

Exploiting Channel Reciprocity in Massive MIMO

Xiwen JIANG, Florian Kaltenberger, Raymond Knopp, Luc Deneire *

Email: xiwen.jiang@eurecom.fr

5G Wireless Networks

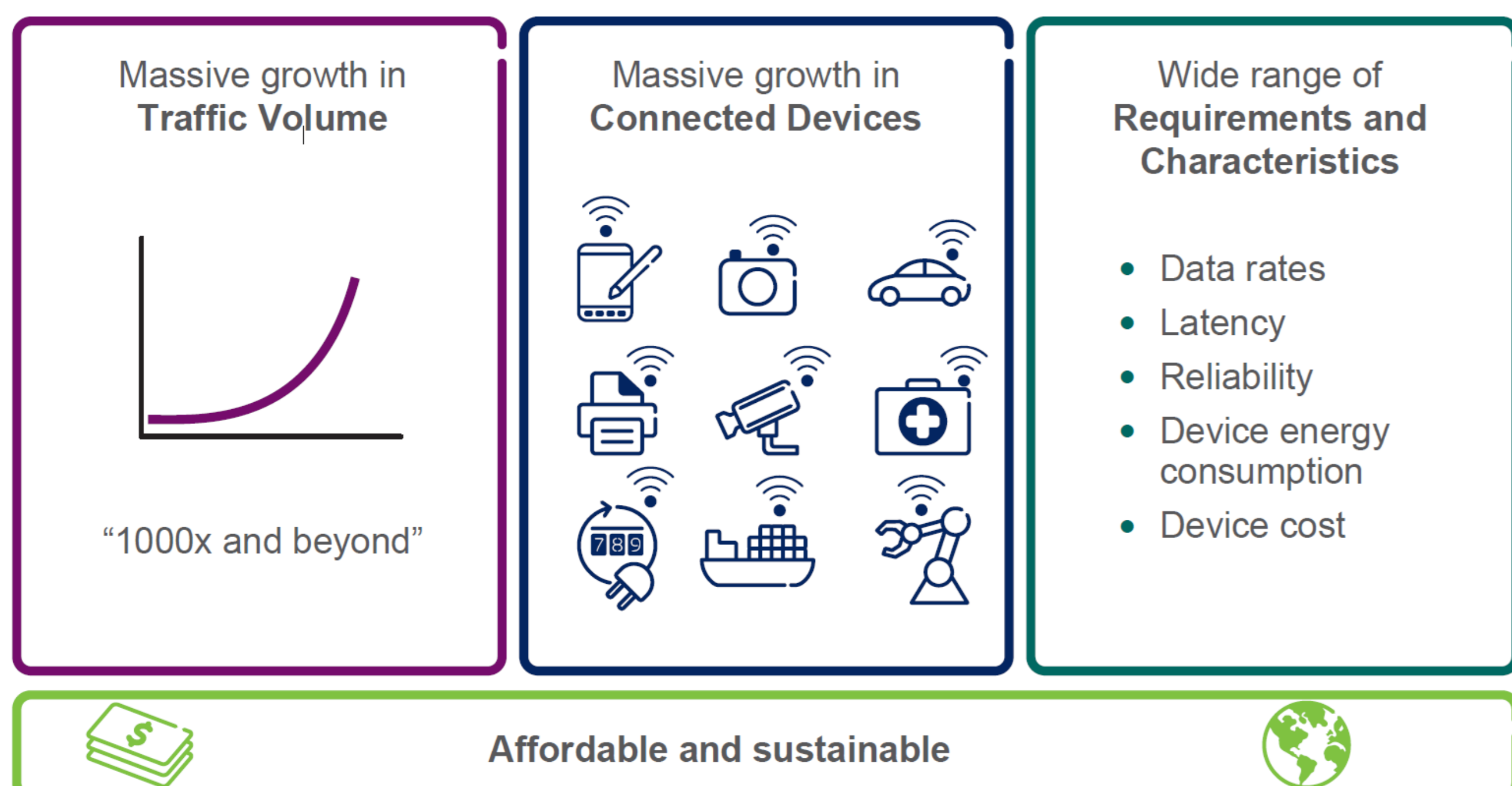


Figure 1: Key challenges for future radio access [1]

