Sonardyne

UM-8254

User Manual for Janus – Acoustically Aided QC and Post Processing

Issue C1

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24-hour Emergency Telephone Helpline: +44 (0) 1252 877600

The Sonardyne 24-hour helpline is answered at the UK Headquarters during normal office hours (08:00 to 17:00). Outside these hours, your call is automatically transferred to an agency, which logs the details of your emergency and alerts the appropriate Sonardyne personnel.

Our aim is to make sure emergency requests are dealt with immediately during office hours and are responded to within 30 minutes at all other times.

Please note the helpline is for emergency use only.

If you require non-emergency product support, please contact your nearest Sonardyne office. Alternatively, contact the Sonardyne Head Office:

Sonardyne International Ltd
Blackbushe Business Park
Yateley
Hampshire
GU46 6GD
United Kingdom

T: +44 (0) 1252 872288

F: +44 (0) 1252 876100

E: support@sonardyne.com

Note

Email and telephone support is available during normal UK office hours (08:00 to 17:00).

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Amendment History

The amendment history records all amendments and additions made to this manual.

Issue	Revision	Date	Comments	Section	Page
A	1	13/05/2011	Initial Issue	All	All
A	2	06/07/2011	Installation Revised	All	All
A	3	11/08/2011	Revised requirements, installation and some features. Added some stand-alone specific notes.	All	All
A	4	25/10/2011	Major change from offshore use	All	All
A	5	11/11/2011	Updated installation procedure	All	All
A	6	01/12/2011	Updated to MATLAB R201b. Update general use + dongle	All	All
A	7	05/12/2011	Updated DVL calibration	All	All
A	8	12/12/2011	Minor updates	All	All
B	0	19/06/2012	Complete reformatting of manual to bring in line with new branding	All	All
B	1	15/04/2013	Minor updates for Janus v1.0.2, Sections 4 & 5.	All	All
C	1	11/11/2021	Update for Janus 1.6 Release Formatted with new branding style	All	All

Section 1 – Introduction

1.1 Purpose

This User Manual describes the user operation of Janus software to post process INS data from Sonardyne's SPRINT product family.

1.1 Scope

This user manual includes the following Janus software tasks: Import INS data, QC raw sensor and aiding data, post process and export navigation solutions using Janus software to improve real time performance.

1.2 Related Publications

The following publications can be referred to in conjunction with this manual.

Table 1-1 Related Publications

Publication	Title
Sonardyne Safety Manual	*Operational and Safety Precautions*
UM-8253	*SPRINT User Manual*
UM-8253	*SPRINT-Nav User Manual*
UM-8334	*SPRINT-Nav Mini User Manual*

1.3 Conventions

The following conventions are used in this manual.

Table 1-2 Conventions used in this Manual

Format	Convention
Boldface Type	User Input, Menu Options, Keys, e.g. Click **OK**
Arrow (**>**)	Selection of an additional menu item e.g. **File >Save**
Italic Type	References to Figures, Tables, Sections and internal/external source

Section 2 – Technical Description

Janus is an Acoustically Aided Inertial Navigation System (AAINS) Quality Control (QC) and Post Processing (PP) tool.

Janus can be used for operations such as:

- Quality Control of real-time navigation
- DVL calibration
- Post-processing

Janus supports the Rauch-Tung-Streibel Kalman smoothing of recorded IMU and aiding sensor data, this is also known as forwards and backwards processing, and generally referred to as Kalman smoothing.

Unlike filtering, for every point in time the Kalman smoothing makes use of both past and future sensor data to determine the optimal navigation solution.

Navigation is initially performed by processing data forwards, similar to the real-time navigation of the SPRINT/SPRINT-Nav/SPRINT-Nav Mini INS/Hybrid algorithm.

Mathematically it is not very different to perform navigation going backwards in time and Kalman smoothing is simply the optimal combination of the two solutions. Kalman smoothing is a very practical tool with the following important characteristics:

- Statistically optimum absolute accuracy
  - High accuracy
- Optimal relative accuracy (completely smooth and continuous navigation data) ideal for:
  - Digital terrain model (DTM) generation from high resolution sonar.
  - Pipeline “out of straightness” surveys
  - Metrology
- INS high dynamic performance is fully preserved – AINS Kalman smoothing is not simple low pass filtering.

2.1 Time Base Conventions

2.1.1 INS System Time

Janus makes use of the INS internal system time base (sys time) for all navigation computations.

All times within Janus, including plots are (sys time) unless otherwise specifically stated.

Key INS system time characteristics are:

- Continuously increasing from 0 at INS power up (or full system reset)
- 100% free from jumps with a resolution/precision better than 1 μSec.
- Based entirely on INS high accuracy crystal oscillator with no corrections applied (offset/scale).

Note

System Time is also known as Instrument Time.

2.1.2 Universal Time Co-ordinated (UTC)

The system time relationship to UTC is tracked by the INS to support its use of UTC time tagged aiding sensor data (e.g. GPS) and for the generation of UTC tagged navigation data outputs (e.g. INGGA).

Section 3 – Installation

This section defines the minimum system requirements to run Janus software and installation instructions.

3.1 Minimum System Requirements

The following requirements should be used as a guideline if the software is to be installed on a computer other than the Sonardyne supplied Marine Computer.

The minimum system operating requirements for Janus are as follows:

- I7 2.8 GHz processor
- Recommended requirements: Windows 10 (UK English)
- Recommended RAM requirements: 8+GB

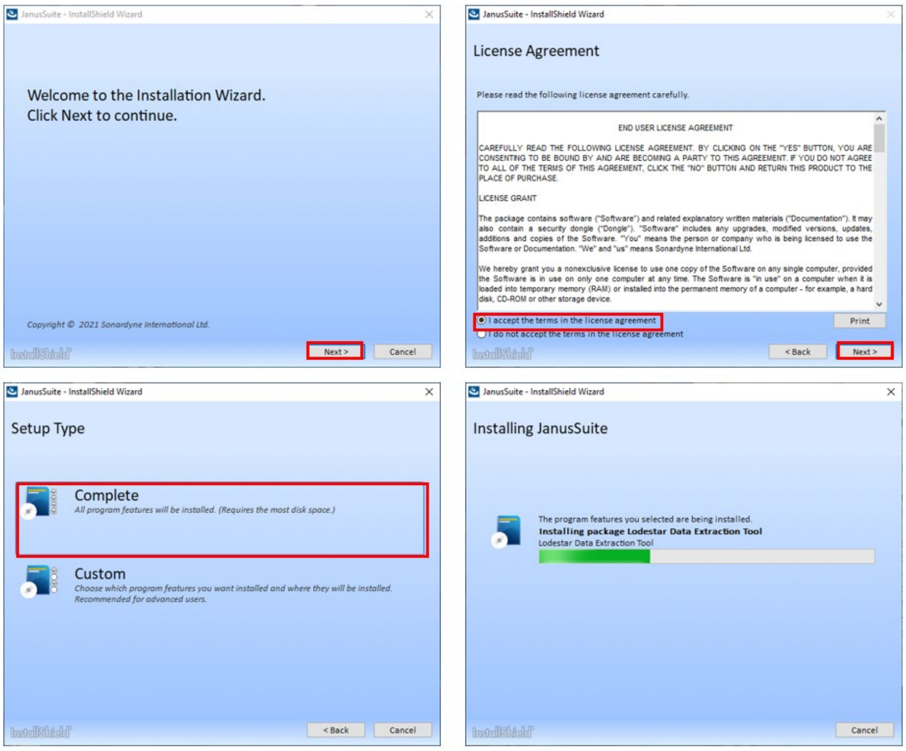
3.2 Software Installation

It is recommended to copy the Janus software installation folder locally onto the computer prior to installation, either from the USB Memory stick included in the system kit or donwloaded from the Sonardyne FTP site.

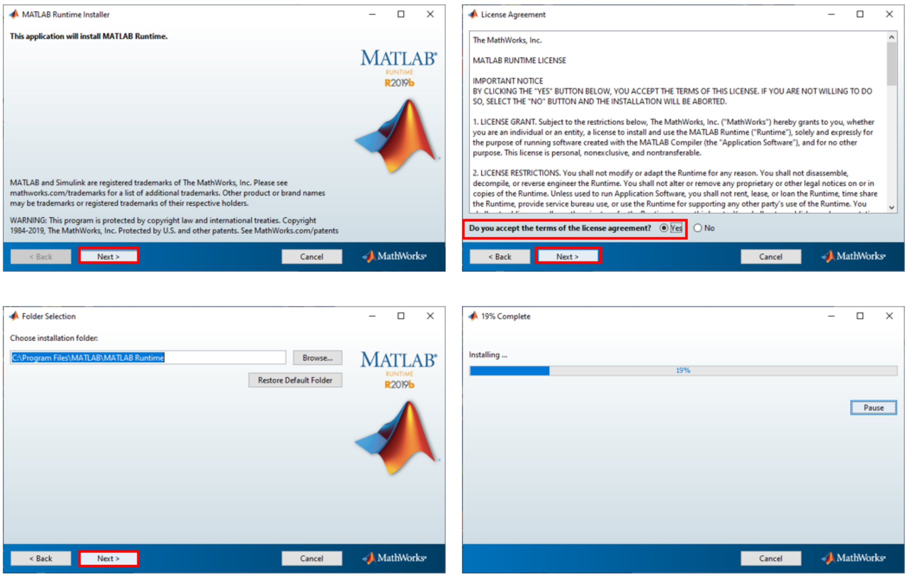
To install Janus software:

1. Double click the setup executable.

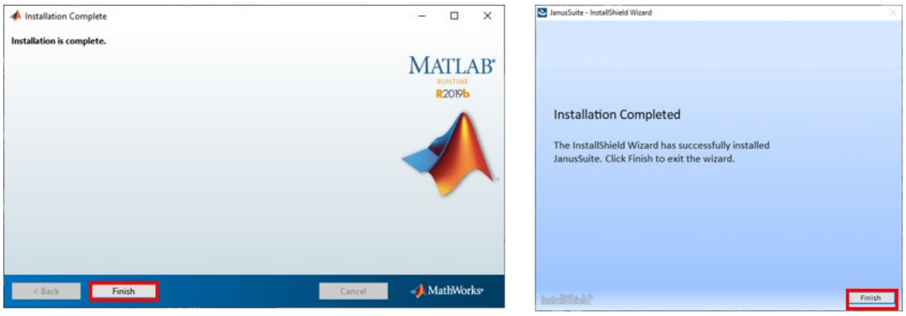
2. Select default options and select **Complete** Janus insatalltion.



3. Select default options for Matlab installation.



4. After the Matlab installtion has completed, a computer restert may be required, follow on screen instructions.

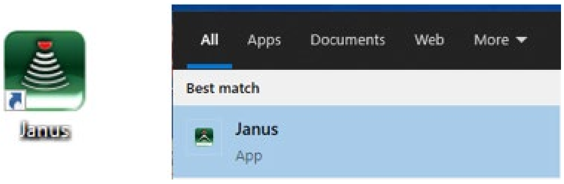


Note

The Janus custom installation option does not install.

3.3 Open Janus

On successful installation, double-click on the Janus.exe icon on the desktop or type Janus in the Windows Start menu.



Note

Janus can take up to 30 seconds to open.

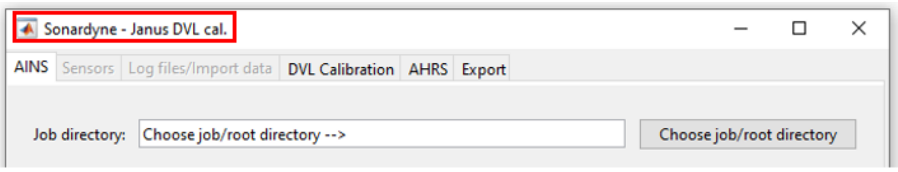
3.4 Janus Function levels

There are two types of Janus variants: DVL Cal only and full post processing.
These are dongle controlled; DVL Cal Only variant is included with all SPRINT, SPRINT-Nav and SPRINT-Nav Mini systems.

3.4.1 Janus DVL Cal Only

The DVL Cal only variant supports:

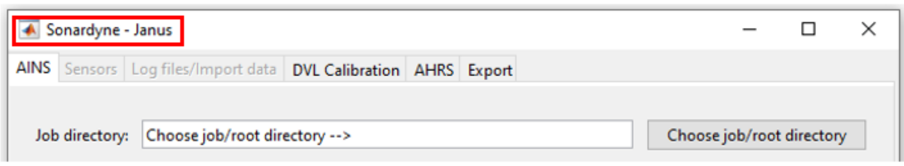
- BIST (system status)
- Sensor (raw aiding data QC)
- DVL Calibration (for SPRINT and DVL separate Systems only)
- Plot Real Time Navigation



3.4.2 Janus Full Post Processing

The Full Post Processing variant supports:

- BIST (system status)
- Sensor (raw aiding data QC)
- DVL Calibration (for SPRINT and DVL separate Systems only)
- Post processed and Smoothed Post Processed solutions
- Output Navigation solutions export files



Note

Contact Sonardyne Support to upgrade to Janus Full Post Processing version (stock code 620-0219).

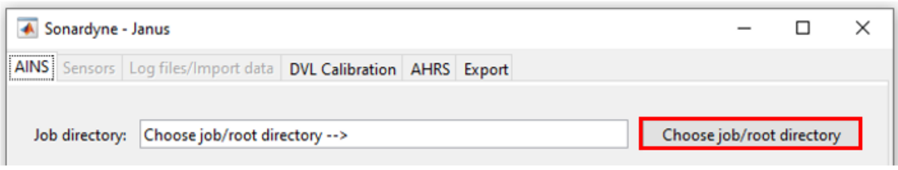
Section 4 – Logfiles/Import Data

This section describes how to import SPRINT, SPRINT-Nav and SPRINT-Nav Mini data into Janus as well as the addition of externally logged position data into a Janus data set.

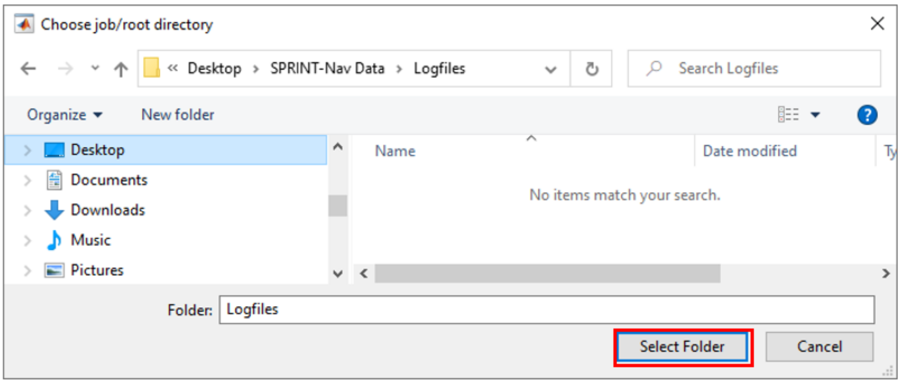
4.1 Importing Data

To import data (.bin) into Janus, copy the INS logfiles locally onto the computer (either topside SPRINT/SPRINT-Nav or internal logfiles and SPRINT-Nav Mini), follow the steps described below:

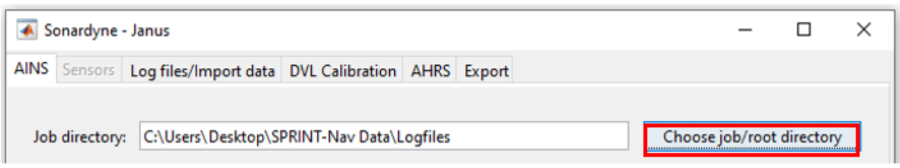
1. Open Janus software, select the **AINS** tab and then click **Choose job/root directory**.



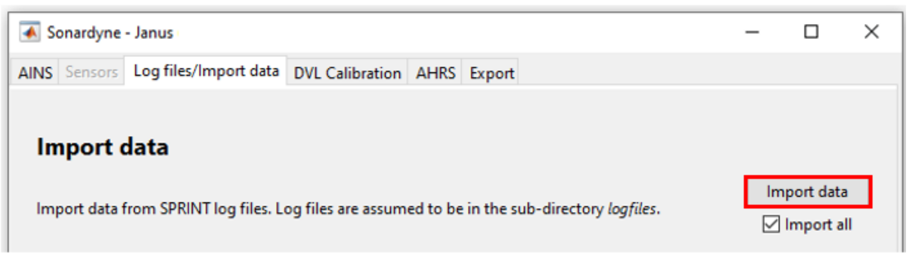
2. Select the folder containing the INS logfiles and then click **Select Folder**.



