



**PLANET · SmartPNT**  
**多源融合智能导航**

# **Data00\_20240719\_100C\_CAR\_complex Data Description**

**School of Geodesy and Geomatics, Wuhan University**

**July 2024**

# Directory

|          |                                             |           |
|----------|---------------------------------------------|-----------|
| <b>1</b> | <b>Overview .....</b>                       | <b>3</b>  |
| <b>2</b> | <b>Collection Devices .....</b>             | <b>3</b>  |
| 2.1      | Devices Overview .....                      | 3         |
| 2.2      | Devices Lists .....                         | 4         |
| 2.3      | Introduction to the Main Devices.....       | 5         |
| 2.3.1    | Novatel SPAN-ISA-100C .....                 | 5         |
| 2.3.2    | HGuide I300 .....                           | 5         |
| 2.3.3    | Novatel PwrPak7 .....                       | 6         |
| 2.3.4    | Septentrio mosaic-X5 .....                  | 6         |
| 2.3.5    | Trimble Alloy.....                          | 7         |
| 2.4      | Devices Connections Relationship.....       | 8         |
| 2.5      | Devices Installation Relationship .....     | 8         |
| 2.5.1    | Coordinate System Definition .....          | 8         |
| 2.5.2    | Lever Arm Relationship.....                 | 8         |
| <b>3</b> | <b>Data Collection Trajectory.....</b>      | <b>9</b>  |
| <b>4</b> | <b>Data Inventory.....</b>                  | <b>10</b> |
| <b>5</b> | <b>Data Overview .....</b>                  | <b>11</b> |
| <b>6</b> | <b>True Value Processing.....</b>           | <b>12</b> |
| 6.1      | Processing Methods .....                    | 12        |
| 6.2      | Computation Results .....                   | 13        |
| 6.2.1    | Ambiguity Fixed Situation .....             | 13        |
| 6.2.2    | IMU flag .....                              | 13        |
| 6.2.3    | Forward/Backward Position Discrepancy ..... | 14        |
| 6.2.4    | Forward/Backward Attitude Discrepancy.....  | 14        |

## 1 Overview

**Data Packet Name:** Data00\_20240719\_100C\_CAR\_complex

**Collection Date:** 2024.07.19

**Collection Location:** Wuhan City, Hubei Province, China

**Collection Scene:** Elevated Road; Open Sky; Tunnel; Urban Area; Street Trees

**Collection Method:** SUV-mounted Collection

## 2 Collection Devices

### 2.1 Devices Overview

The data packet is collected by the SmartPNT-mini, a multi-source navigation sensor platform (which integrates multiple sensors such as vision camera, lidar, inertial navigation, GNSS receiver, etc.), the Novatel SPAN-ISA-100C inertial measurement unit, and two GNSS receivers. All equipment is equipped by SUV vehicles. The schematic diagram of the collection vehicle and equipment is shown in Figure 2-1 and Figure 2-2 (see Table 2-1 for details of the equipment abbreviation in the figure, and the specific model of the equipment corresponding to it).

