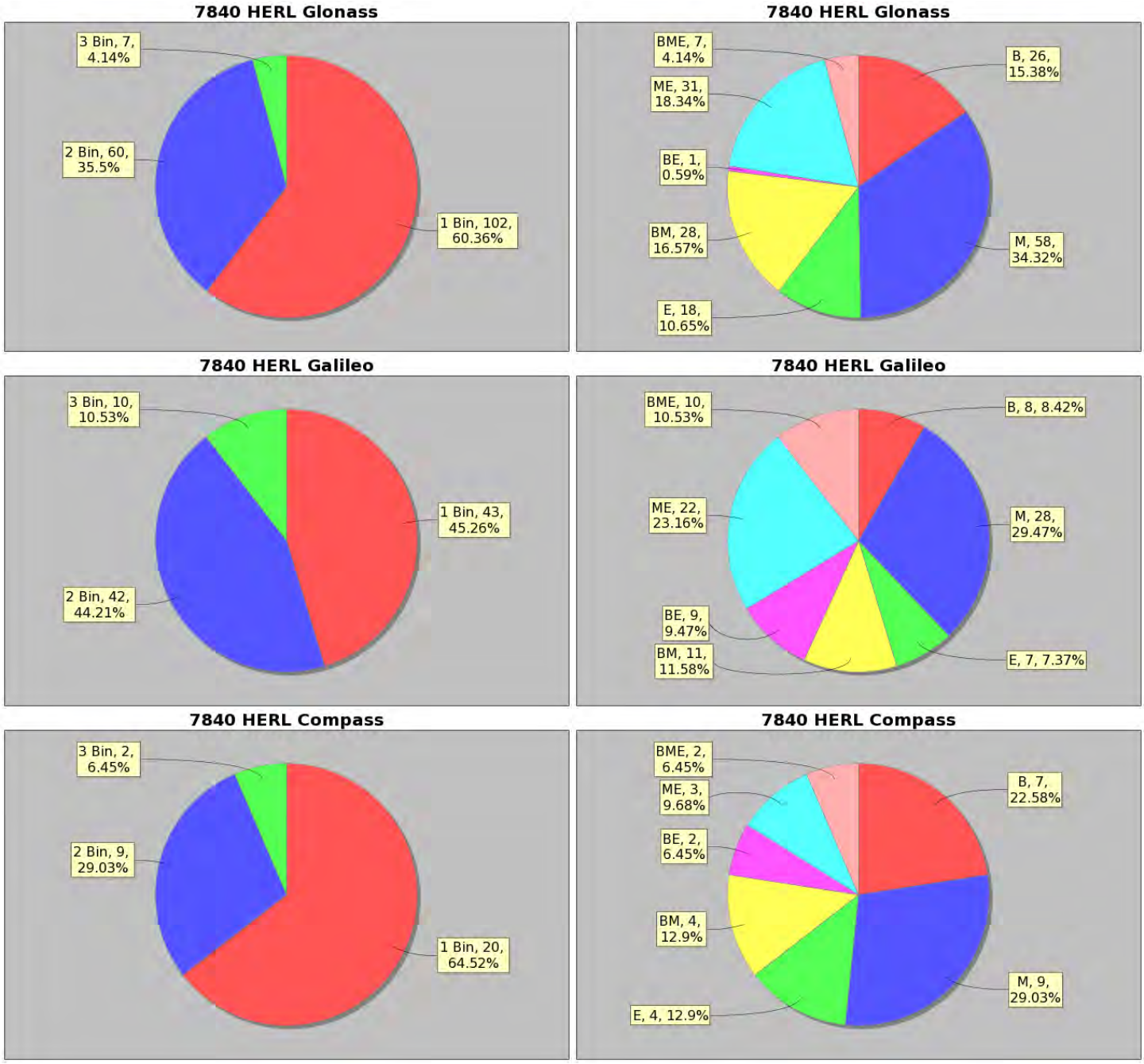



***Figure 1-29.*** *Pass Segment Pie Charts by HERL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

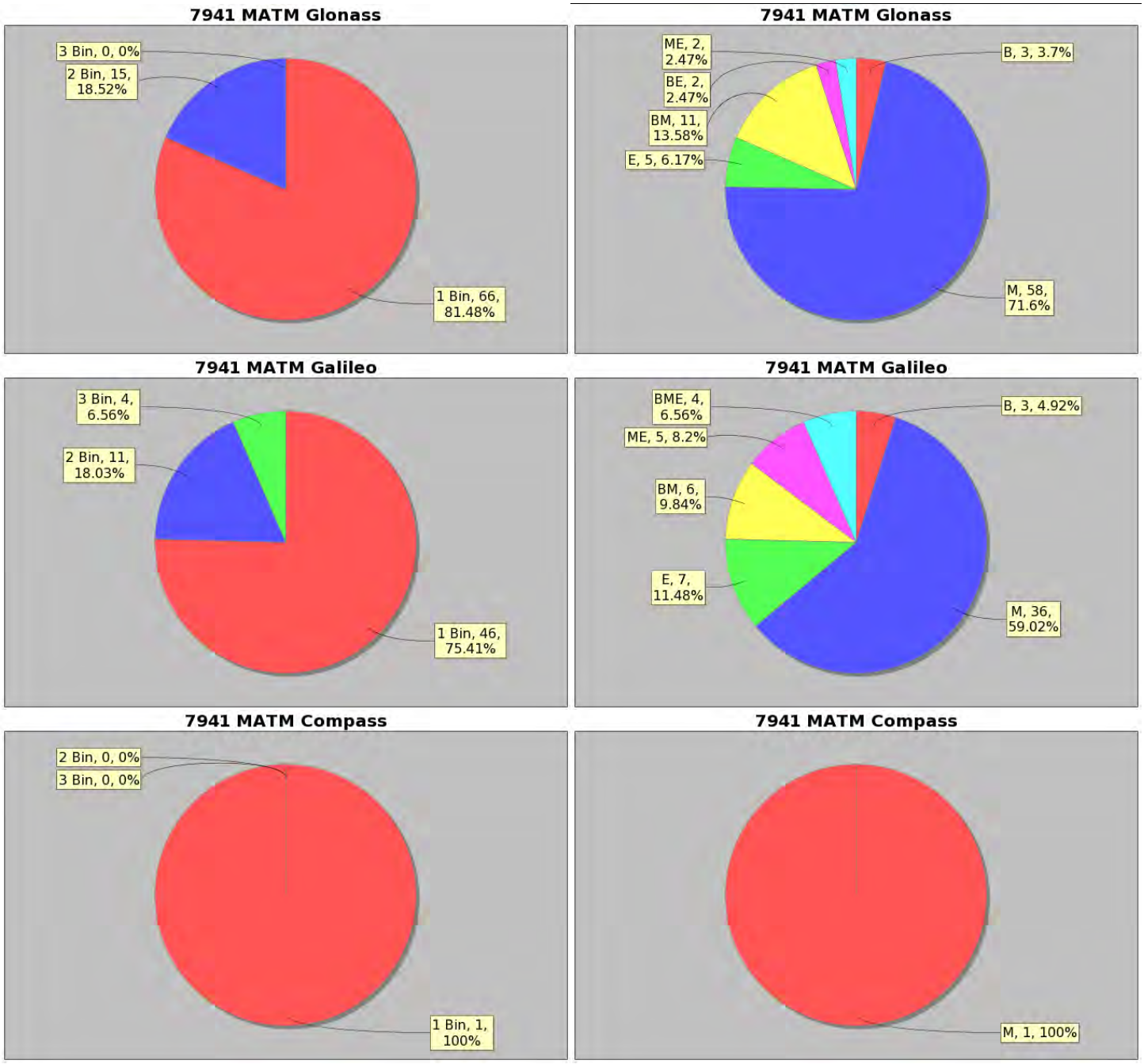



***Figure 1-30.*** *Pass Segment Pie Charts by MATM for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

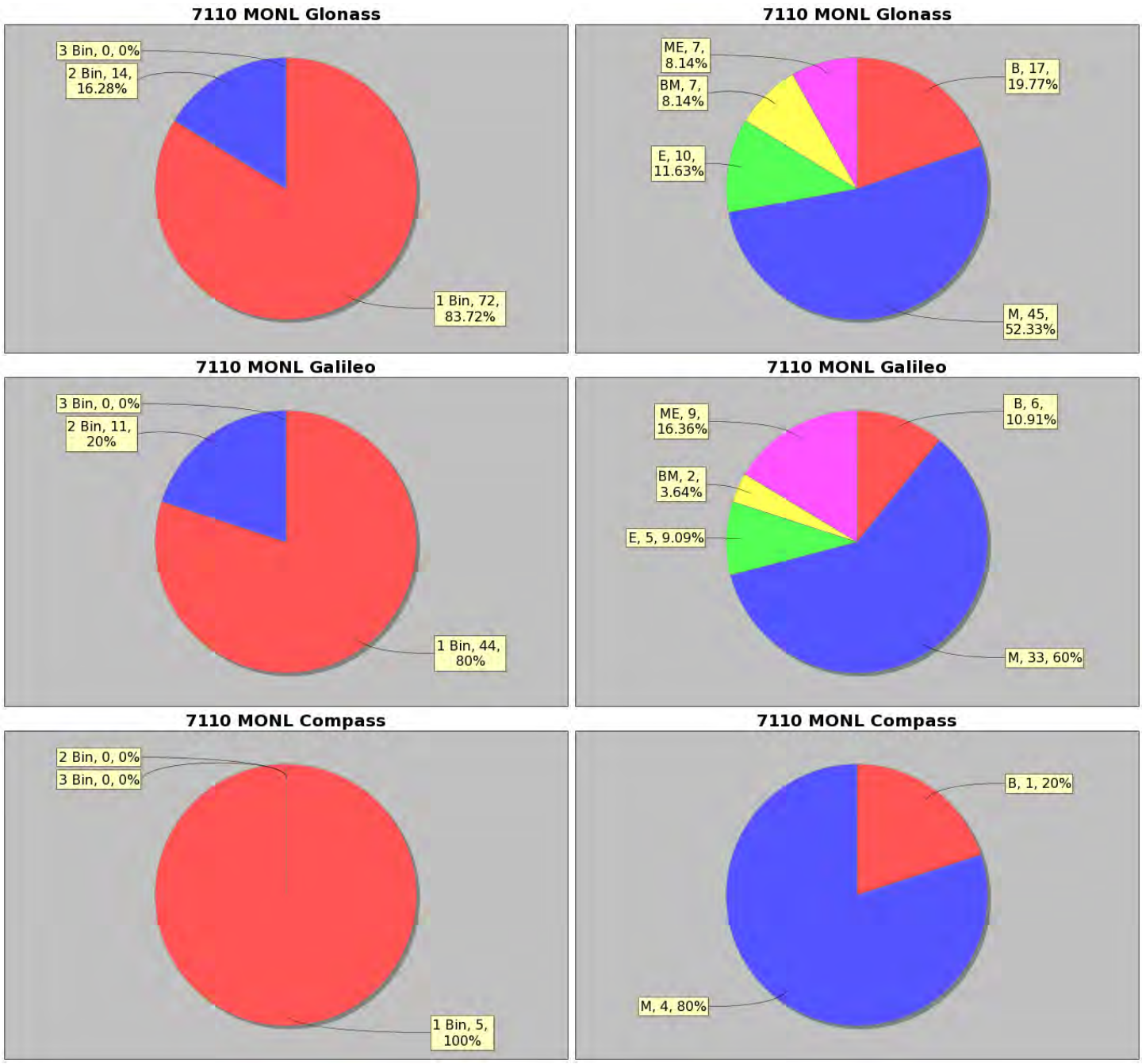



***Figure 1-31.*** *Pass Segment Pie Charts by MONL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

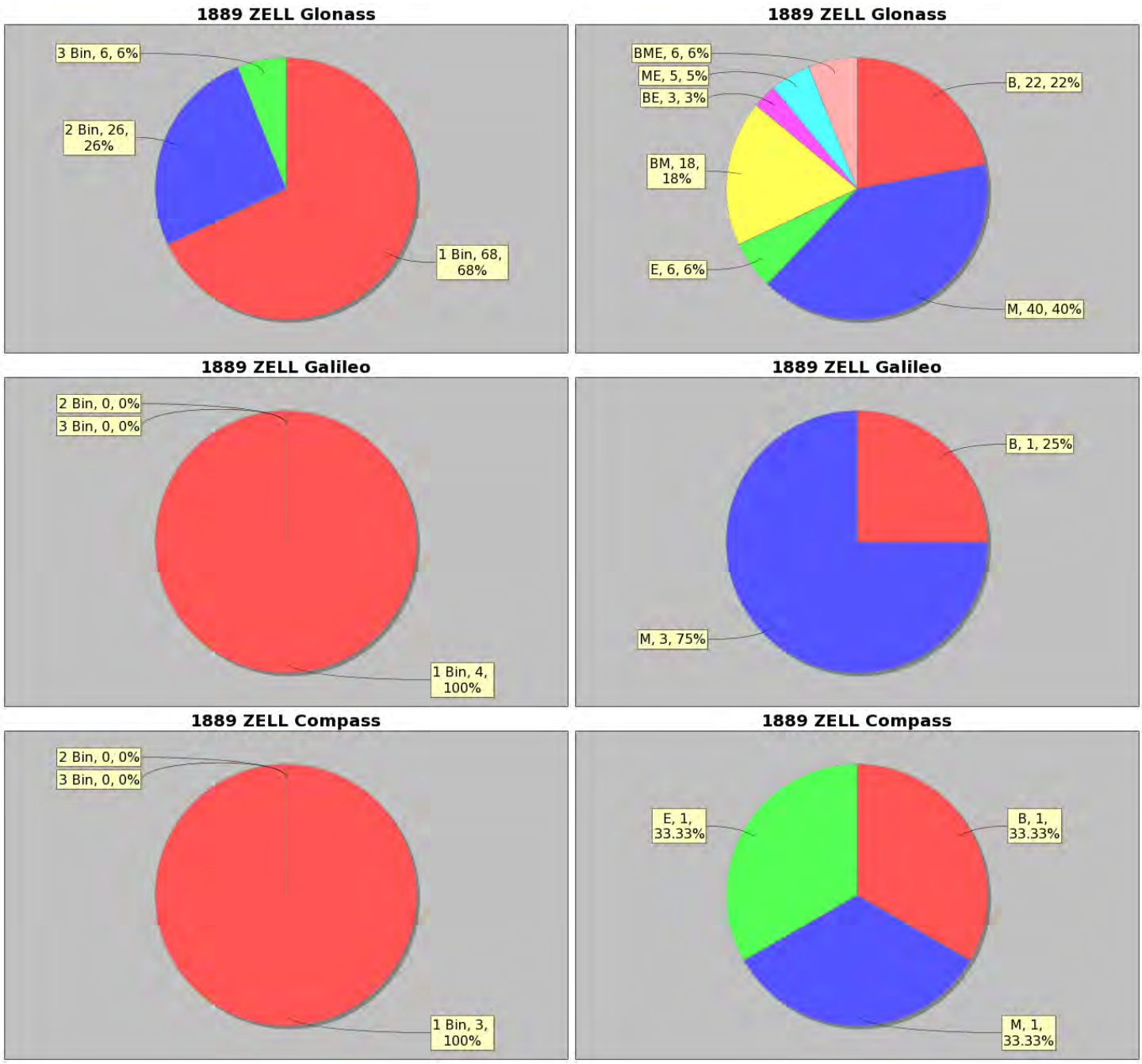



***Figure 1-32.*** *Pass Segment Pie Charts by ZELL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

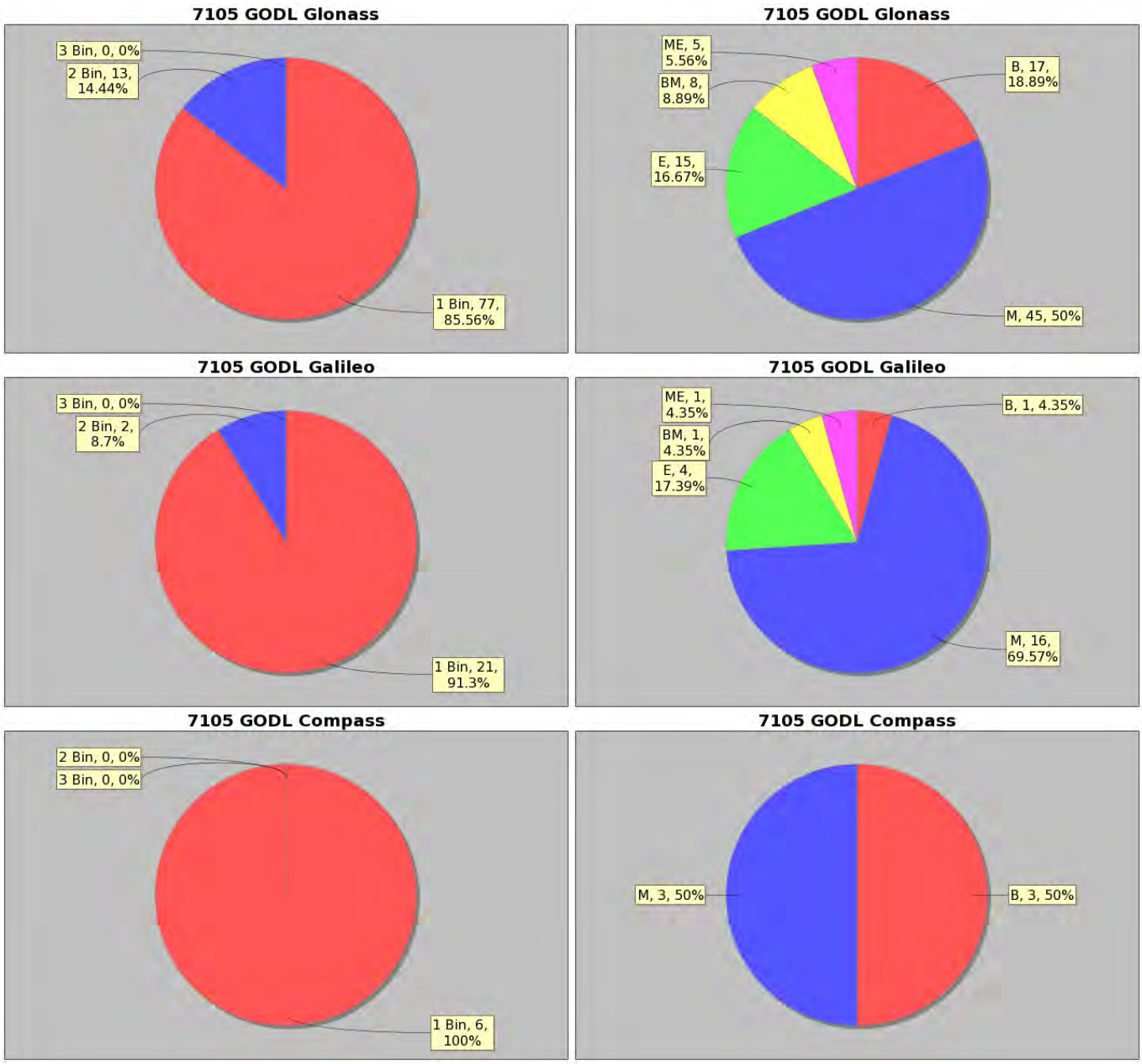



***Figure 1-33.*** *Pass Segment Pie Charts by GODL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

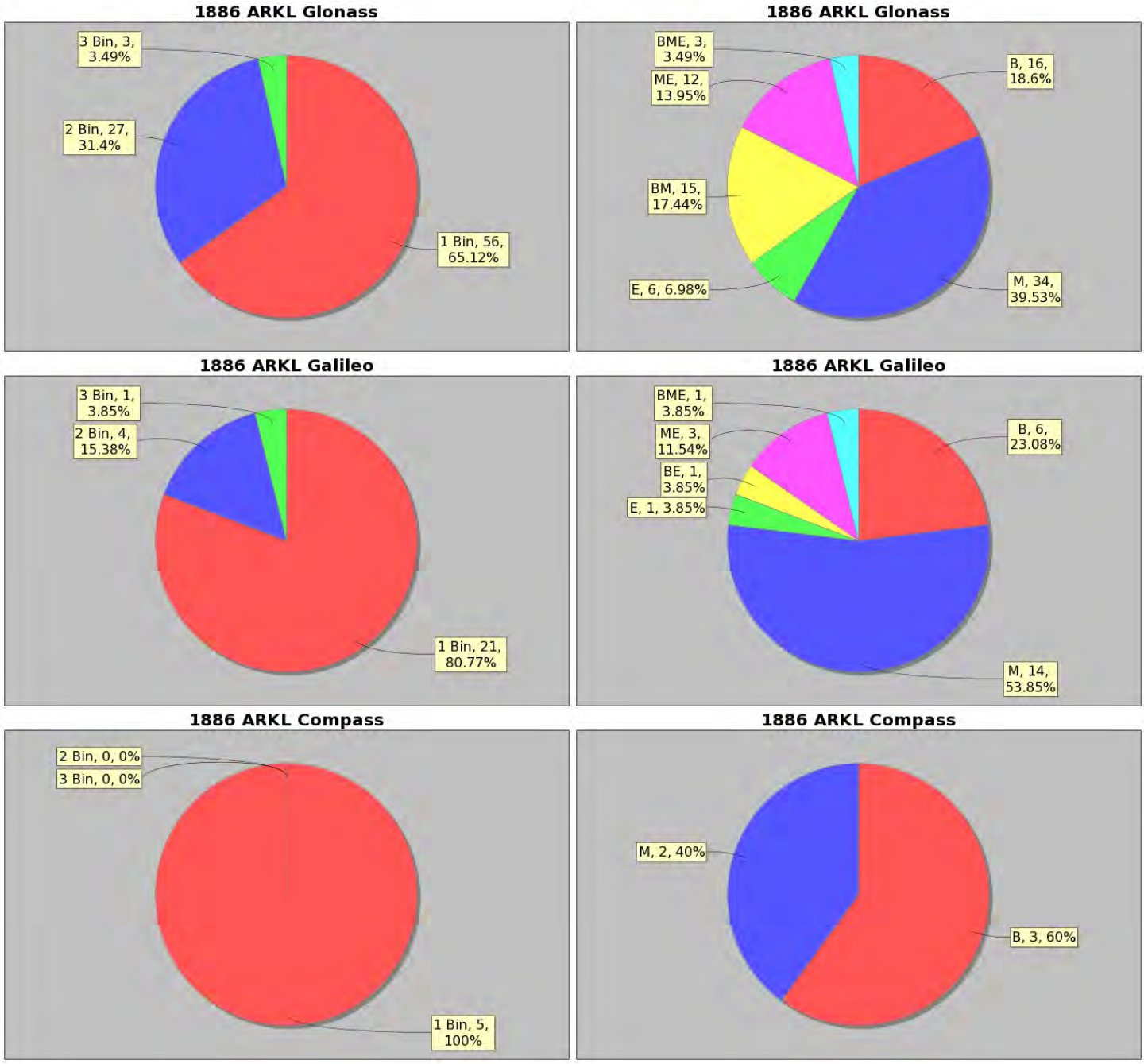



***Figure 1-34.*** *Pass Segment Pie Charts by ARKL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

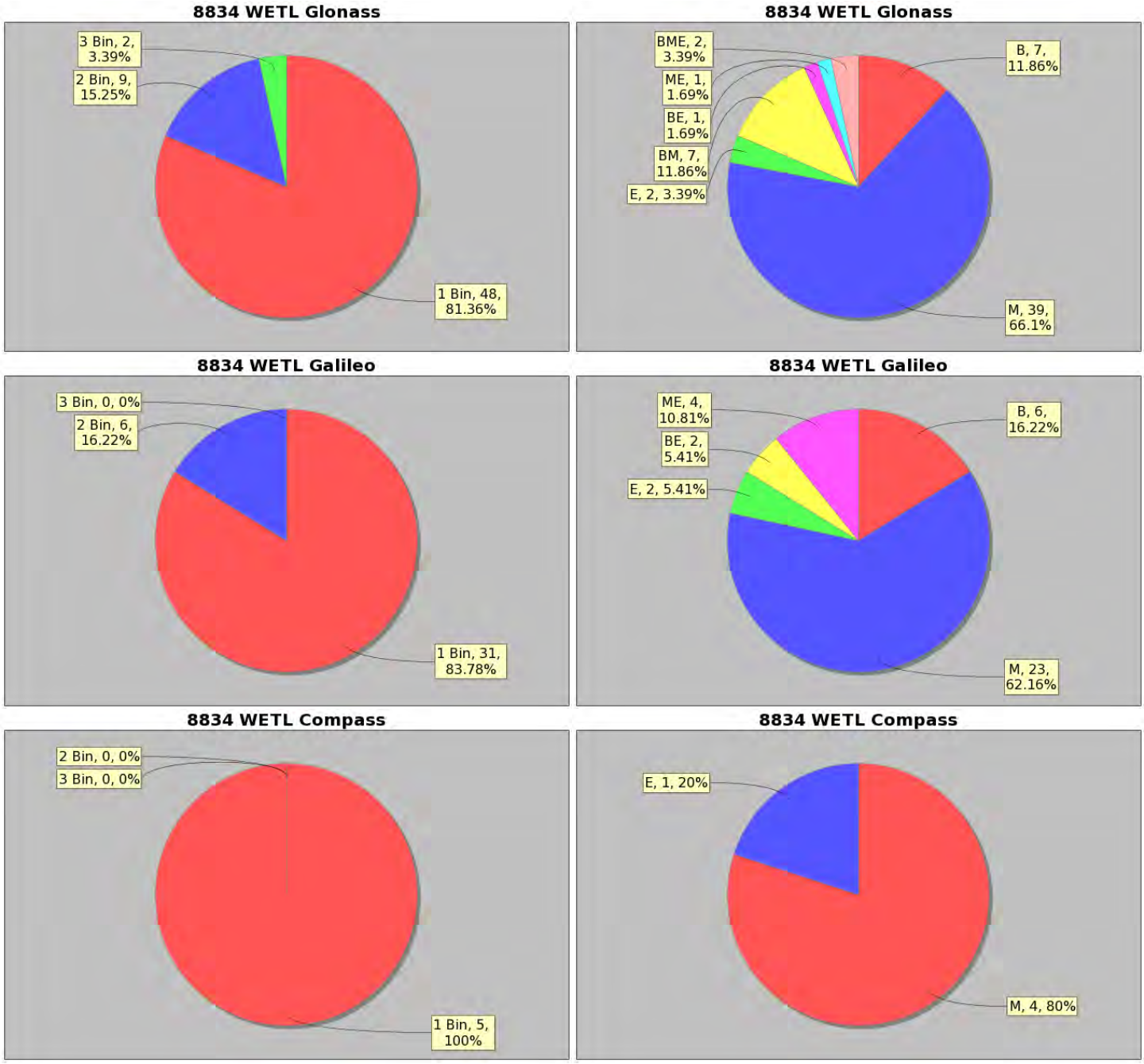



***Figure 1-35.*** *Pass Segment Pie Charts by WETL for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

Figures 47 to 74 are tracking samples from the CDDIS daily files taken from 2015/01/25 to 2015/02/07; for each station a fortnight is shown and ranging from a day is shown in local time. The charts display the range record information such that each range record is printed as at least 1 minute (for visibility) or if the range records are close to each other (within 1 minute) the range records are printed as one block.

From these chart, GRAZ tracked during the day time frequently. Other stations that also tracked during the daytime include YARL, STL3, CHAL, SHA2, GRAZ, HERL, and MATM. The remaining stations performed little to no day time tracking.

All stations also show some degree of interleaving.

