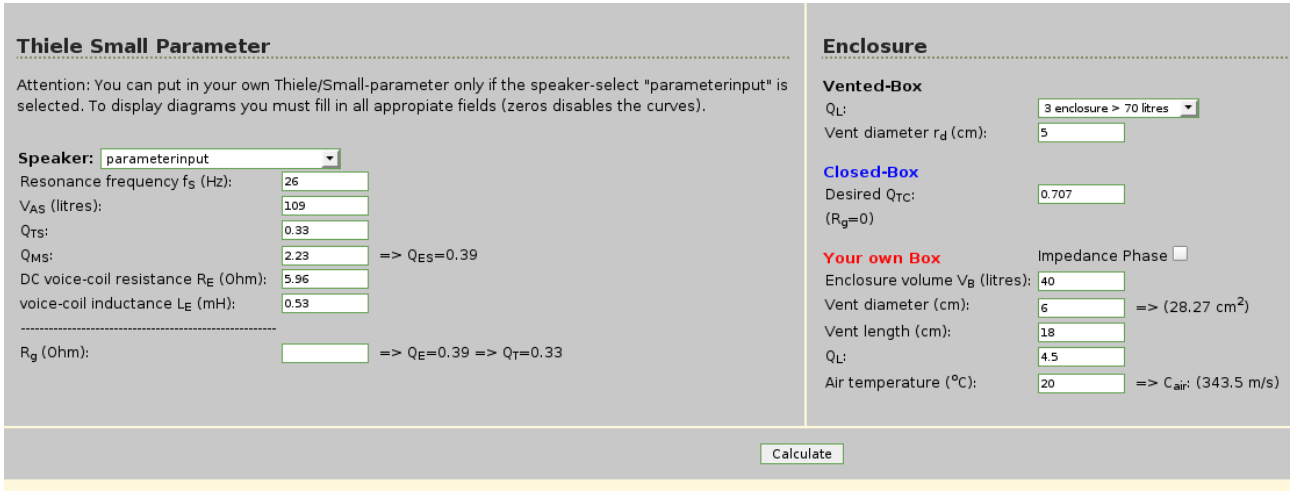
Spice Simulation of a Loudspeaker with Thiele Small Parameter:

The parameters calculated by the online enclosure calculation (www.micka.de/org/en) can help you in using an electrical circuit together with spice to simulate an enclosure speaker system. For instance you can expand your schematic with a voice coil inductance, crossover or baffle-step compensation network. As a result you can find a sound pressure frequency response, step response or an impedance response for your loudspeaker system.

For this simulation you need:
www.micka.de/org/download/spice-tsp.asc.zip (Spice File)
www.linear.com/designtools/software/ltspice.jsp (LTspice IV – simulation program free of charge)
knowledge of spice simulation

