

Radiation pollution and its impact on living creatures in and around Bangalore

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ABSTRACT

Radiation is a composition of energy, the one which gets emitted from any gadget of electronic origin which can travel through space. The amount of radiation being emitted by electronic gadgets has been escalating every year over the decade that has eventually led to radio-frequency noise pollution. The utilization of number of smart phones has expanded over the years that has no side effects on humans as this level (on an average of 1.72 GHz) of radiation pollution is tolerable by us but has accelerated the degradation of the lives of small birds such as sparrows leading to endangered bird population. The emitted radiations are non-ionizing in nature which causes interference in signal communication. Interference can be quoted as unwanted disturbance which leads to challenges like coverage problem, reception problem or even accessibility problems. Spectrum analysis tools are being included into radio system these days which proves its use by helping in analyzing the radiated signals. They offer insufficient information with respect to spectrum of a signal. To solve the above quoted complication of analyzing the spectrum, we have made use of the Real Time Spectrum Analyzer i.e., RTSA which can measure wide band of spectrum (particularly RF signal). We have also made use of USB-based battery powered RTSAs like Tektronix RSA306 which serves as a fruitful device to measure the radiations emitted in each region ranging from 9 kHz to 6.2 GHz. This device was beneficial in our radiation hunting applications. We have gathered radiation statistics across eleven locations in Bangalore which could be used to examine and analyze the radiation pollution levels in diverse environments. Based on our research data input, it reveals that the radiation pollution strength (on average across 11 observations is 1.72 GHz) in and around Bangalore is lower than the threshold limit as per the World Health Organization (WHO) that ranges from 900 MHz- 1800 MHz. As of now there are no side effects from the signal to the human beings in and around Bangalore.

Keywords: Tektronix; RSA306; RTSA; Radiation Hunting; WHO.

INTRODUCTION

With the uplift in technology, man has come across the dilemma of appreciating the information he has or to be shameful for the evil deeds that have resulted from his technological advancements. One such issue is radiation. Man built mobile phones and other electronic gadgets that fulfil his needs, but he hasn't yet seen any adverse consequences from his work. With today's cutting-edge 4G and 5G technologies, man has failed to understand how his innovations affect both nature and humanity. Magnetic compatibility is the capacity to run the surrounding circuits without influence (EMC). This concept is essentially the

highest achievement in enabling device independence for electromagnetic wave transmission. Even the most sophisticated electronic circuits today have the issue of absorbing nearby electromagnetic radiations. The use Electromagnetic compatibility (EMC) makes it possible for them to function without interfering with the EM waves being broadcast by other nearby devices. The first-time humanity saw the significant, yet subtle harm radiation emitted by gadgets was for military purposes. Nuclear weapon was a drastic effect of electronic pulse produced by their explosion and high-powered radar systems. The first effect of these weapons was to damage the device and the environment. Electronic devices could run at high clock speeds thanks to Boolean Logic, which gained traction in the 1970s. However, because to these advancements, this circuitry became more vulnerable to the effects of EMI, making EMC protections necessary for the device's safe and effective operation¹. Electromagnetic interference refers to presence of undesirable radiation obstructing the smooth functioning of nearby electronic circuits. Sometimes electromagnetic interference is used constructively for jamming network signal in case if an agency is dealing with criminals.

Most of the electronic devices in the present world are based on wireless transfer technology which indirectly emits some radiation i.e., electromagnetic radiation into the nature. It is present in low frequency, yet they are potentially carcinogenic. This truly represents that with evolving technology we are not only bringing in new innovations but also indirectly driving in some effects due to it. If at all this frequency increases drastically it will affect humans and living creatures' life on this earth. We visited few places in Bangalore, where we measured the electromagnetic radiation in the given area. The electromagnetic radiation was measured at these places which turned out to be less than the threshold as given by WHO (World health organization) which is safe. Figure 1 shows the map of the study area.

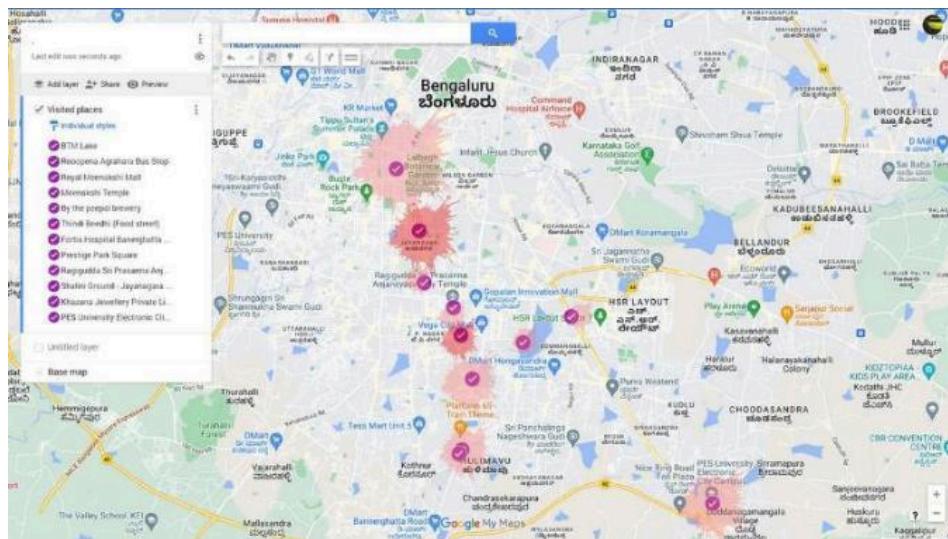


Fig 1 Map of the study area

MATERIALS AND METHOD

In our environment, Electromagnetic radiation (EMR) can be ranging from very short to long wavelengths. In the case study that we've worked upon, we have recorded the EMR that is radiated and tried to check the effect of different EMR emitted by the electronic devices on the environment. From various signals found in our environment, most of it is found to be modulated communications signals, interference events, and pulsed tactical signals- making it impossible to detect the signal by a normal device. Modern day electronics and future communication devices having complex modulations, larger spread of the

spectrum pulsed, and coherent radio techniques increases the challenge of detection with the present techniques in normal EMI detectors. Also, to inspect and interpret the standard and test the features of these communication signals, we need some kind of processor to promptly process and store these values to differentiate with the signals generated over time t and this process should be instantaneous in nature. A real-time spectrum analyzer shows the EQ spectrum in real-time, or right as it's happening. In RTSA or Real-time Spectrum Analyzer, Fast Fourier Transforms are drawn upon to apprehend and acknowledge the type of EMI signal in real time, meaning that the operating speed of the gadget is parallel to that of the real systems that is simulating and has a probability of intercept is equal to 1 despite exceptionally dense environments.

In our project, we have made use of the device ‘Tektronix RSA306 real-time spectrum analyzer’ and along with it used the software ‘Signal Vu-PC™ software offered by Tektronix besides providing the device. The RSA306 makes use of the computer/laptop and Tektronix SignalVu-PC™ RF Signal Analysis Software to come up with instantaneous spectral analysis, streaming capture, and deep signal analysis capabilities for signals from 9 kHz to 6.2 GHz, everything being economical, compact, and convenient portable package that is best suited for field, factory and scholastic utilization.

The RSA306 exercises with SignalVu-PC, a potential program that is the basis of Tektronix efficiency signal analyzers. SignalVu-PC provides scrutiny which wasn't formerly cost-effective. Real-time operation of the DPX acquisition technology is authorized in the PC, additional minimizing the cost of hardware to a greater extent. The RSA306 and Signal Vu software is as shown in figure 2.

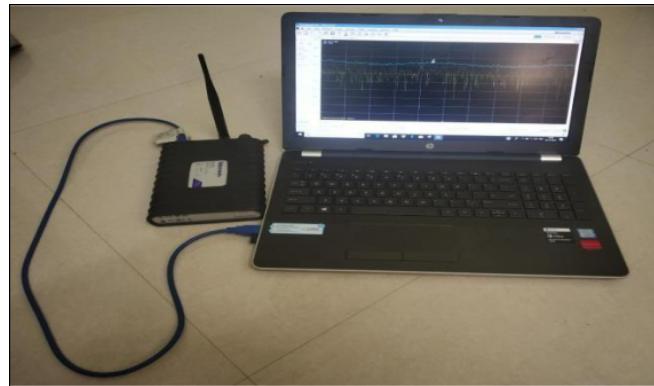


Fig 2. RSA306 and Signal Vu software

RESULT AND DISCUSSION

The measured average electromagnetic radiation in different location of the study area is shown in figure 3. The real time EMI readings in Bangalore and snippets of reading from the RTSA signal analyzer as shown in figure 4.

The safe guidelines as put out by WHO (World Health Organization) in the year 2020 for larger RF Electromagnetic field range from 100 KHz (kilohertz) to 300 GHz (gigahertz). After taking readings across multiple places the minimum value stands at 1.71 GHz and the maximum stands around 1.75 GHz which is safe for humans and the living creatures as per WHO issued EMI exposure levels limit²⁻³.

