GeoSurveys

RYKNIELD STREET ROMAN ROAD, SUTTON PARK, SUTTON COLDFIELD

PHOTOGRAMMETRY AND LiDAR
UAS LANDSCAPE SURVEY

REGISTERED ORGANISATION CIfA

Ryknield Street Roman Road, Sutton Park

Photogrammetry and LiDAR UAS Landscape Survey

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Acknowledgements

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Executive Summary

SUMO GeoSurveys conducted a UAS RGB photogrammetry landscape survey of the Roman road Ryknield Street, within the boundary of Sutton Park, Sutton Coldfield. UAS LiDAR survey of the area was conducted by Aetha. The surveys were commissioned by ULAS to record the archaeological assets within the survey area, which comprises c. 73 ha of land, in accordance with a brief issued by the Friends of Sutton Park. The data were processed in Agisoft Metashape and QGIS.

The UAS Photogrammetry and LiDAR surveys conducted at the Roman Road within Sutton Park, Sutton Coldfield, have successfully produced a detailed visual record of the landscape along the length of the road.

Ryknield Street Roman Road lies towards the western boundary of Sutton Park. The road, as defined by the agger, is predominantly extant for c. 2.5 km. There have been several truncations along the route of the road over time, and the longest uninterrupted section measures c. 0.4 km in length and is located towards the southern end. The agger is present in various stages of preservation and erosion, and it was predominantly mapped through LiDAR data, which has the benefit of stripping back covering vegetation to reveal the ground surface beneath. The agger appears to be c. 8 m wide at its maximum and is generally straight along its length, except for a section of possible slumping towards the centre of the survey area. A well-defined linear depression that respects the orientation of the agger in this area was initially believed to be the roadside ditch, but after further consideration it appears that the agger slumps to the west, extending beyond the linear depression. If this depression is a ditch at the side of the road, it would be a later feature, one that was constructed after the agger had slumped westwards. Where the agger is better-preserved, it is expressed as a low, flat-topped mound, and remains to a height of not greater than c. 0.4 m.

The ditches that once ran parallel to either side of the road are now discontinuous in their preservation. Those sections of ditch that remain visible are generally shallow and choked with vegetation and were mapped through LiDAR data. Where the ditches are better-preserved, they remain to a depth of not greater than c. 0.2 m and generally appear to be c. 3.5 m in width. The longest visible uninterrupted section measures c. 191 m in length.

A series of probable pits were observed either side of the agger along its length. The pits were more prevalent towards the northern end of the road, with fewer towards the south. Without ground investigation it is uncertain whether these features are construction pits associated with the road, or something else.

The course of the original boundary of Streetly Wood is visible as a relict shallow ditch and micro-topographic earthwork bank towards the northern end of the survey area. This curving feature is predominantly preserved within woodland.

A short length of holloway—with a possible continuation to the north—was observed towards the southwest of the survey area. The holloway is expressed as a shallow linear depression at surface level and remains to a depth of c. 0.50 m where better preserved. To the northwest of the holloway, a short length of bank and ditch that may predate the Deer Park outer boundary earthwork was observed.

A sub-rectangular structure was observed at NGR SP 08664 97676. The feature is located to the west of the Roman road and its orientation respects its alignment. The structure comprises two ditches and a low micro-topographic bank that are located approximately 18 m west of the road. A pathway appears to extend from the possible structure towards the north by east, parallel to the road, for c. 105 m. From the UAS data, the orientation and location of the feature gives the impression that this structure may be contemporary with road. However, this is highly unlikely given the findings of the ULAS (Beamish 2025) report, and this feature more likely relates to the golf course.

A series of possible structures—as represented by often ephemeral, micro-topographic earthworks¬ and depressions—were observed along the length of the survey area.

To the north of the survey area, a series of features are aligned along a northwest by west to southeast by east orientation—which generally follows the alignment of the fairway. This group comprises four features defined by low micro-topographic earthworks and shallow depressions. Three of the features are grouped together, with an outlier situated approximately 50m to the east.

Approximately 165 m to the south is another group of earthworks that are partly hidden by trees and partly visible on the fairway. The features are aligned along a similar orientation to the group to the north and comprise two parallel micro-topographic earthworks that are aligned either side of a sub-rectangular shallow depression, and a C-shaped earthwork that bounds a shallow sub-rectangular depression.

In the south of the survey area are three possible structures. The northernmost is defined by an L-shaped micro-topographic earthwork. The central possible structure(s) appears to be a complex of low, micro-topographic earthworks and a limited number of shallow depressions located towards the northwest of the feature. It is uncertain whether the earthworks represent foundations or something else. Towards the south is a small sub-rectangular depression that is aligned along a northwest to southeast orientation. There is a small gap of c. 3 m in width along the northeast side which allows access to the interior.

1. Introduction

1.1 Project Background

SUMO GeoSurveys conducted a UAS RGB photogrammetry landscape survey of the Roman road Ryknield Street, within the boundary of Sutton Park, Sutton Coldfield. UAS LiDAR survey of the area was conducted by Aetha. The surveys were commissioned by ULAS to record the archaeological assets within the survey area, which comprises *c*. 73 ha of land (Figure 1), in accordance with a brief issued by the Friends of Sutton Park. The data were processed in Agisoft Metashape and QGIS.

1.2 Site Details

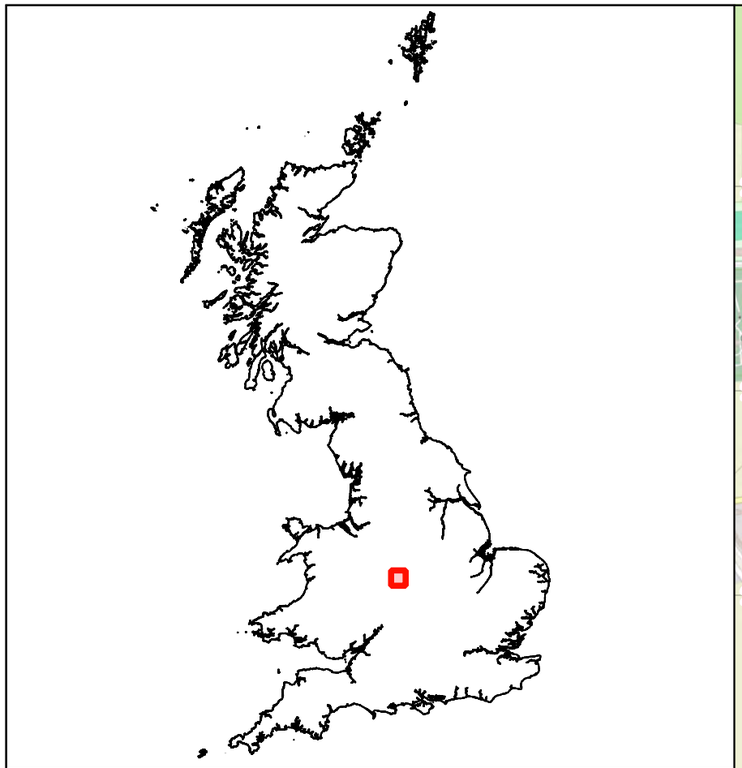
NGR / Postcode	SP 08578 97612 / B74 2EP
Location	The survey area is located along the western side of Sutton Park, adjacent to the B4138, Thornhill Road
HER	Birmingham City Council Historic Environment Record
Civil Parish	Sutton Coldfield
County	West Midlands
Geology	**Bedrock:** Interbedded sandstone and conglomerate of the Chester Formation **Superficial:** Sand and gravel from Glaciofluvial Deposits and River Terrace Deposits (BGS 2025)
Archaeology	Remains of a Roman road
Survey Methods	UAS RGB photogrammetry UAS LiDAR
Study Area	*c*. 73 ha
Topography	The site comprises ground that is predominantly flat with elevation of *c*. 140 m above Ordnance Datum (aOD) in the south and north and a slightly raised band of ground, at an elevation of *c*. 160 m aOD, crossing roughly east to west across the northern area
Current Land Use	Scheduled Monument (within which lies a golf course)

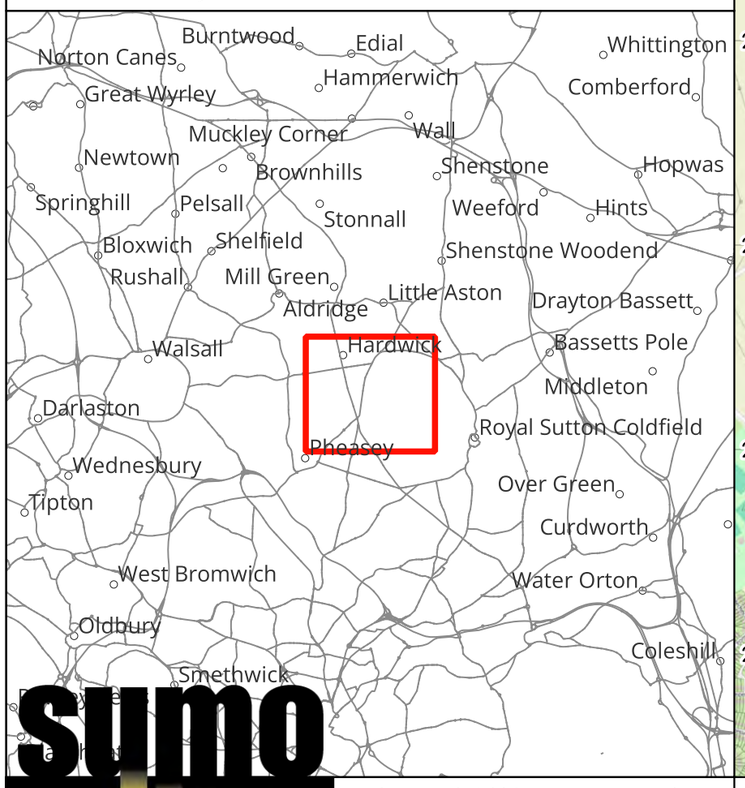
1.3 Aims and Objectives

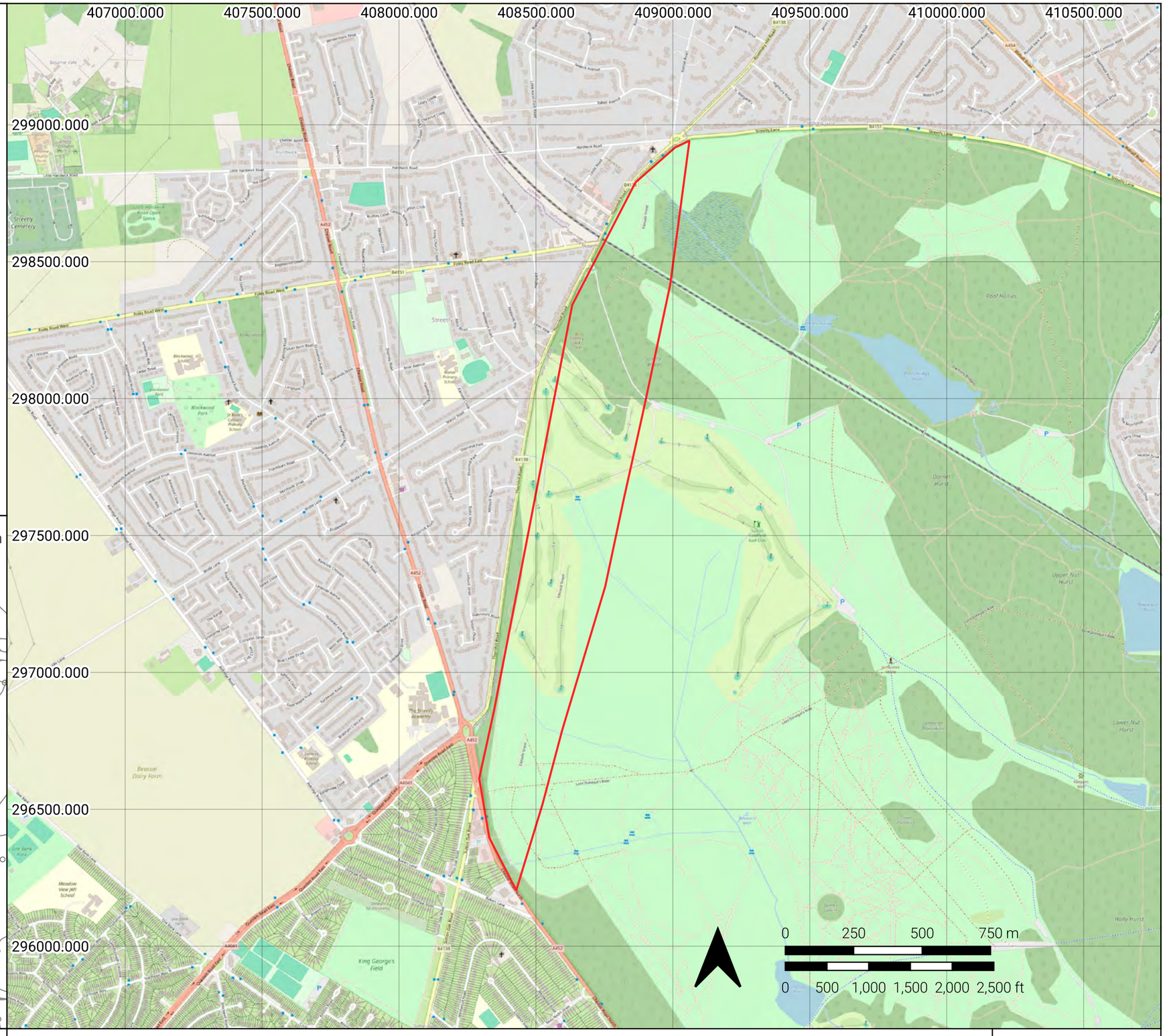
To conduct a detailed UAS (drone) geospatial landscape survey using RGB photogrammetry and LiDAR of the survey area.

The objectives of the UAS geospatial survey were:

- Undertake a UAS geospatial survey using RGB photogrammetry and LiDAR for analysis
- Document the survey result
- Ensure all work was carried out in accordance with the *Code of Conduct* of the Chartered Institute for Archaeologists (CIfA) (2022); and in line with current Historic England guidance for photogrammetry and landscape surveys (HE 2017a; 2017b)







Project	Ryknield Street Roman Road
Client	ULAS
Date	11/07/2025
Job No.	SUMO-15842-1

Location map
Scale 1:15000 at A3

CRS: OSGB36 / British National Grid. EPSG:27700

Figure 1

2. Methodology

2.1 Survey Methodology

2.1.1 Photography

An Unmanned Aircraft System (UAS) with a gimbal-mounted camera was flown at an average elevation of 101 m (331 ft) above ground level.

2.1.2 Photogrammetry

Images were processed in Agisoft Metashape photogrammetric software to produce a 3D pointcloud with a Point Density of 4.59 points/m^2. Data were exported as a raster Digital Elevation Model (DEM) with an average 46.7 cm/pix spatial resolution and an orthophoto with an average 2.64 cm/pix.

2.1.3 Referencing

The photogrammetric models were referenced by eleven ground control points (GCPs) that were distributed across the area. The eleven points— which provided an average error of 9.85 mm across the area (Table 1)— are visible in the aerial photographs and were also surveyed using high accuracy GPS to facilitate georeferencing to OS coordinates.

Point	Easting	Northing	Elevation
1	408520.828	296587.942	141.562
2	408479.769	296360.457	140.656
3	408400.295	296793.318	143.782
4	408565.549	296890.487	144.380
5	408437.481	297156.959	150.791
6	408534.093	297570.230	150.771
7	408797.747	297746.514	153.031
8	408712.267	297979.118	160.716
9	408616.615	298171.619	165.332
10a	408939.384	298243.762	146.970
10b	408976.769	298813.459	141.518

Table 1 Coordinate data for the GCPs

2.2 Survey Methodology – LiDAR

A UAS fitted with a YellowScan Surveyor ULTRA 2 LiDAR sensor was flown at an elevation of 65m above ground level (AGL) using smart terrain follow, at a flight speed of 5 m/s. The LiDAR data was acquired with a 50% horizontal overlap across 58 strips over four flights. For more detailed information see LiDAR UAV Data Acquisition Report in Appendix 1.

2.3 Data Processing And Visualisation

2.3.1 Directional Light Shading (Hillshade)

Simulated illumination of the terrain surface from a chosen light source direction. This gives the viewer an intuitive sense of the 3D topography but can fail to reveal some features that are aligned with the light source. This has been achieved using the hillshade capabilities within QGIS.

2.3.2 Ambient Light Shading (Occlusion)

Simulated illumination of the terrain surface from a continuous encompassing light source. Illumination of a given point is determined by surrounding terrain and other objects which occlude incoming light and simulates diffuse and scattered light that is reflected by various surfaces. It gives the viewer an intuitive sense of the 3D topography but can fail to reveal subtle features near much larger objects. This has been achieved using both Relief Visualisation Toolbox (RVT) and Terrain Shading within QGIS.

2.3.3 Visualisation for Archaeological Topography (VAT)

This method requires the combination of four information layers (terrain hillshade, slope, openness (positive), and sky-view factor) into a single raster output. The blending of the input layers enables enhanced visibility of features of varied scale and orientation on terrain from very flat to very steep (Verbovšek *et al* 2019). This has been achieved using Relief Visualisation Toolbox (RVT) within QGIS.

2.3.4 Multi-scale Topographic Position (MSTP)

The Multi-scale Topographic Position approach is based on calculating an integral image from a Digital Elevation Model and applying multi-scale statistical analysis of the deviation from mean elevation. The results are combined into a single output that is composed of macro-, meso-, and micro-scale results (Guyot *et al* 2018). This has been achieved using Relief Visualisation Toolbox (RVT) within QGIS.

2.3.5 Terrain Slope Analysis

Slope analysis measures the steepness or gradient of a surface, which is then typically expressed as a percentage or in degrees. This has been achieved using RVT within QGIS.

2.3.6 Terrain Flattening

Terrain flattening entails constructing a mathematical model that approximates broad-scale variation in the topography. This model surface is then subtracted from the original DEM to produce a new dataset that reflects only smaller scale features. This has been achieved using Anomaly. The symbology scale for the flattened terrain comprises a zero-point (coloured white) with negative (coloured dark blue to light blue) and positive (coloured orange to red) values representing depression below surface or protrusion above surface respectively. There is no measurement value (e.g. metres) for this symbology scale.

3. RESULTS

3.1 INTRODUCTION

The results from the UAS RGB photogrammetry and LiDAR surveys are presented below as a series of figures followed by a discussion. The Feature numbers are consistent with the Observation numbers recorded by ULAS in the accompanying field report *An Archaeological Walkover Survey at Sutton Park NNR, Royal Sutton Coldfield, Birmingham, West Midlands. SP 08600 97200 (centre)* (Beamish and Hunt 2025).

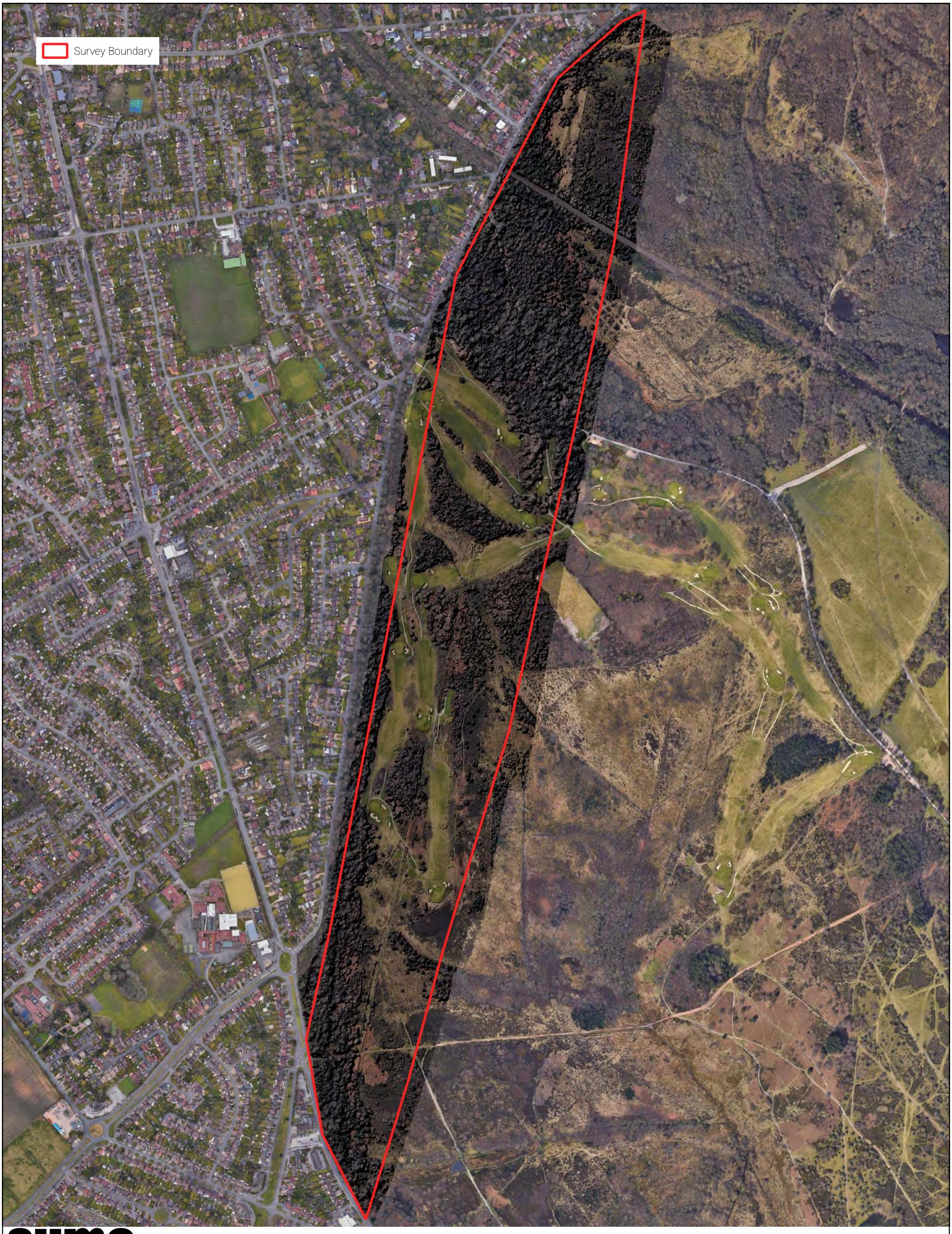
Survey Boundary

Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	2

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Orthomosaic generated from UAS photogrammetry



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	3

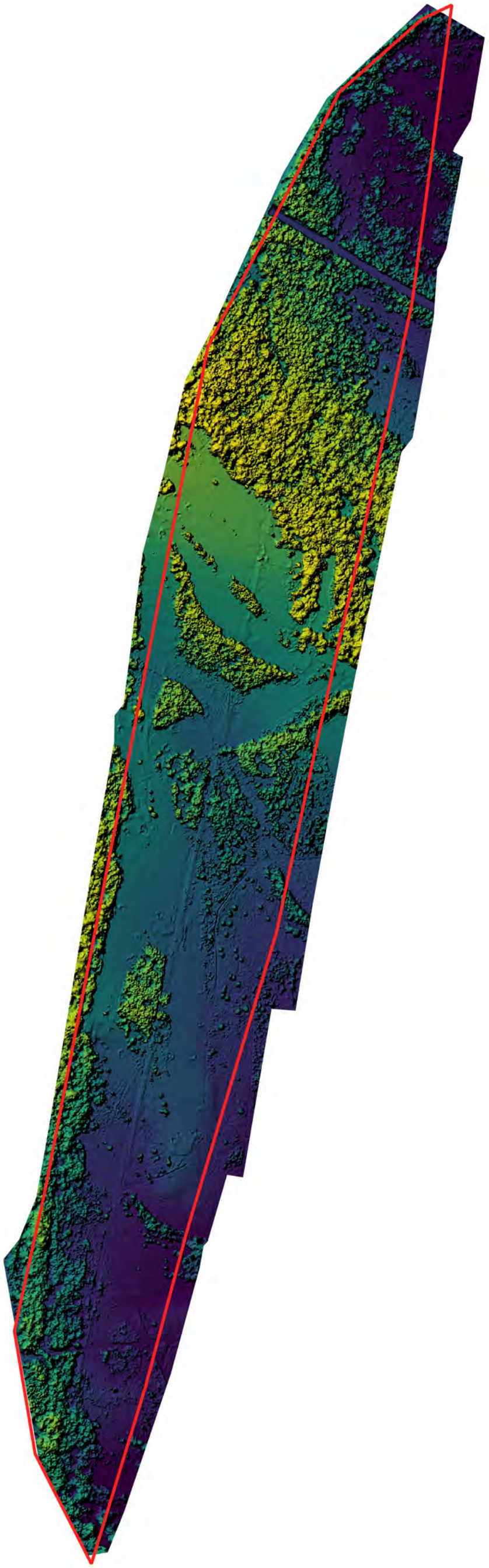
0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Digital Elevation Model with hillshade overlaid onto satellite imagery. Map Data: Google

Survey Boundary

139 m aOD — 184 m aOD



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	4

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

DEM with elevation colour-scale expressed in metres above Ordnance Datum (aOD)

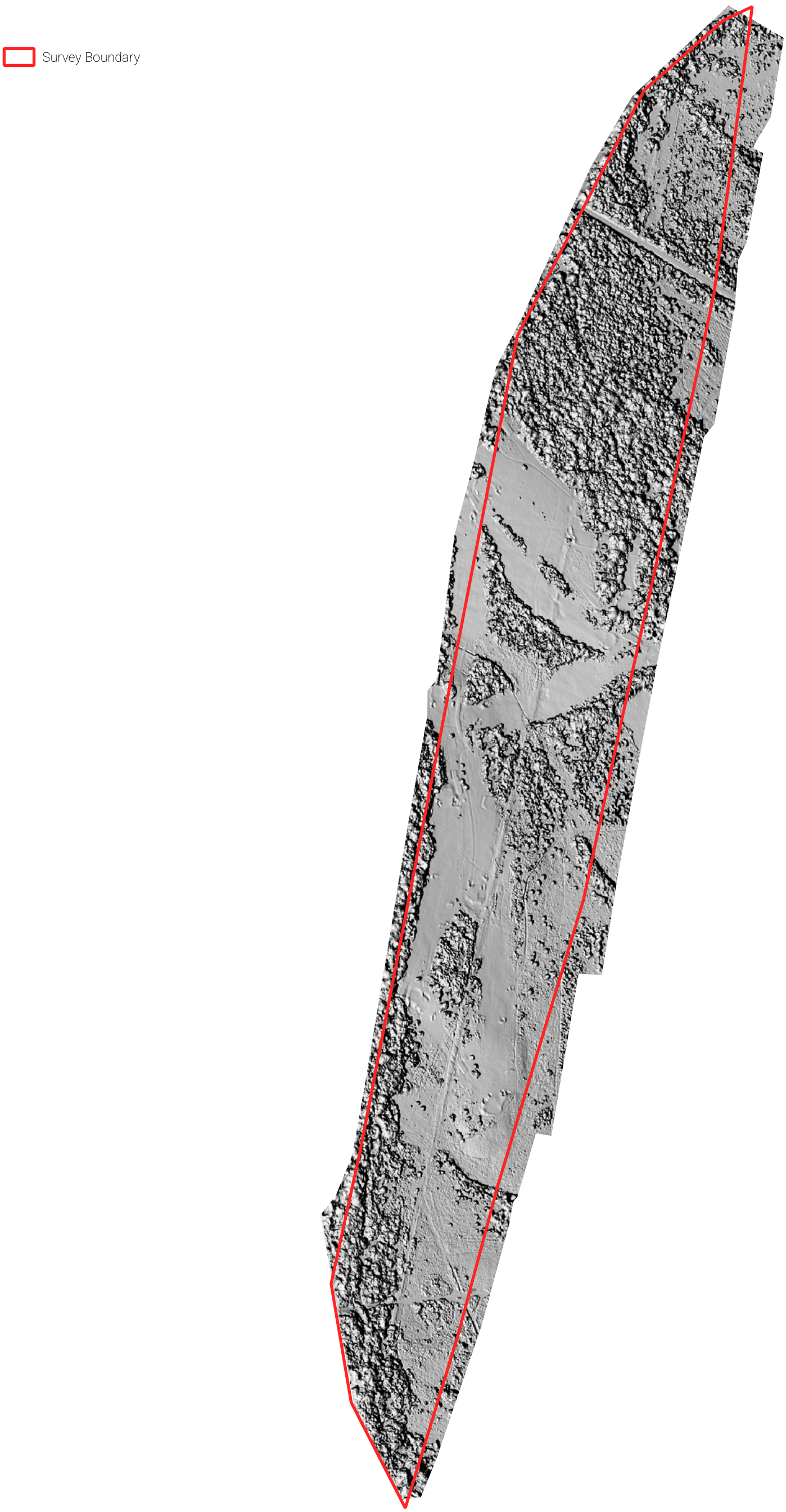
Survey Boundary

Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	5

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Digital Elevation Model with hillshade. Azimuth 315 degrees / Altitude 45 degrees / Z factor 2



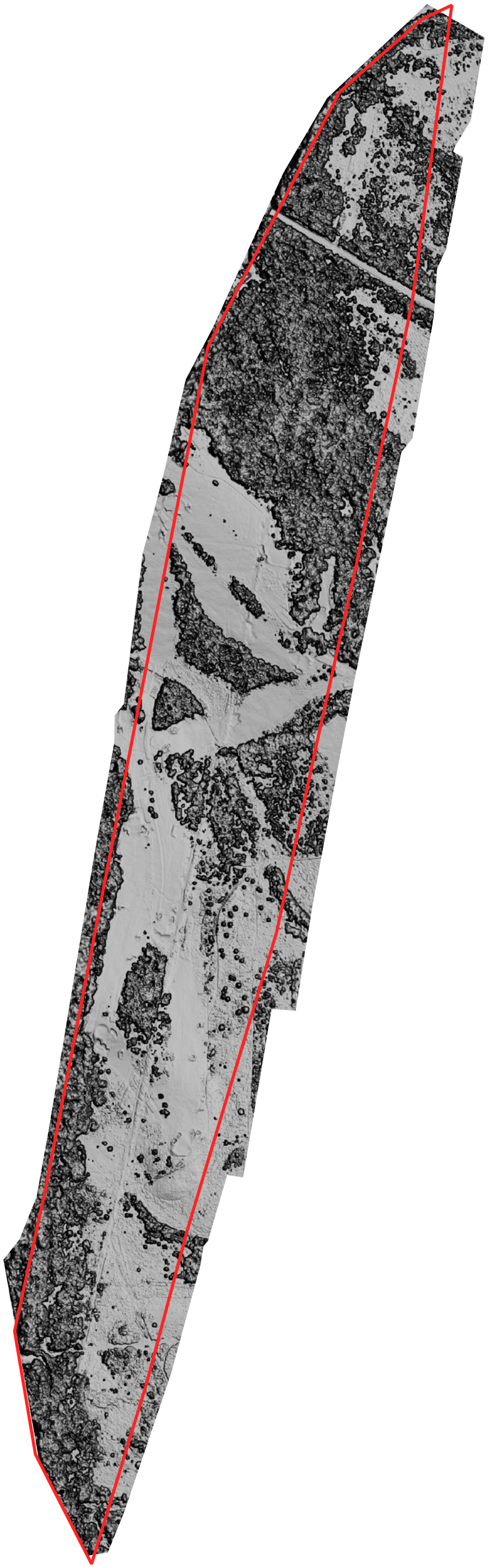
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	6

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Digital Elevation Model with hillshade. Azimuth 240 degrees / Altitude 45 degrees / Z factor 2

Survey Boundary



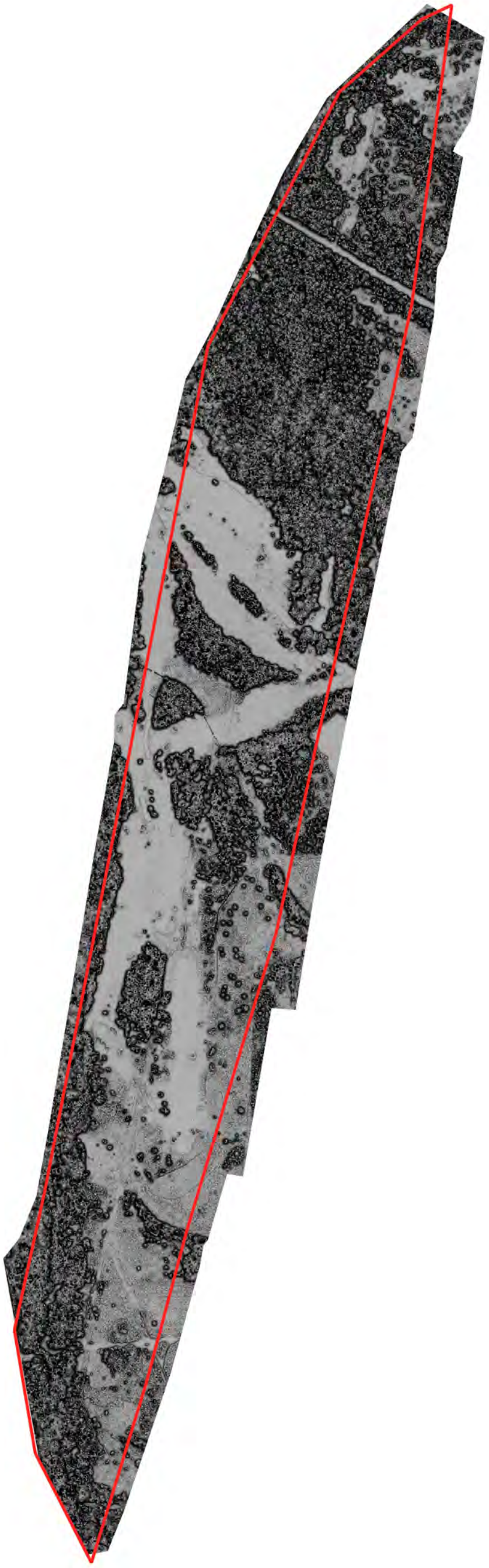
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	7

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Digital Elevation Model with hillshade using multidirectional light source

Survey Boundary



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	8

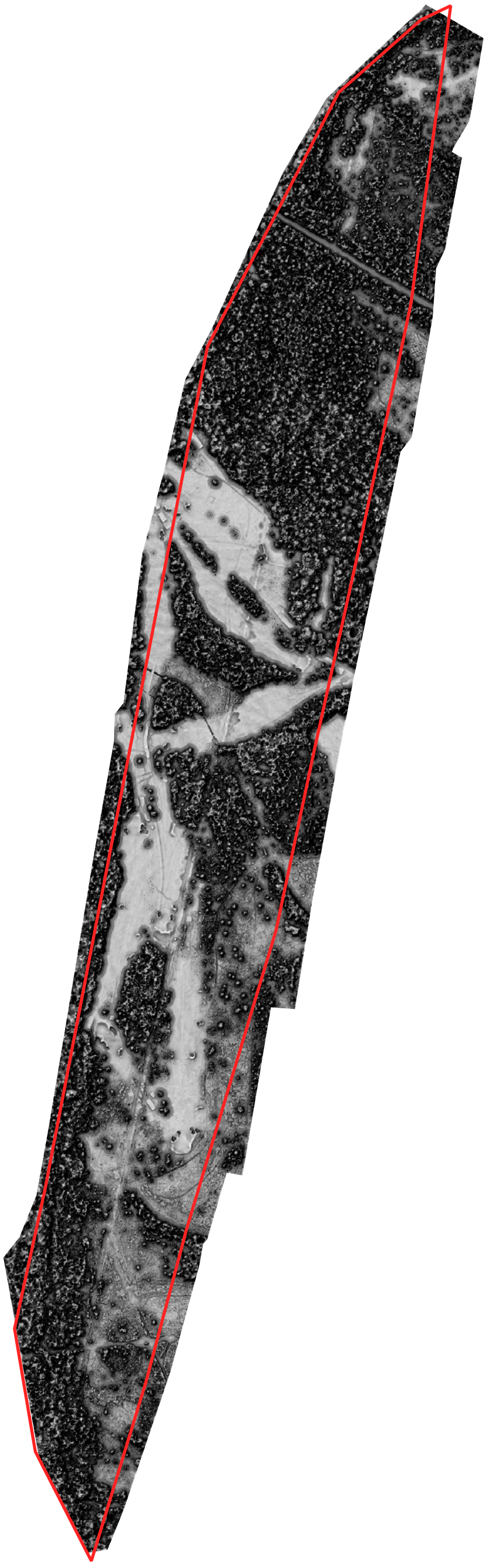
0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Composite skyview analysis comprising RVT Anisotropic Sky-view and Terrain Shading Ambient Occlusion

Survey Boundary

0 1



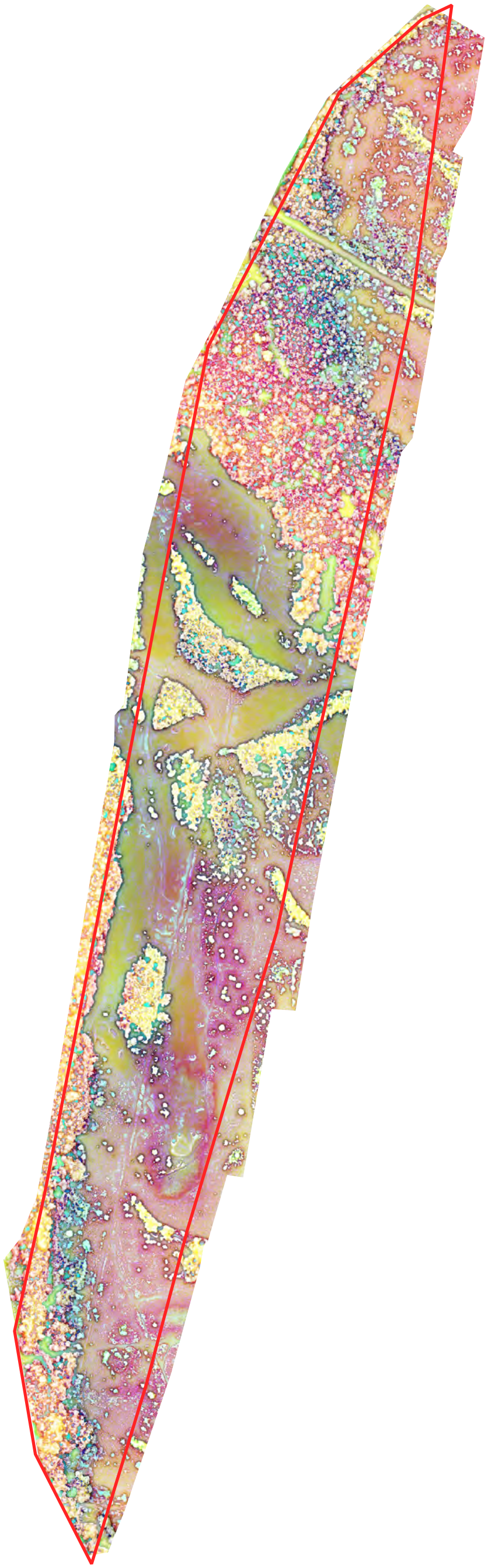
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	9

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

RVT Visualization for Archaeological Topography (VAT) combined

Survey Boundary



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	10

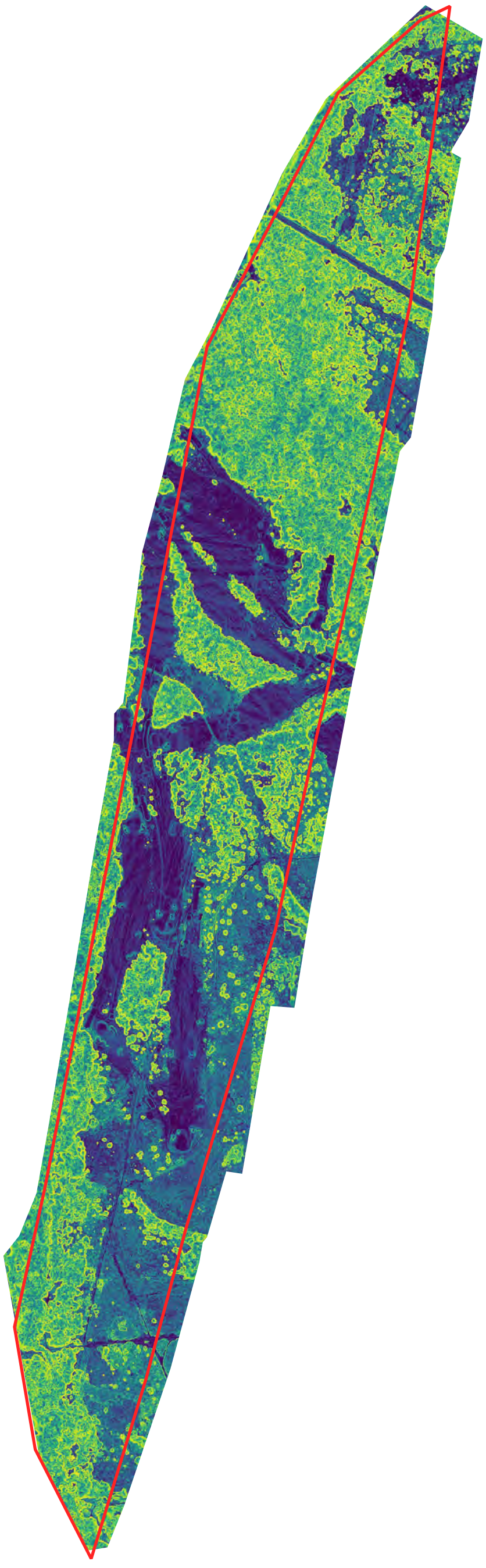
0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

RVT enhanced Multi-scale Topographic Position analysis

Survey Boundary

0° 88°



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	11

0 100 200 300 400 500 m

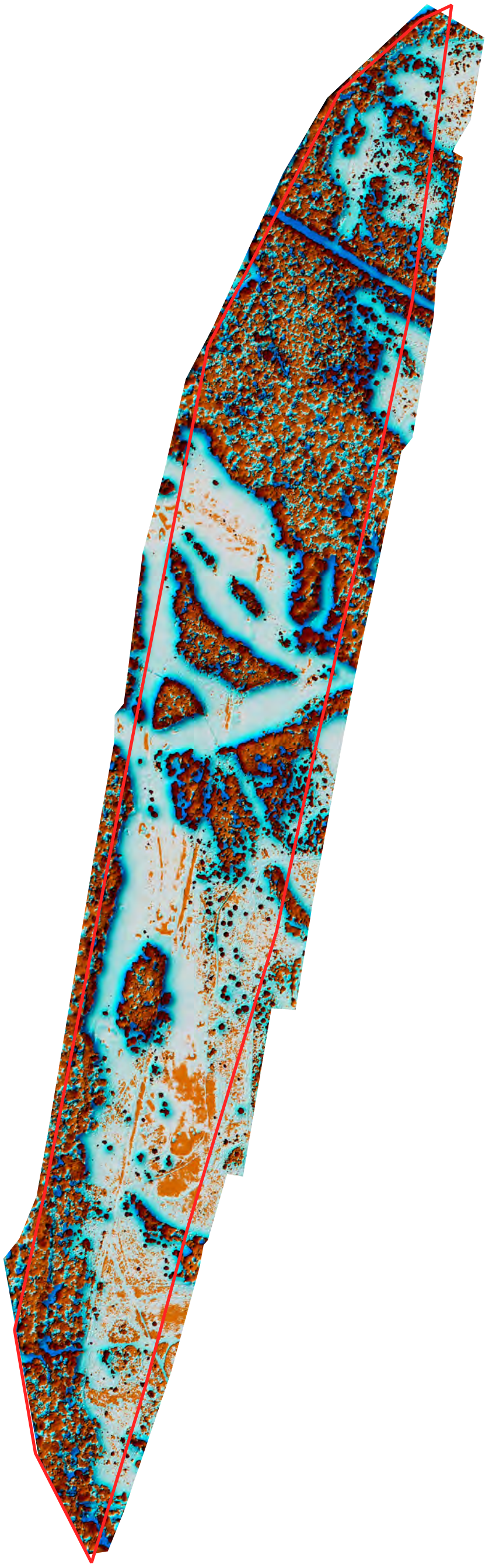
0 250 500 750 1,000 1,250 1,500 ft

RVT slope analysis

Survey Boundary

-

+



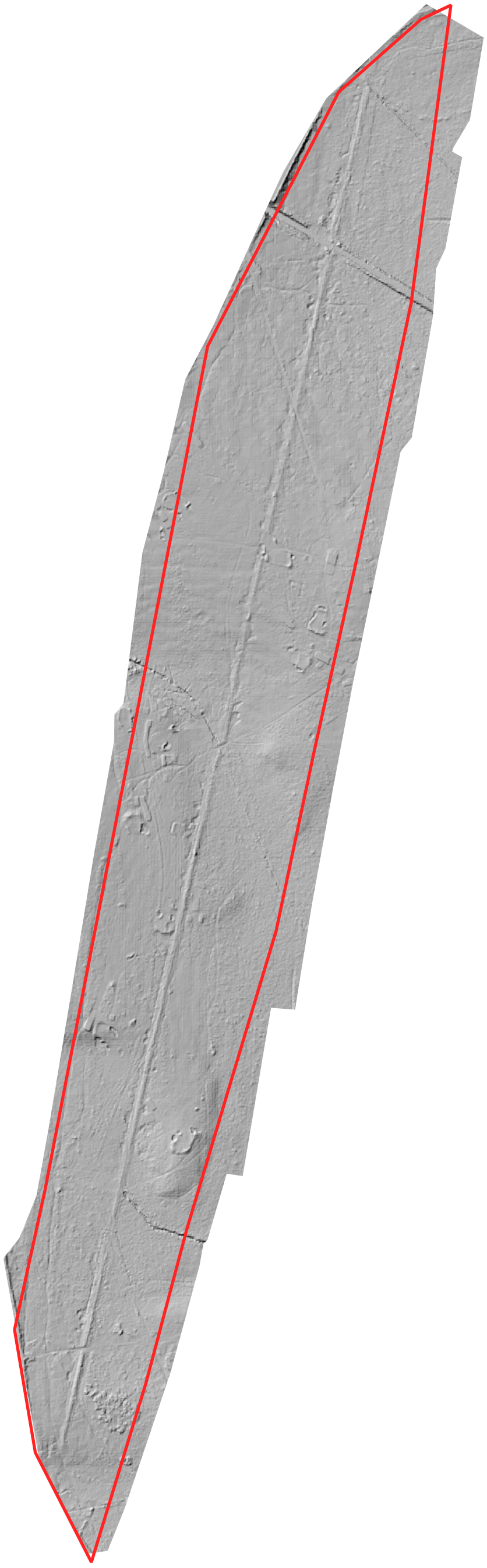
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	12

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Terrain flattened Digital Elevation Model

Survey Boundary



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
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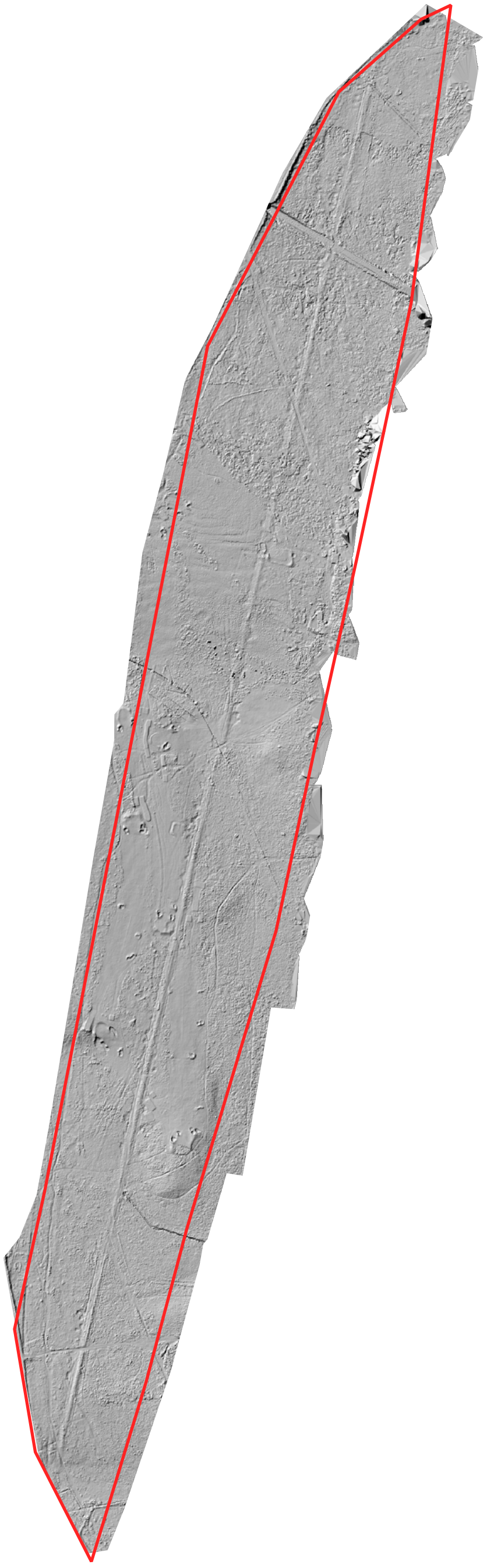
Job No.	SUMO-15842-1	**Figure**	13

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Publicly available (DEFRA) LiDAR. Resolution 1 m

Survey Boundary



Project	Ryknield Street Roman Road	**Drawn**	SW
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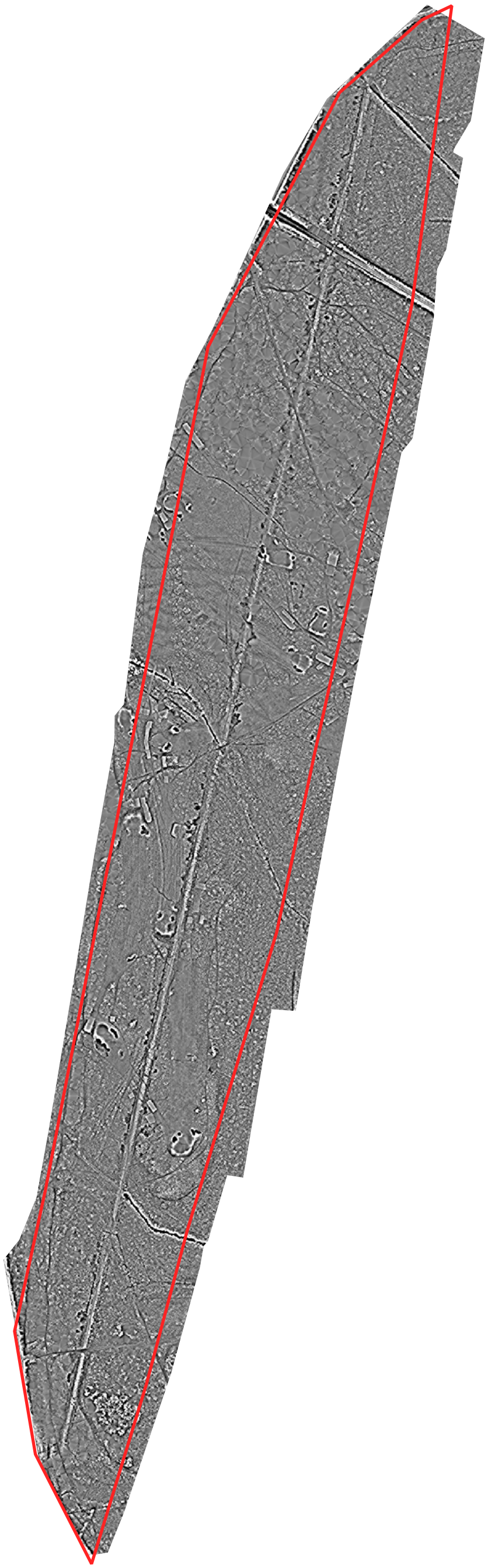
Job No.	SUMO-15842-1	**Figure**	14

0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

LiDAR data derived from UAS survey. Resolution - 5 cm grid

Survey Boundary



Project	Ryknield Street Roman Road	**Drawn**	SW
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0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

LiDAR Topographic Position Index (TPI)

Survey Boundary

Derived from both UAS RGB and LiDAR

- Linear depression (Strong)
- Linear depression (Weak)
- Linear mound (Strong)
- Linear mound (Weak)

Derived from LiDAR

- Linear depression (Strong)
- Linear depression (Weak)
- Linear mound (Strong)
- Linear mound (Weak)
- Roman agger
- Ditch
- Pits?
- Slumped agger?
- Pathway

Project	Ryknield Street Roman Road	**Drawn**	SW
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0 100 200 300 400 500 m

0 250 500 750 1,000 1,250 1,500 ft

Interpretation of features - Overview

Survey Boundary

Derived from both UAS RGB and LiDAR

Linear depression (Weak)

Linear mound (Weak)

Derived from LiDAR

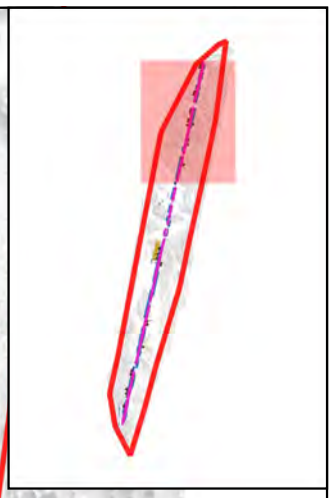
Linear depression (Weak)

Linear mound (Weak)

Roman agger

Ditch

Pits?



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5

Project	Ryknield Street Roman Road	**Drawn**	SW
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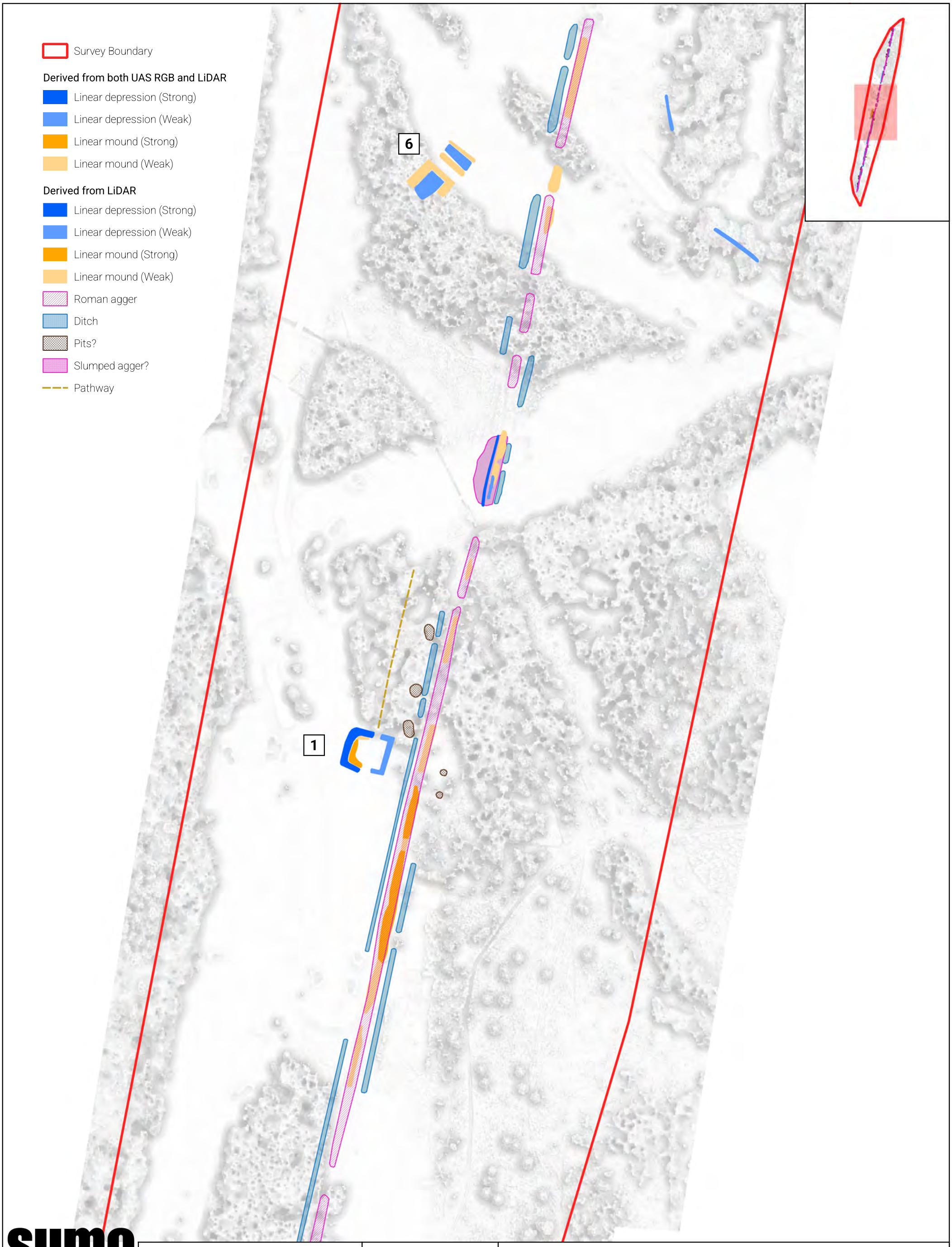
0 50 100 150 m

0 100 200 300 400 500 ft

Interpretation of features - North



Project	Ryknield Street Roman Road	**Drawn**	SW
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Job No.	SUMO-15842-1	**Figure**	18

0 50 100 150 m

0 100 200 300 400 500 ft

Interpretation of features - Central

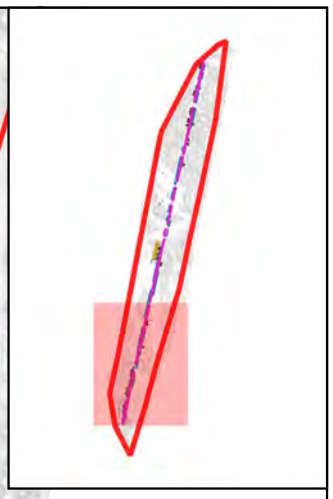
Survey Boundary

Derived from both UAS RGB and LiDAR

- Linear depression (Weak)
- Linear mound (Strong)
- Linear mound (Weak)

Derived from LiDAR

- Linear depression (Weak)
- Linear mound (Strong)
- Linear mound (Weak)
- Roman agger
- Ditch
- Pits?



7

8

9

4

3

Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.1
Date	04/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	19

0 50 100 150 m

0 100 200 300 400 500 ft

Interpretation of features - South

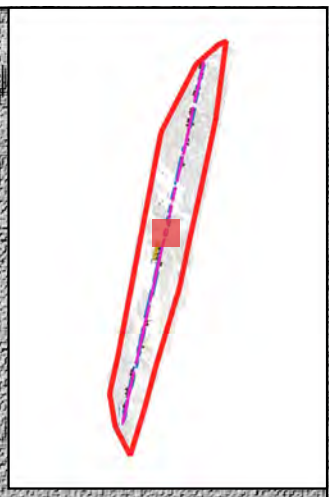
Survey Boundary

Derived from both UAS RGB and LiDAR

- Linear depression (Strong)
- Linear depression (Weak)
- Linear mound (Weak)

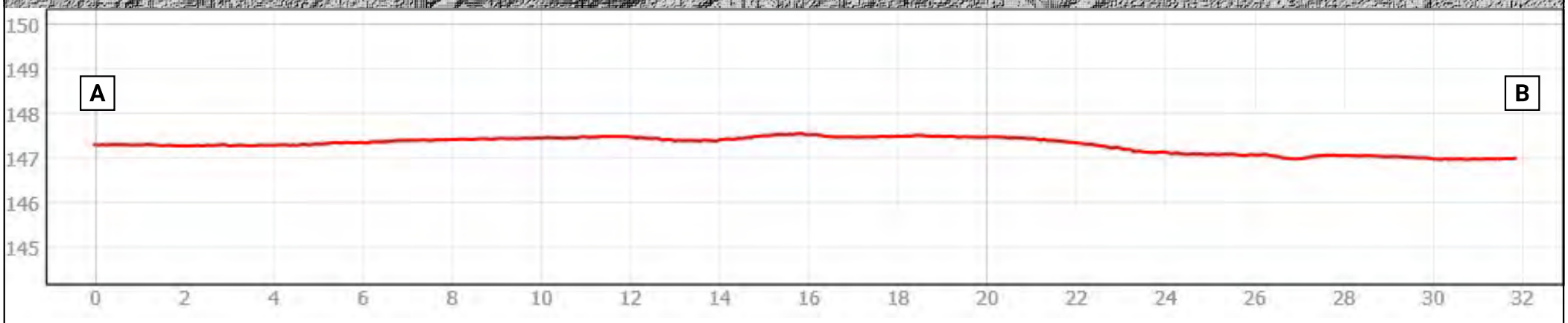
Derived from LiDAR

- Linear depression (Strong)
- Linear depression (Weak)
- Linear mound (Weak)
- Ditch
- Slumped agger?



A

B



Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.3
Date	11/07/2025	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Figure**	20

0 5 10 15 m

0 10 20 30 40 50 ft

Profile across agger in area of possible slumping

4. Discussion

4.1 Introduction

The UAS photogrammetry survey has enabled the construction of an orthomosaic image (Figure 2), Digital Elevation Model (DEM) (Figure 3), and 3D photogrammetric model of the immediate landscape surrounding the Roman Road of Ryknield Street at Sutton Park.

4.2 Ground Conditions

The ground conditions were variable across the c.70ha extent of the survey area. Much of the site is covered in woodland and thick vegetation, except for the areas cultivated for the golf course including fairways, teeing grounds, and greens which are composed of well-kept grass.

4.3 Digital Elevation Model

A DEM was produced for the survey area from the RGB photogrammetry. Elevation in metres above Ordnance Datum is depicted using a colour-scale overlay (Figure 4). The DEM provides a good indication of the topographic characteristics through hillshade manipulation in a Geographical Information System (GIS) (Figures 5–7). This technique is also useful for the identification of micro-topographical archaeological features expressed at surface level.

4.4 GIS Analysis

Hillshade analysis of the DEM using different light azimuths has shown there to be a limited number of subtle micro-topographic features. More detailed analysis using RVT Anisotropic Sky-view did not produce any significant results beyond those achieved through hillshade analysis, and so this was cross-checked using Terrain Shading Ambient Occlusion analysis from which the results were similar. A composite illustration of the two techniques was created (Figure 8). Visualisation Archaeological Topography (VAT) analysis was also applied (Figure 9) along with Multi-scale Topographic Position analysis (Figure 10). RVT Slope analysis was conducted to produce a visualisation of the general aspect of terrain (Figure 11). The DEM was flattened using Anomaly software to further enhance the visibility of any possible micro-topographic features (Figure 12).

4.5 Assessment

The interpretation results are depicted on Figures 16–20. An atlas of the Roman Road—which comprises 1:1000 scale map pages, spot heights, and feature section profiles—is included as Appendix 1.

4.5.1 Historic Mapping

Consultation of historic mapping (NLS 2025—not reproduced) showed the course of the Roman road on all Ordnance Survey editions, with editions from the 1940s onwards often depicting the agger and partial ditches to either side.

4.5.2 Historic Satellite Imagery

A review of historic satellite imagery through Google Earth (not reproduced) offered no further insights.

4.5.3 LiDAR

A review of publicly available LiDAR data (Figure 13) has helped define the route of the Roman road through areas covered by trees and dense woodland. Where the LiDAR has removed the vegetation cover, the shallow remnants of the roadside ditches were discernible in places along its route. A series of possible building foundations were also defined with more clarity in the LiDAR data than the UAS derived DEM. The publicly available LiDAR has a resolution of 1 m.

UAS derived LiDAR has provided an increased resolution DEM of the terrain within survey area. It has offered additional clarity to areas that are fuzzy or indistinct in the lower resolution DEFRA LiDAR. The UAS derived LiDAR has a resolution of 0.05 m. However, both datasets suffer where extensive vegetation and tree cover are extant.

4.5.4 Ryknield Street Roman Road, Roadside Ditches, and Possible Construction Pits

Ryknield Street Roman Road lies towards the western boundary of Sutton Park. The road, as defined by the agger, is predominantly extant for *c*. 2.5 km. There have been several truncations along the route of the road over time, and the longest uninterrupted section measures *c*. 0.4 km in length and is located towards the southern end. The agger is present in various stages of preservation and erosion, and it was predominantly mapped through LiDAR data, which has the benefit of stripping back covering vegetation to reveal the ground surface beneath. The agger appears to be *c*. 8 m wide at its maximum and is generally straight along its length, except for a section of possible slumping towards the centre of the survey area (Figure 20). A well-defined linear depression that respects the orientation of the agger in this area was initially believed to be the roadside ditch, but after further consideration it appears that the agger slumps to the west, extending beyond the linear depression. If this depression is a ditch at the side of the road, it would be a later feature, one that was constructed after the agger had slumped westwards. Where the agger is better-preserved, it is expressed as a low, flat-topped mound, and remains to a height of not greater than *c*. 0.4 m.

The ditches that once ran parallel to either side of the road are now discontinuous in their preservation. Those sections of ditch that remain visible are generally shallow and choked with vegetation and were mapped through LiDAR data. Where the ditches are better-preserved, they remain to a depth of not greater than *c*. 0.2 m and generally appear to be *c*. 3.5 m in width. The longest visible uninterrupted section measures *c*. 191 m in length.

A series of probable pits were observed either side of the agger along its length. The pits—which were depicted in the LiDAR data as dark/black features—were more prevalent towards the northern end of the road, with fewer towards the south. The probable pits are generally located under tree cover and within the denser woodland to the north of the site, and should be considered with caution, as they may represent tree throws or similar. Without ground investigation it is uncertain whether these features are construction pits associated with the road, or something else.

4.5.5 Sub-Rectangular Structure

A sub-rectangular structure [**1**] (Figure 18) was observed was observed at NGR SP 08664 97676. The feature is located to the west of the Roman road and its orientation respects its alignment. The feature comprises a

well-defined C-shaped ditch to the west—that measures *c*. 47 m in length by *c*. 5 m in width at its maximum—and a less defined, shallow, reverse C-shaped ditch to the east—that measures *c*. 38 m in length by *c*. 5 m in width at its maximum. Along the western side—interior to the ditch—is a low micro-topographic earthwork bank that respects the shape of the ditch and measures *c*. 30 m in length by *c*. 4 m in width at its maximum. There is a gap between the ditches on the northern side, that measures *c*. 4.5 m in width and an opposing gap on the southern side that measures *c*. 6.5 m in width, which give access to the interior. The eastern ditch of the feature is located approximately 18 m west of the road.

A pathway—which is hidden within woodland and appears well-defined on the LiDAR data—appears to extend from the possible structure towards the north by east, parallel to the road, for *c*. 105 m.

From the UAS data, the orientation and location of the feature gives the impression that this structure may be contemporary with road. However, this is highly unlikely given the findings of the ULAS (Beamish 2025) report, and this feature more likely relates to the golf course.

4.5.6 Boundary of Streetly Wood

The course of the original Boundary of Streetly Wood [**2**] (MBM816) is visible as a relict shallow ditch and micro-topographic earthwork bank towards the northern end of the survey area. This curving feature is predominantly preserved within woodland, which makes tracking its course problematic. Where it is visible it is represented by a low bank and shallow ditch that has become segmented along its length.

4.5.7 Holloway

A short length of holloway [**3**] (MBM2910)—with a possible continuation to the north—was observed towards the southwest of the survey area. The holloway is expressed as a shallow linear depression at surface level and remains to a depth of *c*. 0.50 m where better preserved.

4.5.8 Bank and Ditch To The South Of The Survey Area

To the northwest of the holloway, a short length of bank and ditch [**4**] (SPMBM4132) that may predate the Deer Park outer boundary earthwork was observed.

4.5.9 Other Possible Structures

A series of possible structures—as represented by often ephemeral, micro-topographic earthworks¬ and depressions—were observed along the length of the survey area. These features are best represented in the LiDAR Topographic Position Index (TPI) (see Figure 15).

To the north of the survey area (Figure 17), a series of features [**5**] are aligned along a northwest by west to southeast by east orientation—which generally follows the alignment of the fairway. This group comprises four features defined by low micro-topographic earthworks and shallow depressions. Three of the features are grouped together, with an outlier situated approximately 50m to the east. The features are irregular in plan, with the largest measuring *c*. 17 m by *c*. 17 m and the smallest measuring *c*. 8 m by *c*. 9 m.

Approximately 165 m to the south is another group of earthworks [**6**] that are partly hidden by trees and partly visible on the fairway. The two features are aligned along a similar orientation to group [**5**]. To the north, two parallel micro-topographic earthworks—that measure *c*. 21 m in length by *c*. 4 m in width at maximum—are aligned either side of a sub-rectangular shallow depression that measures *c*. 20m in length by *c*. 7 m in width. Immediately southwest of this is a C-shaped earthwork that bounds a shallow sub-rectangular depression. The earthwork measures *c*. 48 m in length by *c*. 6.5 m in width at maximum, whilst the sub-rectangular depression measures *c*. 18 m in length by *c*. 11 m in width.

In the south of the survey area are three possible structures. The northernmost [**7**] is defined by an L-shaped micro-topographic earthwork that measures *c*. 22 m in length by *c*. 4.5 m in width and a shallow sub-square depression that measures *c*. 11m by *c*. 11 m.

The central possible structure(s) [**8**] appears to be a complex of low, micro-topographic earthworks and a limited number of shallow depressions located towards the northwest of the feature. The earthworks—which occupy an area that measures *c*. 91 m in length by *c*. 70 m in width— are generally aligned along a northwest

to southeast orientation and appear to define bounded spaces of unknown purpose. It is uncertain whether the earthworks represent foundations or something else.

Approximately 40 m to the south of group [**8**] is a small sub-rectangular depression [**9**] that measures *c*. 16 m in length by *c*. 11 m in width. The feature is aligned along a northwest to southeast orientation. There is a small gap of *c*. 3 m width along the northeast side which allows access to the interior. It is uncertain what this feature represents.

5. Conclusions

5.1 Limitations

The central to southern survey area comprises a landscaped golf course. Thick vegetation, including heathers and other coarse and scrubby plants, is spread across the southern part of the site along with sporadic groups of trees. A dense band of woodland crosses the site towards the north, covering much of the ground in this area. The ground to the northeast of the survey area was very wet and marshy.

5.2 Conclusion

The UAS Photogrammetry and LiDAR surveys conducted at the Roman Road within Sutton Park, Sutton Coldfield, have successfully produced a detailed visual record of the landscape along the length of the road.

Ryknield Street Roman Road lies towards the western boundary of Sutton Park. The road, as defined by the agger, is predominantly extant for *c*. 2.5 km. There have been several truncations along the route of the road over time, and the longest uninterrupted section measures *c*. 0.4 km in length and is located towards the southern end. The agger is present in various stages of preservation and erosion, and it was predominantly mapped through LiDAR data, which has the benefit of stripping back covering vegetation to reveal the ground surface beneath. The agger appears to be *c*. 8 m wide at its maximum and is generally straight along its length, except for a section of possible slumping towards the centre of the survey area. A well-defined linear depression that respects the orientation of the agger in this area was initially believed to be the roadside ditch, but after further consideration it appears that the agger slumps to the west, extending beyond the linear depression. If this depression is a ditch at the side of the road, it would be a later feature, one that was constructed after the agger had slumped westwards. Where the agger is better-preserved, it is expressed as a low, flat-topped mound, and remains to a height of not greater than *c*. 0.4 m.

The ditches that once ran parallel to either side of the road are now discontinuous in their preservation. Those sections of ditch that remain visible are generally shallow and choked with vegetation and were mapped through LiDAR data. Where the ditches are better-preserved, they remain to a depth of not greater than *c*. 0.2 m and generally appear to be *c*. 3.5 m in width. The longest visible uninterrupted section measures *c*. 191 m in length.

A series of probable pits were observed either side of the agger along its length. The pits were more prevalent towards the northern end of the road, with fewer towards the south. Without ground investigation it is uncertain whether these features are construction pits associated with the road, or something else.

The course of the original boundary of Streetly Wood is visible as a relict shallow ditch and micro-topographic earthwork bank towards the northern end of the survey area. This curving feature is predominantly preserved within woodland.

A short length of holloway—with a possible continuation to the north—was observed towards the southwest of the survey area. The holloway is expressed as a shallow linear depression at surface level and remains to a depth of *c*. 0.50 m where better preserved. To the northwest of the holloway, a short length of bank and ditch that may predate the Deer Park outer boundary earthwork was observed.

A sub-rectangular structure was observed was observed at NGR SP 08664 97676. The feature is located to the west of the Roman road and its orientation respects its alignment. The structure comprises two ditches and a low micro-topographic bank that are located approximately 18 m west of the road. A pathway appears to extend from the possible structure towards the north by east, parallel to the road, for *c*. 105 m.

From the UAS data, the orientation and location of the feature gives the impression that this structure may be contemporary with road. However, this is highly unlikely given the findings of the ULAS (Beamish 2025) report, and this feature more likely relates to the golf course.

A series of possible structures—as represented by often ephemeral, micro-topographic earthworks and depressions—were observed along the length of the survey area.

To the north of the survey area, a series of features are aligned along a northwest by west to southeast by east orientation—which generally follows the alignment of the fairway. This group comprises four features defined by low micro-topographic earthworks and shallow depressions. Three of the features are grouped together, with an outlier situated approximately 50m to the east.

Approximately 165 m to the south is another group of earthworks that are partly hidden by trees and partly visible on the fairway. The features are aligned along a similar orientation to the group to the north and comprise two parallel micro-topographic earthworks that are aligned either side of a sub-rectangular shallow depression, and a C-shaped earthwork that bounds a shallow sub-rectangular depression.

In the south of the survey area are three possible structures. The northernmost is defined by an L-shaped micro-topographic earthwork. The central possible structure(s) appears to be a complex of low, micro-topographic earthworks and a limited number of shallow depressions located towards the northwest of the feature. It is uncertain whether the earthworks represent foundations or something else. Towards the south is a small sub-rectangular depression that is aligned along a northwest to southeast orientation. There is a small gap of *c*. 3 m in width along the northeast side which allows access to the interior.

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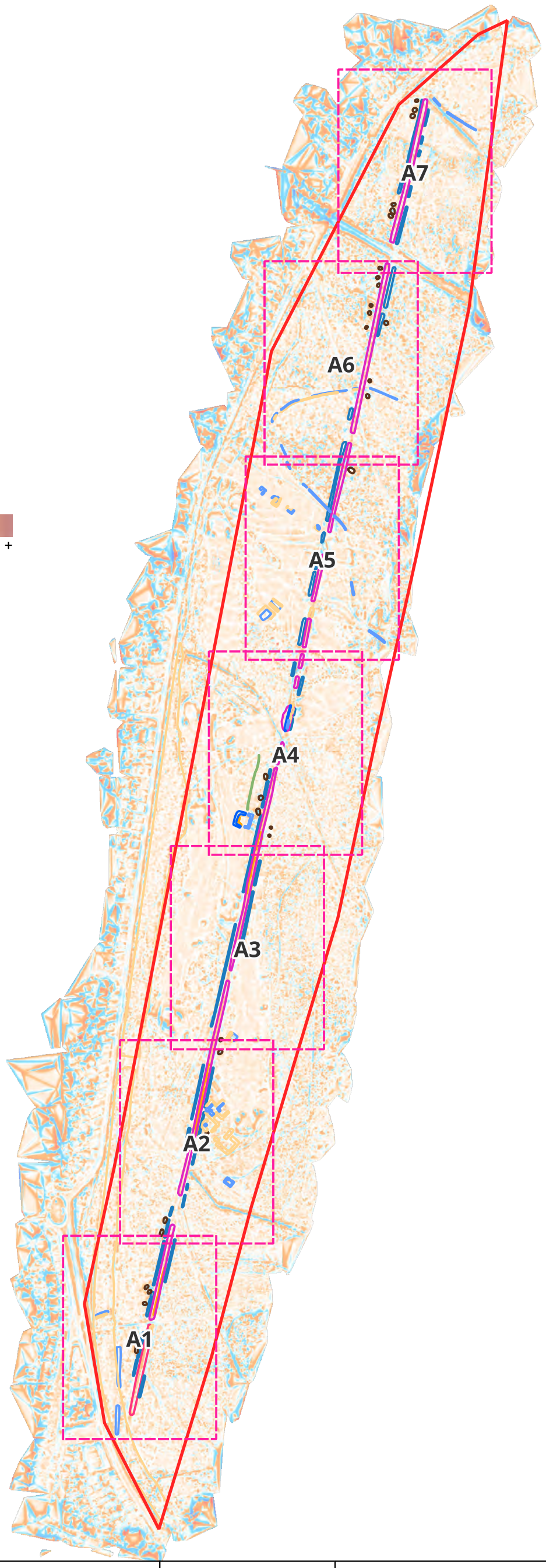
Appendix 1 – Atlas

ATLAS LEGEND

- Atlas Pages
- Survey Boundary
- Linear depression (Strong)
- Linear depression (Weak)
- Linear mound (Strong)
- Linear mound (Weak)
- Modern features
- Possible structure?
- Roman agger
- Ditch
- Pits?
- Slumped agger?
- Pathway
- Feature spot heights
- Feature profiles
- --10-- Contours

\- +

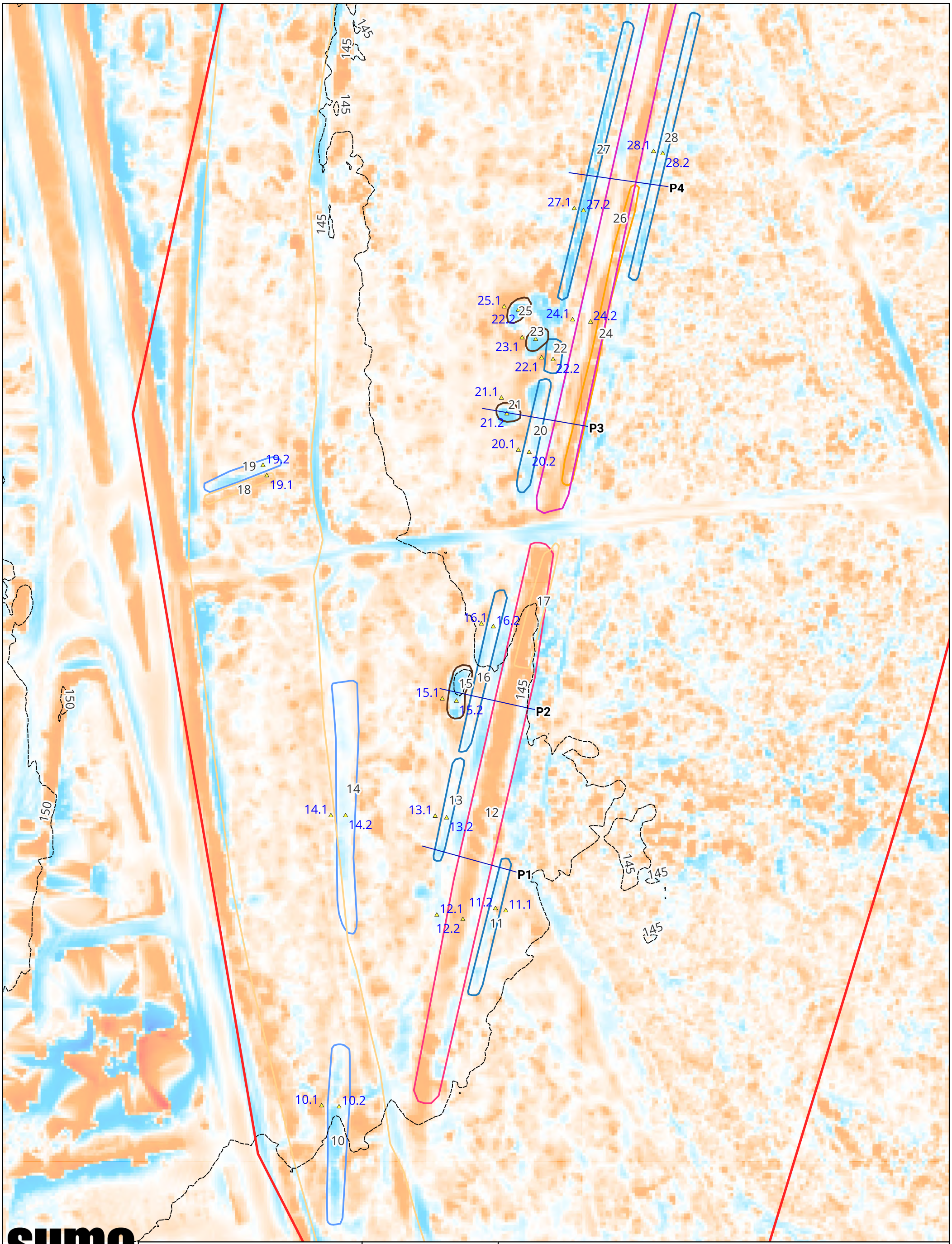


Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

0 100 200 300 400 500 m

0 500 1,000 1,500 ft

Atlas Overview



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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	1

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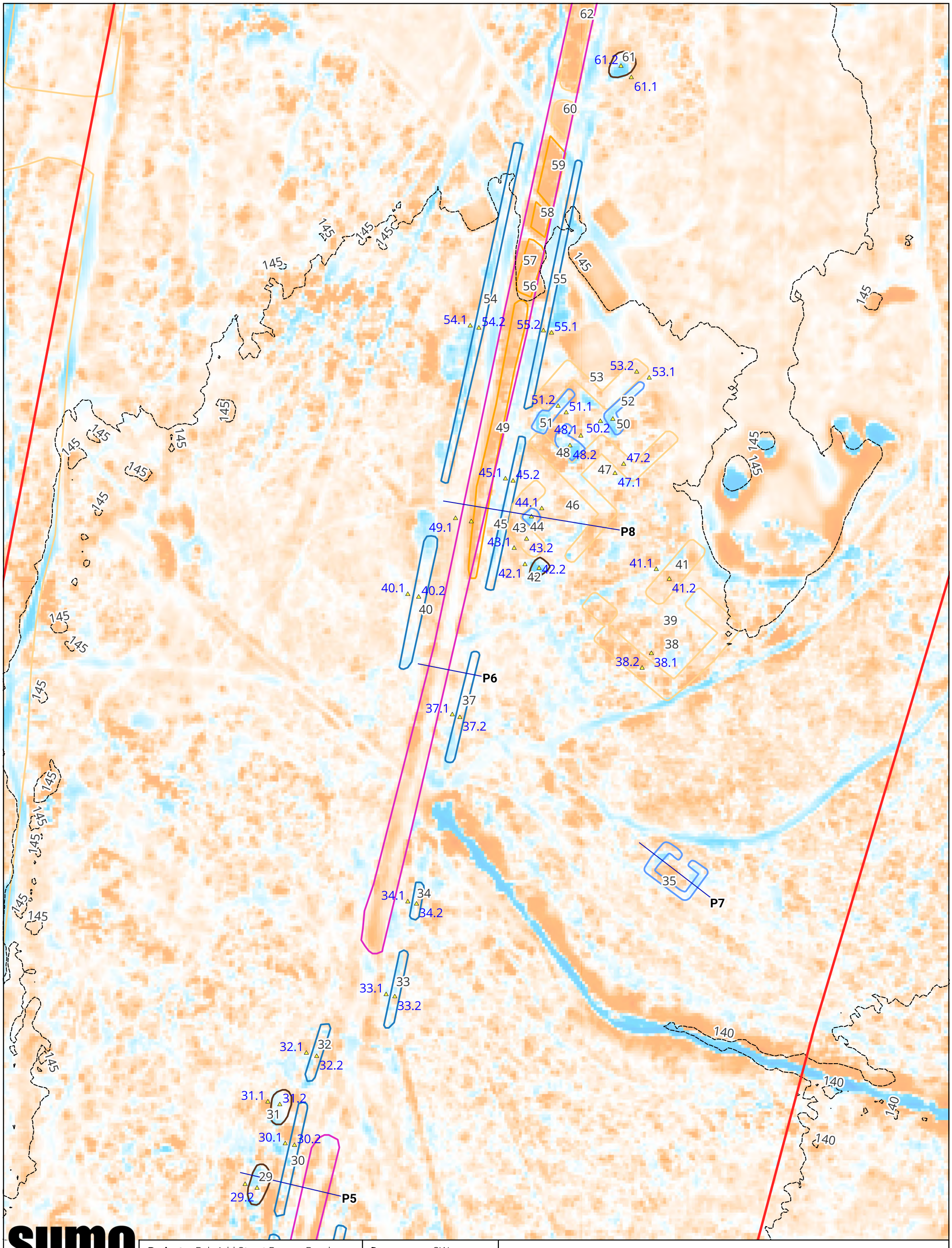

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Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	2

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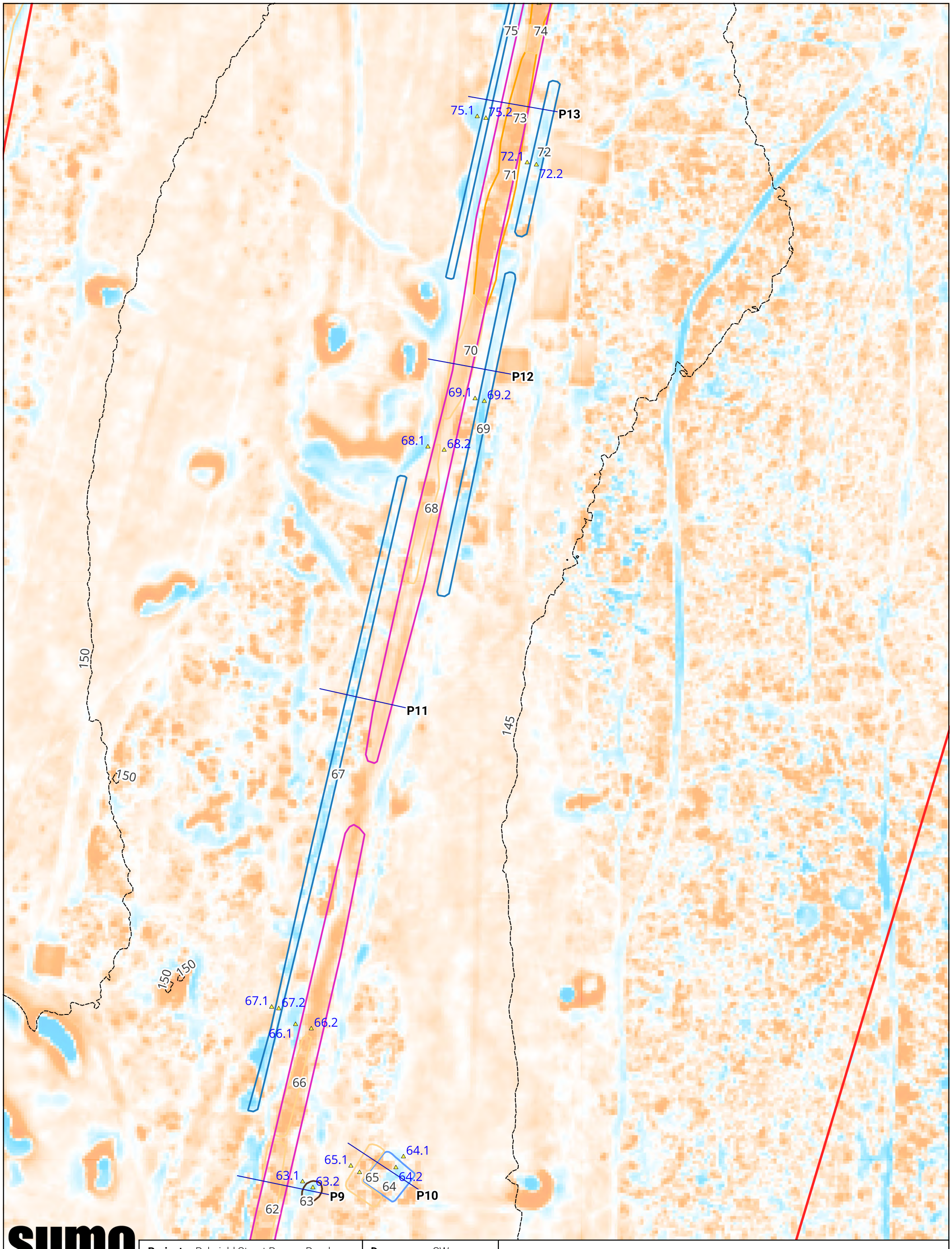

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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
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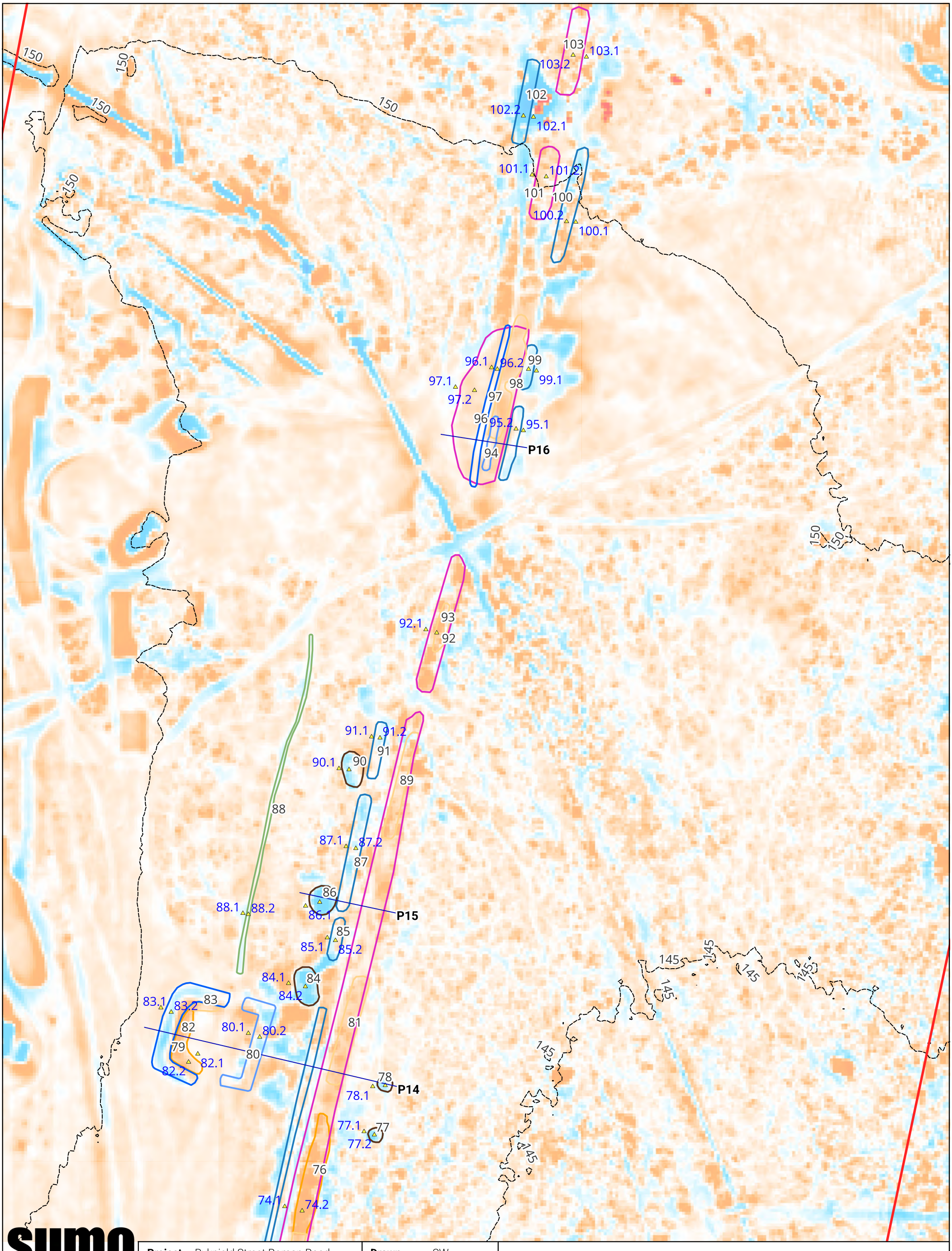

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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	4

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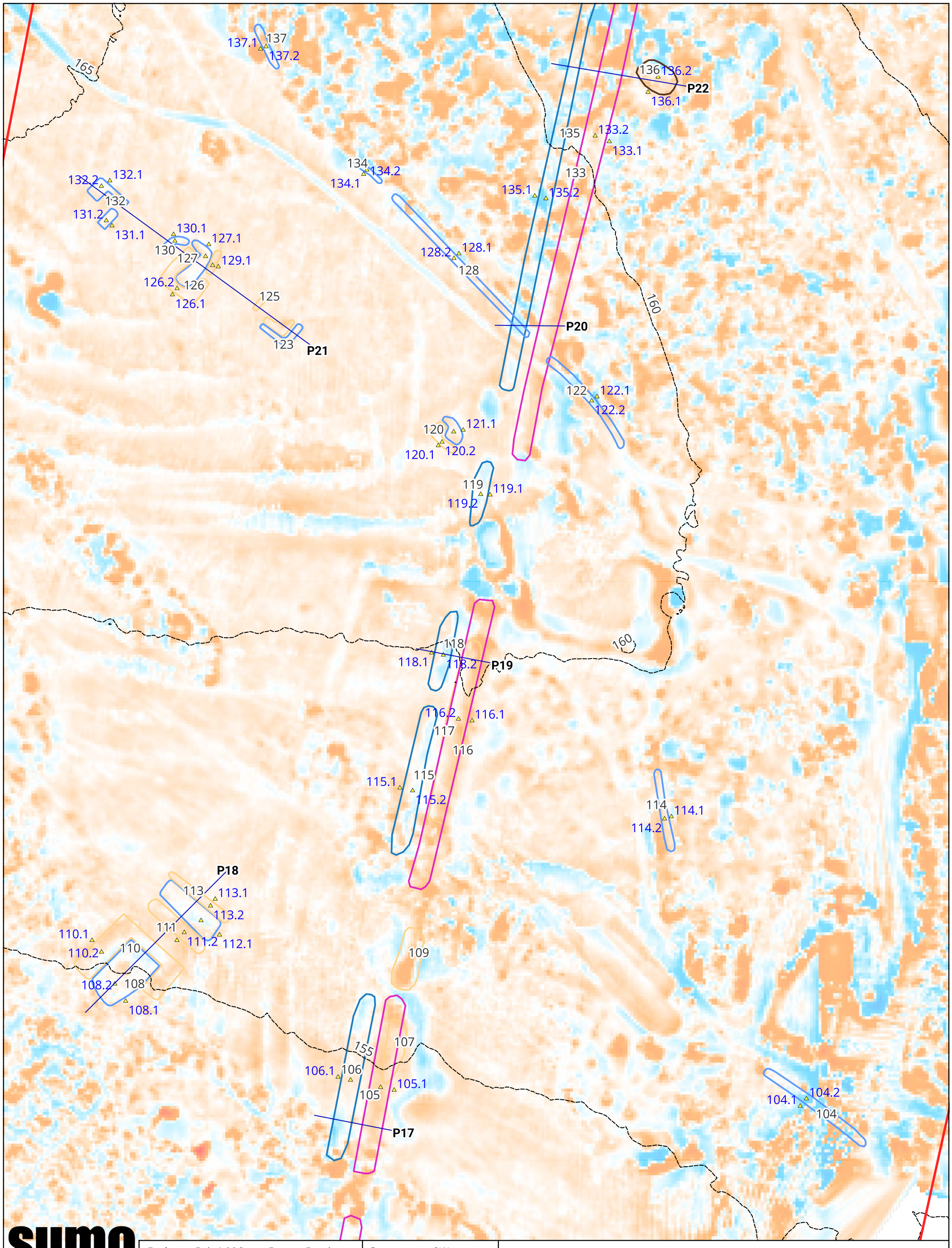

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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	5

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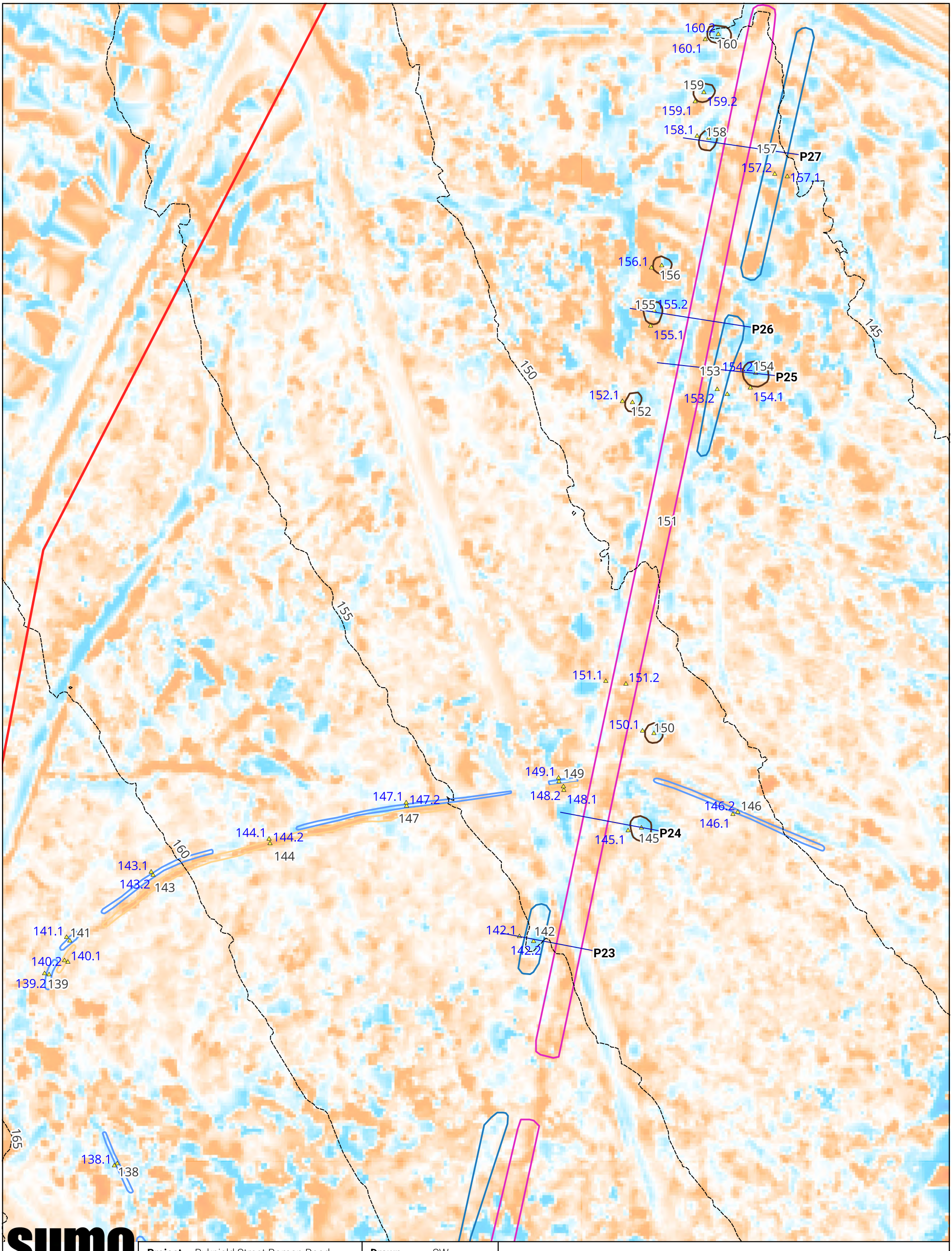

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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	6

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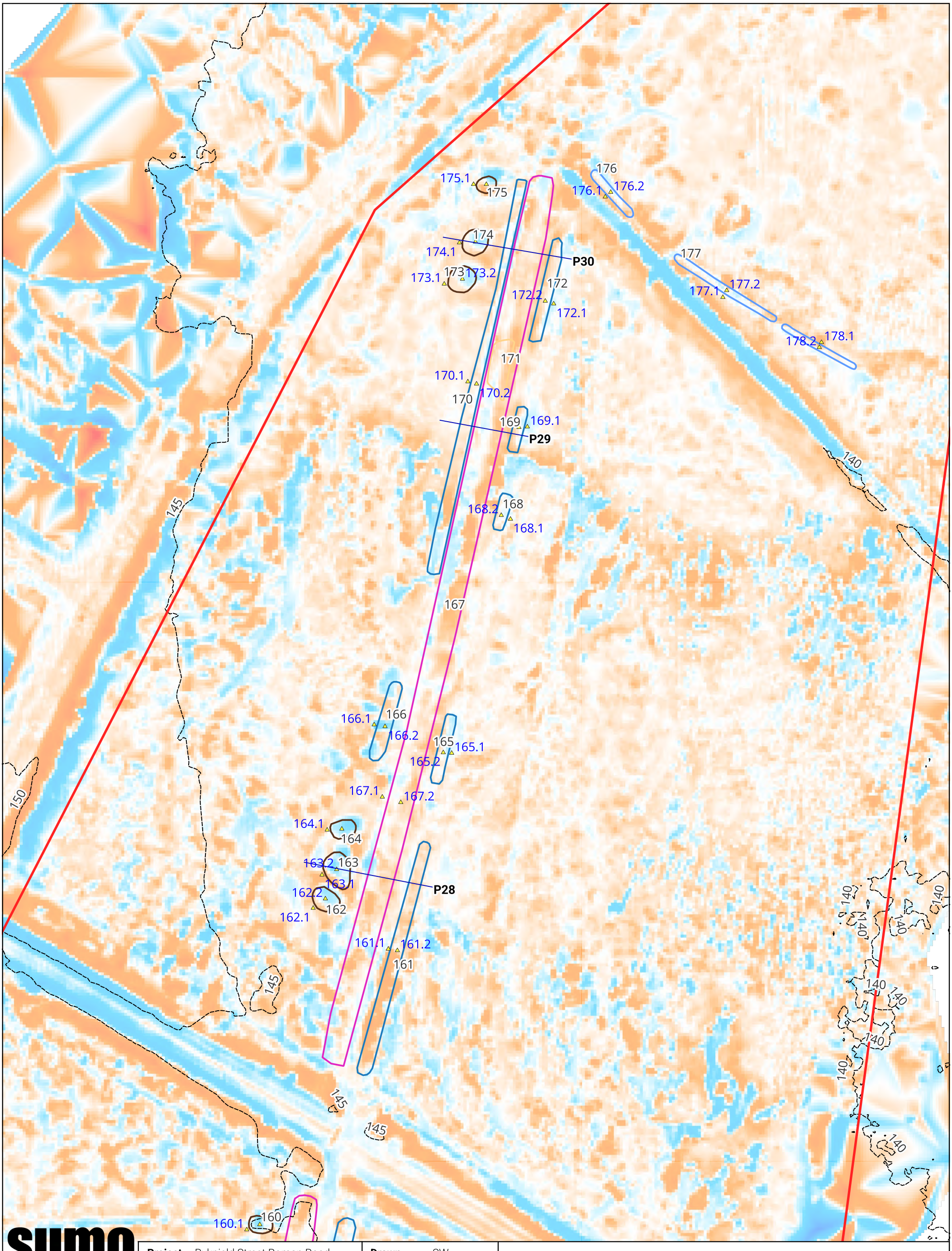

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Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1	**Page**	7

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0 50 100 150 200 250 ft

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11.2	145.29
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12.2	145.9
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13.2	145.76
14.1	146.83
14.2	146.57
15.1	145.62
15.2	144.99
16.1	144.77
16.2	144.57
19.1	146.49
19.2	146.21
20.1	143.48
20.2	143.4
21.1	143.62
21.2	143.09
22.1	143.58
22.2	143.16
22.2	142.85
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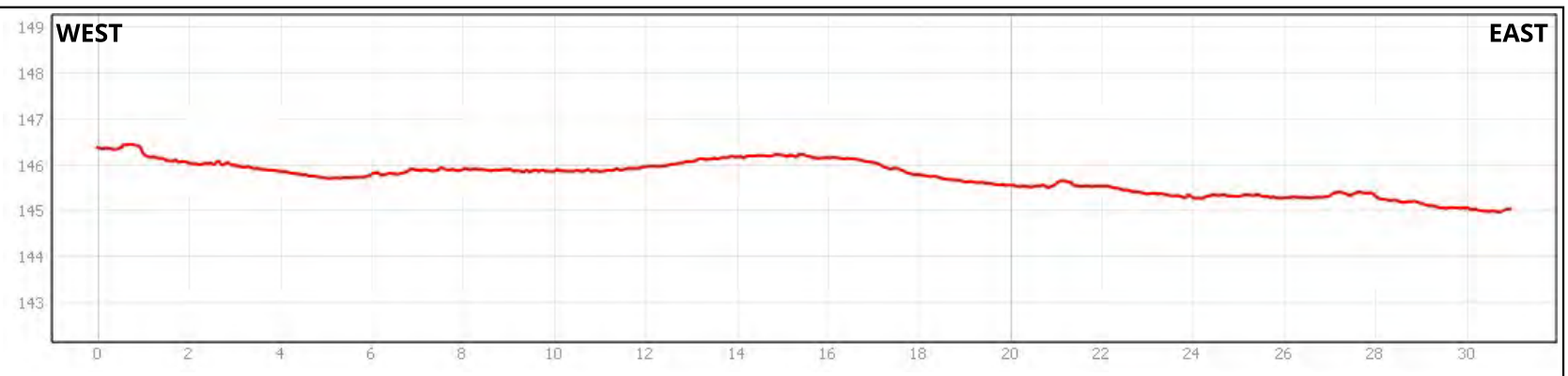

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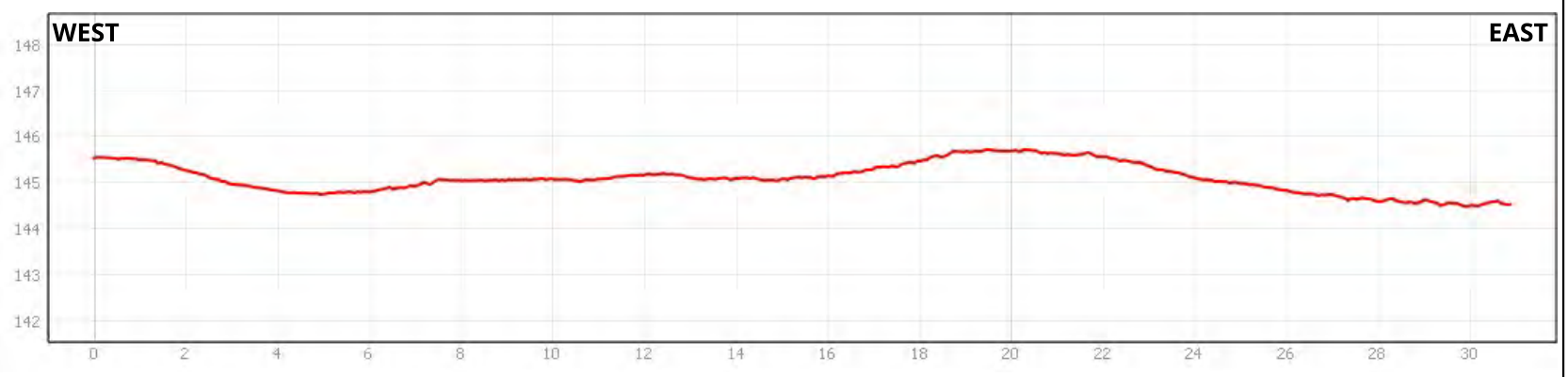

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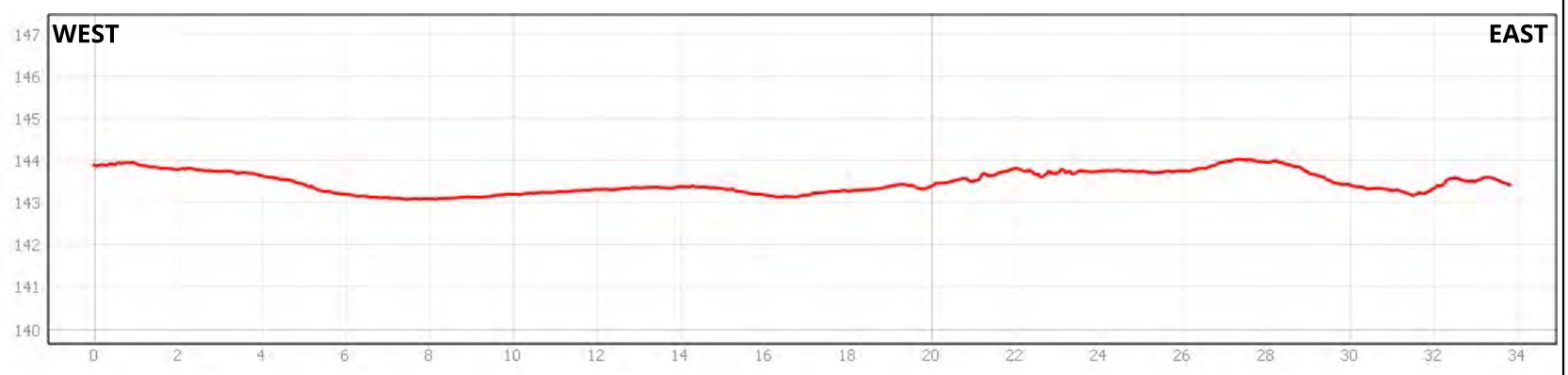

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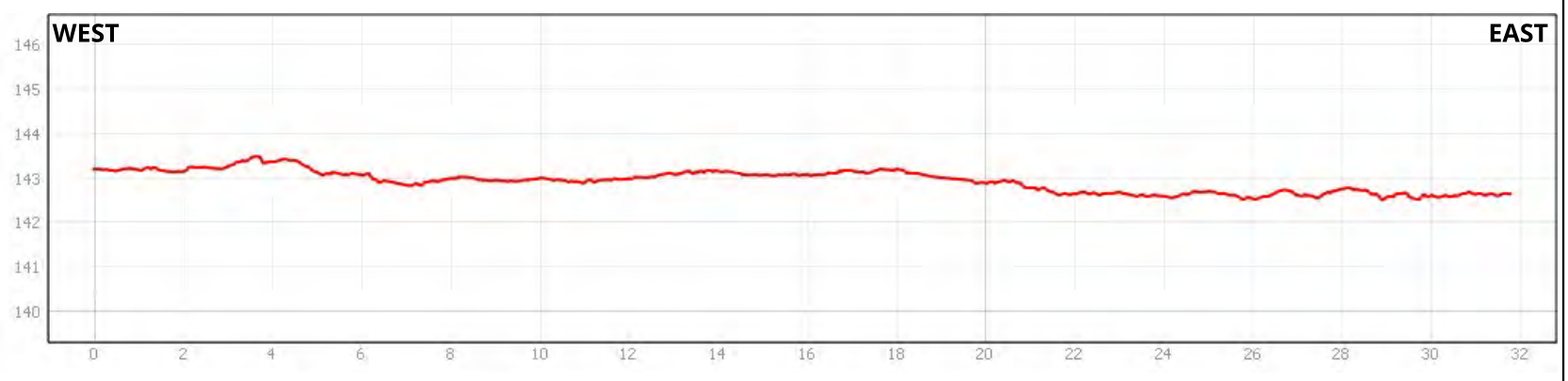

Profile 4

Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

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Profile X Axis = Distance m aOD

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33.2	142.14
34.1	142.37
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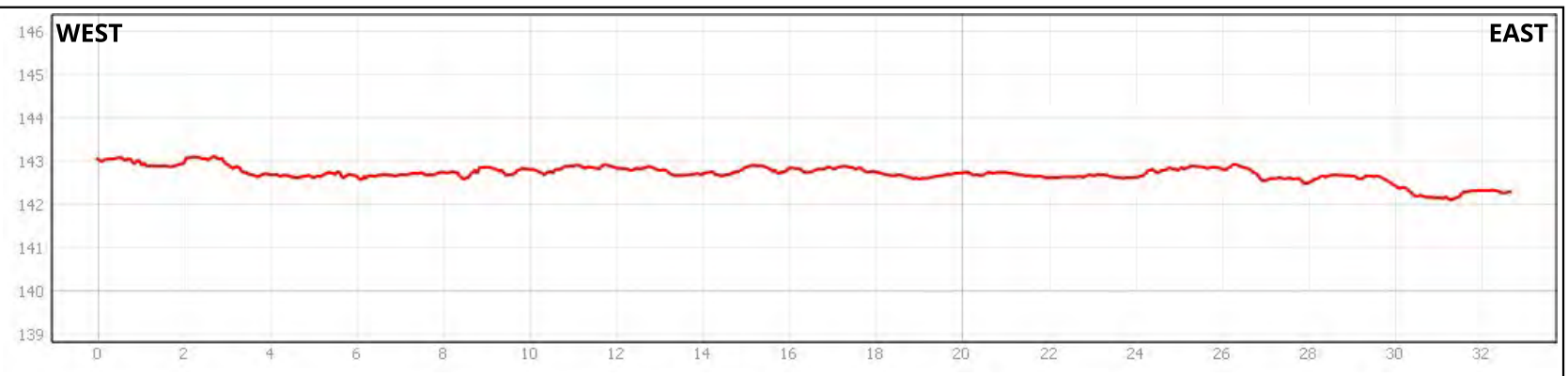

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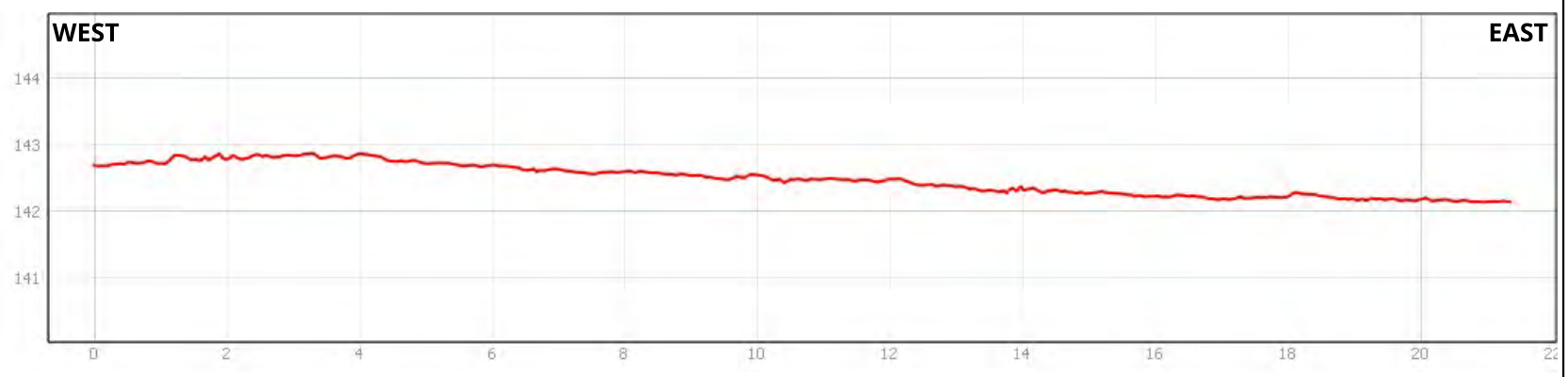
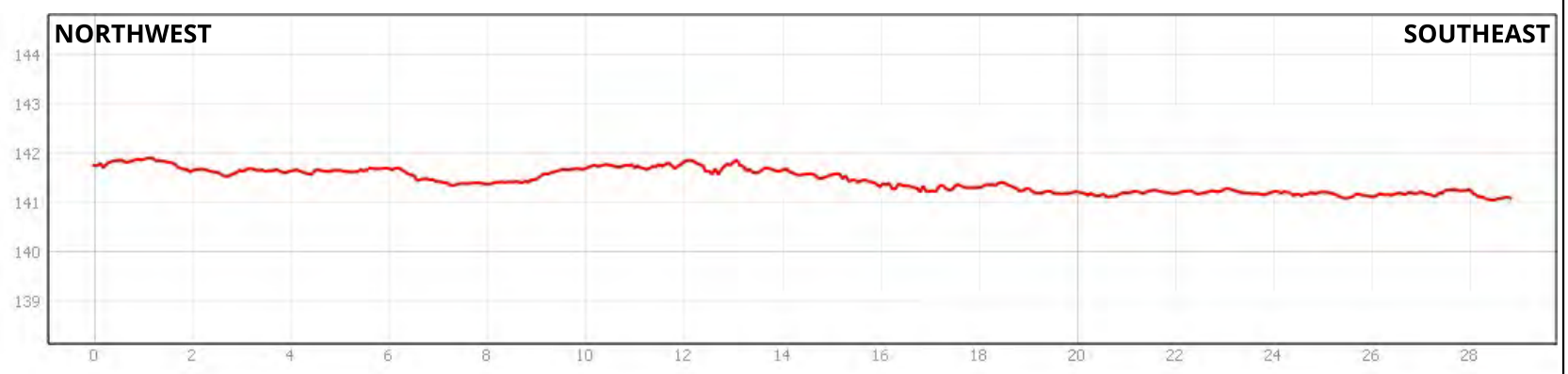
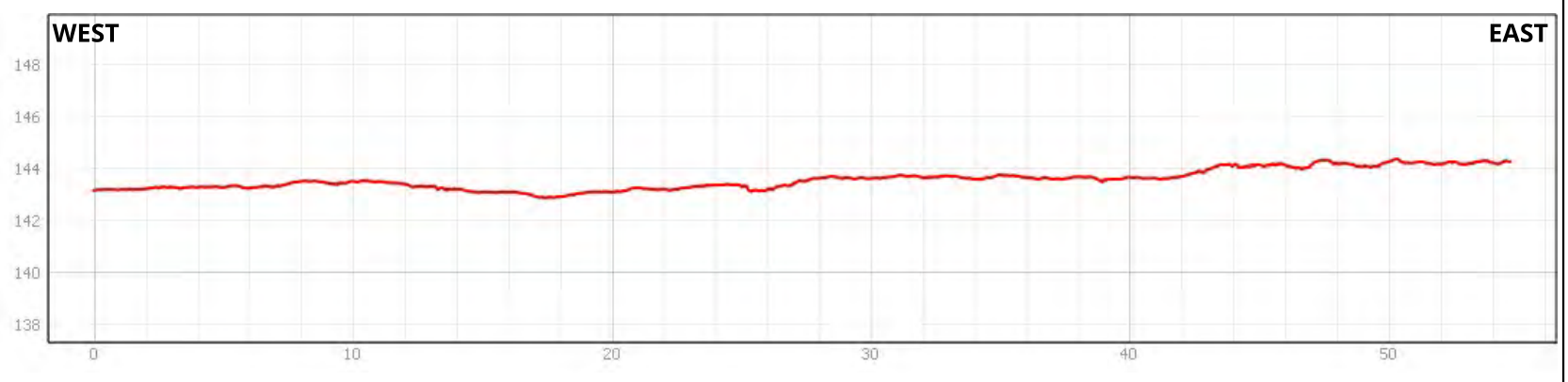


Profile 6



Profile 7

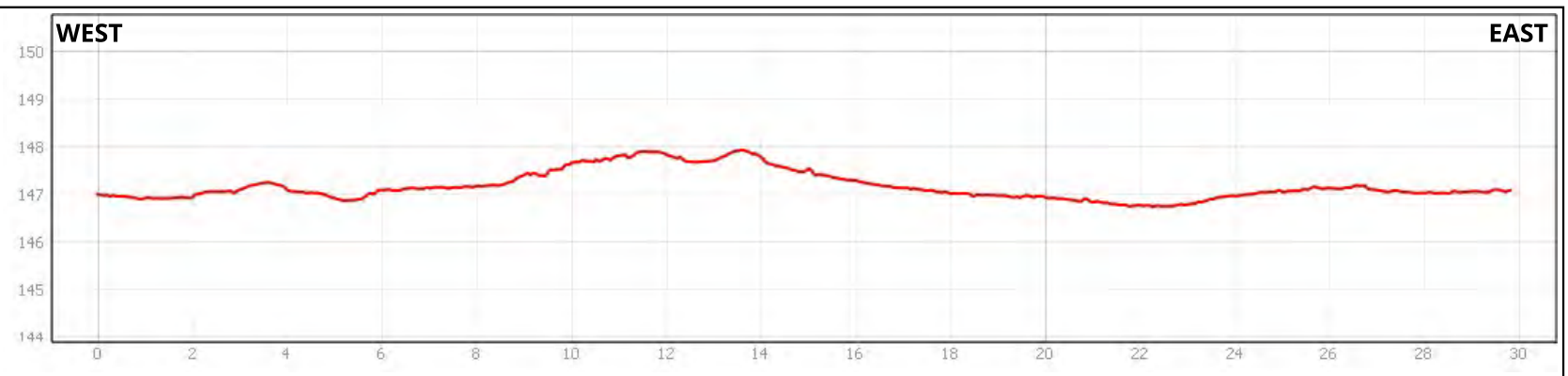


Profile 8

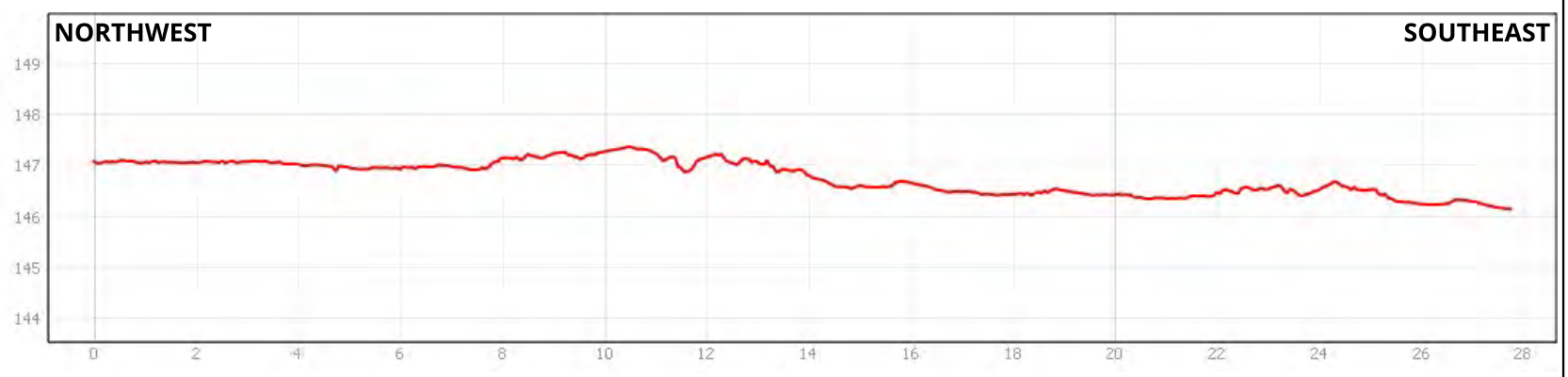
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

Profile Y axis = Elevation m aOD
Profile X Axis = Distance m aOD

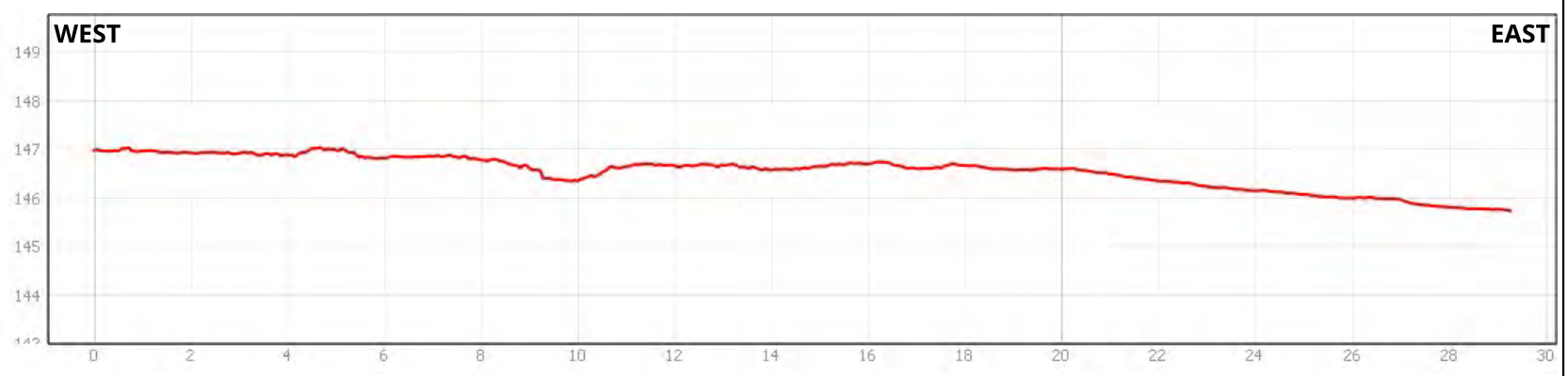
Spot Height	Value (m aOD)
61.1	146.41
61.2	145.92
63.1	147.09
63.2	146.81
64.1	146.37
64.2	146.71
65.1	147.03
65.2	147.01
66.1	147.42
66.2	147.8
67.1	147.8
67.2	147.65
68.1	146.4
68.2	146.46
69.1	146.23
69.2	146.01
72.1	147.43
72.2	147.15
75.1	147.54
75.2	147.69



