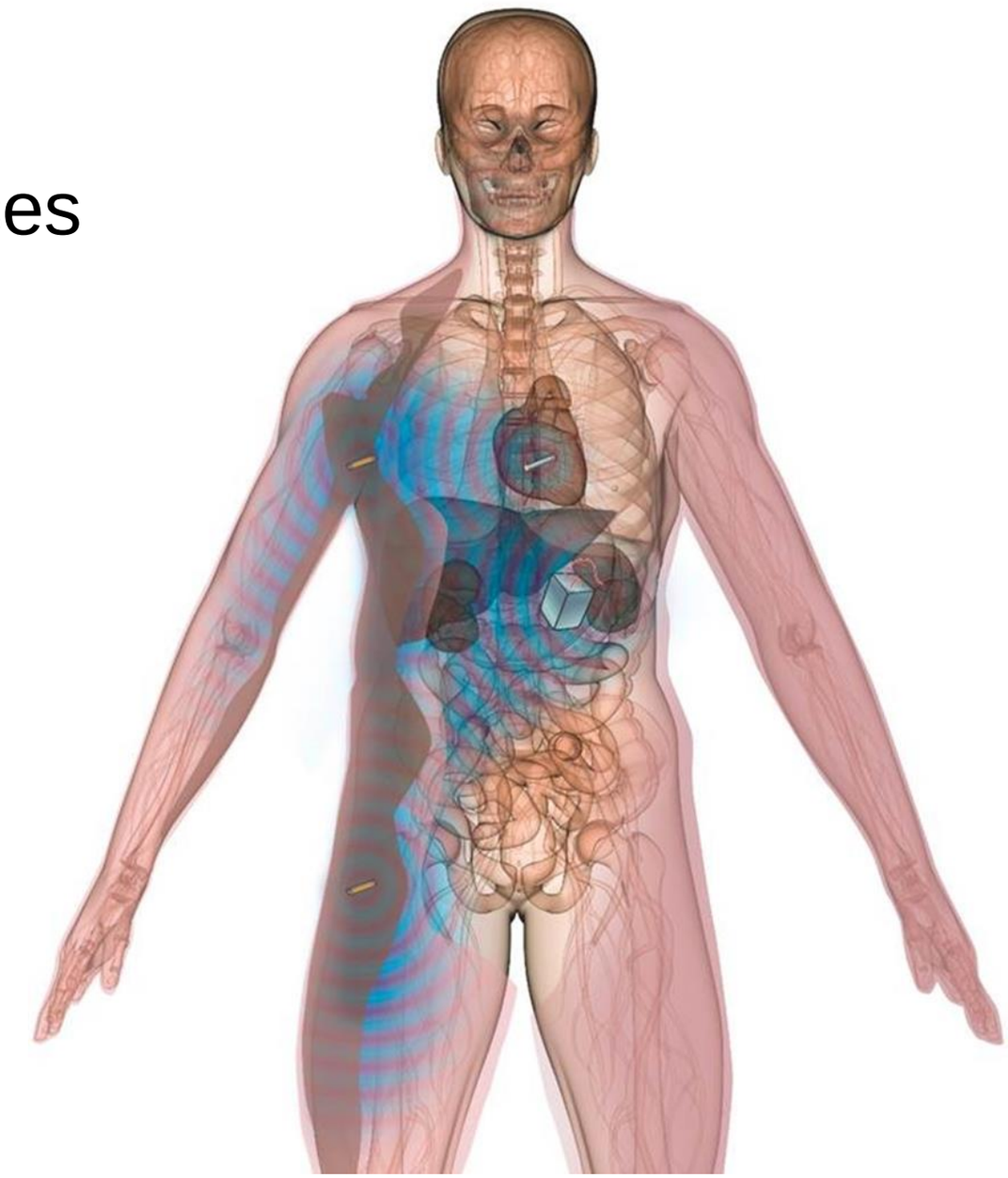
LifeSec: Don’t Hack my Body

Thiemo Voigt

LifeSec project including Robin Augustine, Noor Badariah Asan, Mauricio Perez, Abbas Arghavani, Anders Ahlén, André Teixeira, Subhrakanti Dey, Bobins Augustine, Laya Joseph, Bappaditya Mandal, Pramod Rangaiah, Johan Engstrand, Fatih Emre Tosun (EE), Sam Hylamia, Christian Rohner, Wenqing Yan, Madushanka Padmal, Konrad Krentz, Qi Lin (IT), Anna Nilsson, Christoffer Cederland, Maria Mani (University Hospital)

