

Report on GNSS Training

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Team No: 02

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1. TEAM 02

1.1. EXECUTIVE SUMMARY

In this report we have shown results of different positioning and correction techniques with and without data processing. These include Single Point Positioning (SPP), Differential GNSS (DGNSS) and Real Time Kinematics (RTK), in Single, Continuous and Instantaneous modes using UbloxF9P receiver as rover and NETRq receiver as base (where applicable). Fixed and float data was analyzed for different techniques and their variations. The error in positioning was corrected using RTK post processing.

In addition to this, the report includes a brief outlook on MADOCA and CLAS using Japanese QZSS constellation as a method of Precise Point Positioning (PPP) technique.

Processed and unprocessed data for each of the techniques and RTKDroid have been shown in this report with error and correction explained.

1.2. TEAM MEMBERS

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1.3. INTRODUCTION

1.3.1. SINGLE POINT POSITIONING (SPP)

The Single Point Positioning (SPP) technique permits one GPS receiver to determine the absolute coordinates of a point with respect to a coordinate system such as WGS84.

1.3.2. PRECISE POINT POSITIONING (PPP)

PPP is a positioning technique that removes or models GNSS system errors to provide a high level of position accuracy from a single receiver. A PPP solution depends on GNSS satellite clock and orbit corrections, generated from a network of global reference stations. Once the corrections are calculated, they are delivered to the end user via satellite or over the Internet. These corrections are used by the receiver, resulting in centimeter level or better positioning with no base station required.

1.3.3. DIFFERENTIAL GLOBAL NAVIGATION SATELLITE SYSTEM (DGNSS)

Differential GNSS (DGNSS) is a kind of [GNSS Augmentation](#) system based on an enhancement to primary GNSS constellation(s) information by the use of a network of ground-based reference stations which enable the broadcasting of differential information to the user also called rover to improve the accuracy of his position. It consists of the determination of the GNSS position for an accurately-surveyed position known as reference station. Given that the position of the reference station is accurately known, the deviation of the measured position to the actual position and more importantly the corrections to the measured pseudoranges to each of the individual satellites can be calculated. These corrections can thereby be used for the correction of the measured positions of other GNSS user receivers.

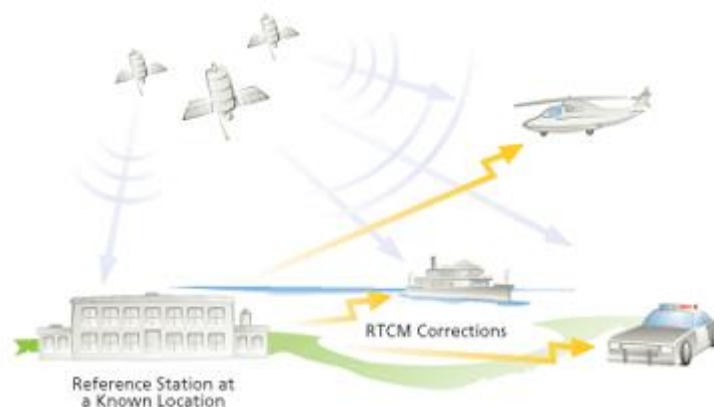


Figure 1: DGNSS Schematic

1.3.4. REAL TIME KINEMATICS (RTK)

Real-time kinematic positioning is a satellite navigation technique used to enhance the precision of position data derived from satellite-based positioning systems such as GPS, GLONASS, Galileo, NavIC and BeiDou.

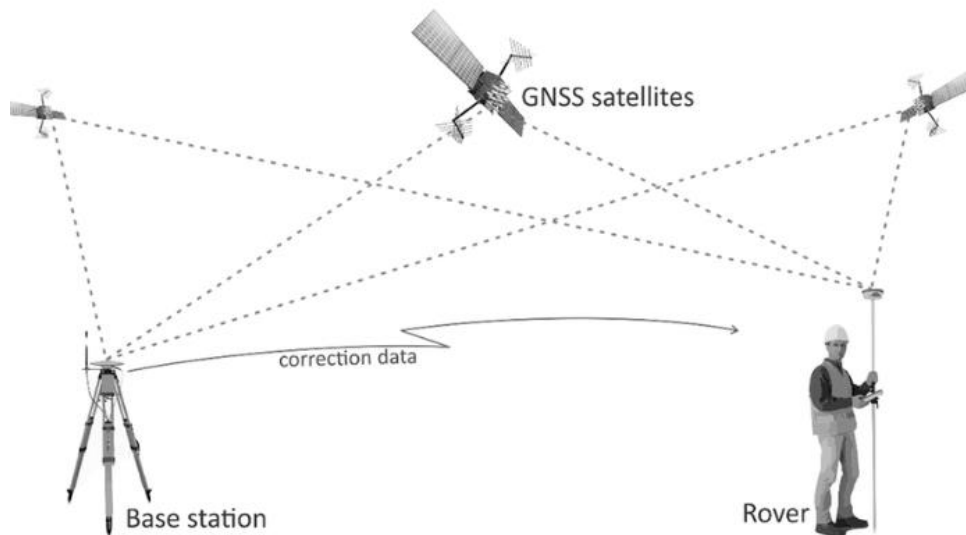


Figure 2: RTK Schematic

1.3.5. MULTI-GNSS ADVANCED DEMONSTRATION TOOL FOR ORBIT AND CLOCK ANALYSIS (MADOCA)

JAXA has developed the precise GNSS orbit and clock estimation system, named "MADOCA (Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis)". Using MADOCA products, user positions could be calculated accurately without any reference stations.

MADOCA is the precise GNSS orbit and clock estimation system. These basic requirements are as follows: Multi-GNSS Support (GPS, GLONASS, Galileo, BeiDou and QZSS)

1. Both of Offline and Real-Time Estimator
2. Precise Estimation using latest models
3. Reduction of Processing Time by Multi-threading
4. Maintainability and Portability which can run on note PC

