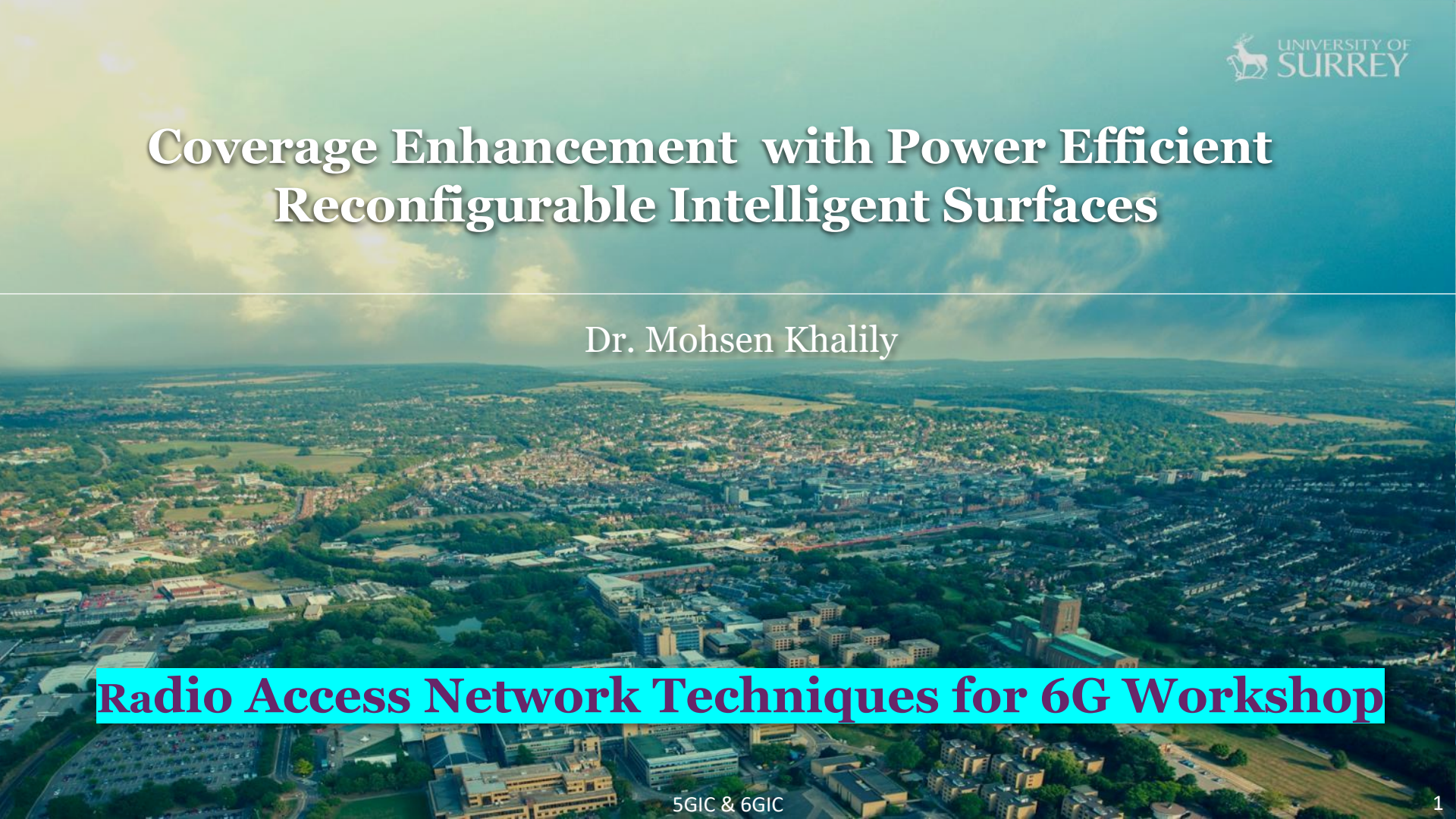
Coverage Enhancement with Power Efficient Reconfigurable Intelligent Surfaces

