FACULTY OF ENGINEERING AND ARCHITECTURE

EFFECTS ON WILDLIFE (FLORA AND FAUNA) OF 5TH GENERATION WIRELESS COMMUNICATION

A Literature Review of Effects of Radio-Frequency Electromagnetic Field Exposure of Non-Human Vertebrates, Invertebrates, and Plants

Arno Thielens (31/05/2021)

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE

Antenna

RF Electromagnetic Fields

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE

Antenna

RF Electromagnetic Fields

GHENT UNIVERSITY

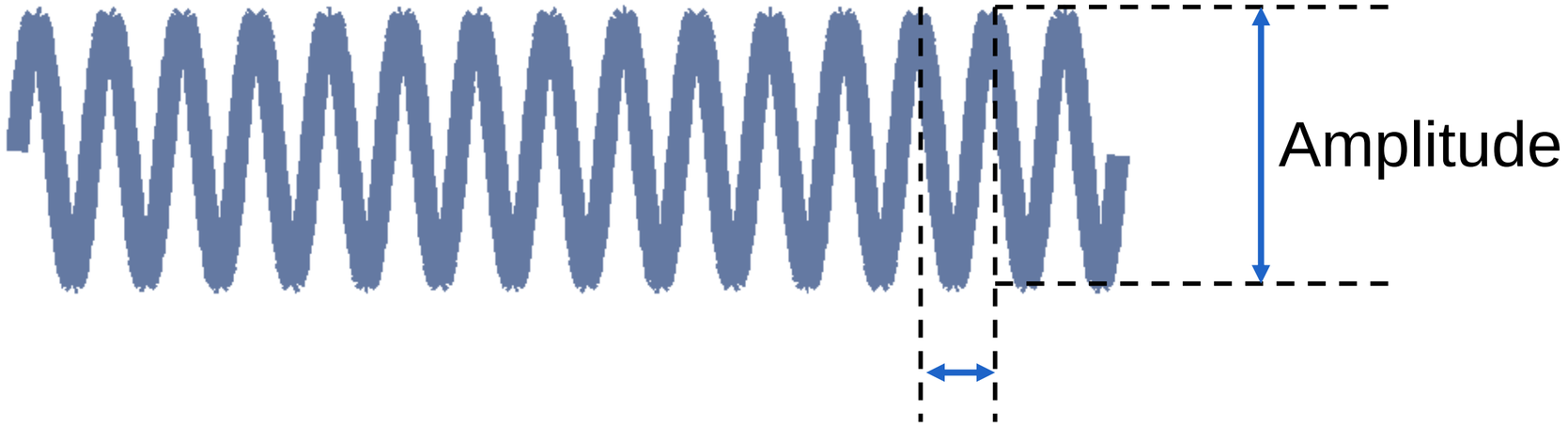
imec

Arno Thielens, contact: arno.thielens@ugent.be

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE

Antenna

RF Electromagnetic Fields



