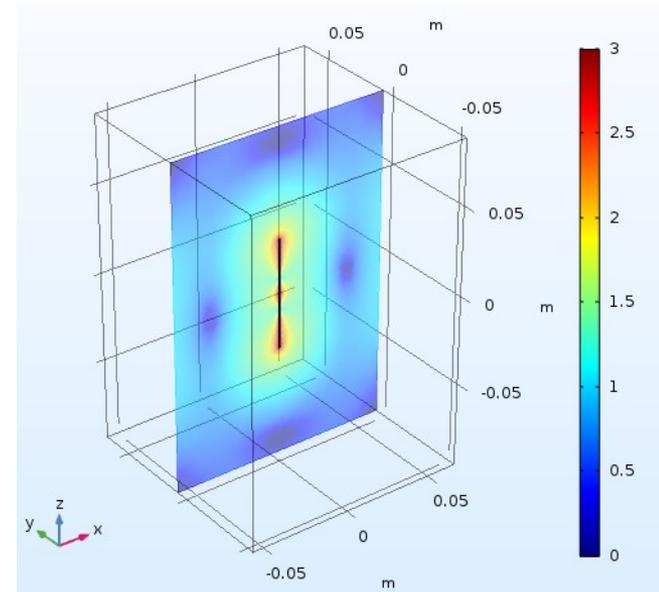
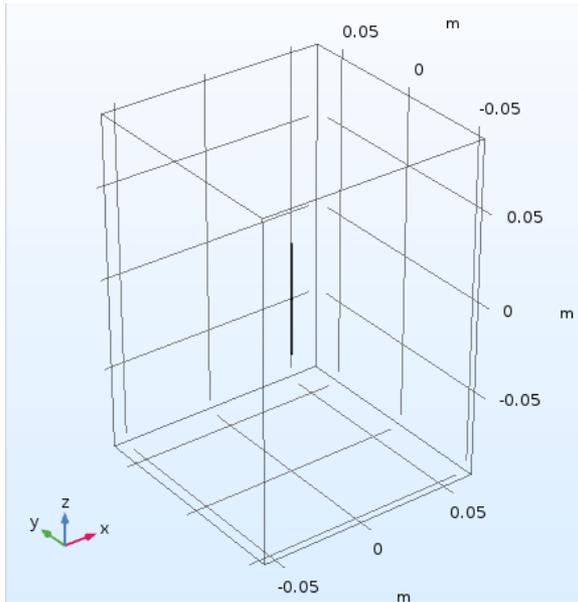
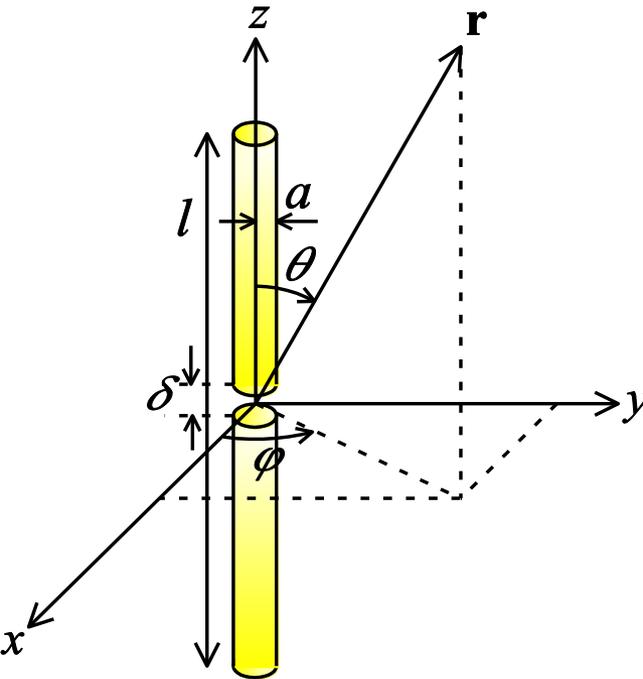


