

High-Resolution Propagation Measurements Using EMC Antennas-a Numerical Study

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Overview

- Numerical Models of typical EMC antenna types
- Impulse responses of selected antennas
- Signal Processing
- Enhanced range resolution results



Motivation

- I'm a “geek” & I have radio in my blood!
- Can we use ordinary EMC antennas to perform high-resolution time-domain measurements?
- Frequency range of interest 30-1000 MHz
- Provide a tool for telecom & EMC engineers for propagation measurements and facility evaluations



Antenna Modeling

- Use NEC-2 to model selected EMC antennas
- Dipole
- Biconical
- Log-Periodic Dipole Array (LPDA)



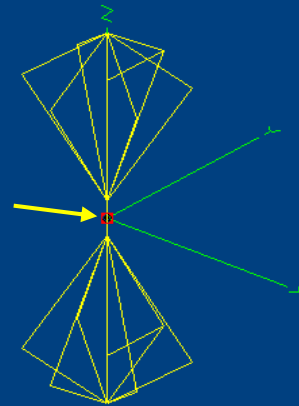
Biconical
30-200 MHz

Dipole
 $L=1$ m

LPDA
9 elements
200-1000 MHz

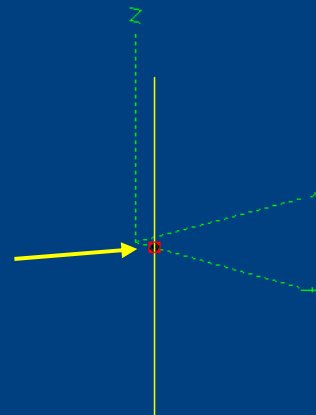
a)

Delta Function
Voltage Source
or
200 Ohm
Resistive
Load



b)

Delta Function
Voltage Source
or
50 Ohm
Resistive Load

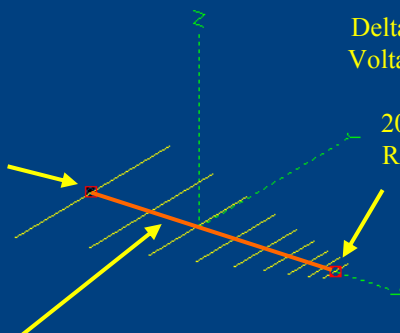


c)

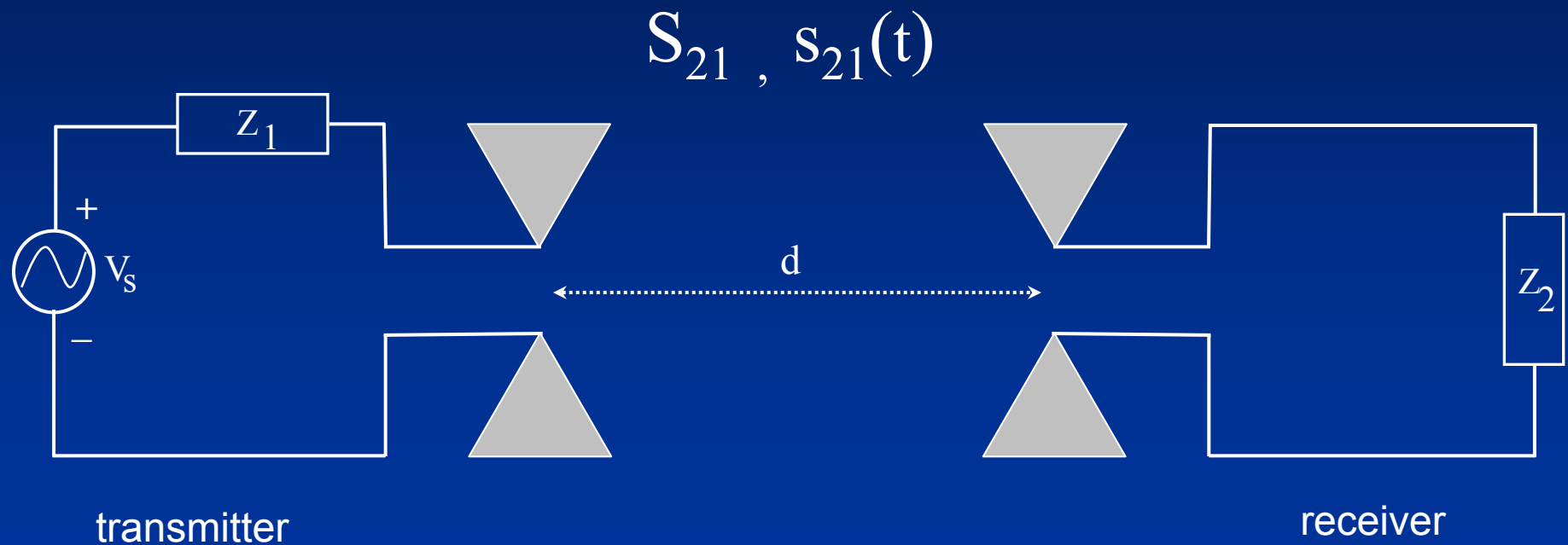
200 Ohm
Termination
resistance

Delta Function
Voltage Source
or
200 Ohm
Resistive
Load

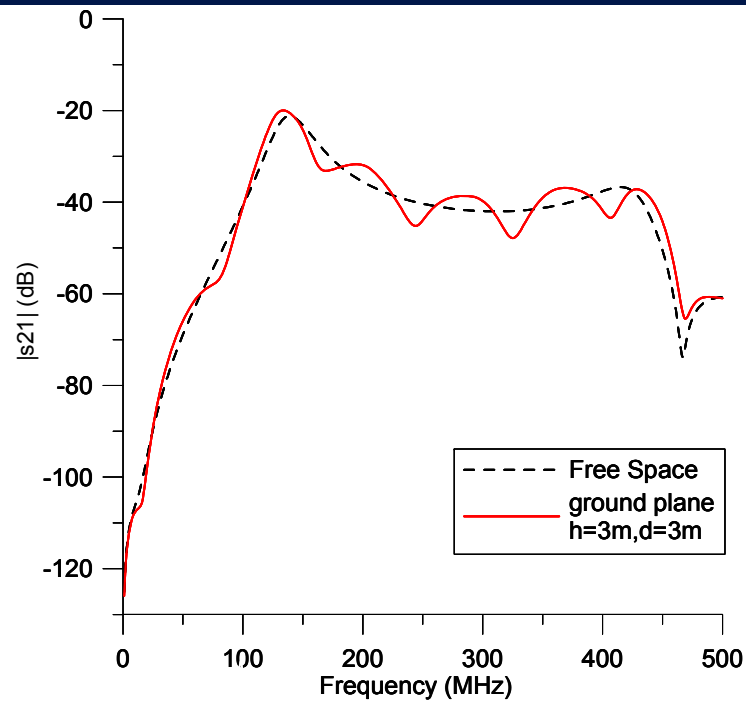
Ideal 200 Ohm
Interconnecting
Transmission Lines



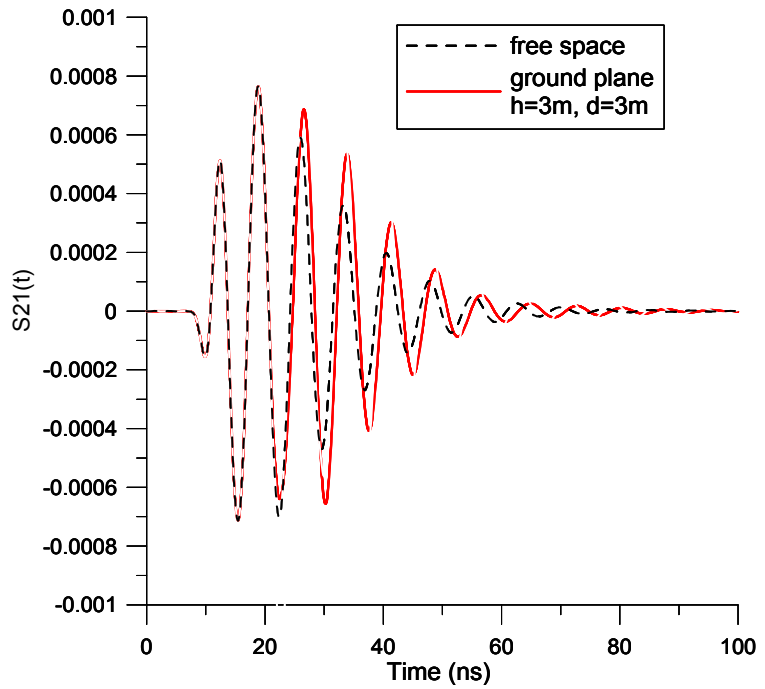
Consider 2 antennas in free space
say $d = 3 \text{ m}$...



