

Use of RF Absorbing Materials for EMI Control

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PART-1

Application of Lossy Materials: - Metal enclosure -

Metal box photos



Fig 1a – Front view showing horizontal slot



Fig 1b – Rear view showing vertical slot

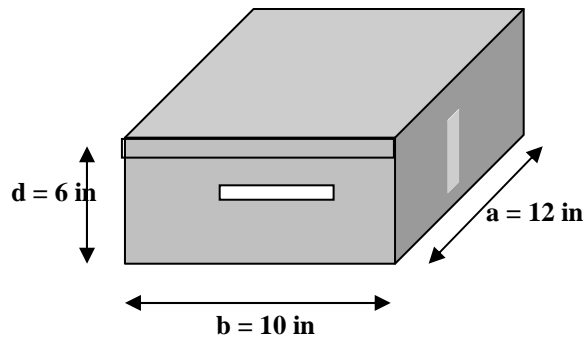


Fig 1c – Inside view showing probe element



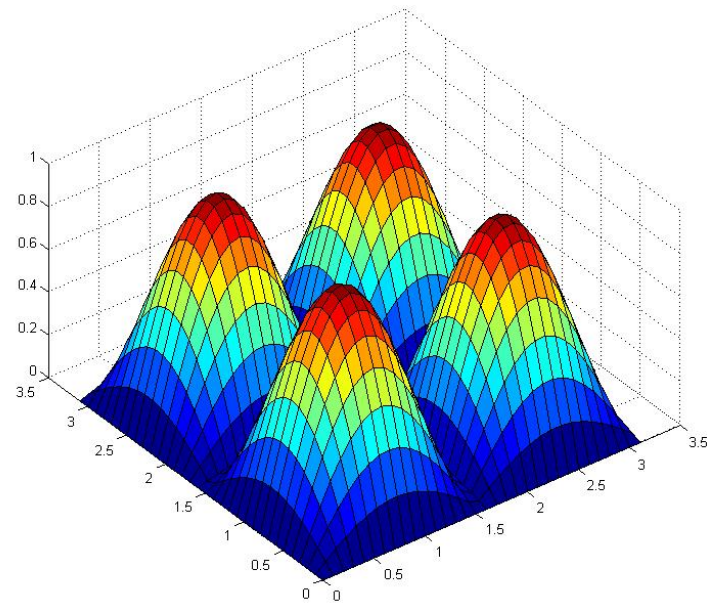
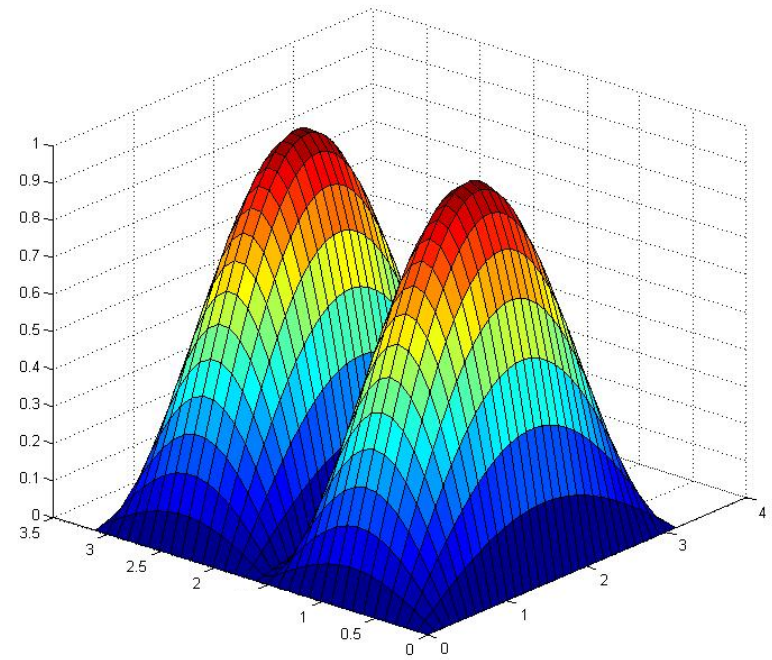
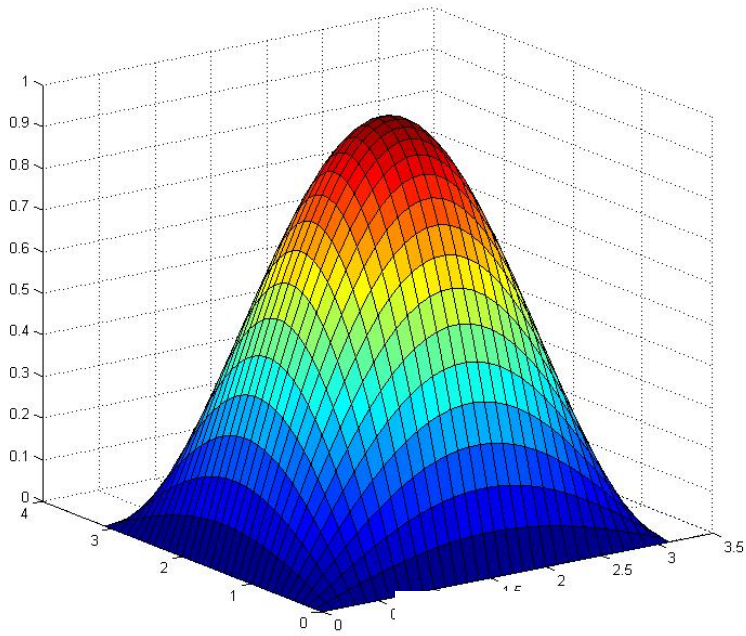
Fig 1d – Inside view showing application of ARC material

Metal box high order modes computation (up to 2.5GHz)



$$f = \frac{1}{2 \sqrt{\mu\epsilon}} \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2 + \left(\frac{l}{d}\right)^2}$$

12 in	10 in	6 in	TE _(n,m,l)			FREQ [GHz]
0.3048	0.254	0.1524	1	1	0	0.768725362
0.3048	0.254	0.1524	1	0	1	1.100427154
0.3048	0.254	0.1524	0	1	1	1.147825176
0.3048	0.254	0.1524	1	1	1	1.248875742
0.3048	0.254	0.1524	2	0	1	1.391942483
0.3048	0.254	0.1524	1	2	1	1.614293255
0.3048	0.254	0.1524	1	0	2	2.029087414
0.3048	0.254	0.1524	1	1	2	2.113278598
0.3048	0.254	0.1524	2	1	2	2.278708052
0.3048	0.254	0.1524	0	2	2	2.295650352
0.3048	0.254	0.1524	2	2	2	2.497751484



Resonance of the slots

$$f_r \rightarrow f \quad \left| \quad @ L_{slot} = \frac{\lambda}{2} \quad \text{OR,} \quad f_r = \frac{c}{2 * L_{phys}} \right.$$

