Poster Pitches

#	Name	Group	Poster Title
1	Marzieh Hashemipour Nazari	ES	Hardware implementation of Iterative Projection Aggregation (IPA) decoding of Reed-Muller codes
2	Anouk Hubrechsen	EM	Antenna Efficiency towards 6G in a mm-Wave Reverberation Chamber
3	Martijn de Kok	EM	Ka-band High-Power Active Antenna Integration
4	Yu Zhao	ECO	Power allocation cell-free massive MIMO: Using deep reinforcement learning methods
5	Tom van Nunen	EM	Wireless Power Transfer to a Brain Implant
6	Niels Vertegaal	EM	Shape Memory Alloy Antennas
7	Roel Budé	EM	Measurements of point-to-multipoint FPA antenna
8	Berna Eraslan	ECO	Ultra reliable Intra aircraft Wireless Communication
9	Erik Bertram	IC	Hardware Solutions for Intra Aircraft Wireless Communication
10	Ngoc (Quan) Pahm	ECO	Auto-Aligned Optical Receiver for Indoor OWC System
11	Carolina Amaral	ECO	Hybrid mm-wave/optical wireless system for indoor environment
12	Carina Barbio	ECO	Luminaire free LiFi systems
13	Shoajuan (Jessie) Zhang	ECO	Optical Wireless Data Center Network
14	Piyush Kaul	IC	Waveguide-integrated Silicon-ICs
15	Leroy Driessen	EM	INTENSE: More neurons, more data

Hardware implementation of Iterative Projection Aggregation (IPA) decoding of Reed-Muller codes

Contact: Marzieh Hashemipour-Nazari < s.m.Hashemipour.Nazari@tue.nl>
Supervisors: Alexios Balatsoukas-Stimming, Kees Goossens

Background

Ultra-Reliable Low-Latency Communication (**URLLC**) systems

Short packets ⇨ **error-correction is challenging!**

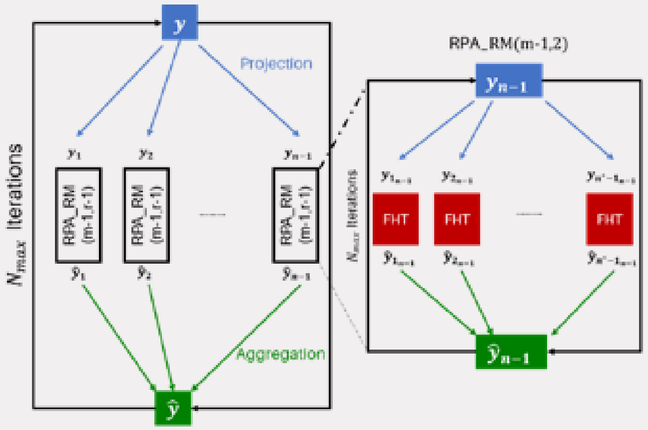
Recursive projection aggregation (**RPA**) decoding for Reed-Muller (RM) codes [1]

Pro

- Good error-correcting performance

Con

- Non-standard structure for the hardware implementation

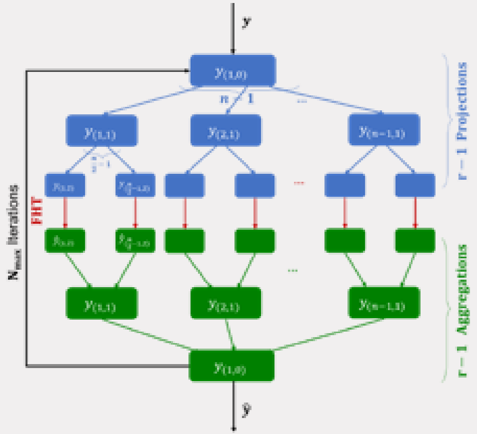


Contributions

Our contributions:

1. We transform the **recursive** structure into an **Iterative** structure with **minimal error-correction degradation**

Iterative Projection Aggregation (**IPA**)



2. We explore the effect of commonly used approximation techniques
3. We describe an **efficient hardware implementation**

[1] Min Ye and Emmanuel Abbe, "Recursive projection-aggregation decoding of Reed-Muller codes," IEEE Transactions on Information Theory (2020).

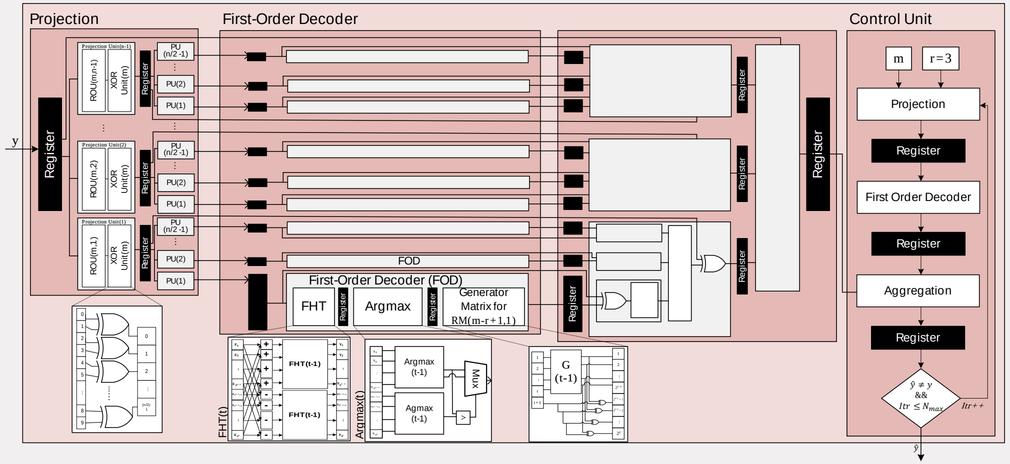
Hardware implementation of Iterative Projection Aggregation (IPA) decoding of Reed-Muller codes

Contact: Marzieh Hashemipour-Nazari < s.m.Hashemipour.Nazari@tue.nl>
Supervisors: Alexios Balatsoukas-Stimming, Kees Goossens

Hard-decision IPA

Fully parallel architecture

- Hard-decision IPA (HIPA) [2]



LUTs	FFs	Throughput	Latency
602,712	65,699	171 Mbps	375 ns

Implementation results for HIPA for RM(6,3)

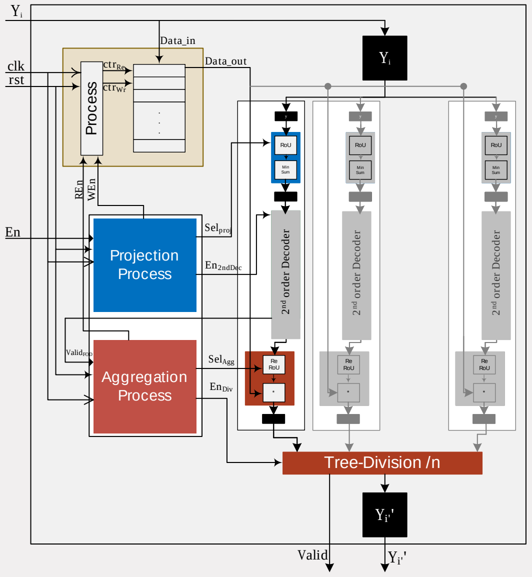
Soft-decision IPA

Partial parallel architecture

- Soft-decision IPA (SIPA)
  - Pipe-line structure
  - Flexible architecture

PUs	LUTs	FFs	Throughput	Latency
1	37,752	34,806	2.535 Mbps	77 us
2	40,773	35,649	5.07 Mbps	38.5 us
4	49,170	38,544	10.14 Mbps	19.65 us
8	70,509	45,480	20.28 Mbps	10.2 us
16	104,217	60,555	40.56 Mbps	5.47 us
32	162,276	87,913	81.12 Mbps	3.11 us

Implementation results for SIPA for RM(6,3)



[2] M. Hashemipour-Nazari, K. Goossens, and A. Balatsoukas-Stimming, "Hardware Implementation of Iterative Projection-Aggregation Decoding of Reed-Muller Codes," ICASSP (2021).

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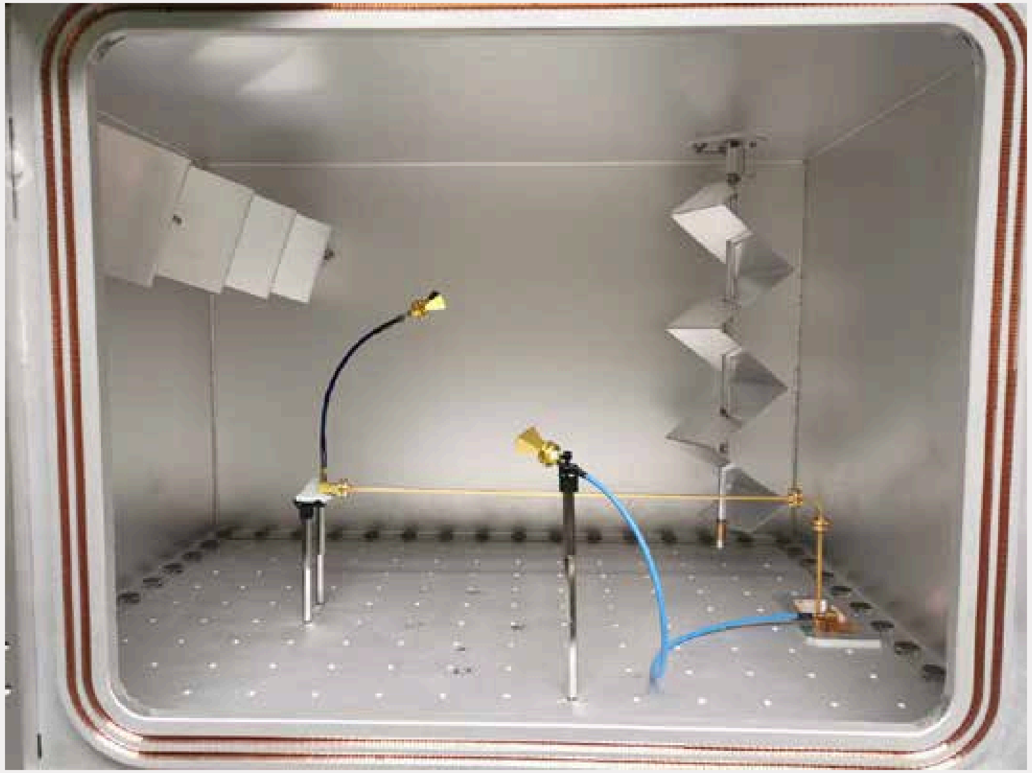
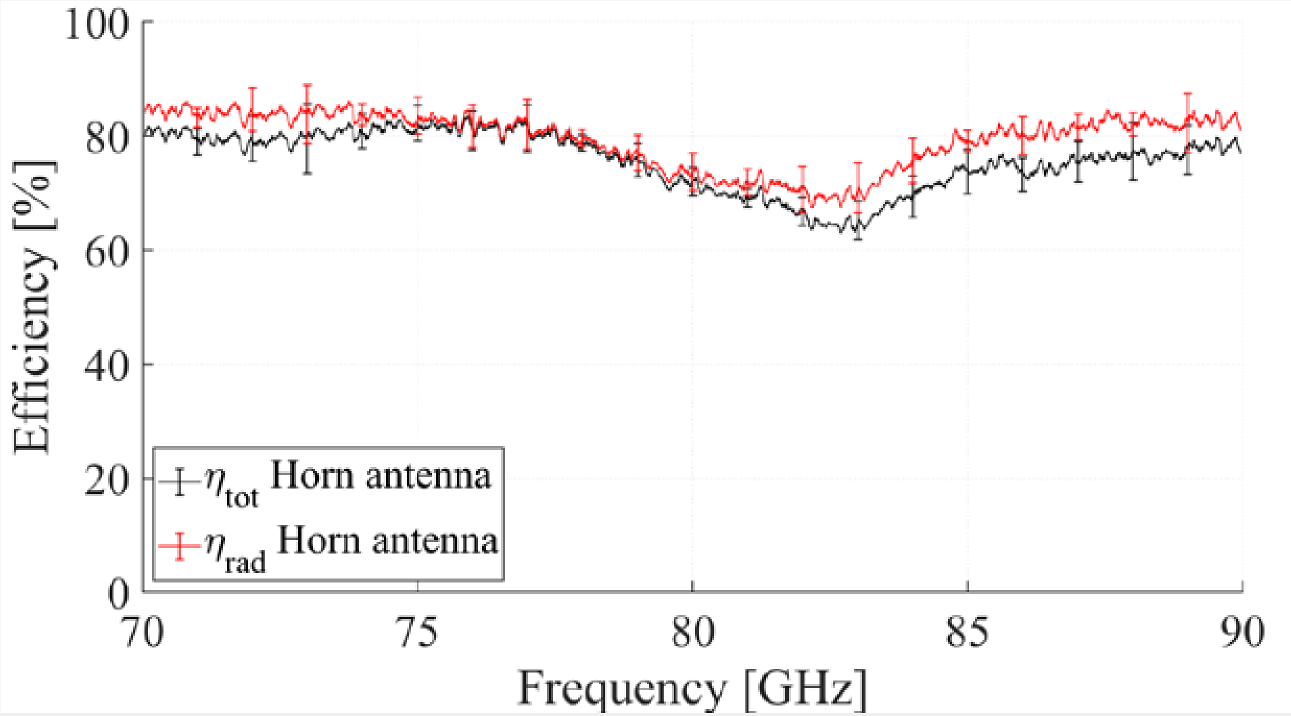
TU/e

