SAND2008-3267C

Ion trap layout

Mysteries of the universe revealed

Dan Stick

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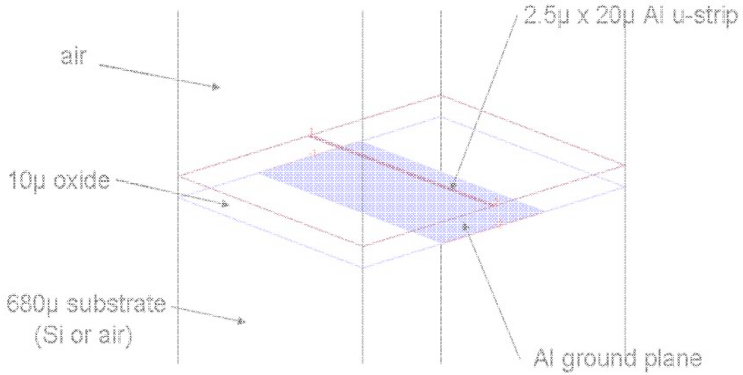
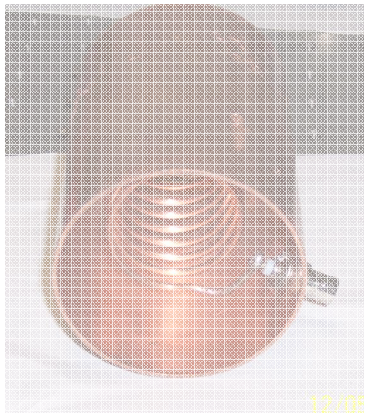
Outline

