



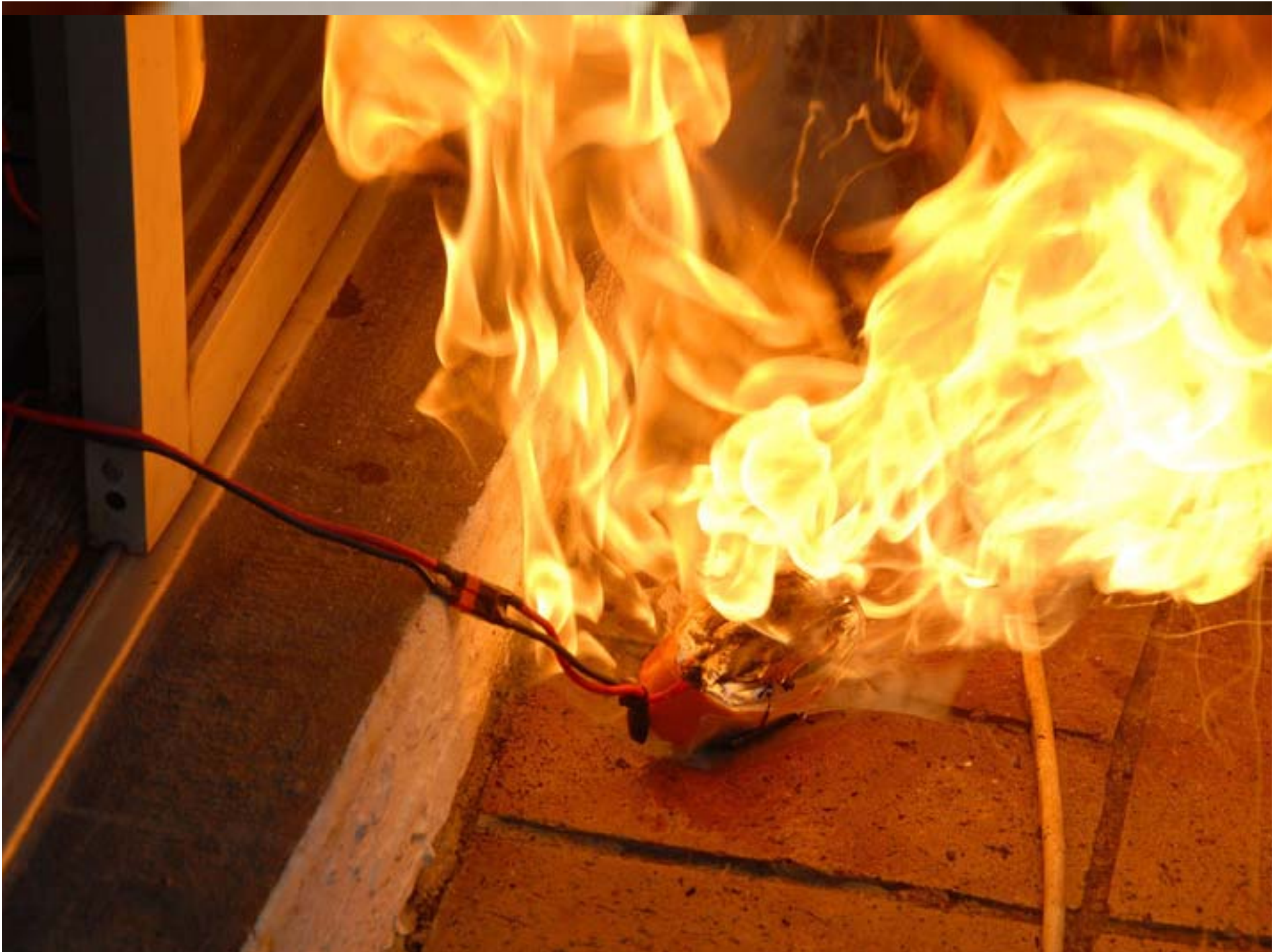
**Are Commercial
Microwave Ovens not
(not safe)?**

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Outline

✧ Introduction

- ✧ What are microwaves ovens?
- ✧ Why to worry about microwave radiation?
- ✧ What causes microwave ovens to leak?

✧ Microwave Oven Safety Standard

✧ Classification of Microwave Ovens Effects

1. Direct effects on the food.
2. Microwave radiation impacts on Human health
3. Microwave radiation impacts on wireless devices
4. Danger due to misuse (EM concepts! EE340 😊)

Outline

- ⊗ Measurements objectives
- ⊗ Measurement Setup
- ⊗ Experimental Tests and Analysis
 1. Leakage power and distance relationship
 2. Food placement effect on leaking power
 3. Receiver polarization effect
 4. Radiation pattern
 5. Variability between different microwave ovens
 6. In-out band radiation
- ⊗ Results and Recommendations
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Introduction

What are microwaves ovens?

1. Microwave ovens employ microwave radiation primarily to cook or heat food.
2. This is accomplished by using microwaves emitted from a magnetron, to excite water, oil, fat and other polarized molecules within the food to be heated.
3. This excitation is fairly uniform, leading to food being heated everywhere all at once (except in thick objects), a feature not seen in any other heating technique.
4. When used properly it heat food quickly, efficiently, and safely.

Introduction

Why worry about microwave radiation?

1. Exposure to sufficiently high levels of microwaves will cause heating. In the case of human tissue, excessive heating could have serious health effects such as deep tissue burns and hyperthermia. *(compare with mobile!)*
2. With the latest technological advances in door seal design and with proper maintenance, microwave oven leakage has been greatly minimized or eliminated.

Microwave Ovens Safety

What causes microwave ovens to leak?

Oven **door slightly separate** from the oven enclosure due:

- Slamming the oven door
- Dirt or food caught in the door seals & hinges
- Basic wear , tear, and door corrosion
- Broken or missing door glass
- Manufacturing defects

Commercial Ovens are not necessary according to the standards !

Safety Standards

1. FDA limits the amount of microwaves that can leak from an oven throughout its lifetime to **5 mW/cm²** at approximately 2 inches from the oven surface.
2. Exposure average time of 6 min.
3. Typical levels of radiation leakage from microwave ovens is about **0.2 mW/cm²** .

Classification of Effects

1. Microwave radiation effects on food

Radiation do not remain in the food when the power is turned off. Neither can they make the food radioactive. Therefore, food cooked in a microwave oven is not a radiation hazard.

- Uneven heating
- Destroy vitamins
- Reduced hemoglobin and cholesterol values
- Higher incidence of stomach and intestinal cancers

Classification of Effects

2. Microwave radiation impacts on health

- Skin cancer
- Blood disorders
- Headaches and dizziness
- Increased stress
- Birth defects in pregnant women
- Central nervous system damage
- Temporary sterility in men
- Cardiovascular problems
- Interference with some pacemakers
- Decrease in immune system competency

Claimed

Classification of Effects

3. Microwave radiation impacts on wireless devices

- Runs at 2.45 GHz band.
- Interference with the ISM (industrial, scientific, and medical) band.
 - Bluetooth devices
 - Wi-Fi
 - Cordless phones

Classification of Effects

4. Danger due to misuse (Concept of Operation)

- Operating with conductors (metallic elements)
- Water and Coffee explosions
- Eggs

Experiment not to be Experimented!

