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## Compte-rendu de mission. Acquisition de données Lidar par drone. Mission du 08/03/2022 – Terre-de-Bancalié (81)

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# Commune de Terre-de-Bancalié (81), site de La Roque Acquisition de données Lidar par drone

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*Mission du 08/03/2022*





## Compte-rendu de mission Acquisition de données Lidar par drone

Mission du 08/03/2022 – Terre-de-Bancalié (81)

N. Poirier, C. Calastrenc

### 1. Objectif et contexte

La mission d'acquisition de données Lidar par drone du 08/03/2022 a été réalisée sur la commune de Terre-de-Bancalié (81), autour du site de La Roque.

L'objectif était de réaliser le relevé tridimensionnel du sous-bois dans le but de rechercher des anomalies d'intérêt archéologique autour des vestiges du site castral médiéval.

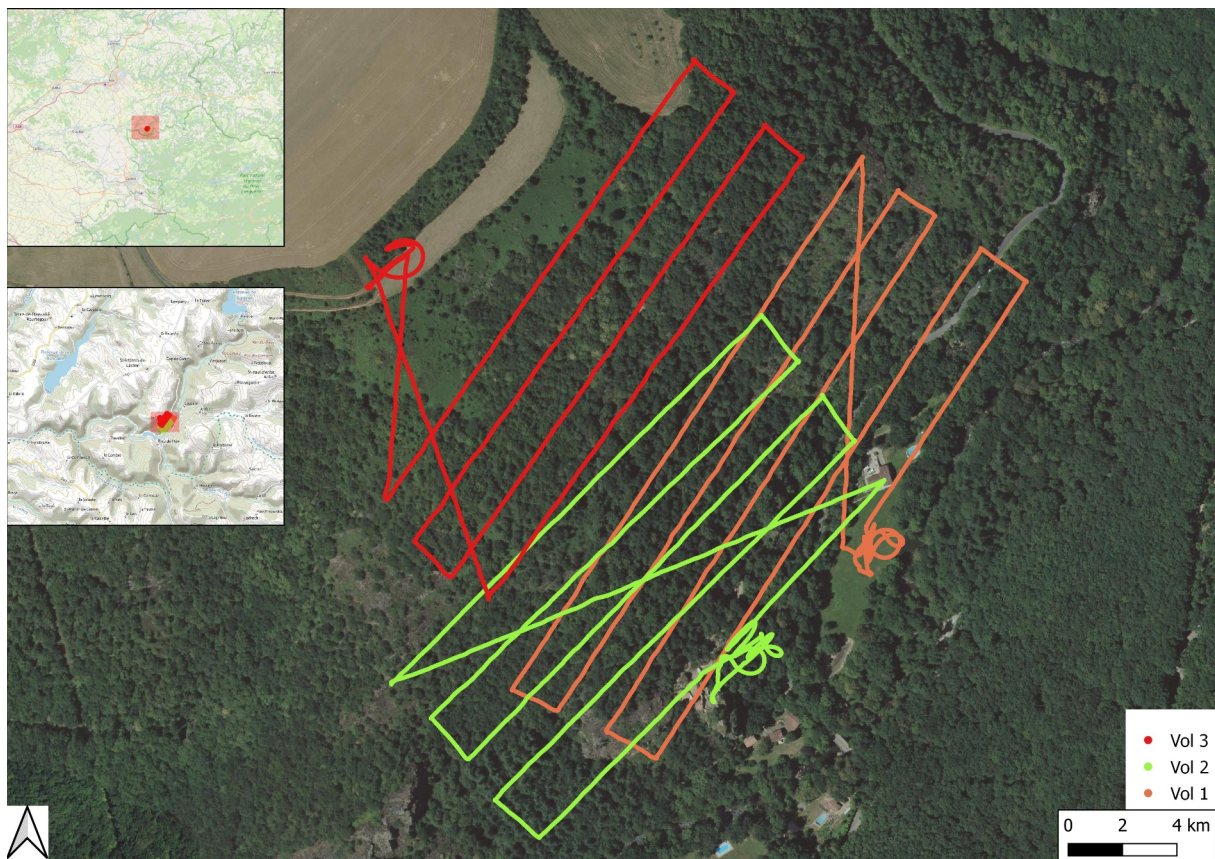


Figure 1- Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Localisation de la zone couverte par les vols Lidar par drone (Fond – IGN et OSM)

### 2. Conditions de vol

Compte-tenu des contraintes de maintien du drone à vue et du caractère très accidenté et abrupt du versant à documenté, 3 vols ont été réalisés : le premier au départ du fond de vallon, le deuxième depuis le site castral, et le dernier depuis le rebord de plateau. Ces 3 vols ont été réalisés à 50m de hauteur au-dessus du sol à une vitesse moyenne de 4m/s.

La couverture obtenue est le meilleur compromis entre la surface à couvrir dans le respect des règles d'usage du drone et la densité minimale des points sols permettant une détection archéologique.

### 3. Traitement des nuages de points

#### 3.1. Évaluation des nuages de points bruts

Les 3 vols ont été assemblés en un seul nuage de points comprenant un peu moins de 21 M de points pour une surface documentée de 30 ha, soit une densité d'échos (végétation comprise) d'environ 70 points/m<sup>2</sup>.

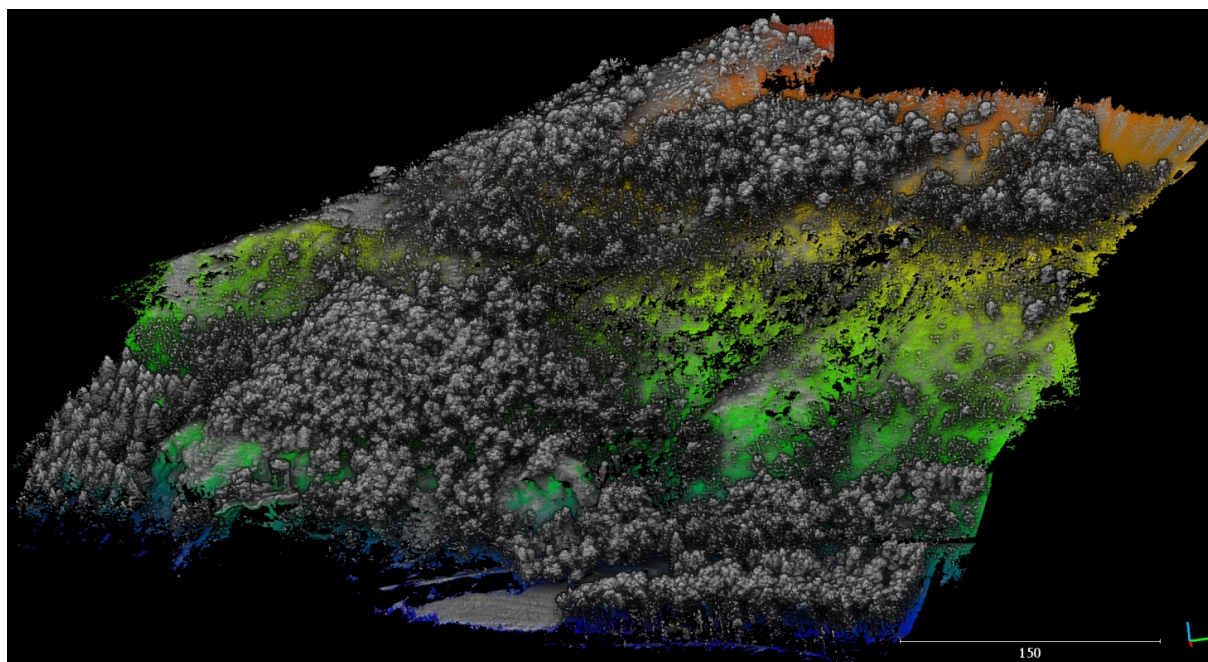


Figure 2- Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Nuage de points total

#### 3.2. Correction des imprécisions GPS

Les données issues de ces vols ont été corrigées des imprécisions GPS en utilisant les données fournies par les bornes du Réseau Géodésique Permanent de l'IGN (disponibles gratuitement sur le site [www.rgp.ign.fr](http://www.rgp.ign.fr)) et au logiciel PosPac de Applanix<sup>1</sup> (cf. rapports de correction en annexe).

#### 3.3. Extraction des points sols

Après plusieurs tests réalisés en utilisant différents algorithmes et logiciels, c'est finalement le filtrage obtenu avec l'outil d'extraction du terrain de 3D-Reshaper<sup>2</sup> qui s'est révélé le plus satisfaisant. Un premier filtrage « agressif » utilisant un réglage des pentes moyennes de 45 % et une grille d'extraction de 50 cm a été testé, mais c'est finalement un filtrage « adapté » au caractère très accidenté du secteur, utilisant des pentes de 80 % et la même

<sup>1</sup><https://www.applanix.com/>

<sup>2</sup><https://www.axsess-solutions.com/logiciel3dnuagepoint.html>



grille d'extraction de 50 cm qui permet la meilleure préservation des infractuaosités rocheuses, mais aussi une part importante de végétation basse qui n'a pas permis au faisceau laser d'atteindre le sol (Figure 3).

Ce filtrage « adapté » permet de retenir un peu moins de 9M de points, soit environ 30/m<sup>2</sup>. Les densités sont variables en fonction de la distance par rapport au capteur et les variations de végétation (Figure 4).

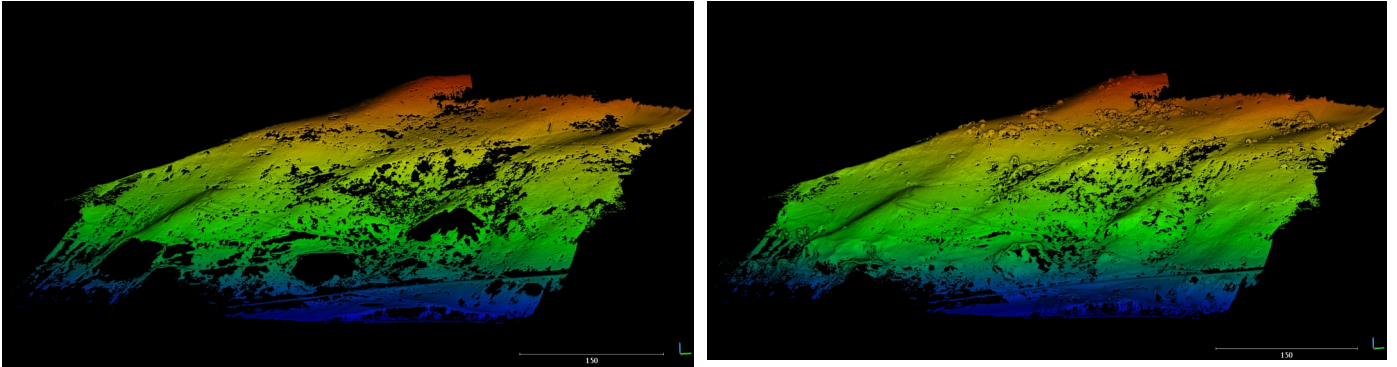


Figure 3- Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Nuage de points-sol (filtrage agressif à gauche, adapté à droite)

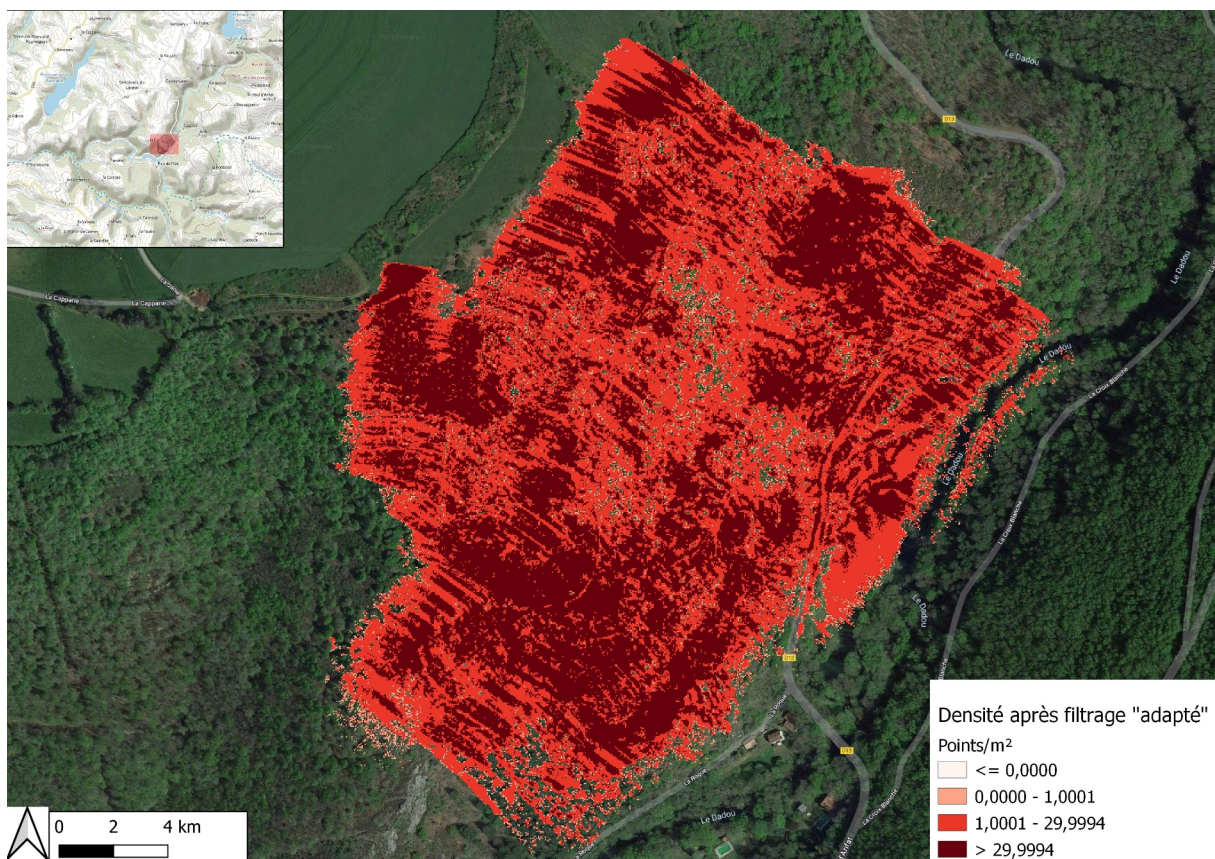


Figure 4- Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Densité des points-sols



#### 4. Génération des visualisations des MNT

Dans CloudCompare, avec l'outil Raster, un Modèle Numérique de Terrain (MNT) d'une résolution de 50 cm a été généré en ne prenant en compte que les points sols.

Avec le logiciel RVT (Relief Visualization Toolbox<sup>3</sup>) développé par l'Institute of Anthropological and Spatial Studies du ZRC-SAZU (Slovénie), il est possible d'appliquer plusieurs traitements aux MNT ainsi produits :

- Ombrage : simulation d'un éclairage et des ombrages correspondants selon une direction et un azimuth défini par l'opérateur
- Ombrages cumulés depuis des directions différentes
- Gradient de pente
- Modèle de relief local (SLRM) : suppression des grandes tendances de la topographie du terrain au profit de l'accentuation des micro-reliefs (locaux)
- Sky-view factor : mesure du pourcentage de ciel visible depuis chaque pixel du modèle

Ces différents traitements permettent de multiplier les visions du même espace et de mieux identifier les indicateurs archéologiques. Nous livrons ci-après les visualisations les plus efficaces, mais l'ensemble des données sont fournies par lien de téléchargement. Toutes sont géoréférencées et immédiatement intégrables dans un projet SIG.

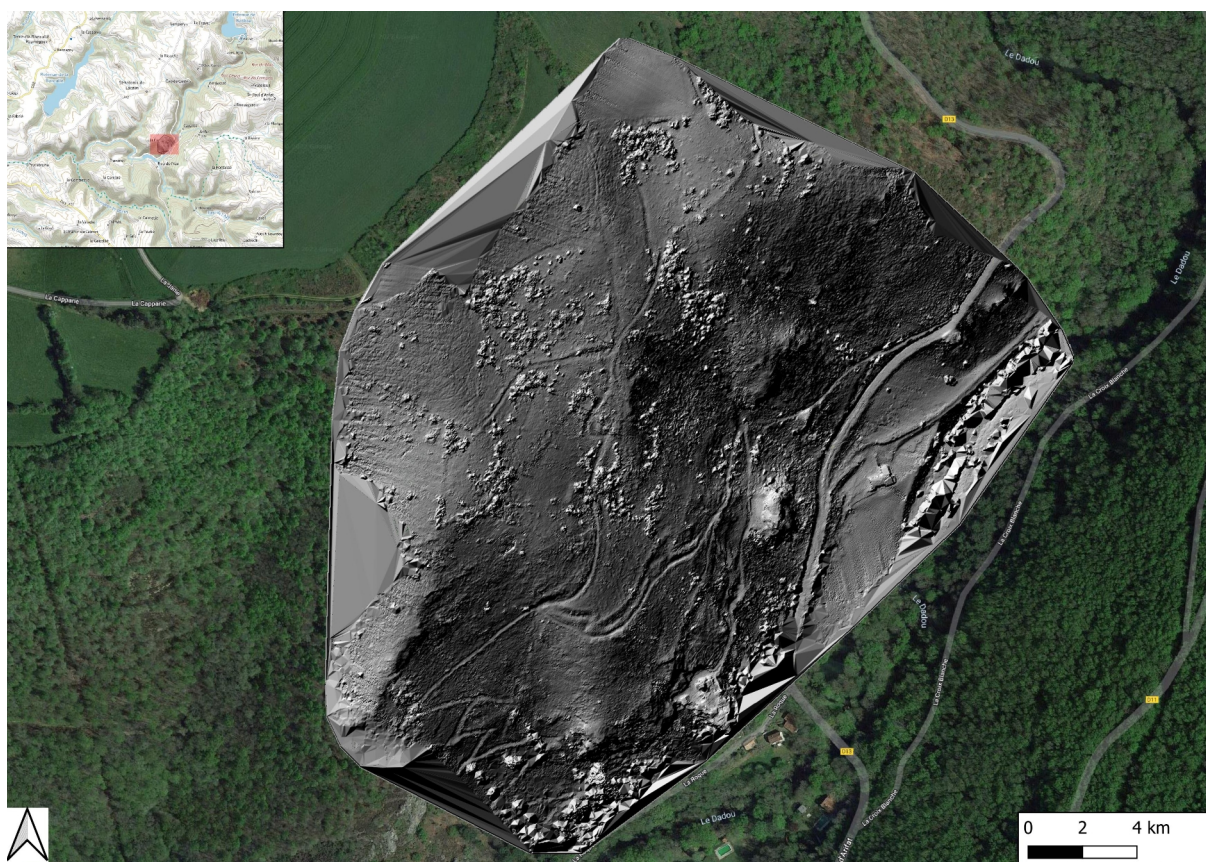


Figure 5 - Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Hillshade - Azimuth 315° - Hauteur 35° (RVT)

3 <https://iaps.zrc-sazu.si/en/rvt#v>



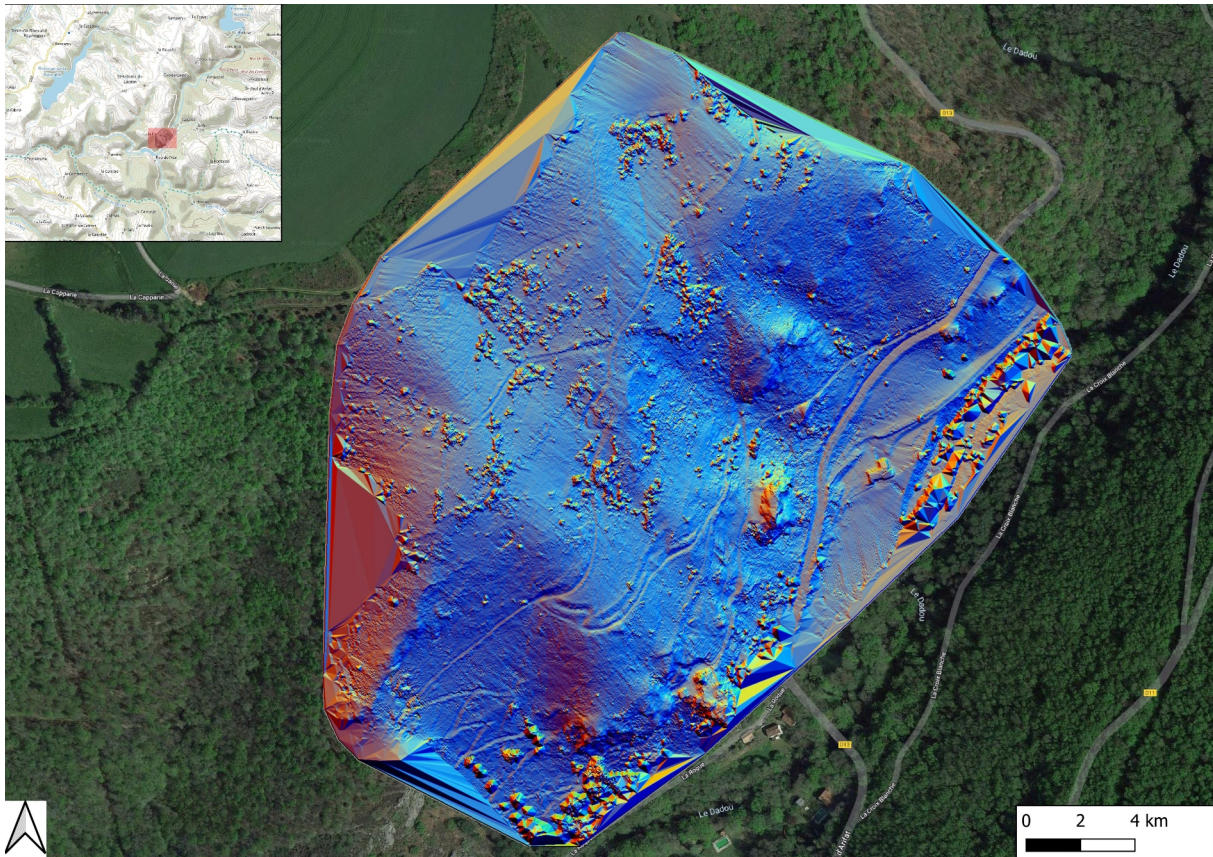


Figure 6 - Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Multi-hillshade - 16 directions - 35 degrés (RVT)

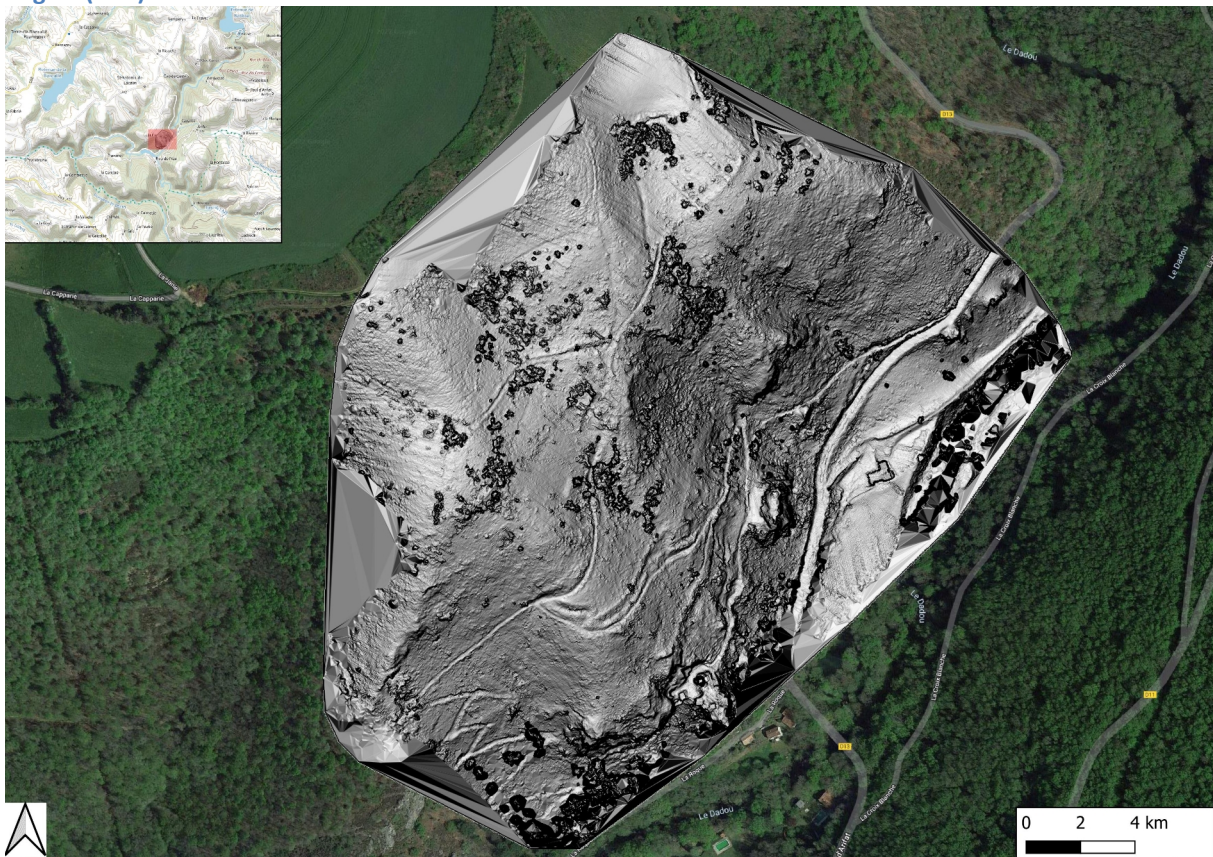


Figure 7 - Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Slope gradient (RVT)





Figure 8 - Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Sky View Factor – Rayon 20 px - 16 directions (RVT)

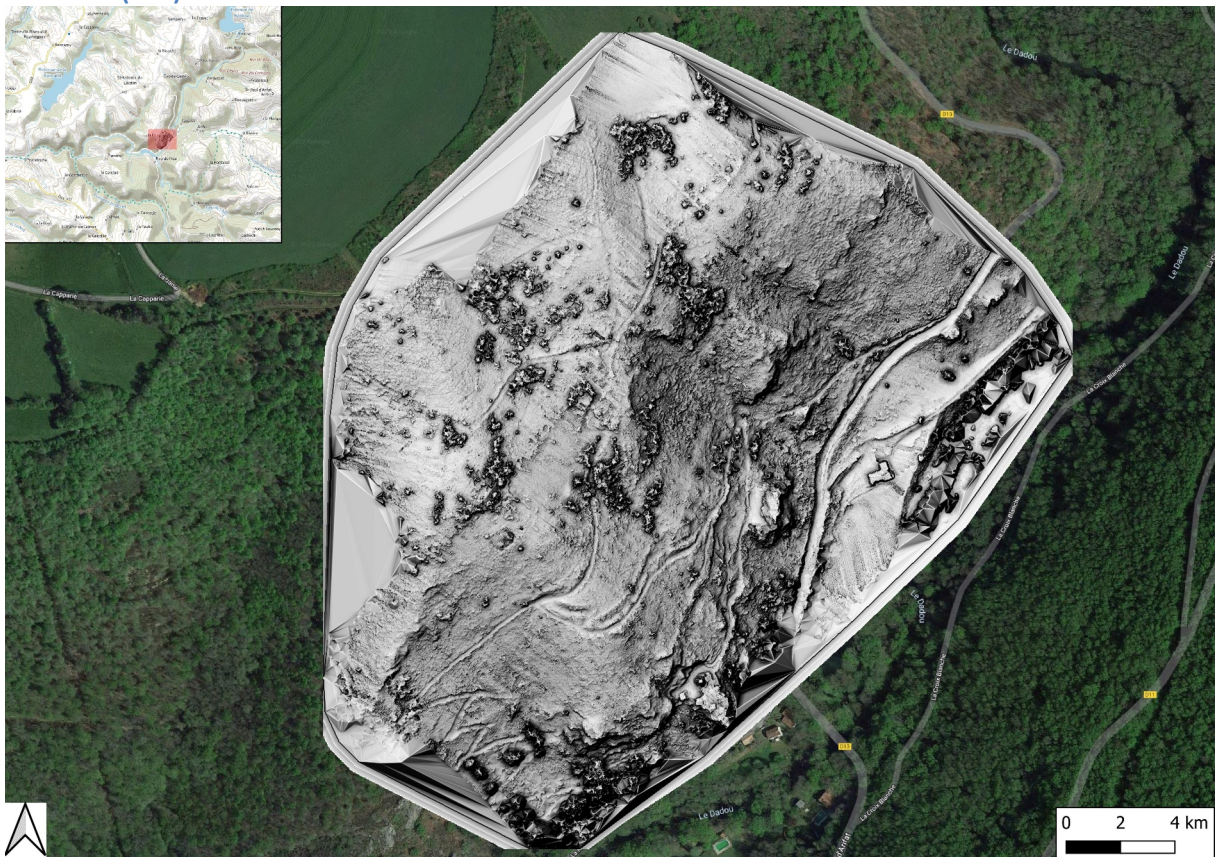


Figure 9 - Terre-de-Bancalié (81), La Roque – mission du 08/03/2022 - Visualization for Archaeological Topography (VAT) (RVT)



Nous laissons le soin aux responsables thématiques du projets, meilleurs connaisseurs de leur sujet et de leur terrain, le soin d'interpréter finement ces résultats.

Données livrées avec le présent rapport :

- Nuage de points total au format \*.las : 220308\_CastelRoc\_merge.las
- Nuage de points sols filtrés avec le logiciel 3D Reshaper au format \*.las : 3Dreshape\_sol\_80pc.las
- Modèle Numérique de Terrain à la résolution de 50 cm issus du nuage de points-sols : raster\_3Dreshaper\_sol\_80pc\_50cm.tif
- Ensemble des visualisations de ce MNT au format \*tif et géoréférencées pour intégration SIG.
- Ensemble des cartes produites pour le présent rapport.

## General Information

### Mission Information

Project name	CastelRoc
Processing date	2022-03-09 09:58:29
Mission date	2022-03-08 08:46:52
Mission duration	00:19:07.997
Processing mode	IN-Fusion Single Base
GPS Station	LSDA

### Rover Hardware Information

Product	APX 15 AVX 210 VER0 174
Serial number	S/N001
IMU type	59
Receiver type	APX-15v3
Antenna type	AV14



## Project File List

### Rover Data Files

File name	File type
YS-20220308-084646.T04	T04 Rover Data

### Input Files

File Name	File type
Ephm0670.22g	GLONASS Broadcast Ephemeris
Ephm0670.22n	GPS Broadcast Ephemeris
albm067z.22o	GNSS SingleBase
lsda067z.22o	GNSS SingleBase

### Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
YS_44_Post_Pac.txt	ASCII Export Output

## Rover Data Summary

First raw data file	YS-20220308-084646.T04		
Last raw data file	YS-20220308-084646.T04		
Start GPS week	2200		
Start time	204412.000 (3/8/2022 8:46:52 AM)		
End time	205560.000 (3/8/2022 9:06:00 AM)		
Start of fine alignment	204614.000 (3/8/2022 8:50:14 AM)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
<b>IMU Installation Lever Arms &amp; Mounting Angles</b>			
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.006	0.218	-0.435
Reference to Primary GNSS lever arm std dev [m]	0.020		
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

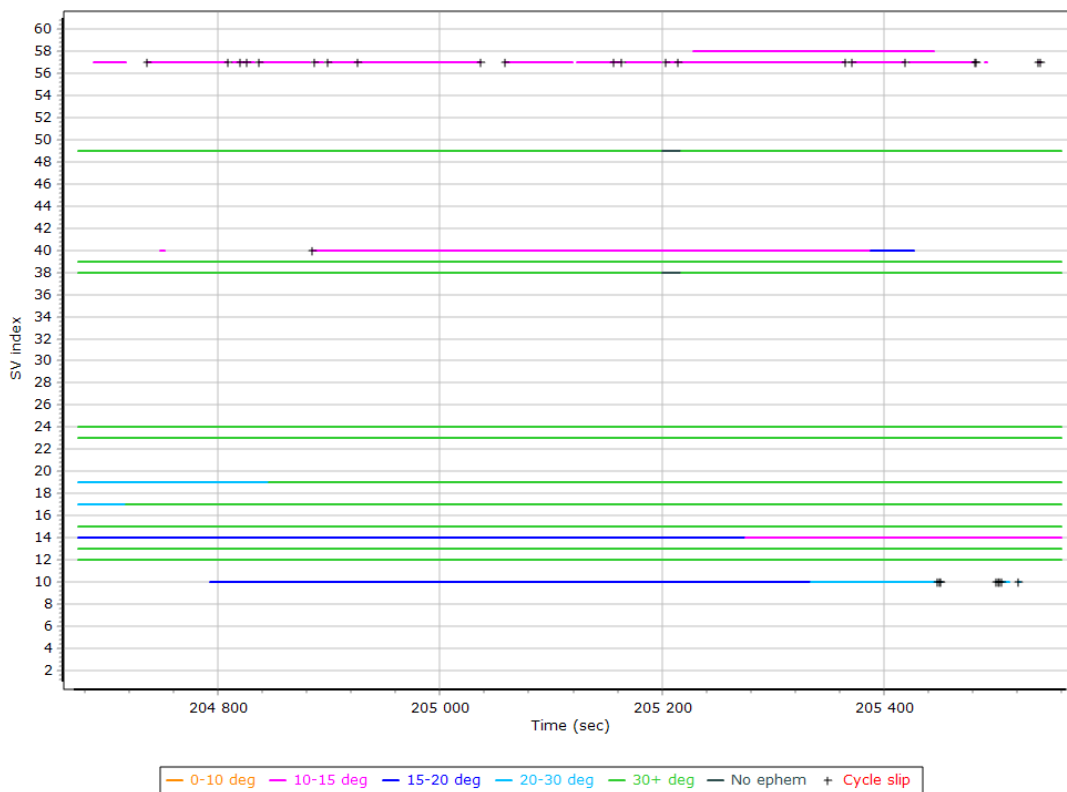


## Raw Data QC

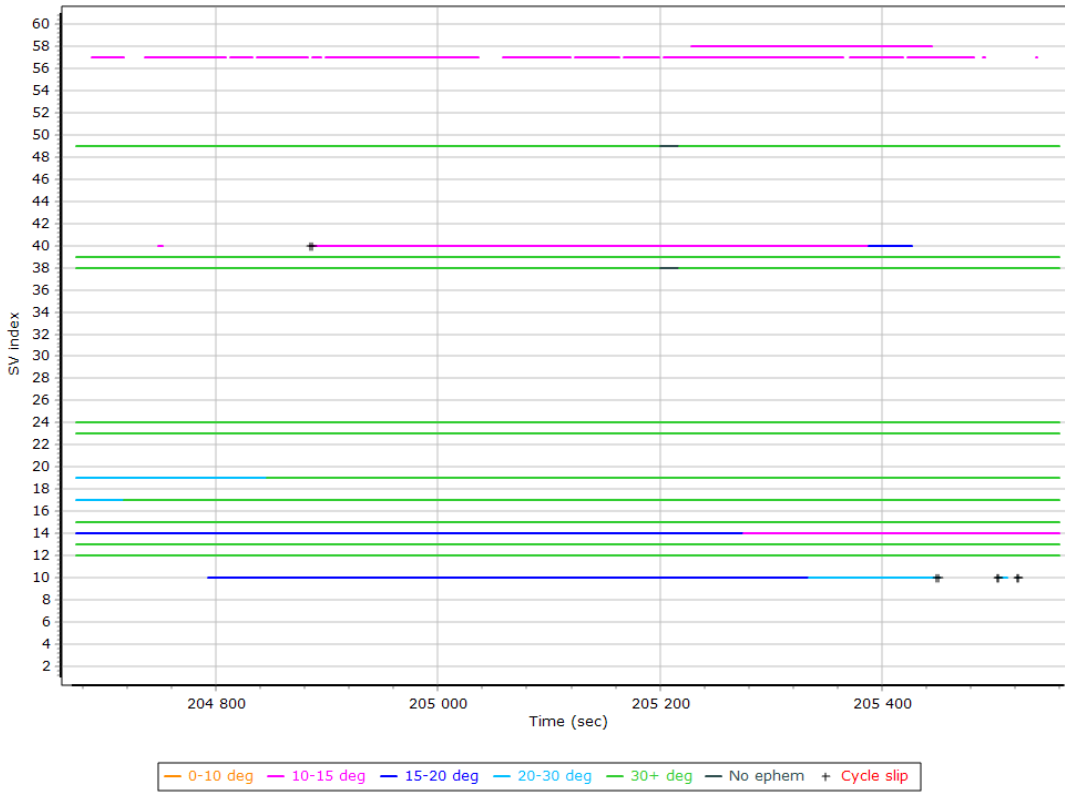
### Raw IMU Import QC Summary

IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	229720
Termination Status	Normal
IMU Anomalies	0

