BACHELOR THESIS

Electrical and Electronic Engineering

Measurement of Microwave In-Room Transfer Function (Antenna-Antenna)

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OUTLINE
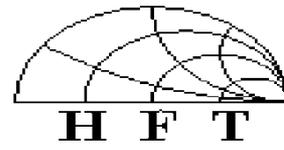
1- THESIS TASK

2- HISTORY

3- BRIEFING

4- MEASUREMENT

5- CONCLUSION

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THESIS TASK
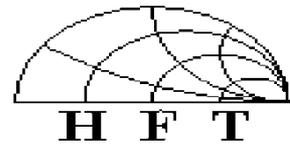
Channel Transfer Function Measurement with usage of S-Parameter

Investigation of Statistical relations

Phase & Amplitude vs. Position & Frequency

HISTORY
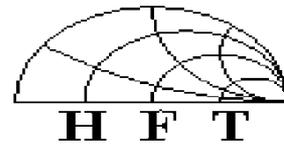
Oldest Far-Field Communication System

- Smoke Signals - Wireless Communication

First groundbreaking work

- "Possibility of error-free transmission by using optimum power in frequency selective channels", *by Claude Shannon* in 1948

Cellular Communication

- Started in 1970s and formulated within those years as well

Ultra-Wideband Systems (UWB)

- Spectrum Assignment till 2000
- In 2000 leakage of free spectrums
- UWB works within assigned spectrums but no interference

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BRIEFING

Vector Network Analyzer

- Ability of measuring S-Parameters
- Very good Calibration

Omni-Directional Antennas

- Receiver and Transmitter
- Used for point-to-multipoint network
- Increase of power/receiving sensitivity in one plane

Top View

Zero Gain Antenna Coverage

Side View

High Gain, Omni-Directional Antenna Coverage

Omni Antenna aligned vertically

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BRIEFING
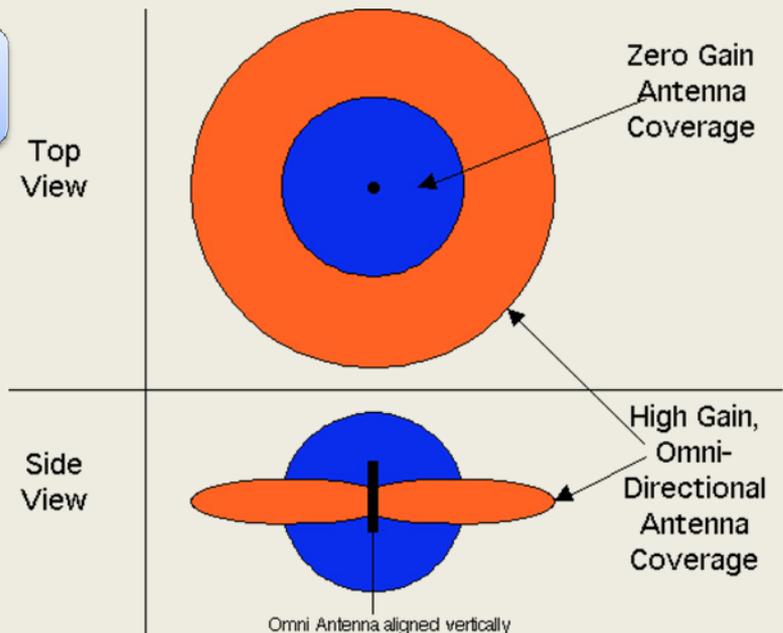
Line Of Sight (LOS) / Non-Line Of Sight (NLOS)

LOS: Direct Path

- Transmitter and receiver antenna in eye contact
- No Object in between
- Reflection

NLOS: No Direct Path

- Transmitter and receiver antenna in eye contact
- Objects between transmitter and receiver
- Reflection, Refraction and Defraction