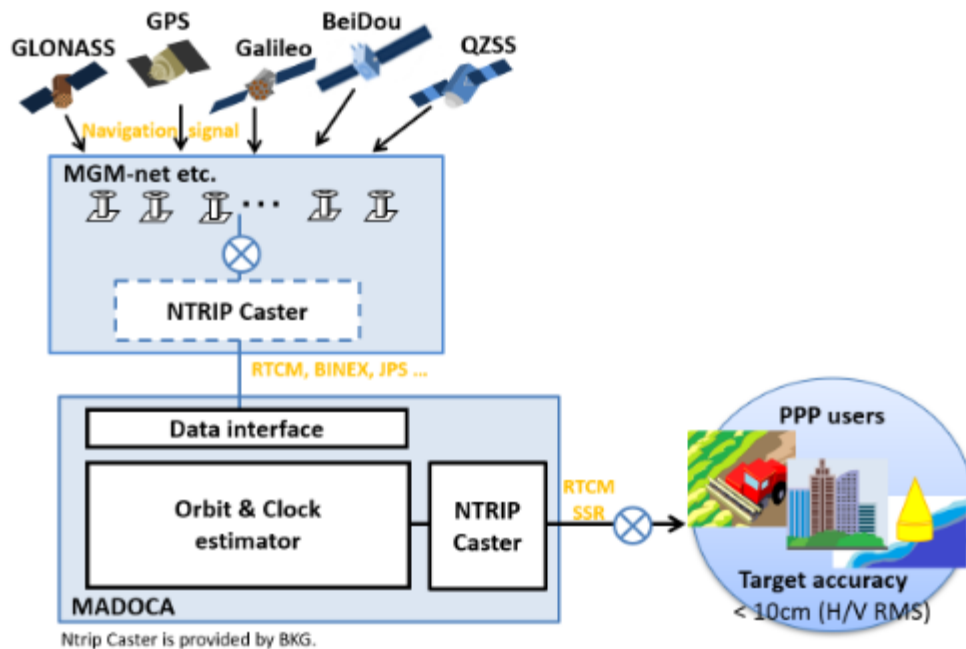


Figure 3: MADOCA Schematic

1.4. SURVEY/DATA LOGGING/DATA PROCESSING

Following are the specifications of the survey and receiver used:

GNSS Receiver: u-blox 8 series

Multi-GNSS: GPS, Galileo, QZSS, Beidou

Data Logging Sessions:

Data 1: Static, 20 min, on corner of table, used Tablet PC for settings of receivers

