UNIVERSITY OF PASSAU

# Security-Analyse der Eurobalise

DRSS
Digital Rail Summer School

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*Andreas Weber*
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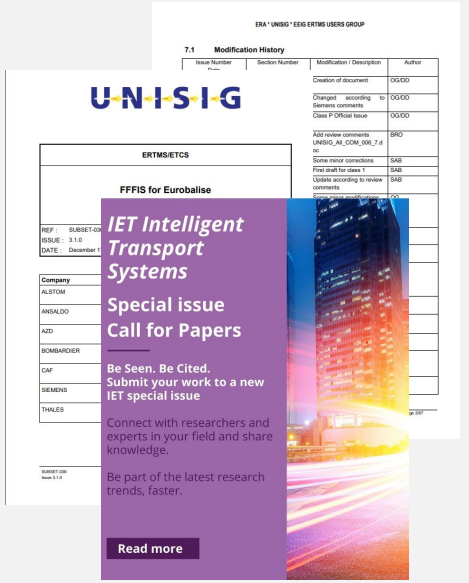
*Jannes Mennenga*
*Lukas Knobel*

***Betreuer: Simon Unger***

# Artefacts


HackRF One
GREAT SCOTT GADGETS


ERA * UNISIG * EEIG ERTMS USERS GROUP
7.1 Modification History
UNISIG
ERTMS/ETCS
FFFIS for Eurobalise
IET Intelligent Transport Systems
Special issue
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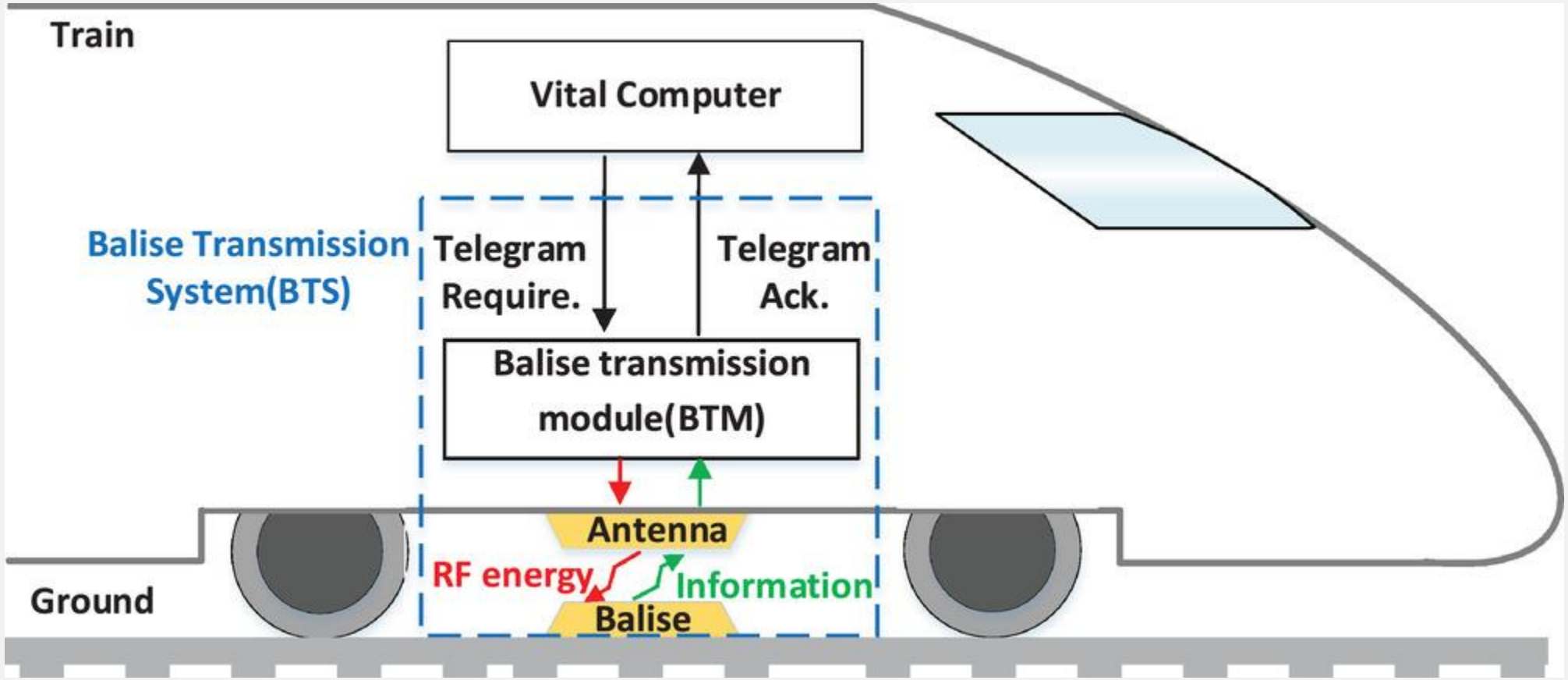
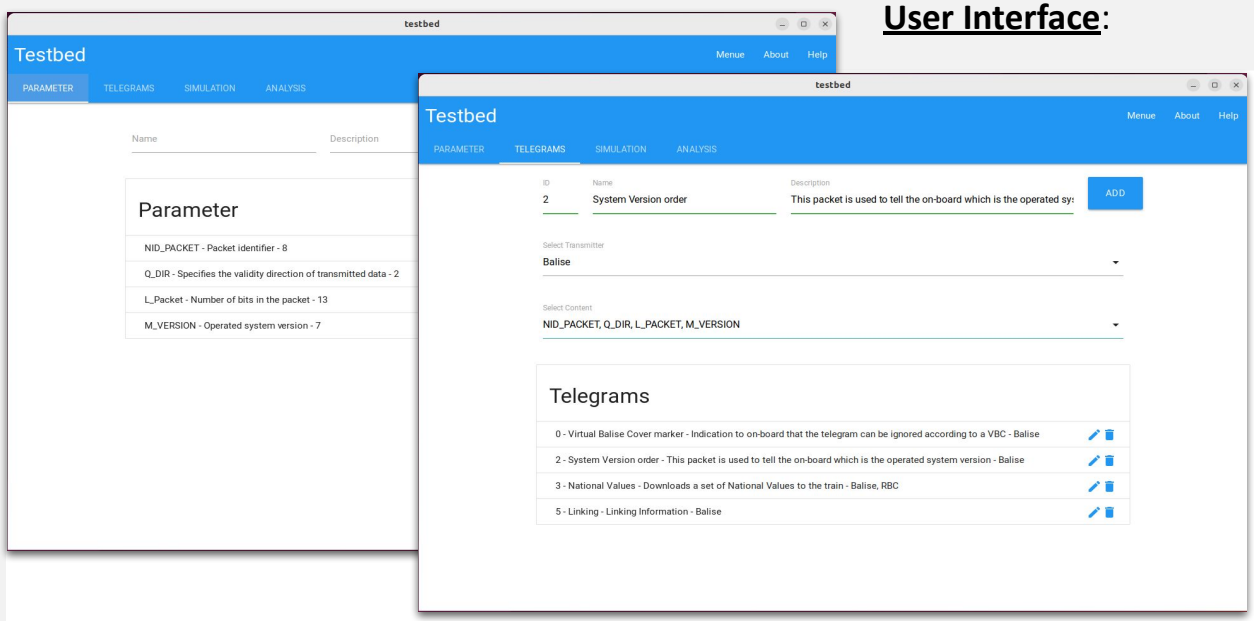
# EU Train Control System (ETCS)

