2nd harmonic Booster cavity. Thermal analyses.

April 16, 2015

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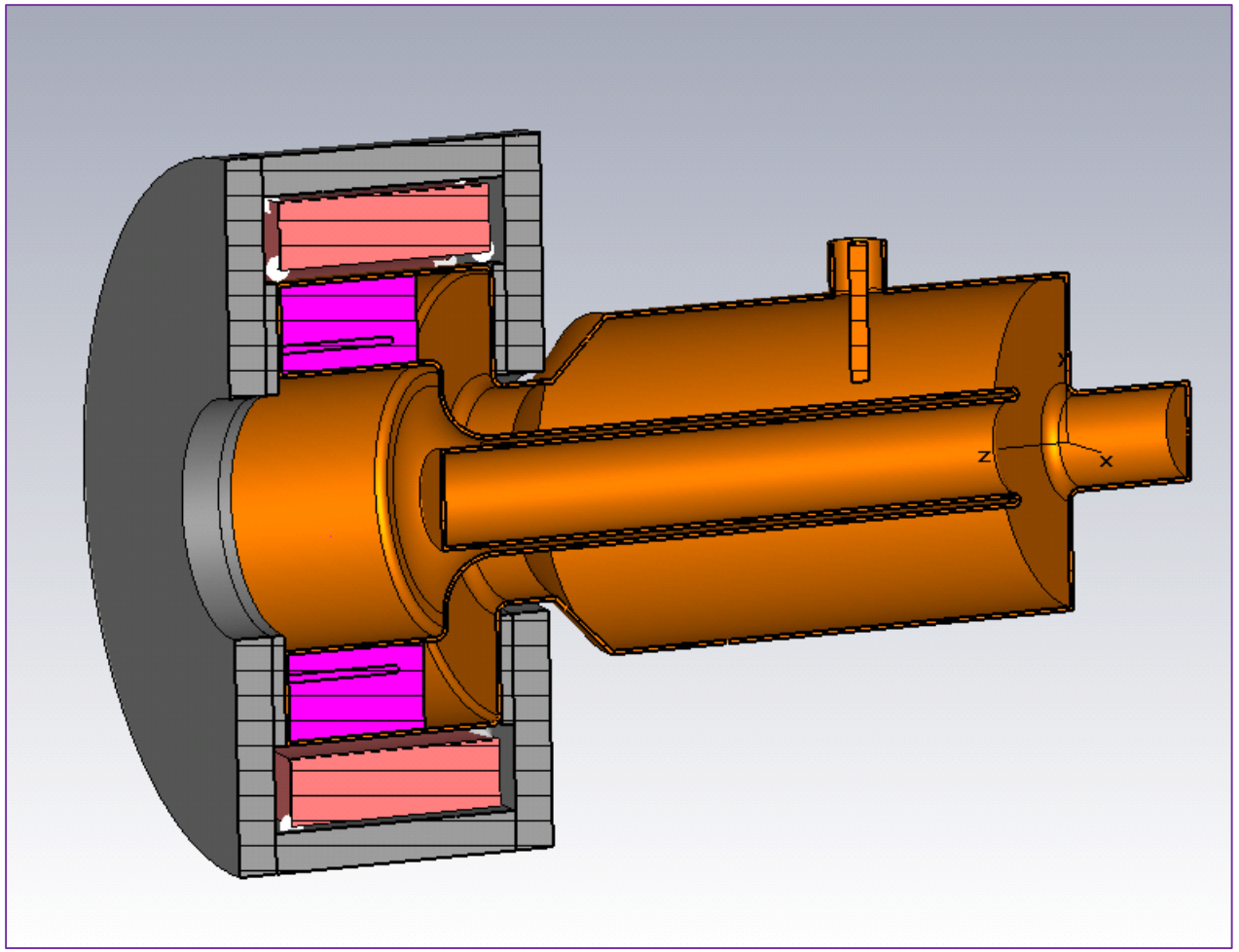
Current basic design



