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Typical 5G Scenarios in Republic of Croatia – Measured Values of Electric Field

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HrZZ Hrvatska zaklada za znanost

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CONTENT

INTRODUCTION

- In recent years, a new technology known as 5G New Radio (5G NR) has played a significant role in wireless communication.
- To mitigate potential adverse effects of non-ionizing radiation and to enable continuous monitoring of electromagnetic field (EMF) levels, measurements conducted in the vicinity of the base station antenna (BSA) are constantly of significant public interest.
- Currently, the most commonly used frequency range in 5G NR is between 3.5 GHz and 3.8 GHz with a channel bandwidth of 100 MHz.

Fig I. Typical BSA

MEASUREMENT PROCEDURES IN 5G NR

- There are several measurement procedures applicable in 5G NR:
  - A Code-Selective Procedure (CSP),
  - Frequency-Selective Procedure (FSP) and
  - Channel Power Procedure (ChP)

- The ChP measurement procedure is based on measuring the power (electric field) of the transmitted channel in the frequency domain.

- To perform ChP measurements, an active data flow is required.

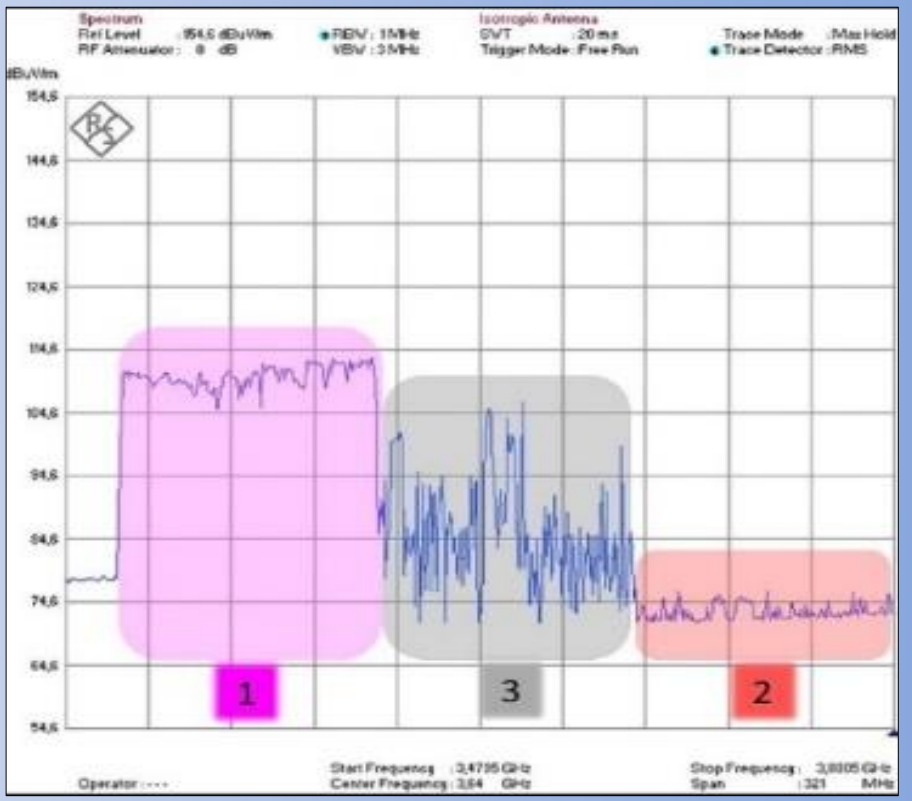

Fig II. Channel Power measurement procedure

MEASUREMENT-BASED DATABASE

- For the purpose of this study, a measurement-based database has been developed comprising 3,000 measurement records collected between 2023 and 2025 in the vicinity of 547 BSA distributed across the territory of Croatia.
- In addition to the measured electric field values, the database includes the distance between each measurement location and the corresponding BSA, exposure area type, MIMO configuration, antenna type, total antenna tilt, effective isotropic radiated power (EIRP), main lobe horizontal offset, and an indoor/outdoor measurement indicator.
- It is important to emphasize that all measurement results have been obtained using the ChP measurement procedure, taking into account the TDD correction factor (0,75) and a predefined measurement uncertainty.
- No Power Reduction Factor (PRF factor) was included in the post-processing procedure.