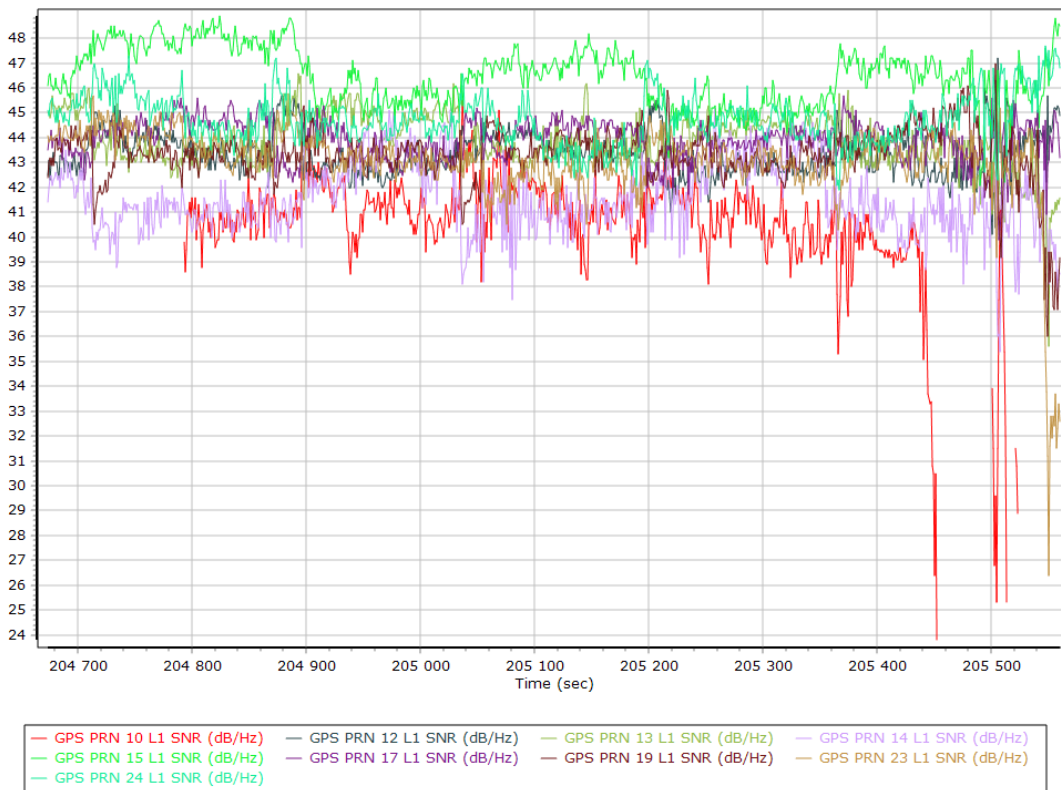
### L1 Satellite Lock/Elevation



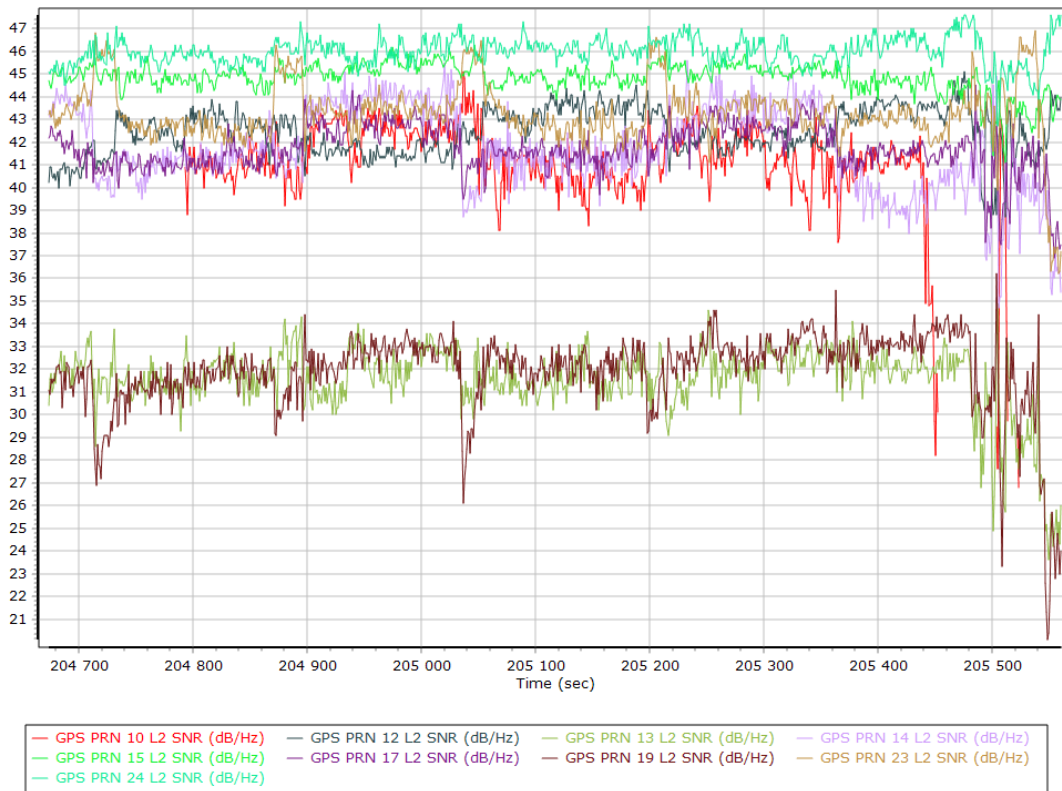
## L2 Satellite Lock/Elevation



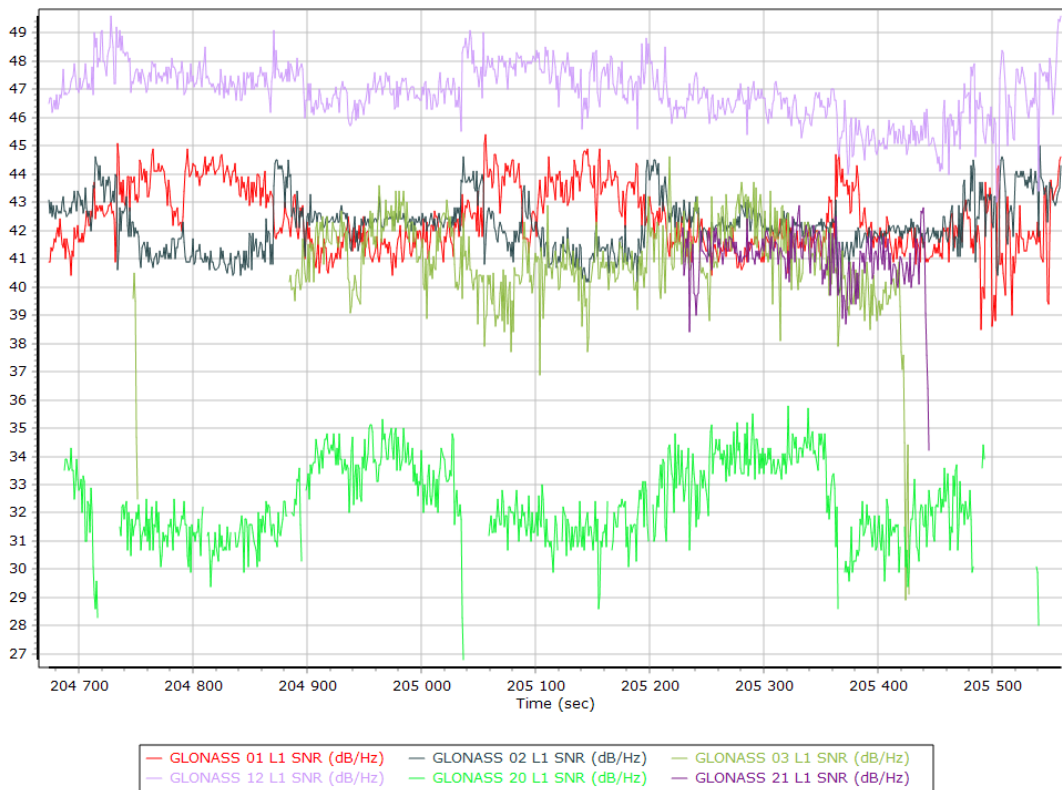
## GPS L1 SNR



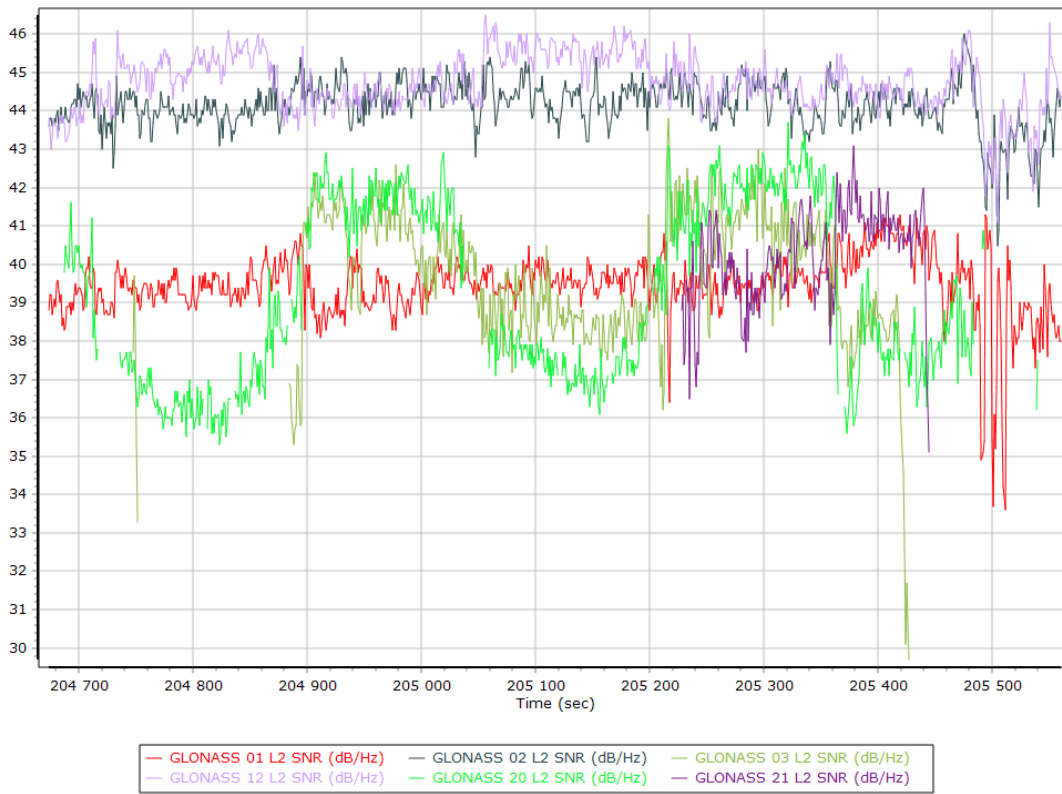
## GPS L2 SNR



## GLONASS L1 SNR



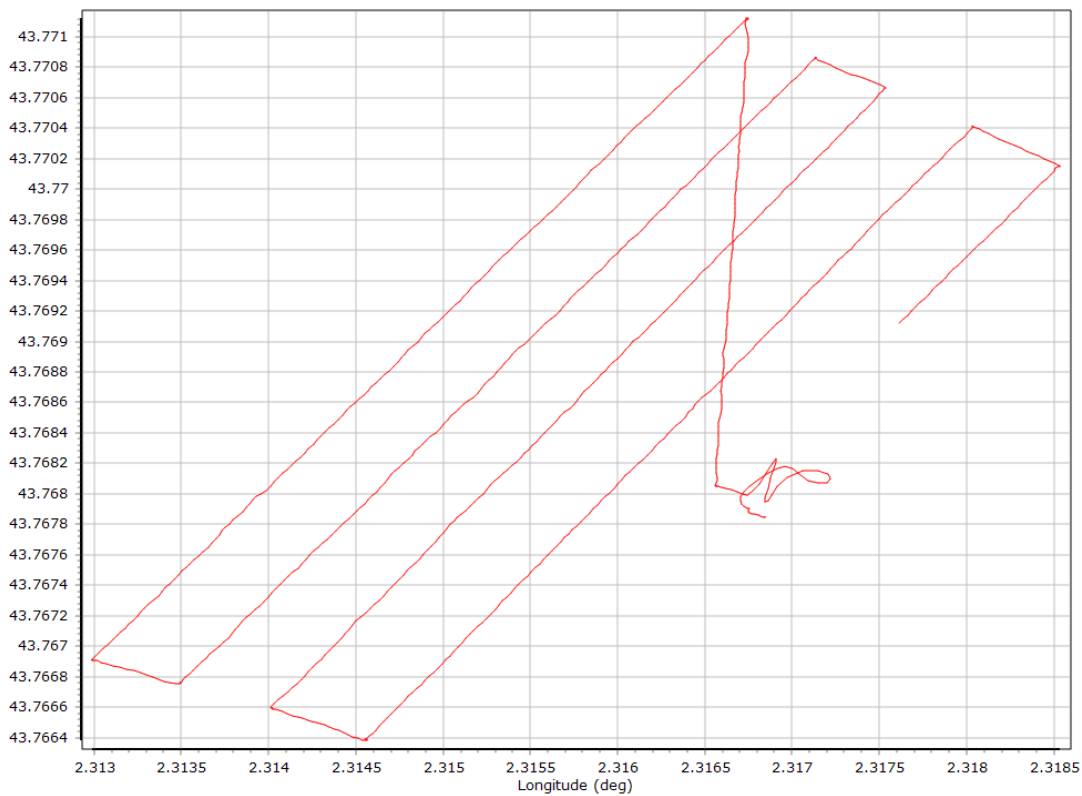
## GLONASS L2 SNR



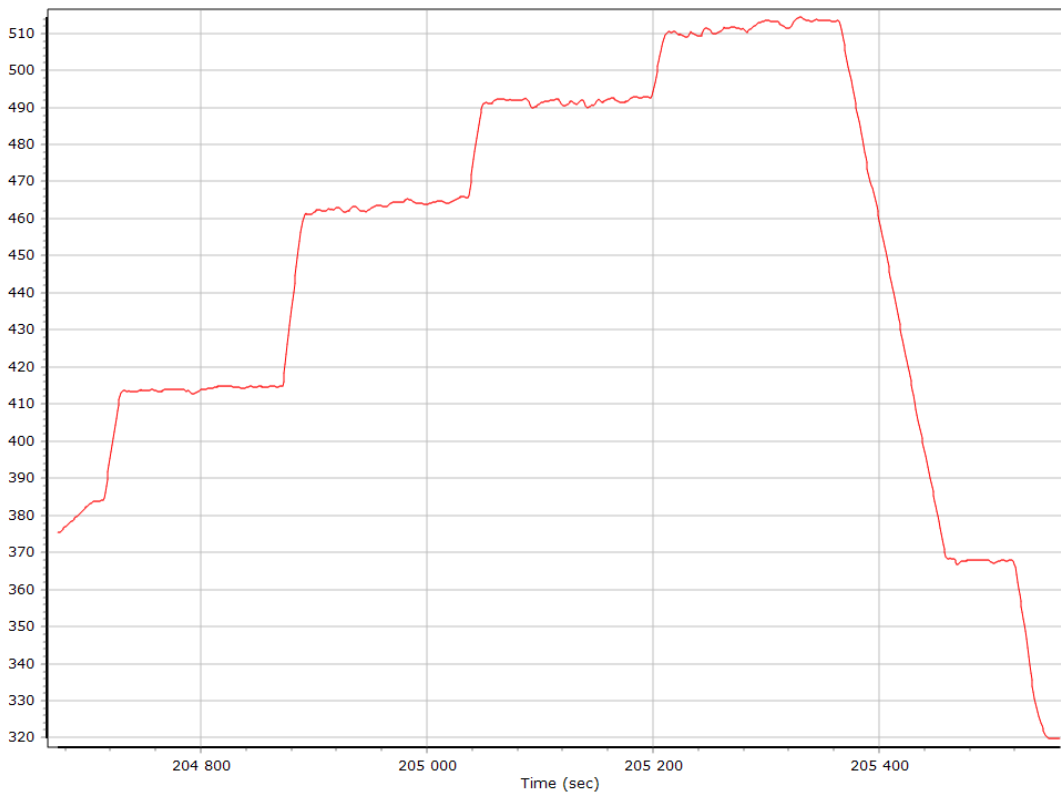


## Trajectory Information

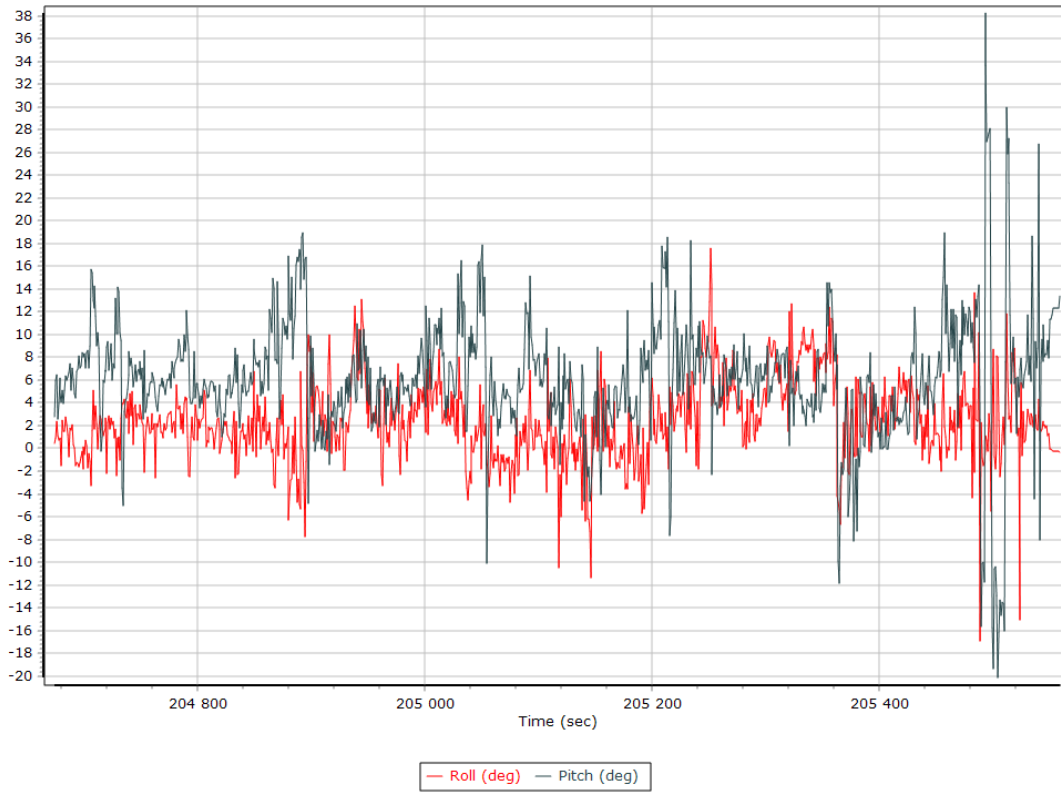
### Top View



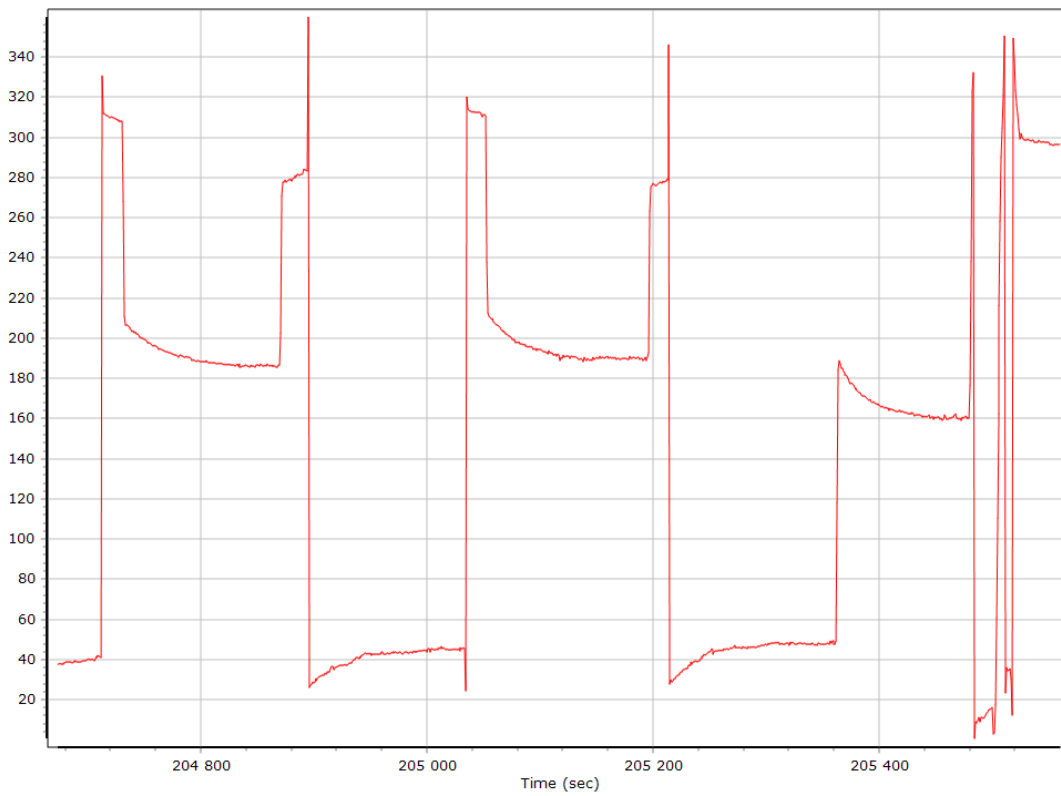
### Altitude



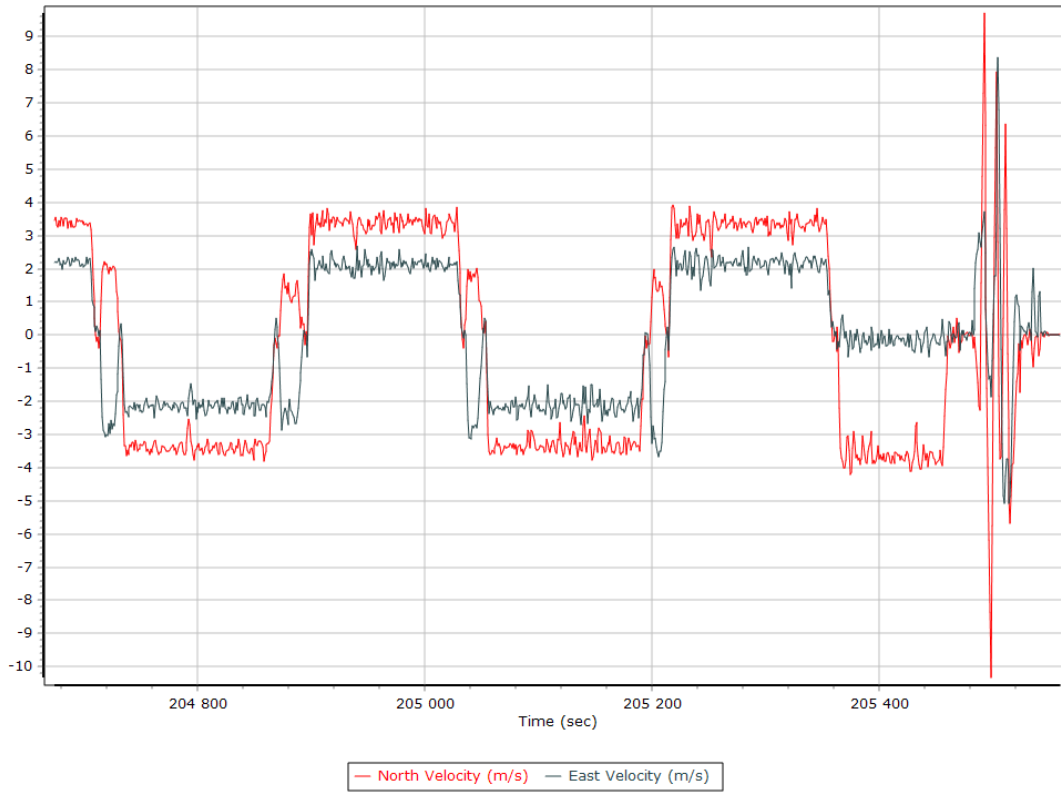
## Roll/Pitch



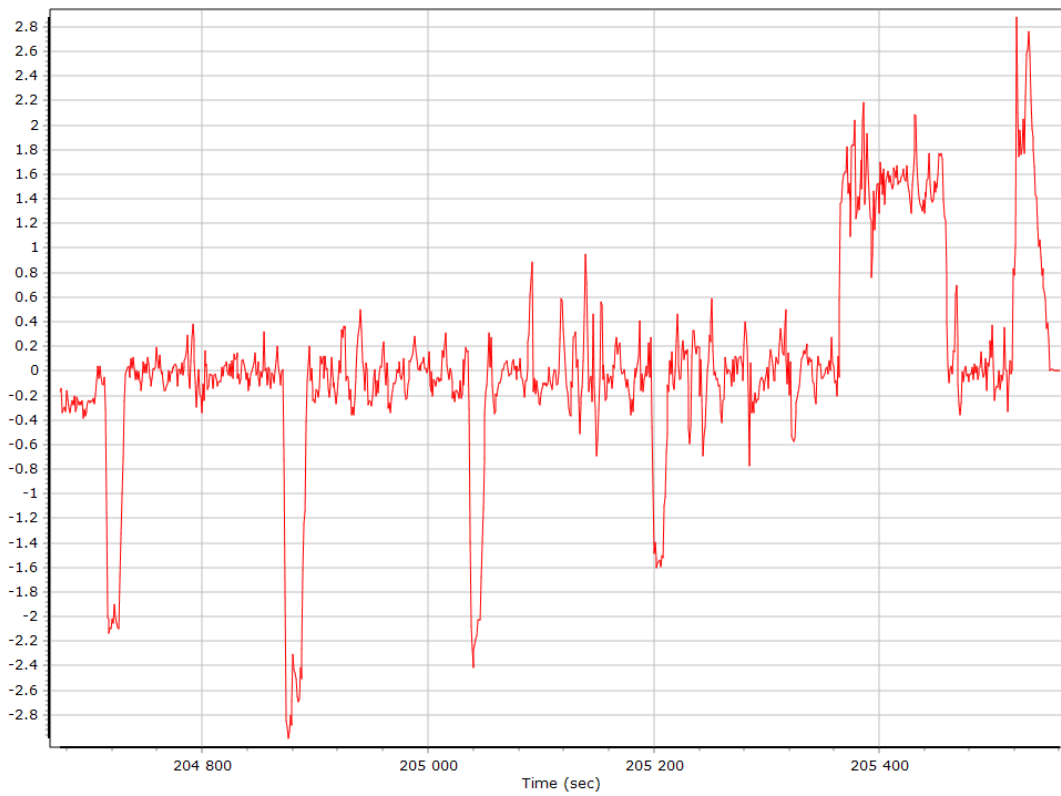
## Heading



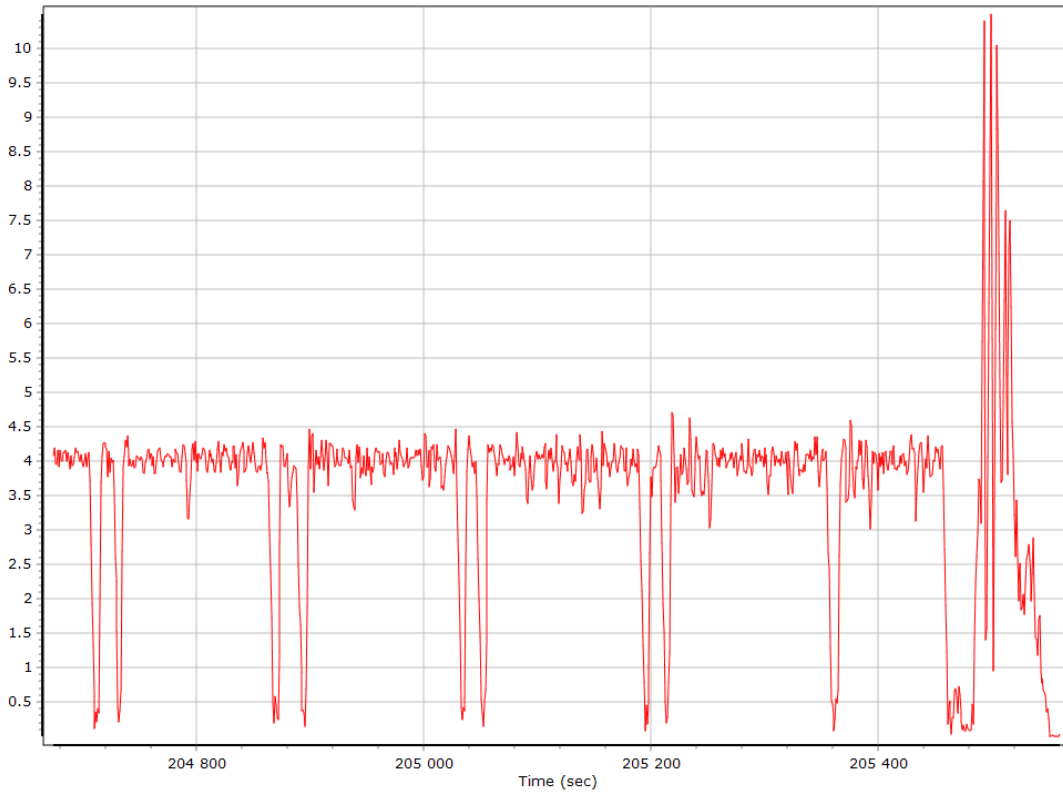
## North/East Velocity



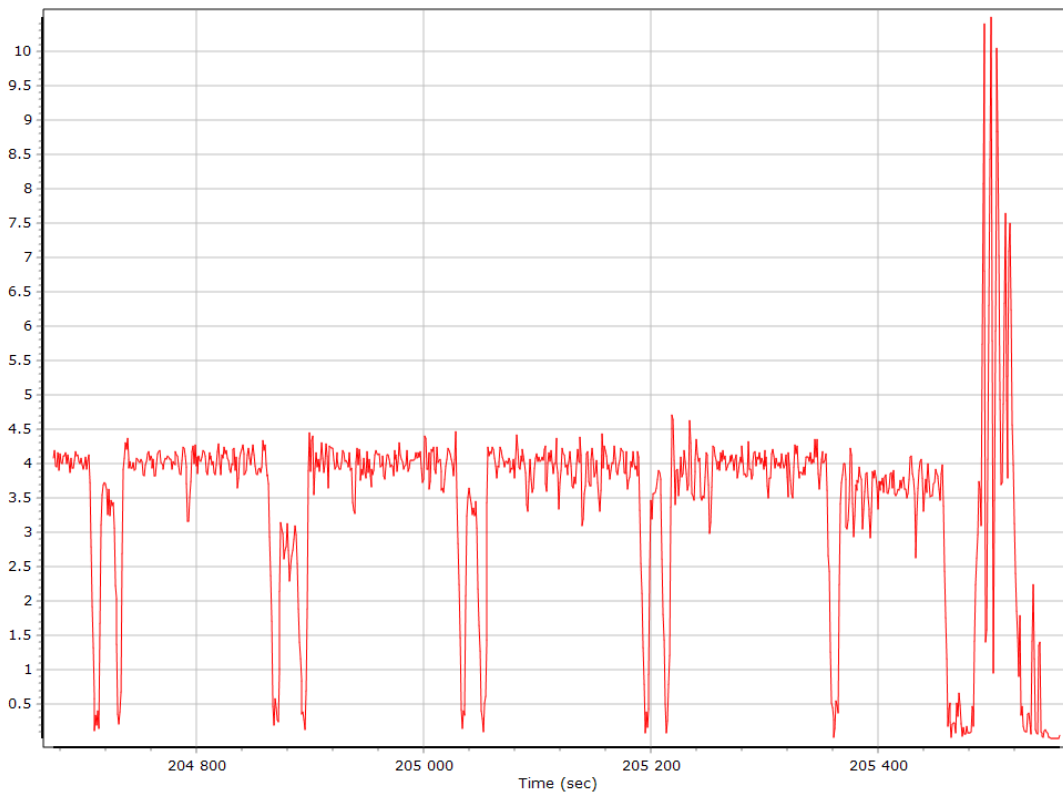
## Down Velocity



## Total Speed



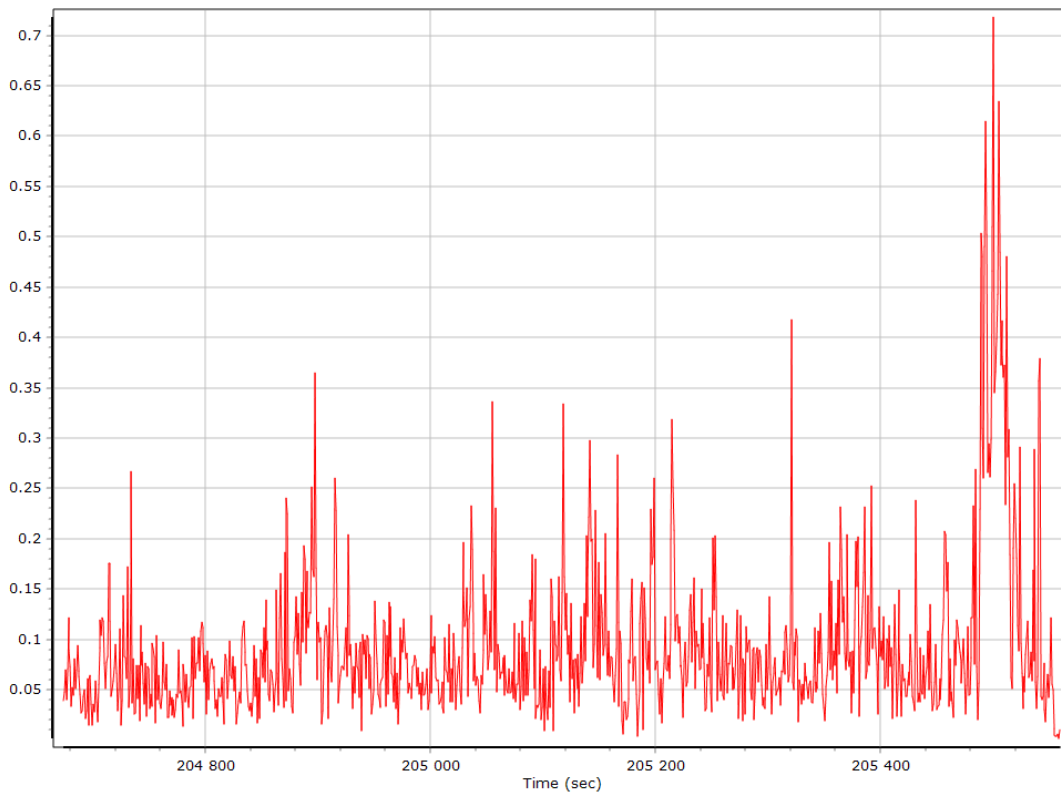
## Ground Speed



## Body Acceleration



## Total Body Acceleration





## Body Angular Rate



## Base Station Information

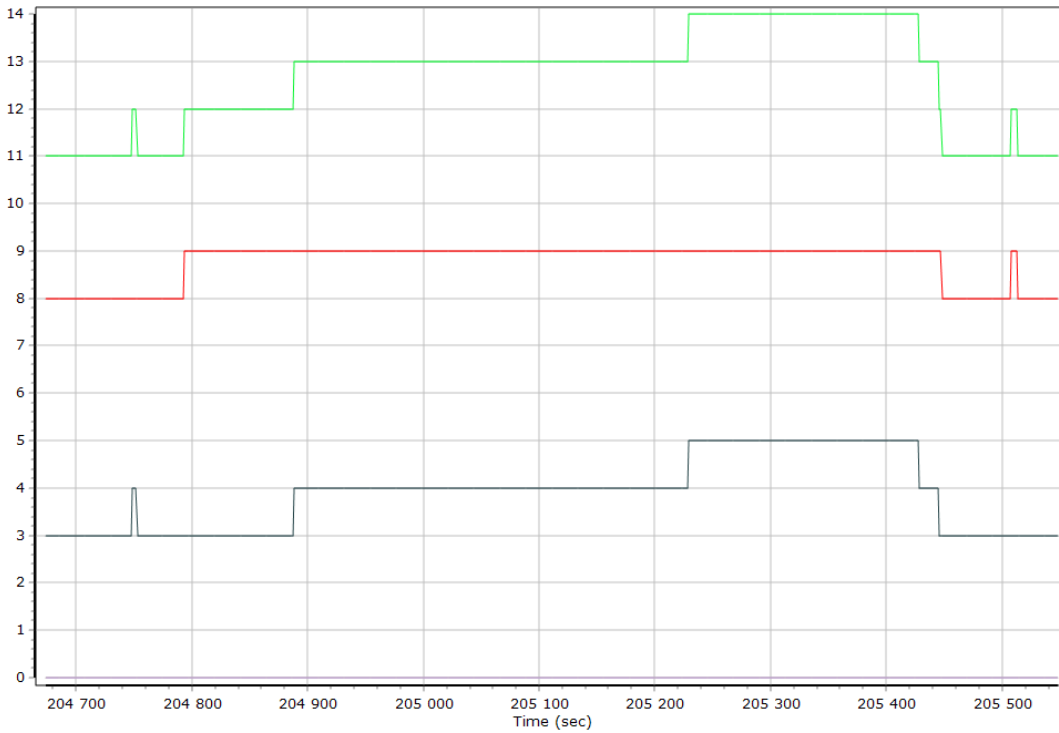
Station ID	LSDA		
Filename	lsda067z.22o		
Start date	3/8/2022 8:00:00 AM		
End date	3/8/2022 4:59:59 PM		
Duration	08:59:59.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Trimble	NetR9	5212K83326
Antenna manufacturer, model	AeroAntenna	AT1675-120 w/SPKE Dome	
Antenna height [m]	0.072		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC [m]	0.08085		
Latitude	N43°57'05.59919"		
Longitude	E2°10'16.98821"		
Ellipsoidal height [m]	221.02700		
Frame	ITRF00		
Epoch	1997		
Ellipsoid	WGS84		
Velocity North [mm/y]	0		
Velocity East [mm/y]	0		
Velocity Up [mm/y]	0		

## GNSS QC

### GNSS QC Statistics

Statistics	Min	Max	Mean
Baseline length [km]	23.21	23.58	
Number of GPS SV	6	9	9
Number of GLONASS SV	0	5	4
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Total number of SV	7	14	12
PDOP	1.58	2.30	1.90
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (s)	1136.00	0.00	0.00
Percentage	100.00	0.00	0.00

### Num SVs in solution

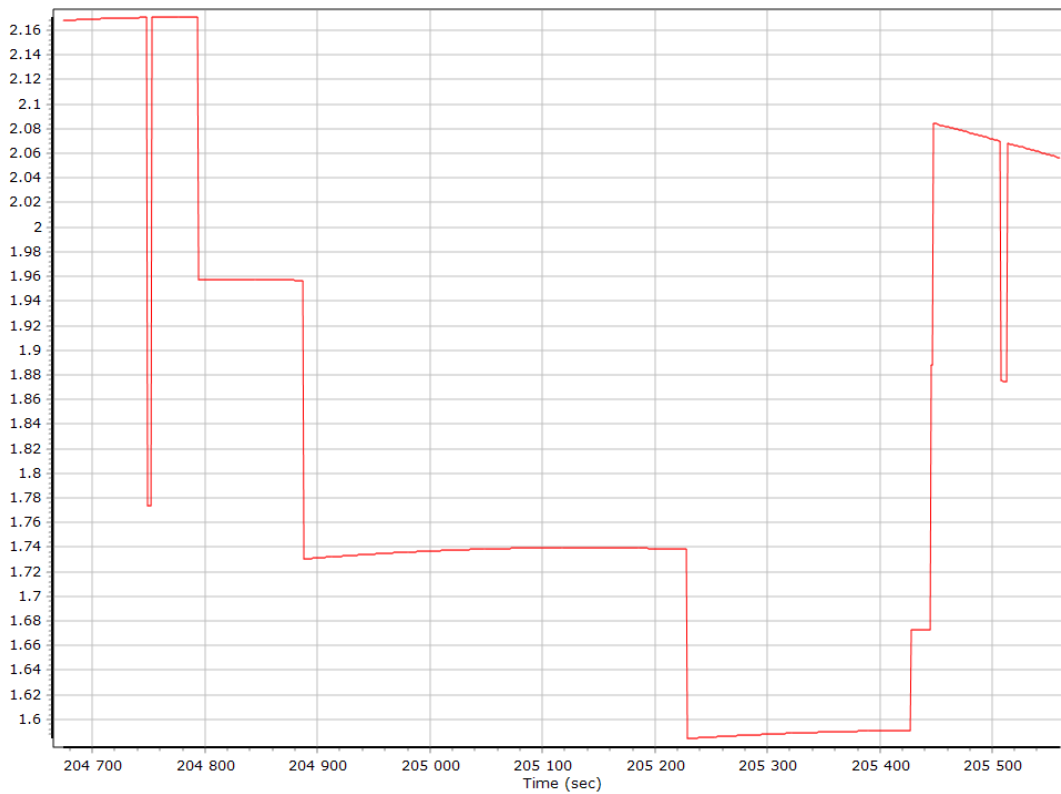


— Number of GPS — Number of GLONASS — Number of QZSS — Number of BEIDOU — Total Number

## Forward/Reverse Separation

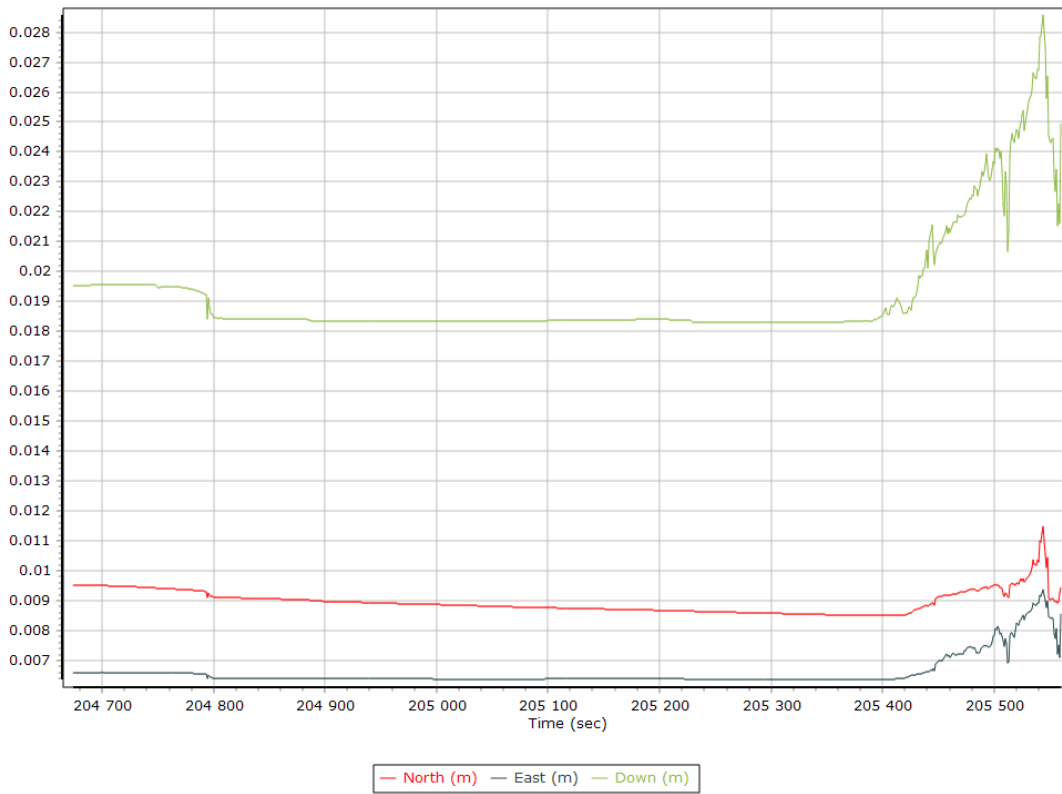


## PDOP





## Estimated Position Accuracy



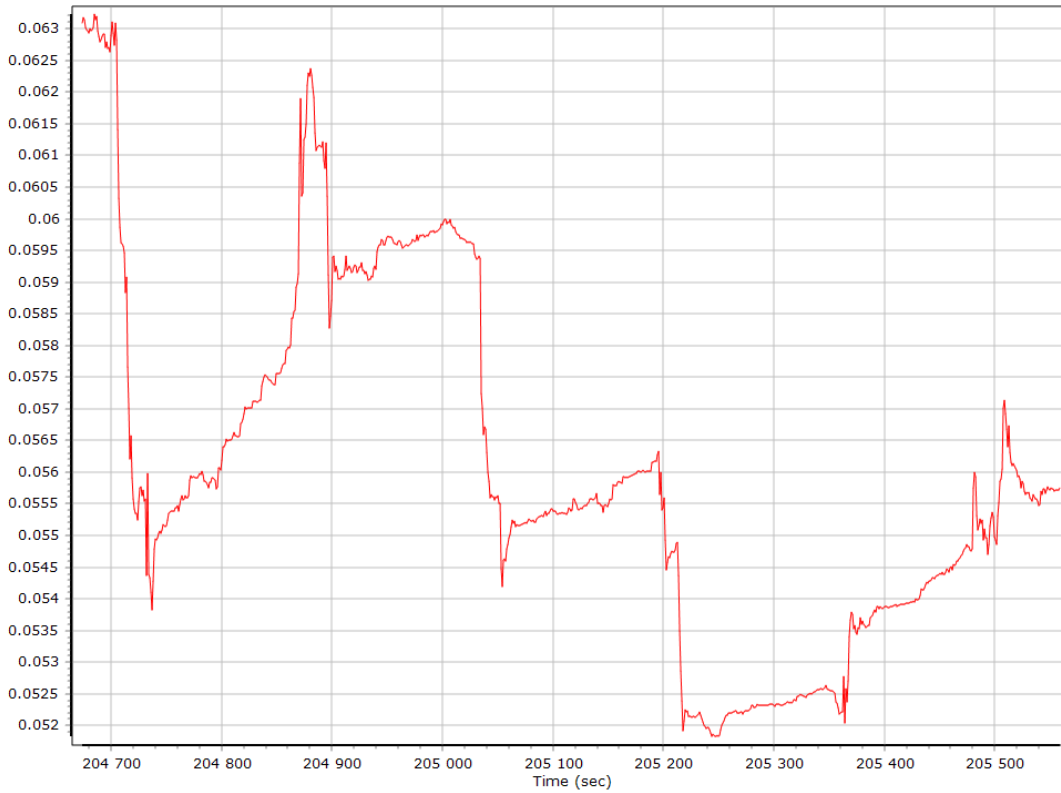
## GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	LSDA		
Processing start time	204412.003 (3/8/2022 8:46:52 AM)		
Processing end time	205560.000 (3/8/2022 9:06:00 AM)		
Initial attitude source	Primary GNSS Track		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.056	0.195	-0.417
Reference to Primary GNSS lever arm std dev [m]	0.100	0.100	0.100
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

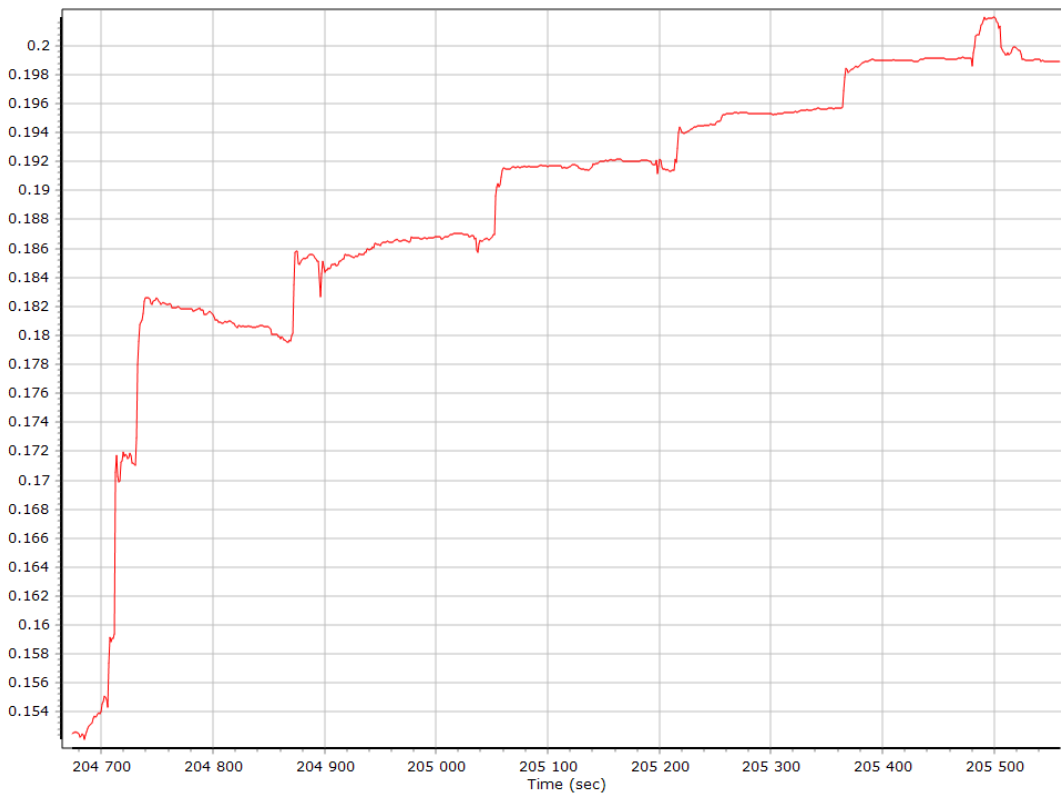
## Calibrated Installation Parameters

### Reference-Primary GNSS Lever Arm

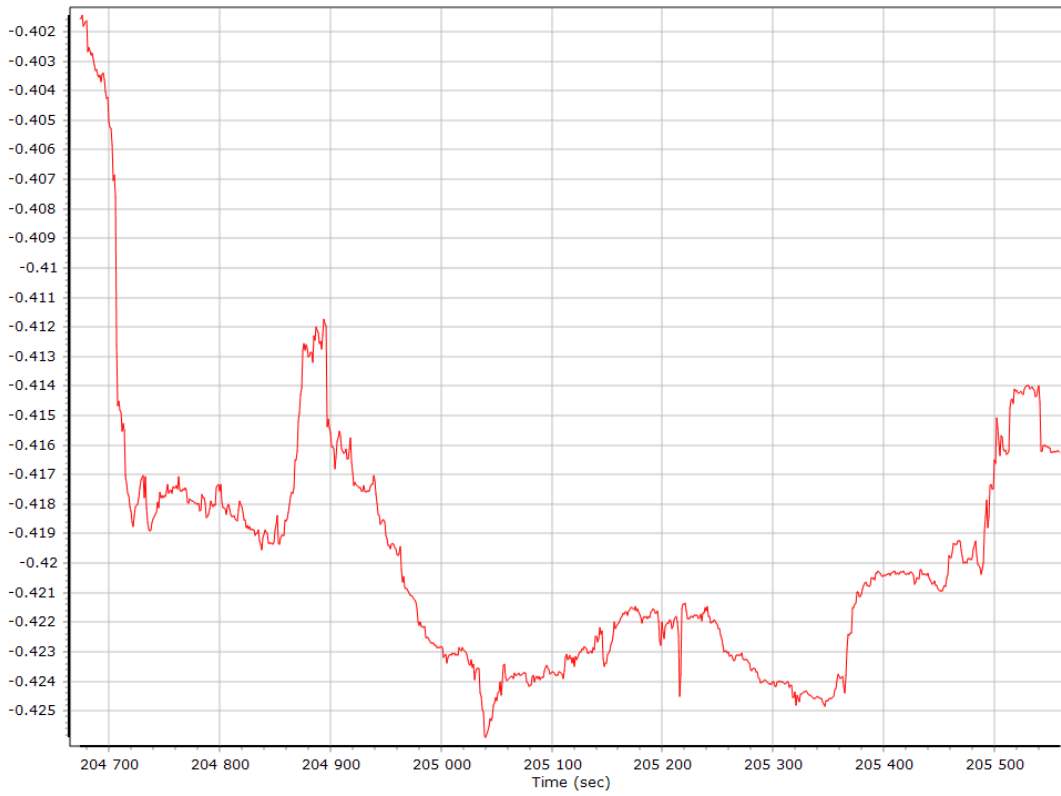
#### X Reference-Primary GNSS Lever Arm (m)



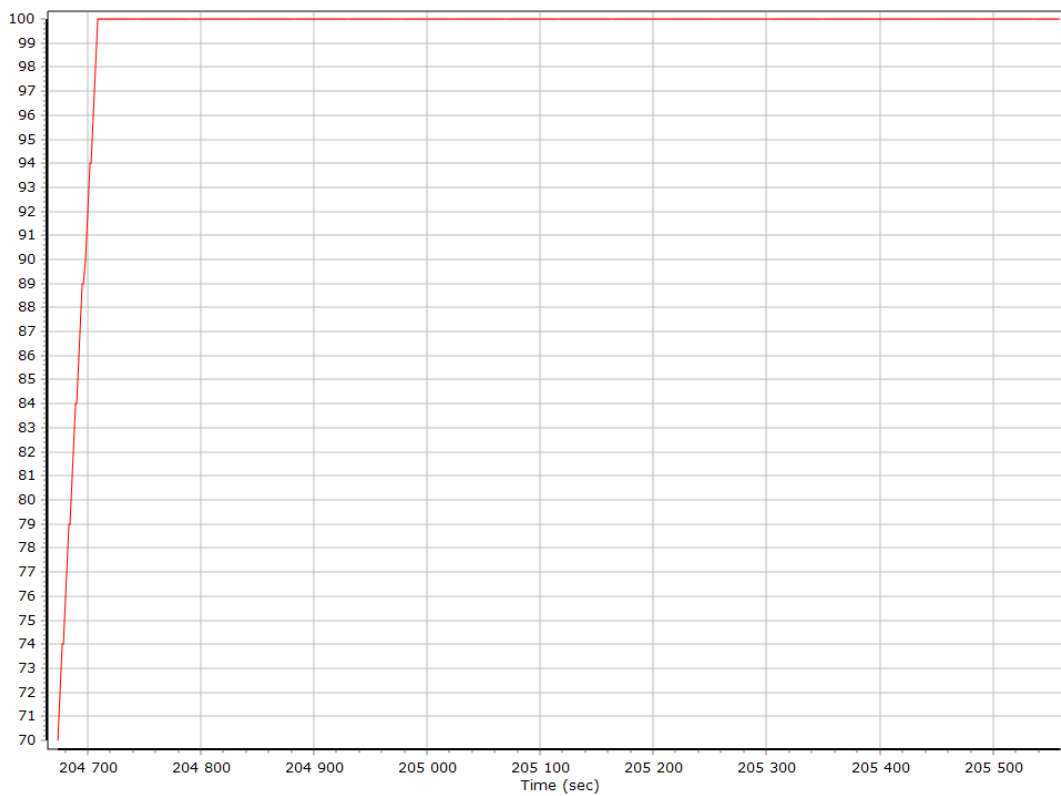
#### Y Reference-Primary GNSS Lever Arm (m)



### Z Reference-Primary GNSS Lever Arm (m)



### Reference-Primary GNSS Lever Arm Figure of Merit

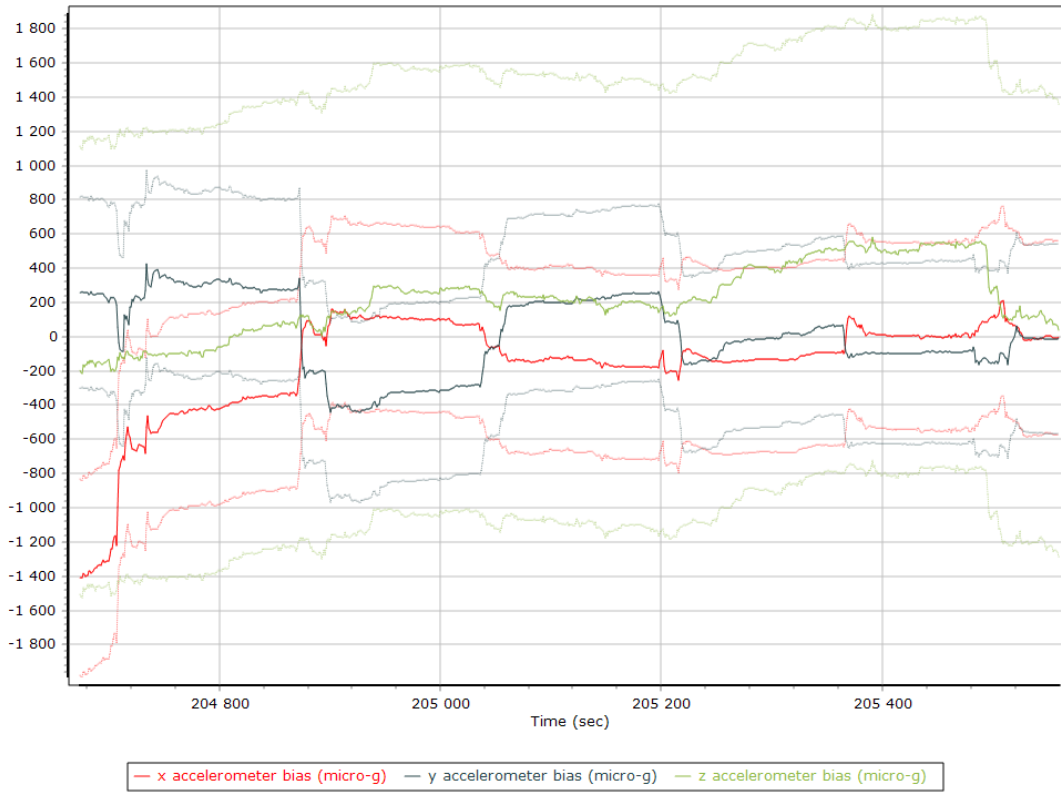




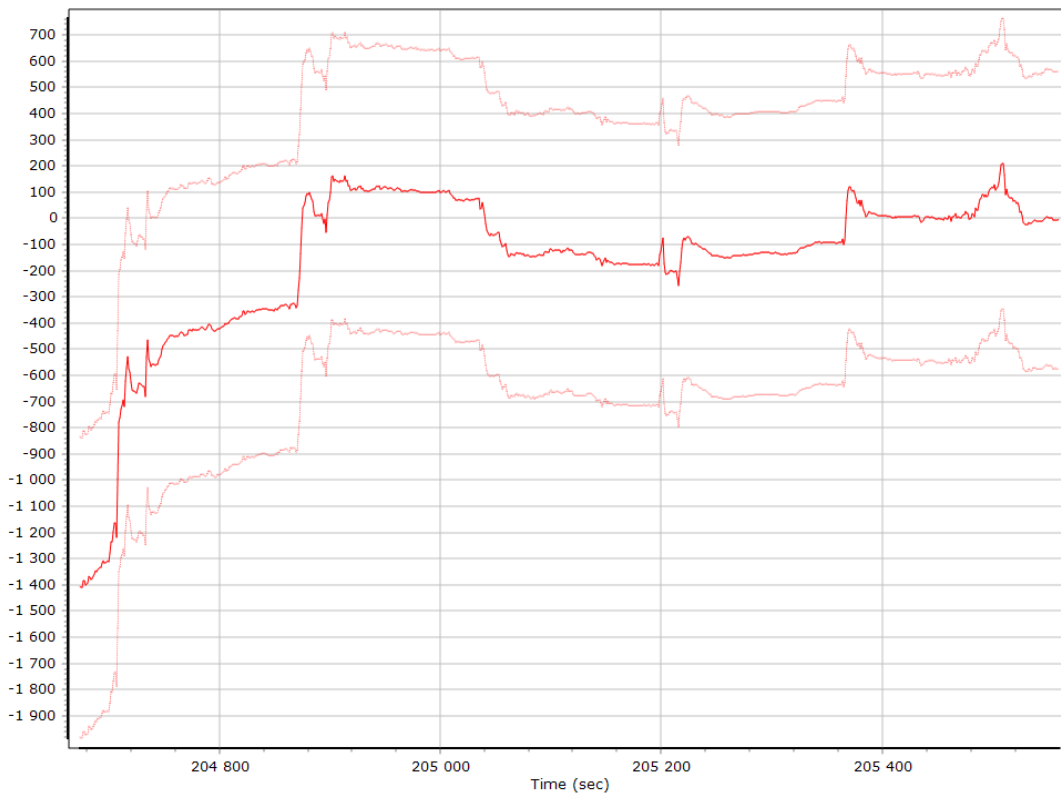
## Smoothed IN-Fusion QC

### Smoothed Estimated Errors, Reference Frame

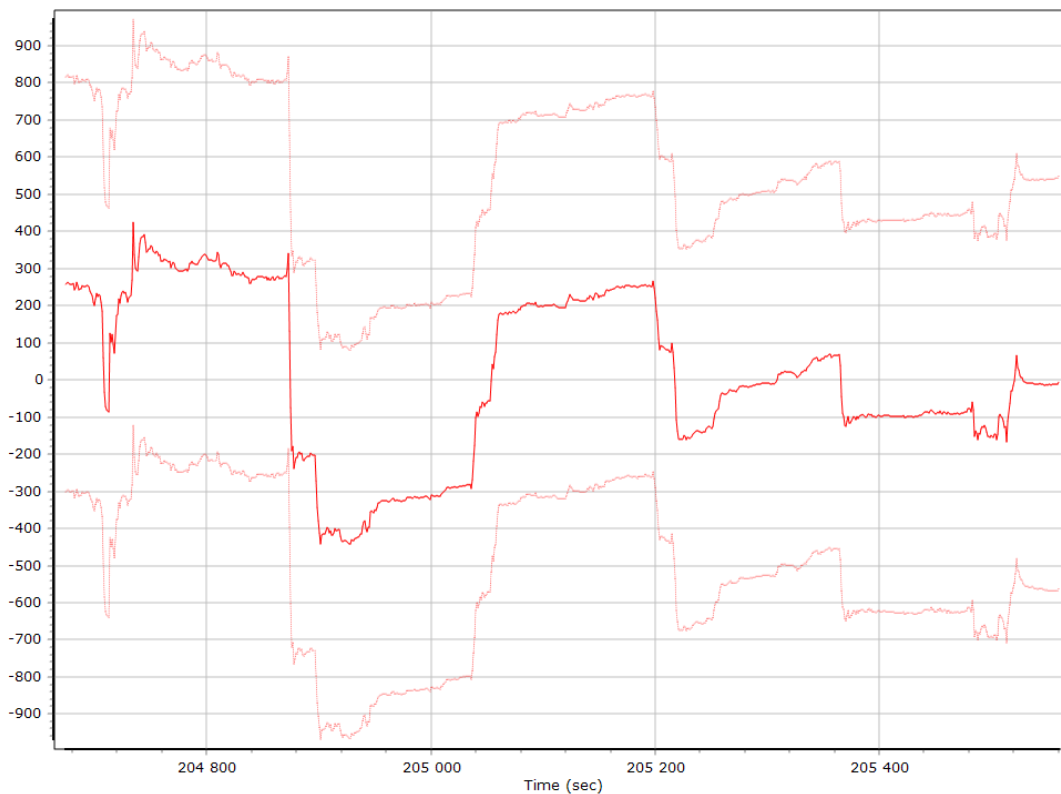
#### Accelerometer Bias (micro-g)



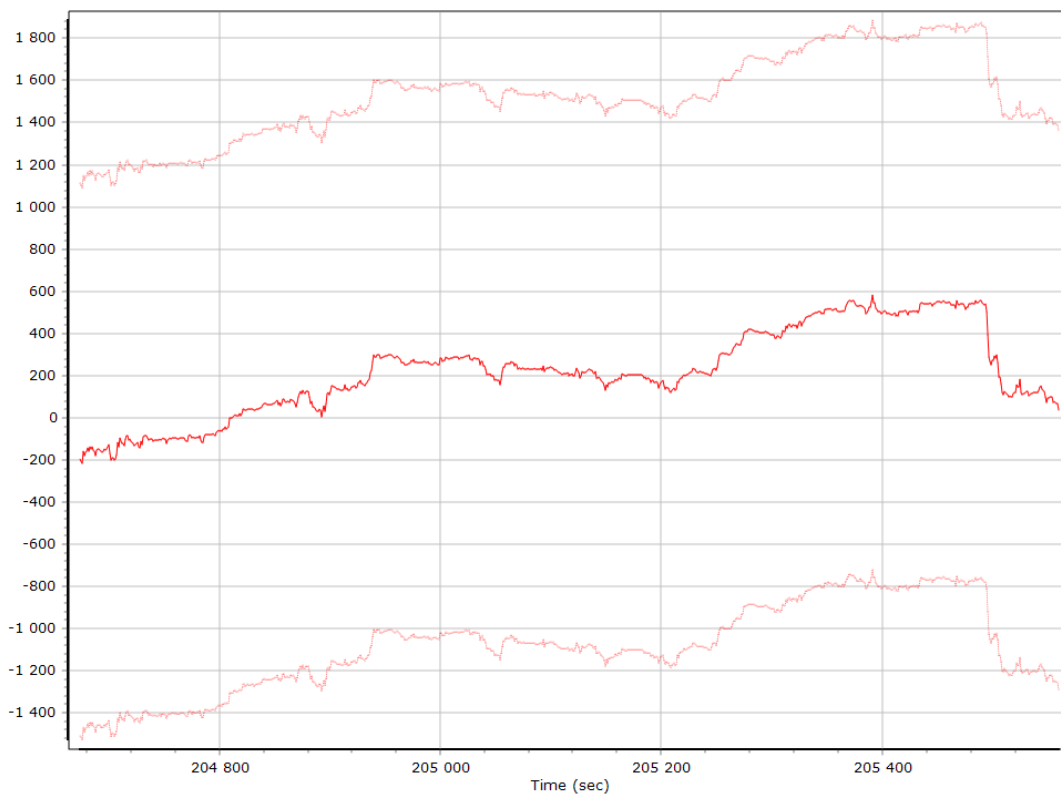
#### X Accelerometer Bias (micro-g)



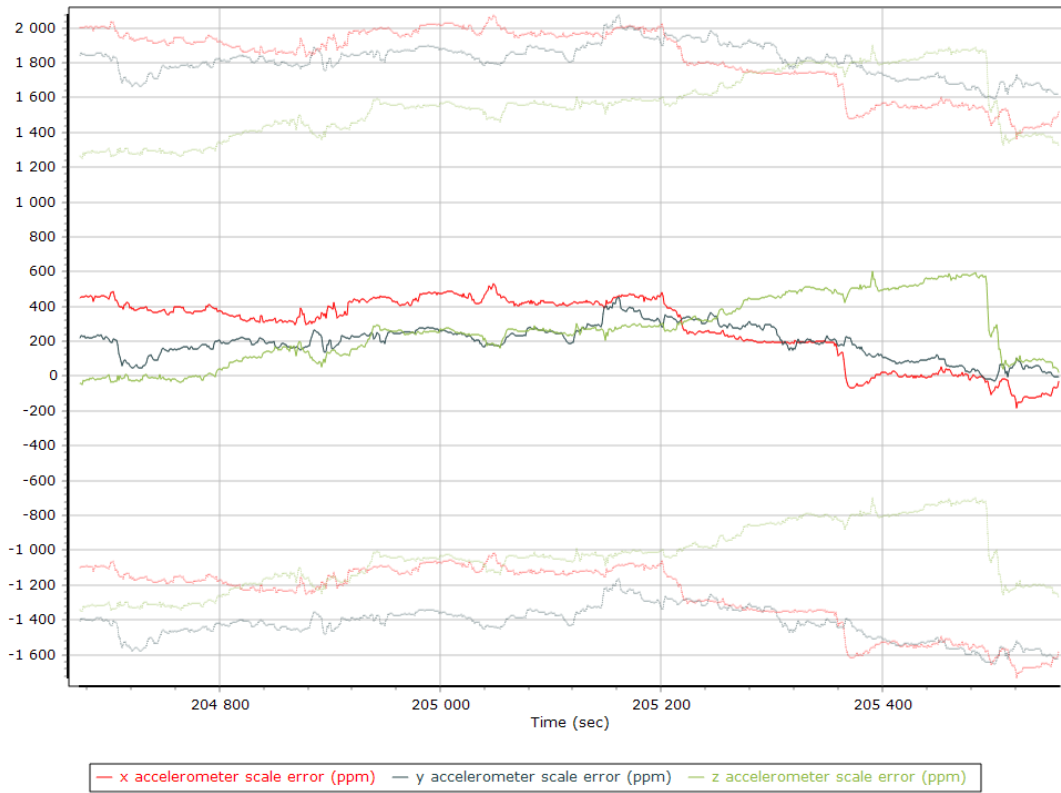
### Y Accelerometer Bias (micro-g)



