Project Title:

Portable kit for detecting trapped and buried people in ruins and avalanches

Project Acronym:

RESCUECELL

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 315007

Subject:

D6.2 – Report of Final validation in snow avalanches – WP6

Dissemination Level: PUBLIC

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V1.0	Leonardo Santiago	10/04/2015	Final revision

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Executive Summary

Once the RESCUECELL system was integrated, all the functionalities were tested in terms of accuracy, and performance under real scenarios in collapsed structures[1] and snow. For this purpose, a set of tests and procedures were defined based on the preliminary tests under WP3 and WP5.

This deliverable describes the results of the procedure[2] followed to analyse the data recorded in the test in Line of Sight (LoS) scenario as well as the snow scenario. The results obtained in by the Positioning Algorithm in booth scenarios are also described. The deliverable ends with a summary of the results of the tests carried out under task 6.2. Furthermore, some recommendations for further research are pointed out.

[1] For more details please refer to D6.1 Report of Final validation in collapsed structures
[2] In D6.1 Report of Final validation in collapsed structures, the procedure to analyse the data is detailed.

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Contents

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1. Validation test of the RESCUECELL Technology (snow scenario)

Following the same procedures as the ones defined for the validation tests under collapsed buildings the validation protocol for the snow scenario was defined. After the execution of the validation tests for collapsed buildings[3] in Thessaloniki a set of recommendations were defined for the following tests. These recommendations as well as the implemented techniques to correct/mitigate the detected issues are listed below.

Implement a signal corrections in the Detection Algorithm to improve the Signal to Noise ratio (SNR).

Signal corrections algorithms were added to the Detection Algorithm (DA) in the sNodes. The performance of the DA improved.

Add further processing in the sNodes and CC

During the test carried out in Thessaloniki, only the ToA information was sent to the CC. In order to improve the performance of the DA instead of using a generated burst, the burst from each sNode are correlated with themselves. This approach requires for the entire signal (or just the burst with a timestamp) to be sent to the CC for analysis using the Positioning Algorithm (PA).

In order to overcome the low bandwidth of the GPRS data link (or ZigBee implementation) a Wi-Fi interface was integrated in the sNodes[4]. Using the Wi-Fi backhaul the entire signal can be send to the CC.

Use more sNodes (at least 7)

During the test in Thessaloniki, only five sNodes were used. Unfortunately, in some cases one or two nodes did not received the signal with sufficient SNR affecting the performance of the PA. For the snow scenarios seven more sNodes were manufactured prior the validation tests for the snow scenario. A total of 12 sNodes were available for the test.

Evaluate the positioning algorithm also with larger areas.

Planned for the following tests.

Place the mobile phone at a side of the area and at the centre to better assess the accuracy of the RESCUECELL system.

Planned for the following tests.

[3] For more details please refer to D6.1 Report of Final validation in collapsed structures
[4] For more details, please refer to *D5.1 Report on System integration and initial test*

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1.1. (Extra) Line of Sight Validation Tests in Castelldefels (Spain)

The final meeting of the RESCUECELL project took place in Barcelona. UPC hosted the meeting on December 10th, 2014. In order to demonstrate the use of the RESCUECELL kit, a test in Castelldefels was planned by UPC and ATEKNEA. In Figure 1 several sNodes can be observed where positioned during the tests.

Figure 1. LOS Tests. Castelldefels

As shown in the simulations performed under WP2[5], the LoS scenario has a similar effect on the radio signal propagation as the snow scenario. Hence, the results of the LoS are valid to validate the system (up to a certain extend) the results of a snow scenario. The figures bellow show the results of the LoS tests carried out in Castelldefels.

During this tests, several scenarios were tested. The sNodes were moved as well as the MT.

[5] For more details please refer to *D2.3 Report and source code of final MT location*

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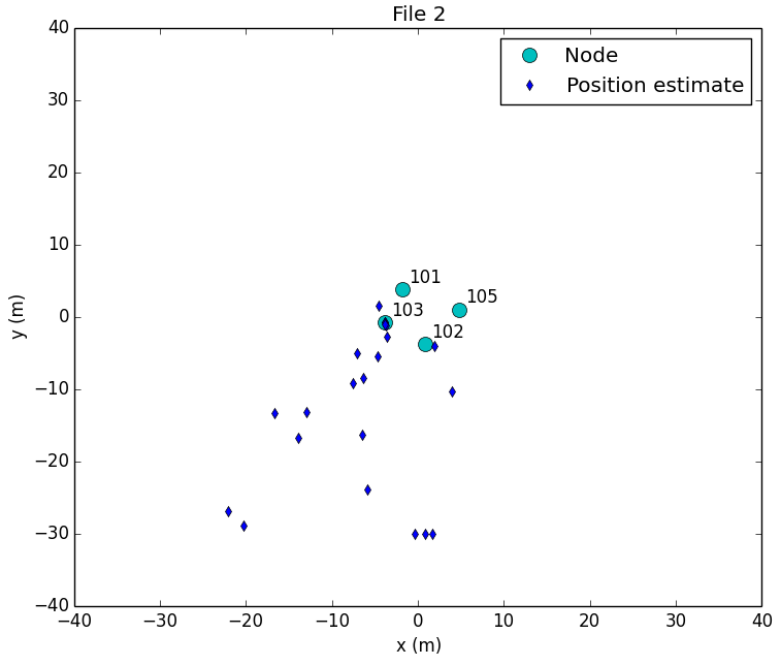

