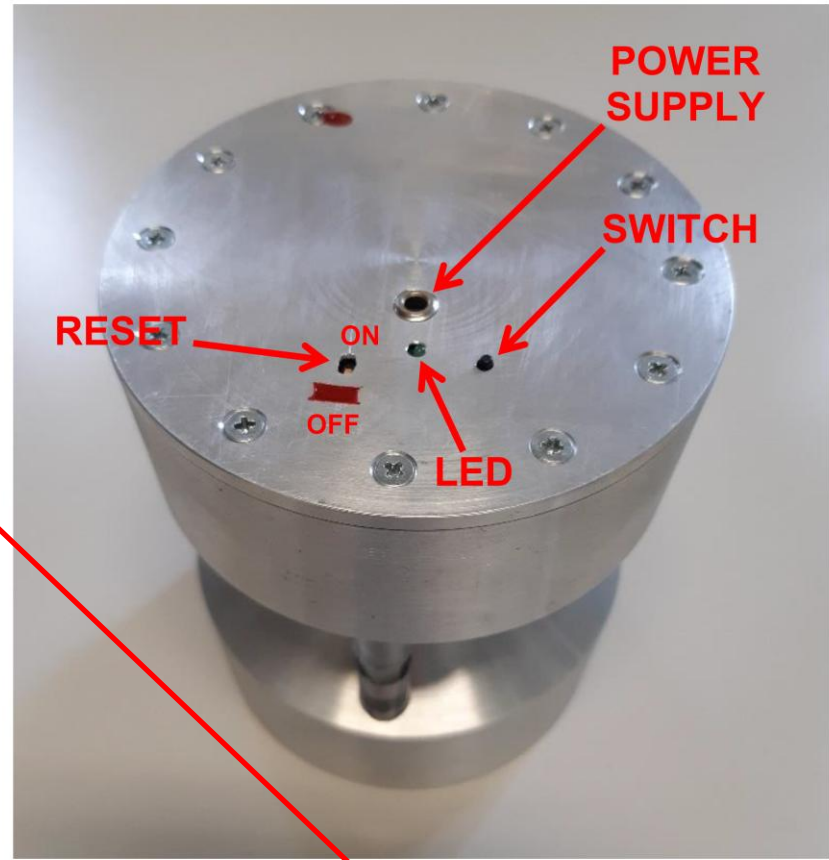


# Proficiency Testing of Radiated Emission Measurements PTC(RE-30-6000-VIII)

Firenze, 15<sup>th</sup> of January 2025  
Rev.0

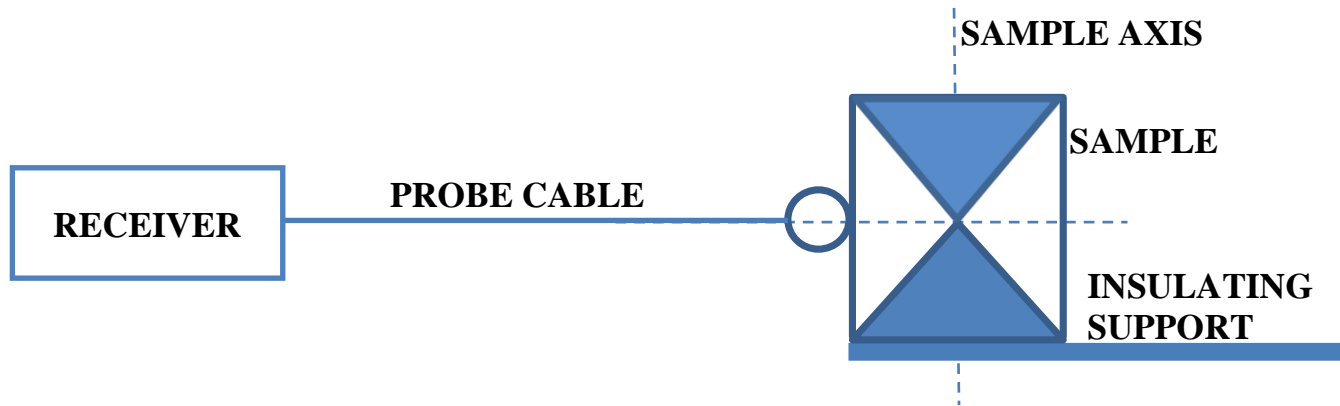
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# Travelling Sample for the 30 MHz to 6 GHz frequency range (Radiated Emission)



