

# LifeSec: Don't Hack my Body

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

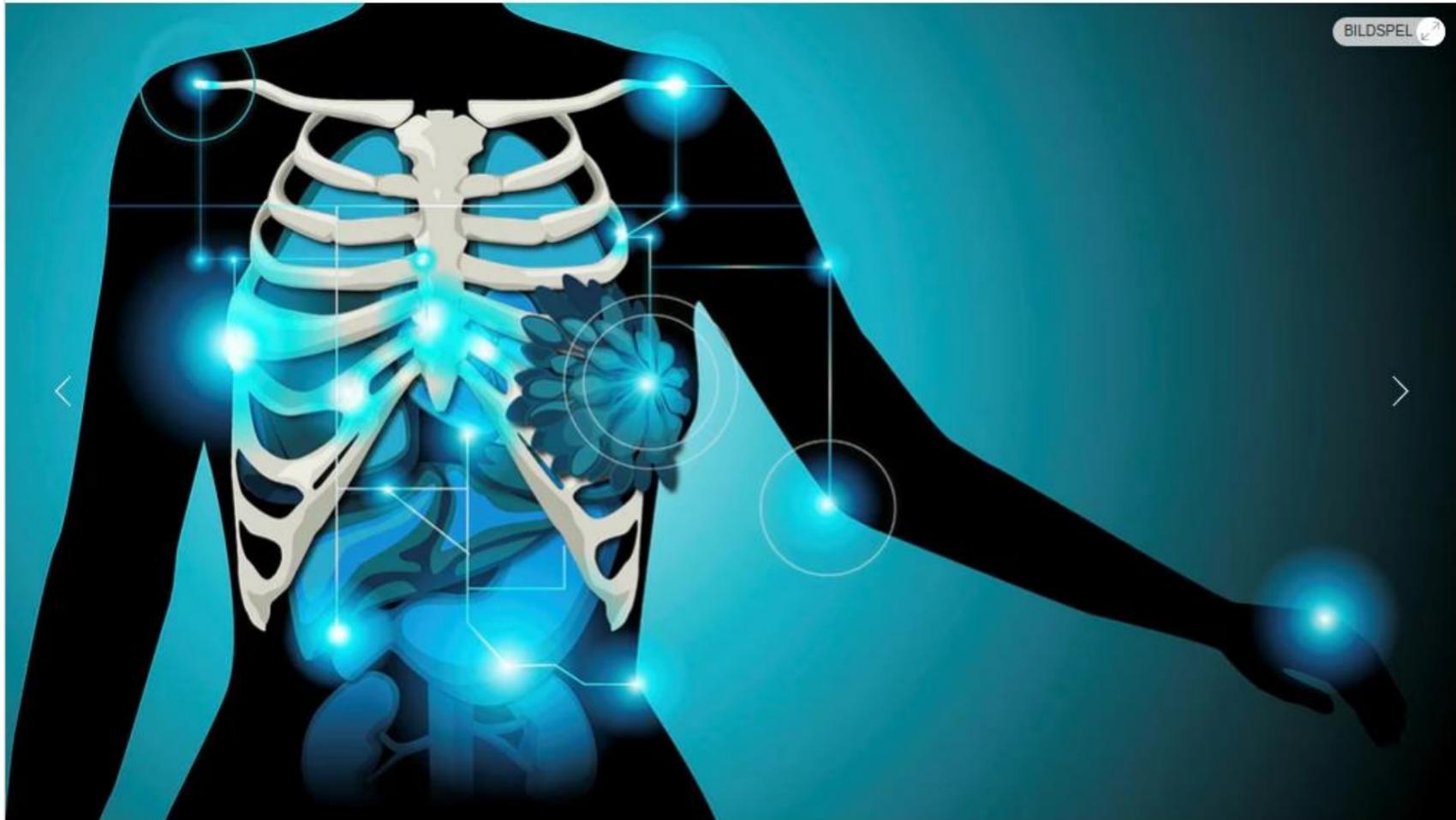
# Taken up by Dagens Nyheter

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**SVERIGE**

## Fet kommunikation kräver skydd mot hackare

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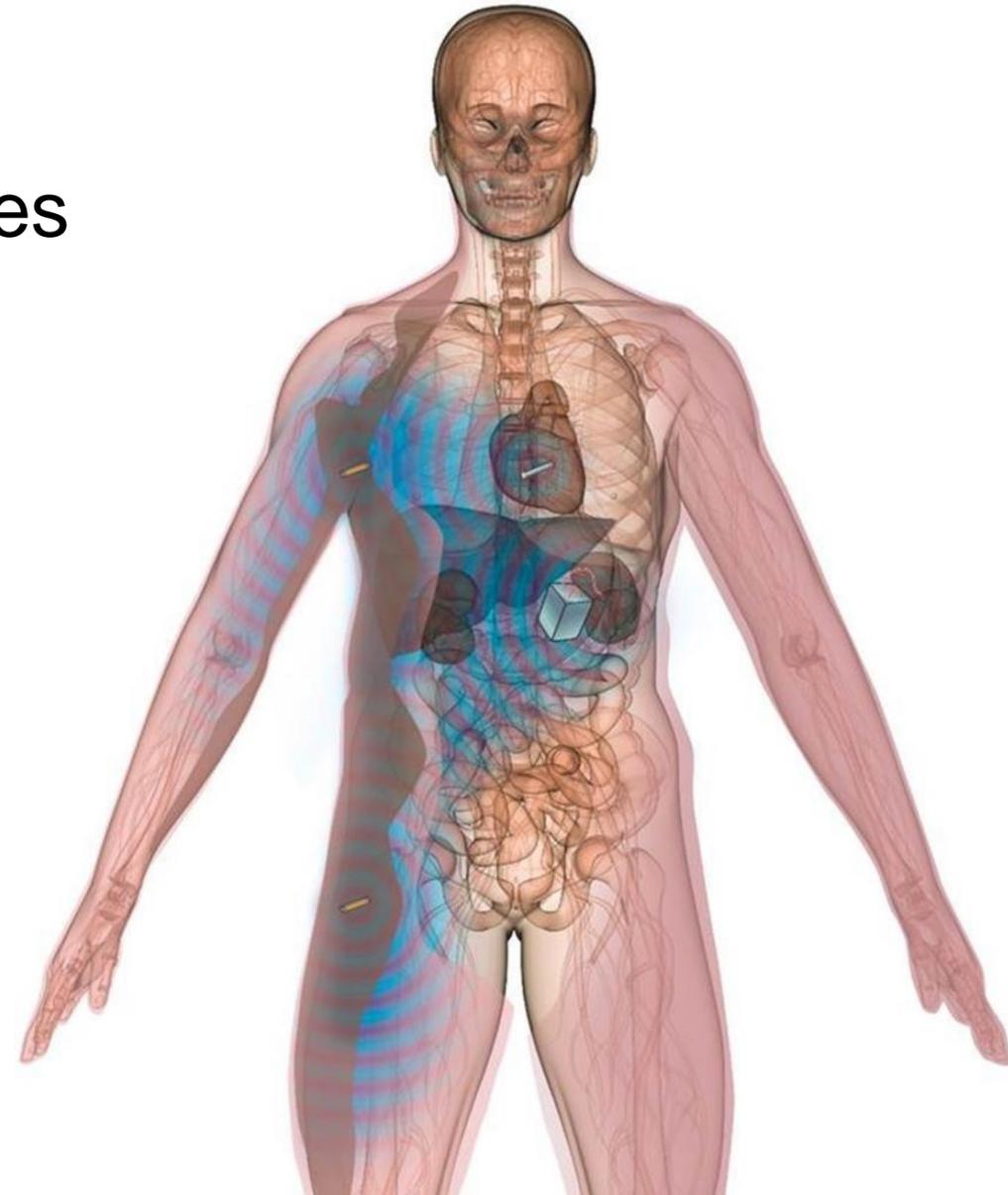
BILDSPEL 

**Bild 1 av 3** När forskarna utvecklar Internet i kroppen är det stort fokus på att göra den nya kommunikationstekniken säker från början.  
Illustration: Elin Lindwall

