



**Wavenology EM<sup>TM</sup>**

# Experience Hybrid Techniques

Manual of A New Full-Wave Transient  
Electromagnetic Field Simulator

**Wave Computation Technologies, Inc.**

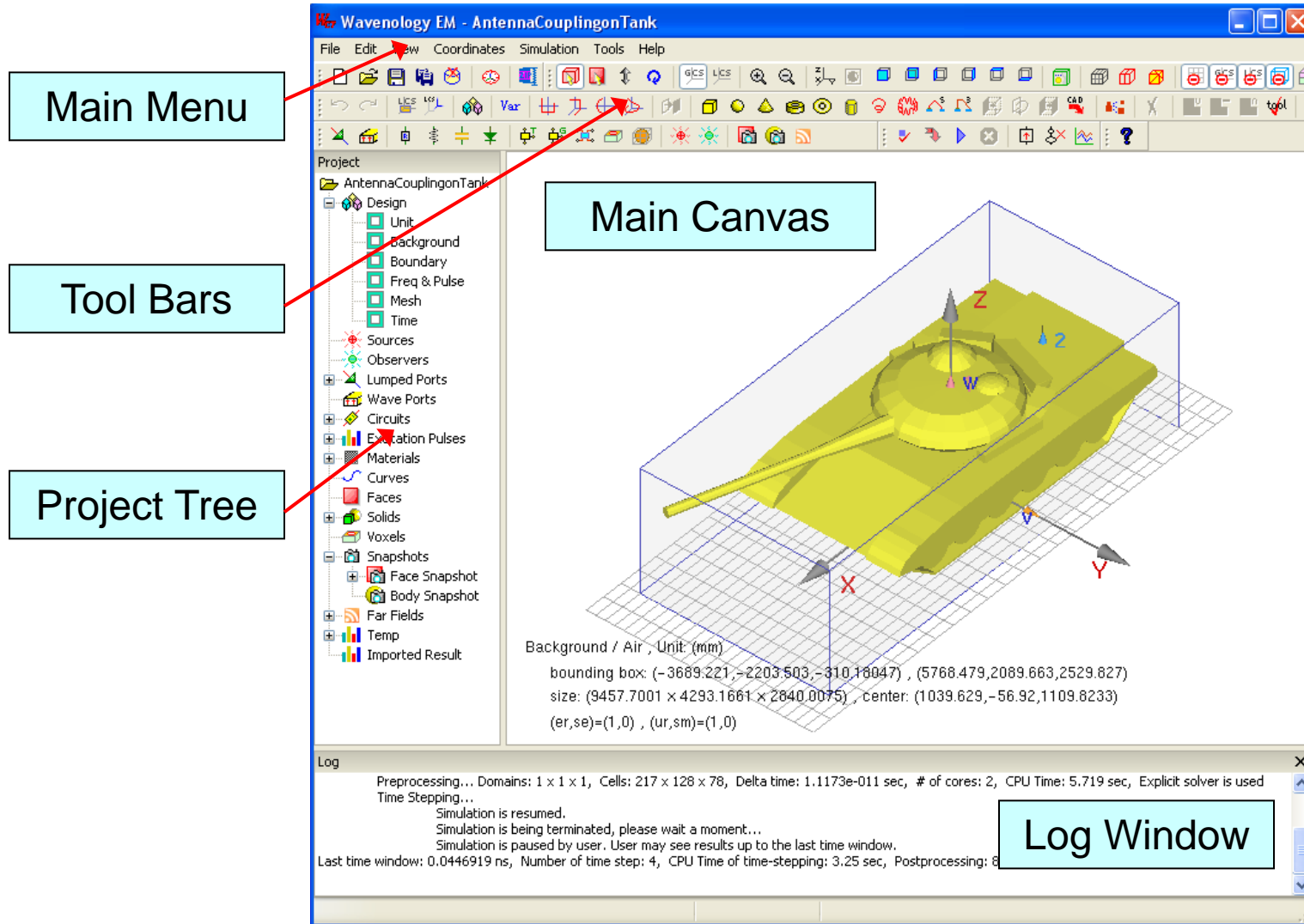
[www.wavenology.com](http://www.wavenology.com)

August 30, 2012

# Outline

- Overview
- Simulation Setup
- Model Construction
- Result Exploration
- Additional Features
- Summary

# Integrated Design Environment



The screenshot shows the Wavenology EM - AntennaCouplingTank software interface. The window title is "Wavenology EM - AntennaCouplingTank". The interface includes a main menu (File, Edit, View, Coordinates, Simulation, Tools, Help), a toolbar with various icons, and a project tree on the left. The main canvas displays a 3D model of an antenna structure in a yellow color, with a coordinate system (X, Y, Z) and a bounding box. The log window at the bottom shows simulation progress and status messages.

**Main Menu**

**Tool Bars**

**Project Tree**

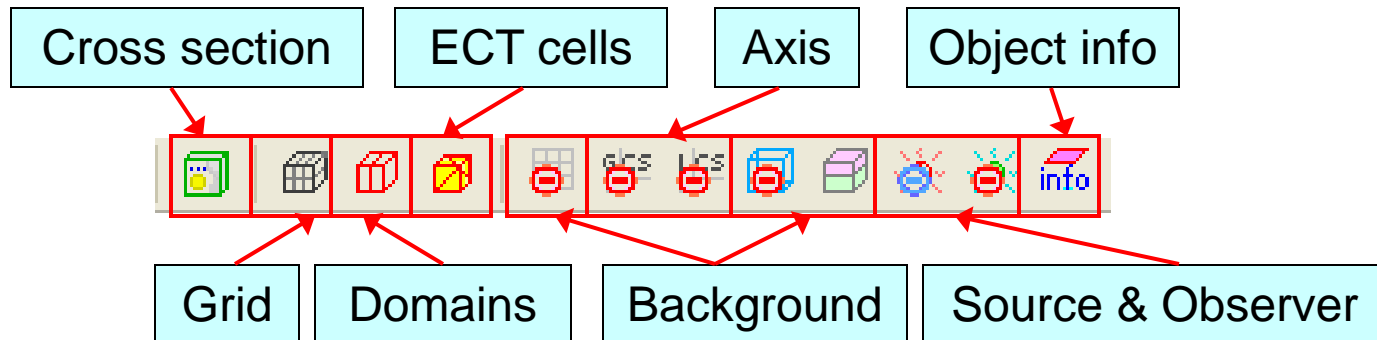
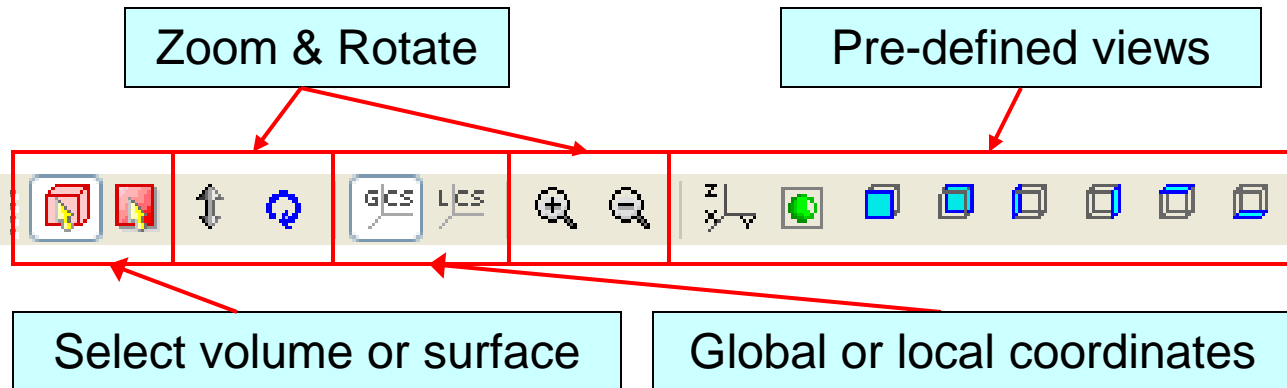
**Main Canvas**

Background / Air, Unit: (mm)  
 bounding box: (-3689.221,-2203.503,-310.18047) , (5768.479,2089.663,2529.827)  
 size: (9457.7001 x 4293.1661 x 2840.0075) , center: (1039.629,-56.92,1109.8233)  
 (er,se)=(1,0) , (ur,sm)=(1,0)

**Log Window**

Preprocessing... Domains: 1 x 1 x 1, Cells: 217 x 128 x 78, Delta time: 1.1173e-011 sec, # of cores: 2, CPU Time: 5.719 sec, Explicit solver is used  
 Time Stepping...  
 Simulation is resumed.  
 Simulation is being terminated, please wait a moment...  
 Simulation is paused by user. User may see results up to the last time window.  
 Last time window: 0.0446919 ns, Number of time step: 4, CPU Time of time-stepping: 3.25 sec, Postprocessing: 6

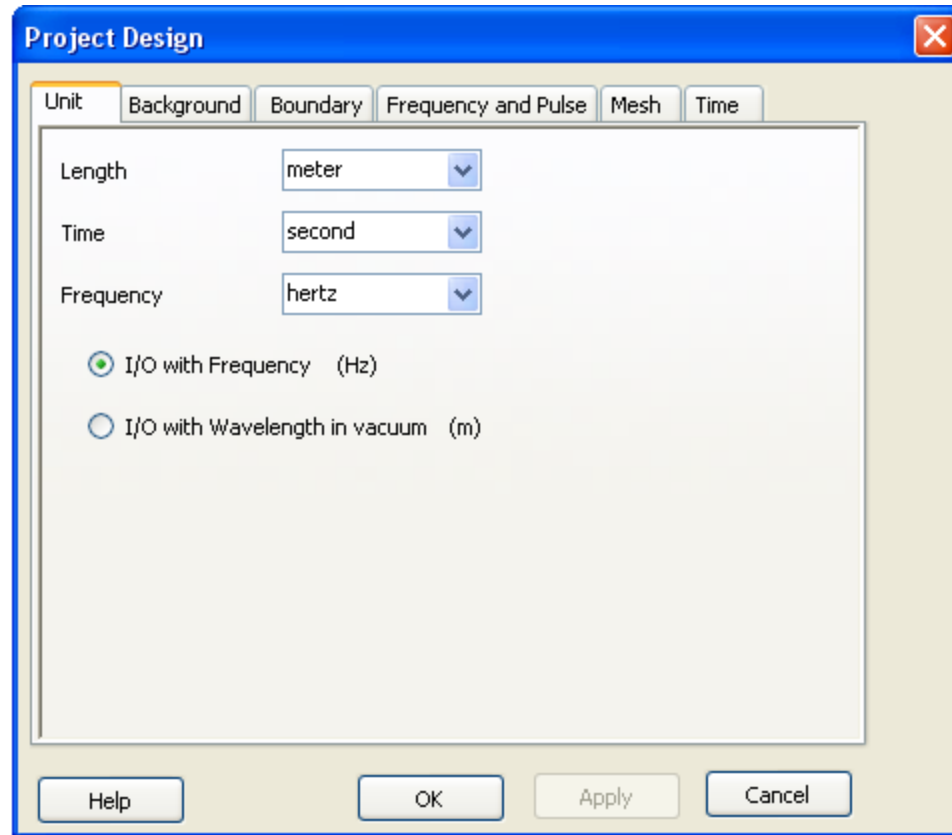
# View Tool Bars



# Simulation Setup

- Design
  - Unit
  - Background
  - Boundary
  - Freq & Pulse
  - Mesh
  - Time
- Sources
  - Types
    - E / M Dipoles
    - E / M Polarized Plane Waves
    - Gaussian Beam
    - Bessel Beam
    - Near Field Ingestion
  - Time-Domain Signatures
    - BHW
    - Gaussian
    - Ricker
    - Delta
    - Rectangle
    - Sine
    - User Defined
- Observers
- Ports
  - Lumped Ports
  - Wave Ports
- Circuits
  - SPICE Circuits
  - Sub-Circuits
  - Internal Resistor
  - Internal Inductor
  - Internal Capacitor
  - Internal Diode
  - Internal Josephson Junction
- Materials
  - PEC
  - PMC
  - Air
  - Dielectric
  - Dispersive
  - Conducting
  - Lossy
  - Inhomogeneous (voxel)
  - (Anisotropic)

