



# CREW



## Cognitive Radio Experimentation World

# Experimental Analysis and Simulative Validation of Dynamic Spectrum Access for Coexistence of 4G and Future 5G Systems [EURECOM]

## Goals

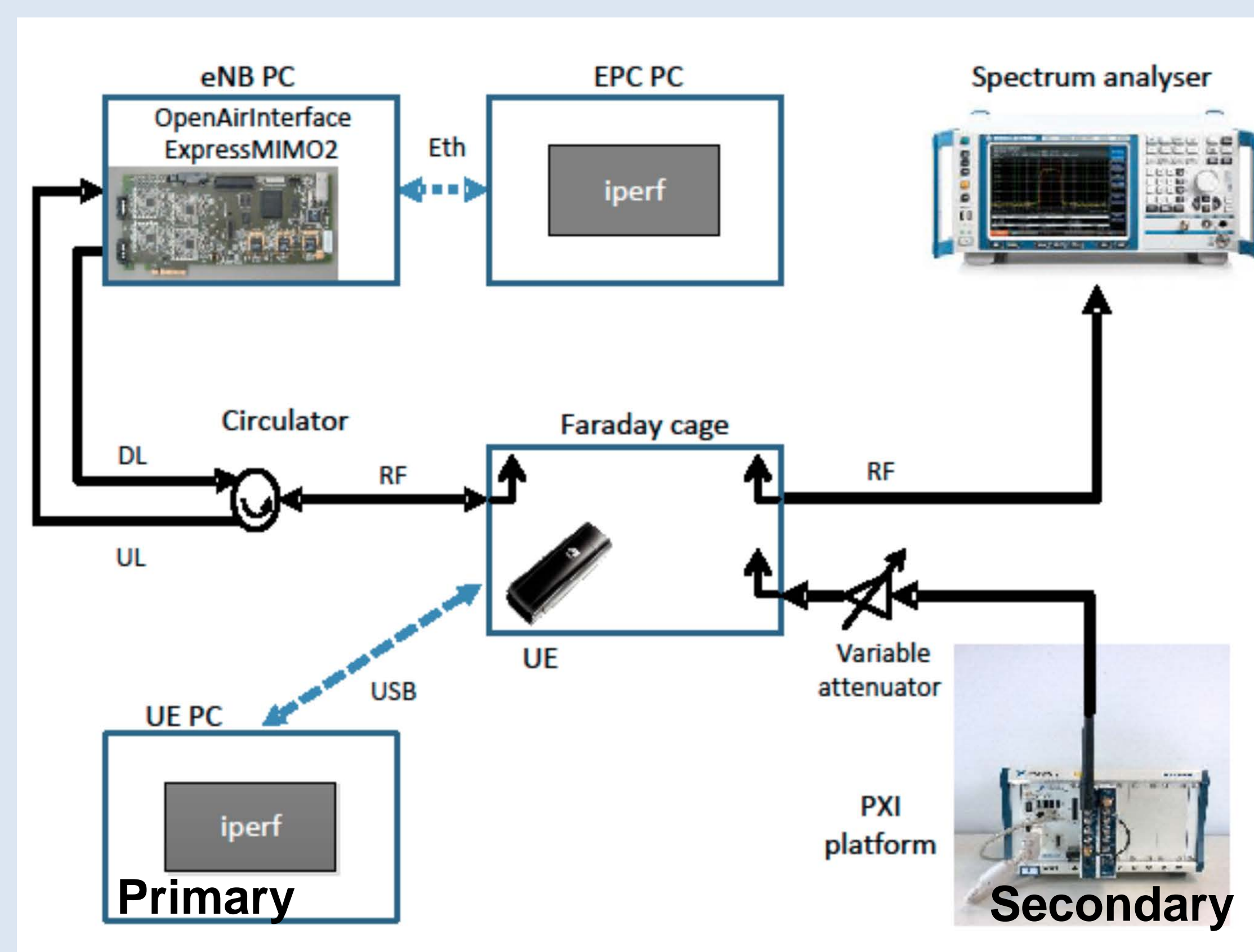
- LTE uplink coexistence study
  - Which impact has a secondary Cognitive Radio (CR) on a primary LTE system?
- Different waveforms are used for the CR:
  - OFDM (Orthogonal Frequency-Division Multiplexing)
  - SC-FDE (Single-Carrier Frequency Domain Equalization)
  - GFDM (Generalized Frequency Division Multiplexing)