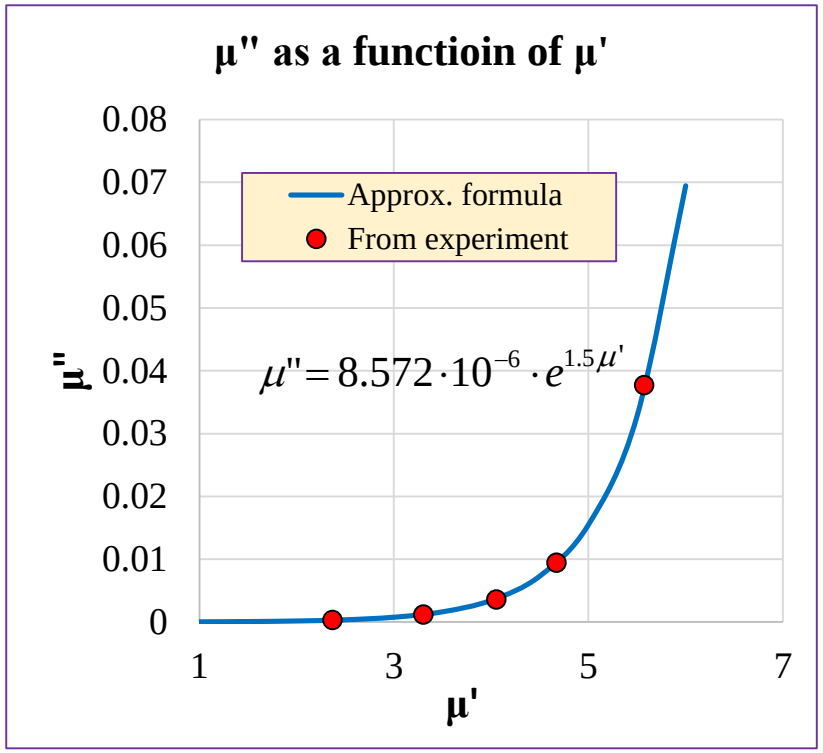
Changes and corrections:

- Tapering now is included in basic design for more uniform bias field. Also it allows simplifying of simulations (will be explained).
- Gaps between cavity walls and yoke are closed
- Cooling cylinder is removed from the design until final thermal simulations confirm its necessity.
- Garnet B(H) curve from experiments (name is Al800_exp_4 in CST material library) will be used.
- Garnet $\tan\delta_m$ from experiment will be used.
- Garnet $\tan\delta_e = 0.0001$ assumed (larger value does not agree with experiment)

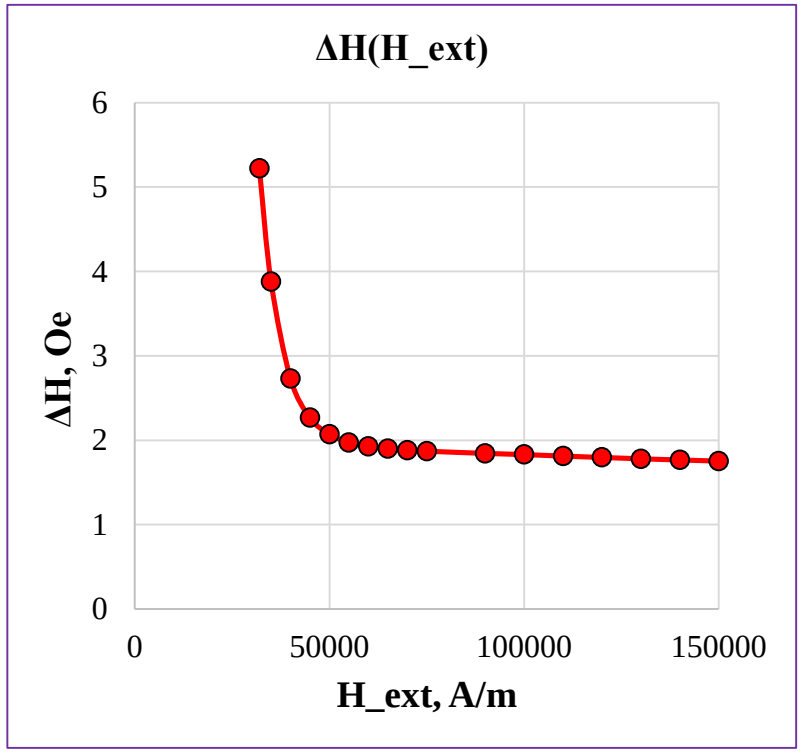
Taking into account experimental losses

The function ΔH(H_ext) was defined from experimental μ”(μ’). It was defined at f = 9.4 GHz for convenience, i.e. to have it comparable with previous simulations, but actually it doesn’t matter since damping coefficient α ~ ΔH /f).

