Package Level EMI Study

Y. L. Li

Contributors:

EPG: Dong Zhong, Y. L. Li

DPG: Steven Ji

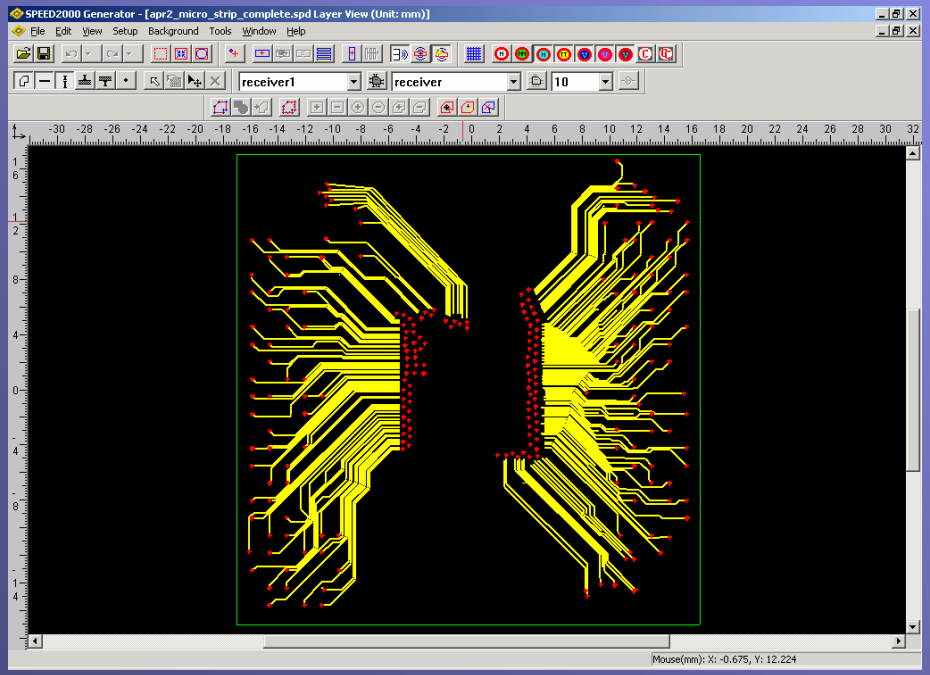
TMG: Gang Ji, Jiangqi He

Oct. 26, 2003

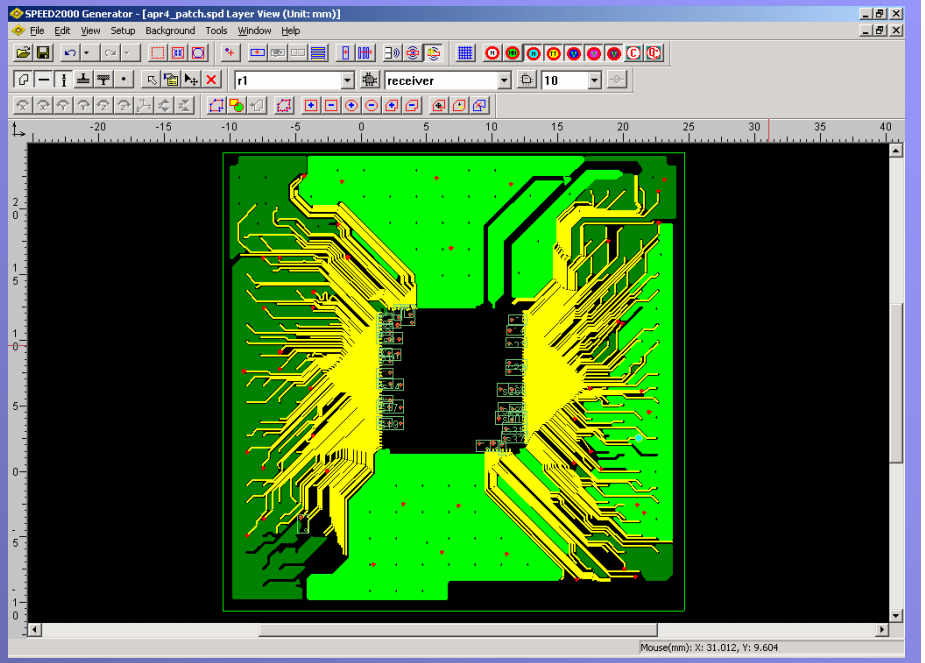
Outlines

- Package microstrip lines with patches vs. without patches
- Ground Stitching Study
- Retreated Power Planes w/ and w/o Ground Ring Study
- Conclusion