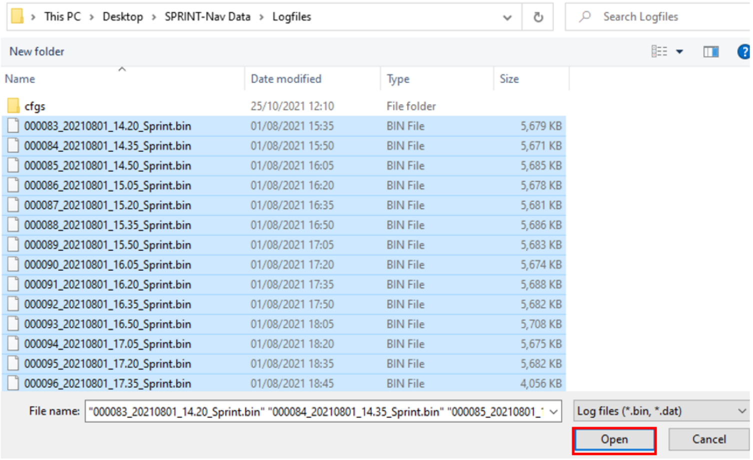
3. The job directory field will be populated with the destination address.



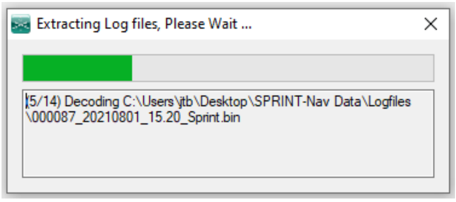
4. Click on the **Logfiles/Import data** tab and then click **Import data**.



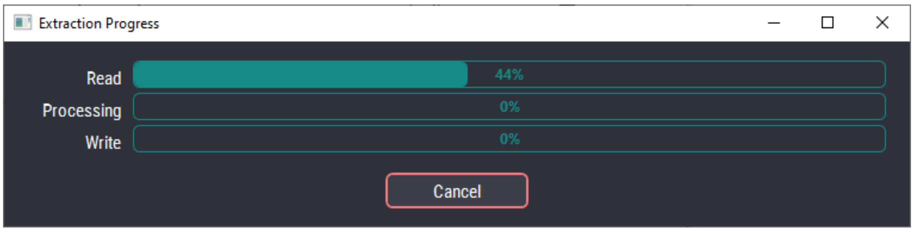
5. Select required logfiles for import and then click **Open**.



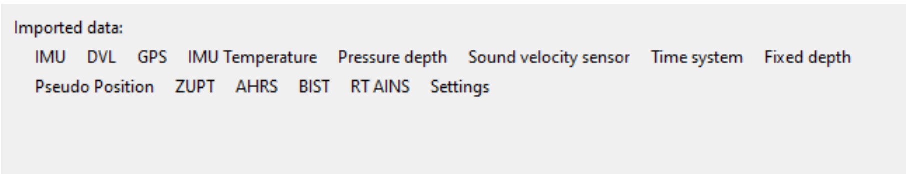
- If importing SPRINT or SPRINT-Nav logfiles the following data extraction progress bar will appear.



- If importing SPRINT-Nav Mini logfiles the following data extraction progress bar will appear.

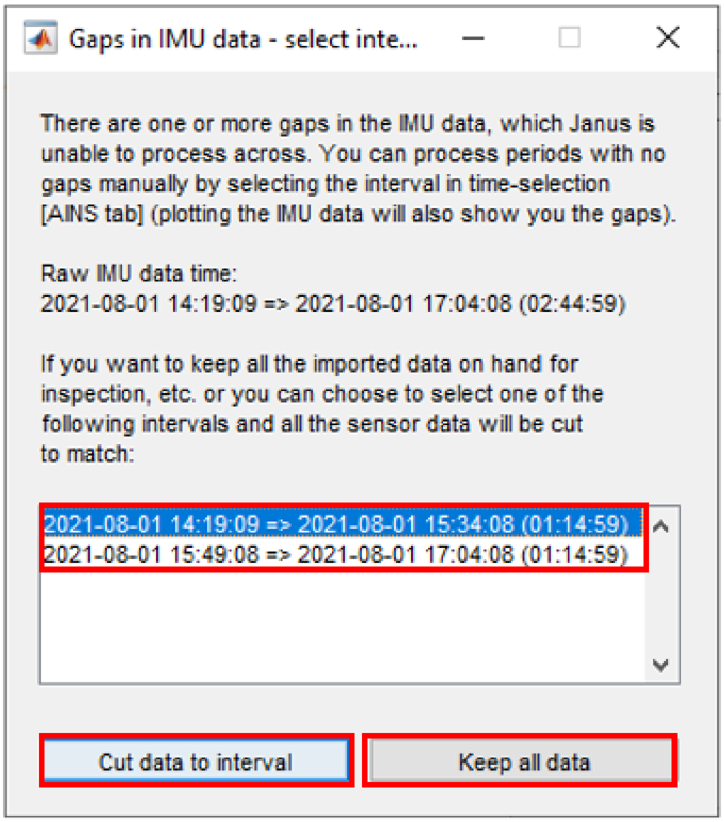


6. When the data extraction has been completed, the Import data fields will be populated with the extracted data.



7. If there are any gaps in the imported data, the following warning appears in the Janus software with the following options:
   - Cut data to interval – Janus only imports the user selected group of logfiles.
   - Keep all data – Janus imports all data resulting in gaps in IMU data (restricted to only post processing data either side of the gap(s) in IMU data.

Figure 1 IMU data import warning



Note

Gaps in IMU data within the imported logfiles may be due to the retrival process. Download the suspect logfile(s) again and import into Janus. If the warning consists, conatct Sonardyne Support.

4.2 Importing External Position Data

To import external logged position data into Janus (not contained in the INS logfile), follow the instructions below:

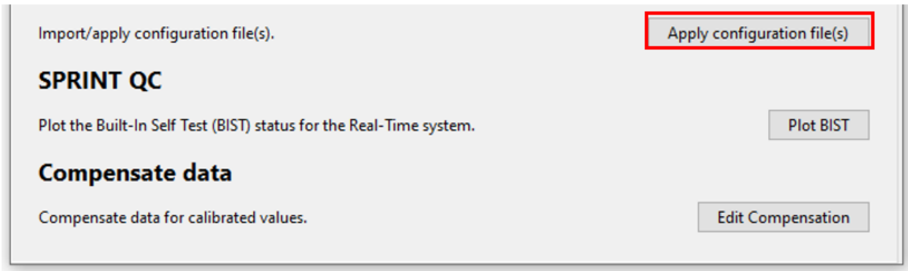
1. Convert the position data into a message format supported by Janus, a list of formats are published in the data formats file that is included with the Janus software C:\Users\Public\Documents\Sonardyne\Janus\Data Formats
2. Rename the file susbl.asc
3. Import the INS data into Janus sensor folder.
4. Delete the susbl.asc into the compensated, compensatedRT and uncompensated folders.
5. Copy the external logged data susbl.asc into the compensated, compensatedRT and uncompensated folders.
6. Navigate to the AINS tab and re-select the Choose job/root directory, this will automatically load the external aiding file. The new data will appear in the aiding sensor tab and will be able to process the INS data using the externally logged susbl data.

Note

Donot reselect the import data button as this will overwrite the external aiding data with the original aiding data from the INS logfile.

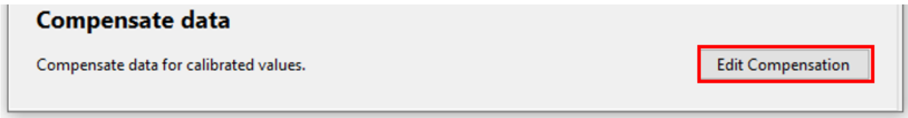
4.3 Apply Configuration File(s)

The **Apply Configuration File(s)** option allows a common configuration file to be applied to the imported data containing settings that may be specific to a vehicle or application.



4.4 Edit Compensation

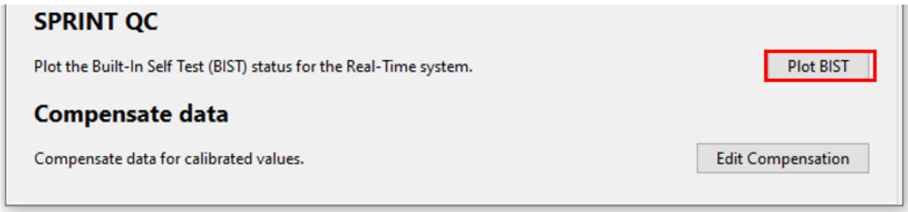
The **Edit Compensation** option allows sensor data to be modified (e.g. Accelerometer and Gyro user offsets); this should only be modified if instructed by Sonardyne Support.



Section 5 – BIST

The Built In-Self-Test (BIST) displays the health and operational status (real time) of the hardware and AHRS/INS algorithms (if status/warning flag plot line is high then that status/warning is true/raised).

The BIST plots from a SPRINT(-Nav) are described in *Section 5.1*, and BIST plots from a SPRINT-Nav Mini are described in *Section 5.2*.



5.1 BIST Plots (SPRINT/SPRINT-Nav)

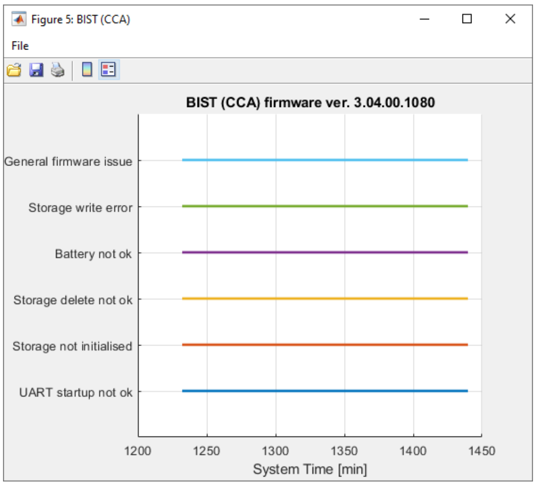
These BIST plots are delivered in five different BIST plots:

- CCA
- Comms
- AINS
- AHRS
- IMU

5.1.1 BIST CCA Plot

The CCA (Circuit Card Assembly) plot displays warnings related to the electronics within the SPRINT/SPRINT-Nav/SPRINT-Nav Mini (plot status flags are high if warning is active).

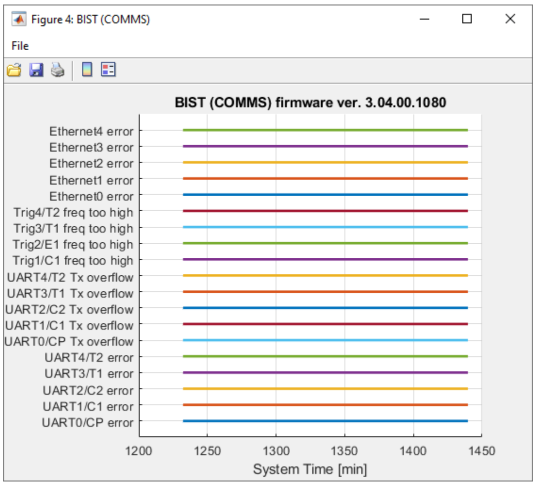
Figure 2 BIST CCA Plot



5.1.2 BIST Comms Plot

The Comms BIST plot shows the status of all transmit/receive communications of the SPRINT/SPRINT-Nav/SPRINT-Nav Mini hardware (serial, ethernet and triggers).

Figure 3 BIST Comms Plot



Note

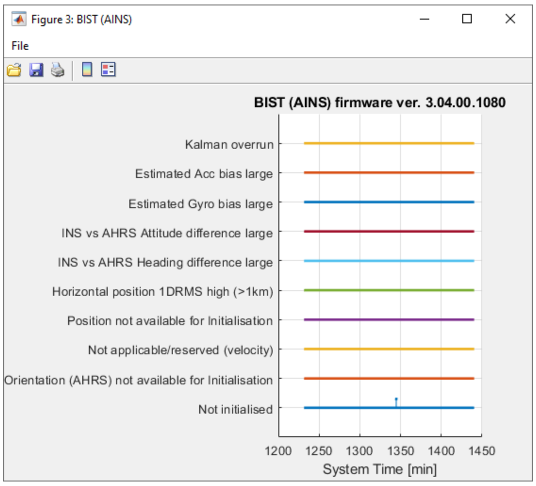
Common cause of BIST Comms warnings are cabling issues, this may cause comms errors/overflow and/or trigger freq too high.

5.1.3 BIST AINS Plot

The AINS (Aided INS) plot shows the status of the INS algorithm, including INS initialised and AHRS orientation settled flags.

The AINS and AHRS attitude and heading are compared during real time operation, if these observations differ by a significant amount, then the BIST state is raised (common cause is when the AHRS has settled using an incorrect latitude).

Figure 4 BIST AINS Plot



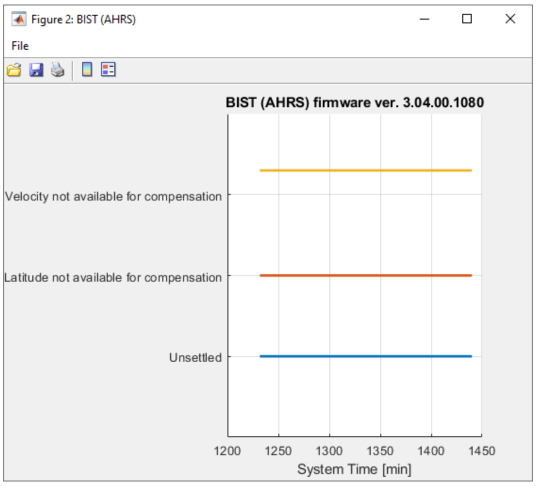
Note

Accelerometer and Gyro Bias Large warnings are usually cause by incorrect lever arms/ mounting angles configured in the INSsystem of timing issues with aiding data.

5.1.4 BIST AHRS Plot

The AHRS plot shows the status of the AHRS algorithm.

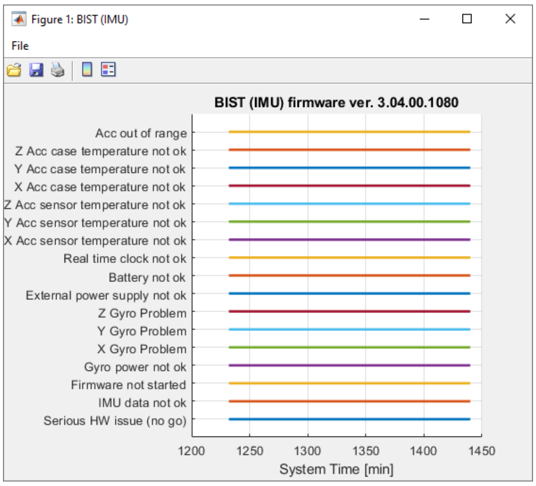
Figure 5 BIST AHRS Plot



5.1.5 BIST IMU Plot

The IMU BIST shows the status of the individual sensors of the inertial measurement unit (IMU).

Figure 6 BIST IMU Plot



Note

If any of these warnings are active, contact Sonardye support (including INS logfiles).

5.2 BIST Plots (SPRINT-Nav Mini)

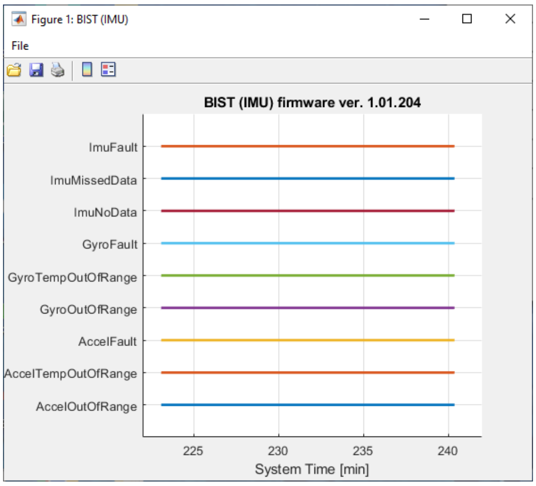
These BIST plots are delivered in five different BIST plots:

- IMU
- UARTs 0, 1 & 2
- TRIGs 0 & 1
- AHRS
- GAINS
- DVL
- SYSTEM

5.2.1 IMU BIST Plot

The IMU BIST plot displays sensor and IMU status.