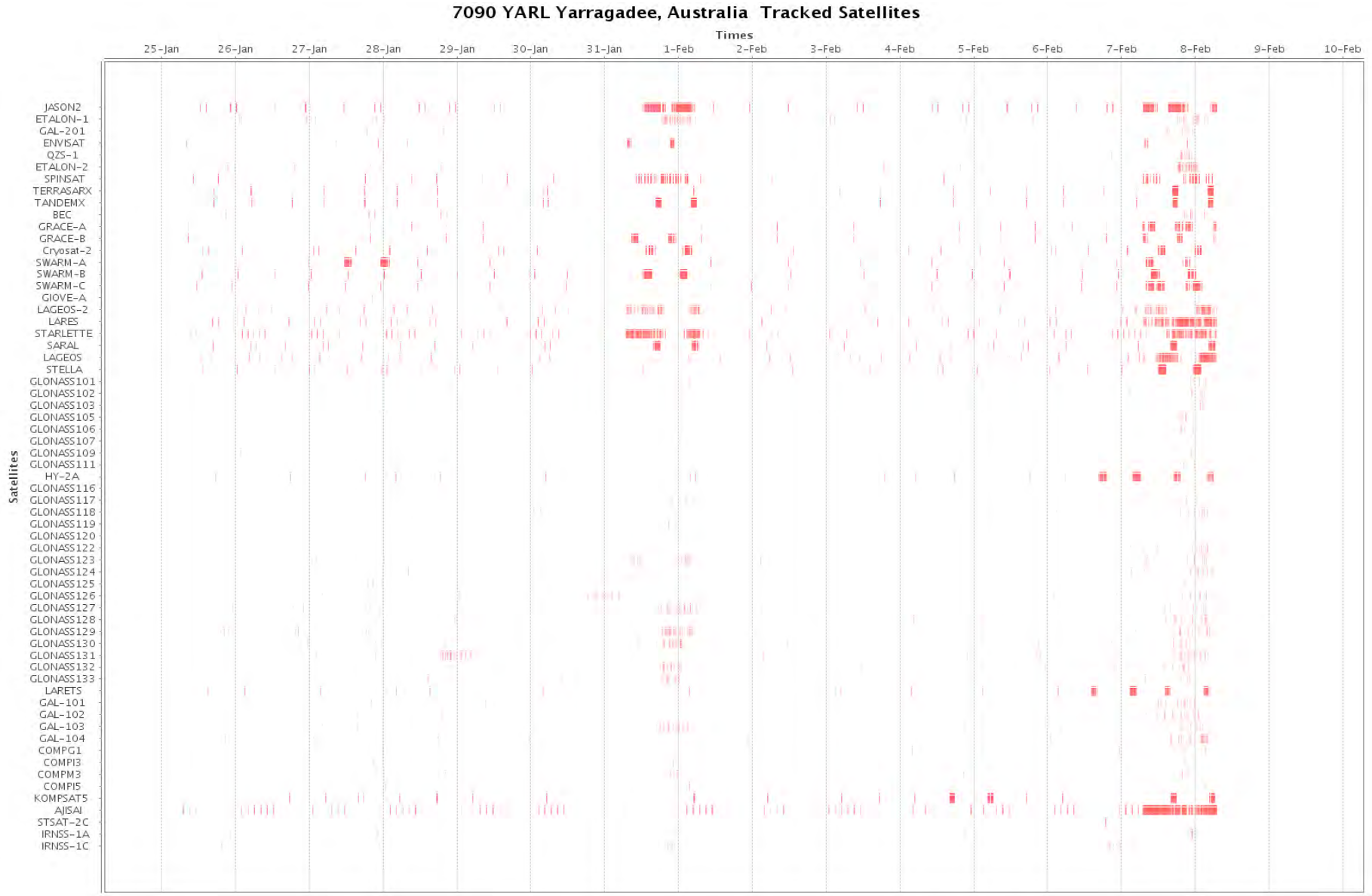



***Figure 1-36.*** *YARL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

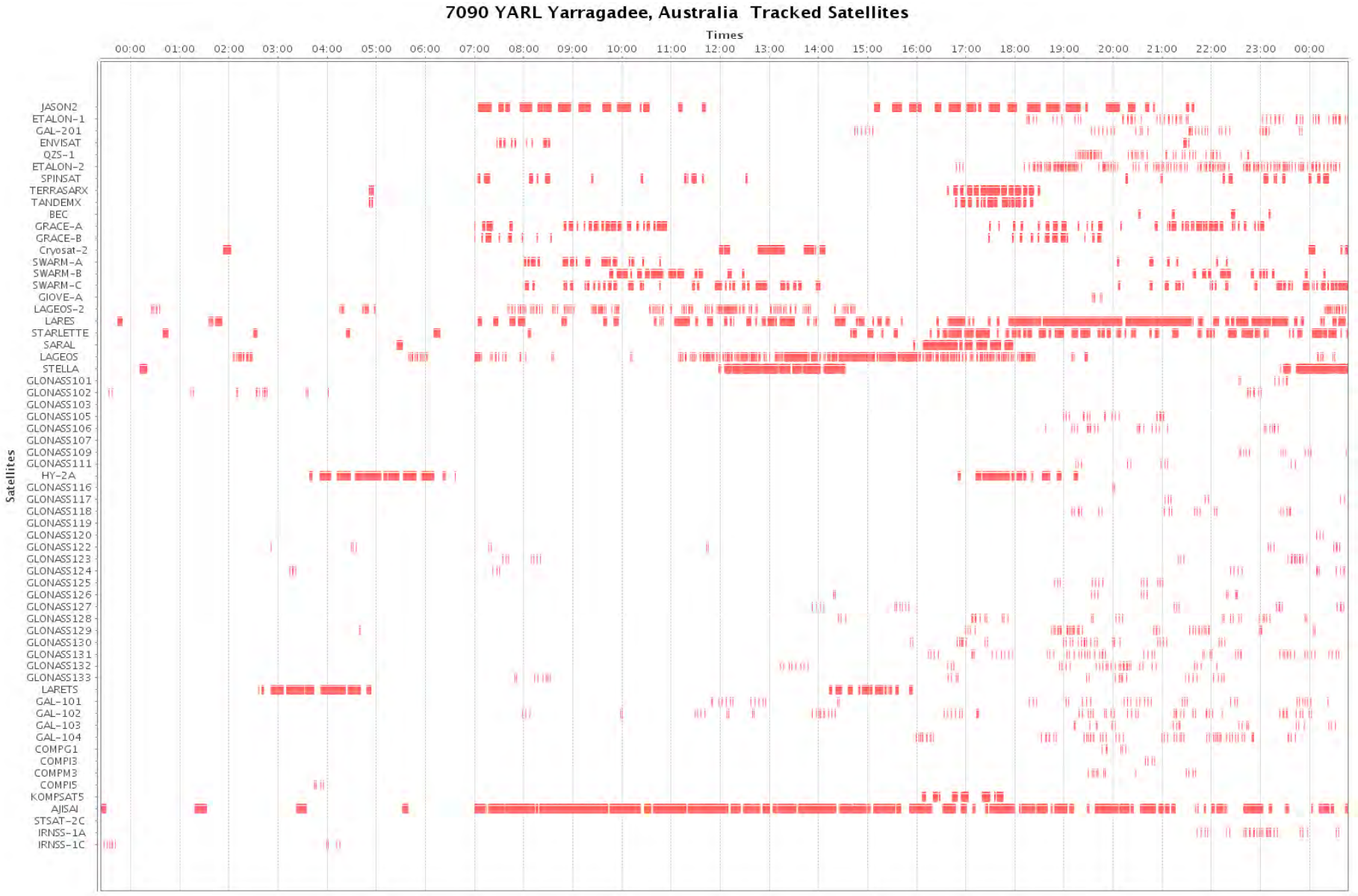



***Figure 1-37.*** *YARL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

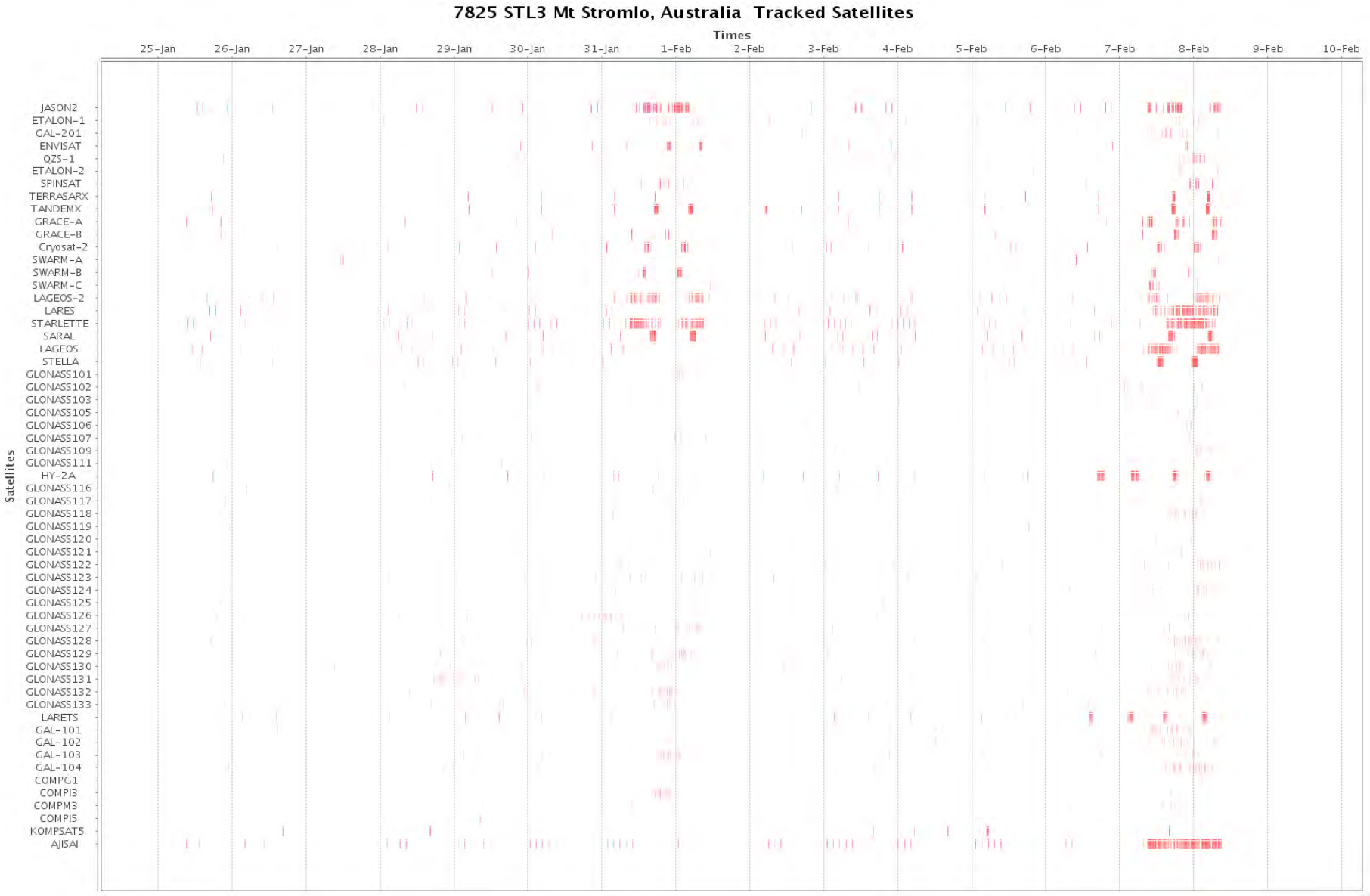



***Figure 1-38.*** *STL3 Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

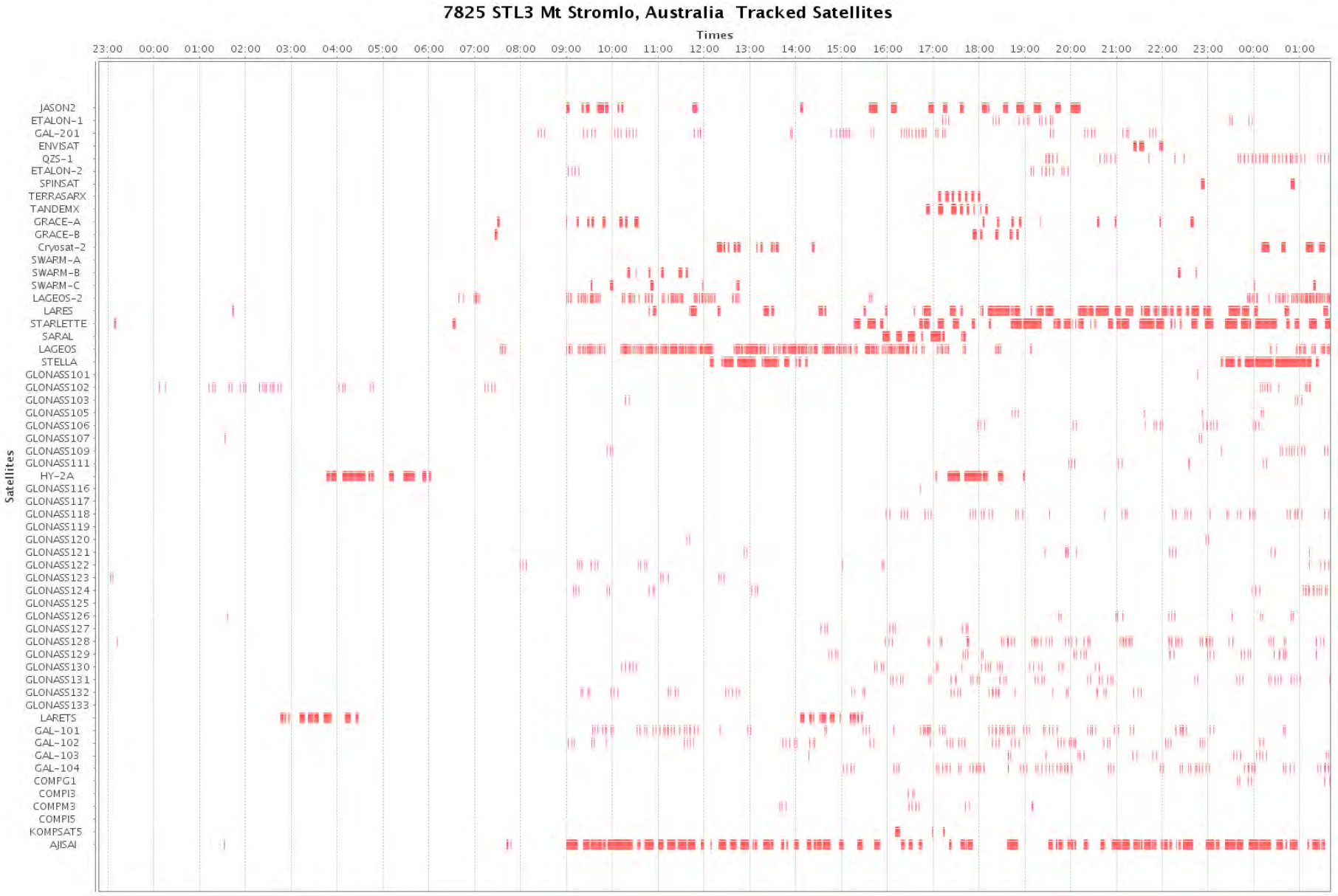



***Figure 1-39.*** *STL3 Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

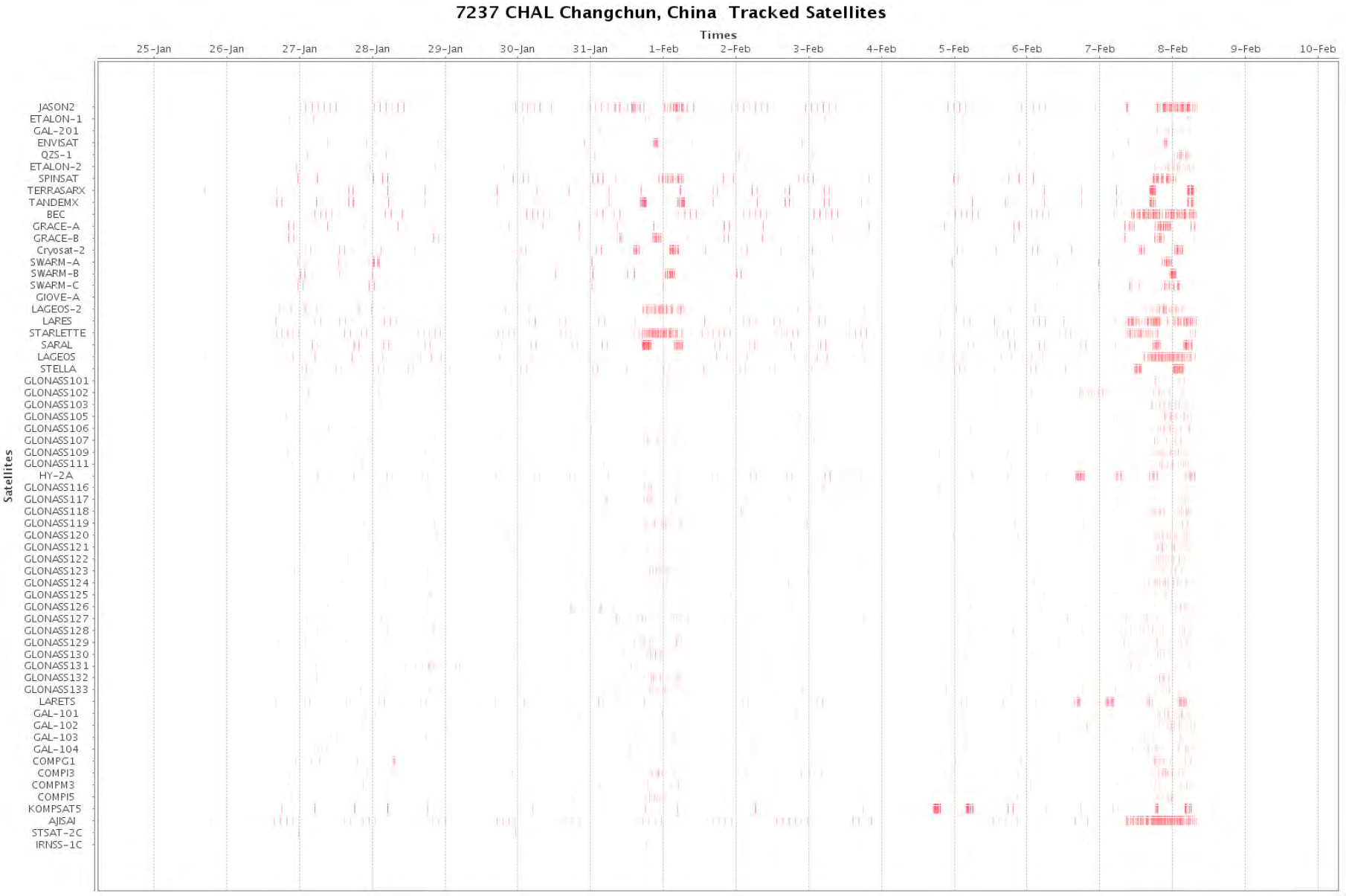



***Figure 1-40.*** *CHAL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

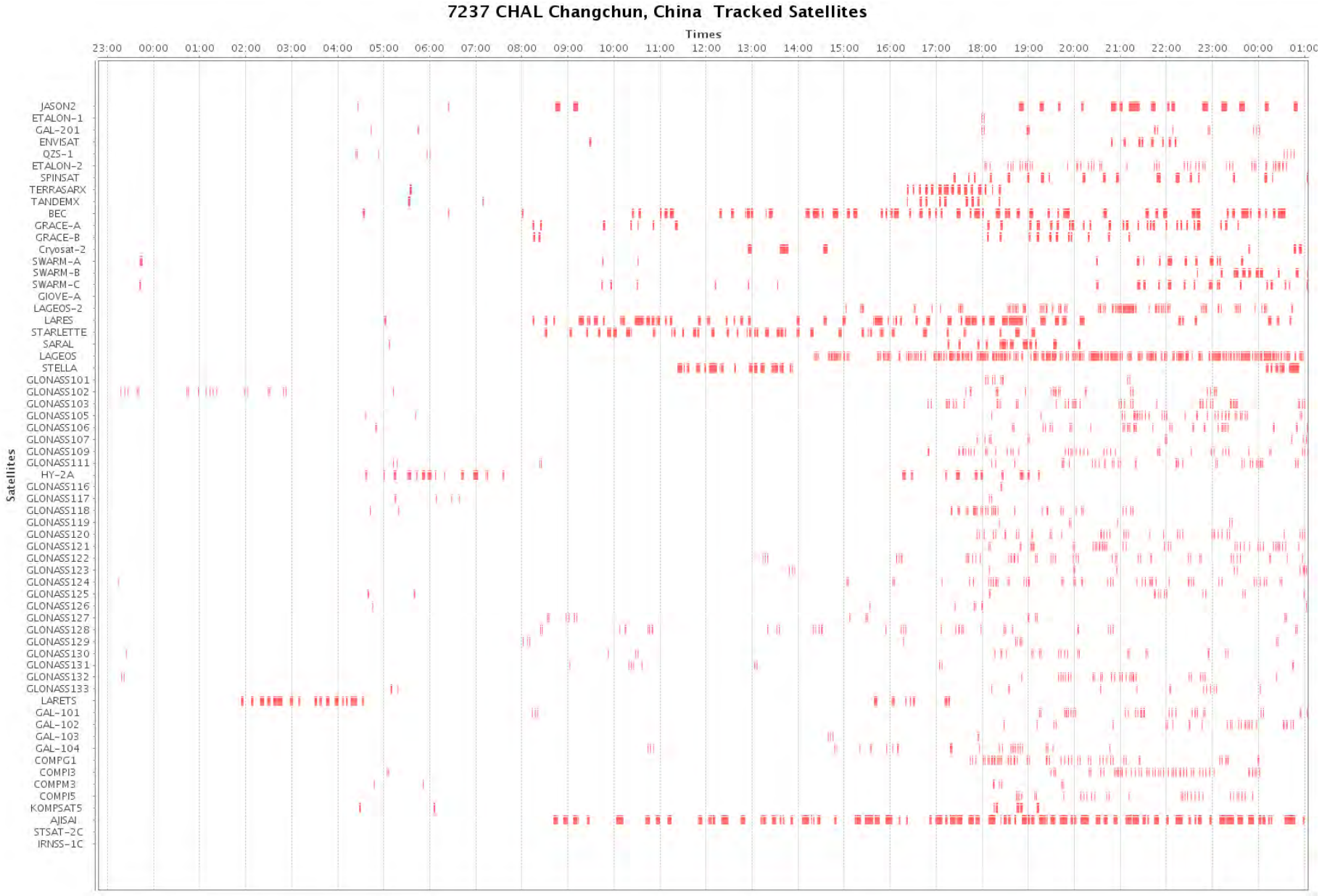