**TRAVELLING SAMPLE WITH 4 COLUMN STANDS**  
**NON-ISOTROPIC PATTERN OVER H-PLANE AT HIGH-FREQUENCY**

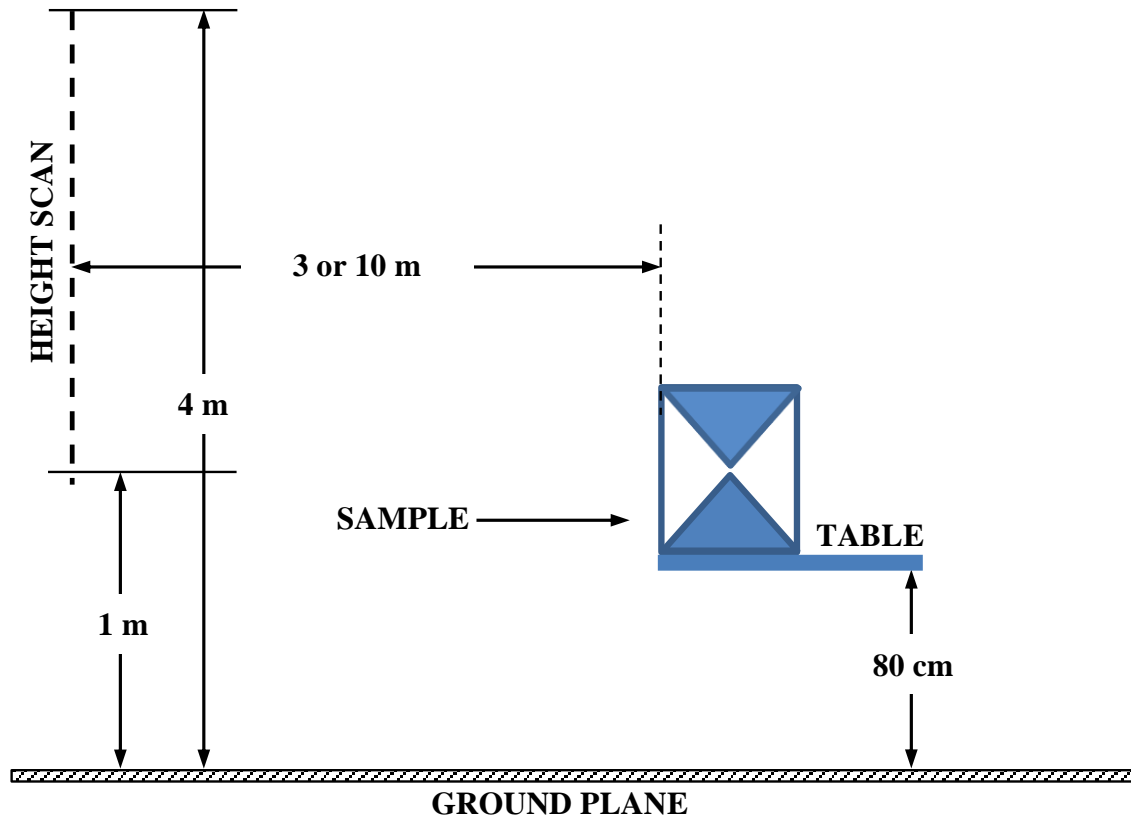
# Preliminary verification



Harmonic #	Frequency MHz	$P_{\text{ref}}$ dBm	$P_{\text{m}}$ dBm	$\Delta$ dB
6	198	-44	Measured value	Deviation

Verification of the power that the probe delivers to the receiver  
 $|\Delta| < 3 \text{ dB}$

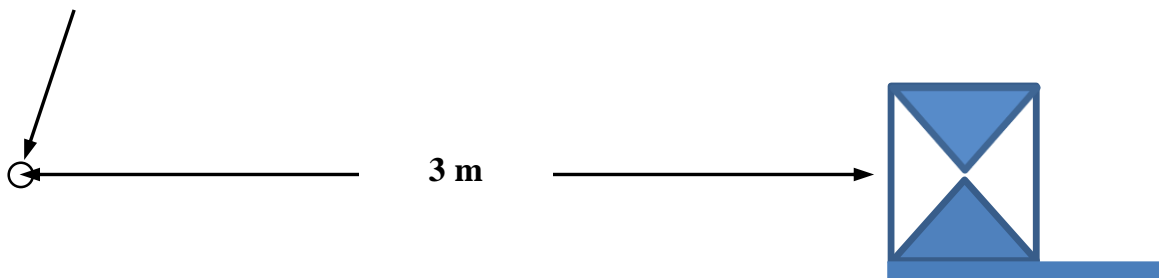
# Measurement setup



30 to 1000 MHz frequency range, semi-anechoic room (3 or 10 m)

# Measurement setup

Measure the field  
here



30 to 1000 MHz and 1000 to 6000 MHz frequency ranges in a fully-anechoic room

# General information

- Number of participants: 16
- Start date: November 2023
- Stop date: December 2024
- Scheme of the proficiency test PTC(RE-30-6000-VIII):  
<https://www.dinfo.unifi.it/vp-436-schemes-of-the-proficiency-tests.html>
- Issues faced:
  - Some laboratories issued the report (annex C) with a severe delay (several months) with respect the expected date (1 week after measurements).
  - 1 multi-site laboratory was severely delayed in performing measurements with respect to the scheduled weeks (nearly 3 months). The PT closed with the same delay.