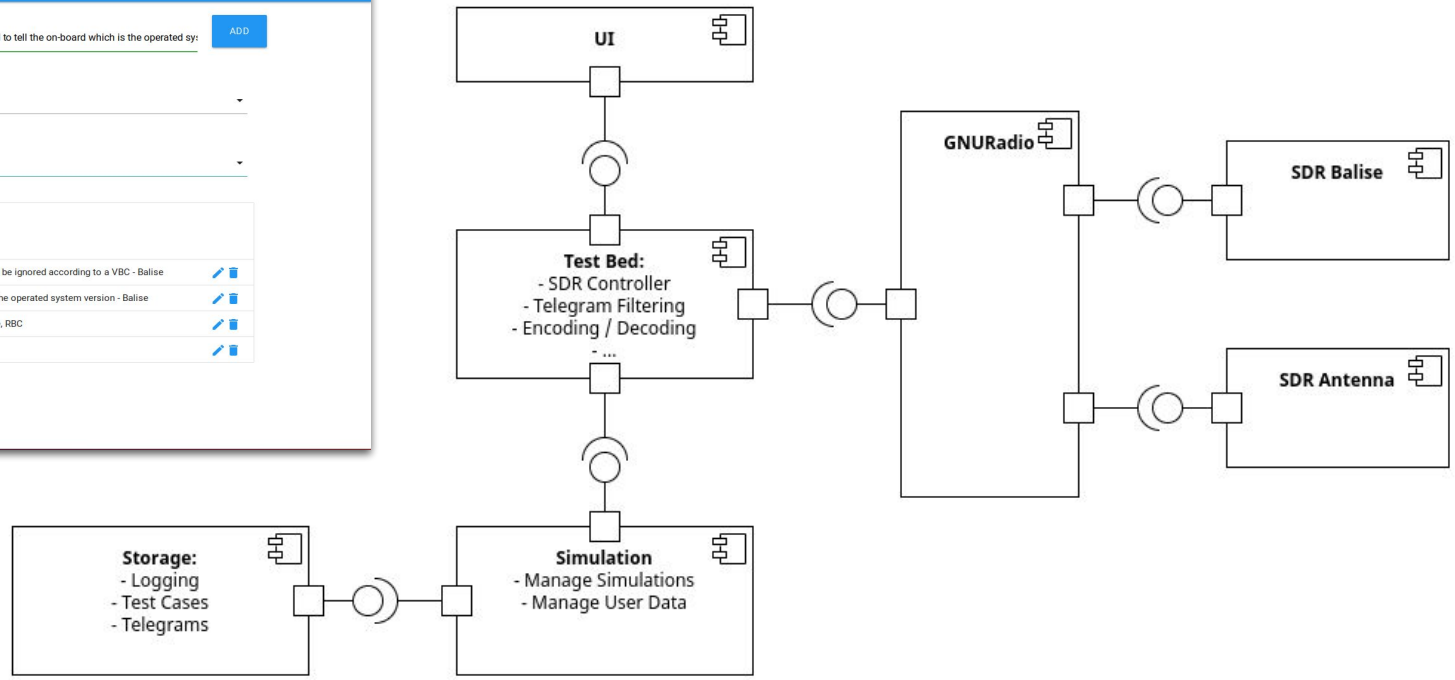


# Implementation of Testbed

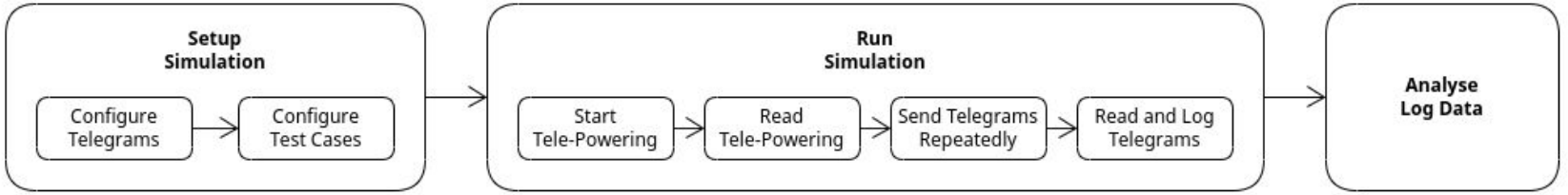
**User Interface**:




**Architecture**:

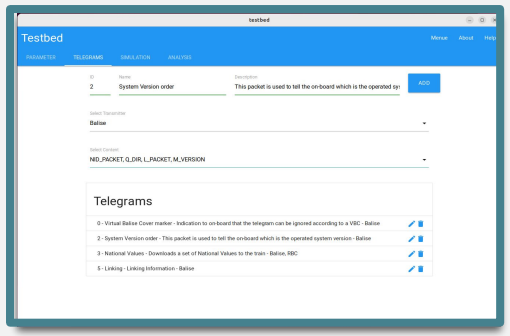



**Workflow**:



# Planned Setup

Software Testbed

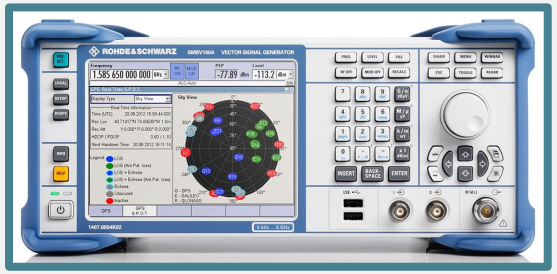



Python Interface of GNU-Radio


FSK

PWM Signal

Signal Generator




HF Linear Amplifier

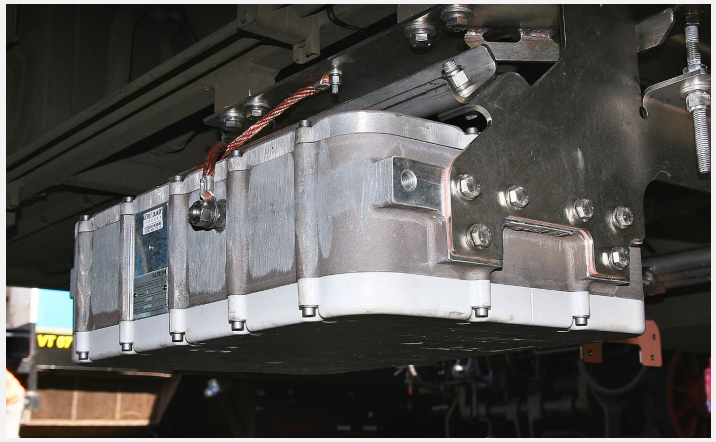
Inductor Coil

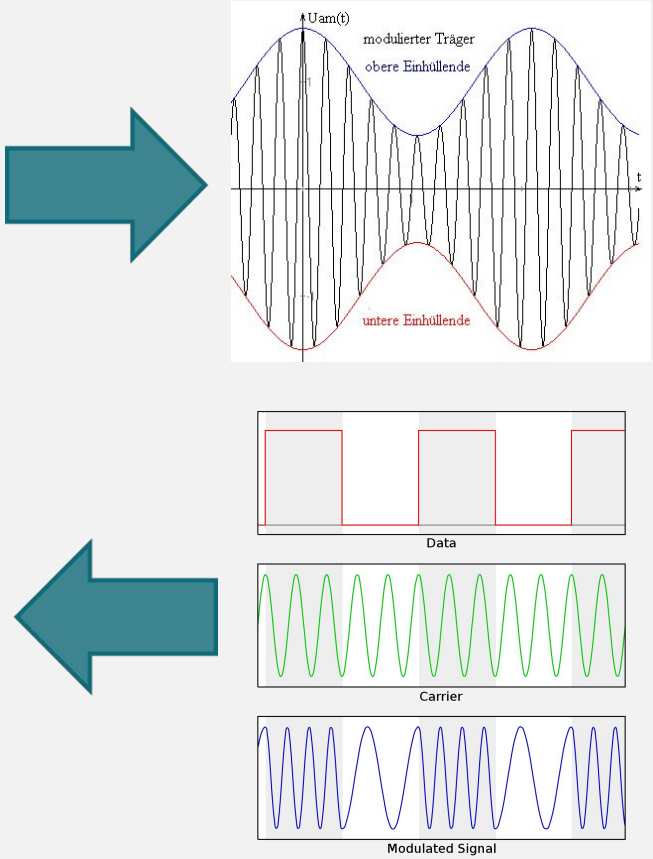
AM

Inductive Powering

# Communication between Balise and BTM Antenna

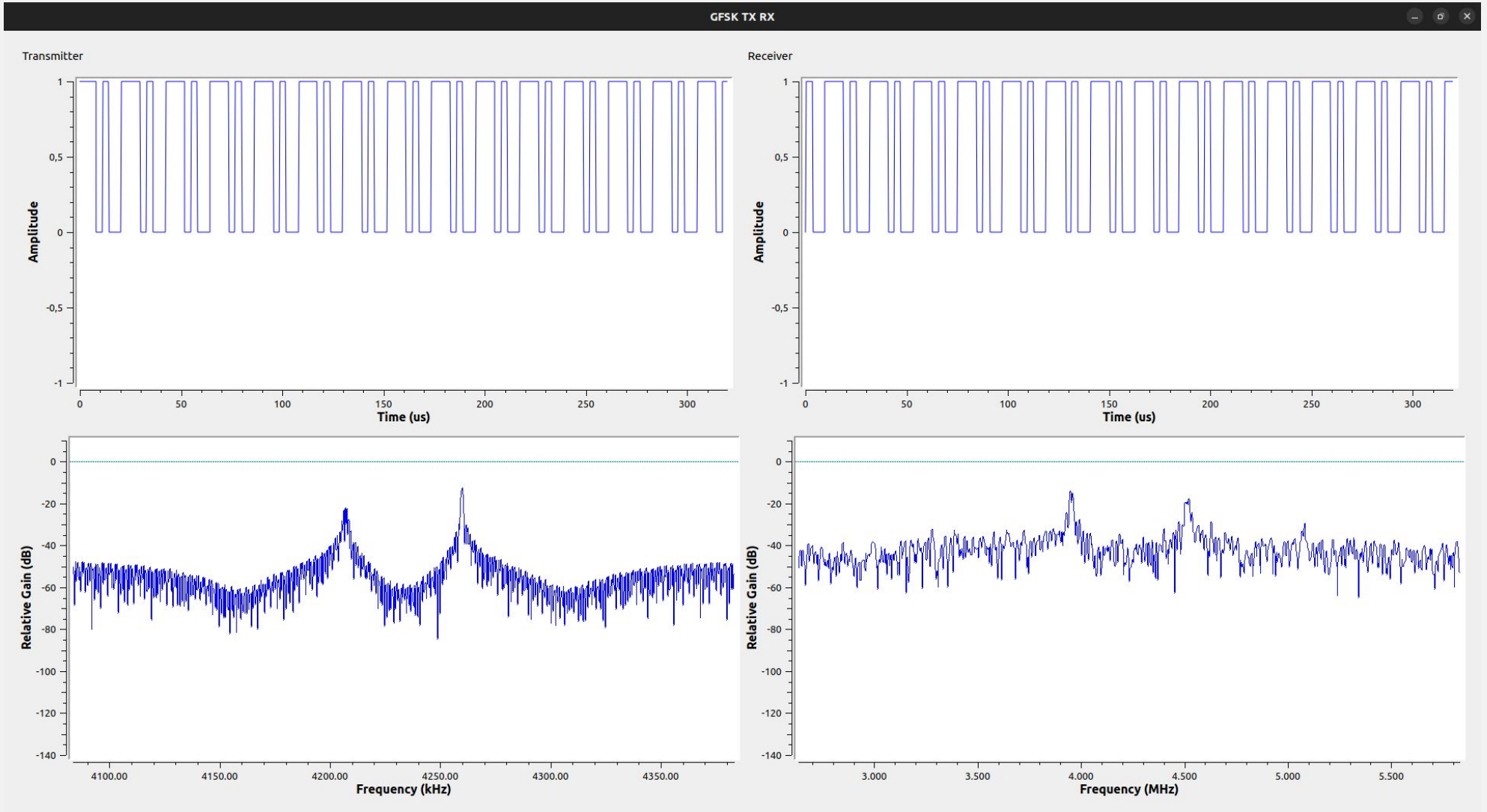
**Amplitude Modulation (AM) for Downlink**
**27.095 MHz inductive powering**



