

Post-Processing INS/GNSS

Workflow Qinertia / PPIMMS



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Support Email
support@viametrisbusiness.com

Support Phone
+33 188 33 01 70

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1 PRELIMINARY

This document describes the procedure to calculate the trajectory of a system using Qinertia and how to integrate the result in PPiMMS.

We will consider that the user has done a standard acquisition with a bMS3D/vMS3D system and that she has exported her acquisition in the .aar format.

2 POST-PROCESSING INS/GNSS IN QINERTIA

2.1 LOCATING THE FILE TO PROCESS

Qinertia requires as an input a file containing all the data from the inertial measurement unit. This file is within the aar archive and is called: "xMS3D_XXXXXXX_XXXXXX_INS_oData.bin". This file is only accessible once the aar archive has been imported in PPiMMS.

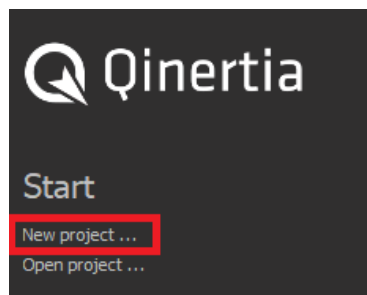
N.B.: 1) it is possible to separately export the aar file and the file "xMS3D_XXXXXXX_XXXXXX_INS_oData.bin" required by Qinertia from the tablet application.

2) for all systems updated before October 2018, the data file of the inertial measurement unit was called "xMS3D_XXXXXXX_XXXXXX_INSFrameReader_oData.s8". It is necessary to change the extension so that Qinertia can recognize the file. It has to be modified from "s8" to "bin".

2.2 CREATION AND CONFIGURATION OF THE PROJECT

2.2.1 PROJECT CREATION

- Launch Qinertia
- To create a new project , select "New project ...".



2.2.2 "CREATE A NEW PROJECT" WINDOW

- Chose the "Automotive" mode for an acquisition with the system used on a car, "UAV" for a motorized use and "Pedestrian" for a pedestrian use.
- Fill in the project name ("Project name"), the company name ("Organization name"), the username ("User name").
- Type in or browse through the explorer using "Browse" to provide the folder name in which the Qinertia project will be saved ("Save project to").
- Type in or browse through the explorer using "Browse" to provide the folder containing the data to process ("Import from directory").

Qinteria

Create a new project

Automotive

Project name: 20190704_124602_vMS3D_demo

Organization name: Viametris

User name: TG

Save project to: C:/Users/Thomas/Documents/Qinteria Browse

Import from directory: Browse

Please select or drag and drop an import directory. Qinteria will automatically detect files to import.

Next > Cancel

- The software automatically lists the files that can be post processed. Select the one that you are interested in and click "Next".

Qinteria

Create a new project

Automotive

Project name: 20190704_124602_vMS3D_demo

Organization name: Viametris

User name: TG

Save project to: C:/Users/Thomas/Documents/Qinteria Browse

Import from directory: L:/vms Browse

SBG Systems INS detected

Qinteria has detected in the selected import directory INS project.
Please select which files you would like to import to make sure data are contiguous.

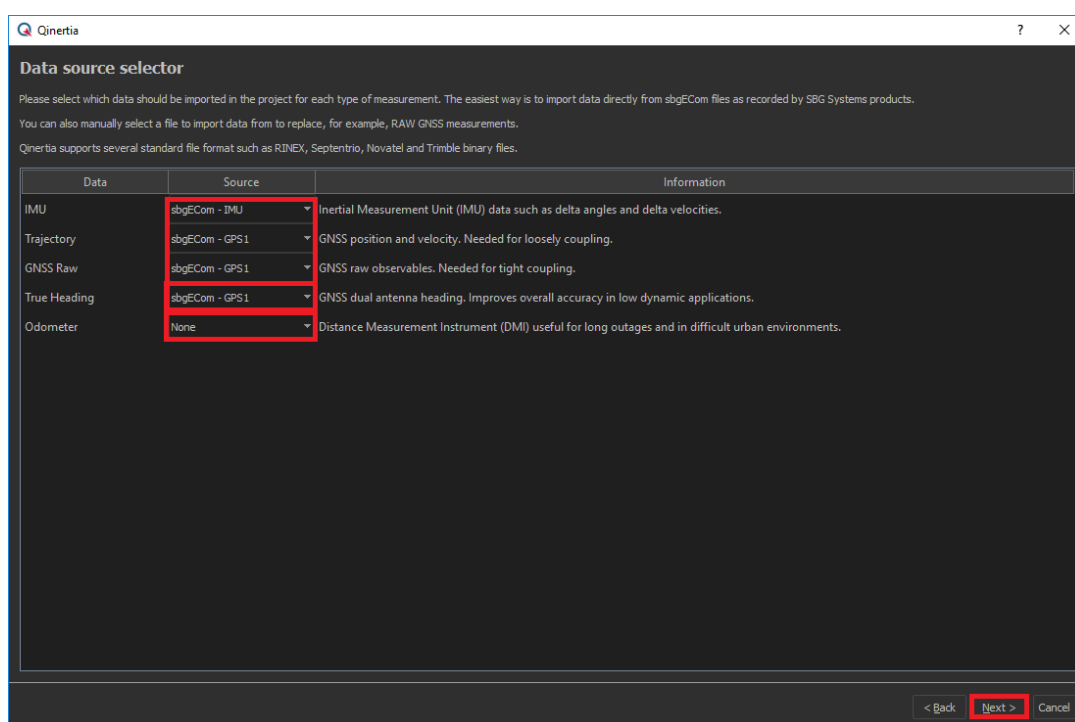
File name	UTC Begin	UTC End	Data rate
☐ 20190516_134223_vMS3D_INSFrameContinuousRecorder_oData.bin	16/05/2019 16:42:12	16/05/2019 16:50:22	200 Hz
☐ 20190517_124705_vMS3D_INSFrameContinuousRecorder_oData.bin	17/05/2019 15:46:53	17/05/2019 16:01:54	200 Hz
☐ 20190618_070409_vMS3D_INSFrameContinuousRecorder_oData.bin	18/06/2019 10:02:59	18/06/2019 10:13:09	200 Hz
☐ 20190618_071455_vMS3D_INSFrameContinuousRecorder_oData.bin	18/06/2019 10:13:43	18/06/2019 10:55:57	200 Hz
☐ 20190704_072057_vMS3D_INSFrameContinuousRecorder_oData.bin	04/07/2019 10:19:21	04/07/2019 10:36:17	200 Hz
☐ 20190704_114115_vMS3D_INSFrameContinuousRecorder_oData.bin	04/07/2019 14:39:38	04/07/2019 14:49:56	200 Hz
☐ 20190704_120359_vMS3D_INSFrameContinuousRecorder_oData.bin	04/07/2019 15:02:20	04/07/2019 15:41:34	200 Hz
☒ 20190704_124602_vMS3D_INSFrameContinuousRecorder_oData.bin	04/07/2019 15:44:23	04/07/2019 16:10:29	200 Hz