Motivation

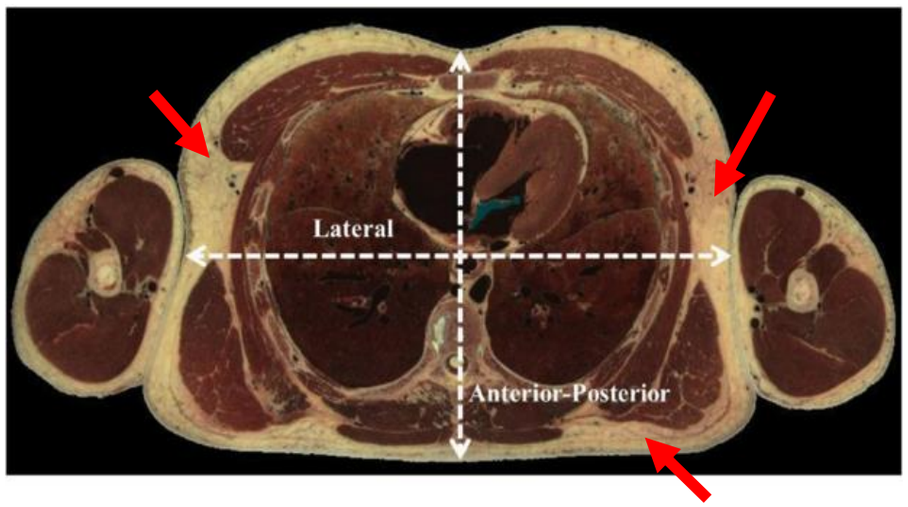
- 2005, 25 Mio US citizens had implanted devices
- Number will increase
  - People get older, multiple diseases
- Examples:
  - Drug delivery systems
  - Artificial organs (kidney)
  - Intracranial pressure monitoring devices
- Should network these devices



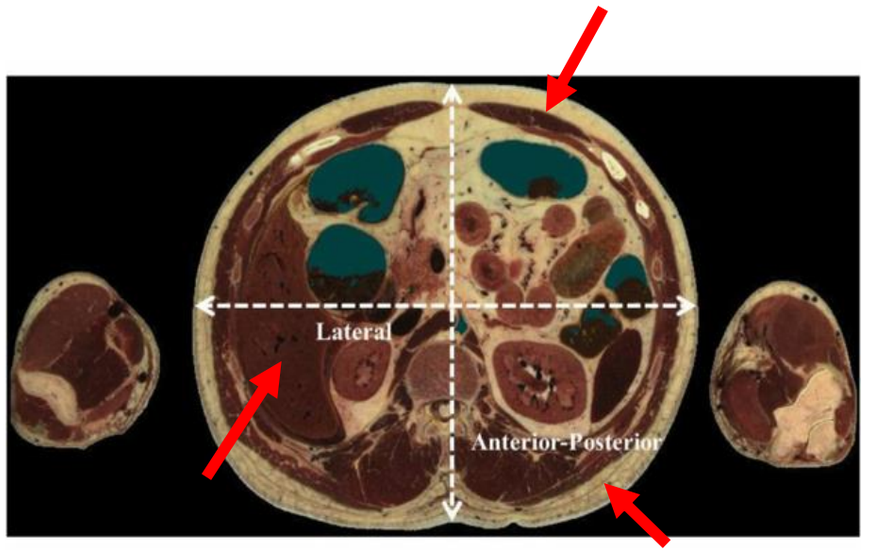
New communication for in-body networks: RF through the Fat Layer