Antenna Efficiency towards 6G in a mm-Wave Reverberation Chamber

Anouk Hubrechsen, a.hubrechsen@tue.nl





Antenna Efficiency towards 6G in a mm-Wave Reverberation Chamber

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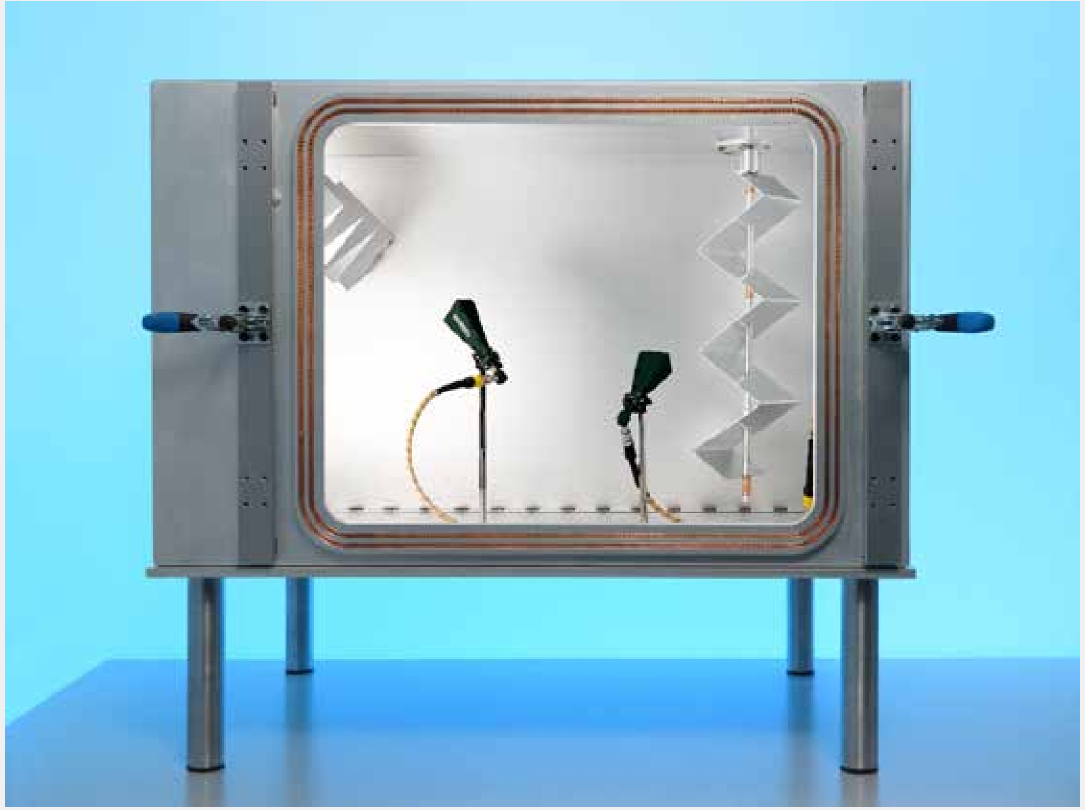


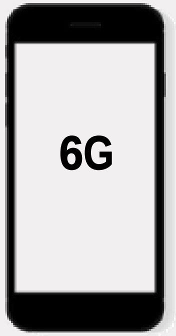
New measurement methods towards 6G

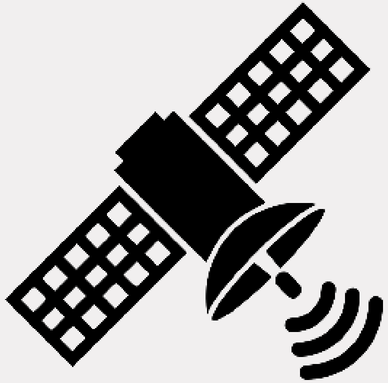
- Integrated antennas
- Electrically-small antennas
- Contactless characterization
- Full phased-array systems
- OTA wireless testing at mm-Wave

Ka-band High-Power Active Antenna Integration

Contact: Martijn de Kok, m.d.kok@tue.nl

- Ka-band (26.5-40 GHz)
  applications:

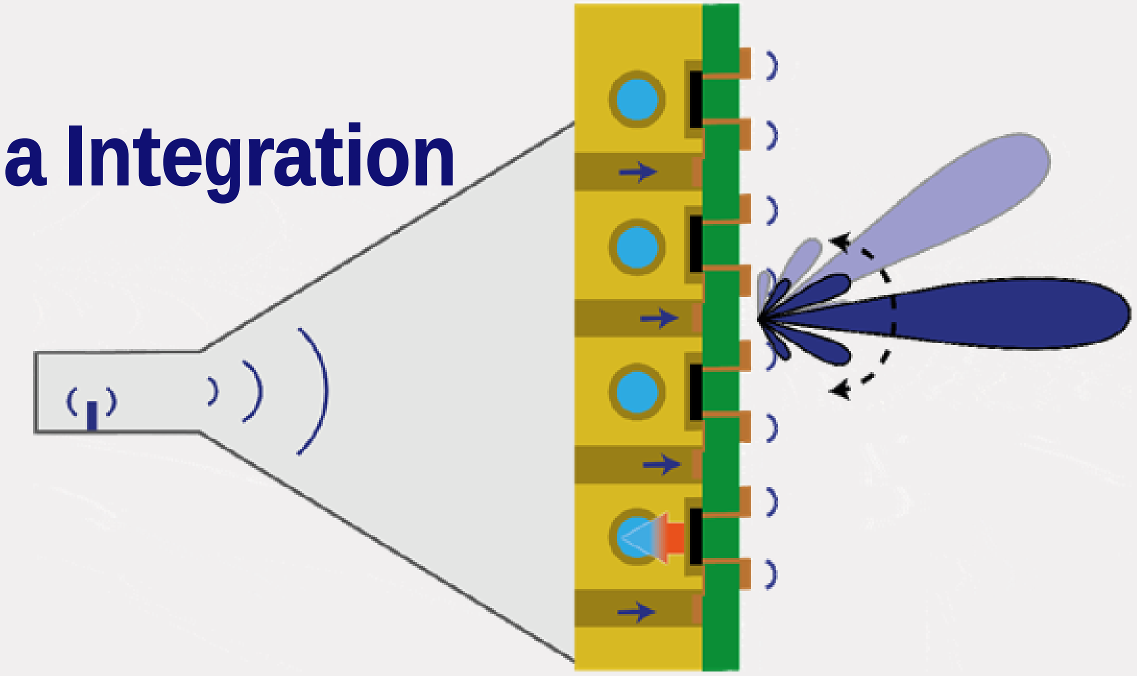


- Size, Weight and Power (SWaP) & Cost requirements
- Capable but expensive III-V technologies
- **Co-design of amplifier & antenna for optimum P_{out} & efficiency**
  - Direct matching
  - Short interconnects
  - Power combining

Ka-band High-Power Active Antenna Integration

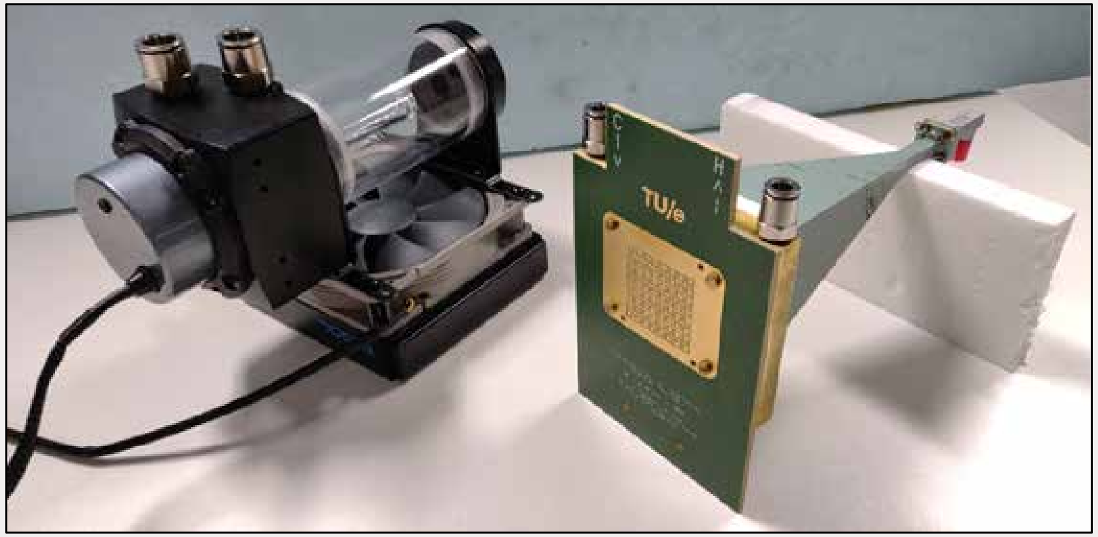
Contact: Martijn de Kok, m.d.kok@tue.nl



Example of current work:

- Transmitarray for radar applications
  - High-EIRP phased array
  - 5G technology: BiCMOS-based ICs
  - Thermal considerations

- Prototype has been realized
  - Measurements in progress



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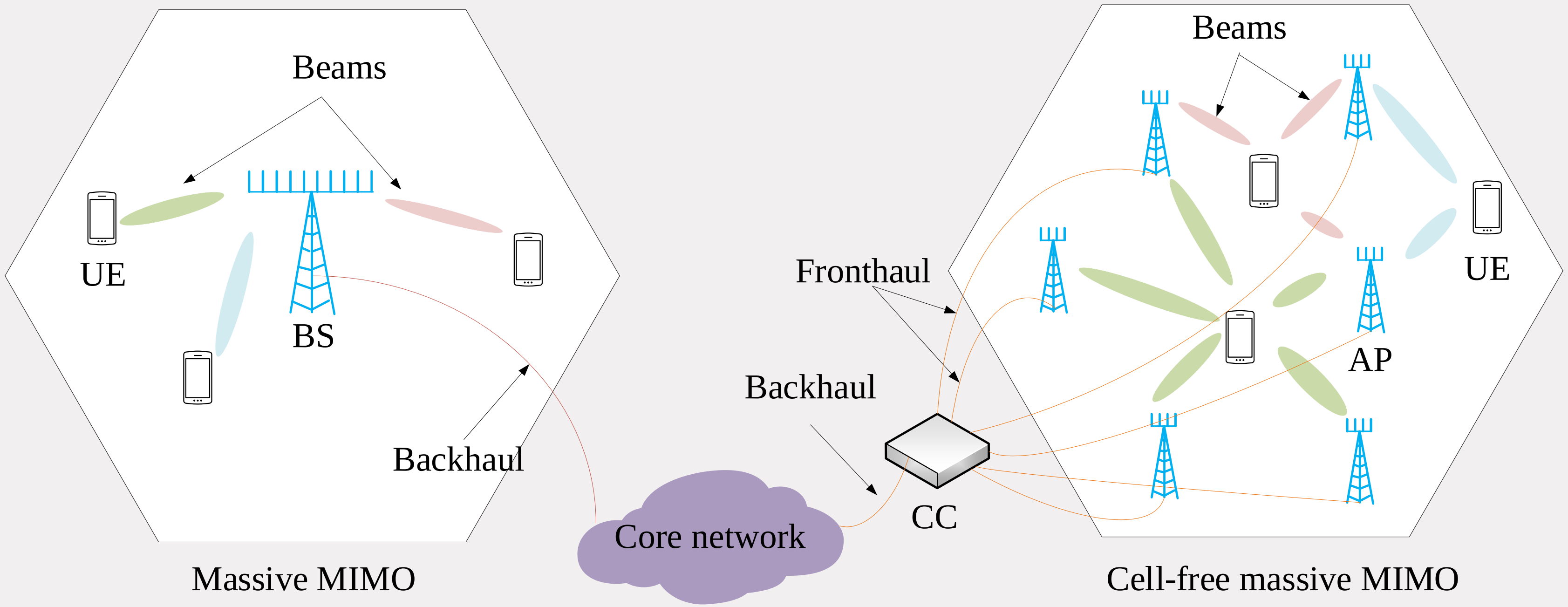
Power allocation in cell-free massive MIMO: Using deep reinforcement learning methods