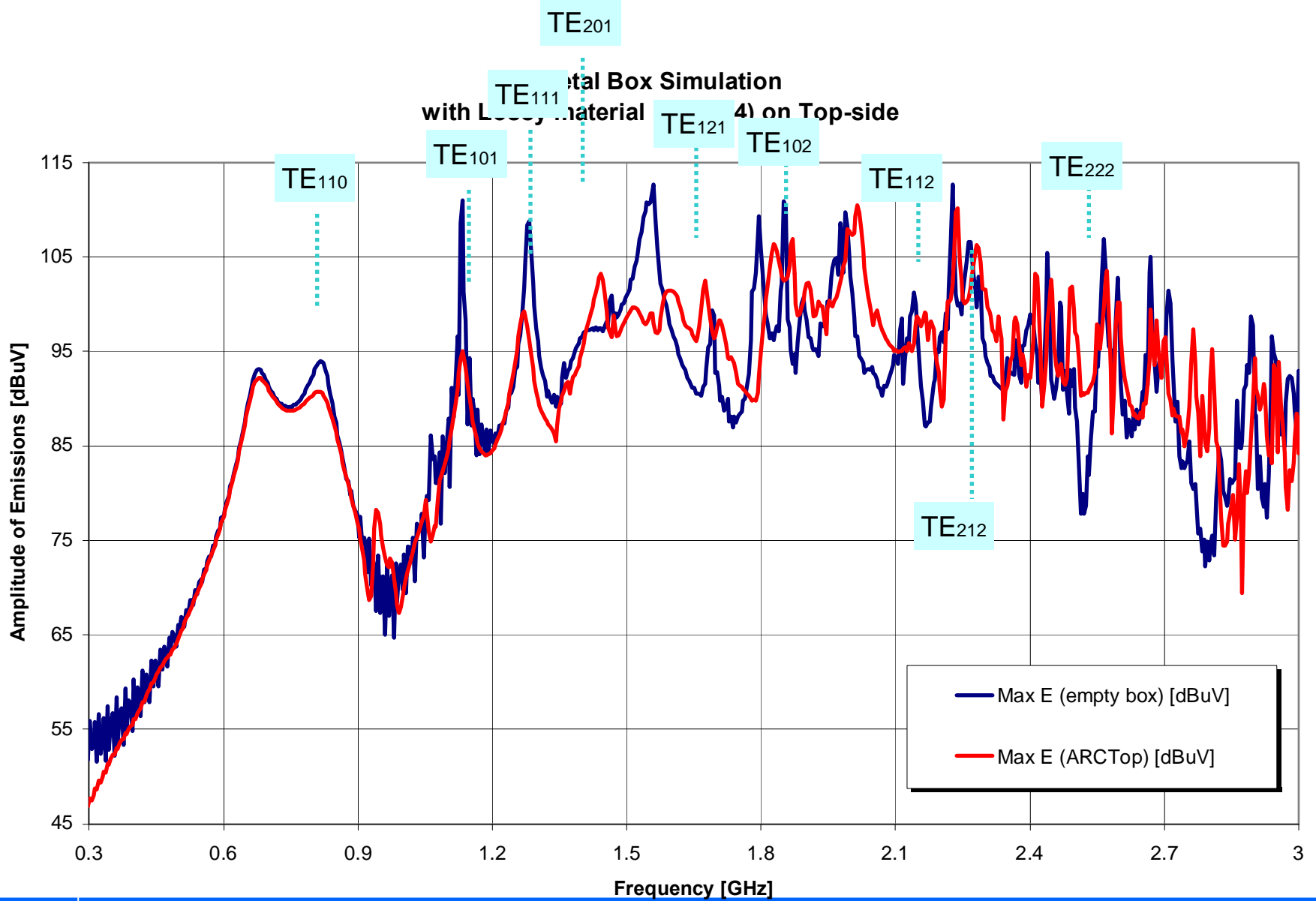
- **Slot 1:**

- Horizontal slot
- $L_{phys} = 8\text{in}$
- $F_{Res} = 738\text{MHz}$

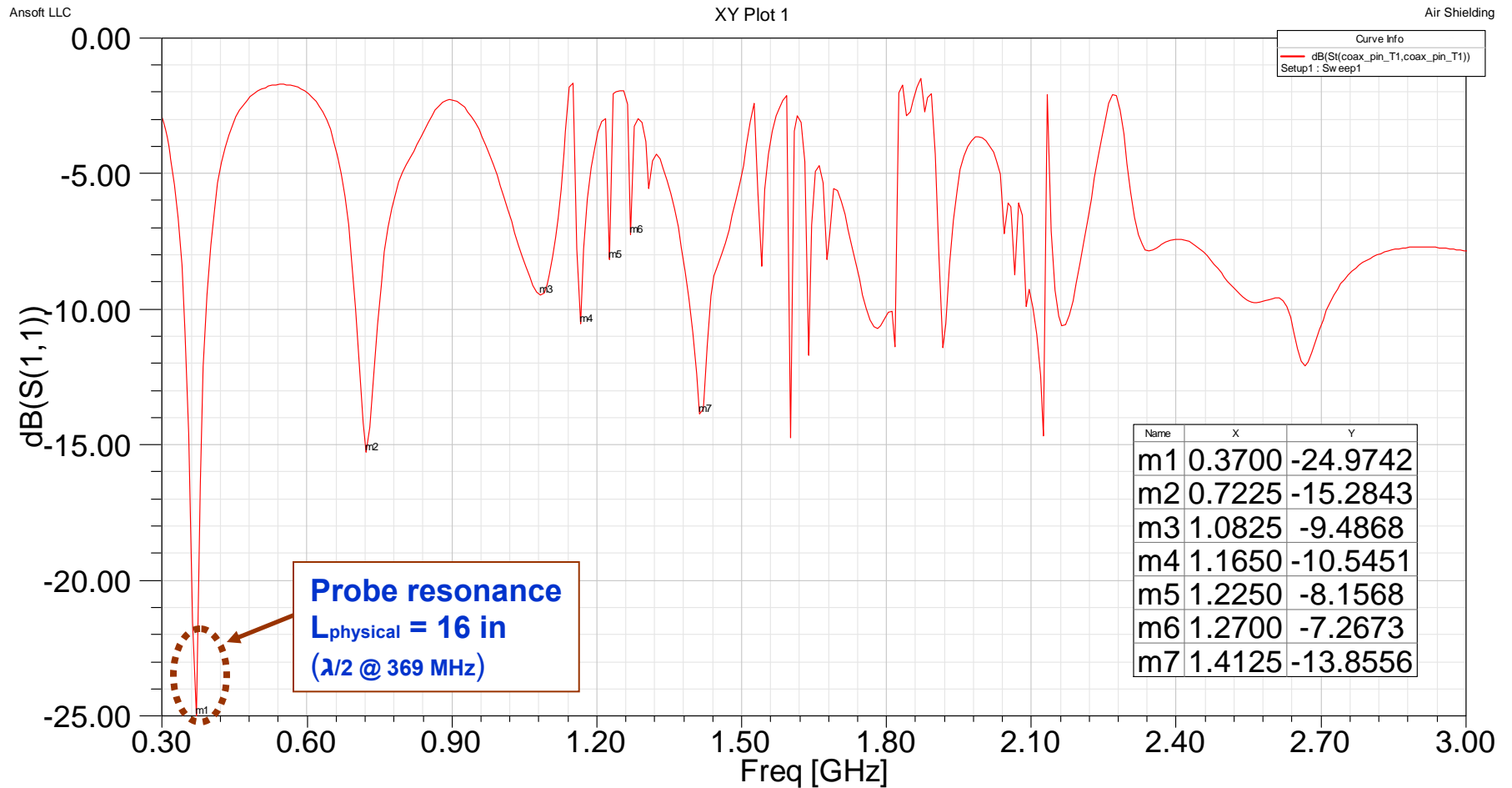
- **Slot 2:**

- Vertical slot
- $L_{phys} = 4\text{in}$
- $F_{Res} = 1.47\text{GHz}$

FDTD Simulation



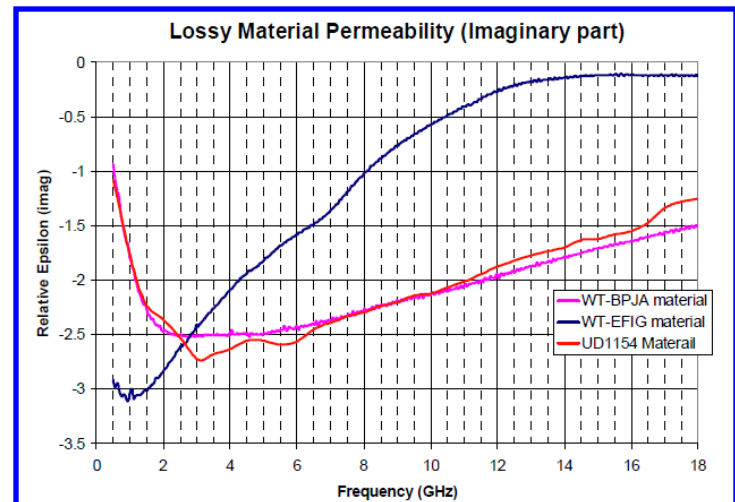
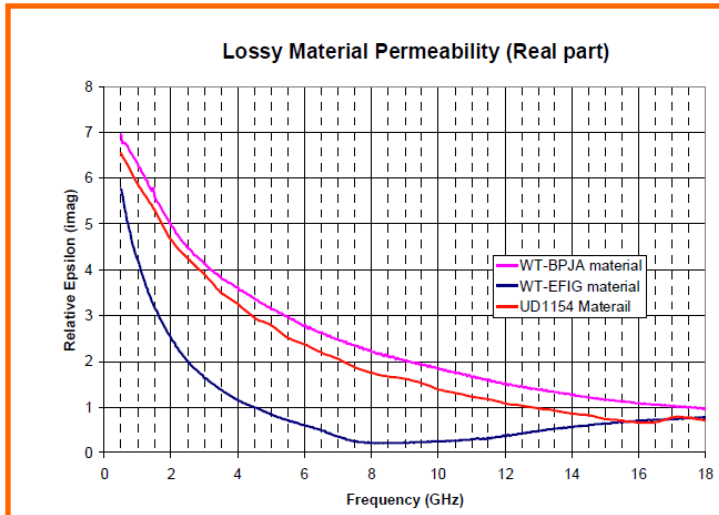
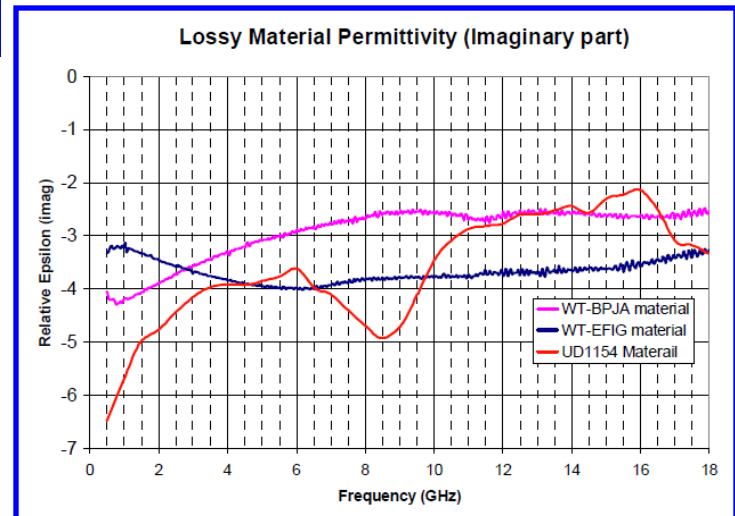
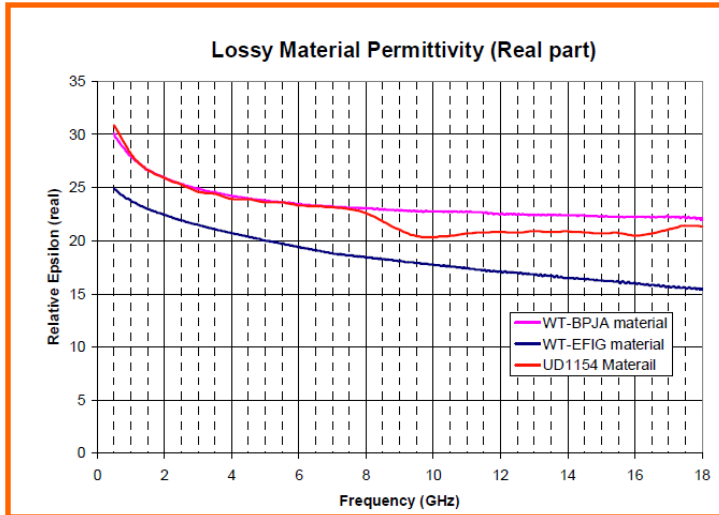
Metal enclosure resonance HFSS simulation



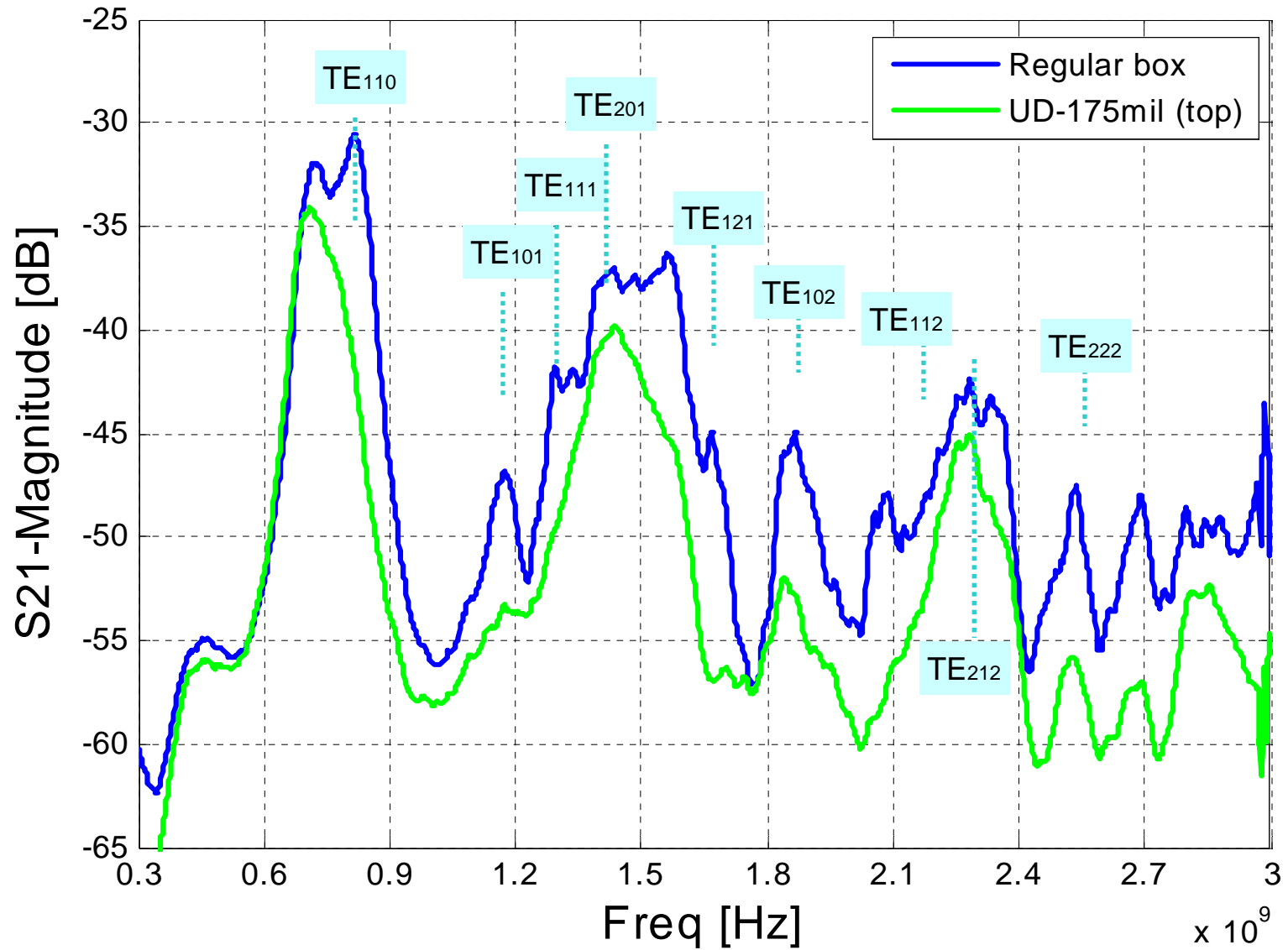
Lossy Material Specifications

$$\epsilon_r = \epsilon'_r + j\epsilon''_r$$

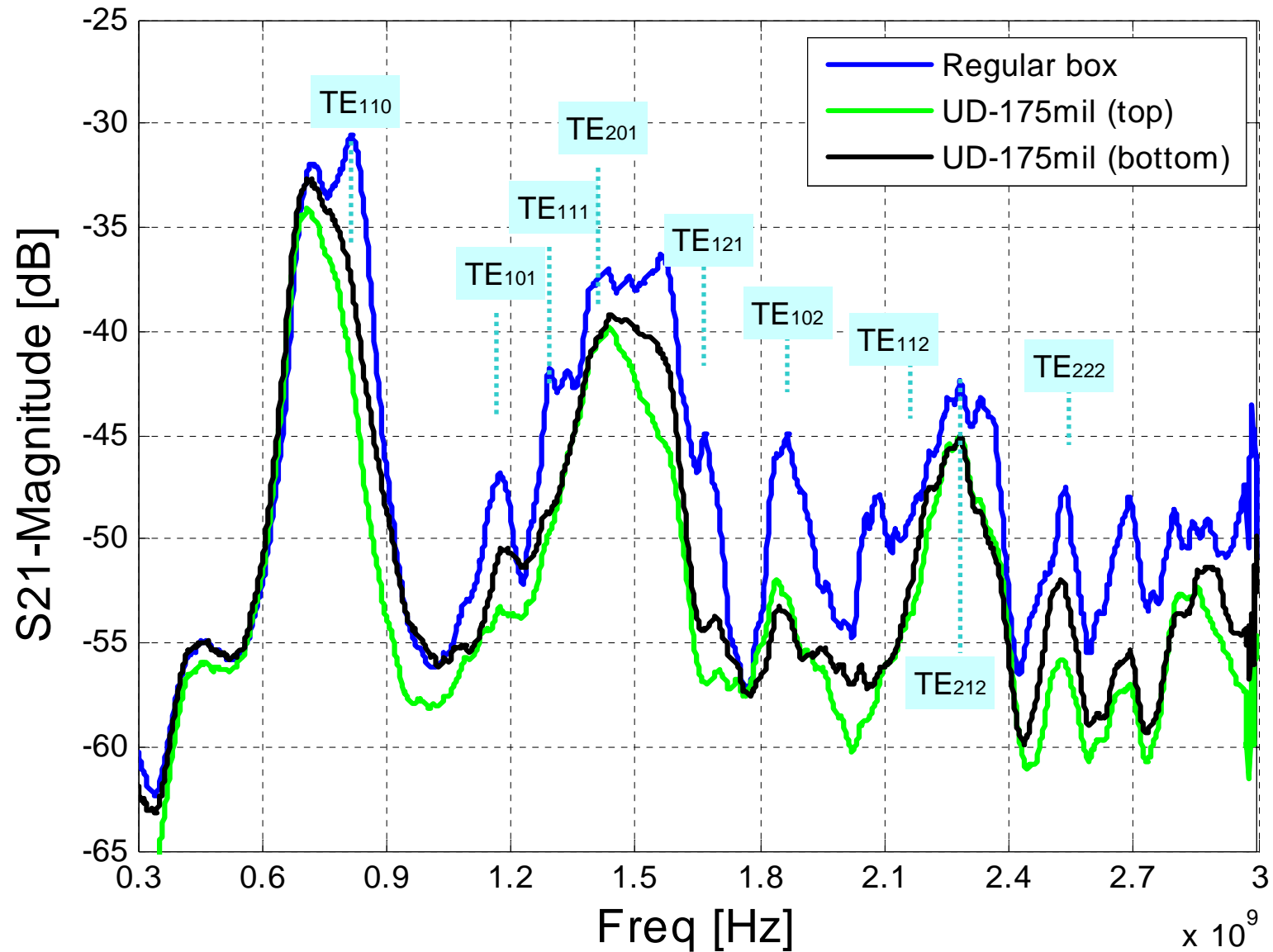
$$\mu_r = \mu'_r - j\mu''_r$$



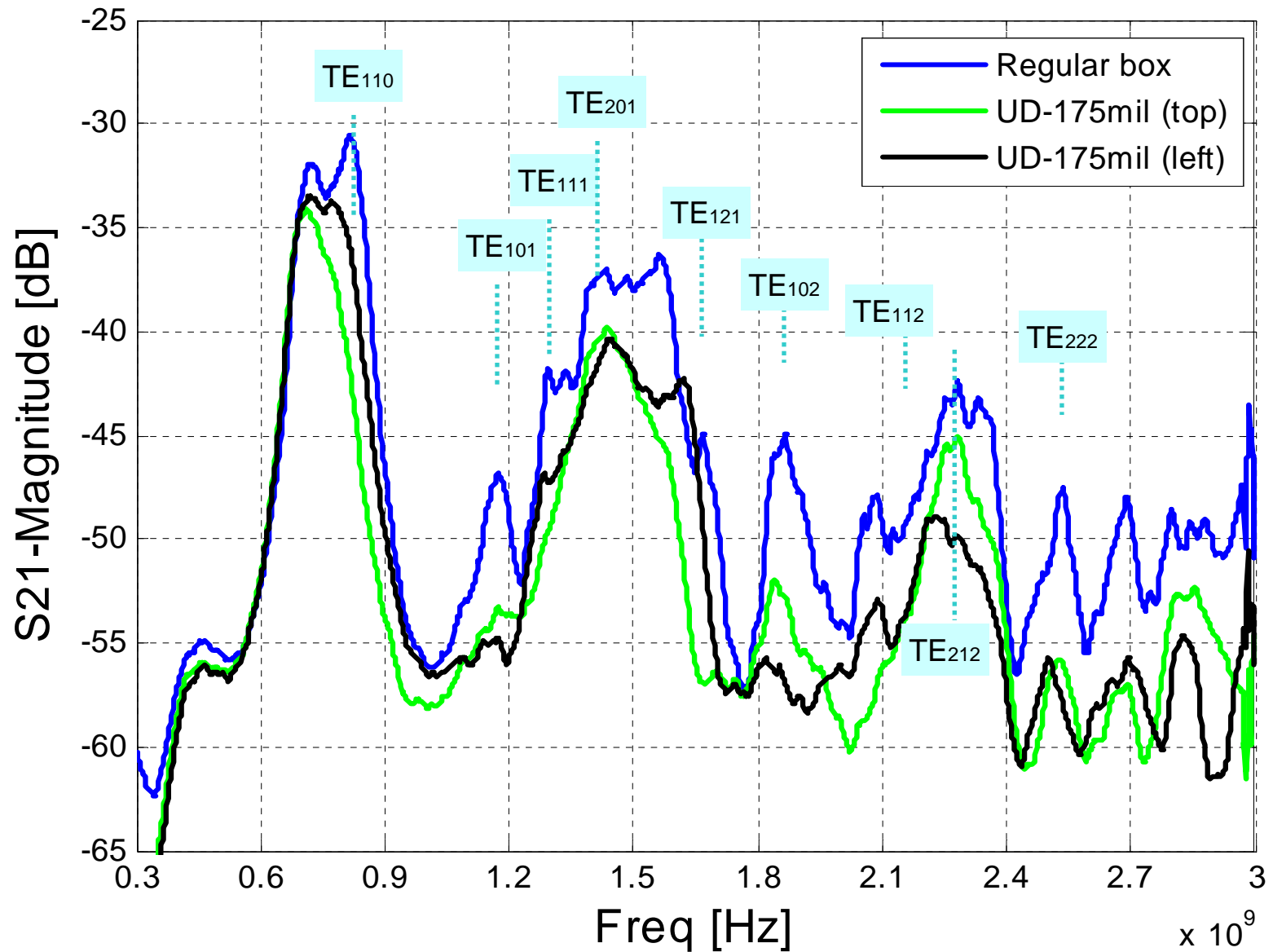
Effect of adding lossy material (Type: UD11554) on top-side