Deselect all Select all

Next > Cancel

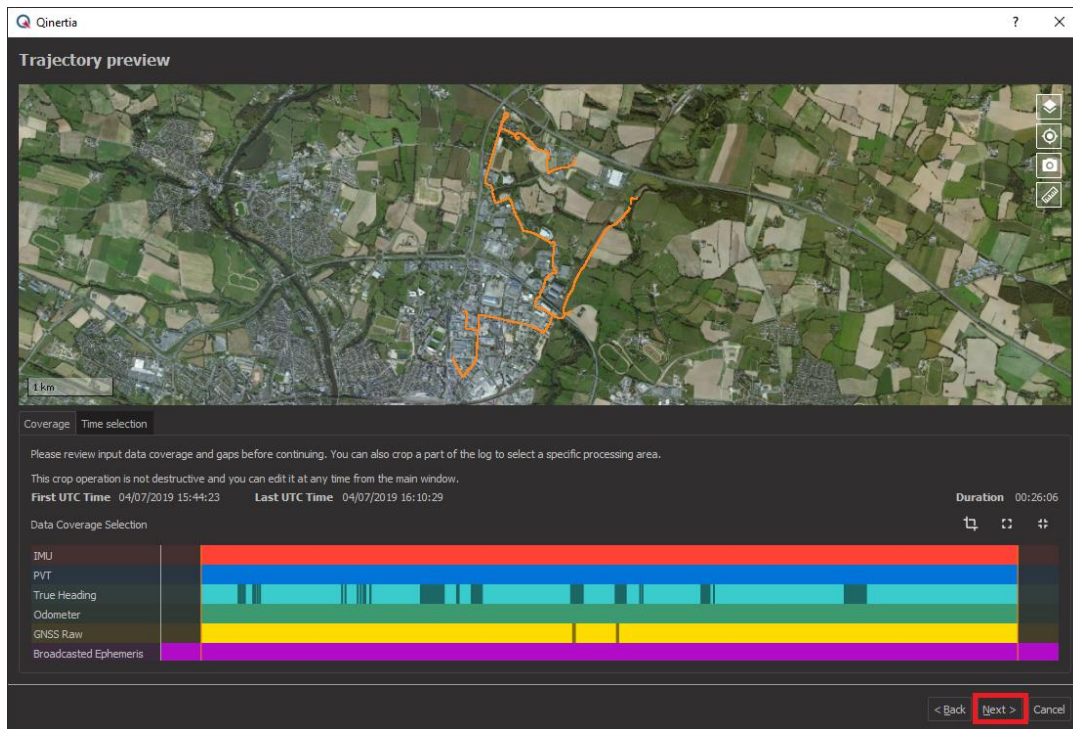
2.2.3 "DATA SOURCE SELECTOR" WINDOW

- Check that the *IMU*, *Trajectory* and *GNSS Raw* data have been well recorded (value "*sbgECom*" in the column "*Source*").
- *True Heading* data should be present if a second GNSS antenna has been used for the acquisition (value "*None*" otherwise).
- *Odometer* data should be present ("*sbgECom – Odometer*") if an odometer has been used for the acquisition (value "*None*" otherwise).
- In the example below, a second GNSS antenna has been used but not an odometer.
- Click "*Next*".



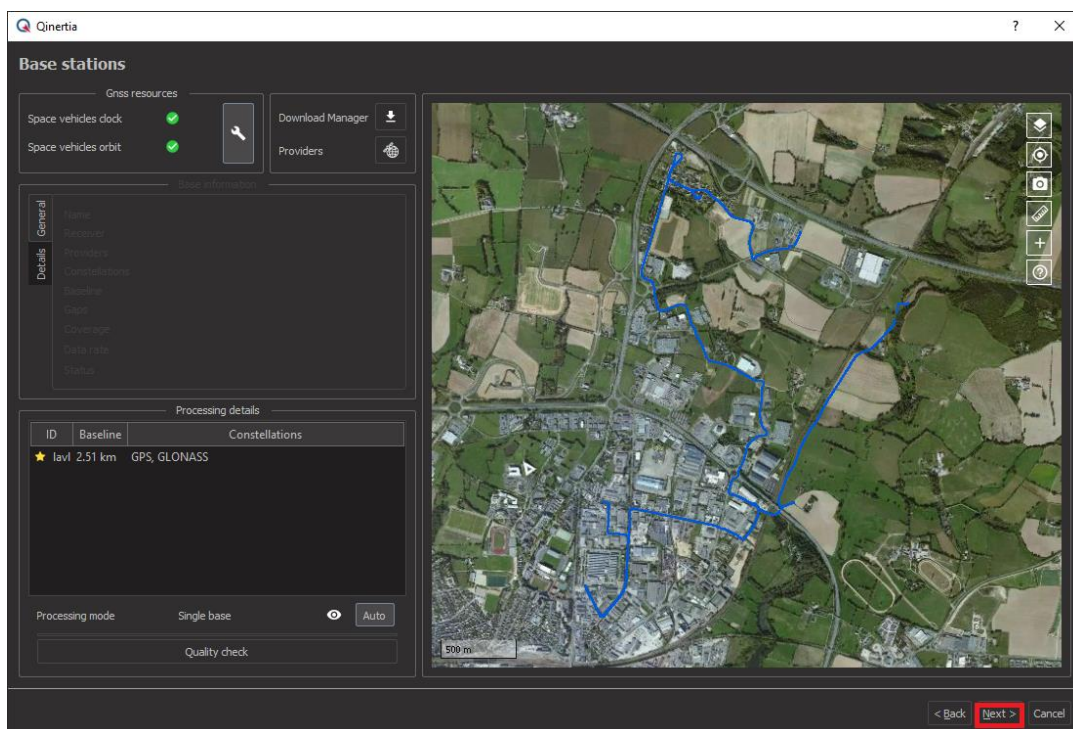
2.2.4 "TRAJECTORY PREVIEW" WINDOW

This window allows the user to ensure the data integrity of the acquisition. It is also possible to select a temporal frame to post process. By default, the whole acquisition is post processed. Gaps can occur in the "*True Heading*" data on the zones where the GNSS reception is not good enough. Click "*Next*" to continue.



