



Innovative navigation using GNSS integrated by INS applied to aerial special plants

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Special aerial transportation plants follow European Norms and PTS (Specific Technical Recommendations). Verification of norms fulfilment requires specific measurements on structures, infrastructure, security plants. Some aspects are not taken into account by the actually used methodologies, so the application of GNSS/INS measurements integrated by high accuracy topographic measurements are of particular interest in this domain.

Different tests have been carried out by the authors during the last years using **GNSS/INS techniques in post-processing and in real time (RTK)**.

Cables and cabins dynamic behaviours have been monitored, also under severe situations, calculating the catenary envelope during operative phase, the cabin oscillations due to sudden emergency breaks in order to analyse the passengers safety and comfort level, the so called pumping effect, some structural checks to verify the norm allowances, the dynamic torsion effects on the pillars due to cabin passages. Using actual adopted methodologies these aspects cannot be monitored.



Fig. 1 Funifor - Ravascletto (UD) plant with the Topcon antennas on the roof of the cabin

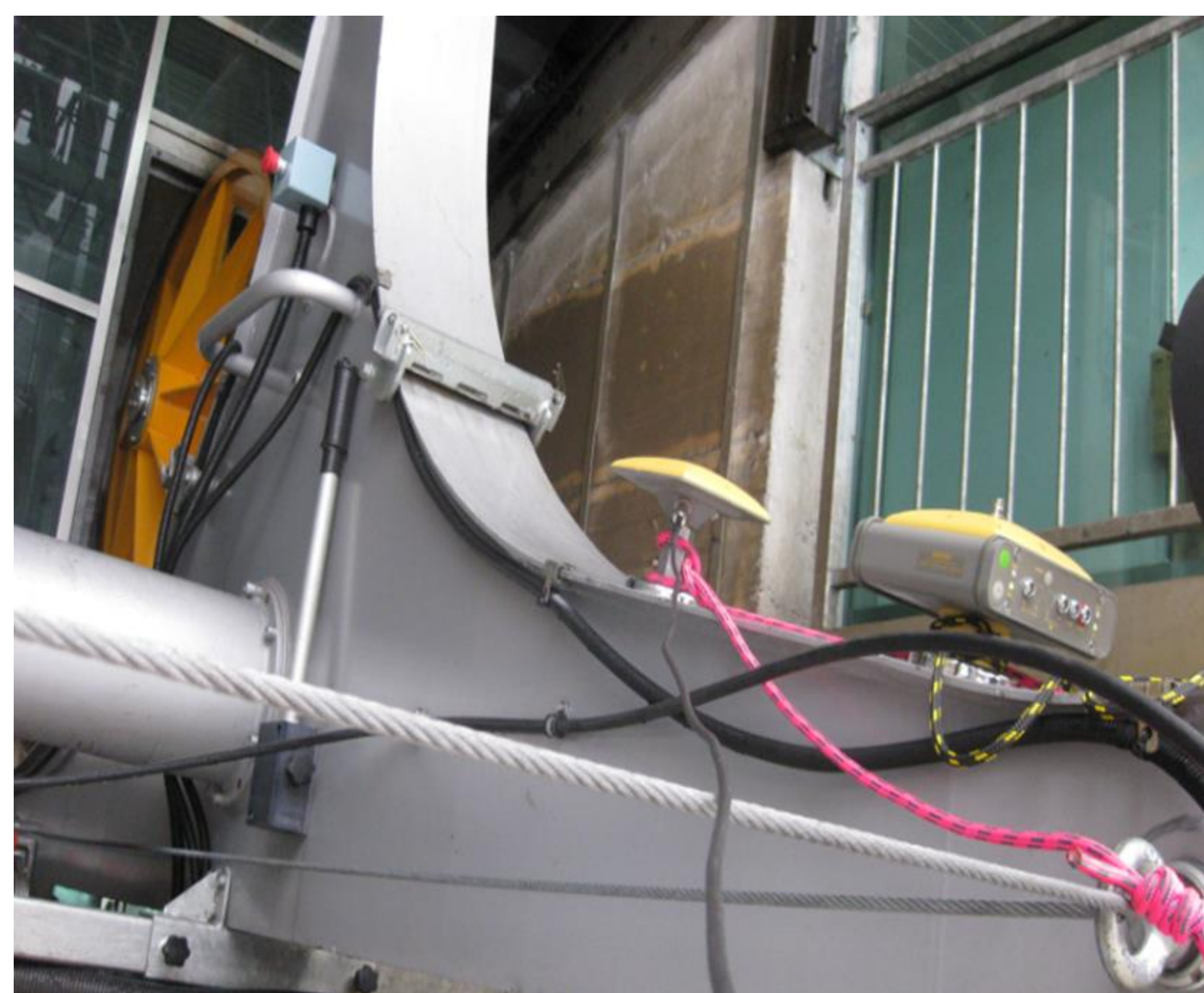
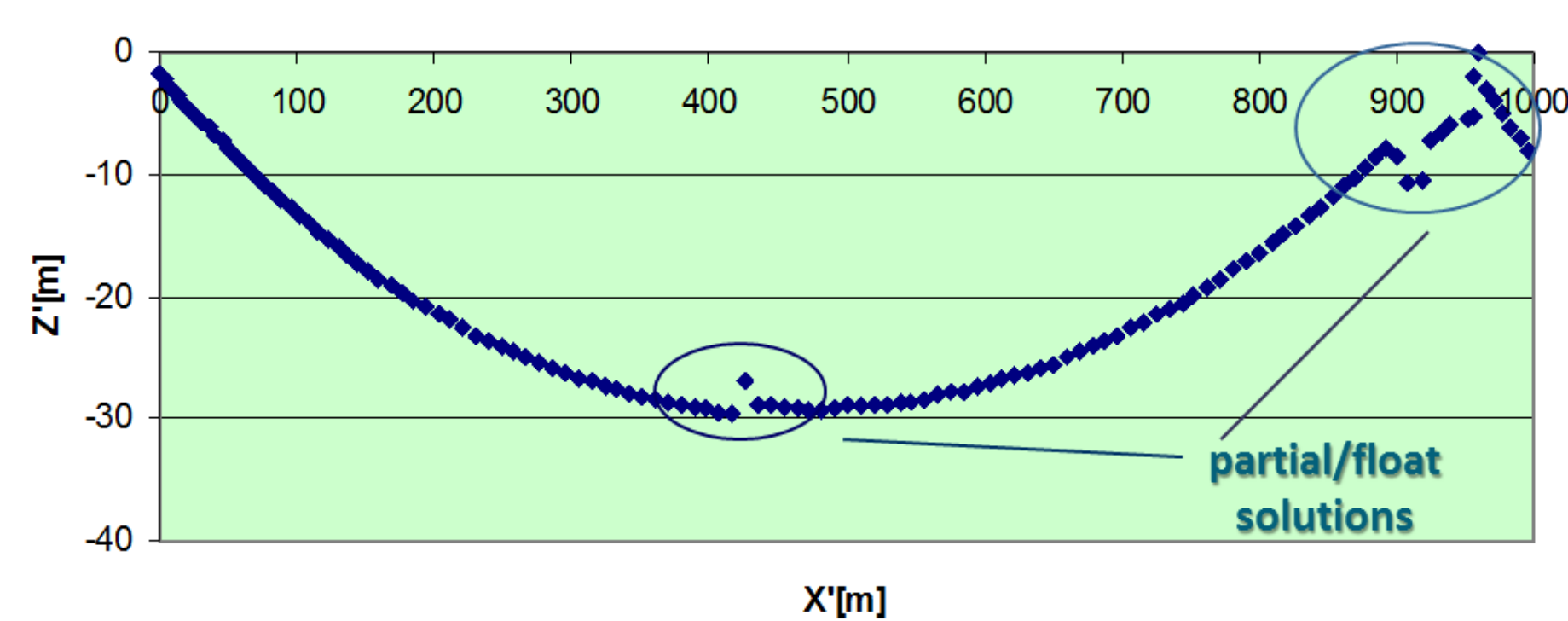


Fig. 2 A detail of the cabin roof - Funifor plant - Ravascletto (UD) with the Legacy and Hyper Pro Topcon antenna and receiver