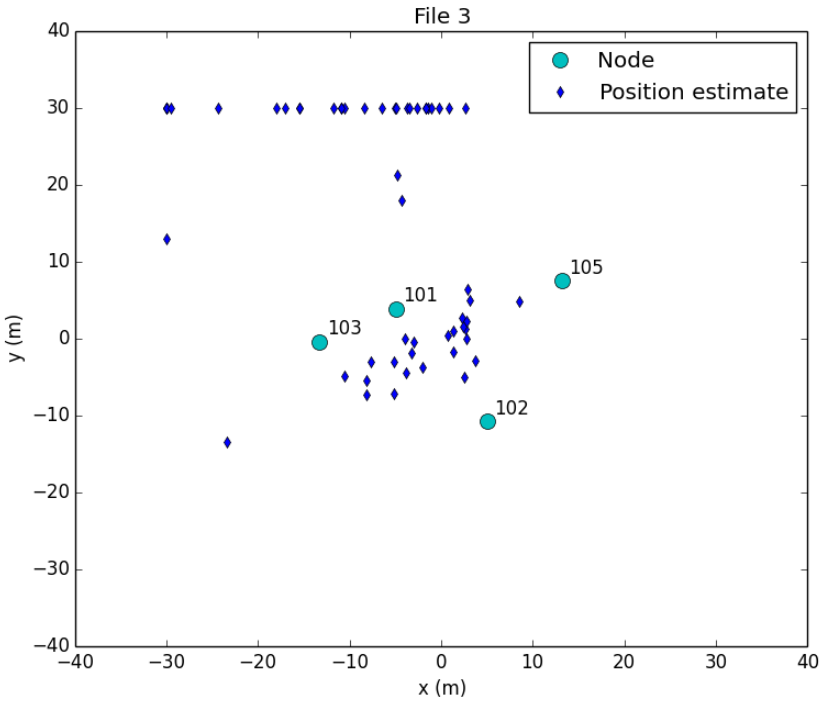

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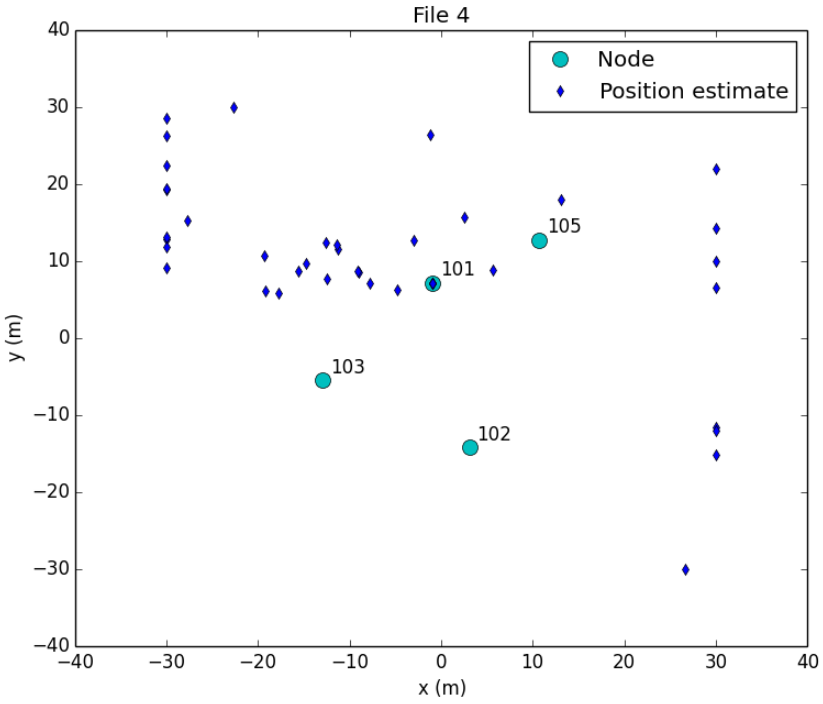

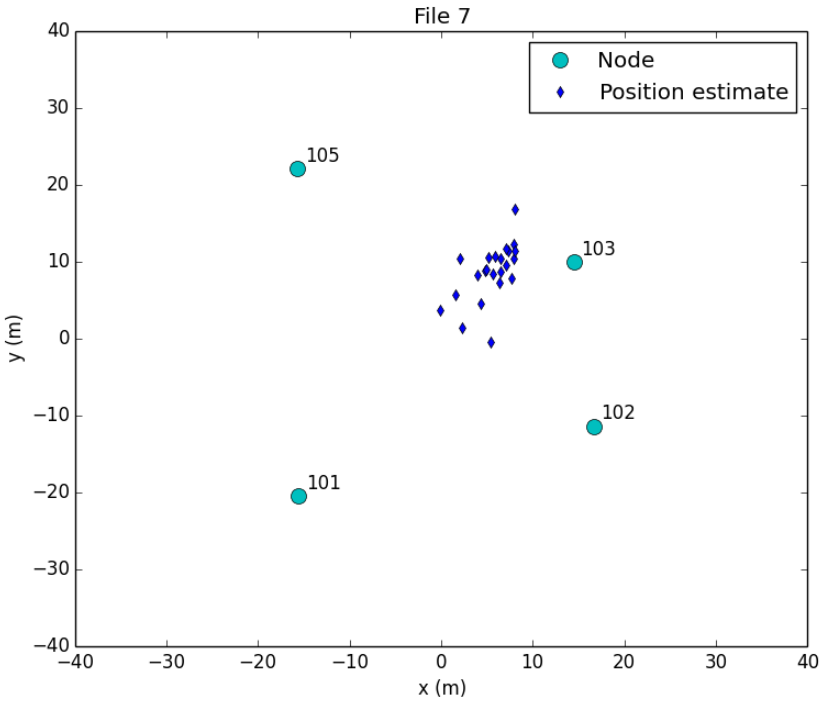

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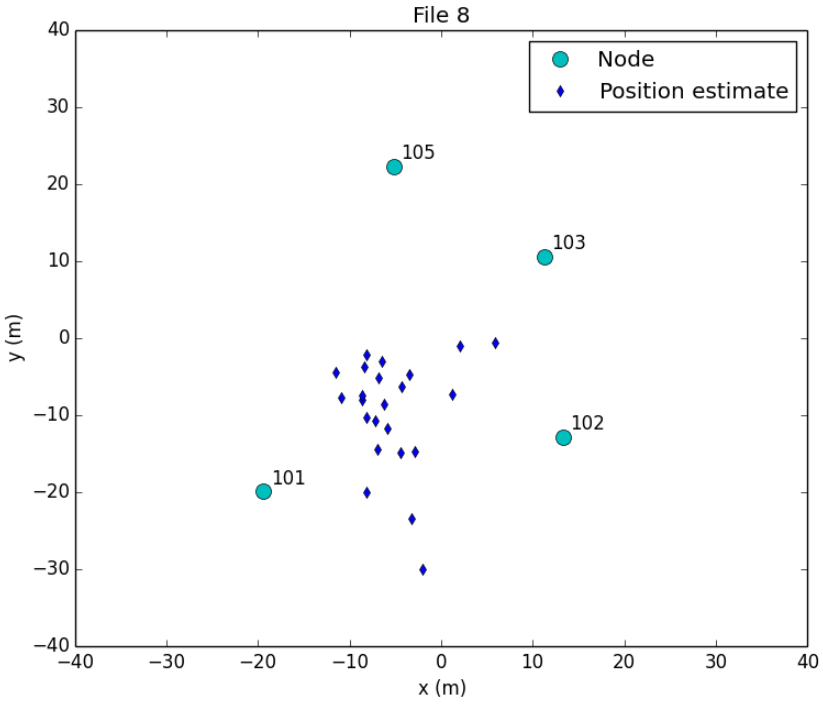