# Design - Unit



- I/O with Frequency
  - Determine the bandwidth of the simulation through frequency range
- I/O with Wavelength in vacuum
  - Determine the bandwidth of the simulation through freespace wavelength range

# Design – Background

**Project Design**

Unit: Background | Boundary | Frequency and Pulse | Mesh | Time

Homogeneous Background Material: LorentzMat1

Use Layered Medium

Layer Stack Orientation: [Dropdown]

(Note: The bottom position and layer thicknesses are along the stack orientation. Double click to begin each cell edit.)

	Bottom Position or Layer Thickness	Material	Action
Top		Air	
			Add
2	0.5	LorentzMat1	Delete
1	0.1	PEC	Delete
Bottom	0	Air	

Buttons: Help, OK, Apply, Cancel

**Project Design**

Unit: Background | Boundary | Frequency and Pulse | Mesh | Time

Homogeneous Background Material: LorentzMat1

Use Layered Medium

Layer Stack Orientation: Z

(Note: The bottom position and layer thicknesses are along the stack orientation. Double click to begin each cell edit.)

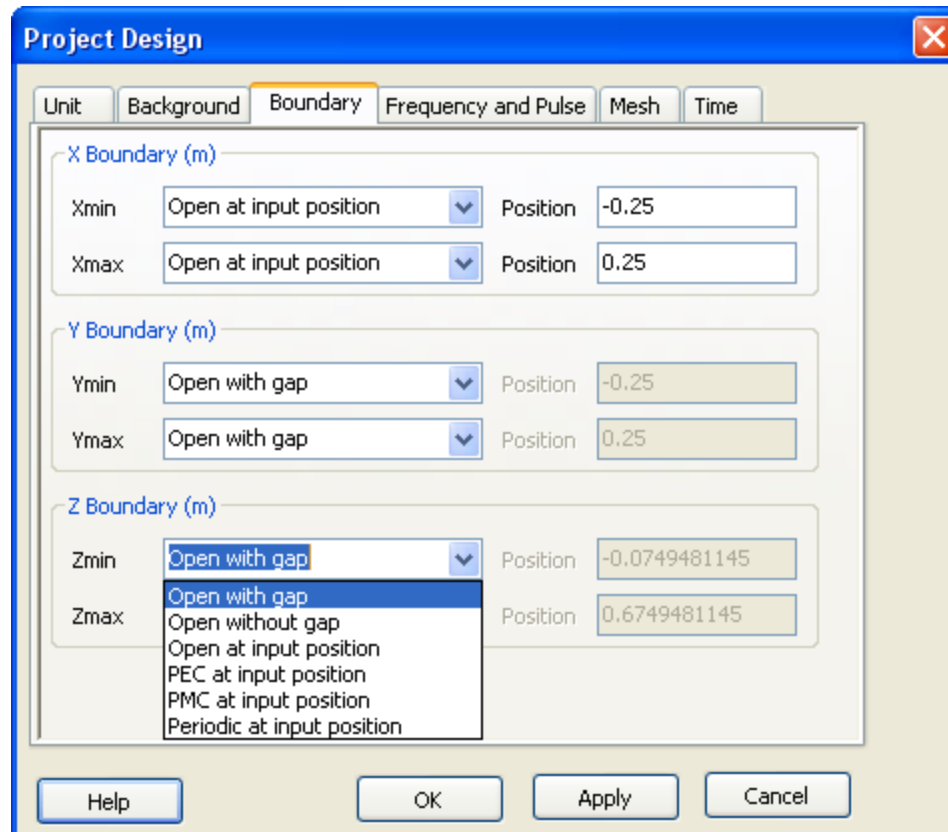
	Bottom Position or Layer Thickness	Material	Action
Top		Air	Add
			Delete
2	0.5	LorentzMat1	Delete
1	0.1	PEC	Delete
Bottom	0	Air	

Buttons: Help, OK, Apply, Cancel

- Support both homogeneous and layered medium as background
- Both user defined and pre-defined material library can be applied

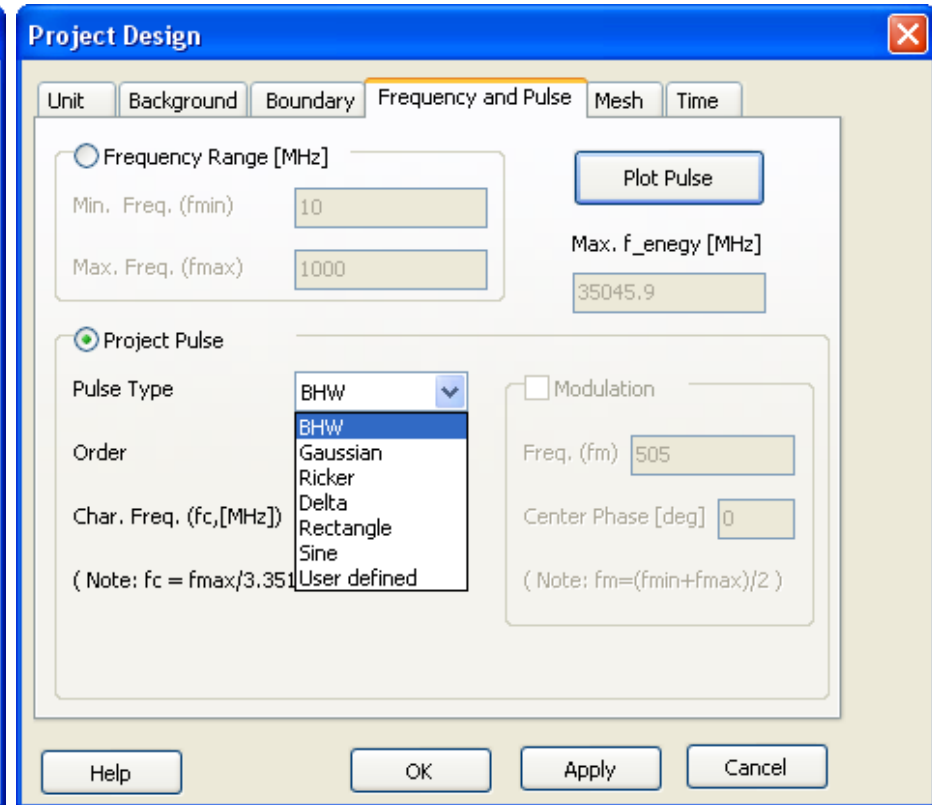
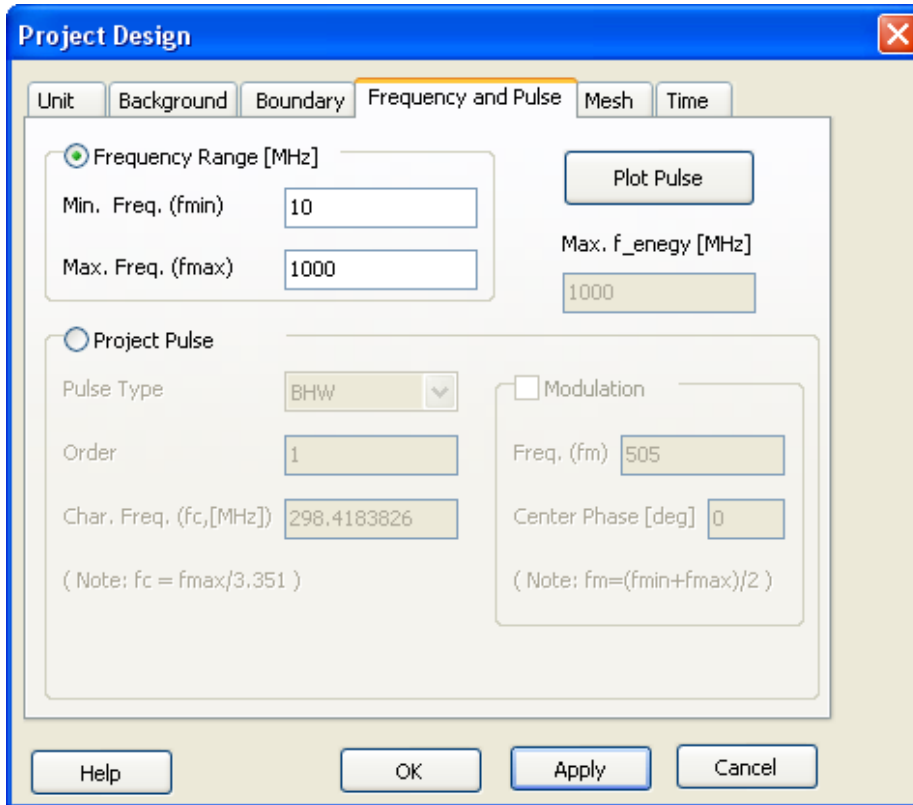
# Design – Boundary