Source: Dagens Nyheter

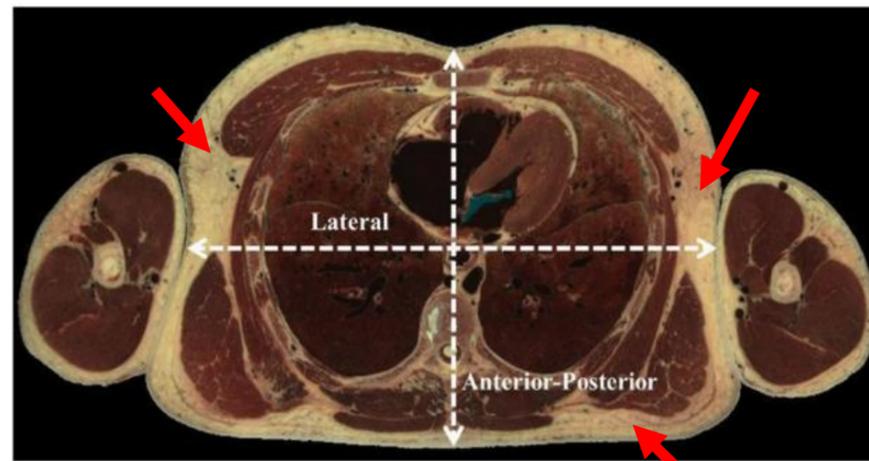
# Motivation

- 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

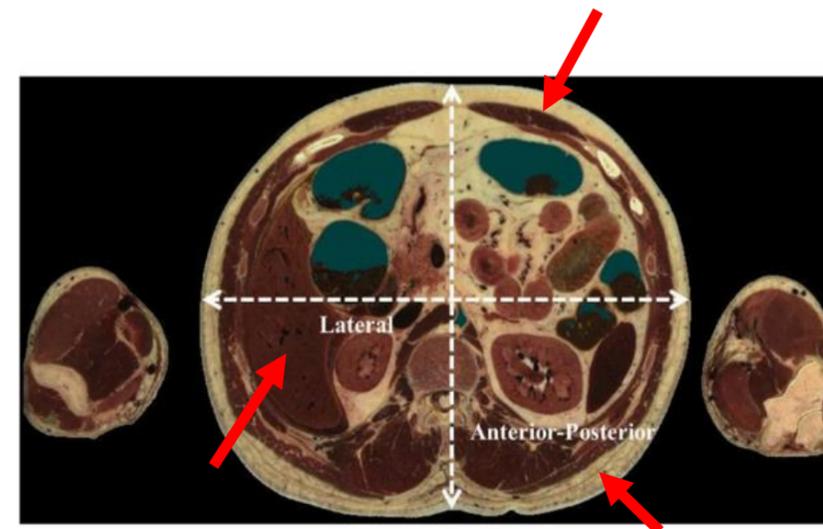


# New communication for in-body networks: RF through the Fat Layer

- Existing methods not sufficient
- RF Communication through fat layer
- Fat is everywhere in the body

