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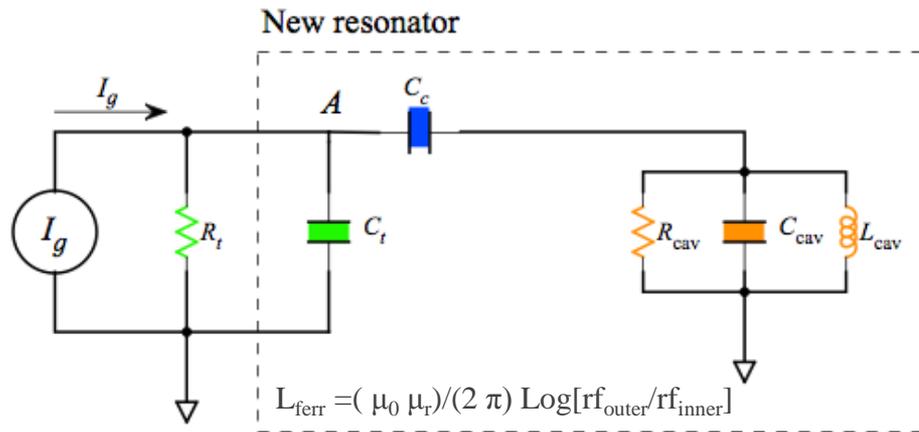
On discrepancy between transmission model and 3D CST simulations

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2nd Harmonic cavity Meeting

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Thermal losses in the transmission model



For $\mu = \mu' = 3.5$ the model gives $f = 76$ MHz (start of ramp).
 For $\tan \delta_m = \mu'' / \mu' = 0.000467$ and voltage of 100 kV the model gives instantaneous thermal losses (Tan)
 $P = 62.5$ kW.

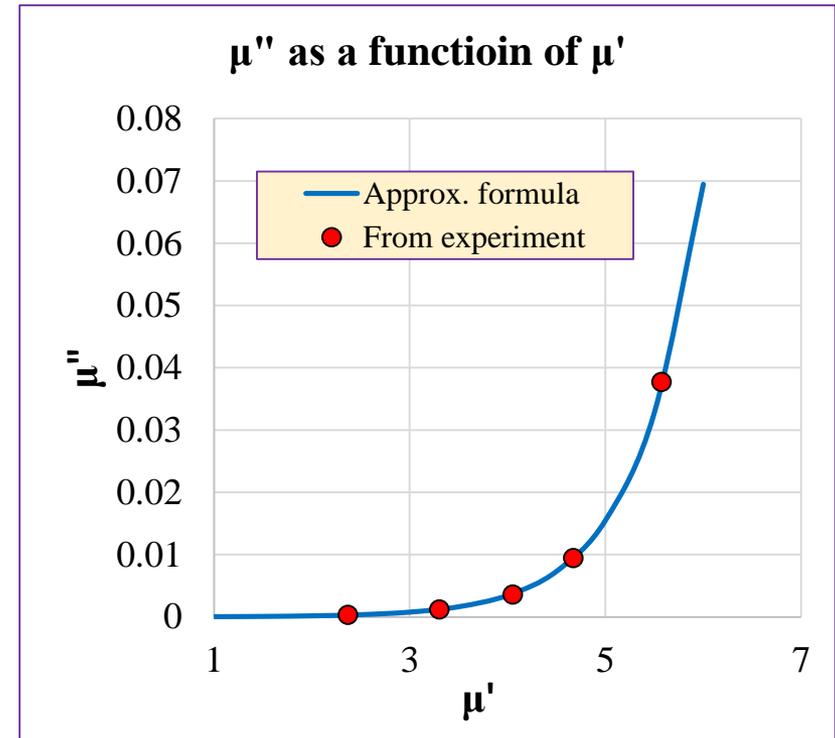
According to the 3D simulations the instantaneous thermal losses at the start of ramp are

$$P_{total} = P_{ferrite} + P_{copper} = 12 \text{ kW} + 9 \text{ kW} = 21 \text{ kW}$$

This is a big discrepancy.

A primary suspect responsible for that is non-uniformity of fields.