RESUSLTS

- Thanks to the provided technical antenna data, it has been determined that only four 5G antenna manufacturers are represented.

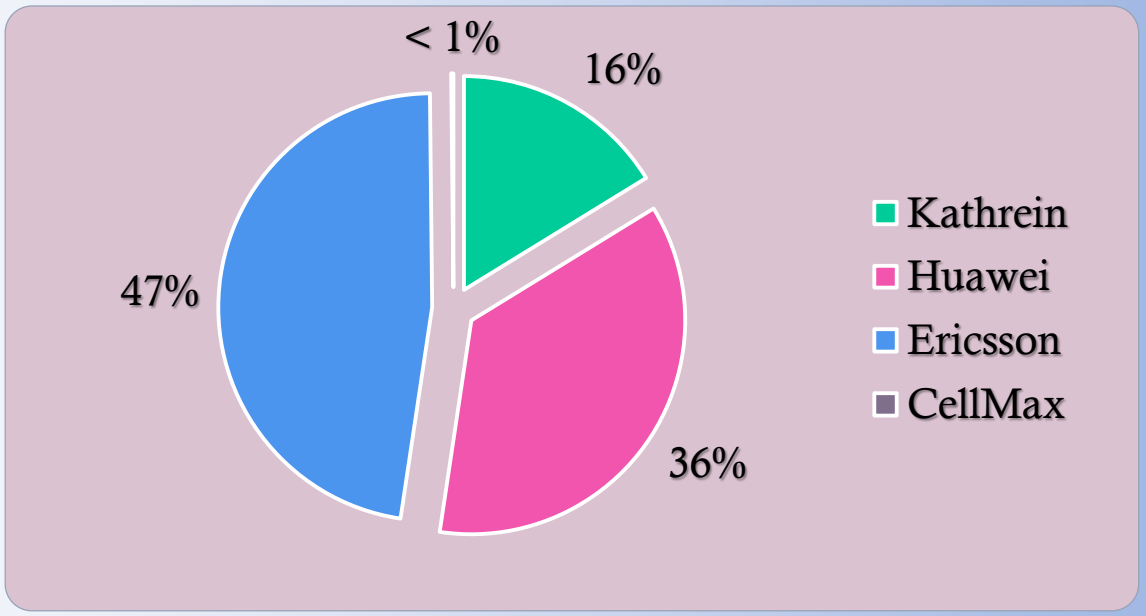

Fig III. The shares of 5G antenna manufacturers

RESUSLTS

- Since 5G technology employs multiple transmitters and receivers, it is interesting to examine the MIMO systems present in the considered BSA:

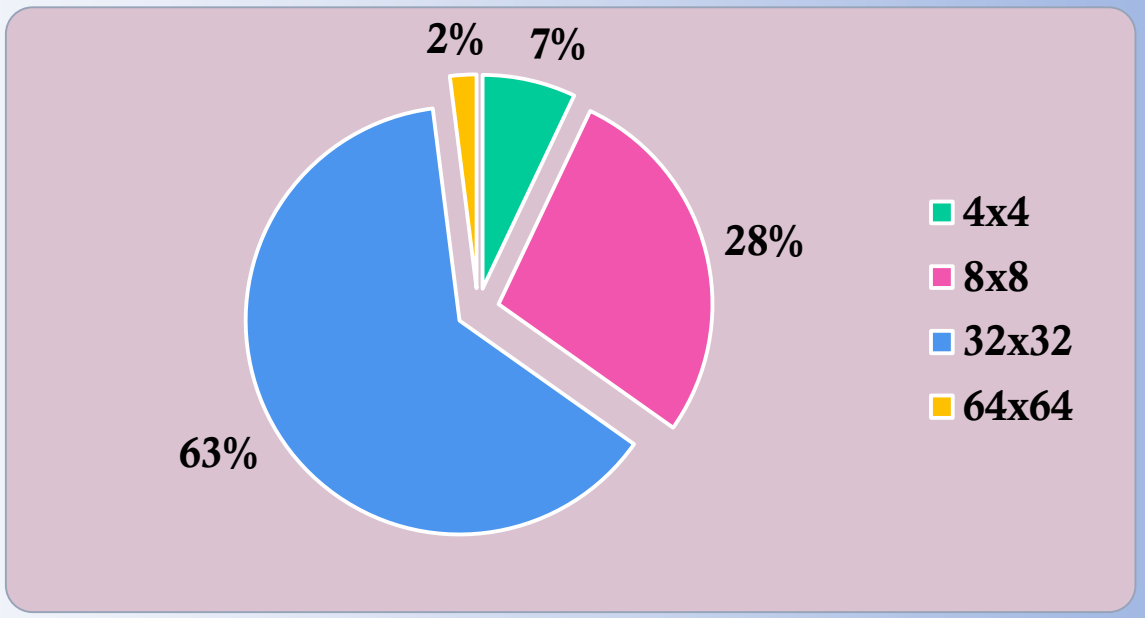

Fig IV. MIMO configuration shares

RESUSLTS

- The measurements have been conducted at distances ranging from 3 m to 382 m from the BSA.
- Nearly 85% of the measurements have been taken within 200 m of the BSA (Fig V.)
- The average horizontal main lobe offset is found to be 10.7° (Fig VI.)

