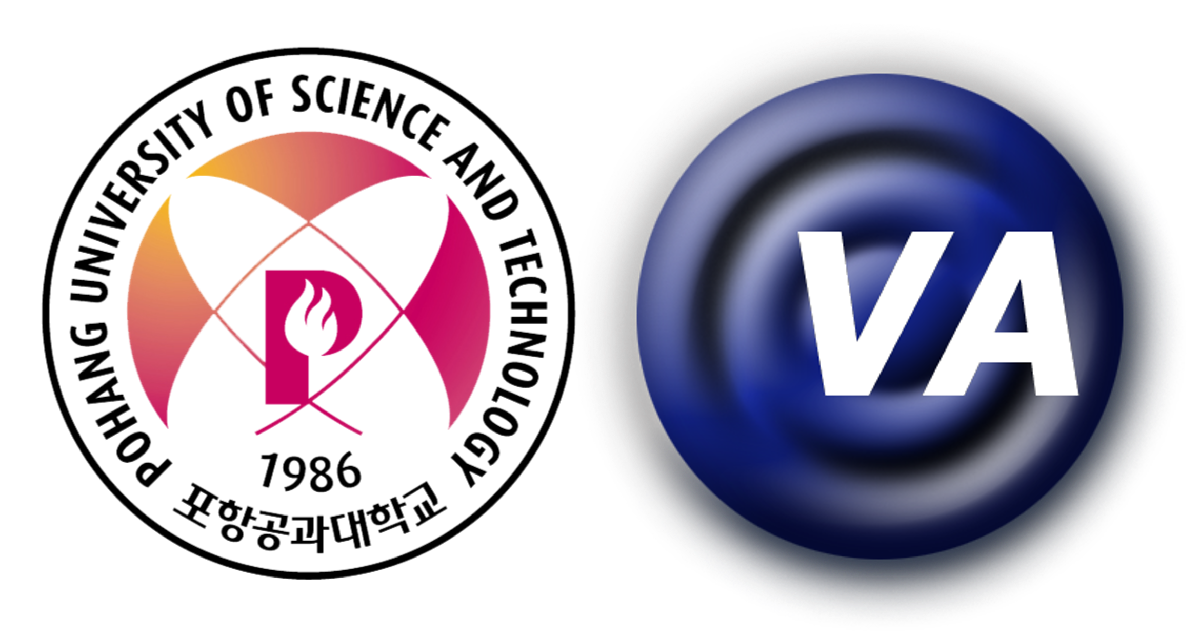
**Modeling and Simulation of Trumpet Electro-mechanic Horn**

**2022**

**Vibration and Acoustic Transducers Laboratory**

**Pohang University of Science and Technology**



***Woongji Kim***

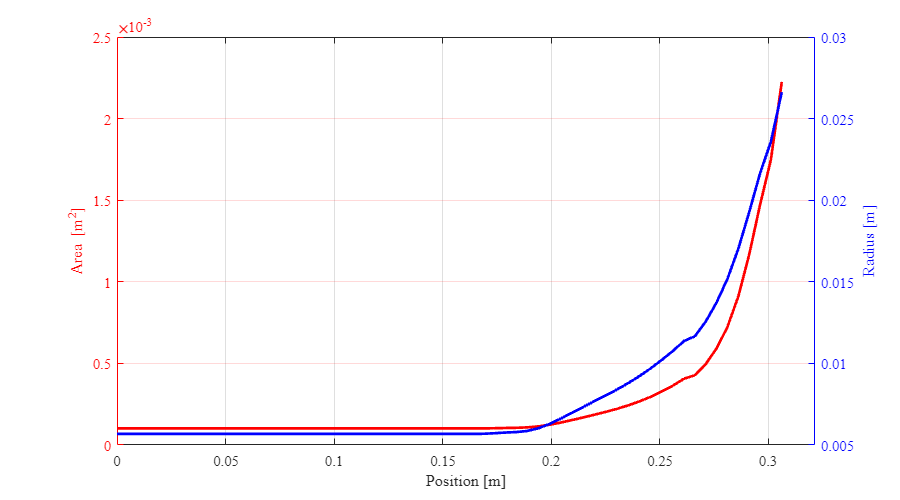
[wj.kim@postech.ac.kr](mailto:wj.kim@postech.ac.kr)