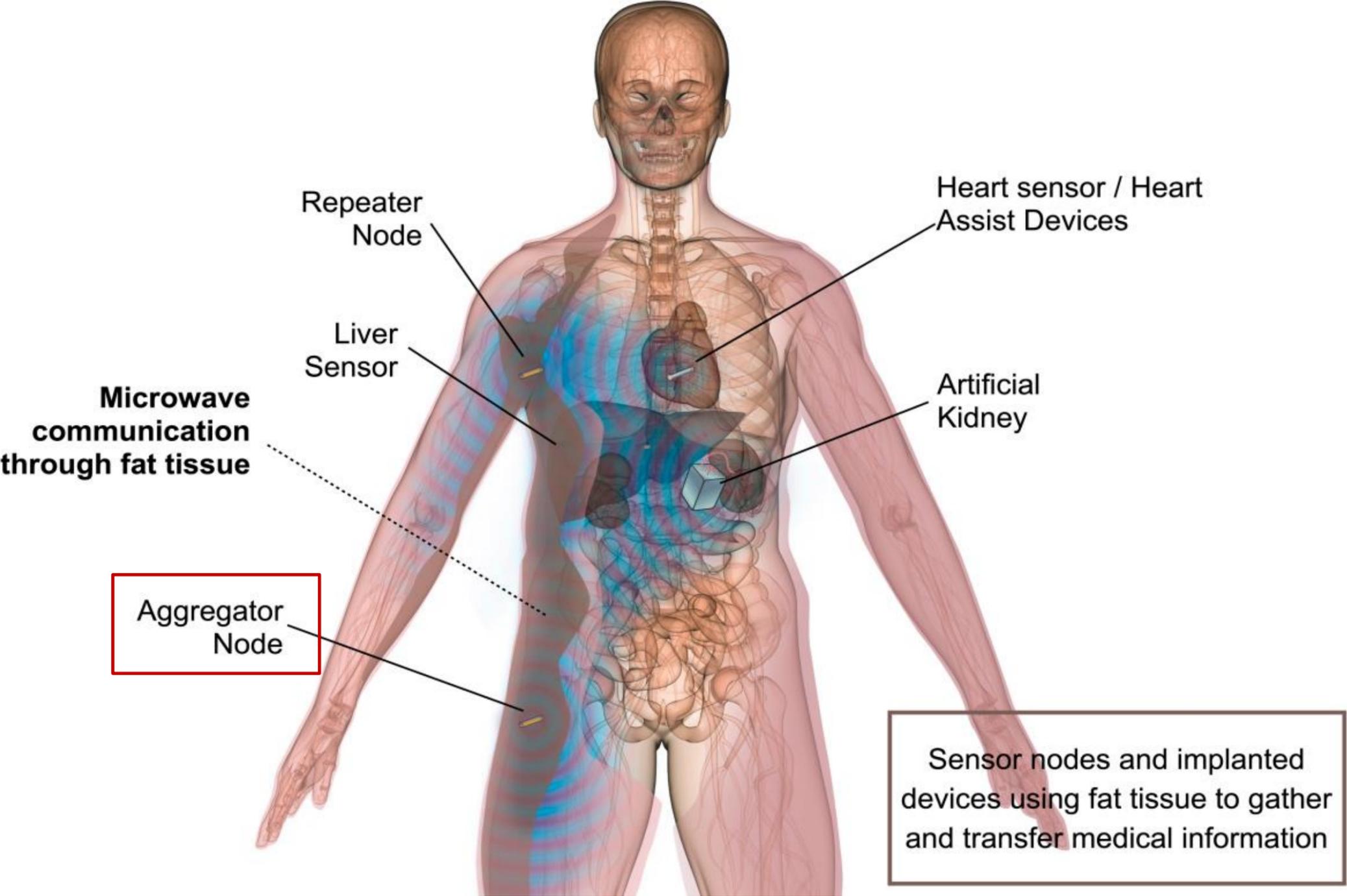


(a) Mid-chest



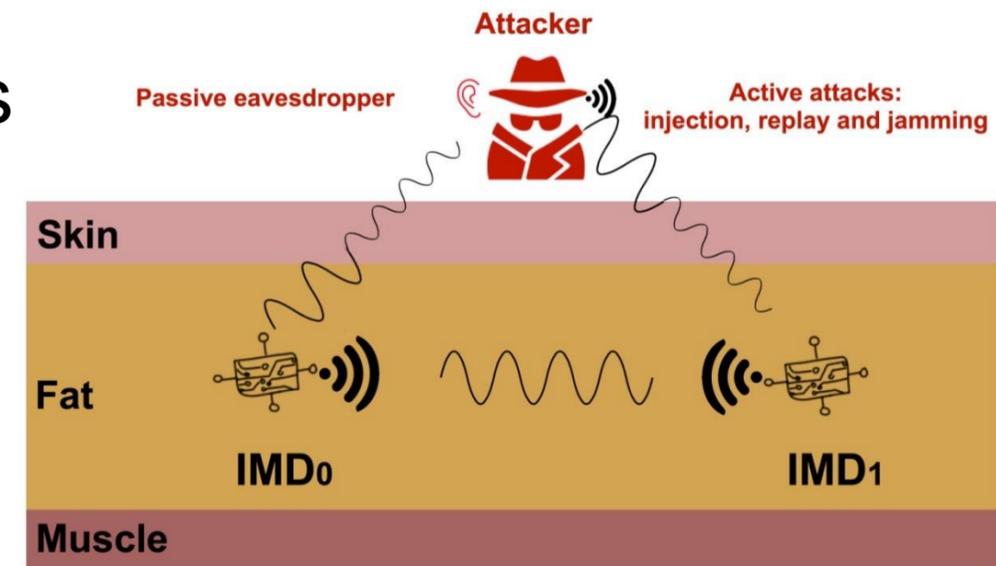
(b) Mid-abdomen

# LifeSec Networking



# Security a Must

- Attackers take over implanted devices
  - Life-threatening
  - 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

## Objective:

secure in-body sensor networks based on fat layer communication

# Participating Groups

All groups are from Uppsala University

- Networked Embedded Systems 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