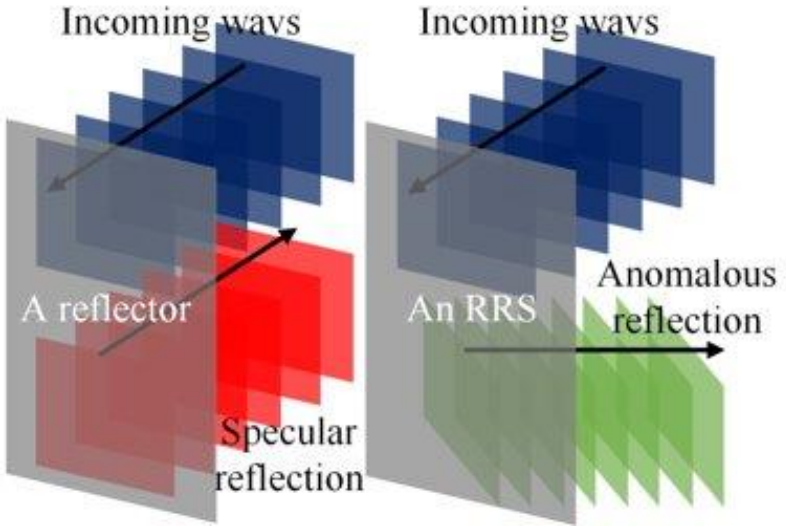
Dr. Mohsen Khalily



Radio Access Network Techniques for 6G Workshop

Outline

- Introduction
- Control over the Propagation Environment
- Network Operators' Challenges
- Current Technologies
- Reconfigurable Inteligent Surface
- 6GIC's RRSs
- Static RRS
- Dynamic RRS
- Multibeam and Widebeam RRS
- RRS channel measurement
- THz channel measurement



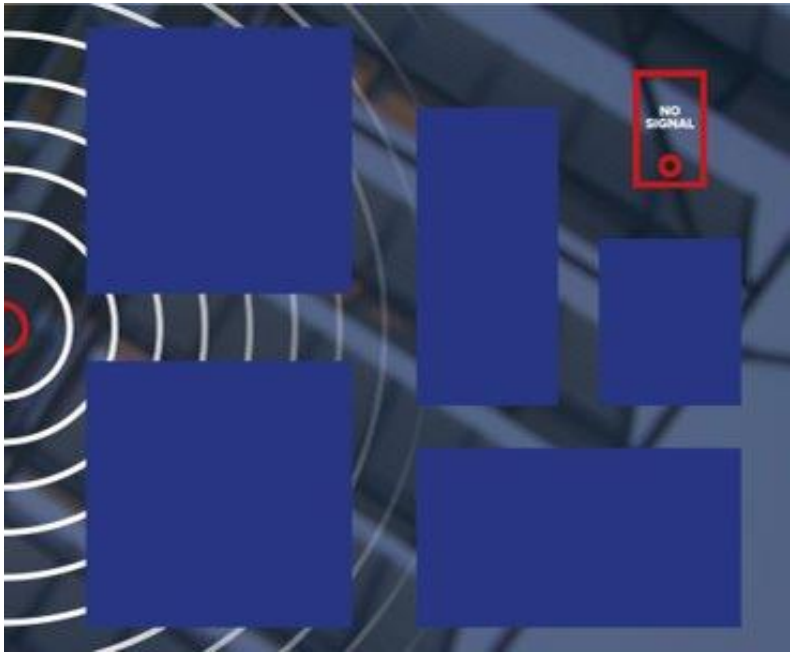
Introduction

•Wireless communication engineers envision a fully connected world where there is a seamless wireless connectivity for Everyone and Everything.

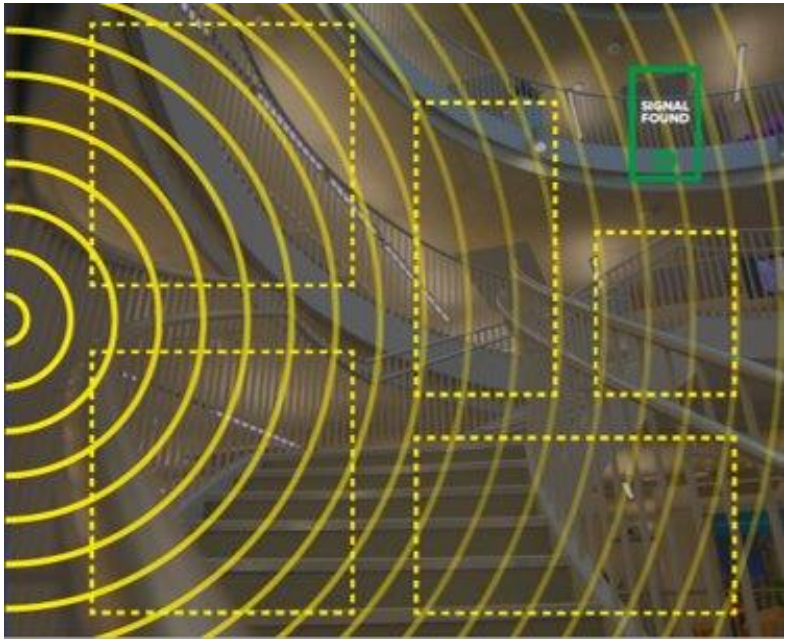
•Current 5G and future 6G wireless networks will be required to fulfil an ever-increasing demand for connectivity at an unprecedented scale.

