UNIVERSITEIT GENT

FACULTEIT INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR

Academiejaar 2015-16

Thesispresentaties 2016-17

WAVES - Wireless

waves

iMinds
CONNECT.INNOVATE.CREATE

+ 500 publicaties

+ 50 projecten

37 onderzoekers

waves

wireless, acoustics, environment & expert systems

UNIVERSITEIT GENT

INTEC

iMinds

CONNECT.INNOVATE.CREATE

Wireless

Green ICT

Medische toepassingen

Wireless body area networks

Performantie van draadloze netwerken

Blootstelling aan elektromagnetische velden

Communicatie en propagatie voor draadloze netwerken

Promotors: prof. Luc.Martens | prof. Wout.Joseph | prof. Emmeric.Tanghe

Supervisors: Margot.Deruyck | Xu.Gong | David.Plets | Amine.Samoudi | Arno.Thielens | Gunter.Vermeeren

@intec.UGent.be

Low exposure

Energy efficient

Maximum coverage

Green ICT

Proposal Master Proof

Accounting for Energy Cost when Designing Energy-Efficient Wireless Access Networks

Promotor

Prof Luc Martens, Prof Wout Joseph

Supervisor

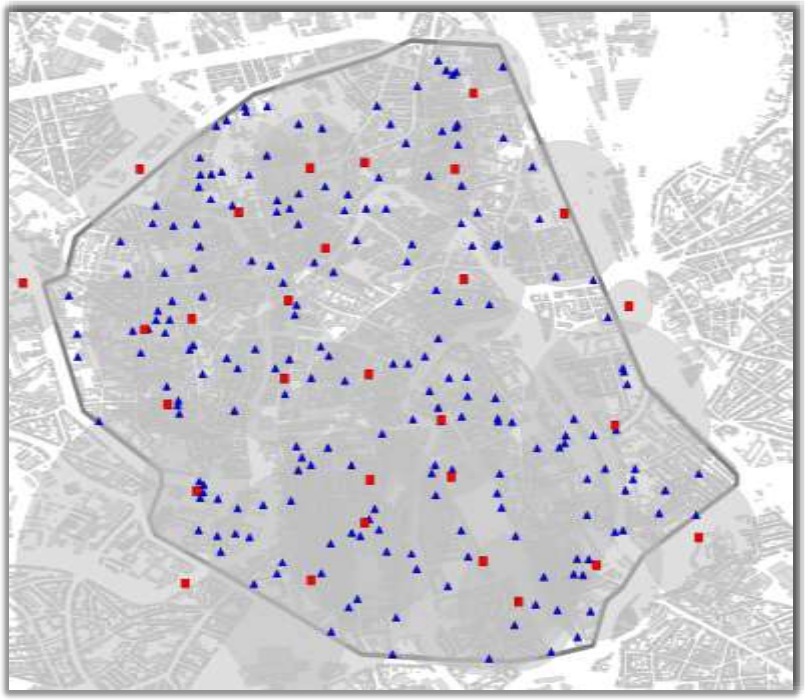
Margot Deruyck

Energy cost in network design

- **Context**
  - In literature: lot of effort to develop energy-efficient networks
  - However: for companies, the energy cost is the most appropriate parameter
  - How can we take into account energy cost as a parameter during the network design process?
    - And still develop an energy-efficient network?

Energy cost in network design

- **Aim**
  - Develop an algorithm for the design of an energy-efficient network by taking into account energy cost as extra parameter
  - Evaluate influence on the network, (renewable) energy provisioning system, and battery system
- **Method**
  1. Literature study
     - Design of energy-efficient wireless access networks
     - Identify prediction models for energy cost and energy production
  2. Implementation of an algorithm
     - In Java, tool available in research group
  3. Evaluation/comparison of different scenarios
     - Proofing your algorithm works
     - Recommendations for practical implementation



- **Contact**
  - margot.deruyck@intec.ugent.be

Proposal Master Proof

Designing Heterogeneous Green Wireless Access Networks

Promotor

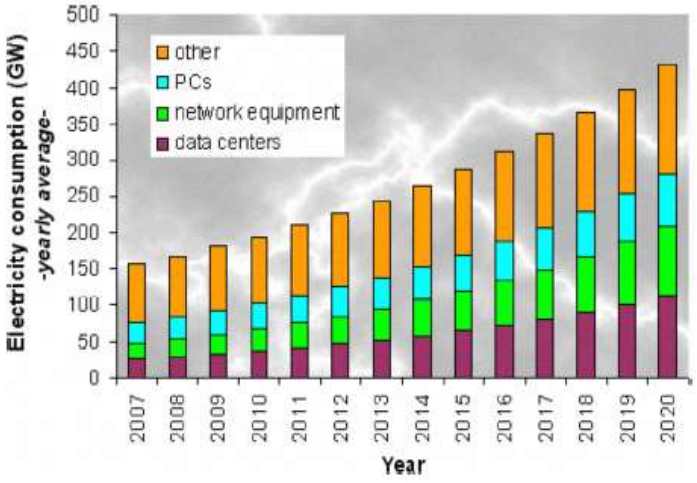
Prof Luc Martens, Prof Wout Joseph

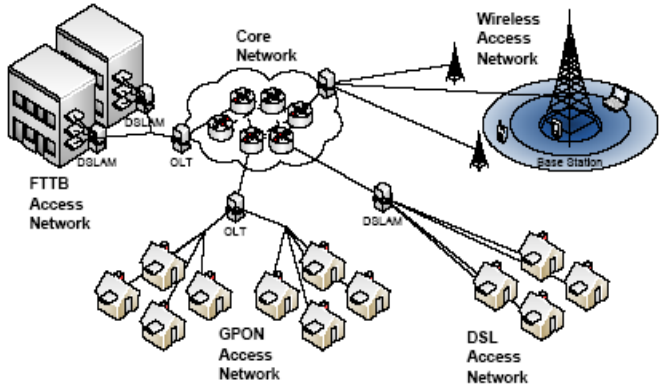
Supervisor

Margot Deruyck

Heterogeneous green networks

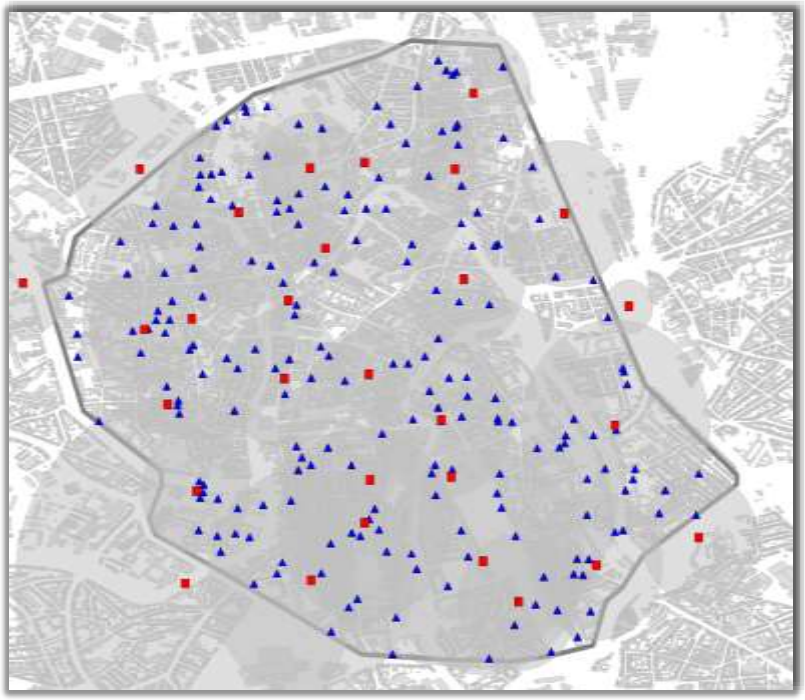
- **Context**
  - ICT: 4% of worldwide energy consumption
    - Expected to double in the next 10 to 15 years
  - Wireless access networks are large consumers
  - Important to quantify the power consumption of the different elements in the network
  - Also human exposure becomes more and more important
  - We developed a deployment tool for future green wireless access networks
    - Disadvantage: only one wireless technology is considered





Heterogeneous green networks

- **Aim**
  - Support for heterogeneous networks
    - Multiple wireless technologies at the same time
- **Method**
  1. Literature study
     - Design of energy-efficient wireless access networks
     - Power consumption of the different base station types and technologies
     - Evaluation of the human exposure
  2. Implementation of an algorithm
     - In Java, tool available in research group
     - Design of an energy-efficient network with low human exposure by choosing the right base station type and technology at each location
  3. Evaluation/comparison of different scenarios
     - Proofing your algorithm works
     - Recommendations for practical implementation



- **Contact**
  - margot.deruyck@intec.ugent.be

Proposal Master Proof
(Industrial science: Informatics only)

Designing and visualizing green wireless access networks based on Google Maps

Promotor

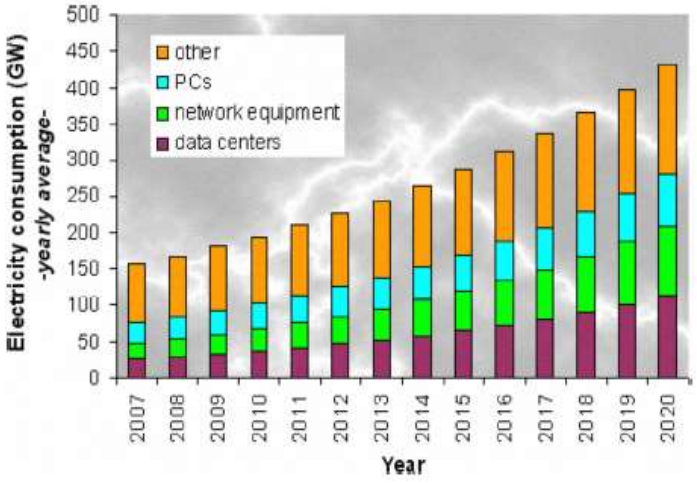
Prof Luc Martens, Prof Wout Joseph

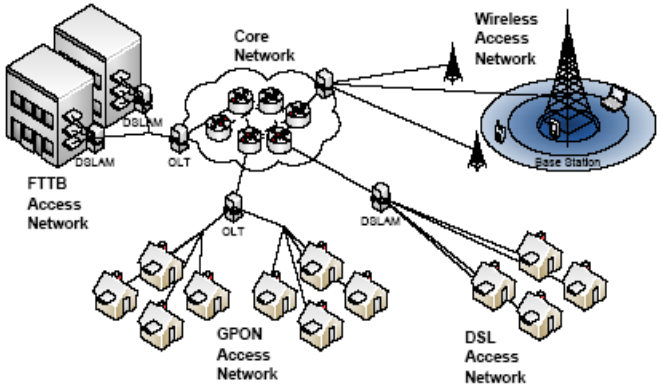
Supervisor

Margot Deruyck

Green ICT

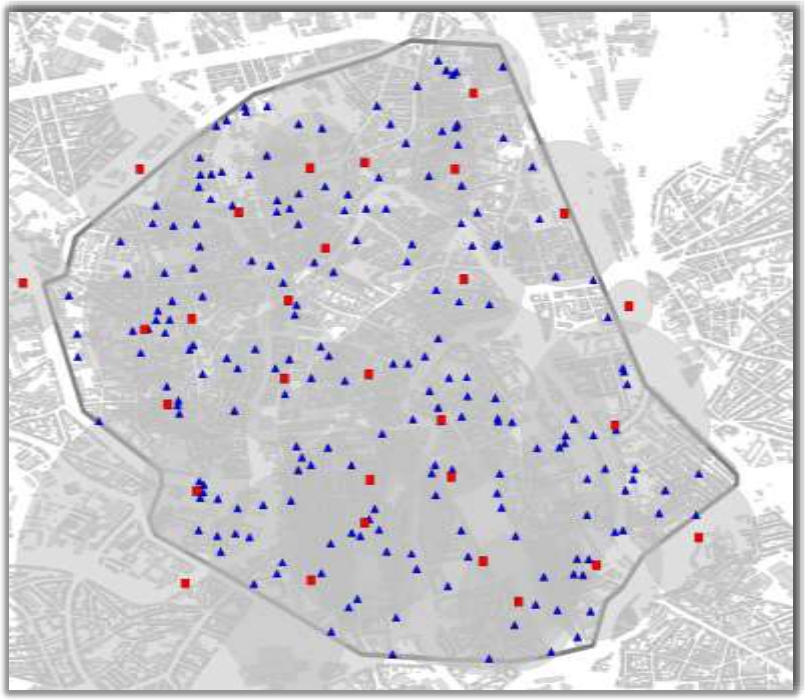
- **Context**
  - ICT: 4% of worldwide energy consumption
    - Expected to double in the next 10 to 15 years
  - Wireless access networks are large consumers
  - Important to quantify the power consumption of the different elements in the network
  - Also human exposure becomes more and more important
  - We developed a deployment tool for future green wireless access networks
    - Disadvantage: only compatible with shape files





Green ICT

- **Aim**
  - Supporting Google Maps as well
  - Visualizing the network performance
- **Method**
  - Based on the simulation tool (in Java) developed in our research group
  - Input based on Google Maps
    - Indicating the area to cover
    - Extract all the needed information about the area
    - Provide compatibility with the tool
    - Design of an appropriate GUI
  - Output: visualize the network in Google Maps
    - Visualize the performance
      - Bit rate, coverage, signal strength, heath map exposure, etc.



- **Contact**
  - margot.deruyck@intec.ugent.be

UNIVERSITEIT GENT

FACULTY OF ENGINEERING

Master Thesis 2016 - 2017

Green Factory: Optimization of Industrial Electricity Consumption Cost by Production Scheduling

Supervisors

Prof. Wout Joseph, Prof. Luc Martens

Mentors

Xu Gong, Toon De Pessemier

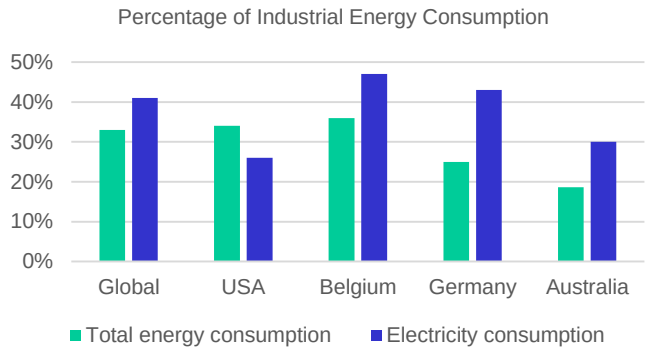
Contact

xu.gong@intec.ugent.be

waves

iMinds
CONNECT.INNOVATE.CREATE

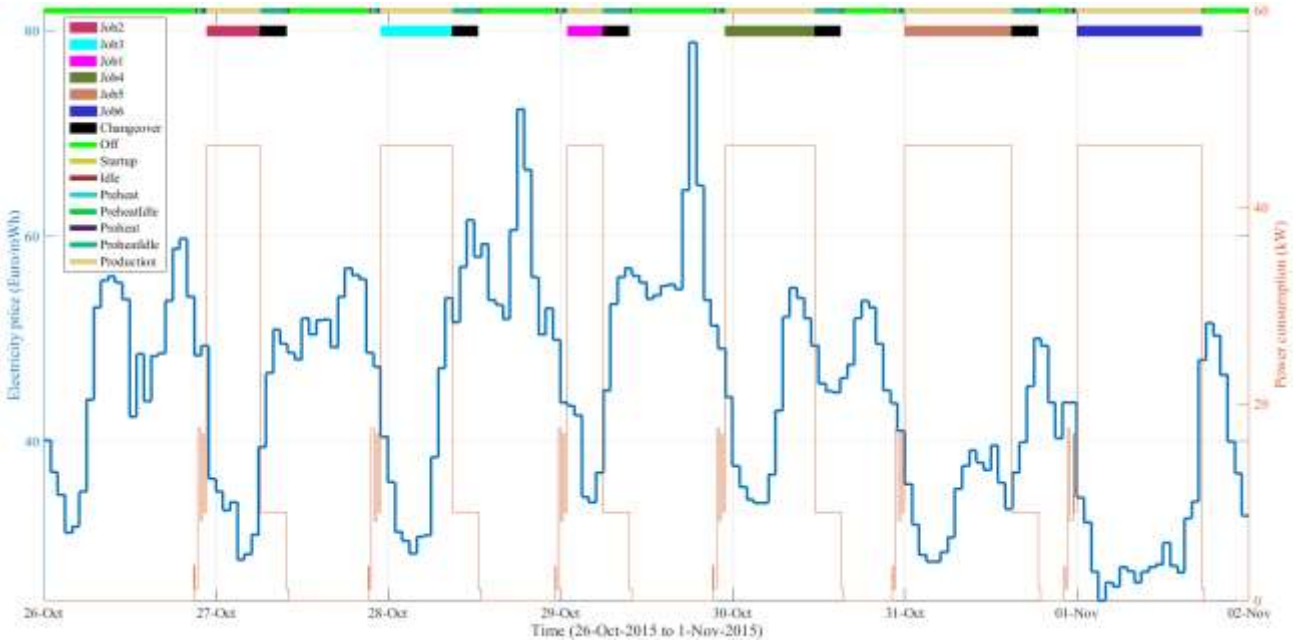
Background



- The global industry leads to very high energy consumption
- Expenditure on energy consumption is becoming no longer negligible for industrial enterprises
- Volatile electricity price over time
- Higher greenhouse gas (GHG) emissions during peak hours of electricity demand
- The production activities on industrial machines/lines are usually scheduled in advance either manually or automatically, which provides high potential to control and minimize the industrial energy consumption by using computer-based intelligence