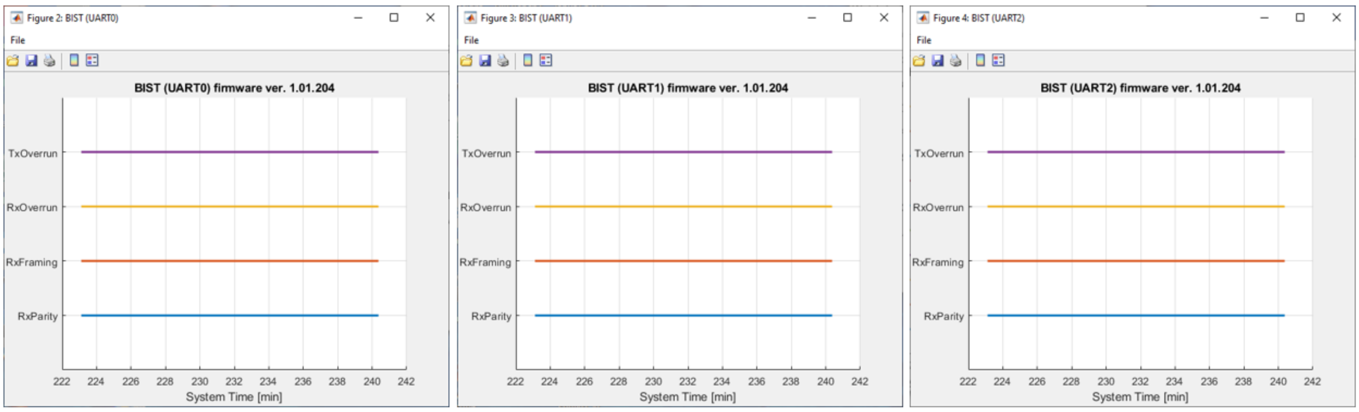
Figure 7 BIST IMU Plot (SPRINT-Nav Mini)



5.2.2 UARTs 0, 1 & 2 Plots

Figure 8 BIST UART Plots (SPRINT-Nav Mini)

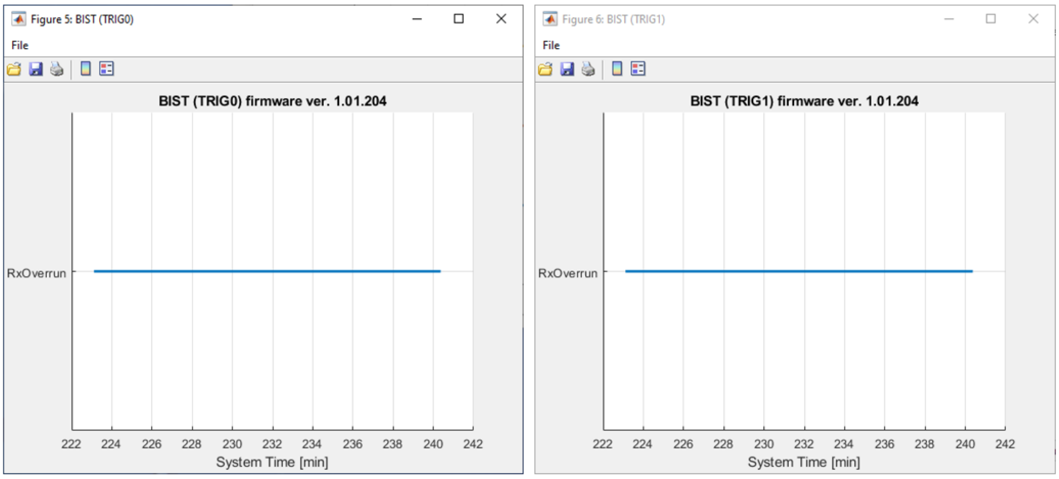
The UART plots display any communication issues with all of the SPRINT-Nav Mini serial ports.



5.2.3 TRIGs 0 & 1 Plots

The TRIG plots display status of the SPRINT-Nav Mini receive trigger status.

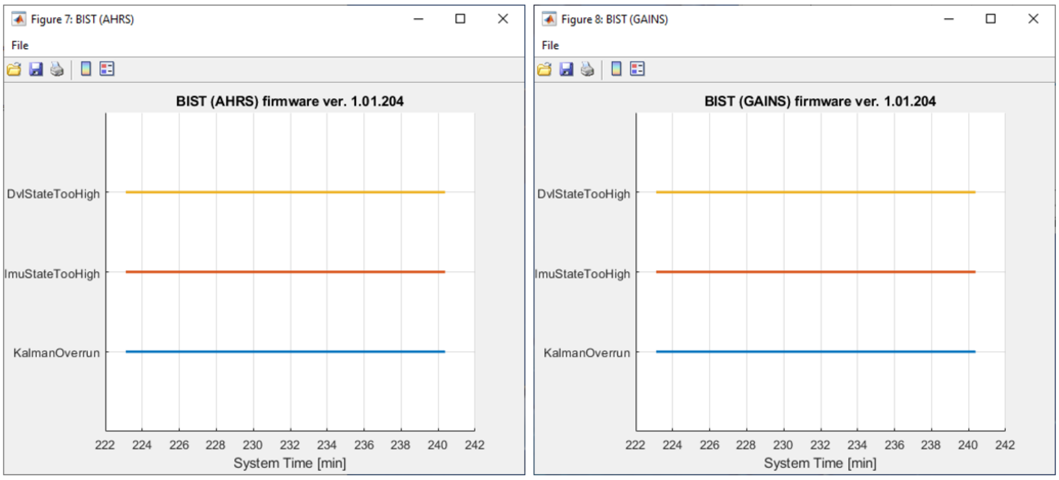
Figure 9 BIST TRIG Plots (SPRINT-Nav Mini)



5.2.4 AHRS & GAINS (Algorithm) Plots

The AHRS and GAINs Plots show the status of all SPRINT-Nav Mini algorithms.

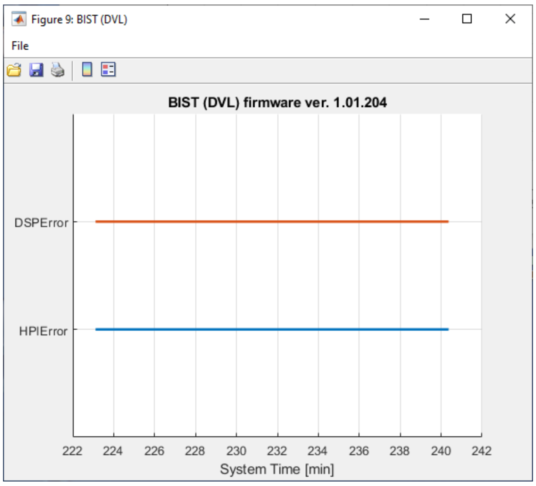
Figure 10 BIST AHRS & GAINS Plots (SPRINT-Nav Mini)



5.2.5 DVL Plot

This plot shows the status of the DVL internal hardware.

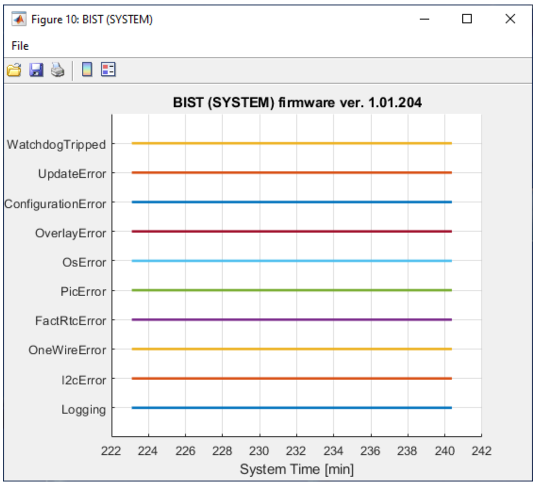
Figure 11 BIST DVL Plot (SPRINT-Nav Mini)



5.2.6 SYSTEM Plot

This plot displays all system errors/status.

Figure 12 BIST SYSTEM Plot (SPRINT-Nav Mini)



Section 6 – Sensors

The Sensor tab in Janus allows the user to view all available raw aiding that has been configured in the SPRINT/SPRINT-Nav/SPRINT-Nav Mini (regardless of whether the aiding is enabled/disabled during real time navigation).

This menu also allows the user to carry out quality control of the raw aiding data, with the ability to configure rejection parameters and selection of aiding sensors to use for post processed/smoothed post processed navigation solution.

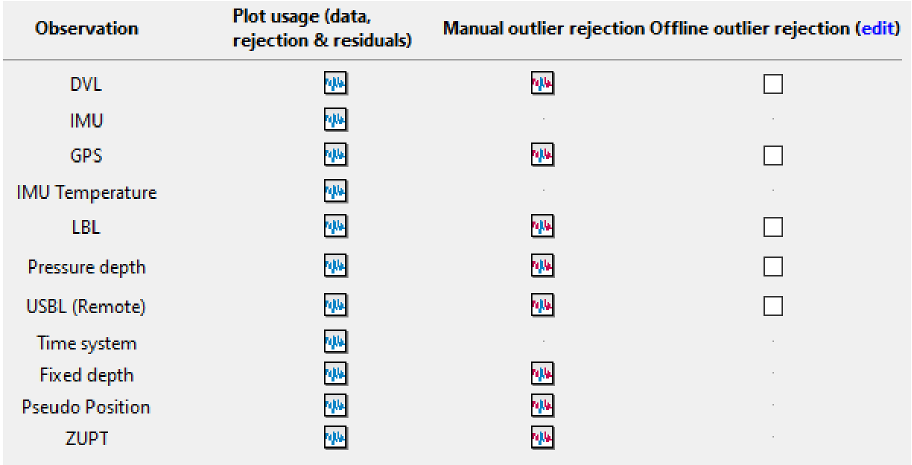
6.1 Raw Aiding Data and Observations

The observation table in the Sensors menu displays all available aiding, with the ability to either manually reject or configure outlier rejection for post processing navigation.

6.1.1 Observations Table

The raw sensor/aiding data is listed under the **Observations** column, along with plot usage, manual and offline outlier rejection.

Figure 13 Observations Table

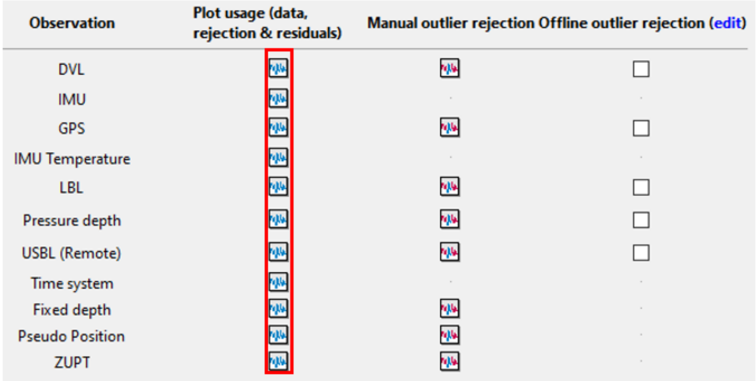


Observation	Plot usage (data, rejection & residuals)	Manual outlier rejection	Offline outlier rejection (edit)
DVL			☐
IMU		·	·
GPS			☐
IMU Temperature		·	·
LBL			☐
Pressure depth			☐
USBL (Remote)			☐
Time system		·	·
Fixed depth			·
Pseudo Position			·
ZUPT			·

6.1.2 Plot Usage (data, rejection & residuals)

The **Plot usage (data, rejection & residuals)** column allows the user to view the different sensor. aiding data used for real time/post processed navigation, including any rejection of the data and residuals.

Figure 14 Observations Table – Data Plots



Observation	Plot usage (data, rejection & residuals)	Manual outlier rejection	Offline outlier rejection (edit)
DVL			☐
IMU		·	·
GPS			☐
IMU Temperature		·	·
LBL			☐
Pressure depth			☐
USBL (Remote)			☐
Time system		·	·
Fixed depth			·
Pseudo Position			·
ZUPT			·

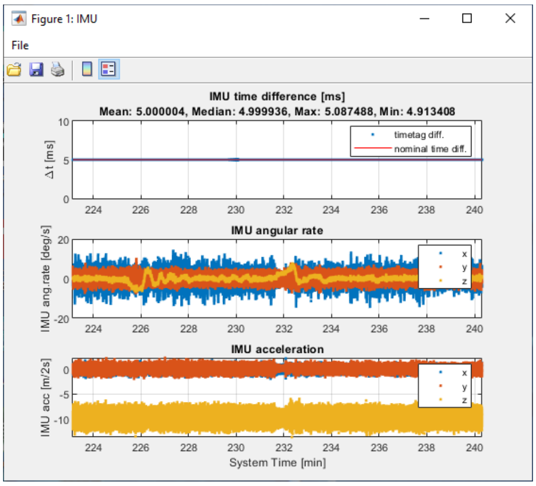
Note

If plotting this prior to post processing the INS data, these plots will be from the real time navigation soultion. If a Run Navigation solution has been processed in Janus then the plot useage will reflect the offline solution.

To view each observation (sensor/aiding data) click on the **Plot Usage** button; this will produce plots of all logged sensor and aiding data in the INS logfile(s). Examples of observation plots are shown below:

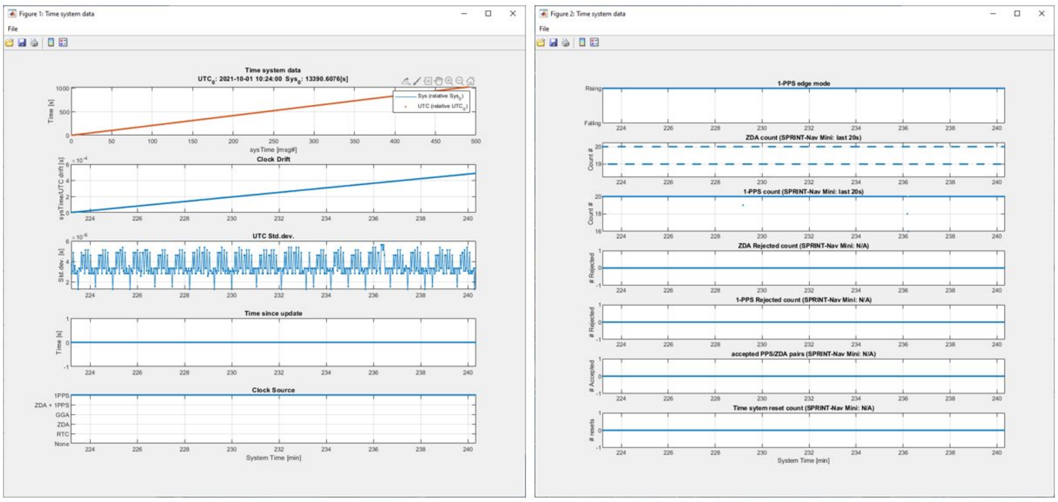
- **IMU**
  The raw IMU data is displayed (acceleration, angular rates and IMU time difference between IMU data).

Figure 15 IMU Plot



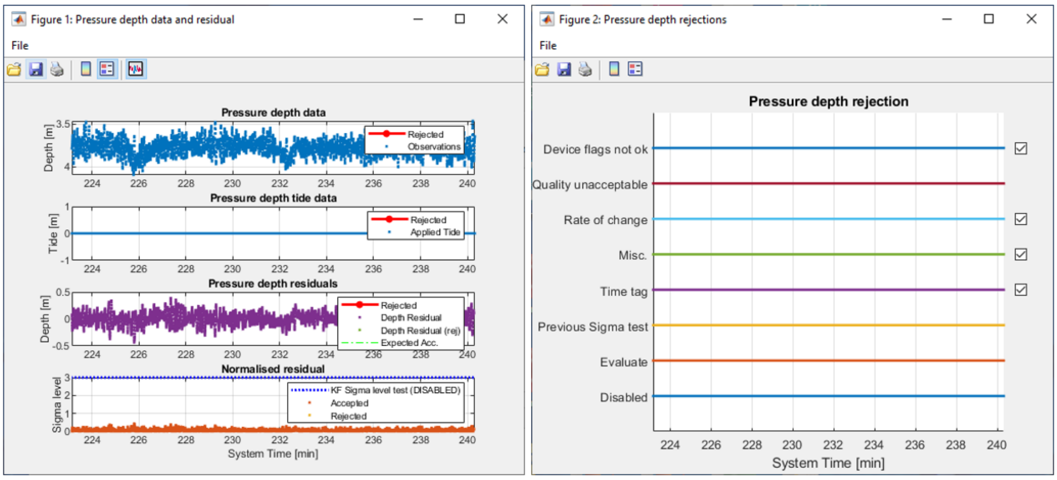
- **Time System**
  The time system usage plots show how the time system is configured, which includes system time vs UTC time, clock drift of the system's real time clock, standard deviation of UTC, time since the system has received an update and the clock source (e.g. ZDA+1PPS, 1PPS etc). The second plot displays PPS edge and accepted/rejected/count of ZDA and 1PPS.