•This will require all future generations of Smart, Intelligent and Efficient.

Control over the Propagation Environment



A lack of control over the *propogation environment*



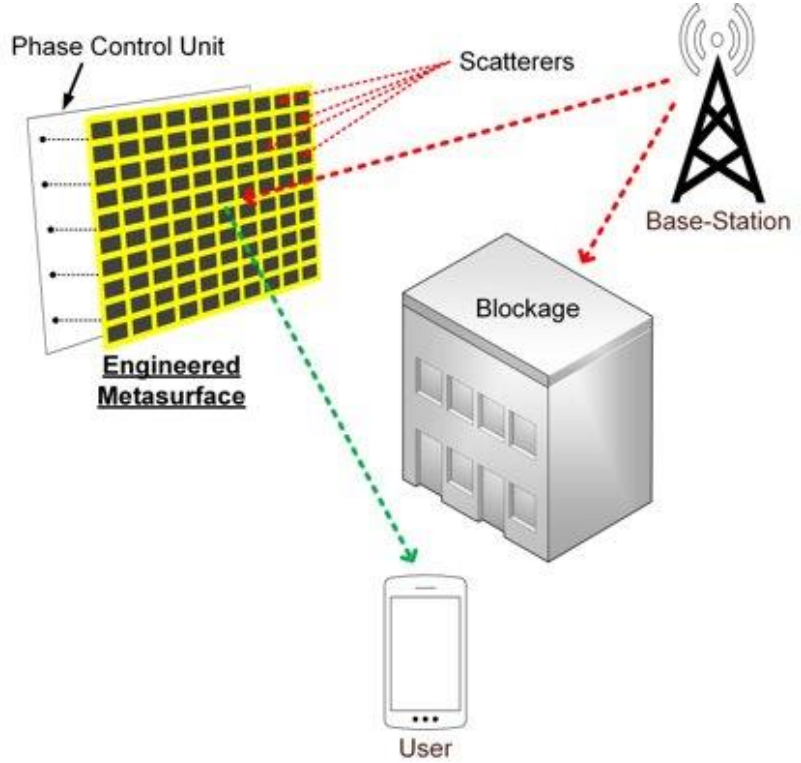
A controlled *propogation environment*

Network Operators' Challenges

- Lack of seamless connectivity leading to poor quality of (QoS) especially in harsh propagation environments.
- Supporting billions of online devices with such high data which ultimately results in a higher carbon footprint of the network.
- Uneven user distribution due to various practical challenges in the urban environment leading to an unequal resource utilisation at the BSs.

