Intermediate frequencies: A challenge in terms of science and technological development?

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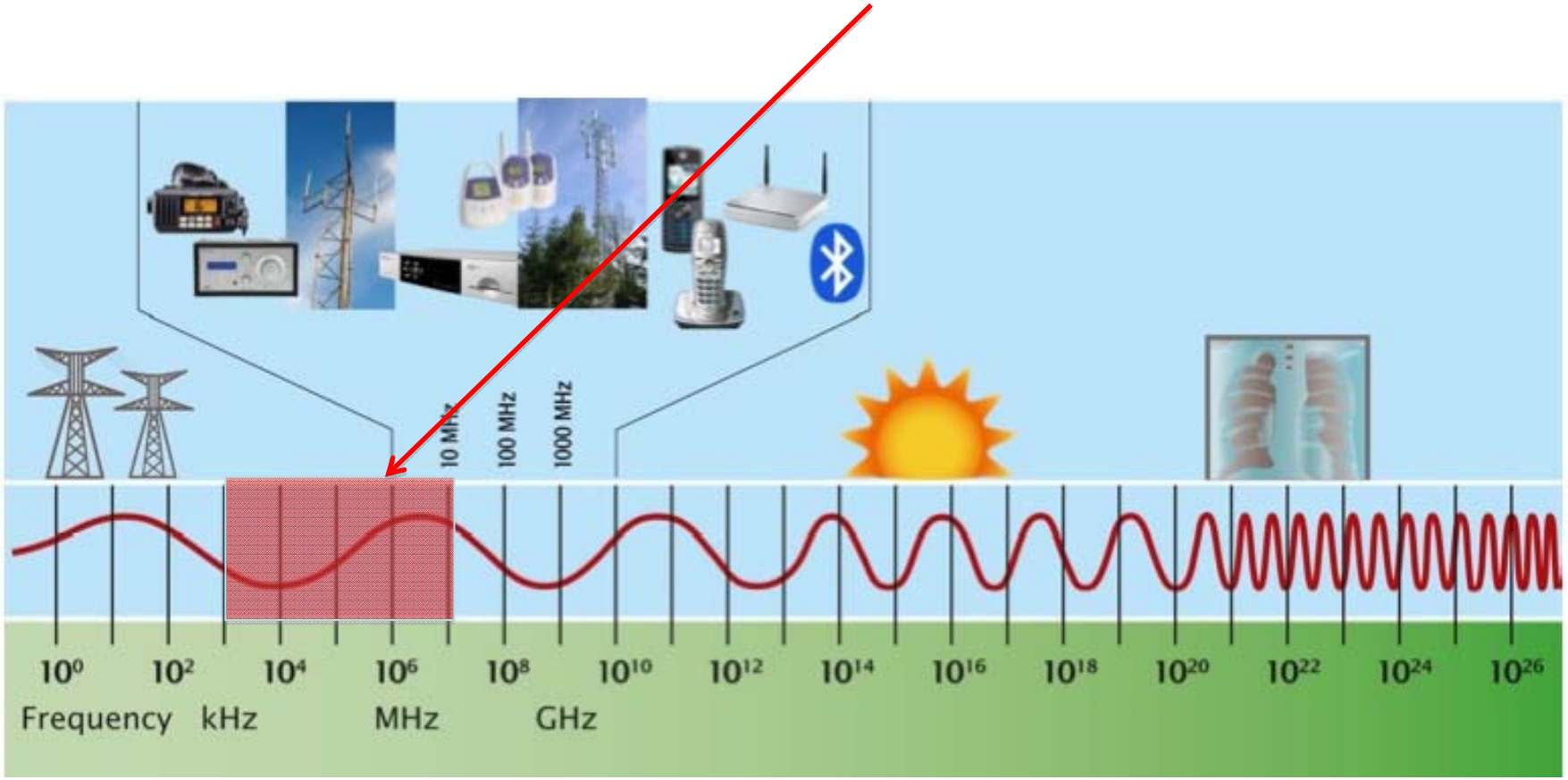
CONTENT

- Sources
- Dosimetry & interaction mechanisms
- Exposure assessment
- Epidemiology
- Biology
- Health risk assessment
- Conclusion

