

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)

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE



Antenna

RF Electromagnetic Fields



RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE



Antenna

RF Electromagnetic Fields

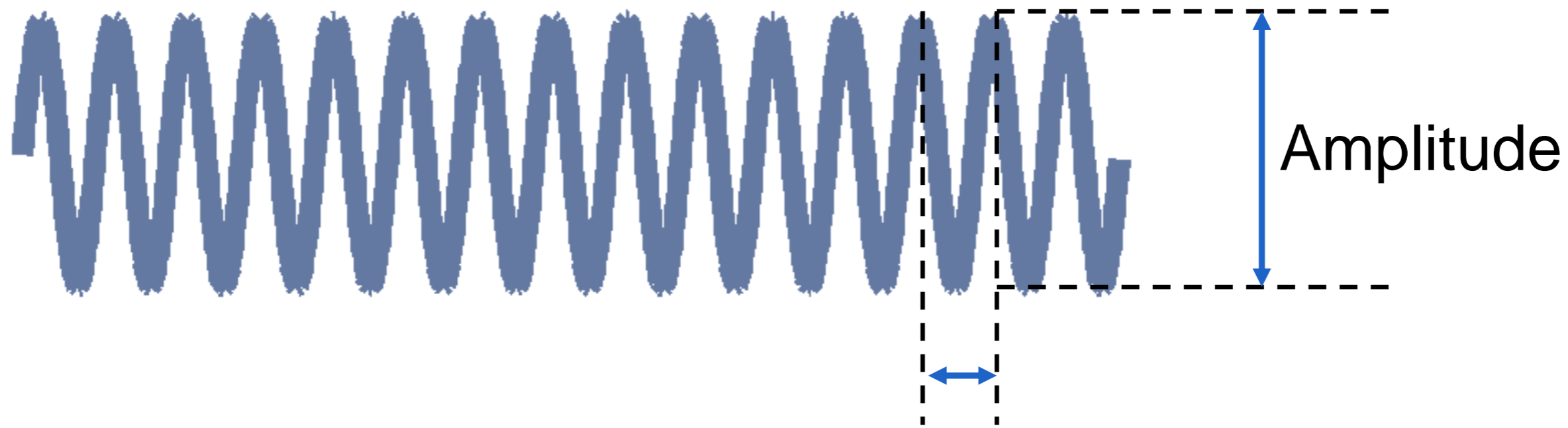


RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE



Antenna

RF Electromagnetic Fields



Wavelength