Experiment



Dispersive model built in CST

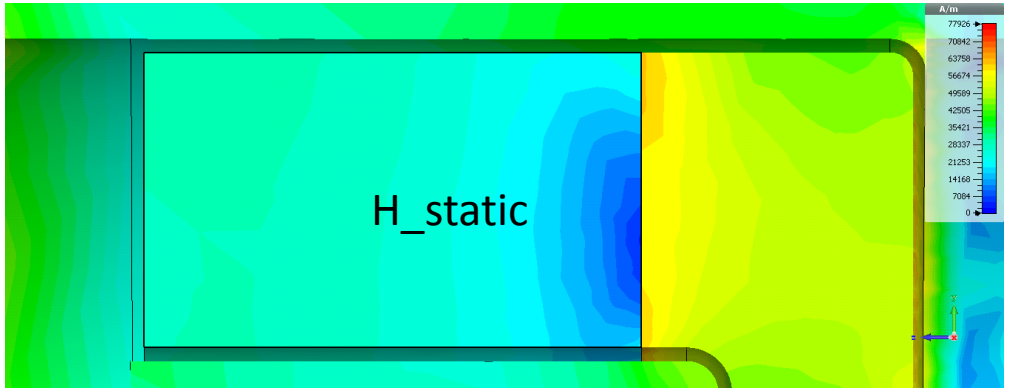


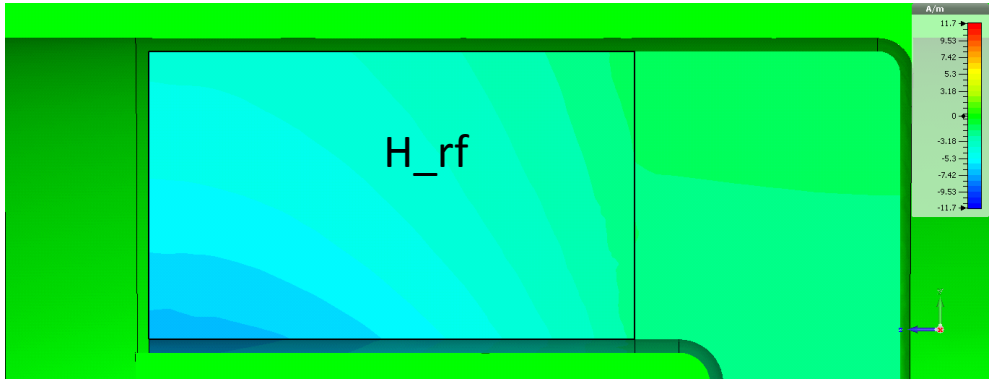
1. H_ext is set in the model
2. FD problem is solved to find resonance frequency F
3. μ’ corresponding H_ext and F is extracted from the dispersive model of the garnet.
4. μ” is defined from experimental curve and assigned to the garnet.
5. FD problem is solved again to obtain losses for given μ”

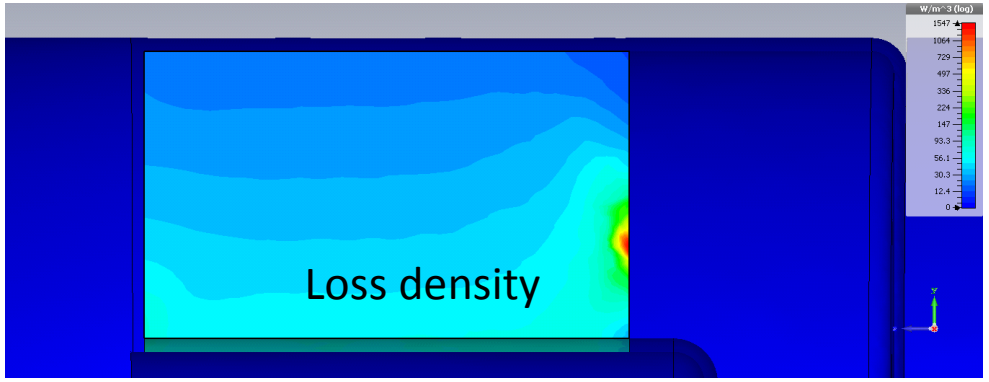
In this approach μ“ and μ‘ are **average** over garnet volume, i.e. the field non-uniformity is not taken into account properly. Hopefully will be fixed in future with a help of 2D COMSOL simulations.