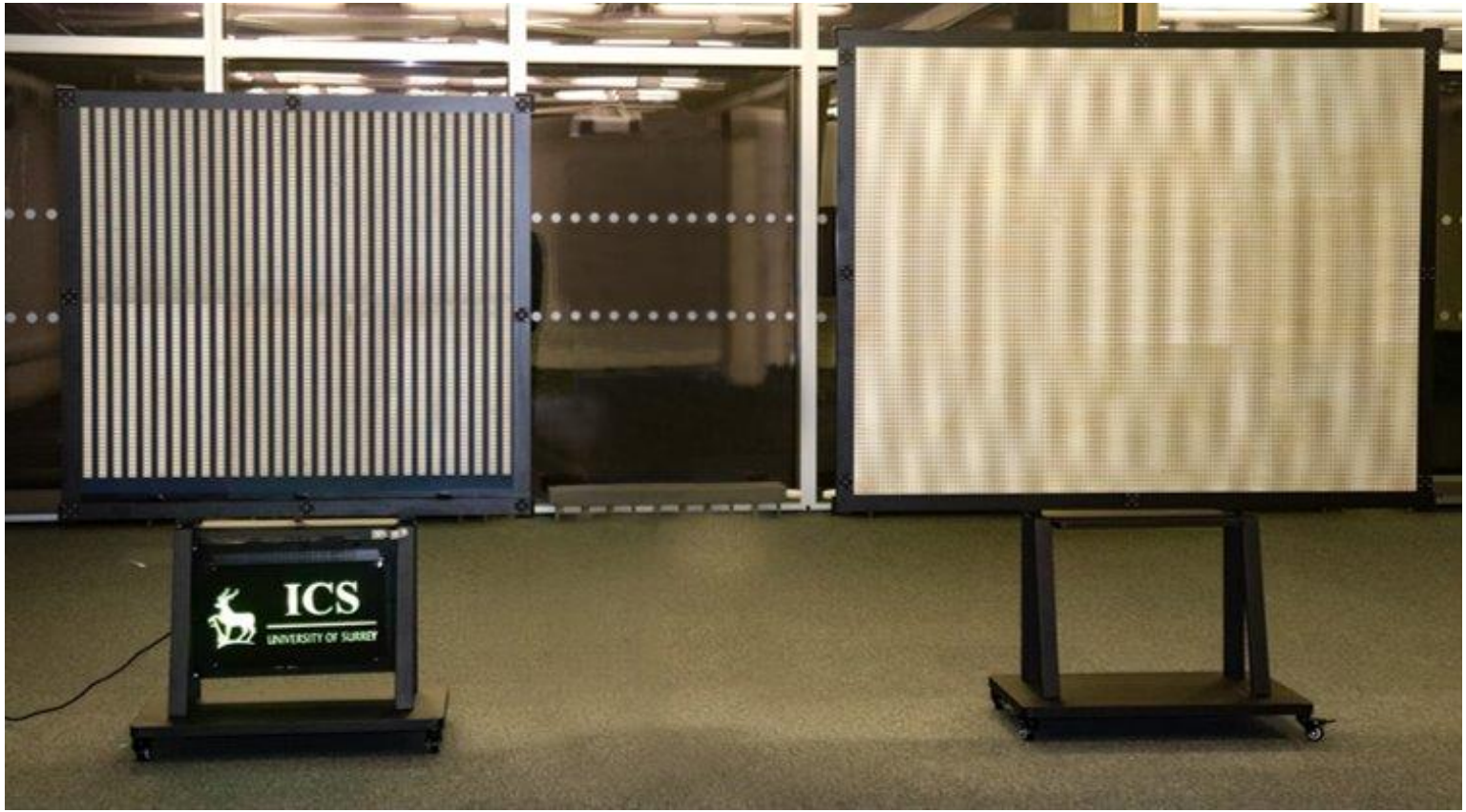
- Large-scale antenna systems e.g, Massive MIMO systems
- Relay nodes, heightened power consumption and reduced network efficiency.
- Although, ultra-dense networks can be a solution for coverage enhancement, they can increase the interference level and require backhaul planning along with higher infrastructure management costs.
- Using co-operative BSs would also require higher density while switching to sub-6GHz. (For mmWave scnearios)

Reconfigurable Intelligent Surface



- RIS are typically composed of a large metasurface sheet backed by a control unit.
- Capable of flexible manipulation of an arbitrary EM wavefront.
- RIS does not require intense backhaul planning.
- RIS can be made of smart elements that are not impaired by noise amplification.
- RIS capable of controlling the state of individual elements and can sense the environment to cut down power consumption.
- RIS can improve coverage by forming strong NLoS path where the LoS path is either blocked or not sufficiently strong.