SOURCES: Frequency spectrum

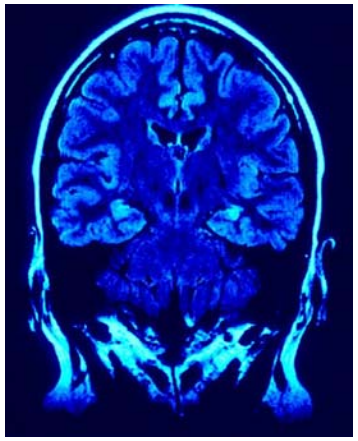
- LF from 1 to 100 kHz and RF from 100 kHz to 300 GHz (ICNIRP)
- Intermediate frequencies, IF, from 3 kHz to 10 MHz



SOURCES

- **Industry**:
  - wireless power transfer
  - dielectric heater sealers, induction and plasma heaters (150 W to 600 kW, 1 kHz to 43 MHz)
  - broadcast and communications transmitters,
- **General public**:
  - domestic induction cookers (ca. 20 kHz)
  - proximity readers (RFID)
  - electronic article surveillance systems and other anti-theft devices,
  - computer monitors and CRT television sets,
  - compact fluorescent lights, CFL (30-60 kHz)
  - power line carrier (smart grids)
  - Body-worn devices (smart clothes)
  - electric vehicles

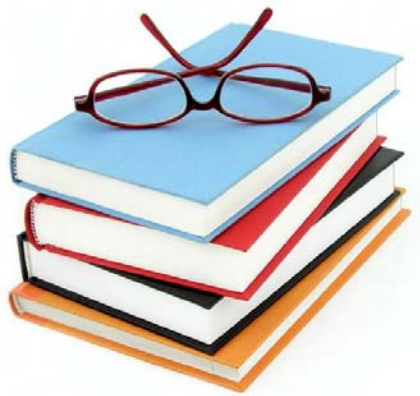
SOURCES



- **Hospitals**:
  - MRI systems (switched gradients, 10 kHz),
  - electromagnetic nerve stimulators, electro-surgical units (100 kHz),
  - other devices for medical treatment.
- **Military**:
  - power units,
  - submarine communication transmitters,
  - high frequency (HF) transmitters.

LITERATURE

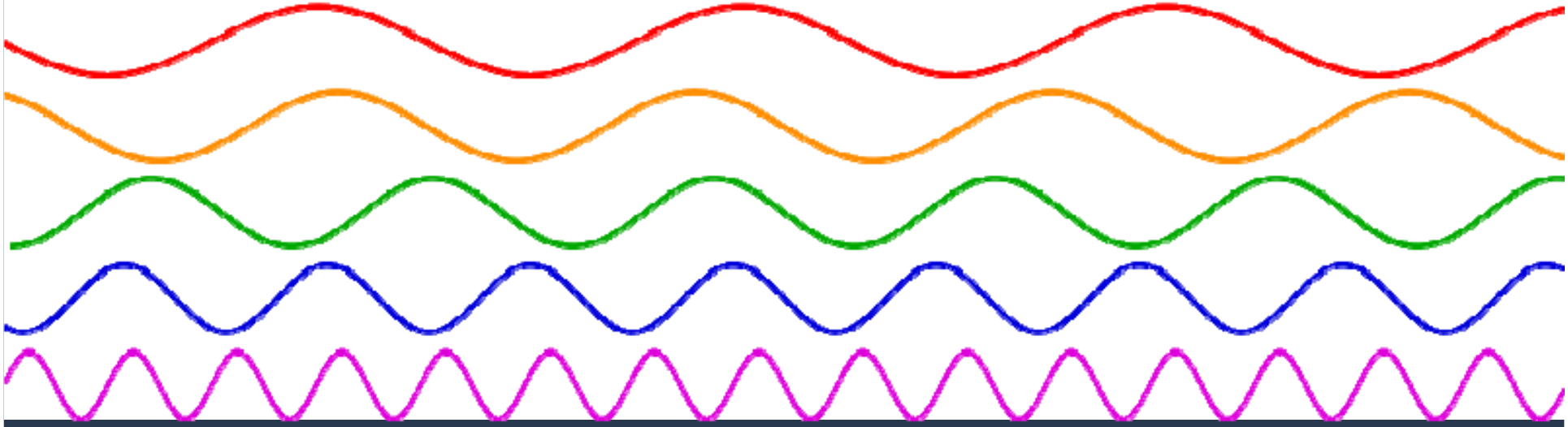
- ICNIRP (2004) Statement related to the use of security and similar devices utilizing EMF
- De Seze (2006) ERS (in French) Biological and health effects of IF
- WHO (2005) Information Sheet on IF
- SCENIHR (2007, 2009)
- EMF-NET (2009)
- EFHRAN reports (2010)
  - Animal and cell models
  - Human epidemiological studies