Extreme field distributions

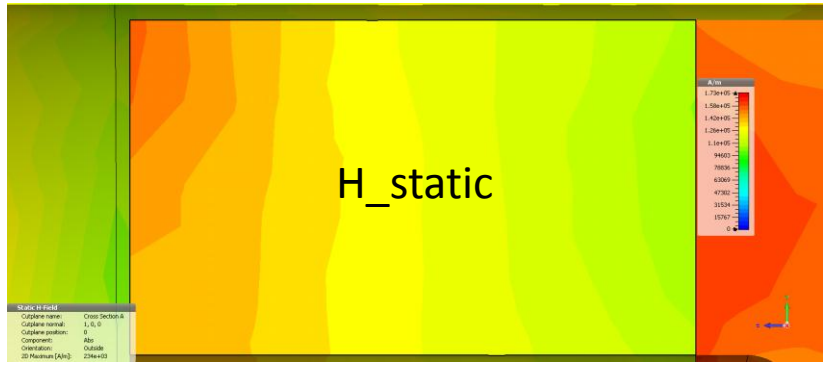
H_ext=32 kA/m, F=75.6 MHz

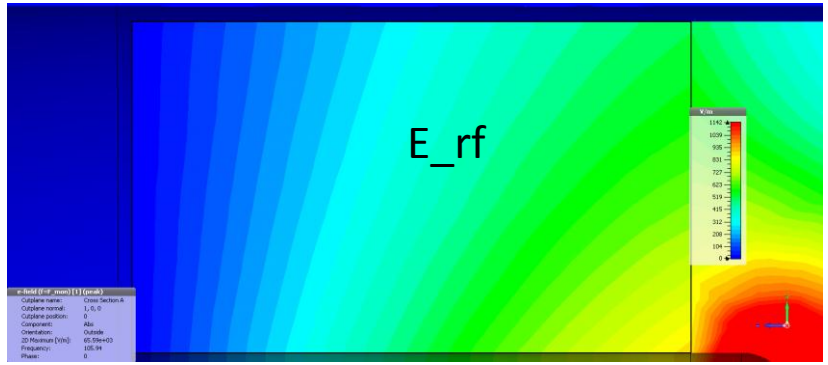


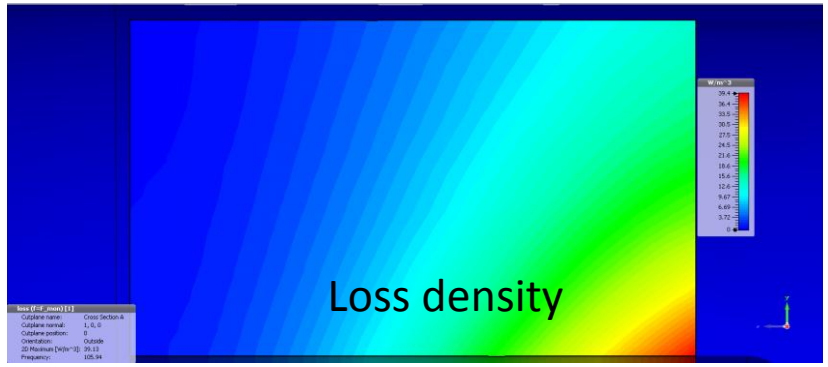




