Enabling Ultra-High Accuracy Positioning in Challenging Environments (NAVISP-EL-1-26)

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ANAVS

Advanced Navigation Solutions

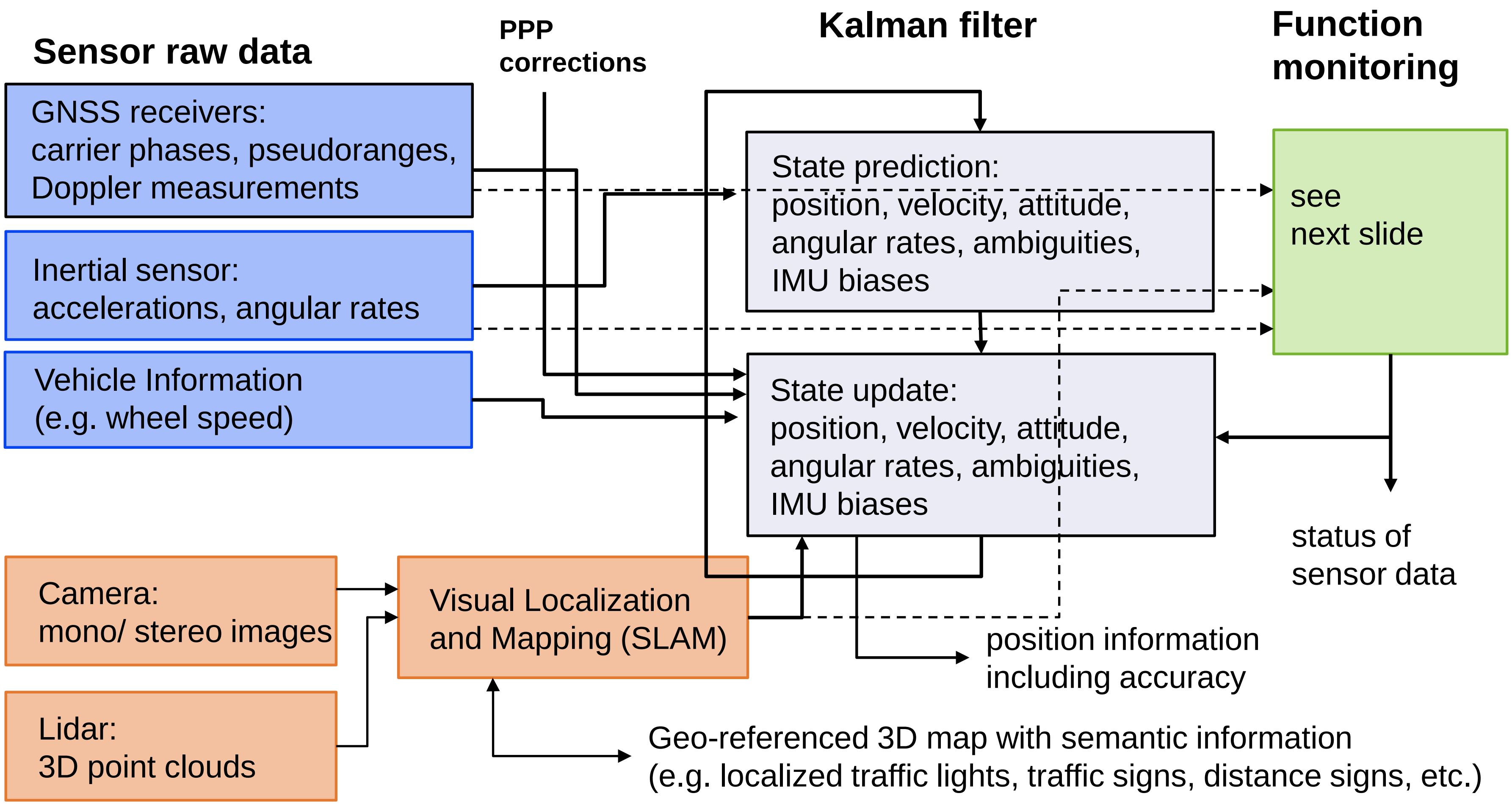
Project Objectives

- Development of a state-of-the-art and of an innovative Precise Point Positioning (PPP) technique with carrier phase Integer Ambiguity Resolution (IAR)

- Key innovations of the innovative PPP solution:
  - PPP using Galileo High Accuracy Service (HAS) corrections
  - GNSS + INS + odometry tight coupling with extended Kalman filter
  - Integration of position information obtained from visual positioning 3D LIDAR SLAM

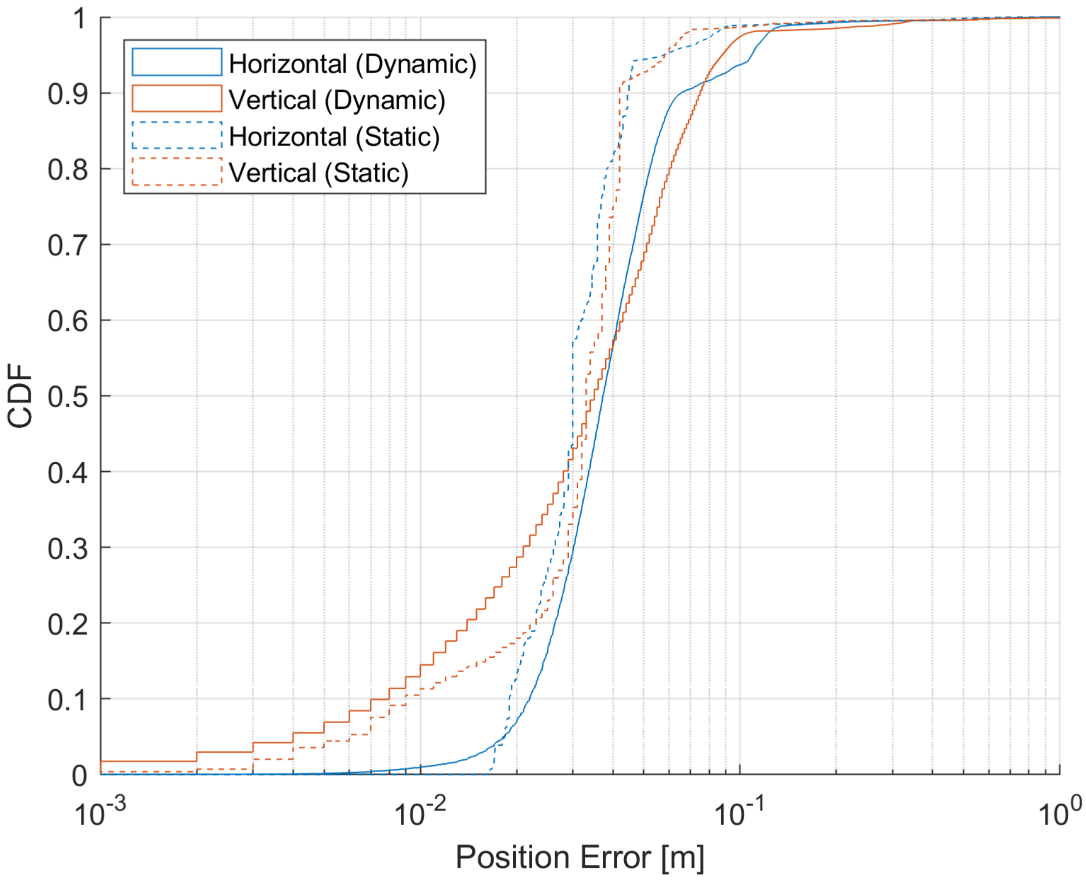
- Performance Assessment in challenging environment

