Comparison of Rectangular and Spherical Models

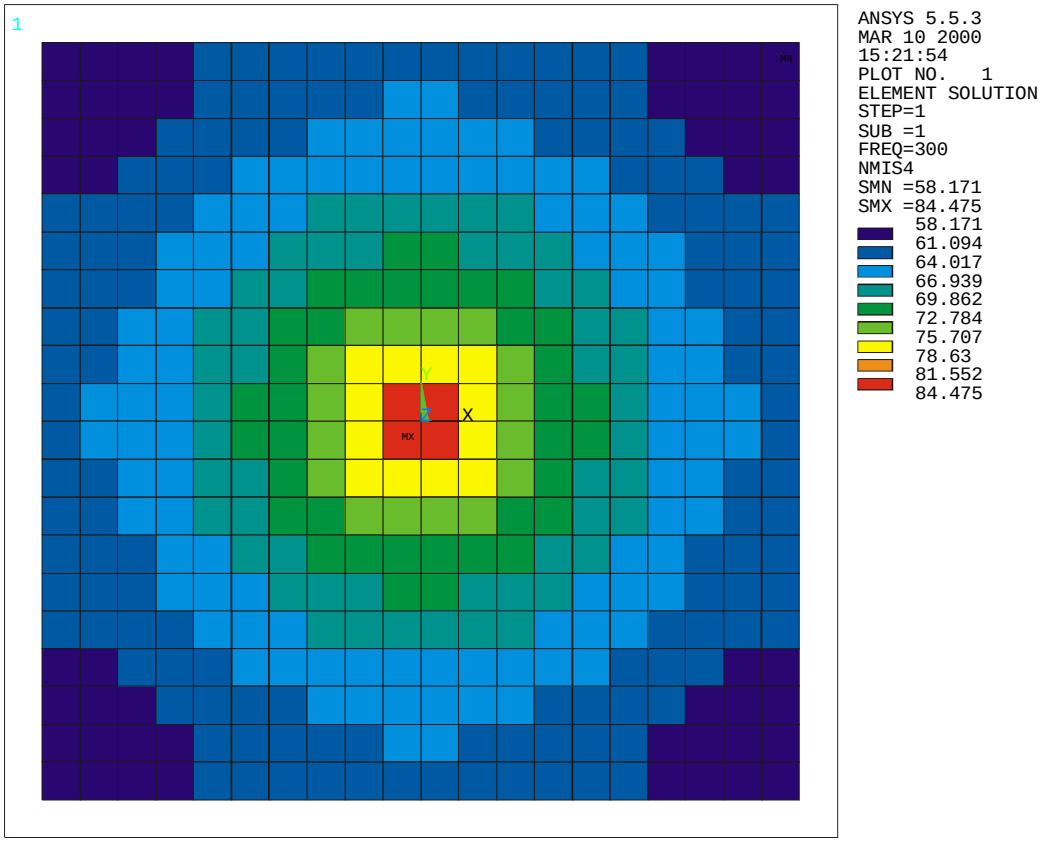
The purpose of this investigation was to compare the two modelling techniques for an infinite boundary. The first technique involves setting the elements on the edges of the model to have an absorptive property by changing the material properties so that `mu=1`. The second technique involves the use of infinite elements (`infinite129`) that must be placed on a constant radius curvature.