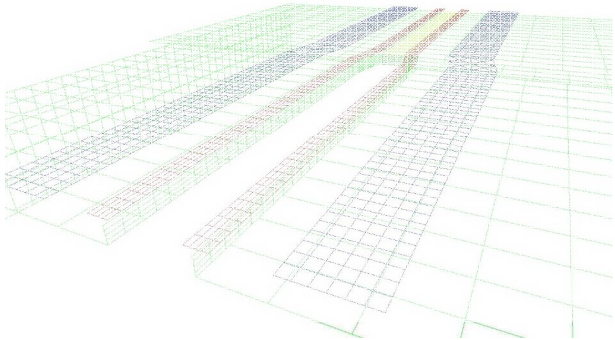
1. Capacitance & power loss



2. Power dissipation

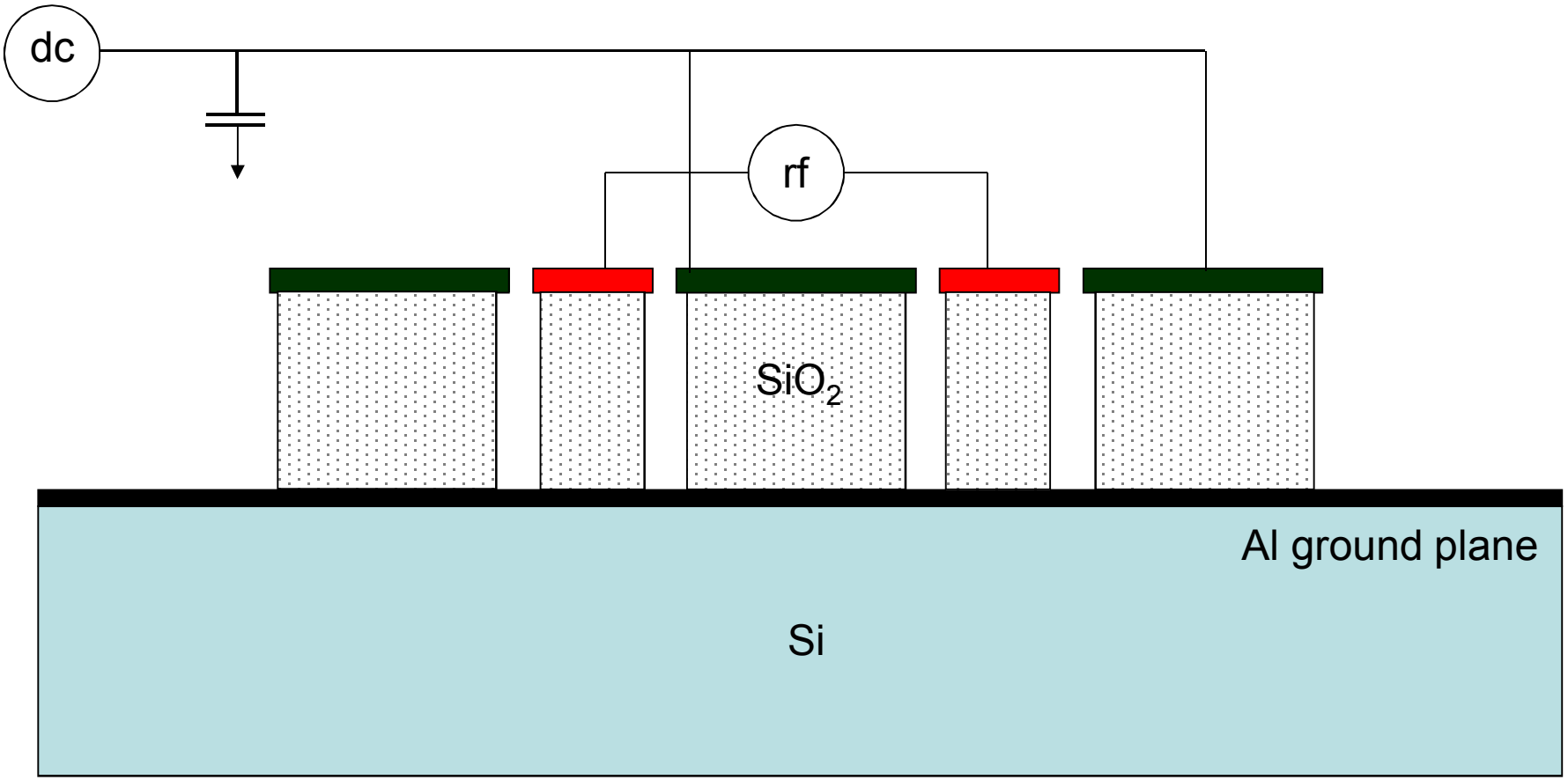


3. Loading zone shuttling

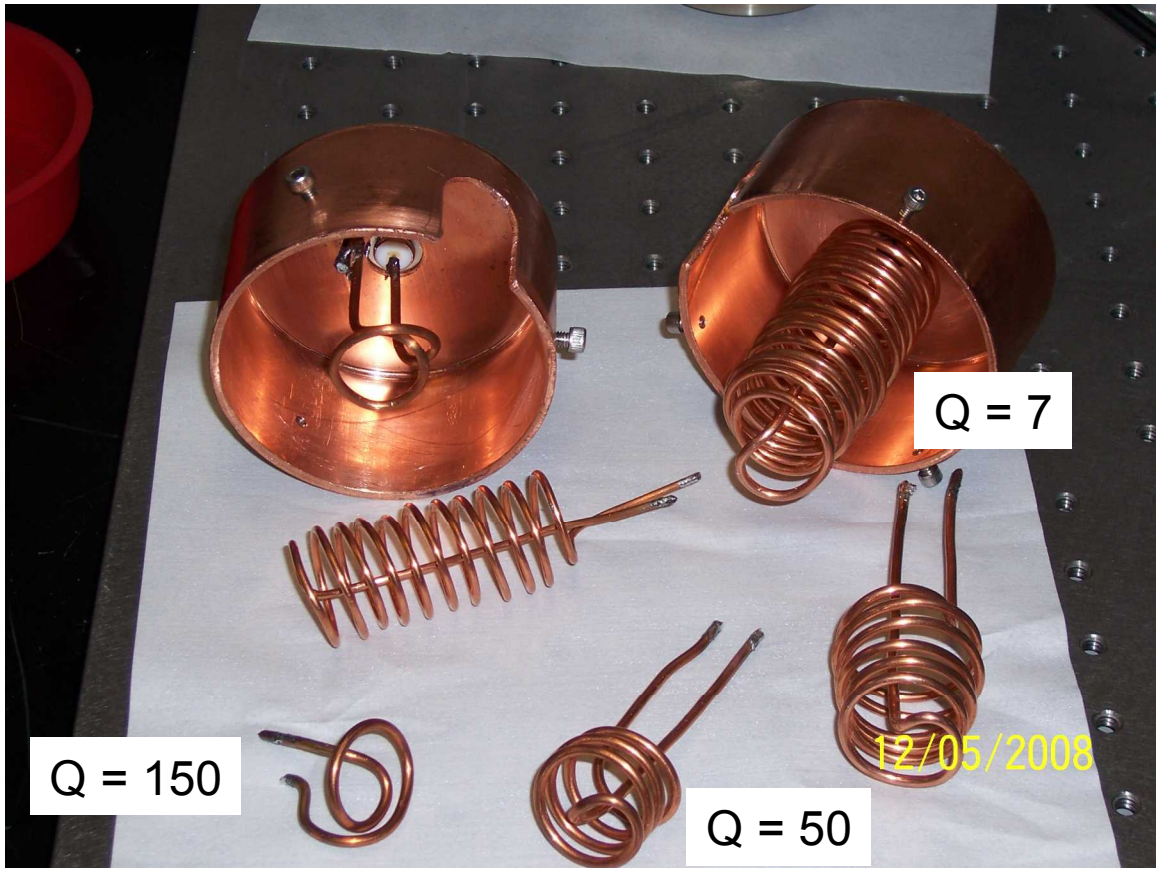


4. Discussion

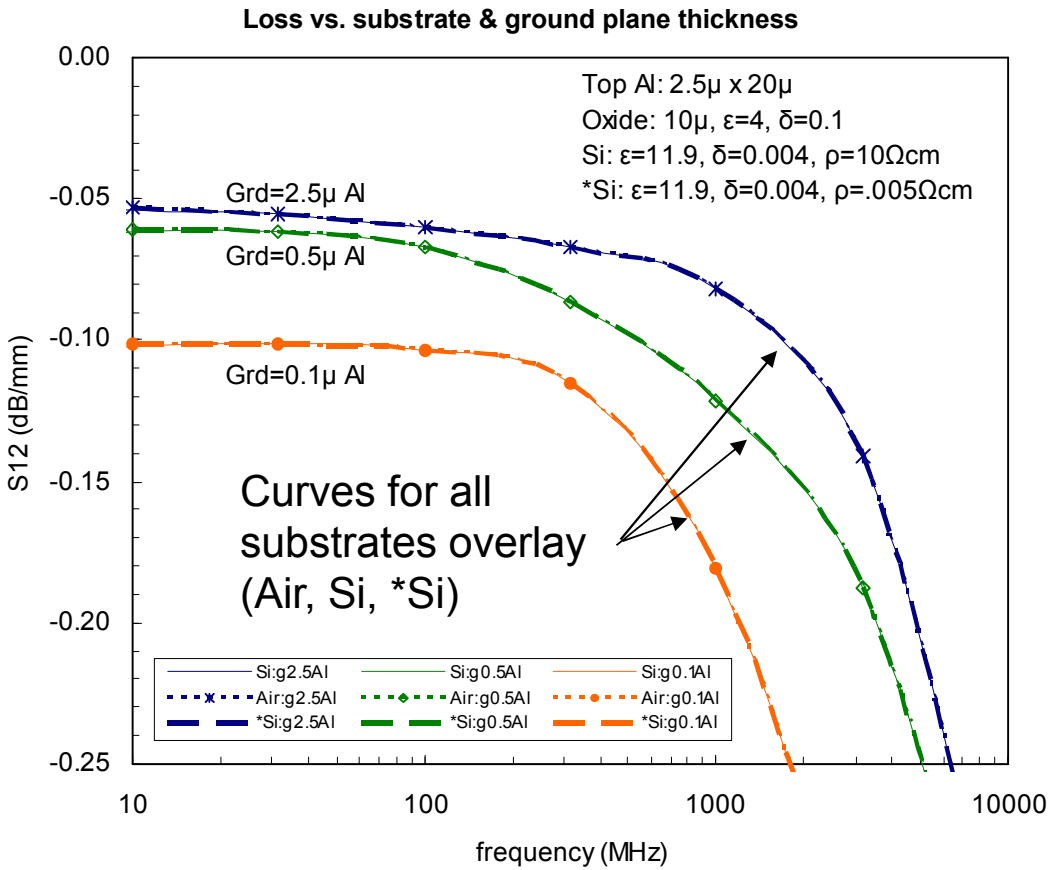