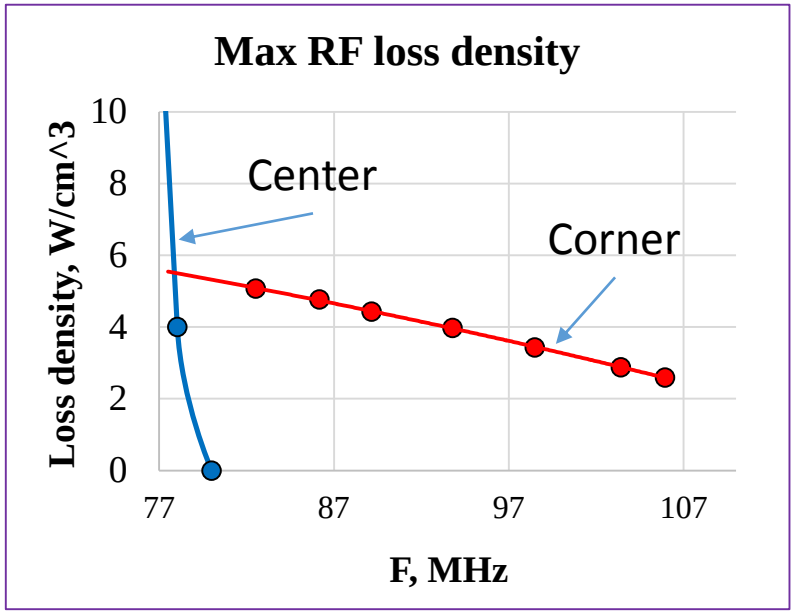
H_ext=120 kA/m, F=105.9 MHz



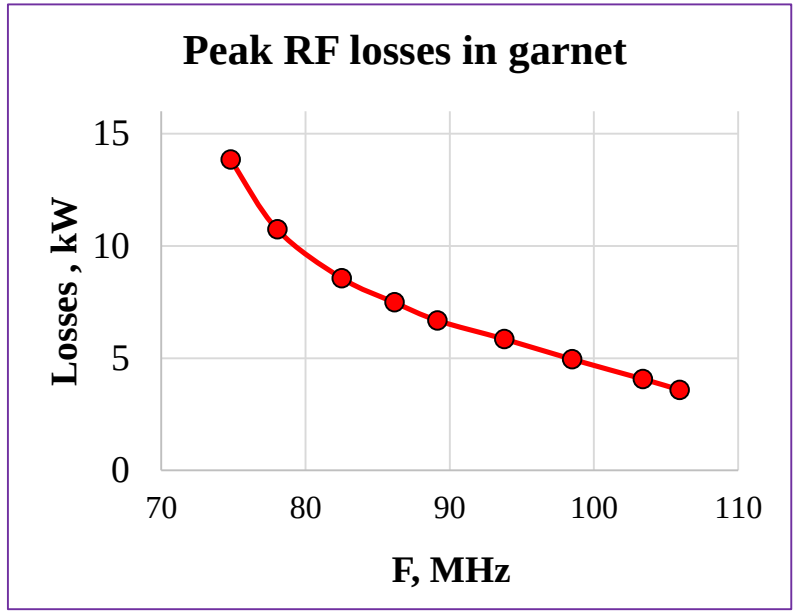


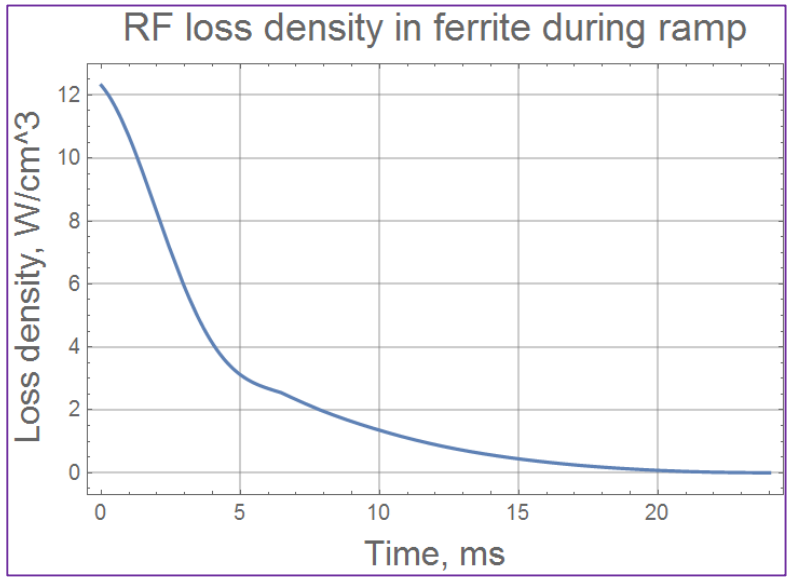


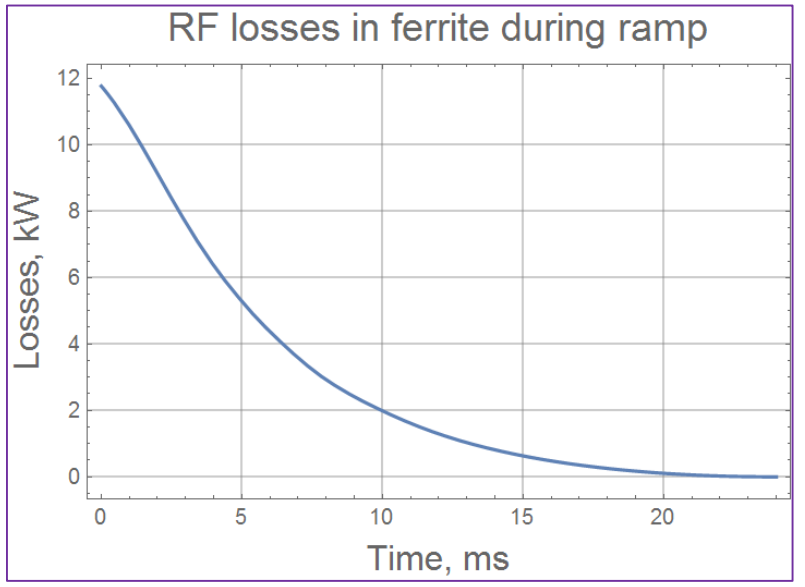