- Existing methods not sufficient
- RF Communication through fat layer

- Fat is everywhere in the body

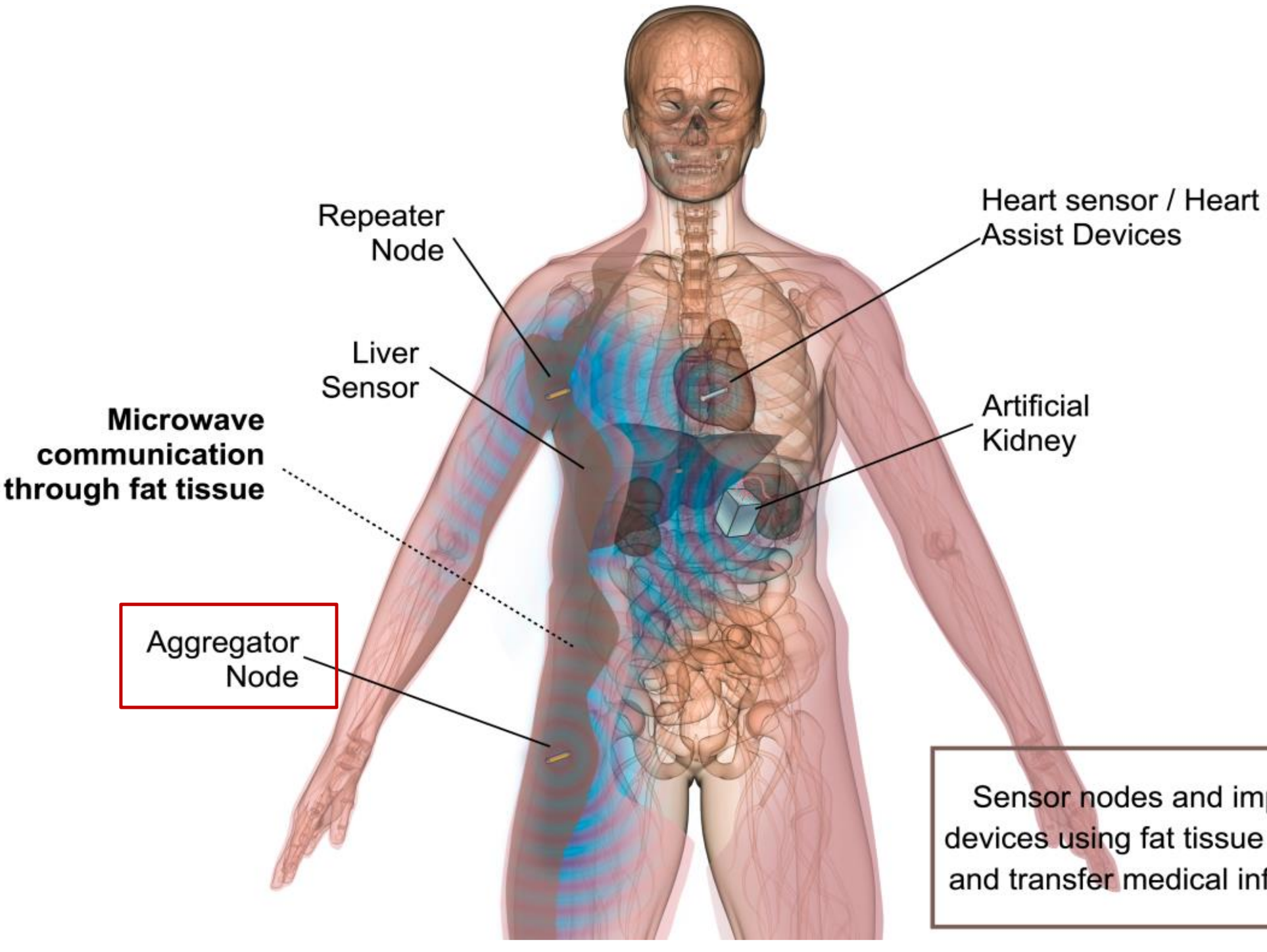


(a) Mid-chest



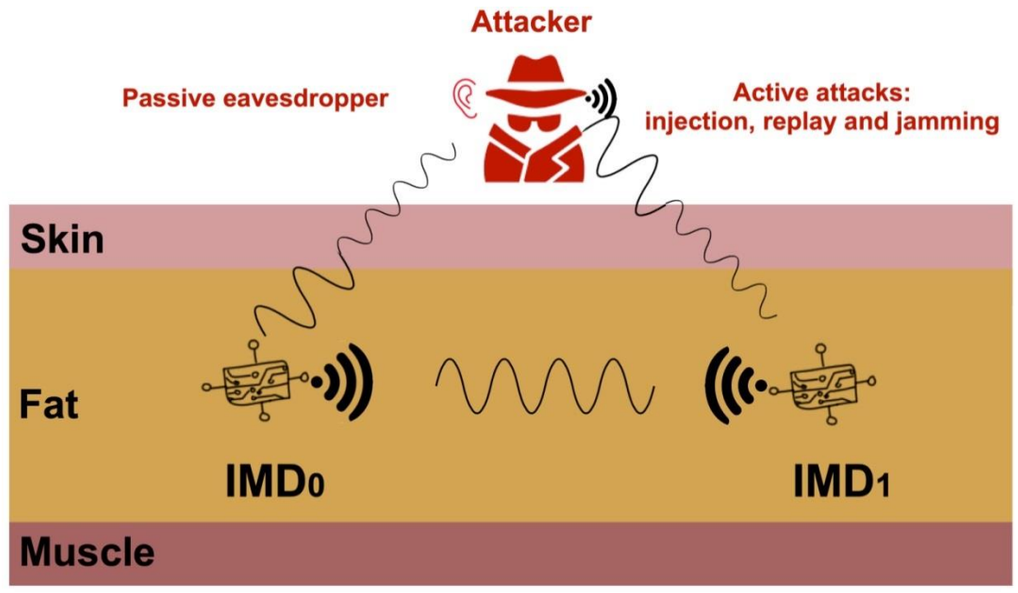
(b) Mid-abdomen

LifeSec Networking



Security a Must

- Attackers take over implanted devices
  - Life-threating
  - Install ransomware
- Collected data private and sensitive
- Secure control loops inside the body



- Security in the body challenging:
  - Very low power
  - Space-constraints
  - New channel for communication and sensing
  - Provide access to medical personal in emergency scenarios