Arno Thielens, contact: arno.thielens@ugent.be

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE

Antenna

RF Electromagnetic Fields

Exposed Organism

GHENT UNIVERSITY

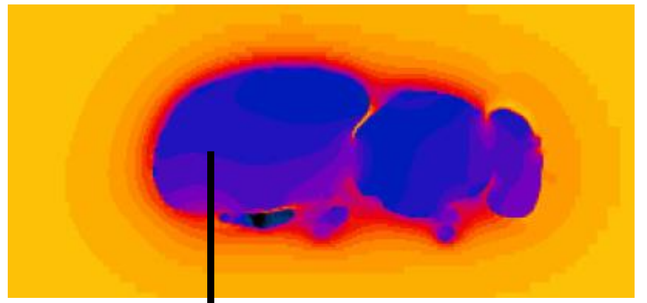
imec

Arno Thielens, contact: arno.thielens@ugent.be

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE

Antenna

RF Electromagnetic Fields



Part of these fields can penetrate the organism

- Field absorption
- Biological Effects

0 dB

-50 dB

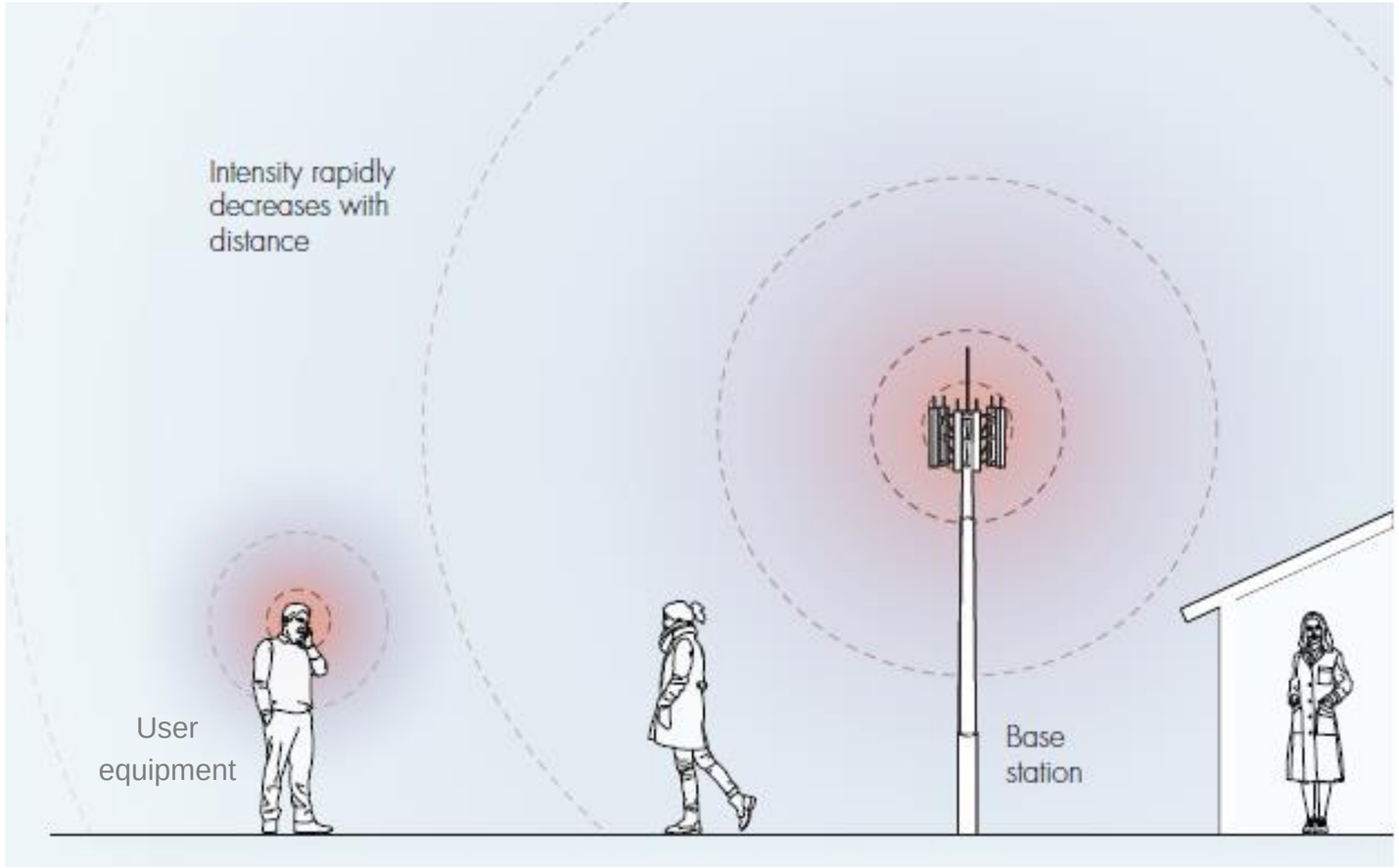
$$20\ log_{10}(\frac{E}{E_{max}})$$

GHENT UNIVERSITY

imec

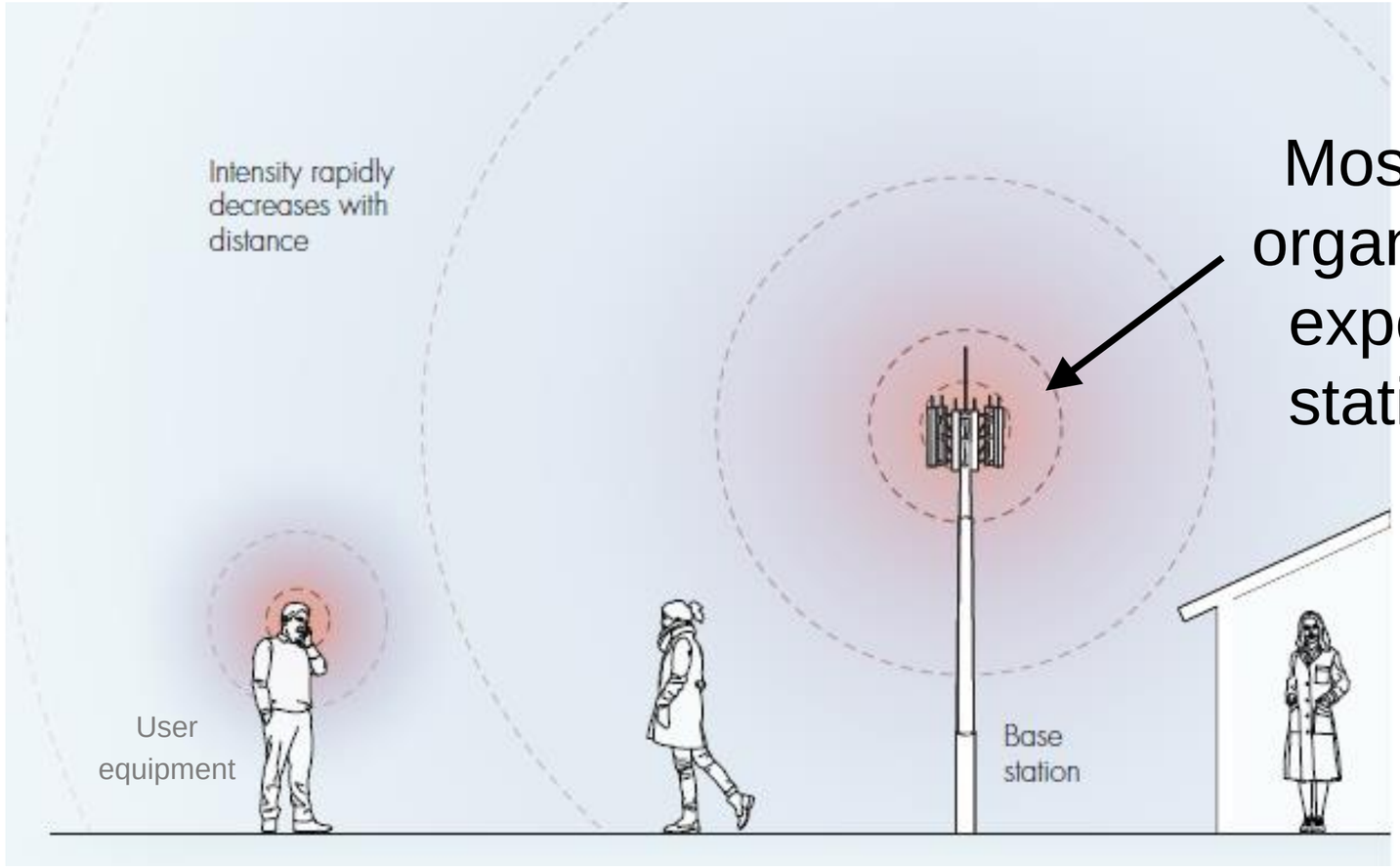
Arno Thielens, contact: arno.thielens@ugent.be

