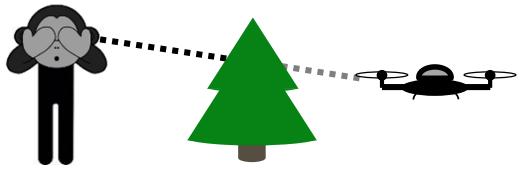
Navigation

Testbeds for Unmanned Aircraft Systems Beyond Visual Line-Of-Sight

AHORN 2018, Veysonnaz



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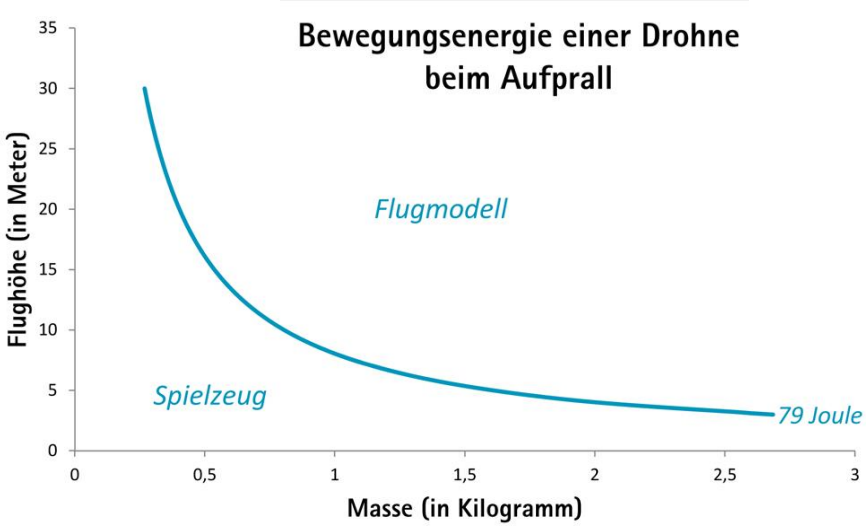
- Introduction to Unmanned Aircraft Systems
- Project DEMONA
  - Navigation module
  - Testbed: Ultralight aviation
  - Test flights
  - **Challenges and limits**
  - Testbed: Drone
- Applications in the Alps

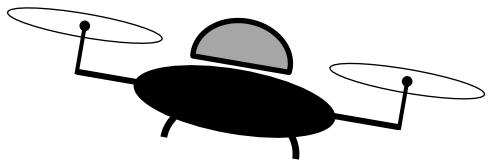
Unmanned Aircraft – what is it?

- Unmanned Aircraft System (UAS),
  (UAV, Remotely-piloted aircraft system (RPAS), *drone*)

- Toy drones up to 79 joule kinetic energy,
  max. height 30 m over ground, max. 250 g,
  not in the aviation law (Luftfahrtgesetz, LFG)



Source: bmvit



Unmanned Aircraft – what is it?

- 3 classifications of *UAVs* in the law (§24 LFG):

Aircraft Model

non-commercial use | *VLOS* | *up to 25 kg* | *up to 500 m action radius*

license required (for altitudes beyond 150 m)

Drone Class I

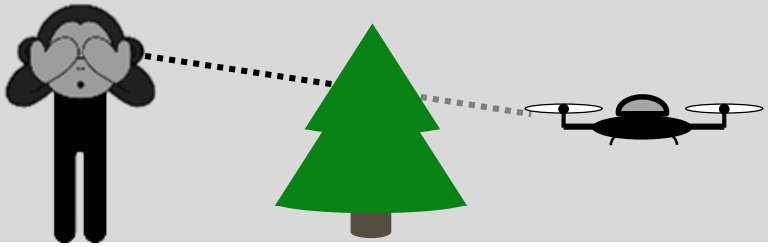
commercial use and/or camera (piloting-unrelated) | *VLOS*

license required

Drone Class II

commercial use | *BVLOS*

license required



- Currently, the ICAO (International Civil Aviation Organization) does not provide minimal standards for
  - the necessary data link used for piloting and monitoring of the aircraft
  - the required collision avoidance for ground-based and airborne obstacles (*detect & avoid*)
  - the required navigational performance for ensuring a securely delimited flight path from other air traffic

ICAO

- Demonstration of UAS Integration for VLL (Very Low Level) Airspace Operations
  - BMVIT/FFG: Program line TAKE OFF 2015
  - Development of a licensable reference architecture for lightweight UAS class II and minimal equipped mobile ground control station
- Project consortium:

FH JOANNEUM Luftfahrt / Aviation

IGASPIN

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

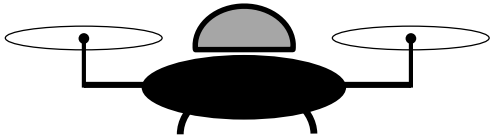
ifG TU Graz

austro CONTROL

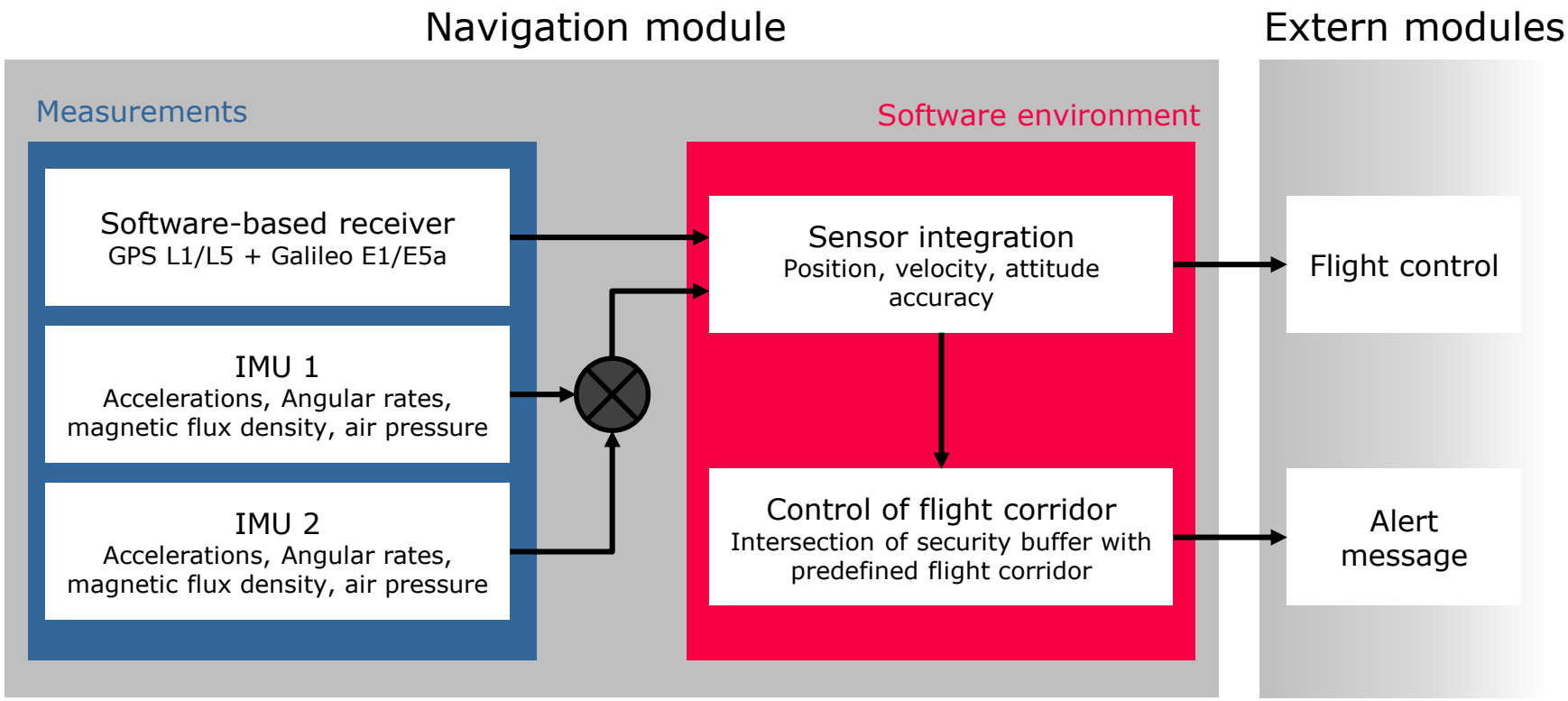
TeleConsult AUSTRIA

DRONERESCUE.AT

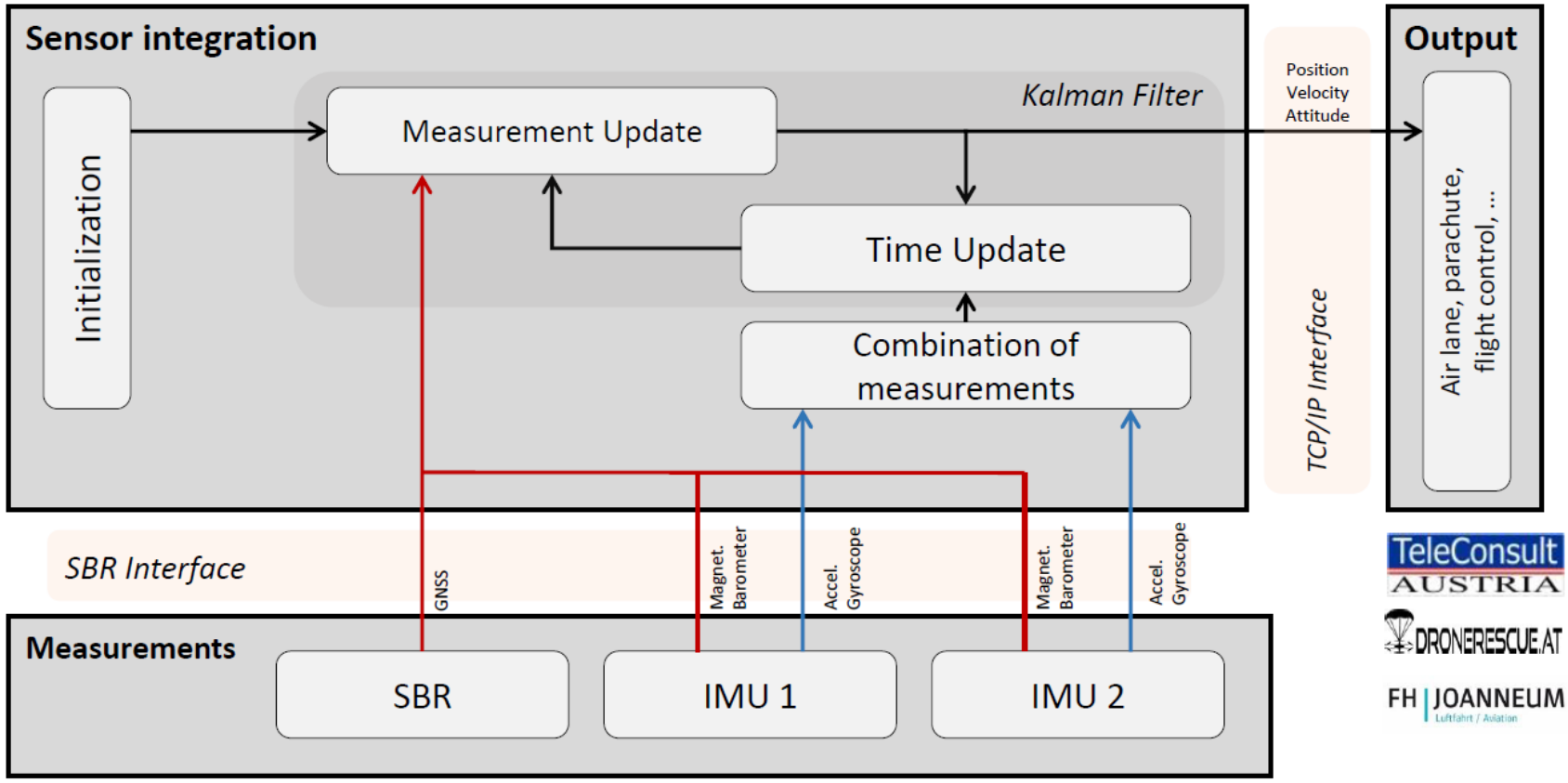
- 3 innovative components:
  - GNSS software receiver
    - GPS + Galileo
    - Multi-frequency signals
  - Integration with inertial data
    - Bypassing of GNSS outages
    - Increase of measurement redundancy and security
  - Quantification of potential positioning errors
    - Maintainance in designated flight corridor