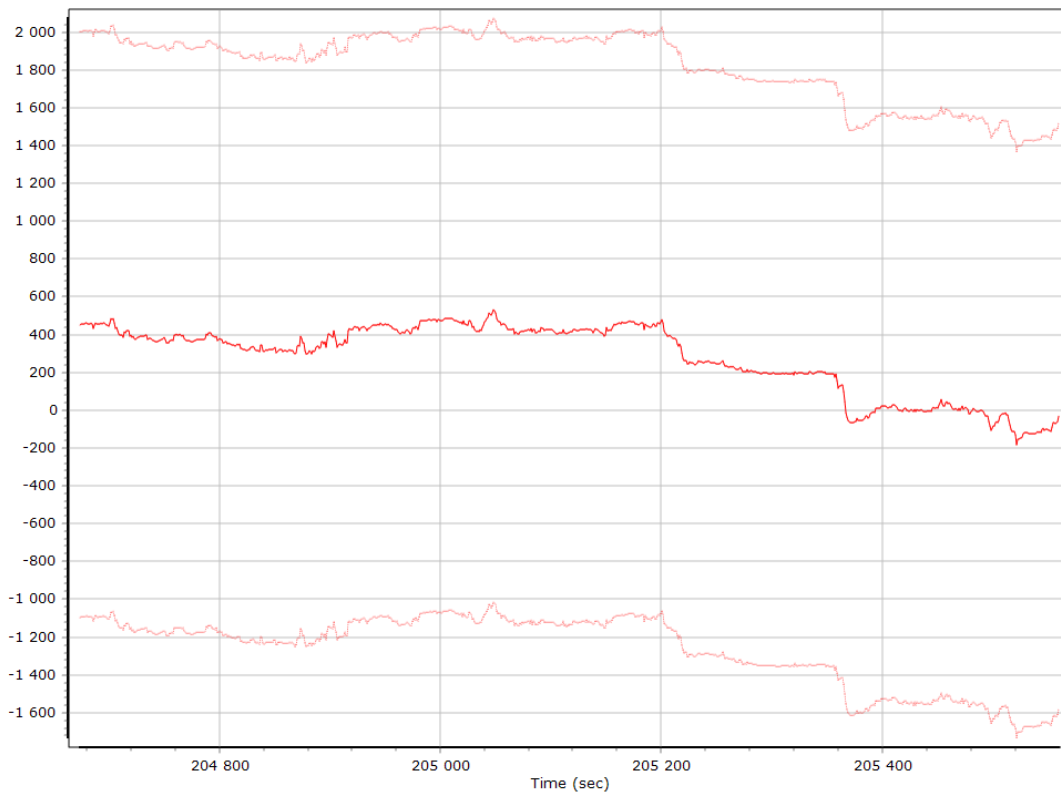
### Z Accelerometer Bias (micro-g)



### Accelerometer Scale Error (ppm)

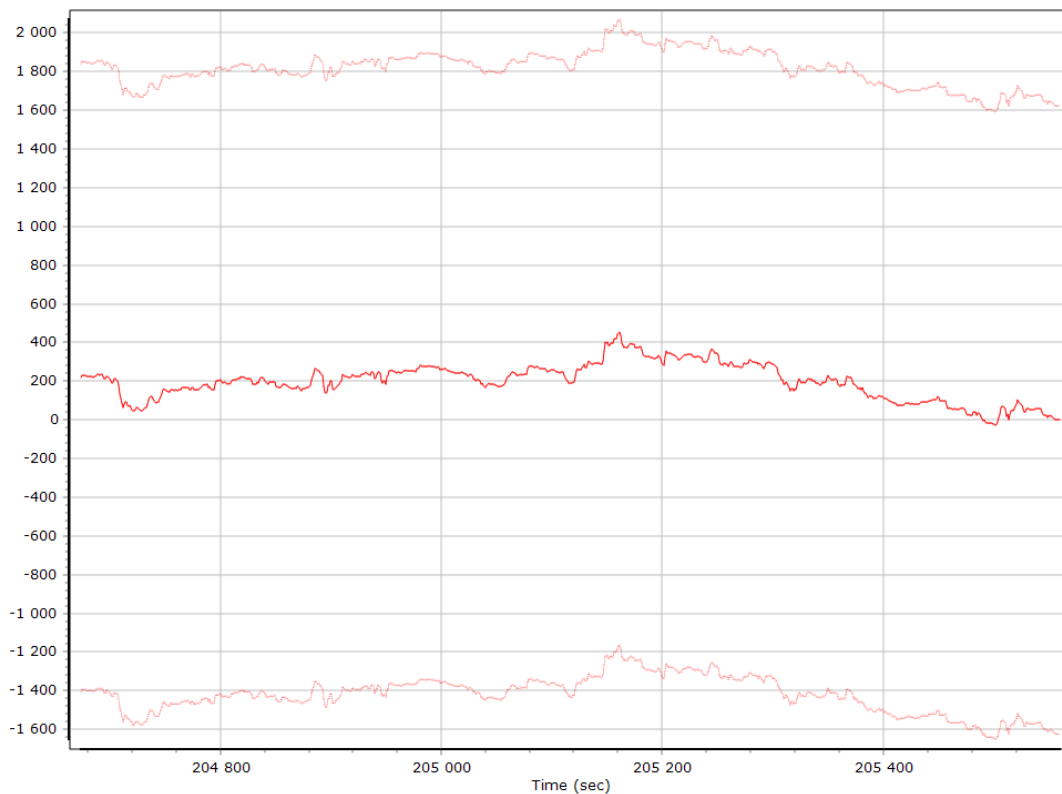


### X Accelerometer Scale Error (ppm)

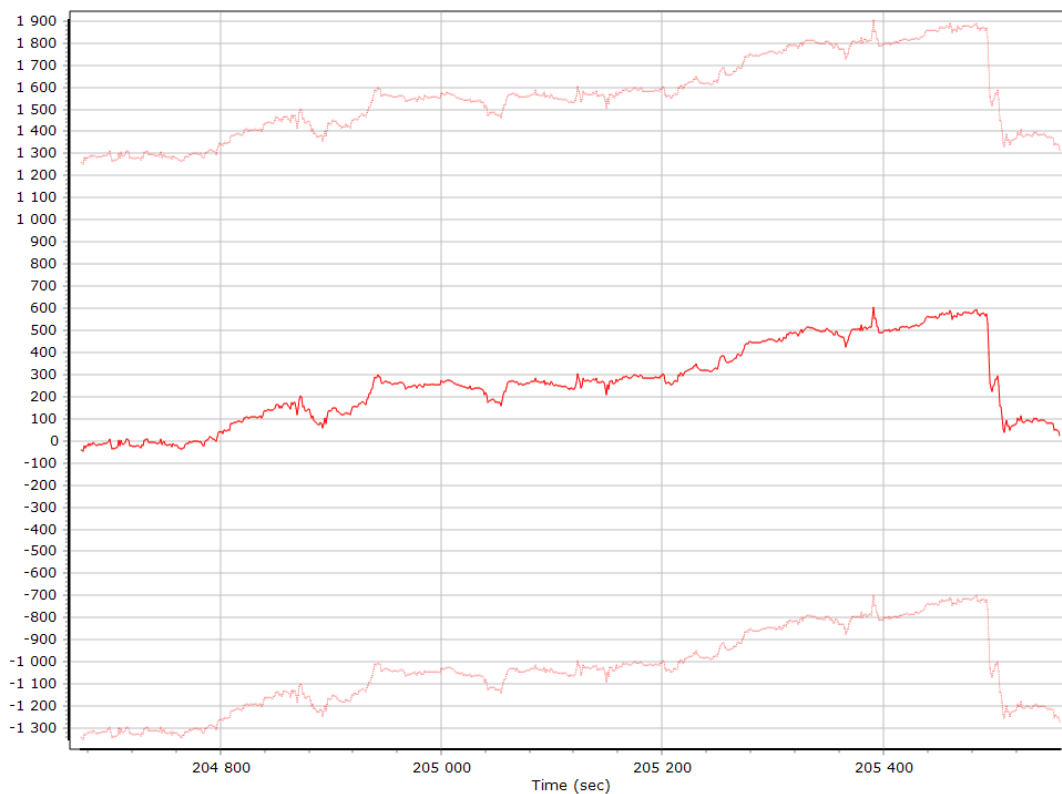




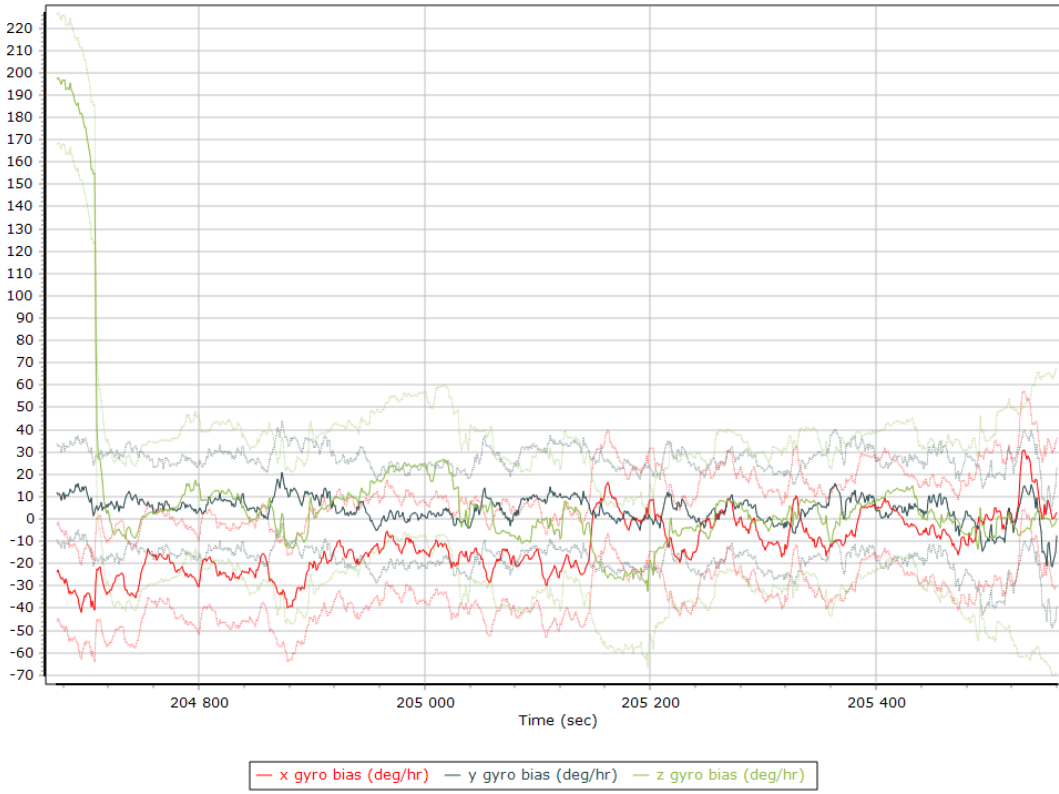
### Y Accelerometer Scale Error (ppm)



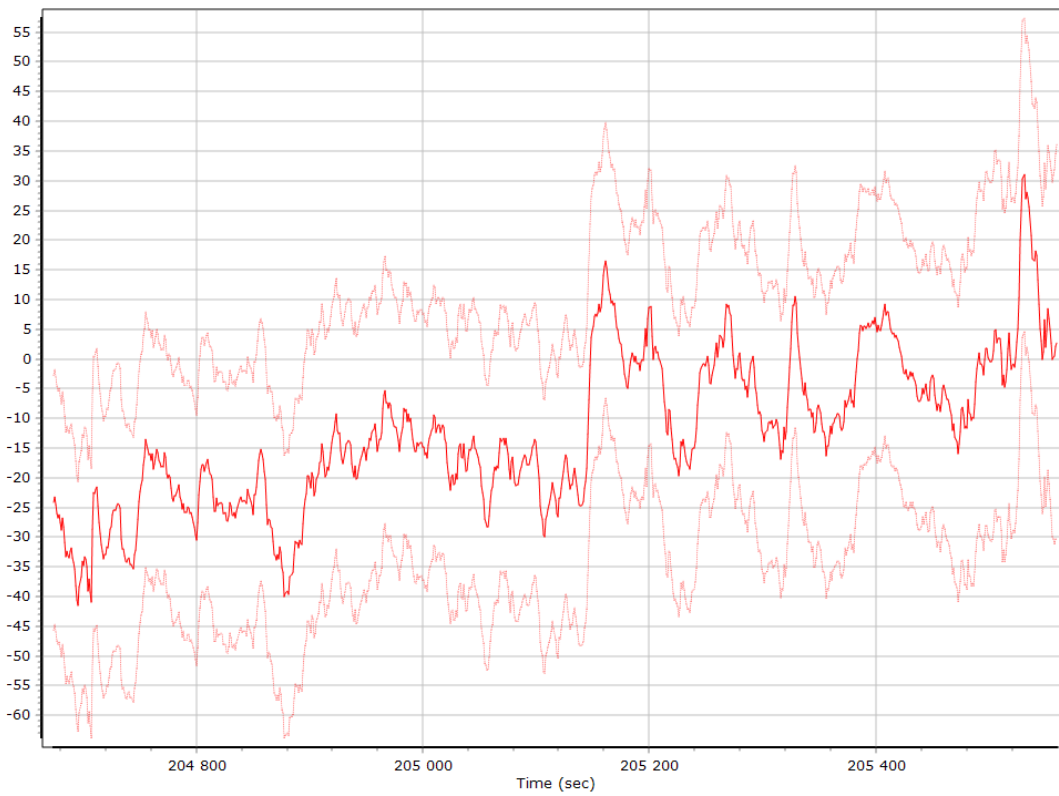
### Z Accelerometer Scale Error (ppm)



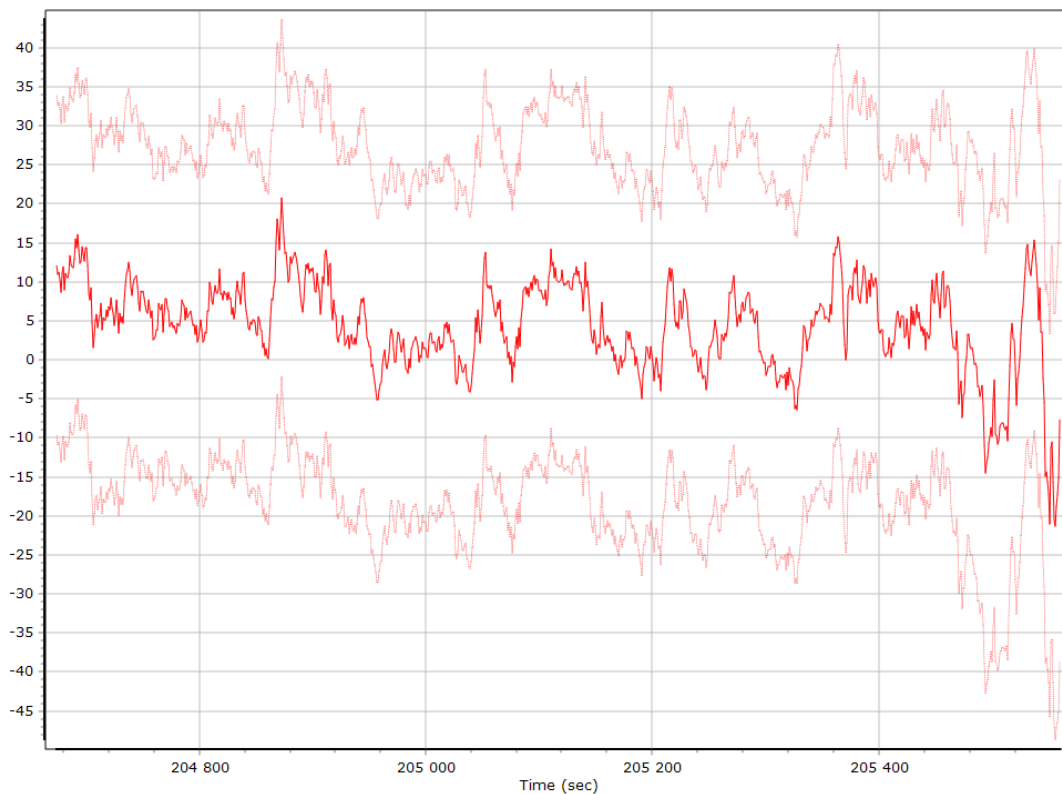
### Gyro Bias (deg/h)



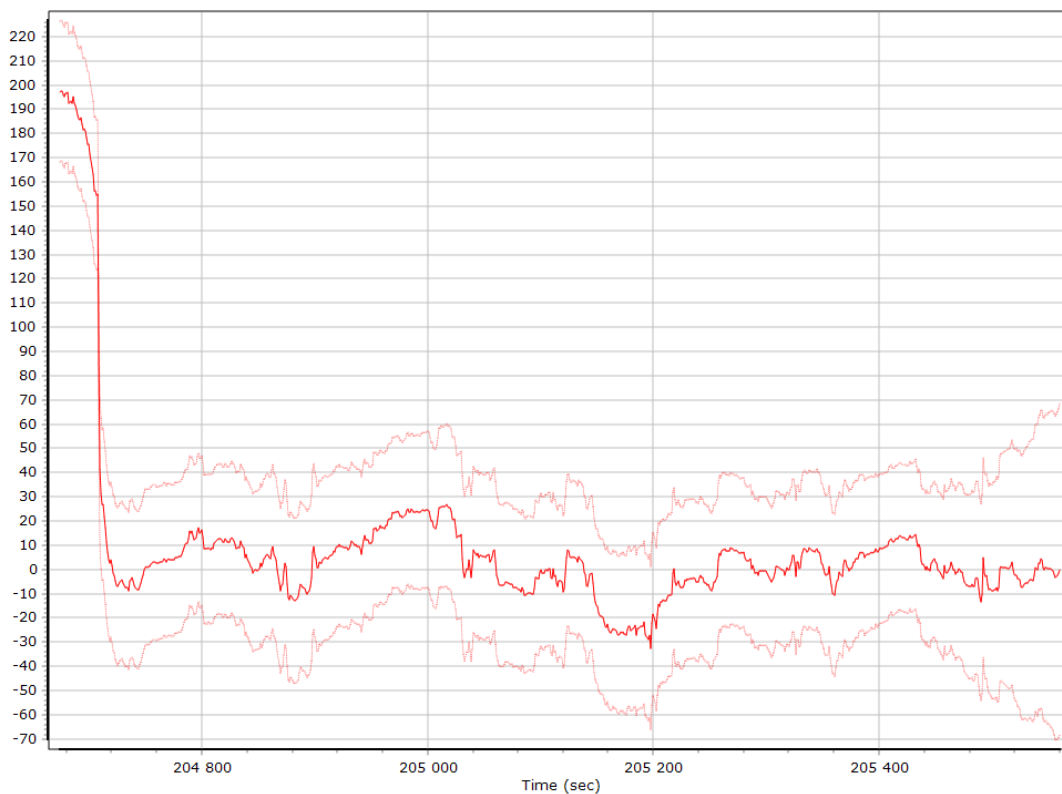
### X Gyro Bias (deg/h)



### Y Gyro Bias (deg/h)

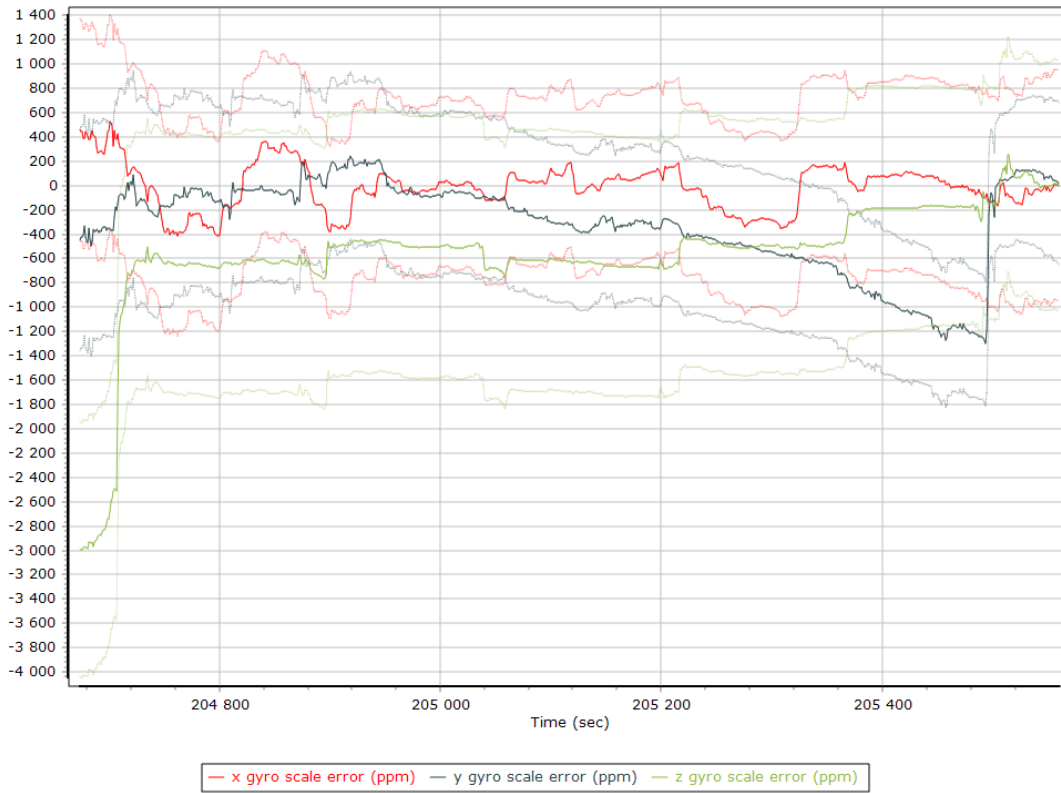


### Z Gyro Bias (deg/h)

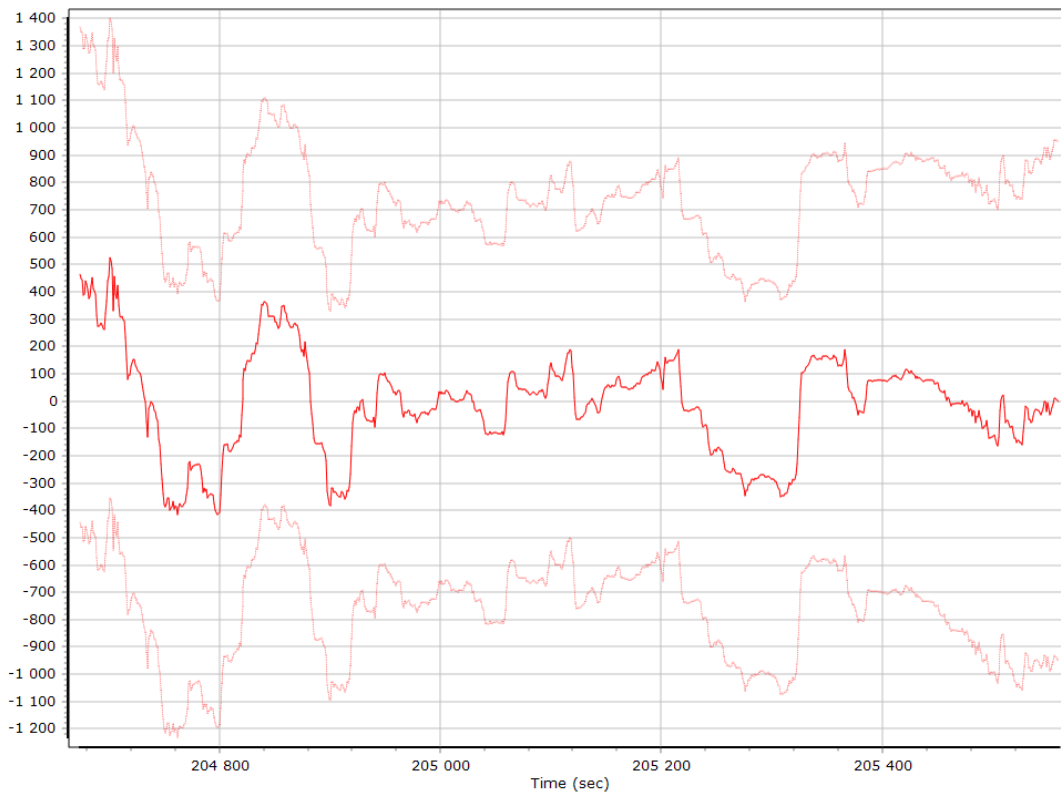




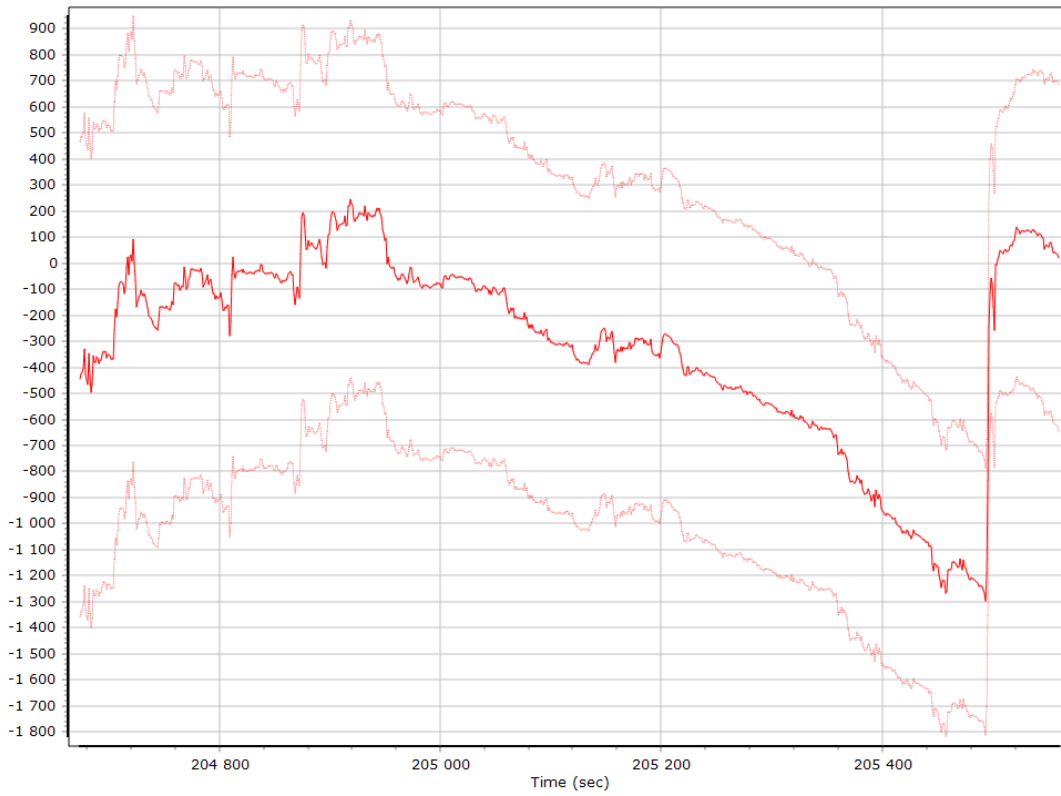
### Gyro Scale Error (ppm)



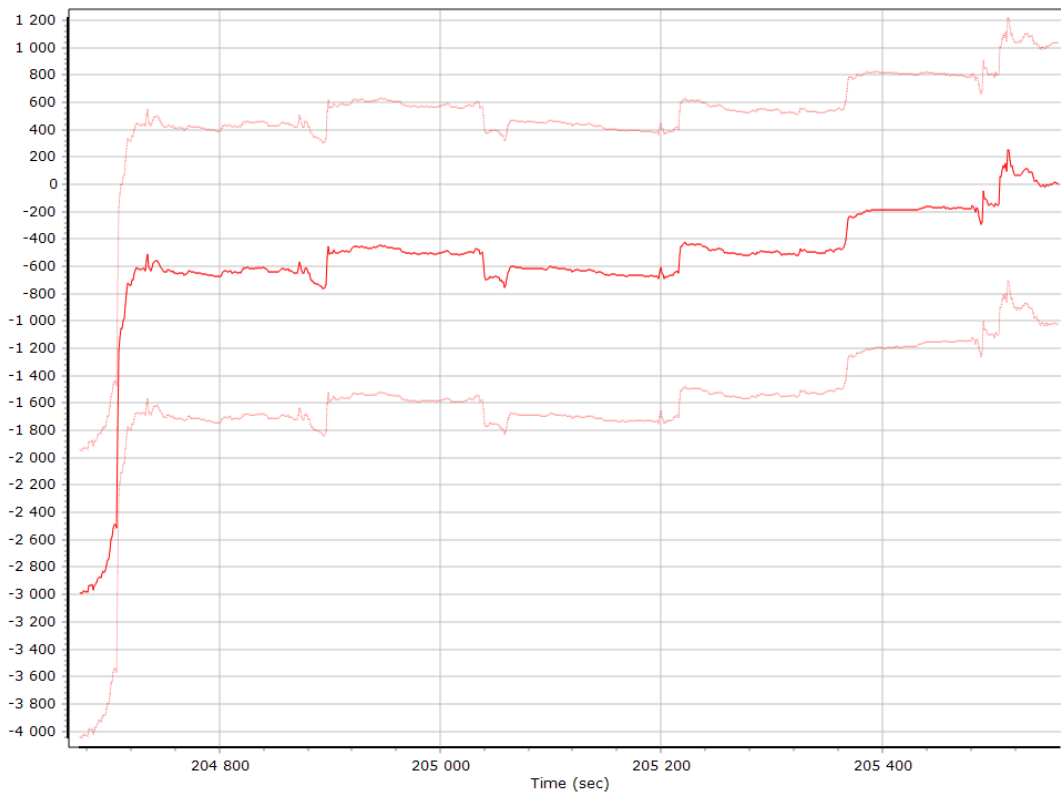
### X Gyro Scale Error (ppm)



### Y Gyro Scale Error (ppm)

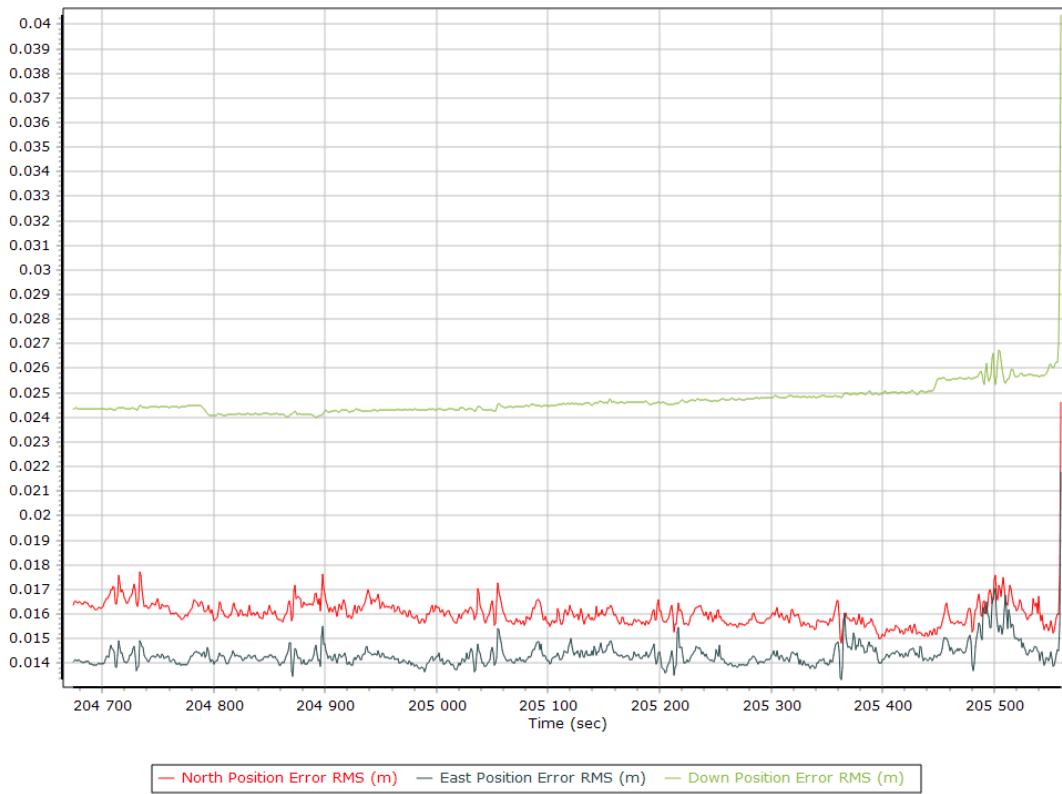


### Z Gyro Scale Error (ppm)

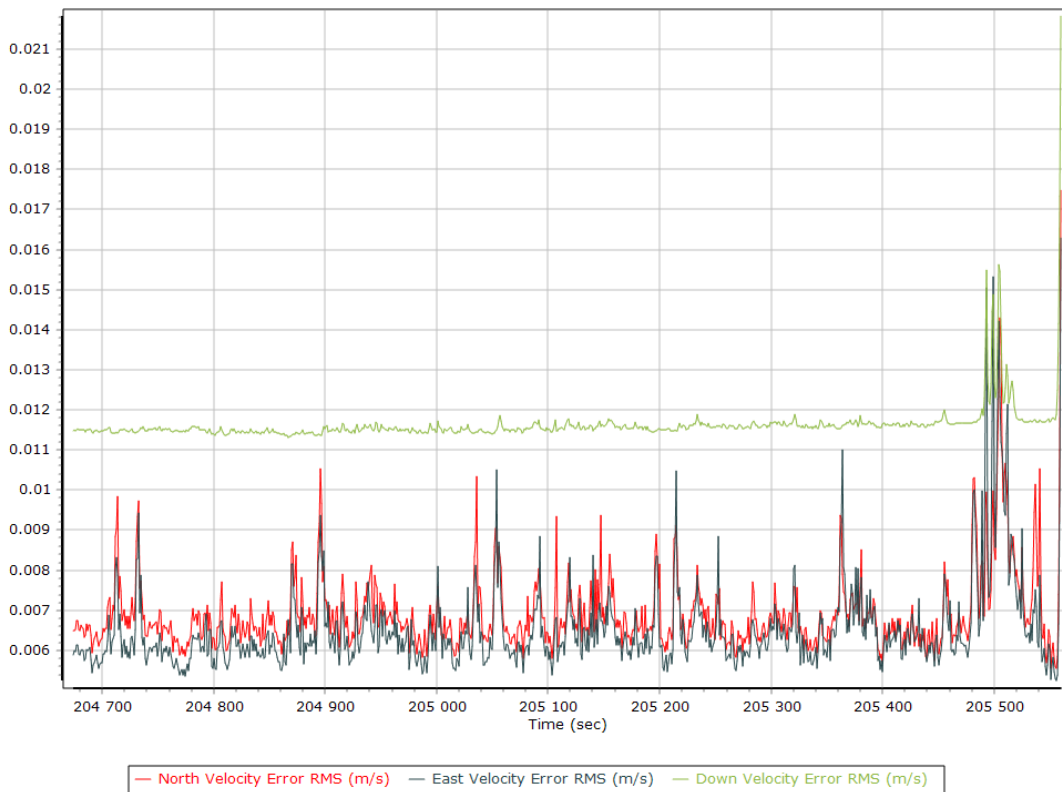


## Smoothed Performance Metrics

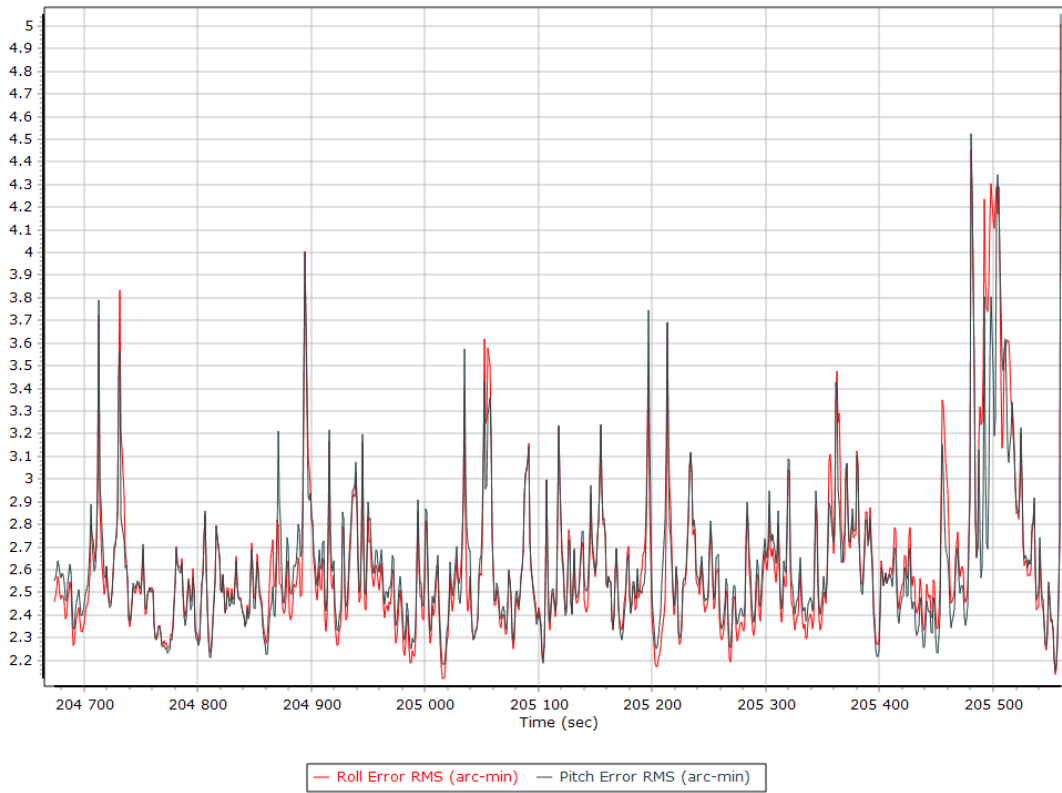
### Position Error RMS (m)



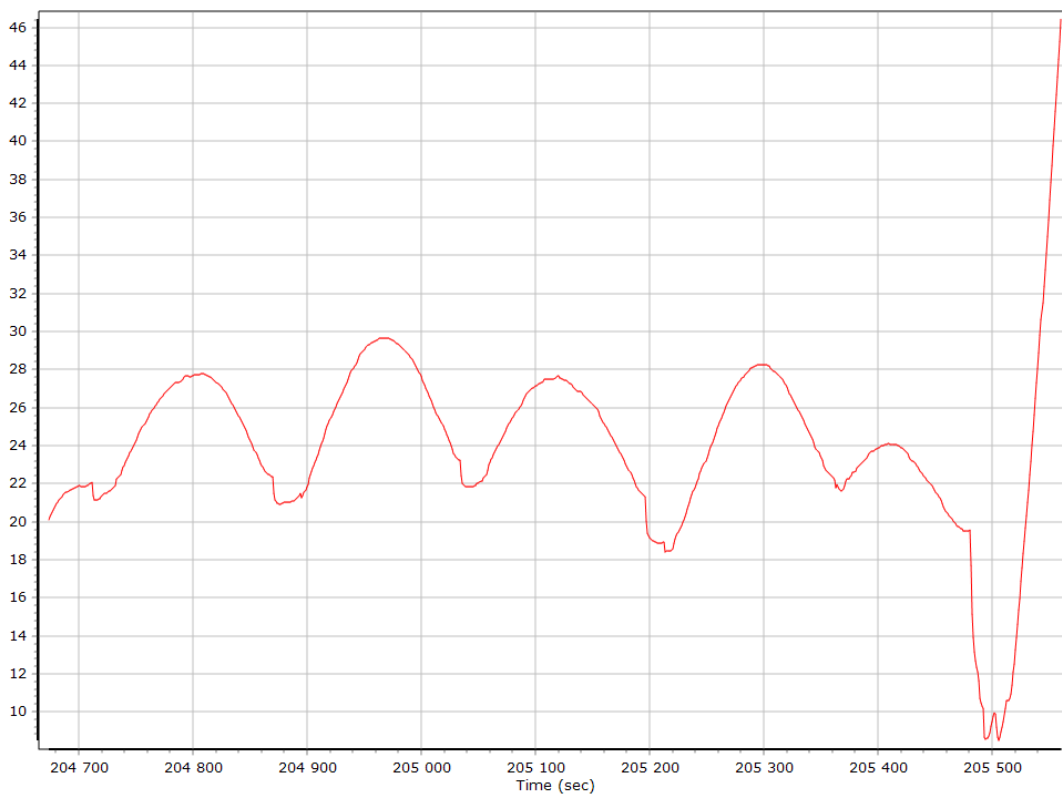
### Velocity Error RMS (m/s)



### Roll/Pitch Error RMS (arc-min)



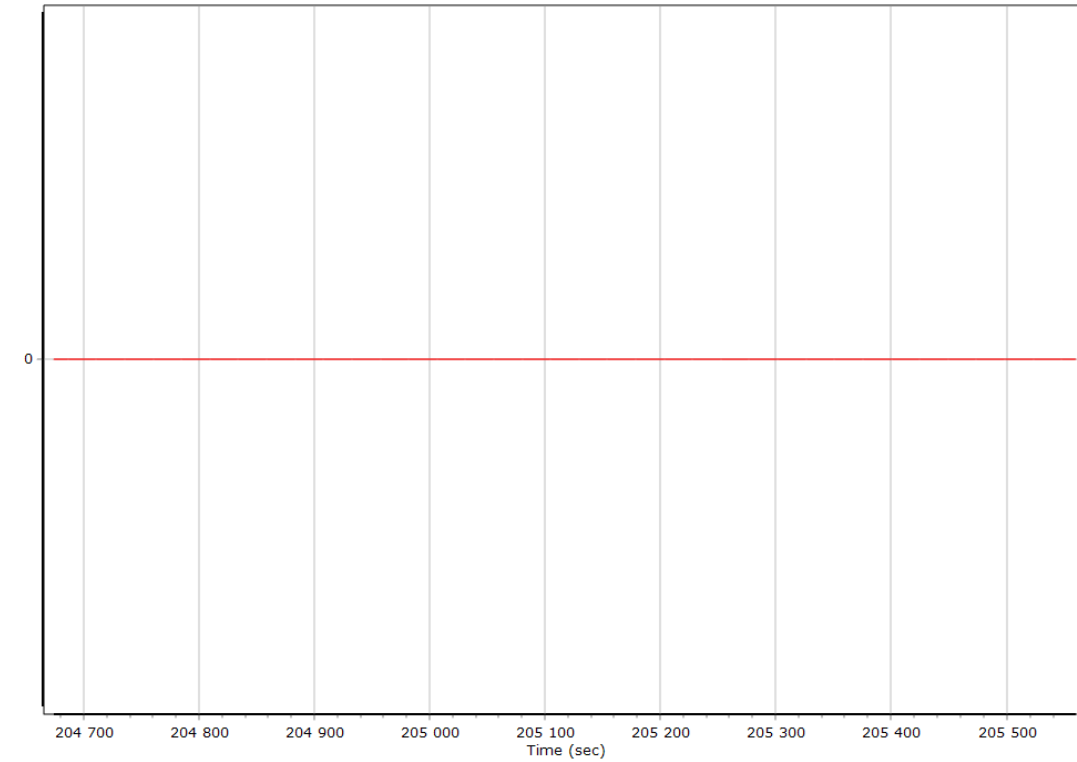
### Heading Error RMS (arc-min)





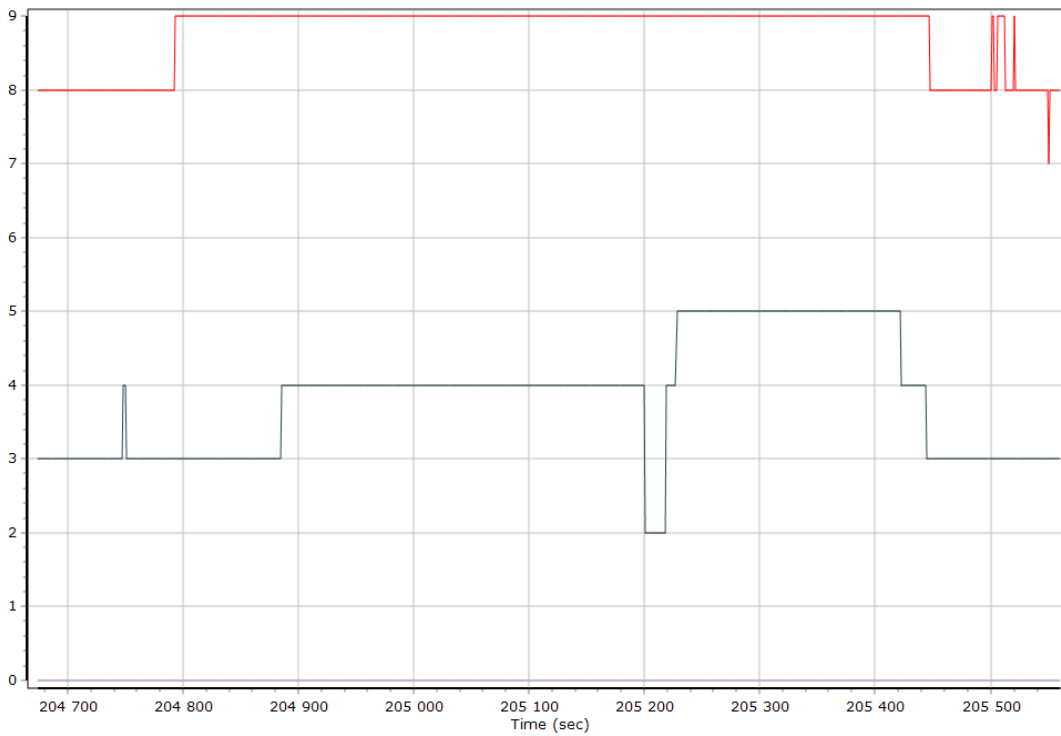
## Smoothed Solution Status

### Processing Mode



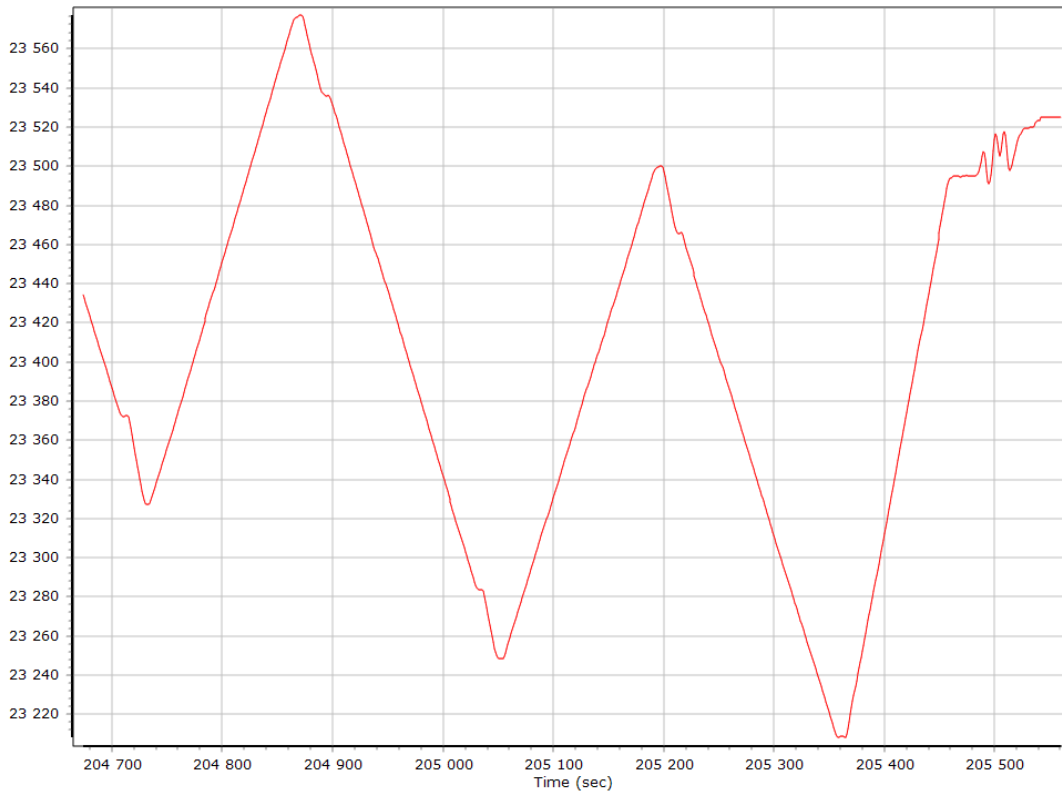
0 = Fixed NL, 1 = Fixed WL, 2 = Float, 3 = DGNSS, 4 = RTCM, 5 = IAPPP, 6 = C/A, 7 = GNSS Nav, 8 = DR

### Number of Satellites

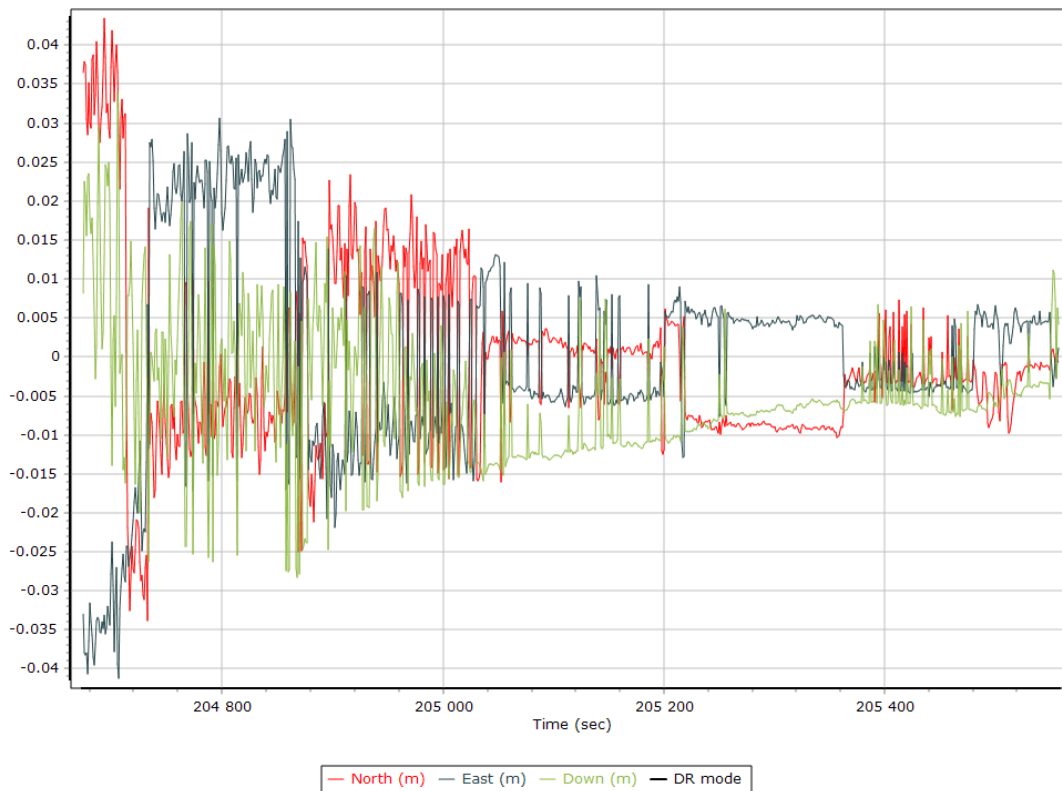


— Number of GPS Satellites — Number of GLONASS Satellites — Number of QZSS Satellites — Number of BEIDOU Satellites

### Baseline Length



### SBET IAkar Separation



## Export Summary

Export file	YS_44_Post_Pac.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	Deg Decimal	
Export start time	204610.001 (3/8/2022 8:50:10 AM)		
Export end time	205560.001 (3/8/2022 9:06:00 AM)		
Height option	Ellipsoid Height		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		

## EO Summary

EO file			
EO format			
Lever arm [m]	0.000	0.000	0.000
Boresight angles [arcmin]	0.000	0.000	0.000
Output rate	All Records		
Rotation sequence	x omega	y phi	z kappa
Local shift [m]	0.000	0.000	0.000
Output units (coordinate / angle / lat & lon)	Meter	Degree	Deg Decimal
Height option	Ellipsoid Height		
WGS84 height flag	False		
Scale height option	False		
Kappa cardinal rotation [deg]	0		
Solution in use	Post-processed		
EO start time	204610.001 (3/8/2022 8:50:10 AM)		
EO end time	205560.001 (3/8/2022 9:06:00 AM)		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		



## General Information

### Mission Information

Project name	CastelRoc49
Processing date	2022-03-09 10:50:26
Mission date	2022-03-08 09:38:13
Mission duration	00:17:32.989
Processing mode	IN-Fusion Single Base
GPS Station	ALBM

### Rover Hardware Information

Product	APX 15 AVX 210 VER0 174
Serial number	S/N001
IMU type	59
Receiver type	APX-15v3
Antenna type	AV14

## Project File List

### Rover Data Files

File name	File type
YS-20220308-093749.T04	T04 Rover Data

### Input Files

File Name	File type
Ephm0670.22g	GLONASS Broadcast Ephemeris
Ephm0670.22n	GPS Broadcast Ephemeris
albm067z.22o	GNSS SingleBase
lsda067z.22o	GNSS SingleBase
albm067z.22o	GNSS SingleBase
lsda067z.22o	GNSS SingleBase

### Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
49_PostPac.txt	ASCII Export Output