Contact: Yu Zhao, y.zhao3@tue.nl



UE=User equipment BS=Base station AP=Access point CC=Central controller

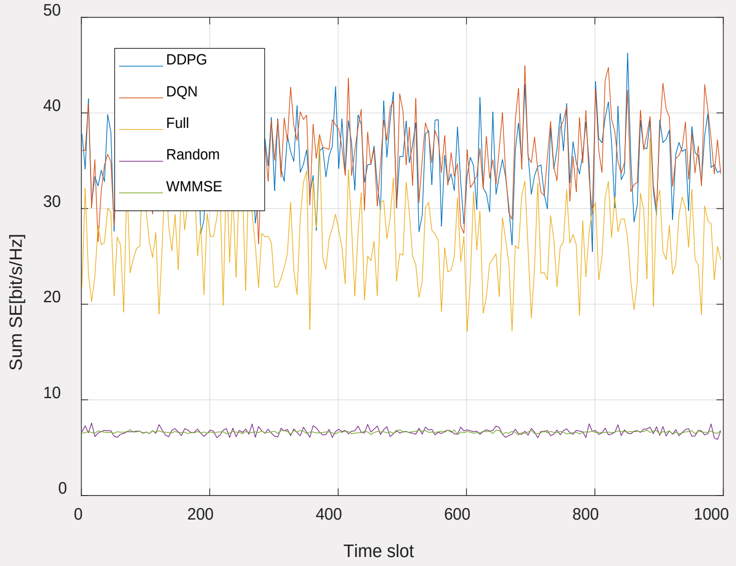
- Cell-free massive MIMO.
- Power allocation: Non-convex and NP-hard.
- Time constraints: Channel variation.
- Low-complexity method

Power allocation in cell-free massive MIMO: Using deep reinforcement learning methods

Contact: Yu Zhao, y.zhao3@tue.nl

3GPP TR 38.901 indoor mixed office scenario

Parameter	Value
Coverage volume	120m×50m×3m
K, number of UEs	10
N, number of APs	12
Maximum downlink transmission power per AP	200 mW
Carrier frequency	2 GHz
Bandwidth	200 MHz
Noise power	-74 dBm
Distribution of UE velocity	U(0, 1) m/s



- Normalized conjugate beamforming.
- Maximizing the total spectral efficiency.
- Rayleigh channel model.
- Deep Q-network (DQN)
- Deep deterministic policy gradient (DDPG).

Execution time of the DRL methods and the WMMSE algorithm (in ms)

Method	Mean	Max	Min	Standard deviation
DQN	0.66	0.97	0.52	0.03
DDPG	0.63	0.99	0.51	0.04
WMMSE	621.23	759.63	592.16	16.35

Compared to existing algorithms, our proposed deep reinforcement learning methods:

1. Achieve better sum-SE performance.
2. Require substantially less execution time.

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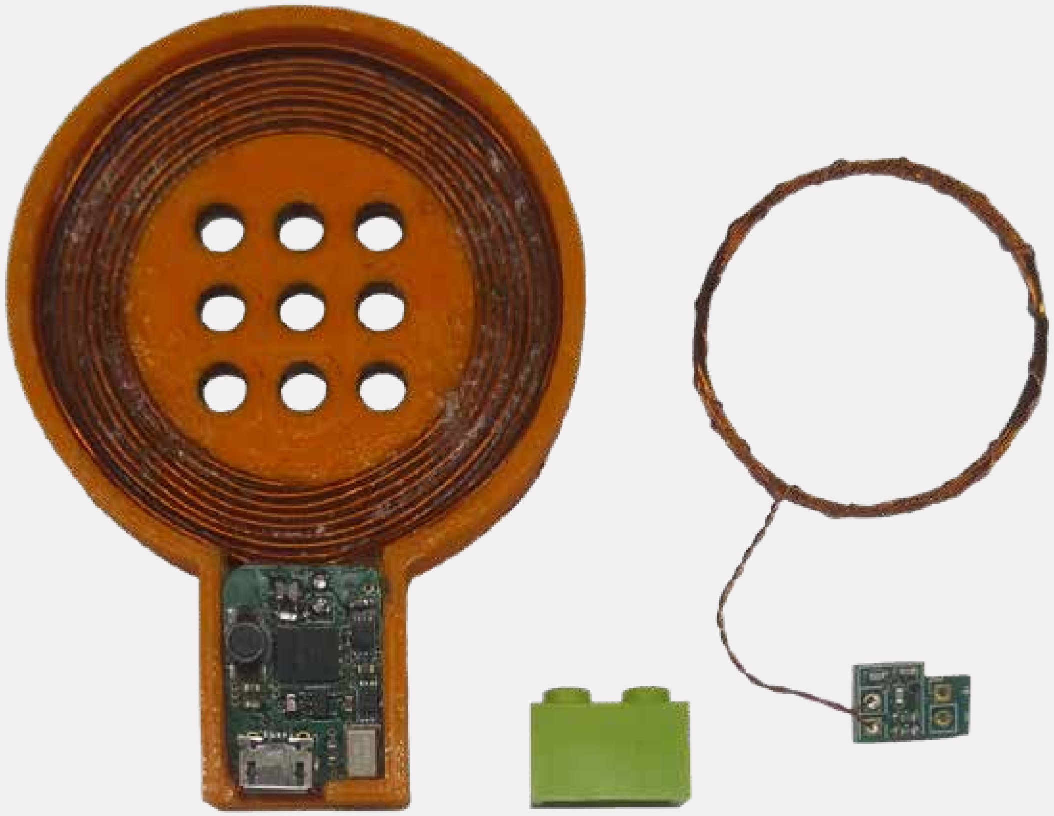
Wireless Power Transfer to a Brain Implant

Contact: Tom van Nunen, t.p.g.v.nunen@tue.nl



NESTOR project:

Artificial Vision for the Blind

Brain implant, 1024 electrodes in visual cortex

Wireless data and power transfer

Estimated max 60 mW

Design for 74 mW

Class-E inverter à Tx coil: 10T, Ø 55 mm, 1 mm wire

Class-DE rectifier à Rx coil: 8T, Ø 35 mm, 0.25 mm wire

Wireless Power Transfer to a Brain Implant

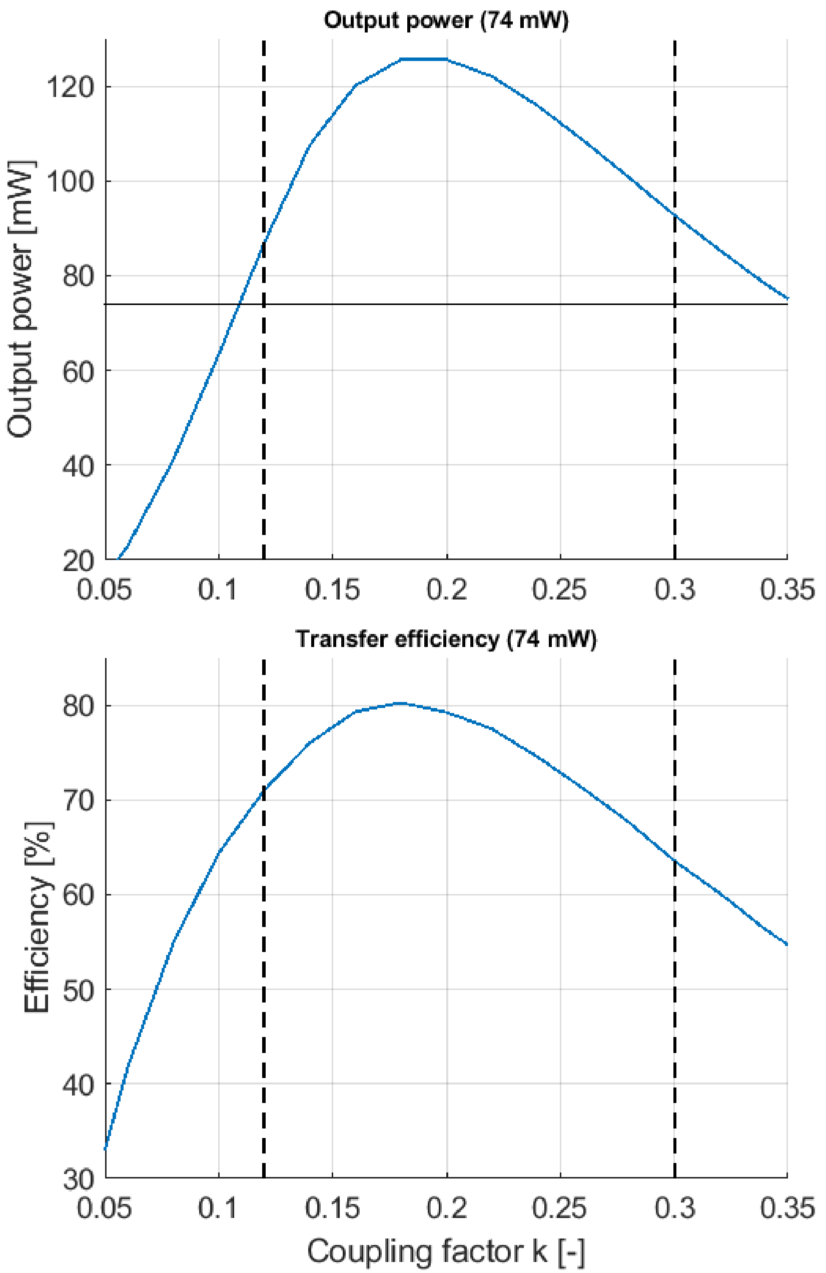
Contact: Tom van Nunen, t.p.g.v.nunen@tue.nl

$8 \leq z \leq 15$ mm
$0 \leq r \leq 15$ mm
} $0.12 \leq k \leq 0.30$ à $k_{opt} = 0.18$

$64 \leq \eta \leq 80$ % (including inverter and rectifier)

Compliant with

- IEEE Std C95.1 (SAR)
- ICNIRP (SAR)
- ETSI EN 303 417 (Field strength)
- ISO 14708-3 (Electronics heating)



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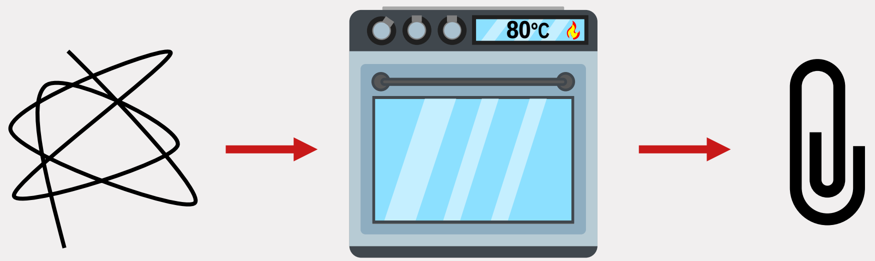
Shape Memory Alloy Antennas