- PEC, PMC
- Open
- Periodic





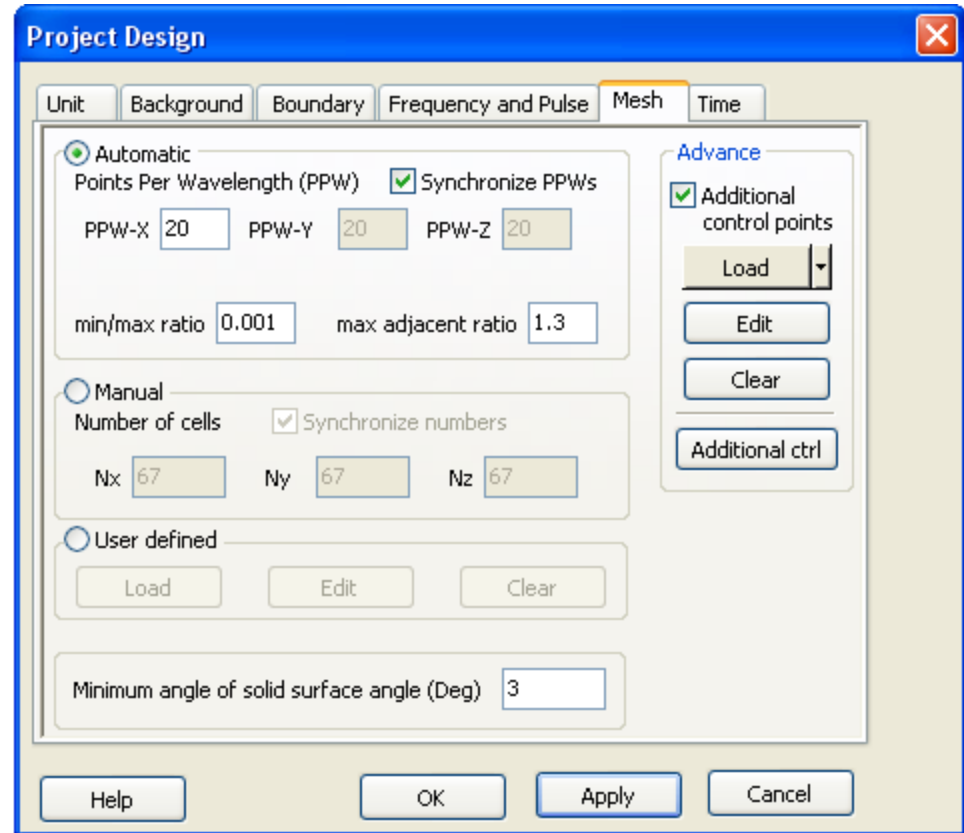
# Design – Frequency & Pulse



- When specify a frequency range the default wideband source will be applied
- User can also select his/her own project pulse
- Click the “Plot Pulse” button will show the time-domain signal of the source

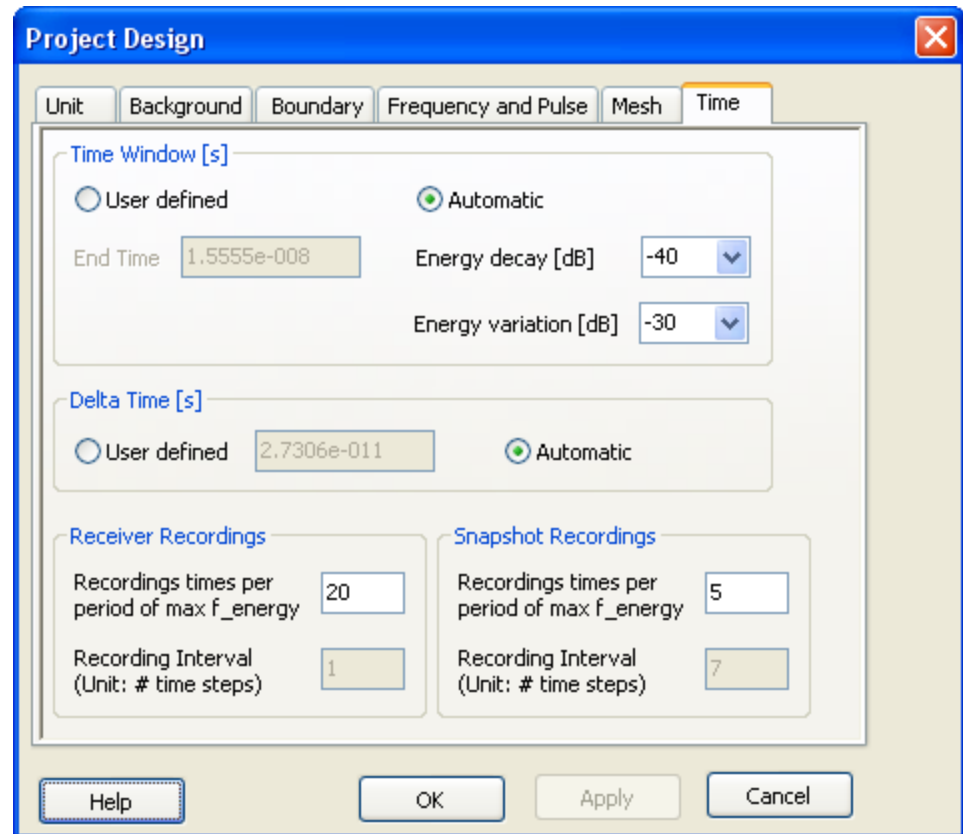
# Design – Mesh

- Automatic
  - User only need to specify the points per wavelength (PPW). Everything else will be automatically determined
  - User can also further control the automatic mesh by customizing the min/max cell ratio and max adjacent cell ratio
  - Additional control points can be added to the automatic mesh as well
- Manual
  - User can also manually control the mesh density along each dimension
- User defined
  - A fully customized mesh can also be defined by the user with a mesh point file

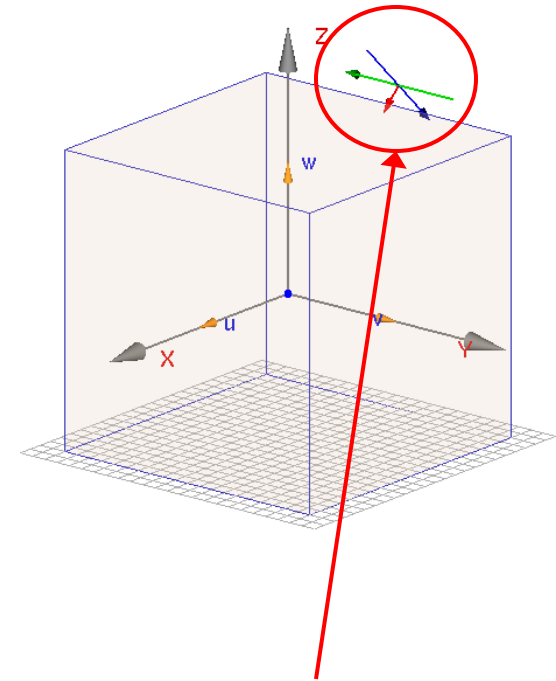
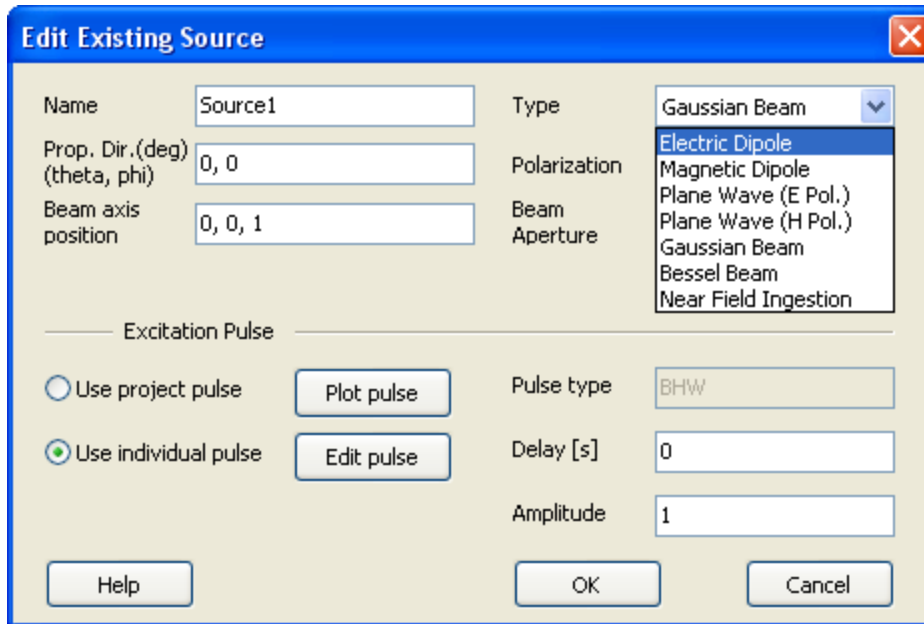


# Design – Time

- Time Window
  - Controls the simulation time
  - User defined time window will force the simulator stop at the time barrier specified by the user
  - Automatic will estimate the energy decay and variation level, the simulation will stop when the specified threshold is reached. (Carefully used for high-Q system)
- Delta Time
  - Time step for the simulation
- Recording Intervals
  - Allow the user to control the recording intervals of the solution
  - This will impact the resolution of the displayed result



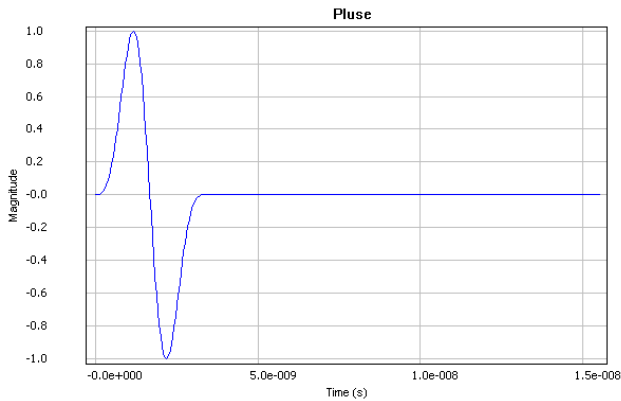
# Sources – Types



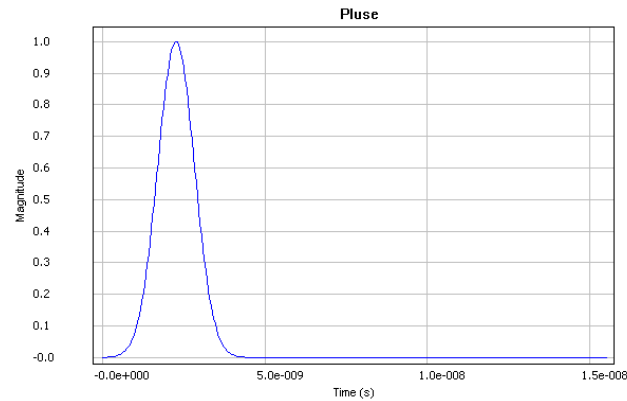
- Dipole
- Plane Wave
- Beams
- Near Field Ingestion

- For plane wave and beams, an indicator will be displayed of its propagation and polarized directions