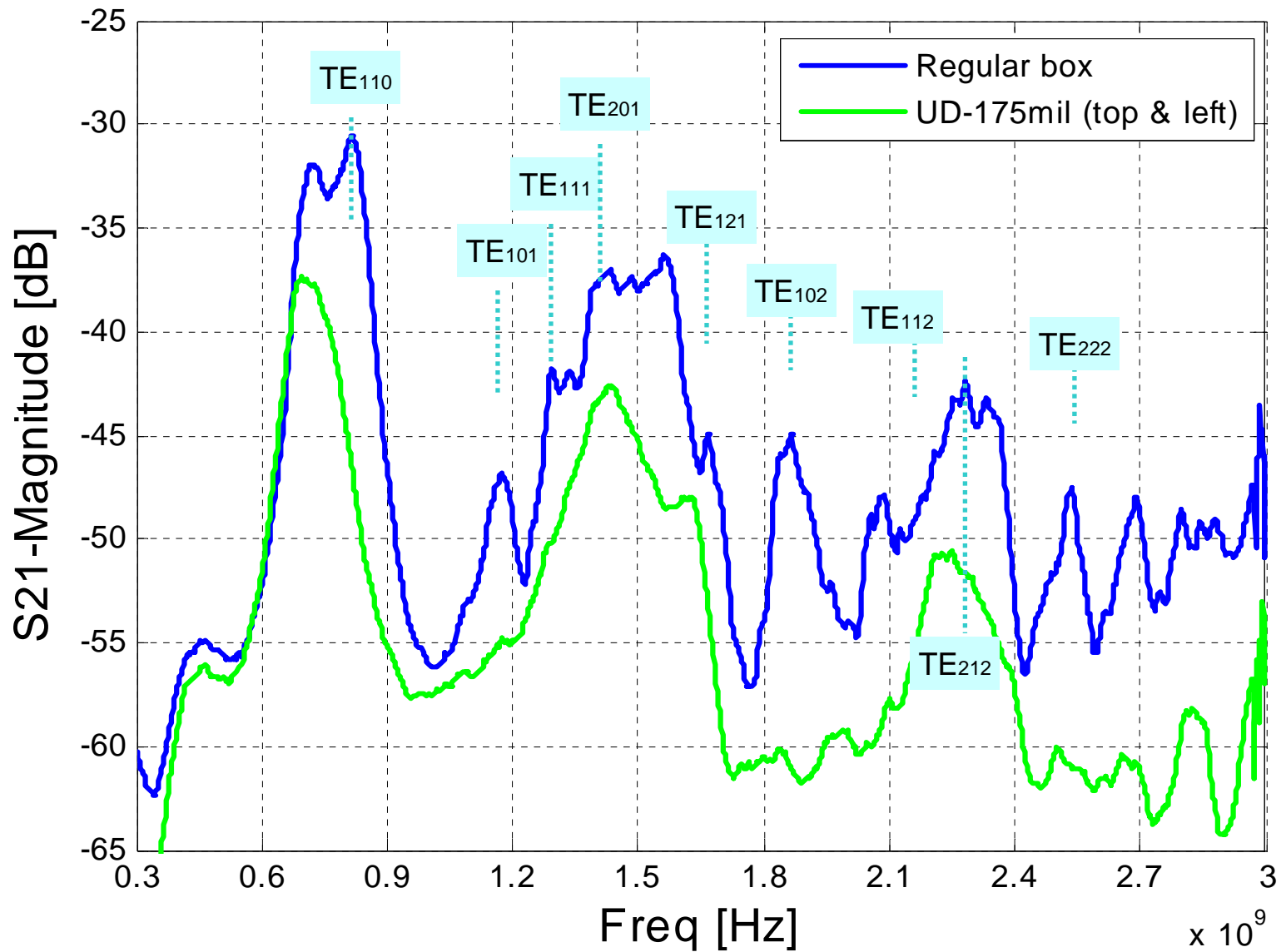
Effect of adding lossy material to either Top or Bottom side



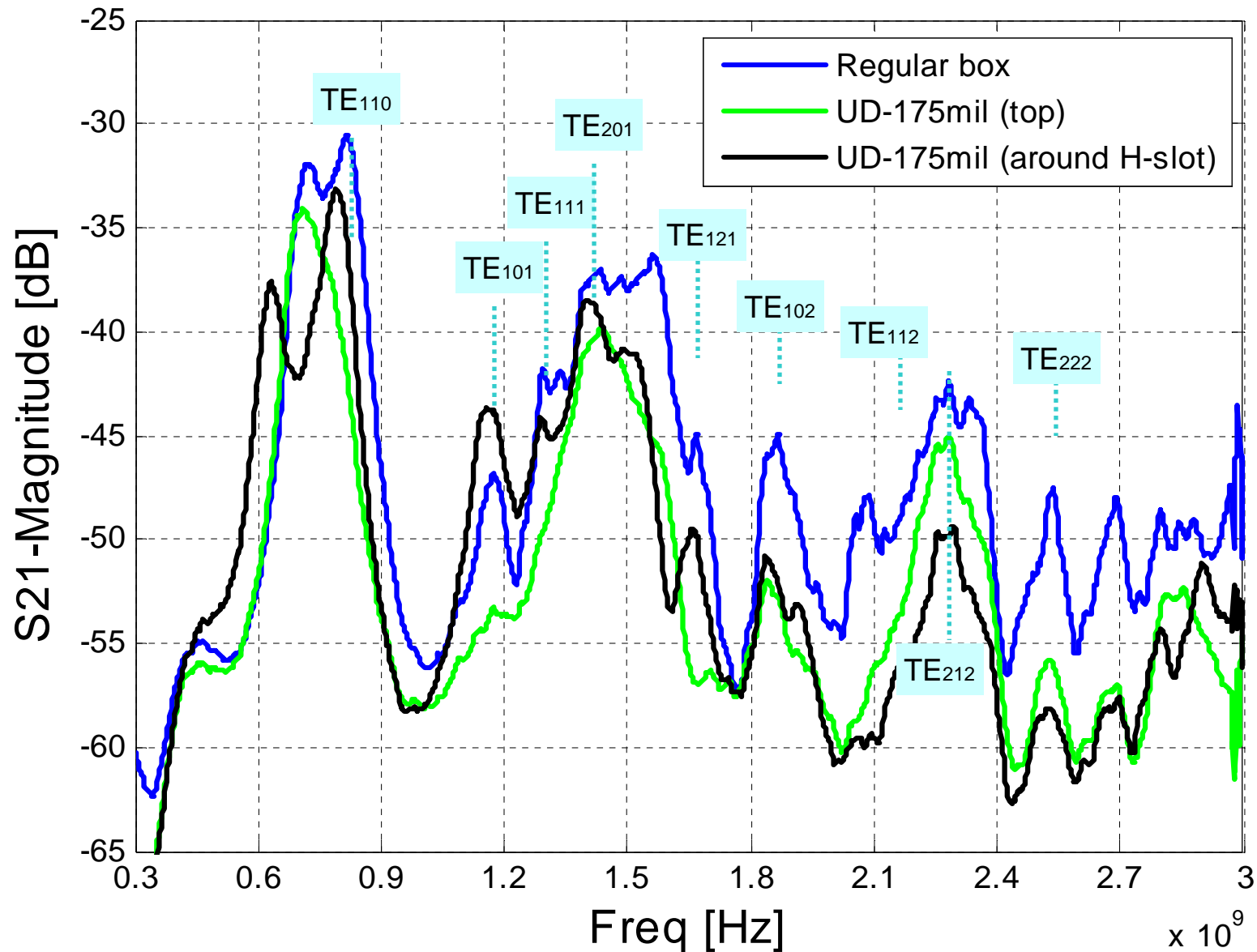
Effect of adding lossy material to either Top or Left side



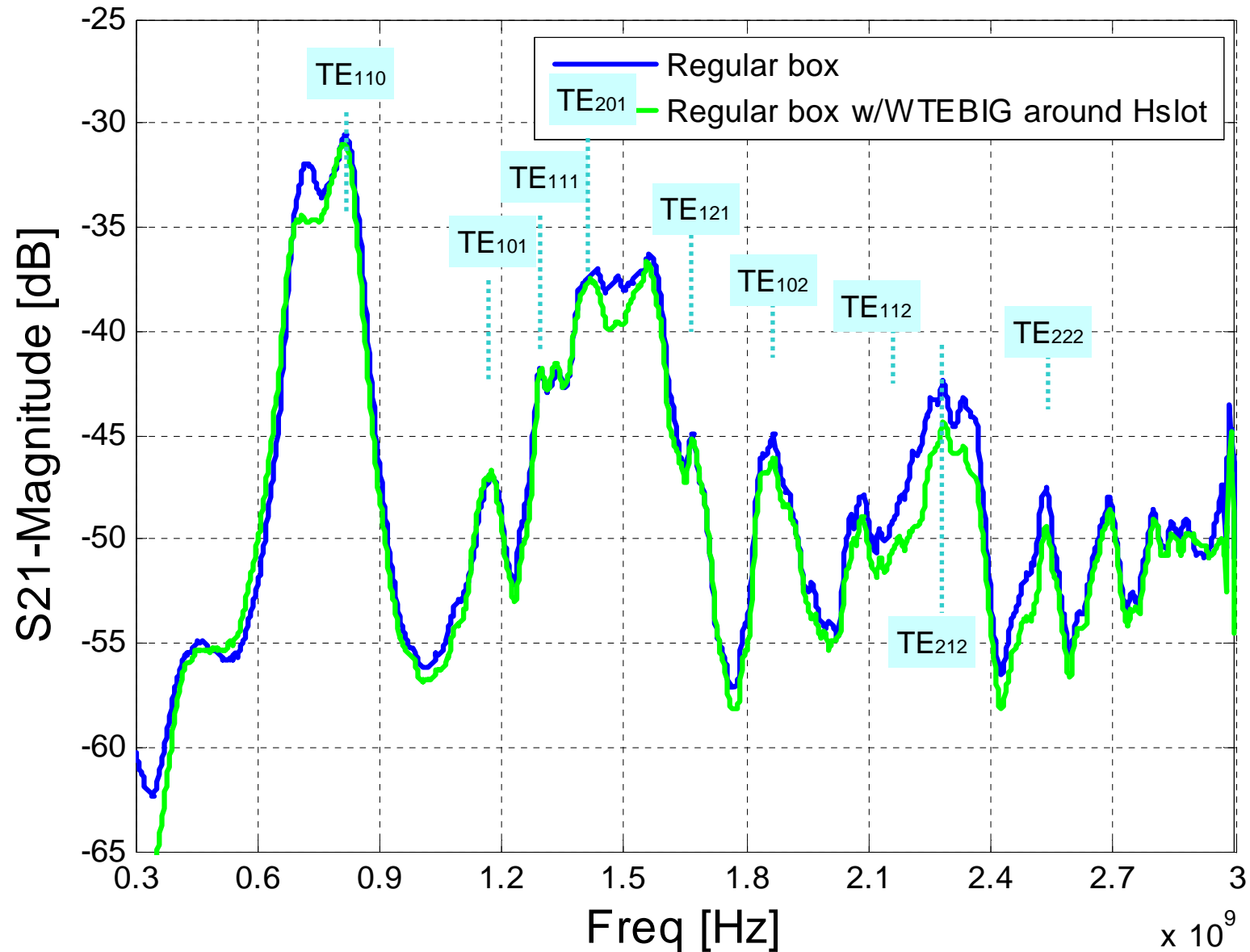
Effect of adding lossy material to BOTH Top & Left side



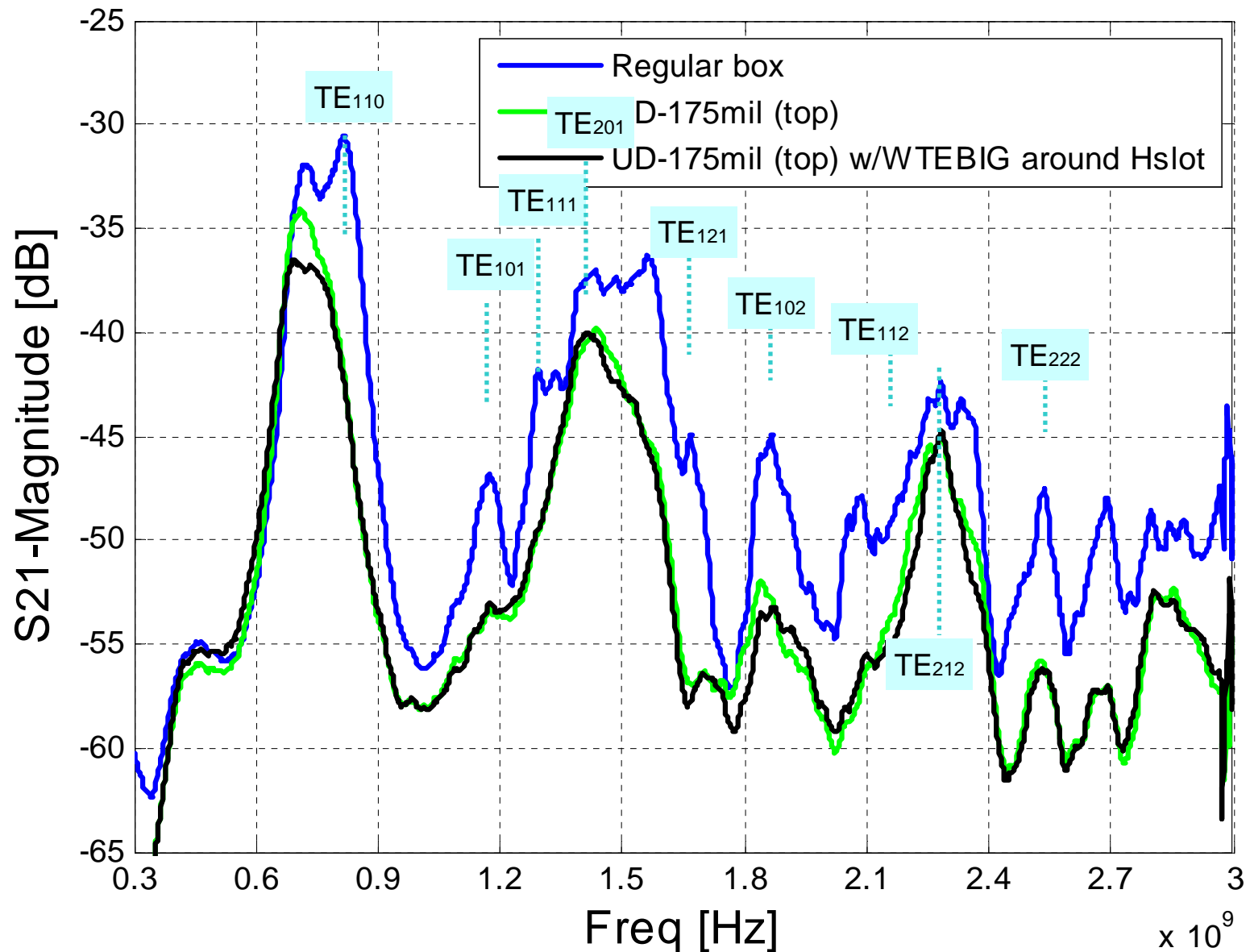
Effect of adding lossy material around H-slot: Type: UD11554



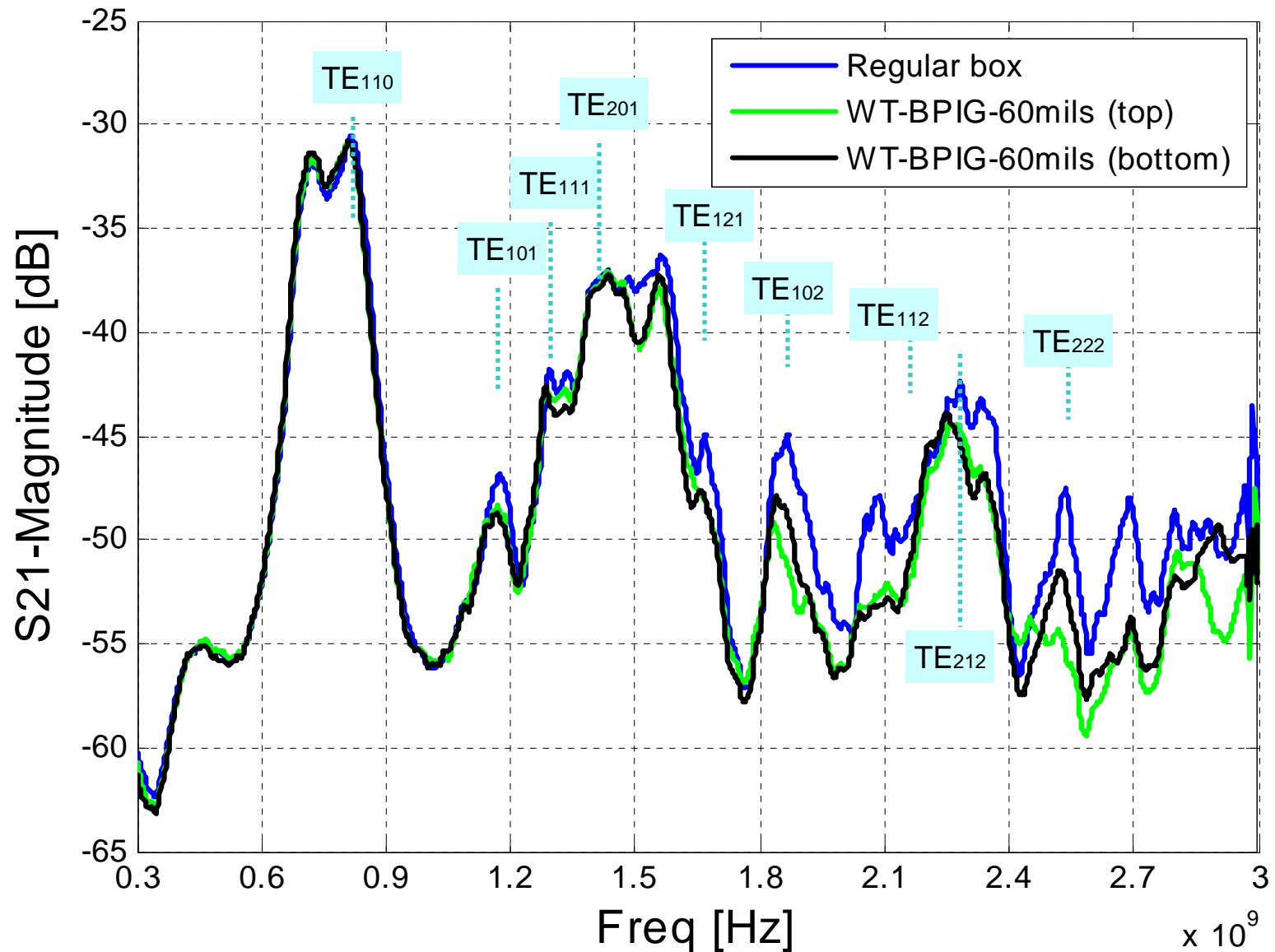
Effect of adding lossy material around H-slot: Type: WTEBIG