Package microstrip lines w/wo patches



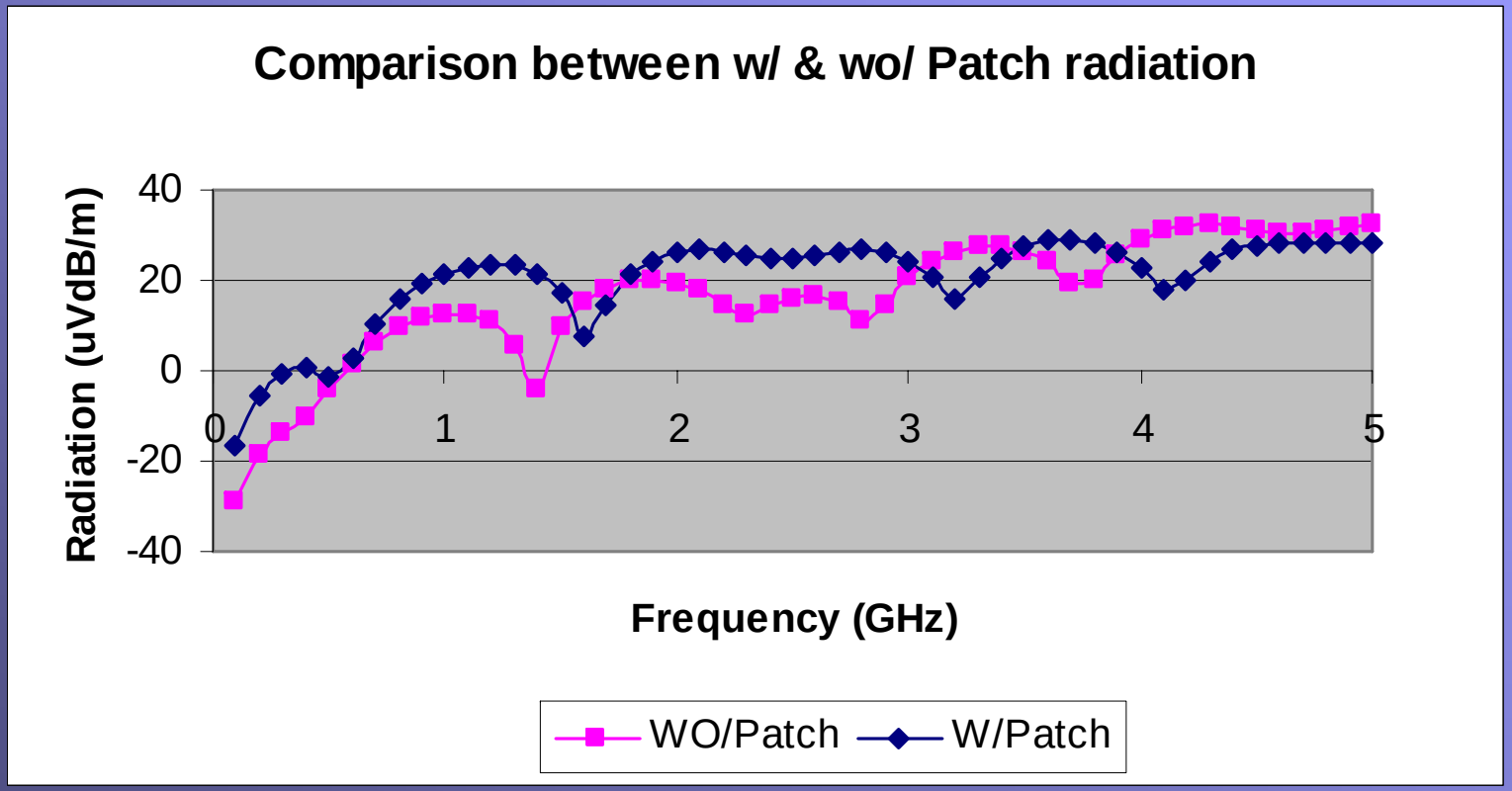
Microstrip line without patches



Microstrip line with patches

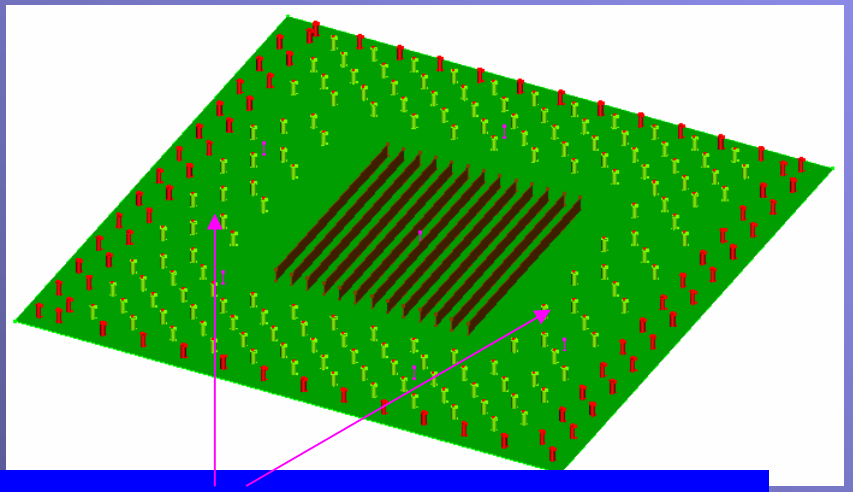
Package microstrip lines w/wo patches

Radiation W/ vs. WO/Patches

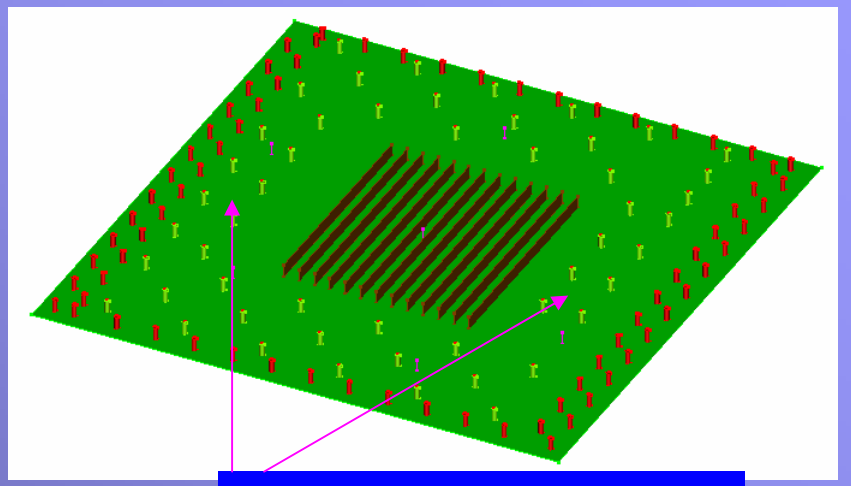