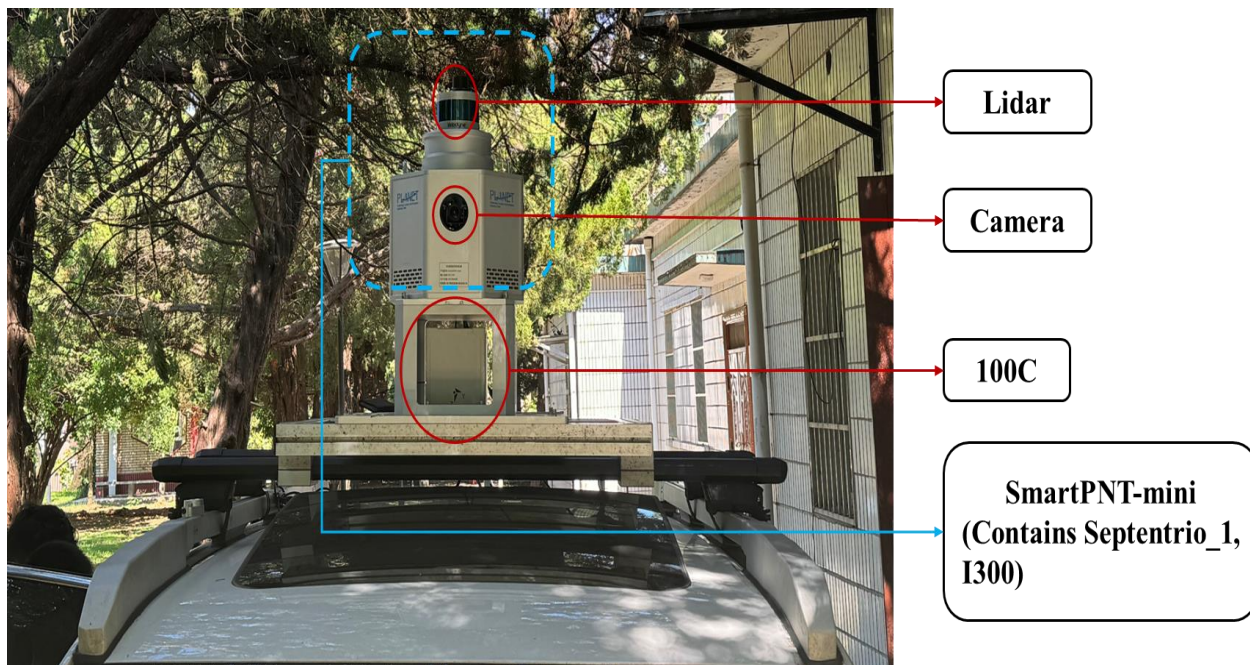


Figure2-1 Front view of the collection device

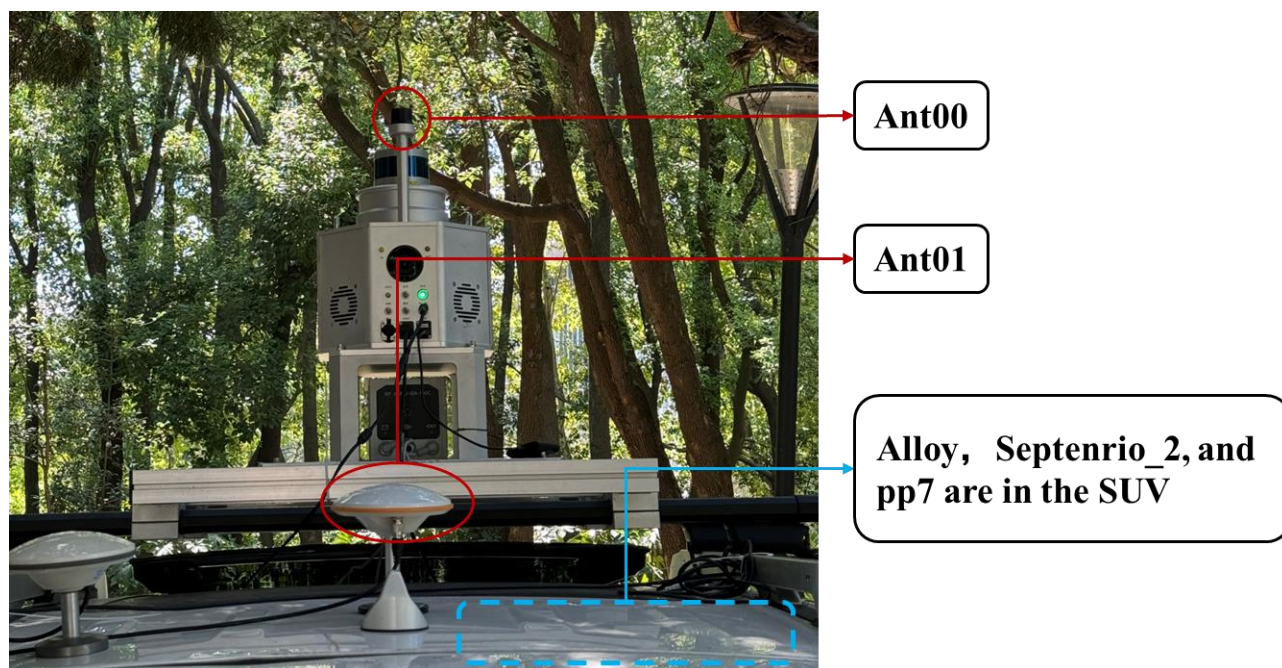


Figure2-2 Behind view of the collection device

## 2.2 Devices Lists

Table 2-1 Devices Inventory List

| Type          | Model                   | Abbreviation (The devices' names in the text are all referred to by the abbreviations in this table) | Quantity |
|---------------|-------------------------|------------------------------------------------------------------------------------------------------|----------|
| IMU           | Novatel SPAN-ISA-100C   | 100C                                                                                                 | 1        |
|               | HGuide I300             | I300                                                                                                 | 1        |
| GNSS Receiver | Novatel PwrPak7         | PP7                                                                                                  | 1        |
|               | Septentrio mosaic-X5    | Septentrio_1, Septentrio_2                                                                           | 2        |
|               | Trimble Alloy           | Alloy                                                                                                | 1        |
| Antenna       | Hitarget spiral antenna | Ant00                                                                                                | 1        |
|               | bynav BY500             | Ant01                                                                                                | 1        |

## 2.3 Introduction to the Main Devices

### 2.3.1 Novatel SPAN-ISA-100C



Figure2-3 Novatel SPAN-ISA-100C

The SPAN-ISA-100C is a near-navigation-class inertial measurement unit that integrates a three-axis fiber optic gyroscope and a full-temperature compensated MEMS accelerometer. In this acquisition, the SPAN-ISA-100C interacts with NovAtel's PwrPak7 receiver through a high-reliability IMU interface, and the PwrPak7 receiver fuses GNSS and IMU measurement data to output high-precision 3D position, velocity, and attitude information at a frequency of 200Hz.

### 2.3.2 HGuide I300



Figure2-4 HGuide I300