a)



b)

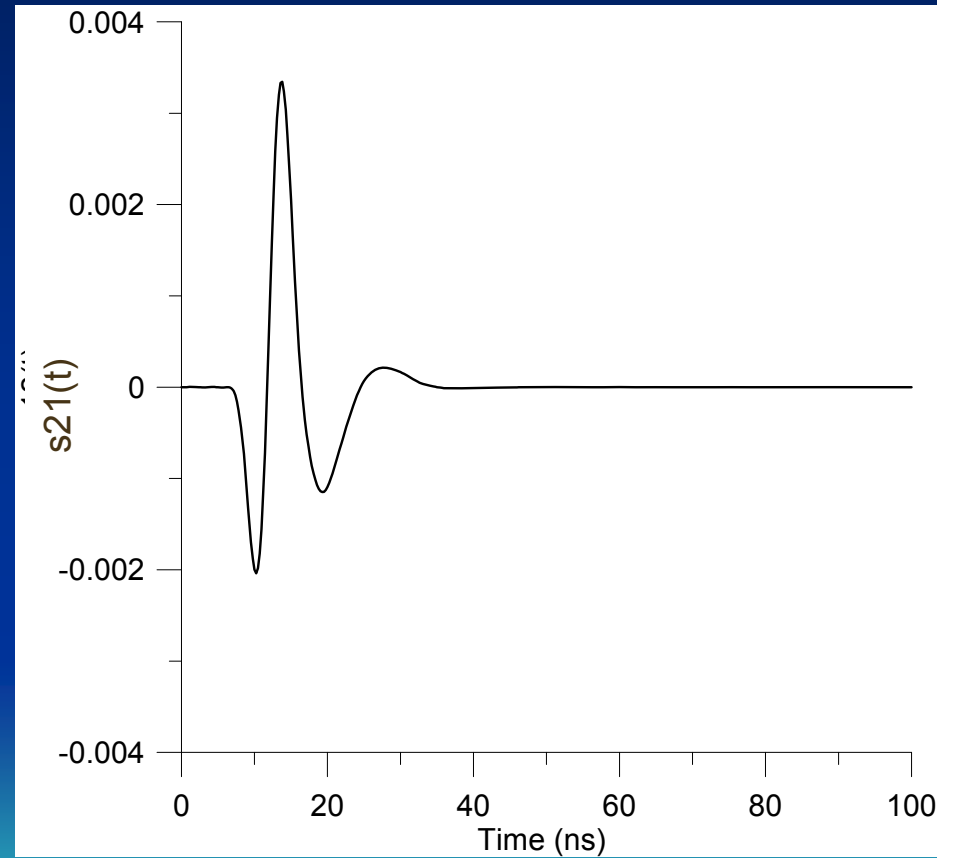
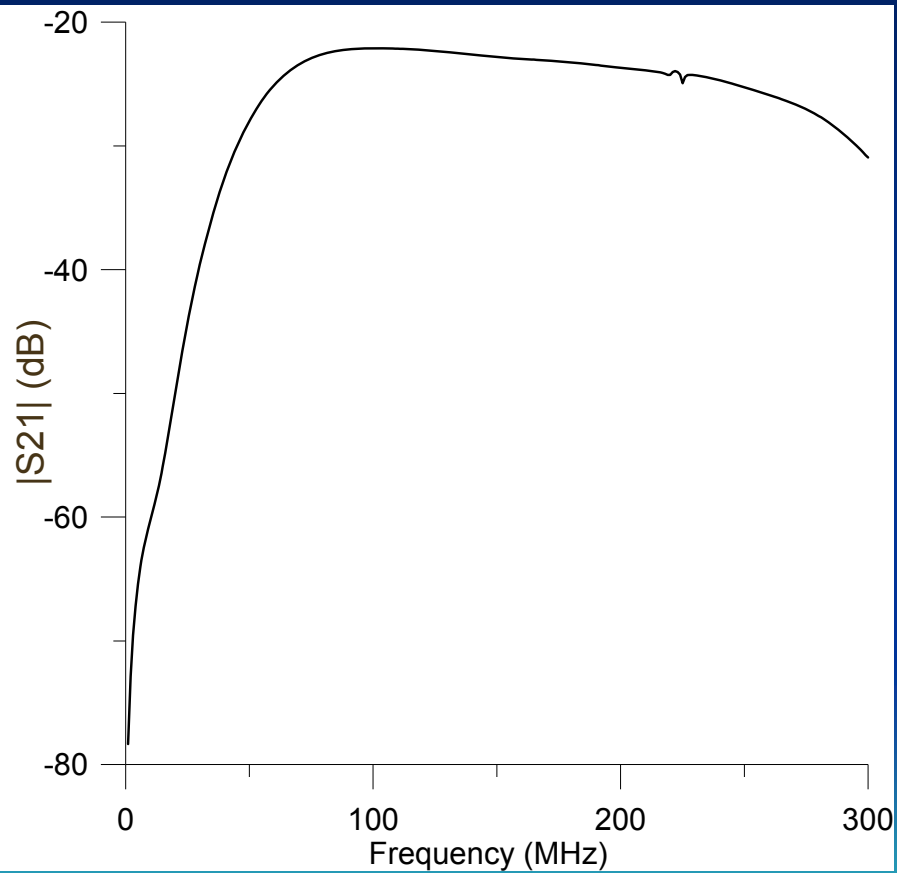


In Addition...