DOSIMETRY

- Interaction mechanisms are those of the adjacent frequency ranges: IF fields
  - induce electric fields and currents in the lower *f* range (ELF)
  - induce heating in the upper *f* range (RF)
- IEC International Electrotechnical Commission (2004) #62226.

  *Exposure to electric or magnetic fields in the low and intermediate frequency range - Methods for **calculating** the current density and internal electric field induced in the human body.*

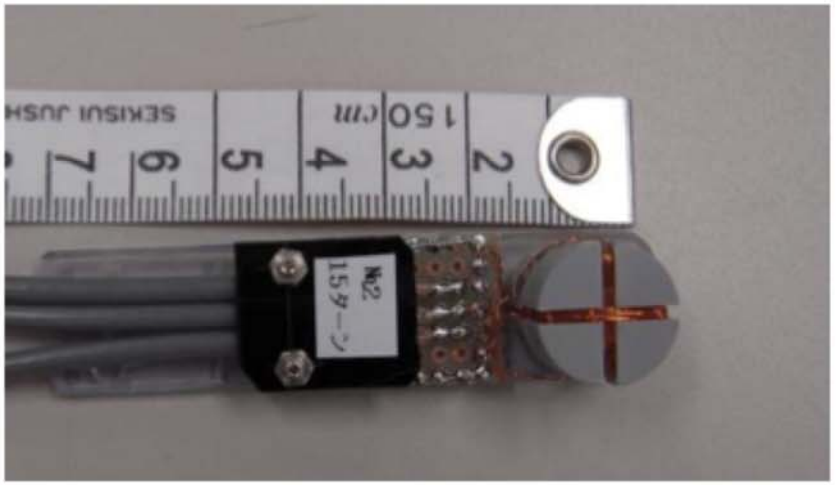


EXPOSURE ASSESSMENT

- Most IF systems employ inductive fields:
  - there is negligible propagating field
  - exposures of people are generally limited to the near-field magnetic field
- Fields may decrease as $1/r^3$ - $1/r^6$ at short distances

EXPOSURE ASSESSMENT

- GLORE (2011) Wake et al., Japan



Height: 13 mm
Diameter: 16 mm
Frequency region: 1 kHz to 6 MHz

EXPOSURE ASSESSMENT

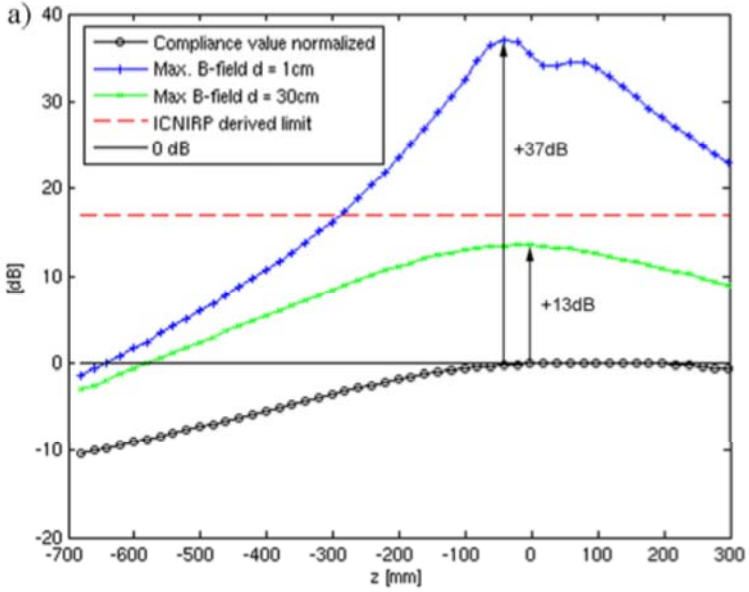
- EAS
  - For most systems, exposure is well below the ICNIRP limits. However, under worst case conditions, reference levels may be exceeded when in close vicinity of some EAS systems.