***Figure 1-41.*** *CHAL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

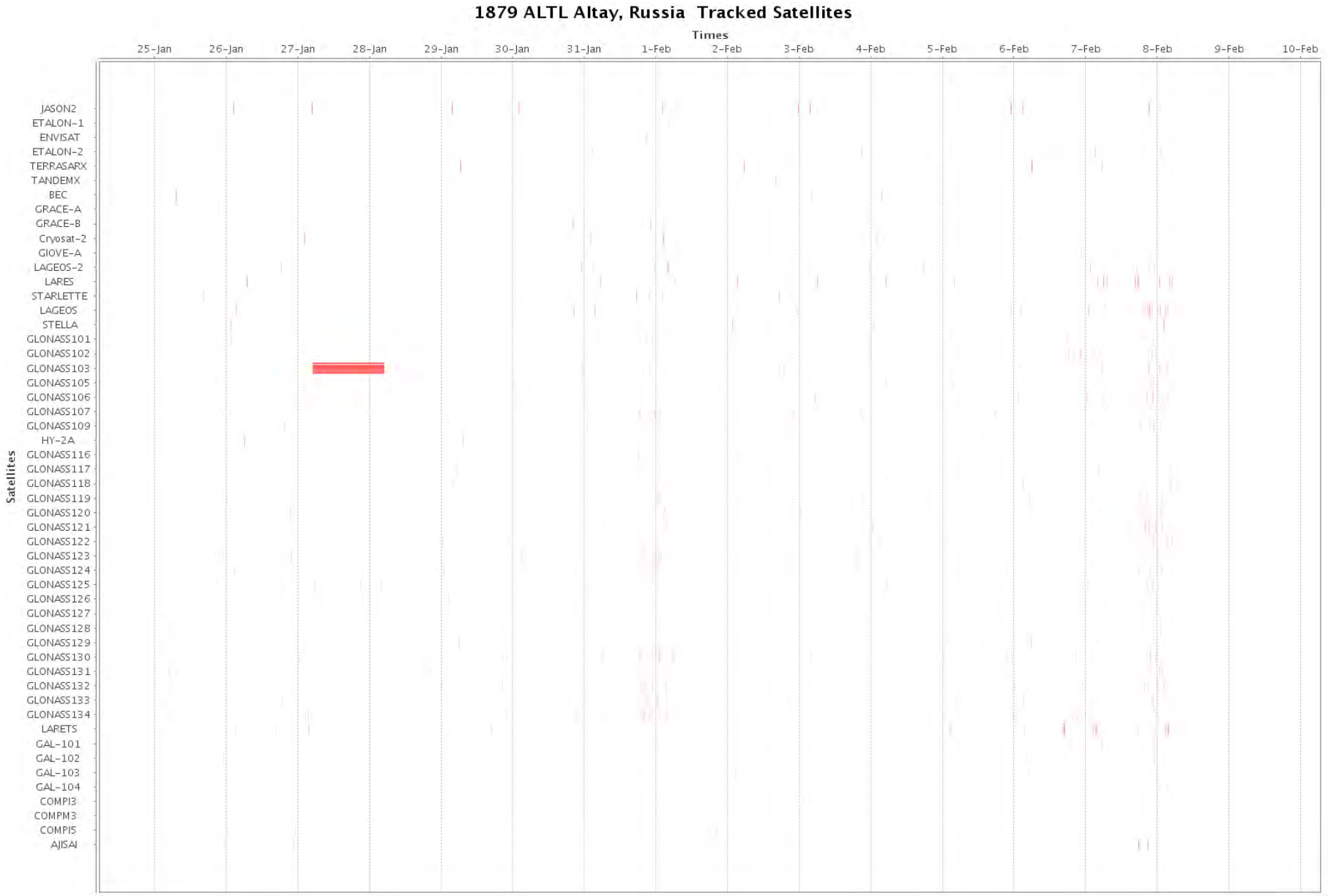



***Figure 1-42.*** *ALTL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

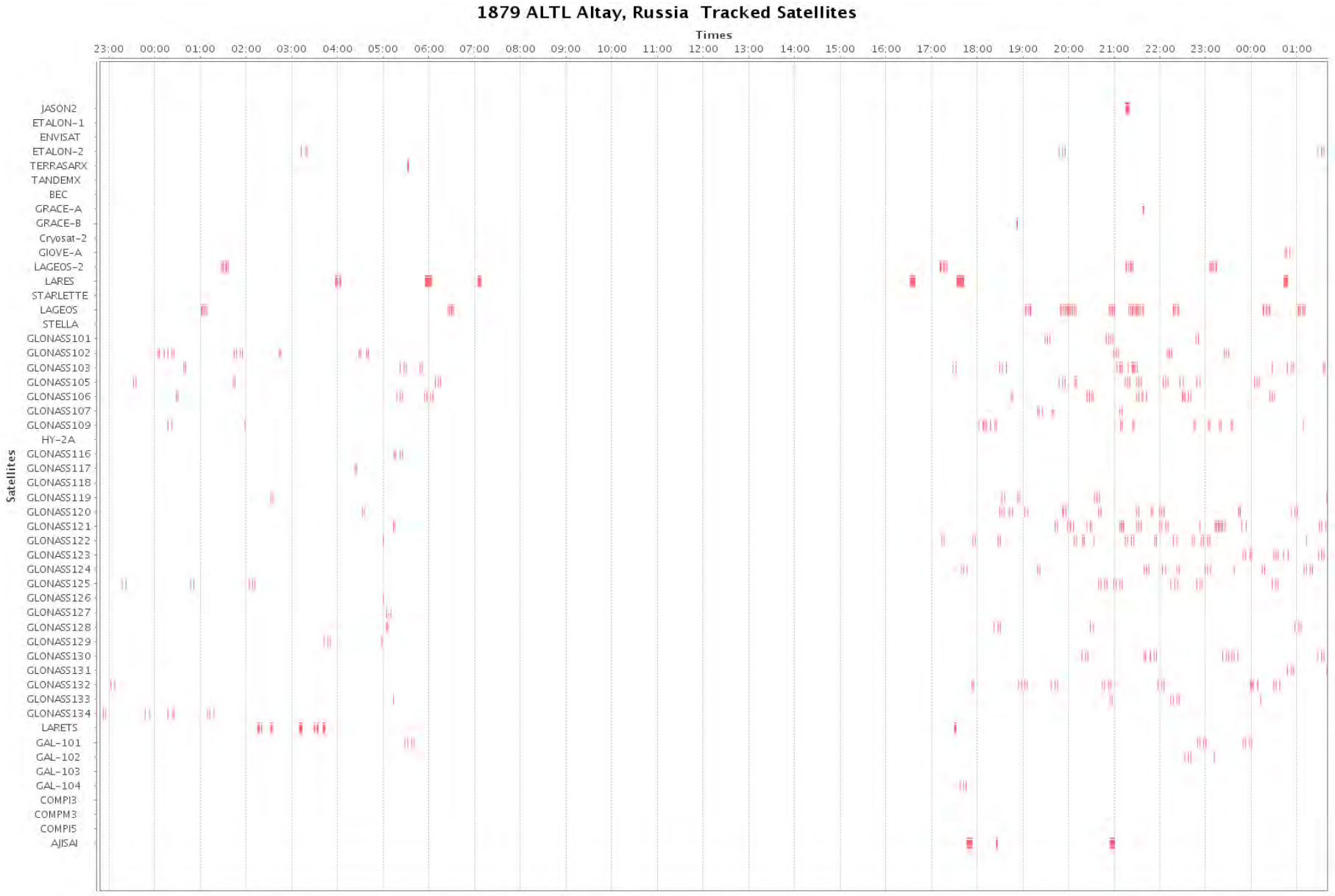



***Figure 1-43.*** *ALTL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

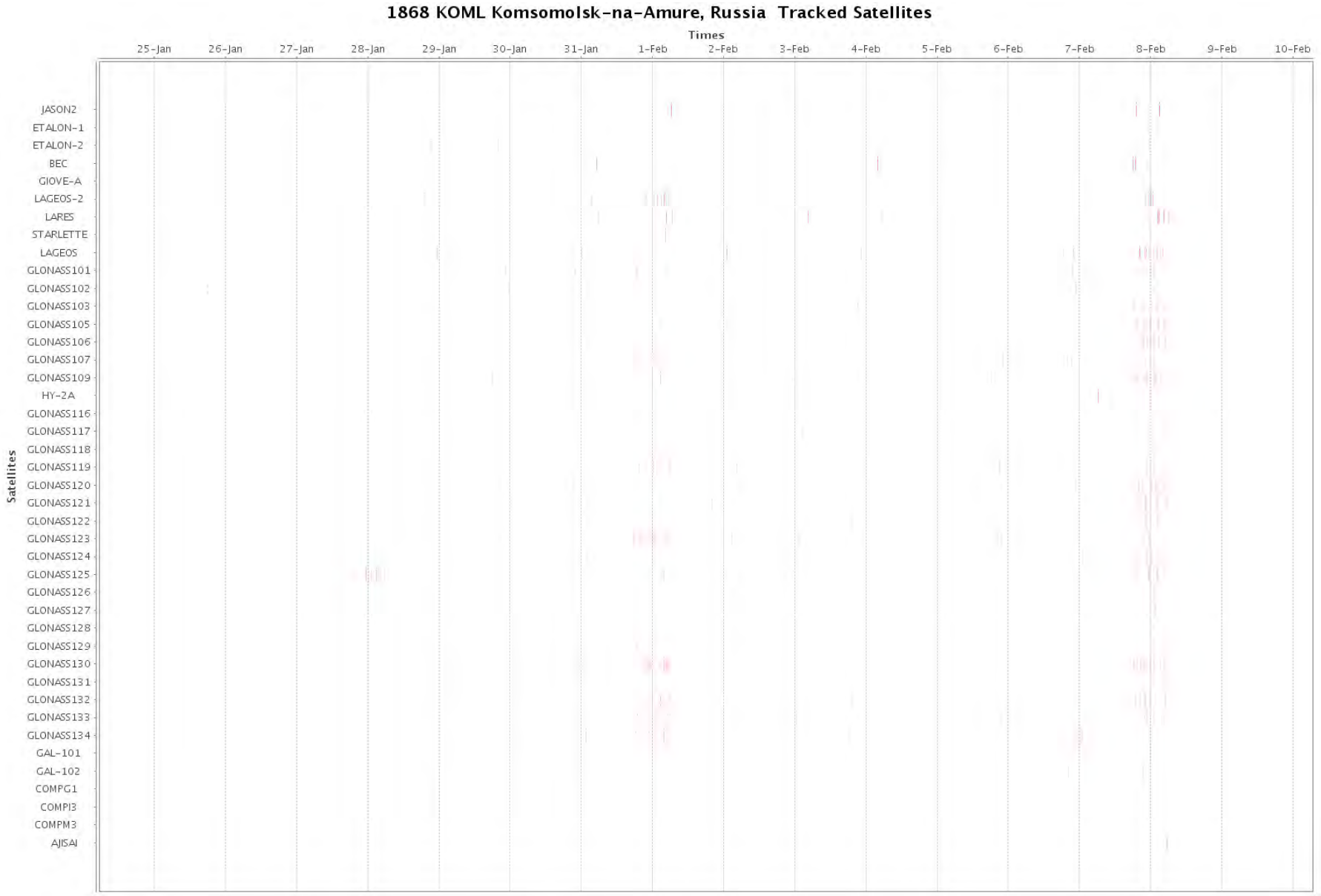



***Figure 1-44.*** *KOML Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

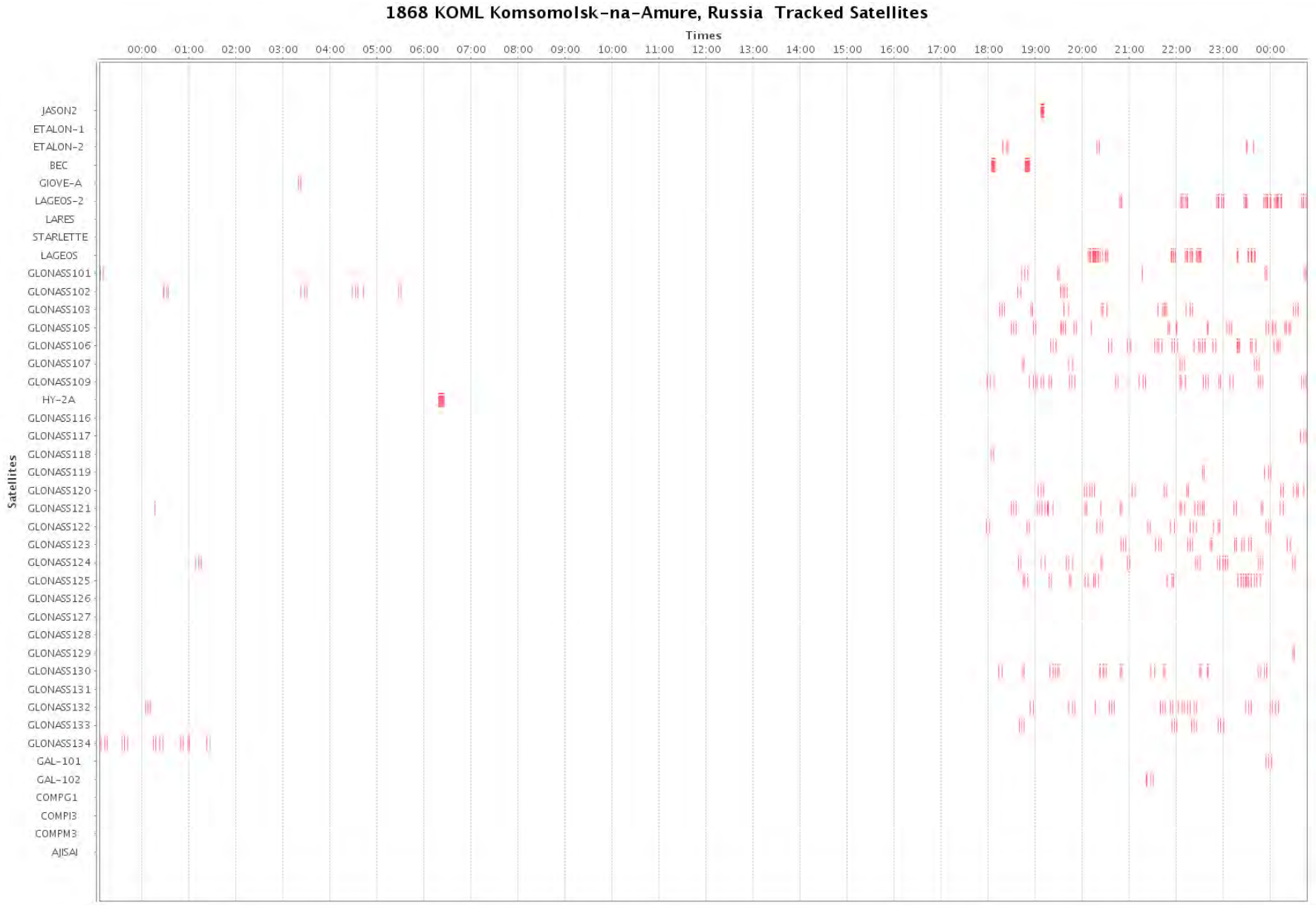



***Figure 1-45.*** *KOML Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

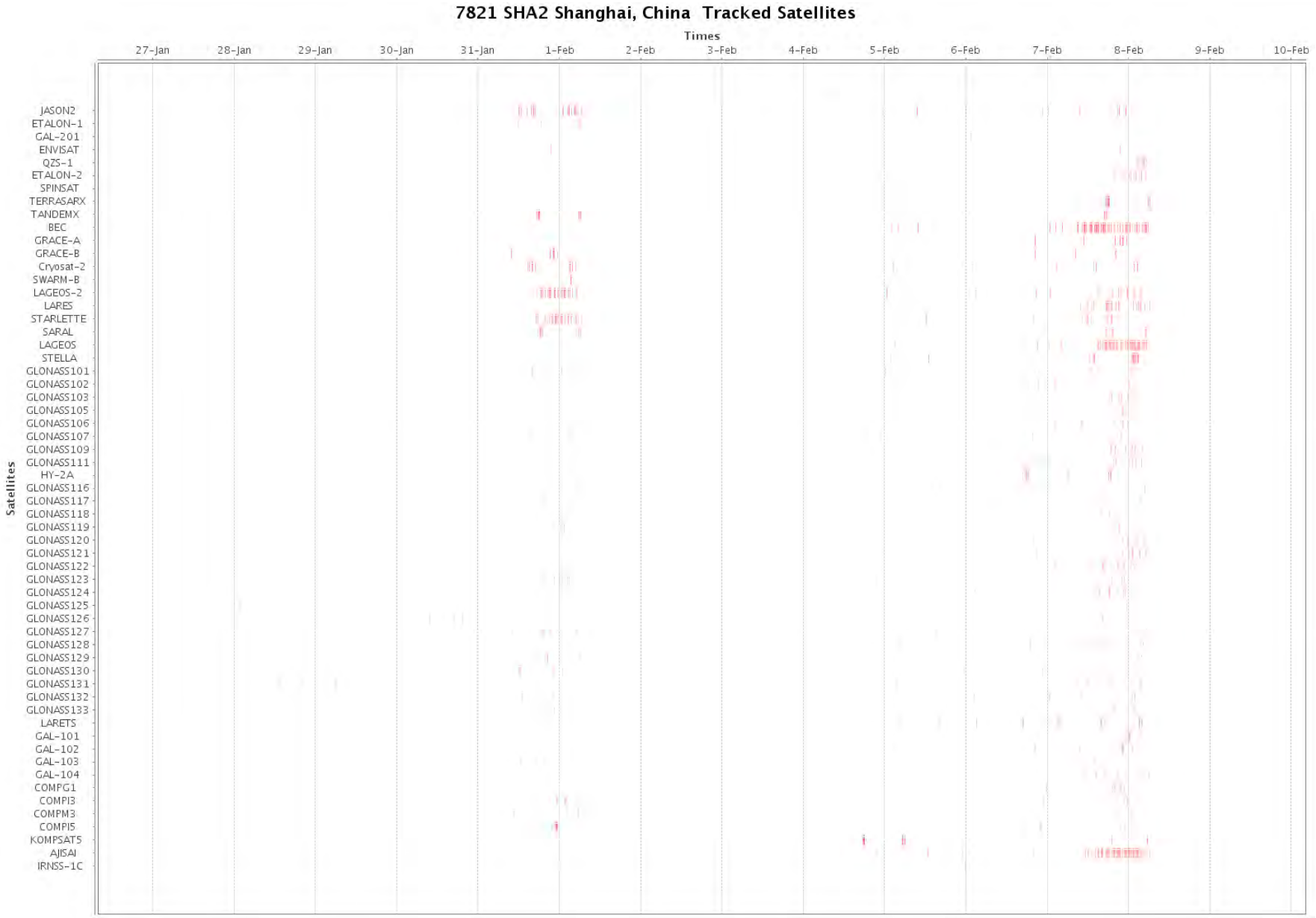