The HGuide I300 is a tactical-grade inertial guide that can be easily integrated into a variety of architectures with its industry-standard communication interface and wide input voltage range, featuring small size, light weight, and low power consumption. The HGuide i300 includes MEMS gyroscopes and accelerometers that utilize an internal environmental isolation system to attenuate unwanted inputs commonly found in real-world applications, ensuring the HGuide i300's ruggedness. The HGuide i300 includes MEMS gyroscopes and accelerometers, and utilizes an

internal environmental isolation system to attenuate unwanted inputs commonly found in real-world applications, ensuring that the HGuide i300 is rugged. The device outputs inertial data at 200 HZ for this acquisition.

### 2.3.3 Novatel PwrPak7



**Figure2-5 Novatel PwrPak7**

The PwrPak7 is a compact receiver for scalable GNSS signals with internal storage and INS options. The PwrPak7 is capable of tracking all current and upcoming GNSS constellation and satellite signals. It also offers optional integrated INS support for continuous position, velocity and attitude determination during short GNSS interruptions. It features a powerful GNSS engine, on-board NTRIP v1.0 and v2.0 client and server support, 16 GB of internal storage and enhanced connectivity options including serial, USB, CAN and Ethernet. This acquisition utilizes two PwrPak7 receivers all housed within the SmartPNT-mate, connected to two different antennas and inertial guides, outputting raw observations fused with GNSS, IMU.

### 2.3.4 Septentrio mosaic-X5



**Figure2-6 Septentrio mosaic-X5**

Septentrio mosaic-X5 is a full-constellation, multi-frequency, high-precision GNSS module in a low-power surface-mount package with multiple interfaces designed for high-volume applications such

as robotics and autonomous systems, capable of tracking all GNSS constellations and supporting a wide range of current and future signals. With its built-in AIM+ anti-jamming technology, Septentrio provides a strong guarantee for industrial high-precision GNSS positioning applications. In this acquisition, Septentrio is mainly used to receive mobile station observation data and base station data provided by Qianxun Position's FindCM service.