COMSOLによるダイポールアンテナの解析

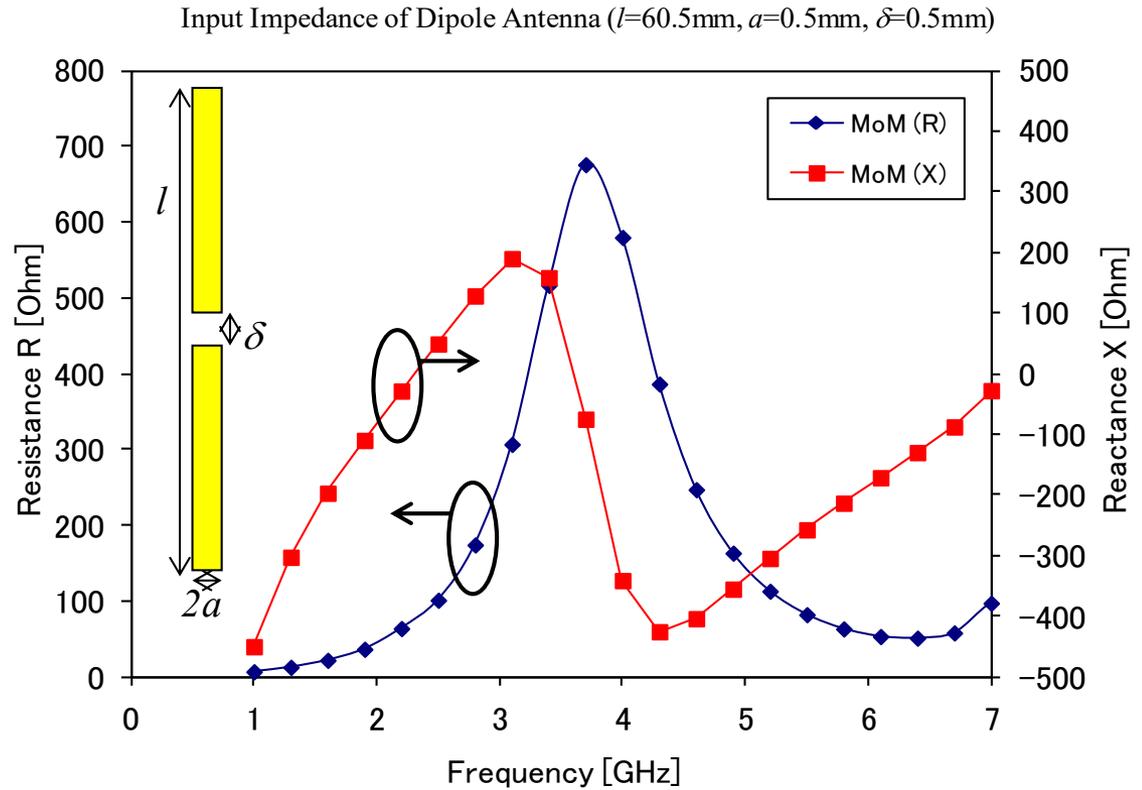
COMSOL 5.3a



平野 拓一



$l=60.5$ mm
 $a=0.5$ mm
 $\delta=0.5$ mm



パラメータ

dipole_antenn

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1

Settings Properties

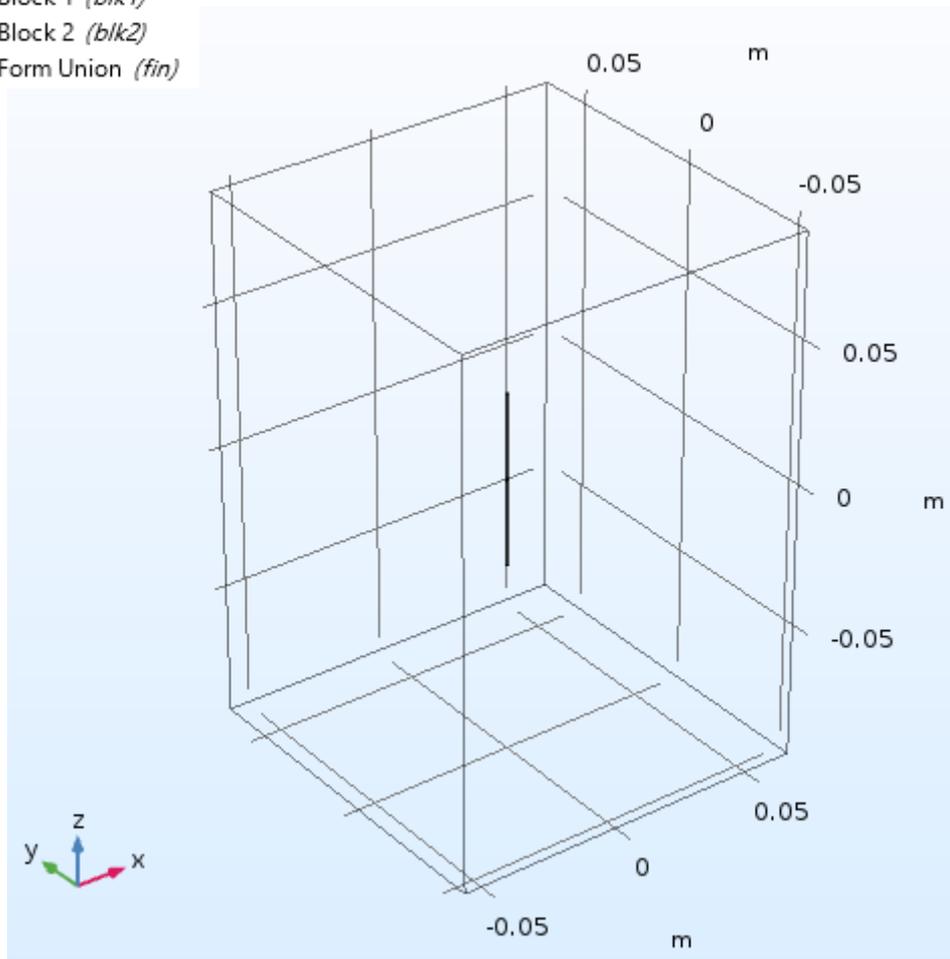
Parameters

Parameters

Name	Expression	Value	Description
l	60.5 [mm]	0.0605 m	Length of dipole
a	0.5 [mm]	5E-4 m	Radius of dipole
d	0.5 [mm]	5E-4 m	Length of gap
wl	122 [mm]	0.122 m	
aw_x	wl	0.122 m	
aw_y	wl	0.122 m	
aw_z	l+w	0.1825 m	

モデル

- ▶ Definitions
- ▶ Geometry 1
 - Cylinder 1 (*cyl1*)
 - Cylinder 2 (*cyl2*)
 - Block 1 (*blk1*)
 - Block 2 (*blk2*)
 - Form Union (*fin*)



Cylinder

Build Selected Build All Objects

Label:

Object Type

Type:

Size and Shape

Radius: m

Height: m

Position

x: m

y: m

z: m

Axis

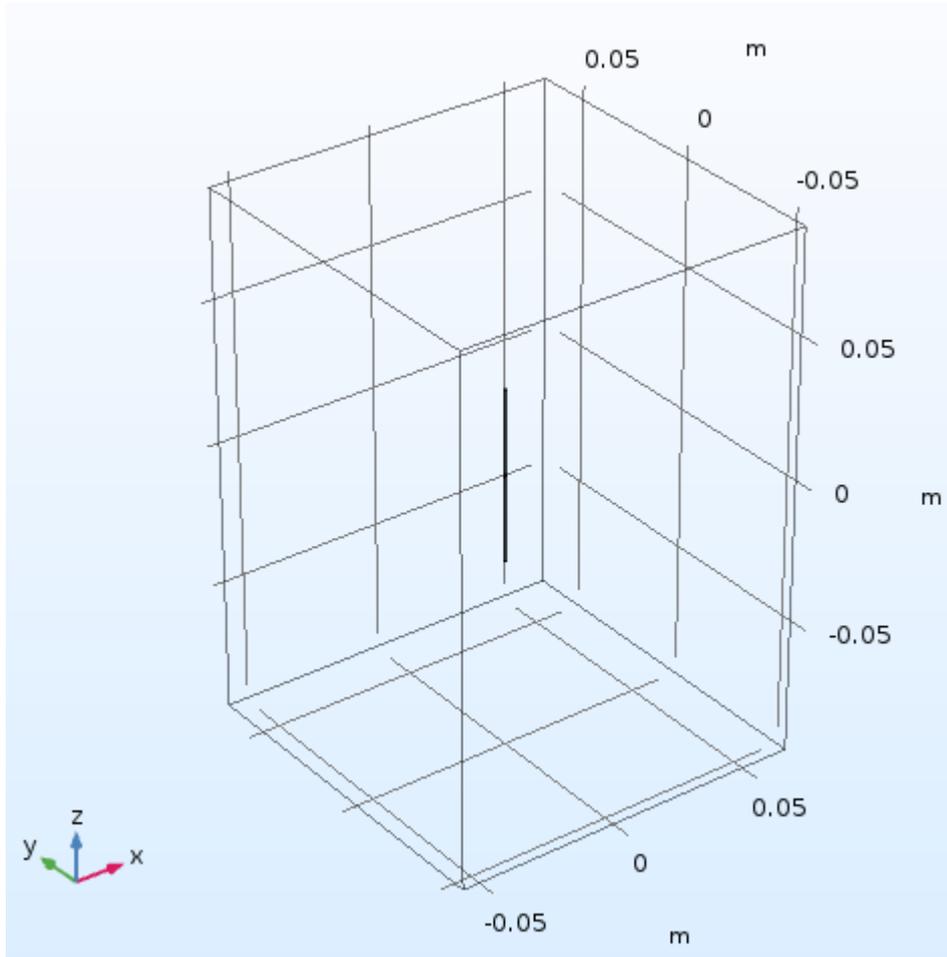
Axis type:

Rotation Angle

Rotation: deg

Coordinate System

Work plane:



Cylinder

Build Selected Build All Object

Label:

Object Type

Type:

Size and Shape

Radius: m

Height: m

Position

x: m

y: m

z: m

Axis

Axis type:

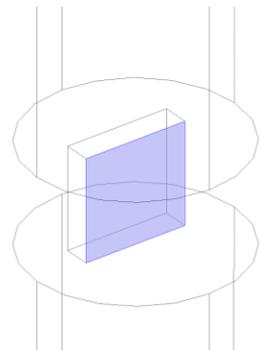
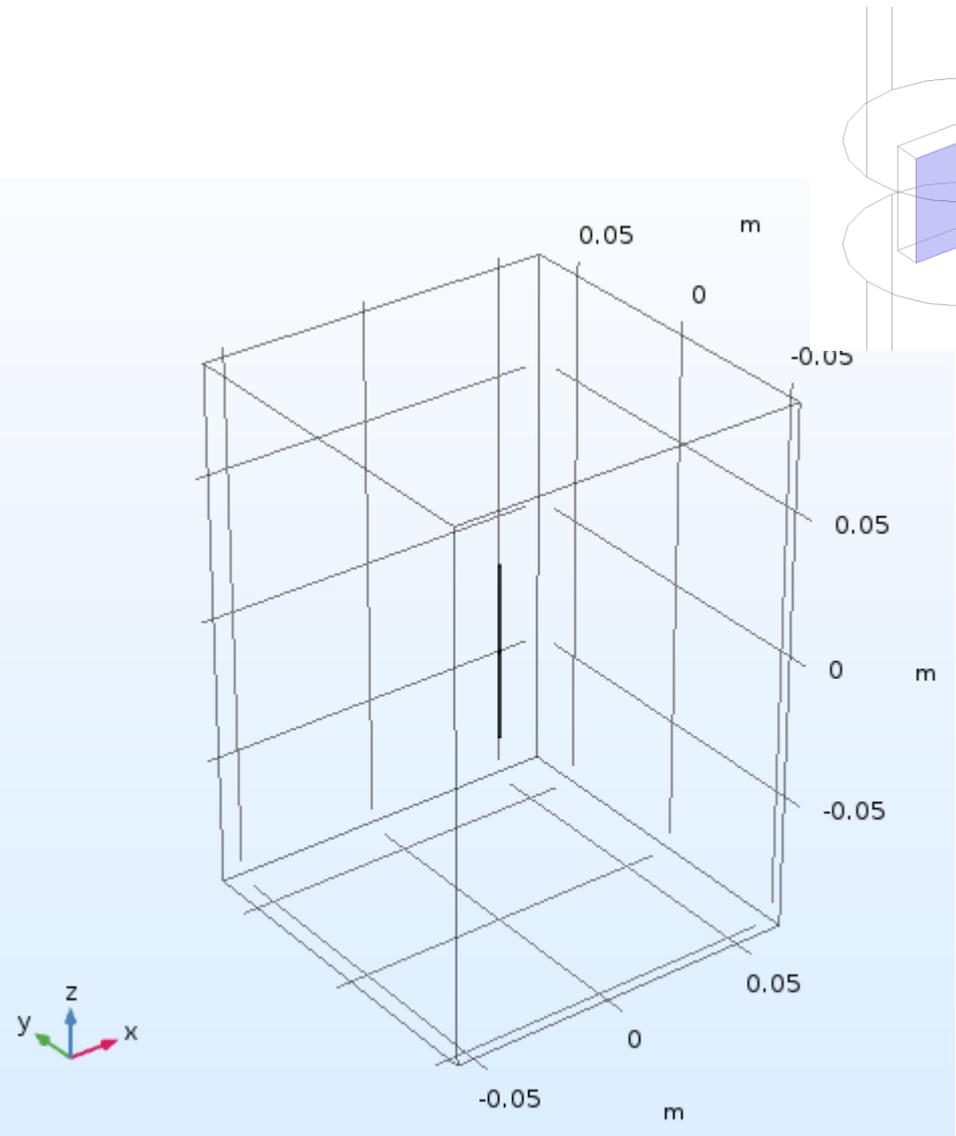
Rotation Angle

