Prediction of the Loudspeaker Total Harmonics Distortion Using Comsol Multiphysics

François Malbos[1], Michal Bogdanski[2], Michael Strauss[2]
1. Harman France, VPDT, 12 bis, rue des Colonnes du Trône, Paris, 75012, France
2. Harman Becker Automotive Systems, VPDT, 135 Schlesische Straße, Straubing, D94315, Germany

Introduction: For automotive applications, simulation methods are used to optimize the position and orientation of speakers. Since a loudspeaker is a non linear device, the sound pressure includes harmonics. Engineers at Harman are optimizing the audio performance by predicting and minimizing the amplitude of the harmonics.

Computational Methods: The harmonics are mainly created by 3 non linear speaker components (force factor, suspension stiffness and voice coil inductance).
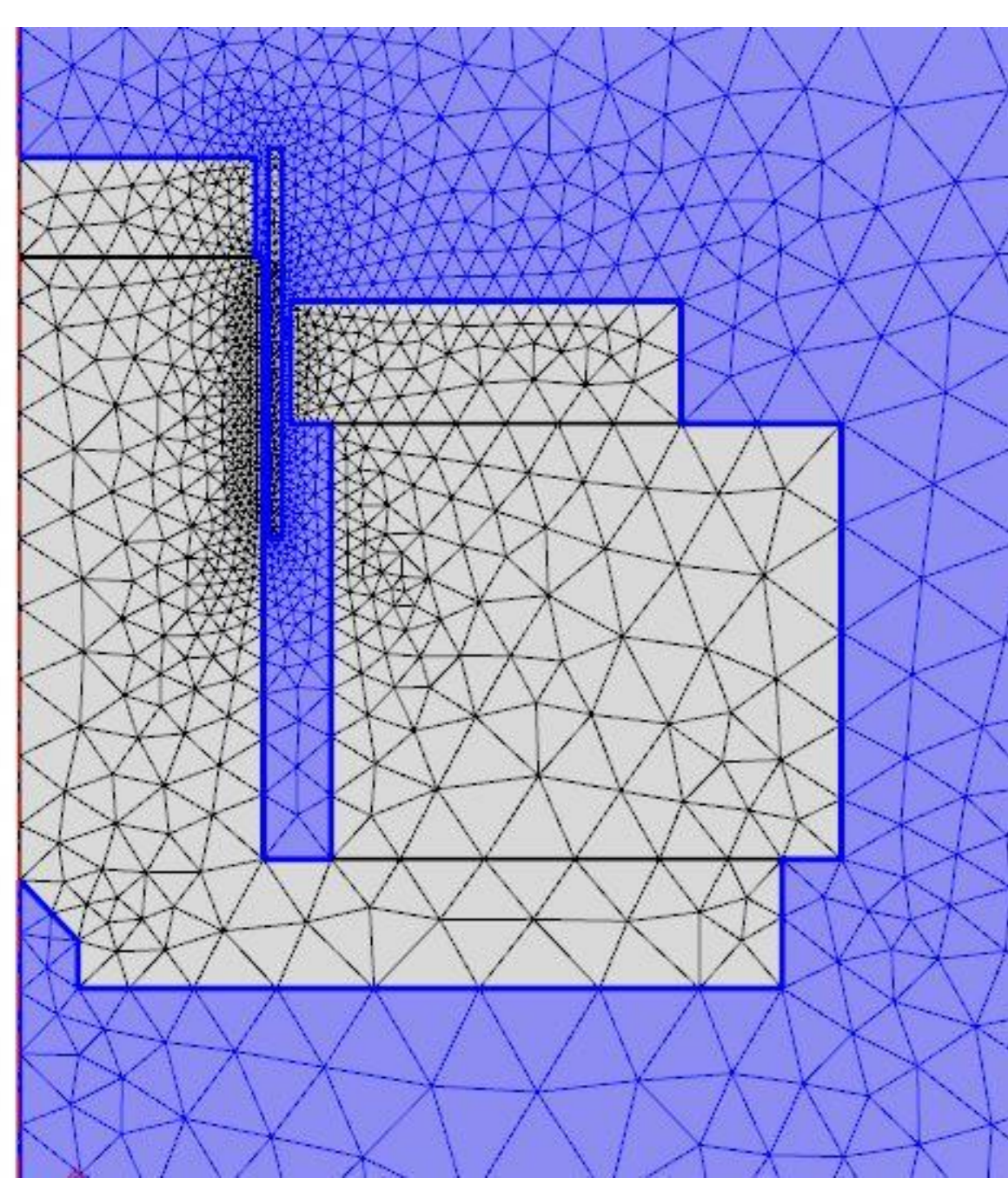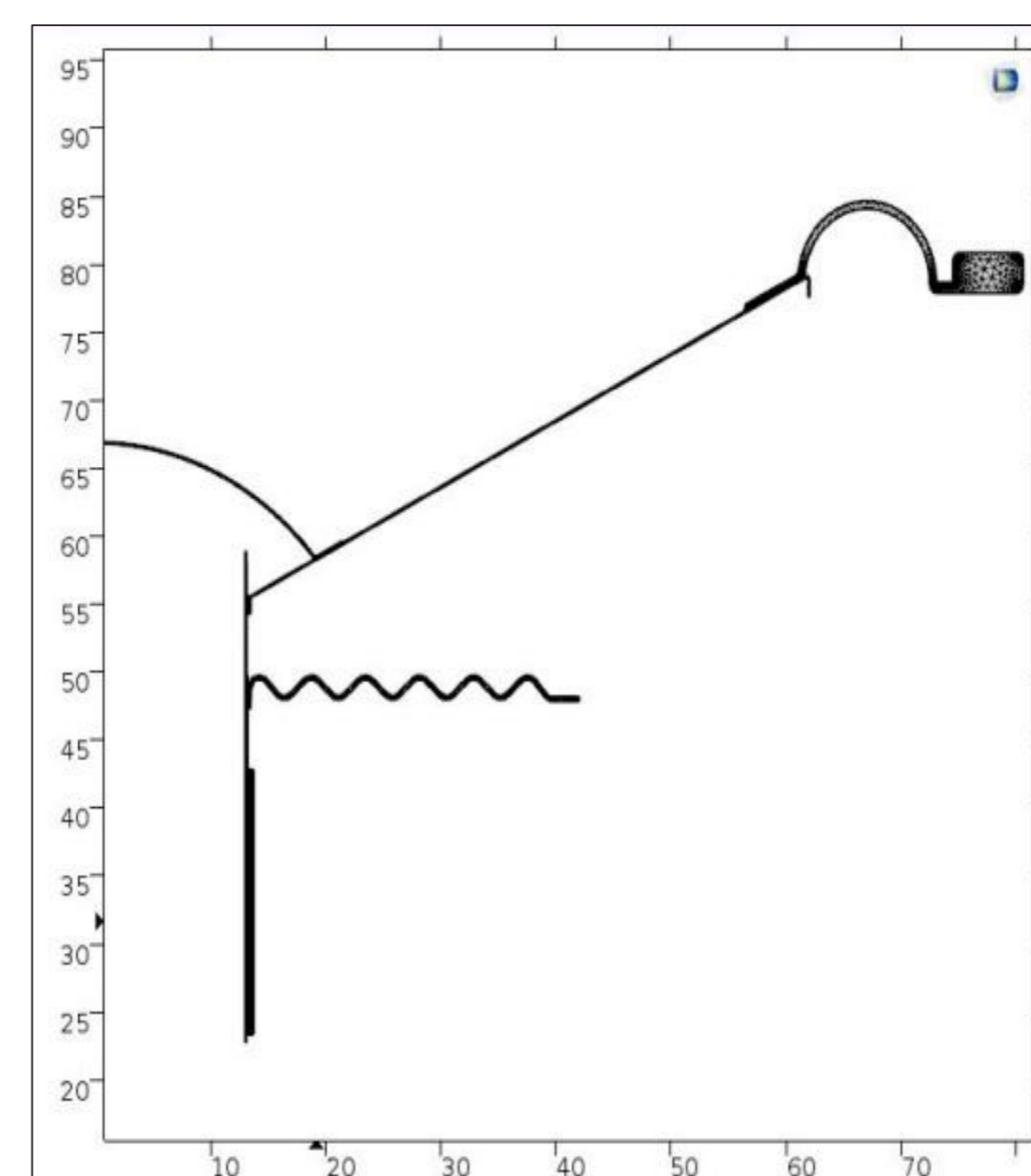