GFDM related publications:

## Experimental Setup

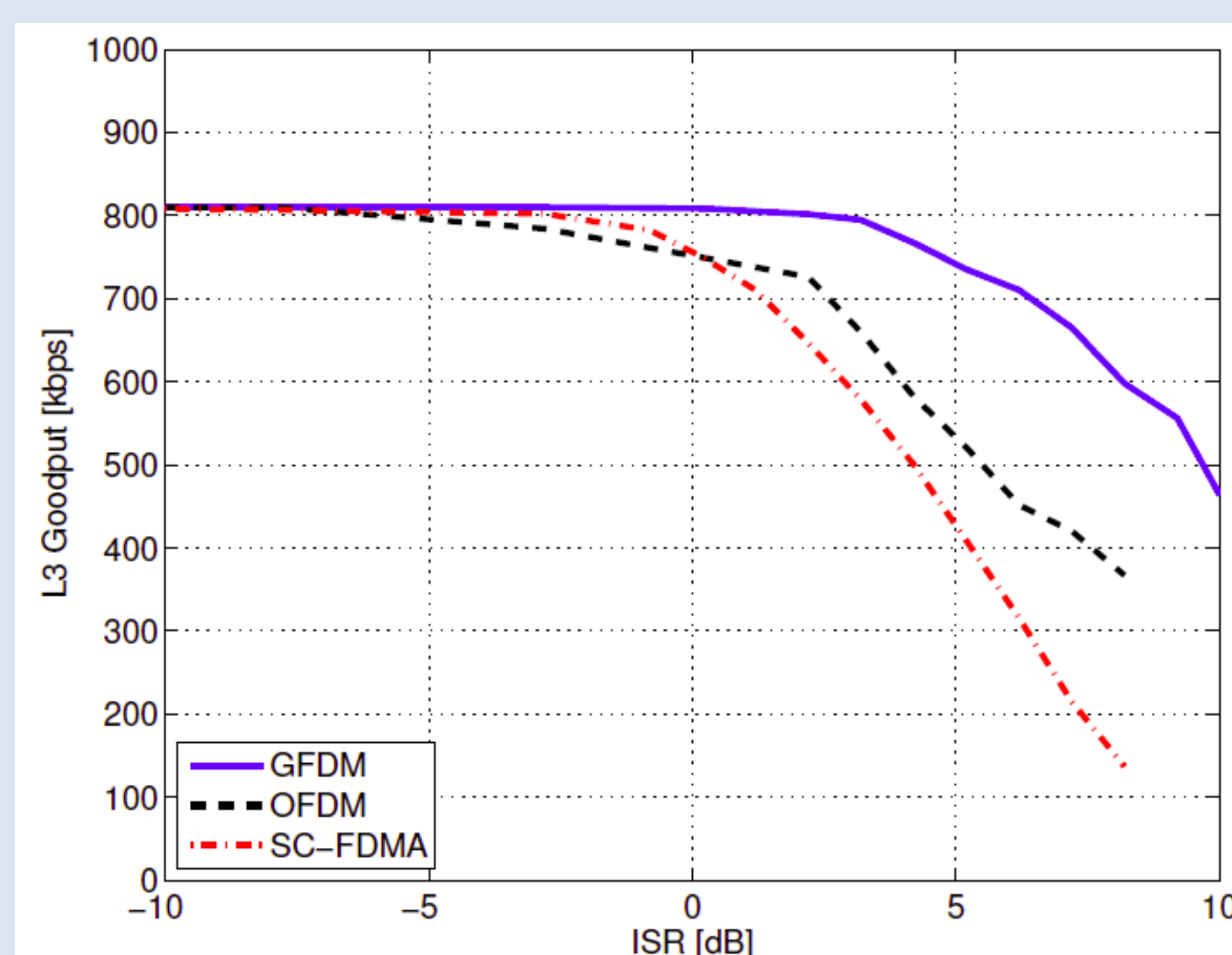
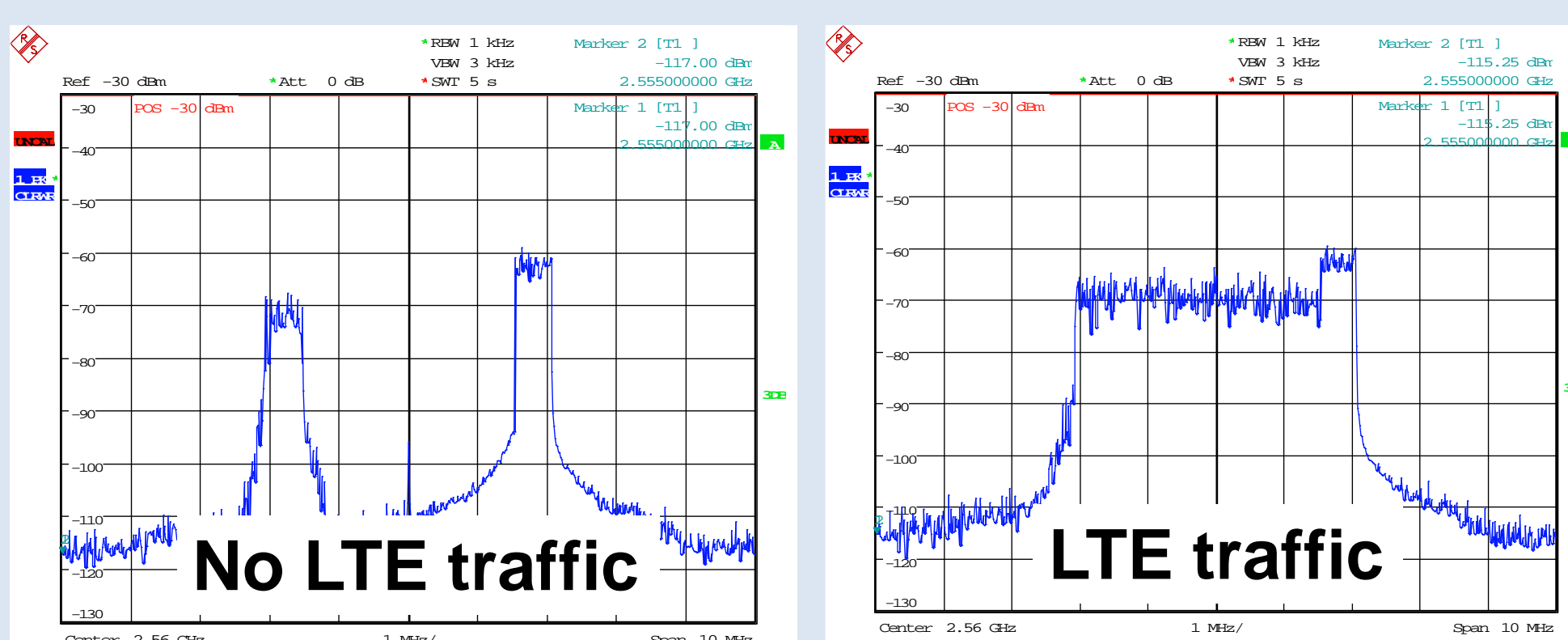
- Primary LTE system
  - Uplink frequency: 2.68 GHz
  - Bandwidth: 5 MHz
  - Resource Blocks (RB) for UE: 1-20
  - RBs for Control channels: 0, 24
  - Free RBs for CR: 21-23
- Secondary system
  - Number of subcarrier: 512
  - Number of active subcarrier: 36
  - Cyclic prefix length: 40
  - Pulse shaping filter\*: Raised cosine
  - Number of subsymbols\*: 15
  - Number of active subsymbols\*: 13