***Figure 1-46.*** *SHA2 Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

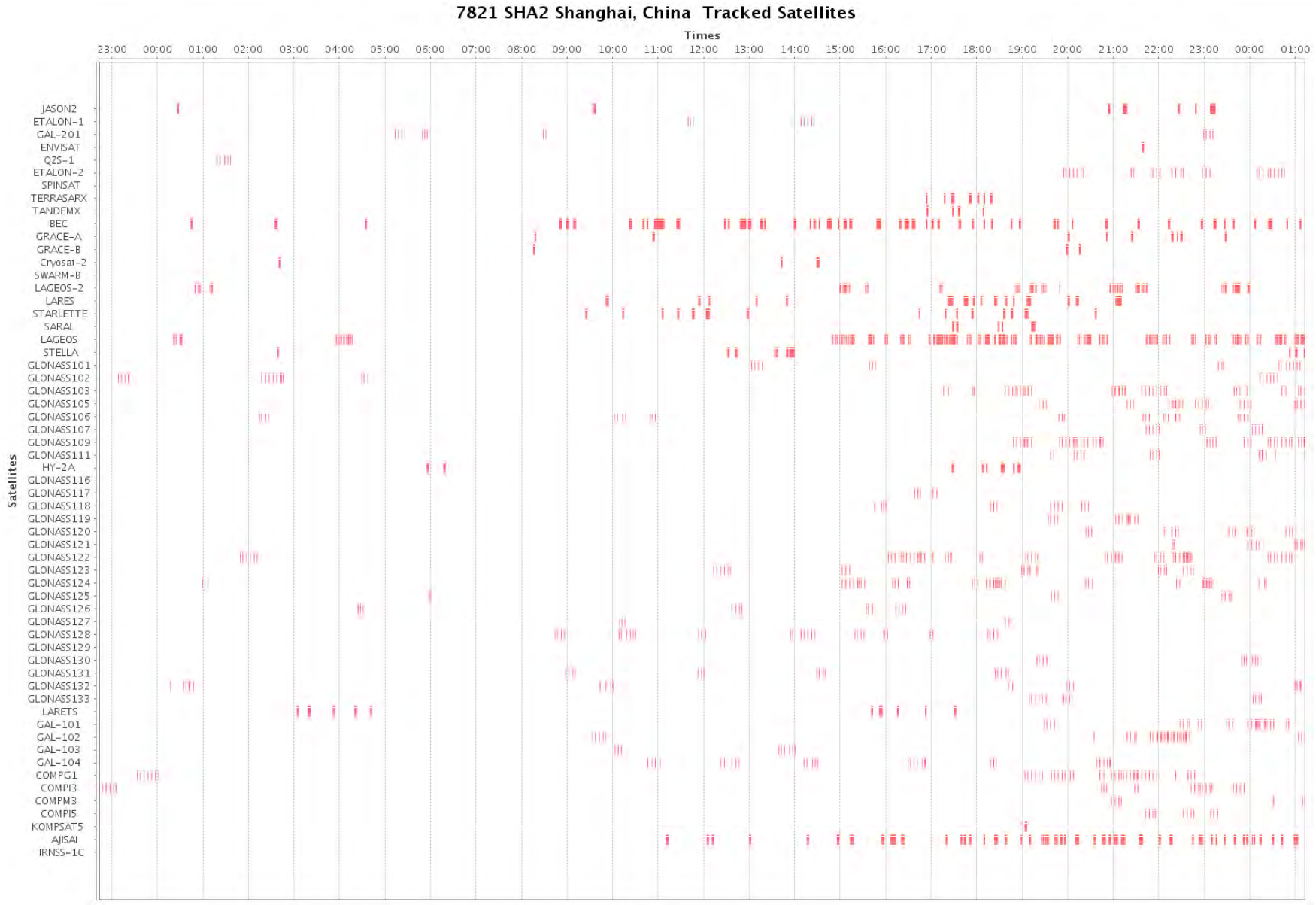



***Figure 1-47.*** *CHAL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

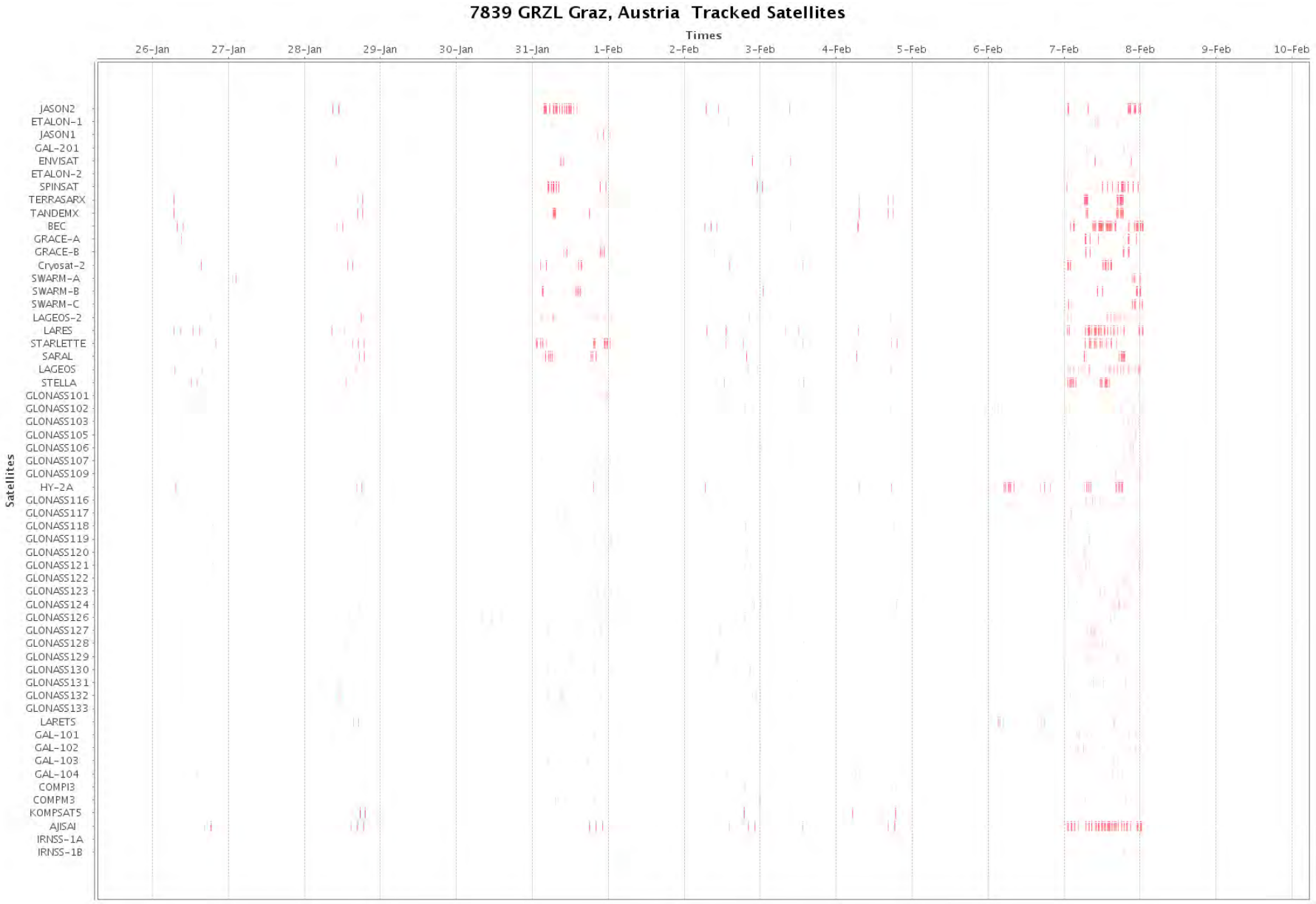



***Figure 1-48.*** *GRZL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

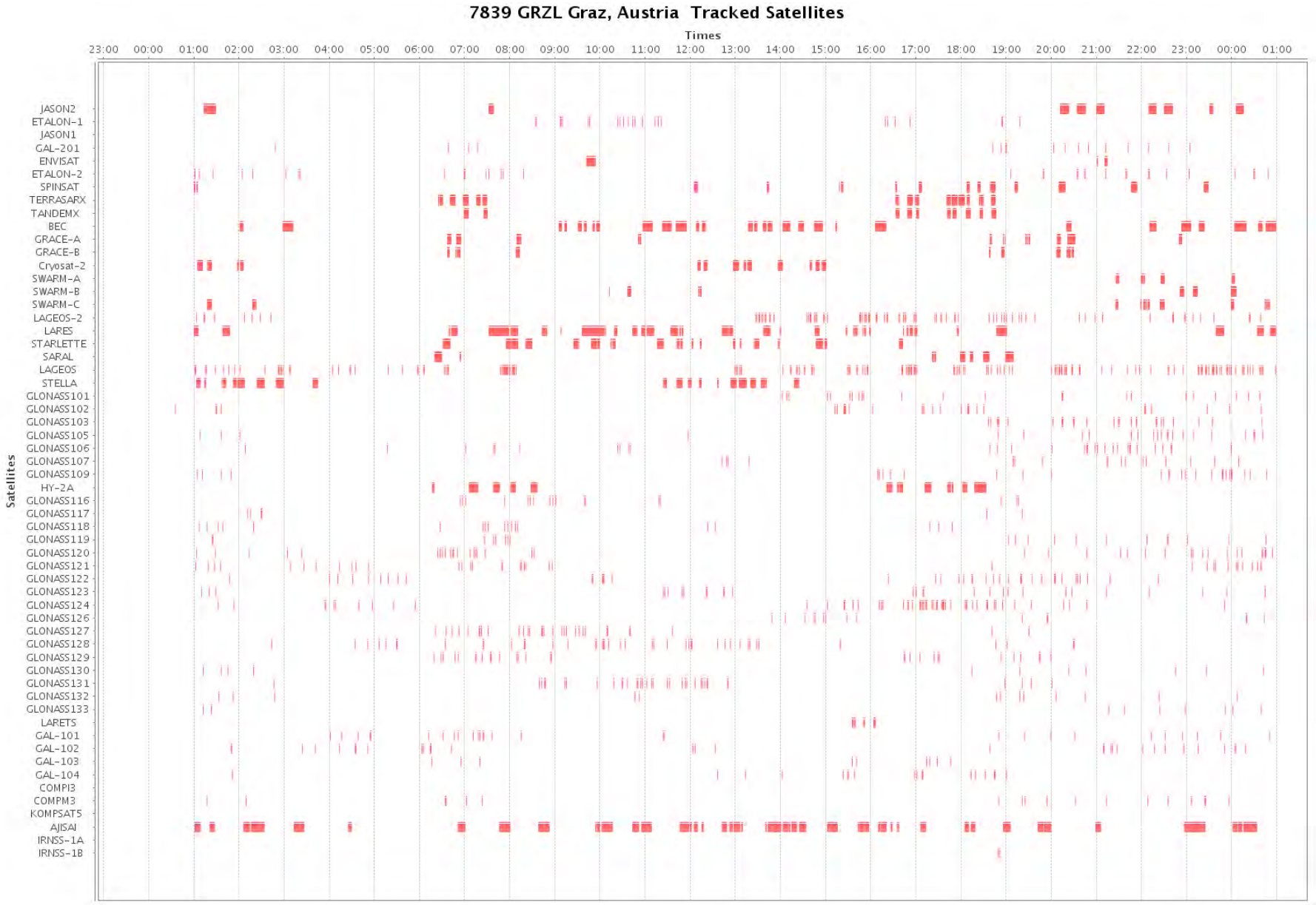



***Figure 1-49.*** *GRZL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

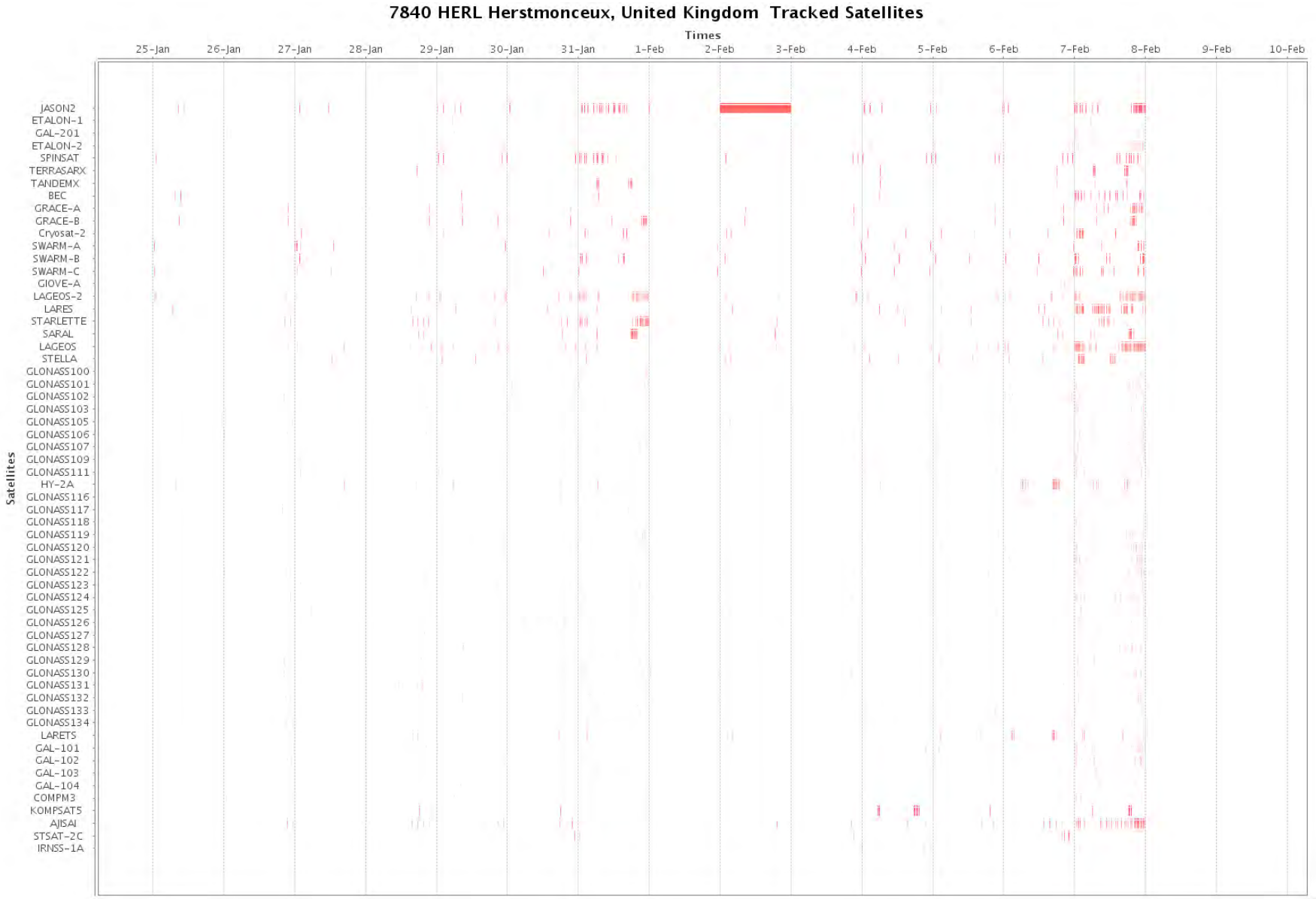



***Figure 1-50. HERL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015***

***Figure 1-51.*** *HERL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

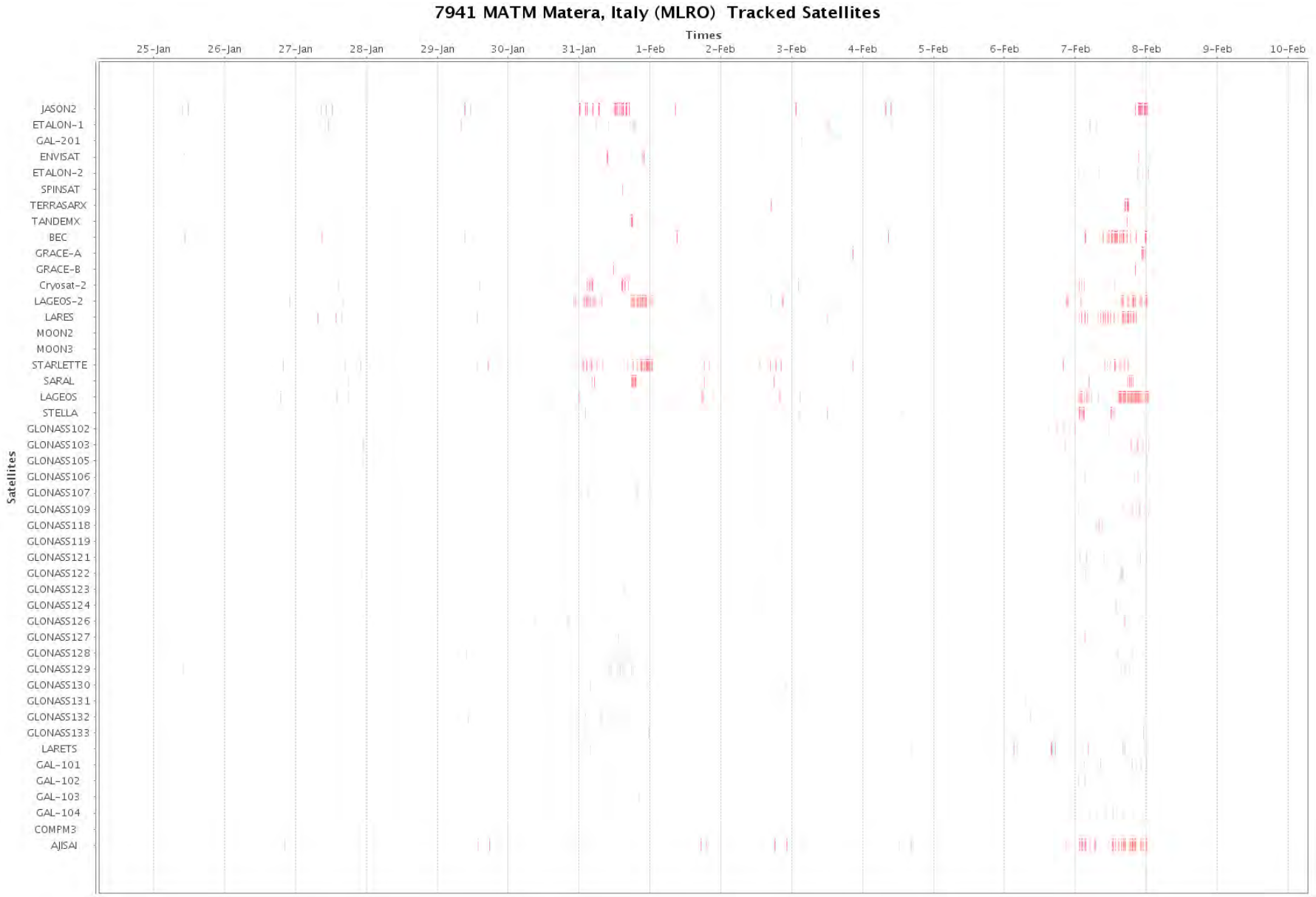