- CFL
  - in normal domestic use for room illumination, exposure of CFL users to IF fields is almost negligible.

EXPOSURE ASSESSMENT

- Induction heating
  - Reference levels may be exceeded
    - *Field Exposure From Induction Cooking*
      Viellard et al. (2007) ITIS Foundation, Zurich

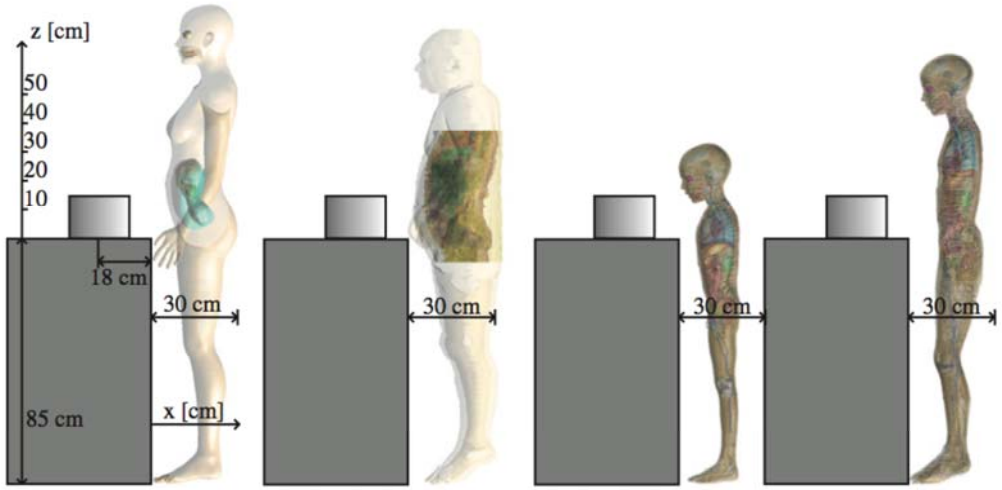
Induced currents for such a worst-case compliant appliance would exceed the basic restrictions by nearly a factor of 10 (EN50366 standard for compliance testing)



EXPOSURE ASSESSMENT

- Induction heating

Kos et al.
Phys. Med. Biol. (2011)



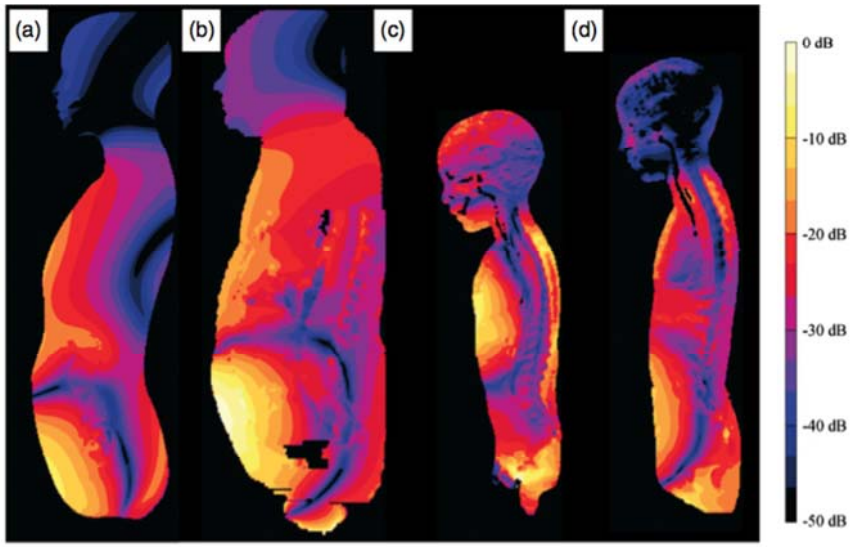


Figure 3. A cross section showing the *E* field values through the centre of the body. 0 dB represents 0.1 V m^{-1}. The models are (a) 26 weeks pregnant, (b) 30 weeks pregnant, (c) 6 year old child and (d) 11 year old child.

EPIDEMIOLOGY

- Very few epidemiological data available.
- Evidence comes from older studies based on job title as surrogate for exposure.
- Groups studied included users of CRT- VDUs and radio and telegraph operators.
- Outcomes studied included cancer as well as effects on the eye, the cardiovascular system and reproductive effects.
- Although no particular risks were indentified, the quality of the studies was limited.
- No recent epidemiological studies investigating risks of IF fields have been published.