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# Import horn and parallel section geometry from text file

Geom\_Horn = readtable("Geom\_Horn.txt", opts);



# Acoustical components

## Physical properties of air

air.rho0 = 1.21; % Density, [kg/m^3]

air.c = 343; % Speed, [m/s]

air.gamma = 1.402;% Ratio of specific heat, [1]

air.p\_ref = 20e-6;% Reference for sound pressure level, [Pa]

## Parallel section

ac.ps.x = Geom\_Horn.Location(2); % Length

ac.ps.s = Geom\_Horn.Area(2); % Area

ac.ps.n = 20; % No. of subsection

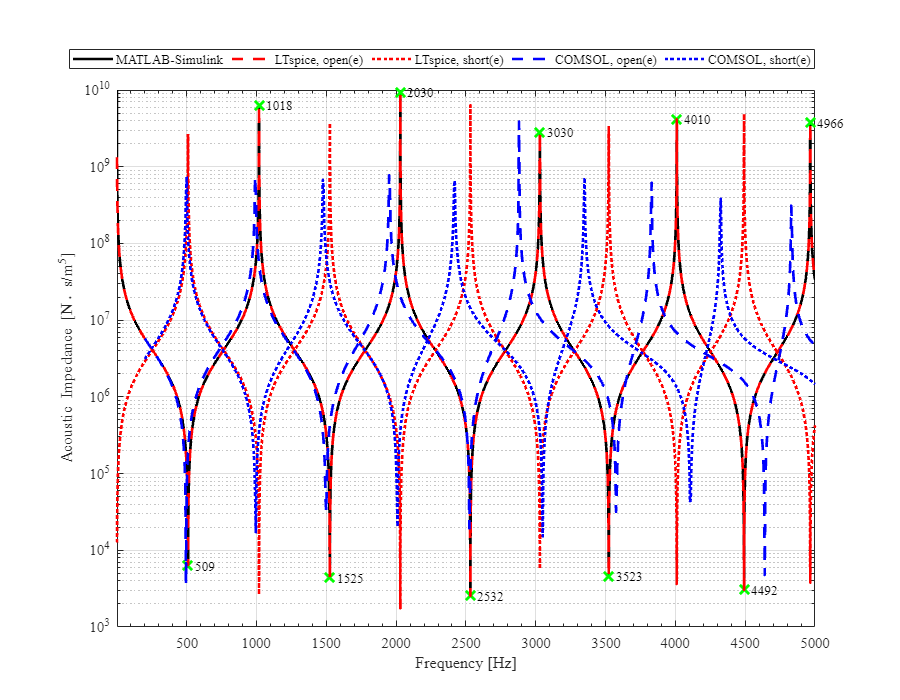
ac.ps.L = air.rho0/ac.ps.s\*(ac.ps.x/ac.ps.n); % L in T network of subsection

ac.ps.C = ac.ps.s/(air.rho0\*air.c^2)\*(ac.ps.x/ac.ps.n);

% C in T network of subsection

%% Specify the model name

ac.ps.model = 'AC\_Parallel\_Section';



## Horn

ac.ho.x = Geom\_Horn.Location(3:end)-Geom\_Horn.Location(2:end-1);

