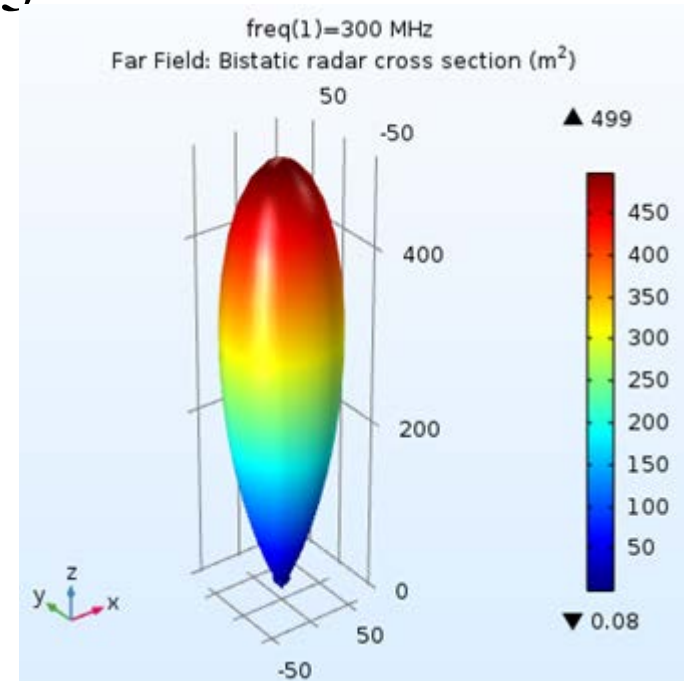
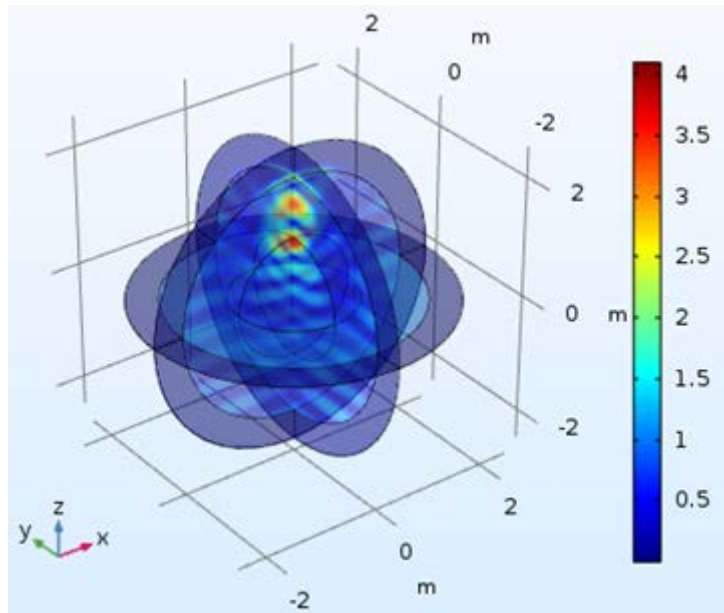
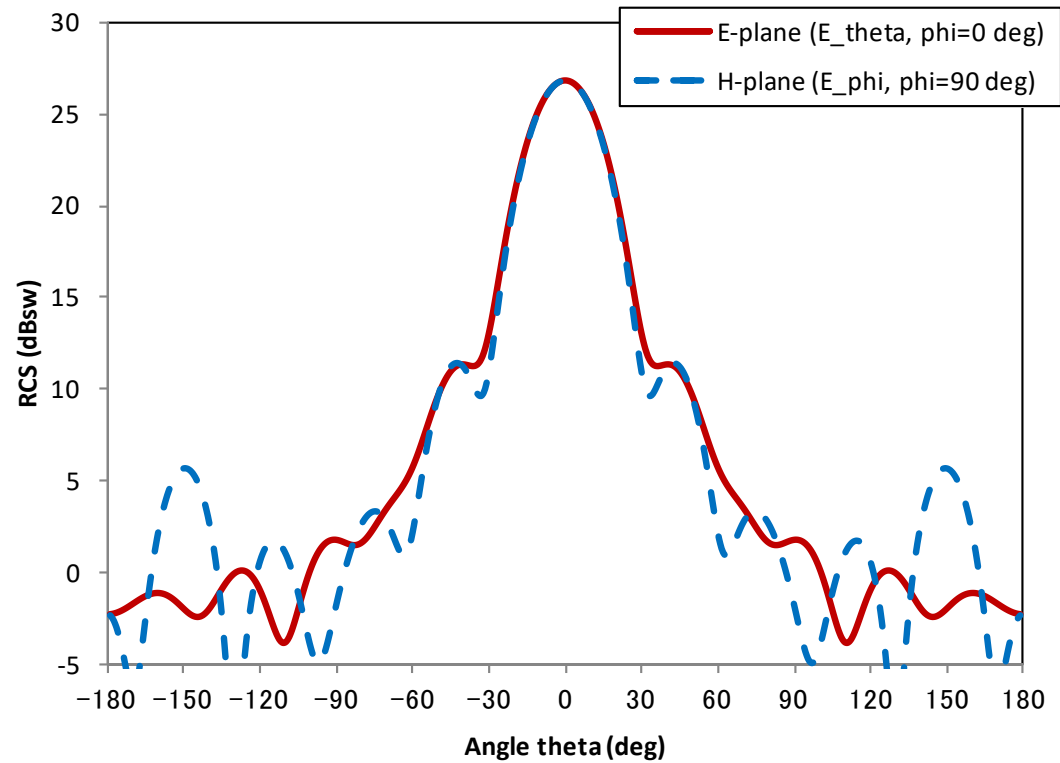
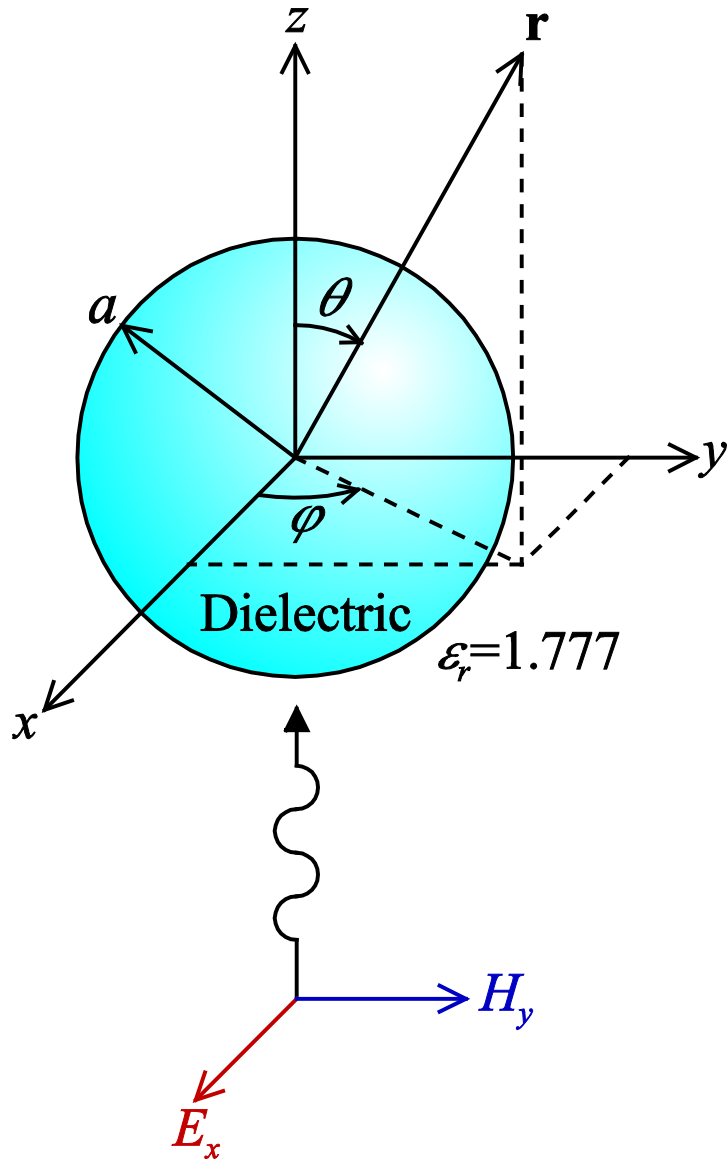