System Architecture

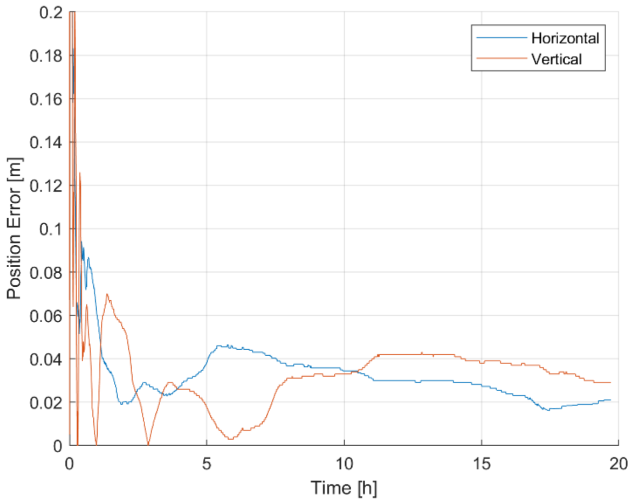


State-of-the-Art PPP solution:

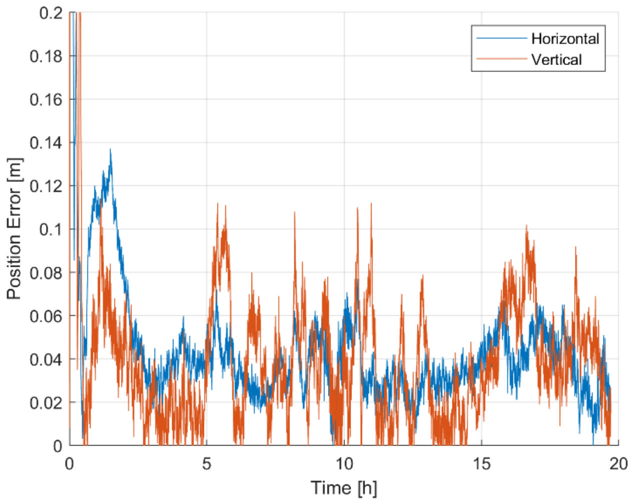
Long-term accuracy analysis for static receiver



