An Overview of

Resonance Frequency Deviation in the FDM Readout
LT-Spice

Amin Aminaei, 31 January 2022

REF: Presentation:

Analysis of currents open loop, closed loop, NWA via AC bias, NWA via FB, By: G. de Lange, 2019

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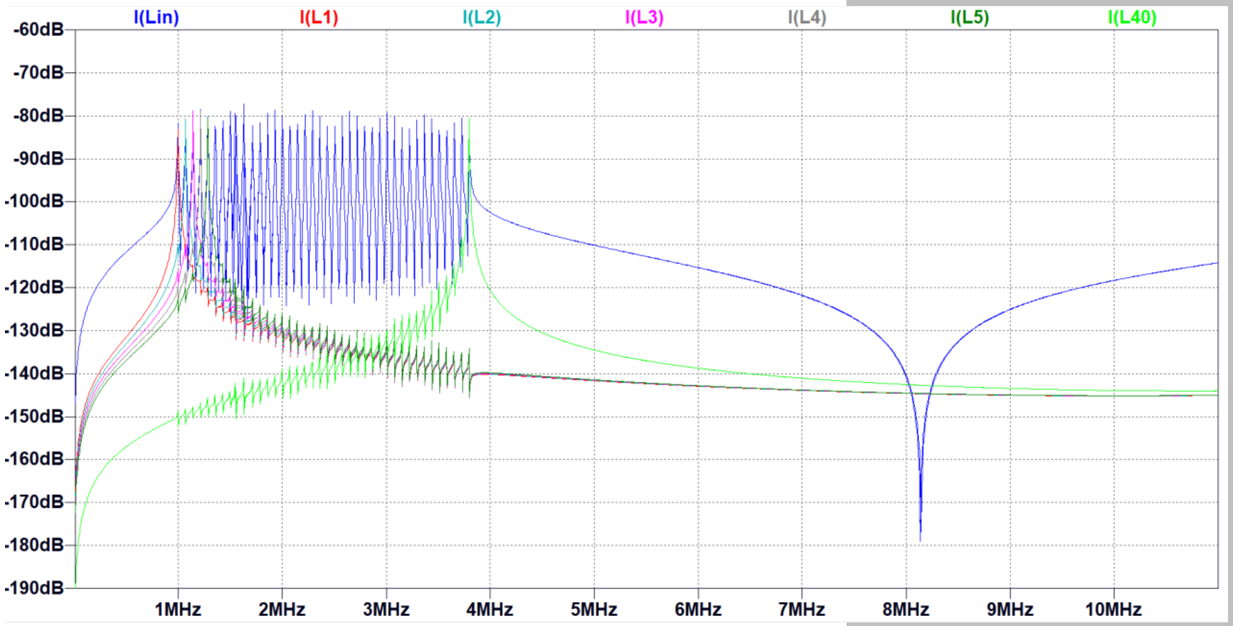
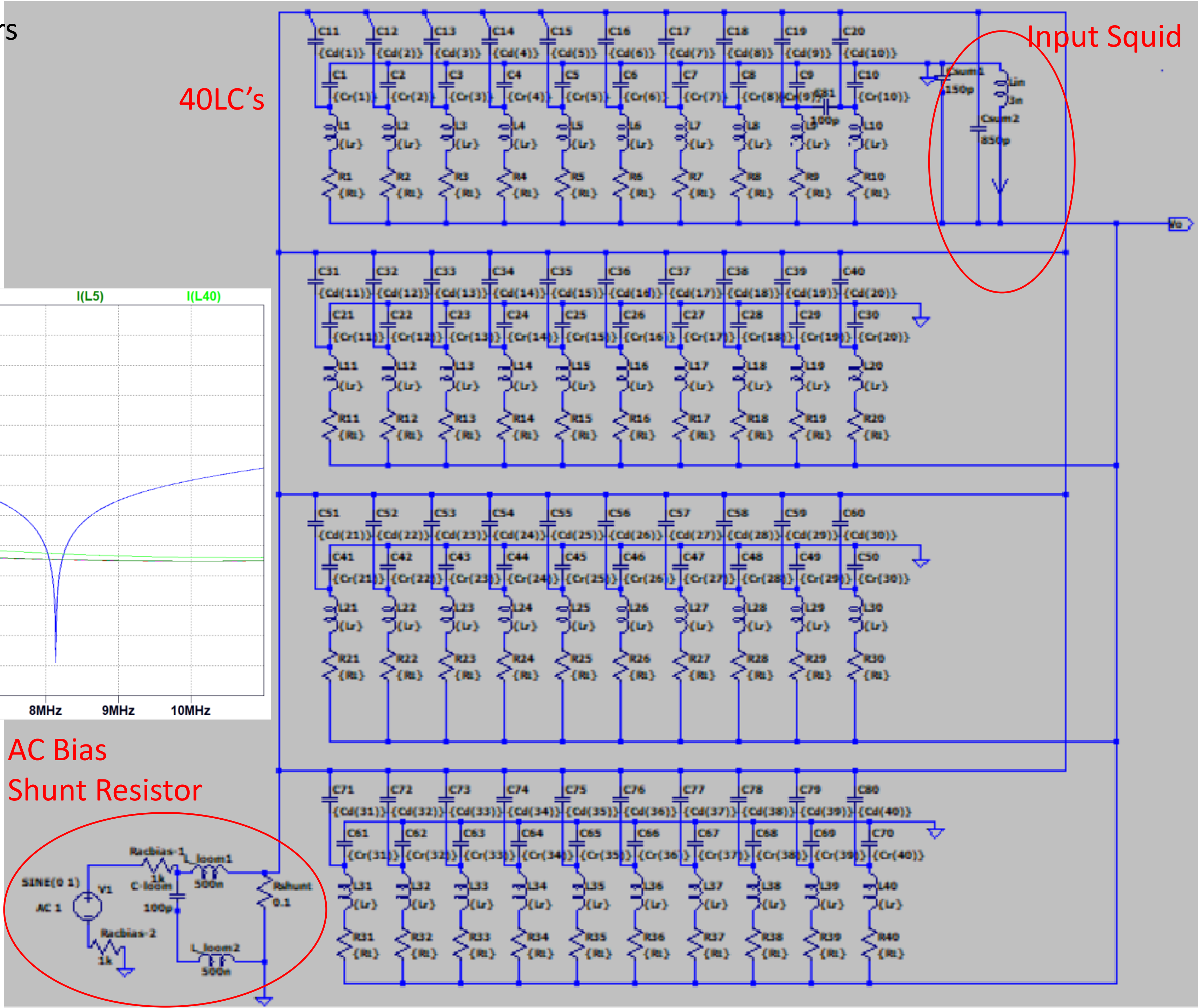
Simulation of an FDM with 40 LC resonators