### 2.3.5 Trimble Alloy



Figure2-7 Trimble Alloy

The Alloy receiver is a versatile device for infrastructure and field development applications. It can be used as a CORS base station for Trimble Pivot software or other software applications, a radio or cellular RTK or DGNSS base station, provides simultaneous support for TCP/IP, UDP/IP, or serial output of correction signals, and can be used as a mobile receiver for field measurements. With a built-in GNSS receiver and up to two internal batteries, the receiver supports both GNSS and Wi-Fi antenna connections. A 4-line OLED display allows users to monitor satellite tracking, data logging status, Wi-Fi and power.

In addition to the obvious reference station function, the Alloy receiver can be used as an RTK mobile station or a static mobile station for surveying projects. The unit is capable of logging GNSS data to internal memory and downloading it to a computer via serial (cable or Bluetooth), Ethernet or Wi-Fi connections. The receiver can be configured by connecting to a cell phone via the front panel display, a network interface for Ethernet or Wi-Fi, and a mobile network interface for Wi-Fi. The GNSS observations received by Alloy were used as mobile station data for solving in this acquisition.

## 2.4 Devices Connections Relationship

Table2-2 Device Connection Relationships

| Combinations | GNSS Receiver | IMU  | Antenna |
|--------------|---------------|------|---------|
| ①            | PP7           | 100C | Ant01   |
| ②            | Septentrio_1  | I300 | Ant00   |
| ③            | Alloy         | ×    | Ant01   |
| ④            | Septentrio_2  | ×    | Ant01   |

## 2.5 Devices Installation Relationship

### 2.5.1 Coordinate System Definition

Table2-3 Coordinate System Definition

| Object         | Coordinate System | Placement Angles (X, Y, Z) in the Carrier System |
|----------------|-------------------|--------------------------------------------------|
| Carrier System | Right-Forward-Up  | -                                                |
| 100C           | Back-Left-Down    | (180, 0, -90)                                    |
| I300           | Down-Right-Back   | (0, 90, -90)                                     |

### 2.5.2 Lever Arm Relationship

Table2-4 Lever Arm between devices

| IMU                        | Device | Lever Arm (X,Y,Z) (m)      |
|----------------------------|--------|----------------------------|
| 100C<br>(Right-Forward-Up) | I300   | (0.000 , 0.008 , 0.410)    |
|                            | Ant00  | (0.000, -0.112 , 0.528)    |
|                            | Ant01  | (-0.052 , -1.050 , -0.078) |

(Note: Here, only the lever arm relationships from the 100C to other inertial navigation systems and antennas are provided. The lever arm relationships from other inertial navigation systems to each antenna can be derived from these.)

### 3 Data Collection Trajectory

The data collection trajectory for this set is shown in Figure 3-1.