## Rover Data Summary

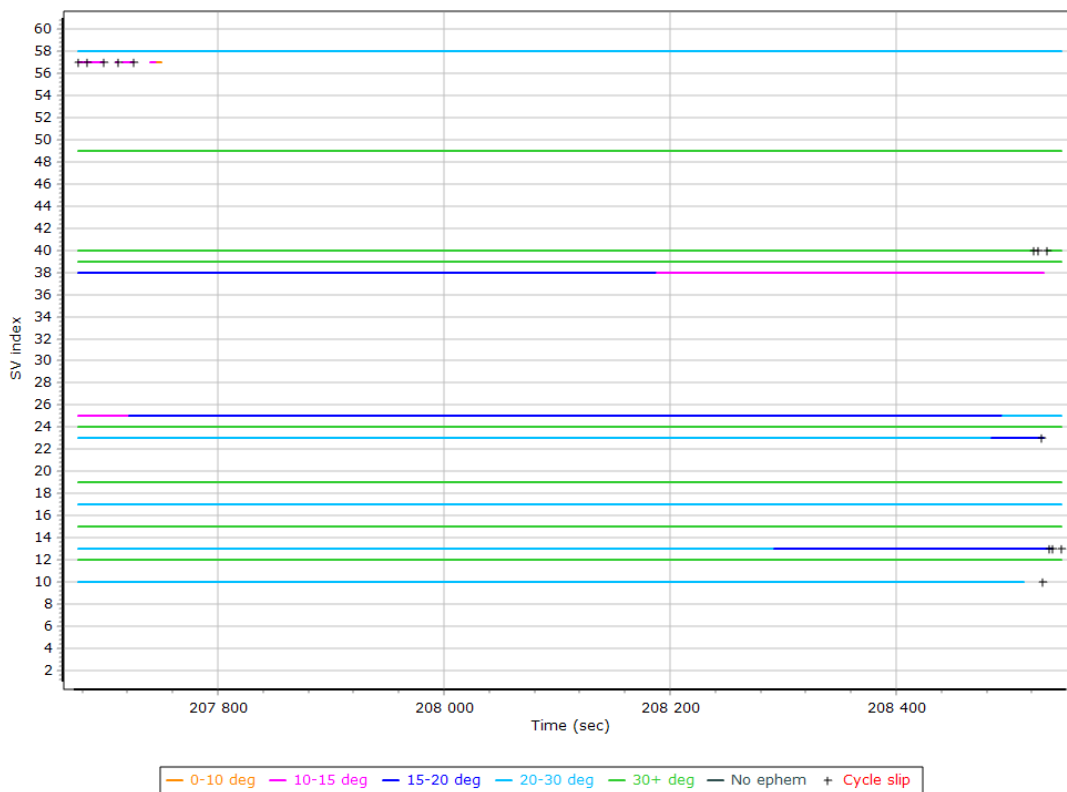
First raw data file	YS-20220308-093749.T04		
Last raw data file	YS-20220308-093749.T04		
Start GPS week	2200		
Start time	207493.000 (3/8/2022 9:38:13 AM)		
End time	208546.000 (3/8/2022 9:55:46 AM)		
Start of fine alignment	207616.000 (3/8/2022 9:40:16 AM)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
<b>IMU Installation Lever Arms &amp; Mounting Angles</b>			
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.006	0.218	-0.435
Reference to Primary GNSS lever arm std dev [m]	0.020		
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

## Raw Data QC

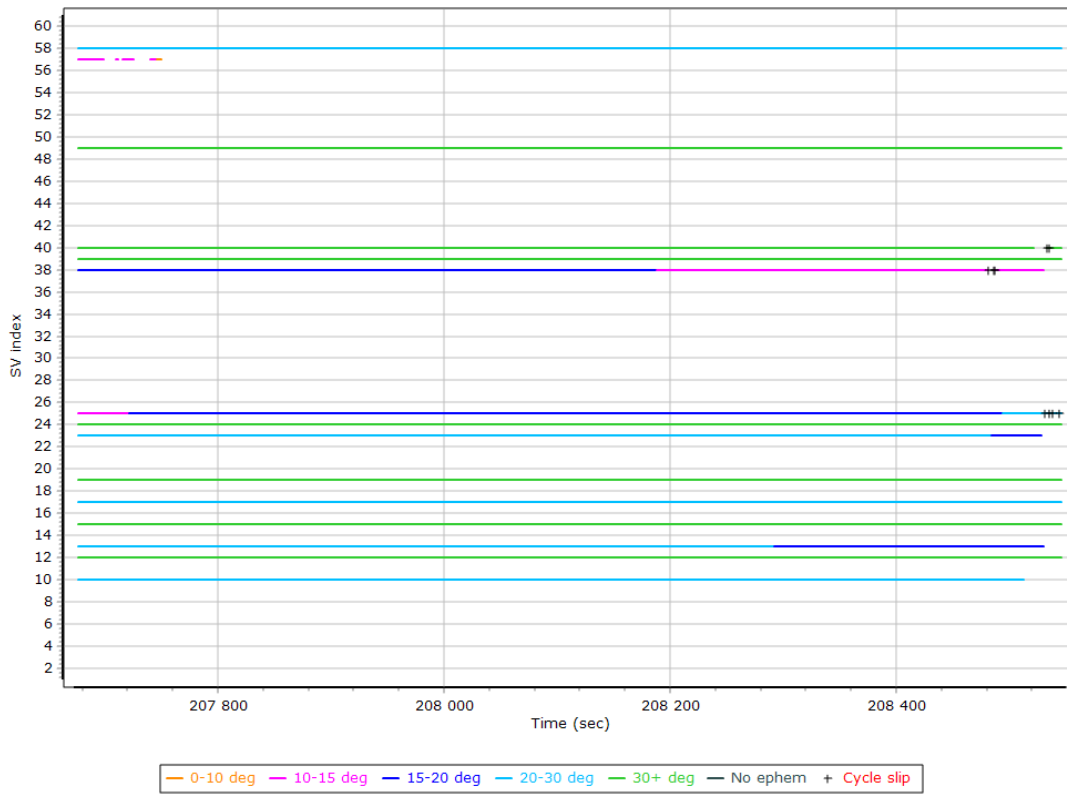
### Raw IMU Import QC Summary

IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	210630
Termination Status	Normal
IMU Anomalies	0

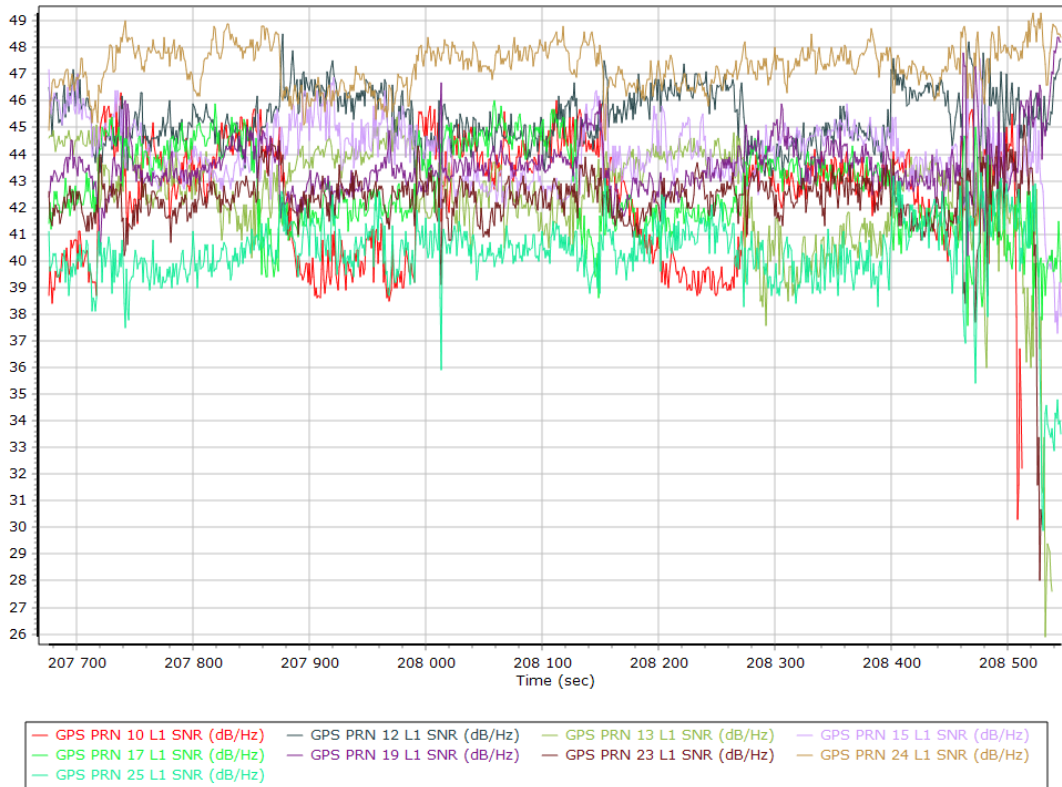
### L1 Satellite Lock/Elevation



## L2 Satellite Lock/Elevation

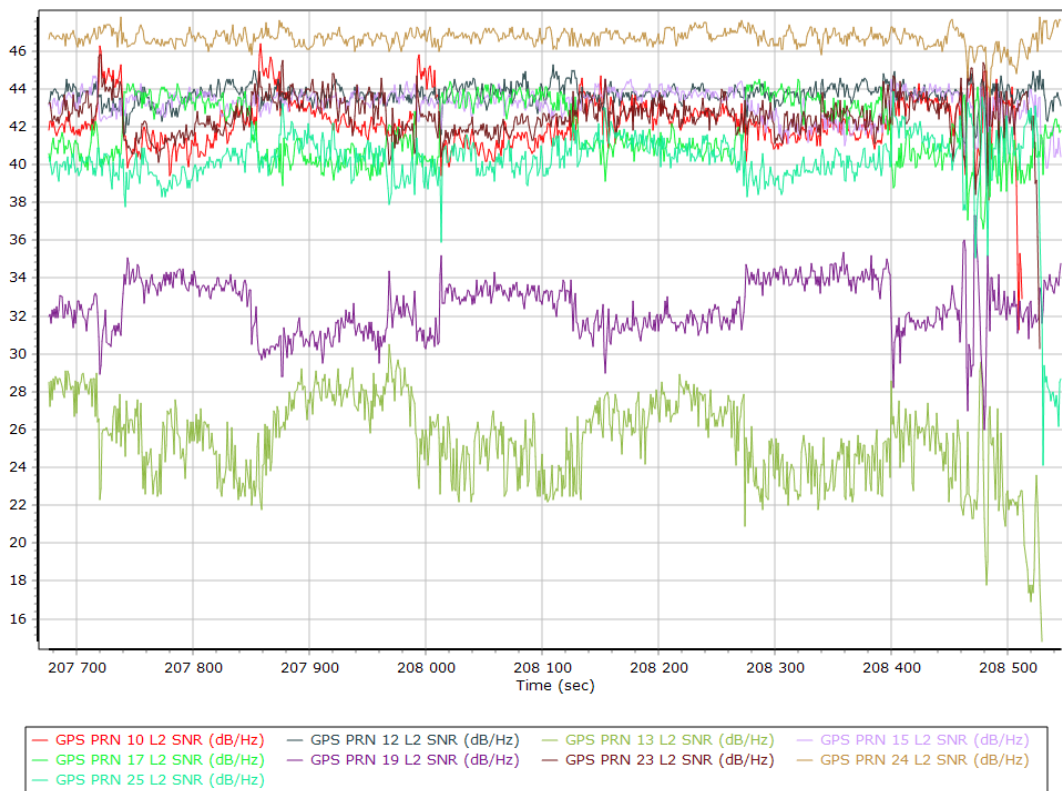


## GPS L1 SNR

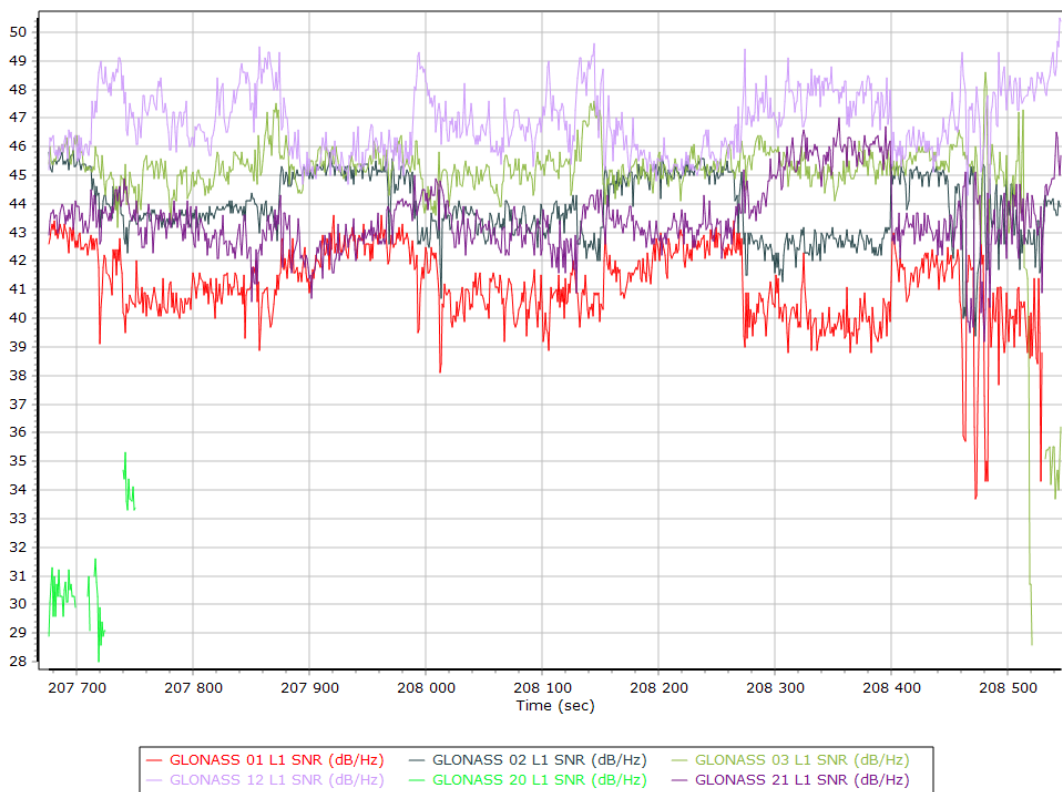




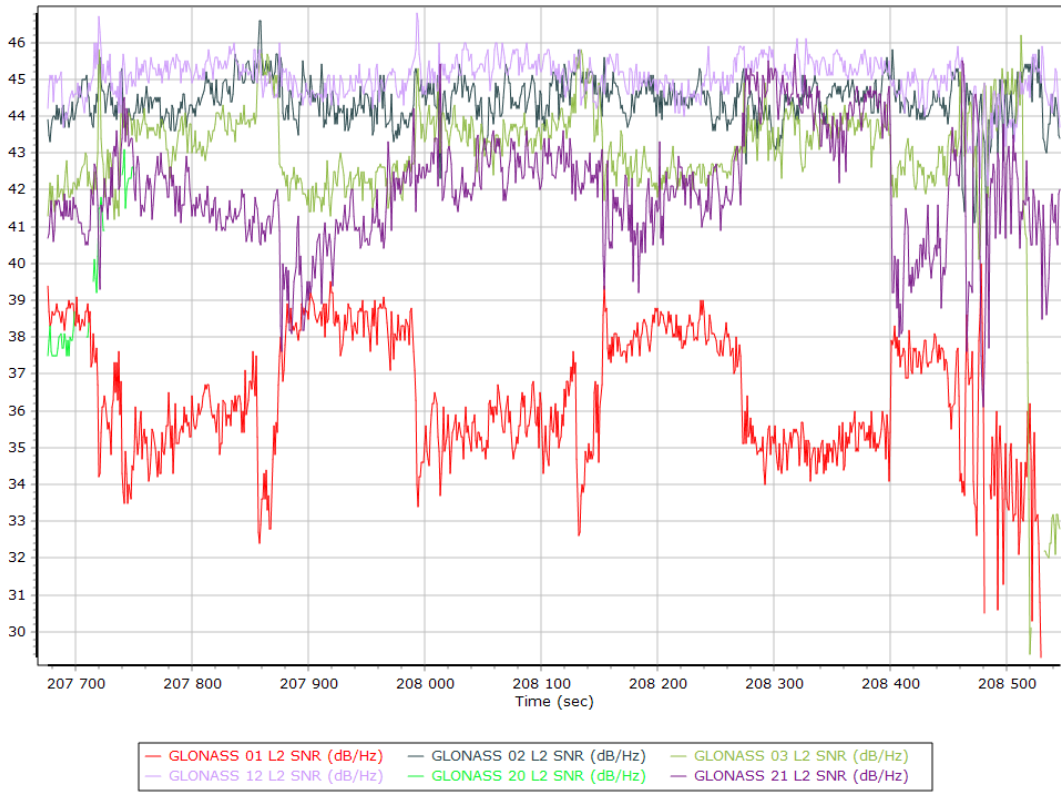
### GPS L2 SNR



### GLONASS L1 SNR

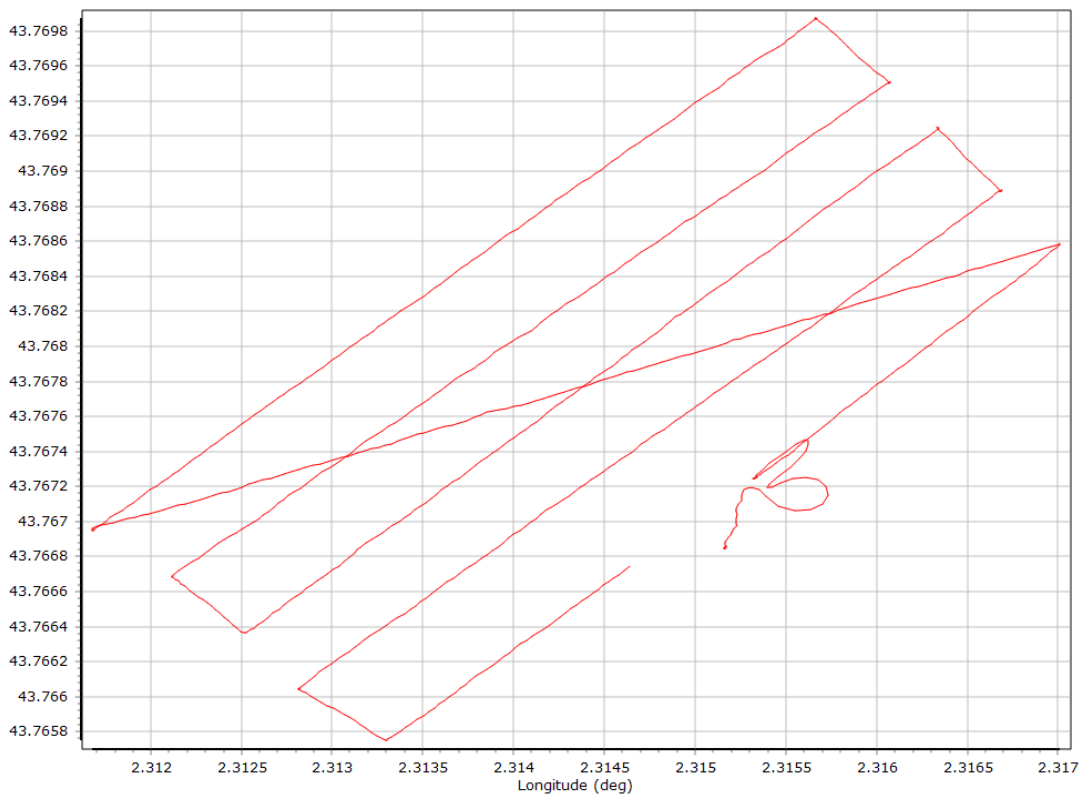


## GLONASS L2 SNR

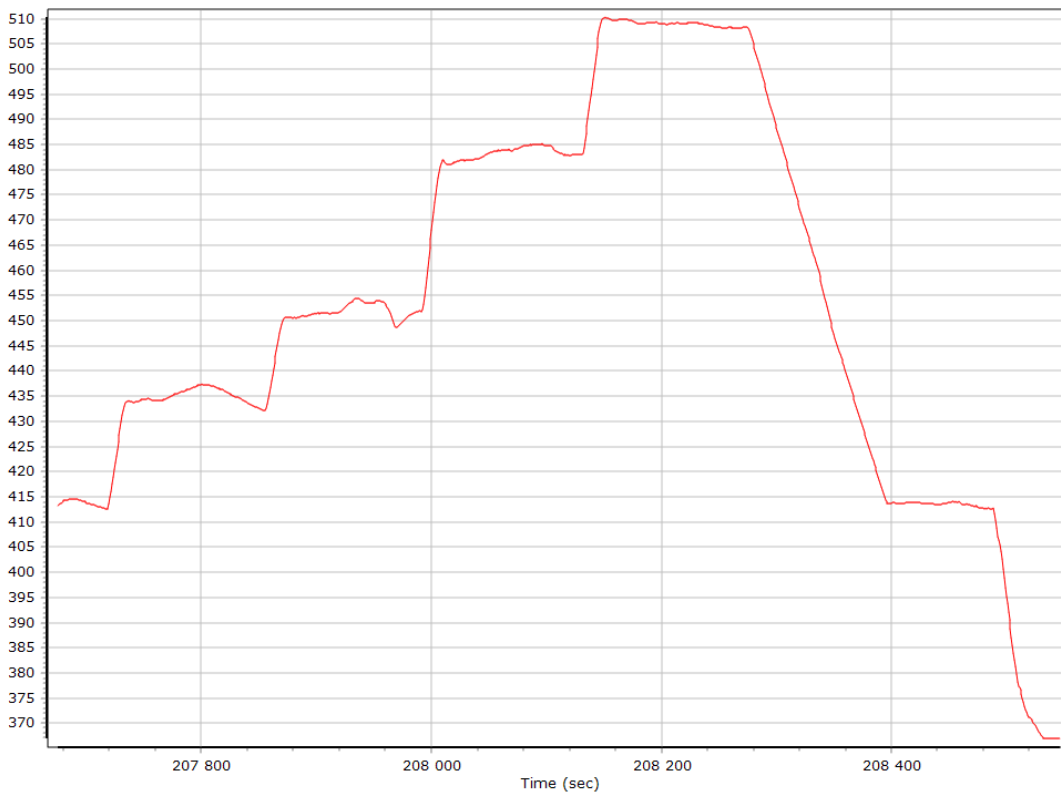


## Trajectory Information

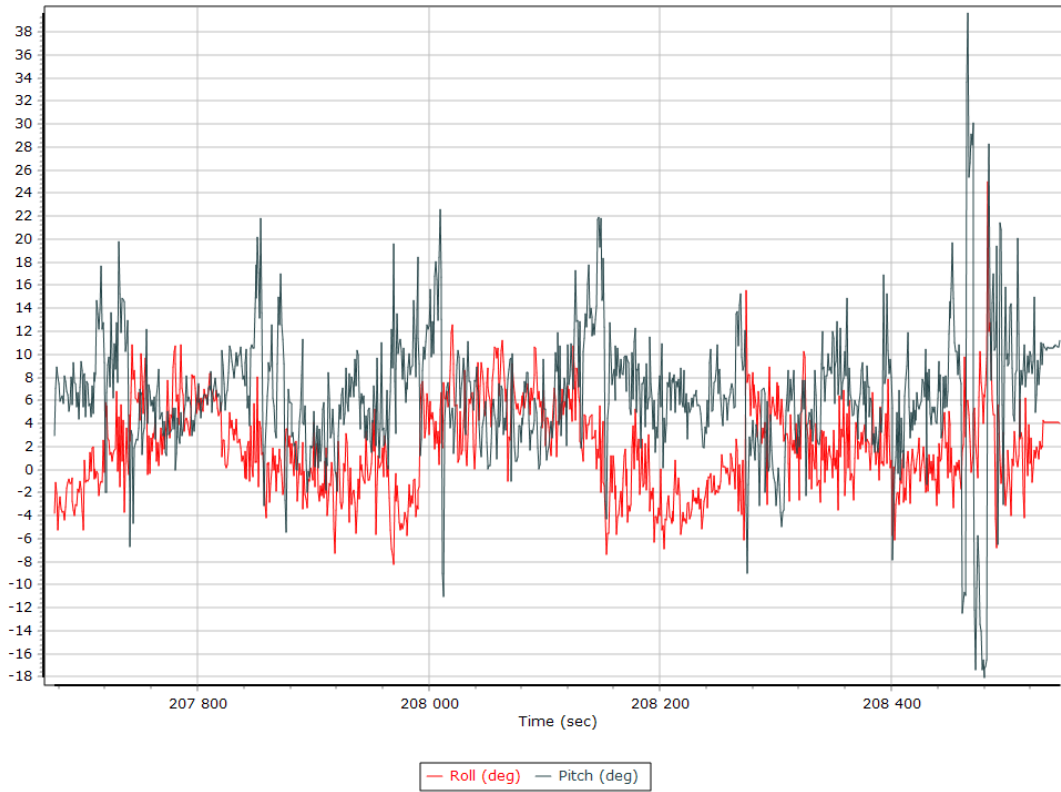
### Top View



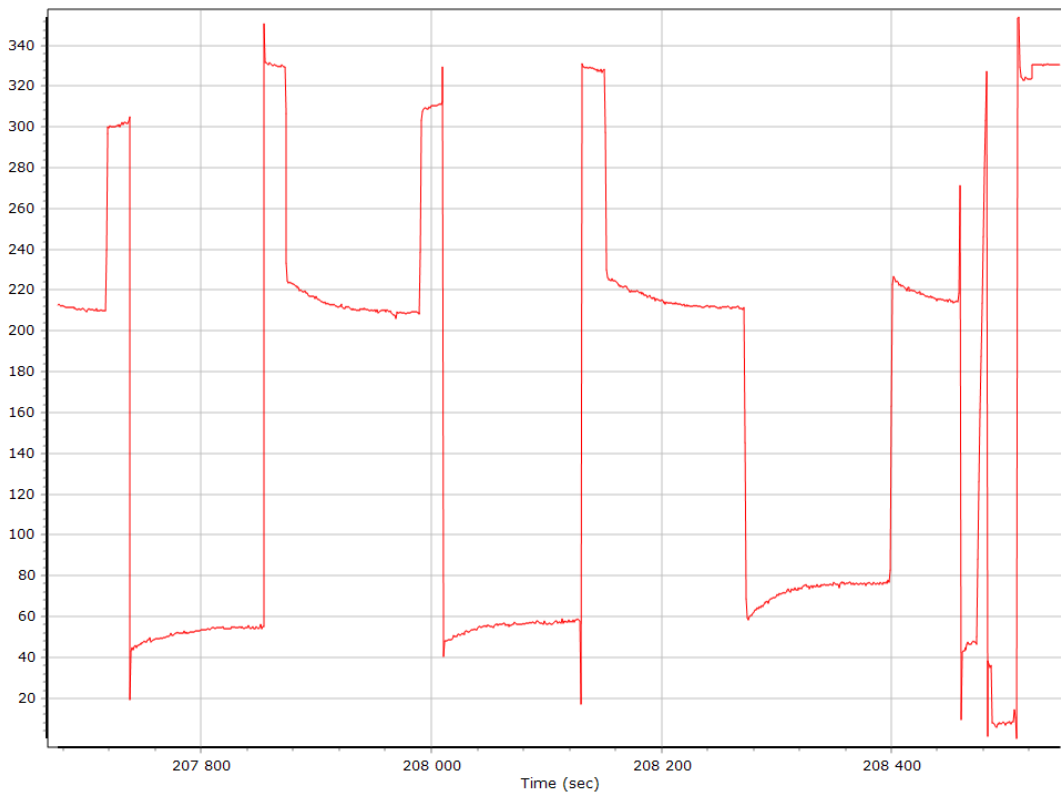
### Altitude



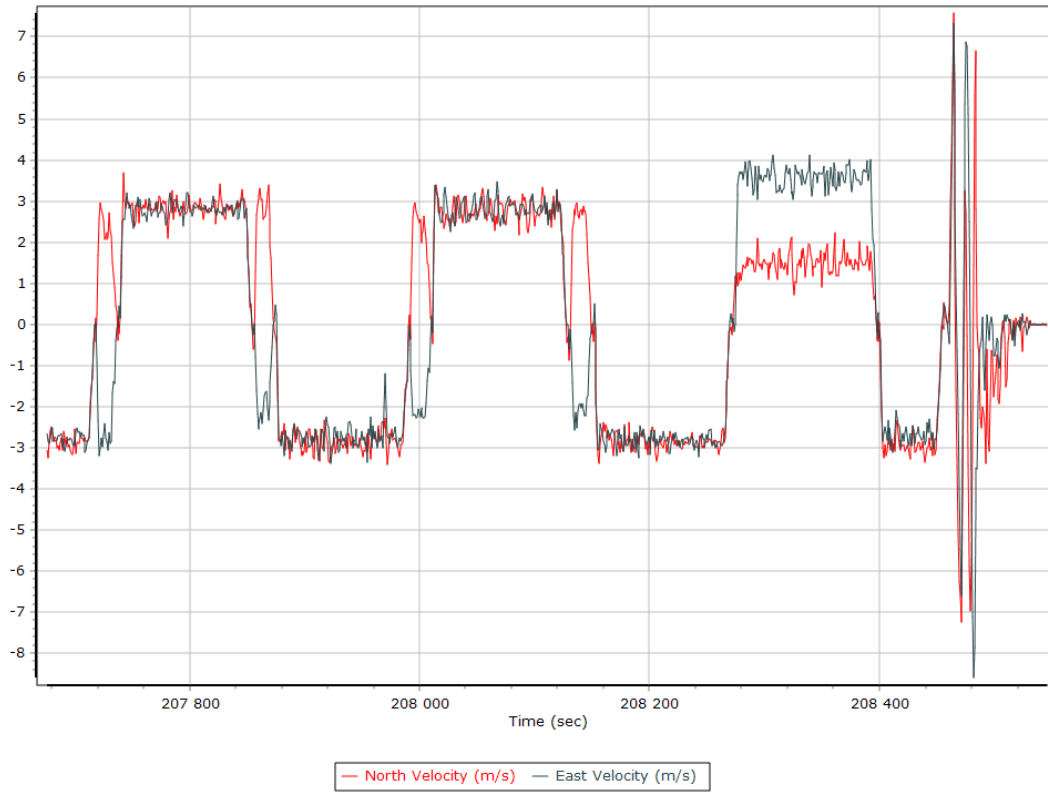
## Roll/Pitch



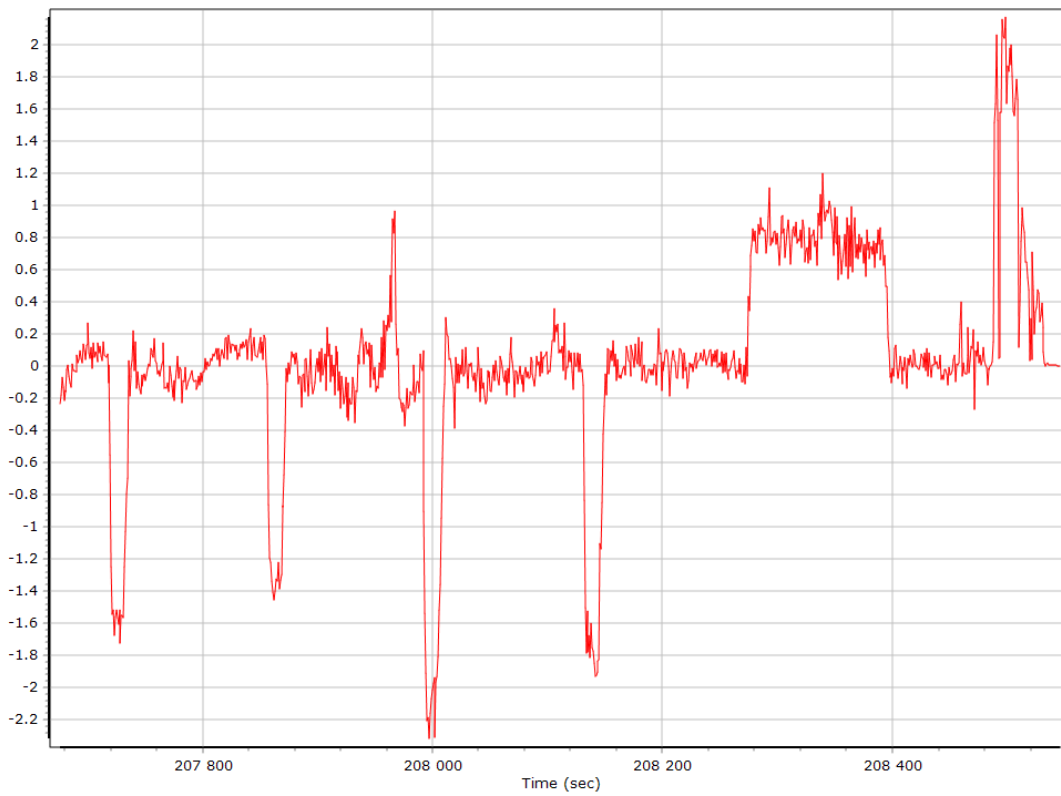
## Heading



## North/East Velocity

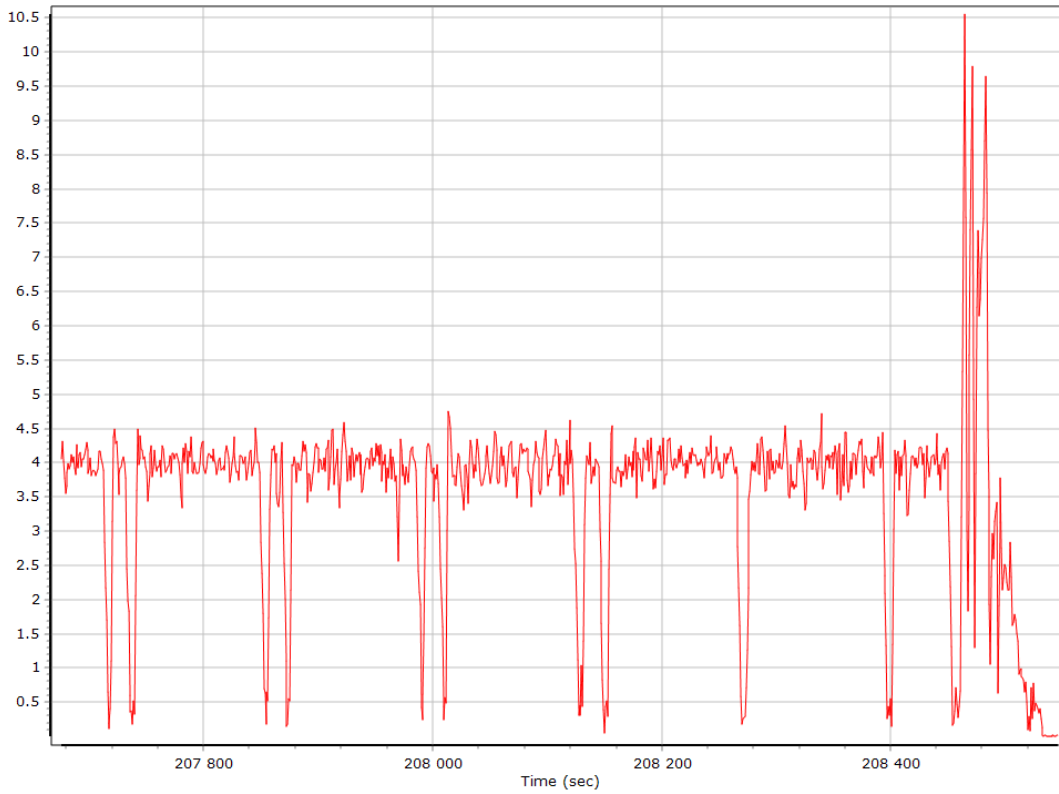


## Down Velocity

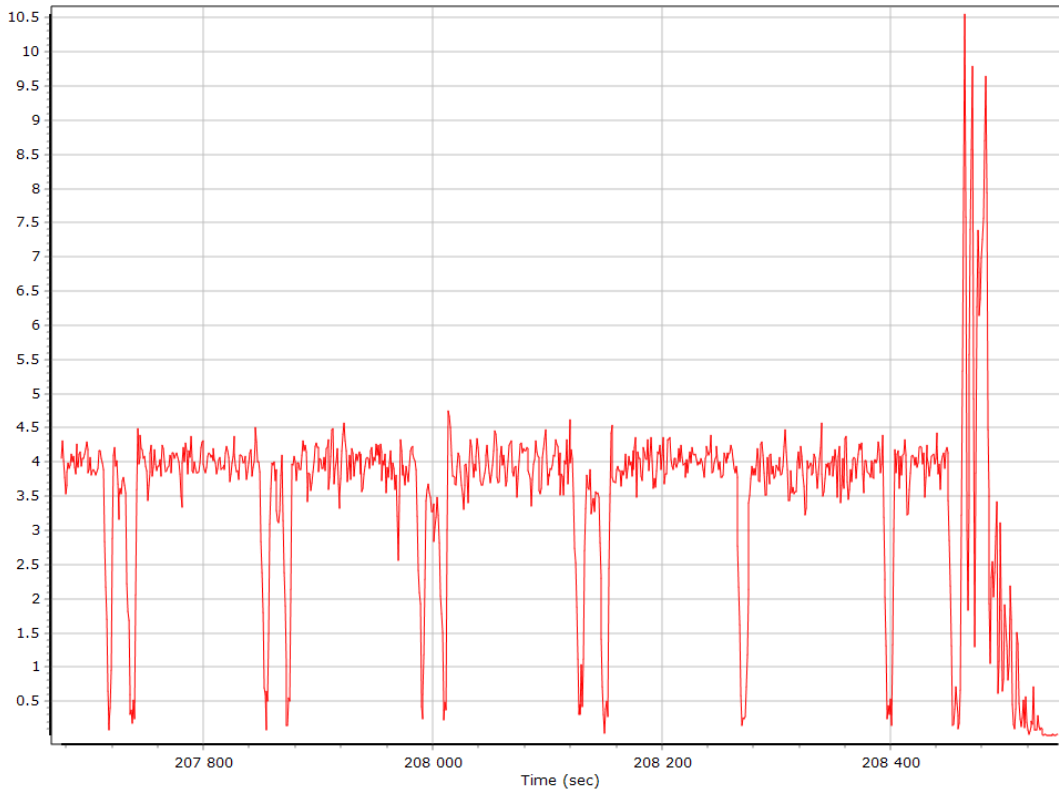




## Total Speed



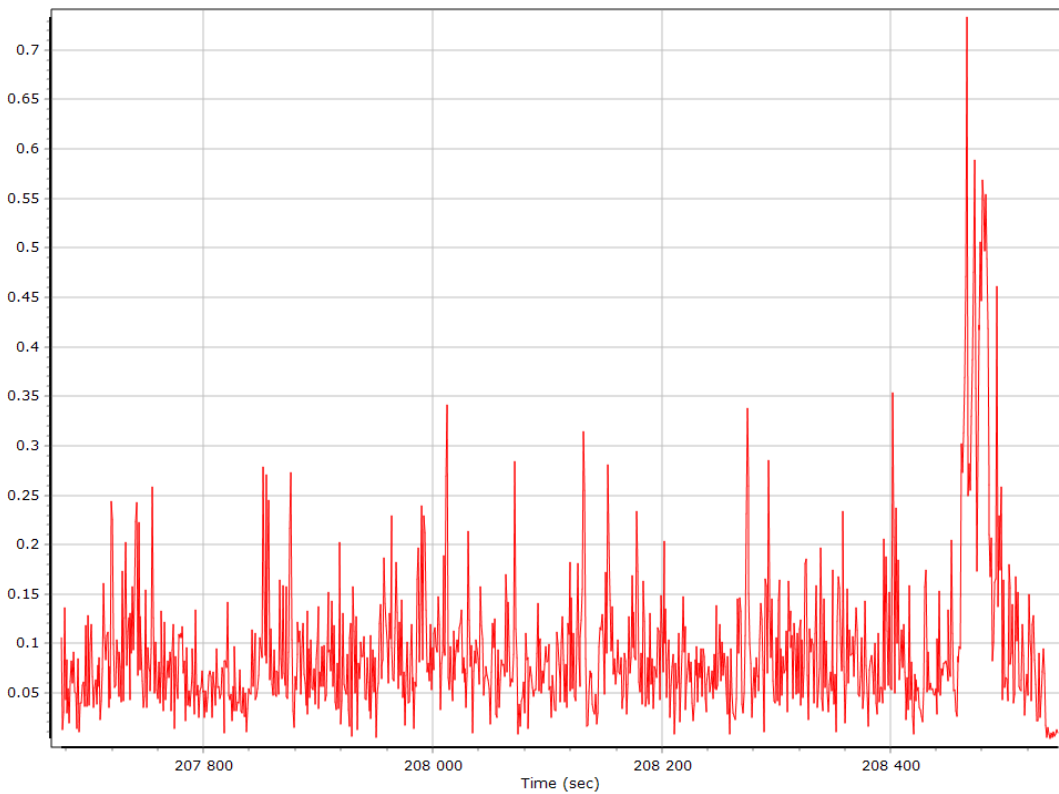
## Ground Speed



## Body Acceleration



## Total Body Acceleration



## Body Angular Rate



## Base Station Information

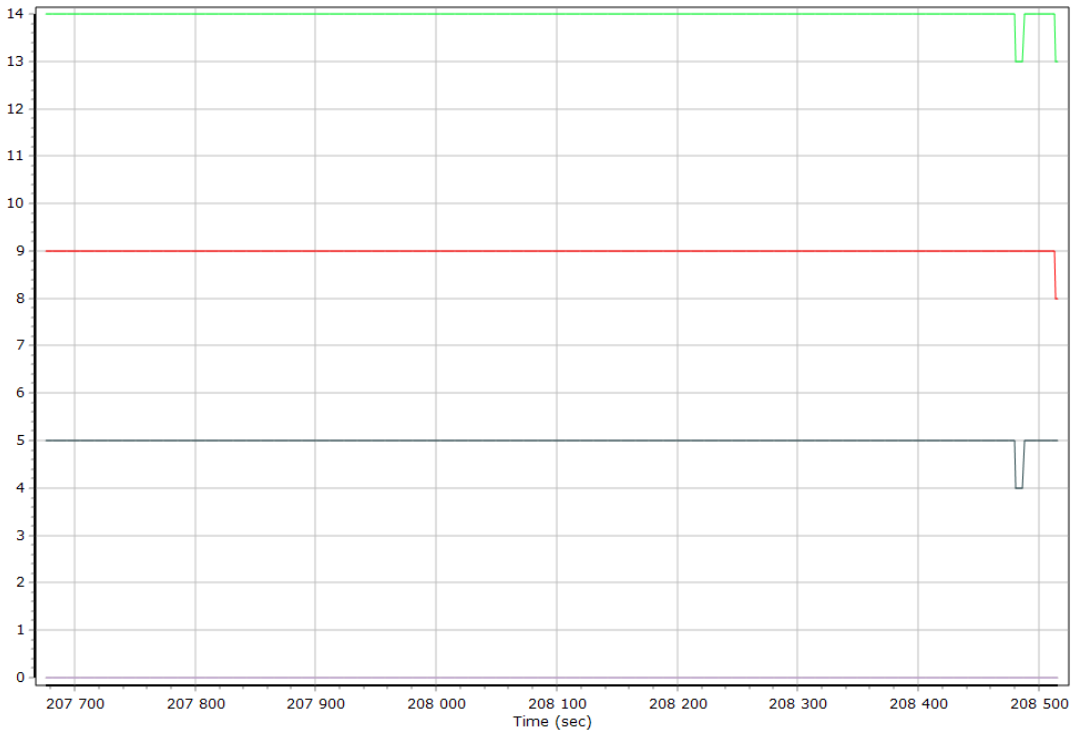
Station ID	ALBM		
Filename	a1bm067z.22o		
Start date	3/8/2022 8:00:00 AM		
End date	3/8/2022 4:59:59 PM		
Duration	08:59:59.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Trimble	NetR9	5647R50543
Antenna manufacturer, model	Trimble	Zephyr Geodetic 2 RoHS	
Antenna height [m]	0.000		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC [m]	0.08546		
Latitude	N43°56'49.74078"		
Longitude	E2°09'08.78934"		
Ellipsoidal height [m]	222.72020		
Frame	ITRF00		
Epoch	1997		
Ellipsoid	WGS84		
Velocity North [mm/y]	0		
Velocity East [mm/y]	0		
Velocity Up [mm/y]	0		

## GNSS QC

### GNSS QC Statistics

Statistics	Min	Max	Mean
Baseline length [km]	23.67	23.95	
Number of GPS SV	5	9	9
Number of GLONASS SV	3	5	5
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Total number of SV	8	14	14
PDOP	1.36	4.79	1.52
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (s)	1023.00	0.00	0.00
Percentage	100.00	0.00	0.00

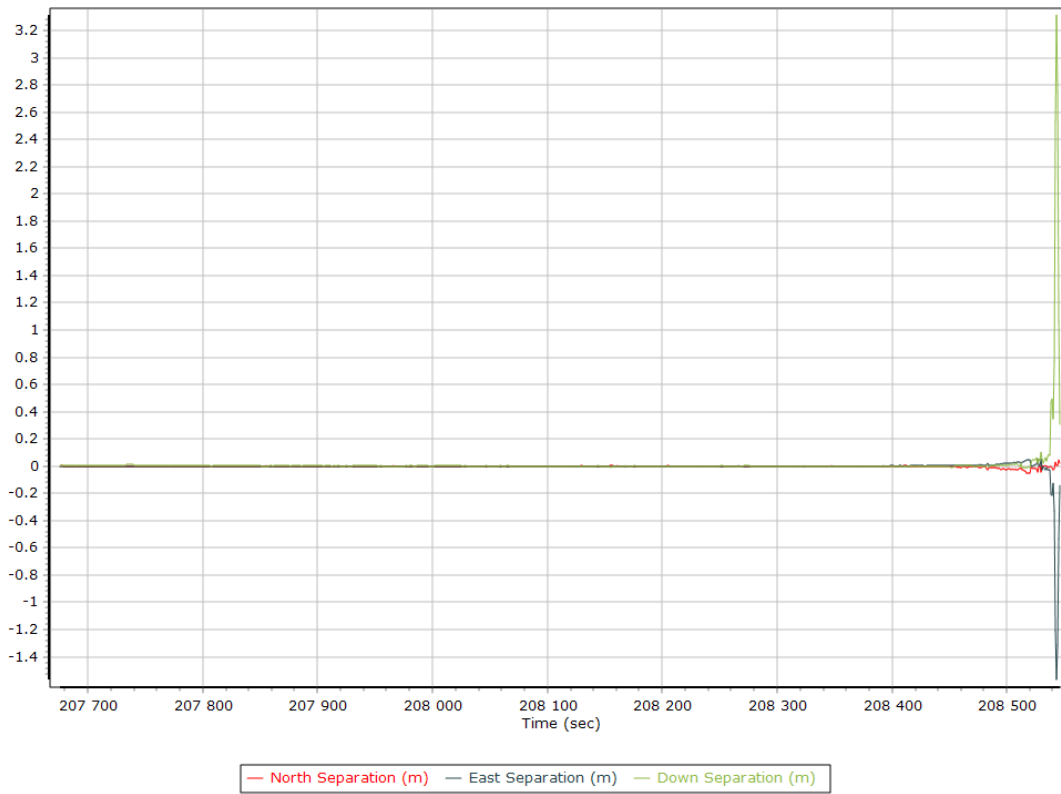
### Num SVs in solution



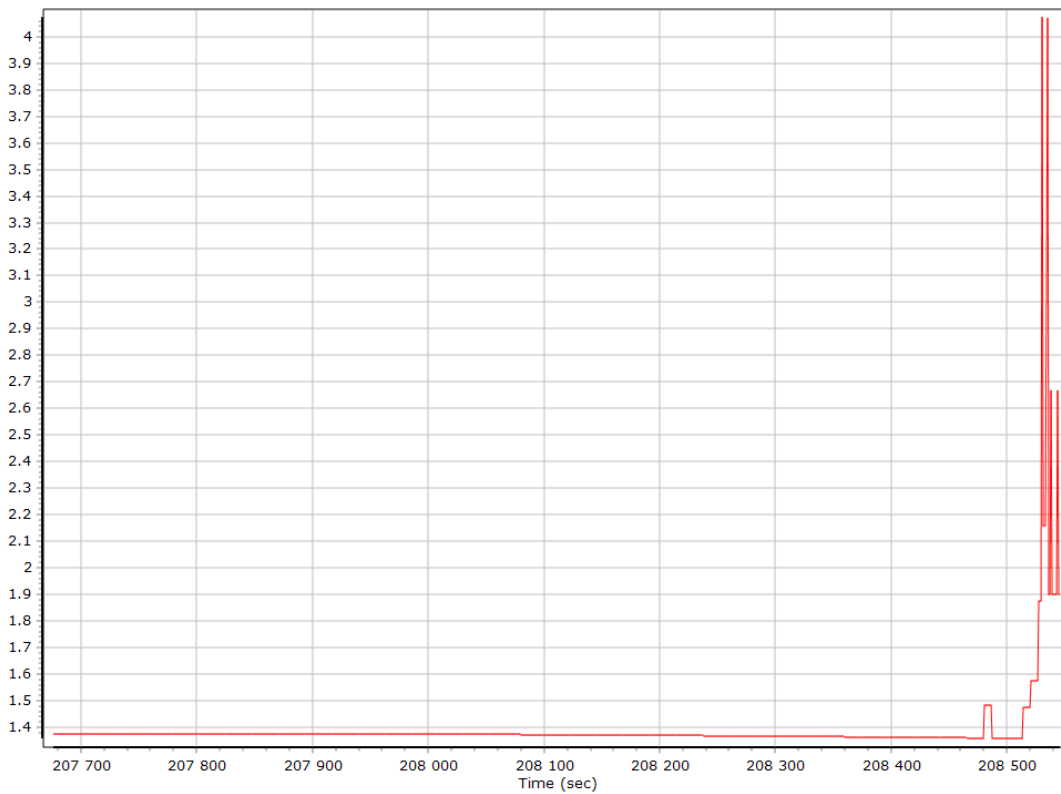
— Number of GPS — Number of GLONASS — Number of QZSS — Number of BEIDOU — Total Number