Data 2: Kinematic, used RtkDroid

Data 3: Static, 5 min, used RtkDroid

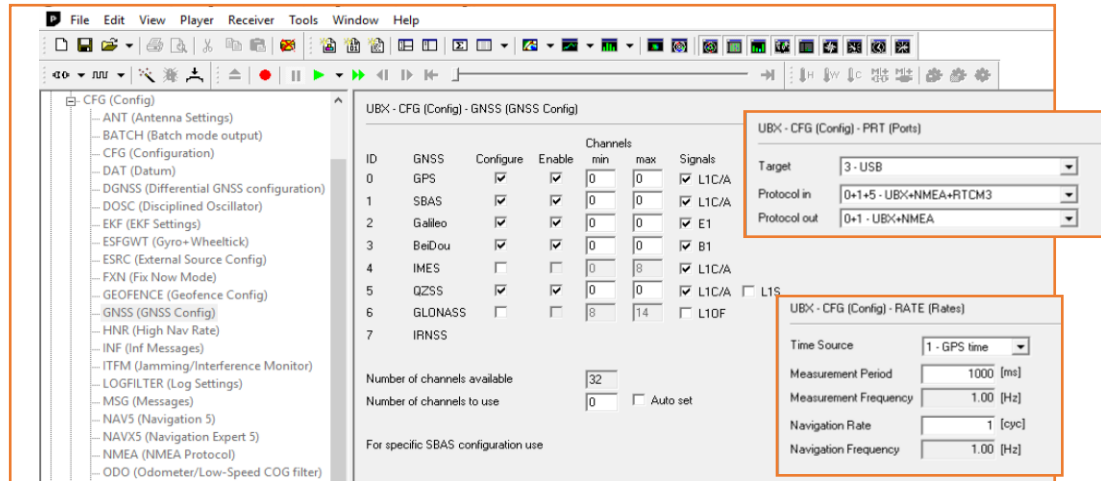


Figure 4: RTK Settings for Data 1

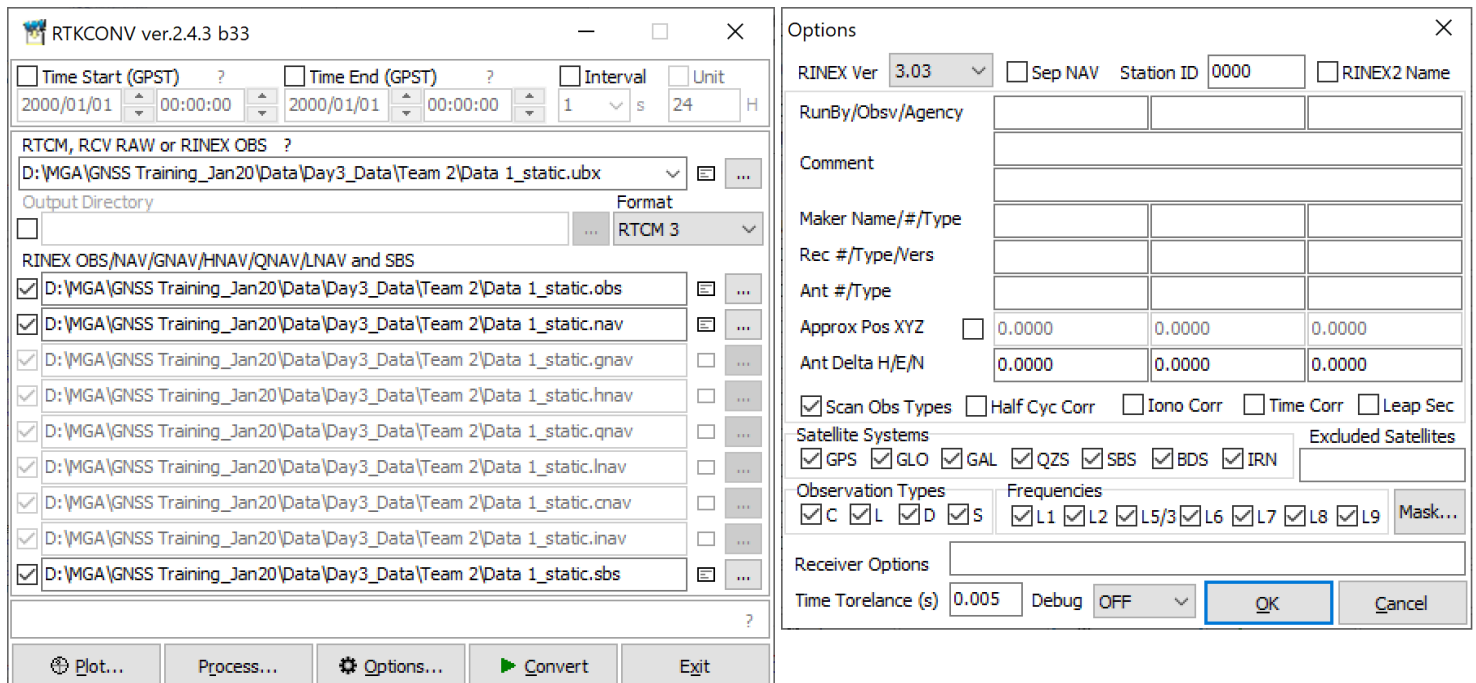


Figure 5: RTK Settings 2 for Data 1

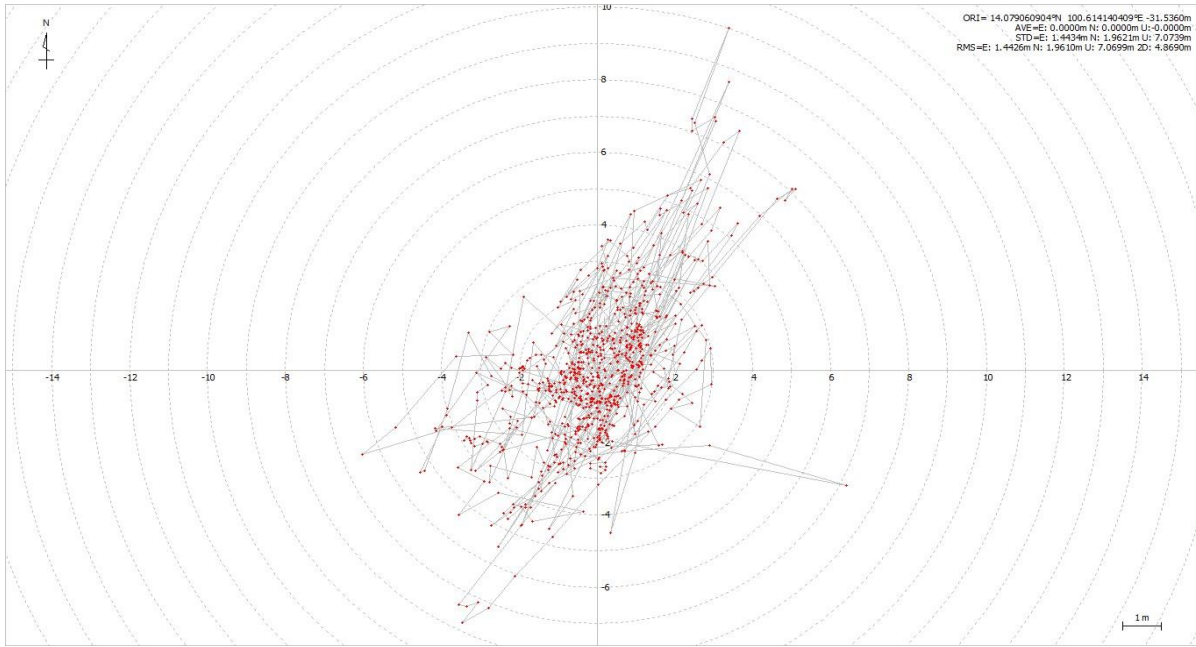


Figure 6: SPP for Data 1