Radiation from Microstrip linec w/ vs. wo patches are mixed
for wide frequency range, ie., no significant difference between two designs

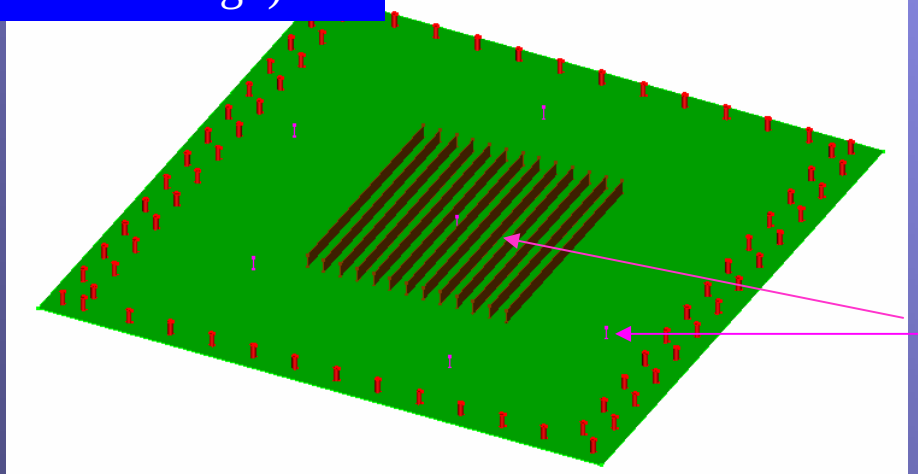
Ground Stitching Study: Three Different Via Densities



Power/Ground Vias are Fully Populated
(Current Checkerboard Design)