Navigation module



Navigation module



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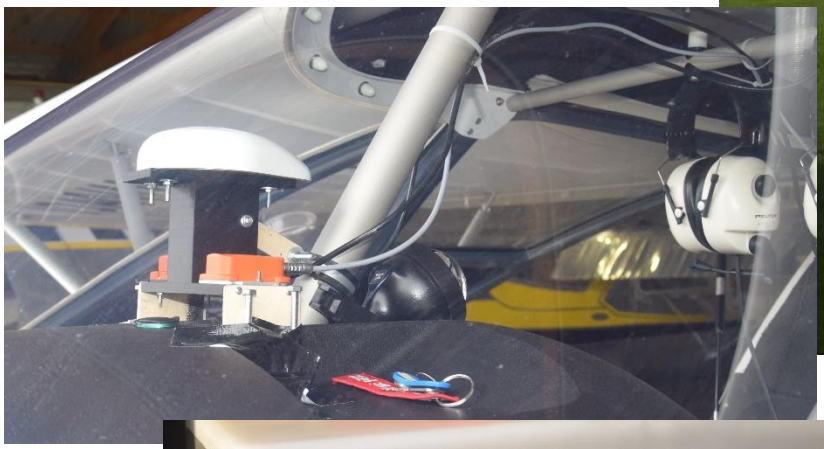
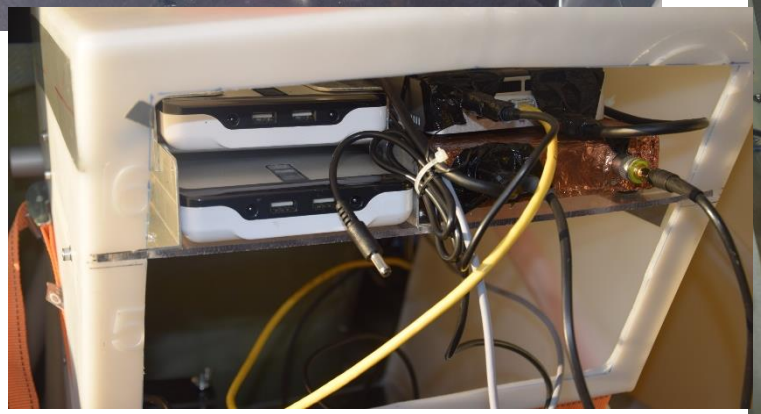
SBR ... Software-based Receiver

Testbed UL

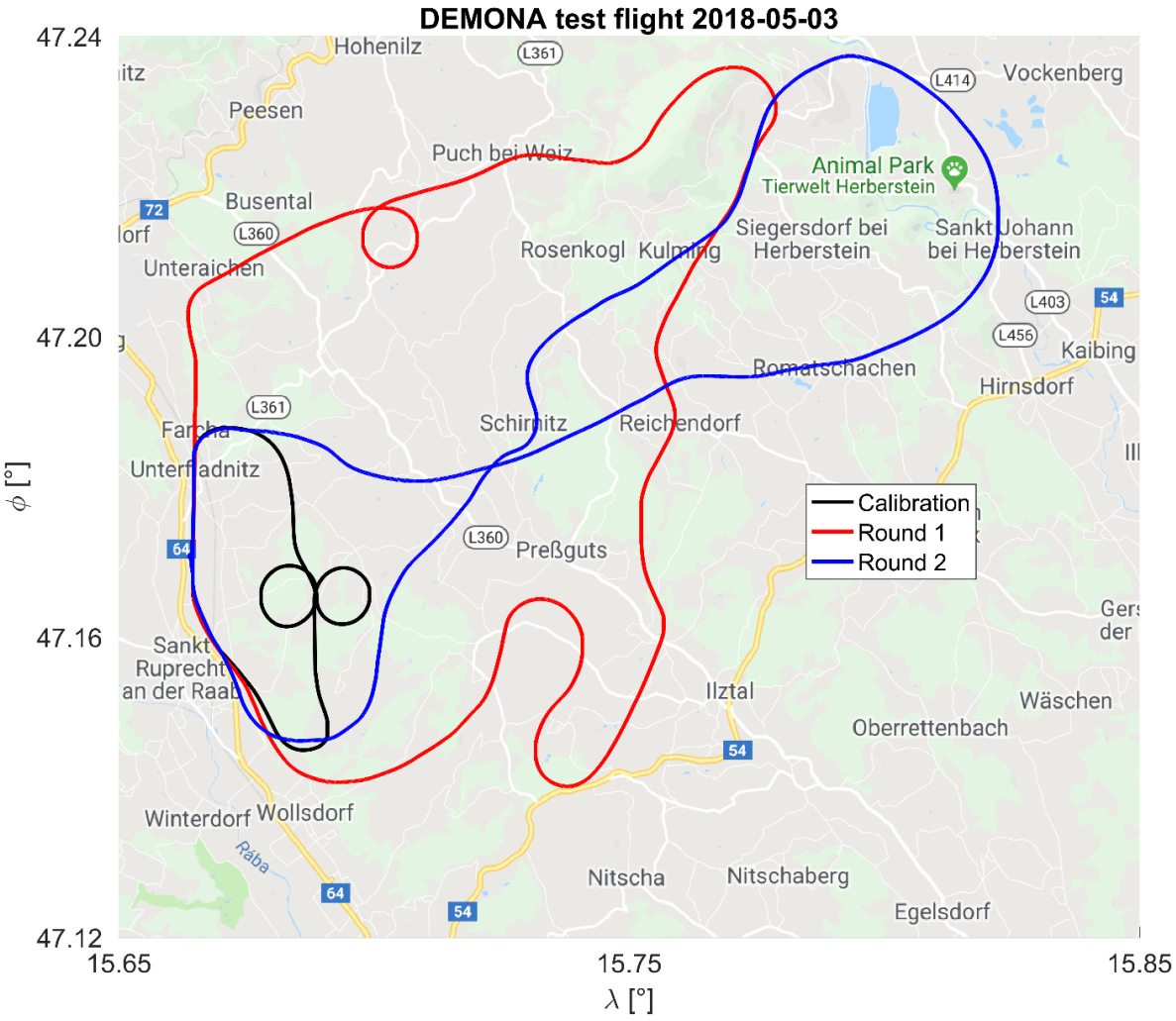
- Ultralight (UL) aviation





- Determination of leverarm (IMU to GNSS antenna)

Test flight UL



Challenges and limits

Latency of data signal

Not enough satellites (L1+L5)