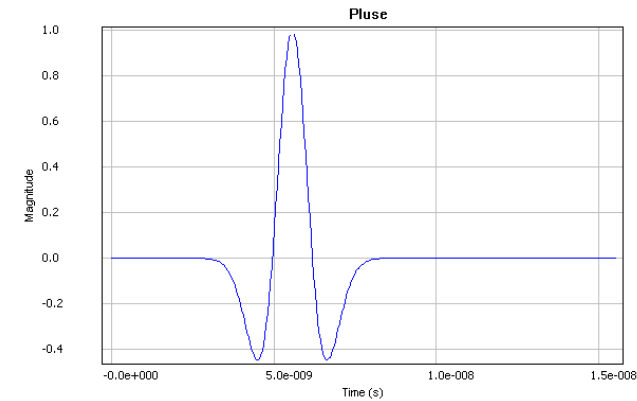
# Sources – Time Domain Signatures



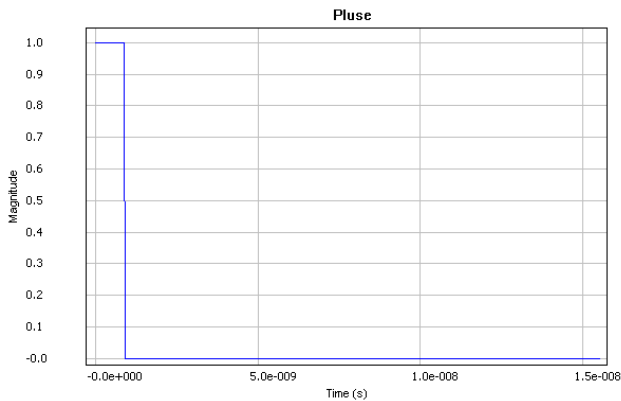
BHW



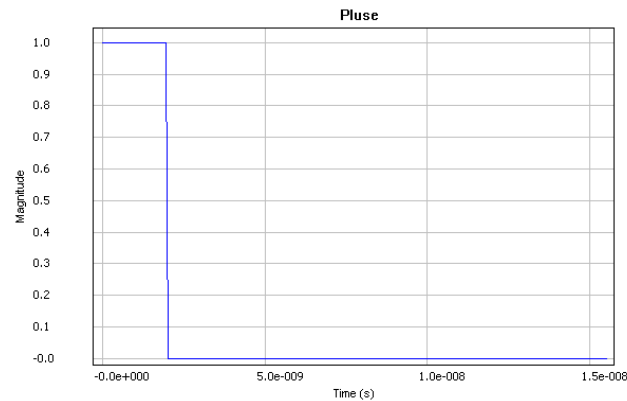
Gaussian



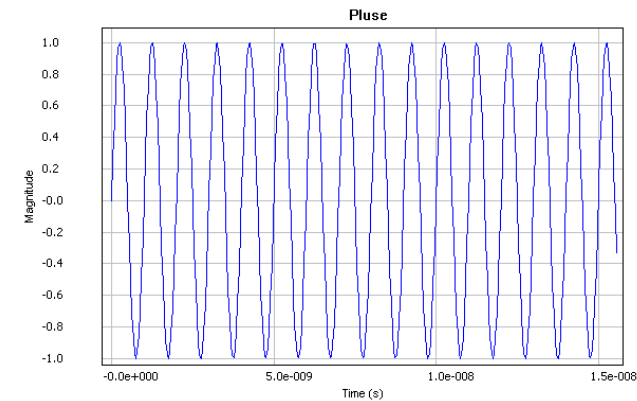
Ricker



Delta

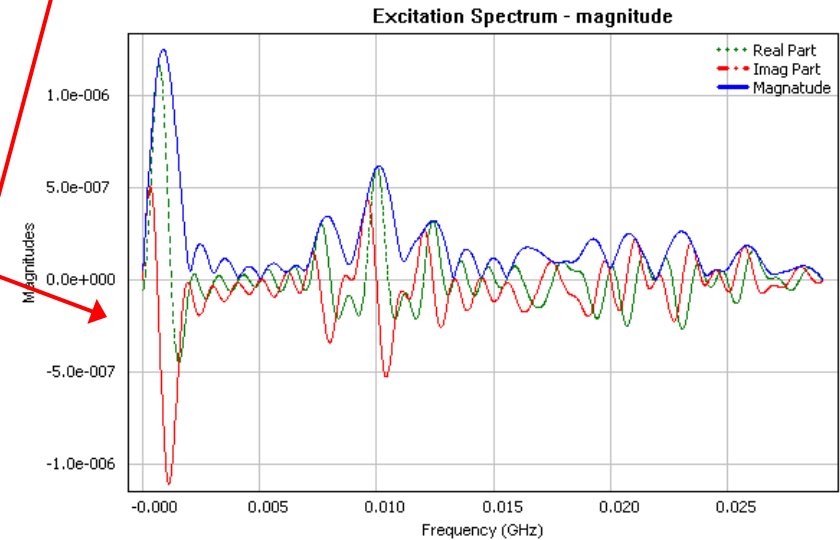
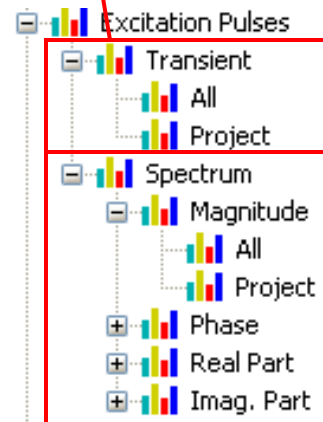
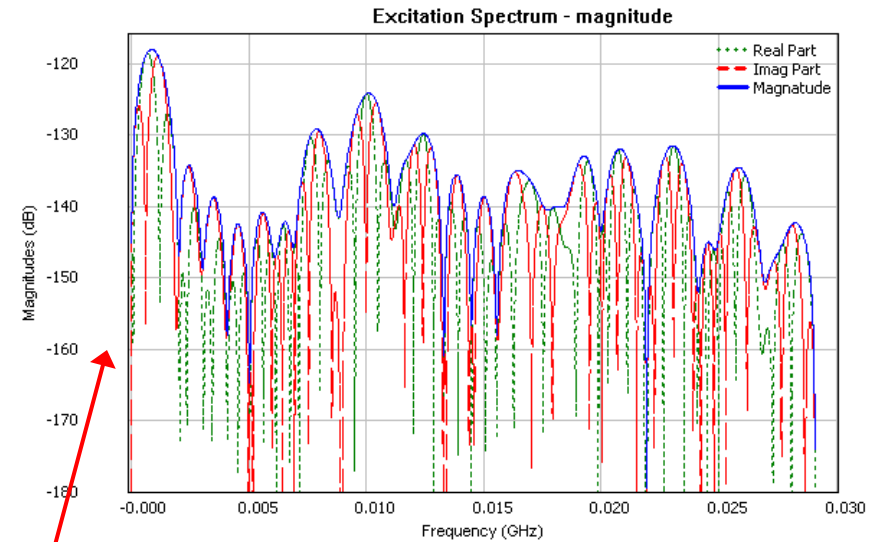
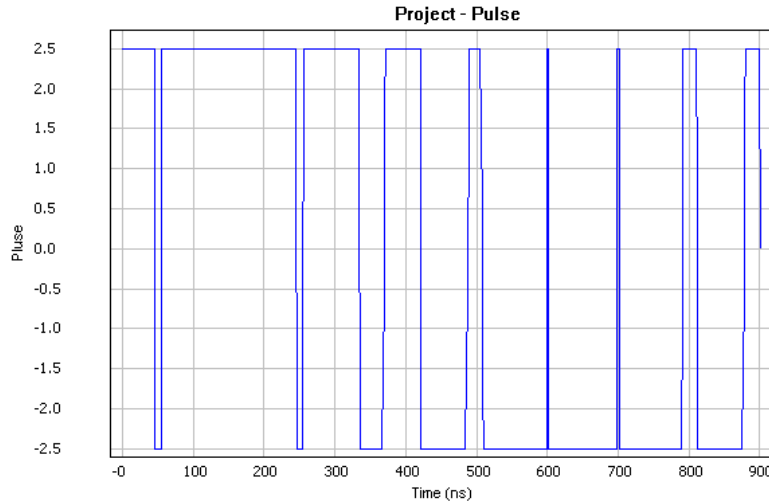


Rectangle



Sinusoid

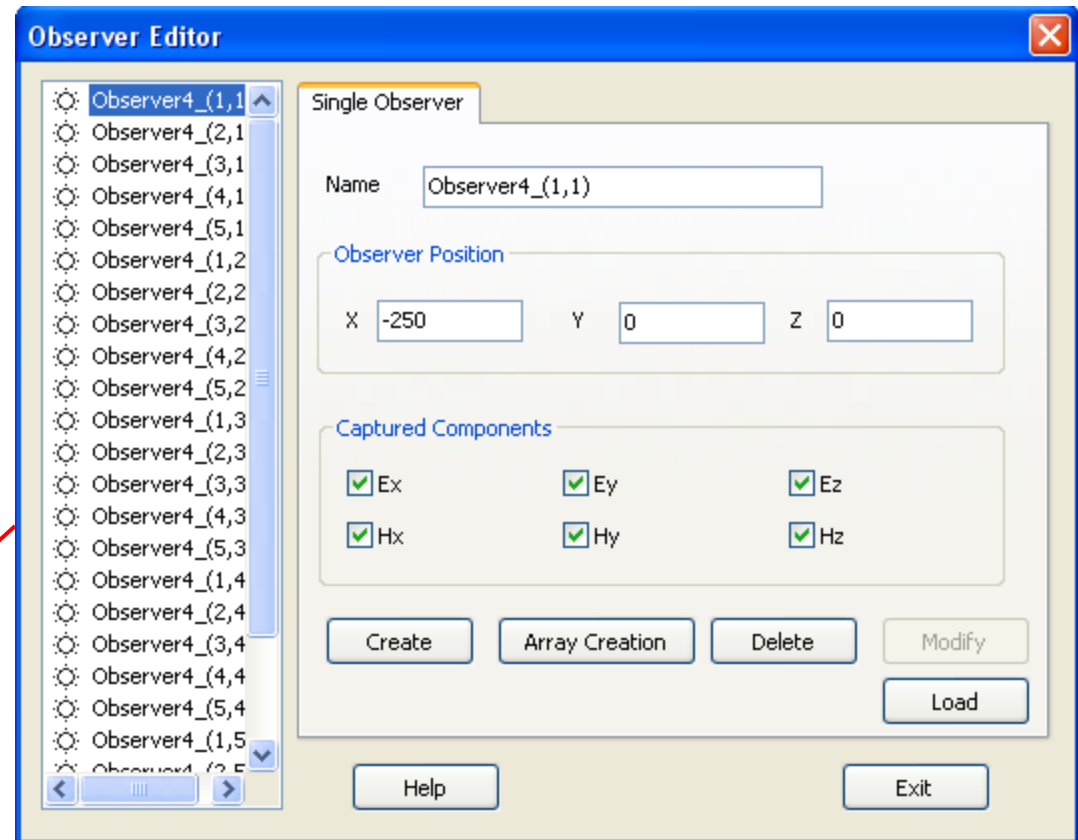
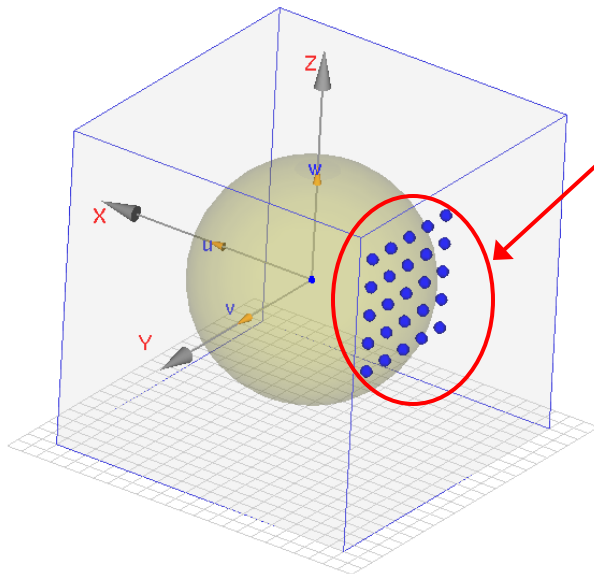
# Sources – User Defined Pulses