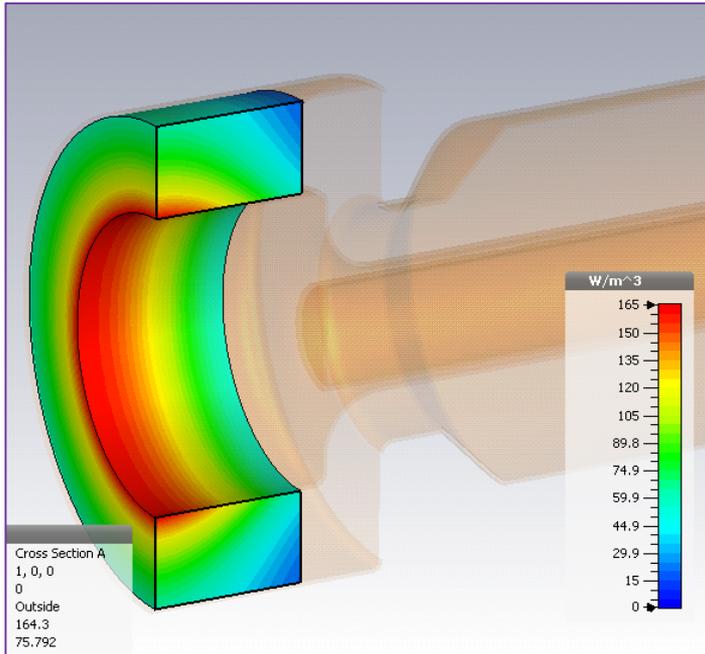
From 16April2015_2nd_Harm.ppt



Here μ'' and μ' are **average** over garnet volume, i.e. the field non-uniformity in the so called “Thin plate” set-up is not taken into account properly.

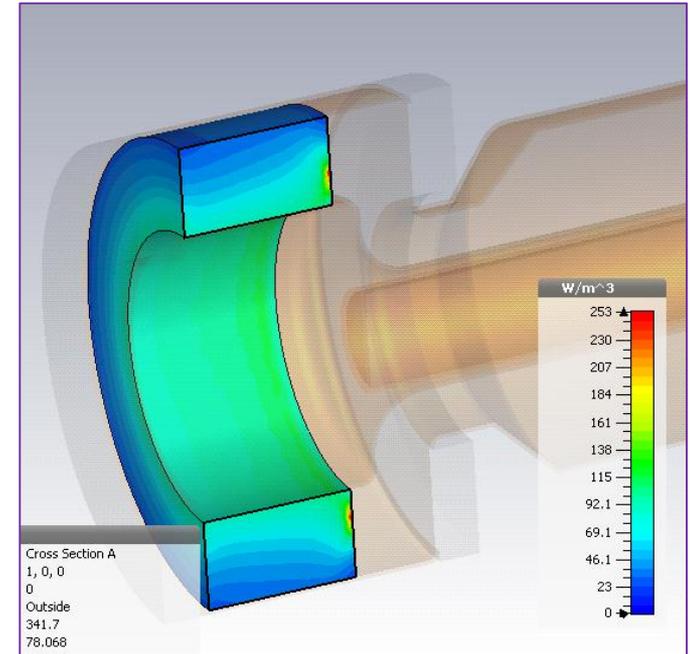
Thermal losses in 3D model

Garnet with fixed parameters $\mu' = 3.5$, $\tan\delta_e = 0.0001$ and $\tan\delta_m = 0.000467$. Equivalent to transmission model



$F = 75.792 \text{ MHz}$
 $P_{\text{ferrite}} = 67 \text{ kW}$
 $P_{\text{copper}} = 9 \text{ kW}$
 $P_{\text{total}} = 78 \text{ kW}$

Garnet with parameters obtained from “thin plate” experiment. $H_{\text{ext}} = 35000 \text{ A/m}$. $dH = 3.88 \text{ Oe}$.



$F = 78.07 \text{ MHz}$
 $P_{\text{ferrite}} = 10.6 \text{ kW}$
 $P_{\text{copper}} = 9 \text{ kW}$
 $P_{\text{total}} = 19.6 \text{ kW}$

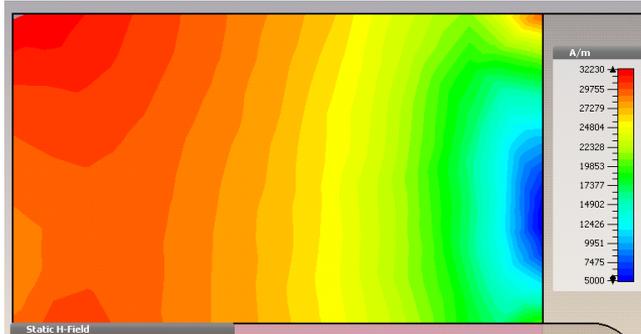
Loss density

$$P = 2\pi f \mu_0 \mu'' |\mathbf{H}|^2 \left[\text{W/m}^3 \right]$$

Quite different loss density distribution presumes different total losses. But difference is too big to be explained by non- uniformity only. An additional factor is material properties obtained by averaging from “thin plate” experiment.