Station assumption



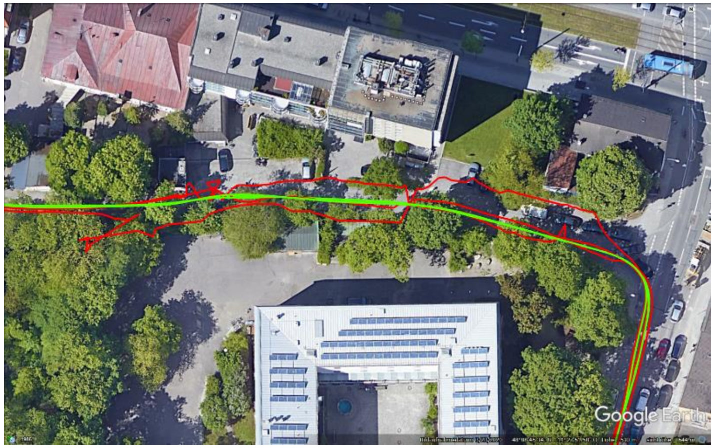
Kinematic assumption

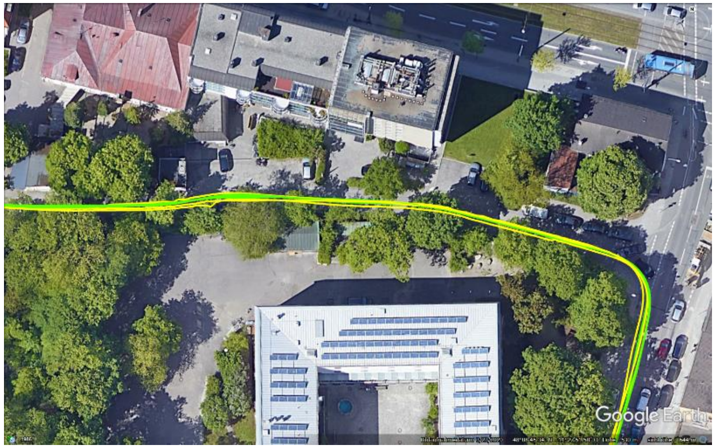


Key Performance Results in Challenging Environment

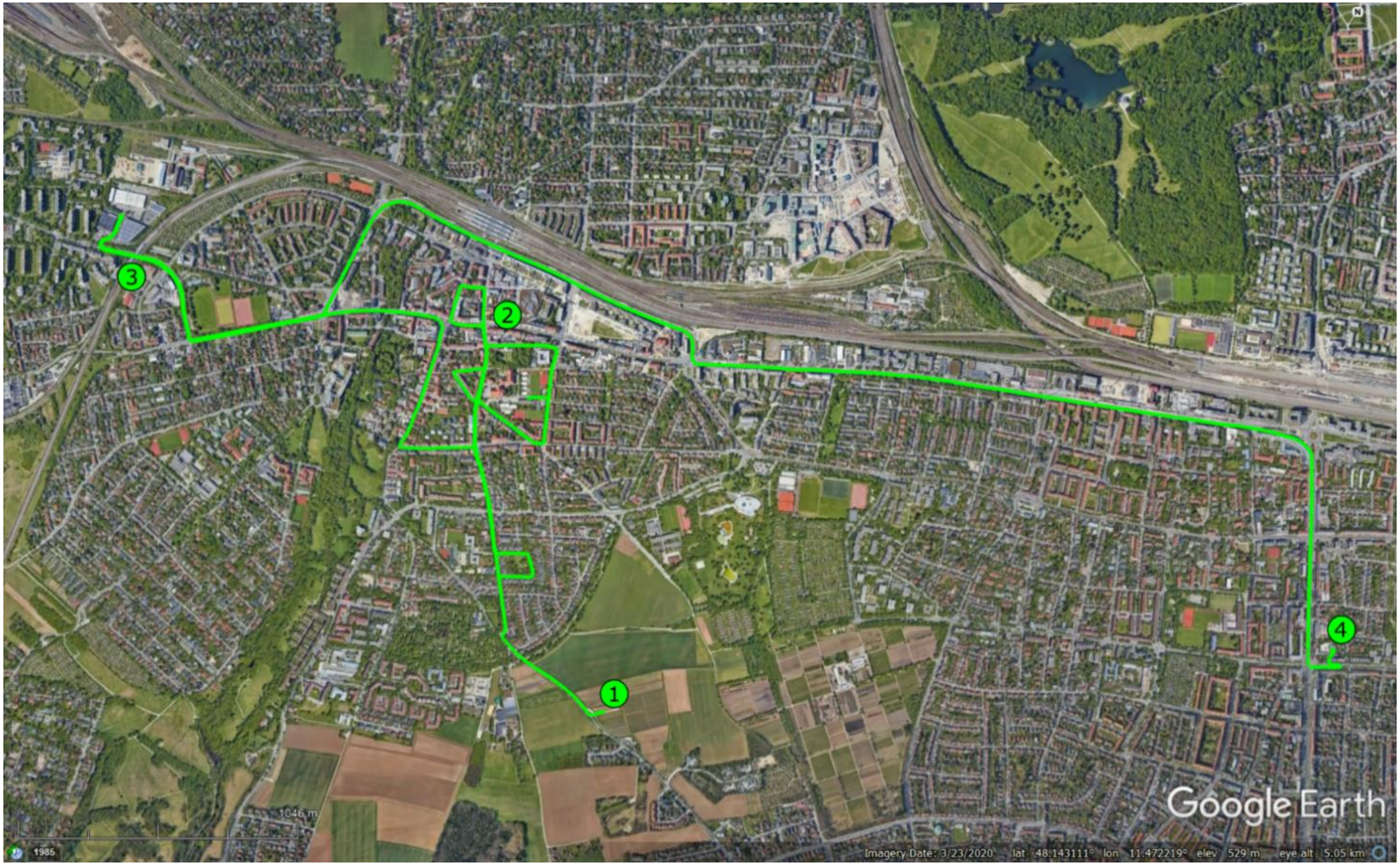
- Narrow street
- Lots of trees
- High multipath
- Low signal strength

red: GNSS-only **PPP**
yellow : GNSS + INS + ODO **PPP**
green: GNSS + INS + ODO **RTK** reference





Key Performance Results in Challenging Environment



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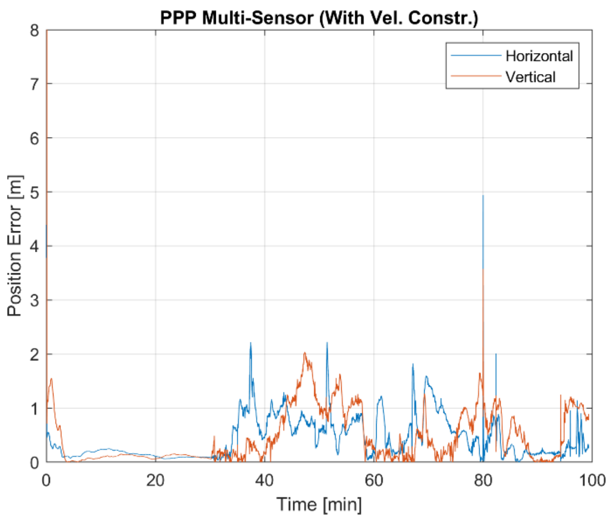
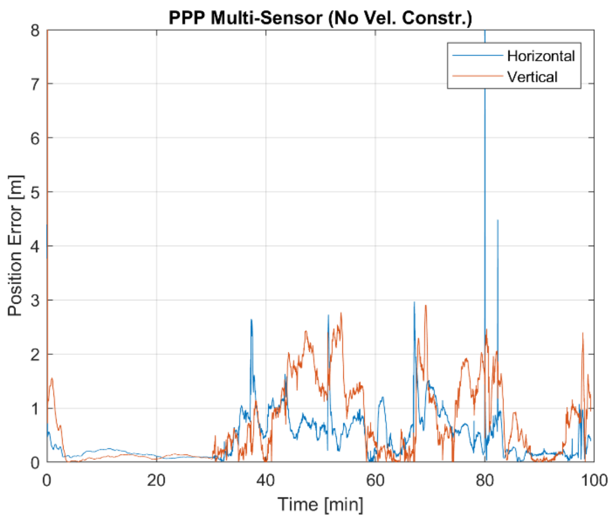
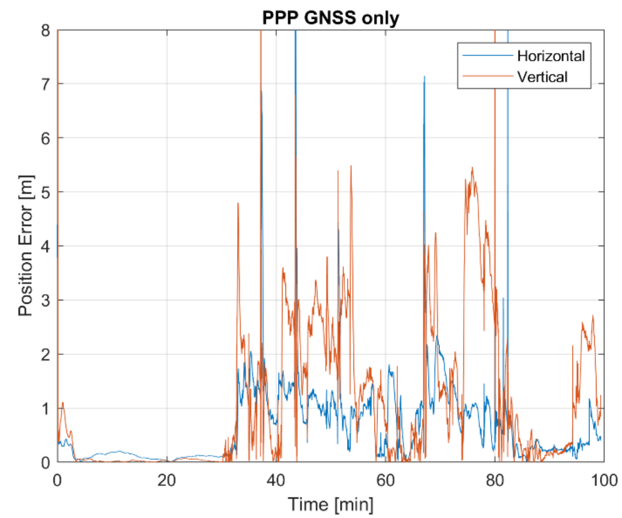