Fig. 3 The Lagazuoi plant Cortina d'Ampezzo (BL)

Mountain station - central pillar (Topcon Legacy)



Mountain station - central pillar (Topcon Hyper-Pro)

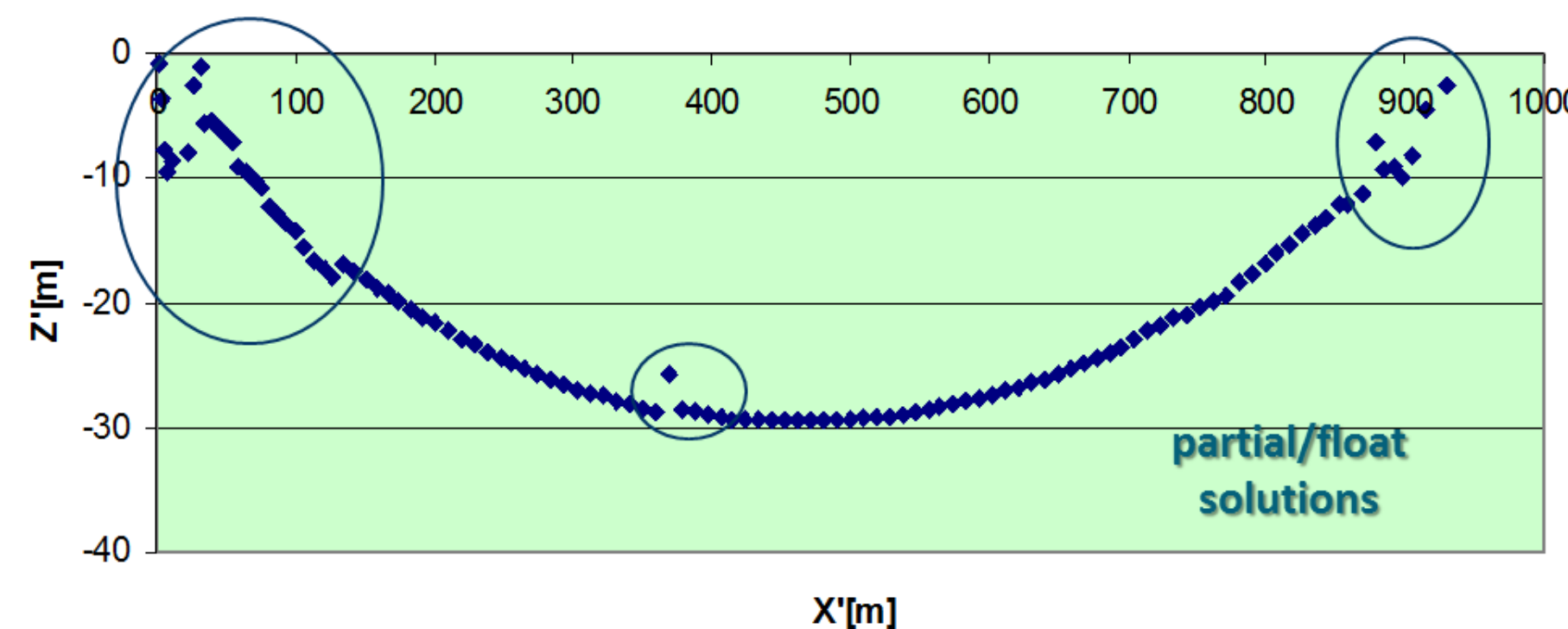


Fig. 4 The catenary envelope- Funifor plant Ravascletto (UD)