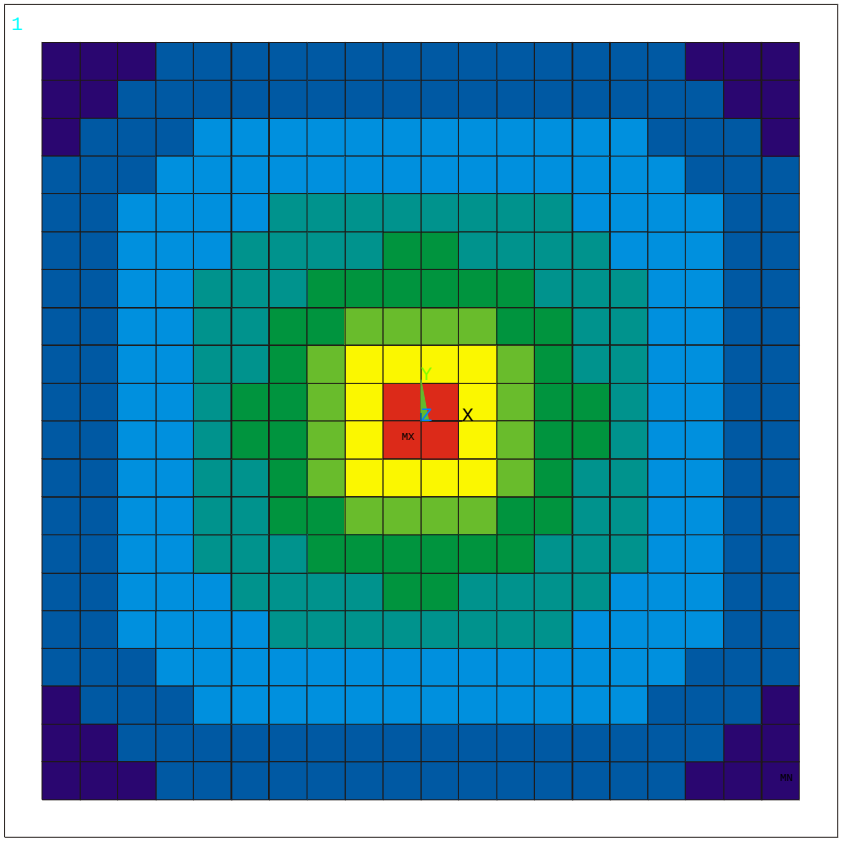
Cube

The size of the box was 1m × 1m × 1m and the element size was 0.05m. The Ansys tutorial on acoustics advises that the absolute minimum number of elements per wavelength is 6. The recommended number is at least 8 EPW. If the aim is to use 10 elements per wavelength, then the maximum frequency that can be analysed is 688Hz. The analysis was conducted at 300Hz, 600Hz, 800Hz and 1000Hz. The effects of insufficient EPW should be noticeable at 800Hz and 1000Hz.

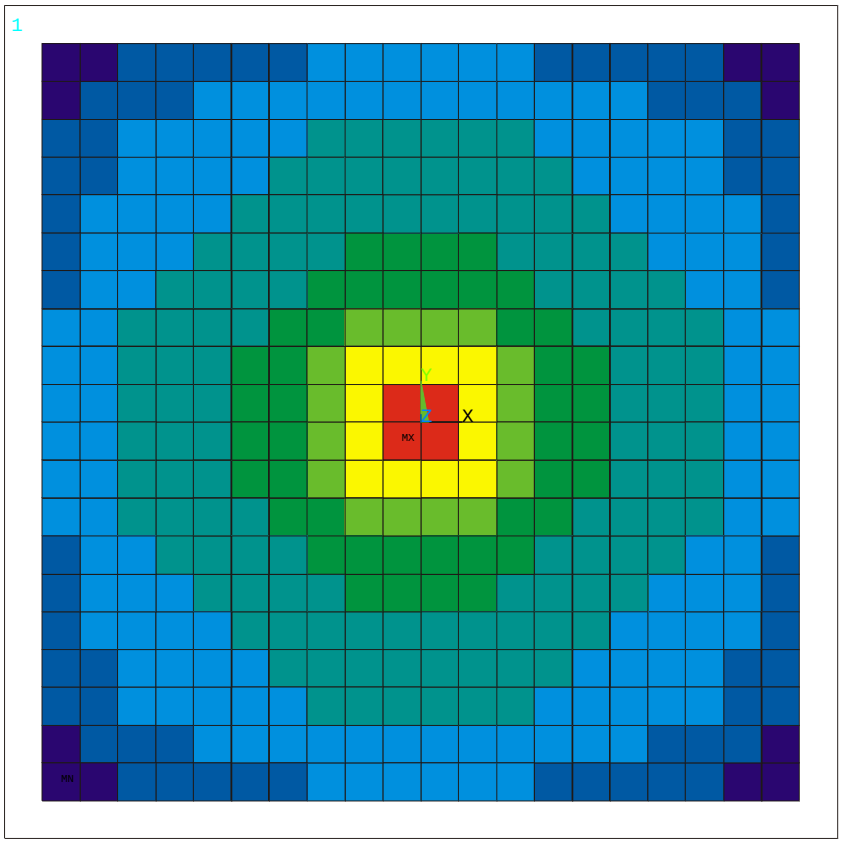
Results

The following figures show the sound pressure level in dB (re 20μPa) when the node at the centre of the model was applied with a 1Pa harmonic pressure. The elements at the edges of the model were changed to have an absorption of `mu=1`. Results are shown for 300Hz, 600Hz, 800Hz and 1000Hz.