Figure 16 Time System Plots



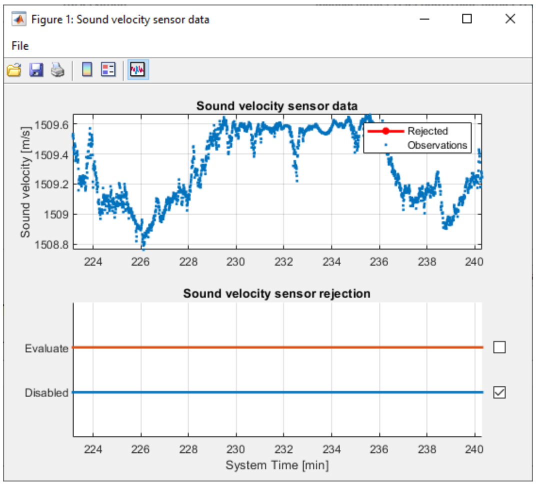
- **Pressure Depth**
  The pressure depth usage plots show the raw depth and residuals as well as rejection criteria.

Figure 17 Pressure Depth Plots



- **Sound Velocity**
  The sound velocity usage plot displays the raw Sound Velocity and rejection plots.

Figure 18 Sound Velocity Plot



- **DVL**
  The DVL usage plot shows DVL bottom track data and quality metrics, residuals, status and DVL rejection.

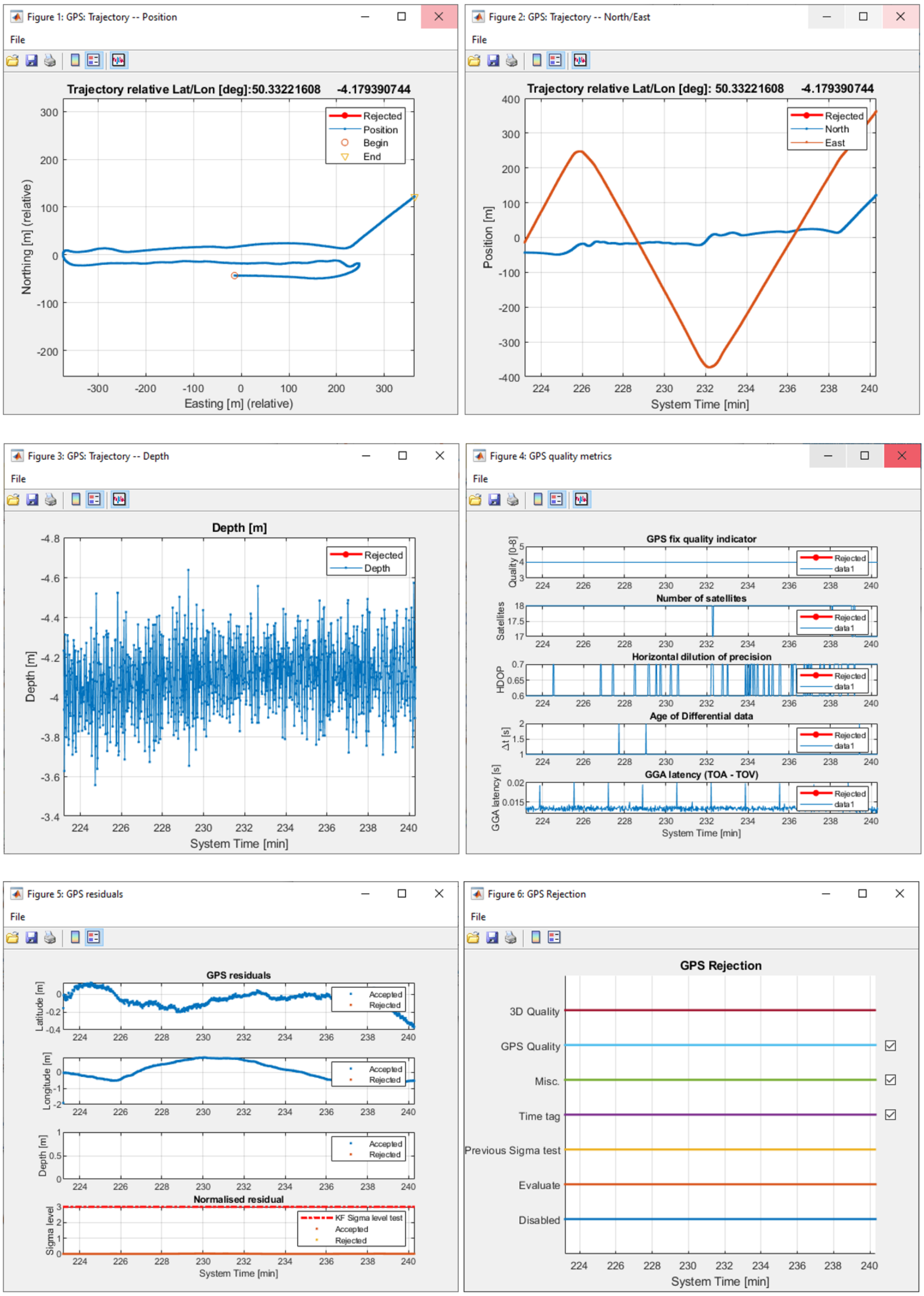
Figure 19 DVL Plots

Note

DVL Beam Rejections plot is accessed by clicking the beam rejection button on DVL Rejection plot menu.

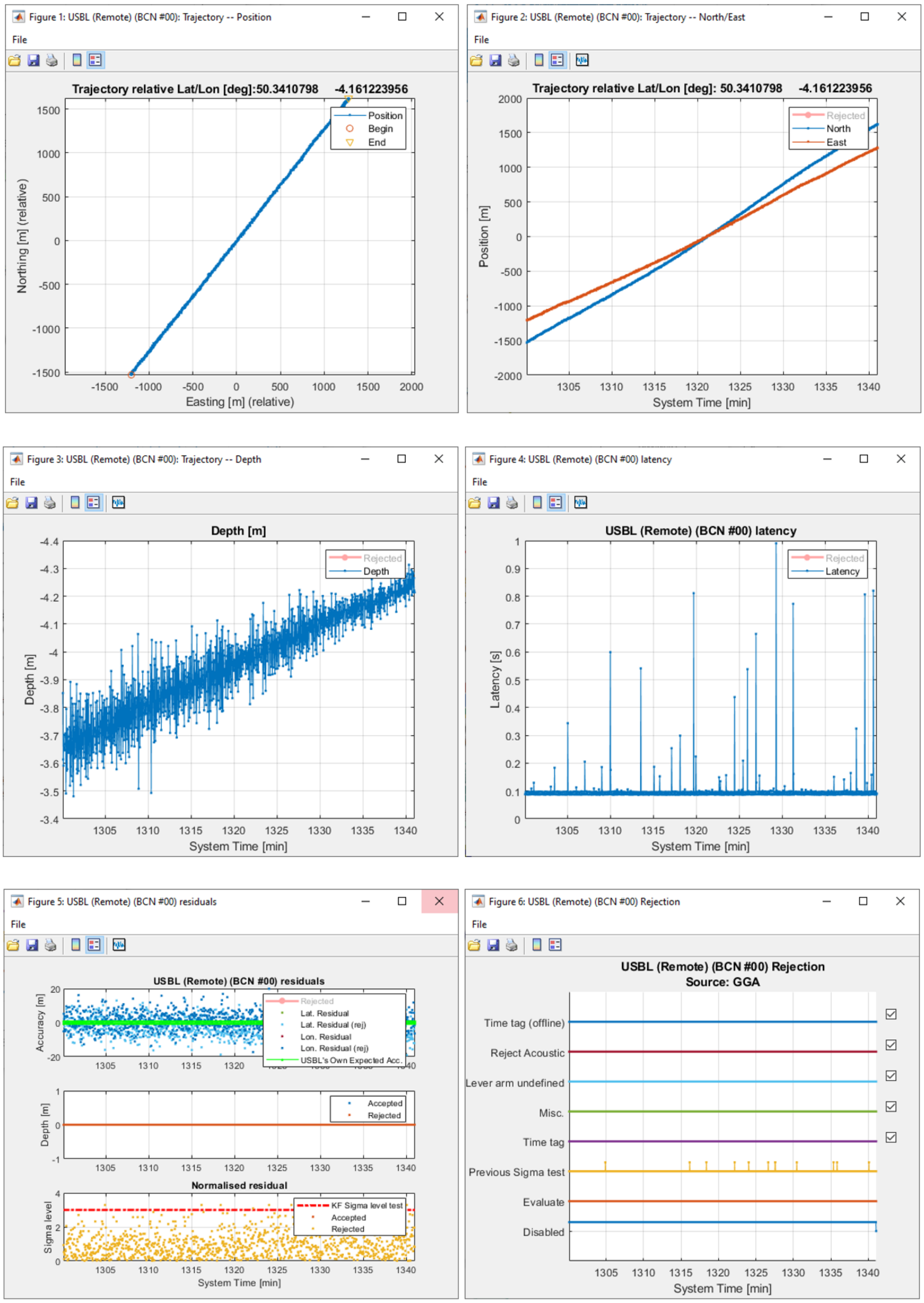
- **GPS**
  The GPS usage plots displays the raw GPS position, residuals, quality metrics and rejection criteria.

Figure 20 GPS Plots



- **USBL (Remote)**
  The USBL (Remote) usage plots show raw USBL position, latency, residuals, and rejection criteria.

Figure 21 USBL (Remote) Plots



- **LBL**
  The LBL usage plots show the raw LBL data, residuals, and rejection criteria.

Figure 22 LBL Plots

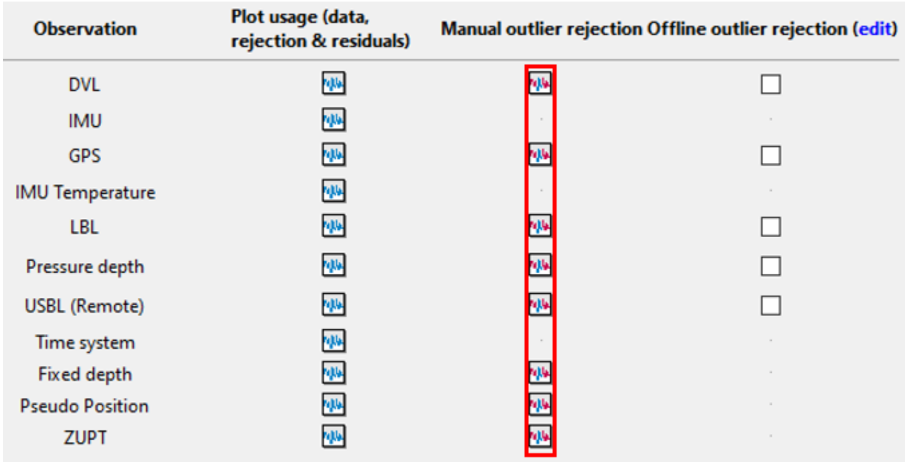
Note

Pseudo Position is a very coarse motion constraint, for advance users only.

6.1.3 Manual Outlier Rejection

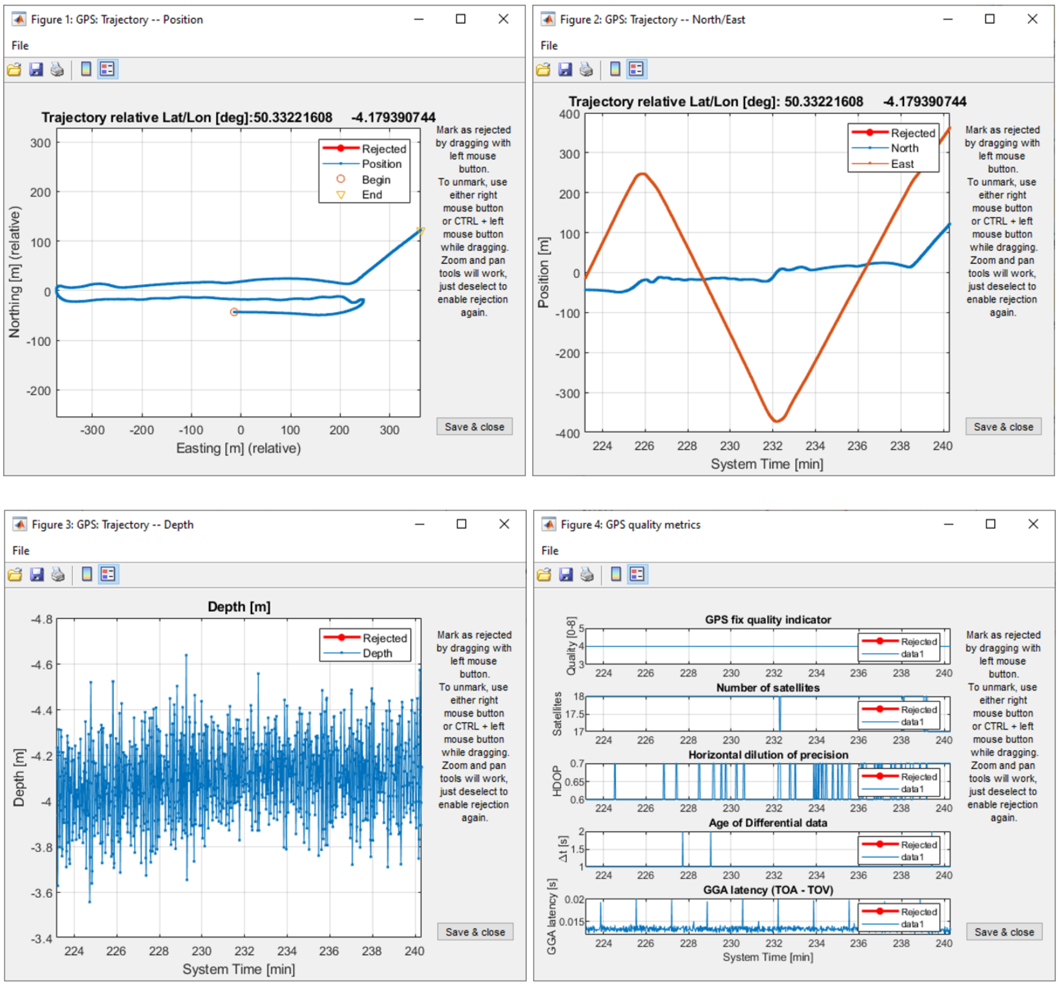
The raw aiding data can be manually rejected by clicking the manual outlier rejection for the related data.

Figure 23 Observations Table – Manual Rejection



Observation	Plot usage (data, rejection & residuals)	Manual outlier rejection	Offline outlier rejection (edit)
DVL			☐
IMU			
GPS			☐
IMU Temperature			
LBL			☐
Pressure depth			☐
USBL (Remote)			☐
Time system			
Fixed depth			
Pseudo Position			
ZUPT			

Figure 24 Manual Rejection Before Plot



- To manual reject the data, drag the cursor (with left mouse button pressed in) over the data to be rejected and unclick the mouse button and then click **Save & close**.

- To undo the manual rejection, drag the cursor (with right mouse button pressed in) over the data to be rejected and unclick the mouse button and then click **Save & close**.