Purpose

- To create advanced algorithms for automatically scheduling production activities, which take the volatile electricity price into consideration
- These algorithms are loadable into an internal memory of one or several digital computers, and executable for intelligently recommending an optimal production schedule
- Multiple optimization objectives: energy cost minimization, total weighted tardiness/earliness minimization, makespan minimization, GHG emissions minimization, etc.
- Main parts of the thesis: (1) Literature review, (2) problem formulation, (3) optimization and implementation, (4) numerical validation and analysis



- Methods
  - Literature review: optimization metaheuristics, energy-concious production scheduling
  - Problem formulation: mixed-integer programming (MIP), a model proposed
  - Optimization and implementation: coding of the MIP model and the optimization metaheuristic, preferably in Java
  - Numerical validation and analysis: various numerical experiments to test the correctness of the implementation, and further to assess the performance of the proposed energy-concious production scheduling method to reduce energy cost (and/or GHG emissions)
  - Bonus: (1) performance benchmark between the proposed energy-concious production scheduling method and the ones at WAVES, (2) joint publication for conferences and/or journals

Direct user feedback for domestic energy use

Promotors

Arnold Janssens, Wout Joseph

Supervisors

Jelle Laverge, David Plets, Marc Delghust, Kris Vanhecke, Toon De Pessemier

Context

- Environment-friendly buildings
- More efficient use of energy
- Current energy usage in high-performance buildings turns out to be higher than design targets, due to inefficient user behaviour

➔Direct user feedback

- Might reduce energy consumption with > 20%
- Makes building occupants more aware of energy

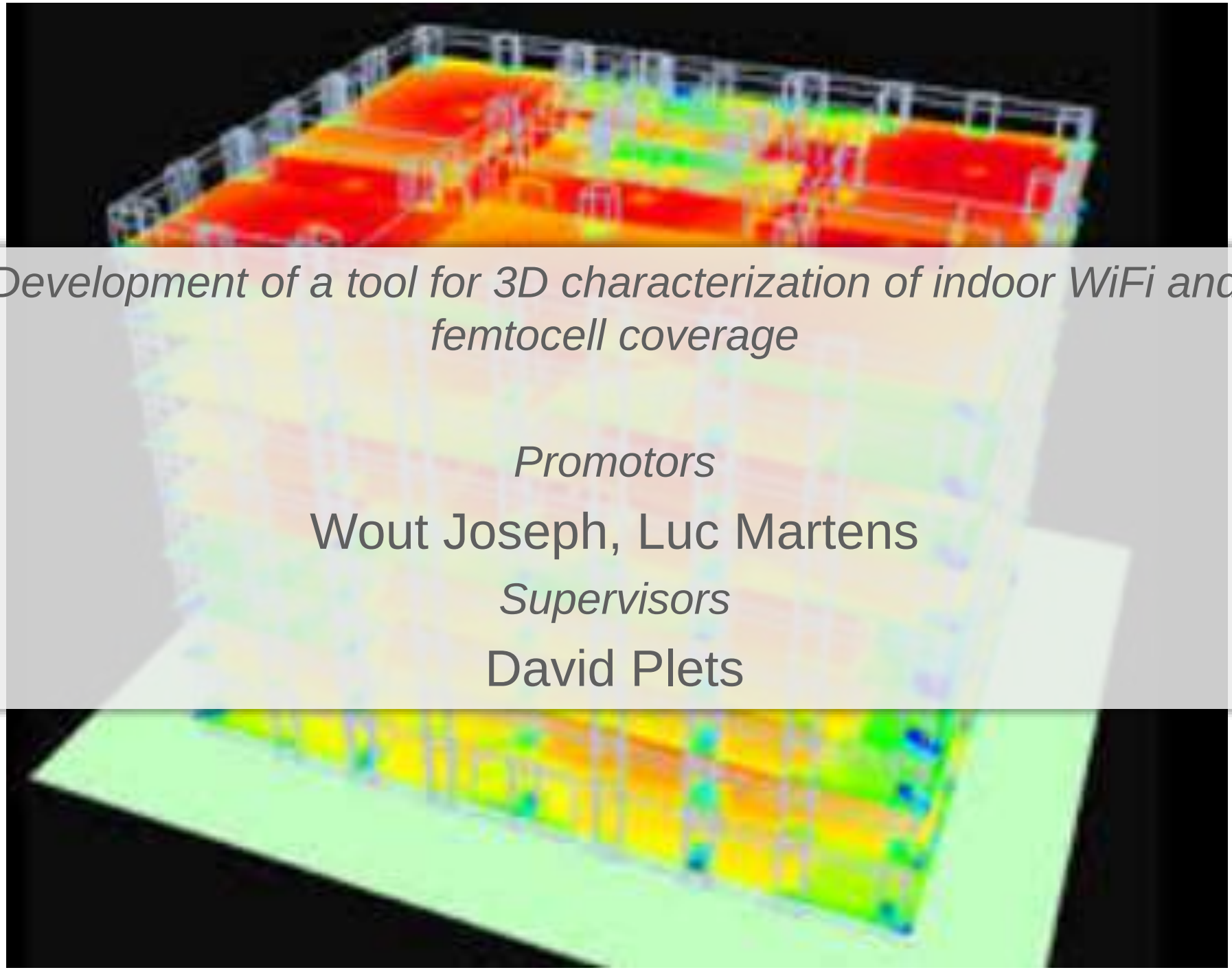
- Implementation of user feedback platforms not straightforward

Goal

- Implement and test operational prototype of user feedback tool (heating, water, electricity)
  - Neighbourhood in Kortrijk equipped with extensive energy monitoring
- Concrete goals
  - Set up web application
  - Link monitoring data to application in real-time
  - Select and implement data reduction and normalization methods
  - Select and develop graphical representation of results
  - Test user acceptability and effectiveness of the tool

Draadloze netwerken:

propagatie / lokalisatie / performantie



Development of a tool for 3D characterization of indoor WiFi and femtocell coverage

Promotors

Wout Joseph, Luc Martens

Supervisors

David Plets

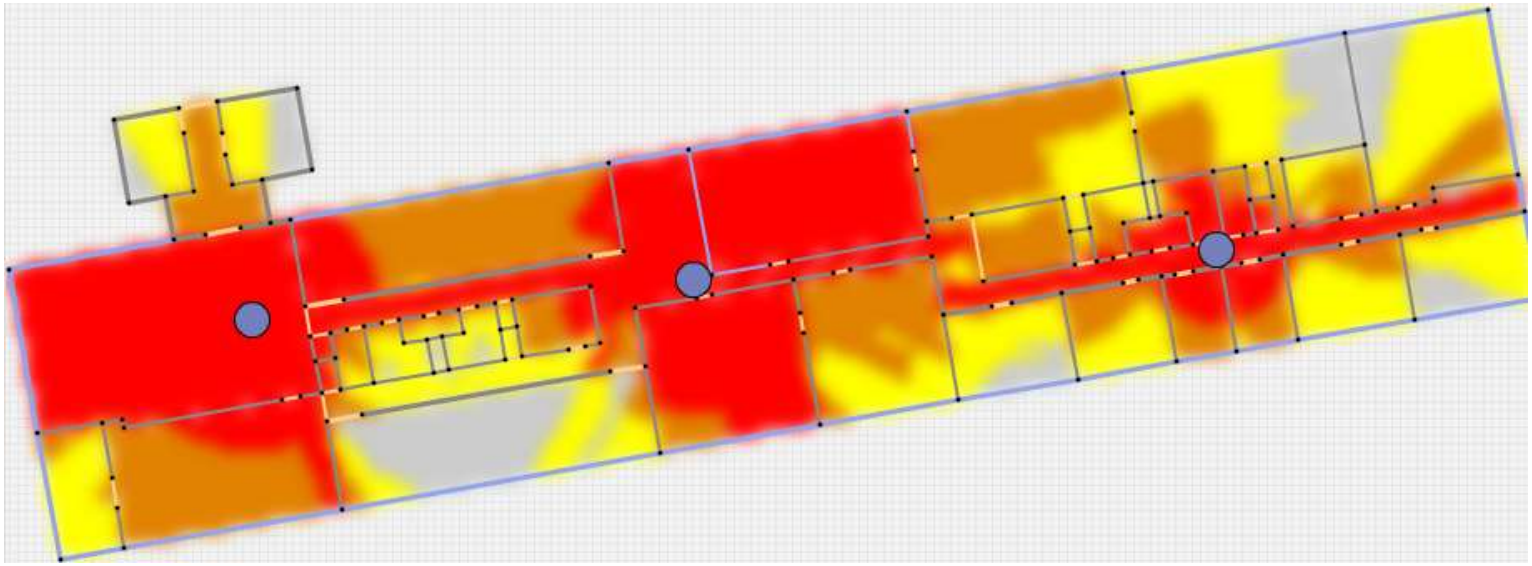
Context

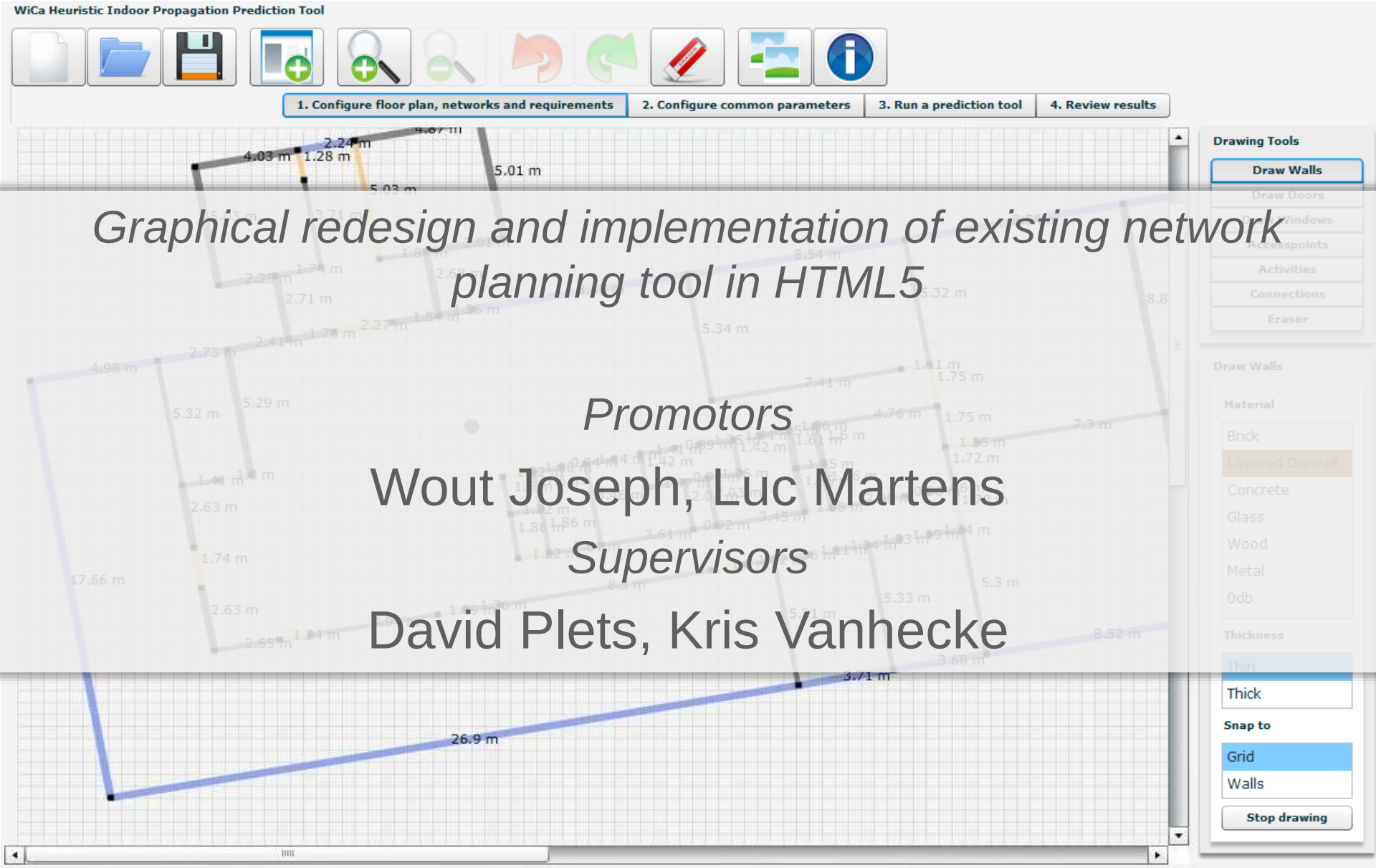
- Expansion of wireless networks, also indoor
  - Very complex environment
- Prediction tools require accurate path loss models
  - Environment (office vs. industrial)
  - 3D influences
    - Height transmitter (access point) and receiver (laptop)
    - Floor of transmitter and receiver
  - Transmission frequency (2.4 – 5 GHz)
  - Technology (WiFi vs. 4G femtocells)

- Accurate determination of influences is necessary

Goal

- Design of indoor 3D network planning tool by accurately characterising influencing factors on path loss
  - Execute path loss measurements to assess influence of height, frequency, environment,...
  - Analyse date and construct models
  - Incorporate models in existing tool





