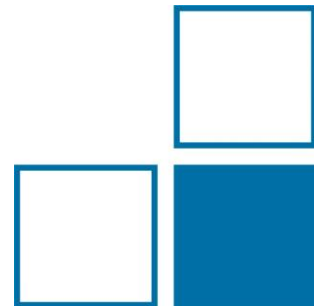


# Development of the Airborne Measurement Platform

EMWT, December 6<sup>th</sup> 2017

Marius Mihalachi



# Contents



- PTB UAS fleet
- UAS Setup
- Differential GNSS
- Interconnect Board
- Mission Planning
- Android App

- Use of UAS as universal measurement platform
- Up to 4 kg payload
- Onboard position and attitude stabilization
- Standalone flight system by means of GNSS and magnetometer
- Automatic flying of waypoints, flying around points of interest, triggering of waypoint-events
- Holding of a measurement position, flight time of 10 – 20 min.
- Telemetry data, FPV (First Person View)

# PTB UAS Fleet



PTBee 1



PTBee 2

# PTB UAS Fleet



2009

PTBee 1



2012

PTBee 2



WERAN

PTBee 3A



WERAN

PTBee 3B



WERAN

PTBee 3C



WERAN

PTBee 3D

# PTB UAS Fleet



PTBee 4

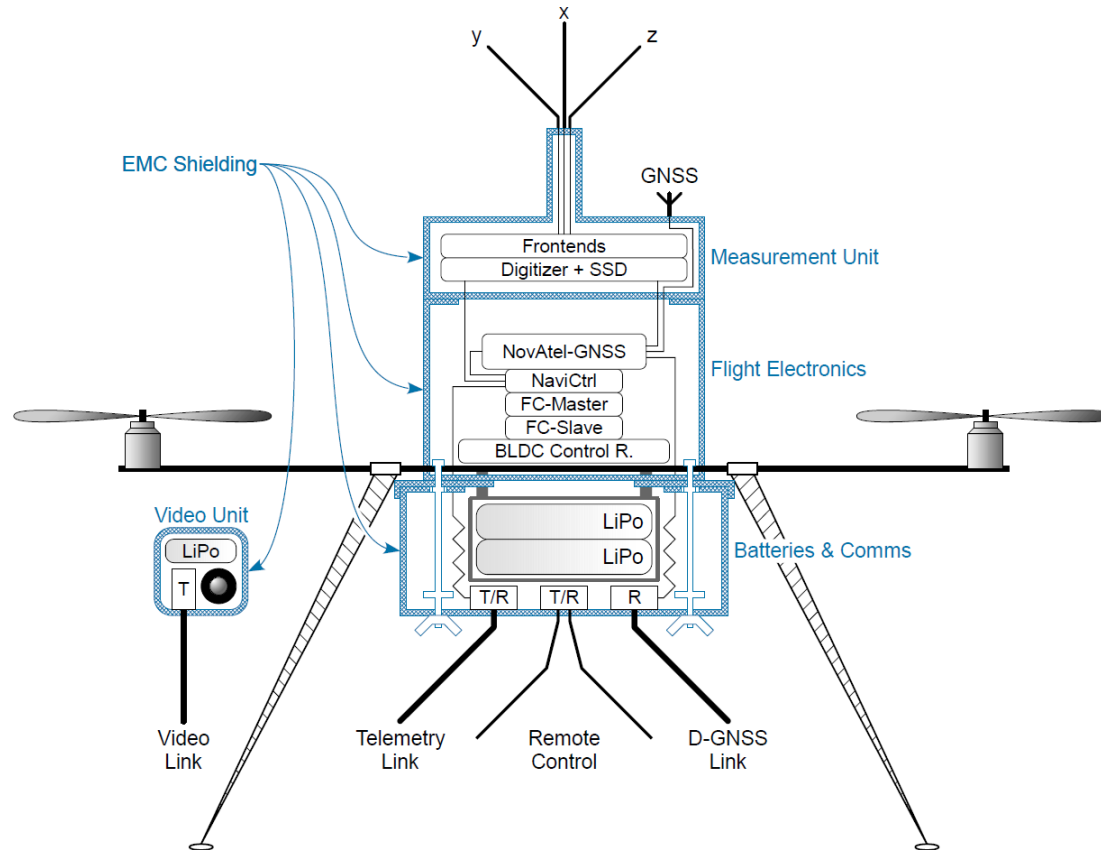


PTBee 3C

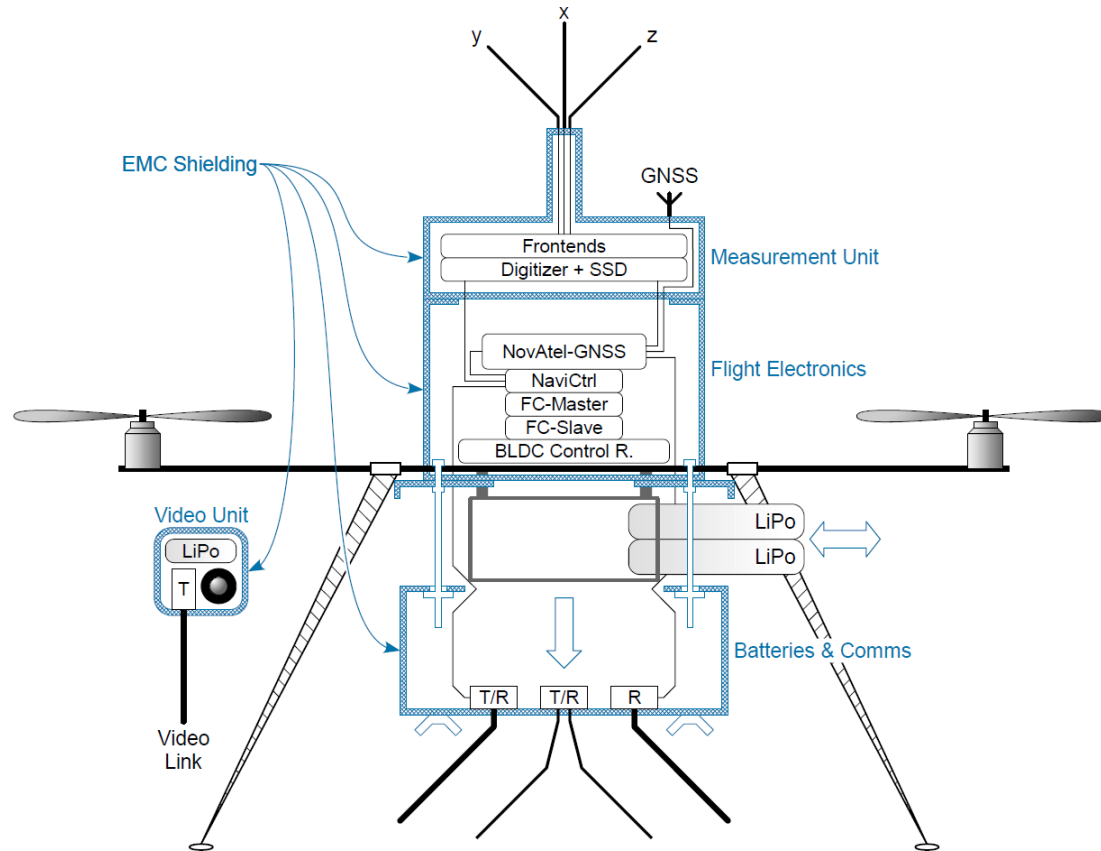


PTBee 3D

# UAS Setup





# UAS Setup





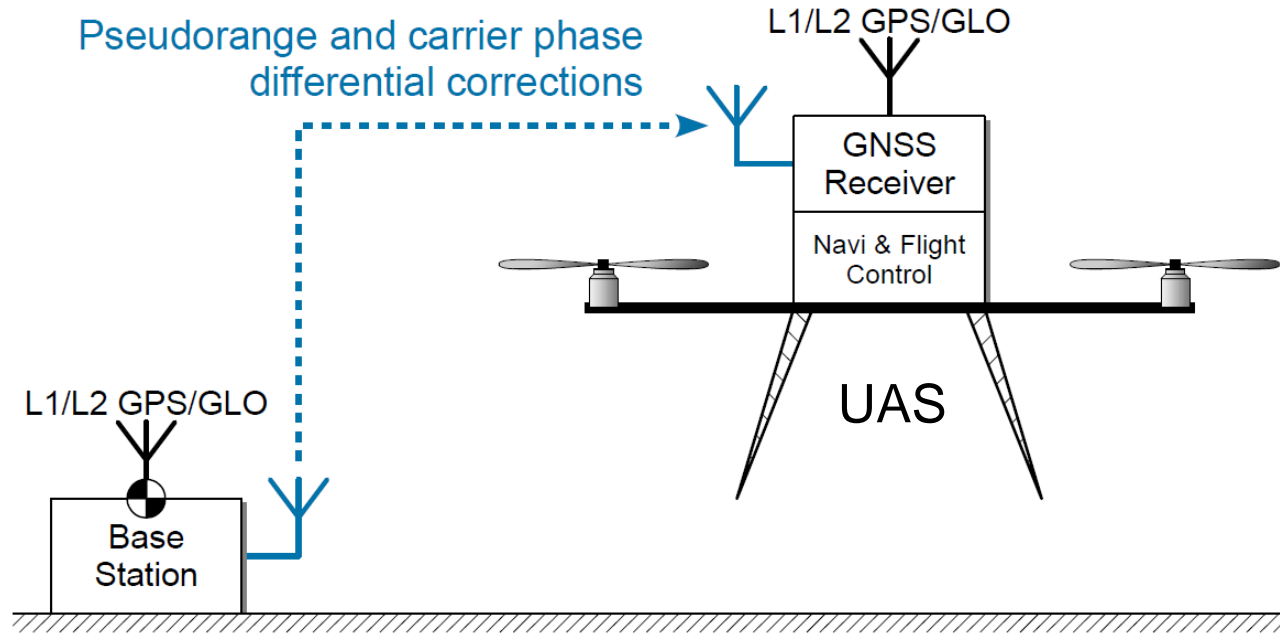
# UAS GNSS Receiver

Receiver			
		ublox LEA-6S	NovAtel OEM615
			
Antenna			
	Type	Passive	Active
	Form	Patch	Helix
	Constellations	GPS	GPS, GLONASS
	Tracking	L1	L1, L2
Horizontal Accuracy (Datasheet)			
	L1	2.5 m CEP	1.5 m RMS
	L1+L2	---	1.2 m RMS
	SBAS	2.0 m CEP	0.6 m RMS
	PR-DGNSS	---	0.4 m RMS
	RTK (RT-2®)	---	1 cm + 1 ppm RMS
Max. Refresh Rate			
		5 Hz	20 Hz