# COMSOLによる誘電体球による平面波散乱の解析

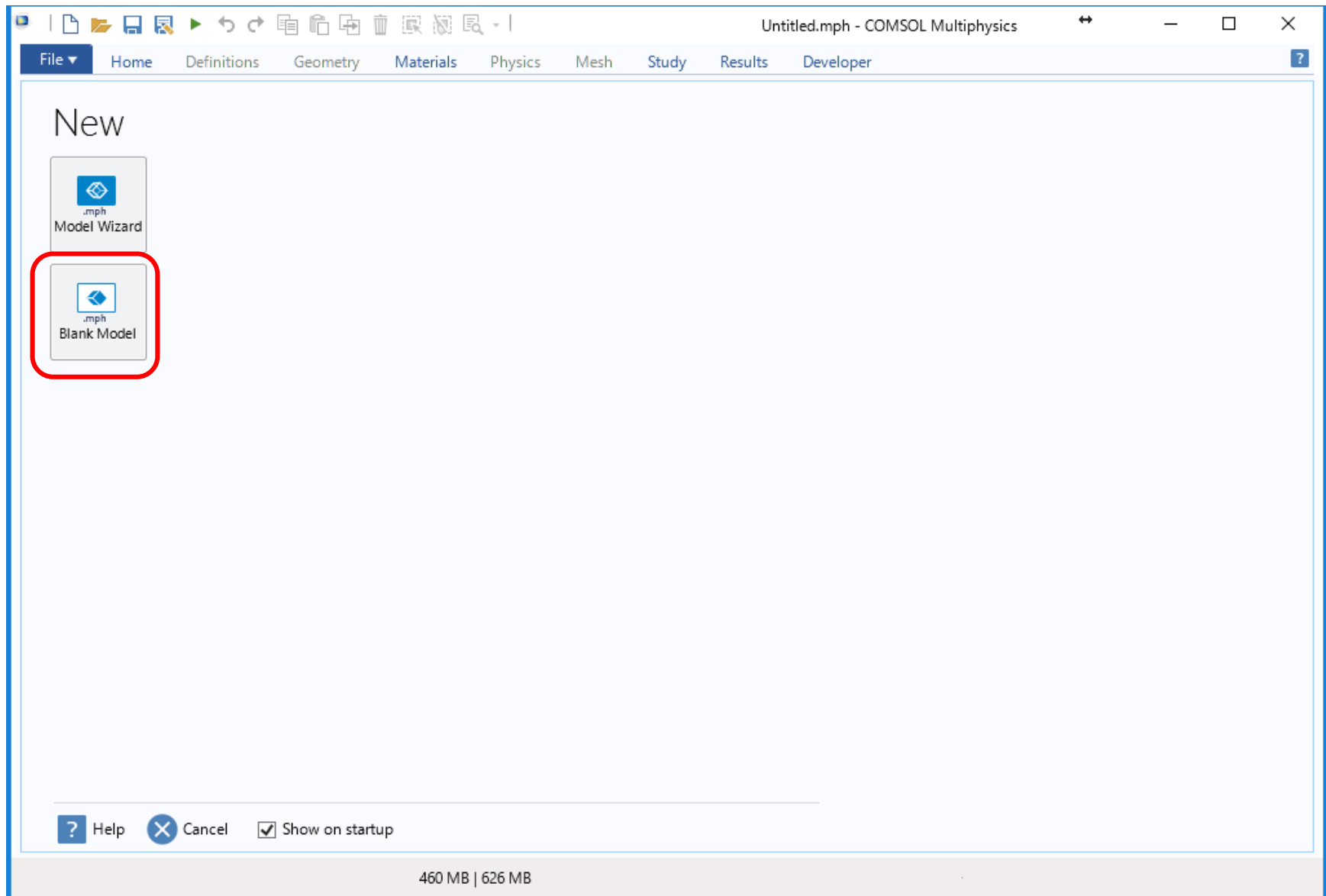
## COMSOL 5.3



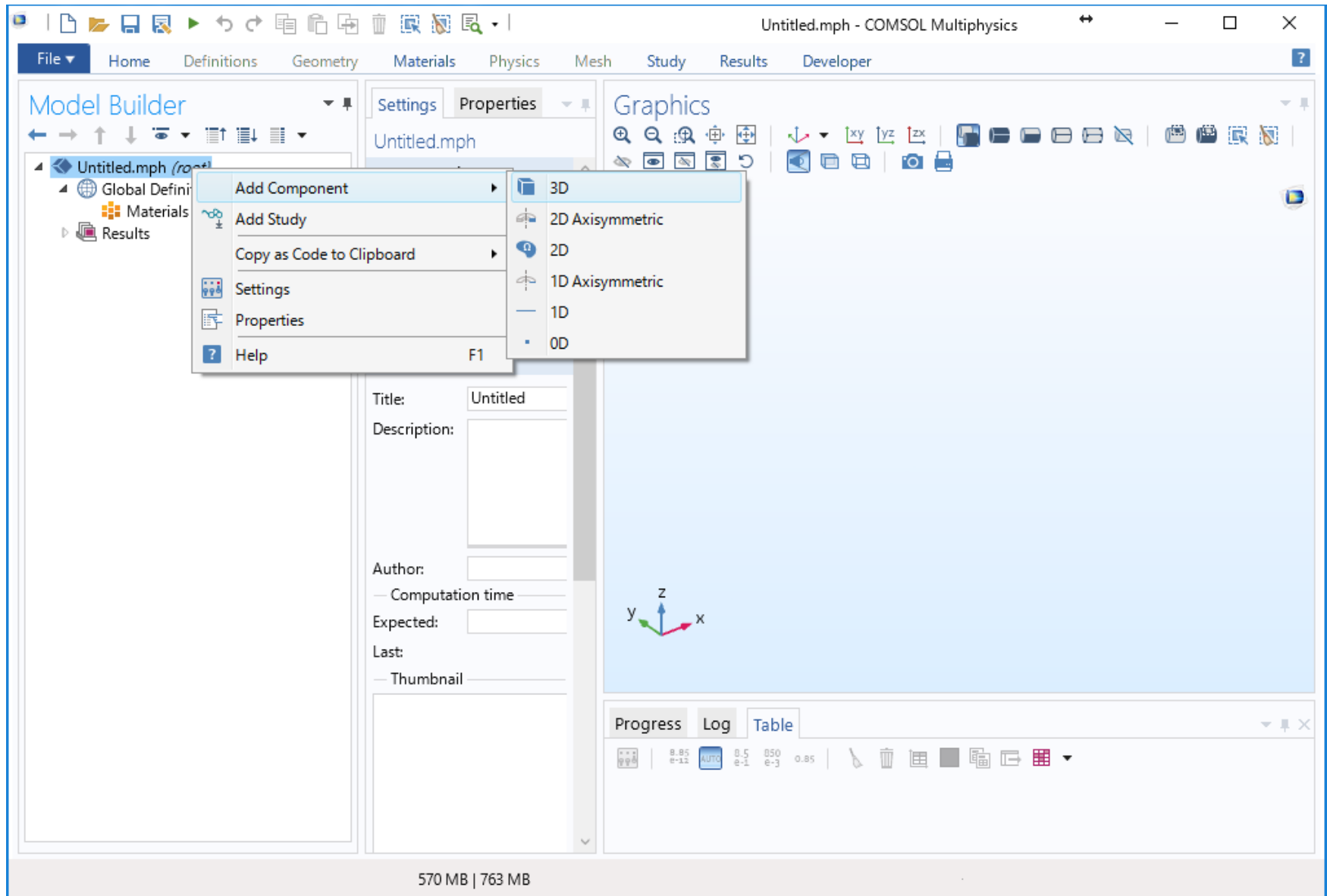
平野 拓一



# COMSOLを起動



# 3Dモデルを追加



# フィジックスを追加

The screenshot displays the COMSOL Multiphysics software interface. The main window title is "Untitled.mph - COMSOL Multiphysics". The top menu bar includes "File", "Home", "Definitions", "Geometry", "Materials", "Physics", "Mesh", "Study", "Results", and "Developer".

The left sidebar, labeled "Model Builder", shows a tree view of the model structure:

- Untitled.mph (root)
  - Global Definitions
  - Materials
  - Component 1 (comp1)
    - Definitions
    - Geometry 1
      - Form Union (fin)
      - Materials
    - Electromagnetic Waves, Frequency Domain
      - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
    - Mesh 1
    - Results

The central "Settings" pane is currently displaying the properties for "Electromagnetic Waves, Frequency Domain". The "Label" is "Electromagne" and the "Name" is "emw". The "Domain Selection" is set to "All domain". The "Formulation" is set to "Full field". The "Analysis Methodology" is set to "Fast".

The right sidebar, labeled "Add Physics", is open and shows a list of physics interfaces. The "Add to Component" and "Add to Selection" buttons are visible at the top. The "Recently Used" list includes:

- Electromagnetic Waves, Frequency Domain
- Transmission Line (tl)
- AC/DC
- Acoustics
- Chemical Species Transport
- Fluid Flow
- Heat Transfer
- Radio Frequency
- Electromagnetic Waves, Frequency Domain (highlighted)
- Electromagnetic Waves, Time Explicit (ew)
- Electromagnetic Waves, Transient (temw)
- Transmission Line (tl)
- Structural Mechanics
- Mathematics

The bottom status bar shows "628 MB | 776 MB".

# スタディを追加

Untitled.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

**Model Builder**

- Untitled.mph (root)
  - Global Definitions
  - Materials
  - Component 1 (comp1)
    - Definitions
    - Geometry 1
      - Form Union (fin)
      - Materials
      - Electromagnetic Waves, Frequency Domain