I(Lin)=SUM[I(L1)+I(L2)+..+I(L40)]



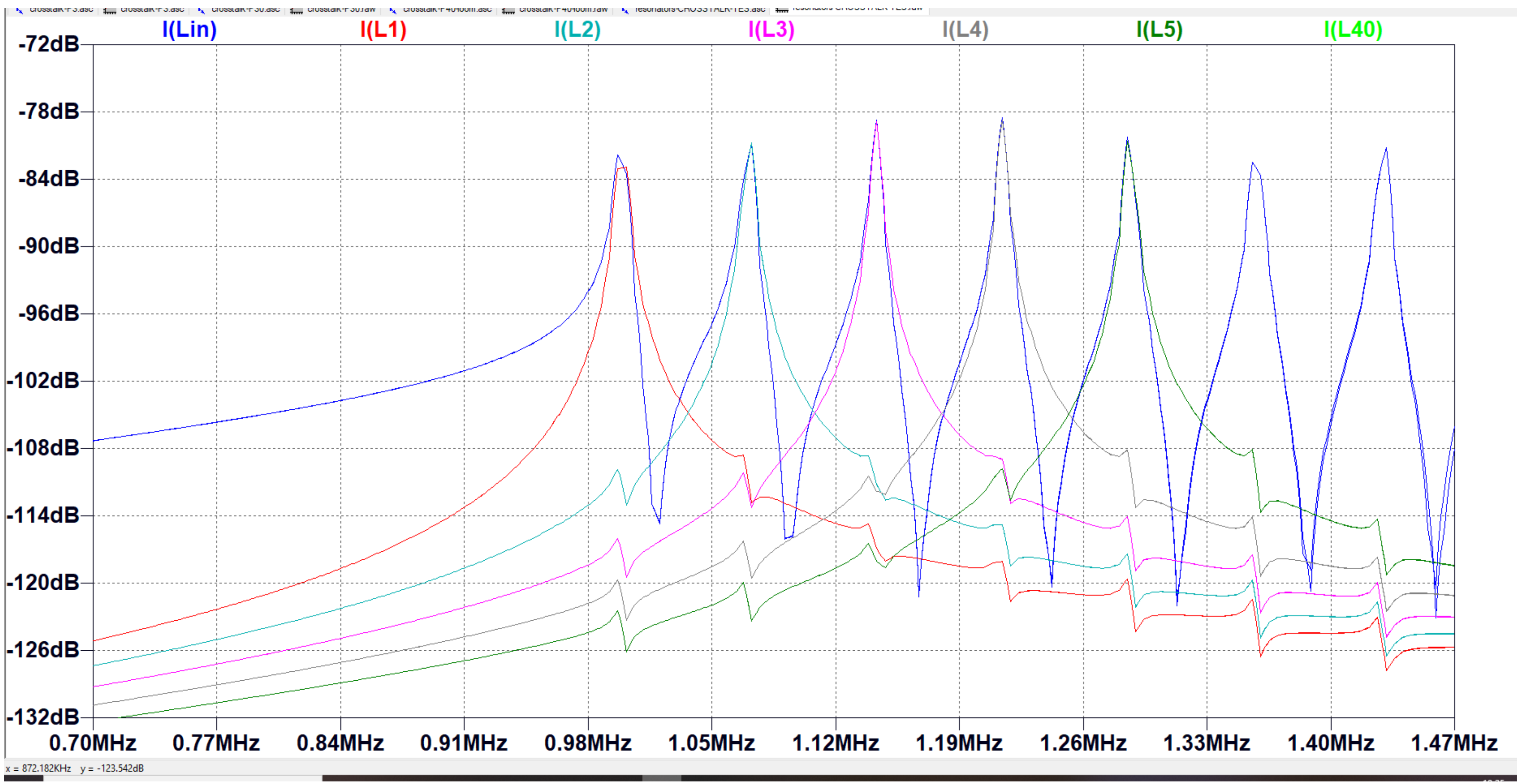


Possible causes of frequency deviation

I(Lin)@f1 ≠ I(L1) I(Lin)@f2 ≠ I(L2) I(Lin)@f40 ≠ I(L40)

....

Crosstalk
(Carrier Leakage)



resonators-CROSSTALK-TES.asc

Possible Causes of Crosstalk [1,2]

REMINDER

Mechansim	Dependence	Mitigation
Thermal Leakage	Interpixel distance on sensor array	Thermalization layer De-focussing
Carrier Leakage	In TES bias circuit, depends on L_{flt}, R_n , Δf	Increase Δf
Common Impedance	In readout circuit, depends on Δf, L_{com}, f , L_{flt}	Increase Δf Lower L_{com}
Non linear amplification	Mostly in SQUID depends on Gain- BW, Dynamic Range (DR)	Higher GBW More DR
Coupling between wires and circuits	Mutual L'_s and leakage C'_s	Shielding the circuits
Else?		