Figure 25 Applying Manual Rejection

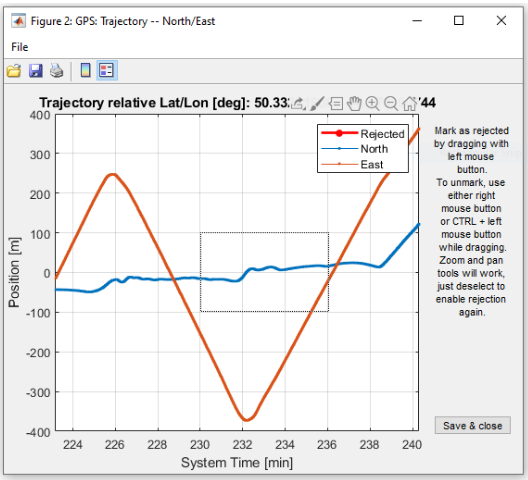
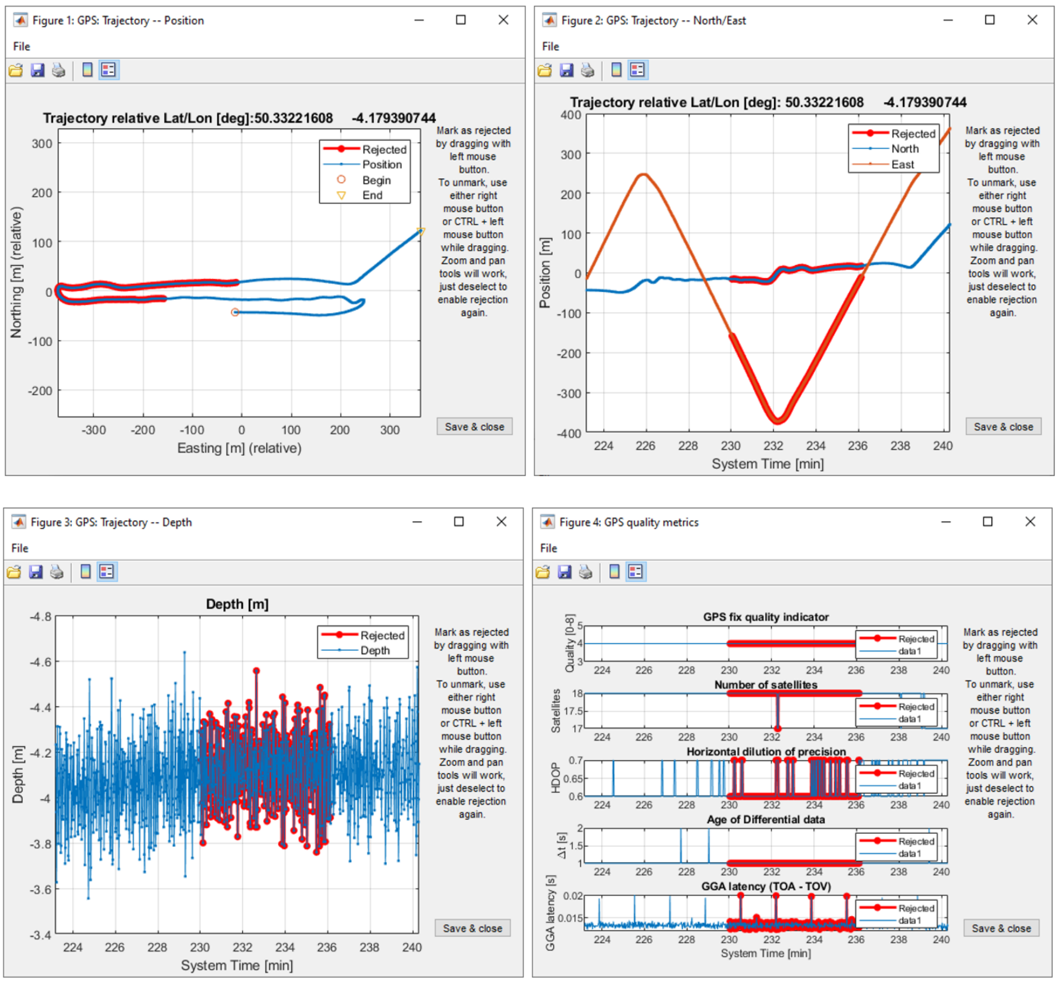


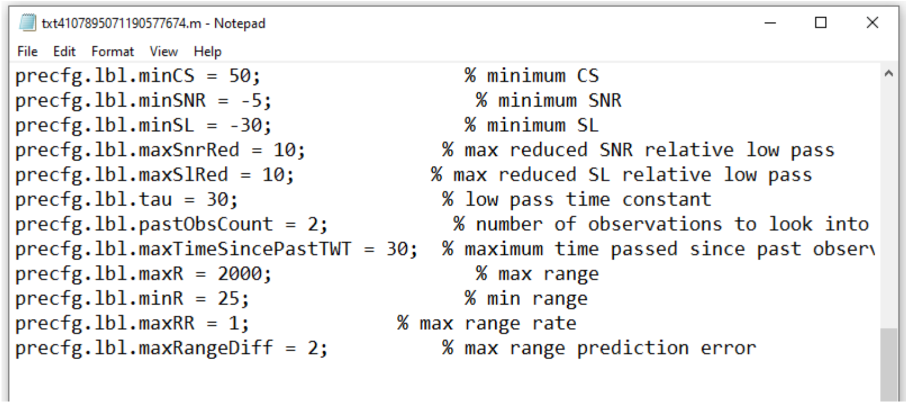
Figure 26 Manual Rejection After Plot



6.1.4 Offline Outlier Rejection

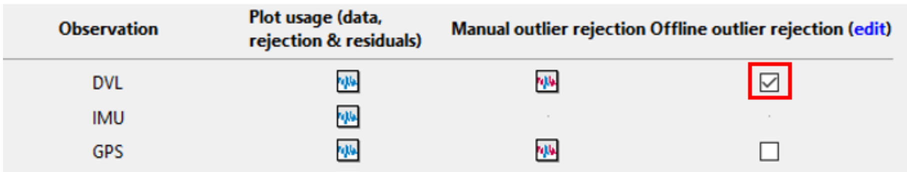
The offline outlier rejection allows the user to set rejection criteria which when enabled will automatically reject the aiding data that falls outside of these criteria during post processing of the navigation. To reject aiding data using the offline outlier rejection, simply click on the (edit) link within the corresponding column in the observation table, this will open a text file where the user can then set the rejection limits on the required aiding data.

Figure 27 Offline Outlier Rejection File



```
precfg.lbl.minCS = 50;                  % minimum CS
precfg.lbl.minSNR = -5;                  % minimum SNR
precfg.lbl.minSL = -30;                 % minimum SL
precfg.lbl.maxSnrRed = 10;            % max reduced SNR relative low pass
precfg.lbl.maxSlRed = 10;            % max reduced SL relative low pass
precfg.lbl.tau = 30;                  % low pass time constant
precfg.lbl.pastObsCount = 2;           % number of observations to look into
precfg.lbl.maxTimeSincePastTWT = 30;  % maximum time passed since past obser\
precfg.lbl.maxR = 2000;                  % max range
precfg.lbl.minR = 25;                   % min range
precfg.lbl.maxRR = 1;               % max range rate
precfg.lbl.maxRangeDiff = 2;          % max range prediction error
```

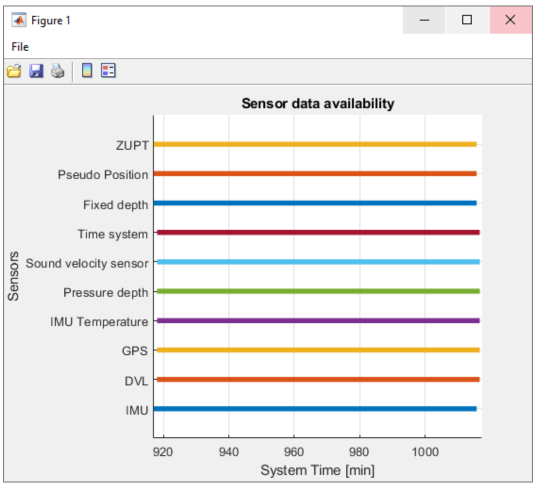
Once the rejection limits have been entered, save the text file, then enable the check box for the corresponding aiding to apply the changes for post processing.



6.1.5 Data Overview

The data over plot shows all available sensor data received by the SPRINT/SPRINT-Nav system (regardless of whether the sensors were used for real time aiding).

Figure 28 Data Overview



6.2 Transponder Database

The transponder database displays the configuration and position of each beacon used within the LBL solution. Each LBL beacon can be enable/disabled as an aiding source when LBL is used as an aiding source to the INS, set in the on/off control table.

Figure 29 Transponder Database

Transponder Database

Use the table to edit values and to enable or disable the use of transponders.

ID	Lat. [deg]	Lon. [de...	Depth [...	TAT [ms]	hDrms [...	vSigma ...	Sv [m/s]	Sv sigm...	Use
2303	50.363	-4.17	26.3	200	0	0	�	0	☑
2305	50.364	-4.171	28.07	280.0	0	0	�	0	☑
2309	50.364	-4.17	23.76	440.0	0	0	�	0	☑

6.3 On/Off Control

The on/off control table allows the enable/disable of sensors for postprocessing.

Use the insert and remove row(s) buttons and enter time in seconds from power up (as shown on all Janus plots as time) and disable/enable aiding sensor accordingly. When running navigation in the AINS tab, the data will be processed with what has been selected in the on/off control table.

Figure 30 On/Off Control Table

On/off control

Use the table to turn sensors on/off at a given time. De-select by right-clicking the table.

Time [min]	DVL	GPS	LBL	Pressure ...	USBL (Re...	Fixed dep...	Pseudo P...	ZUPT
0	☑	☐	☐	☑	☑	☐	☐	☐
43.221	☑	☐	☑	☑	☑	☐	☐	☐
43.238	☑	☐	☑	☑	☐	☐	☐	☐
51.521	☑	☑	☑	☑	☑	☐	☐	☐

Insert row | Remove row(s)

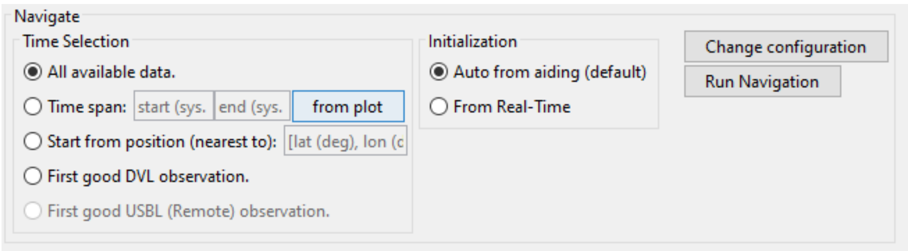
Section 7 – AINS

The INS data can be post processed to improve the accuracy/precision of the real-time INS navigation solution within the Janus AINS tab.

7.1 Post Processing

The INS data can be post processed by clicking **Run Navigation** (ensure that any aiding data rejection and enable/disable sensor configurations have been applied in the aiding sensor tab prior to clicking Run Navigation).

Figure 31 AINS Navigate Options



7.1.1 Time Selection

Janus AINS tab offers post processing of the navigation data with respect to the following options:

- All available data: Janus will process all available data within the logfile.
- Time Span: Post processing data from a defined start and end time.
- Start from position (nearest to): Janus will post process data starting from the nearest position that has been user defined.
- First good DVL observation: Post process data from the first good/accepted DVL observation.
- First good USBL (Remote) observation: Post process data from the first good/accepted USBL observation.

7.1.2 Initialization

Janus AINS tab offers initialisation options for post processing of the navigation data:

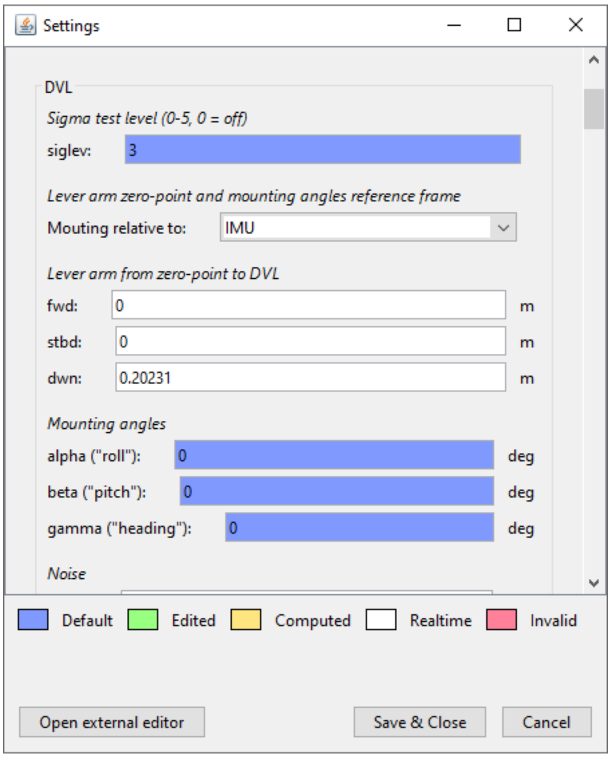
- Auto from aiding (default): INS algorithm will initialise from the aiding selected for offline processing post processed/smoothed navigation solution.
- From Real-Time: INS algorithm initialised from the real time aiding data.

7.1.3 Change Configuration

Real time configuration parameters can be modified for post processing by clicking **Change configuration** and modifying lever arms, mounting angles and navigation/sensor parameters as required and then clicking **Save & close**.

If applying updated lever arms and/or mounting angles, ensure the correct reference frame/point is used (IMU/vehicle). For further information instrument frame, see UM-8253 SPRINT-Nav, UM-8253 SPRINT or UM-8334 SPRINT-Nav Mini.

Figure 32 AINS Navigate Settings



7.2 Navigation Plots

Real time and post processed navigation can be plotted under the following areas:

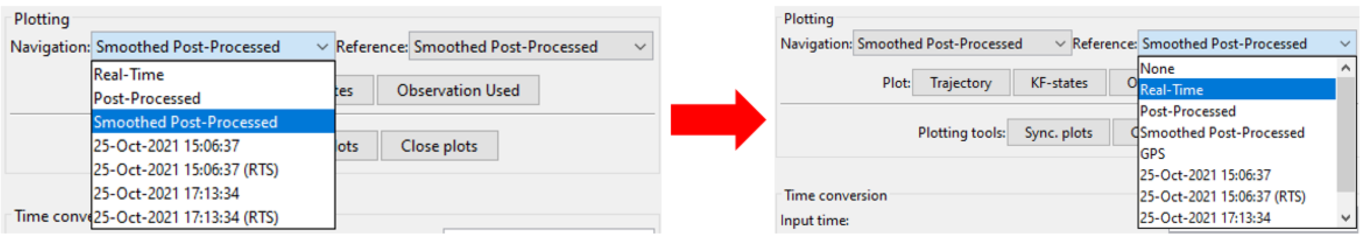
- Trajectory
- KF-States
- Observations Used

To plot navigation, first select the primary navigation solution in the navigation drop-down list.

The real time is the real time solution/performance of the INS, Post-Processed is the most recent post processed solution in the forward direction only and the smoothed post processed is the most recent forwards and backwards smoothed solution (previous processing solutions are date and time stamped of the date of processing with RTS indicating the smoothed solution).

If the INS data has not been post processed then only the Real time option will be available).

