Hw5.2

Report date	Nov 17, 2025, 8:58:57 PM

Contents

1 Global Definitions

Date	Nov 16, 2025, 12:10:32 PM

GLOBAL SETTINGS

Name	Hw5.2.mph
Path	\\clusterfsnew.ceas1.uc.edu\students\brooksl\desktop\hw5.2.mph
Version	COMSOL Multiphysics 6.3 (Build: 420)

USED PRODUCTS

Acoustics Module
COMSOL Multiphysics

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
length	10[m]	10 m	
height	1[m]	1 m	
rho1	1026[kg/m^3]	1026 kg/m³	
c1	1500[m/s]	1500 m/s	
rho2	2070[kg/m^3]	2070 kg/m³	
c2	1730[m/s]	1730 m/s	
p_input	1[Pa]	1 Pa	
theta_i	70[deg]	1.2217 rad	
f_study	10[kHz]	10000 Hz	

1.2 SHARED PROPERTIES

1.2.1 Default Model Inputs

Tag	cminpt

2 Component 1

SETTINGS

Description	Value
Unit system	Same as global system (SI)

2.1 DEFINITIONS

2.1.1 Coordinate Systems

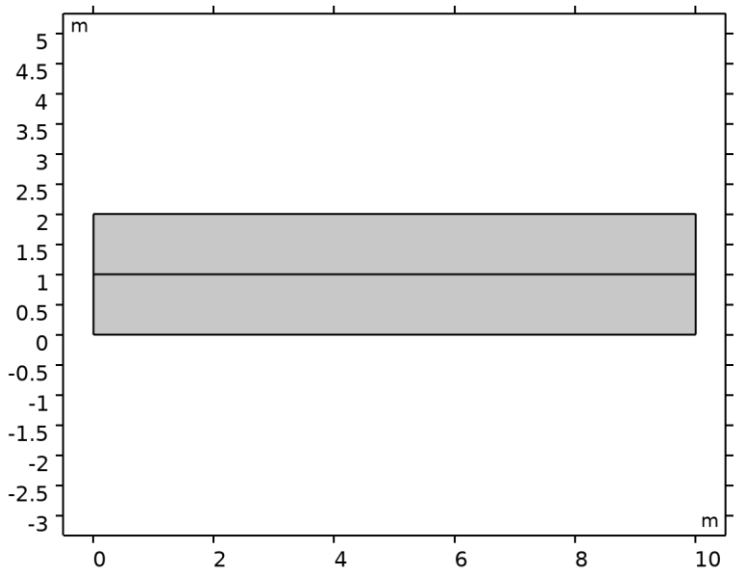
Boundary System 1

Coordinate system type	Boundary system
Tag	sys1

COORDINATE NAMES

First	Second	Third
t1	n	to

2.2 GEOMETRY 1



Geometry 1

UNITS

Length unit	m
Angular unit	deg

GEOMETRY STATISTICS

Description	Value

Description	Value
Space dimension	2
Number of domains	2
Number of boundaries	7
Number of vertices	6

2.2.1 Rectangle 1 (r1)

SIZE AND SHAPE

Description	Value
Width	length
Height	height

POSITION

Description	Value
Position	{0, 0}

2.2.2 Rectangle 2 (r2)

SIZE AND SHAPE

Description	Value
Width	length
Height	height

POSITION

Description	Value
Position	{0, height}

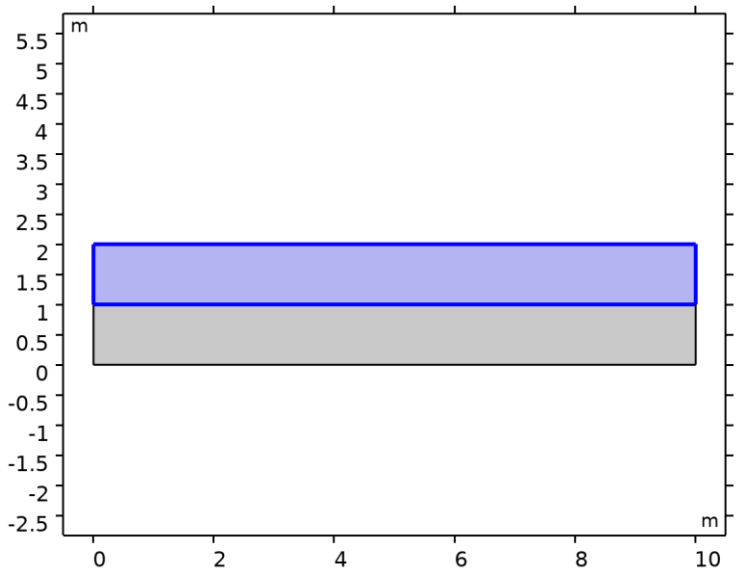
2.2.3 Form Union (fin)

INFORMATION

Description	Value
Build message	Formed union of 2 solid objects. Union has 2 domains, 7 boundaries, and 6 vertices.