Effect of adding lossy material around H-slot: Type: WTEBIG



Effect of WT-BPIG material

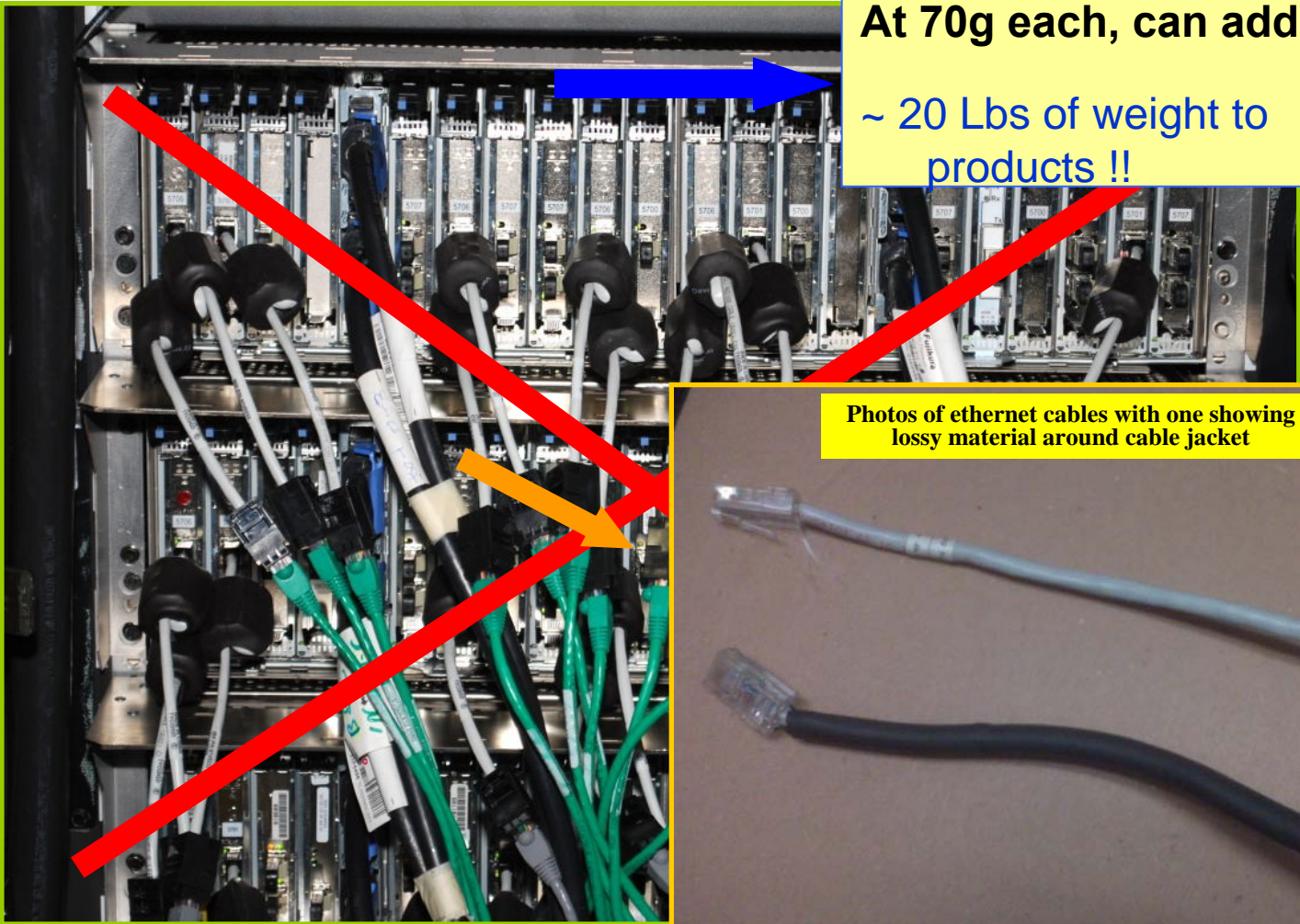


PART-2

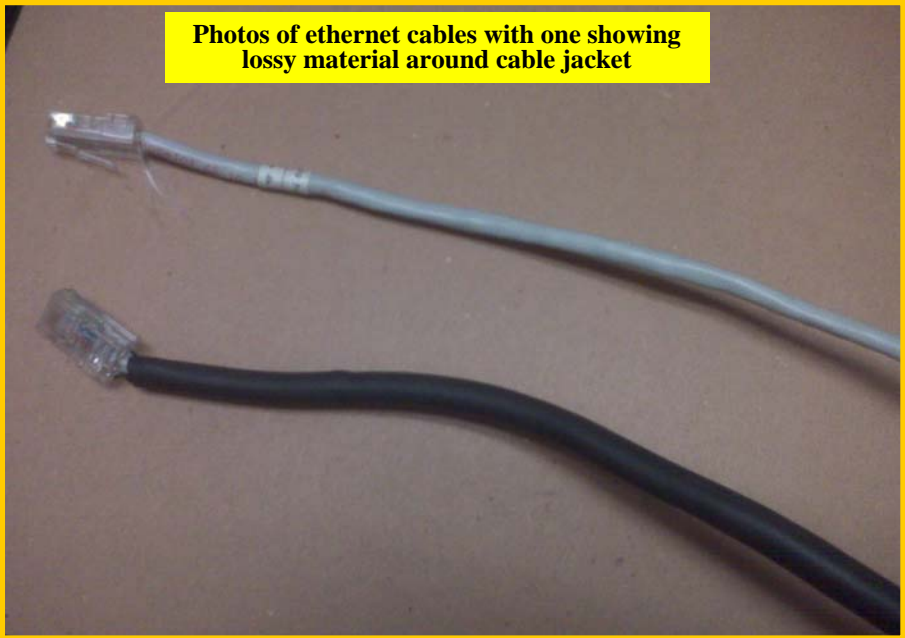
Application of Lossy Materials:
- High speed I/O Cables -

EMI Control for I/O Cables – Absorbing Material vs Ferrites

Rear view photo of zMR showing Ferrite dongles on cables

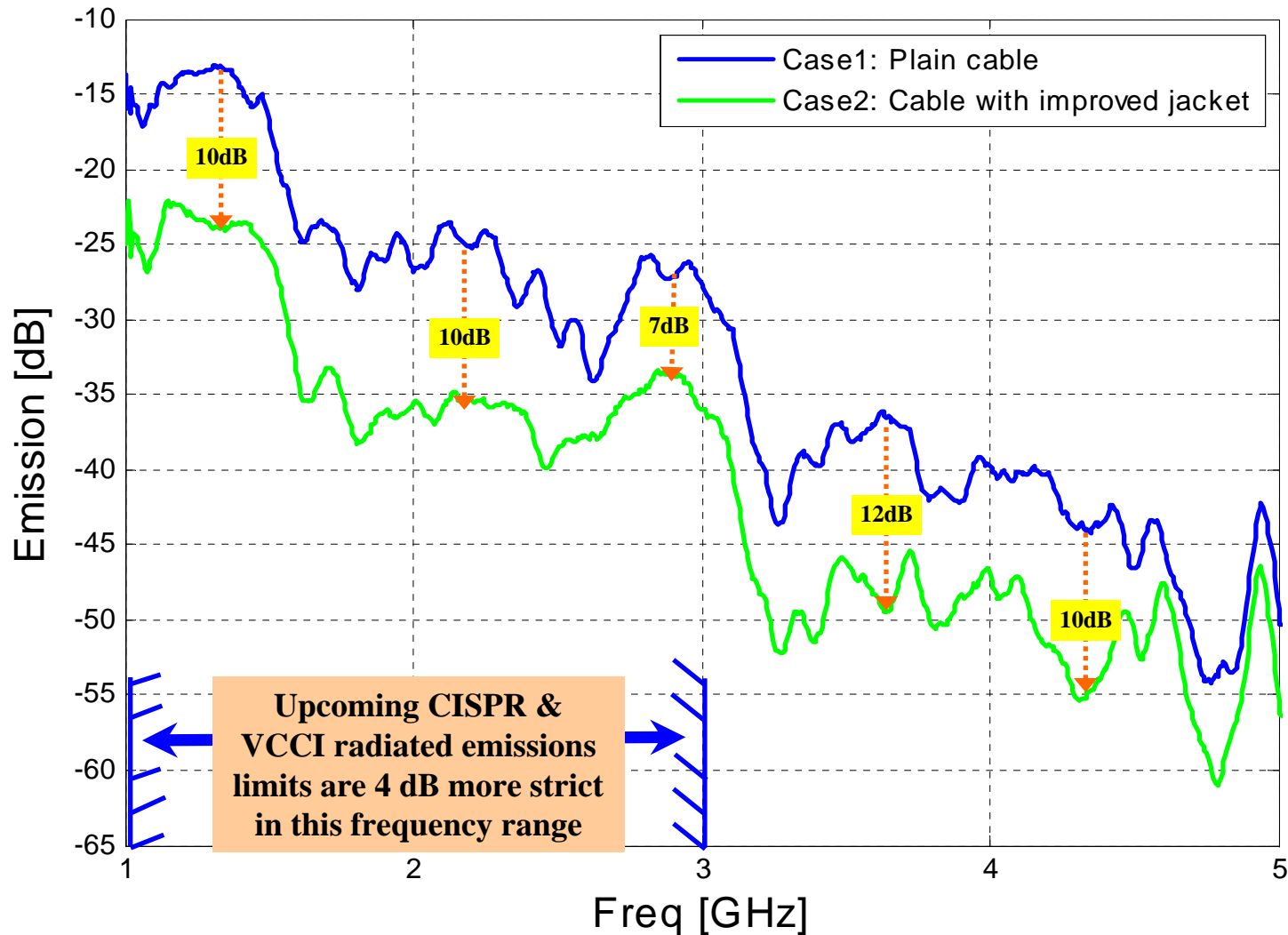


**At 70g each, can add:
~ 20 Lbs of weight to
products !!**

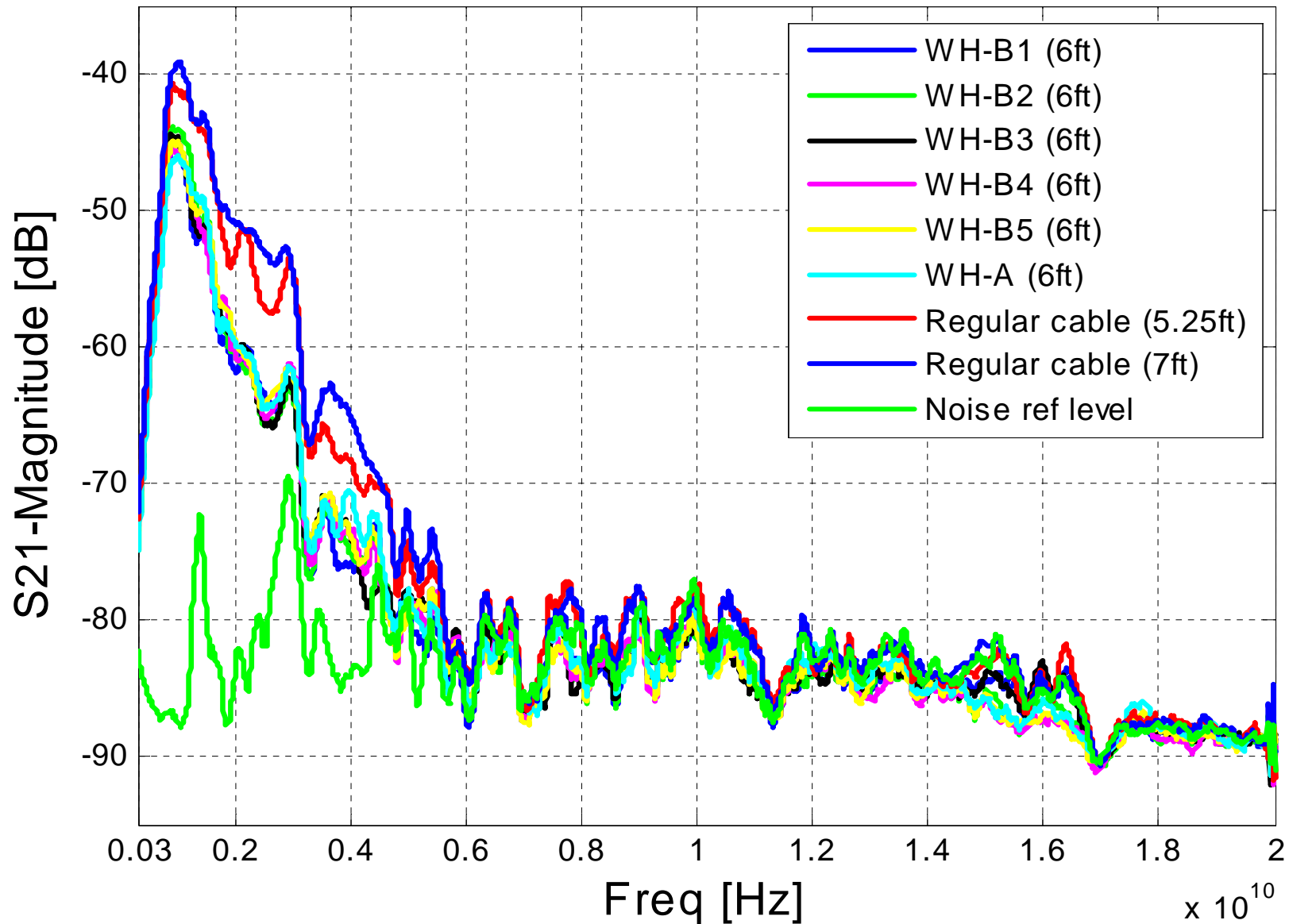


**Photos of ethernet cables with one showing
lossy material around cable jacket**

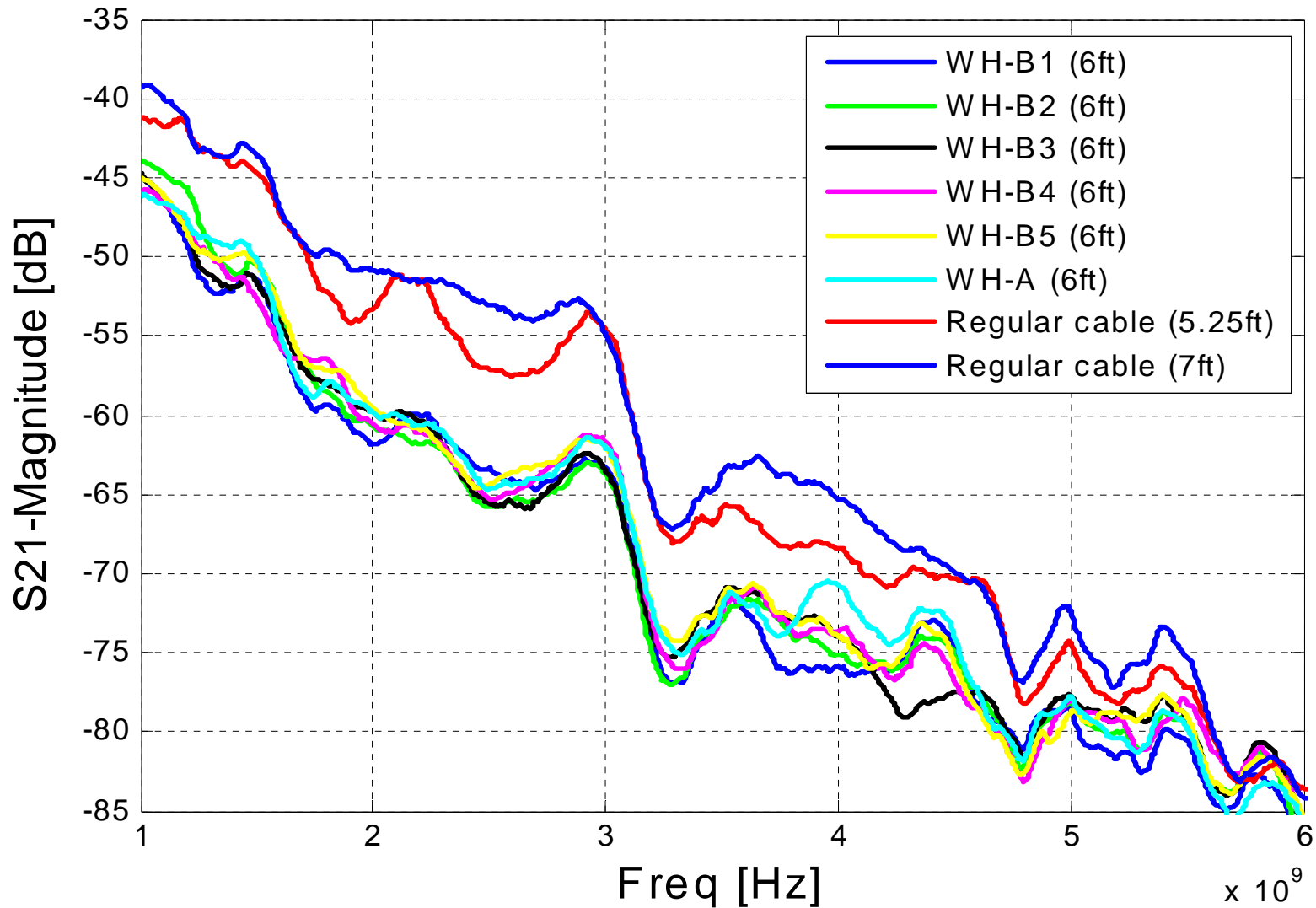
EMI Control for I/O Cables – Absorbing Material Performance