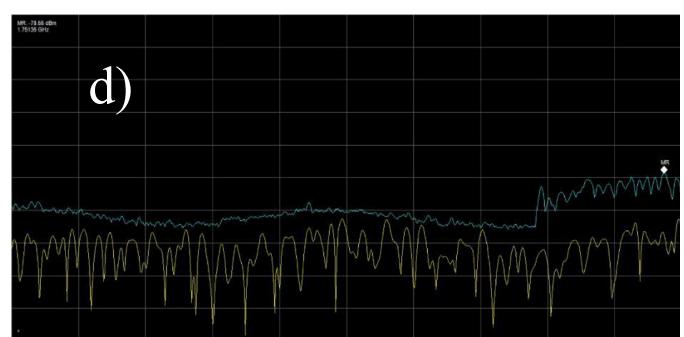
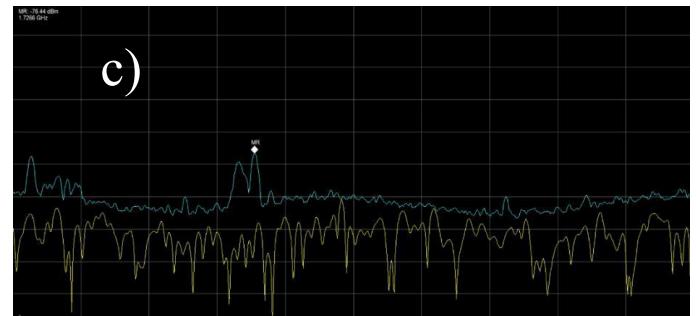
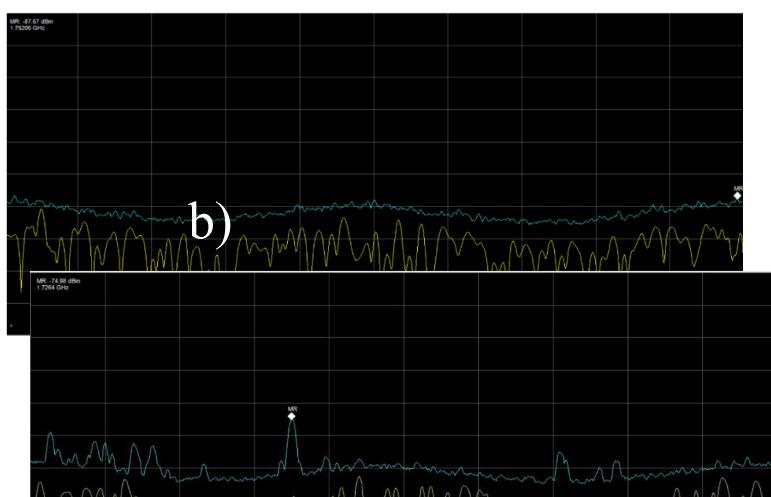
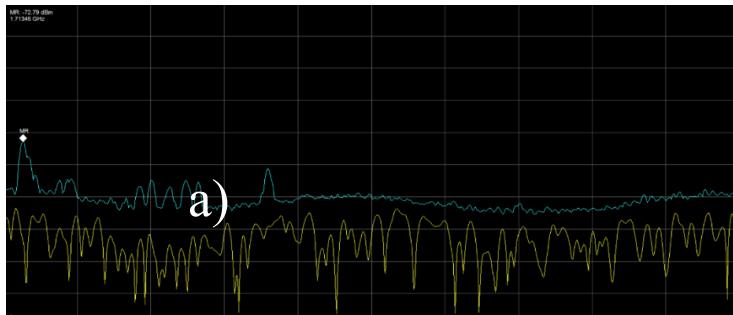
To minimize the effect of electromagnetic radiation we use a popular organic semiconductor like Polyaniline (also known as PANI). PANI is an organic polymer that can be used as a conducting polymer. Its property is acquired by appropriate doping. PANI can adsorb heavy metals of different electrical charge by electrostatic attraction because its surface charge can be altered by doping/cleaning. Moreover, it can adsorb heavy metals by

other mechanisms such as Van der Waal forces, pi-pi interaction, hydrogen bonding and chelation⁴.

PLACES	Readings (in GHz)	
BTM LAKE	1.71345	1.71565
BY THE PEEPAL BREWERY	1.7264	1.75205
FOOD STREET	1.7266	1.7266
SHALINI GROUND	1.7237	1.75135
KHAZANA JEWELLERY	1.7136	1.7136
MEENAKSHI MALL(OUTSIDE)	1.7135	1.72995
MEENAKSHI MALL(INSIDE)	1.7264	1.715
MEENAKSHI TEMPLE	1.71345	1.72535
PRESTIGE PARK	1.71655	1.72945
RAGIGUDDA TEMPLE	1.7135	1.75
SILK BOARD BUST STOP	1.72635	1.7268

Fig 3. Readings from places where EMI levels were measured

PLACES	Readings (in GHz)
Lalbagh	2.38665
Basavangudi (Corner House)	2.419375
PESU ECC Cricket Ground	2.39975
PESU ECC Classrooms (with mobiles)	2.422675
PESU ECC Classrooms (without mobiles)	2.3876
Vega City Mall	2.3985



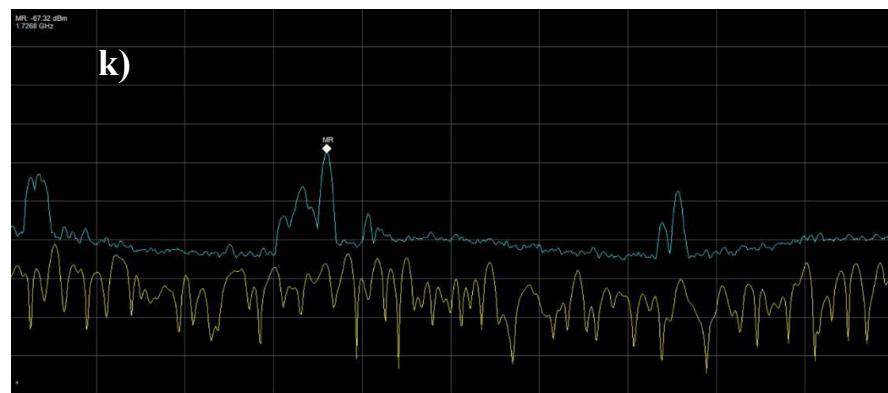
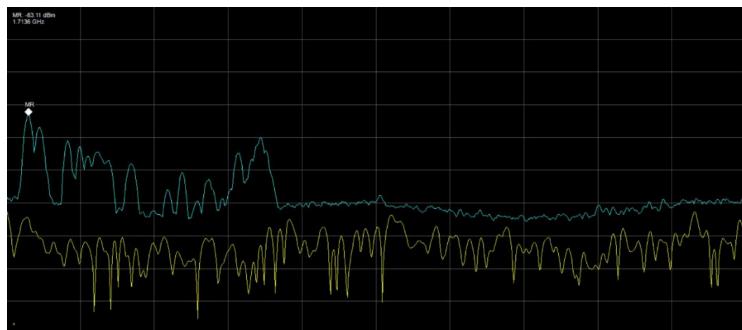
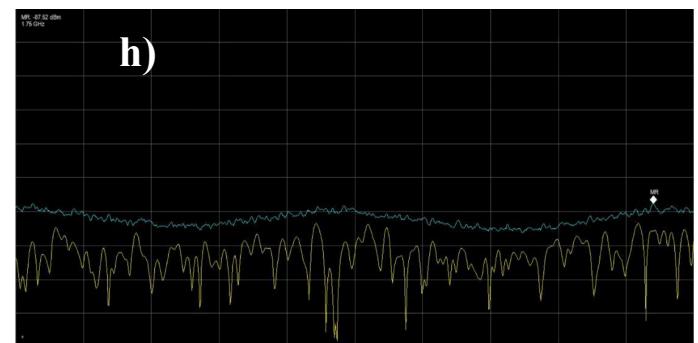
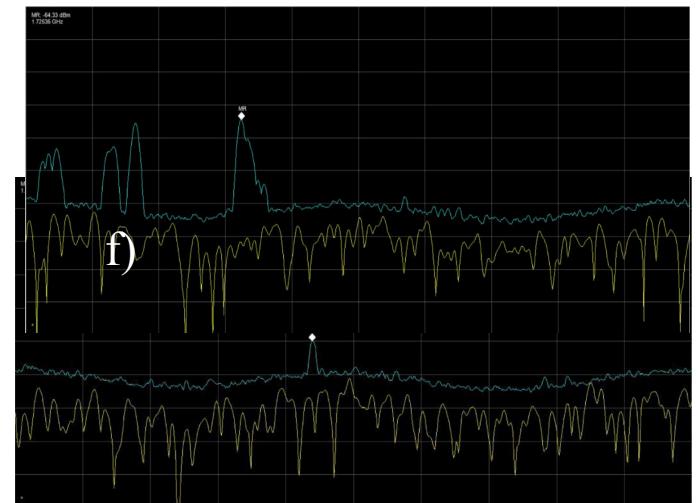
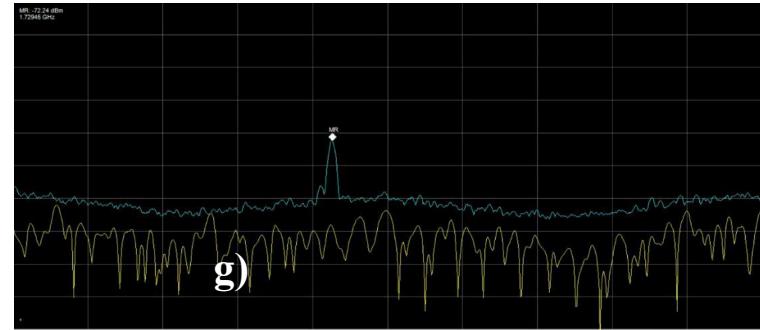


Fig 4: Snippets of reading from the RTSA signal analyzer a) BTM LAKE, b) BY THE PEEPAL BREWERY, c) Food Street, d) Shalini ground Jayanagar, e) Khazana Jewellery Jayanagar, f) Meenakshi mall (outside), g) Meenakshi mall (inside), h) Meenakshi Temple, i) Prestige Park, j) Ragigudda Temple, k) Silk Board Bus Stand