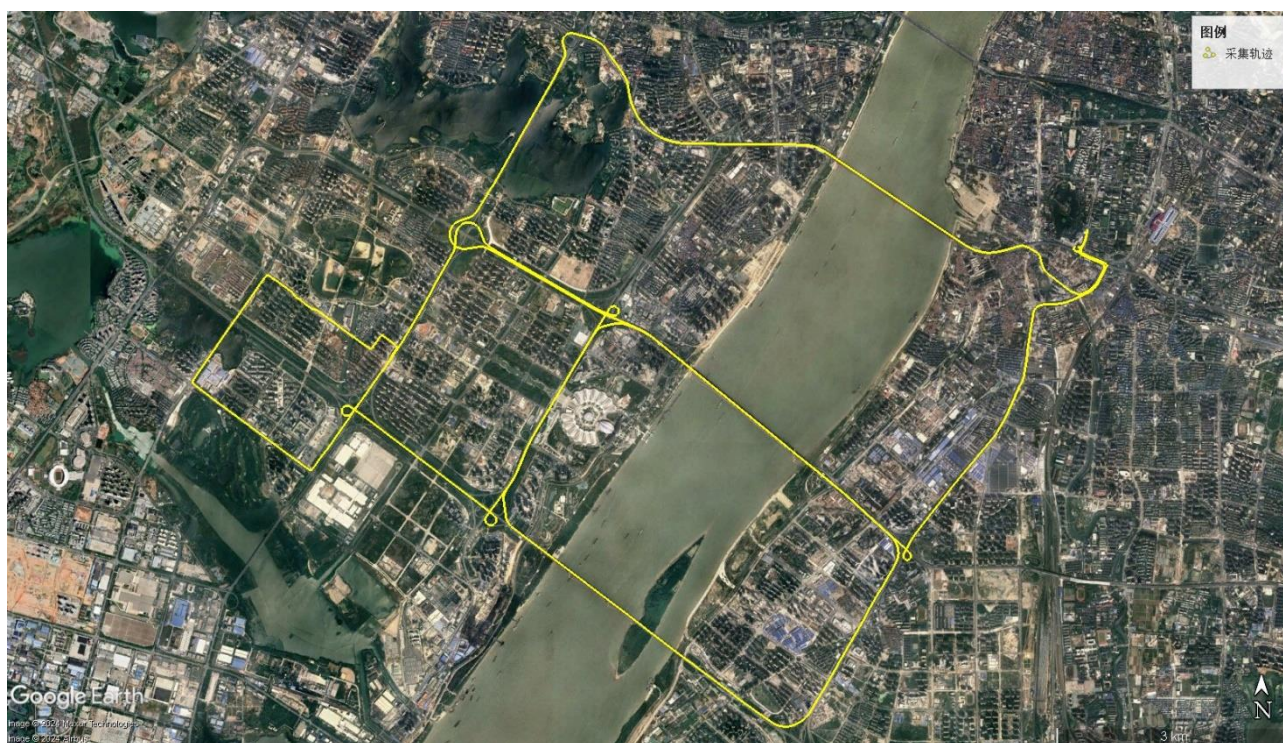


Figure3-1 Data Collection Trajectory

## 4 Data Inventory

**Table4-1 Data Inventory**

| Device                             | Type                                                                                                                                                          | Whether Included | File Name                                                                                                                                                     |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Base Station of Wuhan University   | GNSS Observation Data                                                                                                                                         | ×                |                                                                                                                                                               |
| Septentrio_2+Ant01                 | GNSS Observation Data<br>(Base station data from Qianxun Position's FindCM service, which may include multiple GNSS observation files due to station changes) | ✓                | BASE_01.24O; BASE_02.24O;<br>BASE_03.24O; BASE_04.24O;<br>BASE_05.24O; BASE_06.24O;<br>BASE_07.24O; BASE_08.24O;<br>BASE_09.24O; BASE_10.24O;<br>BASE_11.24O; |
|                                    | GNSS Observation Data                                                                                                                                         | ✓                | ROVE_04.24O                                                                                                                                                   |
| Alloy+Ant01                        | GNSS Observation Data                                                                                                                                         | ✓                | ROVE_01.24O                                                                                                                                                   |
| 100C+pp7 +Ant01                    | Inertial Navigation Data                                                                                                                                      | ✓                | 100C.imr                                                                                                                                                      |
|                                    | GNSS Observation Data                                                                                                                                         | ✓                | ROVE_02.24O                                                                                                                                                   |
| I300+                              | Inertial Navigation Data                                                                                                                                      | ✓                | I300.imr                                                                                                                                                      |
| Septentrio_1+Ant00                 | GNSS Observation Data                                                                                                                                         | ✓                | ROVE_03.24O                                                                                                                                                   |
| Broadcast Satellite Ephemeris Data |                                                                                                                                                               | ✓                | Brdm2010.24p                                                                                                                                                  |
| Precise Satellite Ephemeris Data   |                                                                                                                                                               | ✓                | WUM0MGXFIN_2024201000<br>0_01D_05M_ORB.SP3                                                                                                                    |
| Satellite Clock Offset Data        |                                                                                                                                                               | ✓                | WUM0MGXFIN_2024201000<br>0_01D_30S_CLK.CLK                                                                                                                    |