&
Frequency

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE



Antenna

RF Electromagnetic Fields



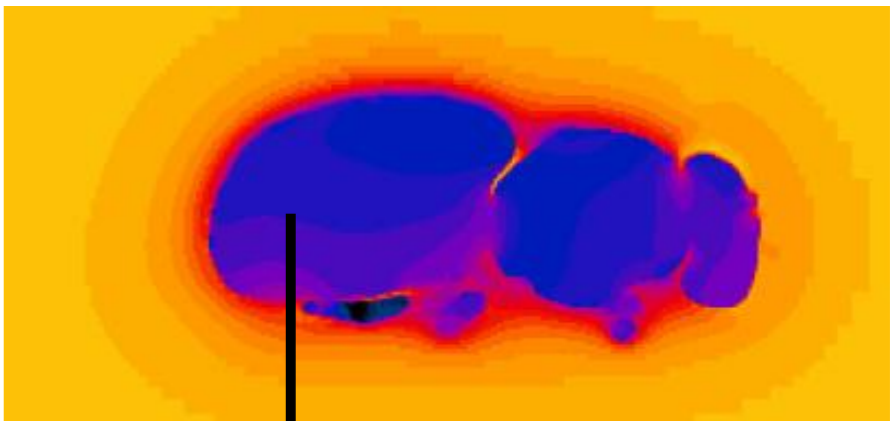
Exposed Organism

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE



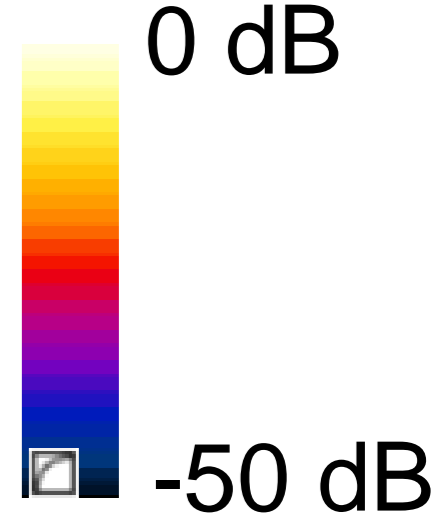
Antenna

RF Electromagnetic Fields



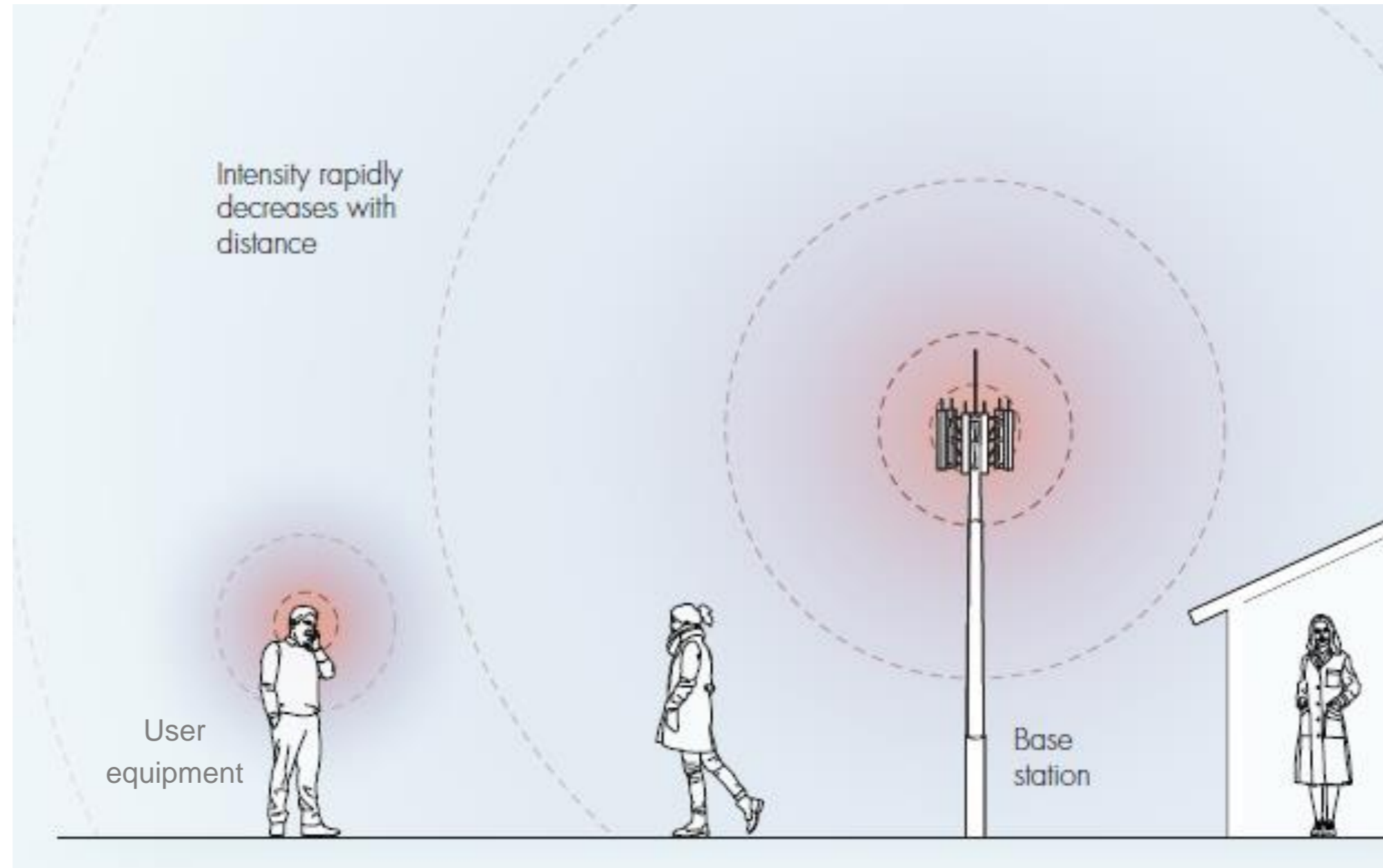
Part of these fields can penetrate the organism