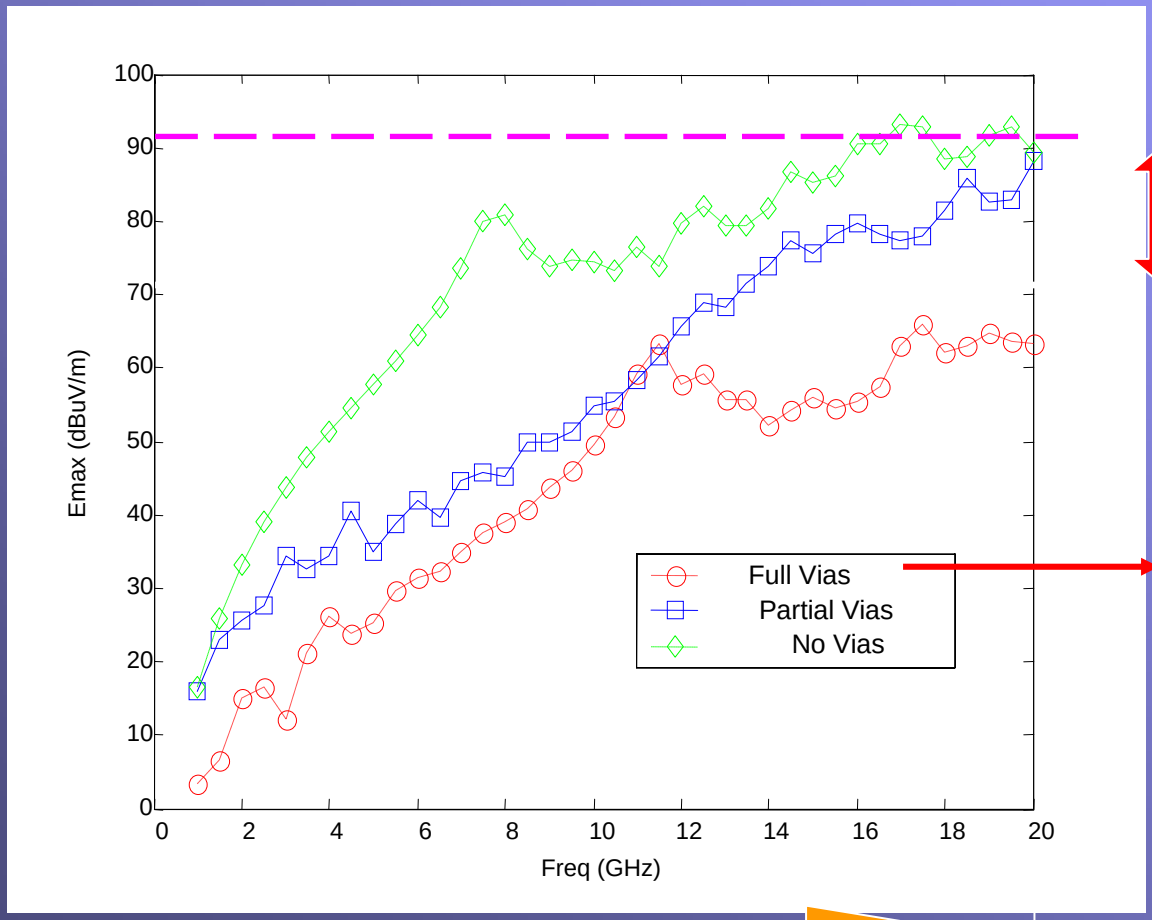
Partially Populated



sources