## 5 Data Overview

Table5-1 Data Overview

| File Name                    | Format    | Recording Time (GPST)      | Output Frequency | Data Quality                    |
|------------------------------|-----------|----------------------------|------------------|---------------------------------|
| BASE_01.24O--<br>BASE_11.24O | RINEX3.04 | 02:10:03.000--03:55:52.000 | 1HZ              | Normal                          |
| ROVE_01.24O                  | RINEX3.04 | 02:10:32.000--03:53:30.000 | 1HZ              | Interruptions in tunnel section |
| ROVE_02.24O                  | RINEX3.04 | 02:10:45.000--03:55:14.000 | 1HZ              | Interruptions in tunnel section |
| ROVE_03.24O                  | RINEX3.04 | 02:12:41.000--03:52:43.000 | 1HZ              | Interruptions in tunnel section |
| ROVE_04.24O                  | RINEX3.04 | 02:09:25.000--03:55:53.000 | 1HZ              | Interruptions in tunnel section |
| 100C.imr                     | IMR       | 02:10:48.409--03:55:14.212 | 200HZ            | 1 Large gap (0.019s)            |
| I300.imr                     | IMR       | 02:14:27.498--03:52:43.046 | 200HZ            | Normal                          |

(Note: All data recorded in Table 5-1 is dated GPST: 2024/07/19)

## 6 True Value Processing

### 6.1 Processing Methods

**Processing Software:** Inertial Explorer 8.90.8304 [64-bit]

**Processing Mode:** GNSS/IMU Tight Integration

**Use of Precise Ephemeris:** No

**Use of Odometer:** No

**Data Used:**

- **Base station data from Qianxun Position's FindCM service:** BASE\_01.24O -- BASE\_11.24O
- **Alloy's Rover Station Data:** ROVE\_01.24O
- **100C's Inertial Navigation Data:** 100C.imr