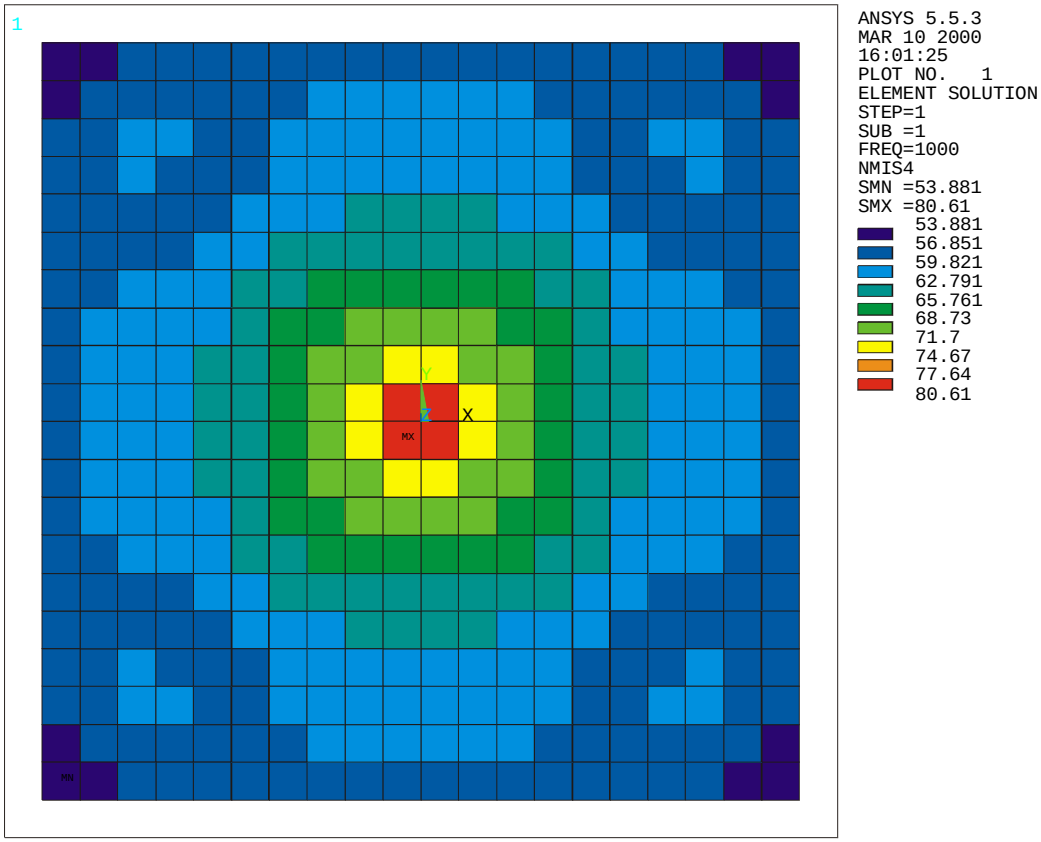




ANSYS 5.5.3
MAR 10 2000
14:53:29
PLOT NO. 1
ELEMENT SOLUTION
STEP=1
SUB =1
FREQ=600
NMIS4
SMN =53.438
SMX =81.062
53.438
56.507
59.577
62.646
65.715
68.785
71.854
74.923
77.993
81.062