<u>Objective:</u>

secure in-body sensor networks based on fat layer communication

Participating Groups

All groups are from Uppsala University

- Uppsala Networked Objects Group, Thiemo Voigt (PI)
- Communications Research Group, Christian Rohner (Co-PI)
- Microwaves in Medical Engineering Group, Robin Augustine (Co-PI), Mauricio Perez
- Signals and Systems, Anders Ahlén (Co-PI), Subhrakanti Dey, André Teixeira (now assoc prof cybersecurity at IT)
- Maria Mani (Co-PI), plastic and reconstructive surgery

Goals

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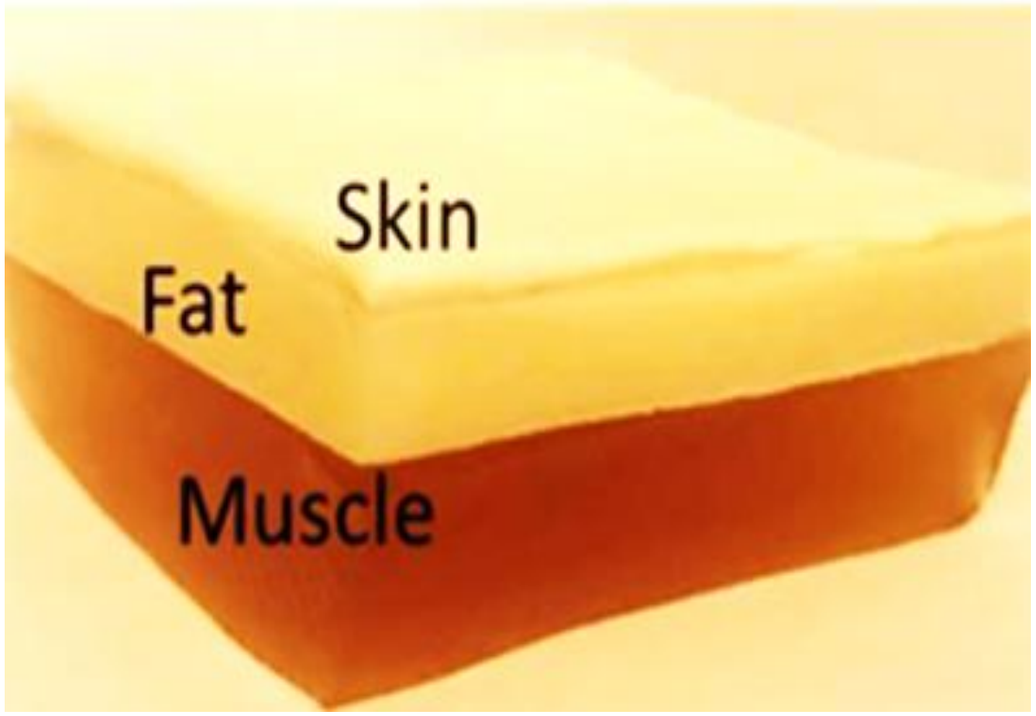
- Secure in-body sensor networks
  - Secure and privacy-preserving communication and sensing based on fat-channel communication
- Secure in-body closed loop control
- Overall security to and from external world

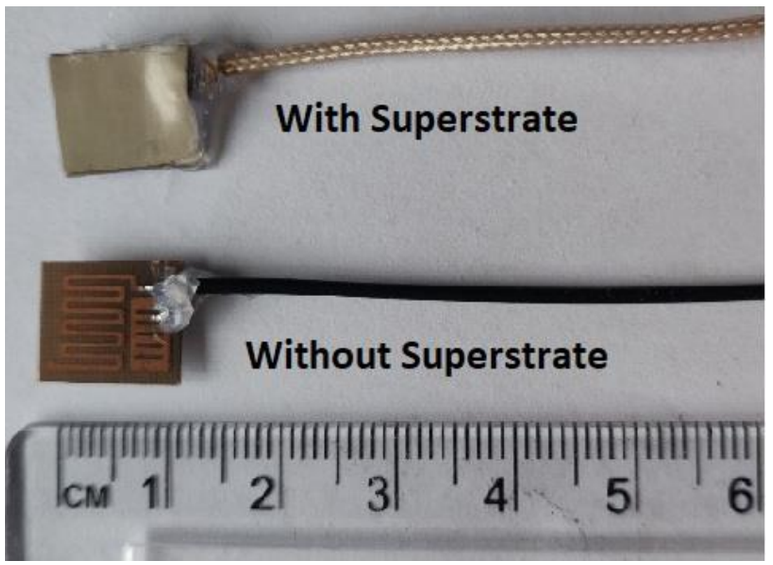
Demonstrator:

- Series of phantoms (emulating artifacts)



