Hw5.3

Report date	Nov 16, 2025, 1:21:15 PM

Contents

1 Global Definitions

Date	Nov 16, 2025, 1:20:39 PM

GLOBAL SETTINGS

Name	Hw5.3.mph
Path	\\clusterfsnew.ceas1.uc.edu\students\brooksl\desktop\hw5.3.mph
Version	COMSOL Multiphysics 6.3 (Build: 420)

USED PRODUCTS

COMSOL Multiphysics
Acoustics Module

COMPUTER INFORMATION

CPU	Intel64 Family 6 Model 198 Stepping 2, 28 cores, 63.46 GB RAM
Operating system	Windows 11

1.1 PARAMETERS

PARAMETERS 1

Name	Expression	Value	Description
width	2[cm]	0.02 m	
height	1[cm]	0.01 m	

2 Component 1

SETTINGS

Description	Value
Unit system	Same as global system (SI)

2.1 DEFINITIONS

2.1.1 Coordinate Systems

Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

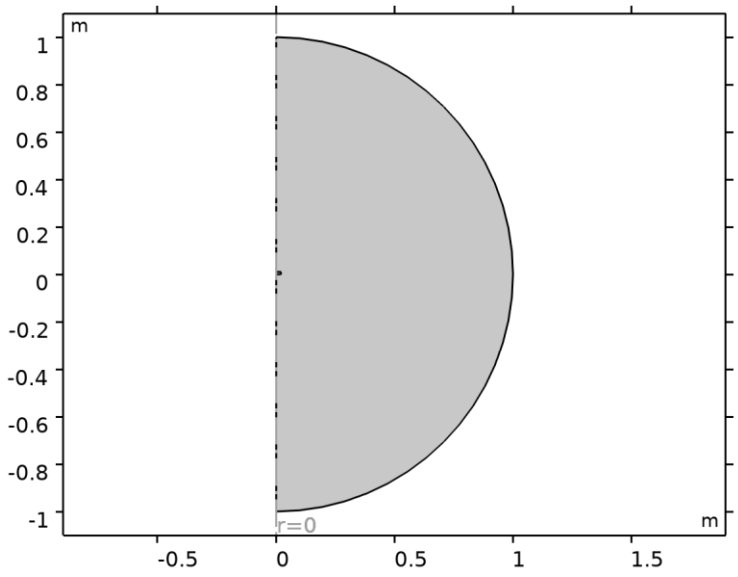
COORDINATE NAMES

First	Second	Third
t1	to	n

SETTINGS

Description	Value
Axis	phi

2.2 GEOMETRY 1



Geometry 1

UNITS

Length unit	m

Angular unit	deg

GEOMETRY STATISTICS

Description	Value
Space dimension	2
Number of domains	1
Number of boundaries	7
Number of vertices	7

2.2.1 Rectangle 1 (r1)

SIZE AND SHAPE

Description	Value
Width	width
Height	height

POSITION

Description	Value
Position	{0, 0}

2.2.2 Circle 1 (c1)

SIZE AND SHAPE

Description	Value
Radius	1

POSITION

Description	Value
Position	{0, 0}

2.2.3 Difference 1 (dif1)

INPUT OBJECTS

Description	Value
Objects to add	geom1, Geometry geom1: Object: c1
Objects to subtract	geom1, Geometry geom1: Object: r1

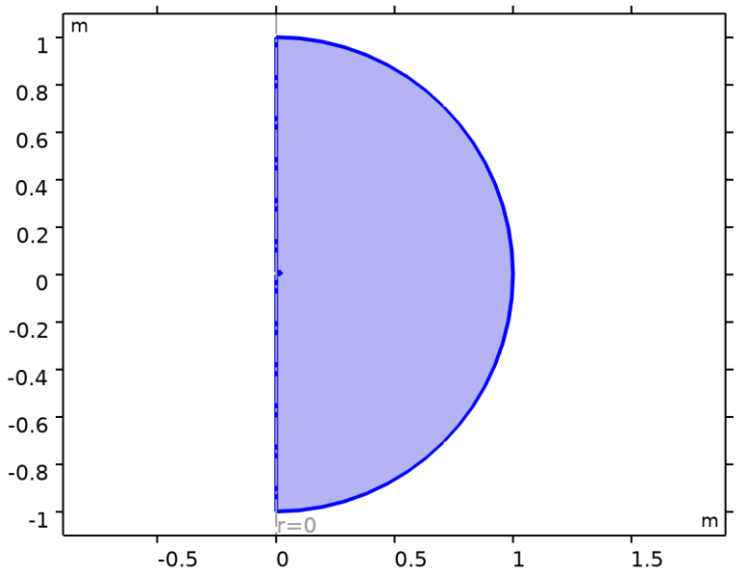
2.2.4 Form Union (fin)

INFORMATION

Description	Value
Build message	Formed union of 1 solid object. Union has 1 domain, 7 boundaries, and 7 vertices.