# Measurement procedure: preliminary verification

- Radiated electromagnetic field measurement must be preceded by a preliminary verification of the correct operation of the Sample by using the magnetic field probe provided by the Coordinator, a short section of coaxial cable (length less than 1 m, not provided by the coordinator) and a receiver (spectrum analyzer or EMI receiver). The verification shall be as follows:
  - Connect the probe to the input of the receiver through the short section of coaxial cable.
  - Put the Sample on the same table used for radiated emission testing of table-top equipment.
  - Turn on the Sample. The Sample shall be fed by its internal battery (the Sample shall not be connected with the power supply).
  - Place the probe in the position sketched in slide 3. In particular the probe shall be positioned so that its cable is perpendicular to the axis of the Sample and at half height of the Sample. The plane of the loop shall be the one containing the probe cable and the axis of the Sample. The probe shall touch the plastic wall of the Sample.
  - Use your hand to support the probe. No special care is required.
  - Measure the power  $P_m$  that the probe delivers to the input of the receiver at the frequency of the 6th harmonic (about 198 MHz). Register the values of  $P_m$  (in dBm, rounded to the integer) in the table in slide 3. Calculate and annotate the deviation  $\Delta$  (in dB, rounded to the integer).
  - Verify that:
    - The measured power decreases by at least 20 dB rotating the probe by 90°;
    - $-3 \text{ dB} < \Delta < 3 \text{ dB}$

## Measurement procedure: 30 – 1000 MHz, semi-anechoic room

- The scope of the measurement is to obtain the best estimate and measurement uncertainty of the maximum electric field strength, in dB( $\mu$ V/m), emitted by the Sample in vertical polarization at the specified horizontal distance from the Sample (3 or 10 m) at a height between 1 and 4 m above the reflecting ground plane, see slide 4. The reference of the Sample for distance measurement is the plastic wall of the Sample. The use of the same measuring instrumentation as that used for radiated emission tests in the corresponding frequency range is recommended. Measurement frequencies are selected by the Coordinator.
- Measurement procedure is according to §7.3 of EN 55016-2-3:2017/A1:2019.



## Measurement procedure: 30 – 1000 MHz and 1000-6000 MHz, fully-anechoic room

- The scope of the measurement is to obtain the best estimate and measurement uncertainty of the electric field strength, in dB( $\mu$ V/m), emitted by the Sample at 3 m distance from the Sample in the boresight direction. The reference of the Sample for distance measurements is the plastic wall of the Sample facing the receiving antenna. The use of the same measuring instrumentation as that used for radiated emission tests in the corresponding frequency range is recommended. Measurement frequencies are selected by the Coordinator.
- Measurement procedure is according to §7.4 of EN 55016-2-3:2017/A1:2019 and §7.6 of EN 55016-2-3:2017/A1:2019.

# Other instructions

- It is up to the Laboratory to charge the battery before preliminary verification and measurement. Handle the Sample with care.
- The EMI receiver's detector shall be set to average.
- The measurement result provided by the Laboratory shall be:
  - The estimate  $x$ , expressed in dB( $\mu\text{V}/\text{m}$ ), of the amplitude of the selected harmonics;
  - The expanded uncertainty of the estimate  $x$ ,  $U_{lab}$ , expressed in dB and obtained multiplying the combined standard uncertainty by the coverage factor  $k = 2$  (which corresponds to a coverage probability of about 95 % assuming normal distribution).
- The Laboratory may assign a different value of  $U_{lab}$  to each measured frequency.
- The measured disturbance electric field strength  $x$ , in dB( $\mu\text{V}/\text{m}$ ), shall be rounded up to 1 decimal figure (e.g. 68,5 dB( $\mu\text{V}/\text{m}$ )). Measurement uncertainty  $U_{lab}$ , in dB, shall be rounded up to 2 significant figures (e.g. 3,2 dB).