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Leakage Currents I(f1,f2,,f40)

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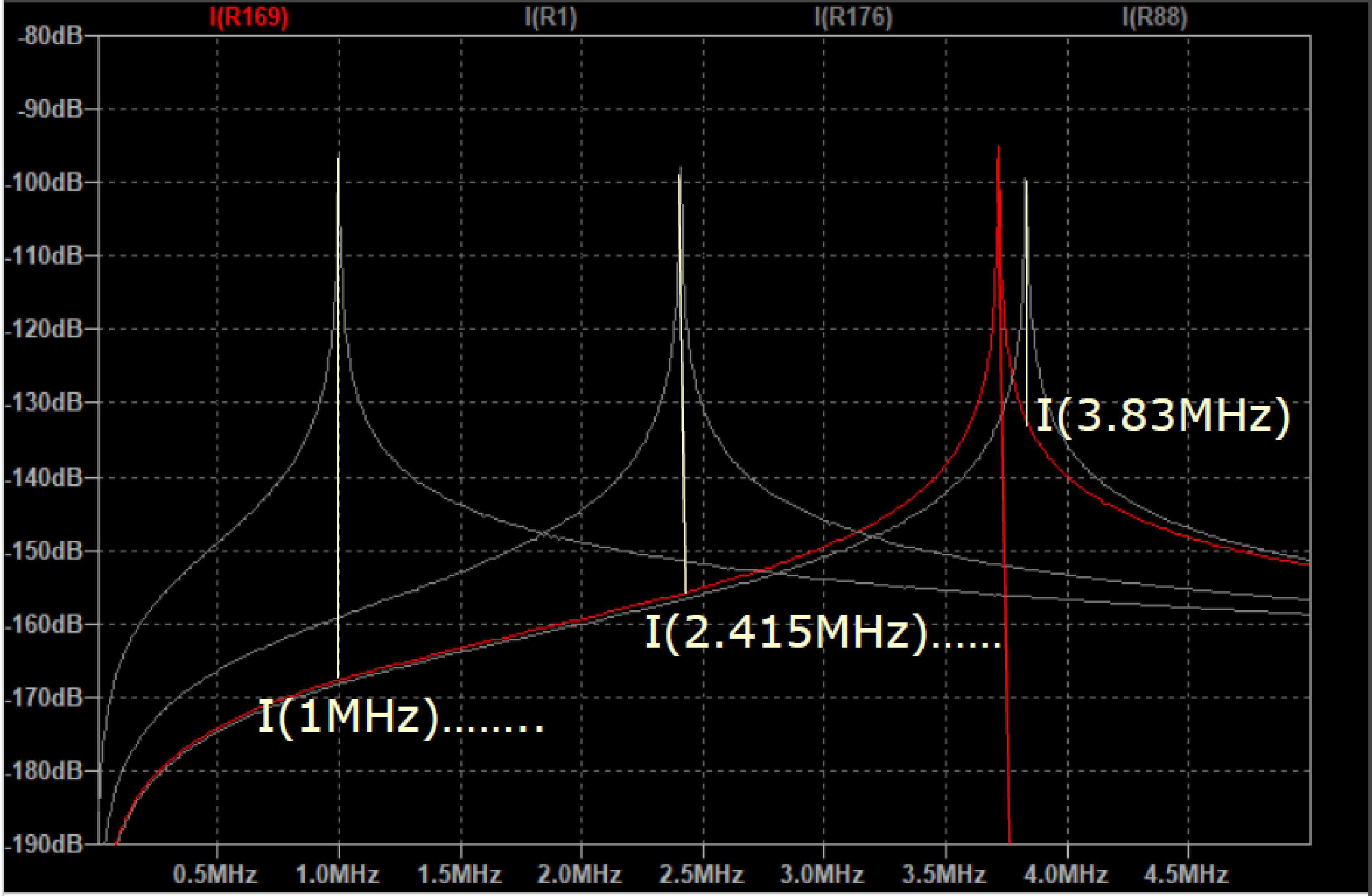