- User can provide a fully customized time domain signal and load it into Wavenology EM
- Automatic interpolation and re-sampling will be performed
- The spectrum of the user defined signal will be automatically performed

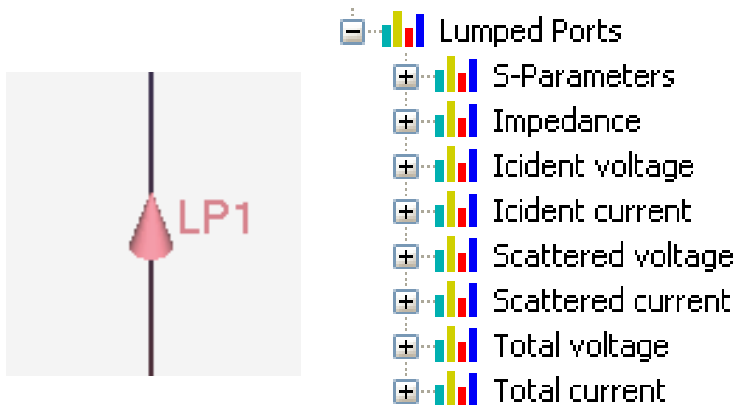
# Observers

- Field components can be selected based on user's interest
- Array Creation is supported
- Fully customized observer position can be loaded from an external file



# Ports – Lumped Ports

- Can be used as source and/or observer
- S-parameters, impedance, incident voltage/current and total voltage/current will be automatically calculated after the simulation



### Lumped Port Editor

**General**

Name

**Type**

S Parameter Port   Plus AC Resistance

DC Resistance

**Excitation Pulse**

Use project pulse  Delay [ns]

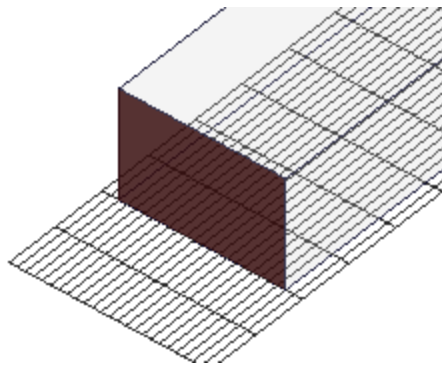
Use individual pulse  Amplitude

**Positions**

Negative (Start) Terminal  Positive (End) Terminal



# Ports – Wave Ports



- [-] Wave Ports
- [+] S-Parameters
- [+] Impedance
- [+] Incident voltage
- [+] Incident current
- [+] Scattered voltage
- [+] Scattered current
- [+] Total voltage
- [+] Total current

### Wave port setup

Name:  Type:  Port Normal:

**Size**

Enclose Selected Area Only

Input Rectangle Bounding Box

Corner 1: x1:  y1:  z1:

Corner 2: x2:  y2:  z2:

**Boundary Condition**

Left:  Right:  Top:  Bottom:

Number of Mode:  Multiple Pins Setting:  Mesh Control:

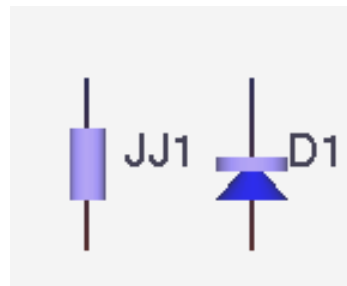
Impedance Normalization (ohm):  Polarization Angle:

**Excitation Pulse**

Use project pulse  Delay [ns]:

Use individual pulse  Amplitude:

# Circuits – Josephson Junction & Diode



Definition of internal Josephson Junction and Diode

**Josephson Junction Editor**

Name: JJ1

**Junction Parameters**

Critical Current (A): 0.0001

Junction Resistor (Ohm):

Junction Capacitor (F):

**DC Bias**

Type: Current Src Value: 0

**Position**

Start Terminal: 7.8565, 3, 0

End Terminal: 7.8565, 3, 1.044

Reverse

Help OK Cancel

**Modify Lumped Diode**

**General**

Name: D1 Emission Factor: 1

**Parameters**

Temperature (K): 300 Saturation Current (A): 0.001

**Position**

Negative (Start) Terminal: 7.8565, 4, 0

Positive (End) Terminal: 7.8565, 4, 1.044

Reverse

**Start -> End Diode Polarization**

P-N Junction  N-P Junction

Help OK Cancel

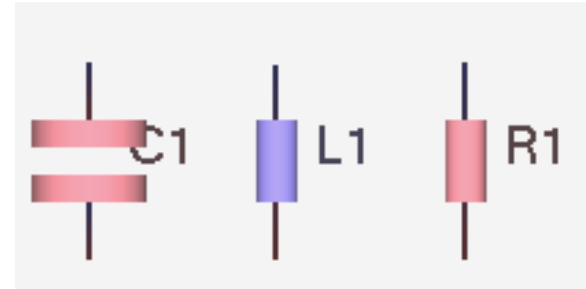
# Circuits – R, L, C

**Modify Lumped Capacitor**

General  
 Name: C1 Unit: F

Parameter  
 DC Component: 50  Plus AC Component

Position  
 Negative (Start) Terminal: 7.8565, 5, 0  
 Positive (End) Terminal: 7.8565, 5, 1.044



Definition of internal capacitor, inductor and resistor

**Modify Lumped Inductor**

General  
 Name: L1 Unit: H

Parameter  
 DC Component: 50  Plus AC Component

Position  
 Negative (Start) Terminal: 7.8565, 6, 0  
 Positive (End) Terminal: 7.8565, 6, 1.044

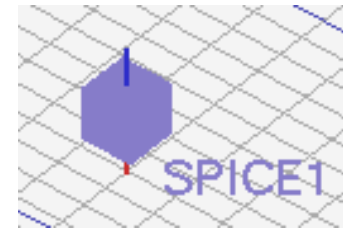
**Modify Lumped Resistor**

General  
 Name: R1 Unit: Ohm

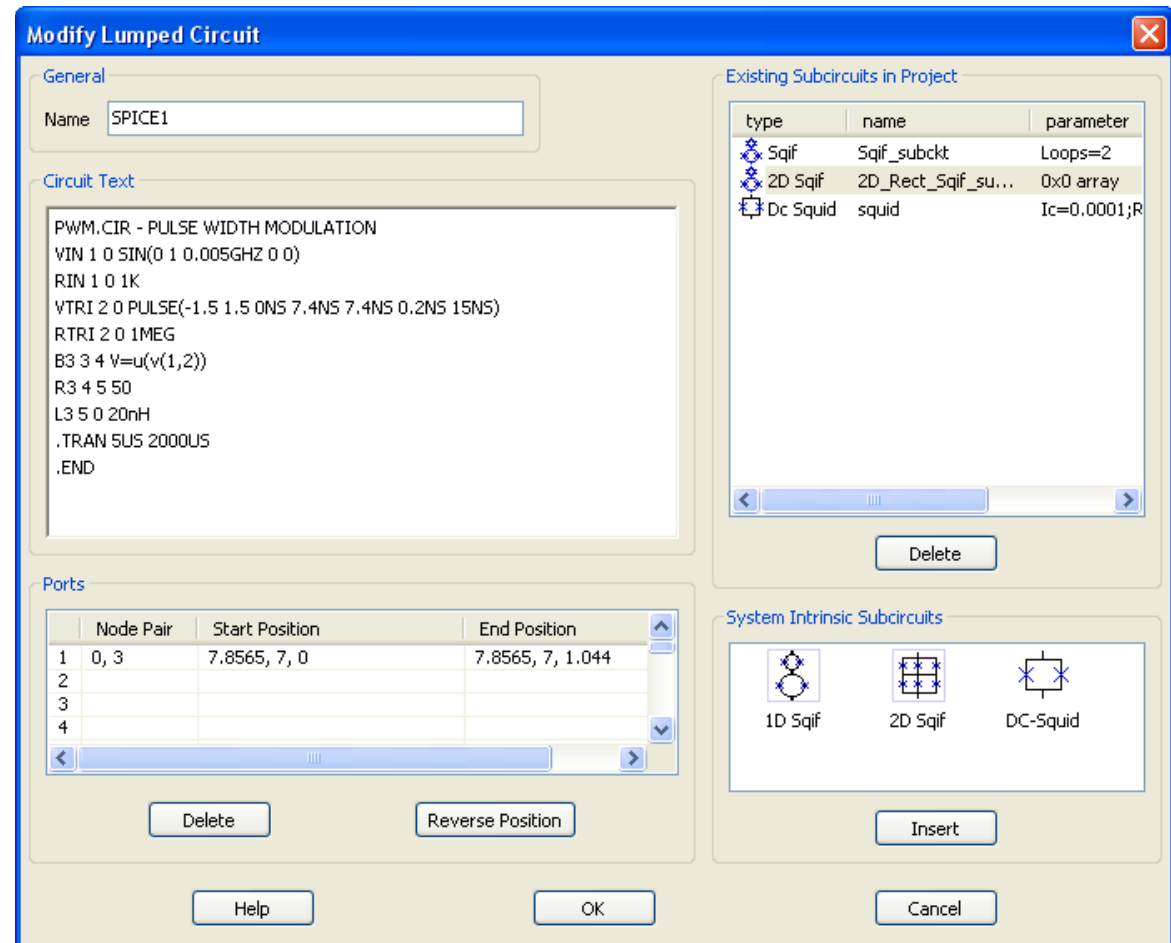
Parameter  
 DC Component: 50  Plus AC Component

Position  
 Negative (Start) Terminal: 7.8565, 7, 0  
 Positive (End) Terminal: 7.8565, 7, 1.044

# Circuits – SPICE (1)



- SPICE circuits can be defined through standard SPICE netlist file
- The port that communicate with the EM solver must be defined if the circuit is co-simulated together with other components
- Sub-circuits are supported
- Intrinsic quantum circuit elements such as 1D and 2D SQIF and DC SQUID



**Modify Lumped Circuit**

**General**

Name:

**Circuit Text**

```
PWM.CIR - PULSE WIDTH MODULATION
VIN 1 0 SIN(0 1 0.005GHZ 0 0)
RIN 1 0 1K
VTRI 2 0 PULSE(-1.5 1.5 0NS 7.4NS 7.4NS 0.2NS 15NS)
RTRI 2 0 1MEG
B3 3 4 V=u(v(1,2))
R3 4 5 50
L3 5 0 20nH
.TRAN 5US 2000US
.END
```

**Ports**

	Node Pair	Start Position	End Position
1	0, 3	7.8565, 7, 0	7.8565, 7, 1.044
2			
3			
4			

**Existing Subcircuits in Project**

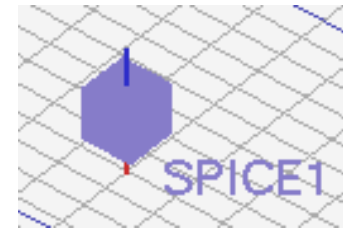
type	name	parameter
	Sqif_subckt	Loops=2
	2D_Rect_Sqif_su...	0x0 array
	squid	Ic=0.0001;R...