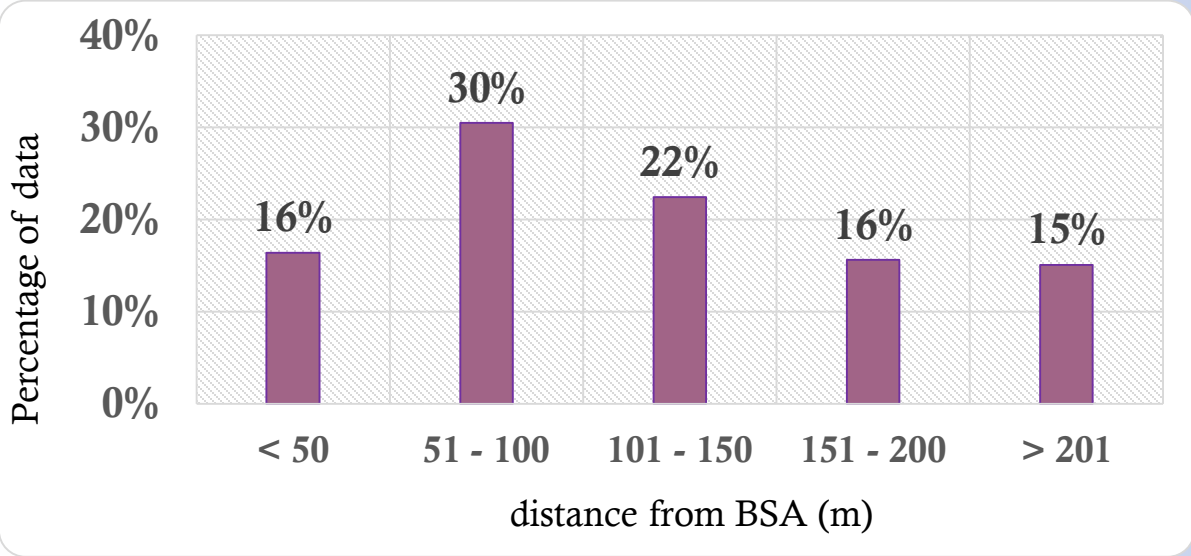

Fig V. Distribution of distances between measurement locations and BSA

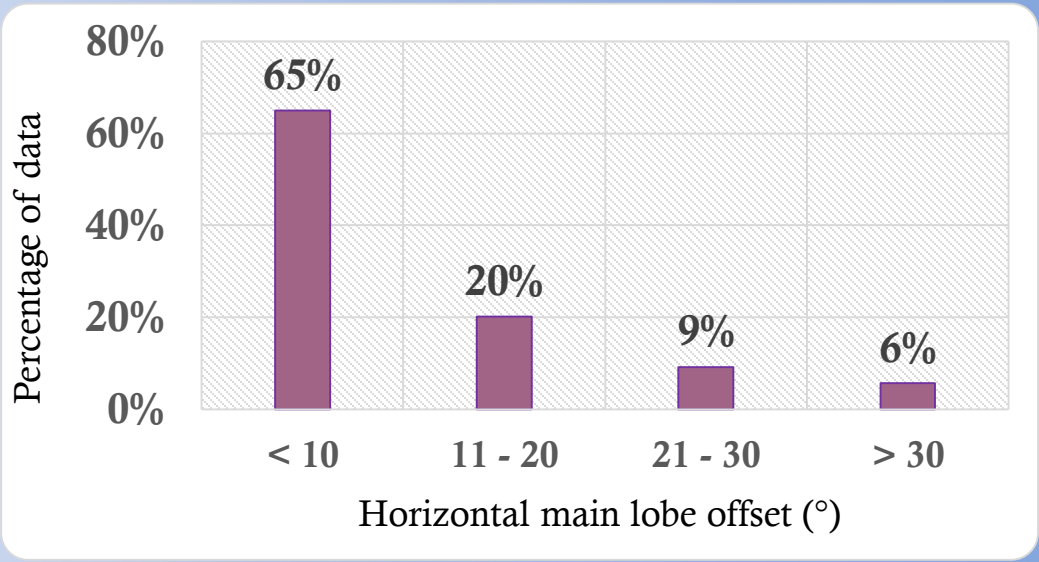

Fig VI. Percentage of data within specific horizontal main lobe offset

RESUSLTS

- The average radiated power is 64.6 dBm.
- Within two standard deviations, the radiated power is most likely to fall within the range between 55 and 74 dBm, approximately.

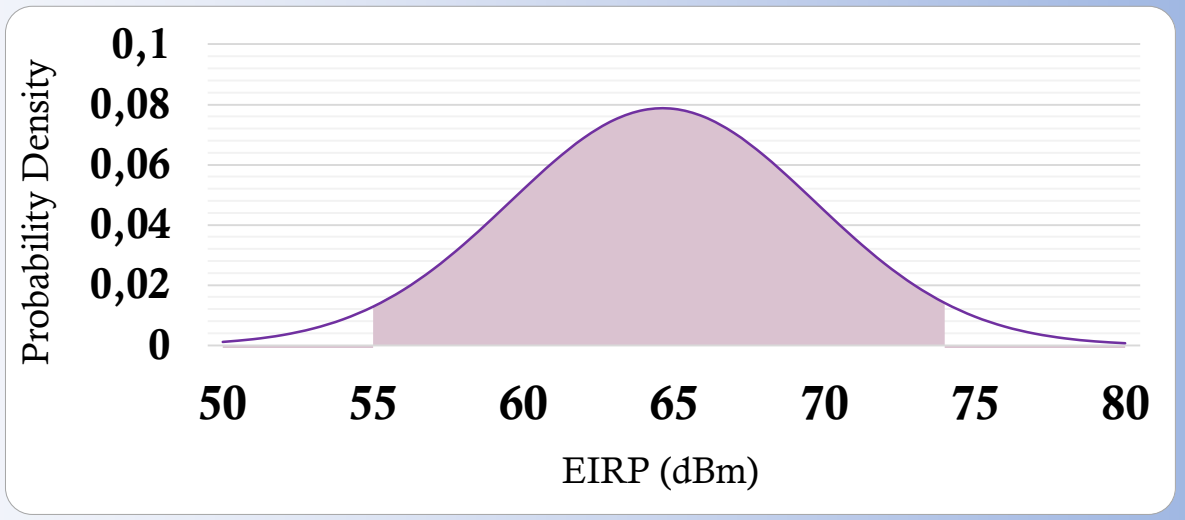

Fig. VII. Distribution of distances between measurement locations and BSA

RESUSLTS

- The minimum detected electric field strength is 0.1 V/m
- The highest value reaches 34.9 V/m.
- The average measured value is 4.5 V/m.
- Standard deviation is equal to 3.6 V/m.
- Double standard deviation is equal to 7.2 V/m