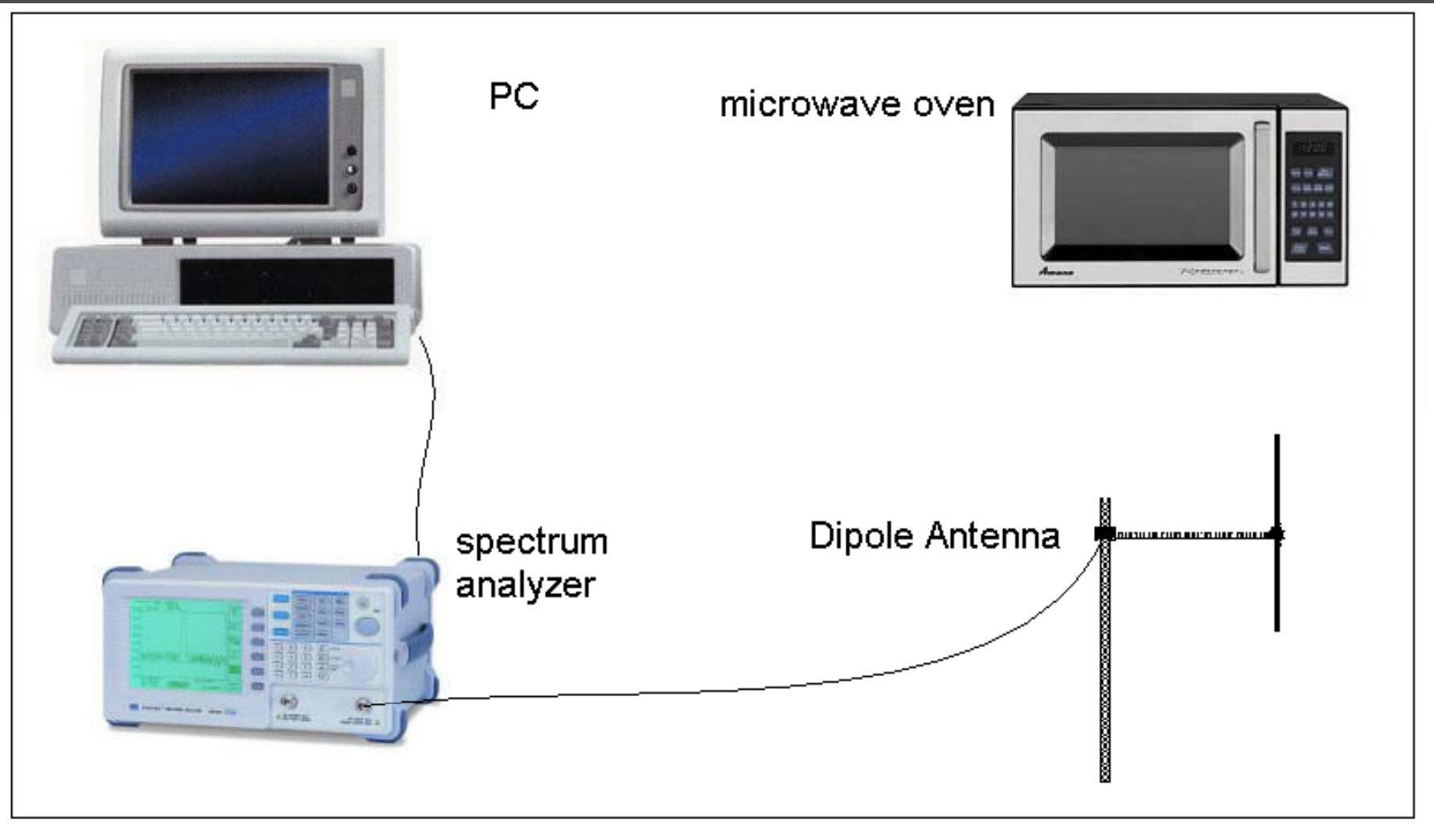
- **Removed for your safety!**

Measurements Objective

To illustrate the variation of radiation leakage under different conditions. Tested scenarios include:

- The relation between leakage power and distance from the oven
- The impact of the relative position of the load (food) within the oven on the amount of leaking power
- Receiver polarization effect
- Radiation pattern
- Variability among different Microwave ovens
- In-out Band radiation

Measurements Setup



Spectrum Analyzer

- A wide band, very sensitive receiver
- Displays received signal strength (y-axis) against frequency (x-axis).

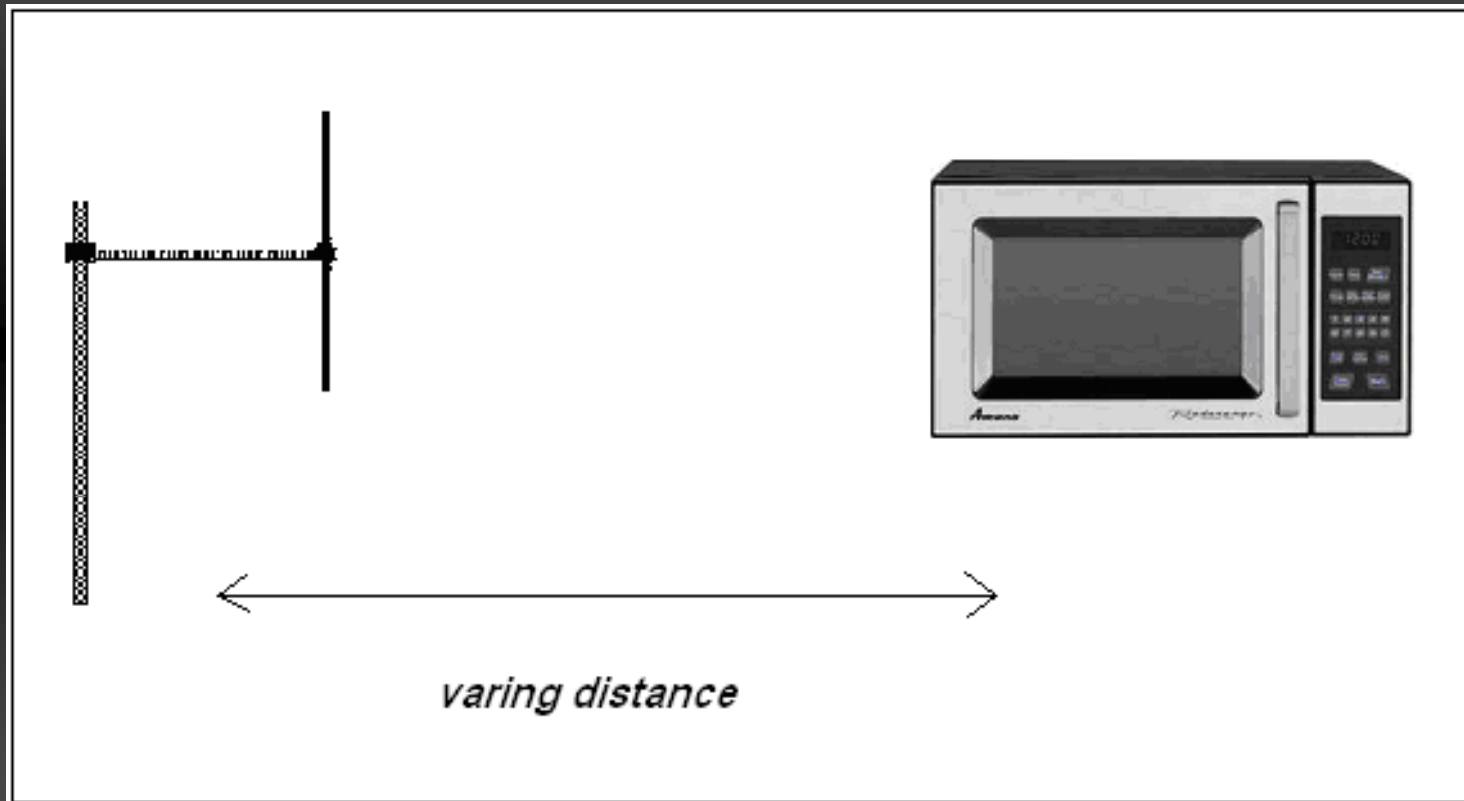
Range: 2.4-2.5 Ghz

501 points



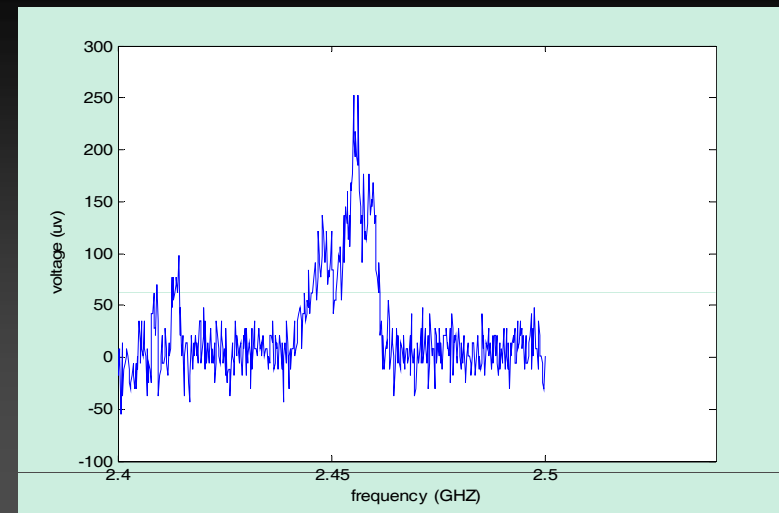
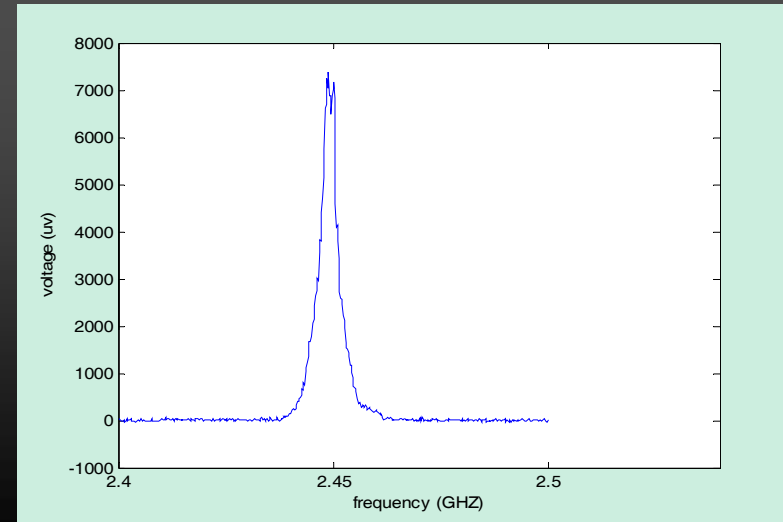
Experimental Tests & Analysis