RF losses



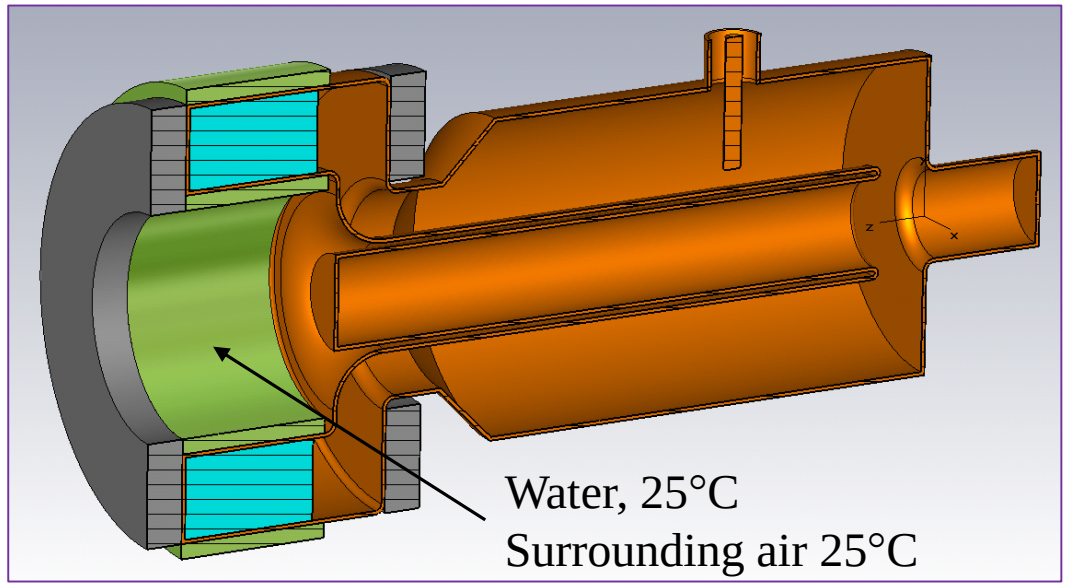
Thermal losses and average max loss density in the garnet		
V_eff, kV	P_losses, kW	Loss density, W/cm^3
100	1	0.8
125	1.56	1.23