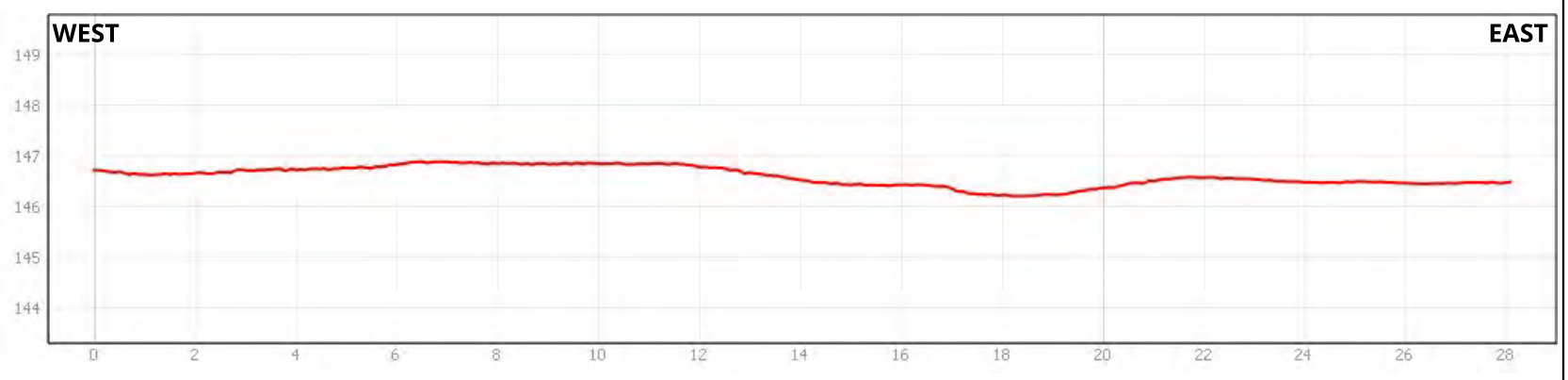
Profile 9



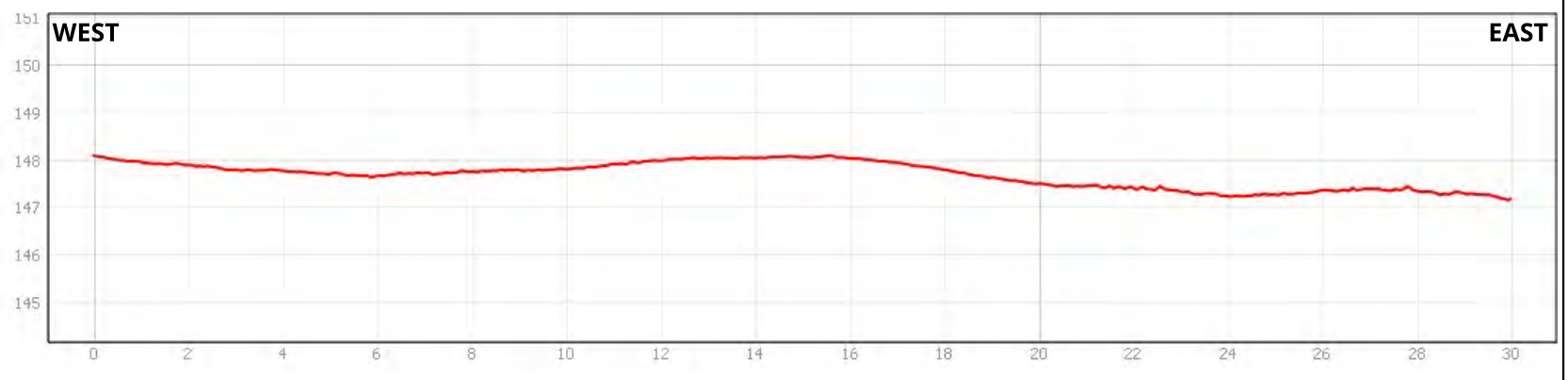
Profile 10



Profile 11



Profile 12

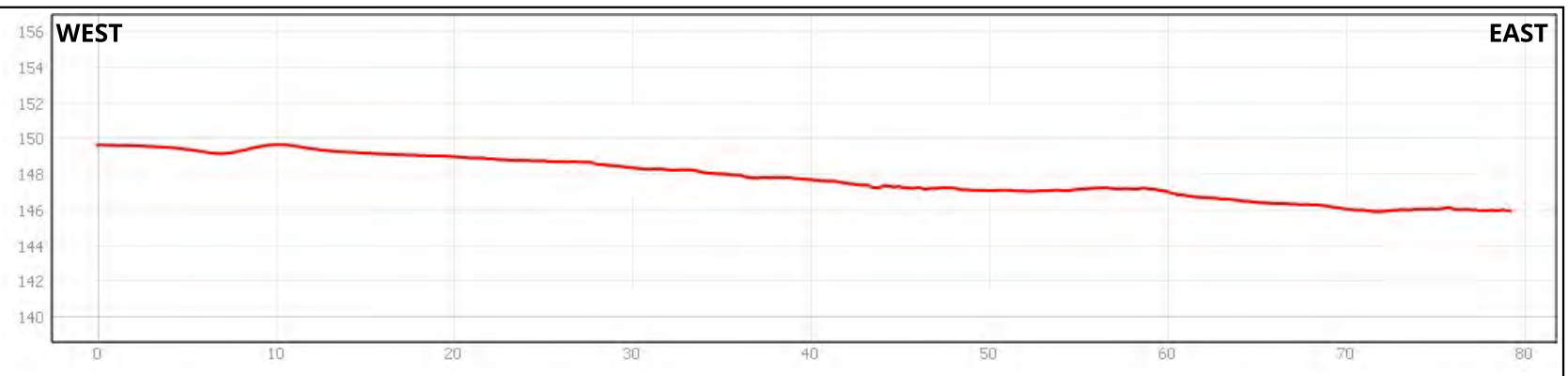


Profile 13

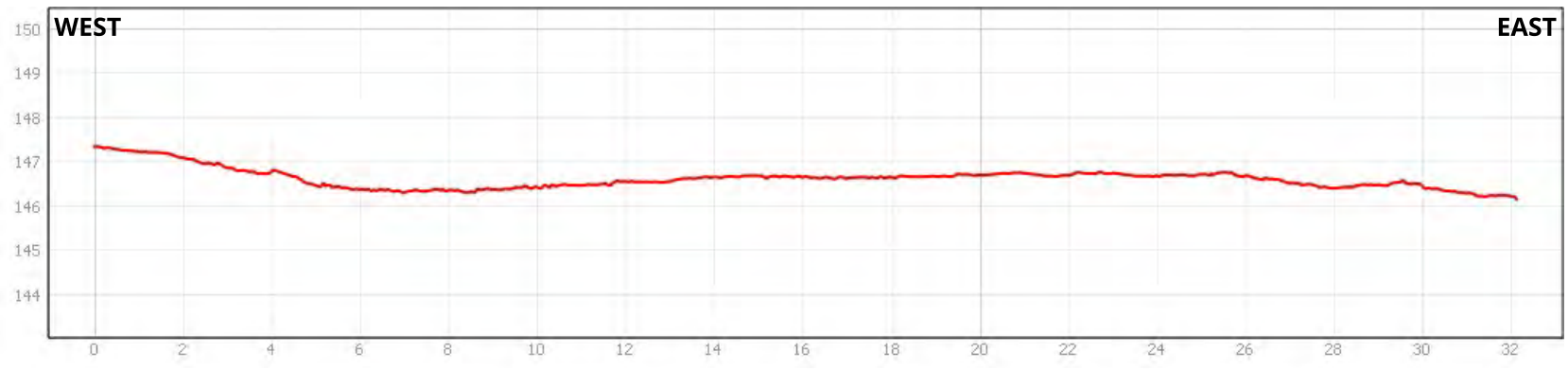
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

Profile Y axis = Elevation m aOD
Profile X Axis = Distance m aOD

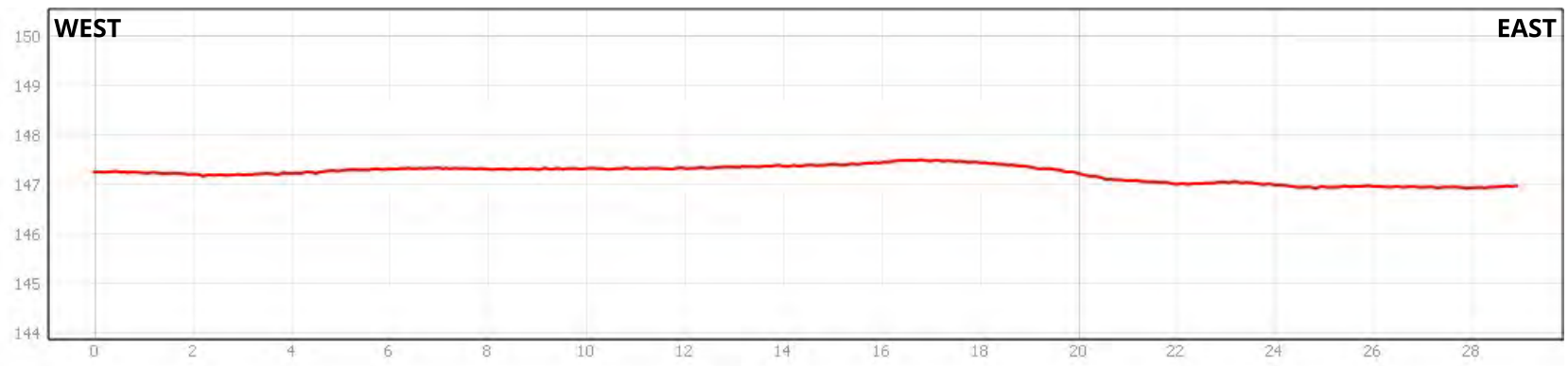
Spot Height	Value (m aOD)
74.1	147.73
74.2	148.16
77.1	146.38
77.2	146.12
78.1	146.27
78.2	145.89
80.1	148.33
80.2	147.84
82.1	149.09
82.2	149.34
83.1	149.52
83.2	149.16
84.1	147.67
84.2	146.73
85.1	146.89
85.2	146.71
86.1	147.04
86.2	146.38
87.1	146.89
87.2	146.53
88.1	148.48
88.2	148.36
90.1	146.88
90.2	146.46
91.1	146.68
91.2	146.61
92.1	146.84
92.2	147.3
95.1	147.11
95.2	147.28
96.1	148.07
96.2	147.94
97.1	147.46
97.2	147.77
99.1	147.4
99.2	147.52
100.1	149.56
100.2	149.54
101.1	149.98
101.2	150.02
102.1	150.59
102.2	150.17
103.1	151.13
103.2	151.27



Profile 14



Profile 15

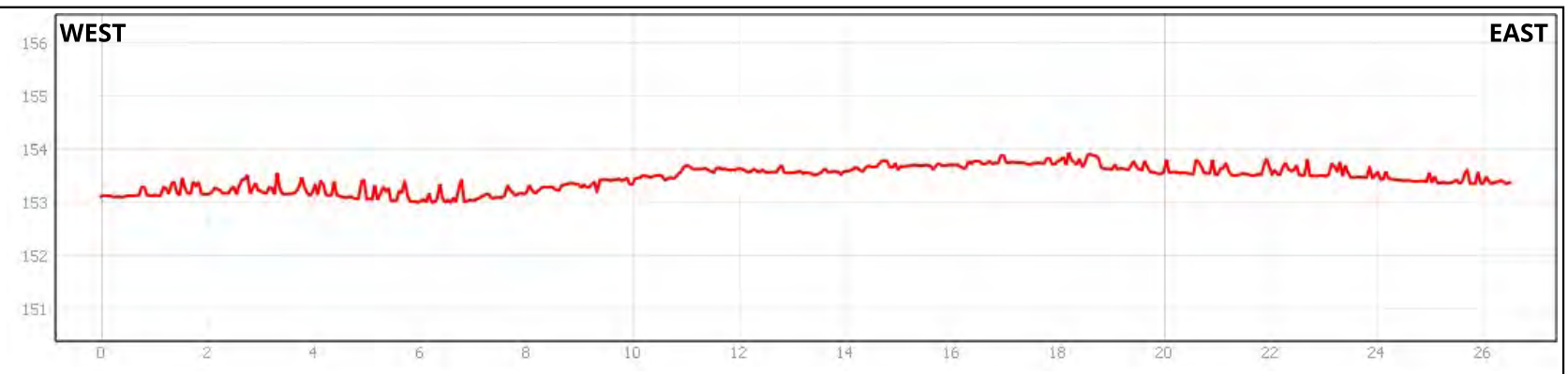


Profile 16

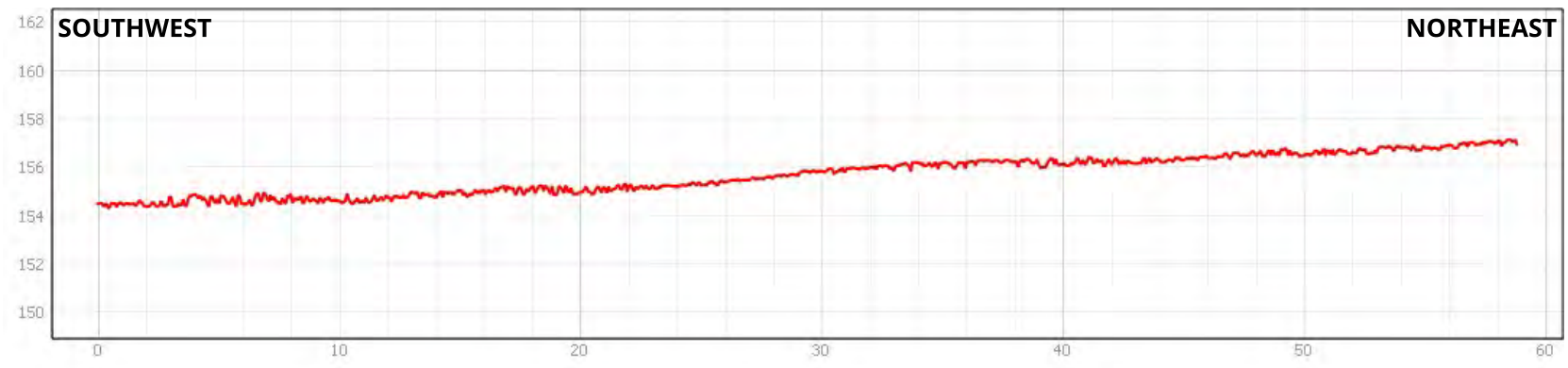
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

Profile Y axis = Elevation m aOD
Profile X Axis = Distance m aOD

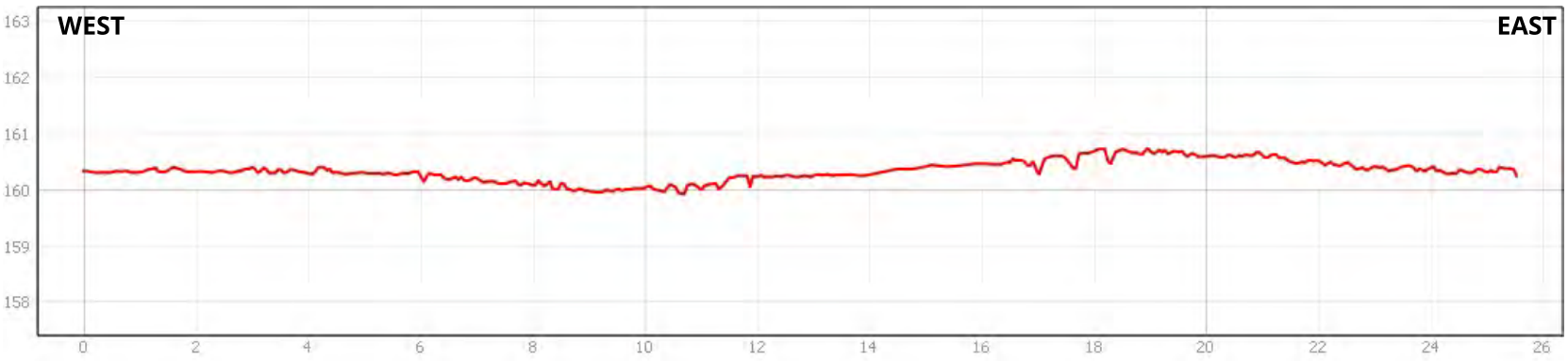
Spot Height	Value (m aOD)
104.1	156.23
104.2	156.01
105.1	154.37
105.2	154.73
106.1	154.47
106.2	154.53
108.1	154.69
108.2	154.63
110.1	155.62
110.2	155.49
111.1	156.02
111.2	155.8
112.1	156.12
112.2	155.91
113.1	156.37
113.2	156.44
114.1	158.84
114.2	158.94
115.1	159.1
115.2	158.78
116.1	159.91
116.2	159.87
118.1	160.26
118.2	160.1
119.1	161.46
119.2	161.34
120.1	161.99
120.2	161.92
121.1	161.96
121.2	161.94
122.1	161
122.2	161.35
126.1	163.68
126.2	163.75
127.1	163.83
127.2	163.86
128.1	162.24
128.2	162.36
129.1	163.8
129.2	163.82
130.1	164.21
130.2	164
131.1	164.29
131.2	164.34
132.1	164.66
132.2	164.6
133.1	159.88
133.2	160.12
134.1	162.96
134.2	162.86
135.1	161.29
135.2	161.1
136.1	159.15
136.2	158.78
137.1	164.06
137.2	163.81



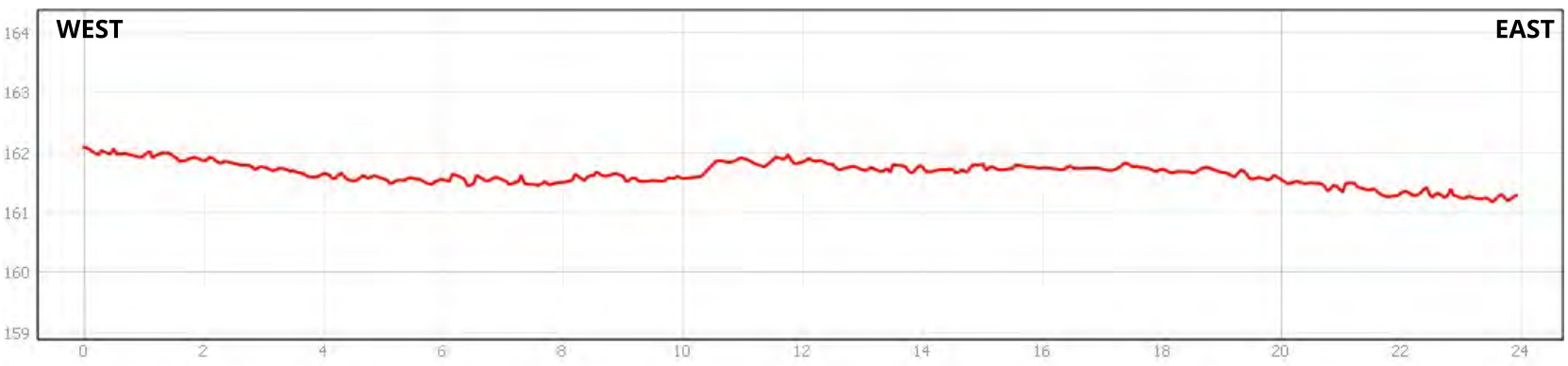
Profile 17



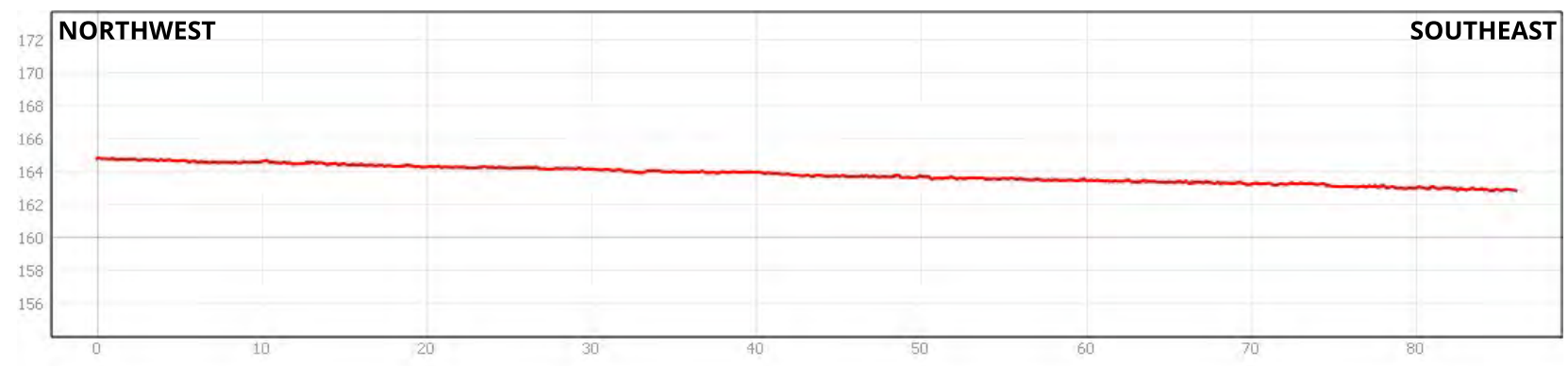
Profile 18



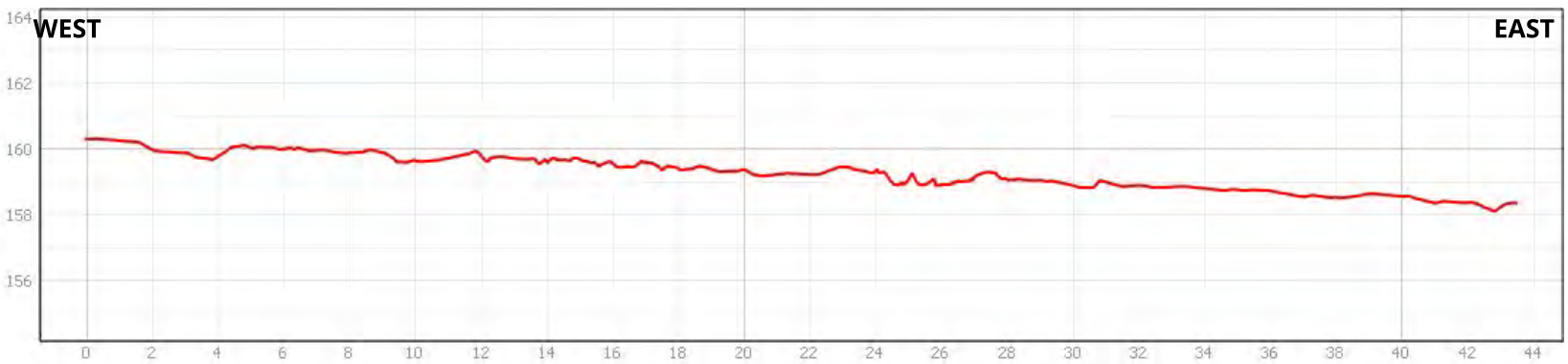
Profile 19



Profile 20



Profile 21

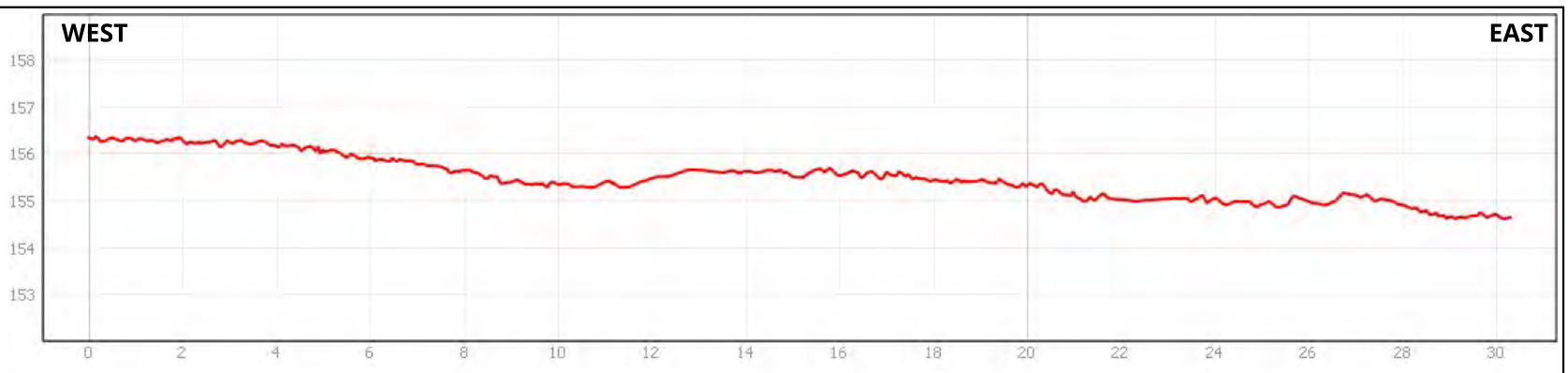


Profile 22

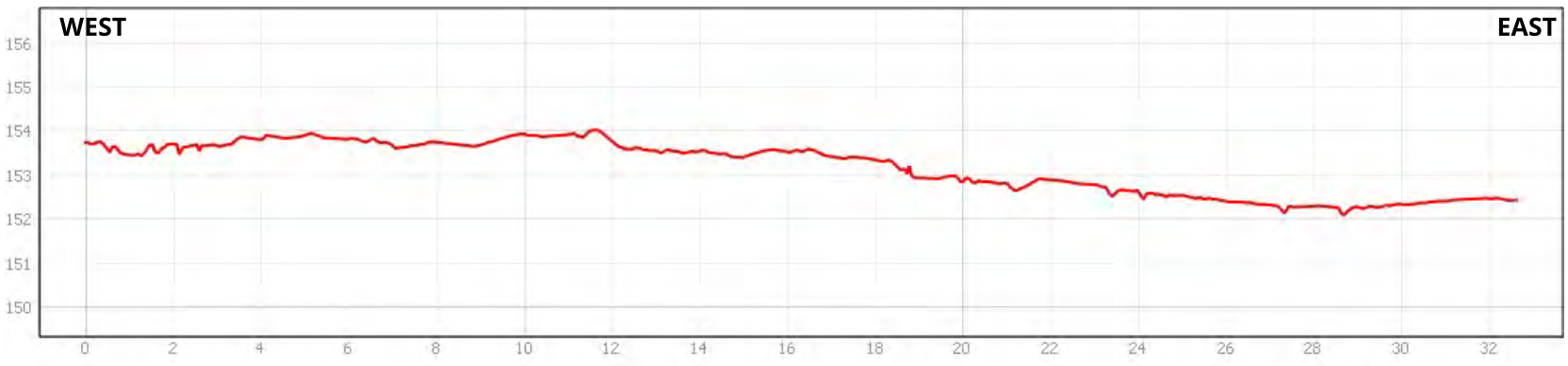
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

Profile Y axis = Elevation m aOD
Profile X Axis = Distance m aOD

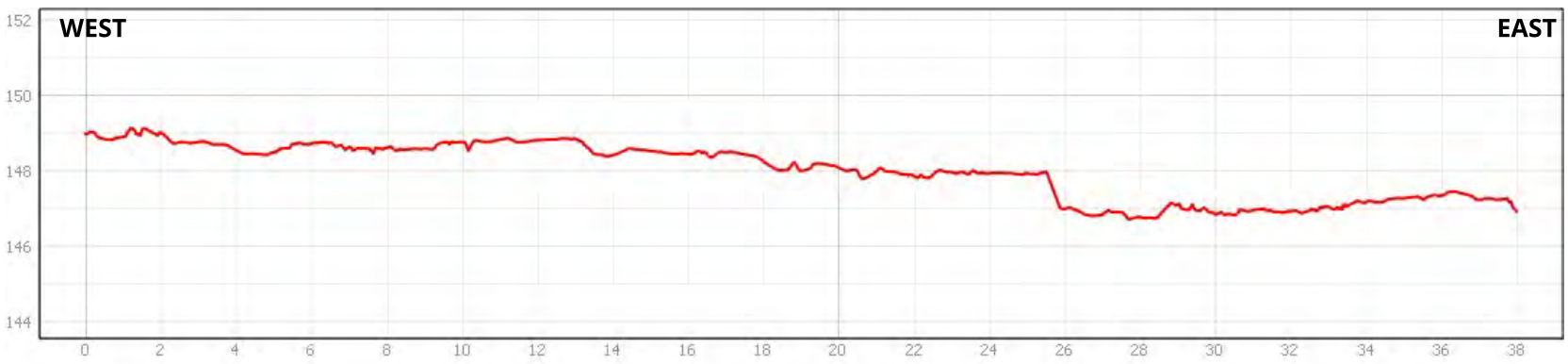
Spot Height	Value (m aOD)
138.1	163.76
138.2	163.62
139.1	163.93
139.2	163.71
140.1	163.39
140.2	163.48
141.1	163.1
141.2	162.94
142.1	156.04
142.2	155.39
143.1	161.19
143.2	161.08
144.1	158.99
144.2	159.28
145.1	152.99
145.2	152.62
146.1	151.68
146.2	151.67
147.1	156.44
147.2	156.19
148.1	154
148.2	154.02
149.1	153.75
149.2	153.45
150.1	152.18
150.2	151.82
151.1	152.4
151.2	152.43
152.1	149.61
152.2	149.27
153.1	148.11
153.2	148.43
154.1	147.76
154.2	147.1
155.1	148.87
155.2	147.27
156.1	148.64
156.2	148.06
157.1	146.3
157.2	146.43
158.1	146.53
158.2	146.11
159.1	146.62
159.2	146.06
160.1	146.27
160.2	145.52



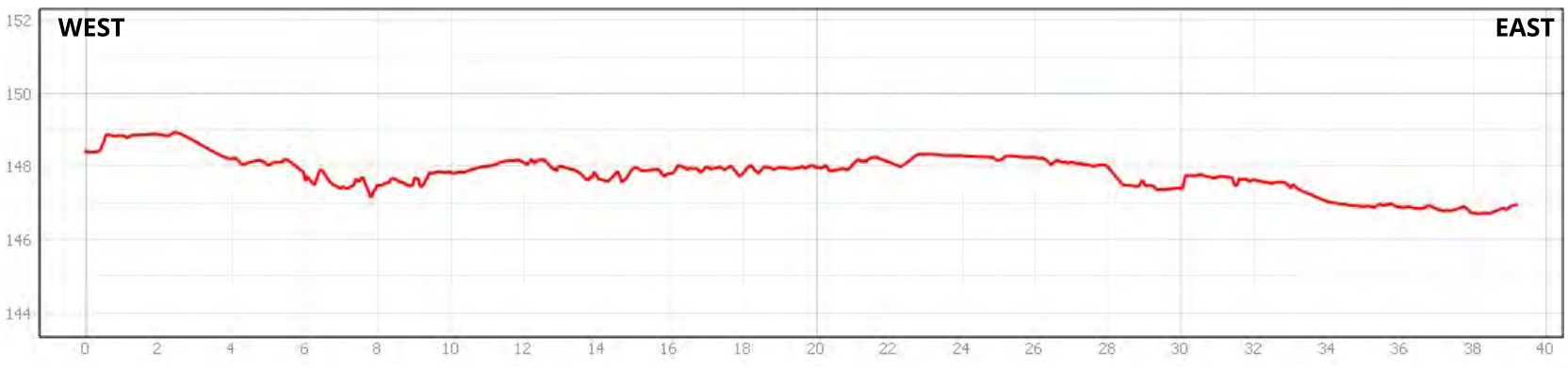
Profile 23



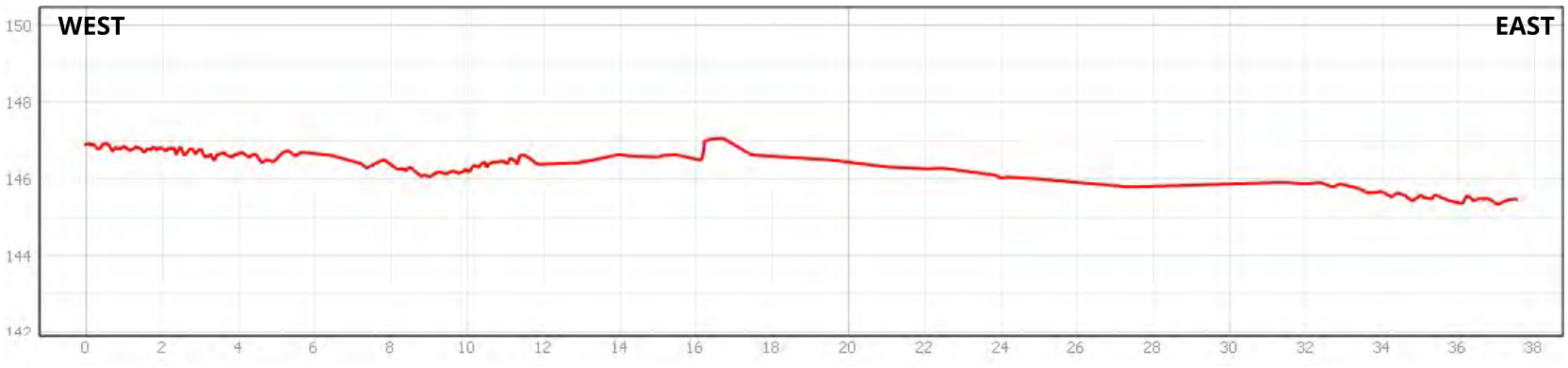
Profile 24



Profile 25



Profile 26

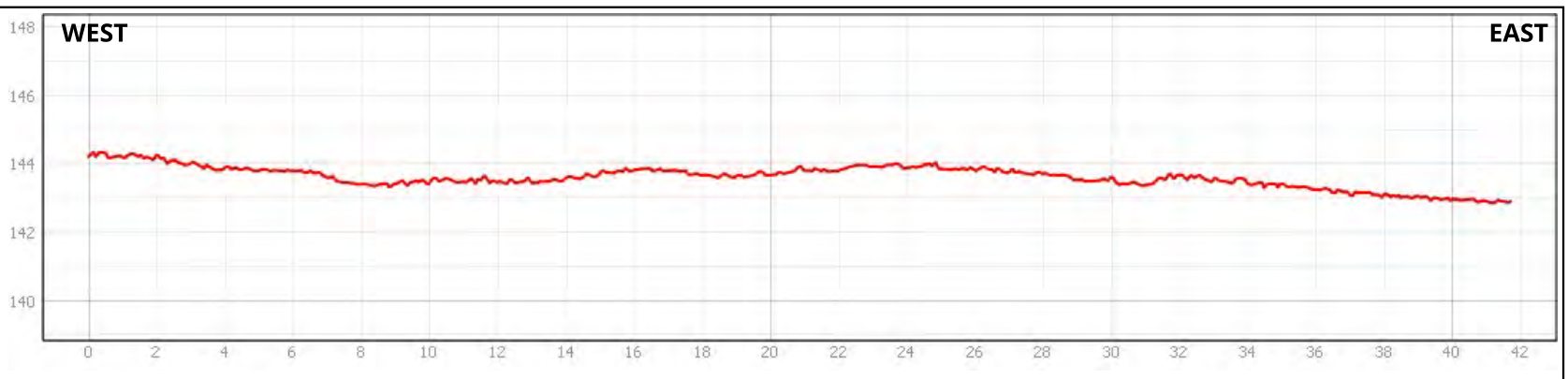


Profile 27

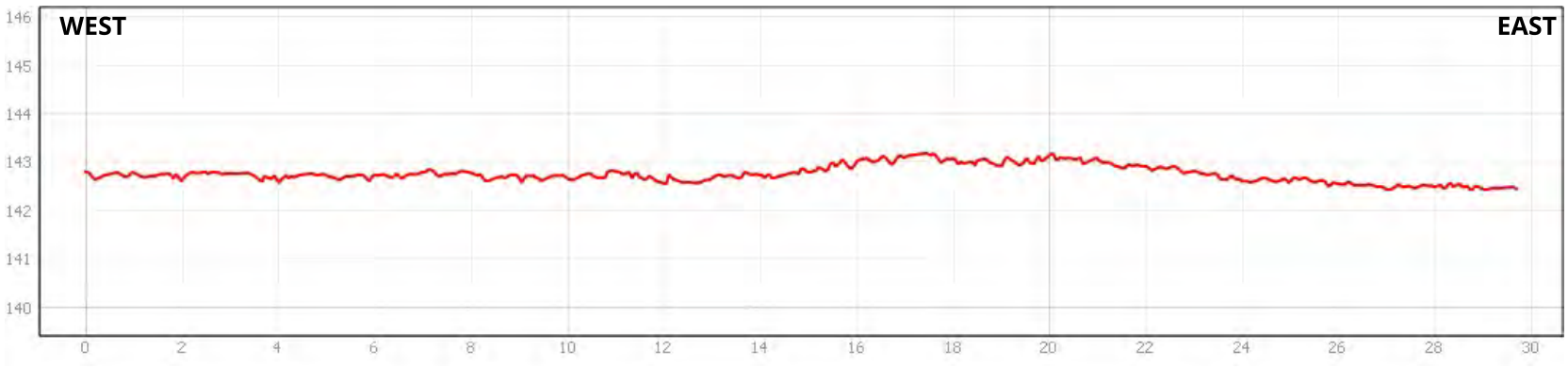
Project	Ryknield Street Roman Road	**Drawn**	SW
Client	ULAS	**Version**	1.0
Date	03/07/25	**Surveyed**	SW, SB
Job No.	SUMO-15842-1		

Profile Y axis = Elevation m aOD
Profile X Axis = Distance m aOD

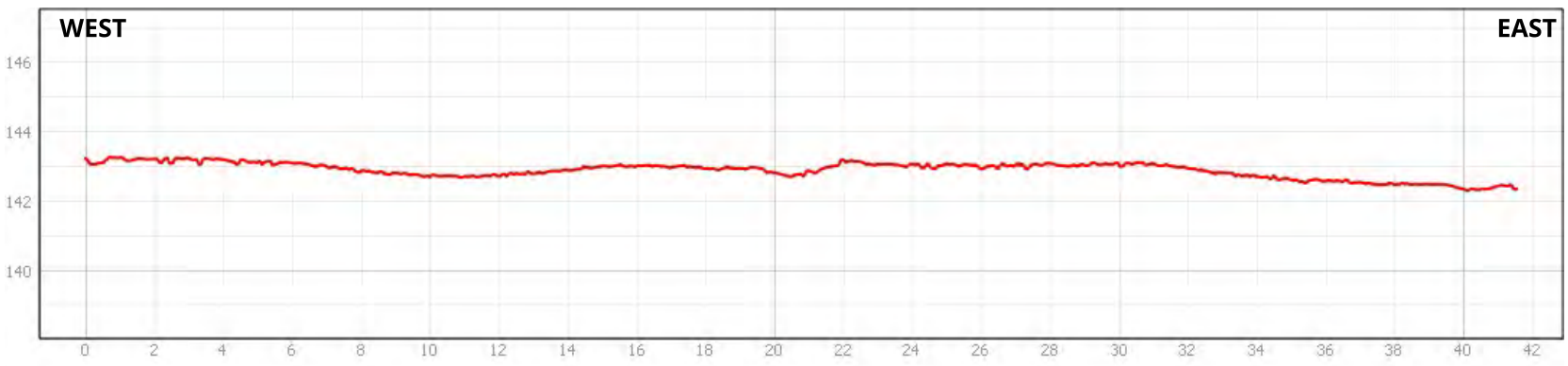
Spot Height	Value (m aOD)
161.1	144.27
161.2	143.88
162.1	144.23
162.2	143.8
163.1	144.25
163.2	143.45
164.1	143.87
164.2	143.41
165.1	142.5
165.2	142.71
166.1	142.89
166.2	142.65
167.1	143.28
167.2	143.27
168.1	142.12
168.2	142.18
169.1	142.49
169.2	142.72
170.1	142.7
170.2	142.77
172.1	142.47
172.2	142.76
173.1	143.01
173.2	142.74
174.1	143.11
174.2	142.82
175.1	143.29
175.2	143.17
176.1	142.59
176.2	142.33
177.1	141.88
177.2	142.03
178.1	141.98
178.2	141.78



Profile 28



Profile 29



Profile 30

Project	Ryknield Street Roman Road	**Drawn**	SW	Profile Y axis = Elevation m aOD Profile X Axis = Distance m aOD
Client	ULAS	**Version**	1.0	
Date	03/07/25	**Surveyed**	SW, SB	
Job No.	SUMO-15842-1			

Appendix 2 – Processing Reports

Roman Road, Sutton Park

Processing Report
07 February 2025

Survey Data

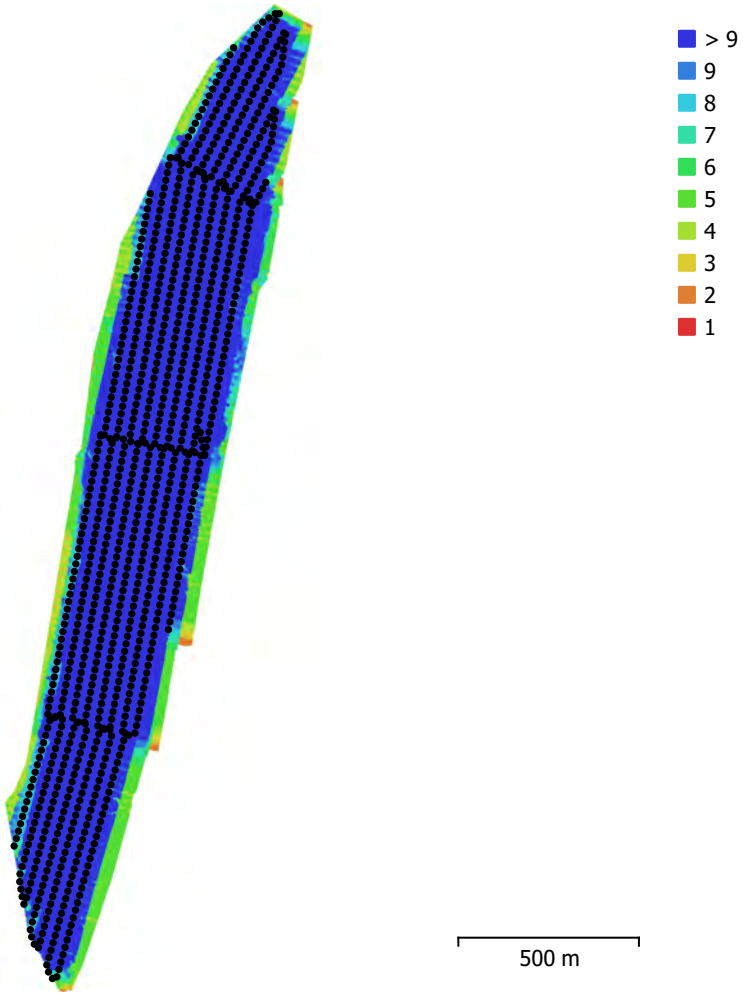


Fig. 1. Camera locations and image overlap.

Number of images:	1,015	Camera stations:	1,015
Flying altitude:	101 m	Tie points:	2,225,361
Ground resolution:	2.64 cm/pix	Projections:	8,348,999
Coverage area:	0.923 km²	Reprojection error:	1.66 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
M3M, 0.2 mm f/2.8 (12.2…	5280 x 3956	12.29 mm	3.36 x 3.36 µm	No

Table 1. Cameras.

Camera Calibration

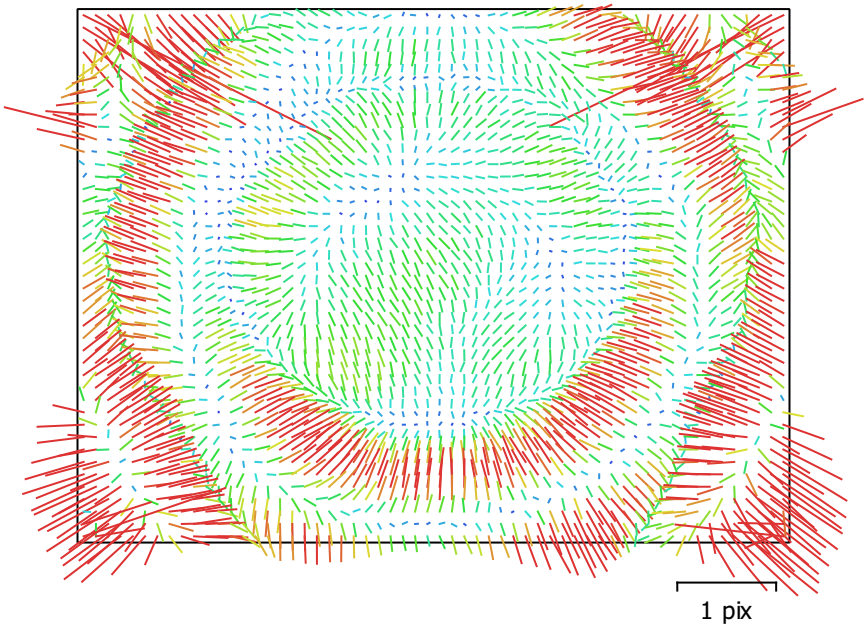


Fig. 2. Image residuals for M3M, 0.2 mm f/2.8 (12.29mm).

M3M, 0.2 mm f/2.8 (12.29mm)

1015 images

Type	Resolution	Focal Length	Pixel Size
Frame	**5280 x 3956**	**12.29 mm**	**3.36 x 3.36 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2
F	**3697.63**	0.22	1.00	0.26	-0.34	-0.03	-0.00	0.05	-0.38	0.48	-0.45	-0.09	0.08
Cx	**2.21891**	0.027		1.00	-0.09	-0.10	0.06	0.02	-0.11	0.13	-0.12	0.05	0.03
Cy	**-8.73992**	0.023			1.00	-0.03	-0.08	-0.02	0.13	-0.16	0.15	0.04	0.02
B1	**-0.836111**	0.0049				1.00	-0.00	0.02	-0.01	0.01	-0.01	0.02	0.01
B2	**0.125176**	0.0048					1.00	0.00	-0.00	0.00	-0.00	-0.03	0.02
K1	**0.0189765**	2.8e-05						1.00	-0.92	0.84	-0.81	-0.01	0.01
K2	**-0.254867**	0.00015							1.00	-0.98	0.96	0.04	-0.04
K3	**0.417583**	0.0003								1.00	-0.99	-0.05	0.05
K4	**-0.191383**	0.00019									1.00	0.04	-0.04
P1	**-0.000588488**	8.7e-07										1.00	0.01
P2	**-0.000332245**	7.4e-07											1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

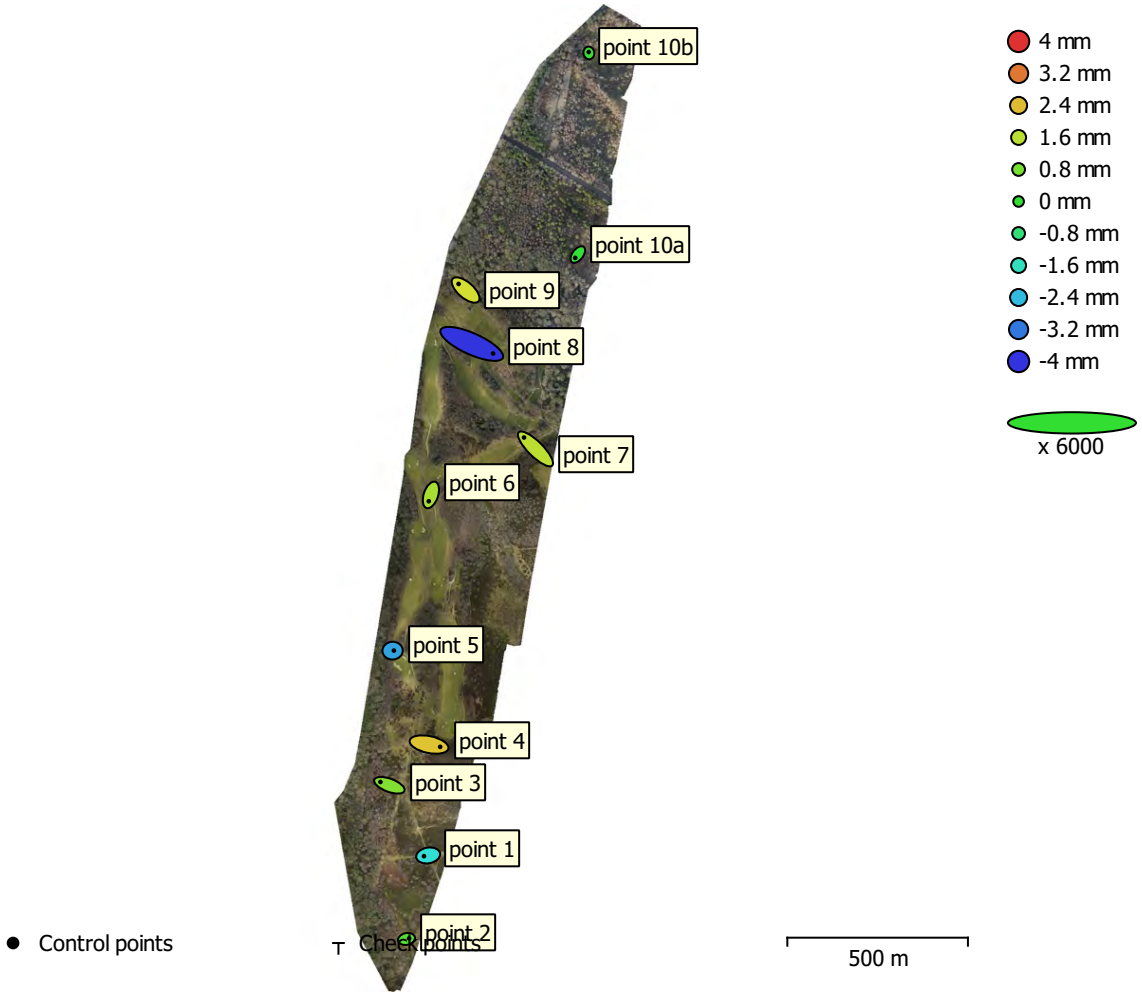


Fig. 3. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (mm)	Y error (mm)	Z error (mm)	XY error (mm)	Total (mm)
11	8.252	5.03361	1.92832	9.66606	9.85653

Table 3. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (mm)	Y error (mm)	Z error (mm)	Total (mm)	Image (pix)
point 1	-3.85006	-0.676408	-1.87695	4.33629	0.327 (9)
point 2	2.46884	0.551857	0.405898	2.56212	0.283 (8)
point 3	-8.24567	3.04711	0.924539	8.83916	0.289 (19)
point 4	10.2511	-2.1322	2.31618	10.7236	0.346 (20)
point 5	1.17355	0.0538334	-2.68079	2.9269	0.342 (14)
point 6	-1.97724	-5.81732	1.3763	6.29642	0.297 (15)
point 7	-10.5505	10.4801	1.61191	14.958	0.340 (23)
point 8	19.7659	-8.87167	-3.97048	22.0264	0.402 (24)
point 9	-6.47423	5.60599	1.88161	8.76831	0.298 (10)
point 10a	-2.41459	-3.09483	-0.0686093	3.92593	0.295 (12)
point 10b	-0.147142	0.853582	0.0804078	0.869896	0.429 (21)
Total	**8.252**	**5.03361**	**1.92832**	**9.85653**	**0.345**

Table 4. Control points.

X - Easting, Y - Northing, Z - Altitude.

Digital Elevation Model

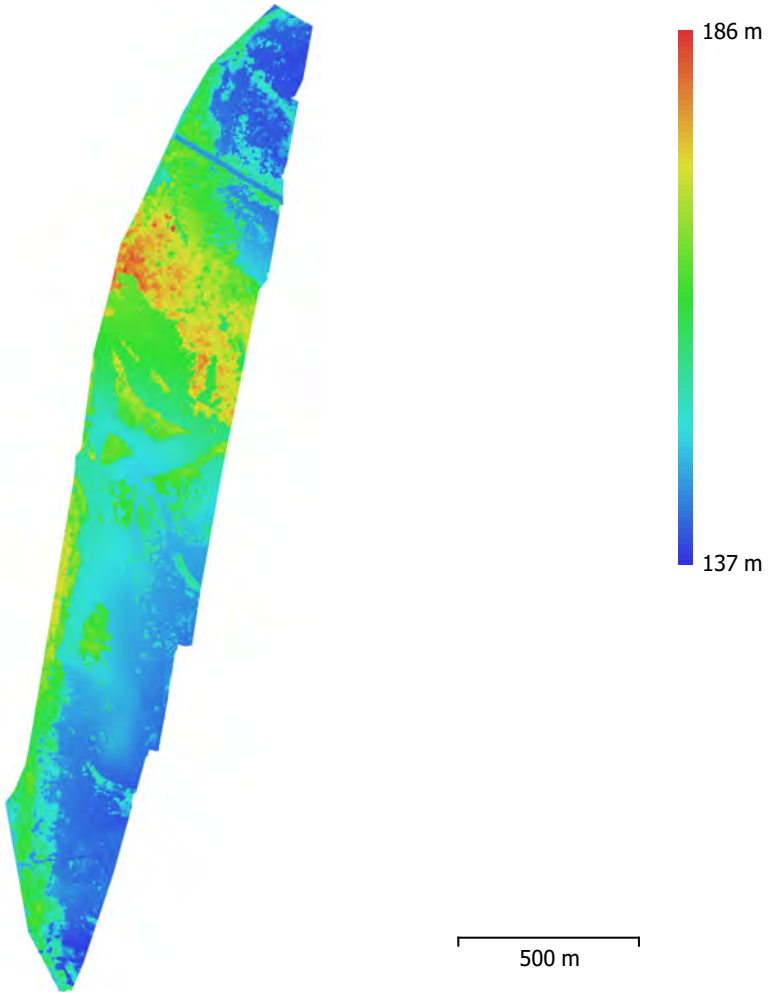


Fig. 4. Reconstructed digital elevation model.

Resolution:	46.7 cm/pix
Point density:	4.59 points/m²

Processing Parameters

General	
Cameras	1015
Aligned cameras	1015
Markers	11
Shapes	
Polygon	1
Coordinate system	WGS 84 (EPSG::4978)
Coordinate system	OSGB36 / British National Grid + ODN height (EPSG::7405)
Rotation angles	Yaw, Pitch, Roll
Tie Points	
Points	2,225,361 of 2,613,657
RMS reprojection error	0.152607 (1.65651 pix)
Max reprojection error	1.61186 (86.1065 pix)
Mean key point size	8.27408 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	3.89808
Alignment parameters	
Accuracy	Medium
Generic preselection	Yes
Reference preselection	No
Key point limit	1,000,000
Key point limit per Mpx	1,000,000
Tie point limit	1,000,000
Exclude stationary tie points	No
Guided image matching	Yes
Adaptive camera model fitting	No
Matching time	32 minutes 14 seconds
Matching memory usage	1.31 GB
Alignment time	13 minutes 29 seconds
Alignment memory usage	2.63 GB
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	27 seconds
Date created	2025:02:06 11:48:41
Software version	2.1.1.17821
File size	214.01 MB
Point Cloud	
Points	113,114,730
Point attributes	
Color	None
Normal	
Point classes	
Created (never classified)	113,114,730
Depth maps generation parameters	
Quality	Medium
Filtering mode	Mild
Max neighbors	16
Processing time	21 minutes 14 seconds

Memory usage	1.49 GB
Point cloud generation parameters	
Processing time	14 minutes 17 seconds
Memory usage	4.80 GB
Date created	2025:02:06 12:38:00
Software version	2.1.1.17821
File size	1.01 GB
Model	
Faces	4,688,393
Vertices	2,353,892
Vertex colors	3 bands, uint8
Texture	8,192 x 8,192 x 4, 4 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Mild
Max neighbors	16
Processing time	21 minutes 14 seconds
Memory usage	1.49 GB
Reconstruction parameters	
Surface type	Arbitrary
Source data	Depth maps
Interpolation	Enabled
Strict volumetric masks	No
Processing time	10 minutes 57 seconds
Memory usage	7.92 GB
Texturing parameters	
Mapping mode	Generic
Blending mode	Mosaic
Texture size	8,192
Enable hole filling	No
Enable ghosting filter	Yes
UV mapping time	4 minutes 37 seconds
UV mapping memory usage	2.34 GB
Blending time	9 minutes 11 seconds
Blending memory usage	22.61 GB
Date created	2025:02:06 12:48:49
Software version	2.1.1.17821
File size	654.35 MB
DEM	
Size	1,822 x 5,881
Coordinate system	OSGB36 / British National Grid + ODN height (EPSG::7405)
Reconstruction parameters	
Source data	Model
Interpolation	Enabled
Processing time	13 seconds
Memory usage	179.96 MB
Date created	2025:02:07 16:07:32
Software version	2.1.1.17821
File size	22.49 MB
Orthomosaic	
Size	7,287 x 23,523
Coordinate system	OSGB36 / British National Grid + ODN height (EPSG::7405)
Colors	3 bands, uint8
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM

Enable hole filling	Yes
Enable ghosting filter	No
Processing time	5 minutes 31 seconds
Memory usage	1.20 GB
Date created	2025:02:07 16:17:33
Software version	2.1.1.17821
File size	877.59 MB

System

Software name	Agisoft Metashape Professional
Software version	2.1.1 build 17821
OS	Windows 64 bit
RAM	255.68 GB
CPU	Intel(R) Xeon(R) W-2275 CPU @ 3.30GHz
GPU(s)	NVIDIA GeForce GTX 1660 Ti

Vantage UAV Drone Services	LiDAR UAV Data Acquisition Report	29/02/2025

1. Project Overview

General Information

Field	Details
Project Name	Sutton Roman Road
Client/Stakeholder	Sumo Services
Survey Location	Park Rd, The Royal Town of Sutton Coldfield, Birmingham, Sutton Coldfield B74 2YT
Survey Date	26/02/2025
Surveyor(s)	Jon White, Jon Love
Objective	Provide geometry for digitisation of archaeological features of interest on and around the Roman Road.
Flight Area	Approximately 75ha area, 150m offset width adjacent to the length road within the boundaries of the Sutton Park area. 

2. Equipment & Configuration

Hardware Specifications

Equipment	Model/Specifications
UAV Platform	DJI Matrice 300 RTK
LiDAR Sensor	YellowScan Surveyor ULTRA 2
GNSS/IMU System	Applanix APX15 IMU, AV18 GNSS Antenna
Additional Sensors	RGB Orthoimagery provided by Sumo Services for colourisation of the final point cloud deliverable
Ground Control Points (GCPs)	Ground Control Points provided by Sumo Services for cross referencing of elevation, Base Station and hard standing features utilised in validation of X&Y accuracy.
Base Station Used	eSurvey e500 GNSS Receiver
Reference Data Sources	See attached POSPac processing report for each flight's individual reference data, quality assessment, and validation.

3. Flight Planning & Execution

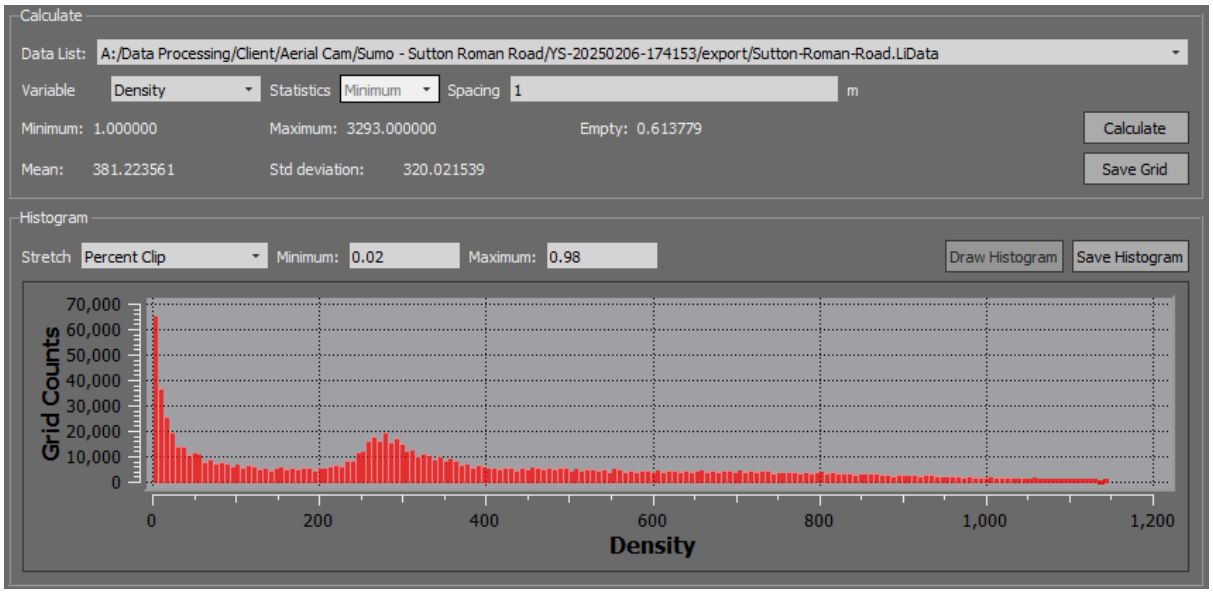
Mission Parameters

Flight Parameters	**Details**
Flight Planning Software	DJI Pilot 2
Flight Altitude (m AGL)	65m AGL smart terrain follow
Flight Speed (m/s)	5m/s
Overlap Settings	50% Horizontal Overlap
Scan Rate/Density	(Points per square meter or pulse repetition rate)
Number of Flight Lines	58 strips over 4 Flights
Total Flight Time (hh:mm:ss)	Strip Duration: 00:49:22 Flight Duration 1hr 15m +/-20m
Weather Conditions	Wind speeds: 2m/s Low, 9m/s High Gusting
Any Flight Issues	Battery set B displayed critical error, take-off postponed and faulty batteries isolated. Alternate battery sets deployed instead.

4. Data Collection & Logging

Acquisition Details

Data Collected	Details
Total LiDAR Points Collected	(Raw point cloud size, e.g., X billion points)
GNSS Observation Duration	(Minutes, if applicable)
Base Station Position	(Lat, Long, Ellipsoid Height, Datum)
GCP Data Collection	See Sumo Services GCP processing report.
Raw Data File Formats	.LAZ , .GeoTIFF
Raw Data Backup Location	Aetha NAS Storage (retained for 2 years, free retrieval) AWS Glacier S3 Deep Storage (retrieval fees apply after 2 years)



5. Data Processing Workflow

Processing Steps

Processing Workflow	Details
Software Used	Applanix POSPac v9.1, YellowScan CloudStation v2502.0.1, GreenValley International LIDAR360 v7.2
GNSS/IMU Data Processing	PPK workflow, corrections and lever arms applied, SBET file generation
Point Cloud Preprocessing	Georeferencing, strip alignment, strip overlap removal, low point removal, noise filtering
Ground Classification	Bare Earth filtering method – automated
Point Cloud Classification	Ground, Unclassified
DEM/DSM/DTM Generation	5cm grid, Spike-free TIN interpolation
Accuracy Assessment	(RMSE calculation, checkpoint validation, comparison with ground truth data)
Final Data File Formats	.LAZ, .GeoTIFF
Final Data Storage Location	Deliverable as direct data transfer link to Sumo Service, available at Raw Data Backup Locations seen in item 4.Data Collection & Logging

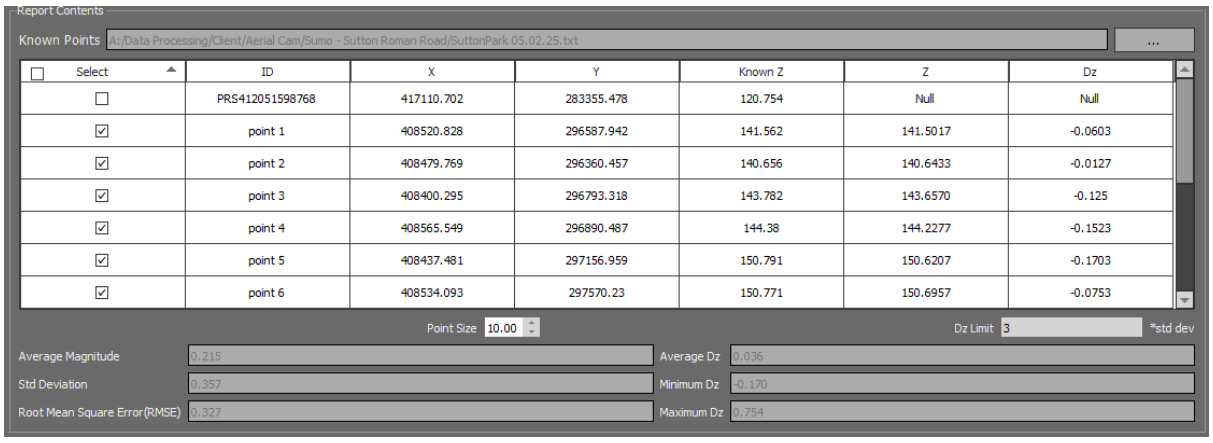
6. Deliverables & Quality Assessment

Final Outputs

Deliverable	Status (/)
Point Cloud (.las/.laz)	
DEM/DSM (.tif)	
Contours (.shp/.dwg)	
Classified Point Cloud (.las)	
Orthoimage (.tif, if applicable)	
Flight Report (.pdf)	

Accuracy Metrics

Metric	Results
GCP RMSE (XYZ error values)	0.327m not excluding those outside the LIDAR boundary 0.099m with outliers removed
Relative Accuracy Check	See strip alignment report .pdfs for strip-to-strip alignment reporting.



7. Summary & Recommendations

Final Assessment

Summary Aspects	Details
Overall Data Quality Assessment	Higher than anticipated deviation from GCPs was experienced in preliminary processing due to an incomplete GNSS observables cycle on the final flight. Correction to nearest cloud and GCPs yields less than ideal results, but still within tolerance for the feature analysis to be performed.
Challenges Encountered	Battery failure and vehicle access limitations posed time delays on-site, however were overcome by conducting a post-sunset flight to capture the remaining region to ensure timeframes were met.
Lessons Learned & Recommendations	Despite rigorous battery testing and charge cycle awareness, precautions will continue to be taken pertaining to safe LiPo operation, particularly regarding their volatility and sensitivity to cold weather conditions.

Prepared by: Jon White
Date: 03/03/2025
Reviewed by: Jon Love
Final Approval: 03/03/2025

YellowScan

Strip Adjustment Report

Instrument details

Type / model	YellowScan Surveyor Ultra
Serial number	SB100010

Main measures

Misadjustment	GCPs misadjustment
0.088m ➞ 0.067m	0.113m ➞ 0.140m

Project summary

Flight name	YS-20250206-143232
Trajectory file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-143232/GNSS PostProcess/postprocess_20250218-122623/YS-20250206-143232sbet.txt
LiDAR file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-143232/YS-20250206-143232.hesai
Number of strips	17
Flight name	YS-20250206-154148
Trajectory file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-154148/GNSS PostProcess/postprocess_20250218-122623/YS-20250206-154148sbet.txt
LiDAR file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-154148/YS-20250206-154148.hesai
Number of strips	11
Flight name	YS-20250206-162908
Trajectory file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-162908/GNSS PostProcess/postprocess_20250218-122623/YS-20250206-162908sbet.txt
LiDAR file	A:/Data Processing/Client/Aerial Cam/Sumo - Sutton Roman Road/YS-20250206-162908/YS-20250206-162908.hesai
Number of strips	13

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YellowScan

Strip adjustment results

Method

Iterations	3
Adjustment method	Robust

Strip misadjustment

	Mean		STDDEV		RMSE	
	Initial	Final	Initial	Final	Initial	Final
Global	0.088	0.067	0.072	0.055	0.114	0.086

Strip-to-strip measurements

	Mean		STDDEV		RMSE	
Strip	Initial	Final	Initial	Final	Initial	Final
Flight YS-20250206-143232						
S1	0.093	0.070	0.074	0.056	0.119	0.090
S2	0.086	0.066	0.071	0.055	0.112	0.086
S3	0.089	0.069	0.073	0.056	0.115	0.089
S4	0.089	0.071	0.073	0.057	0.115	0.091
S5	0.087	0.068	0.072	0.055	0.113	0.087
S6	0.087	0.067	0.071	0.054	0.112	0.086
S7	0.079	0.061	0.067	0.052	0.104	0.080
S8	0.081	0.059	0.068	0.050	0.106	0.078
S9	0.079	0.057	0.065	0.050	0.102	0.076
S10	0.079	0.055	0.066	0.048	0.103	0.073
S11	0.082	0.055	0.067	0.048	0.105	0.073
S12	0.082	0.061	0.068	0.051	0.107	0.080
S13	0.078	0.058	0.064	0.048	0.101	0.075
S14	0.082	0.060	0.073	0.050	0.110	0.078
S15	0.079	0.057	0.068	0.049	0.104	0.075
S16	0.086	0.061	0.073	0.051	0.112	0.079
S17	0.076	0.061	0.066	0.052	0.101	0.081
Flight YS-20250206-154148						
S1	0.083	0.061	0.069	0.053	0.108	0.081
S2	0.084	0.062	0.070	0.053	0.110	0.082

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	Mean		STDDEV		RMSE	
Strip	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
S3	0.085	0.065	0.068	0.054	0.109	0.084
S4	0.088	0.064	0.071	0.053	0.113	0.083
S5	0.087	0.064	0.070	0.053	0.112	0.083
S6	0.094	0.070	0.075	0.056	0.120	0.089
S7	0.096	0.071	0.075	0.056	0.122	0.090
S8	0.102	0.075	0.078	0.058	0.129	0.095
S9	0.092	0.072	0.072	0.056	0.117	0.091
S10	0.097	0.075	0.075	0.059	0.123	0.095
S11	0.095	0.070	0.074	0.056	0.120	0.090
Flight YS-20250206-162908						
S1	0.087	0.061	0.072	0.053	0.113	0.080
S2	0.085	0.065	0.072	0.054	0.111	0.084
S3	0.099	0.065	0.079	0.054	0.127	0.084
S4	0.086	0.064	0.072	0.053	0.112	0.083
S5	0.091	0.064	0.075	0.054	0.118	0.083
S6	0.088	0.068	0.074	0.054	0.115	0.087
S7	0.088	0.061	0.075	0.053	0.116	0.081
S8	0.082	0.058	0.072	0.052	0.109	0.078
S9	0.088	0.057	0.075	0.052	0.115	0.077
S10	0.084	0.060	0.073	0.052	0.111	0.080
S11	0.096	0.063	0.076	0.055	0.122	0.083
S12	0.086	0.069	0.074	0.057	0.113	0.089
S13	0.080	0.067	0.068	0.055	0.105	0.087

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Ground control points

Usage

Number of usable GCPs	7
Total provided	14

GCPs misadjustment

		MEAN		STDDEV		RMSE	
Strip	**# GCPs used**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Global	7	0.113	0.140	0.110	0.217	0.158	0.258

Strip-to-GCPs misadjustment

		MEAN		STDDEV		RMSE	
Strip	**# GCPs used**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Flight YS-20250206-143232							
Strip 1	2	0.088	0.035	0.015	0.019	0.089	0.040
Strip 2	2	0.189	0.195	0.114	0.161	0.221	0.253
Strip 3	1	0.043	0.087	0.000	0.000	0.043	0.087
Strip 4	1	0.106	0.100	0.000	0.000	0.106	0.100
Strip 5	2	0.087	0.082	0.047	0.064	0.099	0.104
Strip 6	2	0.058	0.029	0.055	0.024	0.080	0.038
Strip 7	1	0.019	0.093	0.000	0.000	0.019	0.093
Strip 8	1	0.067	0.067	0.000	0.000	0.067	0.067
Strip 9	1	0.124	0.084	0.000	0.000	0.124	0.084
Strip 10	1	0.006	0.024	0.000	0.000	0.006	0.024
Strip 11	1	0.340	0.346	0.000	0.000	0.340	0.346
Strip 12	1	0.069	0.010	0.000	0.000	0.069	0.010
Strip 13	1	0.034	0.024	0.000	0.000	0.034	0.024
Strip 14	1	0.015	0.040	0.000	0.000	0.015	0.040
Strip 15	1	0.059	0.042	0.000	0.000	0.059	0.042
Strip 16	1	0.053	0.164	0.000	0.000	0.053	0.164
Strip 17	2	0.103	0.026	0.046	0.024	0.113	0.036
Flight YS-20250206-154148							

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		MEAN		STDDEV		RMSE	
Strip	# GCPs used	Initial	Final	Initial	Final	Initial	Final
Strip 1	2	0.088	0.035	0.015	0.019	0.089	0.040
Strip 2	2	0.189	0.195	0.114	0.161	0.221	0.253
Strip 3	1	0.043	0.087	0.000	0.000	0.043	0.087
Strip 4	1	0.106	0.100	0.000	0.000	0.106	0.100
Strip 5	2	0.087	0.082	0.047	0.064	0.099	0.104
Strip 6	2	0.058	0.029	0.055	0.024	0.080	0.038
Strip 7	1	0.019	0.093	0.000	0.000	0.019	0.093
Strip 8	1	0.067	0.067	0.000	0.000	0.067	0.067
Strip 9	1	0.124	0.084	0.000	0.000	0.124	0.084
Strip 10	1	0.006	0.024	0.000	0.000	0.006	0.024
Strip 11	1	0.340	0.346	0.000	0.000	0.340	0.346
Flight YS-20250206-162908							
Strip 1	2	0.088	0.035	0.015	0.019	0.089	0.040
Strip 2	2	0.189	0.195	0.114	0.161	0.221	0.253
Strip 3	1	0.043	0.087	0.000	0.000	0.043	0.087
Strip 4	1	0.106	0.100	0.000	0.000	0.106	0.100
Strip 5	2	0.087	0.082	0.047	0.064	0.099	0.104
Strip 6	2	0.058	0.029	0.055	0.024	0.080	0.038
Strip 7	1	0.019	0.093	0.000	0.000	0.019	0.093
Strip 8	1	0.067	0.067	0.000	0.000	0.067	0.067
Strip 9	1	0.124	0.084	0.000	0.000	0.124	0.084
Strip 10	1	0.006	0.024	0.000	0.000	0.006	0.024
Strip 11	1	0.340	0.346	0.000	0.000	0.340	0.346
Strip 12	1	0.069	0.010	0.000	0.000	0.069	0.010
Strip 13	1	0.034	0.024	0.000	0.000	0.034	0.024

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GCPs misadjustment distribution

GCP id	Strip #	Misadjustment	
		Initial	Final
point 1	5	0.040	0.018
	6	0.003	0.005
	7	-0.019	-0.093
	8	-0.067	-0.067
	9	-0.124	-0.084
	10	0.006	0.024
point 2	11	0.340	0.346
	12	0.069	-0.010
	13	0.034	-0.024
	14	-0.015	-0.040
	15	-0.059	-0.042
	16	0.053	0.164
	17	0.057	0.001
point 3	1	0.073	-0.016
	2	-0.076	-0.034
	3	-0.043	-0.087
	4	-0.106	-0.100
	5	-0.134	-0.146
	6	0.113	0.054
	17	-0.149	-0.050
	26	0.165	-0.117
	27	0.061	-0.088
	28	-0.074	-0.323
point 4	1	-0.103	-0.054
	2	-0.303	0.356
	23	0.481	0.731
	24	0.419	0.091
	25	-0.074	-0.121
	26	-0.154	-0.033
	27	-0.443	-0.105
	28	0.037	1.365

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GCP id	Strip #	Misadjustment	
		Initial	Final
point 5	19	-0.060	-0.161
	20	-0.069	-0.160
	21	-0.115	-0.160
	22	-0.132	-0.129
	23	-0.095	-0.054
	28	0.013	0.093
point 6	33	-0.092	-0.101
	34	-0.053	-0.075
	35	-0.107	-0.121
	36	-0.182	-0.128
	37	-0.065	-0.179
	41	-0.209	-0.091
point 7	37	-0.061	0.089
	38	-0.031	-0.129
	39	-0.069	-0.091
	40	-0.080	-0.033

YellowScan

Initial mounting parameters

Boresight angles (°) per laser beam

Laser number	Roll	Pitch	Heading	Laser number	Roll	Pitch	Heading
1	0.200°	0.144°	0.293°	**17**	0.043°	0.138°	0.343°
2	0.181°	0.141°	0.295°	**18**	0.028°	0.140°	0.345°
3	0.161°	0.136°	0.291°	**19**	0.009°	0.142°	0.343°
4	0.140°	0.140°	0.306°	**20**	-0.009°	0.141°	0.347°
5	0.119°	0.142°	0.302°	**21**	-0.035°	0.143°	0.350°
6	0.099°	0.141°	0.307°	**22**	-0.054°	0.142°	0.348°
7	0.077°	0.142°	0.307°	**23**	-0.067°	0.144°	0.348°
8	0.058°	0.137°	0.307°	**24**	-0.085°	0.137°	0.349°
9	0.038°	0.137°	0.310°	**25**	-0.104°	0.145°	0.351°
10	0.016°	0.142°	0.315°	**26**	-0.116°	0.146°	0.343°
11	-0.004°	0.135°	0.328°	**27**	-0.134°	0.152°	0.342°
12	-0.022°	0.132°	0.329°	**28**	-0.149°	0.153°	0.343°
13	-0.042°	0.137°	0.330°	**29**	-0.162°	0.155°	0.340°
14	-0.061°	0.131°	0.336°	**30**	-0.177°	0.159°	0.342°
15	-0.081°	0.134°	0.330°	**31**	-0.191°	0.150°	0.336°
16	-0.099°	0.137°	0.338°	**32**	-0.208°	0.151°	0.342°

Generated on 2025-02-19T16:07:32, with YellowScan CloudStation.

MEAN: MEAN value of absolute errors

STDDEV: STandard DEViation of absolute errors

RMSE: Root Mean Square Error of absolute errors

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General Information

Mission Information

Project name	YS-20250206-143232
Processing date	2025-02-18 12:27:10
Mission date	2025-02-06 14:32:55
Mission duration	00:20:46.000
Processing mode	IN-Fusion Single Base
GPS Station	base

Rover Hardware Information

Product	APX 15 AVX 210
Dynamic Model	Airborne Rotor
Serial number	6202C16694
IMU type	59
Receiver type	APX-15v3
Antenna type	AV18

Project File List

Rover Data Files

File name	File type
YS-20250206-143232.t04	T04 Rover Data

Input Files

File Name	File Type
BRDC00IGN_R_20250370000_01D_MN.rnx	GPS, GLONASS, GALILEO Broadcast Ephemeris
Ephm0370.25g	GLONASS Broadcast Ephemeris
Ephm0370.25n	GPS Broadcast Ephemeris
base0374.25O	GNSS SingleBase

Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
YS-20250206-143232sbet.txt	ASCII Export Output

Rover Data Summary

First raw data file	YS-20250206-143232.t04		
Last raw data file	YS-20250206-143232.t04		
Start GPS week	2352		
Start time	397975.000 (02/06/2025 14:32:55)		
End time	399221.000 (02/06/2025 14:53:41)		
Start of fine alignment	398040.090 (02/06/2025 14:34:00)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
IMU Installation Lever Arms & Mounting Angles			
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.050	0.120	-0.510
Reference to Primary GNSS lever arm std dev (m)	0.020		
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

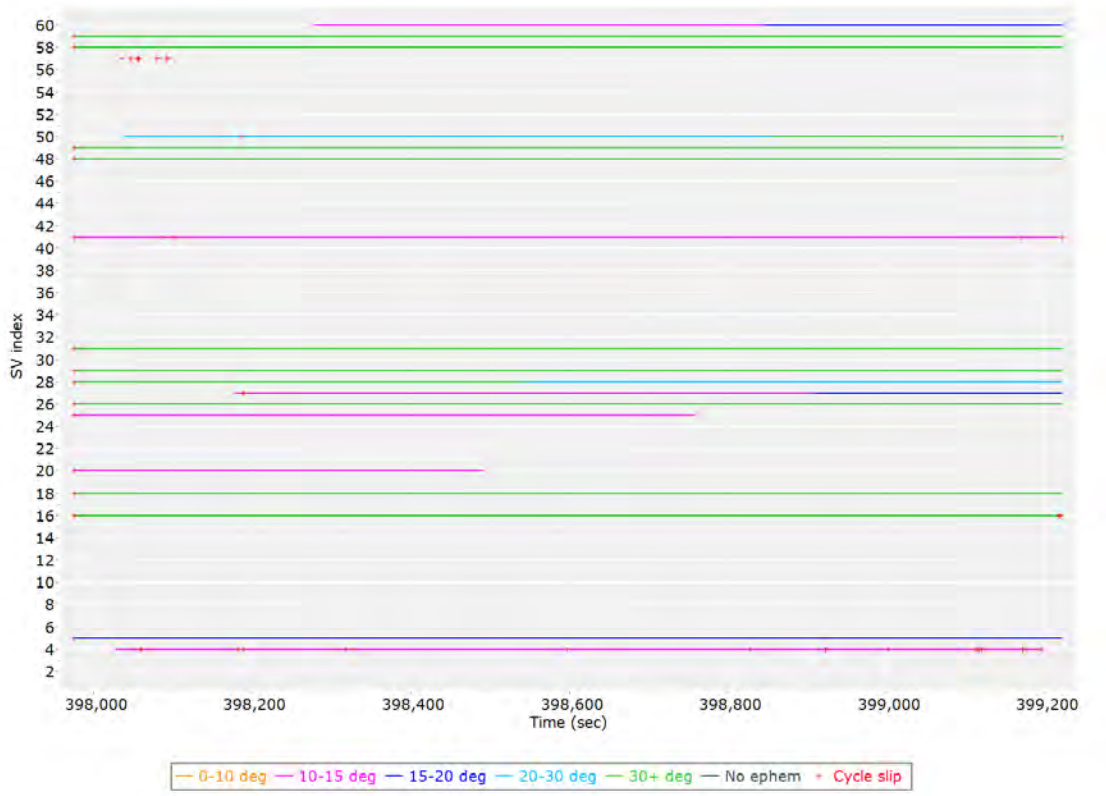
Rover Data QC

Raw IMU Import QC Summary

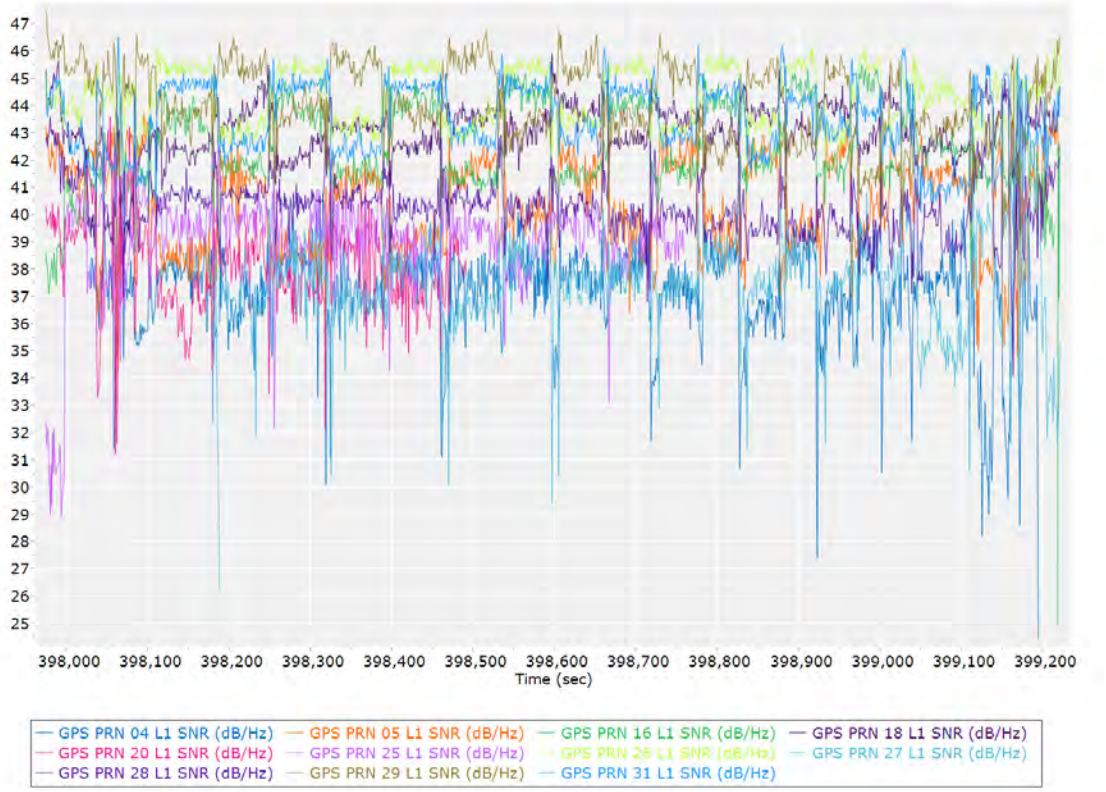
IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	249245
Termination Status	Normal
IMU Anomalies	0

Primary Observables & Satellite Data

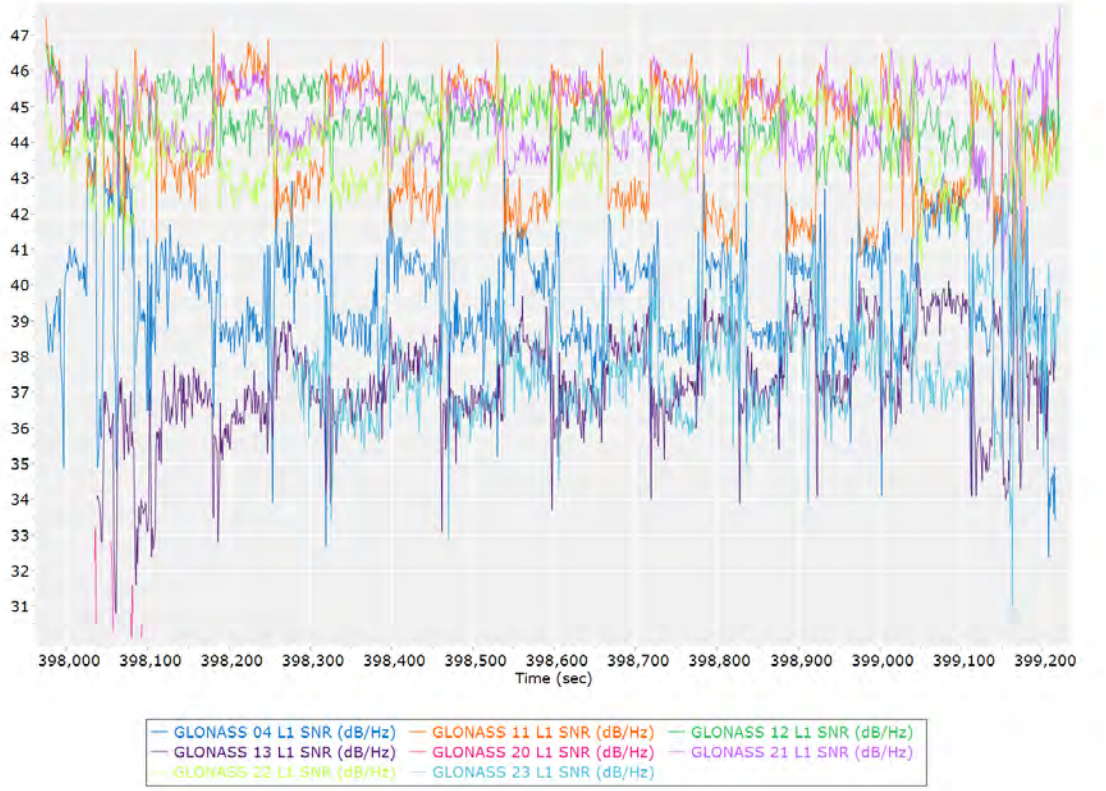
GPS/GLONASS L1 Satellite Lock/Elevation



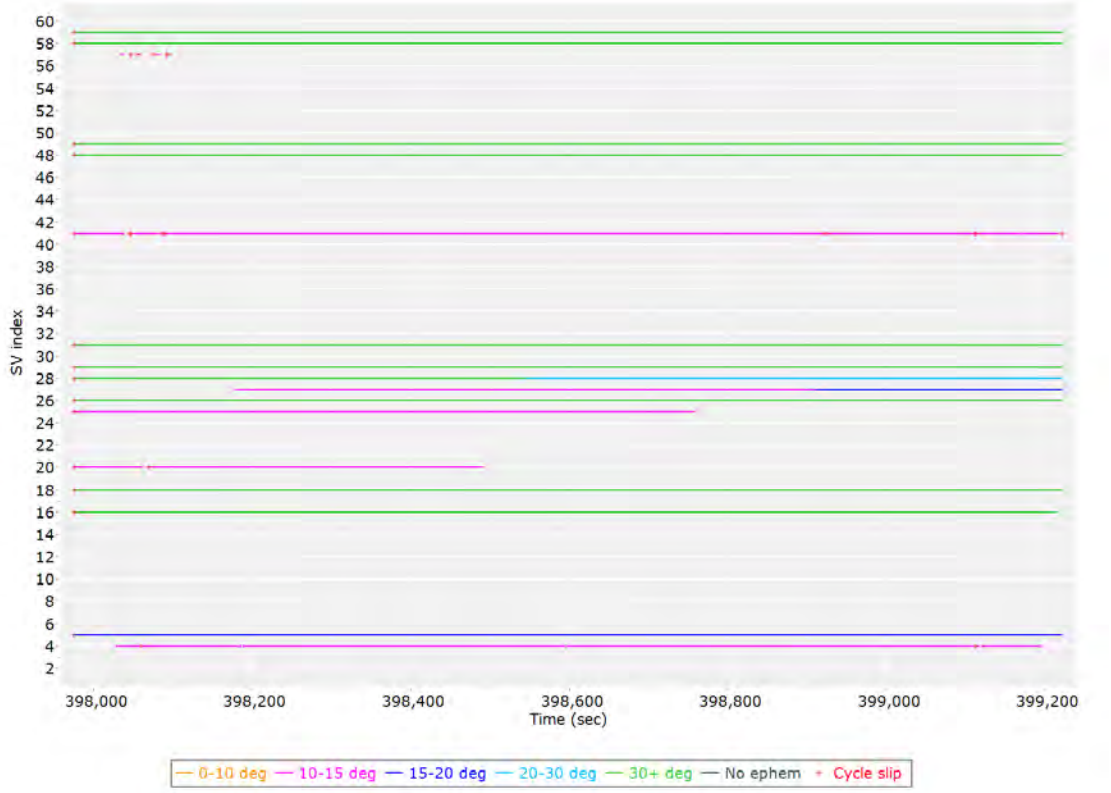
GPS L1 SNR



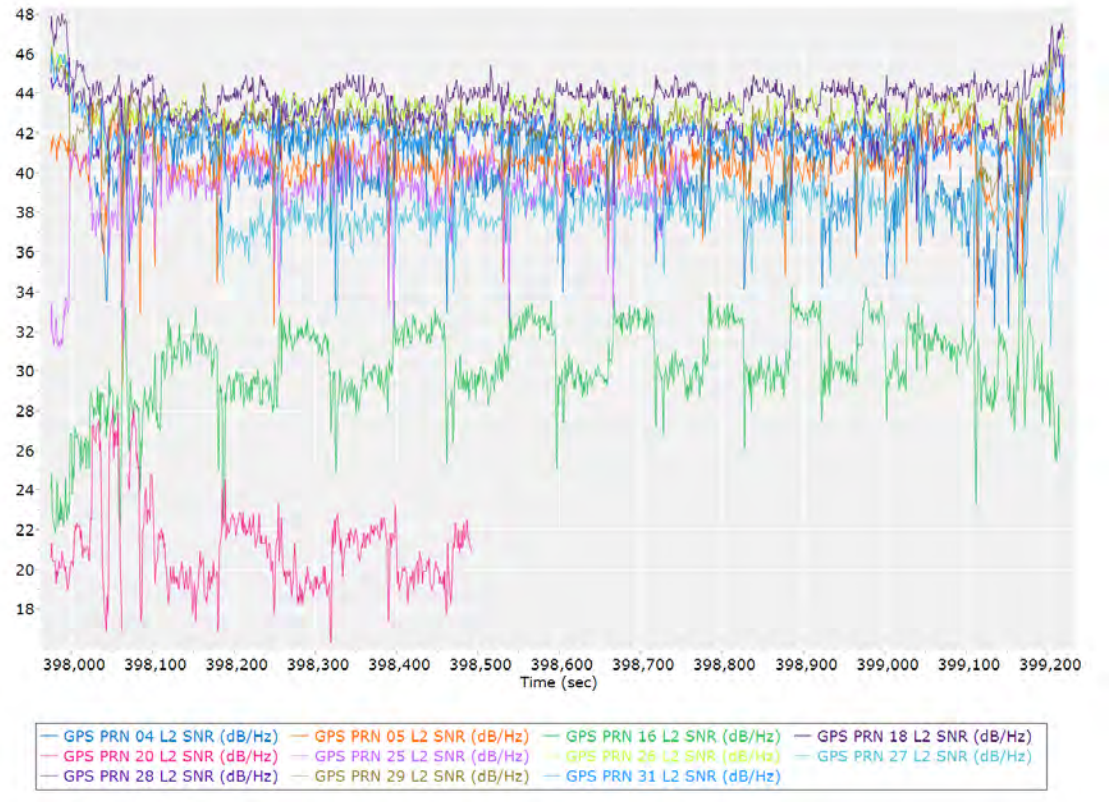
GLONASS L1 SNR



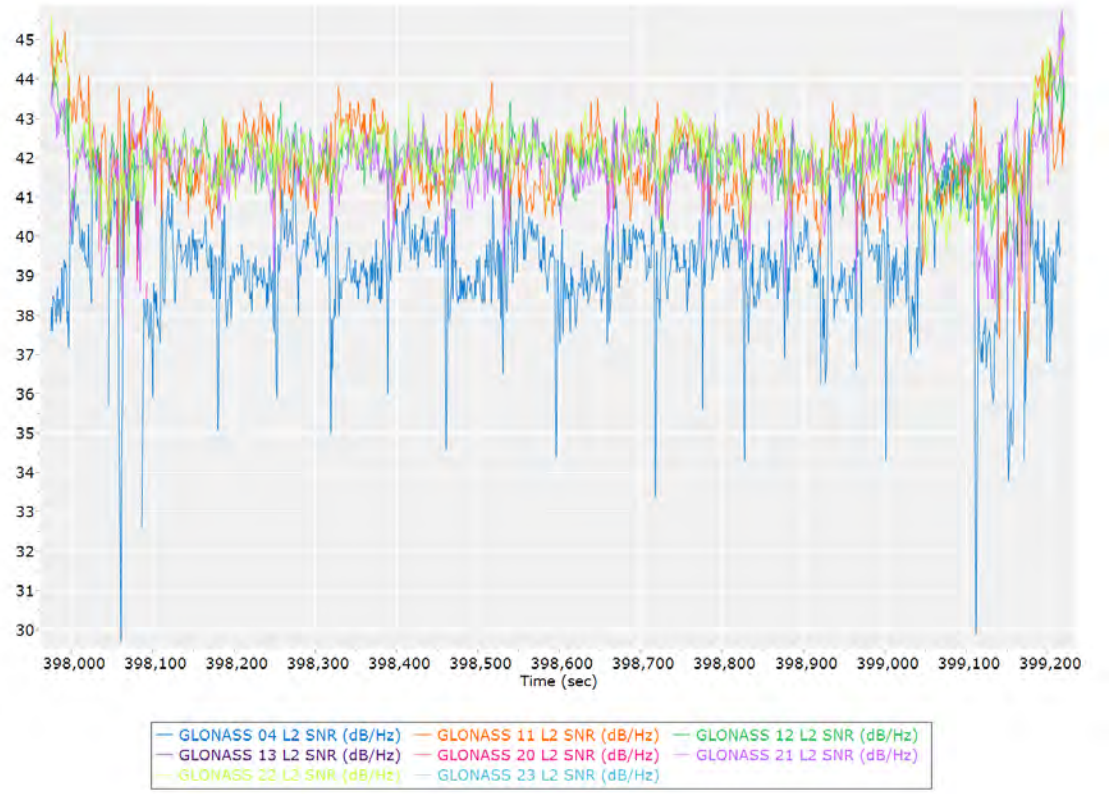
GPS/GLONASS L2 Satellite Lock/Elevation



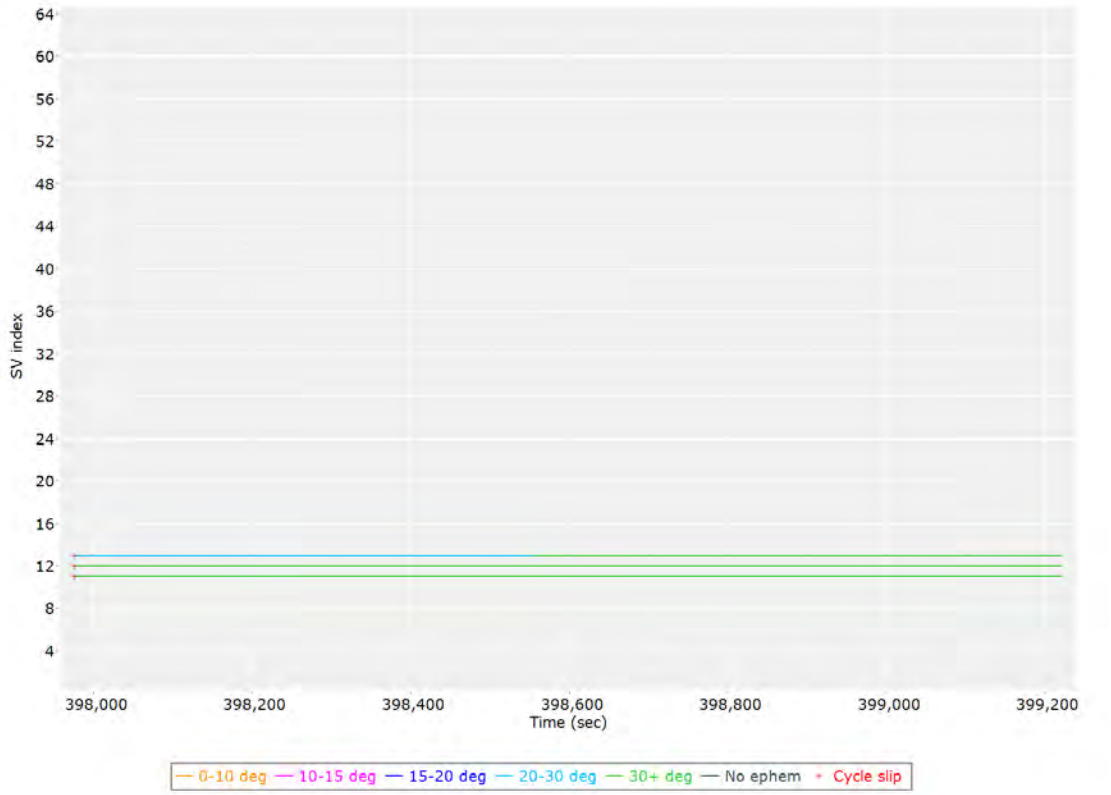
GPS L2 SNR



GLONASS L2 SNR

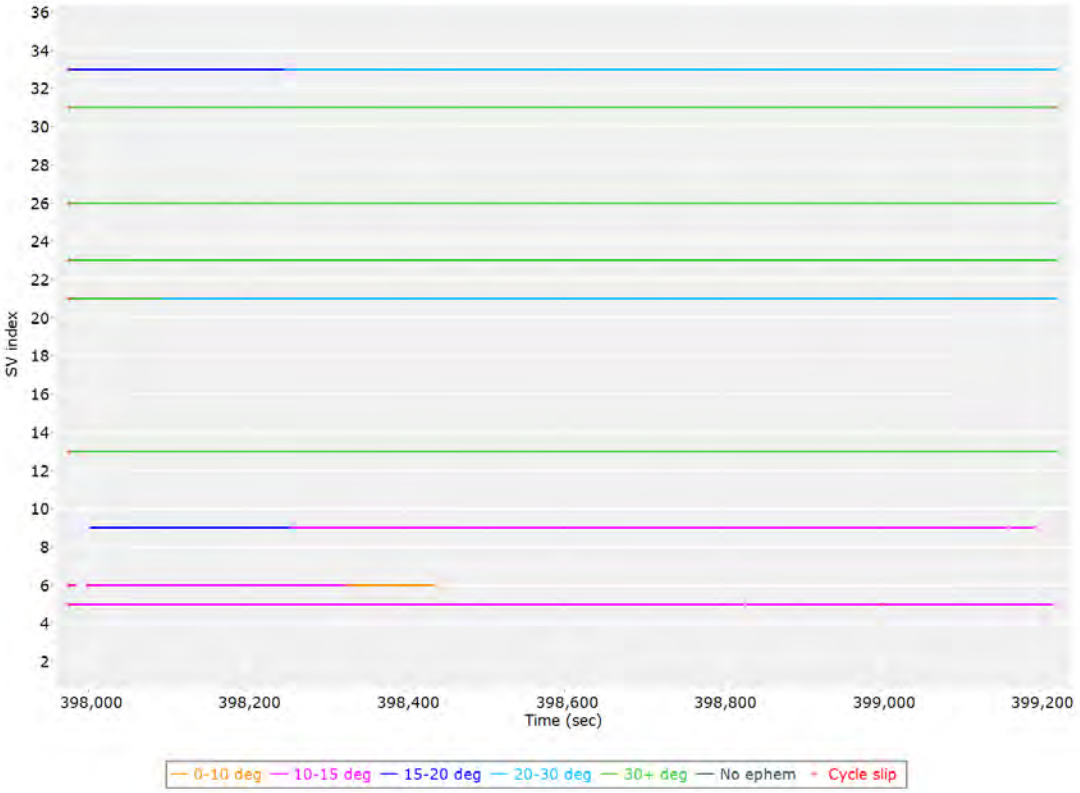


BEIDOU Satellite Lock/Elevation

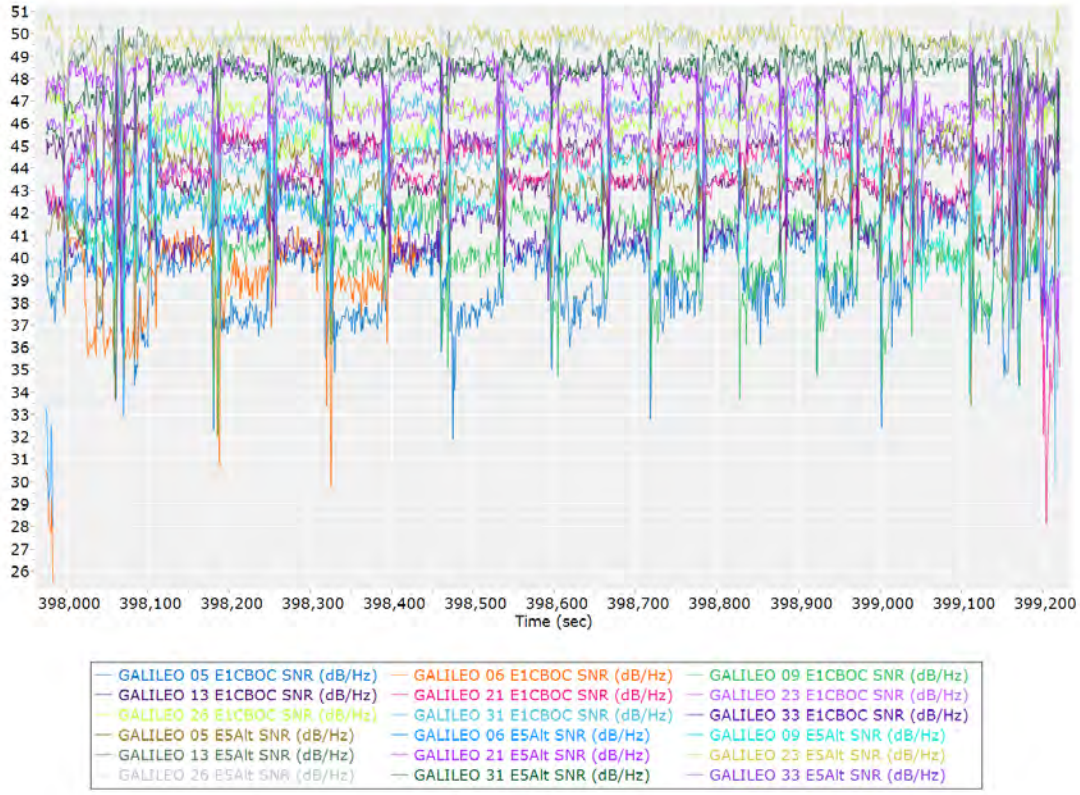


BEIDOU SNR

GALILEO Satellite Lock/Elevation



GALILEO SNR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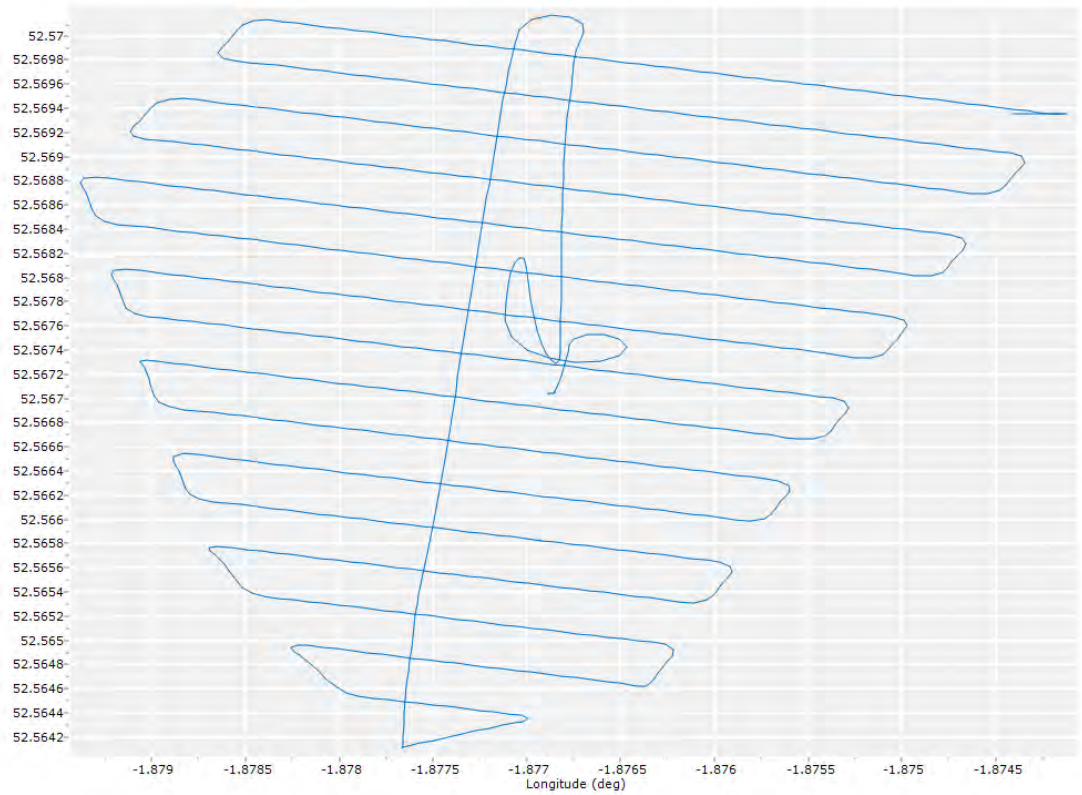
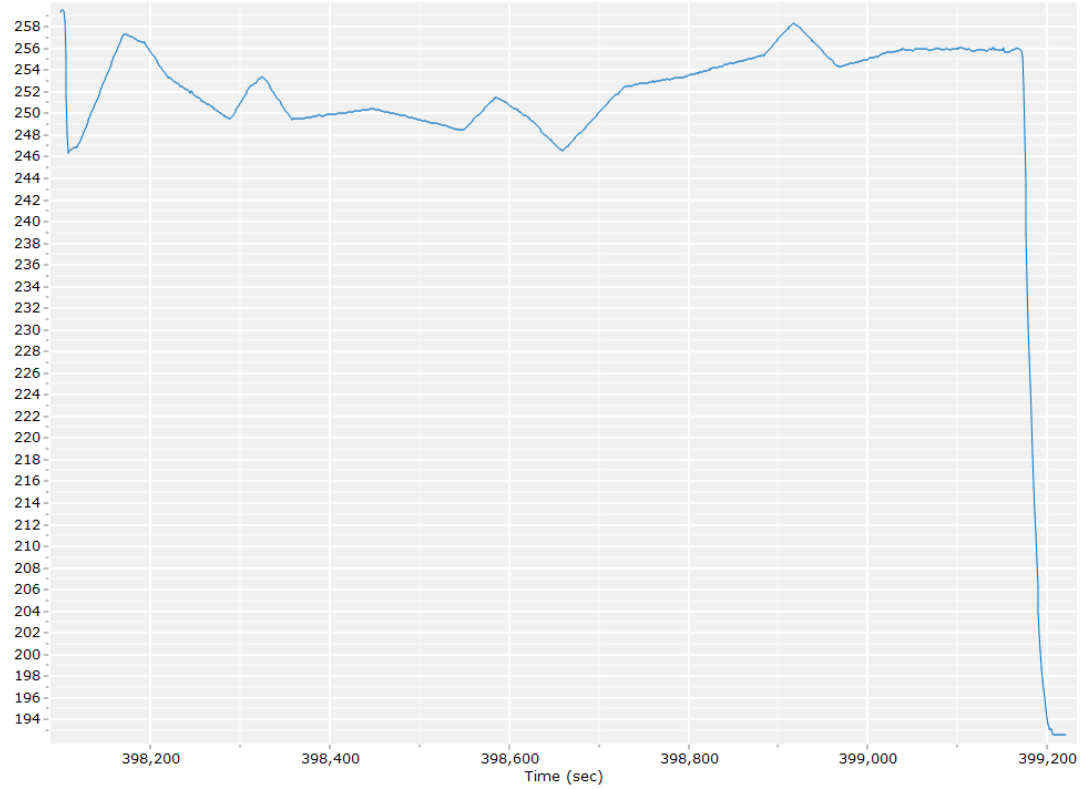
398,000
398,100
398,200
398,300
398,400
398,500
398,600
398,700
398,800
398,900
399,000
399,100
399,200
Time (sec)
GALILEO 05 E1CBOC SNR (dB/Hz)
GALILEO 06 E1CBOC SNR (dB/Hz)
GALILEO 09 E1CBOC SNR (dB/Hz)
GALILEO 13 E1CBOC SNR (dB/Hz)
GALILEO 21 E1CBOC SNR (dB/Hz)
GALILEO 23 E1CBOC SNR (dB/Hz)
GALILEO 26 E1CBOC SNR (dB/Hz)
GALILEO 31 E1CBOC SNR (dB/Hz)
GALILEO 33 E1CBOC SNR (dB/Hz)
GALILEO 05 E5Alt SNR (dB/Hz)
GALILEO 06 E5Alt SNR (dB/Hz)
GALILEO 09 E5Alt SNR (dB/Hz)
GALILEO 13 E5Alt SNR (dB/Hz)
GALILEO 21 E5Alt SNR (dB/Hz)
GALILEO 23 E5Alt SNR (dB/Hz)
GALILEO 26 E5Alt SNR (dB/Hz)
GALILEO 31 E5Alt SNR (dB/Hz)
GALILEO 33 E5Alt SNR (dB/Hz)