2.3 MATERIALS

2.3.1 air



air

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: All domains

MATERIAL PARAMETERS

Name	Value	Unit	Property group
Density	1.15	kg/m³	Basic
Speed of sound	343	m/s	Basic

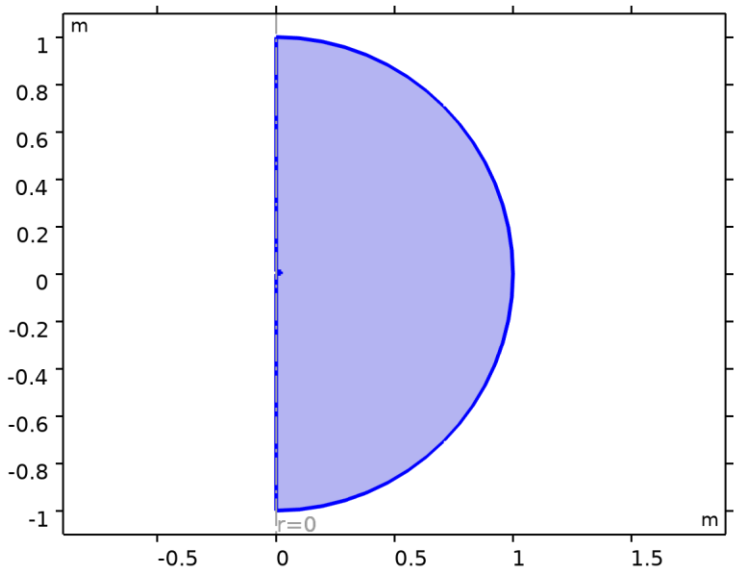
BASIC

Description	Value	Unit
Density	1.15	kg/m³
Speed of sound	343	m/s

2.4 PRESSURE ACOUSTICS, FREQUENCY DOMAIN

USED PRODUCTS

COMSOL Multiphysics
Acoustics Module



Pressure Acoustics, Frequency Domain

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: All domains

EQUATIONS

$$\nabla \cdot \left(-\frac{1}{\rho_c}(\nabla p_t - \mathbf{q}_d)\right) - \frac{k_{eq}^2 p_t}{\rho_c} = Q_m$$

$$p_t = p + p_b$$

$$k_{eq}^2 = \left(\frac{\omega}{c_c}\right)^2 - k_m^2$$

2.4.1 Interface Settings

Physics Symbols

SETTINGS

Description	Value
Enable physics symbols	On

Discretization

SETTINGS

Description	Value
Element order	Quadratic Lagrange

Physics-Controlled Mesh

SETTINGS

Description	Value
Maximum mesh element size control parameter	From study
Number of mesh elements per wavelength	Automatic

Pressure Acoustics Equation Settings

SETTINGS

Description	Value
Azimuthal mode number	0

Global Port Settings

SETTINGS

Description	Value
Port sweep settings	No port sweep
Mode shape normalization	Amplitude normalization

Sound Pressure Level Settings

SETTINGS

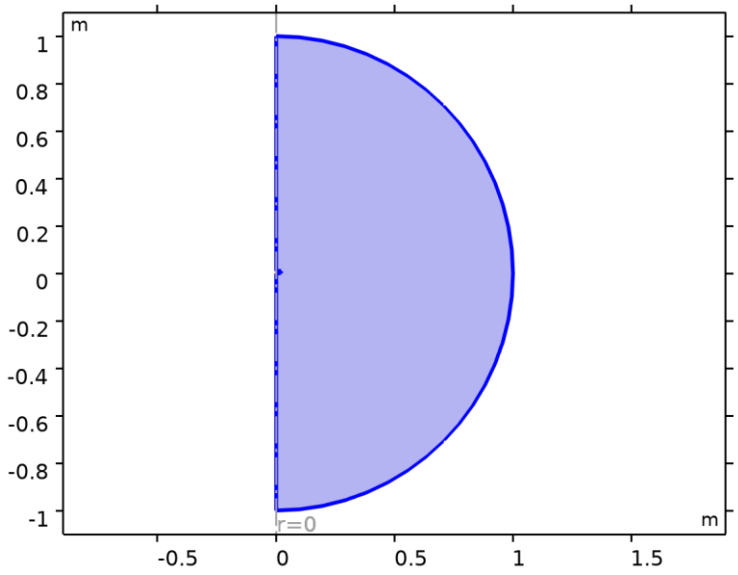
Description	Value
Reference pressure for the sound pressure level	Use reference pressure for air