        - Wave Equation, Electric 1
        - Perfect Electric Conductor 1
        - Initial Values 1
      - Mesh 1
      - Study 1
        - Step 1: Frequency Domain
      - Results

**Settings Properties**

Frequency Domain

Compute

Label: Frequency Domain

Study Settings

Frequency unit:

Frequencies:

Load parameter values:

Reuse solution from previous step

Results While Solving

Physics and Variables Selection

Modify physics tree and variables

Physics interface

Electromagnetic Waves, Frequency Domain

Values of Dependent Variables

Mesh Selection

Adaptation and Error Estimation

Study Extensions

**Graphics**

**Add Study**

+ Add Study

Studies

- Preset Studies
  - Boundary Mode Analysis
  - Eigenfrequency
  - Frequency Domain
  - Frequency-Domain Modal
- Custom Studies
- Empty Study

Physics interfaces in study

Physics	Solve
Electromagnetic Waves, Frequency Domain	<input checked="" type="checkbox"/>

Multiphysics couplings in study

Progress Log Table

8.85	0.5	0.50	0.85
e-12	e-1	e-3	

647 MB | 814 MB

# 変数を定義

The screenshot displays the COMSOL Multiphysics software interface for a model named "dielectric\_sphere.mph". The interface is divided into several main sections:

- Model Builder:** Located on the left, it shows a hierarchical tree of the model's components. The "Parameters" node under "Global Definitions" is selected.
- Settings/Properties:** The central panel shows the "Parameters" settings. A table lists the defined parameters:

Name	Expression	Value	D
a	1 [m]	1 m	
r_abc	a+1	2 m	
w_pml	0.5	0.5	

Below the table, the "Name:" field contains "a", the "Expression:" field contains "1 [m]", and the "Description:" field is empty.

- Graphics:** The right-hand side of the interface shows a 3D coordinate system with x, y, and z axes.
- Progress/Log/Table:** At the bottom right, there is a panel for monitoring the simulation progress, with tabs for "Progress", "Log", and "Table".

At the bottom of the window, the system status bar indicates "716 MB | 836 MB".