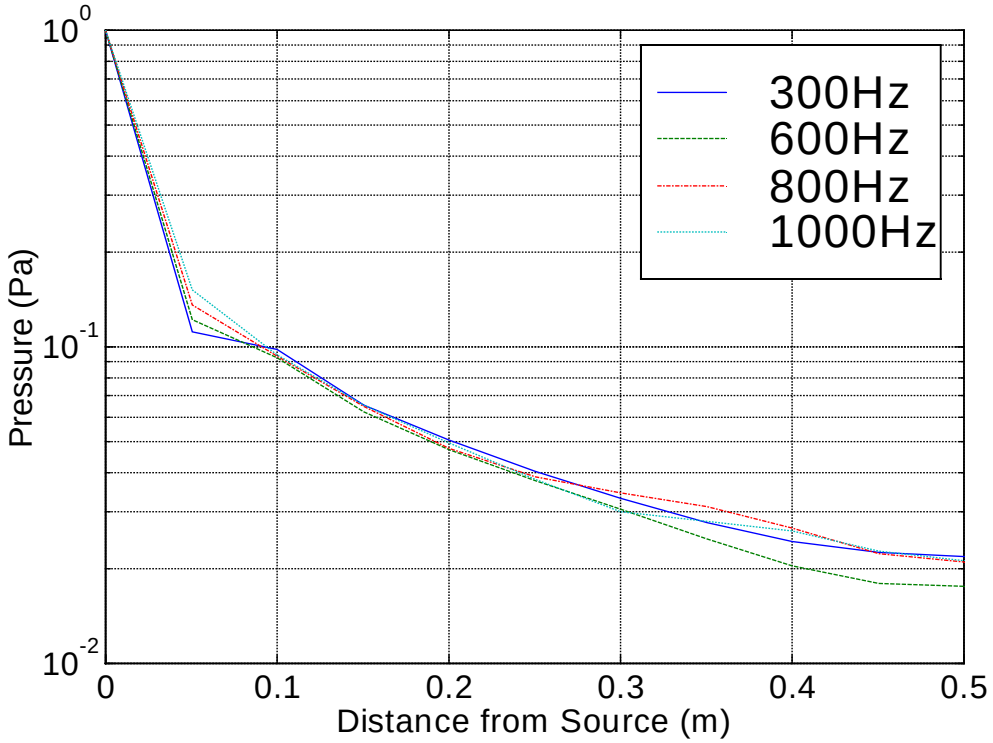


ANSYS 5.5.3
MAR 10 2000
15:39:48
PLOT NO. 1
ELEMENT SOLUTION
STEP=1
SUB =1
FREQ=800
NMIS4
SMN =49.093
SMX =77.756
49.093
52.278
55.463
58.648
61.832
65.017
68.202
71.386
74.571
77.756

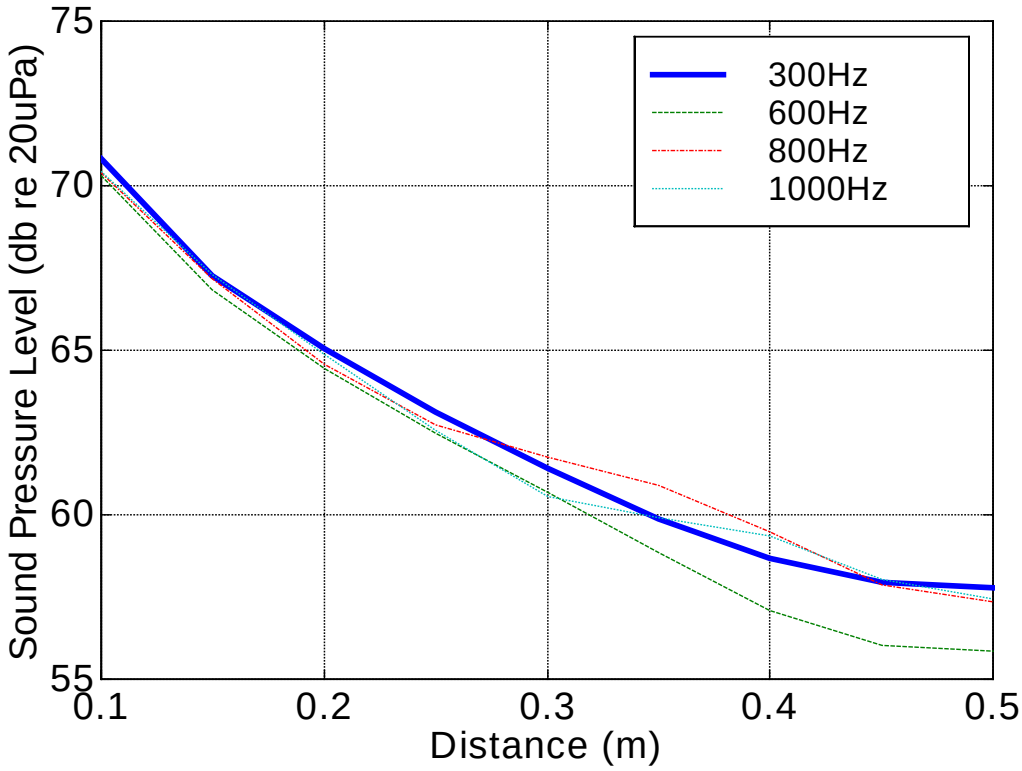


The results show the distortion of the sound field towards the edges of the square. The distortion is quite noticeable at 1000Hz.

The sound pressure level should decay with distance at a rate of 6dB per doubling of distance.



The same graph again plotted on a decibel scale, with the first couple of points removed.