## 6.2 Computation Results

### 6.2.1 Ambiguity Fixed Situation

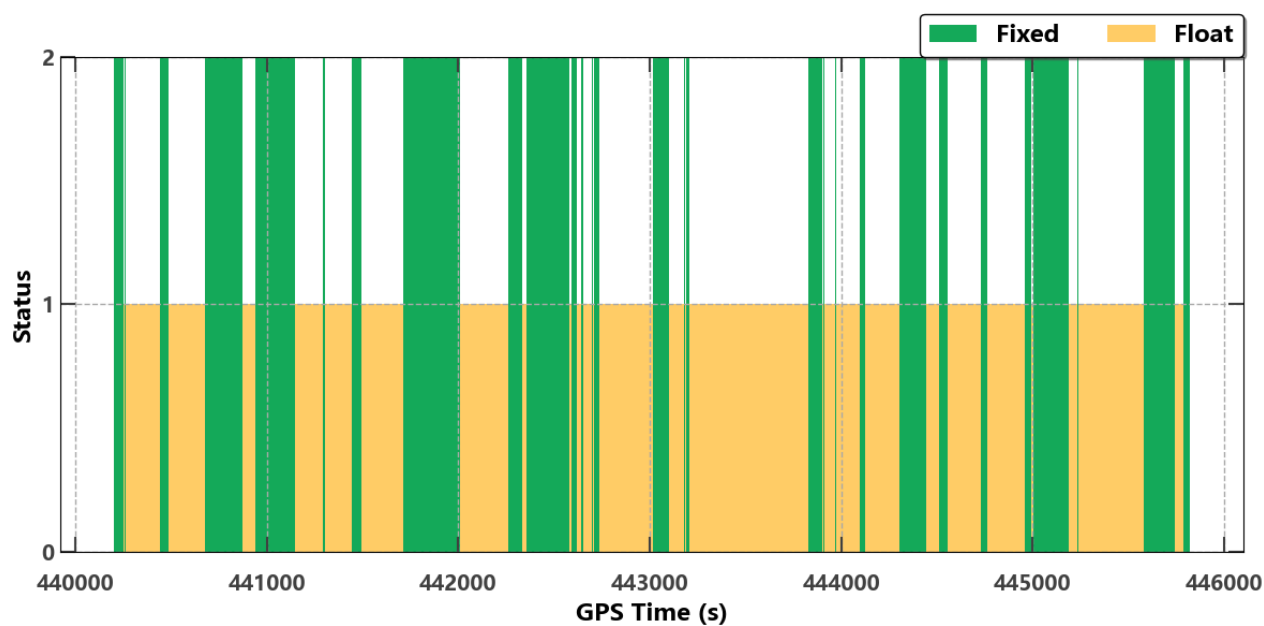


Figure6-1 Ambiguity Fixed Situation

### 6.2.2 IMU flag

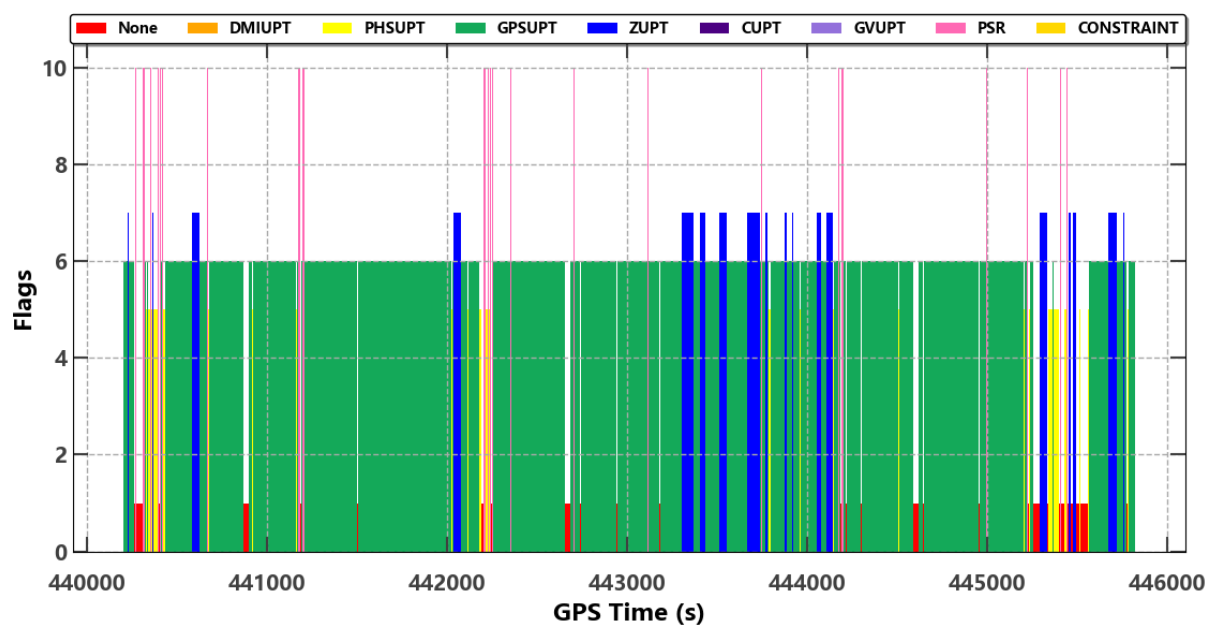


Figure6-2 IMU Flag