Ionosphere

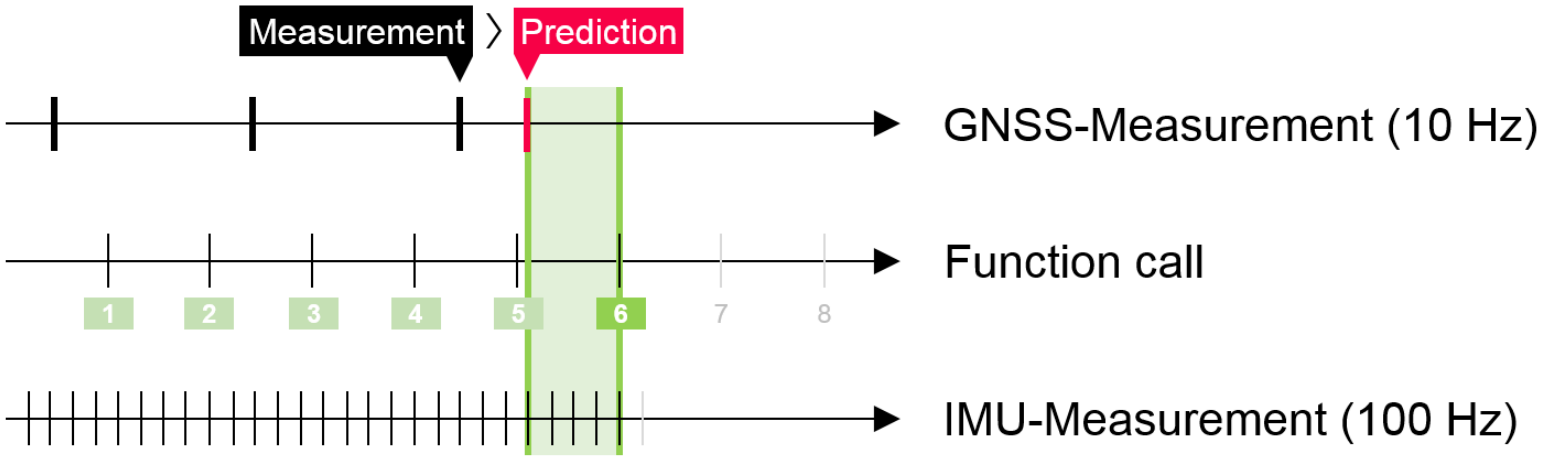
IMU noise

Propeller vibration

Magnetic disturbances

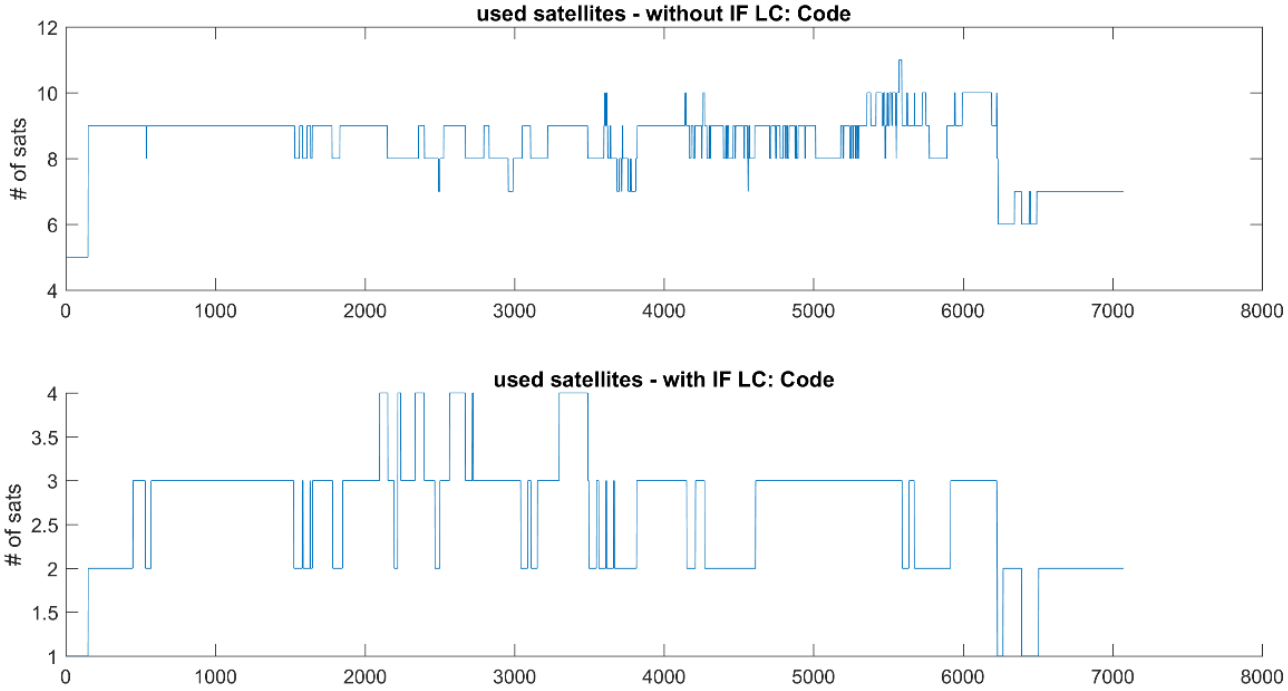
Challenge: latency of data

- GNSS Preprocessing causes latency, raw data is „late“
  → Approach: loosely coupled Kalman filter
  - Separate „GNSS filter“ → Prediction to current epoch and integration with current IMU data in „Integration filter“