$\mathbf{I}_{\text{rms-leakage}} = \sqrt{(\Sigma(I_n)^2)}$

Career Leakage CT@TES$_{_169}$= 11.92%

To be seen at TES$_{_169}$

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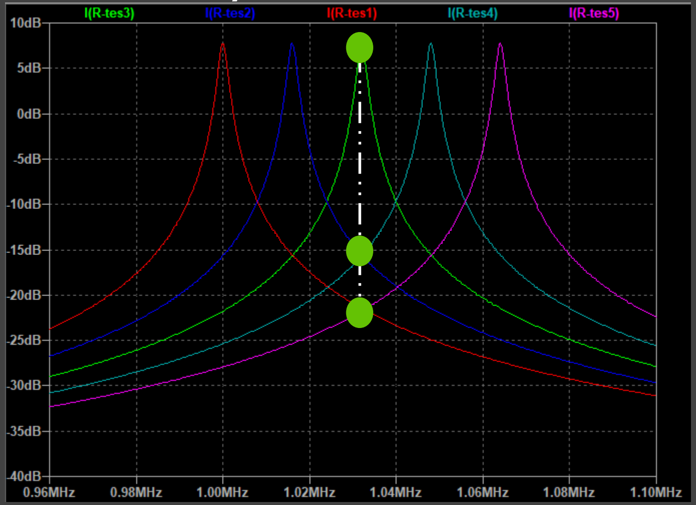
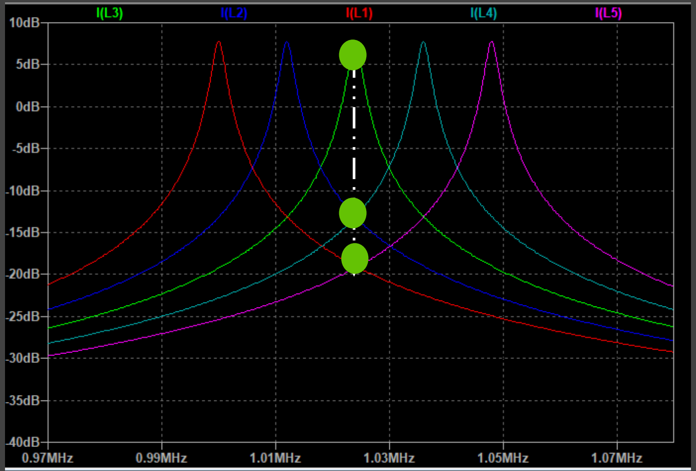
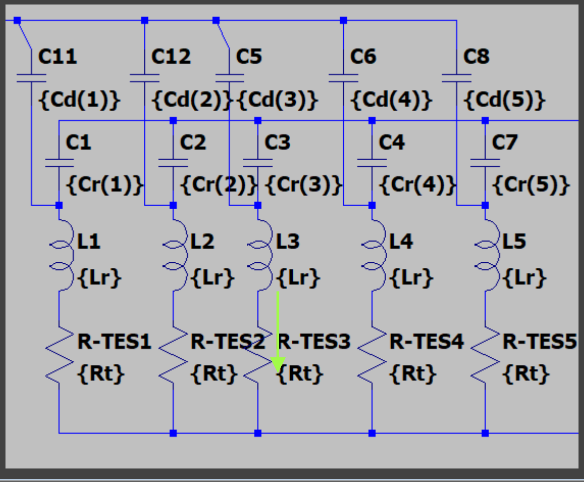
Career Leakage at a fixed resonance frequency – Nearby channels:



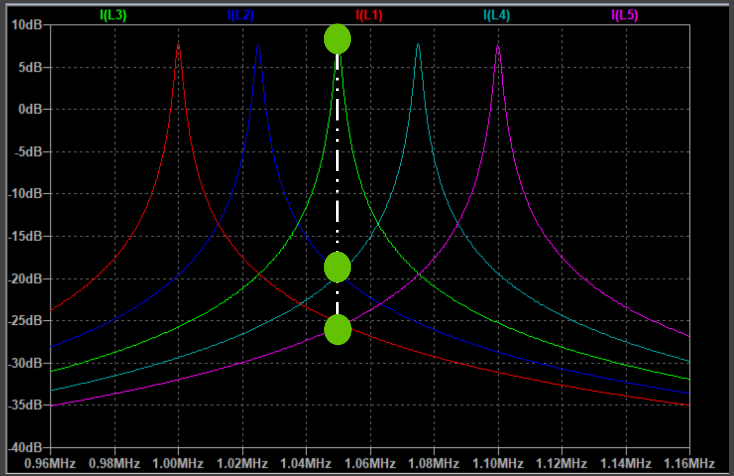
- 5 LCs
- L's 3uH
- R_{TES} 40mOhm
- 1-1.064 MHz
- 16kHz spacing
- 22dB above 1st nearby channels
- 29dB above 2nd nearby channels
- Total current leakage/I_{TES} 1.15%



- Same RLC's
- 1-1.048 MHz
- 12kHz spacing
- 20dB above 1st nearby channels
- 26 dB above 2nd nearby channels
- Total current leakage/I_{TES} 2.05%



REMINDER



- 1-1.10 MHz, Same RLC's
- 25kHz spacing
- 27dB above 1st nearby channels
- 33dB above 2nd nearby channels
- Total current leakage/I_{TES} 0.51 %

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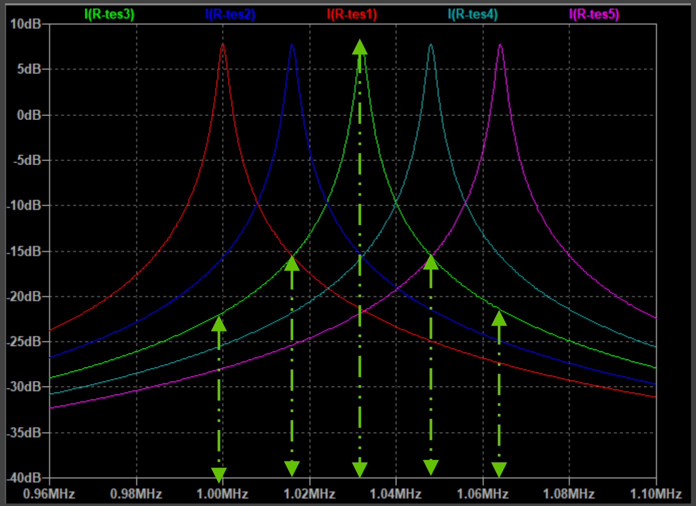
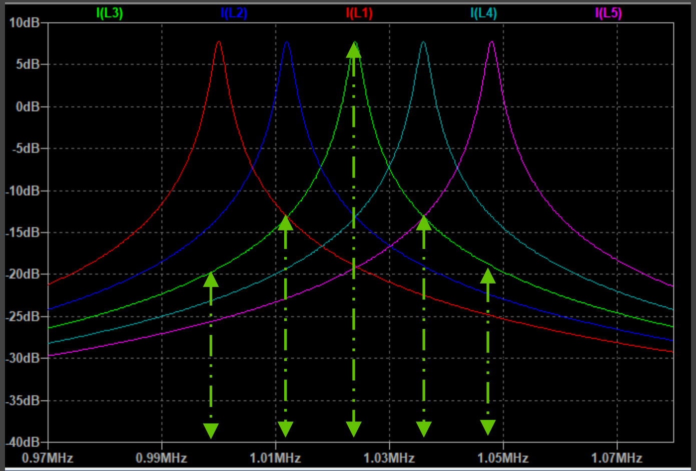
Career Leakage at a fixed TES – Nearby Channels:



- 5 LCs
- L's 3uH
- R_TES 40mOhm
- 1-1.064 MHz
- 16kHz spacing
- Total current leakage/I_TES

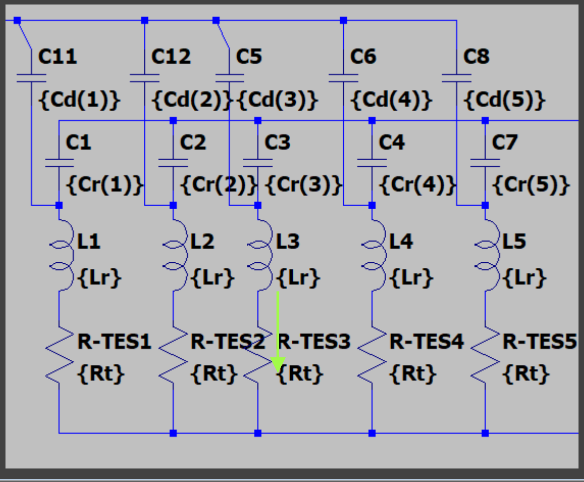
10.7 %



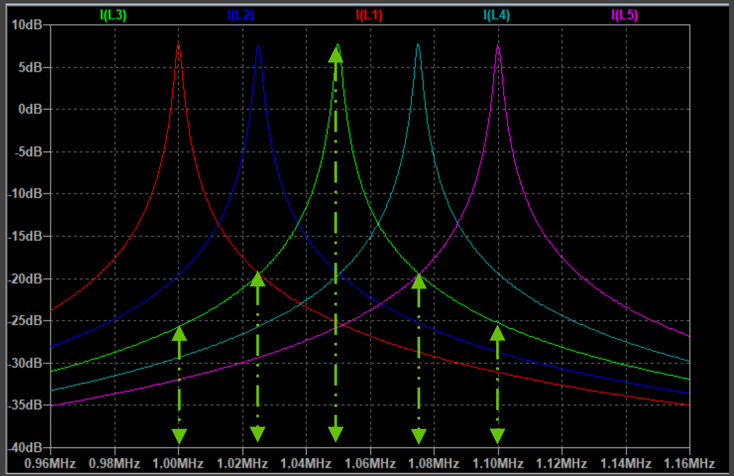
- Same RLC's
- 1-1.048 MHz
- 12kHz spacing