\* Valid for GFDM only

## Results

- Transmission power and waveform varied during the experiment
- UDP traffic measured with Iperf from UE to eNB to determine impact



## Conclusions

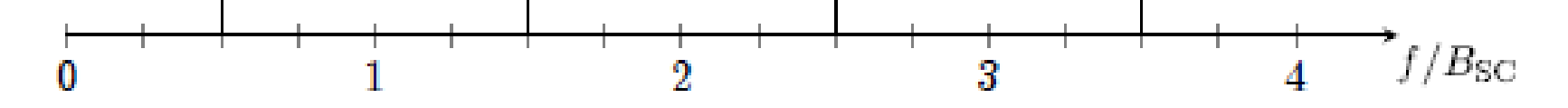
- Secondary system with different waveforms opportunistically exploits spectrum holes in a primary LTE system
- GFDM has a much lower adjacent channel leakage ratio than OFDM or SC-FDE
- GFDM can be used with up to 5dB higher transmit power than the LTE system before any impact is noticeable

## Testimony

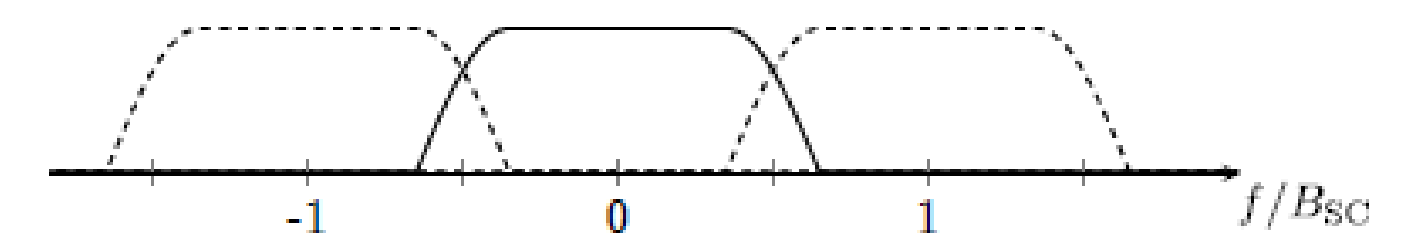
- TestMan simplifies access to SDR platforms in TUD's testbed
- Public available GFDM Matlab library allows external researchers to study 5G candidate waveform GFDM
- CREW has been very supportive during the whole duration of the experiment