2.3 MATERIALS

2.3.1 seawater



seawater

SELECTION

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

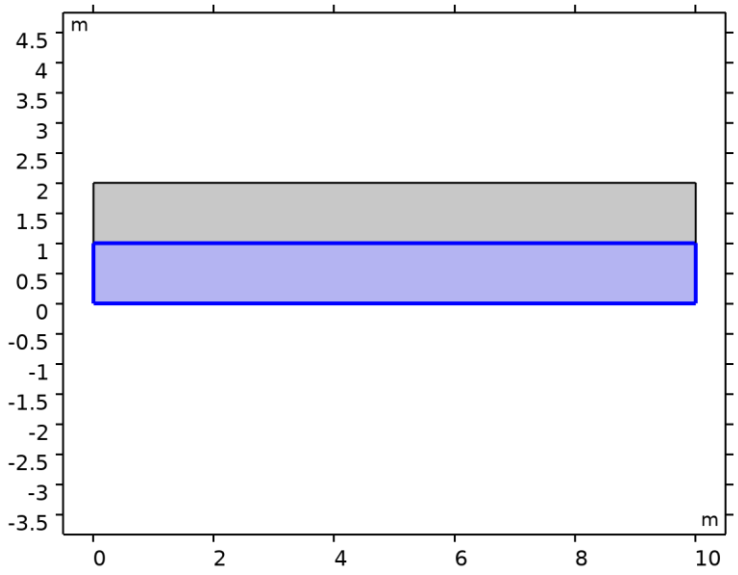
MATERIAL PARAMETERS

Name	Value	Unit	Property group
Density	rho1	kg/m³	Basic
Speed of sound	c1	m/s	Basic

BASIC

Description	Value	Unit
Density	rho1	kg/m³
Speed of sound	c1	m/s

2.3.2 quartz sand



quartz sand

SELECTION

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

MATERIAL PARAMETERS

Name	Value	Unit	Property group
Density	rho2	kg/m³	Basic
Speed of sound	c2	m/s	Basic

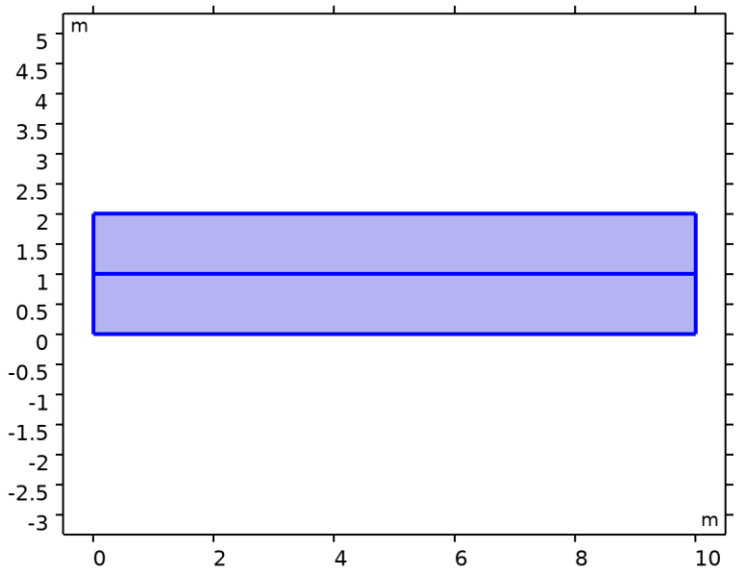
BASIC

Description	Value	Unit
Density	rho2	kg/m³
Speed of sound	c2	m/s

2.4 PRESSURE ACOUSTICS, FREQUENCY DOMAIN

USED PRODUCTS

Acoustics Module
COMSOL Multiphysics



Pressure Acoustics, Frequency Domain

SELECTION

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

EQUATIONS

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

$$p_t = p + p_b$$

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

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	Unit
Out-of-plane wave number	0	rad/m