Graphical redesign and implementation of existing network planning tool in HTML5

Promotors

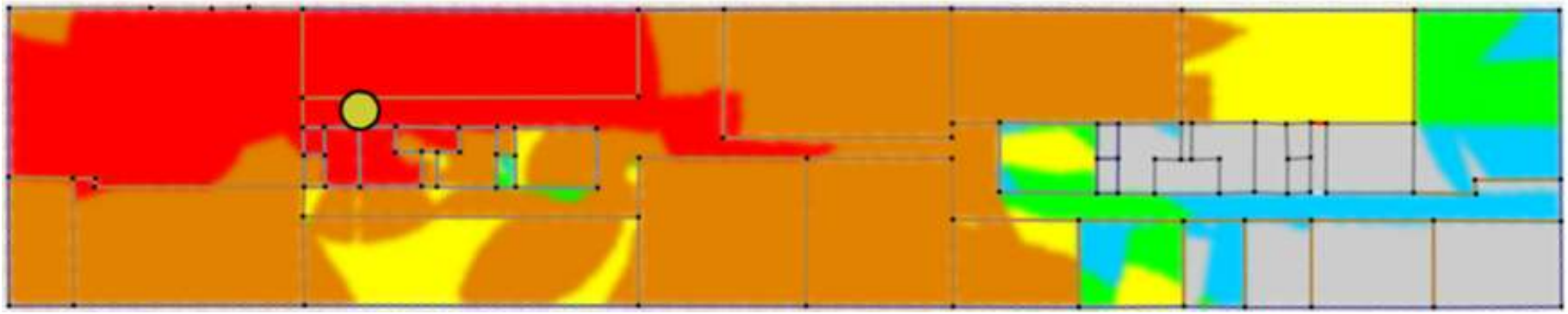
Wout Joseph, Luc Martens

Supervisors

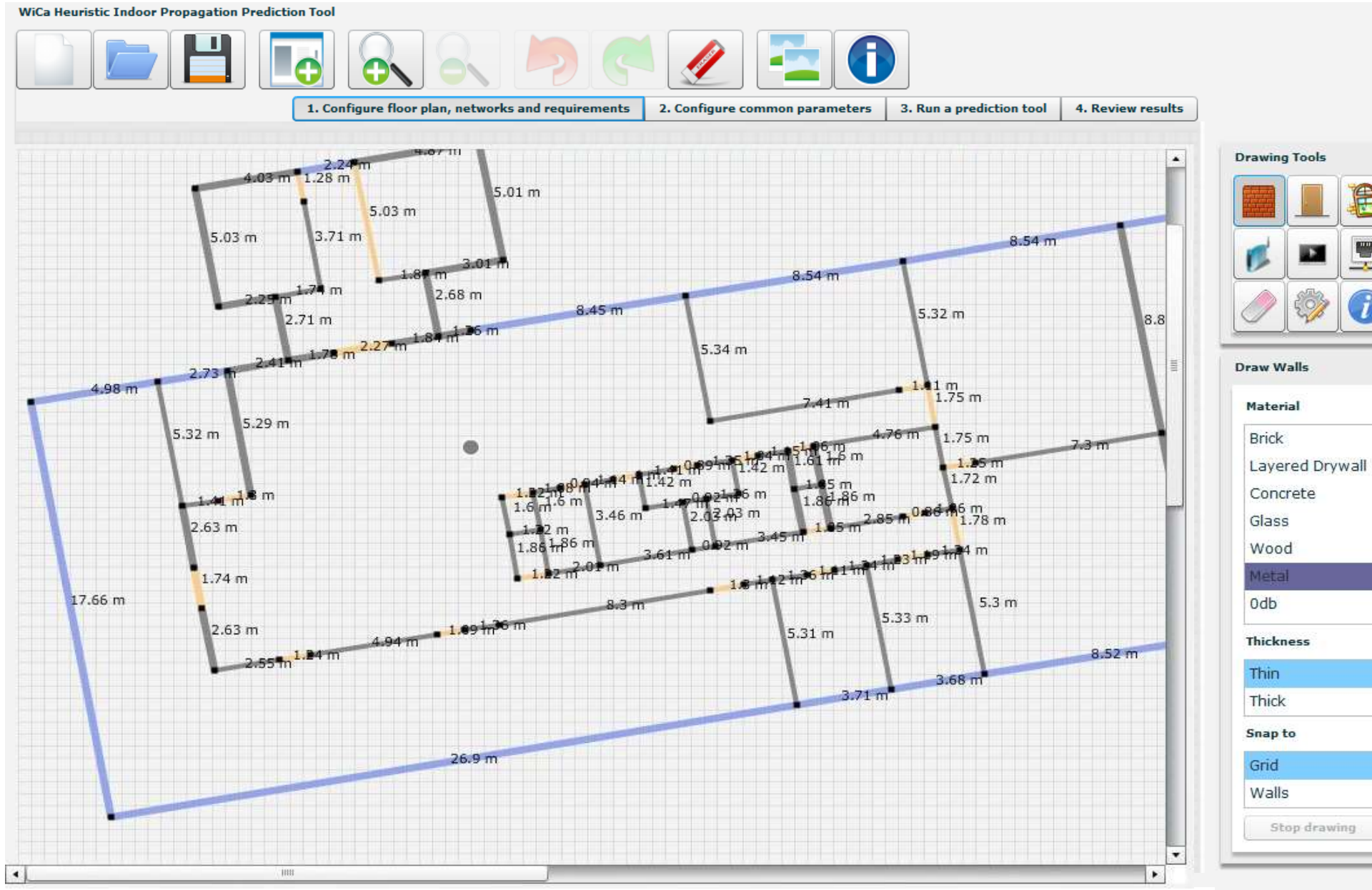
David Plets, Kris Vanhecke

Context

- Increased use of wireless communication in indoor environments
- Automated network planner very useful for network deployers
- Current tool in Adobe Flex 3 (Flash)



Graphical redesign and implementation of existing network planning tool in HTML5



Context

- New, more flexible and standardized technologies available (HTML5)
- Flash being used less and less

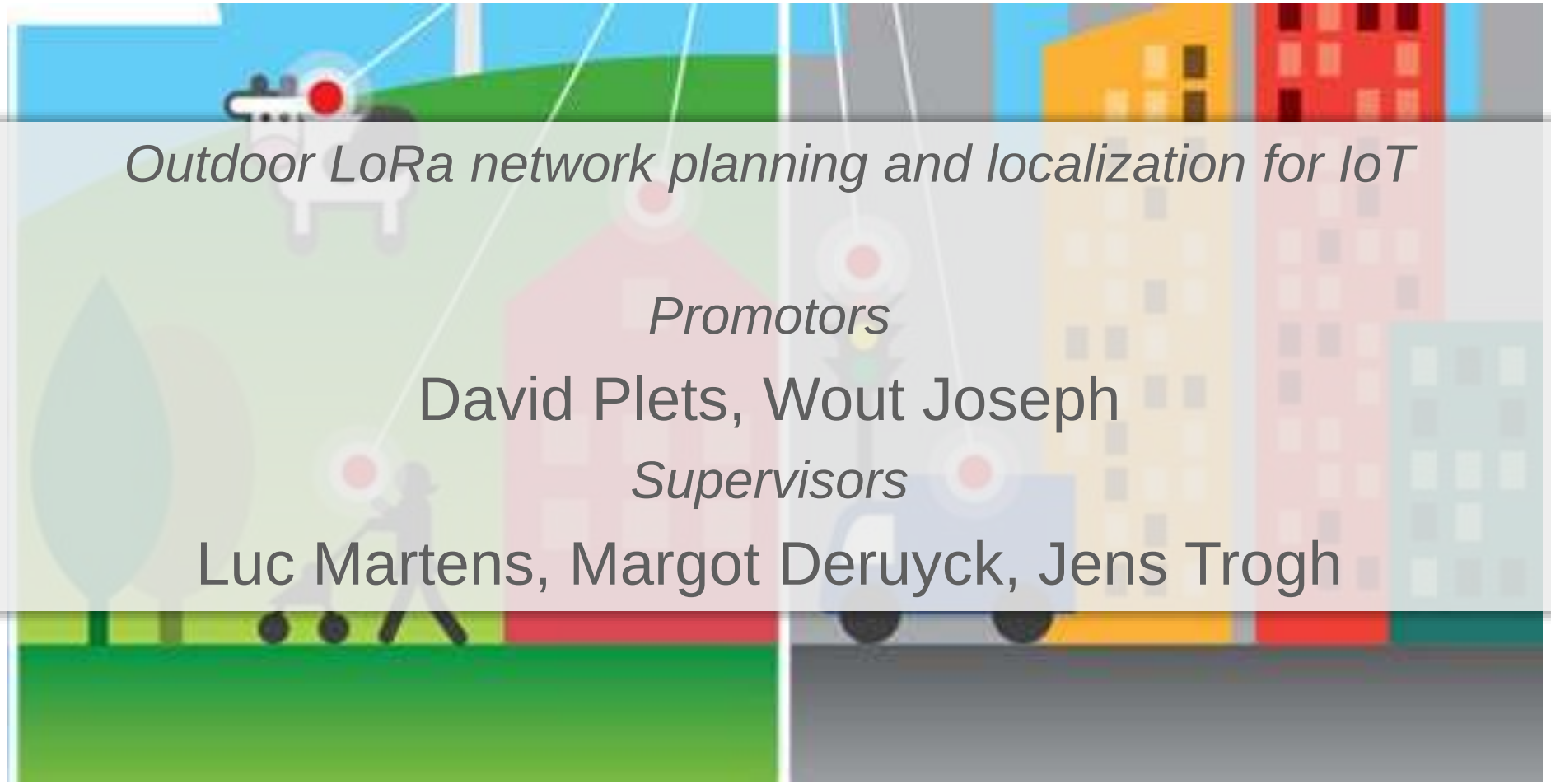
➔Redesign and implementation of existing GUI functionalities (standard HTML, CSS, Javascript)

- Make tool cross-platform and cross-browser

Goal

- Graphical redesign and implementation of existing planner in HTML5

1. Preparatory study on HTML, CSS & Javascript libraries for rich UI development (w2ui, jQuery UI, ToolbarJS)
2. Study current tool architecture & functionalities
3. Identify possible improvements
4. Study requirements for user-friendly application
5. Redesign existing functionalities in HTML5: student is responsible for user interface with backend where algorithms are run
6. User-friendliness, stability, maintainability, efficiency
7. Testing: cross-platform, cross-browser
8. Comparison with original tool



Outdoor LoRa network planning and localization for IoT

Promotors

David Plets, Wout Joseph

Supervisors

Luc Martens, Margot Deruyck, Jens Trogh

Context

- LoRa is a new technology designed to support Internet-of-Things (IoT) applications
  - Low data rates, long range, high sensitivity
  - Smart cities
  - Localization (trash cans, people, boats,...)
- Accurate localization requires
  - Characterization of wireless channel
  - Design of intelligent algorithms

Goal

- Develop and validate wireless channel models for LoRa

1. LoRa literature study
2. Outdoor channel models
3. Set of measurements in Ghent ➔ models
4. Perform LoRa network planning
   - Three LoRa base stations within range for triangulation
5. Develop localization algorithms
   - Based on the developed path loss models
   - Add intelligence (maximum node speed, possible trajectory,...)
6. Final testing phase of localisation algorithms

Wireless localization with a Visible Light Positioning (VLP) algorithm

Promotors

David Plets, Nobby Stevens

Supervisors

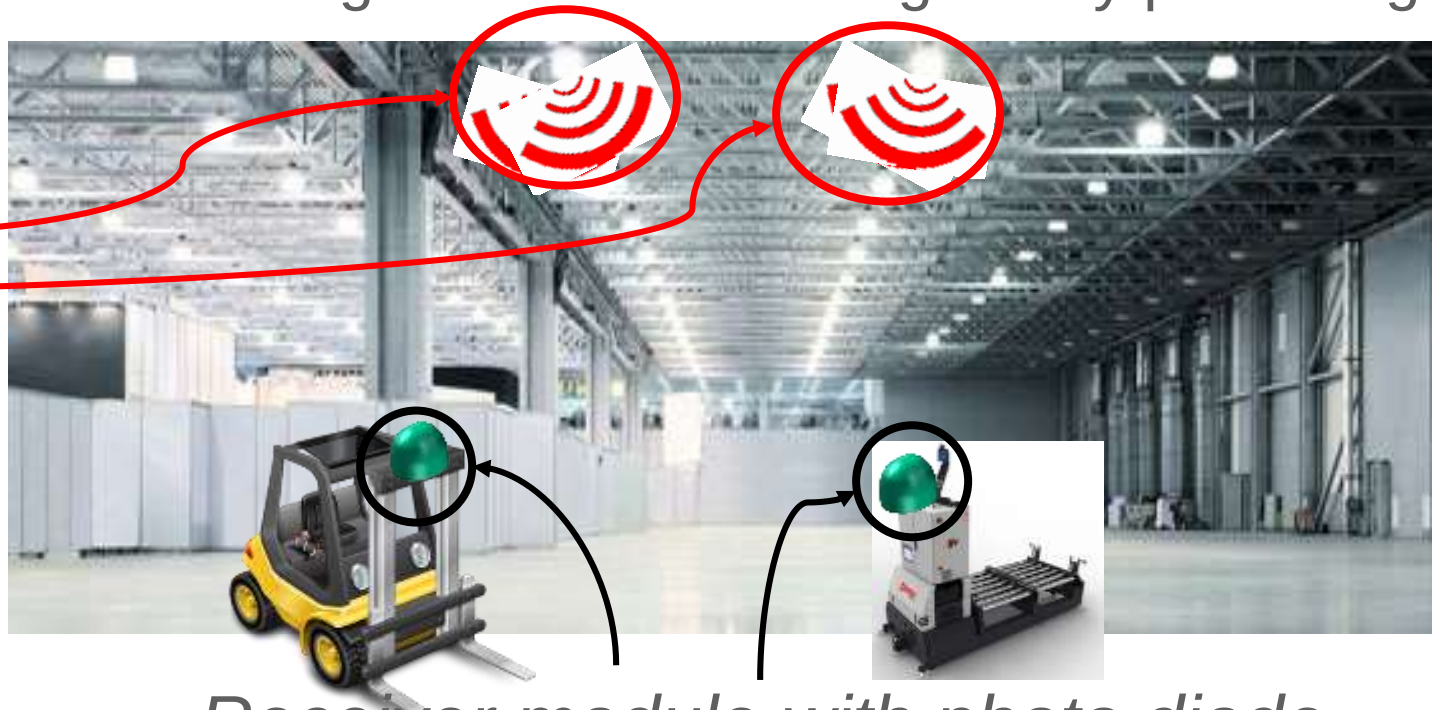
Luc Martens, Jens Trogh, Emmeric Tanghe, Wout Joseph

Context

- Huge interest of industrial players in accurate localization
- Current systems very expensive

➔Location tracking based on visible light very promising

Modulated LED signals from different sources

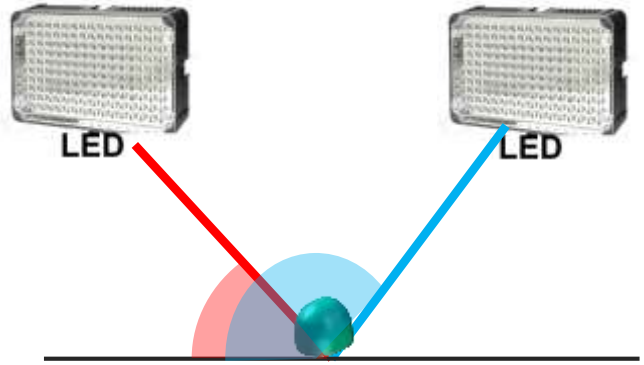


Receiver module with photo diode

Goal

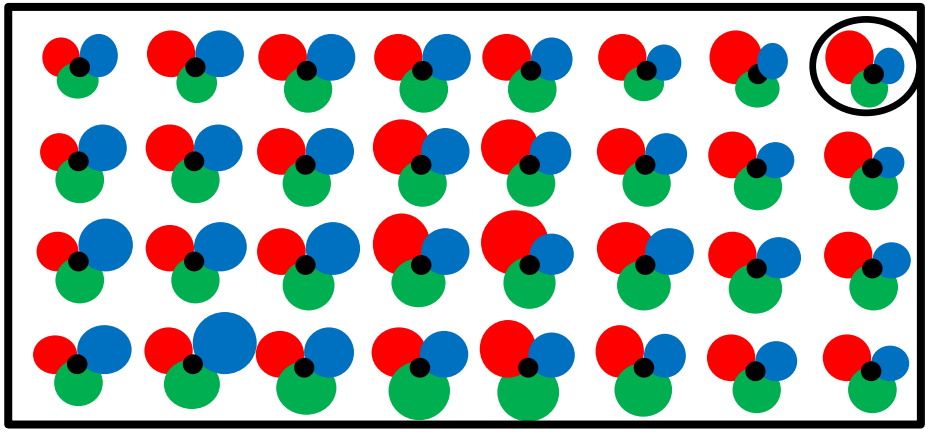
- Develop VLP-based location tracking algorithm

1. Angle-of-Arrival-based



2. RSSI-based
   - Compare measured and predicted light intensities

Thesis in cooperation with KULeuven-DraMCo



Adaptieve locatiebepaling in een MIMO-UWB draadloos netwerk

- Ontwerpen van een algoritme die aan de hand van elektromagnetische propagatiepaden de ongekende positie schat van een mobiele gebruiker

Literatuurstudie

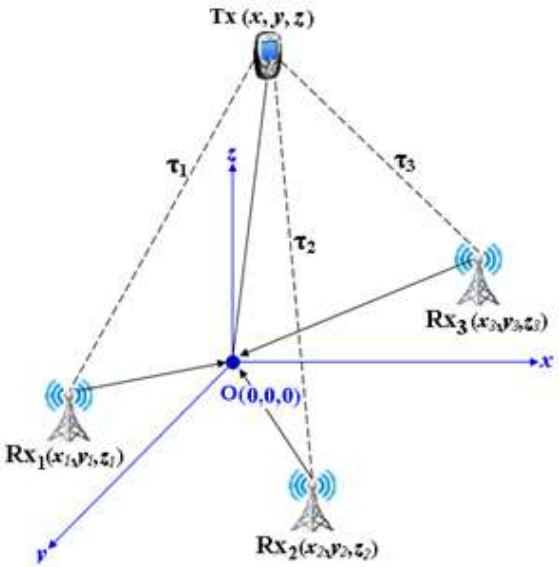
- Schatten propagatiepaden
- Ultra-Wideband technologie
- Algoritmen voor locatiebepaling

Adaptieve locatiebepaling

- Obstructie van directe pad tussen Tx en Rx
- Afwegen verschillende benaderingen (bv. RSSI)
- Ontwerp hybride-strategie die algoritmen combineert

Analyse

- Uitvoeren testmetingen en bepaling evaluatie-metriek
- Parameter sensitiviteits-analyse (AoA, delay, vermogen)
- Betrouwbaarheid locatiebepaling en/of frequentie-gedrag



Clustering van Ultra-Wideband multipad-propagatie

- Ontwerpen van een algoritme die propagatiepaden groepeert op basis van gelijkaardige parameters zoals vermogen en aankomsthoek i.f.v. frequentie

Literatuurstudie

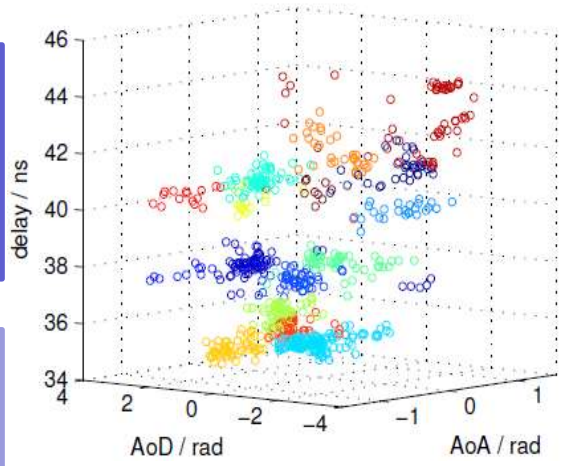
- Schatten propagatiepaden
- Ultra-Wideband en frequentie-afhankelijkheid
- Algoritmen voor clustering van propagatiepaden