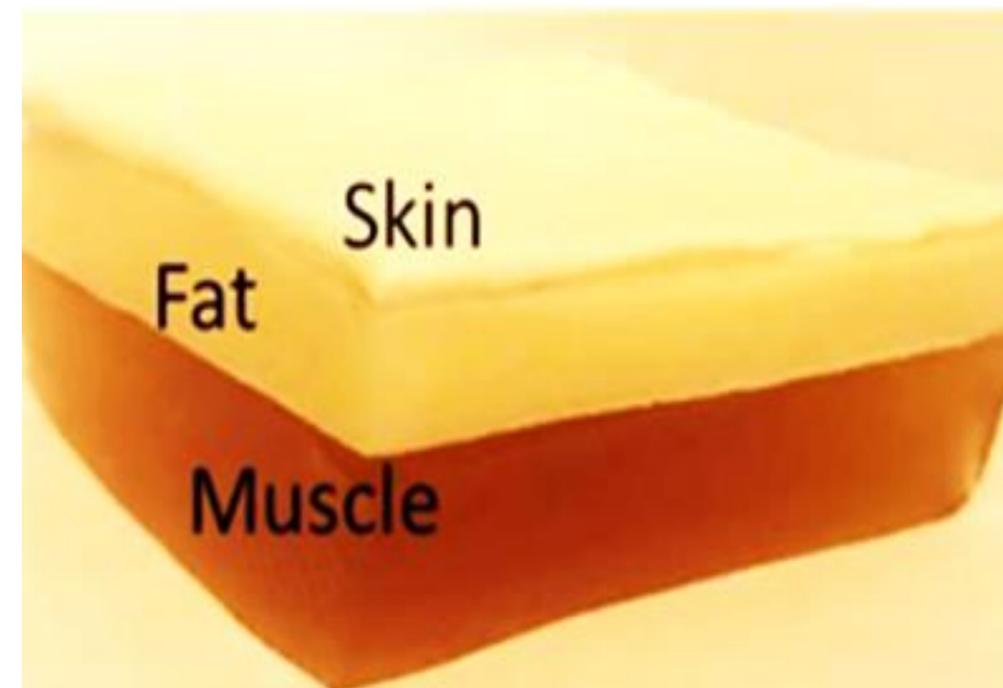
# Goals

## Goals

- 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

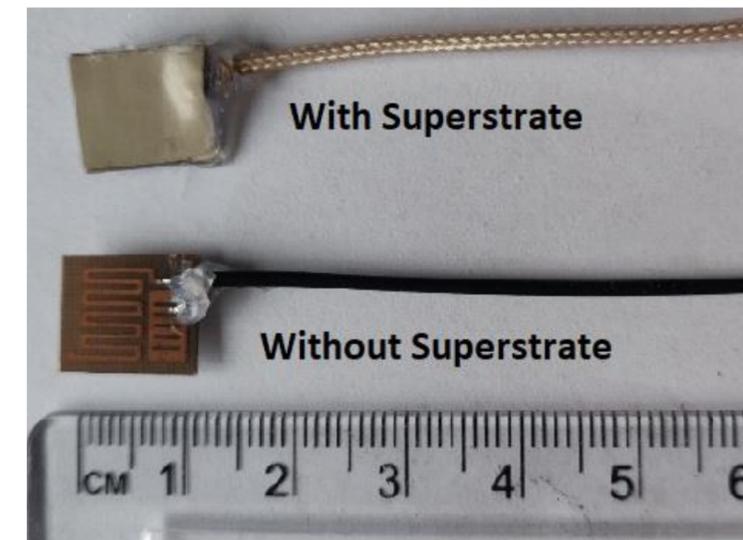
## Demonstrator:

- Series of phantoms (emulating artifacts)



# Results: Secure In-body Sensor Networks

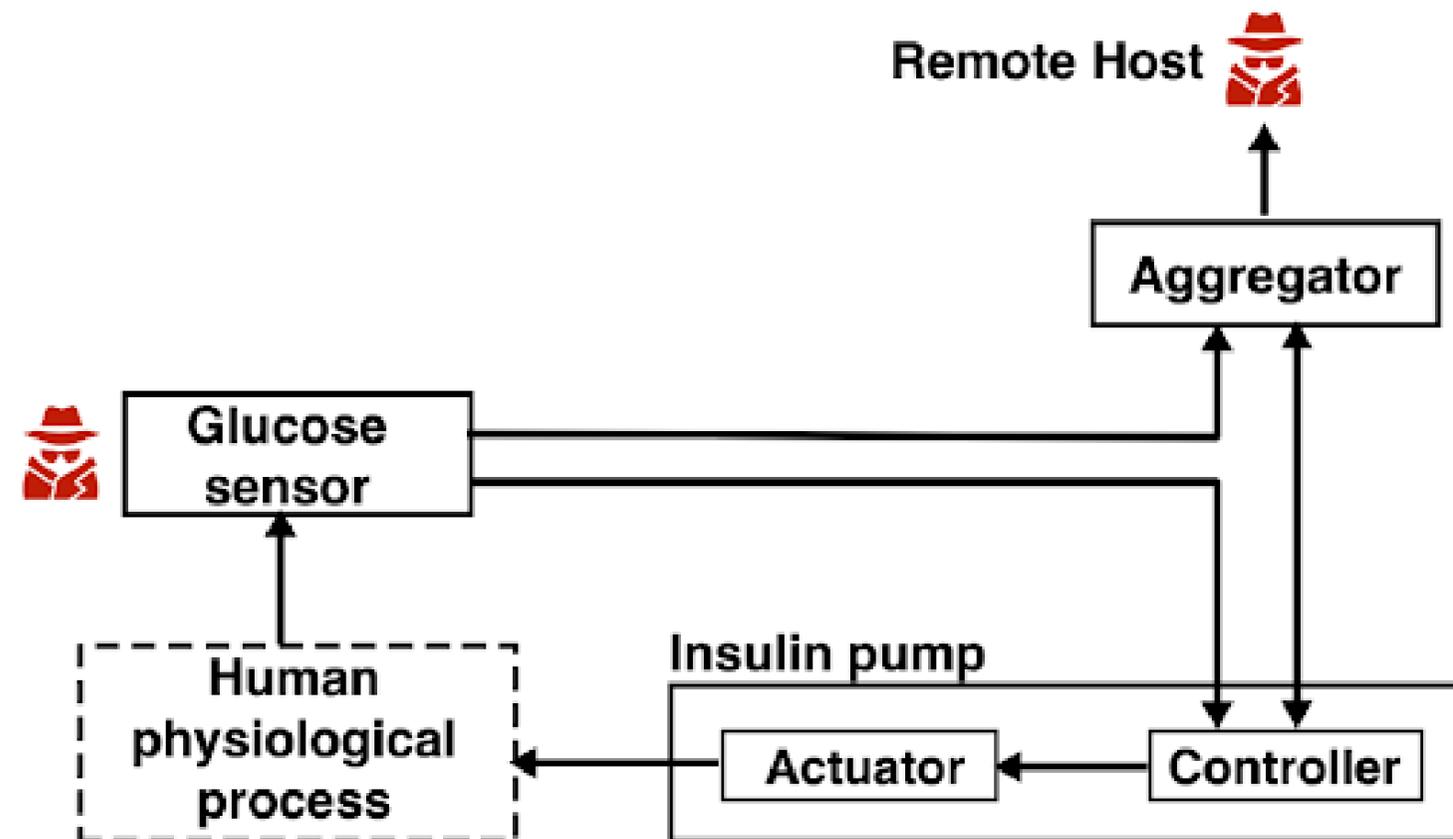
- Security architecture with a focus on key generation and distribution
  - Novel authentication and key distribution protocol (TIEK)
  - Implementation ongoing
- Secure communication
  - Design of antennas to restrict leakage
  - Backscatter communications with Fat IBC
- Privacy-preservation
  - Sensing: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



