

Study of the Uncertainty and its Minimization in the Measurement of Antenna Gain and Electromagnetic fields

Motivation of the work

$$\text{TRUE VALUE} = \text{MEASUREMENT} \pm \text{UNCERTAINTY}$$

- Telecommunication services require **precise measurements** of antenna parameters. Accepted measurement procedures but **no standard for uncertainty**.
- New modulation schemas in communications, measurement equipment and exposure legislation require a correct assessment of the electromagnetic field.

Uncertainty

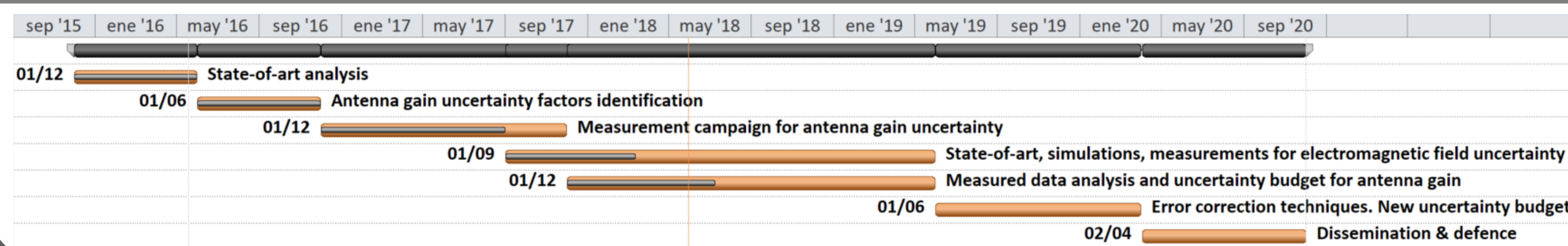
- Quantitative indication of the reliability of the measurement result.
- Implies assessment of all error sources and possible corrections.
- Allows comparison with references or values obtained by others [1].

Thesis objectives

Main objective → characterise uncertainty contributors in antenna gain and electromagnetic field measurements and how to mitigate them:

- State-of-art of uncertainty in antenna and electromagnetic field measurements.
- Identification of the factors contributing to uncertainty.
- Simulations and measurements to quantify each factor.
- Error correction techniques.
- Uncertainty budget.

Research plan



Next year planning

- Simulation and measurements for electromagnetic field uncertainty.
- Analysis of measurement data for antenna gain.
- Uncertainty budgets.
- Study of error correction techniques.

Results & Discussion

ELECTROMAGNETIC FIELD

Uncertainties due to:

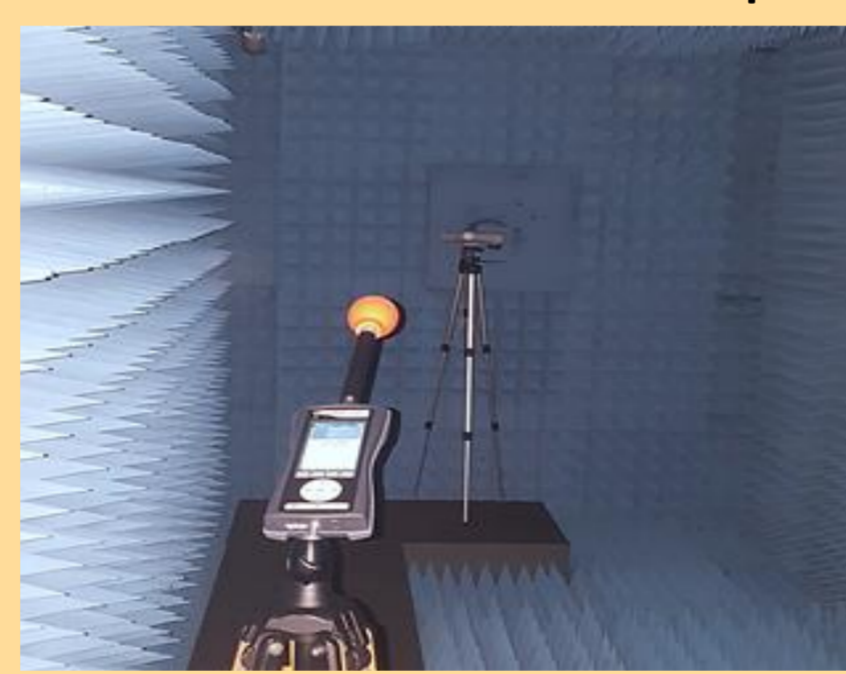
- Measurement equipment
 - Resolution
 - Frequency response
 - Linearity
 - Isotropy
 - Calibration
 - Temperature drift....