Smoothed Trajectory Information

Top View

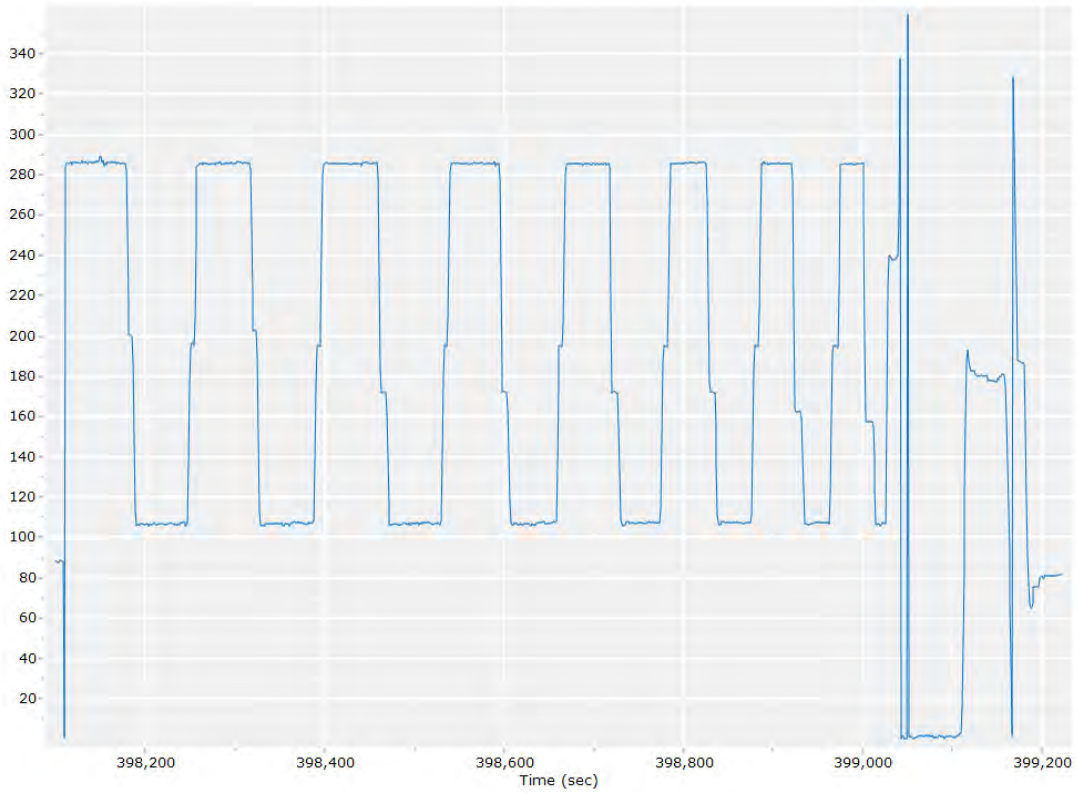


Altitude

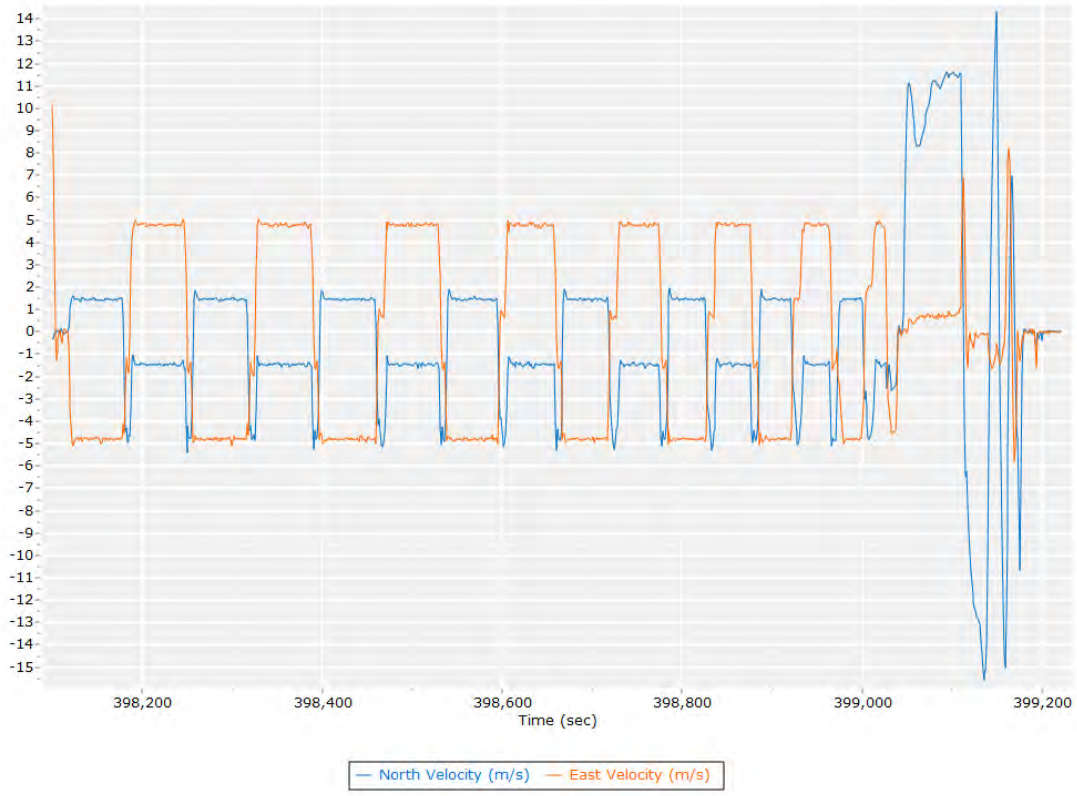


Roll/Pitch

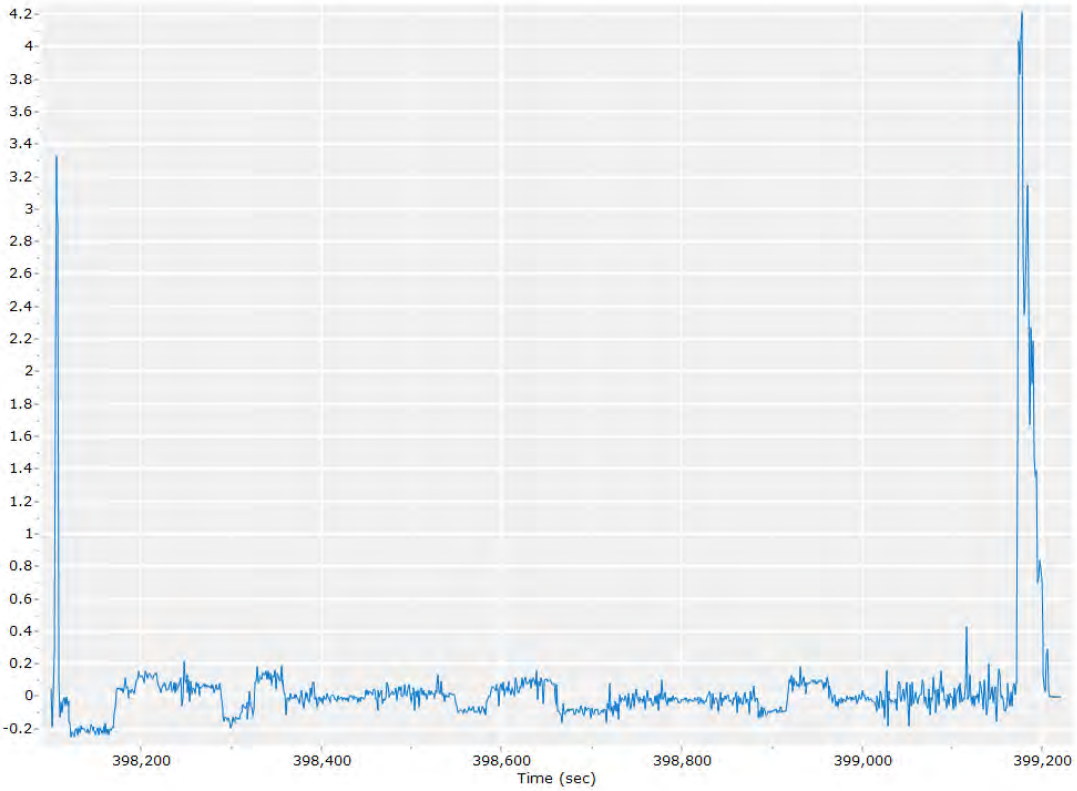
Heading



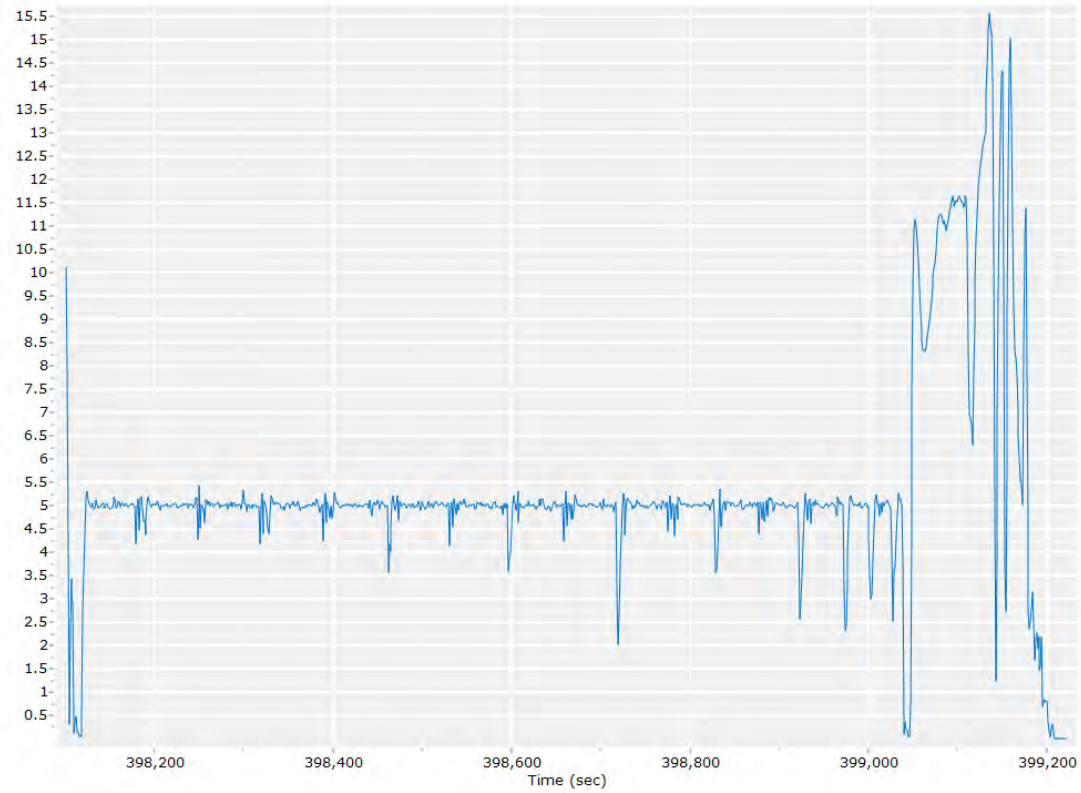
North/East Velocity



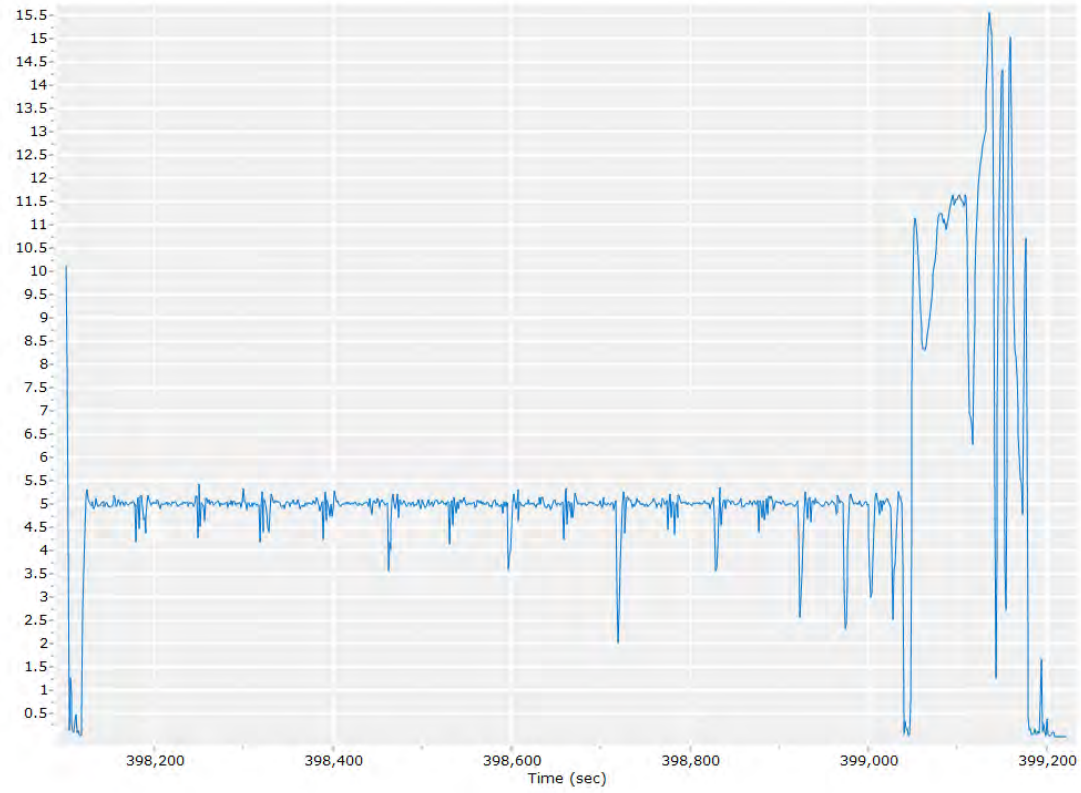
Down Velocity



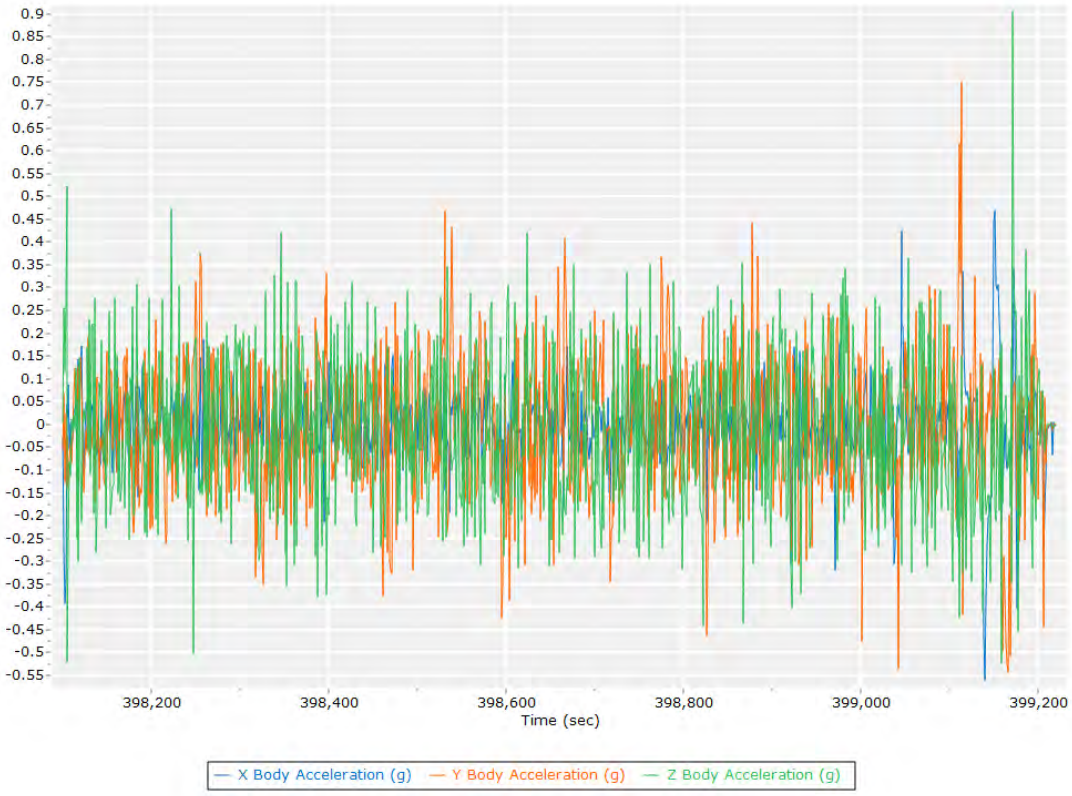
Total Speed



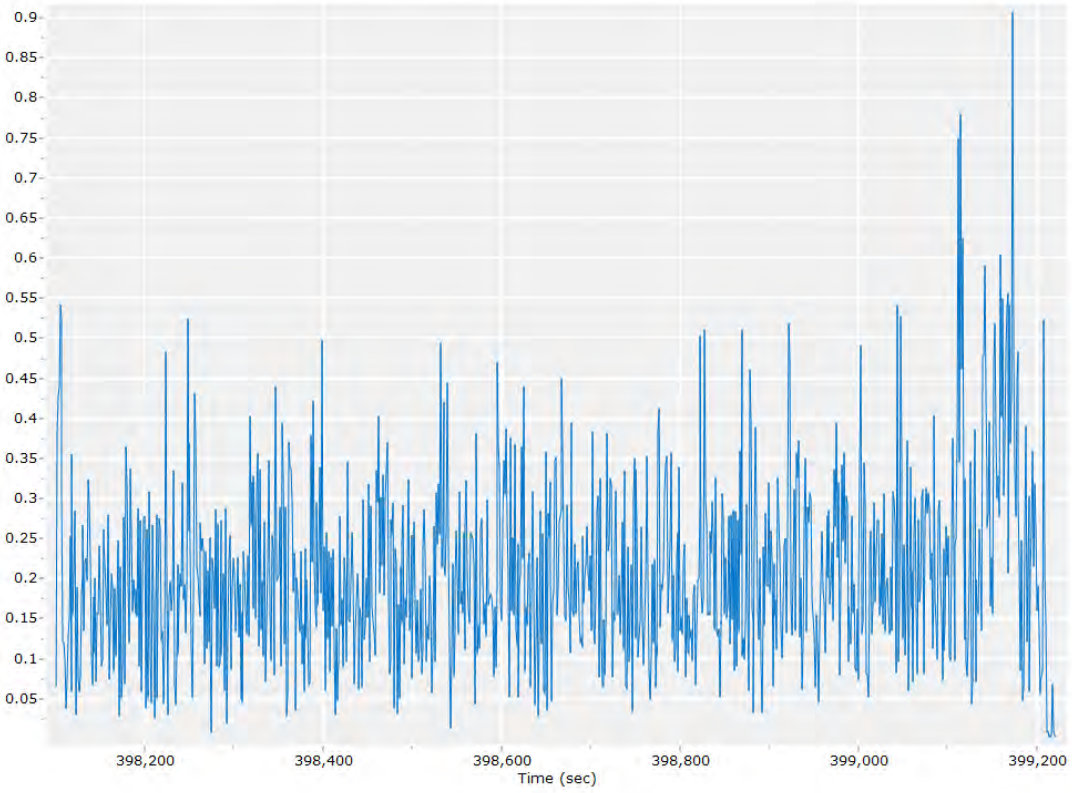
Ground Speed



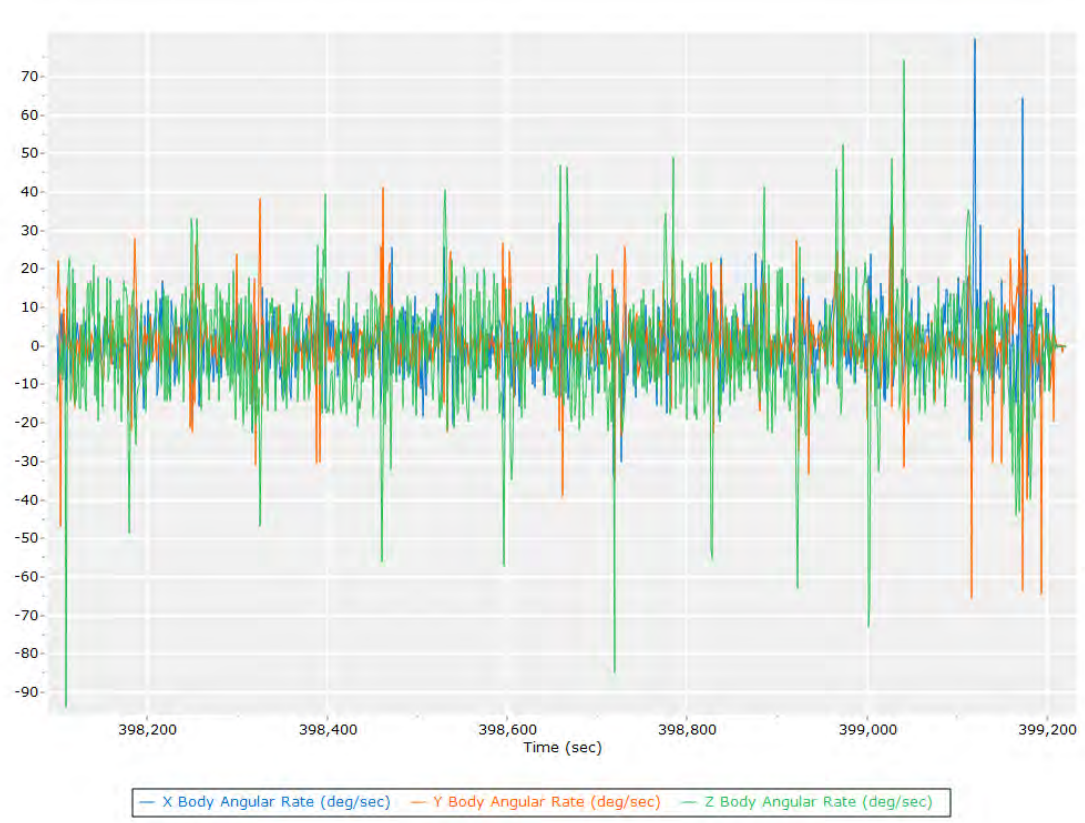
Body Acceleration



Total Body Acceleration

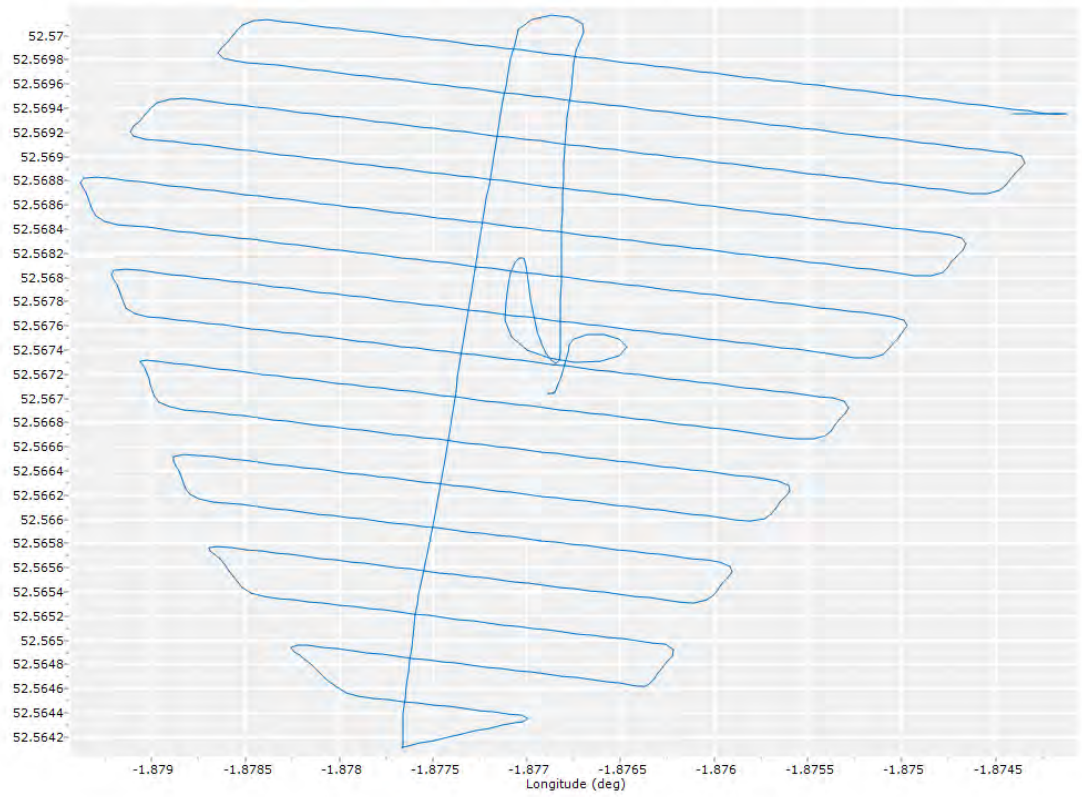


Body Angular Rate

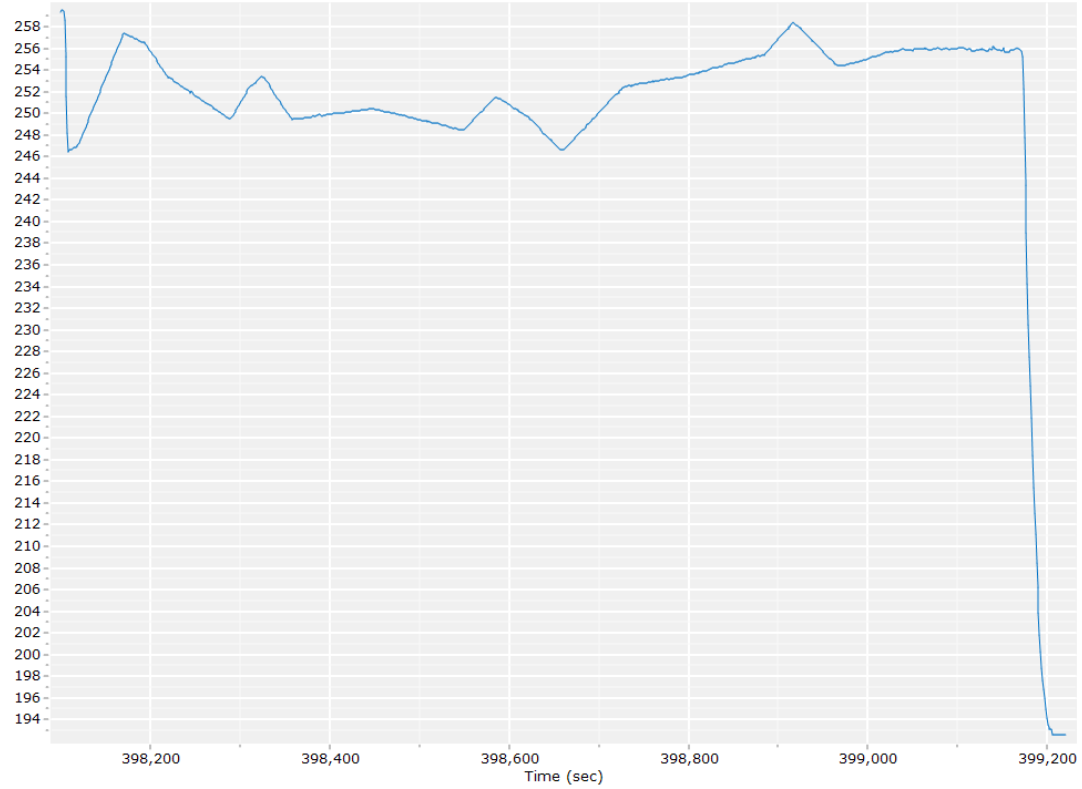


Forward Processed Trajectory Information

Top View

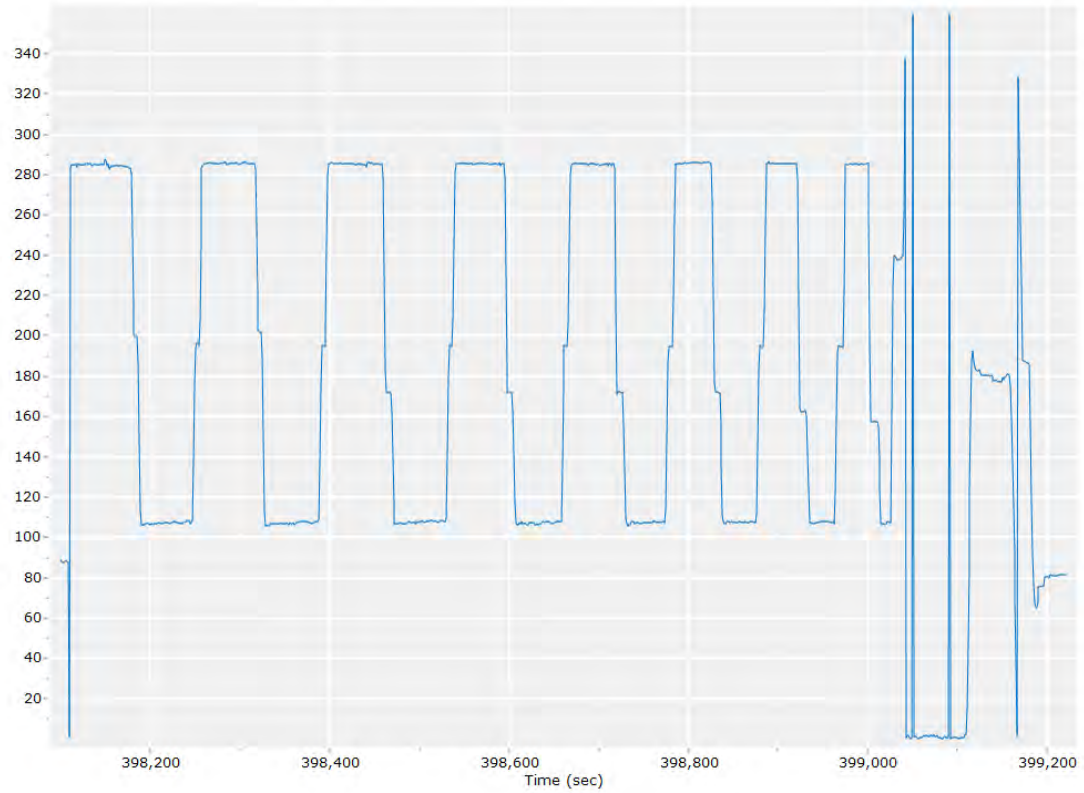


Altitude

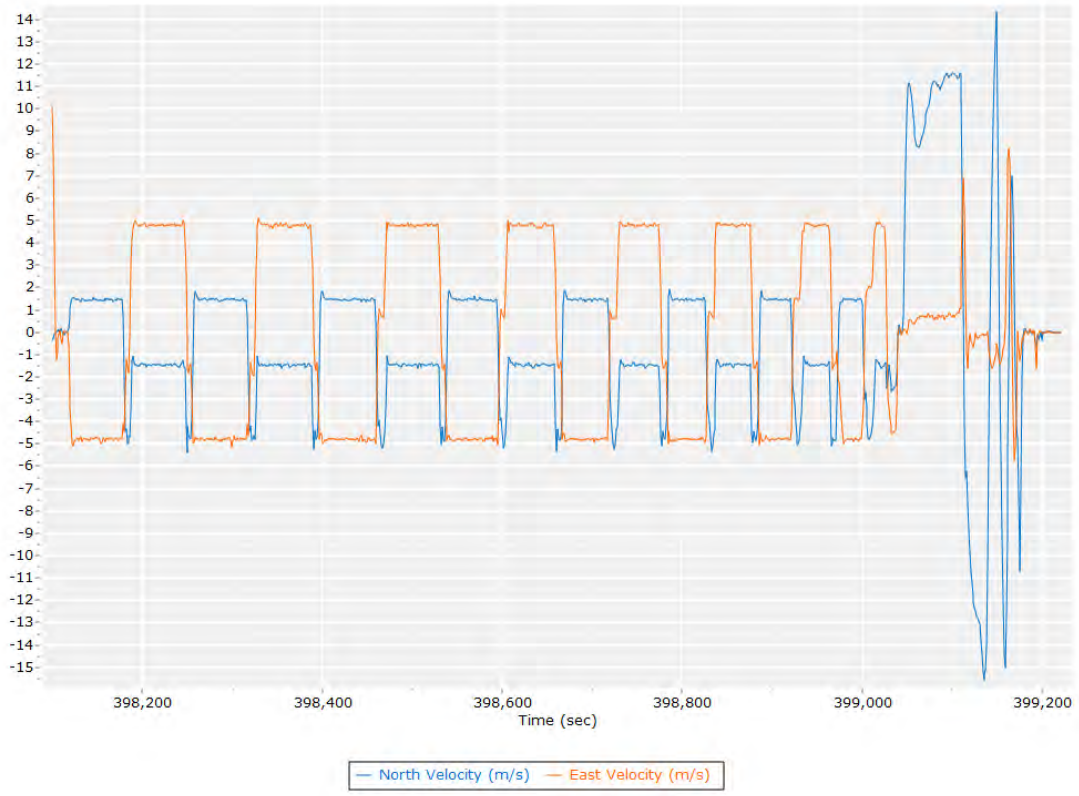


Roll/Pitch

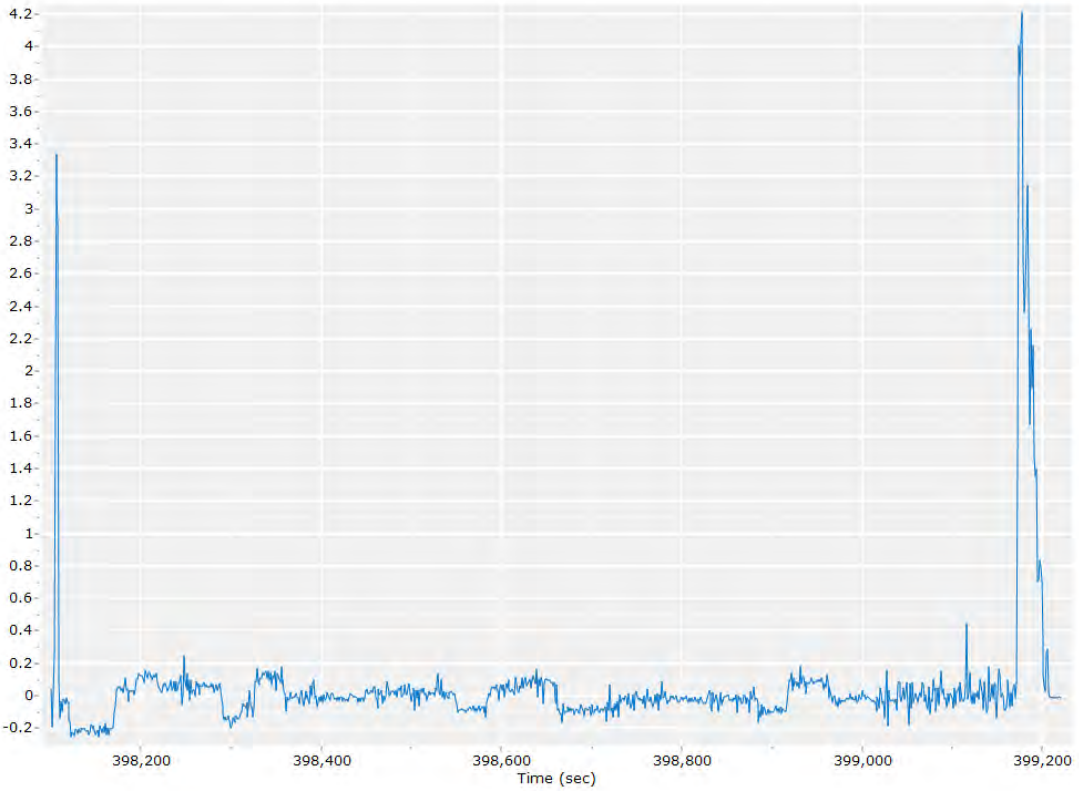
Heading



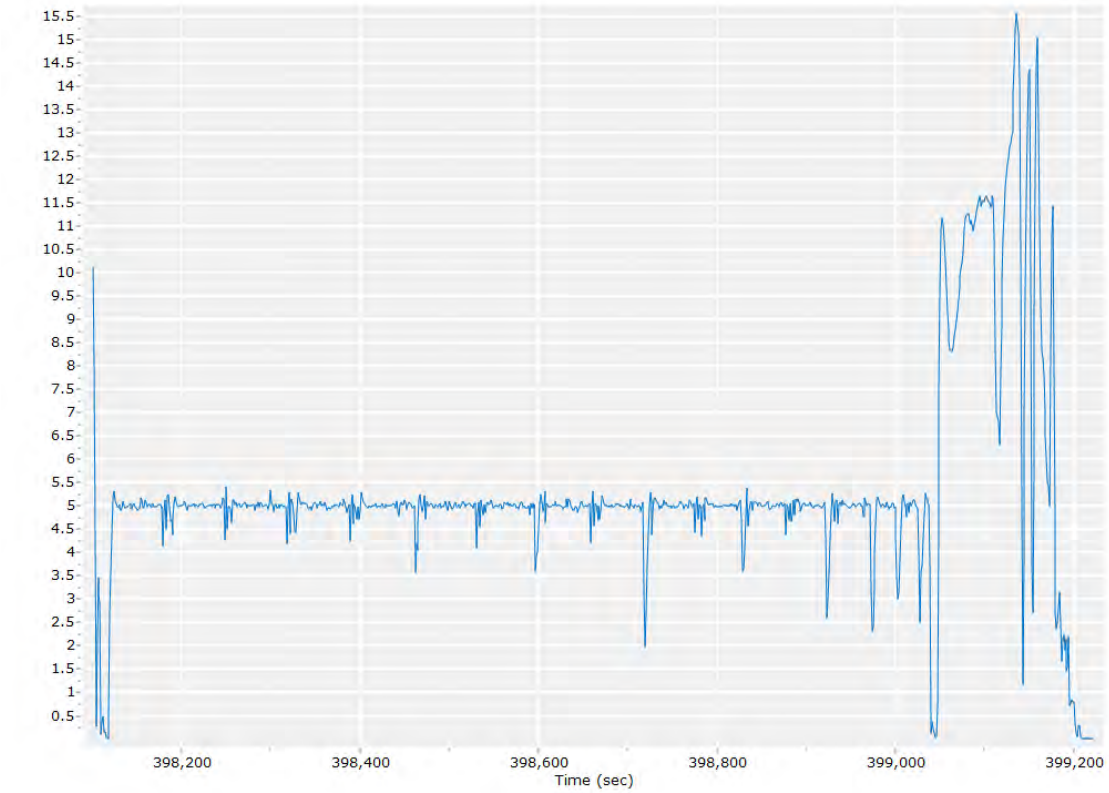
North/East Velocity



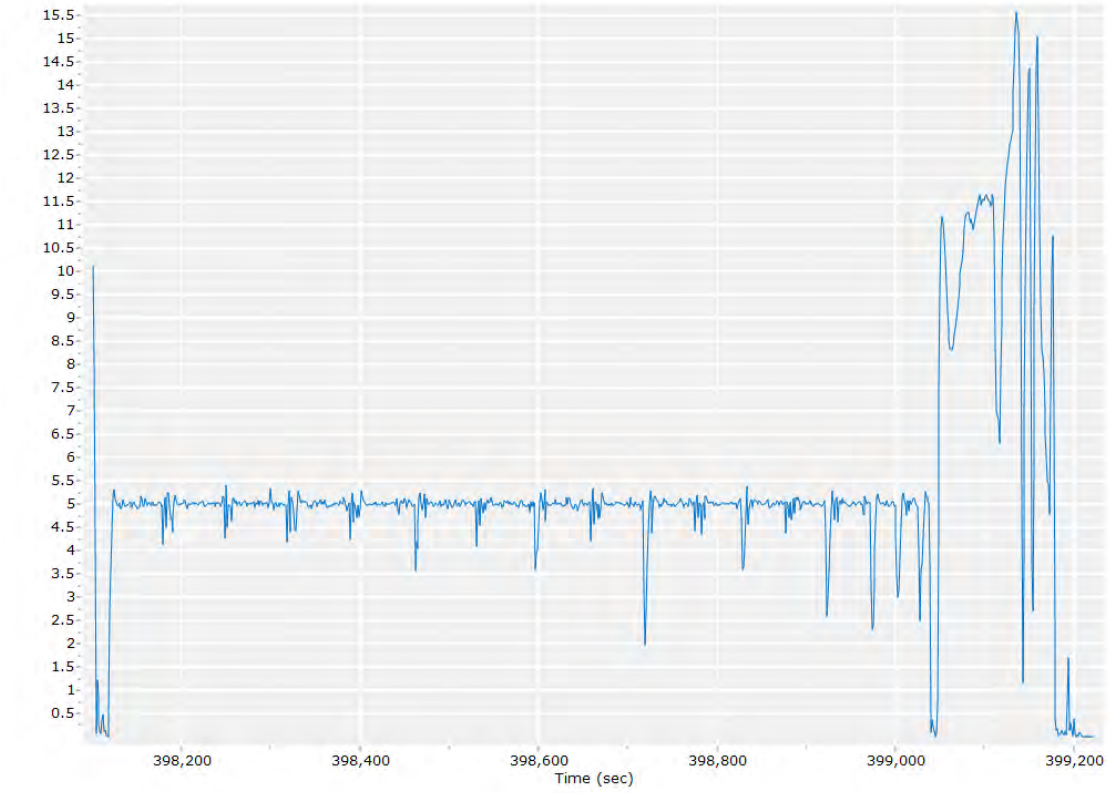
Down Velocity



Total Speed

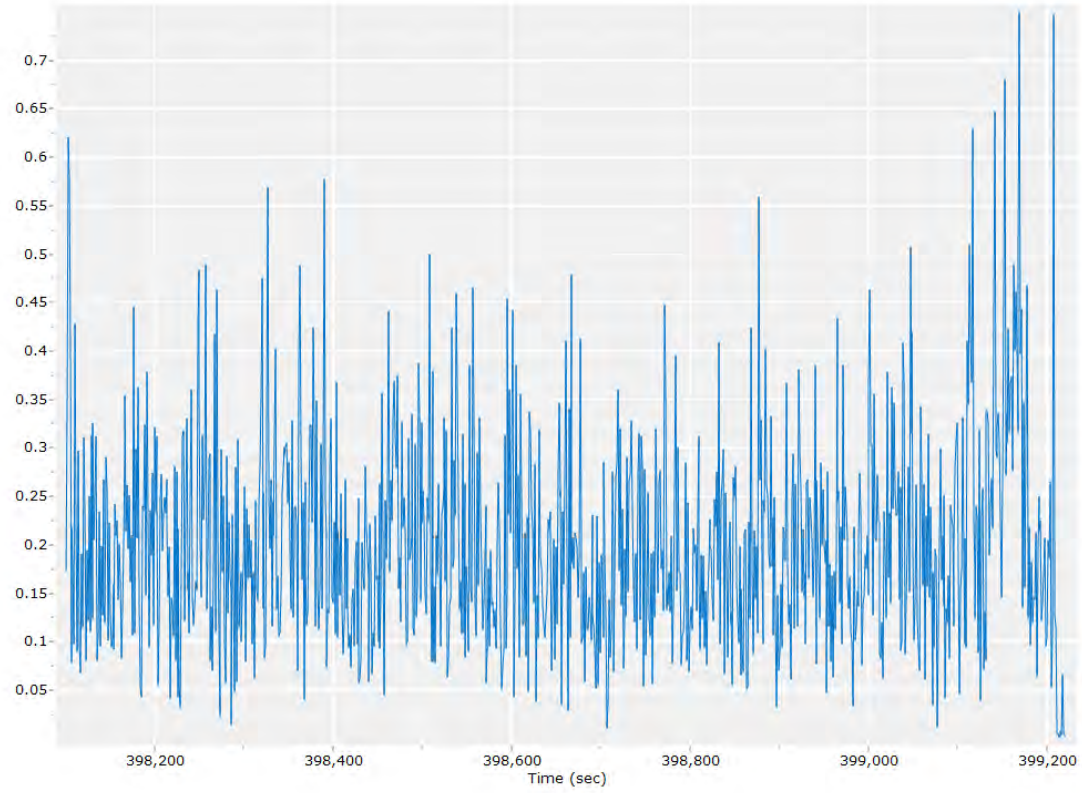


Ground Speed

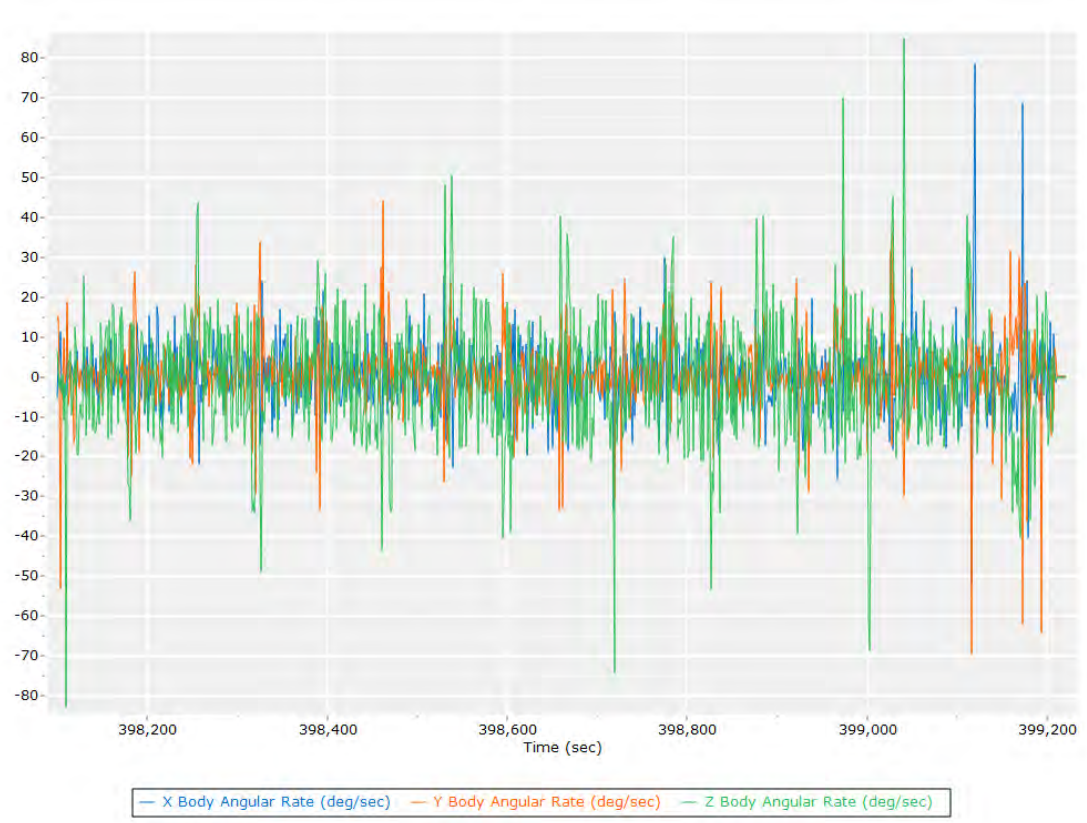


Body Acceleration

Total Body Acceleration



Body Angular Rate

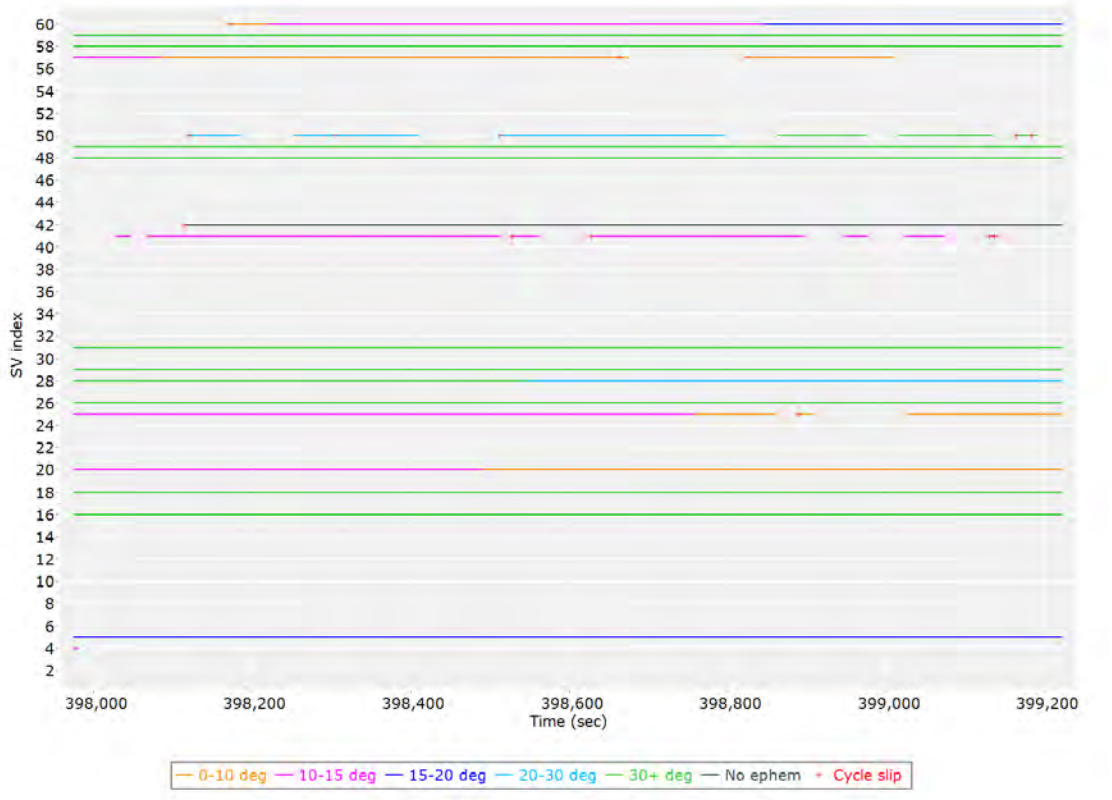


Base Station Information

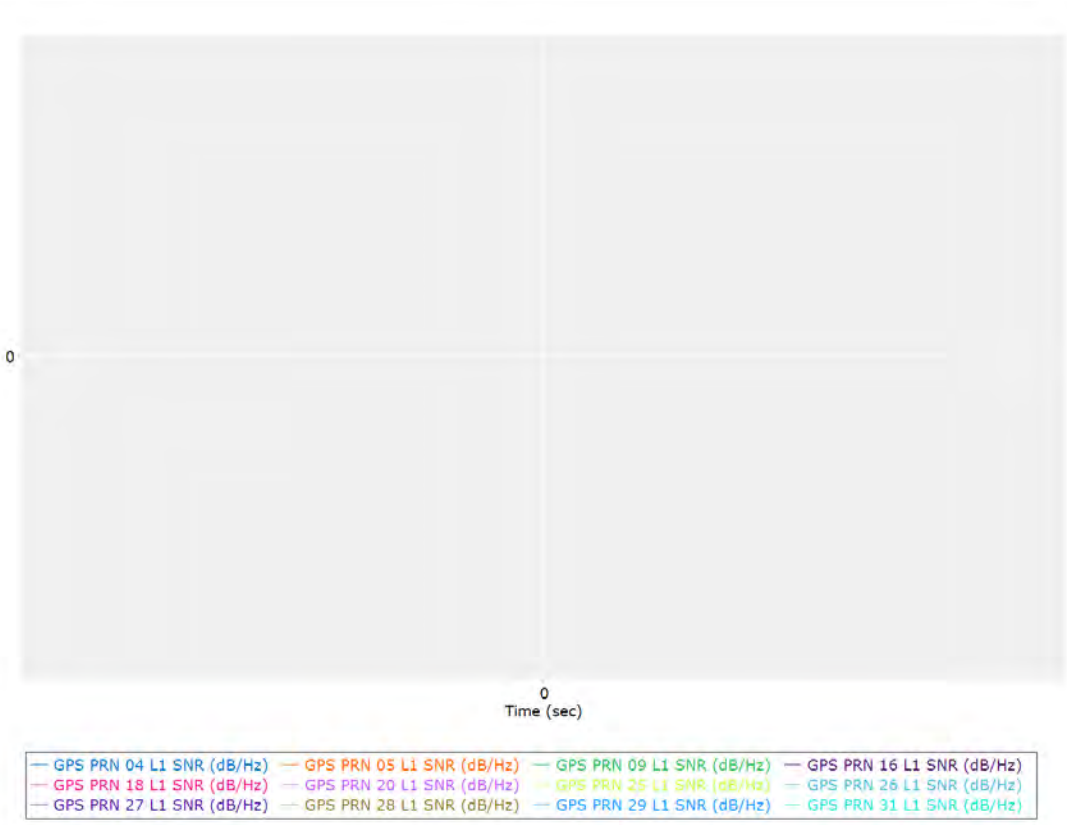
Station ID	base		
Filename	base0374.25O		
Start date	02/06/2025 14:03:16		
End date	02/06/2025 17:06:19		
Duration	03:03:03.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Unknown	Unknown	E5003A21000006
Antenna manufacturer, model	Unknown	Unknown External	
Antenna height [m]	2.079		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC (m)	0		
Latitude	N52°34'01.12122"		
Longitude	W1°52'37.36477"		
Ellipsoidal height (m)	192.72160		
Frame	ITRF2014		
Epoch	2025.0986		
Ellipsoid	GRS_1980		
Velocity North (mm/y)	16.61		
Velocity East (mm/y)	15.72		
Velocity Up (mm/y)	-0.06		

Base Observables & Satellite Data

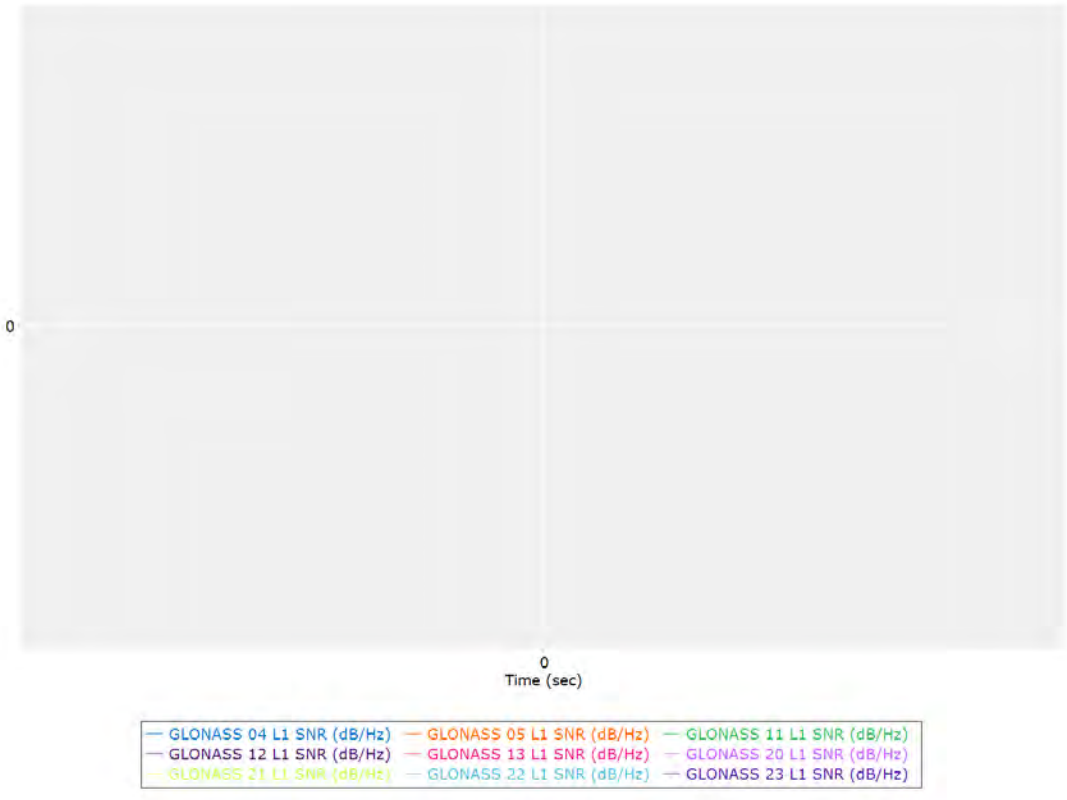
Base GPS/GLONASS L1 Satellite Lock/Elevation



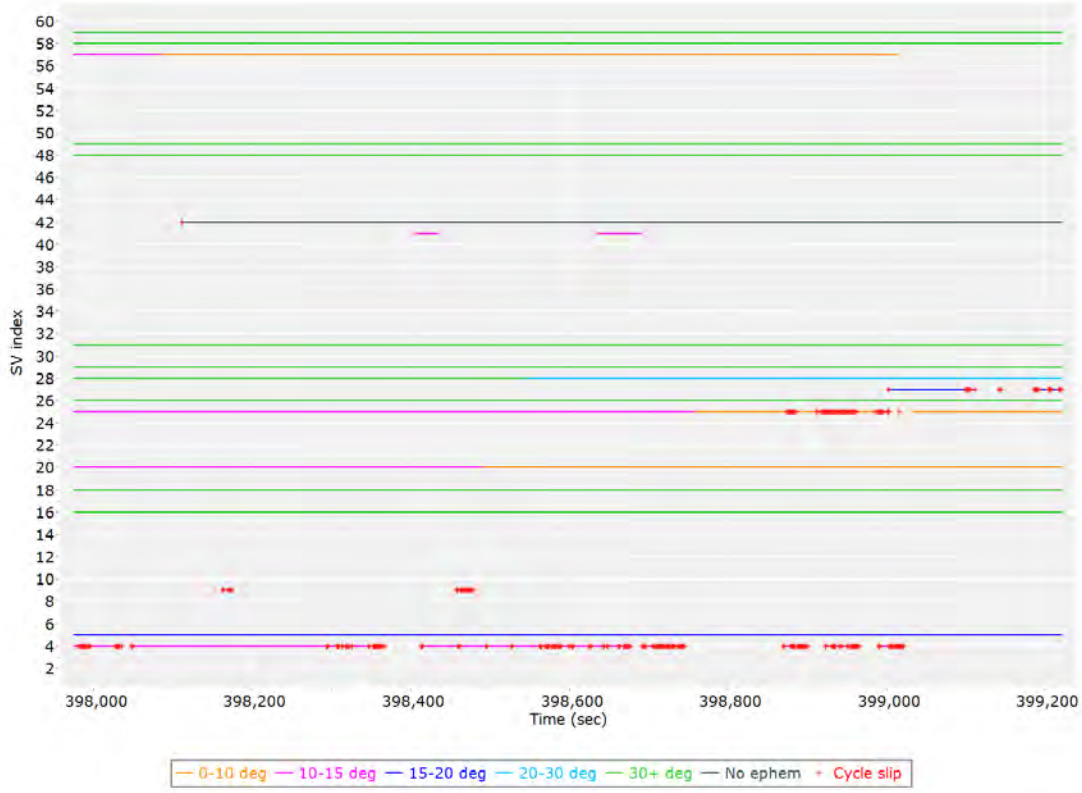
Base GPS L1 SNR



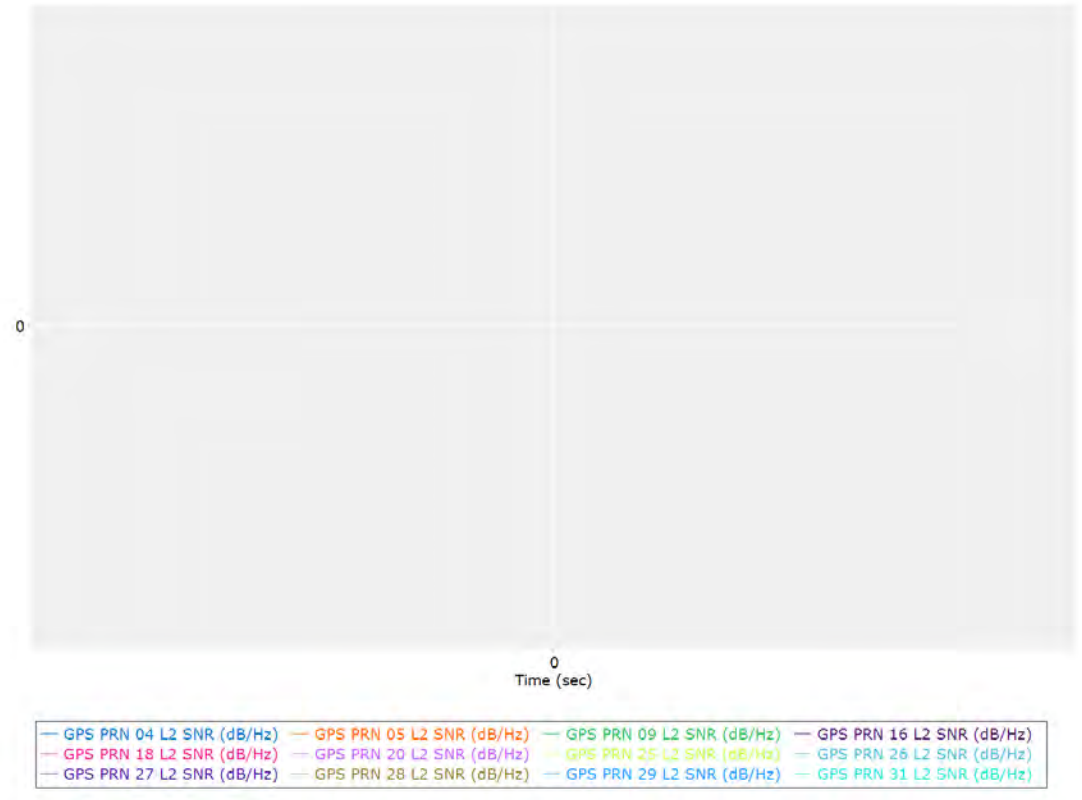
Base GLONASS L1 SNR



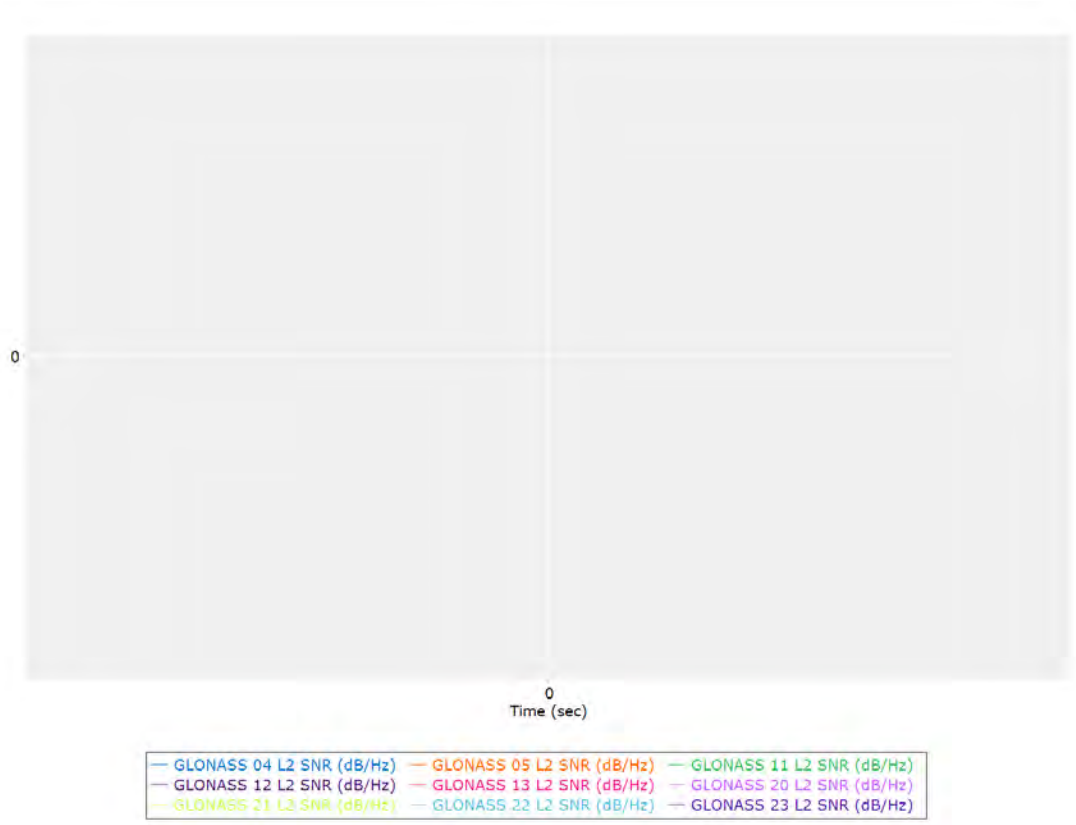
Base GPS/GLONASS L2 Satellite Lock/Elevation



Base GPS L2 SNR



Base GLONASS L2 SNR

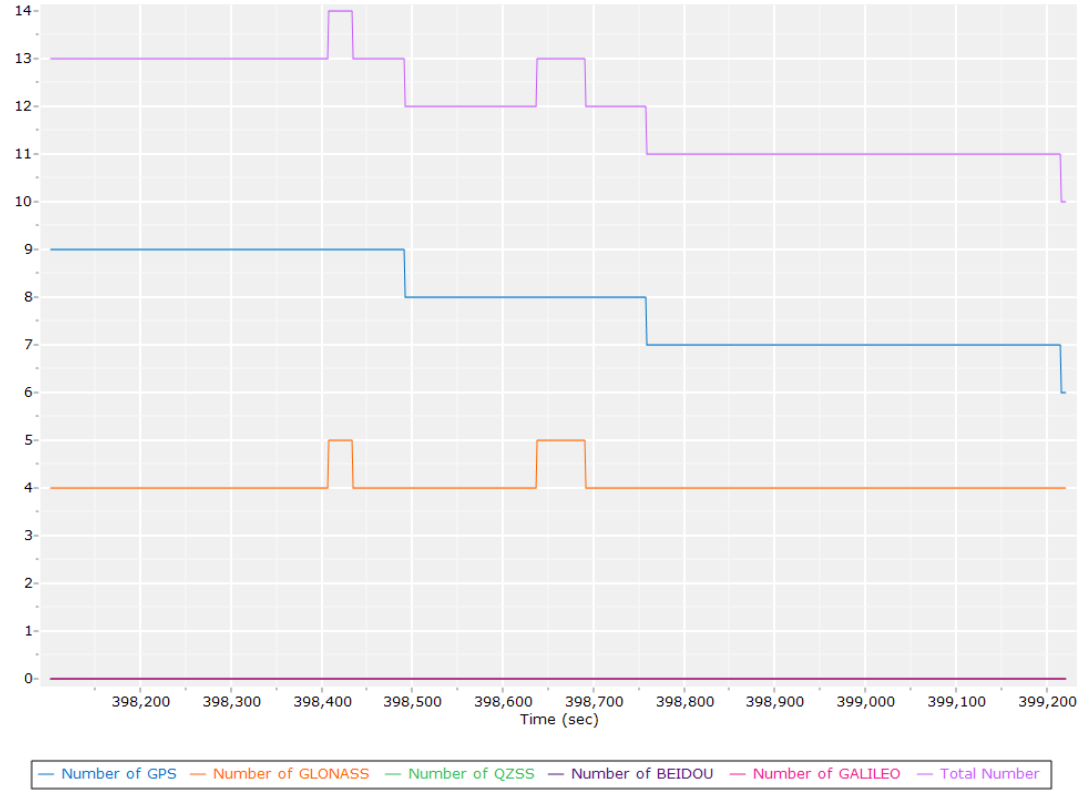


GNSS QC

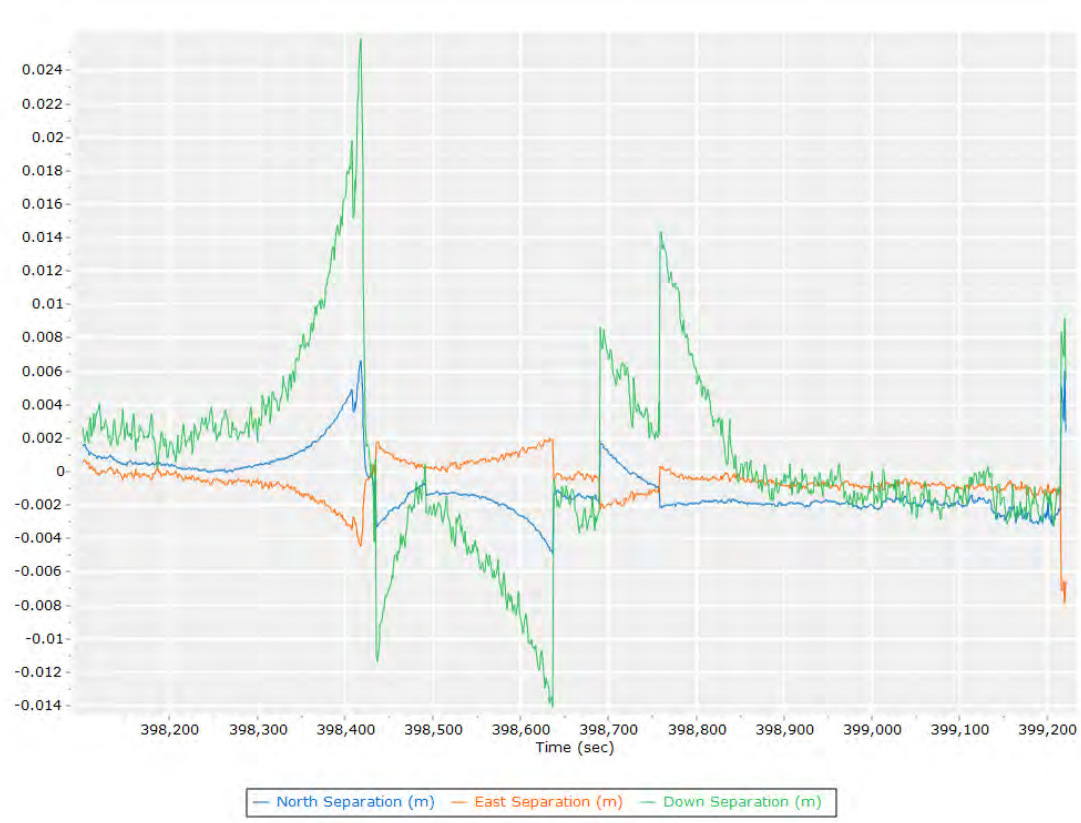
GNSS QC Statistics

Statistics	Min	Max	Mean
Baseline length (km)	0.01	0.37	
Number of GPS SV	6	9	8
Number of GLONASS SV	4	5	4
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Number of GALILEO SV	0	0	0
Total number of SV	10	14	12
PDOP	1.48	2.47	1.98
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (sec)	1246.00	0.00	0.00
Percentage	100.00	0.00	0.00

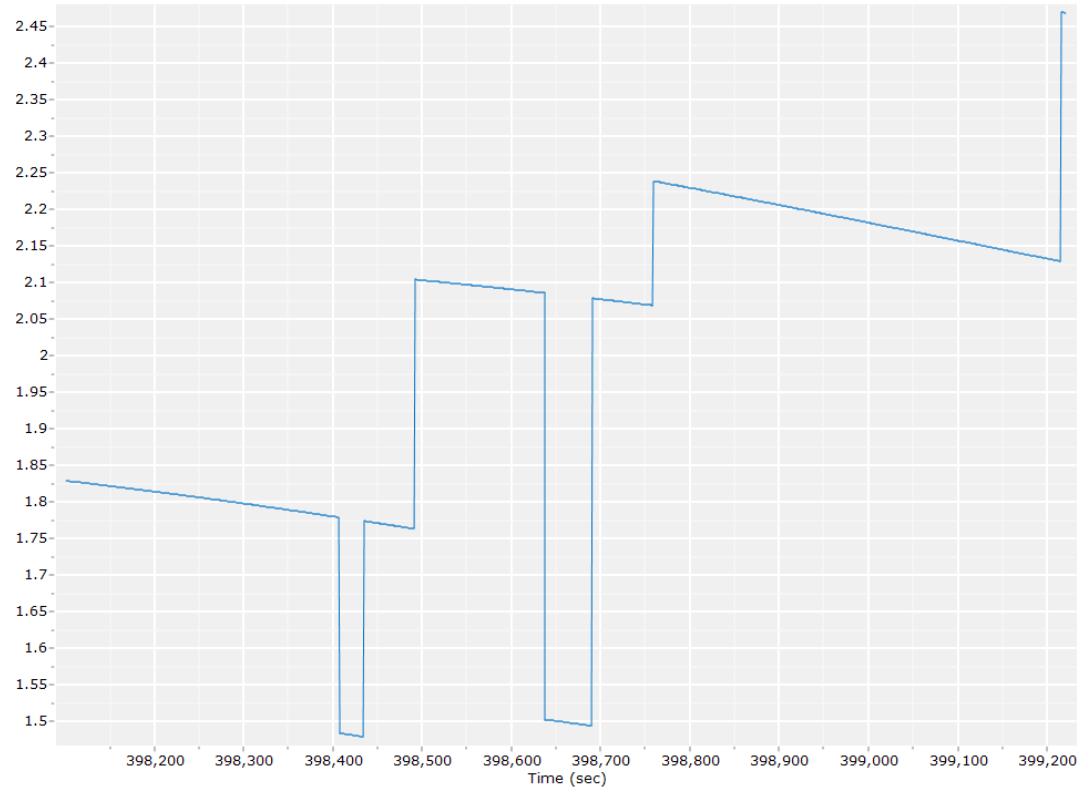
Num SVs in solution



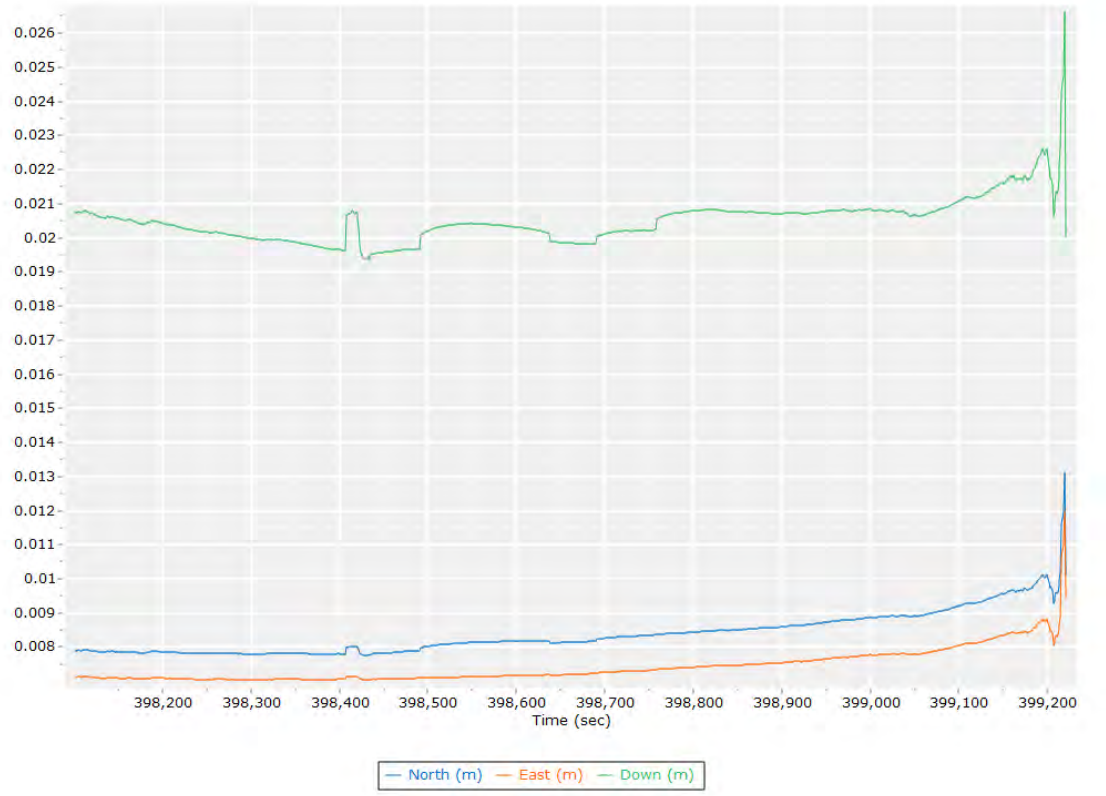
Forward/Reverse Separation



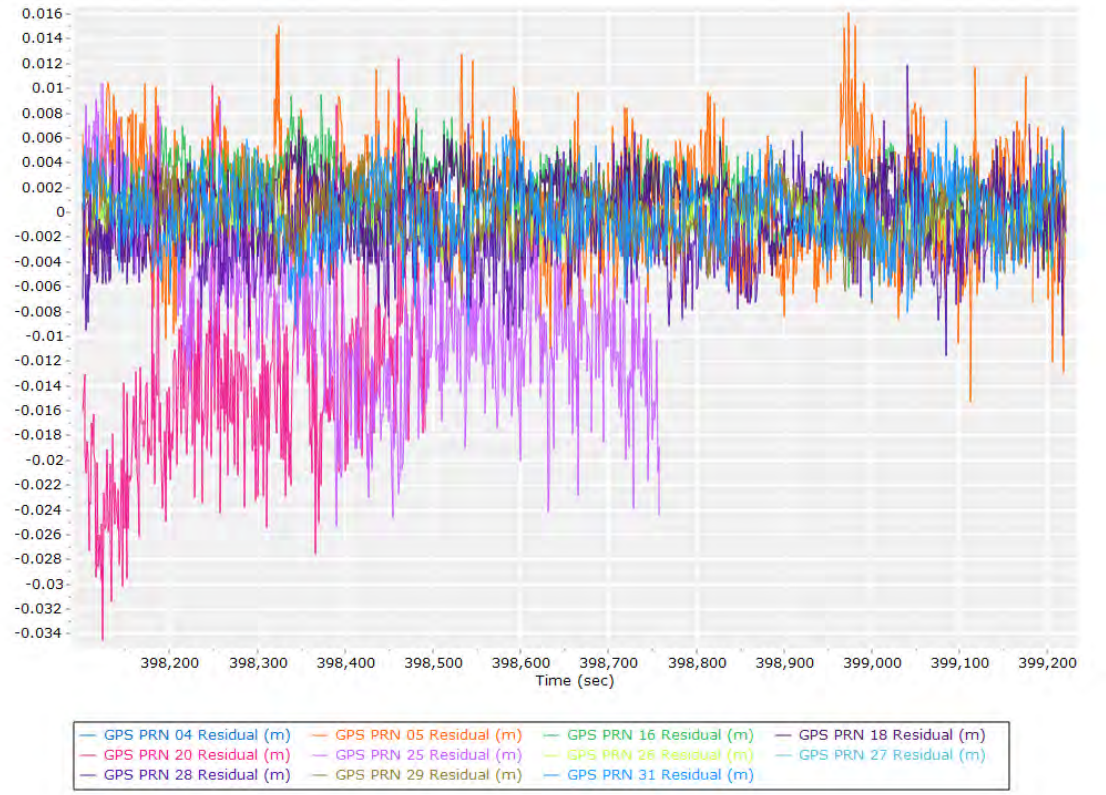
PDOP



Estimated Position Accuracy



GPS Residuals



GLONASS Residuals

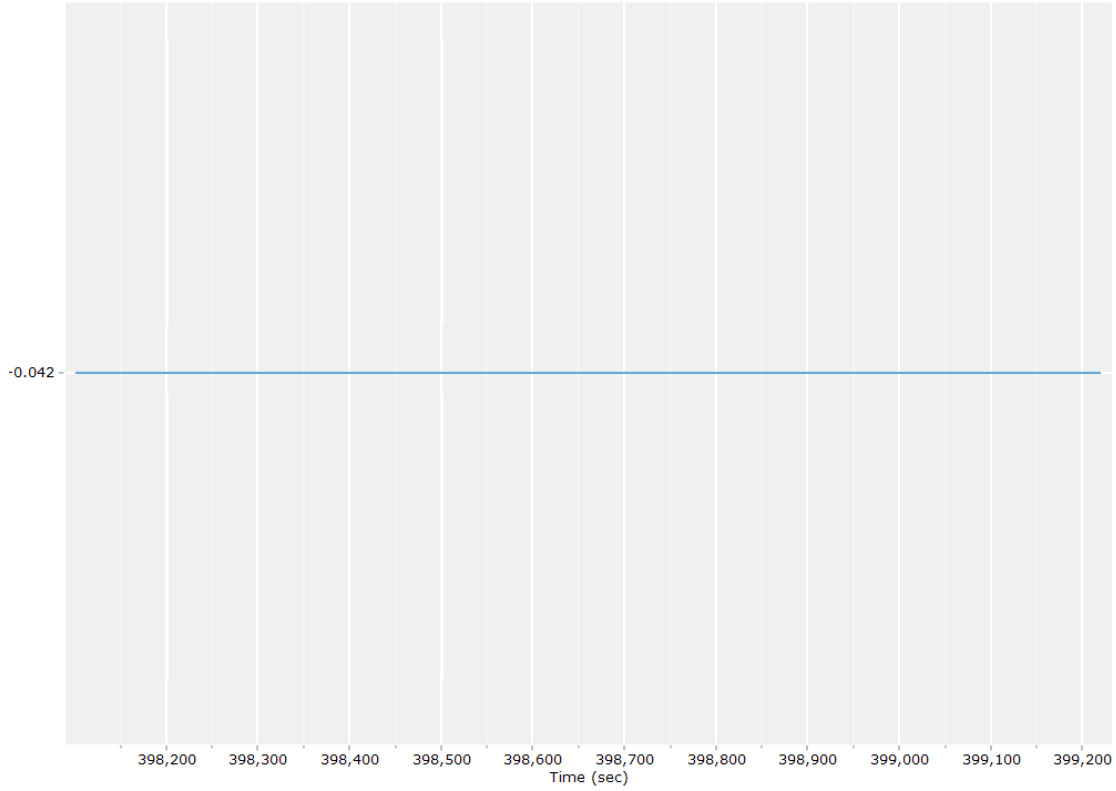
GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	base		
Processing start time	397975.001 (02/06/2025 14:32:55)		
Processing end time	399221.000 (02/06/2025 14:53:41)		
Initial attitude source	Primary GNSS Track, Magnetic Heading		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.042	-0.078	-0.377
Reference to Primary GNSS lever arm std dev (m)	0.030	0.030	0.030
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

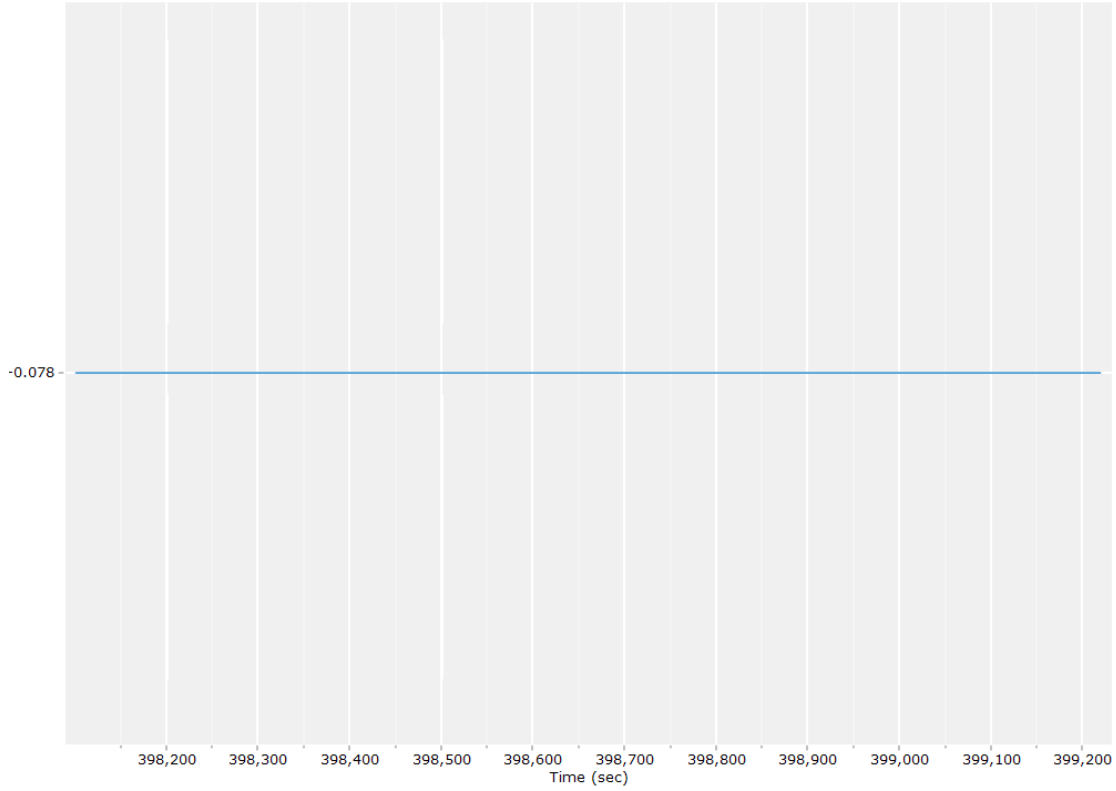
Calibrated Installation Parameters

Reference-Primary GNSS Lever Arm (m)

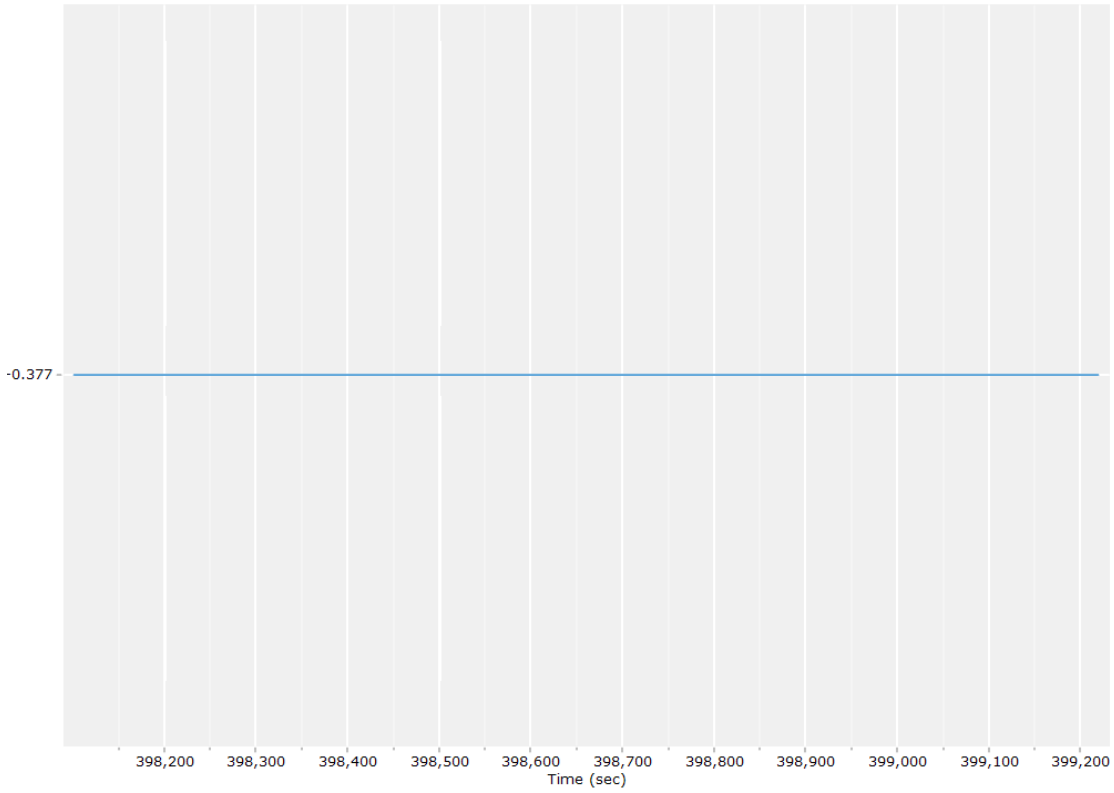
X Reference-Primary GNSS Lever Arm (m)



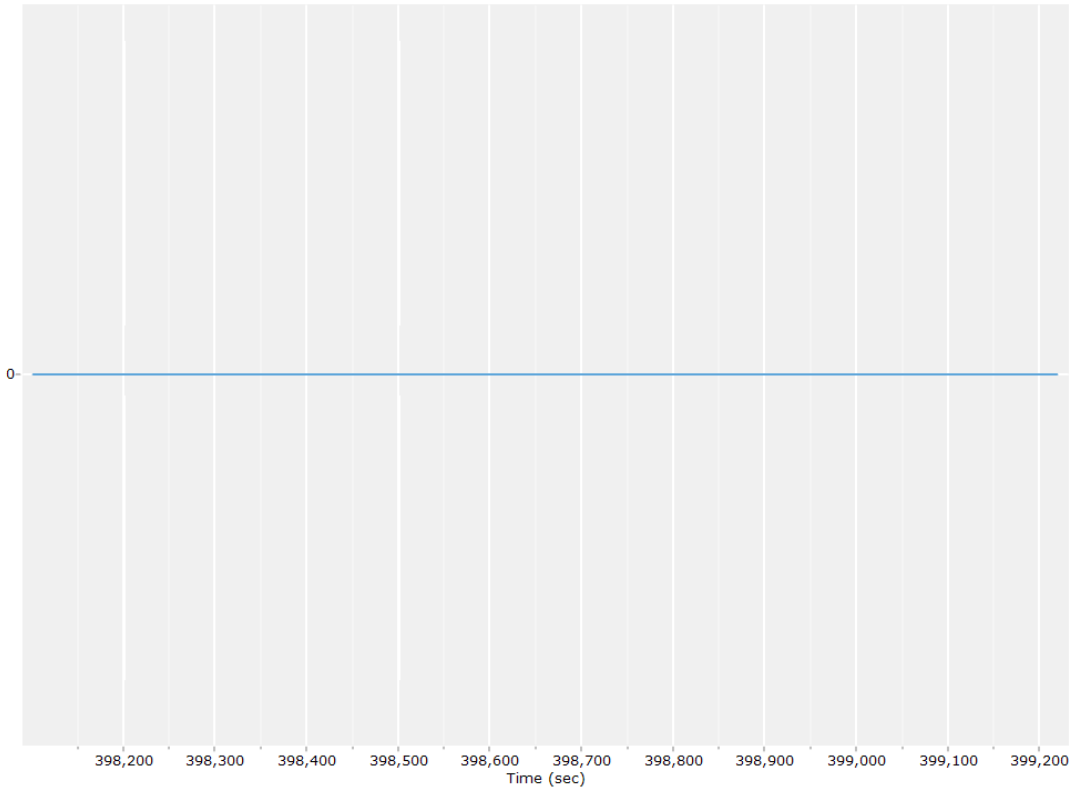
Y Reference-Primary GNSS Lever Arm (m)



Z Reference-Primary GNSS Lever Arm (m)



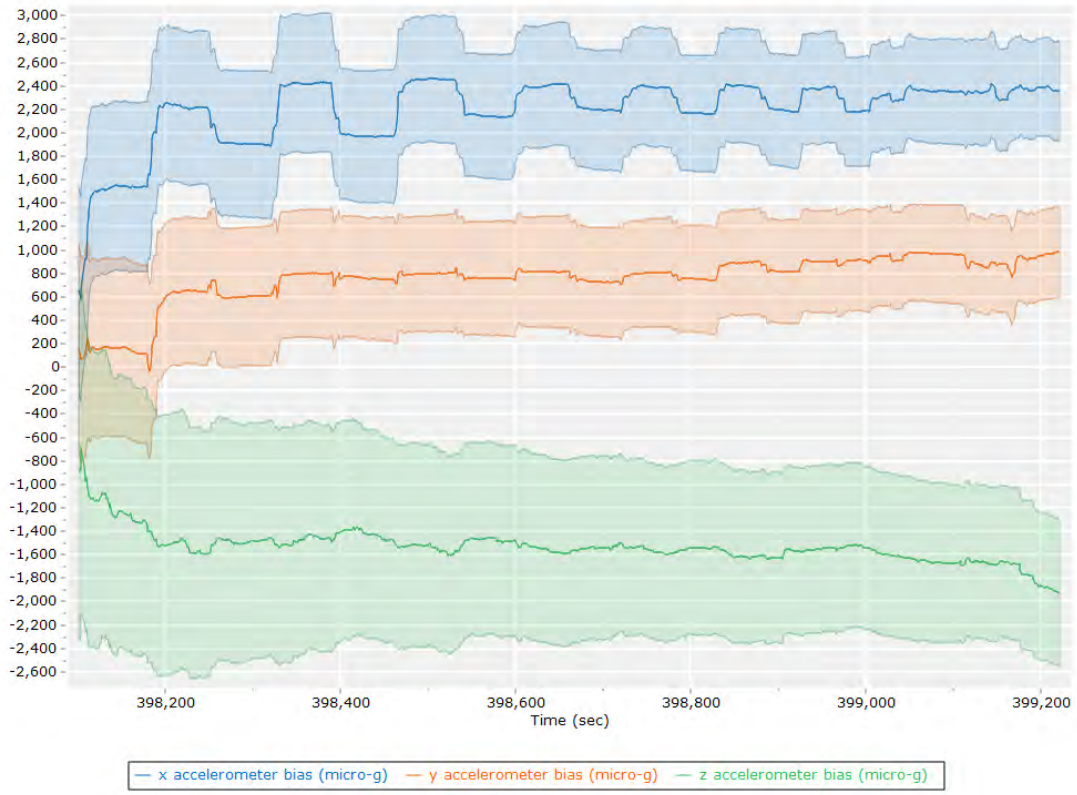
Reference-Primary GNSS Lever Arm Figure of Merit



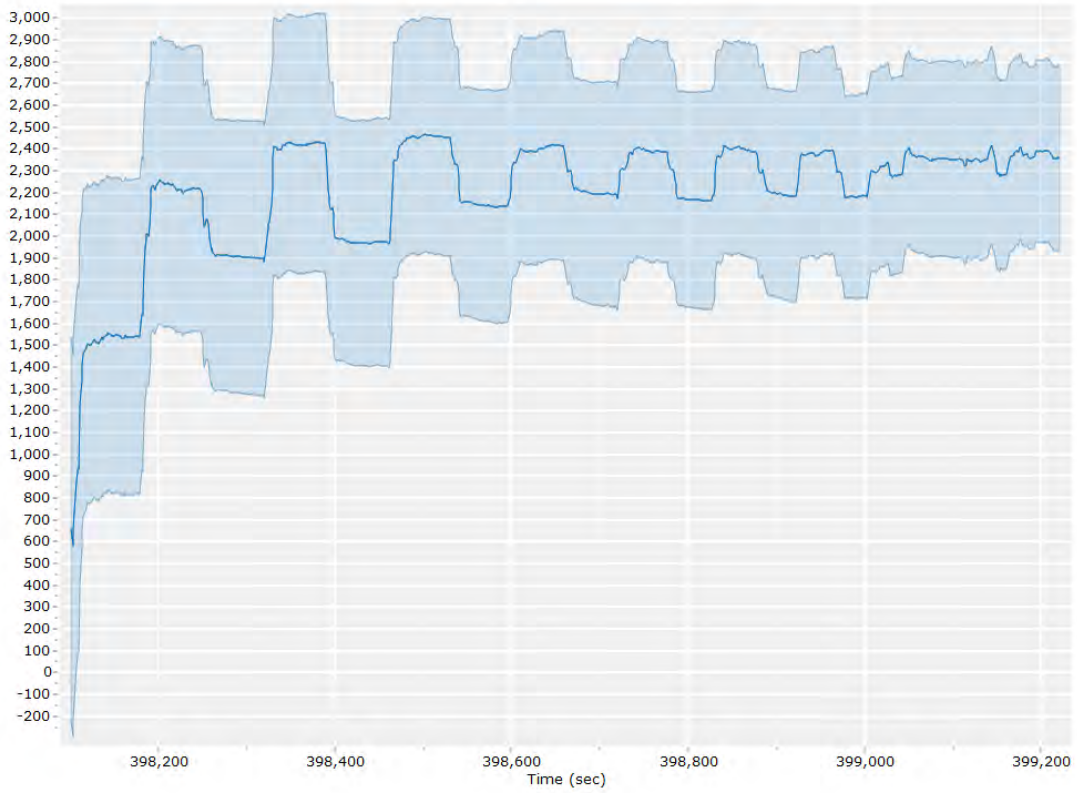
IN-Fusion QC

Forward Processed Estimated Errors, Reference Frame

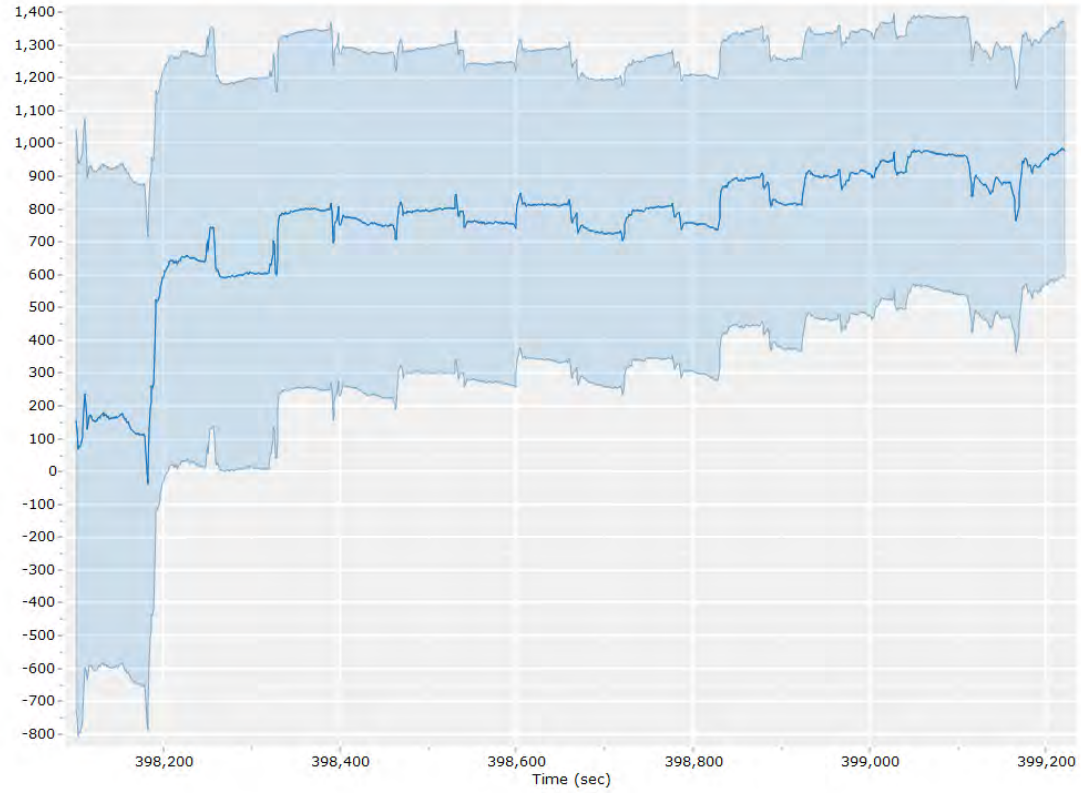
Accelerometer Bias (micro-g)



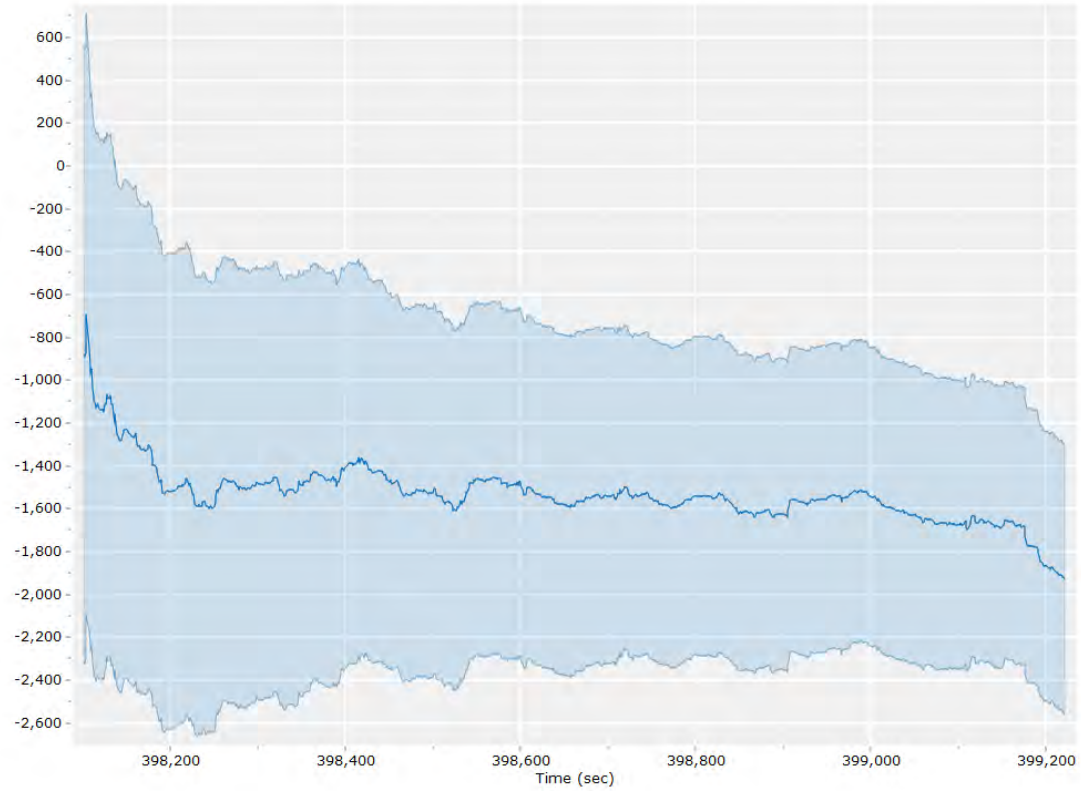
X Accelerometer Bias (micro-g)



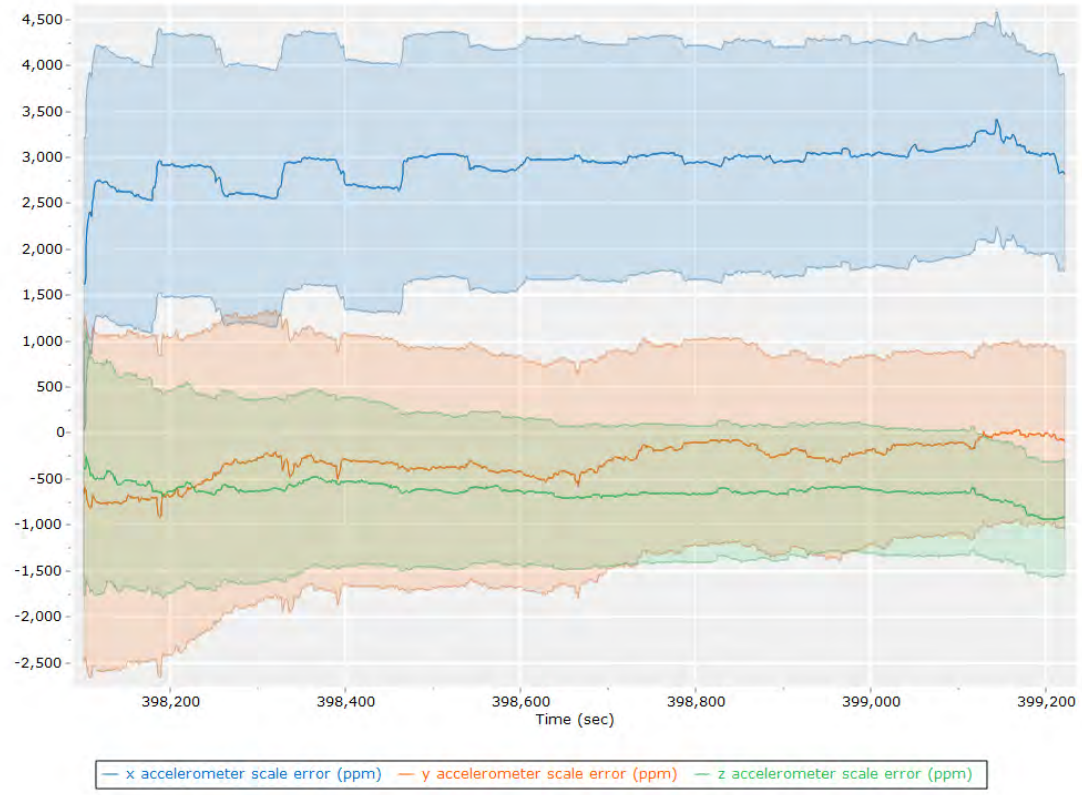
Y Accelerometer Bias (micro-g)



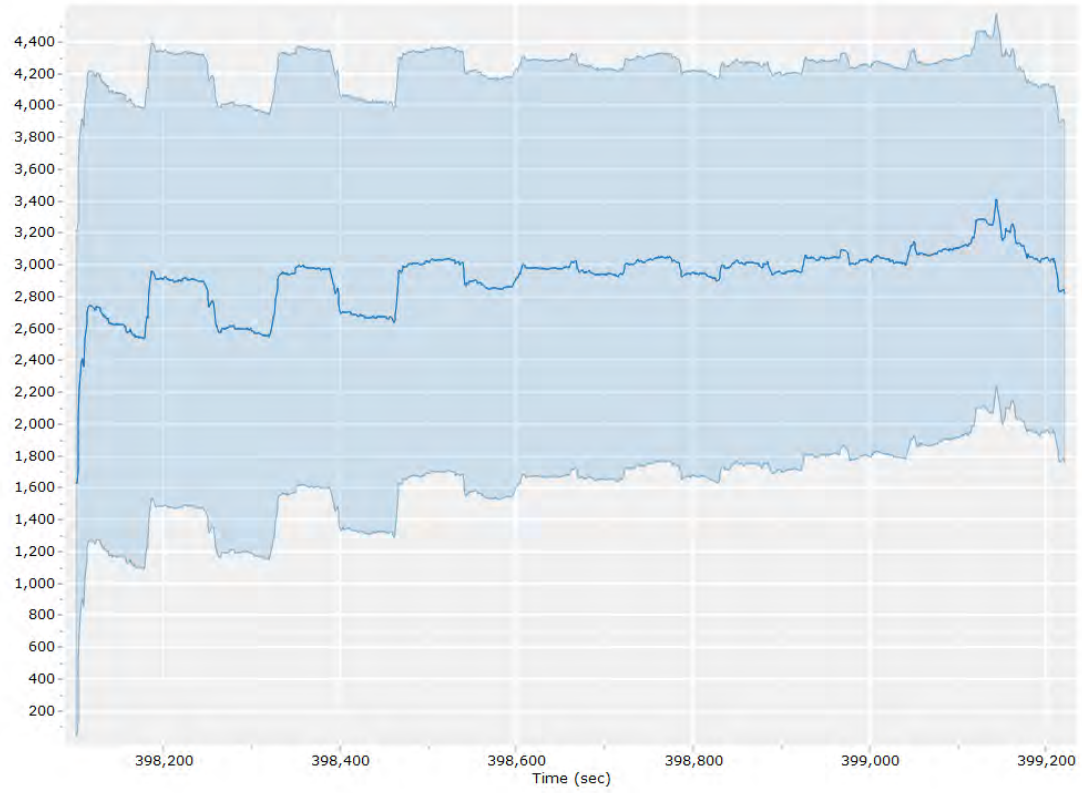
Z Accelerometer Bias (micro-g)



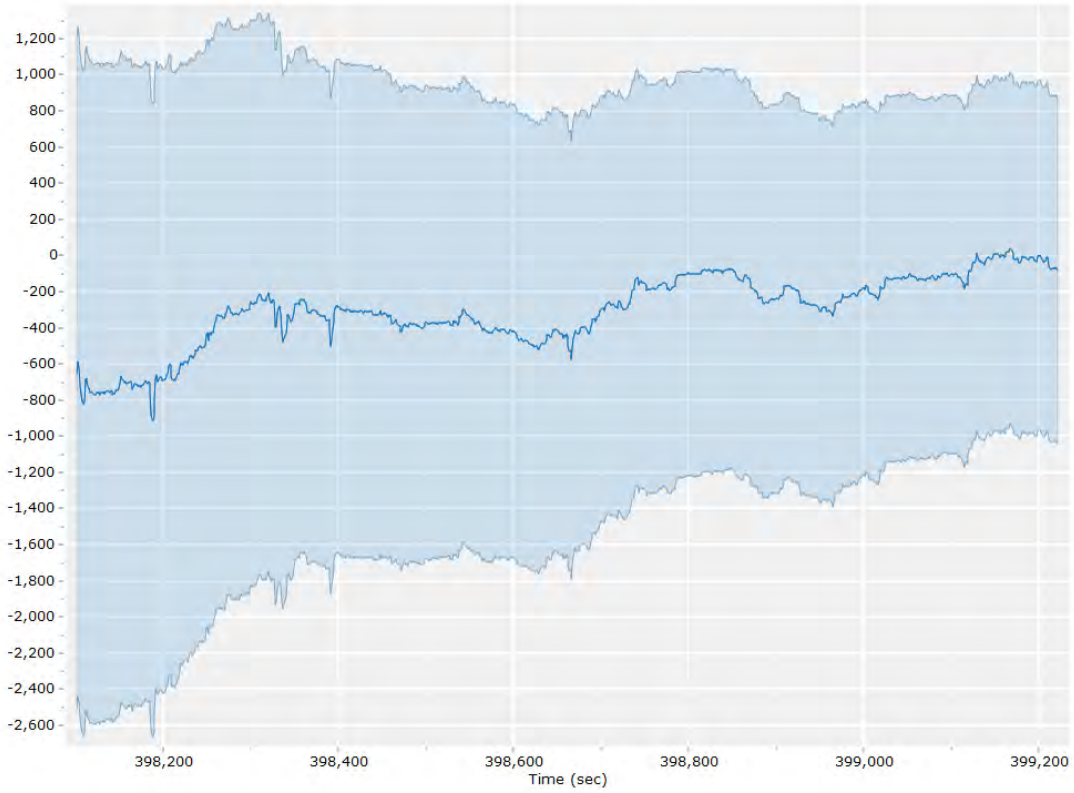
Accelerometer Scale Error (ppm)



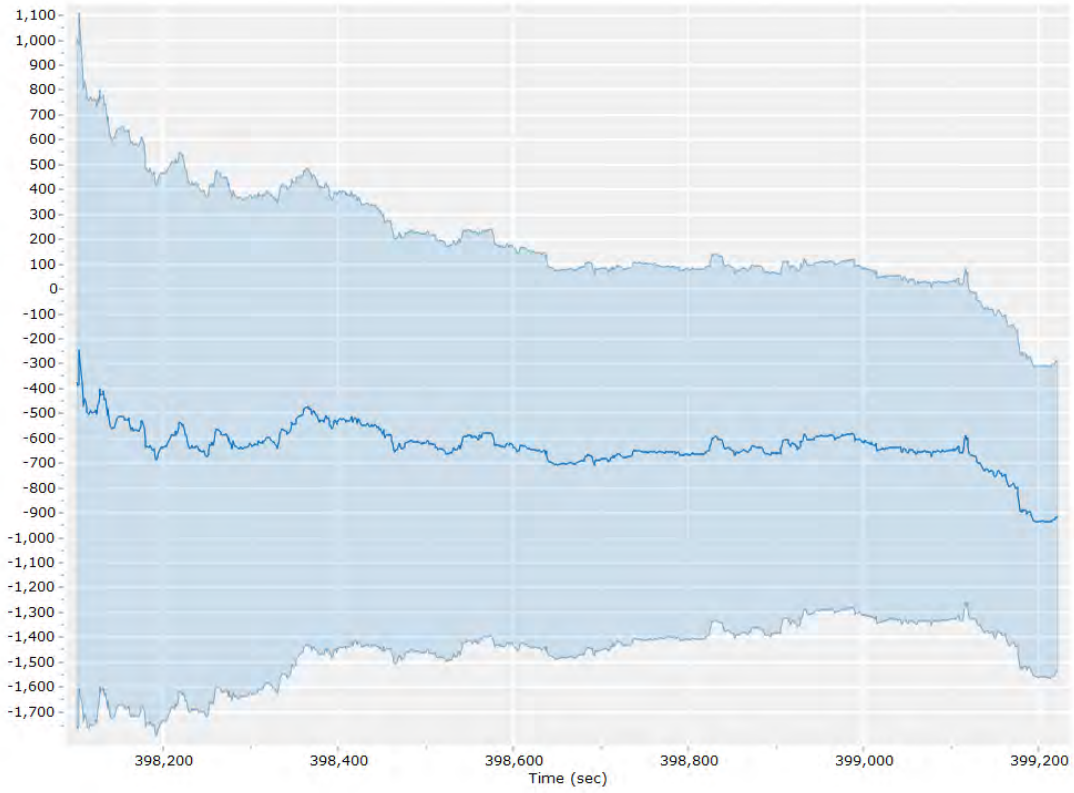
X Accelerometer Scale Error (ppm)



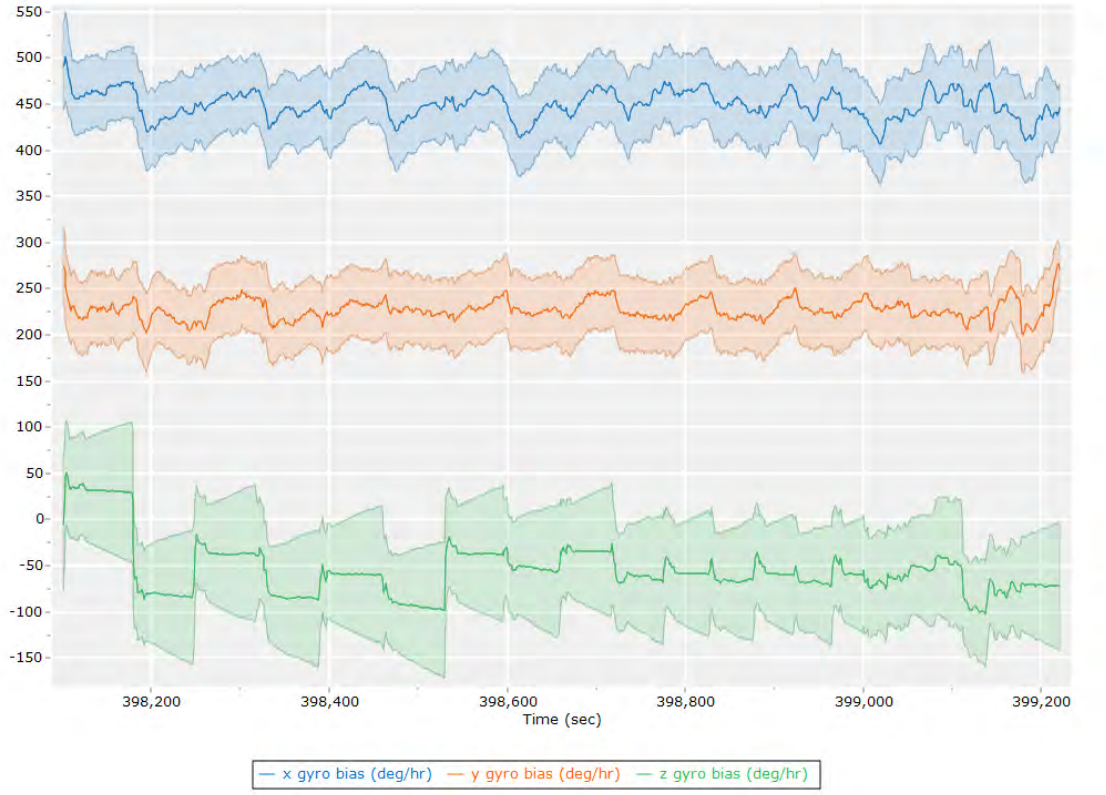
Y Accelerometer Scale Error (ppm)



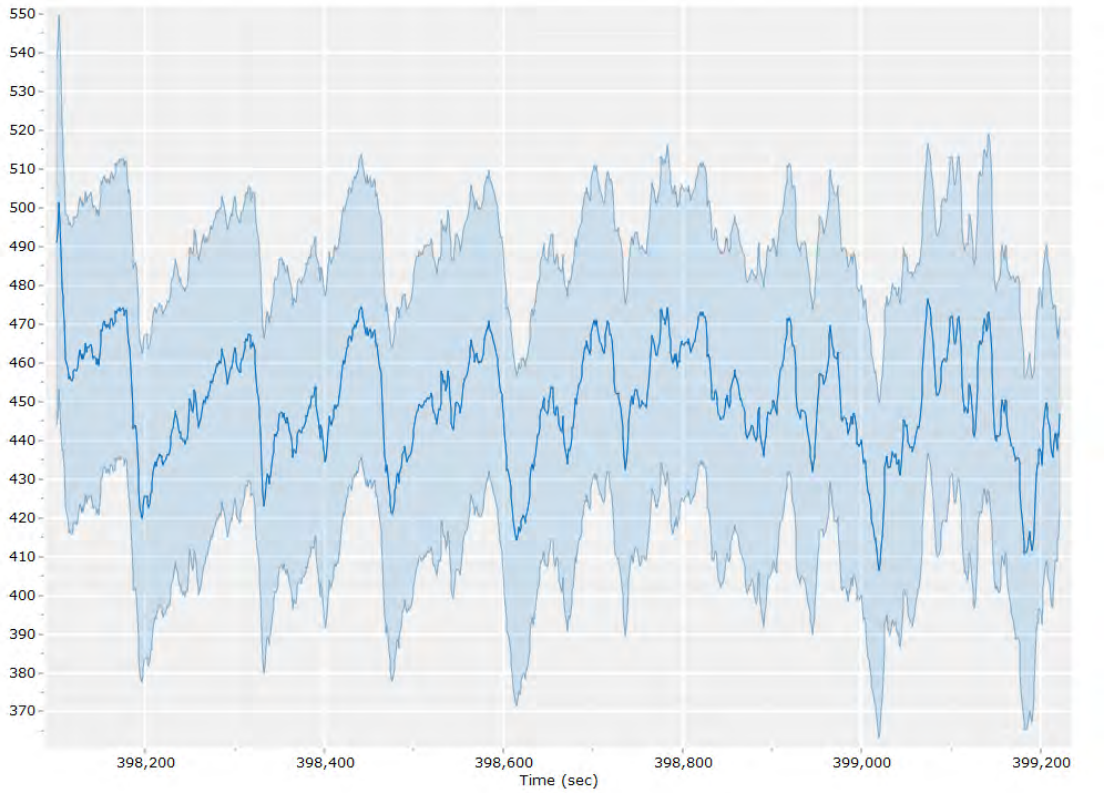
Z Accelerometer Scale Error (ppm)



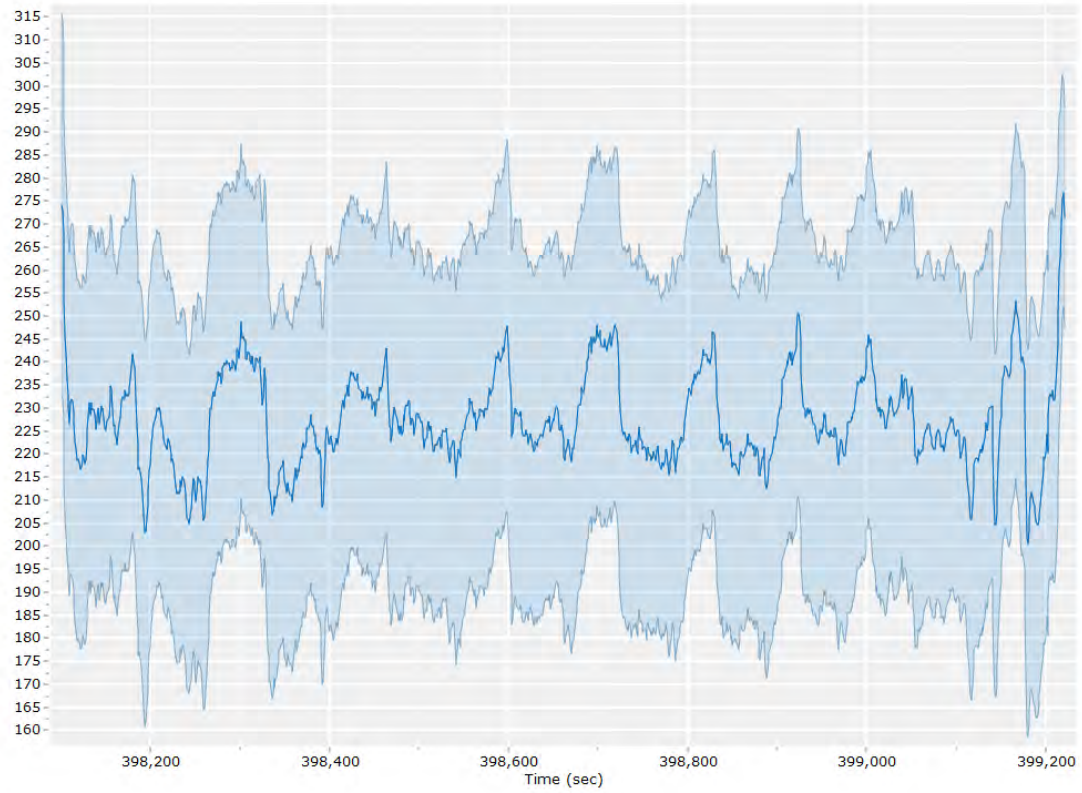
Gyro Bias (deg/h)



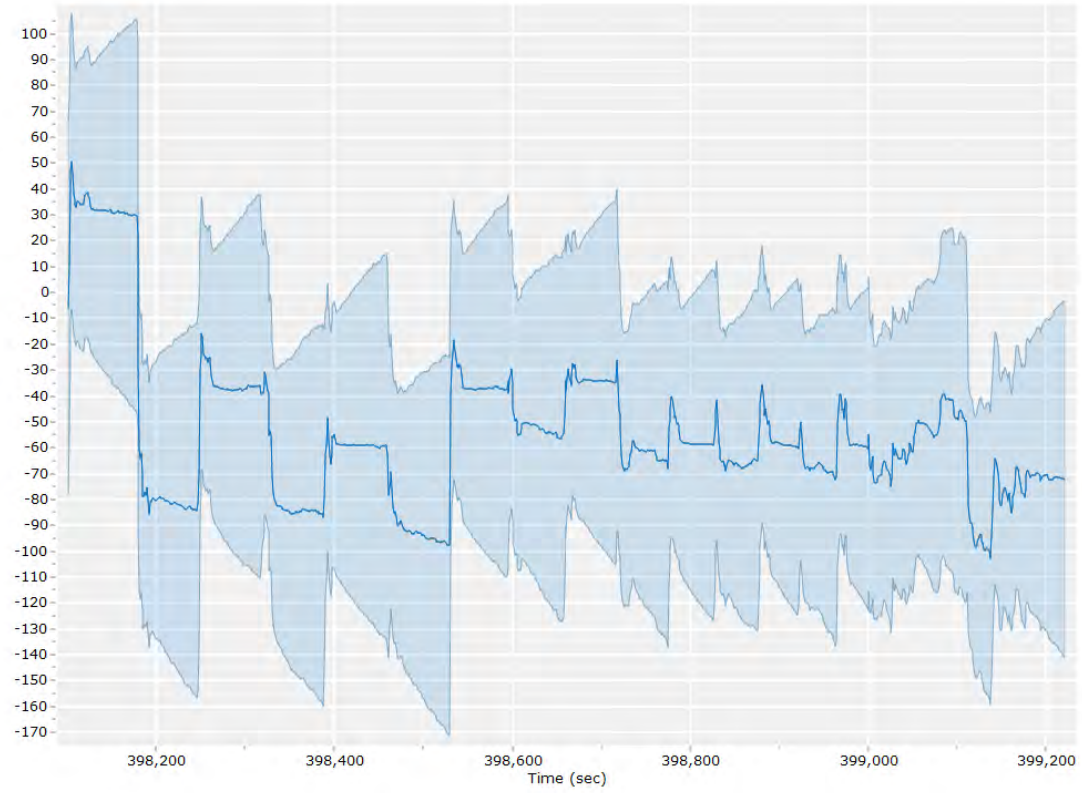
X Gyro Bias (deg/h)



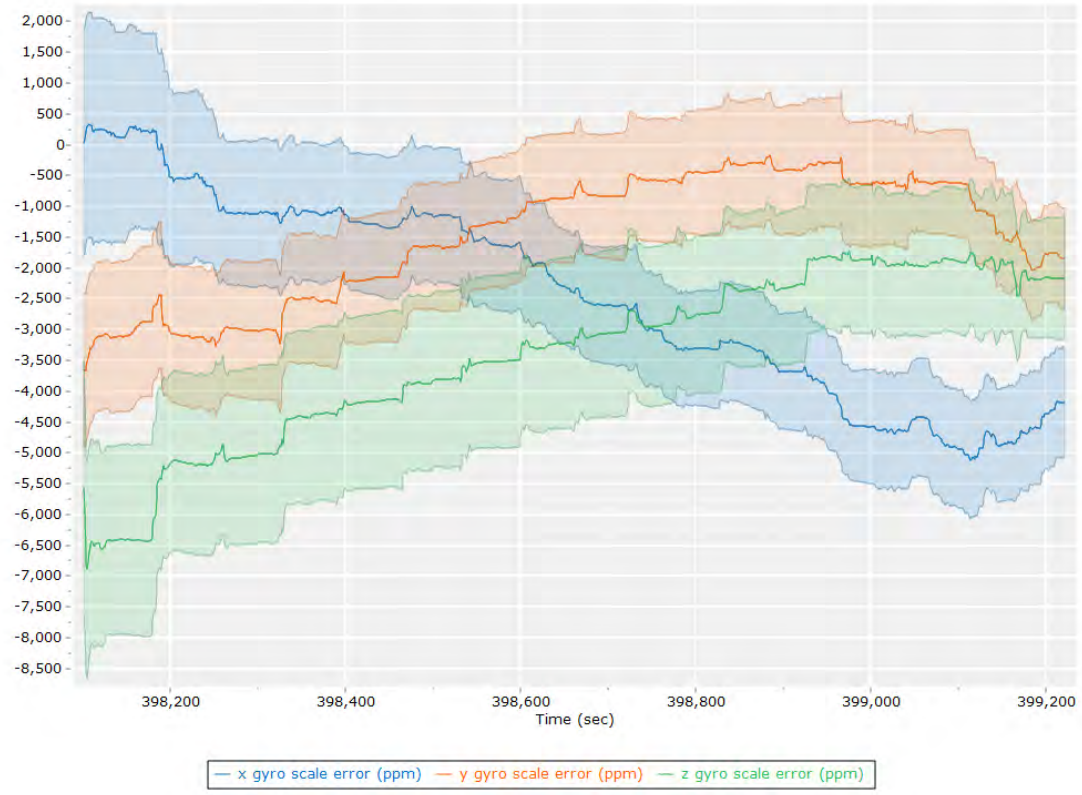
Y Gyro Bias (deg/h)



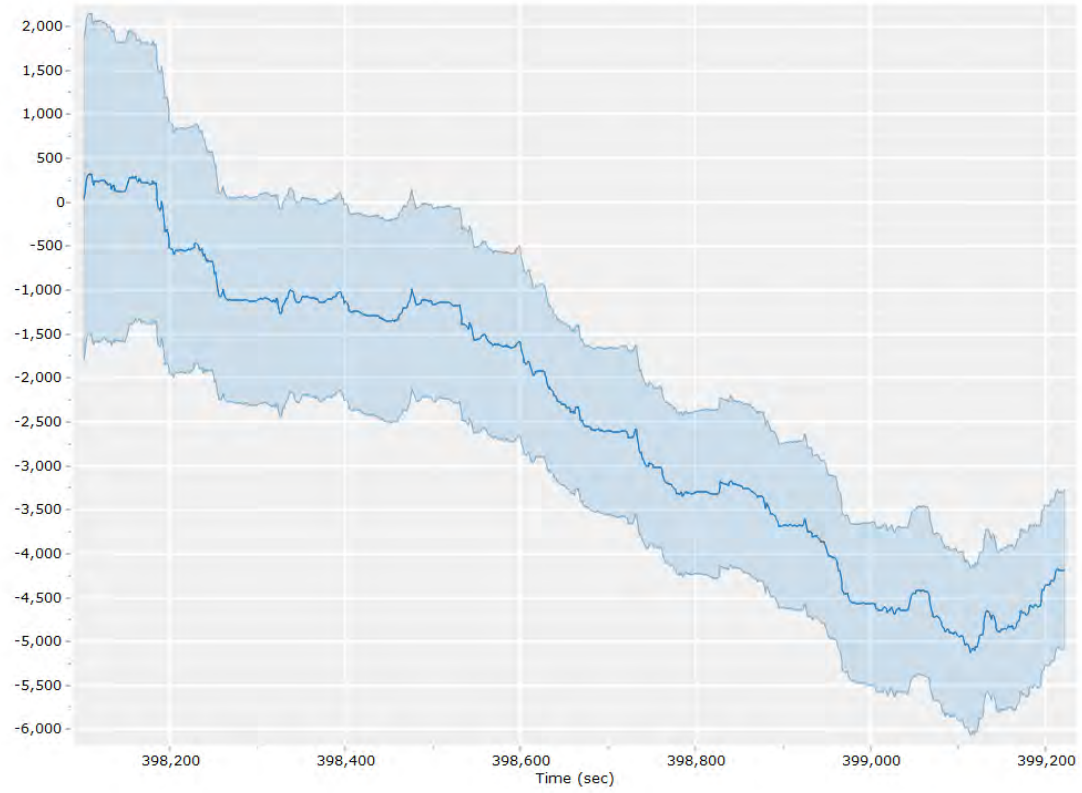
Z Gyro Bias (deg/h)



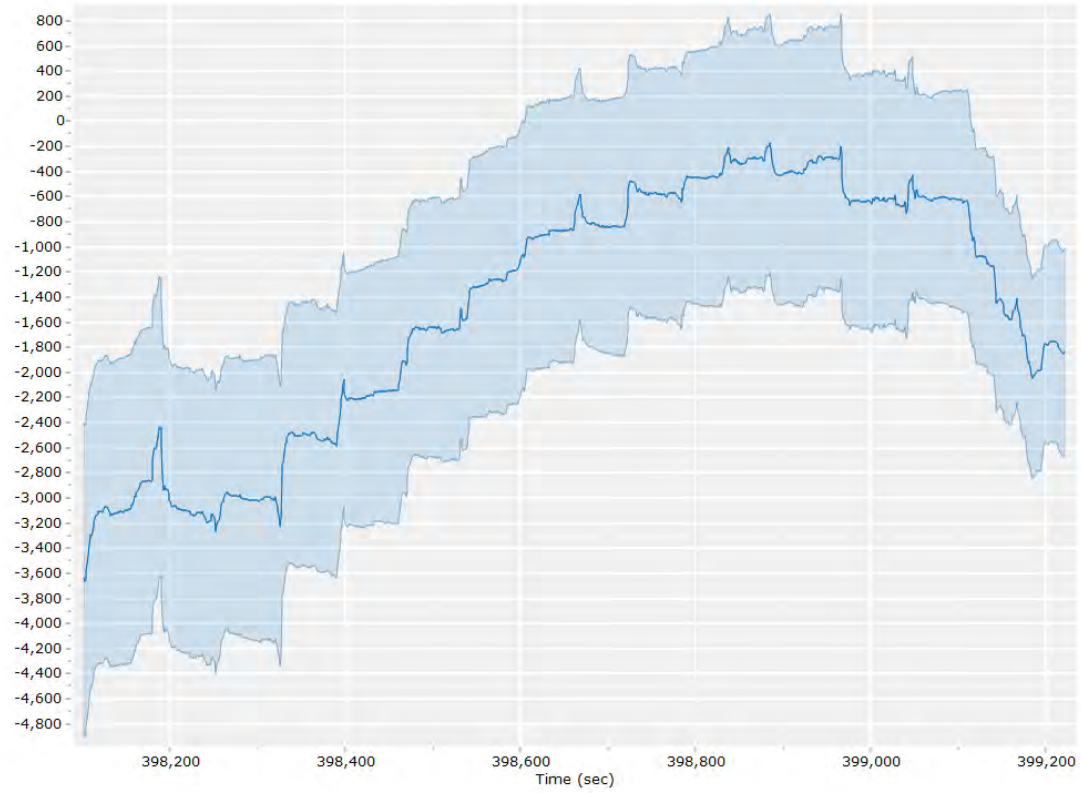
Gyro Scale Error (ppm)



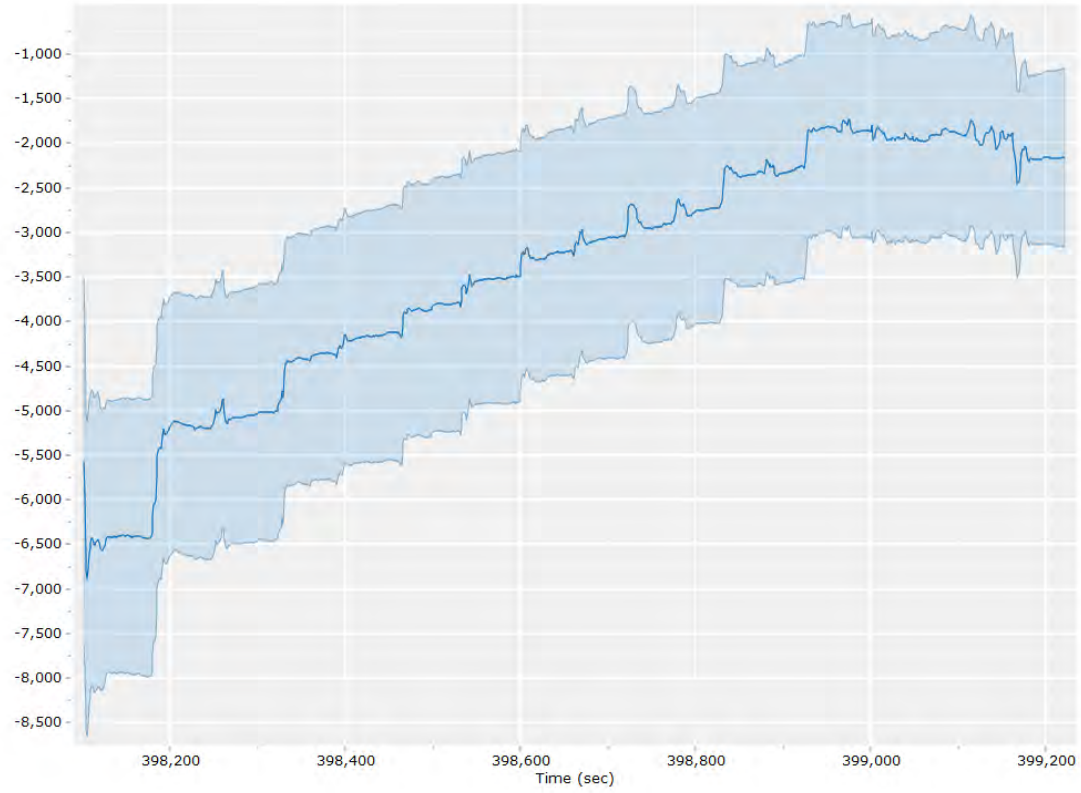
X Gyro Scale Error (ppm)



Y Gyro Scale Error (ppm)

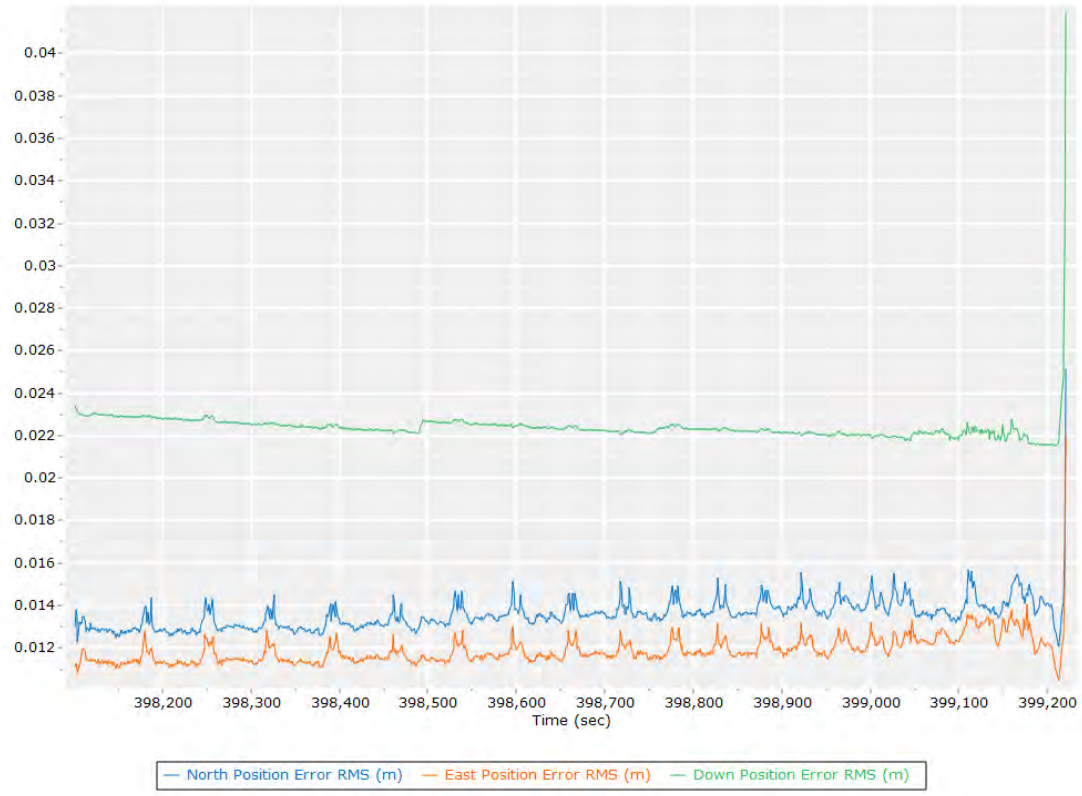


Z Gyro Scale Error (ppm)