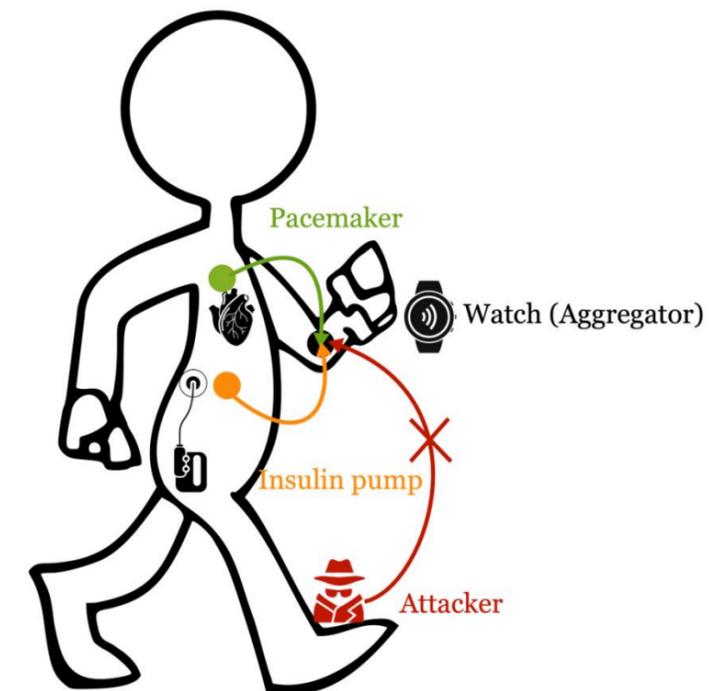
# Results: Security at the Boundary of the Body