% Length of subsection

ac.ho.s = Geom\_Horn.Area(3:end); % Area of subsection

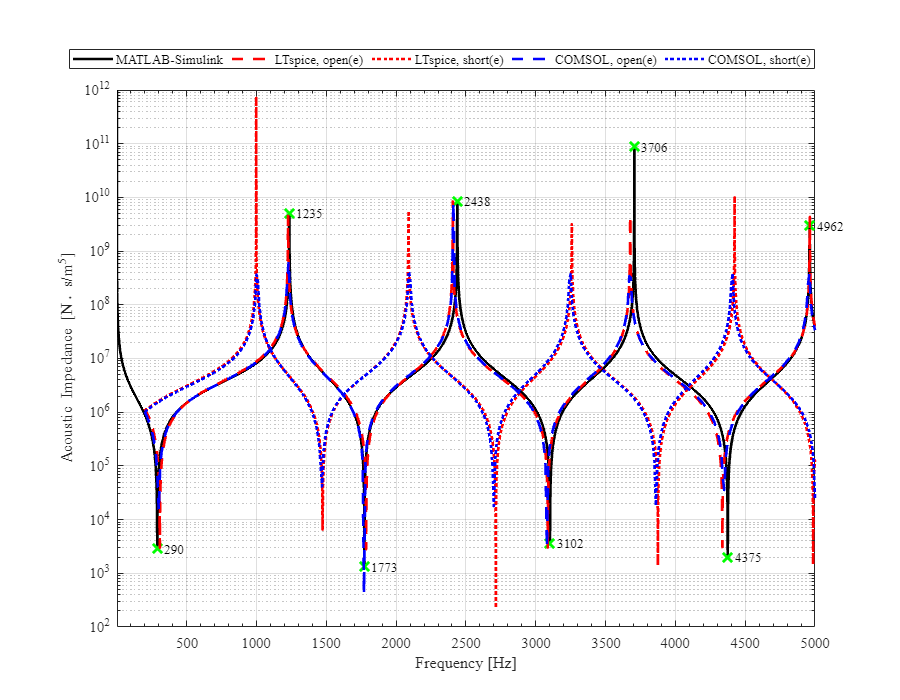
ac.ho.n = size(ac.ho.x); % No. of subsection

ac.ho.L = air.rho0./ac.ho.s.\*ac.ho.x/2; % L in T network of subsection

ac.ho.C = ac.ho.s/(air.rho0\*air.c^2).\*ac.ho.x; % C in T network of subsection

%% Specify the model name

ac.ho.model = 'AC\_Horn';



## Radiation

assumed as a plane circular piston in infinite baffle

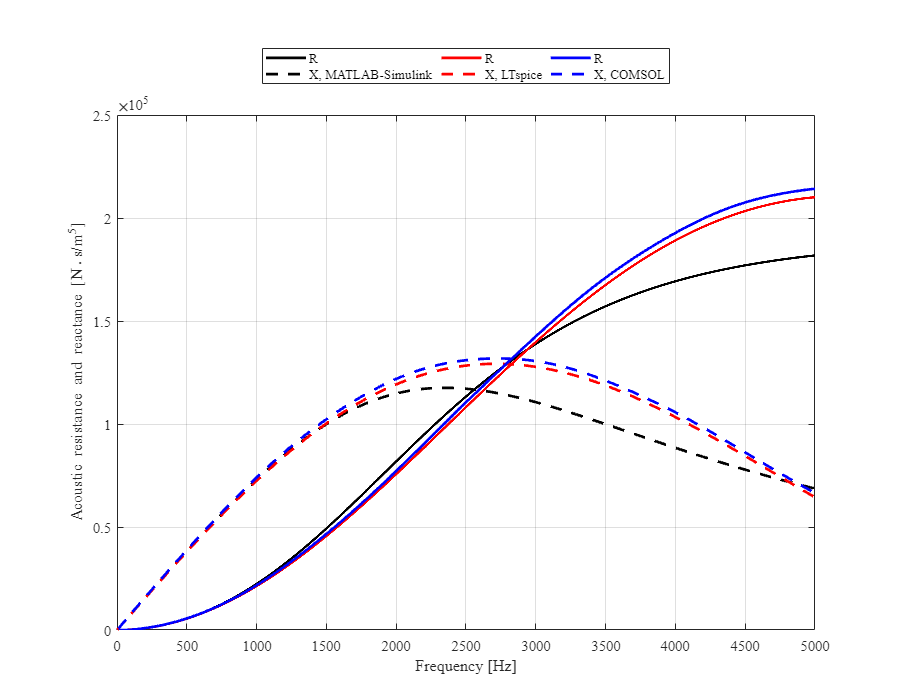
Need to implement 6th order radiation impedance

ac.rad.s = Geom\_Horn.Area(end);

ac.rad.a = sqrt(ac.rad.s/pi);

%% Specify the model name

ac.rad.model = 'AC\_Radiation';