Results: Secure In-body Sensor Networks

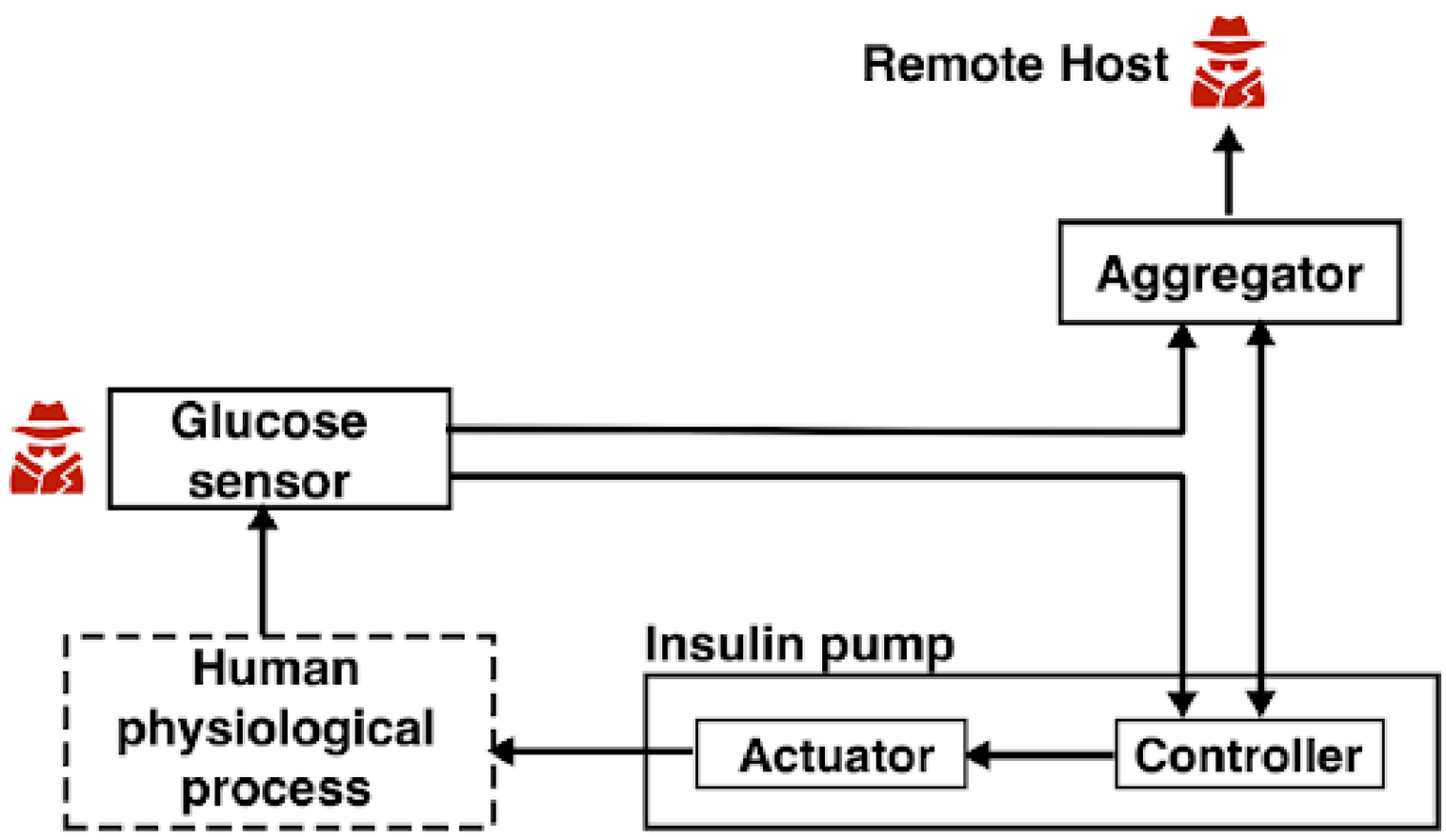
- Security architecture with a focus on key generation and distribution
  - Novel authentication and key distribution protocol (TIEK)
- Secure communication
  - Design of antennas to restrict leakage
  - Backscatter communications with Fat IBC
- Privacy-preservation
  - Sensing: Breast cancer relapse
  - Covert communication



Antennas for Fat IBC

Results:Secure In-body Control Loops

- Focus on physiological model-based attack detection
  - Models for glucose insulin dynamics
  - Malicious attacks on sensor readings
  - Challenges include uncertainty about meals