**System Intrinsic Subcircuits**

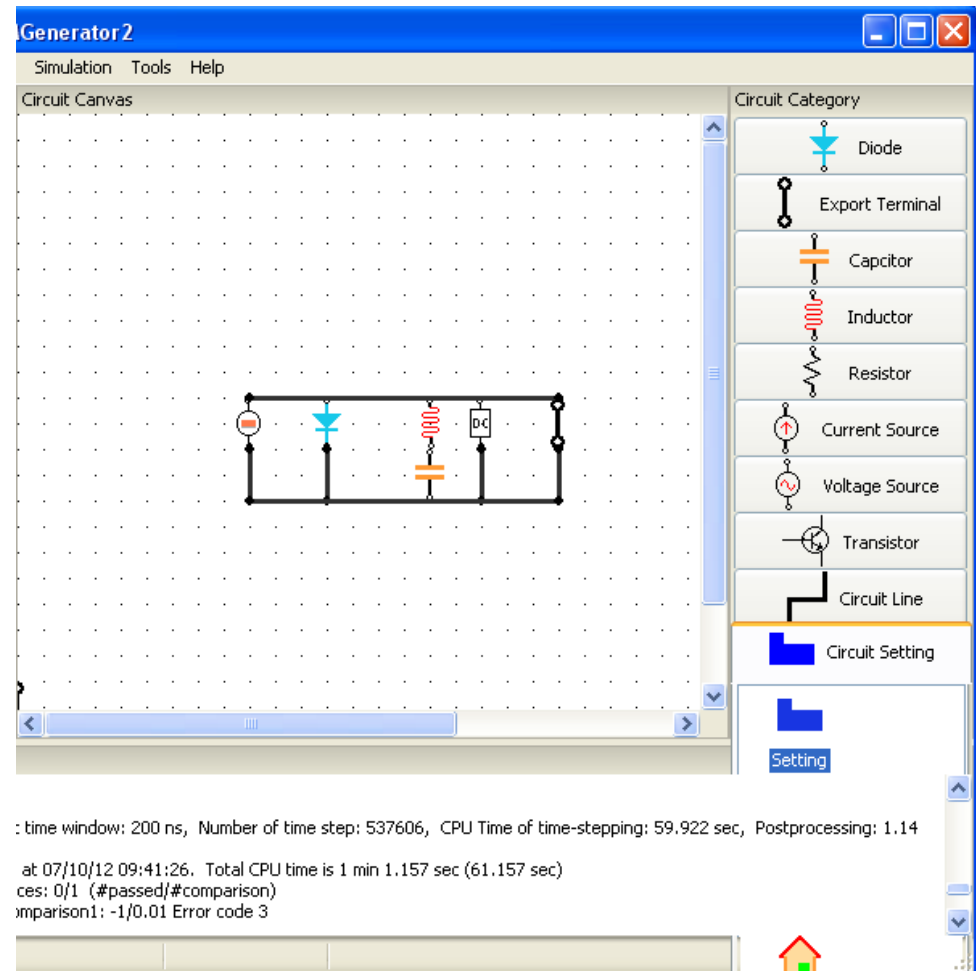
1D Sqif    2D Sqif    DC-Squid

Buttons: Delete, Reverse Position, Help, OK, Cancel

# Circuits – SPICE (2)



- SPICE circuits can also be defined through a GUI
- User can draw their circuits instead of using circuit definition files



Generator2  
Simulation Tools Help

Circuit Canvas

Circuit Category

- Diode
- Export Terminal
- Capacitor
- Inductor
- Resistor
- Current Source
- Voltage Source
- Transistor
- Circuit Line
- Circuit Setting
- Setting

: time window: 200 ns, Number of time step: 537606, CPU Time of time-stepping: 59.922 sec, Postprocessing: 1.14

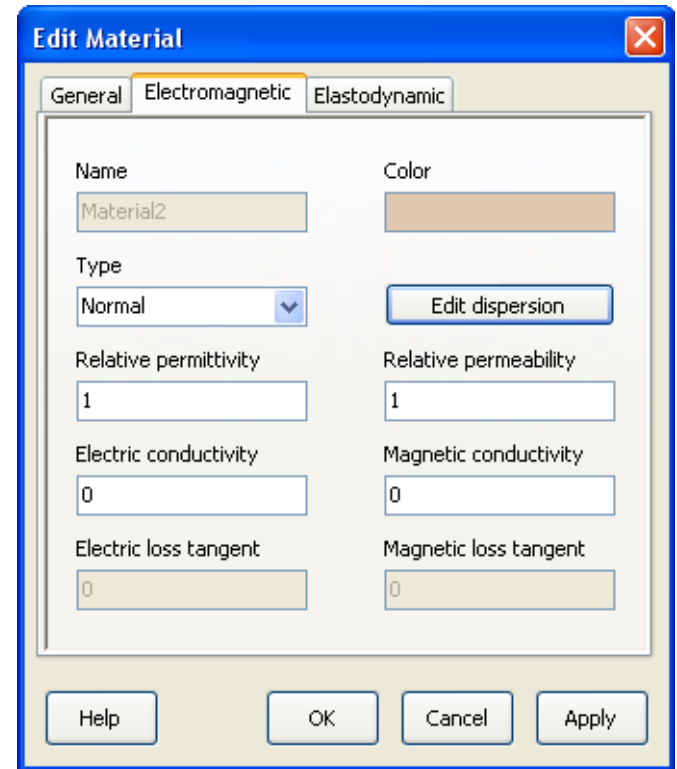
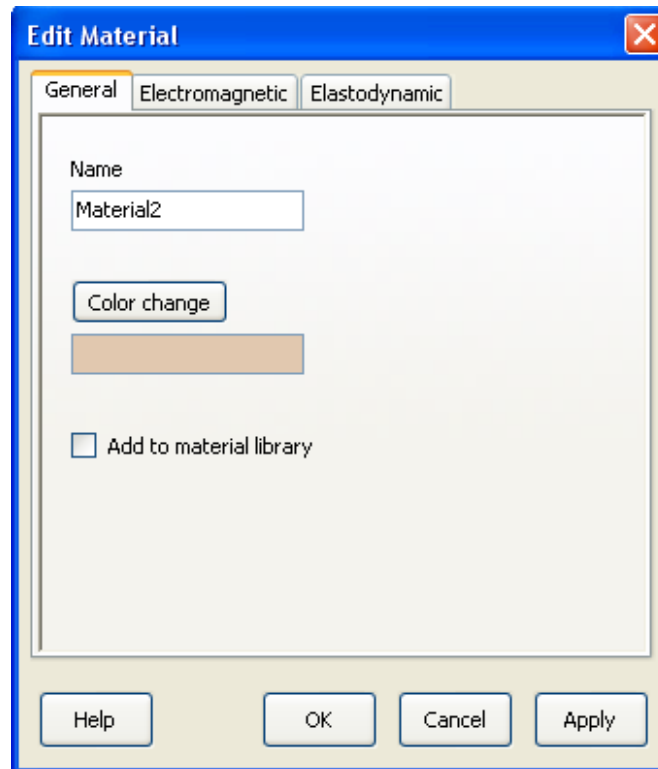
at 07/10/12 09:41:26. Total CPU time is 1 min 1.157 sec (61.157 sec)

ces: 0/1 (#passed/#comparison)

mparison1: -1/0.01 Error code 3

# Materials – User Defined

- Material types
  - Normal
  - PEC / PMC
  - Conductor
  - Dispersive



# Materials – Dispersive

- Debye, Lorentz and Drude

**Dispersive Material**

Relative permittivity  Electric conductivity  Electric loss tangent

**Electric Poles**

Debye    Lorentz    Drude     Add user defined

Eps_r ...	Relax. time (s)
2	0.2
6.5	0.3

Eps_...	Damping c...	Resonant ...

Damping ...	Plasma an...