RMS = 1.2 x CEP

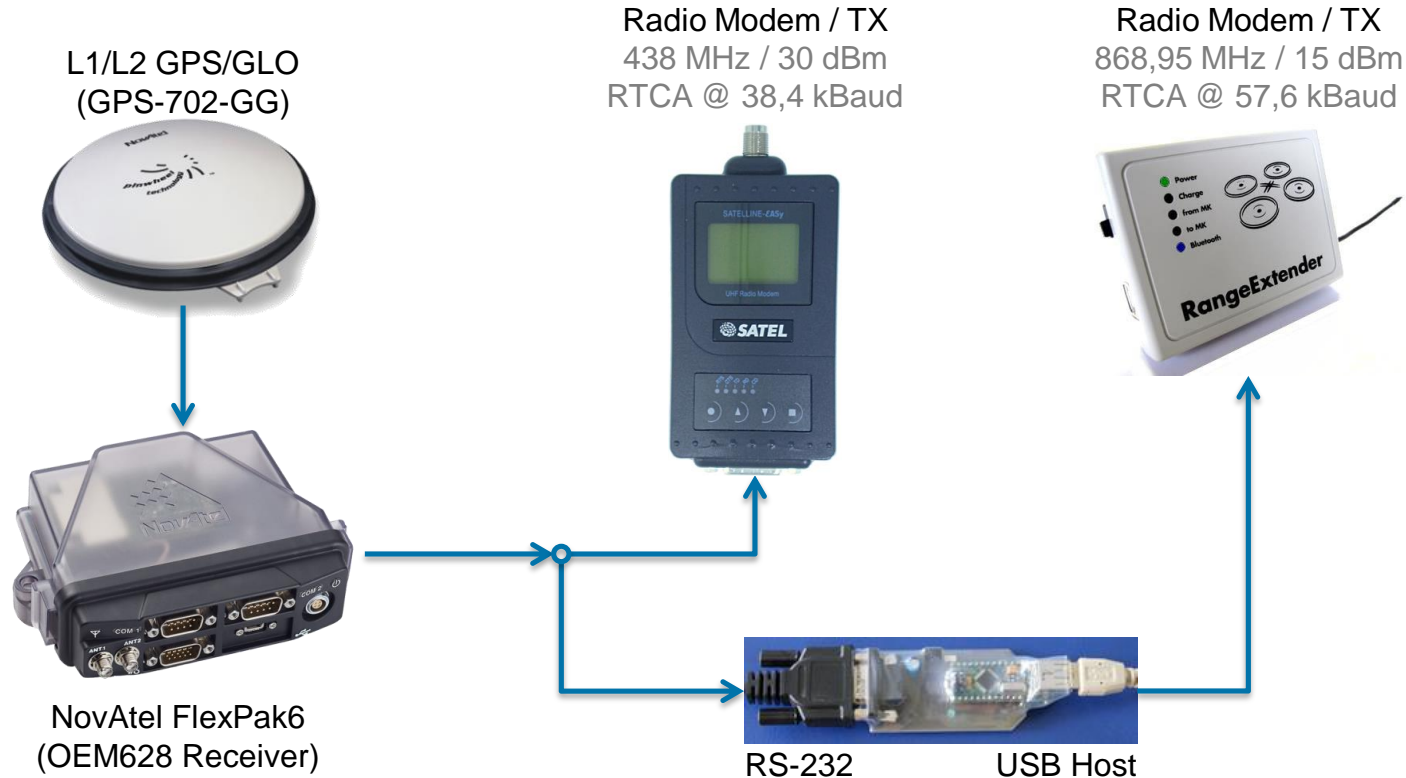
# Differential GNSS

## Overview



# Differential GNSS

## Basis Station



# Differential GNSS

## Basis Station

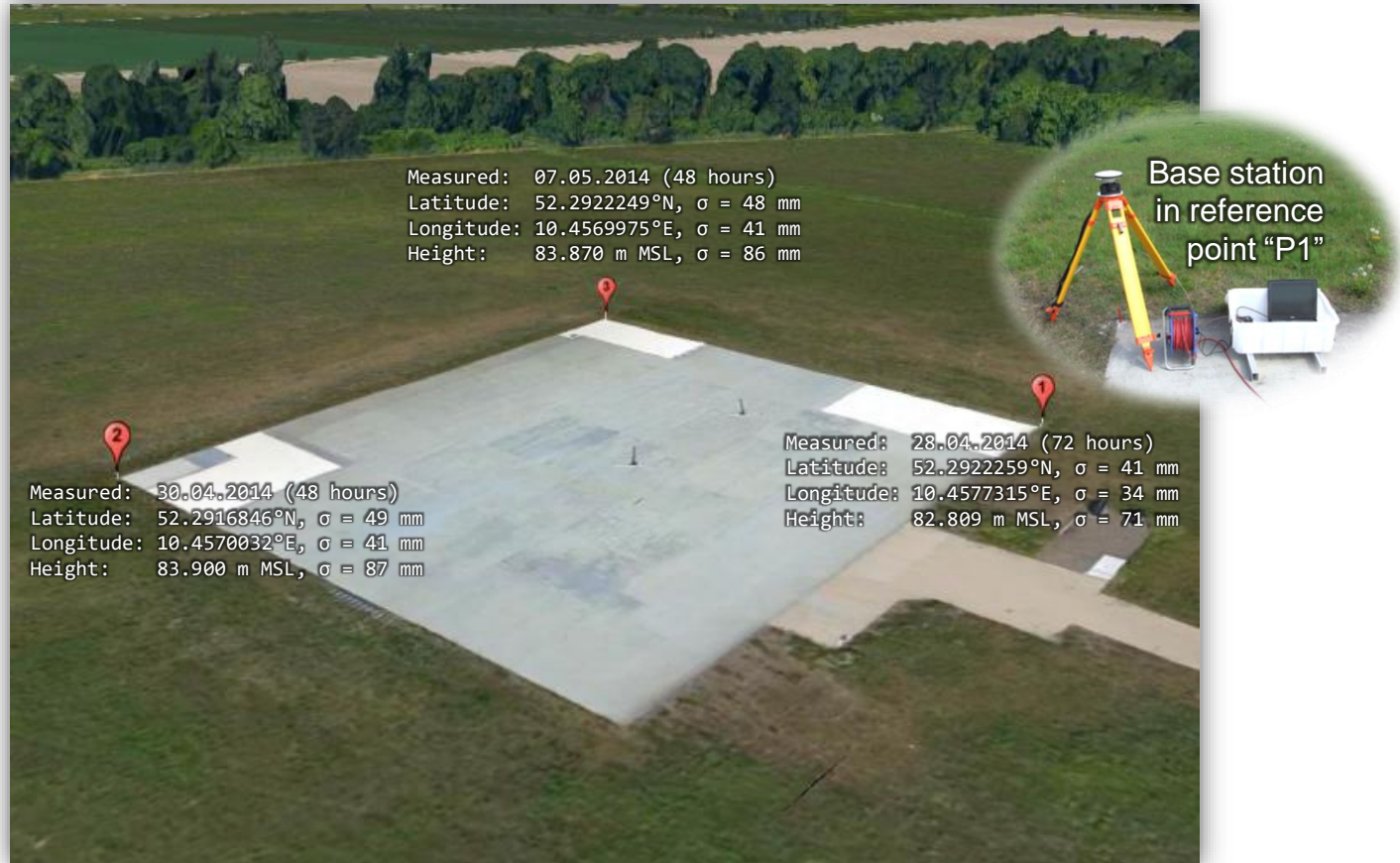
- After power-up the receiver starts the position averaging. During the averaging time the receiver will generate no correction data.
- As soon as the averaging process is completed, the receiver starts to generate correction data. The following RTCA Type 7, NovAtel proprietary, binary messages are used in order to transmit the GNSS differential corrections:



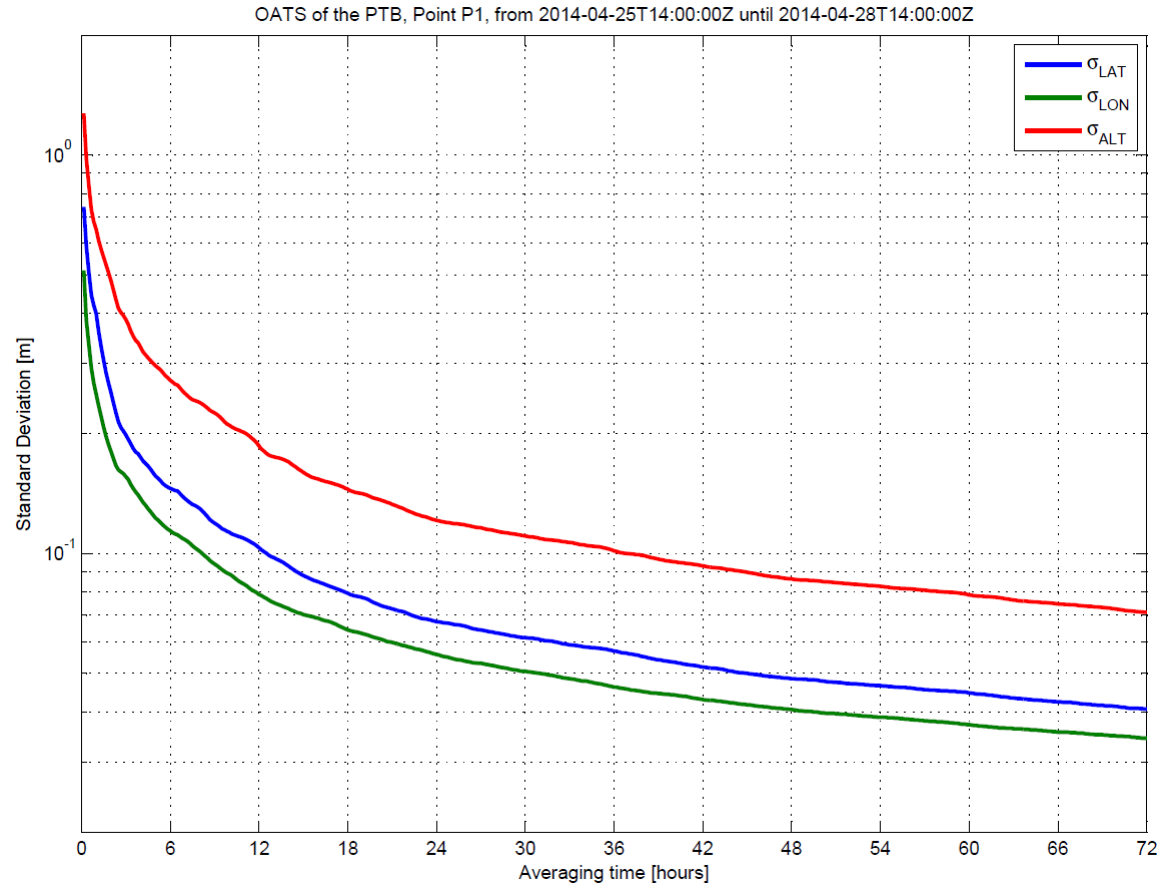
NovAtel FlexPak6  
(OEM628 Receiver)

$\Delta T$	Message	Contents
1 s	RTCAOBS2 (805)	Base Station Observations
5 s	RTCA1 (10)	Differential GPS Corrections
10 s	RTCAREF (11)	Base Station Parameters
10 s	RTCAEPHEM (347)	Ephemeris and Time Information