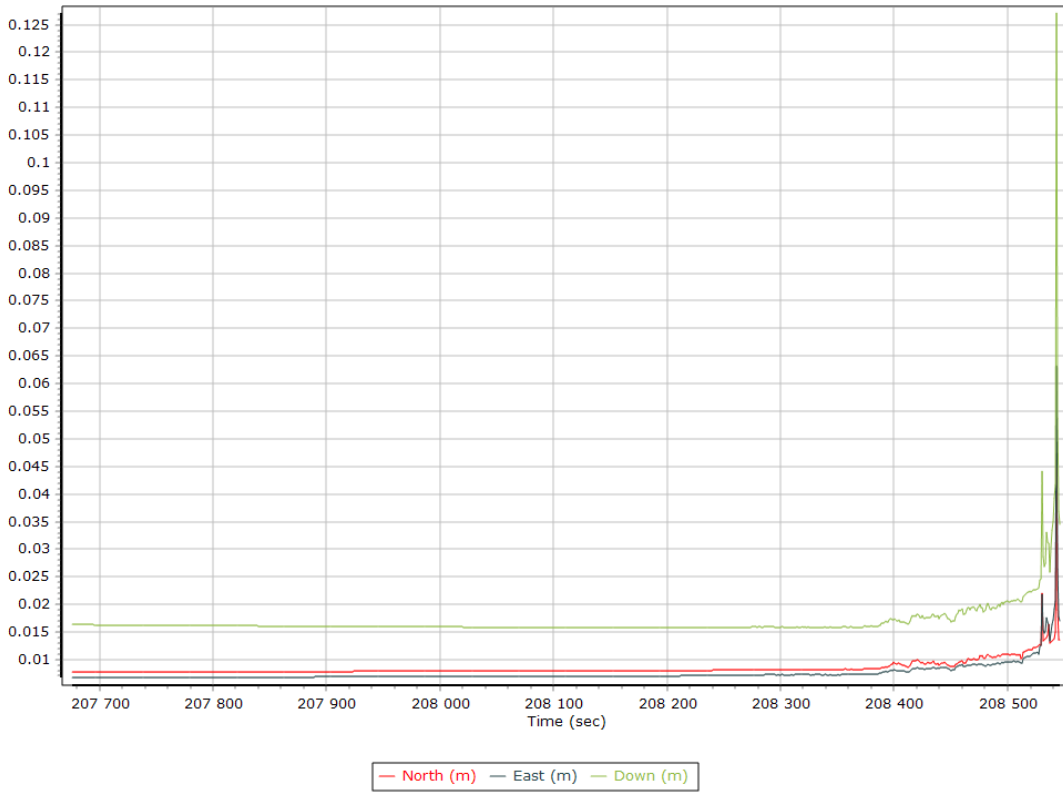
## Forward/Reverse Separation



## PDOP



## Estimated Position Accuracy



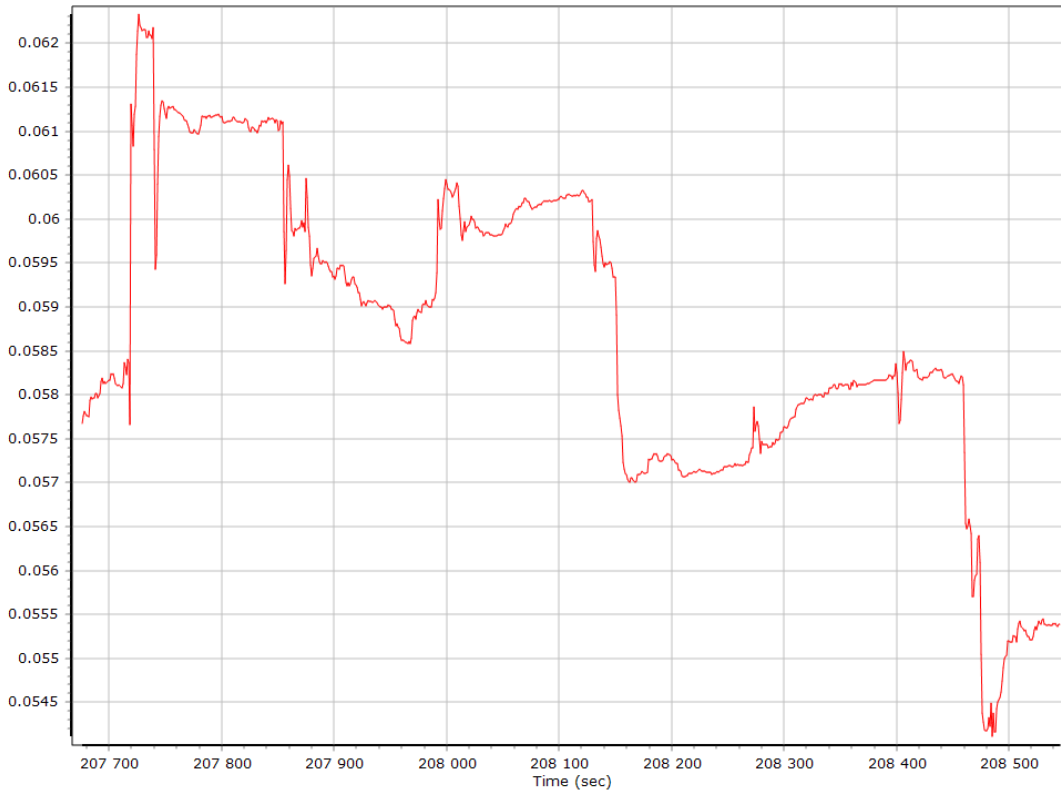
## GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	ALBM		
Processing start time	207493.011 (3/8/2022 9:38:13 AM)		
Processing end time	208546.000 (3/8/2022 9:55:46 AM)		
Initial attitude source	Primary GNSS Track		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.055	0.201	-0.393
Reference to Primary GNSS lever arm std dev [m]	0.100	0.100	0.100
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

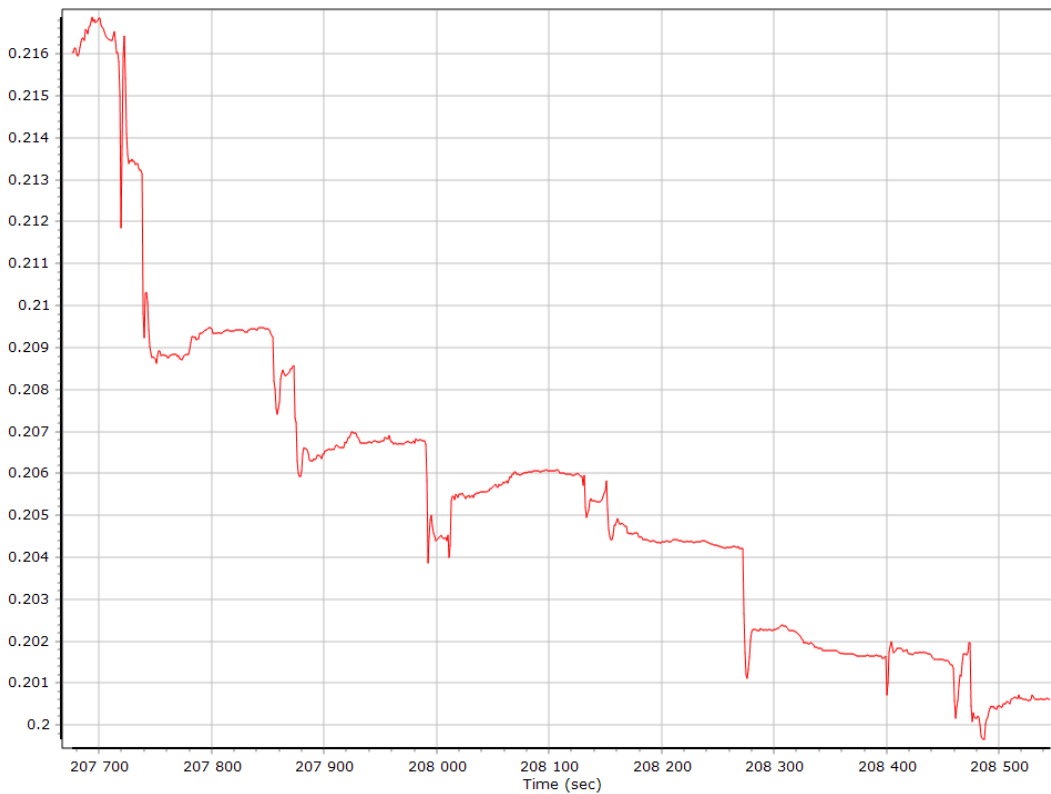
## Calibrated Installation Parameters

### Reference-Primary GNSS Lever Arm

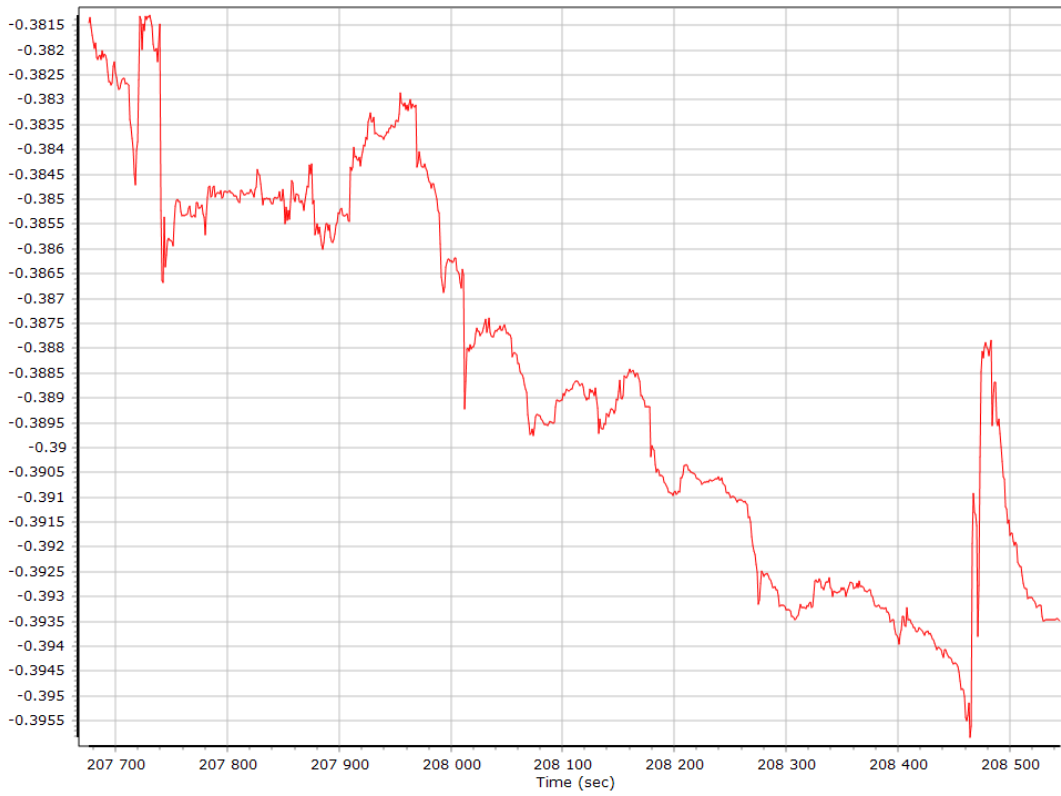
#### X Reference-Primary GNSS Lever Arm (m)



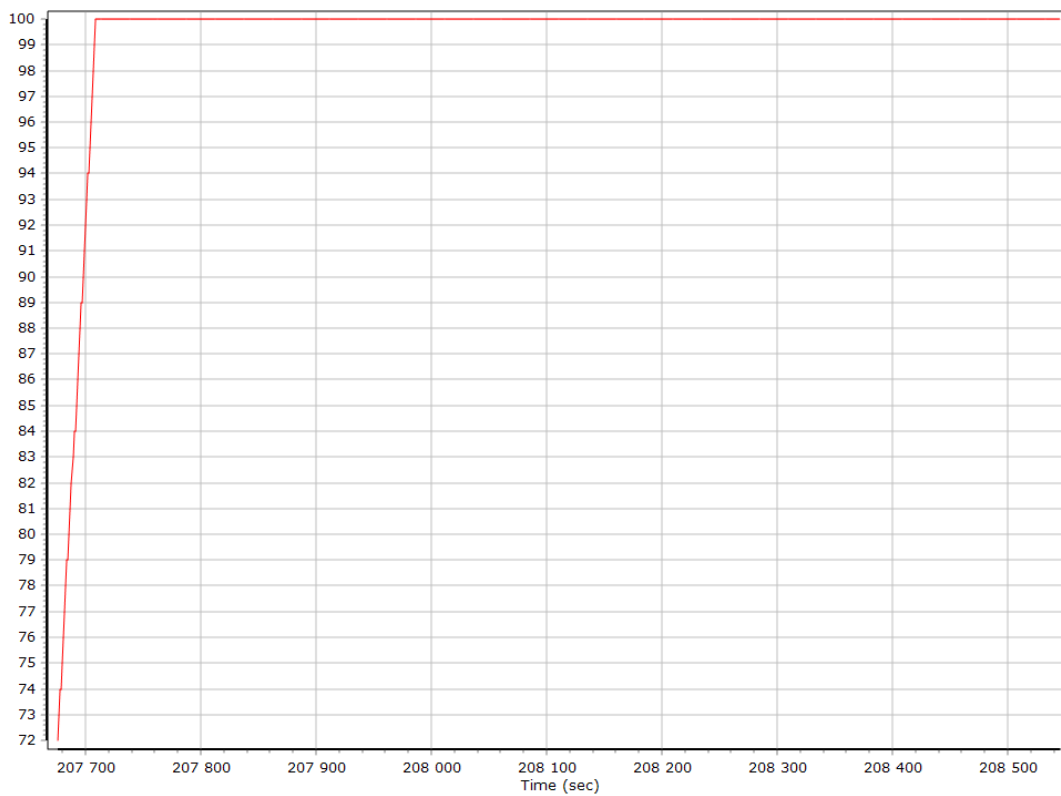
#### Y Reference-Primary GNSS Lever Arm (m)



### Z Reference-Primary GNSS Lever Arm (m)



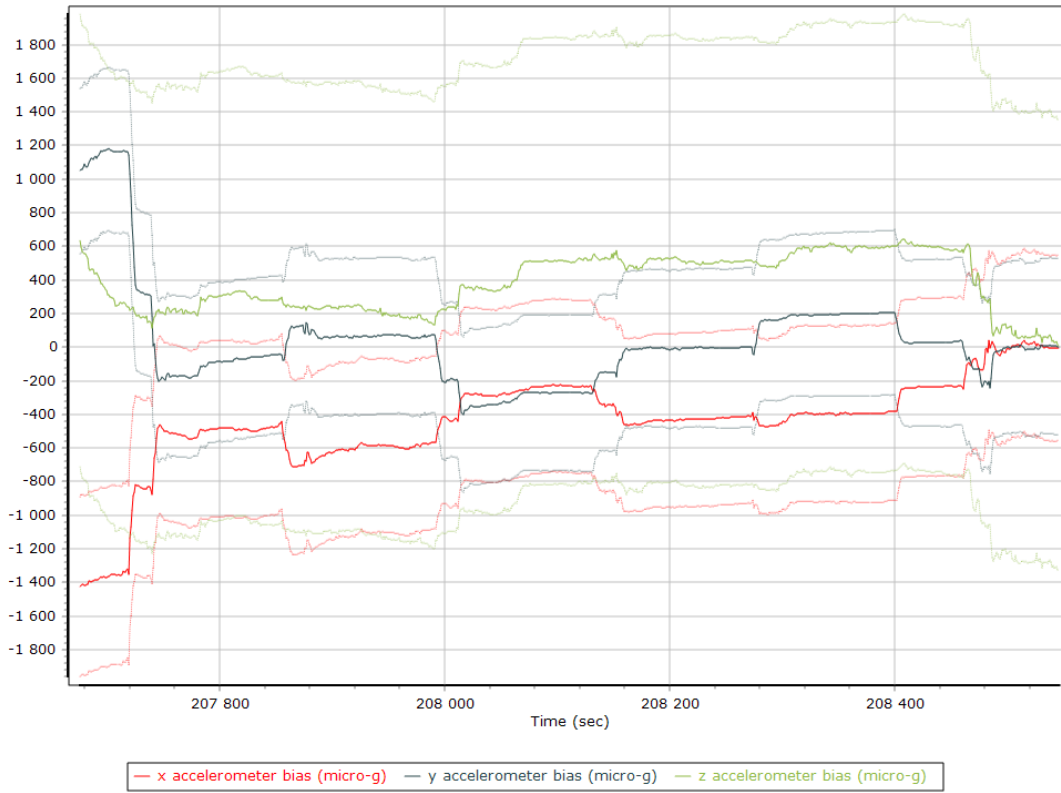
### Reference-Primary GNSS Lever Arm Figure of Merit



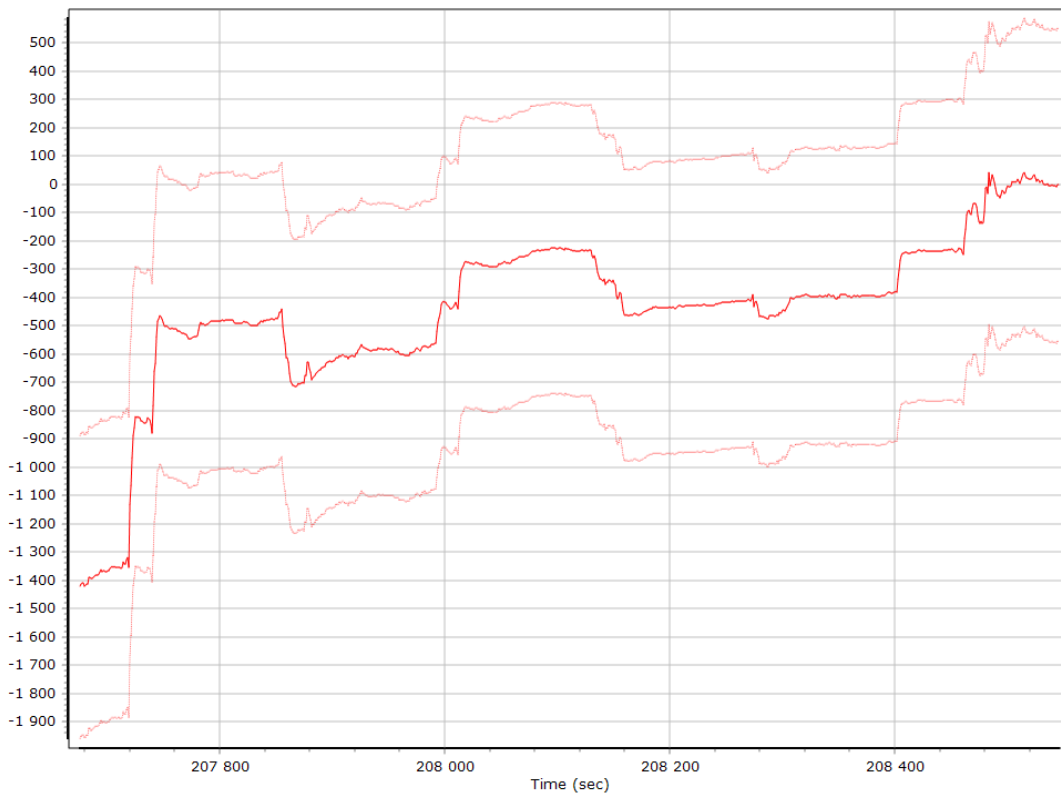
## Smoothed IN-Fusion QC

### Smoothed Estimated Errors, Reference Frame

#### Accelerometer Bias (micro-g)

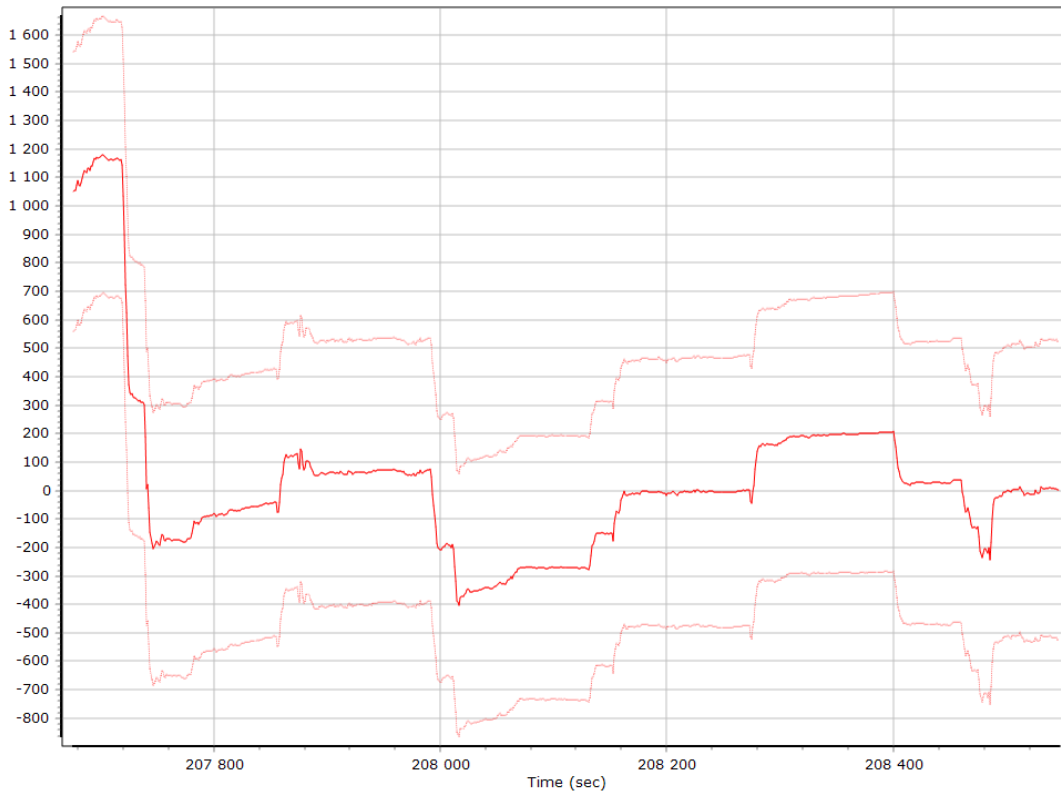


#### X Accelerometer Bias (micro-g)

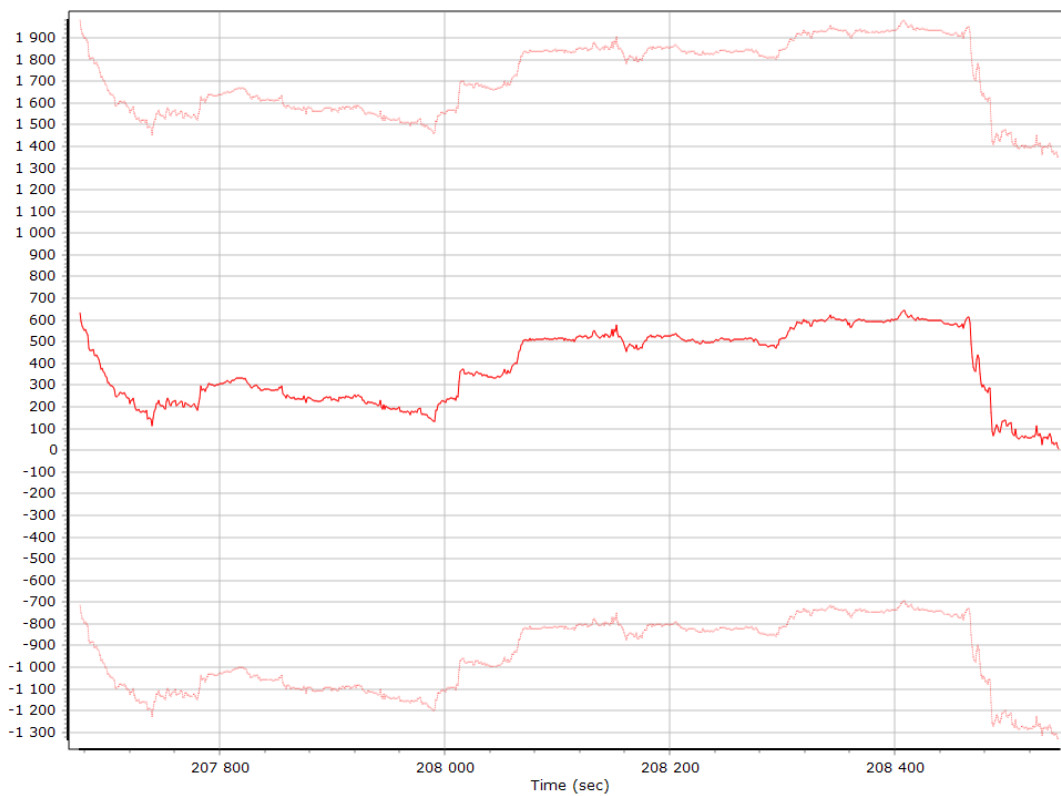




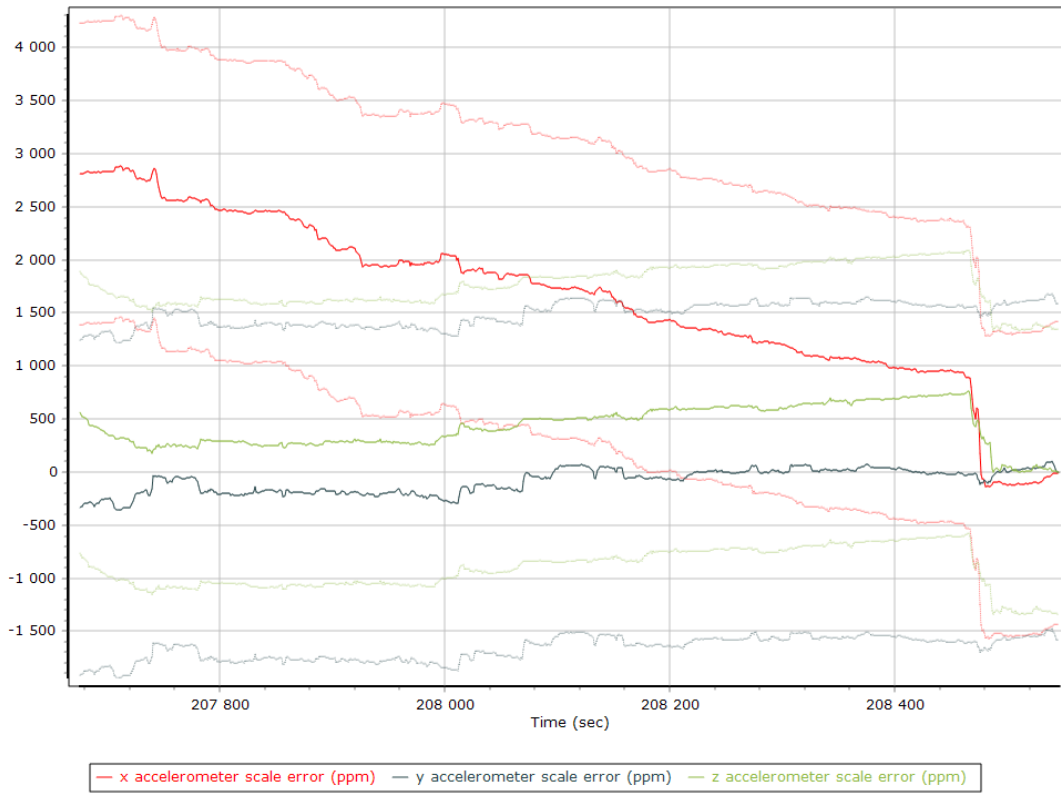
### Y Accelerometer Bias (micro-g)



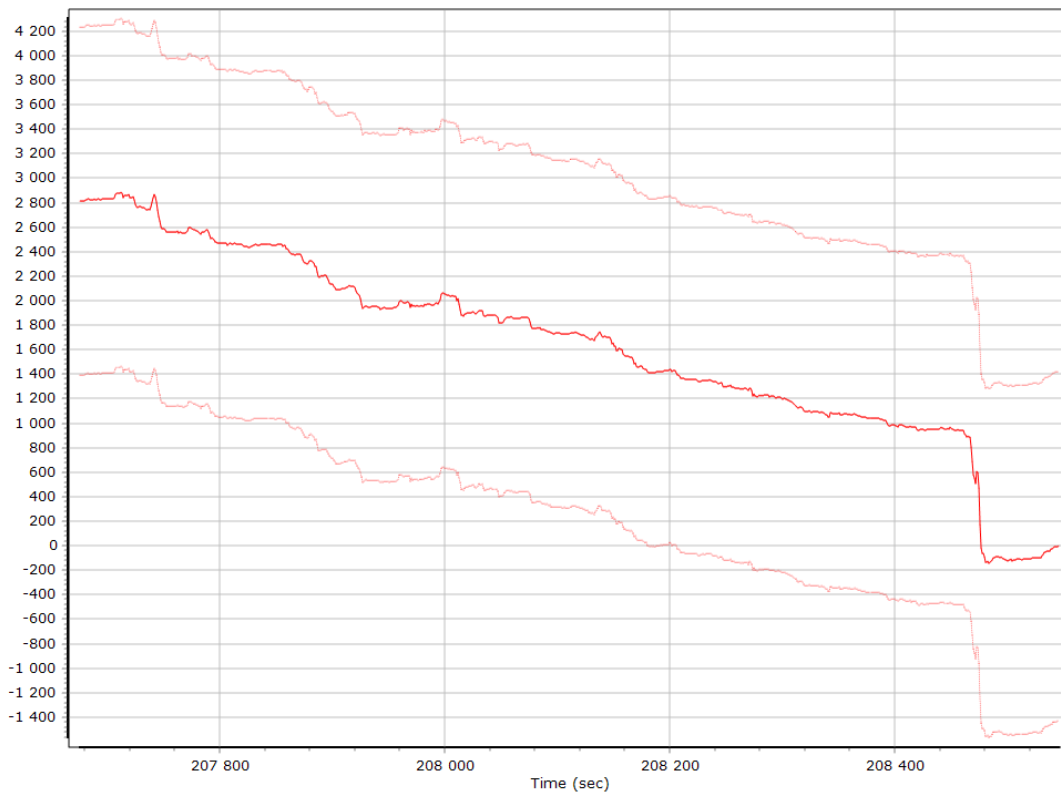
### Z Accelerometer Bias (micro-g)



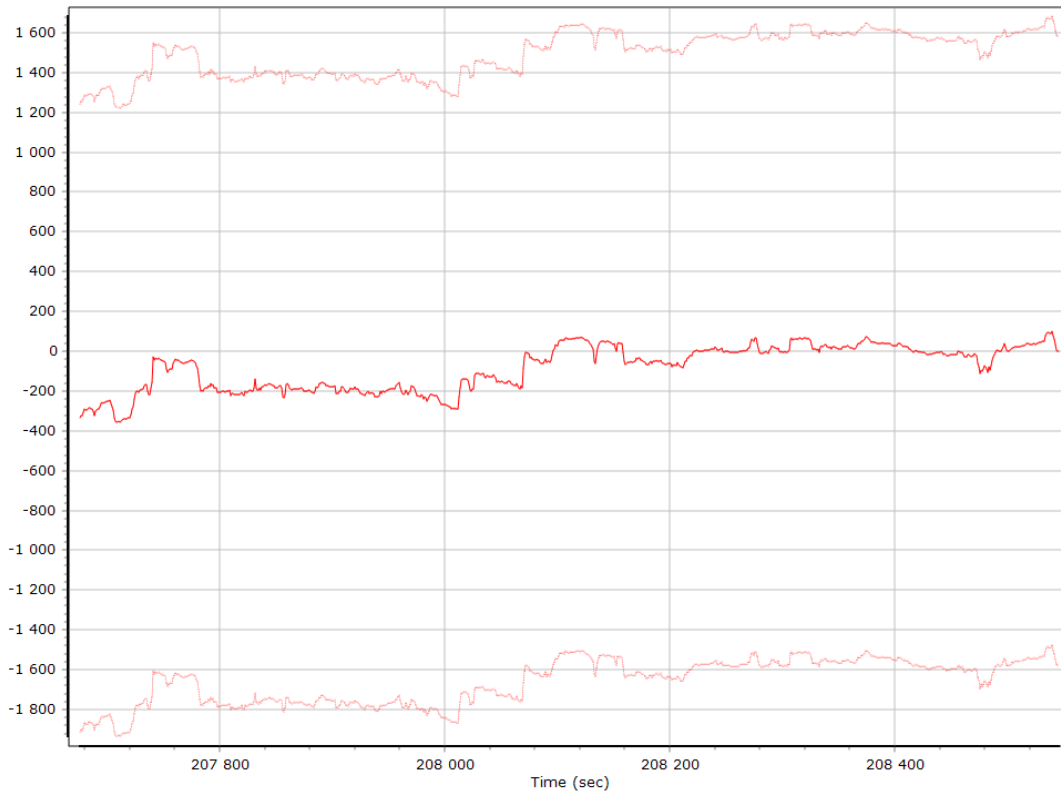
### Accelerometer Scale Error (ppm)



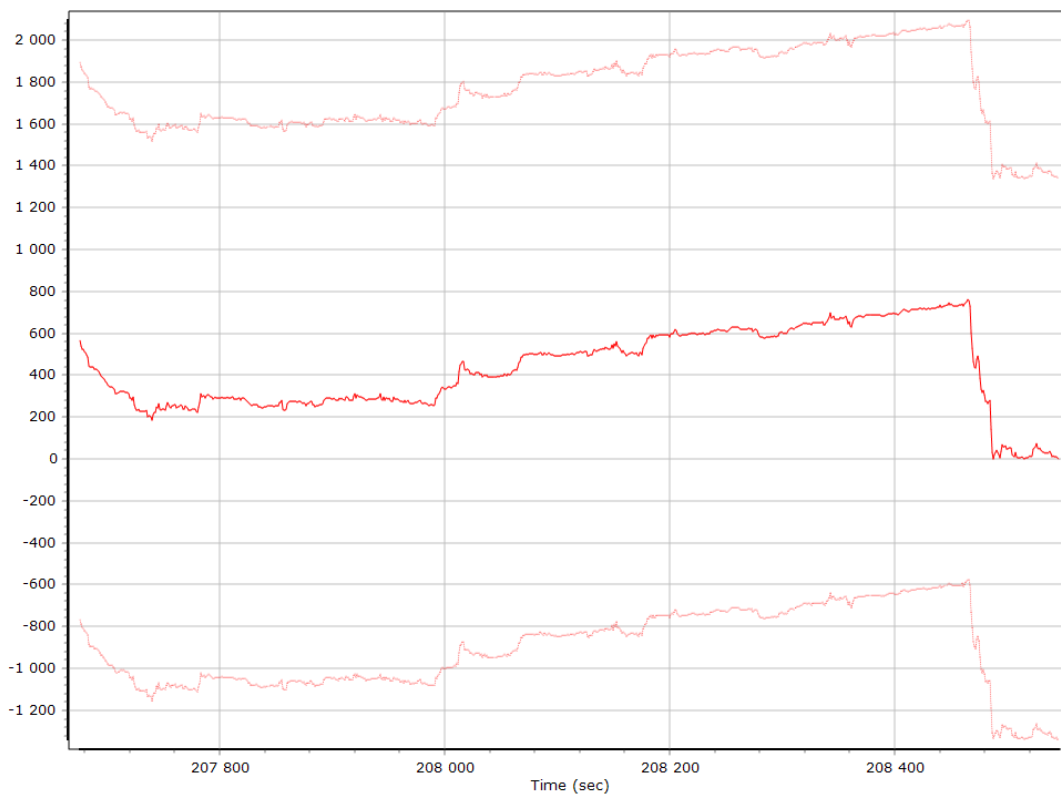
### X Accelerometer Scale Error (ppm)



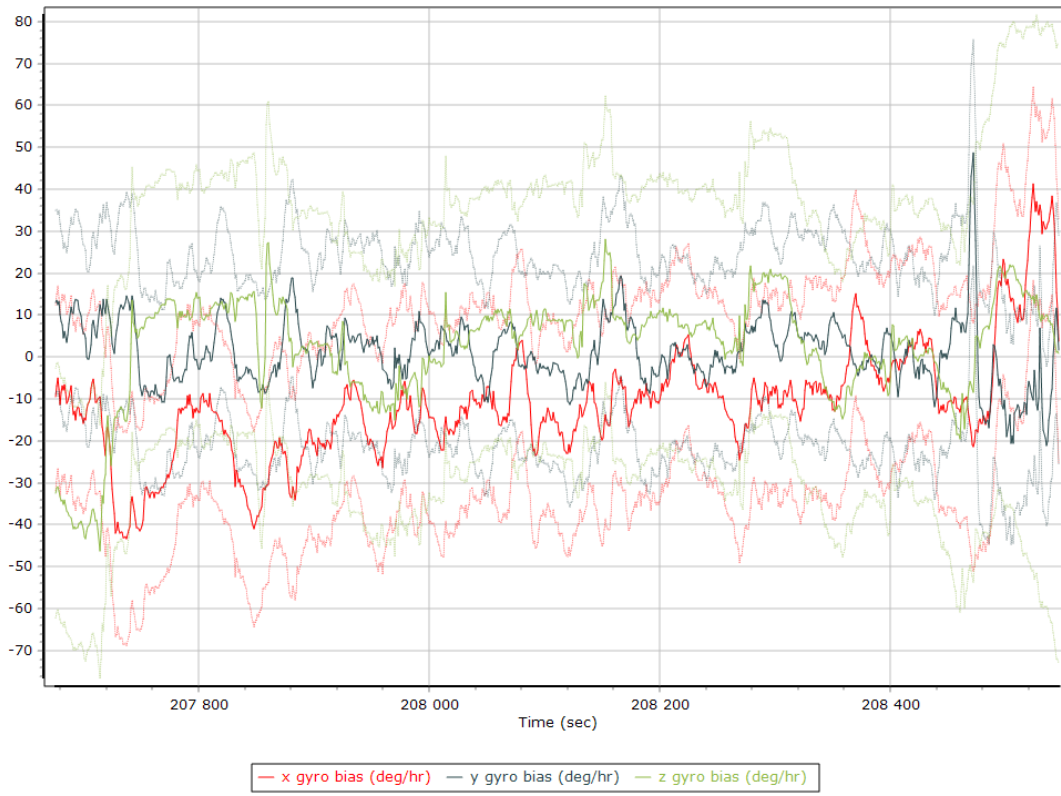
### Y Accelerometer Scale Error (ppm)



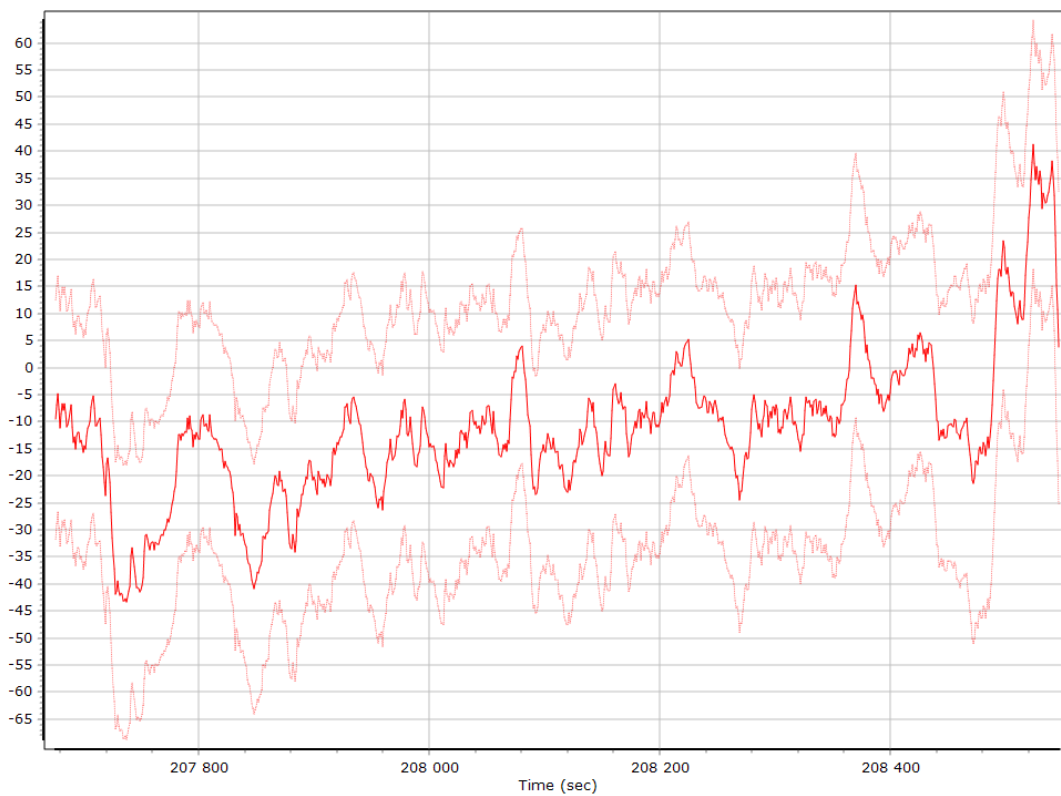
### Z Accelerometer Scale Error (ppm)



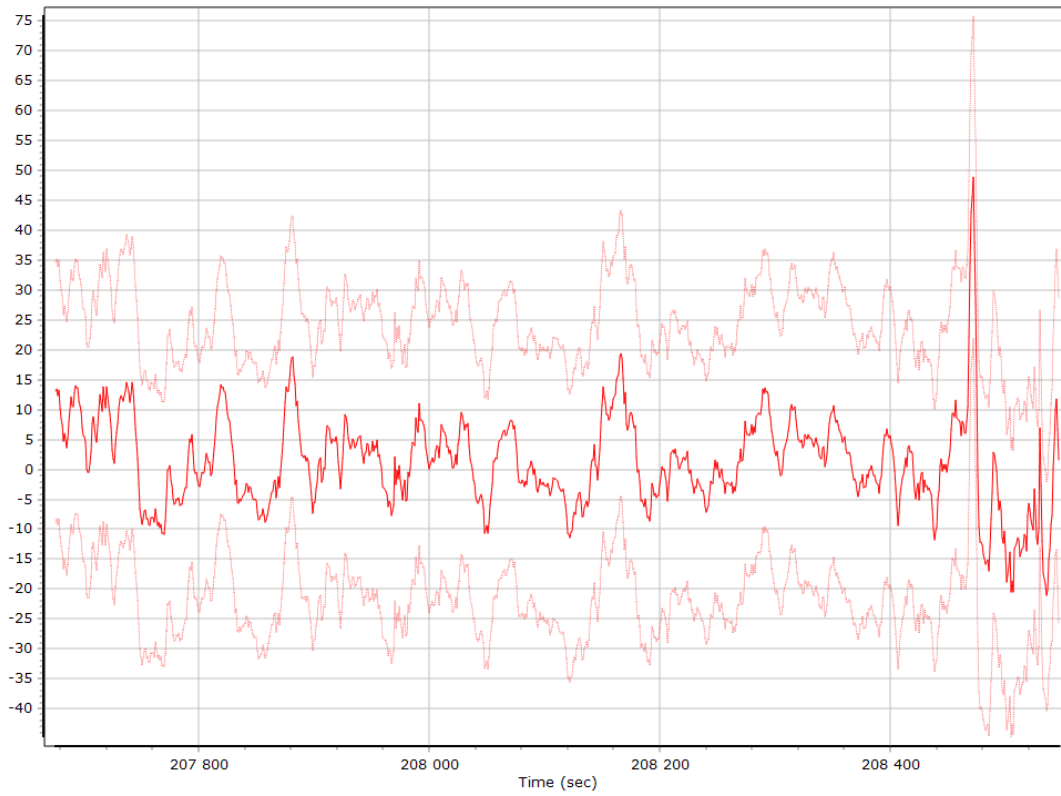
### Gyro Bias (deg/h)



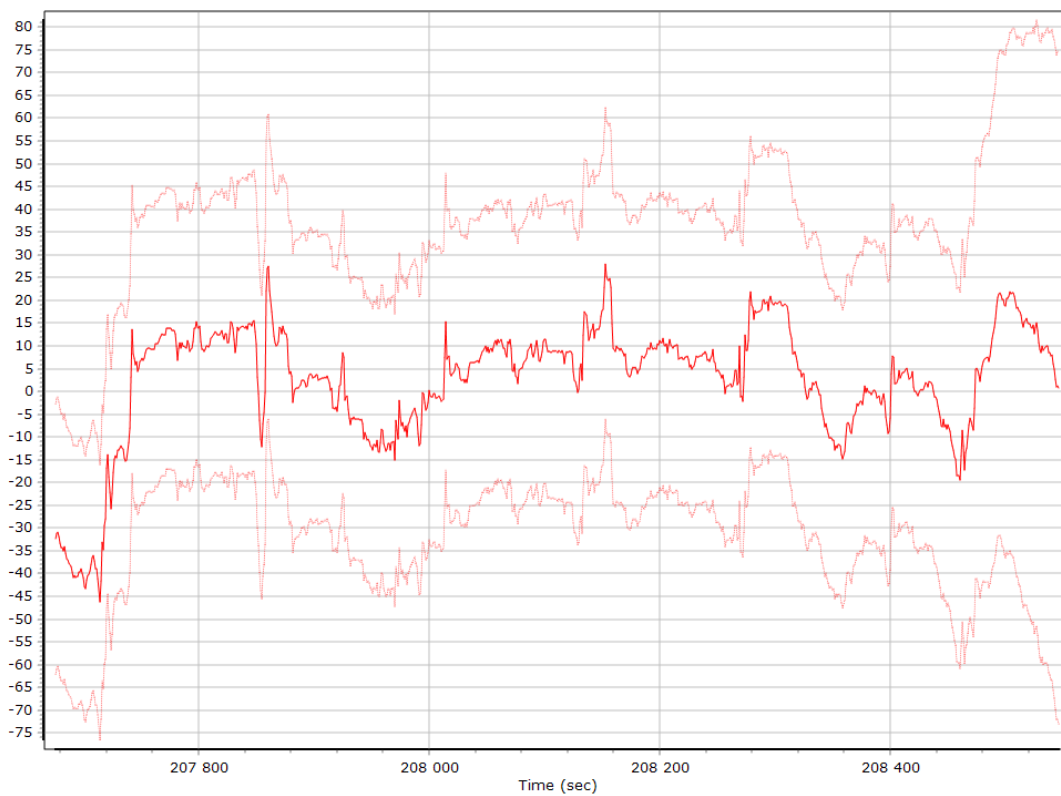
### X Gyro Bias (deg/h)



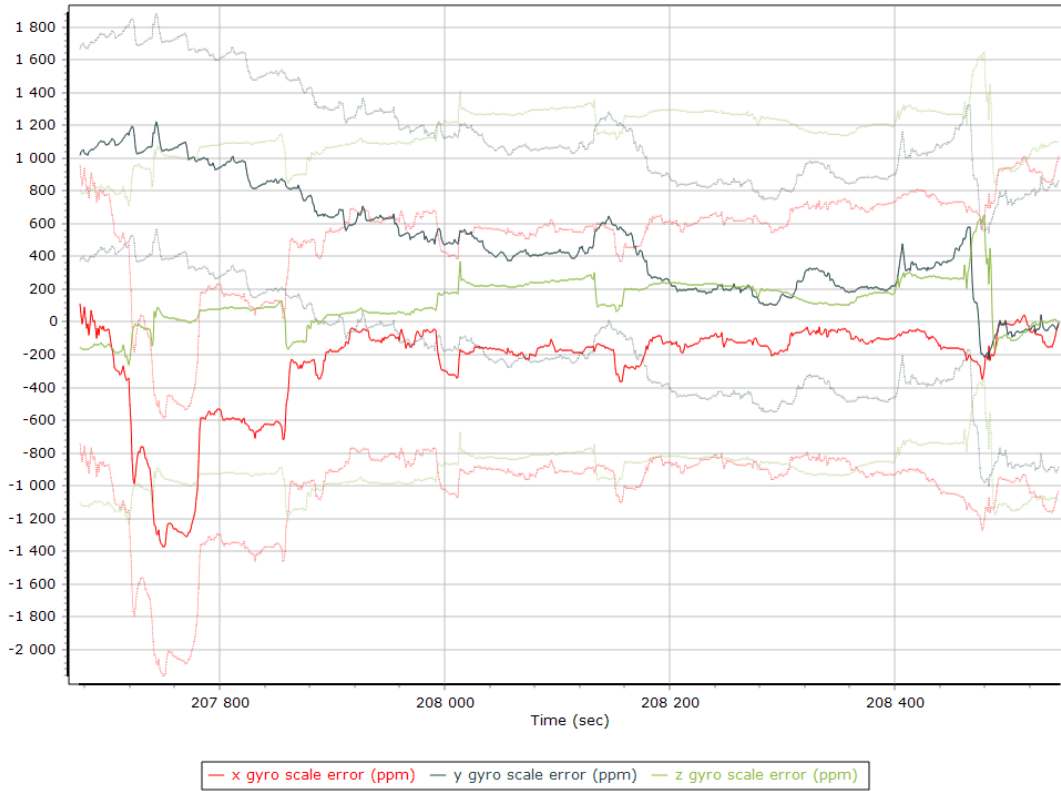
### Y Gyro Bias (deg/h)



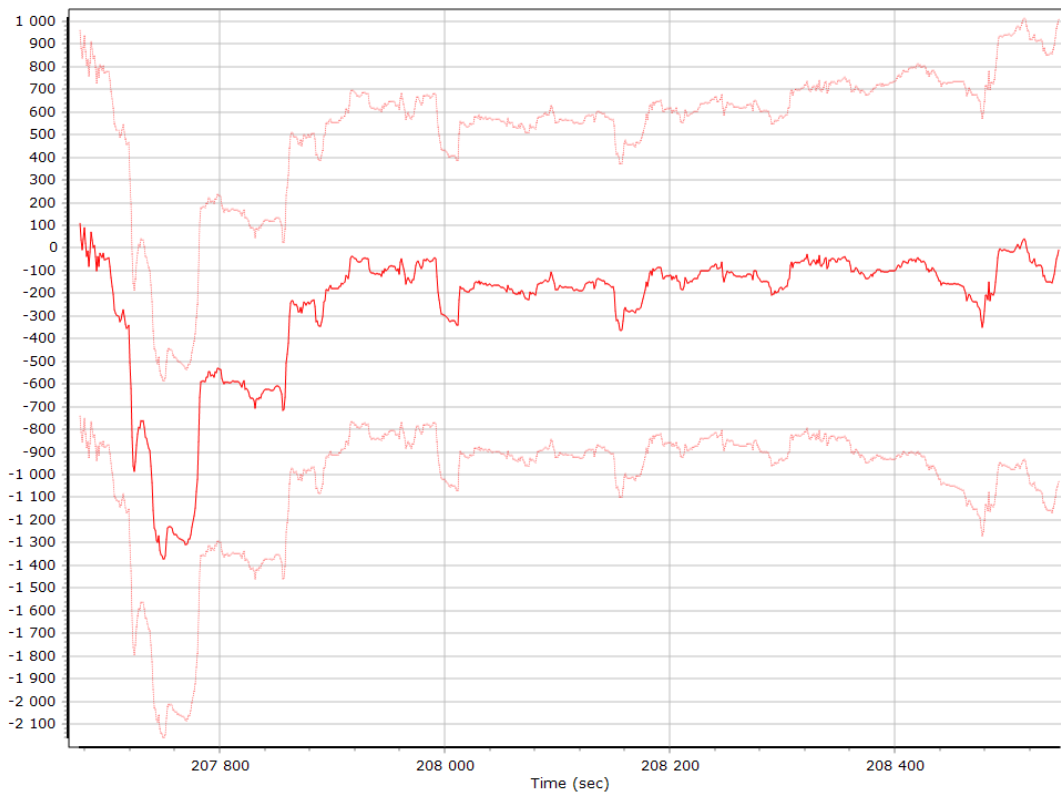
### Z Gyro Bias (deg/h)