Relative permeability  Magnetic conductivity  Magnetic loss tangent

**Magnetic Poles**

Debye    Lorentz    Drude     Add user defined

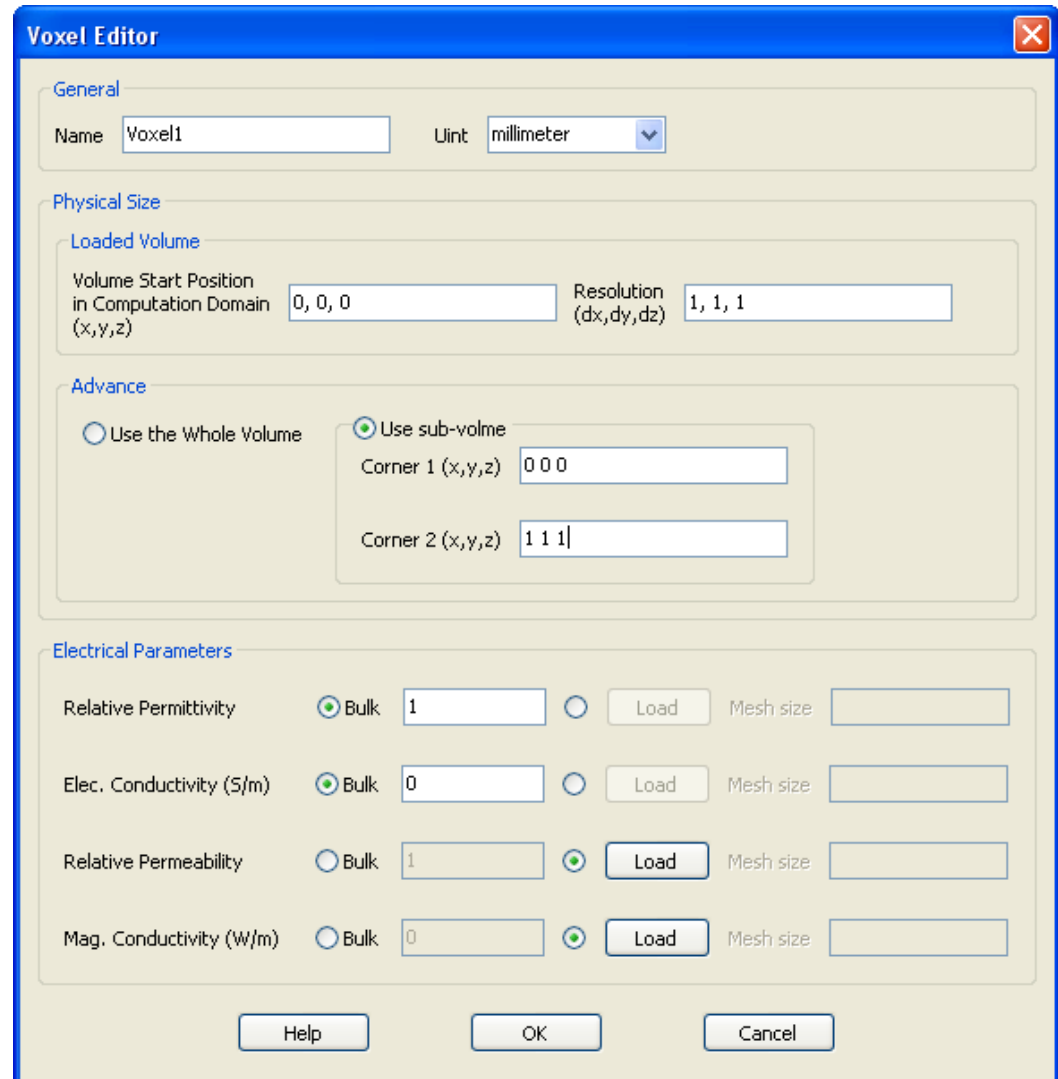
Mu_r (...)	Relax. time (s)

Mu_...	Damping c...	Resonant ...

Damping ...	Plasma an...

# Materials – Voxel

- Voxel definition is also supported
- Either entire volume or sub-volume can be specified with voxel definitions
- The material properties can either be specified or loaded from the external file



The screenshot shows the 'Voxel Editor' dialog box with the following settings:

- General:** Name: Voxel1, Unit: millimeter
- Physical Size:**
  - Loaded Volume:** Volume Start Position in Computation Domain (x,y,z): 0, 0, 0; Resolution (dx,dy,dz): 1, 1, 1
  - Advance:**
    - Use the Whole Volume
    - Use sub-volume
      - Corner 1 (x,y,z): 0 0 0
      - Corner 2 (x,y,z): 1 1 1
- Electrical Parameters:**
  - Relative Permittivity:  Bulk: 1;  Load; Mesh size: [ ]
  - Elec. Conductivity (S/m):  Bulk: 0;  Load; Mesh size: [ ]
  - Relative Permeability:  Bulk: 1;  Load; Mesh size: [ ]
  - Mag. Conductivity (W/m):  Bulk: 0;  Load; Mesh size: [ ]

Buttons at the bottom: Help, OK, Cancel

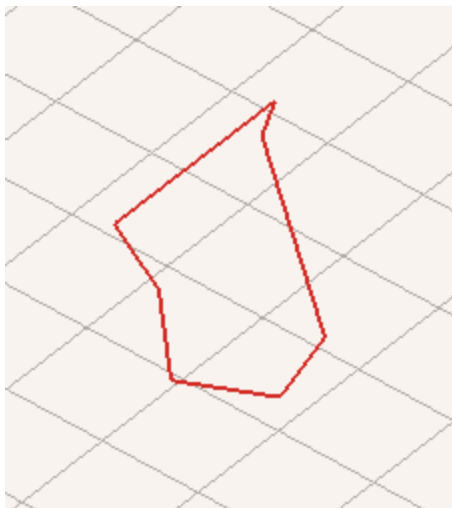


# Model Construction

- Define Geometries
  - Curves
    - 2D Poly Line & Parametric Curve
    - 3D Poly Line & Parametric Curve
  - Faces
    - Cover Curve as Face
  - Solids
    - Box
    - Ellipsoid
    - Cone
    - Elliptical Cylinder
    - Polygon Cylinder
    - Torus
    - Archimedean Spiral
    - Toroidal Spiral
    - Spine Line Bondwire
    - JEDEC 3 Pints Bondwire
    - Body by Sweeping Face along Curve or Axis
    - Body by Lofting Face
  - Import from CAD Models
- Operations on Geometries
  - Union
  - Subtract
  - Intersect
  - Disassemble
  - Array Copy
  - Translate
  - Mirror
  - Rotate
  - Scale

# Curves – 2D Poly Line

- Poly line is defined according to the local coordinate system (u,v)
- User can define its own u and v axis
- Poly line points can be loaded from an external file



**2D Polyline Editor**

Local Coordinates System

Origin

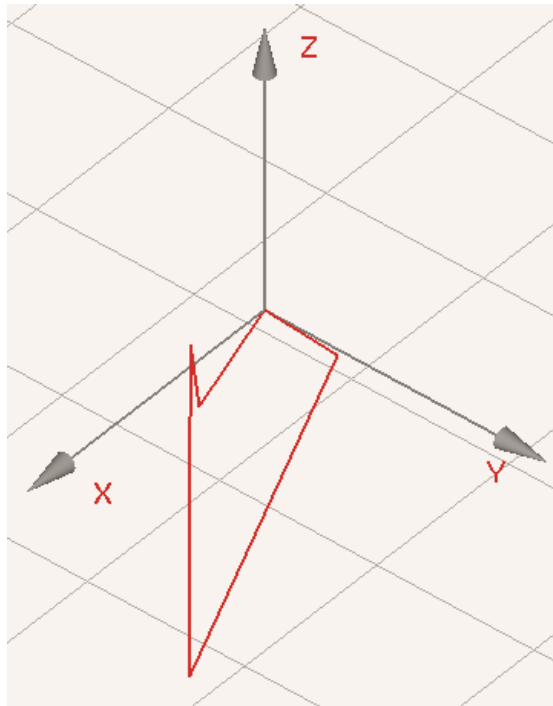
U Axis  V axis

Vertices

	(u, v)
1	0; 0
2	50; 0
3	60; 20
4	80; 40
5	70; 60
6	50; 55
7	30; 30
8	10; 5
9	0; 0
10	
11	
12	
13	

Buttons: Load, Preview, Reset, More Rows, Help, OK, Cancel

# Curves – 3D Poly Line



**3D Polyline Editor**

Local Coordinates System

Origin

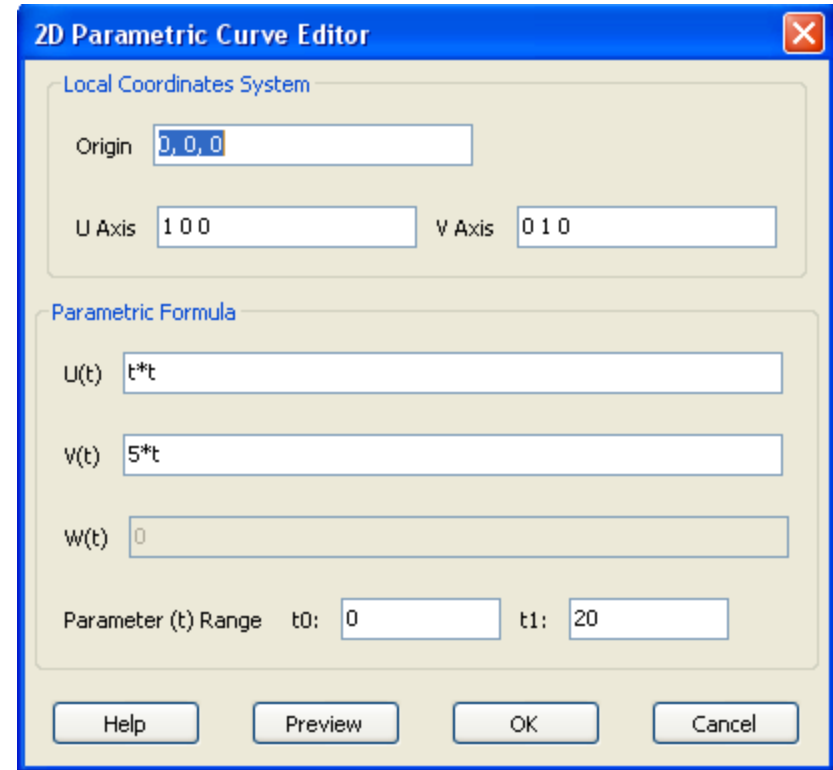
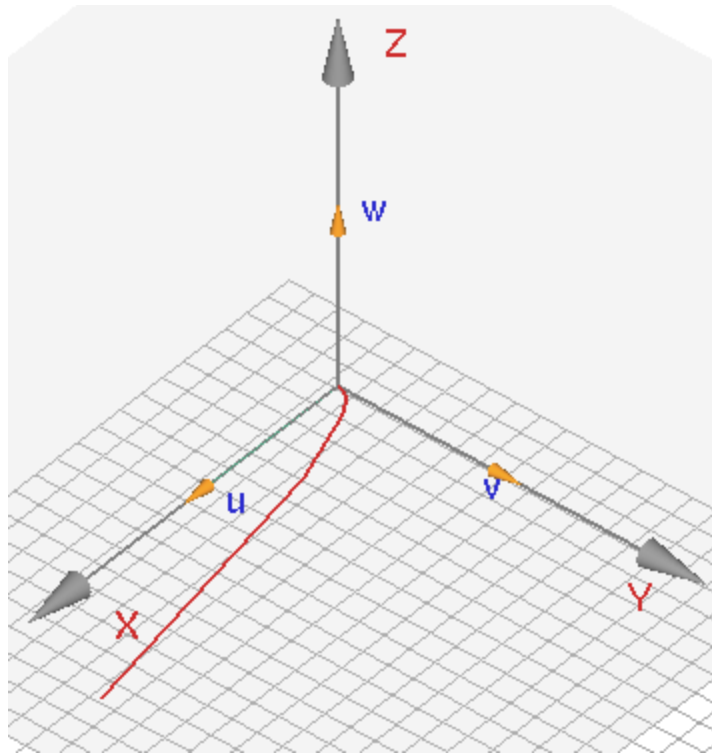
U Axis  V axis