Rotation: deg

Coordinate System

Work plane:

モデル



Block

Build Selected Build All Object

Label:

Object Type

Type:

Size and Shape

Width: m

Depth: m

Height: m

Position

Base:

x: m

y: m

z: m

Axis

Axis type:

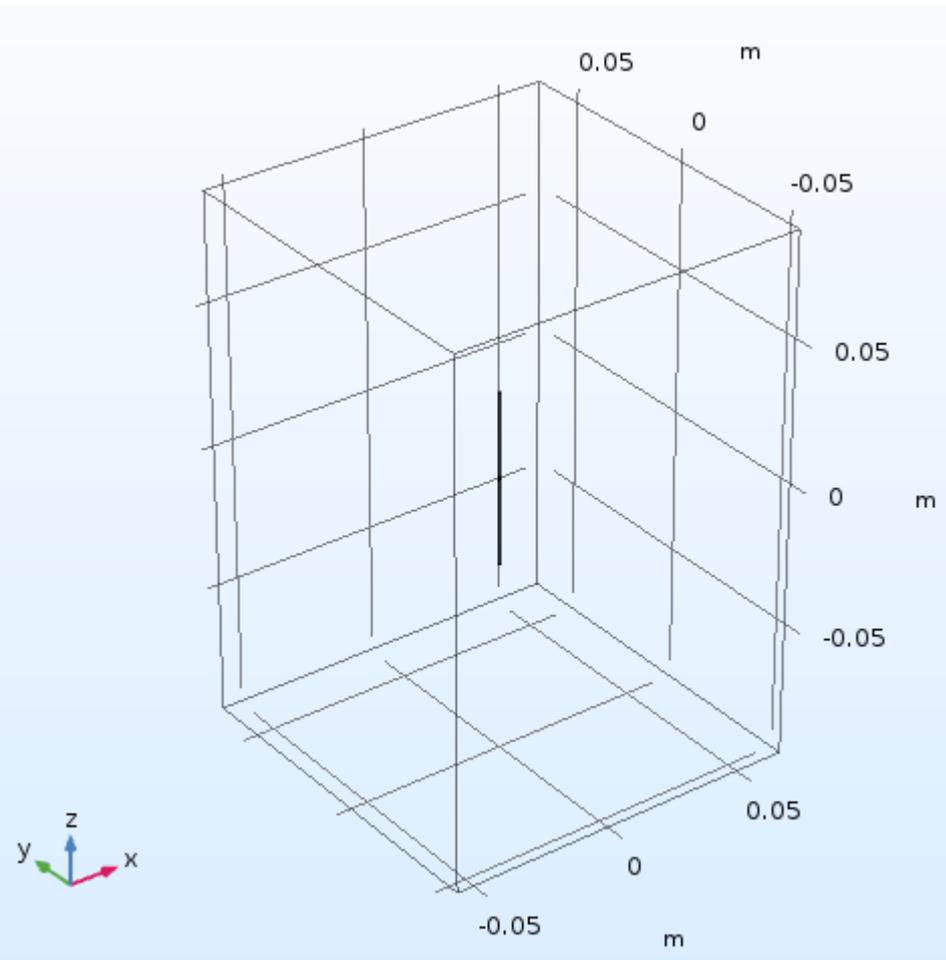
Rotation Angle

Rotation: deg

Coordinate System

Work plane:

モデル



Block

Build Selected Build All Object

Label:

Object Type

Type:

Size and Shape

Width: m

Depth: m

Height: m

Position

Base:

x: m

y: m

z: m

Axis

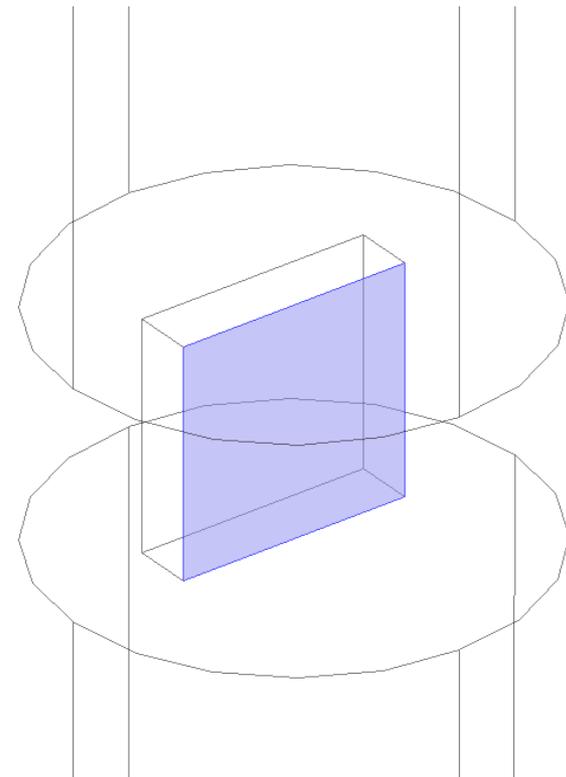
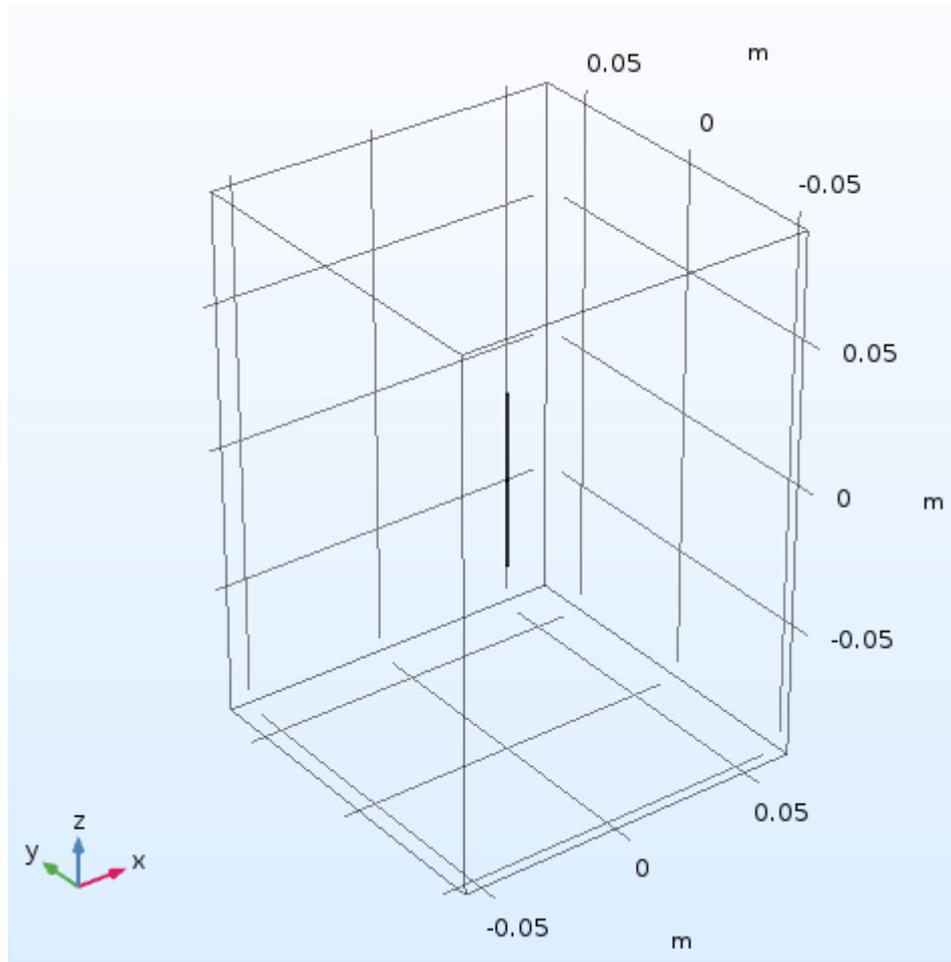
Axis type:

Rotation Angle

Rotation: deg

Coordinate System

Work plane:



The screenshot displays the COMSOL Multiphysics interface for a model named 'dipole_antenna_app.mph'. The top ribbon includes tabs for File, Home, Definitions, Geometry, Materials, Physics, Mesh, Study, Results, and Developer. The 'Physics' section is active, showing 'Electromagnetic Waves, Frequency Domain' and 'Add Physics'. The 'Model Builder' tree on the left shows the model structure, with 'Cylinder 3 (cyl3)' selected. The 'Settings' panel for 'Cylinder' is open, showing parameters like Label, Object Type (Solid), Size and Shape (Radius: a, Height: l/2-d/2), Position (x: 0, y: 0, z: -l/2), and Axis (z-axis). The 'Build All Objects' button is highlighted with a pink arrow. The 'Graphics' window shows a 3D view of the antenna structure. The bottom status bar indicates 776 MB | 973 MB.