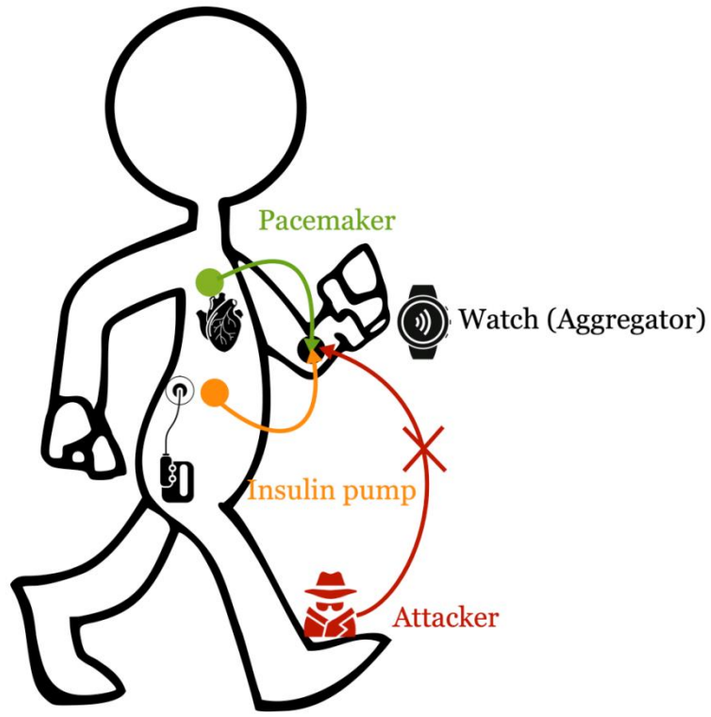
Results:Security at the Boundary of the Body

Secure Connection to the External World Using Aggregator

- Prototype that connects to external databases
- Secure aggregator with trusted execution environment
  - remote compromise and remote denial-of-sleep attacks

Physical Layer Attack Detection

- Detect attacks based on physical layer properties of communication channel
  - Exploiting body movement
  - Device fingerprinting that takes into account wireless channel



Major Achievements

- Good progress towards all the goals
- Strong collaborations between participating groups
- More than 30 peer-reviewed publications
  - 10 have authors from 2 or more departments
  - Awards at top conference
- Development of novel phantoms
  - Research contributions themselves
  - Quantitative data for other research


The 18th ACM Conference on Embedded Networked Sensor Systems
ACM SenSys 2020
November 16-19, 2020

Best PhD Forum Presentation Award

Presented to
Wenqing Yan

For
"Towards Robust and Low-complexity Radiometric Fingerprint"

Jin Nakazawa (general co-chairs) Polly Huang


The 18th ACM Conference on Embedded Networked Sensor Systems
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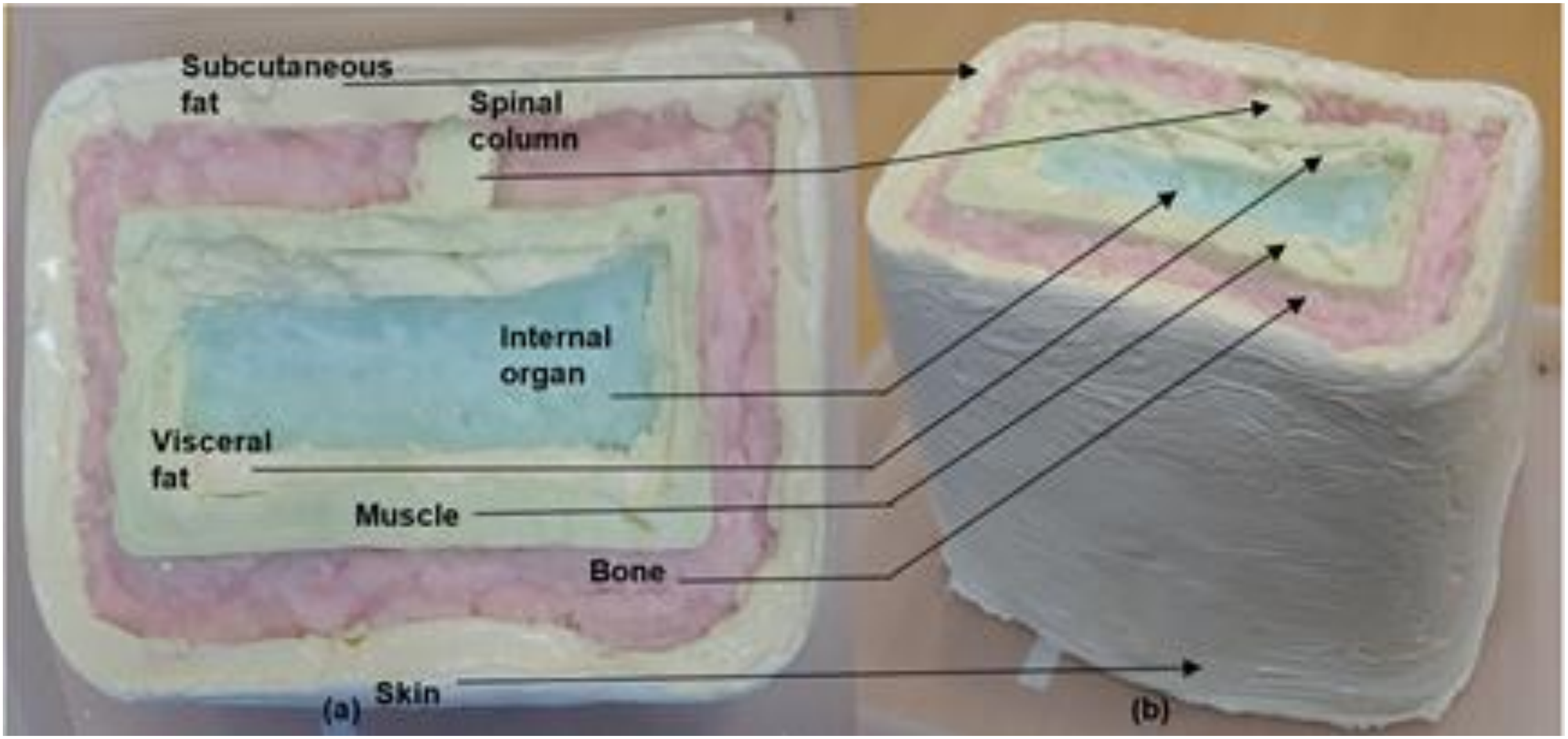
Best Poster Award