Distance Effect Setup

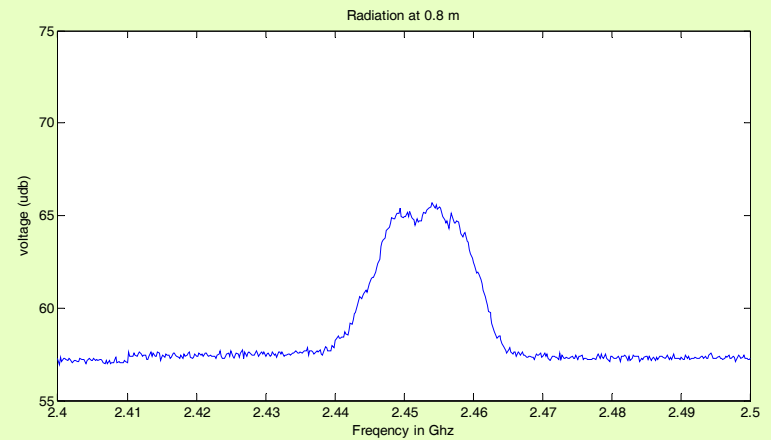
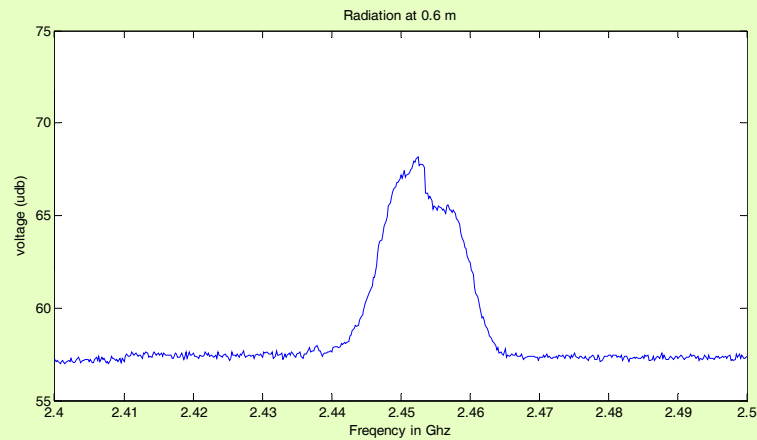
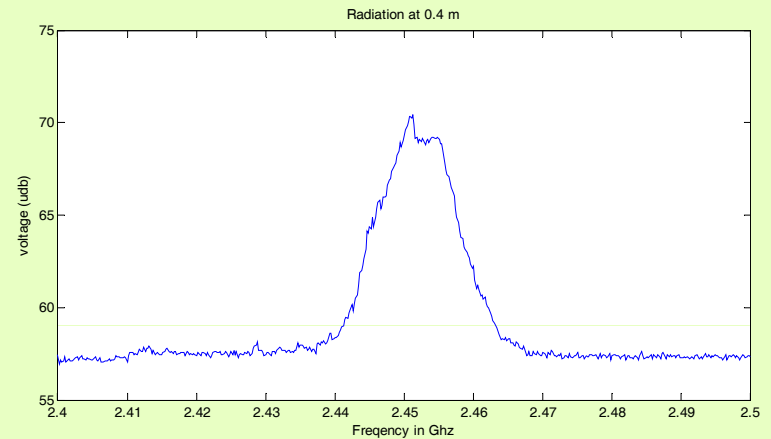
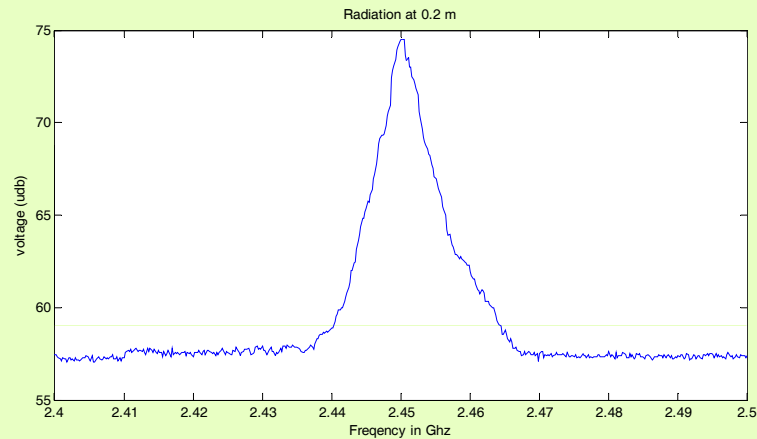


Distance Effect

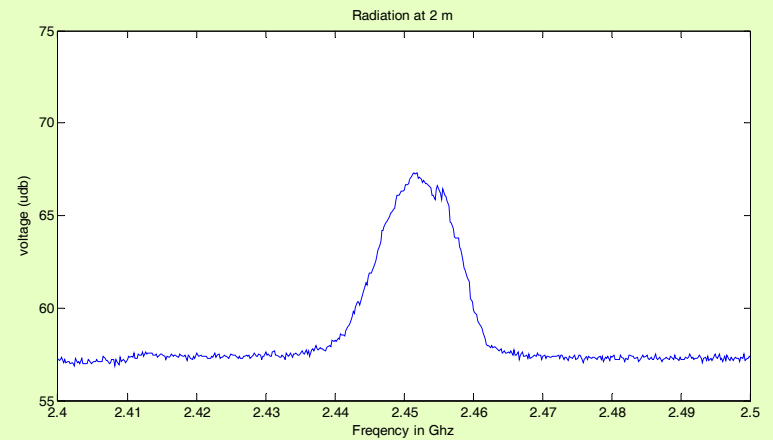
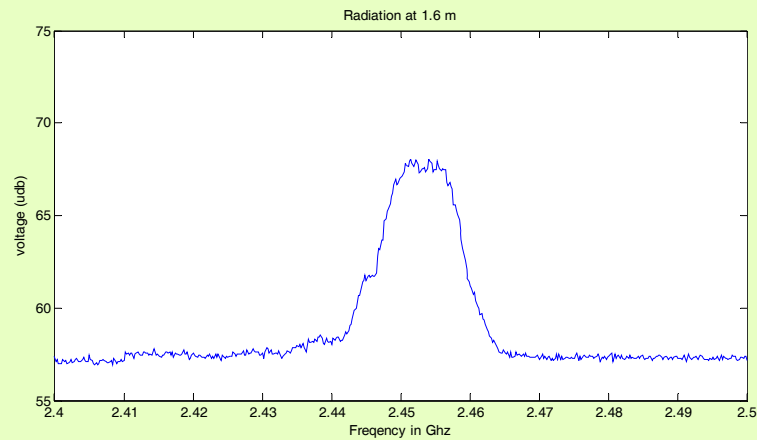
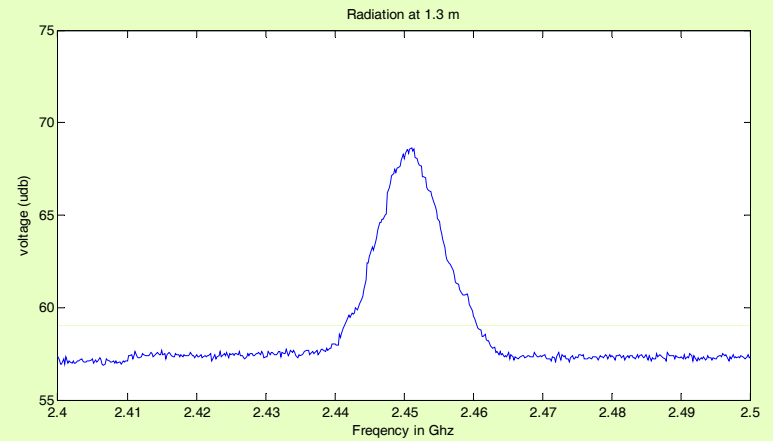
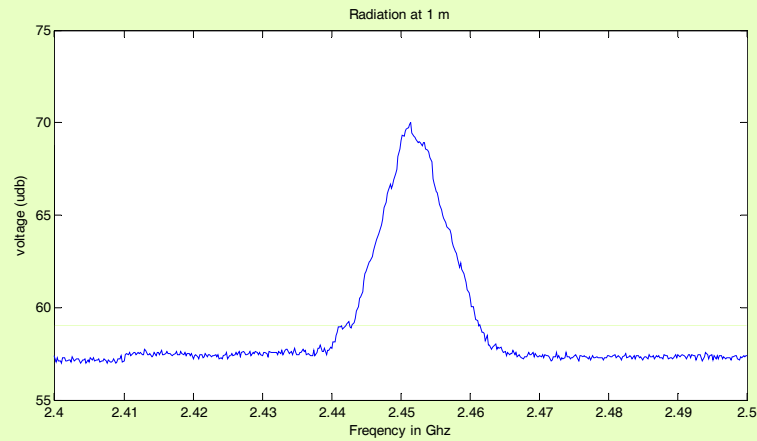
- 16 different distances
- Start from 0.2 m to 18 m
- 5 readings averaged at every distance