RF-EMF EXPOSURE IN TELECOMMUNICATION NETWORKS



Source: Chiaraviglio et al.," Health Risks Associated with 5G Exposure: A View from the Communications Engineering Perspective",arXiv:2006.00944

RF-EMF EXPOSURE IN TELECOMMUNICATION NETWORKS



Most non-human organisms are only exposed to base station antennas

Source: Chiaraviglio et al.," Health Risks Associated with 5G Exposure: A View from the Communications Engineering Perspective",arXiv:2006.00944

UPCOMING CHANGES IN TELECOMMUNICATION NETWORKS

- Current Telecommunication networks operate mainly between 0.45 – 6 GHz

- Telecommunication networks are updated with new generations

→ 5th generation (5G)

  - Set of new frequencies of operation:
    - 694 - 790 MHz
    - 3.4 - 3.8 GHz
    - 24.25 - 27.5 GHz
  - Other technological changes in the network

Changes in RF-EMF exposure of wildlife

↓

Literature review

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

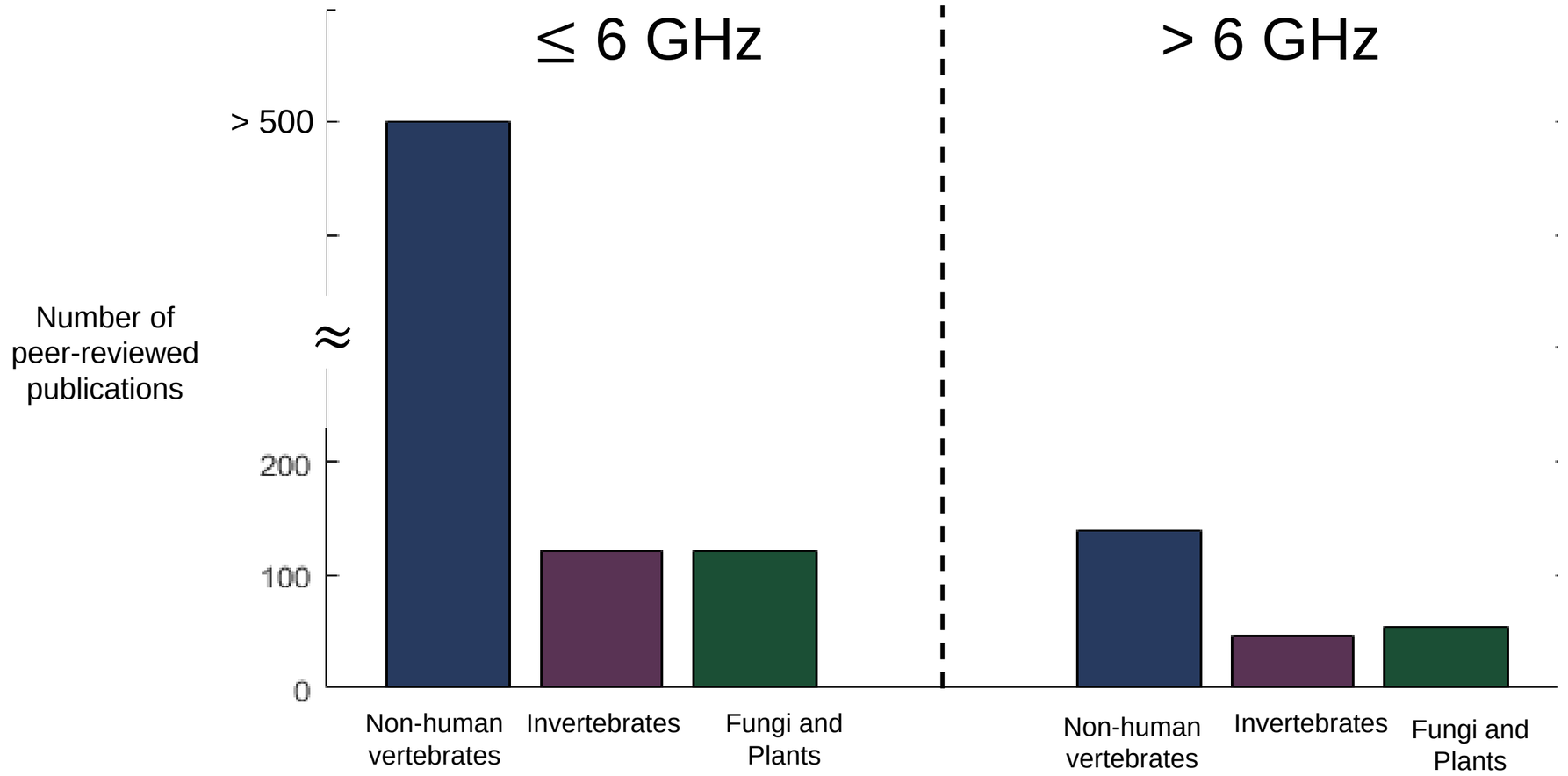
METHODOLOGY

- Literature search in ISI Web of Science
- Subdivided in six categories:
  - **Population** = wildlife, split in three categories:
    1. Invertebrates
    2. Vertebrates
    3. Plants and Fungi
  - **Exposure** = RF-EMF exposure, split in two categories:
    1. 450 MHz – 6 GHz (2G to 4G telecommunication networks)
    2. 6 GHz – 300 GHz (Future telecommunication networks)