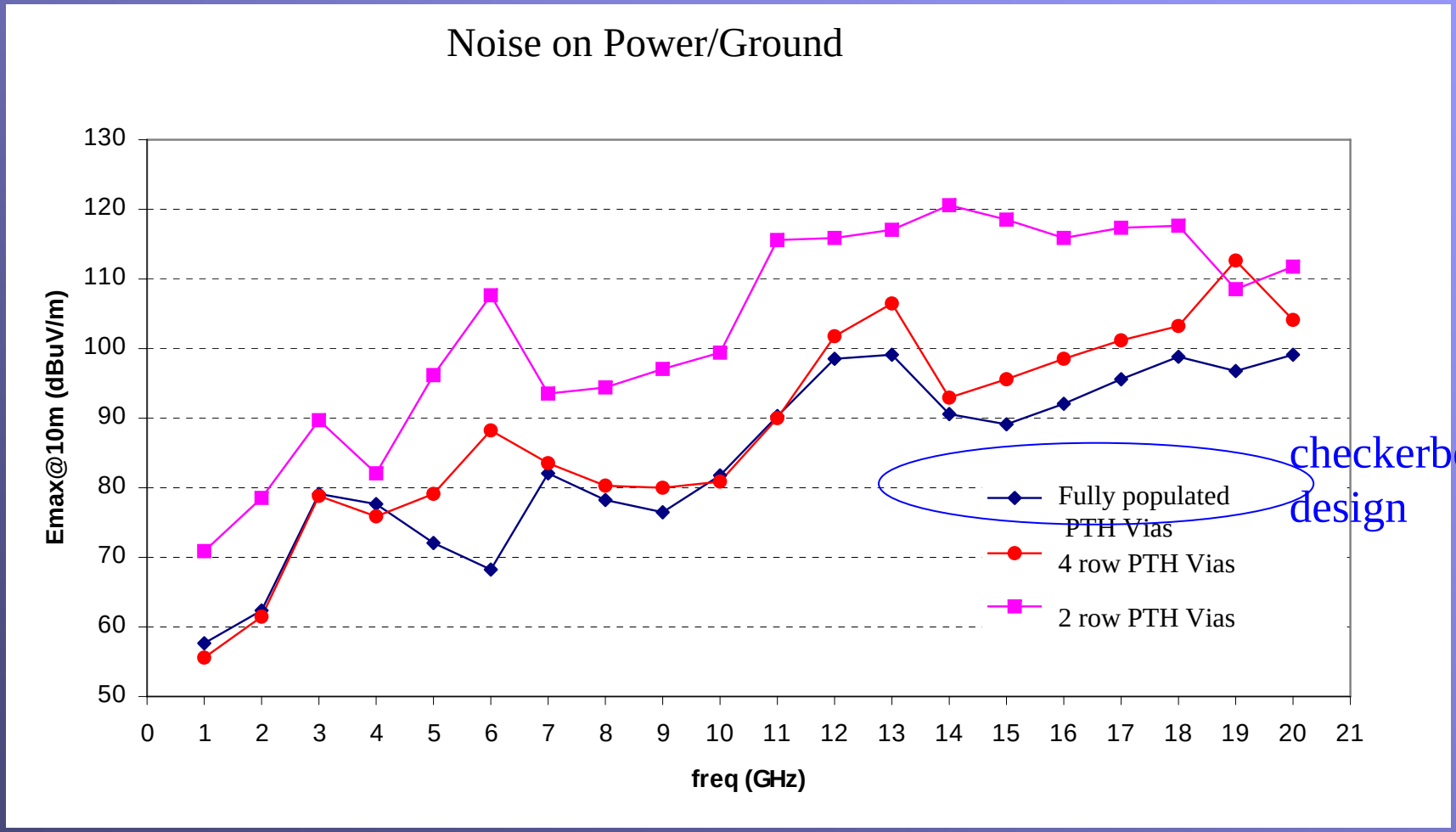
Ground Stitching Vias ; without Power/Ground Vias