「Highlight Result」を選択しておくと、左のメニューで選んでいるオブジェクトに色がついて見やすい

- Materials
 - Air (*mat1*)
 - Basic (*def*)
 - Cu (*mat2*)
 - Basic (*def*)

— Output properties —

Property	Variable	Expression	Unit
Relative permittivity	epsilon_r...	1	1
Relative permeability	mu_r_iso...	1	1
Electrical conductiv...	sigma_is...	0	S/m

— Output properties —

Property	Variable	Expression	Unit
Relative permittivity	epsilon_r...	1	1
Relative permeability	mu_r_iso...	1	1
Electrical conductiv...	sigma_is...	5.8e7	S/m

dipole_antenna_cubic_abc.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Air (mat1)
 - Basic (def)
 - Cu (mat2)
 - Basic (def)
 - Electromagnetic Waves, Frequency Domain
 - Mesh 1
 - Study 1
 - Study 2
 - Results

Settings Properties

Material

Label: Air

Geometric Entity Selection

Geometric entity level: Domain

Selection: Manual

ON	1	
	2 (overridden)	
	3 (overridden)	
	4	

Active

Override

Material Properties

Material Contents

Property	Variable	Value	Unit
<input checked="" type="checkbox"/> Relative permittivity	epsilo...	1	1
<input checked="" type="checkbox"/> Relative permeability	mur_is...	1	1
<input checked="" type="checkbox"/> Electrical conductivity	sigma...	0	S/m

Appearance

Graphics Convergence Plot 1

Progress Log

Model Builder

dipole_antenna_cubic_abc.mph (root)

- Global Definitions
 - Parameters
 - Materials
- Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Air (mat1)
 - Basic (def)
 - Cu (mat2)
 - Basic (def)
 - Electromagnetic Waves, Frequency Domain
 - Mesh 1
 - Study 1
 - Study 2
 - Results

Settings Properties

Material

Label: Cu

Geometric Entity Selection

Geometric entity level: Domain

Selection: Manual

Active

Property	Variable	Value	Unit
Relative permittivity	epsilo...	1	1
Relative permeability	mur_is...	1	1
Electrical conductivity	sigma...	5.8e7	S/m

Graphics Convergence Plot 1

奥の物体を選ぶときは”Selection”を”All domains”にして全て選択してから不要な領域を”-”で除いてもいい。
また、集中ポートの設定で説明するように、奥のものを明示的に選択してもよい。

Object Colorの変更

The screenshot displays the COMSOL Multiphysics interface for a model named 'dipole_antenna_app.mph'. The 'Model Builder' tree on the left shows the hierarchy: dipole_antenna_app.mph (root) > Global Definitions > Parameters 1 > Materials > Dipole (comp1) > Materials > Conductor (mat2) > Basic (def). The 'Settings' window for the selected material is open, showing the 'Appearance' section. A context menu is open over the color selection area, with 'Show Selection Colors' and 'Show Material Color and Texture' checked. The 'Graphics' window shows a 3D model of a vertical dipole antenna in a coordinate system with x, y, and z axes. The 'Progress' window at the bottom right shows a table of Directivity data.

θ (deg)	ϕ (deg)	Directivity	Directivity (dB)
90.000	360.00	1.6764	2.2437

Object Colorの変更

dipole_antenna_app.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Application Dipole Add Component Parameters Variables f(x) Electromagnetic Waves, Frequency Domain Build Mesh Compute S-Parameter (frequency char.) Add Plot Group Layout

Model Definitions Physics Mesh Study Results

Model Builder

- dipole_antenna_app.mph (root)
 - Global Definitions
 - Parameters 1
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Air (mat1)
 - Conductor (mat2)
 - Basic (def)
 - Electromagnetic Waves, Frequency
 - Mesh 1
 - Study 1
 - Study 2
 - Results

Settings

Materials

Material Overview

Material	Selection
Air (mat1)	Domains 1, 3, 5
Conductor (mat2)	Domains 2, 4

Graphics

Progress Log Directivity

θ (deg)	ϕ (deg)	Directivity	Directivity (dB)
90.000	360.00	1.6764	2.2437

823 MB | 1008 MB

解析種別

dipole_antenna_cubic_abc.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1
 - Mesh 1
 - Study 1
 - Results

Settings Properties

Wave Equation, Electric

Label: Wave Equation, Electric 1

Domain Selection

Selection: All domains

Active

1
2
3
4

Override and Contribution

Equation

Show equation assuming:
Study 1, Frequency Domain

$$\nabla \times \mu_r^{-1} (\nabla \times \mathbf{E}) - k_0^2 (\epsilon_r - \frac{j\sigma}{\omega\epsilon_0}) \mathbf{E} = \mathbf{0}$$

Model Input

Coordinate System Selection

Coordinate system:
Global coordinate system

Electric Displacement Field

Electric displacement field model:
Relative permittivity

Relative permittivity:
 ϵ_r From material

Graphics Convergence Plot 1

Progress Log Table 1

8.85
e-12 AUTO 8.5
e-1 850
e-3 0.85

890 MB | 998 MB

遠方界領域の設定(利得・遠方界の計算に必要)^{No. 16}

The screenshot displays the COMSOL Multiphysics interface for a simulation titled "dipole_antenna_cubic_abc.mph". The left-hand side features the "Model Builder" tree, where the "Far-Field Domain 1" is selected under the "Dipole (comp1)" component. The central "Settings" pane shows the configuration for "Far-Field Domain 1", including a "Label" field, a "Domain Selection" dropdown set to "Manual", and a list of active domains containing "1". The right-hand side shows a "Graphics" window with a "Convergence Plot 1" tab, displaying a 3D visualization of a green cubic domain. The axes are labeled with "m" (meters) and range from -0.05 to 0.05. The bottom status bar indicates a memory usage of 885 MB | 993 MB.

遠方界領域の設定(利得・遠方界の計算に必要)^{No. 17}

The screenshot displays the COMSOL Multiphysics software interface for a model named "dipole_antenna_cubic_abc.mph". The main window is divided into several panels:

- Model Builder:** Shows the hierarchical structure of the model, including Global Definitions, Parameters, Materials, and the Electromagnetic Wave physics interface.
- Settings (Far-Field Calculation):** The "Far-Field Calculation" settings are visible. The "Label" is "Far-Field Calculation 1". The "Boundary Selection" is set to "Manual", and a list of boundaries (1, 2, 3, 4, 5, 24) is shown. The "Far-field variable name" is set to "Efar". There are checkboxes for "Symmetry in the x=0 plane", "Symmetry in the y=0 plane", and "Symmetry in the z=0 plane", all of which are currently unchecked. The "Boundary relative to domain" is set to "Outside".
- Graphics:** A 3D visualization of the model is shown, featuring a central vertical dipole antenna structure within a green cubic domain. The axes are labeled x, y, and z, with numerical values ranging from -0.05 to 0.05 meters.
- Messages:** A message window at the bottom displays the following text:
COMSOL Multiphysics 6.0.0.312
[Jan 29, 2022, 3:02 AM] Opened file: G:\Home\hira2\public_html\em_analysis\canonical\dipole_antenna\dipole_antenna_cubic_abc.mph
[Jan 29, 2022, 3:02 AM] Some geometric entities are hidden.

765 MB | 860 MB

境界条件

The screenshot displays the COMSOL Multiphysics interface for a simulation titled "dipole_antenna_cubic_abc.mph". The left-hand side features the "Model Builder" tree, which is expanded to show the "Scattering Boundary Condition 1" under the "Electromagnetic Waves, Frequency Domain" section. The right-hand side shows the "Settings" panel for this boundary condition, with the "Properties" tab selected. The "Boundary Selection" is set to "Manual", and a list of active boundaries (1, 2, 3, 4, 5, 24) is visible. The "Coordinate System Selection" is set to "Global coordinate system". The "Scattering Boundary Condition" section is configured with "No incident field" and "Plane wave" scattered wave type, and "First order" order. The "Graphics" window on the right shows a 3D plot of a green cube centered at the origin, with axes ranging from -0.05 to 0.05 meters. The "Progress" window at the bottom right shows a table with numerical values.