Figure 1. Comsol AC/DC Model

Figure 2. Comsol Structural Mechanics Model

Results: Simulation results were compared with measurement data delivered by a professional loudspeaker measurement system. Total Harmonic Distortion (THD) was predicted based on Comsol and measurement system datasets. Predicted THD was compared with a measurement.
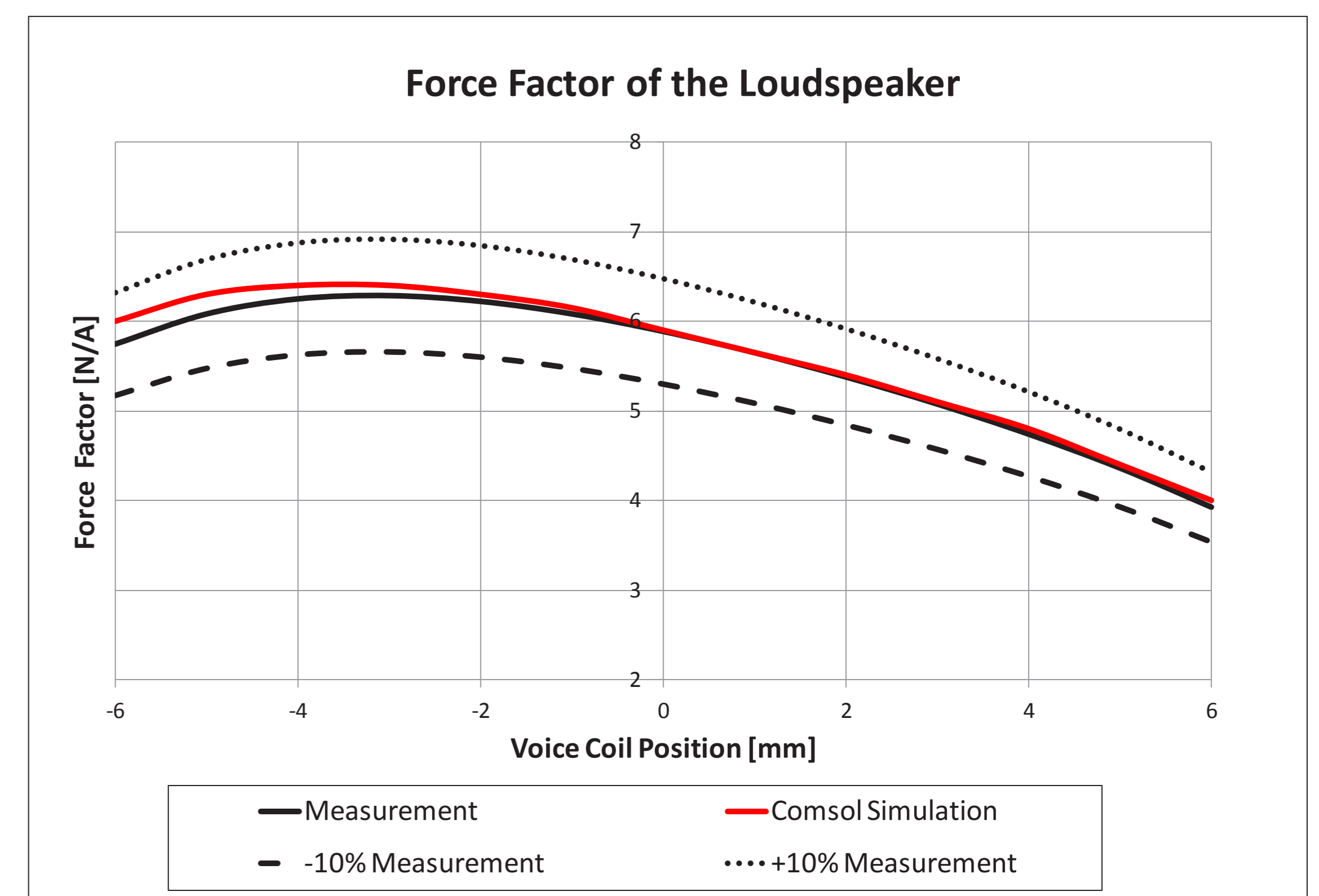

