An SDR testbed using USRP2 for demonstration of MIMO and other wireless techniques

Patrik Eliardsson and Ulrika Uppman

FOI - Swedish Defence Research Agency
Department of Robust Telecommunications

Outline

- Platform
- Different projects
  - DSA
  - Positioning
  - MIMO
- MIMO Implementation
- Conclusion

Target Platform

- GNU Radio
  - Free software toolkit for software radio development
  - Over 100 signal processing block available
  - Signal processing implemented in C++
  - Flow graph glued together with Python
- USRP2
  - Sample clock: 100 MHz
  - Gigabit Ethernet interface
  - Theoretical maximum bandwidth: 25 MHz
  - Cost approx.: $2000

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Dynamic Spectrum Access

- Testbed to show DSA with OFDM
- System with one reciever and one transmitter
- Spectrum sensing using amplitude probability disitribution (APD) detector
- OFDM implementation
  - extending the GNU Radio implementation
  - selected subcarriers are used
  - preamble will not use occupied frequencies
- Experiences
  - Clock stability
  - External reference clock

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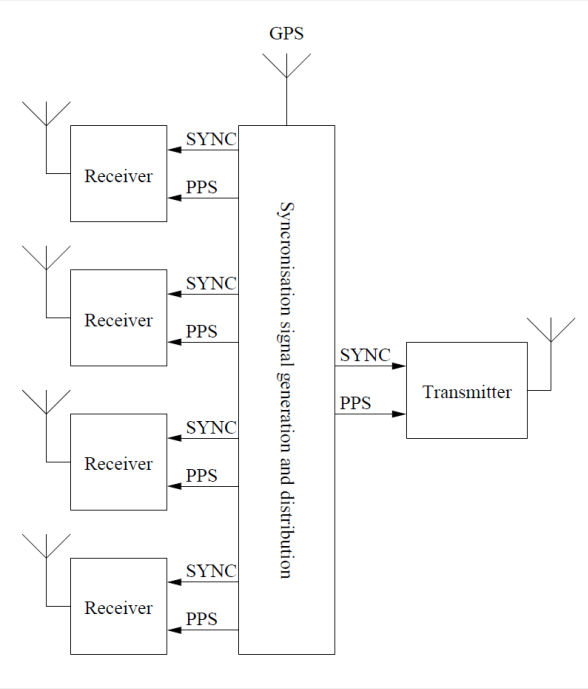
Indoor Positioning

- Radio positioning
- Heavy multipath propagation
- Testbed for algorithm evaluation
- Signal generator as transmitter
- Data collection from USRP2-setup
- Experiences
  - Timestamp synchronization
  - Shielding of hardware
  - Phase offset



Andreas Wernrud, Anders Johansson, Jouni Rantakokko, Patrik Eliardsson and Ulrika Uppman
"**Soldier and first responder RF-positioning in indoor environments**"
13th International Association of Institutes of Navigation World Congress and Exhibition, 2009