### Gyro Scale Error (ppm)

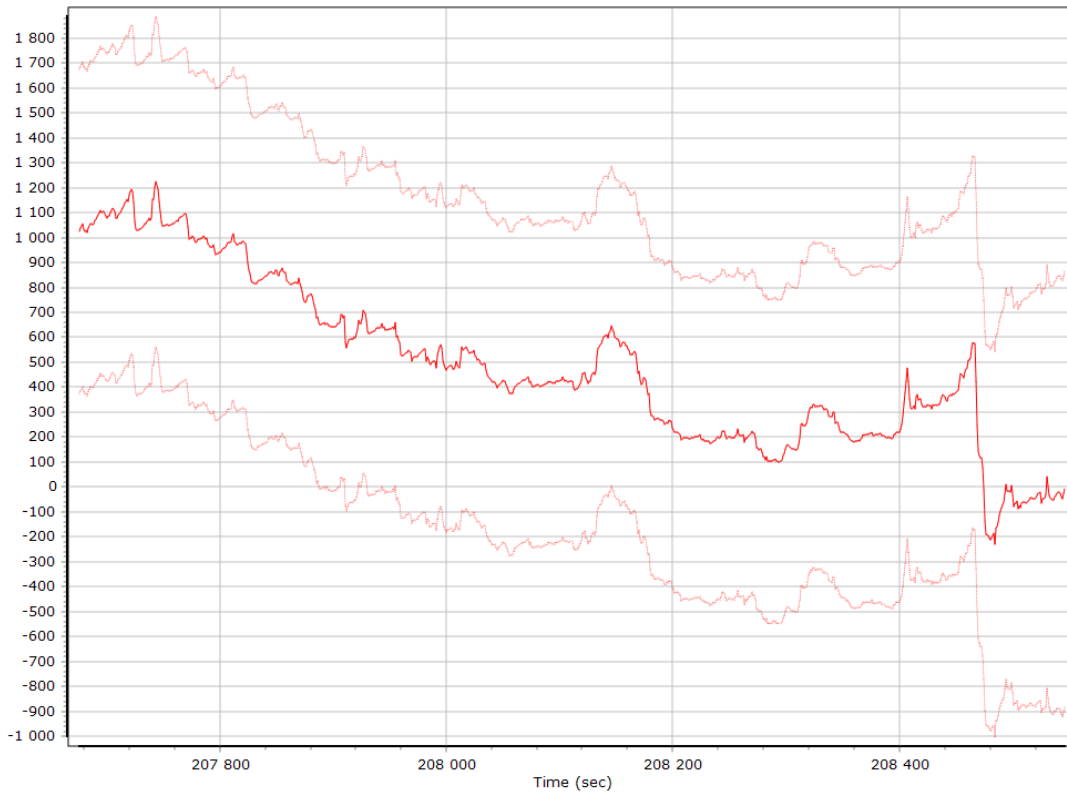


### X Gyro Scale Error (ppm)

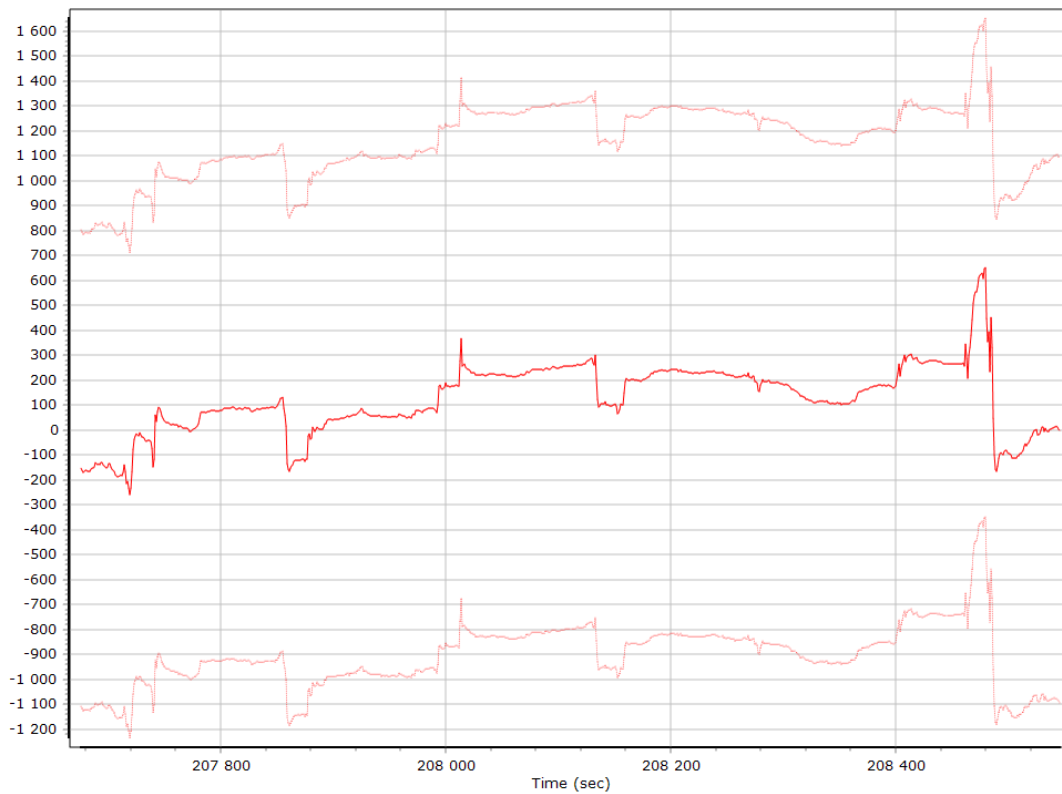




### Y Gyro Scale Error (ppm)

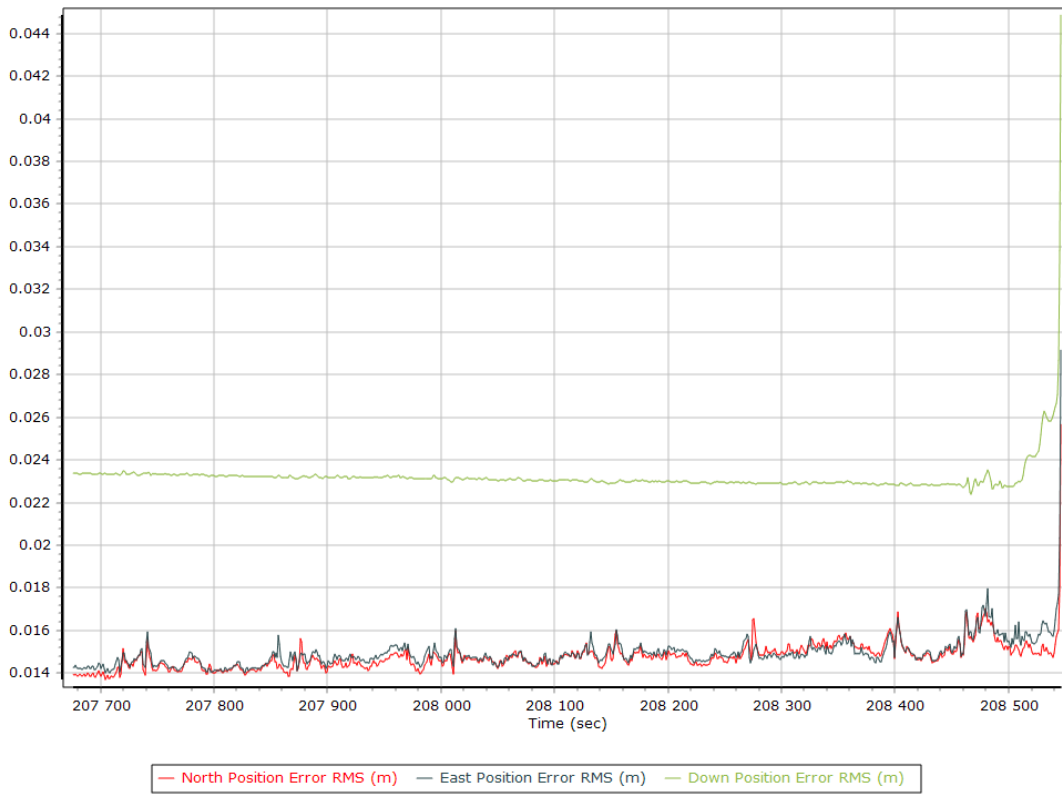


### Z Gyro Scale Error (ppm)

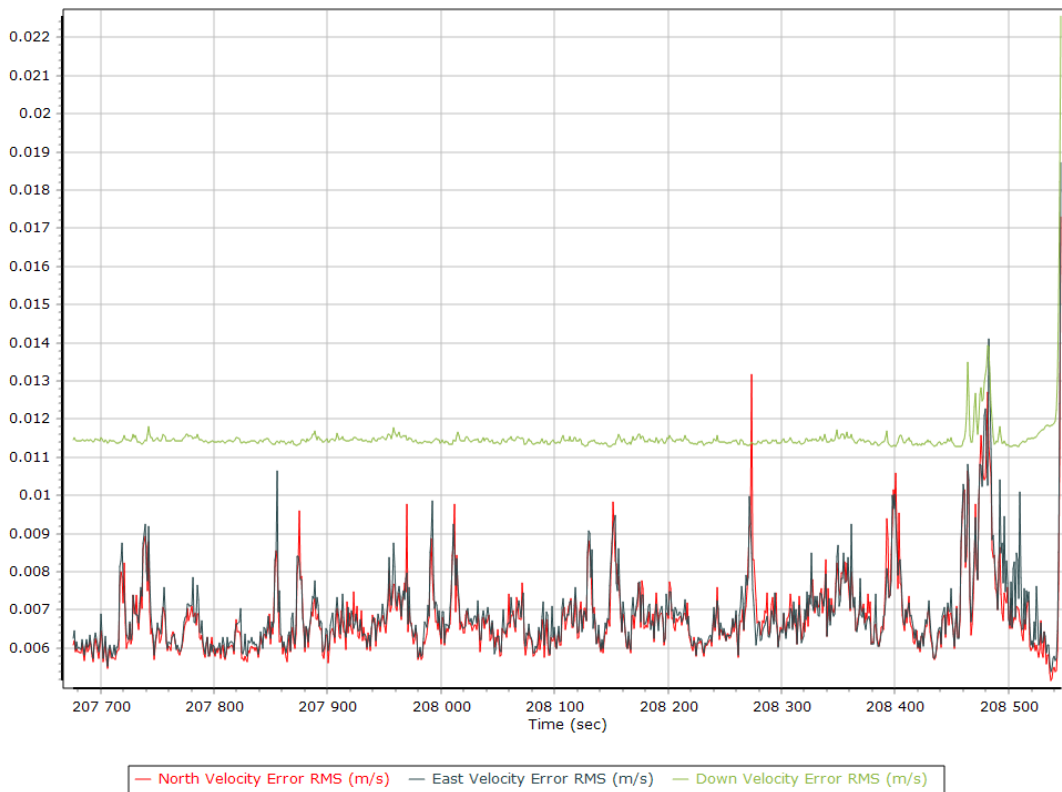


## Smoothed Performance Metrics

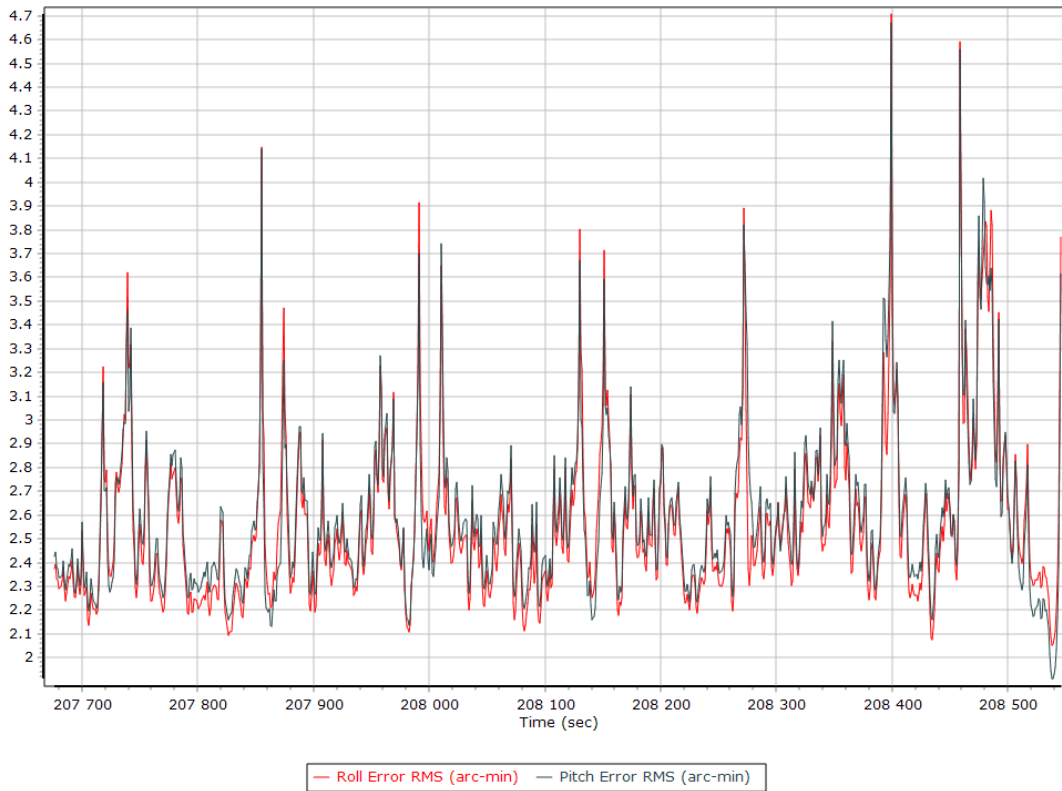
### Position Error RMS (m)



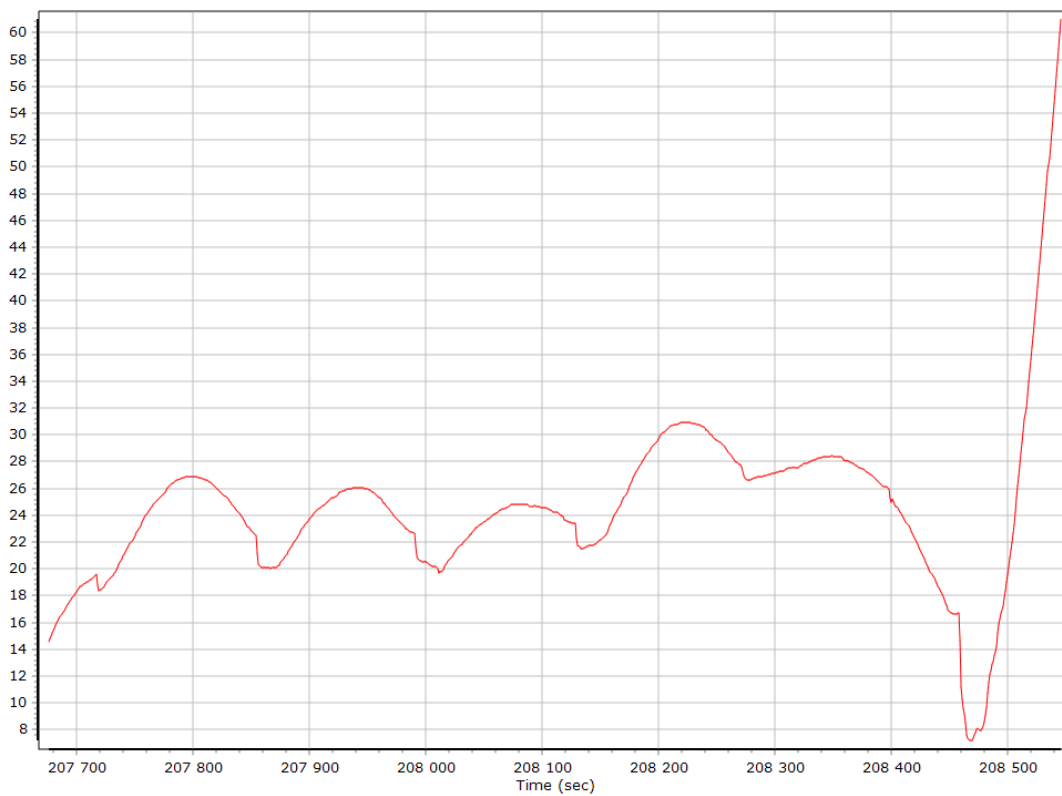
### Velocity Error RMS (m/s)



### Roll/Pitch Error RMS (arc-min)

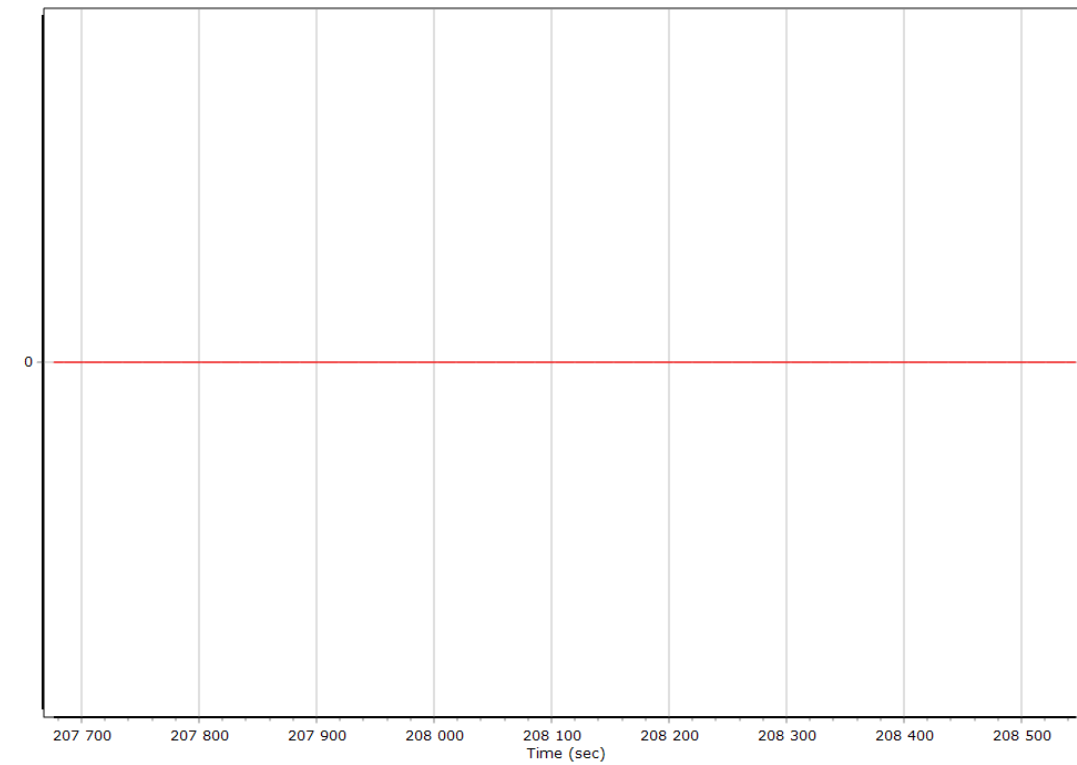


### Heading Error RMS (arc-min)



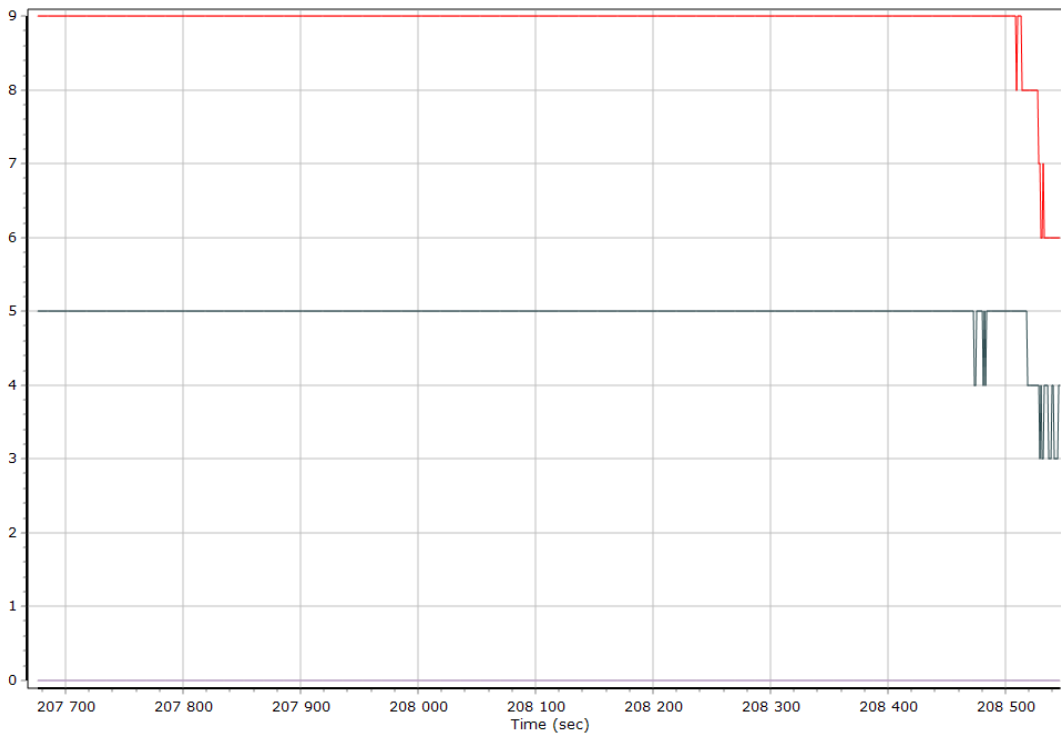
## Smoothed Solution Status

### Processing Mode



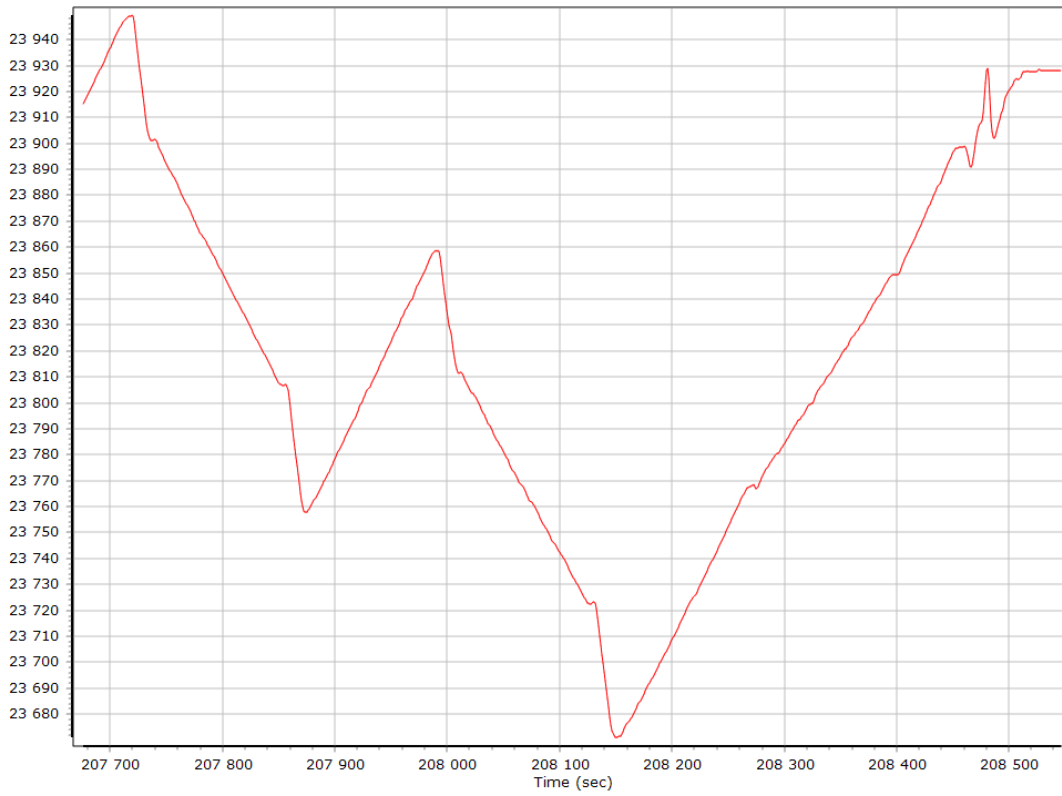
0 = Fixed NL, 1 = Fixed WL, 2 = Float, 3 = DGNSS, 4 = RTCM, 5 = IAPPP, 6 = C/A, 7 = GNSS Nav, 8 = DR

### Number of Satellites

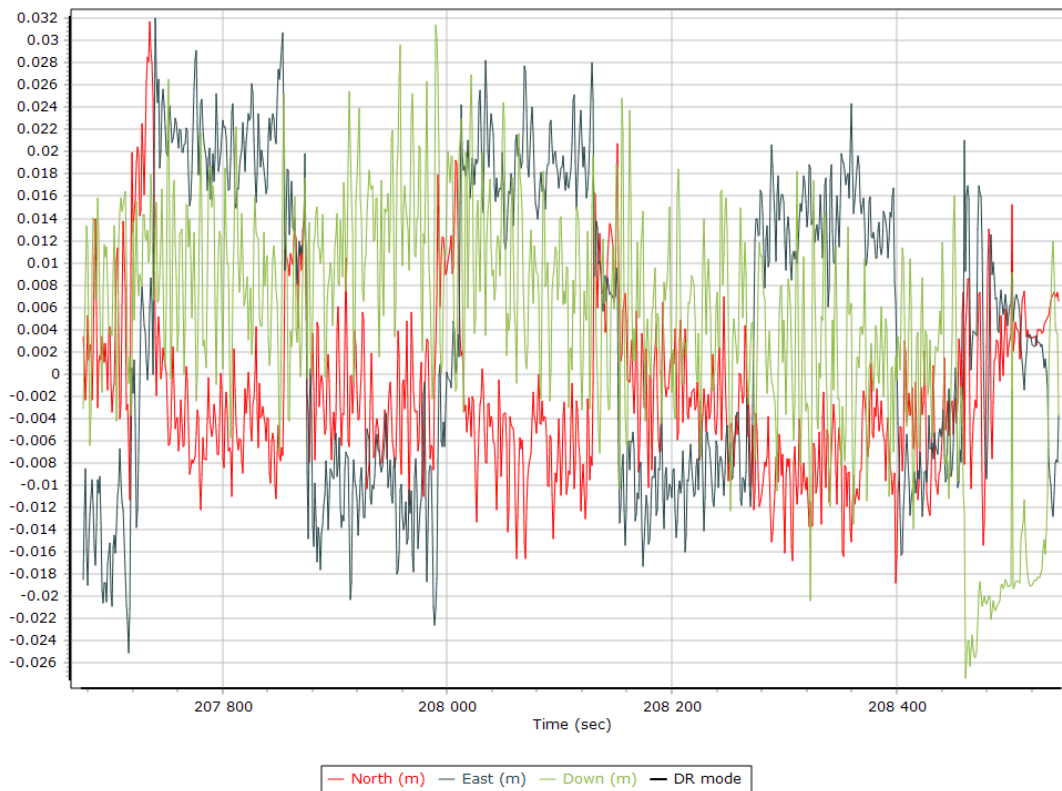


— Number of GPS Satellites — Number of GLONASS Satellites — Number of QZSS Satellites — Number of BEIDOU Satellites

### Baseline Length



### SBET IAKAR Separation



## Export Summary

Export file	49_PostPac.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	Deg Decimal	
Export start time	207610.004 (3/8/2022 9:40:10 AM)		
Export end time	208546.003 (3/8/2022 9:55:46 AM)		
Height option	Ellipsoid Height		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		



## EO Summary

EO file			
EO format			
Lever arm [m]	0.000	0.000	0.000
Boresight angles [arcmin]	0.000	0.000	0.000
Output rate	All Records		
Rotation sequence	x omega	y phi	z kappa
Local shift [m]	0.000	0.000	0.000
Output units (coordinate / angle / lat & lon)	Meter	Degree	Deg Decimal
Height option	Ellipsoid Height		
WGS84 height flag	False		
Scale height option	False		
Kappa cardinal rotation [deg]	0		
Solution in use	Post-processed		
EO start time	207610.004 (3/8/2022 9:40:10 AM)		
EO end time	208546.003 (3/8/2022 9:55:46 AM)		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		

## General Information

### Mission Information

Project name	CastelRoch44
Processing date	2022-03-10 09:22:29
Mission date	2022-03-08 10:29:08
Mission duration	00:14:04.998
Processing mode	IN-Fusion Single Base
GPS Station	ALBM

### Rover Hardware Information

Product	APX 15 AVX 210 VER0 174
Serial number	S/N001
IMU type	59
Receiver type	APX-15v3
Antenna type	AV14

## Project File List

### Rover Data Files

File name	File type
YS-20220308-102844.T04	T04 Rover Data

### Input Files

File Name	File type
Ephm0670.22g	GLONASS Broadcast Ephemeris
Ephm0670.22n	GPS Broadcast Ephemeris
albm067z.22o	GNSS SingleBase

### Output Files

Filename	File type
sbet_Mission 1.out	SBET Trajectory File
44_CastelRoch.txt	ASCII Export Output

## Rover Data Summary

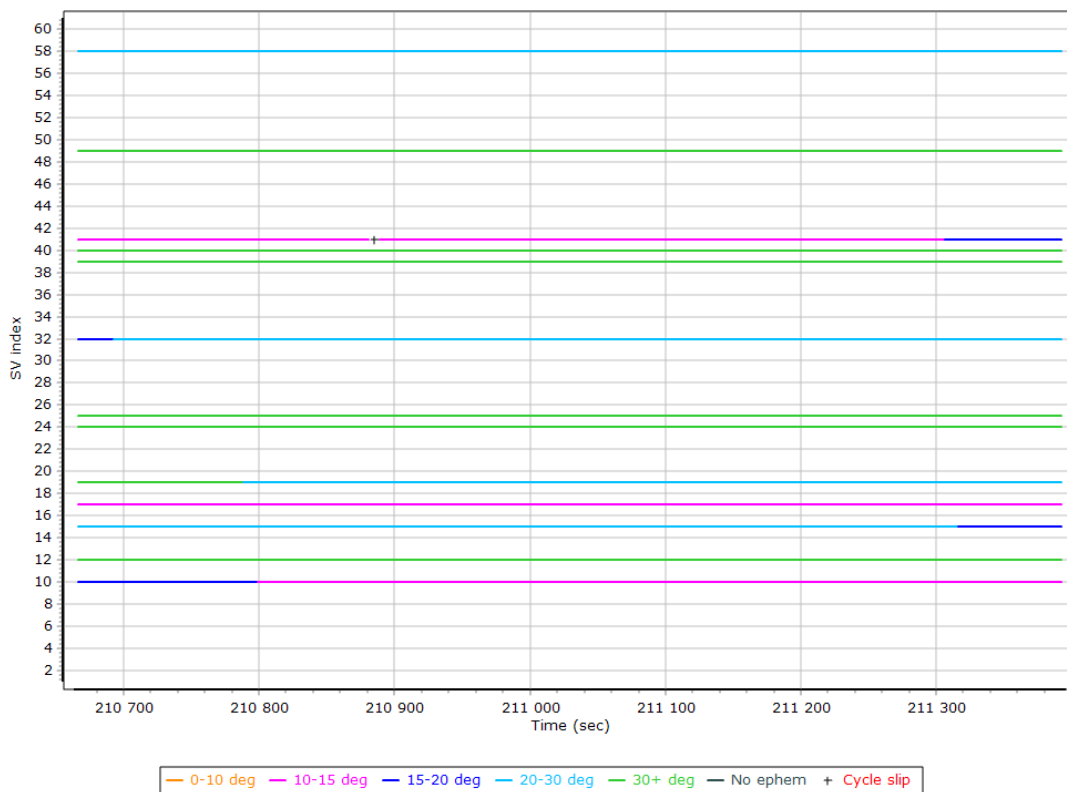
First raw data file	YS-20220308-102844.T04		
Last raw data file	YS-20220308-102844.T04		
Start GPS week	2200		
Start time	210548.000 (3/8/2022 10:29:08 AM)		
End time	211393.000 (3/8/2022 10:43:13 AM)		
Start of fine alignment	210605.600 (3/8/2022 10:30:05 AM)		
Available subsystems	Primary GNSS, IMU		
POS Event Input	None		
Correction data	None		
<b>IMU Installation Lever Arms &amp; Mounting Angles</b>			
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.006	0.218	-0.435
Reference to Primary GNSS lever arm std dev [m]	0.020		
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

## Raw Data QC

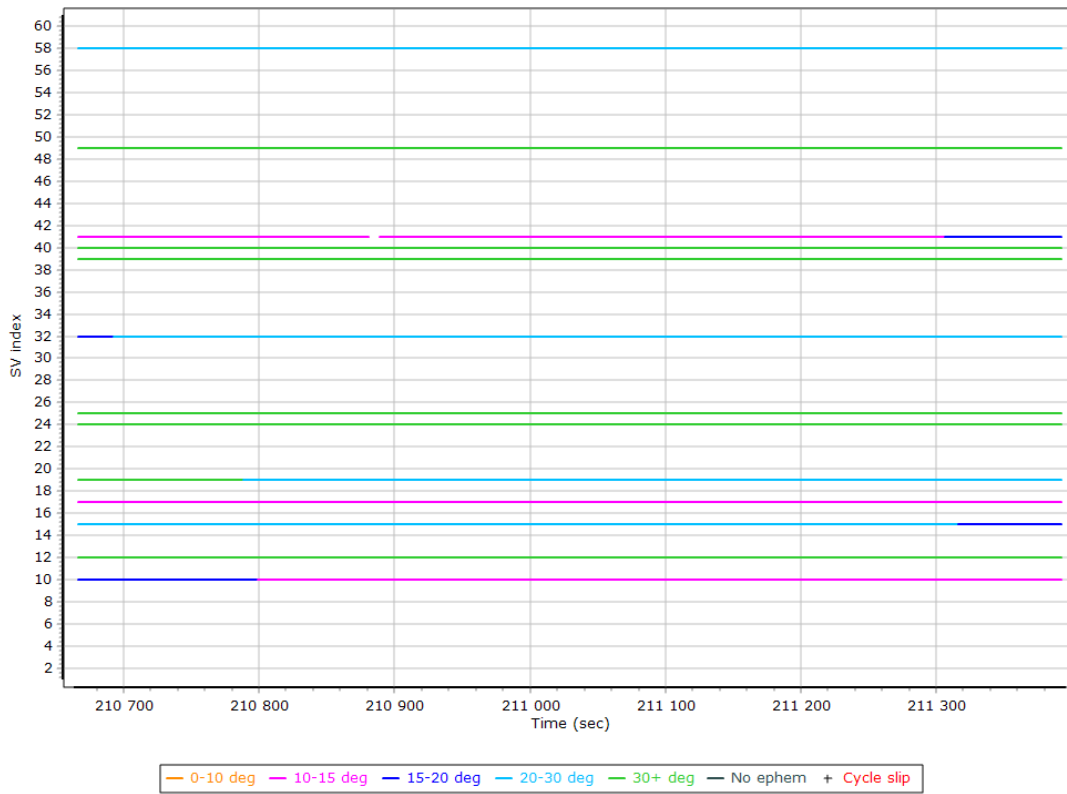
### Raw IMU Import QC Summary

IMU data input file	imu_Mission 1.dat
IMU data check log file	imudt_Mission 1.log
IMU Records Processed	169130
Termination Status	Normal
IMU Anomalies	0

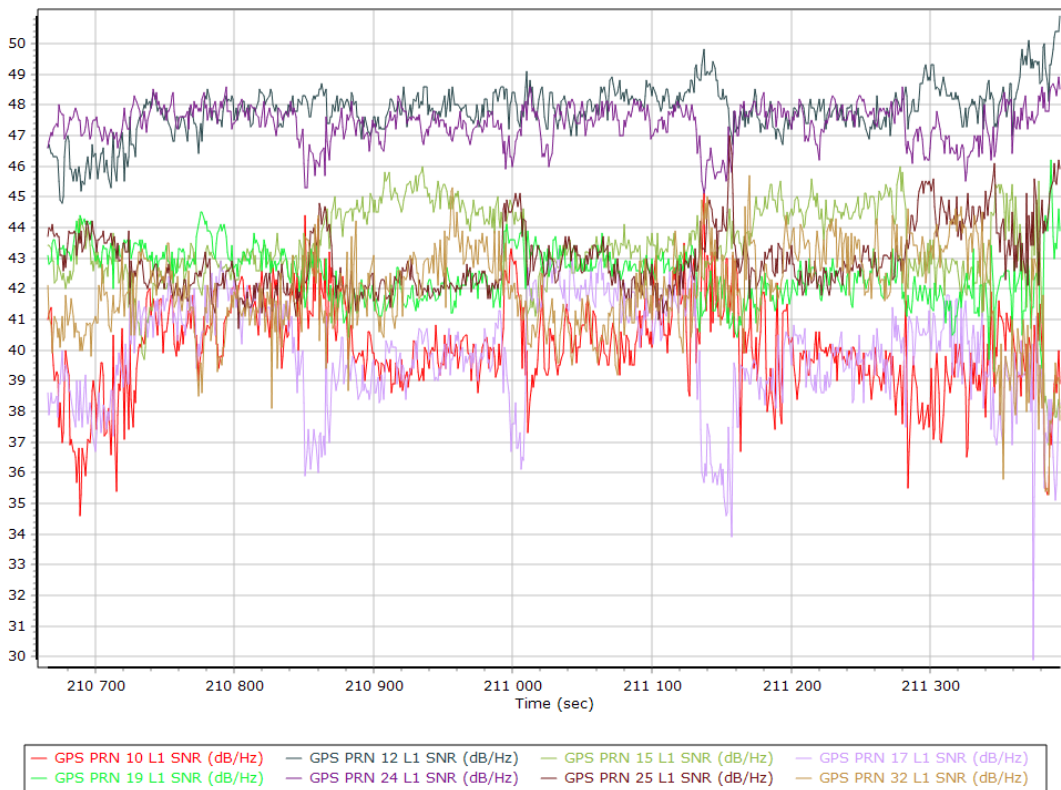
### L1 Satellite Lock/Elevation



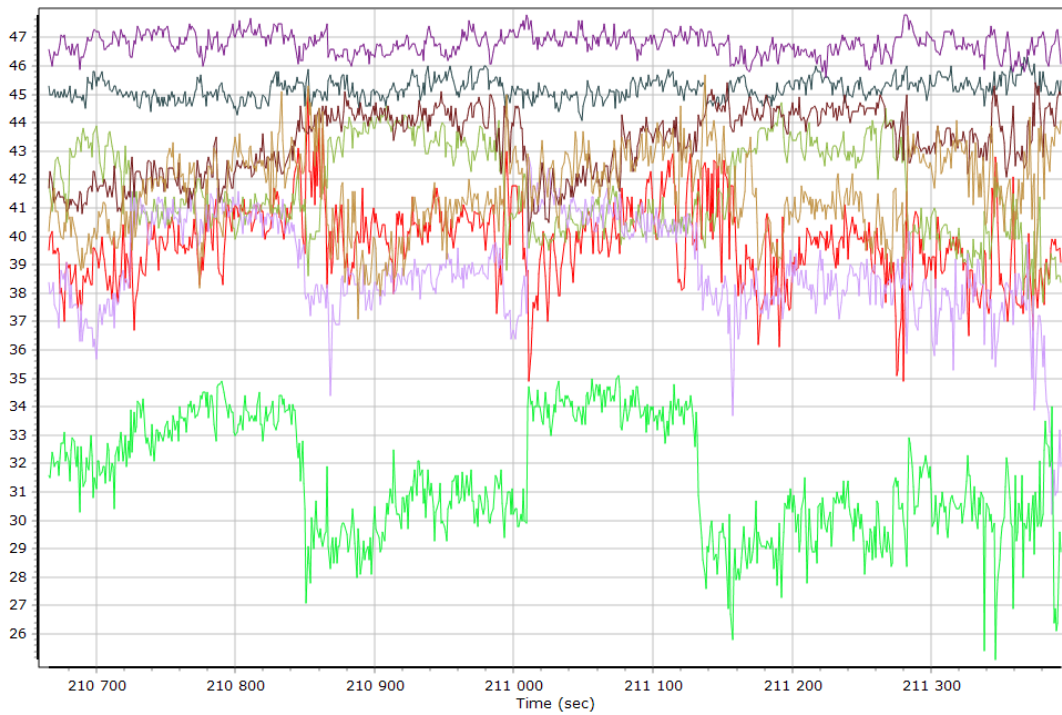
## L2 Satellite Lock/Elevation



## GPS L1 SNR

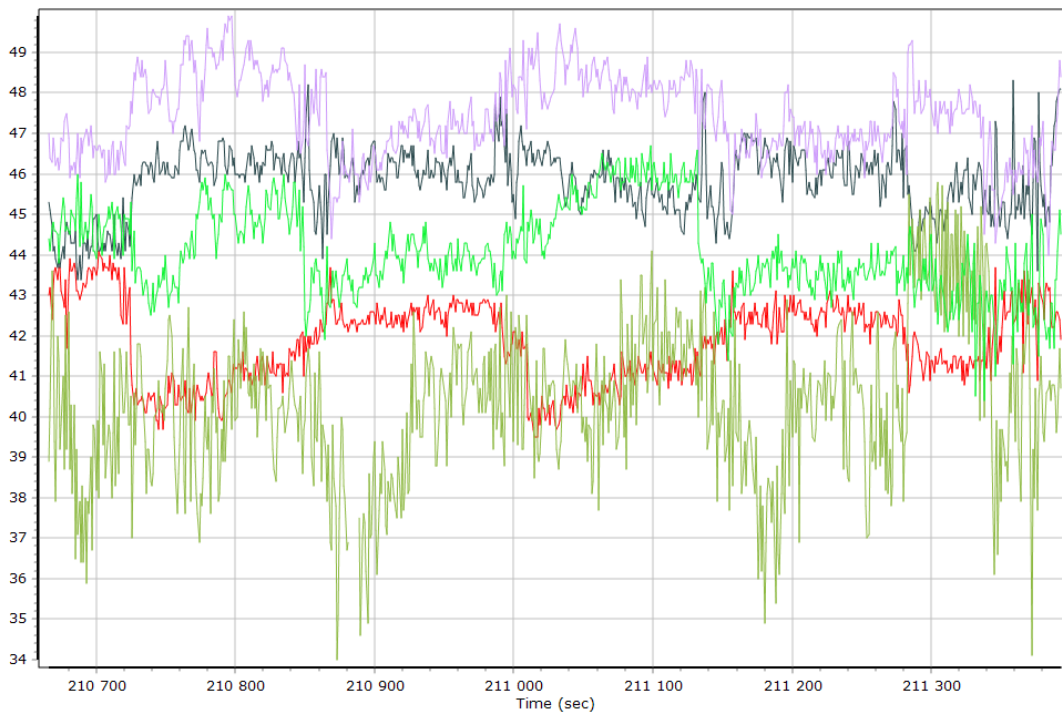


## GPS L2 SNR



— GPS PRN 10 L2 SNR (dB/Hz) — GPS PRN 12 L2 SNR (dB/Hz) — GPS PRN 15 L2 SNR (dB/Hz) — GPS PRN 17 L2 SNR (dB/Hz)  
— GPS PRN 19 L2 SNR (dB/Hz) — GPS PRN 24 L2 SNR (dB/Hz) — GPS PRN 25 L2 SNR (dB/Hz) — GPS PRN 32 L2 SNR (dB/Hz)

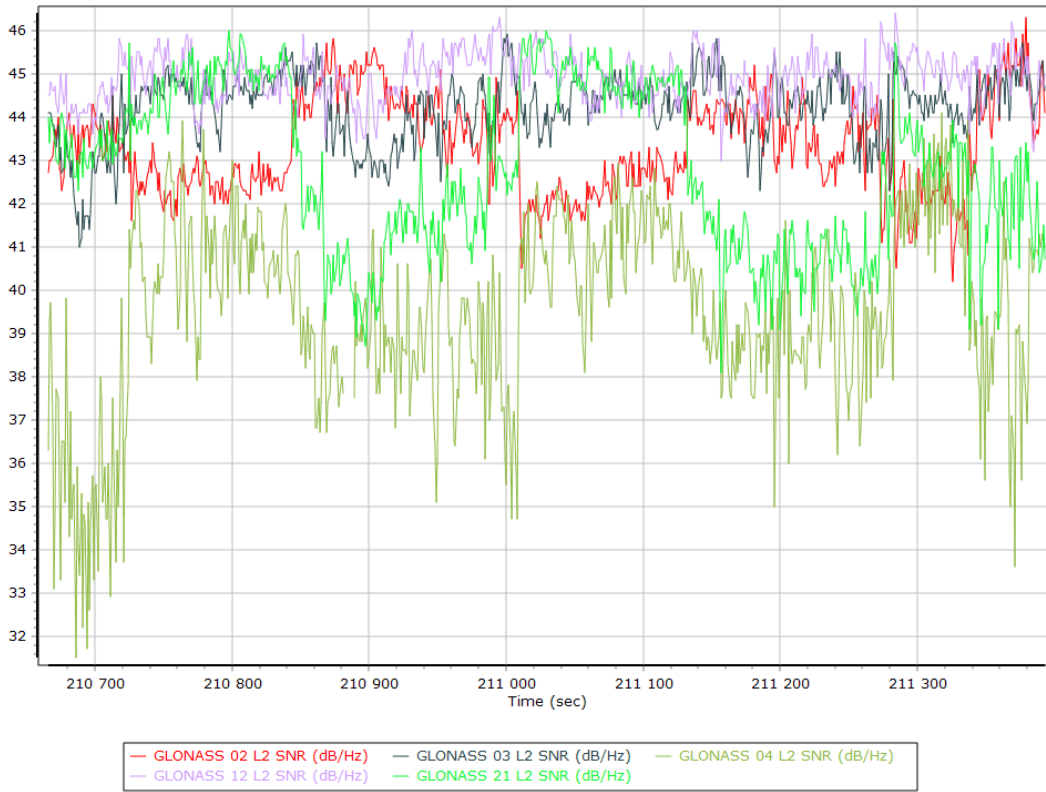
## GLONASS L1 SNR



— GLONASS 02 L1 SNR (dB/Hz) — GLONASS 03 L1 SNR (dB/Hz) — GLONASS 04 L1 SNR (dB/Hz)  
— GLONASS 12 L1 SNR (dB/Hz) — GLONASS 21 L1 SNR (dB/Hz)