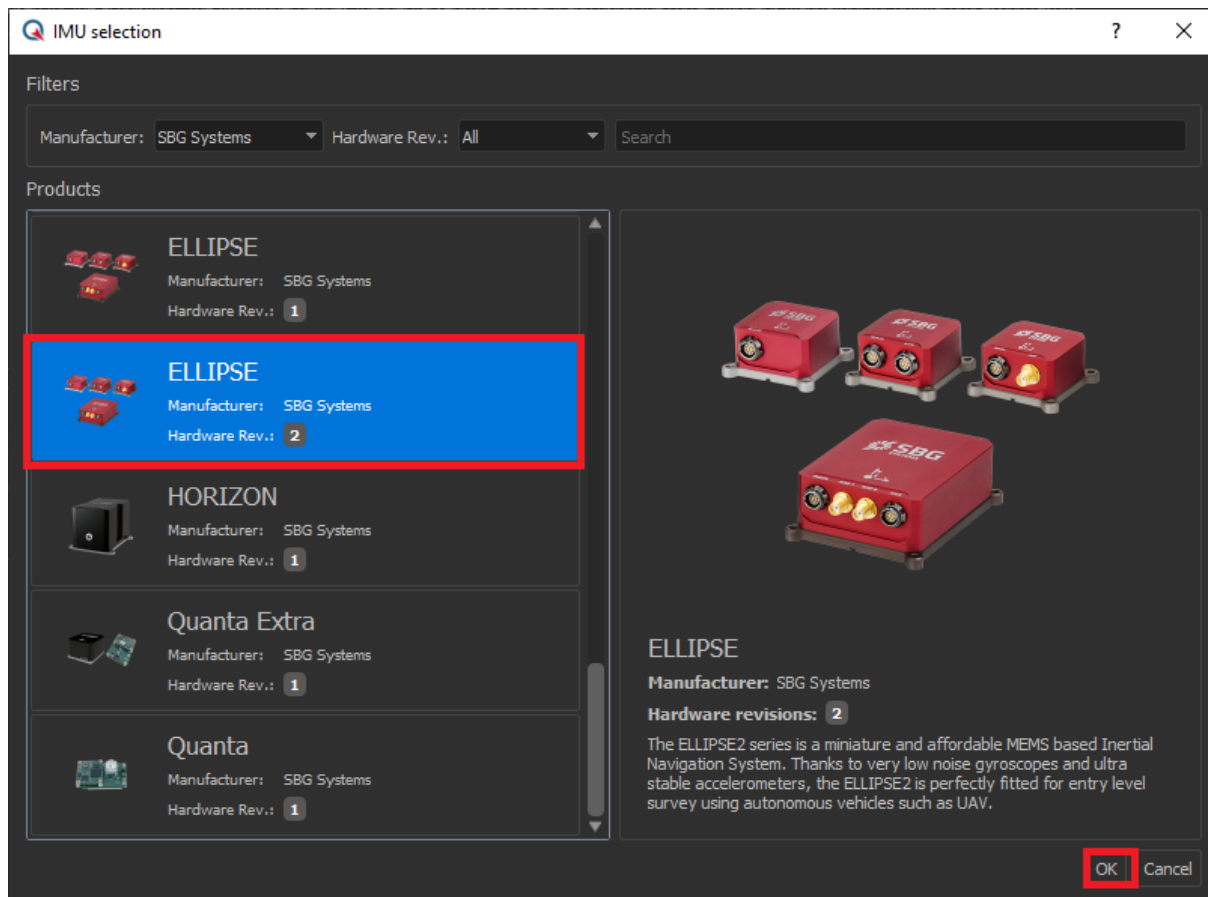
2.2.5 "BASE STATIONS" WINDOW

This window allows the user to choose the base station to use for the processing. By default, the software automatically chooses the nearest base station after a few seconds. Data from base stations can require up to hours to be available. It is also possible to import RINEX file to use another station. Select "Next" to continue.



2.2.6 "IMU SELECTION" WINDOW

The model used in a bMS3D/vMS3D is an ELLIPSE, revision hardware 2. Select this model in the list. Click "OK".



2.2.7 "IMU MODEL" WINDOW

In the next window, check that the reference point of the IMU is set to "Bare IMU" with a reference point in (0, 0, 0). Click "Next".

Qinertia ? X

IMU Model

Please select the IMU model used for the acquisition. The IMU model defines the inertial sensors accuracy and using the correct model is mandatory for optimal processing results.

Selected IMU



ELLIPSE
Manufacturer: SBC Systems
Hardware revisions: 2
 The ELLIPSE2 series is a miniature and affordable MEMS based Inertial Navigation System. Thanks to very low noise gyroscopes and ultra stable accelerometers, the ELLIPSE2 is perfectly fitted for entry level survey using autonomous vehicles such as UAV.

IMU Measurement Point

You can select which point to use as a reference for all mechanical installation measurements. The "Bare IMU" mode doesn't apply any offset on physical IMU data. If you select "Cover Target", the (0,0,0) point will be set to the center of the frame reference drawn on top of the IMU cover.

Select the IMU reference point to use: Bare IMU

Reference point (X,Y,Z): 0.0000 m 0.0000 m 0.0000 m

< Back **Next >** Cancel

2.2.8 "ORIGIN IMU ALIGNMENT" WINDOW

Leave the default parameters in the window "Origin IMU alignment".
Click "OK".

Origin IMU alignment ? X

Qinertia was not able to detect automatically if an alignment has been applied on the imported IMU data.
Please provide the sensor alignment as it has been entered in the INS configuration.