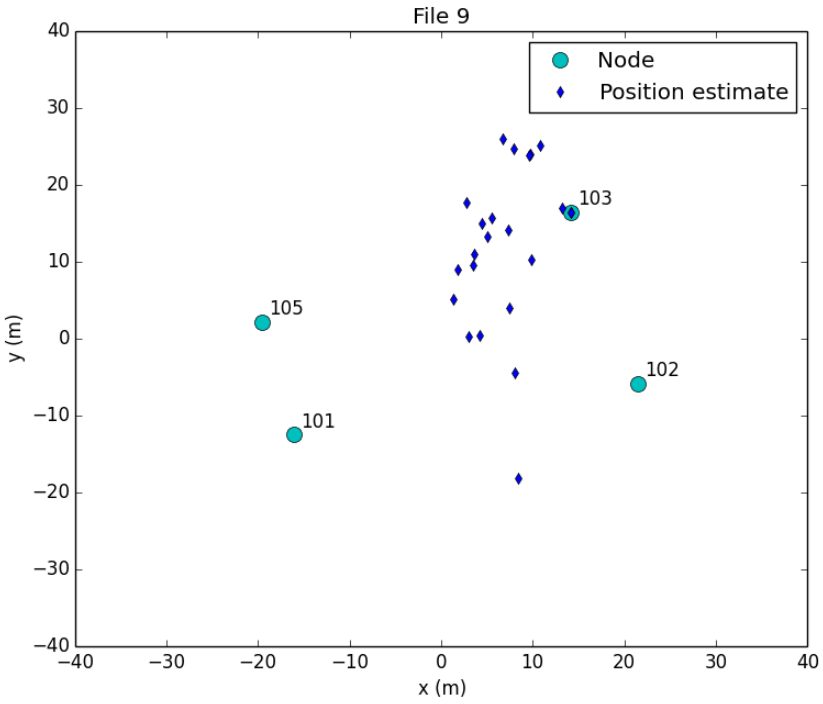

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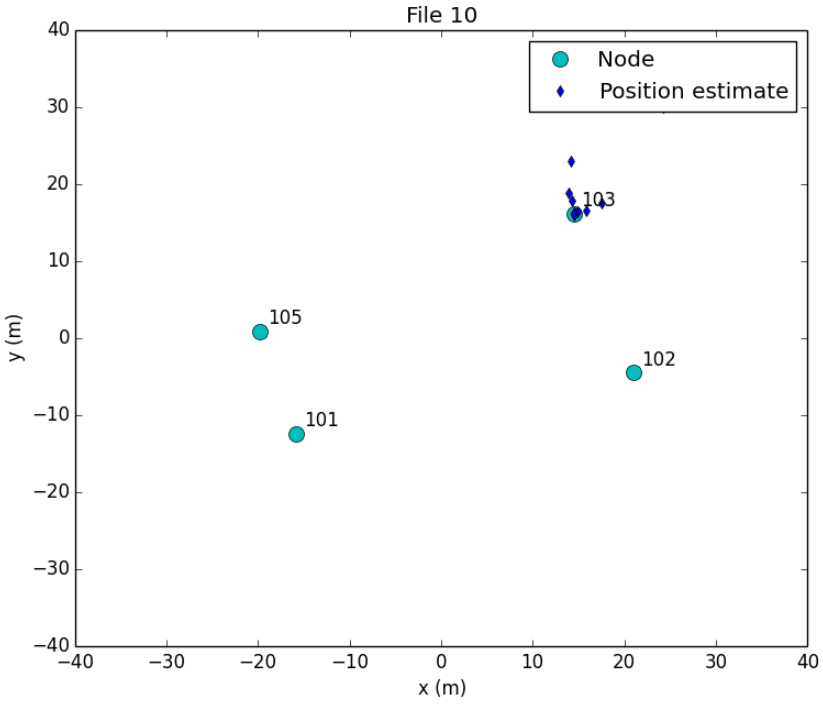

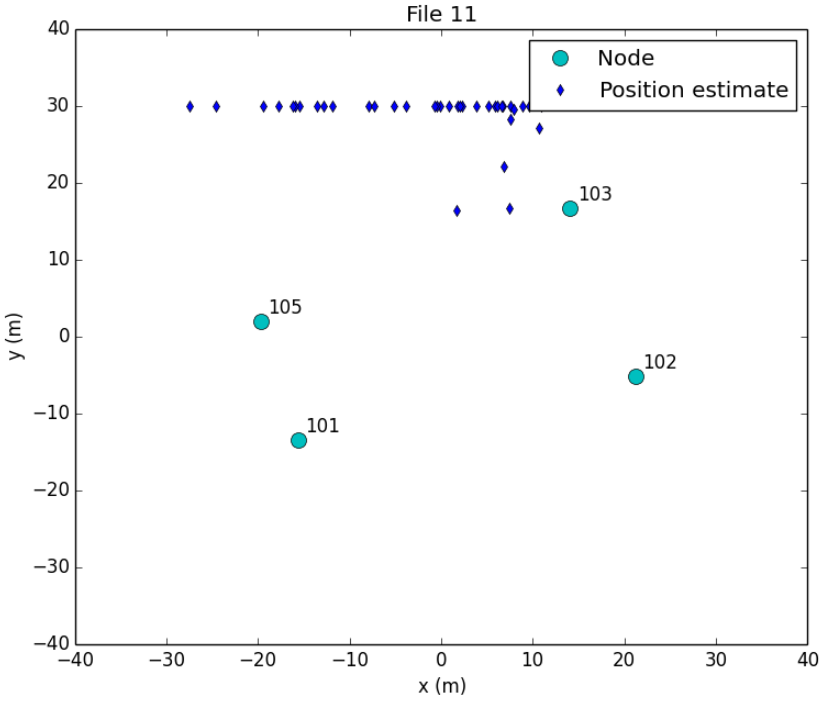

1.2. First Validation tests in Tignes (France) (cancelled)

A first validation tests for the snow scenario was planned for November 26-27, 2014. Unfortunately, due to the snow conditions at the time the tests needed to be performed at a Glacier in Tignes as shown in Figure 2 (Réserve Naturelle de Tignes-Champagny, France, 45.430531, 6.889178). Heavy equipment was necessary against snow, cold and wind.