WALL

R_X

r_2

r_1

α

α

T_X

d

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BRIEFING
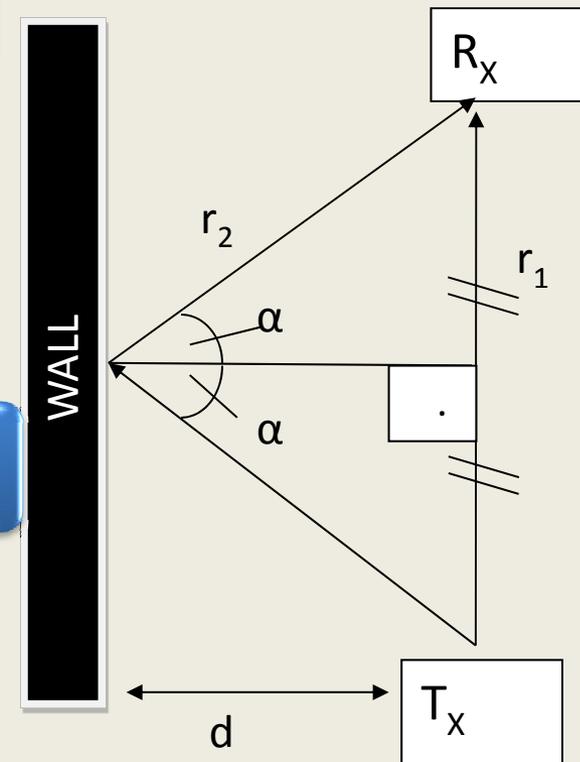
Scattering Parameters
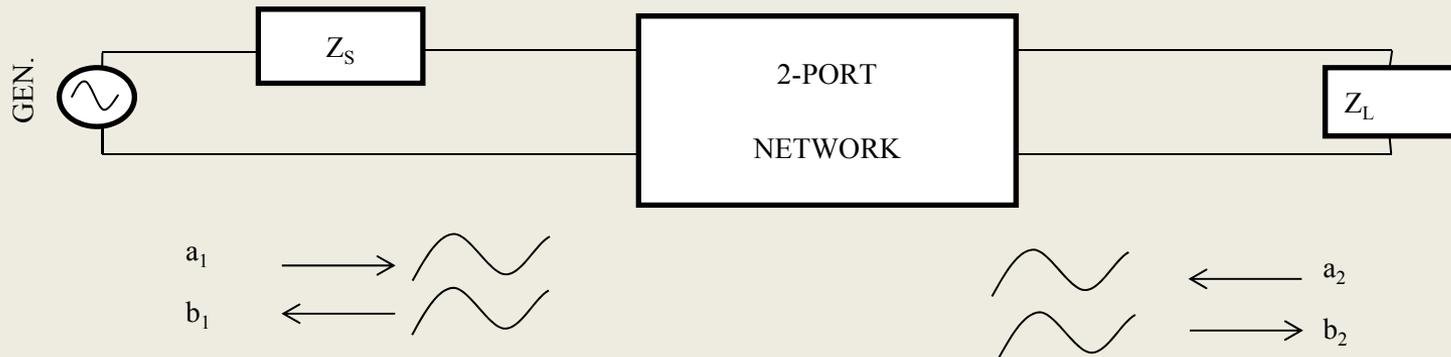
• Description of scattering Incident, Reflected and Transmitted Waves

• Determined by measuring the magnitude and phase

• S_{21} Forward transmission through network $S_{21} = \frac{b_2}{a_1}\big|_{a_2=0}$

• S_{21} used as Channel Transfer Function

BRIEFING
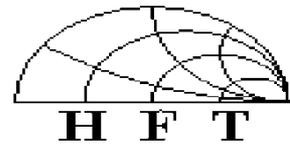
Correlation

"Degree and type of relationship between any two or more quantities/variables in which they vary together over a period."

$$\varsigma = S_{21}^{(1)}(f) * S_{21}^{(2)}(f)$$

Or

$$\varsigma = \int_{-\infty}^{+\infty} S_{21}^{(1)}(f)\, S_{21}^{(2)*}(f + \Delta f)$$

MEASUREMENTS

EQUIPMENT

1- Vector Network Analyzer

2- Omnidirectional Antenna(2X)