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1
 - Mesh 1
 - Study 1
 - Results

Settings Properties

Scattering Boundary Condition

Label: Scattering Boundary Condition 1

Boundary Selection

Selection: Manual

Active

1
2
3
4
5
24

Override and Contribution

Equation

Coordinate System Selection

Coordinate system: Global coordinate system

Scattering Boundary Condition

Incident field: No incident field

Scattered wave type: Plane wave

Order: First order

Graphics Convergence Plot 1

Progress Log Table 1

8.85	AUTO	0.5	850	0.85
e-12		e-1	e-3	

dipole_antenna_cubic_abc.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1
 - Mesh 1
 - Study 1
 - Results

Settings Properties

Lumped Port

Label: Lumped Port 1

Boundary Selection

Selection: Manual

15

Active

Override and Contribution

Equation

Lumped Port Properties

Lumped port name: 1

Type of lumped port: User defined

Height of lumped port: h_{port} d m

Width of lumped port: w_{port} a m

Direction between lumped port terminals:

0	x
0	y
1	z

Terminal type: Cable

Wave excitation at this port:

Graphics Convergence Plot 1

Progress Log Table 1

8.85 e-12 AUTO 8.5 e-1 850 e-3 0.85

878 MB | 991 MB

集中ポート: 選択 (奥にある面を選択するとき) No. 20

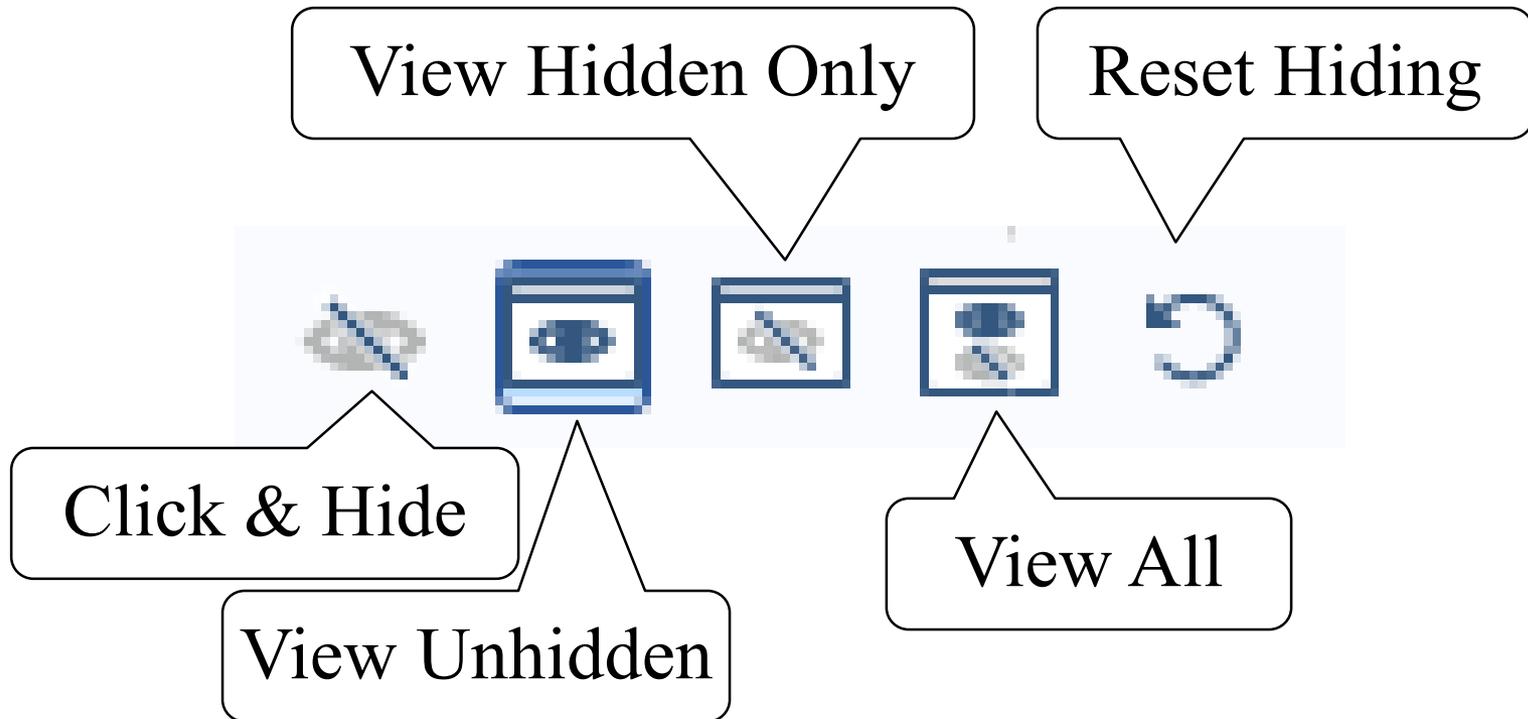
The screenshot displays the COMSOL Multiphysics interface for a model named "dipole_antenna_cubic_abc.mph". The "Model Builder" tree on the left shows the hierarchy: Global Definitions (Parameters, Materials) > Dipole (comp1) > Electromagnetic Waves, Frequency Domain > Lumped Port 1. The "Settings" pane for "Lumped Port" is active, showing the "Manual" selection method. The "Lumped Port Properties" section includes:

- Lumped port name: 1
- Type of lumped port: User defined
- Height of lumped port: h_{port} d m
- Width of lumped port: w_{port} a m
- Direction between lumped port terminals:

0	x
0	y
1	z
- Terminal type: Cable
- Wave excitation at this port: On
- Voltage: V_0 1[V] V

The "Graphics" window shows a 3D view of the dipole antenna structure with a coordinate system (x, y, z) at the bottom left. The "Progress" and "Log" windows are visible at the bottom right. The status bar at the bottom indicates 1.03 GB | 1.21 GB.

集中ポート: 選択 (奥にある面を選択するとき) ^{No. 21}



1. “Click & Hide”を押す。
2. すると、次にクリックした物体(面)は選択から除かれる。ここで、選択したくない物体(面)をクリックして除いておく
3. 選択したい物体(面)が選べるようになったら、もう一度“Click & Hide”を押し、選択できるようにする。
4. そして、物体(面)をクリックすると、奥にあった物体(面)を選択できる。

集中ポート: 選択 (奥にある面を選択するとき) No. 22

The screenshot displays the COMSOL Multiphysics interface for a model named "dipole_antenna_cubic_abc.mph". The "Model Builder" tree on the left shows the hierarchy: Global Definitions > Dipole (comp1) > Electromagnetic Waves, Frequency Domain > Lumped Port 1. The "Settings" pane for "Lumped Port 1" is active, showing the following configuration:

- Selection: Manual
- Active: 15
- Override and Contribution: (empty)
- Equation: (empty)
- Lumped Port Properties:
 - Lumped port name: 1
 - Type of lumped port: User defined
 - Height of lumped port: h_{port} d m
 - Width of lumped port: w_{port} a m
 - Direction between lumped port terminals:

0	x
0	y
1	z
 - Terminal type: Cable
 - Wave excitation at this port: On
 - Voltage: V_0 1[V] V

The "Graphics" window shows a 3D view of the antenna structure with a blue rectangular lumped port highlighted on the back face. A coordinate system (x, y, z) is visible at the bottom left of the graphics window. The "Progress" and "Log" windows are also visible at the bottom right.

1.03 GB | 1.2 GB

解析条件

The screenshot displays the COMSOL Multiphysics interface for a model named "dipole_antenna_cubic_abc.mph". The "Model Builder" tree on the left shows the hierarchy: Global Definitions (Parameters, Materials) > Dipole (comp1) > Definitions > Geometry 1 > Materials > Electromagnetic Waves, Frequency Domain > Wave Equation, Electric 1 > Perfect Electric Conductor 1 > Initial Values 1 > Far-Field Domain 1 > Scattering Boundary Condition 1 > Lumped Port 1 > Mesh 1 > Study 1 > Step 1: Frequency Domain > Solver Configurations > Solution 1 (sol1).

