

Exposure to EMF: measurement methods

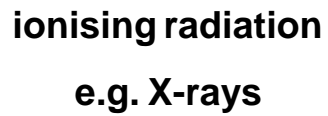
Yvette Christopher-de Vries





Presentation overview

- What are EMF?
- Sources of EMF
- Exposure assessment of EMF
- Measurement devices for quantitative exposure assessment



Physical agents



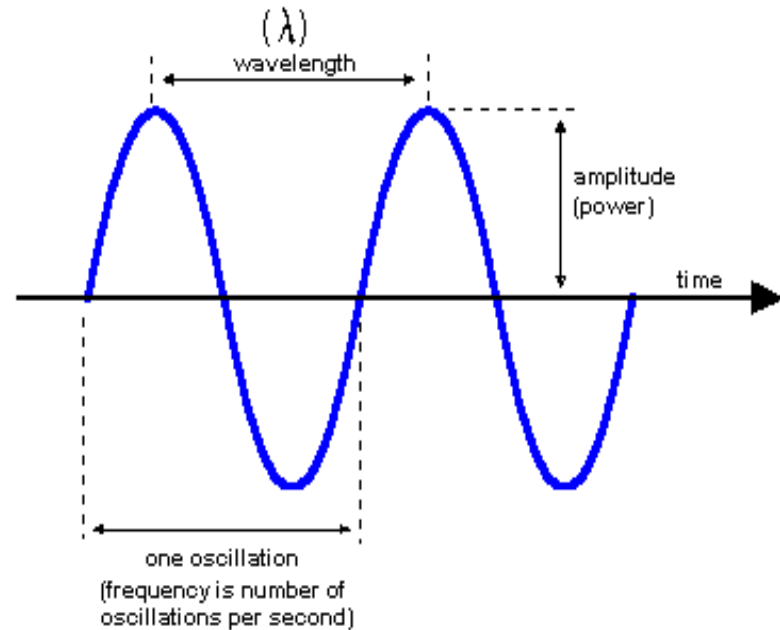
Non-ionising radiation



Characterising EMF

EMF waves are characterised by:

- wavelength
- frequency or
- Amplitude (power)



Characterising EMF

Relationship between wavelength & frequency:

$$\lambda \propto 1/\nu$$

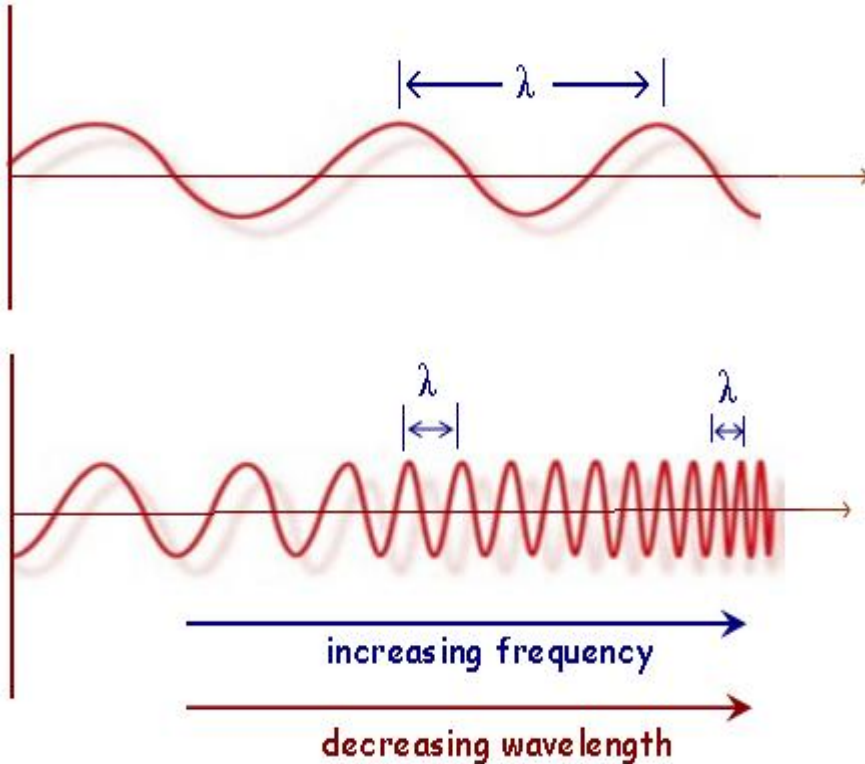
$$\lambda = c/\nu$$

Wavelength = $\frac{\text{speed of light}}{\text{frequency}}$

λ = wavelength (m)

ν = frequency (Hz)

c = speed of light (3×10^8 m/s)