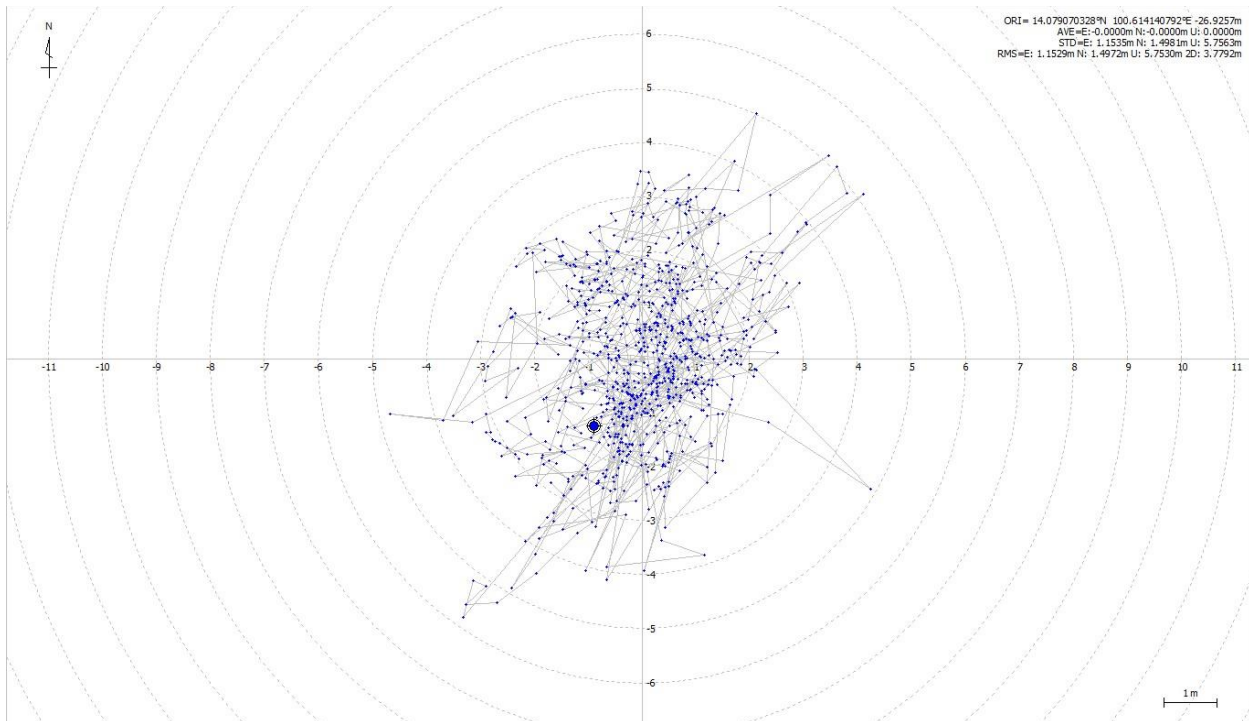


Figure 7: DGNS for Data 1

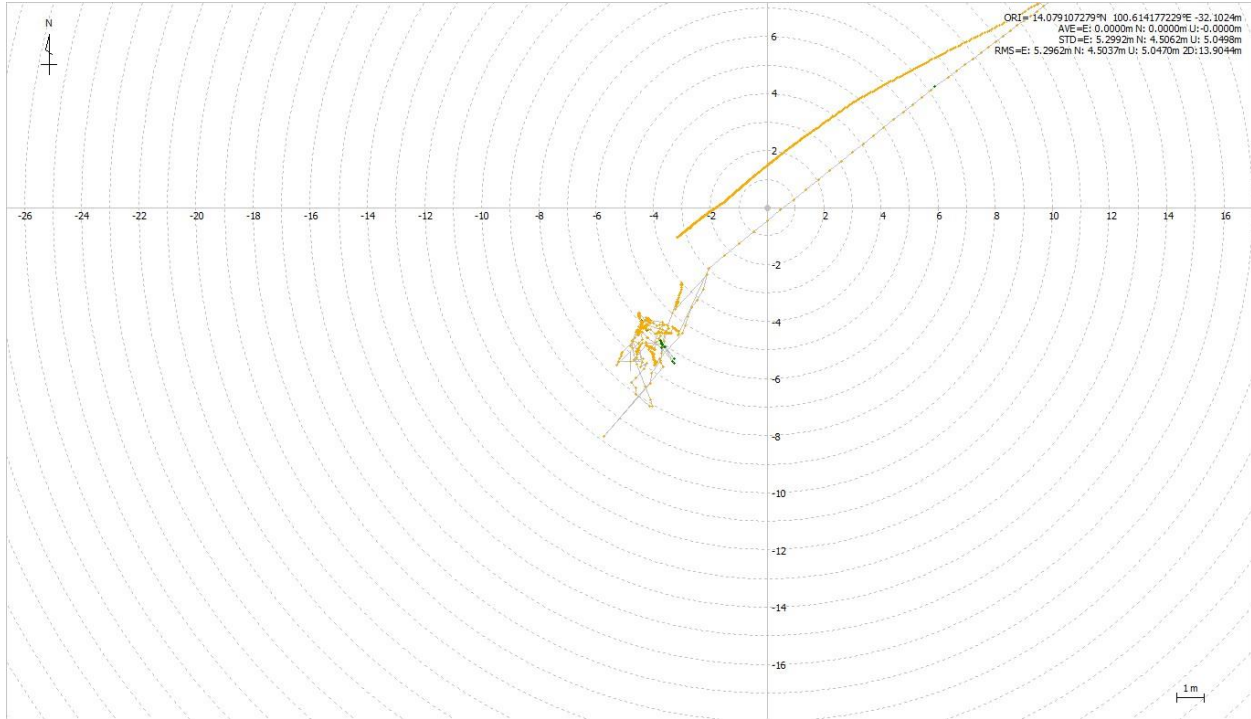


Figure 8: RTK for Data 1

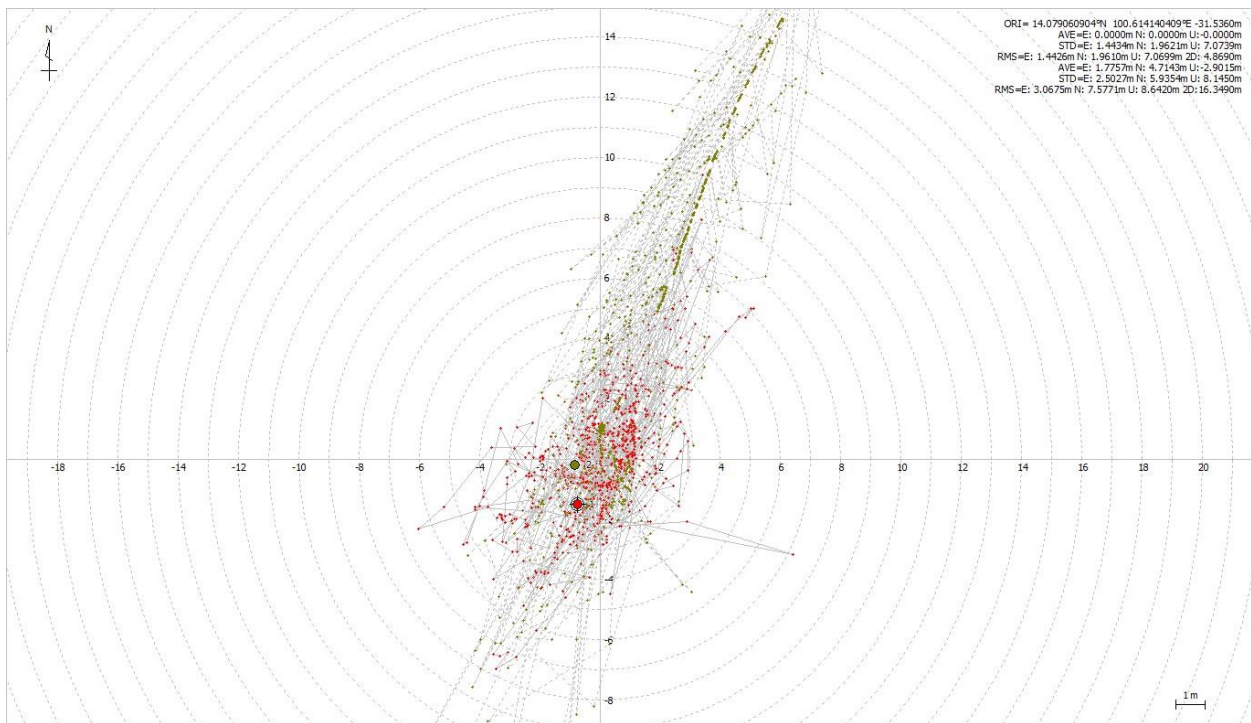


Figure 9: SPP - RTK Overlay for Data 1

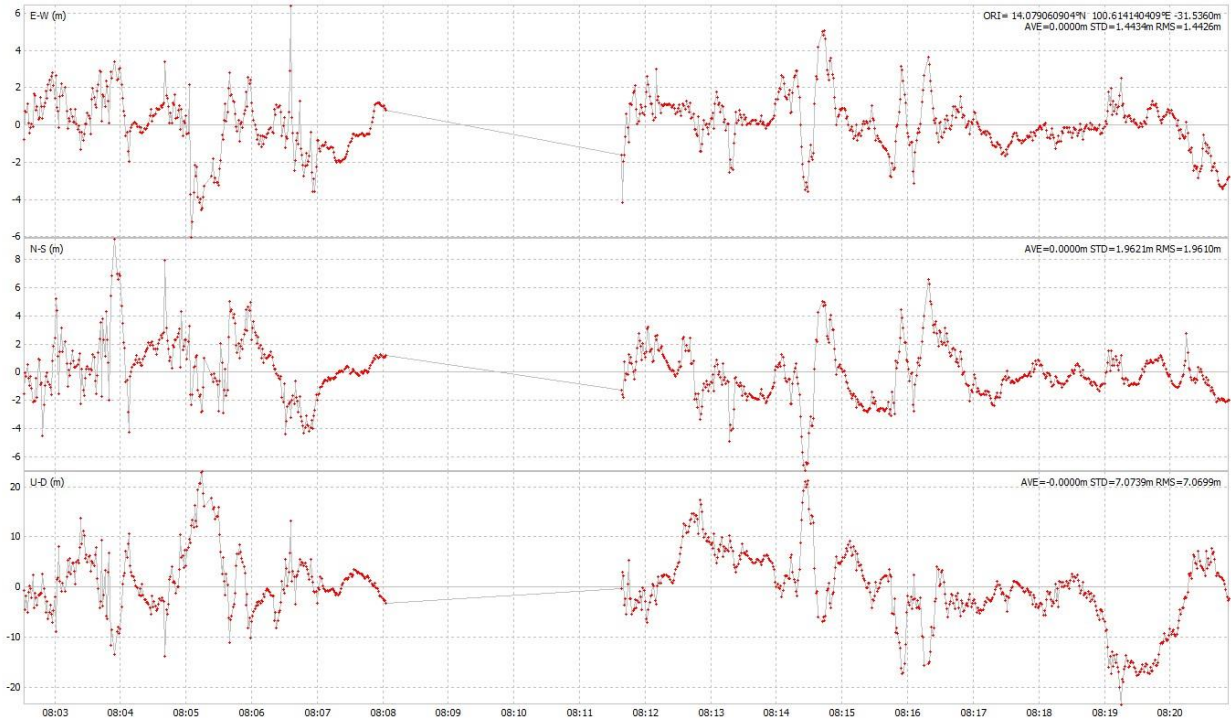


Figure 10 Positions for Data 1