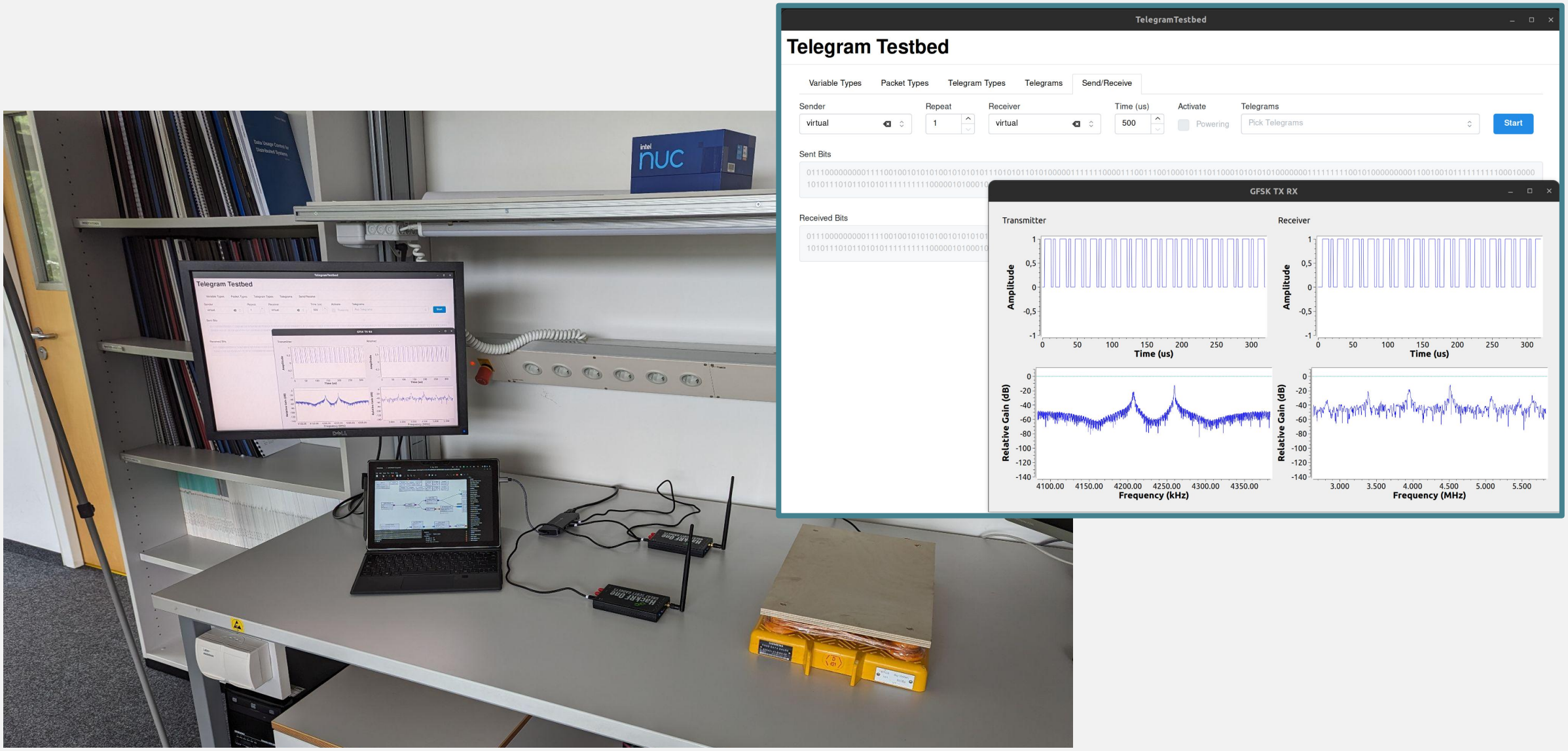



**Frequency Shift Key Modulation (FSK) for the Uplink**
**3.951 MHz for 0, 4.516 MHz for 1**

# Emulation of Balise and BTM Antenna



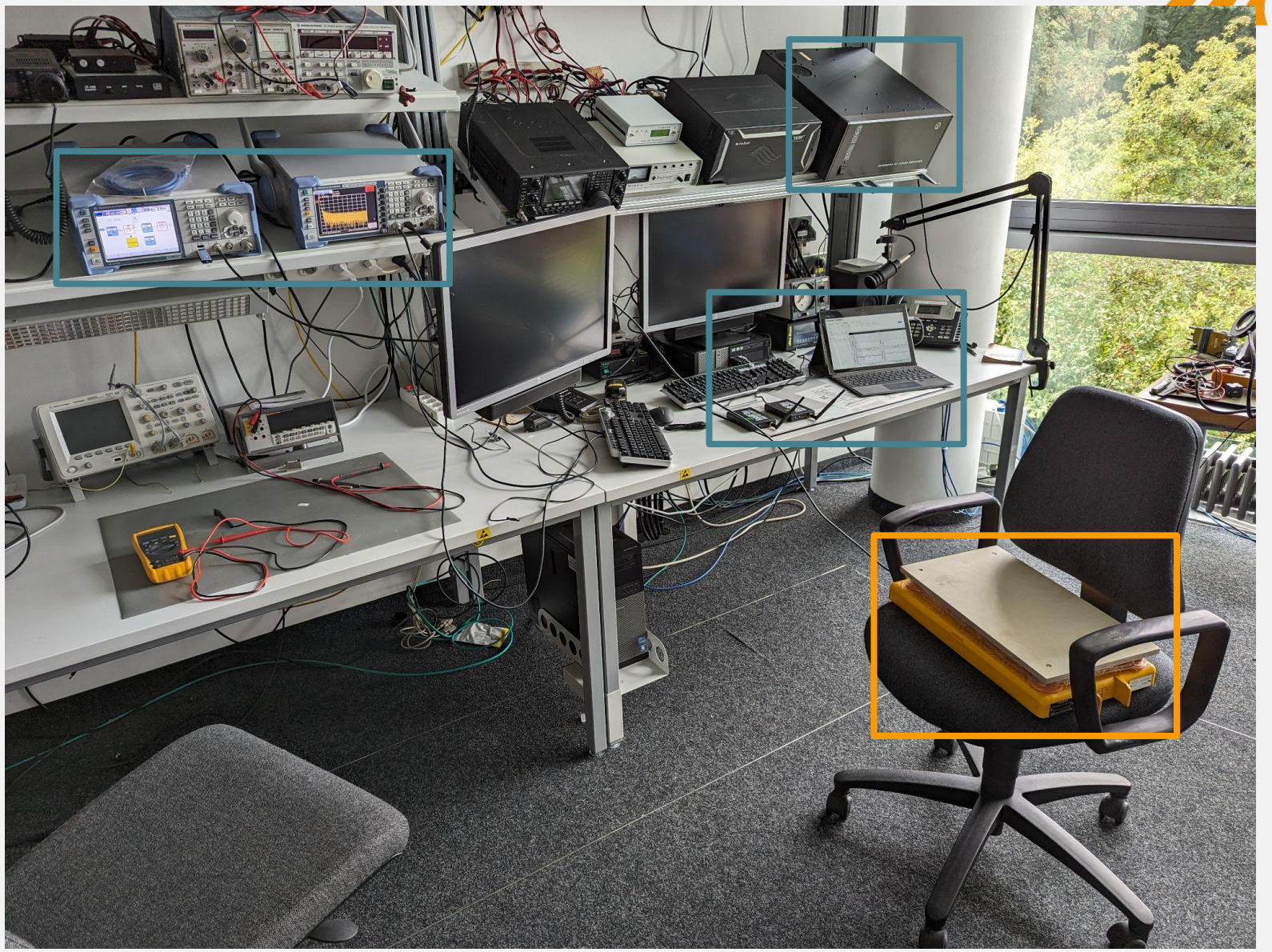
# Emulation of Balise and BTM Antenna



# Challenges

- **Setup for Powering the Balise**
  - Handling and filtering noise
  - Handling legal and technical restrictions
  - Constructing a fitting antenna
- **Lack of …**
  - Data to simulate air-gap noise
  - Publicly available documentation
  - Knowledge about the field and equipment