+

Multi-Sensor PPP with Velocity-Attitude Constraining

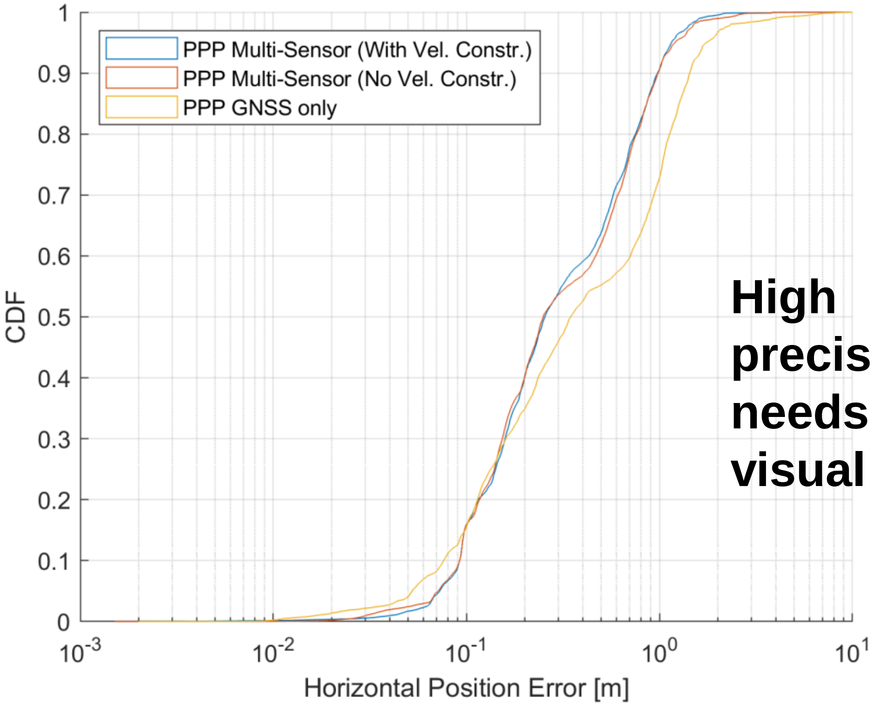
o

Multi-Sensor PPP without Velocity-Attitude Constraining

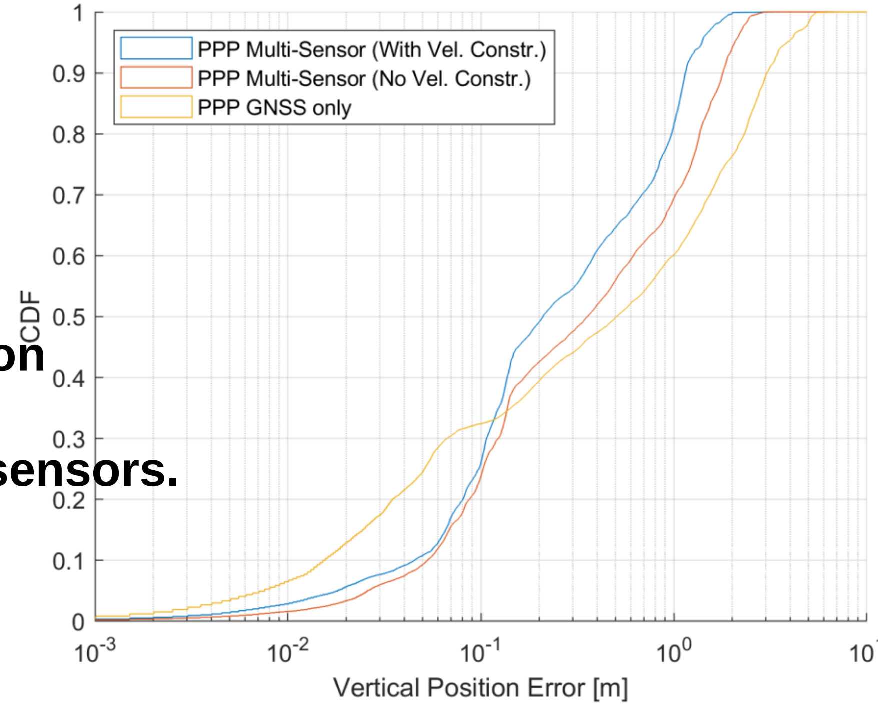
–

GNSS only PPP

Key Performance Results in Challenging Environment



High precision needs visual sensors.