BIOLOGY

- In contrast to ELFand RF EMFs, the biological effects of the intermediate frequency EMFs have not been studied very well (mostly in the past with CRT VDUs).

- Assessments of potential effects and hazards at IF are largely based on extrapolation from knowledge about these lower and higher frequency ranges

BIOLOGY: e.g., Japan, in vitro

Bioelectromagnetics

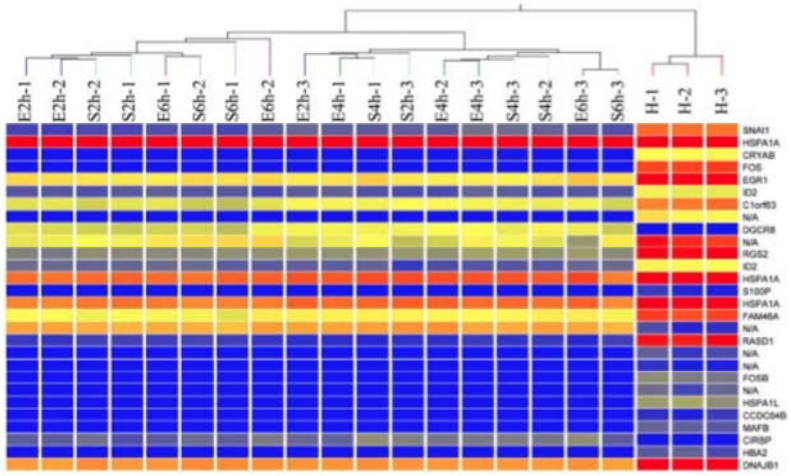
May 2012

Intermediate Frequency Magnetic Field at 23 kHz Does Not Modify Gene Expression in Human Fetus-Derived Astroglia Cells

Tomonori Sakurai, Eijiro Narita, Naoki Shinohara, and Junji Miyakoshi*

Laboratory of Applied Radio Engineering for Humanosphere, Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Japan

Human fetus-derived astroglia cells exposed
at 23 kHz and 100 µT
(0.36 V/m at periphery of Petri dish)
for 2, 4, and 6 h
gene expression profiles (cDNA microarrays)
Positive control 43°C for 2 h
Negative



HEALTH RISK ASSESSMENT: **SCENIHR** (2009)

Scientific Committees
- on consumer products
- on emerging and newly identified health risks
- on health and environmental risks

- Occupational **exposure to IF fields** in certain areas **is considerably higher than exposure to the general public**.
- However, **very little research** on IF and health risks in occupational settings or for the general public have been presented since the previous opinion (2007), and no epidemiological studies have appeared.
- Consequently, the data are still too limited for an appropriate risk assessment.

- *Recommendation*: In view of the increasing occupational exposure to IF among workers in e.g. security, shops, and certain industries it is important that **research in this area is given priority**.

BIOLOGY: e.g., Korea, in vivo

***In vivo* and *In vitro* study for the effects of intermediate frequency (20 kHz)**	▪ 2000 ~ 2005 ▪ Korea Institute of Radiological & Medical Sciences(Dr. Yunsil Lee) ▪ Find out an influence of hematology, biochemical, histology of a mouse. ▪ Study an influence on Fetus Abnormality, breast cancer, skin cancer, lung cancer during pregnancy periods of a rat.

Chronic exposure of Sprague-Dawley rats to 20 kHz triangular magnetic fields

Lee et al. (2010) IJRB

80 male and female rats

30 µT, 8 h/day, 5 days/week for 18 months

Endpoints: Mortality, body weights and organ weights
Tumours

Results: negative

HEALTH RISK ASSESSMENT: EFHRAN project (2011)