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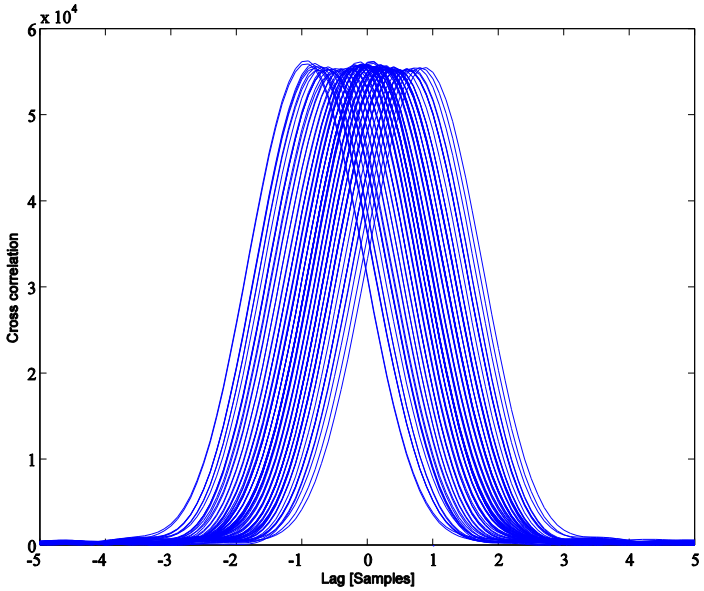
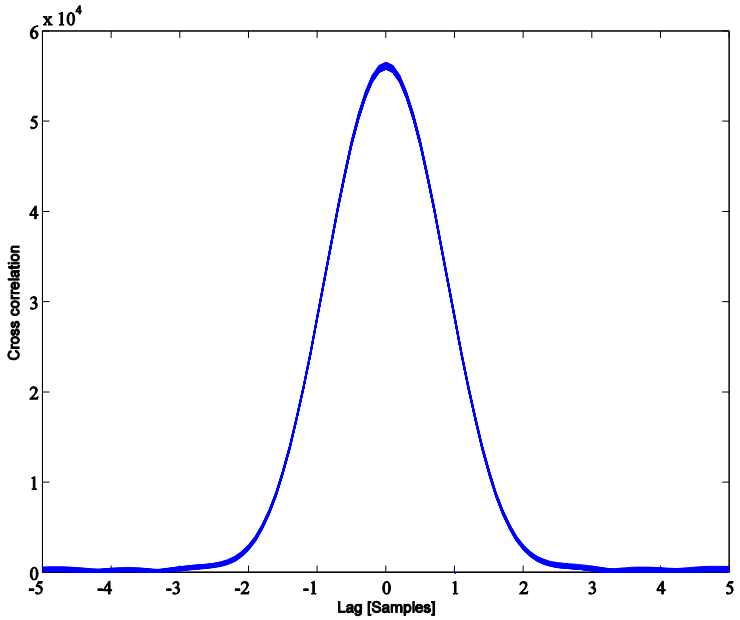
Timestamp Synchronization

- Synchronous reset of the DDC pipelines
- PPS triggered





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MIMO Testbed

- Background and Motivation
- Hardware System Description
- Implementation Details
- Graphical User Interface

Patrik Eliardsson and Ulrika Uppman

"**An SDR implementation of a MIMO Communication Testbed**"

7th Karlsruhe Workshop on Software Radios, WSR'12, Karlsruhe 2012

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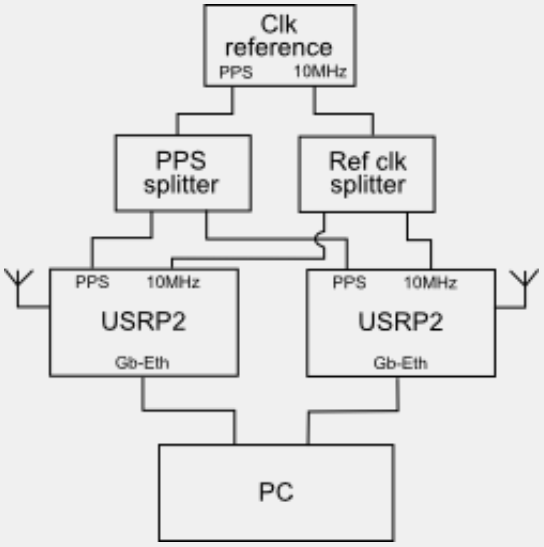
MIMO-technique

- MIMO-techniques can:
  - Increase bandwidth of a radio link
  - Increase robustness of a radio link
- MIMO in VHF-band
  - Small bandwidth
  - Spatial multiplexing vs. spatial diversity
- Demonstration of the benefits with MIMO-techniques in VHF-band.

Testbed Overview

- 2 x 2 MIMO
- The receiver
  - Quad core 2.66 GHz, 12 GB RAM
- The transmitter
  - Dual core 3.06 GHz, 4 GB RAM
- USRP2-units are synchronized with an external time reference.



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Software development

- GNU Radio 3.4.0
- Starting point, available OFDM-example
- Extended with source coding, available gr-trellis
- Added Alamouti MIMO blocks, spatial diversity
- Minor modifications to the existing blocks