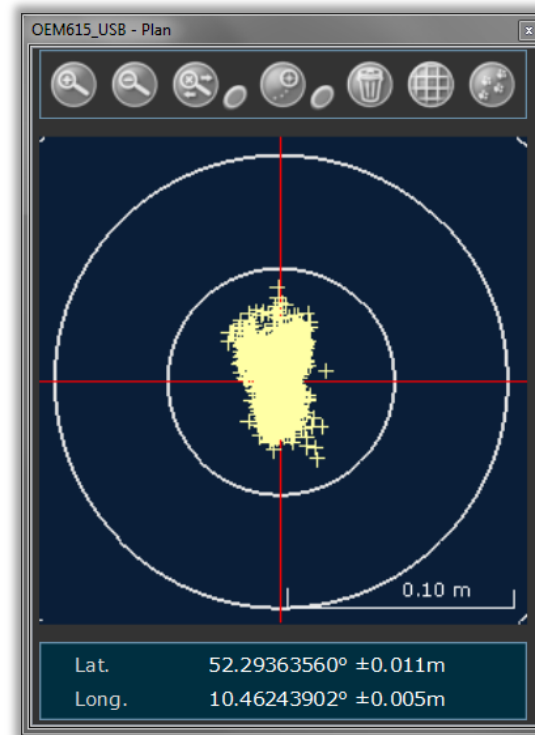
# Reference Points for Differential GNSS



# Differential GNSS: Position Averaging

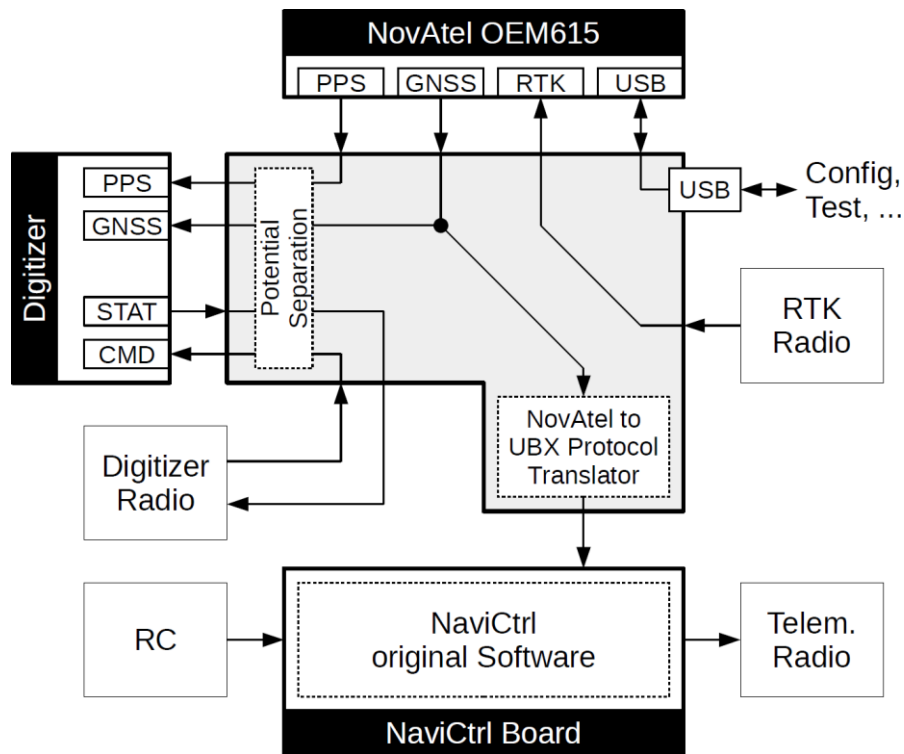


# Differential GNSS: Stationary Position



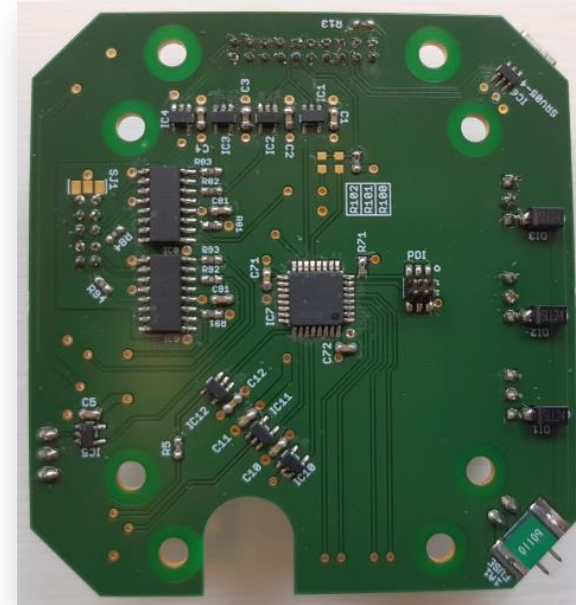
Measurement duration: 3 hours

# Interconnect Board





# Interconnect Board



# Interconnect Board

## Protocol Translator

Message	Bits	Time / ms	Description
BESTXYZB	1440	6.250	Best available Cartesian position and velocity in ECEF coordinates
BESTPOSB	1060	4.601	Best available position in longitude/latitude/height coordinates
BESTVELB	760	3.299	Best available velocity information
Total:	3260	14.149	