Axis misalignment

Entre the device axis misalignment in the vehicle

X Axis: Forward

Y Axis: Right

Z Axis: Down

Fine misalignment

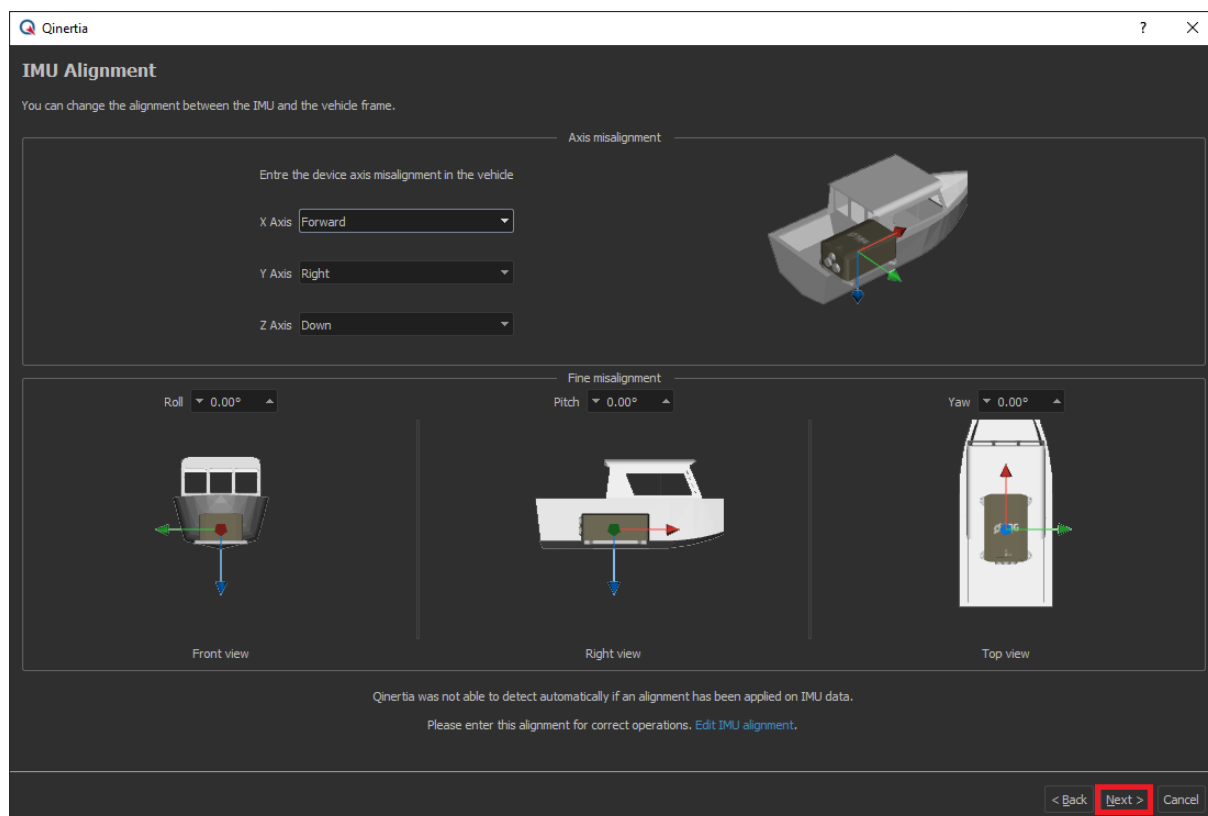
Roll: 0.00° Pitch: 0.00° Yaw: 0.00°

Front view Right view Top view

OK Close

2.2.9 "IMU ALIGNMENT" WINDOW

Leave the parameters by default in the window "IMU Alignment".
Click "Next".



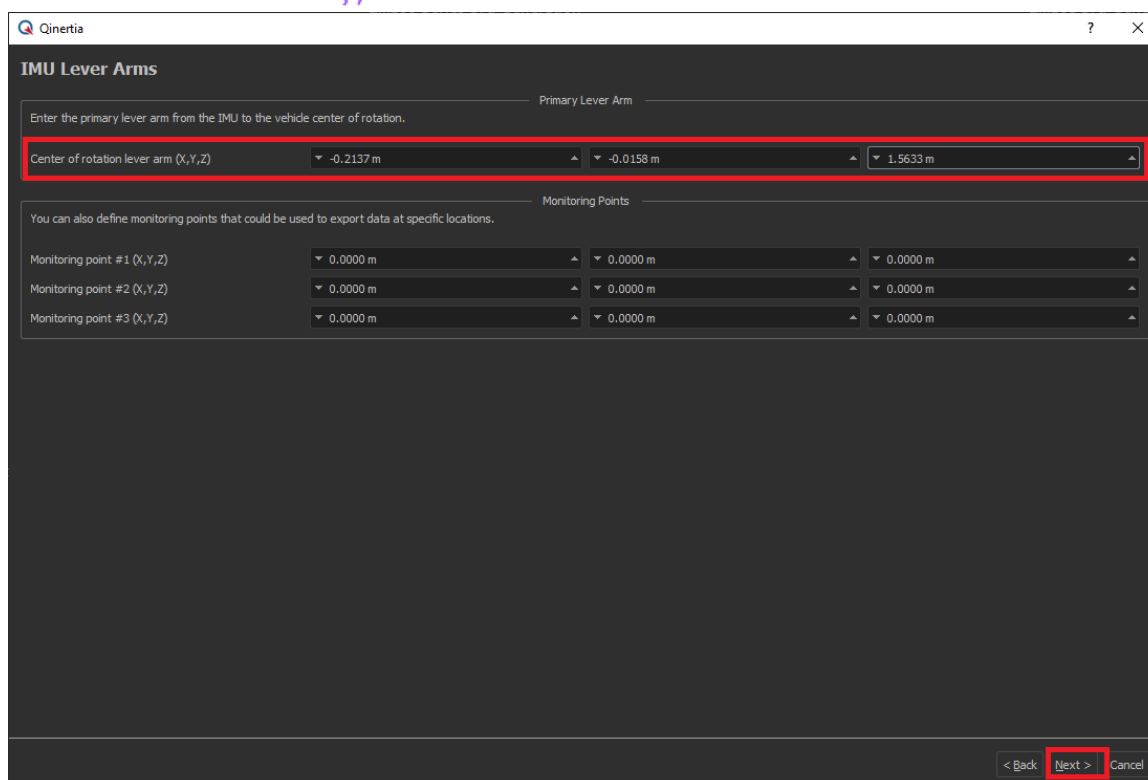
2.2.10 "IMU LEVER ARMS" WINDOW

This chapter is only applicable for a vMS3D. If the acquisition has been done with a bMS3D, the lever to fill is (0, 0, 0).

It is necessary to configure the lever arm existing between the IMU and the rear of the vehicle during an acquisition. To do so, fill the X, Y and Z values in "Center of rotation lever arm (X, Y, Z)". These values are recorded in the file "INSStatus.json" available in the acquisition folder in the category "sensor / lever arm". Click "Next" to continue configuring.

WARNING: the lever arm is not exactly the one entered in the system application during the calibration phase of the system on the field. Indeed, the lever arm entered in the "vMS3D" application is the one between the reference point of the system and the rear of the vehicle. A computation is done in the system to retrieve the real lever arm.

```
"sensor": {
  "alignment": [
    0.0014168465277180076,
    0.009372169151902199,
    -0.013089969754219055
  ],
  "autoAlignedOffset": [
    0,
    0,
    0
  ],
  "leverArm": [
    -0.21372102200984955,
    -0.015887871384620667,
    1.5633838176727295
  ]
},
```



2.2.11 "GNSS SETUP" WINDOW

The next step consists in configuring the GNSS antennas lever arms:

- Single antenna use case: select "*Single antenna mode*" in "*GNSS Heading mode*" and enter the lever arm values in "*Primary Antenna Lever Arm (X, Y, Z)*".
- Double antenna use case: select "*Dual Antenna (known lever arm)*" in "*GNSS Heading mode*" and enter the main GNSS antenna lever arm in "*Primary Antenna Lever Arm (X, Y, Z)*" and the second GNSS antenna lever arm "*Secondary Antenna Lever Arm (X, Y, Z)*".