Ethernet cables w/lossy jackets (up to 20GHz)



Ethernet cables w/lossy jackets (up to 6GHz)



Partially covered cables (20mils thick)

Additional Cable Photos

Fig1(a): 2-inch sectional



Fig1(b): 11-inch coverage



Fig1(c): 23-inch coverage



Fig1(d): 37-inch coverage



Setup Photos

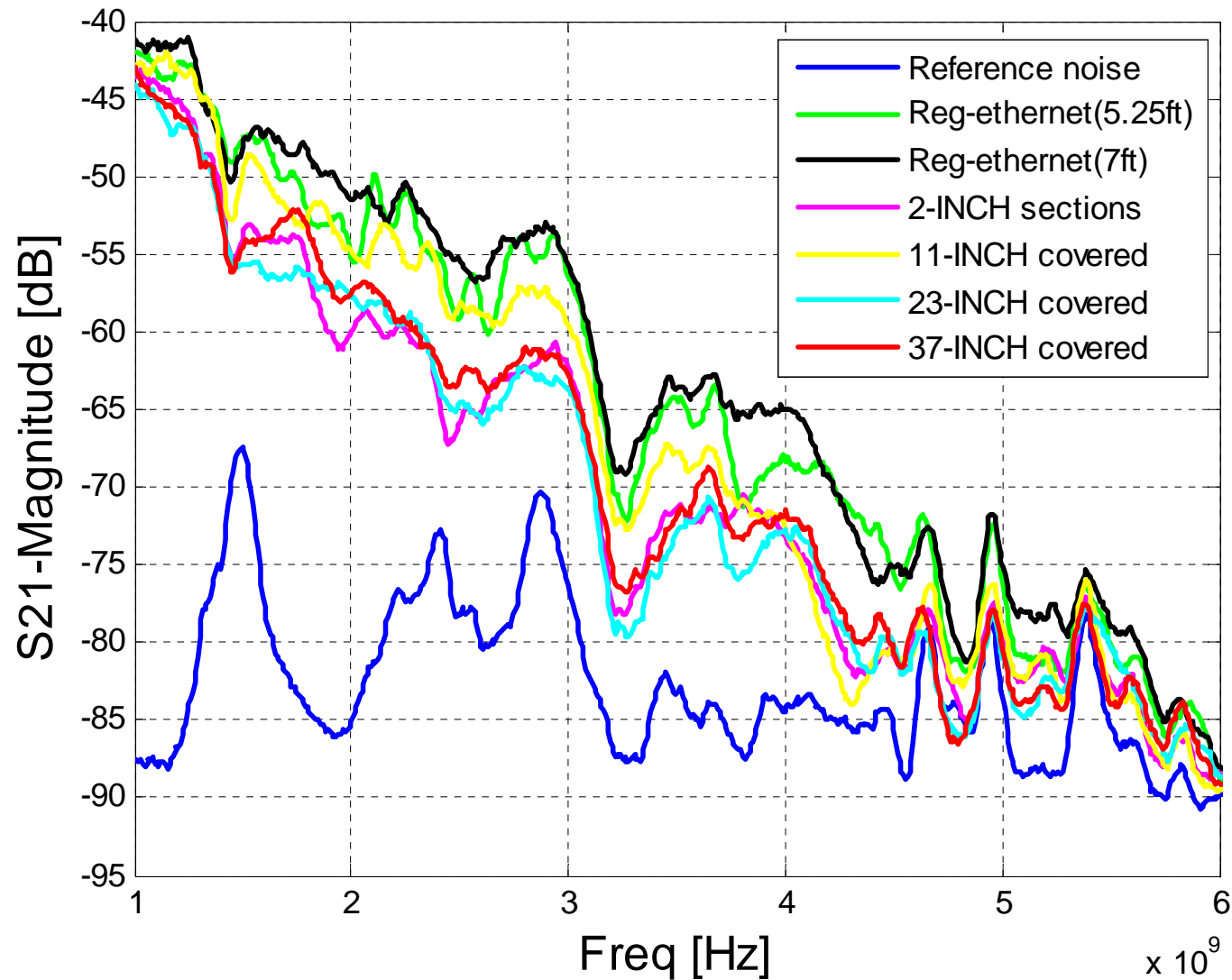
Receive-End



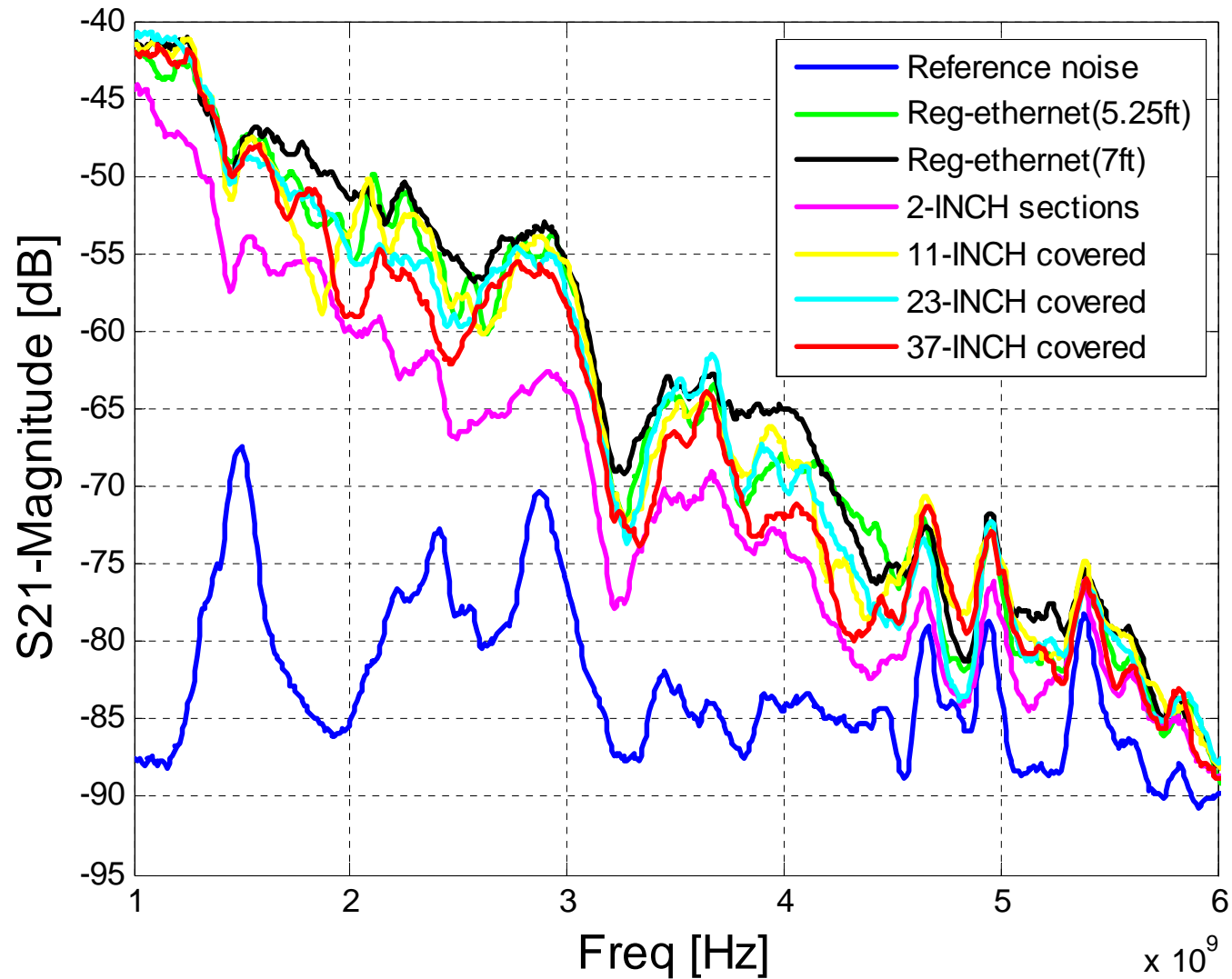
Drive-End

Ethernet cables w/less than full lossy coverage

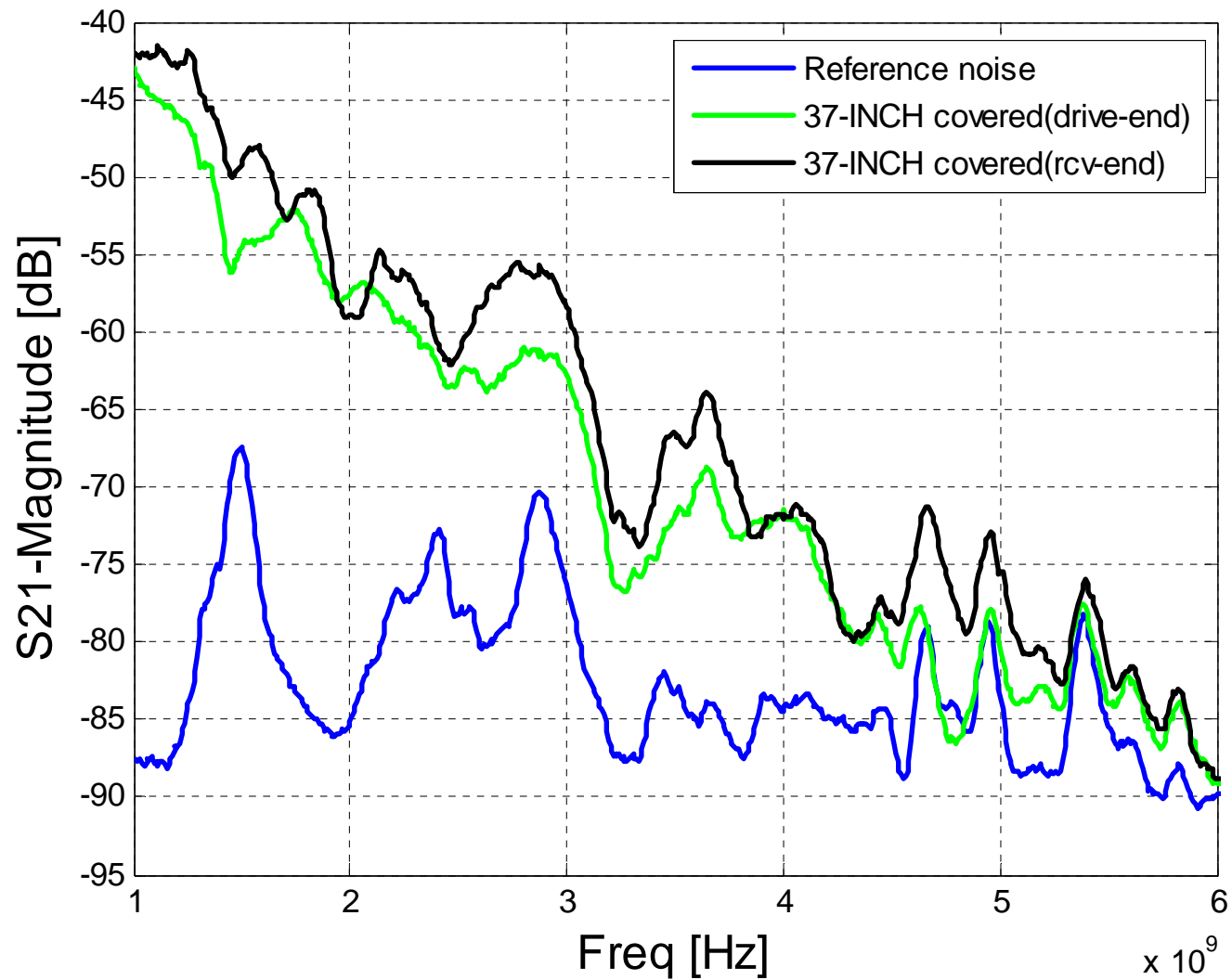
(drive-end)



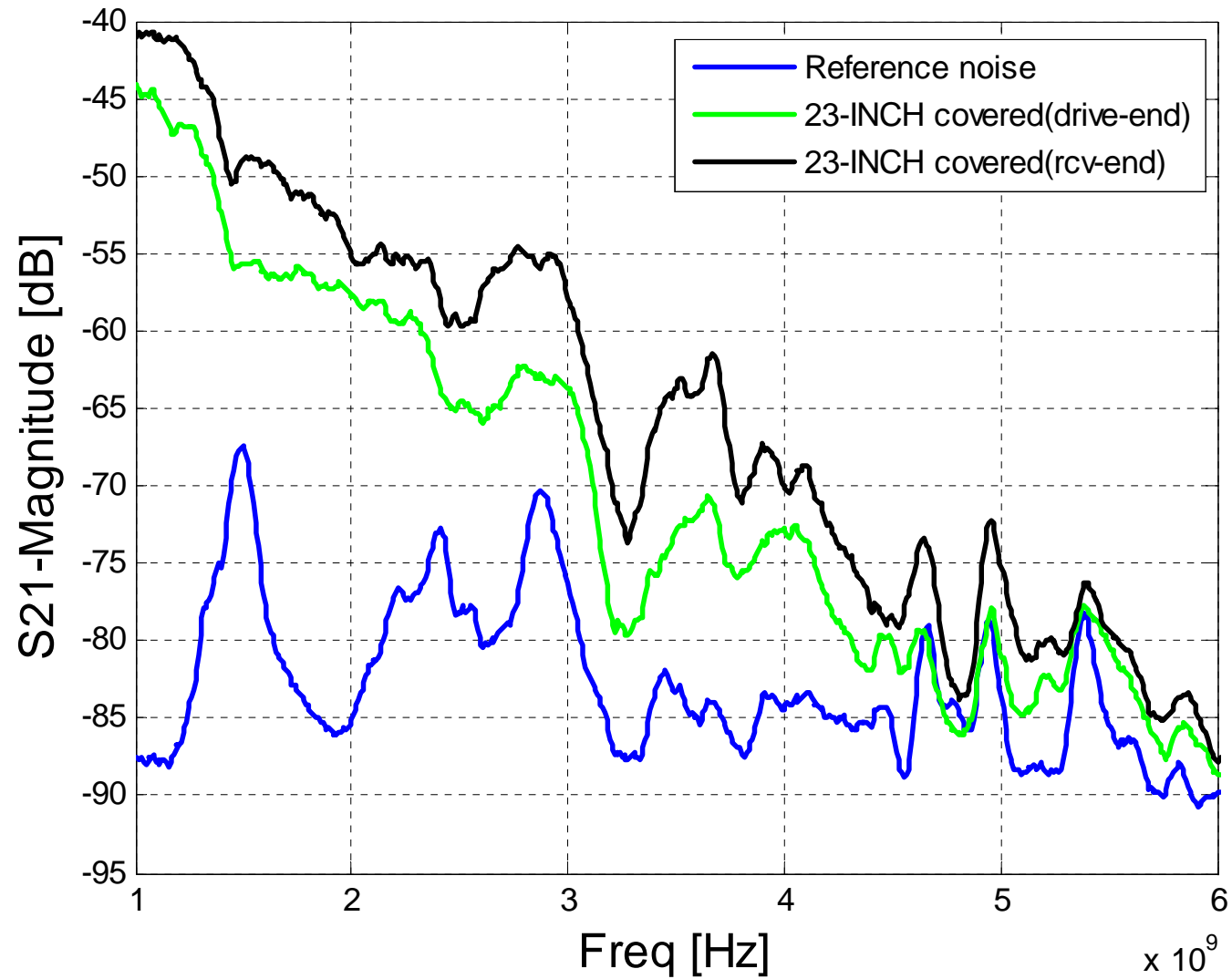
Ethernet cables w/less than full lossy coverage (receive-end)