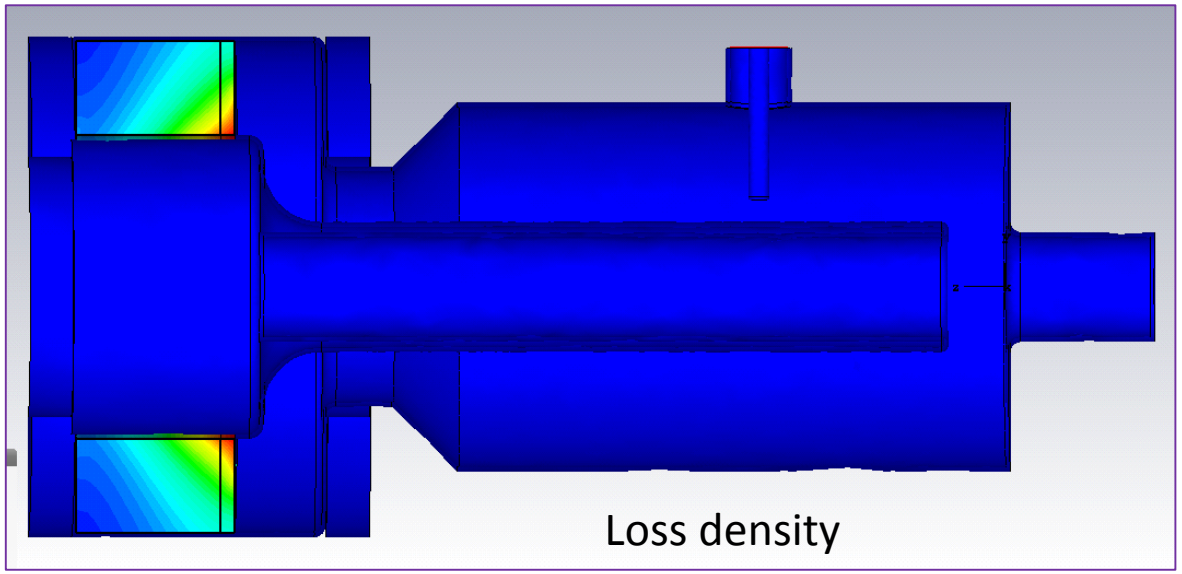






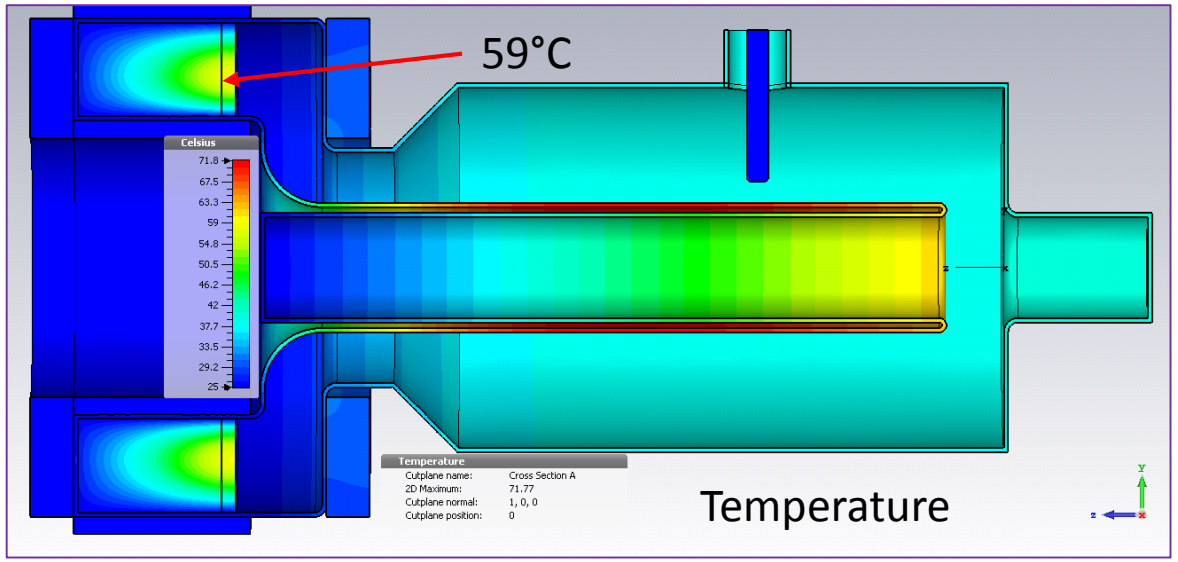
Thermal model and thermal analyses





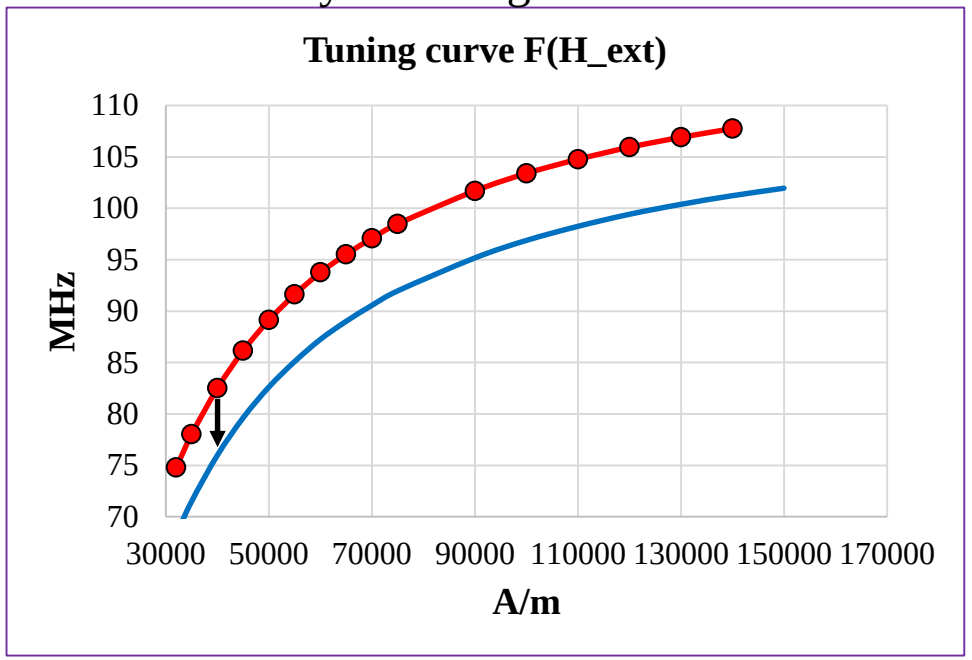
Loss density distribution is fixed as it is at 82.5 MHz

Losses in ferrite of 1.56 kW (1.7 kW total)