- Field absorption
- Biological Effects



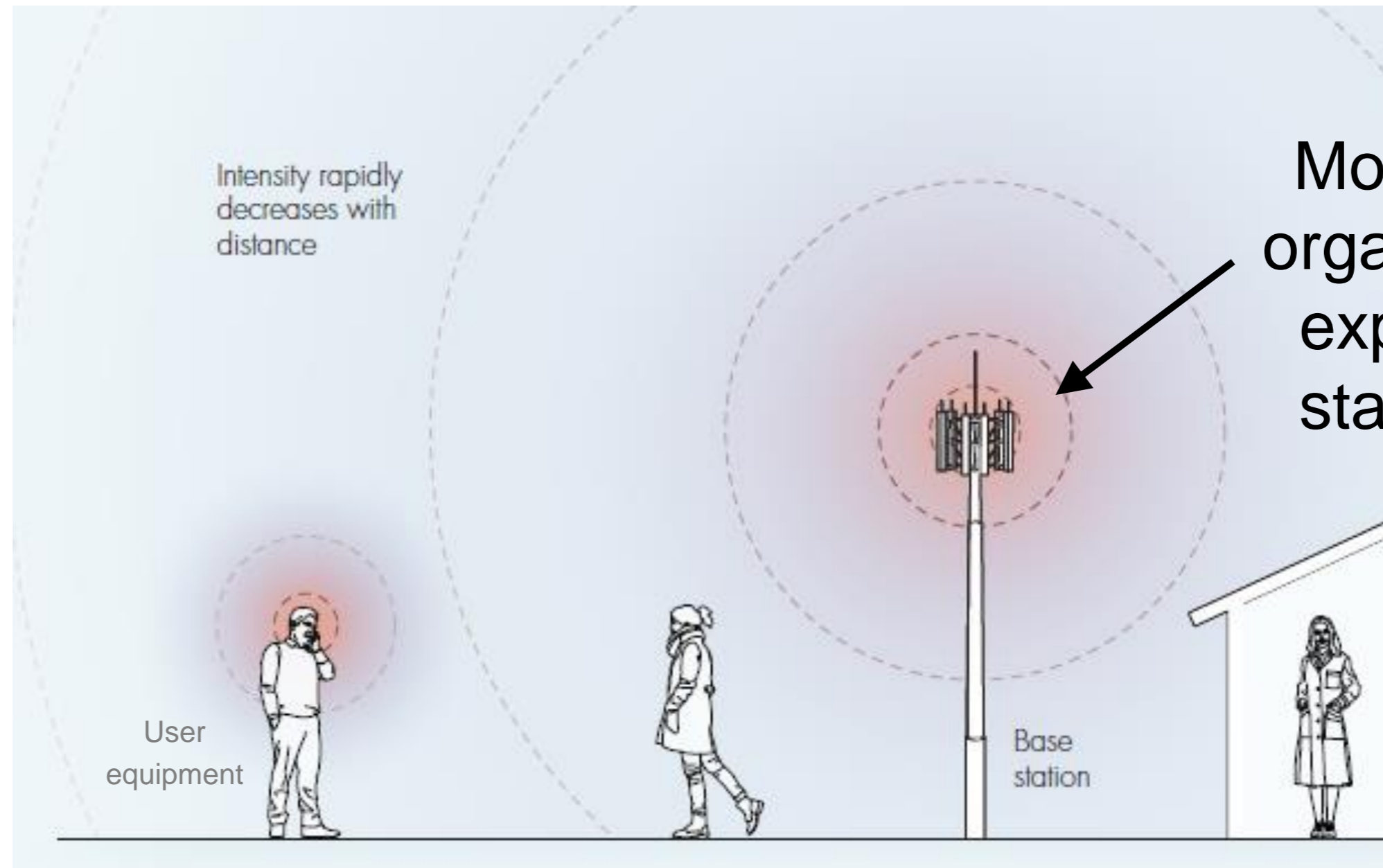
$$20 \log_{10}\left(\frac{E}{E_{max}}\right)$$

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

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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