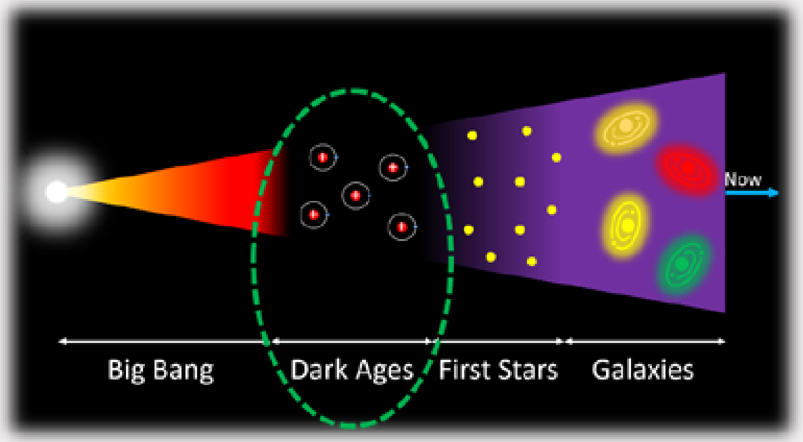
Contact: Niels Vertegaal, c.j.c.vertegaal@tue.nl

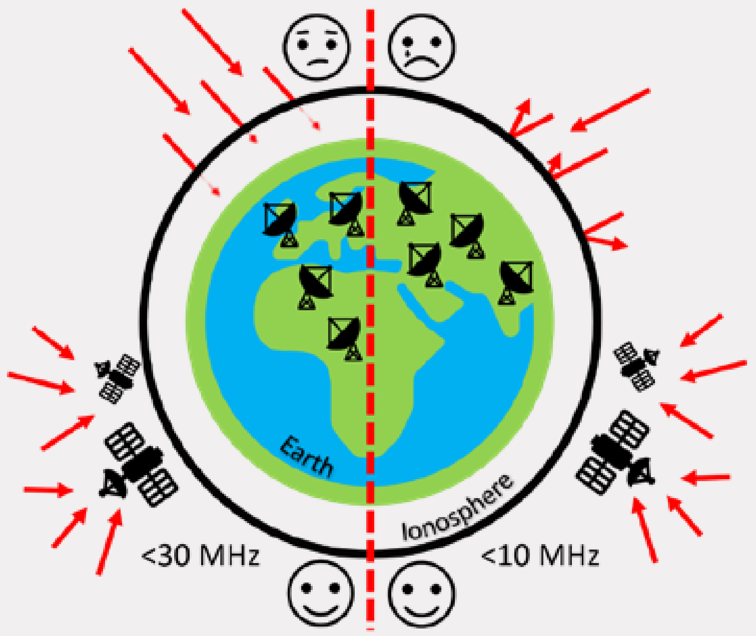
Goal: Design of an antenna for Radio Astronomy in Space

Use Shape memory alloy?

- Train for any shape
- Return when slightly heated







Concept study:

Design antenna for CubeSat using Shape Memory Alloy

Shape Memory Alloy Antennas

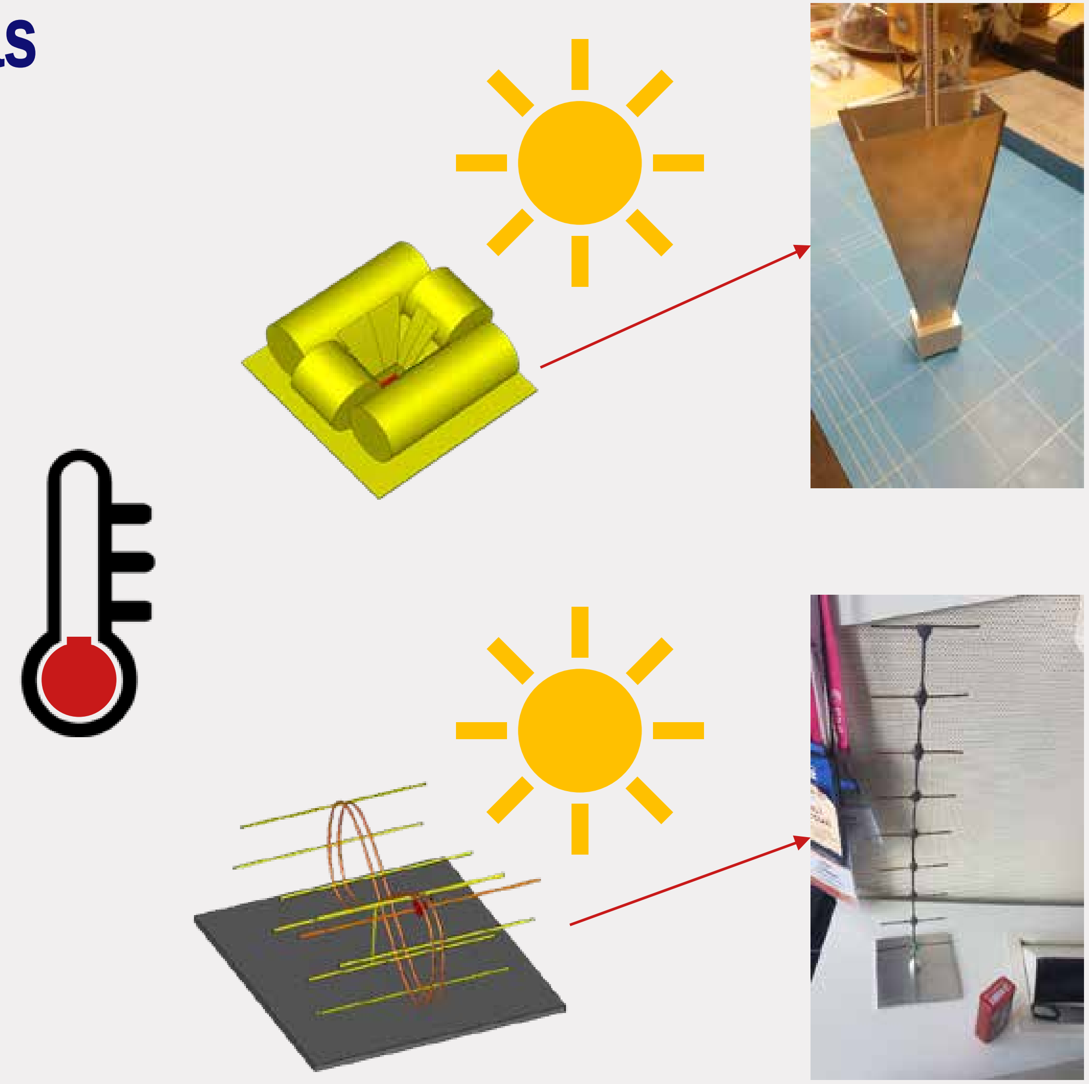
Contact: Niels Vertegaal, c.j.c.vertegaal@tue.nl

Horn Antenna for 12 – 18 GHz

- Ku-Band (Communication to Earth)
- 10x10x5cm (Folded)
- 10x10x20cm (Deployed)

Yagi-Uda for 1420 MHz

- 21-cm Line (Science)
- 10x10x5cm (Folded)
- 10x10x40cm (Deployed)



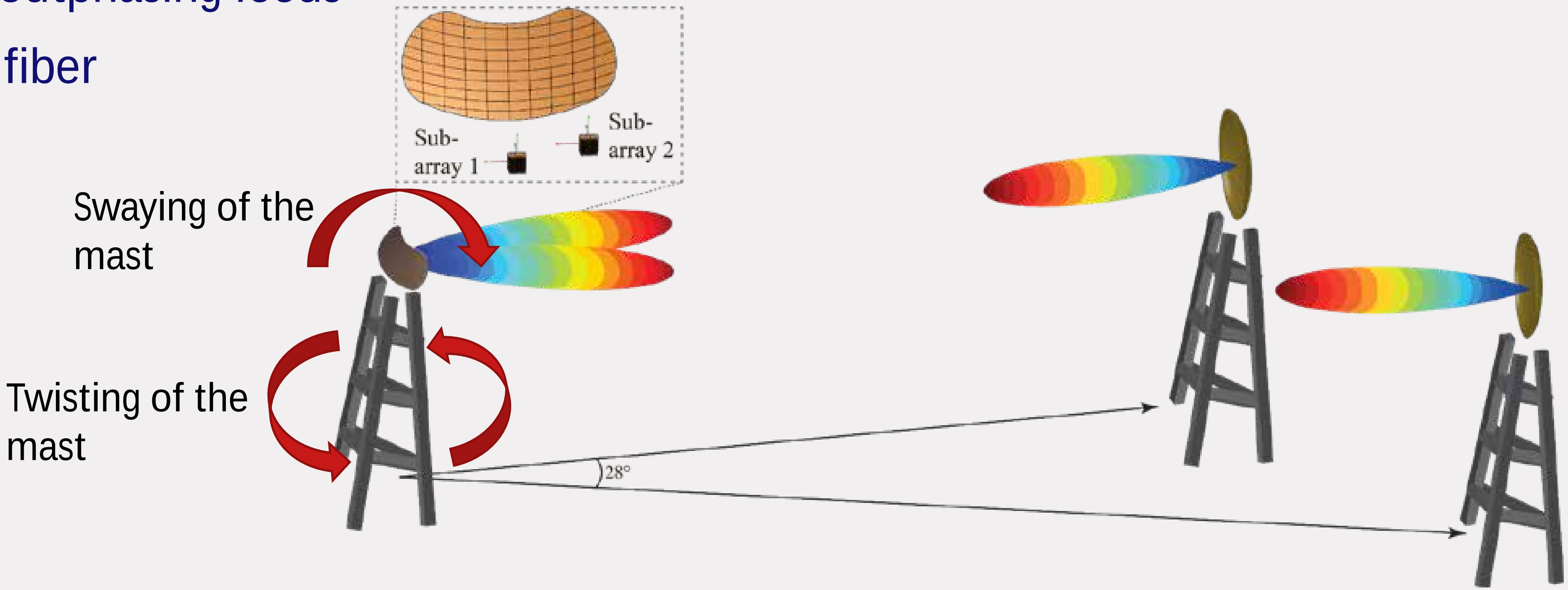
Measurements of point-to-multipoint FPA antenna

Contact: Roel Budé, r.x.f.bude@tue.nl

FREEPOWER Project: point-to-multipoint (p2mp) backhaul and fronthaul with

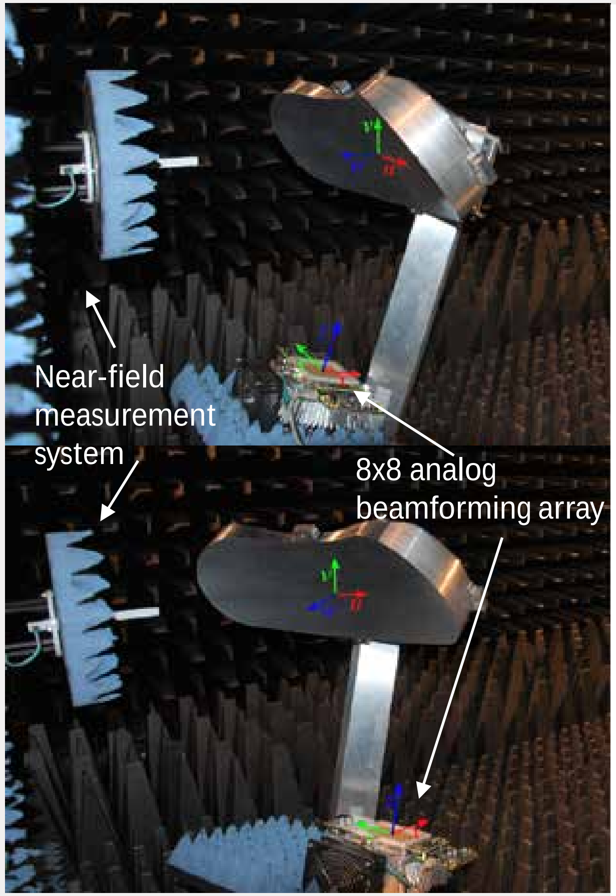
- focal plane array (FPA) antenna
- Power combining outphasing feeds
- Analog radio over fiber