6GIC's RRS

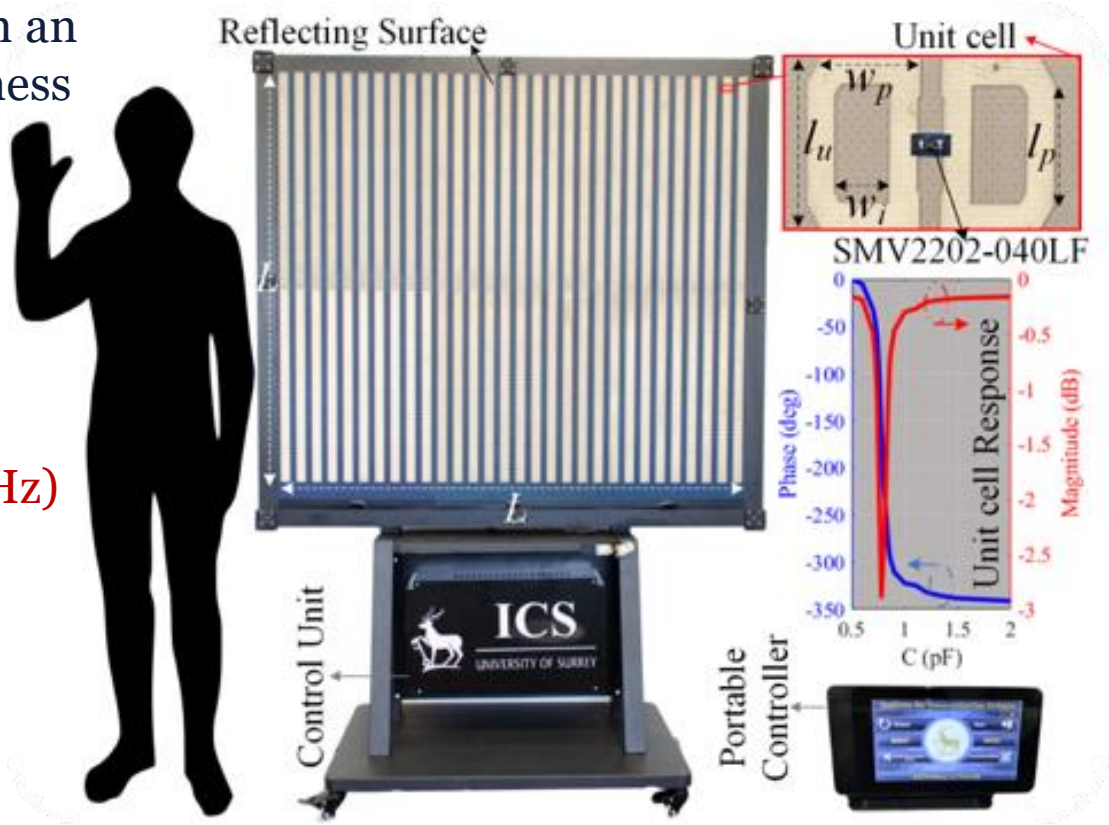


- **Substrate:** F4BT615 is a micro dispersed ceramic PTFE composite with a woven fiberglass reinforcement through scientific formulation and strict technology procedures. Besides , because of the high thermal conductivity , advantage to the heat dissipation of apparatus.

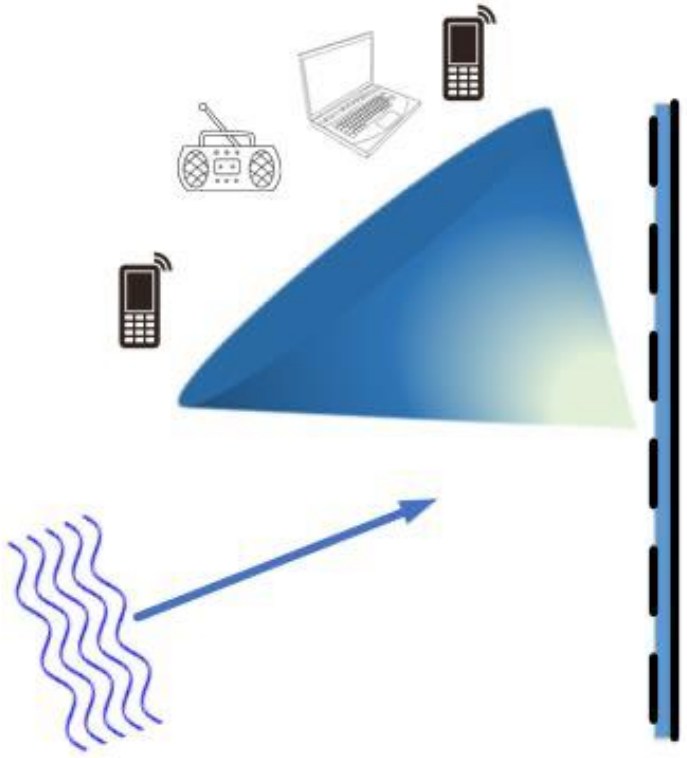
- **Thickness**: **3mm**
- **Unit cells: 11000**
- **Beams: 2 reflected beams towards ±450**
- **Measured Gain: 20 dB**
- **Bandwidth: 400MHz (3.3 GHz- 3.7GHz)**
- **Input power: 0 Watt**