3- Coaxial cable

4- PC

5- Advanced Design Systems (ADS) 2009 Update 1 **(Software)**

6- MATLAB 2011a **(Software)**

MEASUREMENTS

PLACEMENT OF ANTENNAS

285 cm

255 cm

30 cm

30 cm

30 cm

295 cm

325 cm

355 cm

30 cm

30 cm
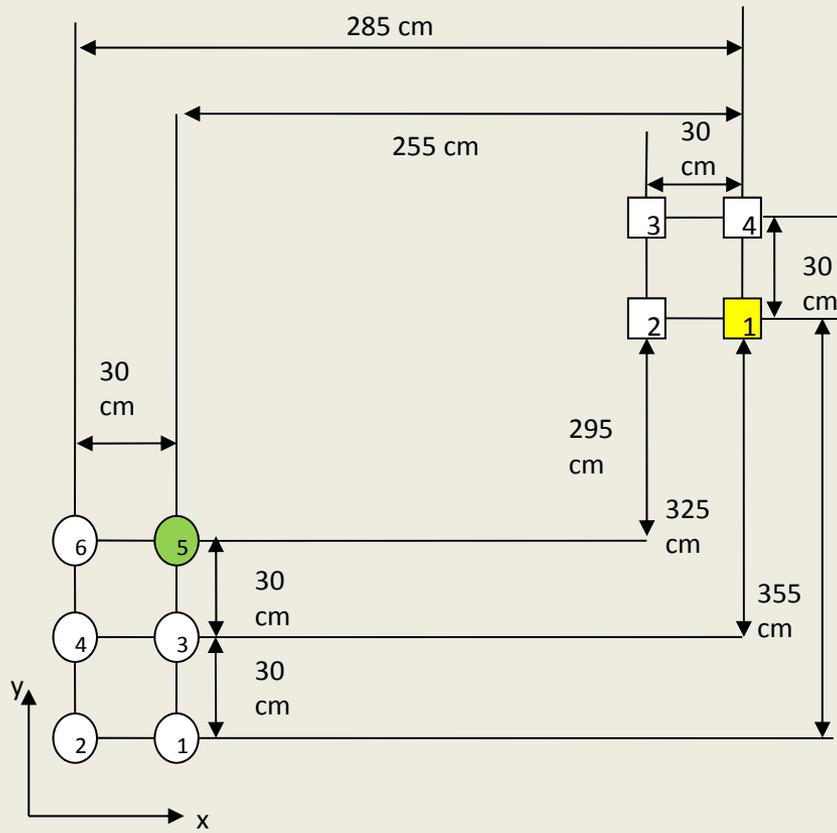
Receiver position 1