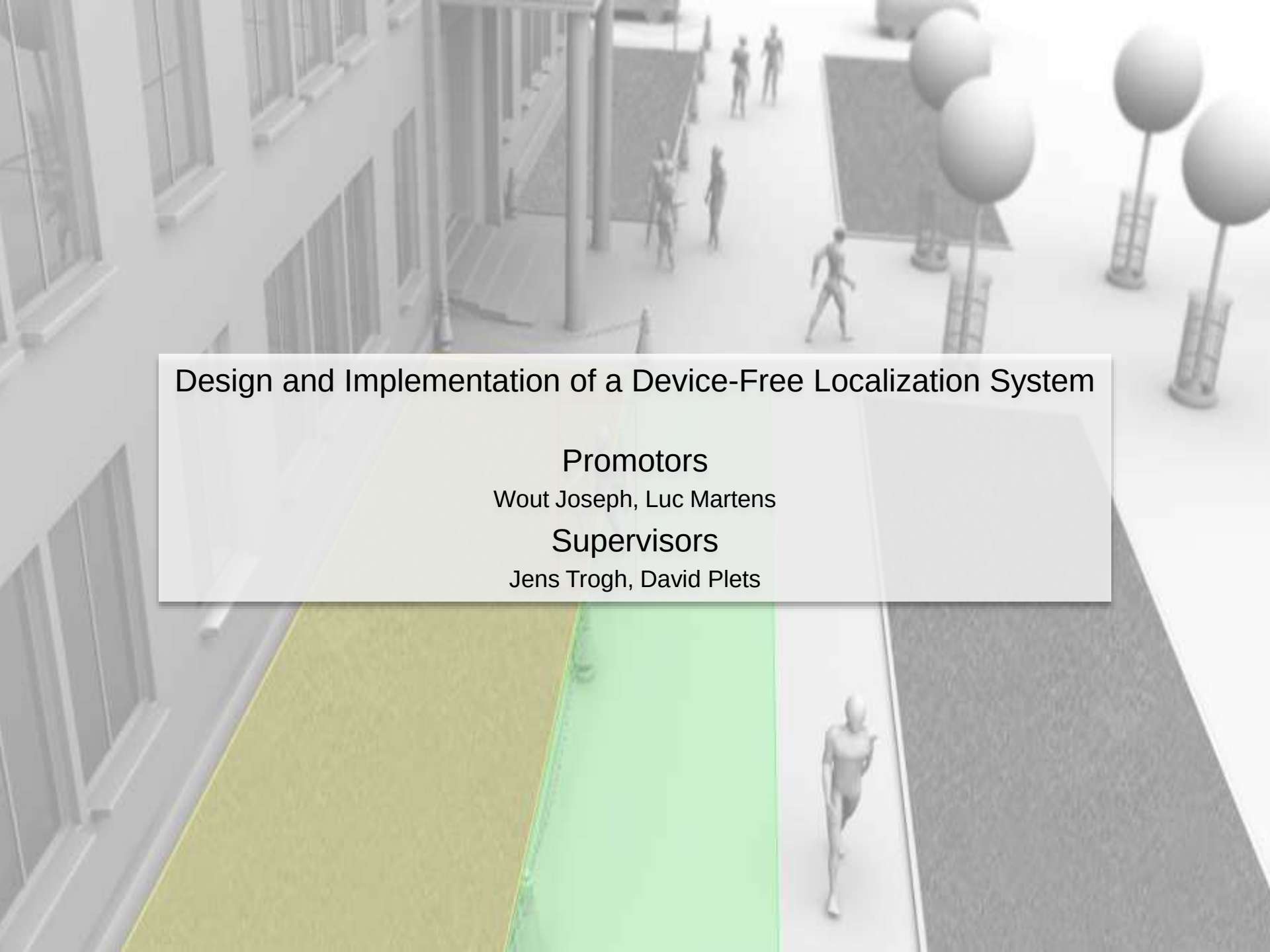
Ontwikkeling clusteringsalgoritme

- Clustering-metriek (AoA, AoD, delay, vermogen)
- Clustering-strategie (apart, gezamenlijk, hybride)
- Combinatie met frequentie-afhankelijkheid van UWB

Analyse

- Uitvoeren testmetingen en bepaling evaluatie-metriek
- Feedback naar algoritme en/of validering met ray-tracing
- Analyse i.f.v. verschillende domeinen (ruimtelijk, frequentie)





Design and Implementation of a Device-Free Localization System

Promotors

Wout Joseph, Luc Martens

Supervisors

Jens Trogh, David Plets

- **Context**
  - Localization and tracking systems
    - Active area of research
    - Applications in many sectors
      - Tracking patients, visitors, equipment, goods,…
  - Device-free localization
    - Passive localization
    - Track an object that is not actively participating
    - Useful for e.g.: intrusion detection, low cost surveillance,…

- **Goals**
  - Development of a device-free localization system
    - Locate one or more persons in a building
    - Track a person as he or she moves through the building
  - Outline
    - Literature study
    - Design of a passive localization system
    - Implementation and verification
    - Validation on wireless testbed

Wireless body area networks / Wireless sensor networks

IoT and cows: lameness detection algorithms for animals

Promotors

David Plets, Bart Sonck

Supervisors

Luc Martens, Said Benaissa, Wout Joseph, Frank Tuyttens, Matthias Van den Bossche

Context

- Anomalies in cow health cause significant loss for the farmer and suffering for the animal
  - Dairy cows with lameness produce much less milk
- Use on-cow sensors for lameness detection
  - Longer lying times
  - Different walking pattern

Goal

- Design of algorithms that derive degree of lameness from on-cow sensors

1. Literature study on lameness and current detection methods
2. Conduct training experiments
    1. Equip cows with sensors (accelerometer, barometer, compass,...)
    2. Track movement of animal with sensors and camera system
    3. Algorithms to detect lying times, degree of movement, (maximal) speed,...
3. Validation experiments on a new set of animals

Goal

4. Test algorithms on lame animals
    1. Characterize differences between healthy and lame cows
    2. Develop lameness detection algorithms
    3. Determine the sensors that have the best predictive performance
5. Analysis of sensor sampling rate vs. energy consumption

Thesis in cooperation with ILVO (Instituut voor Landbouw- en Visserijonderzoek)

Thesisvoorstel

Wireless monitoring of health and performance parameters of race horses

Promotoren

prof. Wout Joseph en prof. Eli De Poorter

Begeleider

Günter Vermeeren

Background

- **Scaling up of farms = TREND in agriculture**
  - Need to monitor livestock to quickly diagnose diseases
  - Wireless Sensor Network (WSN) deployed on animal body
    - Layout
      - Sensors placed **on** and **in** the body
      - Data collector: link to the backend
    - Monitoring of vital signs:
      - Heart beat
      - Body temperature
      - Behavior or Activity
    - Key aspect in the design = energy efficiency
      - Knowledge of path loss (PL) ?

Objective

Investigation of on-body, in-to-out and off-body PL in a wireless sensor network for equine monitoring

- **Tasks:**
  - Literature review on candidate WSN technologies, sensor antennas, LoRa technology, etc.
  - Numerical study of PL using state-of-the-art commercial FDTD simulation tool Sim4Life (ZurichMedTech, Switzerland)
    - Design of homogeneous model of a horse
    - Modelling of selected antennas
    - PL investigation for selected WSN technologies

  - Measurements and tests
    - with LoRa sensors and sensor technologies on phantom models
    - Optionally, measurements on real horses
  - Comparison and ranking of different WSN technologies for energy efficieny

gunter.vermeeren@intec.ugent.be

waves
wireless, acoustics, environment & expert systems

UNIVERSITEIT GENT

FACULTEIT INGENIEURSWETENSCHAPPEN EN ARCHITECTUUR

Thesisvoorstel

Characterization of On-Body Radio Propagation in the 60-GHz Band

Promoteren

Prof. Wout Joseph, Prof. Luc Martens

Begeleider

Reza Aminzadeh

waves

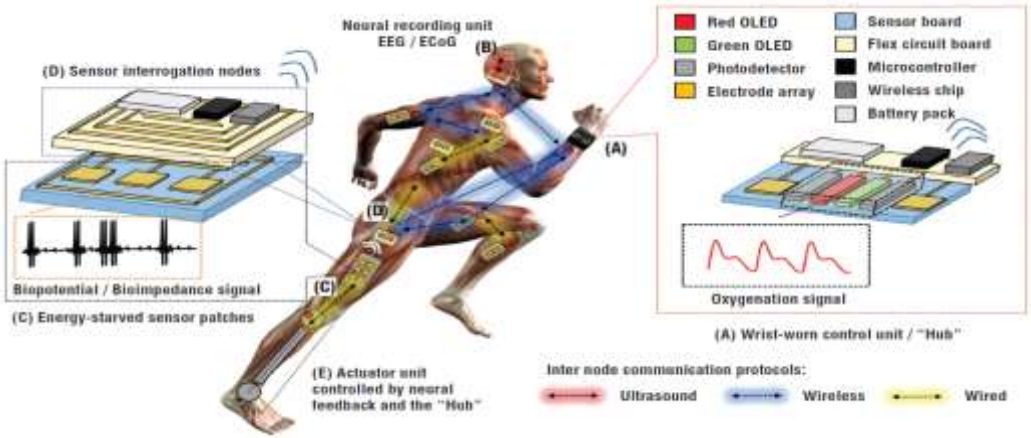
iMinds
CONNECT.INNOVATE.CREATE

Probleemstelling

- 60-GHz wireless communication systems
- Body area networks

- Human body is lossy and is exposed to this radiation

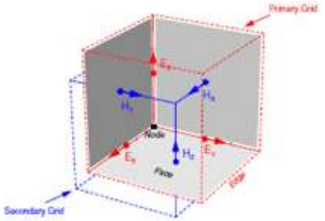
- Efficient design of wearable technologies
- Study on-body propagation in the 60-GHz band

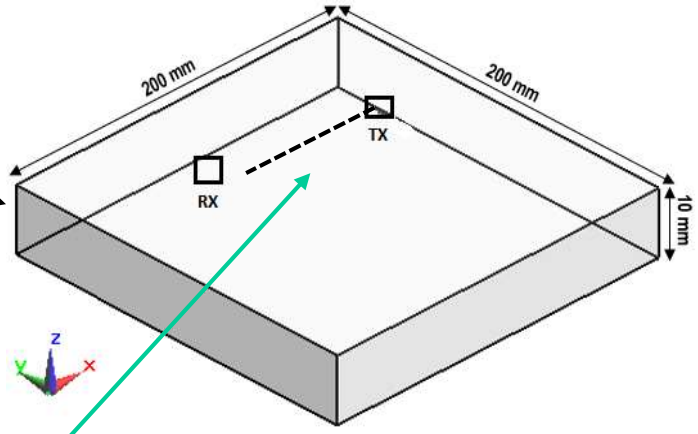


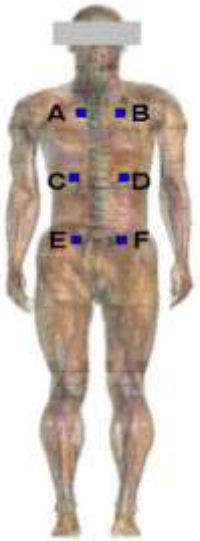
TASKS

- Study of 60 GHz propagation along (on the surface of) the human body
- Goal:
  - Understanding the effect of body morphology on 60 GHz radio propagation
- Computational study

FDTD







- Measurements and validation
  - Using at least two antennas as the transmitter and the receiver on body (different height, distance)
  - Measurement of channel parameters (for example: path gain)

Medische toepassingen

UNIVERSITEIT GENT

FACULTY OF ENGINEERING

Master Thesis 2016 - 2017

Stimulation of neural population for auricular vagus nerve stimulation

Supervisors

Prof. Wout Joseph

Mentors

Amine Samoudi, Emmeric Tanghe

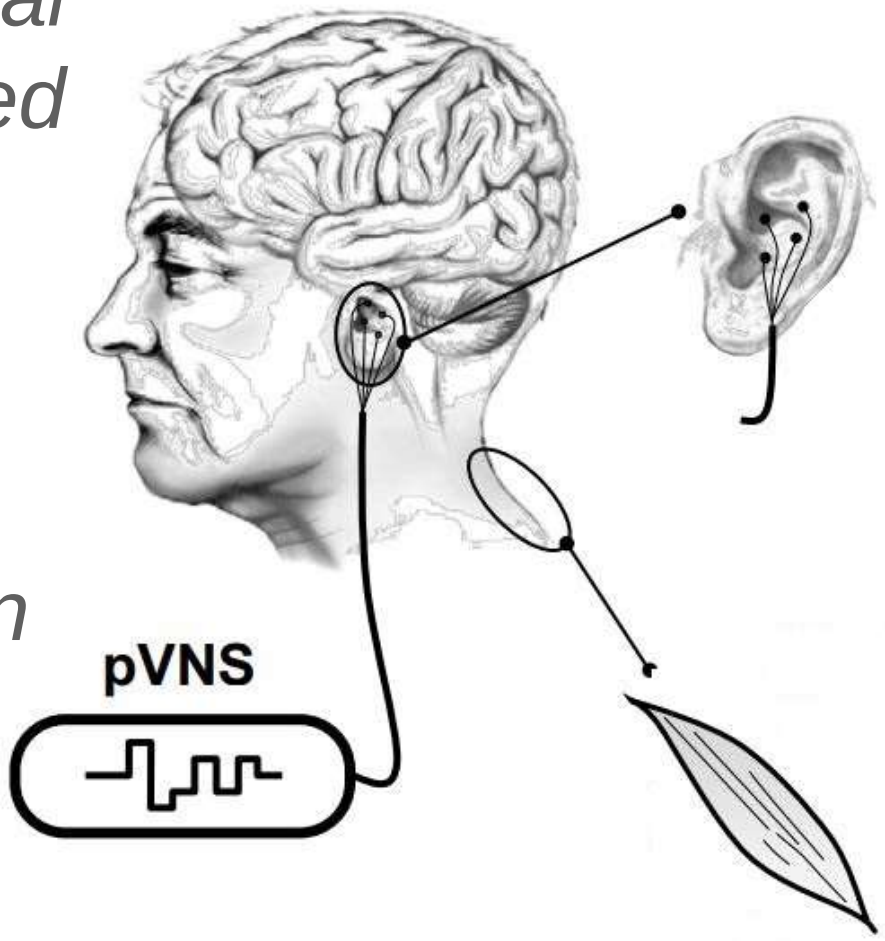
Contact

amine.samoudi@intec.ugent.be

waves

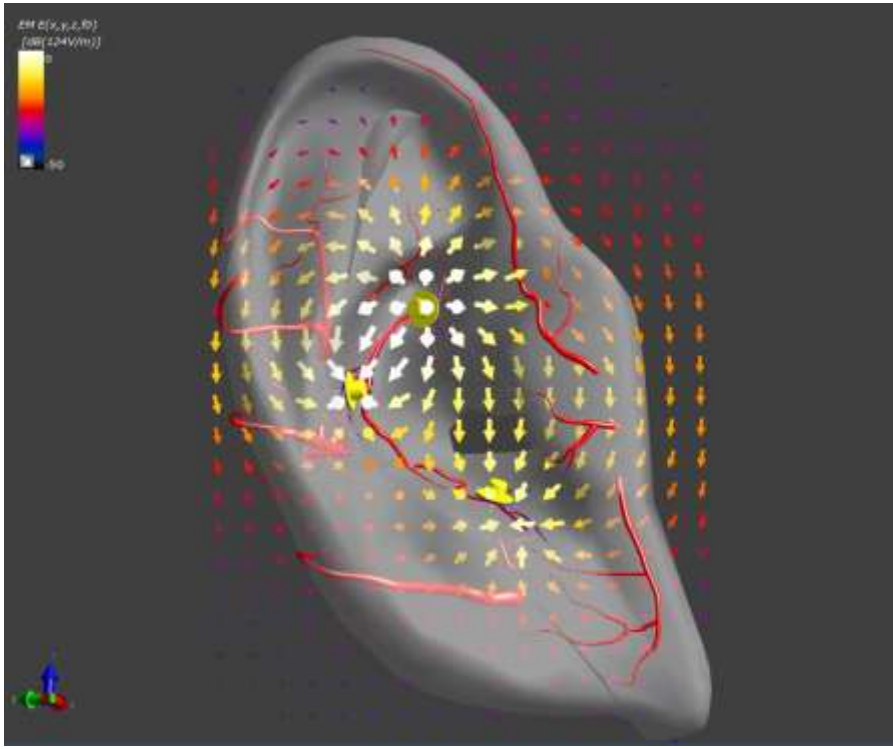
iMinds
CONNECT.INNOVATE.CREATE

- *Stimulation of the cervical vagus nerve by implanted devices: treatment for epilepsy, major depression,…*
- *Auricular Branch of the Vagus Nerve Stimulation => minimally-invasive way of neuromodulative intervention*