CONCLUSION

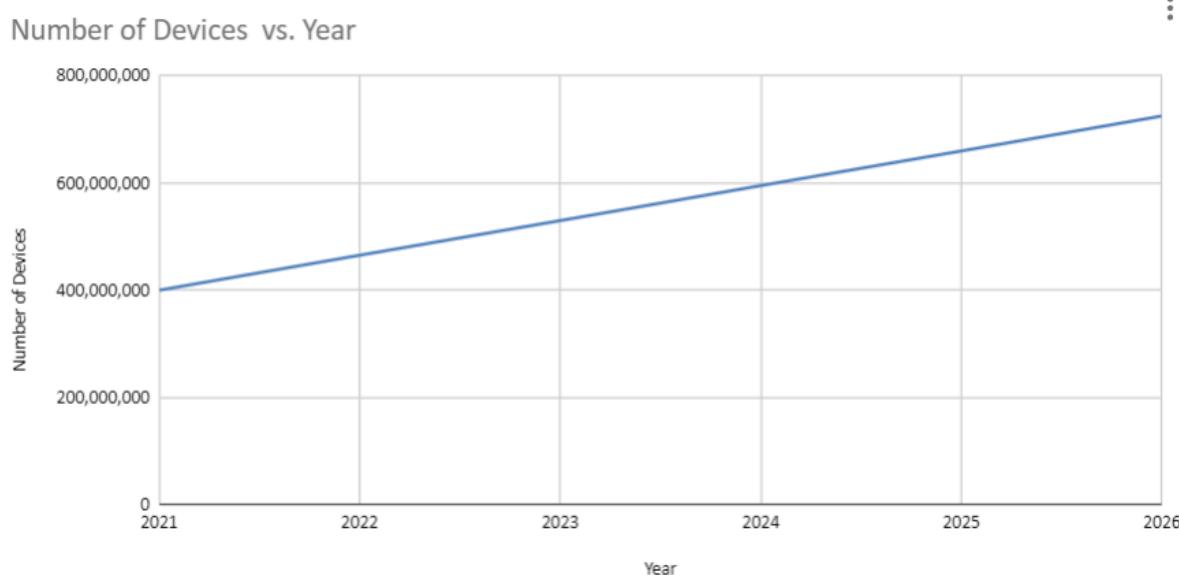
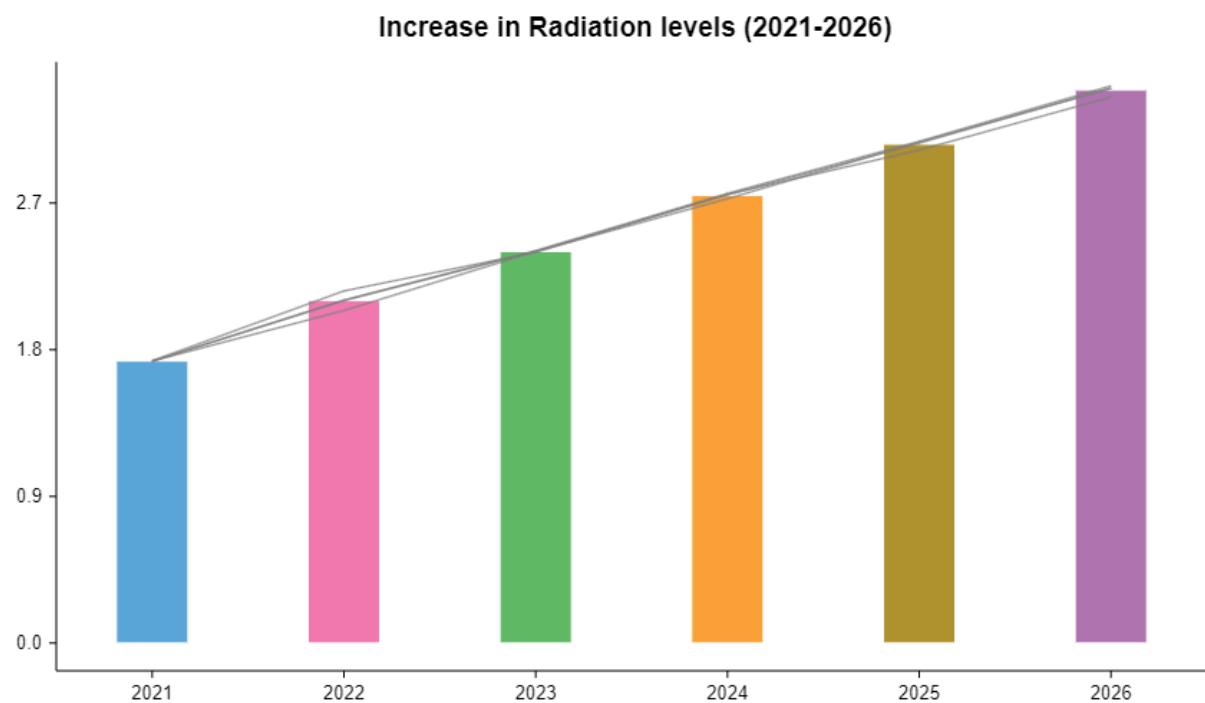
Since we made use of RSA 306 Real Time Spectrum Analyzer by Tektronix it was easier to take the real time readings. Now that we are slowly upgrading our devices and network for easier and efficient communication to 5G it emits higher band radiation than the former (4G). But these changes have subtle effects yet impactful on the living creatures.

During our research, even with the presence of a wide variety of polymers, only selected ones are able to counter electromagnetic radiations, especially PANI. There is no conclusion drawn on why PANI can obstruct electromagnetic waves better than any other conducting polymer, since it's only an observation. Understanding the correlation of physical/chemical properties with conductivity for PANI is difficult to determine as it depends on its state to state

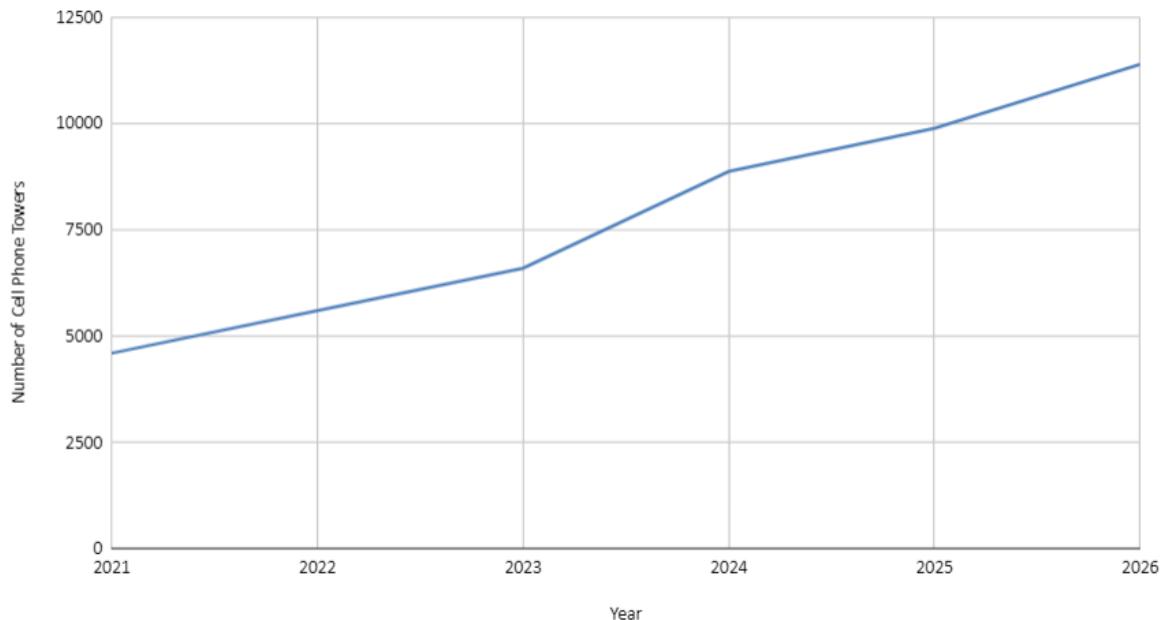
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3. Manoj V, Naveen Kumar A, Revanasiddappa M, "EMF Pollution – Causes, Effects and Protection (Case study)", Recent Innovations in Science and Engineering - RISE 2016, Conference Proceedings. 30th April 2016
4. Telecom Regulatory Authority of India (TRAI) on Effects of Electromagnetic Field Radiation from Mobile Towers and Handsets" - Information paper No: 01/2014 – QoS

Predicted Values and Statistics :