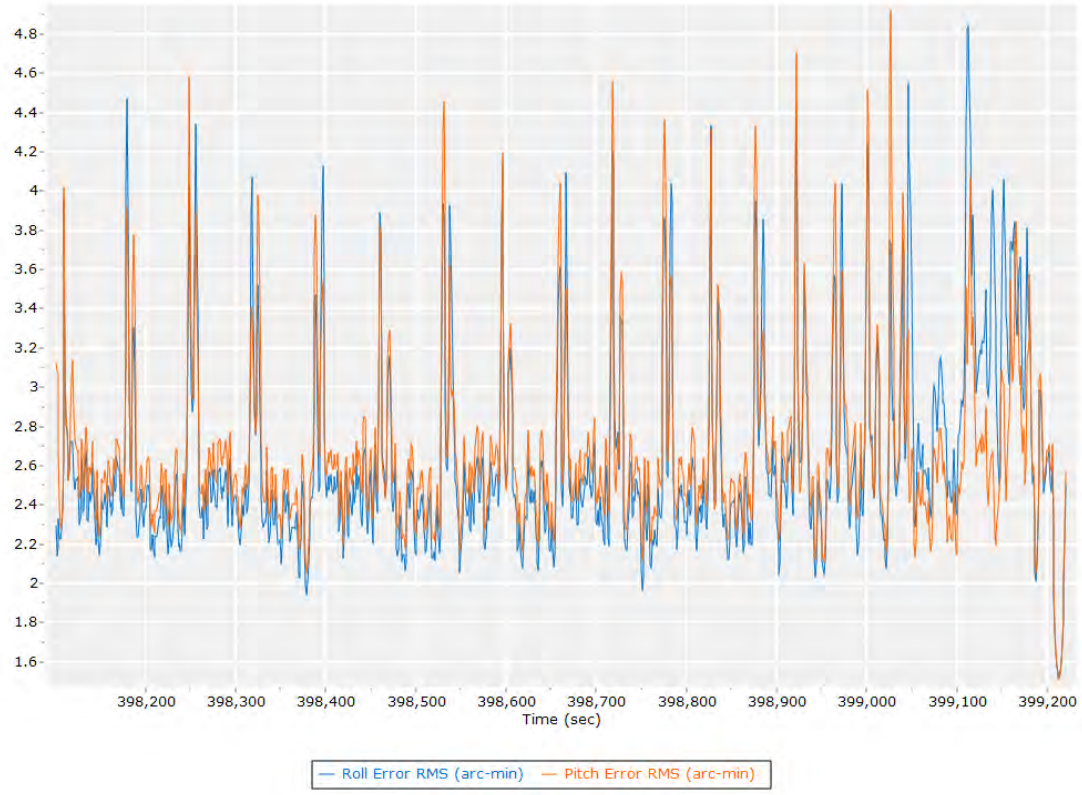
Smoothed Performance Metrics

Position Error RMS (m)

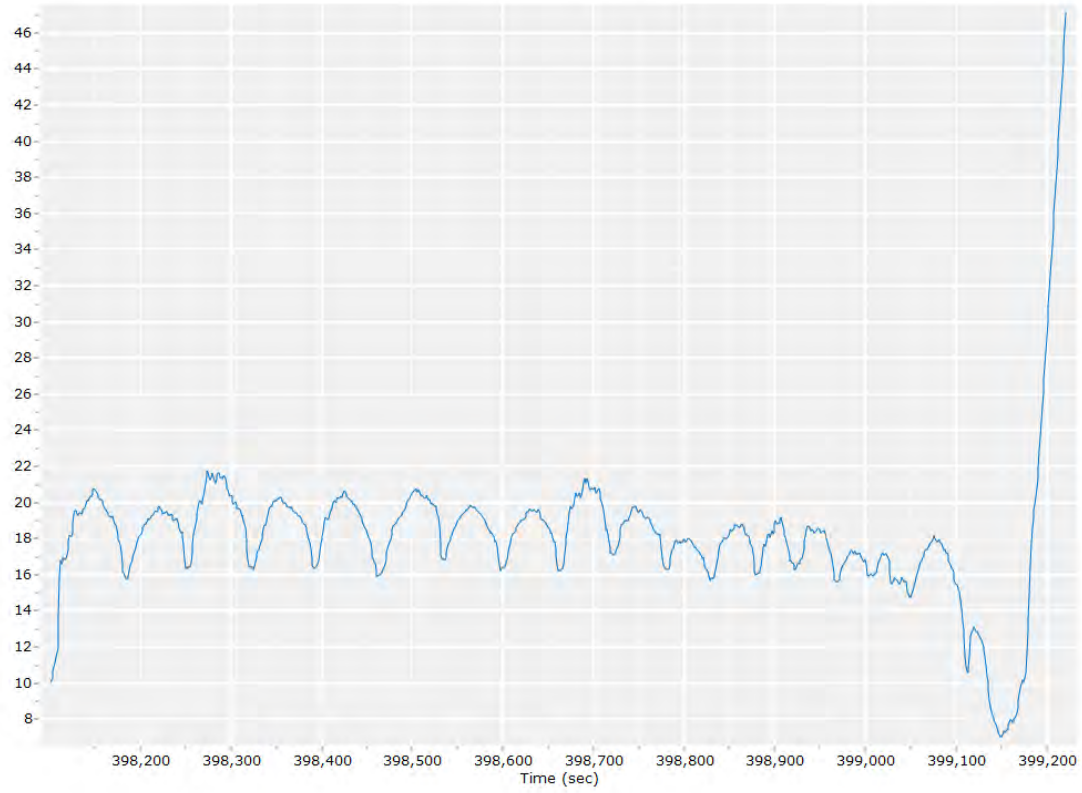


Velocity Error RMS (m/s)

Roll/Pitch Error RMS (arc-min)

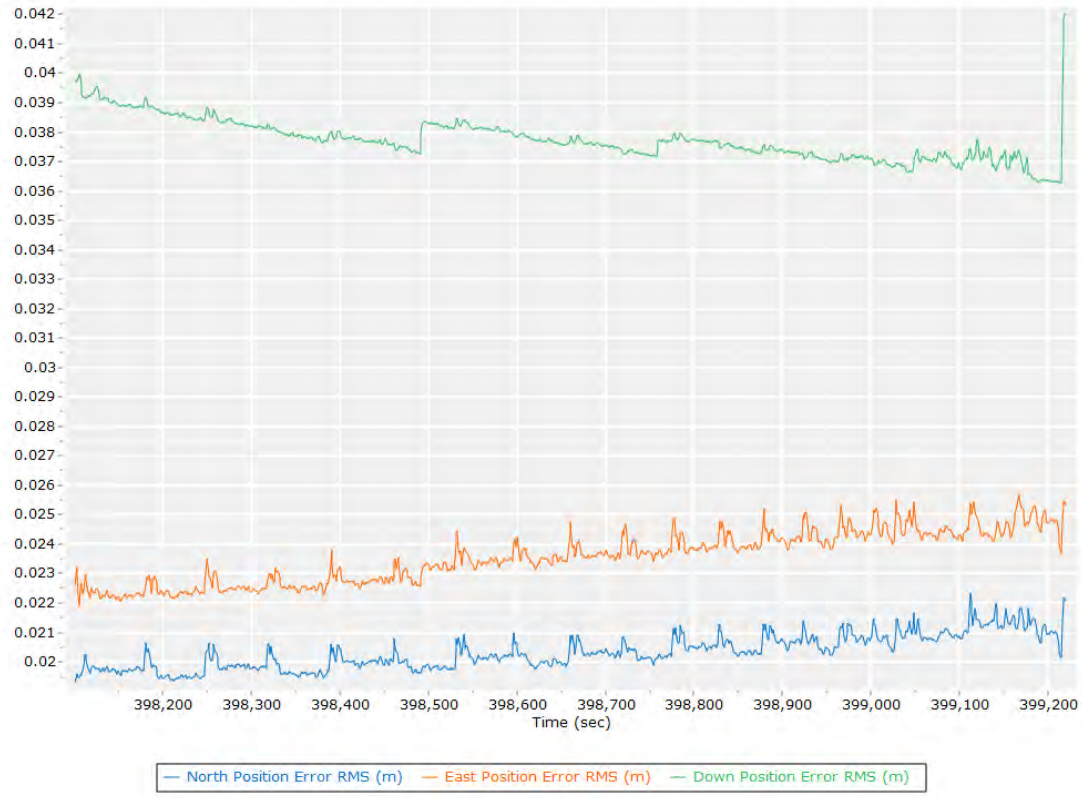


Heading Error RMS (arc-min)

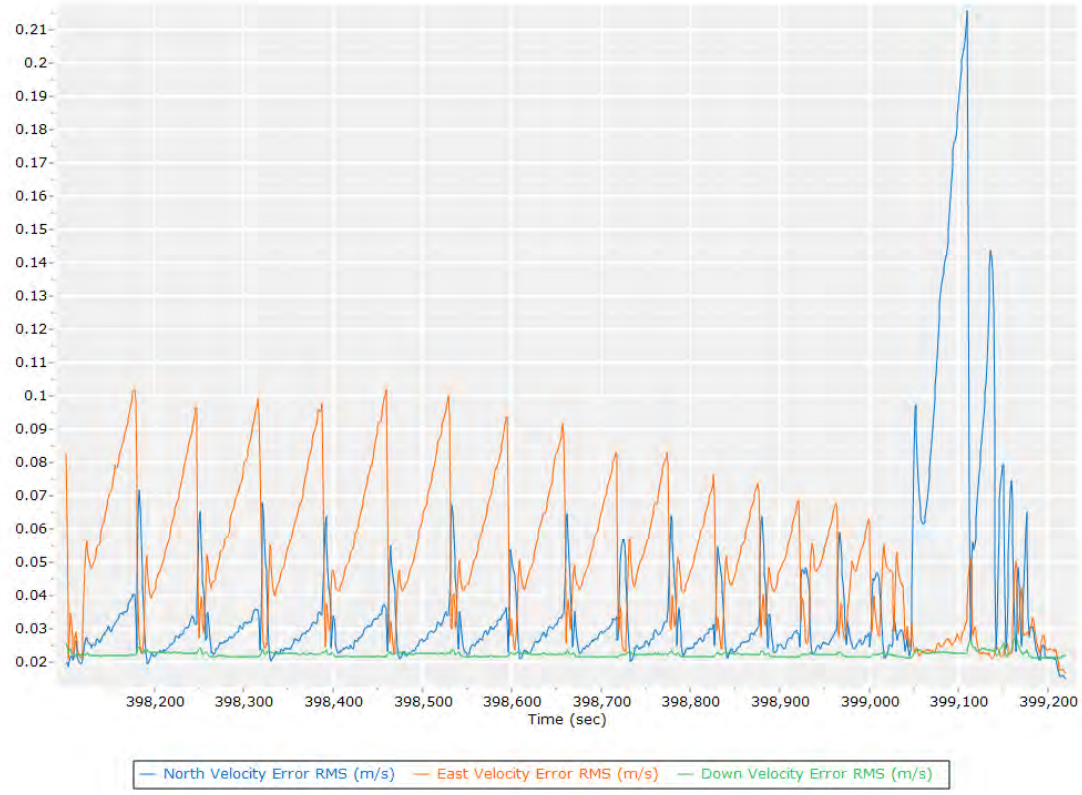


Forward Processed Performance Metrics

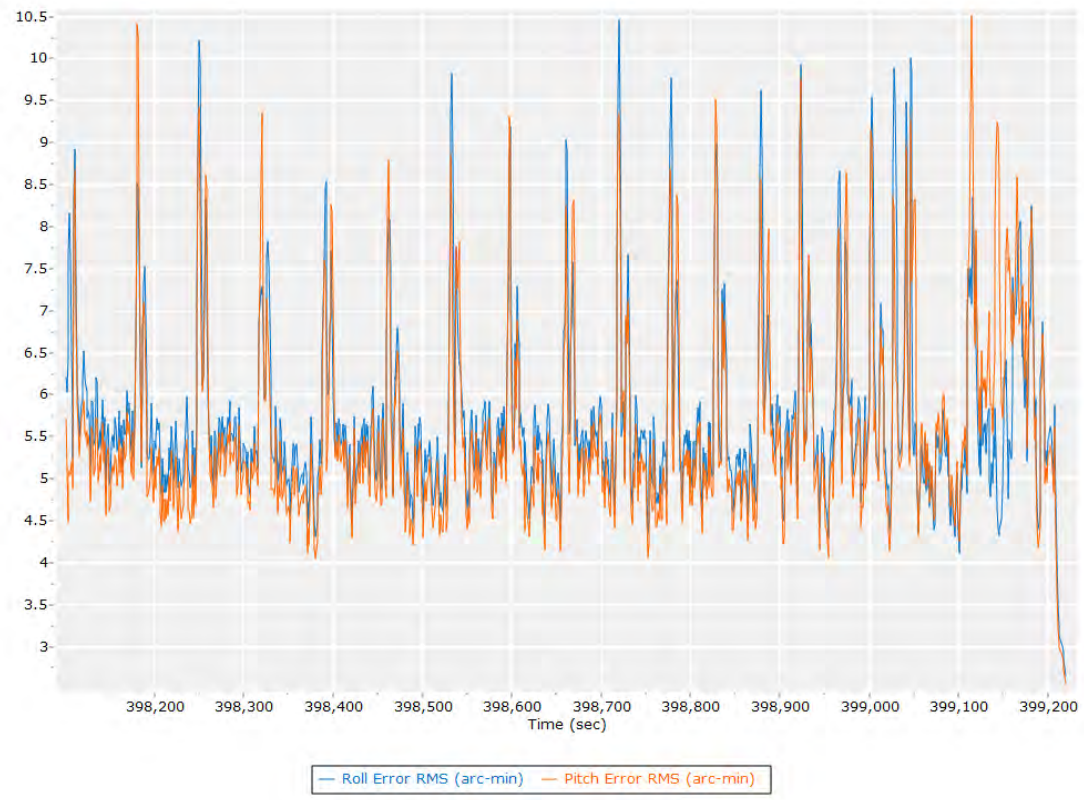
Position Error RMS (m)



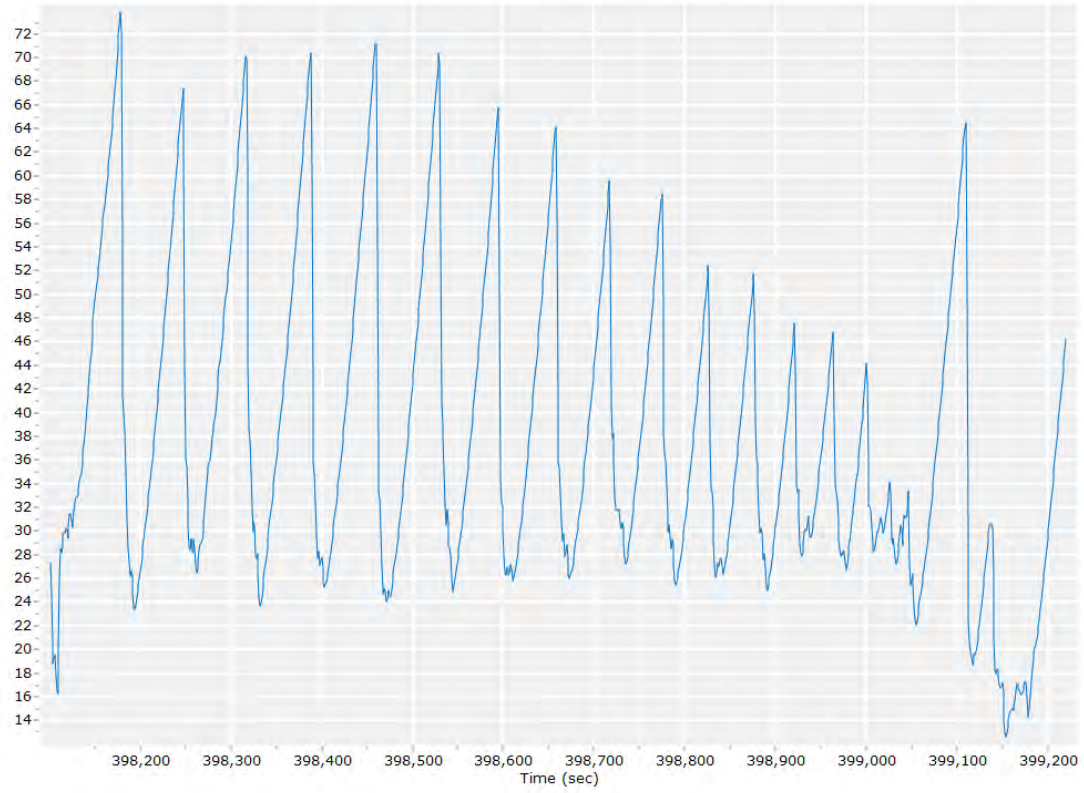
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

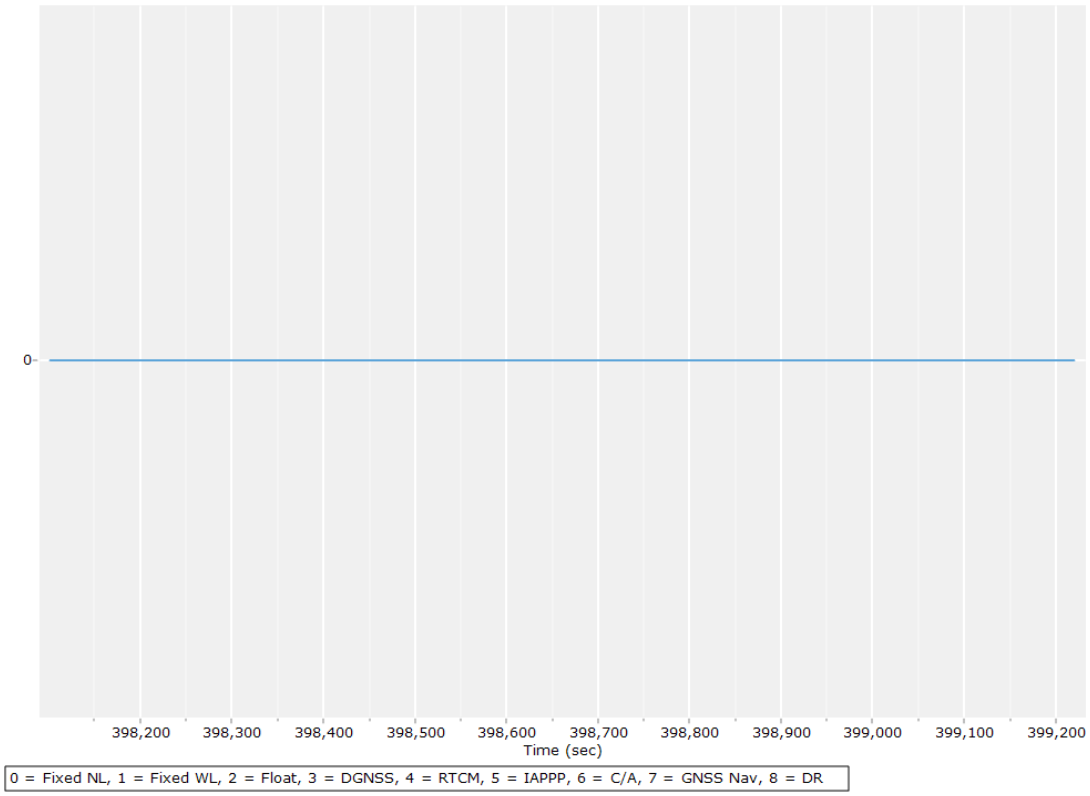


Heading Error RMS (arc-min)

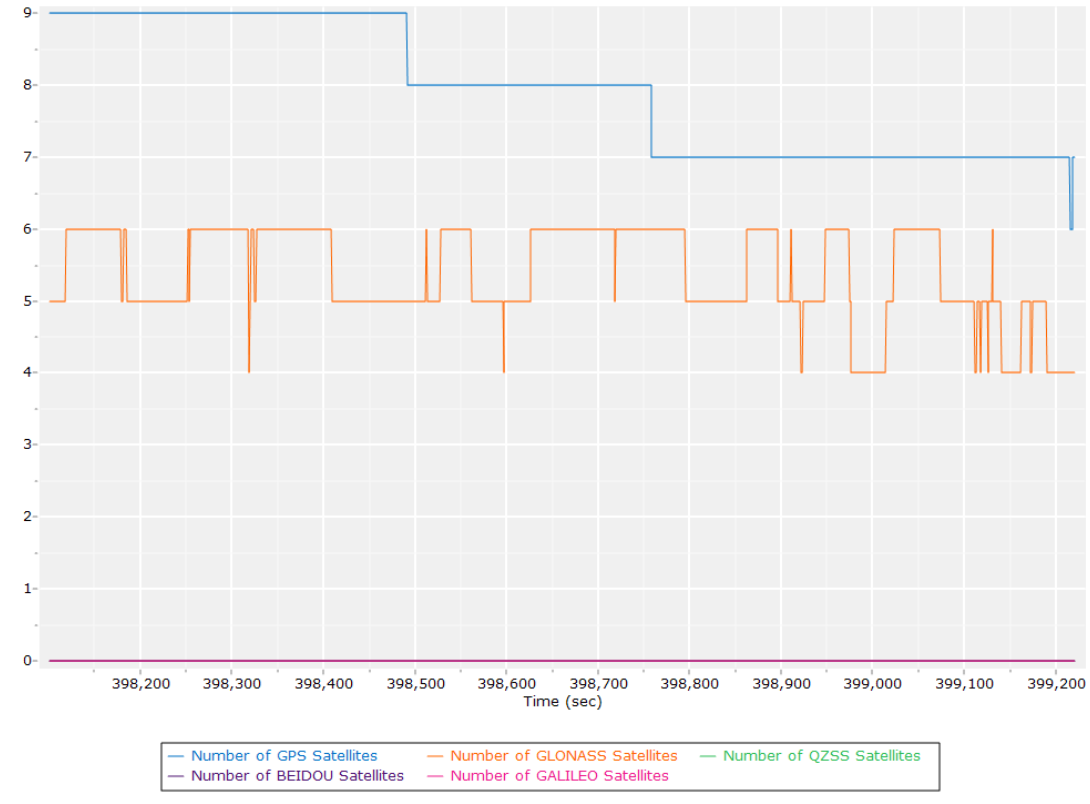


Smoothed Solution Status

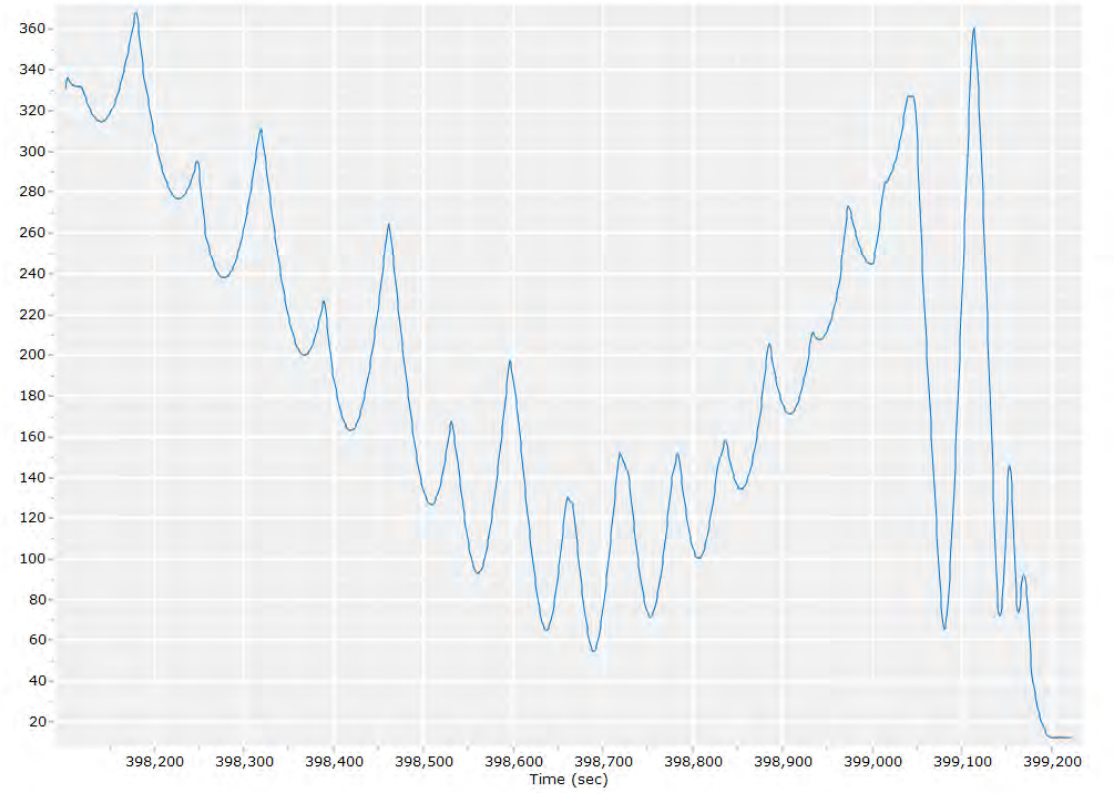
Processing Mode



Number of Satellites

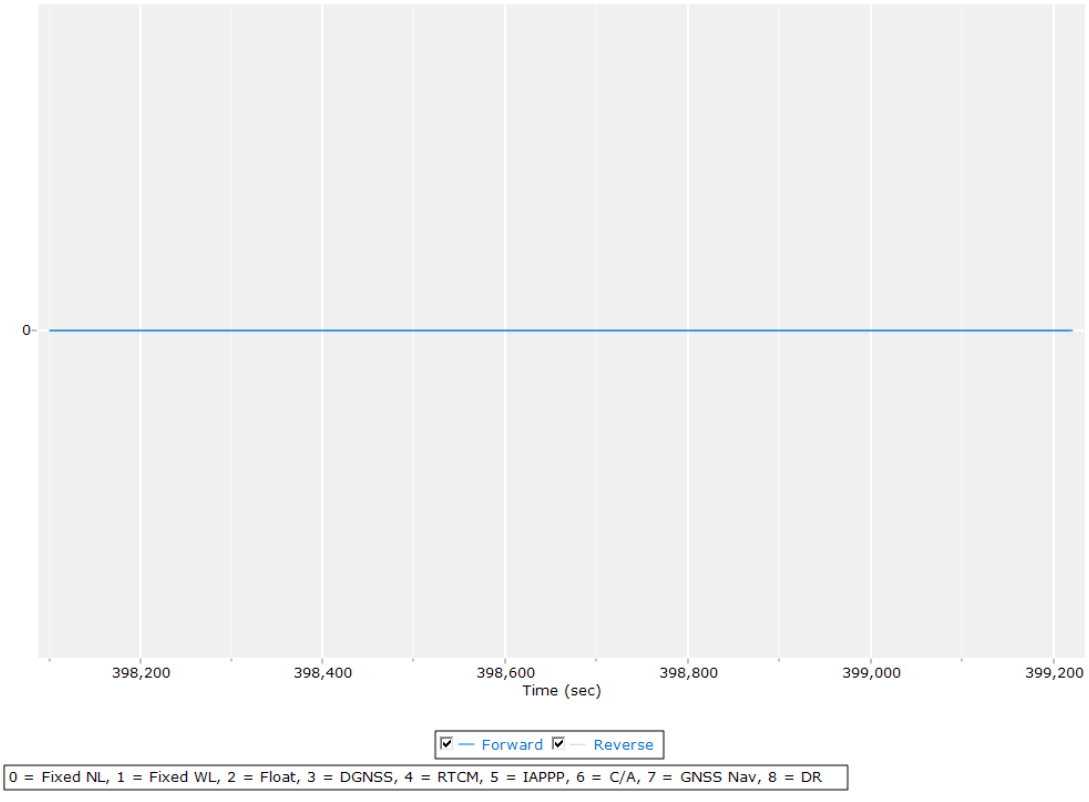


Baseline Length

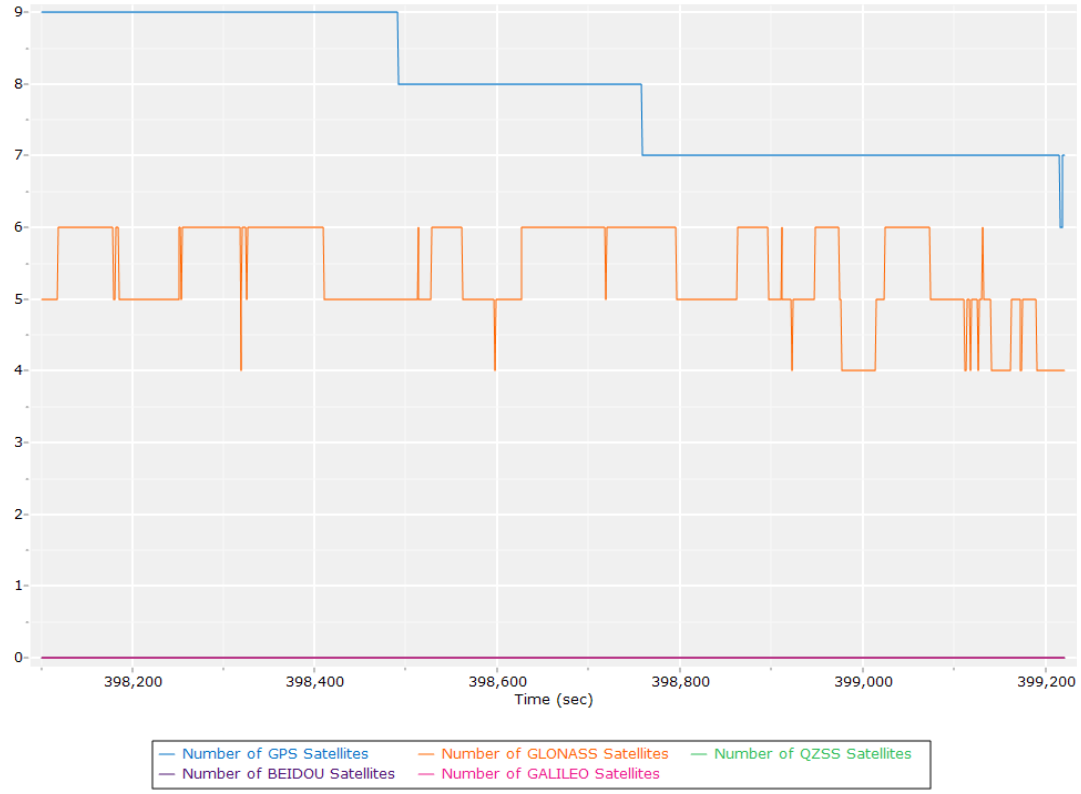


Forward Processed Solution Status

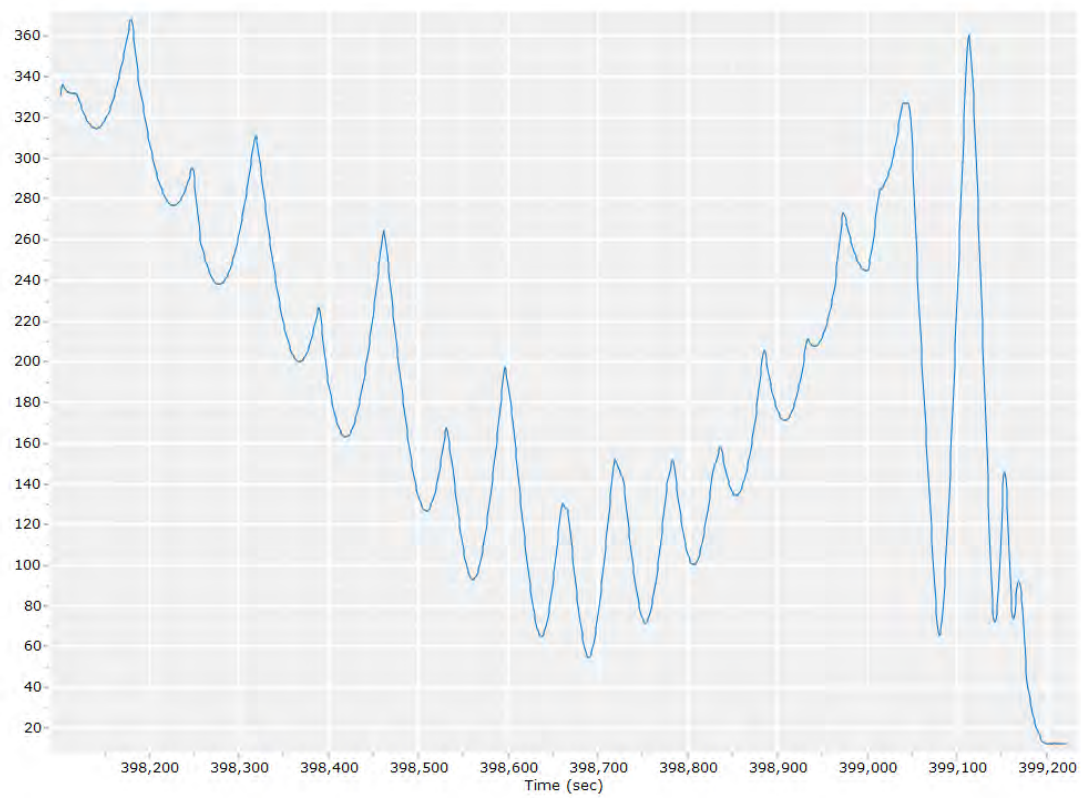
Processing Mode



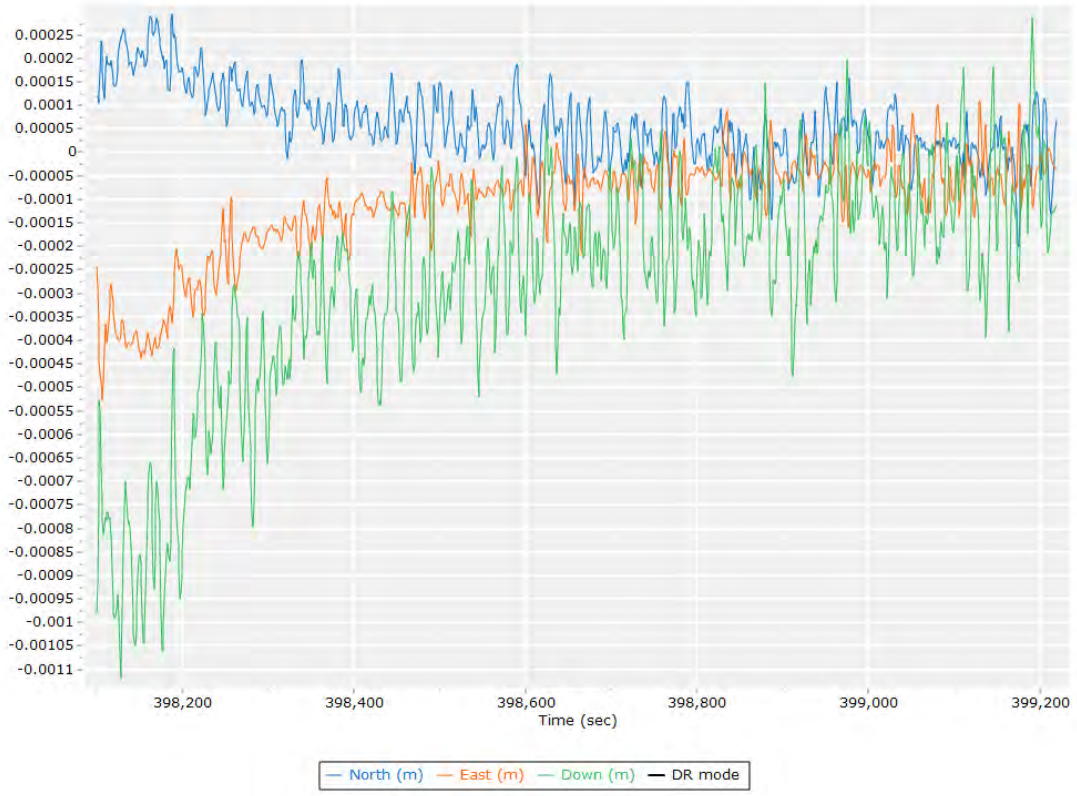
Number of Satellites



Baseline Length



SBET IAKAR Separation



Export Summary Section 1

Export file	YS-20250206-143232sbet.txt		
Export format	ASCII		
Solution in use	Post-processed		
Output rate	All Records		
Reference to Output lever arm (m)	0.000	0.000	0.000
Reference mounting angles (deg)	0.000	0.000	0.000
Output units (Coordinate / Lat & Lon)	Meter	Meter	
Export start time	0.000 (02/02/2025 00:00:00)		
Export end time	395199.000 (02/13/2025 13:46:39)		
Height option	Applanix Orthometric Height		
Geoid model	OSGM15 (United Kingdom)		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 30 (6W to 0W)		
Datum	ETRS89		
Ellipsoid	GRS 1980		
Local Transformation	NONE		
Target Epoch	1989		

General Information

Mission Information

Project name	YS-20250206-154148
Processing date	2025-02-18 12:28:37
Mission date	2025-02-06 15:42:11
Mission duration	00:16:38.000
Processing mode	IN-Fusion Single Base
GPS Station	base

Rover Hardware Information

Product	APX 15 AVX 210
Dynamic Model	Airborne Rotor
Serial number	6202C16694
IMU type	59
Receiver type	APX-15v3
Antenna type	AV18

Project File List

Rover Data Files

File name	File type
YS-20250206-154148.t04	T04 Rover Data

Input Files

File Name	File Type
BRDC00IGS_R_20250370000_01D_MN.rnx	GPS, GLONASS, GALILEO, QZSS, BEIDOU Broadcast Ephemeris
Ephm0370.25g	GLONASS Broadcast Ephemeris
Ephm0370.25n	GPS Broadcast Ephemeris
base0374.25O	GNSS SingleBase

Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
YS-20250206-154148sbet.txt	ASCII Export Output

Rover Data Summary

First raw data file	YS-20250206-154148.t04		
Last raw data file	YS-20250206-154148.t04		
Start GPS week	2352		
Start time	402131.000 (02/06/2025 15:42:11)		
End time	403129.000 (02/06/2025 15:58:49)		
Start of fine alignment	402177.880 (02/06/2025 15:42:57)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
IMU Installation Lever Arms & Mounting Angles			
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.050	0.120	-0.510
Reference to Primary GNSS lever arm std dev (m)	0.020		
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

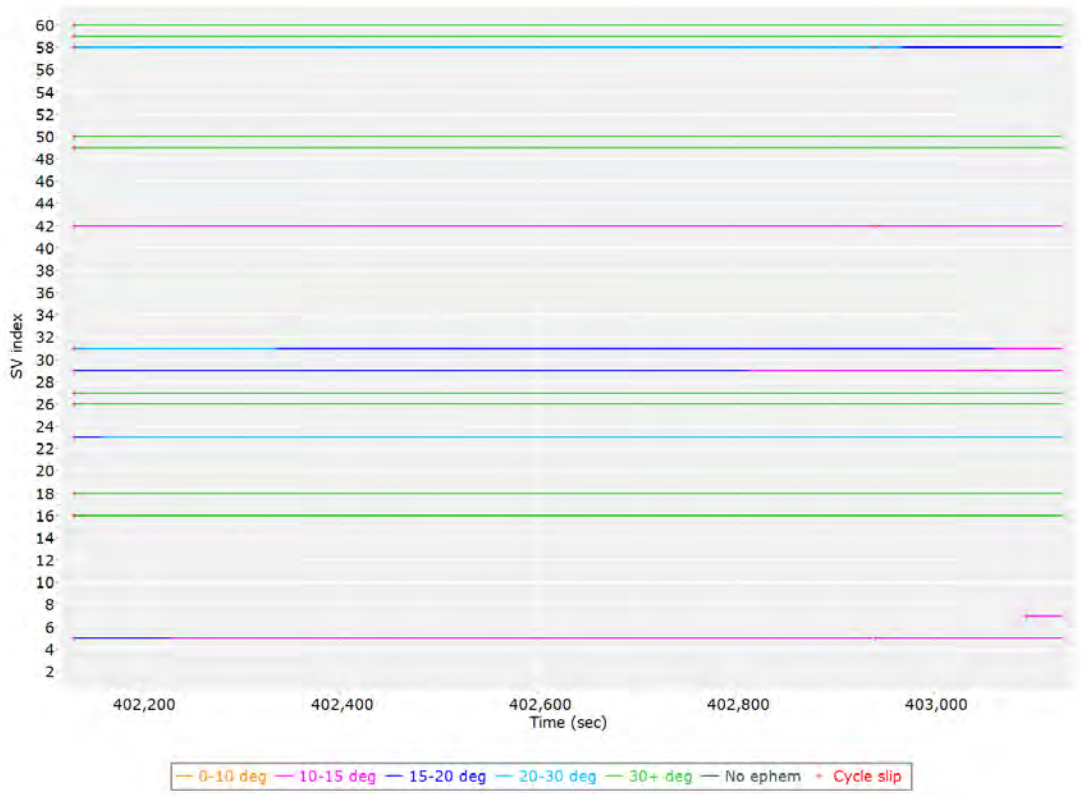
Rover Data QC

Raw IMU Import QC Summary

IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	199658
Termination Status	Normal
IMU Anomalies	0

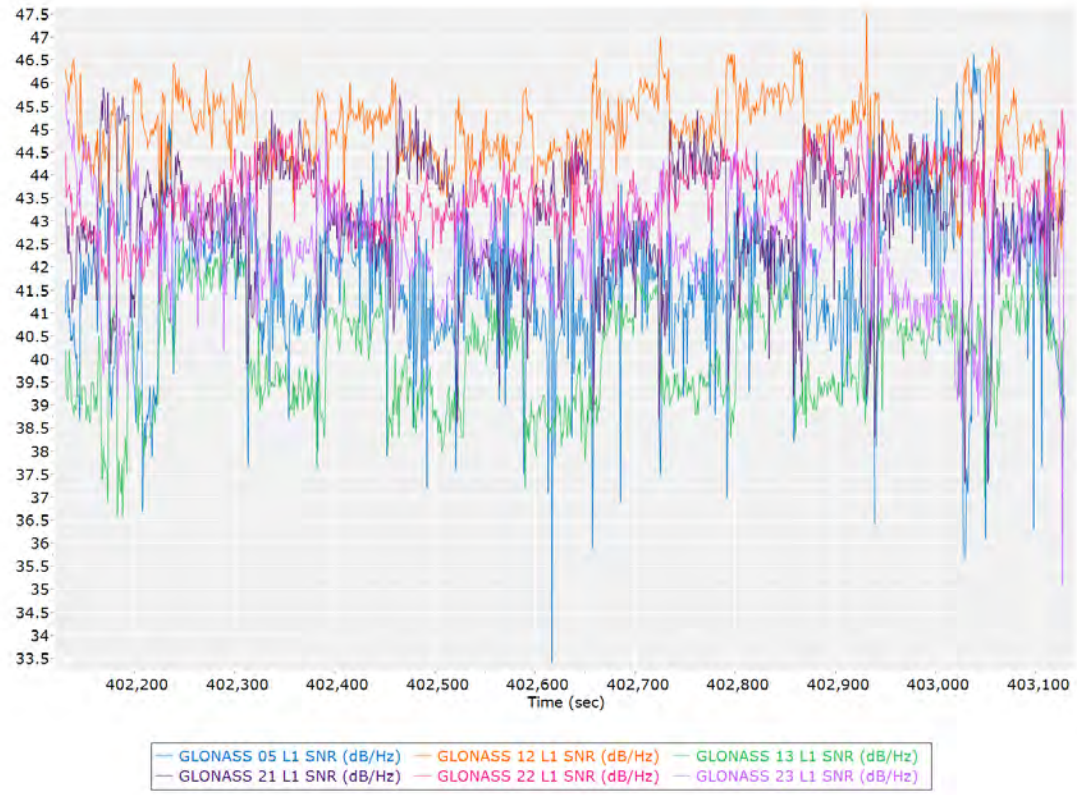
Primary Observables & Satellite Data

GPS/GLONASS L1 Satellite Lock/Elevation

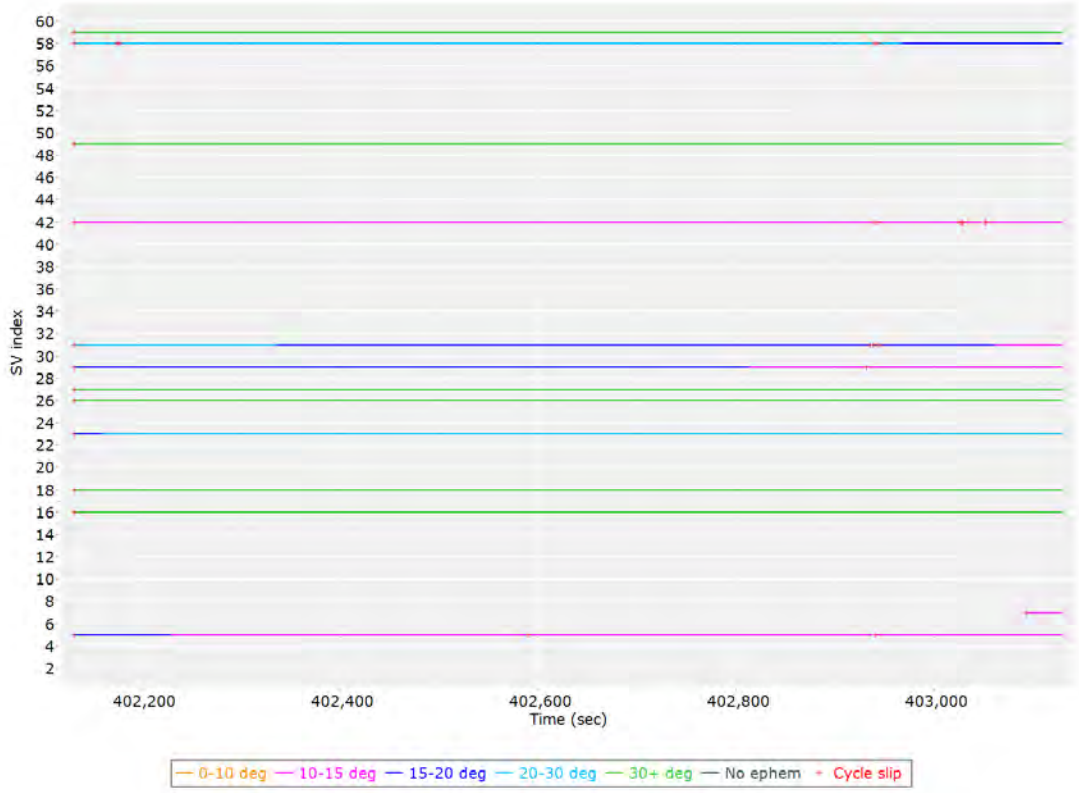


GPS L1 SNR

GLONASS L1 SNR



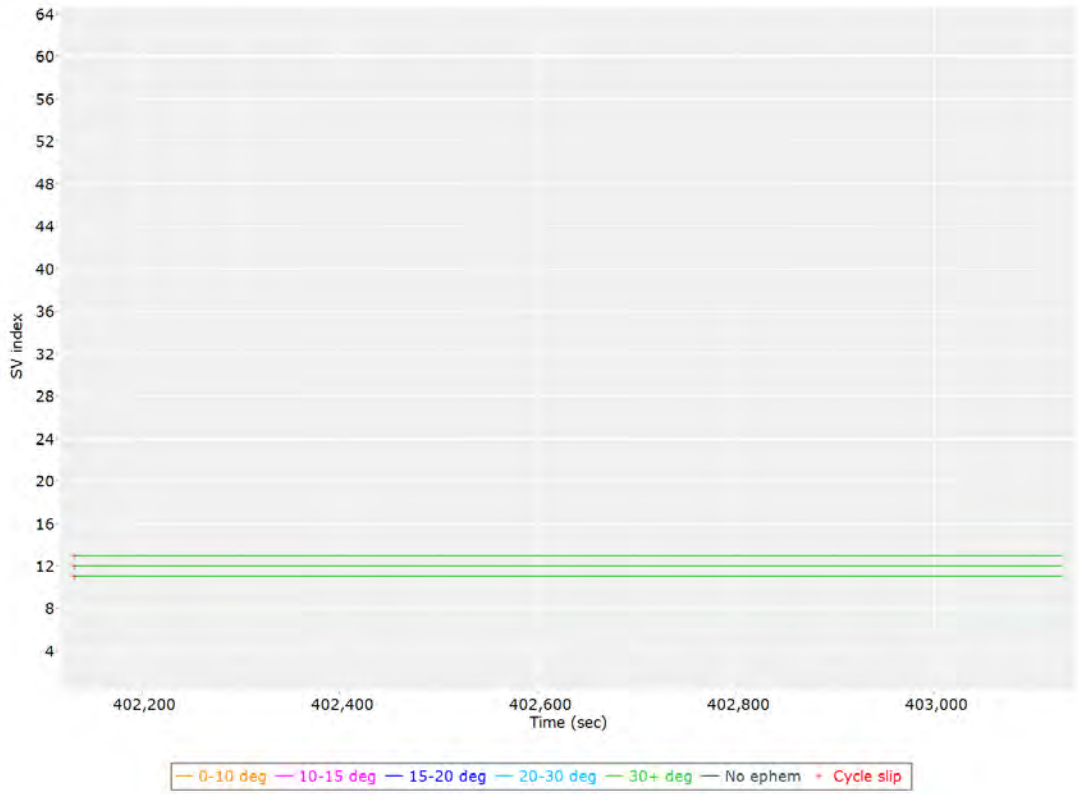
GPS/GLONASS L2 Satellite Lock/Elevation



GPS L2 SNR

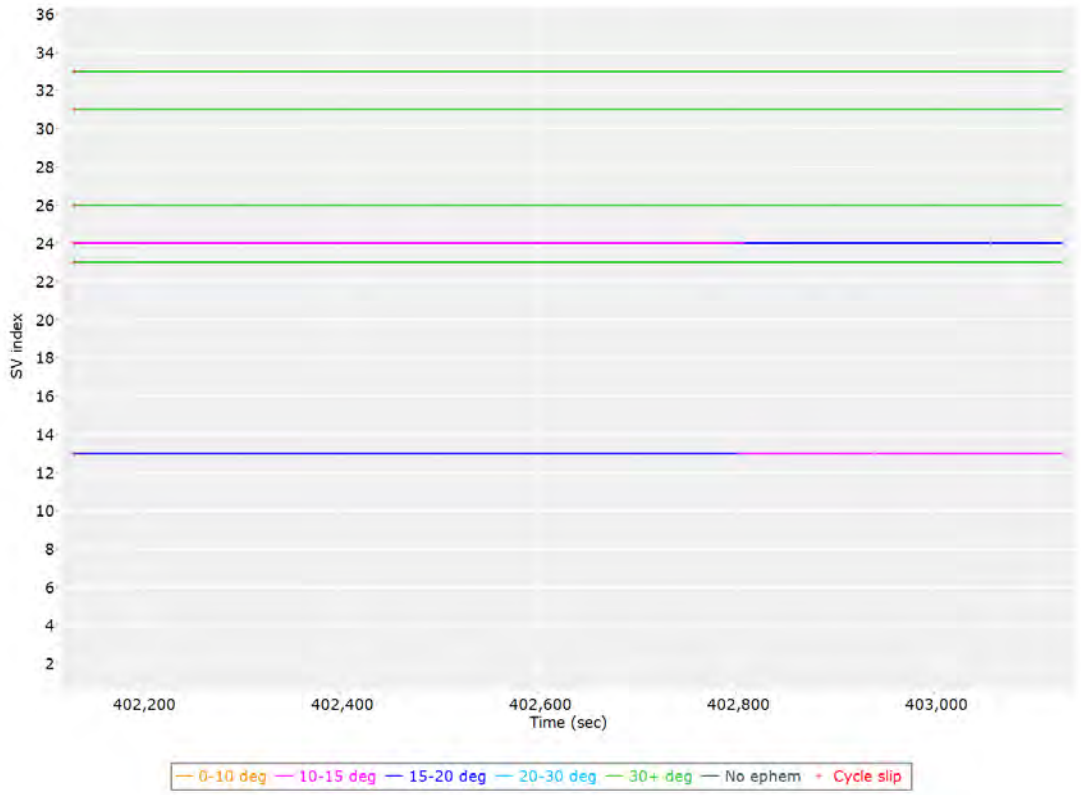
GLONASS L2 SNR

BEIDOU Satellite Lock/Elevation

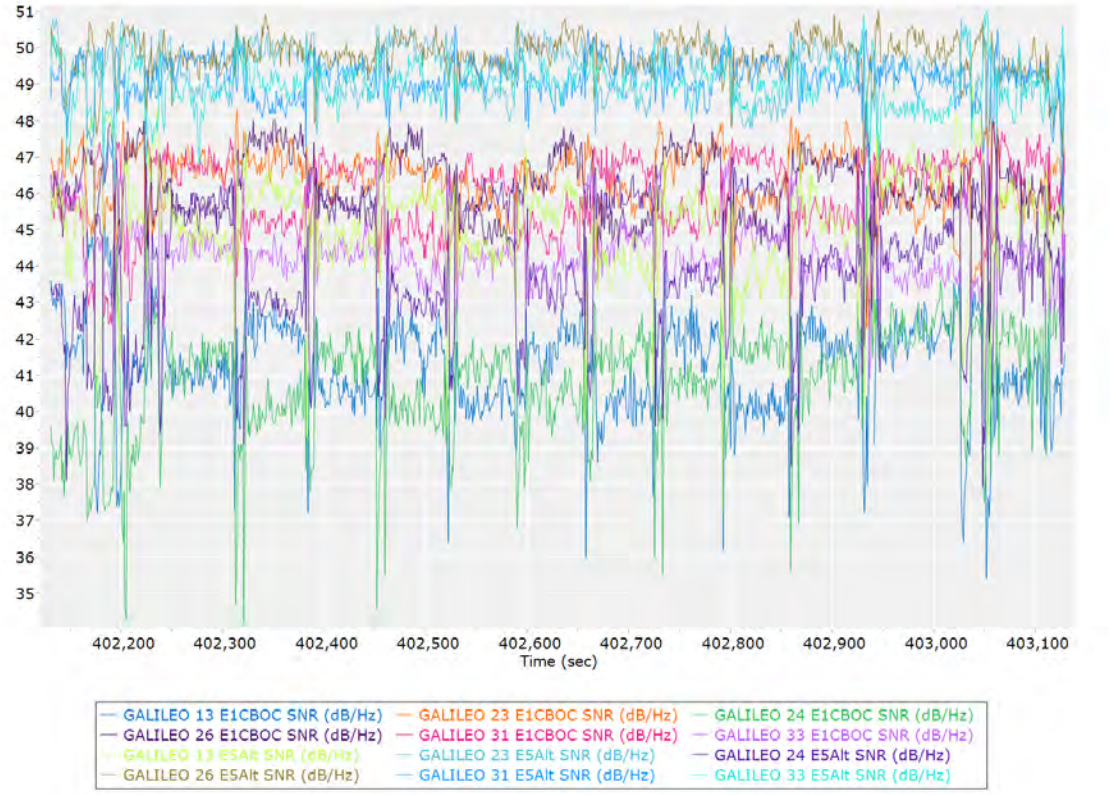


BEIDOU SNR

GALILEO Satellite Lock/Elevation



GALILEO SNR


51
50
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43
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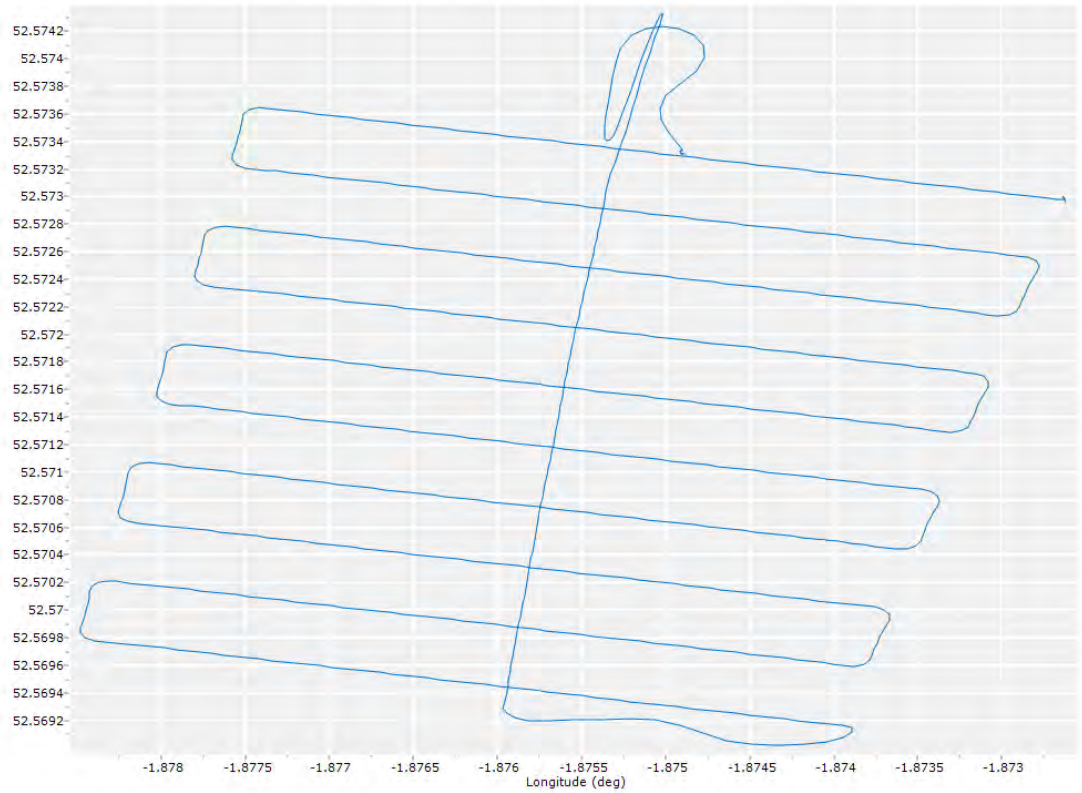
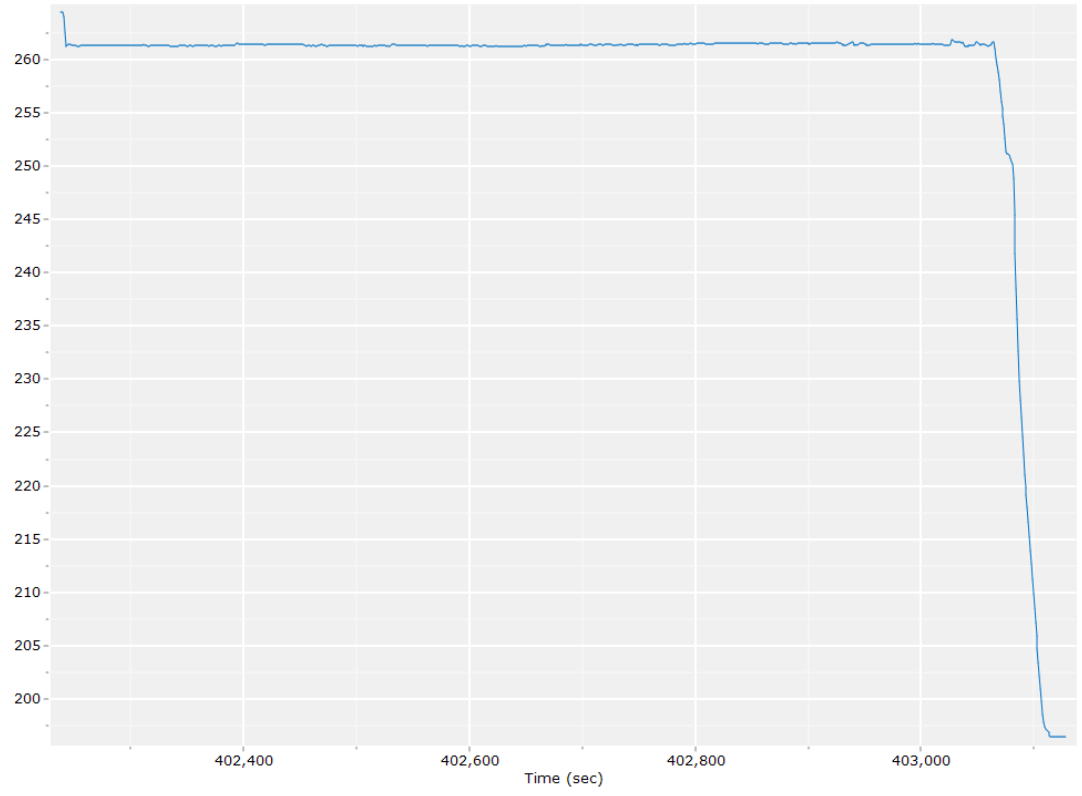
41
40
39
38
37
36
35
402,200
402,300
402,400
402,500
402,600
402,700
402,800
402,900
403,000
403,100
Time (sec)
GALILEO 13 E1CBOC SNR (dB/Hz)
GALILEO 23 E1CBOC SNR (dB/Hz)
GALILEO 24 E1CBOC SNR (dB/Hz)
GALILEO 26 E1CBOC SNR (dB/Hz)
GALILEO 31 E1CBOC SNR (dB/Hz)
GALILEO 33 E1CBOC SNR (dB/Hz)
GALILEO 13 E5Alt SNR (dB/Hz)
GALILEO 23 E5Alt SNR (dB/Hz)
GALILEO 24 E5Alt SNR (dB/Hz)
GALILEO 26 E5Alt SNR (dB/Hz)
GALILEO 31 E5Alt SNR (dB/Hz)
GALILEO 33 E5Alt SNR (dB/Hz)

Smoothed Trajectory Information

Top View

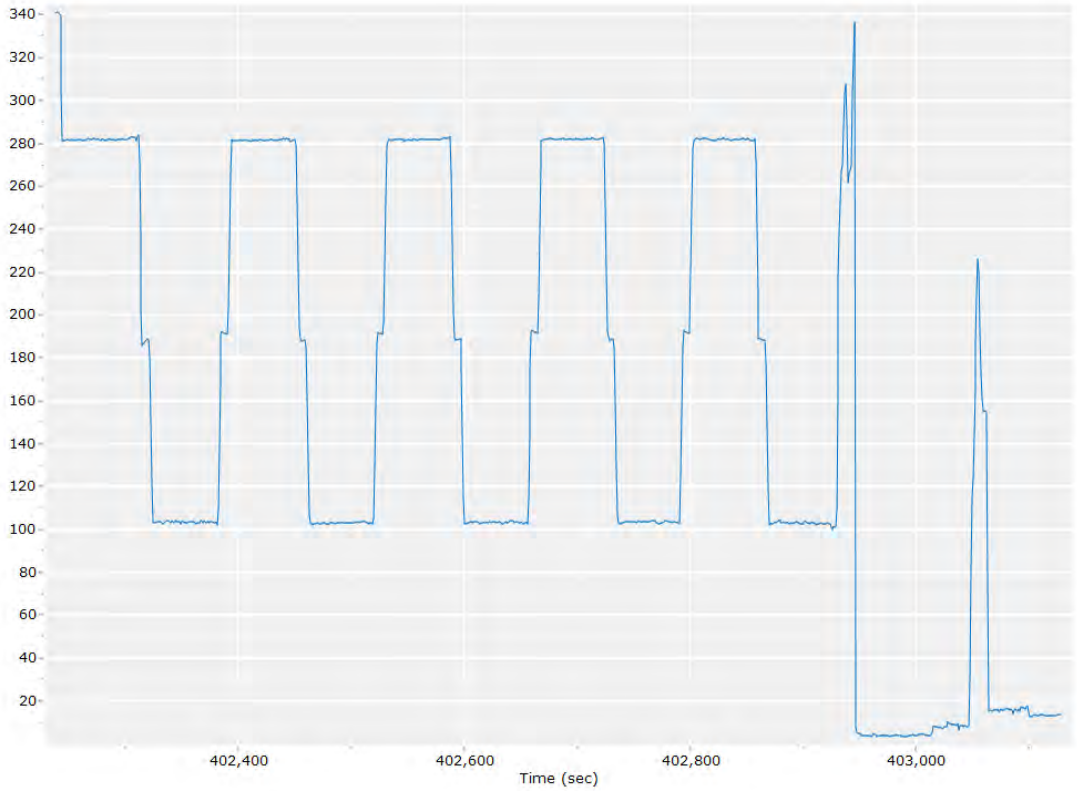


Altitude

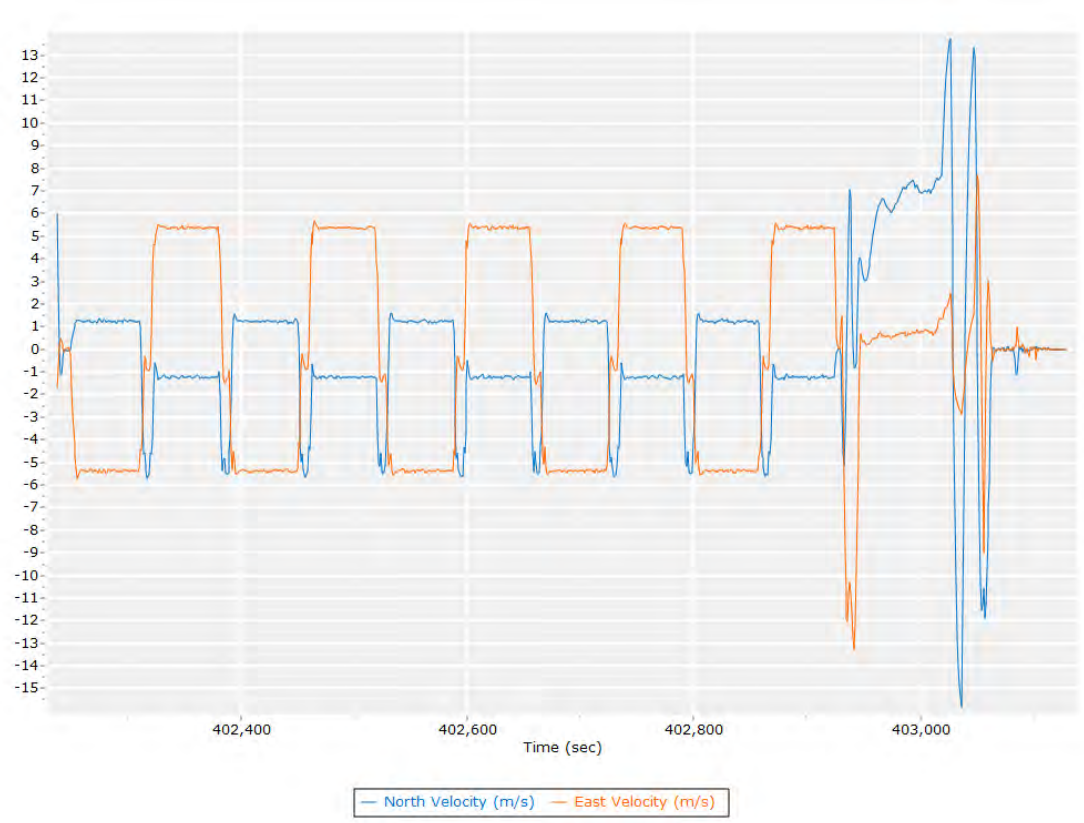


Roll/Pitch

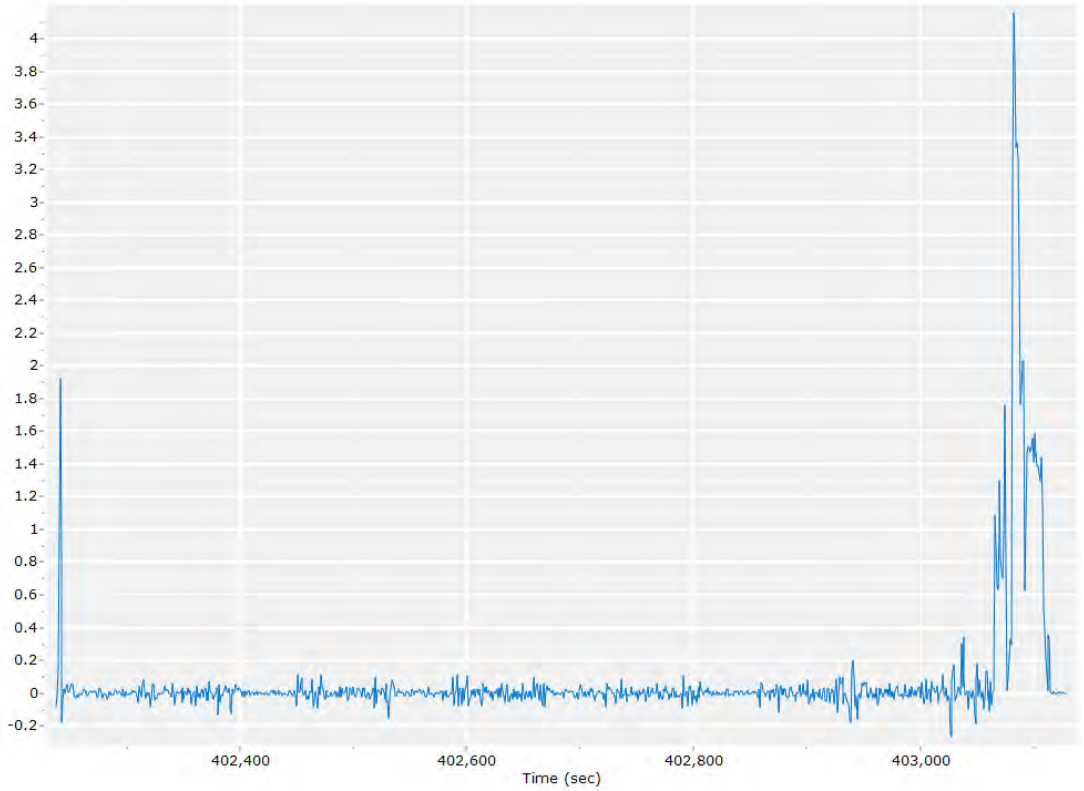
Heading



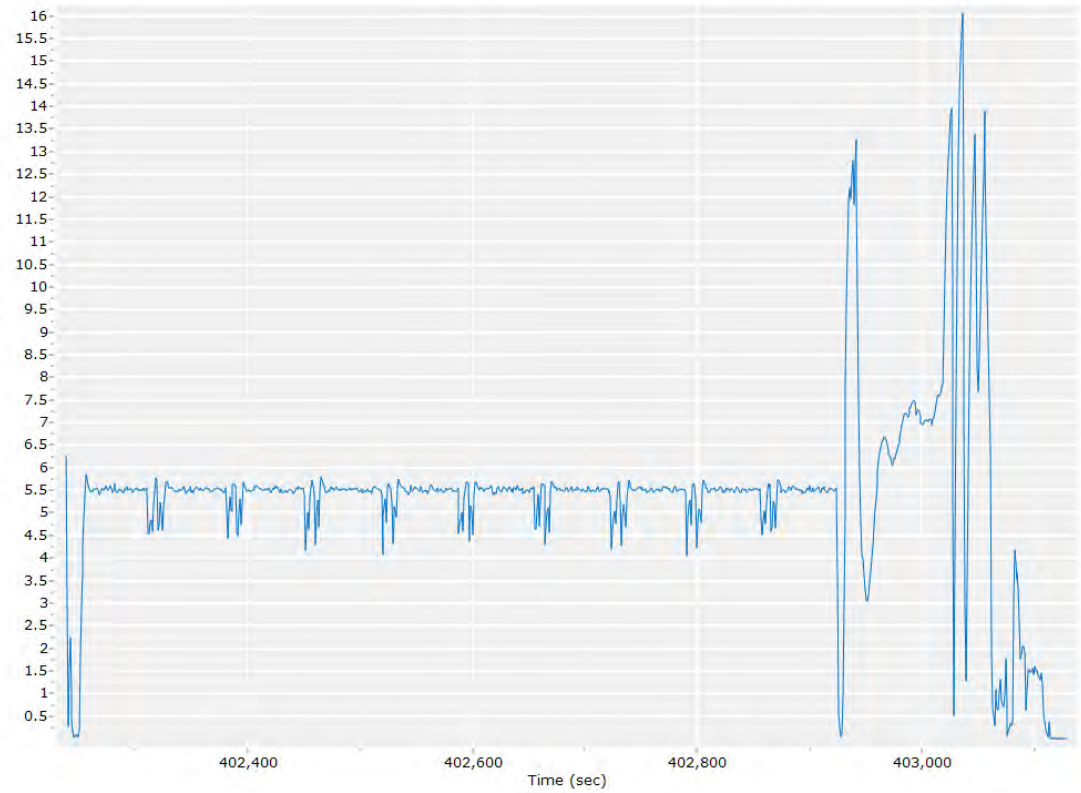
North/East Velocity



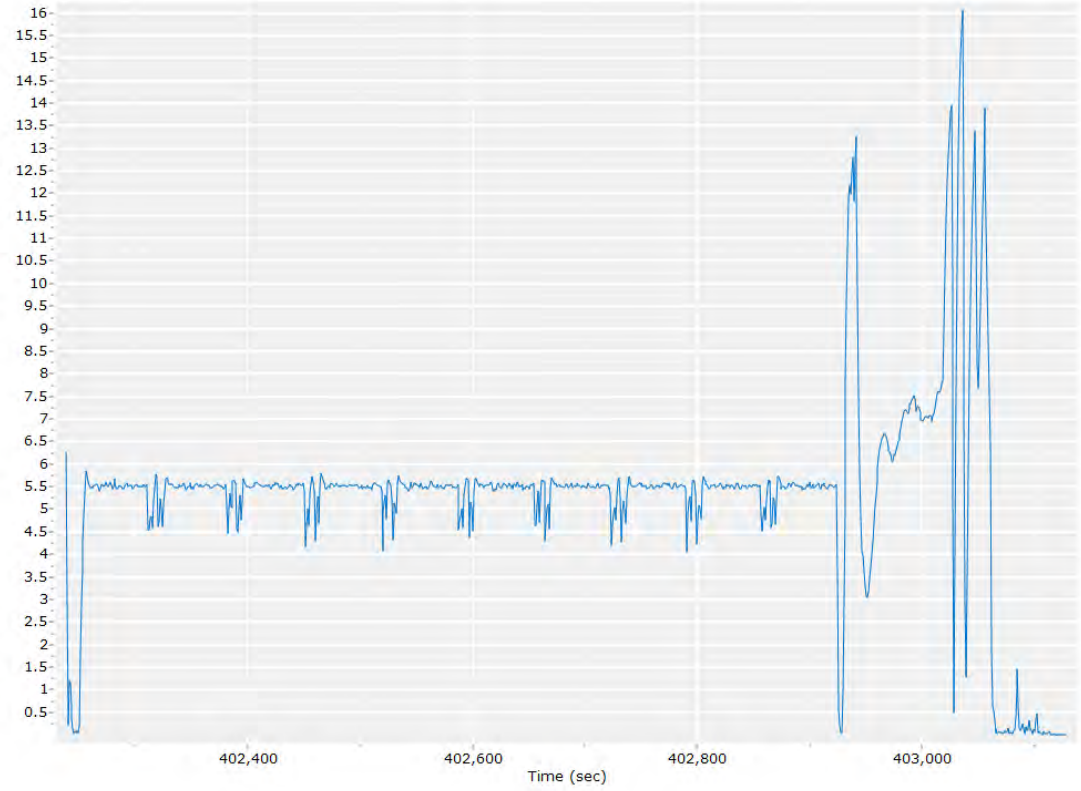
Down Velocity



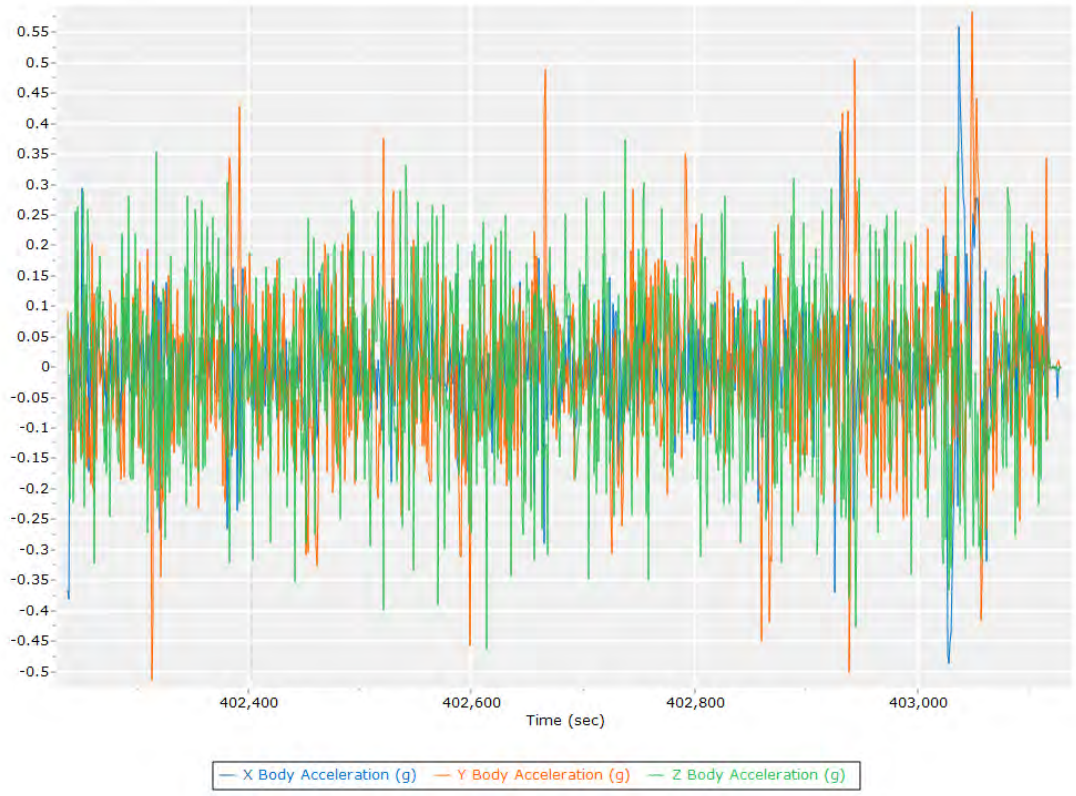
Total Speed



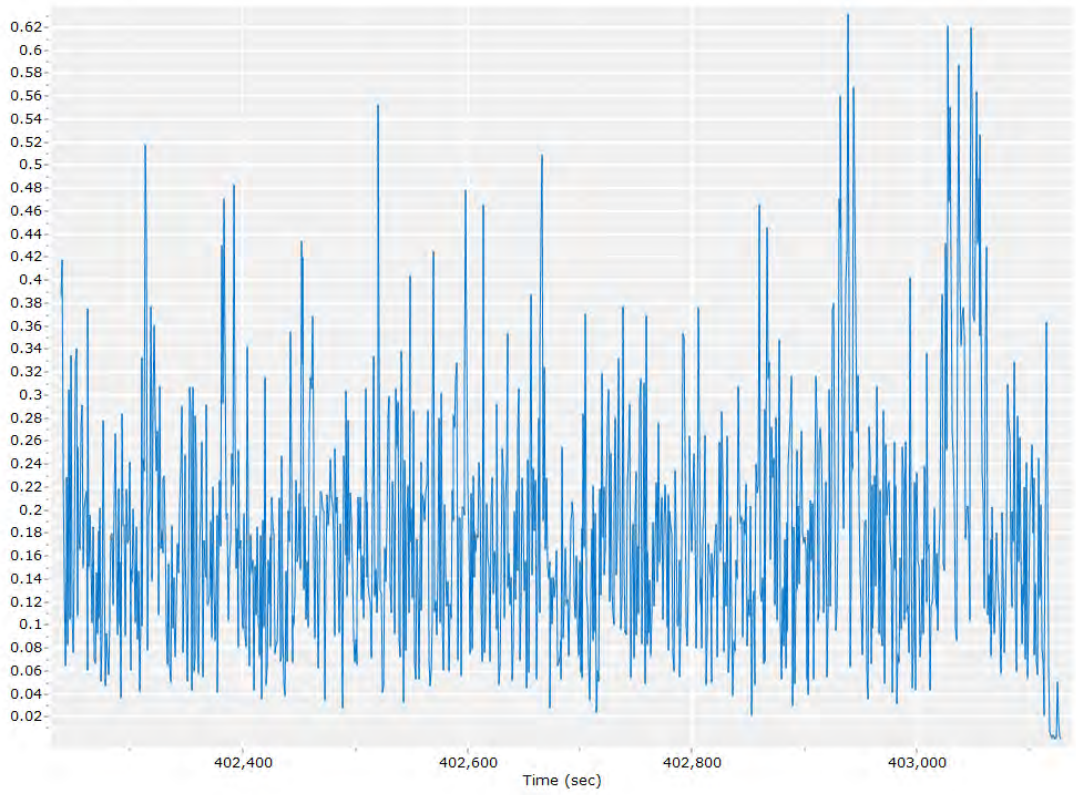
Ground Speed



Body Acceleration



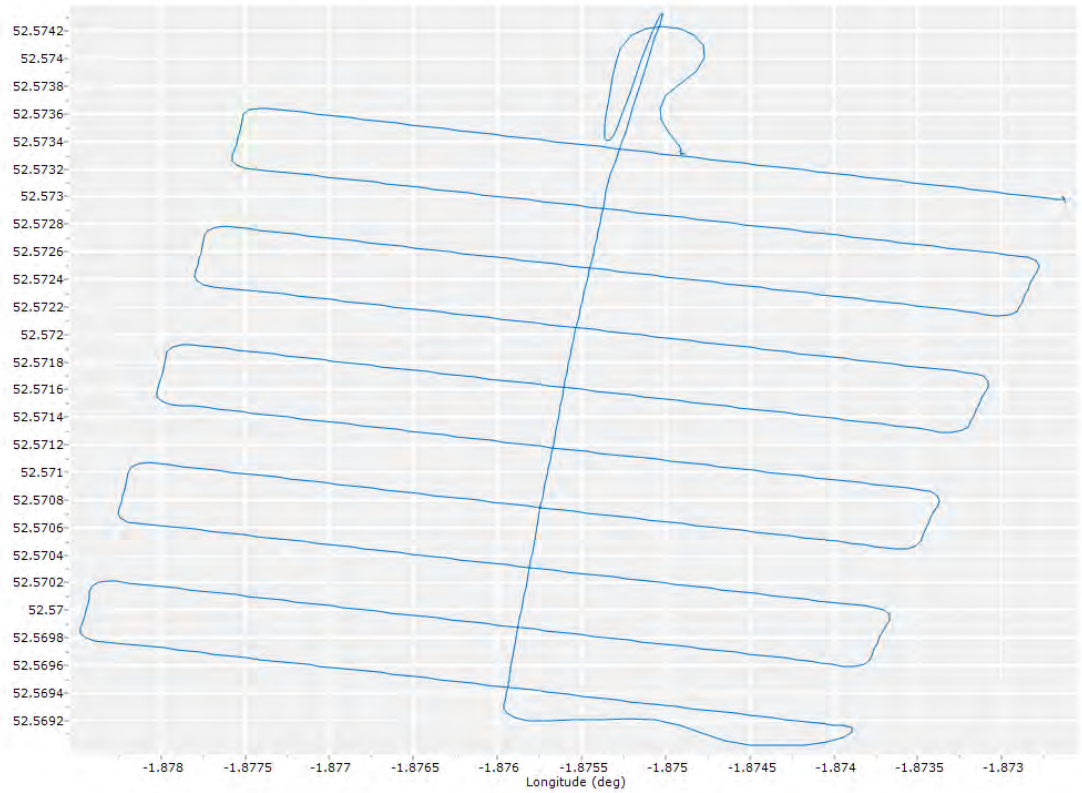
Total Body Acceleration



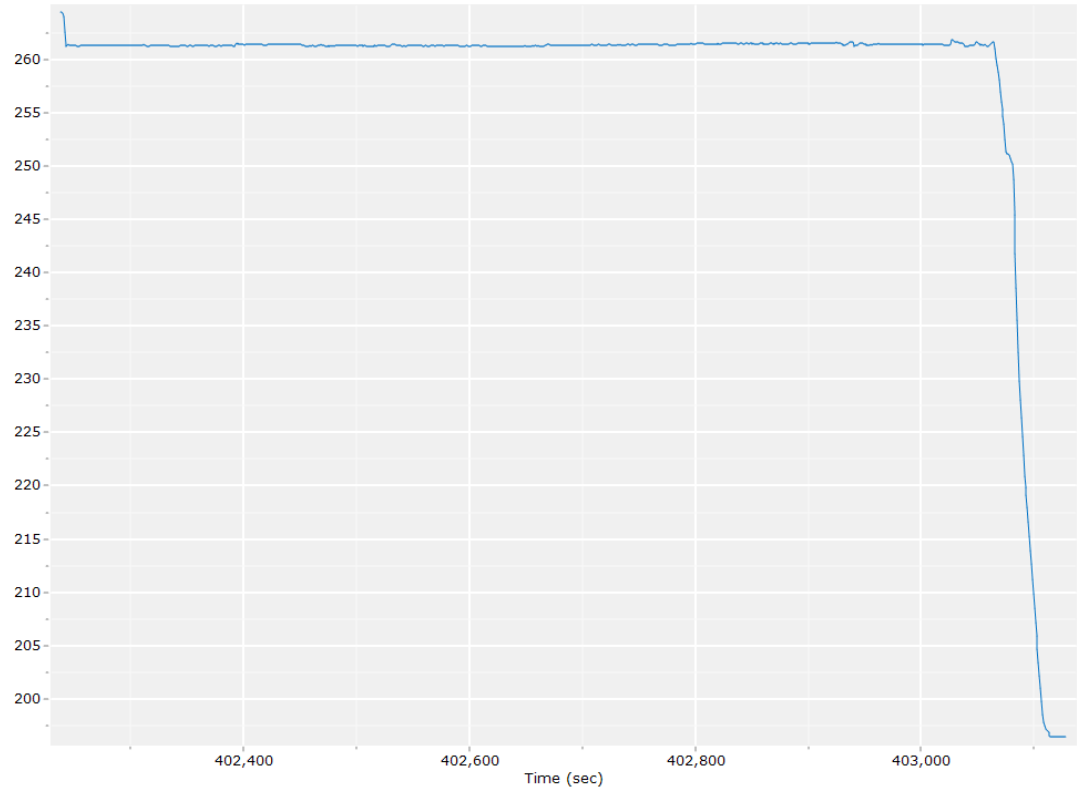
Body Angular Rate

Forward Processed Trajectory Information

Top View

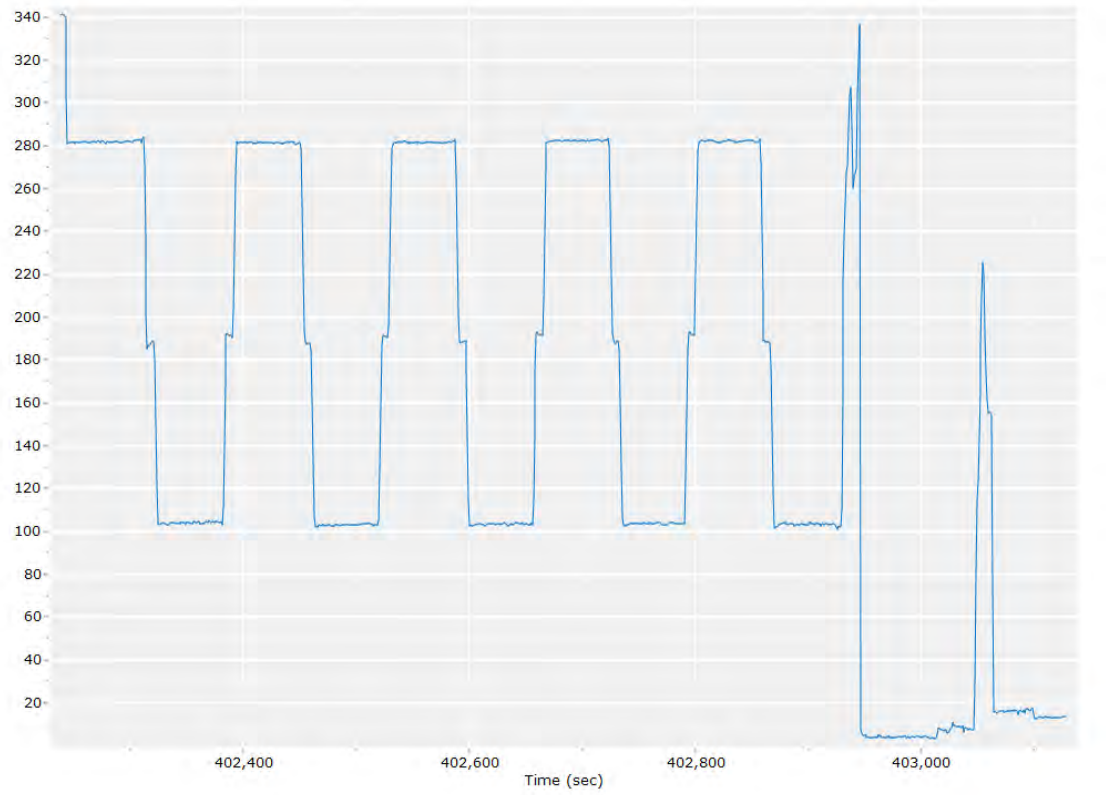


Altitude

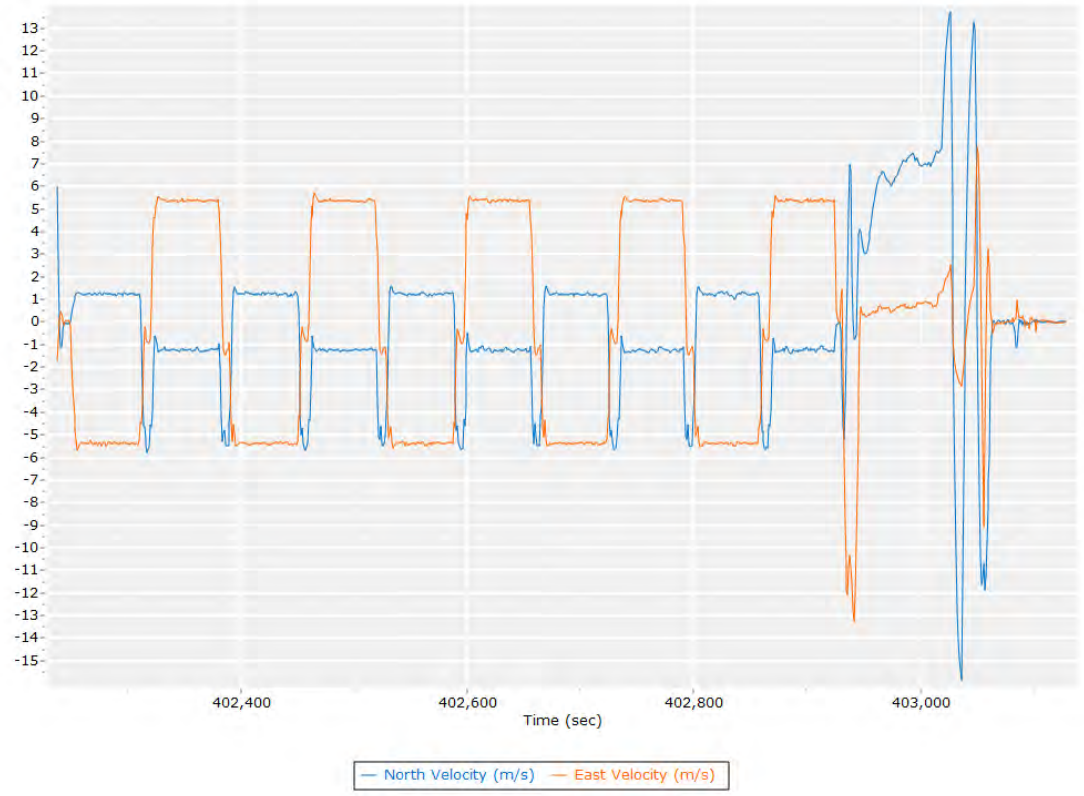


Roll/Pitch

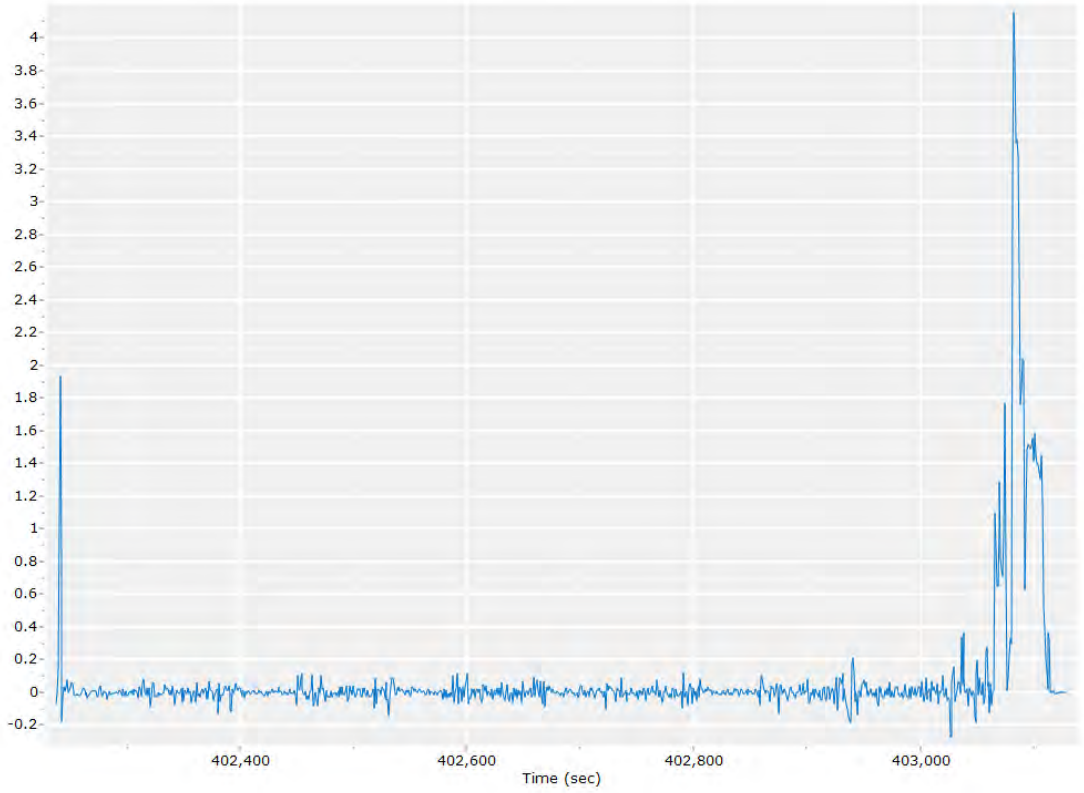
Heading



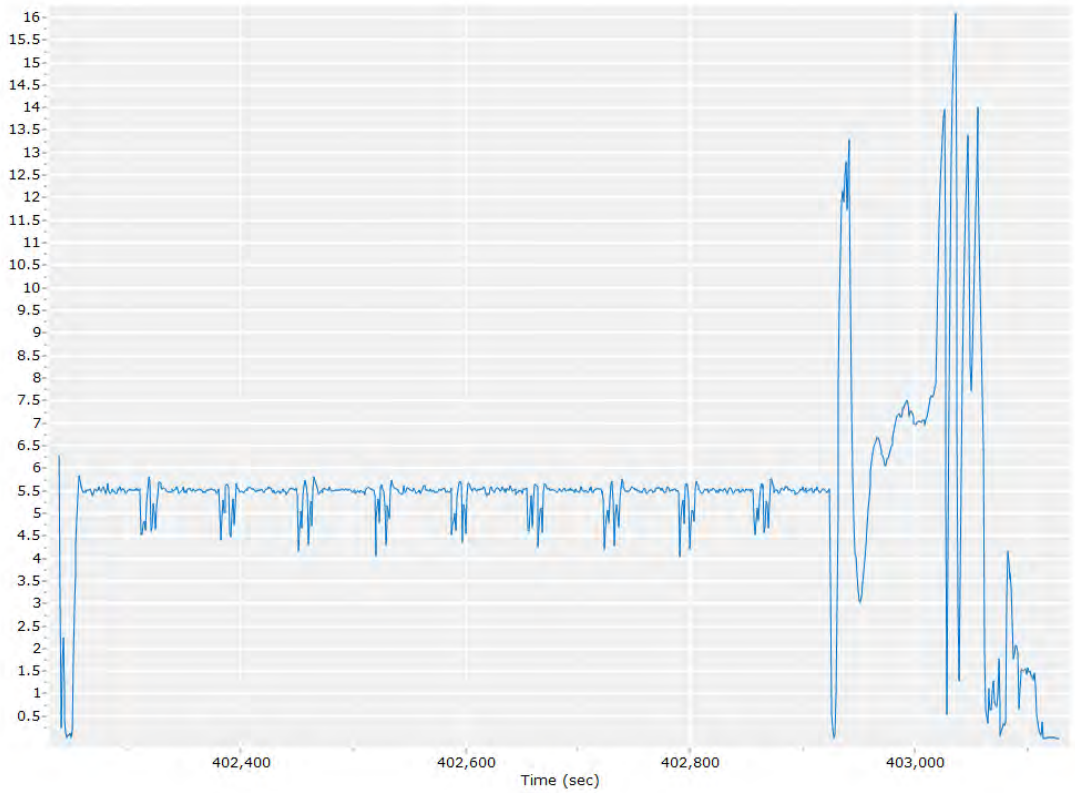
North/East Velocity



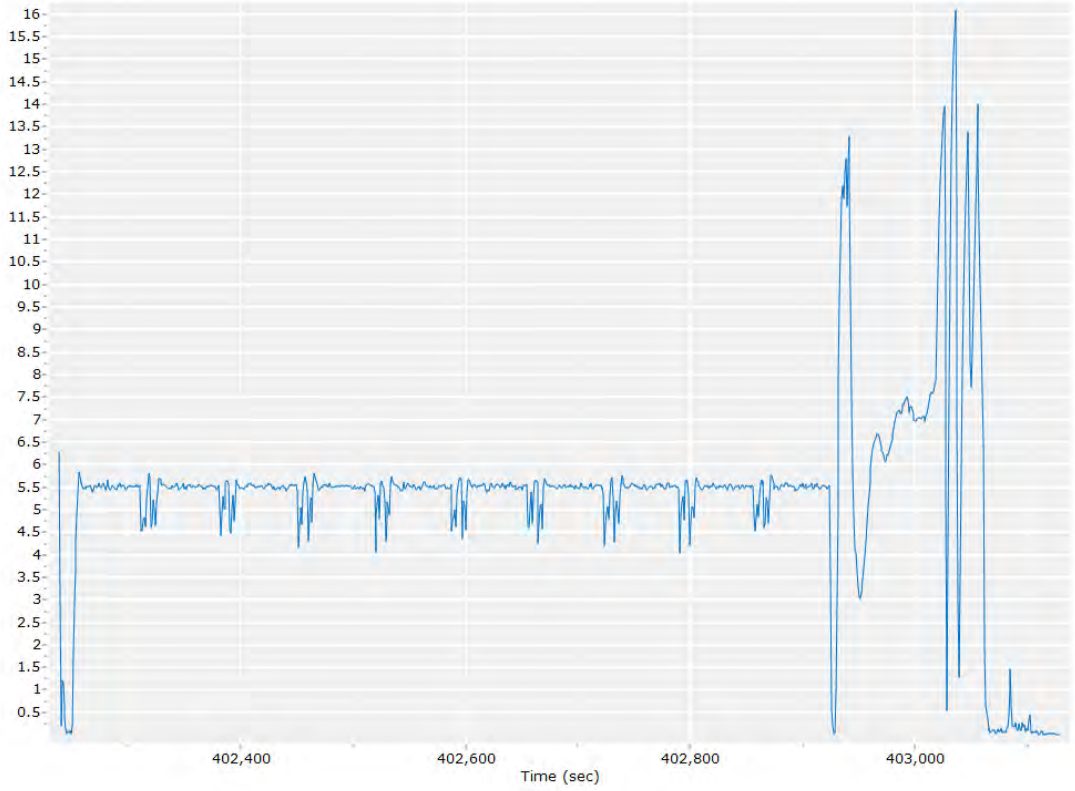
Down Velocity



Total Speed

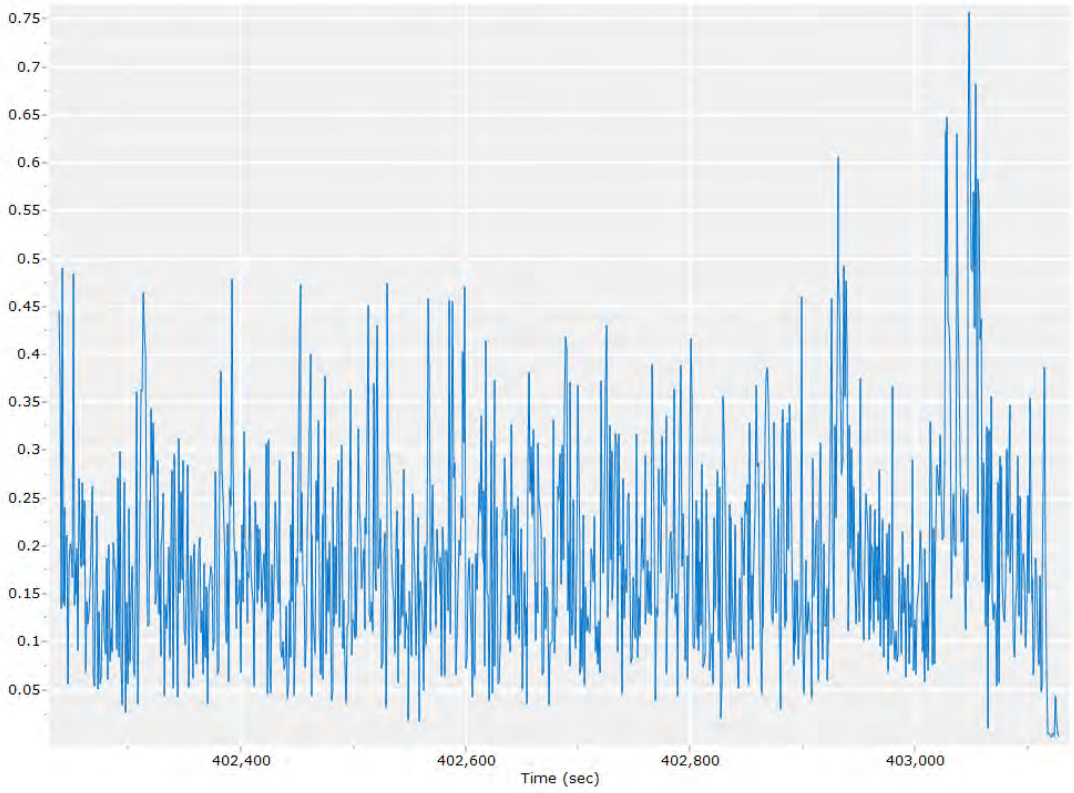


Ground Speed



Body Acceleration

Total Body Acceleration



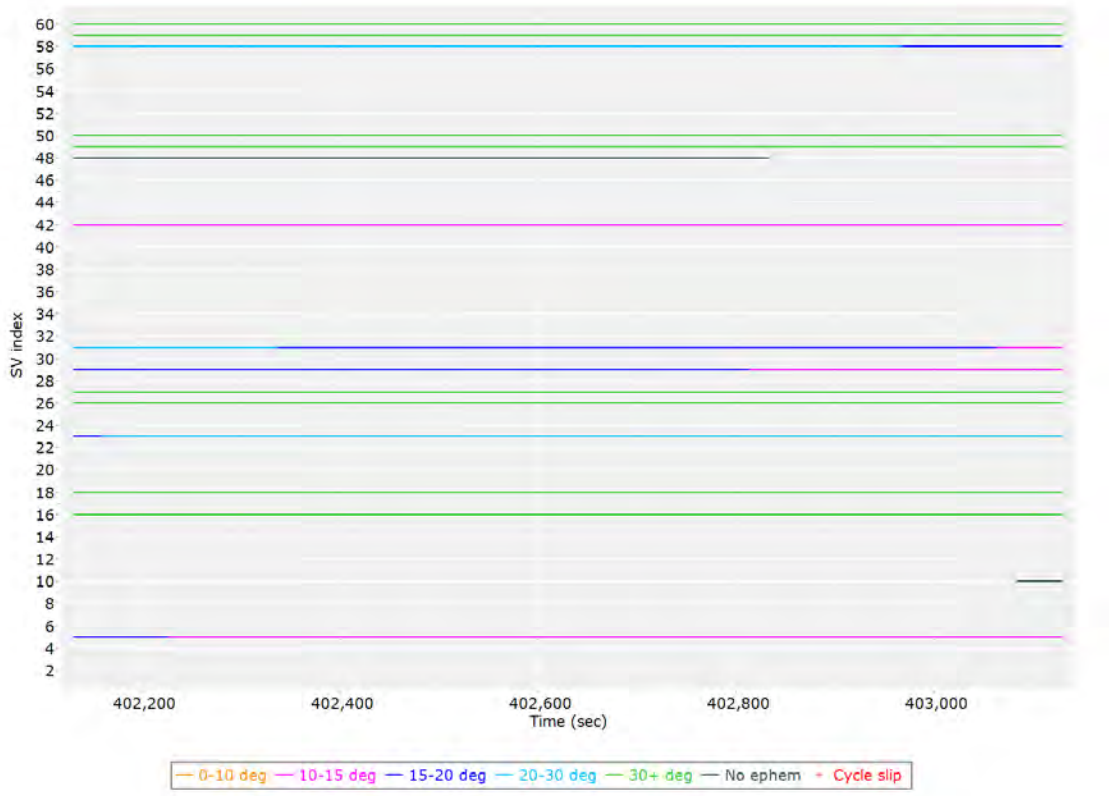
Body Angular Rate

Base Station Information

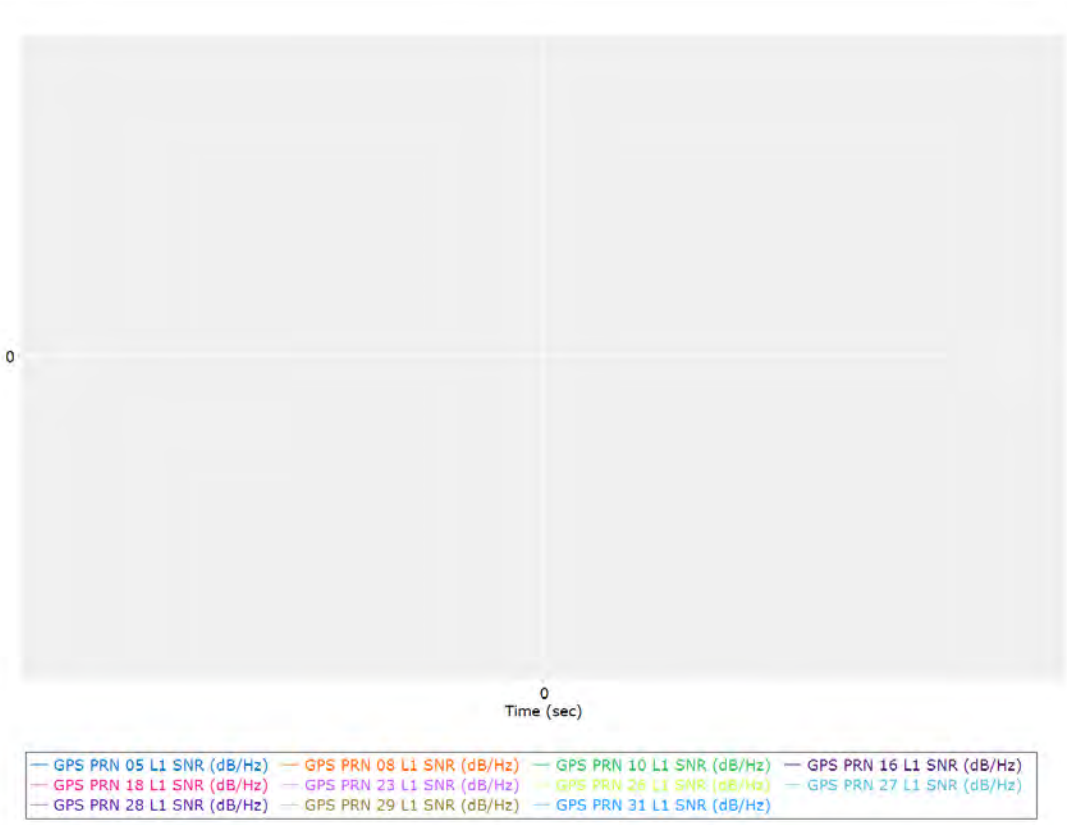
Station ID	base		
Filename	base0374.25O		
Start date	02/06/2025 14:03:16		
End date	02/06/2025 17:06:19		
Duration	03:03:03.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Unknown	Unknown	E5003A21000006
Antenna manufacturer, model	Unknown	Unknown External	
Antenna height [m]	2.079		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC (m)	0		
Latitude	N52°34'01.12122"		
Longitude	W1°52'37.36477"		
Ellipsoidal height (m)	192.72160		
Frame	ITRF2014		
Epoch	2025.0986		
Ellipsoid	GRS_1980		
Velocity North (mm/y)	16.61		
Velocity East (mm/y)	15.72		
Velocity Up (mm/y)	-0.06		

Base Observables & Satellite Data

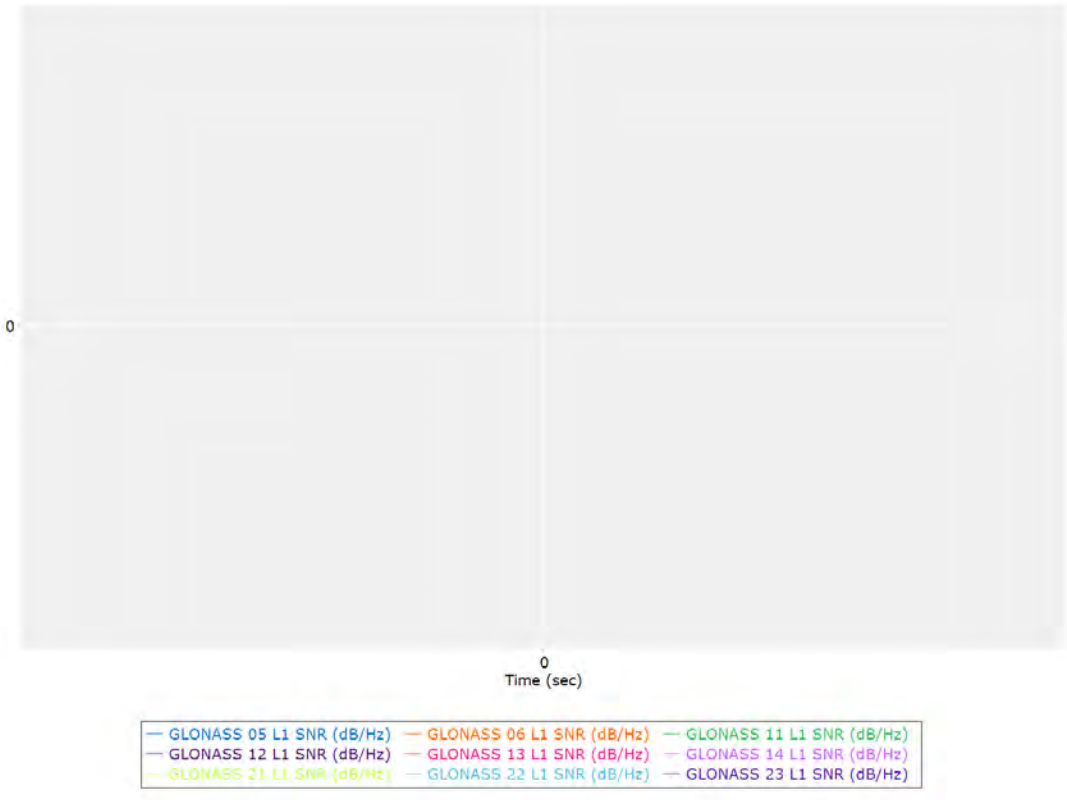
Base GPS/GLONASS L1 Satellite Lock/Elevation



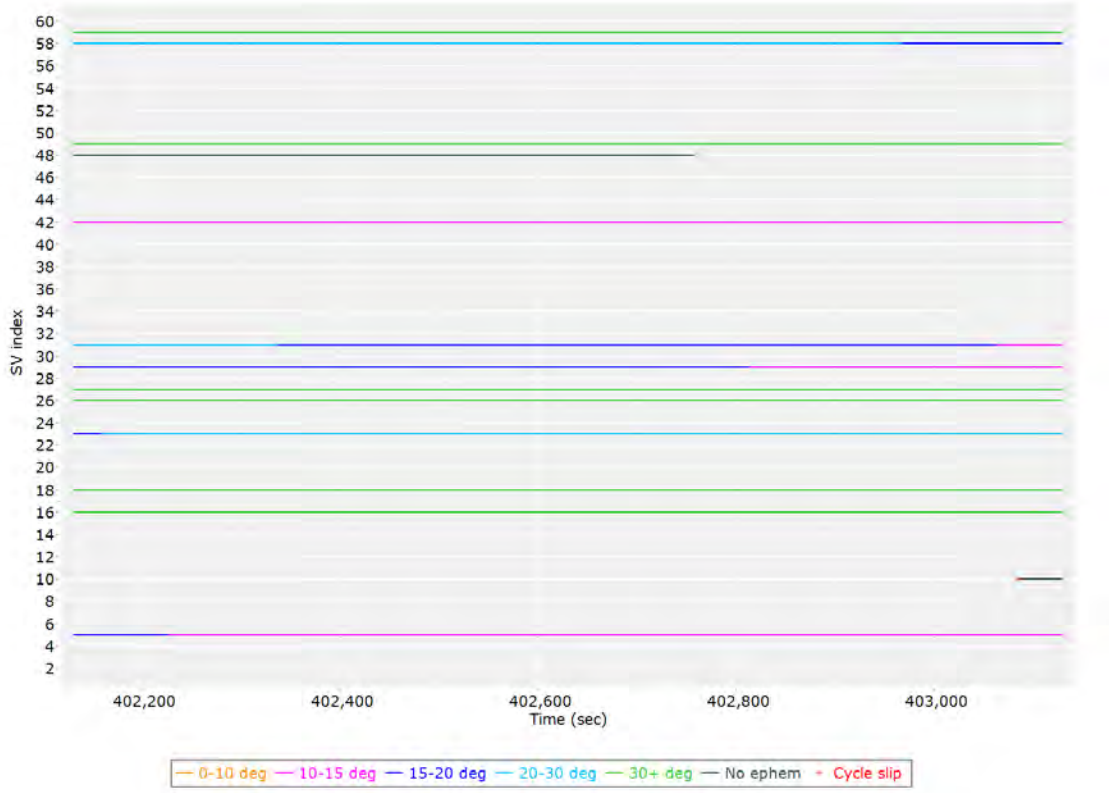
Base GPS L1 SNR



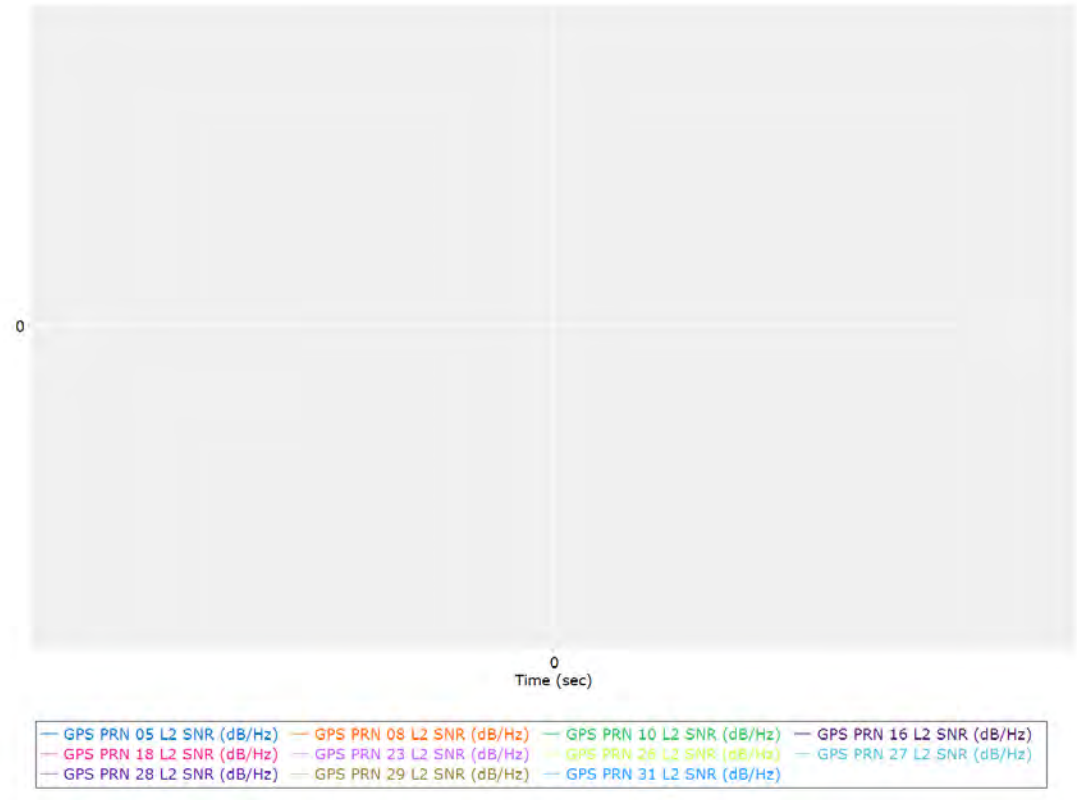
Base GLONASS L1 SNR



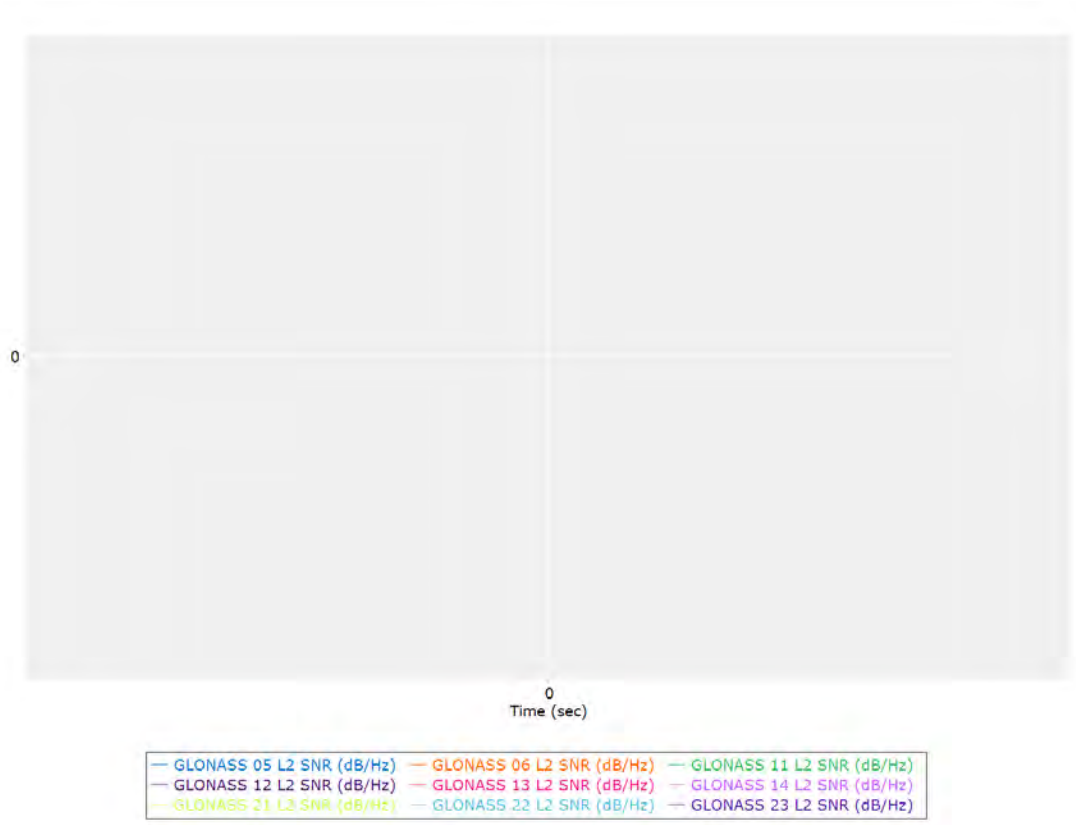
Base GPS/GLONASS L2 Satellite Lock/Elevation



Base GPS L2 SNR



Base GLONASS L2 SNR

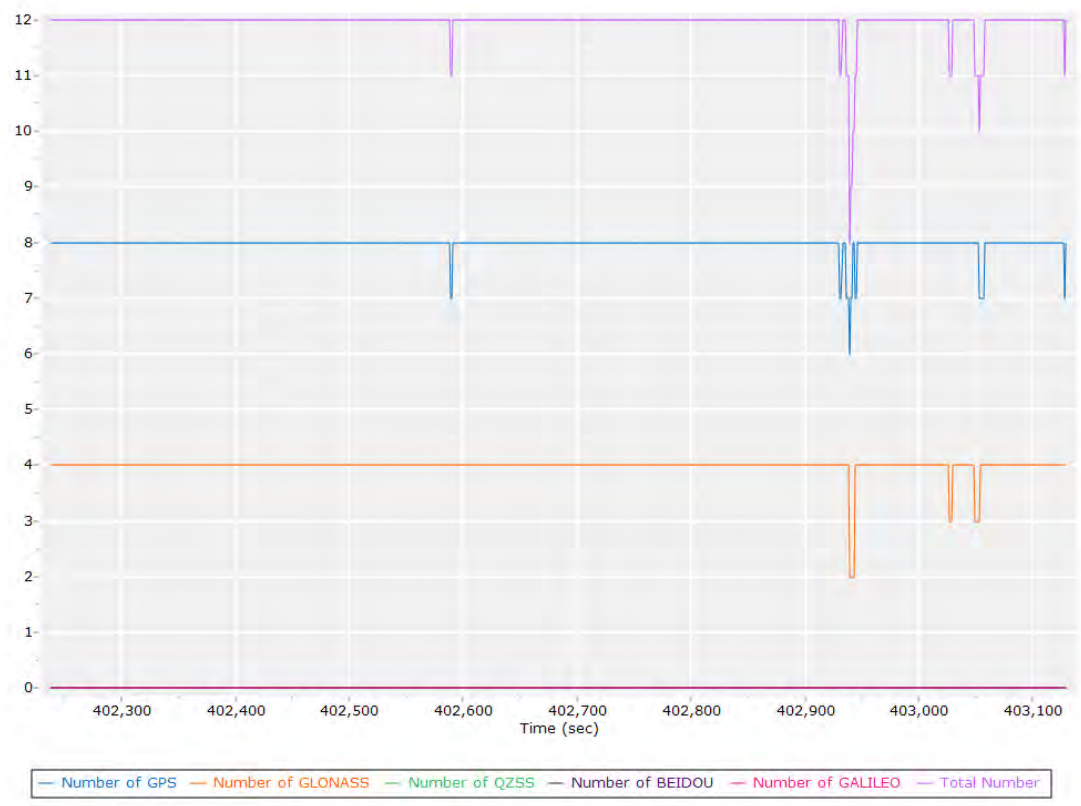


GNSS QC

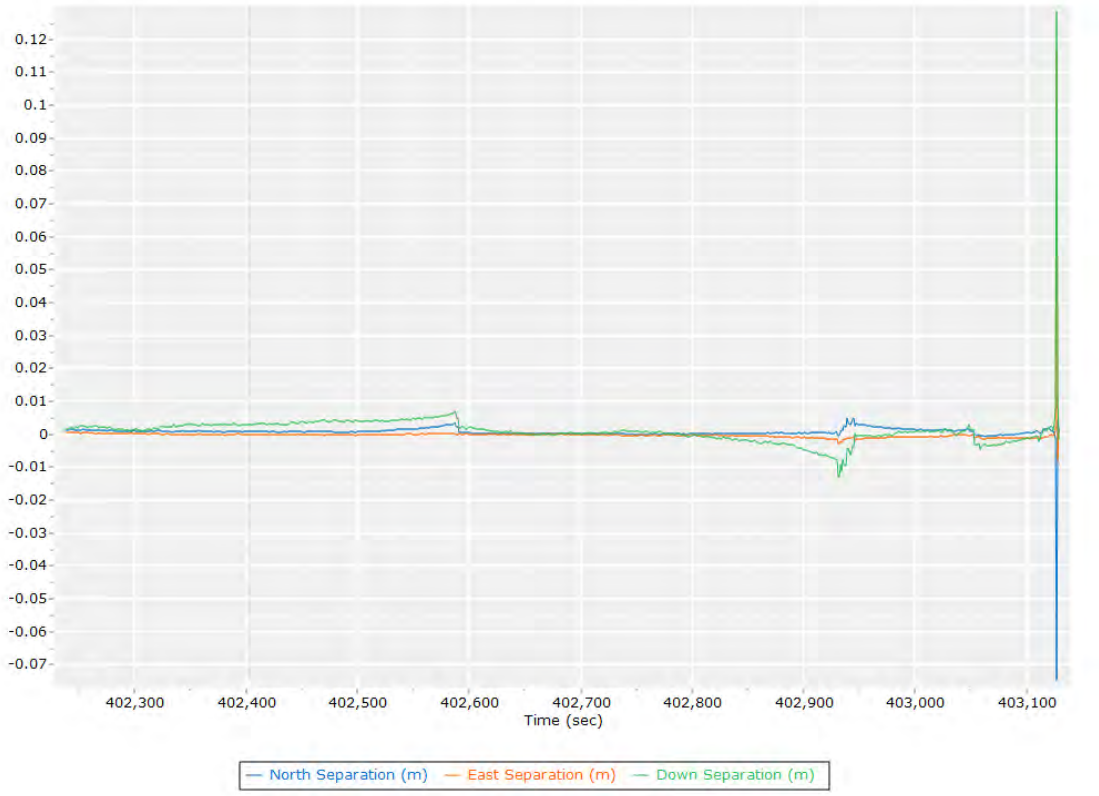
GNSS QC Statistics

Statistics	Min	Max	Mean
Baseline length (km)	0.27	0.83	
Number of GPS SV	6	8	8
Number of GLONASS SV	2	4	4
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Number of GALILEO SV	0	0	0
Total number of SV	8	12	12
PDOP	1.39	2.46	1.44
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (sec)	998.00	0.00	0.00
Percentage	100.00	0.00	0.00