***Figure 1-52.*** *MATM Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

***Figure 1-53.*** *MATM Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

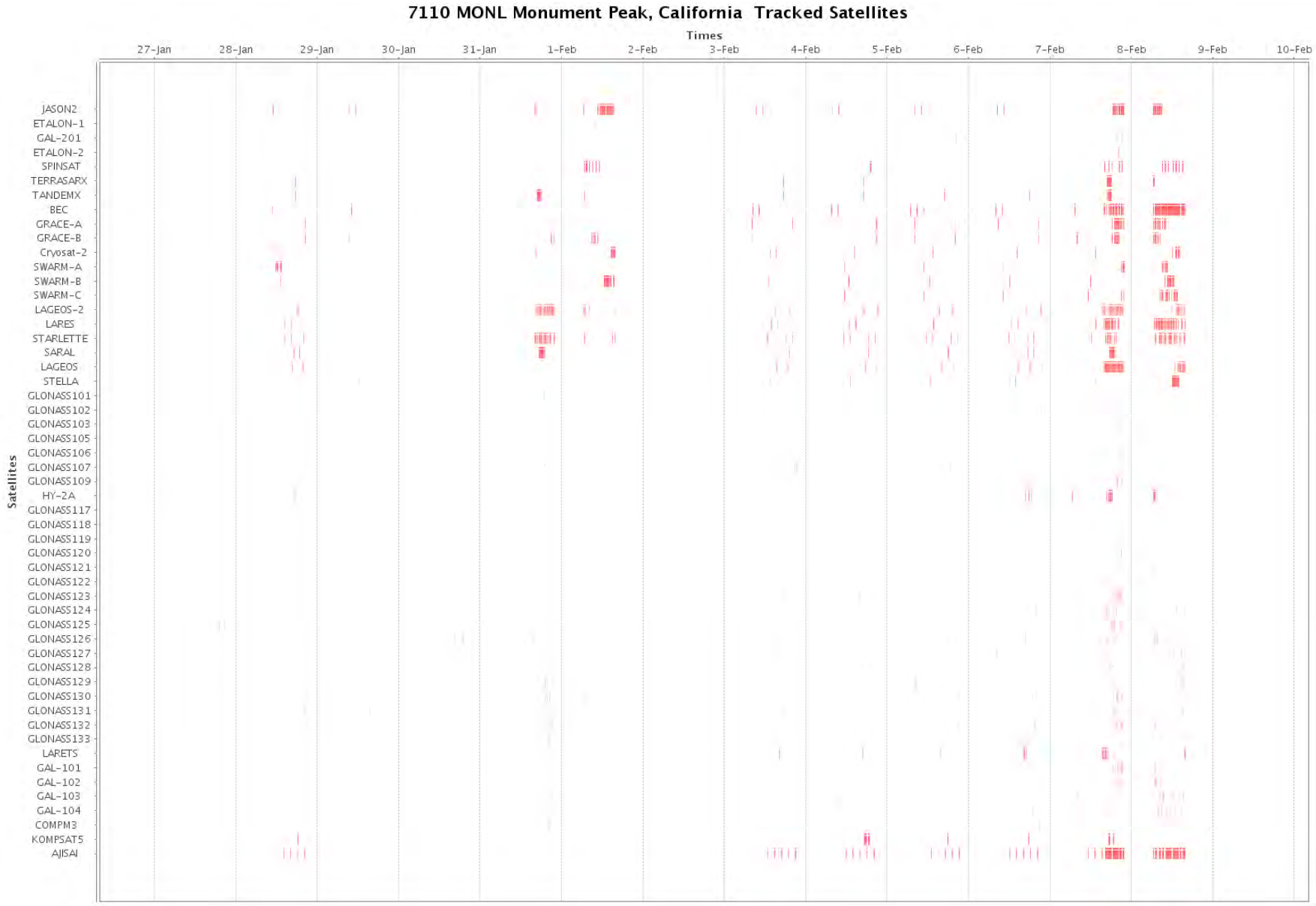



***Figure 1-54.*** *MONL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

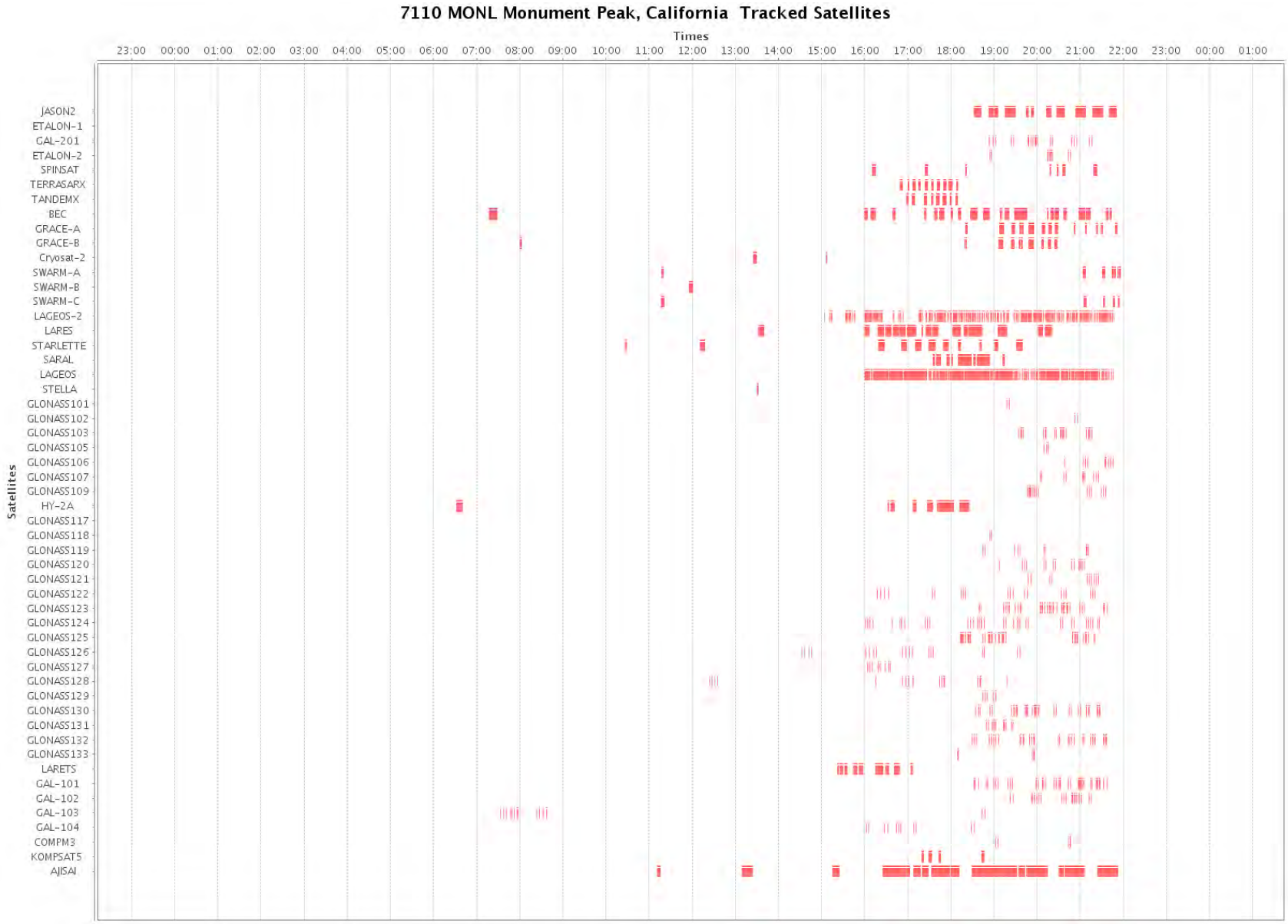



***Figure 1-55.*** *MONL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

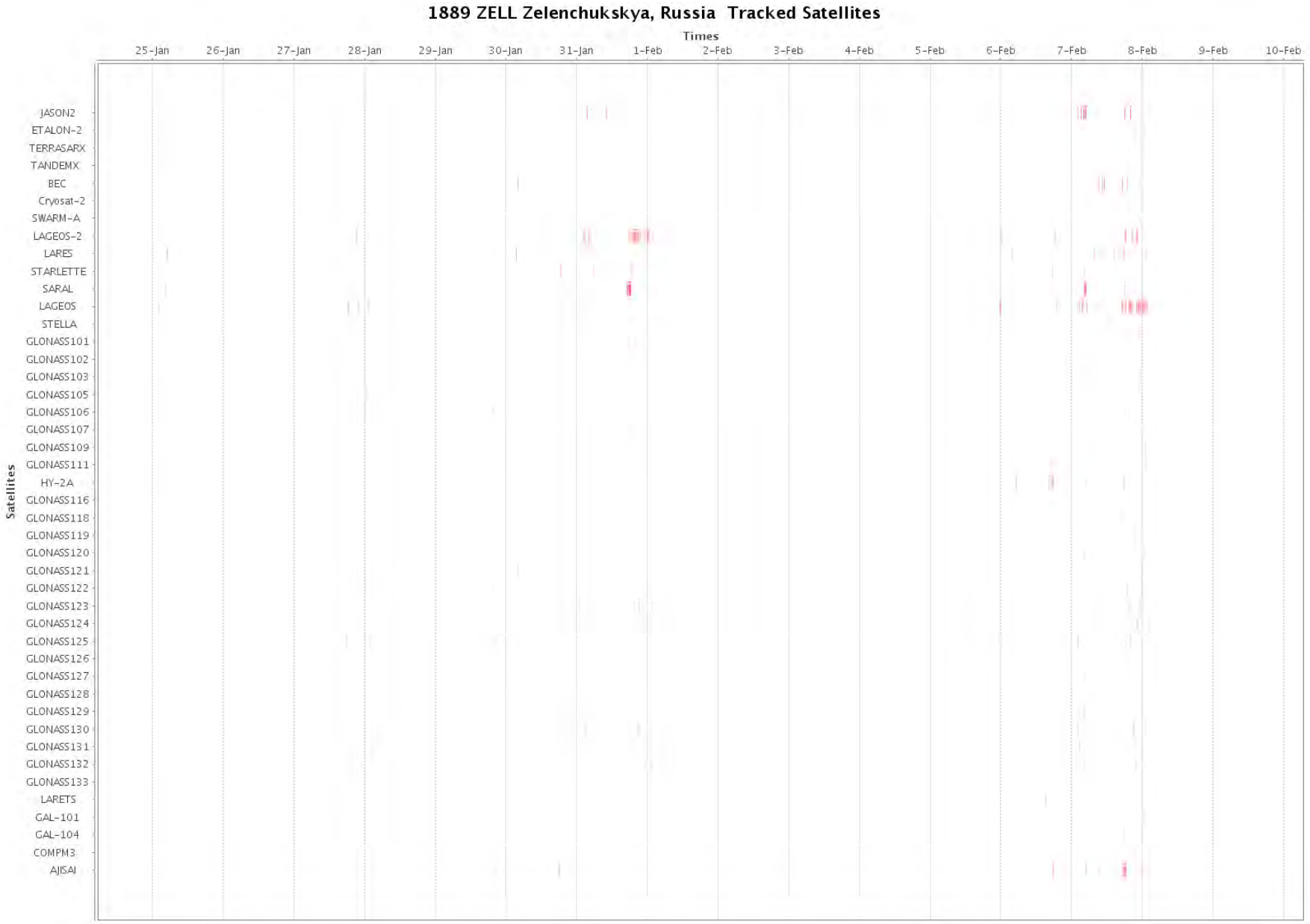



***Figure 1-56.*** *ZELL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

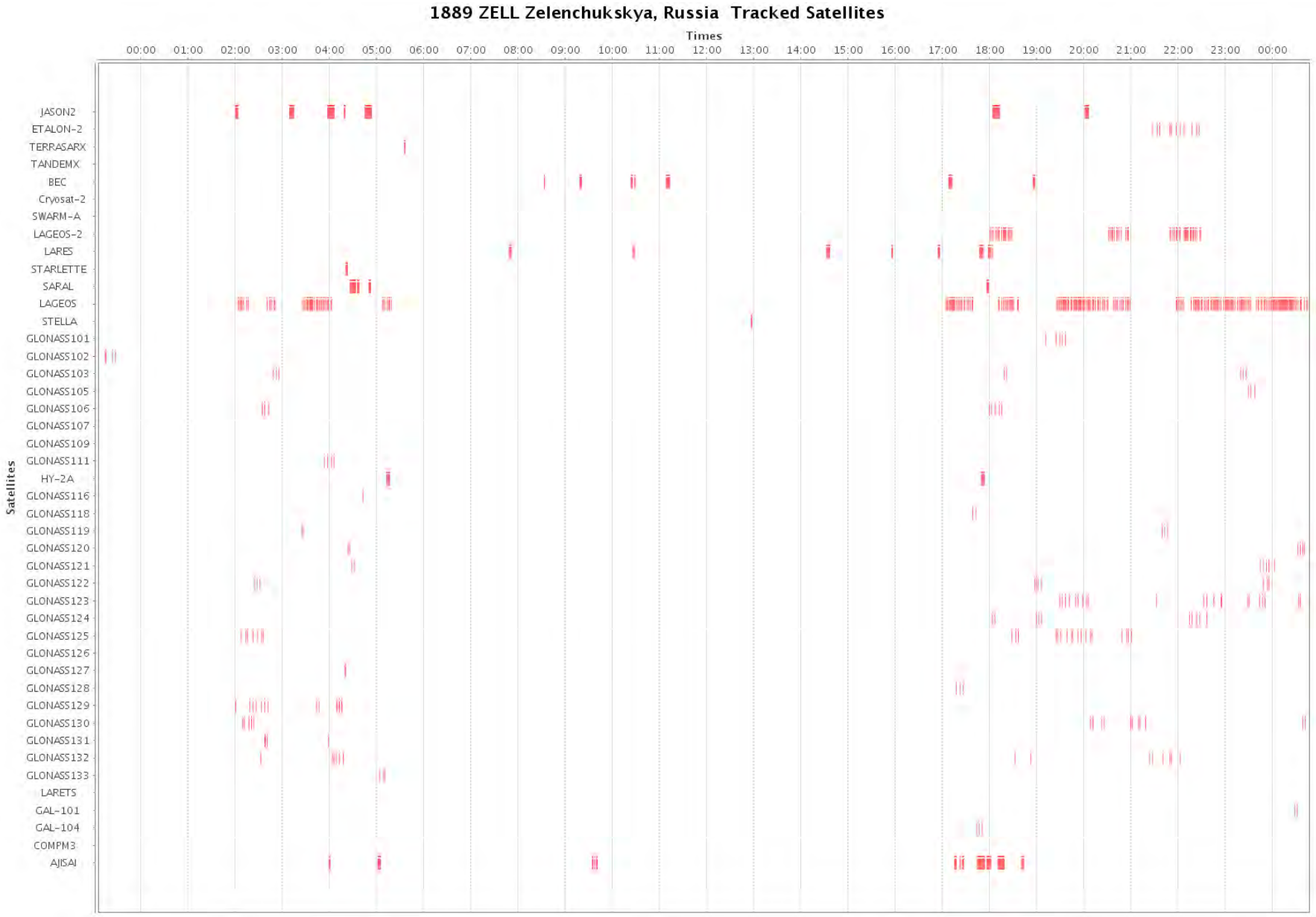



***Figure 1-57.*** *ZELL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

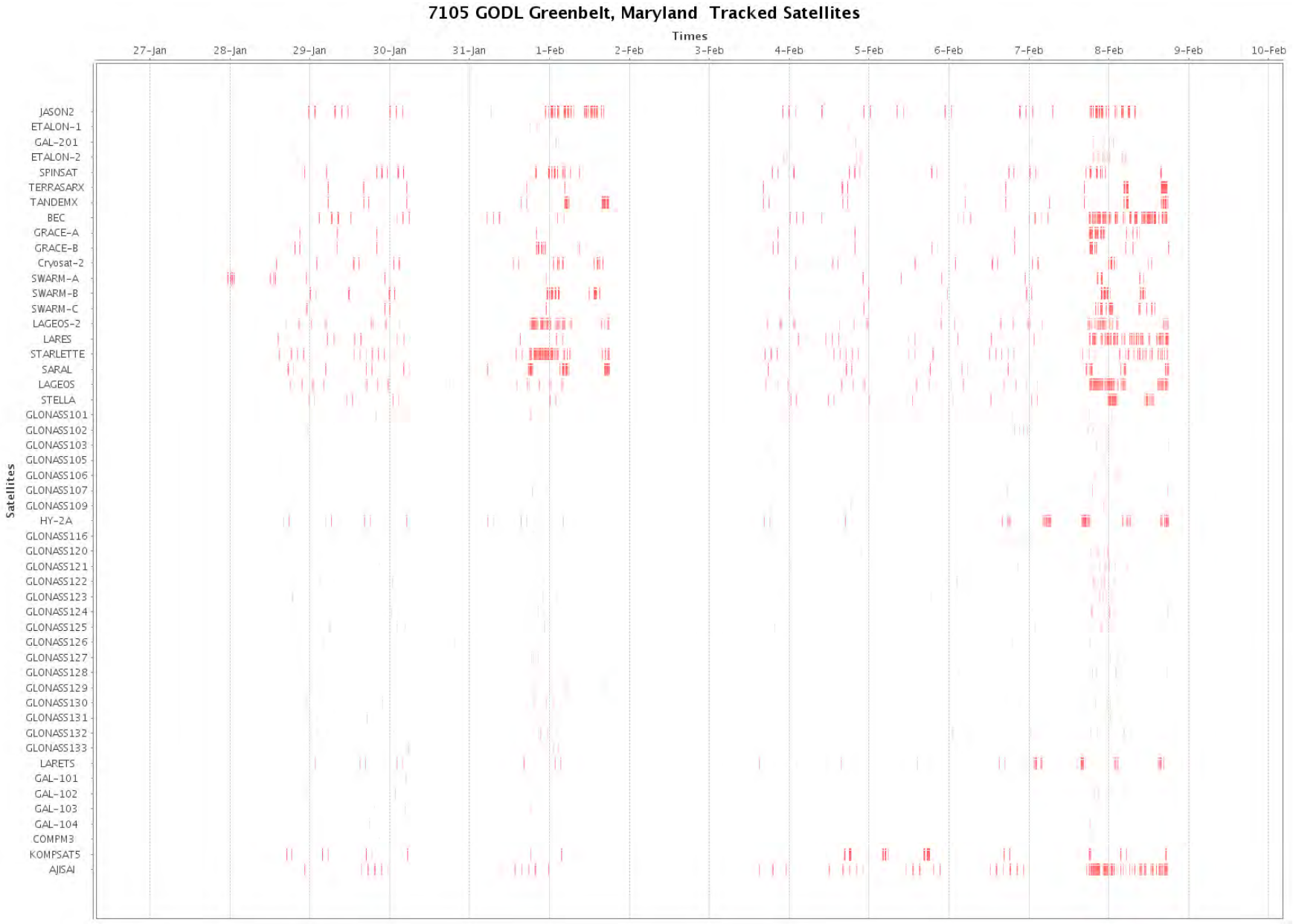