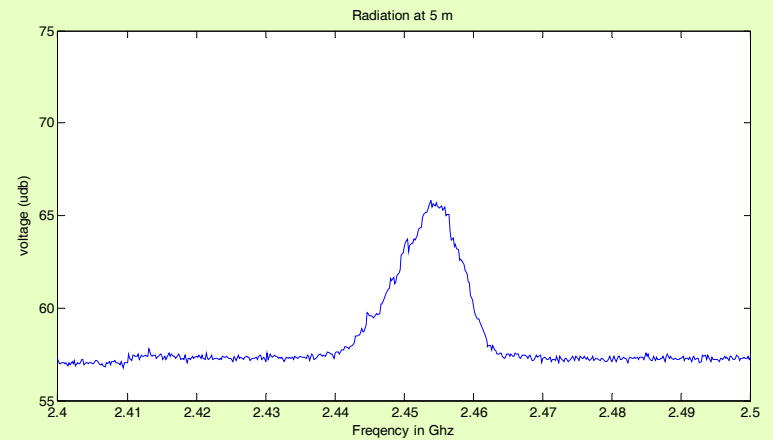
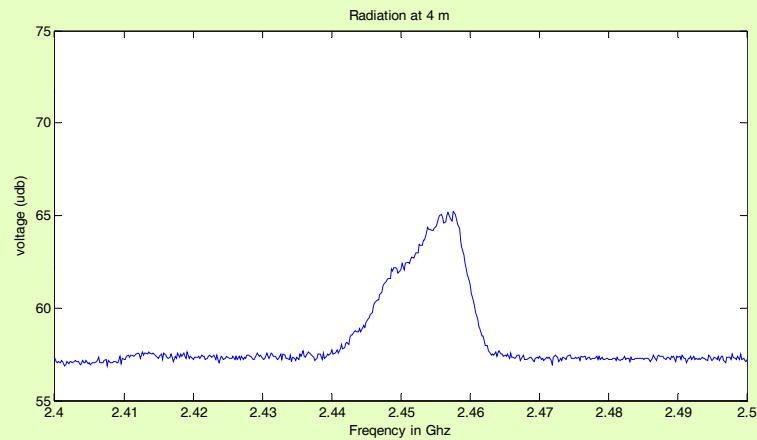
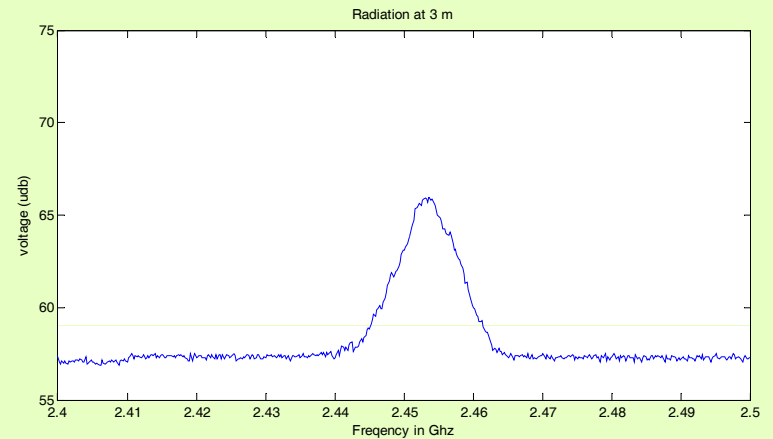
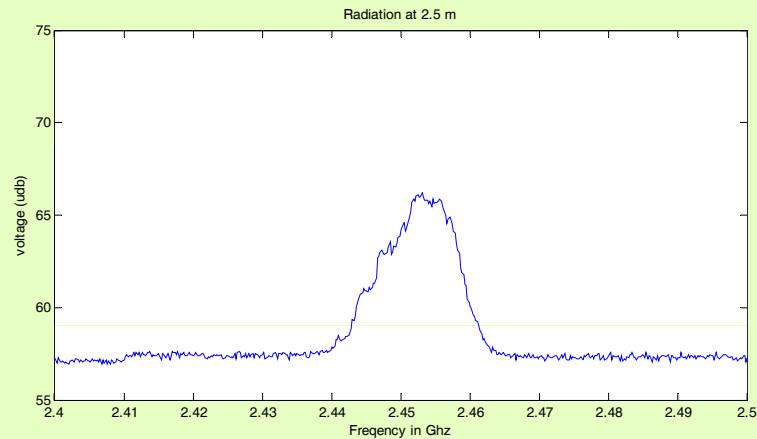
Distance Effect



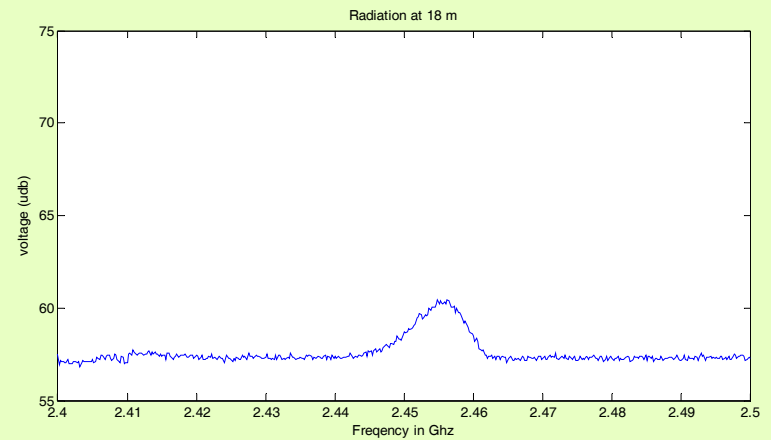
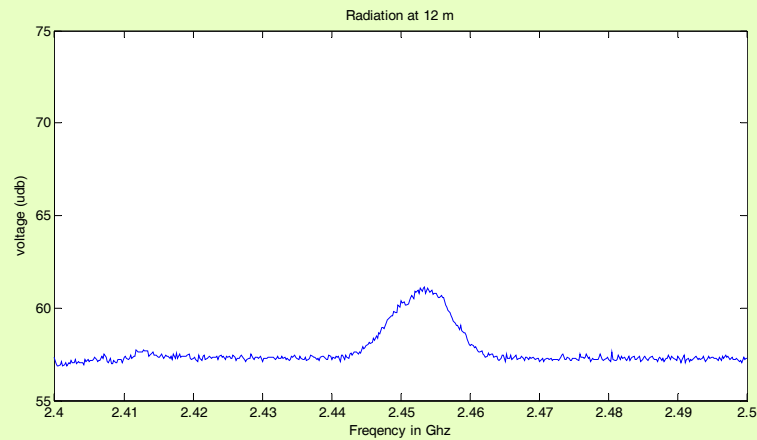
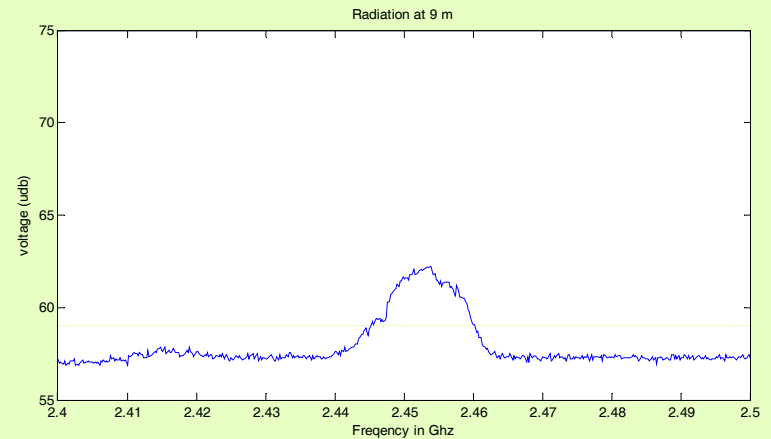
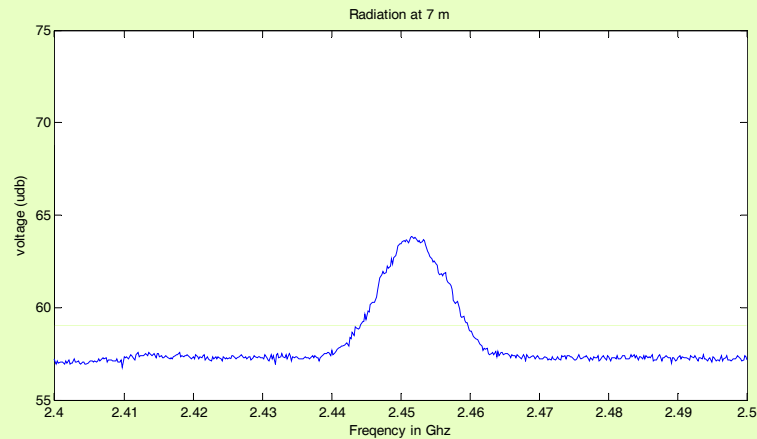
Distance Effect