# 誘電体球を描く

The screenshot displays the COMSOL Multiphysics software interface for a model named "dielectric\_sphere.mph".

- Model Builder:** Shows the hierarchical structure of the model. Key components include:
  - dielectric\_sphere.mph (root)
  - Global Definitions
    - Parameters
    - Materials
  - Component 1 (comp1)
    - Definitions
    - Geometry 1
      - Sphere 1 (sph1) - Selected
      - Form Union (fin)
    - Materials
    - Electromagnetic Waves, Frequency Domain
      - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
    - Mesh 1
    - Study 1
      - Step 1: Frequency Domain
      - Results

- Settings Panel:** Configures the properties of "Sphere 1".
- Object Type: Solid
- Size: Radius:  $a$  m
- Position: x: 0 m, y: 0 m, z: 0 m
- Axis: Axis type: z-axis
- Rotation Angle: Rotation: 0 deg
- Coordinate System: Work plane: xy-plane
- Graphics Window:** Displays a 3D visualization of the sphere. The axes are labeled x, y, and z, with tick marks at -1, -0.5, 0, 0.5, and 1. The sphere is centered at the origin (0,0,0).

726 MB | 866 MB



# 空気とPMLを描く

dielectric\_sphere.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

**Model Builder**

- dielectric\_sphere.mph (root)
  - Global Definitions
    - Parameters
    - Materials
  - Component 1 (comp1)
    - Definitions
    - Geometry 1
      - Sphere 1 (sph1)
      - Sphere 2 (sph2)
      - Form Union (fin)
    - Materials
    - Electromagnetic Waves, Frequency Domain
      - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
    - Mesh 1
    - Study 1
      - Step 1: Frequency Domain
    - Results

**Settings Properties**

**Sphere**

Build Selected Build All Objects

Label: Sphere 2

Object Type

Type: Solid

Size

Radius:  $r_{abc} + w_{pml}$  m

Position

x: 0 m

y: 0 m

z: 0 m

Axis

Rotation Angle

Coordinate System

Layers

Layer name	Thickness (m)
Layer 1	$w_{pml}$
Layer 2	

**Graphics**

Progress Log Table

725 MB | 873 MB

COMSOLでは球は玉ねぎのように多層にできる。  
PMLを設定するときは外側の層をPMLに設定する。

# 材料(真空)の設定

The screenshot shows the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Materials" tab is active in the Settings/Properties panel, showing the material "Vacuum" selected. The "Geometric Entity Selection" section indicates that "All domains" are selected. The "Material Contents" table is visible at the bottom of the settings panel.

Property	Name	Value
<input checked="" type="checkbox"/> Relative permittivity	epsilon <sub>nr</sub>	1
<input checked="" type="checkbox"/> Relative permeability	mu <sub>r</sub>	1
<input checked="" type="checkbox"/> Electrical conductivity	sigma	0

The Graphics window on the right shows a 3D visualization of a sphere with a blue mesh, centered at the origin of a Cartesian coordinate system (x, y, z). The axes range from -2 to 2 meters.

777 MB | 906 MB

# 材料(誘電体)の設定

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Materials" tab is active, showing the "Properties" section for a material labeled "Dielectric".

**Material Properties List:**

- Density
- Diffusion Coefficient
- Dynamic Viscosity
- Electrical Conductivity** (highlighted)
- Electron Mobility
- Extinction Coefficient
- Frequency Factor
- Heat Capacity at Constant Pressure
- Isotropic Structural Loss Factor
- Mass Flux
- Mean Molar Mass
- Permeability

**Geometric Entity Selection:**

- Geometric entity level: Domain
- Selection: Manual
- Active: [Empty box]

**Model Builder (Left Panel):**

- ectric\_sphere.mph (root)
- Global Definitions
- Parameters
- Materials
- Component 1 (comp1)
- Definitions
- Geometry 1
  - Sphere 1 (sph1)
  - Sphere 2 (sph2)
  - Form Union (fin)
- Materials
  - Vacuum (mat1) - Basic
  - Dielectric (mat2) - Basic
- Electromagnetic Waves, Frequency Domain
  - Wave Equation, Electric 1
  - Perfect Electric Conductor 1
  - Initial Values 1
- Mesh 1
- Study 1
  - Step 1: Frequency Domain
- Results

**Graphics (Right Panel):**

A 3D visualization of a sphere centered at the origin of a Cartesian coordinate system (x, y, z). The axes range from -2 to 2 meters. The sphere is rendered with a semi-transparent gray material, showing its internal structure and the coordinate axes.

**Progress (Bottom Panel):**

The progress bar shows the simulation is at 0.5 (50%) of the total time. The total time is 0.85 seconds. The current time step is 0.5 seconds. The time step size is 0.50 seconds. The time step size is 0.85 seconds. The time step size is 0.85 seconds.

# 材料(誘電体)の設定

The screenshot shows the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The Model Builder tree on the left shows the hierarchy: Component 1 (comp1) > Materials > Dielectric (mat2) > Basic. The Properties panel in the center shows the "Basic" property group for the selected material. The "Output Properties and Model Inputs" section is expanded, showing a table of properties.

Property	Variable	Expression
Relative permittivity	epsilon...	1.777
Relative permeability	mur ; m...	1
Electrical conductiv...	sigma ;...	0

The Graphics window on the right displays a 3D model of a sphere with a radius of 2 meters, centered at the origin of a Cartesian coordinate system (x, y, z). The axes are labeled with values -2, 0, and 2 meters.

755 MB | 870 MB

# 材料(誘電体)の設定

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Materials" tab is active, showing the "Properties" section for a material labeled "Dielectric".

**Material Settings:**

- Label: Dielectric
- Geometric Entity Selection: Domain
- Selection: Manual
- Active: ON

**Material Properties:**

- Basic Properties
- Acoustics
- Electrochemistry
- Electromagnetic Models
- Equilibrium Discharge
- External Material Parameters
- Gas Models
- Magnetostrictive Models
- Piezoelectric Models
- Piezoresistive Models
- Semiconductors

**Model Builder (Left Panel):**

- ectric\_sphere.mph (root)
- Global Definitions
- Parameters
- Materials
- Component 1 (comp1)
- Definitions
- Geometry 1
  - Sphere 1 (sph1)
  - Sphere 2 (sph2)
  - Form Union (fin)
- Materials
  - Vacuum (mat1) - Basic
  - Dielectric (mat2) - Basic
- Electromagnetic Waves, Frequency Domain
  - Wave Equation, Electric 1
  - Perfect Electric Conductor 1
  - Initial Values 1
- Mesh 1
- Study 1
  - Step 1: Frequency Domain
- Results

**Graphics (Right Panel):**

The graphics window shows a 3D visualization of a sphere with a red wireframe overlay. The axes are labeled x, y, and z, with numerical values ranging from -2 to 2 meters. The sphere is centered at the origin (0, 0, 0).