Key challenges for future radio access

- Massive growth in traffic volume;
- Massive growth in connected devices;
- Wide range of requirements and characteristics for different services.
- **Emerging technologies for 5G**
 - **MASSIVE MIMO: the focus of our work;**
 - Heterogeneous network (HetNet);
 - Machine to Machine Communications (M2M);
 - Software Defined Network (SDN), etc.

Massive MIMO Prototyping

- **OpenAirInterface (OAI)**
 - Open-source hardware/software development platform and open-forum for innovation in the area of digital radio communications created by EURECOM [2].
- **ExpressMIMO2**
 - OAI's hardware platform interfacing with the OpenAir4G modem
- **Massive MIMO prototype**
 - 64 Antenna array supported by 16 ExpressMIMO2 cards
 - Centralized high end computing engine

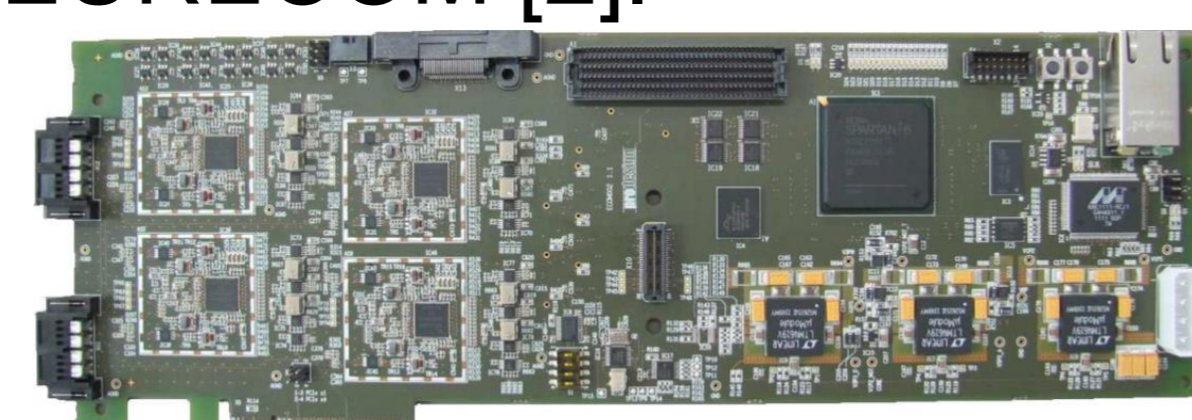