Distance Effect

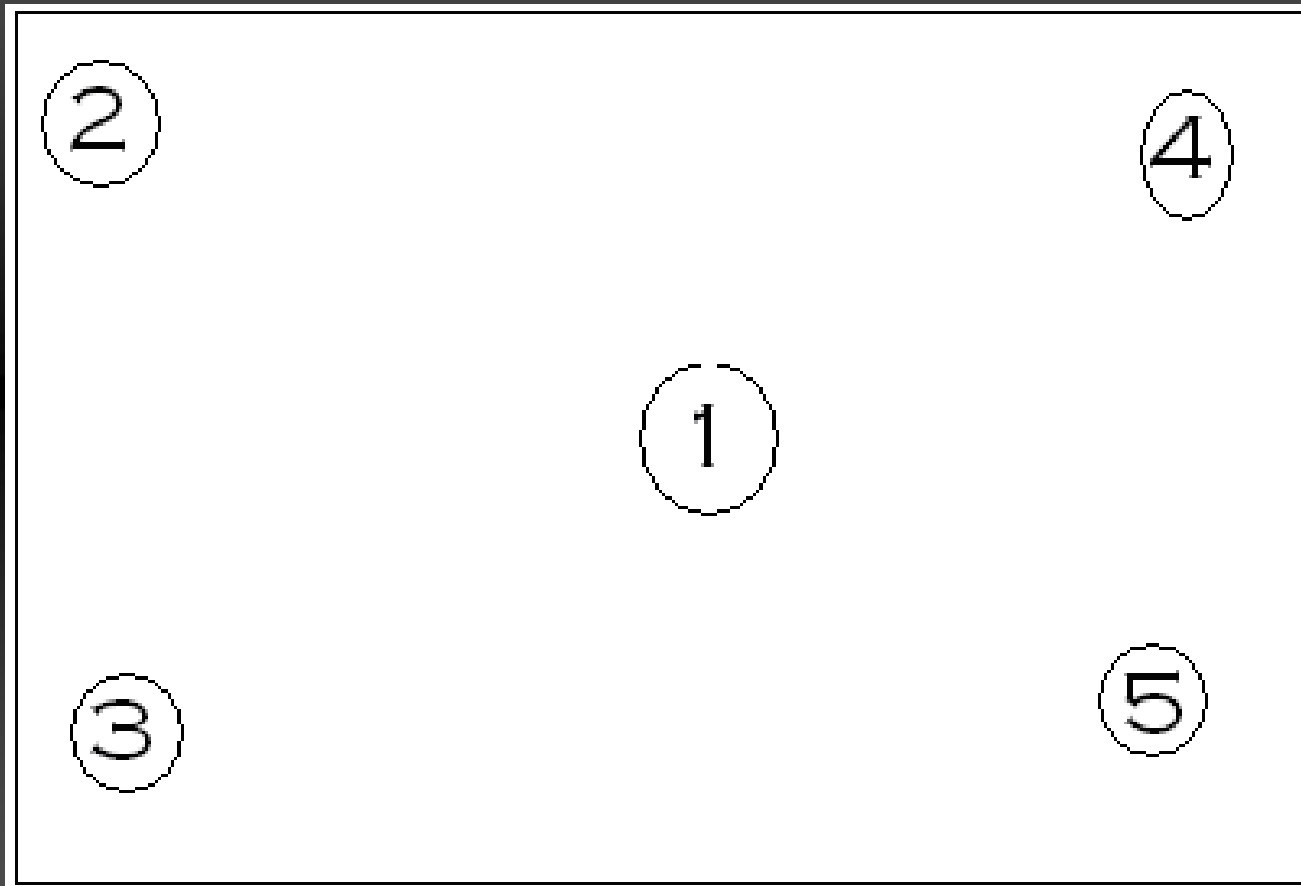


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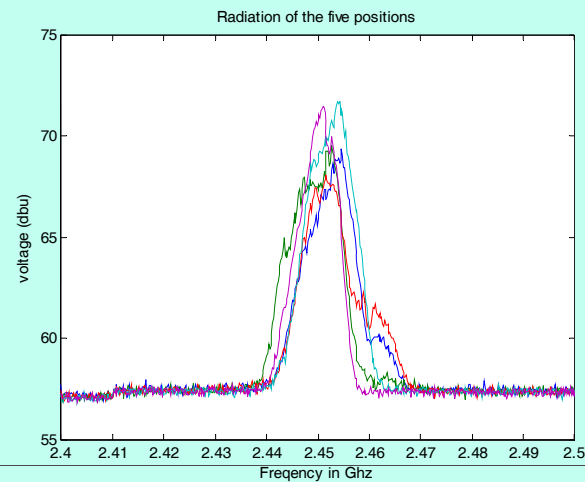
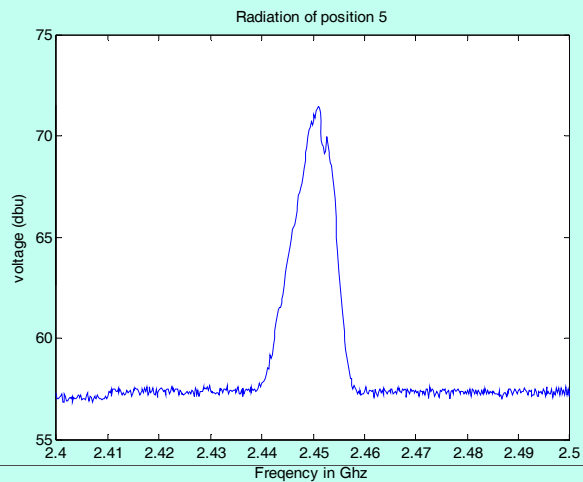
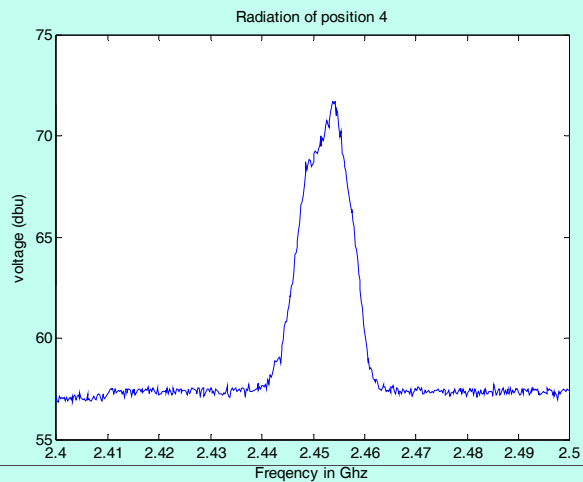
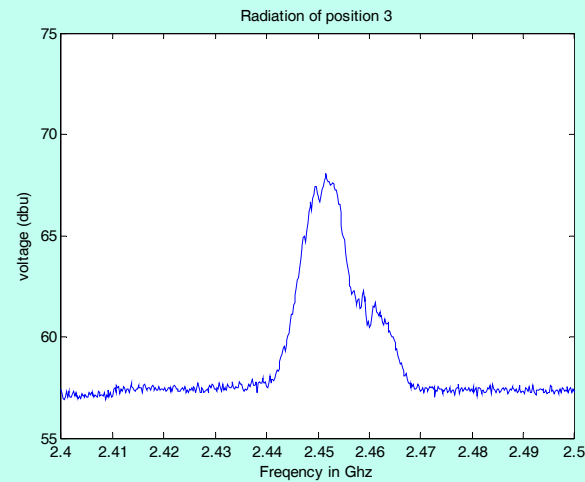
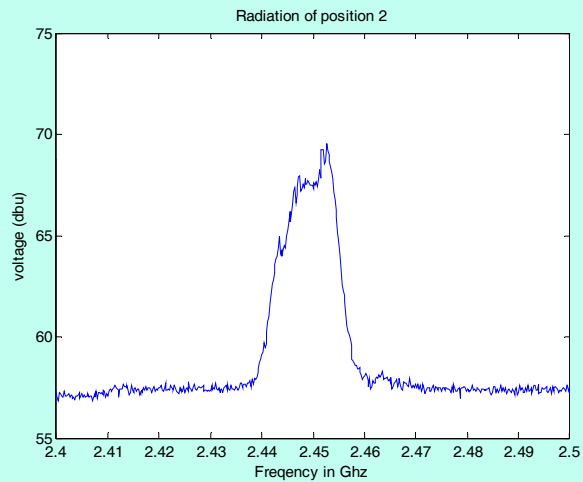
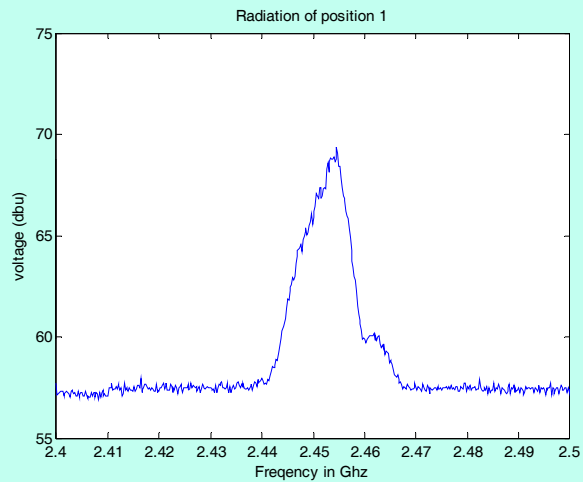