Systematic Literature Review

Arno Thielens, contact: arno.thielens@ugent.be

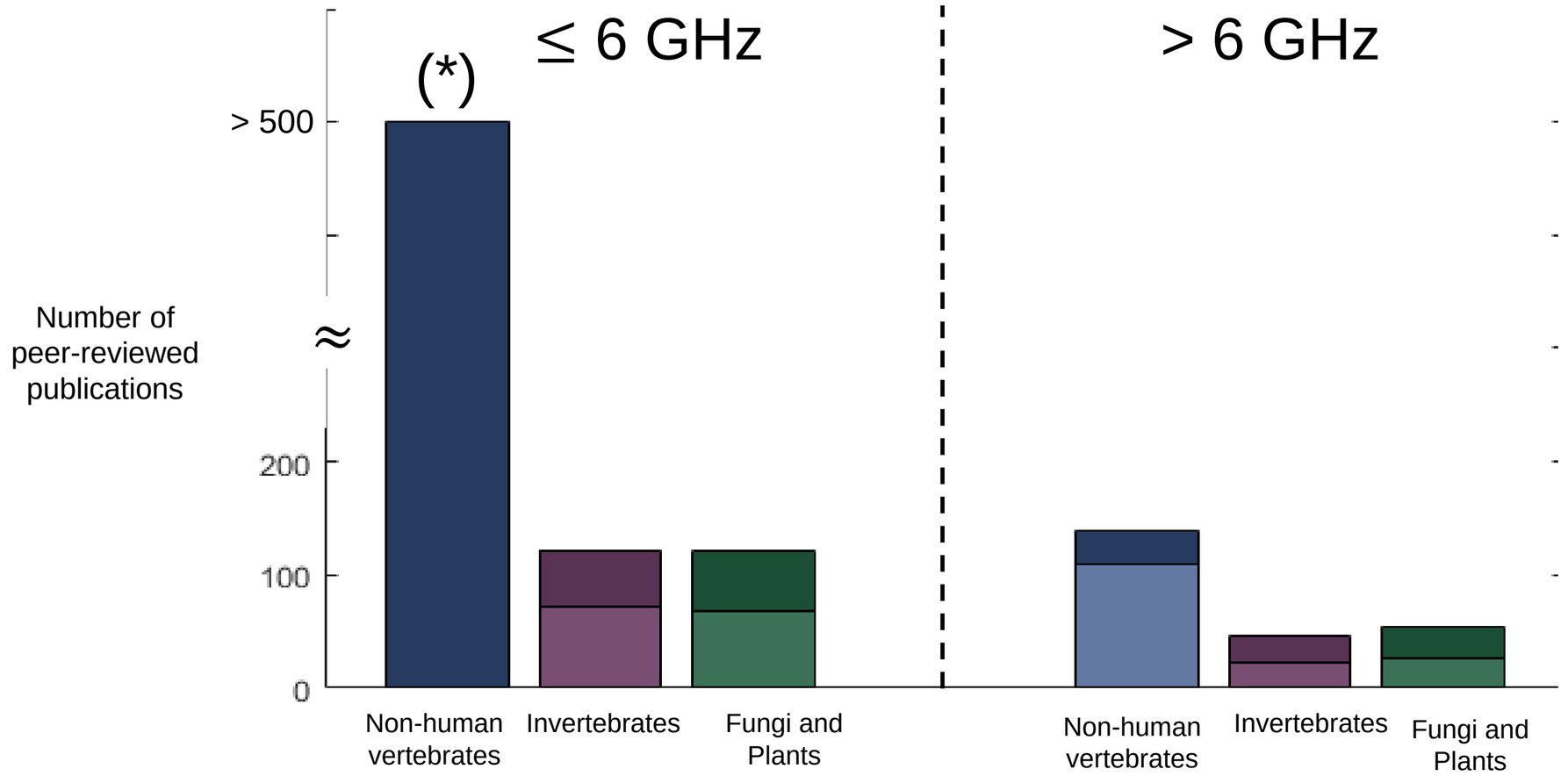
RESULTS



Papers found in database search

Arno Thielens, contact: arno.thielens@ugent.be

RESULTS

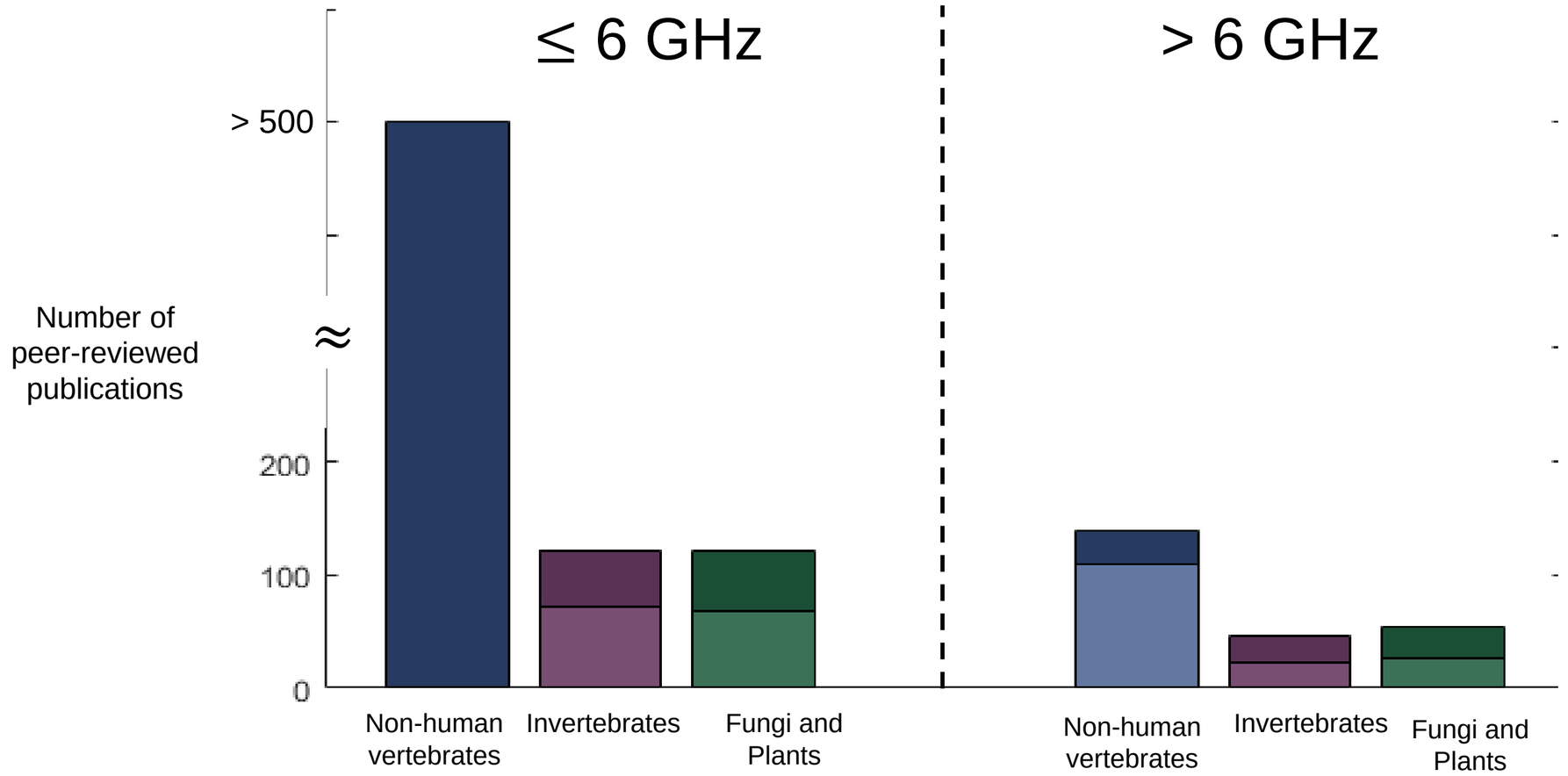


Papers included in systematic review