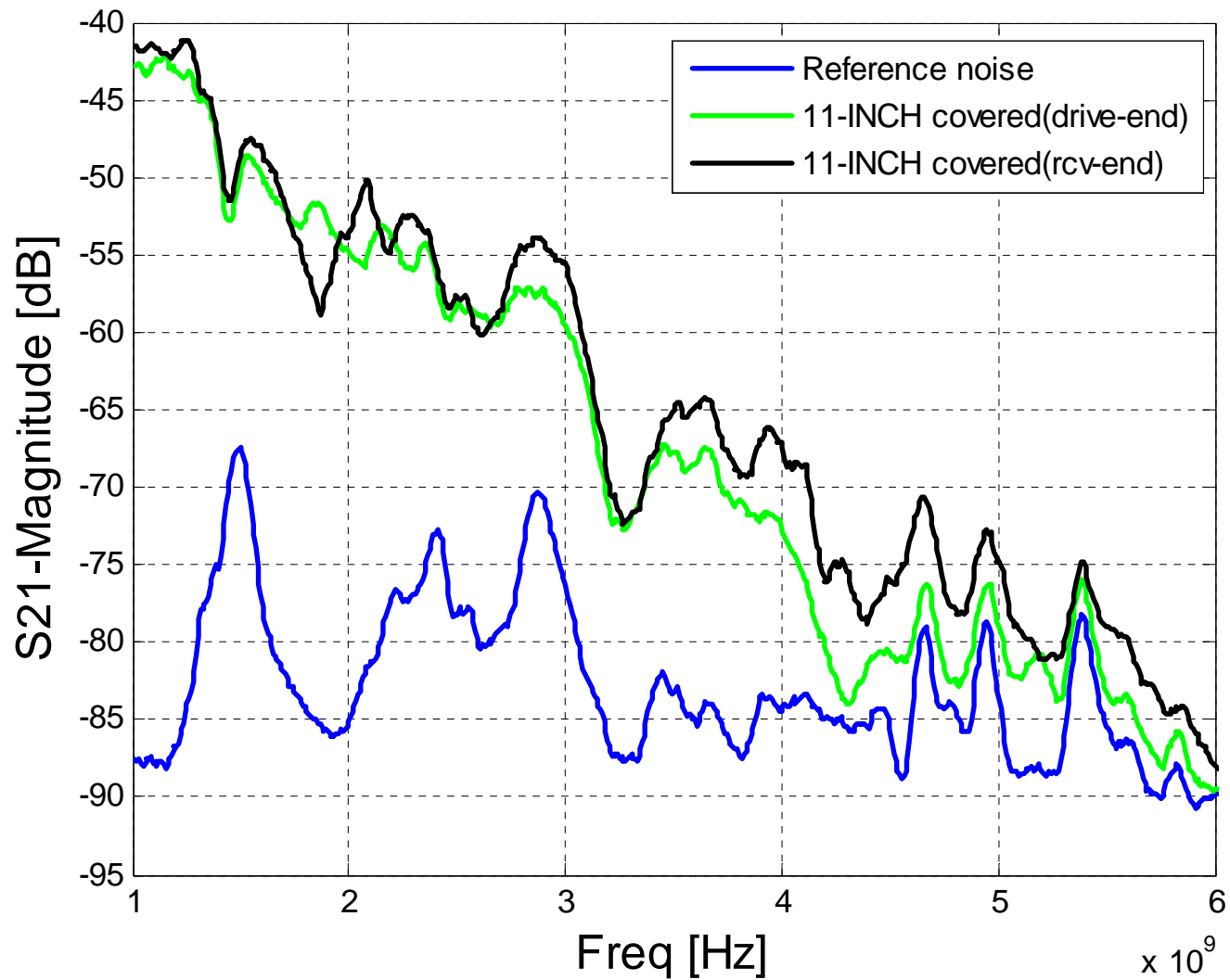
Drive -vs- receive end (1 of 4)



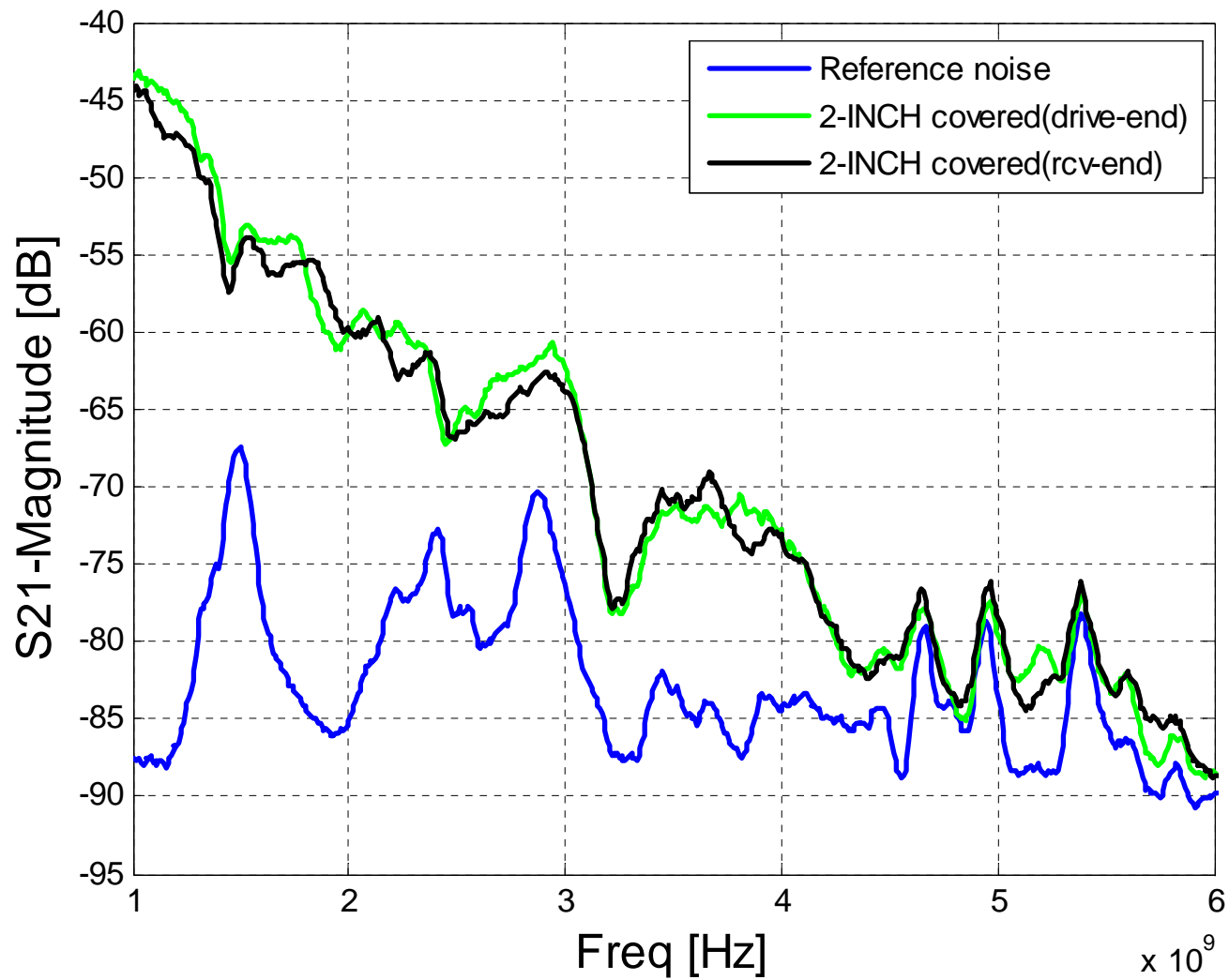
Drive -vs- receive end (2 of 4)



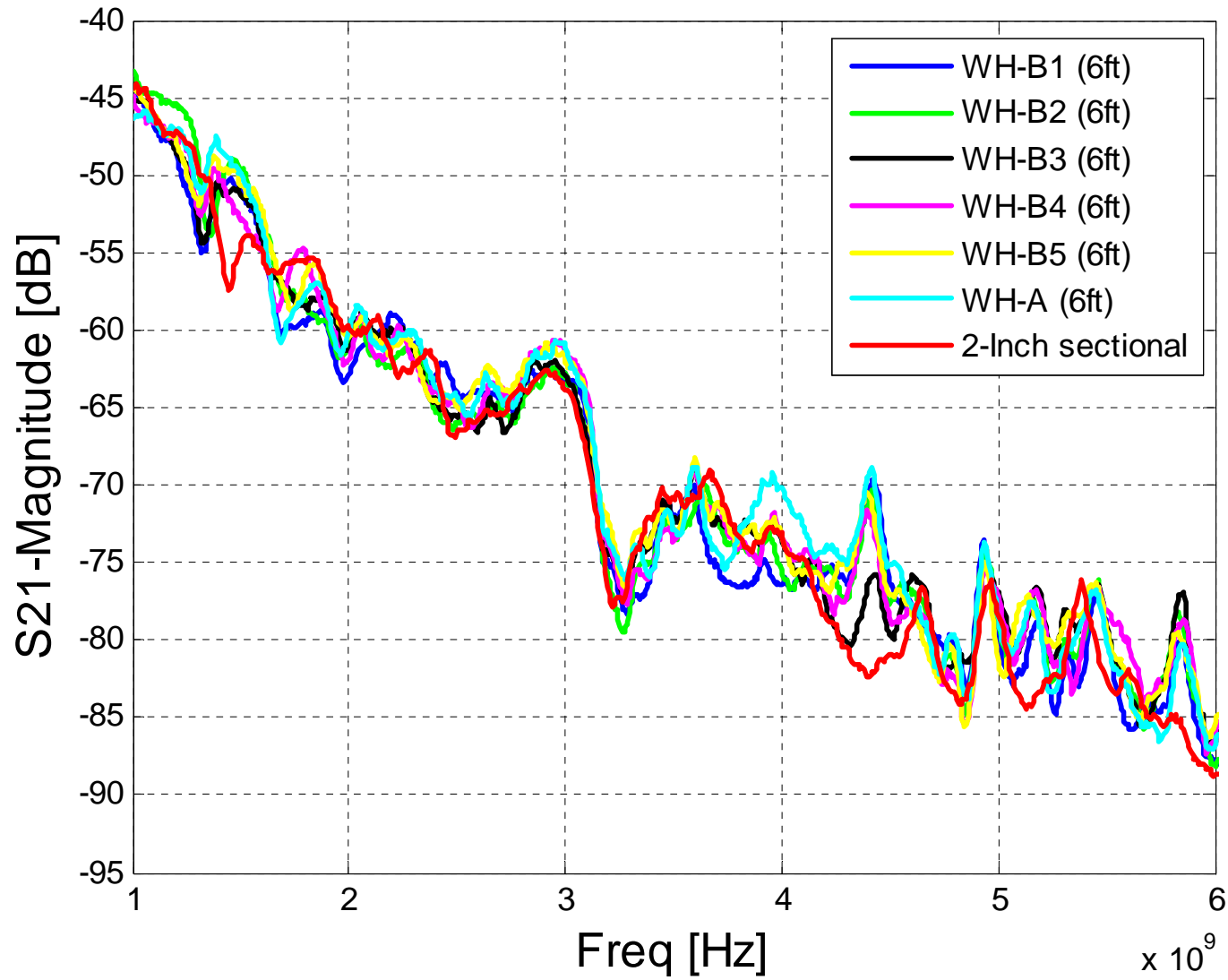
Drive -vs- receive end (3 of 4)



Drive -vs- receive end (4 of 4)