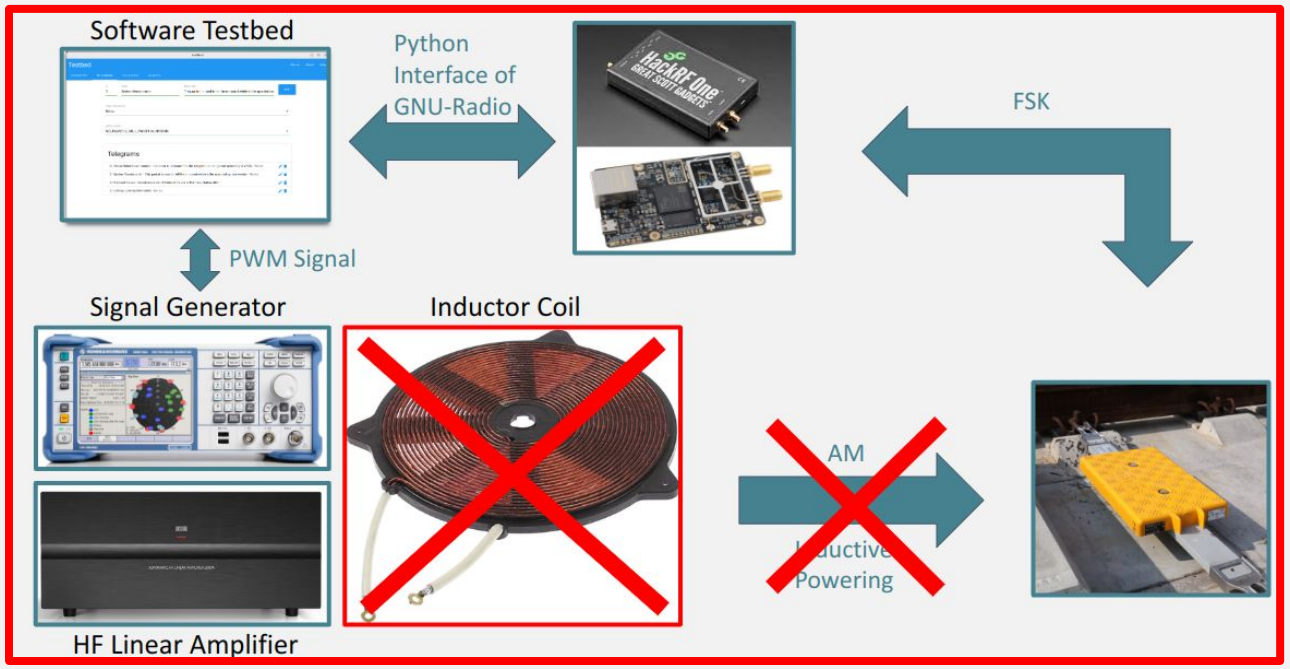
# Final Setup

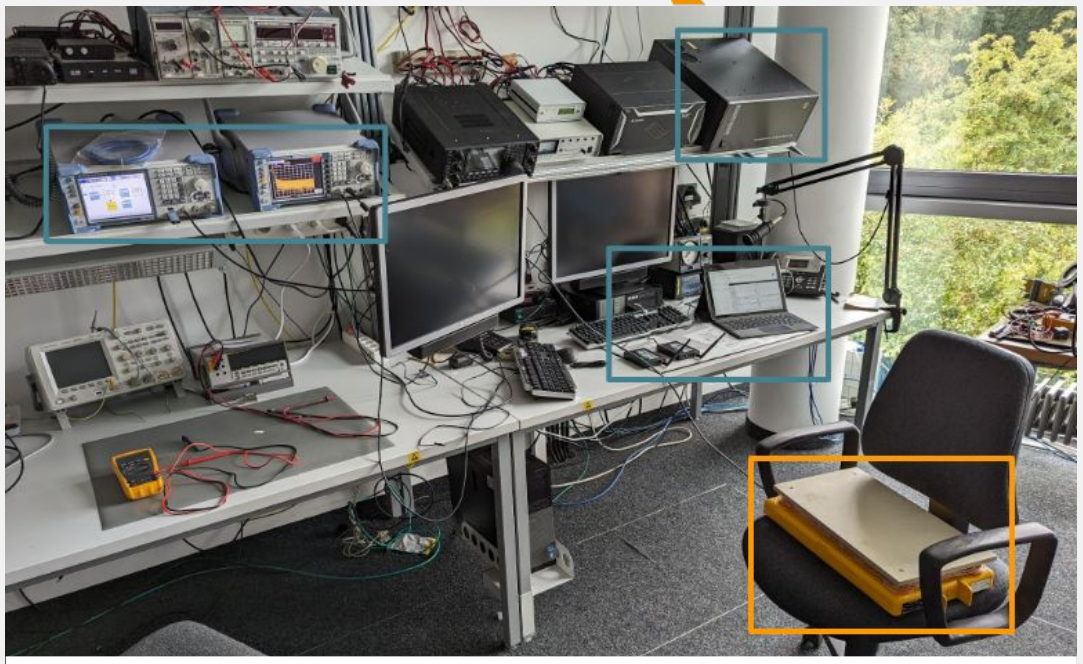


# Results

**Reading the Balise only with SDRs is not possible**

- Fitting equipment
- As well as knowledge in the field is necessary



# Thank you!

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## Implementation of Testbed