(*) meta-review in this category

Arno Thielens, contact: arno.thielens@ugent.be

RESULTS



→ More research needed, in particular on plants, fungi, and invertebrates

→ Uncertainty on biological effects of RF-EMF exposure

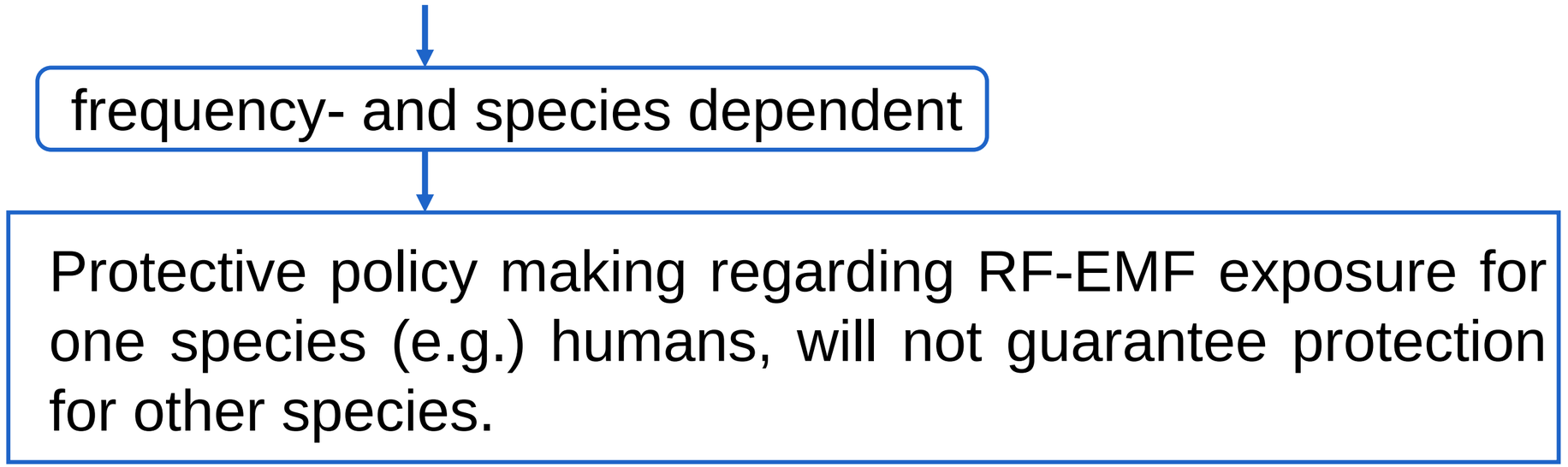
GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