Presented to
Wenqing Yan and Christian Rohner

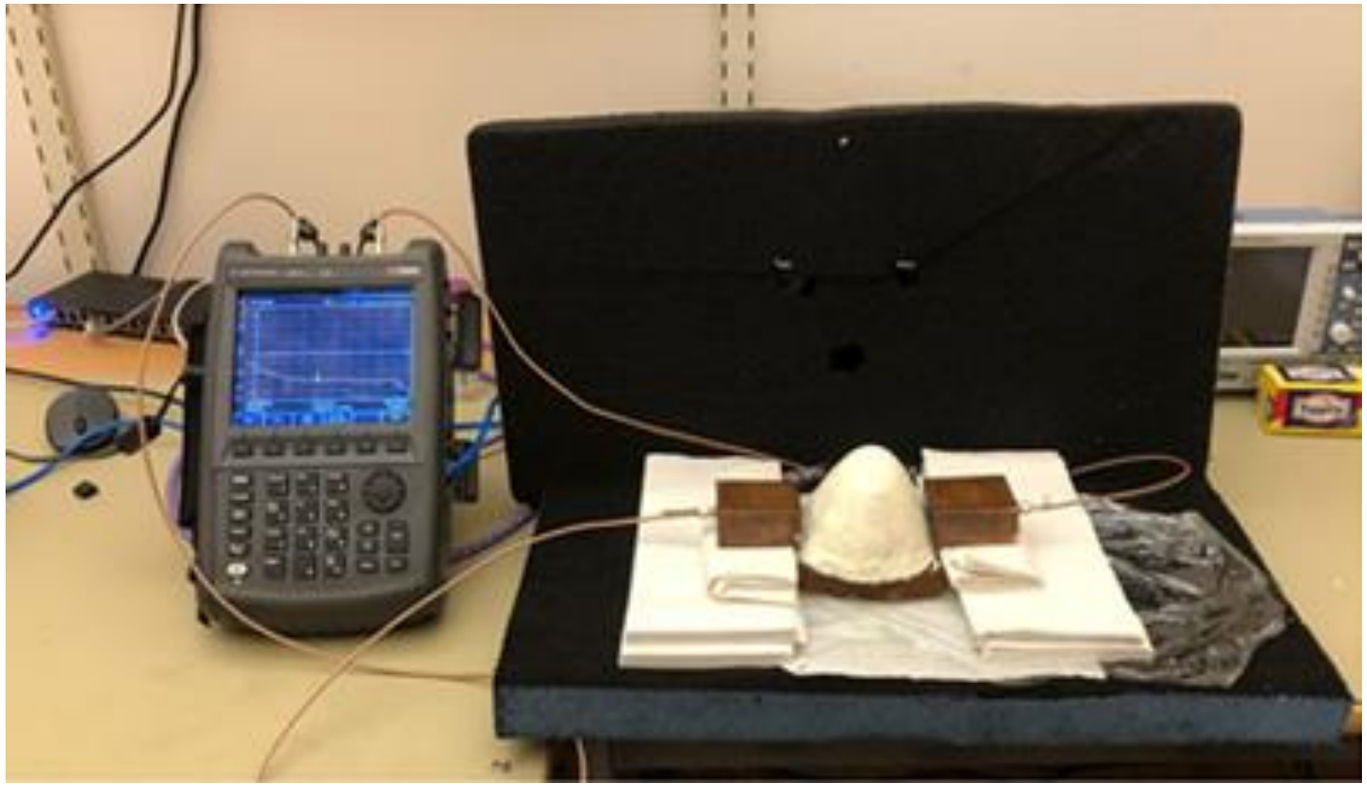
For
"Sensitivity of Radiometric Fingerprint Against Wireless Channel"