## GFDM

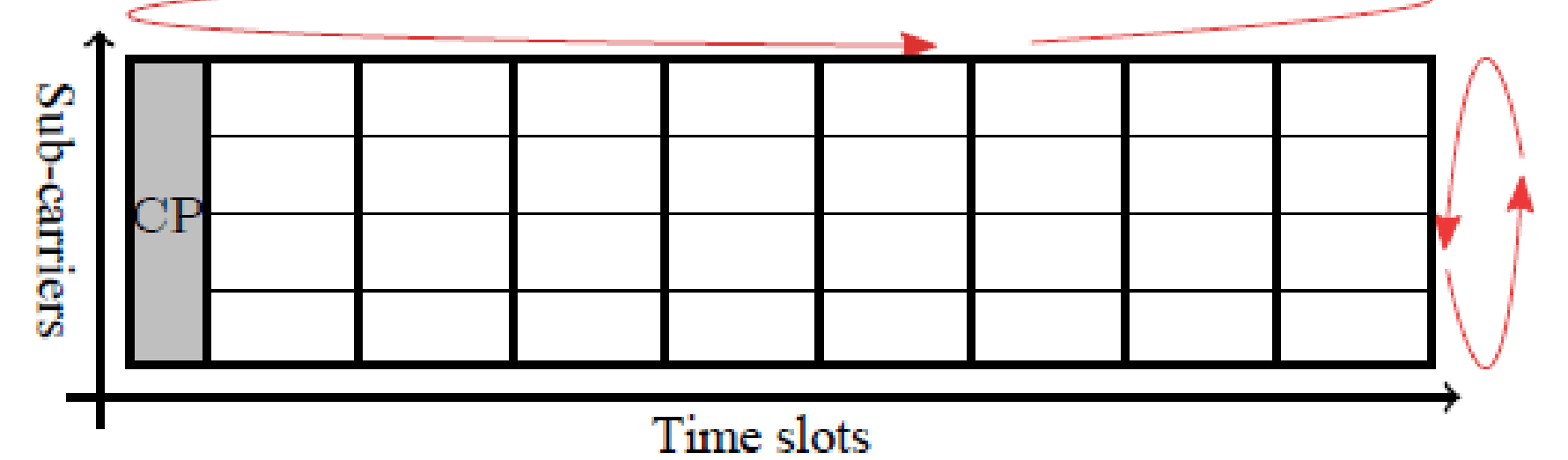
### Multi-carrier system



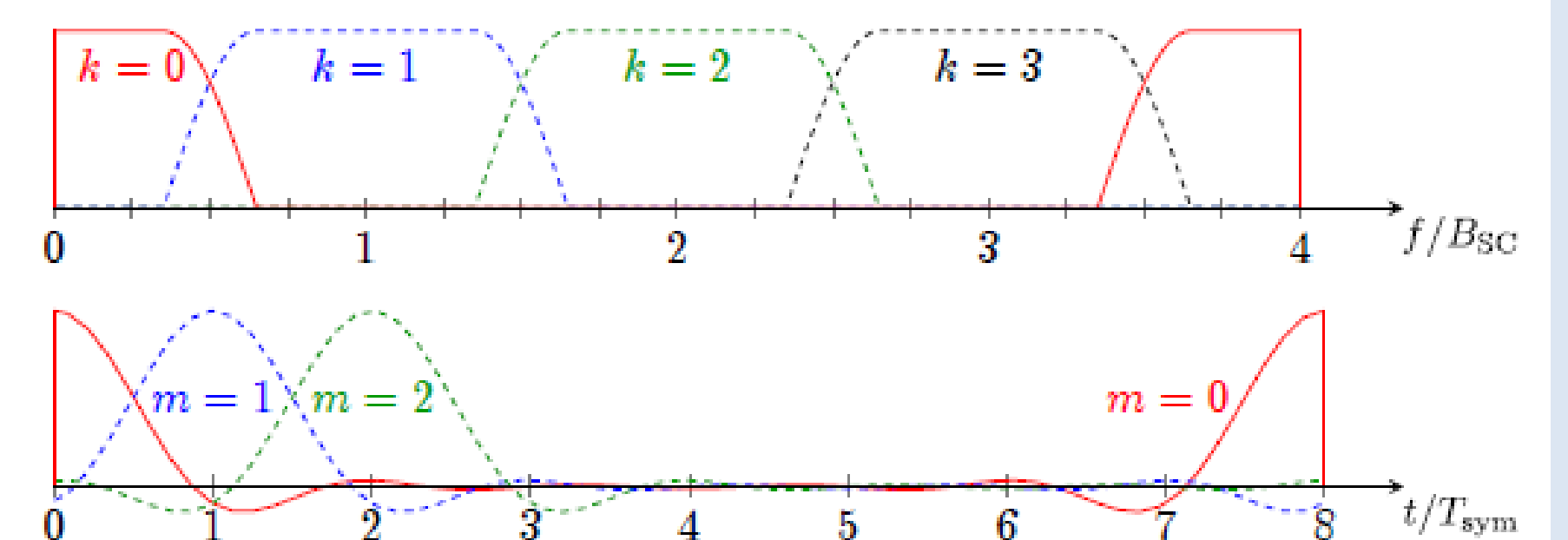
### Pulse Shaped Subcarriers



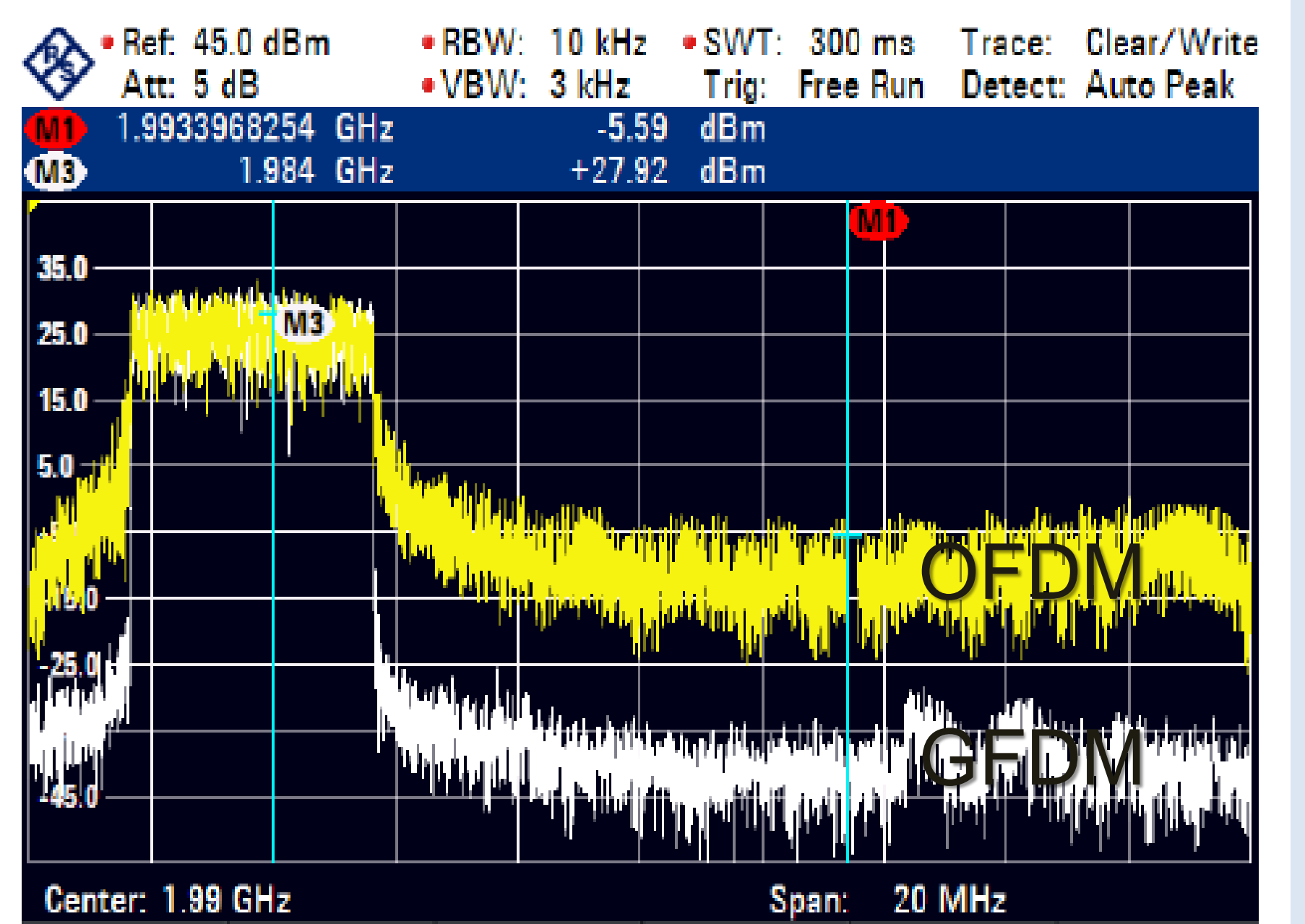
### Block-based Frame Structure



### Circular Signal (Time and Frequency)



### Reduced OOB Emission



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## PROJECT DATA

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