**Progress (Bottom Panel):**

The progress bar shows the simulation progress, with a "Table" button and various icons for data management.

762 MB | 885 MB

# 励振平面波の設定

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Model Builder" on the left shows the hierarchy: Component 1 (comp1) > Geometry 1 > Sphere 1 (sph1) and Sphere 2 (sph2) > Materials > Dielectric (mat2) > Electromagnetic Waves, Frequency Domain. The "Settings" pane for "Electromagnetic Waves, Frequency Domain" is active, showing the following configuration:

- Label: Electromagnetic Waves, Frequency Domain
- Name: emw
- Domain Selection: All domains
- Active: 1, 2, 3, 4, 5, 6
- Equation: Scattered field
- Settings: Formulation: Scattered field; Background wave type: User defined
- Background electric field:  $\exp(-j * \text{emw} . k_0 * z)$
- Port Sweep Settings: (empty)

The "Graphics" window shows a 3D visualization of a blue sphere centered at the origin of a Cartesian coordinate system (x, y, z). The axes range from -2 to 2 meters. The sphere is rendered with a grid of lines, and a coordinate system is visible in the bottom-left corner of the graphics area.

At the bottom of the interface, the memory usage is indicated as 774 MB | 900 MB.

# PMLの設定

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Model Builder" tree on the left shows the hierarchy: dielectric\_sphere.mph (root) > Global Definitions > Parameters > Materials > Component 1 (comp1) > Definitions > Boundary System 1 (sys1) > Perfectly Matched Layer 1 (pml1). The "Settings" pane for "Perfectly Matched Layer" is active, showing the following configuration:

- Label: Perfectly Matched Layer 1
- Name: pml1
- Domain Selection: Manual
- Selection: 1, 2, 3, 4, 7, 8
- Active: ON
- Override: (empty)
- Geometry: Spherical
- Type: Spherical
- Center coordinate: Xm (m) = 0, Ym (m) = 0, Zm (m) = 0
- Scaling: Coordinate stretching type: Polynomial
- Typical wavelength from: (empty)

The "Graphics" window on the right shows a 3D visualization of a blue sphere centered at the origin of a coordinate system with axes x, y, and z. The axes range from -2 to 2 meters. The sphere is surrounded by a grid of lines representing the PML domain.

At the bottom of the interface, the status bar indicates "778 MB | 901 MB".

# 遠方界領域の設定

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The software is running in the "Study" tab, and the "Far-Field Domain" settings are currently active.

**Model Builder:** The left-hand pane shows the model's structure. Under "Component 1 (comp1)", the "Far-Field Domain 1" is highlighted. The model includes two spheres, "Sphere 1 (sph1)" and "Sphere 2 (sph2)", which are combined into a "Form Union (fin)". The physics interface includes "Electromagnetic Waves, Frequency Domain" with "Wave Equation, Electric 1" and "Perfect Electric Conductor 1" applied to the spheres.

**Settings - Far-Field Domain:** The central pane shows the configuration for "Far-Field Domain 1". The "Domain Selection" is set to "Manual", and domain "5" is selected and active. The "Override and Contribution" section is currently empty.

**Graphics:** The right-hand pane shows a 3D visualization of the model. A green dielectric sphere is centered at the origin of a 3D coordinate system (x, y, z). The axes range from -2 to 2 meters. The sphere is surrounded by a grid representing the far-field domain.

**Progress:** The bottom status bar shows the model size as 789 MB | 921 MB. The progress bar indicates that the simulation is in progress, with a value of 0.85.



# スタディを追加 & 解析

dielectric\_sphere.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- dielectric\_sphere.mph (root)
  - Global Definitions
    - Parameters
    - Materials
  - Component 1 (comp1)
    - Definitions
      - Boundary System 1 (sys1)
      - Perfectly Matched Layer 1 (pr)
      - View 1
    - Geometry 1
      - Sphere 1 (sph1)
      - Sphere 2 (sph2)
      - Form Union (fin)
    - Materials
      - Vacuum (mat1)
        - Basic
      - Dielectric (mat2)
        - Basic
    - Electromagnetic Waves, Frequency Domain
      - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
      - Far-Field Domain 1
    - Mesh 1
    - Study 1
      - Step 1: Frequency Domain
      - Results

Settings Properties

Frequency Domain

Compute

Label: Fre Compute (F8)

Study Settings

Frequency unit: MHz

Frequencies: 300 MHz

Load parameter values: Browse... Re...