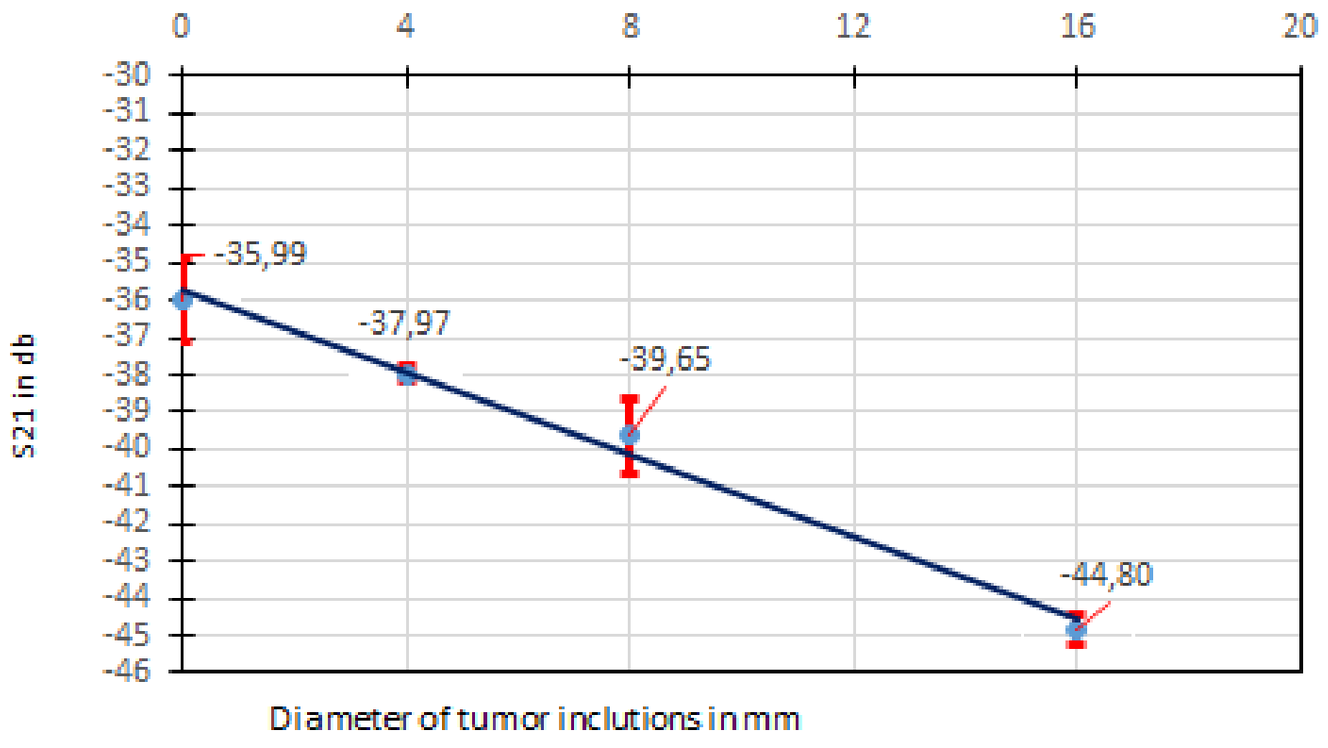
Jin Nakazawa (general co-chairs) Polly Huang

Major Achievements: Phantoms



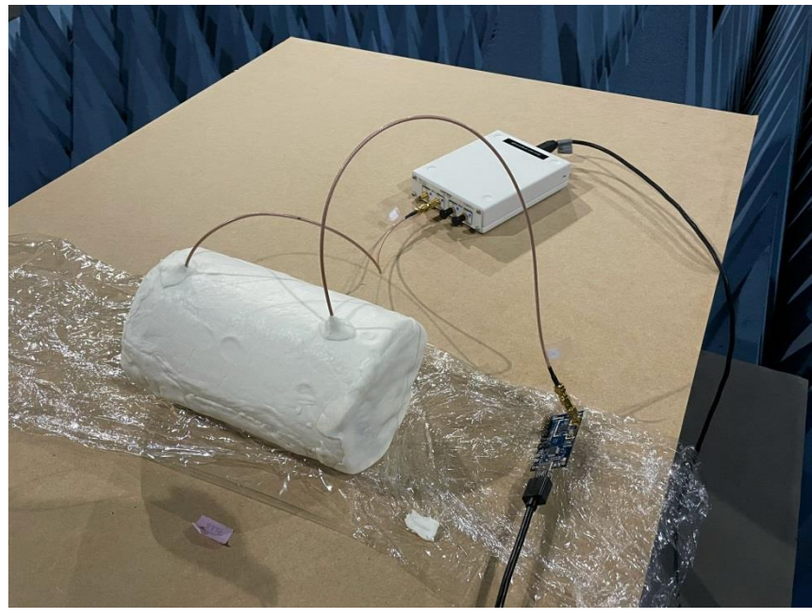
Major Achievements: Phantoms





Summary

- Strong benefits from networking implanted devices
- Build on Fat IBC pioneered at Uppsala University
- Security is of utmost importance
- Exciting, multi-disciplinary project
  - Allows to do work single research groups cannot do
  - Important contributions



Acknowledgements

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