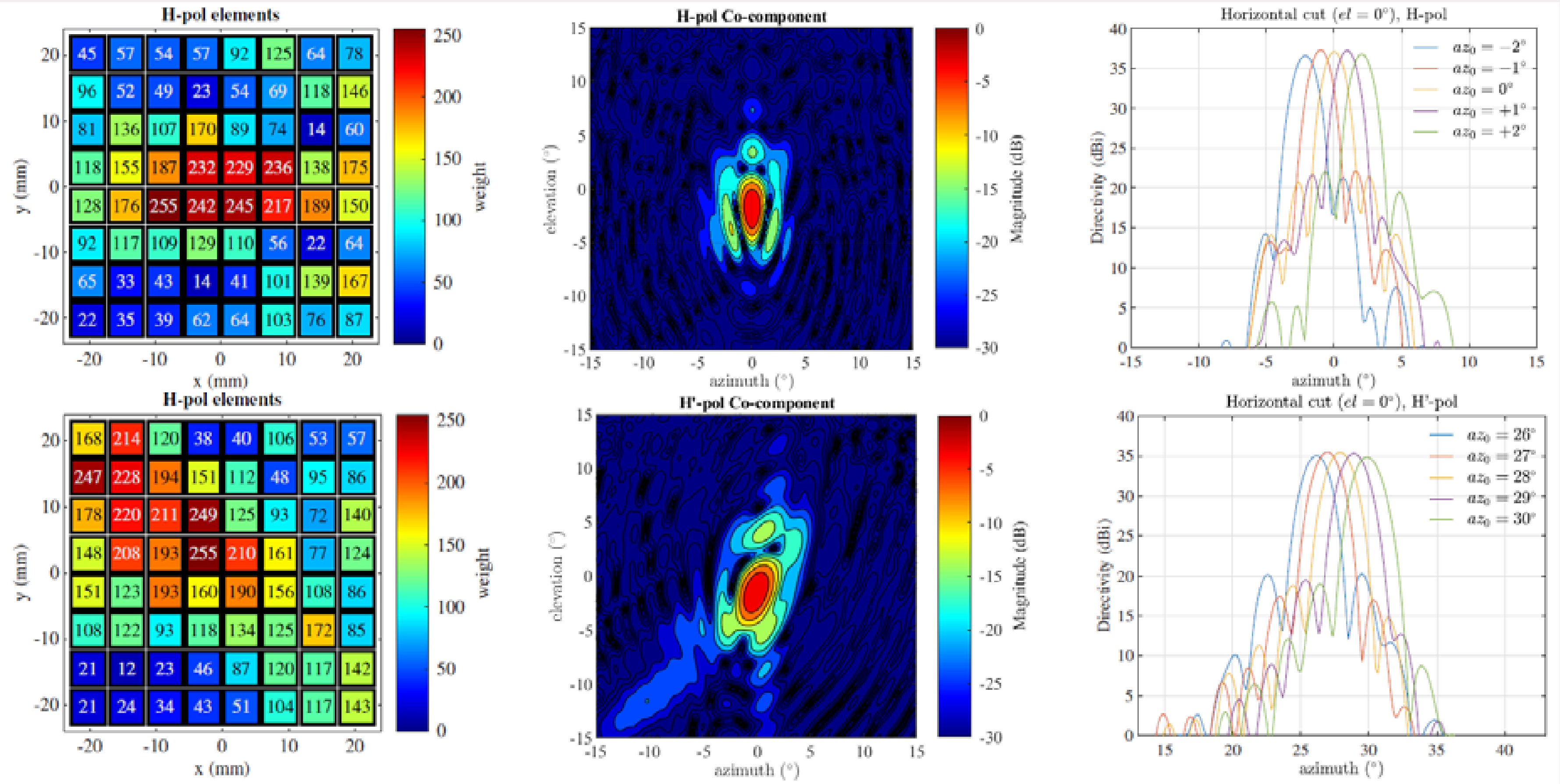
This part: p2mp and twist/sway compensation



E-band point-to-multipoint antenna for fronthaul/backhaul

Contact: Roel Budé, r.x.f.bude@tue.nl





Ultra-reliable Intra-aircraft Wireless Communication

ADENEAS Project (https://www.adeneas-project.eu/)

Contact: Berna Eraslan, b.eraslan@tue.nl

Goal:

- At least 30% decrease in weight, fuel consumption, and maintenance cost
- Increase in efficiency, flexibility and safety

Challenges:

- Real-time applications requiring very high reliability (10-7 failure per flight hour)
- Wireless channel: path-loss & shadowing, interference

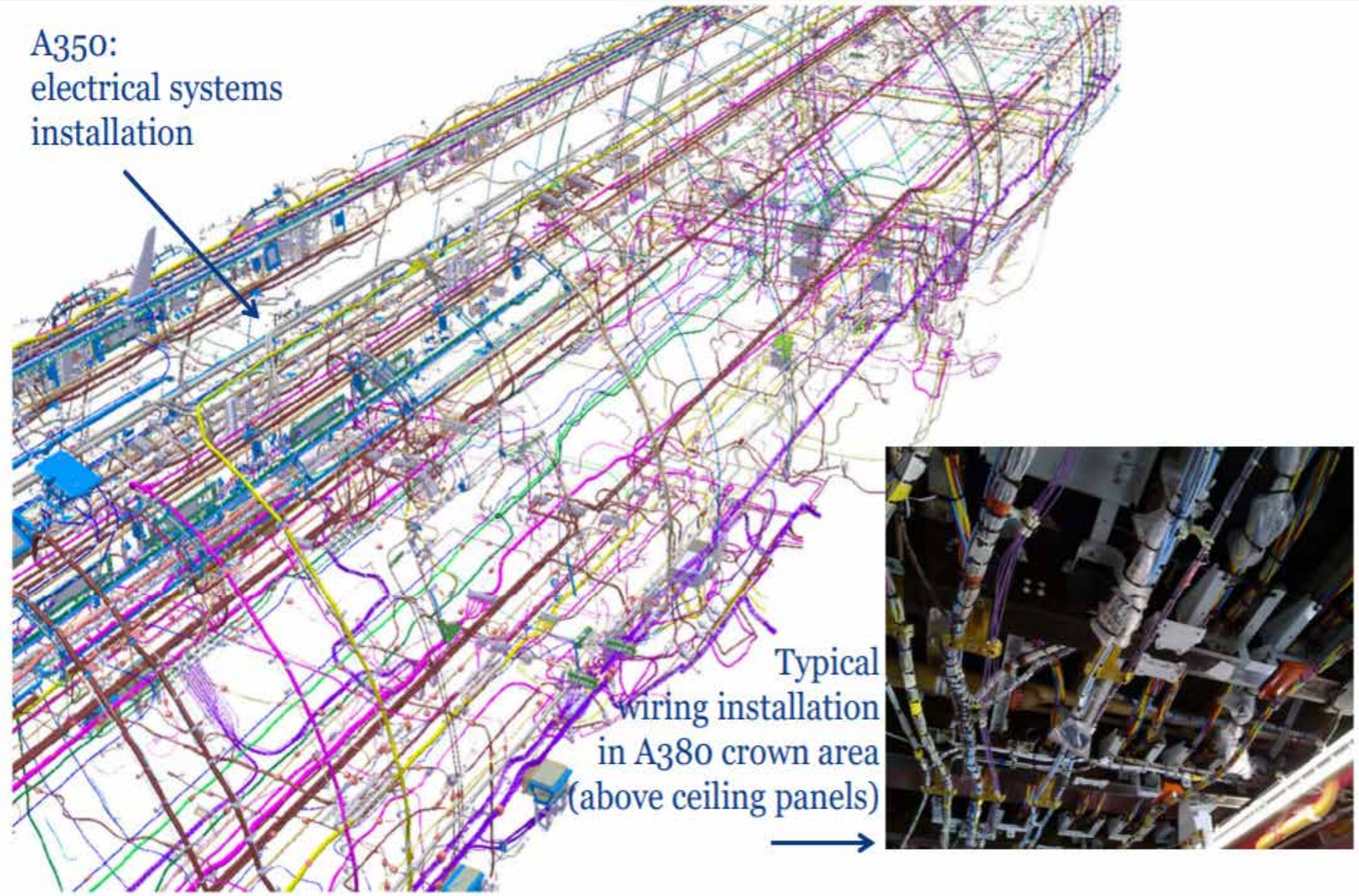


Figure 1: Electrical Wiring in Aircraft (from ICAO Regional WRC-15 Preparatory Workshop)

Reliability Solutions for Ultra-reliable Intra-aircraft Wireless Communication

Contact: Berna Eraslan, b.eraslan@tue.nl

Diversity by using different

- dimensions (spatial, frequency, time, polarization etc.)
- communication layers
- communication medium (wired, wireless, optical wireless comm, mmwave etc)

In network intelligence:

- detect, localize, analyze and predict connectivity disruptions and attacks
- take the necessary countermeasures

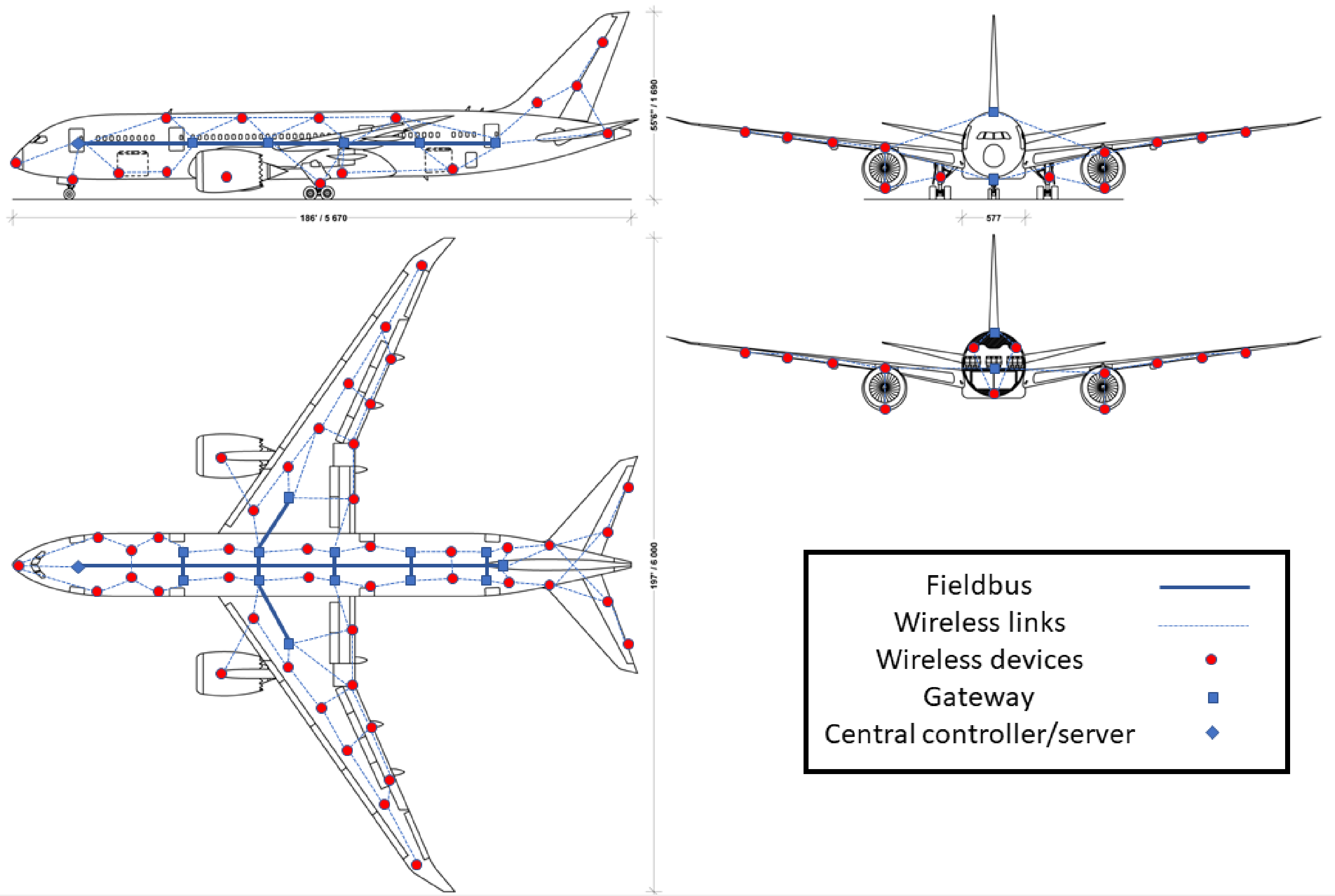
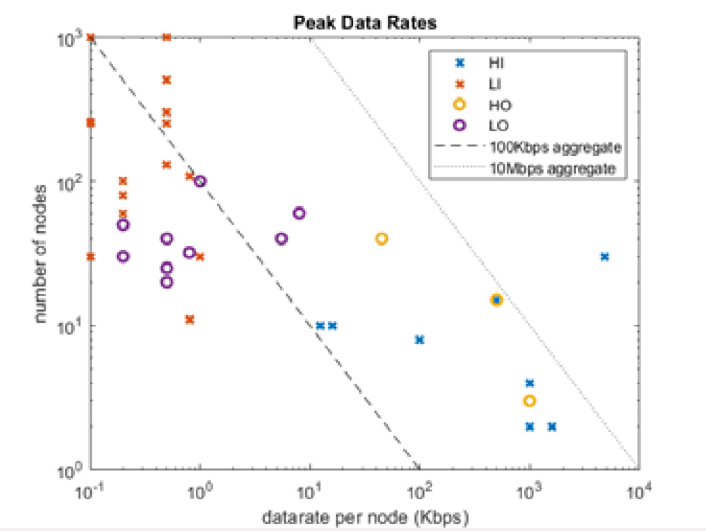