Reuse solution from previous step: Auto

Results While Solving

Physics and Variables Selection

Modify physics tree and variables for study step

Physics interface	Solve for	Discretiza
Electromagnetic Waves, F...	✓	Physics

Values of Dependent Variables

Mesh Selection

Adaptation and Error Estimates

Study Extensions

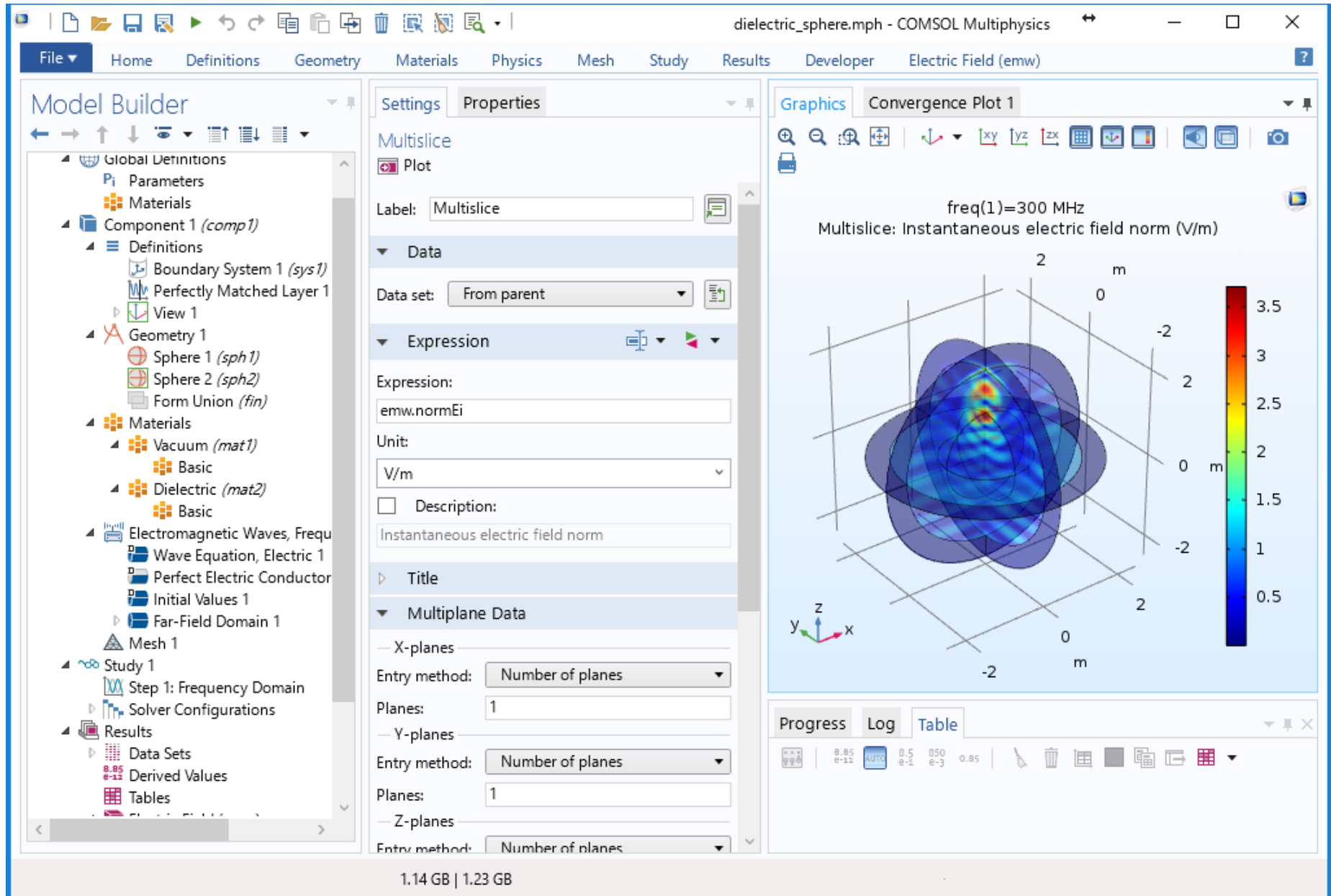
Graphics

波長は1m

Progress Log Table

747 MB | 876 MB

# 電界強度分布(瞬時値)



# 電界強度分布(瞬時値の時間アニメーション) No. 19

dielectric\_sphere.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer Electric Field (emw)

Plot Electric Field (emw) 3D Plot Group 2D Plot Group 1D Plot Group Polar Plot Group Smith Plot Group

Label: Electric Field (emw)

Data set: Study 1/Sol

Parameter value (freq (MHz)): 300

Title

Plot Settings

View: Automatic

Show hidden entities

Propagate hiding to lower dimensions

Plot data set edges

Color: Black

Frame: Spatial (x, y, z)

Color Legend

Show legends

Show maximum and minimum values

Show units

Position: Right

Text color: Black

Multislice: Instantaneous electric f

Progress Log Directivity

$\theta$ (deg)	$\phi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.09 GB | 1.16 GB

# 電界強度分布(瞬時値の時間アニメーション) No. 20

dielectric\_sphere.mph - COMSOL Multiphysics

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Model Builder

- Sphere 1 (sph1)
- Sphere 2 (sph2)
- Form Union (fin)
- Materials
  - Vacuum (mat1)
    - Basic
  - Dielectric (mat2)
    - Basic
- Electromagnetic Waves, Frequency Domain
  - Wave Equation, Electric 1
  - Perfect Electric Conductor
  - Initial Values 1
  - Far-Field Domain 1
- Mesh 1
- Study 1
  - Step 1: Frequency Domain
  - Solver Configurations
- Results
  - Data Sets
  - Views
  - Derived Values
  - Tables
  - Electric Field (emw)
    - Multislice
  - 2D Far Field (emw)
  - 3D Far Field (emw)
  - 1D Plot Group
  - Export
    - Animation 1
  - Reports

Settings Properties

Animation

Show Frame

Label: Animation 1

Scene

Subject: Electric Field (emw)

Target

Target: Player

Animation Editing

Sequence type: Dynamic data exte

Cycle type: Full harmonic

Frames

Number of frames: 16

Frame number: 1

Phase shift: 0

Playing

Display each frame for: 0.1 s

Repeat

Advanced

Graphics Convergence Plot 1

freq(1)=300 MHz  
Multislice: Instantaneous electric field norm (V/m)

2 m  
0  
-2  
2  
0 m  
-2  
2  
0 m

4  
3.5  
3  
2.5  
2  
1.5  
1  
0.5

Progress Log Directivity

$\theta$ (deg)	$\varphi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.25 GB | 1.37 GB

# 遠方界(3D RCS)の出力

The screenshot displays the COMSOL Multiphysics interface for a simulation titled "dielectric\_sphere.mph". The software is running a 3D Far Field (RCS) analysis. The Model Builder on the left shows the hierarchy: View 1, Geometry 1 (Sphere 1, Sphere 2, Form Union), Materials (Vacuum, Dielectric), Electromagnetic Waves, Frequency Domain (Wave Equation, Electric 1, Perfect Electric Conductor, Initial Values 1, Far-Field Domain 1), Mesh 1, Study 1 (Step 1: Frequency Domain), Solver Configurations, Results (Data Sets, Views, Derived Values, Tables, Electric Field (emw), Multislice, 2D Far Field (emw), 3D Far Field (emw), Far Field 1, 1D Plot Group).

The Settings and Properties window for "Far Field 1" is open, showing the following configuration:

- Label: Far Field 1
- Data set: From parent
- Expression:  $emw.bRCS3D$
- Unit:  $m^2$
- Description: Bistatic radar cross section
- Threshold: 0  $m^2$
- Use as color expression:
- Number of elevation angles: 100
- Number of azimuth angles: 50
- Restriction: None

The Graphics window shows a 3D plot of the bistatic radar cross section (RCS) for a frequency of 300 MHz. The plot is titled "Far Field: Bistatic radar cross section ( $m^2$ )". The color scale ranges from 0.08 to 499  $m^2$ . The plot shows a highly directional, elongated shape, characteristic of a radar cross section plot.