Figure 33 AINS Plotting

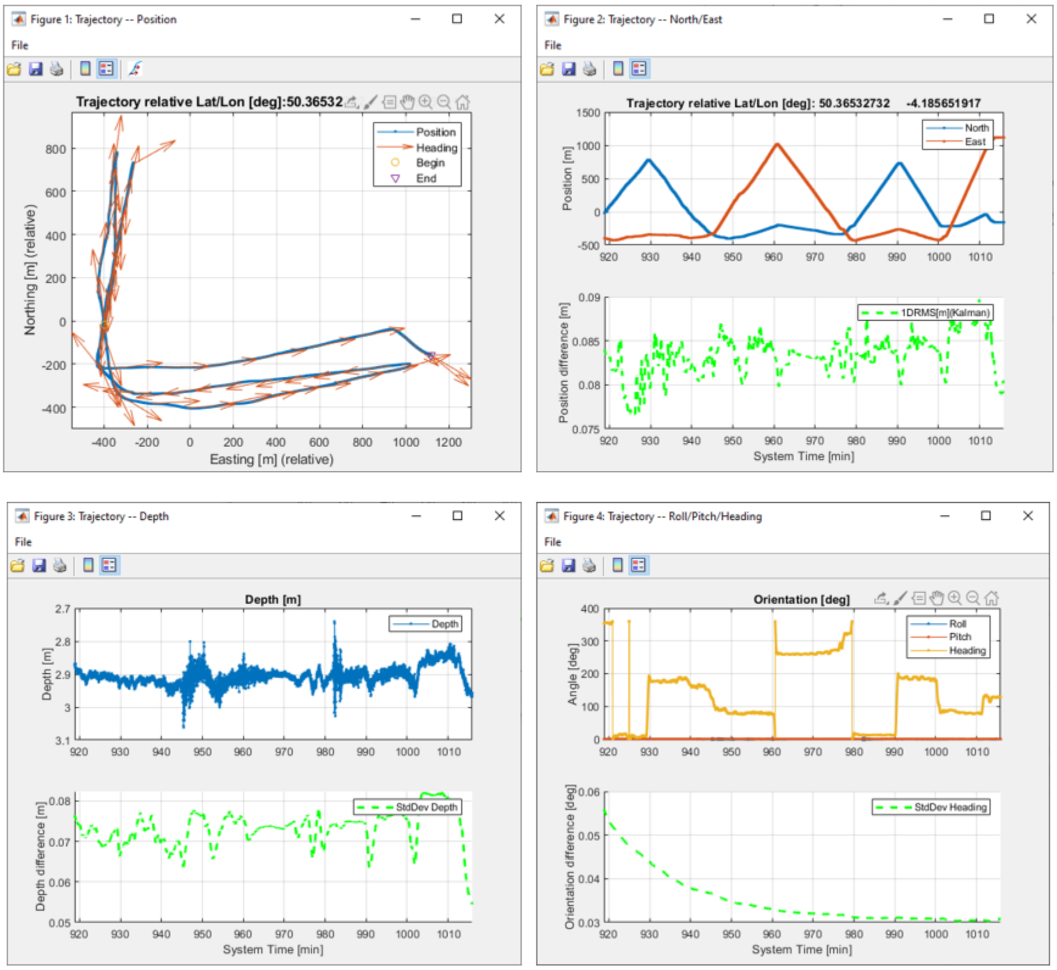


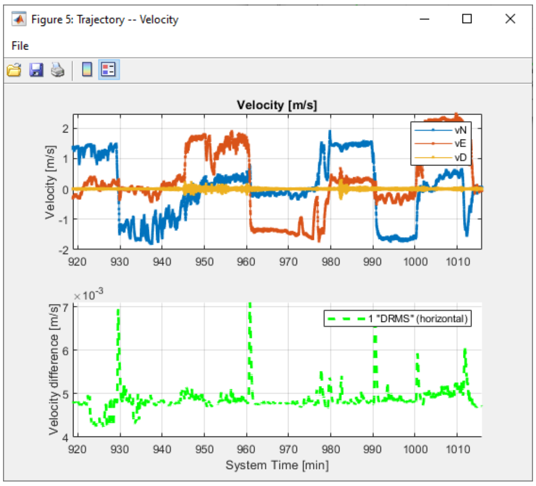
7.2.1 Trajectory

The Trajectory button plots the following navigation information from the select navigation and reference:

- Navigation Position: Overall relative navigation solution.
- Navigation position (North/East): Relative navigation solution showing the individual trajectories in latitude and longitude.
- Depth: Depth of navigation solution.
- Orientation: Orientation of navigation solution.
- Velocity: Velocity of the navigation solution

Figure 34 AINS Trajectory Plots



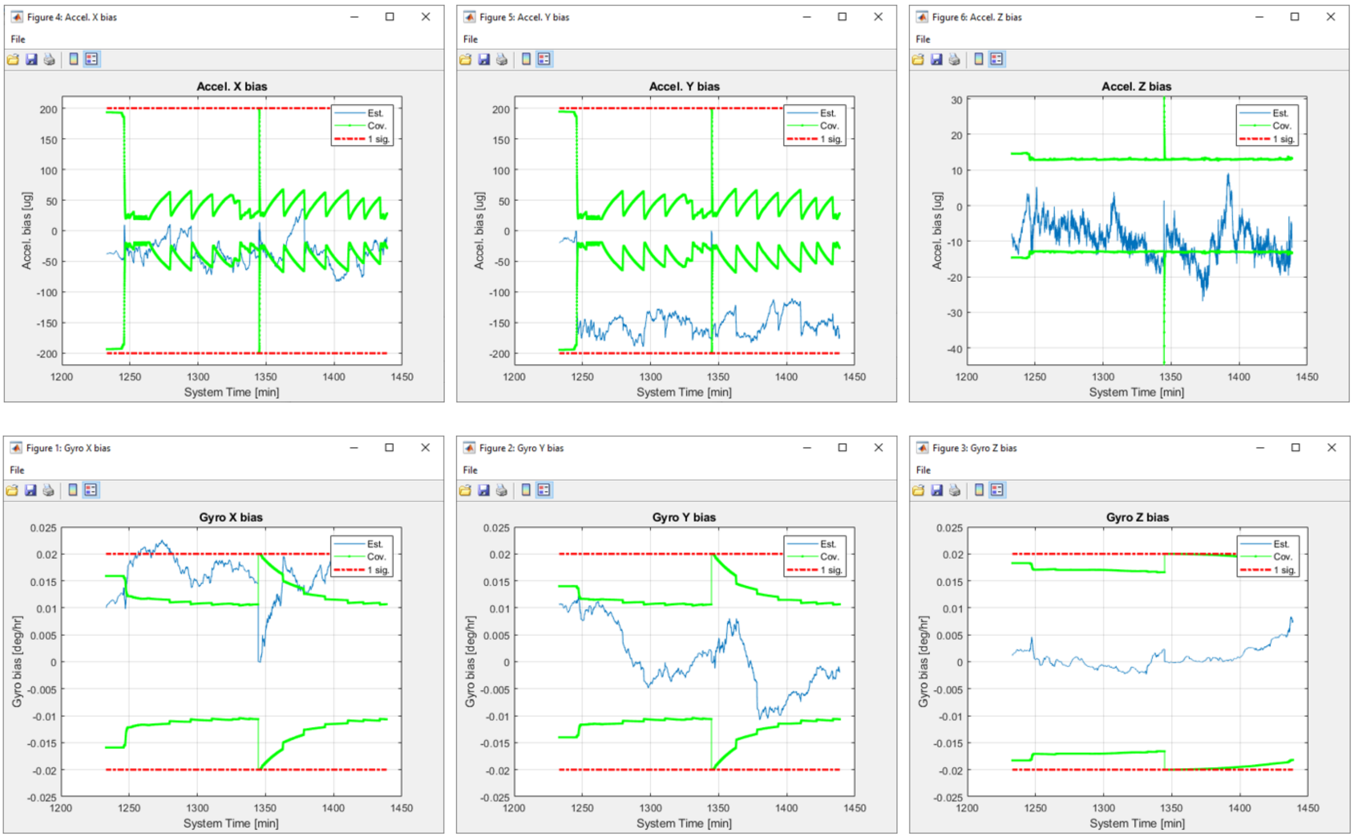


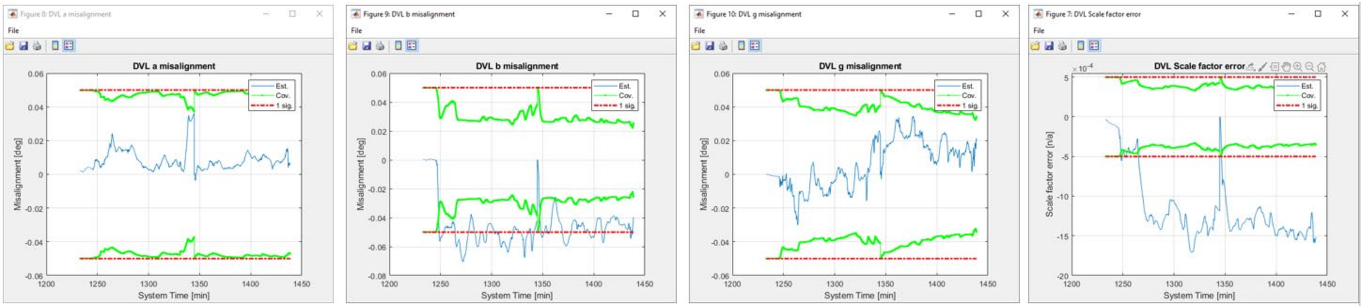
7.2.2 KF States

The Kalman filter states of the selected navigation solution can be viewed, this produces plots for both Accelerometer and Gyro bias estimations as well as DVL misalignment and scale factor estimations.

The blue plot is the bias estimations value, the green is the associated covariance of the estimate and the red line is the 1 sigma level.

Figure 35 AINS KF-State Plots

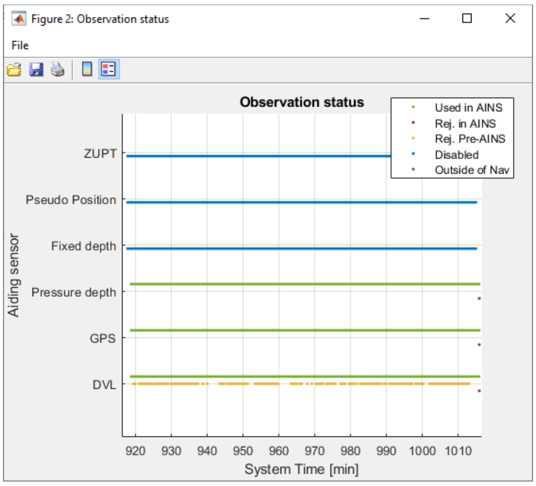




7.2.3 Observation Used

The observations used by the INS are shown within the observations used plot. This plot shows which aiding has been used in the AINS solution and which have not been used with regards to rejection or aiding sensor manually disabled.

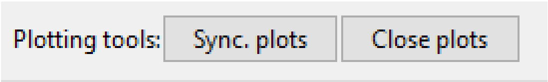
Figure 36 AINS Observation Used Plot



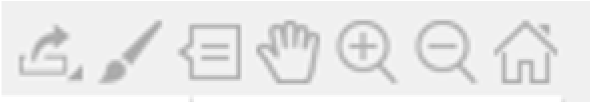
7.2.4 Plotting Tools

There are two plotting tools in Janus, Sync plots and Close plots:

- Sync plots: This function resizes all plots to be the same scale (zoom in on one plot, all plots zoom in)
- Close plots: This function closes all current open plots.



The following plotting tools are available by hovering the mouse over the top right corner of each graph in every Janus Plot:



 Save and Copy plot options

 Data select tool

 Data Tips

 Manual Pan

 Zoom In

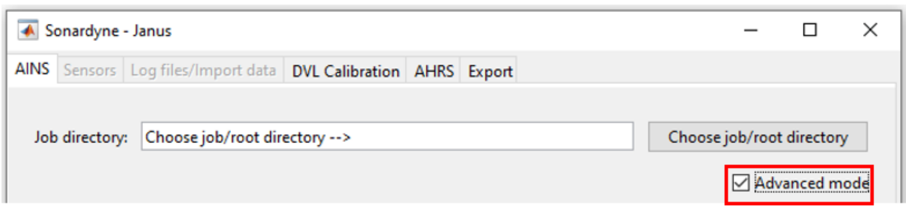
 Zoom Out

 Restore View

7.2.5 Advanced Mode - Apply AINS states

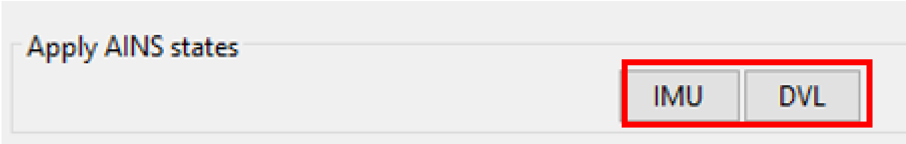
AINS can be applied to the post processed data to improve the navigation solution by compensating the INS algorithm bias estimates and modifying inertial algorithm and DVL Calibration parameters.

1. To apply AINS states, enable the **Advanced Mode** check box.
2. Configure any offline/manual outlier rejection and aiding on/off control that is required, then click the Run Navigation button.



3. When the Run Navigation Solution has completed the Apply AINS states appear with two options available:
    - IMU – Applies IMU AINS states.
    - DVL – Applies DVL AINS states

4. These options will apply IMU and DVL AINS states to the offline configuration, click Run Navigation to use these parameters in the offline navigation solution.



Note

Applying AINS states is recommended for advanced users only.

7.2.6 Time Conversion

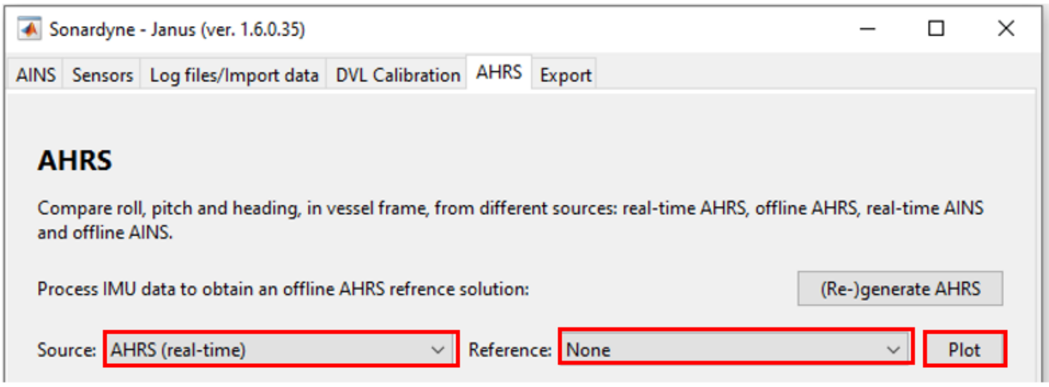
The time conversion option in Janus converts INS system time (minutes from power up) within the SPRINT/SPRINT-Nav data to UTC or vice versa as shown in the below figure.

Figure 37 Time Conversion

Section 8 – AHRS

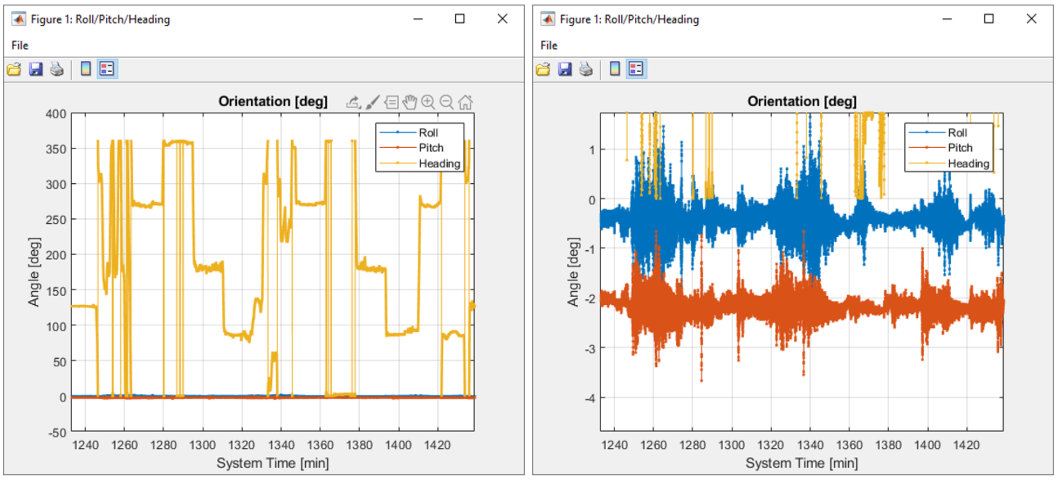
The AHRS tab allows the user to plot and compare the roll, pitch and heading outputs from both AHRS and AINS algorithms, with the ability to create an offline AHRS reference solution by processing the IMU data.

To plot real time AHRS, click on the **AHRS** tab and select **AHRS (real-time)** from the **Source** drop-down list and **None** from the **Reference** drop-down list and then click the **Plot** button.