Trap geometry

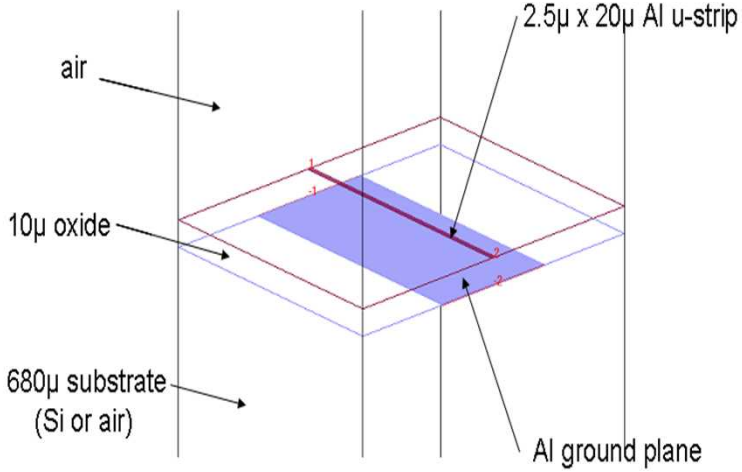


Power dissipation



Power loss vs. ground plane thickness





Conclusions:

1) The substrate under ground plane has no effect on rf losses

2) The ground plane thickness has an important effect on rf losses.