## Compressor

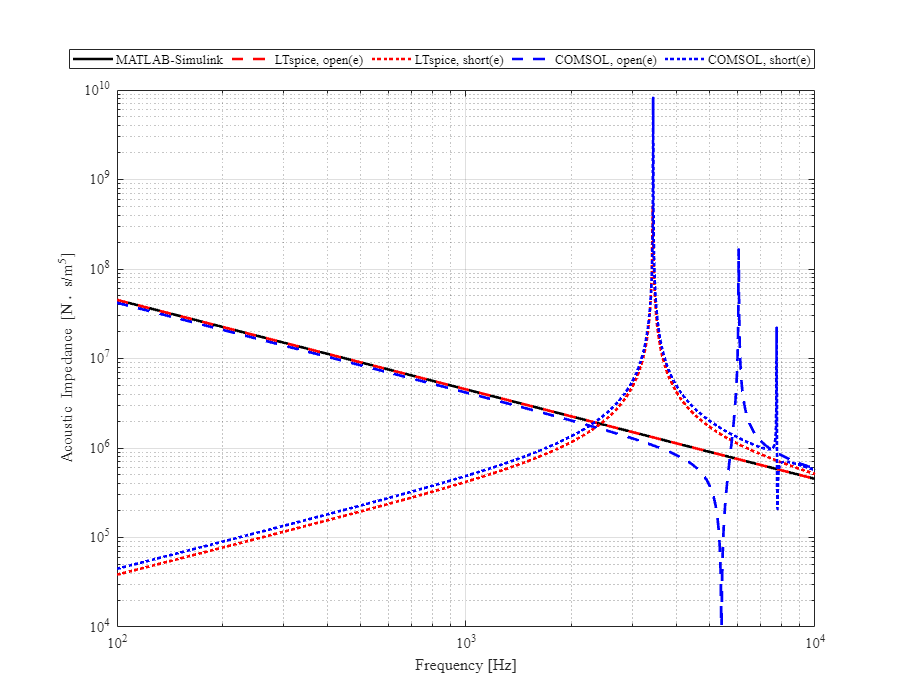
the value from COMSOL Multiphysics

ac.co.L = 38361.196102405345/(2\*pi\*100);

ac.co.C = 1/(2\*pi\*100\*4.518859697974938e7);

%% Specify the model name

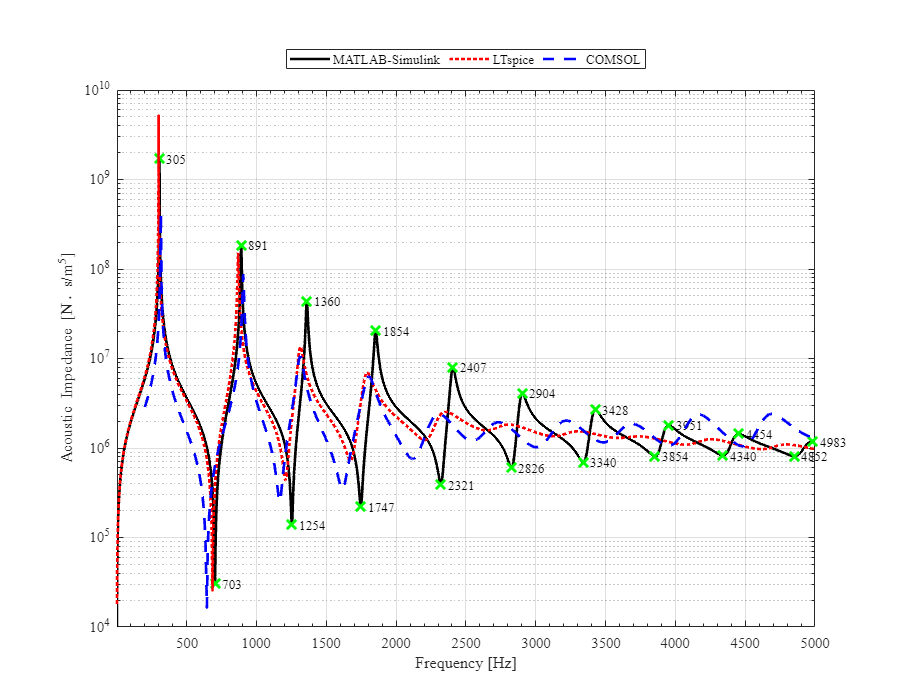
ac.co.model = 'AC\_Compressor';



## Acoustic overall model

%% Specify the model name

ac.all.model = 'AC\_Overall';



# Mechanical components

## Diaphragm modeled by 3DOF linear

me.di.R = 1; % Damping coefficient, [N.s/m]