### 6.2.3 Forward/Backward Position Discrepancy

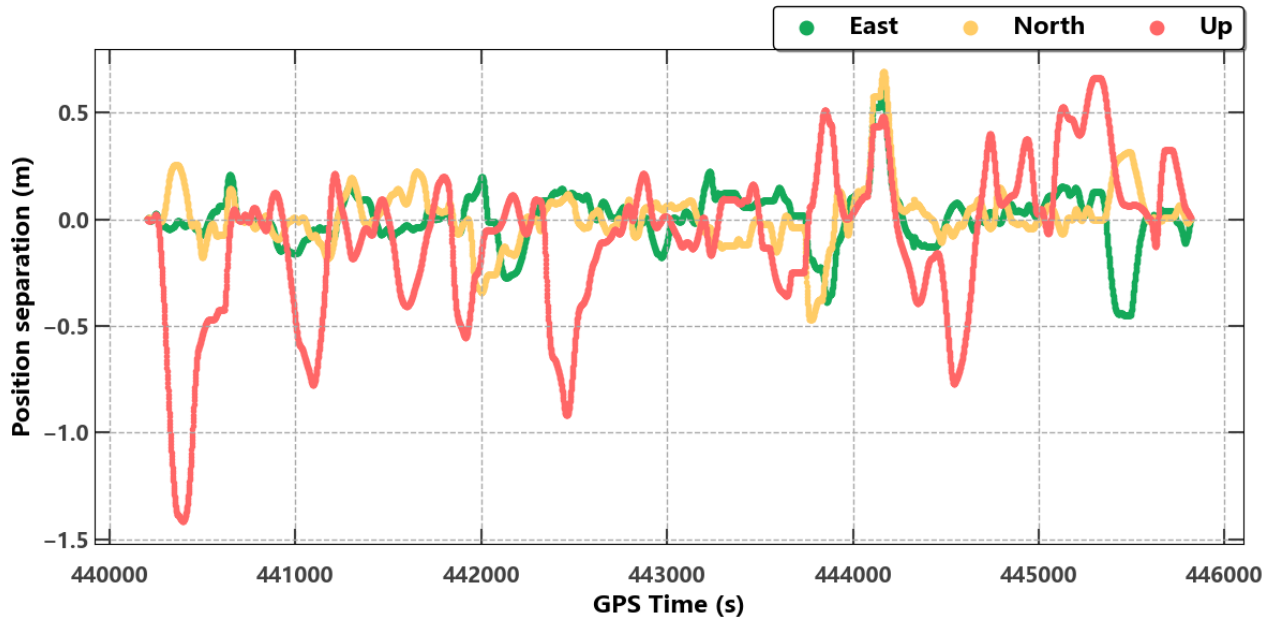


Figure6-3 Forward/Backward Position Discrepancy

### 6.2.4 Forward/Backward Attitude Discrepancy

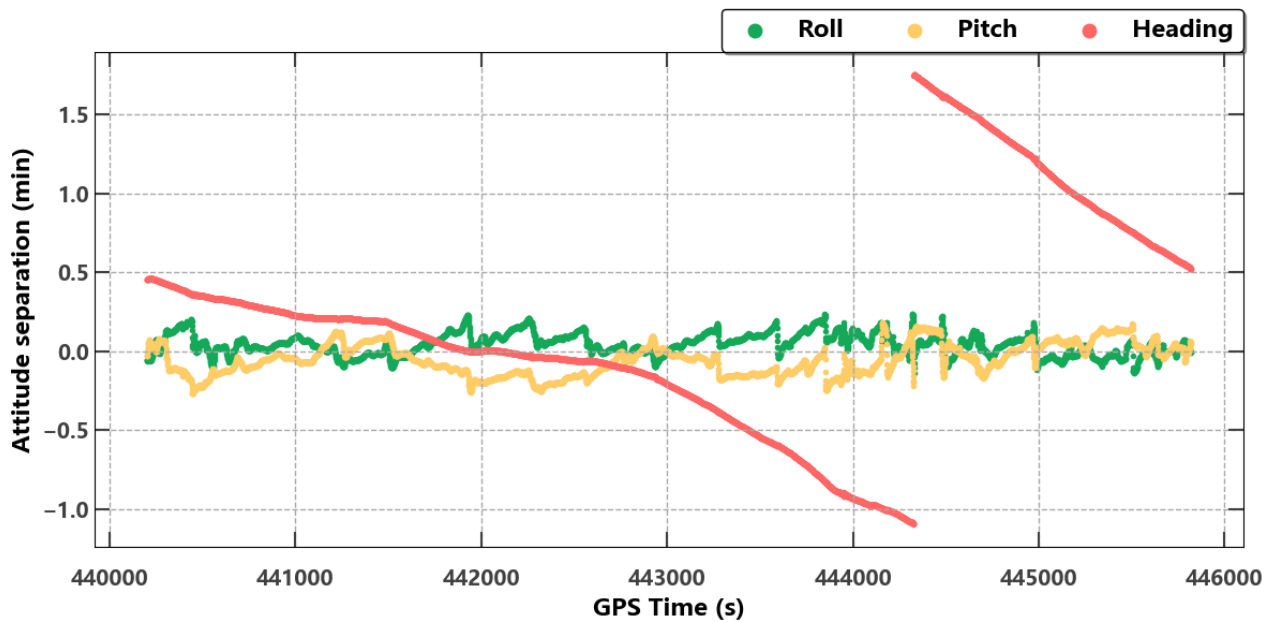


Figure6-4 Forward/Backward Attitude Discrepancy