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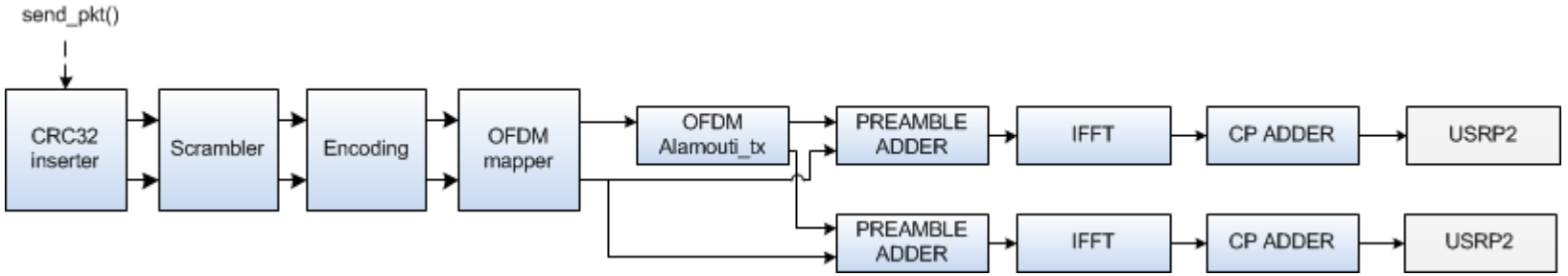
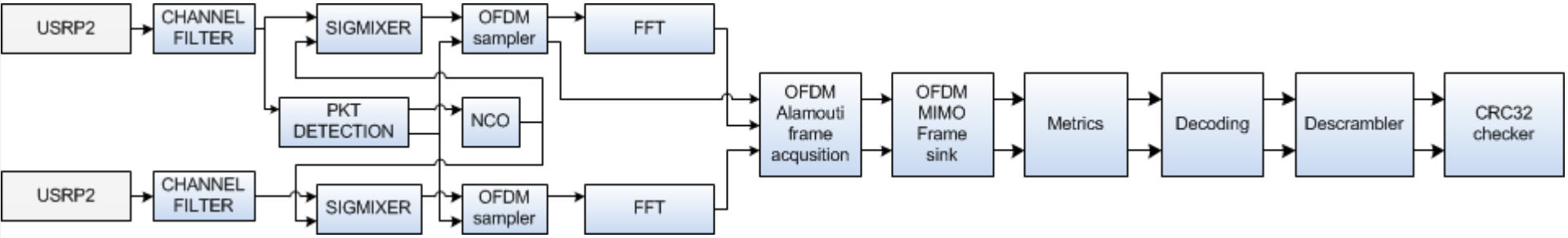
Signal processing

Transmitter



Receiver



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Graphical User Interface

- 3 Different views
- Demonstration view
  - Show received data
  - Enlighten the difference between MIMO and SISO
- Technical view
  - Probes in signal processing
  - Frequency spectrum, constellation plots
- Control view
  - Control the USRP2-settings
  - IP-address, gain, center frequency etc.