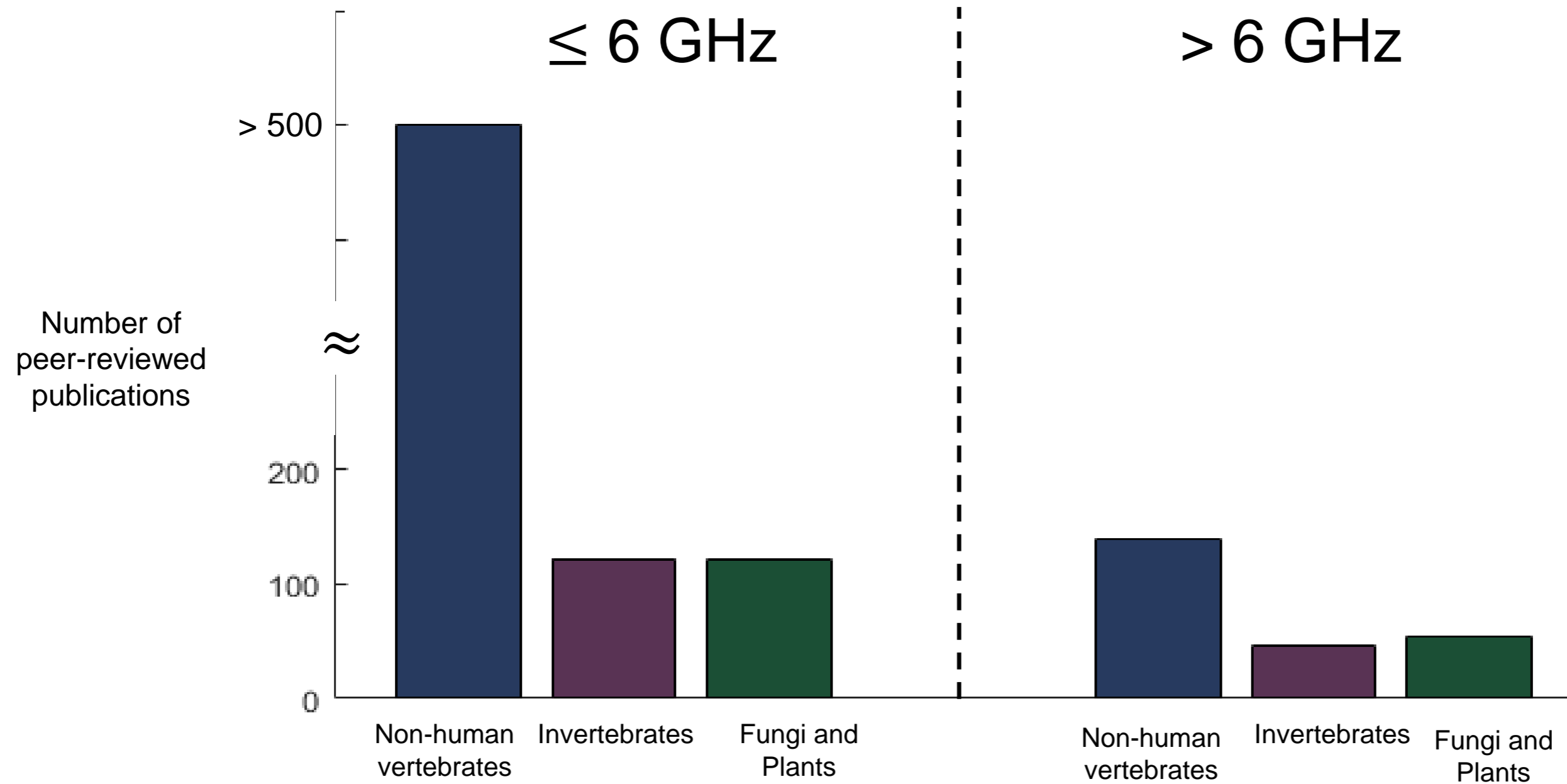
Literature review

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)