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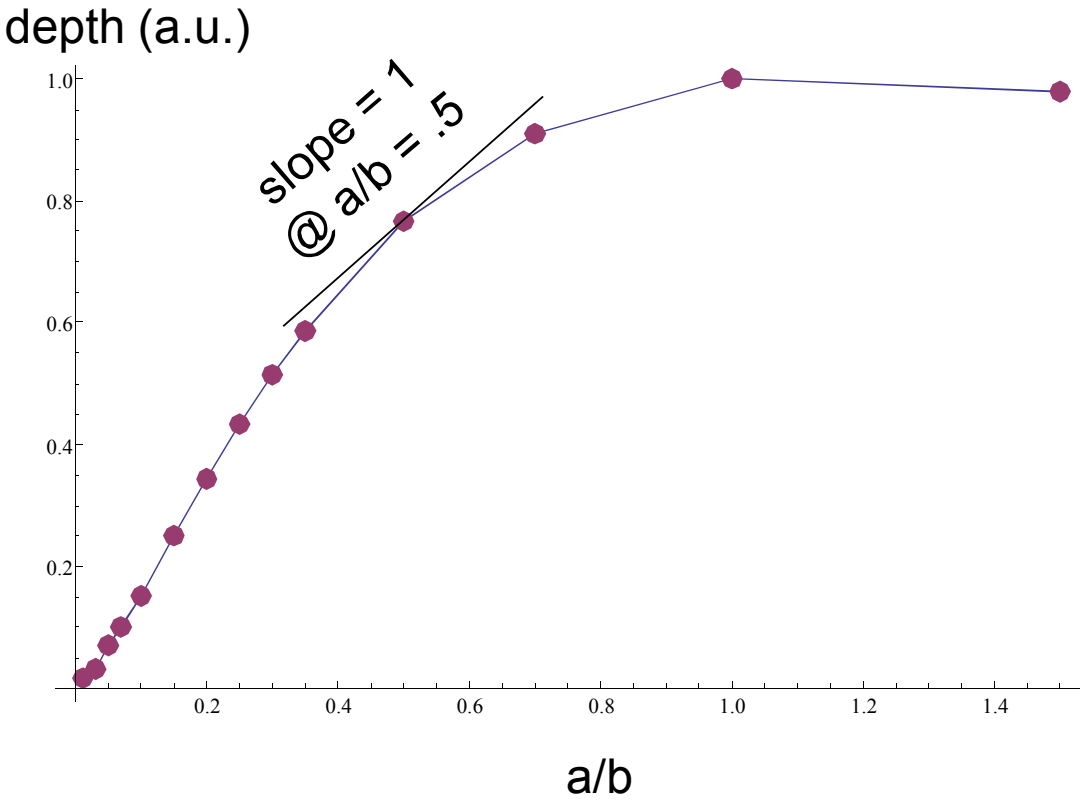
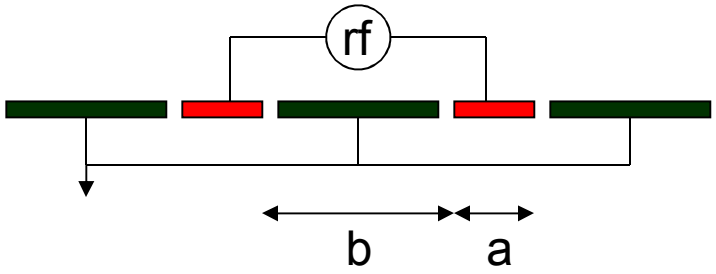
Trap depth and capacitance

For a given RF electrode separation, with all other surfaces grounded, how does the trap depth scale with the (normalized) RF electrode width?





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Increase RF width or voltage?

Metric: maximize $d\Delta/dP_{dissipated}$

$$P_{dissipated} = \frac{1}{2}\Omega^2 C^2 V^2 R$$

Width	Voltage
$w' \rightarrow \alpha\, w$	$v' \rightarrow \alpha\, v$
$P' \rightarrow \alpha\, P$	$P' \rightarrow \alpha^2\, P$
$\Delta' \rightarrow \beta(w)\, \alpha\, \Delta$	$\Delta' \rightarrow \alpha^2\, \Delta$
$d\Delta/dP = \beta(w)\, \alpha / \alpha = \beta(w)$	$d\Delta/dP = \alpha^2/\alpha^2 = 1$