The main GNSS antenna lever arm is in the file "*INSStatus.json*" in the acquisition folder in the category "*gnss1 / leverArm*".

```

"gnss1": {
  "leverArm": [
    0.14588020741939545,
    -0.017321573570370674,
    -0.4174097776412964
  ]
},

```

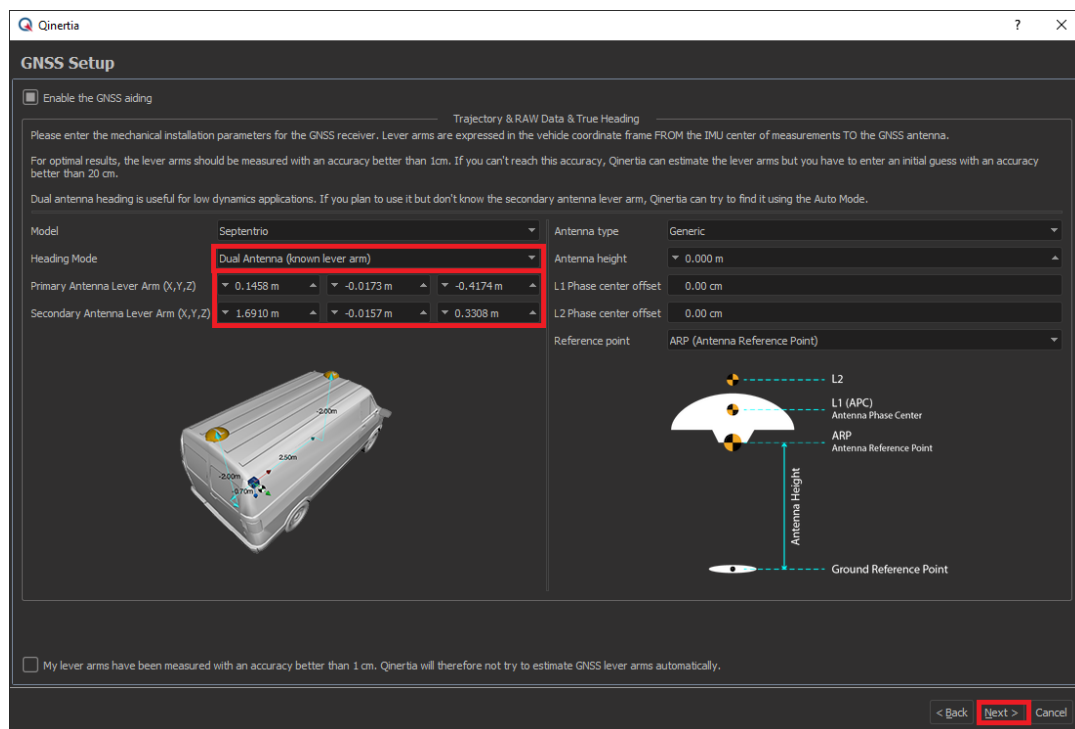
The second GNSS antenna lever arm is in the file "*INSStatus.json*" in the acquisition folder in the category "*gnss2 / leverArm*".

```

"gnss2": {
  "leverArm": [
    1.6910091638565063,
    -0.015735715627670288,
    0.3308417797088623
  ]
},

```

Click "Next" to continue.



2.2.12 "ODOMETER CONFIGURATION" WINDOW

If an odometer has been used during the acquisition, a last configuration window appears. In this one, it is possible to configure the lever arm ("*Lever Arm (X, Y, Z)*") of the odometer, the gain on the odometric velocity as well as the precision of the measurement.

Values to enter for the lever arm are in the file "*INSStatus.json*" in the acquisition folder in the category "*odometer / leverArm*".

```
"odometer": {
  "leverArm": [
    -0.21372102200984955,
    0.7562782410018564,
    1.5633838176727295
  ],
}
```

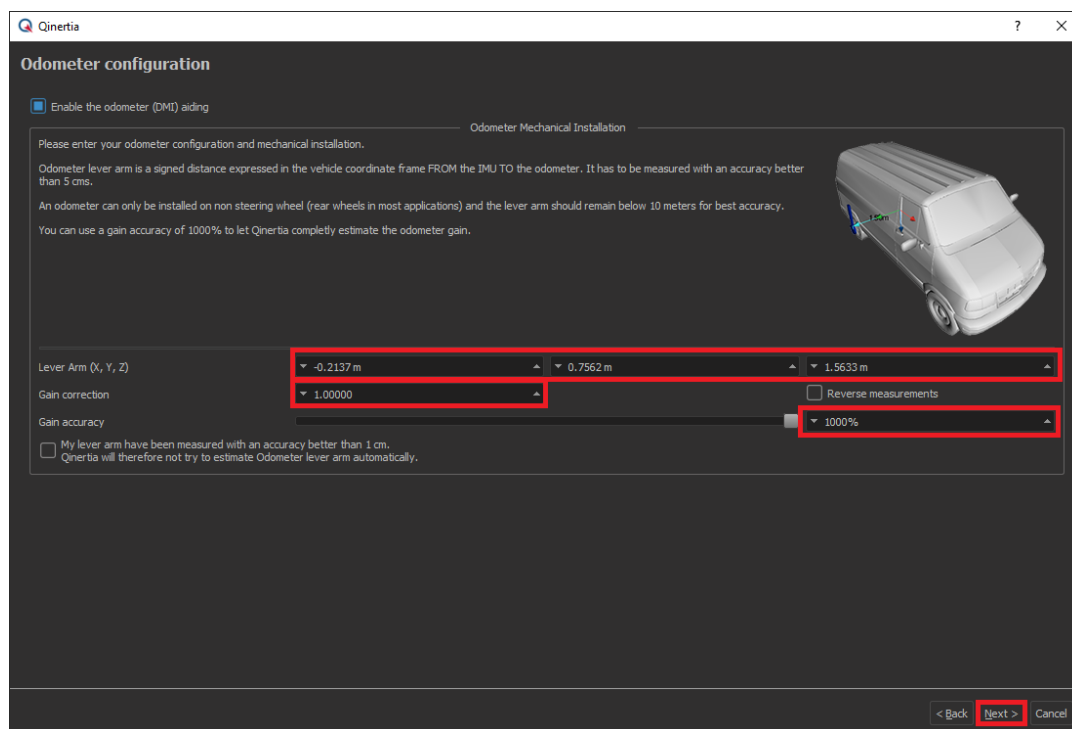
WARNING: it is not the same gain value used during the acquisition.

The gain value should be set to 1 if the velocity of the odometer is correct (namely if the odometer configuration has been correct during the acquisition). If the configuration of the odometer has not been correctly done during the acquisition, it will be necessary to apply a gain factor on the recorded odometric velocity.

If the odometer has been set in the wrong direction during the acquisition, it is possible to invert the result by selecting "*Reverse measurements*".