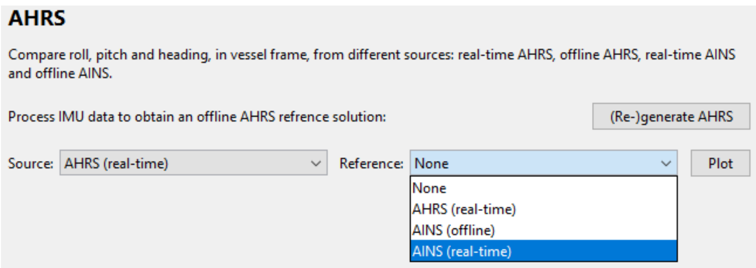


The Roll, Pitch and Heading are plotted, the plot auto sizes to the largest measurement, therefore use the zoom functions on the plot to view the Roll and Pitch.

Figure 38 AHRS Plot



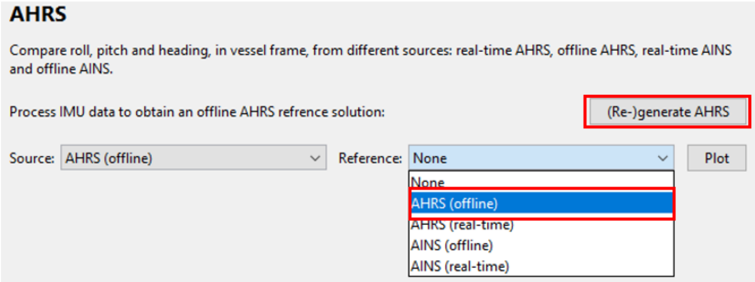
Comparison Roll, Pitch and Heading can be plotted by selecting a reference from either AHRS or AINS solutions.



AHRS Options:

- AHRS (real-time)
- AINS (Offline) – Roll, Pitch and Heading generated by post processed navigation solution.
- AINS (real-time)

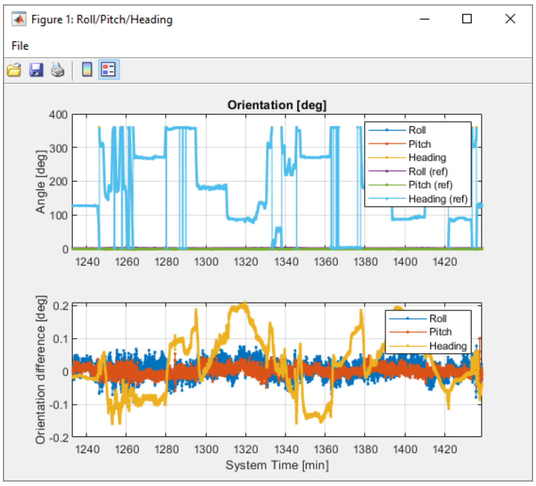
AHRS Roll, Pitch and Heading solution can be generated (automatically processing the raw IMU data to obtain an offline AHRS solution) by clicking the (Re-)generate AHRS button, once the processing is complete, AHRS (offline) will appear in the dropdown menu.



AHRS comparison between AHRS/AINS online/offline solutions can be plotted by selecting populating the source and reference drop-downs.

The below plot shows AHRS (real-time) compared against AINS (real-time) solutions.

Figure 39 AINS Source vs Reference Plot

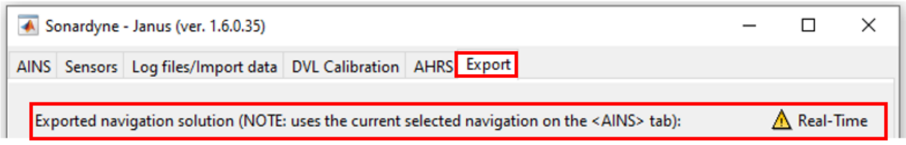


Note

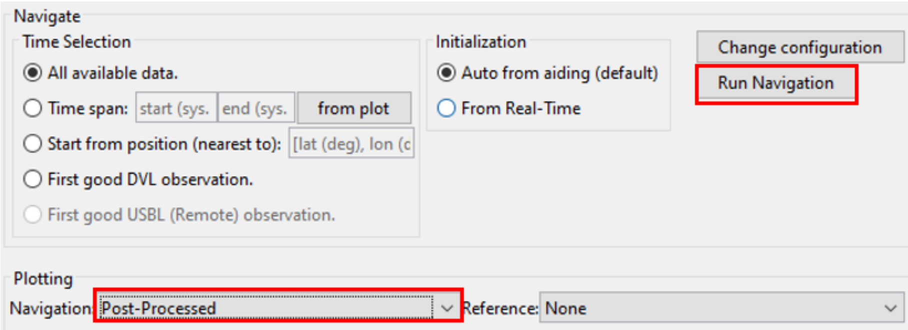
Offline AHRS and (Re-)generate AHRS functions are not supported in SPRINT-Nav Mini data.

Section 9 – Export

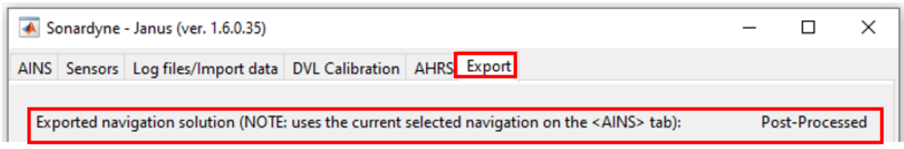
The Janus Export tab allows the user to output navigation solutions from post processed (and smoothed post processed).



- To enable Janus export, complete a postprocessed Navigation Run in the AINS tab and select the required navigation from the plotting option (Post-Processed or Smoothed Post-Processed).

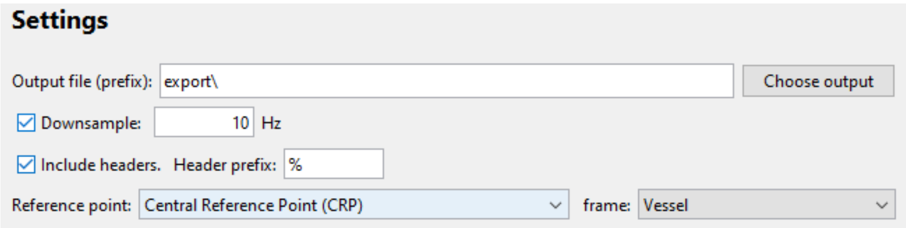


- Click the **Export** tab; the Export button and message previews are now available.



9.1 Export Settings

The following figure shows the available Janus export file settings.

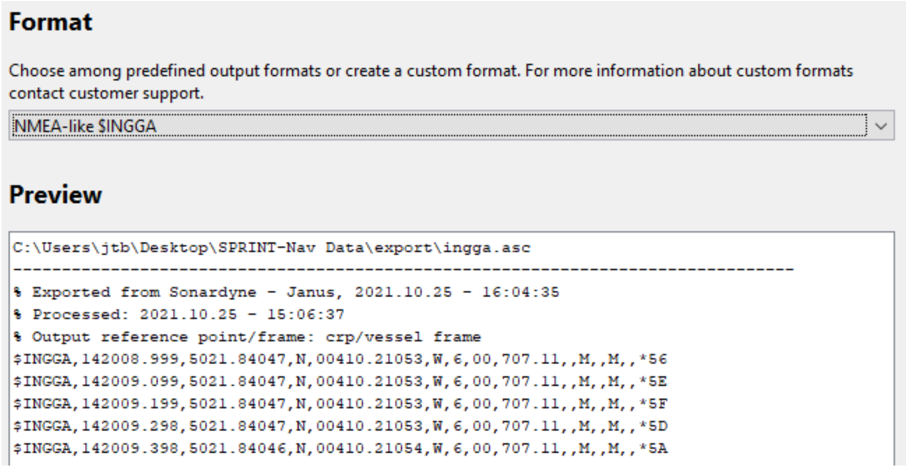


- **Output file (prefix)**: select destination folder for export file.
- **Down sample**: This is the sample rate of the output message to be exported from the postprocessed INS navigation solution. A sample rate of up to the real time navigation state can be set, if this option is disabled then the output rate will equal the real time navigation. To set a sample rate, click the Down sample check box and enter the output data rate value in the down sample field (output rate measured in Hz).
- **Header Prefix**: A header can be applied to the export message, by simply enabling the Include Headers check box and type the required character(s) in the header prefix box. Once the message has been exported to file, the header will then be applied to the message headers.

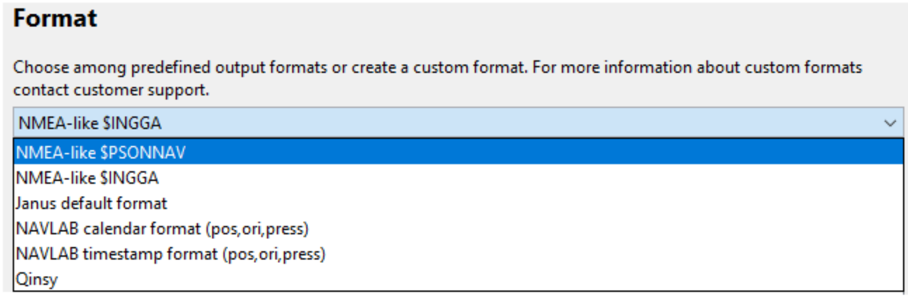
- **Reference point and frame**: The export file solution is calculated with respect to the reference point and frame set by the user (vessel/vehicle or instrument/sensor).

9.2 Export Format & Preview

The export format and preview option in the Janus Export tab allow the user to select the required export file and displays a preview of the format of the message, as shown in the below figure:

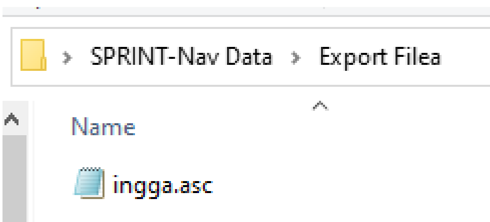


See default export files are shown in the below figure, see *Appendix A* for message formats.



9.3 Export File

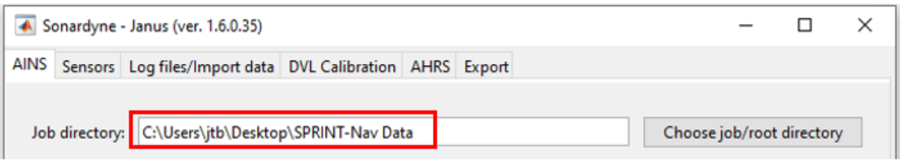
To create the export file, click the **Export** button to produce the message selected in Format.



9.4 Custom Output Message

To create a custom export file:

1. Custom export files can be created using the **exportCustom_template.fmt** file located in **C:\Users\Public\Documents\Sonardyne\Janus\Export Files**.
2. Copy the **exportCustom_template.fmt** to the root directory selected in the **AINS** tab.



3. Rename the **exportCustom_template.fmt** to required name then open the file and follow instructions on how to create message format.

Figure 40 Custom Export File Template

```
% <Format name/description>
% ^^^^^^^^-- first line is used as description in Janus GUI (keep the %-sign at the beginning)
%
% This file serves as an easy-to-use template for custom export formats. For more inspiration have a look at the
formats provided with this release e.g. export<Name>.fmt. Especially if a NMEA type of message string output is needed,
since this is a bit tricky to do.
%
% How to
% ========
% 1. Copy and rename this file to 'export<Name>.fmt e.g. 'exportCustom.fmt'
% 2. Edit the name/description of the very first line. Remeber to keep the %-sign!
% 3. Edit the rest of this file as you like.
% 4. Remove or comment the last line of this file!
% 5. Copy the file to root directory of your Janus job (i.e. the directory you choose in the Janus GUI)
% 6. Your custom export format should now show up the next time you go to the <Export> tab.
%
```

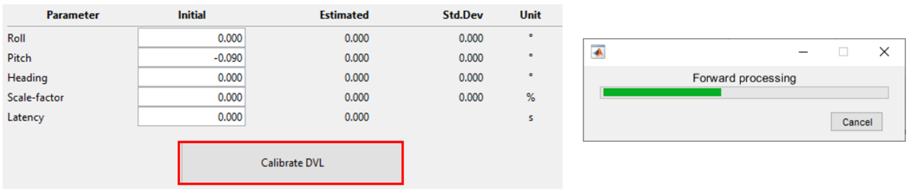
Section 10 – DVL Calibration

The **DVL Calibration** tab allows the user to calibrate a SPRINT DVL calibration (not to be used with SPRINT-Nav and/or SPRINT-Nav Mini).

10.1 DVL Calibration

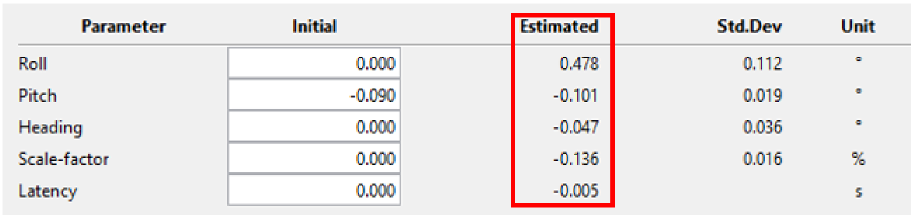
Use the following steps to calculate the DVL Calibration values (see UM-8253 SPRINT A3 for DVL Calibration manoeuvres).

1. Import the SPRINT DVL Calibration logfiles; see *Section 4 – Logfiles/Import Data*.
2. Once data imported, navigate to the DVL Calibration tab. The initial fields are automatically populated by the values read from the real time settings (these values can be changed if necessary).
3. To process the INS data, click **Calibrate DVL**, and then wait for the progress bar to complete.



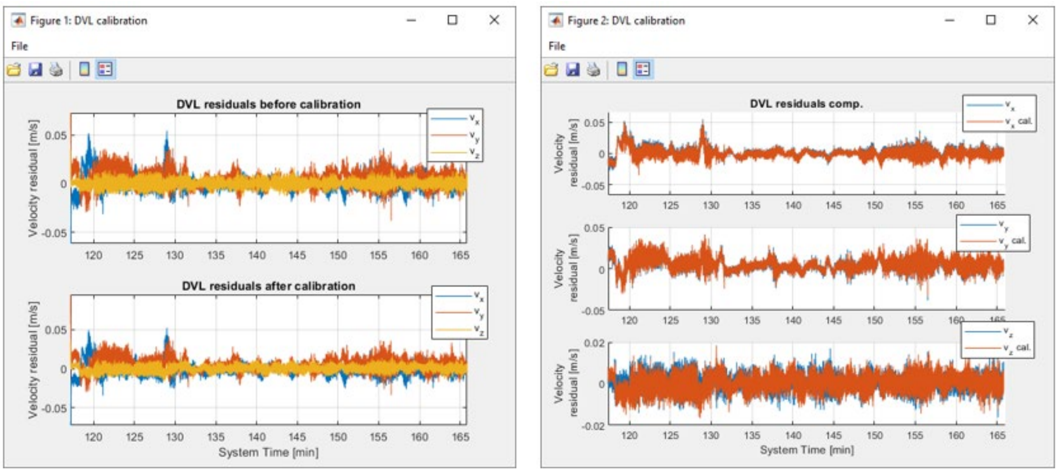
Parameter	Initial	Estimated	Std.Dev	Unit
Roll	0.000	0.000	0.000	°
Pitch	-0.090	0.000	0.000	°
Heading	0.000	0.000	0.000	°
Scale-factor	0.000	0.000	0.000	%
Latency	0.000	0.000		s

- Once finished the before and after DVL residuals will appear, and the calibration values populated in the estimated column.



Parameter	Initial	Estimated	Std.Dev	Unit
Roll	0.000	0.478	0.112	°
Pitch	-0.090	-0.101	0.019	°
Heading	0.000	-0.047	0.036	°
Scale-factor	0.000	-0.136	0.016	%
Latency	0.000	-0.005		s

Figure 41 DVL Calibration Plots



4. The DVL calibration can be saved to file as a PDF by clicking **Save Calibration**. The calibration settings can also be applied to the current data set by clicking **Use Calibration**.

Figure 42 DVL Calibration Report

DVL Calibration Report

Sonardyne SOUND IN DEPTH

Settings:

Lever arms	relative to	Forward (x) [m]	Starboard (y) [m]	Down (z) [m]
IMU	Vehicle (CRP)	0	0	0
USBL	Vehicle (CRP)	0	0	0
DVL	Vehicle (CRP)	0	0	0.203

Mounting angles	relative to	a (roll) [º]	b (pitch) [º]	g (heading) [º]
IMU	Vehicle	0	0	0

Settings	
Tidal correction	off
DVL sound velocity source	sensor
USBL acoustic scale	1

Results:

DVL params	a (roll) [º]	b (pitch) [º]	g (heading) [º]	Scale factor error [%]	Latency [s]
Before	0	-0.090	0	0	0
Calculated	0.478	-0.101	-0.047	-0.136	-0.005
Calculated Accuracy	0.112	0.019	0.036	0.016	

Note: The DVL Euler mounting angles are relative to the Vehicle frame.