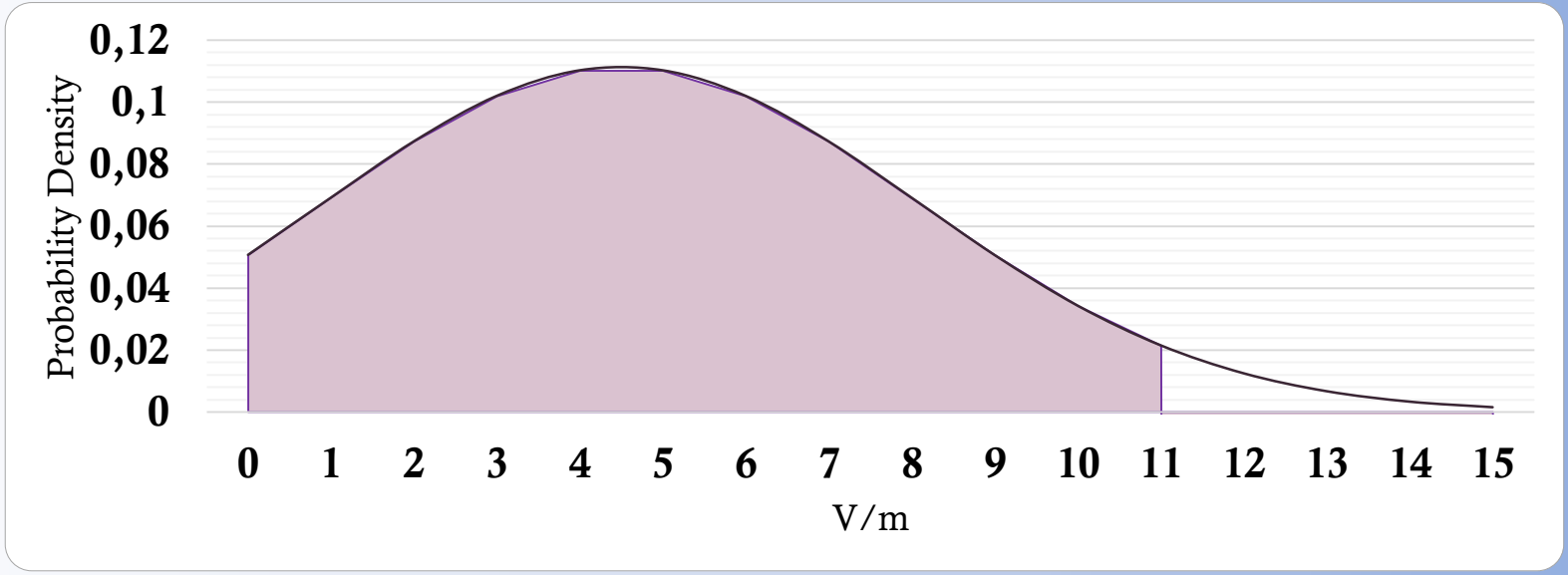

Fig. VIII. Distribution of distances between measurement locations and BSA

RESUSLTS

- The measured values with respect to distance from BSA (red line presents the treshold of 24.40 V/m):