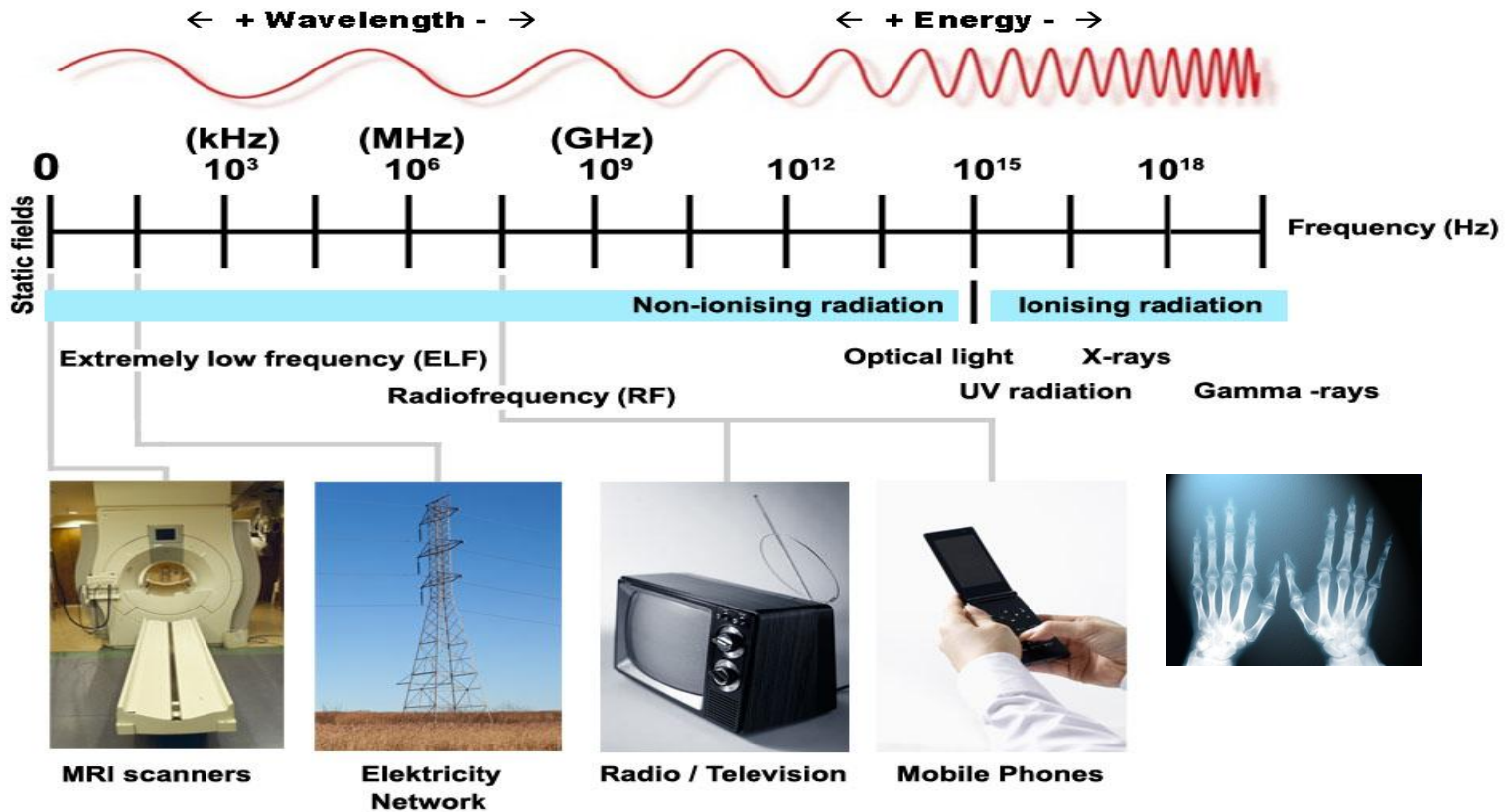




What are EMF?

- **Electromagnetic waves** are a form of **energy**. The quantity of energy contained in a wave depends on the **frequency** and the **wavelength**: the shorter the wavelength, the higher the frequency and energy of the electromagnetic wave.

Electromagnetic spectrum



Man-made sources of EMF



Purpose of the exposure assessment

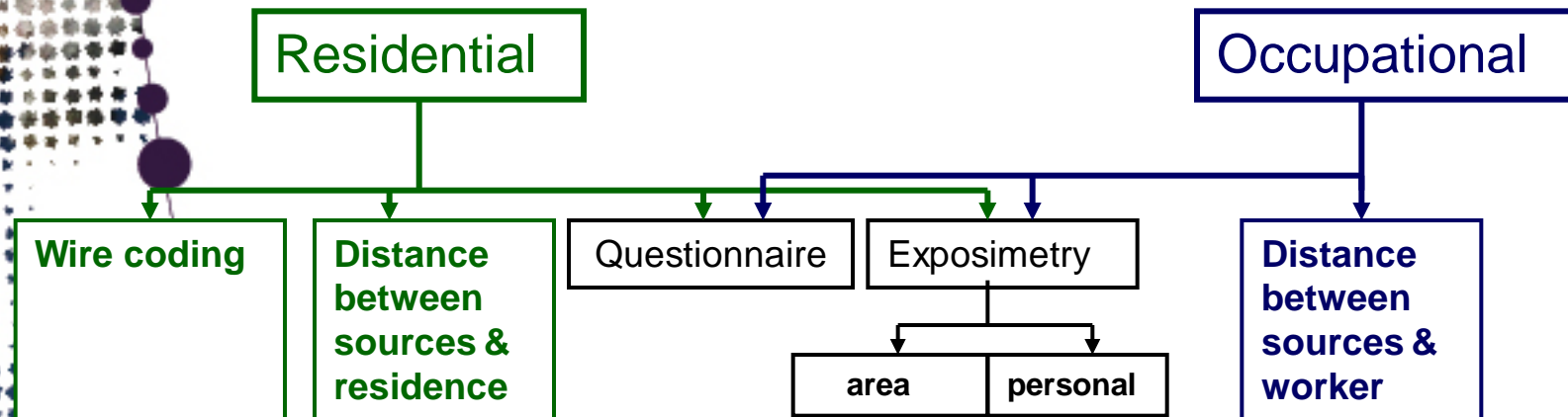
- Hazard surveillance
- Control technology assessment
- Control intervention
- Compliance with exposure guidelines
- Health hazard evaluation
- Epidemiology
- Risk assessment