5. The DVL residuals plots can be opened by clicking the Plot DVL residuals button

10.1.1 Predefined sensor selection

When selected, this option uses the real time aiding sensor selection for the DVL calibration processing. When unselected the user can select which aiding sensors to use for via On/Off Control option in the Sensors tab.

10.1.2 Bypass coarse estimation

The Bypass coarse estimation is a fine alignment that bypasses the coarse calibration processing (the DVL and INS must be already aligned > 1 deg).

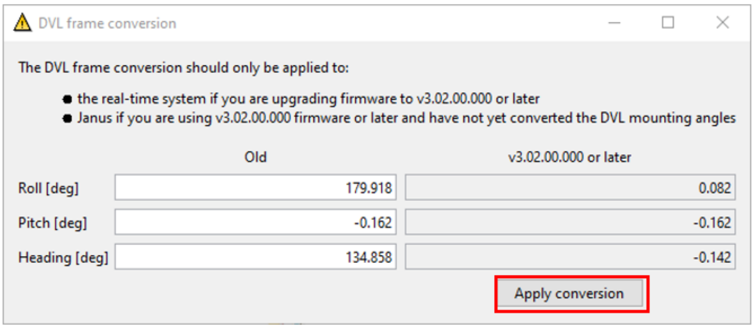
10.1.3 Diagnose calibration

The Diagnose calibration option will save the last DVL calibration processed in the smoothed post processed navigation run including the related sensor residual plots (DVL calibration run will not be visible outside of the DVL Calibration menu if Diagnose Calibration is not enabled).

10.2 DVL Frame Convention

The DVL frame convention tool allows DVL mounting angles in a SPRINT v1.4 system to be converted to a SPRINT v1.5.1 (or later) system convention without the requirement to perform an additional DVL calibration.

- Enter the Roll, Pitch and Heading into the Old field and the new values will be automatically generated. The new DVL mounting angles should be applied to the SPRINT system. Click Apply conversion to update the Janus settings to use for post processing.



Appendix A – Output Message Formats

Janus export files can be generated after post processing INS data (run navigation) for both smoothed and post processed solutions.

A.1 PSONNAV

Table A-1 PSONNAV Message Format

Field	Description
UTC Time	Hour/Minute/Second
Latitude	Degrees
Longitude	Degrees
Major Axis position error ellipse	Metres
Minor Axis position error ellipse	Metres
Direction of major Axis position error ellipse	Degrees
Position status	Position Flag – Valid or Invalid
Depth	Metres
Depth standard deviation	Metres
Roll	Degrees
Pitch	Degrees
Heading	Degrees
Heading standard deviation	Degrees
Orientation status	Orientation Flag – Valid or Invalid
Sensor status	INS Aiding Flags

A.2 INGGA

Table A-2 INGGA Message Format

Field	Description
UTC	Hour/Minute/Second
Latitude	Degrees
Longitude	Degrees
USBL Quality	Metres

A.3 Janus Default Format

A.3.1 Navigation State

Table A-3 Janus Navigation State Message Format

Field	Description
System Time	Seconds from system start up
Latitude	Radians
Longitude	Radians
Depth	Metres
Roll	Radians
Pitch	Radians
Heading	Radians
Velocity North	m/s
Velocity East	m/s
Velocity Down	m/s

A.3.2 Navigation Quality

Table A-4 Janus Navigation Quality Message Format

Field	Description
System Time	Seconds from system start up
Horizontal position accuracy (1DRMS)	
Heading accuracy (1 std dev)	radians

A.4 NAVLAB Calendar Format (Pos, Ori, Press)

A.4.1 Pos

Table A-5 Pos NAVLAB Calendar Message Format

Field	Description
Date	Year/Month/Day
Time	Hour/Minute/Second
Latitude	Degrees
Longitude	Degrees
Depth	Metres

A.4.2 Ori

Table A-6 Ori NAVLAB Calendar Message Format

Field	Description
Date	Year/Month/Day
Time	Hour/Minute/Second
Roll	Degrees
Pitch	Degrees
Heading	Degrees

A.4.3 Press

Table A-7 Press NAVLAB Calendar Message Format

Field	Description
Date	Year/Month/Day
Time	Hour/Minute/Second
Pressure	Bar

A.5 NAVLAB System Timestamp Format (Pos, Ori, Press)

A.5.1 Pos

Table A-8 Pos NAVLAB System Timestamp Message Format

Field	Description
System Time	Seconds from system start up
Latitude	Degrees
Longitude	Degrees
Depth	Metres

A.5.2 Ori

Table A-9 Ori NAVLAB System Timestamp Message Format

Field	Description
System Time	Seconds from system start up
Roll	Degrees
Pitch	Degrees
Heading	Degrees

A.5.3 Press

Table A-10 Press NAVLAB System Timestamp Message Format

Field	Description
System Time	Seconds from system start up
Pressure	Bar

A.6 Qinsy

Table A-11 Qinsy Message Format

Field	Description
UTC Time	Seconds
Latitude	Radians
Longitude	Radians
Depth	Metres

Definitions

Abbreviation/Term	Definition
AAINS	Acoustically Aided Inertial Navigation System
Accelerometer	A sensor that measures changes in velocity (acceleration)
Acoustic Signal	Sonardyne Wideband acoustic signals are discrete signals containing a carrier frequency encoded with identification information. Acoustic signals are used for purposes such as measuring the time of flight between acoustic instruments.
Acoustic Transceiver	An instrument that emits and receives acoustic signals, and extracts information from them. Transceivers can measure the time it takes a signal to travel from its transducer to a transponder and return. Some can encode and send data in a message and extract digital data from a message (Acoustic Telemetry). Used on a surface vessel or to mark a point on the seabed, or fixed to a mobile vehicle for tracking or positioning.
Acoustic Transducer	A device that converts electrical signals into acoustic signals and vice versa. A hydrophone is a device used to convert acoustic signals into electrical signals only. Note: The term is often applied to a complete instrument that contains pre-amplifiers, matching networks etc.
Acoustic Transponder	A specific type of "beacon" that emits an acoustic signal when it detects an interrogating acoustic signal.
Acoustic Transponder (Intelligent Transponder)	A transponder that is managed by a micro-controller. Examples include the COMPATT (COMPuting And Telemetry Transponder) and the WMT (Wideband Mini Transponder). Depending on supported functionality it can: - decode acoustic telemetered commands from a transceiver and can send telemetered data to the transceiver. - measure the distance between itself and other transponders and then telemeter the data to a transceiver. - measure its depth and the temperature of water. - measure a variety of underwater parameters and telemeter these back to the surface. - be used, as an intelligent angle-measuring device, in a Riser Angle Monitoring System. - be fitted with a release mechanism so it can return, on command, back to the surface e.g. if battery power is low
AHRS	Attitude and Heading Reference System An inertial sensor that provides outputs of heading, pitch and roll.
AUV	Autonomous Underwater Vehicle In military applications an AUV is more often referred to as unmanned undersea vehicle (UUV).
AvTrak	Acoustic navigation and communications instrument designed to form part of an integrated AUV tracking and navigation system.
Beacon	The term "beacon" is a generic term that covers "transponders", "responders" and "pingers". The term "beacon" is used in Sonardyne documentation and in subsea positioning literature when the specific type of beacon is not important. See *Acoustic Transponder, Acoustic Responder and Acoustic Pinger*
Co-ordinate Frame	A reference system used to define the position of a body in space. Sonardyne use right- handed Rectangular Cartesian co-ordinate systems in three dimensions, where the three axes used are orthogonal. Co-ordinate frames are also called 'reference frames'.

Abbreviation/Term	Definition
CRP	Common Reference Point The origin of the vessel frame is called the vessel's CRP. The position of a vehicle's CRP is arbitrary and can be at any convenient location on the vehicle.
DB or DBV	Signal level relative to full scale voltage in dBs.
DGPS	Differential Global Positioning System A differential GPS receiver uses corrections from land based receivers to compensate the signals received from satellites with a view to increasing accuracy. GPS is a specific type of GNSS; see *GNSS.*
DPS	Dynamic Positioning System. Automatically maintains a vessel with a constant heading, and in a fixed position without an anchor and provides more flexibility in operation. Normally such a system uses a number of position inputs such as GNSS receivers, taut wire sensors, LBL, SBL or USBL acoustic positioning sensors, wind speed indicators and so on. The system controls thrusters on the vessel to maintain position and attitude in yaw.
DSP	Digital Signal Processing The representation of signals by a sequence of numbers or symbols and the processing of these signals. DSP includes subfields like: audio and speech signal processing, sonar and radar signal processing, sensor array processing.
DVL	Doppler Velocity Log Uses acoustic measurements to capture bottom tracking velocity measurements and can be used to calculate distance travelled.
Fusion	Long BaseLine (LBL) acoustic positioning system. Provides the most accurate method for installing subsea structures, tracking ROVs and conducting acoustic metrology
Geodetic Co-ordinates	The earth is modelled by a reference spheroid (of which there is a large selection). The position of any point on or near the earth surface is defined by an angle of latitude and an angle of longitude. For a point on the spheroid P: - Latitude is defined as the angle between the normal plane at P and the plane of the earth's equator. - Longitude is defined as the angles between the meridians plane through P and the defined zero meridian plane or "Greenwich" plane (see *Geodesy, fourth edition, Bomford, Oxford, sections 2.03 and 4.10(d)* for more precise definitions).
GNSS	Global Navigation Satellite System A multi-user, 24-hour, worldwide radio navigation system using a constellation of satellites. GNSS receivers are capable of tracking and decoding data from the satellites and using it to compute the position and velocity of a vehicle.
GPS	Global Positioning System GPS is a specific type of GNSS; see *GNSS*.
Gyrocompass	A north-seeking gyroscope uses the properties of a gyroscope when its spin axis is maintained horizontal. The gyroscope senses the spin axis of the earth and will align itself with true north. Precision gyrocompasses, such as that in the Sonardyne Lodestar Attitude and Heading Reference System (AHRS) use ring laser gyros, which have no moving parts.
GyroCompatt 6	Combines a Compatt 6 transponder and a Lodestar Attitude and Heading Reference System (AHRS)/Inertial Navigation System (INS) in a single housing.
GyroUSBL	Combines HPT USBL transceiver and a Lodestar Attitude and Heading Reference System (AHRS)/Inertial Navigation System (INS) in a single housing.

Abbreviation/Term	Definition
GyroiUSBL	Combines inverted HPT USBL transceiver and a Lodestar Attitude and Heading Reference System (AHRS)/Inertial Navigation System (INS) in a single housing, usually deployed for subsea operations.
HRP	Heading, Roll and Pitch A compensated vessel frame. This is a frame sharing the same origin as the vessel frame but with the z axis vertical and the y axis parallel with a meridian passing through the origin (points true north).
Heading (Yaw)	Twisting or oscillation of a moving ship about a vertical axis.
INS	Inertial Navigation System A navigation aid that uses a computer, motion sensors and rotation sensors to continuously calculate the position, orientation and velocity of moving object without the need for external references.
IRS	Individual Reply Signal Signal used to uniquely identify a reply from a transponder.
Janus	Quality Control and post-processing INS software for SPRINT. A simple user interface allows quick and easy data editing, post-processing and data export to enhance real time navigation.
Kalman Filter	An adaptive filter what provides optimum filtering of a signal that has been subjected to a non-stationery environment (i.e. when the data is significantly changing during the filter convergence time).
LBL	Long BaseLine A system where two or more transponders are on the seabed. The positions of the transponders are established by a calibration process in a seabed frame. The distances from a transducer to each transponder are measured using a transceiver. The position of the transducer can be computed in the seabed frame. The name comes from the "baselines" joining each transponder.
LUSBL	Long Ultra Short BaseLine A hybrid of an LBL and USBL system. It utilises USBL equipment in an LBL configuration.
Marksman	LUSBL dynamic positioning system. Primarily suited to deep water mobile drilling units, well intervention and heavy lift construction vessels, where the system calculates position relative to a seabed deployed transponder array.
RLG	Ring Laser Gyroscope A sensor that measures rotation.
ROV	Remotely Operated Vehicle A vehicle controlled and powered by a cable connection so it can travel between the sea surface and seabed.
SNR	Signal to Noise Ratio This is the ratio of the signal power to noise power in unit bandwidth generally quoted in dB. Effective operation requires that the strength of a transmitted signal is sufficient to be detected above the noise level at the receiver.
Sonardyne	Sonardyne International Limited and its affiliates.
Sound Velocity	The speed with which sound pressure waves propagate through water. Sound velocity varies with properties such as water temperature, salinity and pressure. This is a core parameter in the accurate operation of acoustic positioning systems.

Abbreviation/Term	Definition
Sound Velocity Profile	Variations of sound velocity with water depth caused by varying temperature, salinity and pressure. In practice the depth cannot be measured directly. Therefore pressure measurements are made, and depth computed, using a knowledge of density. Derivation of density requires a knowledge of temperature and salinity. Salinity is measured indirectly through a measurement of water conductivity. Therefore a popular method of measuring the sound velocity profile is from a profile of pressure, temperature and conductivity and the use of empirically derived formulae to compute depth and sound velocity. Sound velocity can be measured directly using a dedicated and calibrated instrument called a sound velocimeter, although it is still necessary to have the relevant depth measurements available.
SPRINT	Subsea Precision Reference Inertial Navigation An Acoustically aided inertial navigation system for subsea vehicles. The system extends the operating limits of USBL and improves the operational efficiency of LBL by using sparse arrays.
SPRINT-Nav	Subsea Precision Reference Inertial Navigation Technology-Navigation SPRINT-Nav is an all-in-one subsea navigation instrument for underwater vehicles. It combines Sonardyne's SPRINT INS sensor and a Syrinx Doppler Velocity Log (DVL) in a single housing.
SPRINT-Nav Mini	SPRINT-Nav Mini is the world's smallest hybrid acoustic-inertial navigator. It combines carefully selected inertial sensors, a Syrinx Doppler Velocity Log (DVL) and a high accuracy pressure sensor into a single housing, optimised for size, weight and power consumption.
Submersible	A vehicle that operates below the sea surface and can carry a pilot and other personnel in a one atmosphere environment. It carries a supply of air for life support, and power for propulsion and other demands. It is capable of operating autonomously away from its support vessel for a limited time.
Syrinx DVL	Syrinx Doppler Velocity Log A Doppler Velocity Log (DVL) for surface and subsea vehicle navigation.
TAT	Turn-Around Time
TCVR	See *Acoustic Transceiver*
TPDR	See *Acoustic Transponder*
Transceiver	See *Acoustic Transceiver*
Transponder	See *Acoustic Transponder*
Transducer	See *Acoustic Transducer*
True North	The direction of the shortest line that can be drawn, across the surface of the earth, from the observer and the north pole.
USBL	Ultra-Short BaseLine A system similar to an SBL system except the system uses three or more elements in a single transducer array. The measurements it makes are the differences in "time-phase" of the signals from each element. The co-ordinate frame is fixed to the transducer array which must be oriented in the vessel frame to the equivalent to the SBL.
USV	Unmanned Surface Vehicle Sometimes referred to as an Autonomous Surface Vehicle (ASV)
UTC	Universal Time Co-ordinate The primary time standard by which the world regulates clocks and time. Closely related successor to Greenwich Mean Time (GMT).

Abbreviation/Term	Definition
VRG	Vertical Reference Gyroscope A gyroscopically stabilised VRU.

Global Headquarters, UK
T +44 1252 872288
sales@sonardyne.com

Aberdeen, UK
T +44 1224 707875
sales@sonardyne.com

Houston, USA
T +1 281 890 2120
usa.sales@sonardyne.com

Rio das Ostras, Brasil
T +55 22 2123 4950
brasil.sales@sonardyne.com

Singapore, Asia
T+65 6542 1911
asia.sales@sonardyne.com

24/7 Emergency Helpline
T +44 01252 877600
support@sonardyne.com

sonardyne.com