Ground Stitching Study:
Case 1- Noise sources are outside the die shadow

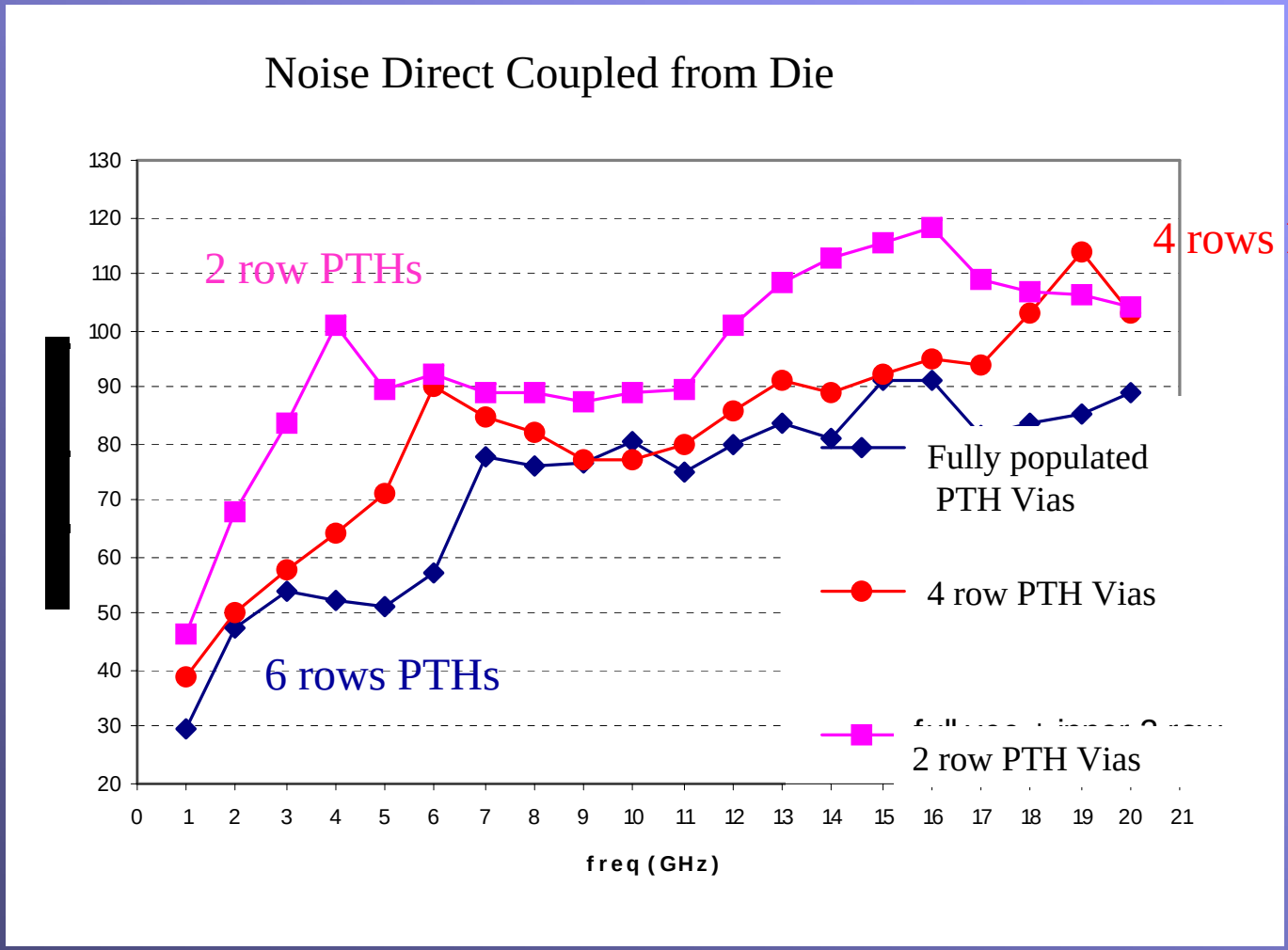


+ The checkerboard design has the best performance.

Ground Stitching Study:
Case 2 - Noise sources are under the die shadow



Ground Stitching Study:
Case 3 - Noise sources are under the die shadow

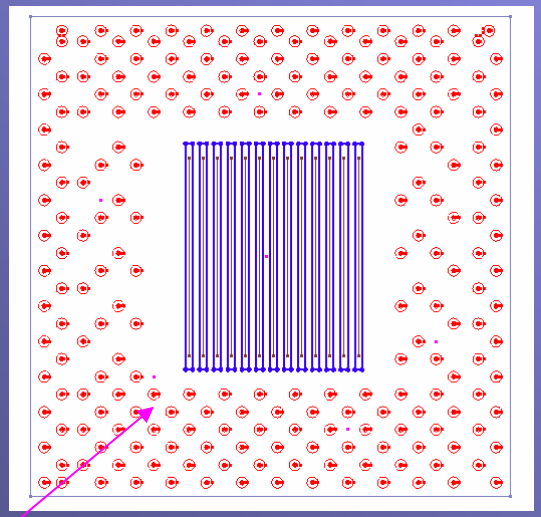


Summary of the Ground Stitching Study:

- There is no need for any additional vias for ground stitching on Power/Ground planes.
- The checkerboard power/ground design provides the best radiation reduction.
  - ➢ The current power delivery system requires a very low package loop inductance design → checkerboard power/ground vias.
  - ➢ Do a good job in power delivery → Significantly reduce EMI issues