Global Port Settings

SETTINGS

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

Sound Pressure Level Settings

SETTINGS

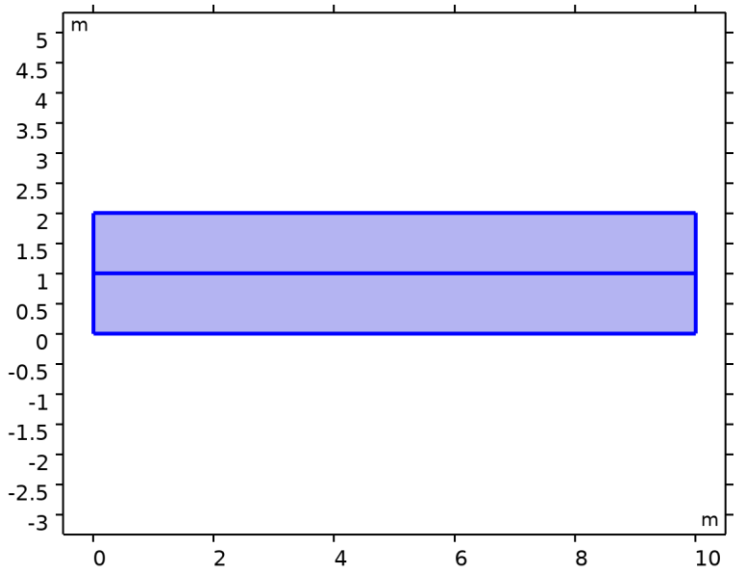
Description	Value
Reference pressure for the sound pressure level	Use reference pressure for air

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

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

$$p_t = p + p_b$$

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

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

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
Temperature	Common model input
Absolute pressure	Common model input

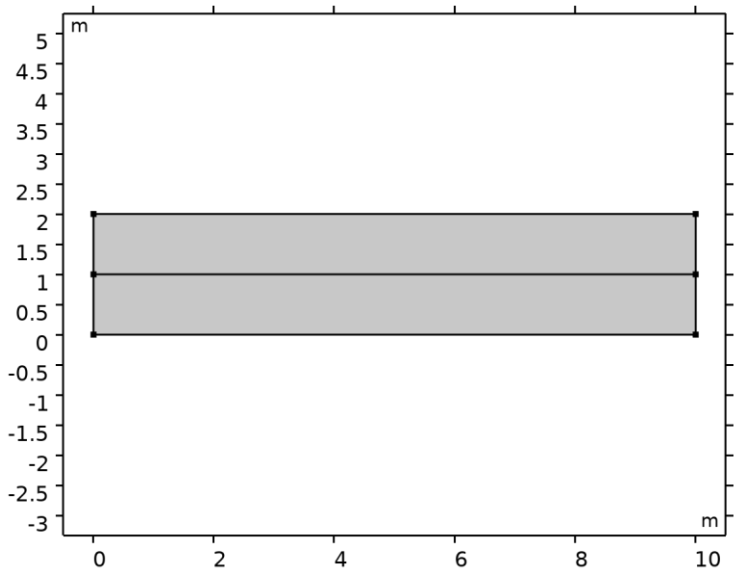
USED PRODUCTS

COMSOL Multiphysics

PROPERTIES FROM MATERIAL

Property	Material	Property group
Density	seawater	Basic
Speed of sound	seawater	Basic
Density	quartz sand	Basic
Speed of sound	quartz sand	Basic