Transmitter position 5

MEASUREMENTS

STEP 1

- **Measuring the S-Parameter and plotting in MATLAB**

MEASUREMENTS

STEP 2

Auto-Correlation

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MEASUREMENTS
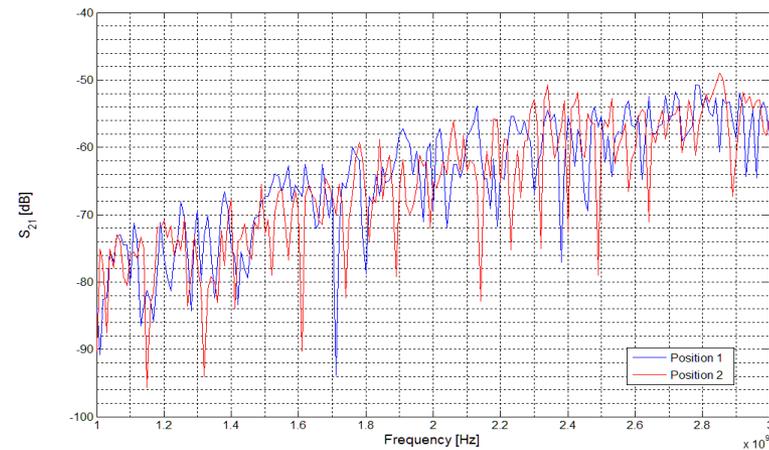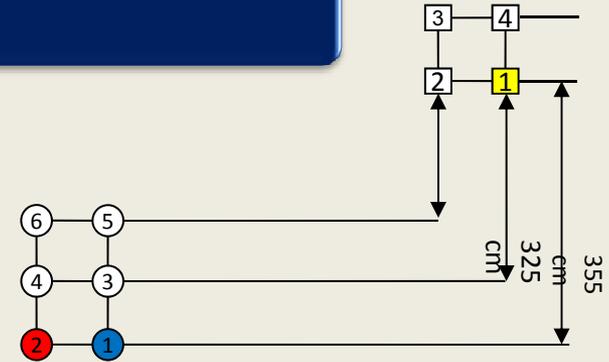