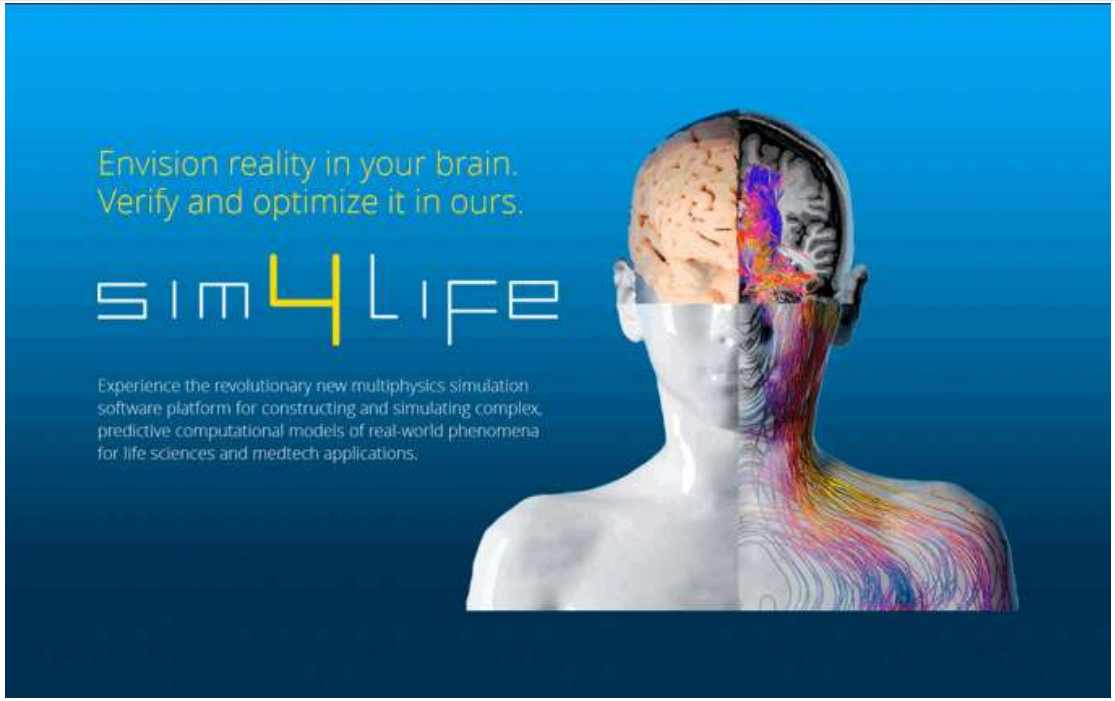
Purpose

1. *Model and simulate the neural population in the ear based on single nerve positions*
2. *Simulate the neural population stimulation with a map of percentage of stimulated neurons.*
3. *Optimize the stimulation pattern (position of the electrodes, electrode depth inside the ear, pulse design) to perform maximum percentage of targeted stimulated nerves.*



Simulation platform

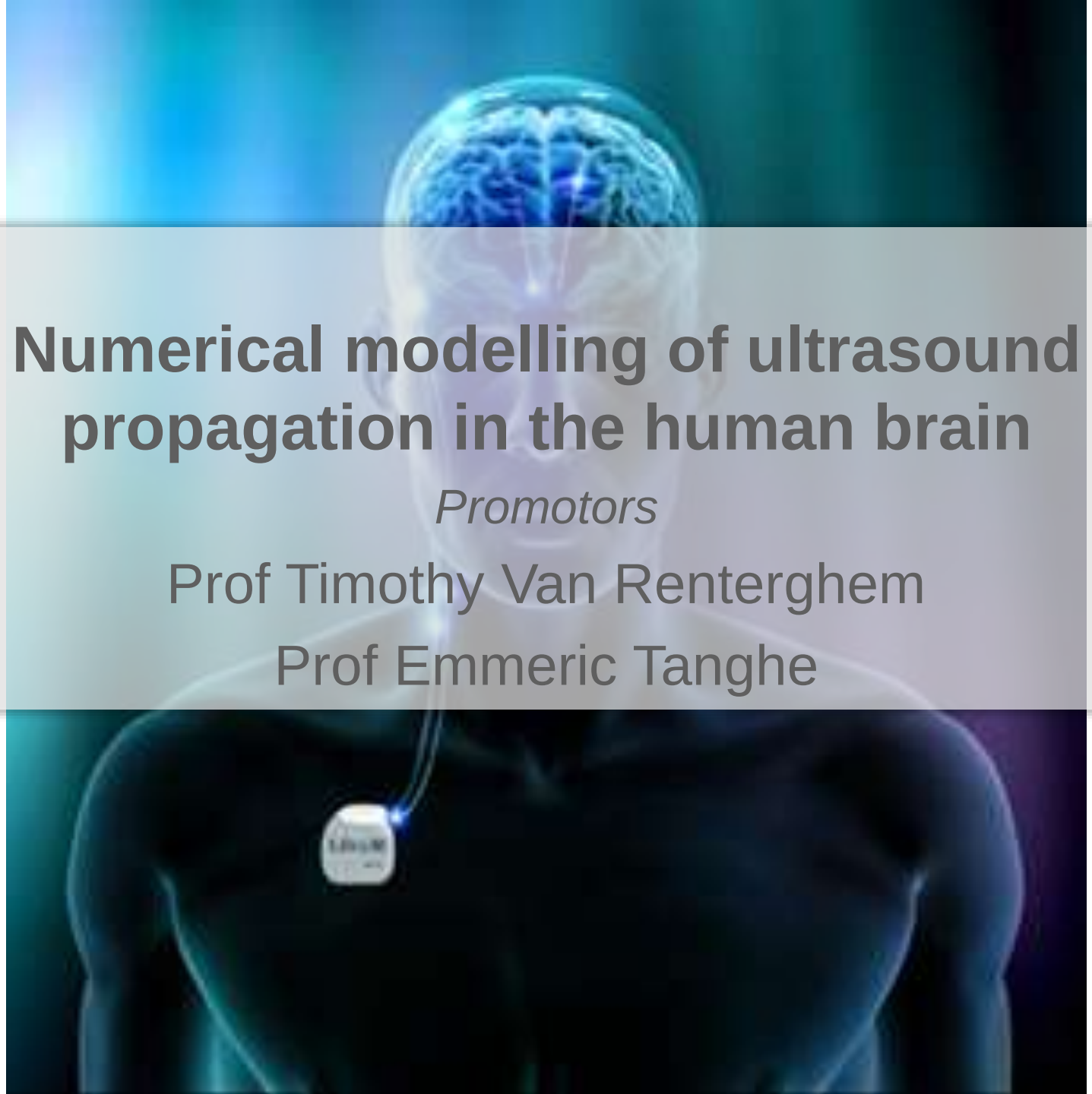
3D Electromagnetic solvers



Low frequency solver

Neuronal solver

amine.samoudi@intec.ugent.be



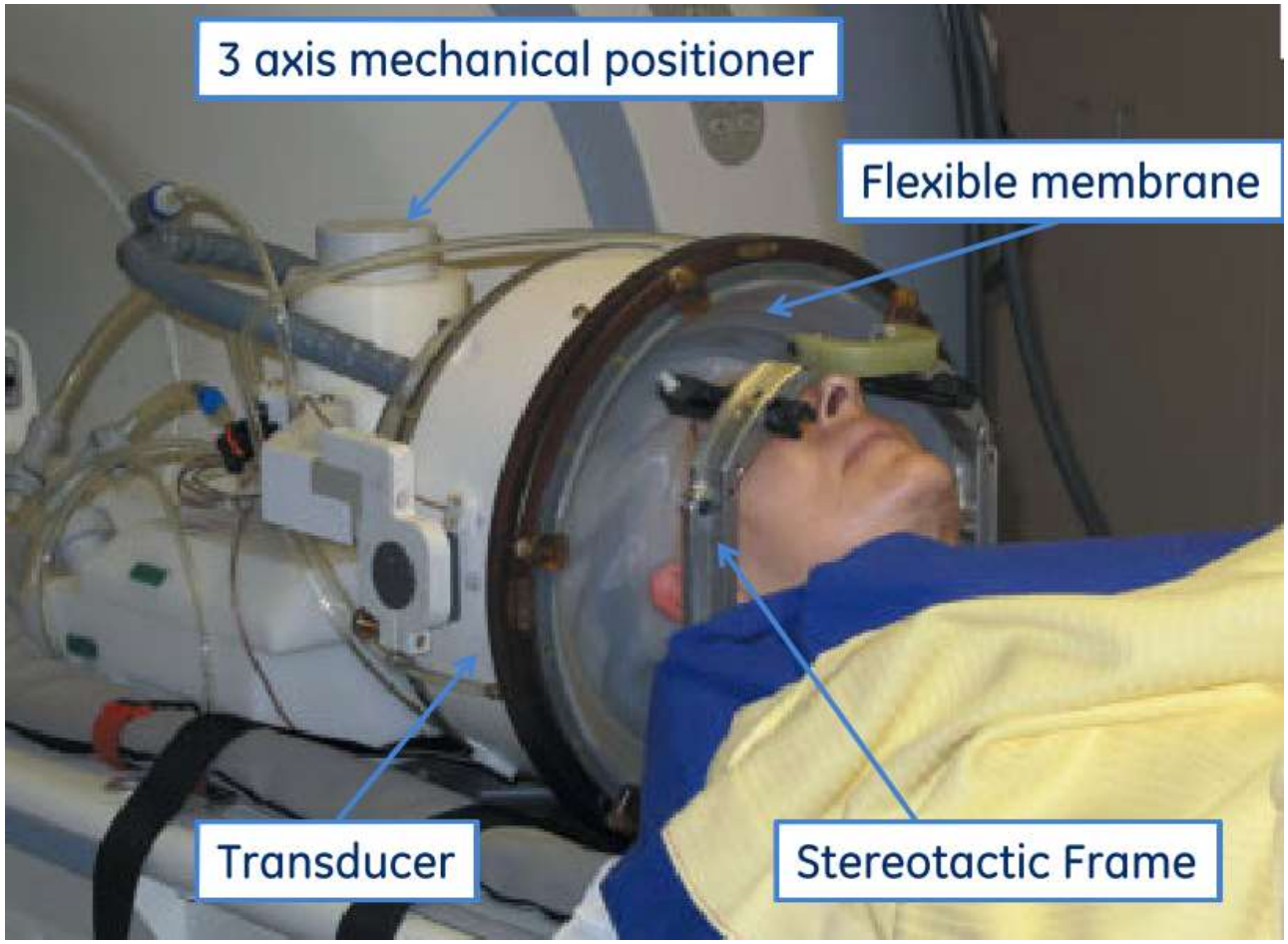
Numerical modelling of ultrasound propagation in the human brain

Promotors

Prof Timothy Van Renterghem

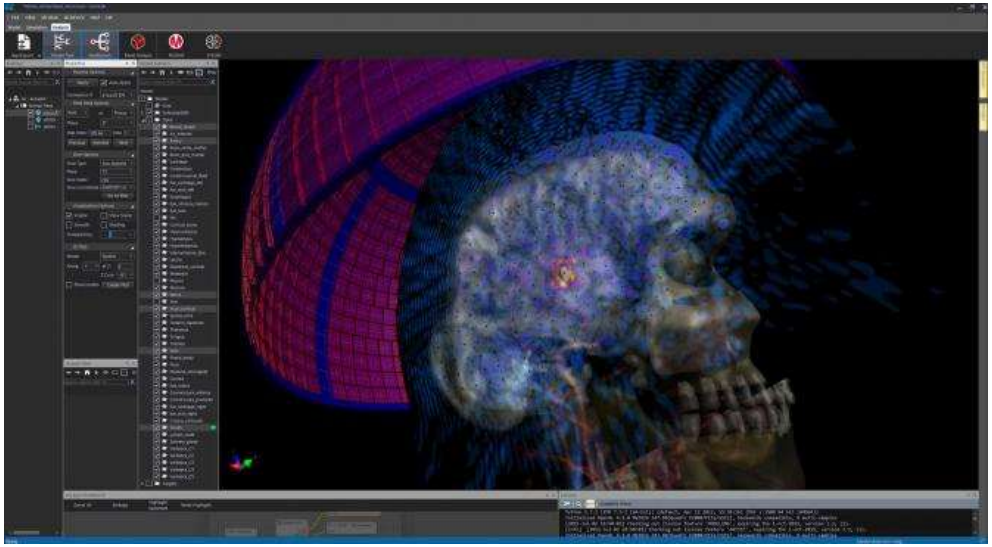
Prof Emmeric Tanghe

- **Low-intensity focused ultrasound (LiFUS)**
  - neuromodulation for treatment of neurological disorders



Methodology

1) **FDTD simulations of US propagation in the brain**
   - in Sim4Life software
2) **Simulations of the neuron electrodynamics during US stimulation**
   - with in-house Matlab code (modifications needed)
3) **Design of US transducer array and stimulation signal**
   - the goal is to target the deep brain



Blootstelling aan elektromagnetische velden

UNIVERSITEIT GENT

FACULTY OF ENGINEERING

Master Thesis 2016 - 2017

Dosimetry of transcranial magnetic stimulation devices for patients and clinical staffs

Supervisors

Prof. Wout Joseph, Prof. Luc Martens

Mentors

Amine Samoudi, Günter Vermeeren

Contact

amine.samoudi@intec.ugent.be

waves

iMinds
CONNECT.INNOVATE.CREATE

Transcranial magnetic stimulation (TMS): technique for noninvasive stimulation of the human brain

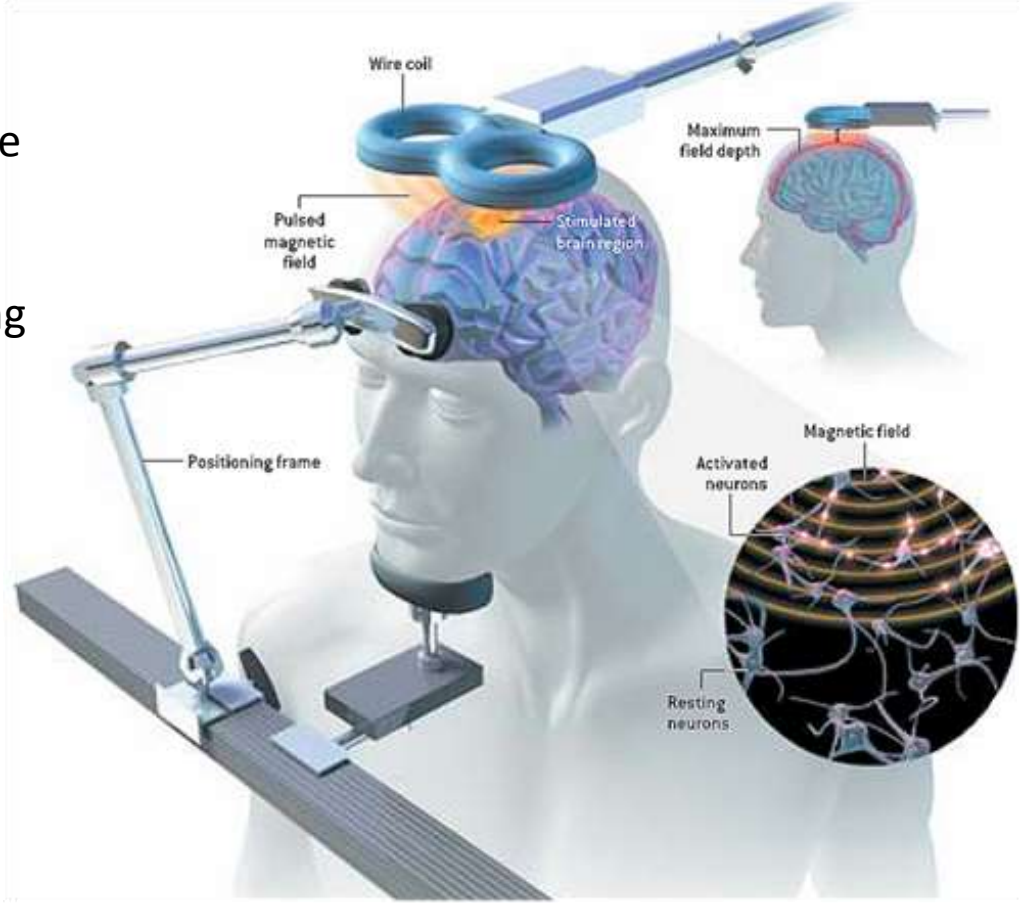
Exposure of the human body to time-varying magnetic fields