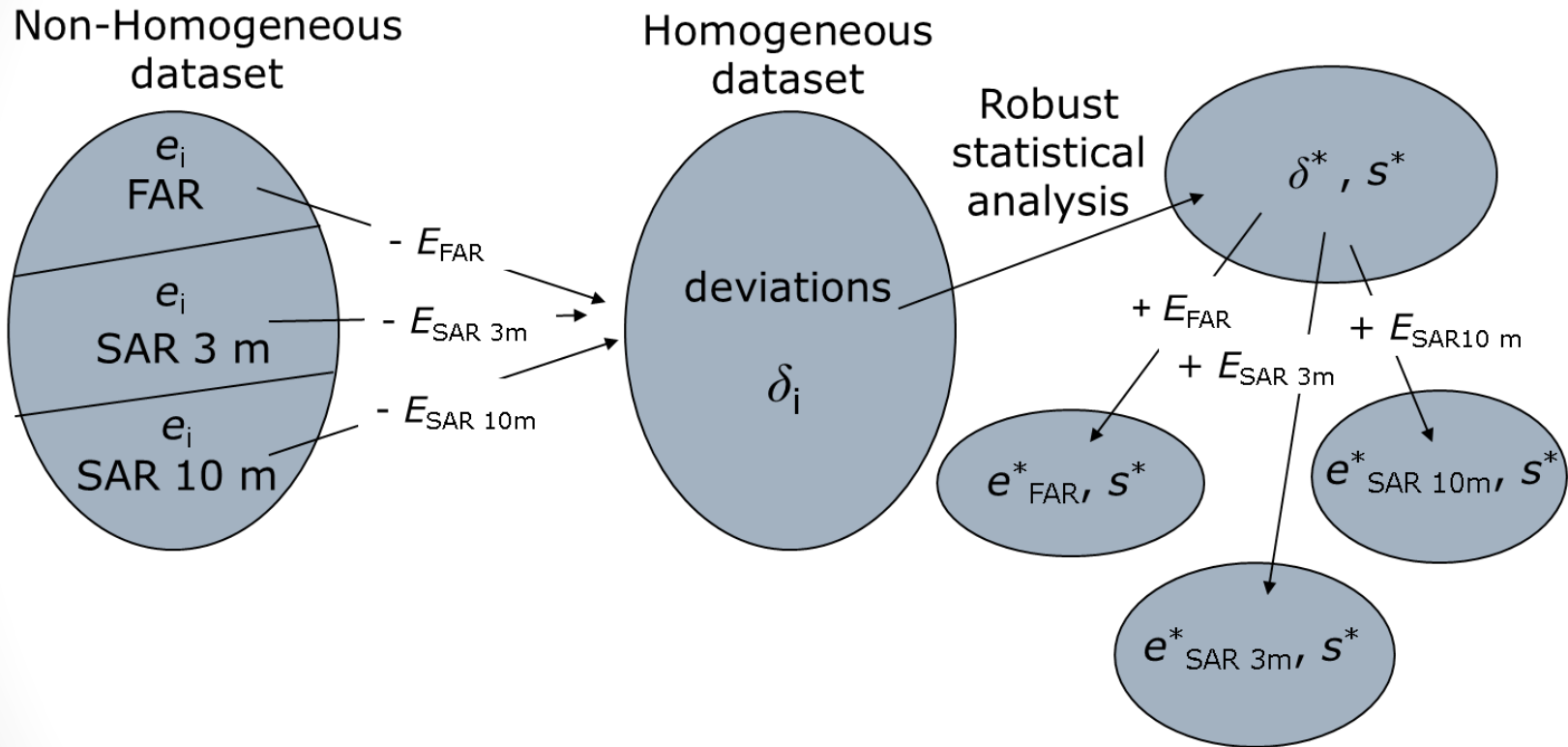
# Reference values

Reference  
values

Statistical analysis of  
measurement results

$\bar{x}^*$ ,  $s^*$

# Inhomogeneous data below 1 GHz



Frequency dependent corrections from FAR to SAR (3 m and 10 m distances and antenna scanning from 1 m to 4 m) are analytically known for short dipoles and applied. This permits to statistically process inhomogeneous data.

# Statistical (robust) analysis

$x_1, x_2, \dots, x_i, \dots, x_p$  } Raw data ( $p$  participants)

$x^* = \text{median of } x_i \quad (i = 1, 2, \dots, p)$

$s^* = 1,483 \text{ median of } |x_i - x^*| \quad (i = 1, 2, \dots, p)$

} Initial reference value

$\delta = 1,5s^*$

$x_i^* = \begin{cases} x^* - \delta, & \text{if } x_i < x^* - \delta \\ x^* + \delta, & \text{if } x_i > x^* + \delta \\ x_i, & \text{otherwise} \end{cases}$

} Transformed set of data

$x^* = \sum x_i^* / p$

$s^* = 1,134 \sqrt{\sum (x_i^* - x^*)^2 / (p - 1)}$

} New reference value  
(iterative algorithm)



# Performance statistic $\zeta$ (Participant)

- Performance statistic  $\zeta$  (clause 9.6 of ISO 13528:2015) that the Coordinator applies to the Participant providing the measurement result  $x_i$  with standard uncertainty  $u_{x_i}$

$$\zeta_i = \frac{x_i - x^*}{\sqrt{u_{x_i}^2 + \left(\frac{1,25 \cdot s^*}{\sqrt{p}}\right)^2}}$$