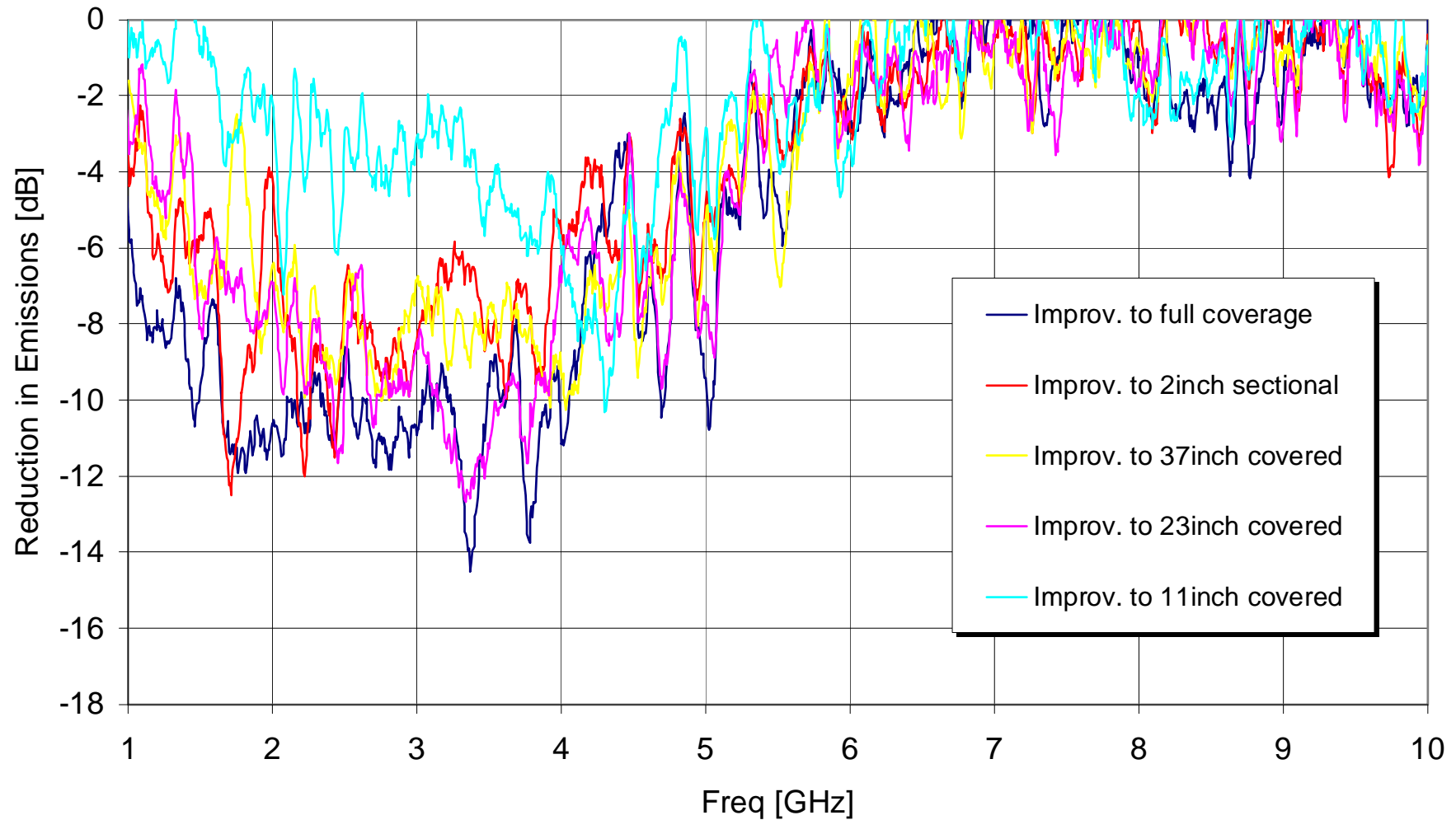


Partially -vs- Fully covered cables



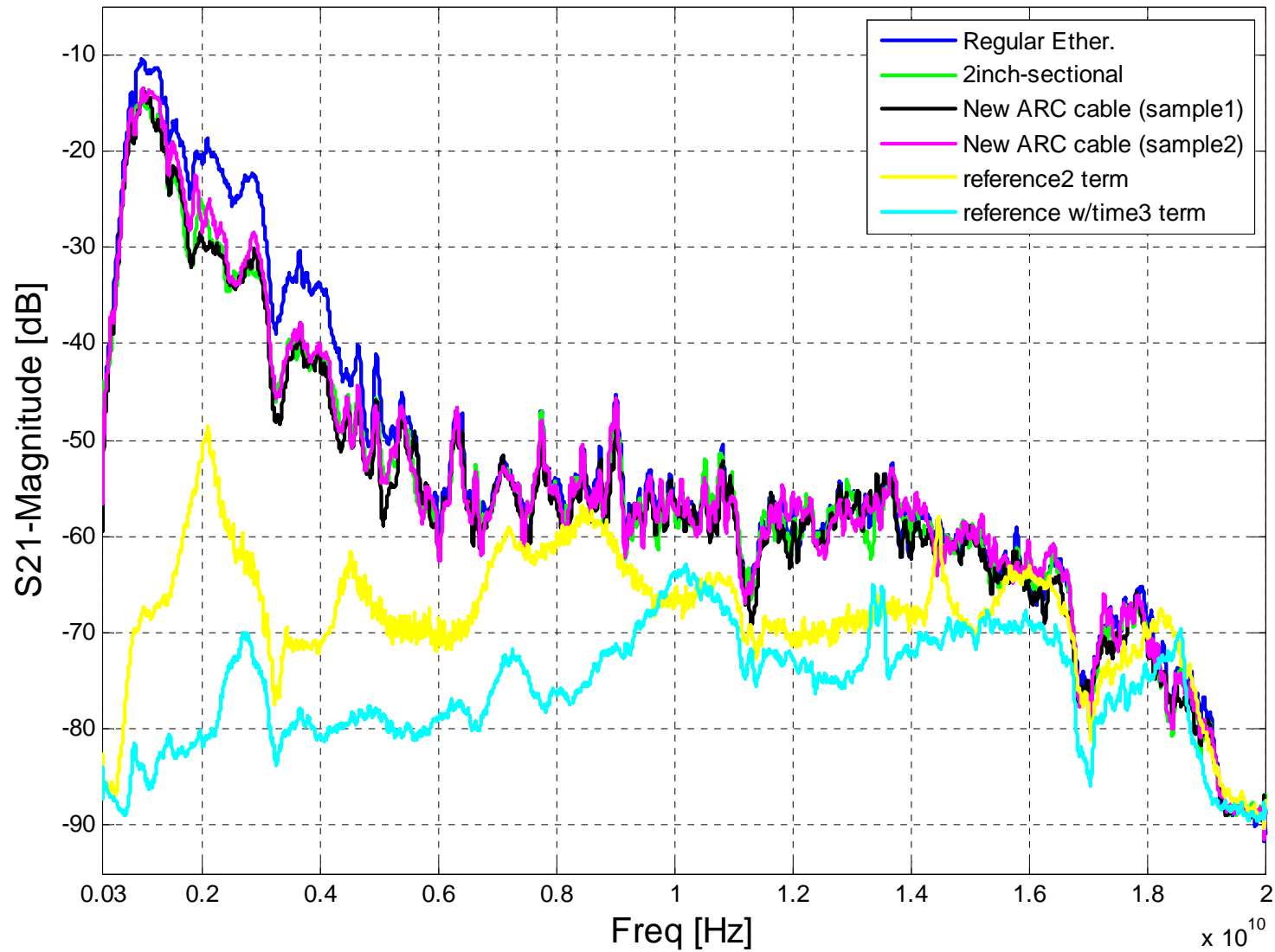
EMI Control for I/O Cables

Ethernet cable emissions improvement due to Lossy material

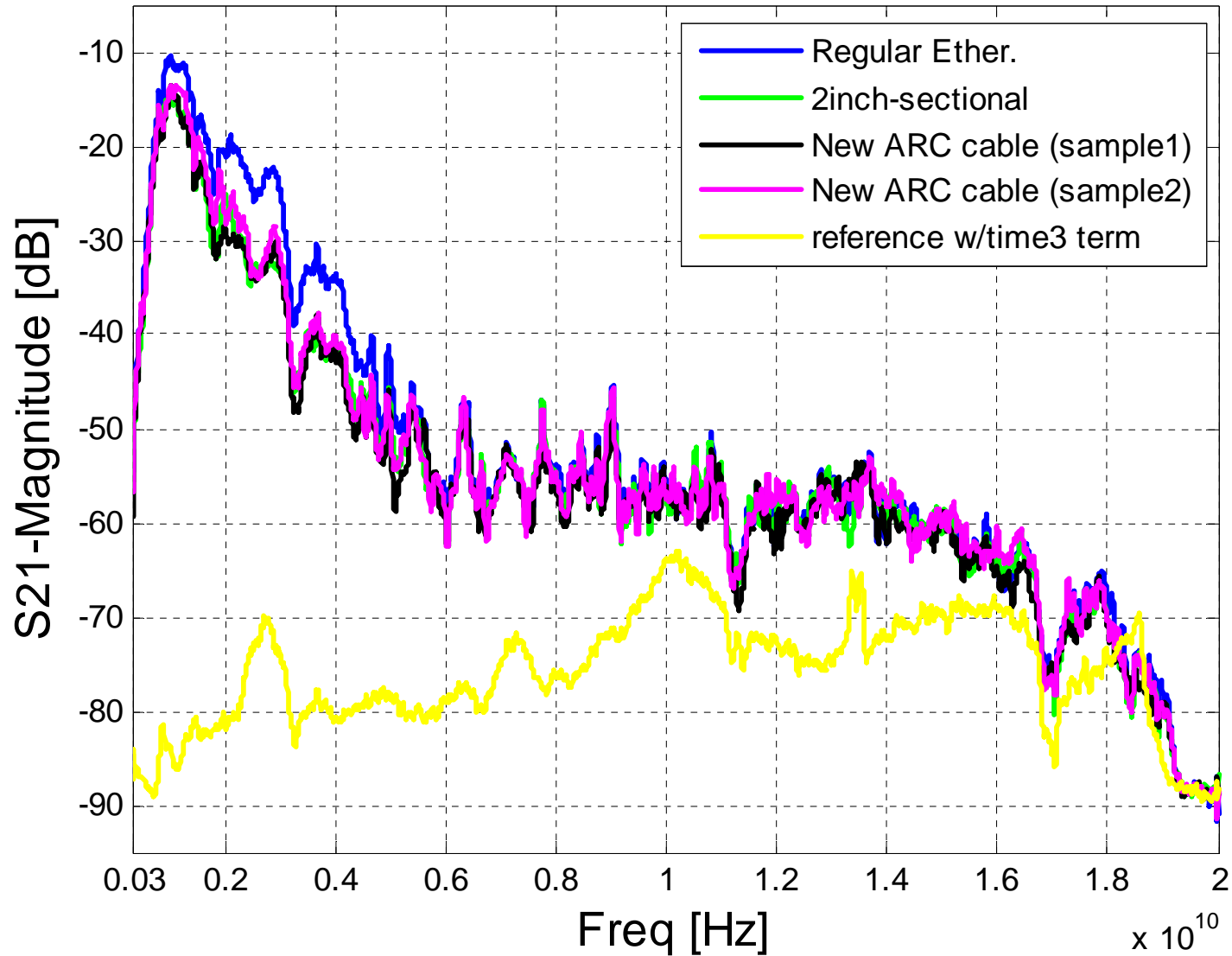


Fully covered cables (10mils thick)

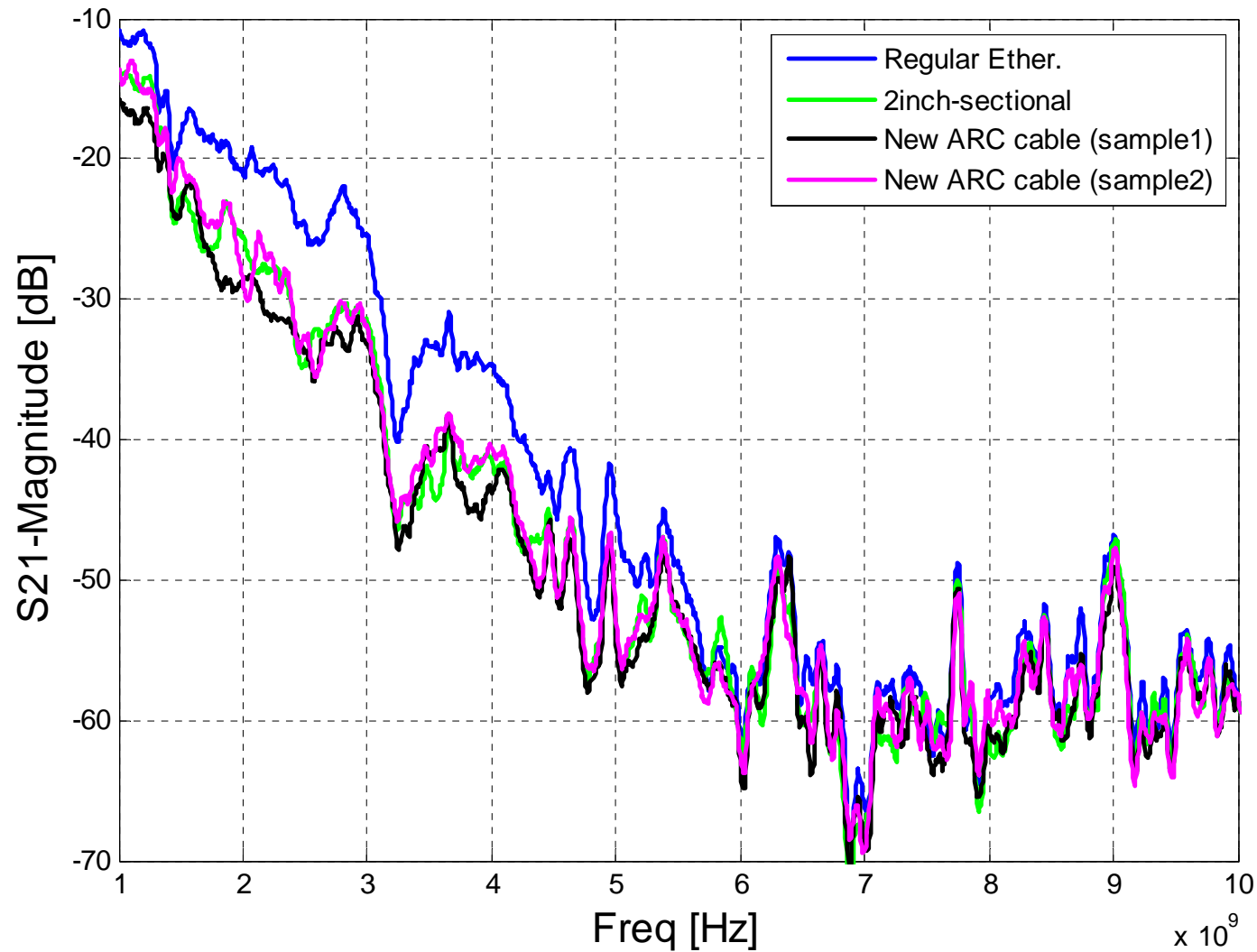
Measurements of cables w/lossy jacket with various reference cables for improved dynamic range (1 of 2)



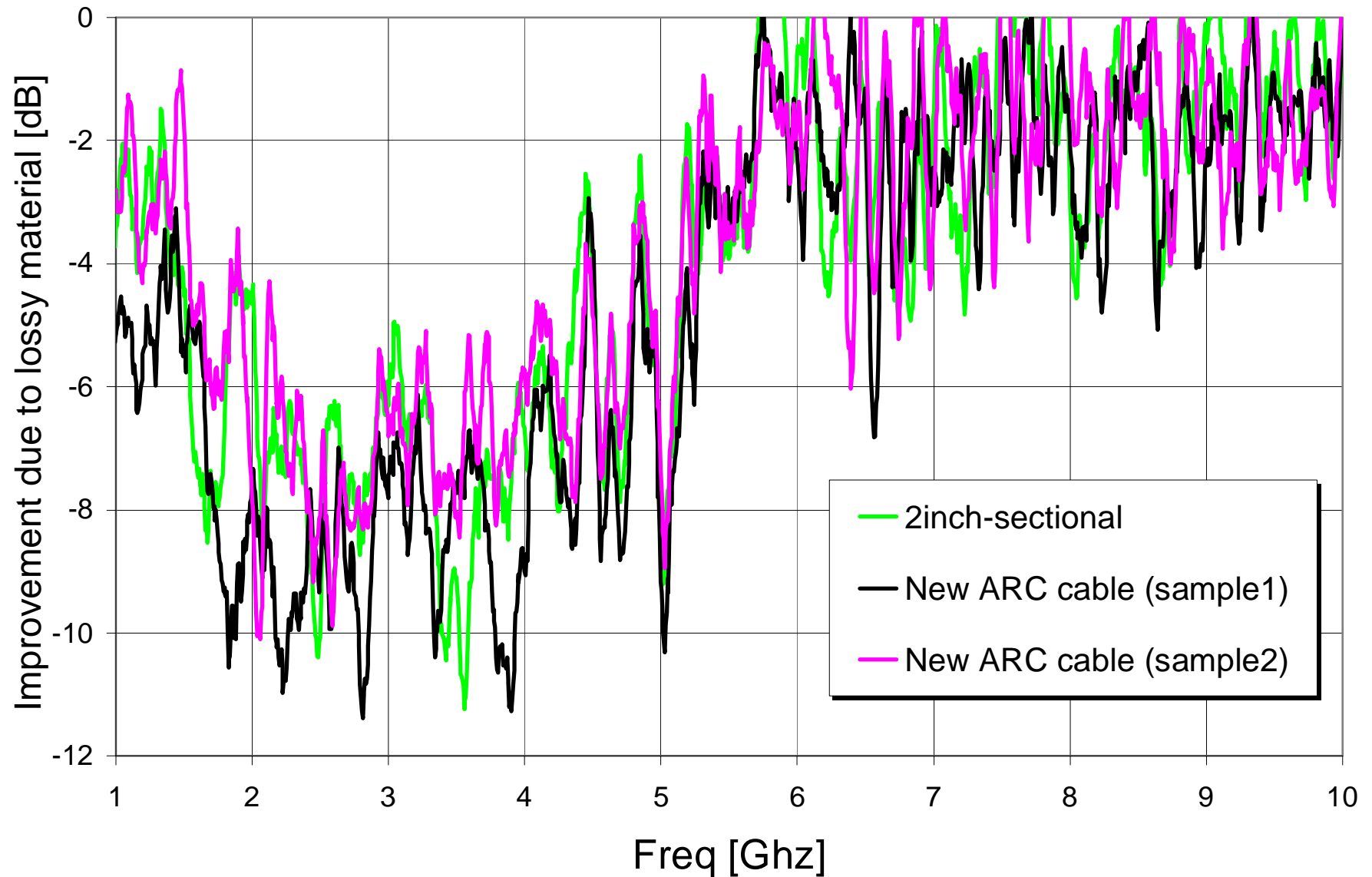
Measurements of cables w/lossy jacket with various reference cables for improved dynamic range (2 of 2)