↓

Induction of internal body currents

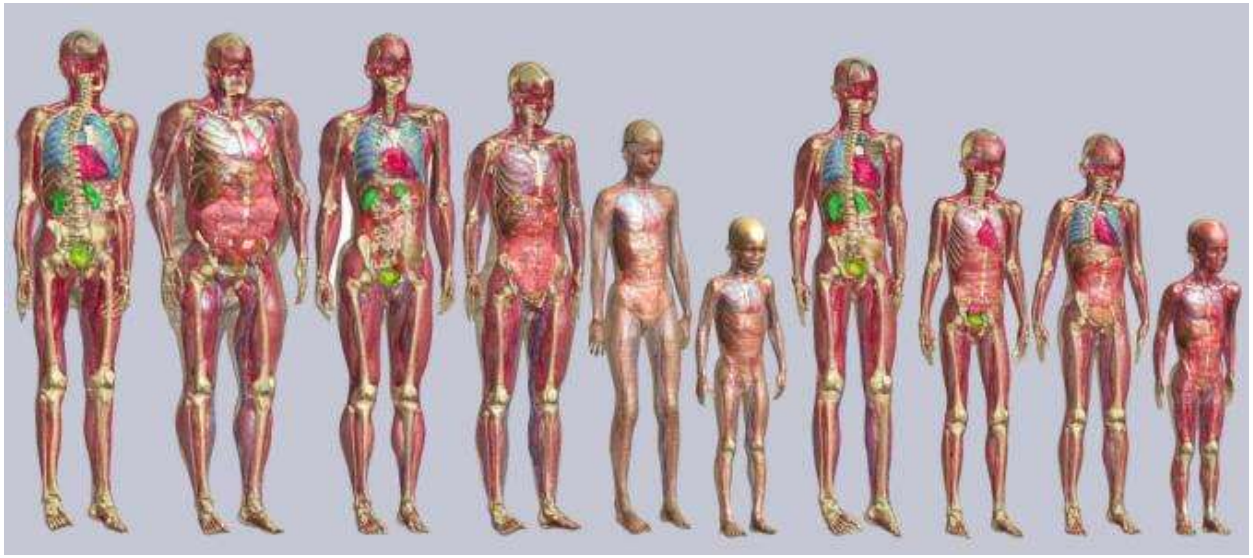
↓

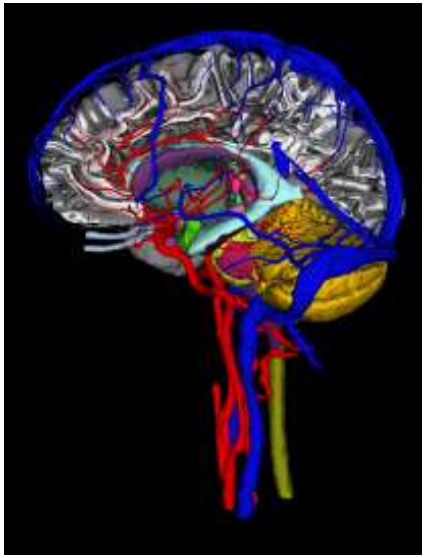
Health problems



Purpose

1. Design and simulate TMS coil
2. Calculate the induced electro-magnetic field in head model functionalized for EM-Neuron simulations
3. Determine exposure of patients and workers exposed to TMS devices

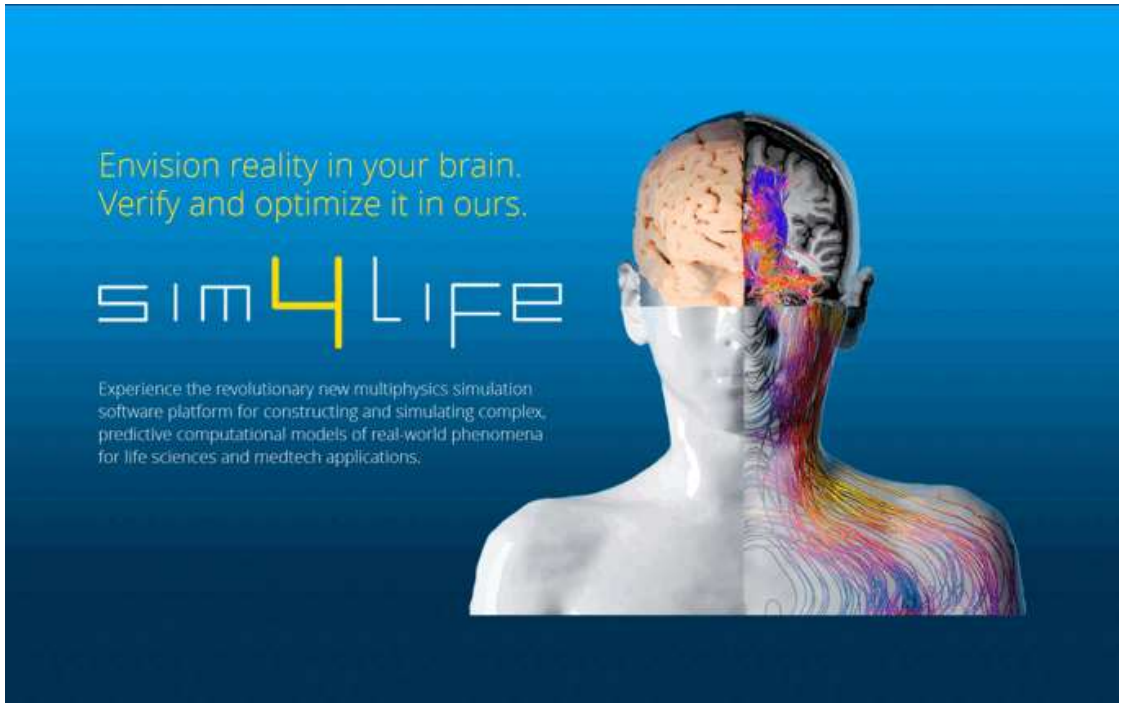




Master thesis on MR dosimetry of TMS

Method

3D Electromagnetic and Neuronal Solvers



WAVES

amine.samoudi@intec.ugent.be

UNIVERSITEIT GENT

FACULTY OF ENGINEERING AND ARCHITECTURE

Thesisvoorstel

Design of a Radio Frequency Personal Exposimeter for FM Band

Promoteren

Prof. Wout Joseph, Prof. Luc Martens

Begeleiders

Reza Aminzadeh, Arno Thielens

waves

iMinds
CONNECT.INNOVATE.CREATE

Probleemstelling

Large Measurement Uncertainty

- Personal exposimeters (PEMs)
- People are exposed to radio-frequency electromagnetic fields (FM radio)

Underestimation of the actual exposure

- Location of PEMs on body → measurement variation
- PEMs are calibrated in free space while they are used on body

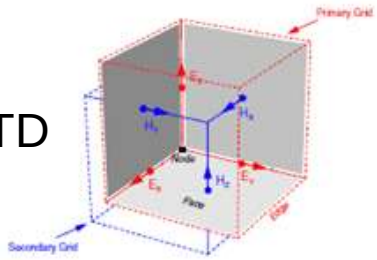
OBJECTIVE

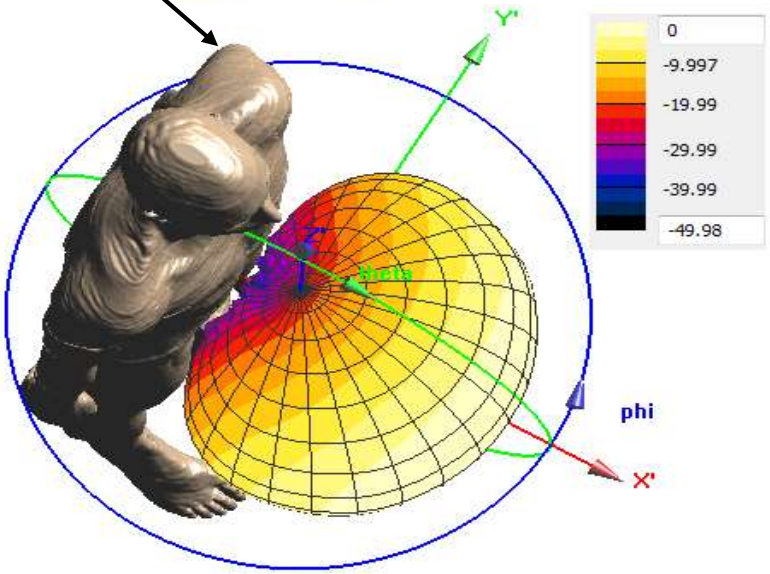
- Design a personal exposimeter for FM band (87.5-108 MHz)
- Investigation whether the designed exposimeter can estimate the actual exposure in FM-band
- Application in real indoor environment

TASKS

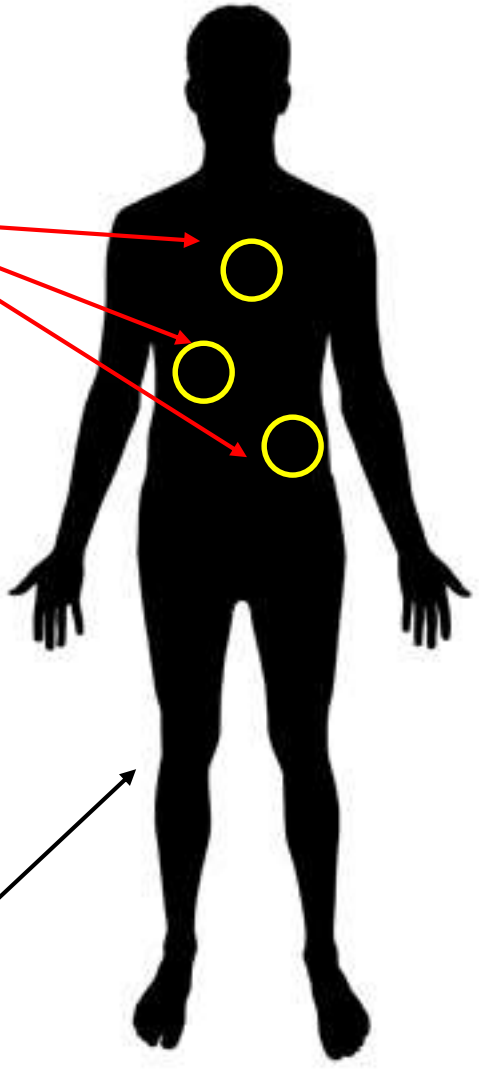
- Numerical simulations

FDTD





Antenna(s)



- On-body calibration of the designed exposimeter
- Measurements in real (indoor, outdoor) environments

Thesisvoorstel

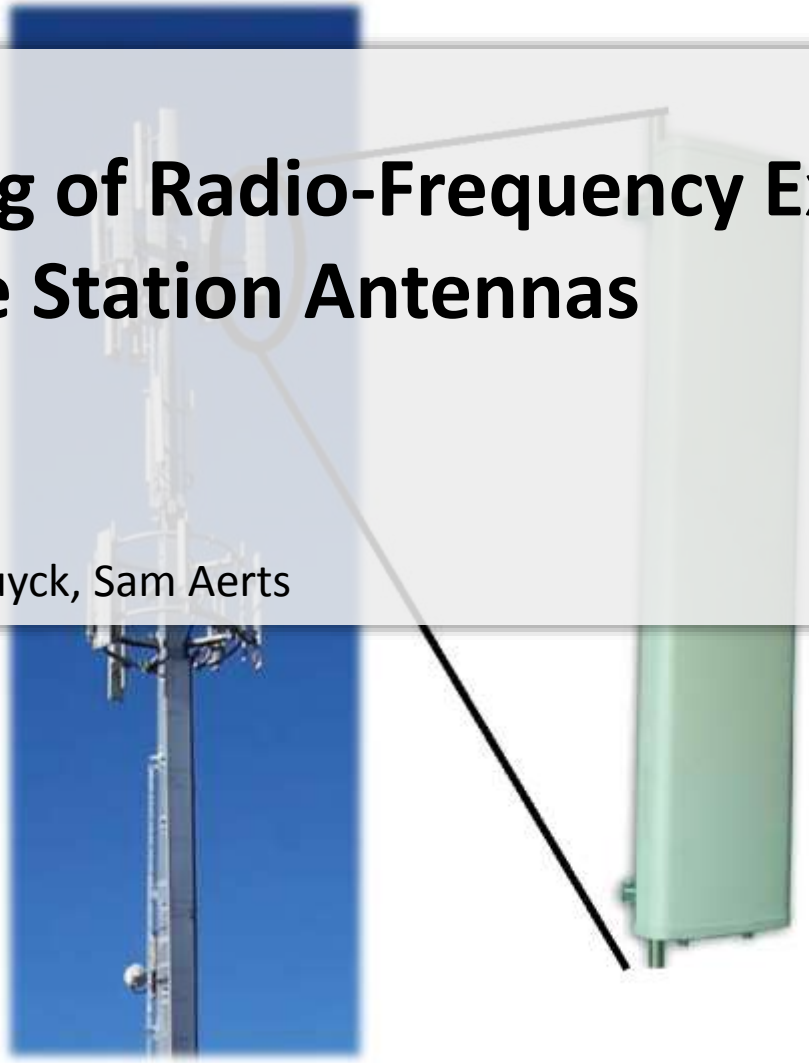
Spatial mapping of Radio-Frequency Exposure Caused by Base Station Antennas