Horizontal

90% Quantile: 98 cm

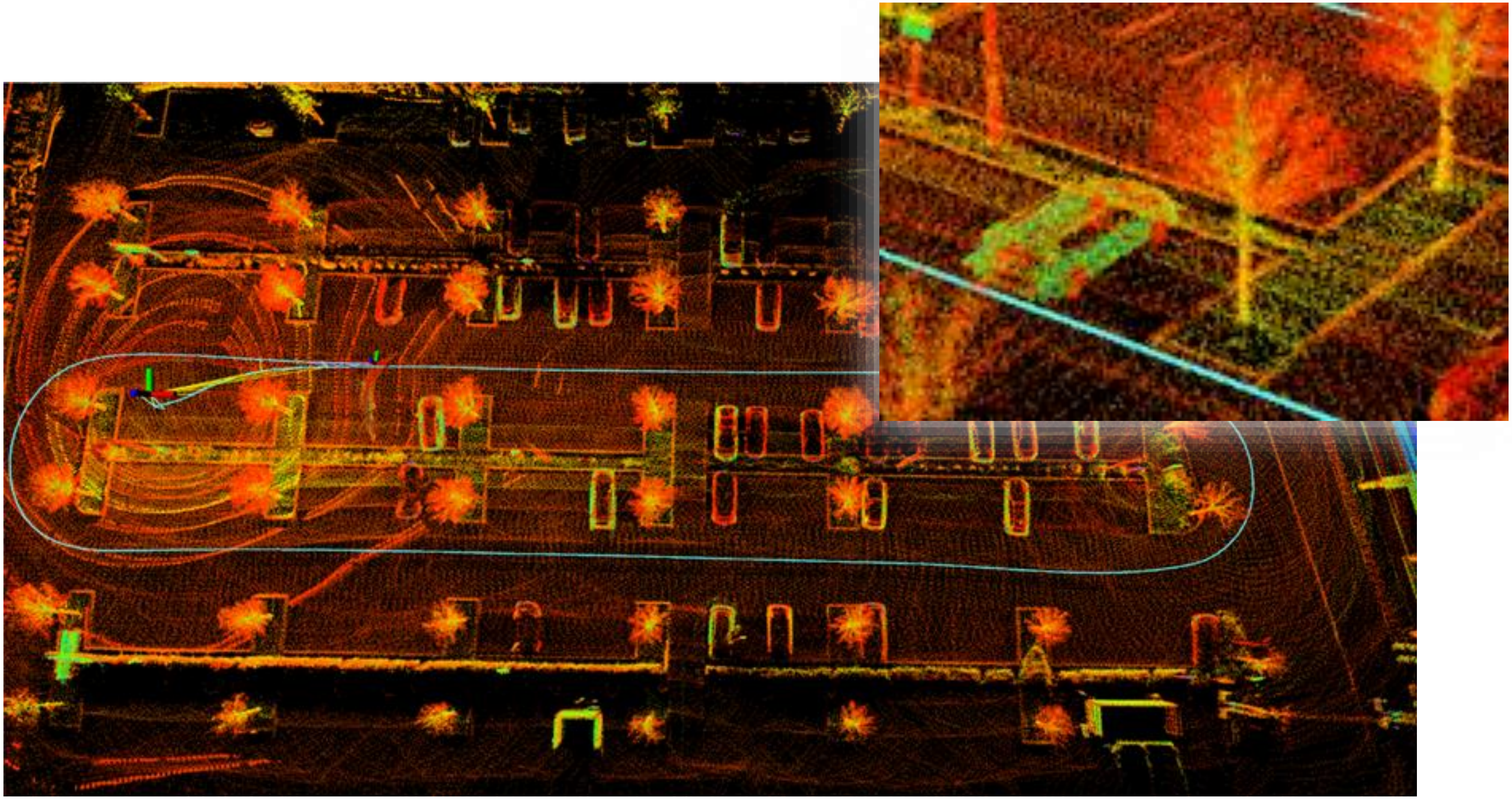
50% Quantile: 25 cm

Vertical

90% Quantile: 115 cm

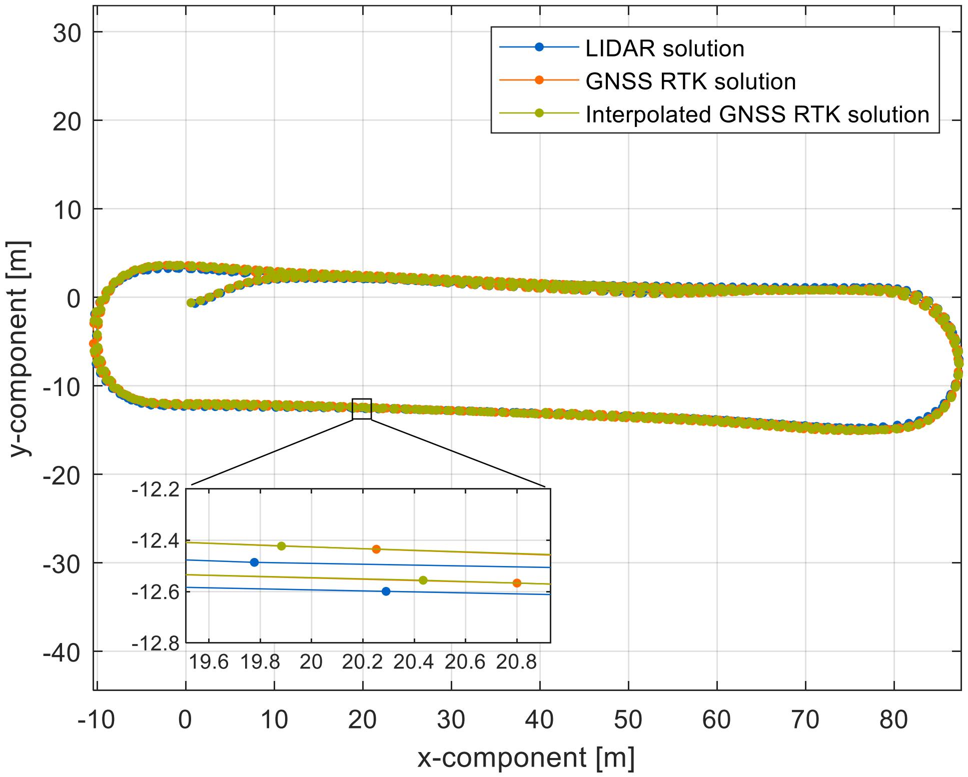
50% Quantile: 21 cm

Key Performance Results – 3D LIDAR SLAM



Key Performance Results – 3D LIDAR SLAM

Analysis of positioning accuracy
using GNSS/ INS tightly coupled RTK positioning as reference