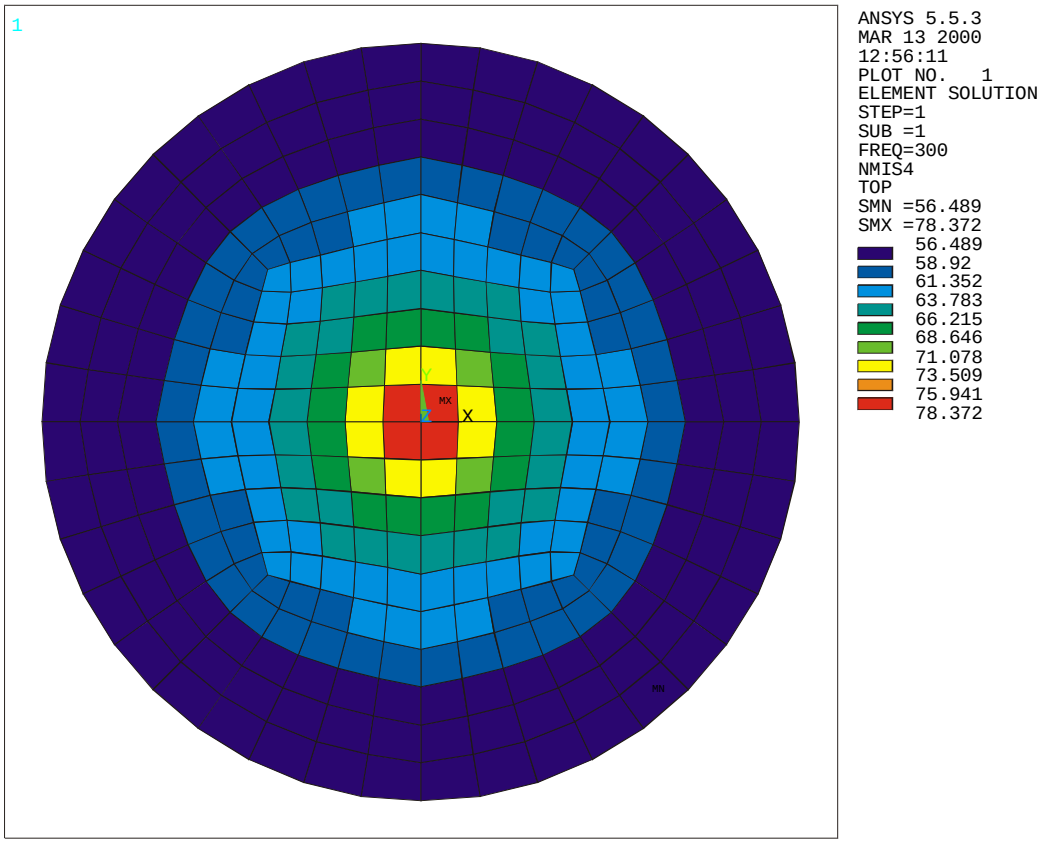
The results show that the sound pressure level roughly decreases with 6dB per doubling of distance.

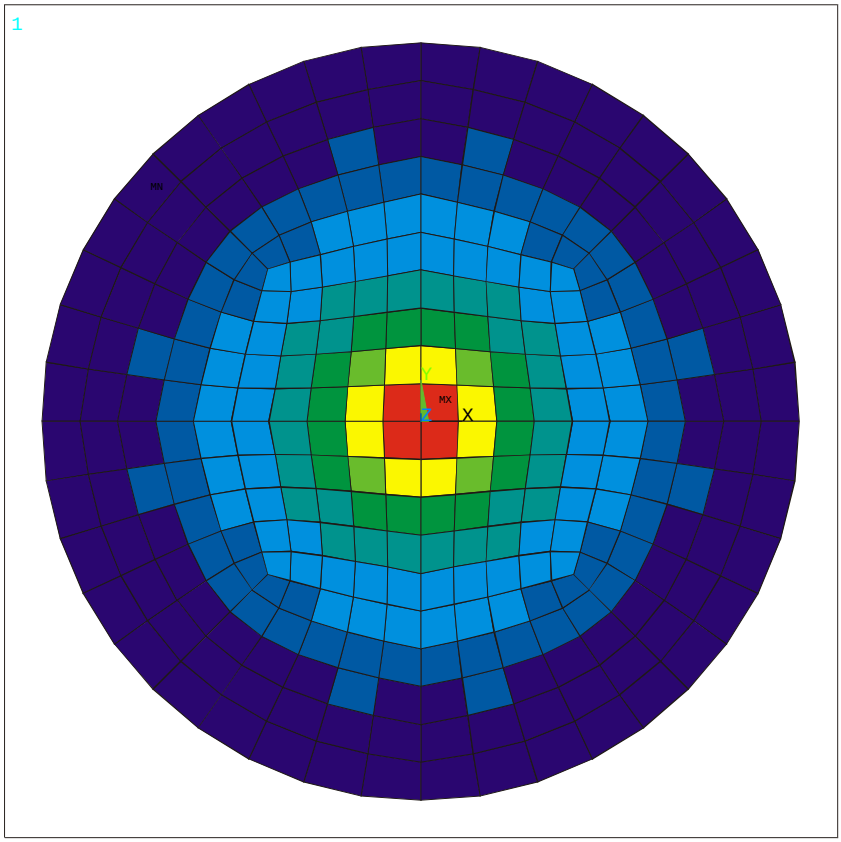
Sphere

A sphere of radius 0.5m was meshed with the same mesh density as the cube. The element size was 0.05m. The edges of the sphere were meshed with `fluid129` infinite acoustic elements.