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Furthermore, due to the glacier situation (crevasse[6]) and safety reasons, the tests were cancelled.

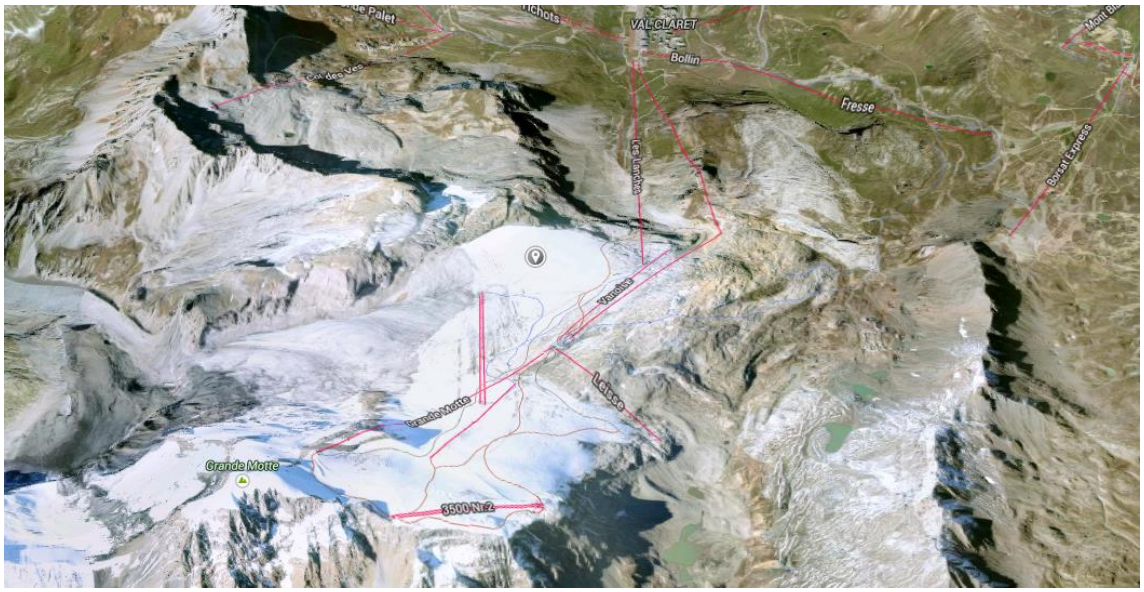

Figure 2. Tignes Glacier (location for First Validation Tests)

The tests for the snow scenario were rescheduled (February 6-7, 2015) and carried out in Tirvia, Spain (Spanish Pyrenees).

1.3. Snow Validation Test in Tirvia (Spanish Pyrenees)

As mentioned above the validation tests for the snow scenario were rescheduled and relocated. The selected location was Tirvia in the Pyrenees of Spain.

Several tests were carried out. The first one during February 6, 2015 aimed at deploying the RESCUECELL kit in a scenario with a lot of snow. A location for this tests was selected with the help of a guide contacted by UPC. During this tests the MT was buried (several locations) under at least 1.30m of snow. After the analysis (on site) of the data, a LoS experiment was also carried out at the end of the date. During the validation tests, some sNodes did not performed as expected and a full revision of the hardware was carried out after the tests.

On February 7, 2015. Mores tests were carried out during the morning (LoS with snow) and during the afternoon (MT buried)

In the next sections can be observed the results of the tests for LoS on snow and buried in snow scenarios.

1.3.1. Line of Sight on Snow

[6] A crevasse is a deep crack, or fracture, found in an ice sheet or glacier.

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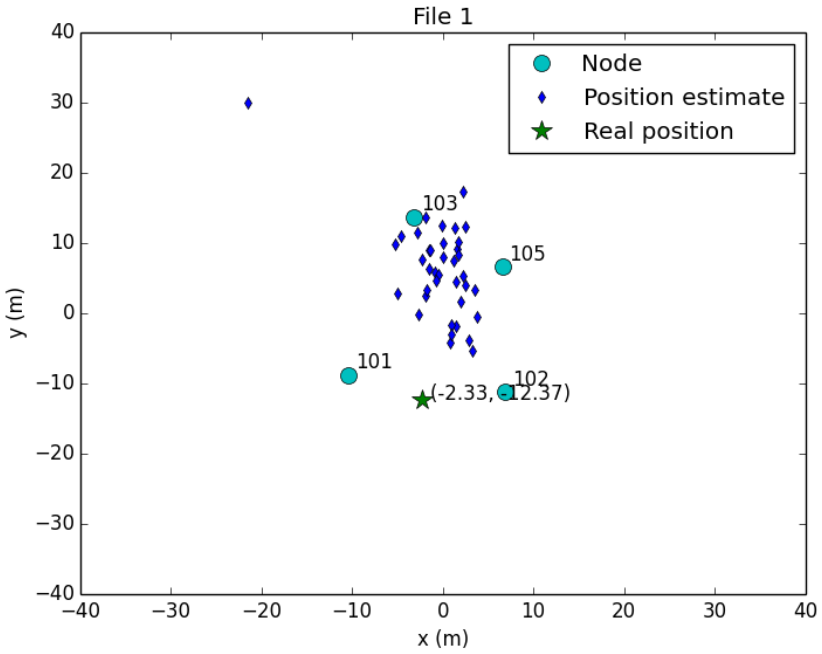