RESULTS

- Literature on RF-EMF exposure of non-vertebrates is limited
- **Dielectric heating** due to RF-EMF exposure is shown for all organisms
  - This heating is associated with a variety of biological effects
  - There is always a **threshold** for when this heating will occur



GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

RESULTS

- Literature on RF-EMF exposure of non-vertebrates is limited
- Dielectric heating due to RF-EMF exposure is shown for all organisms
- Other effects of RF-EMF exposure (see report).

Formulated 4 **policy options**

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 1: FUNDING RESEARCH ON ENVIRONMENTAL EXPOSURE TO RF-EMFS

- Current protective policymaking regarding RF-EMF exposure

  → Only considers biological effects related to human health

- Protective policymaking for **plants, fungi, and non-human animals** should be **based on scientific literature** targeting these species

↕

Research on RF-EMF exposure of non-vertebrates is limited

→ Fund research on:

- Plants, fungi, and invertebrates at frequencies < 6 GHz
- Non-human organisms at frequencies > 6 GHz

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 2: MEASUREMENTS AND MONITORING OF ENVIRONMENTAL RF-EMF EXPOSURE

- Uncertainty on potential effects of RF-EMF exposure of wildlife

  → monitor environmental RF-EMF exposure

- What is the RF-EMF exposure of wildlife? How will this exposure change in the future?



Thielens, Arno, et al. "Radio-frequency electromagnetic field exposure of Western Honey Bees." Scientific reports 10.1 (2020): 1-14.

Methods to perform such measurements exist

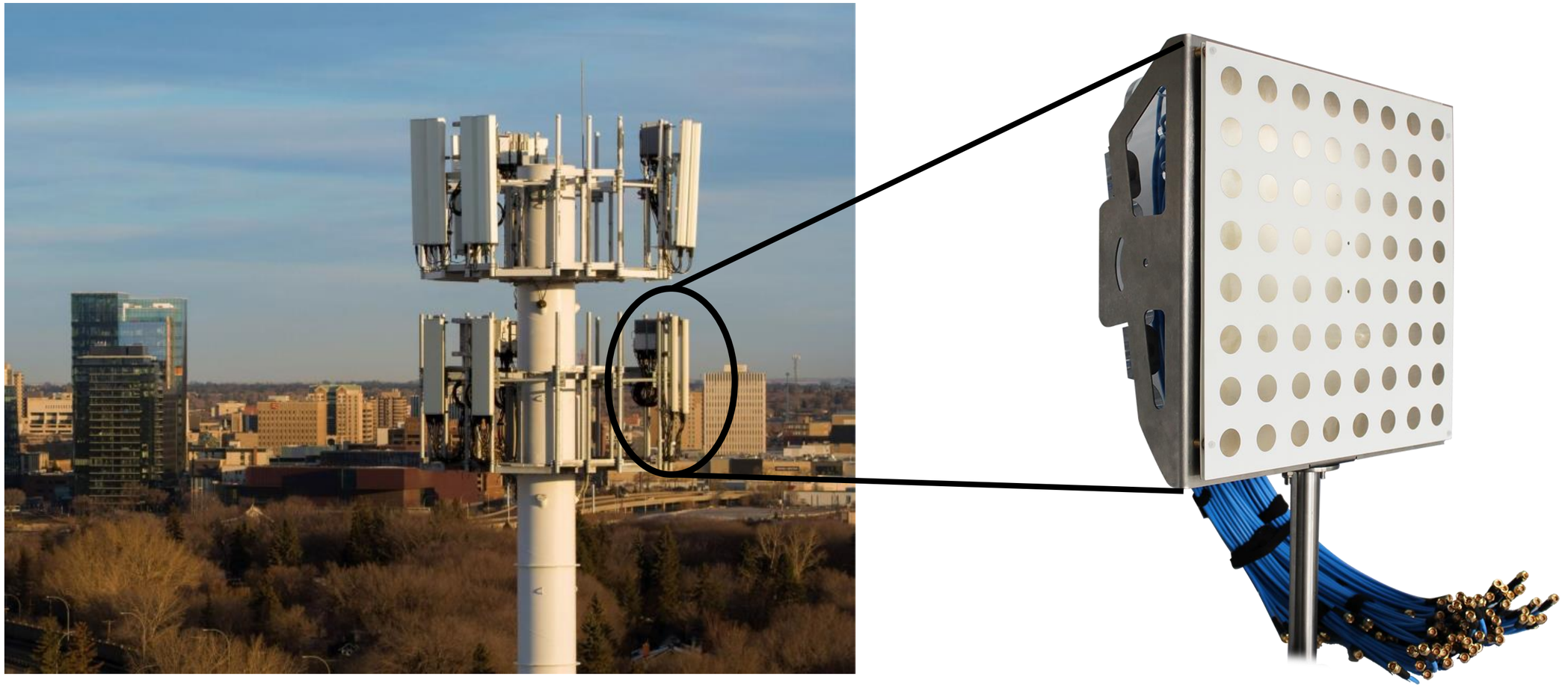
GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 3: MONITORING OF BASE STATION ANTENNAS