The "Settings" pane for "Frequency Domain" is active, showing the following configuration:

- Label: Frequency Domain
- Study Settings:
 - Frequency unit: GHz
 - Frequencies: 2.45 GHz
 - Load parameter values: Browse... Read File
 - Reuse solution from previous step: Auto
- Results While Solving
- Physics and Variables Selection:
 - Modify model configuration for study step:
 - Table with columns: Physics interface, Solve for, Discretization.
 - Row 1: Electromagnetic Waves, Fre..., , Physics settings
- Values of Dependent Variables
- Mesh Selection
- Adaptation and Error Estimates
- Study Extensions

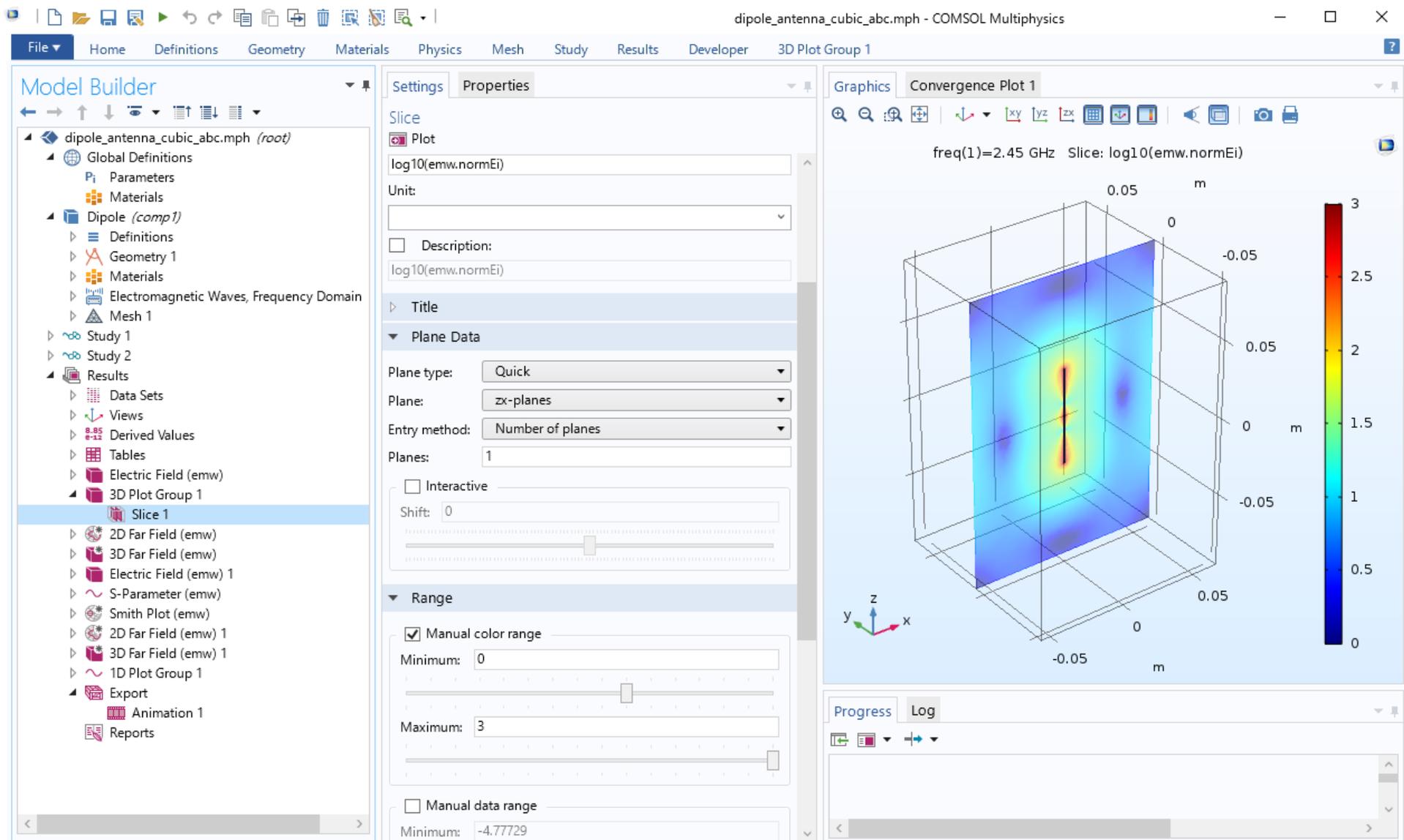
The "Graphics" window shows a 3D visualization of the antenna structure within a cylindrical waveguide, with a coordinate system (x, y, z) at the bottom left.

The "Progress" window at the bottom right shows a table with the following data:

Progress	Log	Table 1
8.85	AUTO	8.5
e-12		e-1
		850
		e-3
		0.85

866 MB | 976 MB

電界分布(dB)



電界分布アニメーション(dB)

The screenshot displays the COMSOL Multiphysics software interface for a simulation titled "dipole_antenna_cubic_abc.mph".

Model Builder (Left Panel): Shows the project hierarchy. The "Results" folder is expanded, showing a "3D Plot Group 1" with a "Slice 1" view selected. Other results include "Electric Field (emw)", "2D Far Field (emw)", "3D Far Field (emw)", "S-Parameter (emw)", and "Smith Plot (emw)".

Settings/Properties (Middle Panel): Configures the animation for "3D Plot Group 1".

- Animation:** Label: Animation 1
- Scene:** Subject: 3D Plot Group 1
- Target:** Target: Player
- Animation Editing:** Sequence type: Dynamic data extension; Cycle type: Half harmonic
- Frames:** Number of frames: 15; Frame number: 1
- Playing:** Display each frame for: 0.1 s; Repeat:

Graphics (Right Panel): Displays "Convergence Plot 1" for "freq(1)=2.45 GHz" with a "Slice: log10(emw.normEi)". The plot shows a 3D visualization of the electric field distribution within a cubic domain (0 to 0.05 m on each axis). A color scale on the right indicates the field magnitude in dB, ranging from 0 (blue) to 3 (red). The plot shows a central dipole structure with a high field intensity (red/yellow) and a color bar on the right ranging from 0 to 3 dB.

Progress/Log (Bottom Right): Shows the simulation progress and log output.

2次元指向性

dipole_antenna_cubic_abc.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer 2D Far Field (emw)

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1
 - Mesh 1
 - Study 1
 - Step 1: Frequency Domain
 - Solver Configurations
 - Solution 1 (sol1)
 - Results
 - Data Sets
 - Views
 - Derived Values
 - Tables
 - Electric Field (emw)
 - 2D Far Field (emw)
 - Far Field 1
 - Far Field 2
 - 3D Far Field (emw)
 - Export
 - Reports

Settings Properties

Far Field

Plot

Label: Far Field 1

Data

Data set: From parent

Expression

Expression: emw.gainEfar

Unit: 1

Description: Far-field gain

Title

Evaluation

Angles

Number of angles: 180

Restriction: None

Compute beam width: Off

Normal

x: 0

y: 0

z: 1

Reference direction

x: 1

y: 0

z: 0

Graphics Convergence Plot 1

Far Field: Far-field gain (1) Far Field: Far-field gain (1)

Progress Log

3次元指向性

dipole_antenna_cubic_abc.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer 3D Far Field (emw)

Model Builder

- dipole_antenna_cubic_abc.mph (root)
 - Global Definitions
 - Parameters
 - Materials
 - Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Wave Equation, Electric 1
 - Perfect Electric Conductor 1
 - Initial Values 1
 - Far-Field Domain 1
 - Scattering Boundary Condition 1
 - Lumped Port 1
 - Mesh 1
 - Study 1
 - Step 1: Frequency Domain
 - Solver Configurations
 - Solution 1 (sol1)
 - Results
 - Data Sets
 - Views
 - Derived Values
 - Tables
 - Directivity
 - Electric Field (emw)
 - 2D Far Field (emw)
 - 3D Far Field (emw)
 - Far Field 1
 - Export
 - Reports

Settings Properties

Far Field

Plot

Label: Far Field 1

Data

Data set: From parent

Expression

Expression: emw.gainEfar

Unit: 1

Description: Far-field gain

Threshold: 0 1

Use as color expression

Title

Range

Evaluation

Angles

Number of elevation angles: 45

Number of azimuth angles: 90

Restriction: None

Compute directivity: On

Directivity expression: emw.normEfar^2

Coloring and Style

Coloring: Color table

Graphics Convergence Plot 1

freq(1)=2.45 GHz Far Field: Far-field gain (1)

1.69

1.6

1.4

1.2

1

0.8

0.6

0.5

0

-0.5

0.2

7.63 × 10⁻⁷

Progress Log Directivity

θ (deg)	φ (deg)	Directivity	Directivity (dB)
90.000	356.00	1.6917	2.2833

1 GB | 1.17 GB

周波数スイープ

The screenshot displays the COMSOL Multiphysics interface for a model named "dipole_antenna_cubic_abc.mph". The software is running in the "Frequency Domain" study settings.