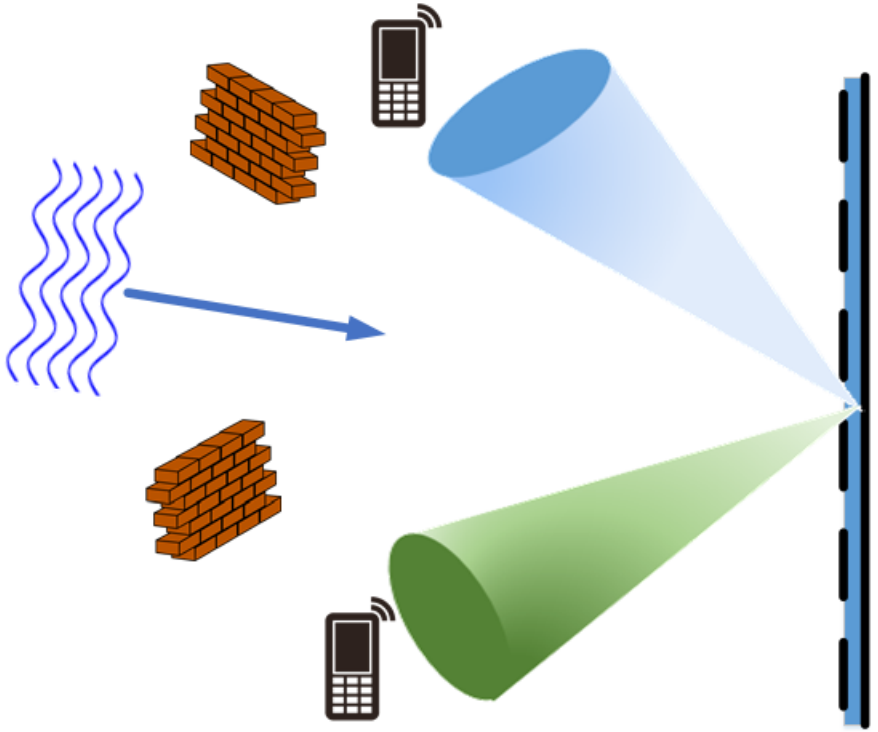
- The patches have been printed on an F4BT450, substrate with a thickness of 1.524mm

- Unit cells: 3000
- Measured Gain: 17dB
- Bandwidth: 700MHz (3.1- 3.8 GHz)