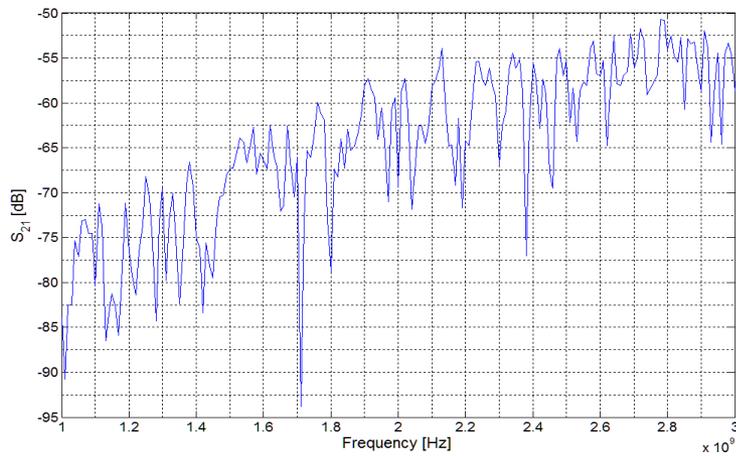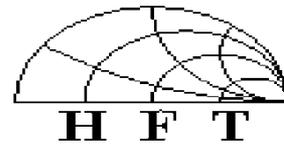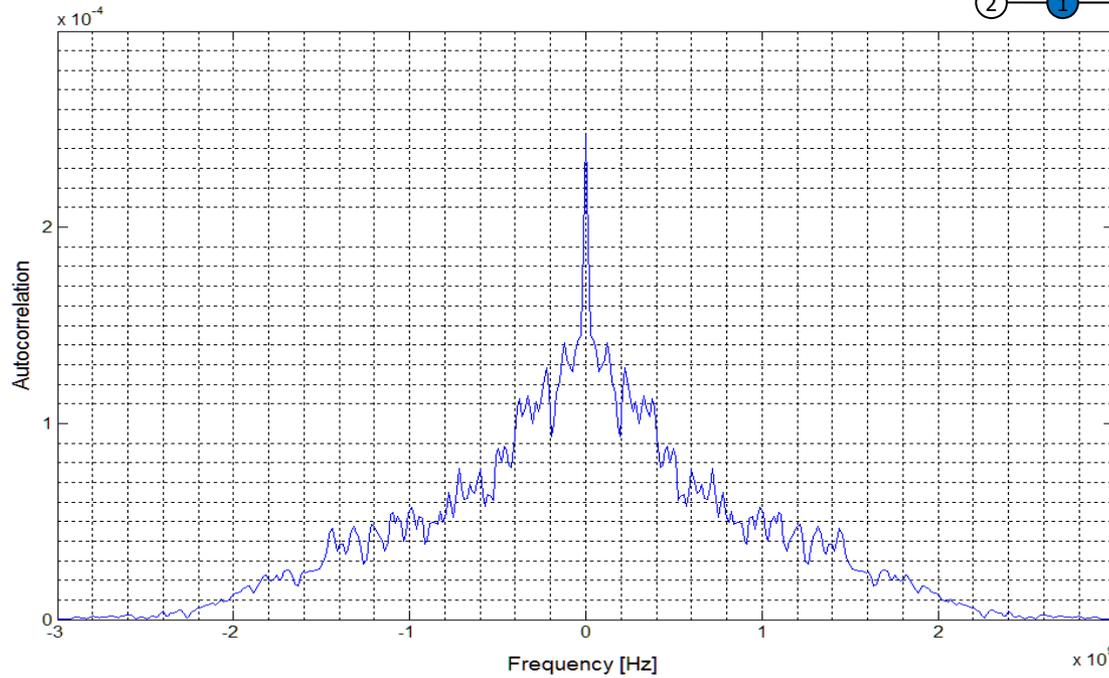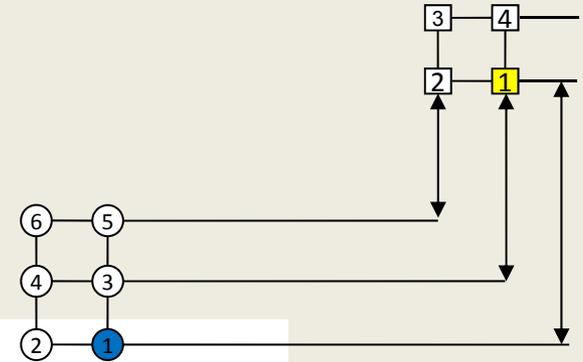
STEP 3
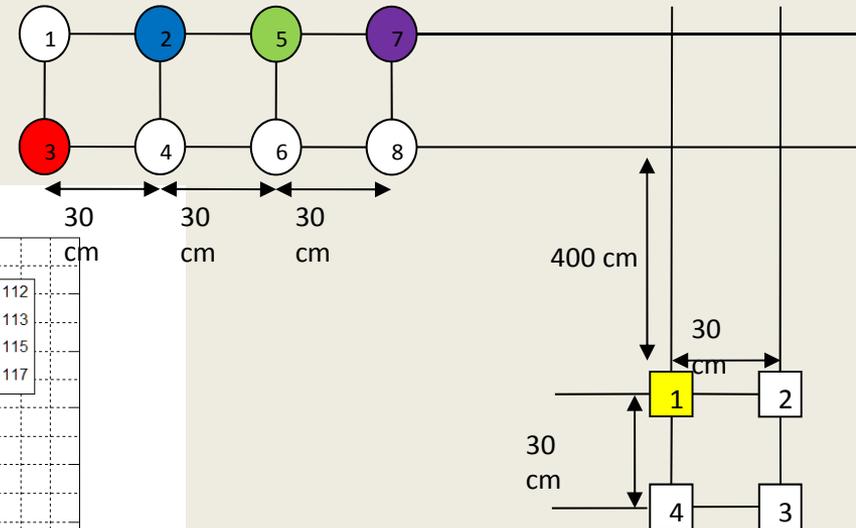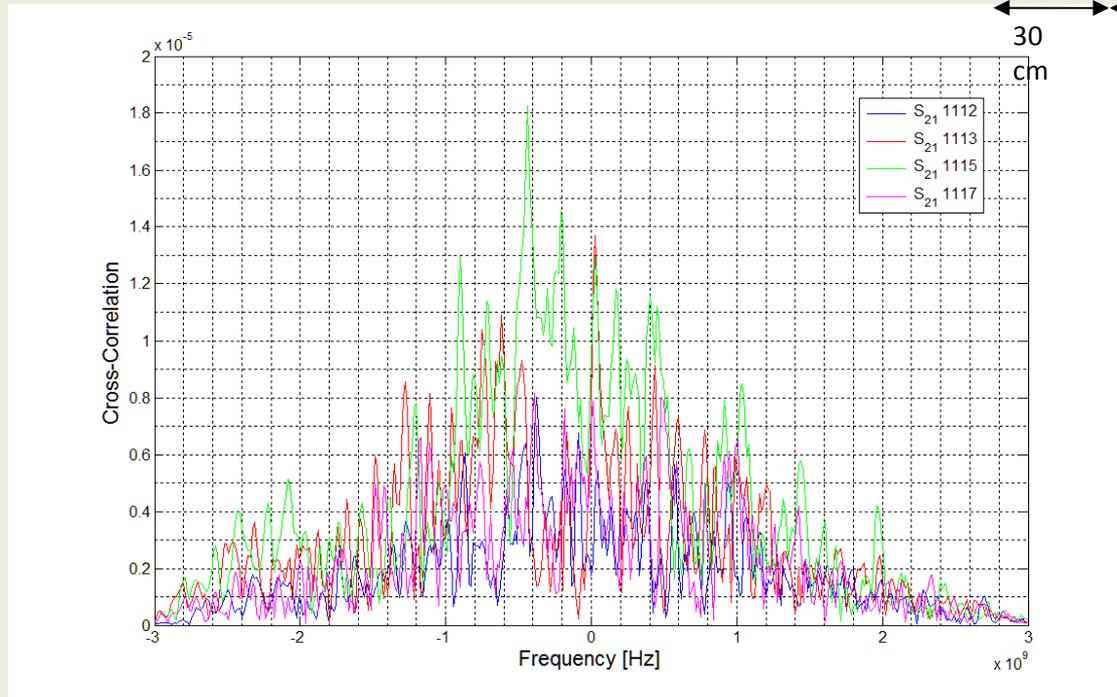
Cross-Correlation