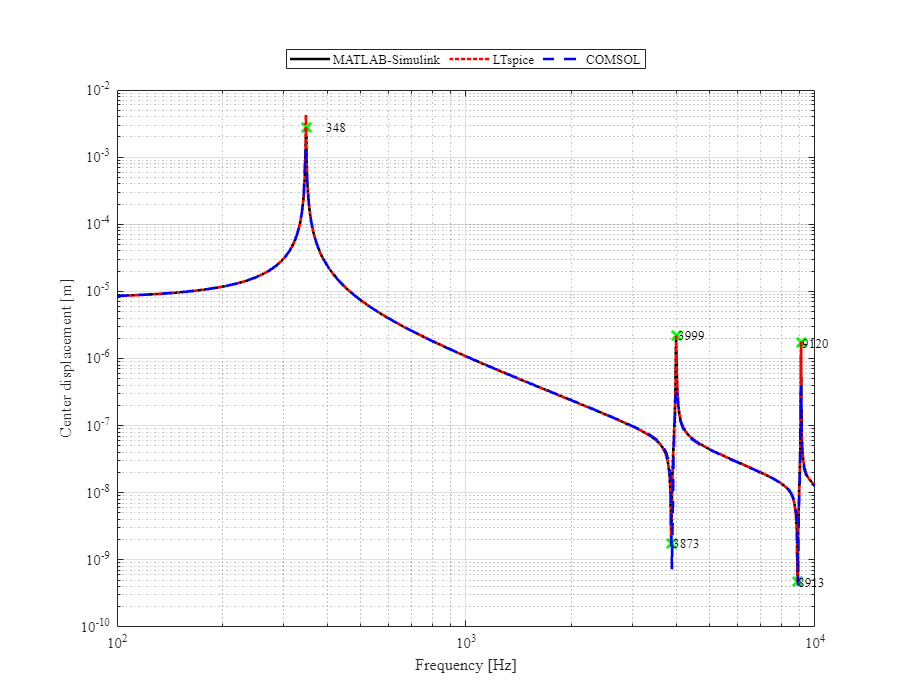
%% for 3DOF linear driver

me.dl.f = [347.8491105695766 4002.8759129004957 9118.609276012086];

me.dl.phi = [37.47048679642662 2.4855617498927827 1.8325667984395029];

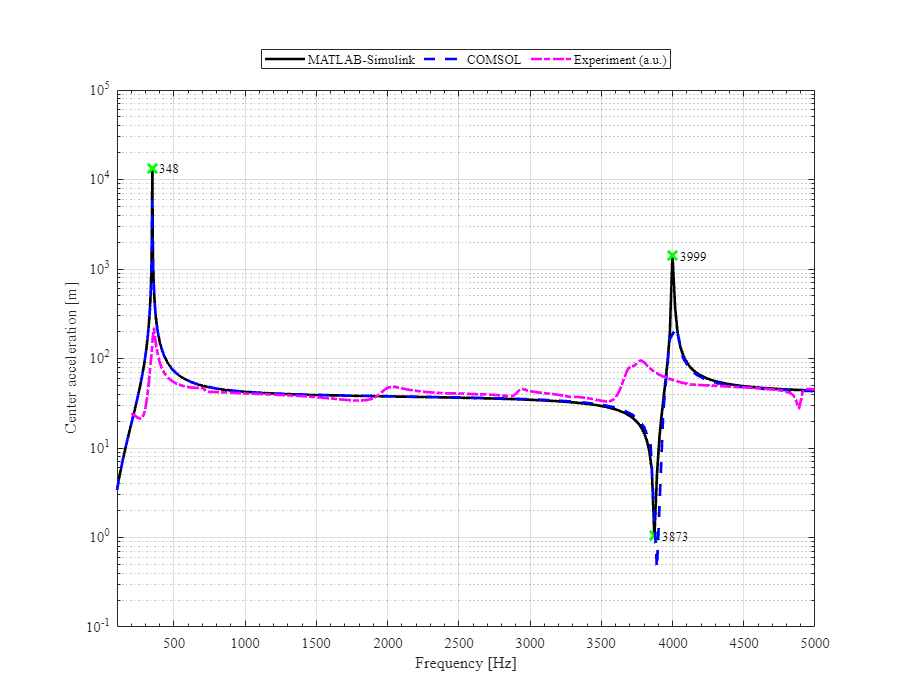
%% Specify the model name

me.dl.model = 'ME\_Diaphragm\_3DOF\_linear';