Typical Wave Speed for Perfectly Matched Layers

SETTINGS

Description	Value	Unit
Typical wave speed for perfectly matched layers	real(acpr.c_c)	m/s

2.4.2 Pressure Acoustics 1



Pressure Acoustics 1

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: All domains

EQUATIONS

$$\nabla \cdot \left(-\frac{1}{\rho_c}(\nabla p_t - \mathbf{q}_d)\right) - \frac{k_{eq}^2 p_t}{\rho_c} = Q_m$$

$$p_t = p + p_b$$

$$k_{eq}^2 = \left(\frac{\omega}{c_c}\right)^2 - k_m^2$$

$$c_c = c, \quad \rho_c = \rho$$

Pressure Acoustics Model

SETTINGS

Description	Value
Fluid model	Linear elastic
Specify	Density and speed of sound
Speed of sound	From material
Density	From material

Model Input

SETTINGS

Description	Value	Unit
Temperature	User defined	
Temperature	293.15	K
Absolute pressure	User defined	
Absolute pressure	1.0133E5	Pa

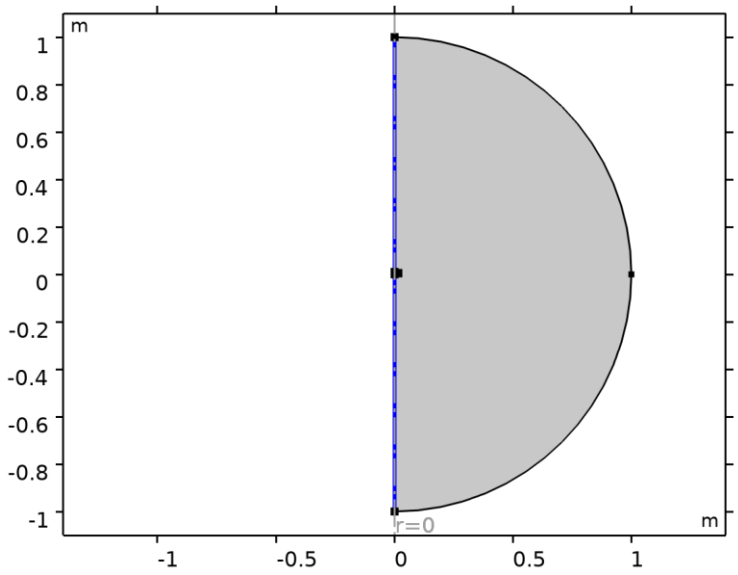
USED PRODUCTS

COMSOL Multiphysics

PROPERTIES FROM MATERIAL

Property	Material	Property group
Density	air	Basic
Speed of sound	air	Basic

2.4.3 Axial Symmetry 1



Axial Symmetry 1

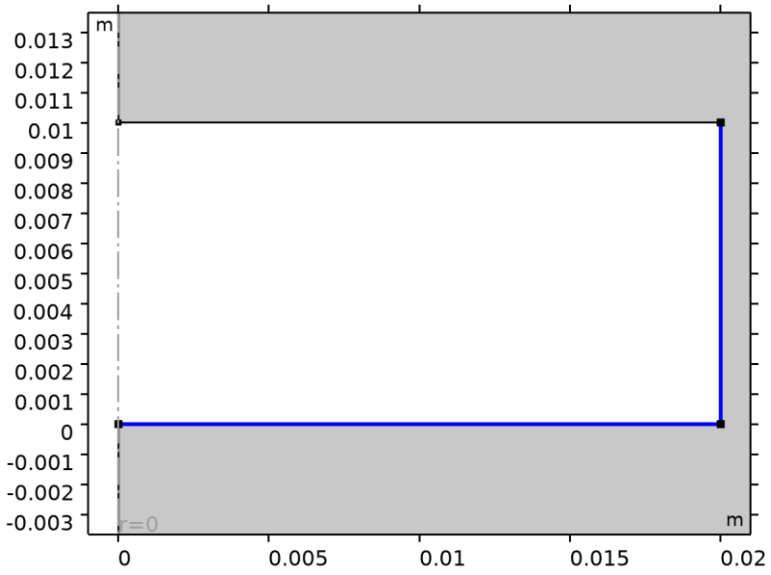
SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 1: All boundaries