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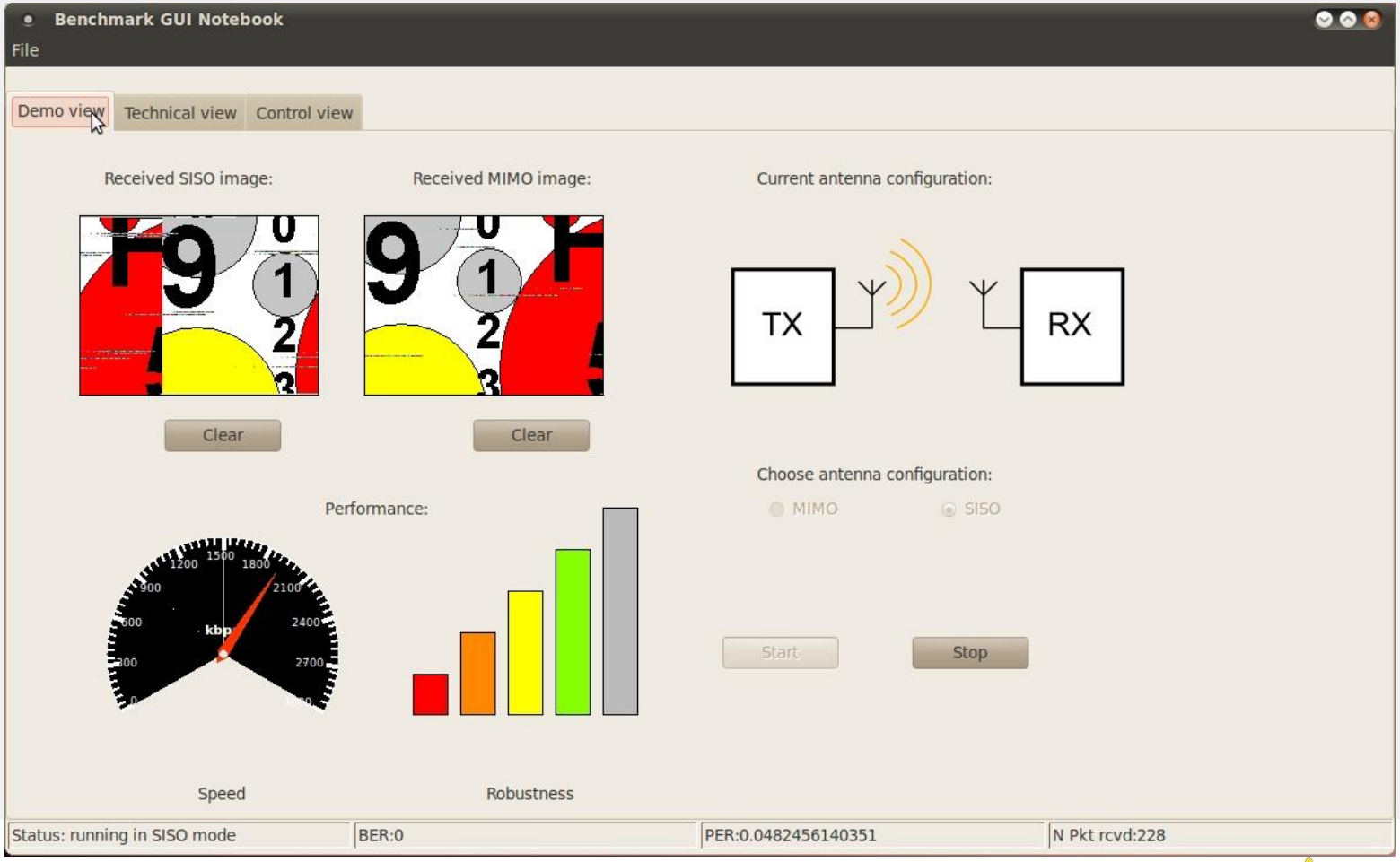
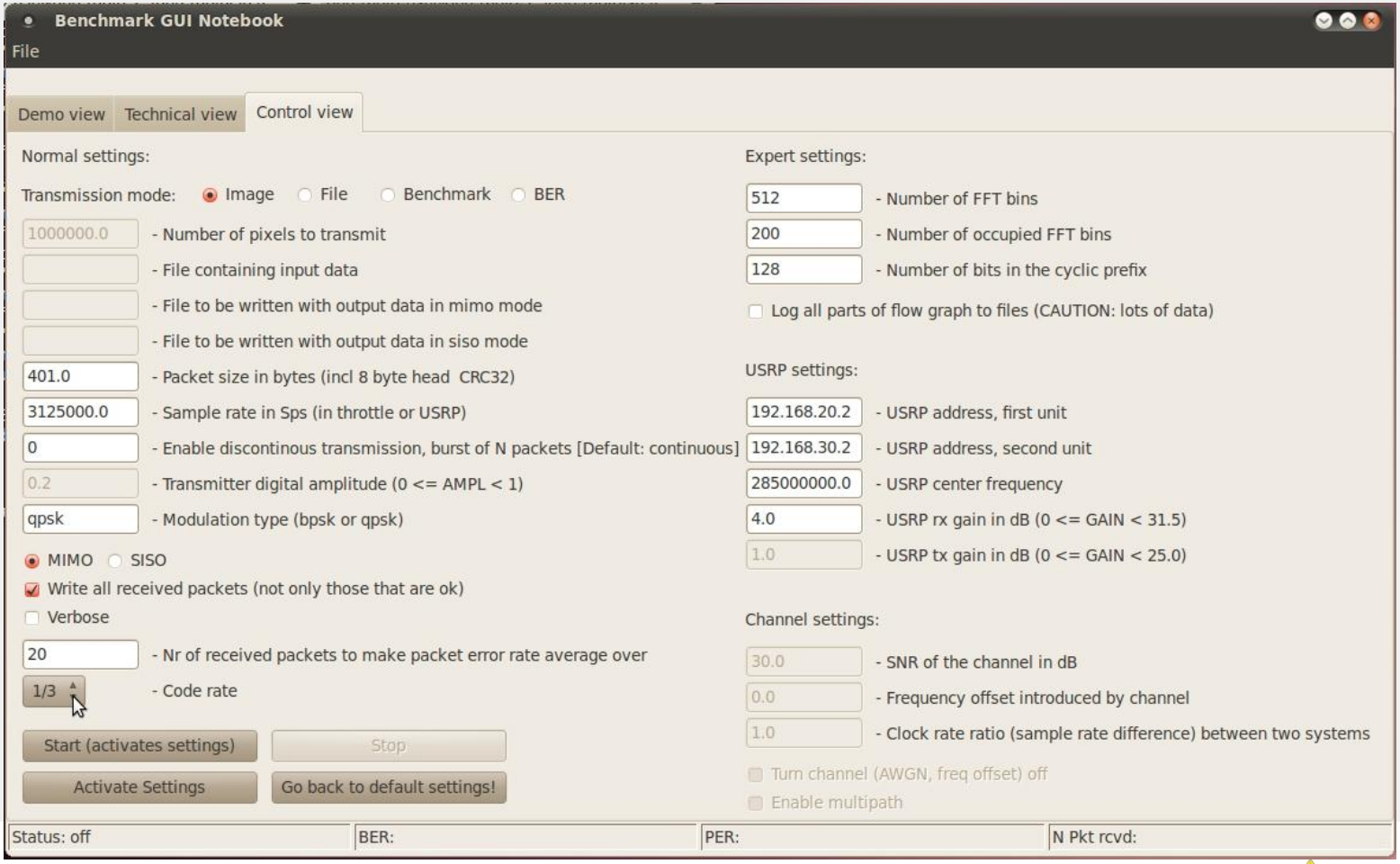
Demo View