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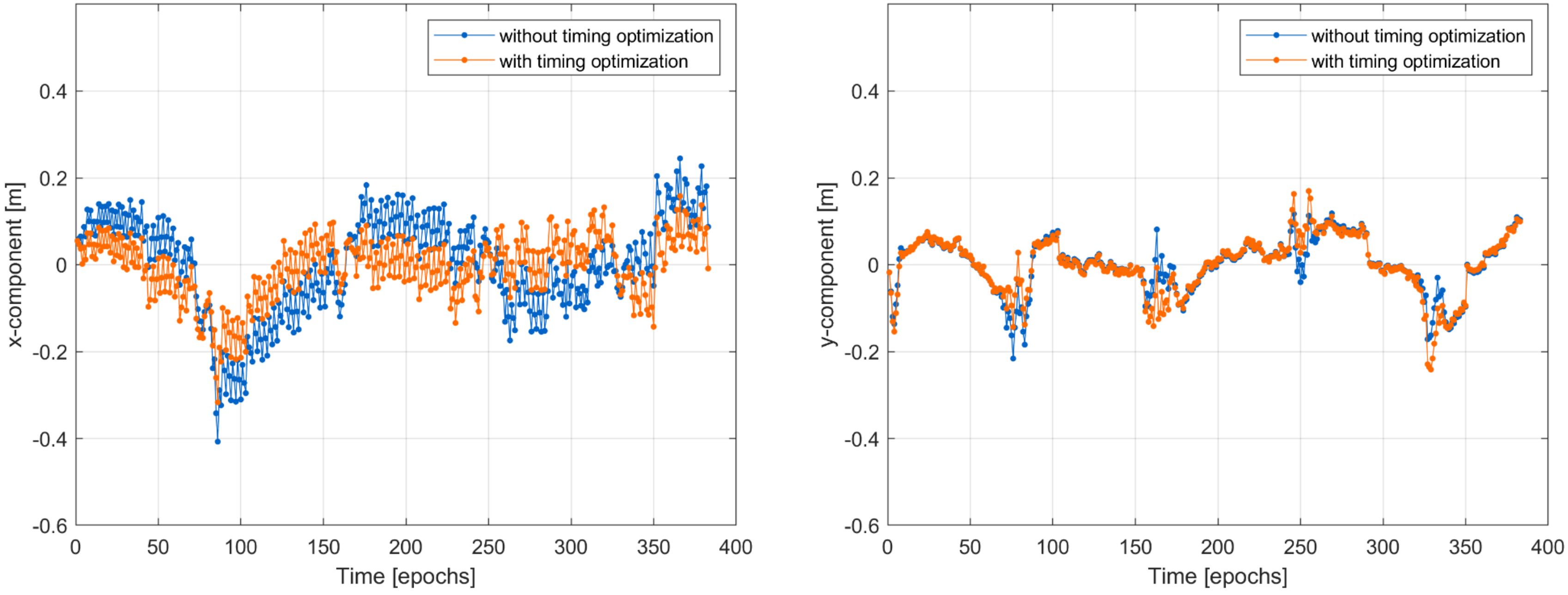


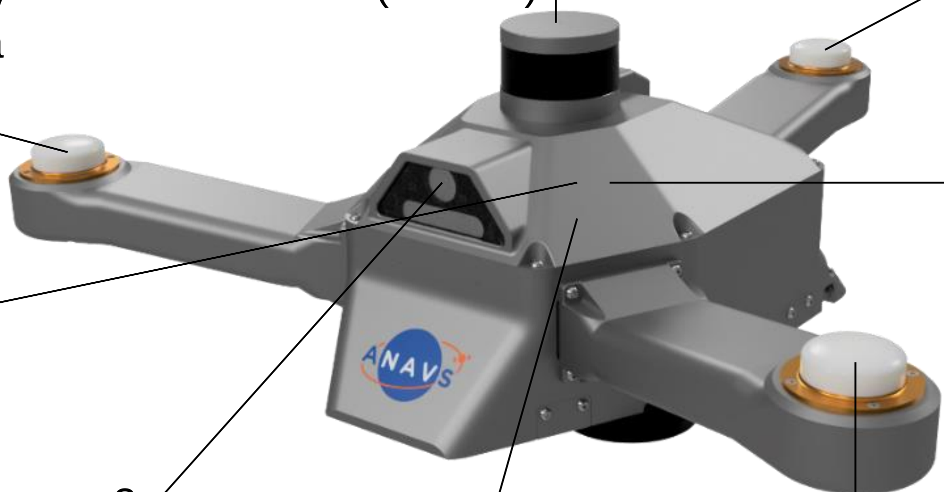
Testing with our Integrated Sensor Platform (ISP)

Velodyne Puck (VLP 16) Lidar:

- measurement range:	100 m
- measurement accuracy:	+/- 3 cm
- Field of view (horizontal):	360°
- Field of view (vertical):	30°

Multi-frequency GNSS antenna

Multi-frequency GNSS antenna



6-core Nvidia ARM:
GPU with
384 Nvidia Cuda cores
and
48 tensor cores

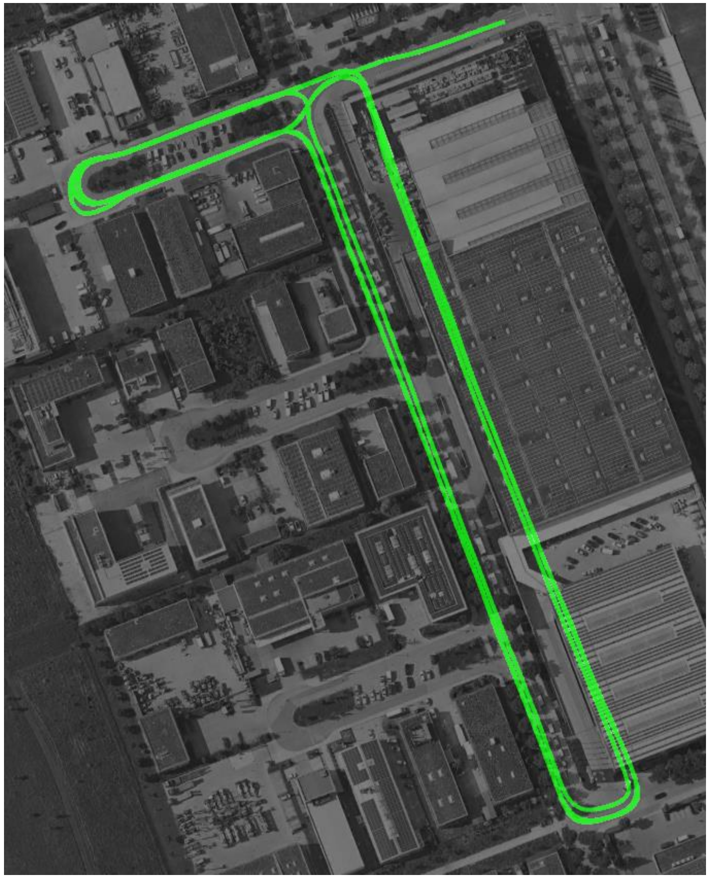
LTE

FLIR Grasshopper 3:
- 163 frames per second
- 1920 x 1200 resolution
- global shutter