Retreated Power planes w/ and w/o Ground ring Study

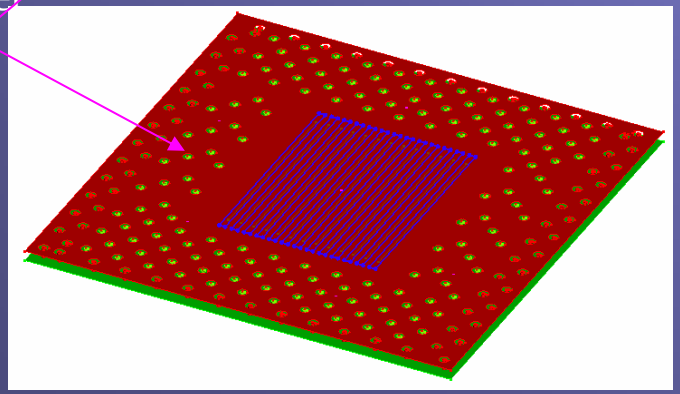
Full Power Plane



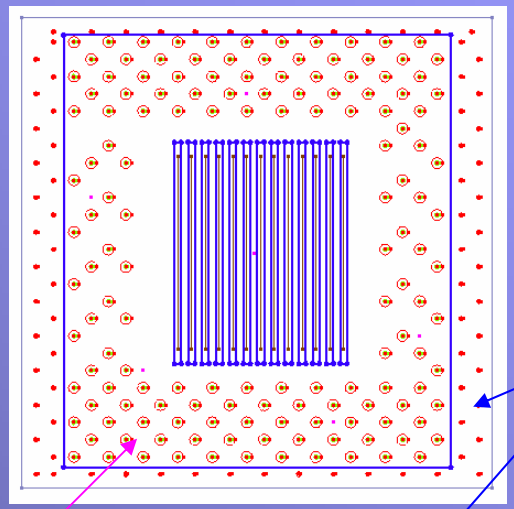
p

G

Power



Retreated Power Plane
with Ground ring

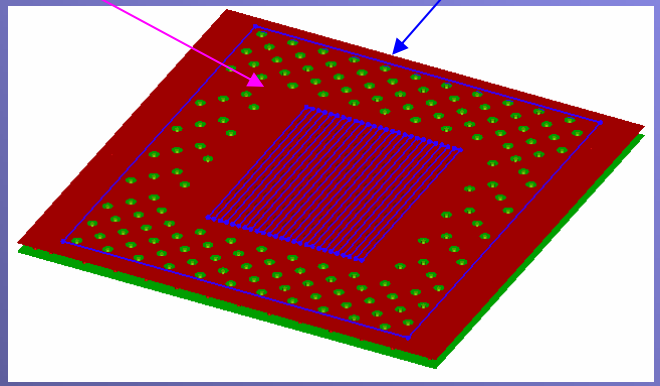


G p G

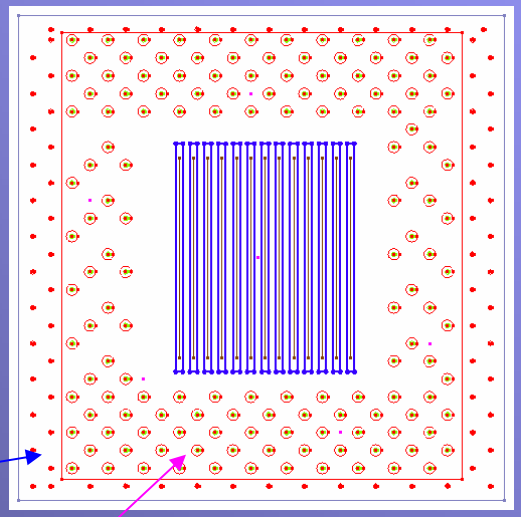
G

Ground ring

Power



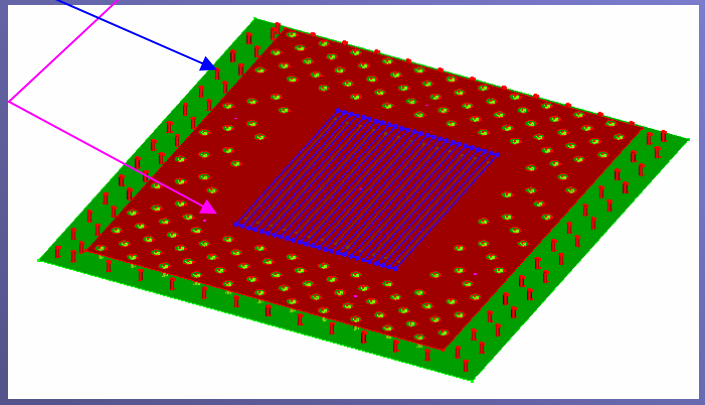
Retreated Power planes w/ and w/o Ground ring Study