S21 XY*XY
X=Receiver Position
Y=Transmitter Pos.

MEASUREMENTS

STEP 2

Auto-Correlation

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MEASUREMENTS
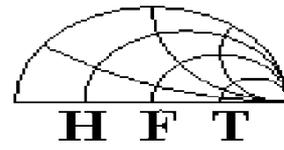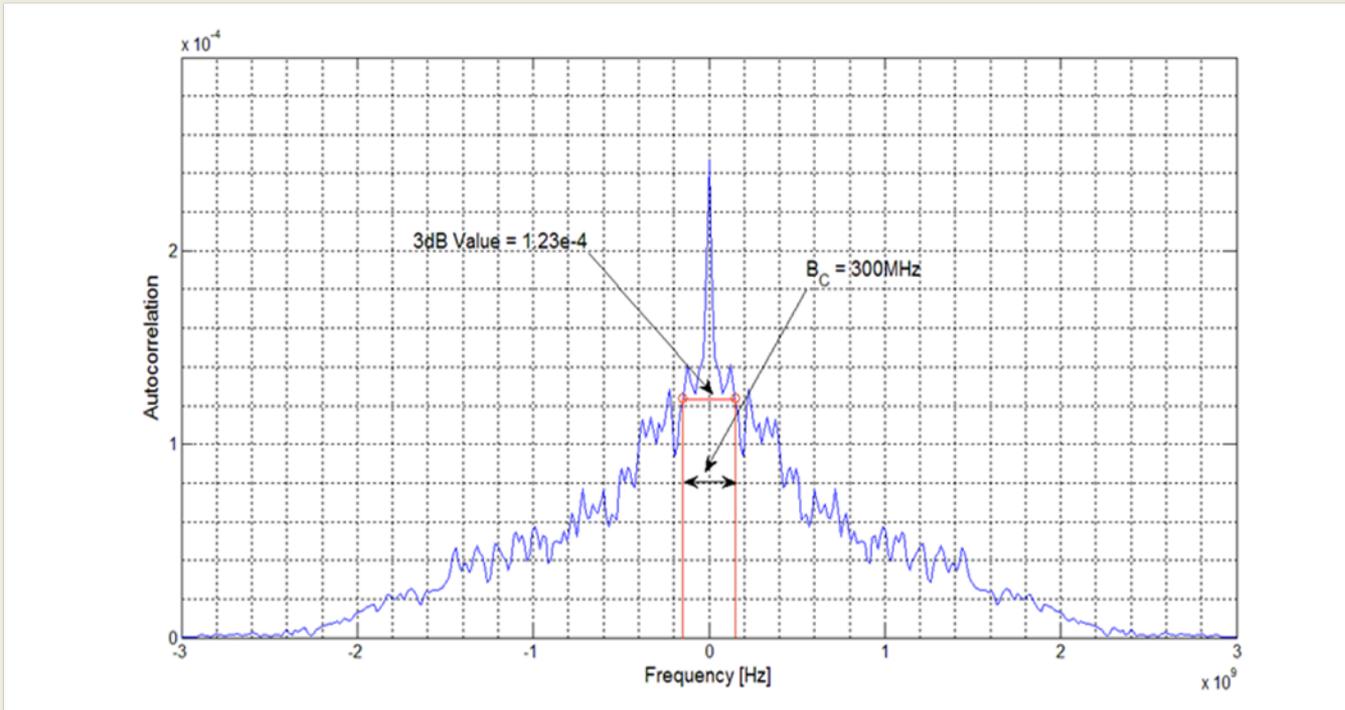
STEP 2
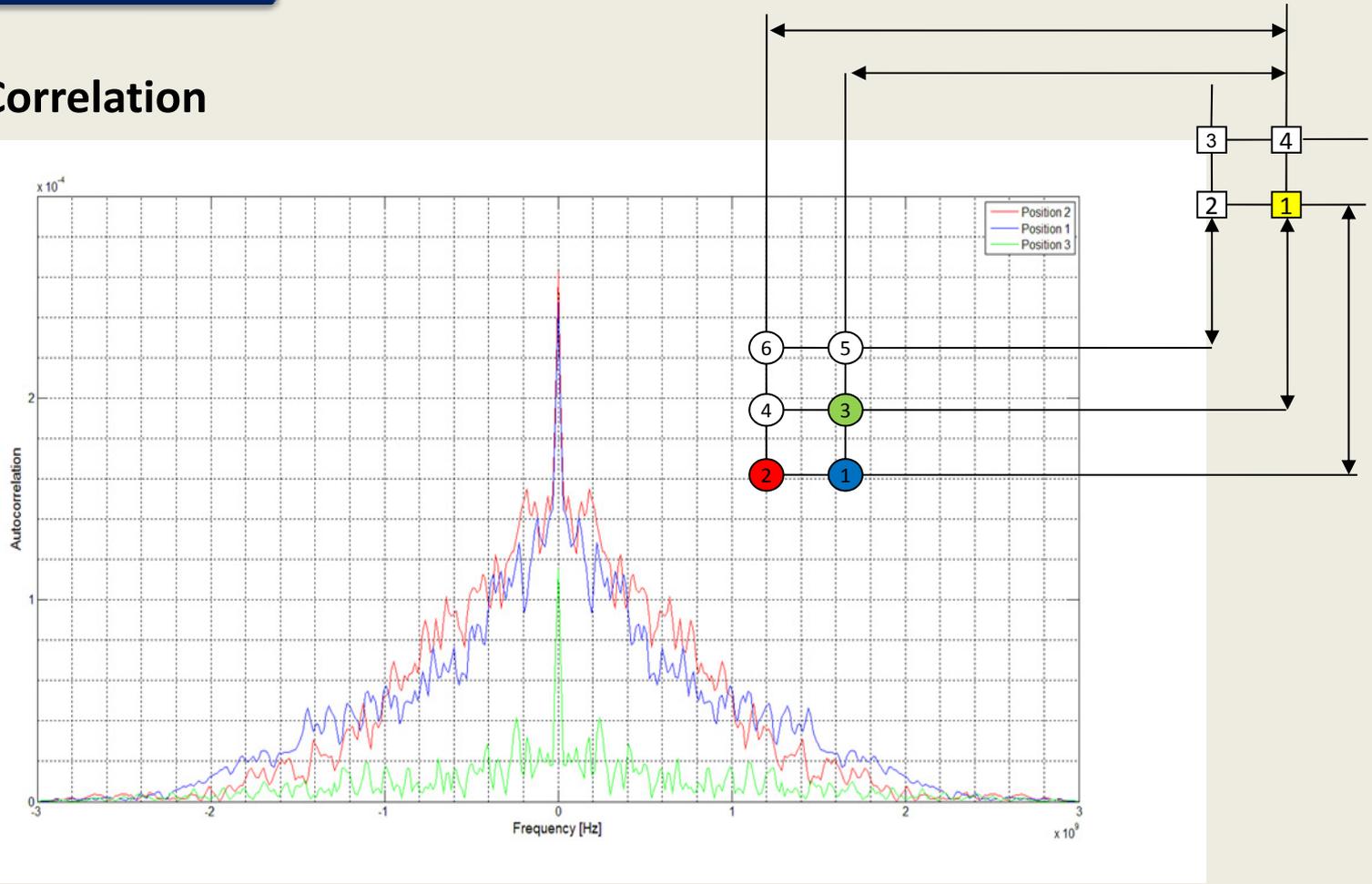
Auto-Correlation