Limit: not enough satellites

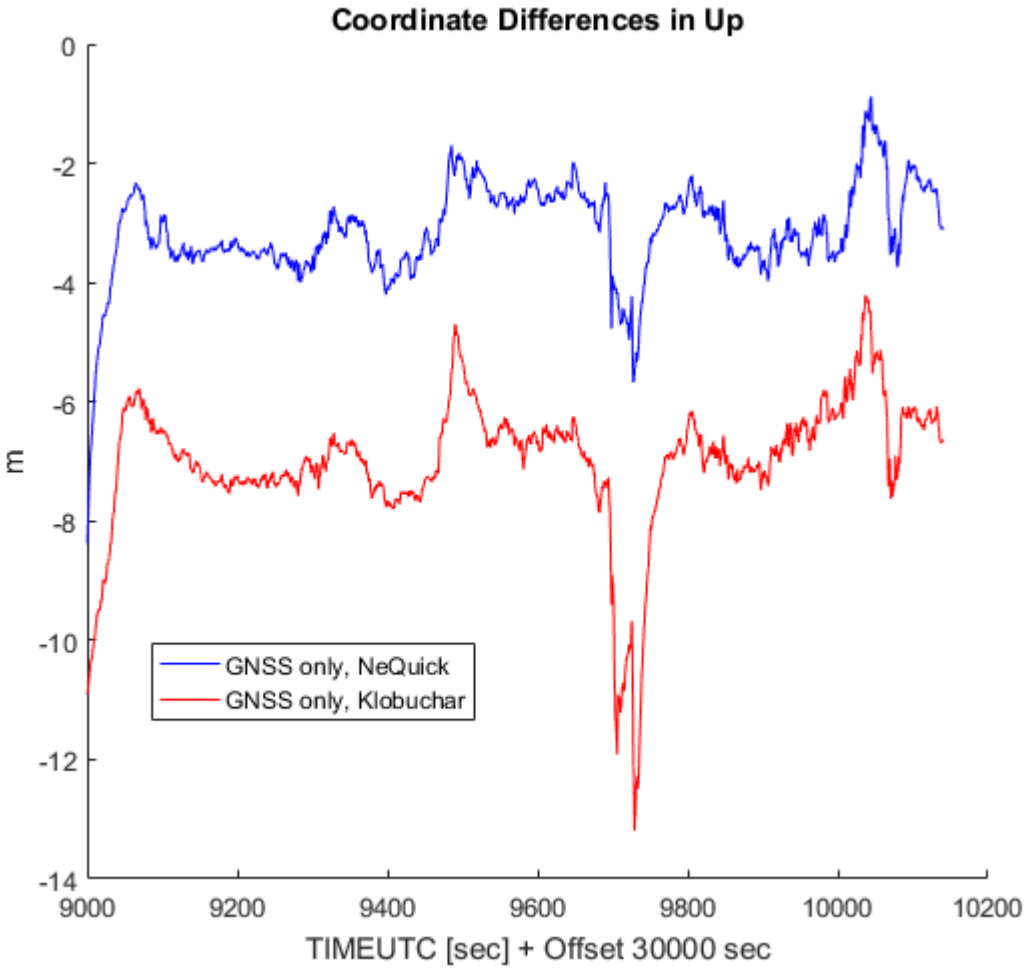
- Ionosphere-free Linear Combination (IFLC) not applicable



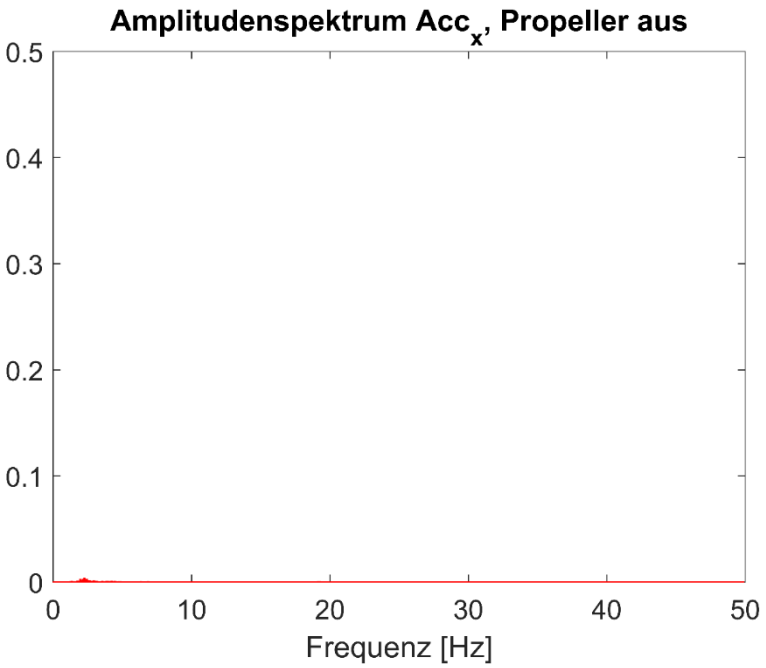
Ionosphere model

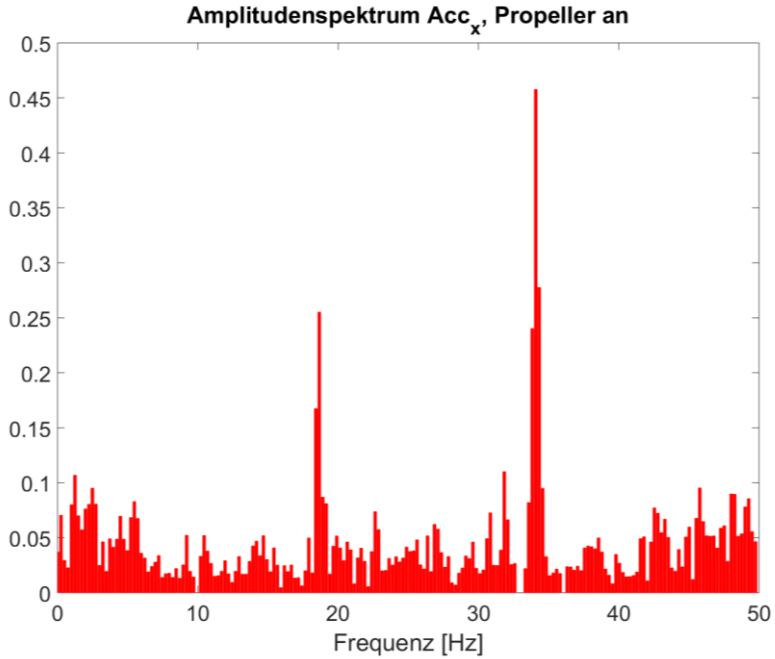
Empirical models based on parametrisation of large amount of collected data:

- Klobuchar
  - reduces about the 50% RMS ionospheric range error
- NeQuick
  - designed to reach a correction capability of at least 70% of the ionospheric code delay (RMS)



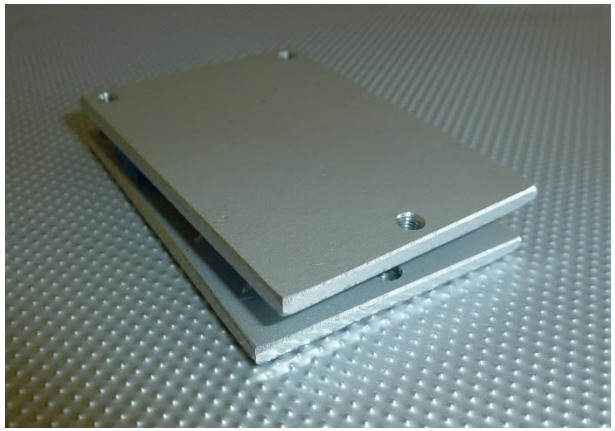
- 2nd test flight – Propeller causes vibration