2.4.3 Sound Hard Boundary (Wall) 1



Sound Hard Boundary (Wall) 1

SELECTION

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

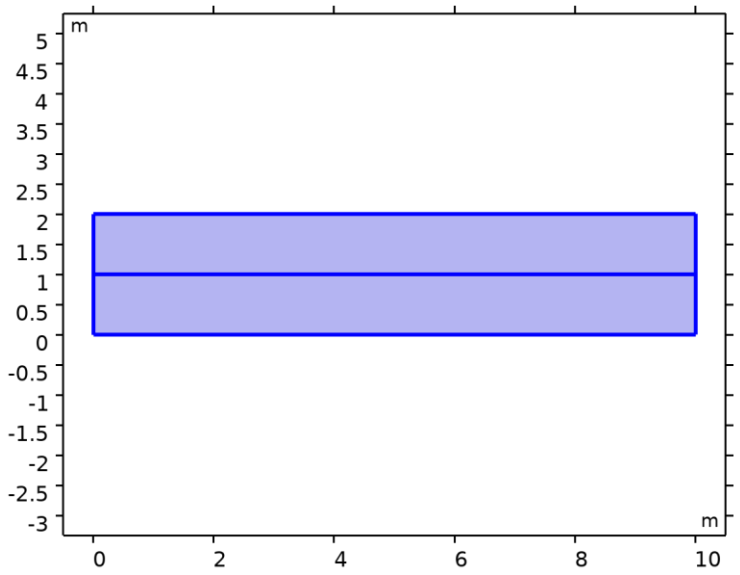
EQUATIONS

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

USED PRODUCTS

COMSOL Multiphysics

2.4.4 Initial Values 1



Initial Values 1

SELECTION

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

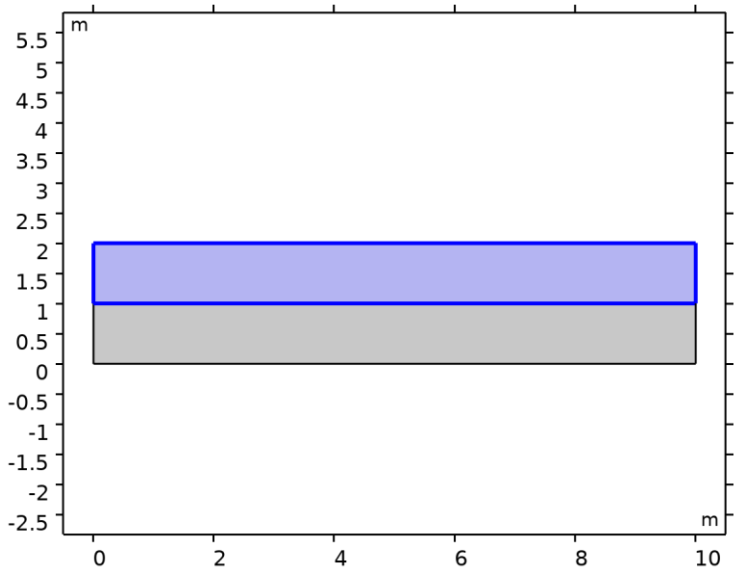
SETTINGS

Description	Value	Unit
Acoustic pressure	0	Pa

USED PRODUCTS

COMSOL Multiphysics

2.4.5 Background Pressure Field 1



Background Pressure Field 1

SELECTION

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

EQUATIONS

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

$$p_t = p + p_b$$

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

$$p_b = p_0 e^{i\phi} e^{-ik_s \frac{(\mathbf{x}\cdot\mathbf{e}_k)}{|\mathbf{e}_k|}}$$

$$k_s^2 = \left(\frac{\omega}{c}\right)^2 - k_z^2$$

$$\mathbf{v}_b = -\frac{\nabla p_b}{i\omega\rho}$$

Background Pressure Field

SETTINGS

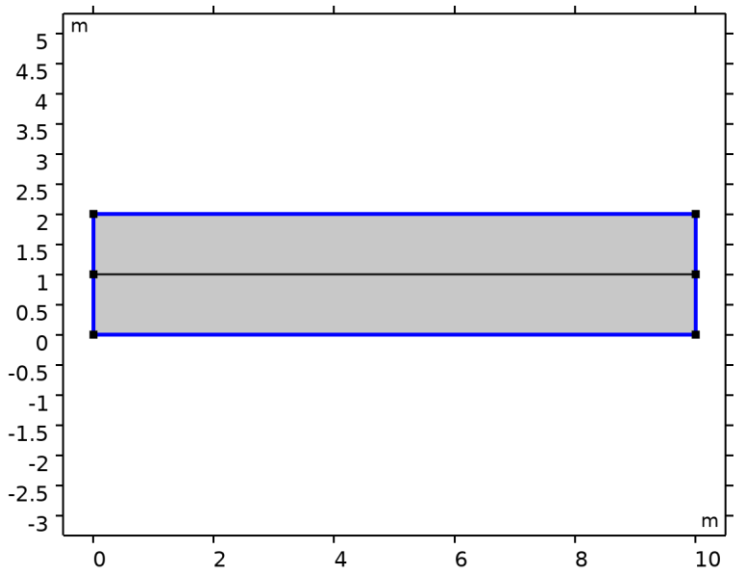
Description	Value	Unit
Pressure field type	Plane wave	
Pressure amplitude	p_input	Pa
Speed of sound	From material	