CONCLUSION
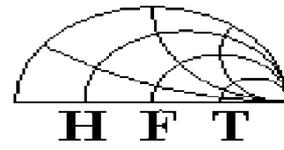
STEP 4

Comparison Auto-Correlation

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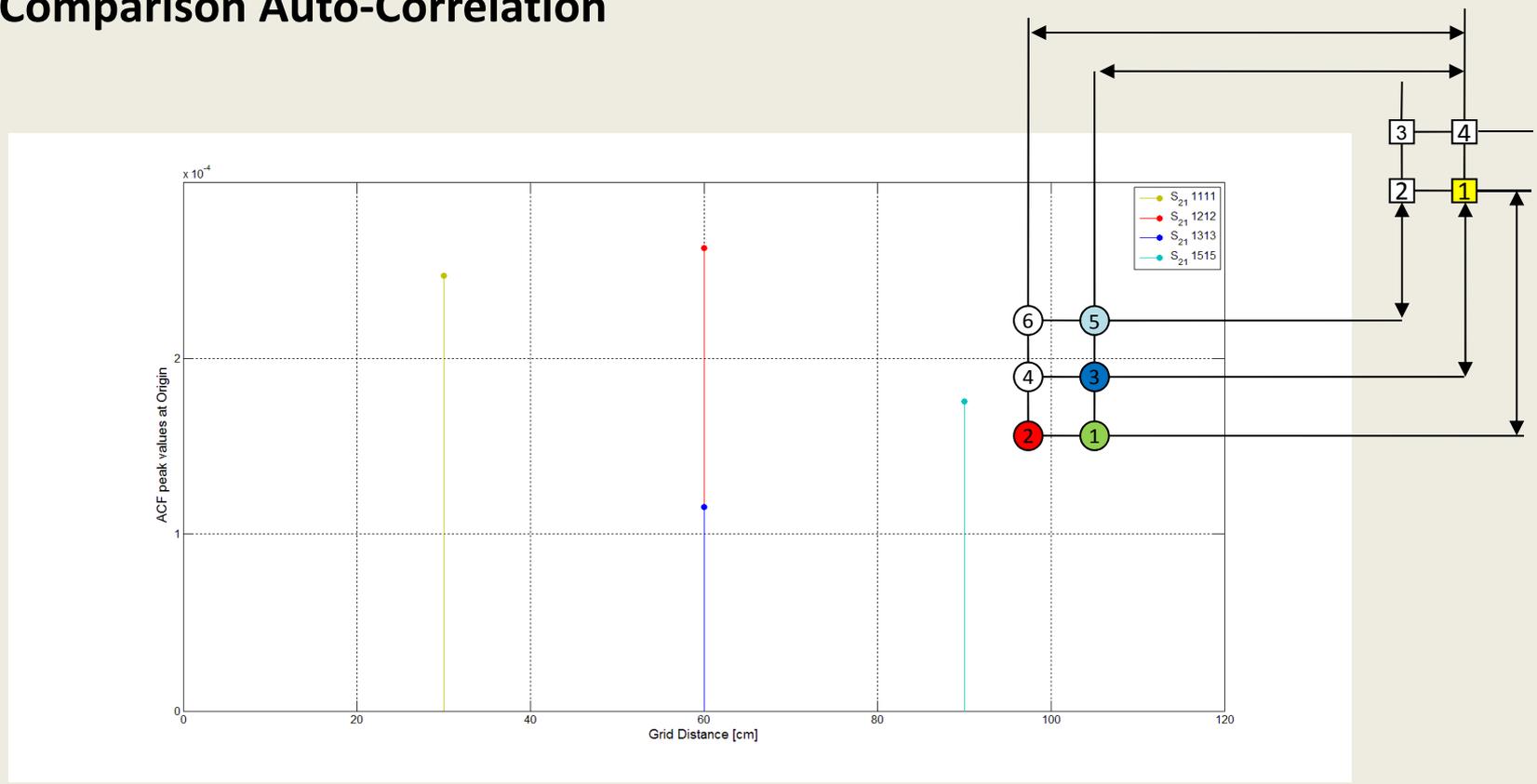
CONCLUSION