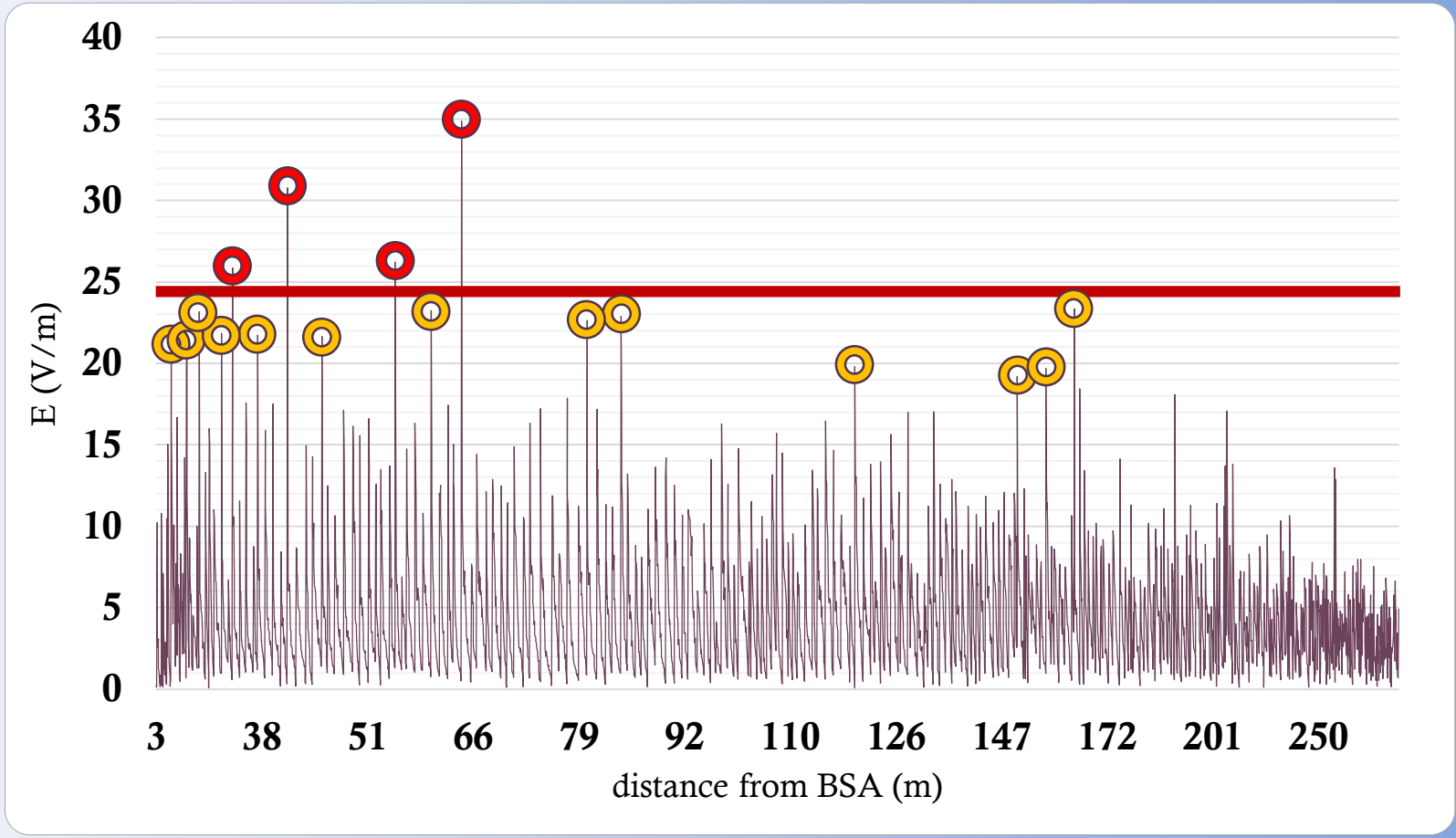

Fig. IX. Electric field strength with respect to distance from BSA

RESUSLTS

- Electric field mean values with standard deviation (σ, green curve) and double standard deviation (2σ, red curve):