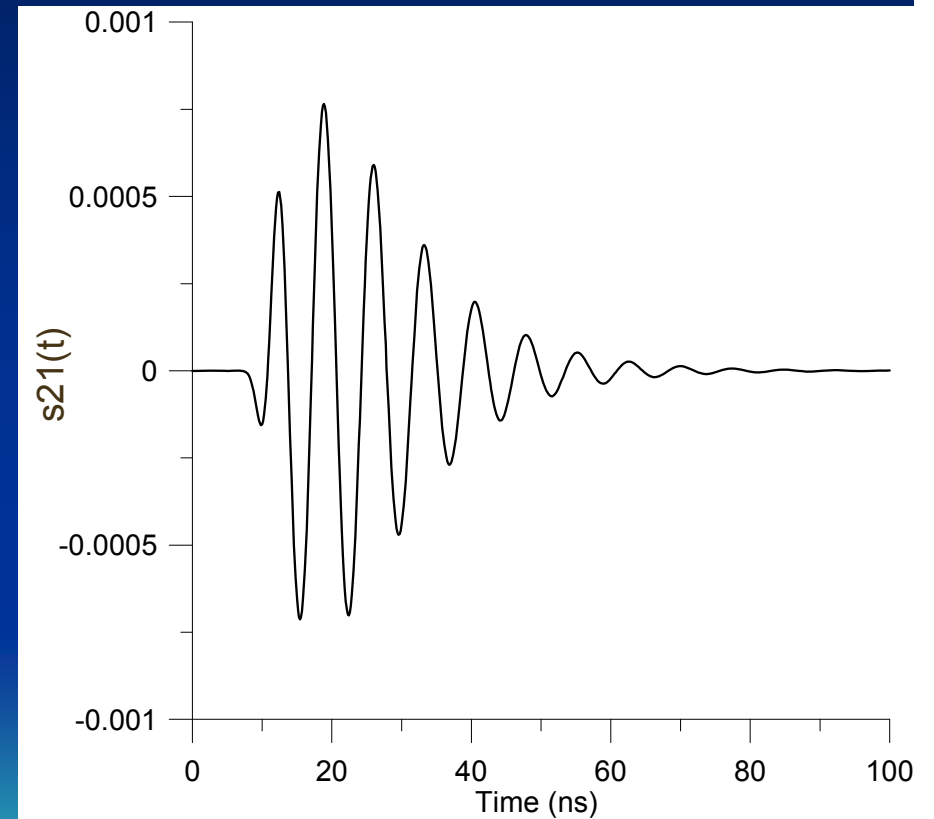
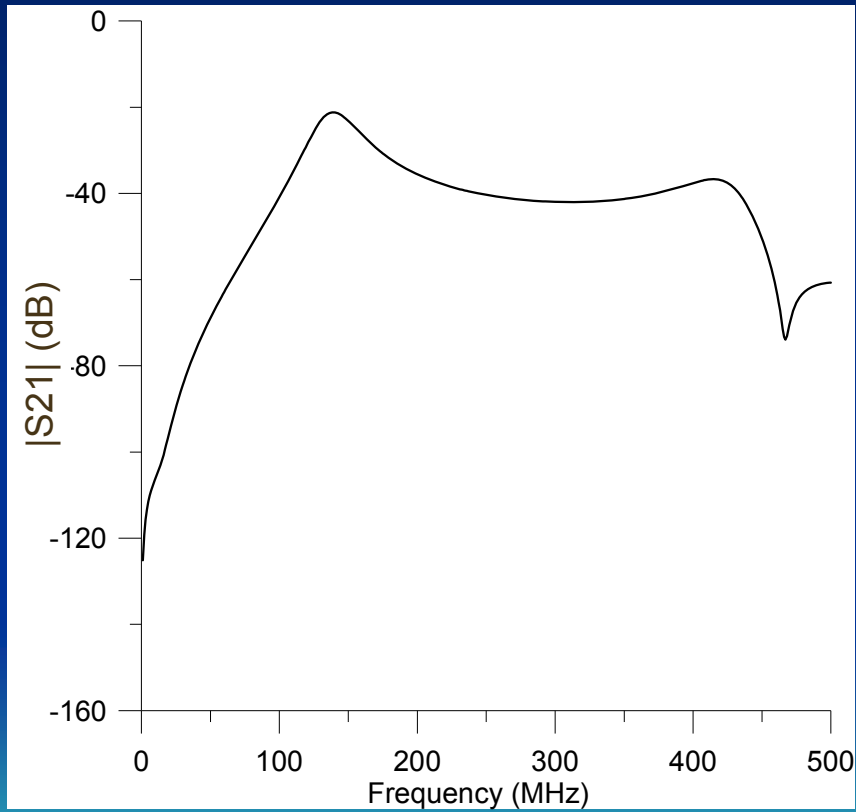
- Let's now simulate a vector network analyzer measurement in a stepped-frequency mode
- Compute transmission S_{21} from the port voltages and currents (magnitude & phase)
- Examine corresponding impulse responses computed from inverse Fourier Transforms



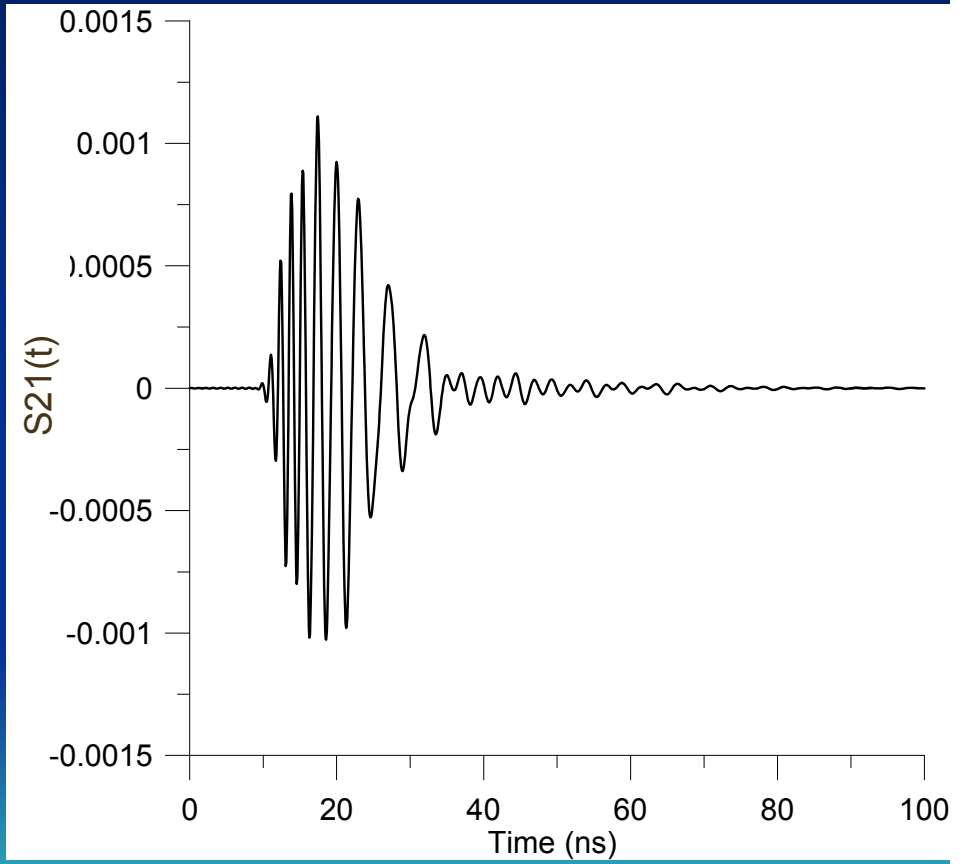
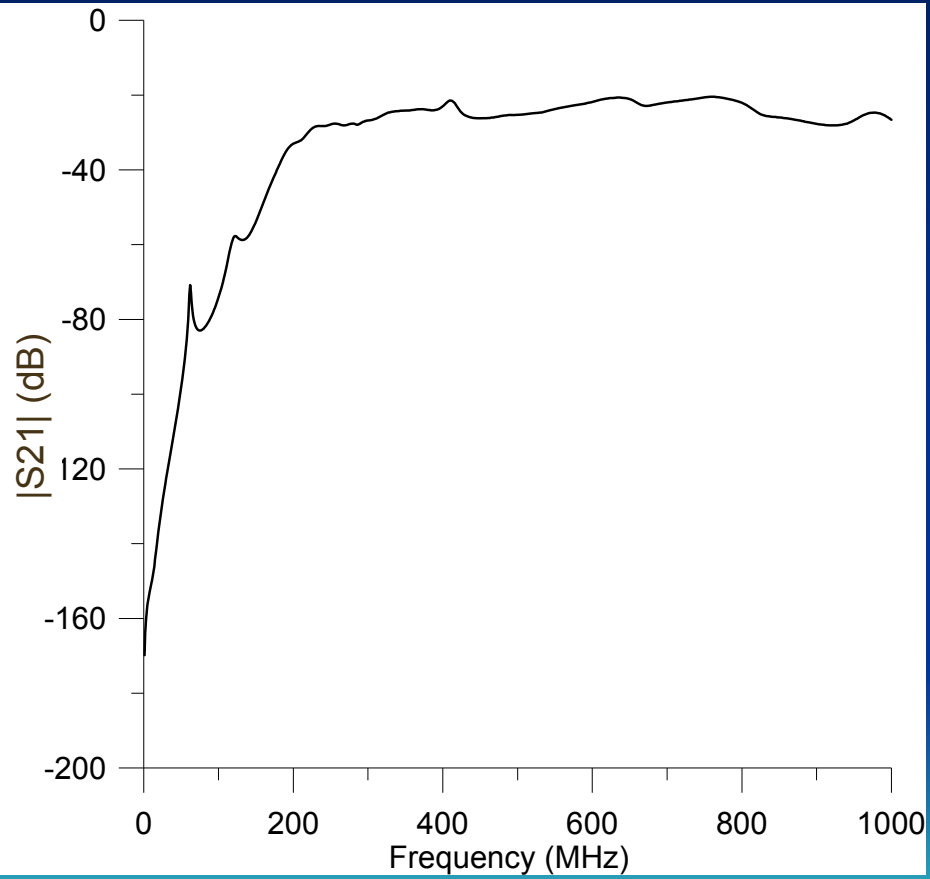
Biconical Dipole