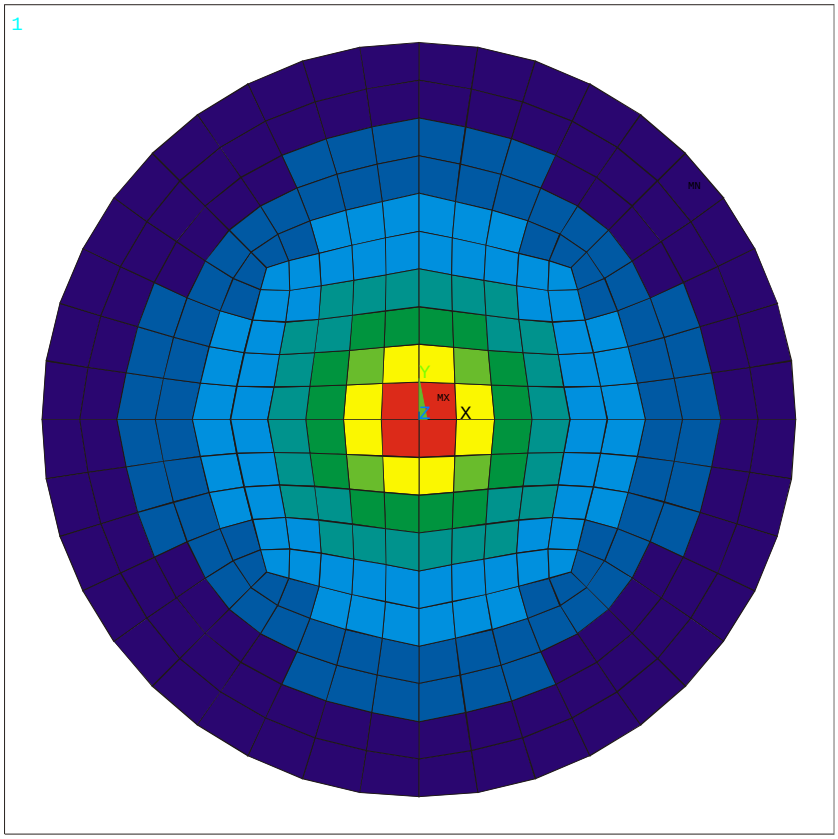
Results

The model was analysed at 300Hz, 600Hz, 800Hz and 1000Hz.

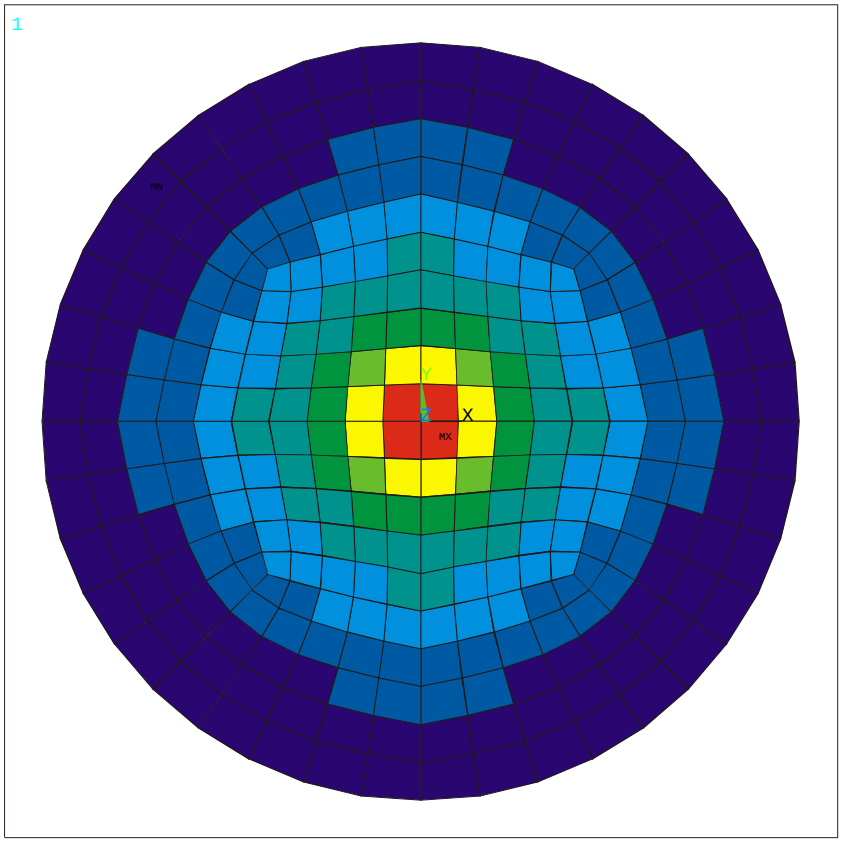




ANSYS 5.5.3
MAR 13 2000
13:06:21
PLOT NO. 1
ELEMENT SOLUTION
STEP=1
SUB =1
FREQ=600
NMIS4
TOP
SMN =56.21
SMX =78.214
56.21
58.655
61.1
63.545
65.989
68.434
70.879
73.324
75.769
78.214