Impact of non-uniformity

$H_{\text{ext}} = 32926$ gives $F = 75.9$ MHz. $\Delta H = ?$ Let's assume it's 30 Oe, then $P_{\text{total}} = 40$ kW.



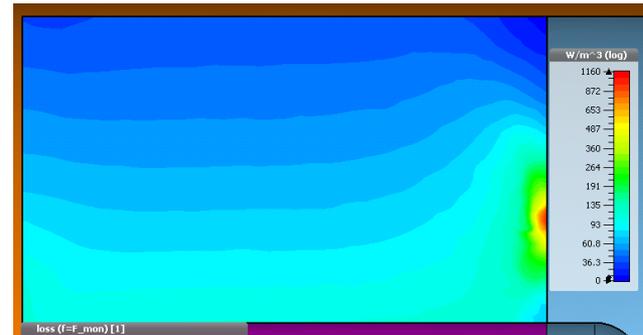
H bias internal, 5- 32.5 kA/m



Distribution of μ' , 2-19, average 3.6 (!)



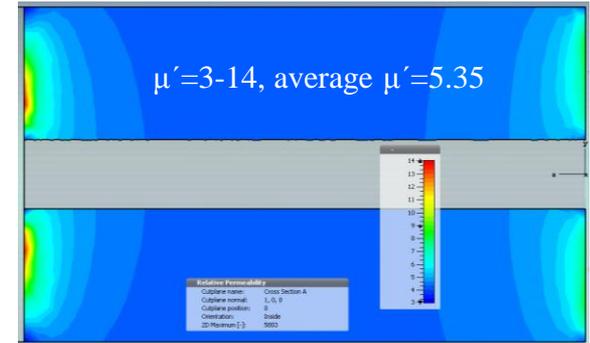
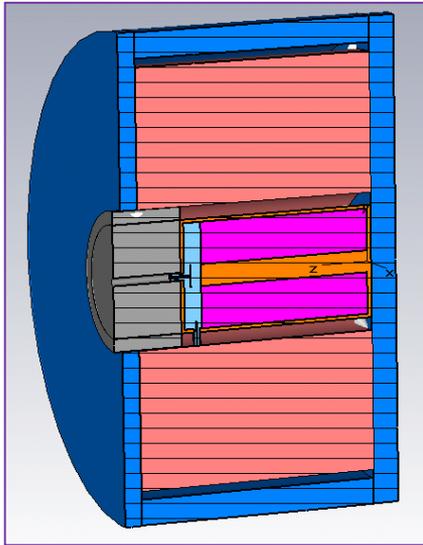
H_{rf} . This distribution defines loss density in case of constant μ' .



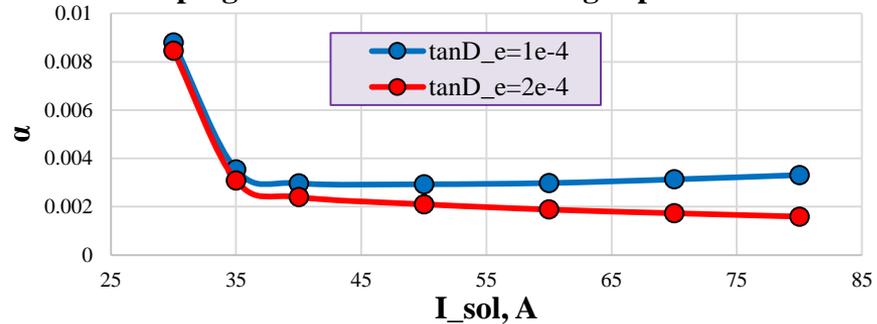
Loss density distribution, 20-1160 W/m³.
Distribution of μ' dominates.