STEP 5

Cross-Correlation

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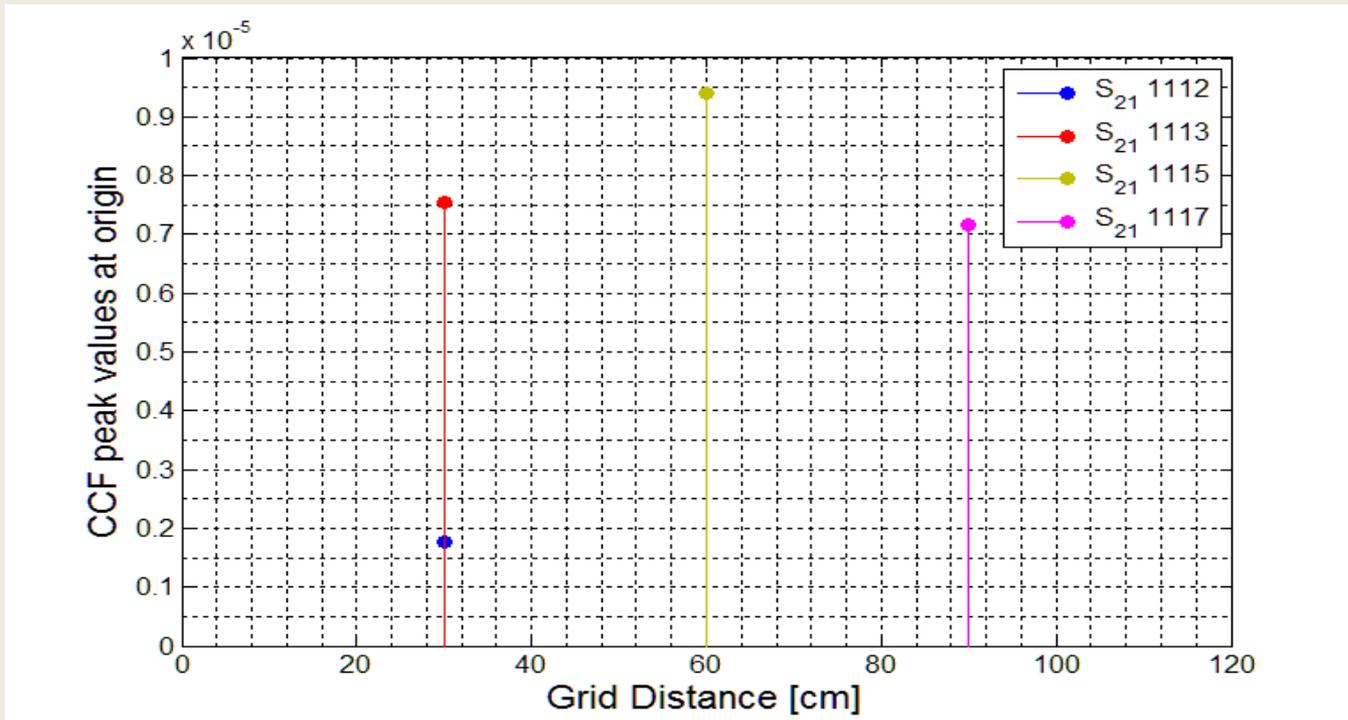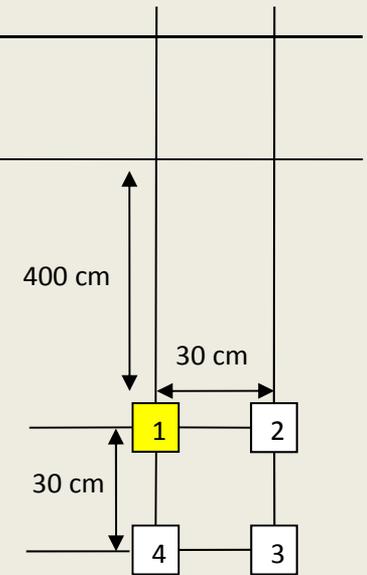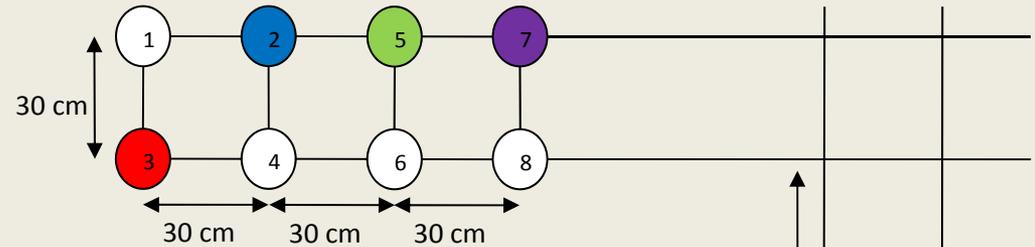
CONCLUSION
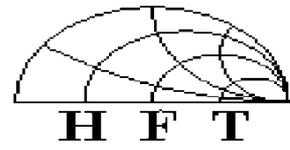
THANK YOU FOR YOUR ATTENTION

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