Retreated Power plane without Ground ring

No Ground ring

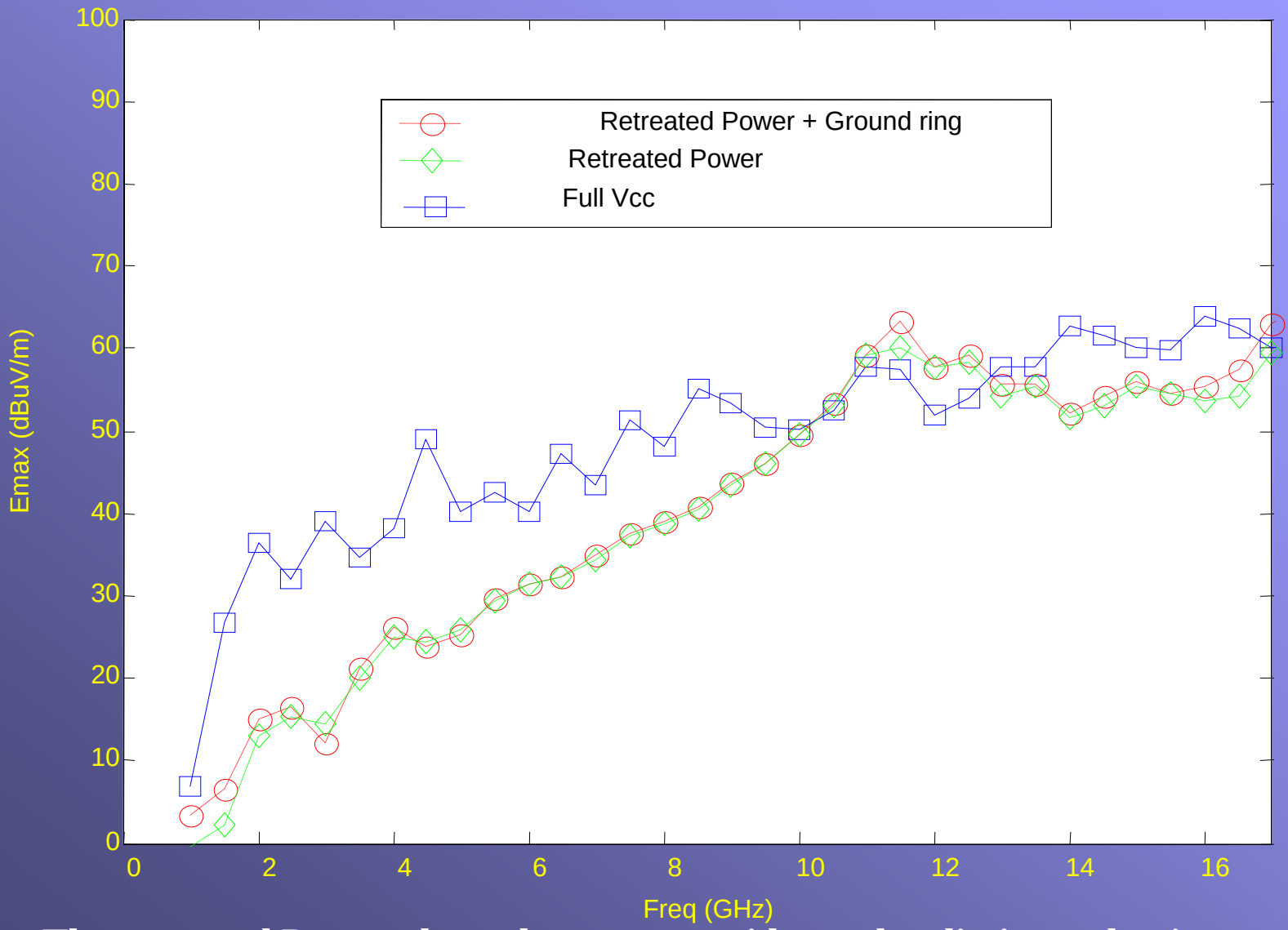
Power



p

G

Retreated Power planes w/ and w/o Ground ring Study



The retreated Power plane alone can provide good radiation reduction.

The Ground ring outside Power plane is not required

Final Design Recommendations for Package Level EMI

• Patches for microstrip lines are no needed.

• There is no need for any additional stitching vias . - The existing checkerboard power/ground design already has fully populated ground vias.

• Effectiveness of retreating power plane is dependent upon having ground via ring (instead of ground ring itself) outside the retreated power plane.

•For future high-frequency applications, the design recommendations are still valid.

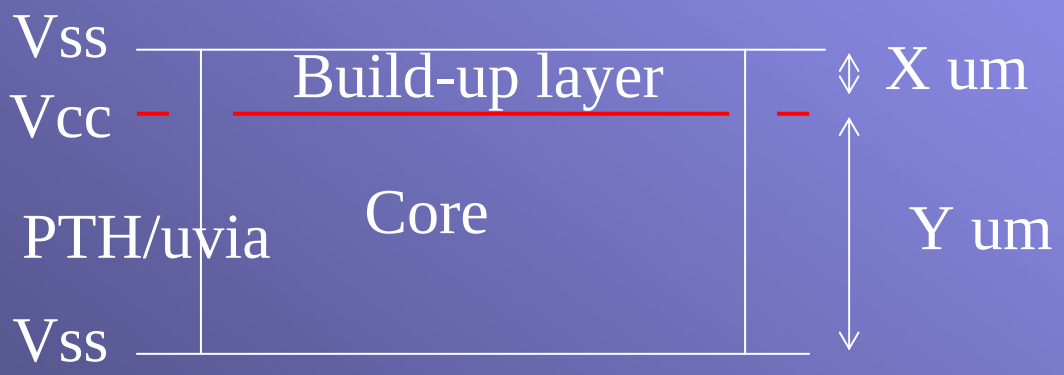
• Package level electrical analysis will focus on power delivery & signal integrity. EMI will be considered in system level.

Backup

Ground Stitching Study Case 1:

Noise sources are outside the die shadow

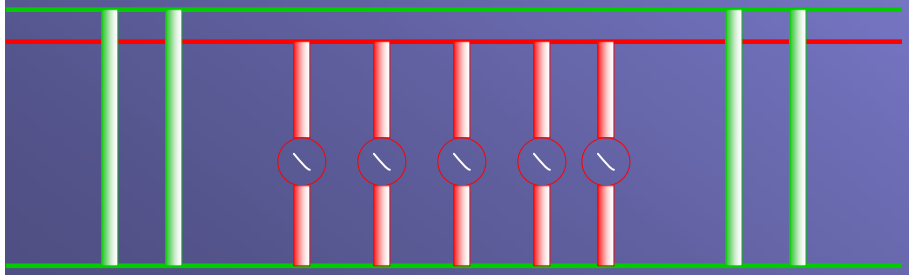
Model Stackup:



Ground Stitching Study Cases 2 & 3:

Noise sources are under the die shadow

Modeling Power ground noise
3-Layer Structure



Modeling die direct coupling
4-Layer Structure