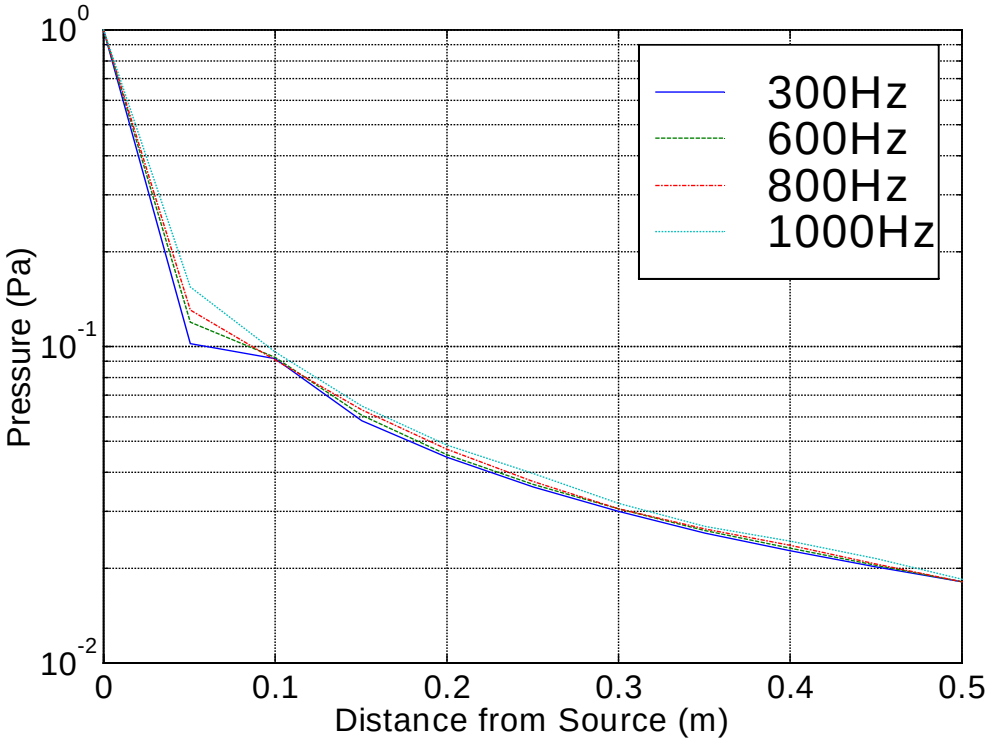
ANSYS 5.5.3
MAR 13 2000
13:17:06
PLOT NO. 1
ELEMENT SOLUTION
STEP=1
SUB =1
FREQ=800
NMIS4
TOP
SMN =58.891
SMX =80.89
58.891
61.335
63.779
66.224
68.668
71.112
73.557
76.001
78.446
80.89



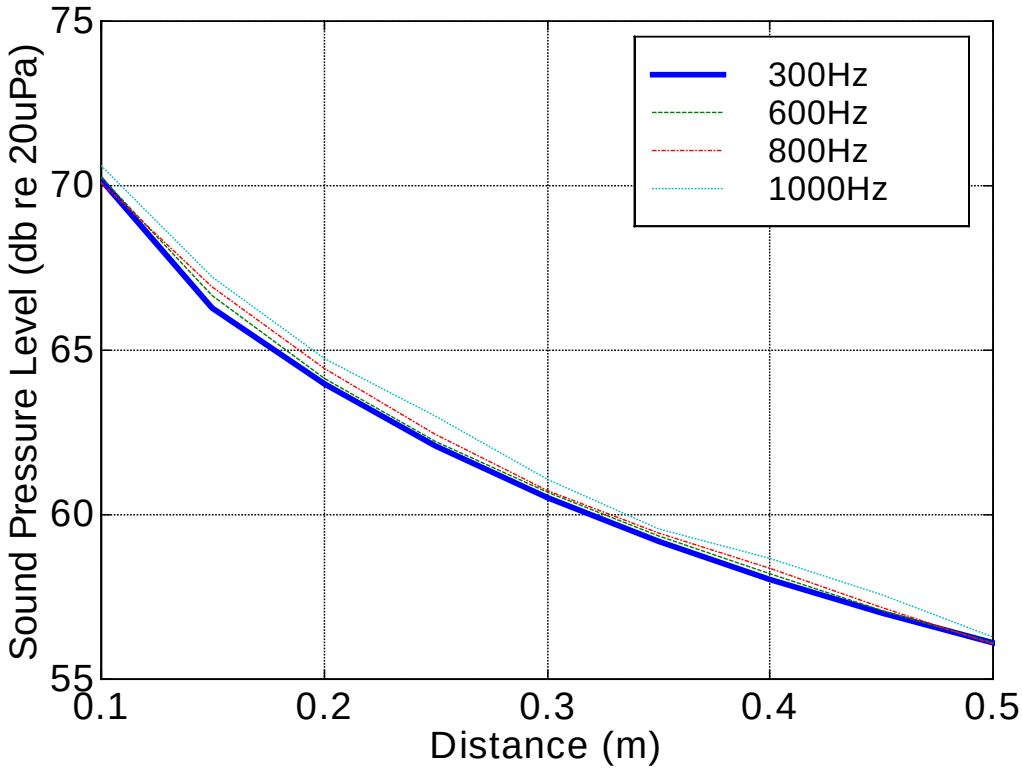
ANSYS 5.5.3
MAR 13 2000
13:25:29
PLOT NO. 1
ELEMENT SOLUTION
STEP=1
SUB =1
FREQ=1000
NMIS4
TOP
SMN =55.797
SMX =77.848