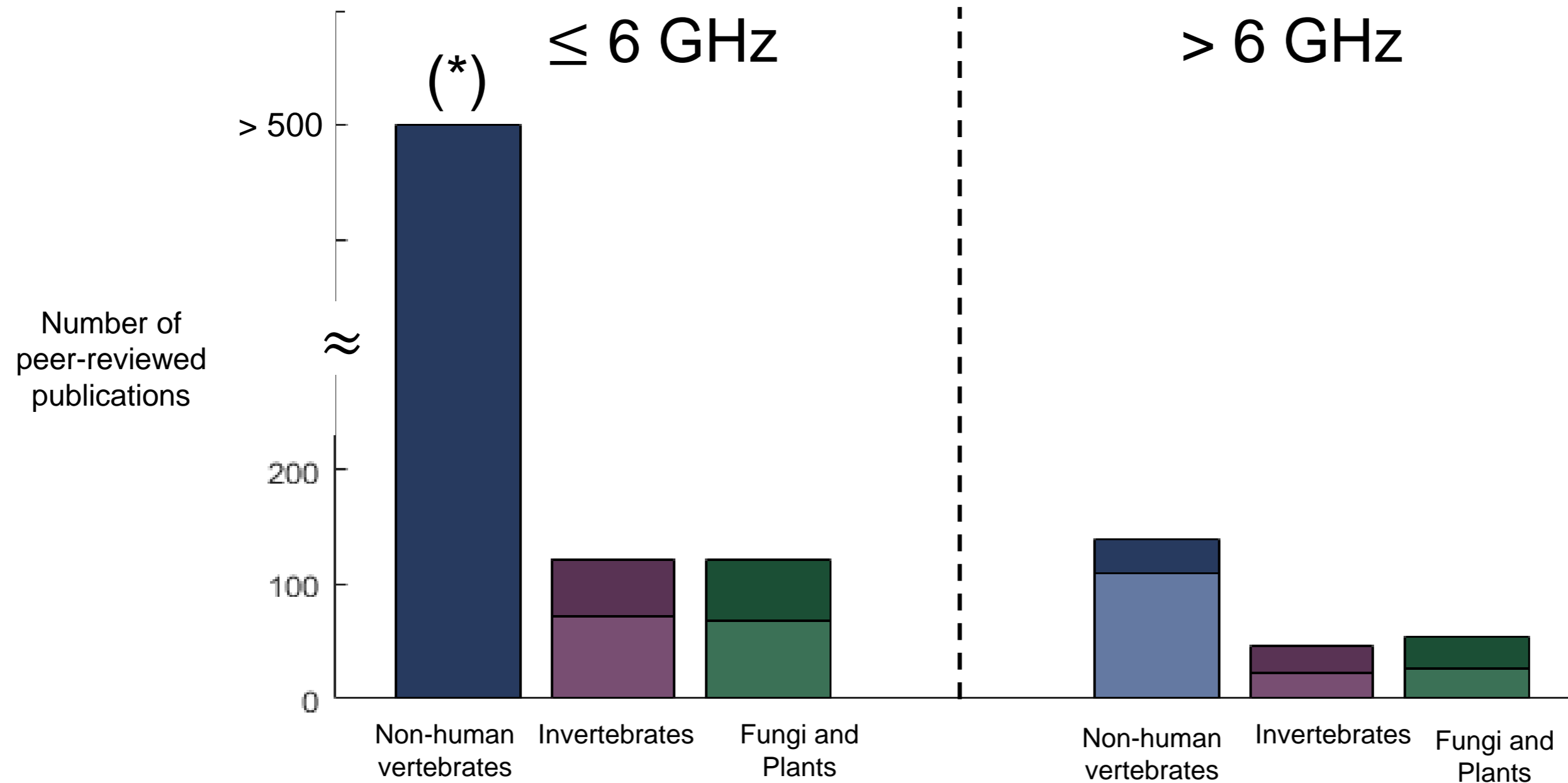
Systematic
Literature Review

RESULTS



Papers found in database search

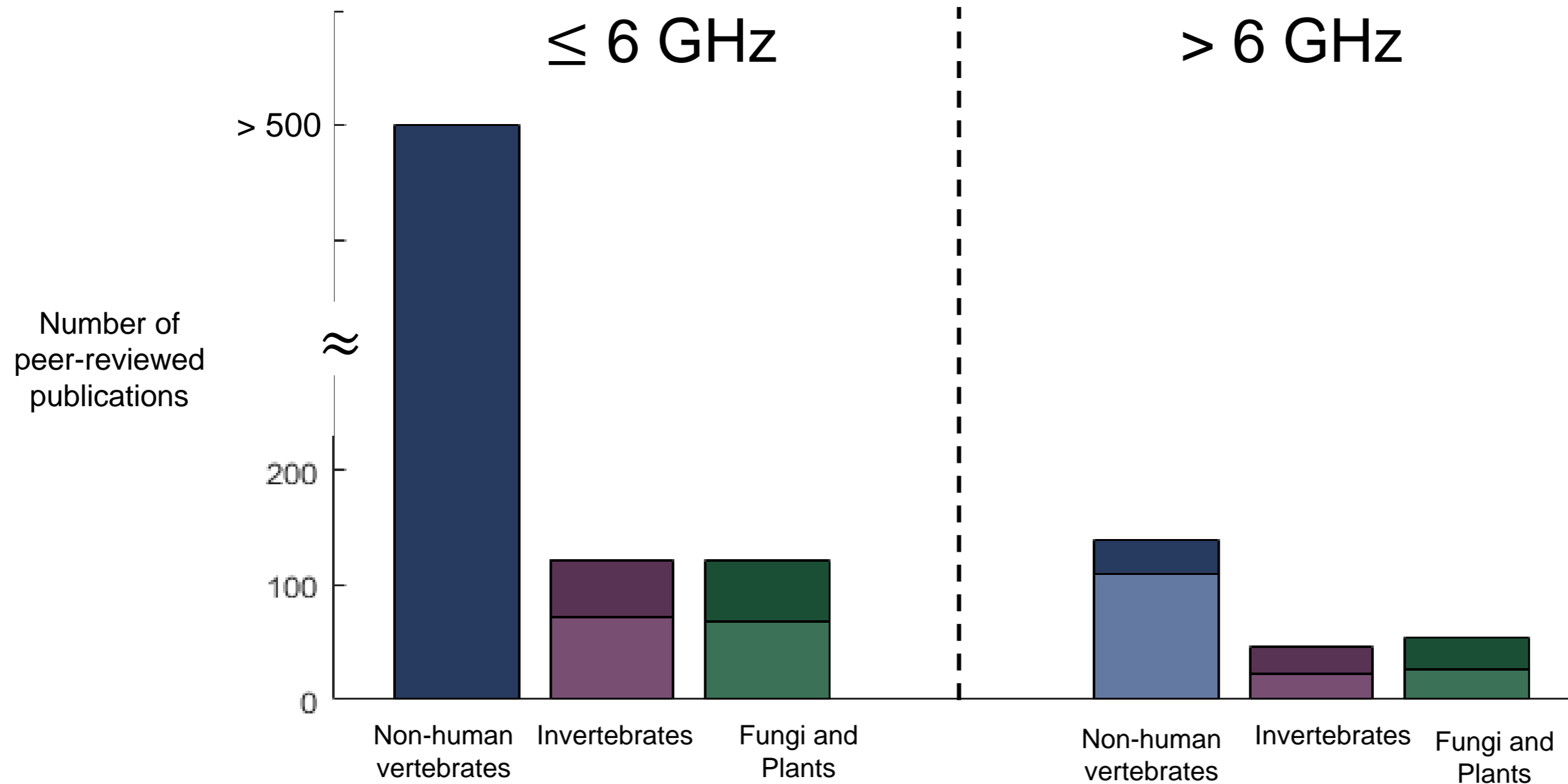
RESULTS



Papers included in systematic review

(*) meta-review in this category

RESULTS



- More research needed, in particular on plants, fungi, and invertebrates
- Uncertainty on biological effects of RF-EMF exposure

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

↓

frequency- and species dependent

↓

Protective policy making regarding RF-EMF exposure for one species (e.g.) humans, will not guarantee protection for other species.

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**

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

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?