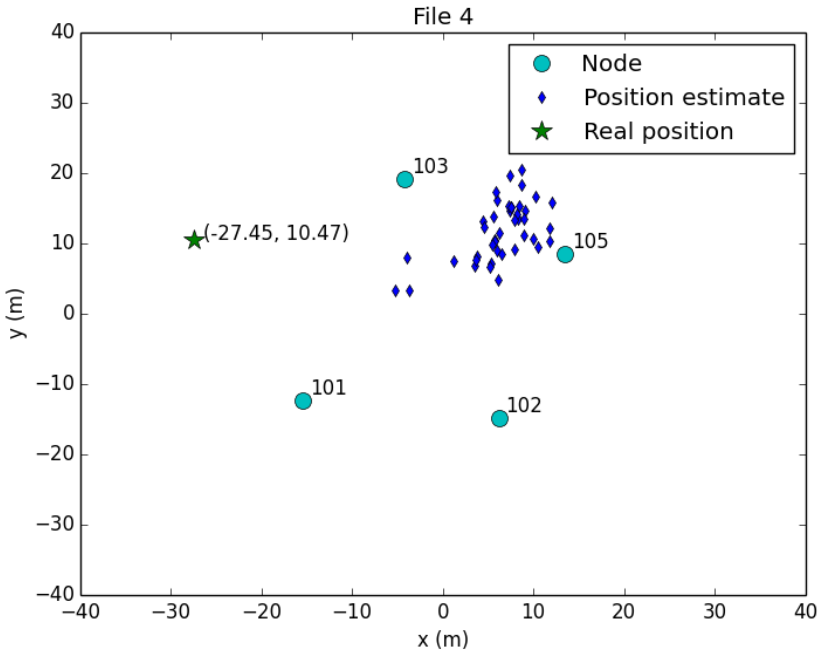

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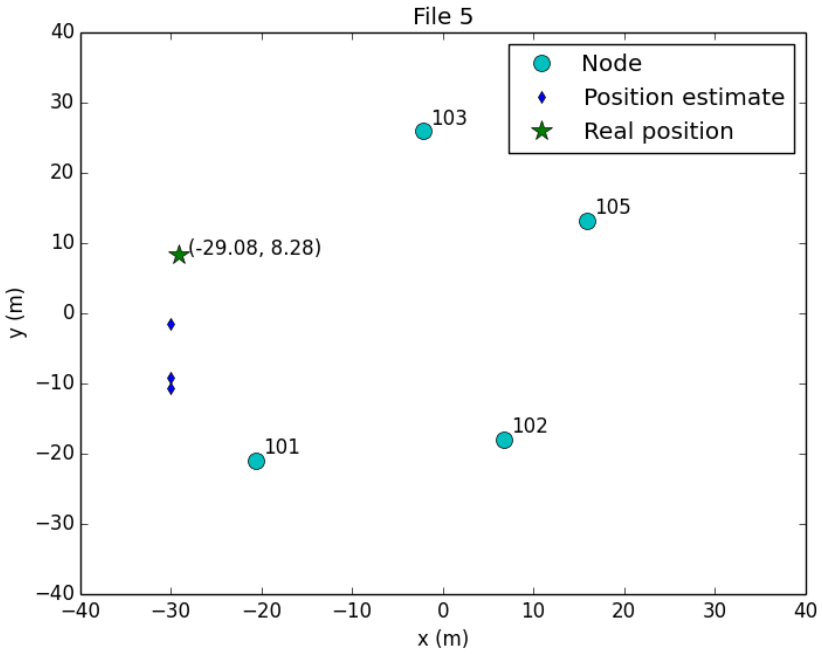

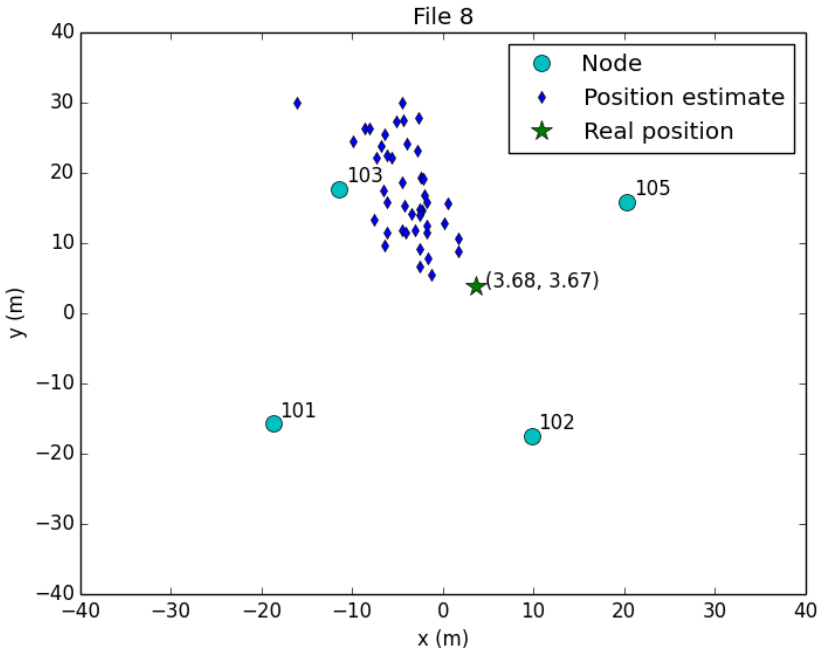

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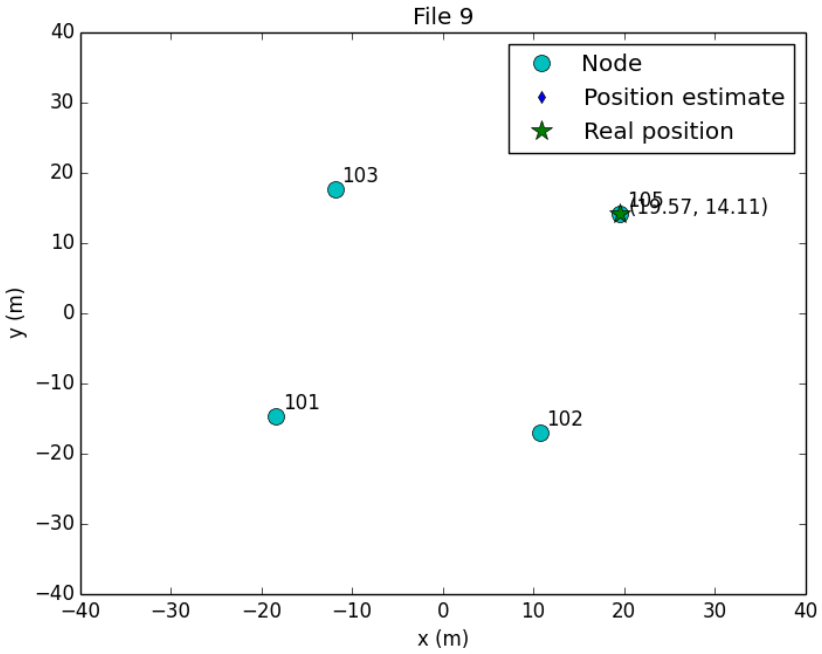