Description	Value	Unit
Wave direction, x-component	sin(theta_i)	
Wave direction, y-component	-cos(theta_i)	
Wave direction, z-component	0	
Phase	0	rad
Calculate background and scattered field intensity	On	
Density	From material	
Material	Domain material	

PROPERTIES FROM MATERIAL

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

2.4.6 Plane Wave Radiation 1



Plane Wave Radiation 1

SELECTION

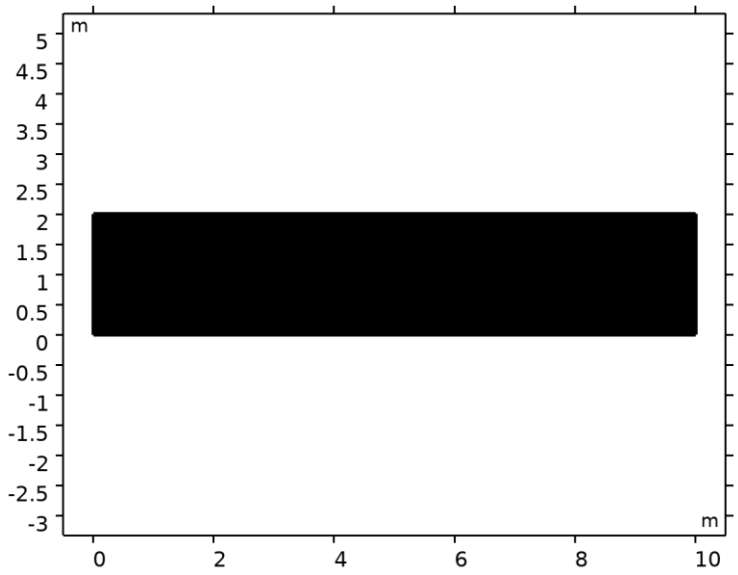
Geometric entity level	Boundary
Selection	Geometry geom1: Dimension 1: Boundaries 1–3, 5–7

EQUATIONS

$$-\mathbf{n}\cdot\left(-\frac{1}{\rho_c}(\nabla p_t-\mathbf{q}_d)\right)+i\frac{k_{eq}}{\rho_c}p+\frac{i}{2k_{eq}\rho_c}\Delta_{\parallel}p=Q_i$$

USED PRODUCTS

2.5 MESH 1



Mesh 1

2.5.1 Size (size)

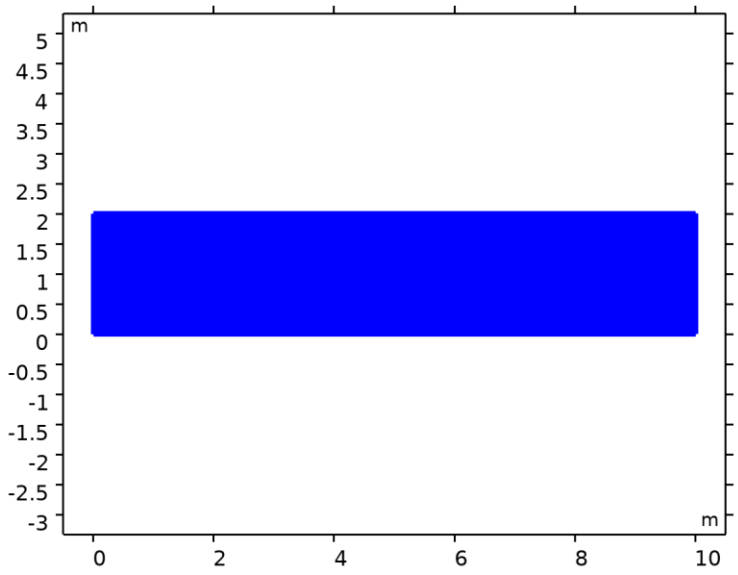
SETTINGS

Description	Value
Maximum element size	0.2
Minimum element size	1E-4
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: Domains 1–2