Promotoren

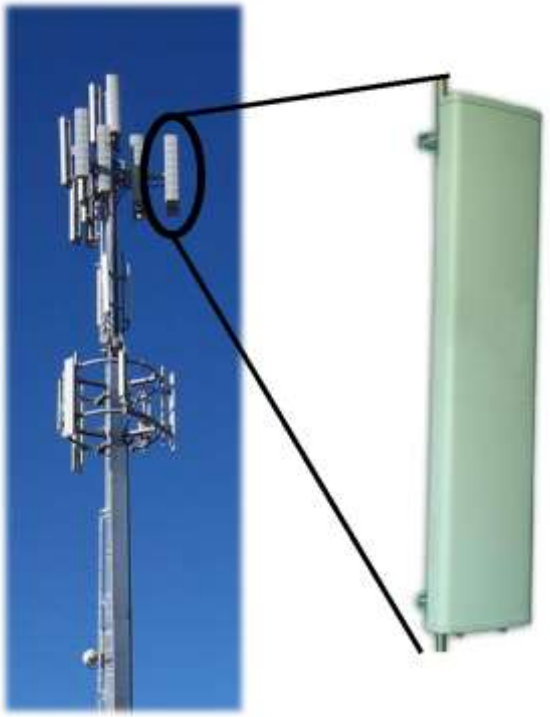
Prof Wout Joseph

Begeleiders

Arno Thielens, Margot Deruyck, Sam Aerts



Probleemstelling



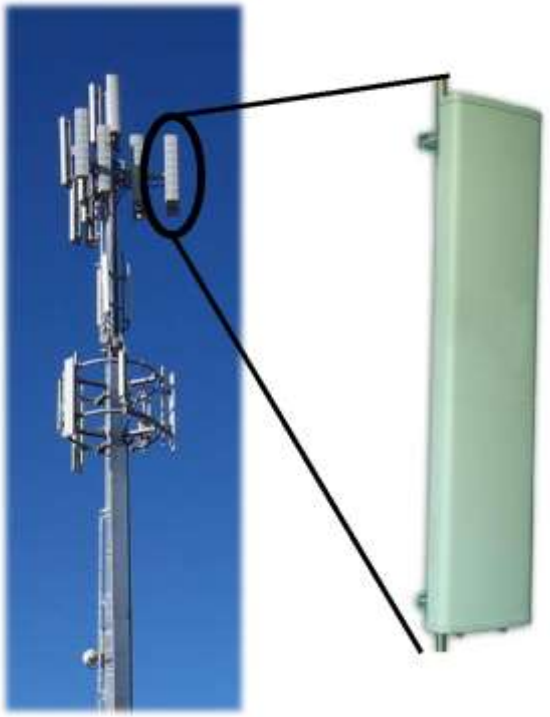
- **Base station antennas**

  ↓

  People are **exposed** to this radiation

- Exposure can be **measured** using **RF probes** or **personal exposimeters**

Probleemstelling



- **Base station antennas** emit Radio-Frequency (RF) radiation

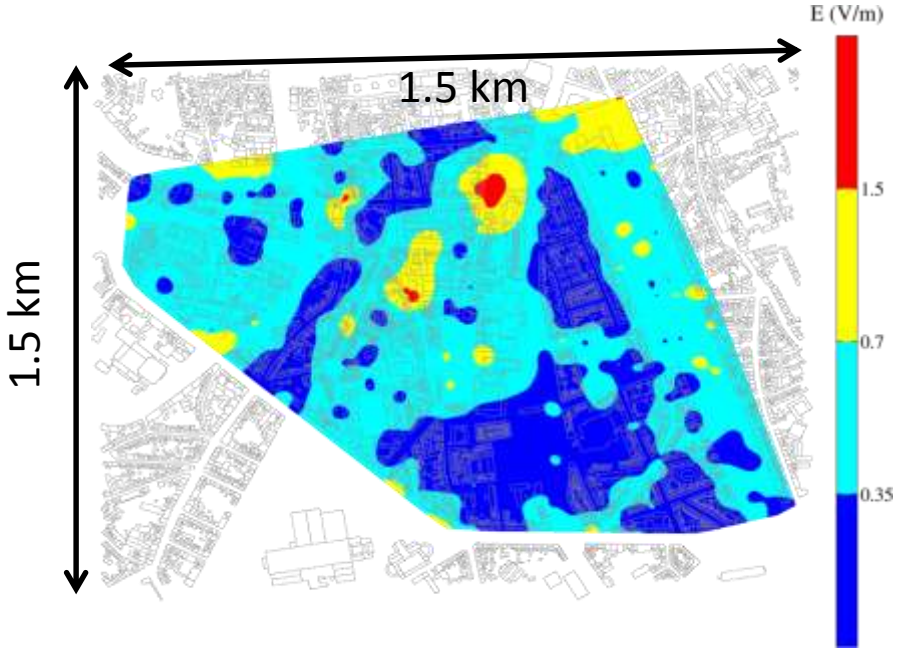
  ↓

  People are **exposed** to this radiation

- Exposure can be **measured** using **RF probes** or **personal exposimeters**

  ↓

  These measurements can be used to make **exposure maps**

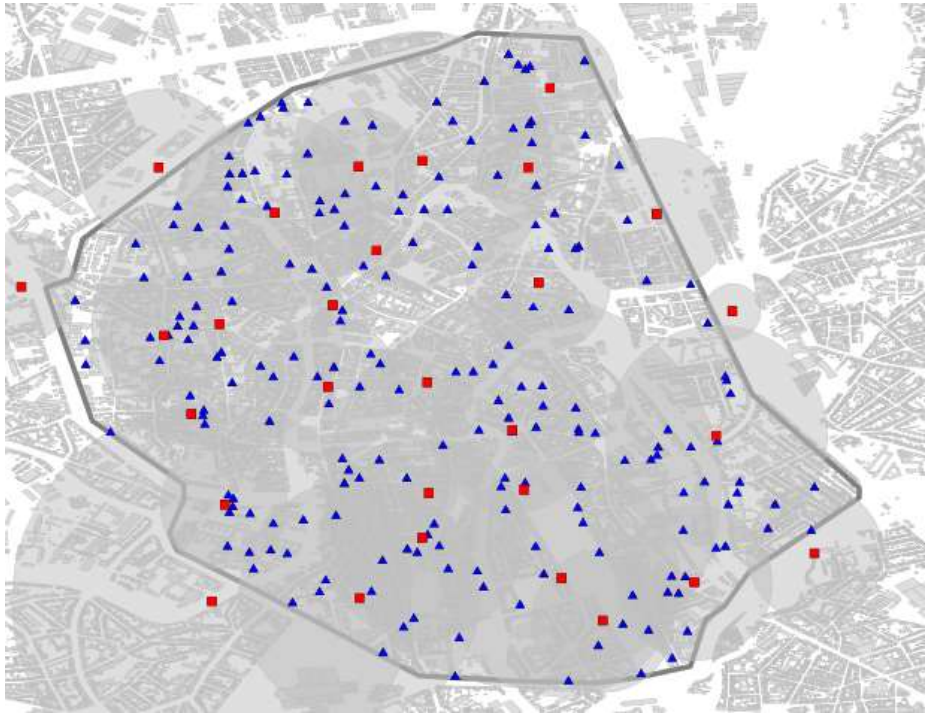


Measuring a large area is:

- **Time-consuming**
- **Expensive**

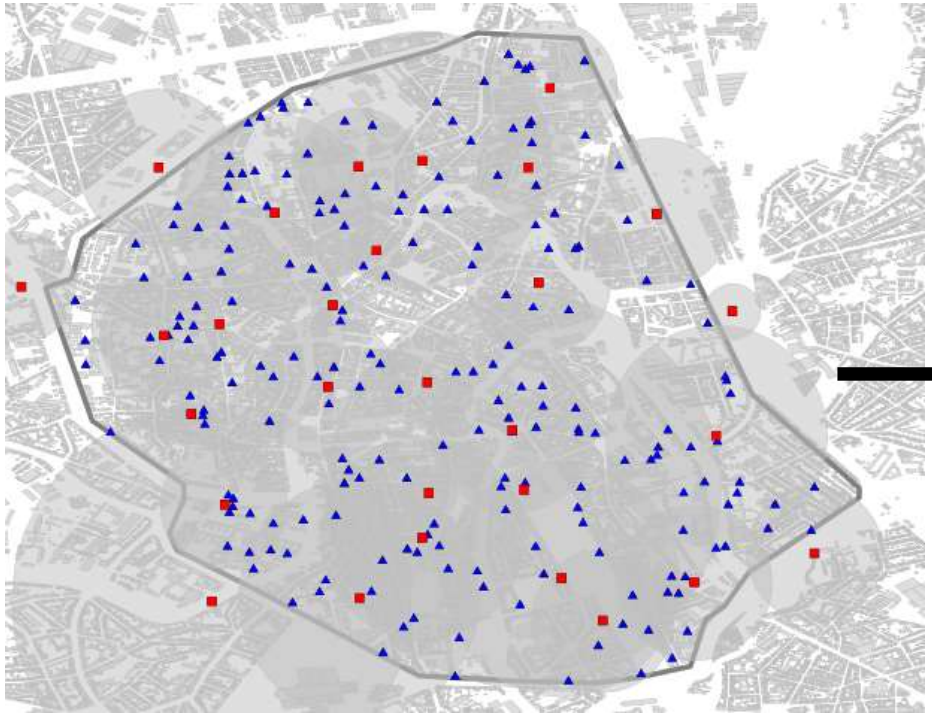
Alternative?

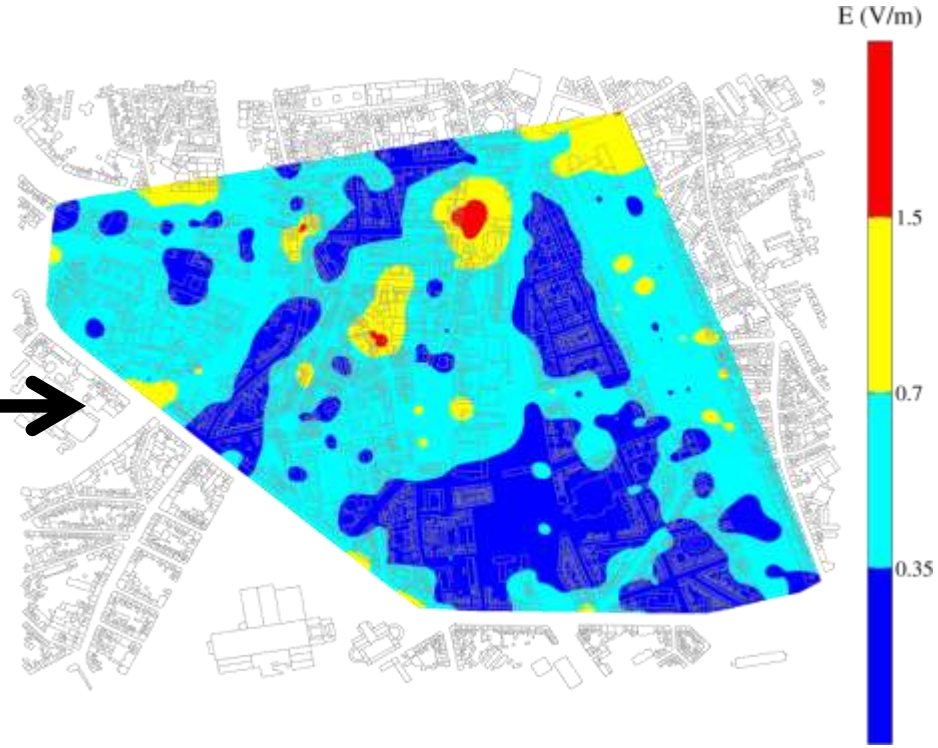
If we know the **location** of all base station antennas?



Alternative?

If we know the **location** of all base station antennas?

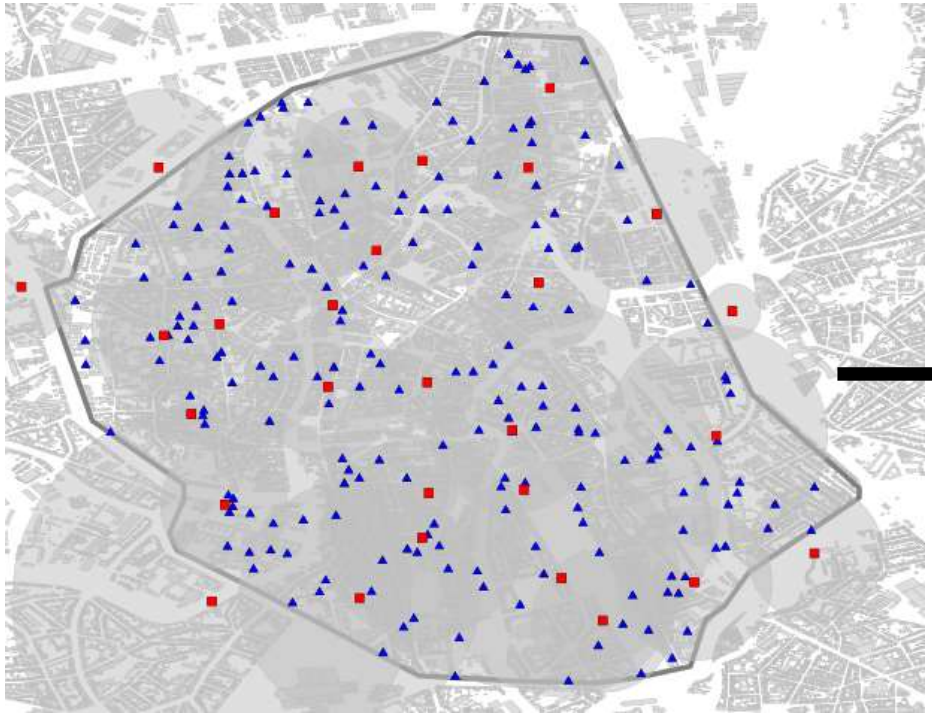


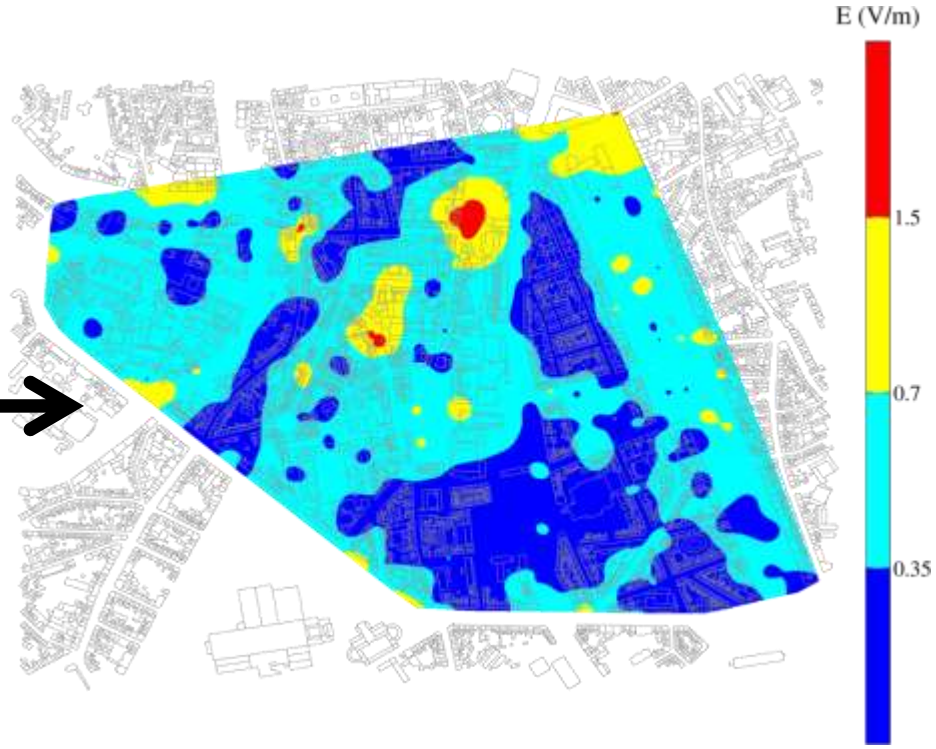


Could we then **simulate** this exposure?

Tasks

Locations of base station antennas in Ghent (Flanders) are known





1. Implement algorithm of **propagation** of RF radiation in tool
2. Translate the result of this propagation into **personal exposure**
3. Validate the results (the exposure map) with **measurements** (the alternative)

Thesisvoorstel

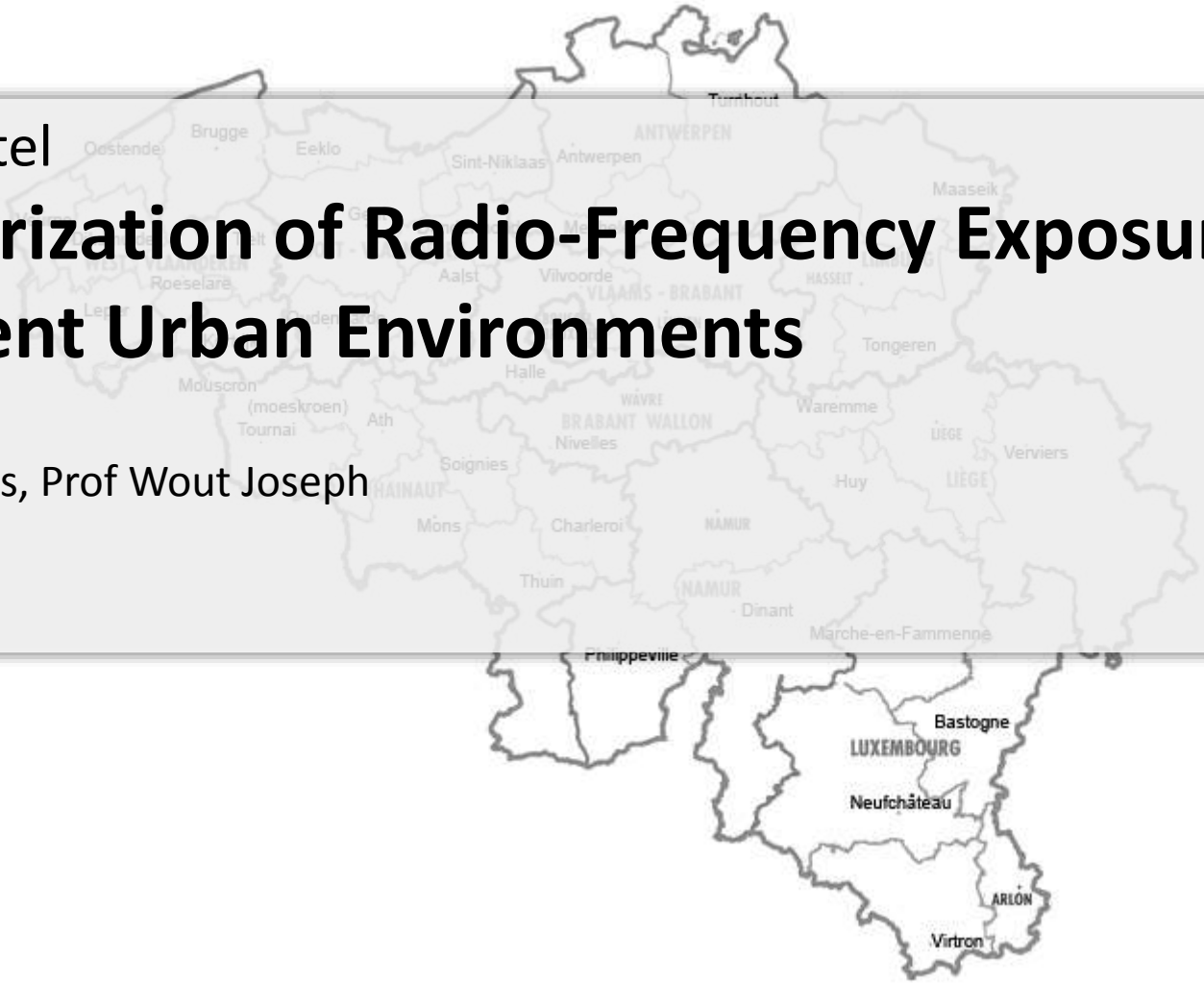
Characterization of Radio-Frequency Exposure Levels in Different Urban Environments

Promotoren

Prof Luc Martens, Prof Wout Joseph

Begeleider

Arno Thielens



Problem

Flanders

f (MHz)	Cumulative Norm (W/m^2)	Residential[1] (W/m^2)
10-400	0.50	0.011
400-2 x 10^3	0.0012 x f	2.7 x 10^{-5} x f
2 x 10^3-10 x 10^3	2.5	0.053

[1]Residential, maximum per antenna

Different Regulations

Does this lead to differences in exposure?