Total current leakage/I_TES

14.3%



REMINDER



- Same RLC's
- 25kHz spacing
- 1-1.10 MHz
- Total current leakage/I_TES

%6.9

Total current leakage/I_TES changes linearly by inverse of frequency spacing

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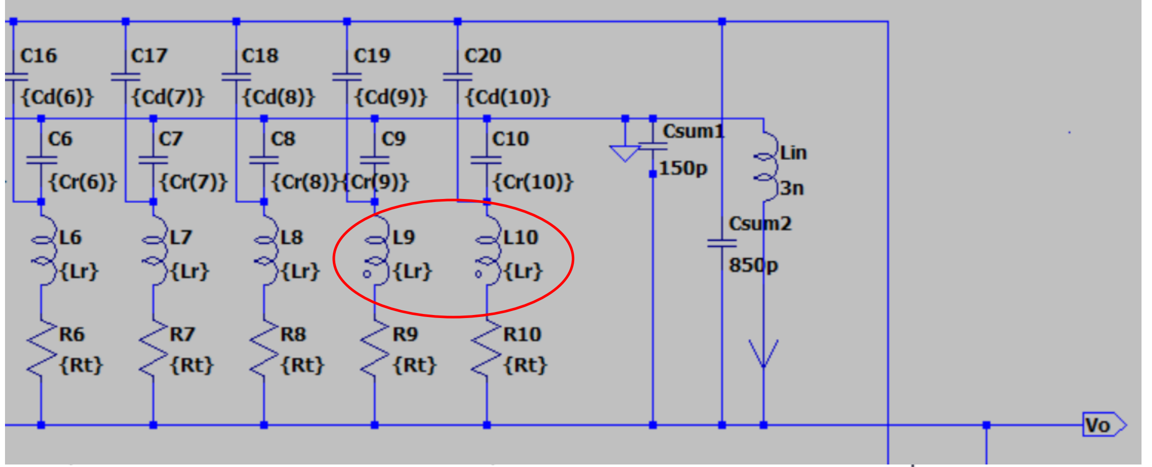
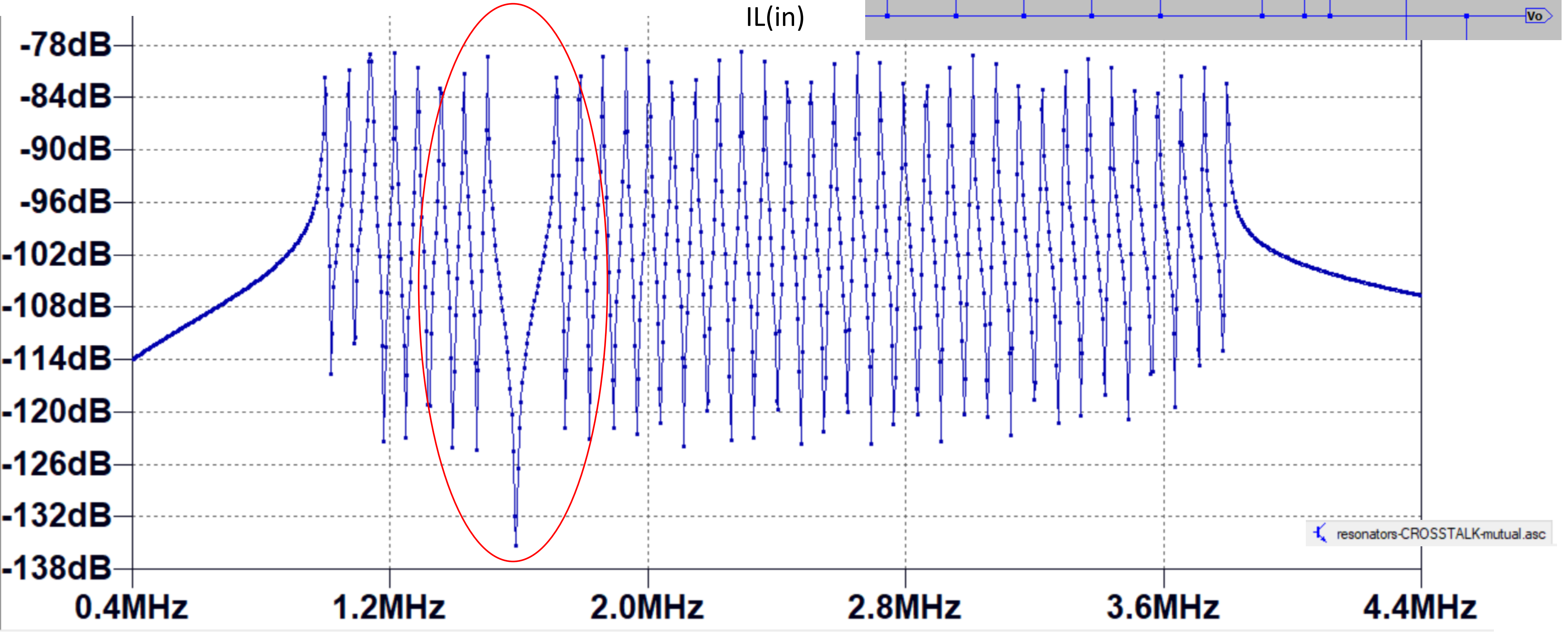
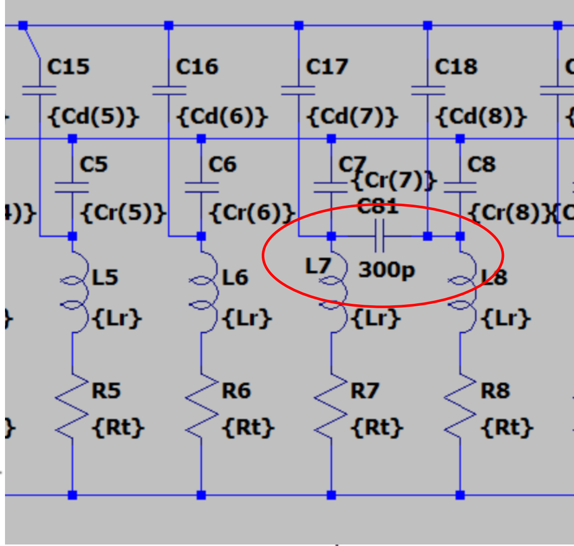
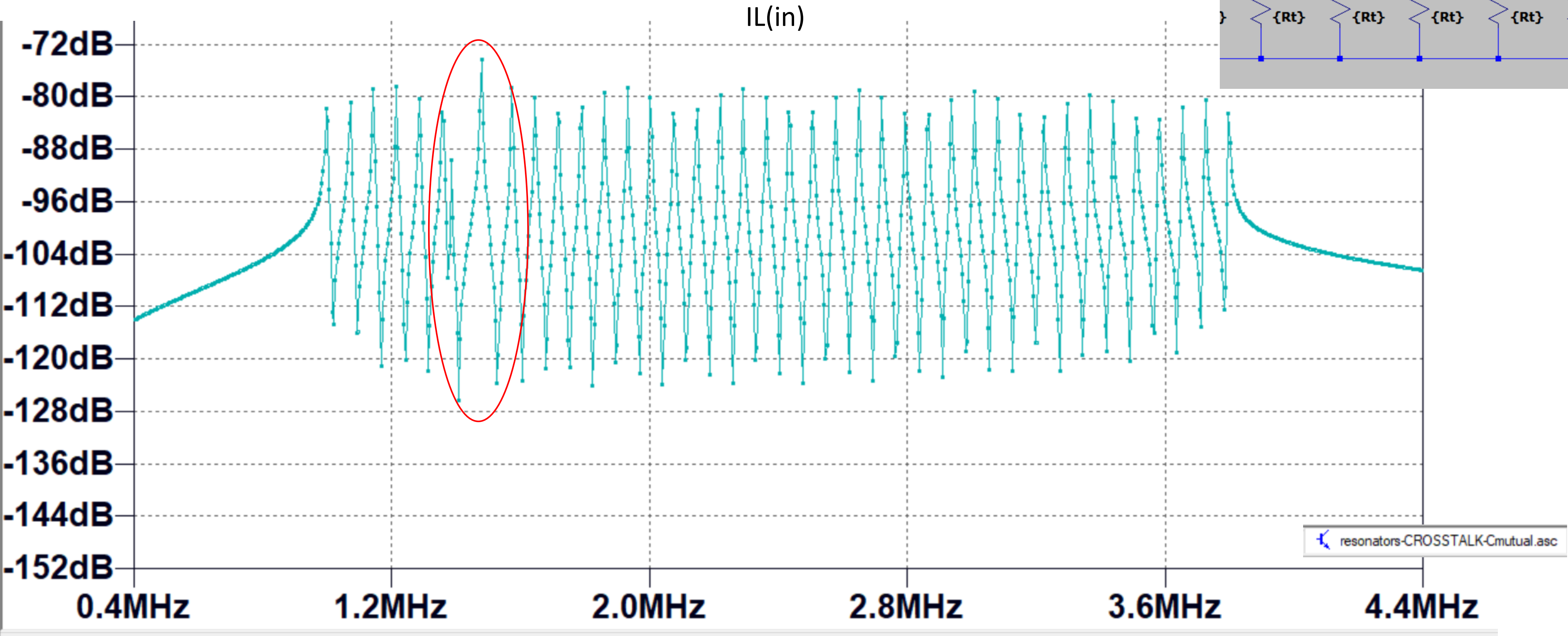
Mutual Inductance (Crosstalk)