USED PRODUCTS

COMSOL Multiphysics

2.4.4 Sound Hard Boundary (Wall) 1



Sound Hard Boundary (Wall) 1

SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 1: All boundaries

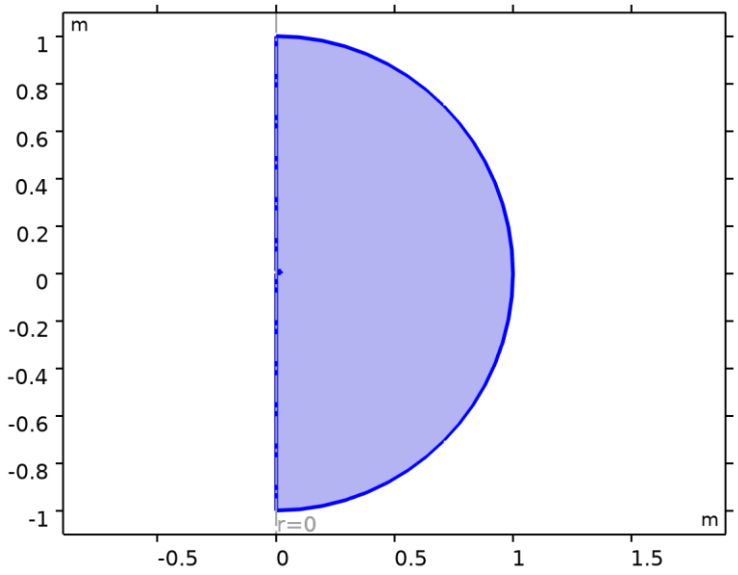
EQUATIONS

$$-\mathbf{n}\cdot\left(-\frac{1}{\rho_c}(\nabla p_t-\mathbf{q}_d)\right)=0$$

USED PRODUCTS

COMSOL Multiphysics

2.4.5 Initial Values 1



Initial Values 1

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: All domains

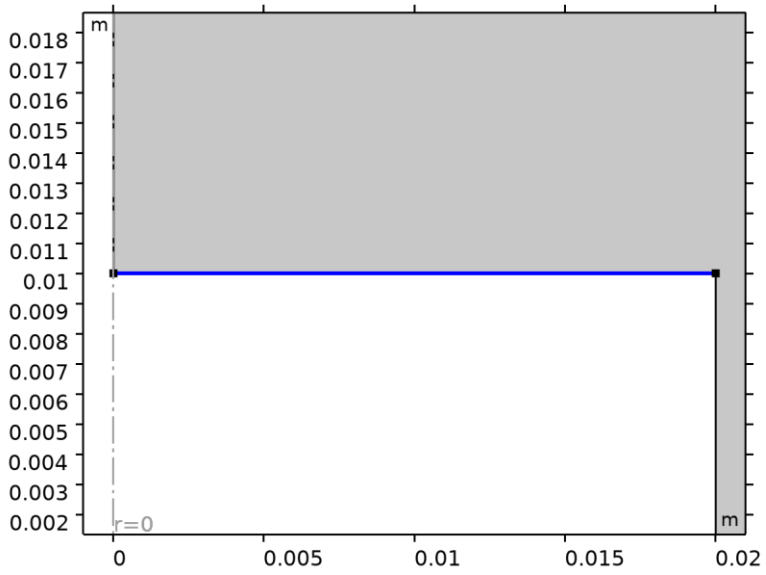
SETTINGS

Description	Value	Unit
Acoustic pressure	0	Pa

USED PRODUCTS

COMSOL Multiphysics

2.4.6 Normal Velocity 1



Normal Velocity 1

SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 1: Boundary 4

EQUATIONS

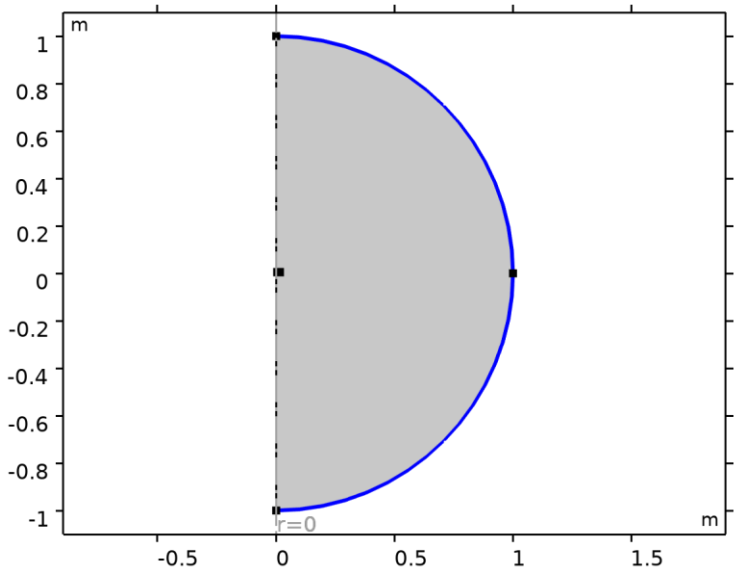
$$-\mathbf{n}\cdot\left(-\frac{1}{\rho_c}(\nabla p_t-\mathbf{q}_d)\right)=i\omega v_n$$