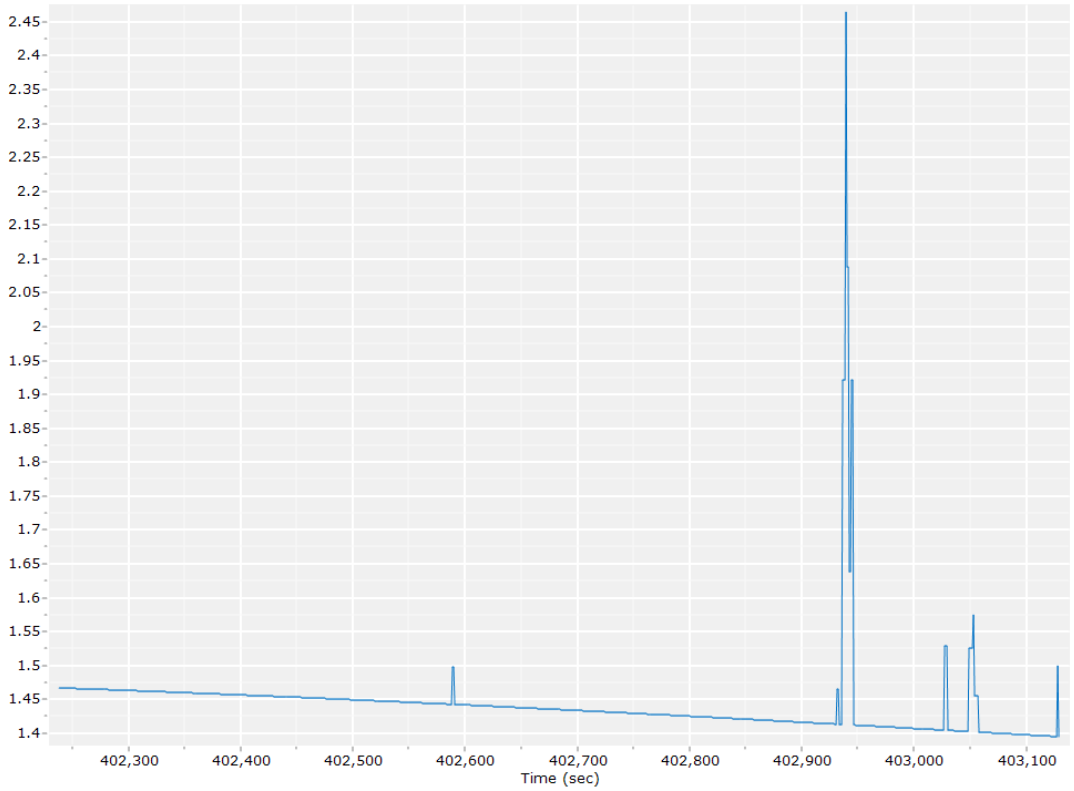
Num SVs in solution



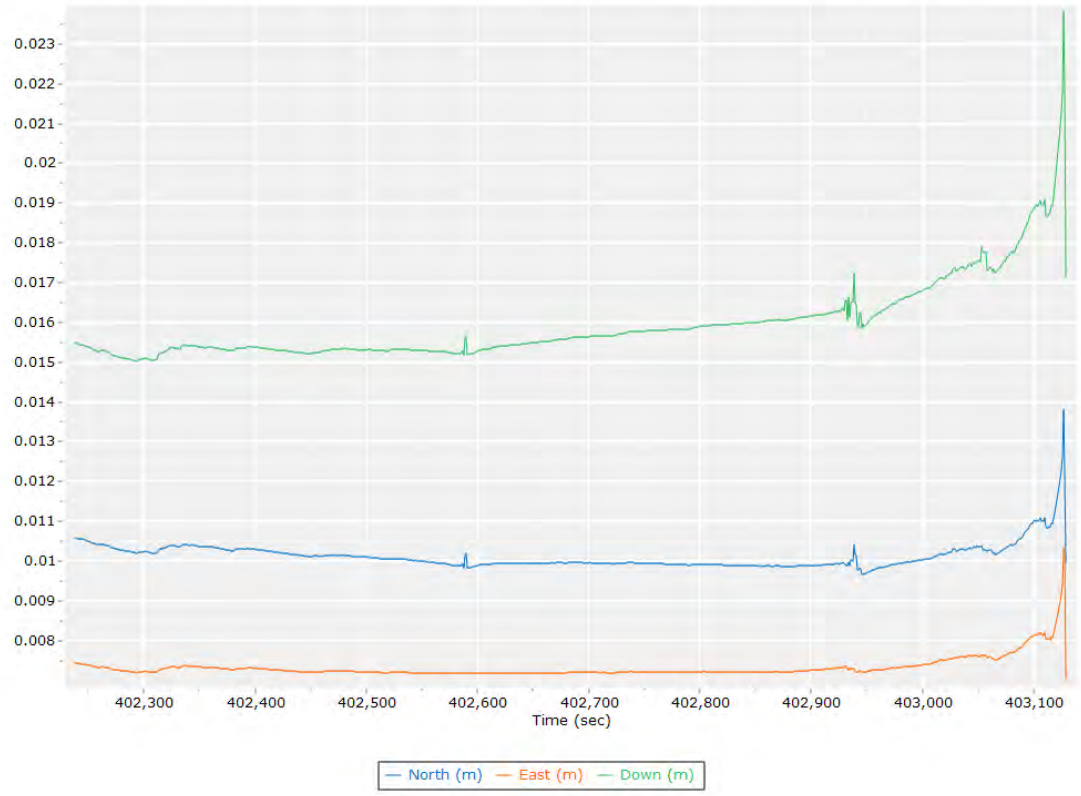
Forward/Reverse Separation



PDOP

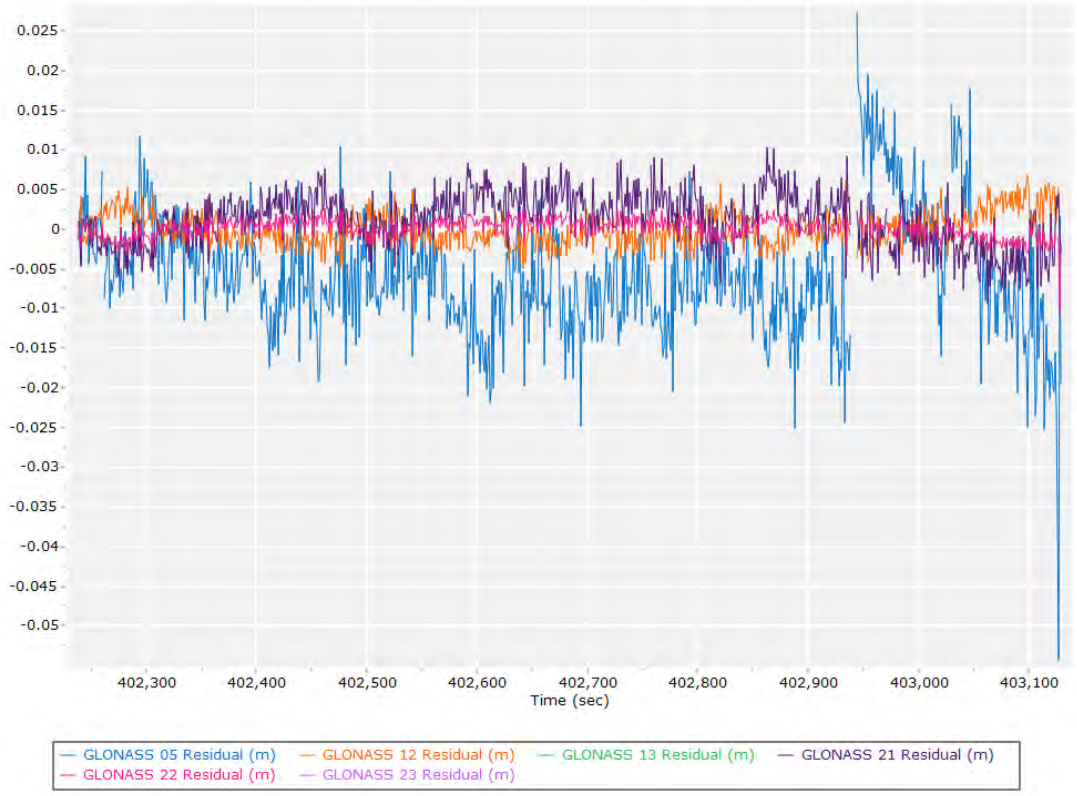


Estimated Position Accuracy



GPS Residuals

GLONASS Residuals



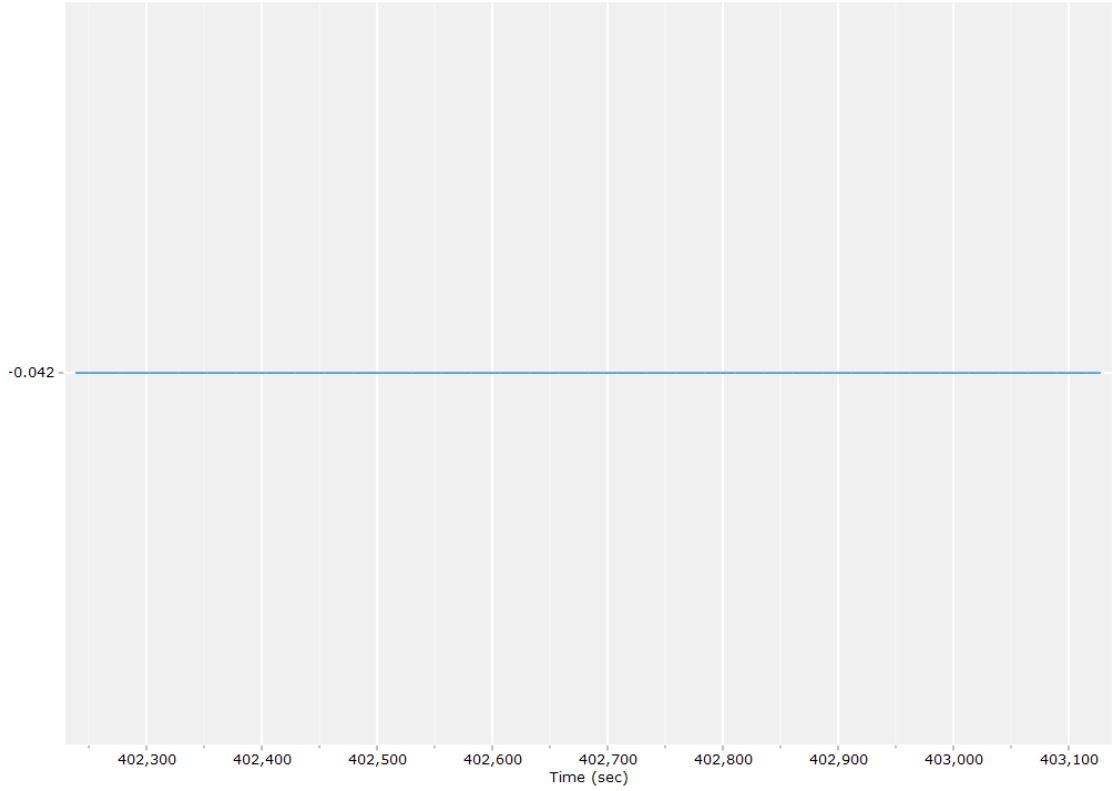
GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	base		
Processing start time	402131.000 (02/06/2025 15:42:11)		
Processing end time	403129.000 (02/06/2025 15:58:49)		
Initial attitude source	Primary GNSS Track, Magnetic Heading		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.042	-0.078	-0.377
Reference to Primary GNSS lever arm std dev (m)	0.030	0.030	0.030
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

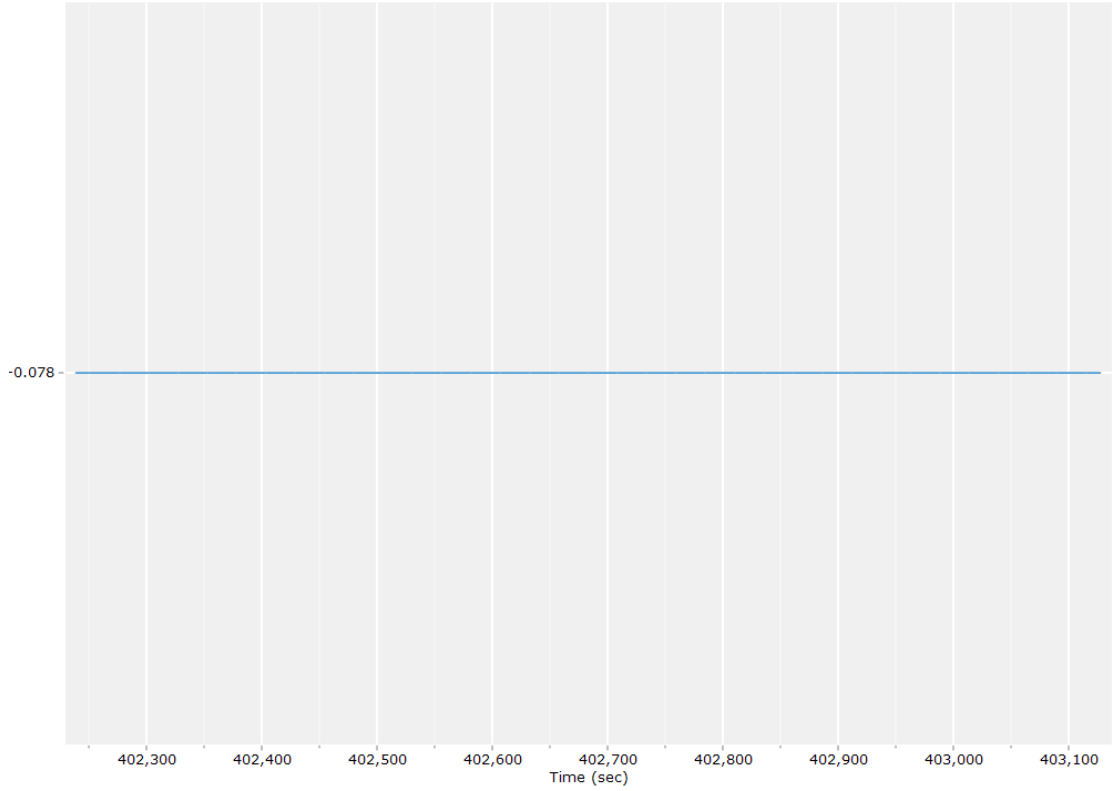
Calibrated Installation Parameters

Reference-Primary GNSS Lever Arm (m)

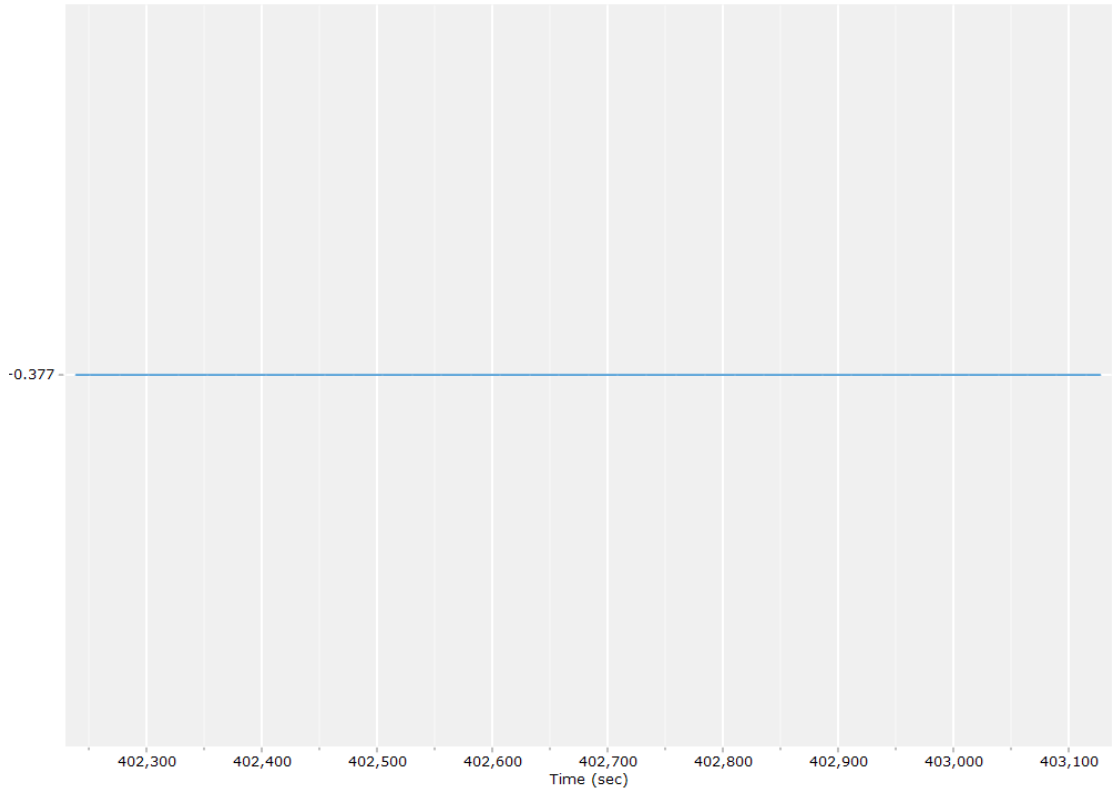
X Reference-Primary GNSS Lever Arm (m)



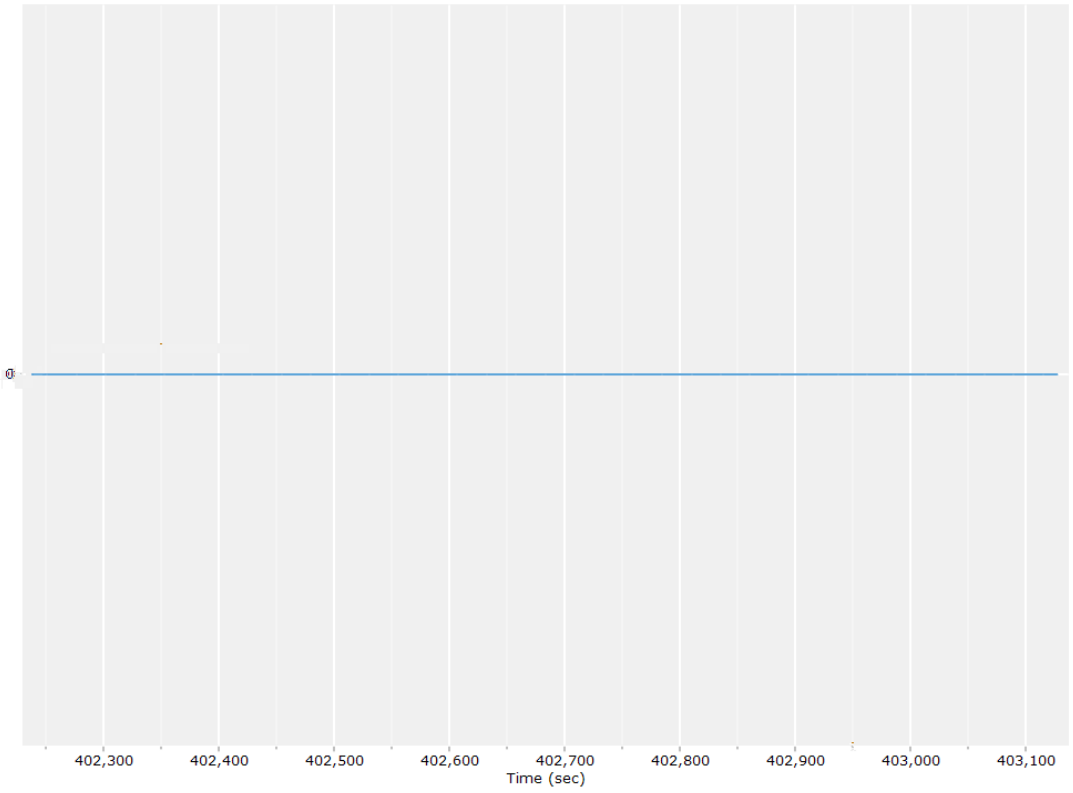
Y Reference-Primary GNSS Lever Arm (m)



Z Reference-Primary GNSS Lever Arm (m)



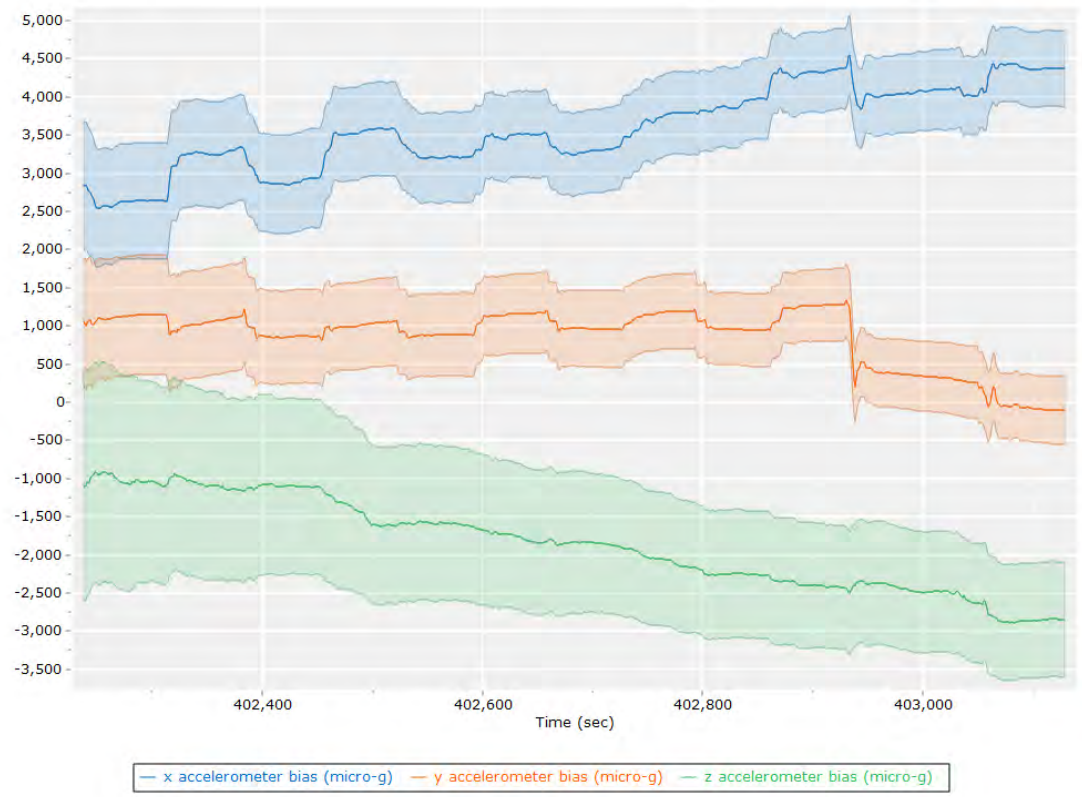
Reference-Primary GNSS Lever Arm Figure of Merit



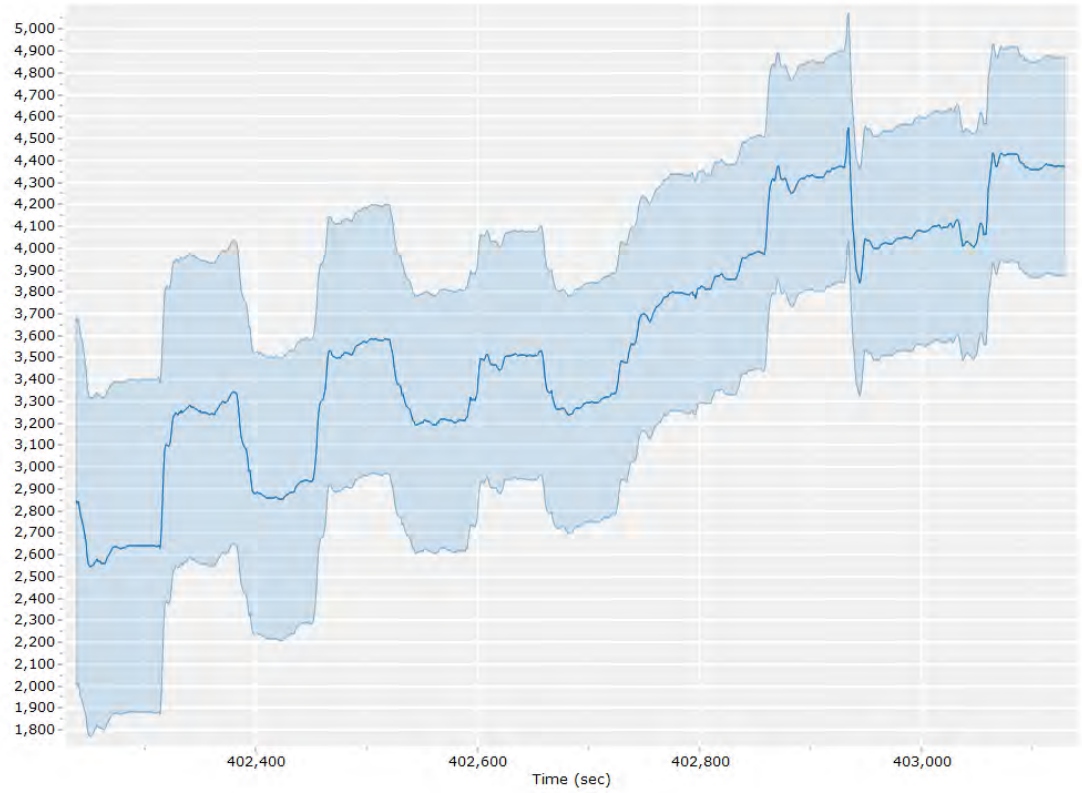
IN-Fusion QC

Forward Processed Estimated Errors, Reference Frame

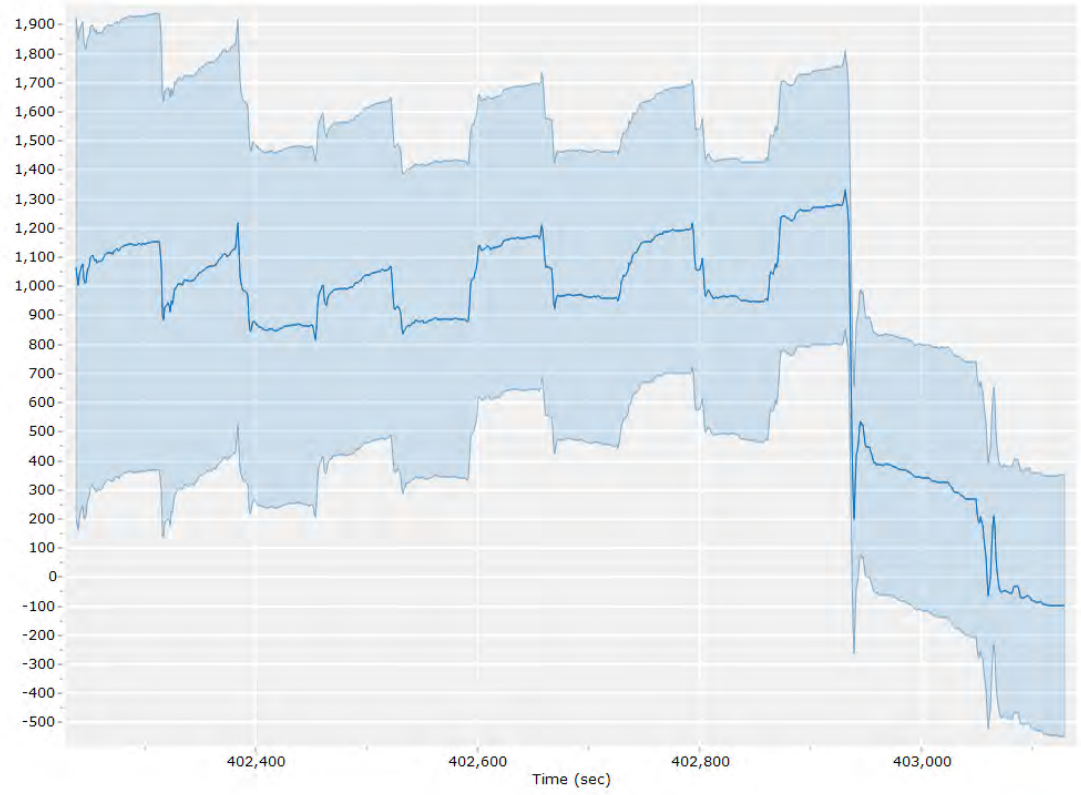
Accelerometer Bias (micro-g)



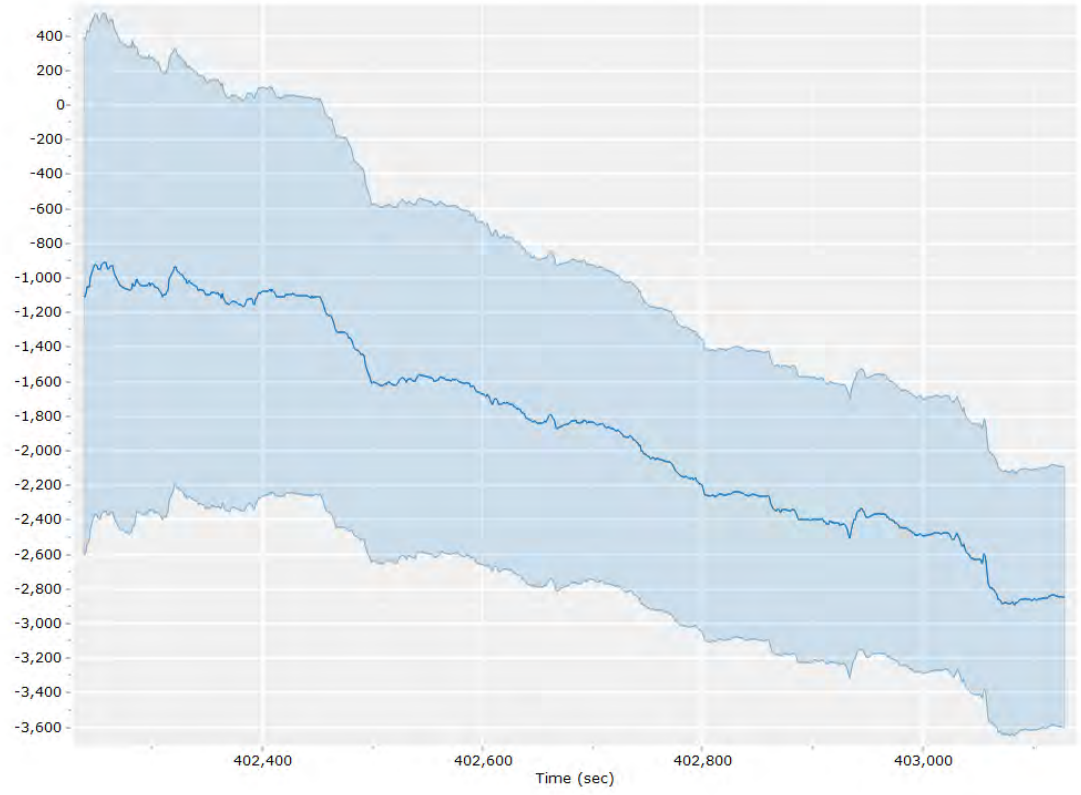
X Accelerometer Bias (micro-g)



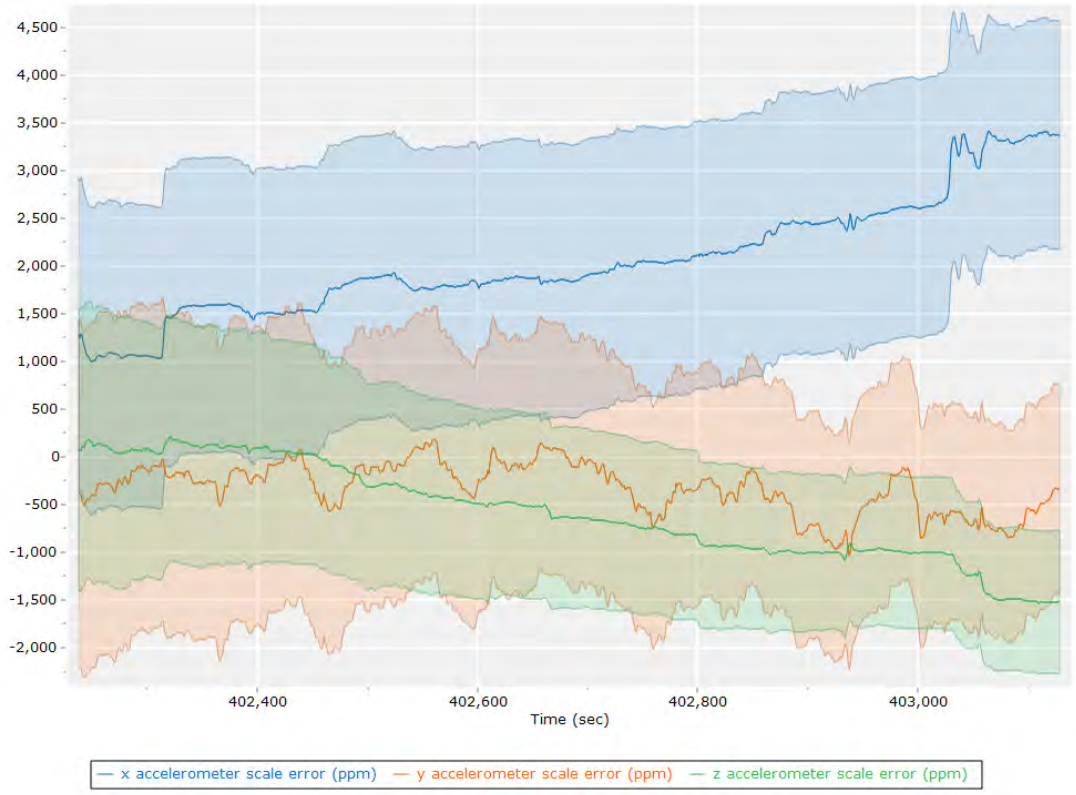
Y Accelerometer Bias (micro-g)



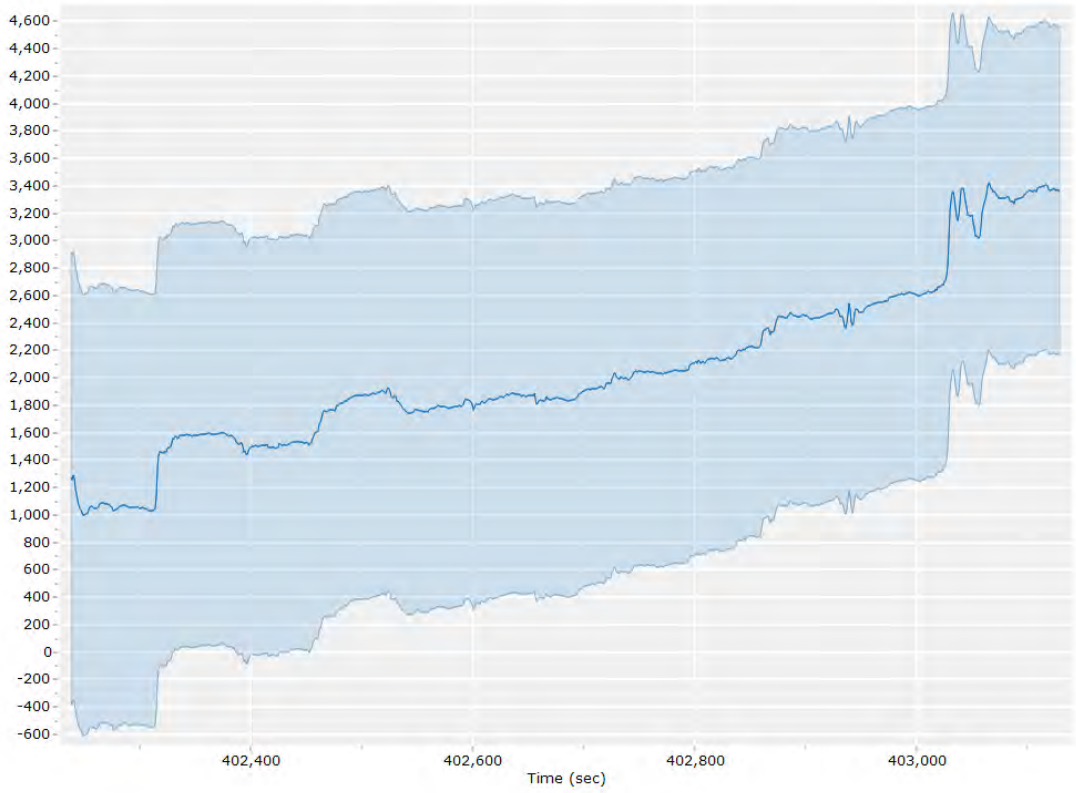
Z Accelerometer Bias (micro-g)



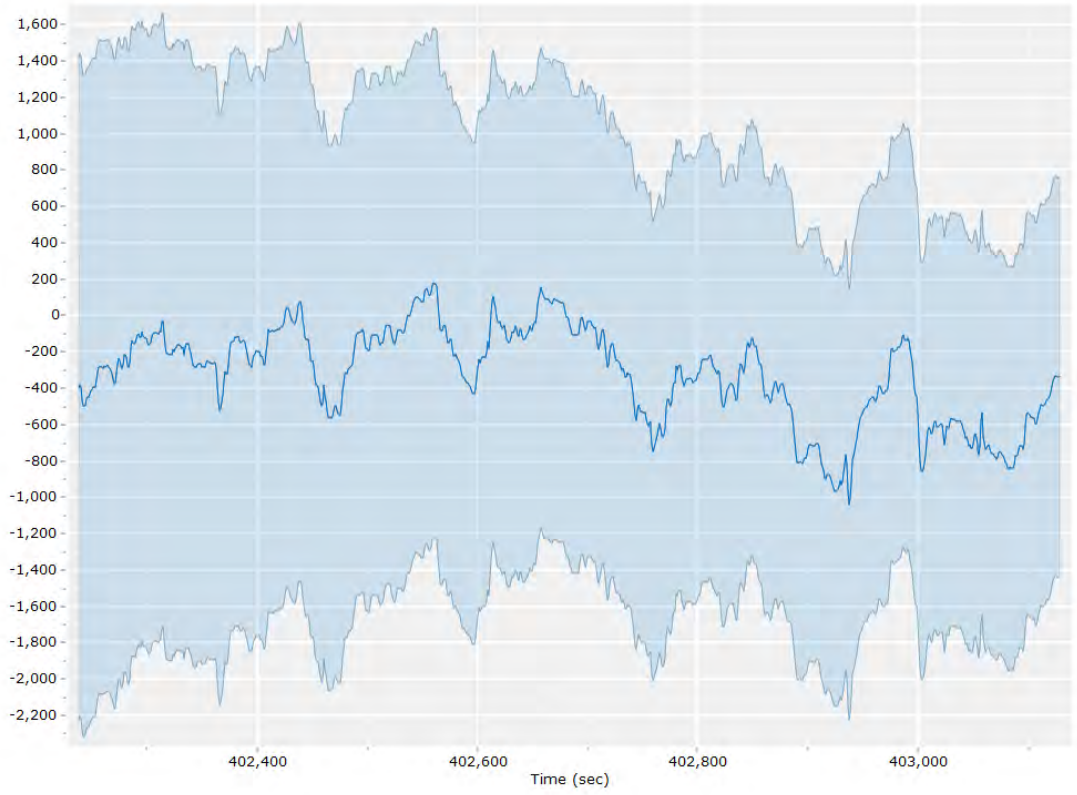
Accelerometer Scale Error (ppm)



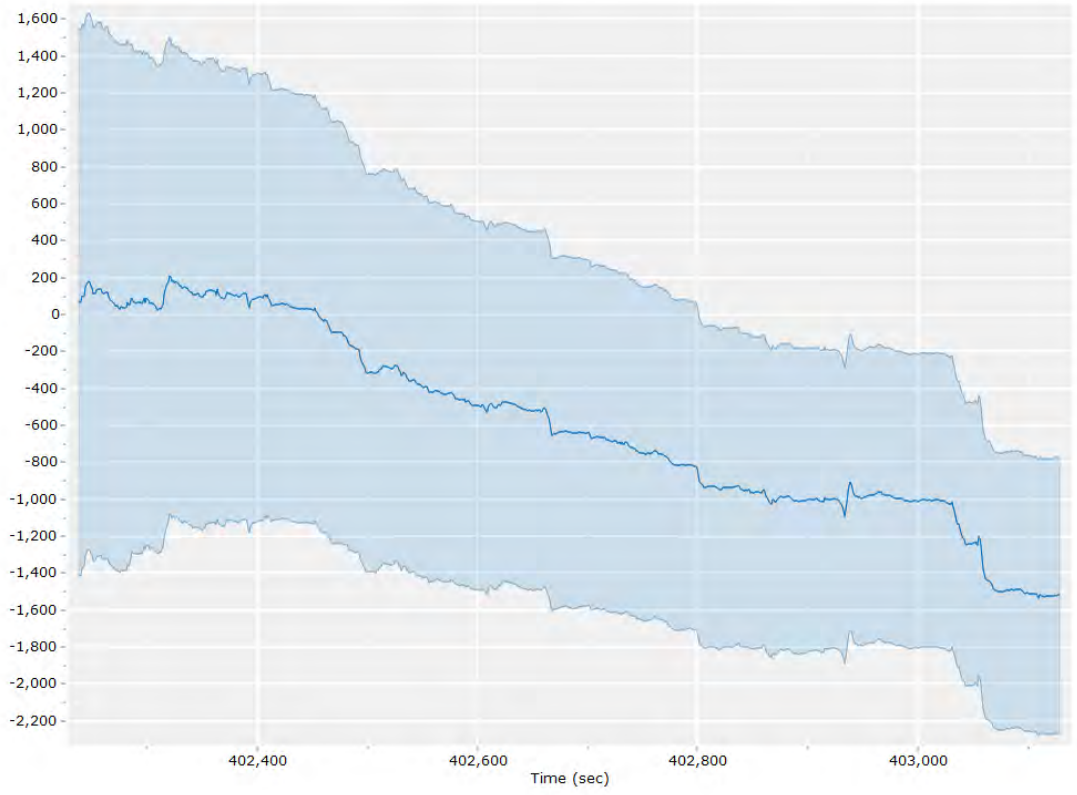
X Accelerometer Scale Error (ppm)



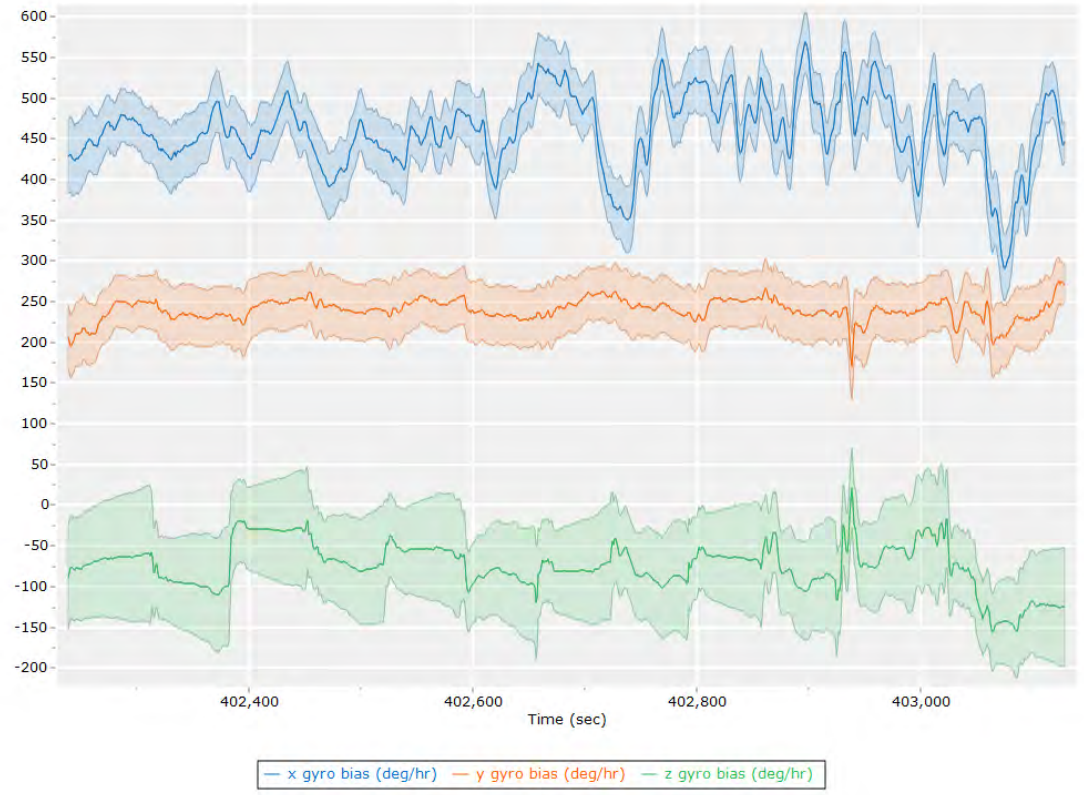
Y Accelerometer Scale Error (ppm)



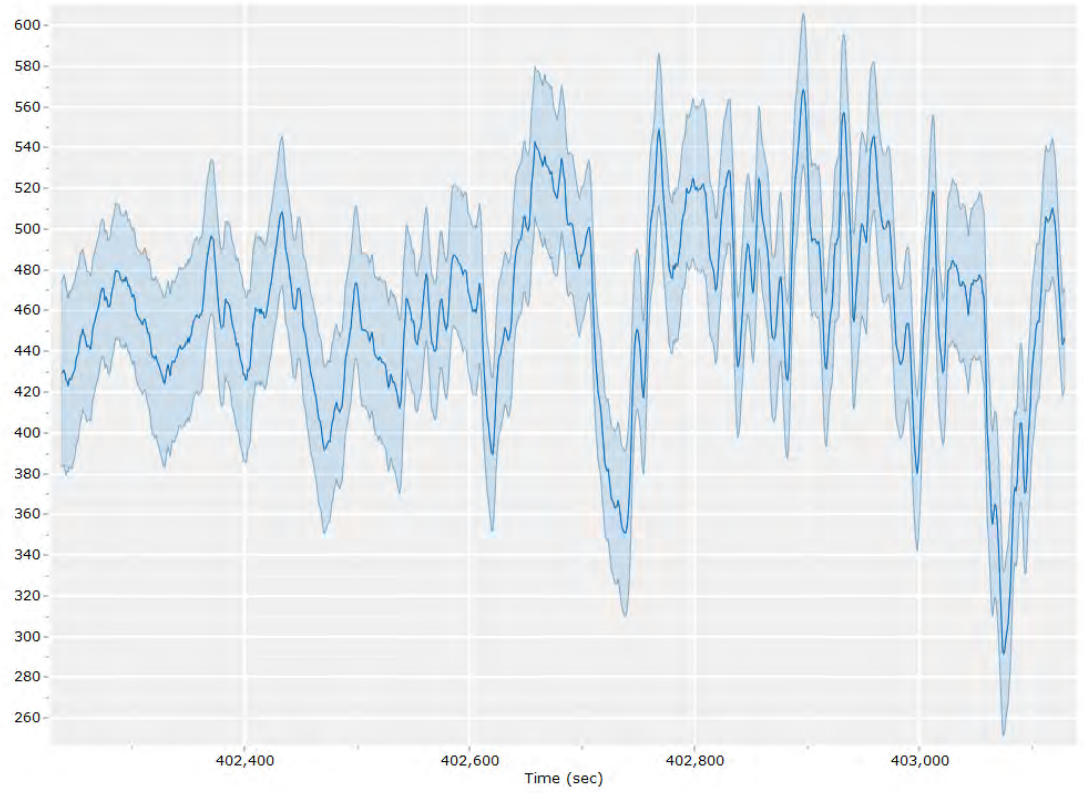
Z Accelerometer Scale Error (ppm)



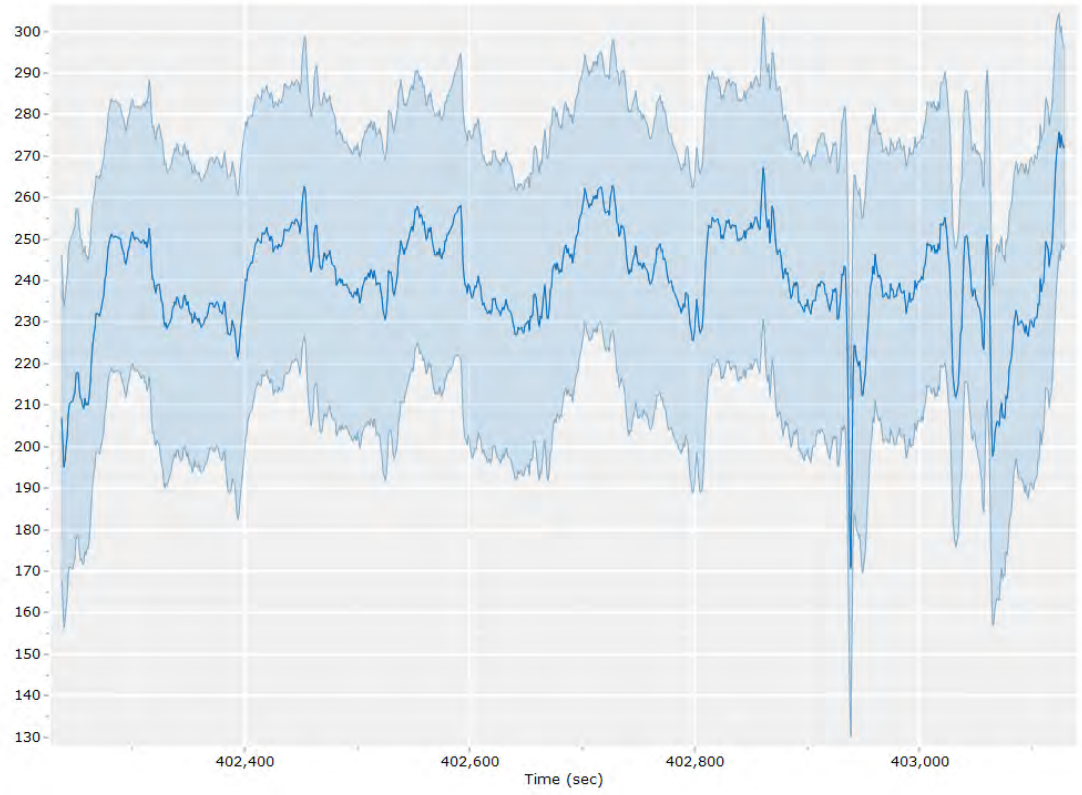
Gyro Bias (deg/h)



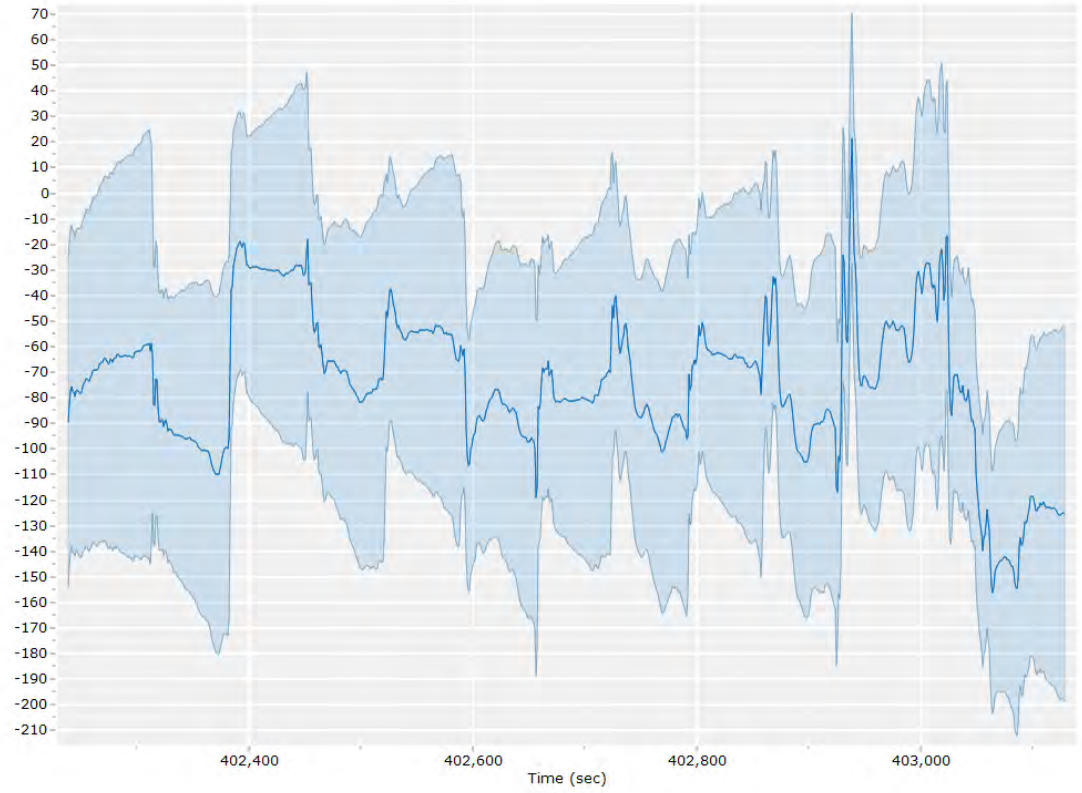
X Gyro Bias (deg/h)



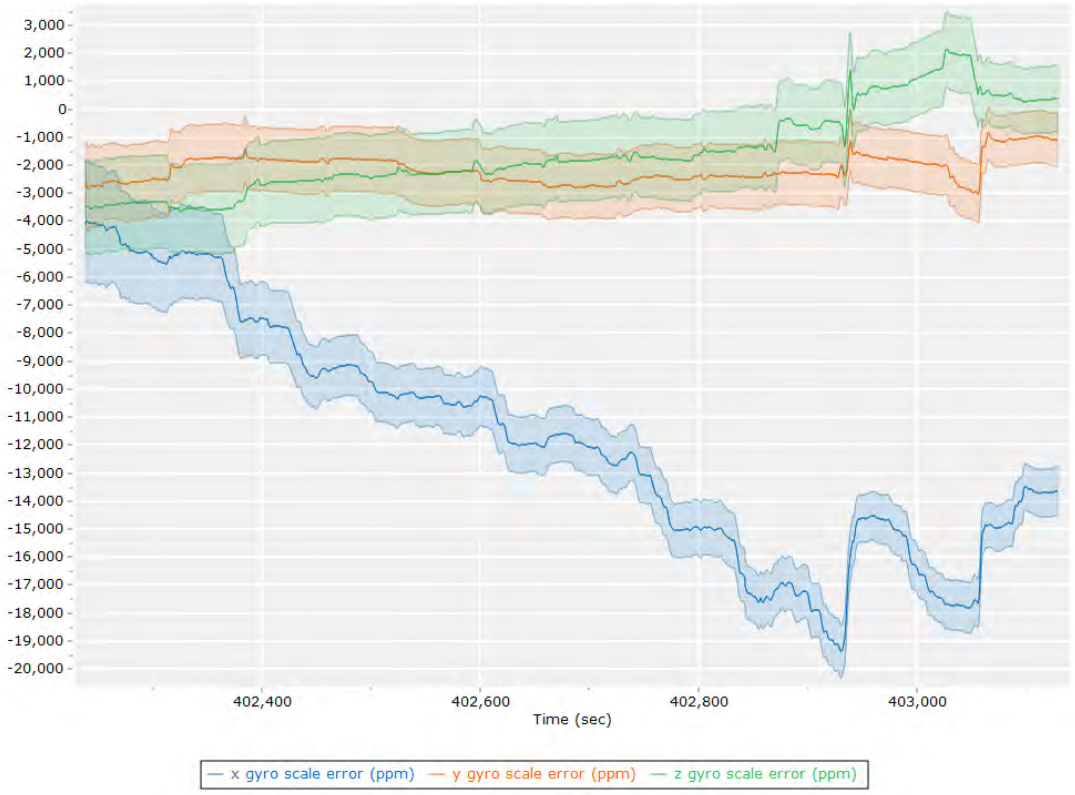
Y Gyro Bias (deg/h)



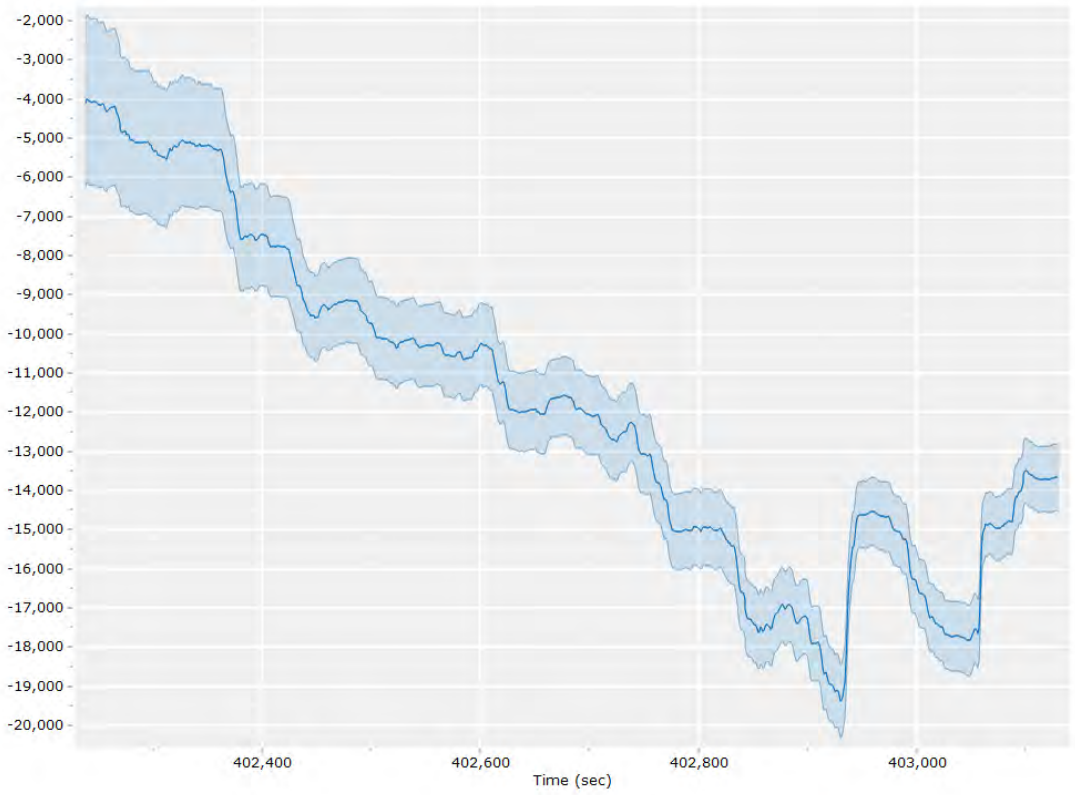
Z Gyro Bias (deg/h)



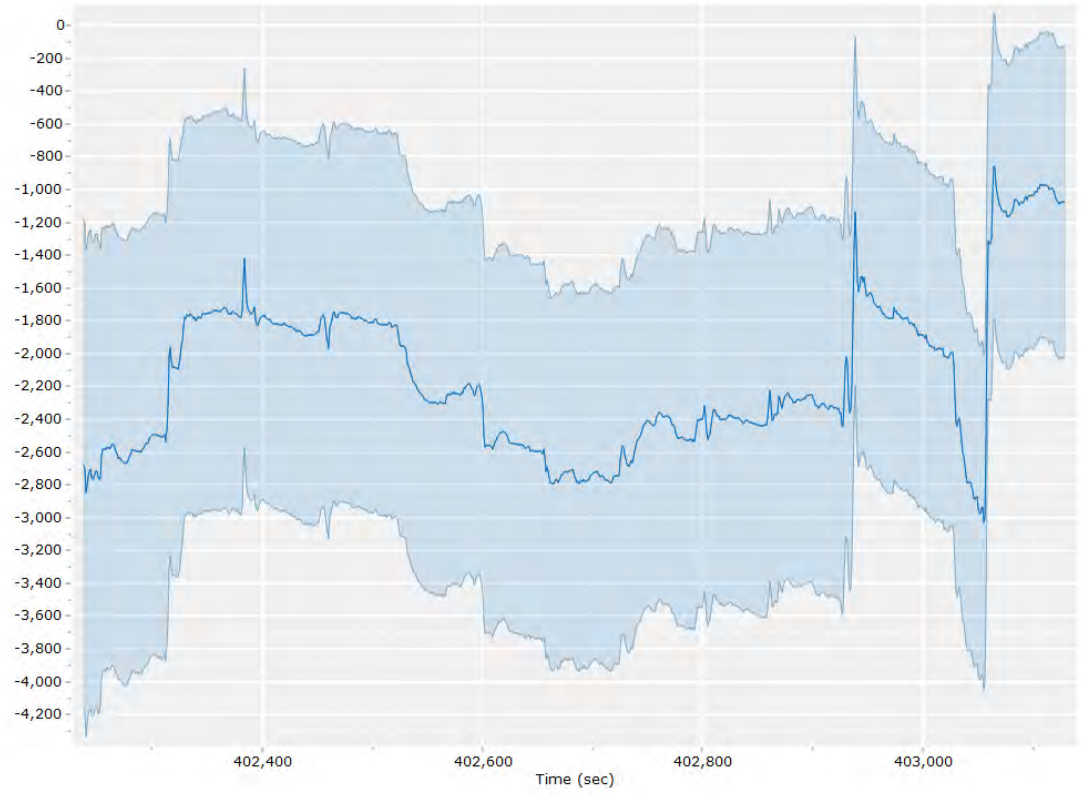
Gyro Scale Error (ppm)



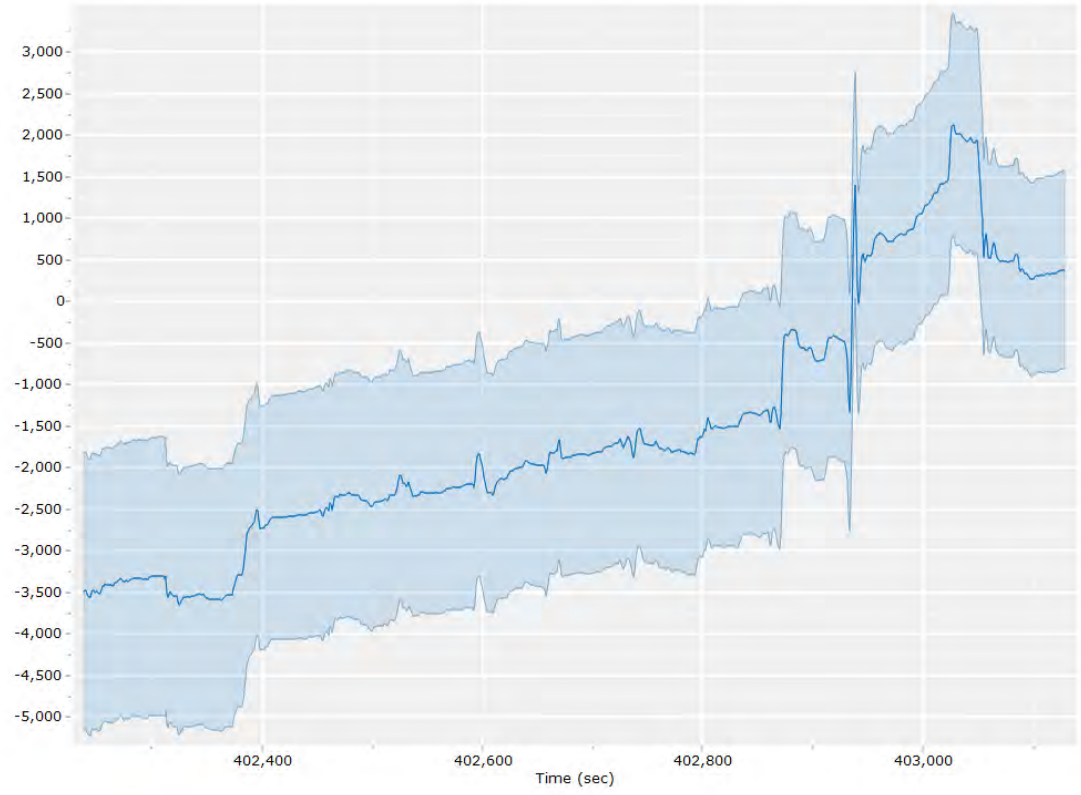
X Gyro Scale Error (ppm)



Y Gyro Scale Error (ppm)

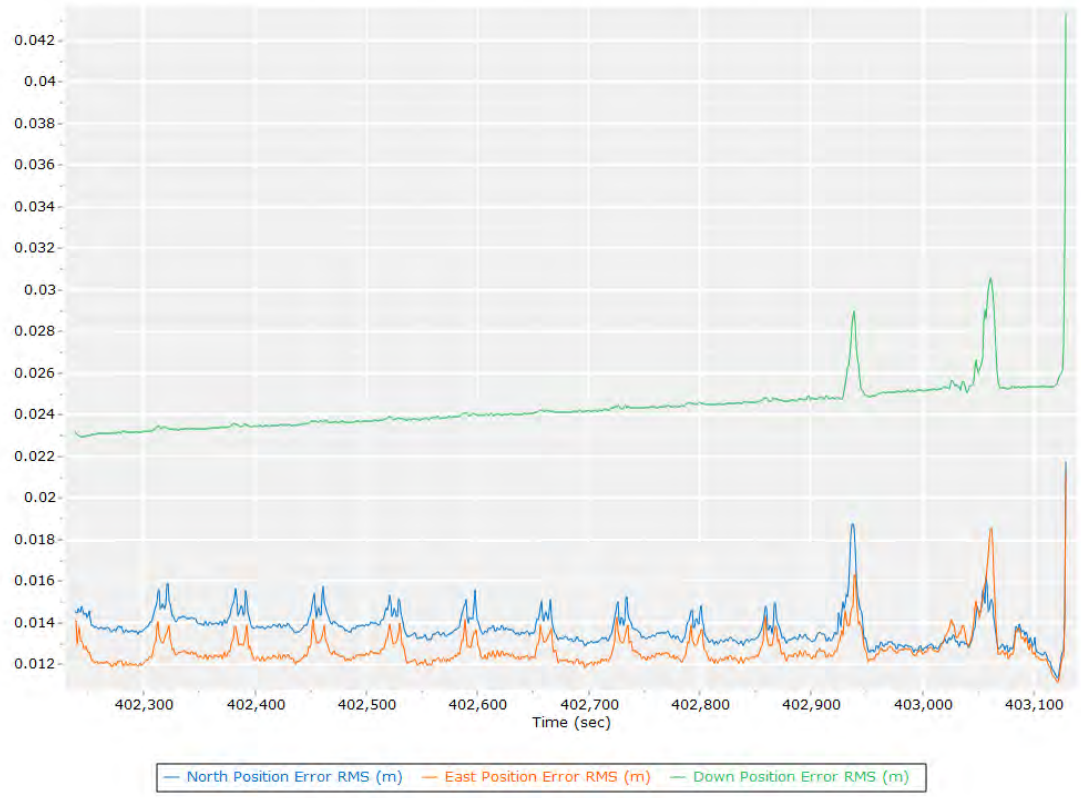


Z Gyro Scale Error (ppm)

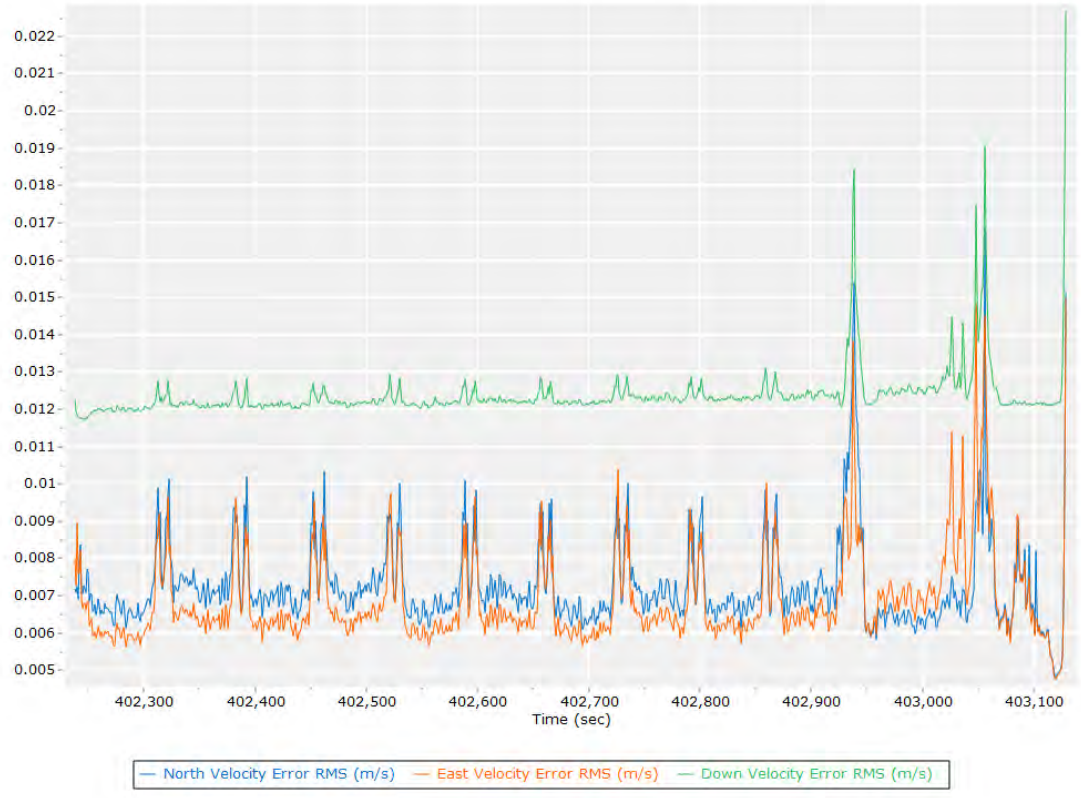


Smoothed Performance Metrics

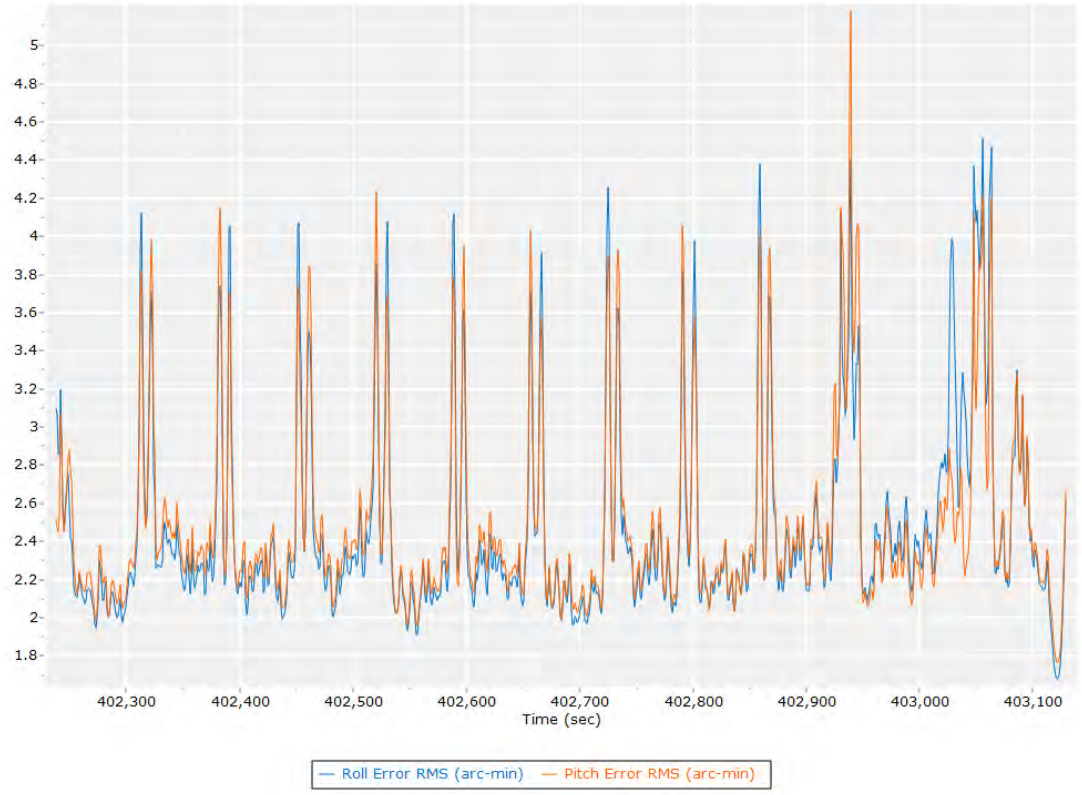
Position Error RMS (m)



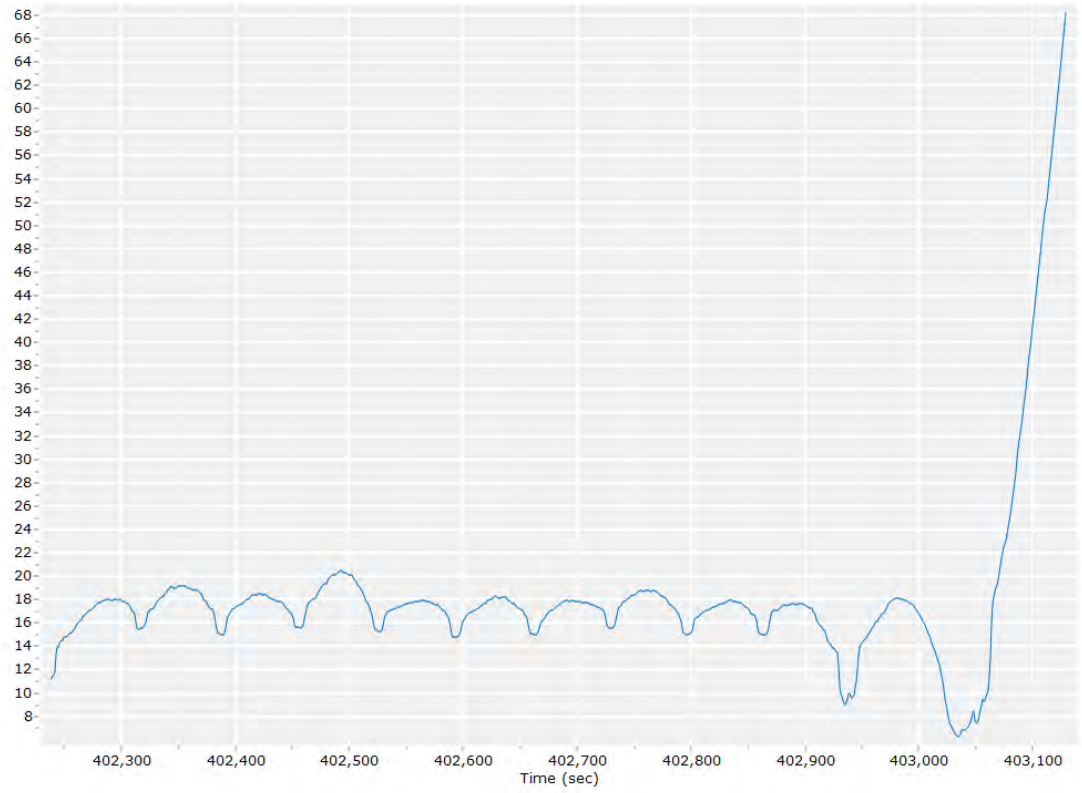
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

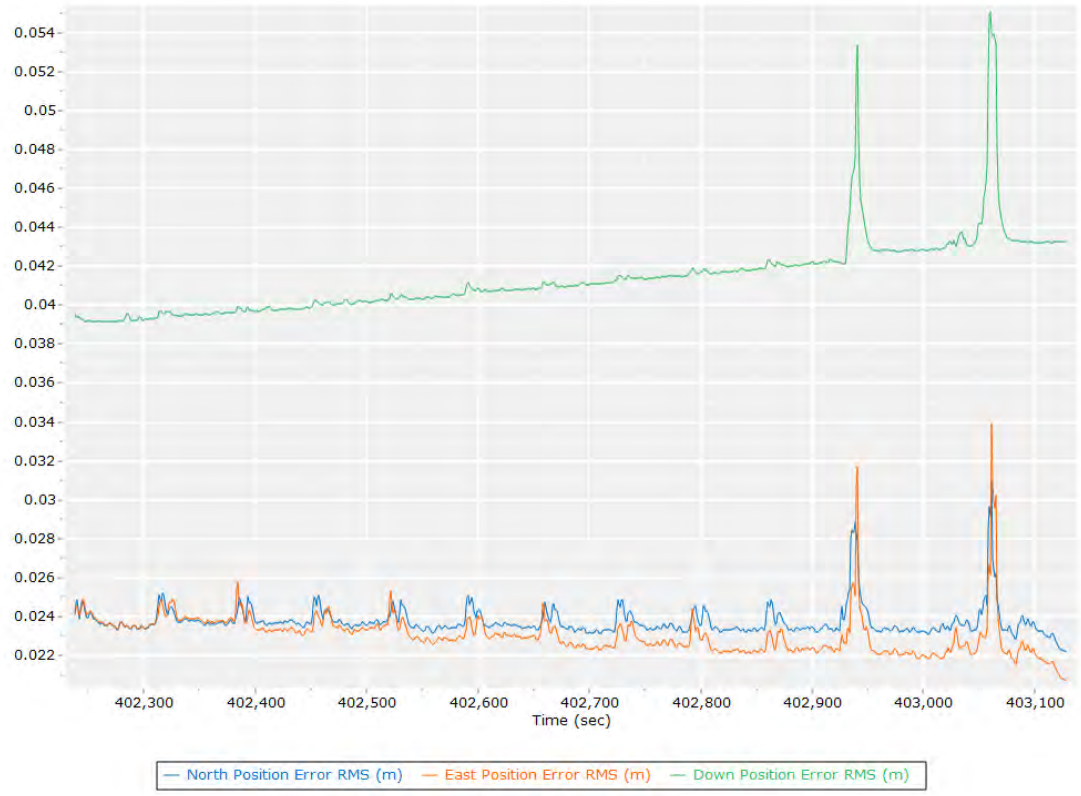


Heading Error RMS (arc-min)

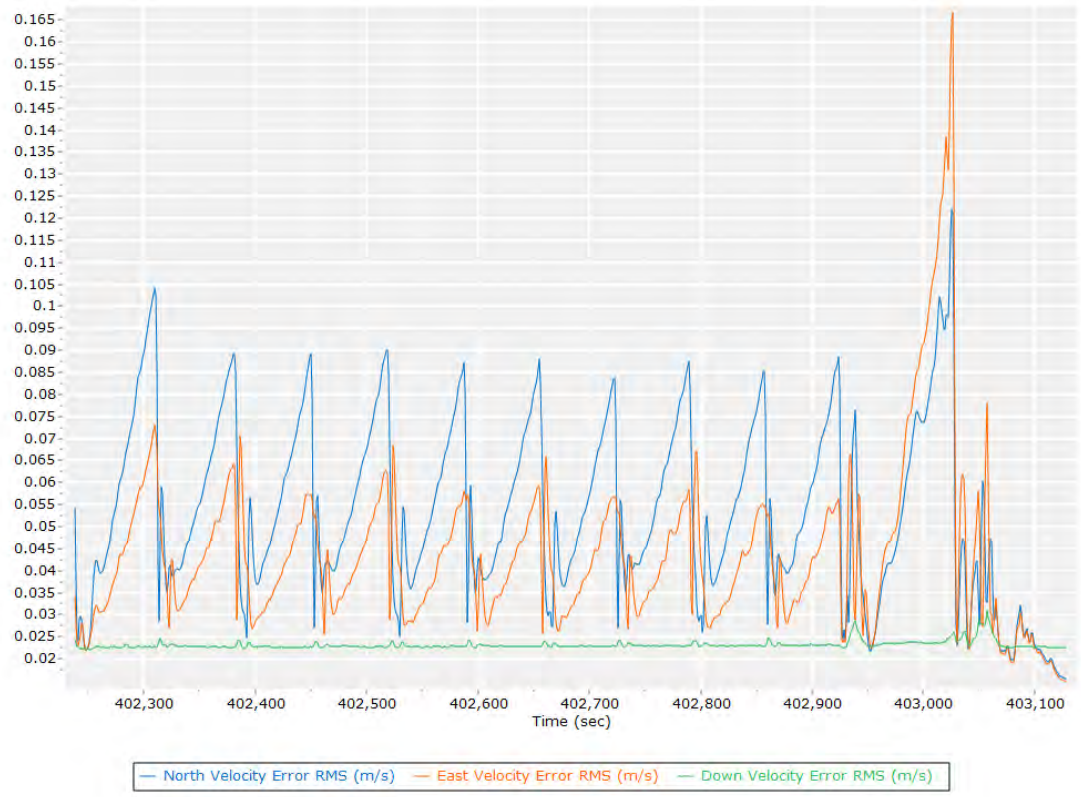


Forward Processed Performance Metrics

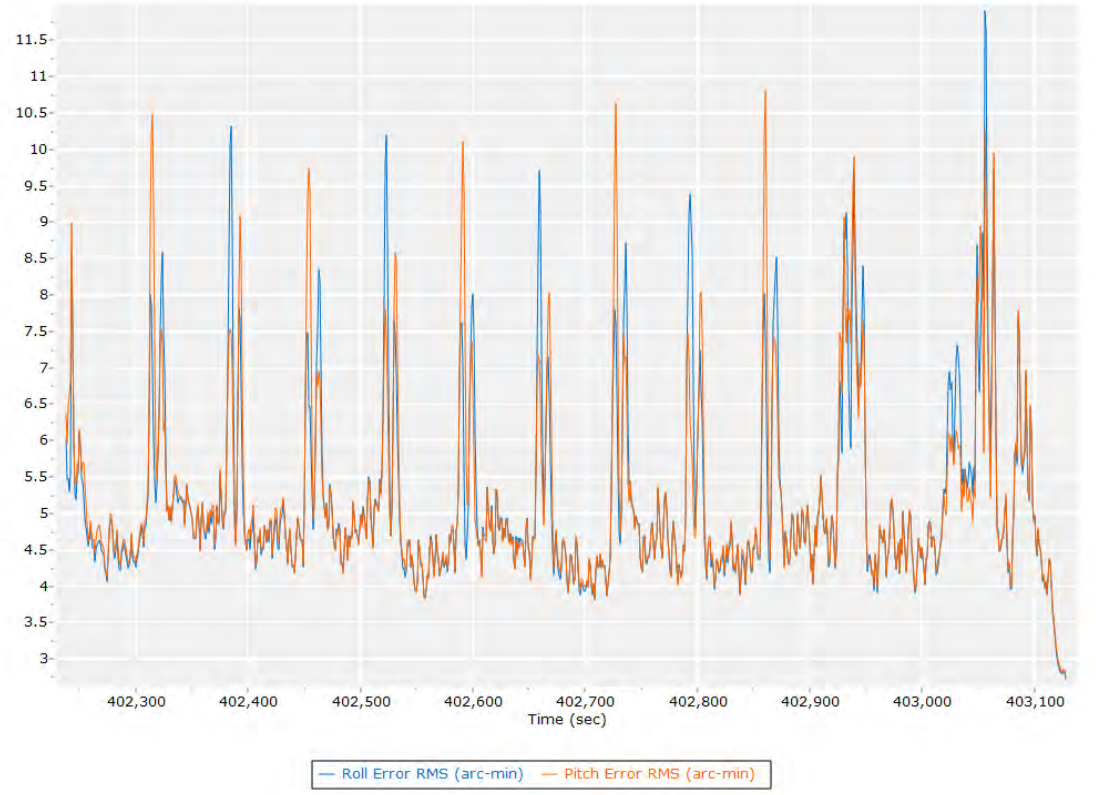
Position Error RMS (m)



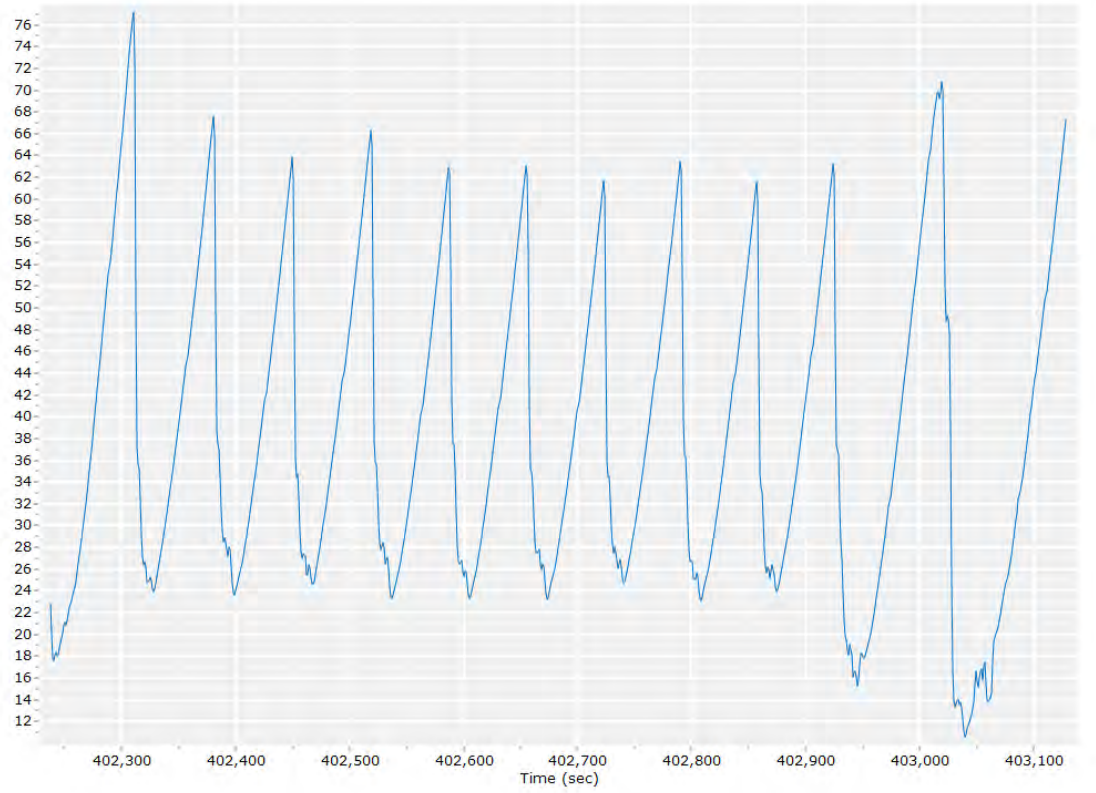
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

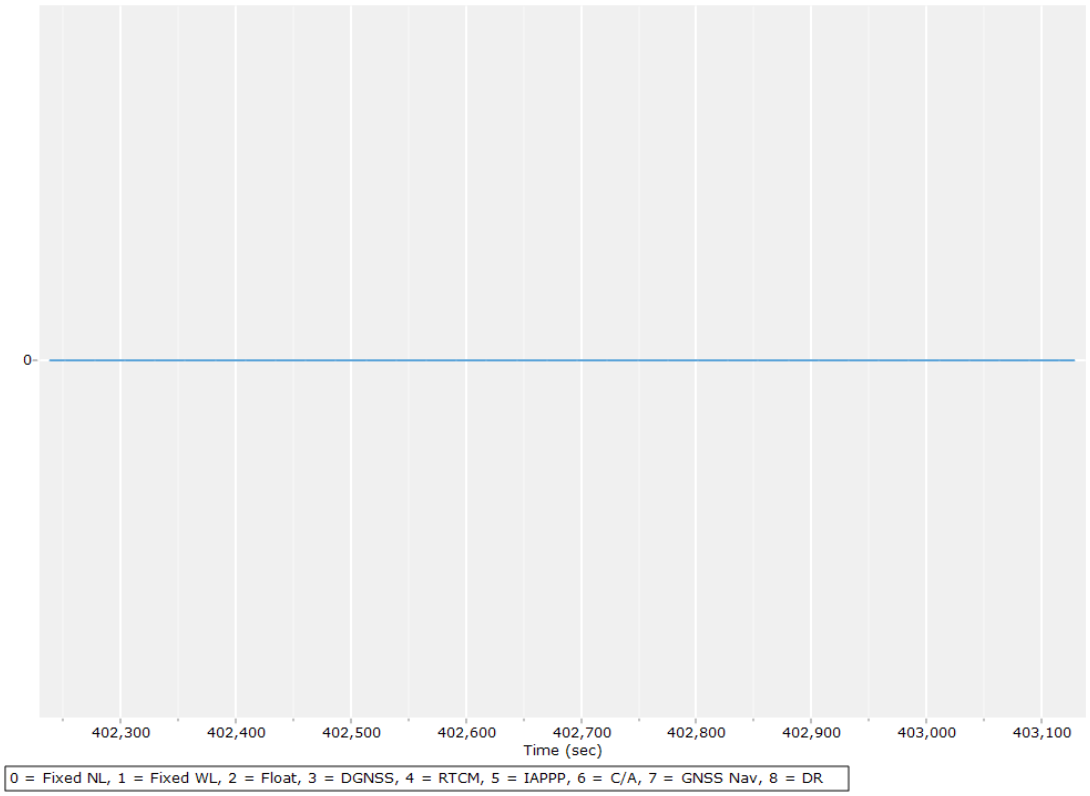


Heading Error RMS (arc-min)

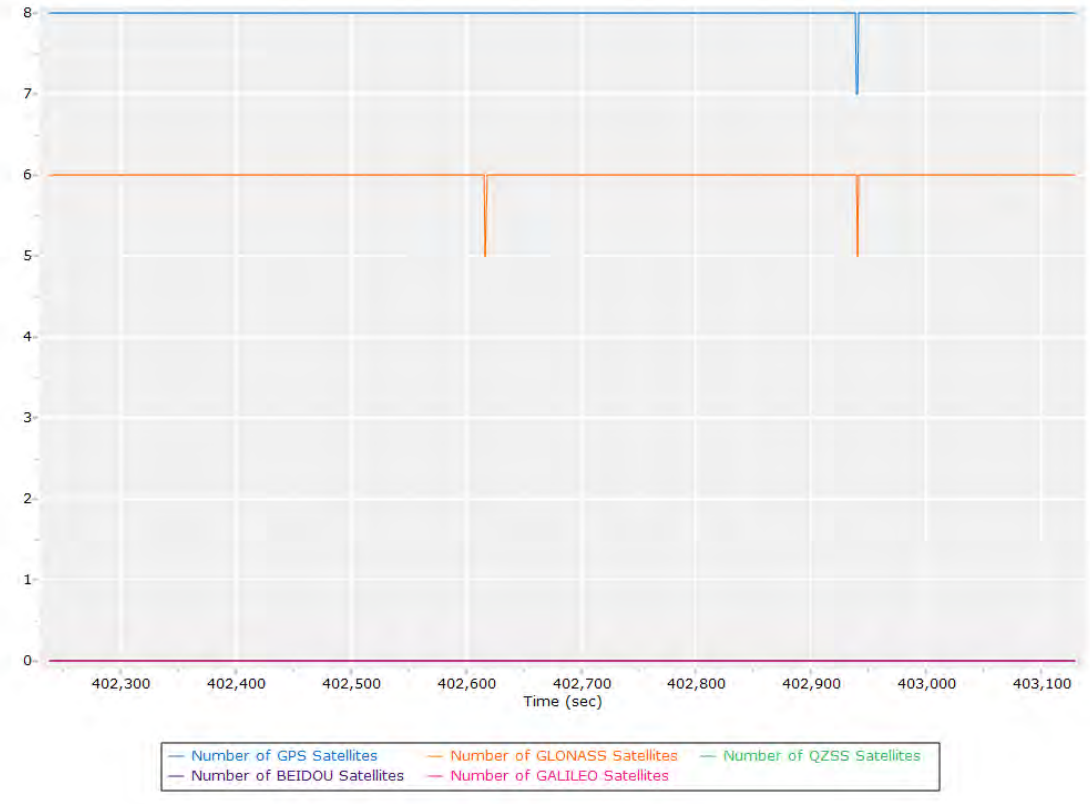


Smoothed Solution Status

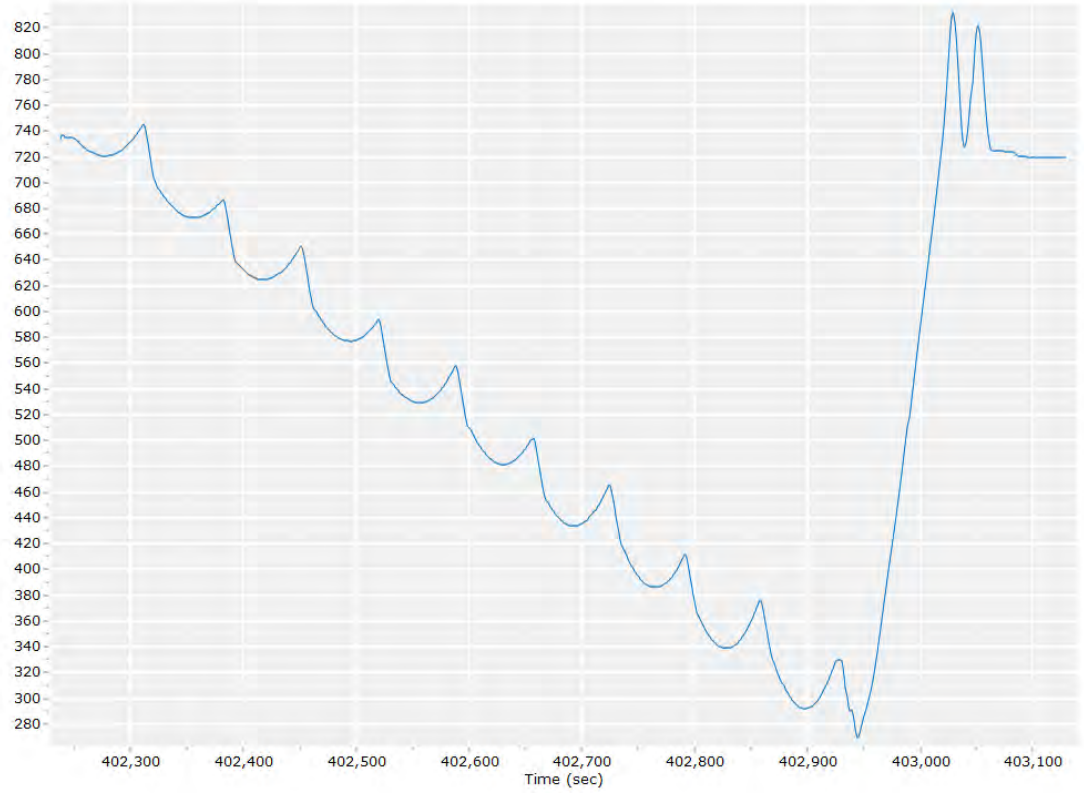
Processing Mode



Number of Satellites

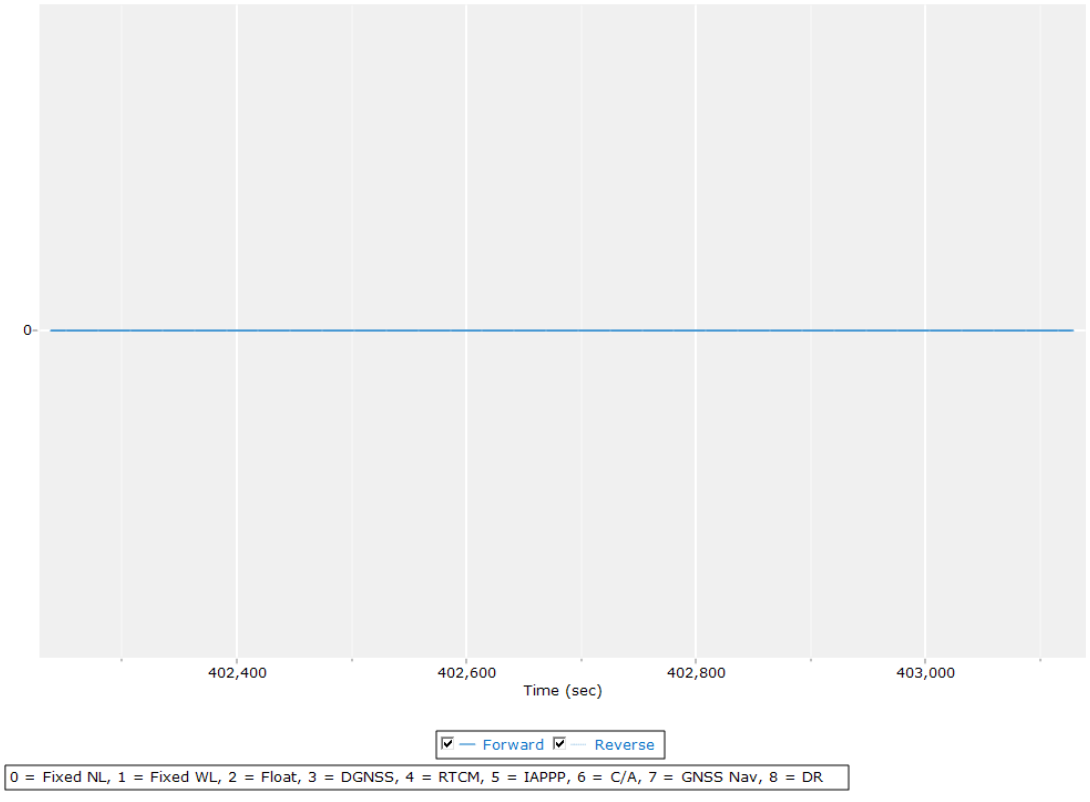


Baseline Length

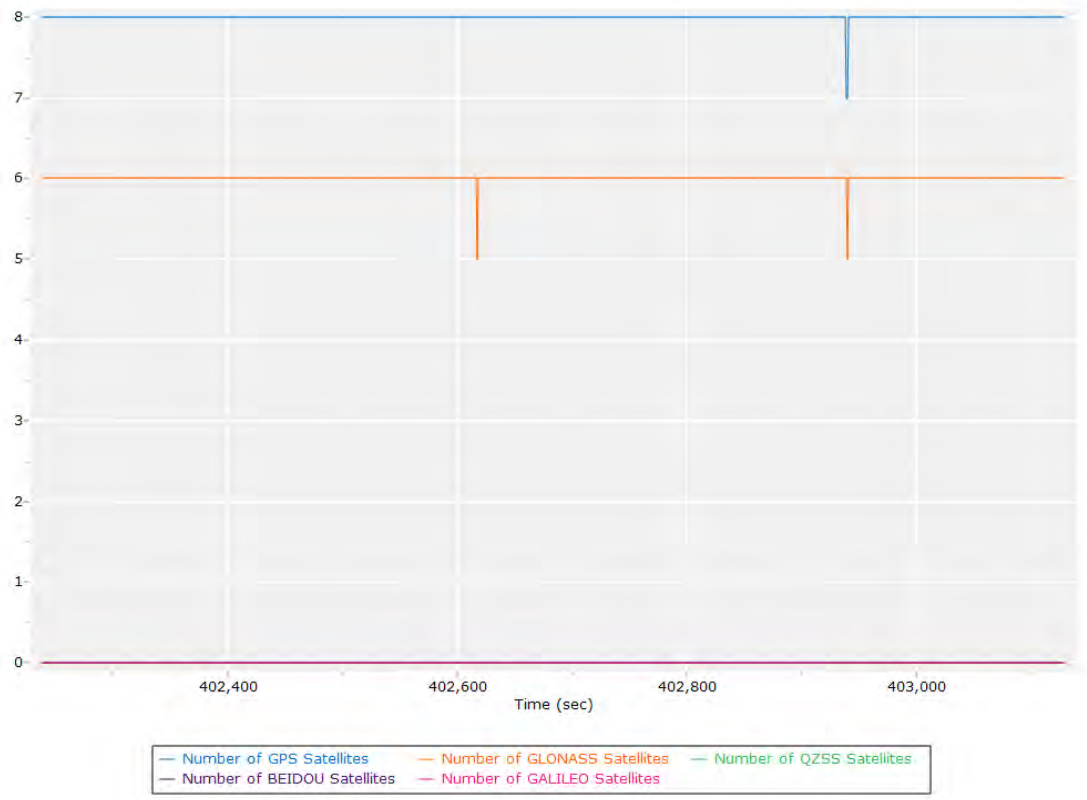


Forward Processed Solution Status

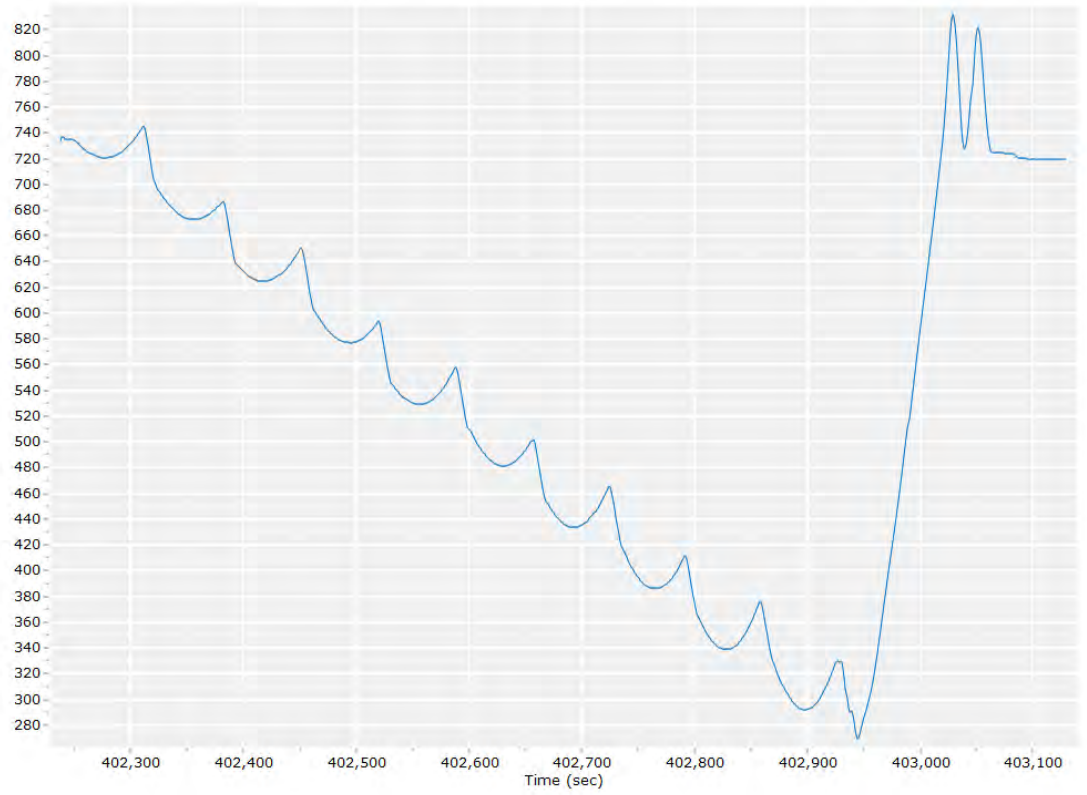
Processing Mode



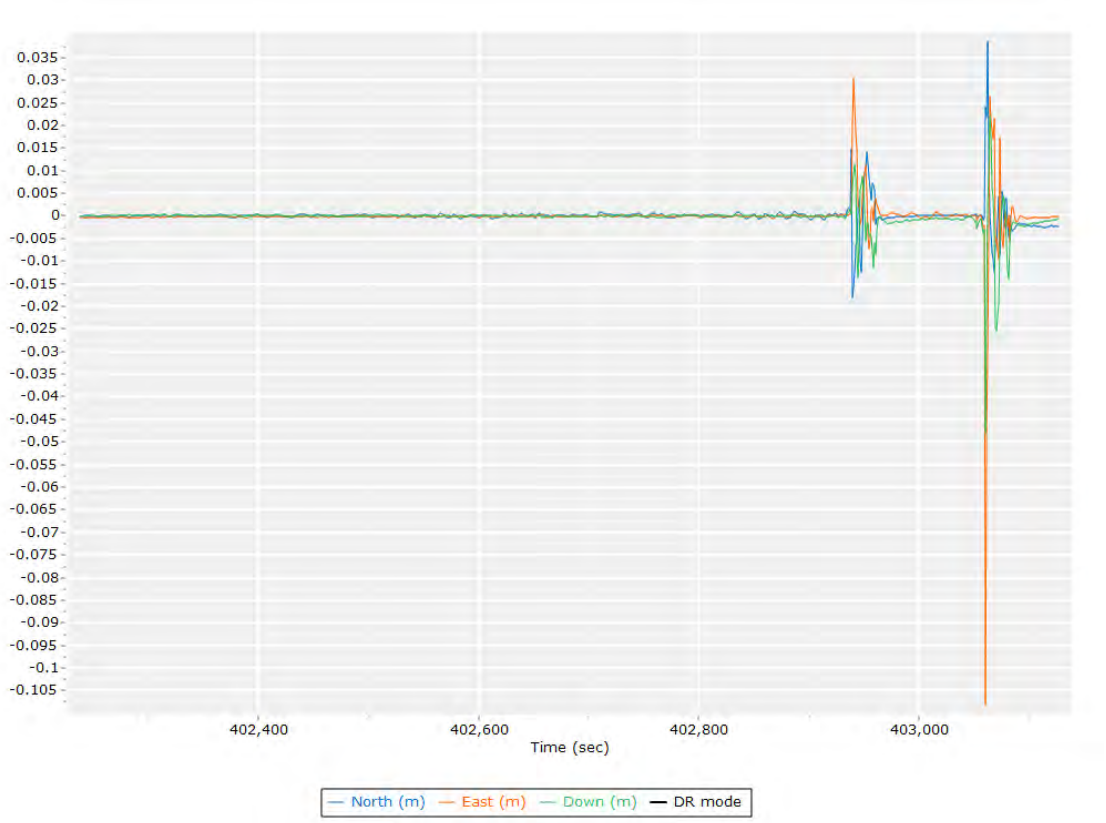
Number of Satellites



Baseline Length



SBET IAKAR Separation



Export Summary Section 1

Export file	YS-20250206-154148sbet.txt		
Export format	ASCII		
Solution in use	Post-processed		
Output rate	All Records		
Reference to Output lever arm (m)	0.000	0.000	0.000
Reference mounting angles (deg)	0.000	0.000	0.000
Output units (Coordinate / Lat & Lon)	Meter	Meter	
Export start time	0.000 (02/02/2025 00:00:00)		
Export end time	395199.000 (02/13/2025 13:46:39)		
Height option	Applanix Orthometric Height		
Geoid model	OSGM15 (United Kingdom)		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 30 (6W to 0W)		
Datum	ETRS89		
Ellipsoid	GRS 1980		
Local Transformation	NONE		
Target Epoch	1989		

General Information

Mission Information

Project name	YS-20250206-162908
Processing date	2025-02-18 12:30:02
Mission date	2025-02-06 16:29:32
Mission duration	00:21:44.000
Processing mode	IN-Fusion Single Base
GPS Station	base

Rover Hardware Information

Product	APX 15 AVX 210
Dynamic Model	Airborne Rotor
Serial number	6202C16694
IMU type	59
Receiver type	APX-15v3
Antenna type	AV18

Project File List

Rover Data Files

File name	File type
YS-20250206-162908.t04	T04 Rover Data

Input Files

File Name	File Type
BRDC00IGS_R_20250370000_01D_MN.rnx	GPS, GLONASS, GALILEO, QZSS, BEIDOU Broadcast Ephemeris
Ephm0370.25g	GLONASS Broadcast Ephemeris
Ephm0370.25n	GPS Broadcast Ephemeris
base0374.25O	GNSS SingleBase

Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
YS-20250206-162908sbet.txt	ASCII Export Output

Rover Data Summary

First raw data file	YS-20250206-162908.t04		
Last raw data file	YS-20250206-162908.t04		
Start GPS week	2352		
Start time	404972.000 (02/06/2025 16:29:32)		
End time	406276.000 (02/06/2025 16:51:16)		
Start of fine alignment	405009.290 (02/06/2025 16:30:09)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
IMU Installation Lever Arms & Mounting Angles			
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.050	0.120	-0.510
Reference to Primary GNSS lever arm std dev (m)	0.020		
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

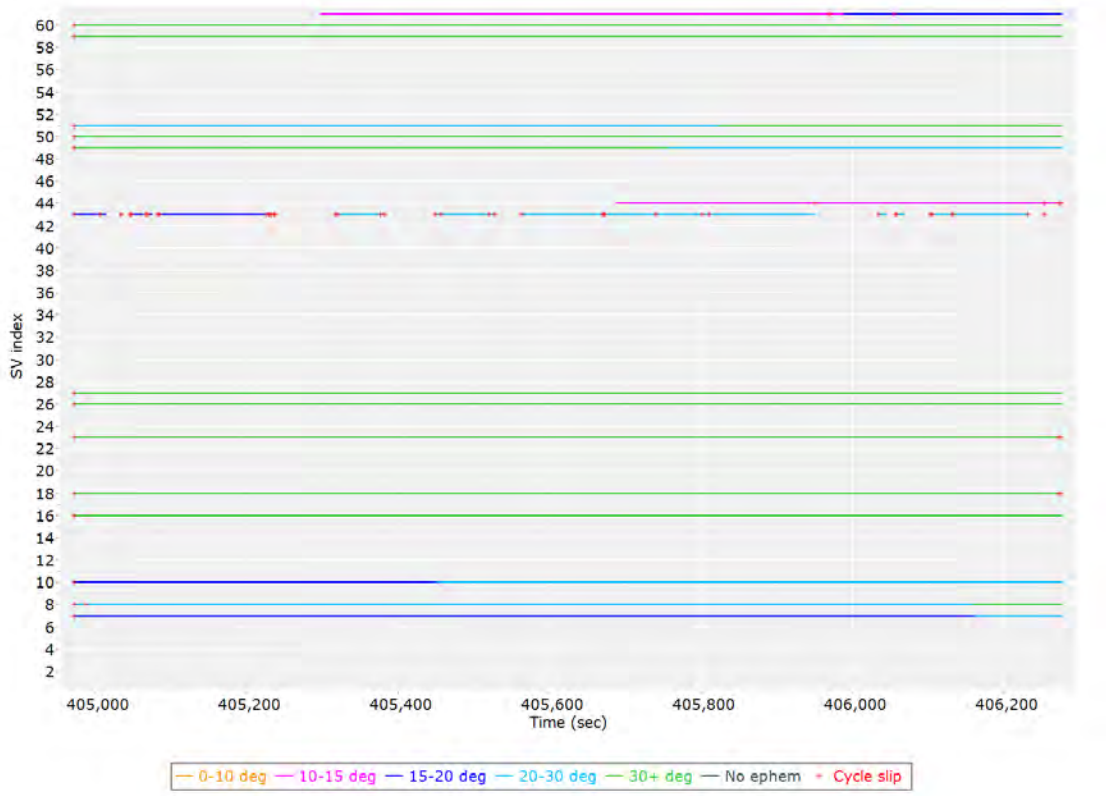
Rover Data QC

Raw IMU Import QC Summary

IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	260888
Termination Status	Normal
IMU Anomalies	0