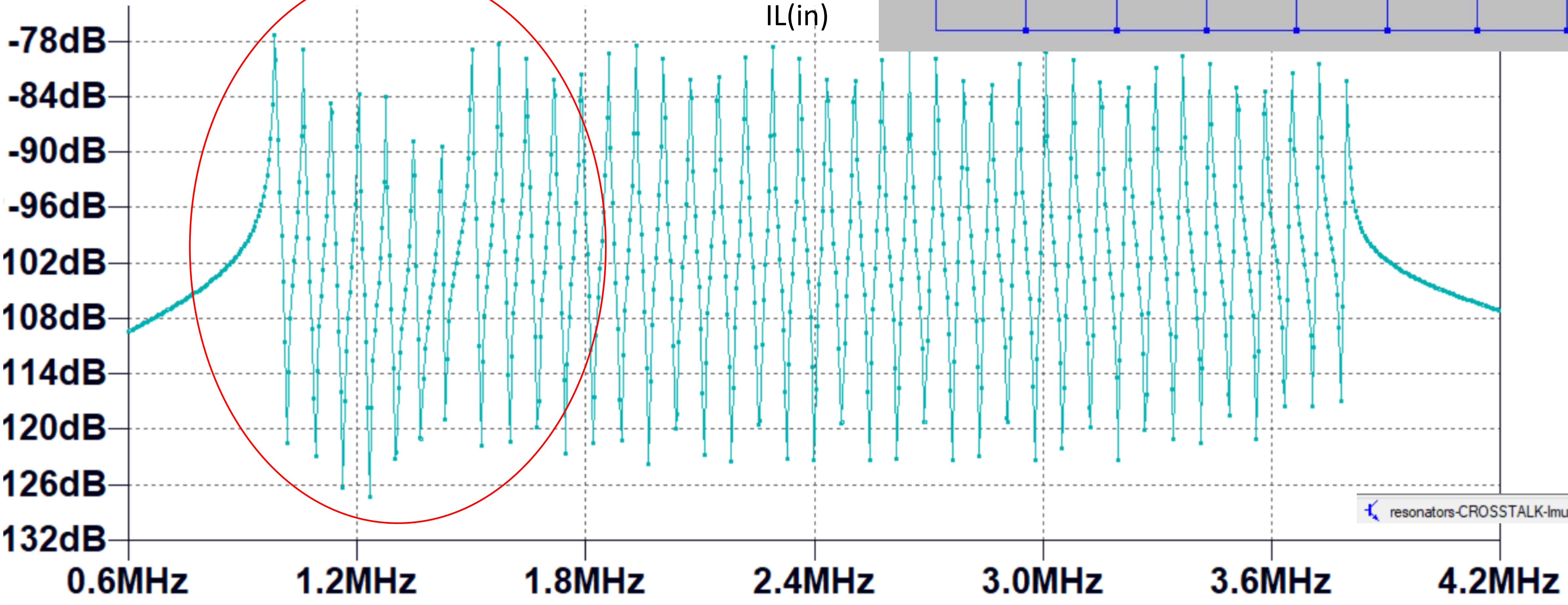


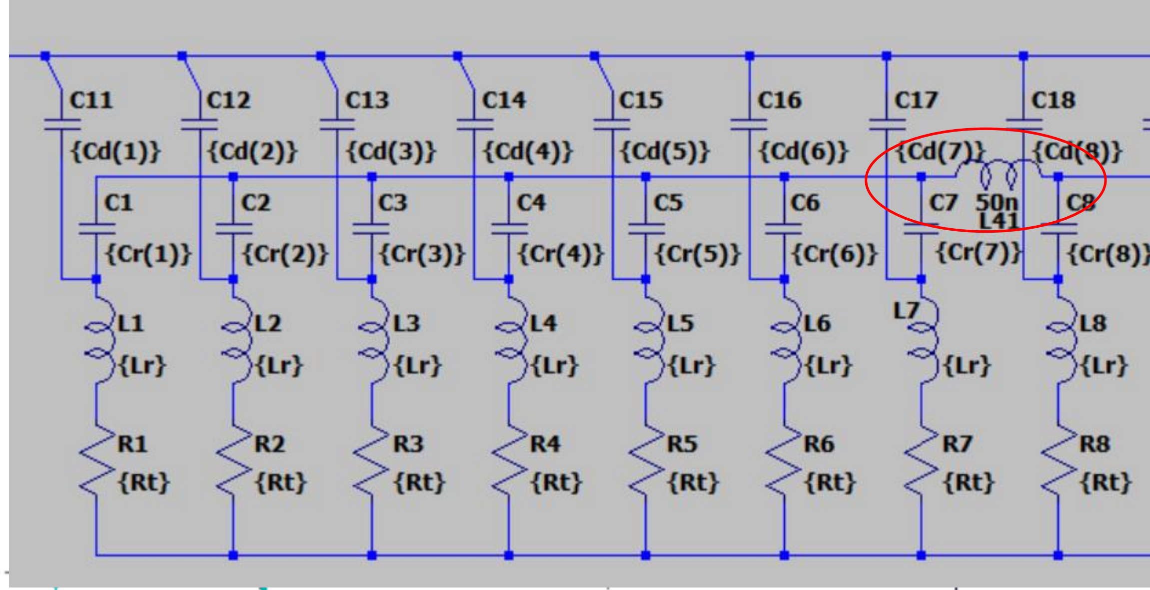
Parasitic Capacitance





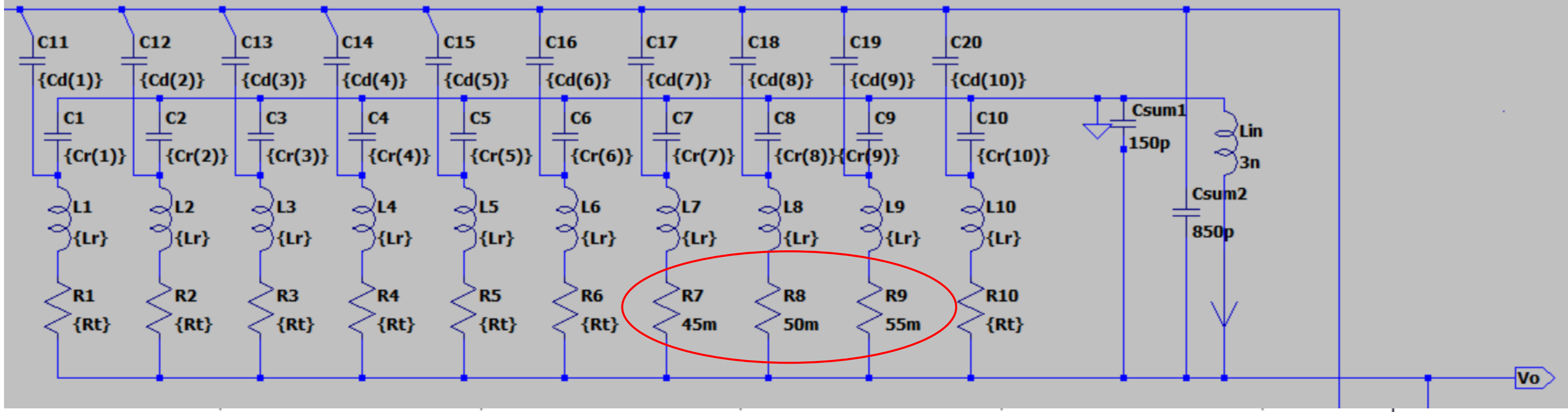
Parasitic Inductance