Size Expression 1

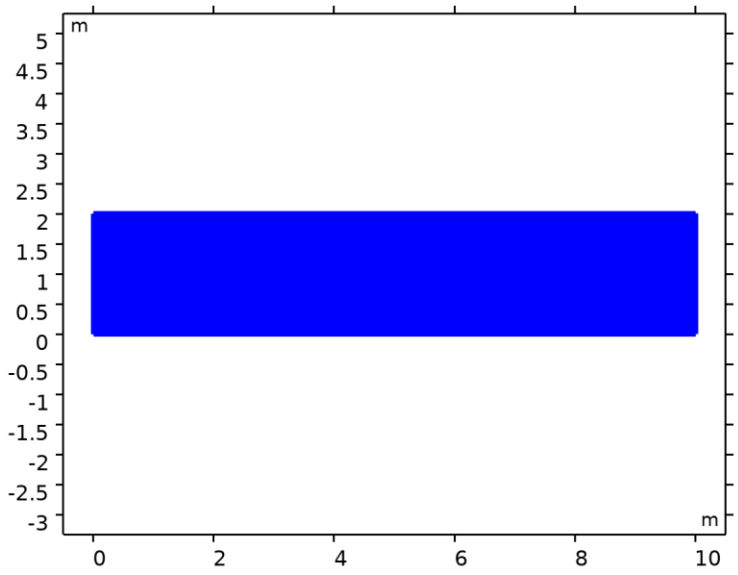
SETTINGS

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 17, 2025, 8:52:46 PM

3 Study 1

COMPUTATION INFORMATION

Computation time	1 s

3.1 FREQUENCY DOMAIN

Frequencies (Hz)
f_study

STUDY SETTINGS

Description	Value
Include geometric nonlinearity	Off

SETTINGS

Description	Value
Frequencies	10000

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	f_study

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	f_study	Hz

Fully Coupled 1 (fc1)

GENERAL

Description	Value

Description	Value
Linear solver	Direct

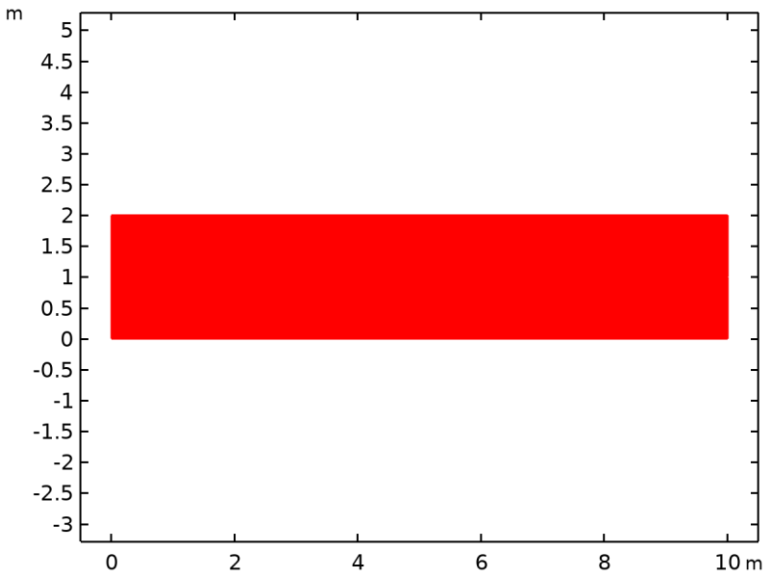
4 Results

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 Cut Line 2D 1

DATA

Description	Value
Dataset	Study 1/Solution 1 (sol1)

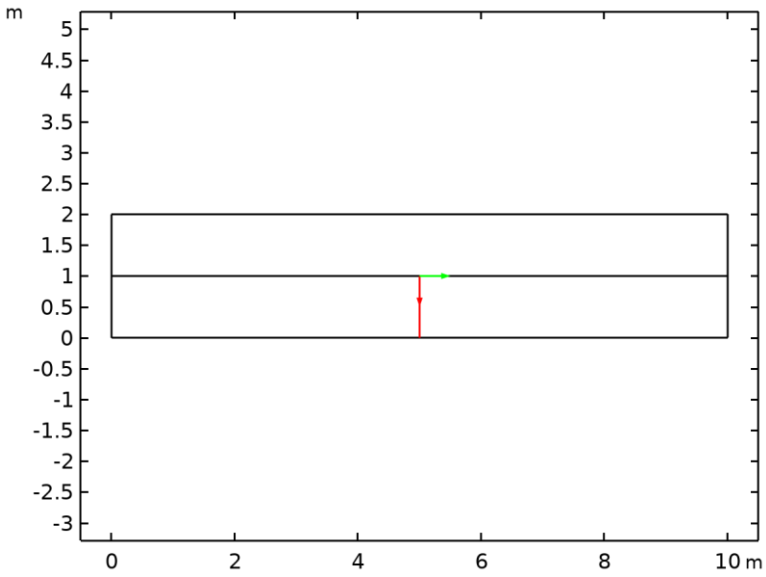
LINE DATA

Description	Value
Line entry method	Two points
Points	{{length/2, height}, {length/2, 0}}