New material parameters

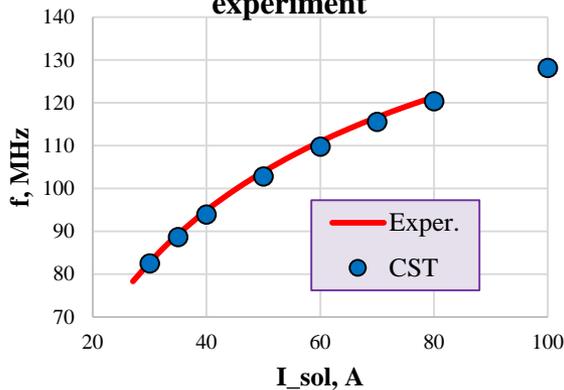
$I_{sol} = 30 \text{ A}$, $F = 82.48 \text{ MHz}$.



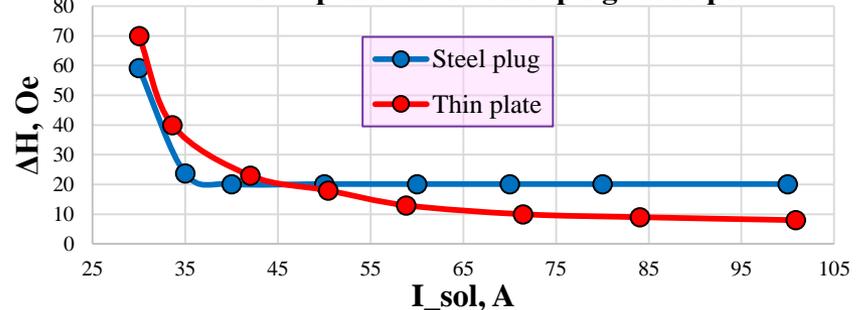
Damping coefficient from SteelPlug experiment



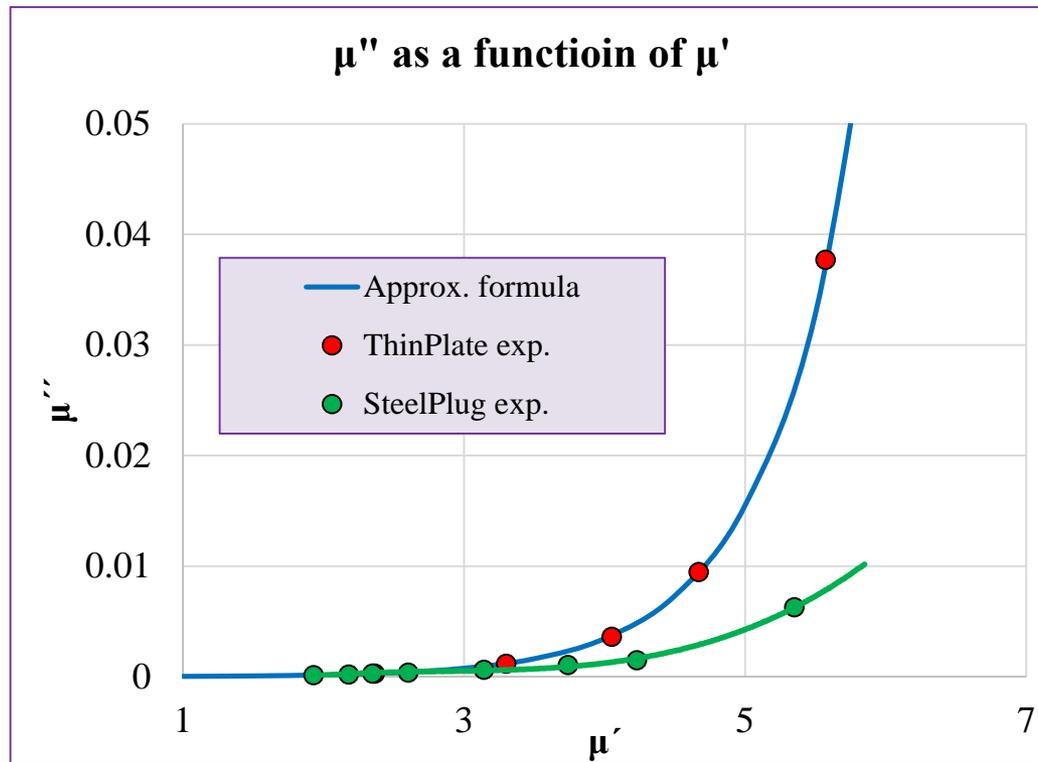
Tuning curve in SteelPlug experiment



ΔH from "thin plate" and "steel plug" set ups



Average μ'' as a function of average μ'



Which is right? Both are right being applied to the particular set-up.