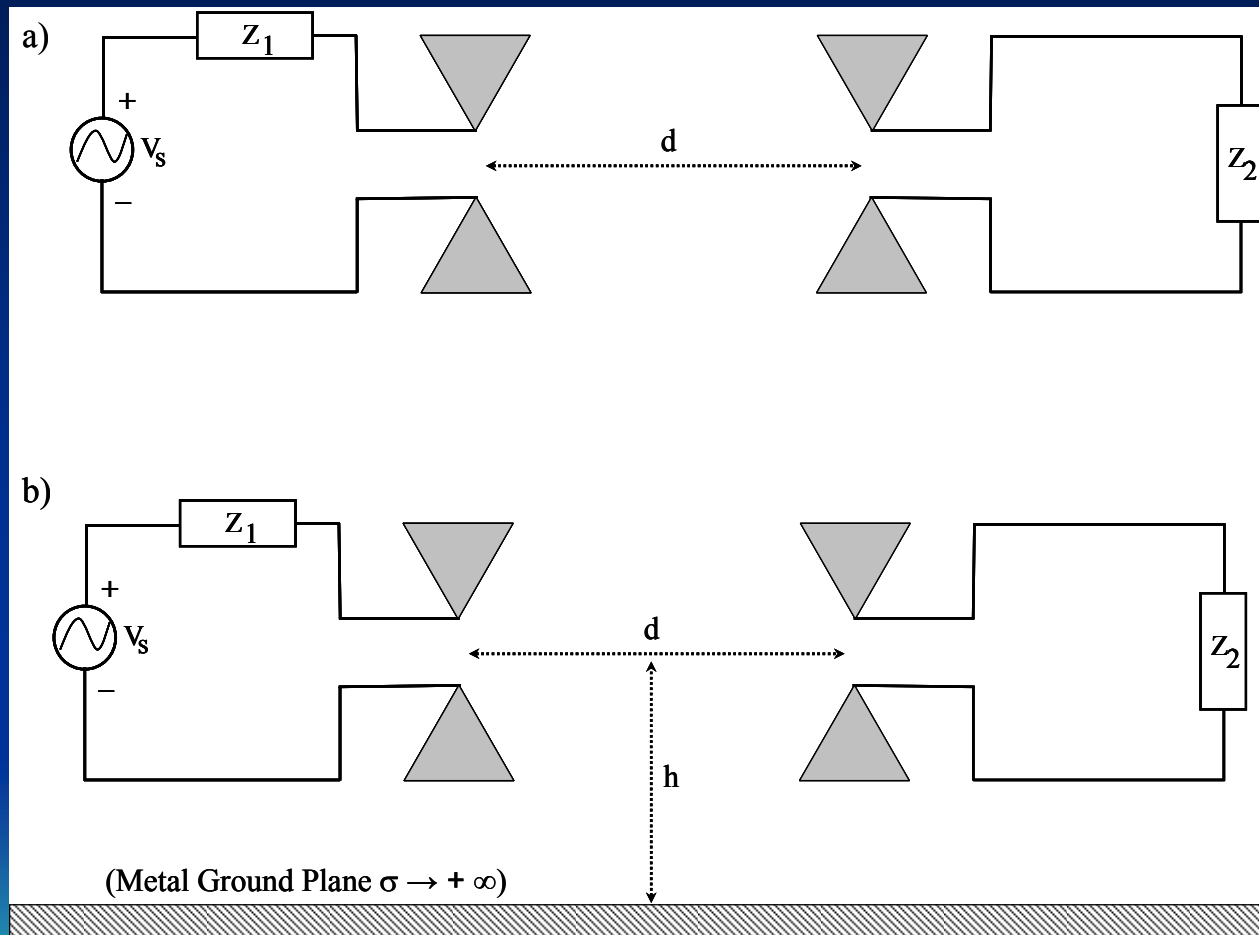
Dipole



LPDA

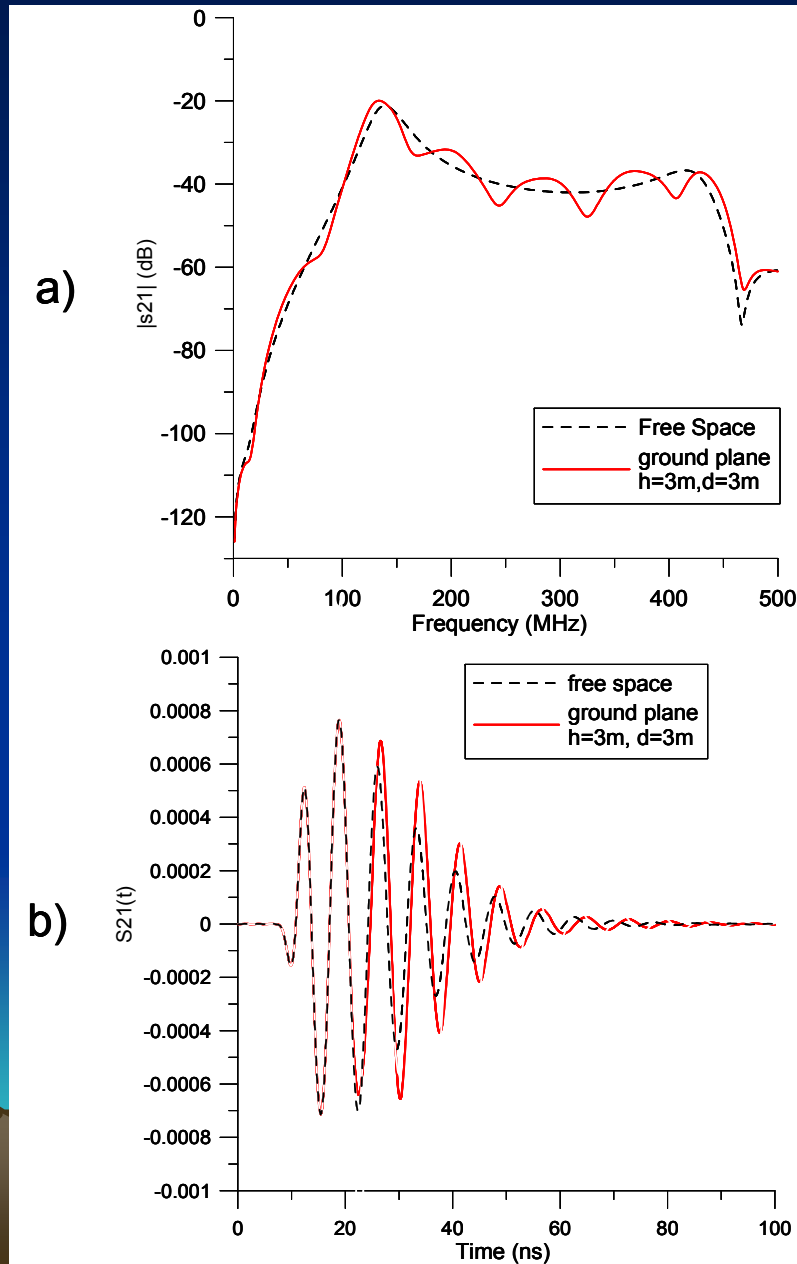


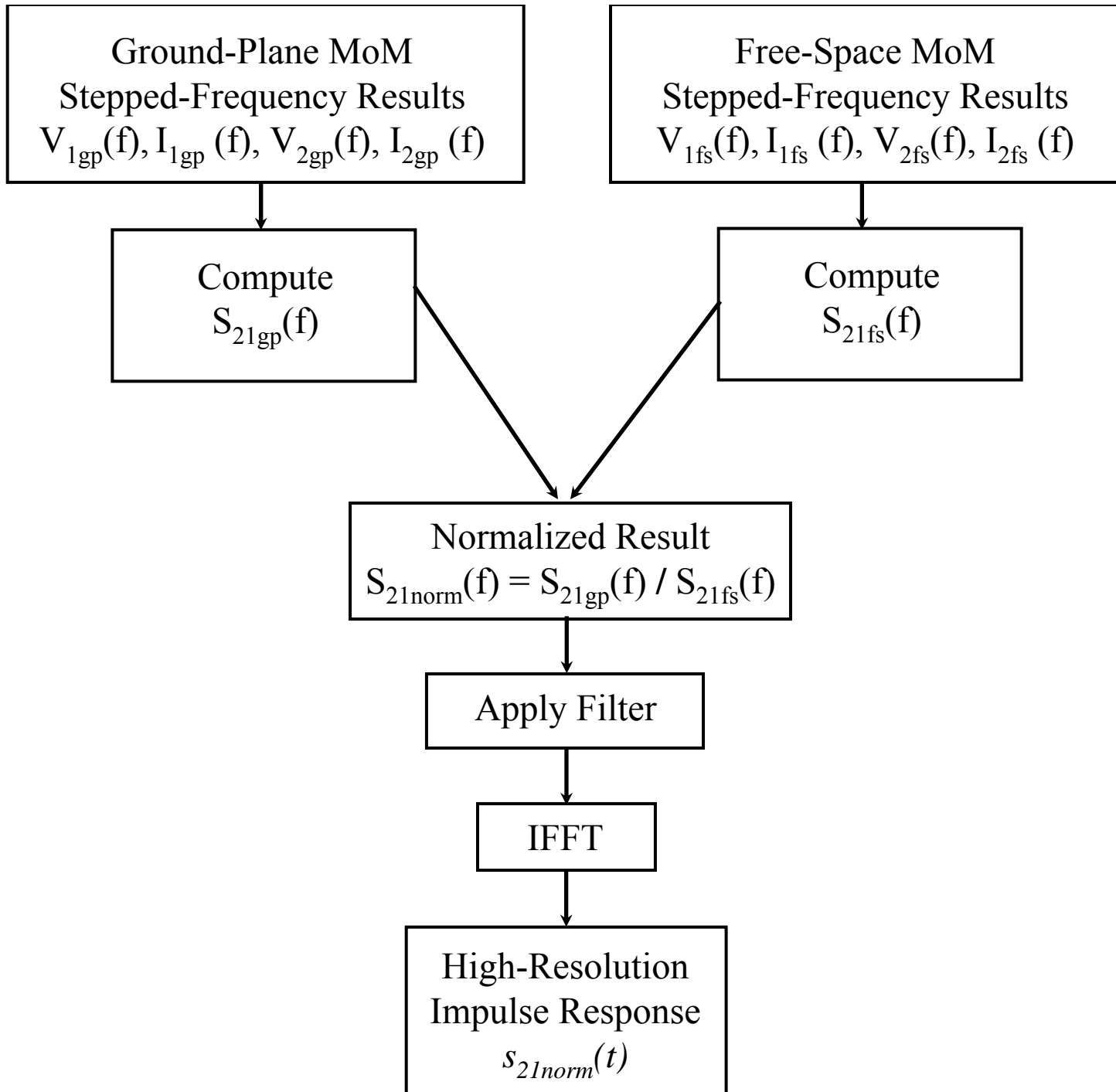