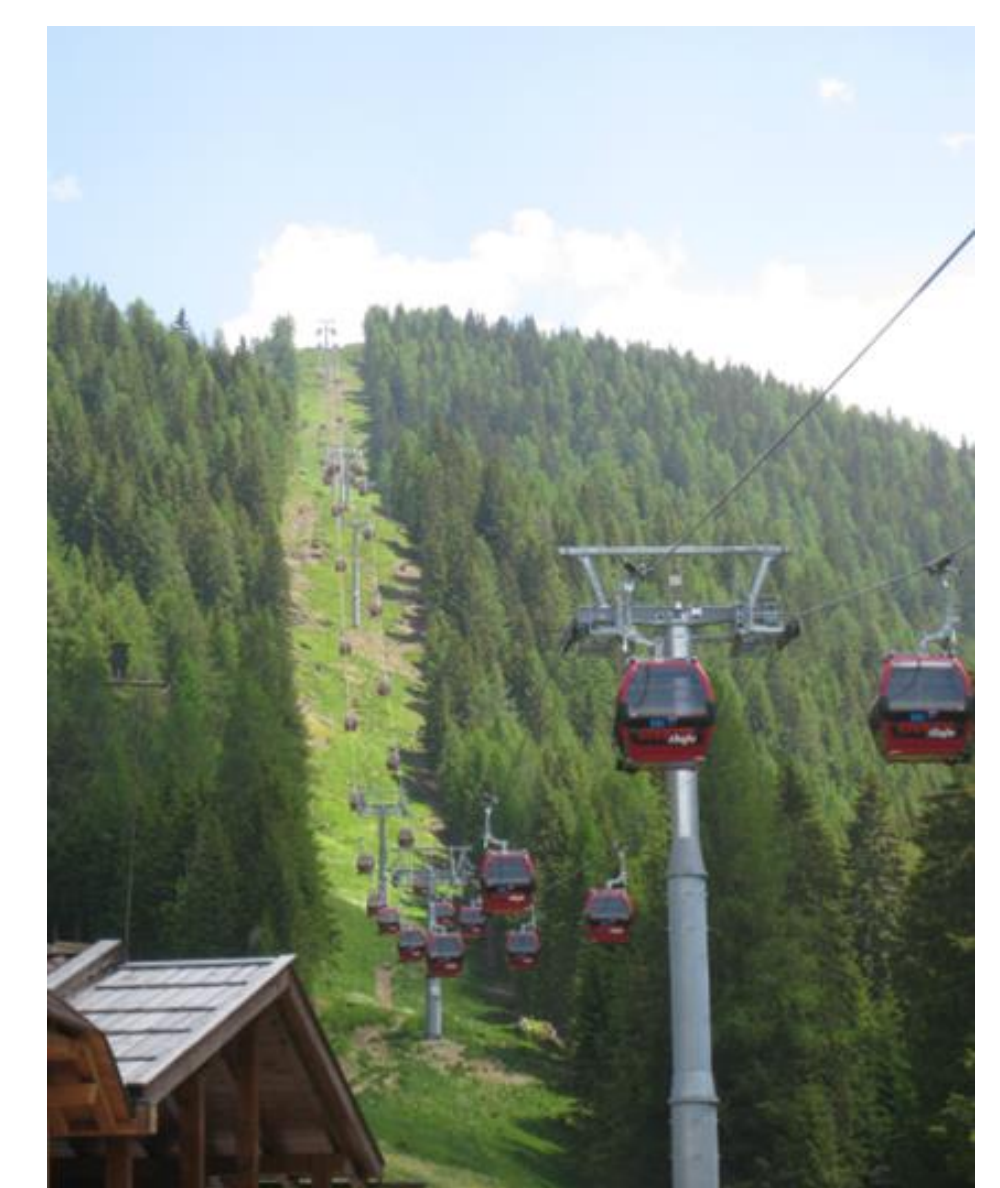


Fig. 5 Alleghe plant (BL)