Benchmark GUI Notebook
File
Demo view
Technical view
Control view
Received SISO image:
Received MIMO image:
Current antenna configuration:
TX
RX
Clear
Clear
Choose antenna configuration:
MIMO
SISO
Performance:
Start
Stop
Speed
Robustness
Status: running in SISO mode
BER:0
PER:0.0482456140351
N Pkt rcvd:228

Control View



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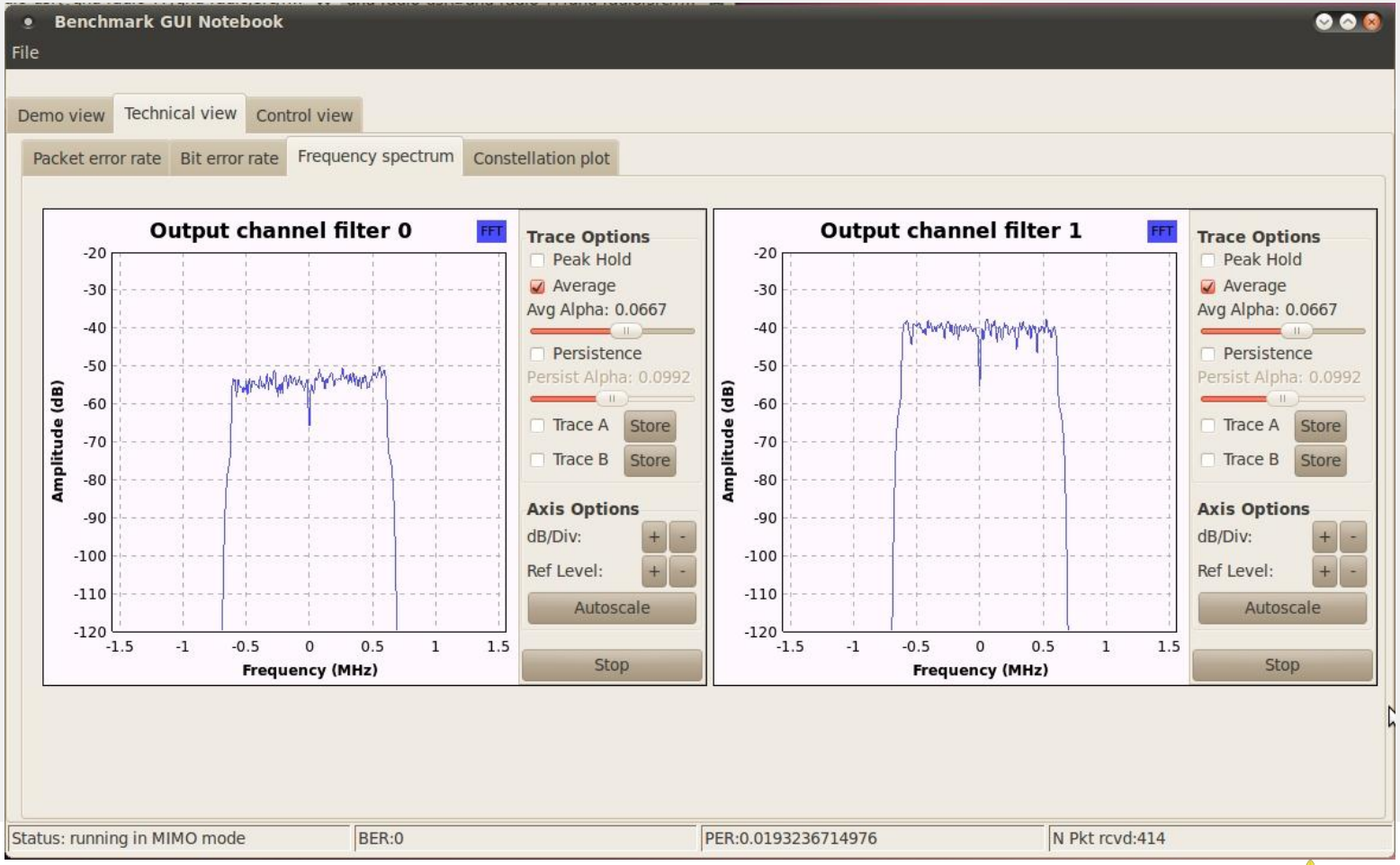
Technical View