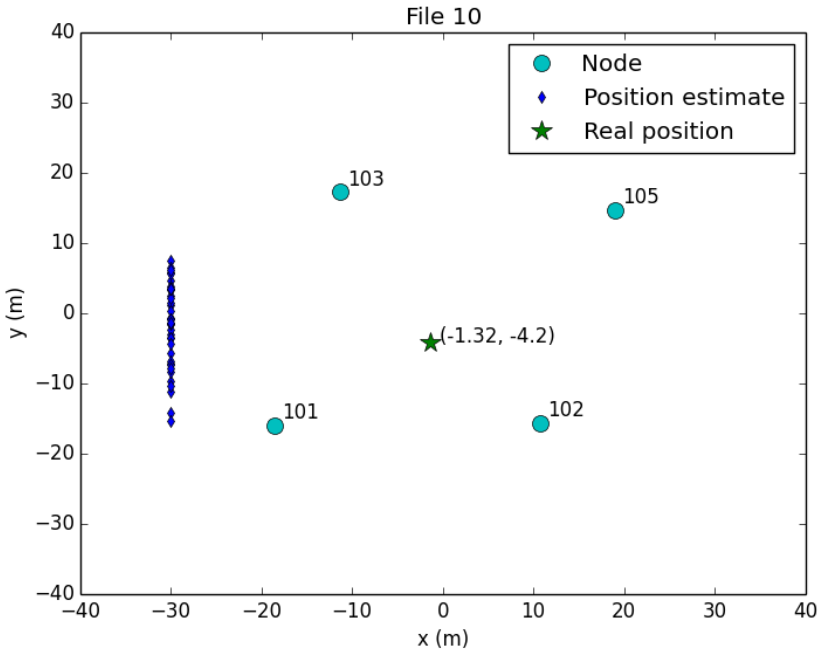

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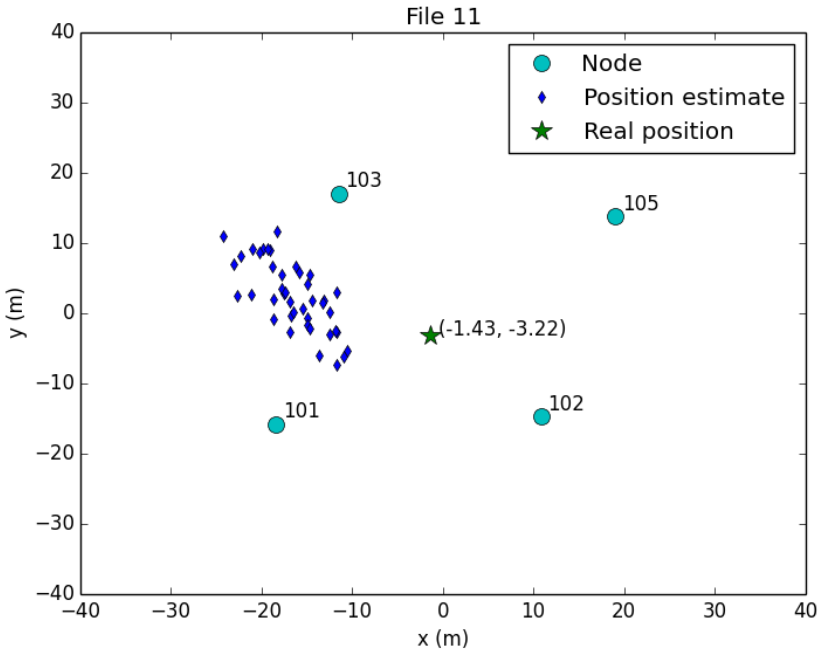