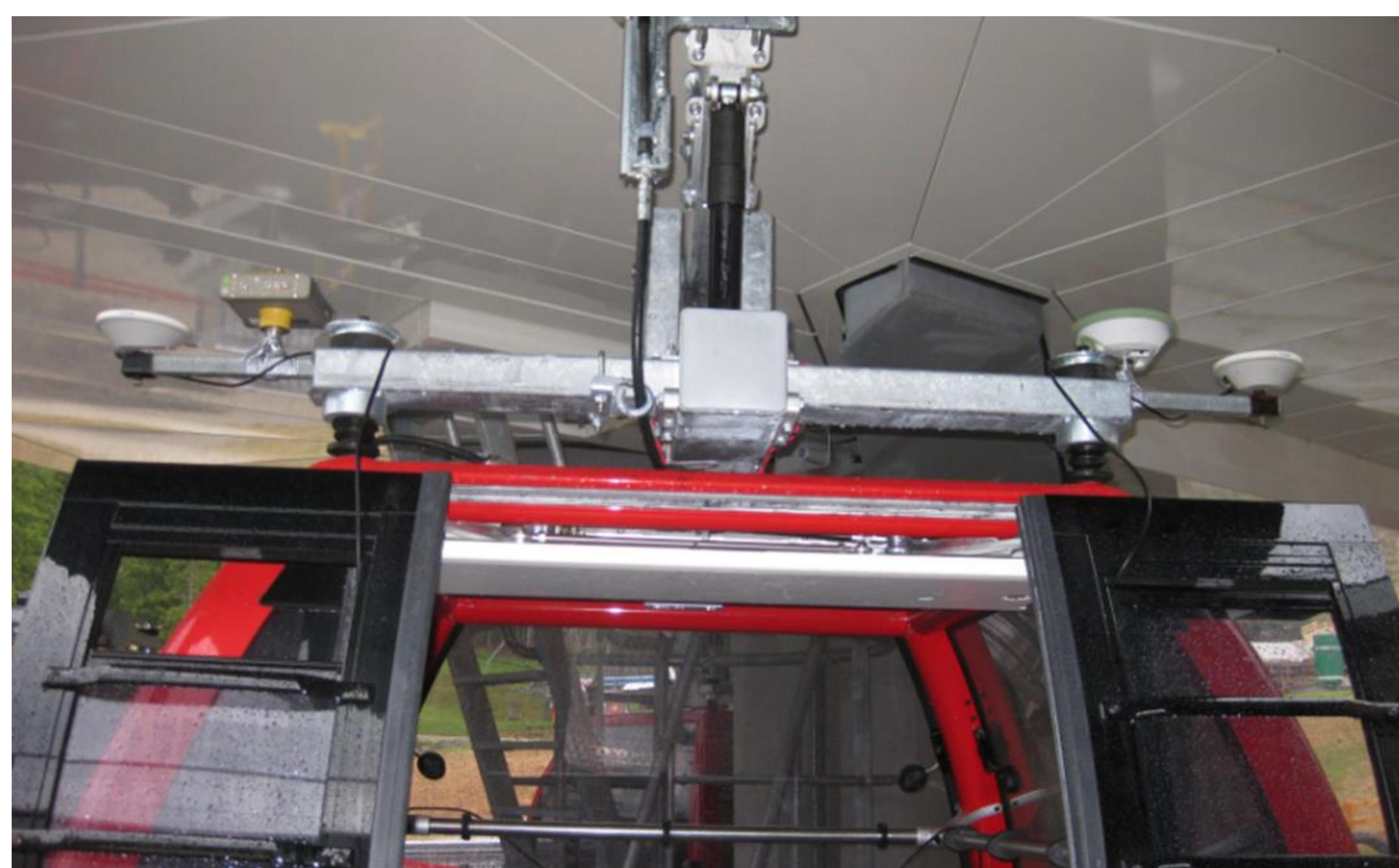