%% Specify the model name

me.dl.model = 'ME\_Diaphragm\_3DOF\_linear\_acc';



## Diaphragm modeled by 1DOF nonlinear

%% for 1DOF non-linear driver

me.dn.M = 0.028596625123380574; % Mass, [kg]

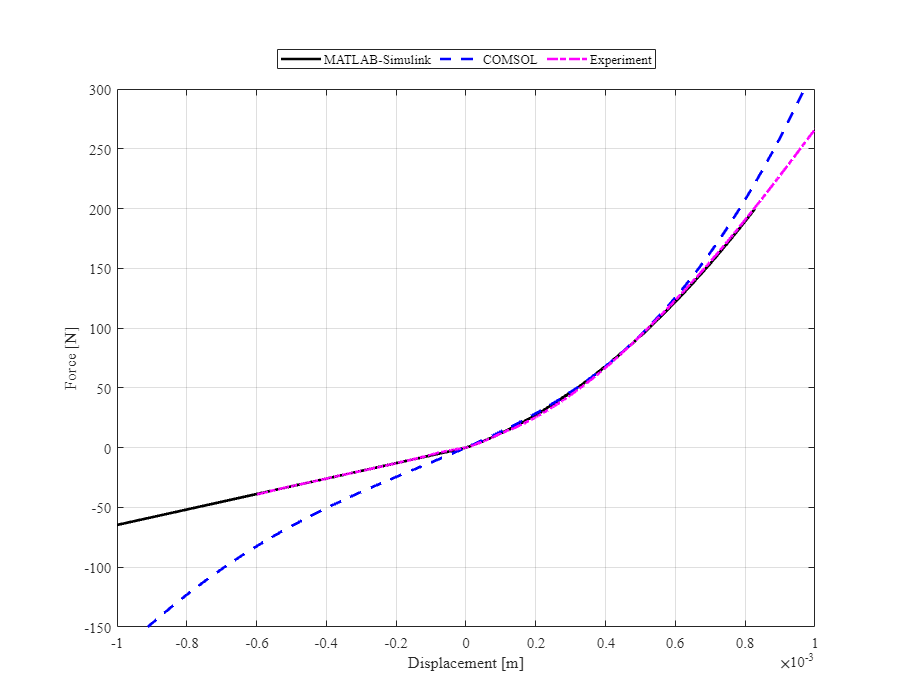
me.dn.Kt = [1.028e+05 1.674e+08 2.022e+05 0 0];

% Positive spring coefficients, [N/m]

me.dn.Kc = [6.466e+04 0 0 0 0];

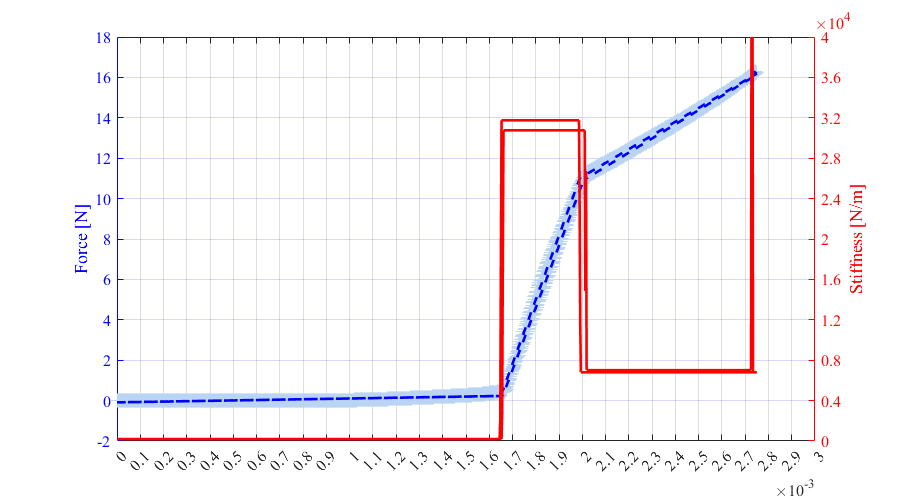
% Negative spring coefficients, [N/m]