Figure 2: ExpressMIMO2 card

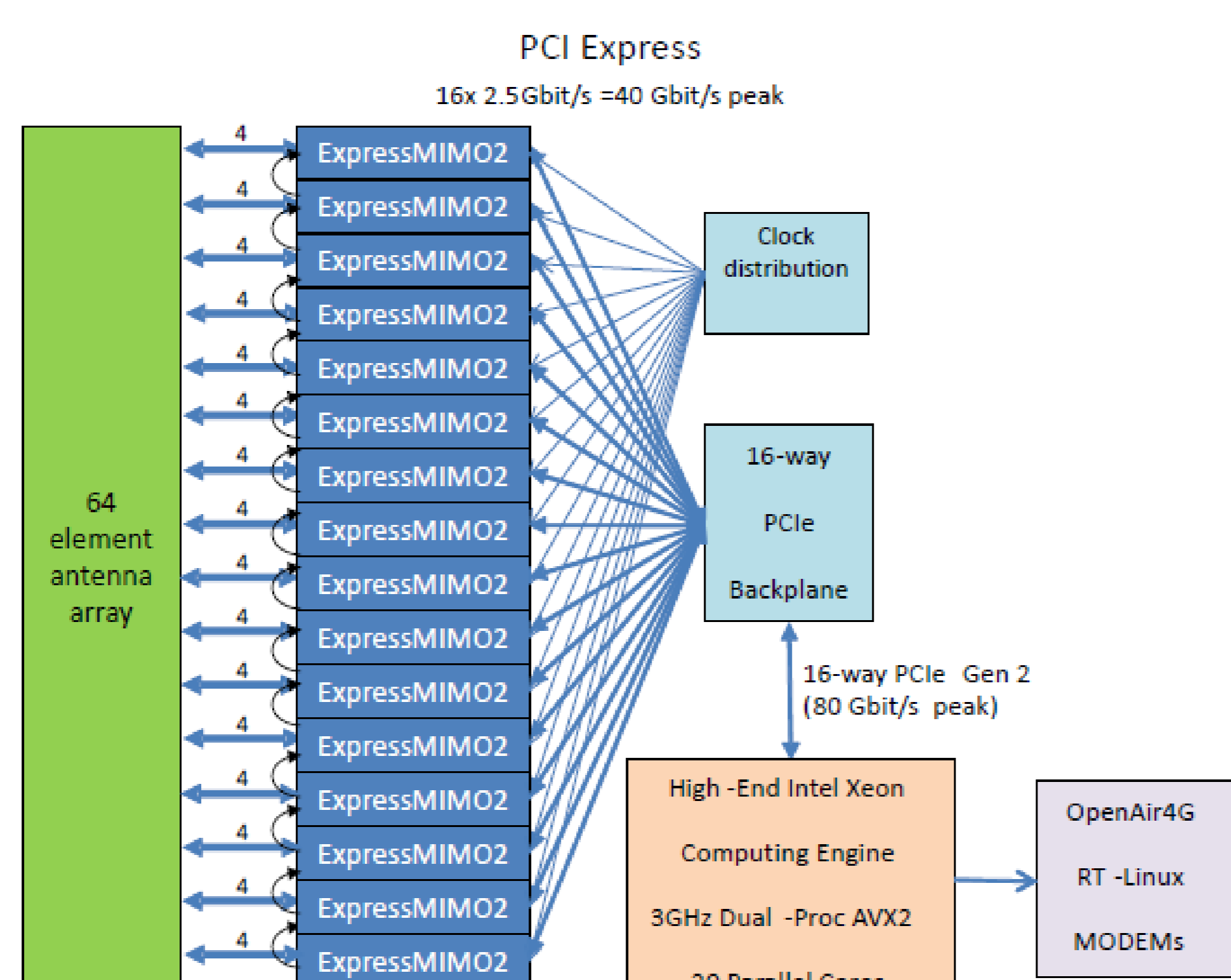


Figure 3: Massive MIMO prototype on OAI

Channel Reciprocity Exploitation

Massive MIMO key challenges

- Acquisition of channel information at transmitter (CSIT);
- Pilot contamination;
- Fast and distributed coherent signal processing;
- Hardware impairment, etc.

Time Division Duplexing (TDD)

- Use TDD channel reciprocity for massive MIMO to ease the acquisition of CSIT : no feedback needed;
- However, hardware non-symmetry destroys the TDD reciprocity.

Relative Calibration

- Compensate the impairment by a multiplicative matrix;
- Cost efficient: no additional hardware needed.

Experimental Results

Measurement on ExpressMIMO2

- 2x1 and 4x1 MISO case using 2 ExpressMIMO2 cards synchronized by cables;
- Measured results:

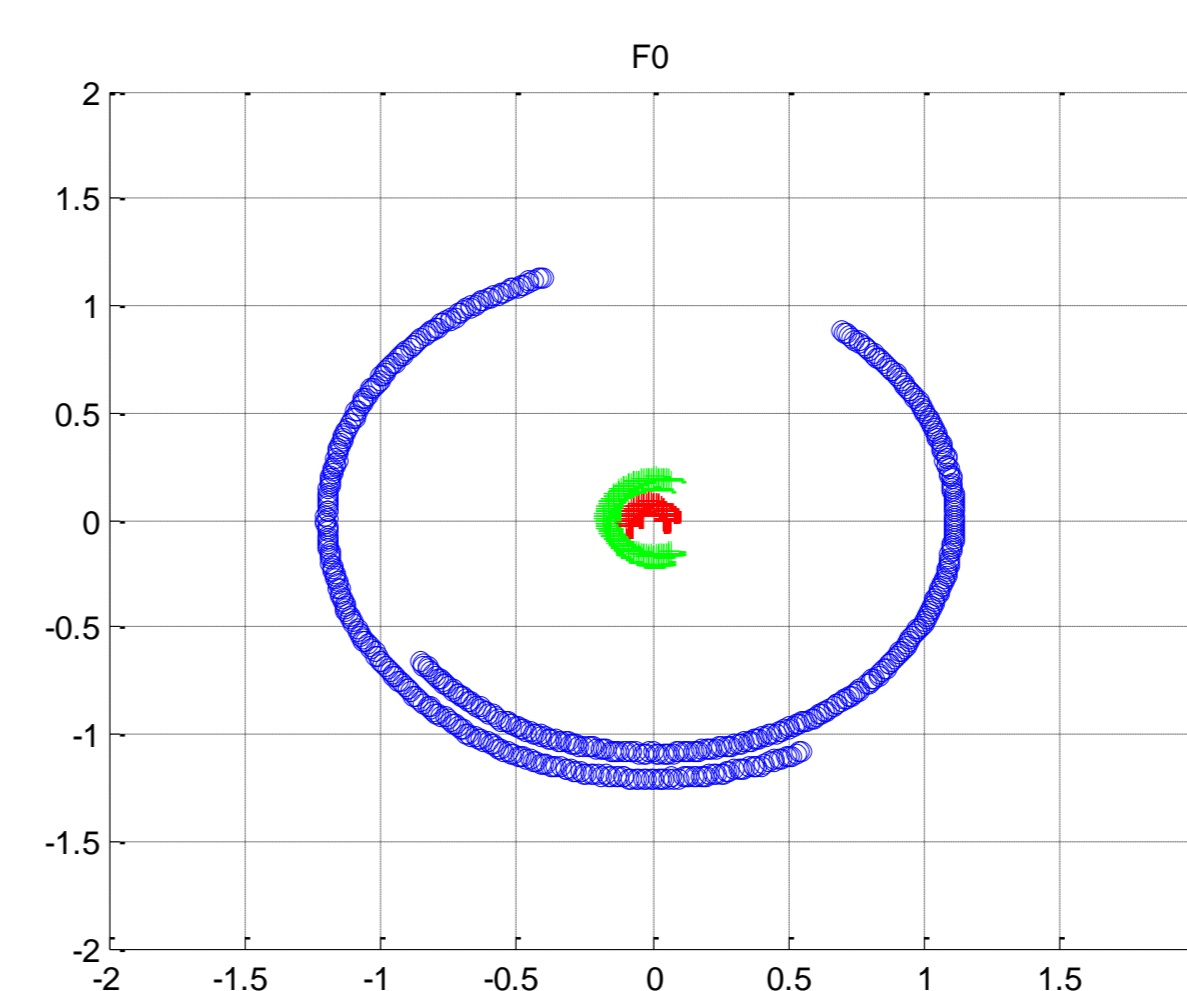


Figure 4: calibration matrix in 2x1 MISO

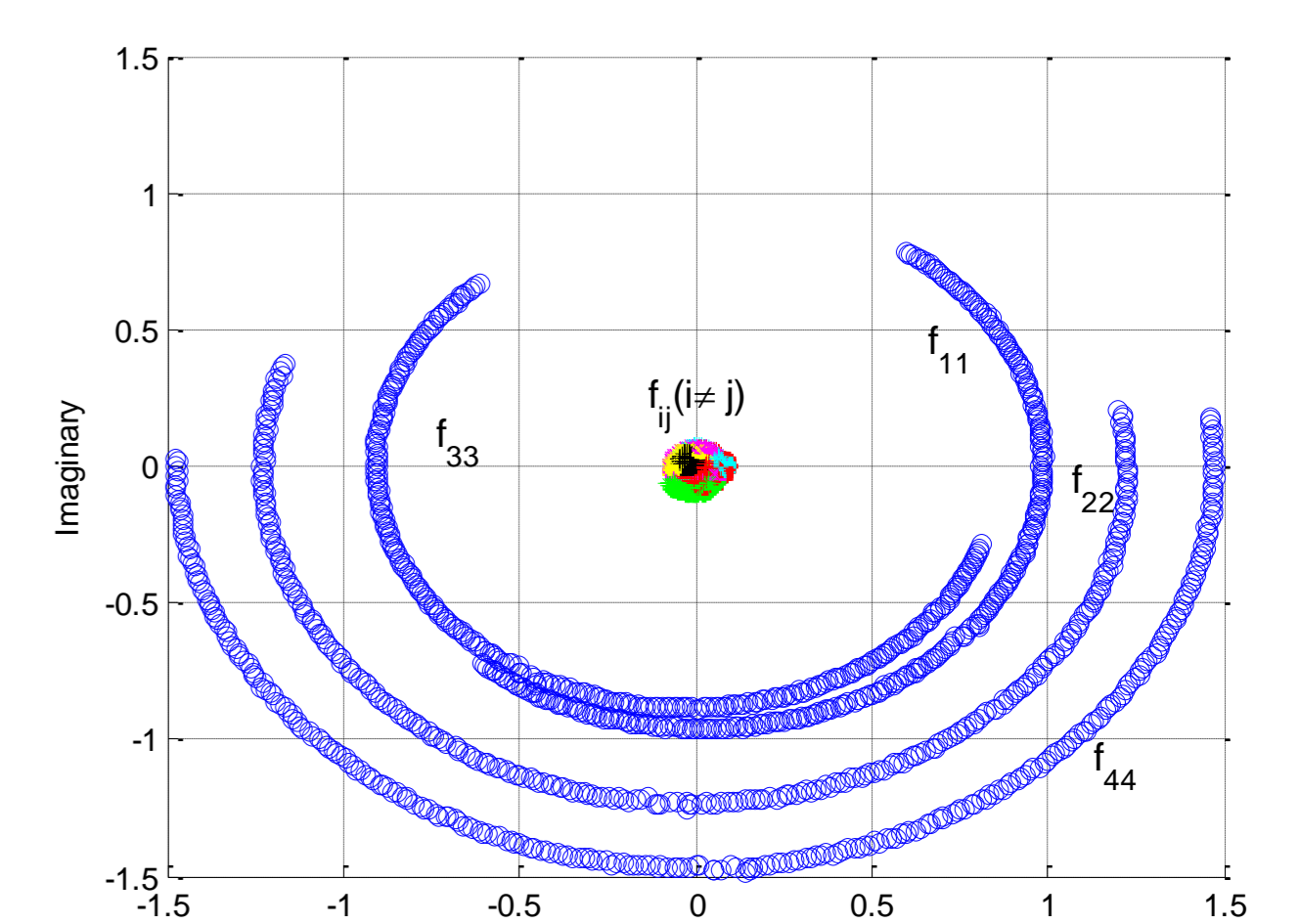


Figure 5: calibration matrix in 4x1 MISO

Beamforming Gain

- Different CSIT acquisition methods: feedback mode, calibration matrix full estimation, diagonal estimation (assume the off-diagonal elements to be zero) and no calibration used.

- Relative calibration fully achieves the channel reciprocity.

Future work

- Scale up the experiment to Massive MIMO case.