Normal Velocity

SETTINGS

Description	Value	Unit
Type	Inward velocity	
Inward velocity	0.01	m/s

2.4.7 Spherical Wave Radiation 1



Spherical Wave Radiation 1

SELECTION

Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 1: Boundaries 6–7

EQUATIONS

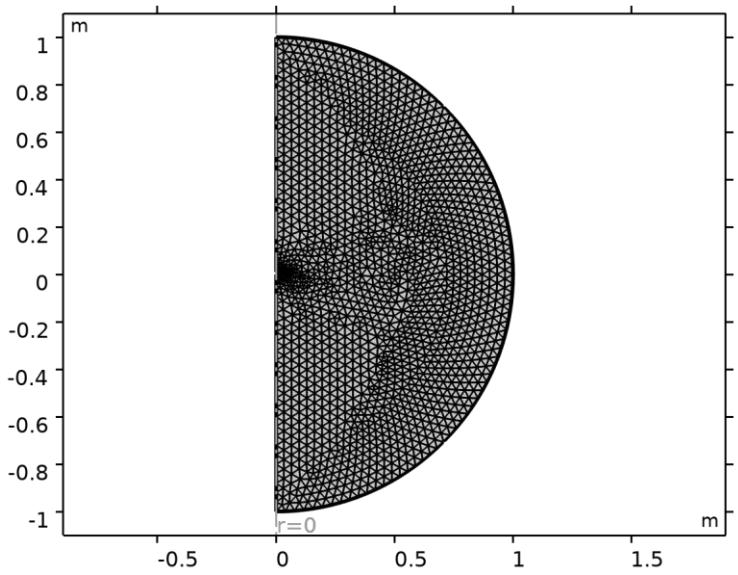
$$-\mathbf{n}\cdot\left(-\frac{1}{\rho_c}(\nabla p_t-\mathbf{q}_d)\right)+\left(ik_{eq}+\frac{1}{r_{rf}}\right)\frac{p}{\rho_c}-\frac{r_{rf}\Delta_{||}p}{2\rho_c(1+ik_{eq}r_{rf})}=Q_i$$

$$r_{rf}=\left|(\mathbf{x}-\mathbf{r}_0)\right|$$

USED PRODUCTS

COMSOL Multiphysics

2.5 MESH 1



Mesh 1

2.5.1 Size (size)

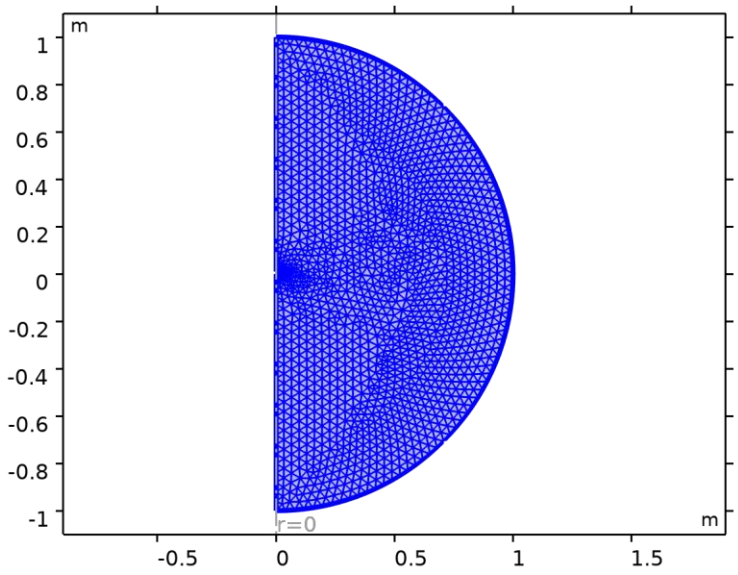
SETTINGS

Description	Value
Maximum element size	0.04
Minimum element size	2E-5
Curvature factor	0.25
Maximum element growth rate	1.2
Predefined size	Extra fine
Custom element size	Custom