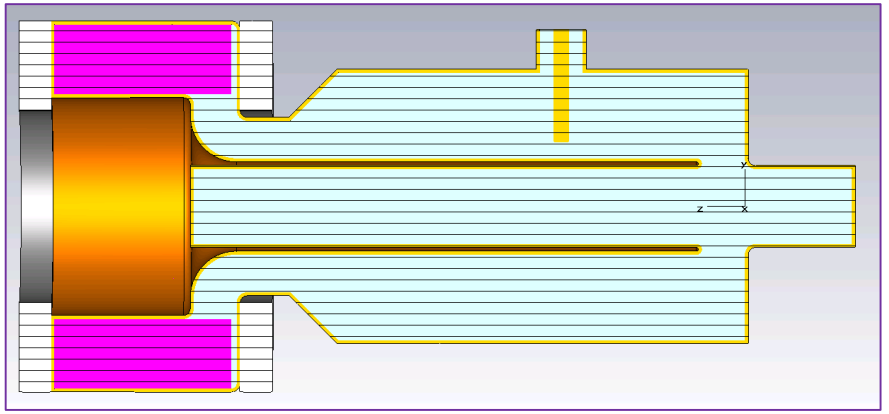


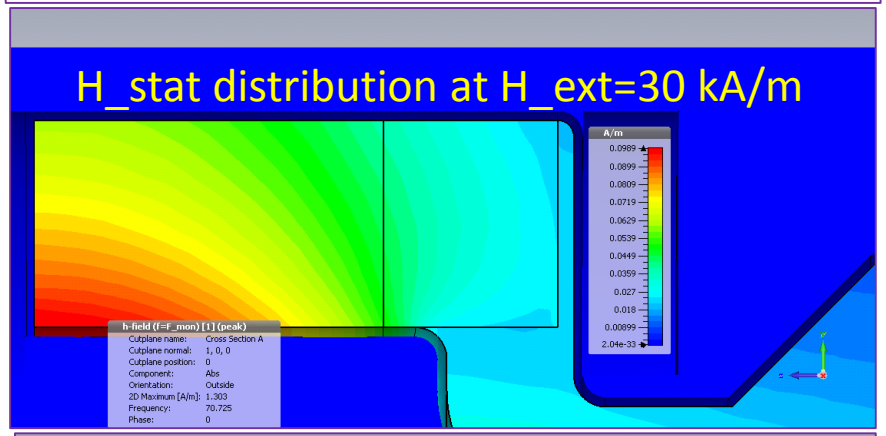
Ridding of the resonance

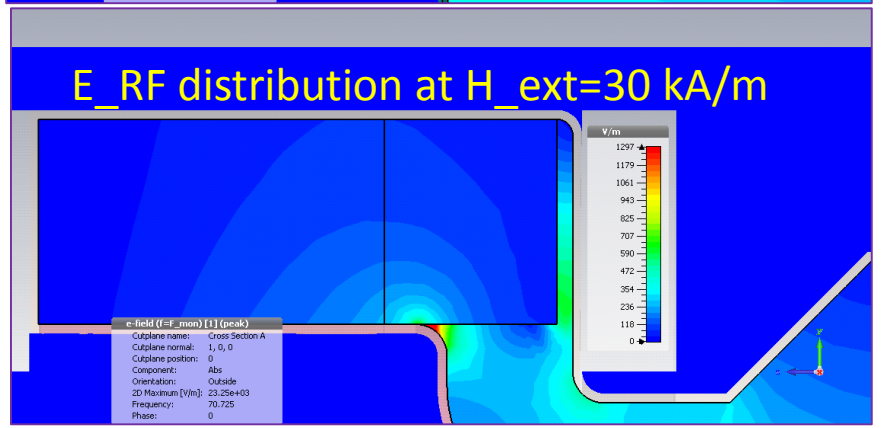
Cavity re-tuning

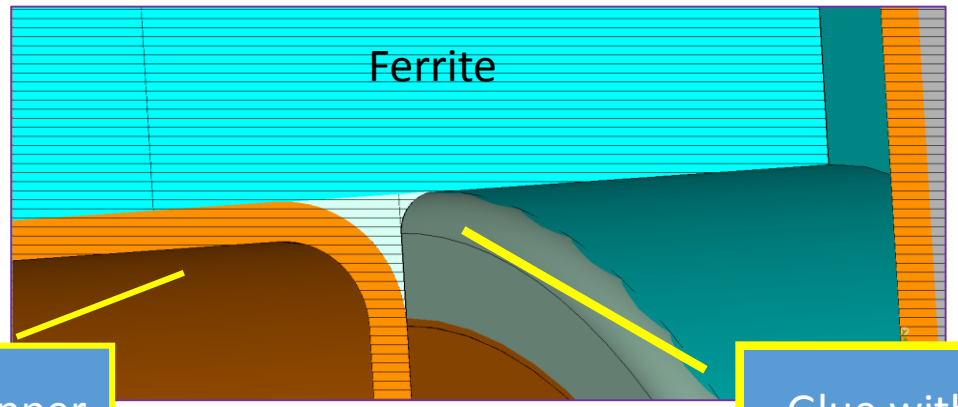


Filling the gap









Copper

Glue with ε ≈ 14