NovAtel ↓ 230.4 kBaud

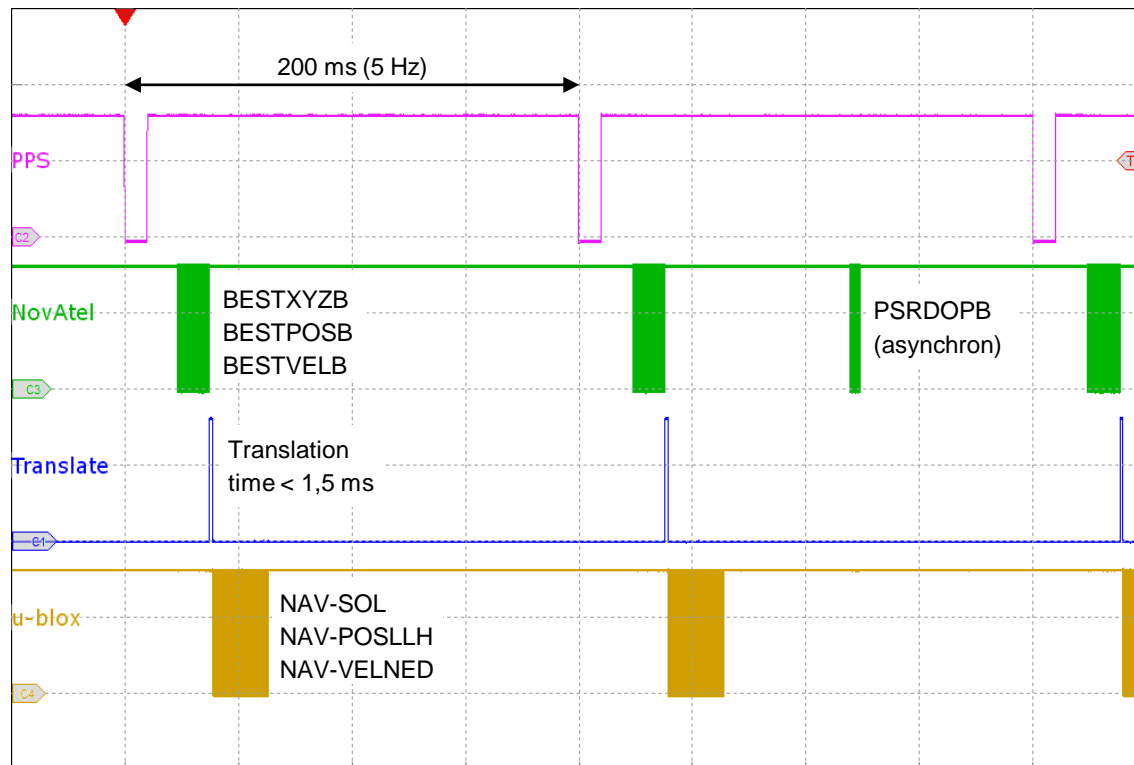
ATxmega32E5  
8-Bit, 32 MHz

u-blox ↓ 57.6 kBaud

Message	Bits	Time / ms	Description
NAV-SOL	600	10.417	Navigation solution information (in ECEF coordinates)
NAV-POSLLH	360	6.250	Geodetic position solution (longitude/latitude/height
NAV-VELNED	440	7.639	Velocity Solution in NED (North/East/Down) coordinates
Total:	1400	24.306	