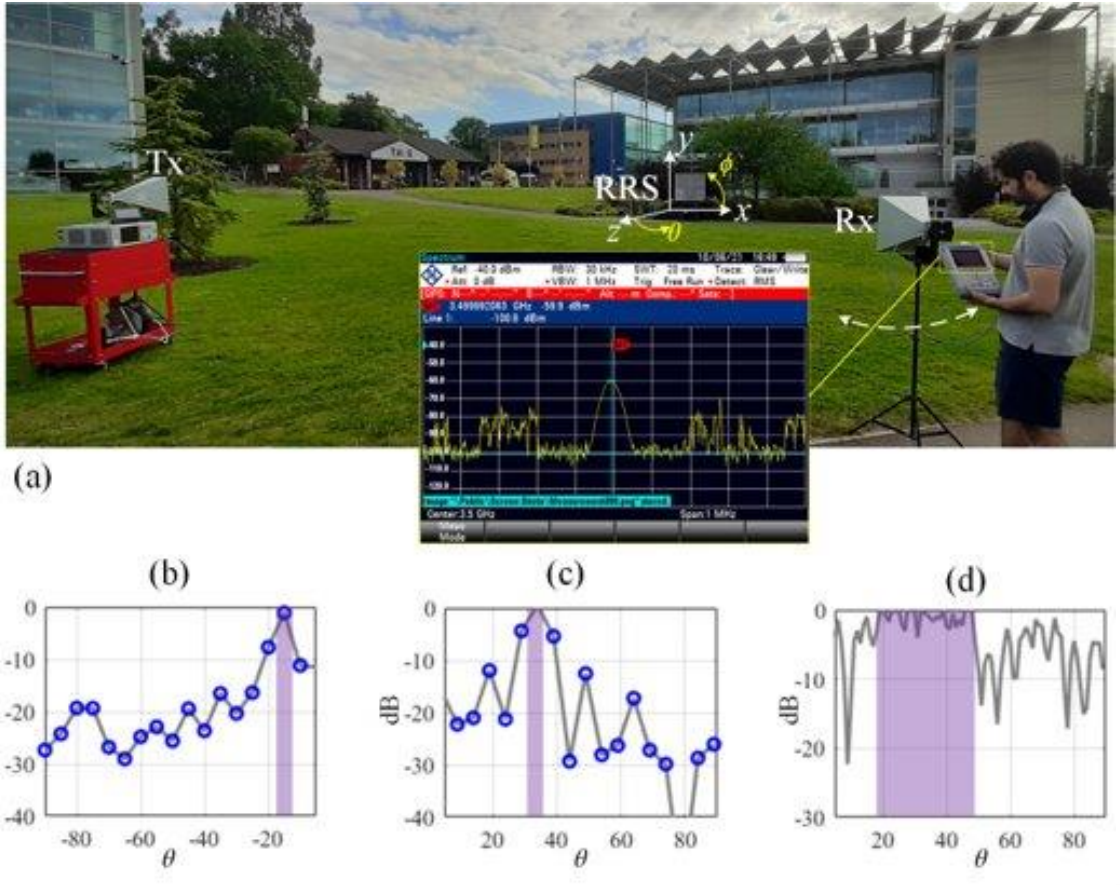


Muli- & Wide-Beam RRS

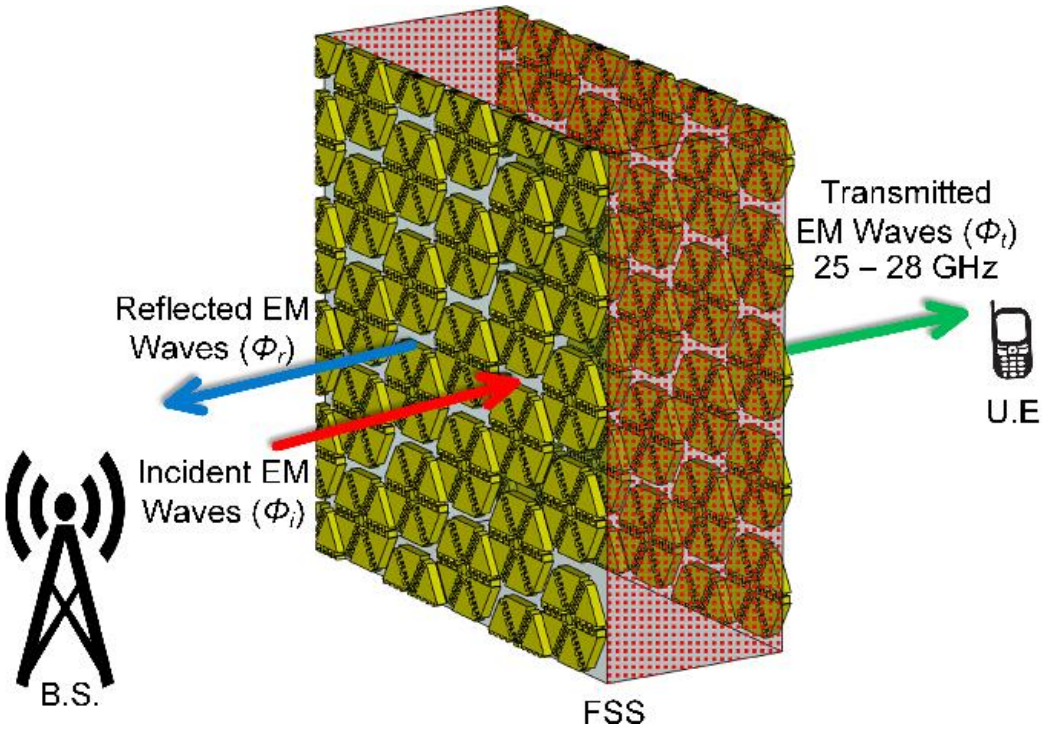




Muli- & Wide-Beam RRS

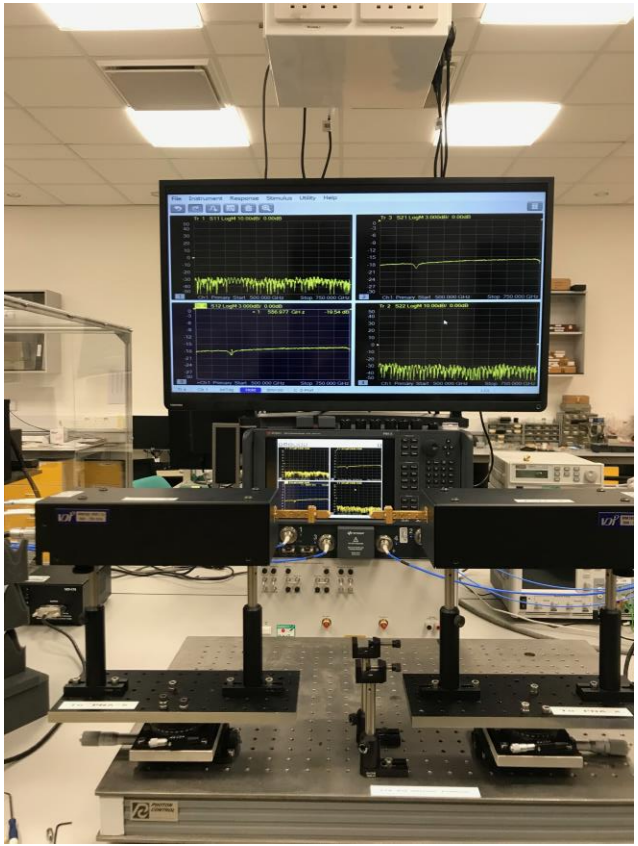


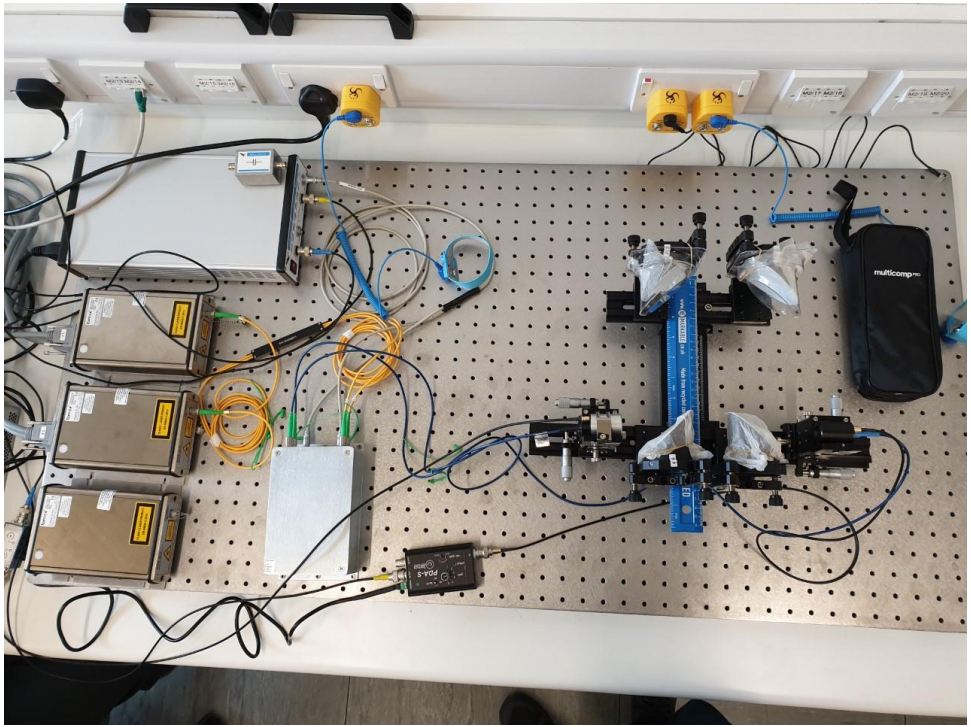
- Fully-transparent and novel transmission surface that can be used to reduce the penetration loss encountered by mmWave frequencies during a typical O2I scenario.
- It is optically transparent, so it can be deployed in buildings as windows or glass panes without impacting the aesthetics of the infrastructure.



Channel Measurement in Presence of RRS

THz Channel Measurement





Thank you for Watching and Listening !