→ for a/b < .5, increase RF width before voltage

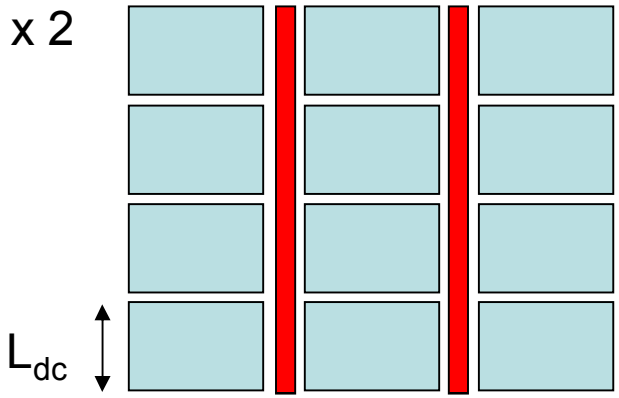
Number of trapping regions

If we limit ourselves to 5 pF of trap capacitance, how many traps can we make?

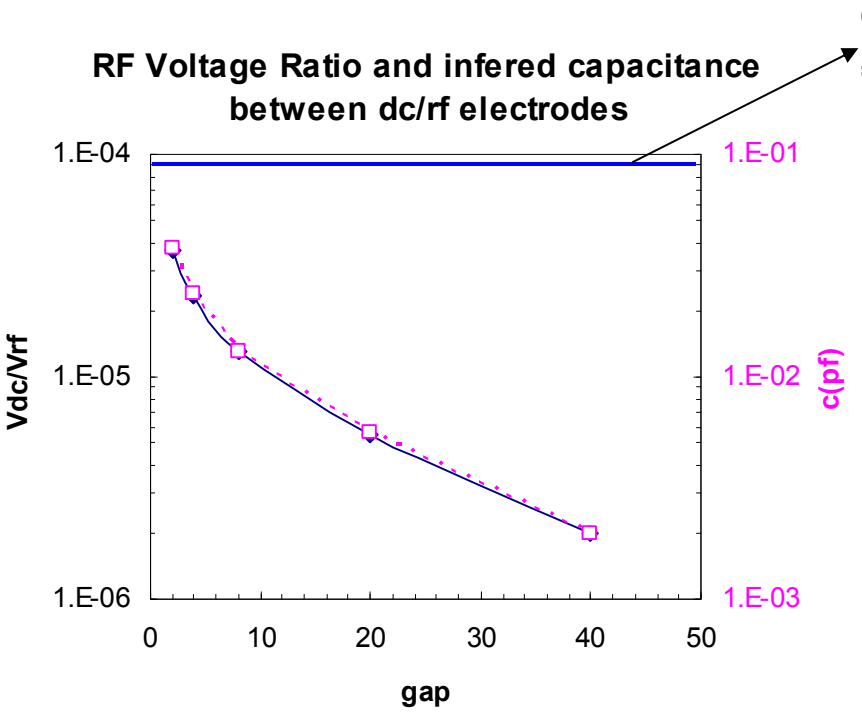
5 pF = 9 pF x 3.9 x (Lrf x 50 microns/20 microns) x 2

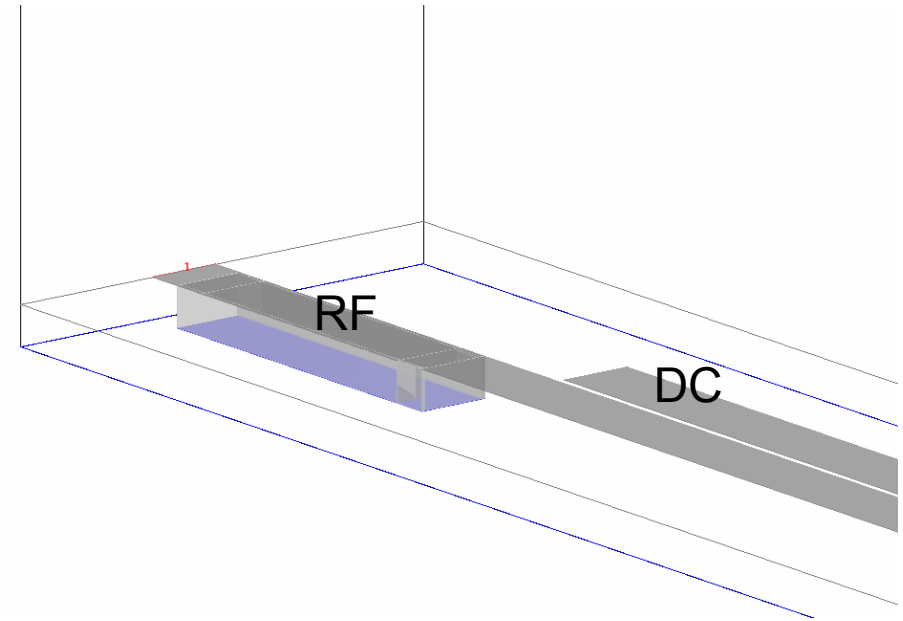
→ Lrf = 3 cm

# of traps = Lrf / Ldc = 300 dc zones



Capacitance to neighboring electrodes





Gaps between lines = 2, 4, 8, 20, 40μm

Sonnet model verified with S parameter data fit to a lumped element model – Jim Stevens