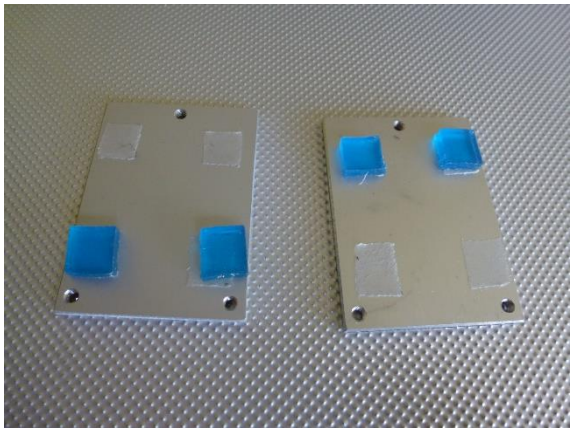




Vibration damping

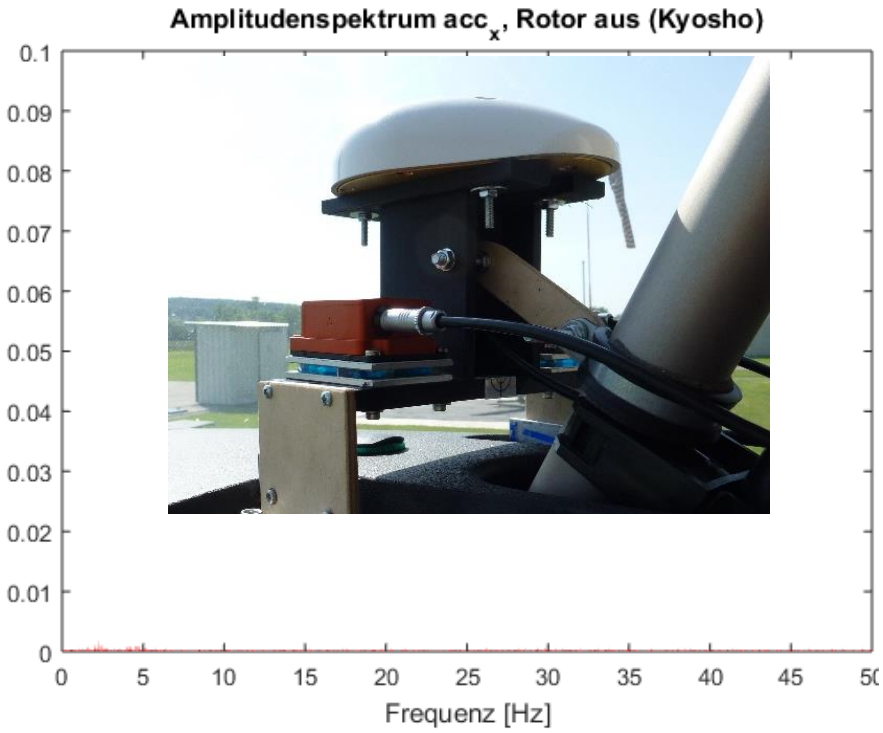
Kyosho
Zeal Tape

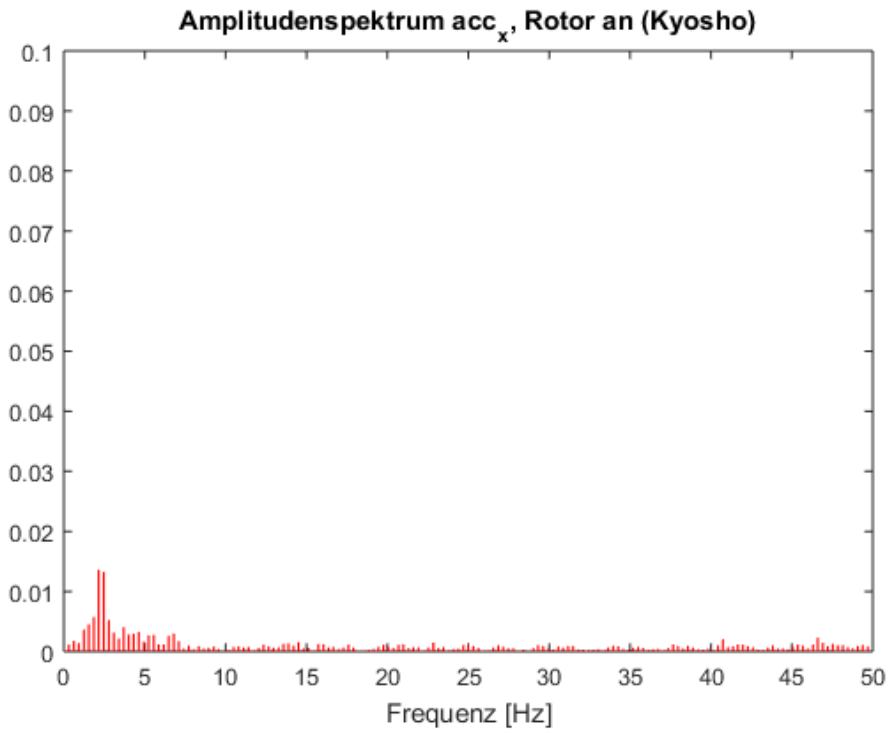




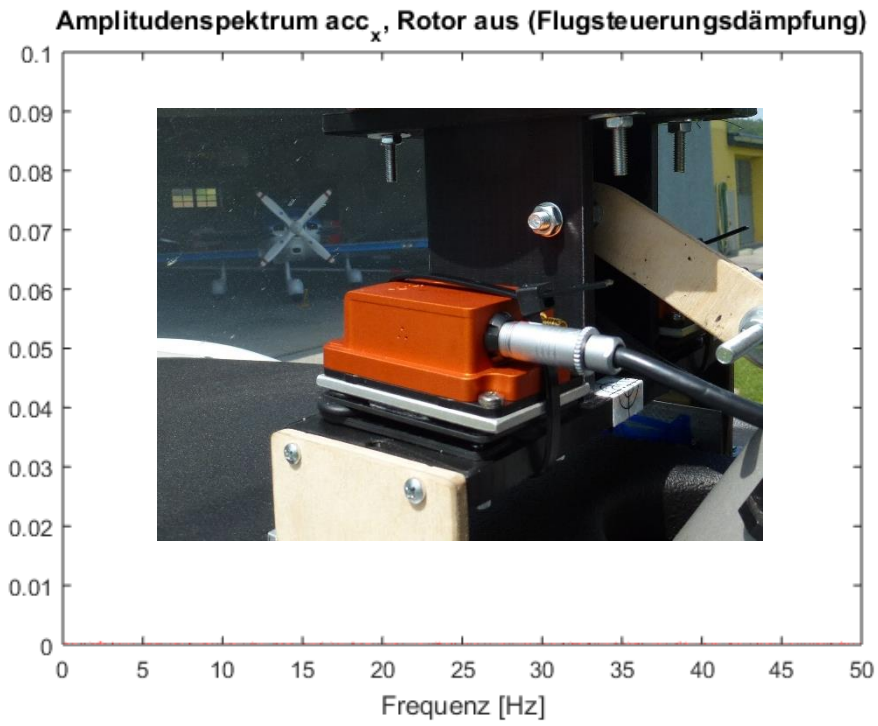
Flight
Controller
Damping

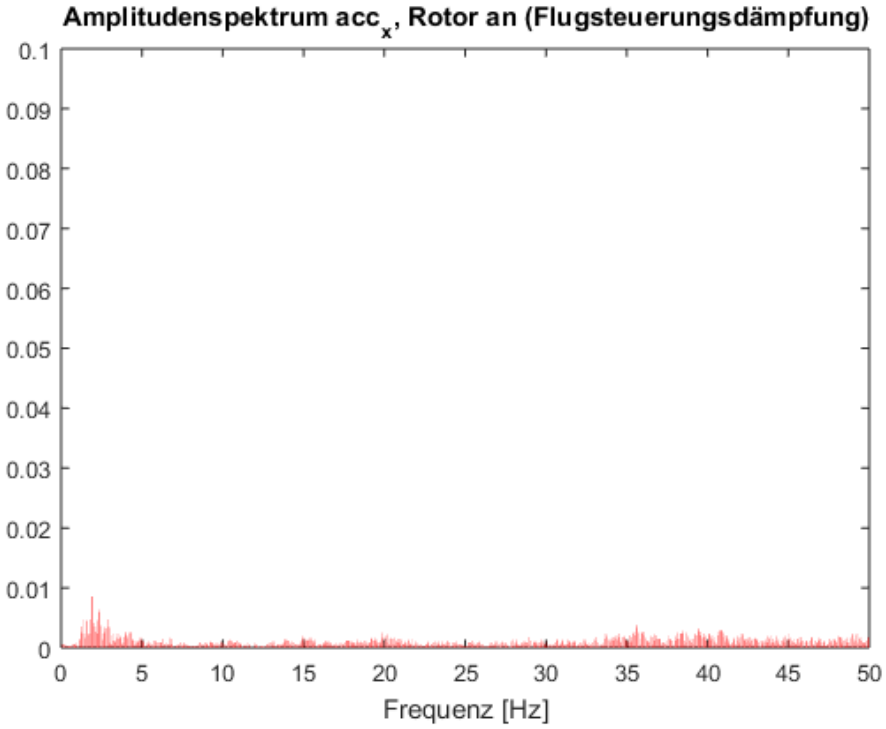
- Vibration damping – Kyosho Zeal Tape



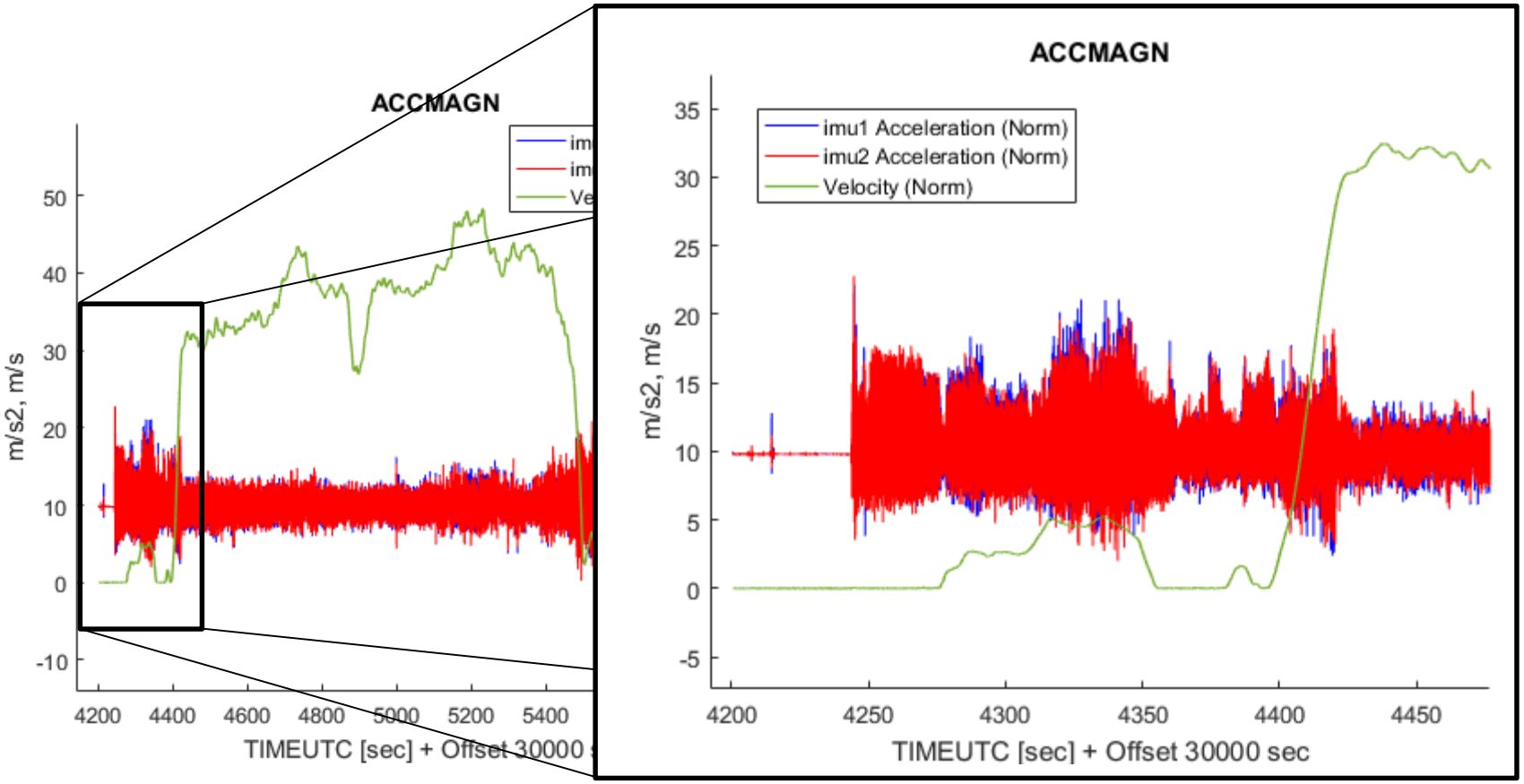


- Vibration damping – Flight Controller Damping



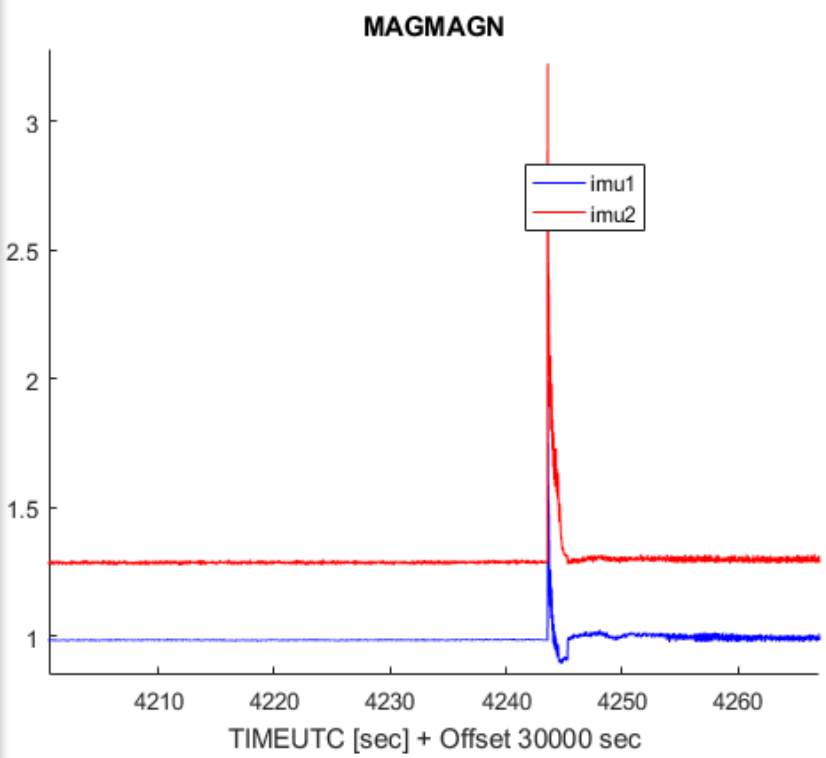


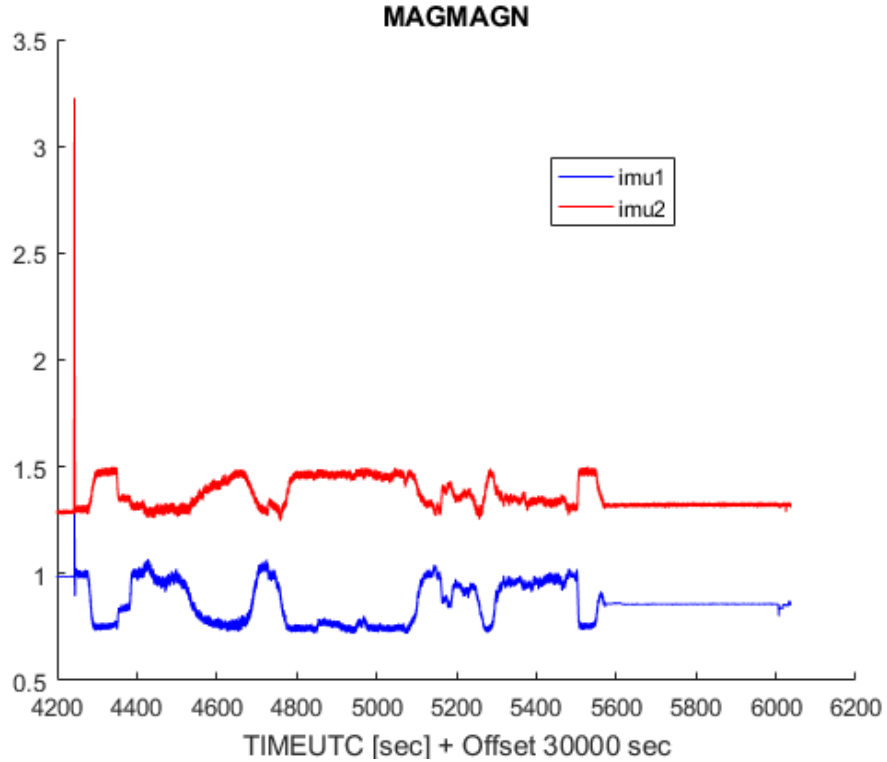
Challenge: IMU noise



Challenge: Magnetometer

- Peak – Engine switch on
- Symmetric anomalies – electromagnetic induction - cockpit





Testbed drone