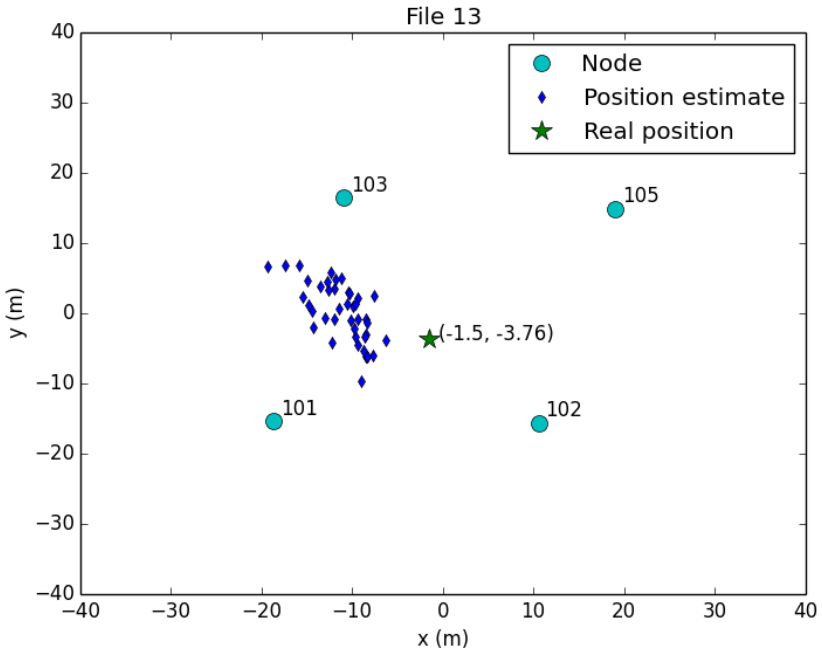

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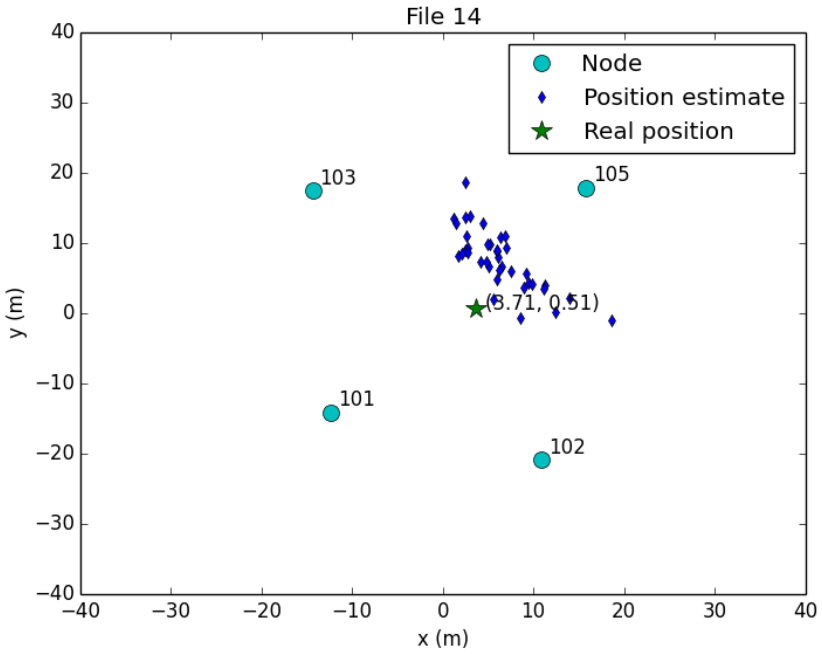

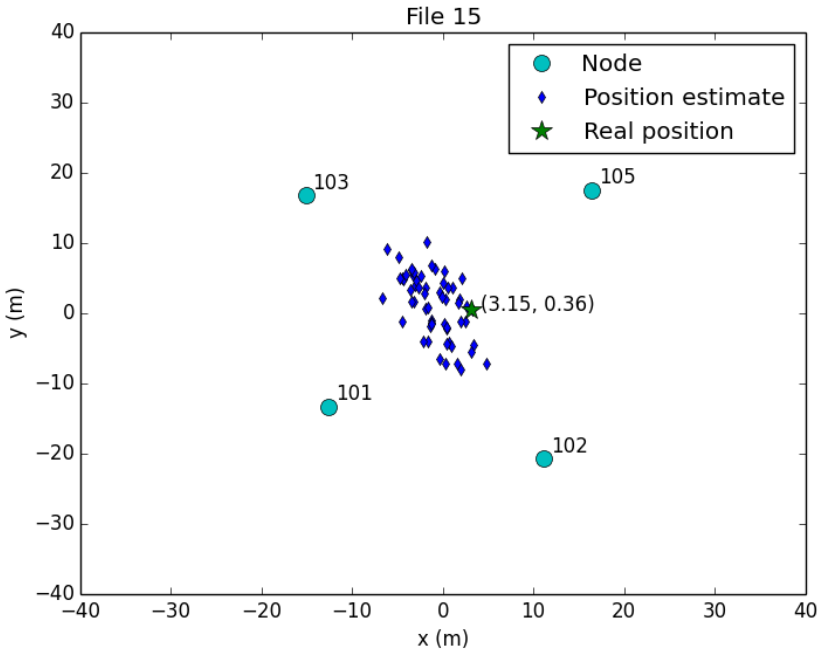

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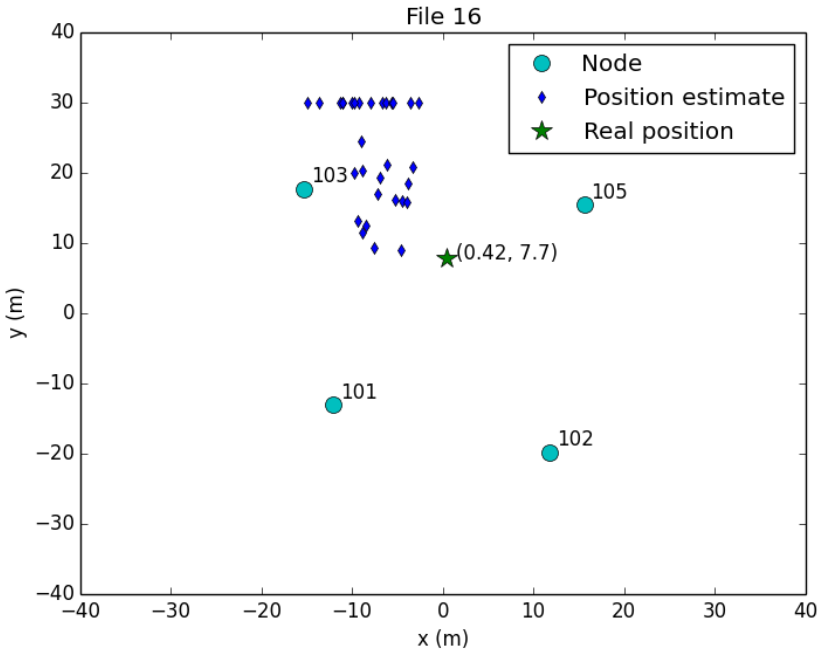