Load Placement Effect

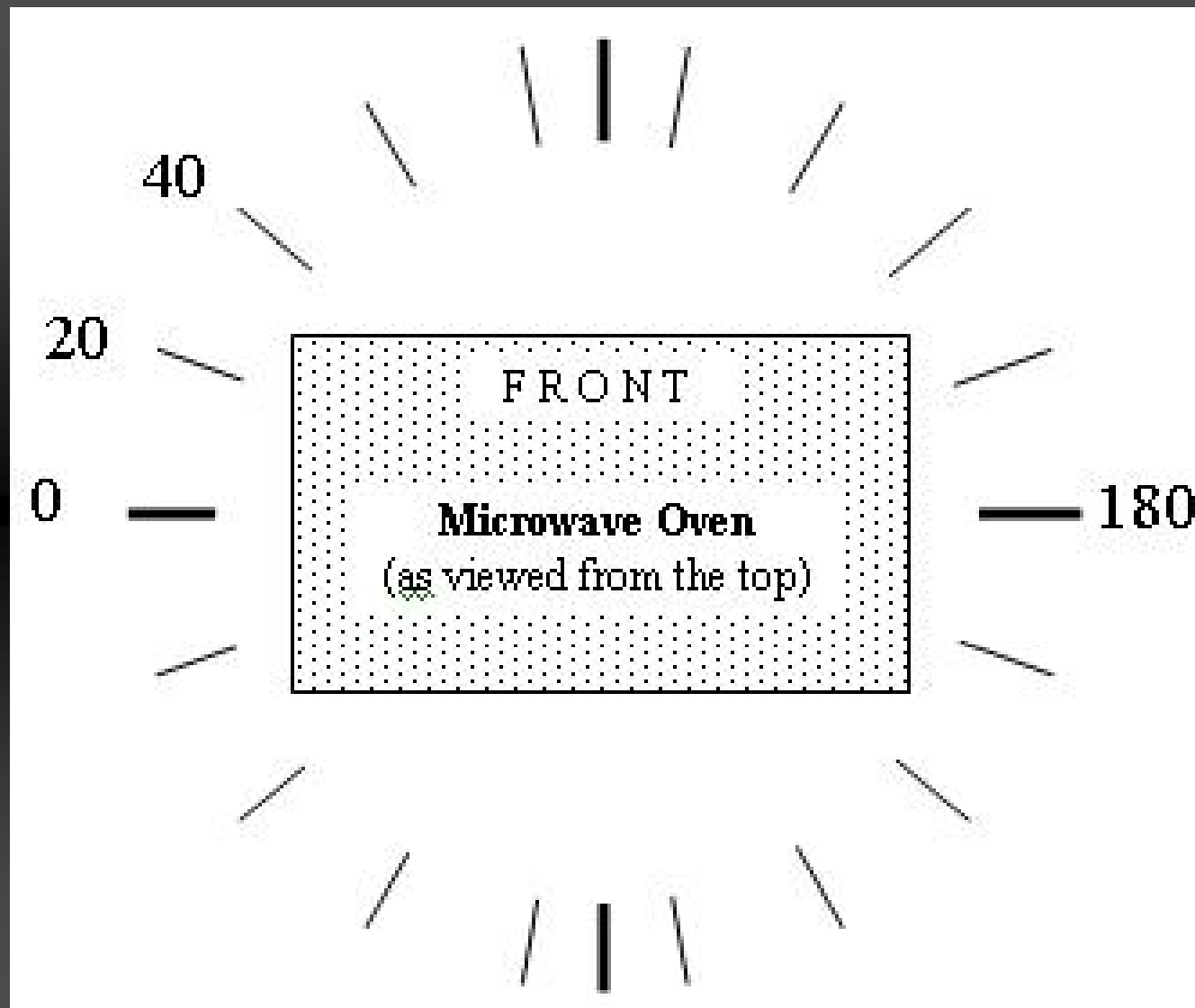
Load Placement in the Oven Cases



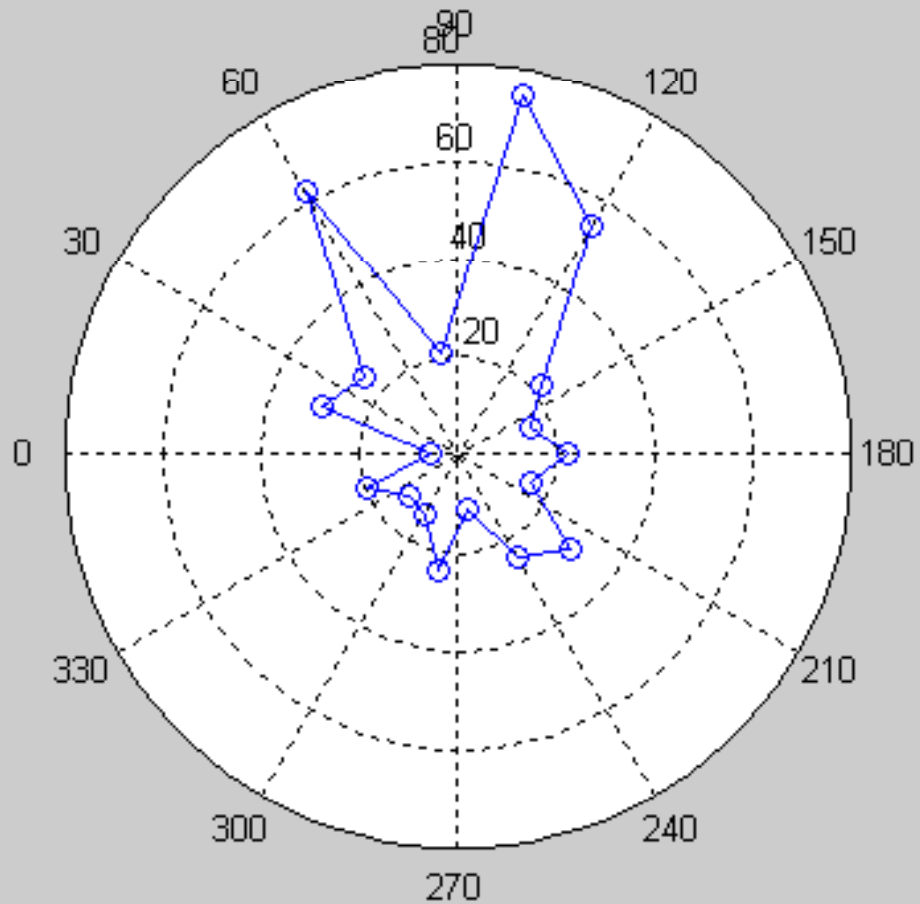
Load Placement Effect



Radiation Pattern



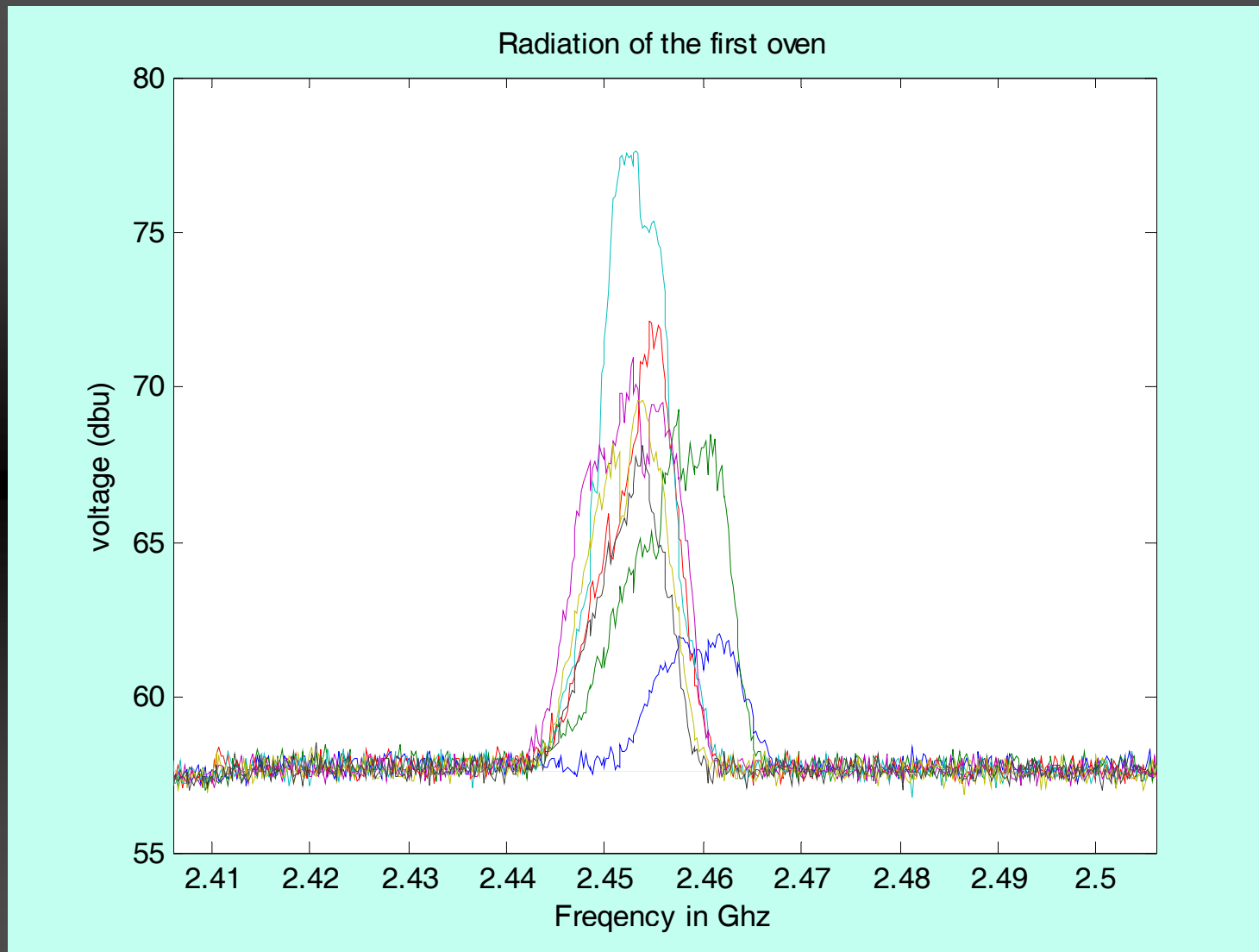
Radiation Pattern



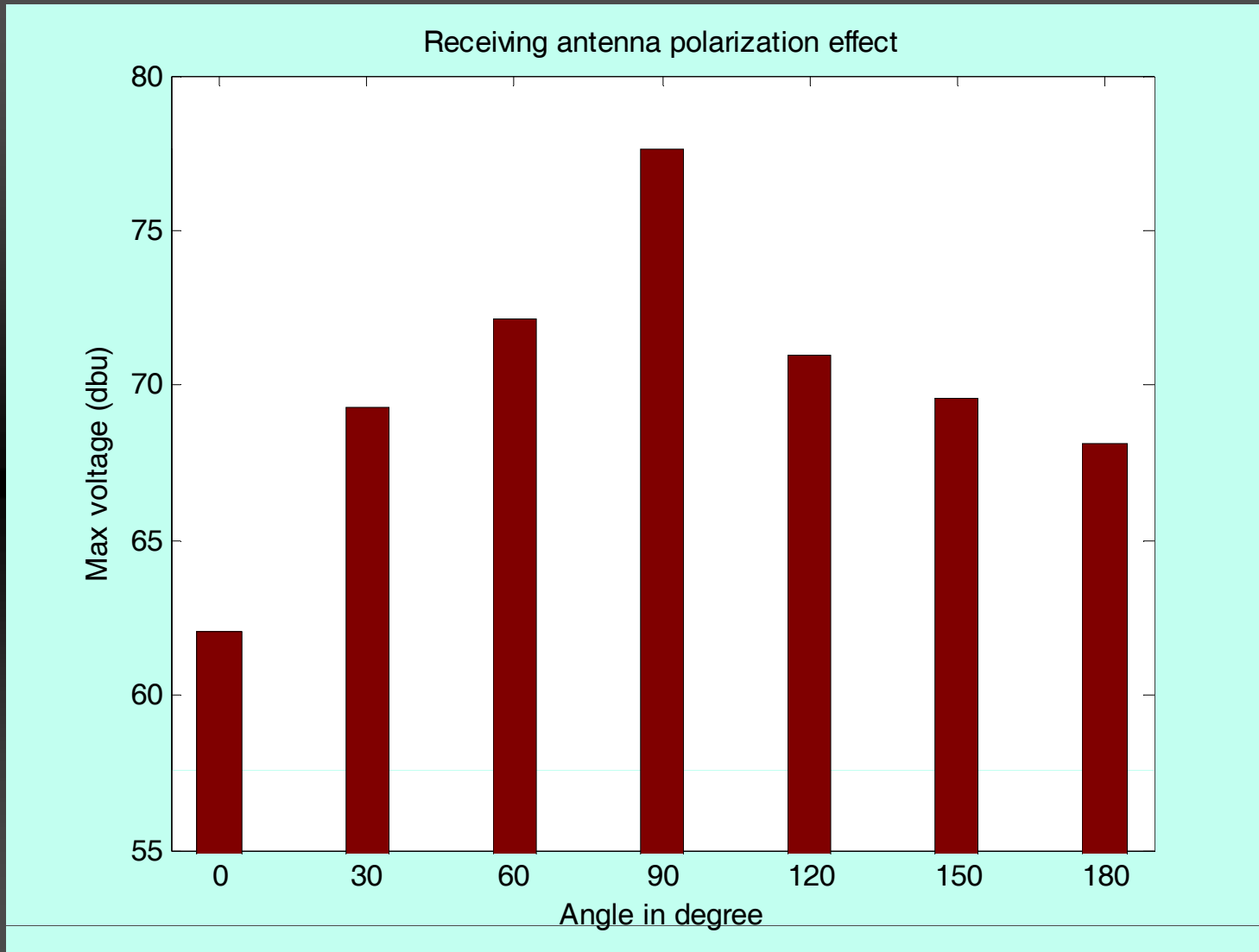
Polarization Effect



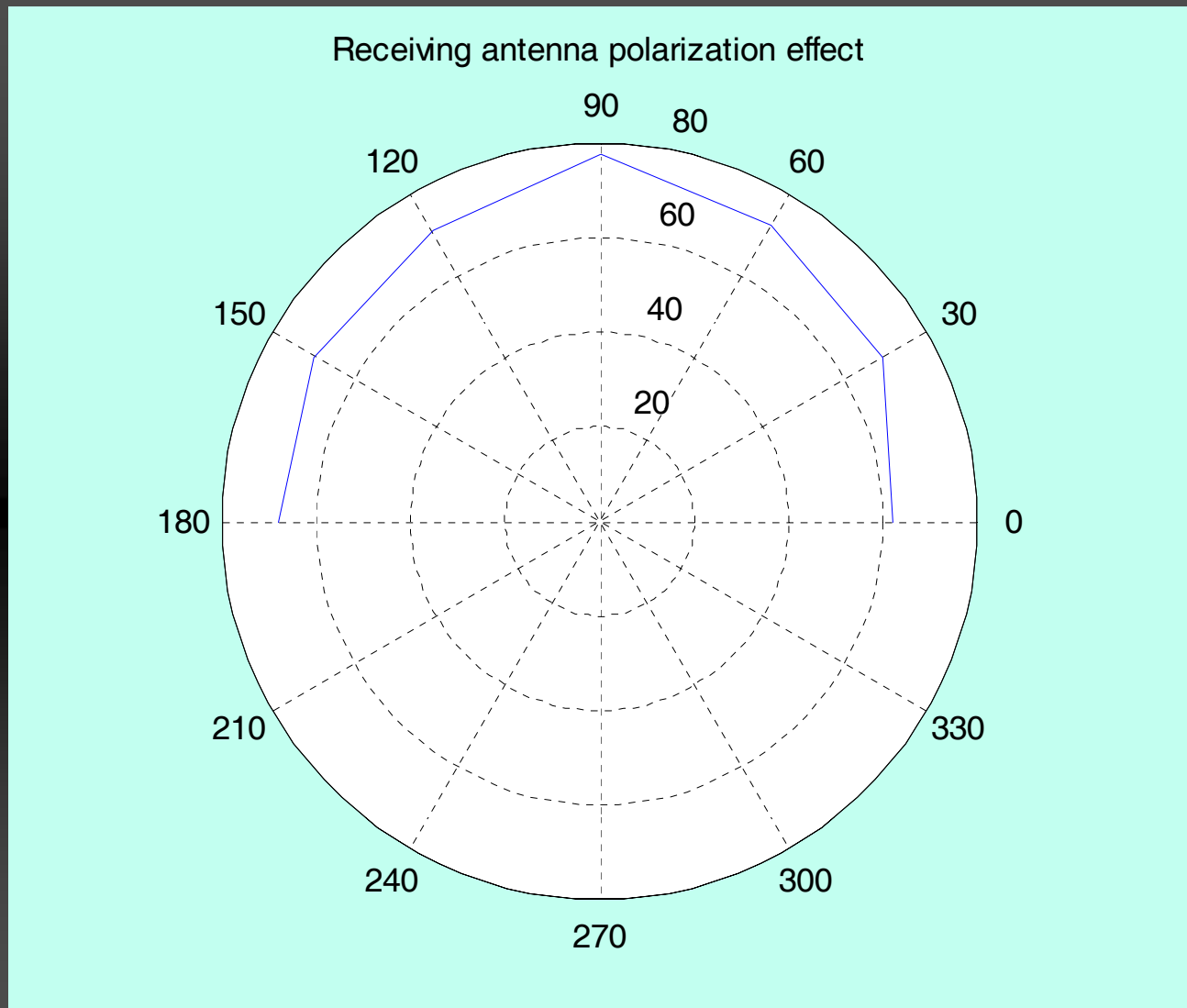
Polarization Effect



Polarization Effect



Polarization Effect

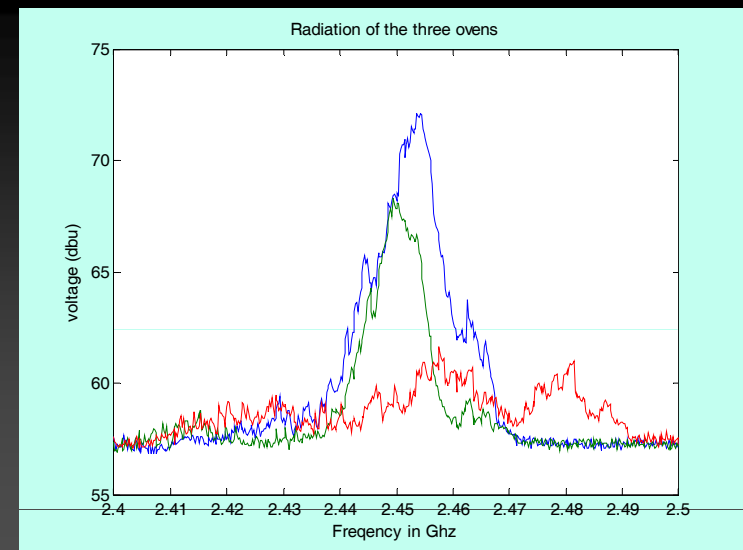
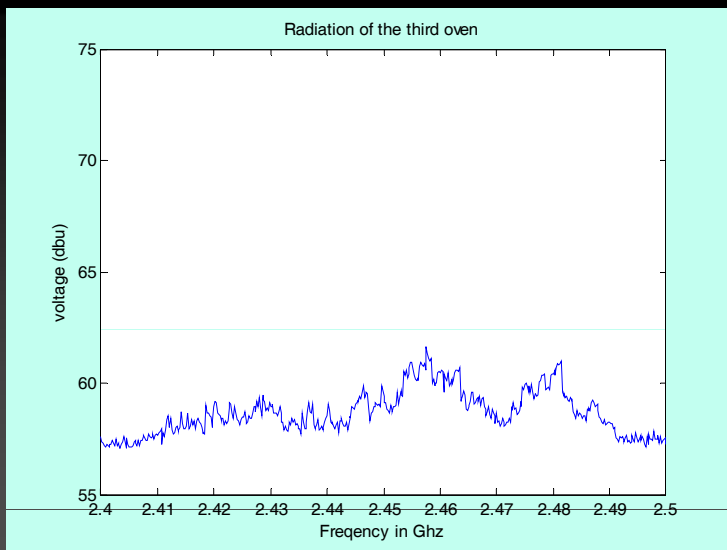
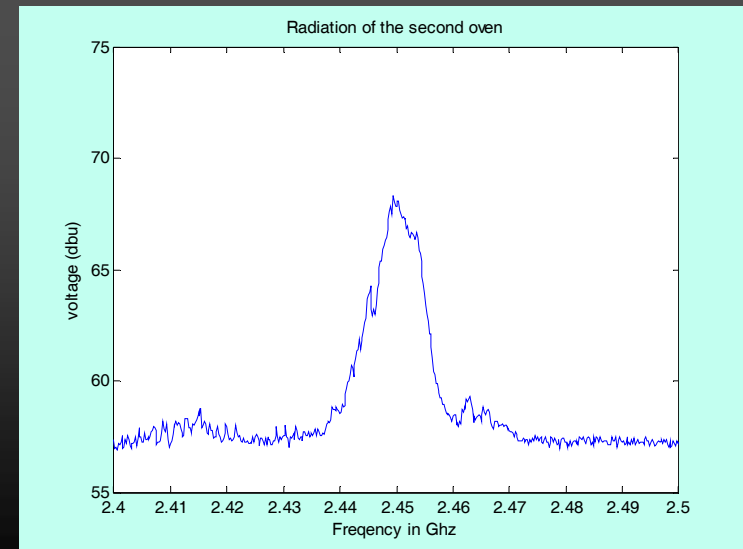
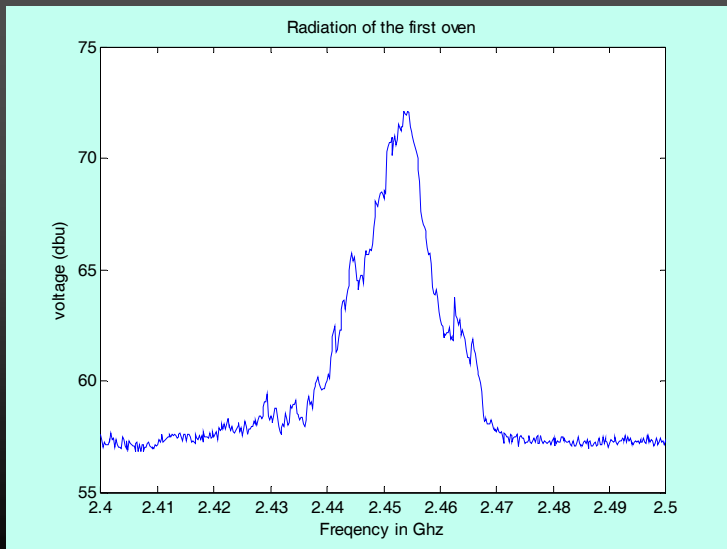


Different Manufacturer Test

Specifications of the three different microwave ovens :

	Rating	Power Consumption	Output Power
First Microwave	AC 127V/60Hz	1350 W	950 W
Second Microwave	AC 127V/60Hz	1300 W	800 W
Third Microwave	AC 127V/60Hz	1100 W	700 W

Different Microwaves Test

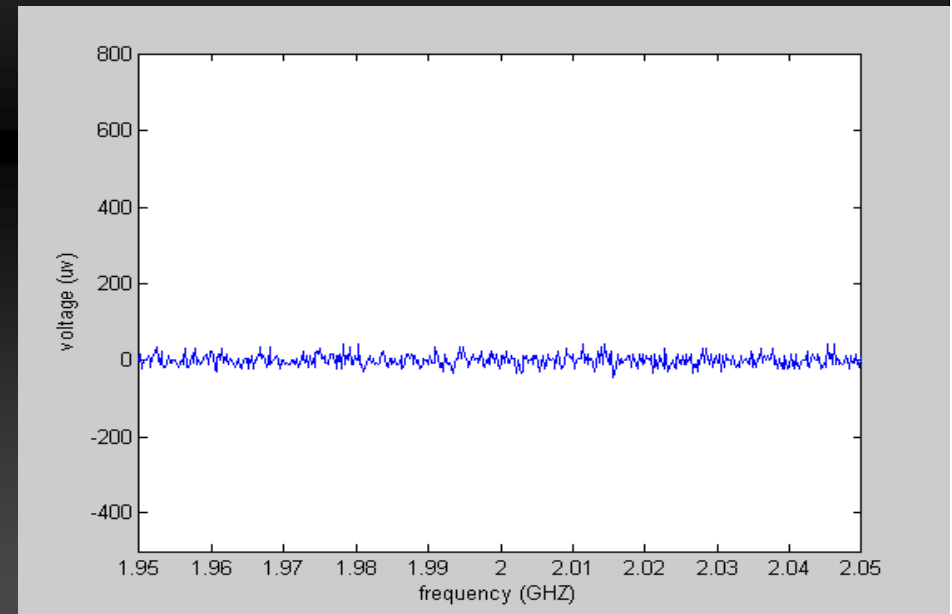
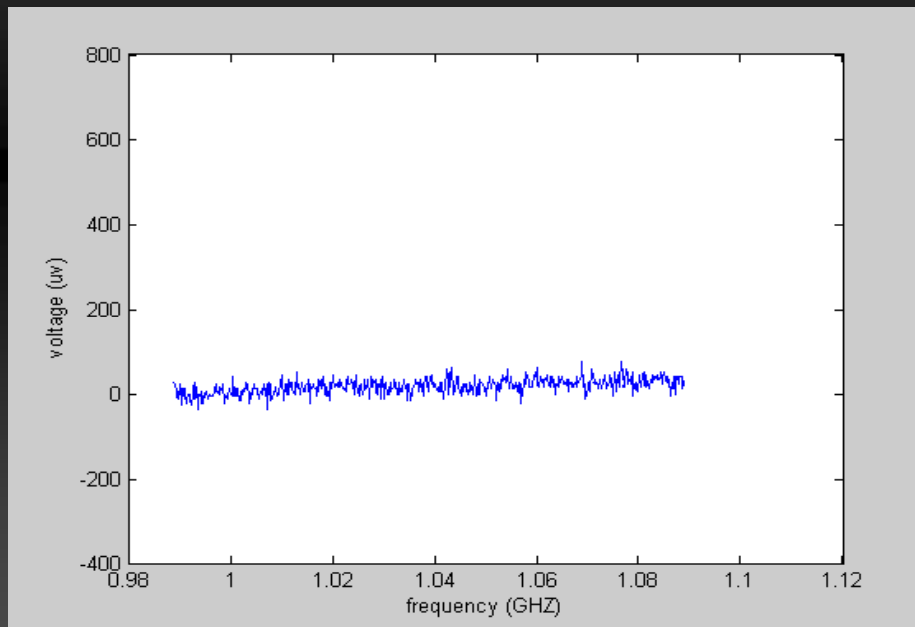


Measurements In Chamber



In - Out Band Check