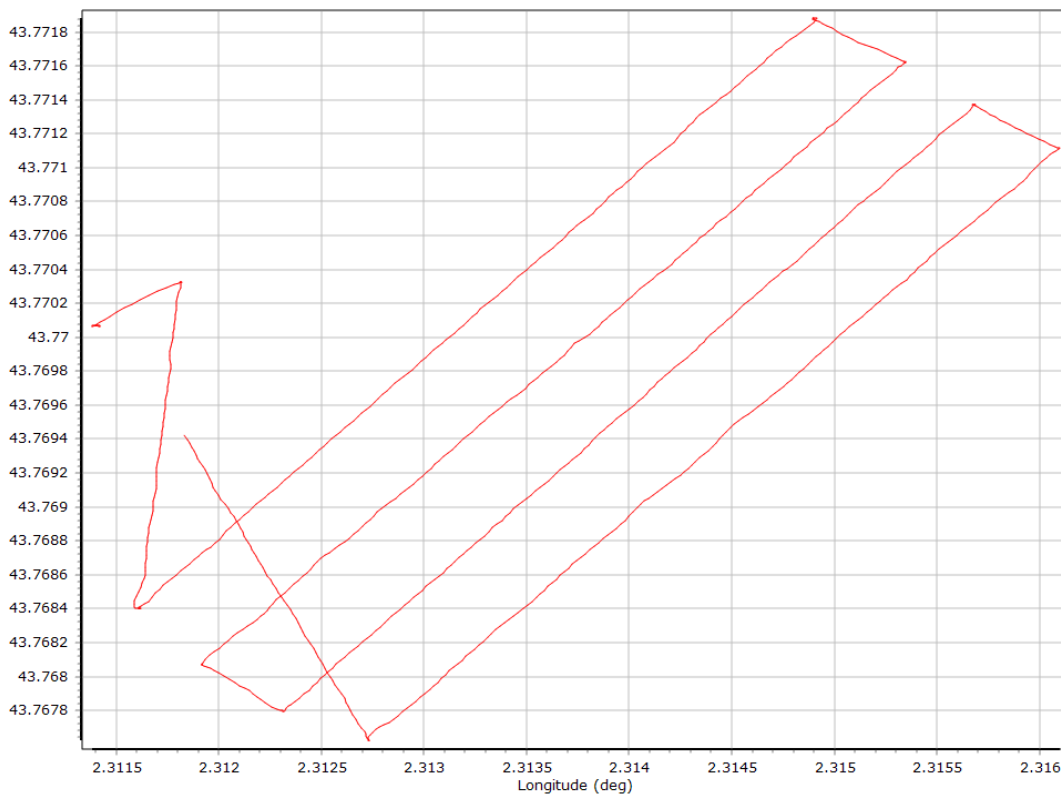


## GLONASS L2 SNR

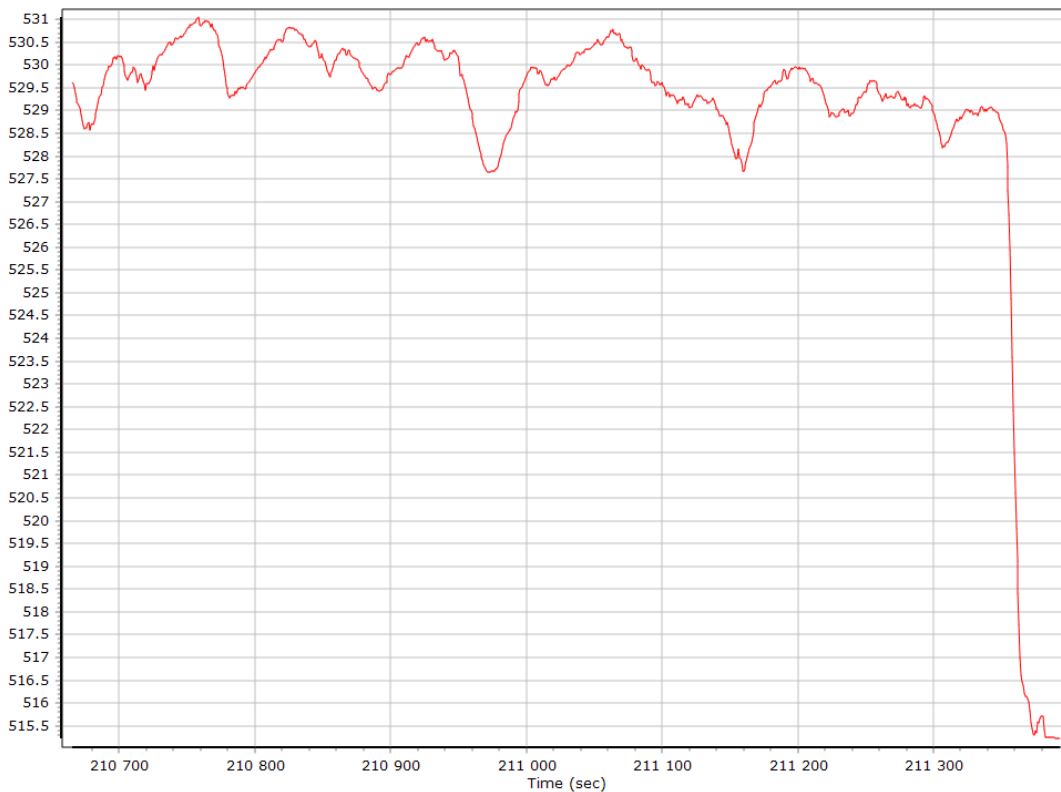


## Trajectory Information

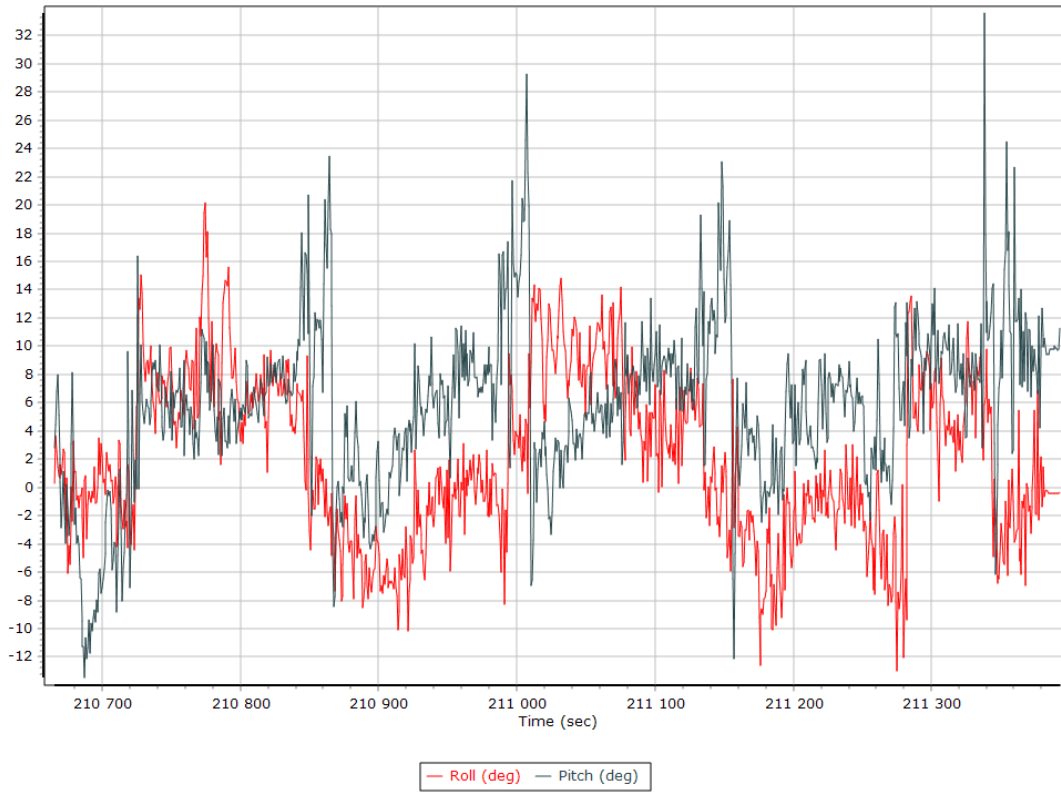
### Top View



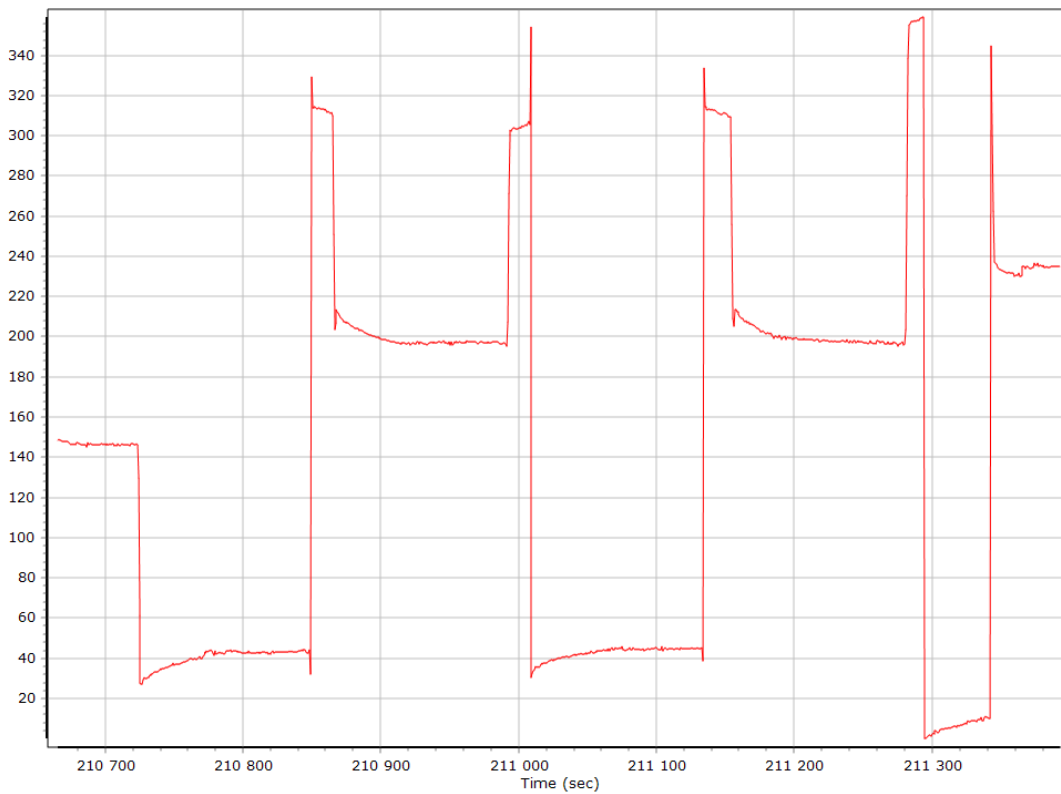
### Altitude



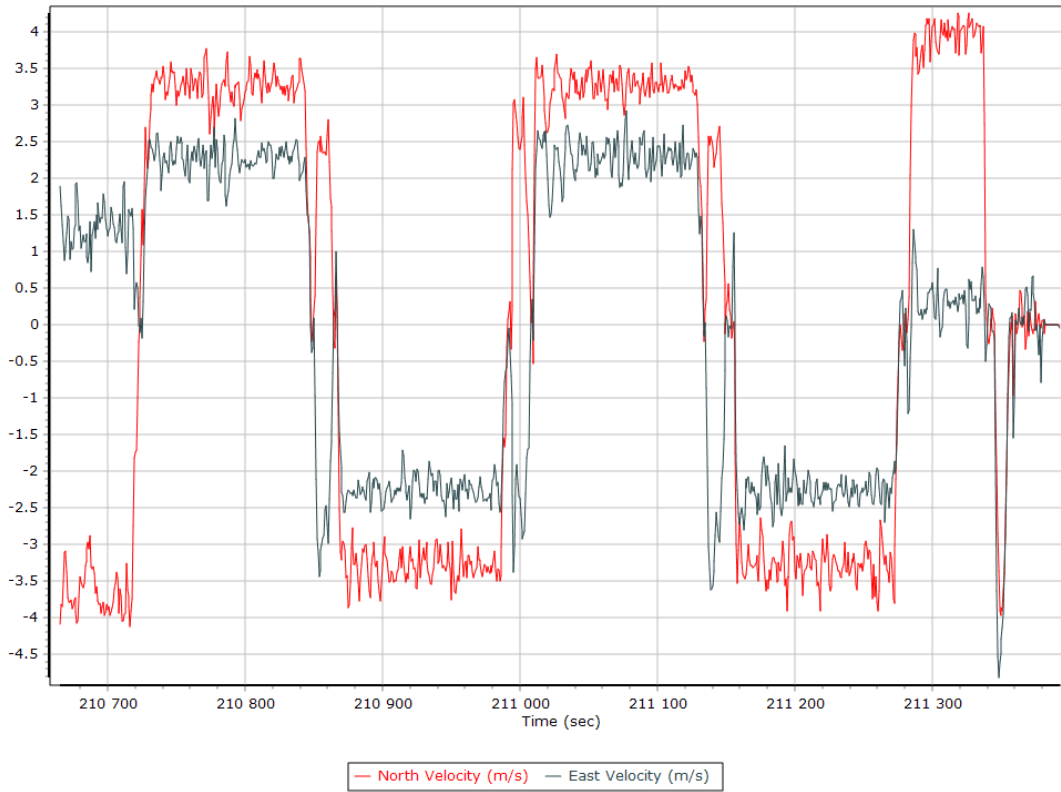
## Roll/Pitch



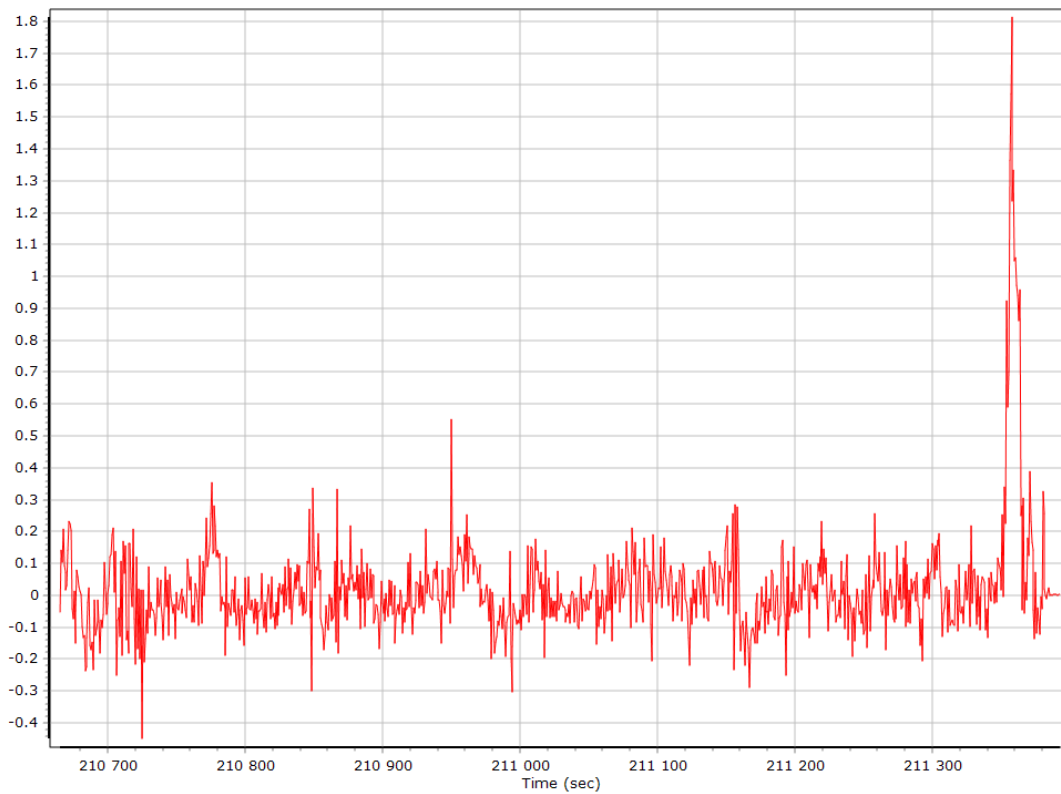
## Heading



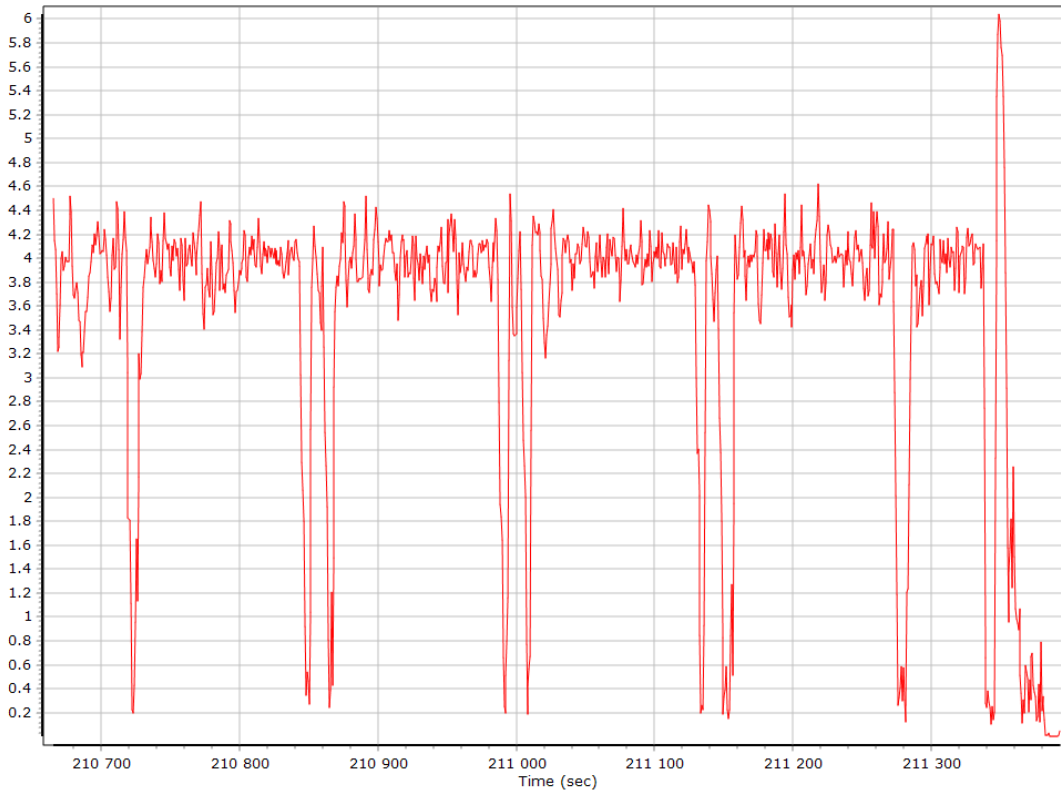
## North/East Velocity



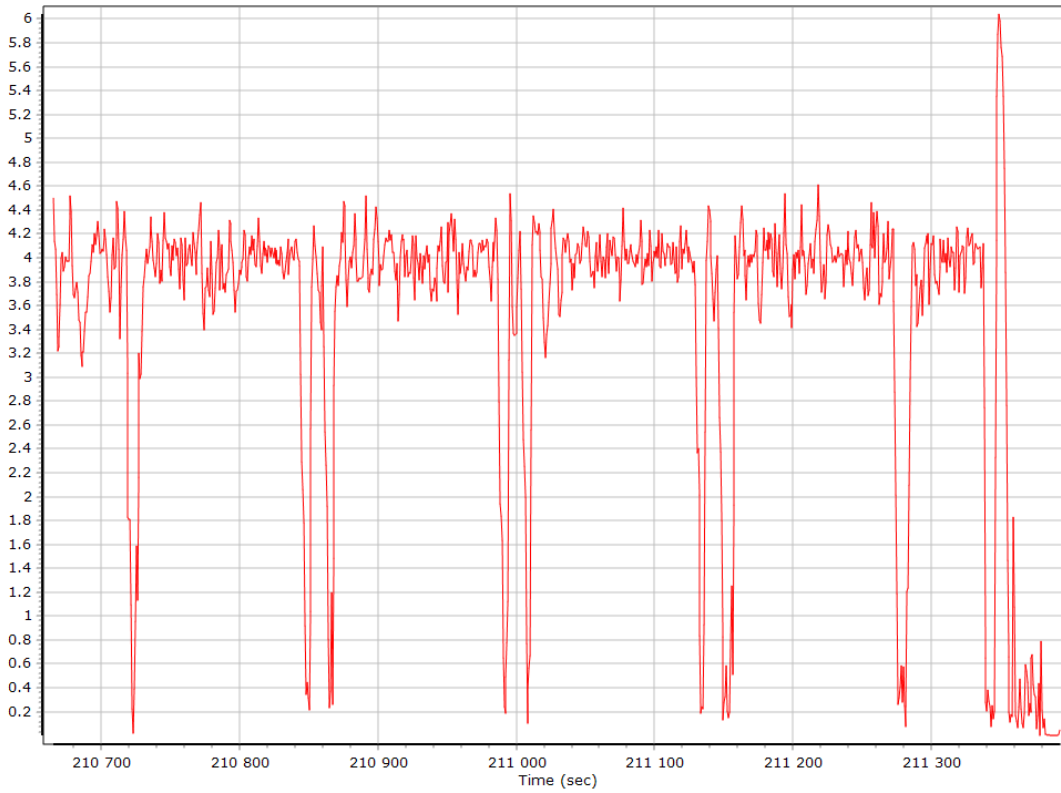
## Down Velocity



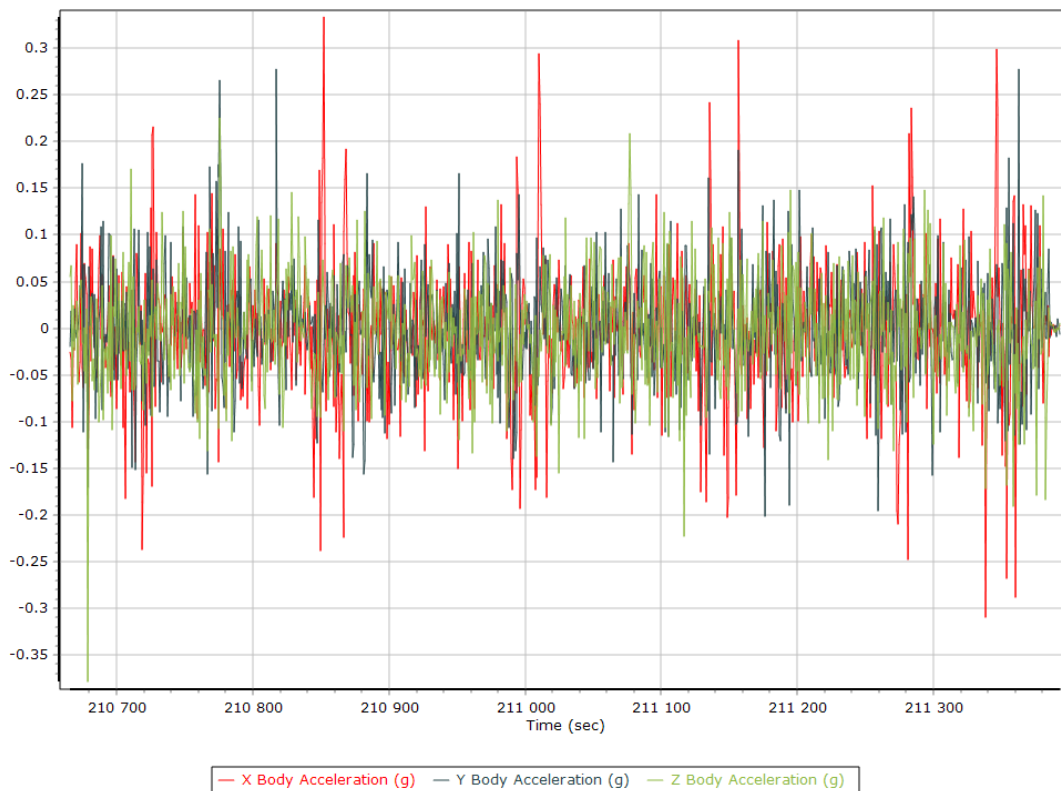
## Total Speed



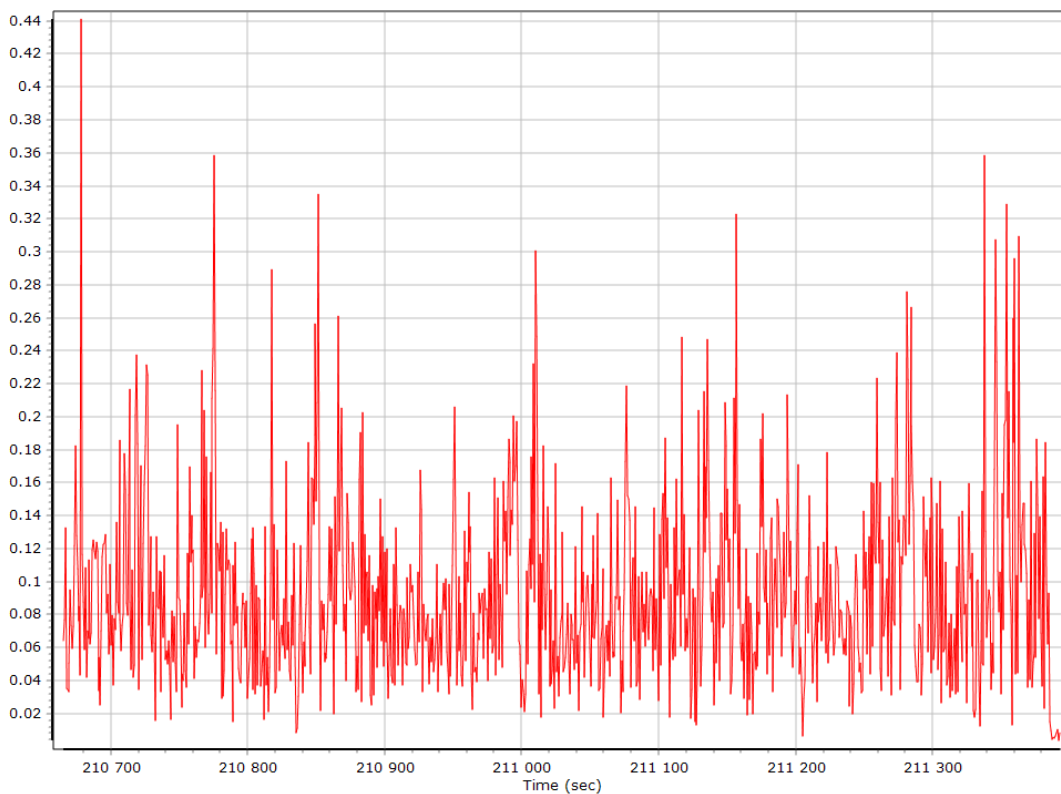
## Ground Speed



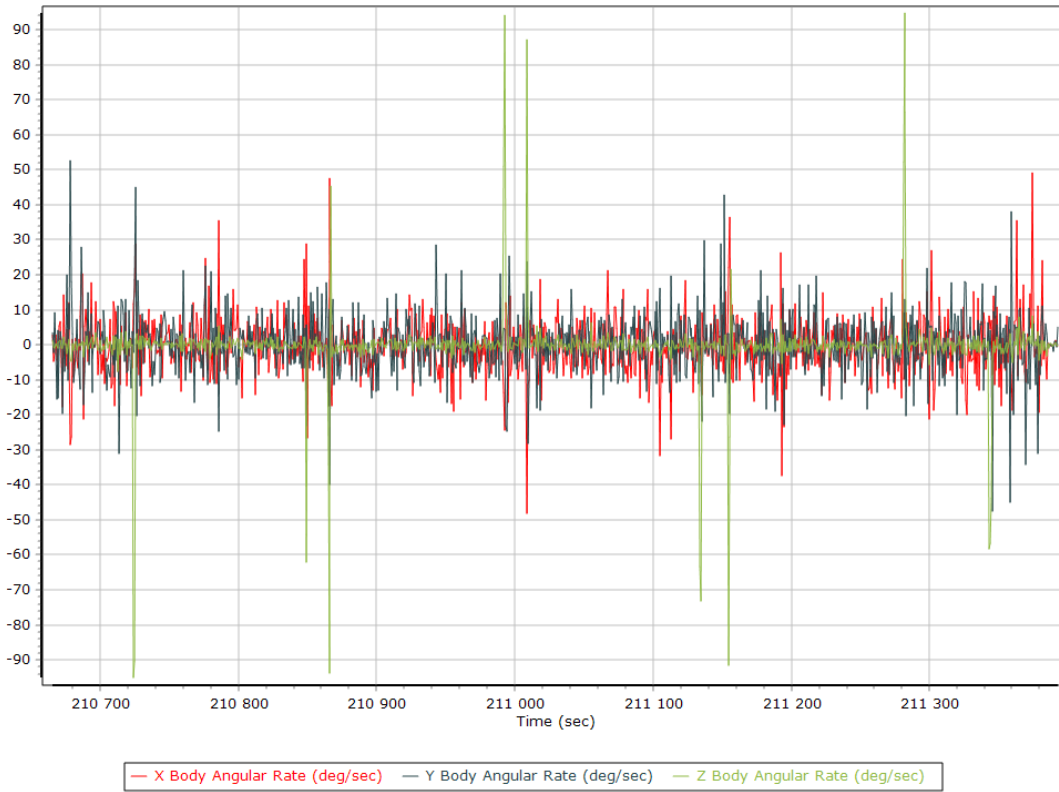
## Body Acceleration



## Total Body Acceleration



## Body Angular Rate



## Base Station Information

Station ID	ALBM		
Filename	a1bm067z.22o		
Start date	3/8/2022 8:00:00 AM		
End date	3/8/2022 4:59:59 PM		
Duration	08:59:59.000		
Data type	GNSS		
Receiver manufacturer, model, serial no.	Trimble	NetR9	5647R50543
Antenna manufacturer, model	Trimble	Zephyr Geodetic 2 RoHS	
Antenna height [m]	0.000		
Antenna measurement method	Bottom of antenna mount		
Offset from measured point to APC [m]	0.08546		
Latitude	N43°56'49.74078"		
Longitude	E2°09'08.78934"		
Ellipsoidal height [m]	222.72020		
Frame	ITRF00		
Epoch	1997		
Ellipsoid	WGS84		
Velocity North [mm/y]	0		
Velocity East [mm/y]	0		
Velocity Up [mm/y]	0		

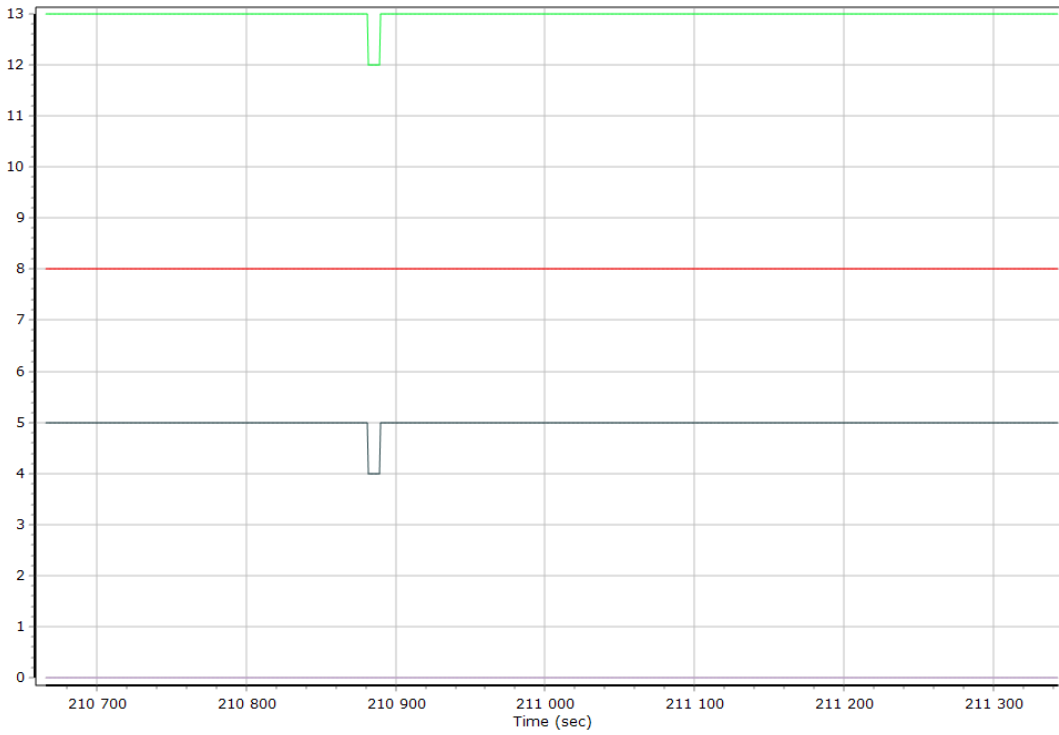


## GNSS QC

### GNSS QC Statistics

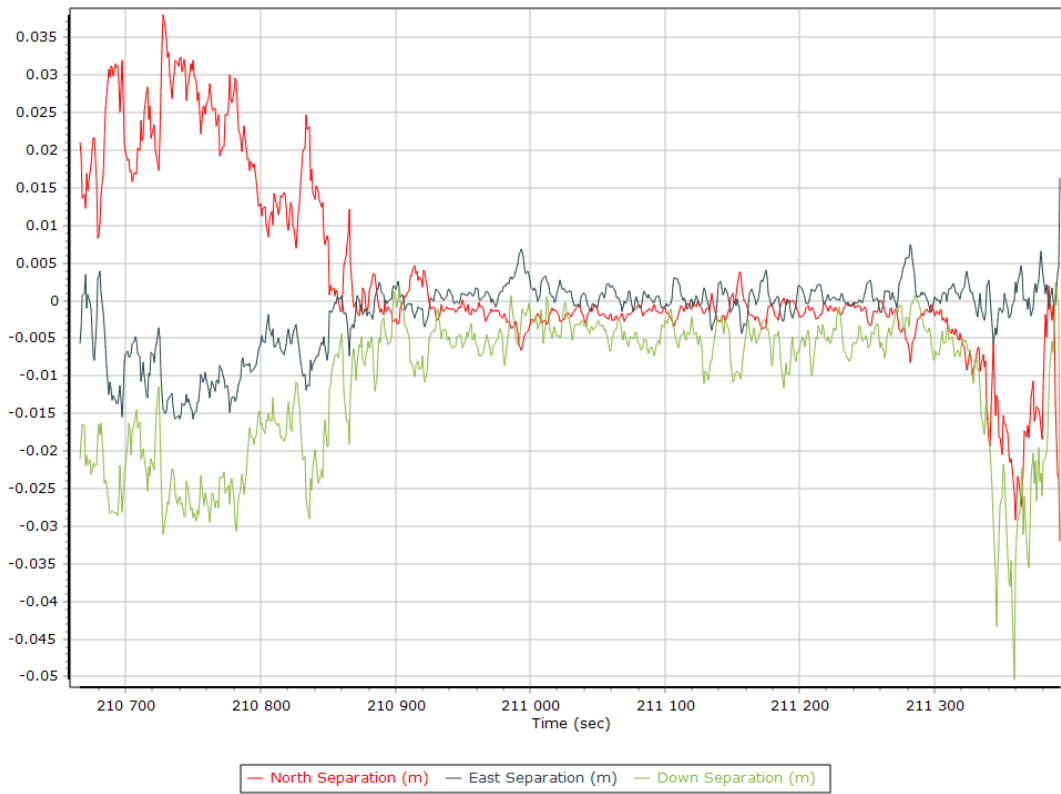
Statistics	Min	Max	Mean
Baseline length [km]	23.44	23.75	
Number of GPS SV	7	8	8
Number of GLONASS SV	4	5	5
Number of QZSS SV	0	0	0
Number of BEIDOU SV	0	0	0
Total number of SV	12	13	13
PDOP	1.37	1.53	1.41
QC Solution Gaps	0.00	0.00	
Solution Type	Fixed	Float	No solution
Epoch (s)	795.00	0.00	0.00
Percentage	100.00	0.00	0.00

### Num SVs in solution

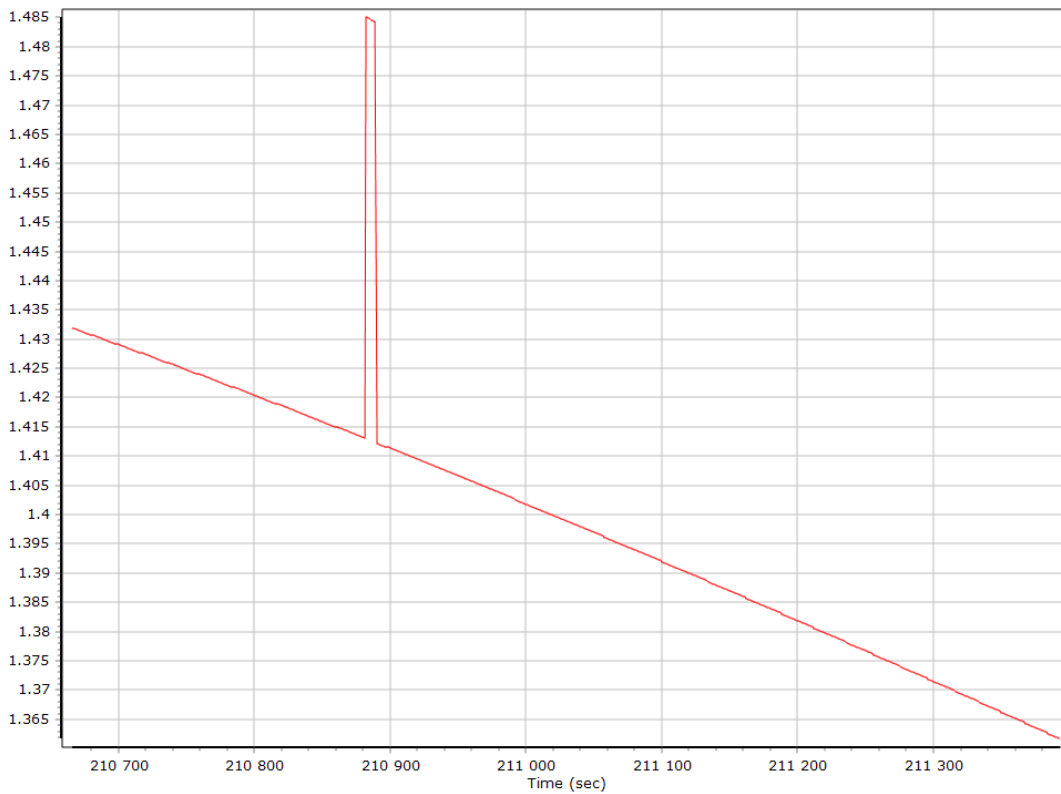


— Number of GPS — Number of GLONASS — Number of QZSS — Number of BEIDOU — Total Number

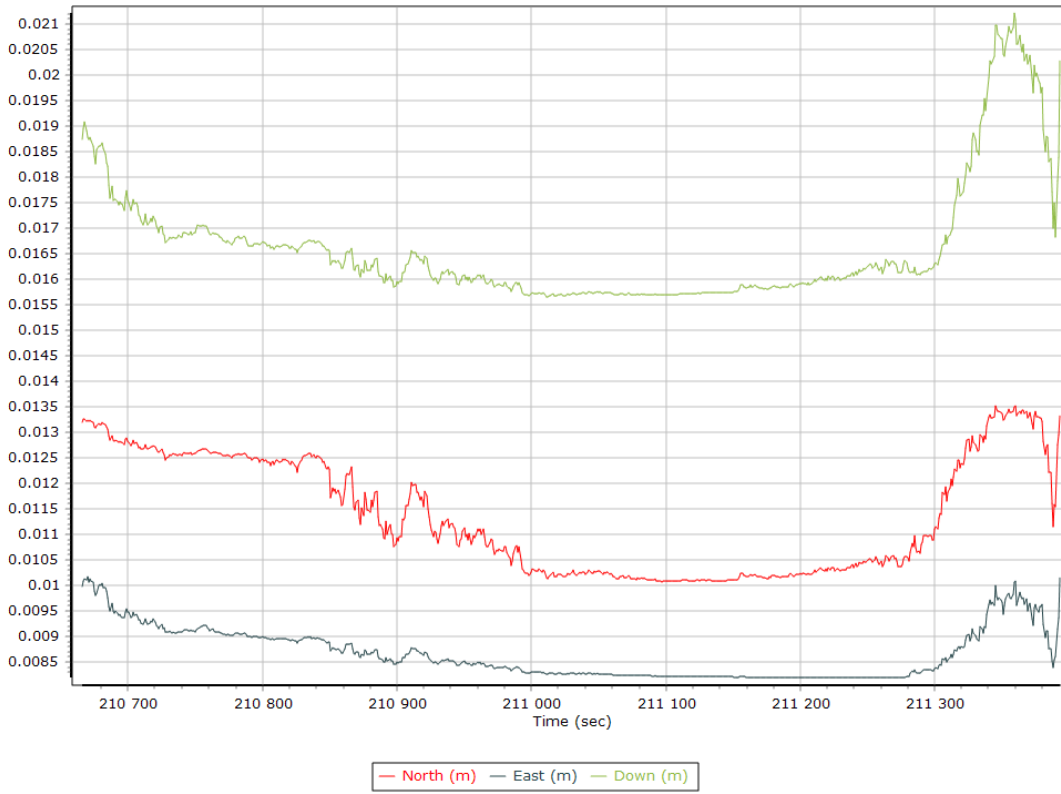
### Forward/Reverse Separation



### PDOP



## Estimated Position Accuracy



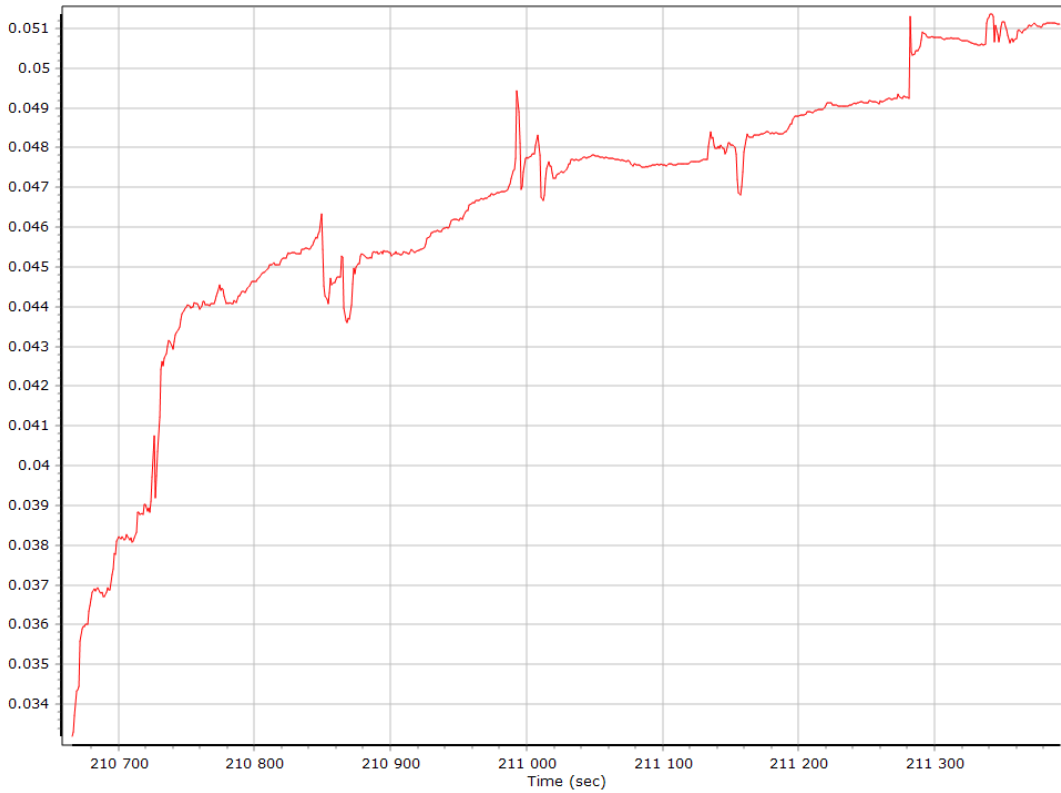
## GNSS-Inertial Processor Configuration

Processing mode	IN-Fusion Single Base		
Stabilized mount	False		
Base station	ALBM		
Processing start time	210548.002 (3/8/2022 10:29:08 AM)		
Processing end time	211393.000 (3/8/2022 10:43:13 AM)		
Initial attitude source	Primary GNSS Track		
IMU Sensor Context	Processing with Onboard IMU		
Reference to IMU lever arm [m]	-0.013	0.108	-0.007
Reference to IMU mounting angles [deg]	0.000	0.000	0.000
Reference to Primary GNSS lever arm [m]	0.051	0.202	-0.396
Reference to Primary GNSS lever arm std dev [m]	0.100	0.100	0.100
Aircraft to Reference mounting angles [deg]	0.000	0.000	0.000

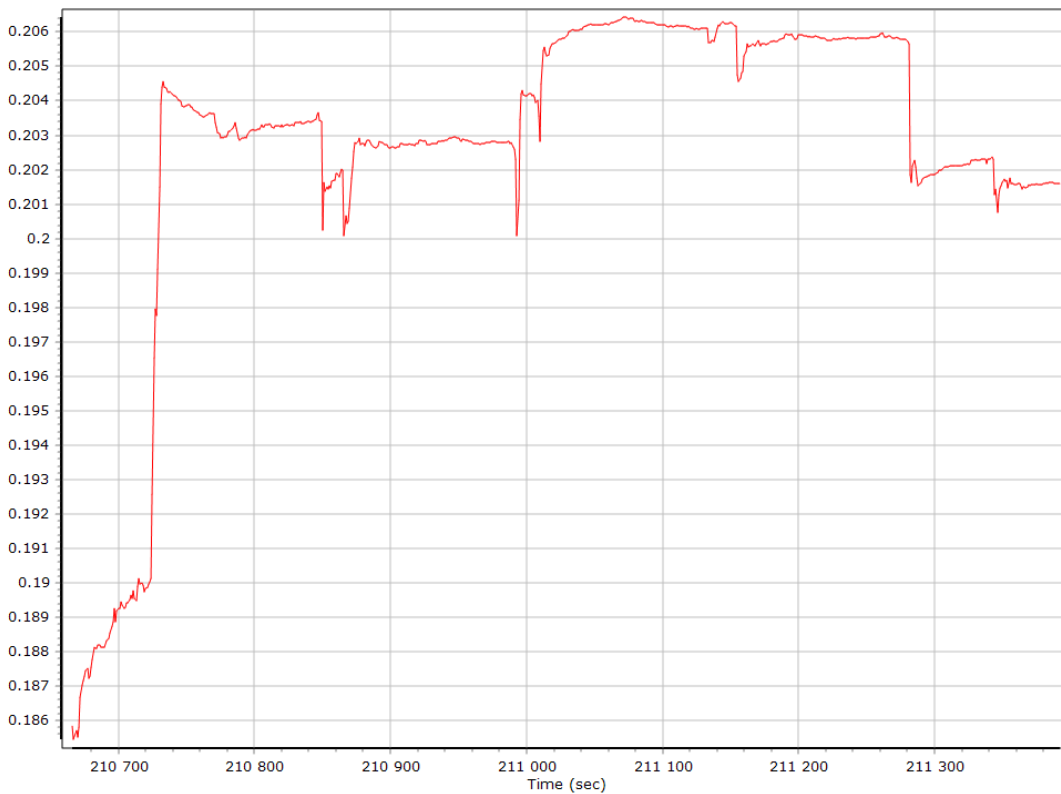
## Calibrated Installation Parameters

### Reference-Primary GNSS Lever Arm

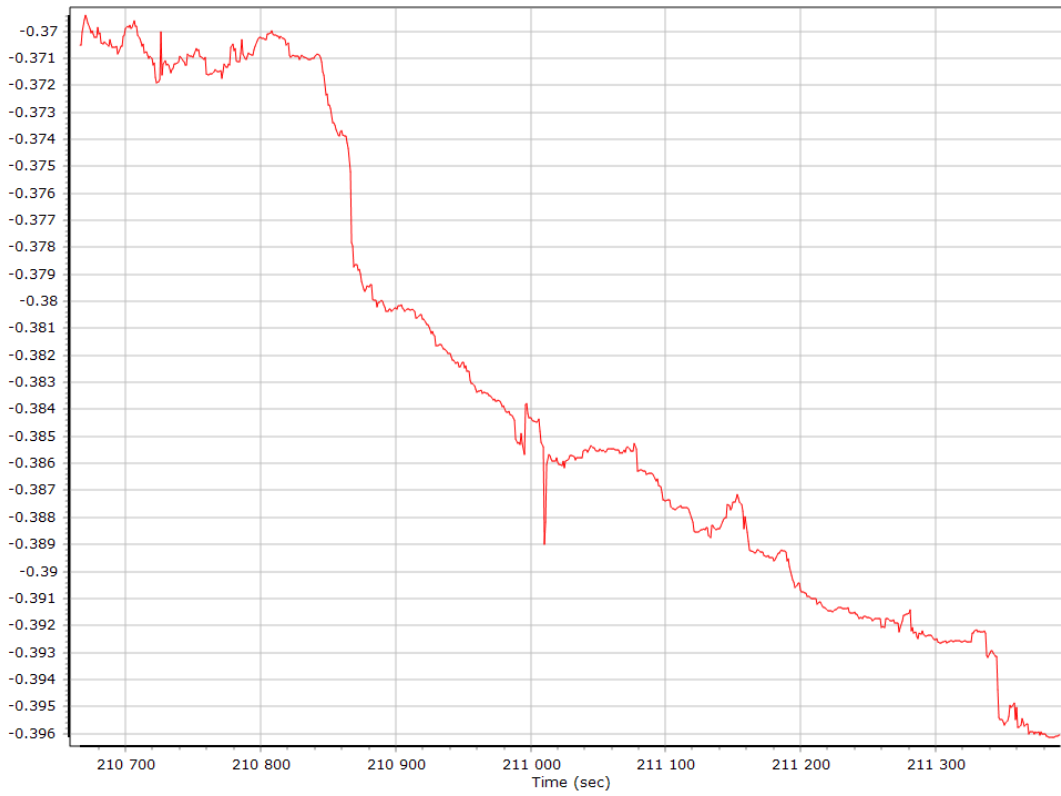
#### X Reference-Primary GNSS Lever Arm (m)



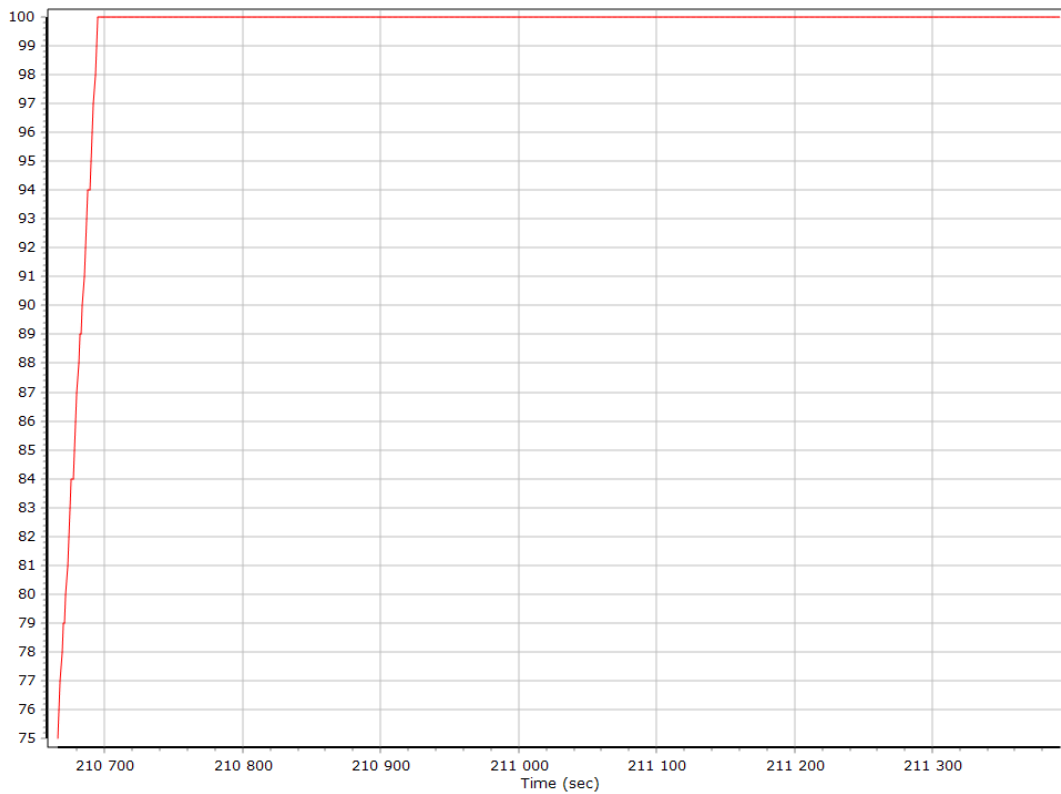
#### Y Reference-Primary GNSS Lever Arm (m)



### Z Reference-Primary GNSS Lever Arm (m)



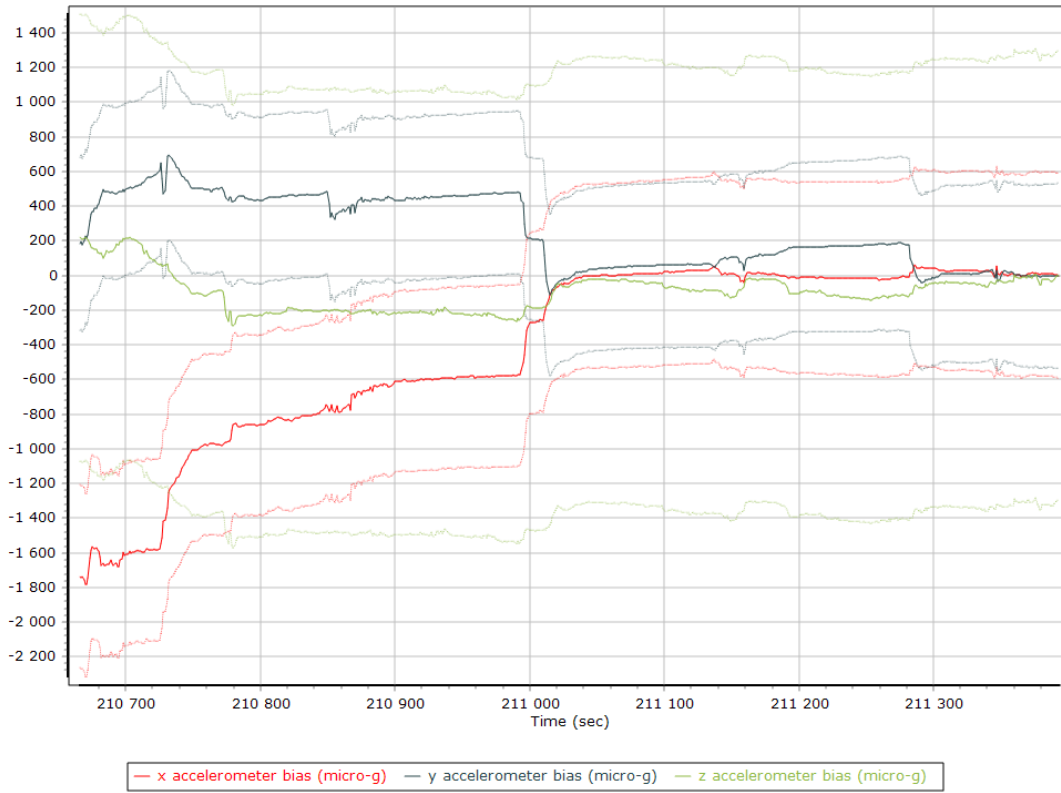
### Reference-Primary GNSS Lever Arm Figure of Merit



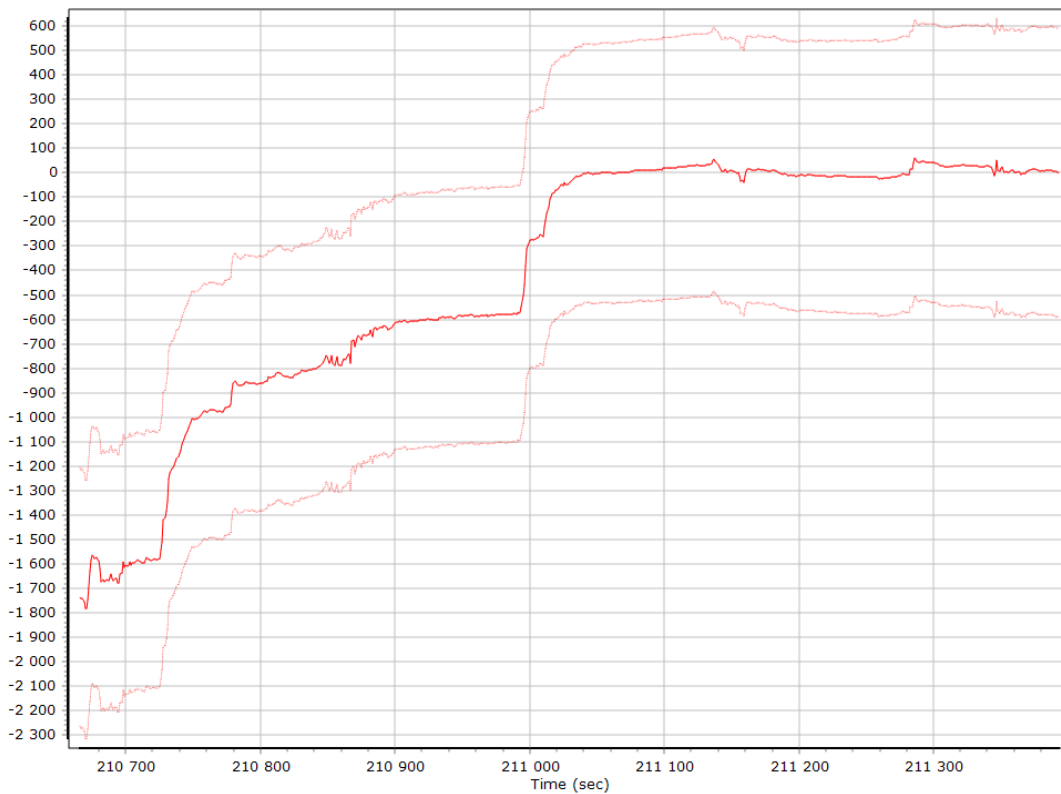
## Smoothed IN-Fusion QC

### Smoothed Estimated Errors, Reference Frame

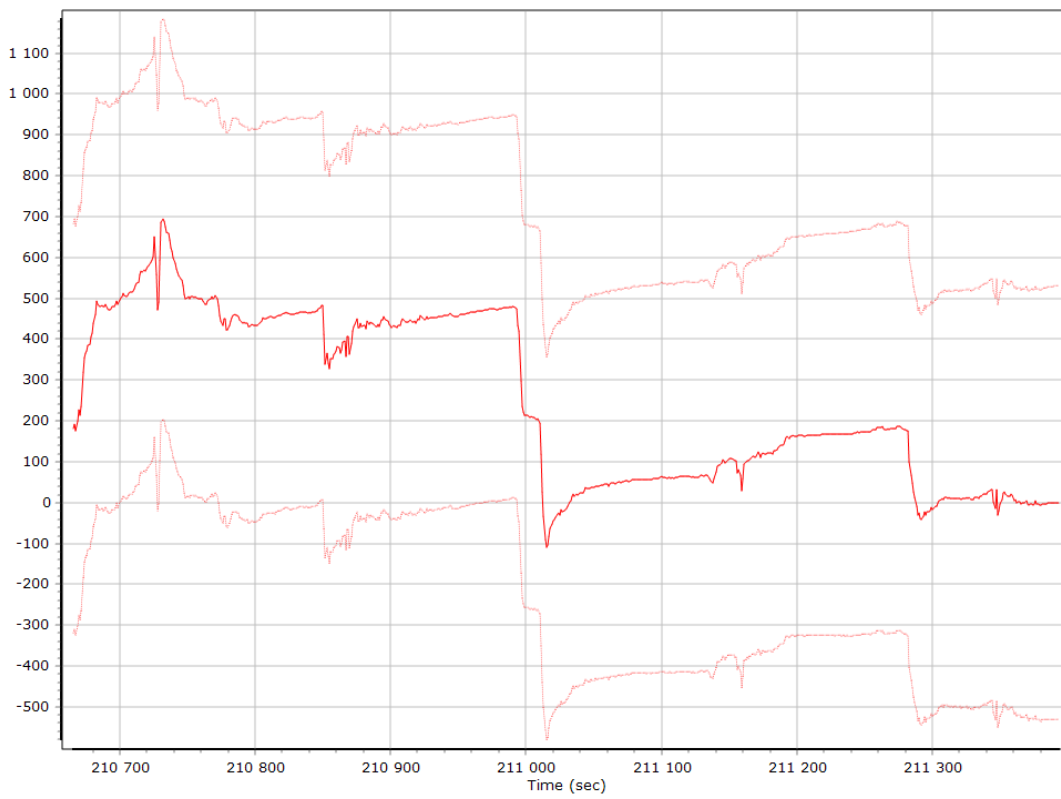
#### Accelerometer Bias (micro-g)



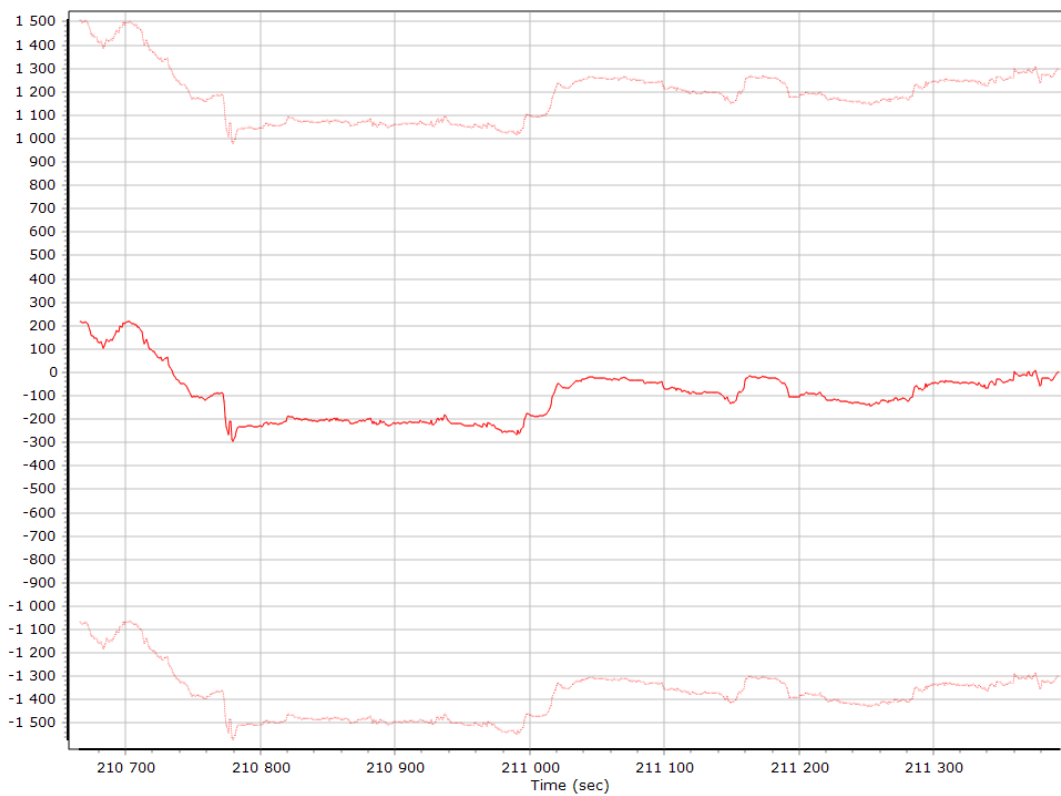
#### X Accelerometer Bias (micro-g)