ADVANCED

Description	Value
Space variable	cln1x

Description	Value
Normal variables	{cln1nx, cln1ny}
Tangent variables	{cln1tx, cln1ty}



Dataset: Cut Line 2D 1

4.1.3 Cut Line 2D 2

DATA

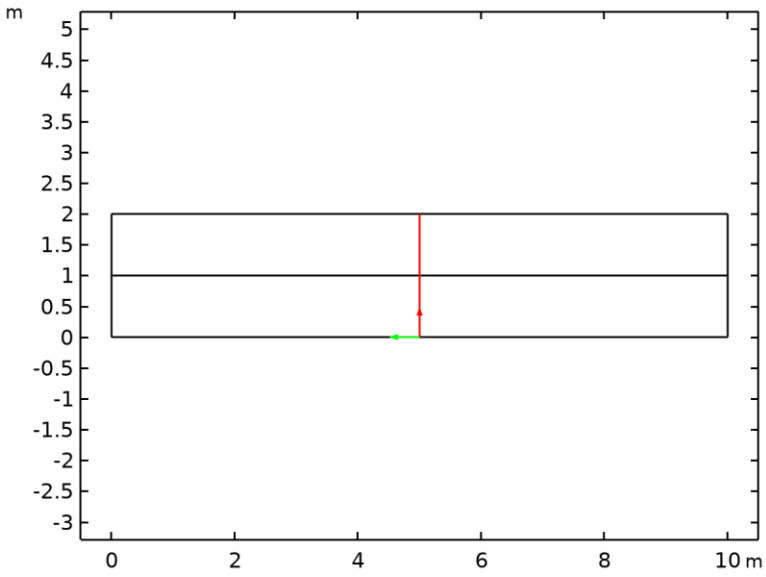
Description	Value
Dataset	Study 1/Solution 1 (sol1)

LINE DATA

Description	Value
Line entry method	Two points
Points	{{5, 0}, {5, 2}}

ADVANCED

Description	Value
Space variable	cln2x
Normal variables	{cln2nx, cln2ny}
Tangent variables	{cln2tx, cln2ty}