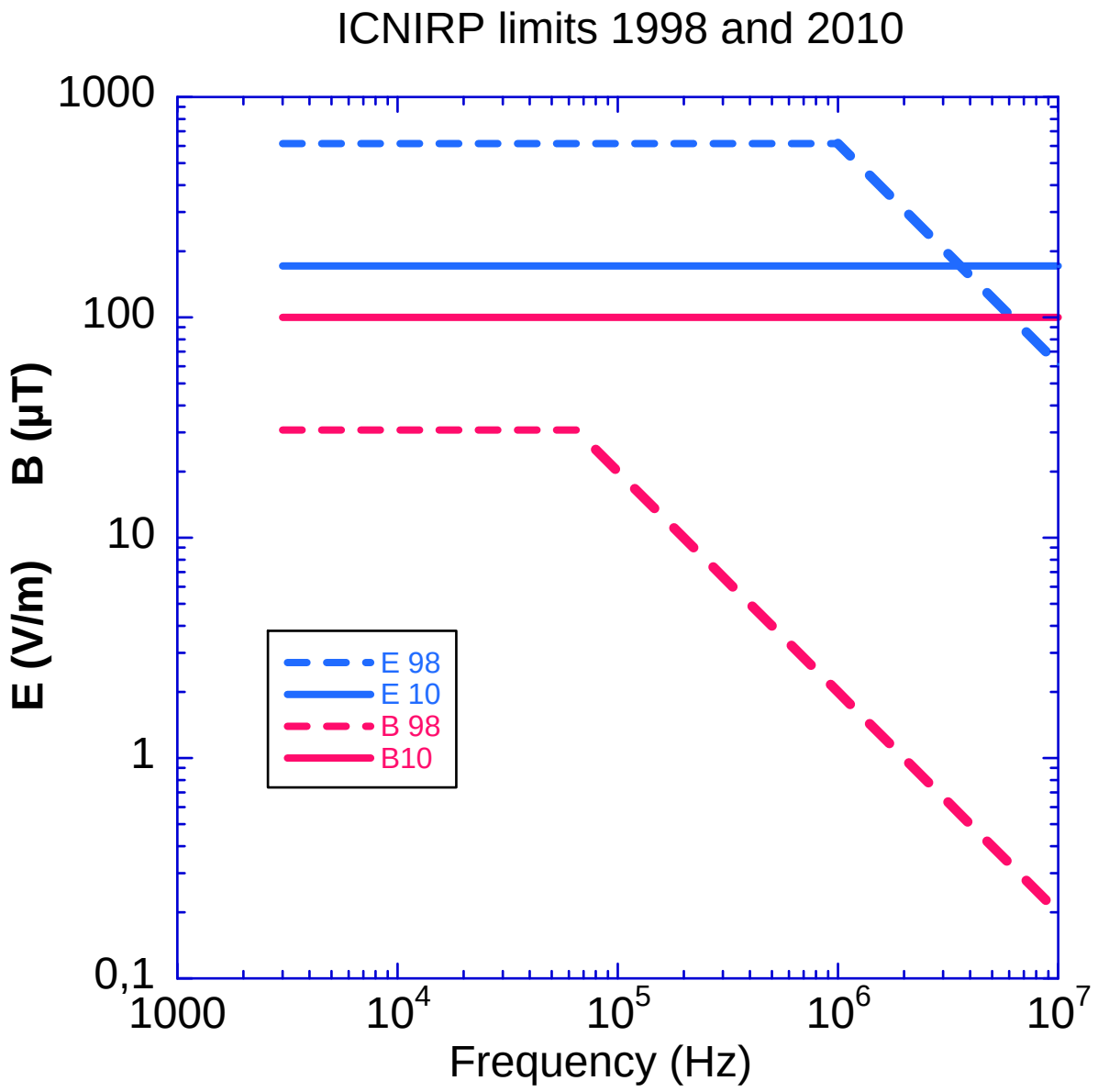
- Human and epidemiological studies

efhran

Outcome	Strength of evidence
All outcomes	Inadequate

- Animal and cell studies

Outcome	Strength of evidence
Development	Lack of effect
Genotoxicity	Lack of effect


ICNIRP limits 1998 and 2010
1000
100
10
1
0,1
E (V/m)
B (µT)
E 98
E 10
B 98
B10
1000
10^4
10^5
10^6
10^7
Frequency (Hz)

CONCLUSION

- Data are still too limited for an appropriate risk assessment,
- Given that occupational and general public exposures at these frequencies are increasing, it would be useful if well-targeted studies could be performed as a priority to address the lack of research (e.g., 2012 call by the French ANSES).

- The challenge is thus:
  - to answer questions on health risks … while the database is almost empty
  - to carry out more studies … while funding level is low

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Merci
beaucoup
pour votre attention !