Measurements of lossy material on cables: Expanded view



Cable emissions improvement due to lossy material



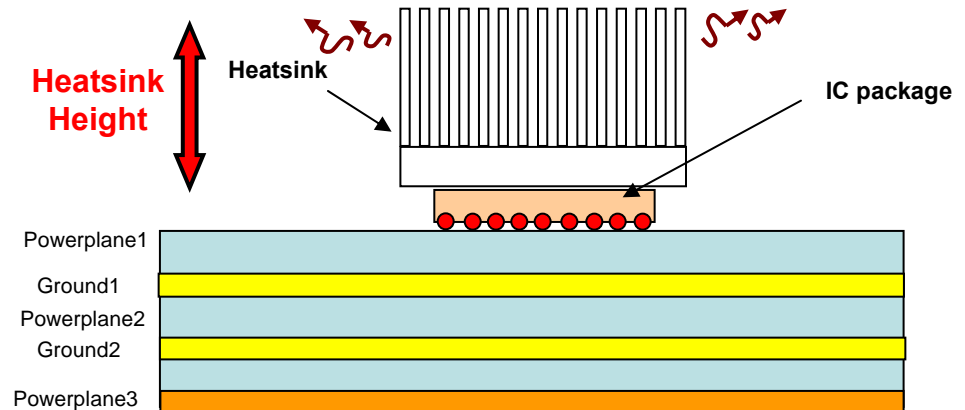
PART-3

Application of Lossy Materials: - I/C Heatsink -

EMI Control for Heatsinks

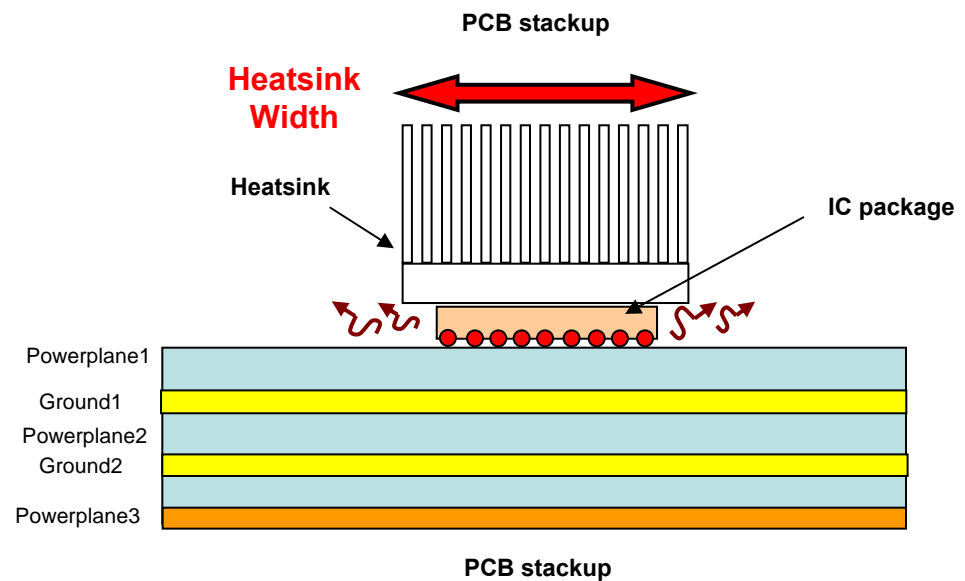
~ 1GHz and Below

- **Monopole Antenna**
 - Dependent on heatsink height
 - Mitigated by grounding heatsink



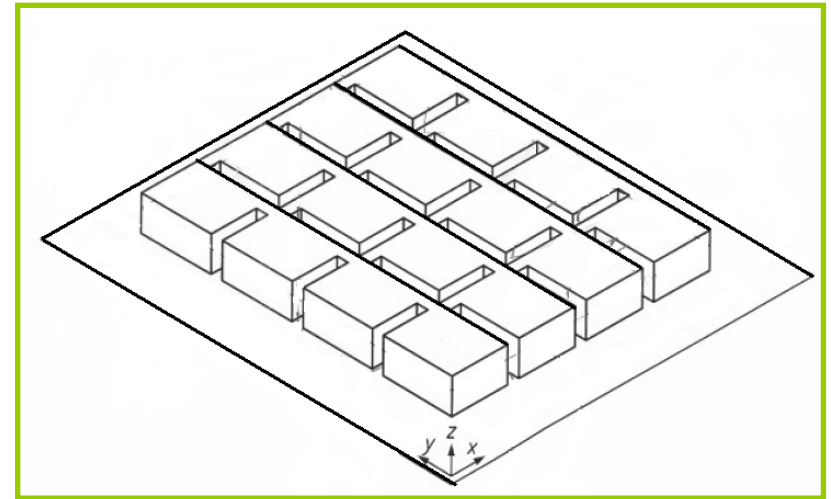
Above 1 GHz

- **Resonant Cavity**
 - Dependent on heatsink length & width
 - Grounding heatsink does not help (can even aggravate)
 - Mitigated by suppressing resonances

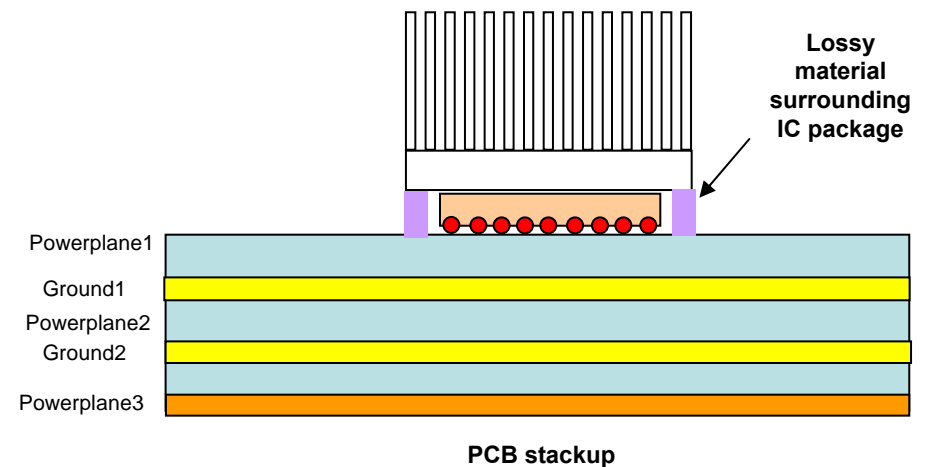


EMI Control for Heatsinks

- **Use EBG structure to suppress cavity resonances and lower emissions**
 - Make heatsink base plate into an EBG structure



- **Add absorbing materials under heatsink to lower emissions**



Photos

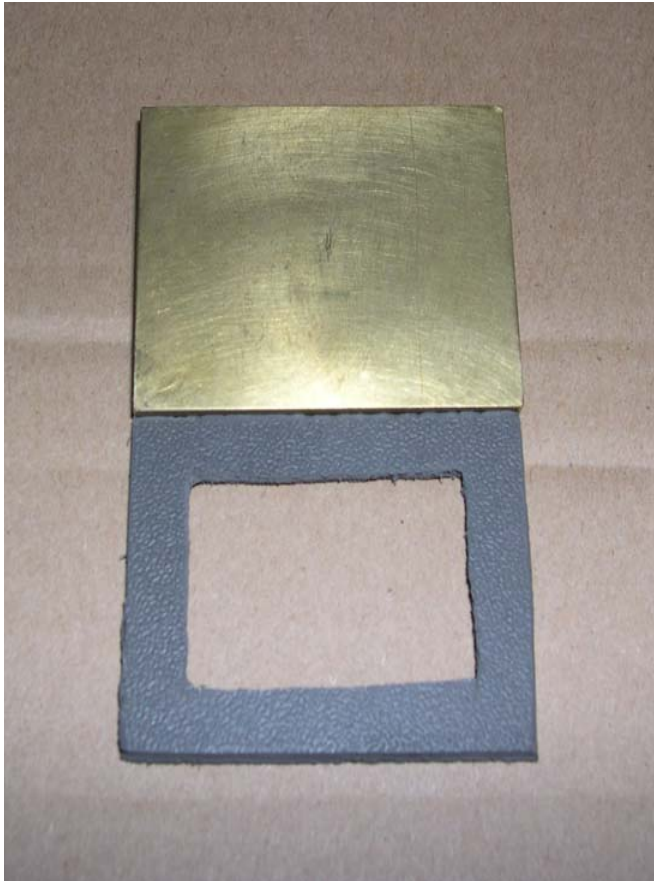


Fig1: HS baseplate w/300-mil thick material

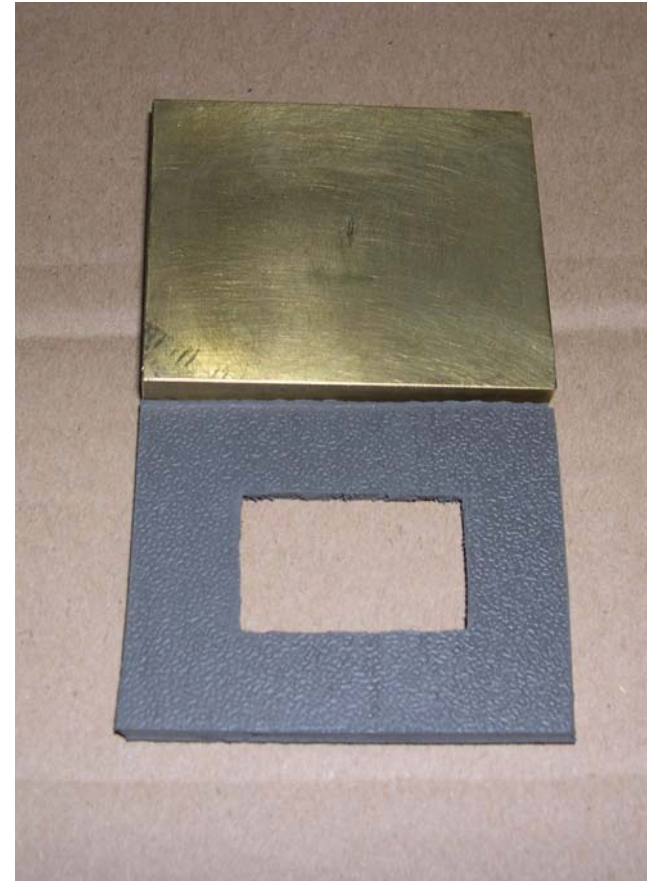
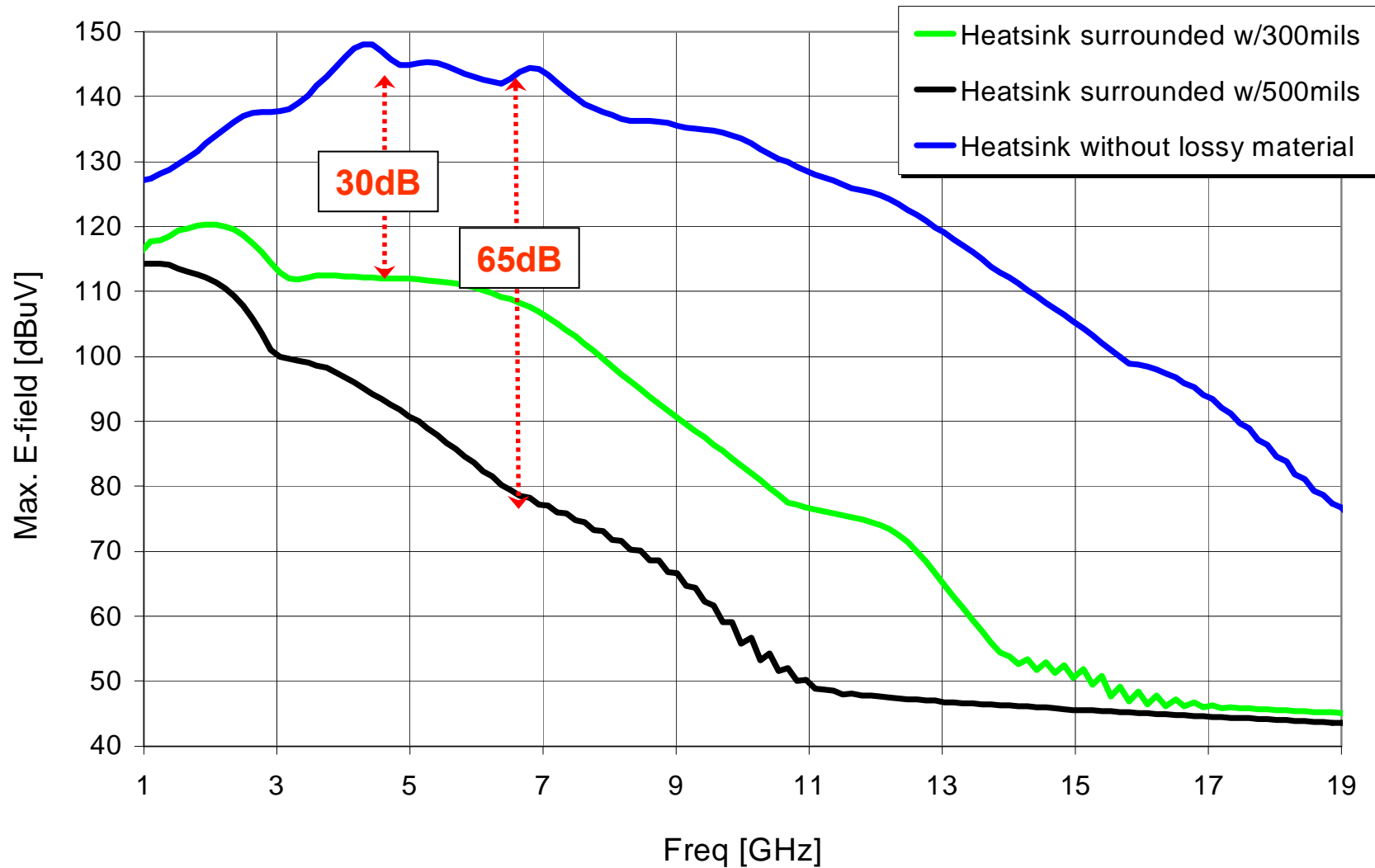


Fig2: HS baseplate w/500-mil thick material

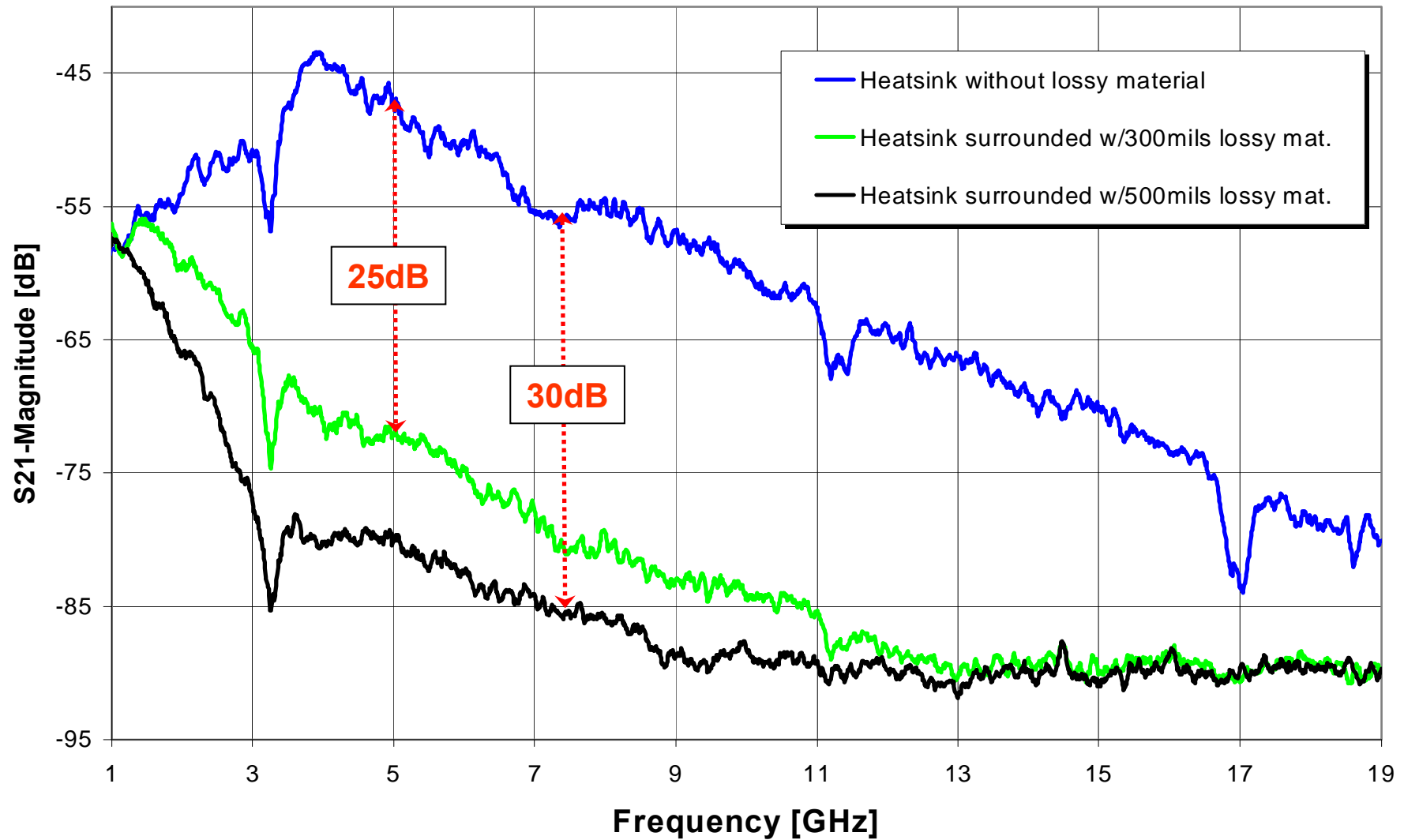
Heatsink surrounded w/UD-175mil

FDTD Simulation data



Heatsink surrounded w/UD-175mil

Actual Measurement Results



Heatsink surrounded w/UD-175mil – SAC data