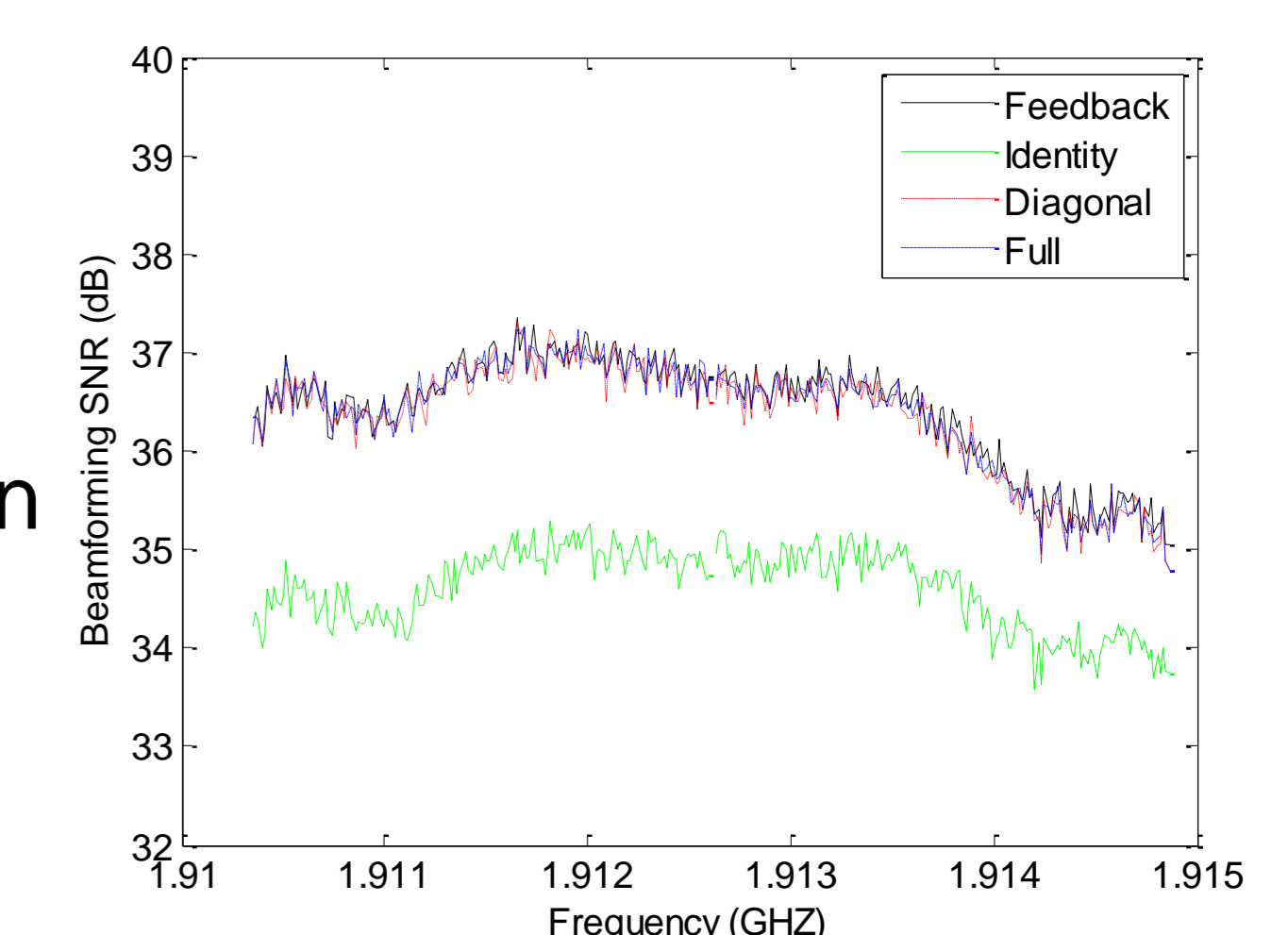


Figure 6: Beamforming performance based on different CSIT acquisition methods (4x1 MISO)

References

- [1] Ericsson, "5G radio access", white paper.
[2] <http://www.openairinterface.org/>

Note *

Luc Deneire is a professor in Université de Nice Sophia Antipolis, Laboratoire I3S