Figure 3. Suspension stiffness simulation
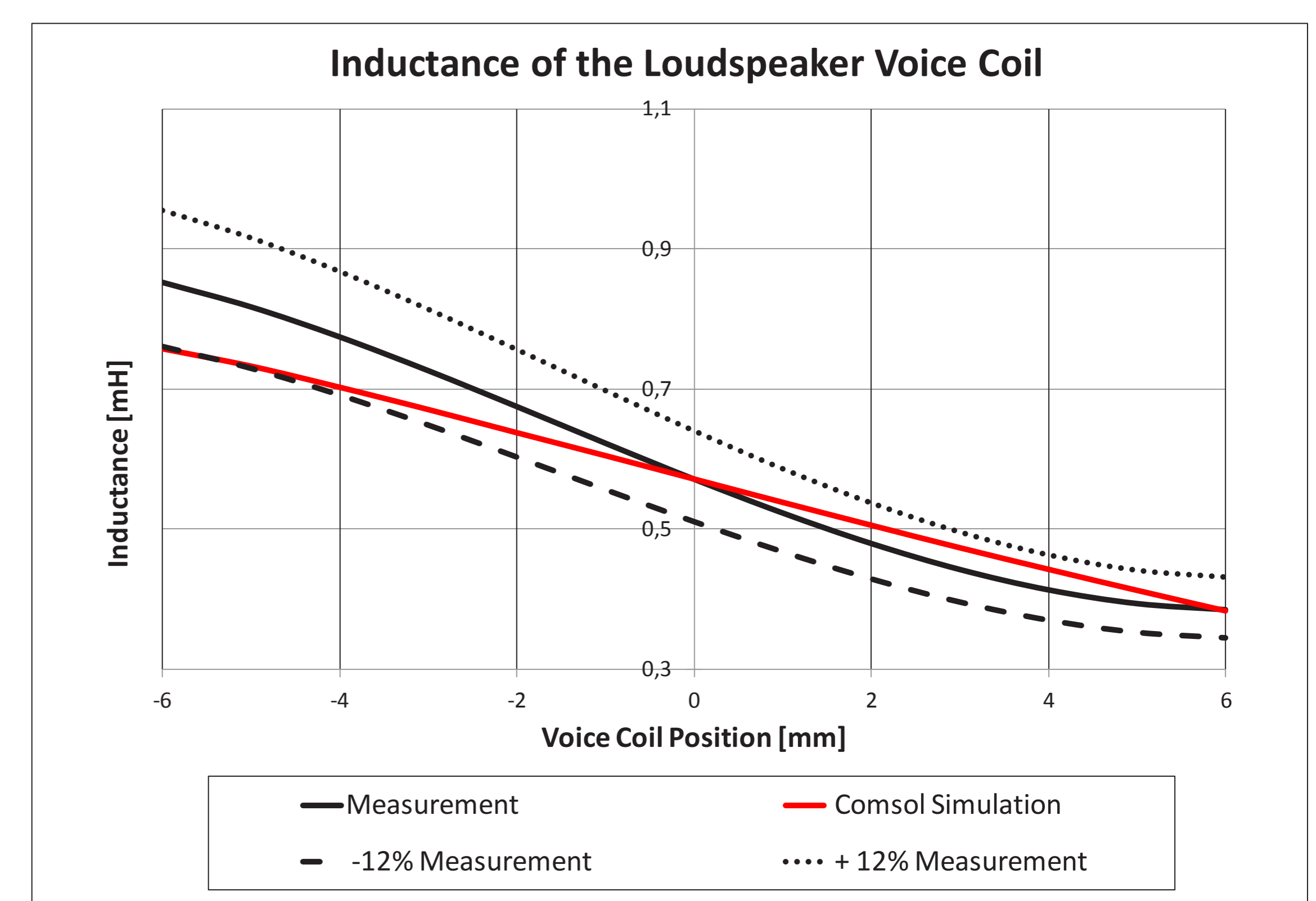