2.5.2 Size Expression 1 (se1)

SELECTION

Geometric entity level	Domain
Selection	Geometry geom1: Dimension 2: Domain 1



Size Expression 1

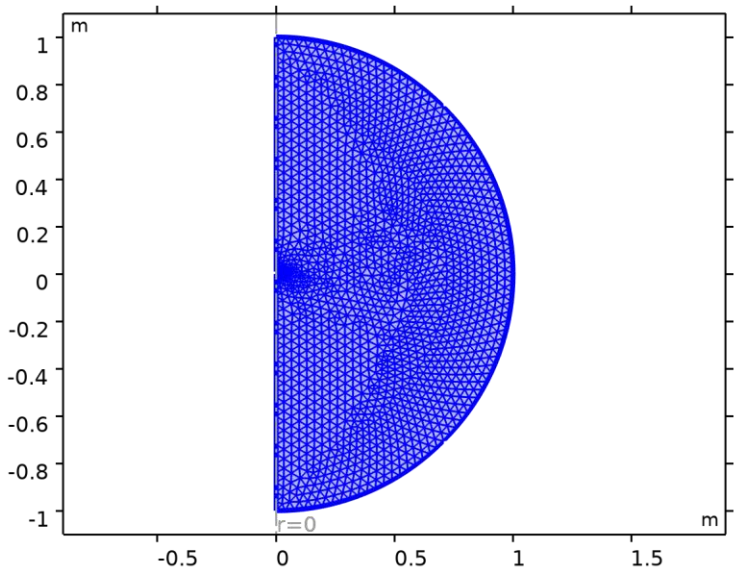
SETTINGS

Description	Value
Evaluate on	Initial expression
Study step	Study 1: Frequency Domain
Size expression	subst(real(acpr.c_c), acpr.freq, freqmax)/freqmax/5
Reevaluate with updated model	

2.5.3 Free Triangular 1 (ftri1)

SELECTION

Geometric entity level	Domain
Selection	Remaining



Free Triangular 1

SETTINGS

Description	Value
Number of iterations	4
Maximum element depth to process	4

INFORMATION

Description	Value
Last build time	< 1 second
Built with	COMSOL 6.3.0.420 (win64), Nov 16, 2025, 12:16:42 PM

3 Study 1

COMPUTATION INFORMATION

Computation time	1 s

3.1 FREQUENCY DOMAIN

Frequencies (Hz)
1000

STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

SETTINGS

Description	Value
Frequencies	1000

PHYSICS AND VARIABLES SELECTION

Key	Solve for
Pressure Acoustics, Frequency Domain (acpr)	On

STORE IN OUTPUT

Interface	Output	Selection
Pressure Acoustics, Frequency Domain (acpr)	Physics controlled	

MESH SELECTION

Component	Mesh
Component 1	Mesh 1

3.2 SOLVER CONFIGURATIONS

3.2.1 Solution 1

Compile Equations: Frequency Domain (st1)

STUDY AND STEP

Description	Value
Use study	Study 1
Use study step	Frequency Domain

Dependent Variables 1 (v1)

GENERAL

Description	Value
Defined by study step	Step 1: Frequency Domain

INITIAL VALUE CALCULATION CONSTANTS

Constant name	Initial-value source
freq	1000[Hz]

Acoustic Pressure (comp1.p) (comp1_p)

GENERAL

Description	Value
Field components	comp1.p

Stationary Solver 1 (s1)

GENERAL

Description	Value
Defined by study step	Step 1: Frequency Domain

RESULTS WHILE SOLVING

Description	Value
Probes	None

Advanced (aDef)

ASSEMBLY SETTINGS

Description	Value
Reuse sparsity pattern	On
Allow complex-valued output from functions with real input	On

Parametric 1 (p1)

GENERAL

Description	Value
Defined by study step	Step 1: Frequency Domain
Run continuation for	No parameter

PARAMETERS

Parameter name	Parameter value list	Parameter unit
freq	1000	Hz

Fully Coupled 1 (fc1)

GENERAL

Description	Value

Description	Value
Linear solver	Direct

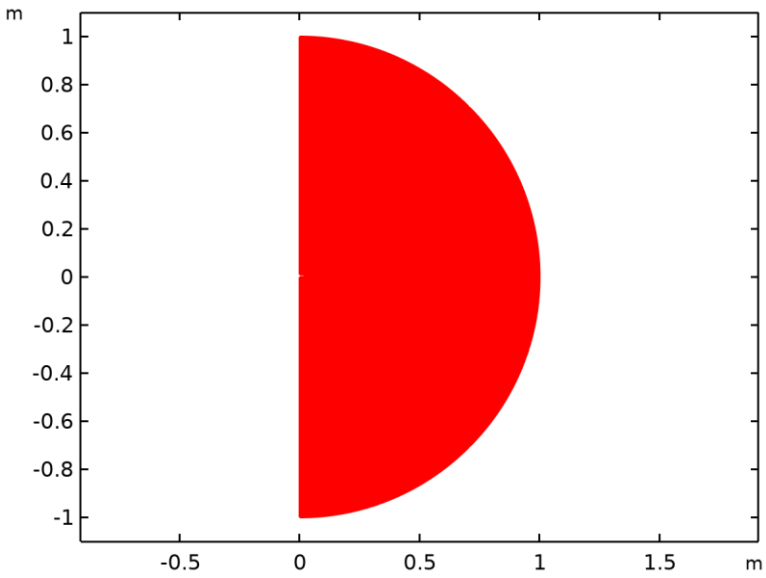
4 Results

4.1 DATASETS

4.1.1 Study 1/Solution 1

SOLUTION

Description	Value
Solution	Solution 1 (sol1)
Component	Component 1 (comp1)