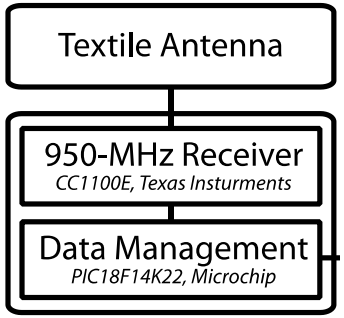
Brussels

f (MHz)	Norm (W/m^2)
10-400	0.043
400-2 x 10^3	1.1 x 10^{-4} x f
2 x 10^3-10 x 10^3	0.22

Method

Measurements of **personal exposure** using a **new measurement device**

4 x



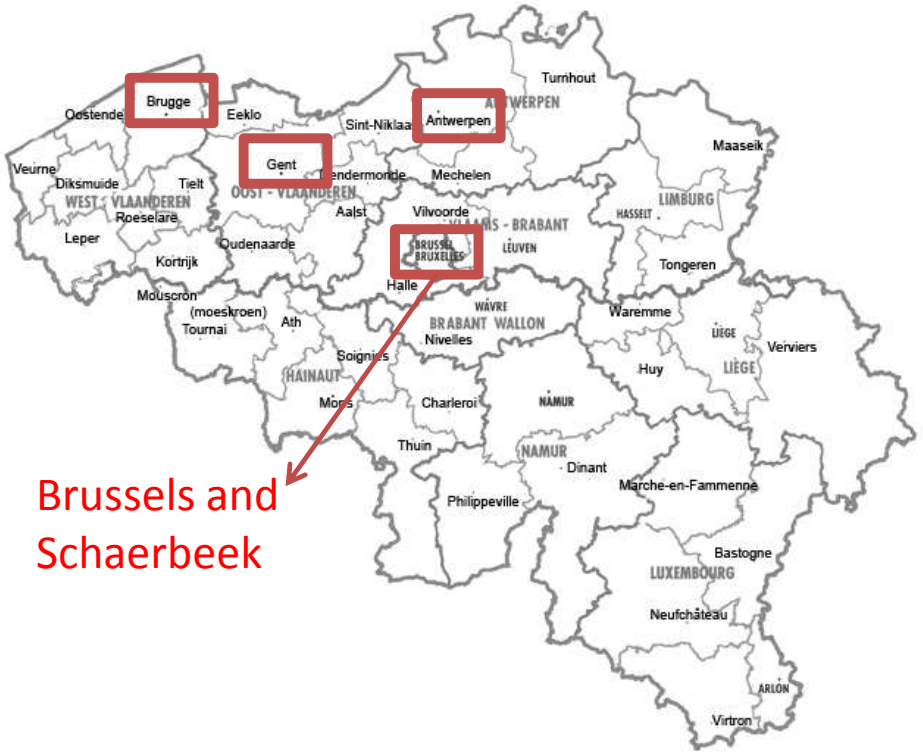
© Ralph Lauren

Method

Measurements in **different micro-environments**

Type of micro-environment	urban*
<u>outdoor areas</u>	
downtown area	2
business area	2
shopping area	2
residential area	2
<u>public places</u>	
railway station	2
bus station	2
university	2
<u>transportation mode</u>	
train	2
bus	2
metro/tram	2
car	2
Total N	**22**

* Antwerp, Ghent, Bruges, Brussels, and Schaerbeek



Comparison of five cities in Flanders and Brussels

Spatiotemporal modelling of environmental exposure to radiofrequency electromagnetic fields

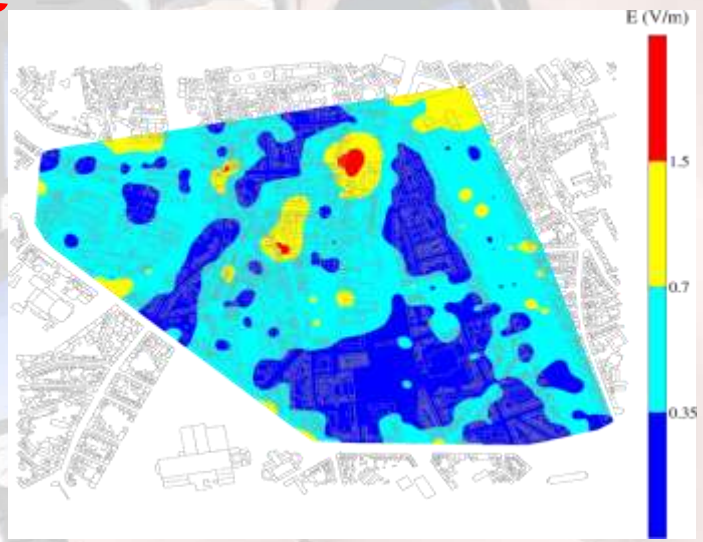
Promotoren: prof. Luc Martens, prof. Wout Joseph
Begeleider: Sam Aerts (*sam.aerts@intec.ugent.be*)

Background

Continue blootstelling aan radiofrequente (RF) elektro-magnetische straling (GSM, UMTS, LTE, Wi-Fi, FM, ...)

? Waar hoeveel ?

Nood aan informatie



In kaart brengen van elektromagnetische straling

➢Moeilijk in real-life: (bewegende) obstakels, interferentie, …

•Simulaties, maar veel nauwkeurige info nodig

•Interpolatie, maar veel tijdrovende metingen nodig

Land-use-regression

Land-use regression (LUR) = techniek die *in-situ* **metingen** combineert met *predictor variabelen* uit **geografische informatie** om tot een blootstellingsmodel te komen.

$$B(x,y,t) = a * m(x,y,t) + b * p(x,y) + c$$

met **B(x,y,t) = blootstelling** op plaats (x,y) en tijdstip t, **m(x,y,t) = meting** op plaats (x,y) op tijdstip t, **p(x,y)** de **predictor-waarde** op plaats (x,y), en a, b, en c constanten.

Wordt **veel gebruikt in *environmental exposure modeling***, maar nog nooit voor blootstelling aan RF-EMF.

Goal

1. Opzoeken van de locatie & **properties van basisstations** in Gent (http://www.sites.bipt.be/) en opslaan in een **Geographical Information System (GIS)**. (Al deels gedaan in vorig onderzoek.)
2. **Meten van de radiofrequente straling in een stratengrid in Gent.** De metingen zullen enkele malen herhaald worden op verschillende tijdstippen om **temporele trends in de blootstelling** vast te stellen.
3. Verwerken van de data met een statistical software package (*R* of *SPSS*) in **een *land use regression model* van de RF blootstelling**.
4. **Valideren van het finale model** met onafhankelijke metingen en data, en vergelijken van de resultaten met bestaande technieken.

Thesisvoorstel

Studie van de absorptie veroorzaakt door de straling van poorten voor elektronische artikelbeveiliging

Promotoren

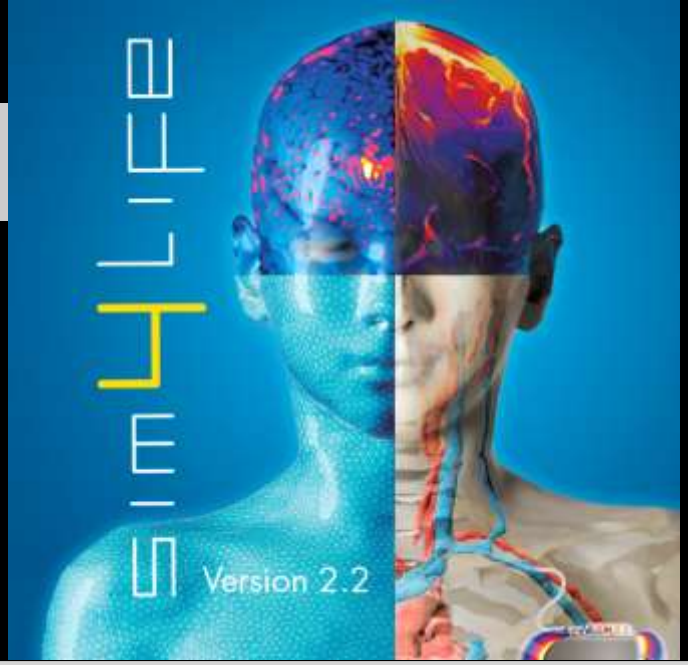
Prof Luc Martens, Prof Wout Joseph

Begeleider

Günter Vermeeren


Referentie niveaus soms overschreden
Doelstelling: Voldaan aan basisrestricties?

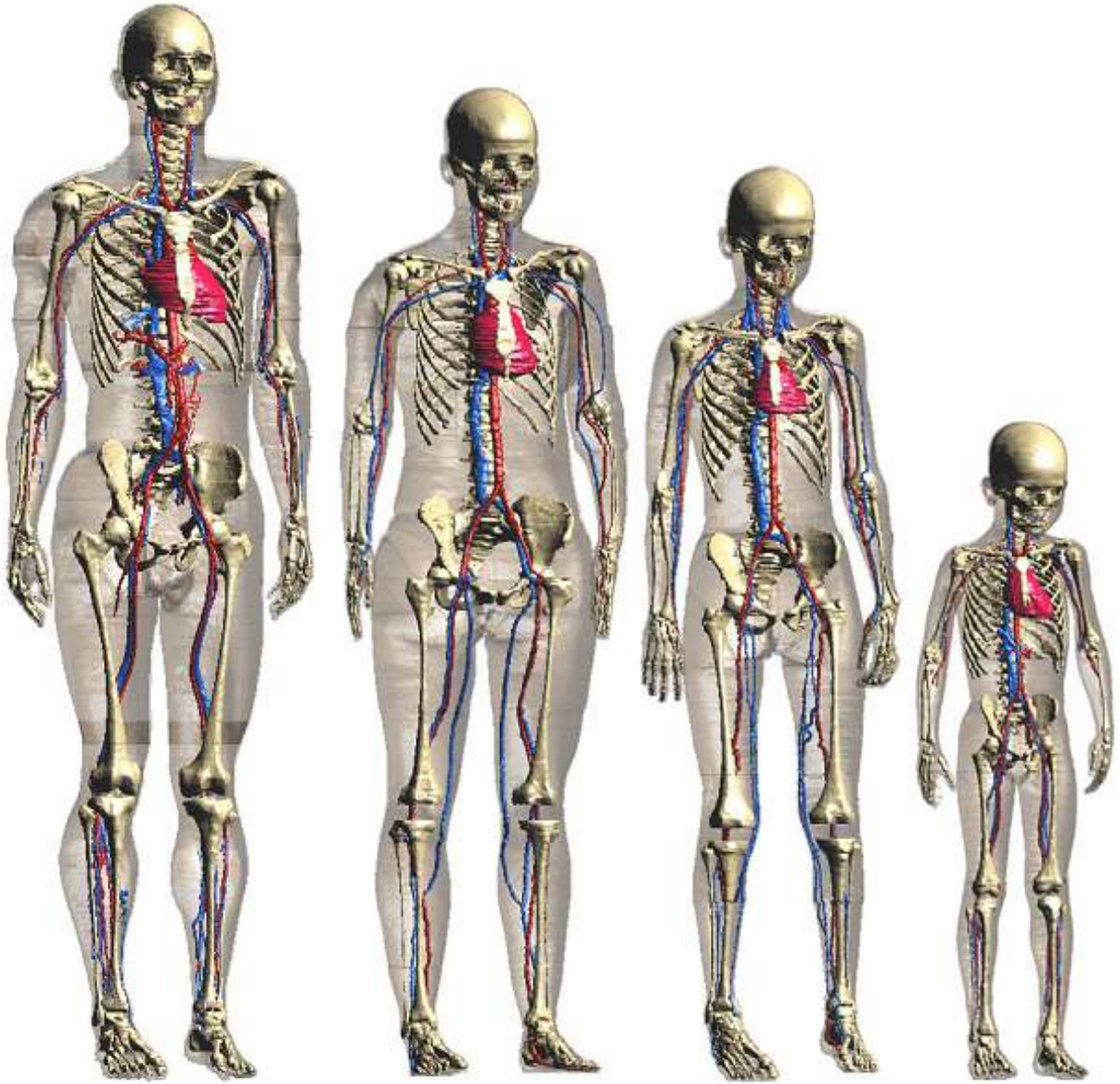
FDTD tool



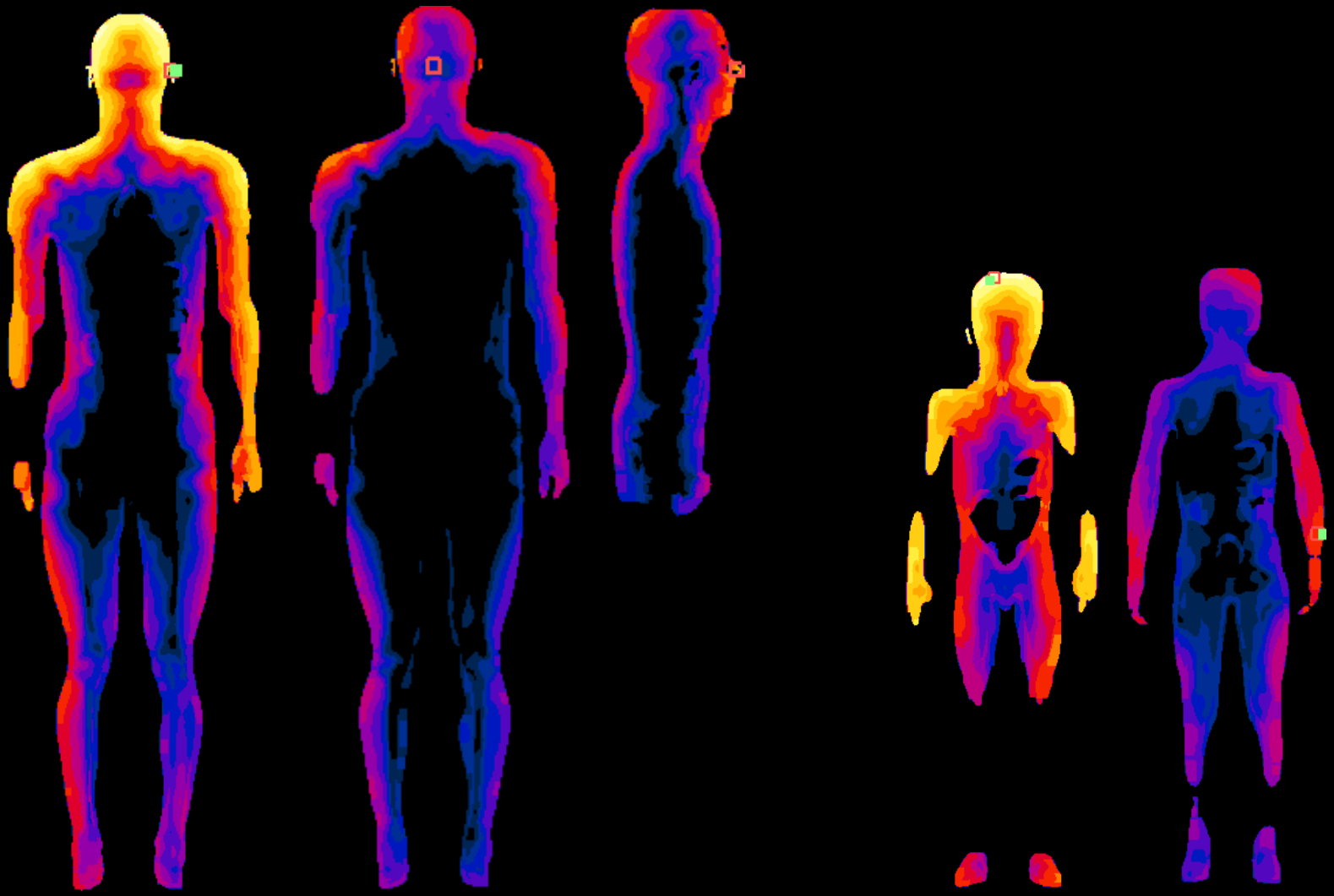
3D electromagnetic solvers

FEKO
Comprehensive Electromagnetic Solutions

Hybrid MoM/ FEM tool



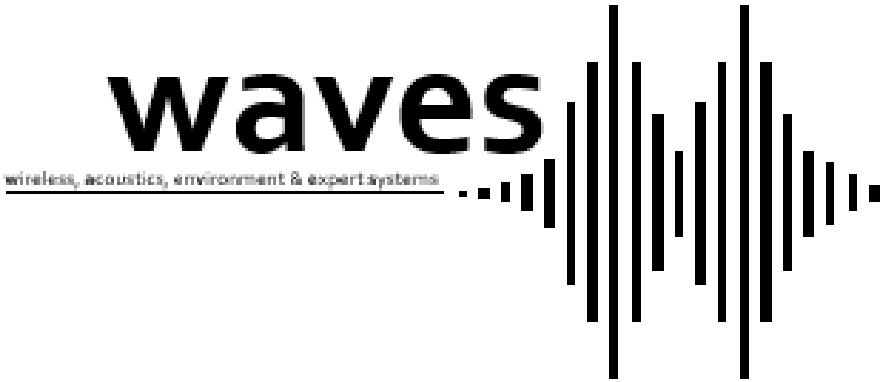
Virtual Family models



EM absorptie in lichaam

gunter.vermeeren@intec.ugent.be

waves
wireless, acoustics, environment & expert systems



http://www.waves.intec.ugent.be