Figure 4. Force factor simulation

Figure 5. Inductance simulation
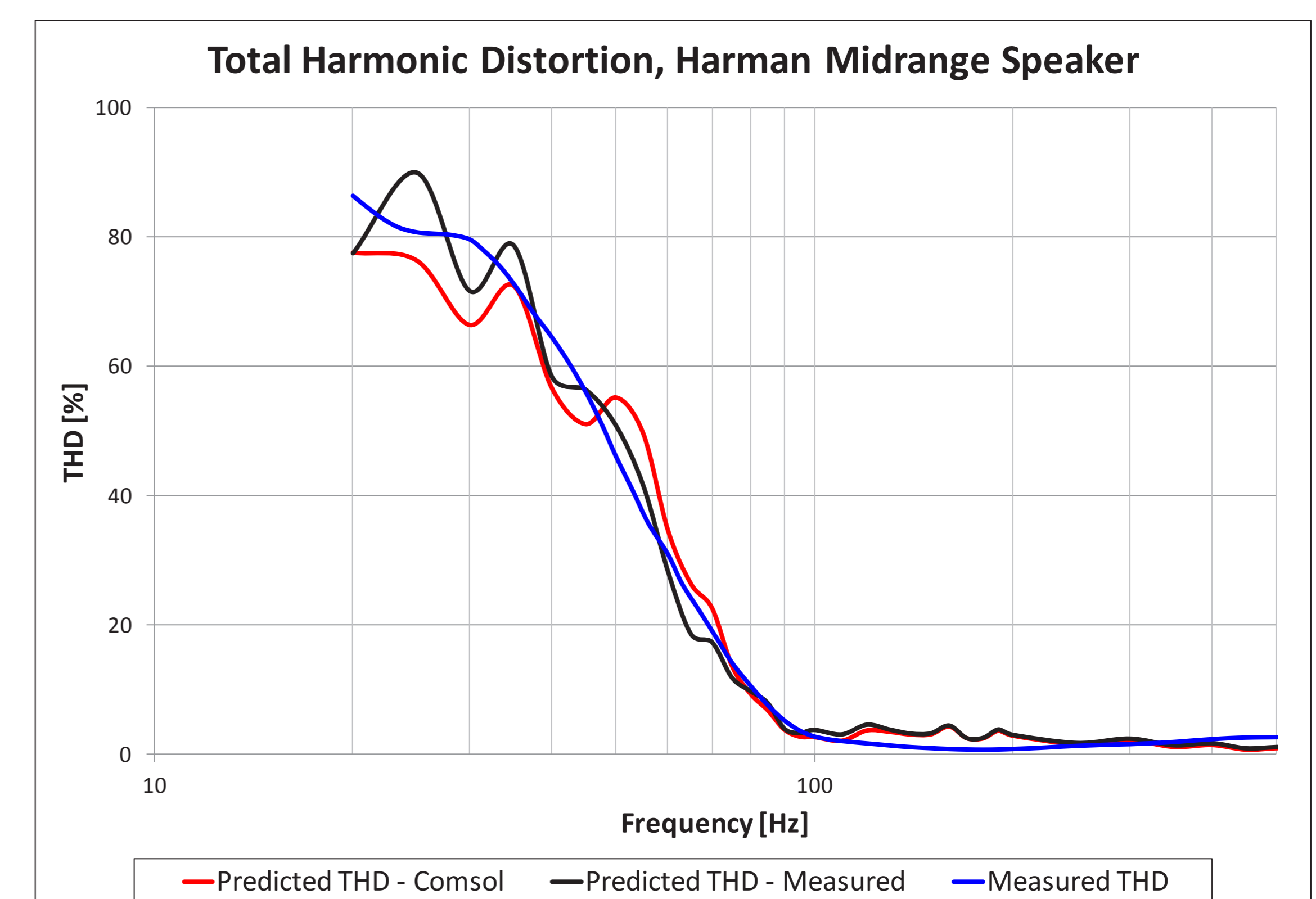
Figure 6. THD prediction and measurement
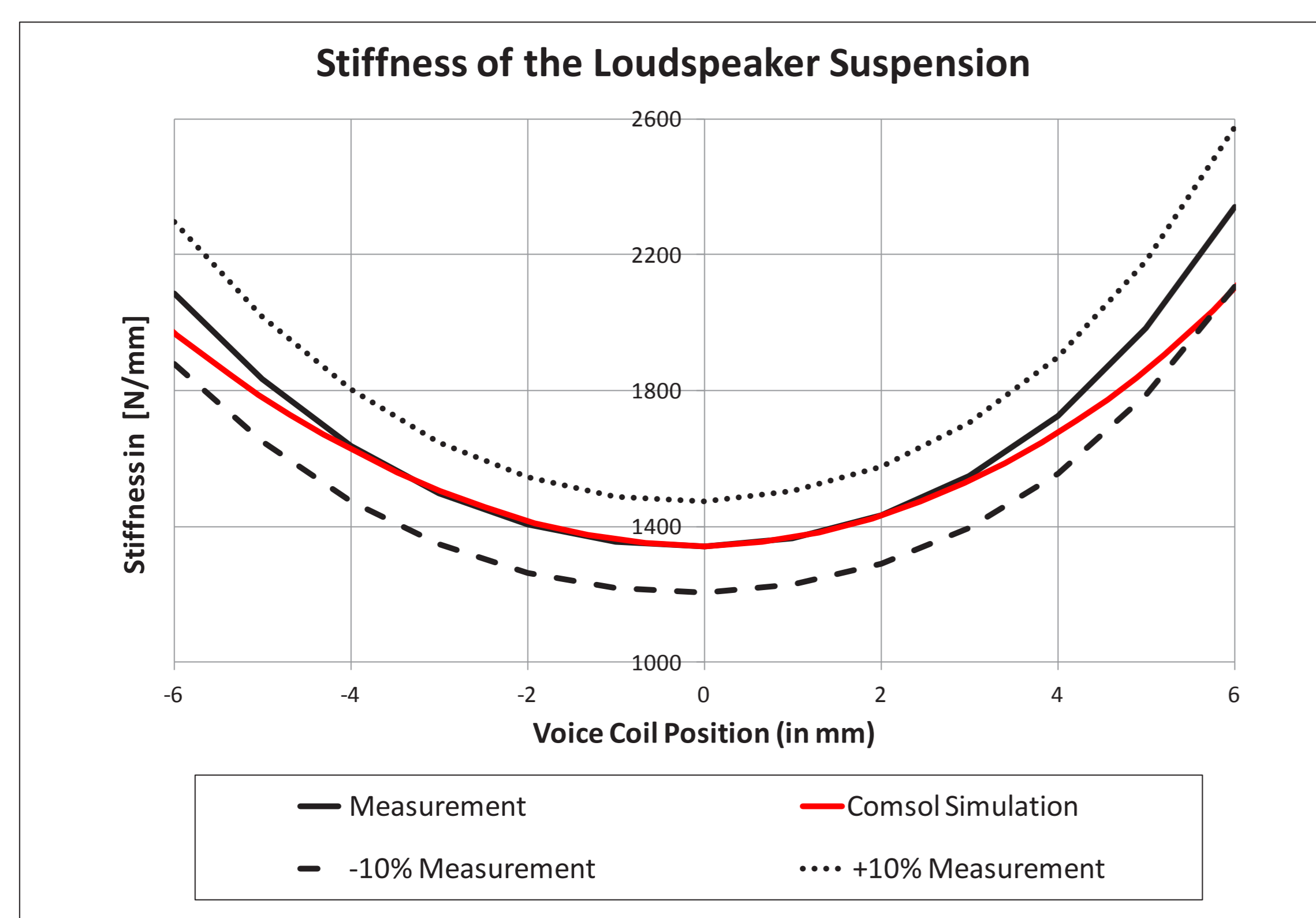
Conclusion: The optimization of the non linear behavior of a loudspeaker can be realized in the virtual domain.

References:

1. W. Klippel, Distortion Analyser - a new tool for assessing and improving electrodynamic speaker, 108th Audio Engineering Society, Convention Paper 5109, (2000)