Purpose of the
exposure assessment

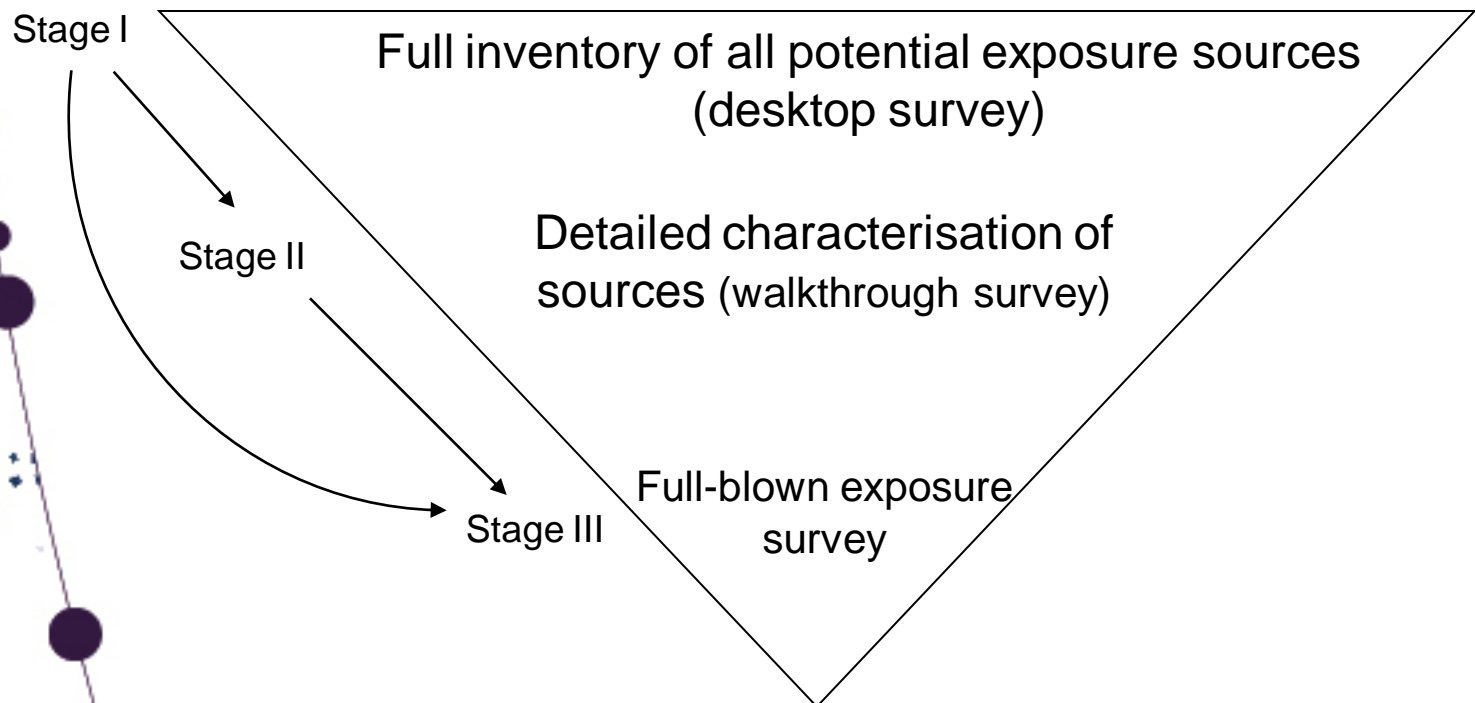


Exposure
assessment method

Exposure methods

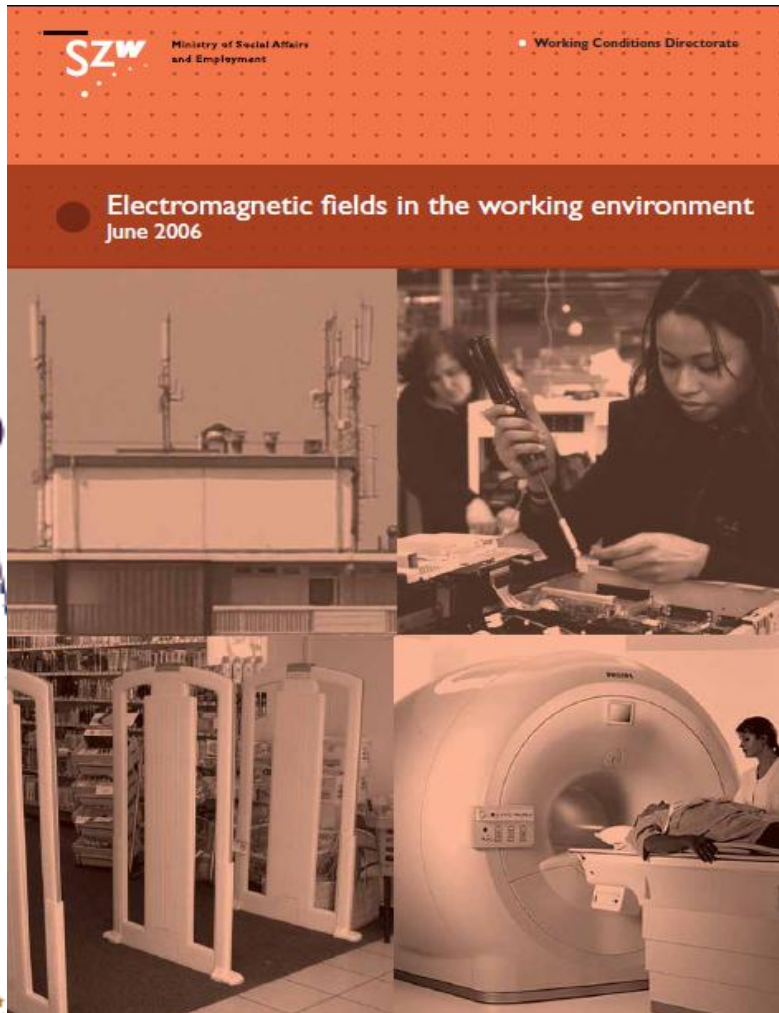