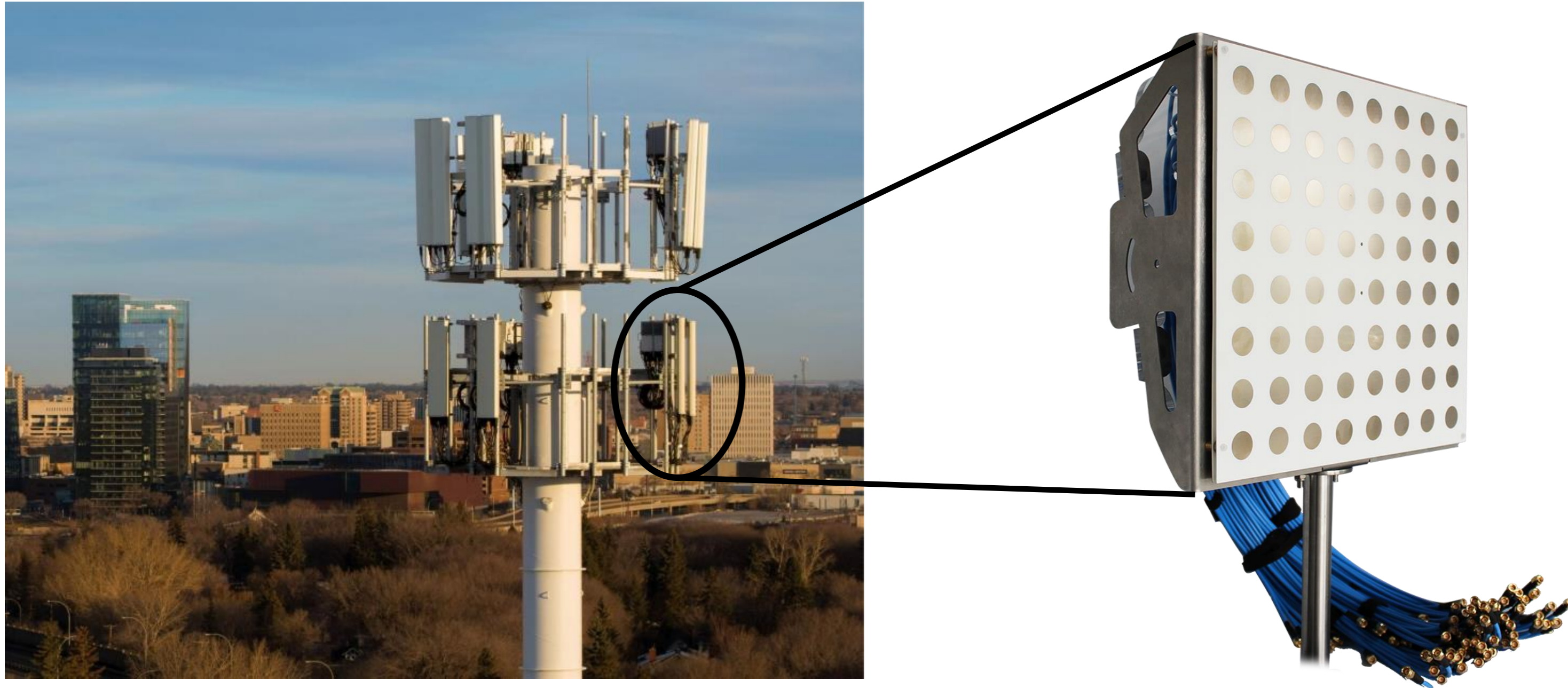


Thielens, Arno, et al. "Radio-frequency electromagnetic field exposure of Western Honey Bees." *Scientific reports* 10.1 (2020): 1-14.