Measured signal

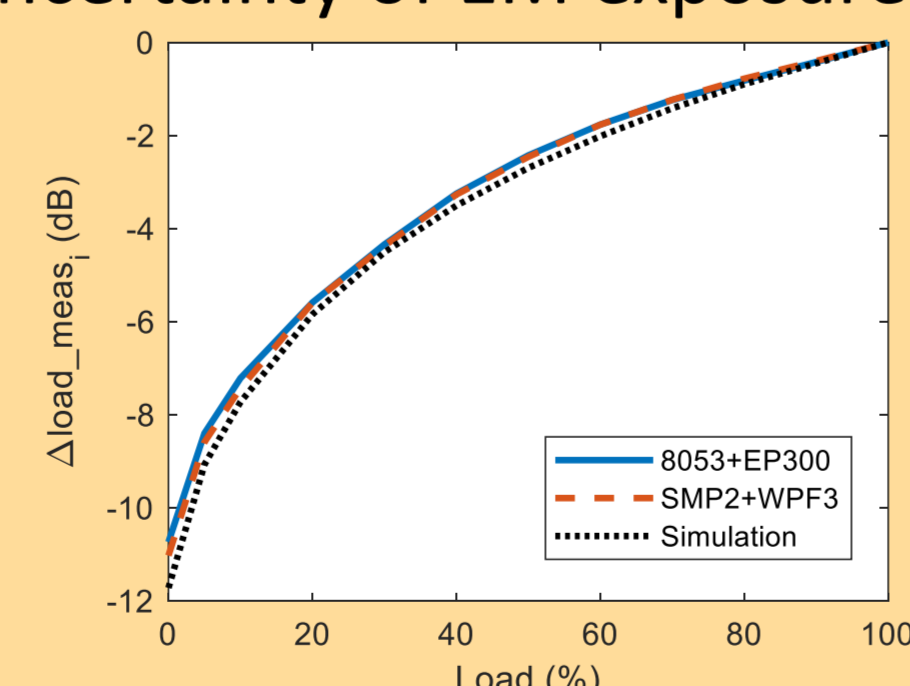
- Modulation
 - Load conditions: →
- E.g. Changes in the field strength due to user load variations lead to uncertainty in EM field exposure assessment [2].

Assessment of uncertainty in EM field exposure measurements due to user load variations:

1. Generation of waveforms with different user load.
2. Simulation of a measurement with an ideal probe.
3. Measurements with real probes.