***Figure 1-58.*** *GODL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

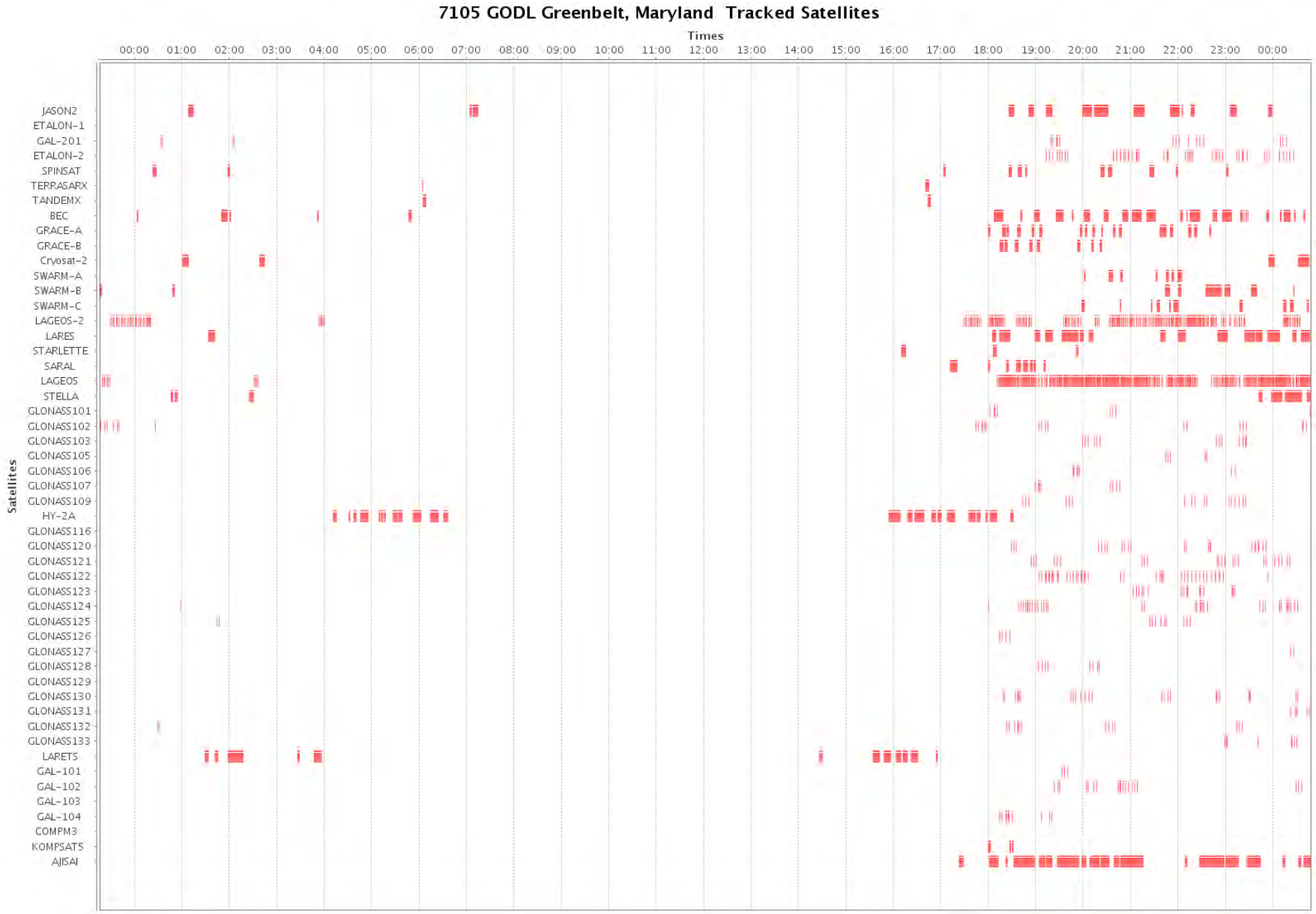



***Figure 1-59.*** *GODL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

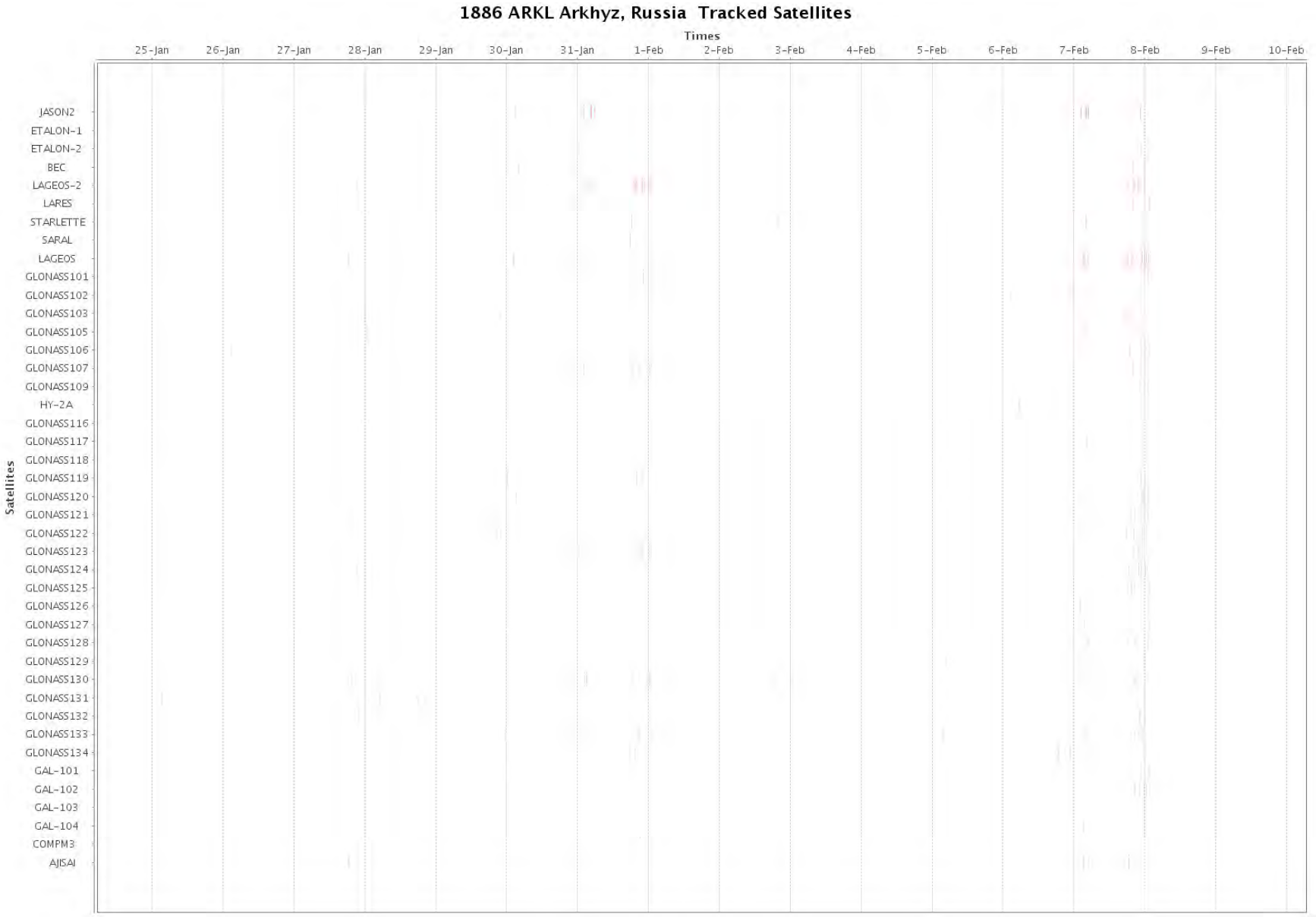



***Figure 1-60.*** *ARKL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

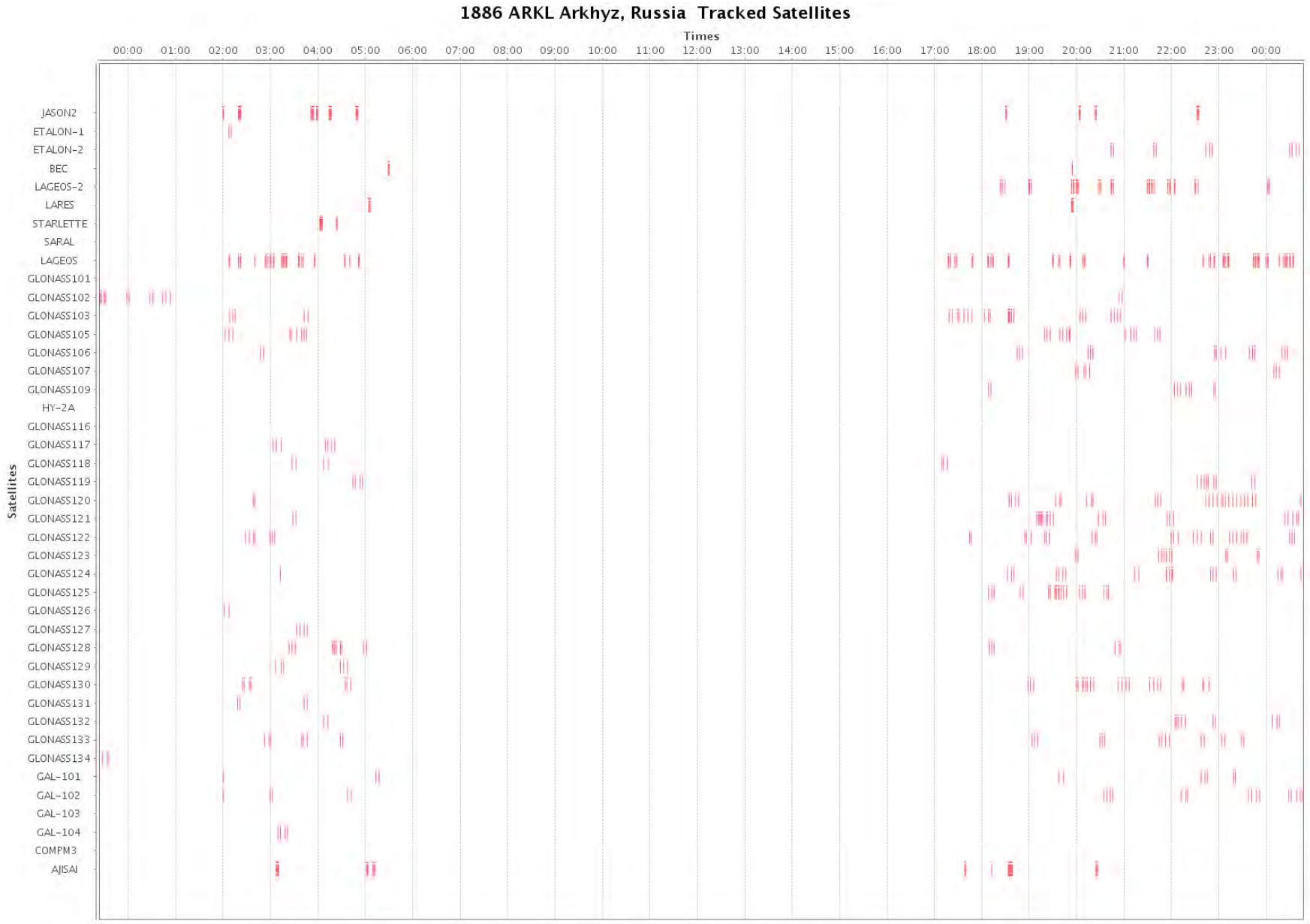



***Figure 1-61.*** *ARKL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

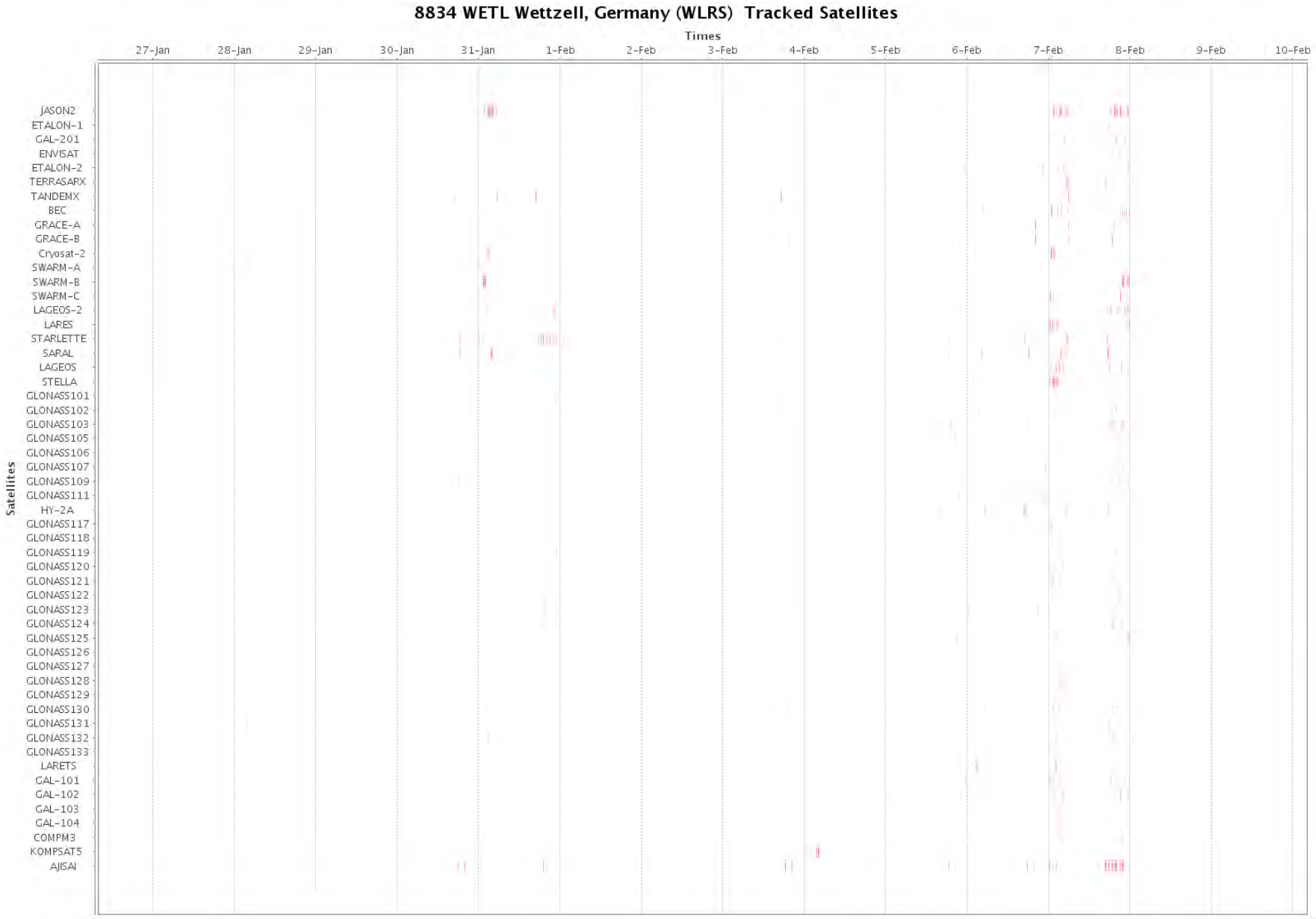



***Figure 1-62.*** *WETL Tracking Sample Jan. 25, 2015 - Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

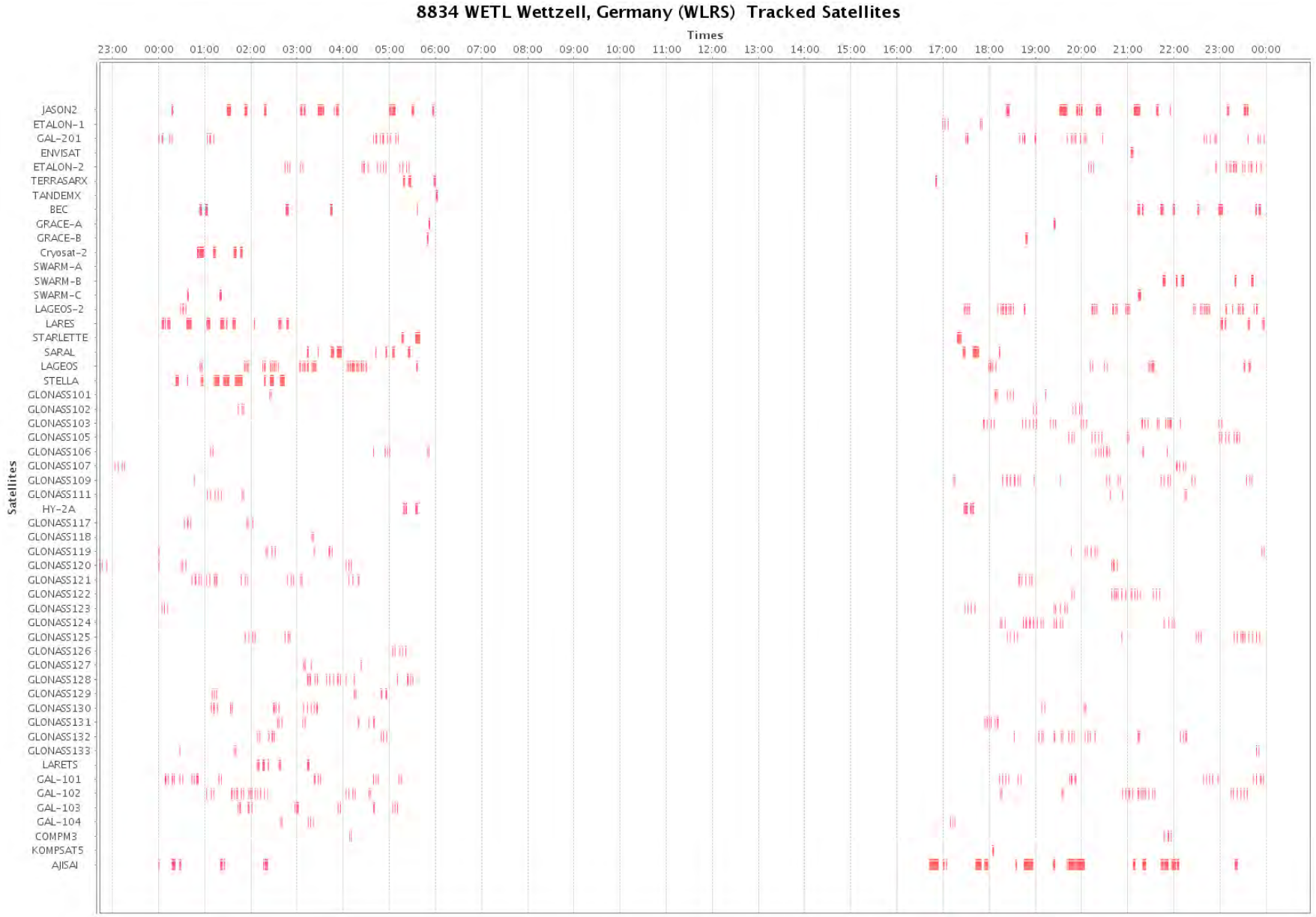



***Figure 1-63.*** *WETL Tracking Sample Feb. 7, 2015 for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

Figures 78 to 81 provide comparisons on how many Campaign and Non-Campaign GNSS satellites were tracked by station. The values include Compass-I3 and Compass-I5. Most stations tracked more Non-Campaign GNSS satellites than Campaign satellites. In fact, multiple stations are tracking the full suite of satellites rather than the campaign specified satellites. Three stations (AREL, HA4T, and KTZL) tracked only Non-Campaign GNSS satellites and had limited normal points for GNSS satellites.