Figure 2: Example Wireless Intra-aircraft Network

Hardware Solutions for Intra Aircraft Wireless Communication

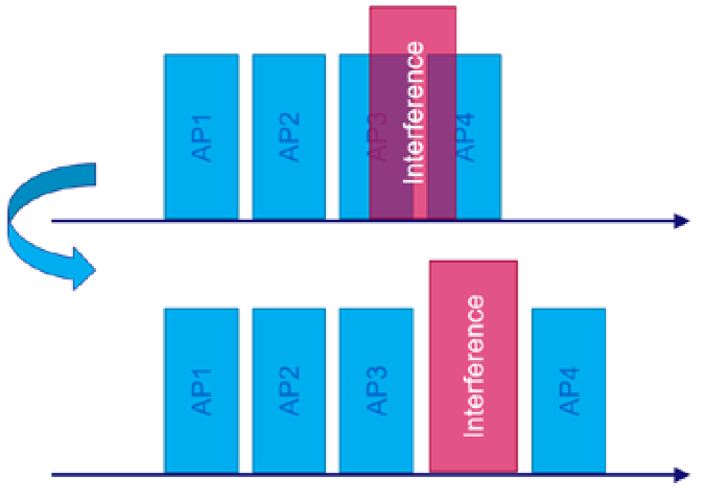
ADENEAS Project (https://www.adeneas-project.eu/)

Contact: Erik Bertram, e.s.bertram@tue.nl



Difficulties:

- High number of nodes
- High reliability
- Stringent spectral requirements (4.3GHz altimeter band)



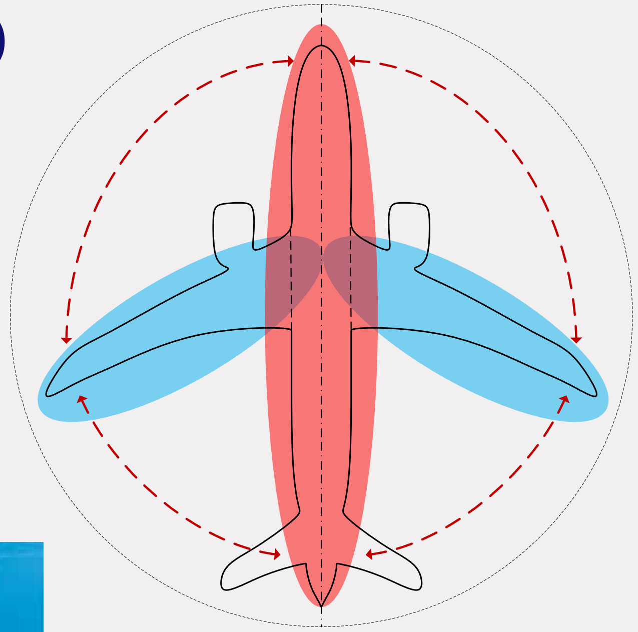
System Solutions:

- Use new unallocated spectrum
- Use cognitive radio + multiple bands
- Increase reuse factor with orthogonal propagation

Hardware Solutions for Intra Aircraft Wireless Communication

ADENEAS Project (https://www.adeneas-project.eu/)

Contact: Erik Bertram, e.s.bertram@tue.nl



Solution space:

- Multi band + spectral awareness (2.3+4.3+5.7GHz)
  - Selective wideband receiver
  - Redundant orthogonal propagation (MIMO, shielding, frequency)
- 300GHz+
  - Free worldwide
  - Large bandwidth
  - Technology limitations: ft/fmax

Auto-Aligned Optical Receiver for Indoor OWC System

Ngoc Quan Pham, n.q.pham@tue.nl

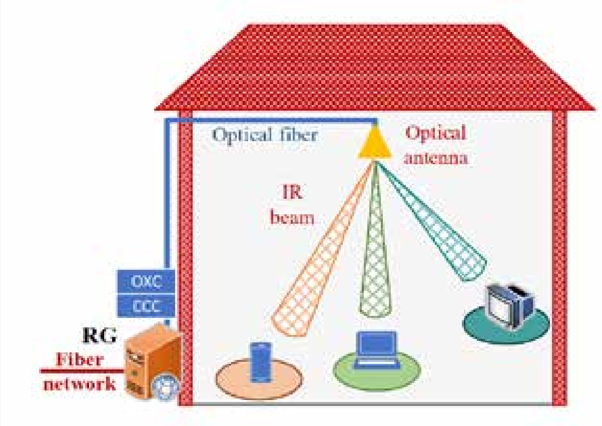
Introduction

- q Demand for wireless connectivity is booming
- q Radio spectrum is getting congested

→ Optical wireless communication

v Steerable narrow optical beams:

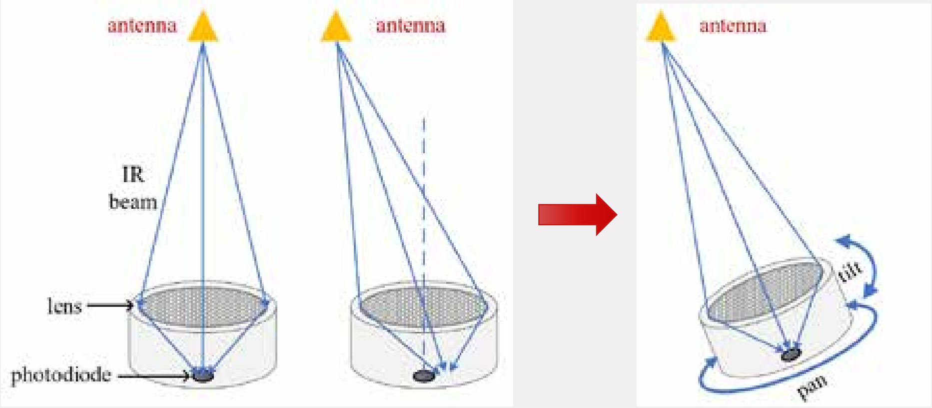
- Ultra-high capacity
- High Security
- Excellent energy-efficiency
- EMI-free



- Ø **CCC**:
  - Network control and management
  - Tunable transceivers
- Ø **OXC**:
  - Dynamic routing to the PRAs
- Ø **PRA**:
  - Fully passive steering optics
  - Multiple beam steering
- Ø **Vision-based Localization**:
  - Camera installed in addition to PRA
  - 4 IR-LED tag at the user terminals

Challenges

- q Limited transmitted power due to eye safety
- q Optical loss due to the beam divergence
- q Narrow field-of-view of optical receiver

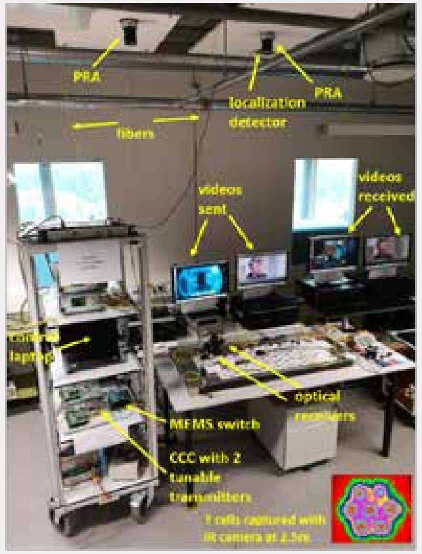


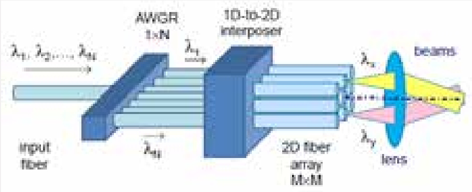
à Propose an auto-aligned receiver employing a dual-axis actuator and a motion tracking sensor to obtain a sufficient link budget for mobile users

Auto-Aligned Optical Receiver for Indoor OWC System

Ngoc Quan Pham, n.q.pham@tue.nl

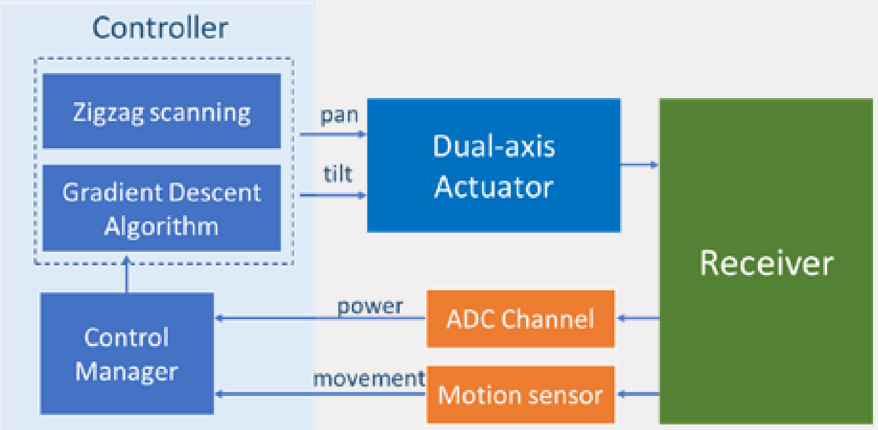
§ Experimental setup





AWGR-based PRA

Localization



Design of Auto-Aligned Receiver

§ Experimental Results

- Proposed algorithm improves 10 times faster than the regular method to maximize the received power from PRA
- Auto-alignment shows the incoming beam is always aligned and is seamlessly coupled to the receiver
- Seamless connection when the receiver moves at a normal walking speed

Hybrid mm-wave/optical wireless system for indoor environment

Contact: Carolina Maria Amaral, c.m.m.sodre.campos.amaral@tue.nl

- *SmartTwo+ is a collaboration project between TU/e, KPN and Eindhoven Engine that aims to integrate the strengths of two new technologies (optical wireless and mm-wave communication systems) to develop a high-capacity wireless system for an indoor environment.*

Small bandwidth require → Wi-Fi

High bandwidth require → Li-Fi

OWC

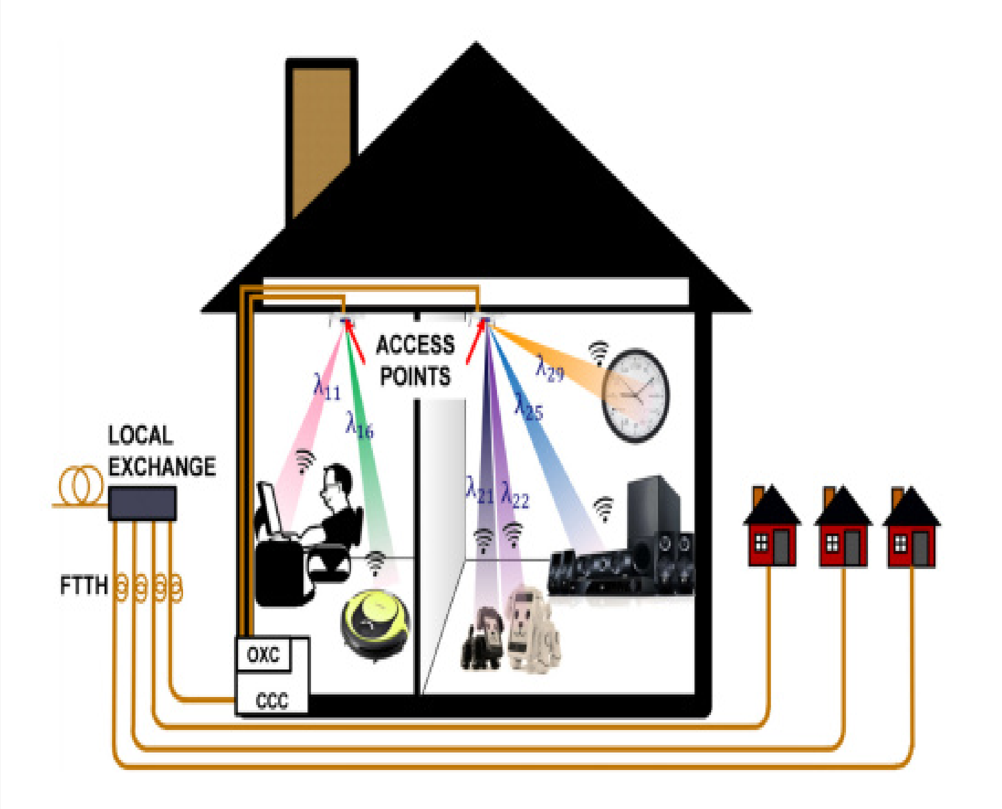
- Wide-unlicensed spectrum
- High data-rate
- Low-energy consumption
- High security and privacy

- IoT brings an increasing number of integrated devices.
- High demand of wireless connection for IoT services.
- Increasing demand for larger bandwidth.
- Indoor scenario can integrate Wi-Fi and Li-Fi/OWC technologies.