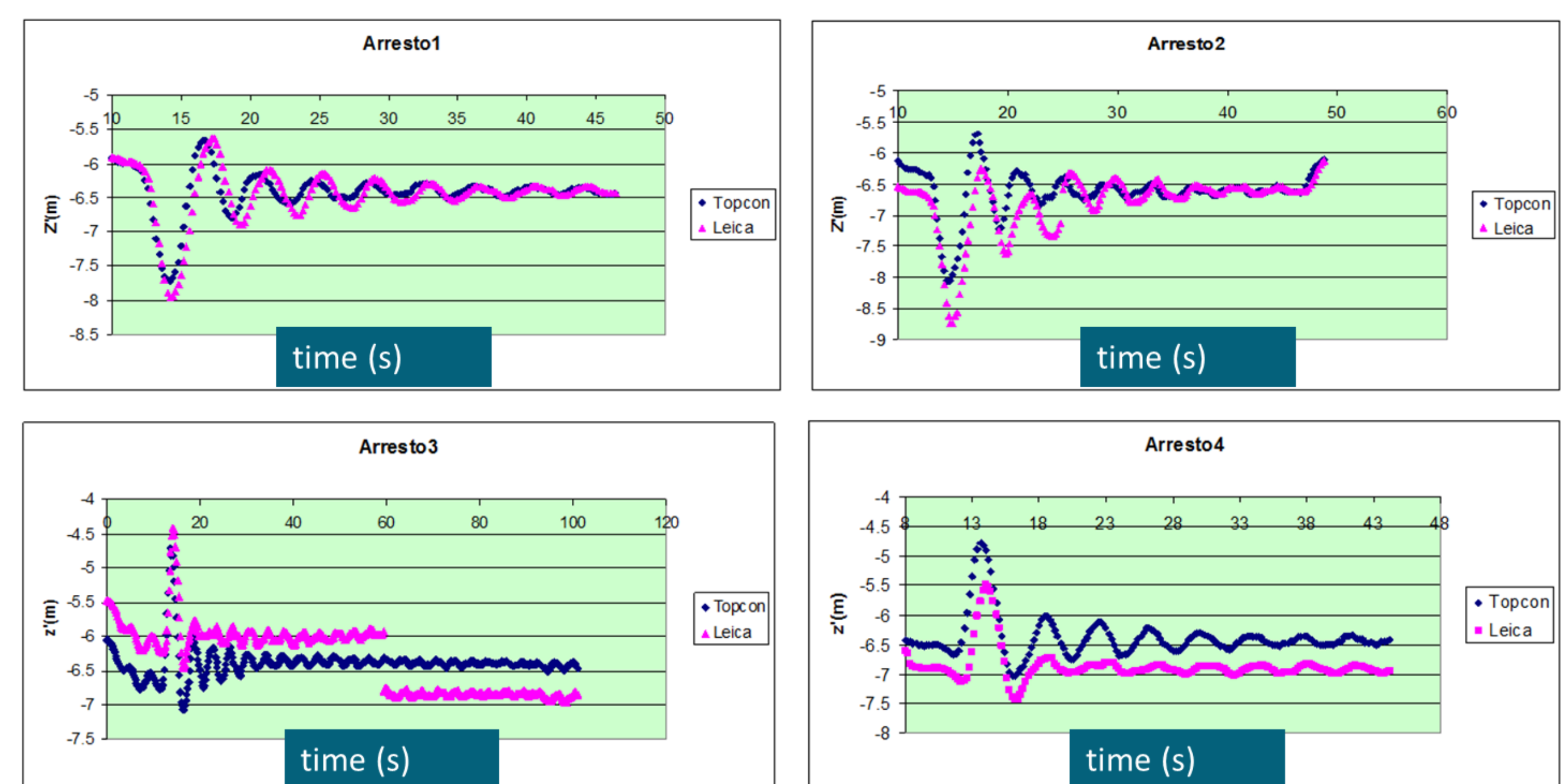