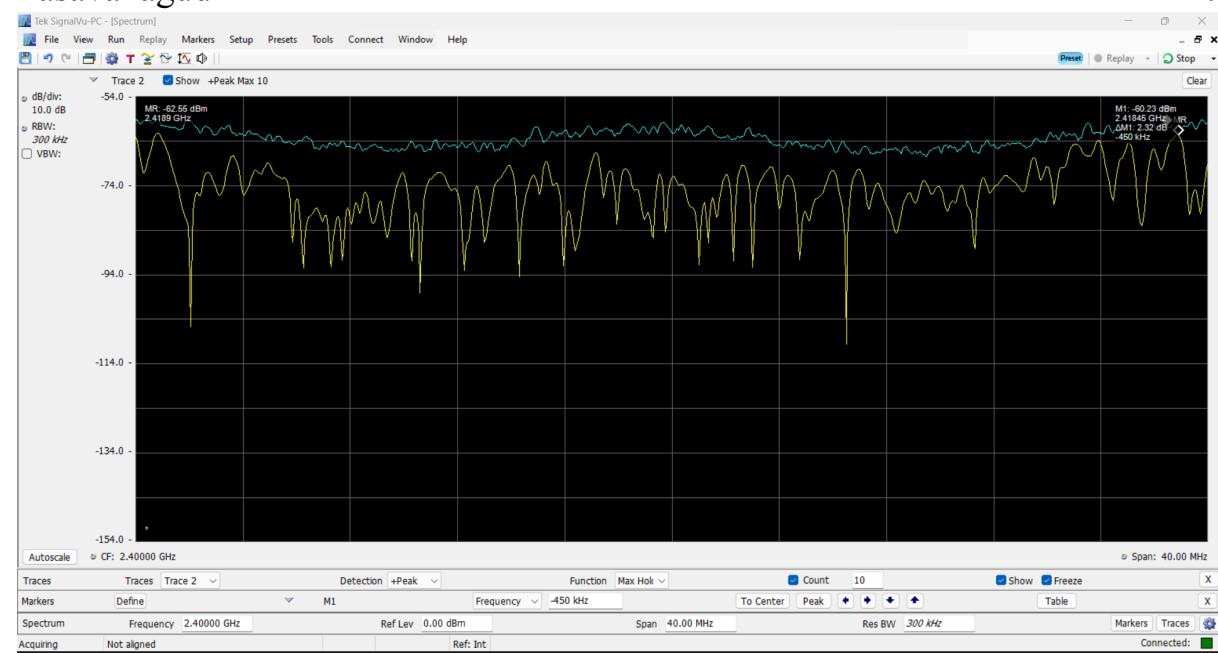


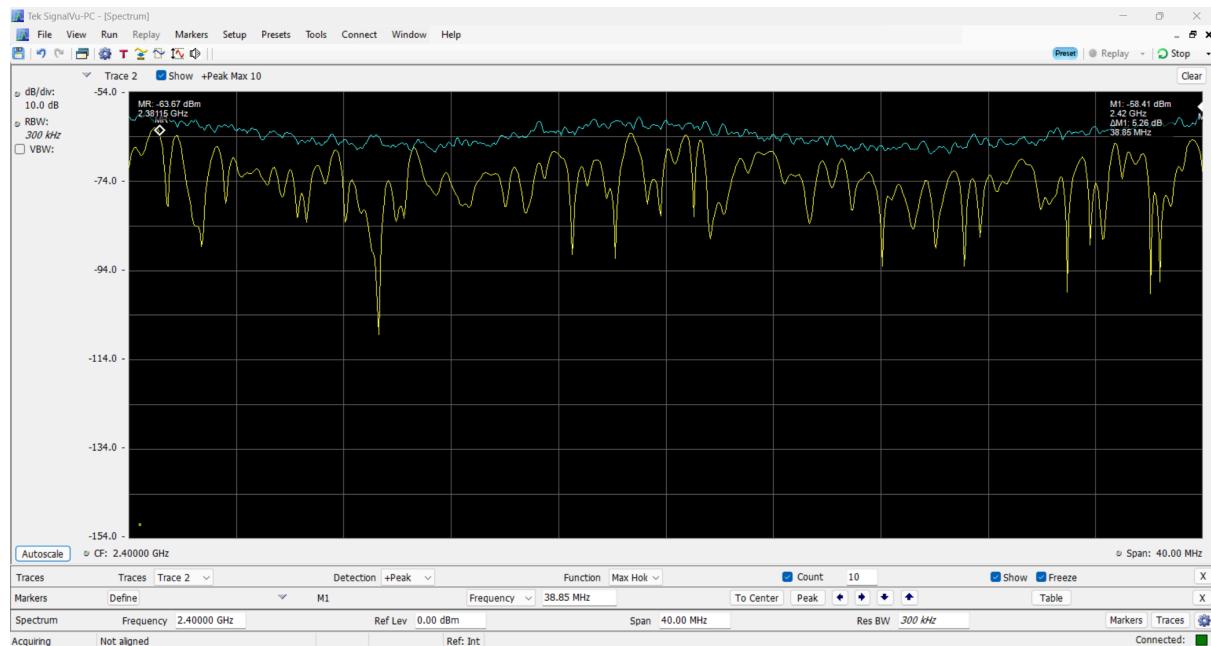
Number of Cell Phone Towers vs. Year



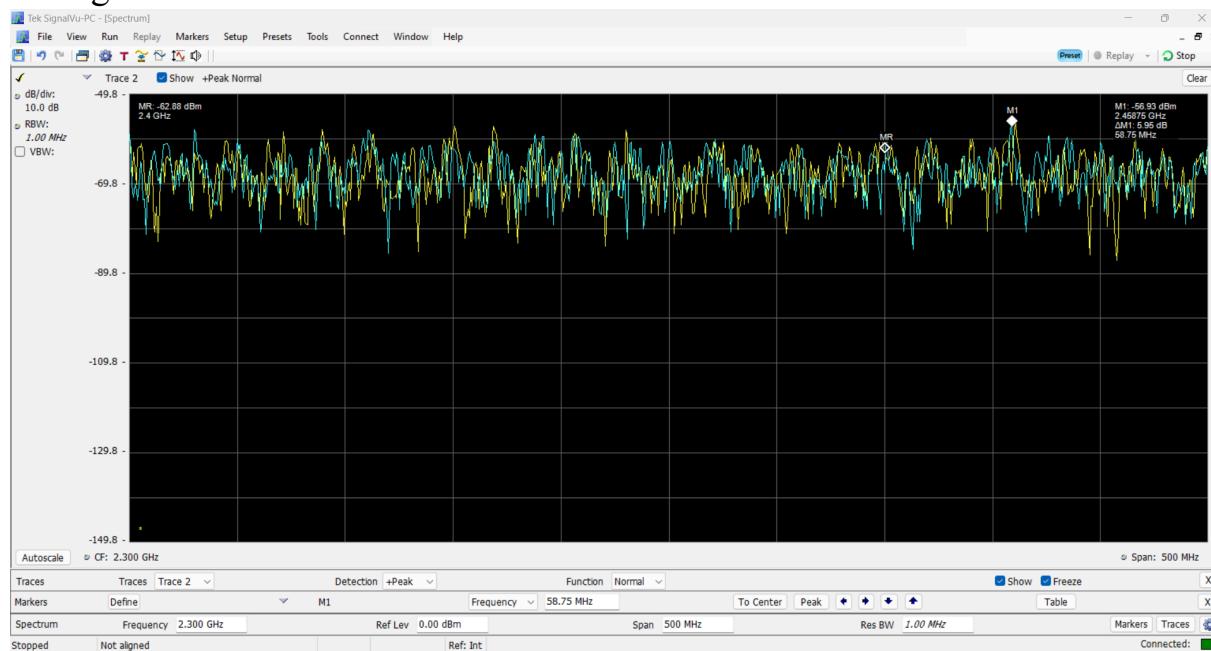