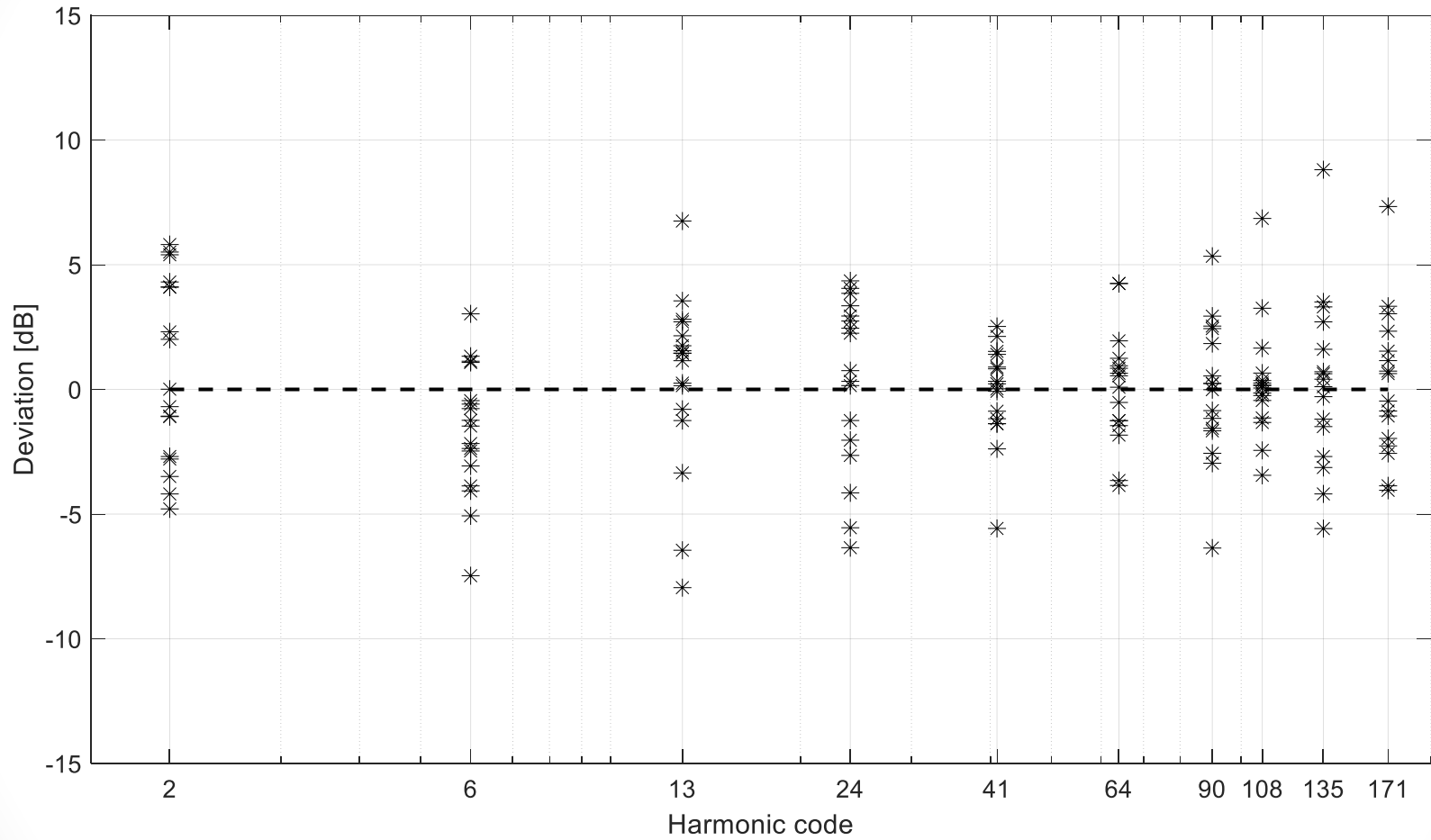
$$\begin{cases} 2 < |\zeta_i| < 3 \Rightarrow \text{warning} \\ 3 < |\zeta_i| \Rightarrow \text{action} \end{cases}$$