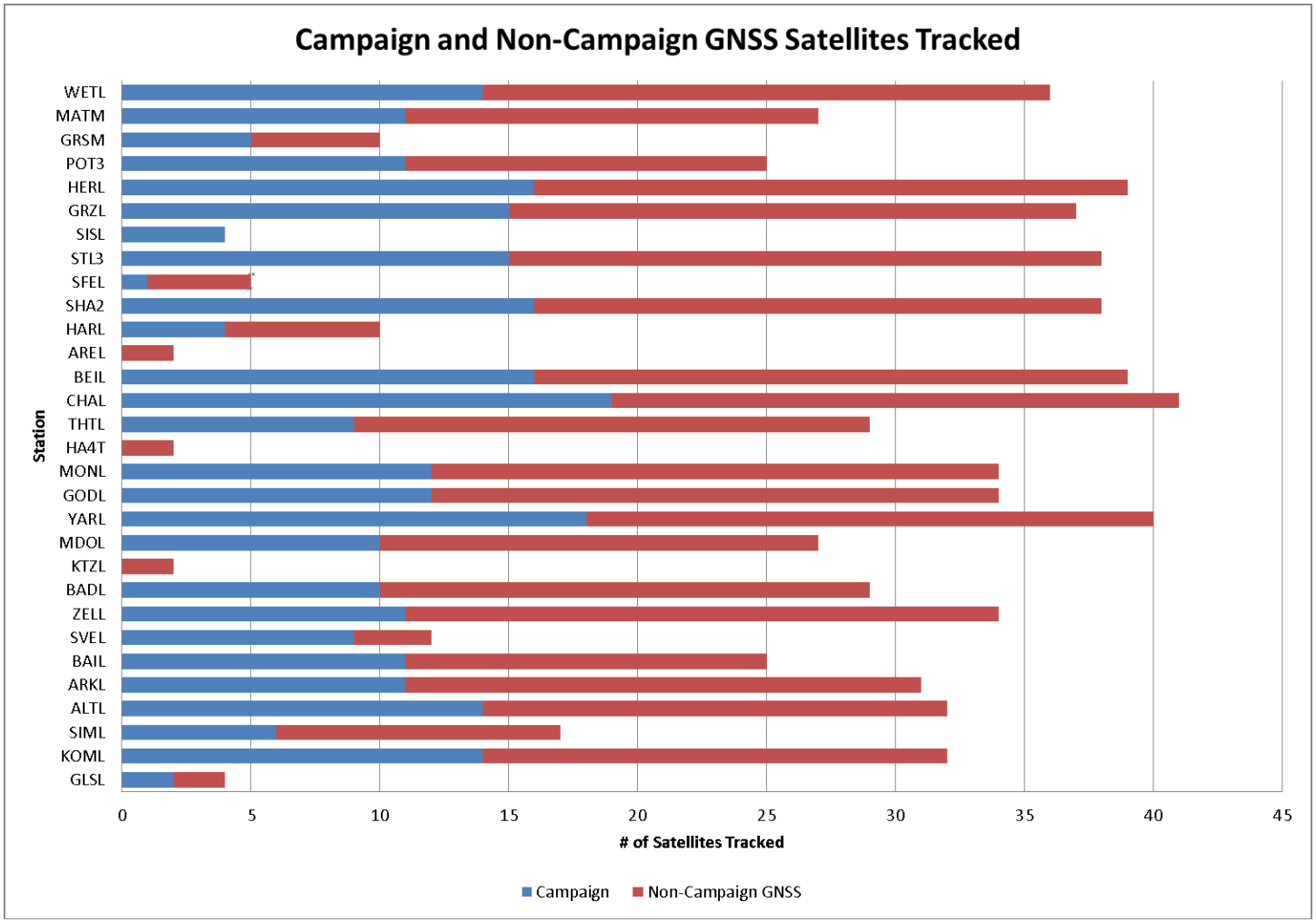



***Figure 1-64.*** *Campaign and Non-Campaign GNSS Satellites Tracked for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

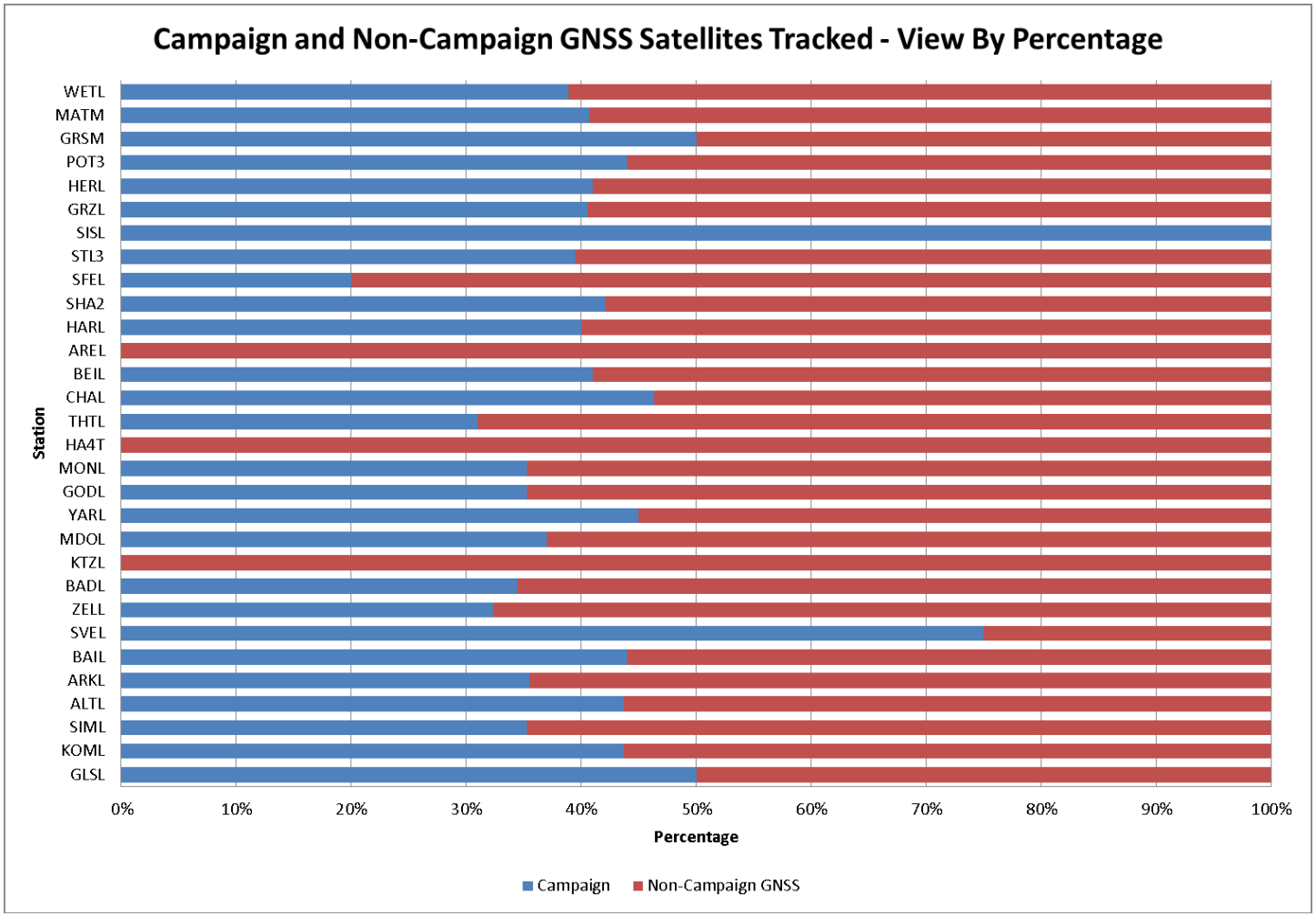



***Figure 1-65.*** *Percentage of Campaign and Non-Campaign GNSS Satellites Tracked for the Second GNSS Campaign; November 24, 2014 -*

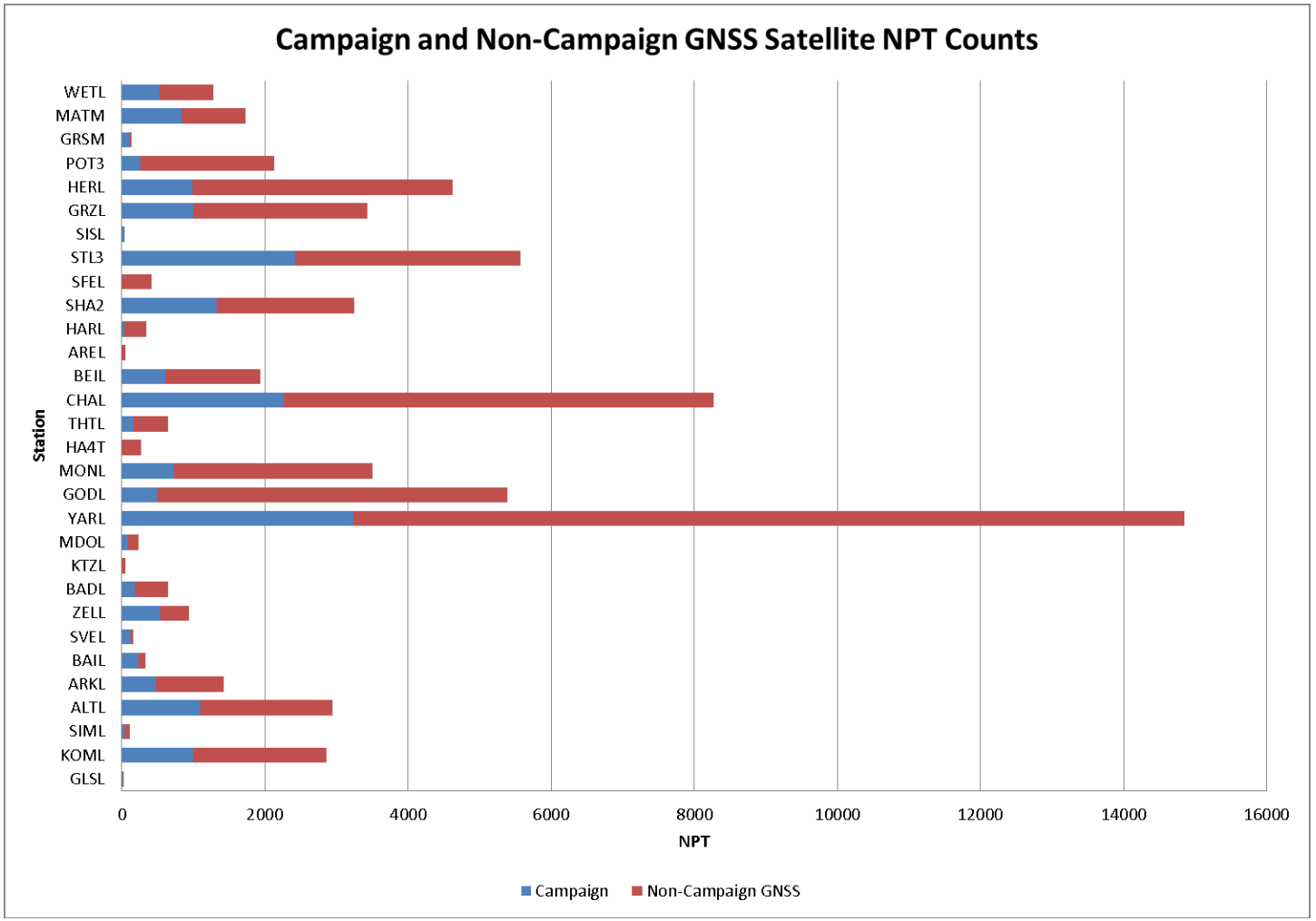



***Figure 1-66.*** *Campaign and Non-Campaign GNSS Satellites NPT Counts for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*

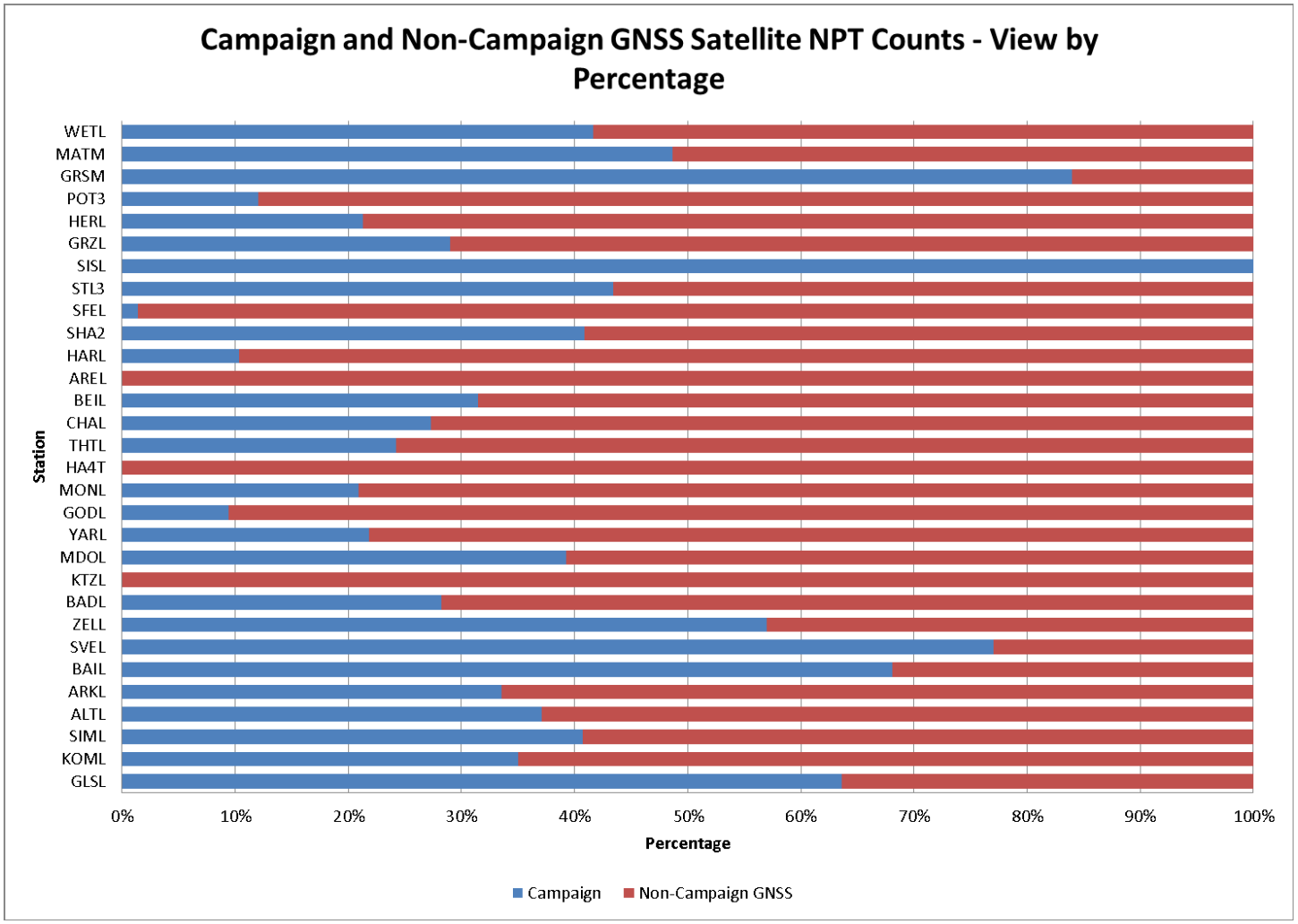



***Figure 1-67.*** *Percentage of Campaign and Non-Campaign GNSS Satellites NPT Counts for the Second GNSS Campaign; November 24, 2014 - February 28, 2015*