Staged approach for compliance monitoring



Stage I tools

Expert

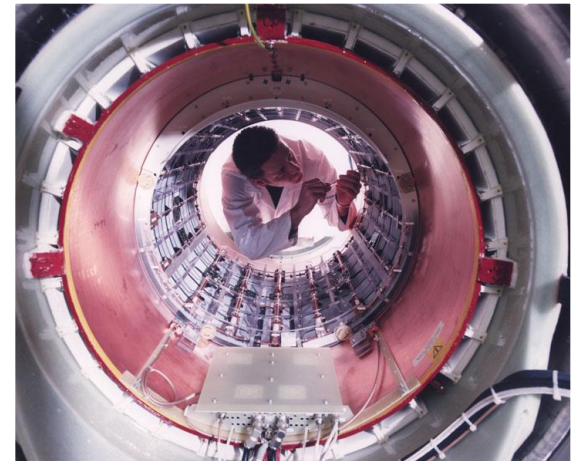
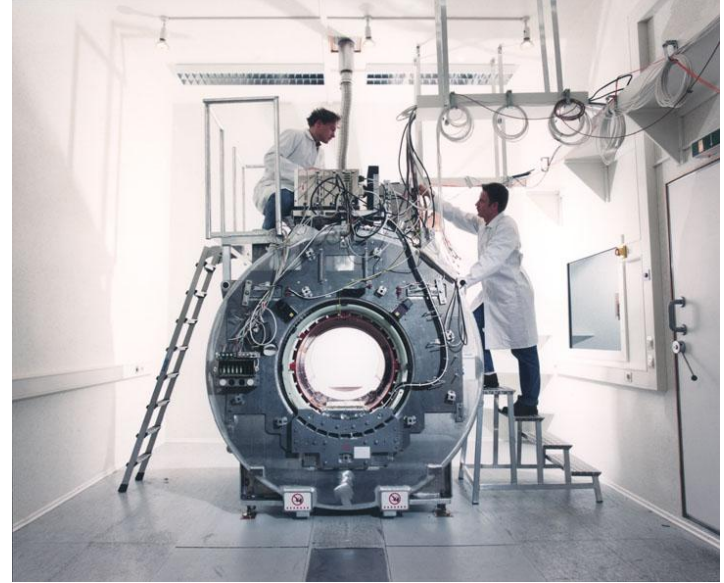