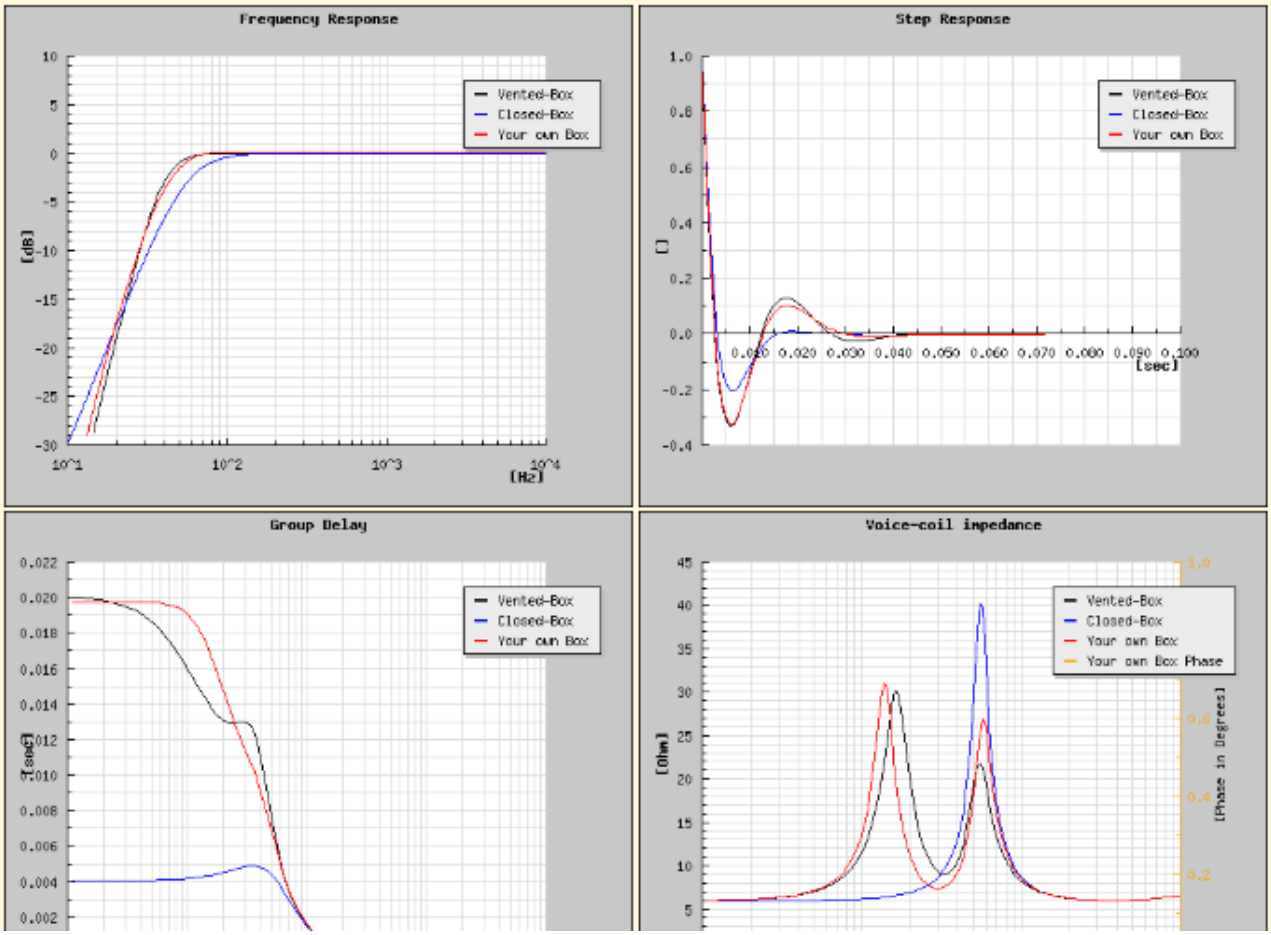
Example Simulation:

First we start with the online enclosure calculation (www.micka.de/org/en):



Fill in the appropriate fields for Thiele Small parameter and „Your own Box“ and calculate.