The confidence level ("*Gain accuracy*") allows to adjust the tolerance on the odometric velocity. A value of 1000 can be used by default.

Once these values recorded, click "Next" to continue.



Odometer configuration

☒ Enable the odometer (DMI) aiding

Odometer Mechanical Installation

Please enter your odometer configuration and mechanical installation.

Odometer lever arm is a signed distance expressed in the vehicle coordinate frame FROM the IMU TO the odometer. It has to be measured with an accuracy better than 5 cms.

An odometer can only be installed on non steering wheel (rear wheels in most applications) and the lever arm should remain below 10 meters for best accuracy.

You can use a gain accuracy of 1000% to let Qinteria completely estimate the odometer gain.

Lever Arm (X, Y, Z)

Gain correction

Gain accuracy

☐ Reverse measurements

☐ My lever arm have been measured with an accuracy better than 1 cm.
Qinteria will therefore not try to estimate Odometer lever arm automatically.

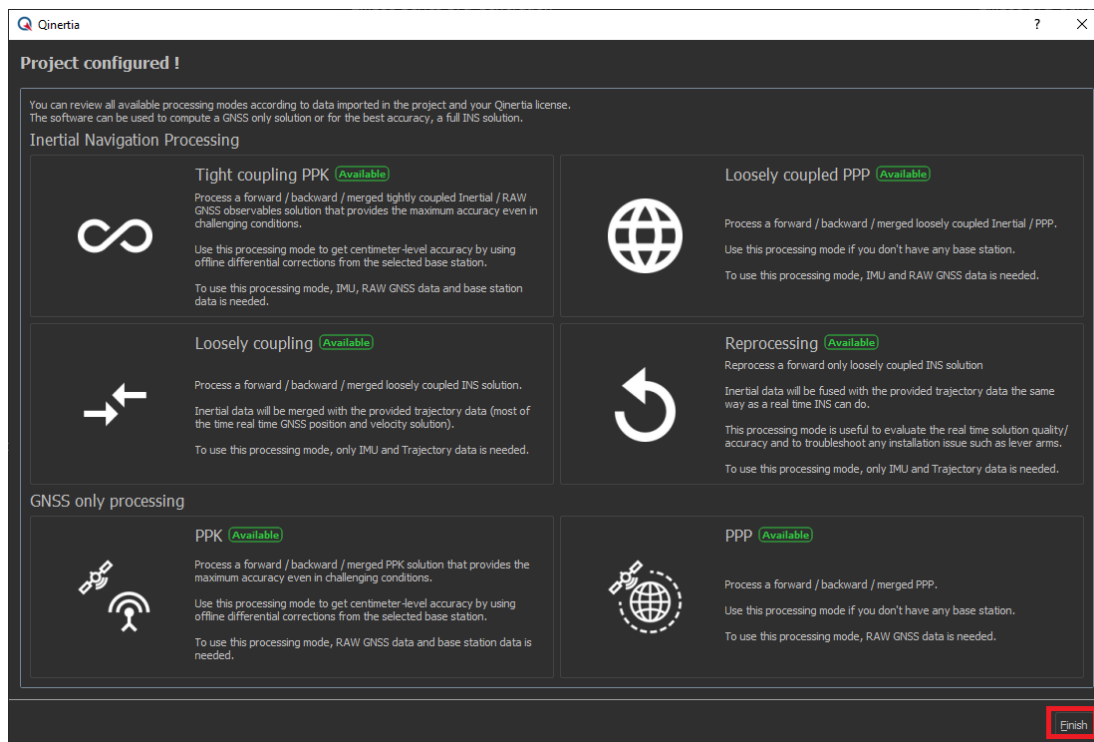
< Back **Next >** Cancel

2.2.13 END OF PROJECT CONFIGURATION

The project is now configured.

The next window shows the possible computation in regard with the provided data. In the following pages we will present the "*Tight Coupling*" and "*GNSS PPK*".

Click "*Finish*" to finish.

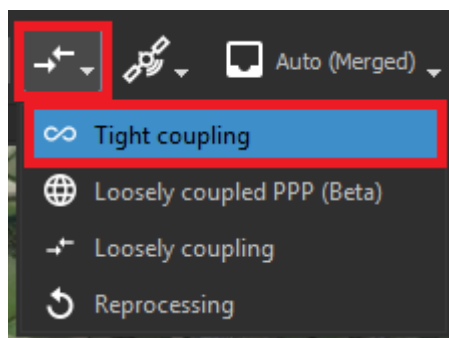


2.3 "TIGHT COUPLING" PROCESSING

If the acquisition has been motorized and present sufficient accelerations to correctly initialize the IMU, a "Tight Coupling" computation can be calculated. The software makes a computation using both the GNSS data (pseudo distances) and the inertial data from the IMU to create a trajectory.

Step 1: Launch a first time the Tight Coupling ("Tight coupling").

Launch the processing "Tight coupling" in the tool menu or in the menu "Project → INS Processing → Tight Coupling".

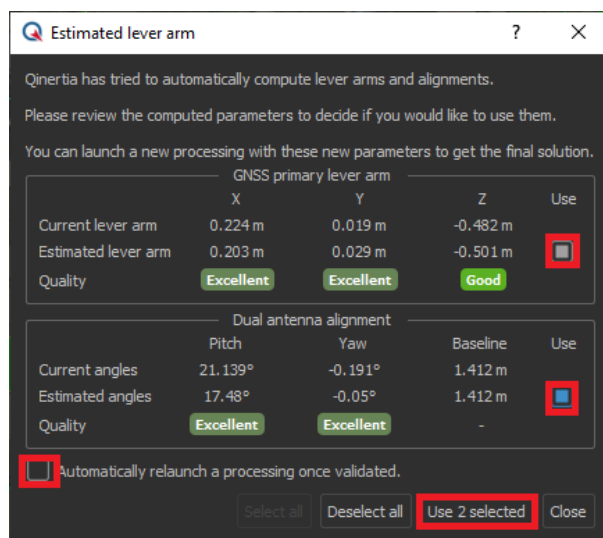


This first step allows to calculate the trajectory of the system while estimating the GNSS lever arms. By the end of the computation, a window will summarize the lever arms found (as well as the alignment of the second antenna) and the quality of the estimation.

N.B: the longer the acquisition duration, the better the precision on the estimated lever arms.

The lever arm estimated can be slightly different than the one measured on the vehicle by the operator. A large difference is not normal.

If the estimations are satisfying, click "Use". A new Tight Coupling computation will take into account the new lever arms. If you want to directly launch the computation click "Automatically relaunch a processing once validated" and click on "Use 2 selected".