Institute for Risk Assessment Sciences

USE



PRODUCTION



Stage I tools

SZW

Ministry of Social Affairs
and Employment

Working Conditions Directorate

Electromagnetic fields in the working environment June 2006



Institute for Risk Assessment Sciences

Stage I tools – identification of EMF sources

Work env.	Category I	Category II	Category III
1. Installation & maintenance	electrical hand-held tools (ex. welding equipment)	Equipment being installed/maintained ...	Troubleshooting work
3. Dielectric heating	-	•Plastic sealers •Wood gluing equip.	-
4. Electricity production & distribution	Bus bars/conductor rails in substations ...	•Power stations •Air-cooled coils in capacitor banks	-
5. Electrochemical	-		rectifiers
6. Induction heating	Automated systems	•With open coils •Larger furnaces	Smaller smelting furnaces (alloying)
7. Welding	Automated systems	Arc welding (cable; electrode holder)	Spot and induction welding, (manual or semi-automated)
13. Other work environments	Induction hobs in hotel & catering industry (food preparation)	•Tape erasers •RF & microwave lighting •Non-destructive testing	

Stage II/III tools



Emdex Lite

Antennessa SPY 120



FREQUENCY
BANDS:

Fm

Tv3

Tetrapol

Tv4/5

Gsm uplink

Gsm downlink

Dect

Umts uplink

Umts downlink

W-lan

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MEASUREMENT

Mr Dose





Measurement  
ranges:

Static: 0 – 3 T;  
3 – 7T

Gradient field:  
0 – 15 T/s



# ELF-EMF meters

| EMF meters                                                                         | Range<br>( $\mu\text{T}$ ) | Resolution<br>( $\mu\text{T}$ ) | Frequency (Hz)                               | sample<br>Rate<br>(secs) |
|------------------------------------------------------------------------------------|----------------------------|---------------------------------|----------------------------------------------|--------------------------|
|   | standard:<br>0.01 – 70     | 0.01                            | 40 – 1000                                    | 4.0                      |
|                                                                                    | High field<br>0.5 -7000    | 0.5                             | 40 - 1000                                    | 4.0                      |
|  | Standard<br>0.01 – 300     | 0.01                            | 40 – 800 (Broadband)<br>100 – 800 (Harmonic) | 1.5                      |
|                                                                                    | High field<br>0.4 -12000   | 0.4                             | 40 – 800 (Broadband)<br>100 – 800 (Harmonic) | 1.5                      |



# Exposure measurements at Stage II

## Walkthrough survey

- Spot or short-term area measurements
- Hand-held EMF meter
- Measurement at known distances from sources e.g. 0.5 m; 1.0 m

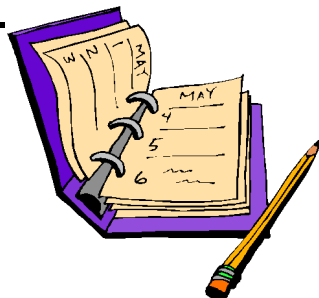


# Exposure measurements at Stage III

- Sampling strategy
  - Personal monitoring
    - Task-based
    - Shift-based
- Measurement equipment
- Meter location: waist, chest
- Work environments (identified in stage II)
- Job/tasks (identified in stage II)
- Repeat sampling