Compare free space and ground-plane results

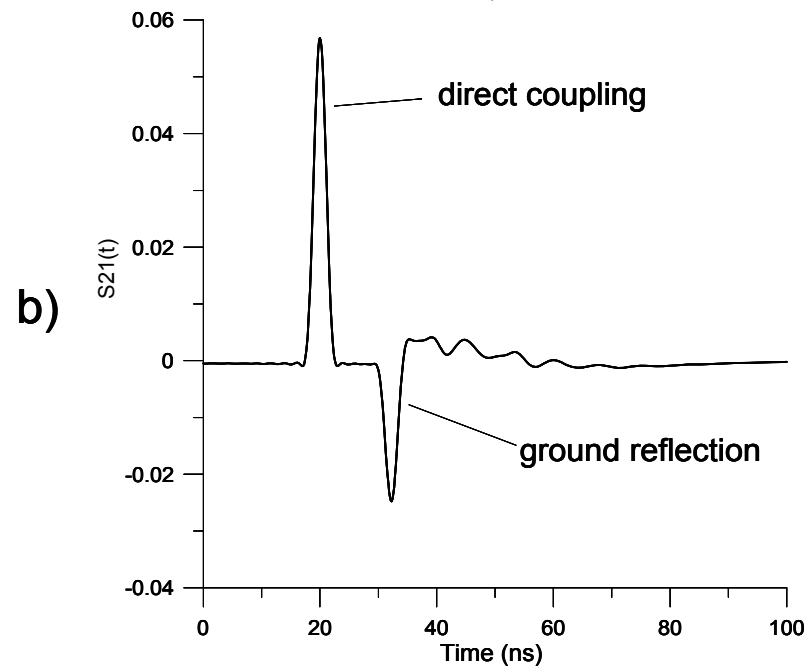
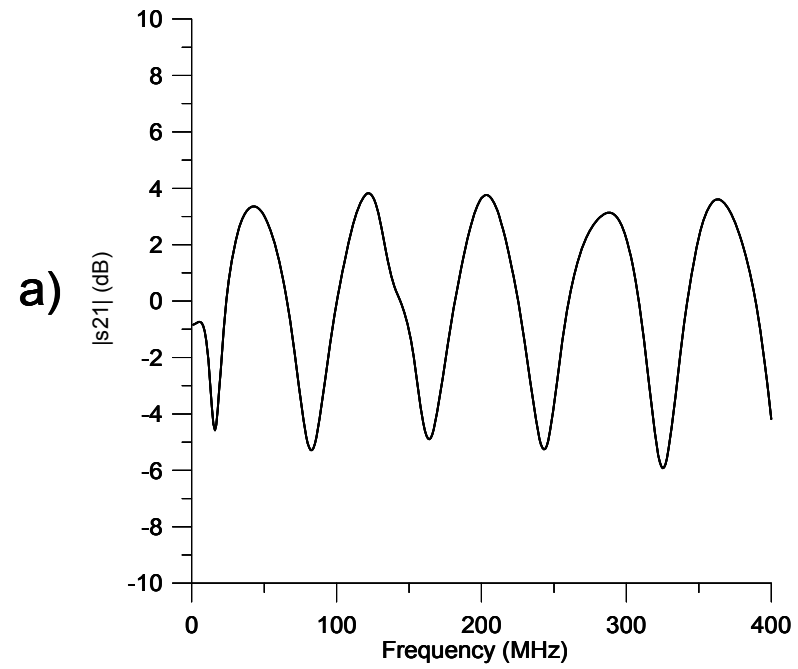


Let's now look at 2 dipoles over a ground plane.....