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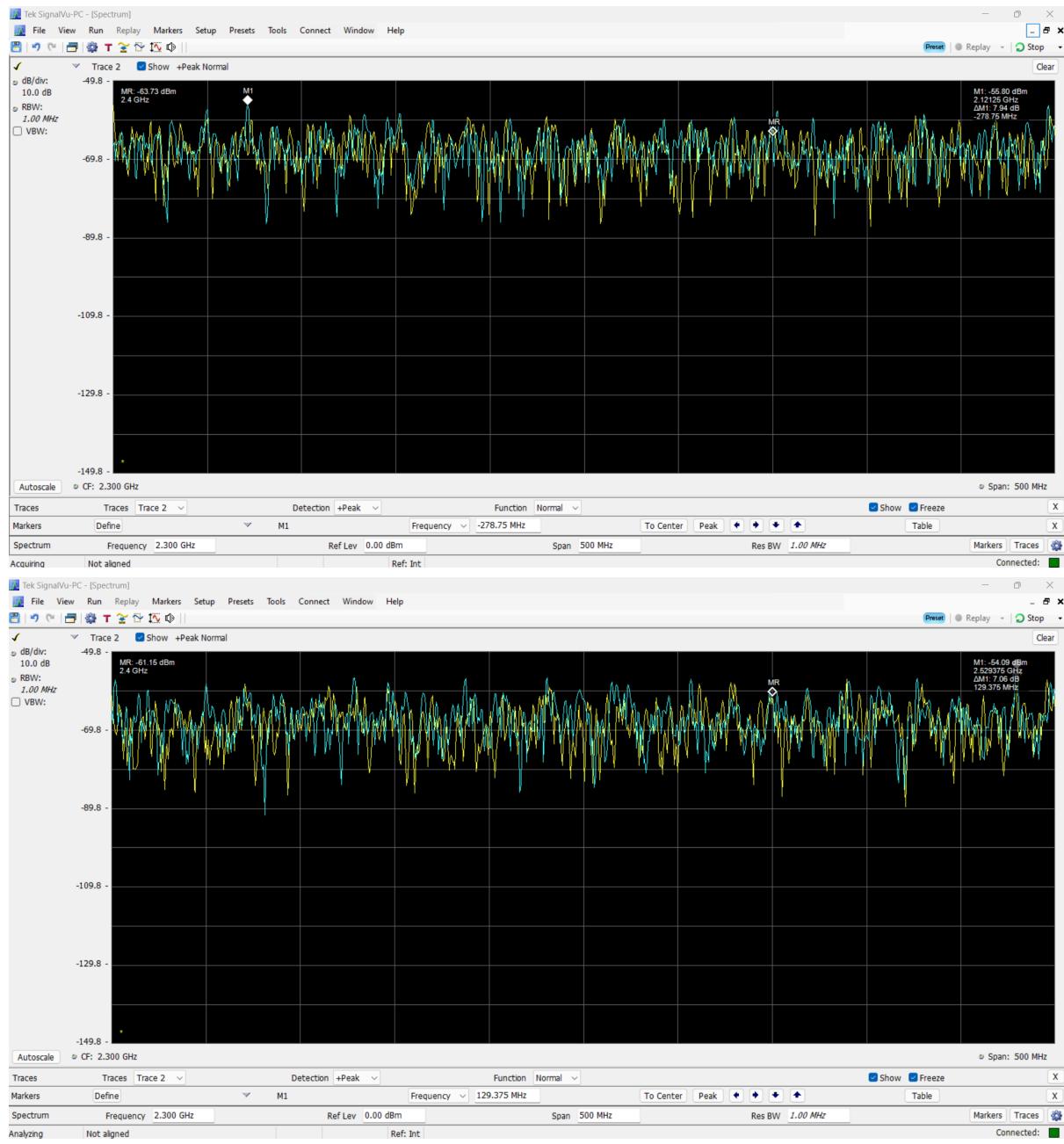
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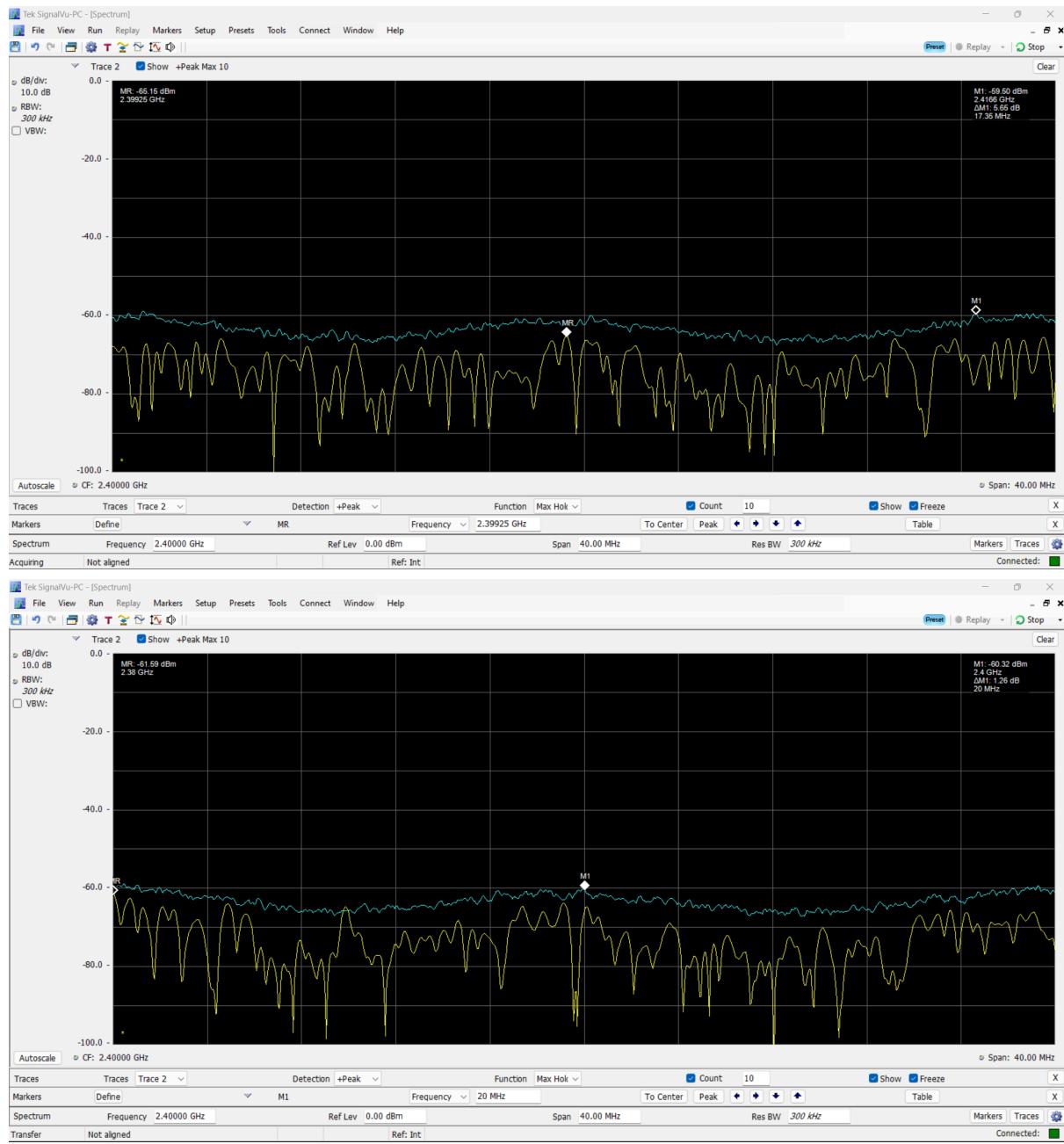