Fig. 6 Alleghe (BL) plant - the bar on a cabin roof on which 4 GNSS antennas have been installed (2 Trimble, 1 Hyper Pro and 1 Leica)



■ RTK trajectory ■ post-processed trajectory

Fig. 7 Alleghe (BL) plant - vertical oscillations due to sudden breaks

Different tests have been carried out on a Funifor - Ravascletto (UD) plant, on Pian de Pezzè, Alleghe (BL) plant, on a Zoldo (BL) chair plant and are planned on a Dolomite cable car plant, using GNSS Topcon Legacy, Hyper Pro, Leica and Septentrio multi-constellation/multi-frequency receivers at a rate of acquisition of 1 and 5 Hz, analysing the post-processed and RTK trajectories.

A motorized total station Leica TS30, allowing submillimetric accuracies, was also used to monitor the central pillars displacements during the two cabins contemporaneous passage.

Cableway cabins dynamic oscillations determination requires: satellite signals continuity, high level of accuracy and redundancy for safety reasons, sensors integration with high accuracy 3D INS, real-time kalman filtering, different multi-constellation/multi-frequency GNSS receivers and integration with classical sensors.

Future developments are relative to standard definitions and norms updating.

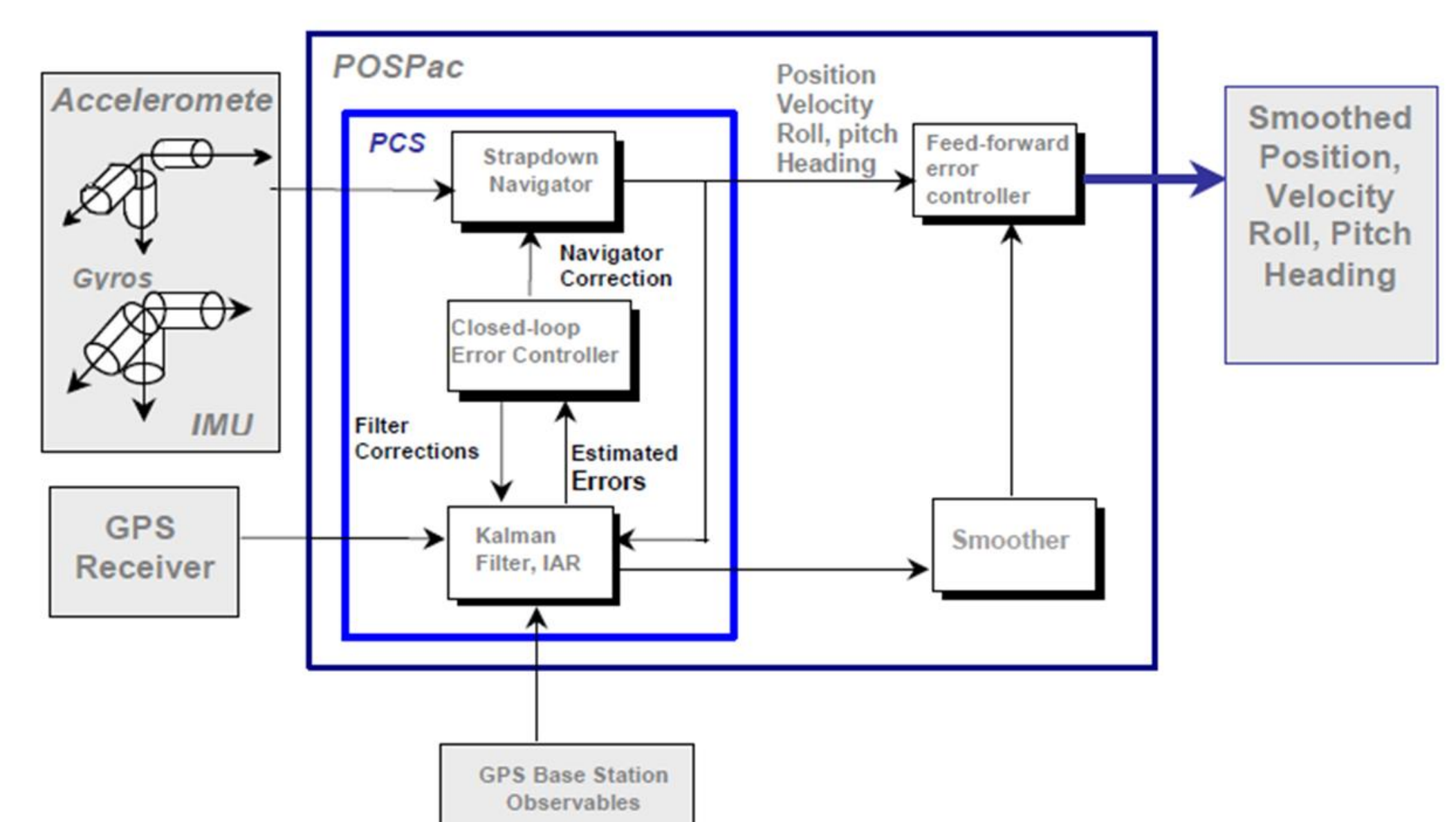


Fig. 8 Applinix POSPac software structure