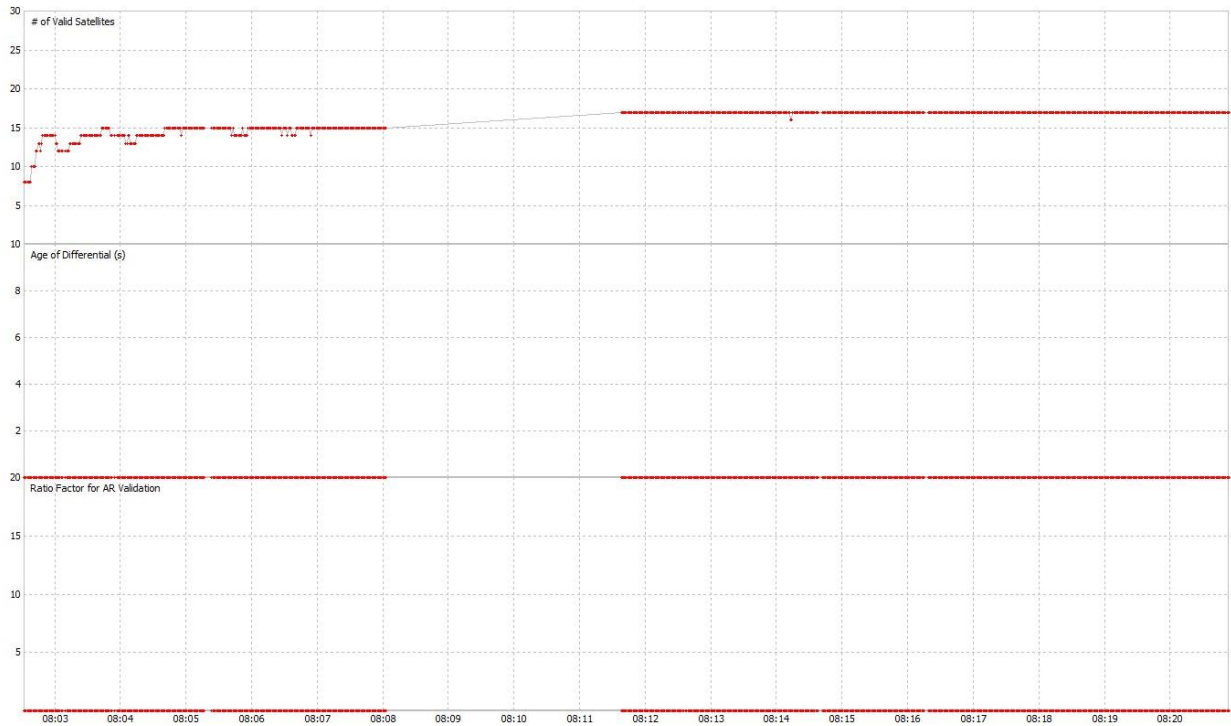


Figure 11: Number of Satellites for Data 1

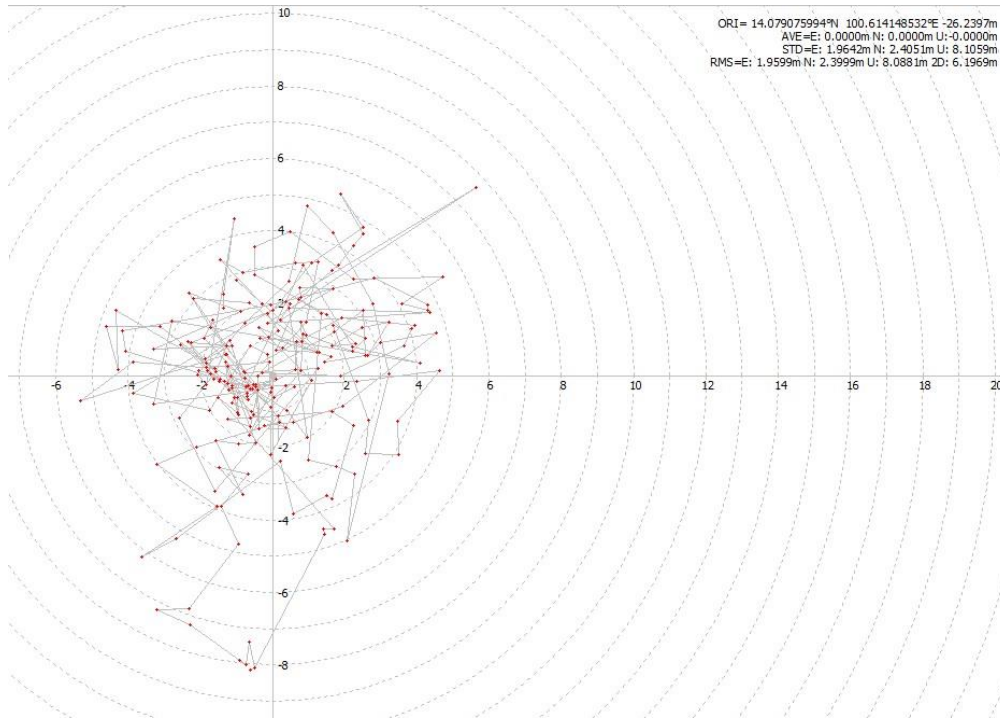


Figure 12: SPP for Data 3

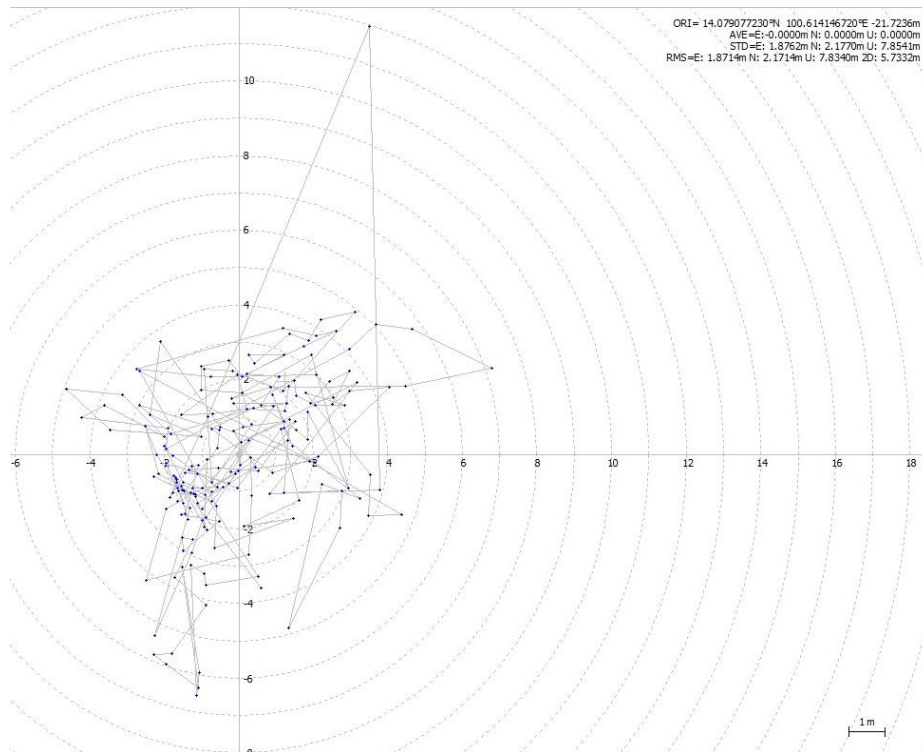


Figure 13: DGNSS for Data 3

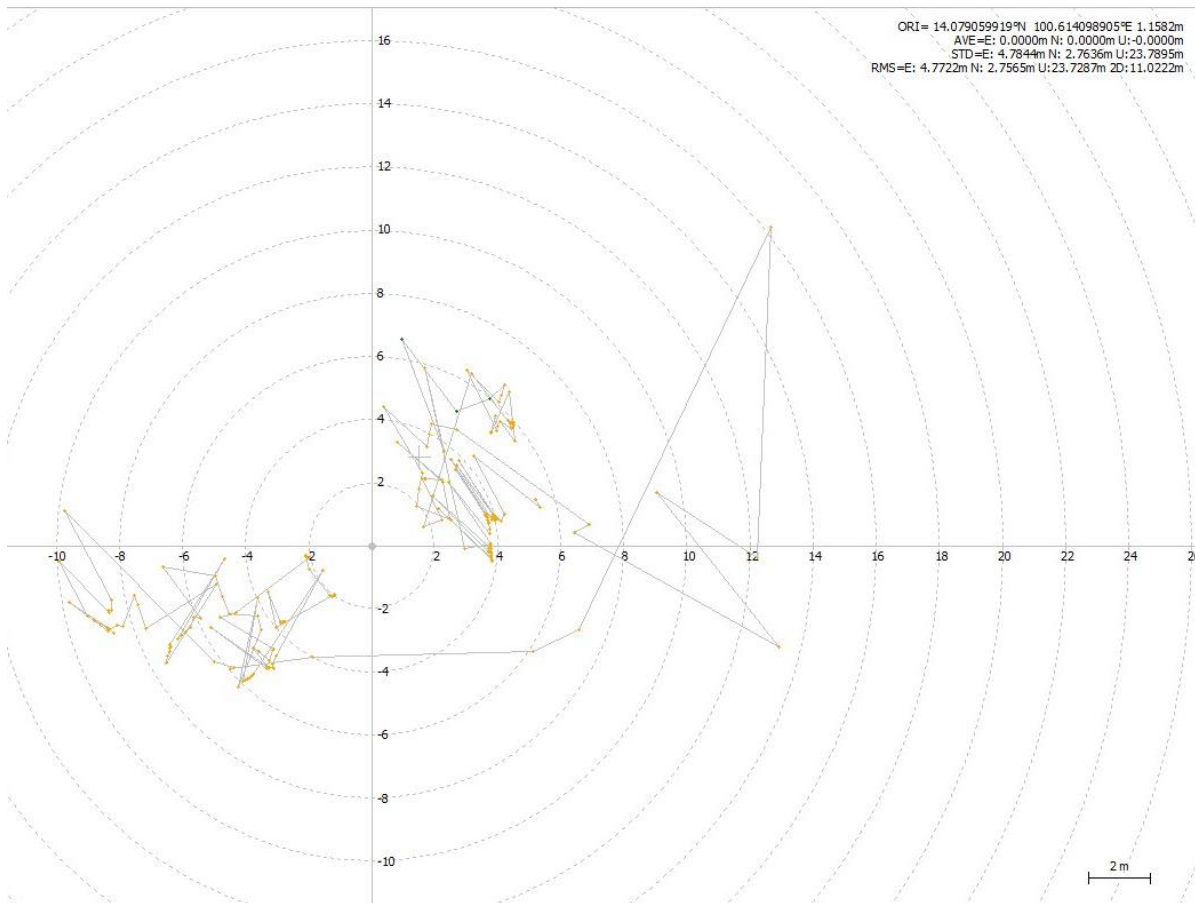


Figure 14: RTK for Data 3

| | | Xave | Yave | Zave | Xstd | Ystd | Zstd |
|------------------------------|------|----------|----------|----------|----------|----------|----------|
| Data 1 /Tablet/ | SPP | 135.6087 | -47.0193 | 354.4981 | 1.418372 | 7.074591 | 1.978027 |
| | dGPS | 136.4264 | -51.1576 | 352.3653 | 0.896954 | 5.816452 | 1.440319 |
| | RTK | 136.6244 | -42.7989 | 350.6311 | 1.368322 | 9.489288 | 3.989327 |
| Data 3 /RTKDroid/ | SPP | 137.3425 | -51.5077 | 351.5903 | 2.333221 | 7.616711 | 3.448237 |
| | dGPS | 137.9508 | -55.8166 | 350.3591 | 2.238273 | 7.306782 | 3.398072 |
| | RTK | 137.0492 | -79.0404 | 346.6506 | 4.029516 | 23.57361 | 4.951302 |