Dataset: Study 1/Solution 1

4.1.2 Revolution 2D 1

DATA

Description	Value
Dataset	Study 1/Solution 1 (sol1)

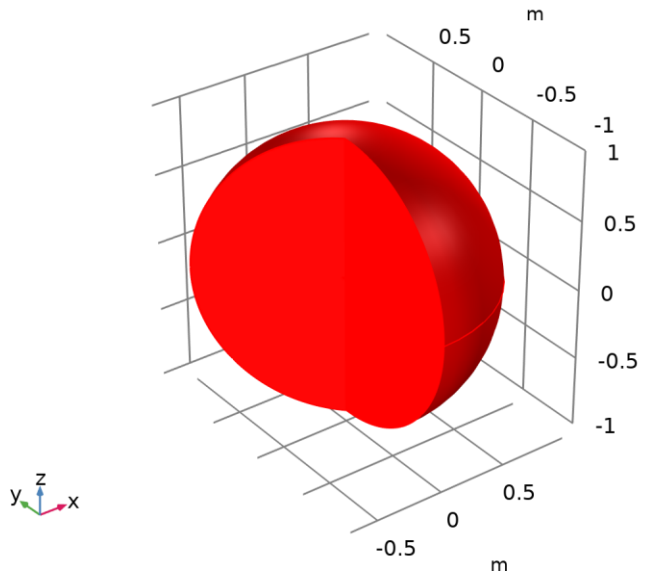
AXIS DATA

Description	Value
Axis entry method	Two points
Points	{{0, 0}, {0, 1}}

REVOLUTION LAYERS

Description	Value
Start angle	-90

Description	Value
Revolution angle	225



Dataset: Revolution 2D 1

4.2 DERIVED VALUES

4.2.1 Line Integration 1

OUTPUT

Evaluated in	Table 1

DATA

Description	Value
Dataset	Study 1/Solution 1 (sol1)