Methods to perform such measurements exist

POLICY OPTION 3: MONITORING OF BASE STATION ANTENNAS

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



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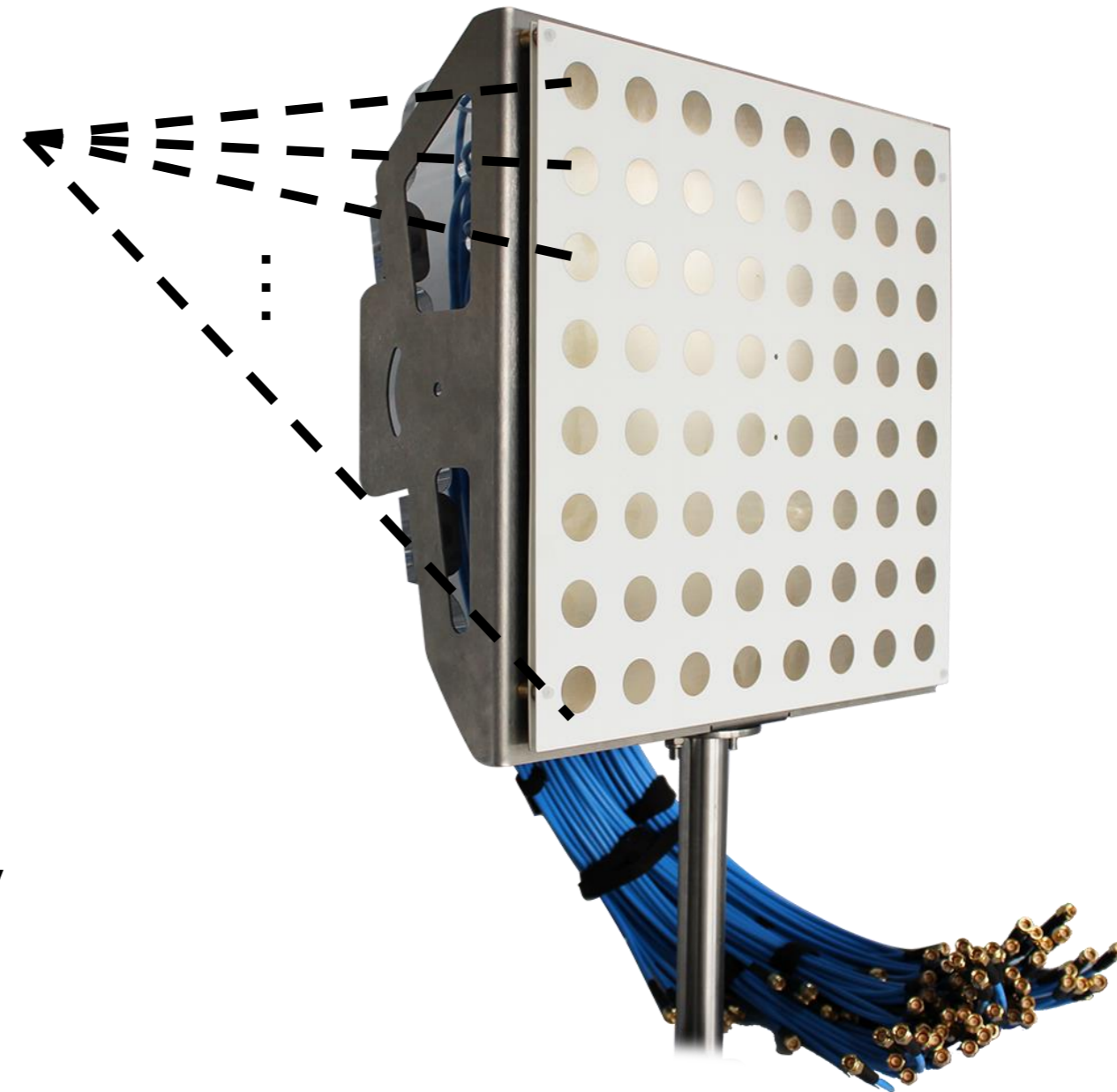
Network operators can control the **input parameters** on each antenna element