## 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
  - Identification of backscatter carriers and tags

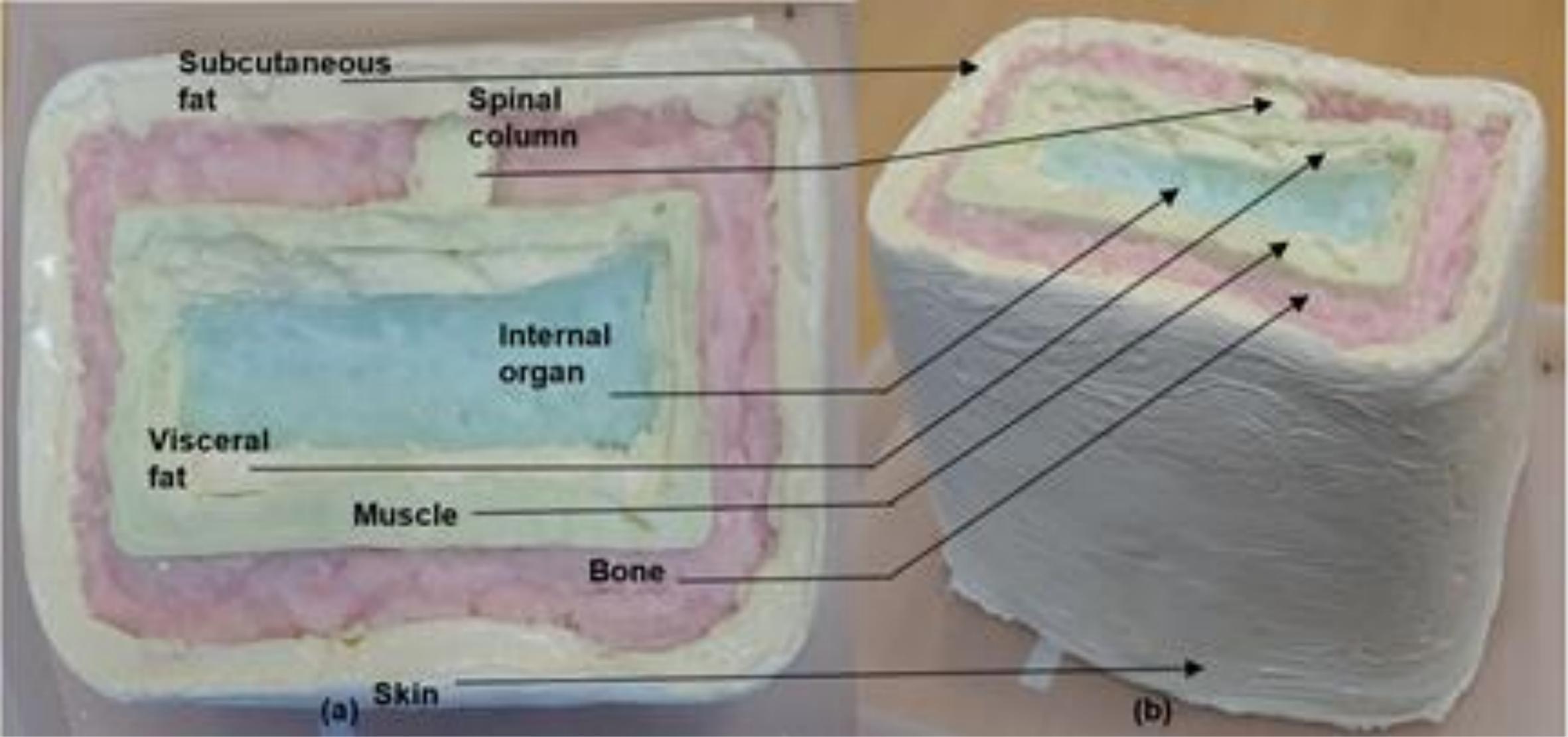


# Major Achievements

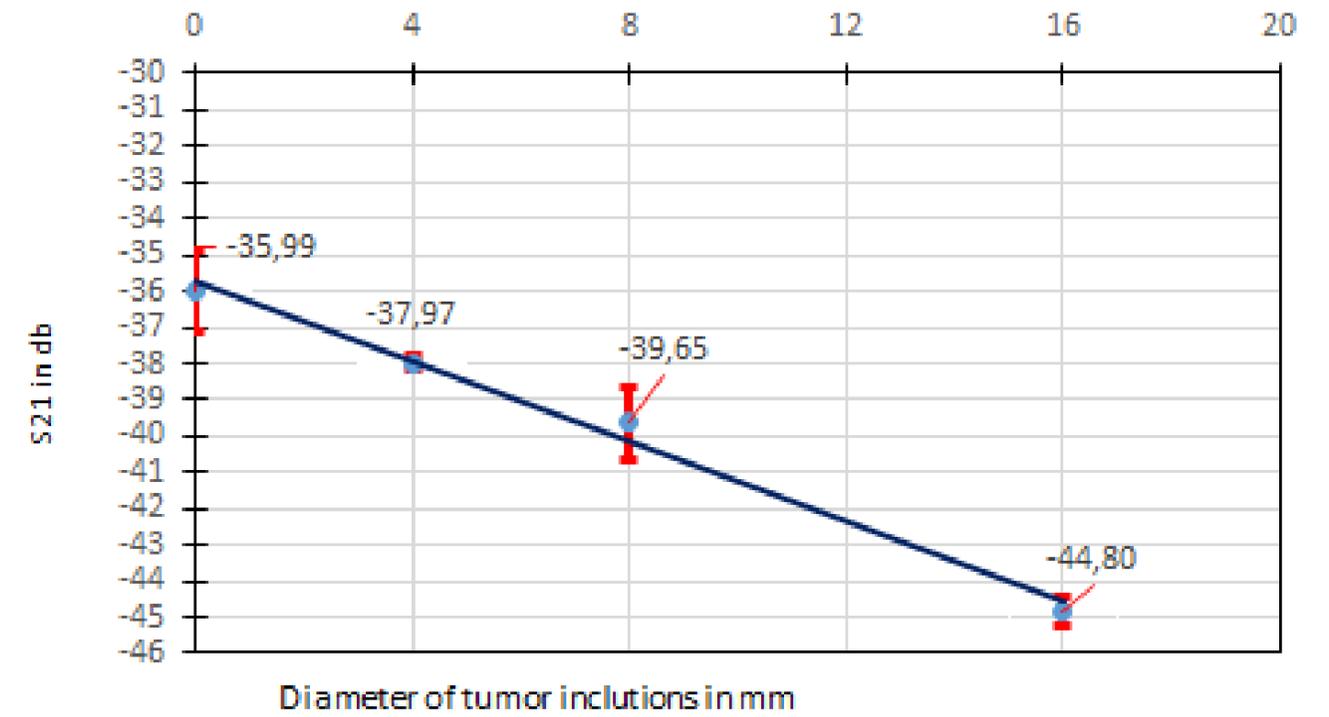
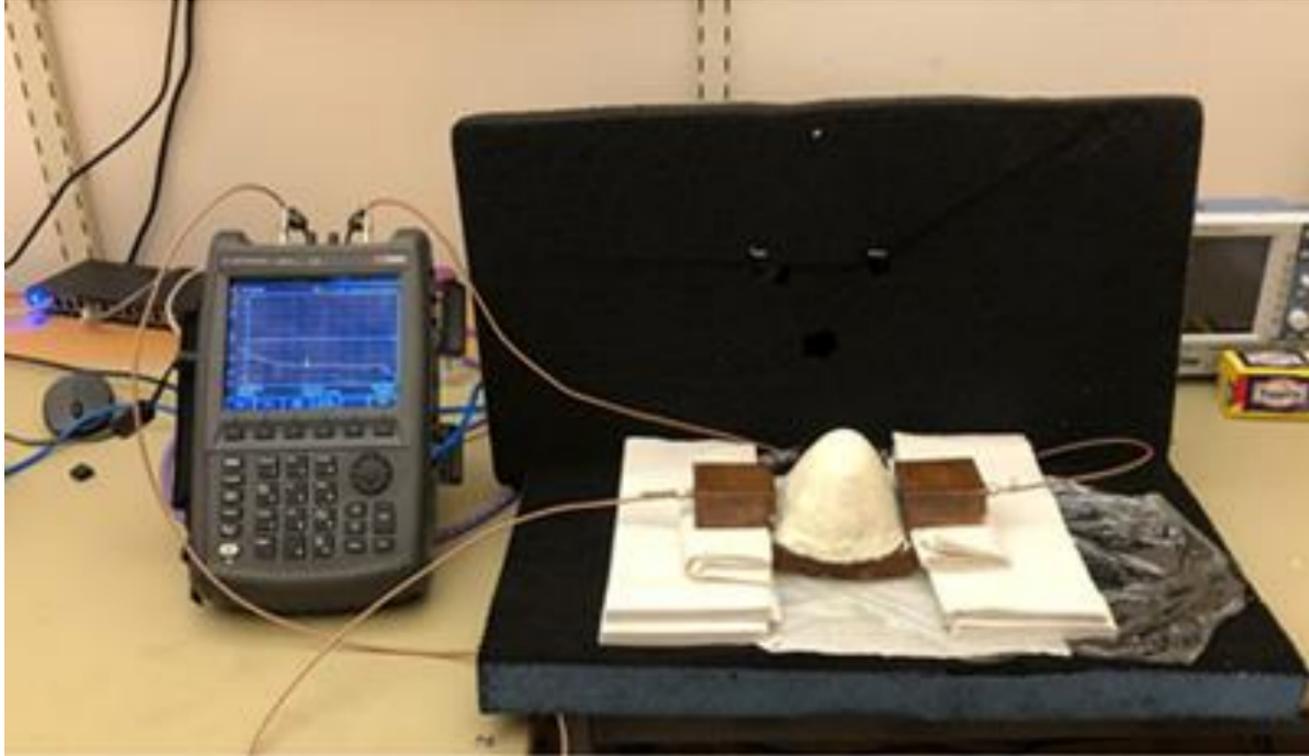
- Good progress towards all the goals
- Strong collaborations between participating groups
- More than 35 peer-reviewed publications
  - 11 have authors from 2 or more departments
  - Awards at top conference
- Development of novel phantoms
  - Research contributions themselves
  - Quantitative data for other research