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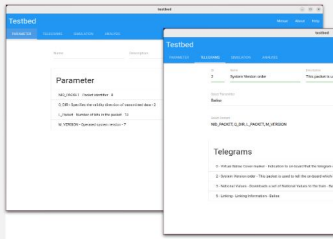
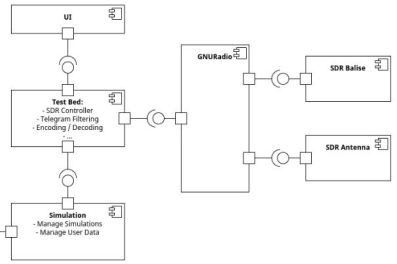
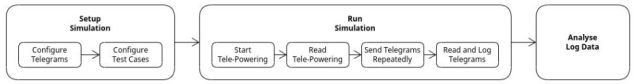



**User Interface:**

**Architecture:**




**Workflow:**






## Emulation of Balise and BTM Antenna

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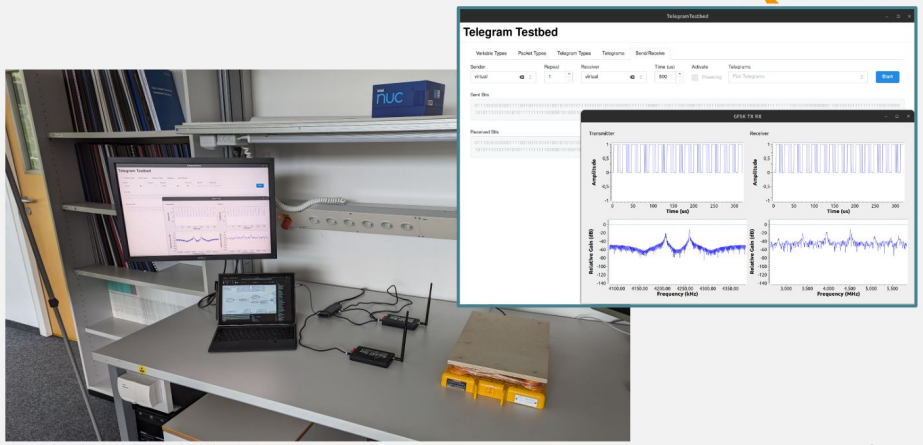




## Task 6: Final Setup

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## Results

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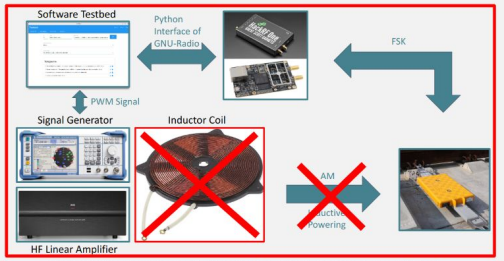


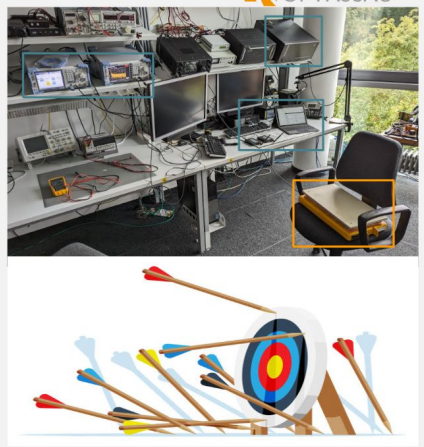

# Literature


**[1]** Modelling and performance analysis of Balise under dynamic energy harvesting in high-speed railway, Li et. al, 2022

**[2]** Modeling and Simulation of Balise Up-Link Data Transmission Based on Finite Element Method, Zhao et. al, 2012

**[3]** Position Manipulation Attacks to Balise-Based Train Automatic Stop Control, Wu et. al, 2018

**[4]** Vulnerabilities, Attacks, and Countermeasures in Balise-Based Train Control Systems, Wu et. al, 2016

**[5]** Modeling and Data Analysis of the Balise System, Zhang et. al, 2018

**[6]** Archived - Set of specifications 3 (ETCS B3 R2 GSM-R B1)