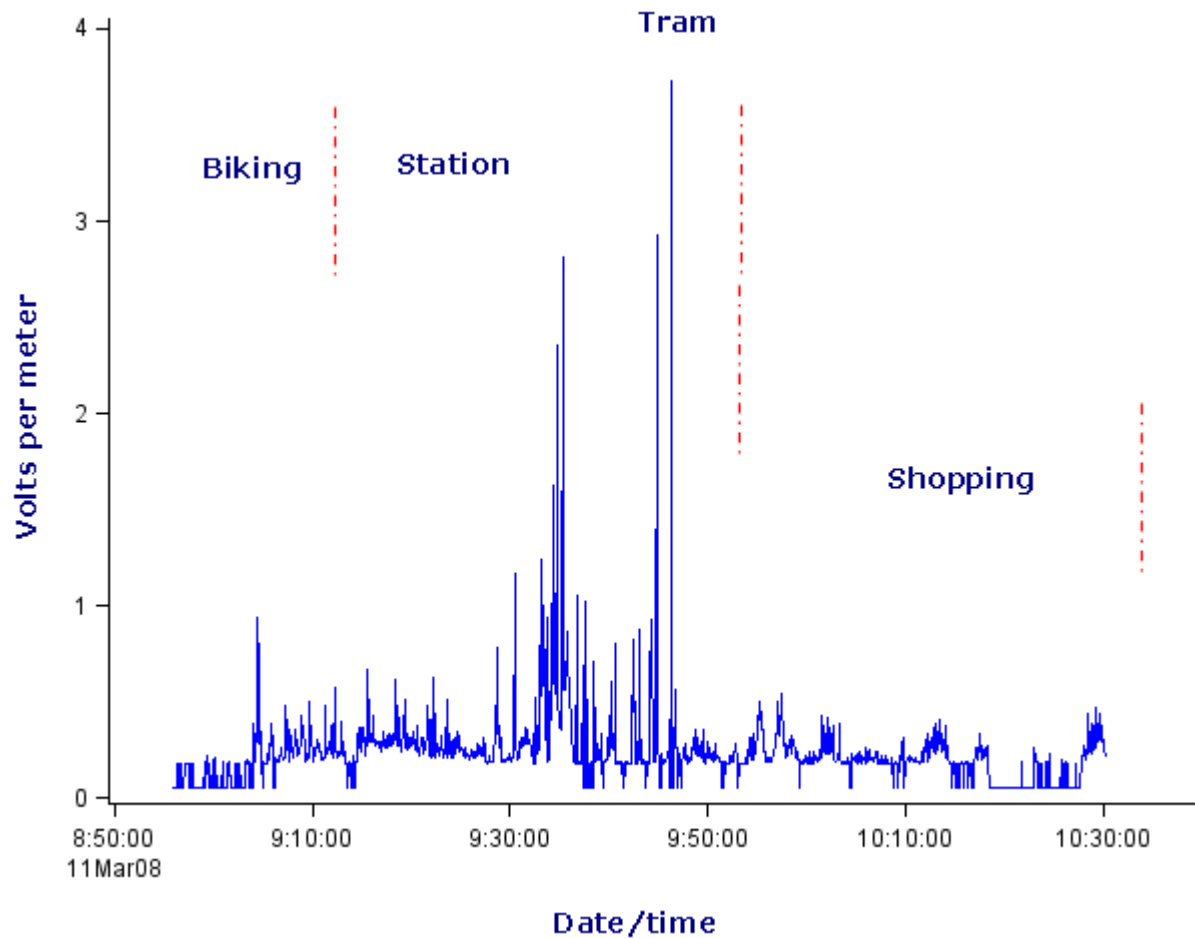
# Personal monitoring

- Exposure data
- Diary data
  - Activities
  - Duration
  - Frequency
  - Location
  - ....





# Exposure monitoring of EMF





# Statistical analysis: ...exposure metrics for EMF

- Traditional metrics
  - TWA-AM
  - TWA-GM
  - 95<sup>th</sup> percentile
  - Max value
  - Geometric standard deviation
- Alternative
  - Peak analysis
    - % measure > threshold
    - Maximum value
    - Rate of change metric

# ...and finally

- In order to choose the appropriate methods to conduct an exposure assessment for EMF one needs
  - to have an understanding of the basic physics for field characterization
  - detailed knowledge of the workplace scenarios (equipment and activity as defined in RIVMs guidance)
  - Knowledge of the available measurement devices including their weaknesses and strengths
  - This will decide on what is the most appropriate approach for the purpose of the exposure assessment