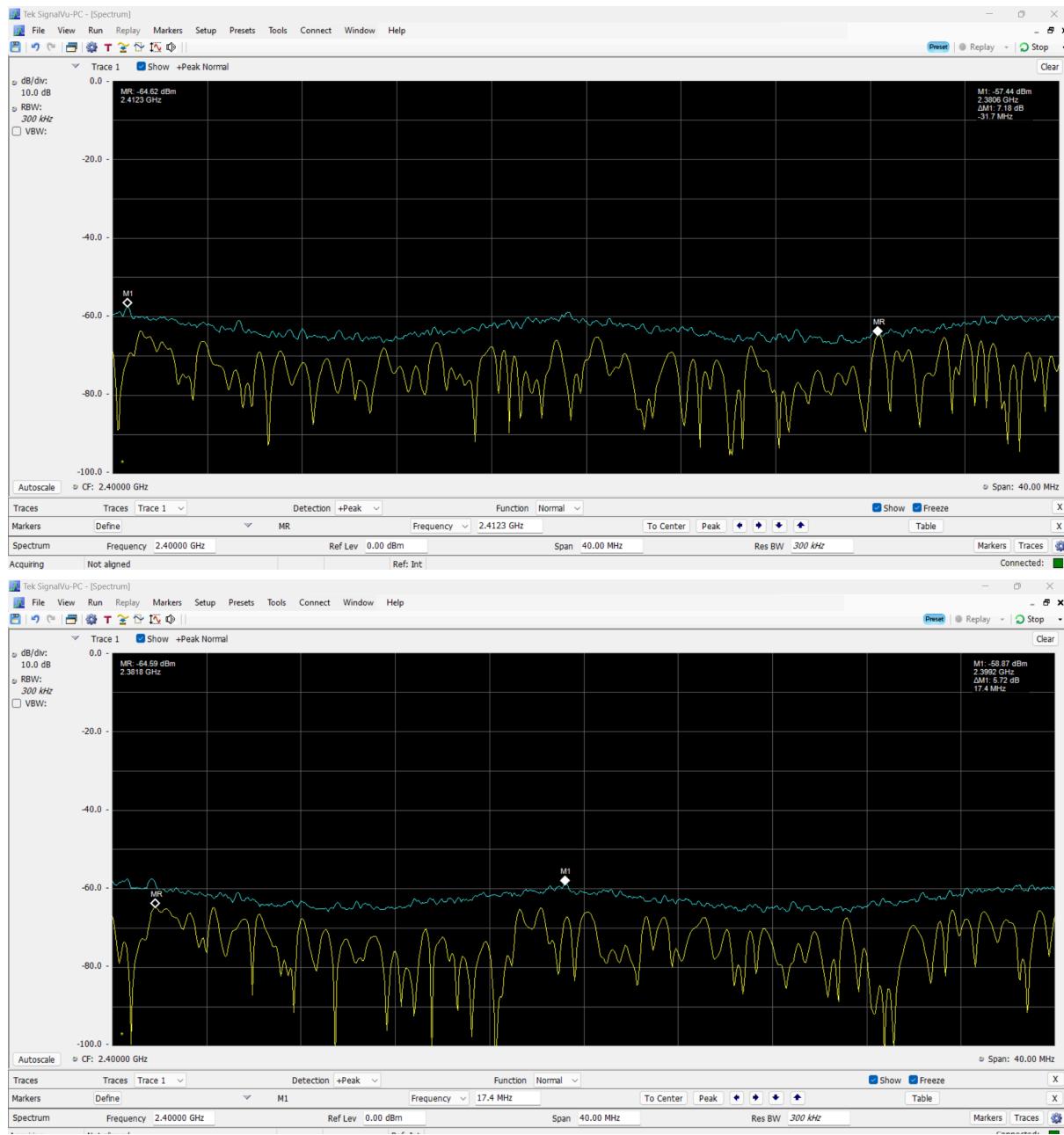


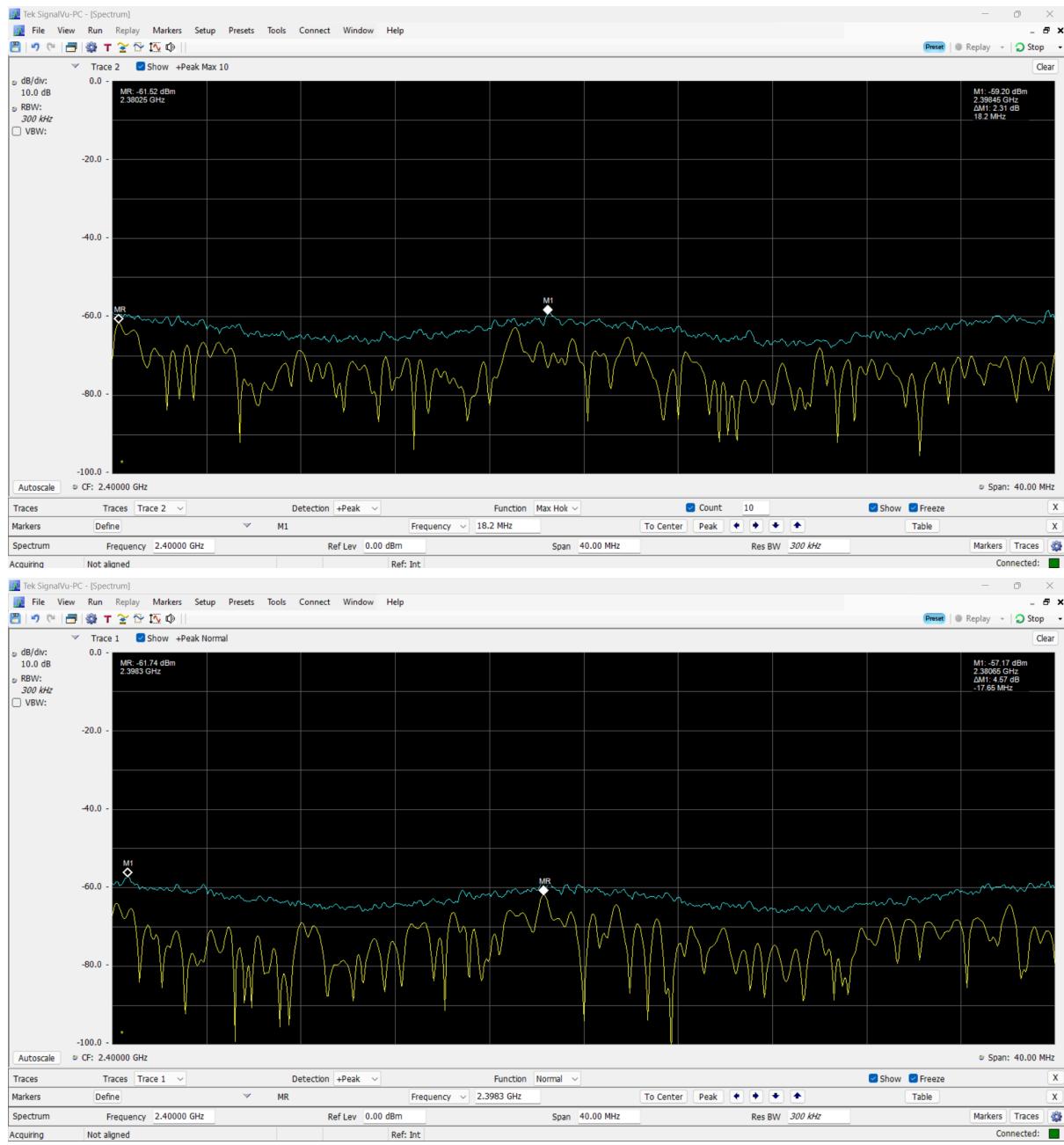
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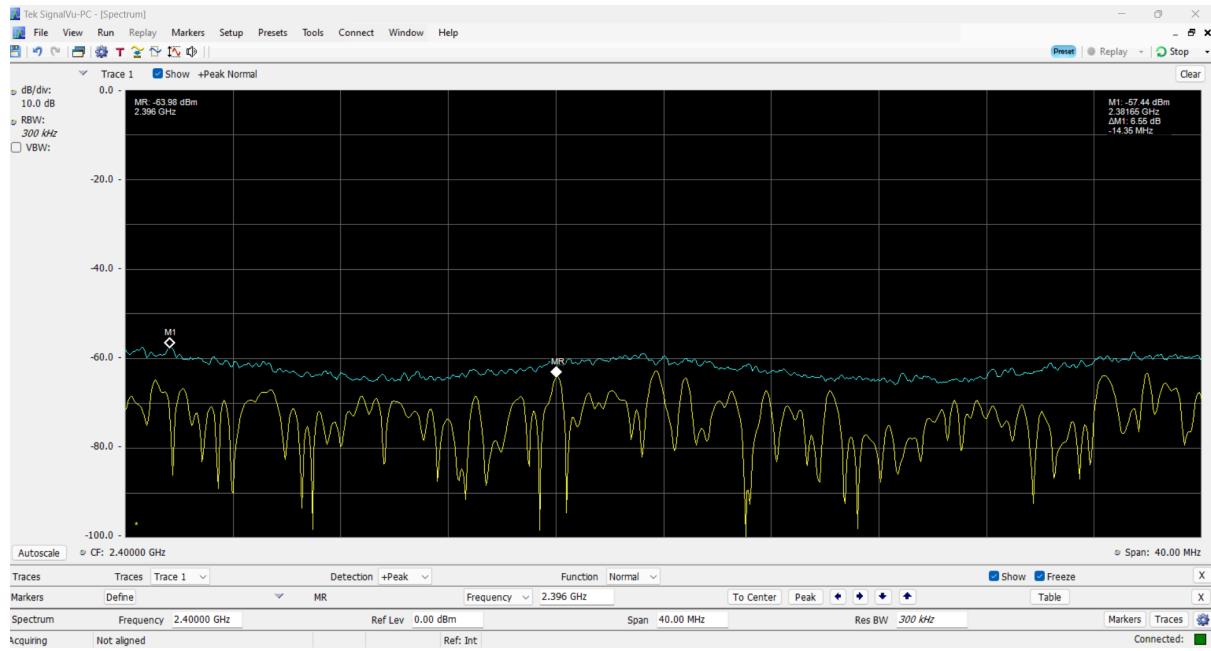