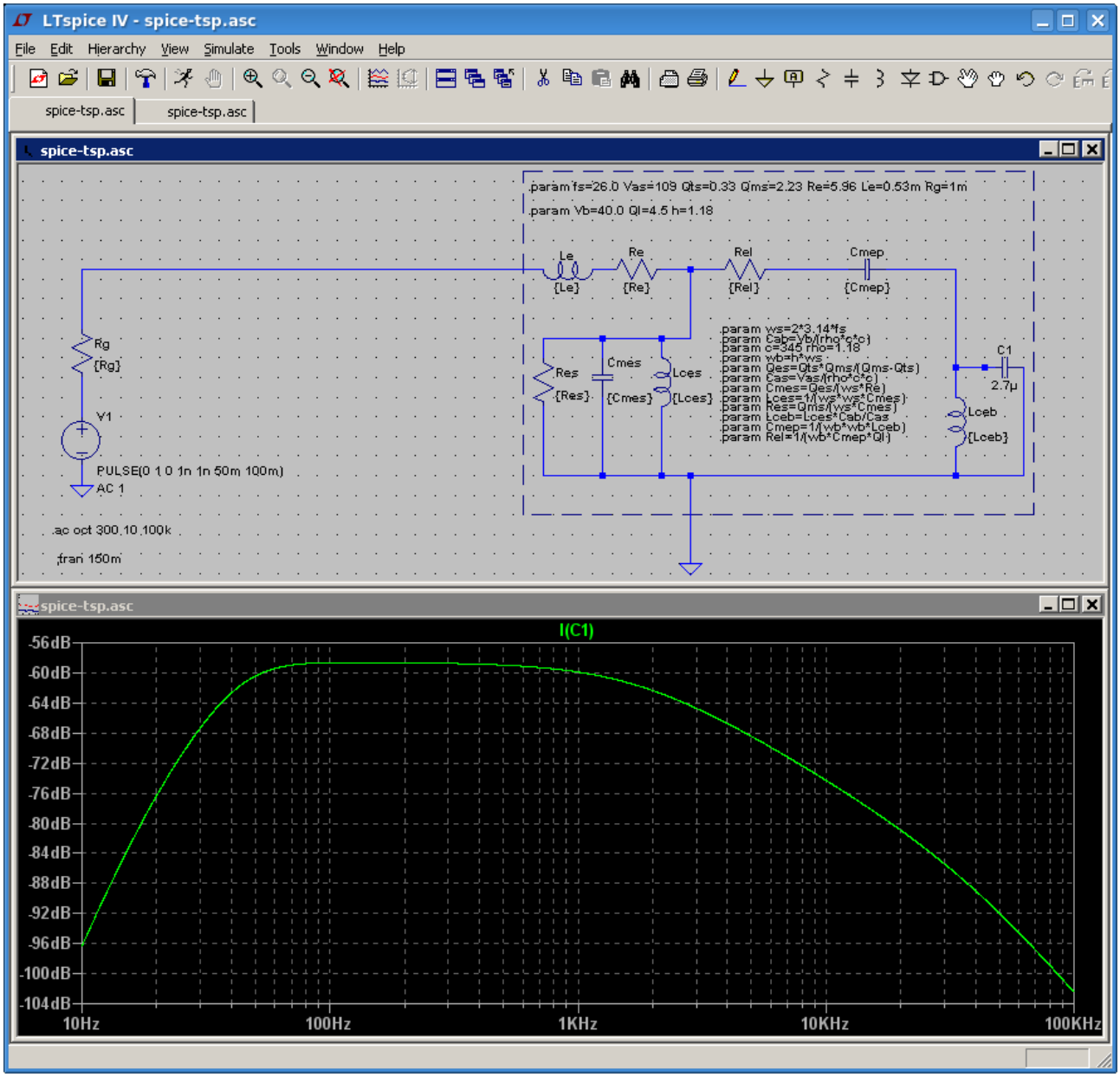
Result:	Vented-Box	Closed-Box without filling	Your own Box	Your own Box parameter for Spice Simulation	
Volume of enclosure	56.09 litres	30.42 litres	40.00 litres	f_S=26.00 Hz	V_B=40.00 litres
Resonance frequency	34.35 Hz	55.66 Hz	30.72 Hz	V_{AS}=109.00 litres	Q_L=4.50
Half power frequency	39.91 Hz	55.71 Hz	42.65 Hz	Q_{TS}=0.33	h=1.18
Vent diameter	5 cm (19.63 cm²)	---	6 cm (28.27 cm²)	Q_{MS}=2.23	
Vent length	5.20 cm	---	18.00 cm	R_E=5.96 Ohm	
Reference efficiency	0.48 %	0.48 %	0.48 %	L_E=0.53 mH	
Sound pressure level (SPL)	88.78 dB/W/m	88.78 dB/W/m	88.80 dB/W/m	R_g=0.00 Ohm	



On top right you will find all parameters for a spice simulation.