- The dominant source of RF-EMFs for wildlife are **base station antennas**



Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 3: MONITORING OF BASE STATION ANTENNAS

- The dominant source of RF-EMFs for wildlife are **base station antennas**

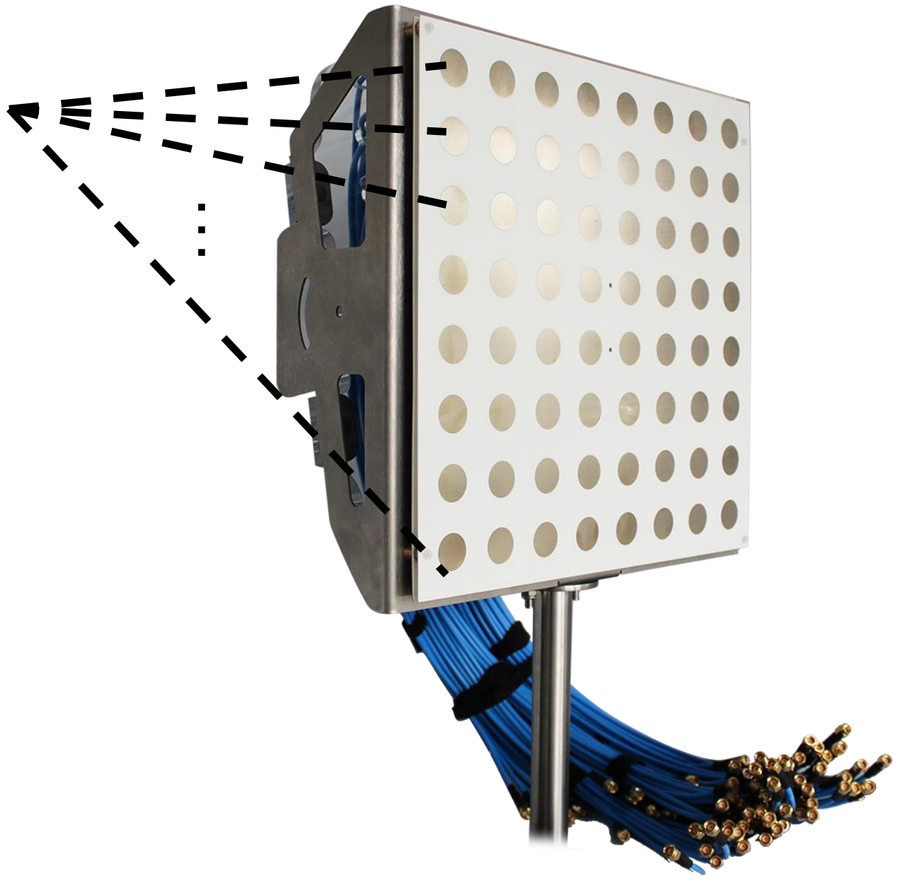
Network operators can control the **input parameters** on each antenna element

↓

These parameters determine environmental exposure to RF-EMFs

↓

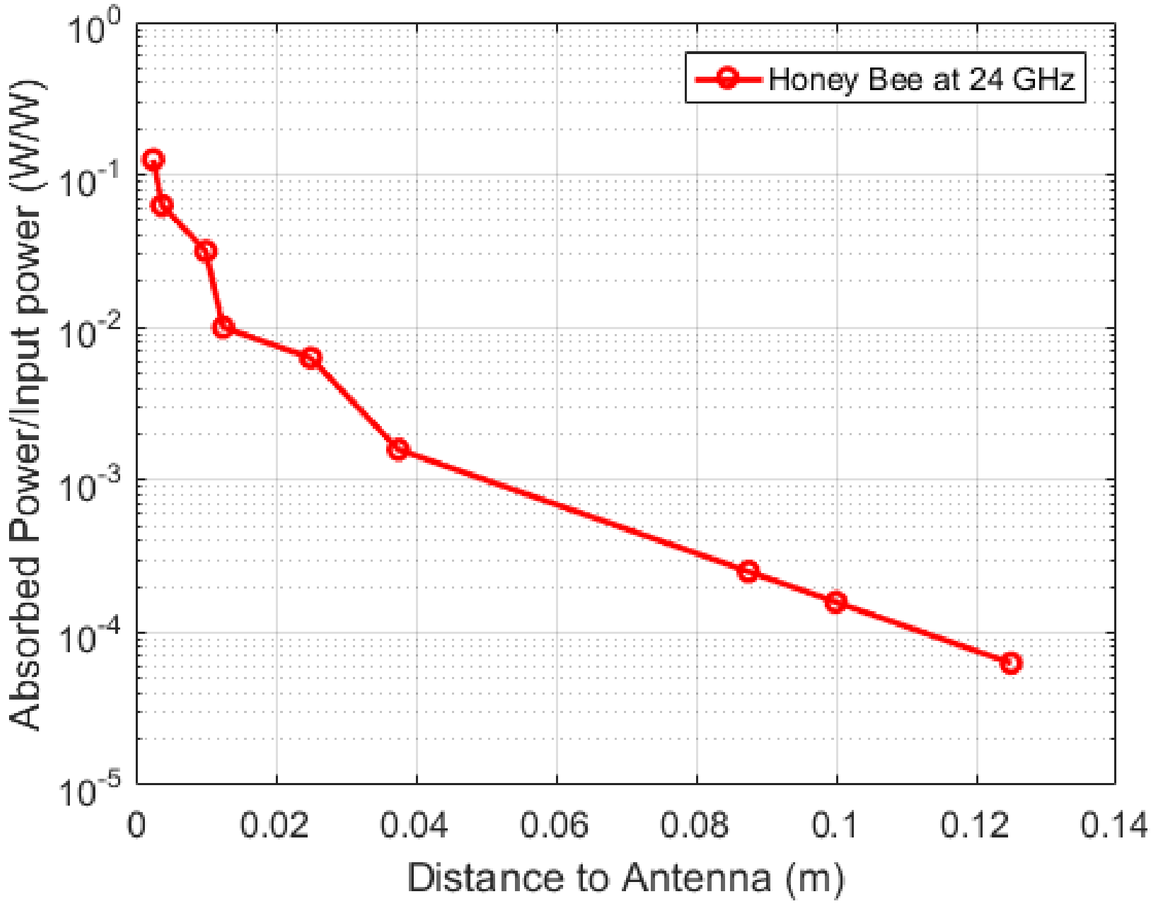
This is proprietary information that is currently not disclosed publicly or to governments