- Designed and built by FH JOANNEUM Luftfahrt / Aviation
- Prototype I

- Prototype II: twice the size, wingspan 3.8 m, licensed as Aircraft model

Planned tests with drone

Navigation

- This autumn as Aircraft Model:
  - Prior tests of equipment, software,…
- Spring 2019 as UAS class II:
  - Final tests
  - Starting and landing at Airport Klagenfurt
  - Predefined routes (some kilometres around the airport, including forest, leave out densely populated area
  - SORA (Specific Operational Risk Assessment) document necessary
  - Security training course
- The consortium is proud to be the first in Austria who will have developed a reference architecture for lightweight UAS class II

Applications in the Alps

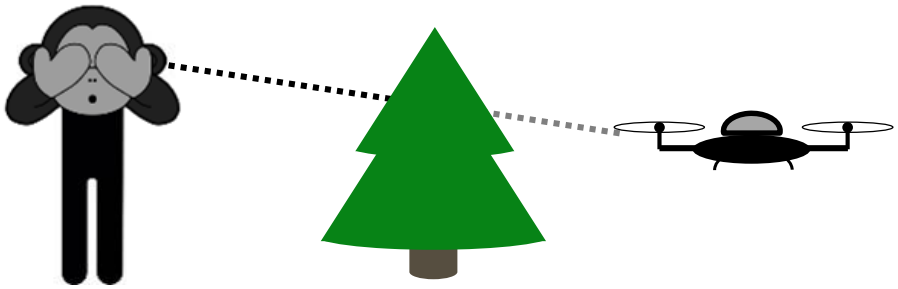
- First-aid drones
- Emergency management (storms, fires, flooding)
- Search for casualties (e.g., avalanches) in mountainous regions
- Wildlife observation and stock counting
- Cartography
- Delivery of supplies
- …

Source: AustroDrones / bmvit

Source: TU Delft

Navigation

Thank you for your attention!



Sources

- https://www.bmvit.gv.at/verkehr/luftfahrt/drohnen/index.html
- https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011306
- https://www.austrocontrol.at/luftfahrtbehoerde/lizenzen__bewilligungen/flugbewilligungen/unbemannte_lfz
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