# Major Achievements: Phantoms

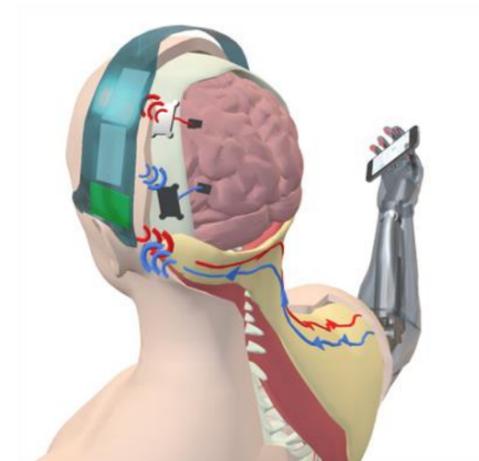
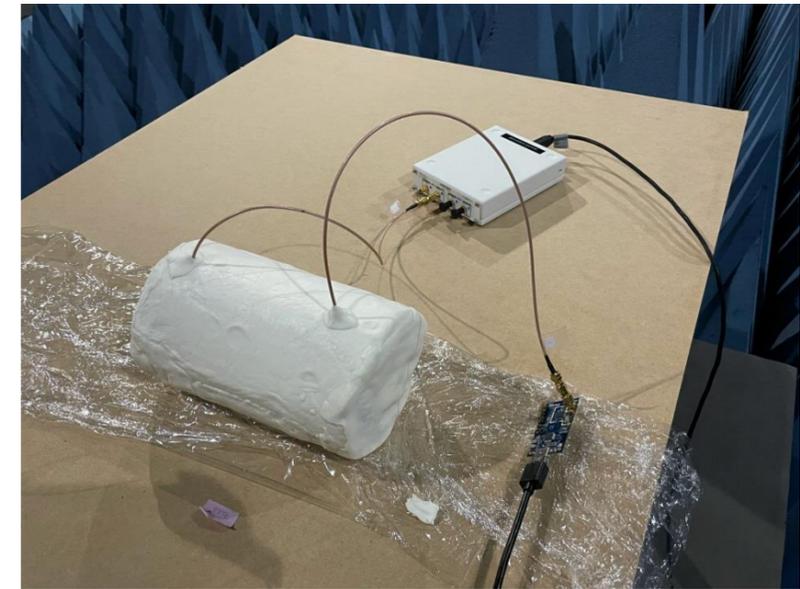


# Major Achievements: Phantoms



# 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
- Basis for exciting ongoing and future projects
  - Connecting brain-computer interfaces to prostheses, electric vehicles etc.
  - Contact us when interested!



# Acknowledgements

Reference group:

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- Ericsson
- RISE

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