$d = h = 3 \text{ m}$



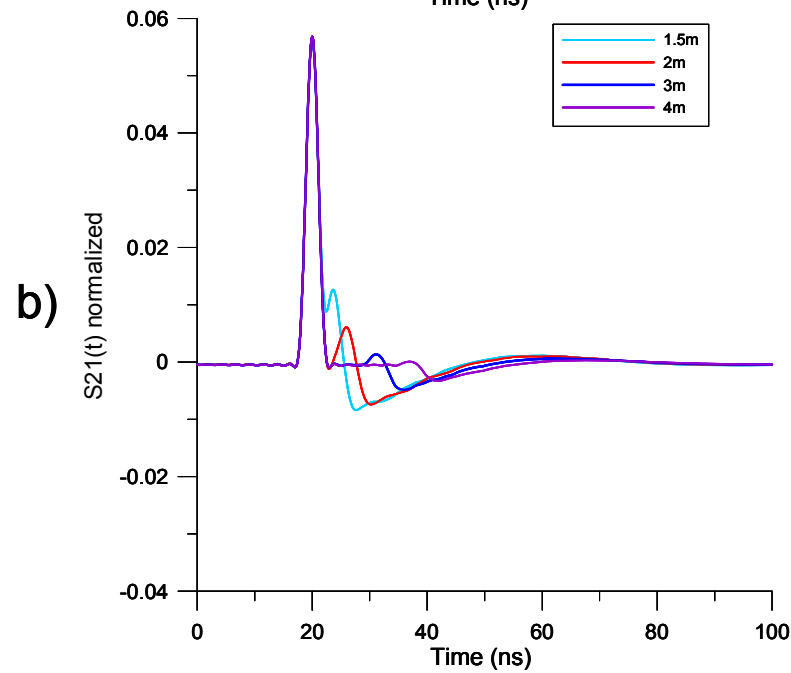
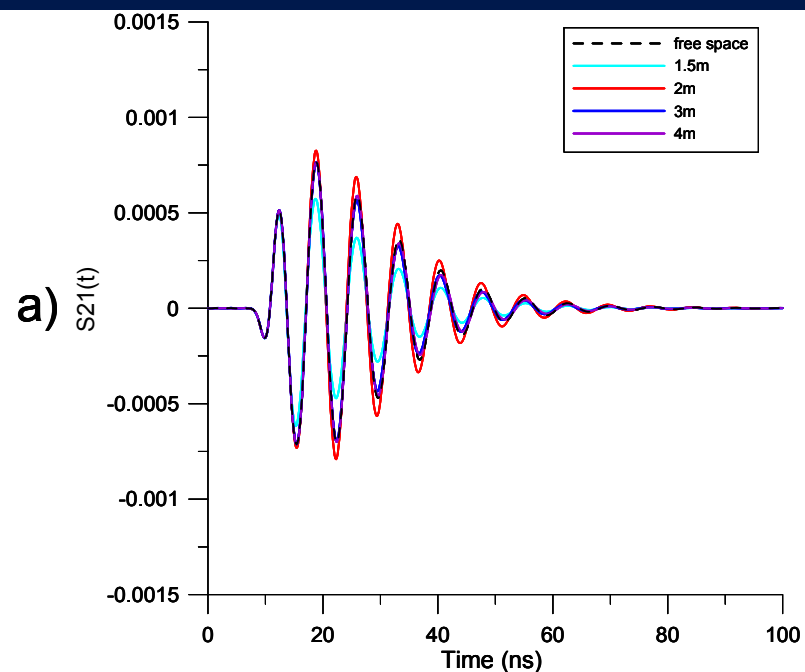
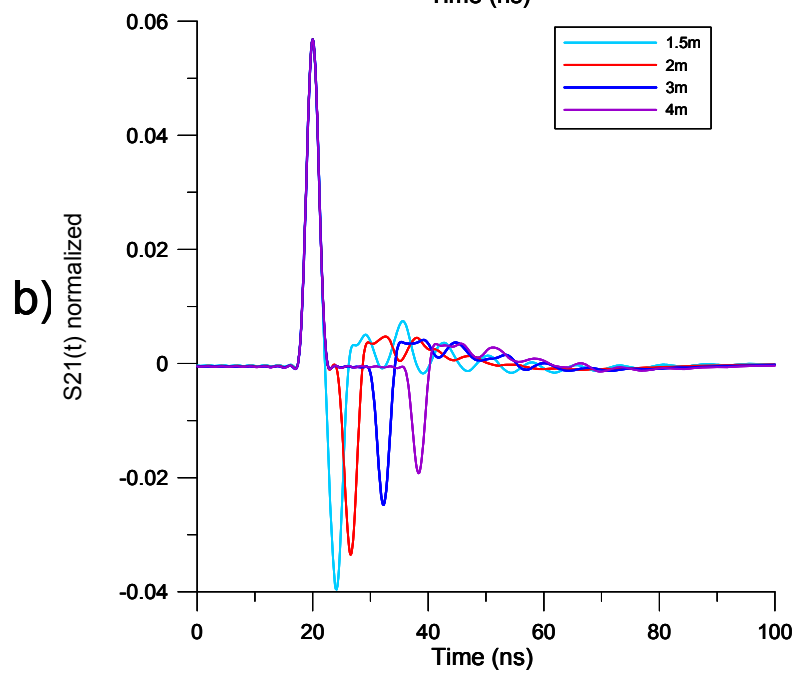
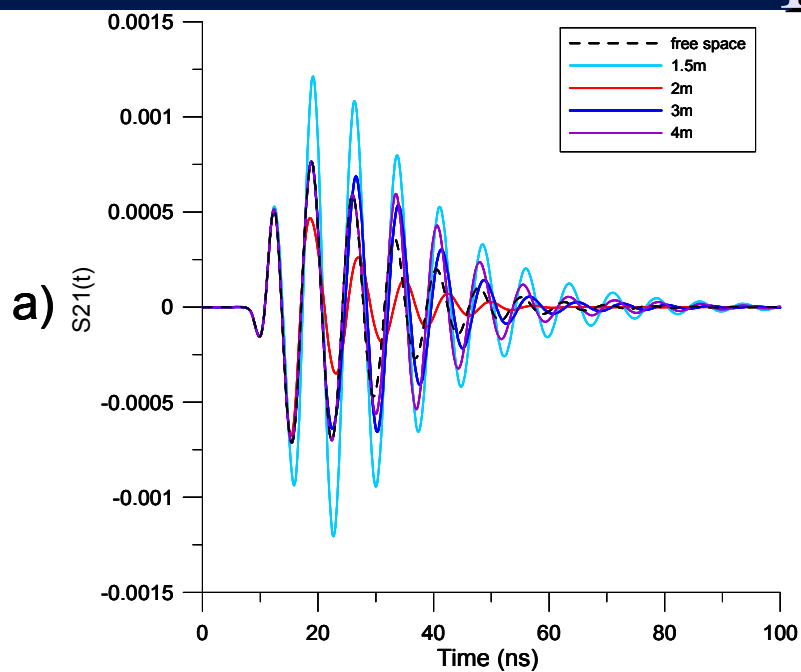