The Progress window shows the simulation progress and a table of Directivity values:

$\theta$ (deg)	$\phi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

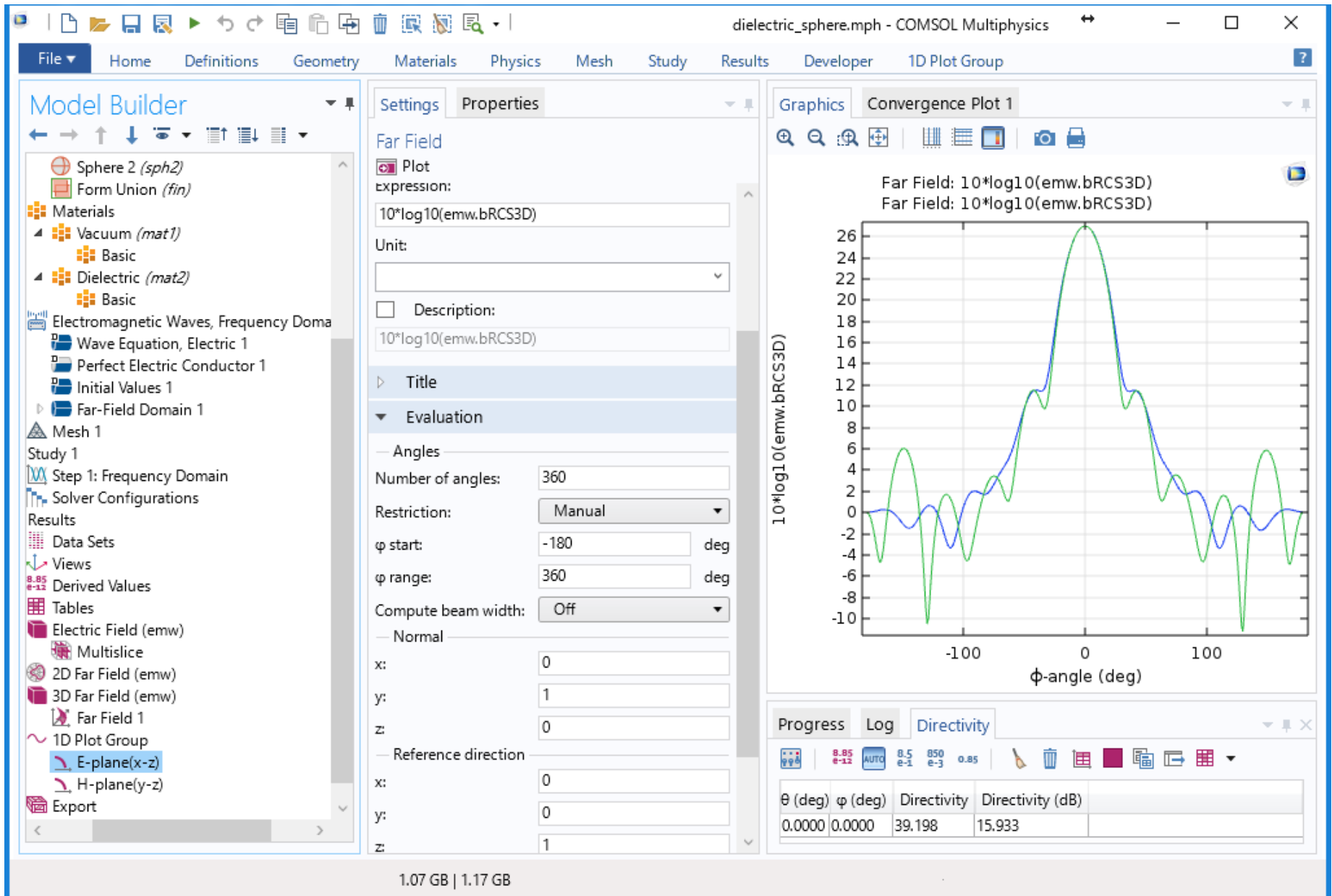
# 遠方界(1D RCS)の出力

The screenshot displays the COMSOL Multiphysics interface for a model named 'dielectric\_sphere.mph'. The 'Model Builder' tree on the left shows the hierarchy of the model, including 'Study 1' and 'Results'. A context menu is open over the 'Results' node, with 'More Plots' selected, showing options like 'Nyquist' and 'Far Field'. The 'Graphics' window shows a 'Convergence Plot 1' with a grid. The 'Directivity' window at the bottom right contains a table with the following data:

$\theta$ (deg)	$\varphi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

At the bottom of the interface, the memory usage is shown as 1.11 GB | 1.17 GB.

# 遠方界(1D RCS)の出力



# 1D プロットをCSVファイルにエクスポート

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Model Builder" tree on the left shows the hierarchy: Sphere 2 (sph2) > Form Union (fin) > Materials > Vacuum (mat1) > Dielectric (mat2) > Electromagnetic Waves, Frequency Domain > Data > Plot. The "Plot" menu is open, showing options like 1D Image, Animation, and Export All. The "Graphics" window on the right shows a "Convergence Plot 1" with two data series: "Far Field: 10\*log10(emw.bRCS3D)" (green line) and "Far Field: 10\*log10(emw.bRCS3D)" (blue line). The plot shows a main peak at 0 degrees and smaller side lobes. The y-axis is labeled "10\*log10(emw.bRCS3D)" and ranges from -10 to 26. The x-axis is labeled "φ-angle (deg)" and ranges from -100 to 100. At the bottom, the "Progress" window shows a table of Directivity data.

θ (deg)	φ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.26 GB | 1.38 GB



# 1D プロットをCSVファイルにエクスポート

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Model Builder" on the left shows a hierarchy of components including "Sphere 2 (sph2)", "Form Union (fin)", "Materials" (Vacuum, Dielectric), "Electromagnetic Waves, Frequency Domain" (Wave Equation, Perfect Electric Conductor, Initial Values, Far-Field Domain), "Mesh 1", "Study 1" (Step 1: Frequency Domain, Solver Configurations), and "Results" (Data Sets, Views, Derived Values, Tables, Electric Field, 2D Far Field, 3D Far Field, 1D Plot Group, and Export). The "Export" option is selected under "Results".

The "Settings" pane for "Plot 1" is visible, showing the "Export" button and the following configuration:

- Label: Plot 1
- Plot group: 1D Plot Group
- Plot: E-plane(x-z)
- File type: Text
- Filename: e\_plane.csv
- Data format: Spreadsheet

The "Graphics" pane shows a "Convergence Plot 1" titled "Far Field:  $10 \cdot \log_{10}(\text{emw.bRCS3D})$ ". The plot shows a peak at  $\phi = 0$  degrees. The y-axis is labeled  $10 \cdot \log_{10}(\text{emw.bRCS3D})$  and ranges from -2 to 26. The x-axis is labeled  $\phi$ -angle (deg) and ranges from -100 to 100.