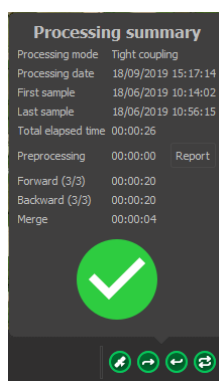


Step 2: Launch the Tight Coupling a second time ("Tight coupling").

The processing can be launched from the menu bar or the tool menu as for the step 1. It can also be automatically launched by the previous window.

This second step starts a computation of the trajectory of the system taking into account the new GNSS lever arm estimated by the software. The estimation being not done, the result is of better quality.

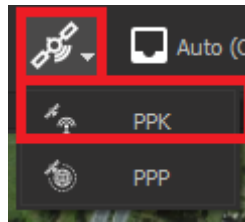
A window appears on the left bottom corner to confirm the proceeding of the processing.



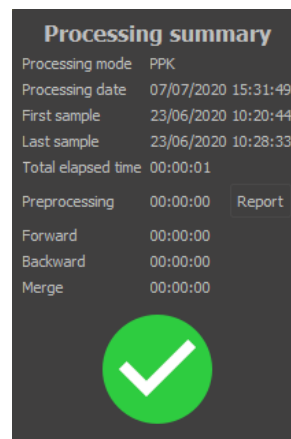
2.4 "GNSS PPK" PROCESSING

Any acquisition having GNSS reception can be processed using "GNSS PPK" whatever the dynamic of the system during the acquisition. For this processing, the software only uses the GNSS data to generate a trajectory. This result is less precise than a "Tight Coupling" processing.

To launch a PPK processing, click on the "GNSS" icon and select "PPK" or in the menu "Project → GNSS Processing → PPK".



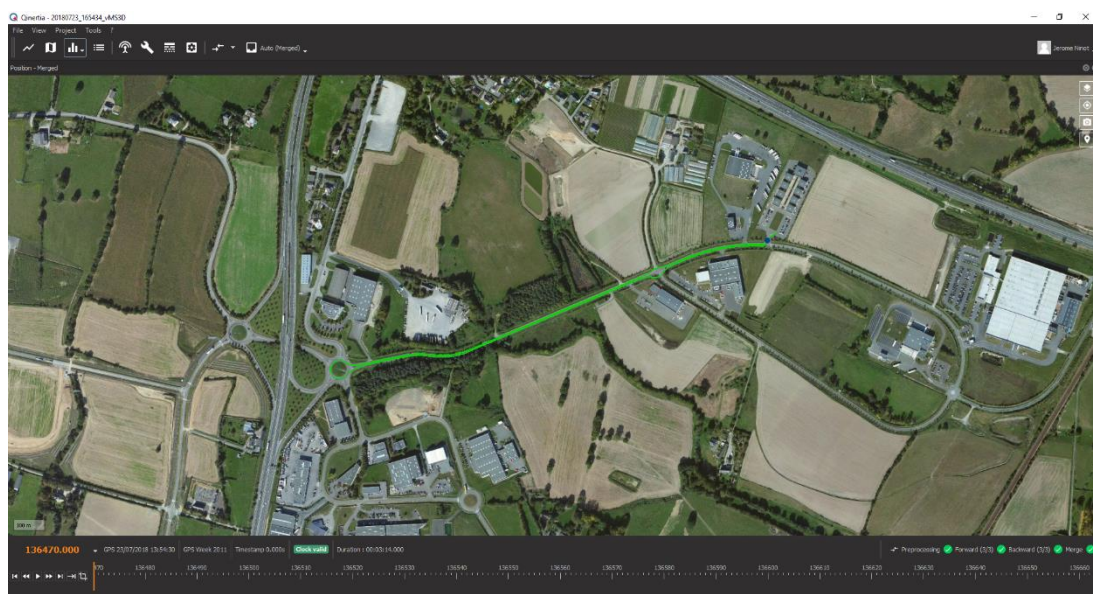
A window appears in the left bottom corner to confirm the good proceeding of the processing.



2.5 RESULT ANALYSIS

It is possible to look at the obtained trajectory by clicking on the icon  in the tool bar or in the menu in "View → Position".

The map appears:



Different graphics are available to control the quality of the result in the menu "View → Add graph" or by clicking directly on the icon .

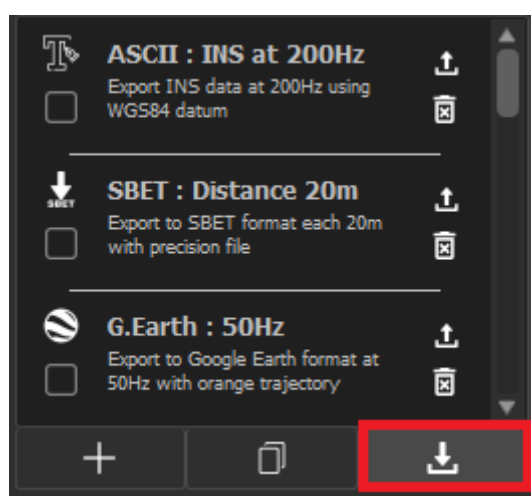
3 QINERTIA DATA EXPORT

It is possible to create export profiles in Qinertia in order to export files understandable by PPiMMS. To do so, access the export window in Qinertia "File → Exports".

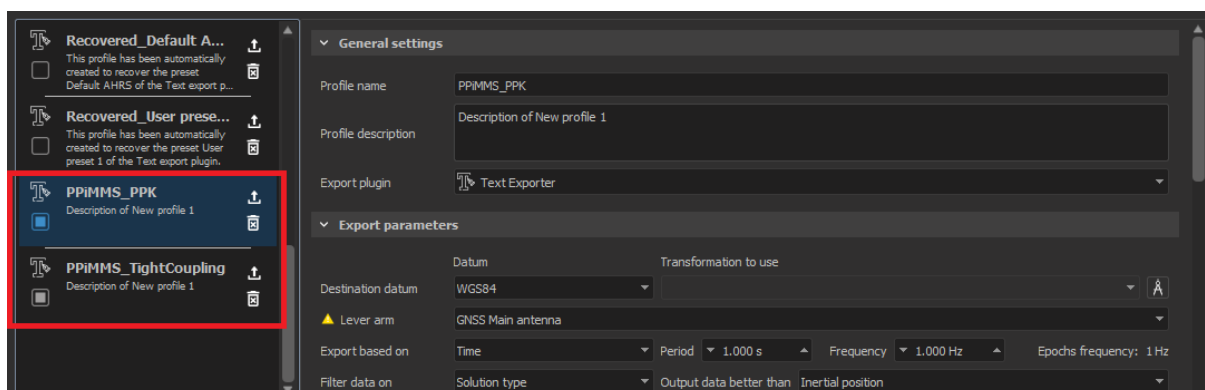
N.B.: the export to PPiMMS was previously done using *grn* and *m* files. These files are now replaced by a unique *txt* file.