Model Builder (Left Panel): Shows the hierarchical structure of the model. The "Step 1: Frequency Domain" is selected. Under "Electromagnetic Waves, Frequency Domain", the following components are listed: Wave Equation, Electric 1; Perfect Electric Conductor 1; Initial Values 1; Far-Field Domain 1; Scattering Boundary Condition 1; and Lumped Port 1. A "Mesh 1" is also defined.

Settings (Middle Panel): The "Frequency Domain" study settings are shown. The "Label" is "Frequency Domain". Under "Study Settings", the "Frequency unit" is set to "GHz" and the "Frequencies" are defined as a "range(1,0.4,9)" GHz. The "Load parameter values" section includes "Browse..." and "Read File" buttons. The "Reuse solution from previous step" is set to "Auto".

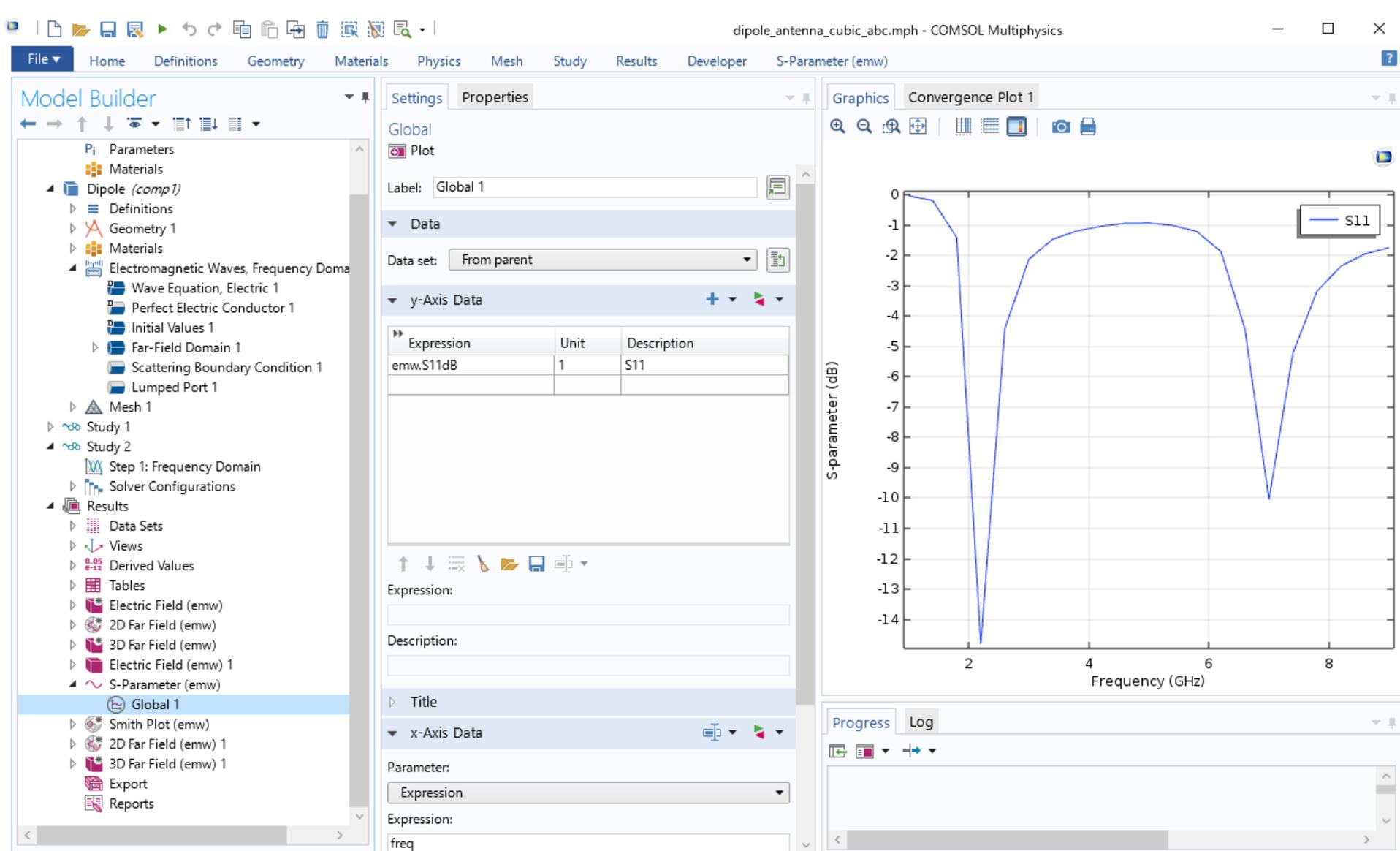
Physics and Variables Selection (Middle Panel): The "Modify model configuration for study step" checkbox is unchecked. The "Physics interface" is "Electromagnetic Waves, Fre..." and the "Solve for" option is checked. The "Discretization" is set to "Physics settings".

Graphics (Right Panel): A 3D wireframe plot of a cubic domain is shown. The axes are labeled x, y, and z, with values ranging from -0.05 to 0.05 meters. A vertical line representing the dipole antenna is visible in the center of the cube.

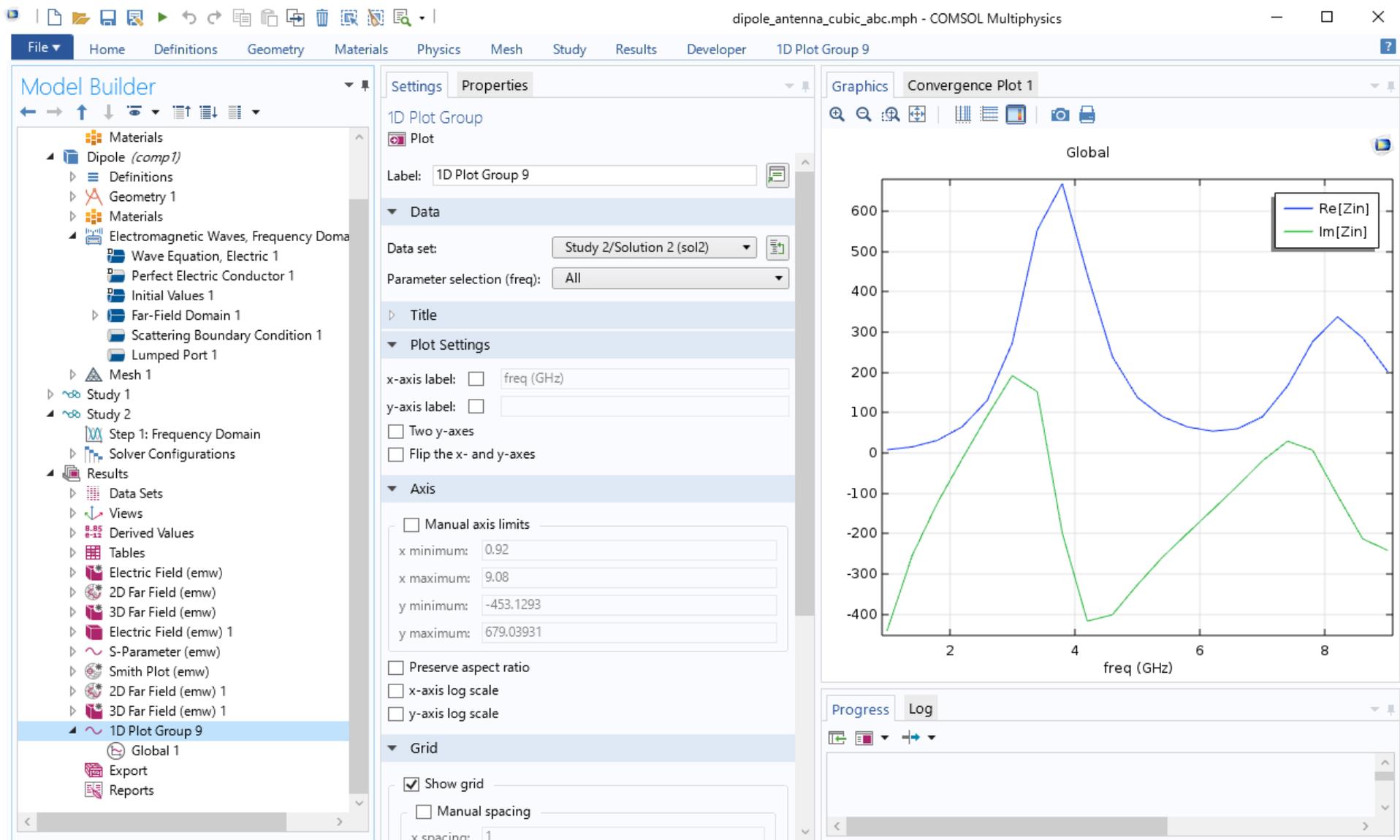
Progress (Bottom Panel): The "Log" and "Directivity" tabs are active. The log shows the following information: "Virtual memory: 1.52 GB", "Ended at 23-7-2020 01:31:32.", and "----- Stationary Solver 1 in Study 2/Solution 2 (sol2) -----".