Hybrid mm-wave/optical wireless system for indoor environment

Contact: Carolina Maria Amaral, c.m.m.sodre.campos.amaral@tue.nl

- Hybrid communication system
  - Wide-band communication
  - Accurate user localization
  - High user density



- OWC downstream in 1550 nm
  - Narrow optical beam steering
  - Dedicated wavelength per user
  - Unshared high capacity link
- mm-wave upstream in 60 GHz
  - 7 GHz available bandwidth
  - Phased-array antenna
  - Beam steering for user localization

Luminaire free LiFi systems

Contact: Carina Barbio, c.ribeiro.barbio.correa@tue.nl

- *ELIoT - Enhance Lighting for the Internet of Things. ELIoT is an Innovation Action project of H2020 with strong industrial and academic partners and aims to introduce Visible Light Communication (VLC) for the realization of dense reliable low-power high-bandwidth connectivity which should bring new features for Internet of Things (IoT) applications.*

- *Future of IoT is defined by a large number of intelligent devices integrated.*
- *Demand on wireless link to integrate IoT services.*
- *Even higher demand for indoor scenarios.*
- *Li-Fi is one technology that can overcome this problem.*

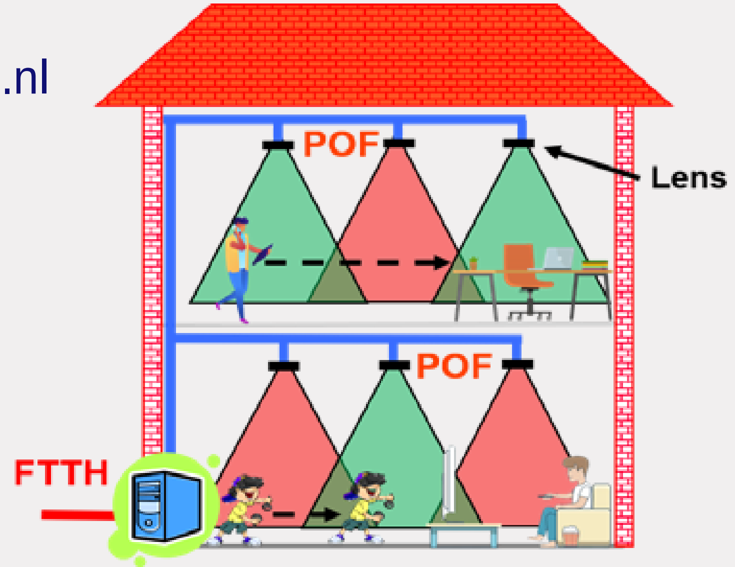
Luminaire free LiFi systems

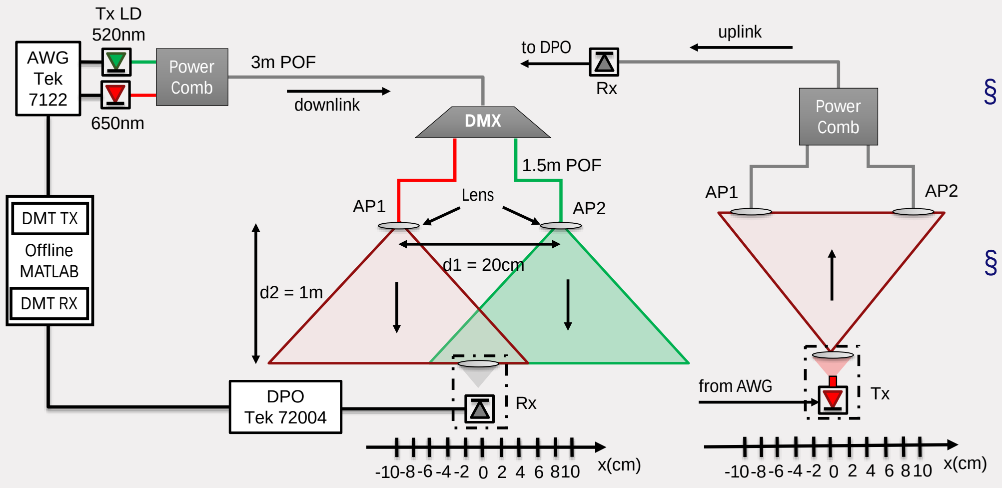
Contact: Carina Barbio, c.ribeiro.barbio.correa@tue.nl

§ Need for a broadband and electromagnetic interference (EMI)-free fronthaul to connect the LiFi access points to the access network.

§ POF outlet for communication offers:

- o No electrical powering and no maintenance is needed → lower price.
- o A lens is used to mark the coverage area
- o High data rates for wireless connectivity.





§ Wavelength Division Multiplexing (WDM):

- ☺ Minimum use of fibres
- ☹ Need more colours LEDs

§ Distributed Multiple-Input and Multiple-Output (D-MIMO)

- o Increase total throughput and reliability
- o Guarantee consistent link performance
- o Enable high user densities
- o Ensure smooth handover between LiFi access points

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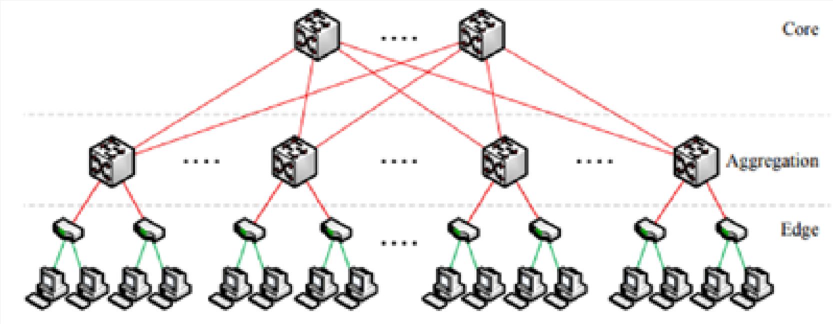
Optical Wireless Data Center Network

Contact: Shaojuan Zhang, s.zhang4@tue.nl

Issues in current DCNs:

- Huge amount of copper and optical fiber cables
- Fixed hierarchical topology



Optical Wireless DCNs: A promising solution

Removing cable complexity

No cable management and maintenance
Easy reconfiguration and relocation

Benefits of optical wireless

More than 40% faster than the fiber transmission
A wider spectrum range: visible, near- and far-infrared
Almost zero attenuation in air
Bandwidth in air larger than in fiber due to absence of waveguide dispersion

Wireless on-demand link

Potential to respond to the dynamically changing and bursty traffic patterns

Optical Wireless Data Center Network

--Based on SOA-based Wavelength Selector and N×N ports AWGR

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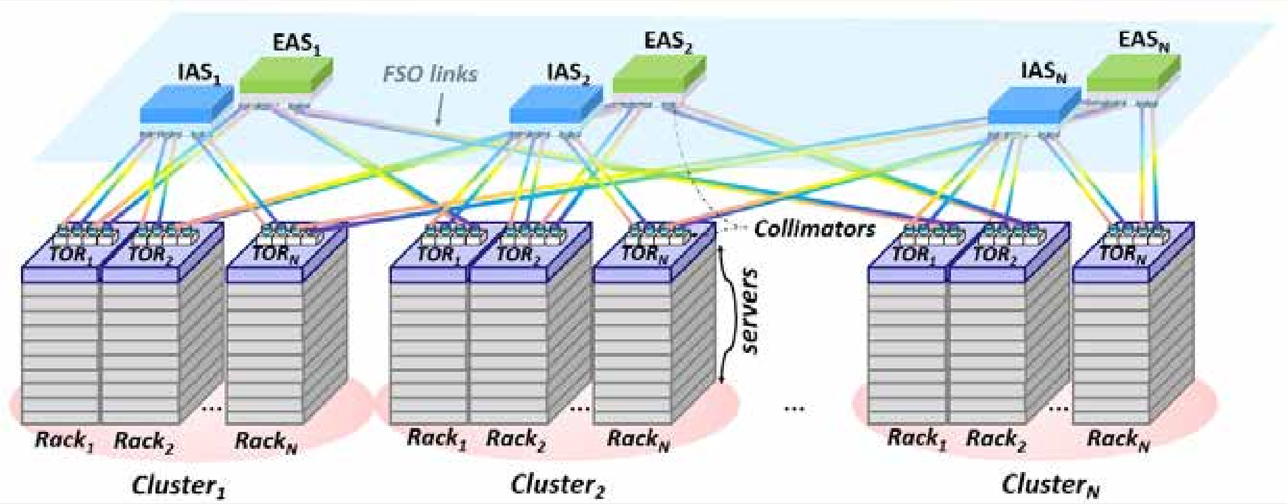
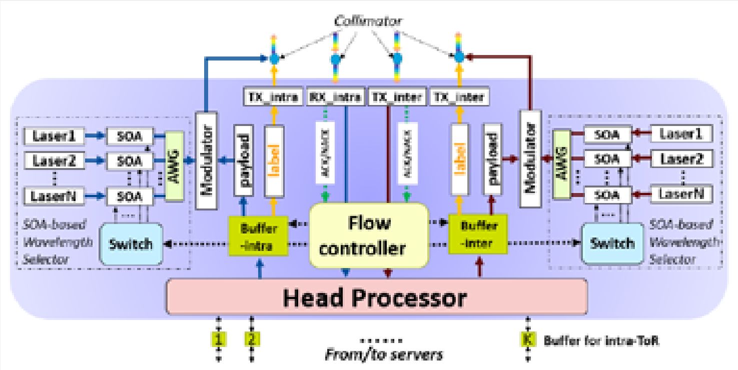


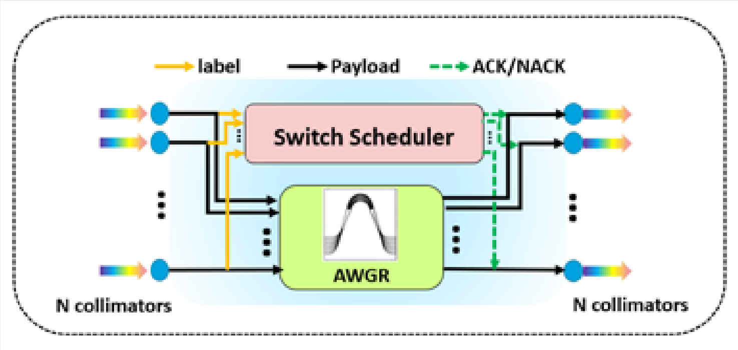
FSO: free space optical; IAS: intra-cluster AWGR based switch; EAS: inter-cluster AWGR based switch; ToR: Top of rack.