# Results

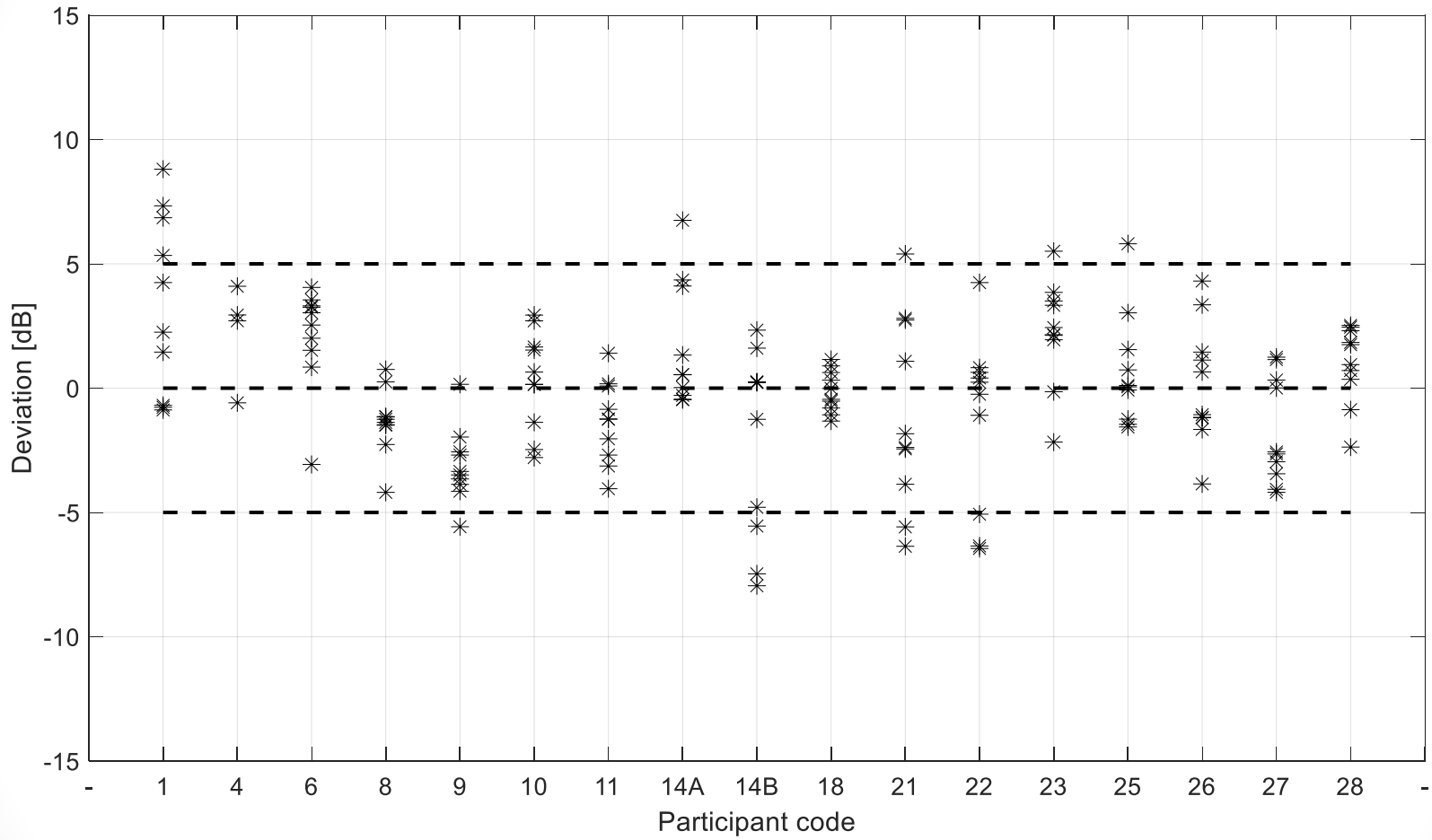
# Harmonic code to frequency conversion

Band	Harmonic code	Frequency MHz
C	2	66
C	6	198
D	13	429
D	24	792
E	41	1353
E	64	2112
E	90	2970
E	108	3564
E	135	4455
E	171	5643