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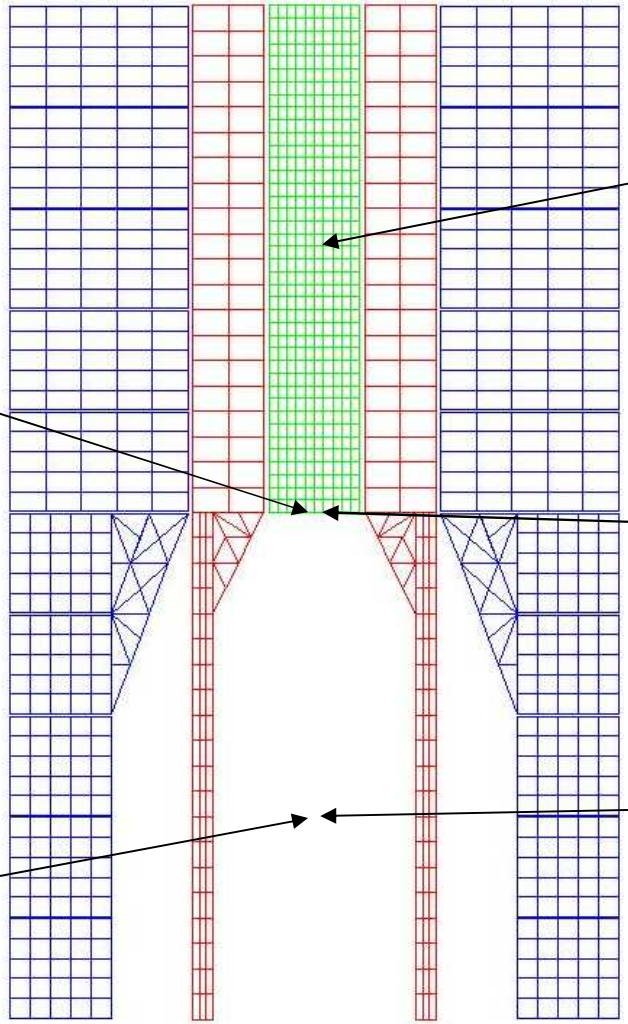
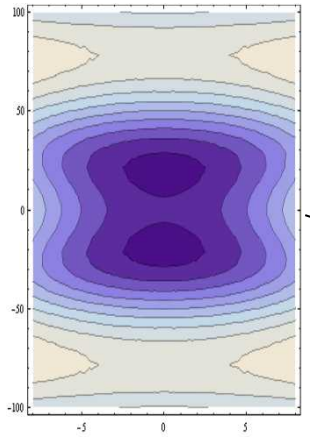
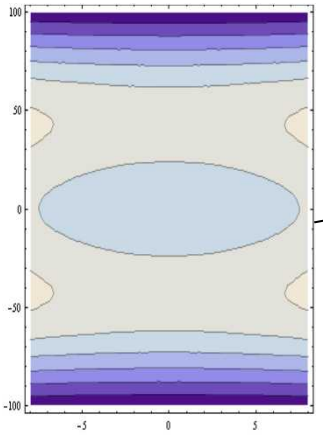
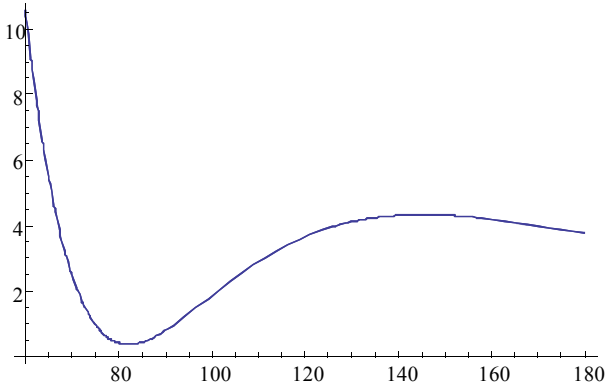
Loading zone