- Two **parallel** inter-and intra-cluster networks
- N clusters - each cluster groups N racks
- **EAS** inter-connectes **N culsters**, **IAS** inter-connects **N ToRs** whithin one cluster
- Each **AWGR based switches** composed of one **FPGA-based switch scheduler** and one **AWGR**
- Packet forwarding is based on the **routing matrix** between the input and output ports of AWGR

SWS-based ToR switch



AWGR-based Optical Switch



Waveguide-integrated Silicon-ICs

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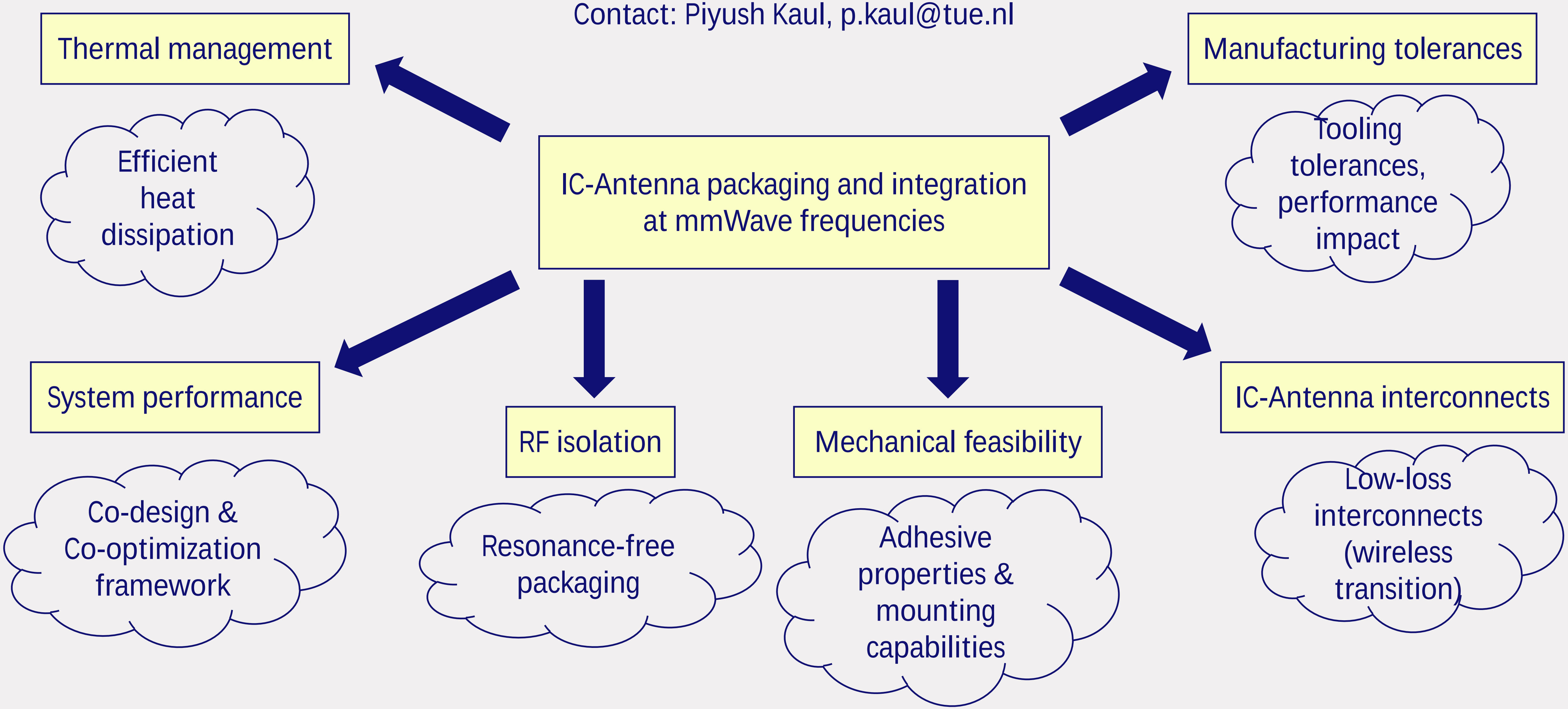

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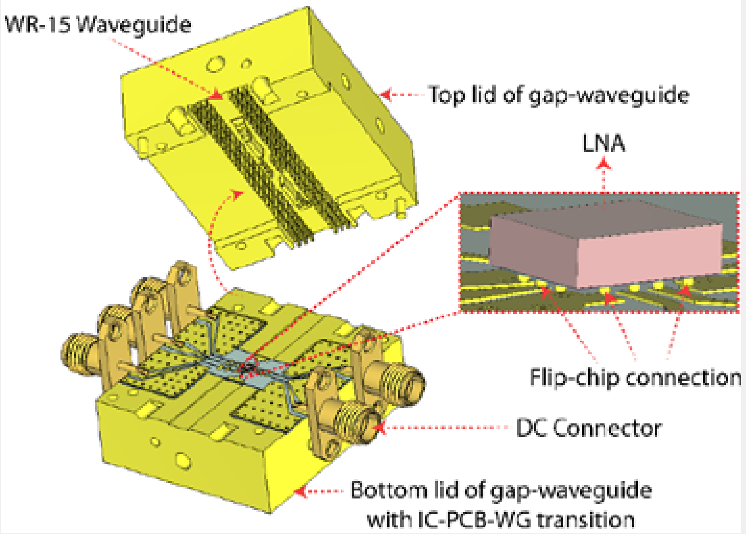

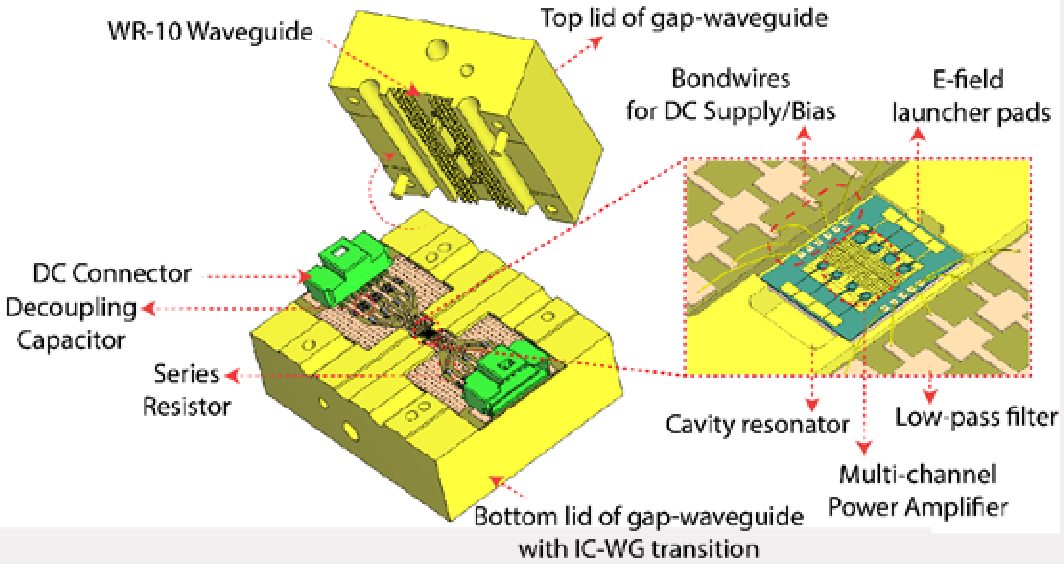

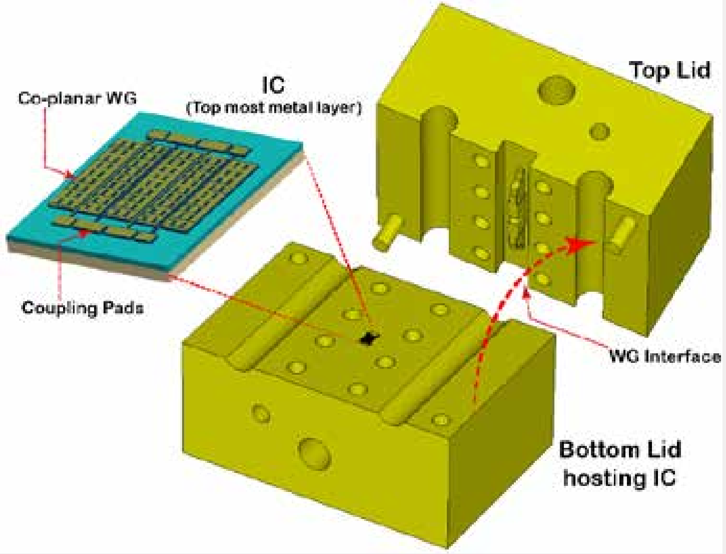

Prototype-I
CMOS-IC to PCB to Waveguide
Wireless Transition

Prototype-III
Multi-channel PA to Waveguide
Wireless Transition

Prototype-II
Si-IC to Waveguide
Wireless Transition
w/ spatial power combiner-splitter

CWTe CENTER FOR WIRELESS TECHNOLOGY EINDHOVEN TU/e

INTENSE: More neurons, more data

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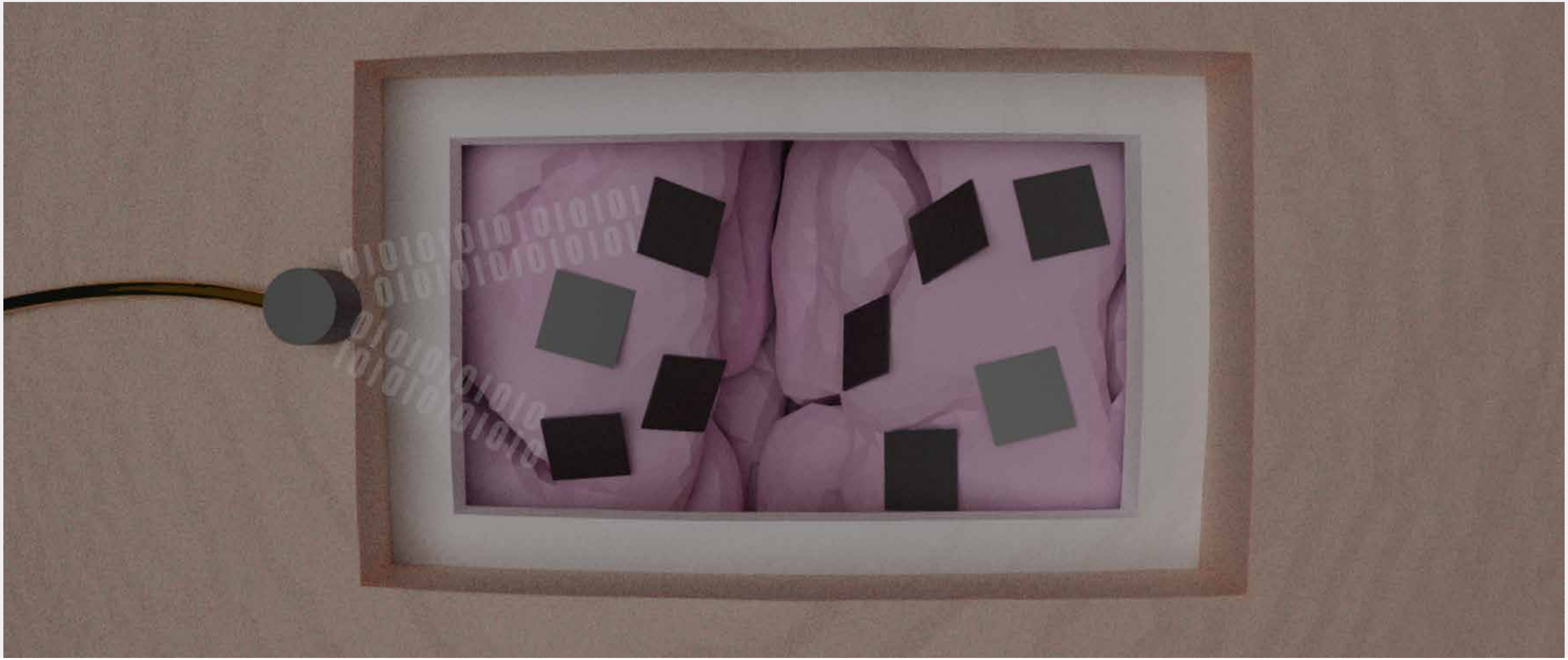

INTENSE: More neurons, more data

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- Interface the brain with 10.000 electrodes, 10x more than before
- Fully wireless communication
- Go from 100Mbps to 1-10Gbps for neuroscientific research
- Multi-implant communication and data compression can serve as a solution
- In my PhD, I will focus on multi-implant communication