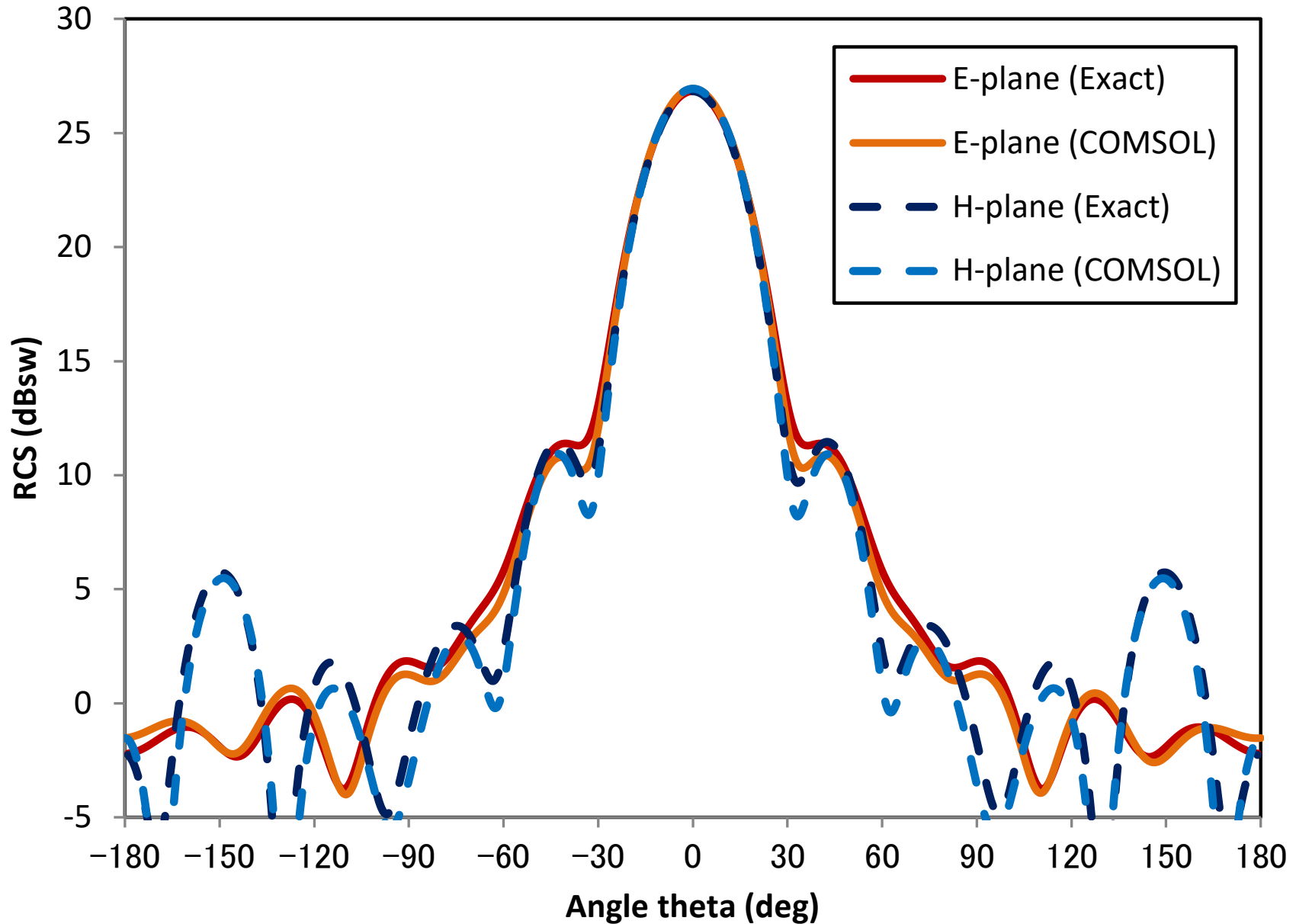
The "Progress" pane at the bottom shows a table with the following data:

$\theta$ (deg)	$\phi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.24 GB | 1.35 GB

## 厳密解との比較

ABCはPMCでないと上手くいかない。



# 【発展】メッシュ制御

The screenshot displays the COMSOL Multiphysics interface for a model named "dielectric\_sphere.mph". The "Mesh" tab is active, showing the "Mesh 1" settings. The "Element size" dropdown menu is open, listing options from "Extremely fine" to "Extremely coarse", with "Normal" selected. The "Graphics" window shows a 3D view of a sphere with a mesh, overlaid on a coordinate system with axes labeled x, y, and z. The axes range from -2 to 2 meters. The "Progress" window at the bottom shows a table of results for Directivity.

$\theta$ (deg)	$\varphi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.21 GB | 1.3 GB

# 【発展】解析結果を削除してファイルサイズを小さく No.28

The screenshot shows the COMSOL Multiphysics interface for a file named 'dielectric\_sphere.mph'. The 'Mesh' tab is selected in the top ribbon. The left sidebar shows a tree view with 'Geometry 1' selected. The central panel displays the 'Geometry 1' properties, including units (meters and degrees) and a checked 'Automatic rebuild' option. The main 3D view shows a sphere with a complex, overlapping mesh. A red box highlights the 'Clear All Meshes' button in the top right corner. At the bottom, a progress bar and a table of results are visible.

$\theta$ (deg)	$\phi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.21 GB | 1.3 GB

# 【発展】解析結果を削除してファイルサイズを小さく<sup>No.29</sup>

The screenshot shows the COMSOL Multiphysics software interface for a file named 'dielectric\_sphere.mph'. The 'Study' tab is active, and the 'Clear All Solutions' button is highlighted with a red rectangle. The interface includes a toolbar with various study and analysis tools, a left-hand tree view showing the model hierarchy, a central property panel for 'Geometry 1', and a 3D visualization of a sphere with a mesh. At the bottom, a progress bar and a data table are visible.

COMSOL Multiphysics - dielectric\_sphere.mph

File Home Definitions Geometry Materials Physics Mesh Study Results Developer

Compute Study 1 Add Study Get Initial Value Show Default Solver Study Steps Parametric Sweep Function Sweep Material Sweep Combine Solutions Study Reference Create Solution Copy Statistics Clear Solutions Clear All Solutions

Parameters  
Materials  
Component 1 (comp1)  
Definitions  
Boundary System 1 (sys1)  
Perfectly Matched Layer 1 (pml1)  
View 1  
Geometry 1  
Sphere 1 (sph1)  
Sphere 2 (sph2)  
Form Union (fin)  
Materials  
Vacuum (mat1)  
Basic  
Dielectric (mat2)  
Basic  
Electromagnetic Waves, Frequency Domain  
Wave Equation, Electric 1  
Perfect Electric Conductor 1  
Initial Values 1  
Far-Field Domain 1  
Mesh 1  
Study 1  
Results

Label: Geometry 1

Units  
 Scale values when changing units  
Length unit: m  
Angular unit: Degrees  
Advanced  
Default repair tolerance: Automatic  
 Automatic rebuild

Progress Log Directivity

$\theta$ (deg)	$\phi$ (deg)	Directivity	Directivity (dB)
0.0000	0.0000	39.198	15.933

1.05 GB | 1.14 GB