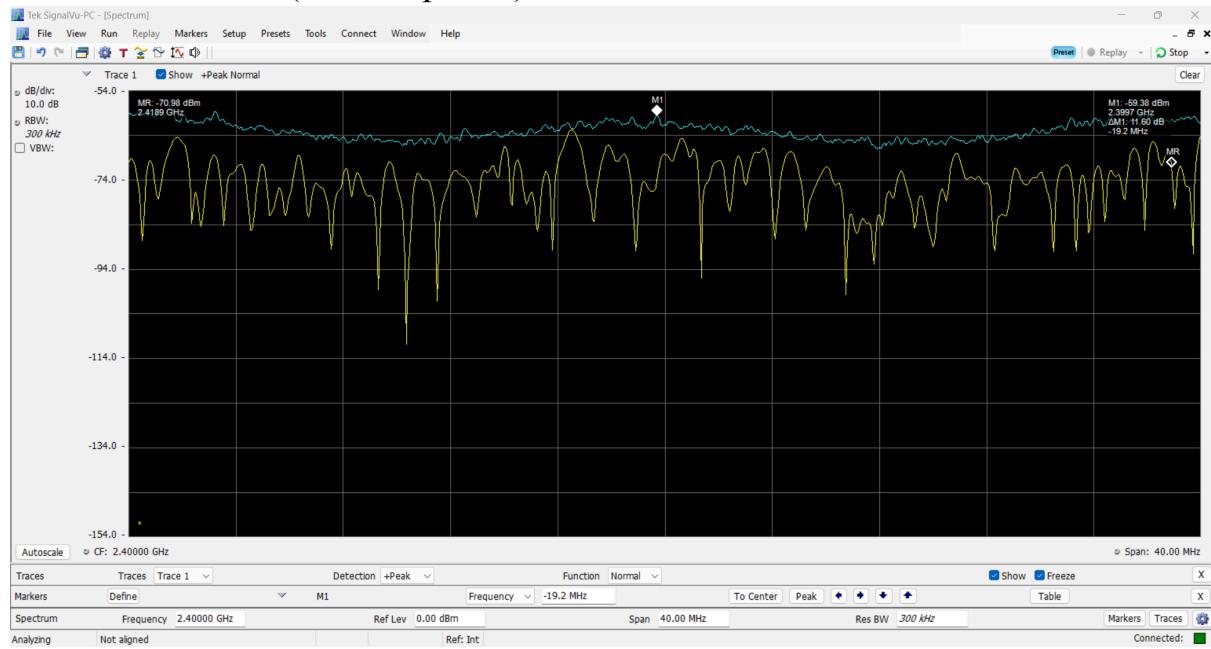


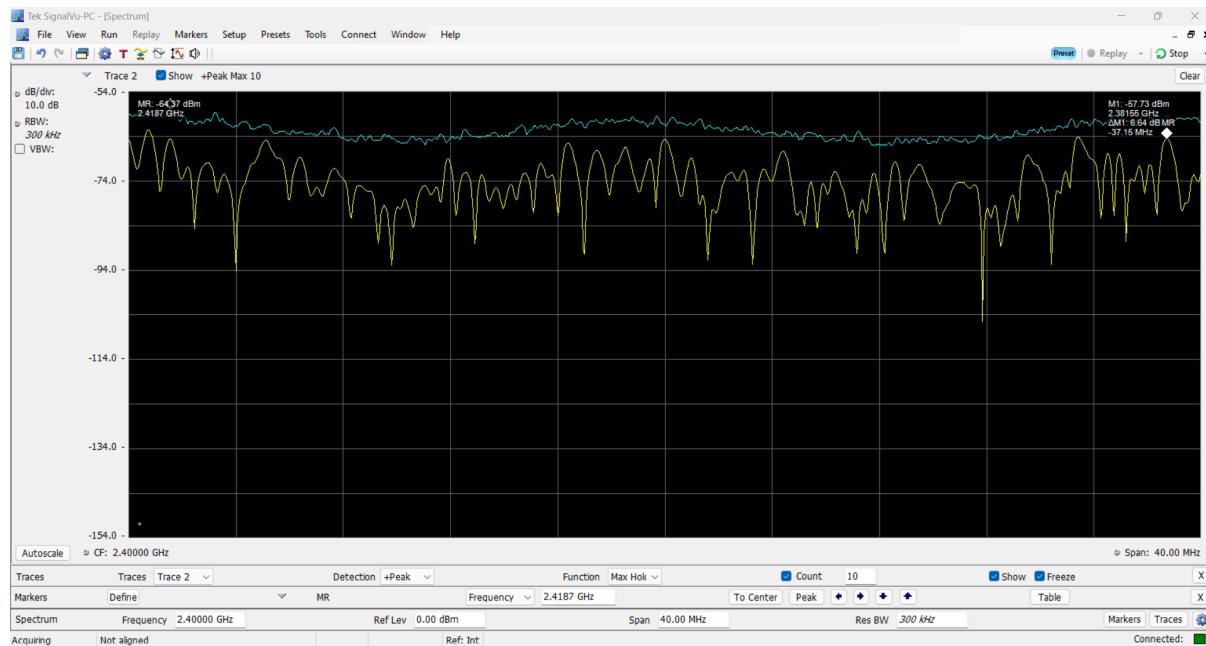




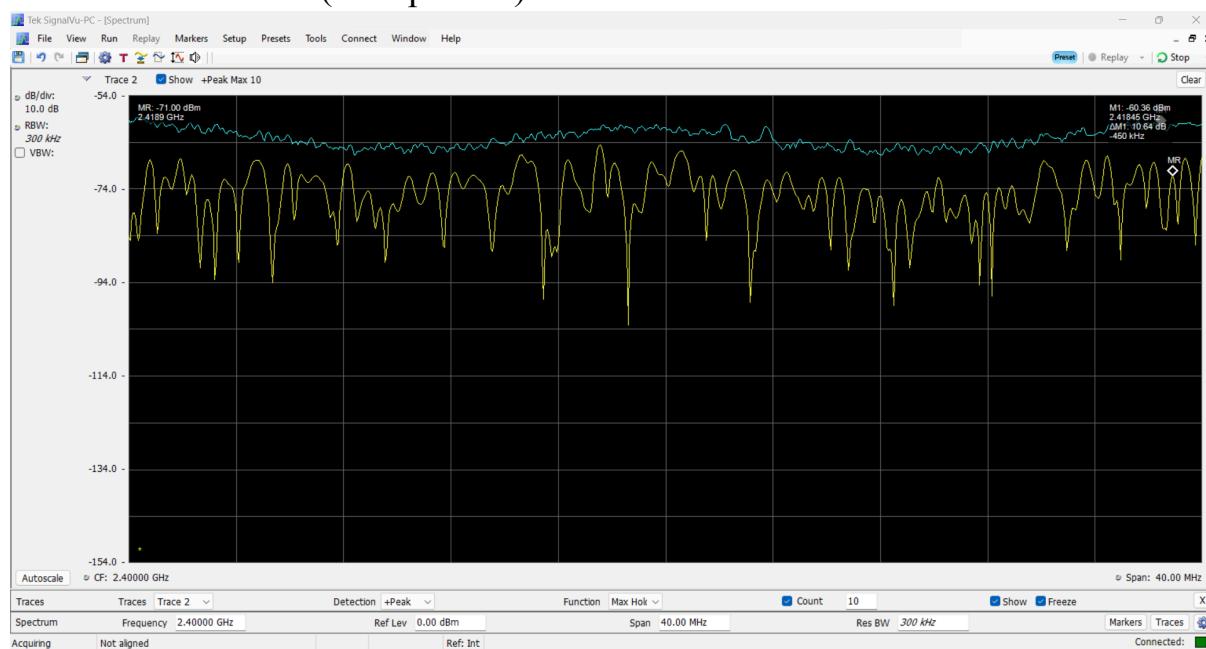


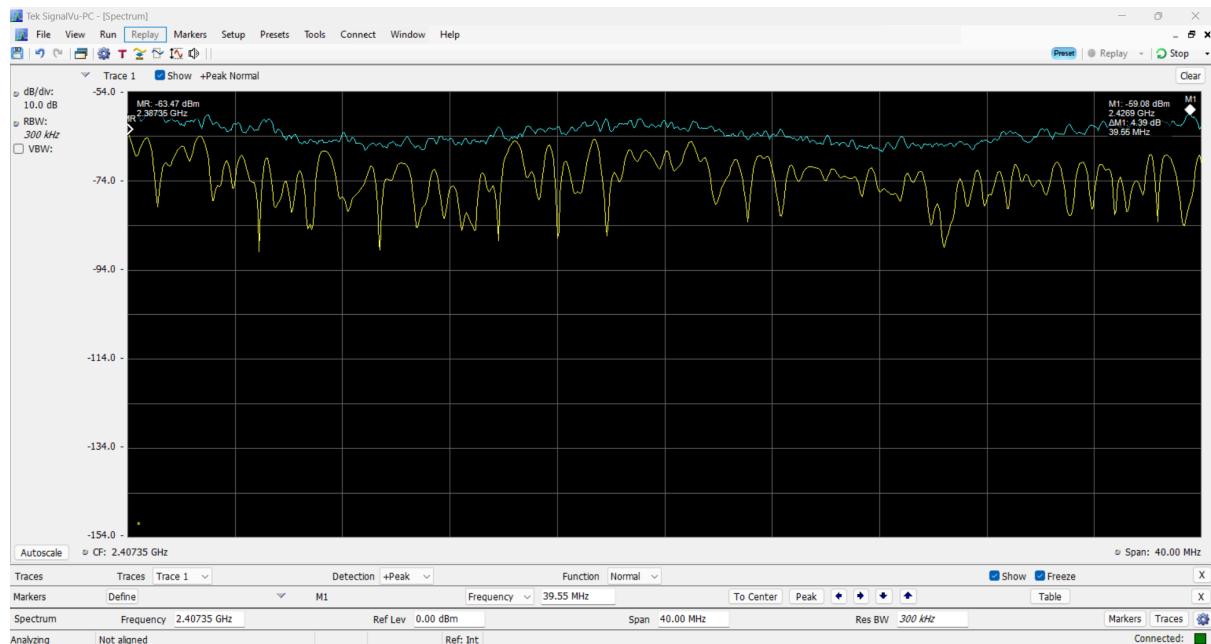
PES EC Classroom (without phone) :