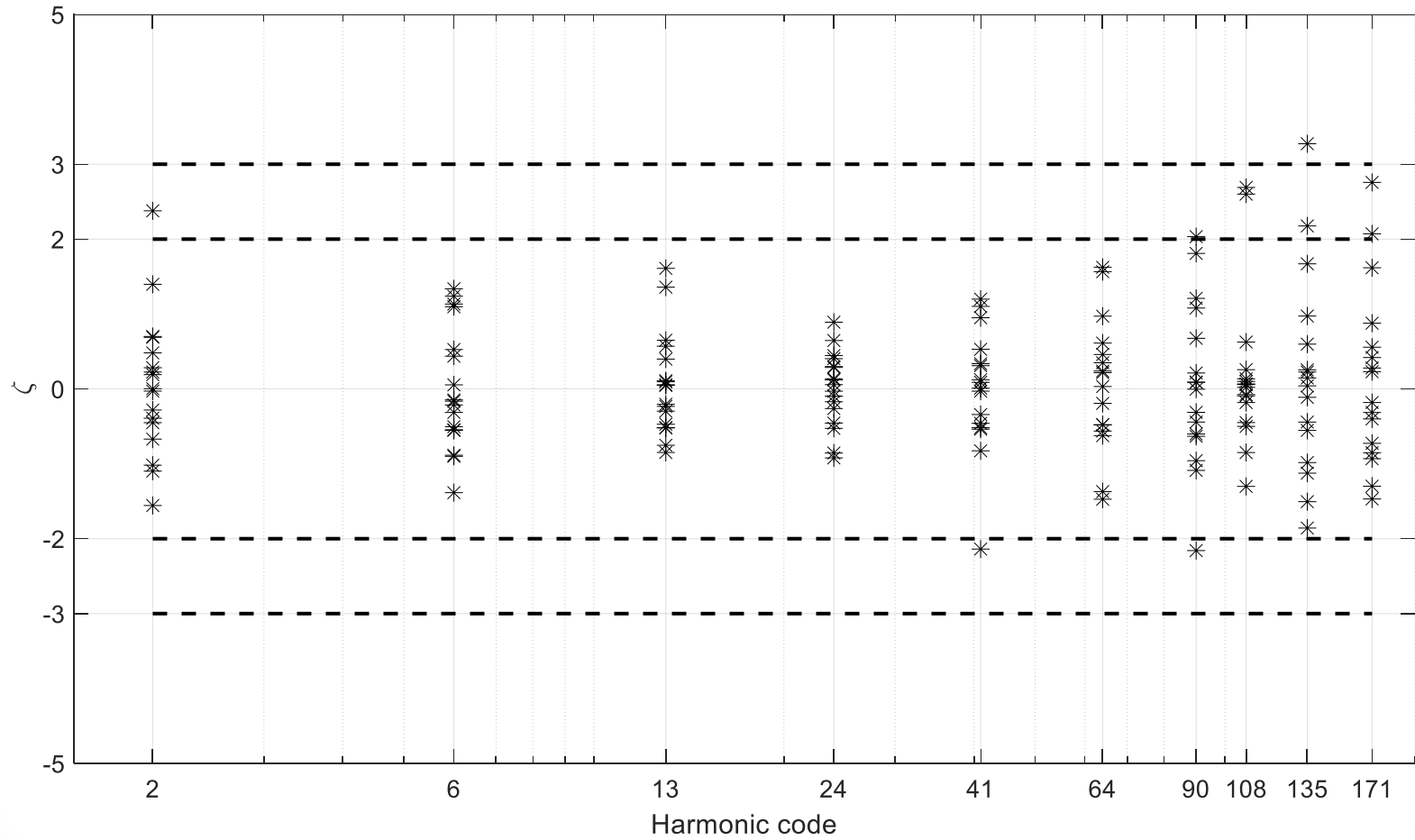




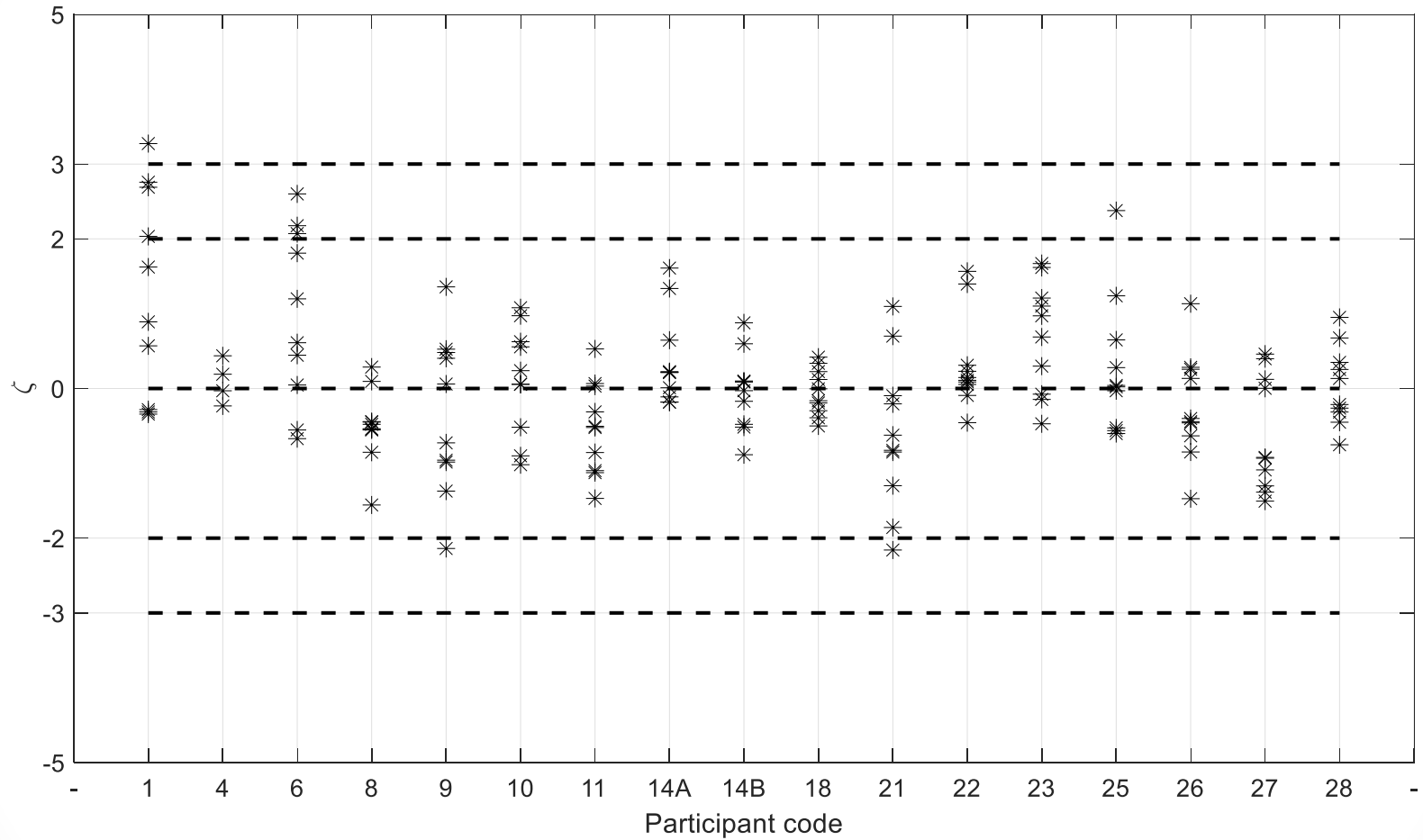
- Deviations from reference value  $x^*$  (horizontal axis is harmonic code)