These parameters determine environmental exposure to RF-EMFs

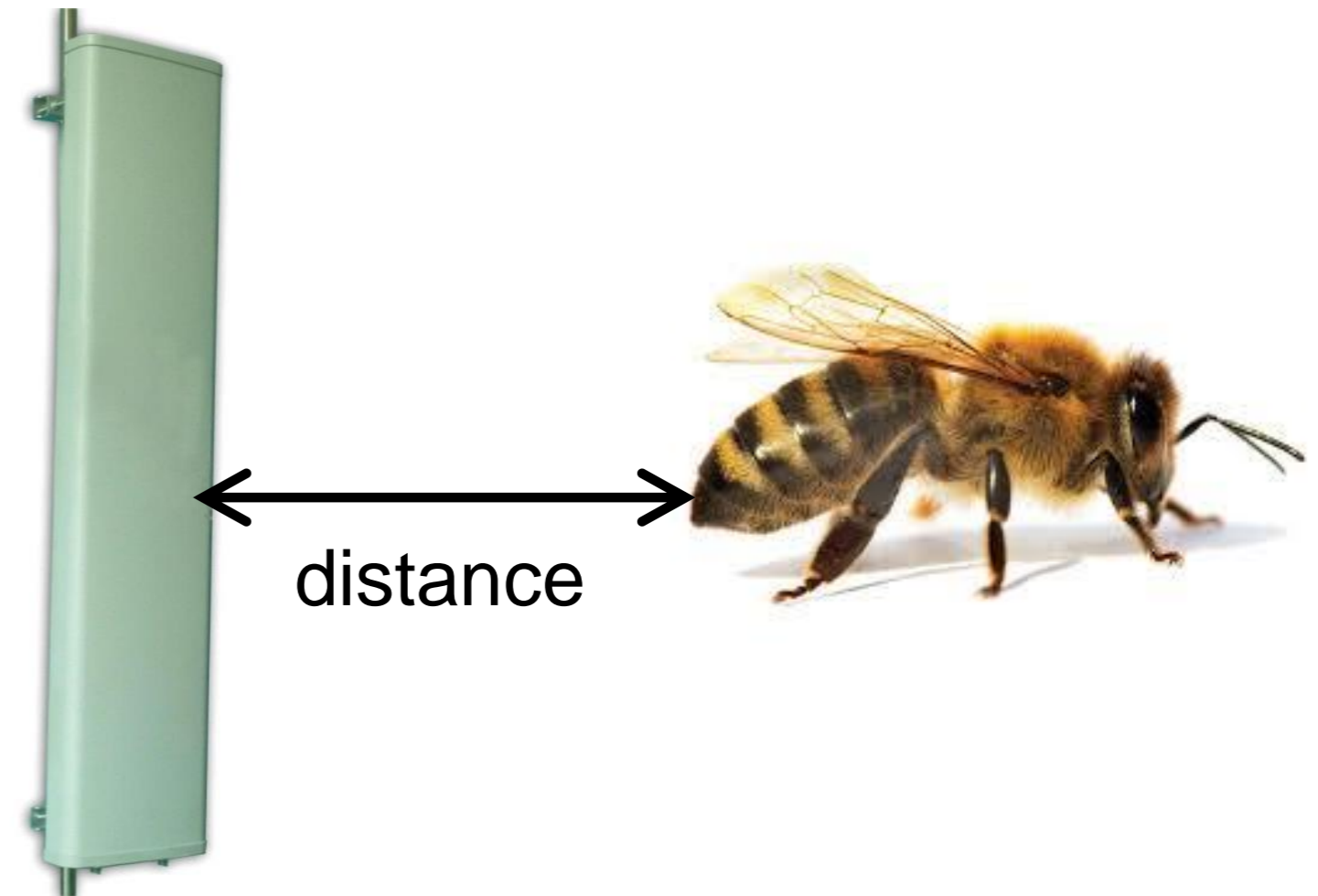
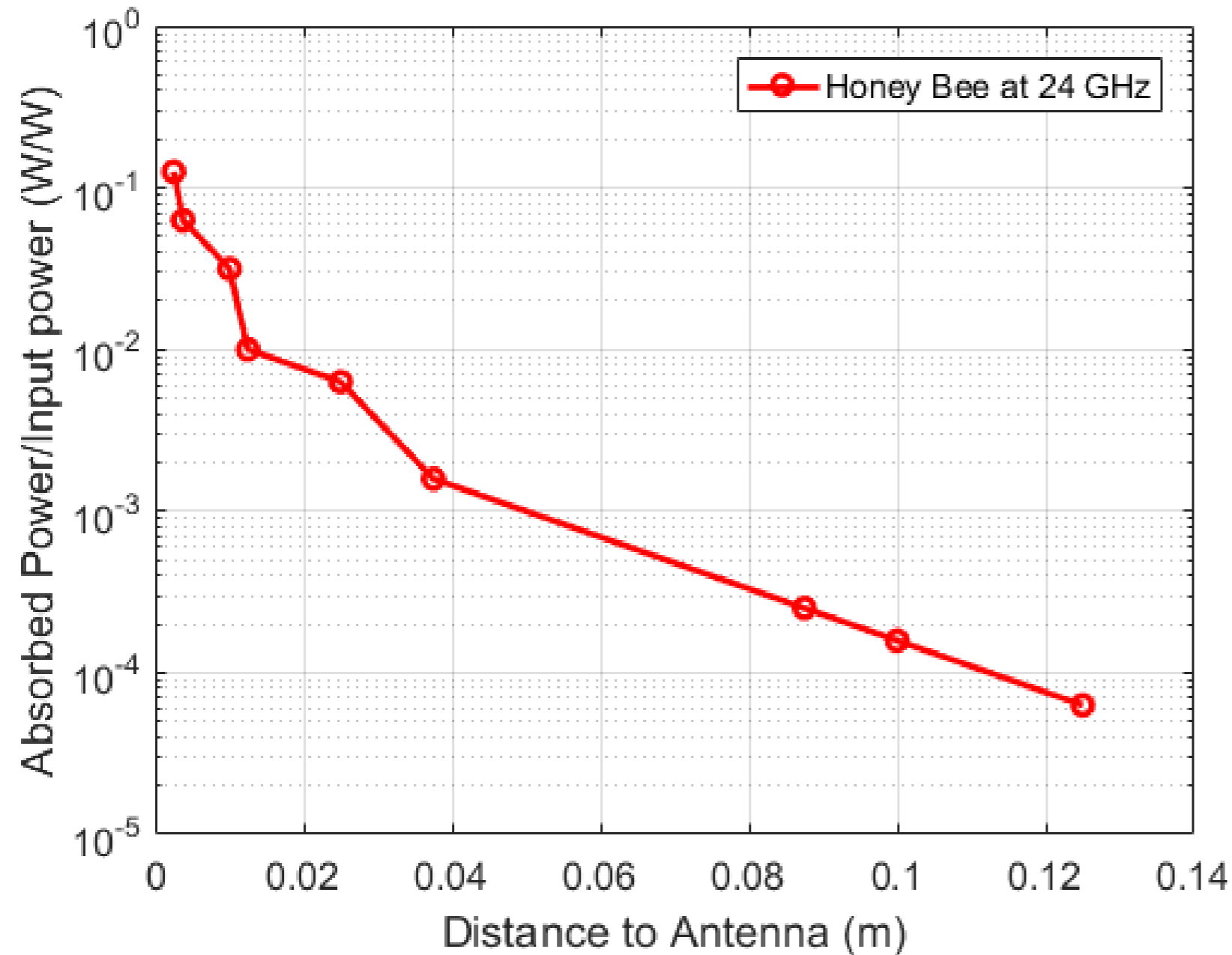


This is proprietary information that is currently not disclosed publicly or to governments



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

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 \longrightarrow limit exposure
 - Measures to ensure minimal separation distance with antenna



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- Compliance studies :
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 - 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

POLICY OPTION 4: EXPOSURE NEAR BASE STATION ANTENNAS



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?



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