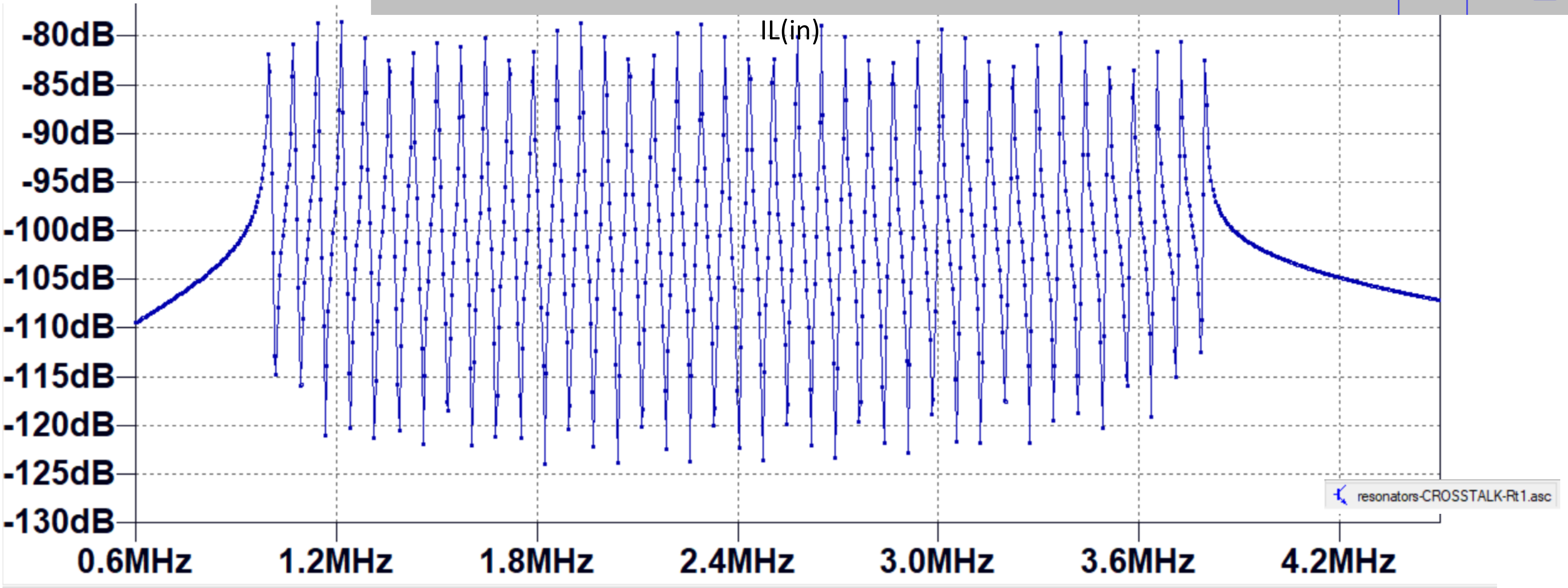




Sensitivity to R_tes
Rt=40mOhm

Not very sensitive!





Extreme variation of R-tes seems to reduce the intensity but no frequency shifting:

Rt7=120mOhm

Rt=40mOhm