EXPRESSIONS

Expression	Unit	Description
acpr.I_mag	W	Intensity magnitude

INTEGRATION SETTINGS

Description	Value
Integration order	4
Compute surface integral	On

4.3 TABLES

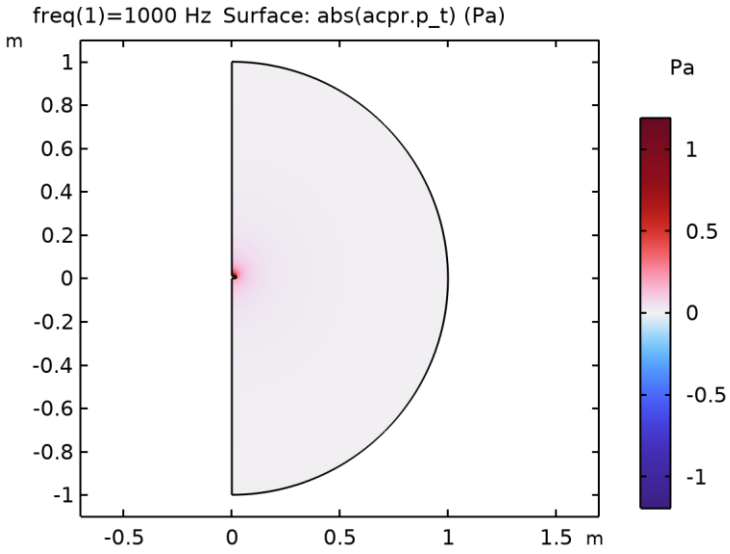
4.3.1 Table 1

Line Integration 1

freq (Hz)	Intensity magnitude (W)
1000	8.2901E-7

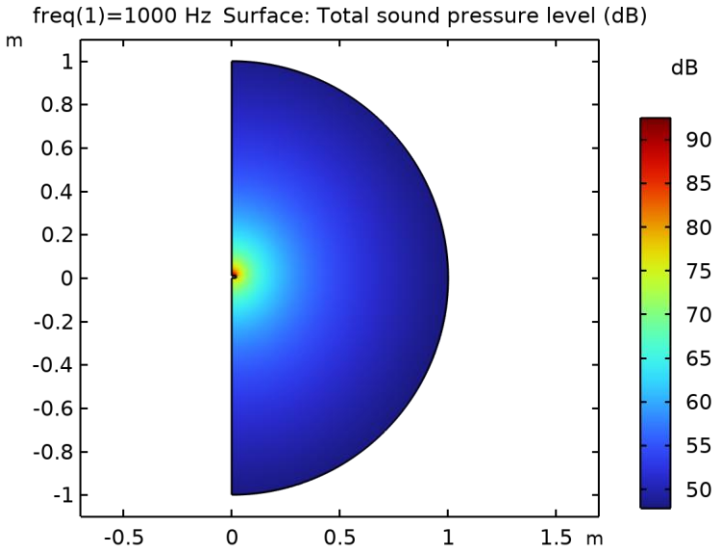
4.4 PLOT GROUPS

4.4.1 Acoustic Pressure (acpr)



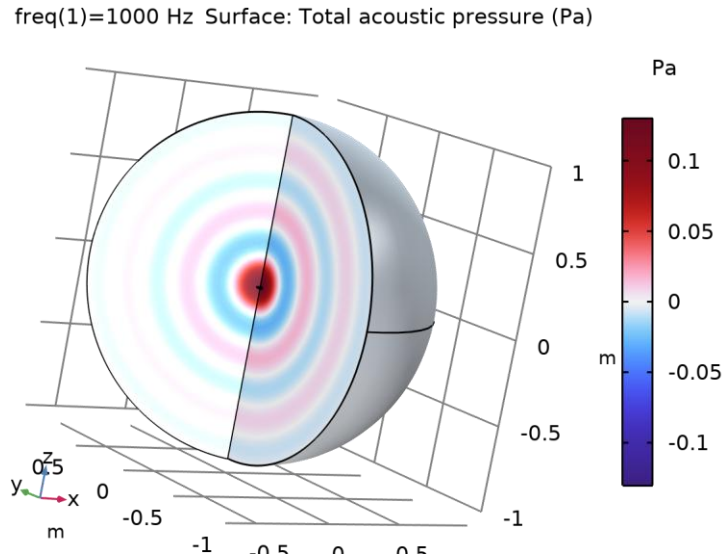
Surface: abs(acpr.p_t) (Pa)

4.4.2 Sound Pressure Level (acpr)



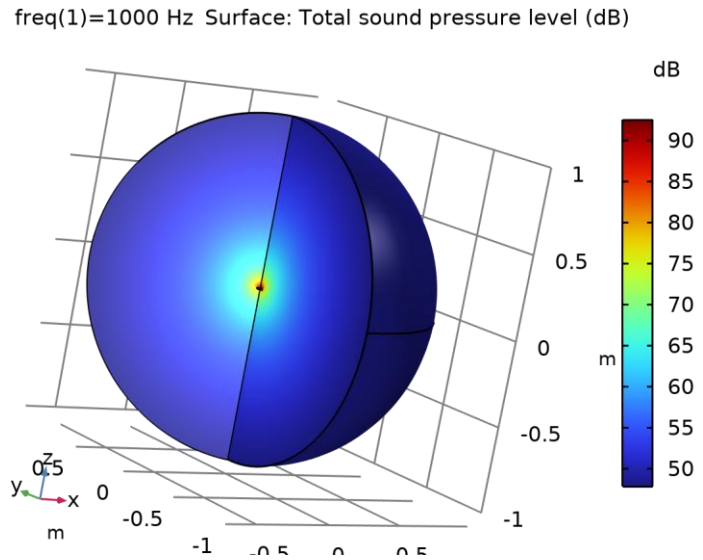
Surface: Total sound pressure level (dB)

4.4.3 Acoustic Pressure, 3D (acpr)



Surface: Total acoustic pressure (Pa)

4.4.4 Sound Pressure Level, 3D (acpr)



Surface: Total sound pressure level (dB)

4.5 EVALUATION GROUPS

4.5.1 Evaluation Group 1

DATA

Description	Value
Dataset	Study 1/Solution 1 (sol1)

FEATURES

Point Evaluation 1

RESULTS

freq (Hz)	abs(acpr.p_t) (Pa), Point: 1	abs(acpr.p_t) (Pa), Point: 3	abs(acpr.p_t) (Pa), Point: 4	abs(acpr.p_t) (Pa), Point: 7	Total sound pressure level (dB), Point: 1	Total sound pressure level (dB), Point: 3	Total sound pressure level (dB), Point: 4	Total sound pressure level (dB), Point: 7
1000	0.0071401	1.1931	0.0074765	0.0070062	48.043	92.502	48.443	47.879

Point Evaluation 1

EXPRESSIONS

Expression	Unit	Description
abs(acpr.p_t)	Pa	

Expression	Unit	Description
acpr.Lp_t	dB	Total sound pressure level