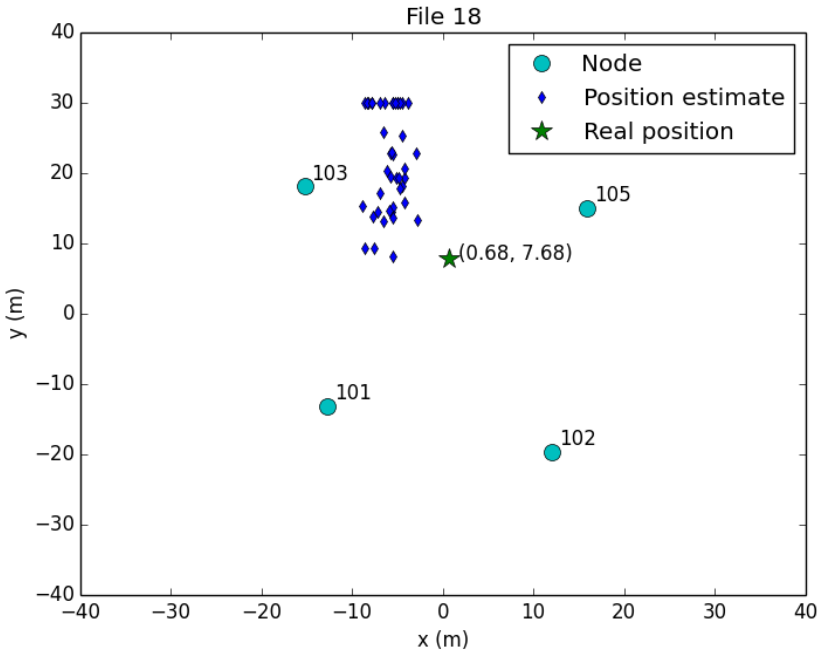

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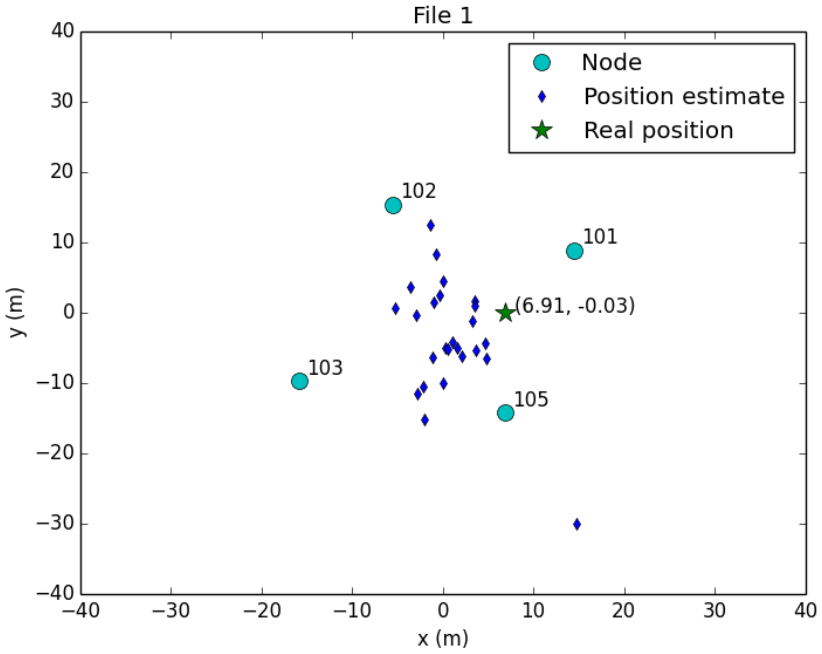
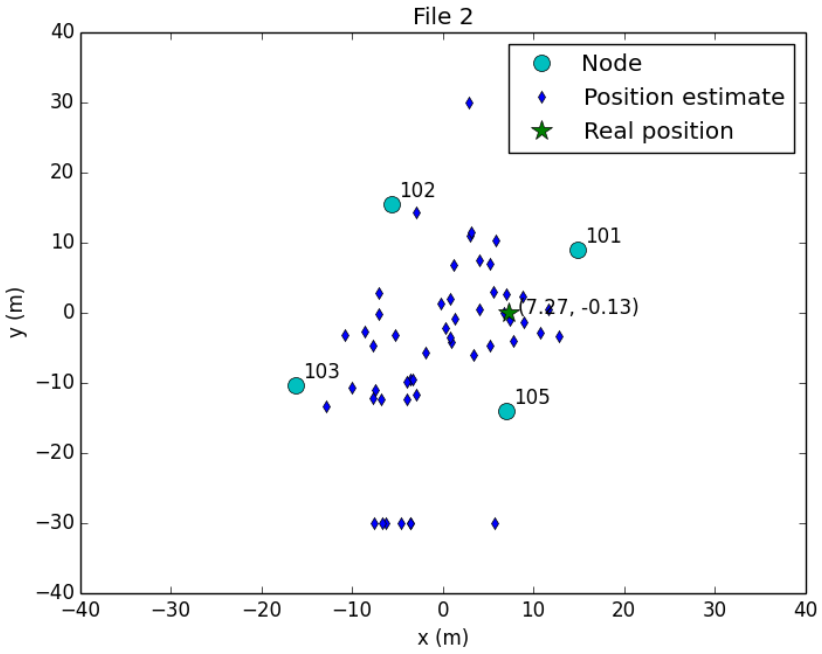
1.3.2. Non Line of Sight on Snow (MT buried under Snow)





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2. Conclusions of the Results of the Validation Test for Snow Scenario and LoS

Several tests in LoS and under snow scenarios were performed with the RESCUECELL kit. Optimizations and enhancements in the algorithms (DA and PA) and the firmware of the sNodes were implemented based on the conclusions and recommendations of the tests carried out in Thessaloniki. The tests carried out aimed at validating the technology taking into account the simulations carried out in WP3. In summary it was tested:

- MT around the centre of the area demarked by the sNodes
- MT on the edges of the area demarked by the sNodes
- MT outside of the area demarked by the sNodes

The results of the tests:

- Cloud of estimated positions diverged towards the limits of the area (defined by the PA in the CC)
    - This happened when the MT was close or outside the edges of area demarked by the sNodes. In the simulations the accuracy of the PA is lowers towards the edges of the area demarked by the sNodes.
- Cloud of estimated positions close to the actual position of the MT.
    - This is the best case scenario. In this case the signal received by the sNodes from the MT is consistent with the GSM signal to be received. In this case, the sNodes calibration procedure was performed correctly.
- Cloud of estimated positions too spread around the action position of the MT
    - In this case, similar to the previous one with the difference that in the calibration of the sNodes did not converged.

The results of the tests performed under task 6.2 validated the simulations carried out under WP2. The validation tests also helped to identify the parts of the technology which need further research in order to achieve a reliable performance. In order to make the system perform better, further research regarding the correction and calibration procedures in the sNode.

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