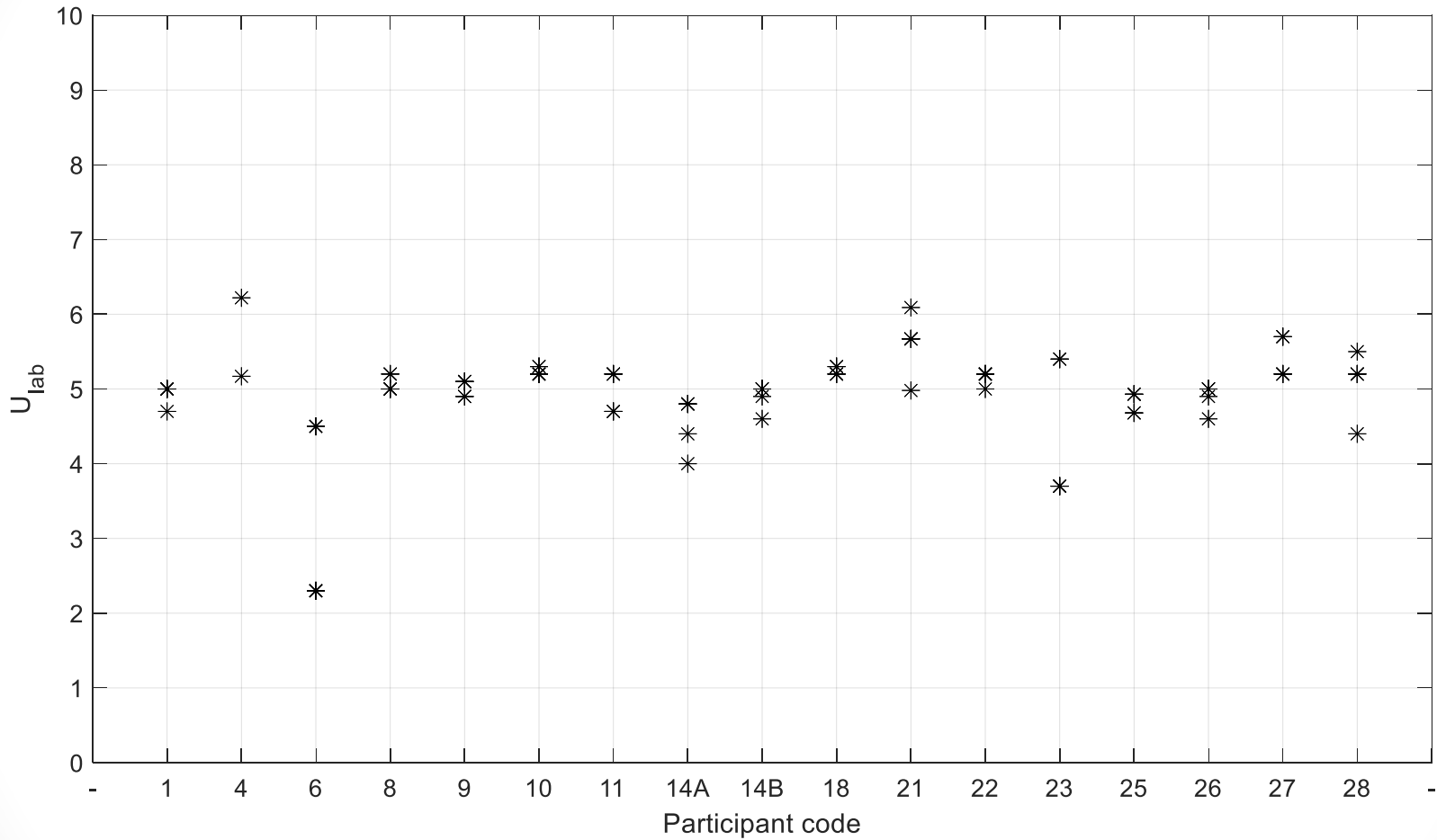
- Deviations from reference value  $x^*$  (horizontal axis is participant code)



- Performance statistic  $\zeta$  (horizontal axis is harmonic code)



- Performance statistic  $\zeta$  (horizontal axis is participant code)



- Expanded uncertainty  $U_{lab}$  (horizontal axis is participant code)

# Measurement reproducibility (quantified by robust std. dev. $s^*$ )

<b>Band</b>	<b>Harmonic #</b>	<b>Frequency MHz</b>	<b><math>s^*</math> dB</b>
C	2	66	2.3
C	6	198	2.4
D	13	429	1.6
D	24	792	1.2
E	41	1353	1.7
E	64	2112	2.5
E	90	2970	2.6
E	108	3564	1.6
E	135	4455	3.2
E	171	5643	2.9

# Remarks

- The raw measurement results provided by the 17 participants at the 10 measurement frequencies selected by the Coordinator are within -8 dB to +10 dB from reference value  $x^*$ .
- 9 warning and 1 action signals are detected over 164 measurement results.
- 12 laboratories do not exhibit any anomaly.
- Standard measurement uncertainty declared by the laboratories comprised between nearly 1,2 dB and 3,1 dB, robust standard deviation  $s^*$  is between 1,2 dB and 3,2 dB.
- Relatively larger spread  $s^*$  at increasing frequency (effect of non-isotropic pattern over H-plane)