55.797
58.247
60.698
63.148
65.598
68.048
70.498
72.948
75.398
77.848

Sphere results with infinite elements



The same results plotted as the sound pressure level on a dB scale

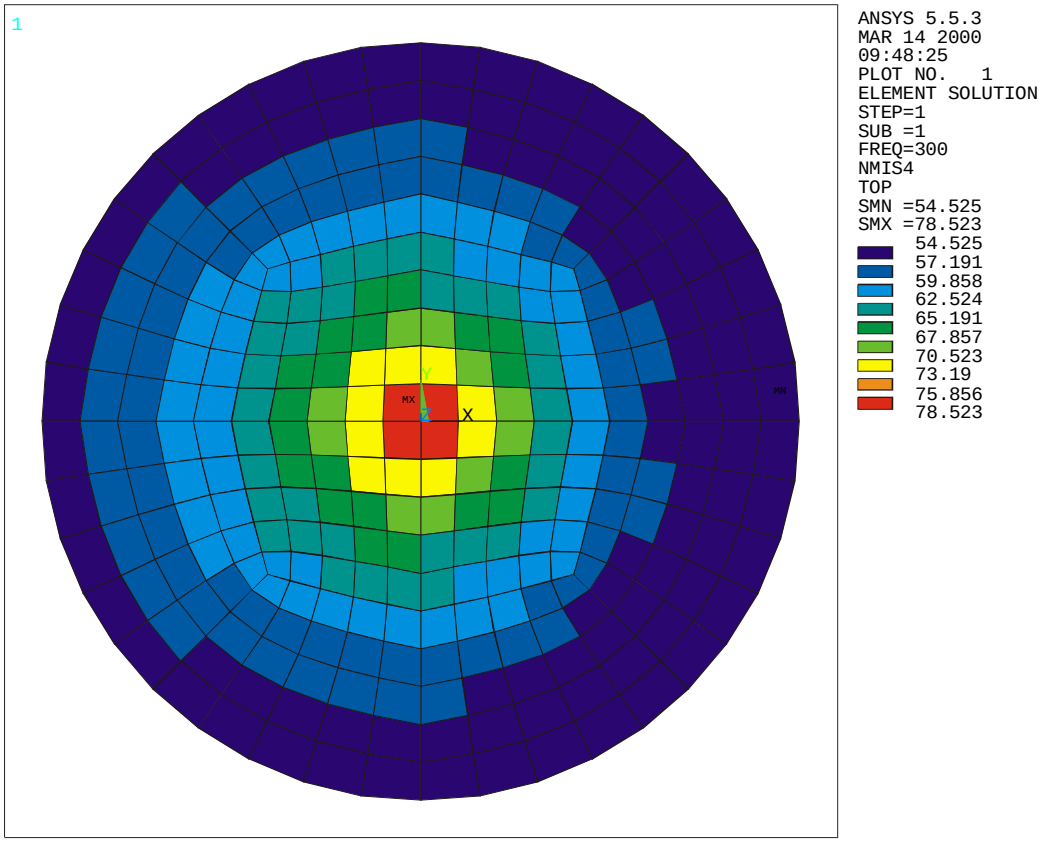


The results show that there is a decrease of 6dB with doubling of distance.

Half Infinite Elements and Half Absorptive Elements

Another model was constructed to compare the infinite elements and the absorptive elements. The outside radius of the left hand side (i.e. $x<0$) used infinite elements. The outside radius of the right hand side (i.e. $x>0$) used absorptive elements.

Results



The sound pressure level at 300Hz along the *x* axis (i.e. *y*=0) was plotted with distance from the centre and is shown below.