Primary Observables & Satellite Data

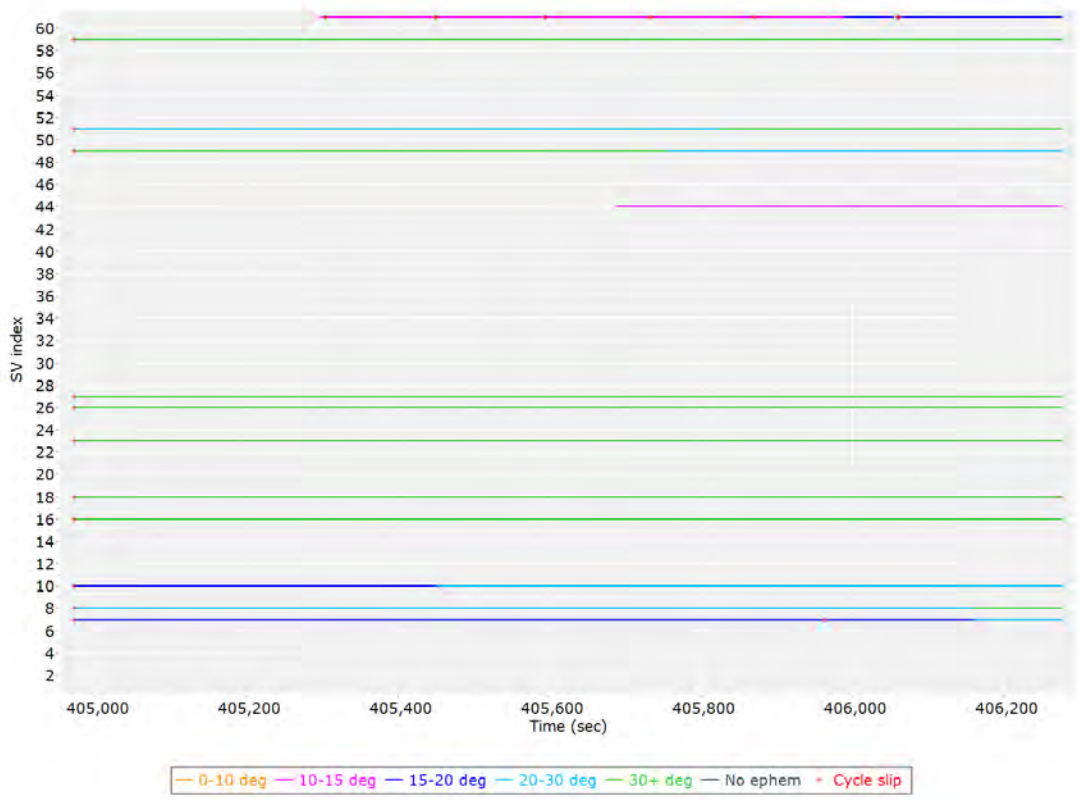
GPS/GLONASS L1 Satellite Lock/Elevation



GPS L1 SNR

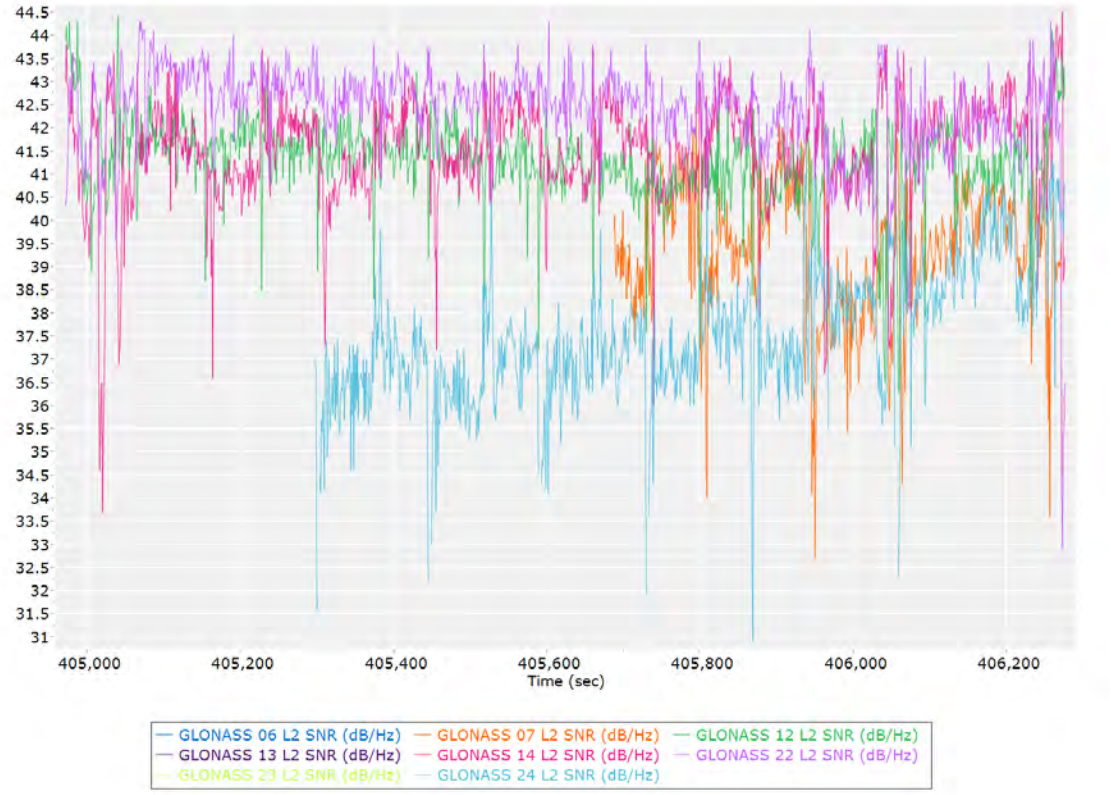
GLONASS L1 SNR

GPS/GLONASS L2 Satellite Lock/Elevation

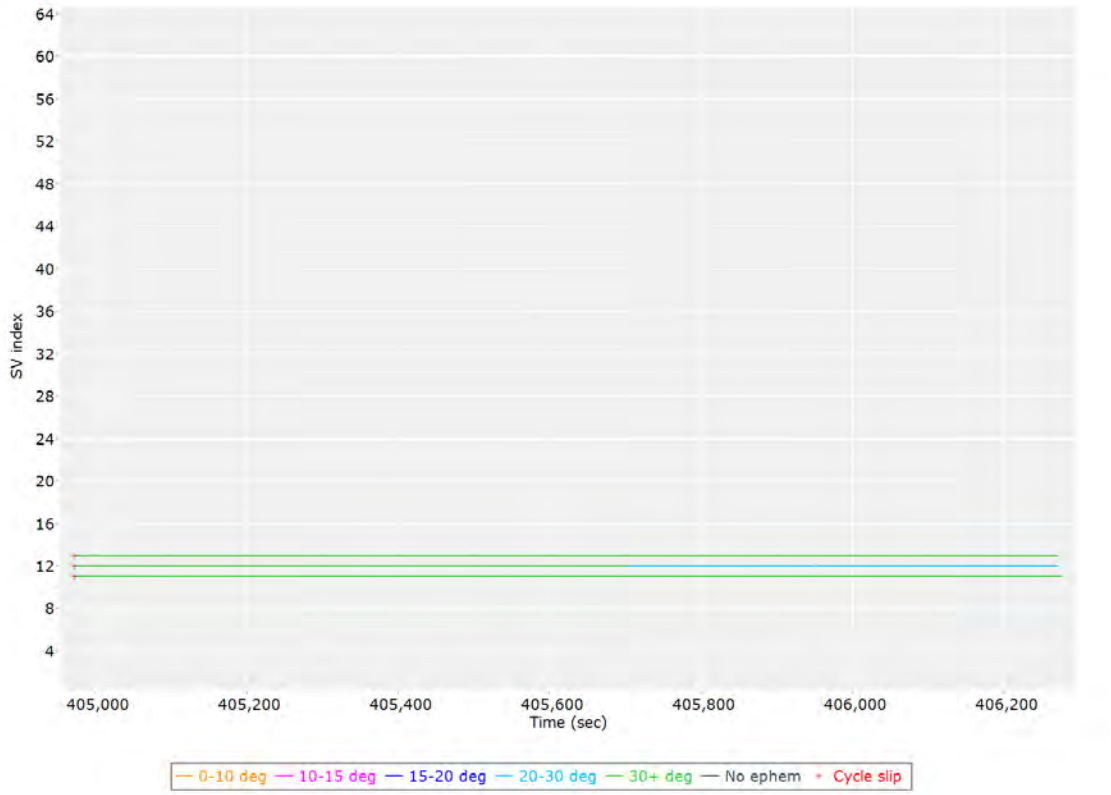


GPS L2 SNR

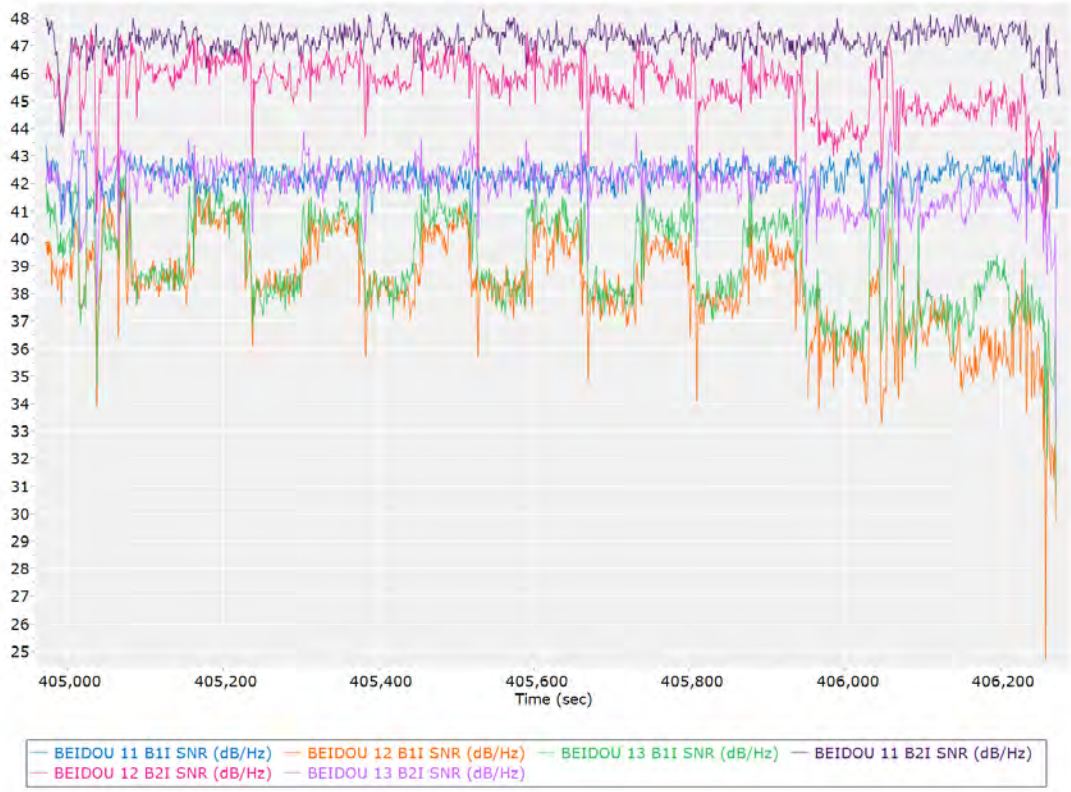
GLONASS L2 SNR



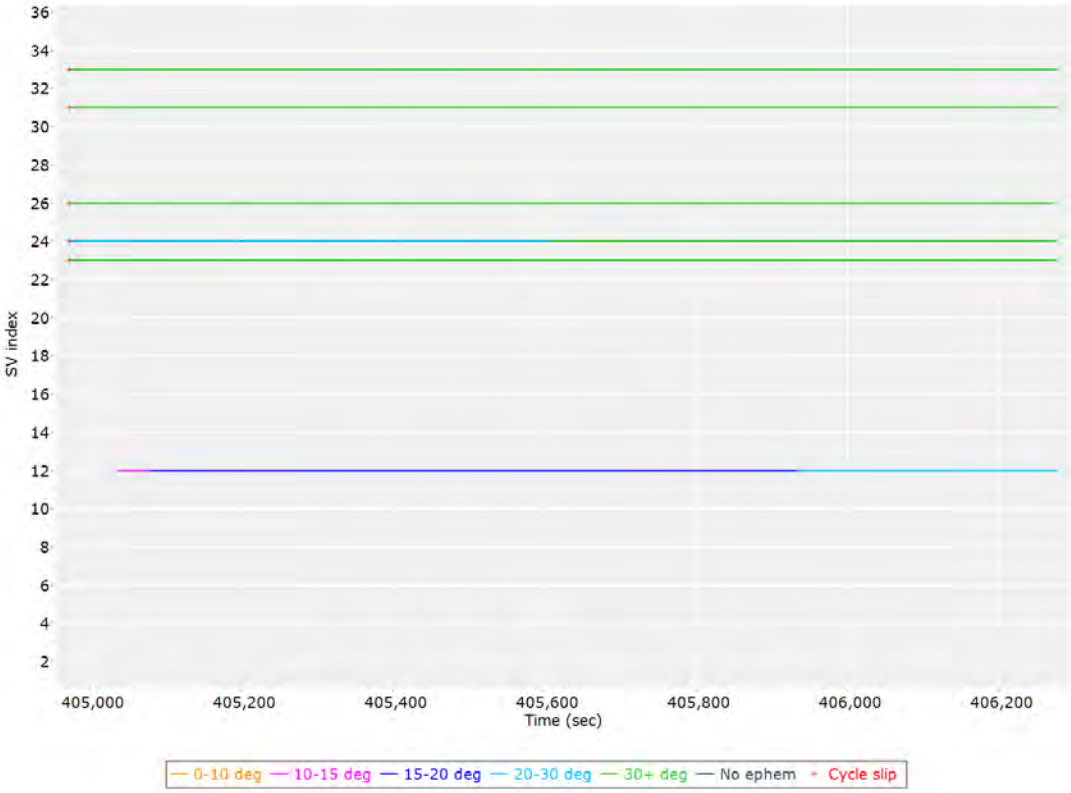
BEIDOU Satellite Lock/Elevation



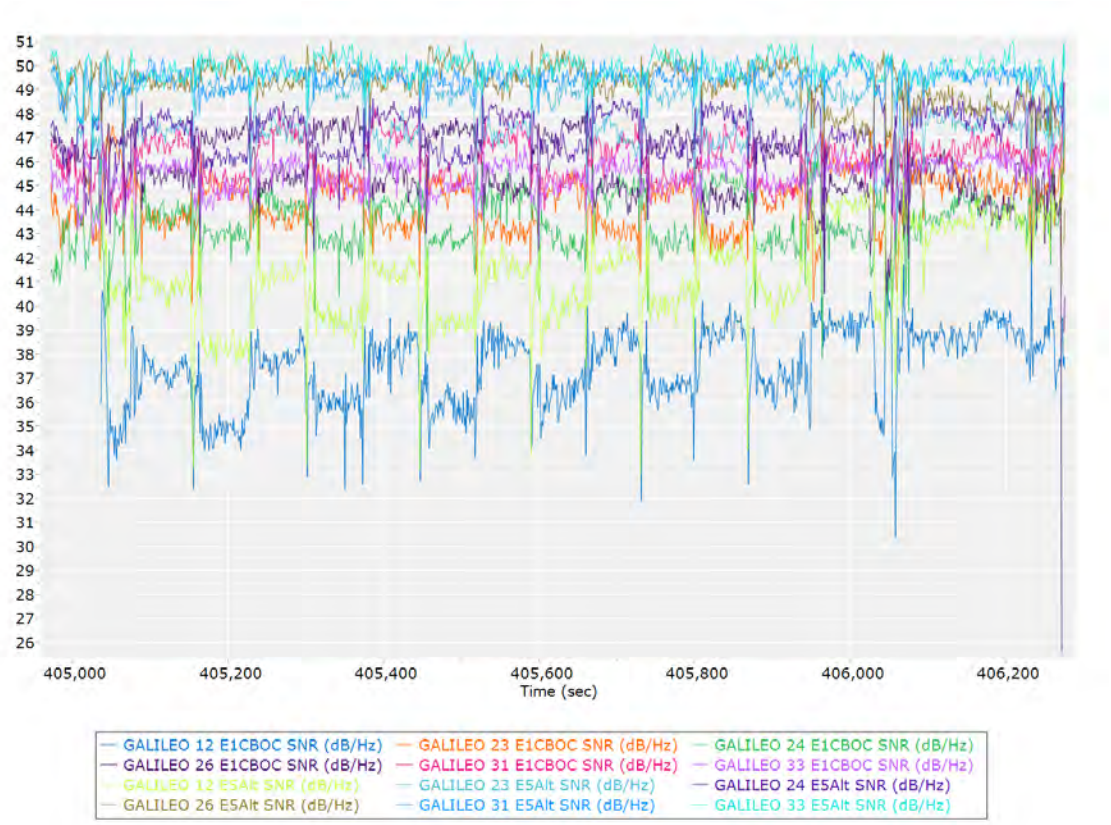
BEIDOU SNR



GALILEO Satellite Lock/Elevation



GALILEO SNR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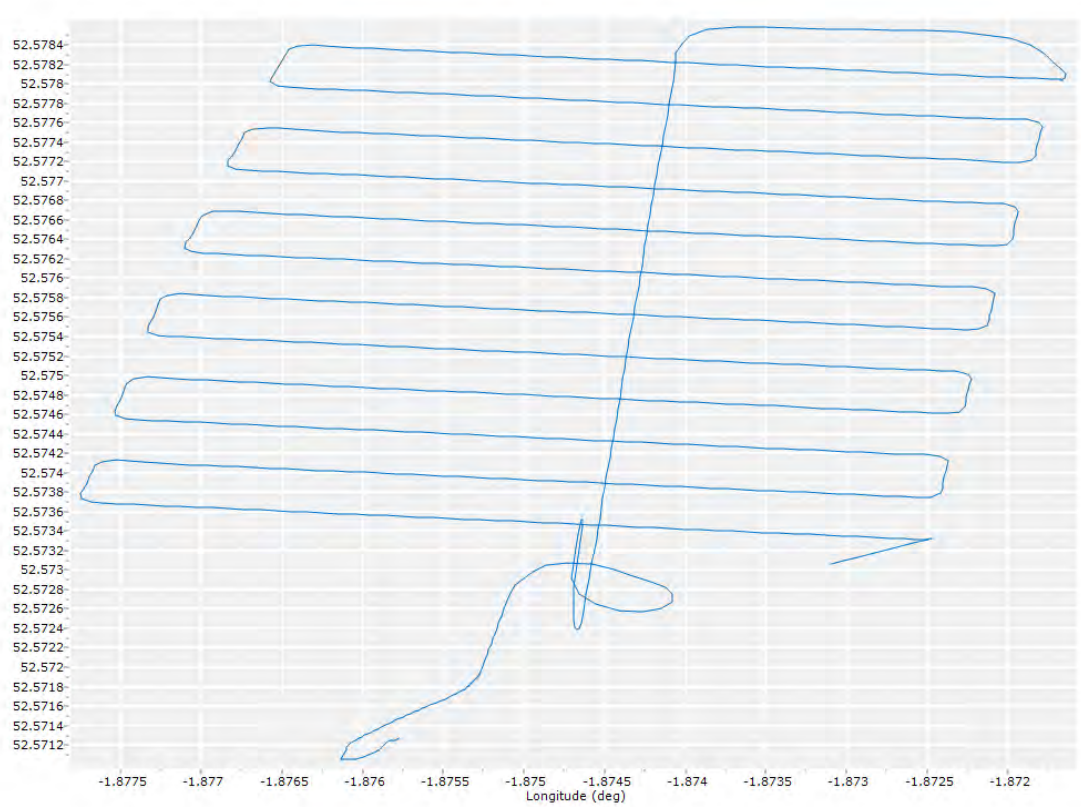
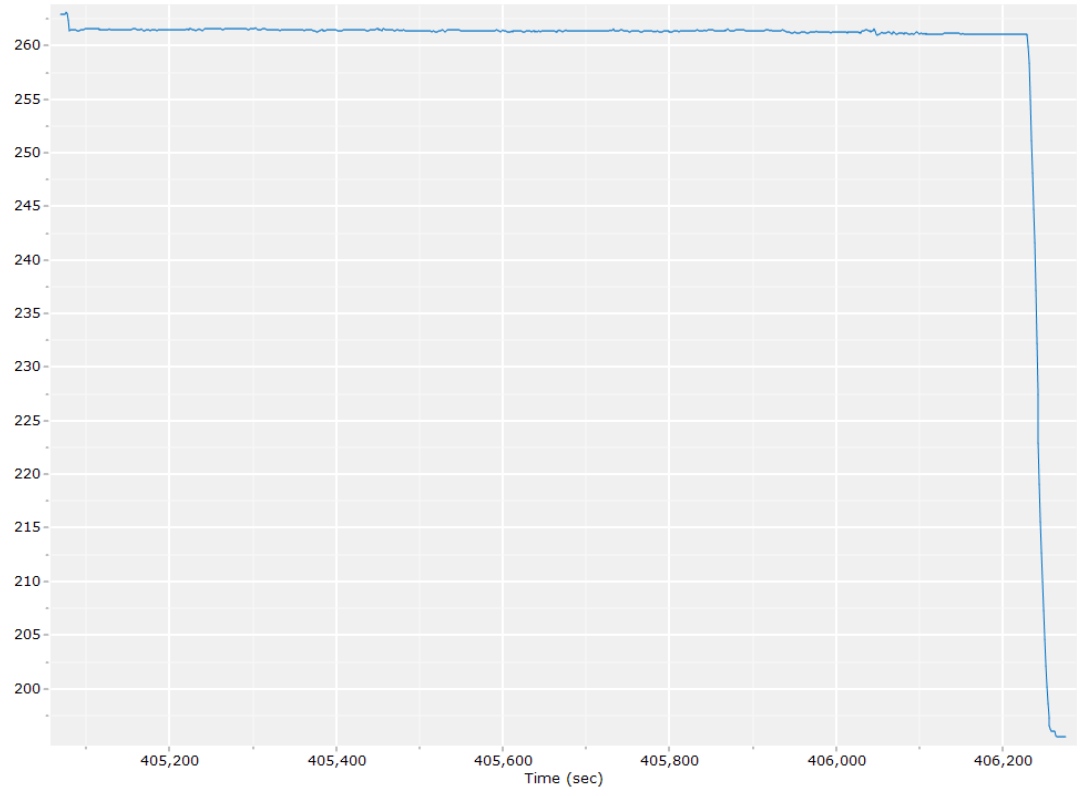
29
28
27
26
405,000
405,200
405,400
405,600
405,800
406,000
406,200
Time (sec)
GALILEO 12 E1CBOC SNR (dB/Hz)
GALILEO 23 E1CBOC SNR (dB/Hz)
GALILEO 24 E1CBOC SNR (dB/Hz)
GALILEO 26 E1CBOC SNR (dB/Hz)
GALILEO 31 E1CBOC SNR (dB/Hz)
GALILEO 33 E1CBOC SNR (dB/Hz)
GALILEO 12 E5Alt SNR (dB/Hz)
GALILEO 23 E5Alt SNR (dB/Hz)
GALILEO 24 E5Alt SNR (dB/Hz)
GALILEO 26 E5Alt SNR (dB/Hz)
GALILEO 31 E5Alt SNR (dB/Hz)
GALILEO 33 E5Alt SNR (dB/Hz)

Smoothed Trajectory Information

Top View

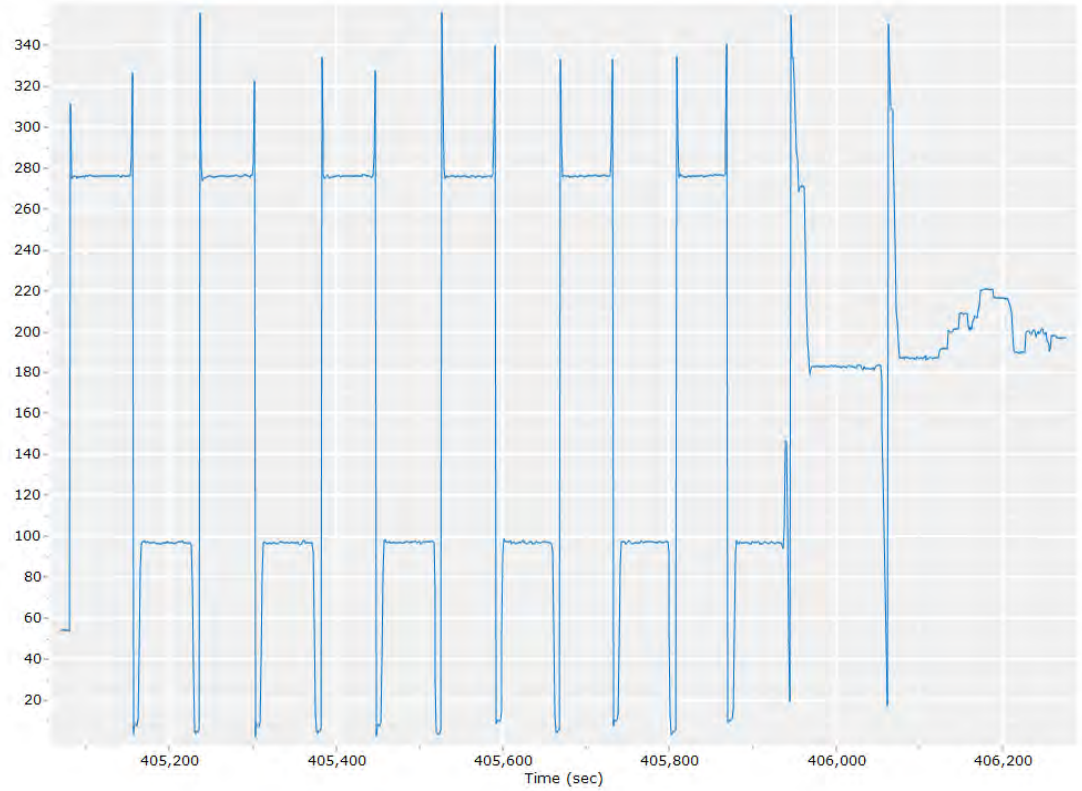


Altitude

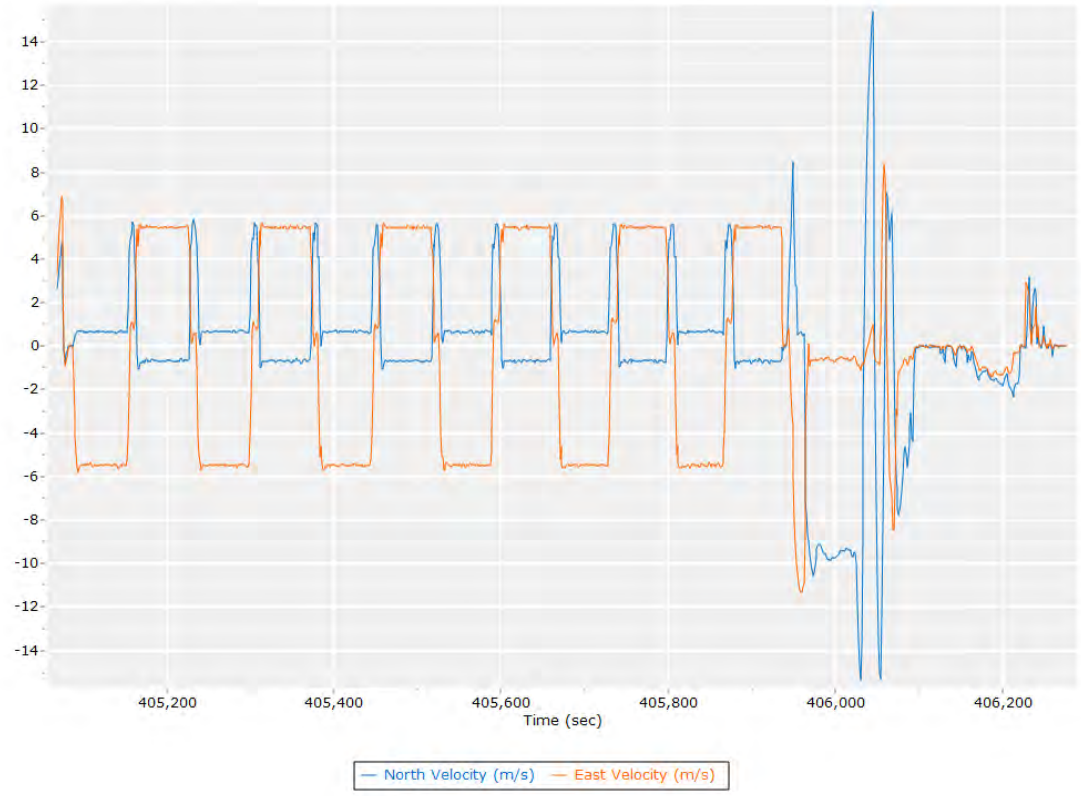


Roll/Pitch

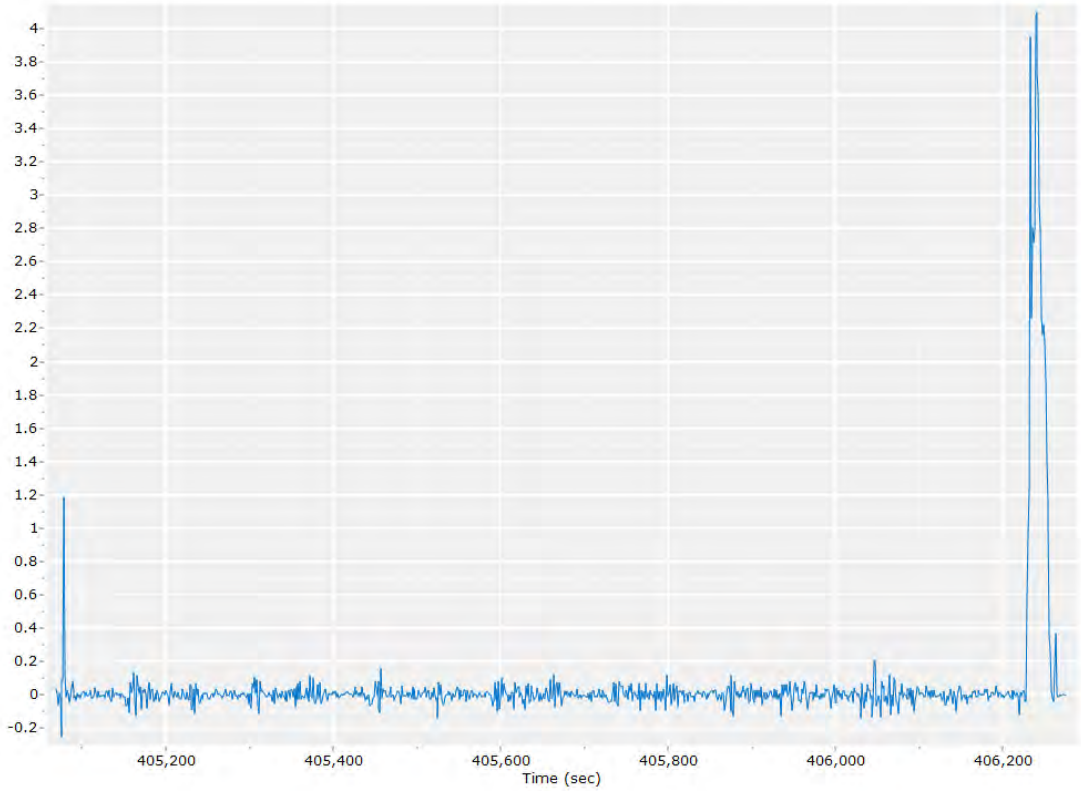
Heading



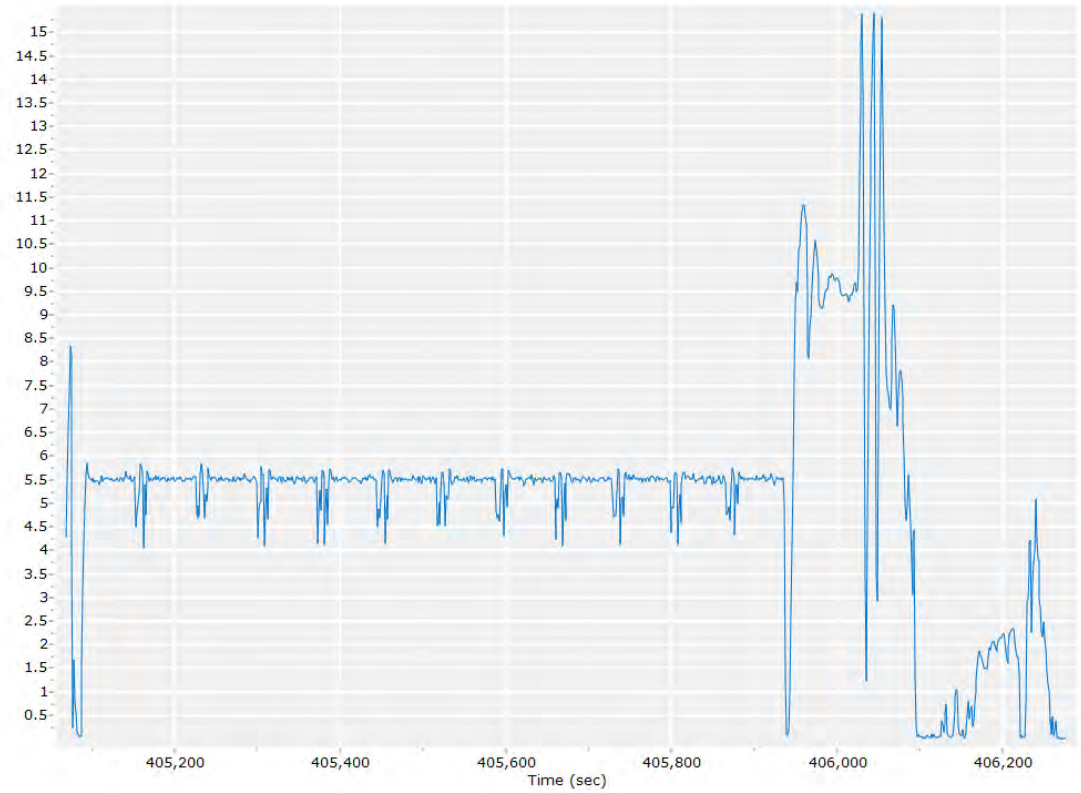
North/East Velocity



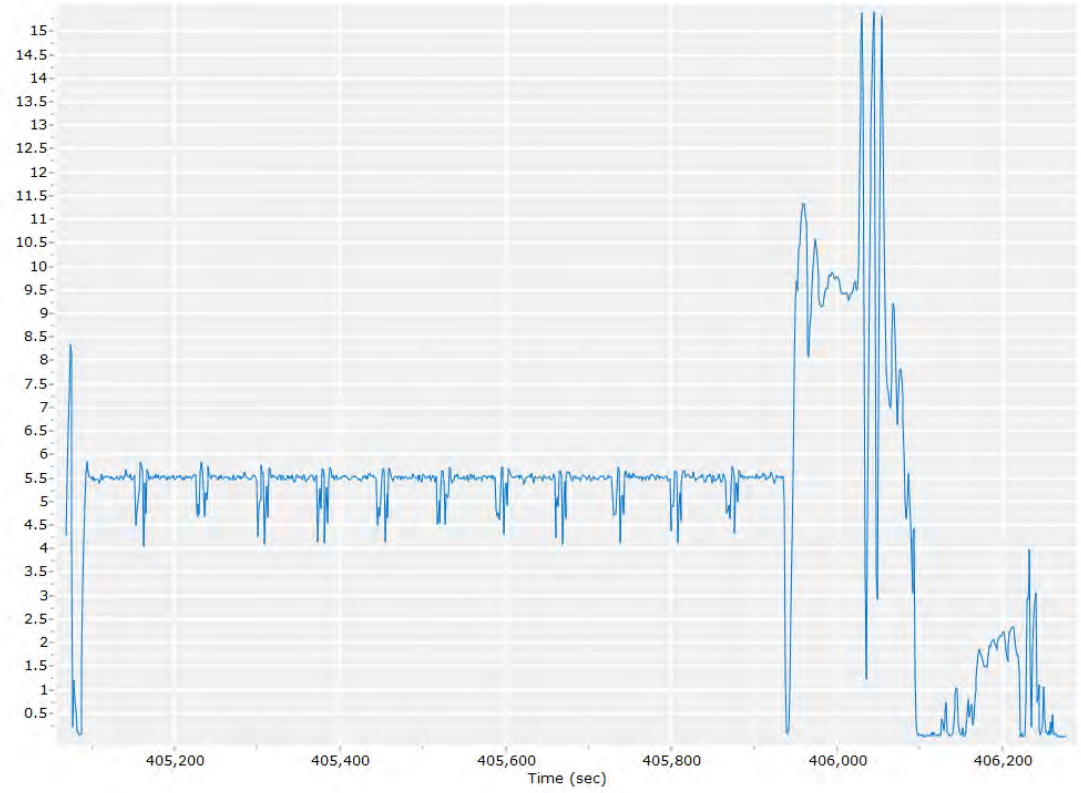
Down Velocity



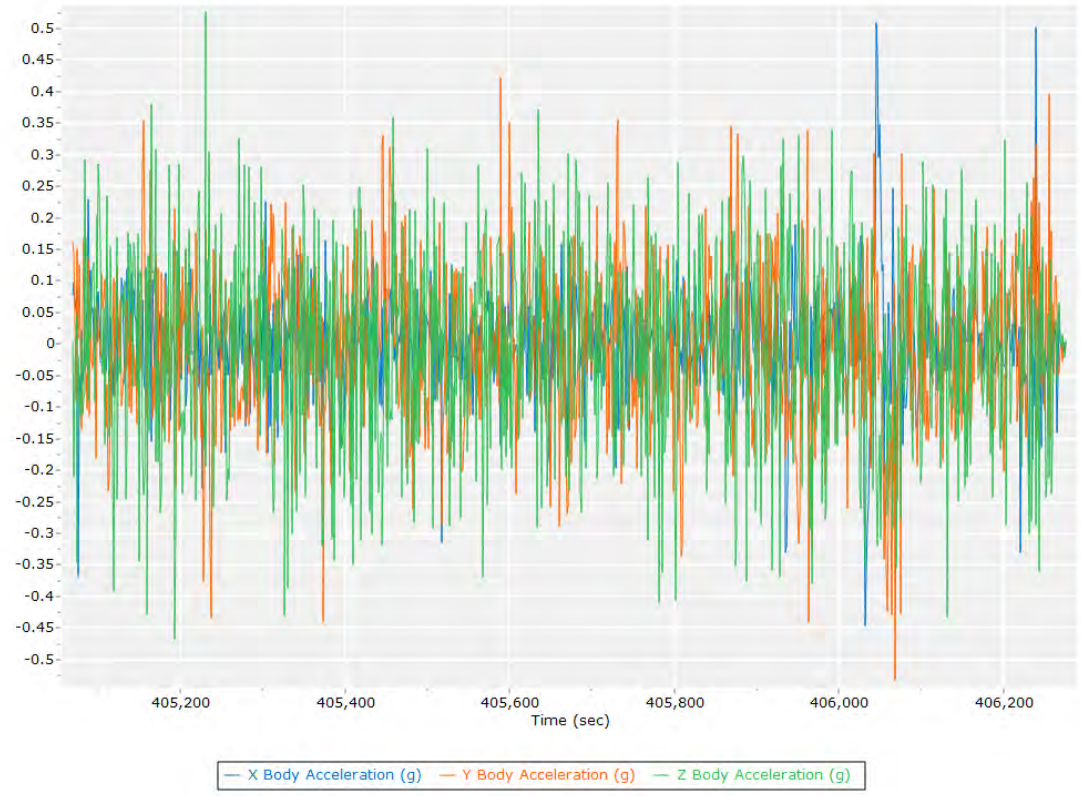
Total Speed



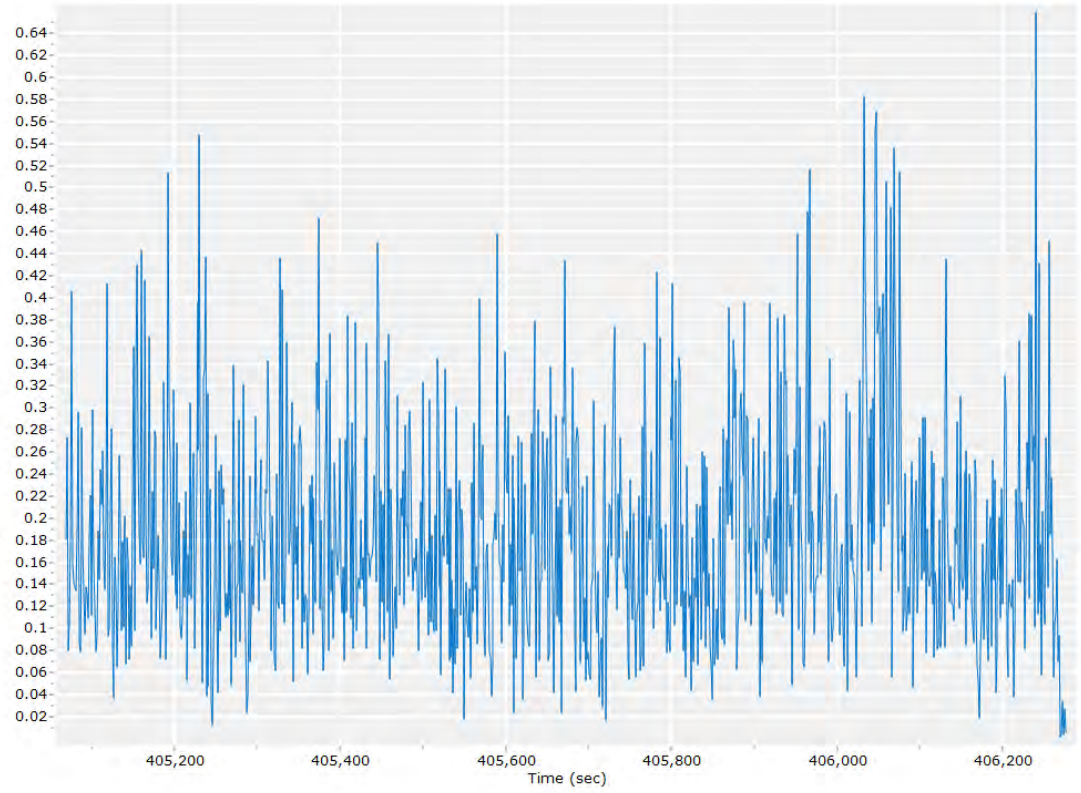
Ground Speed



Body Acceleration



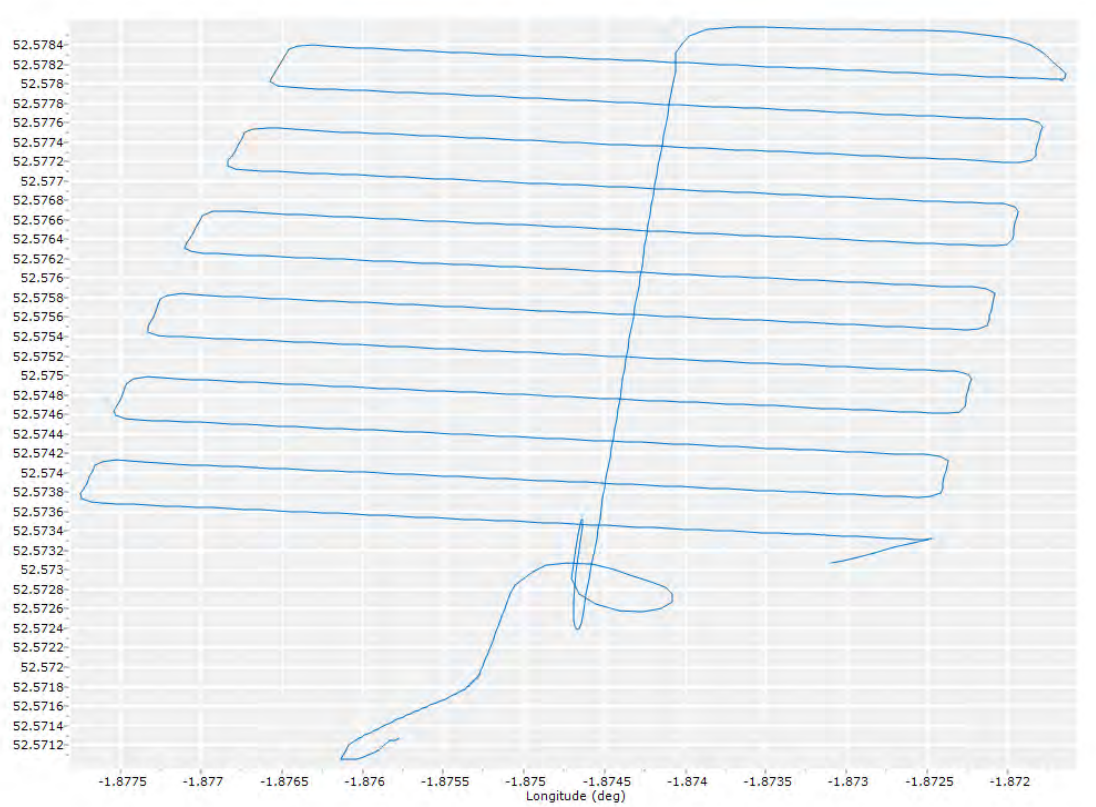
Total Body Acceleration



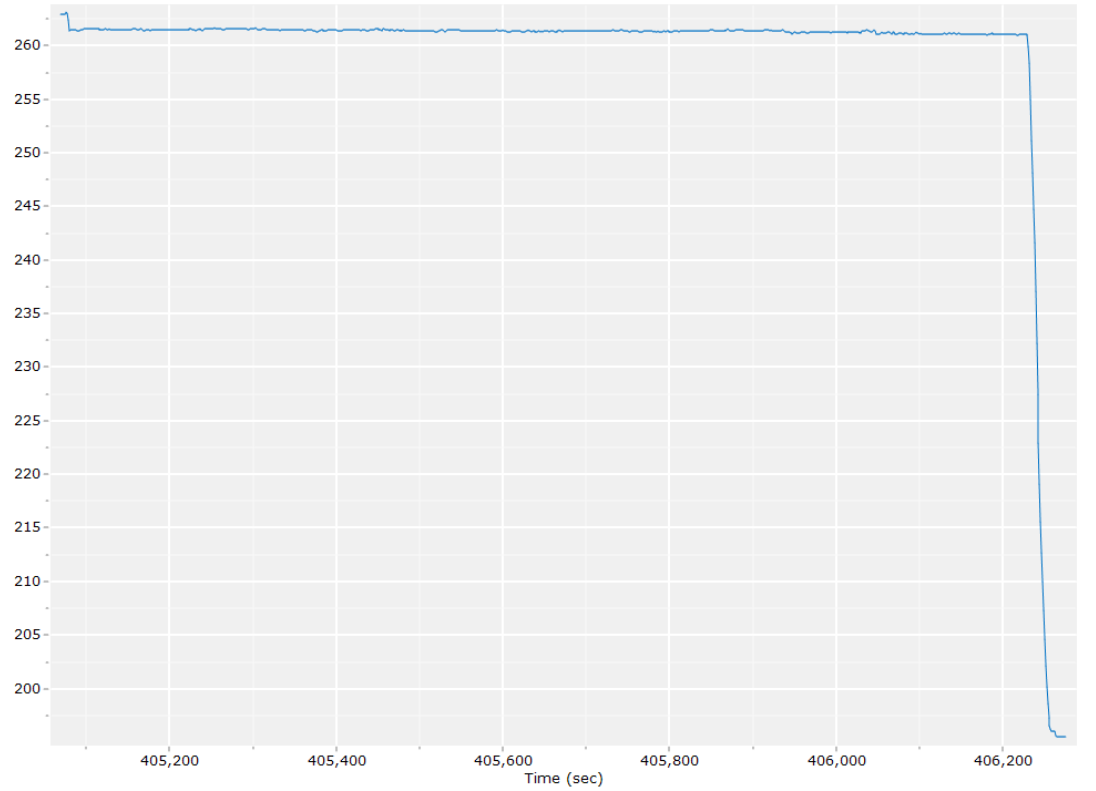
Body Angular Rate

Forward Processed Trajectory Information

Top View

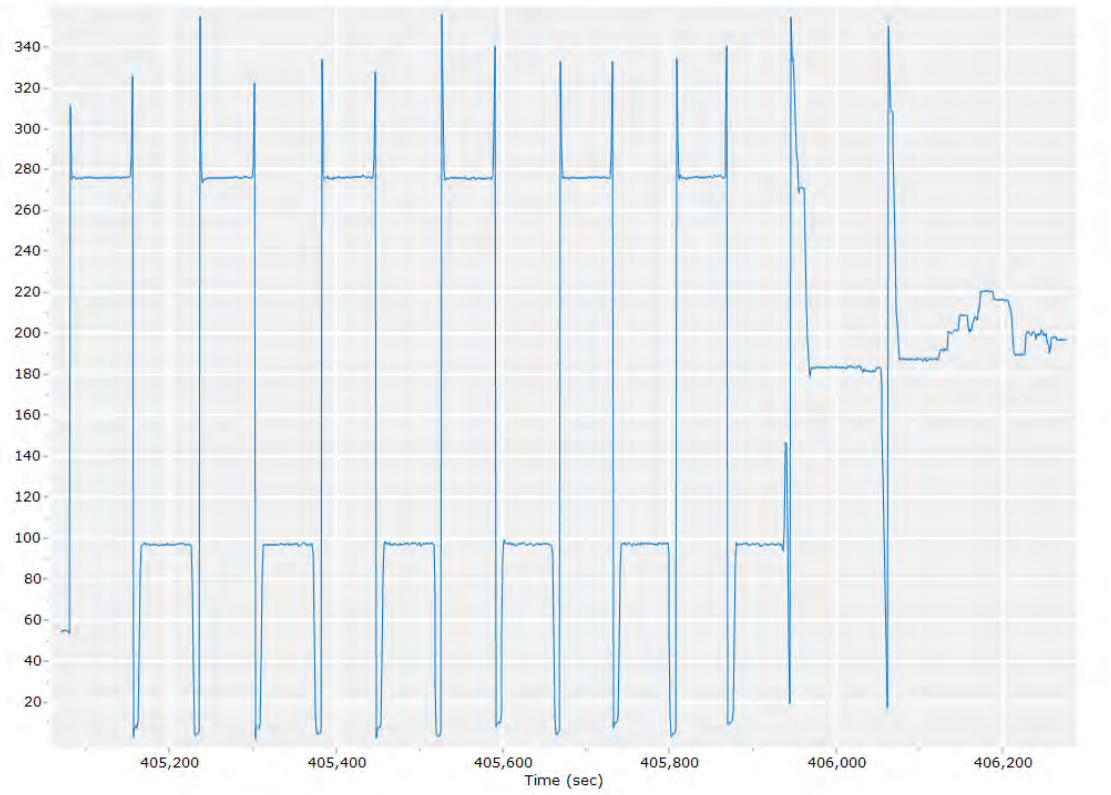


Altitude

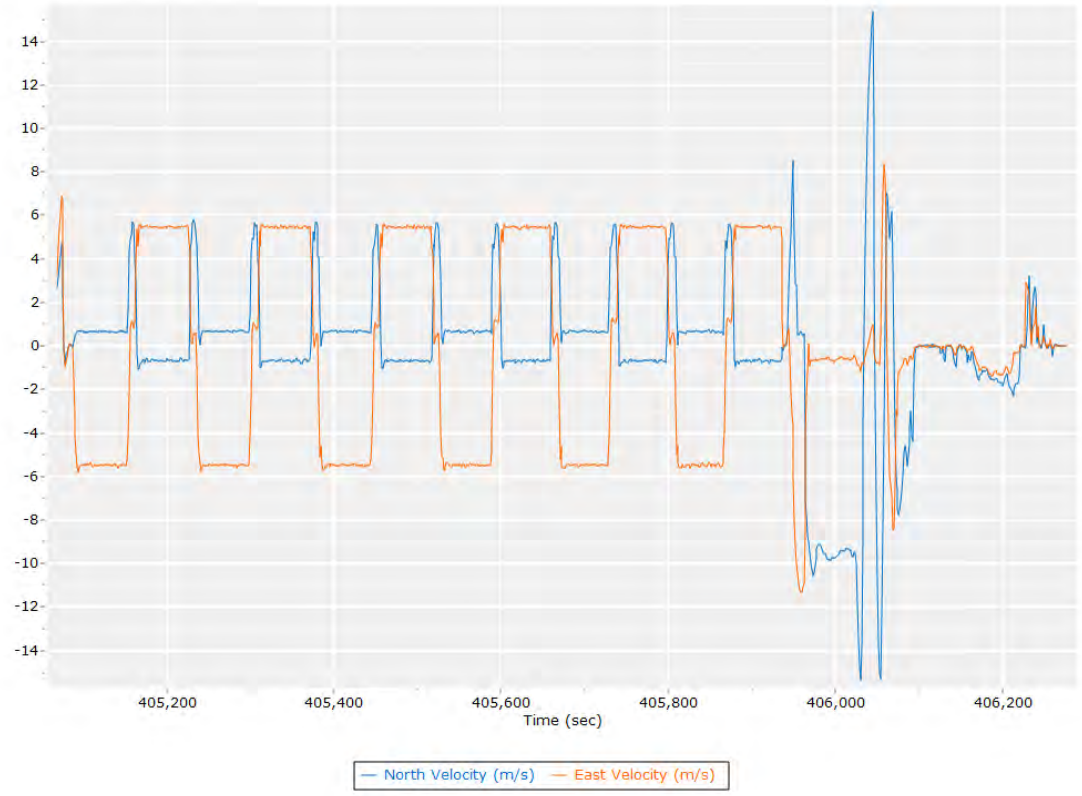


Roll/Pitch

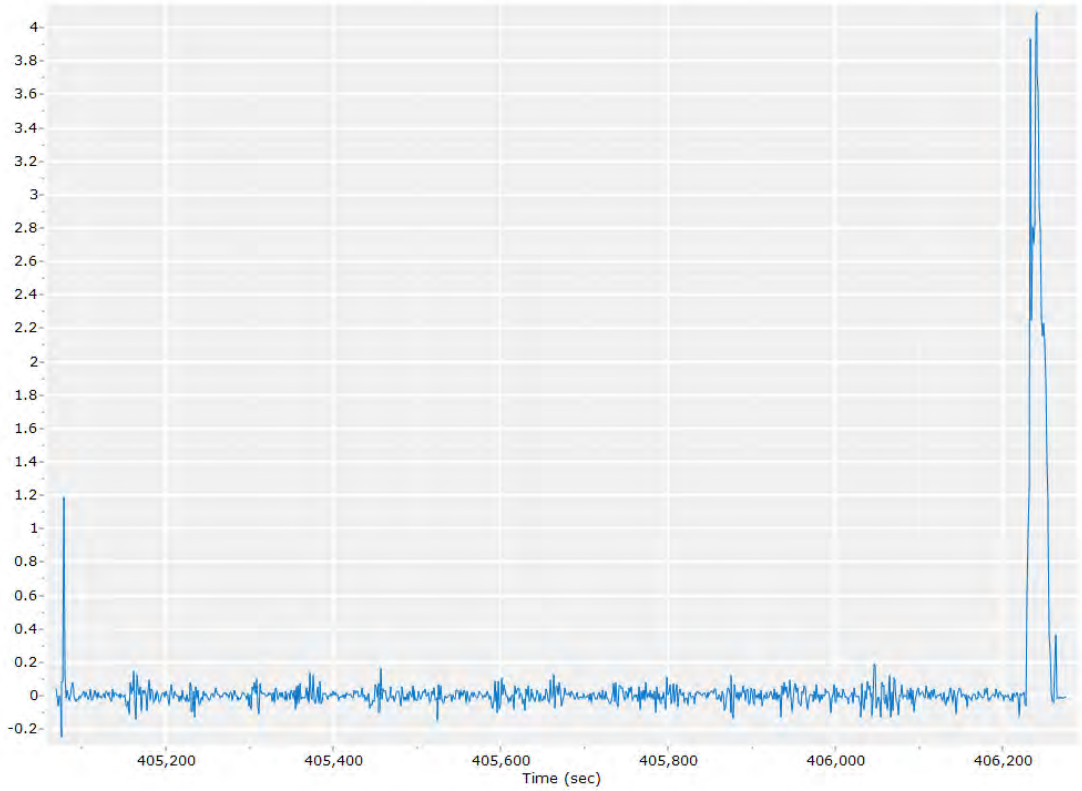
Heading



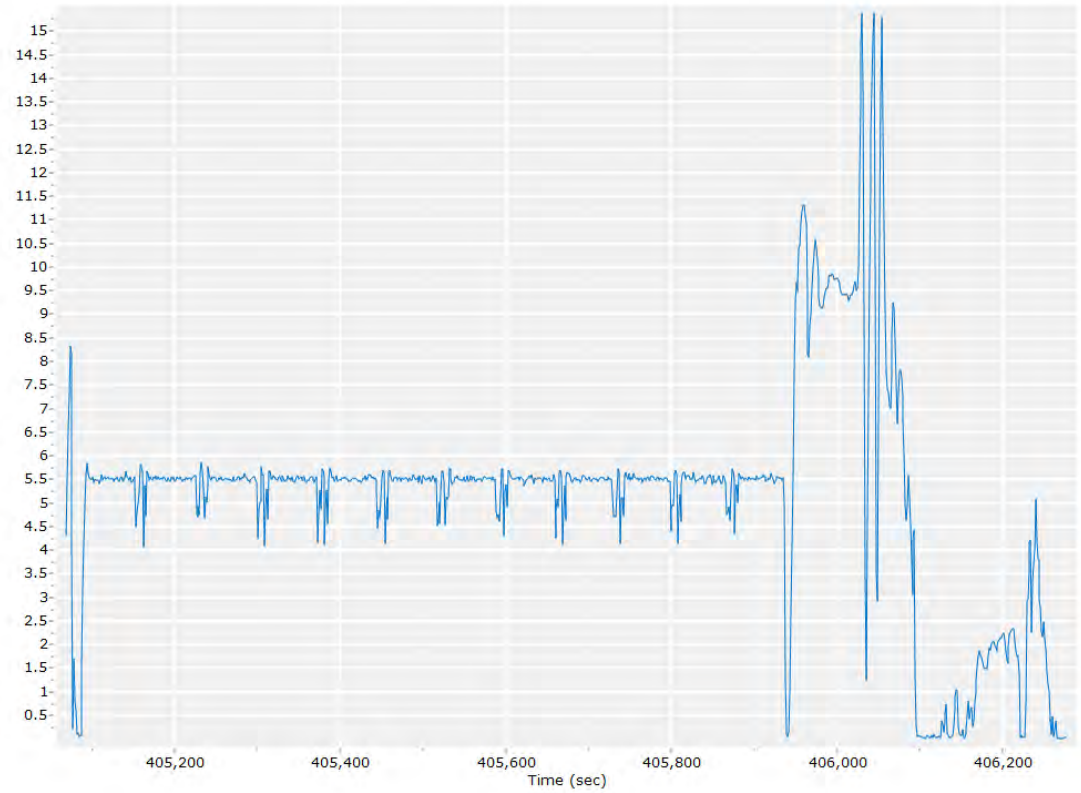
North/East Velocity



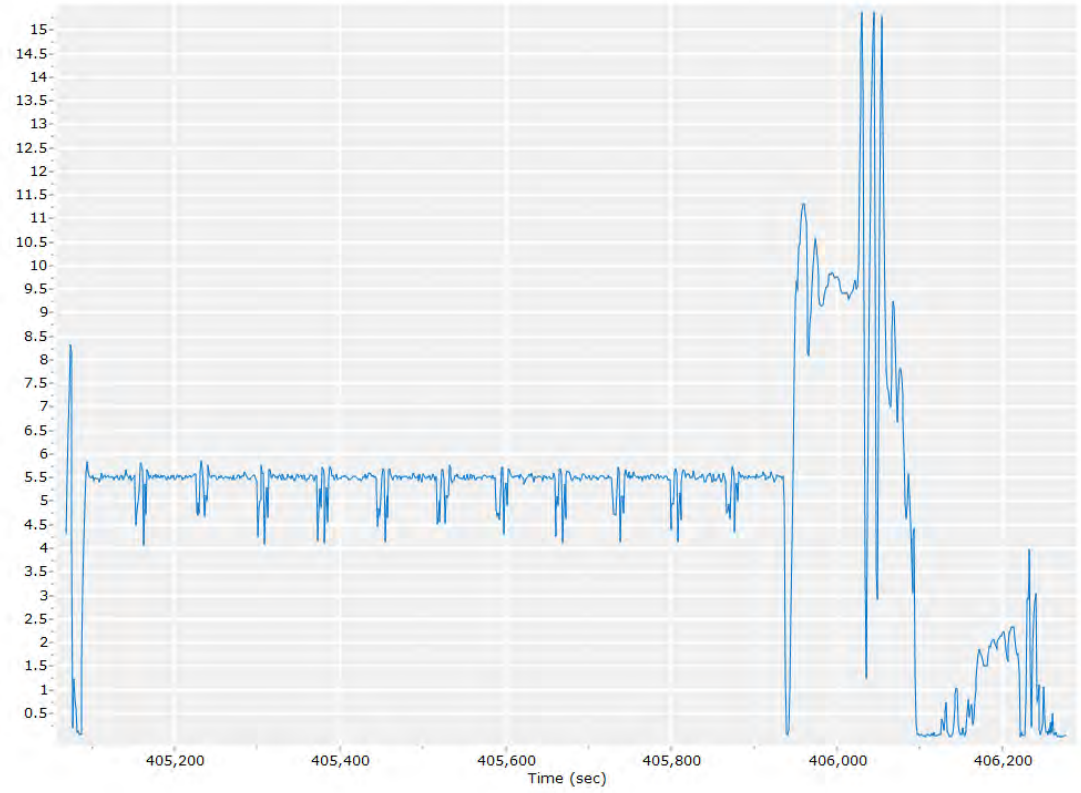
Down Velocity



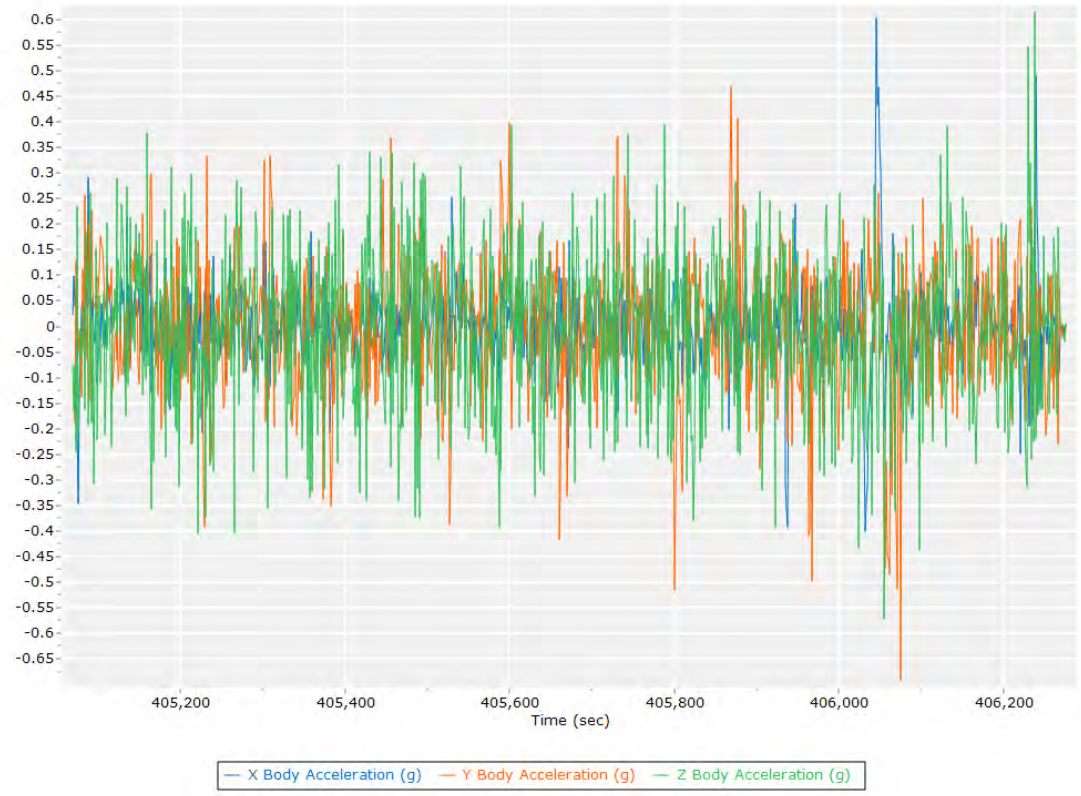
Total Speed



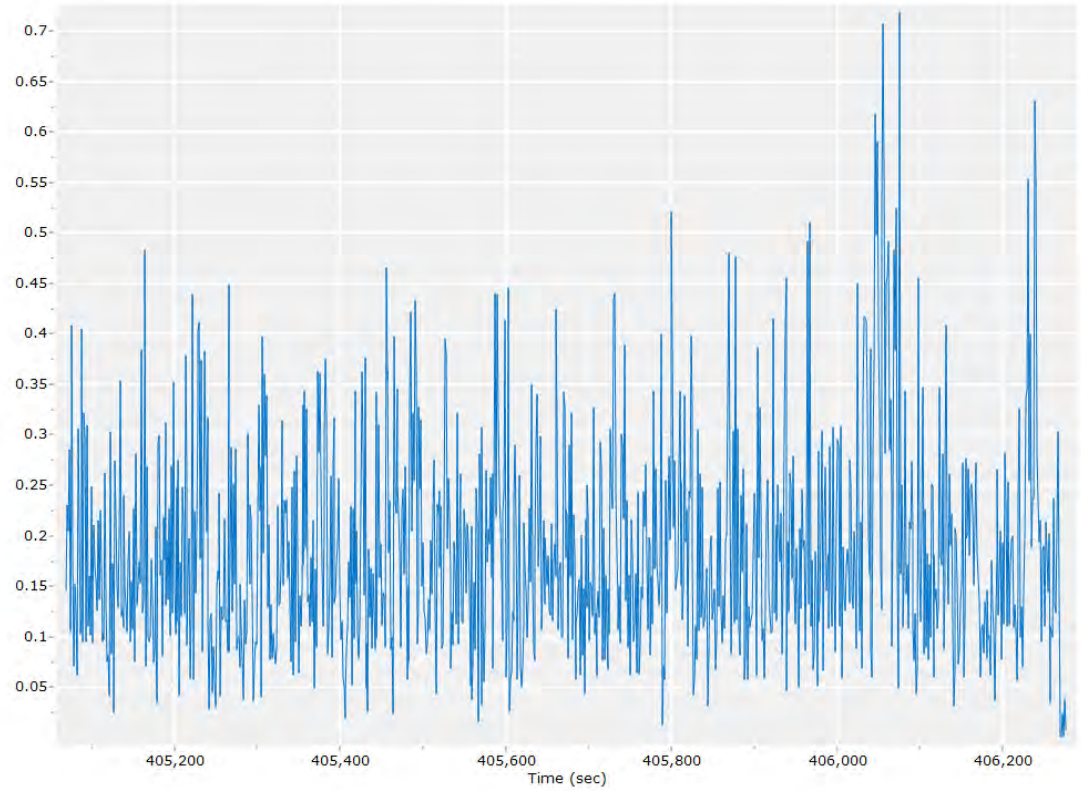
Ground Speed



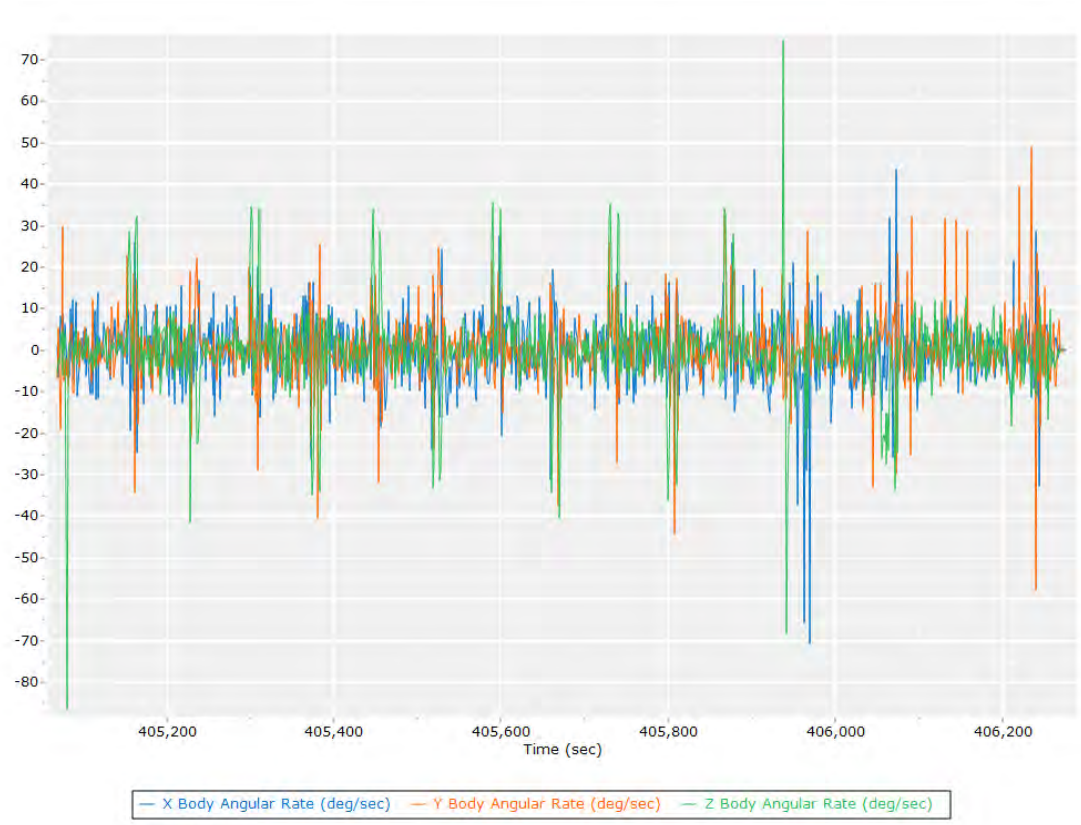
Body Acceleration



Total Body Acceleration



Body Angular Rate

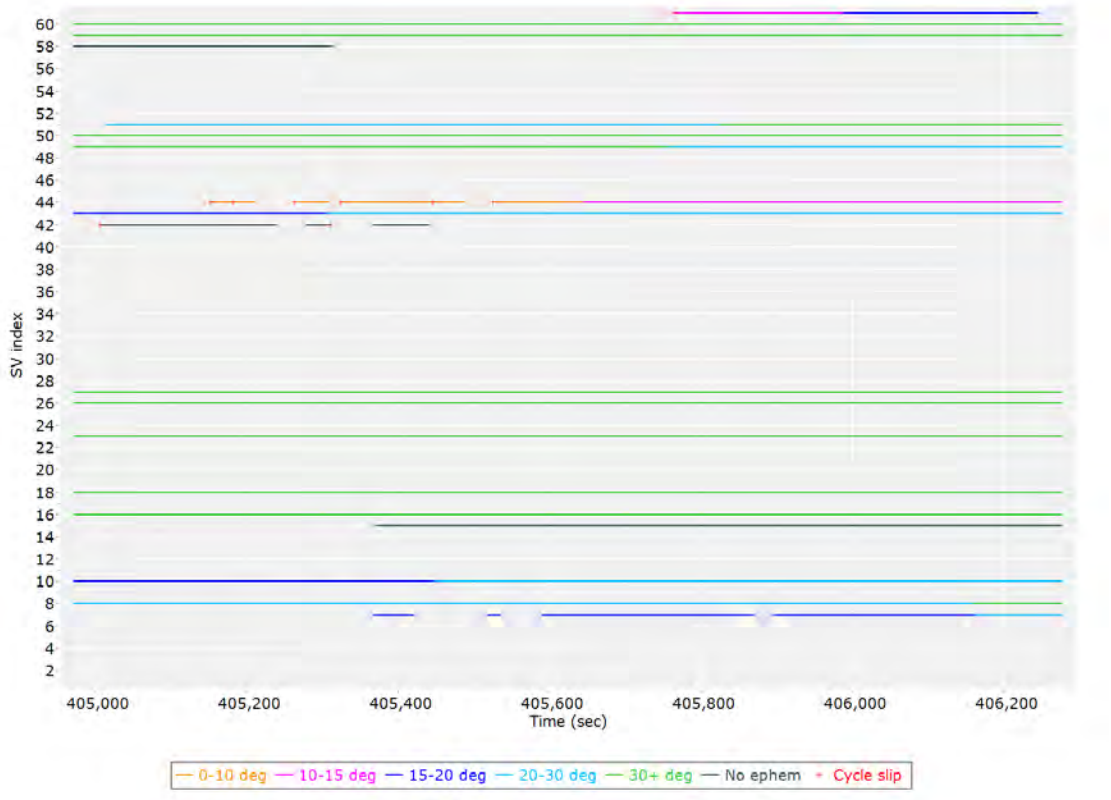


Base Station Information

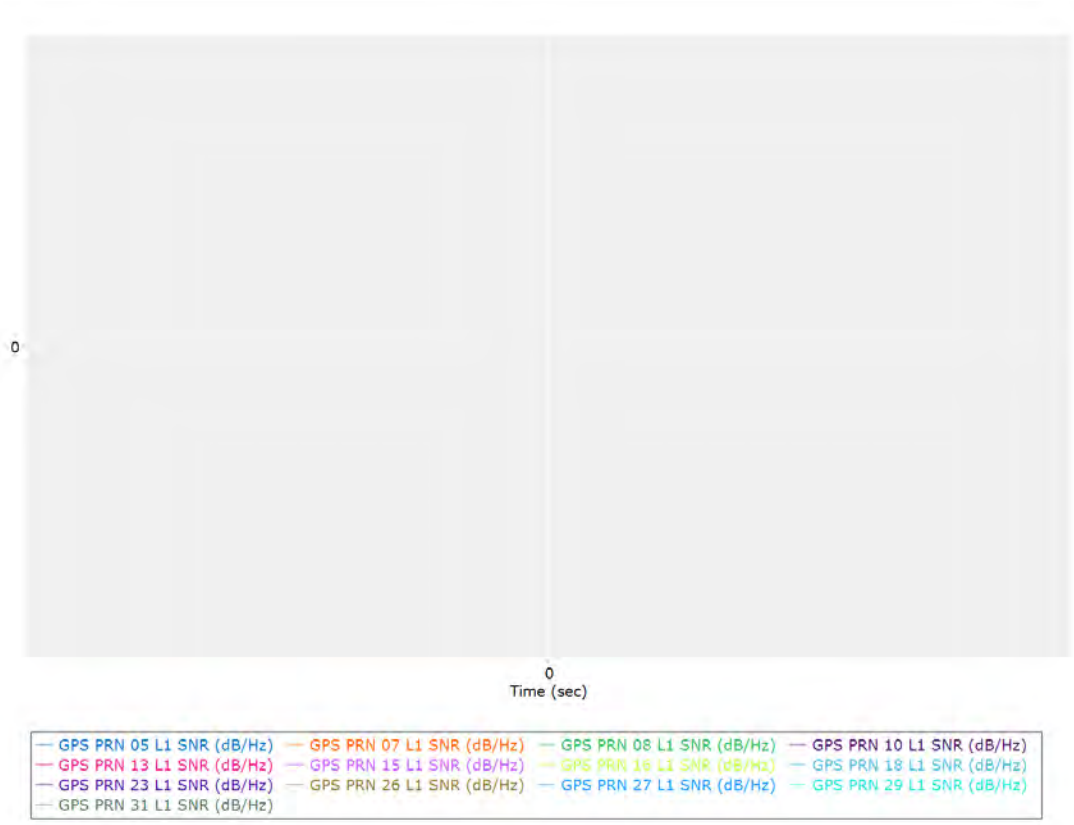
Station ID	base		
Filename	base0374.25O		
Start date	02/06/2025 14:03:16		
End date	02/06/2025 17:06:19		
Duration	03:03:03.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Unknown	Unknown	E5003A21000006
Antenna manufacturer, model	Unknown	Unknown External	
Antenna height [m]	2.079		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC (m)	0		
Latitude	N52°34'01.12122"		
Longitude	W1°52'37.36477"		
Ellipsoidal height (m)	192.72160		
Frame	ITRF2014		
Epoch	2025.0986		
Ellipsoid	GRS_1980		
Velocity North (mm/y)	16.61		
Velocity East (mm/y)	15.72		
Velocity Up (mm/y)	-0.06		

Base Observables & Satellite Data

Base GPS/GLONASS L1 Satellite Lock/Elevation

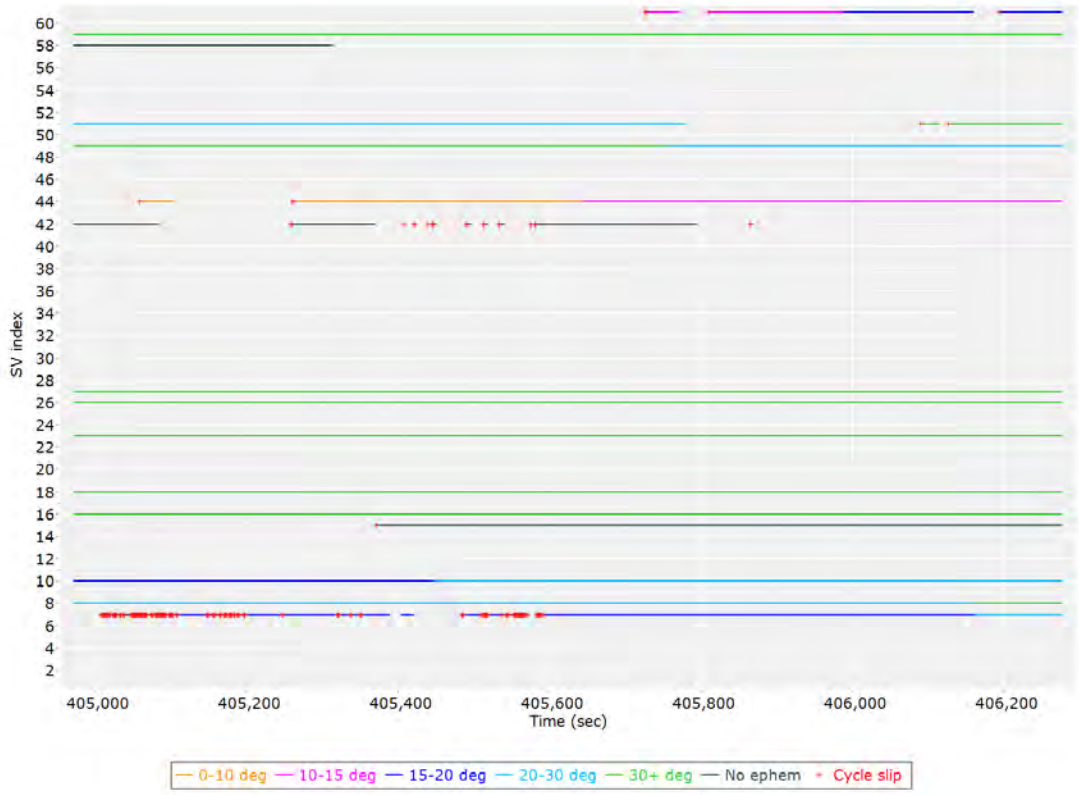


Base GPS L1 SNR

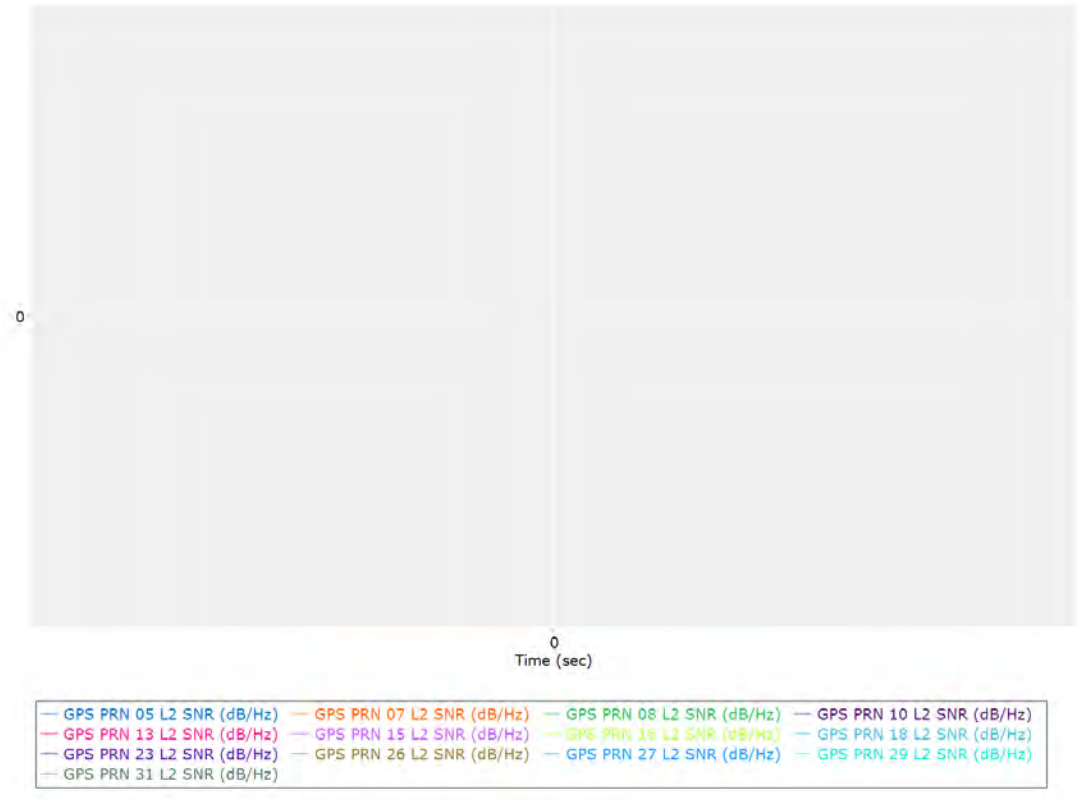


Base GLONASS L1 SNR

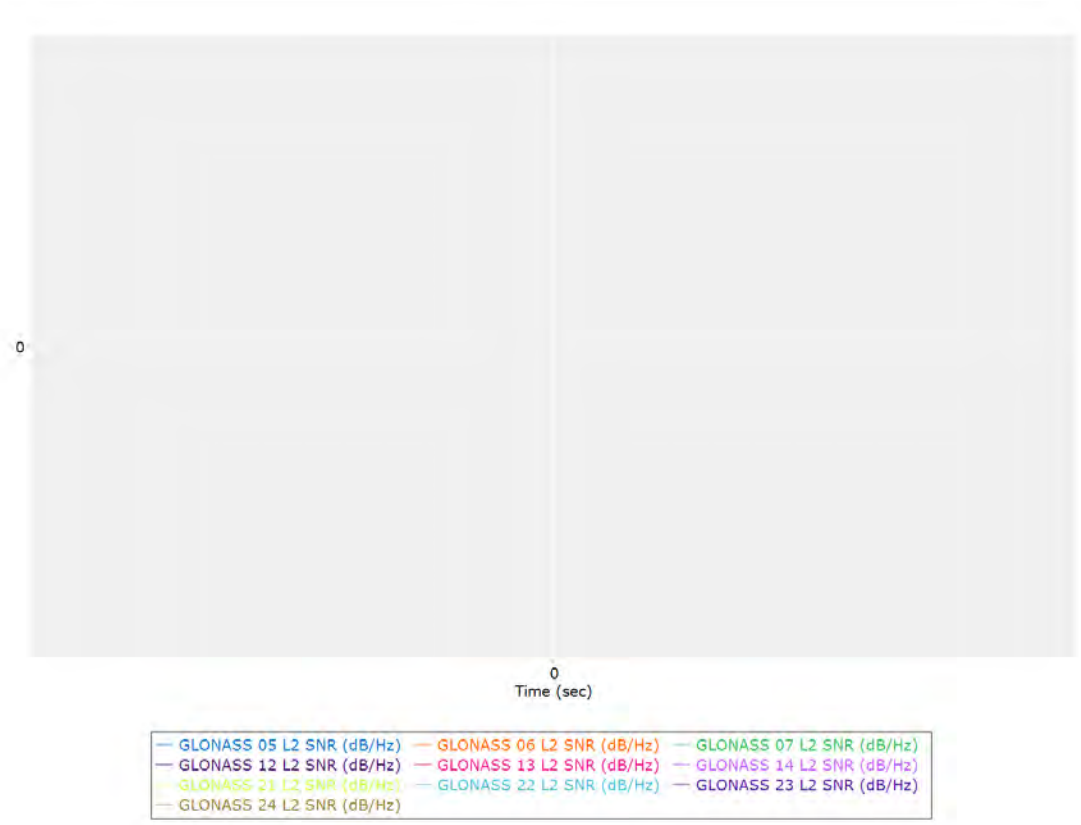
Base GPS/GLONASS L2 Satellite Lock/Elevation



Base GPS L2 SNR



Base GLONASS L2 SNR

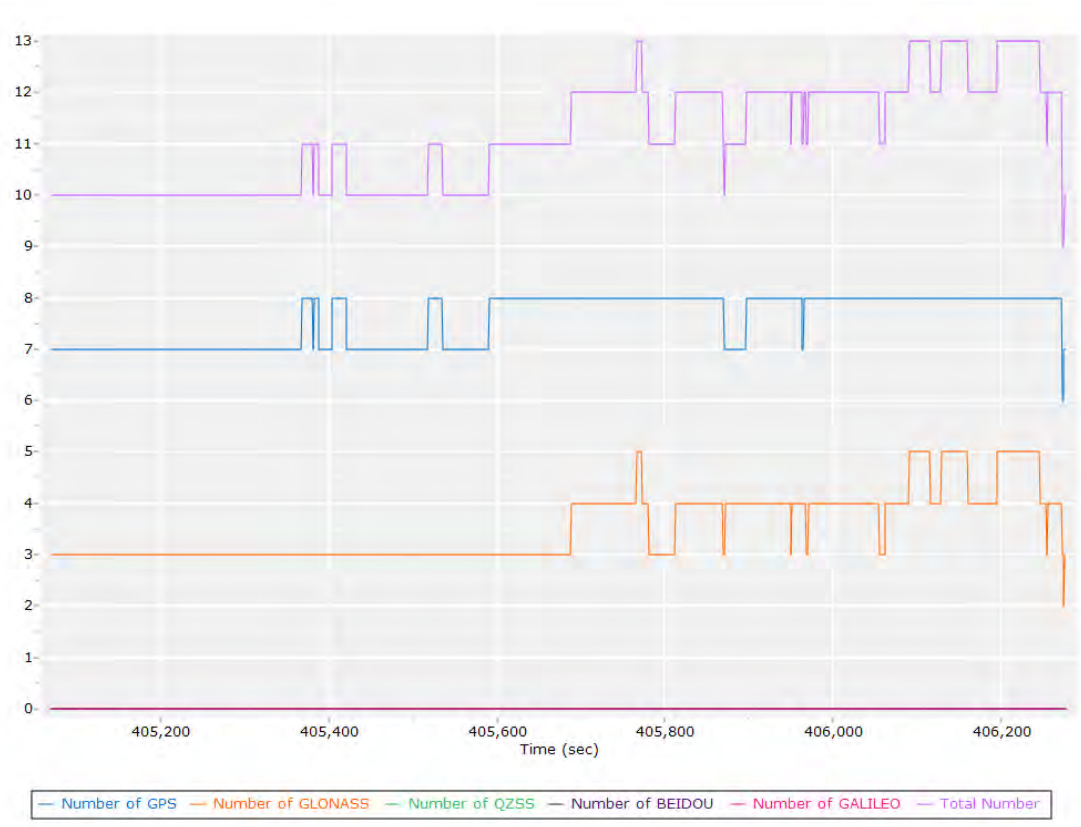


GNSS QC

GNSS QC Statistics

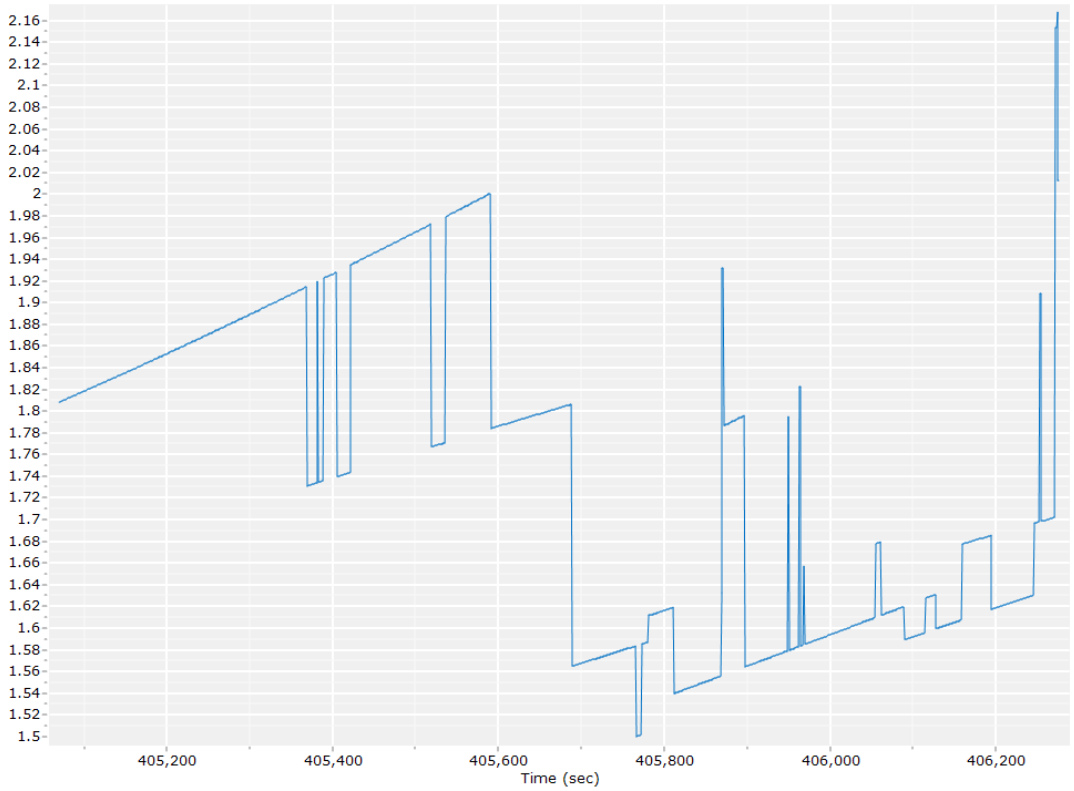
Statistics	Min	Max	Mean
Baseline length (km)	0.46	1.33	
Number of GPS SV	6	8	8
Number of GLONASS SV	0	5	3
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Number of GALILEO SV	0	0	0
Total number of SV	6	13	11
PDOP	1.50	3.63	1.77
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (sec)	1304.00	0.00	0.00
Percentage	100.00	0.00	0.00

Num SVs in solution

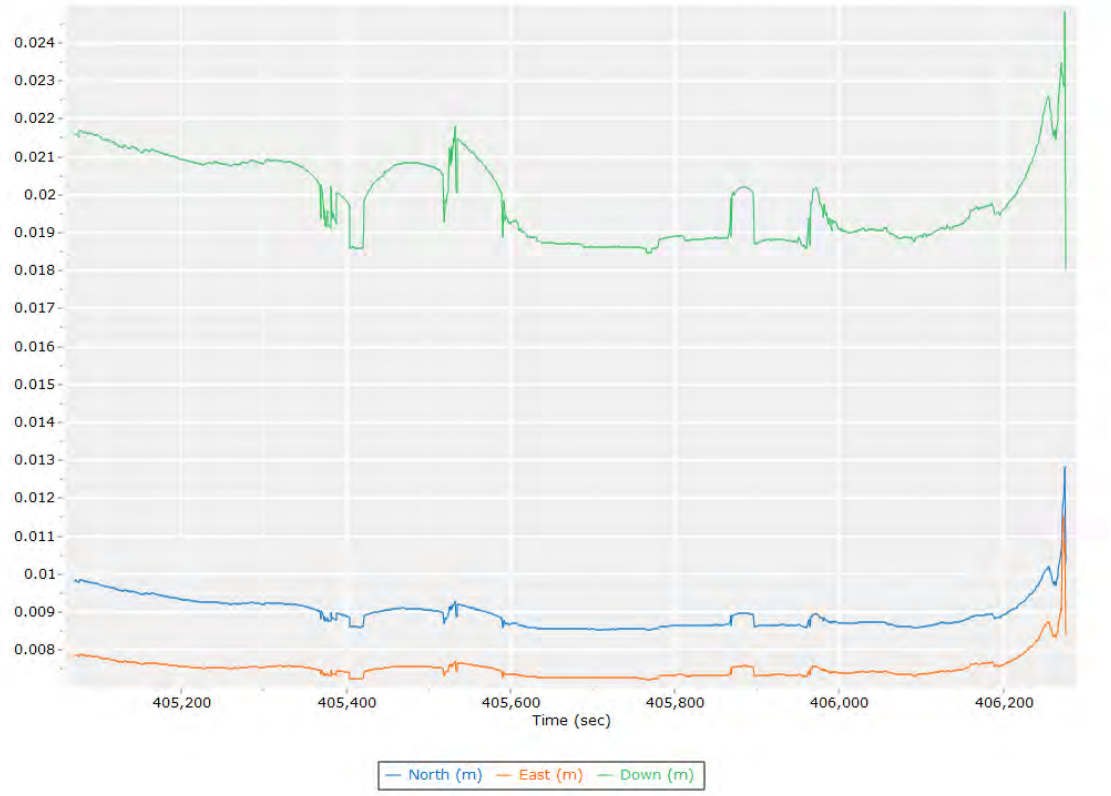


Forward/Reverse Separation

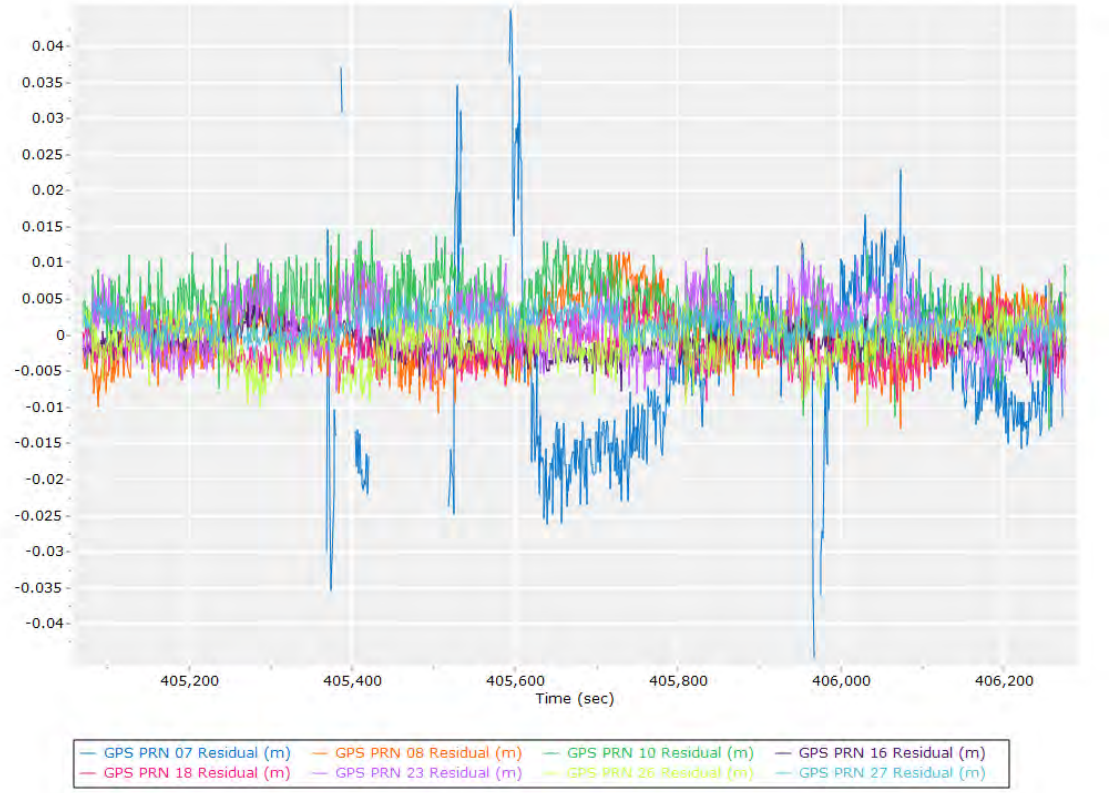
PDOP



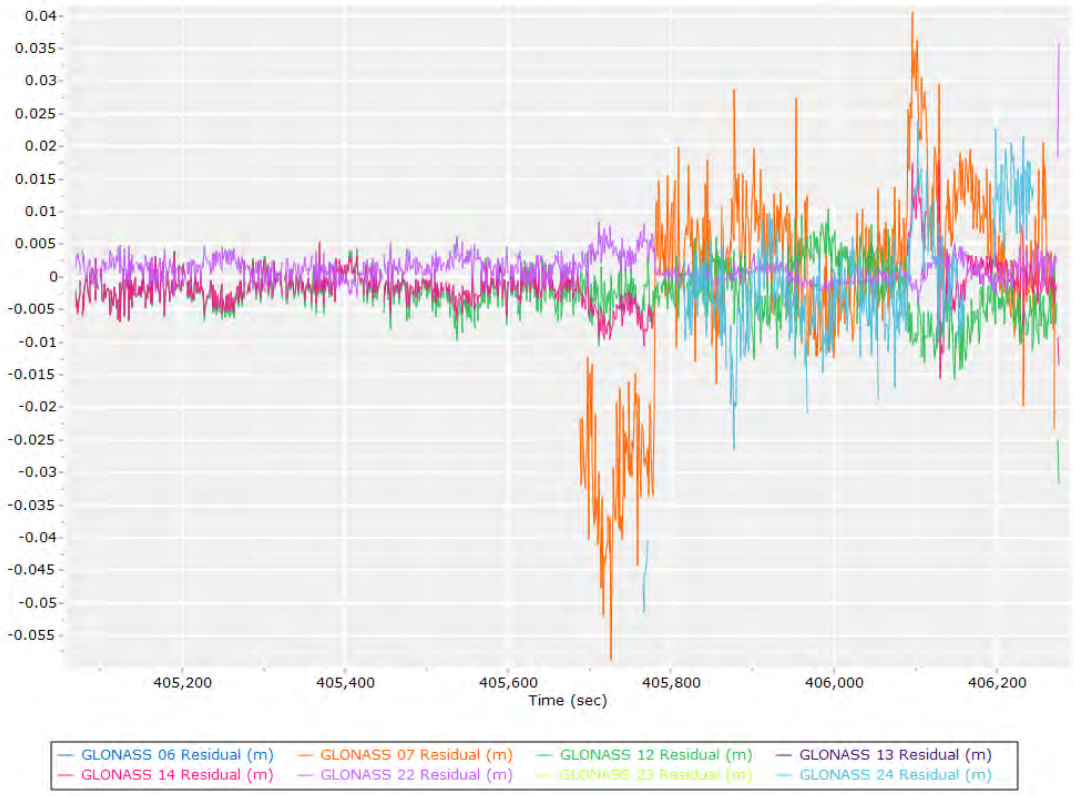
Estimated Position Accuracy



GPS Residuals



GLONASS Residuals



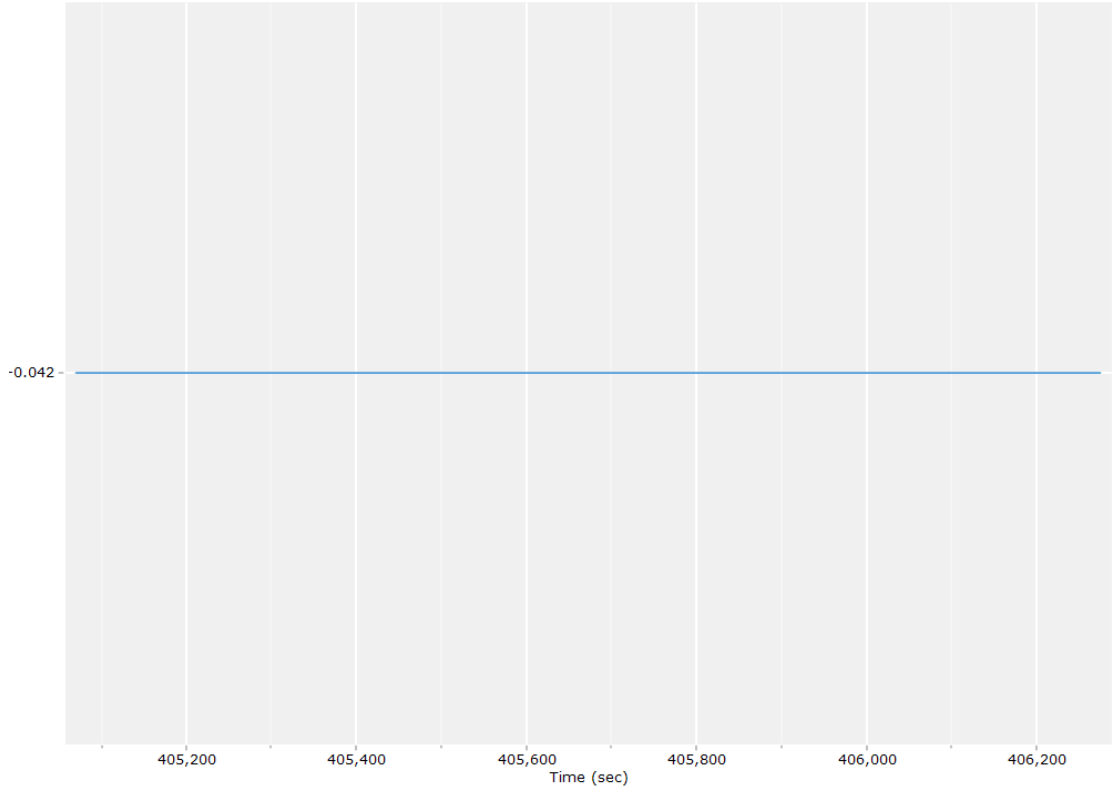
GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	base		
Processing start time	404972.000 (02/06/2025 16:29:32)		
Processing end time	406276.000 (02/06/2025 16:51:16)		
Initial attitude source	Primary GNSS Track, Magnetic Heading		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.042	-0.078	-0.377
Reference to Primary GNSS lever arm std dev (m)	0.030	0.030	0.030
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

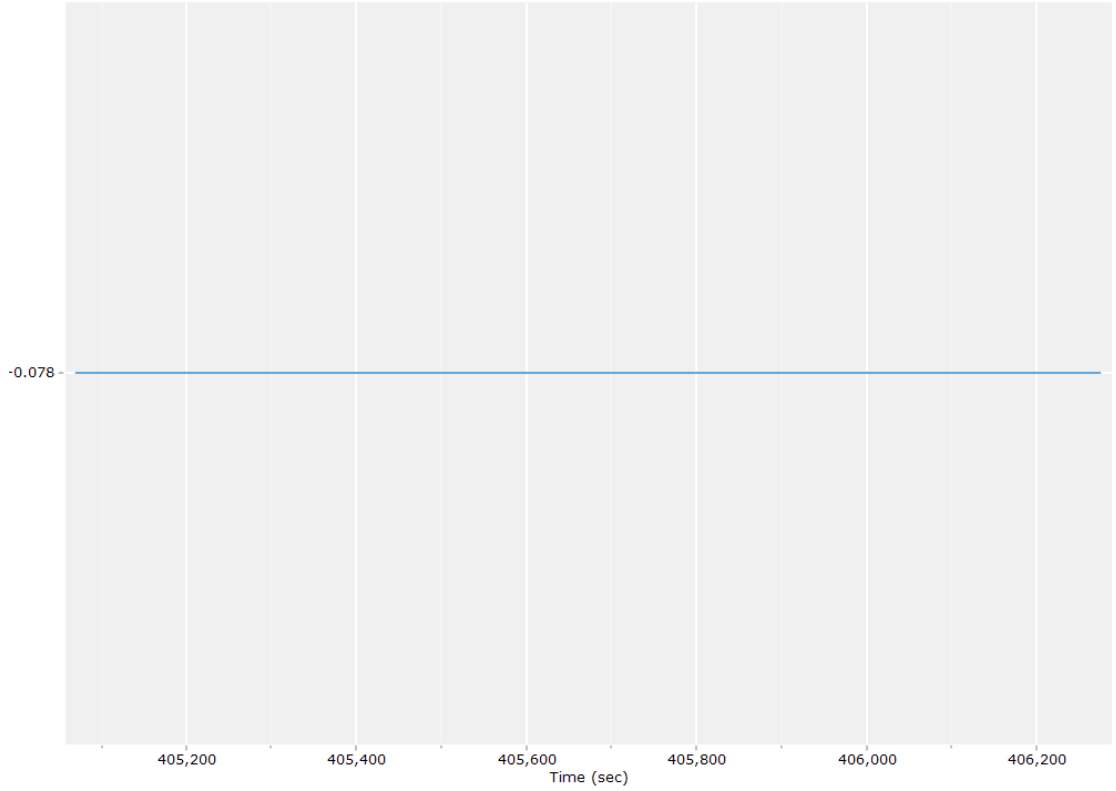
Calibrated Installation Parameters

Reference-Primary GNSS Lever Arm (m)

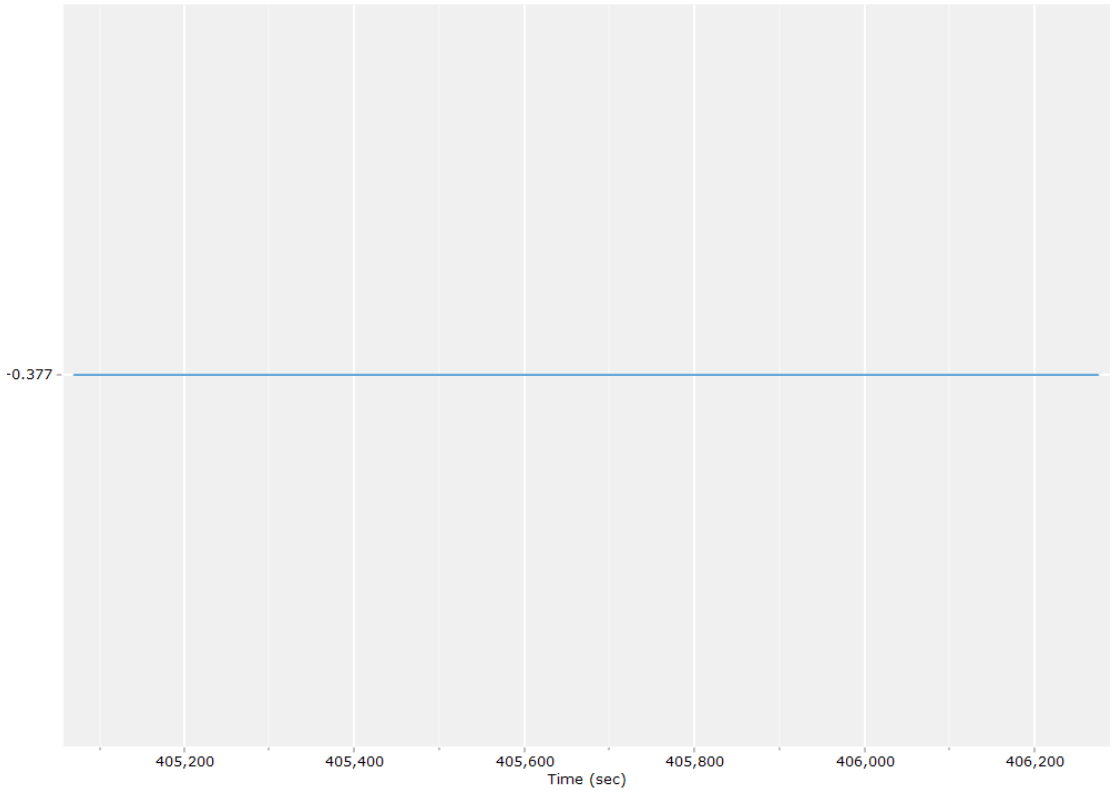
X Reference-Primary GNSS Lever Arm (m)



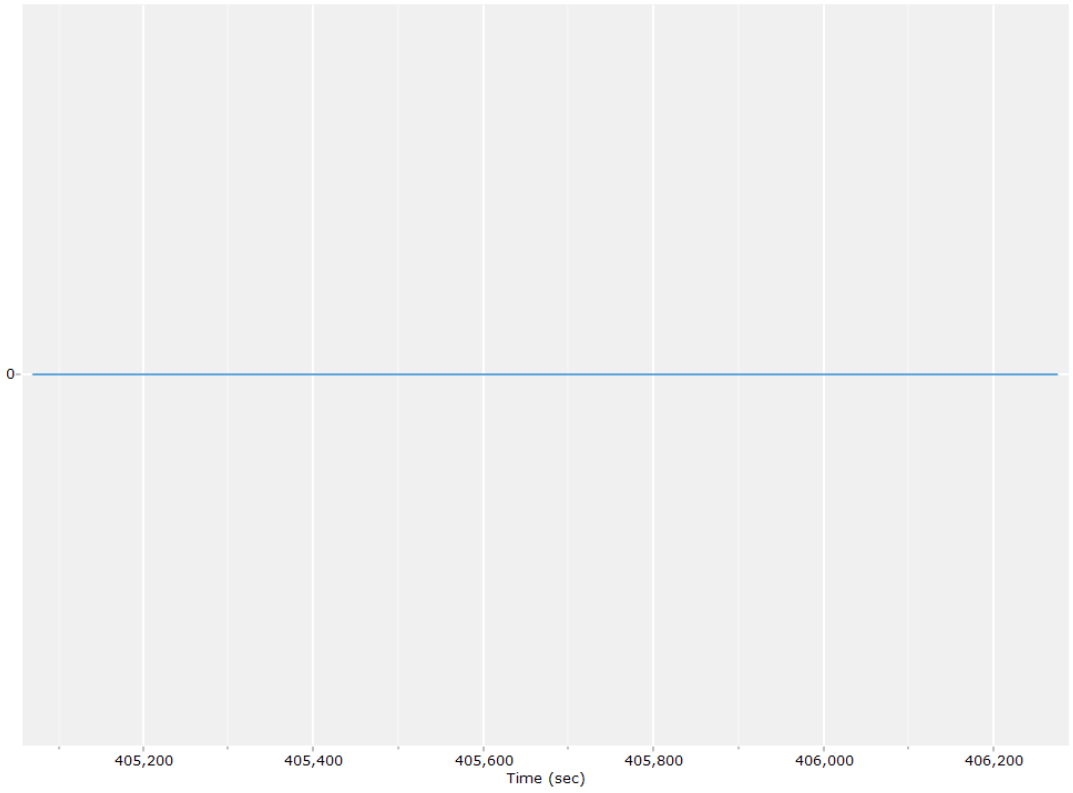
Y Reference-Primary GNSS Lever Arm (m)



Z Reference-Primary GNSS Lever Arm (m)



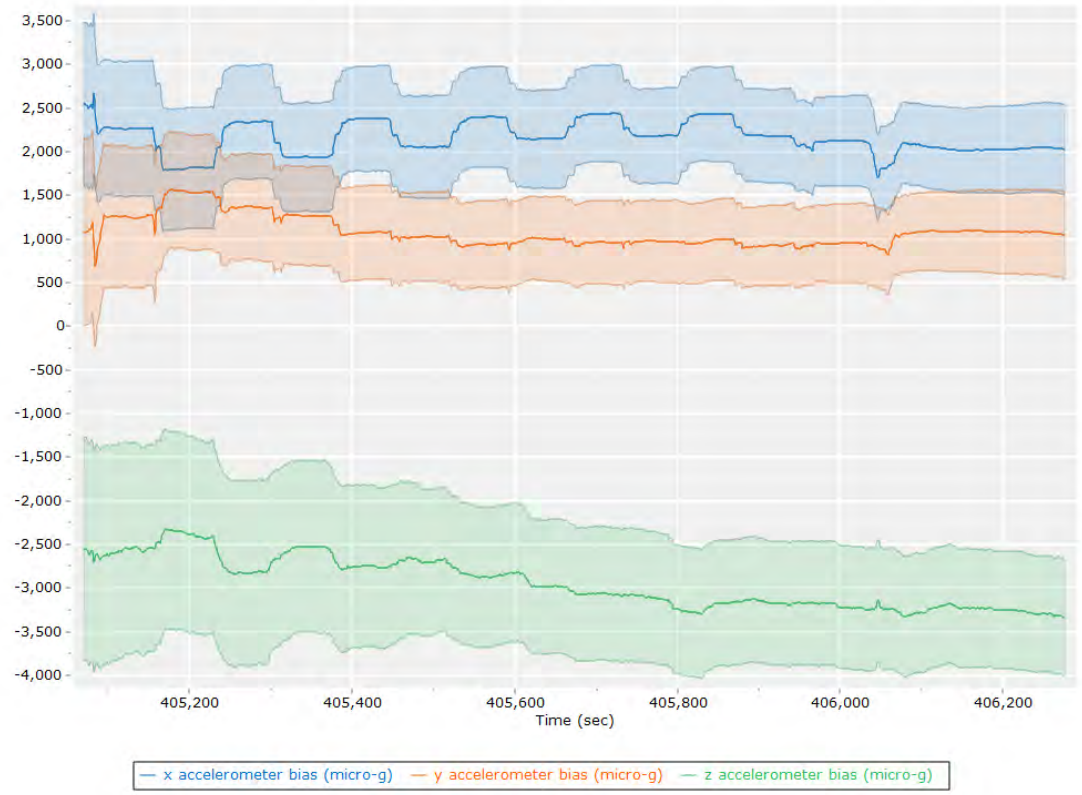
Reference-Primary GNSS Lever Arm Figure of Merit



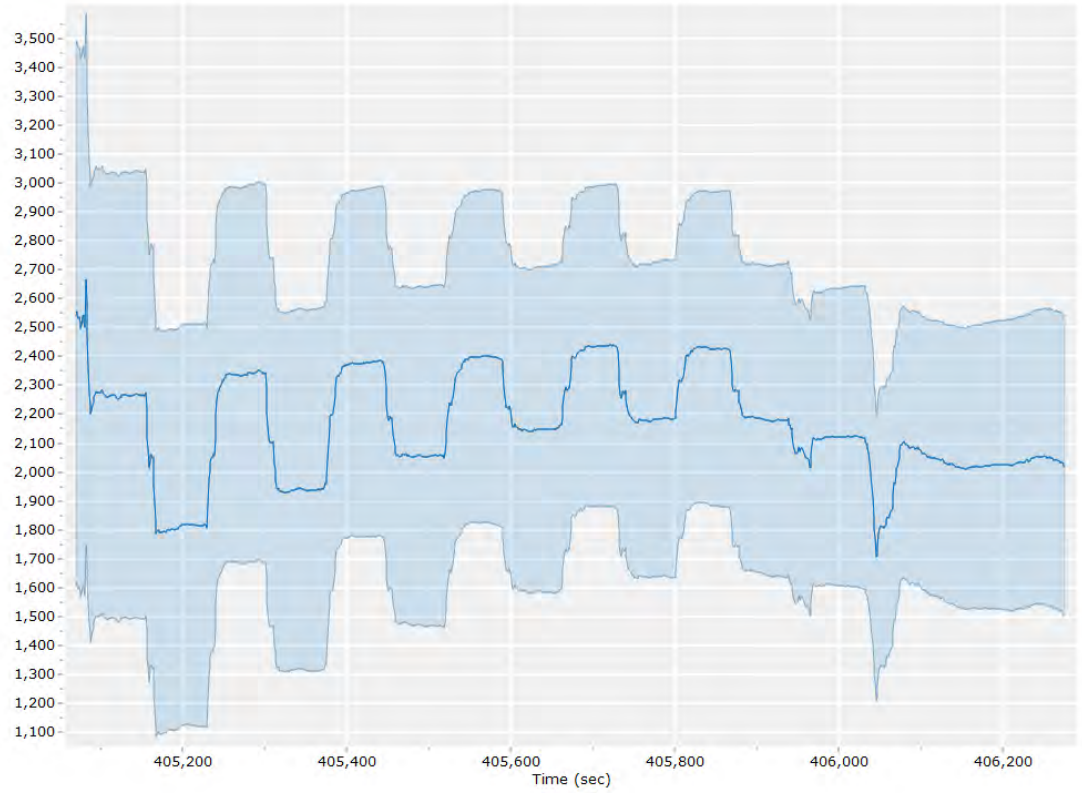
IN-Fusion QC

Forward Processed Estimated Errors, Reference Frame

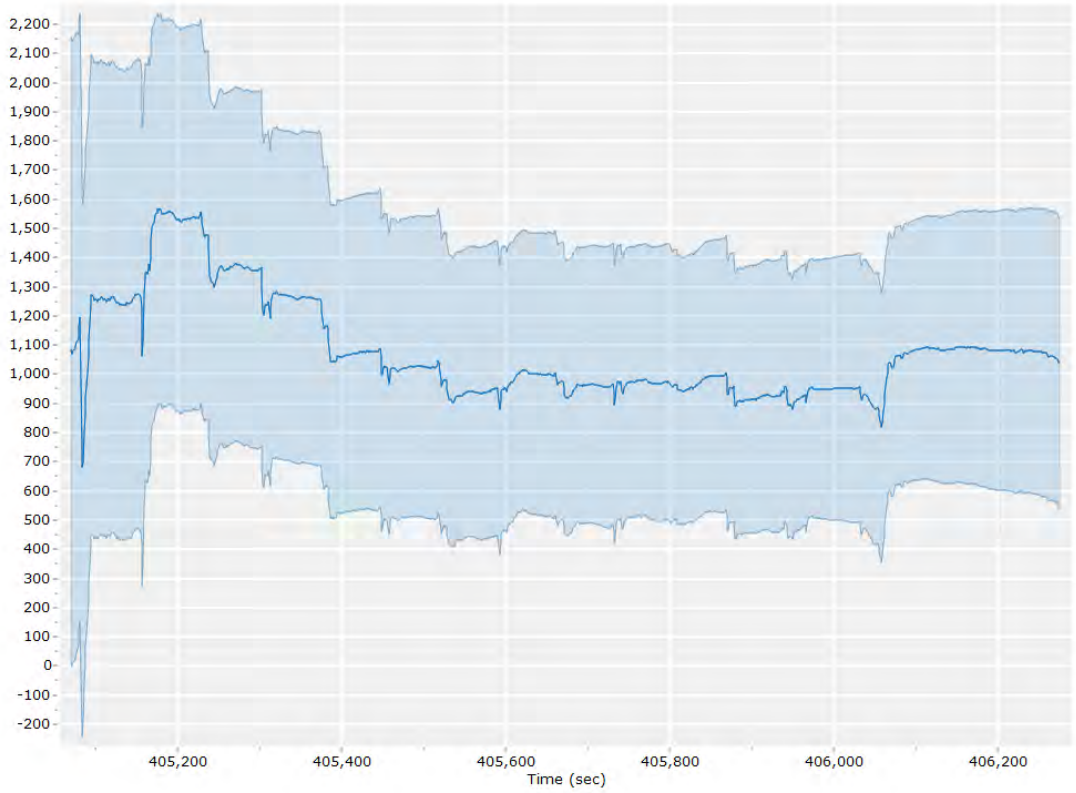
Accelerometer Bias (micro-g)



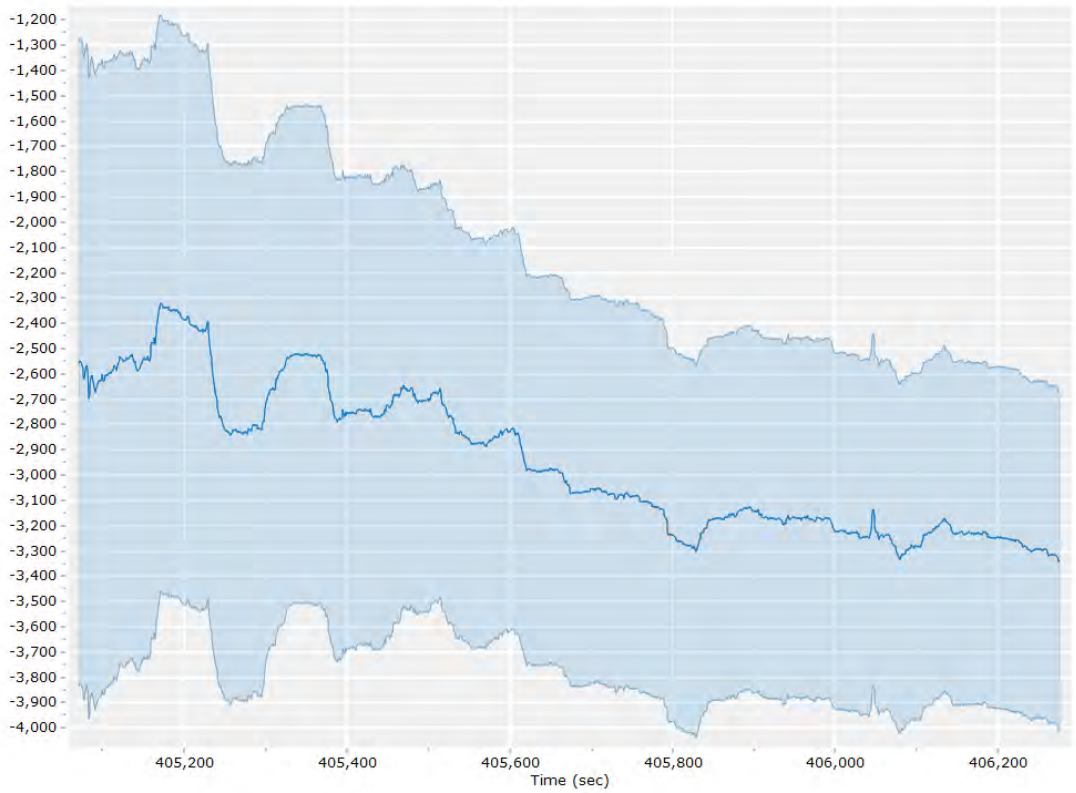
X Accelerometer Bias (micro-g)



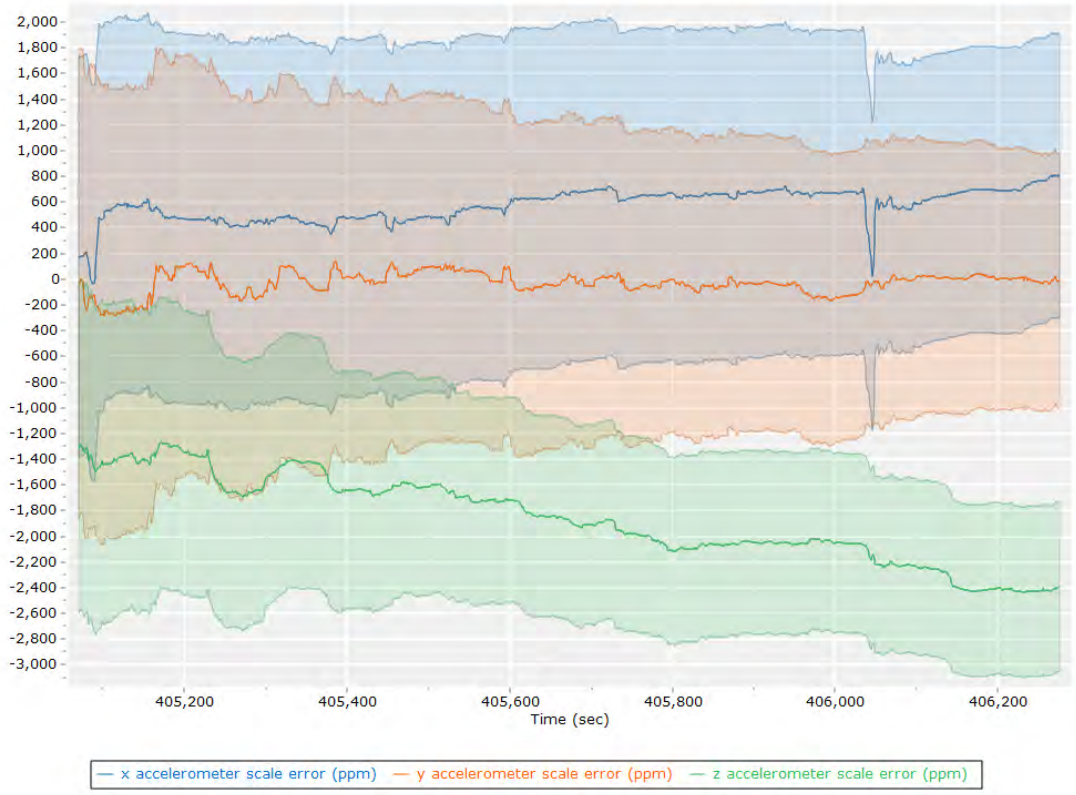
Y Accelerometer Bias (micro-g)



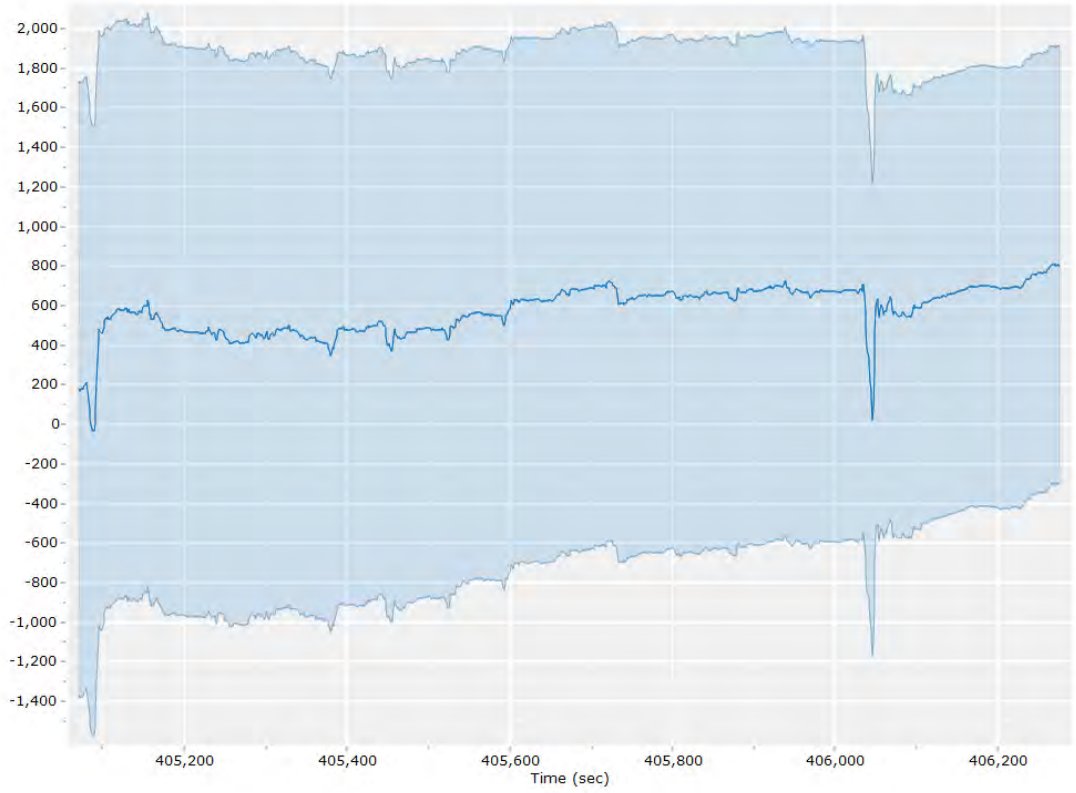
Z Accelerometer Bias (micro-g)



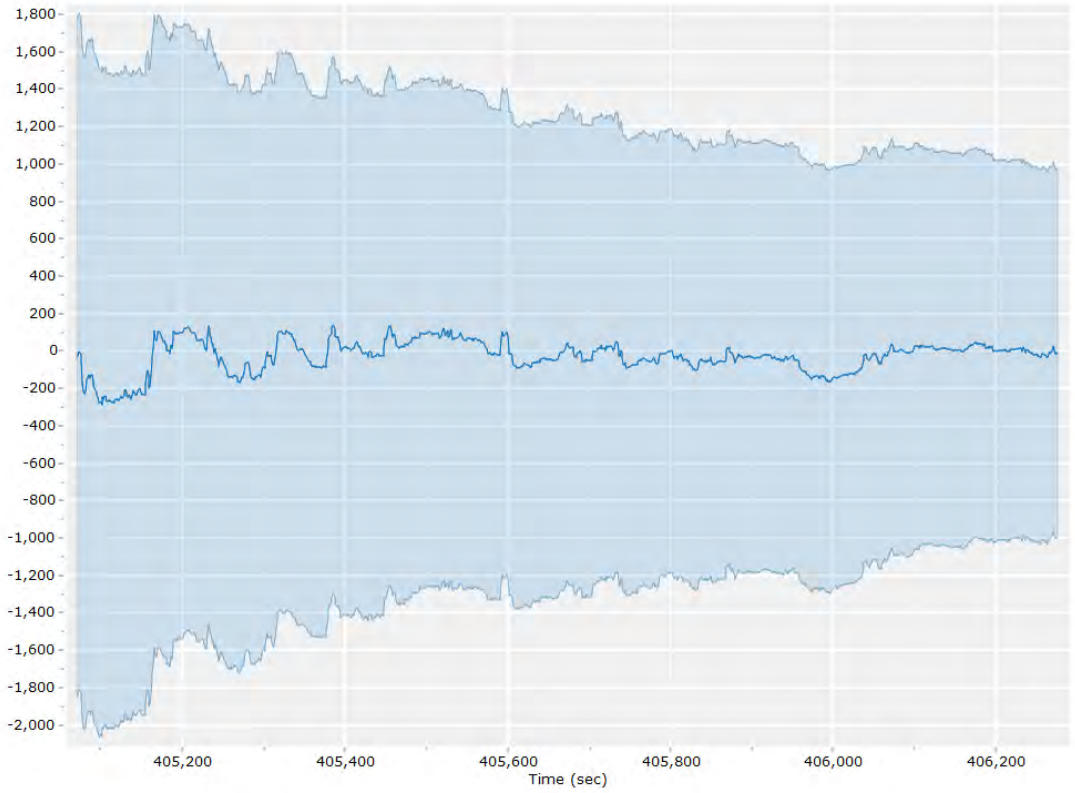
Accelerometer Scale Error (ppm)



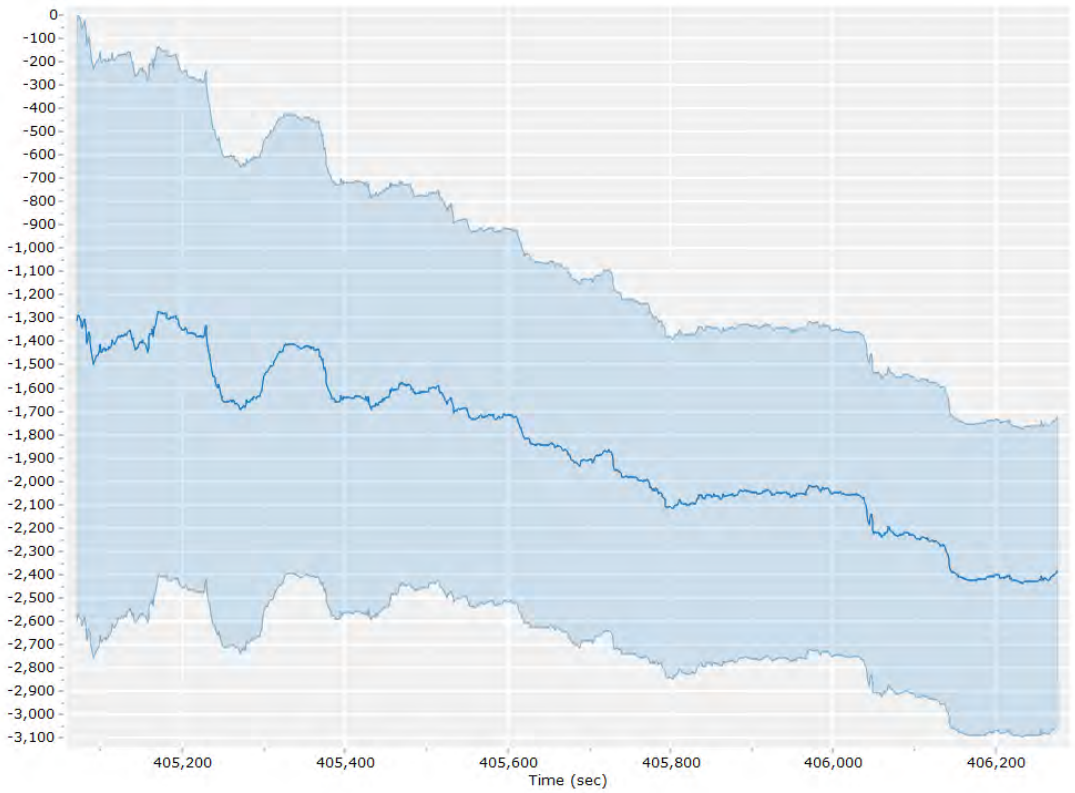
X Accelerometer Scale Error (ppm)



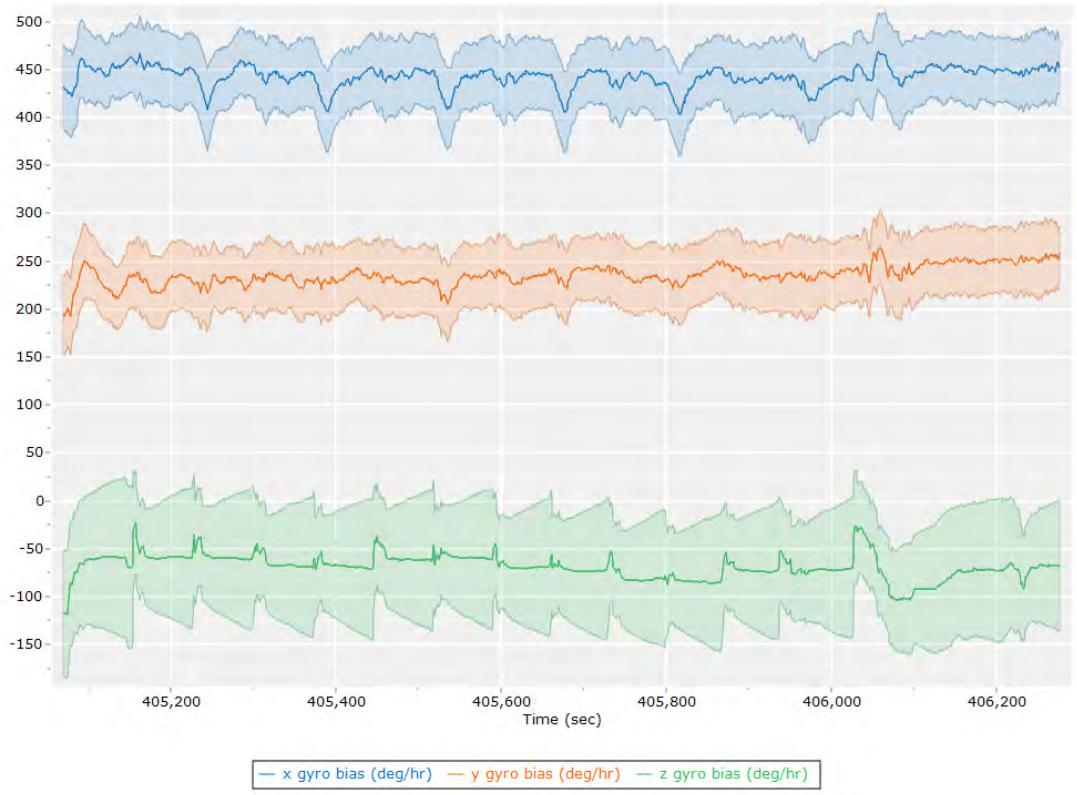
Y Accelerometer Scale Error (ppm)