Dataset: Cut Line 2D 2

4.2 TABLES

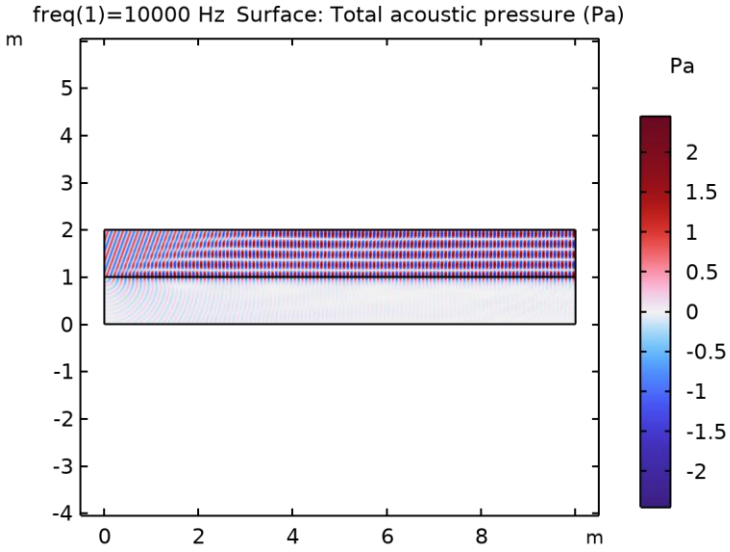
4.2.1 Evaluation 2D

Interactive 2D values

x	y	Value
4.9514	0.19459	-0.0025911
3.6091	0.26523	0.012694

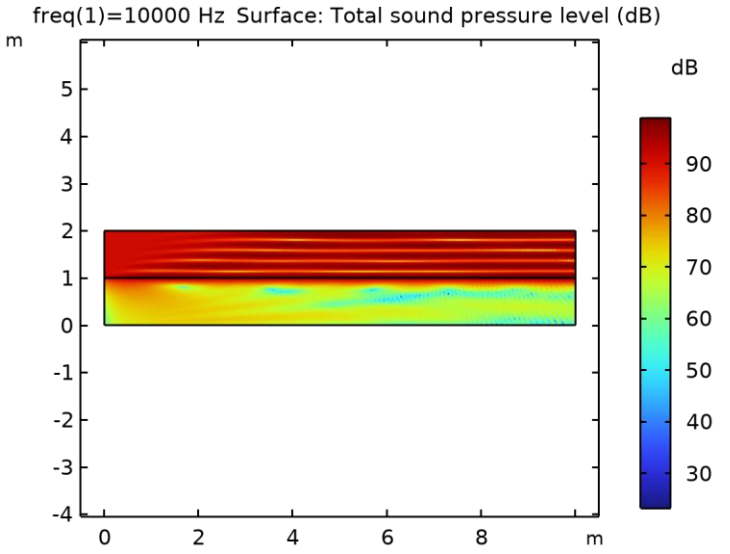
4.3 PLOT GROUPS

4.3.1 Acoustic Pressure (acpr)



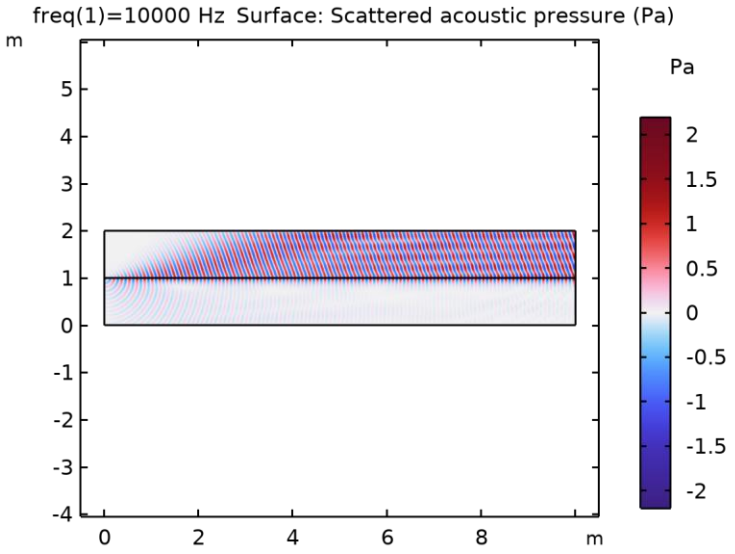
Surface: Total acoustic pressure (Pa)

4.3.2 Sound Pressure Level (acpr)



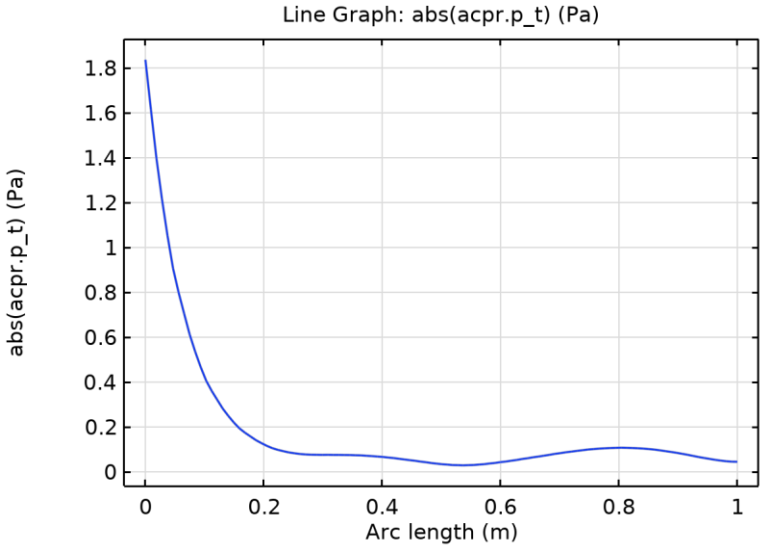
Surface: Total sound pressure level (dB)

4.3.3 Acoustic Pressure (acpr) 1



Surface: Scattered acoustic pressure (Pa)

4.3.4 1D Plot Group 4



Line Graph: abs(acpr.p_t) (Pa)