1.04 GB | 1.23 GB

Frequency-S11

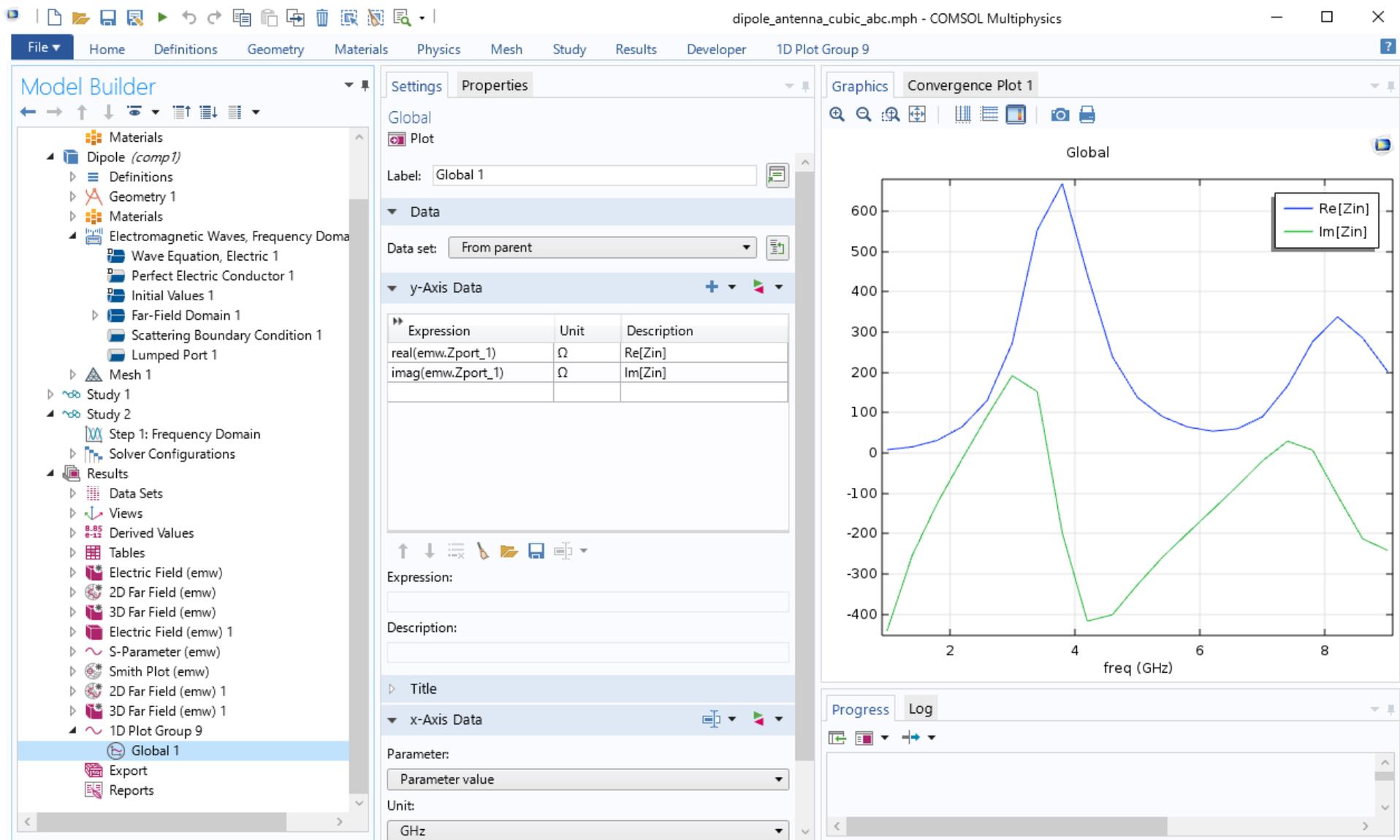


Frequency-Zin



1.03 GB | 1.19 GB

Frequency-Zin



The screenshot shows the COMSOL Multiphysics software interface for a simulation titled "dipole_antenna_app.mph". The "Derived Values" menu is open, showing options like "Point Evaluation", "Global Evaluation", and "Integration". The "Integration" option is selected, and its sub-menu is visible, showing "Volume Integration", "Surface Integration", and "Line Integration". The "Surface Integration" option is highlighted. The main window displays a 3D model of a dipole antenna structure, with a coordinate system (x, y, z) and axes ranging from -0.05 to 0.05 meters. The "Graphics" toolbar is visible, and the "Progress" and "Log" panels are at the bottom.

751 MB | 939 MB

The screenshot displays the COMSOL Multiphysics interface for a dipole antenna simulation. The top menu bar includes File, Home, Definitions, Geometry, Materials, Physics, Mesh, Study, Results, and Developer. The Physics toolbar shows 'Electromagnetic Waves, Frequency Domain' selected. The Graphics window shows a 3D model of a dipole antenna within a rectangular volume, with axes x, y, and z. The axes range from -0.05 to 0.05 meters. The Results window shows a table of Directivity data.

Physics Selection:

- Electric
- Energy and power
 - emw.W - Energy density - J/m^3
 - emw.Wav - Energy density time average - J/m^3
 - emw.Weav - Electric energy density time average - J/m^3
 - emw.Wmav - Magnetic energy density time average - J/m^3
- Power flow, time average - W/m^2
 - emw.intWe - Total electric energy - J
 - emw.intWm - Total magnetic energy - J
 - emw.nPoav - Power outflow, time average - W/m^2
- Far field
- Geometry and mesh
- Global
- Heating and losses
- Magnetic
- Material properties
- Mechanical
- Ports
 - emw.freq - Frequency - Hz

Expressions Table:

Expression	Unit	Description

Directivity Data Table:

θ (deg)	ϕ (deg)	Directivity	Directivity (dB)
90.000	360.00	1.6764	2.2437

The screenshot displays the COMSOL Multiphysics interface for a dipole antenna simulation. The top toolbar includes options for File, Home, Definitions, Geometry, Materials, Physics, Mesh, Study, Results, and Developer. The Physics toolbar shows 'Electromagnetic Waves, Frequency Domain' and 'Add Physics'. The Mesh toolbar includes 'Build Mesh' and 'Mesh 1'. The Study toolbar has 'Compute', 'Study 1', and 'Add Study'. The Results toolbar includes 'Electric Field (emw)', 'Add Plot Group', 'Windows', and 'Reset Desktop'. The Layout toolbar has 'Reset Desktop'.

The Model Builder on the left shows a tree view with the following structure:

- Dipole (comp1)
 - Definitions
 - Geometry 1
 - Materials
 - Electromagnetic Waves, Frequency Domain
 - Mesh 1
 - Study 1
 - Step 1: Frequency Domain
 - Solver Configurations
 - Study 2
 - Results
 - Datasets
 - Views
 - Derived Values
 - S11_Zin
 - S11(dB)
 - S11(deg)
 - Zin (Ohm)
 - Power
 - Input Power
 - Radiated Power
 - Surface Integration 1
 - Tables
 - Electric Field (emw)
 - E-Field(dB)
 - E and H vector field
 - 2D Far Field (emw)
 - 3D Far Field (emw)

The Properties window for 'Surface Integration 1' shows the following settings:

- Label: Surface Integration 1
- Data
 - Dataset: Study 1/Solution 1 (s)
 - Parameter selection (freq): All
- Selection
 - Selection: Manual
 - Selection list: 1, 2, 3, 4, 5, 28
- Expressions
 - Expression: emw.nPoav
 - Unit: W
 - Description: Power outflow, time average

The Graphics window shows a 3D plot of a dipole antenna structure within a bounding box. The axes are labeled x, y, and z, with values ranging from -0.05 to 0.05. The plot is titled 'Convergence Plot 1'.

The Progress window shows the following data:

freq (Hz)	Power outflow, time average (W)
2.4500E9	0.0082049

1.1 GB | 1.41 GB

Poynting Vectorを積分する面を選ぶ。Evaluateを押すと放射電力が計算できる。