hpol

Dipoles

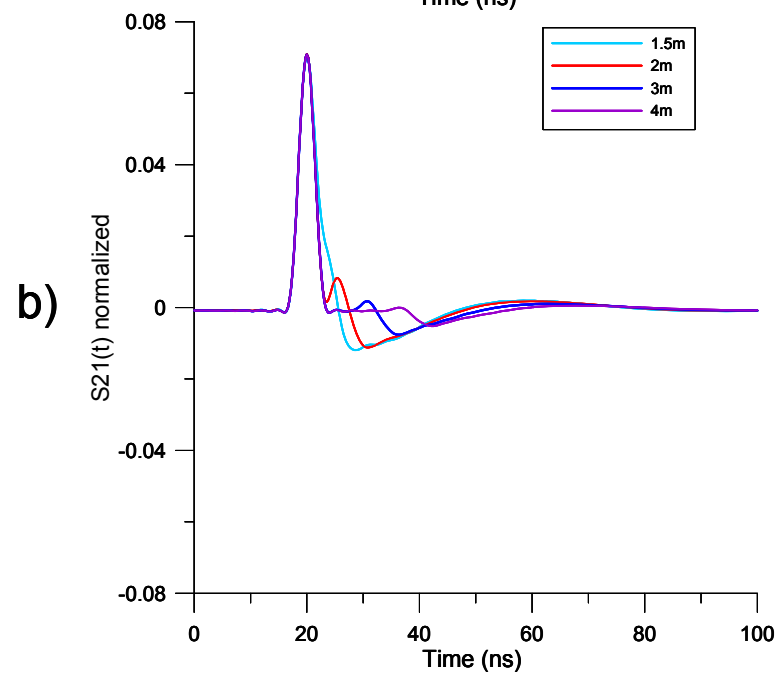
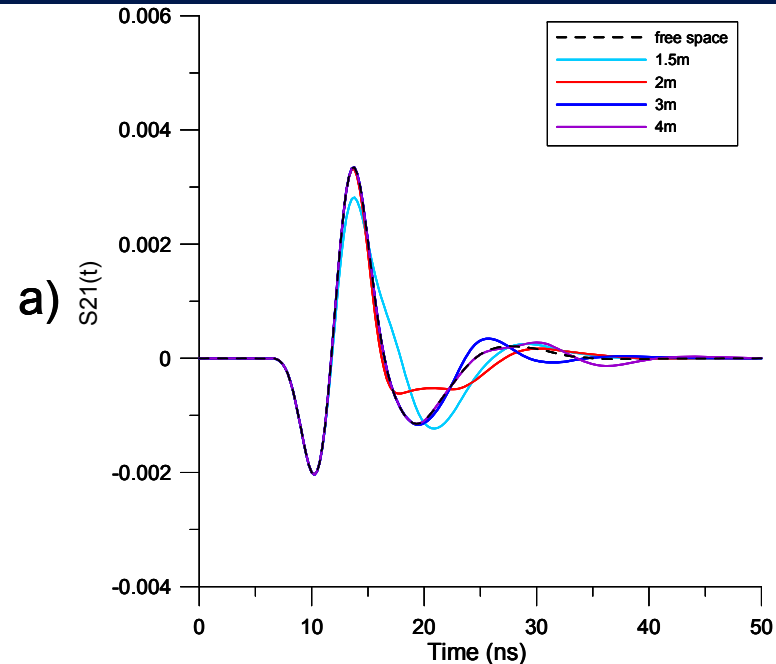
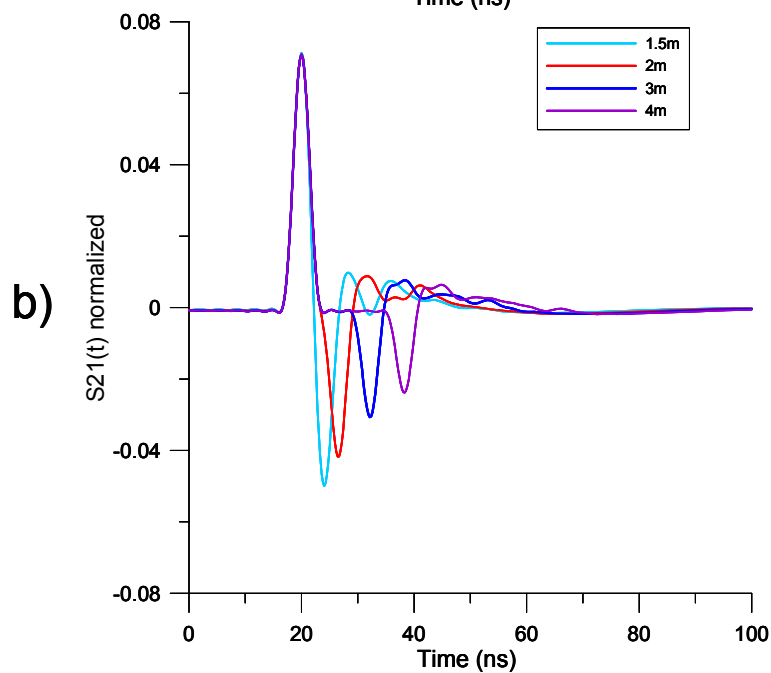
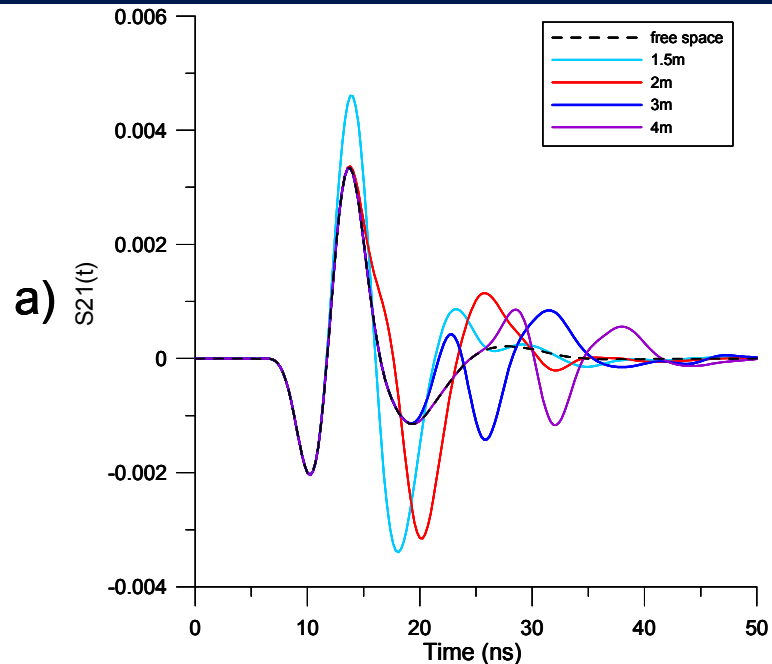
vpol