# Interconnect Board

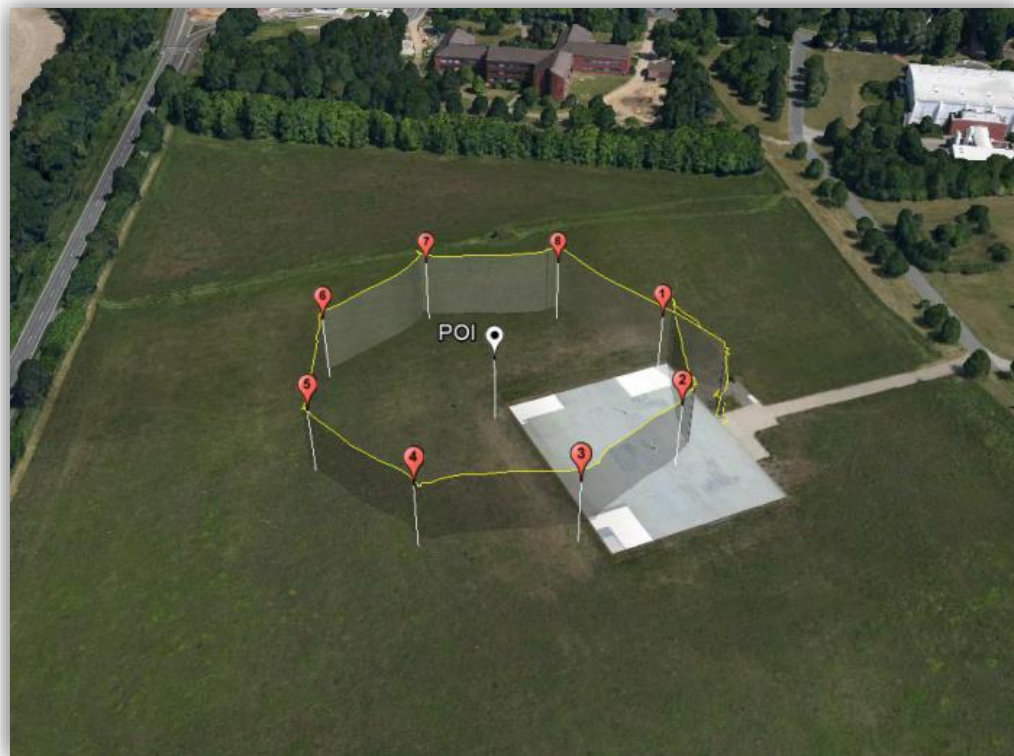
## Protocol Translator



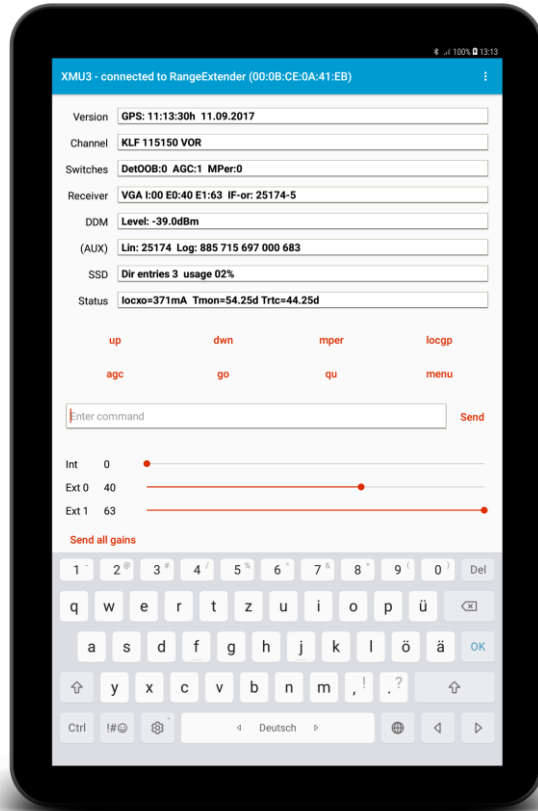
# Mission Planning



# Flight Data in Google Earth



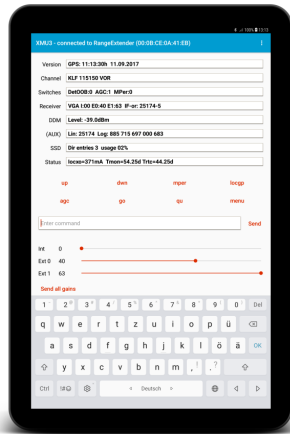
# Android App



- Standard Android App (apk), current version is 3.2
- Full duplex communication over Bluetooth
- Macro definitions for frequently used commands
- (Re-) configurable by the *Digitizer Board* during operation



# UAS Operation during Measurement



- A commercially available UAS was converted into a **scientific airborne platform for on-site EM measurements**
- Measurements can be carried out in a given point in space for an arbitrary\* time duration and with minimal influence on the measured field
- The positioning precision of the platform was greatly improved by use of state-of-the-art GNSS receivers
- The EMC susceptibility was improved against in and out of band interferences by means of shielding
- Video documentation of each measurement flight as well as real-time video downlink (FPV)
- Real-time monitoring and control of the measurement unit using the Android App

\* Subject to the life of the battery pack





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