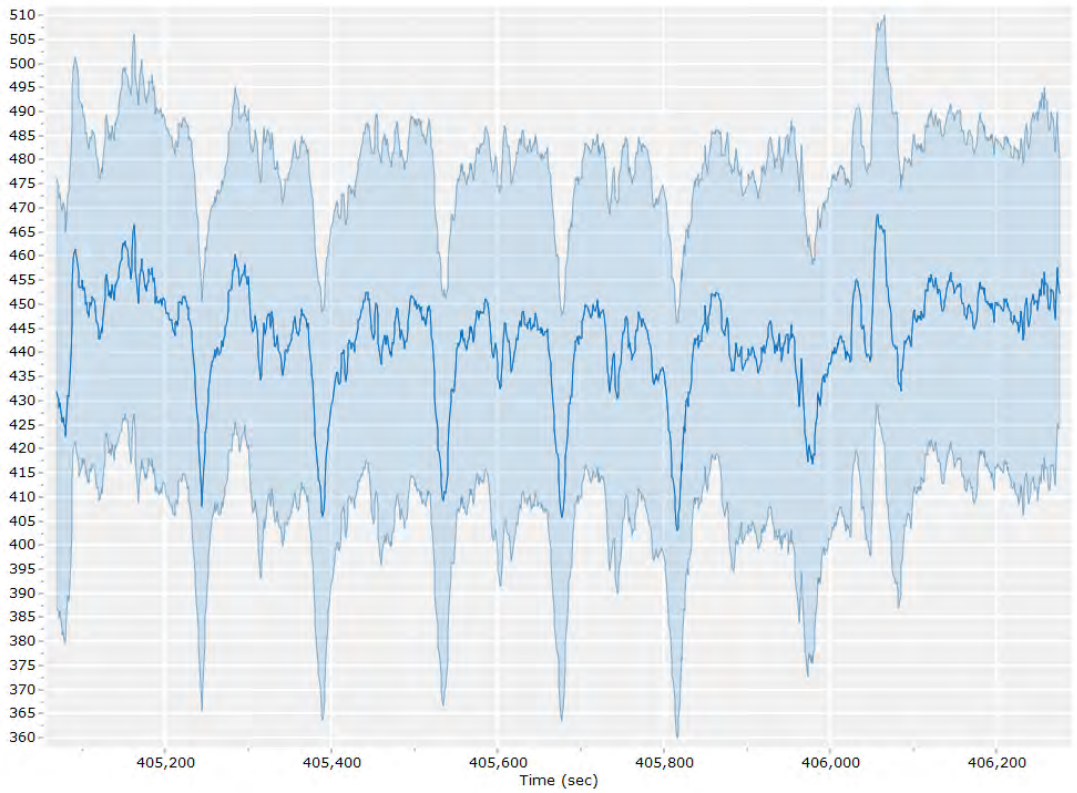
Z Accelerometer Scale Error (ppm)



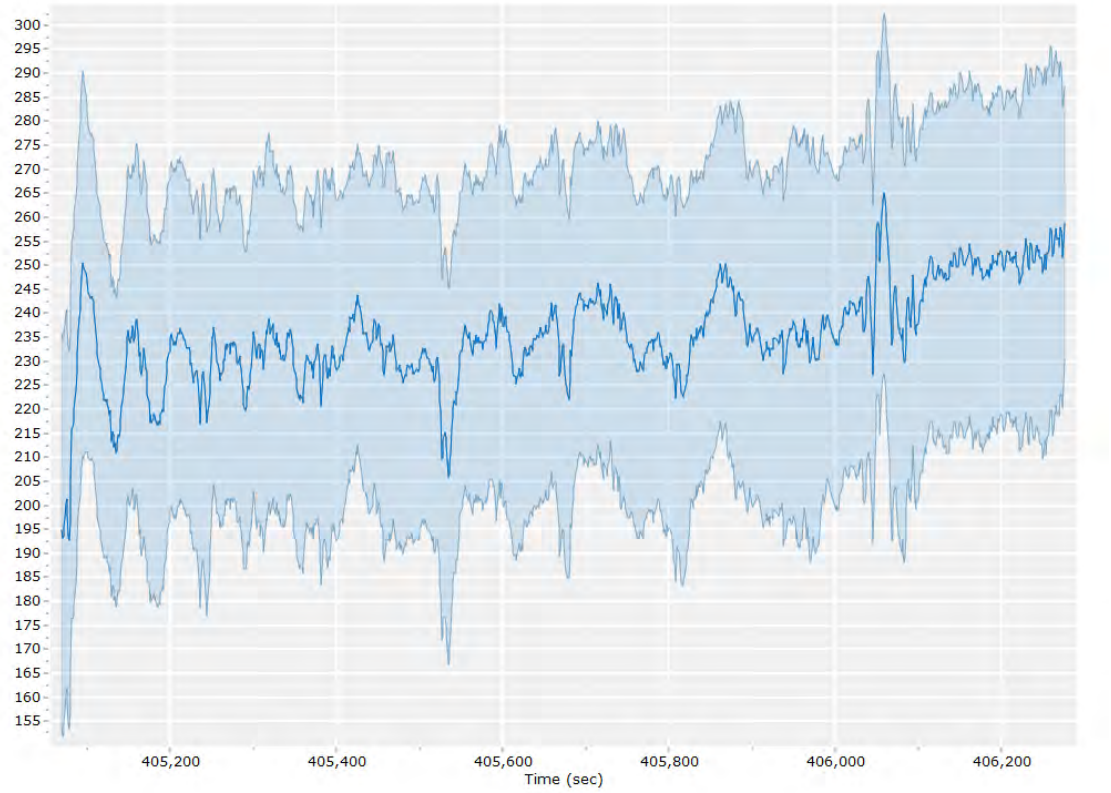
Gyro Bias (deg/h)



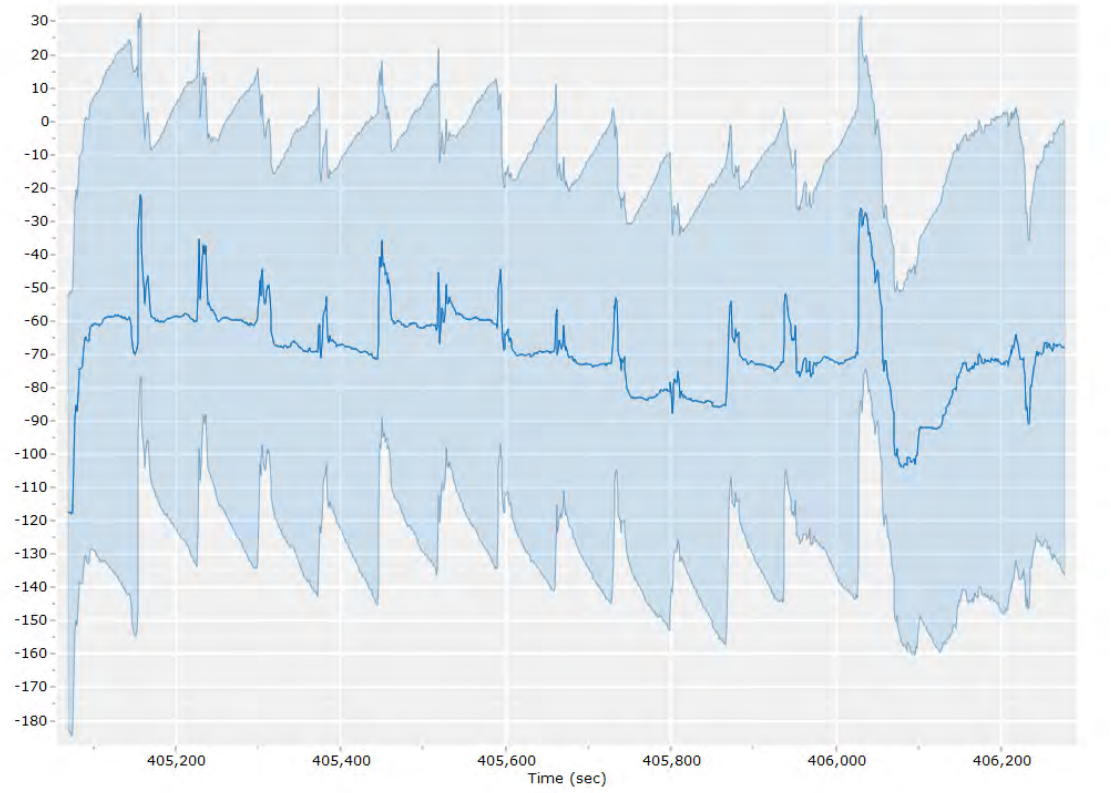
X Gyro Bias (deg/h)



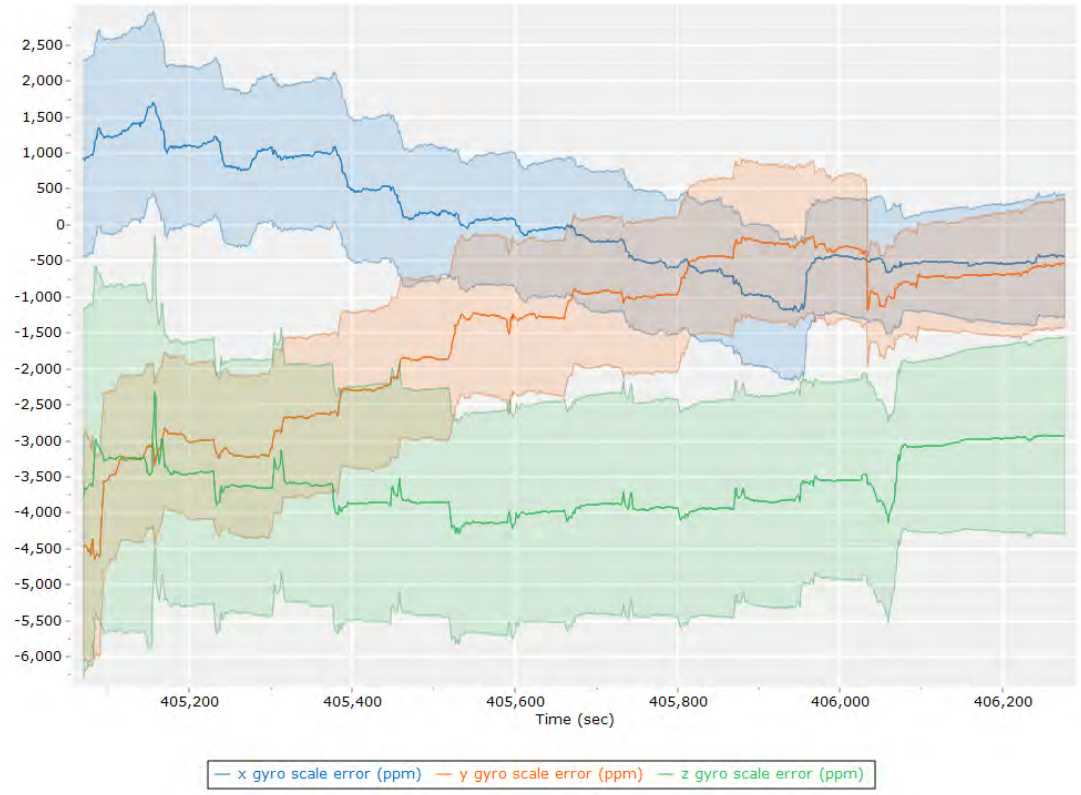
Y Gyro Bias (deg/h)



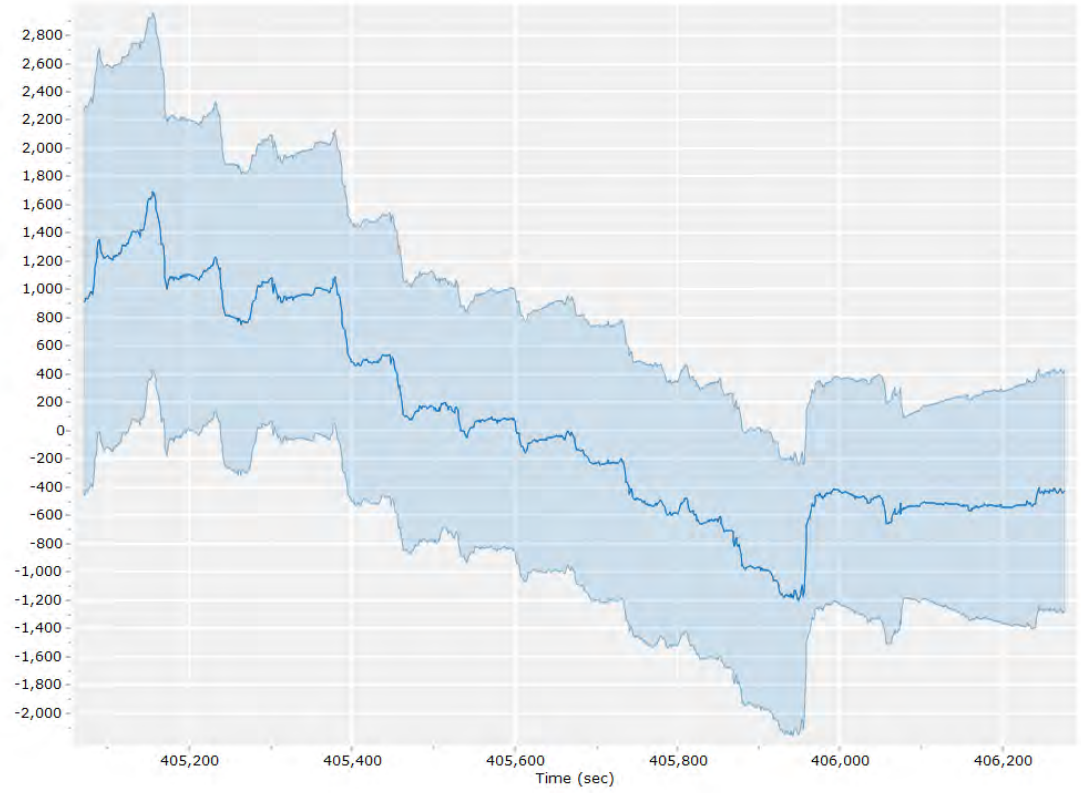
Z Gyro Bias (deg/h)



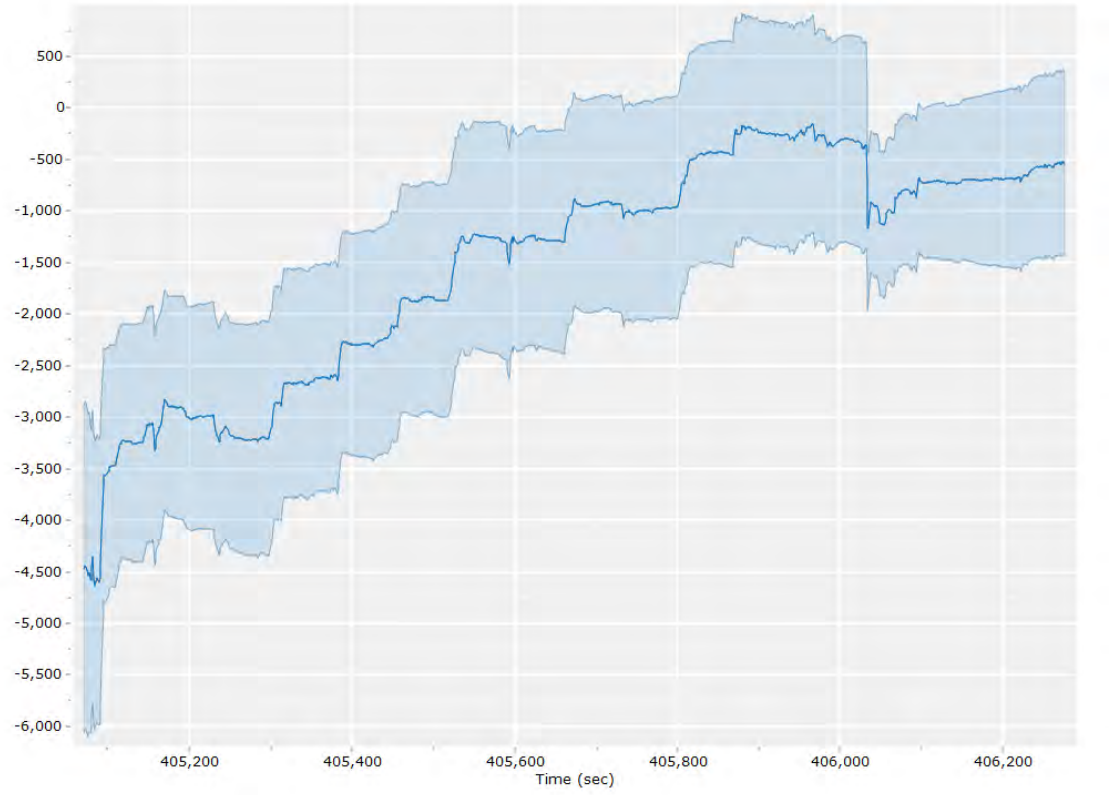
Gyro Scale Error (ppm)



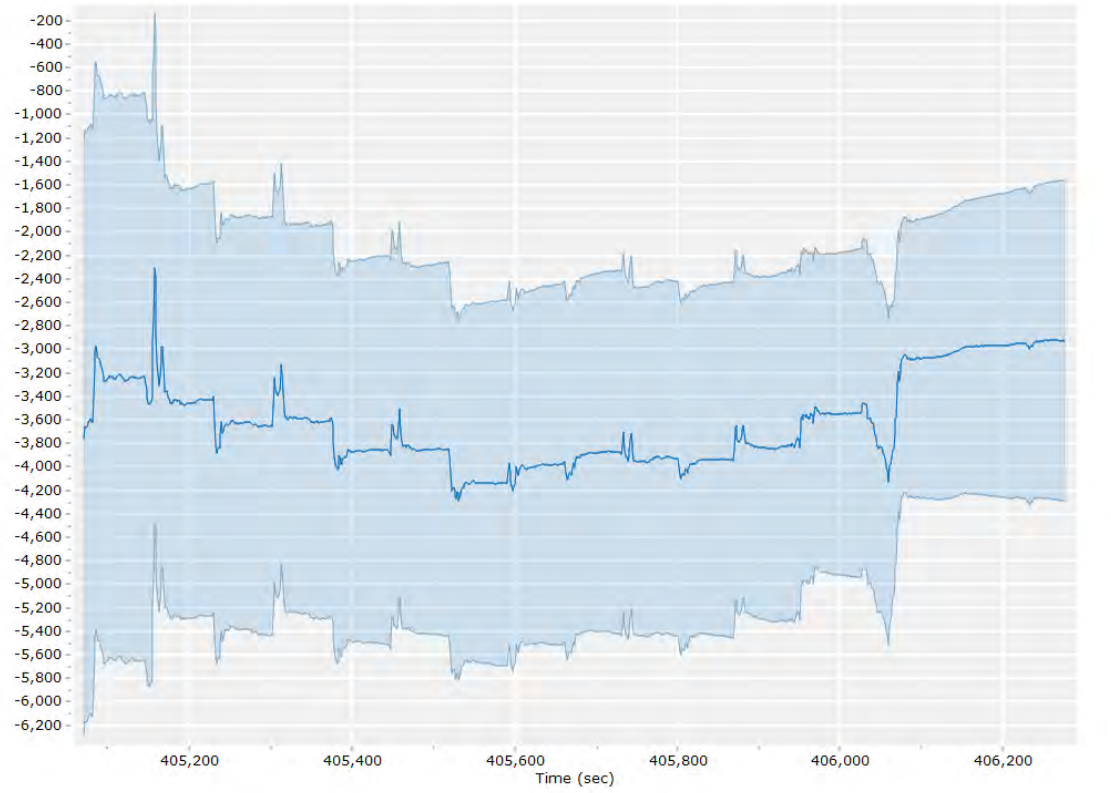
X Gyro Scale Error (ppm)



Y Gyro Scale Error (ppm)

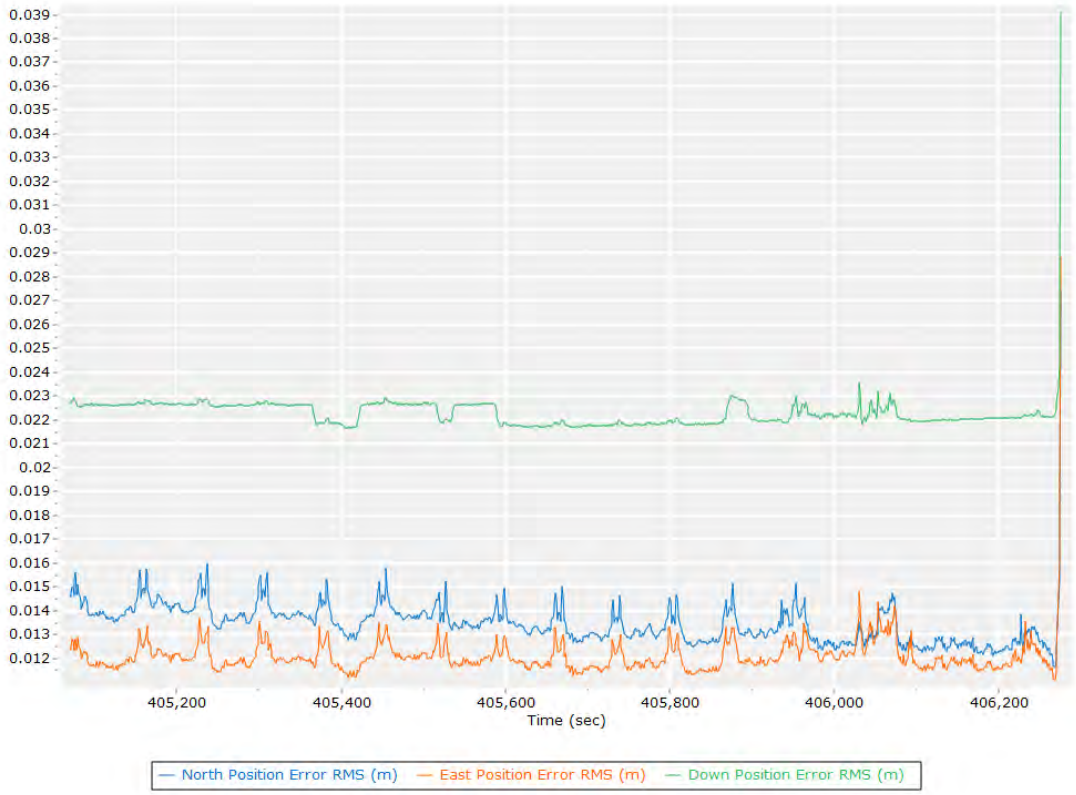


Z Gyro Scale Error (ppm)

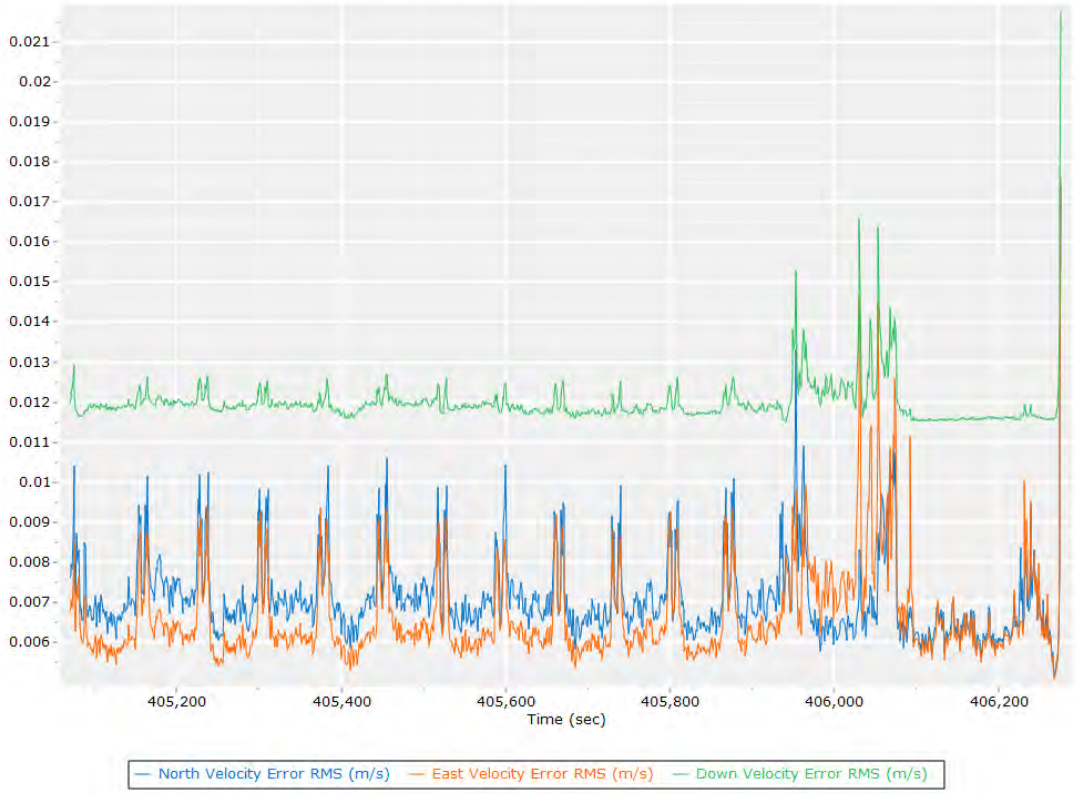


Smoothed Performance Metrics

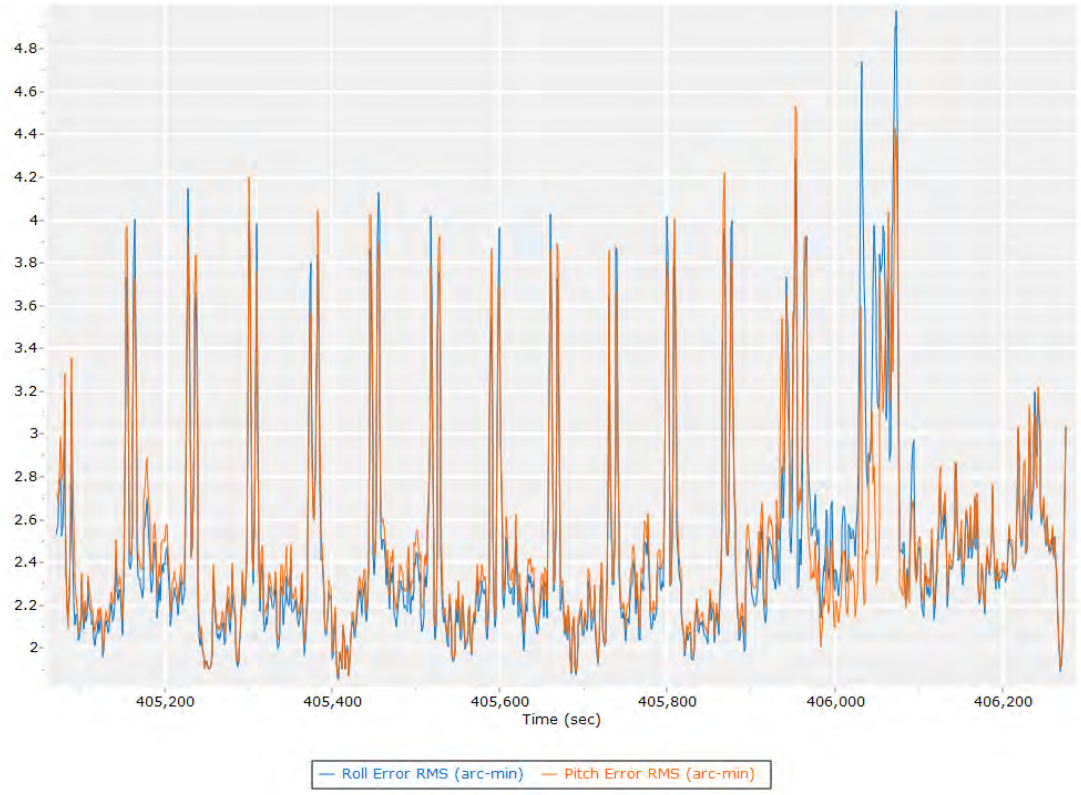
Position Error RMS (m)



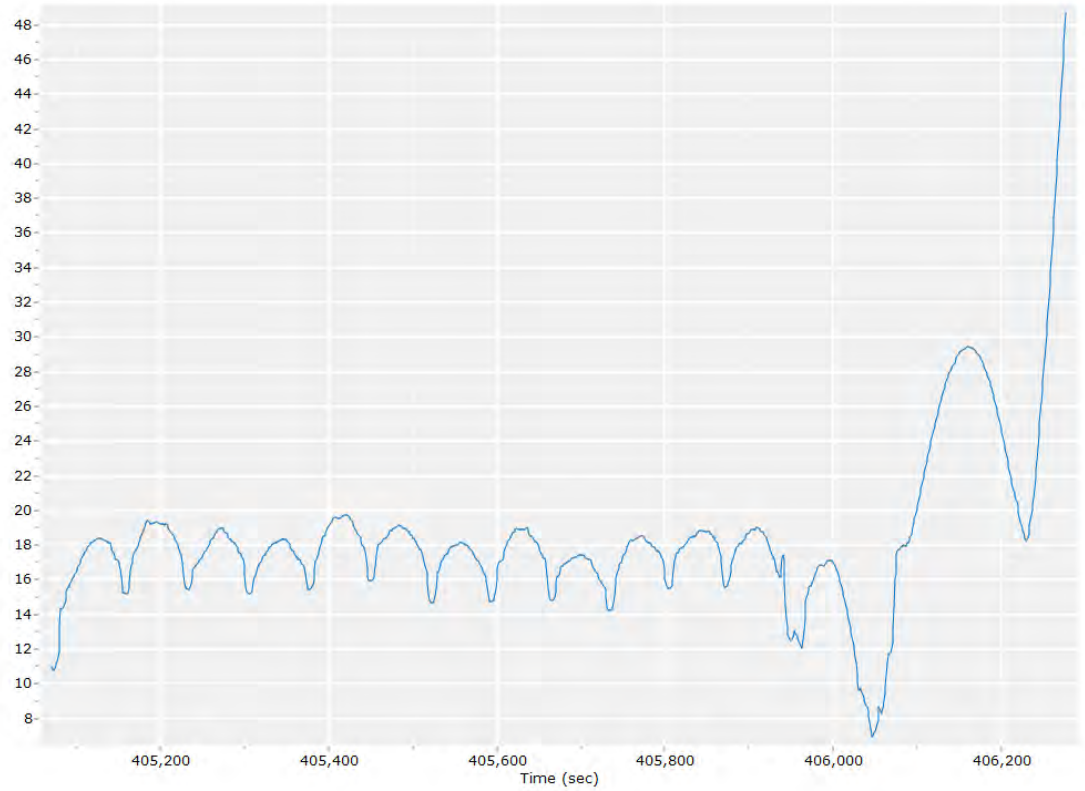
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

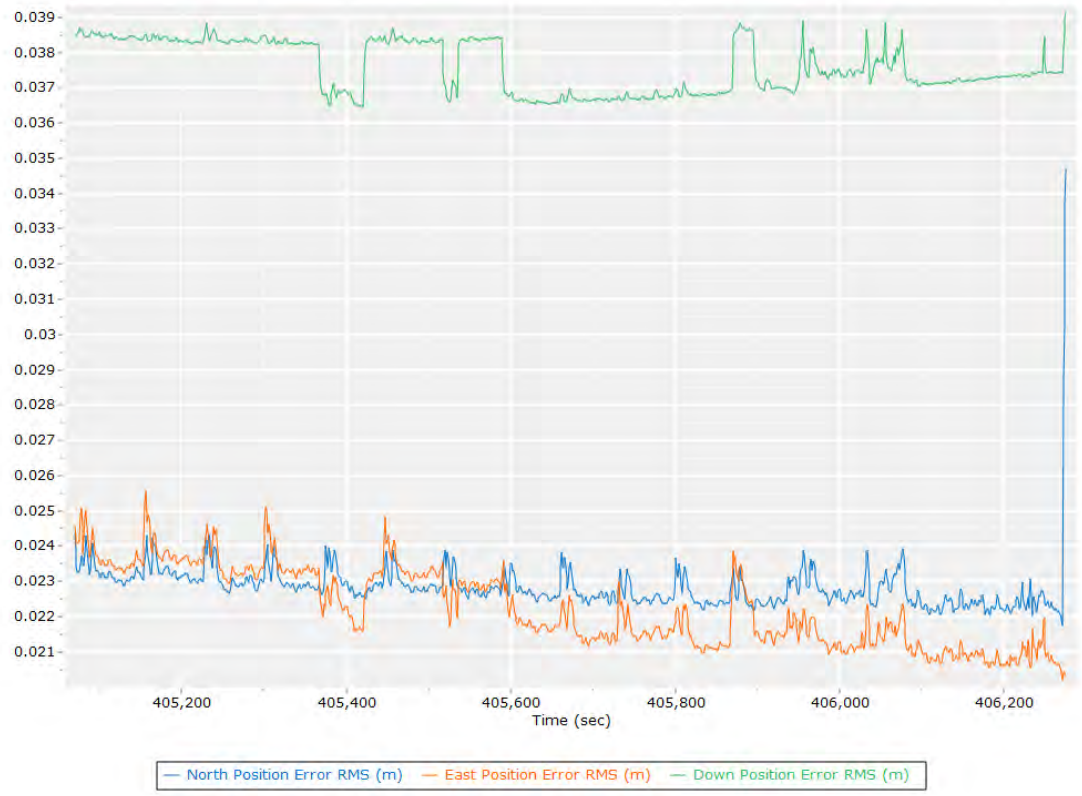


Heading Error RMS (arc-min)

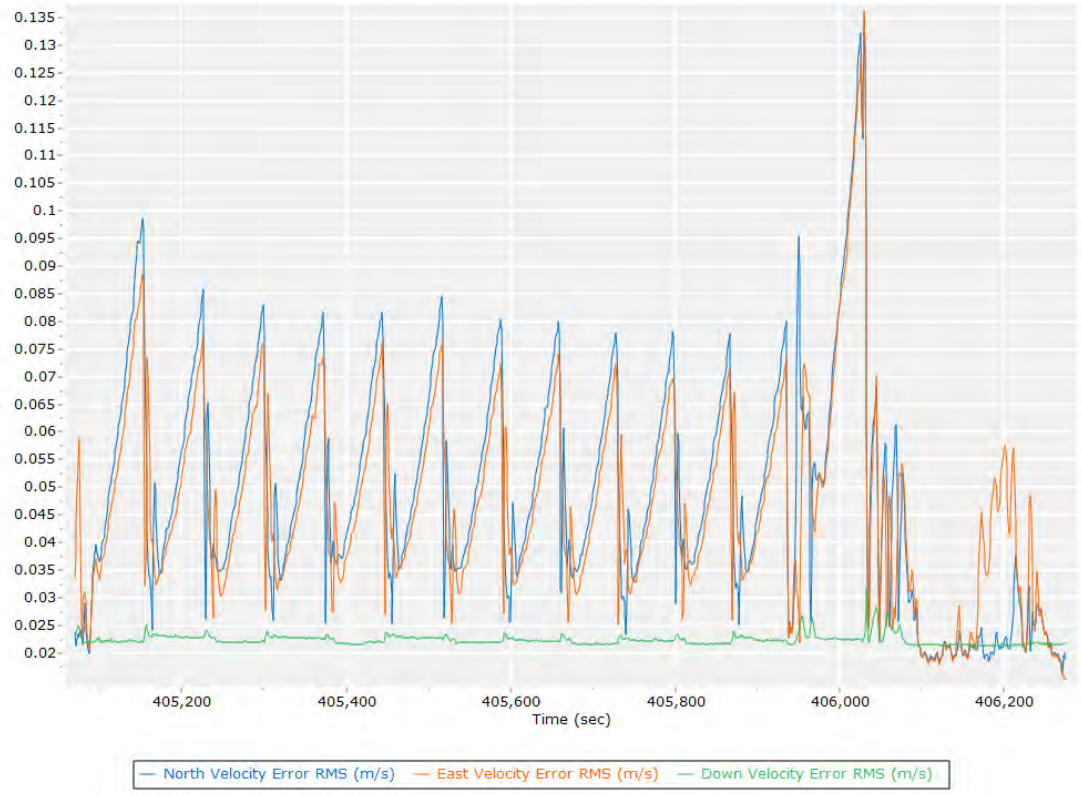


Forward Processed Performance Metrics

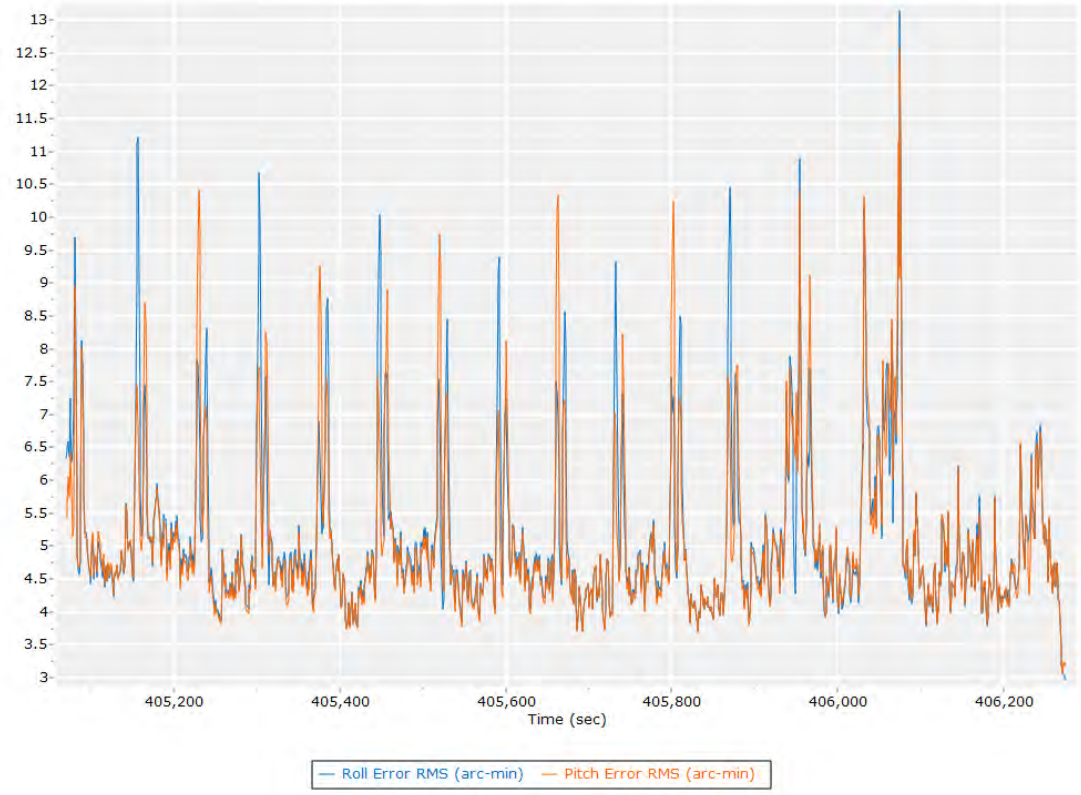
Position Error RMS (m)



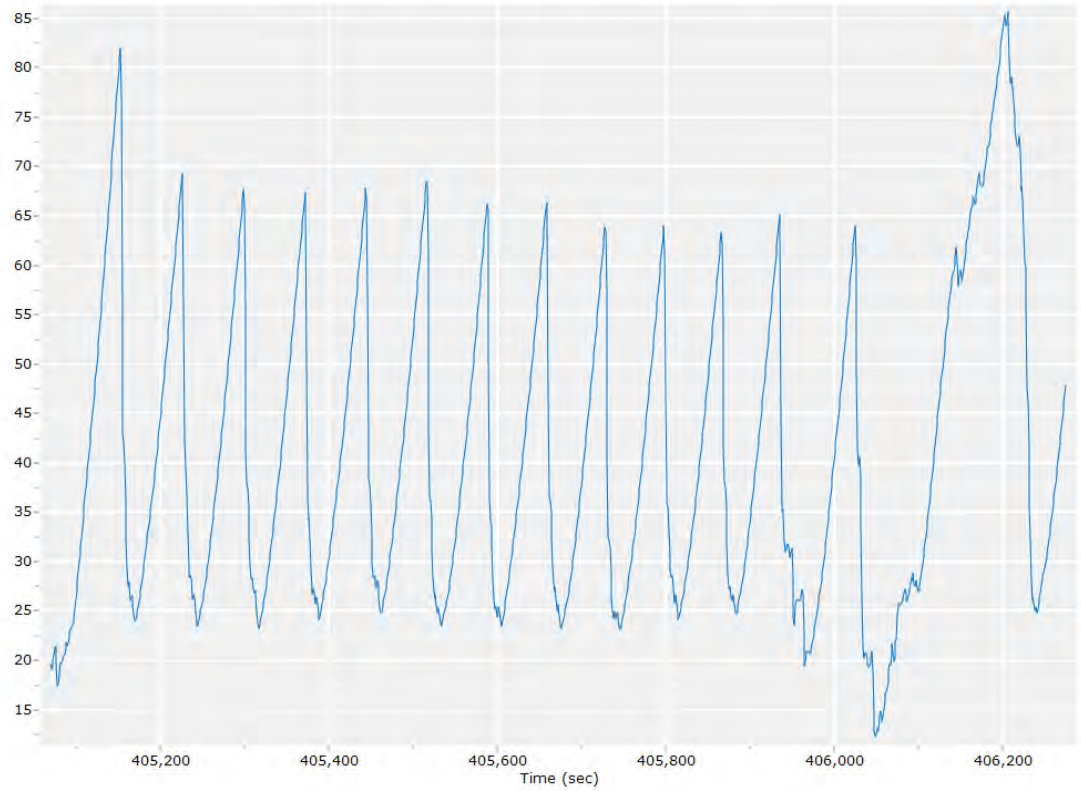
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

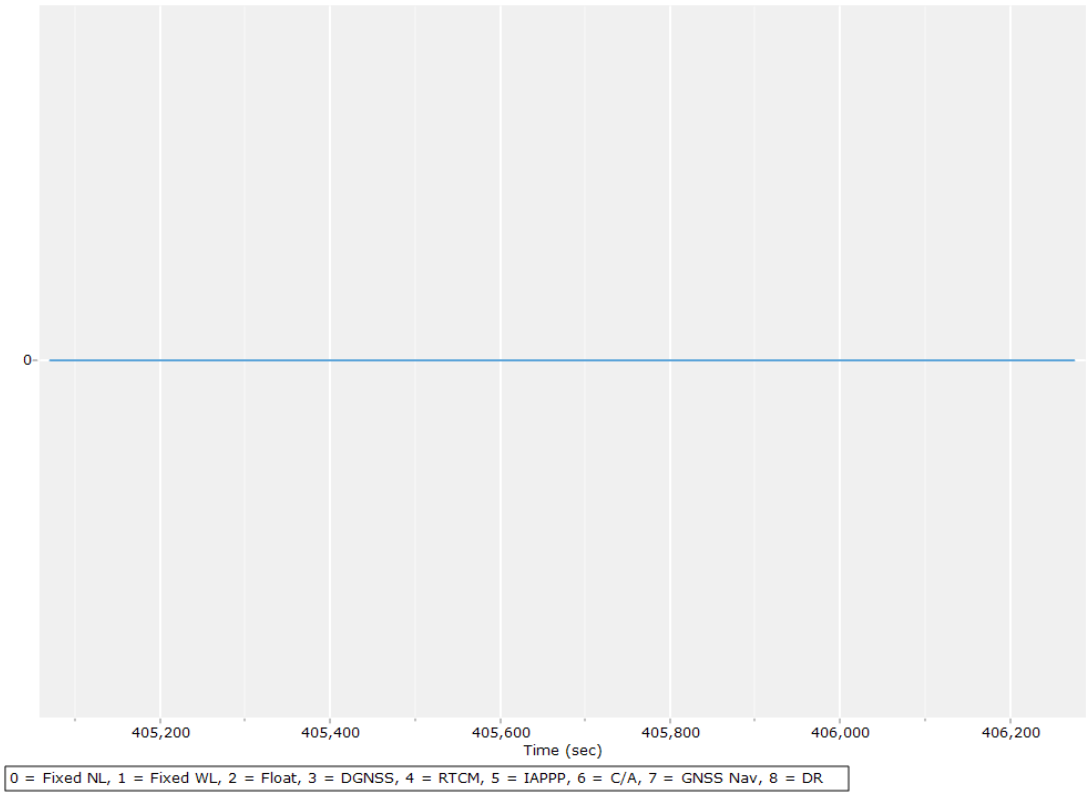


Heading Error RMS (arc-min)

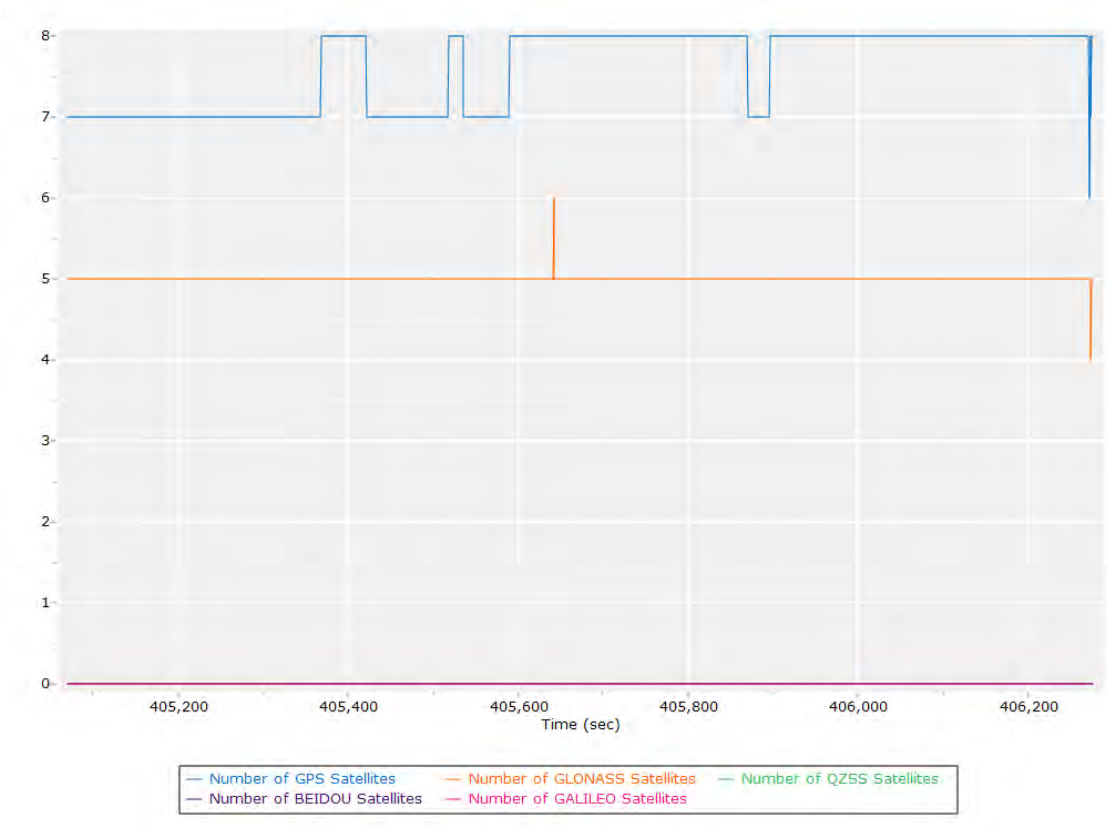


Smoothed Solution Status

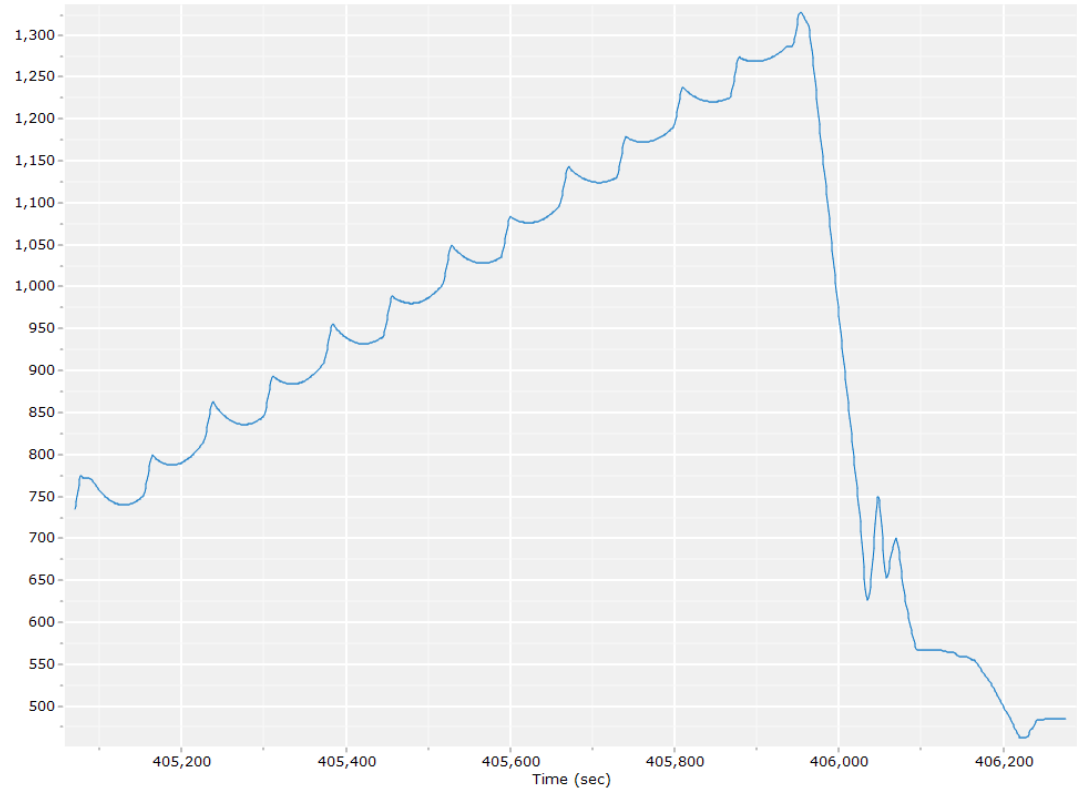
Processing Mode



Number of Satellites

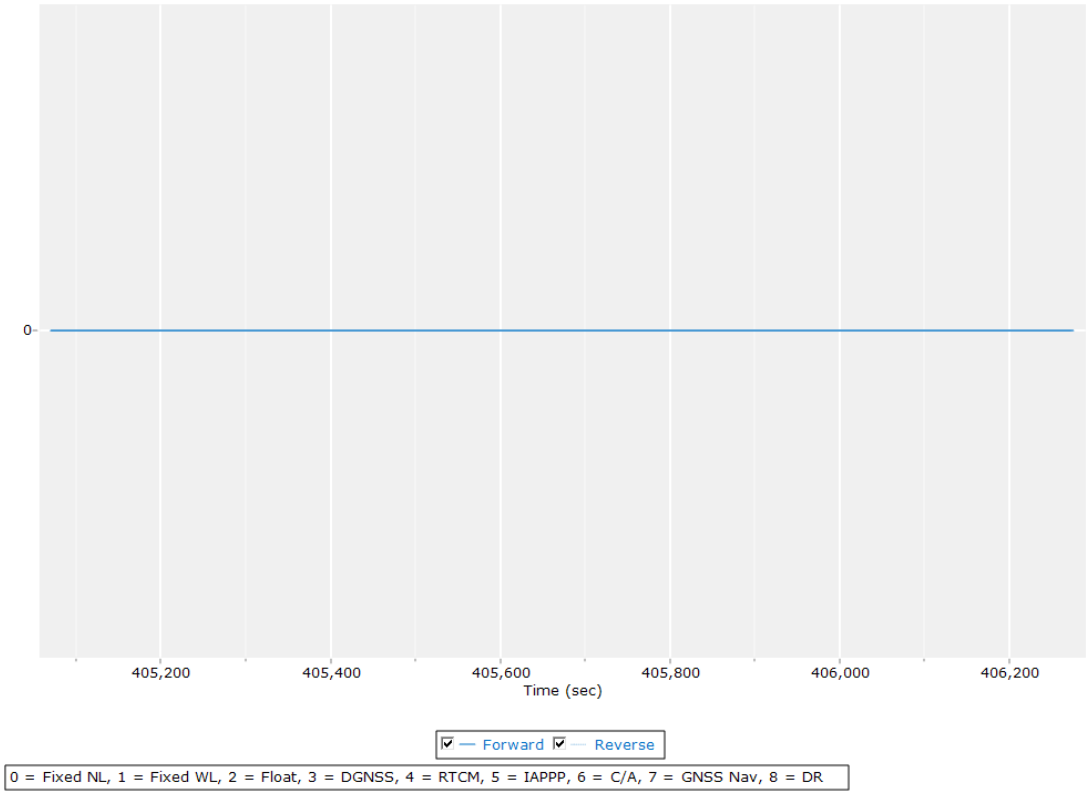


Baseline Length

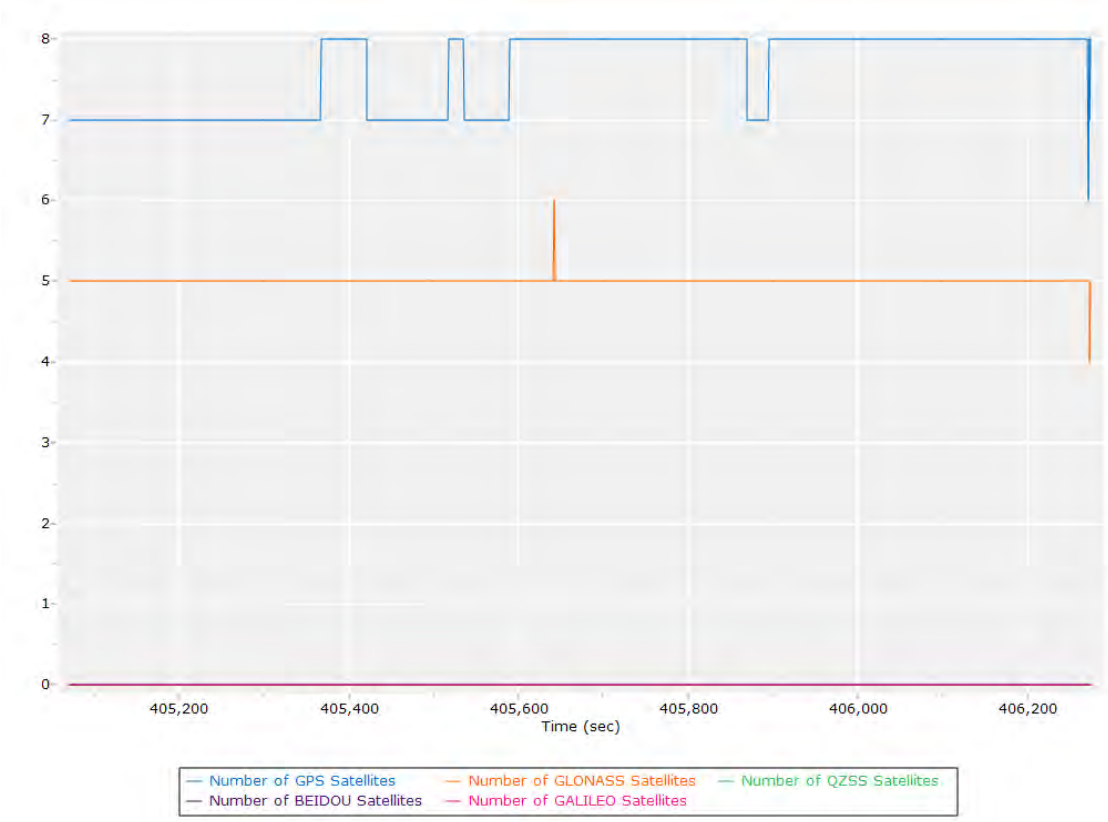


Forward Processed Solution Status

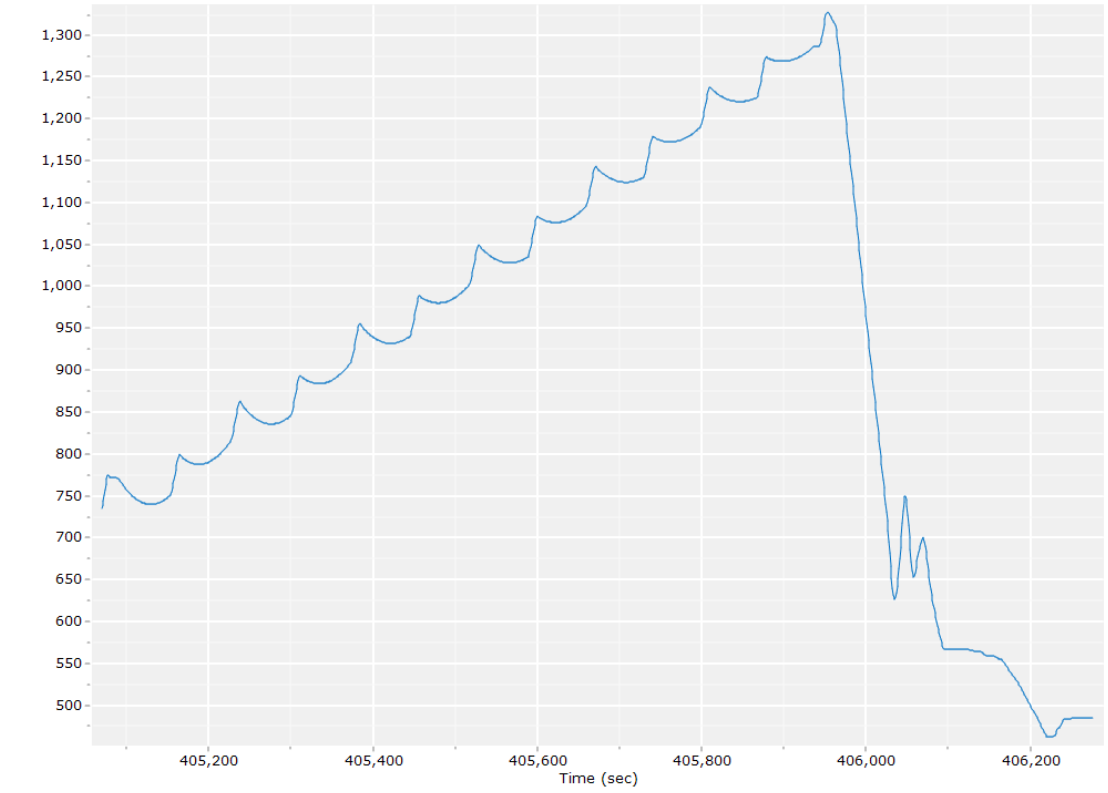
Processing Mode



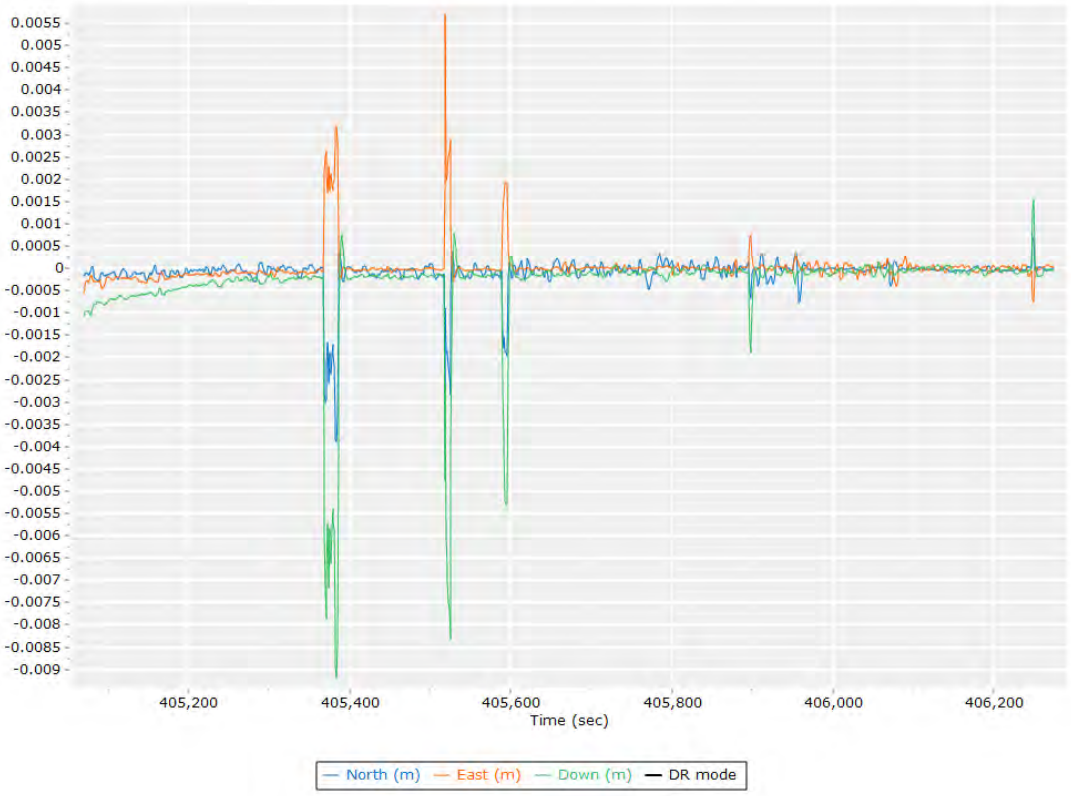
Number of Satellites



Baseline Length



SBET IAKAR Separation



Export Summary Section 1

Export file	YS-20250206-162908sbet.txt		
Export format	ASCII		
Solution in use	Post-processed		
Output rate	All Records		
Reference to Output lever arm (m)	0.000	0.000	0.000
Reference mounting angles (deg)	0.000	0.000	0.000
Output units (Coordinate / Lat & Lon)	Meter	Meter	
Export start time	0.000 (02/02/2025 00:00:00)		
Export end time	395199.000 (02/13/2025 13:46:39)		
Height option	Applanix Orthometric Height		
Geoid model	OSGM15 (United Kingdom)		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 30 (6W to 0W)		
Datum	ETRS89		
Ellipsoid	GRS 1980		
Local Transformation	NONE		
Target Epoch	1989		

General Information

Mission Information

Project name	YS-20250206-174153
Processing date	2025-02-18 12:31:25
Mission date	2025-02-06 17:42:16
Mission duration	00:21:02.000
Processing mode	IN-Fusion Single Base
GPS Station	LICF-10

Rover Hardware Information

Product	APX 15 AVX 210
Dynamic Model	Airborne Rotor
Serial number	6202C16694
IMU type	59
Receiver type	APX-15v3
Antenna type	AV18

Project File List

Rover Data Files

File name	File type
YS-20250206-174153.t04	T04 Rover Data

Input Files

File Name	File Type
BRDC00IGS_R_20250370000_01D_MN.rnx	GPS, GLONASS, GALILEO, QZSS, BEIDOU Broadcast Ephemeris
Ephm0370.25g	GLONASS Broadcast Ephemeris
Ephm0370.25n	GPS Broadcast Ephemeris
licf037r.25o	GNSS SingleBase

Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
YS-20250206-174153sbet.txt	ASCII Export Output

Rover Data Summary

First raw data file	YS-20250206-174153.t04		
Last raw data file	YS-20250206-174153.t04		
Start GPS week	2352		
Start time	409336.000 (02/06/2025 17:42:16)		
End time	410598.000 (02/06/2025 18:03:18)		
Start of fine alignment	409396.090 (02/06/2025 17:43:16)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
IMU Installation Lever Arms & Mounting Angles			
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.050	0.120	-0.510
Reference to Primary GNSS lever arm std dev (m)	0.020		
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

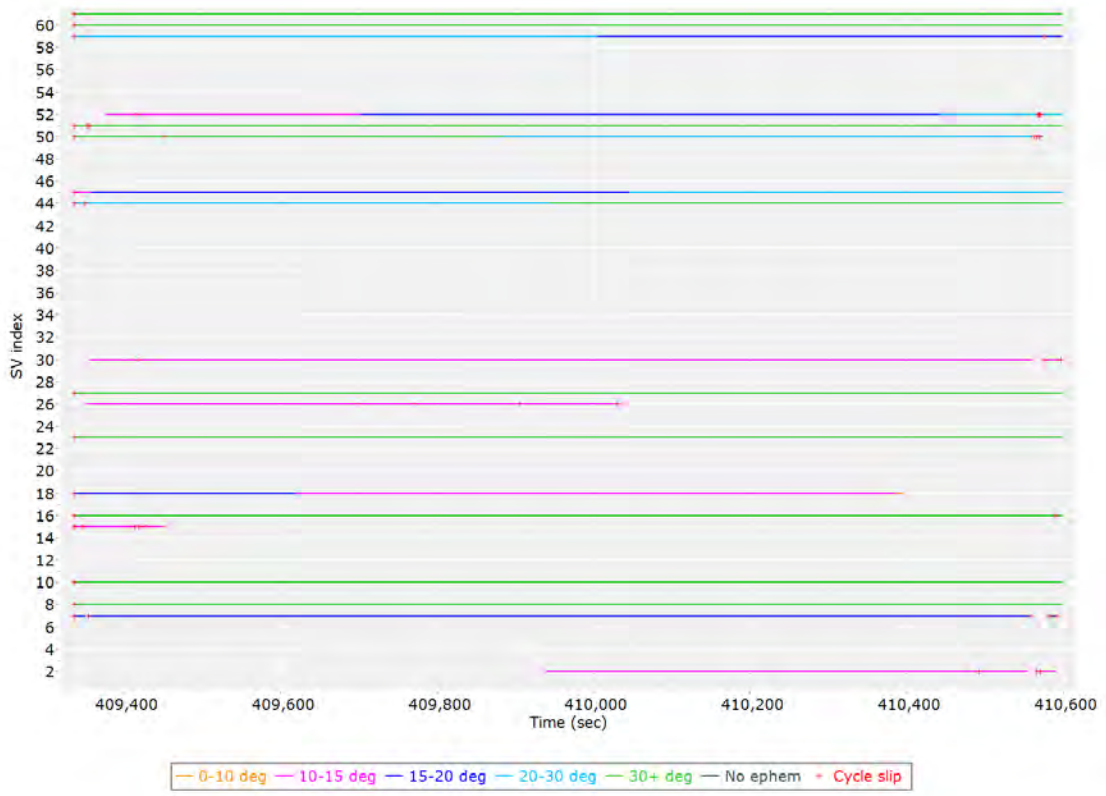
Rover Data QC

Raw IMU Import QC Summary

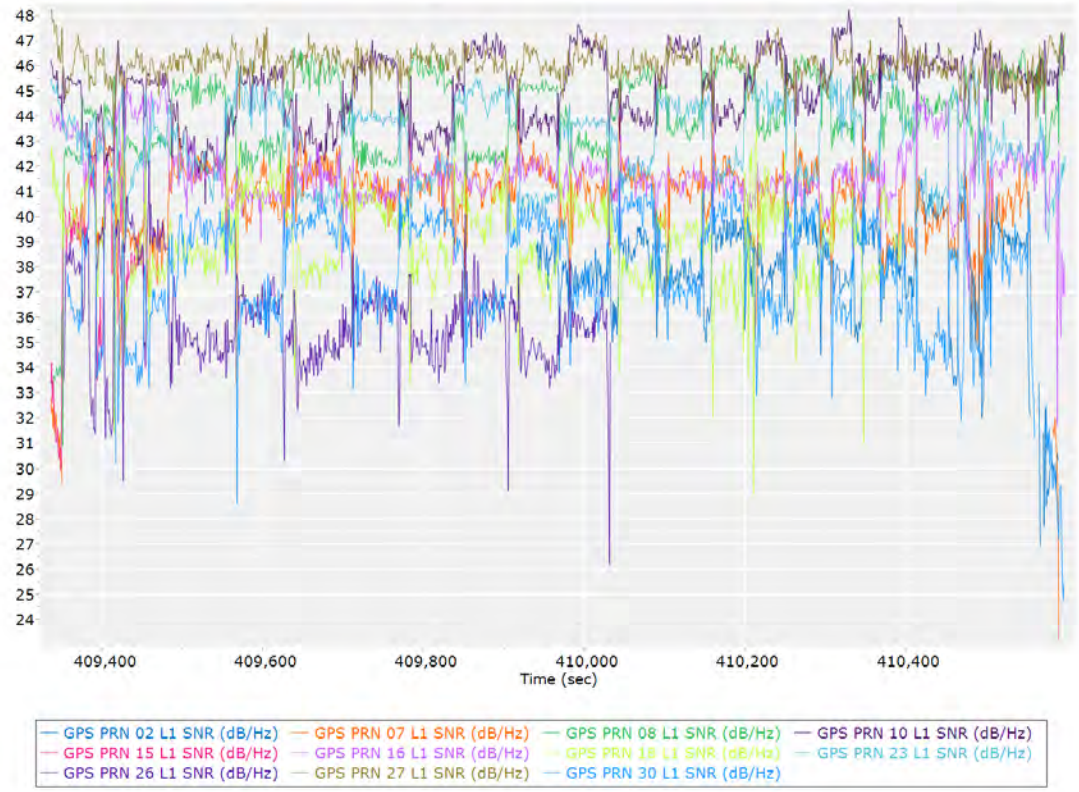
IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	252419
Termination Status	Normal
IMU Anomalies	0

Primary Observables & Satellite Data

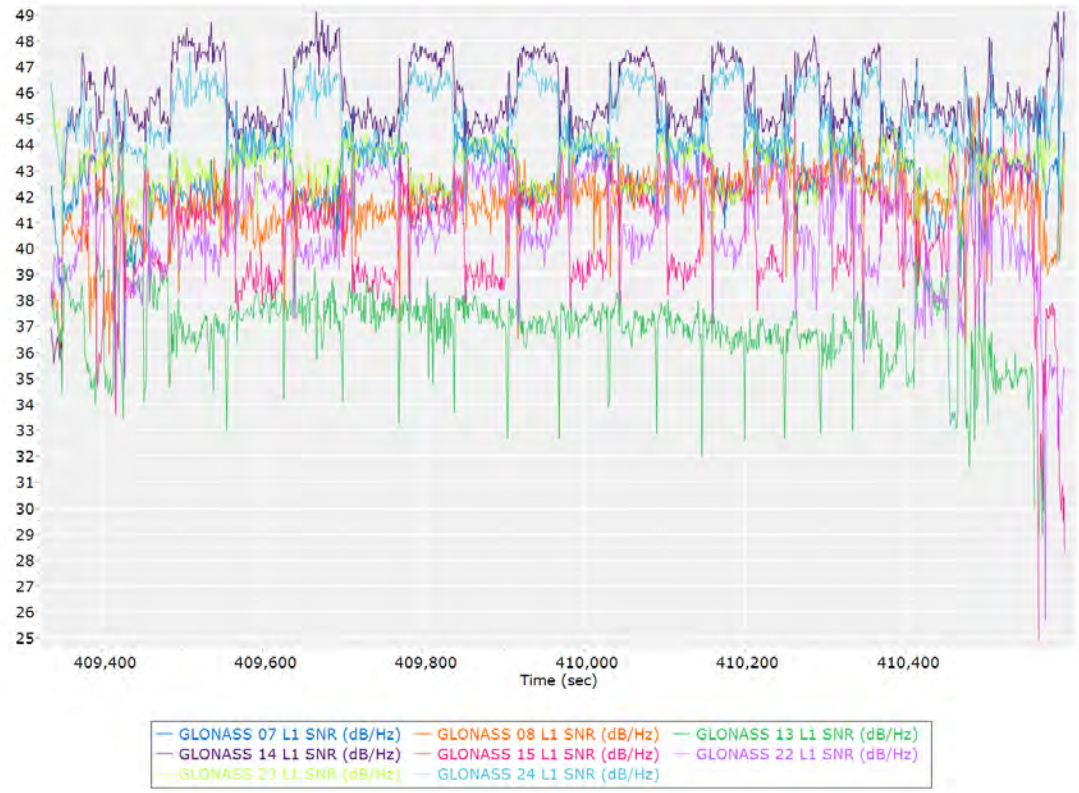
GPS/GLONASS L1 Satellite Lock/Elevation



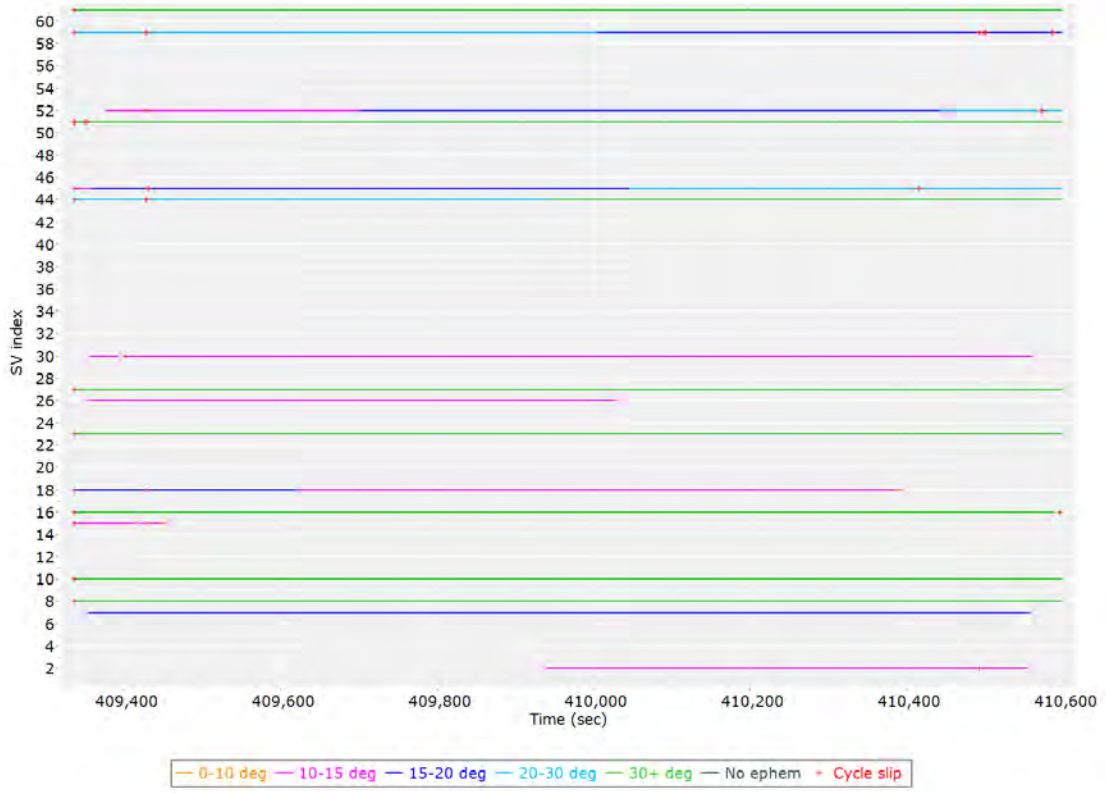
GPS L1 SNR



GLONASS L1 SNR

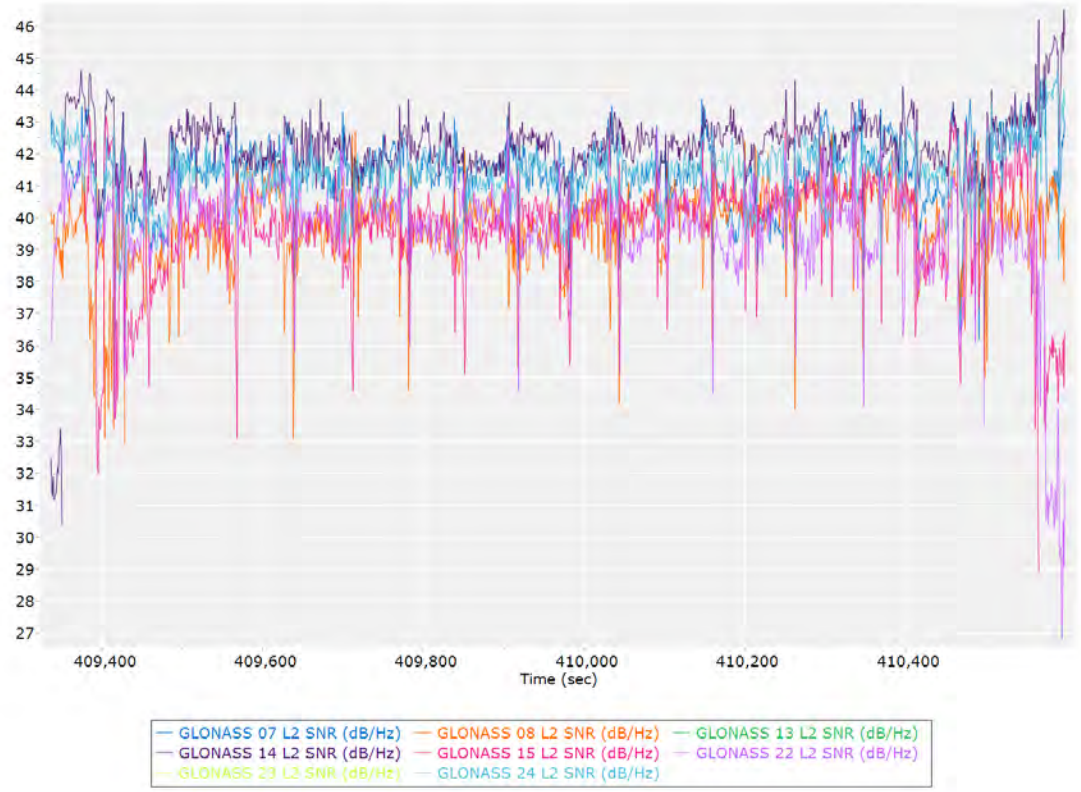


GPS/GLONASS L2 Satellite Lock/Elevation

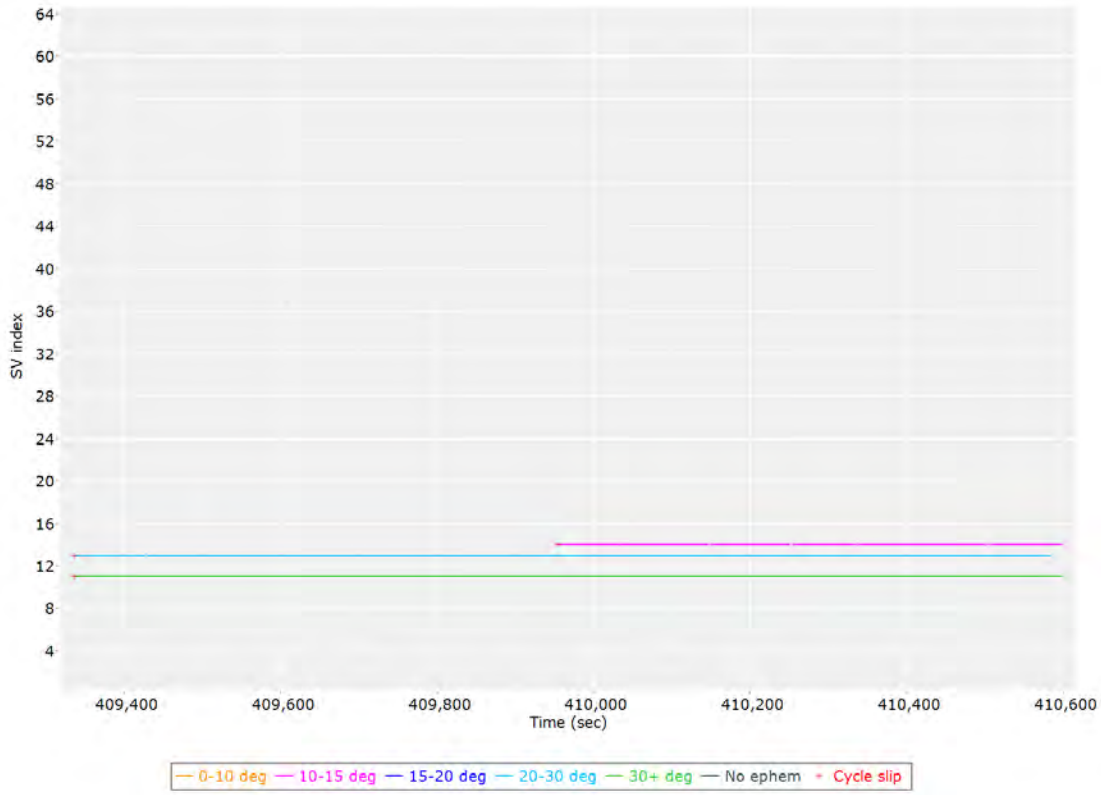


GPS L2 SNR

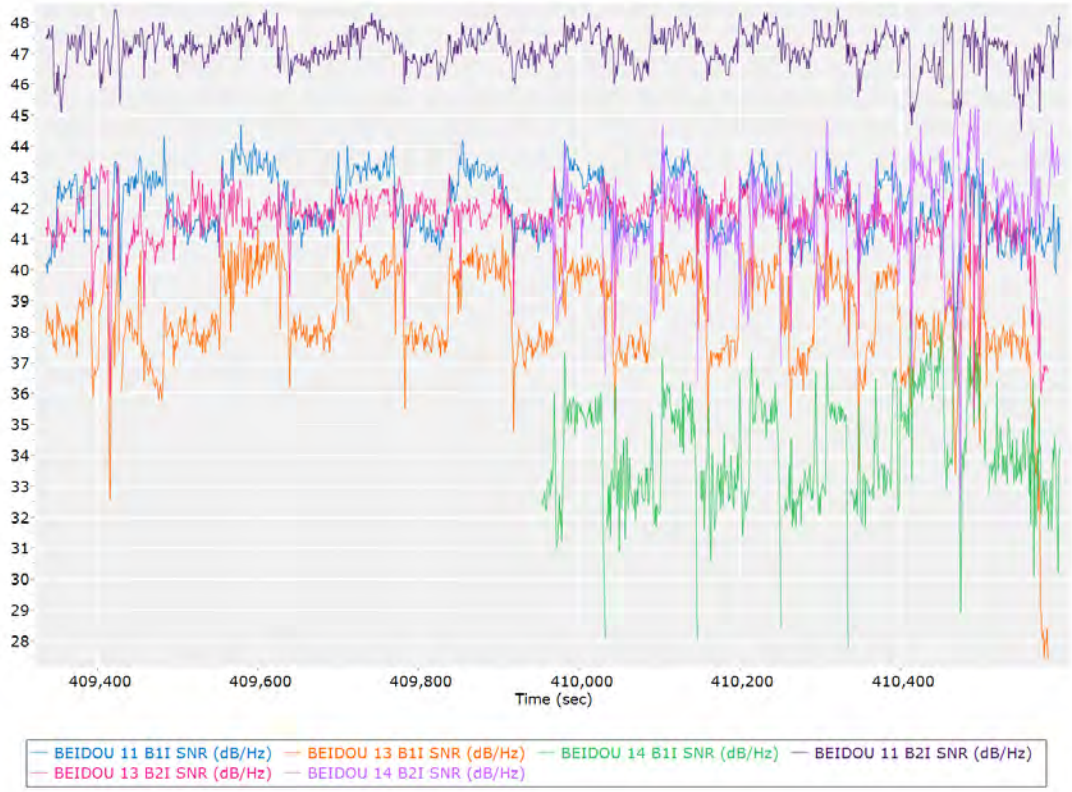
GLONASS L2 SNR



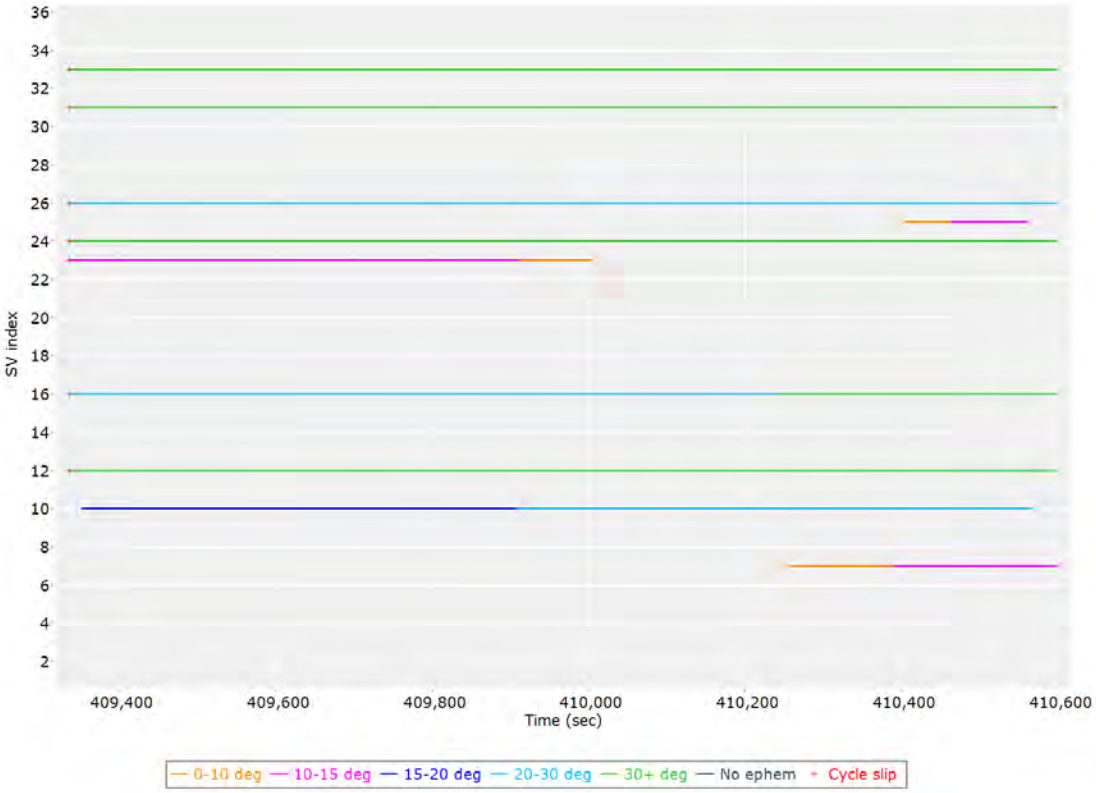
BEIDOU Satellite Lock/Elevation



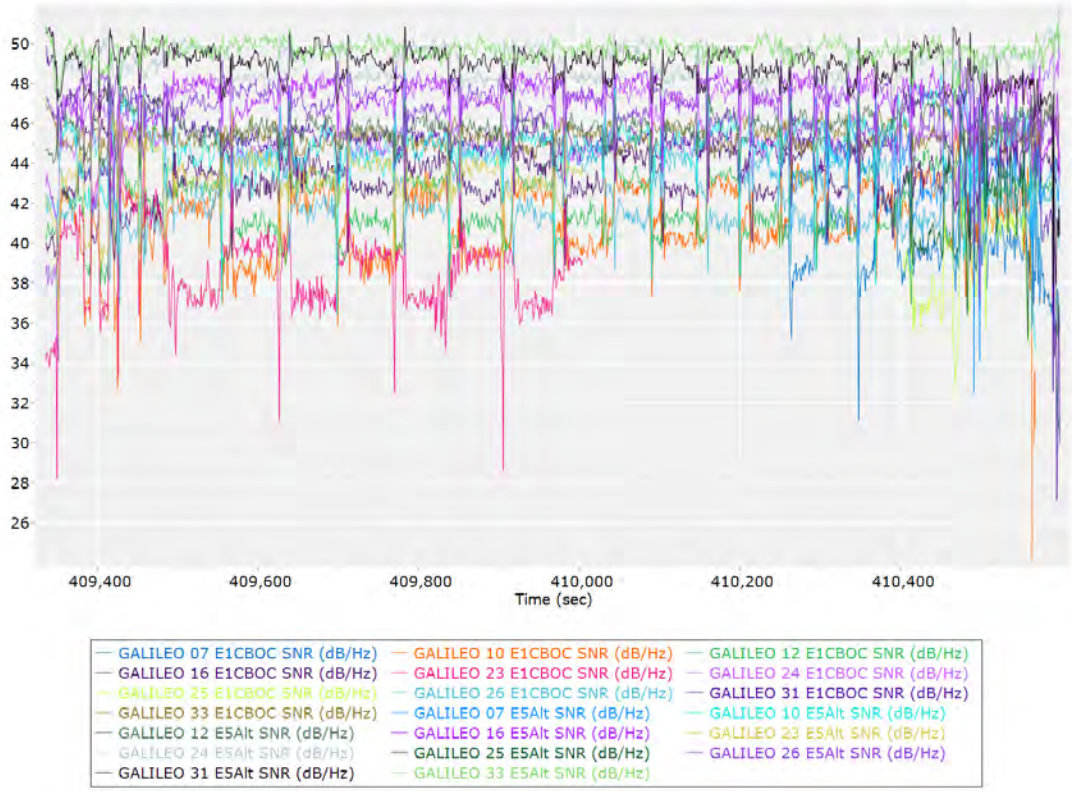
BEIDOU SNR



GALILEO Satellite Lock/Elevation

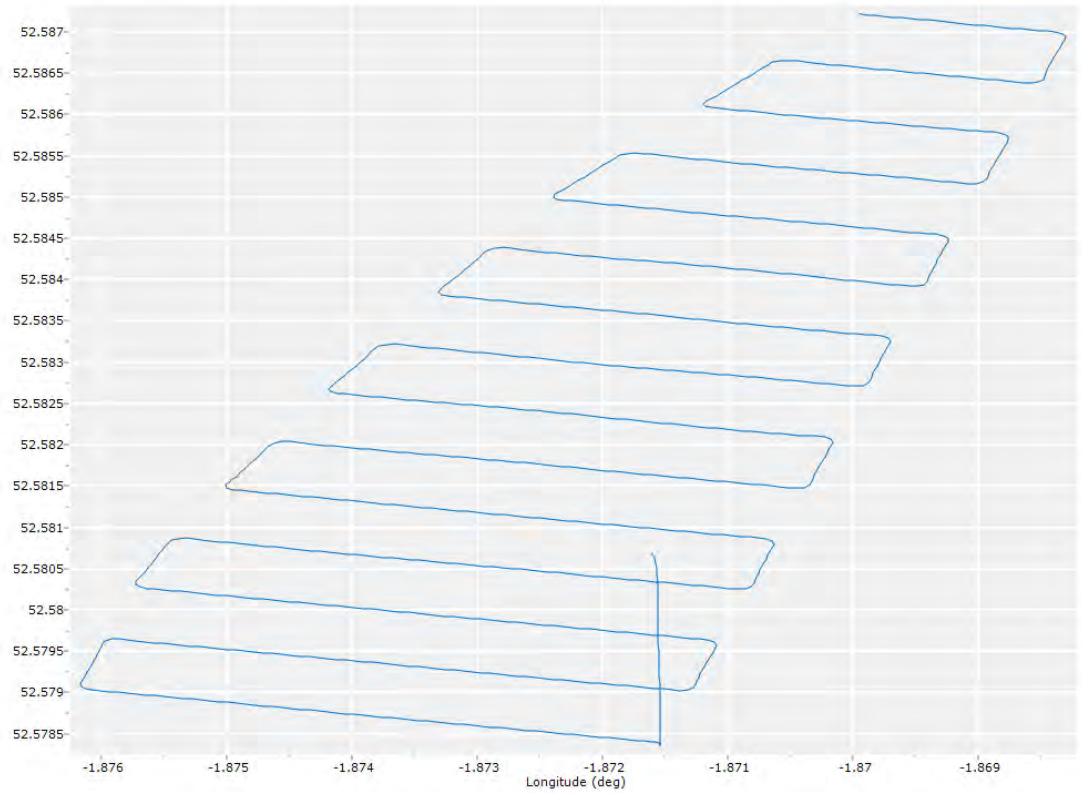


GALILEO SNR

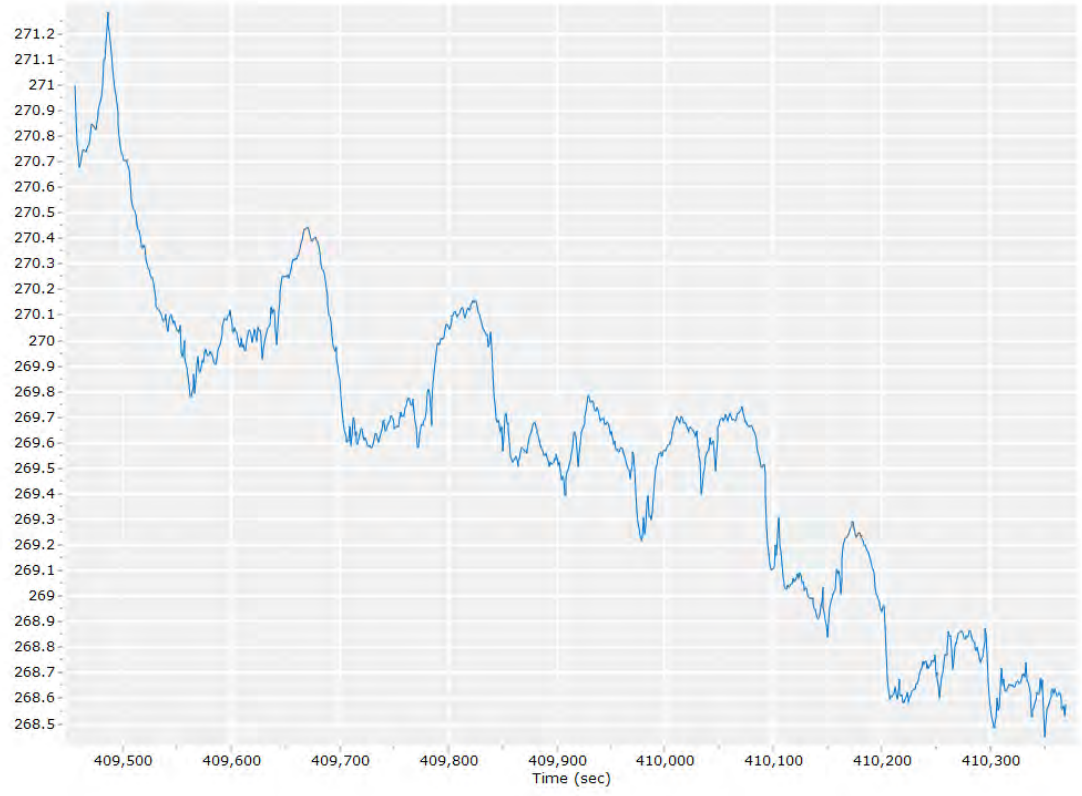

50
48
46
44
42
40
38
36
34
32
30
28
26
409,400
409,600
409,800
410,000
410,200
410,400
Time (sec)
GALILEO 07 E1CBOC SNR (dB/Hz)
GALILEO 10 E1CBOC SNR (dB/Hz)
GALILEO 12 E1CBOC SNR (dB/Hz)
GALILEO 16 E1CBOC SNR (dB/Hz)
GALILEO 23 E1CBOC SNR (dB/Hz)
GALILEO 24 E1CBOC SNR (dB/Hz)
GALILEO 25 E1CBOC SNR (dB/Hz)
GALILEO 26 E1CBOC SNR (dB/Hz)
GALILEO 31 E1CBOC SNR (dB/Hz)
GALILEO 33 E1CBOC SNR (dB/Hz)
GALILEO 07 E5AIt SNR (dB/Hz)
GALILEO 10 E5AIt SNR (dB/Hz)
GALILEO 12 E5AIt SNR (dB/Hz)
GALILEO 16 E5AIt SNR (dB/Hz)
GALILEO 23 E5AIt SNR (dB/Hz)
GALILEO 24 E5AIt SNR (dB/Hz)
GALILEO 25 E5AIt SNR (dB/Hz)
GALILEO 26 E5AIt SNR (dB/Hz)
GALILEO 31 E5AIt SNR (dB/Hz)
GALILEO 33 E5AIt SNR (dB/Hz)