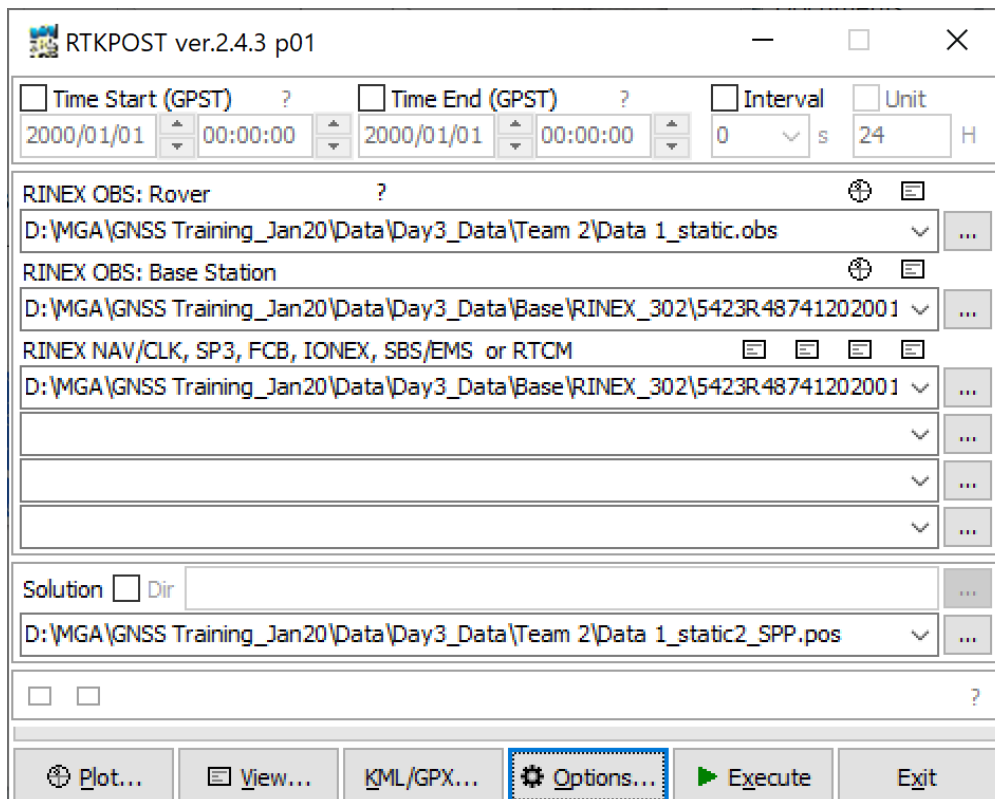


Figure 15 RTK Setting for Data 2

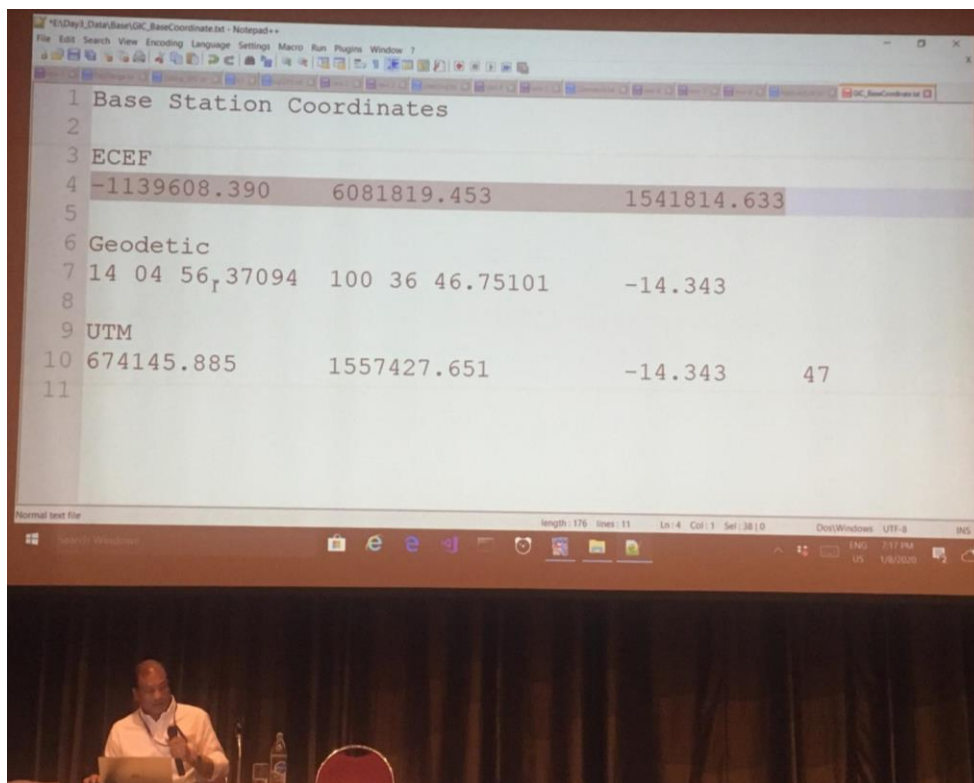


Figure 16 Base Station Coordinates

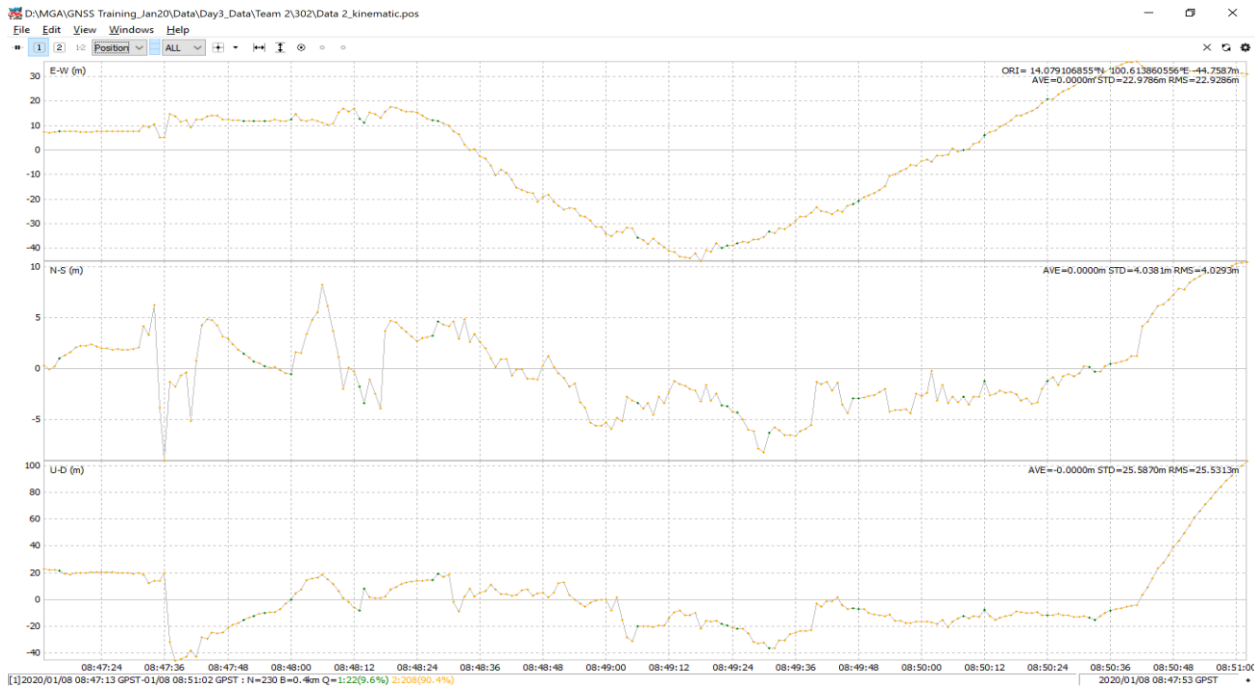


Figure 17: Position for Data 2

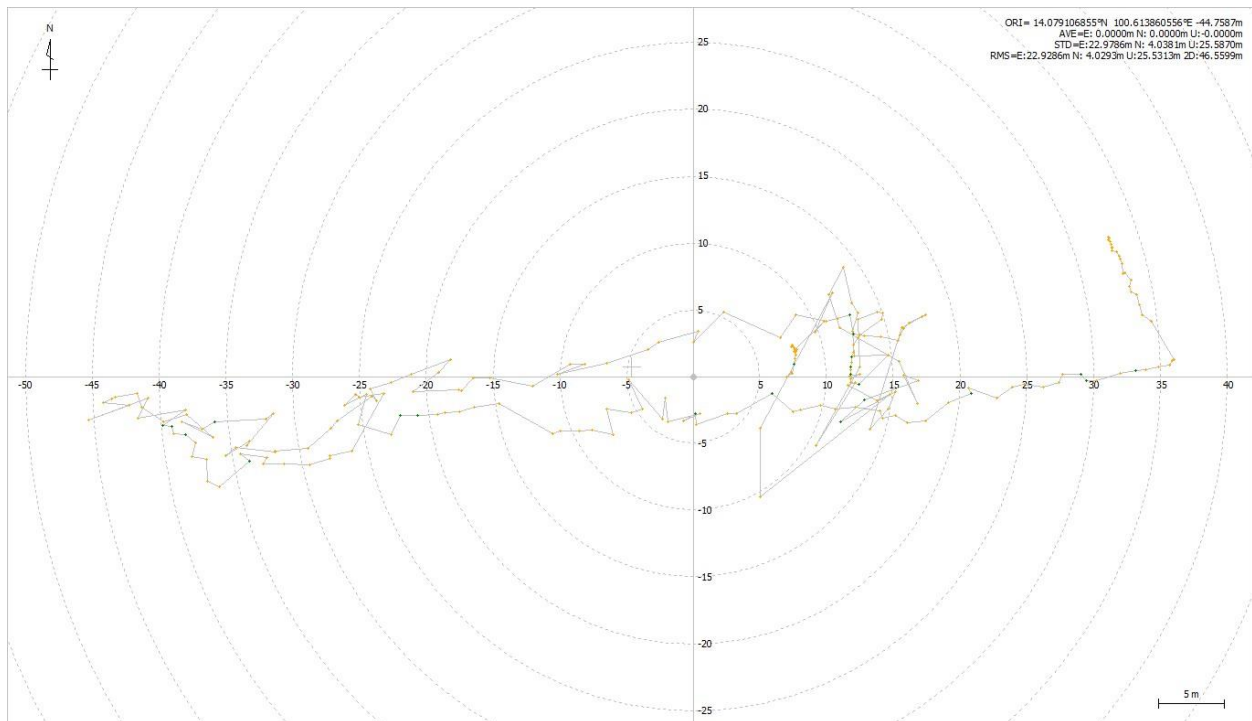


Figure 18: RTK for Data 2

1.5. SUMMARY

It can be observed from the results obtained that the Static Point Positioning data is not very accurate, therefore RTK technique is applied for comparatively better results, however DGNS can provide much more improved results than SPP but a base station is required for execute DGNS. Whereas, post processing from RTK provides positioning accuracy in cm level.

It can also be observed that RTK has various numbers of options to manipulate the data to get a good position estimate. This may include exclusion of weak signals, multipath etc. Understandably the results for Static surveys have a better fixed – float rate than kinematic or dynamic surveys. However, it is also dependent the quality of the receiver. In this case we used M8T receivers for logging data on computer systems and local mobile phone’s GPS receivers for RTKDroid and base station coordinates of those within ICG-AIT premises.

1.6. RECOMMENDATIONS

1. Using high quality receivers such as NETRq can provide good SPP and DGNS results which can further be enhanced using RTK post processing.
2. A lot of options are yet to be explored in RTK tool, which can prove to be helpful in further improving the accuracy.