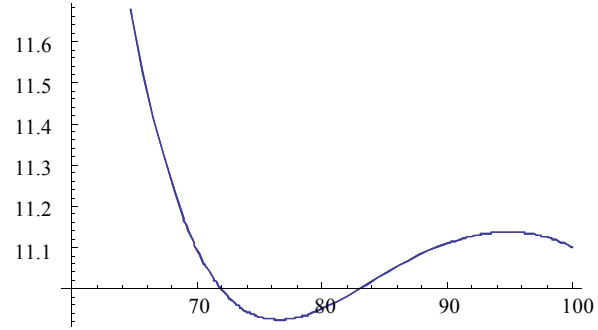
Assumptions: Be+, 200 Vrf @ 20 MHz

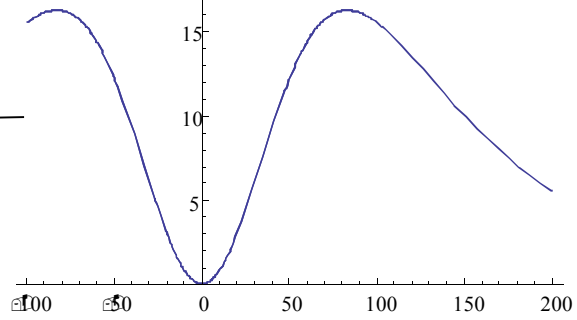












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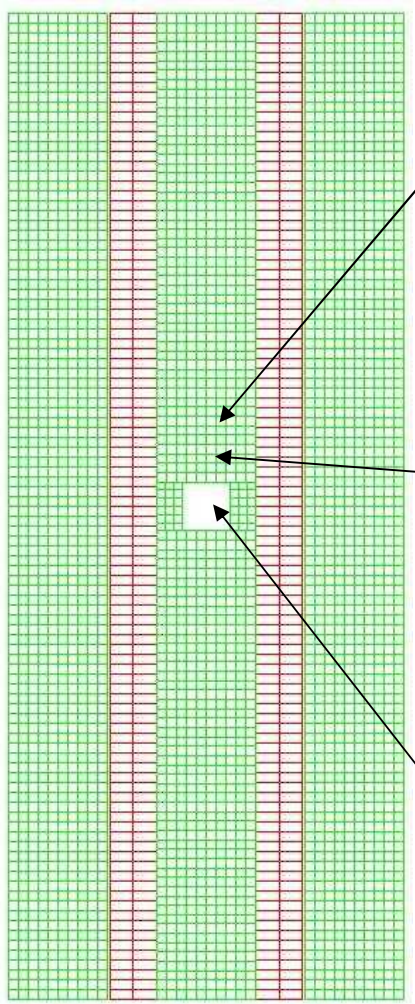
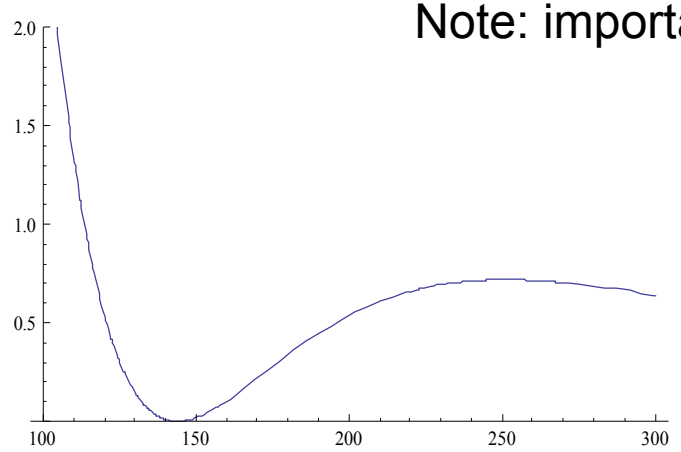
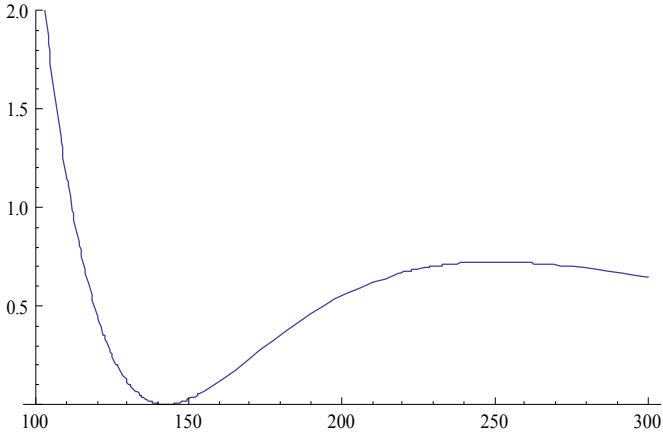
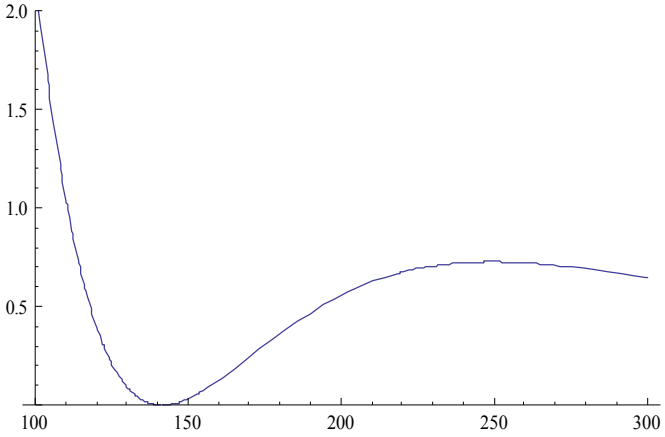
Loading zone - alternate