### Y Accelerometer Bias (micro-g)

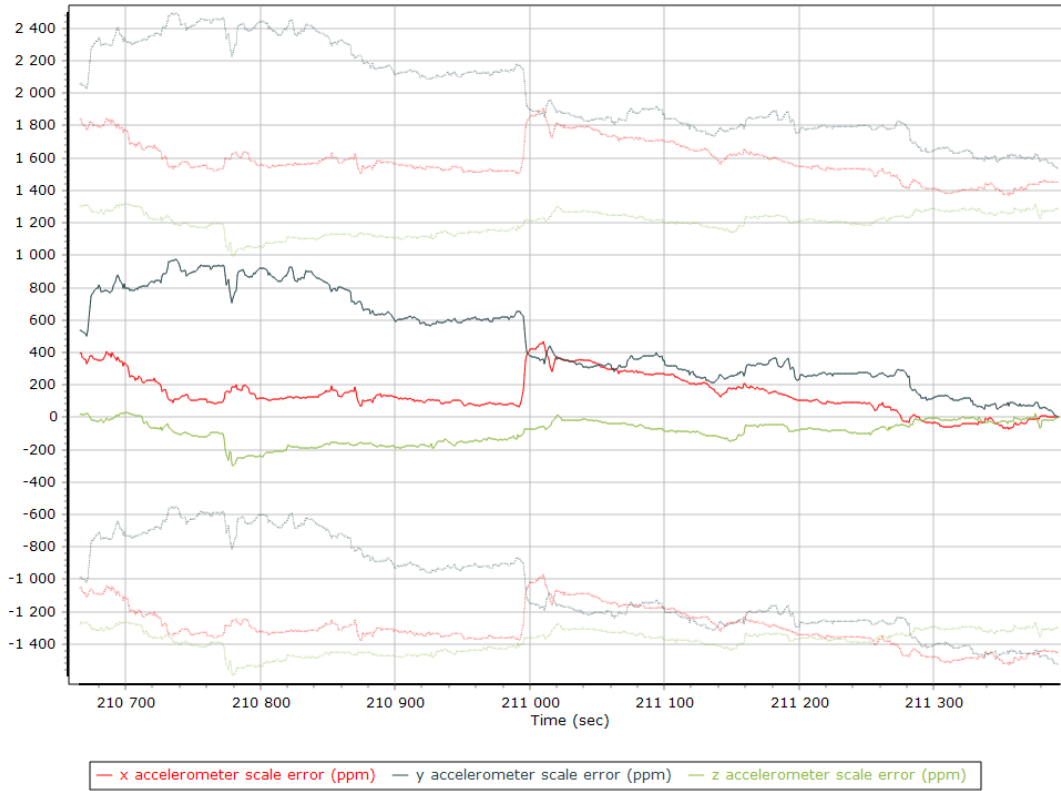


### Z Accelerometer Bias (micro-g)

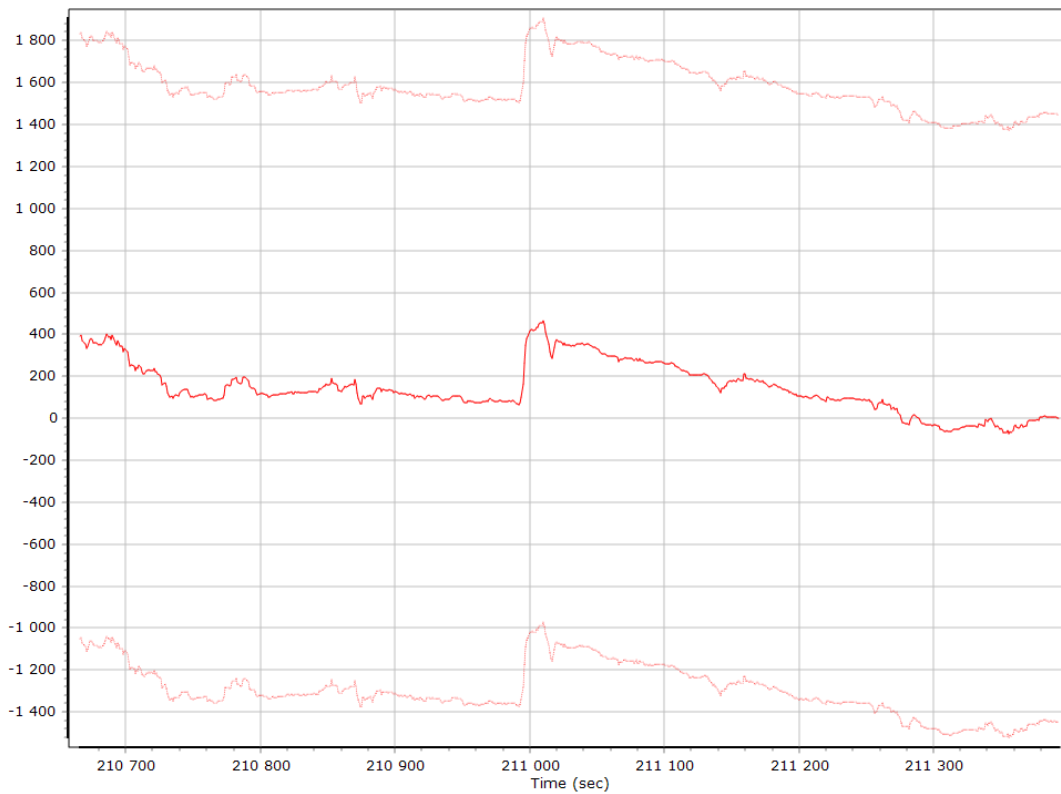




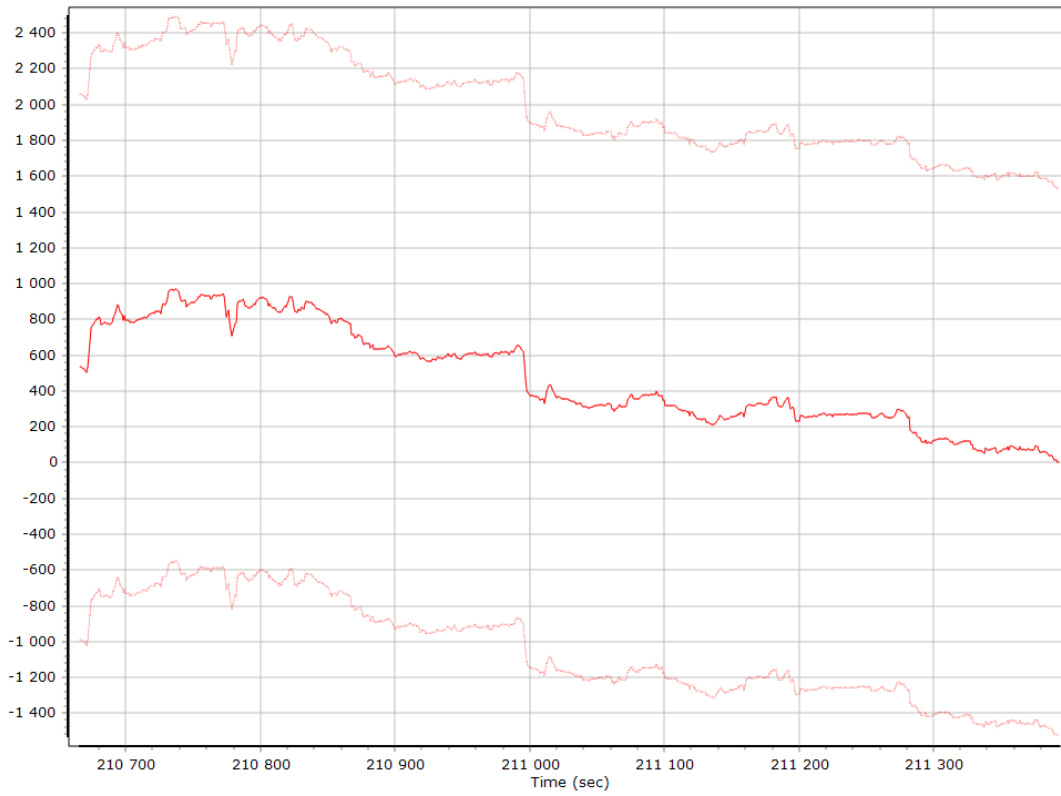
### Accelerometer Scale Error (ppm)



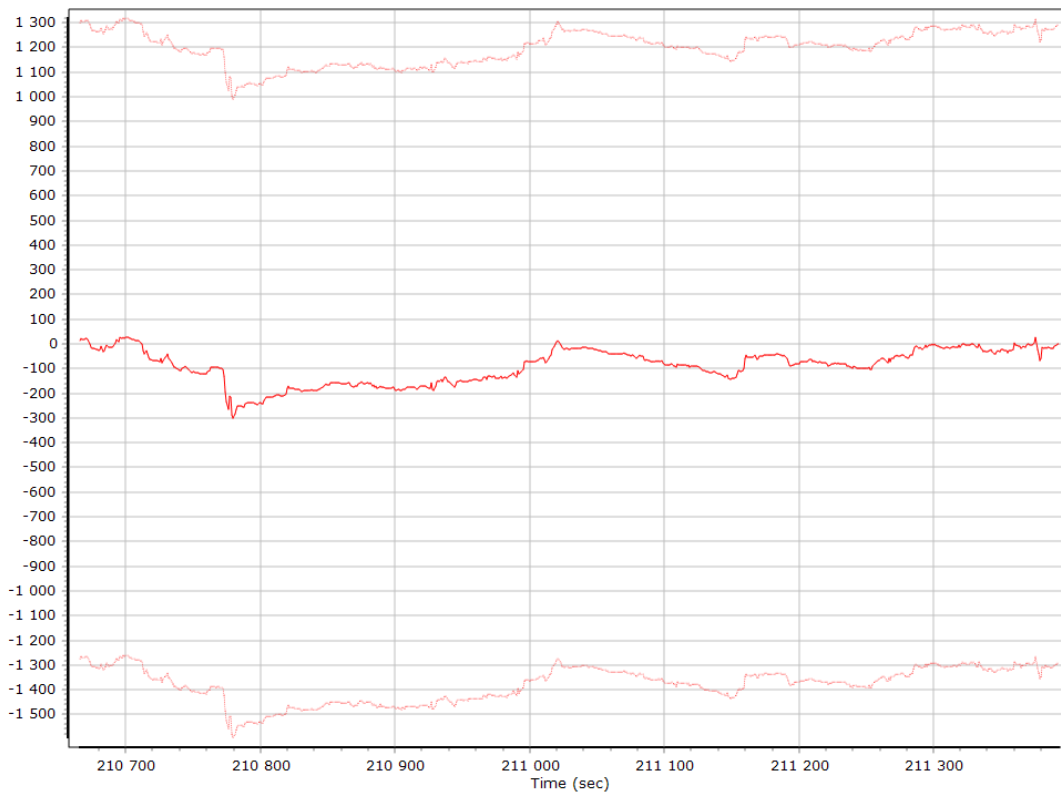
### X Accelerometer Scale Error (ppm)



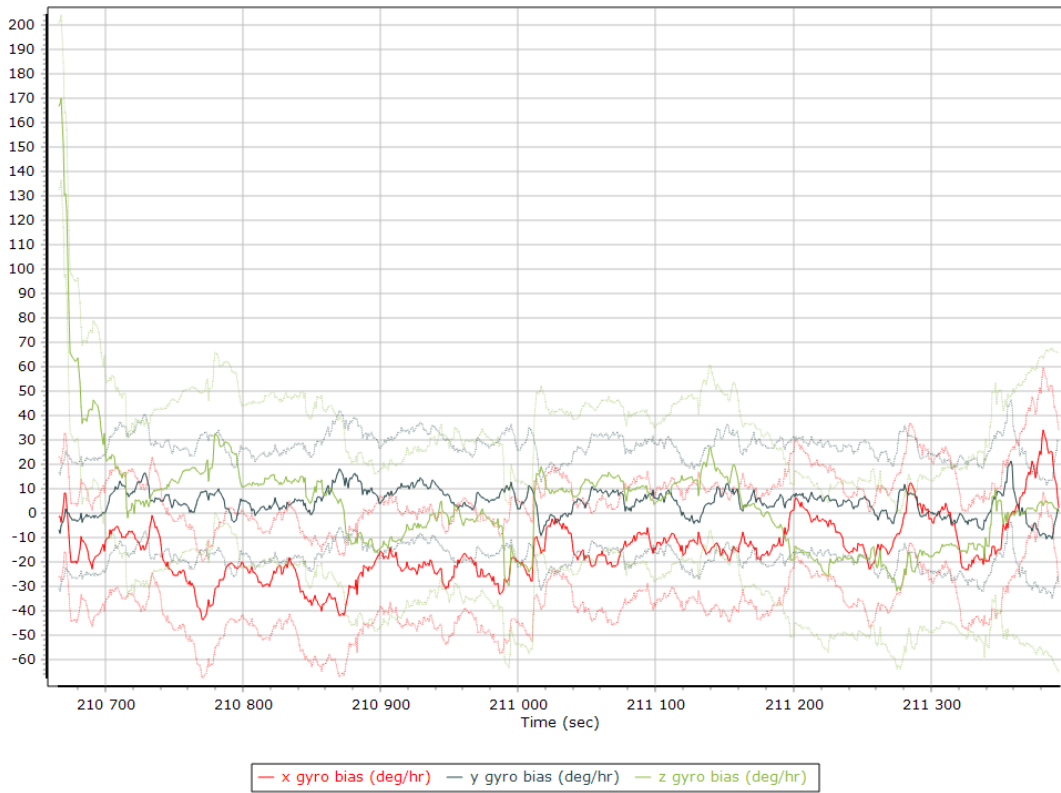
### Y Accelerometer Scale Error (ppm)



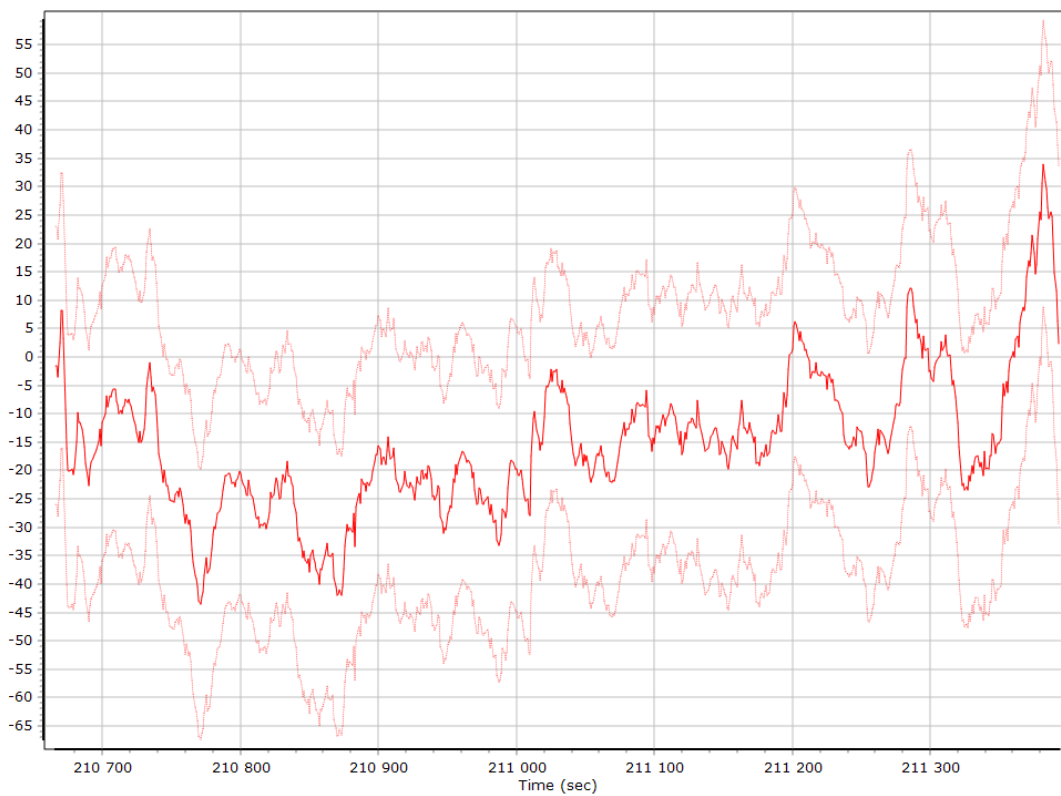
### Z Accelerometer Scale Error (ppm)



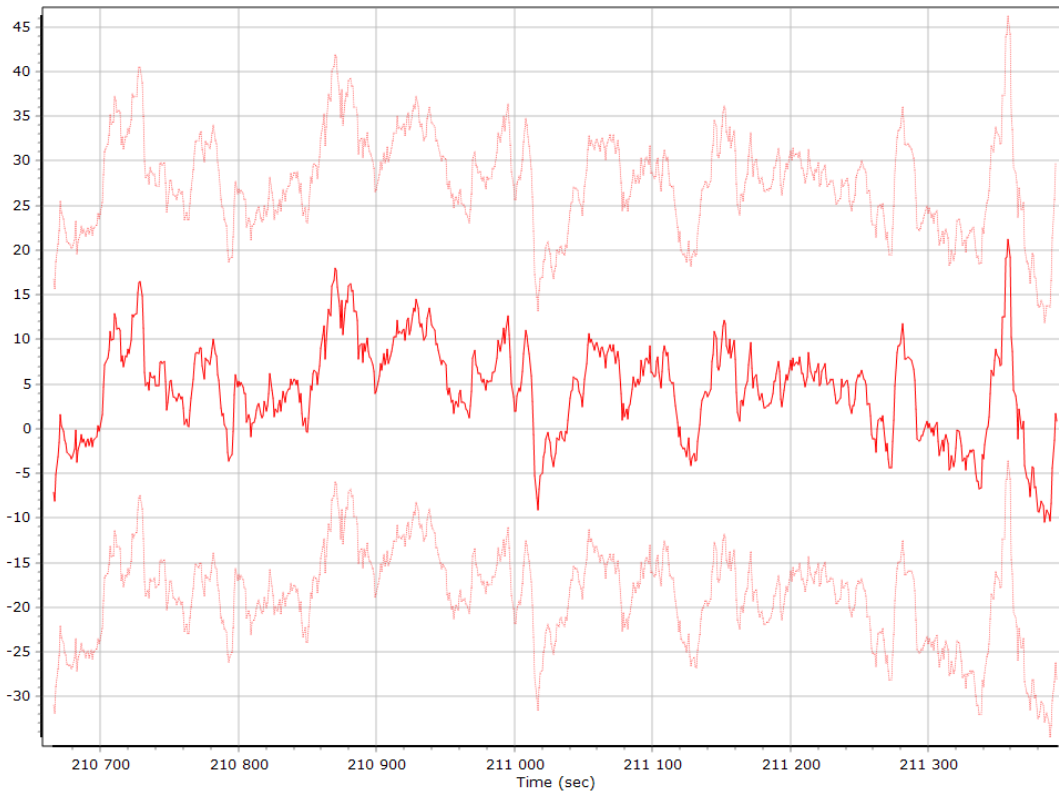
### Gyro Bias (deg/h)



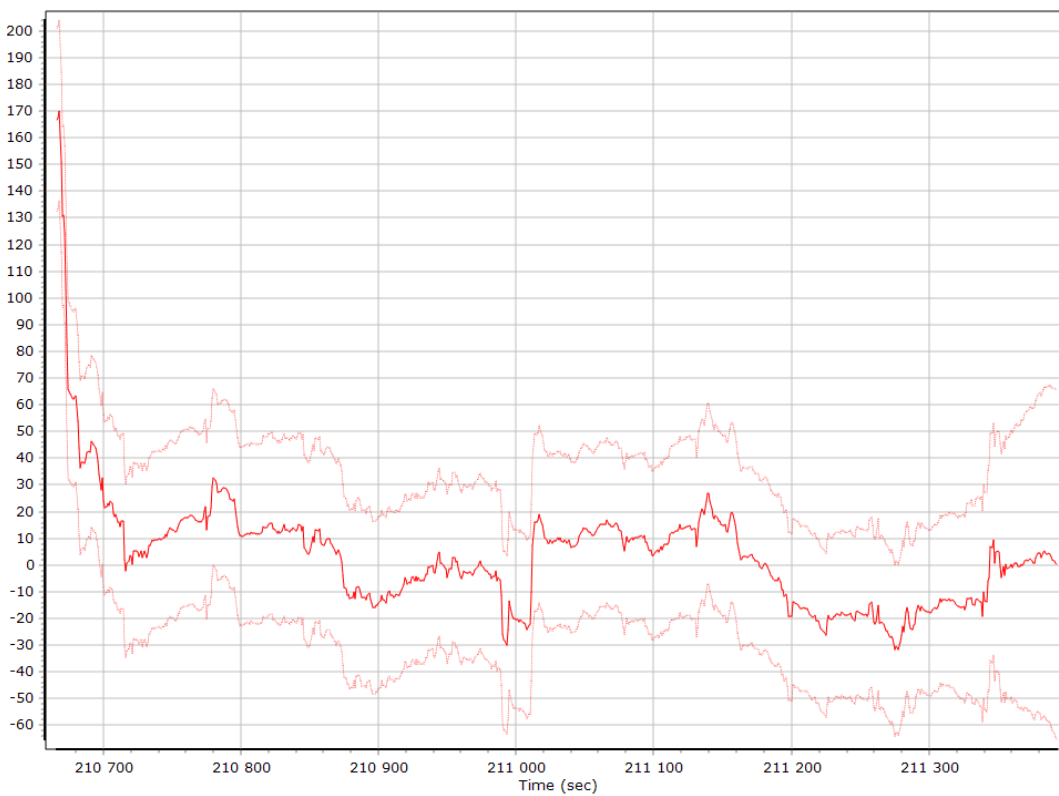
### X Gyro Bias (deg/h)



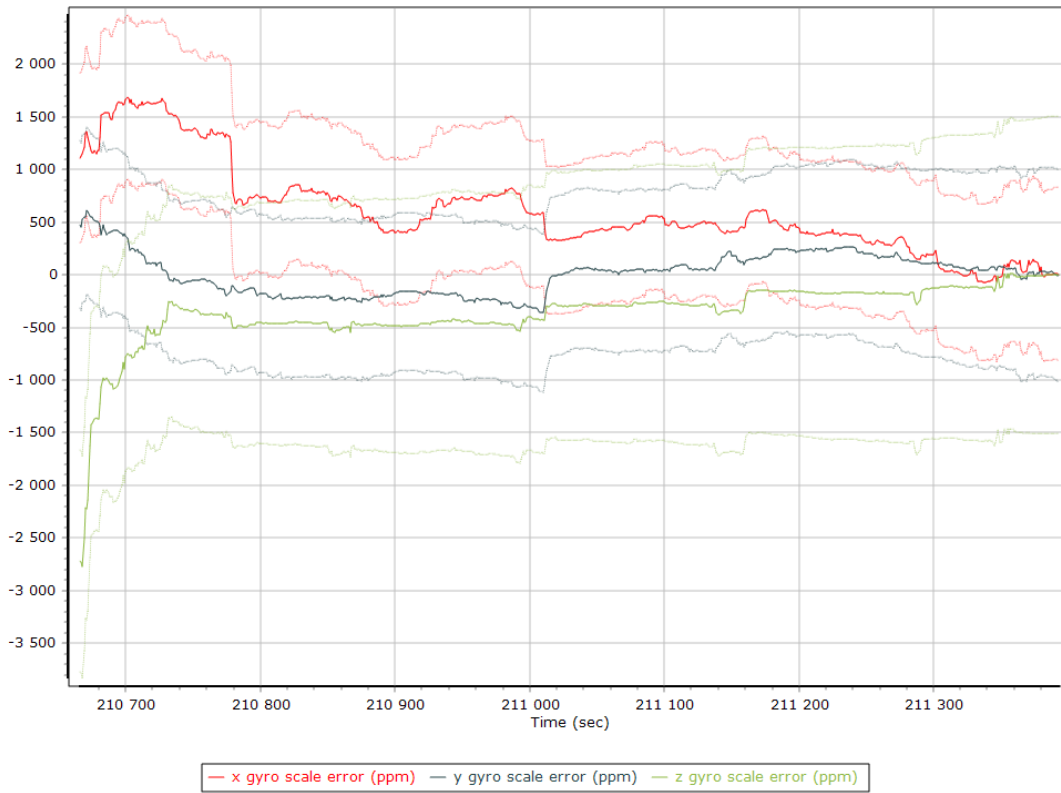
### Y Gyro Bias (deg/h)



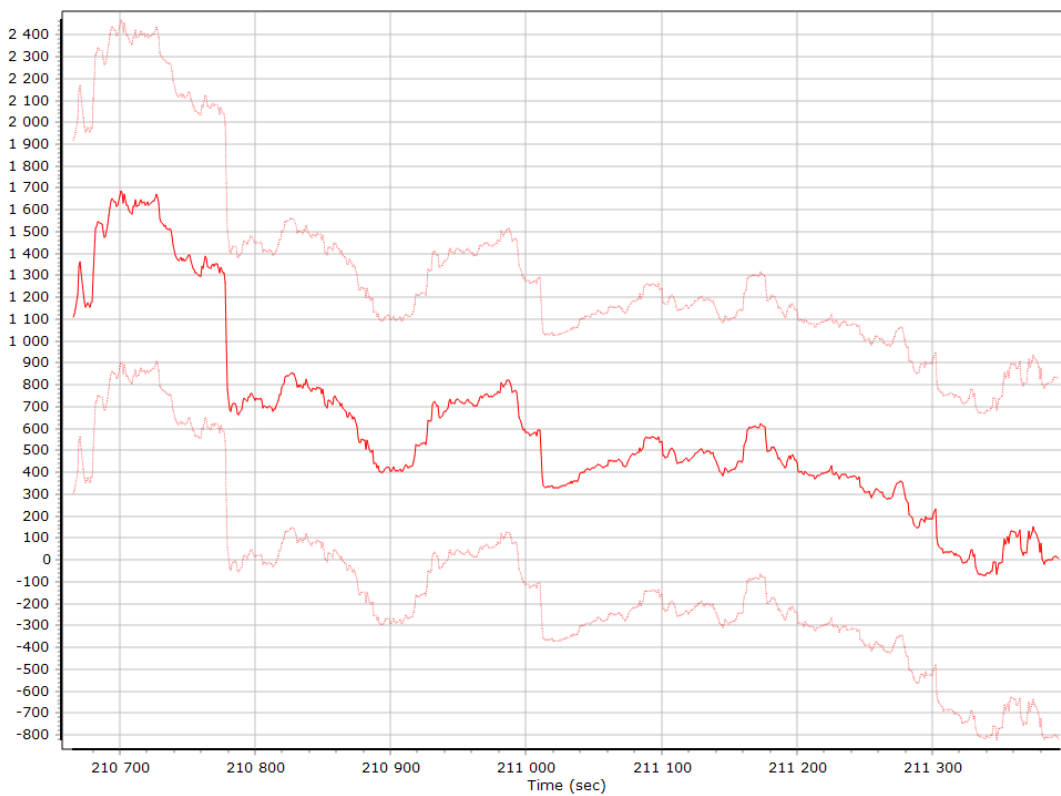
### Z Gyro Bias (deg/h)



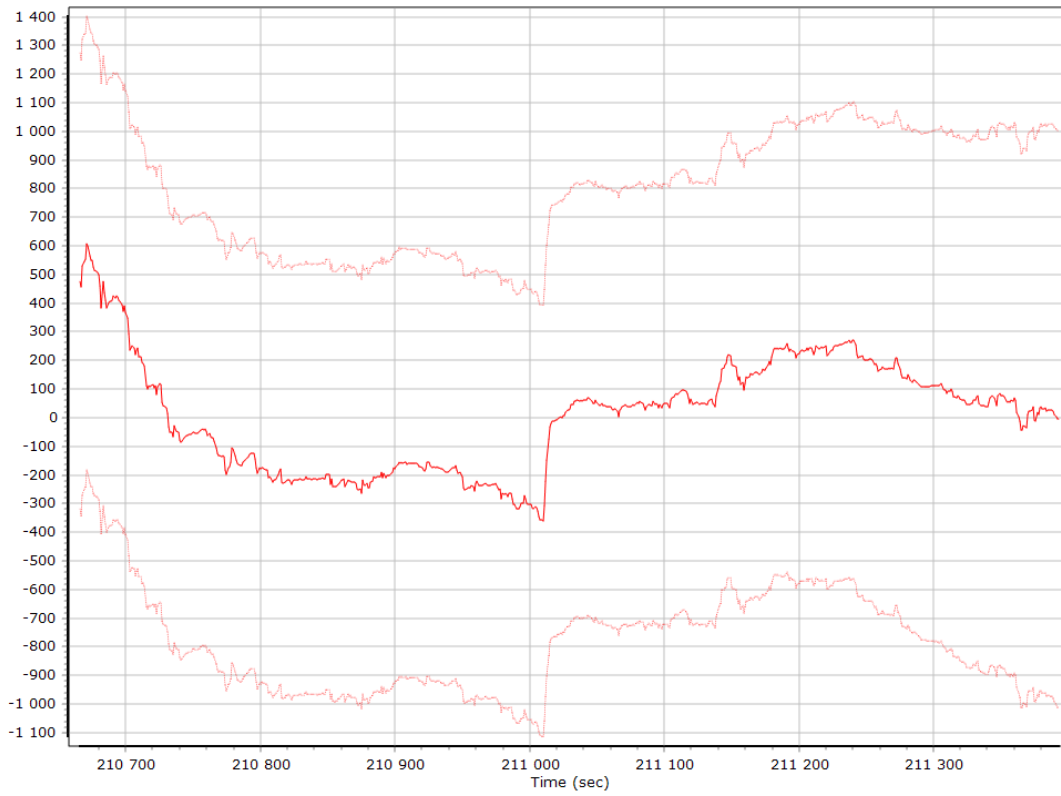
### Gyro Scale Error (ppm)



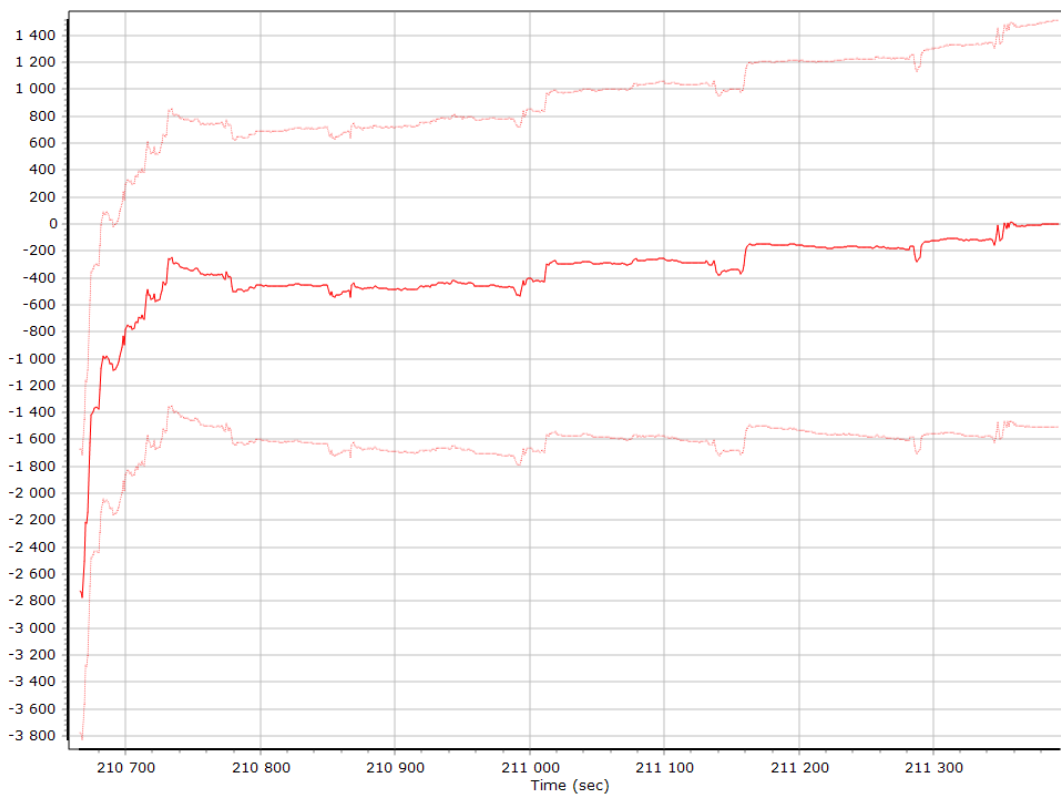
### X Gyro Scale Error (ppm)



### Y Gyro Scale Error (ppm)

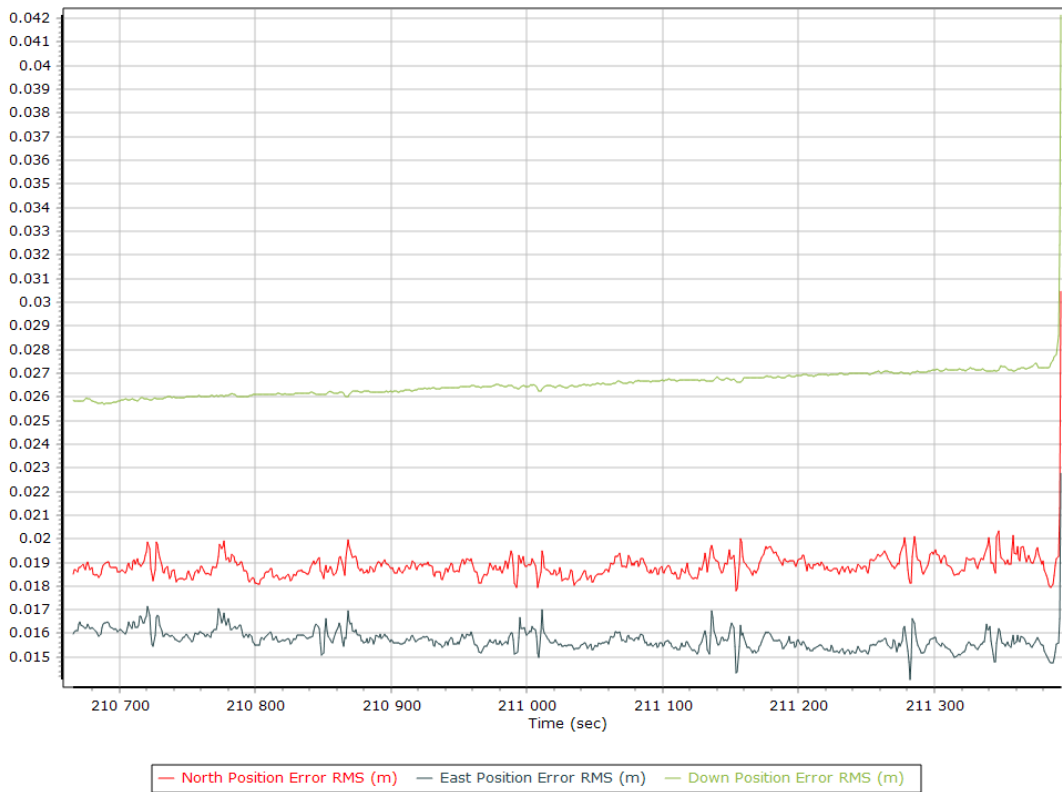


### Z Gyro Scale Error (ppm)

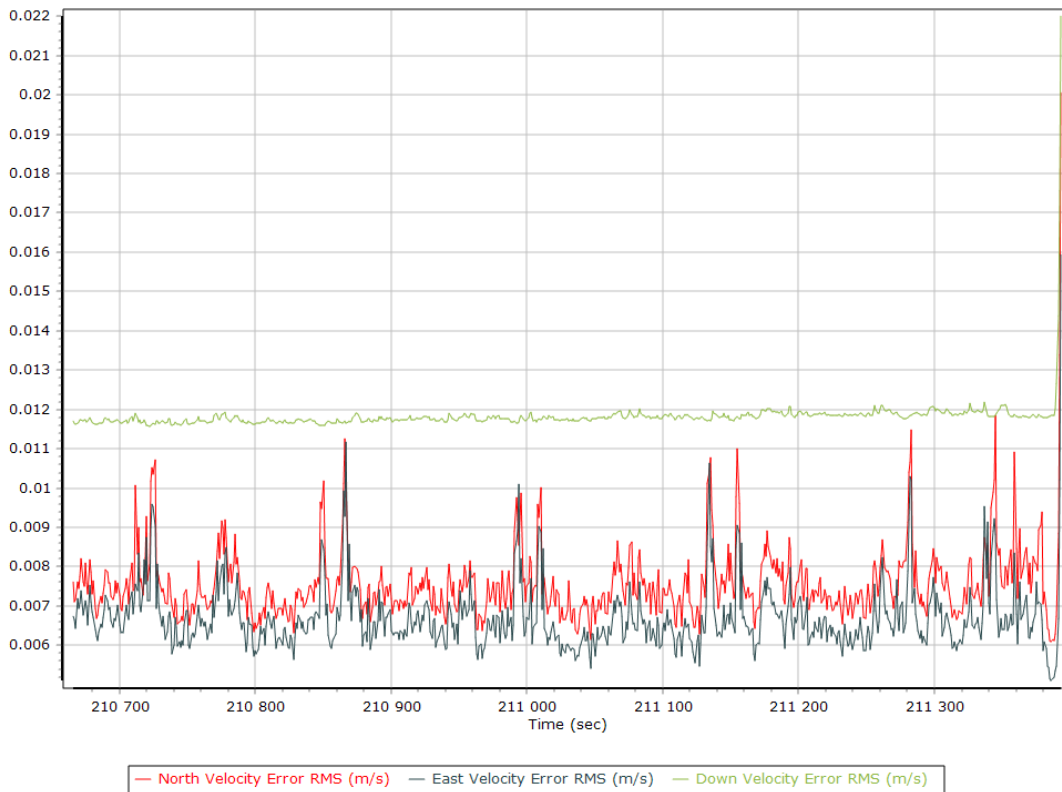


## Smoothed Performance Metrics

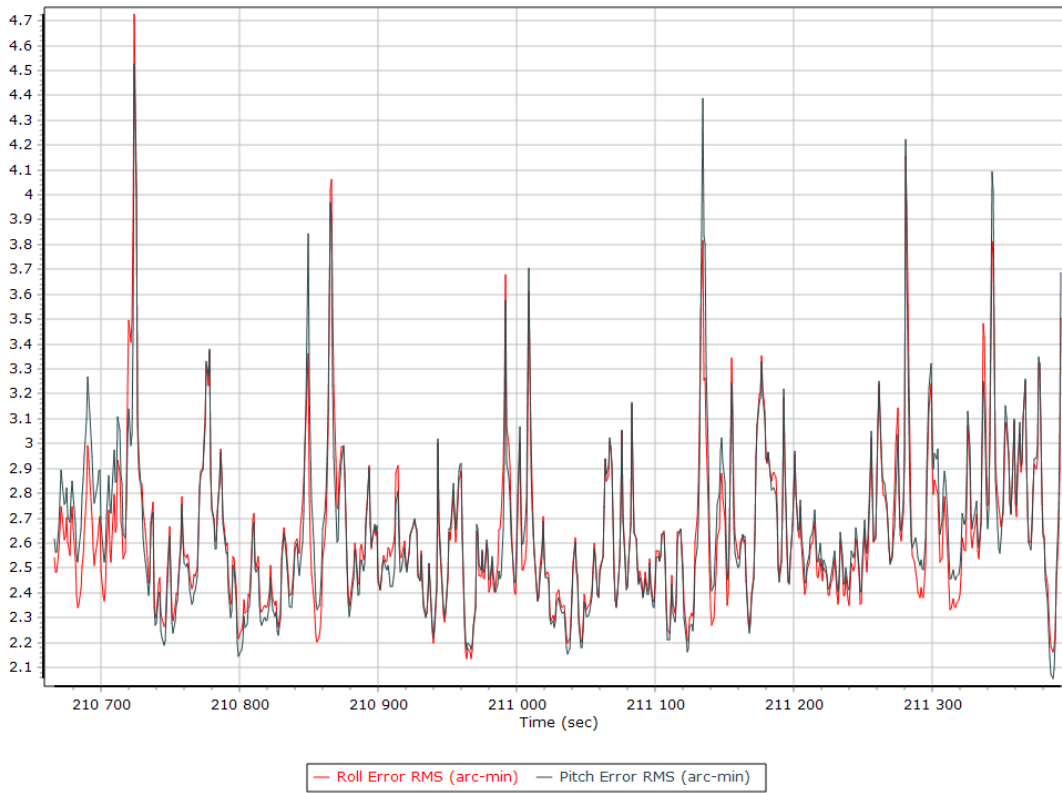
### Position Error RMS (m)



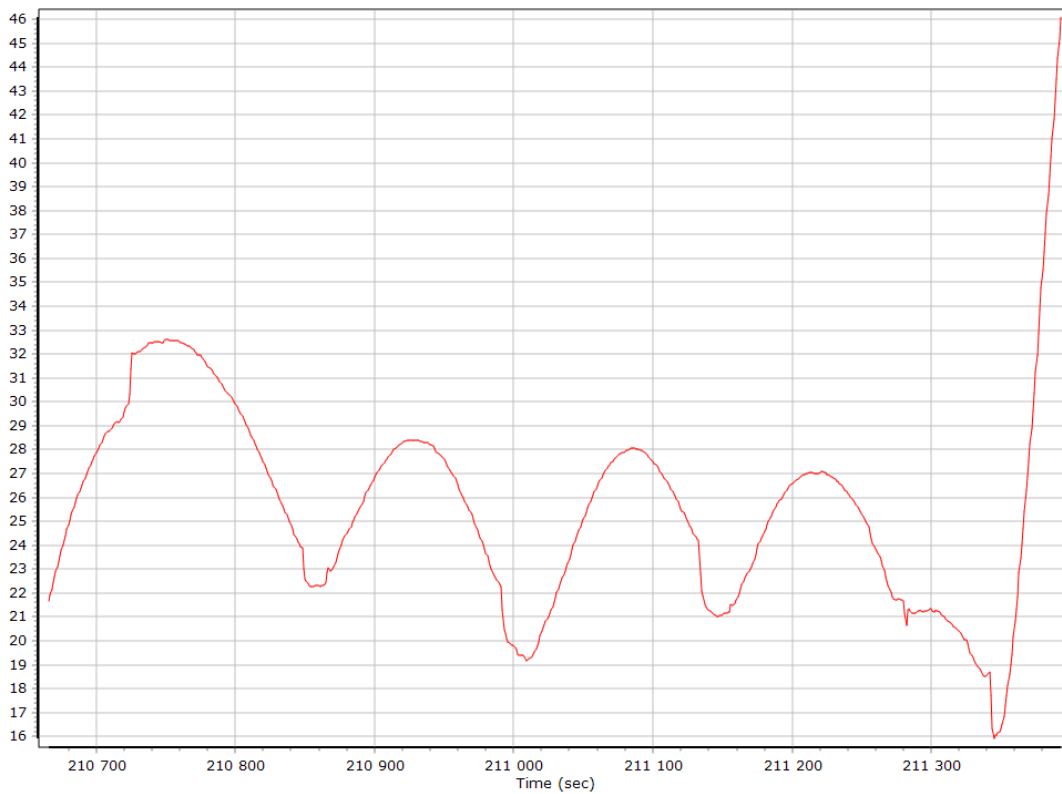
### Velocity Error RMS (m/s)



### Roll/Pitch Error RMS (arc-min)



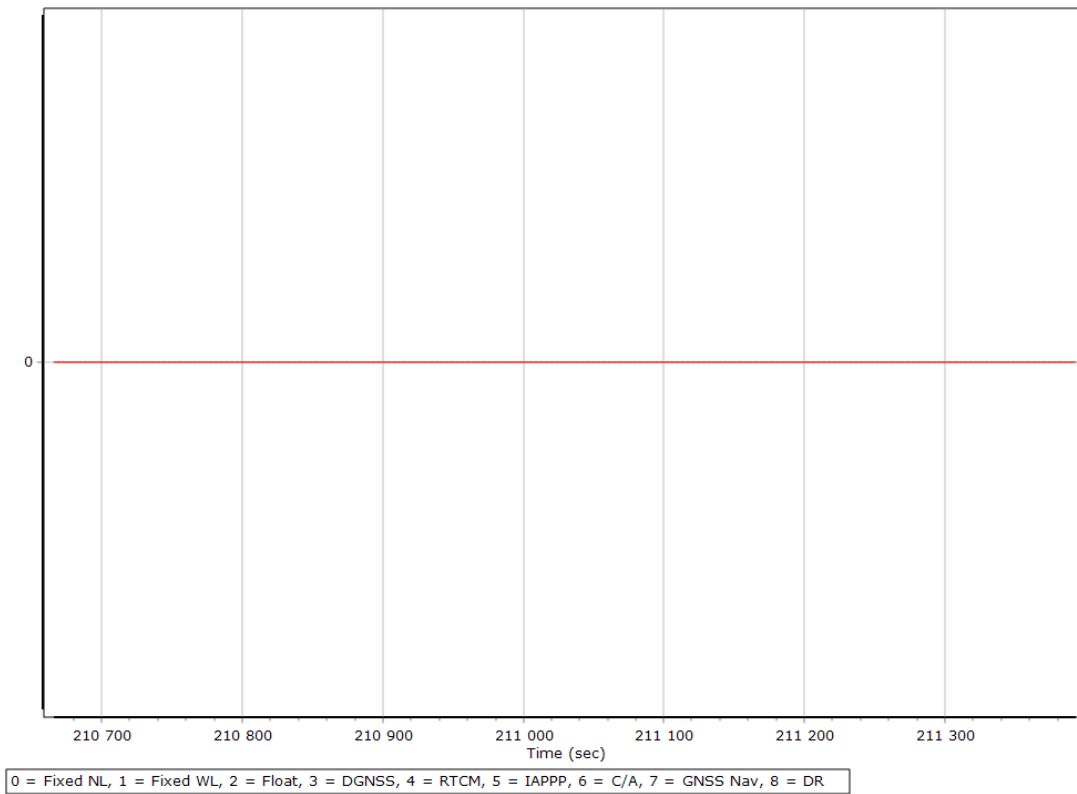
### Heading Error RMS (arc-min)



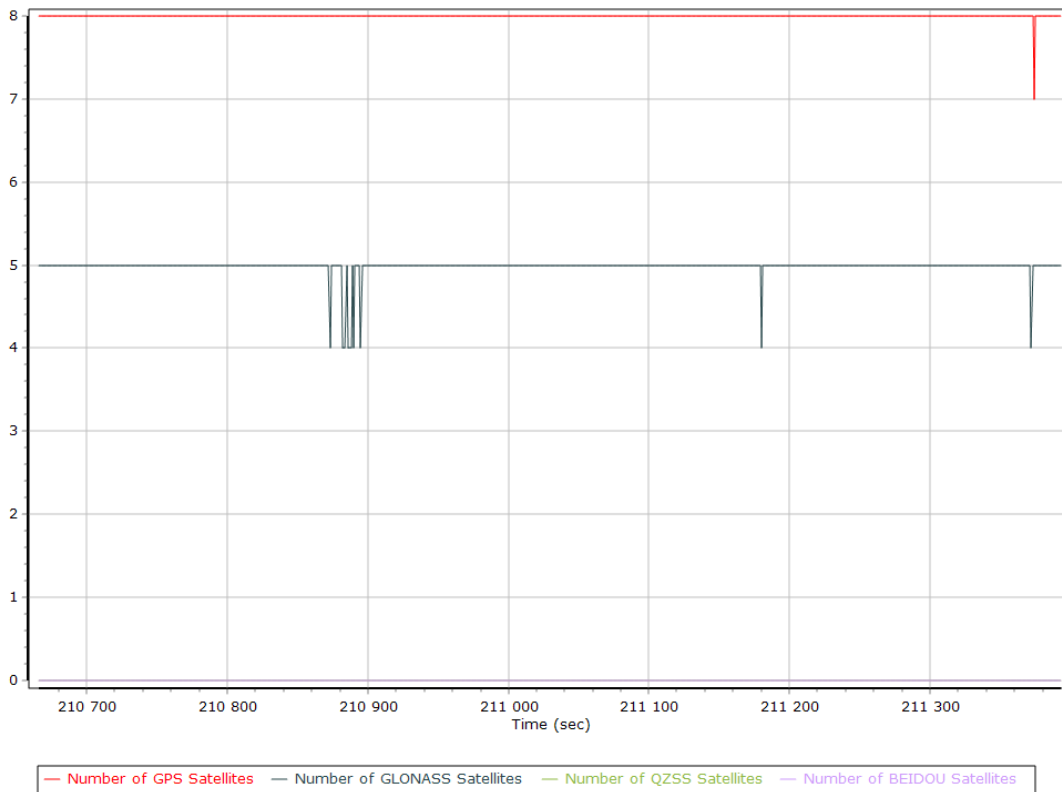


## Smoothed Solution Status

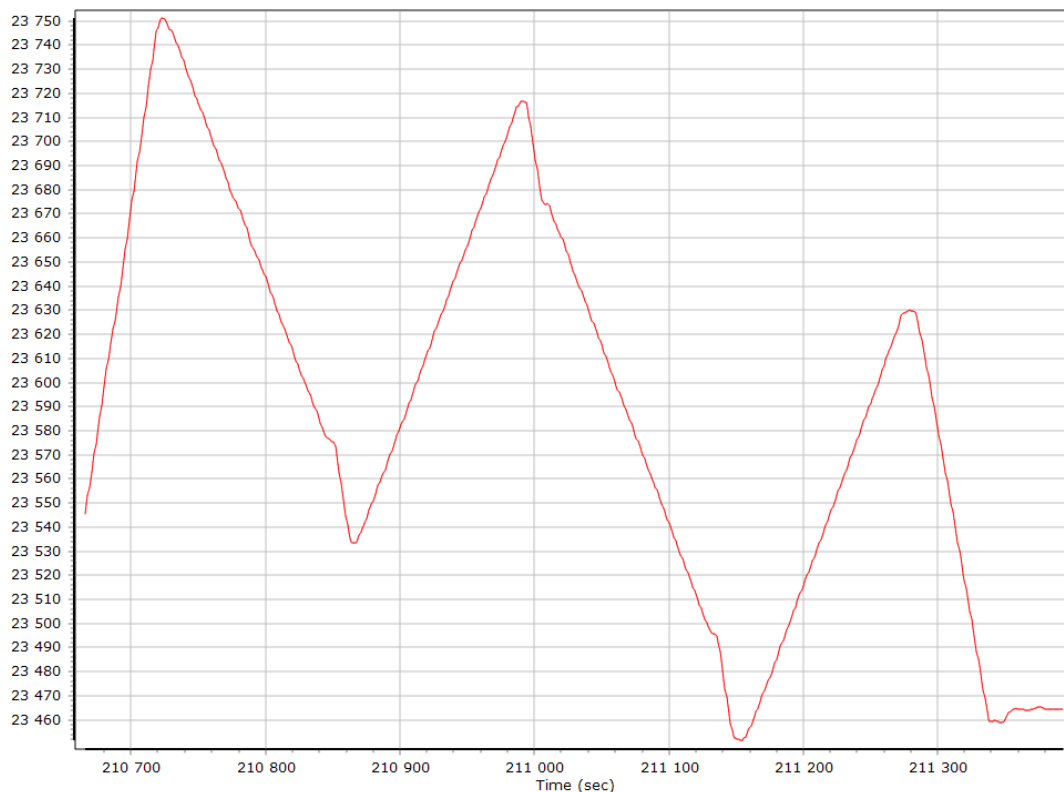
### Processing Mode



### Number of Satellites



### Baseline Length



### SBET IAKAR Separation



## Export Summary

Export file	44_CastelRoch.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	Deg Decimal	
Export start time	210596.001 (3/8/2022 10:29:56 AM)		
Export end time	211393.001 (3/8/2022 10:43:13 AM)		
Height option	Ellipsoid Height		
WGS84 height flag	False		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		

## EO Summary

EO file			
EO format			
Lever arm [m]	0.000	0.000	0.000
Boresight angles [arcmin]	0.000	0.000	0.000
Output rate	All Records		
Rotation sequence	x omega	y phi	z kappa
Local shift [m]	0.000	0.000	0.000
Output units (coordinate / angle / lat & lon)	Meter	Degree	Deg Decimal
Height option	Ellipsoid Height		
WGS84 height flag	False		
Scale height option	False		
Kappa cardinal rotation [deg]	0		
Solution in use	Post-processed		
EO start time	210596.001 (3/8/2022 10:29:56 AM)		
EO end time	211393.001 (3/8/2022 10:43:13 AM)		
Grid	Universal Transverse Mercator		
Zone	UTM North 31 (0E to 6E)		
Datum	WGS84		
Ellipsoid	WGS84		
Local Transformation	NONE		
Target Epoch	2022.180822		