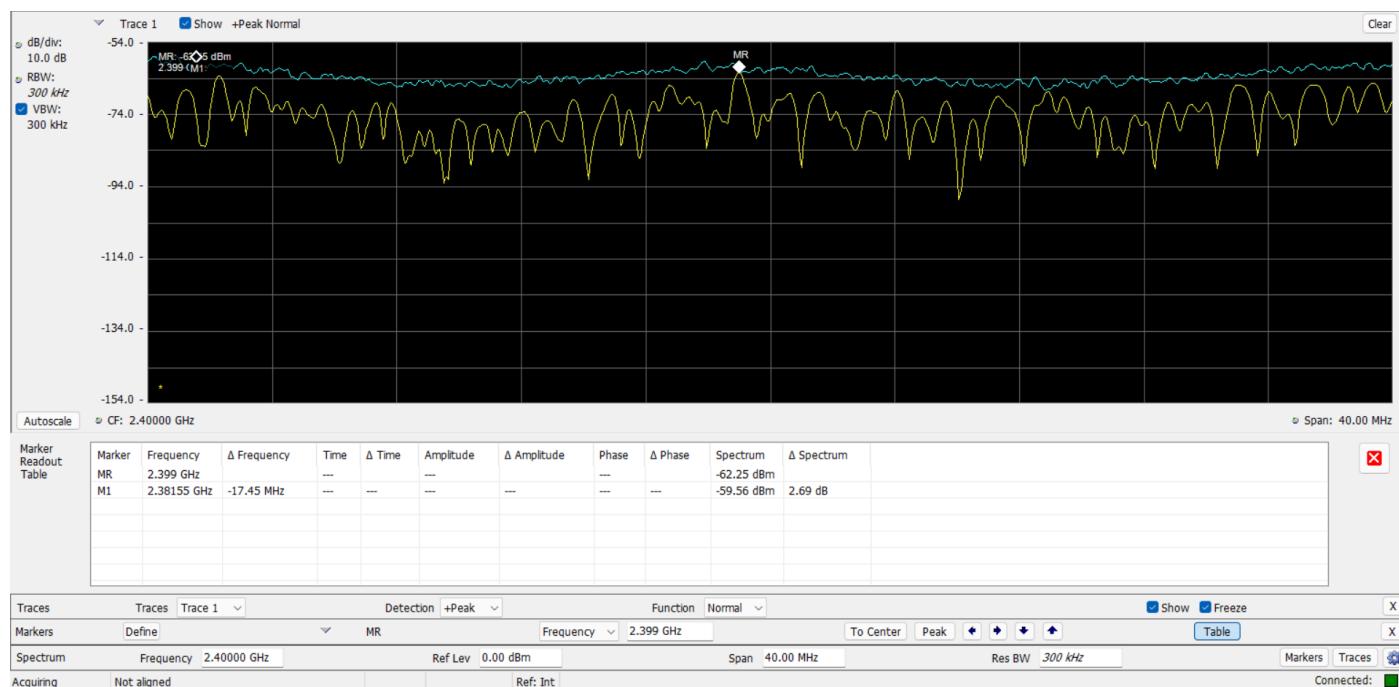


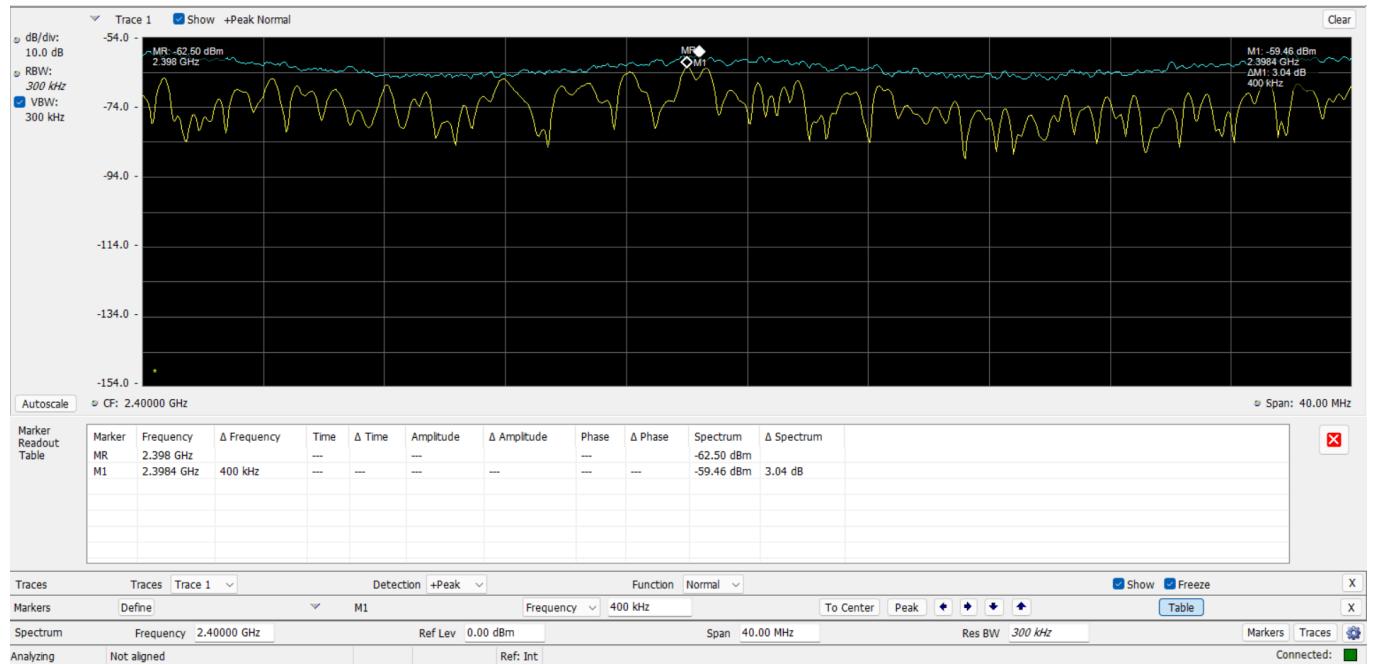
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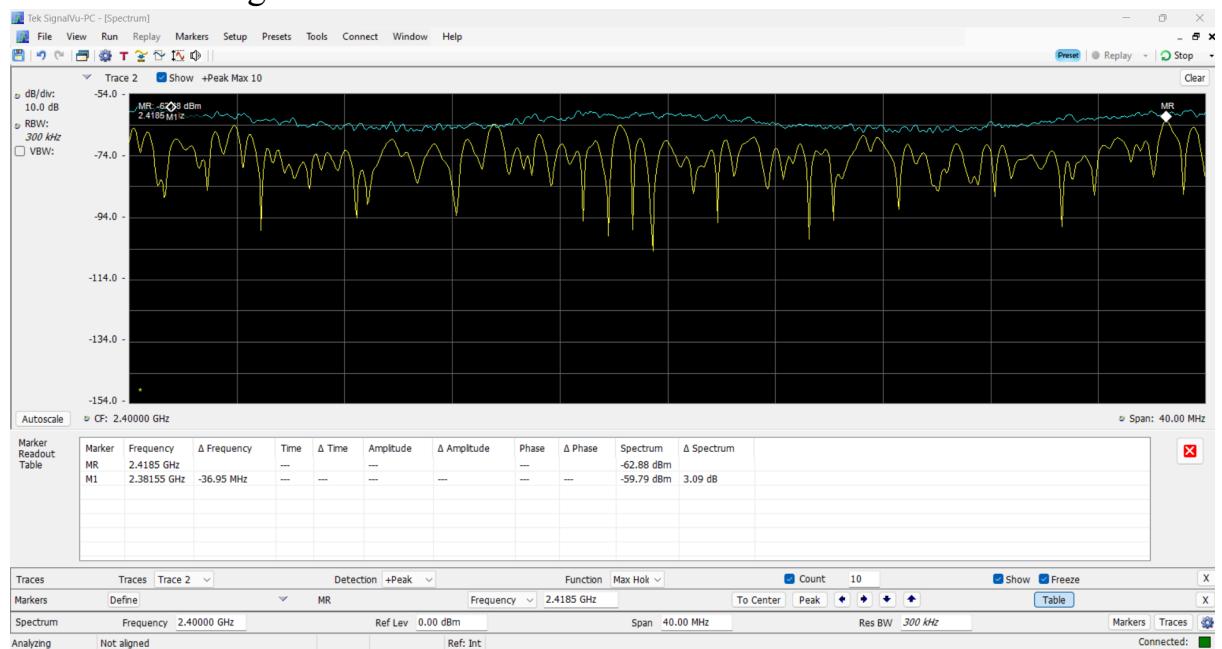


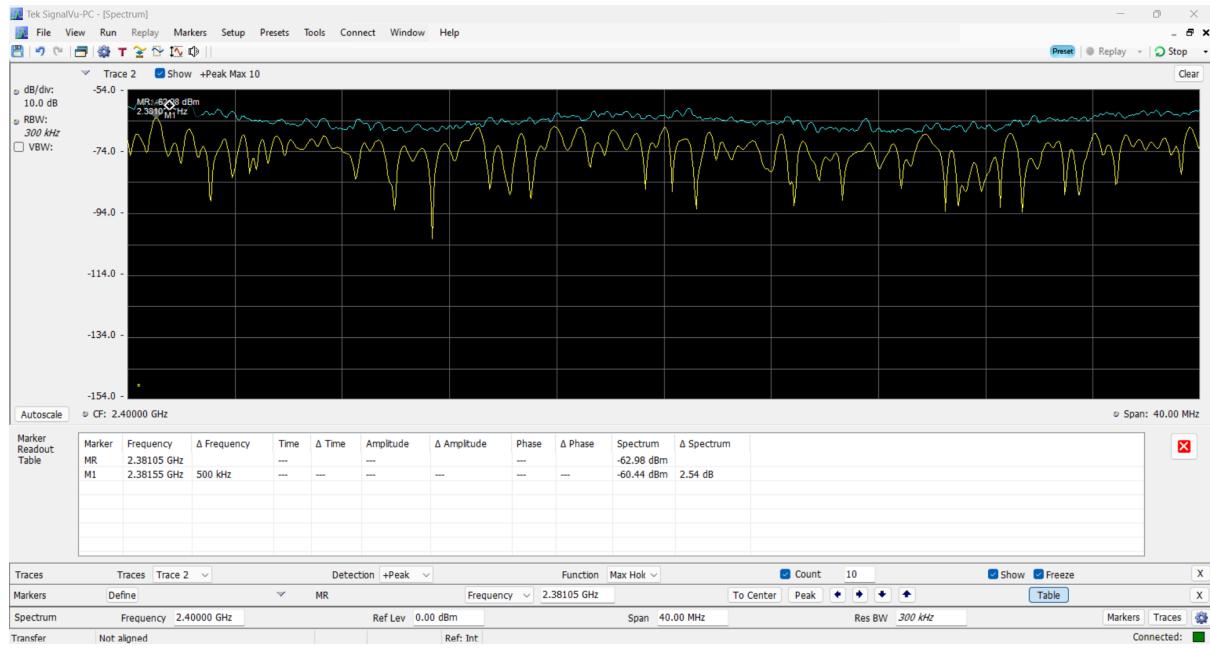
Vega City Mall :





PES EC cricket ground :





MODELLING FOR THE PLOT :

1. Tool used to plot the predictions :
 - a. Google Forecast

2. Working of Google Forecast :
 - a. Linear-Regression:

<https://coefficient.io/how-to-do-a-sales-forecast-with-exponential-smoothing-in-google-sheets#:~:text=The%20FORECAST%20function%20in%20Google,inventory%20requirements%2C%20and%20sales%20growth.>
 - b. .

Simple Linear Regression

Given the observations $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$, we can write the regression line as

$$\hat{y} = \beta_0 + \beta_1 x.$$

We can estimate β_0 and β_1 as

$$\begin{aligned}\hat{\beta}_1 &= \frac{s_{xy}}{s_{xx}}, \\ \hat{\beta}_0 &= \bar{y} - \hat{\beta}_1 \bar{x},\end{aligned}$$

where

$$\begin{aligned}s_{xx} &= \sum_{i=1}^n (x_i - \bar{x})^2, \\ s_{xy} &= \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y}).\end{aligned}$$

For each x_i , the **fitted value** \hat{y}_i is obtained by

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i.$$

- c. <https://blog.golayer.io/google-sheets/google-sheets-forecast>