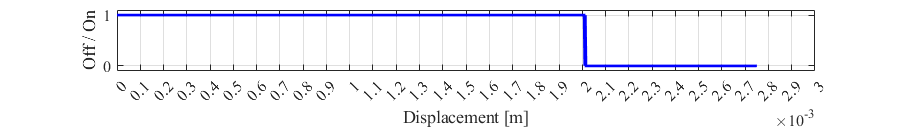
me.fd = load('fd\_nl.mat');



## Spring switch

the values from the experiment result (FD curve of spring)





me.sw.K\_pt = 31e3; % Pretensioned-spring coefficients, [N/m]

me.sw.K = 7e3; % Spring coefficients, [N/m]

# Mechano-acoustical coupling

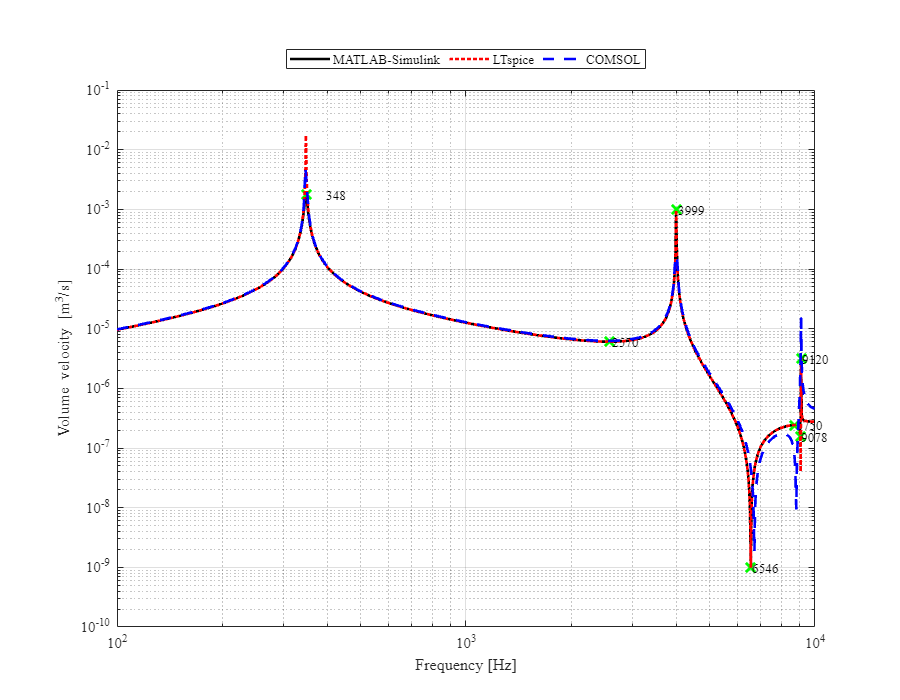
## Diaphragm

ma.di.s = 0.0036417751495247705;

ma.di.psi = [0.49105789017885293 4.641306076294213 0.008159872921131028];

%% Specify the model name

ma.dl.model = 'MA\_Diaphragm\_3DOF\_linear';



# Electrical components

## Coil

el.coil.Ls = 800e-6; % Coil series inductance, [H]

el.coil.Rs = 670e-3; % Coil series resistance, [Ohm]

el.coil.Rs1 = 000e-3; % Additional series resistance, [Ohm]

el.coil.N = 140; % No. of winding turns, [1]

## Power Supply

el.ps.V = 12; % Power supply voltage, [V]

## Switch

el.sw.R\_on = 1e-3; % On state switch resistance, [Ohm]

el.sw.R\_off = 1e7; % Off state switch resistance, [Ohm]

# Magnetic components

ma.arm.r = 5.1e-3; % Armature radius, [m]

# Magneto-mechanical coupling

mm.gap = 1.2e-3; % Gap distance between armature and pole, [m]

# Electro-mechanical coupling

## Switch

em.sw.x\_on\_pt = -70e-6; % Transition position from spring switch free to pretensioned, [m]

em.sw.x\_off = -360e-6; % Transition position from spring switch pretensioned to off, [m]

# Mechano-acoustical coupled model

Sound pressure level frequency response when the armature is sinusoidally excited by 1 [N].

%% Specify the model name

ma.all.model = 'MA\_Overall\_3DOF\_linear\_driver';