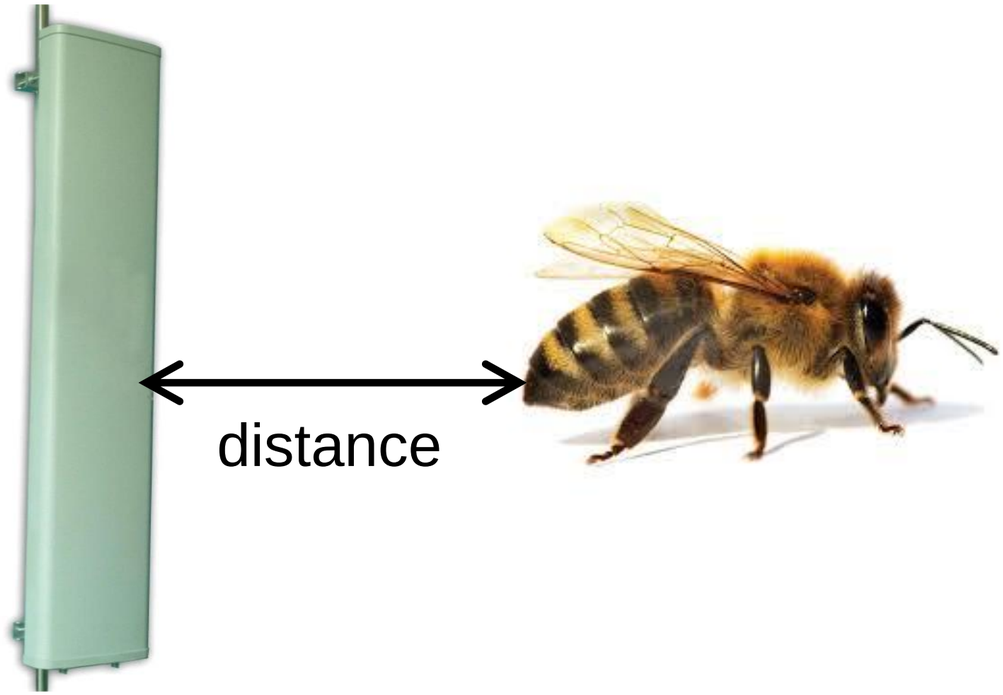


Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 4: EXPOSURE NEAR BASE STATION ANTENNAS

- RF-EMF exposure is **highest near antennas** (for all organisms)





Toribio D. et al. "Near Field Radio-Frequency Electromagnetic Field Exposure of a Western Honey Bee", submitted to IEEE TAP

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 4: EXPOSURE NEAR BASE STATION ANTENNAS

- RF-EMF exposure is **highest near antennas** (for all organisms)
- For **humans**, precautionary measures are taken to avoid this exposure
- Compliance studies :
  - Limits on emitted powers ⟶ limit exposure
  - Measures to ensure minimal separation distance with antenna

POLICY OPTION 4: EXPOSURE NEAR BASE STATION ANTENNAS

- RF-EMF exposure is **highest near antennas** (for all organisms)
- For **humans**, precautionary measures are taken to avoid this exposure
- Compliance studies :
  - Limits on emitted powers ⟶ limit exposure
  - Measures to ensure minimal separation distance with antenna

These could also take into account non-human organisms !

- Exposure limits that take into account all biological effects, not only human health
- Measurements and simulations that take into account different organisms
- Interventions that also ensure minimal separation of all organisms from antennas

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

POLICY OPTION 4: EXPOSURE NEAR BASE STATION ANTENNAS

GHENT UNIVERSITY

imec

Arno Thielens, contact: arno.thielens@ugent.be

CONCLUSION

- Wildlife is exposed to RF-EMFs emitted by telecommunication networks
- This exposure is expected to change in the near future

Literature review of biological effects of RF-EMF exposure of wildlife

Formulated policy options based on the results of this review

Thanks to you and STOA

Questions?

Arno Thielens, contact: arno.thielens@ugent.be