3.1 QINERTIA CONFIGURATION

It is possible to import export profiles in Qinertia. To do so, click on "Import profile(s)" and select the files "PPiMMS_PPK.ppprof" and "PPiMMS_TightCoupling.ppprof" provided. These files are available in the PPiMMS installation folder in "Documentation\Qinertia\profiles".



Profiles appear in the export window:

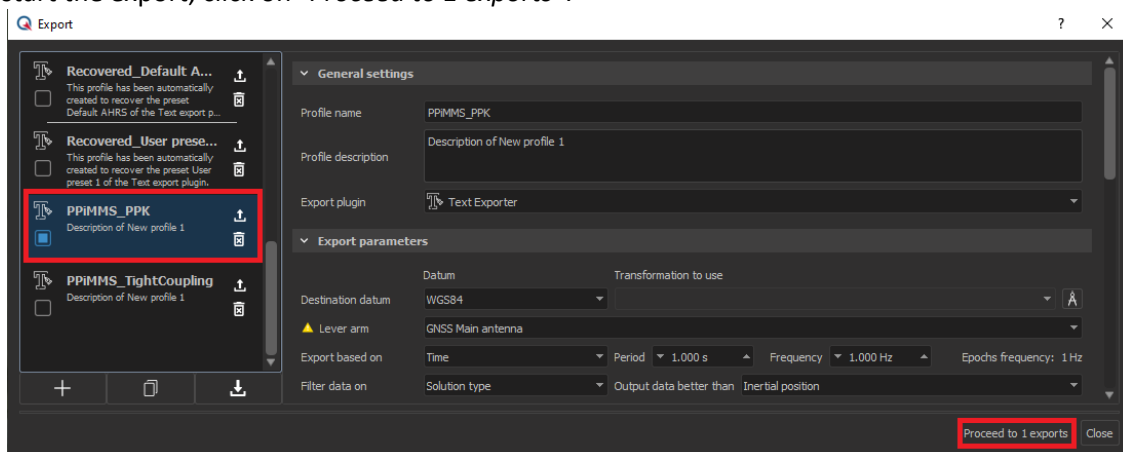


Added profiles are configured to export in WGS84 (to modify if another datum is needed by the user). The output frequency is 200 Hz for a Tight Coupling export and 1 Hz for a PPK export.

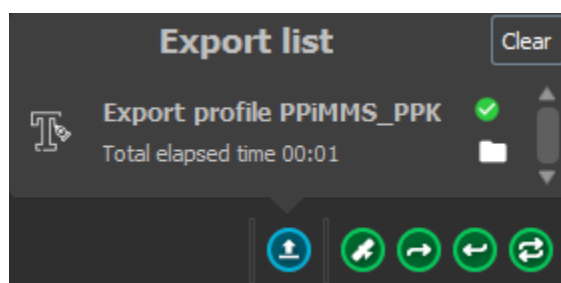
3.2 DATA EXPORT

To export, select the profile corresponding to the processing mode used: Tight Coupling or PPK.

To start the export, click on "*Proceed to 1 exports*".



A new window appear to inform the user about the export proceeding.



N.B.: the exported position corresponds to the position of the IMU for a Tight Coupling computation and to the position of the GNSS antenna for a PPK computation. This information will have to be specified in PPiMMS during the data import.

4 USING THE POST PROCESSED DATA IN PPiMMS

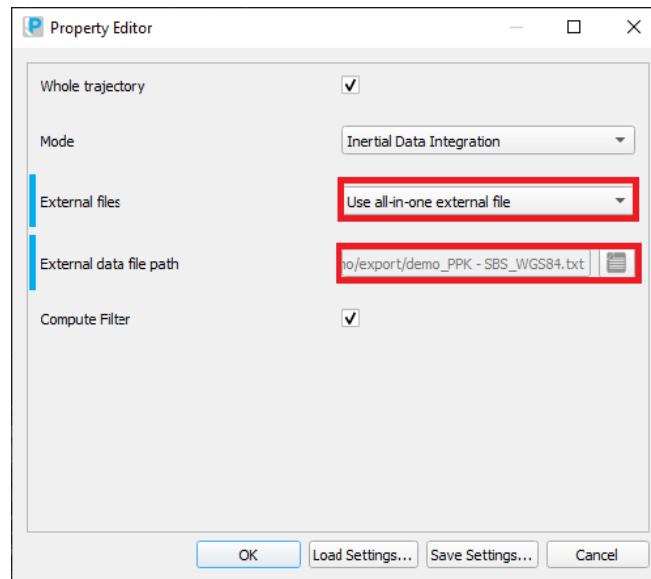
Qinertia data can be integrated in 2 steps of the post processing in PPiMMS.

4.1 ODOMETRIC TRAJECTORY CREATION

During the odometric trajectory computation, it is possible to use the Qinertia exports to calculate a more precise trajectory than the one calculated using real time data in the IMU.

To use the Qinertia data:

- Launch the processing "*Odometric Trajectory Computation...*".
- Select the mode "*Inertial Data Integration*" and the type of external file "*Use all-in-one external file*".
- Browse to the *txt* file exported previously from Qinertia.



It is also possible to choose the mode "*Inertial Data Integration + SLAM*" for the SLAM to trigger in the areas where the criteria of speed or precision of the trajectory calculated by Qinertia are not sufficient.

N.B.: until PPiMMS 2.12.x, exported files from Qinertia and imported by PPiMMS had *grn* and *m* extension. To use this former solution, select "*Use GRN & M external files*" for the parameter "*External files*".

N.B.: if a "*GNSS PPK*" processing has been done in Qinertia, it is not possible to use these data to calculate an odometric trajectory.

4.2 ADDING NAVIGATION CONSTRAINTS

It is also possible to use the exported file to integrate navigation constraints.

To do so:

- Launch the "*Navigation constraint Computation...*".
- Select "*Post processed data*" in "*File Choice*".
- **Select "*NONE*" in the property "*Lever Arm*" if a "*Tight coupling*" has been done in Qinertia and "*GNSS*" if a "*GNSS PPK*" has been done.**
- Browse to the *txt* file in the property "*External File Name*".

It is possible to modify the properties "*Constraint accuracy*" so that only accurate constraints are integrated.

Property Editor

File Choice	Post processed data
Lever Arm	NONE
External File Name	o/export/demo_PPK - SBS_WGS84.txt
Projection (EPSG code)	3948
Projected SRS Name	RGF93 / CC48
Constraints Mode	Distance
Constraints Distance (m)	10.00
Use Constraint Accuracy Threshold	☒
Constraint Accuracy Threshold in XY (m)	0.03
Constraint Accuracy Threshold in Z (m)	0.05

OK Load Settings... Save Settings... Cancel