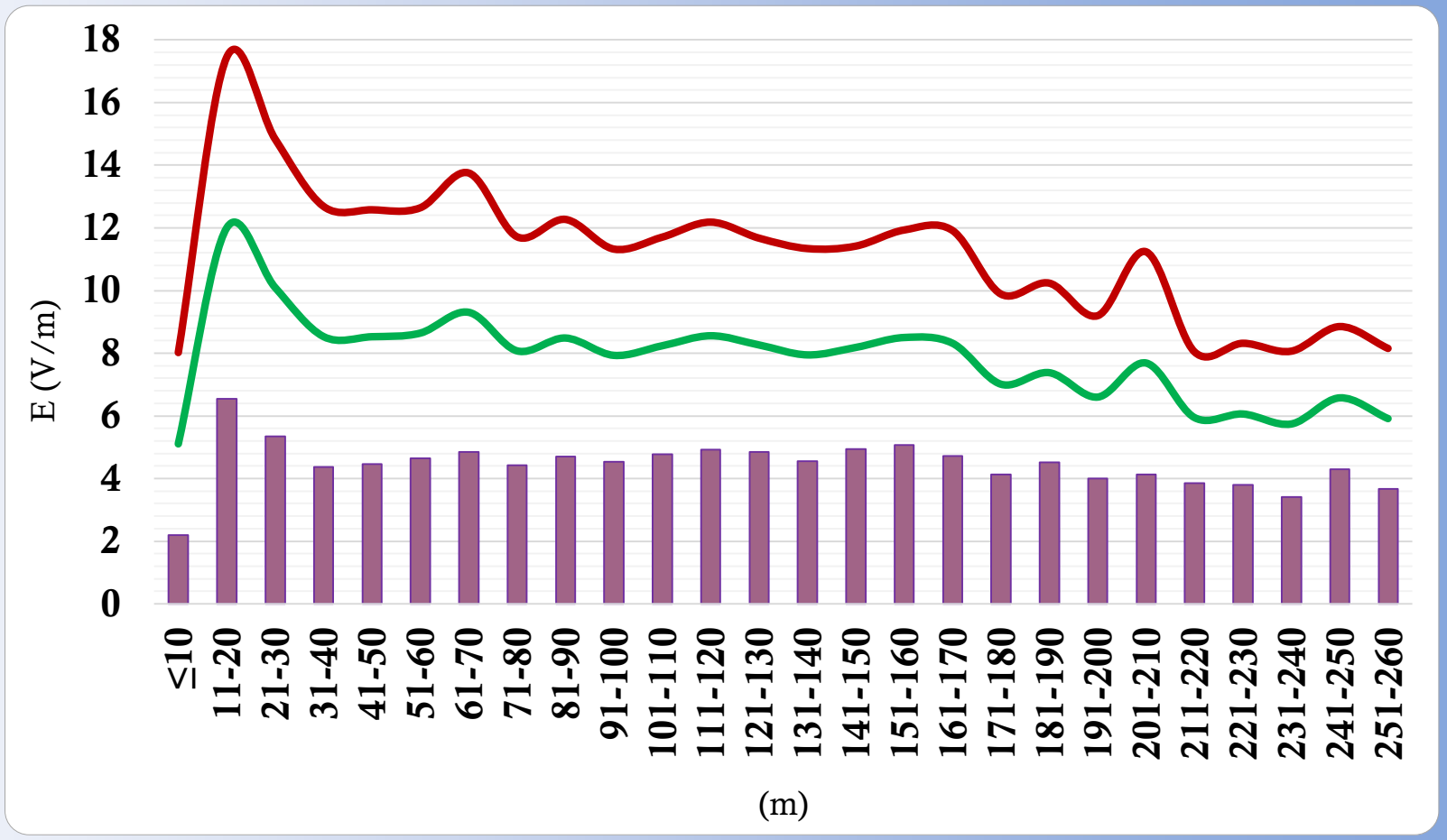

Fig X. Electric field mean values with standard deviation (σ) and double standard deviation (2σ)

DISCUSSION & CONCLUSION

CHALLENGES AND LIMITATIONS

- Field issues! ⇒ Inability to select measurement points with the strongest expected electric field.
- Database missing information:
  - vertical main lobe offset,
  - antenna height,
  - measurement point height,
  - altitudes,…
- FUTURE WORK…

CONCLUSION

- 3,000 electric field measurements.
- three 5G antenna manufacturers are predominantly represented in Croatia.
- The most common MIMO configuration is 32T32R.
- All measured values are below coresponding safety limits, except of four specific cases.
- had the PRF factor been included in the post-processing, the EMF values would have decreased in proportion to √PRF.

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THANK YOU FOR YOUR ATTENTION!

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