- Between 989 MHz and 1089 MHz
- Between 1950 MHz and 2050 MHz



Results & Recommendations

- Users should remain at more than **1 meter distance**; as the measured radiation decreases dramatically with distance.
- Load placement test did not show consistent effect on the radiation, so it can be considered **insignificant**.
- Vertically polarized dipole antenna received **significantly more** radiated power than the horizontally polarized counterpart did.
- Radiation pattern test depicted that the radiation through the **front panel** of the microwave oven is the **highest** and second is the radiation from the back.

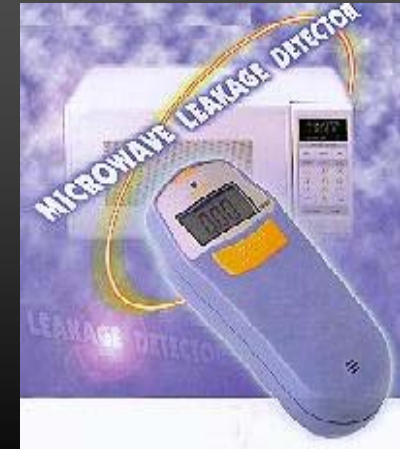
Results & Recommendations

- The **lowest radiation** was measured at the left and right sides.
- As a recommendation, the user should avoid the front and the back of the oven.
- It is also shown that radiated power varies significantly between **different manufacturers**.
- It is recommended that sensitive control rooms which are in the vicinity of microwave ovens should be provided with a digital leakage detector.
- *Can you think of a better redesign the Microwave oven?*

Leakage Detector



- Relatively cheap, sensitive and highly accurate
- Can send warning messages and alarms
- Compare with Mobile radiation !



Experiment to be Experimented!

- There's one simple way to detect a major microwave leak.
- Get a fluorescent tube and hold it against the edges of the oven's door when the oven is on.
- Microwave leakage will make the bulb glow. (Do this in a darkened room so you'll see the slightest glow.)
- This works much better if there is nothing at all inside the oven.

Asante

Eυχαριστώ

Merci

ขอบคุณ

Teşekkürler

Hvala

DMnywd

شكراً

Grazie

Gracias

Bedankt

GADDA GUEY

THANK YOU

Obrigado!

Dankie

Díky

謝謝

WAD MAHAD
SAN TAHAY
ありがとう!
Köszönettel متشكر

Dielen Dank

شكريا

감사합니다

Urakoze

Questions !

Leave you with a question

Q: I want to buy a microwave space heater ! Why do not we have some?