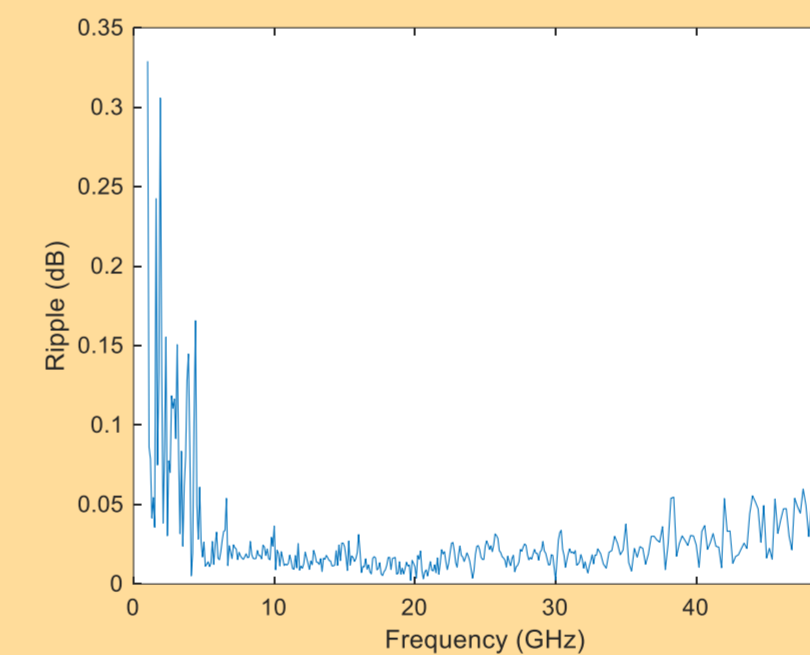


4. Uncertainty of EM exposure level.



ANTENNA GAIN

Chamber ripple



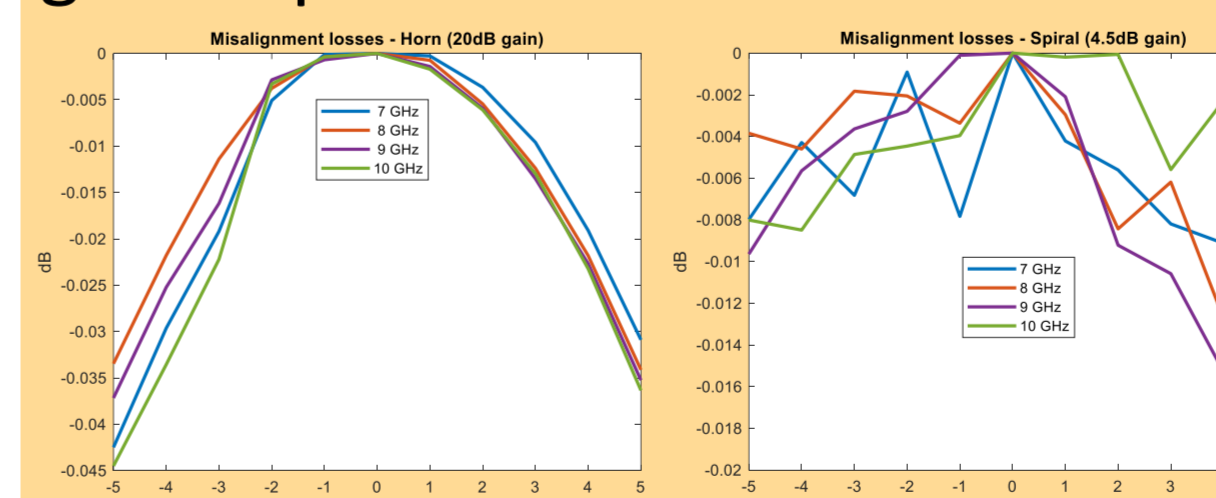
Distance R between antennas

Partial derivatives
 $CR = \partial G / \partial R$; $u_R(G) = |CR| u(R)$

Calibrated device (tape, laser...) with reported $U(R)$

- Calibration uncertainty
- Scale uncertainty

Misalignment: polarization, BW & gain dependant



BOTH

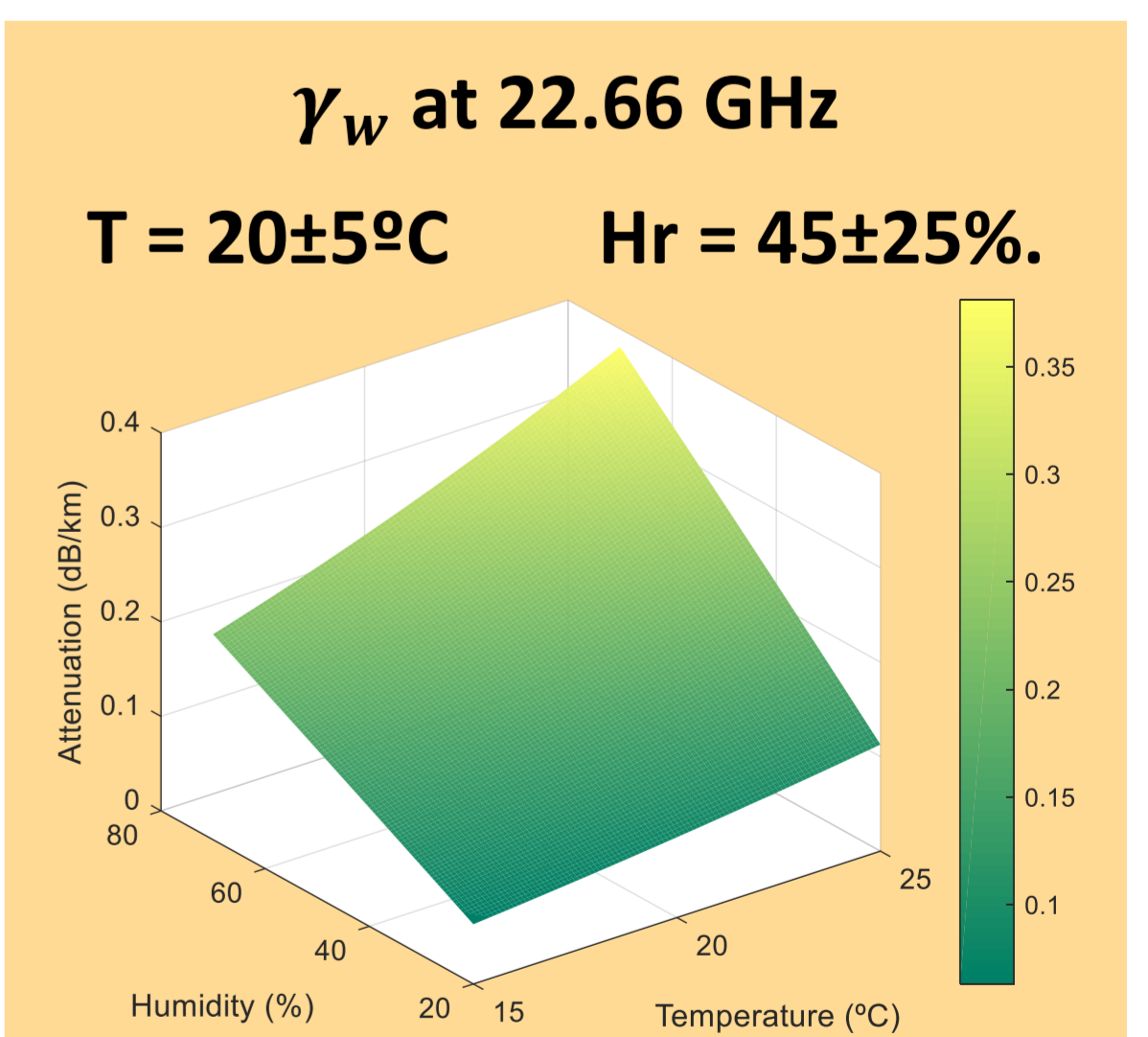
Influence of environmental conditions in electromagnetic measurements uncertainty [3]:

- Always present regardless of the method and facility used.
- Attenuation due to humidity:

$$A = \gamma_w \cdot d$$

Measurement & control of temperature & humidity

Thermo-hygrometer uncertainty



References

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