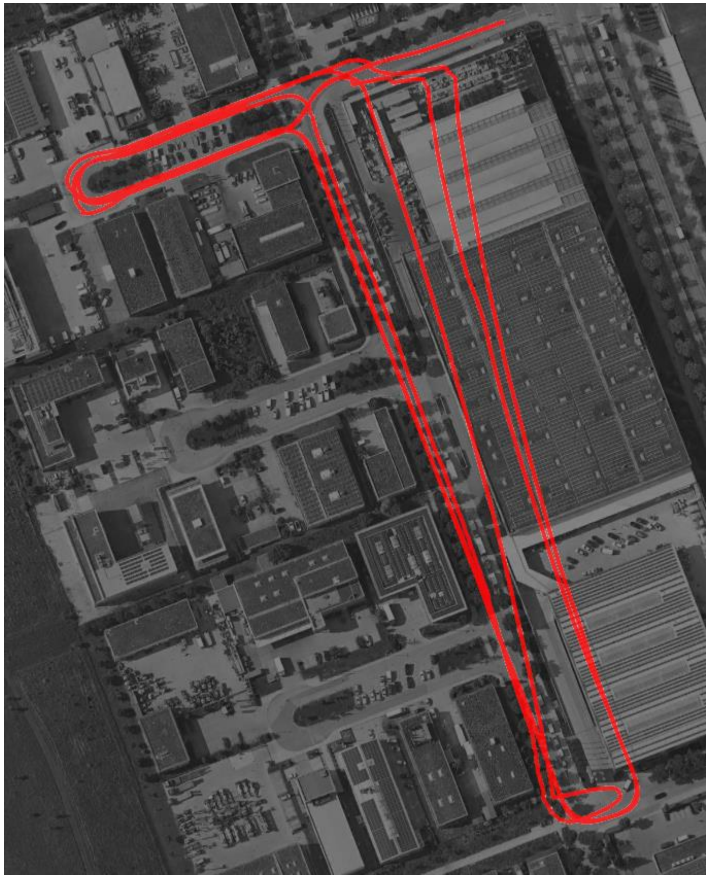
IMU with
3 deg/h bias stability

Multi-frequency GNSS antenna

Benefit of LIDAR in challenging environment

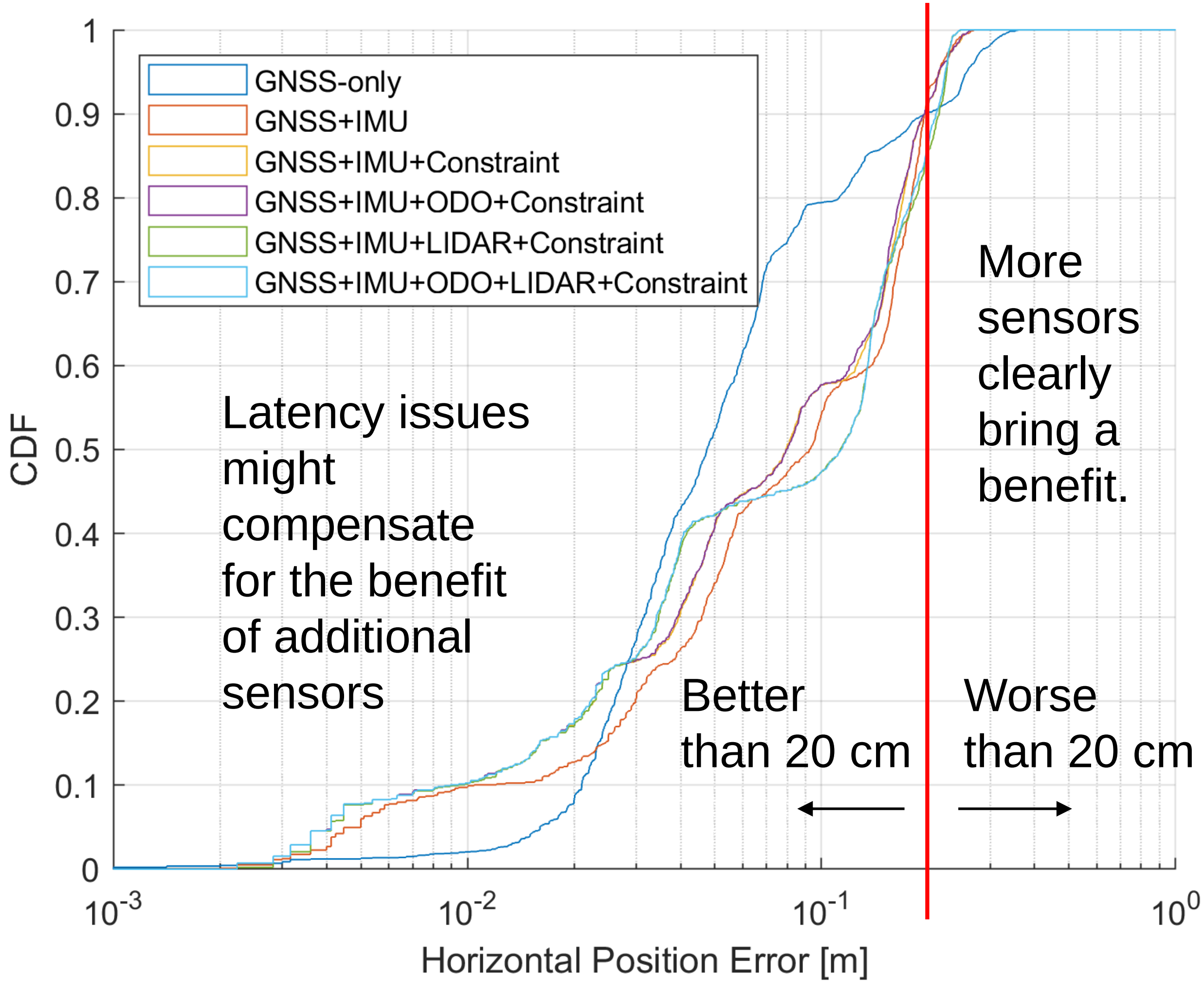


With Lidar

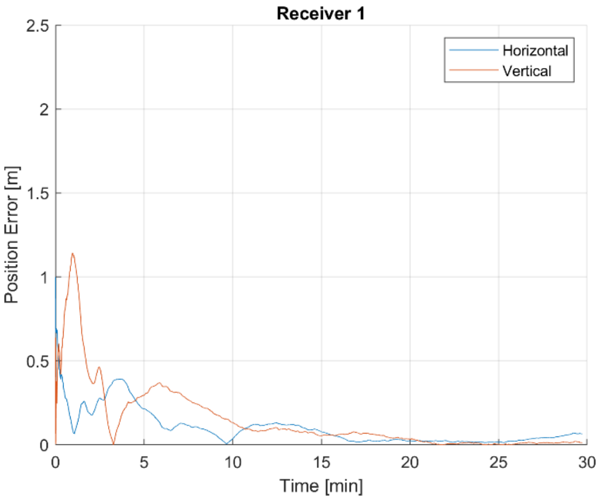


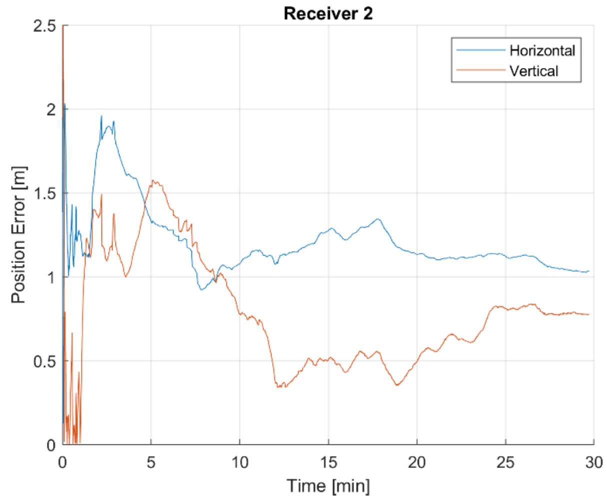
Without Lidar

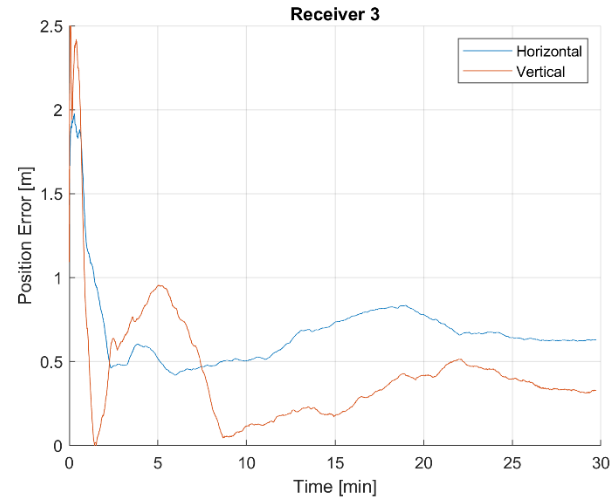
Statistical Assessment of Multi-Sensor Solution



Antenna Analysis