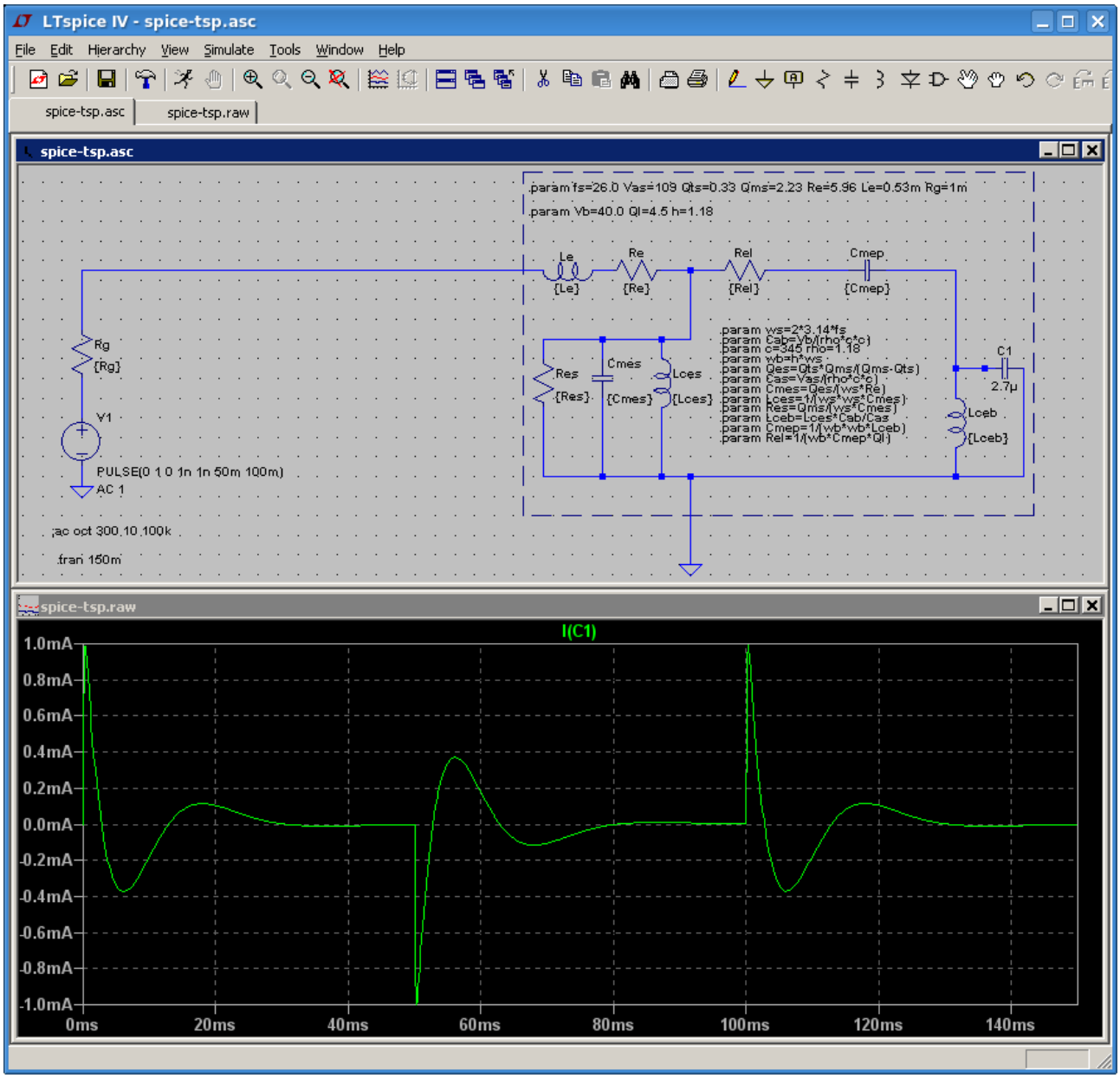
Open your spice file with LTspice. Fill in parameter:
.param fs=26.0 Vas=109 Qts=0.33 Qms=2.23 Re=5.96 Le=0.53m Rg=1m
and
.param Vb=40.0 Ql=4.5 h=1.18

To find the sound pressure frequency response start AC Analysis:



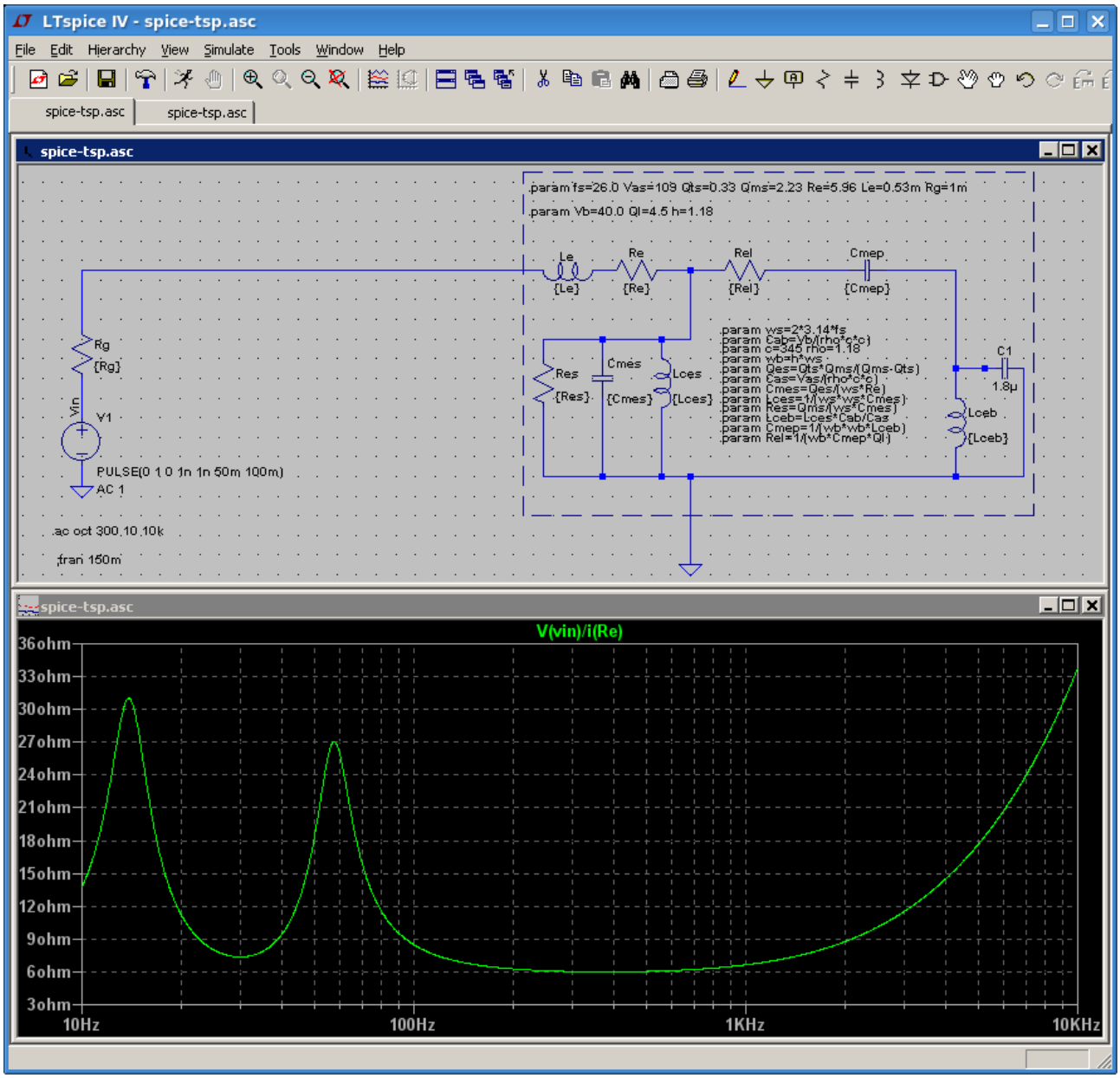
The current through the capacitor C1 corresponds to the sound pressure. The sound pressure fall-off (1kHz and higher) is caused by the voice coil inductance Le.

To achieve a step response we must start a transient analysis:



You can vary the value of C1, but it should be small to minimize it's influence on the circuit.

Finally a simulation for a impedance response of the loudspeaker system:



Much fun!

Jürgen Micka juergen@micka.de

www.micka.org or www.micka.de/org