hpol

Biconicals

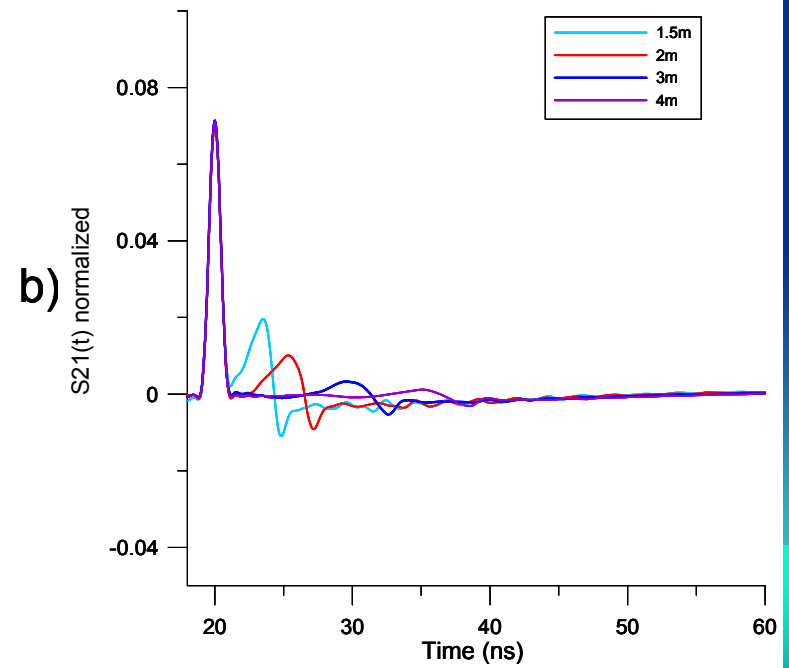
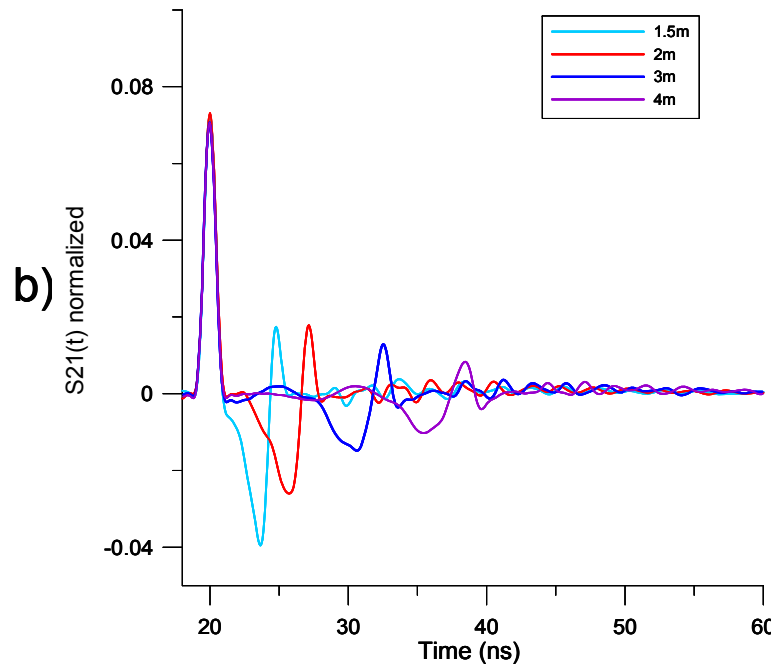
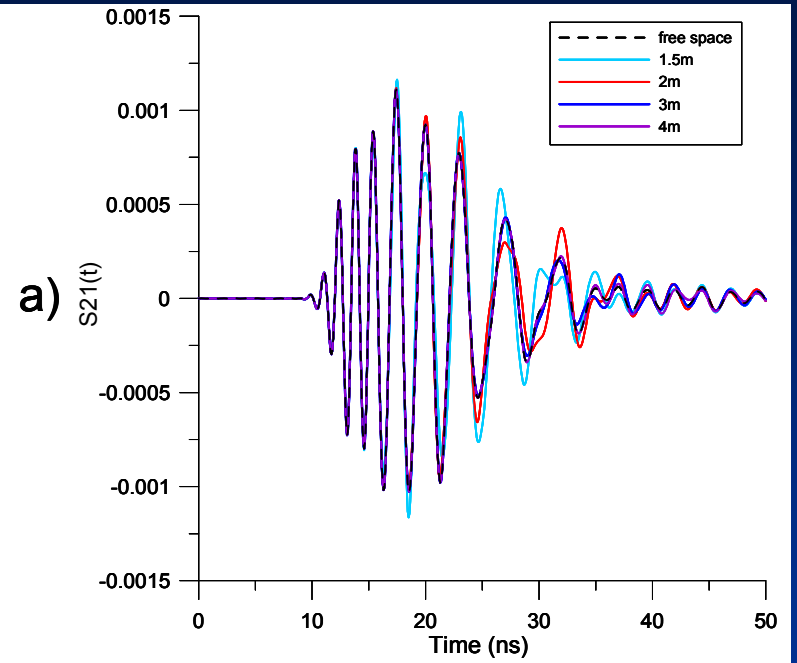
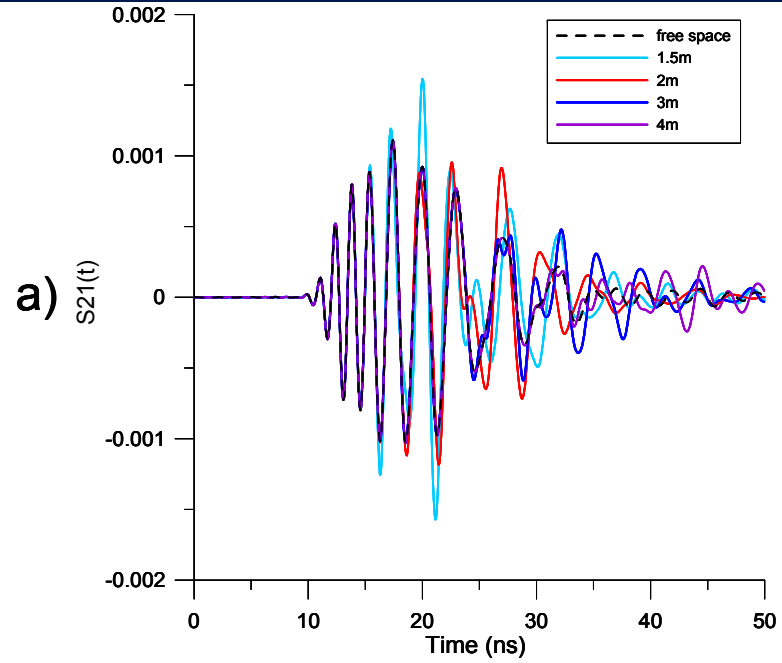
vpol



hpol

LPDAs

vpol



Implementation

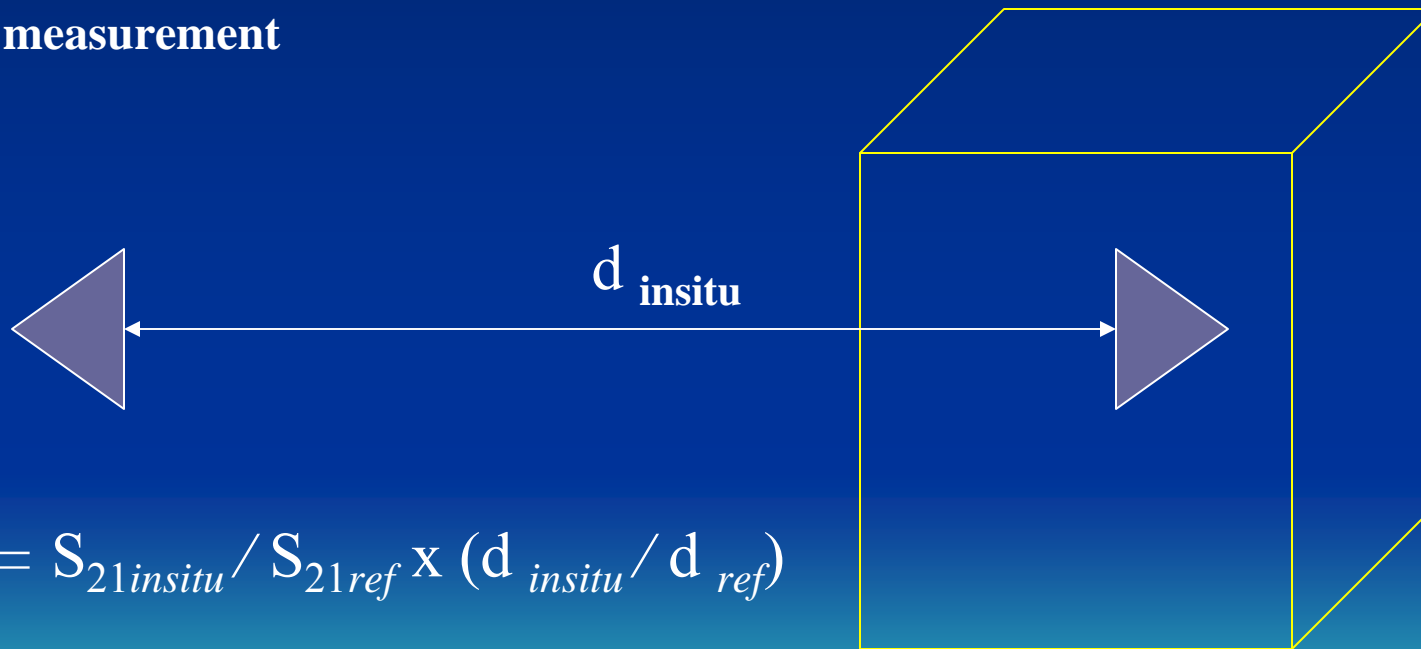
- COTS vector network analyzer
- Free-space reference...Table Mountain
- We need height and no obstructions
- Use time gating to mitigate ground bounce and environmental RF ambients
- Apply RF absorber patch in specular zone



Free-space reference



In-situ measurement



$$S_{21norm} = S_{21insitu} / S_{21ref} \times (d_{insitu} / d_{ref})$$

More work...

- Tests at Table Mountain using COTS antennas
- Numerical Studies & recommendations
- Impact of baluns
- In-situ propagation measurements
- More geeky fun!
- Thanks!