Smoothed Trajectory Information

Top View

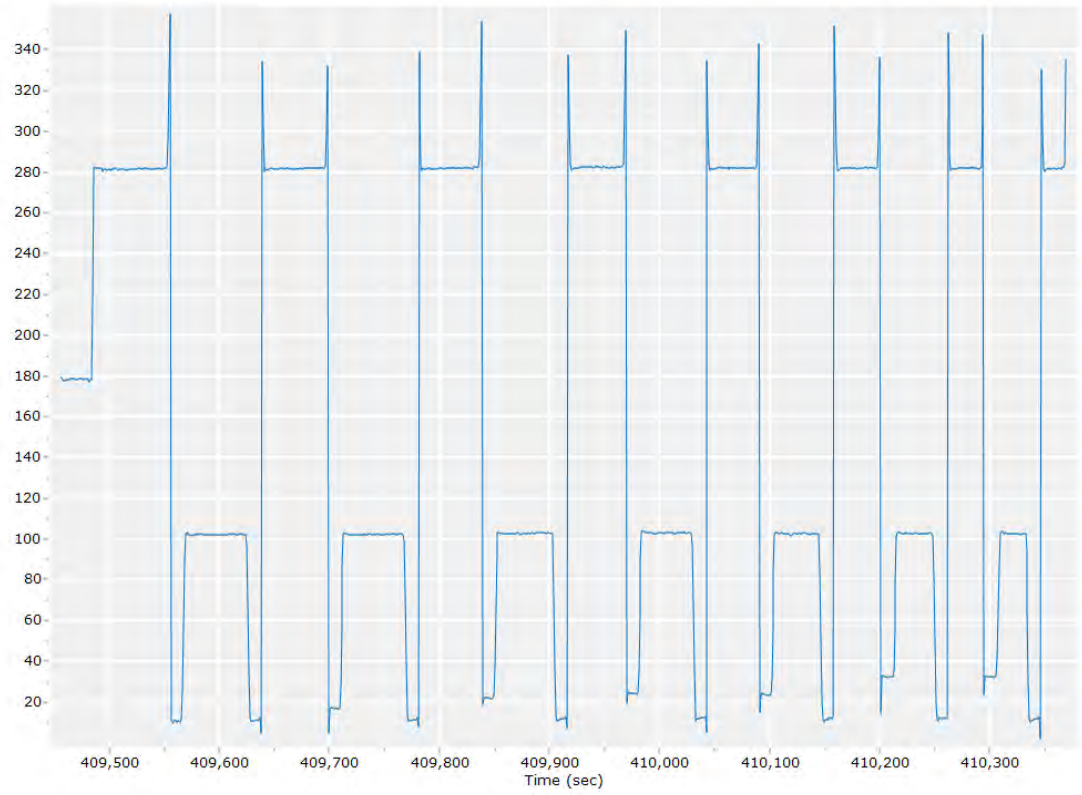


Altitude



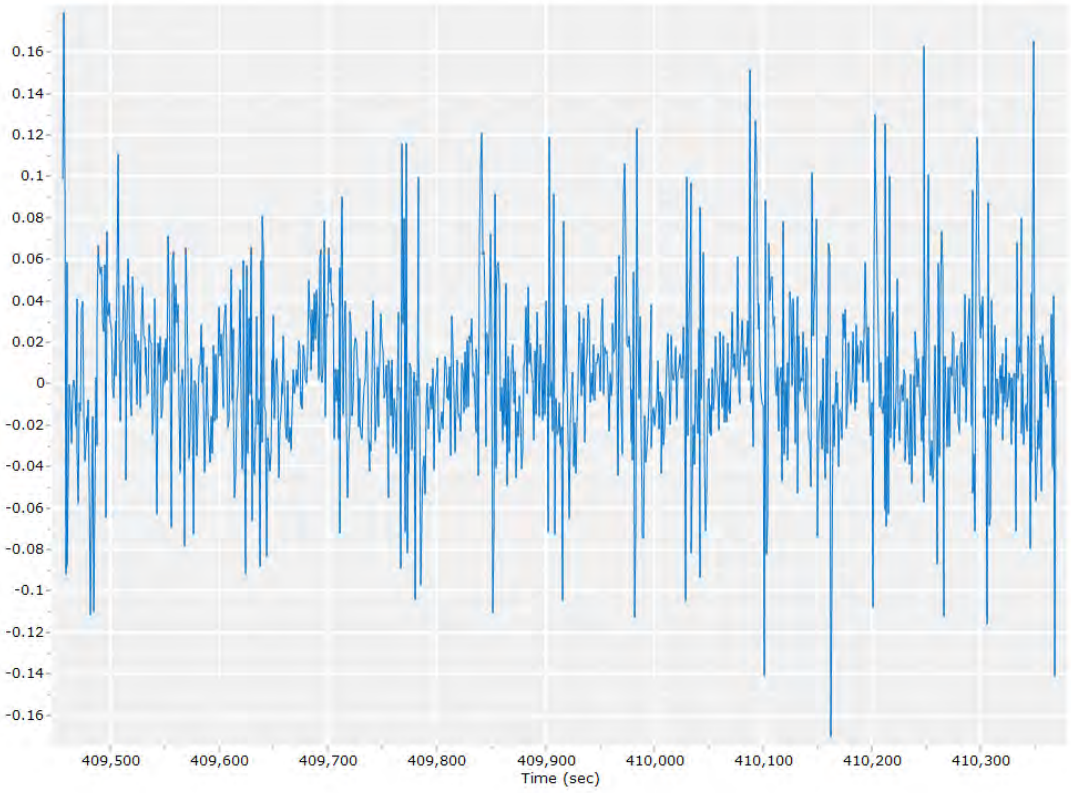
Roll/Pitch

Heading

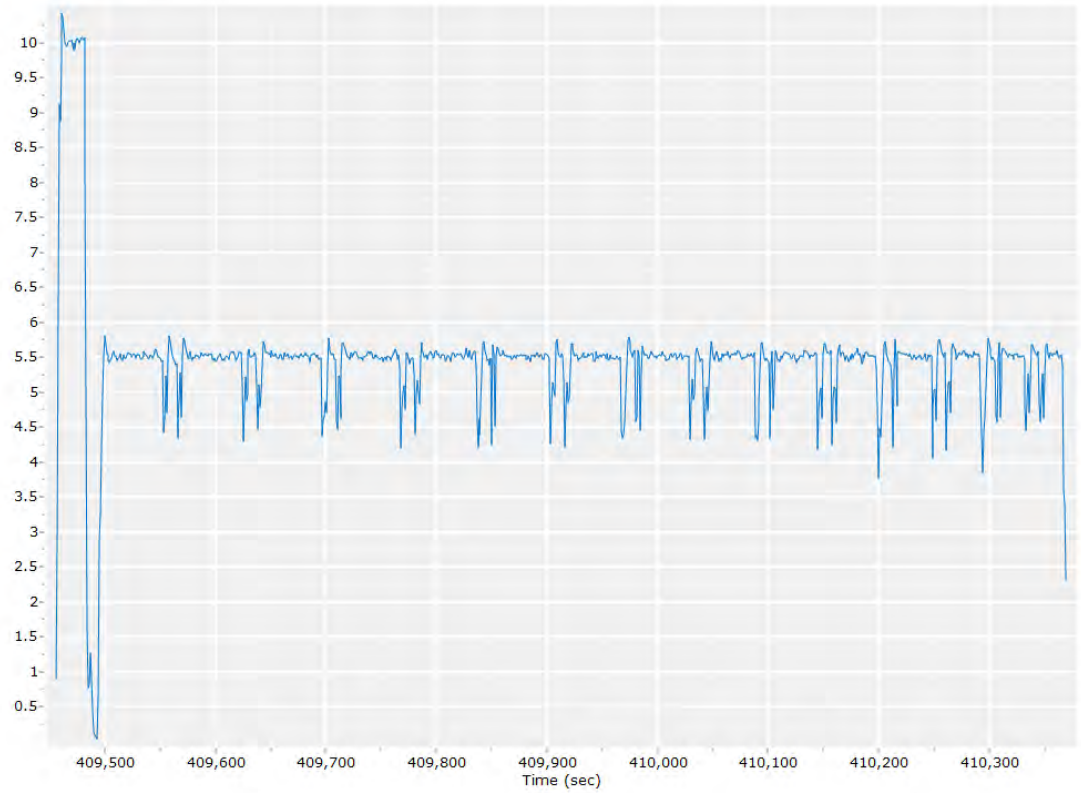


North/East Velocity

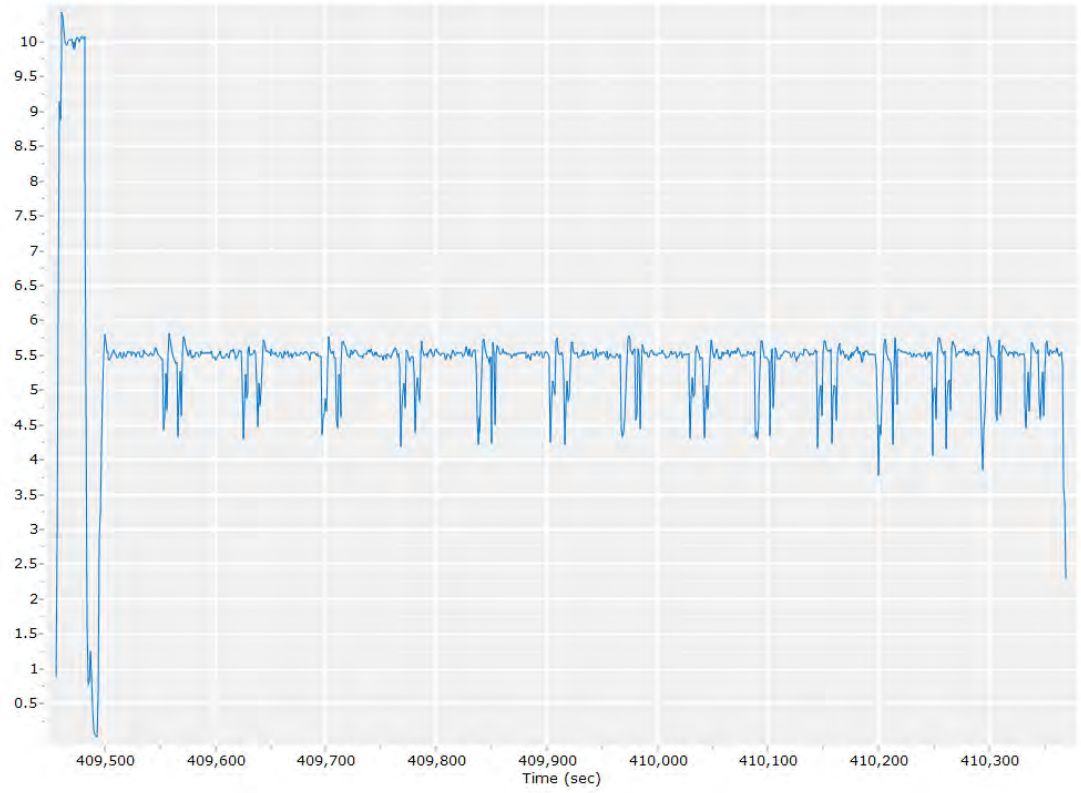
Down Velocity



Total Speed

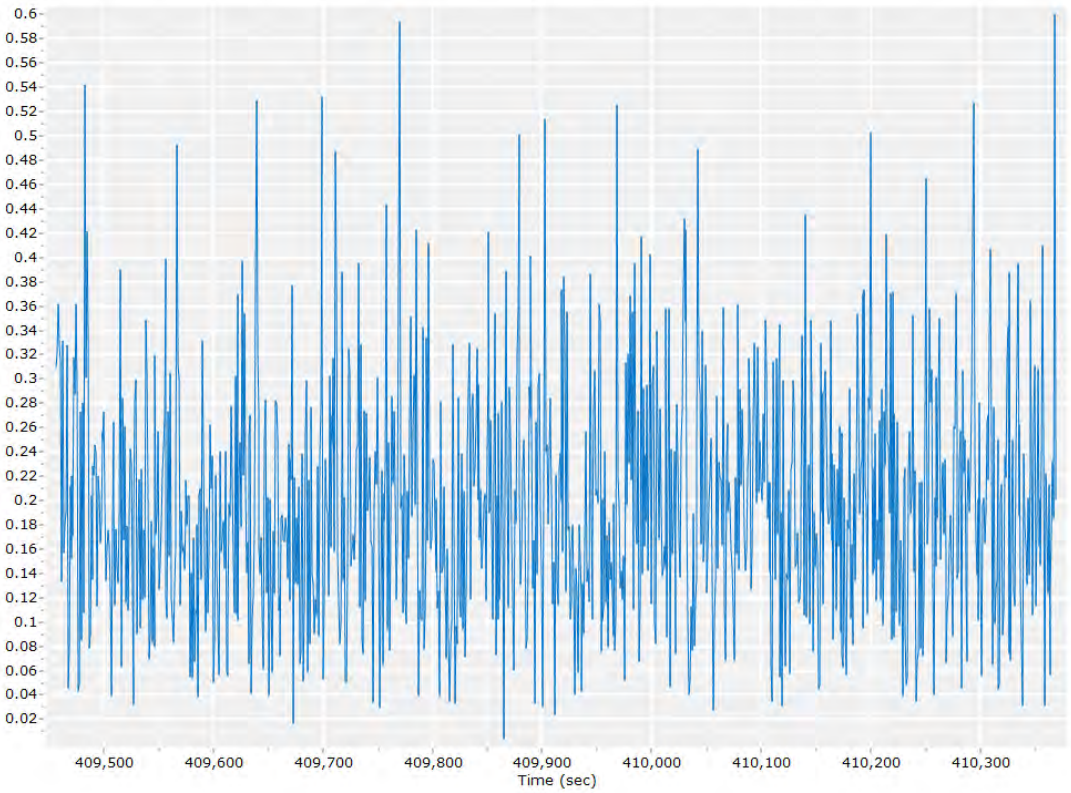


Ground Speed

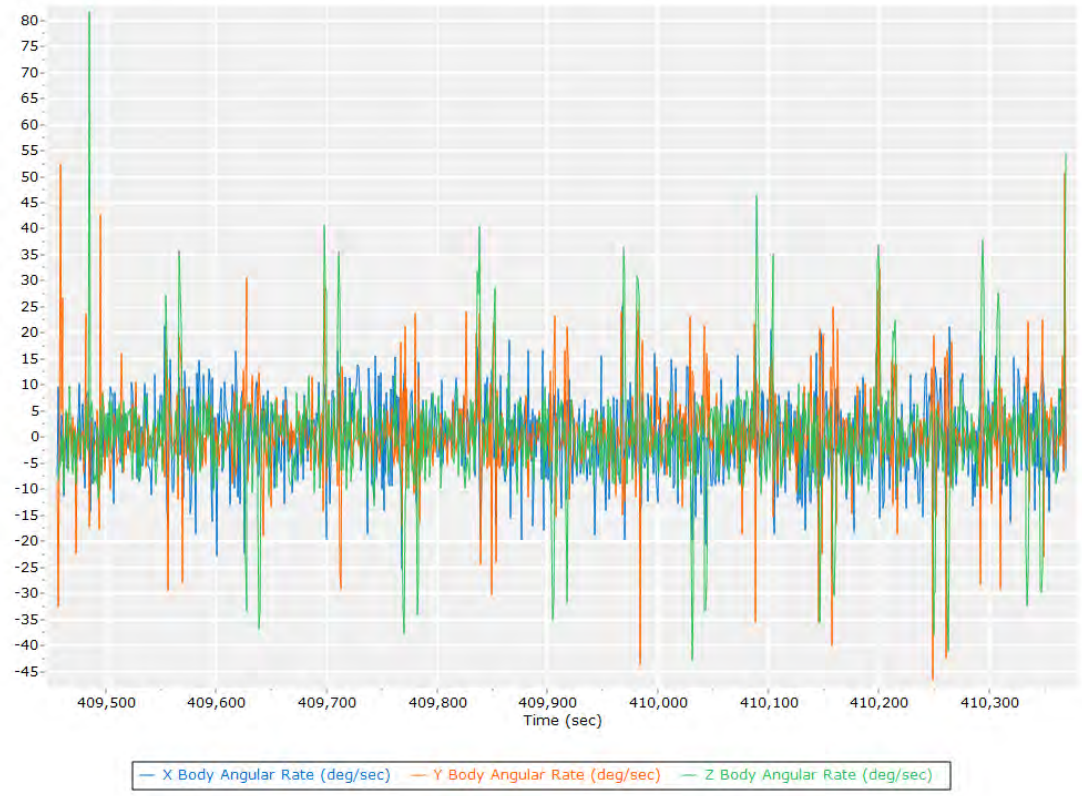


Body Acceleration

Total Body Acceleration

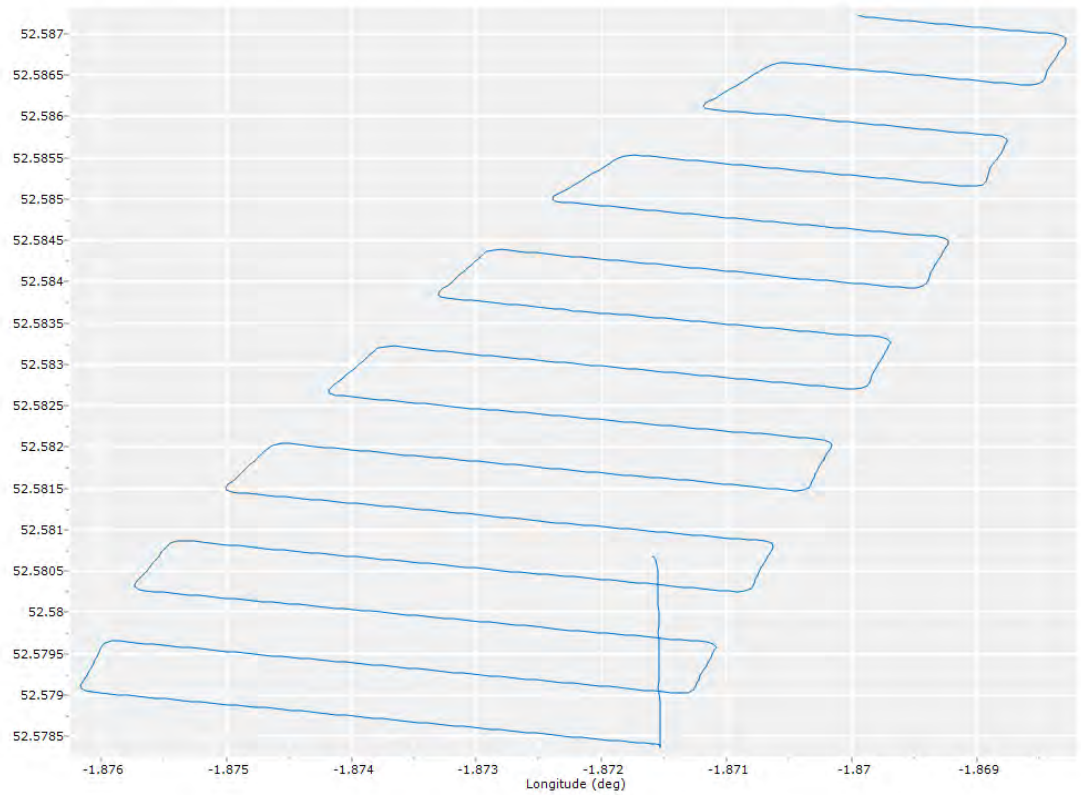


Body Angular Rate

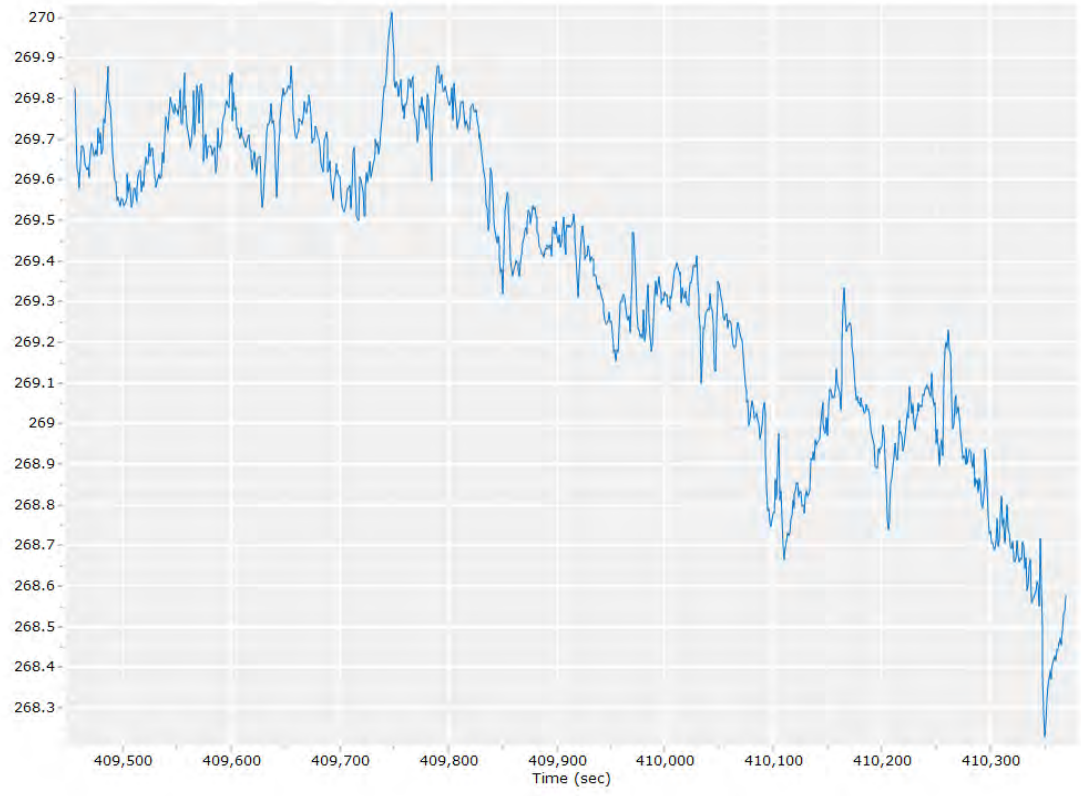


Forward Processed Trajectory Information

Top View

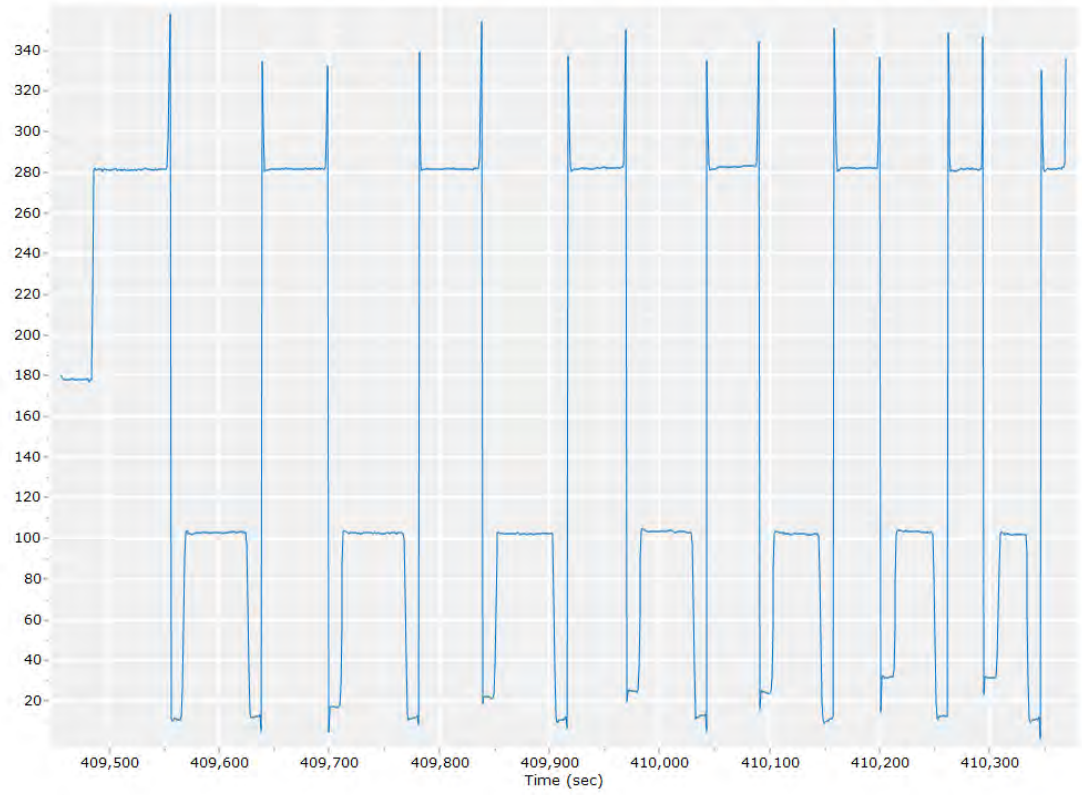


Altitude



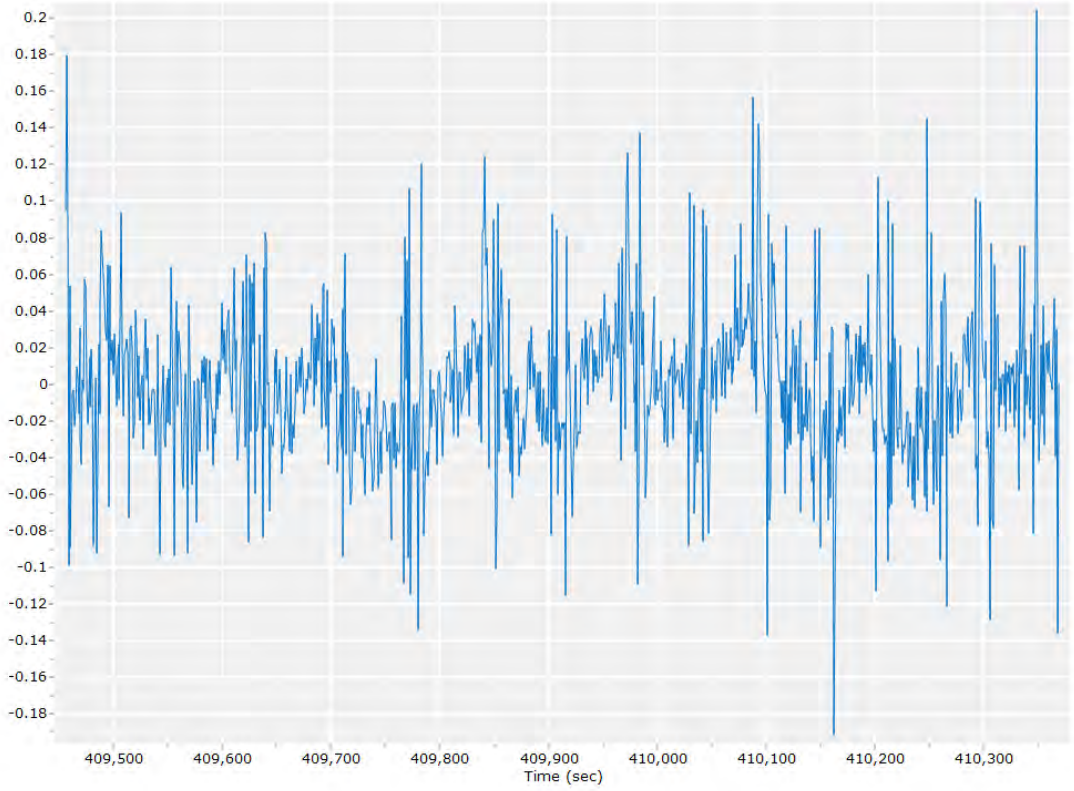
Roll/Pitch

Heading

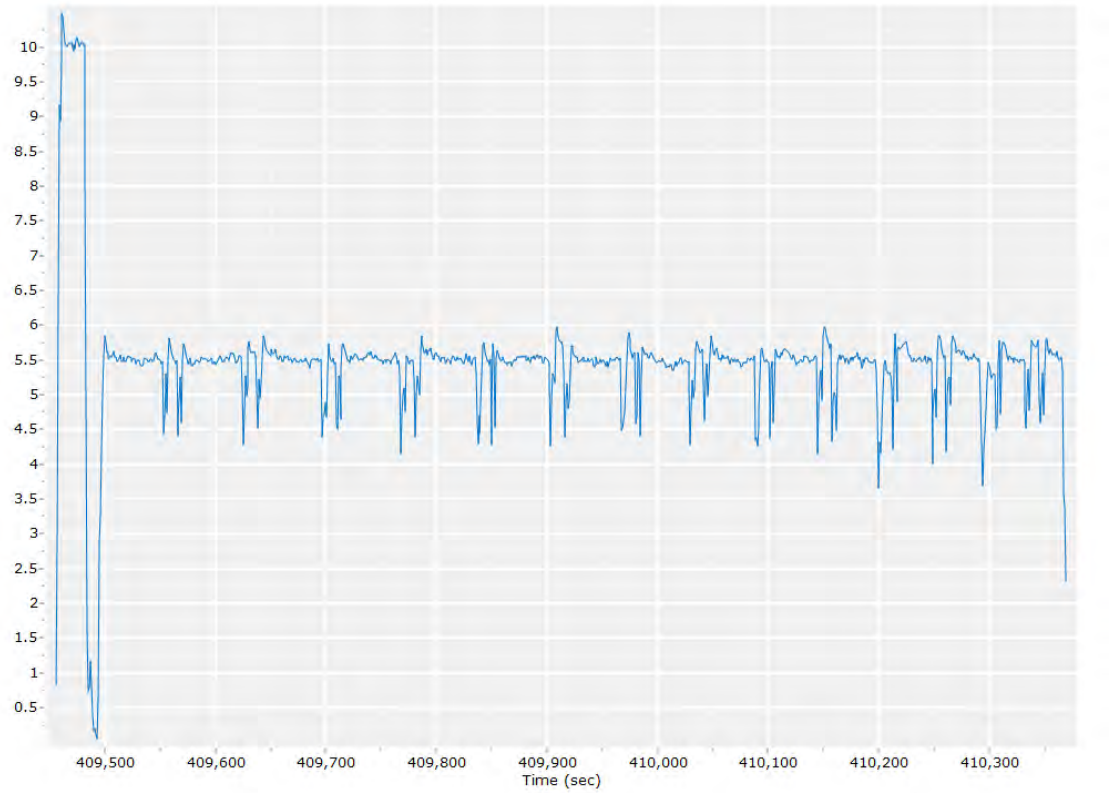


North/East Velocity

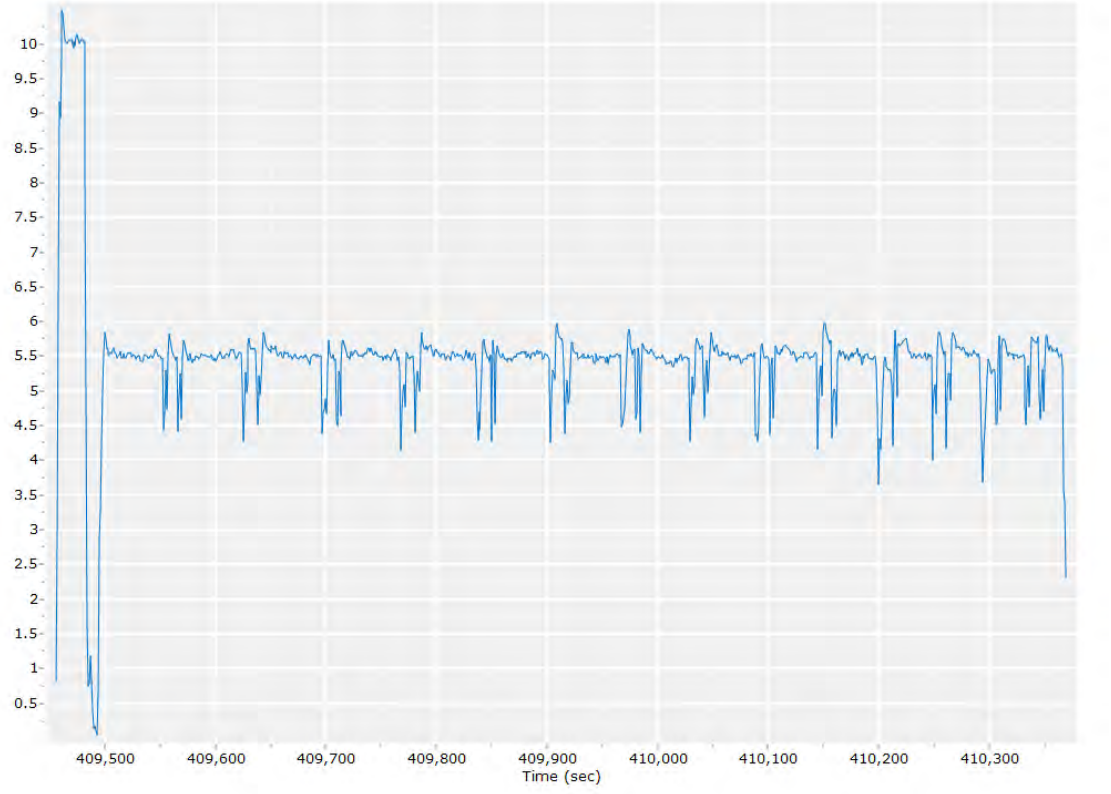
Down Velocity



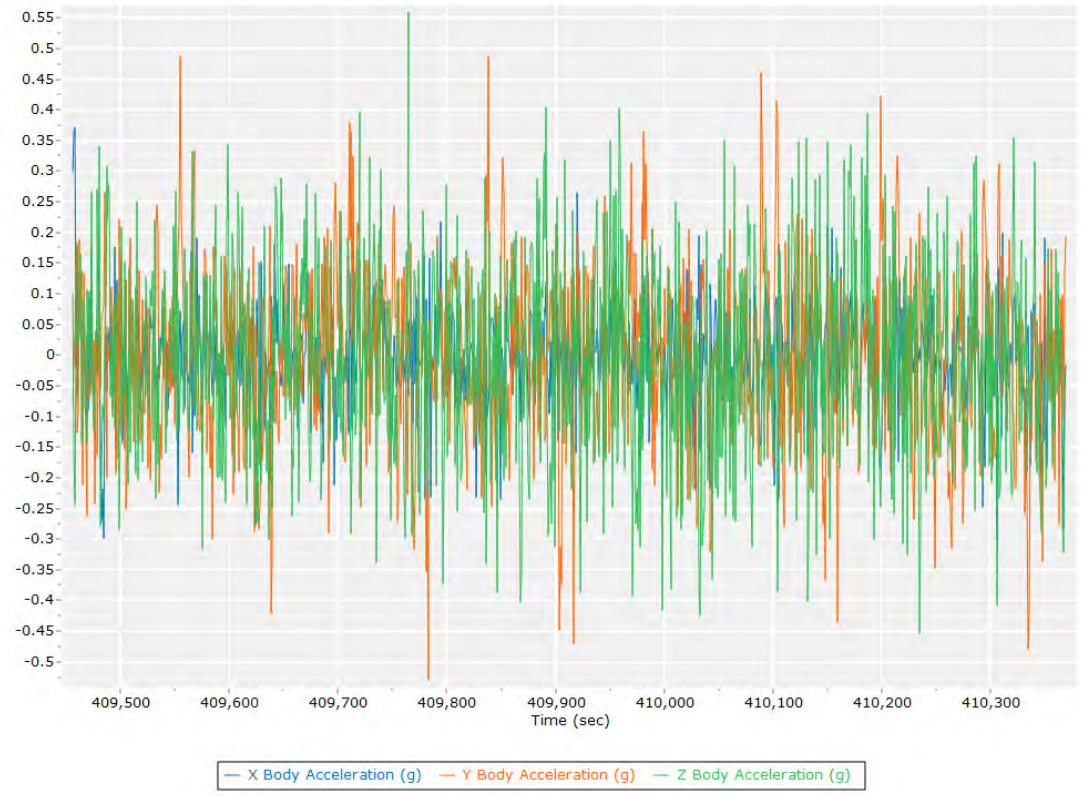
Total Speed



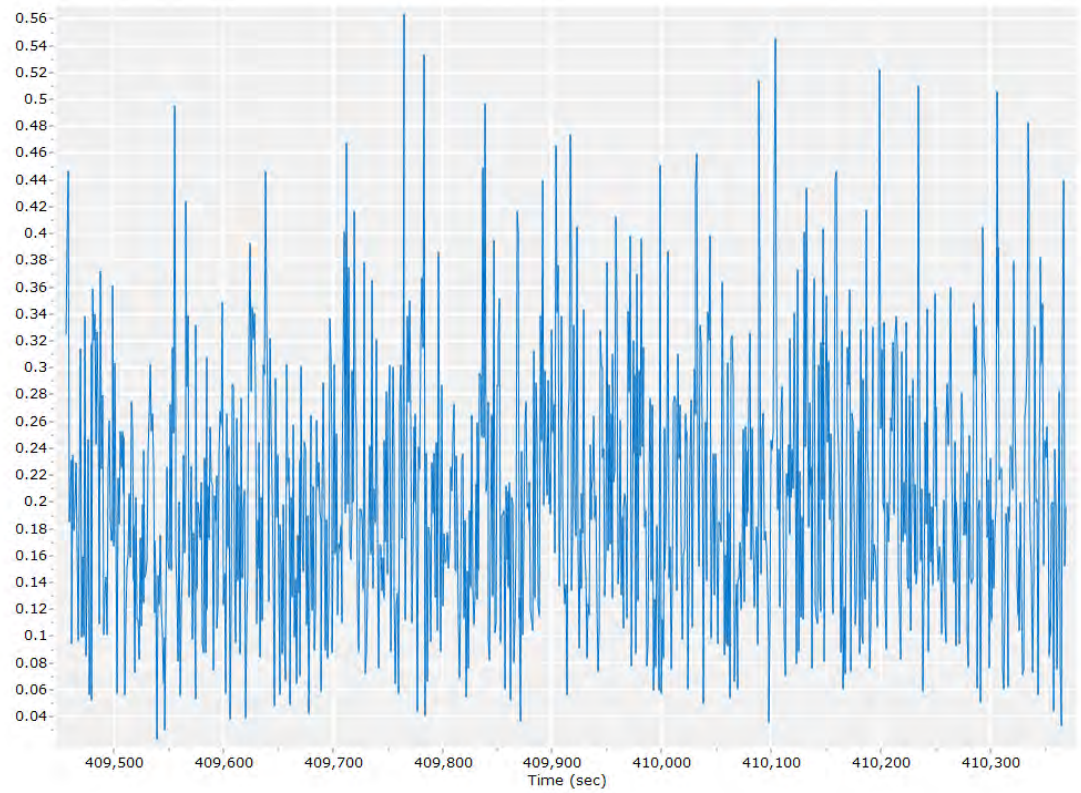
Ground Speed



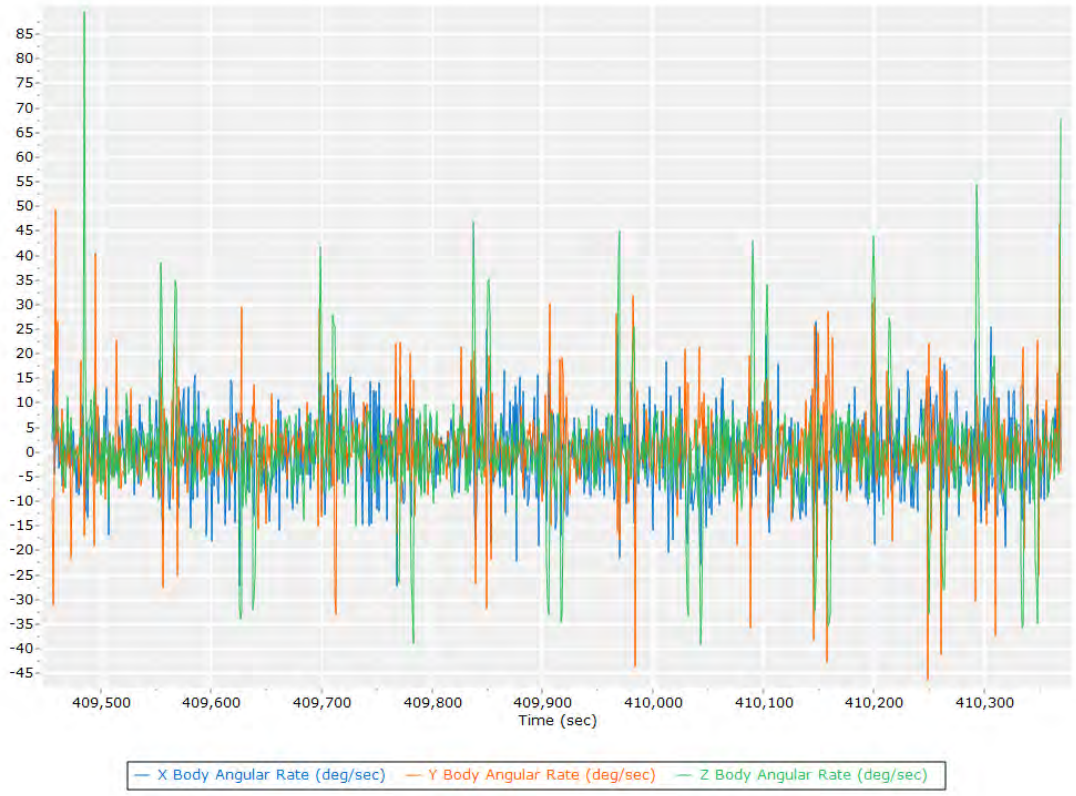
Body Acceleration



Total Body Acceleration



Body Angular Rate

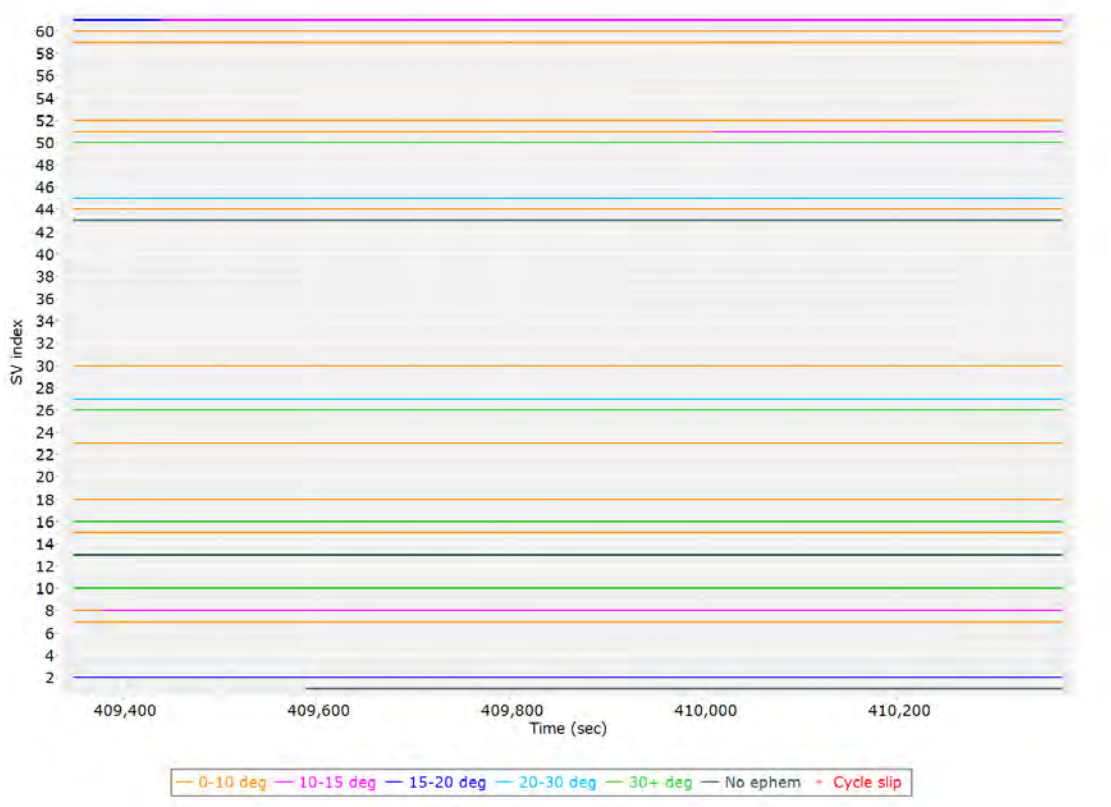


Base Station Information

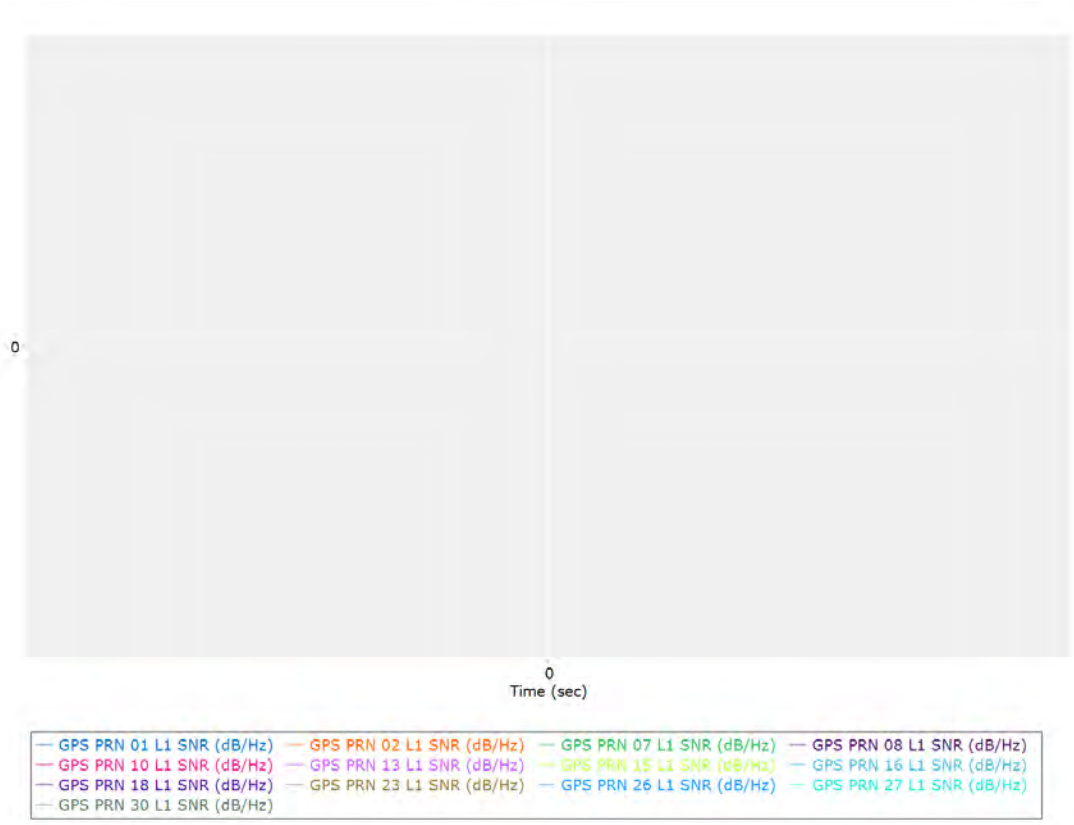
Station ID	LICF-10		
Filename	licf037r.25o		
Start date	02/06/2025 17:00:00		
End date	02/06/2025 17:59:30		
Duration	00:59:30.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Trimble	Alloy	5803R40172
Antenna manufacturer, model	Leica	AR25 w/LEIT Dome	
Antenna height [m]	0.000		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC (m)	0.15508		
Latitude	N0°00'00.00000"		
Longitude	E0°00'00.00000"		
Ellipsoidal height (m)	0.00000		
Frame	ITRF2014		
Epoch	2025.0986		
Ellipsoid	GRS_1980		
Velocity North (mm/y)	18.70		
Velocity East (mm/y)	21.62		
Velocity Up (mm/y)	-0.19		

Base Observables & Satellite Data

Base GPS/GLONASS L1 Satellite Lock/Elevation

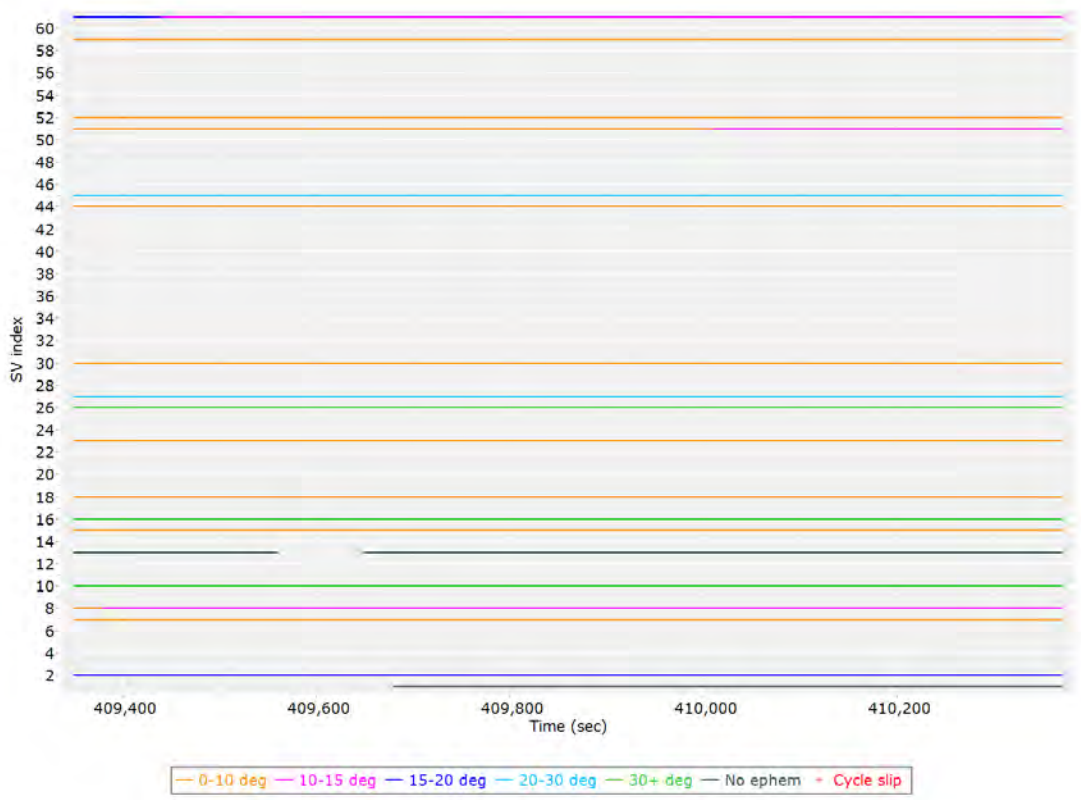


Base GPS L1 SNR

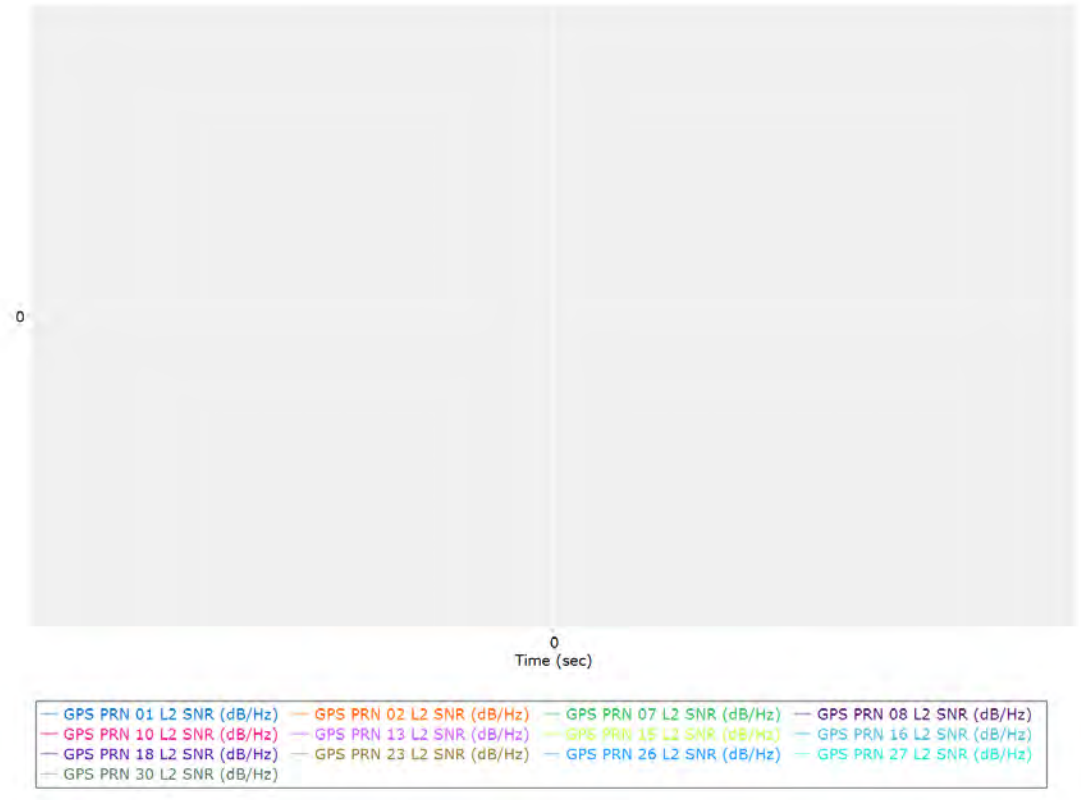


Base GLONASS L1 SNR

Base GPS/GLONASS L2 Satellite Lock/Elevation



Base GPS L2 SNR



Base GLONASS L2 SNR

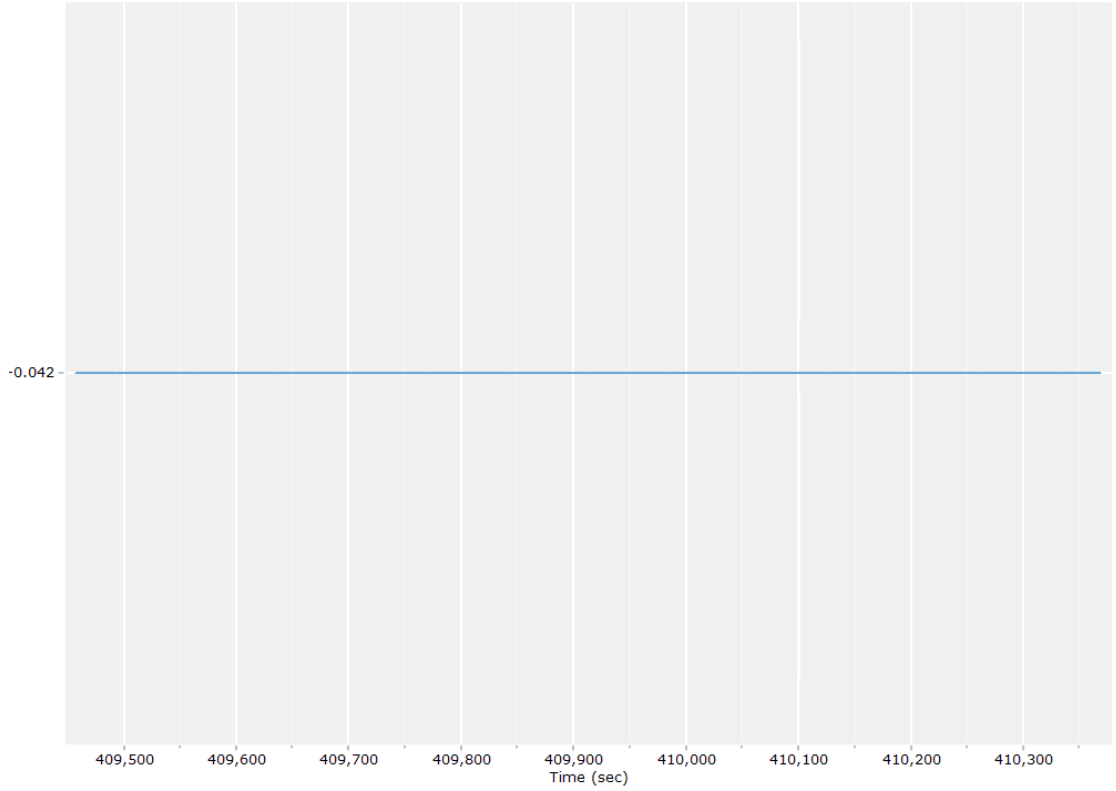
GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	LICF-10		
Processing start time	409336.000 (02/06/2025 17:42:16)		
Processing end time	410598.000 (02/06/2025 18:03:18)		
Initial attitude source	Primary GNSS Track, Magnetic Heading		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm (m)	-0.059	0.000	0.005
Reference to IMU mounting angles (deg)	0.000	-90.000	0.000
Reference to Primary GNSS lever arm (m)	-0.042	-0.078	-0.377
Reference to Primary GNSS lever arm std dev (m)	0.030	0.030	0.030
Aircraft to Reference mounting angles (deg)	0.000	0.000	0.000

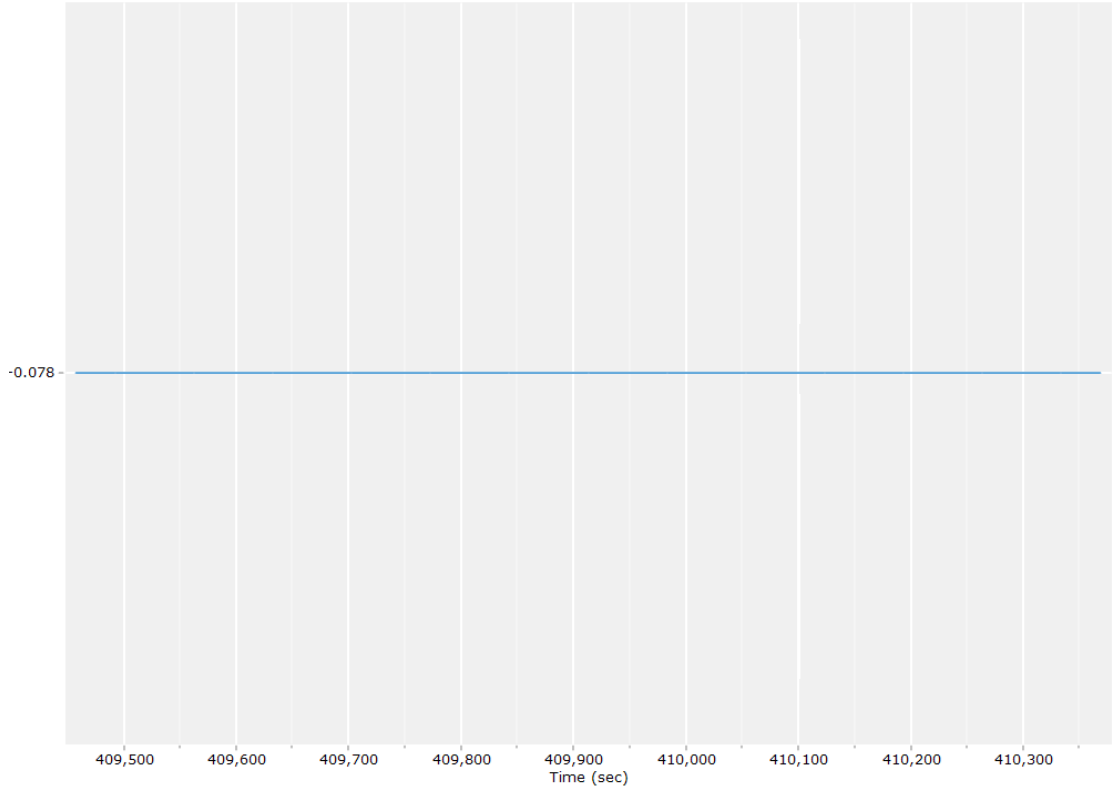
Calibrated Installation Parameters

Reference-Primary GNSS Lever Arm (m)

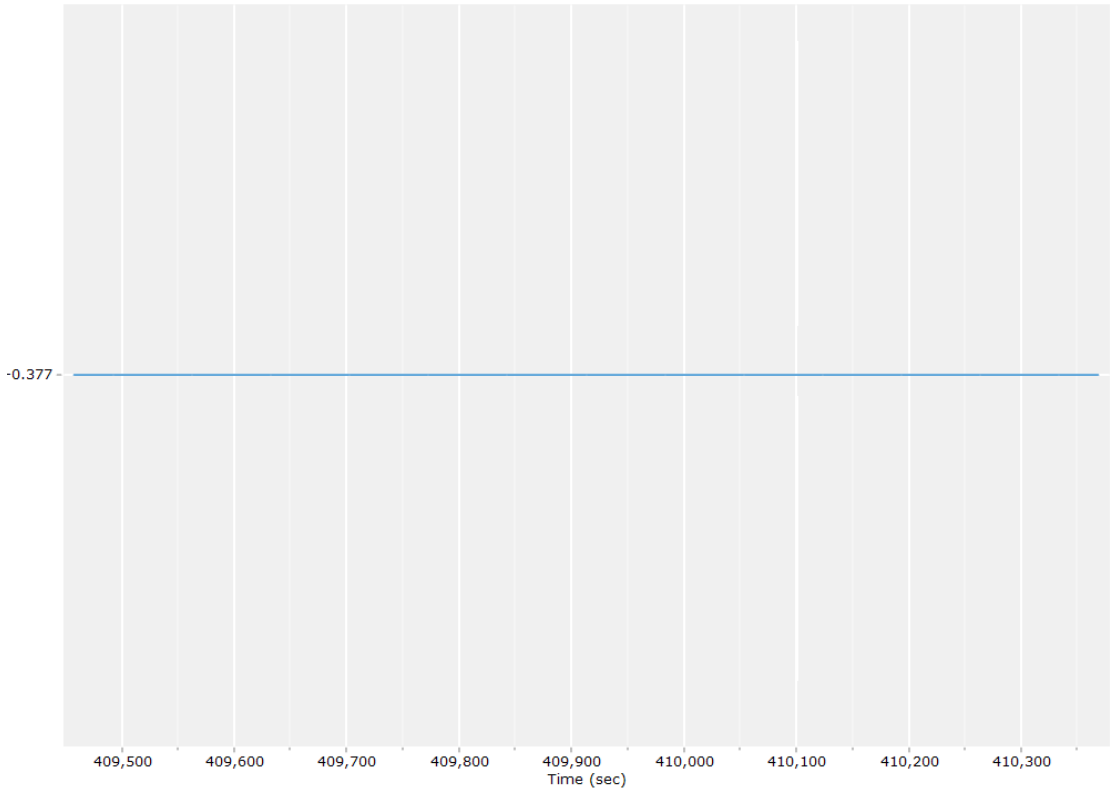
X Reference-Primary GNSS Lever Arm (m)



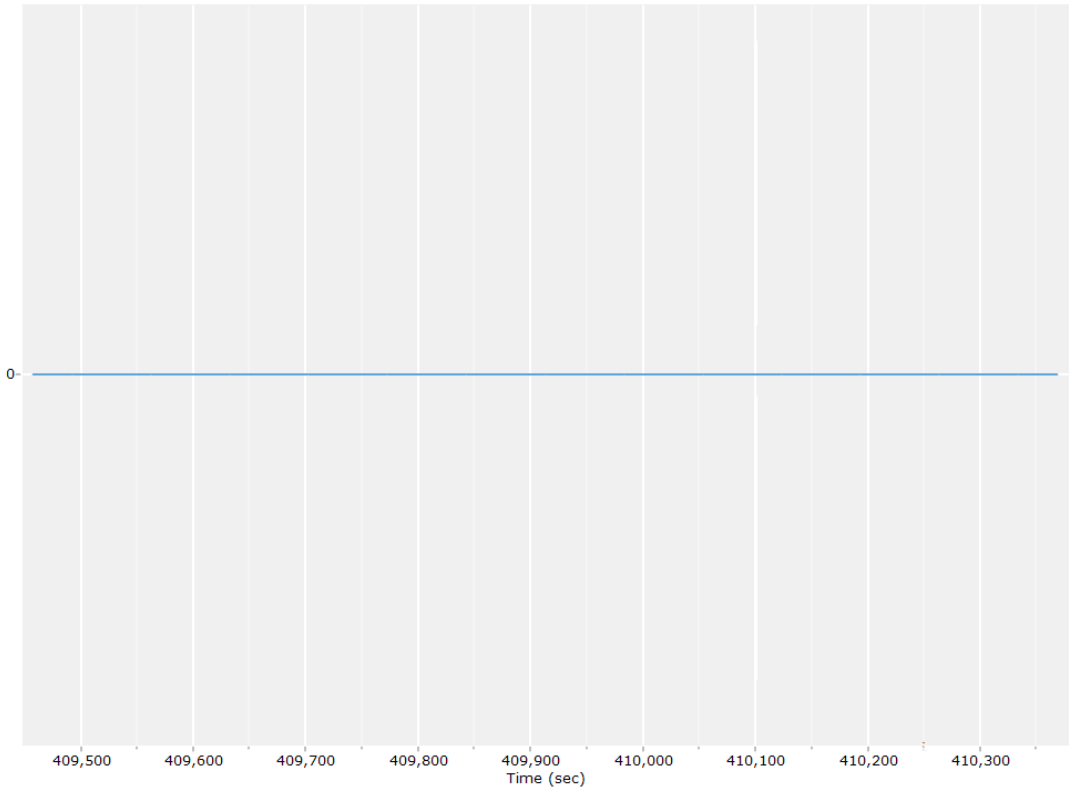
Y Reference-Primary GNSS Lever Arm (m)



Z Reference-Primary GNSS Lever Arm (m)



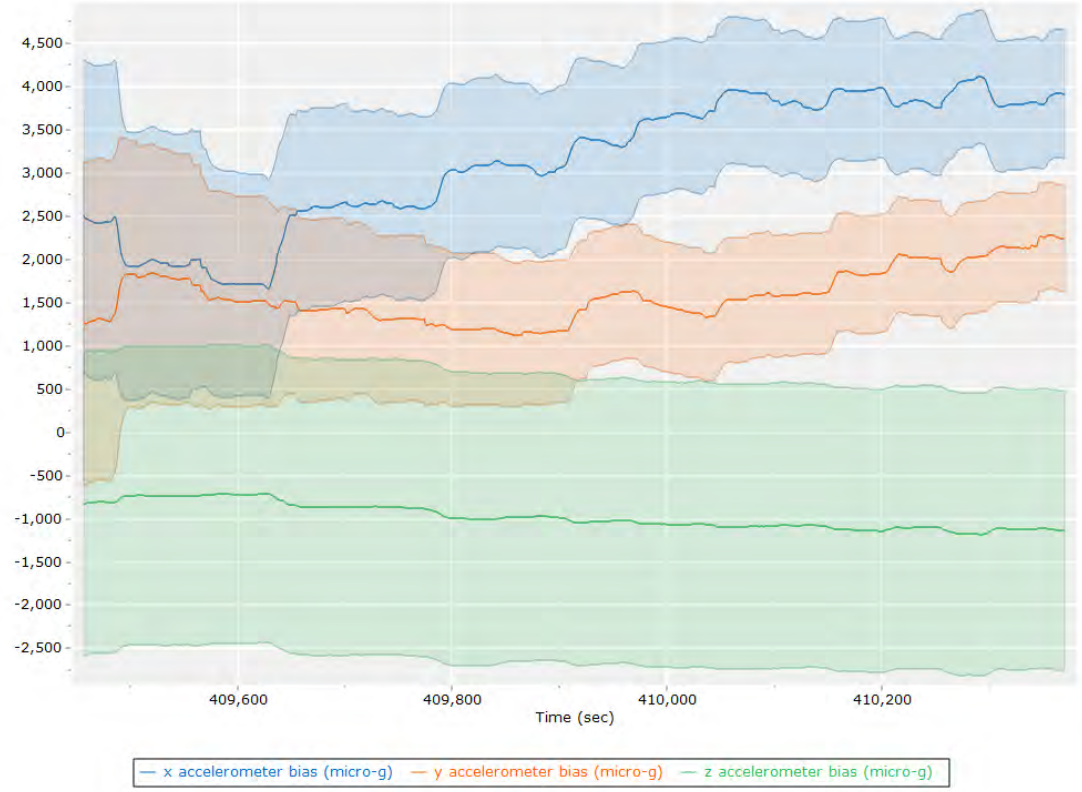
Reference-Primary GNSS Lever Arm Figure of Merit



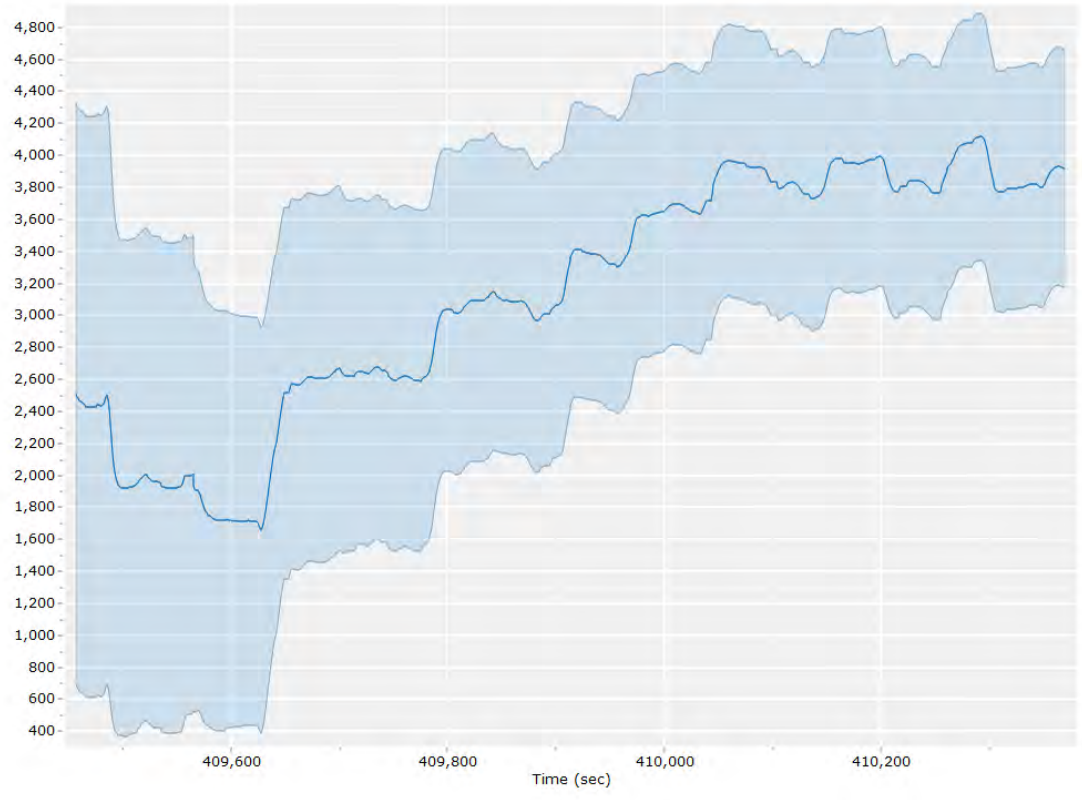
IN-Fusion QC

Forward Processed Estimated Errors, Reference Frame

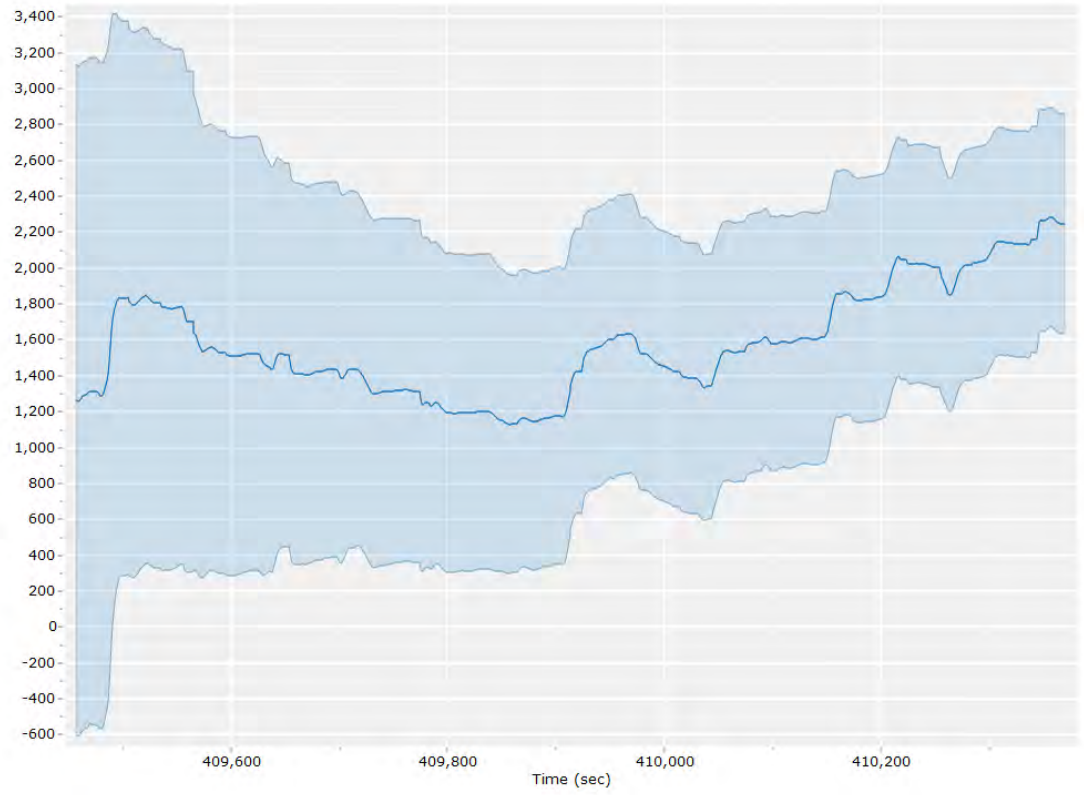
Accelerometer Bias (micro-g)



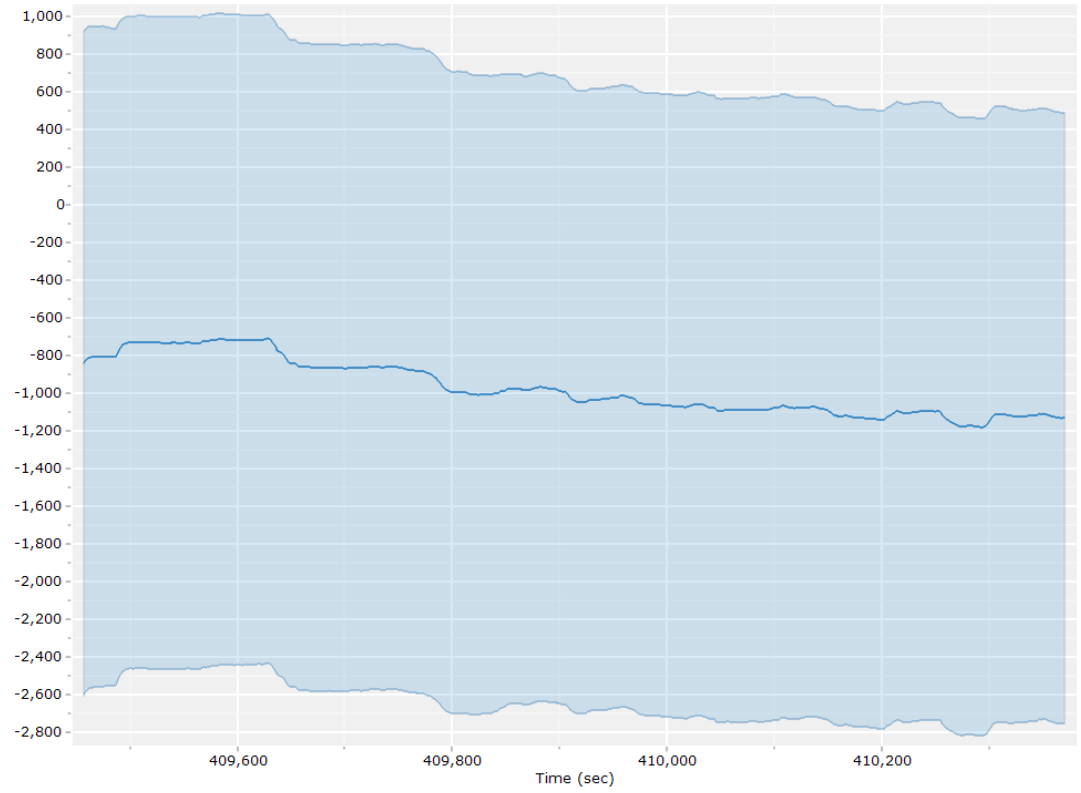
X Accelerometer Bias (micro-g)



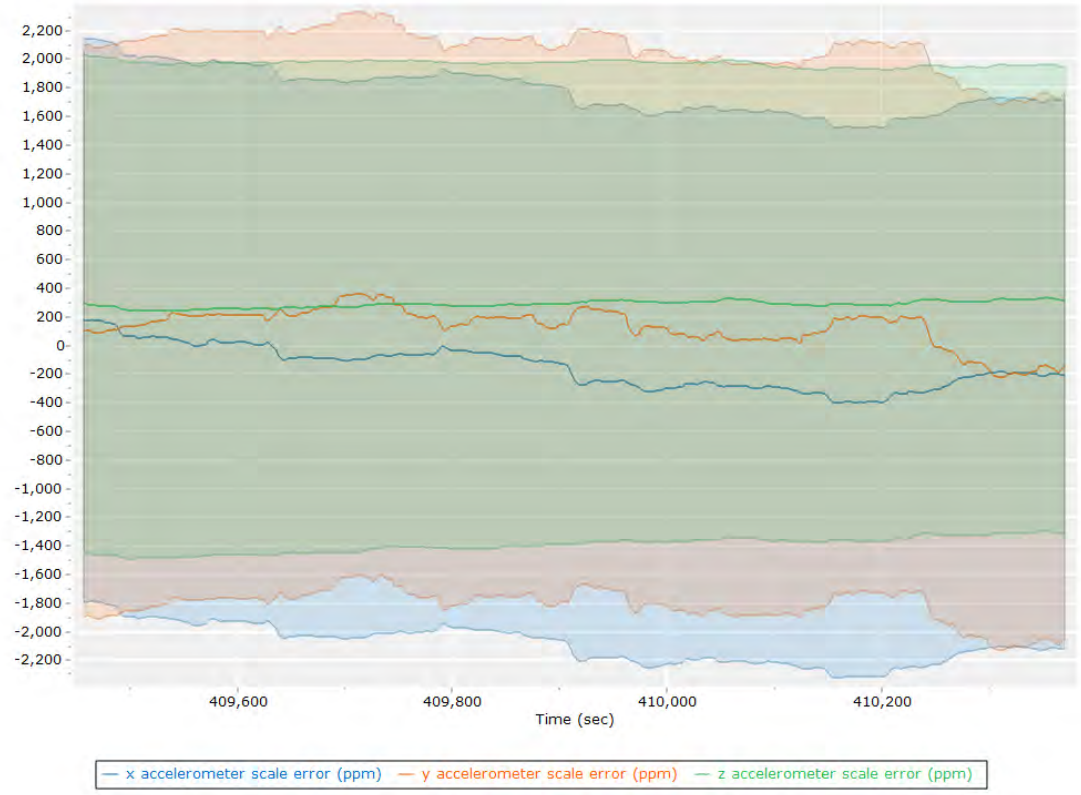
Y Accelerometer Bias (micro-g)



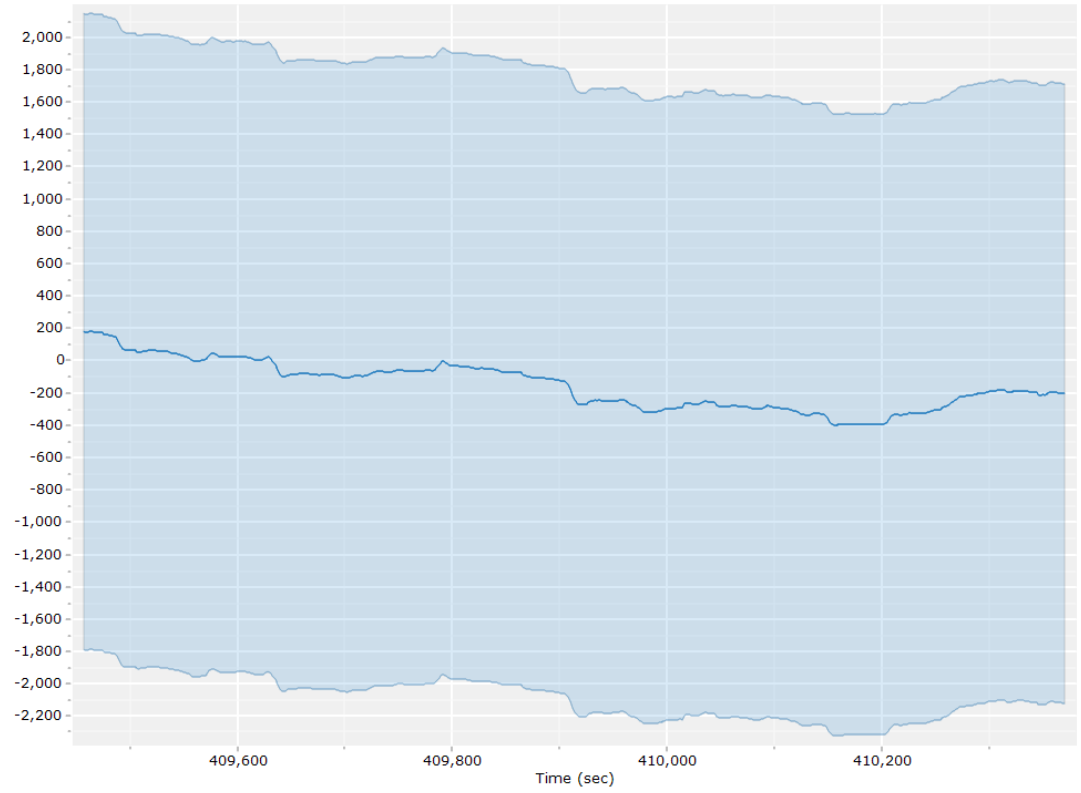
Z Accelerometer Bias (micro-g)



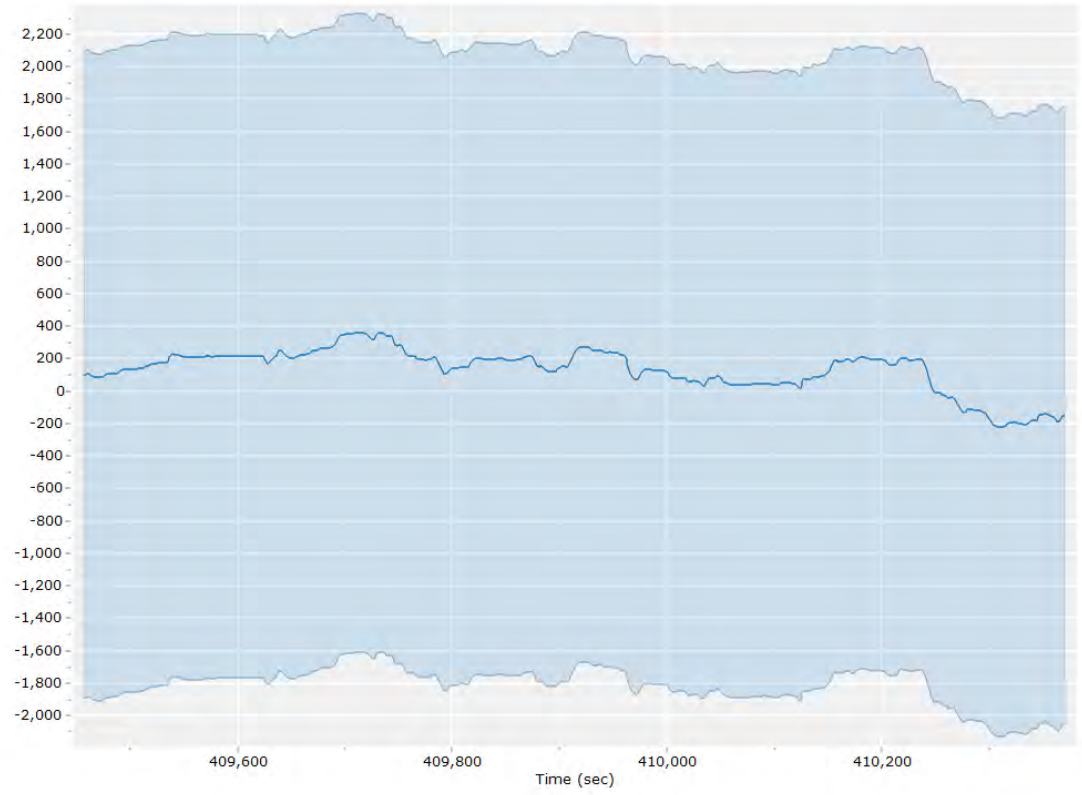
Accelerometer Scale Error (ppm)



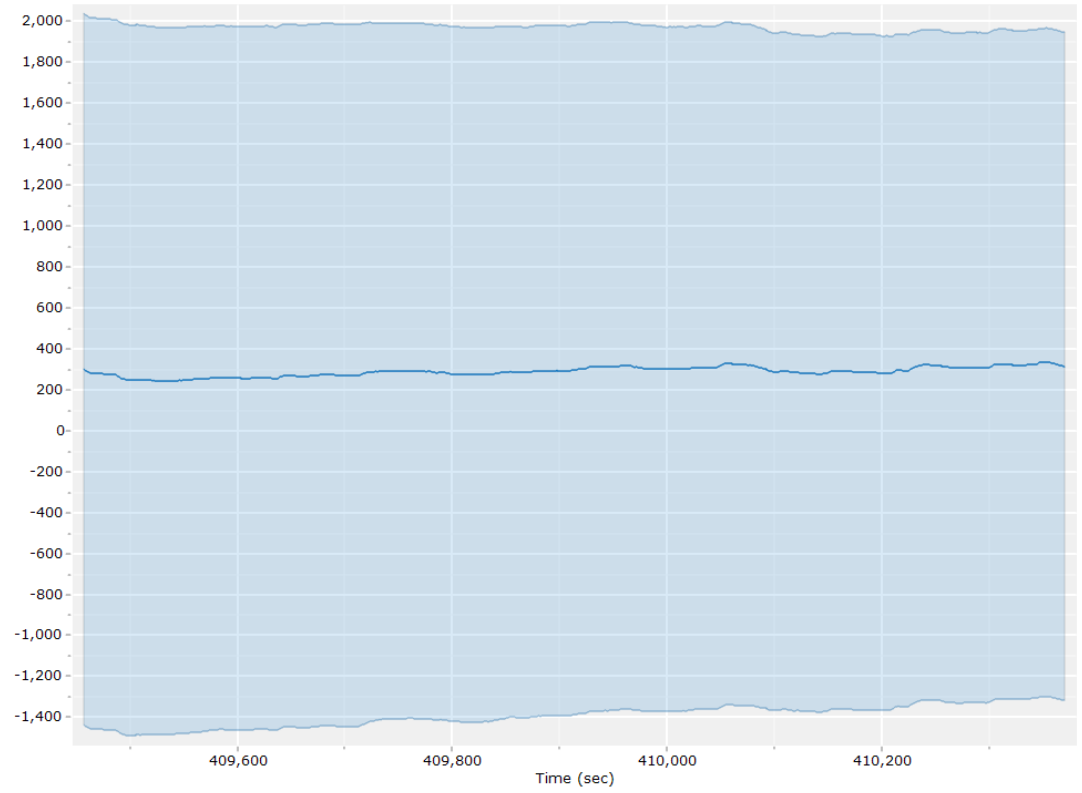
X Accelerometer Scale Error (ppm)



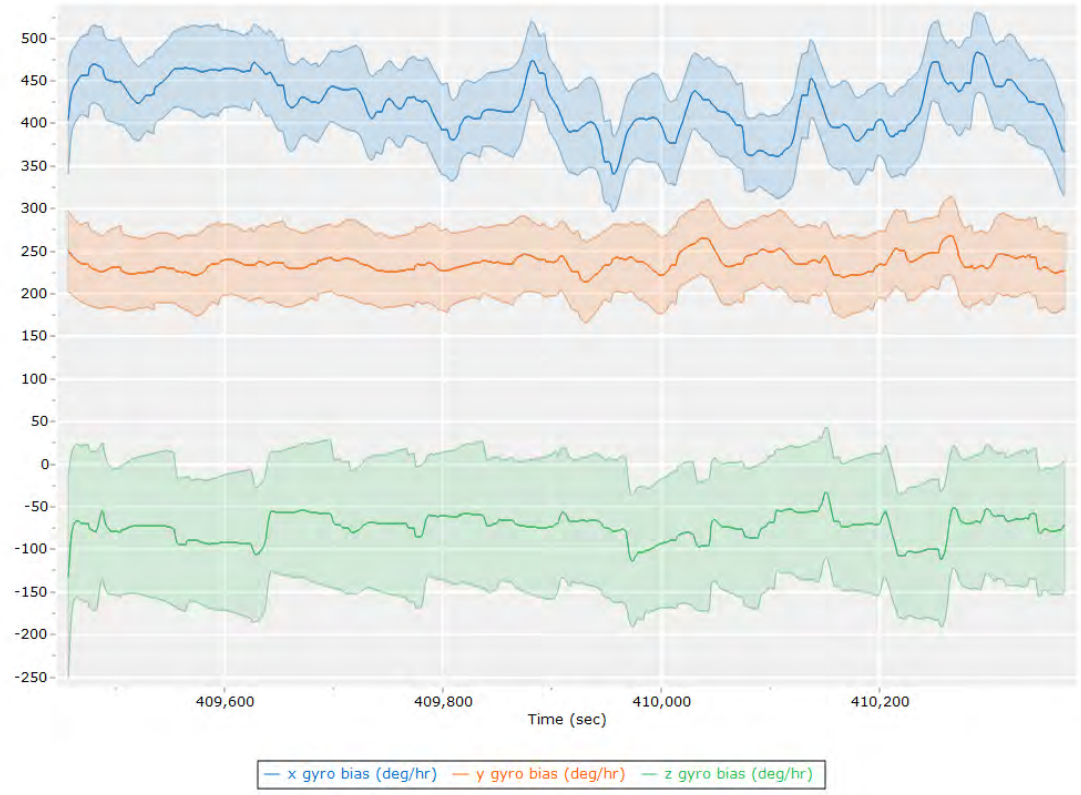
Y Accelerometer Scale Error (ppm)



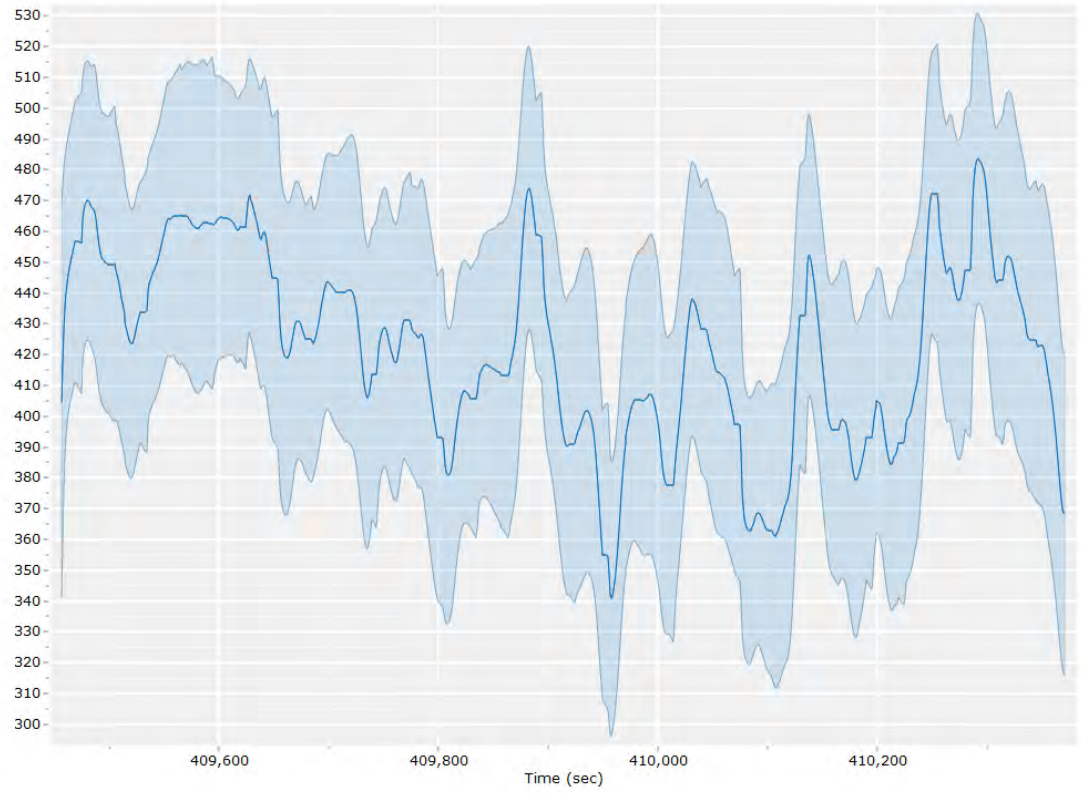
Z Accelerometer Scale Error (ppm)



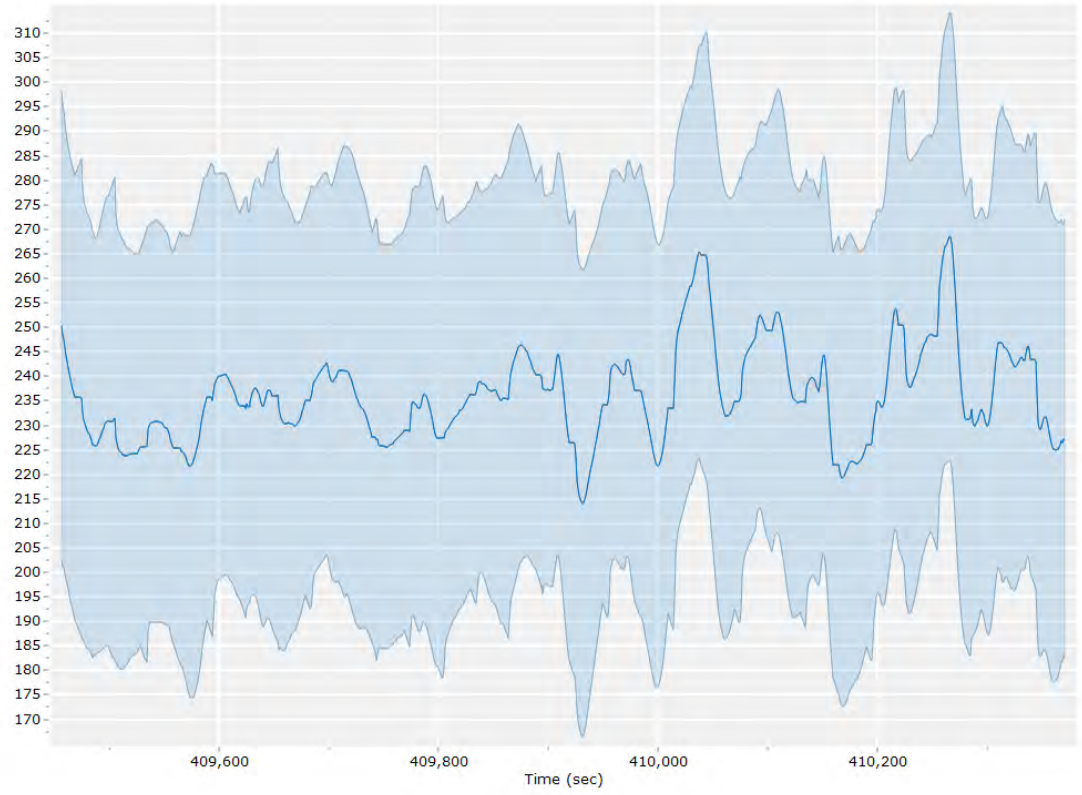
Gyro Bias (deg/h)



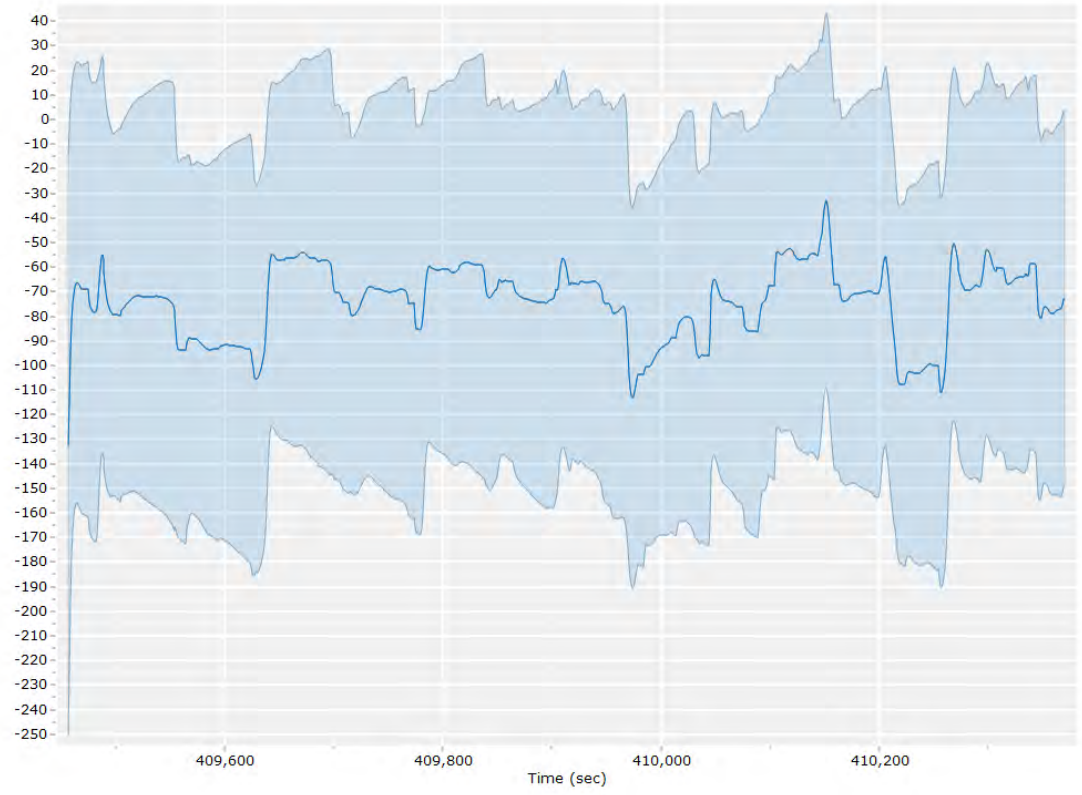
X Gyro Bias (deg/h)



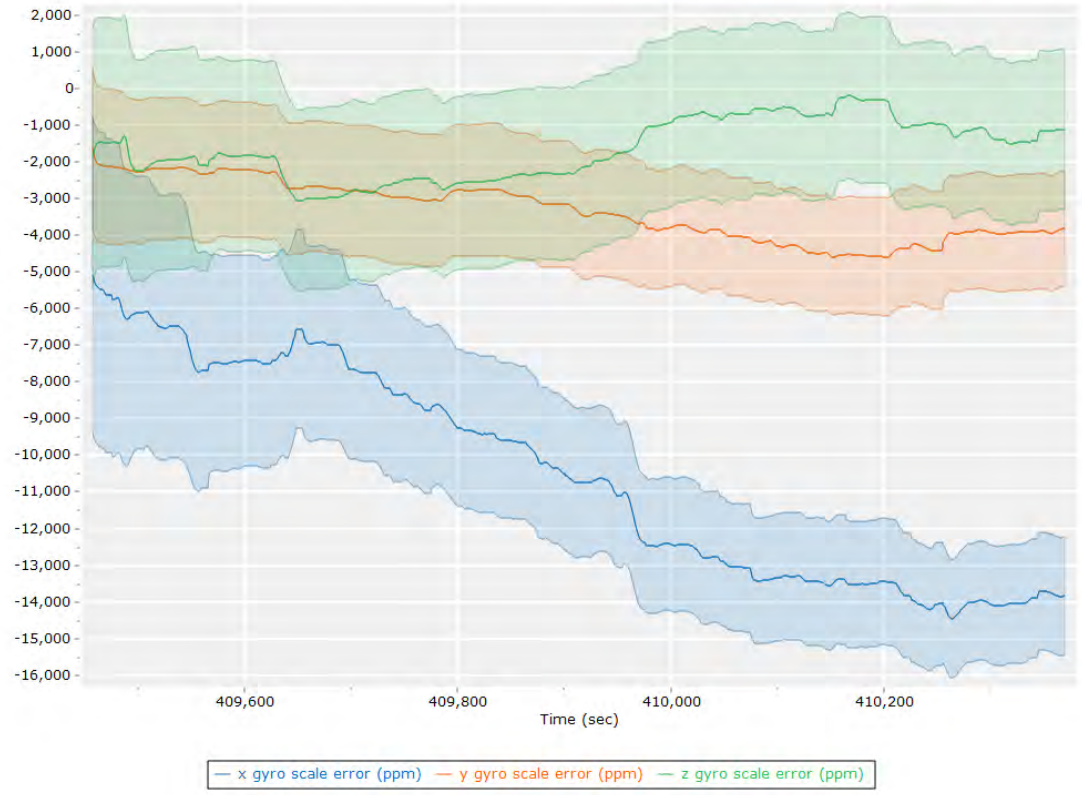
Y Gyro Bias (deg/h)



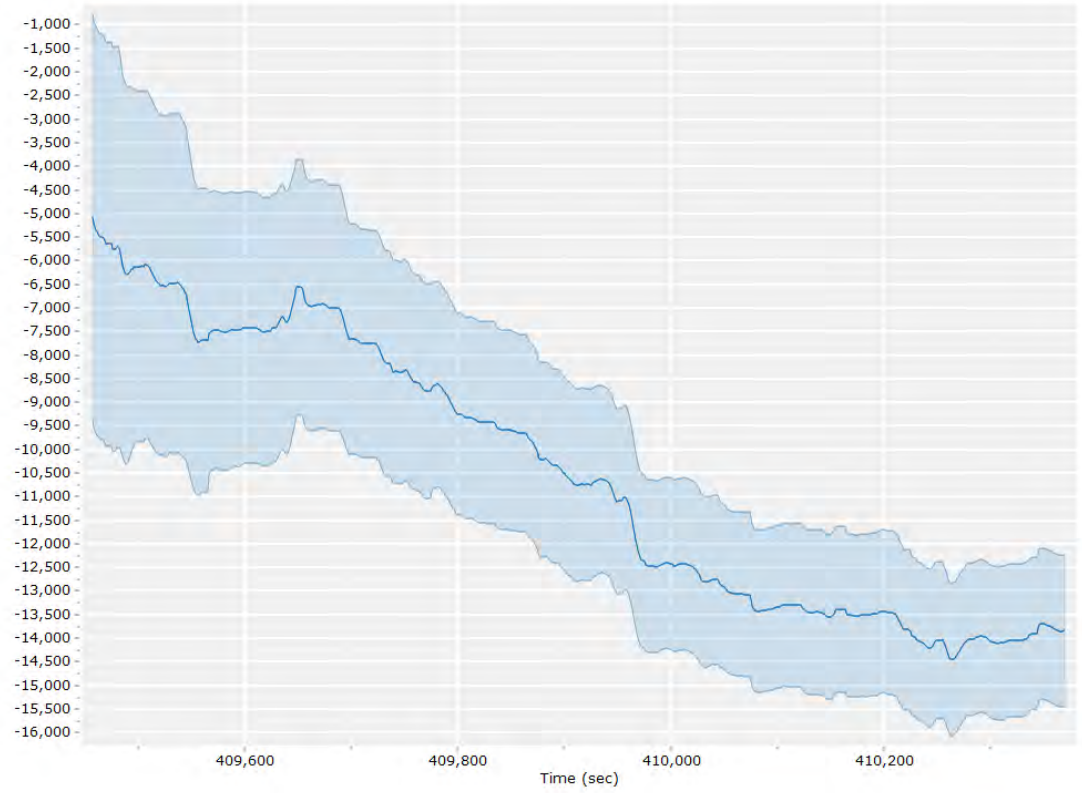
Z Gyro Bias (deg/h)



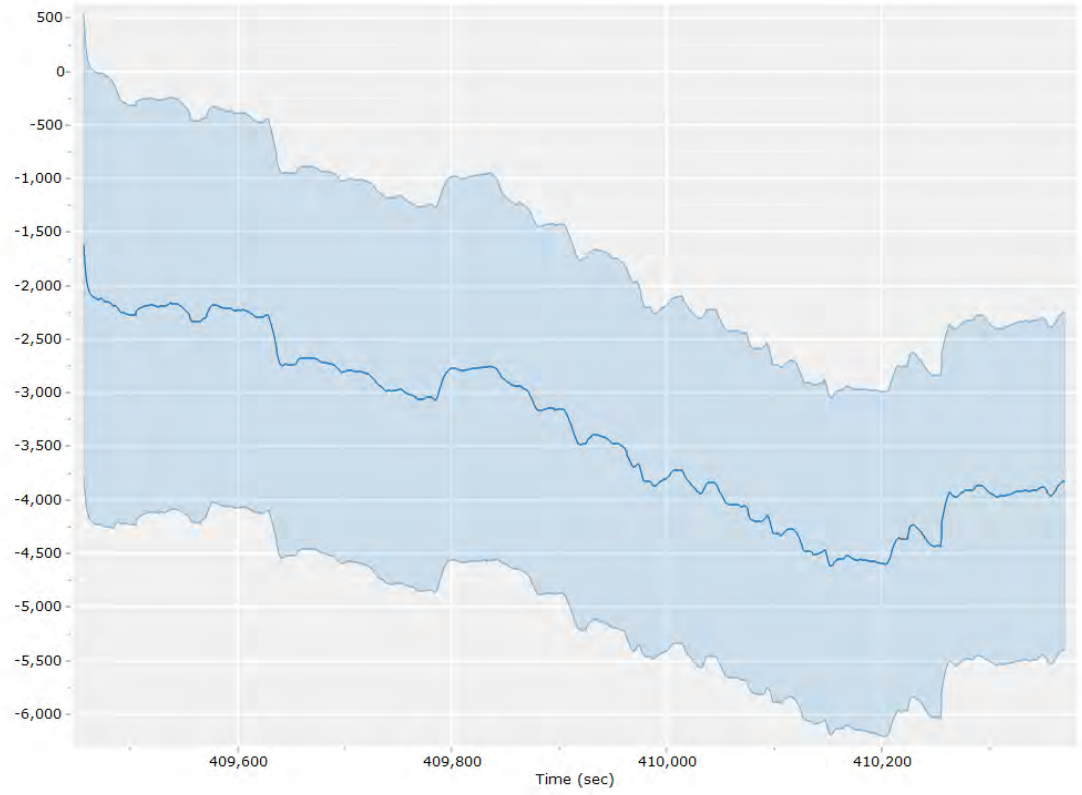
Gyro Scale Error (ppm)



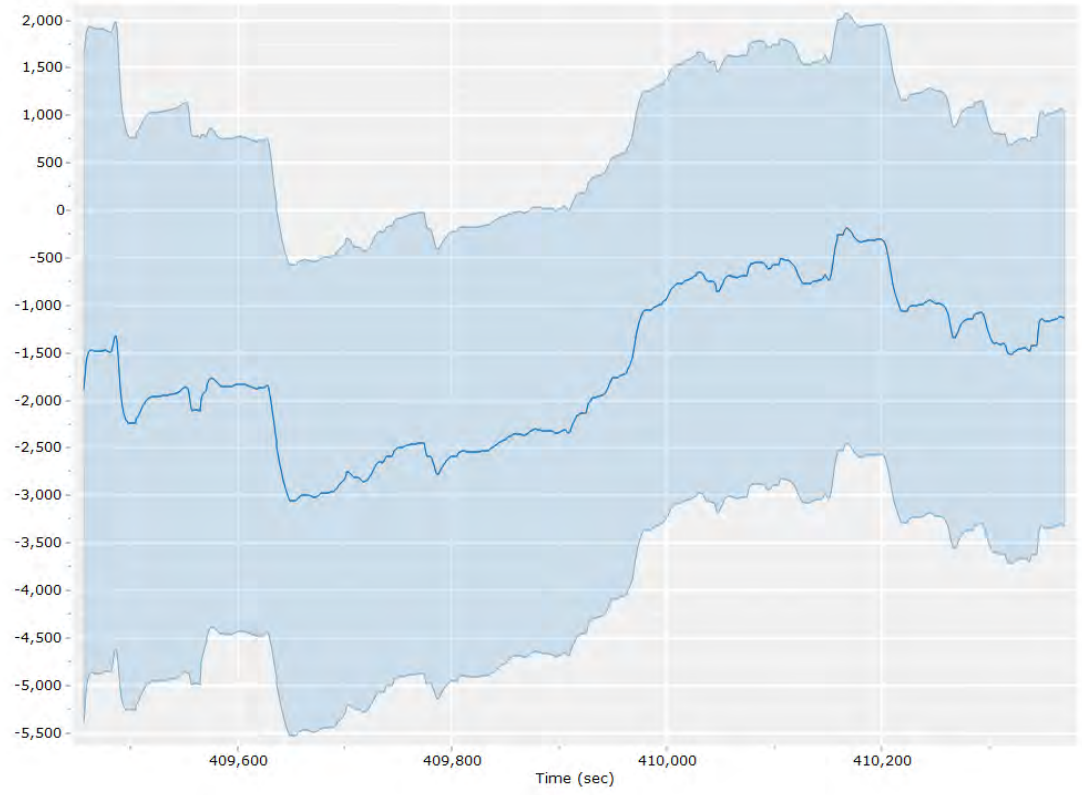
X Gyro Scale Error (ppm)



Y Gyro Scale Error (ppm)

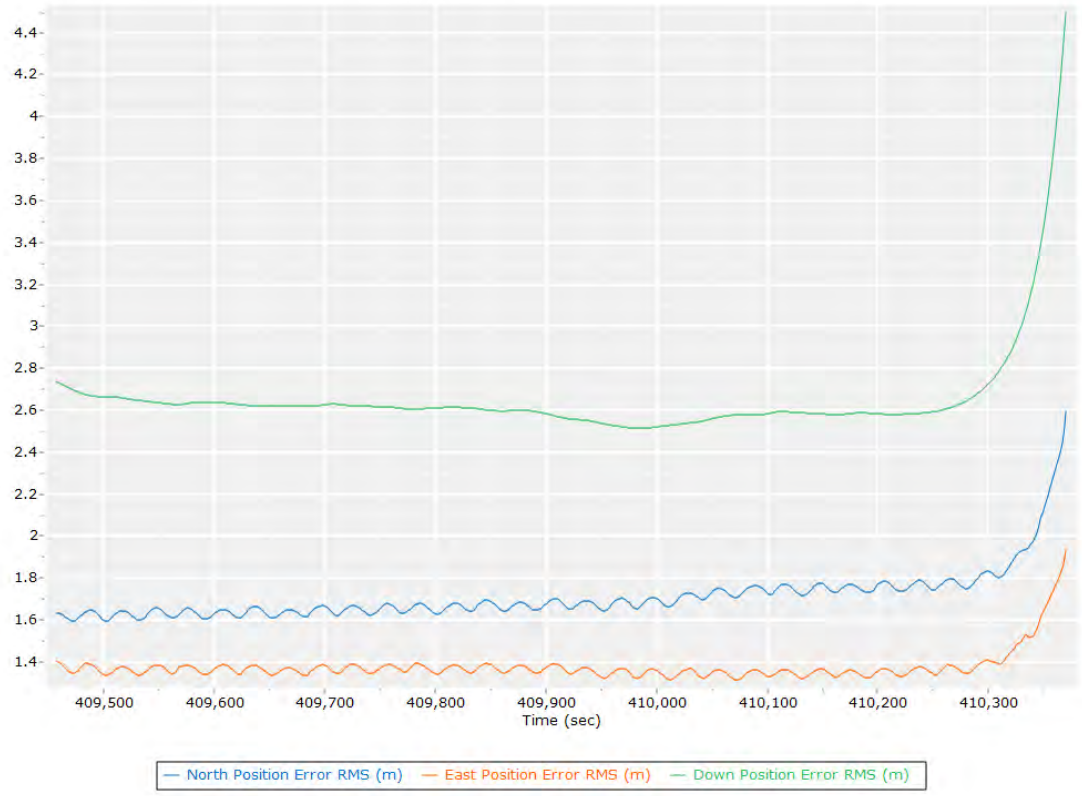


Z Gyro Scale Error (ppm)

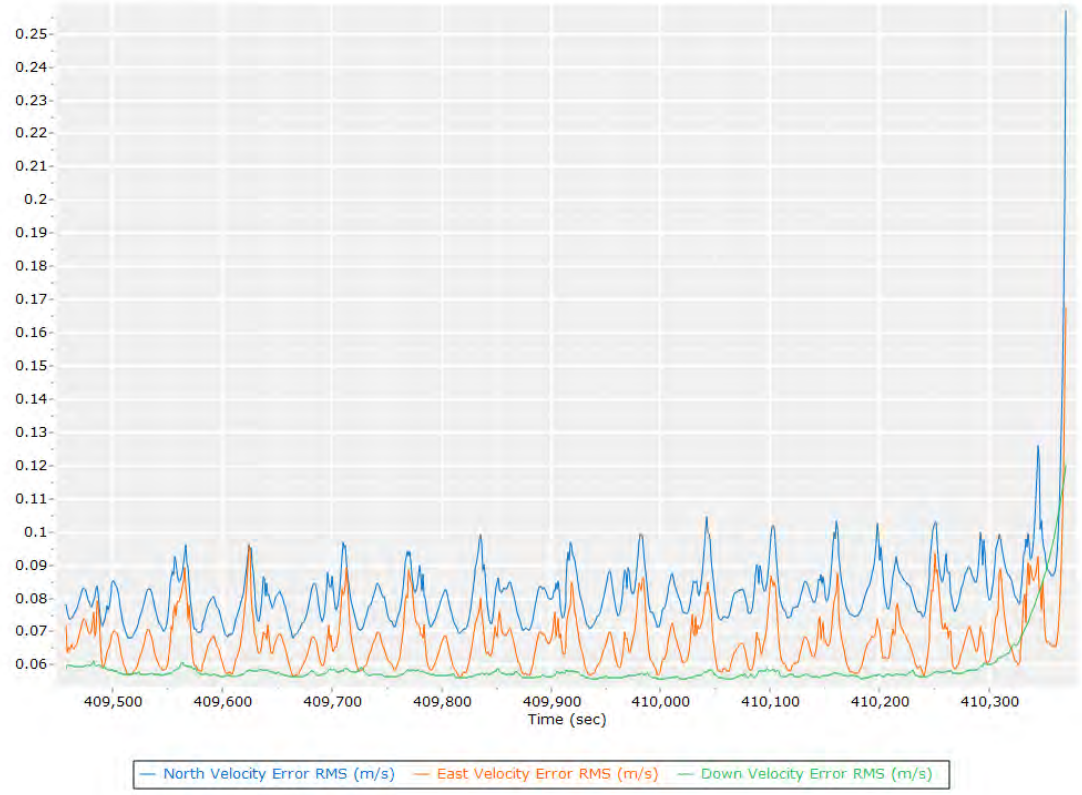


Smoothed Performance Metrics

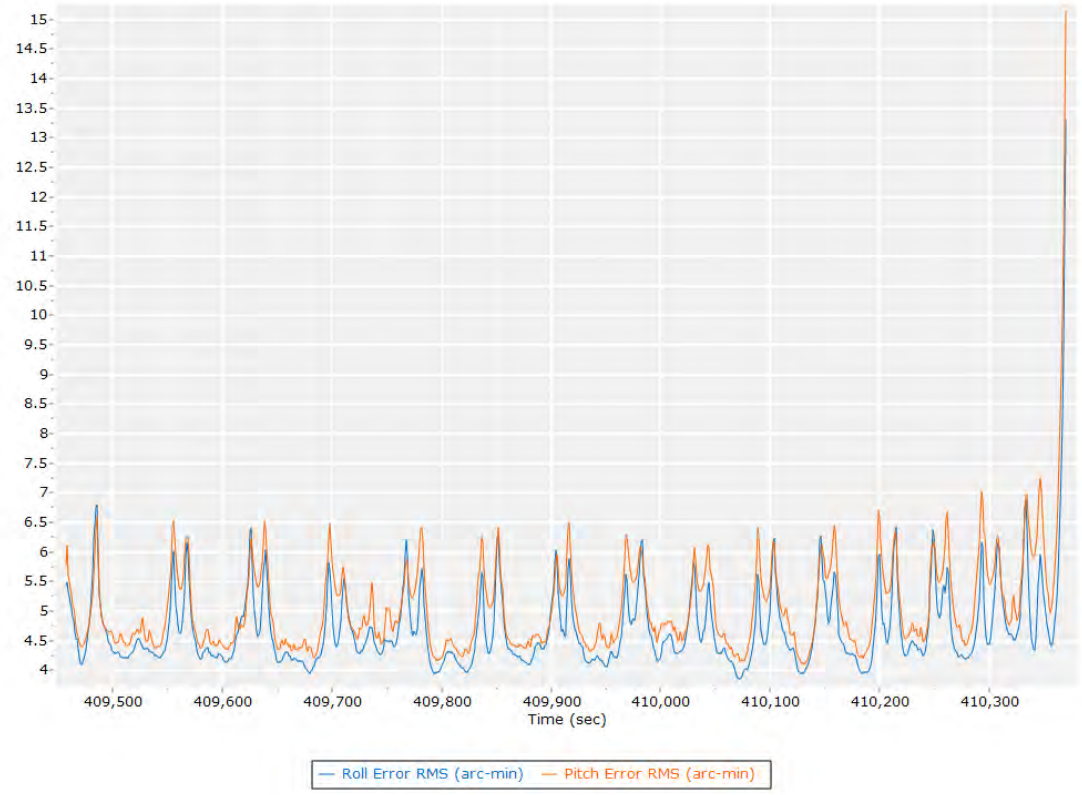
Position Error RMS (m)



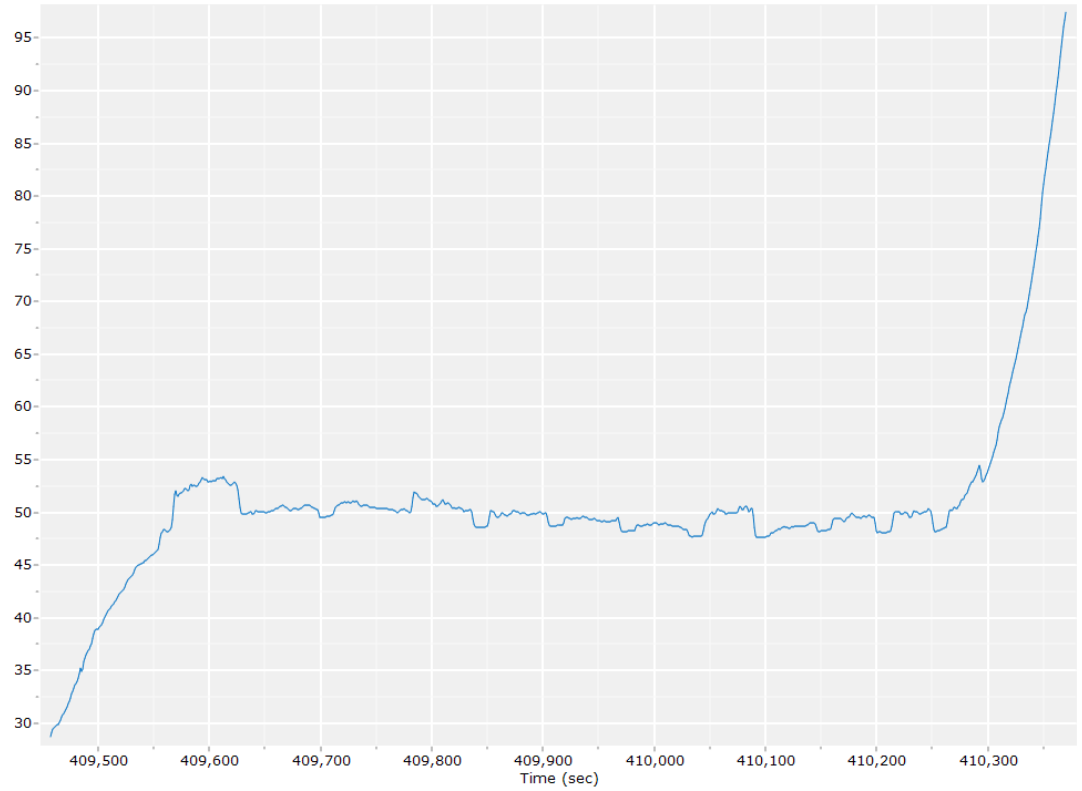
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

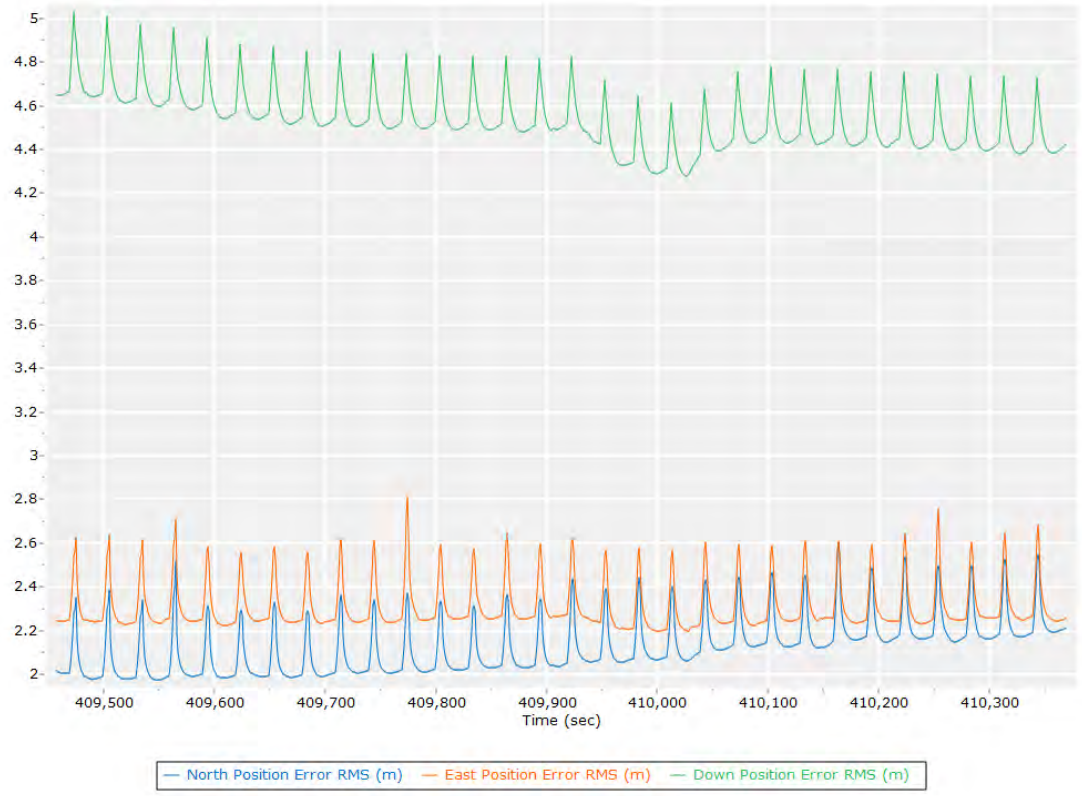


Heading Error RMS (arc-min)

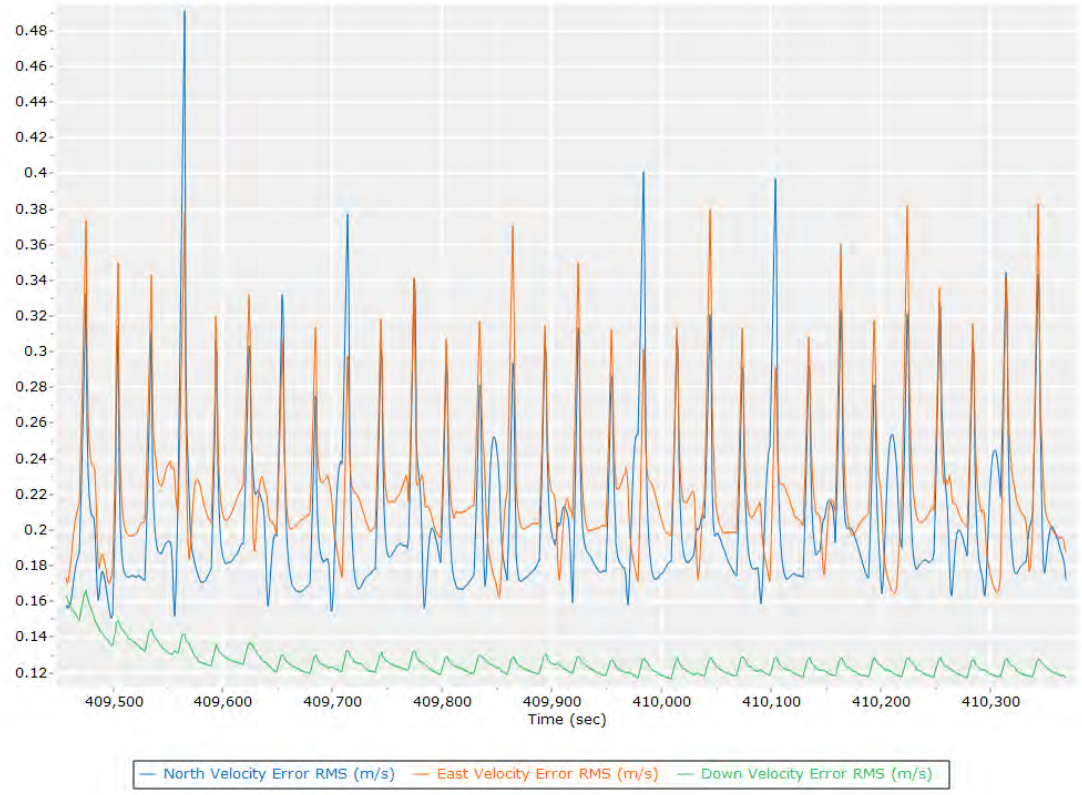


Forward Processed Performance Metrics

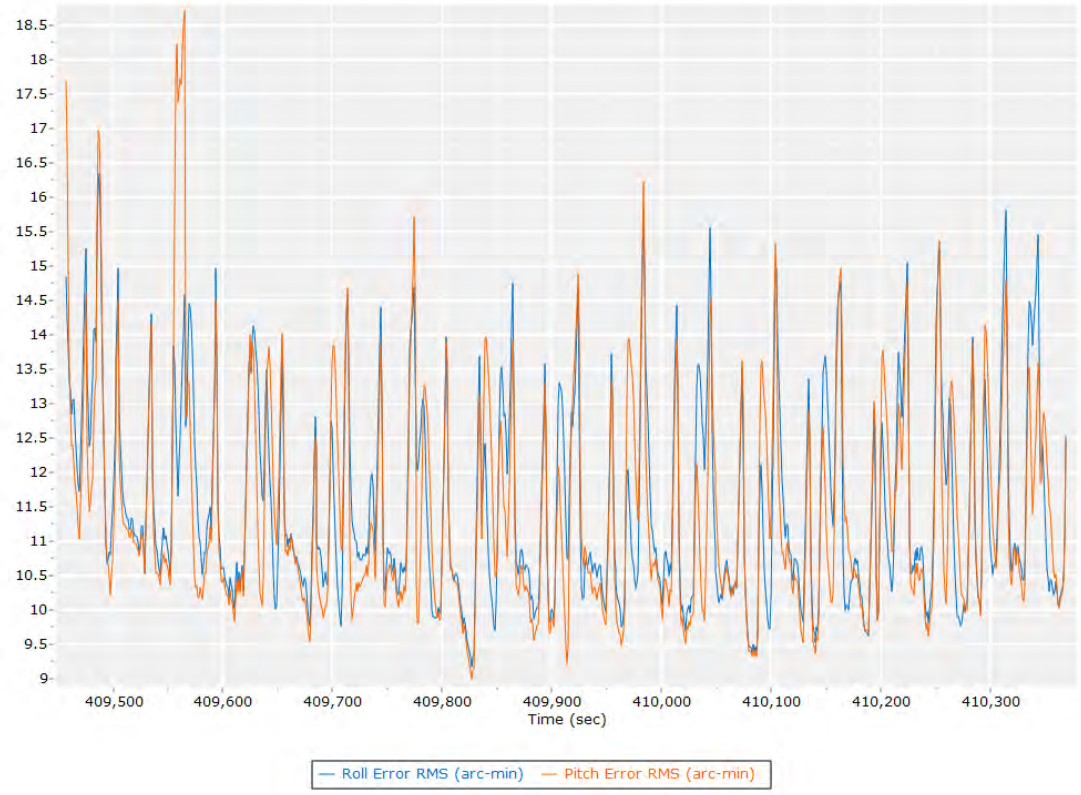
Position Error RMS (m)



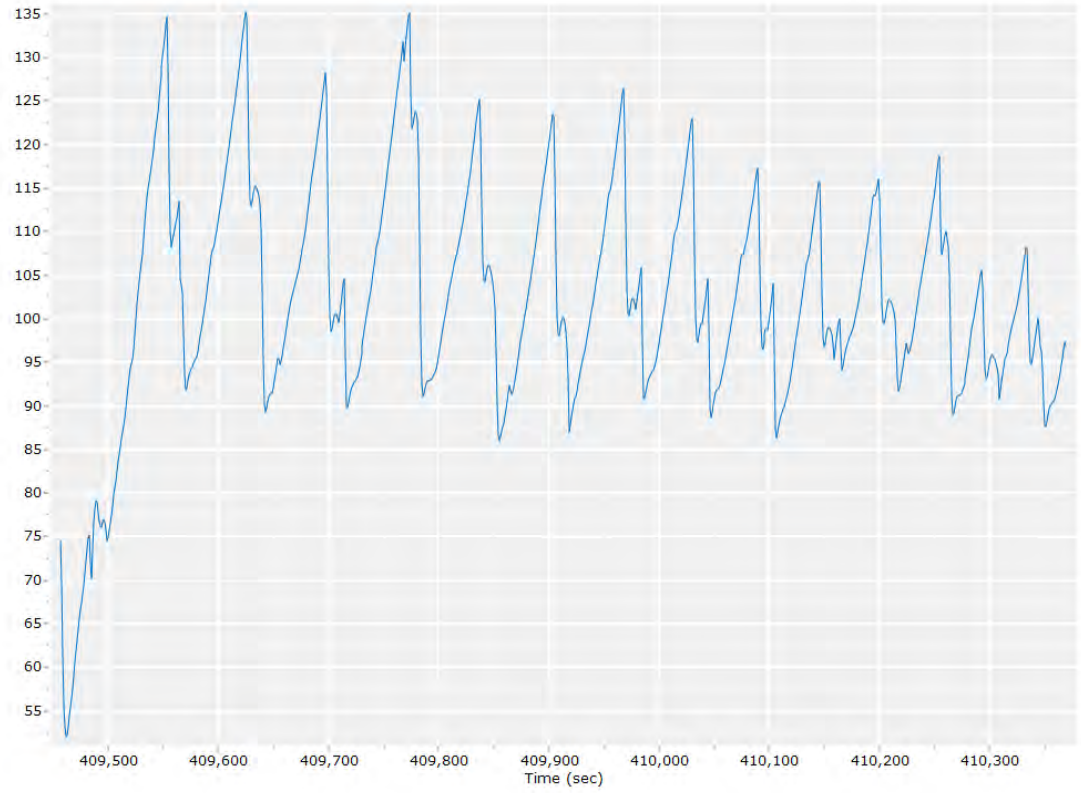
Velocity Error RMS (m/s)



Roll/Pitch Error RMS (arc-min)

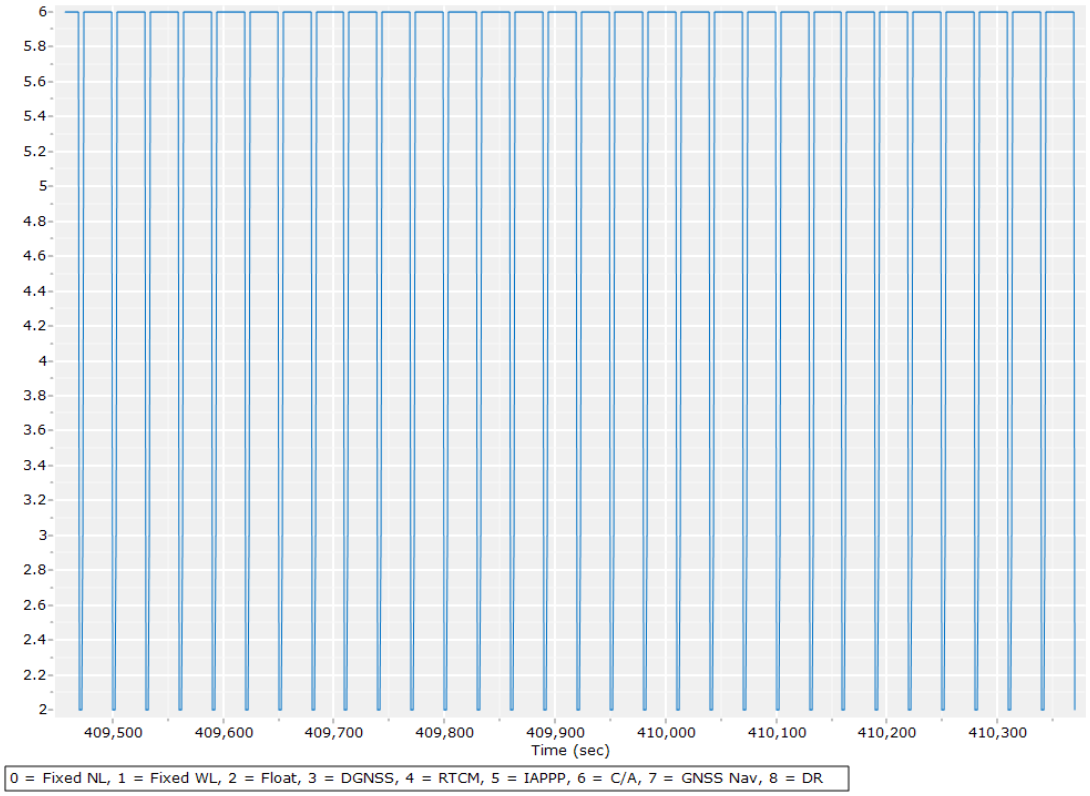


Heading Error RMS (arc-min)

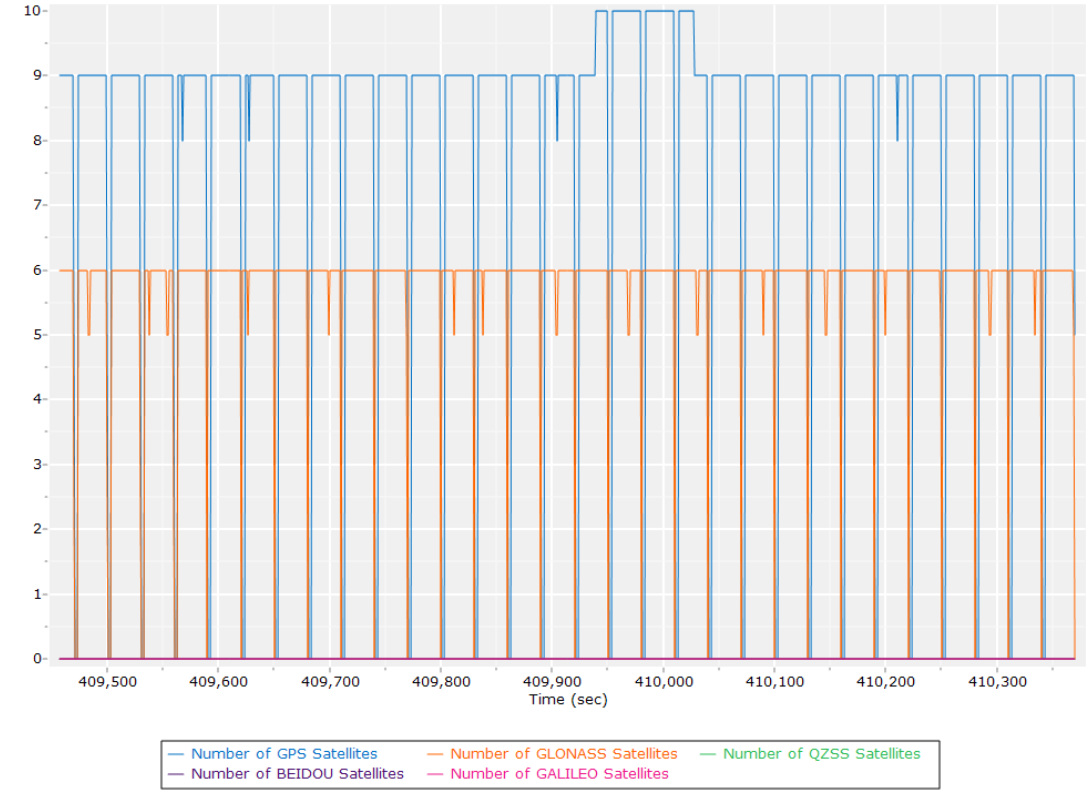


Smoothed Solution Status

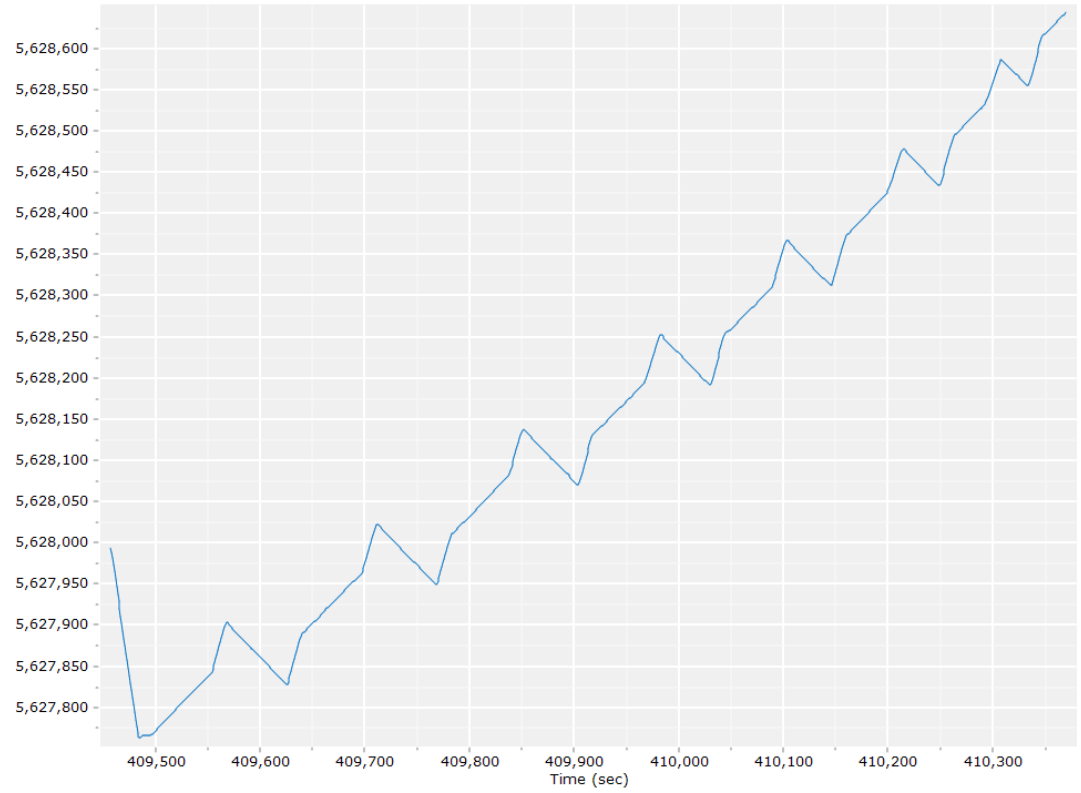
Processing Mode



Number of Satellites

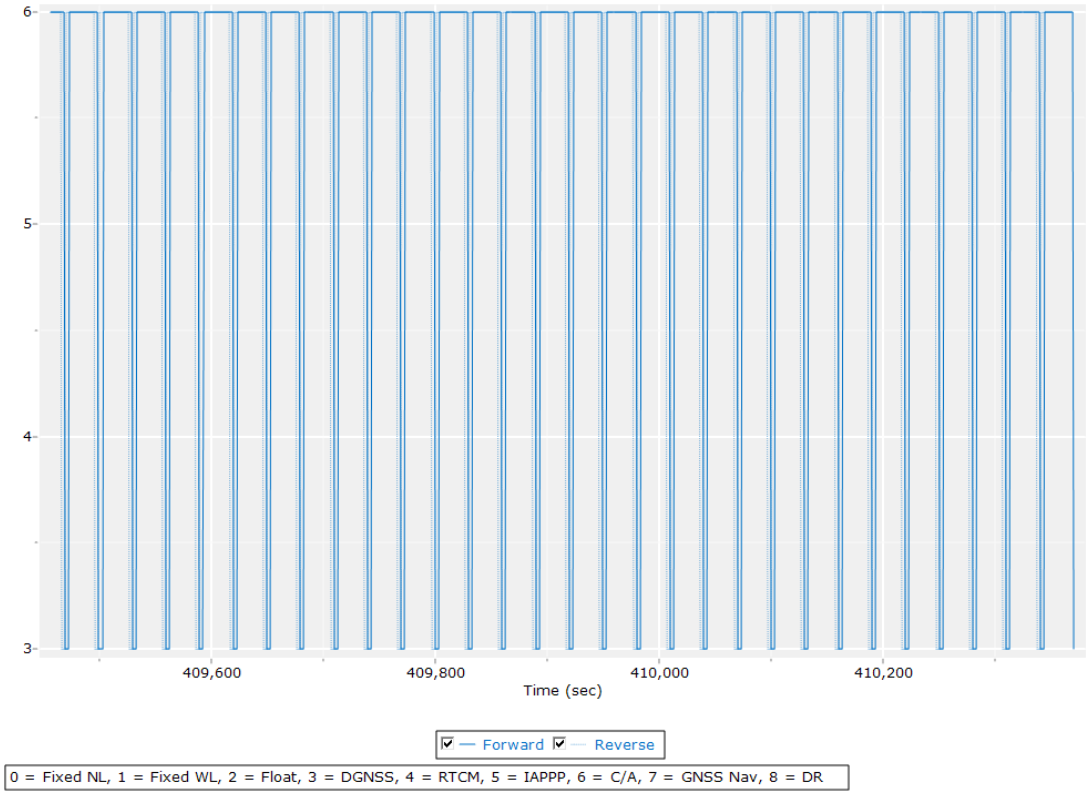


Baseline Length

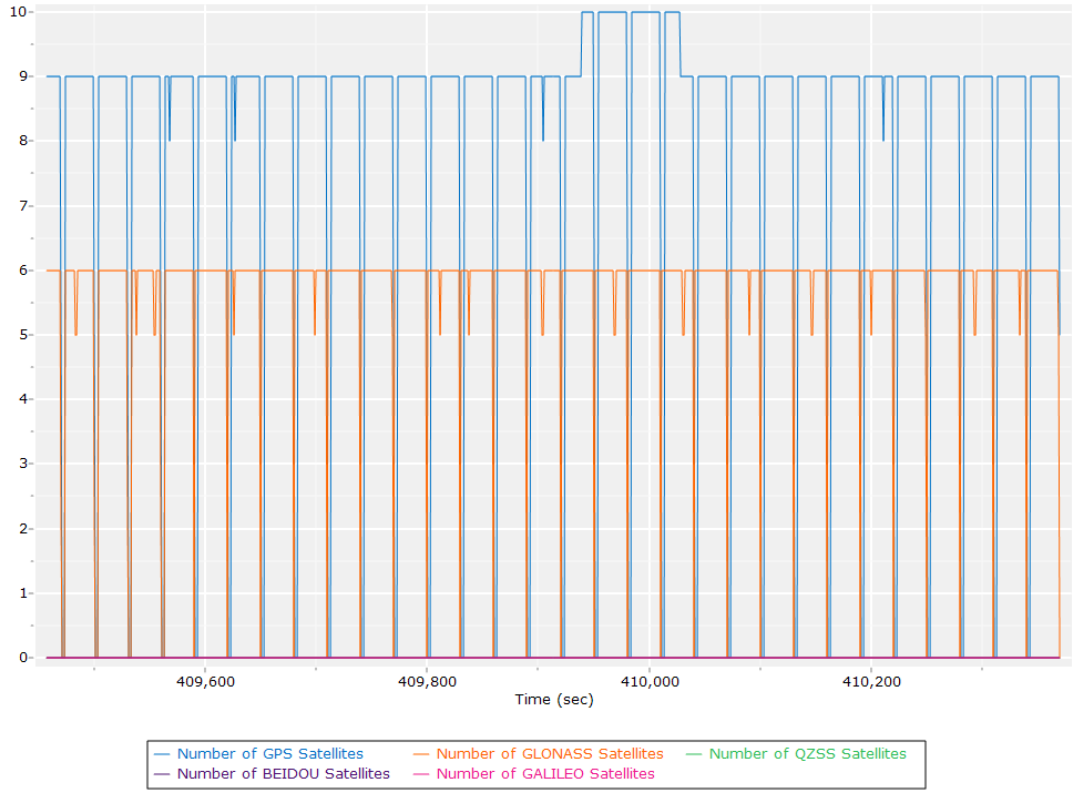


Forward Processed Solution Status

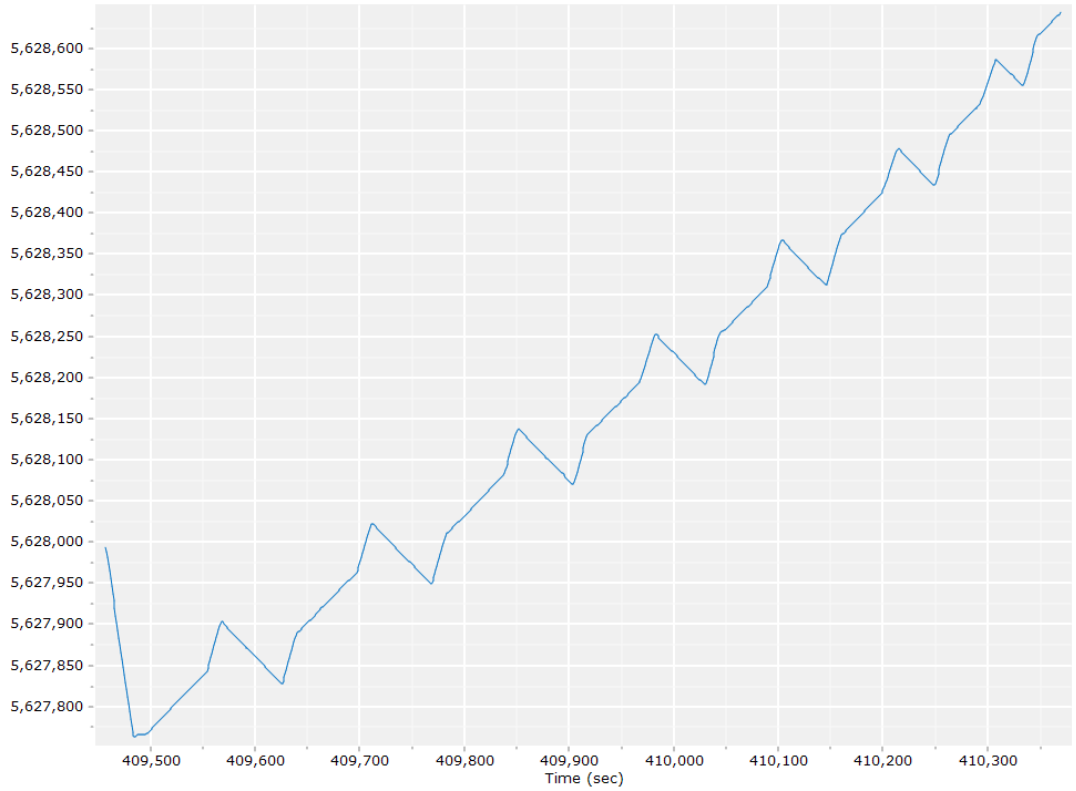
Processing Mode



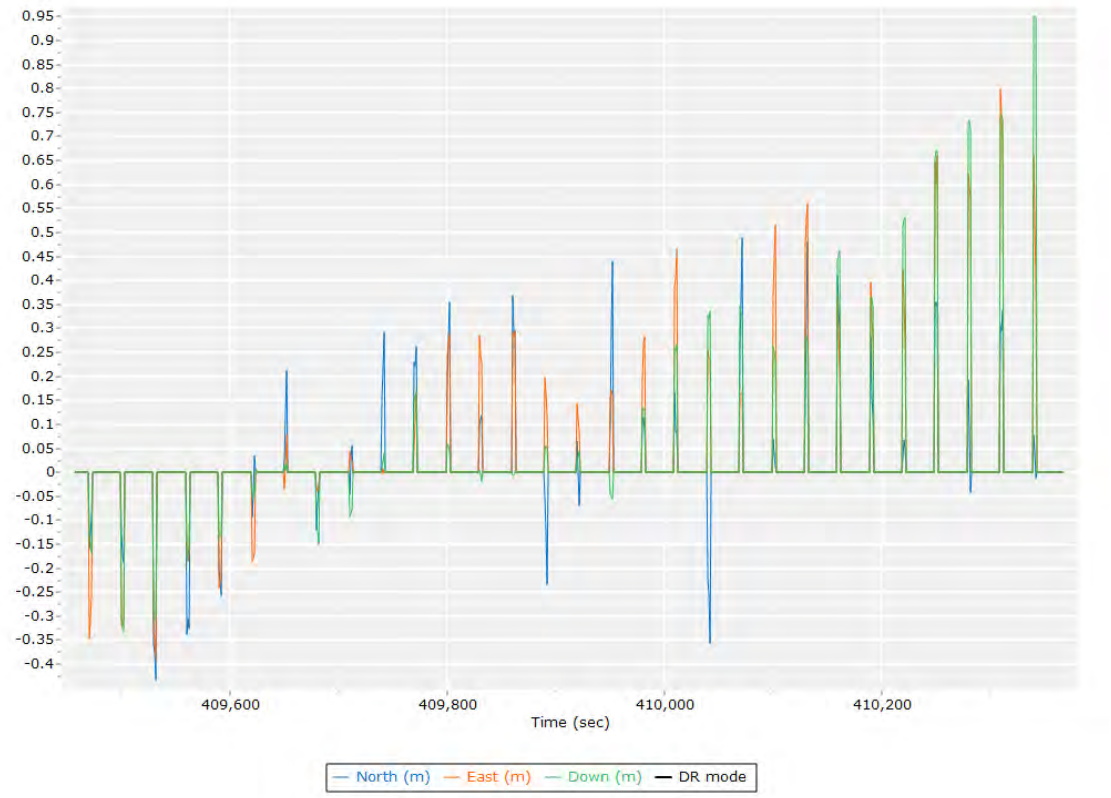
Number of Satellites



Baseline Length



SBET IAKAR Separation



Export Summary Section 1

Export file	YS-20250206-174153sbet.txt		
Export format	ASCII		
Solution in use	Post-processed		
Output rate	All Records		
Reference to Output lever arm (m)	0.000	0.000	0.000
Reference mounting angles (deg)	0.000	0.000	0.000
Output units (Coordinate / Lat & Lon)	Meter	Meter	
Export start time	0.000 (02/02/2025 00:00:00)		
Export end time	395199.000 (02/13/2025 13:46:39)		
Height option	Applanix Orthometric Height		
Geoid model	OSGM15 (United Kingdom)		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 30 (6W to 0W)		
Datum	ETRS89		
Ellipsoid	GRS 1980		
Local Transformation	NONE		
Target Epoch	1989		