Note: important to ground inside of hole









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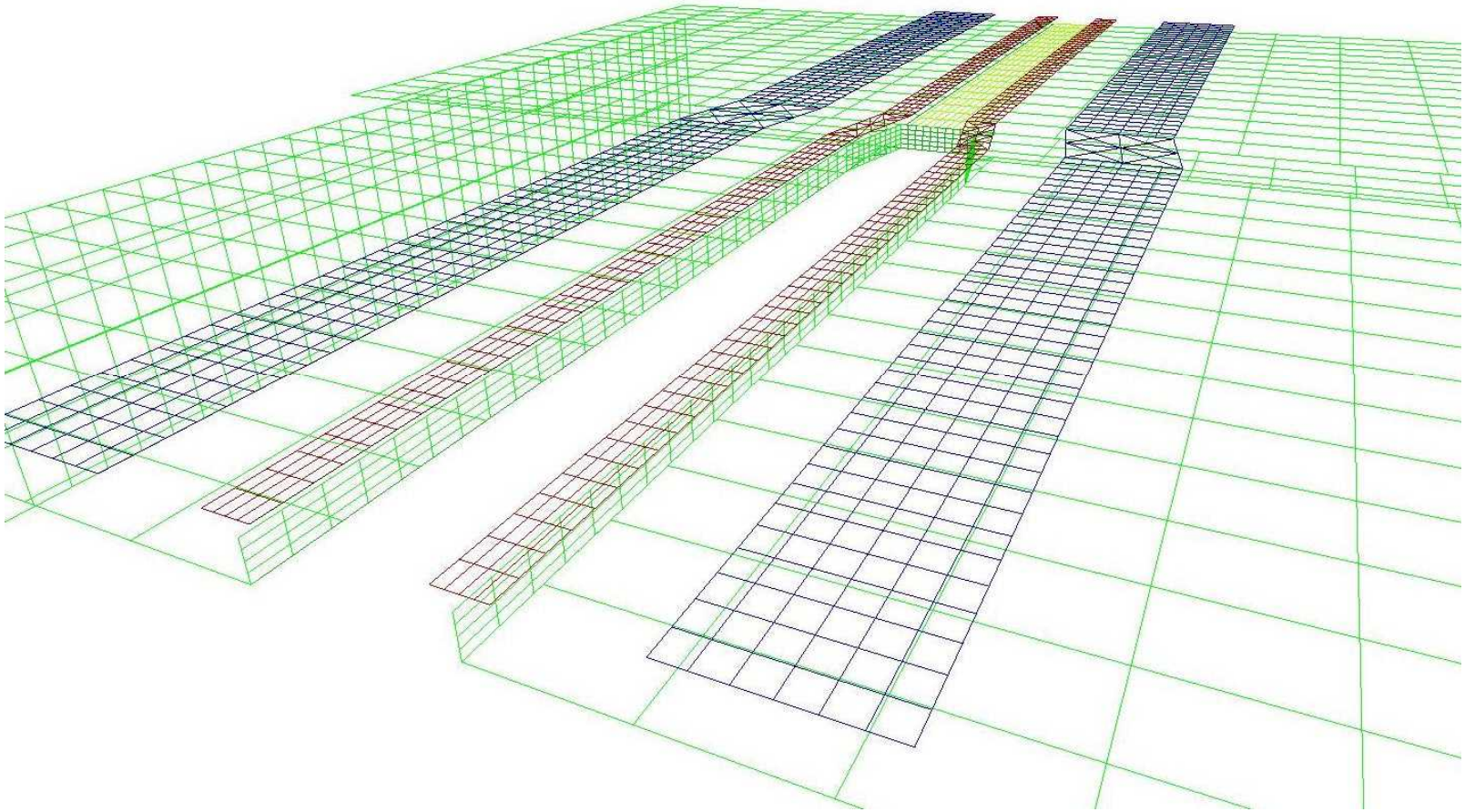
Loading zone – alternate



Discussion