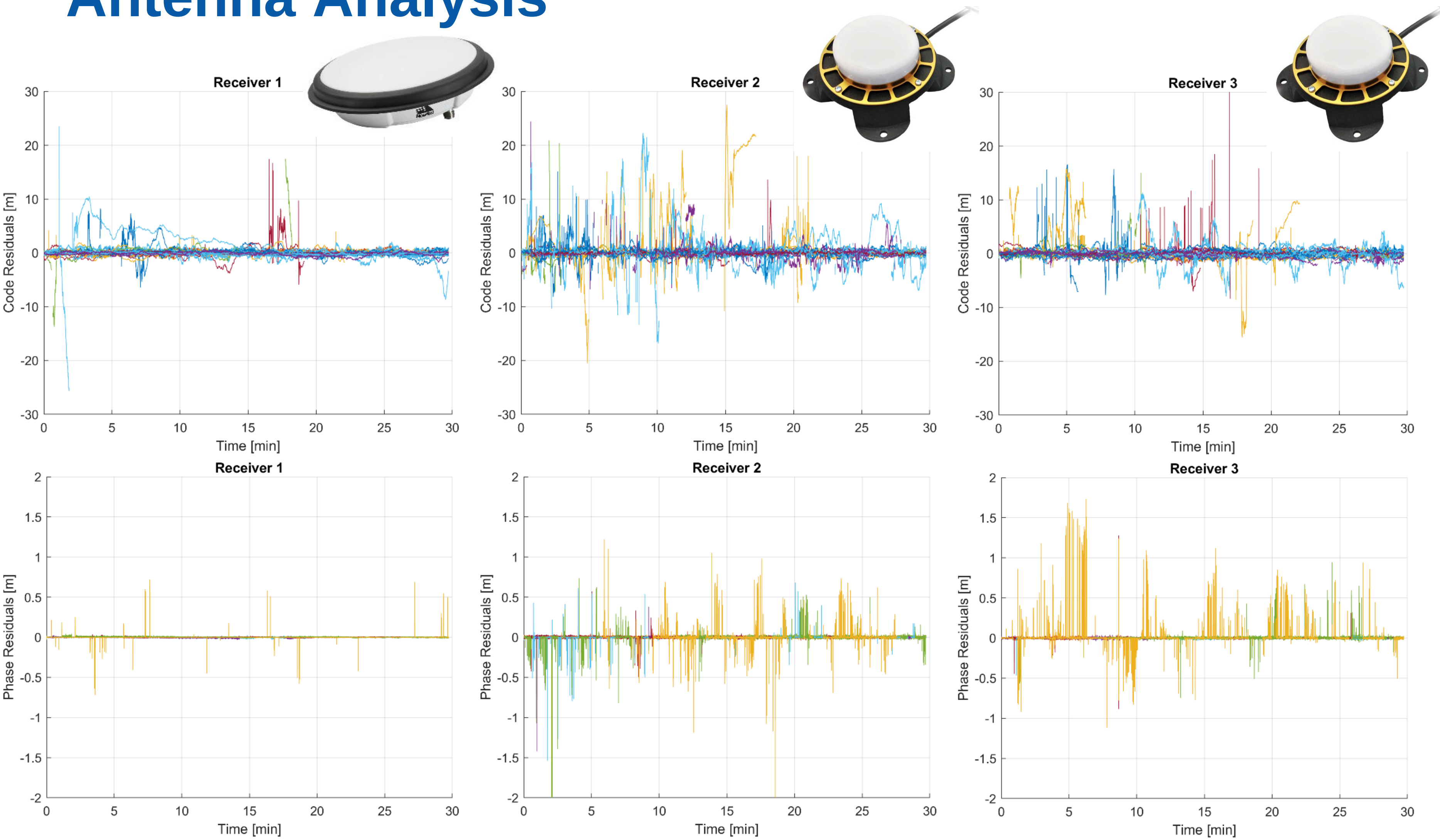




NovaAtel VEXXIS GNSS-850

Tersus AX3703

Antenna Analysis



Final Statements

- The project was an excellent opportunity for ANavS and helped to improve our products significantly.
- We would like to thank Paolo Zoccarato from ESA for the excellent supervision and valuable advice, and would like to thank both ESA and the German delegation for the funding of this project.