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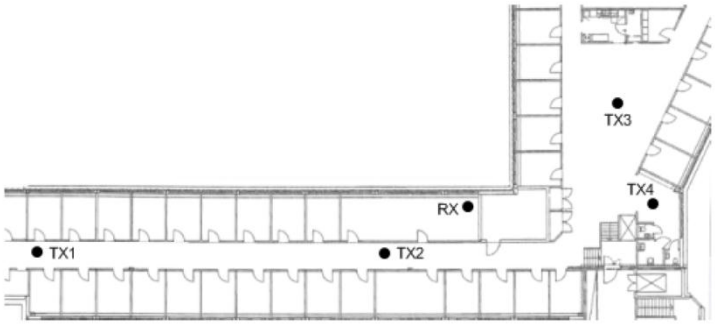
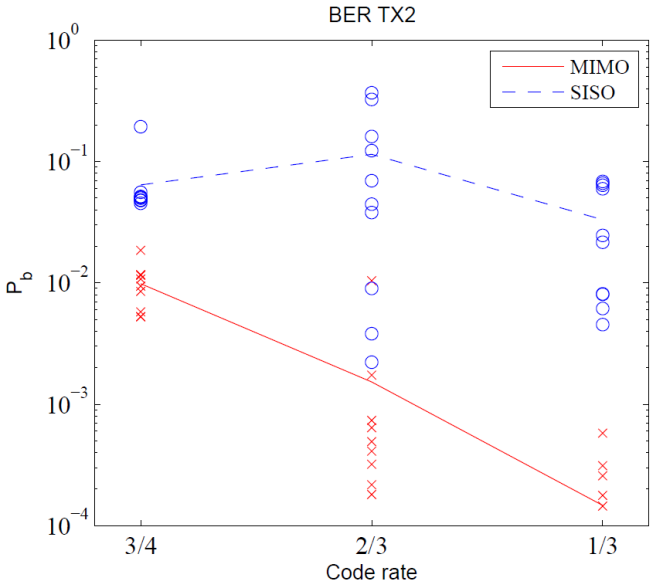
Measurements

- Indoor
- BER
- Higher BER than expected
- MIMO better than the reference SISO implementation





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Conclusion

- USRP2 and GNU Radio platform
- Used in several projects
  - DSA
  - Positioning
  - MIMO
- Will most likely be used in future projects
- Demonstration of the MIMO testbed here today!

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Thank You!

QUESTIONS?

patrik.eliardsson@foi.se and ulrika.uppman@foi.se