Vertices

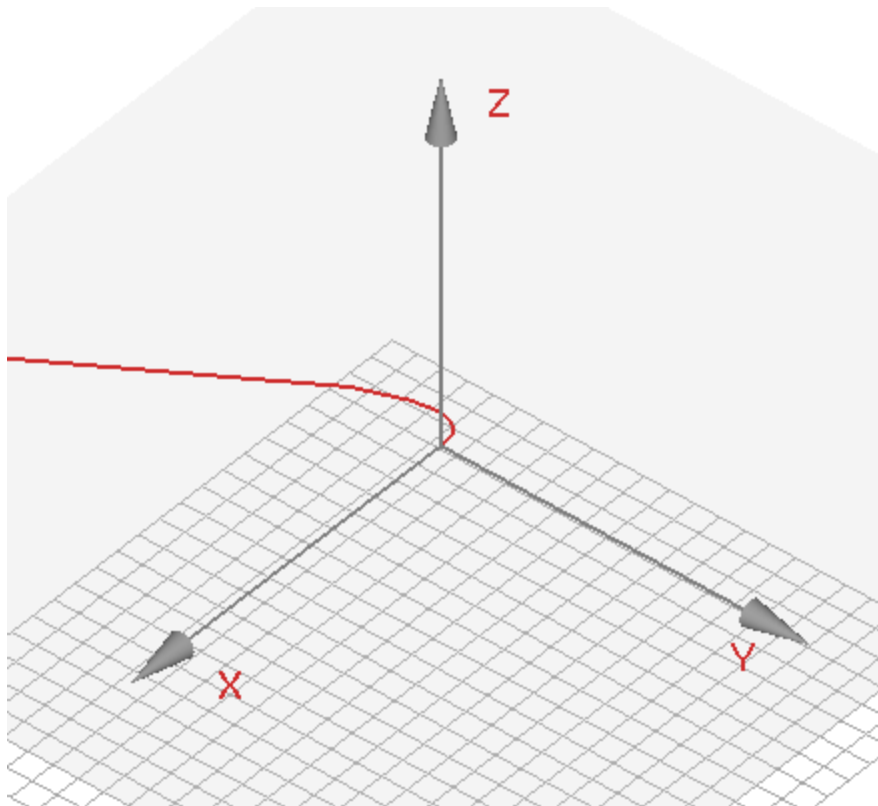
	(u, v, w)
1	0; 0; 0
2	10; 20; 10
3	50; 30; -10
4	20; 5; 10
5	10; -2; -10
6	0; 0; 0
7	
8	
9	
10	
11	
12	
13	

Buttons: Load, Preview, Reset, More Rows, Help, OK, Cancel

# Curves – 2D Parametric Line



# Curves – 3D Parametric Line



**3D Parametric Curve Editor** ✖

Local Coordinates System

Origin

U Axis  V Axis

Parametric Formula

U(t)

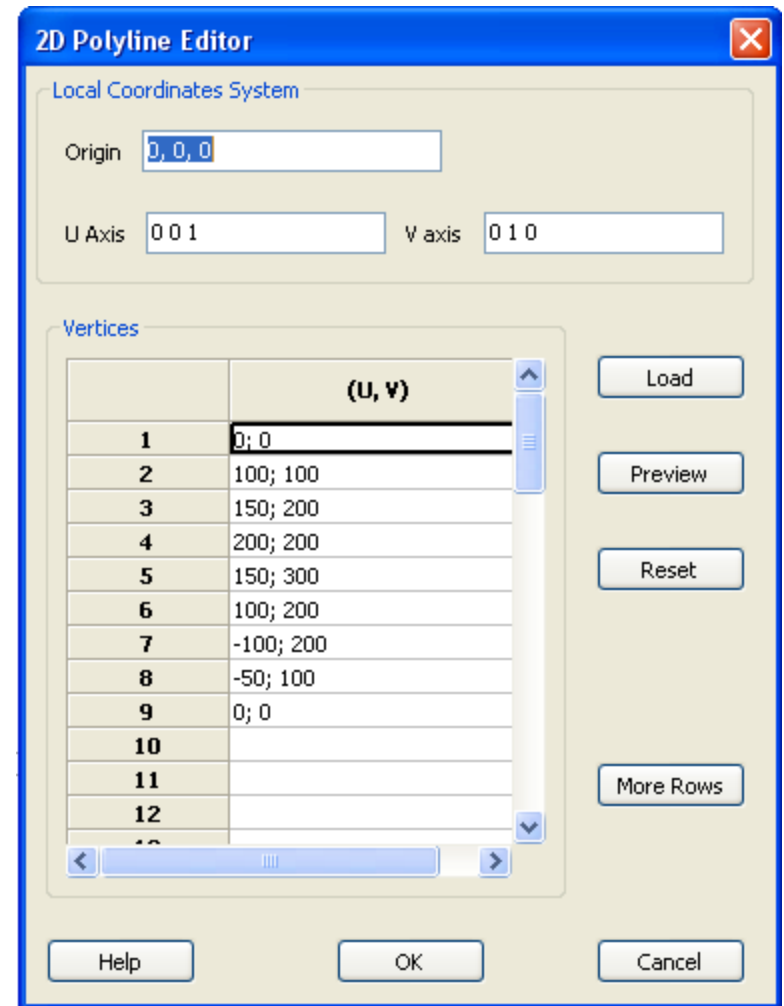
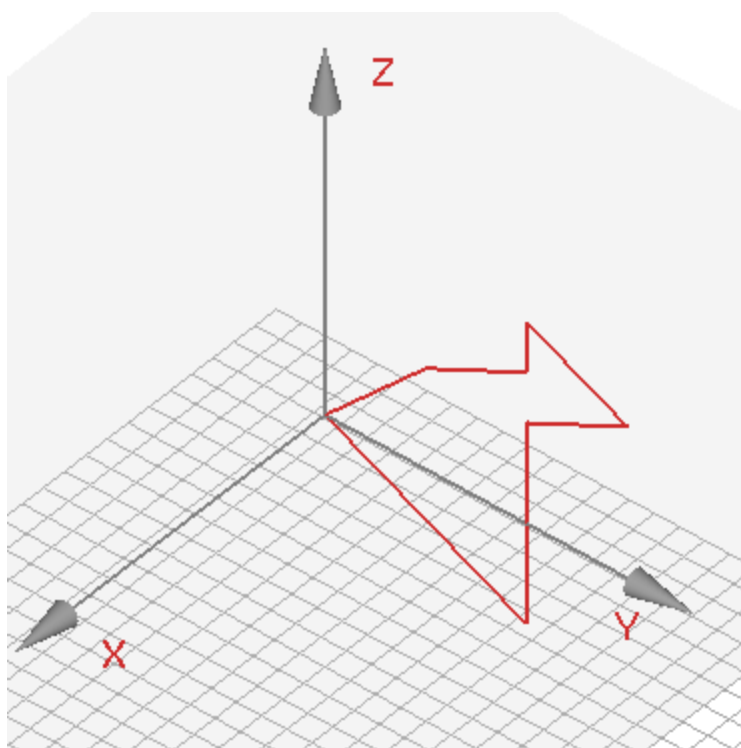
V(t)

W(t)

Parameter (t) Range t0:  t1:

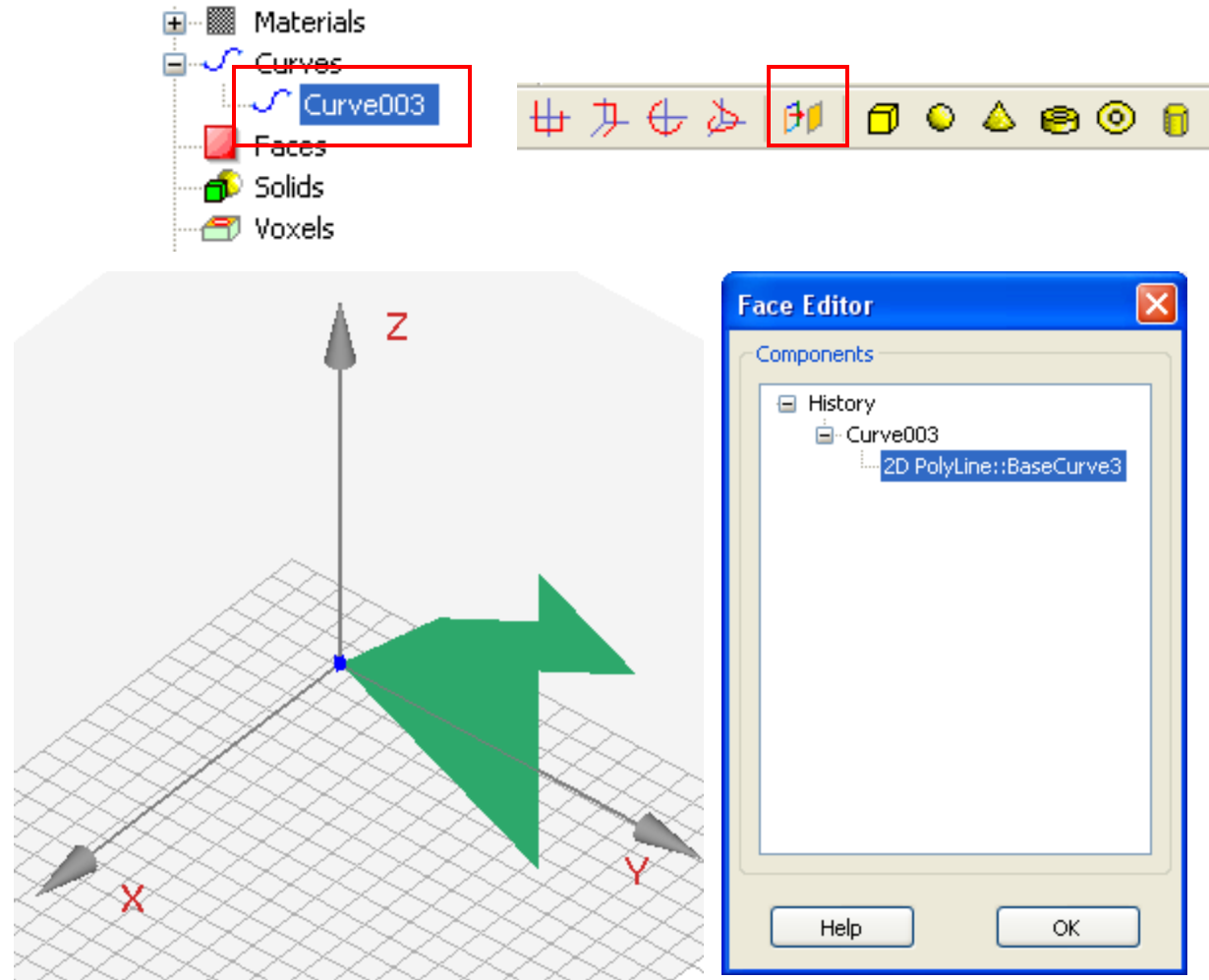
# Faces – Cover from Curves (1)

- Create a 2D poly line
- Such bounding curve must be closed



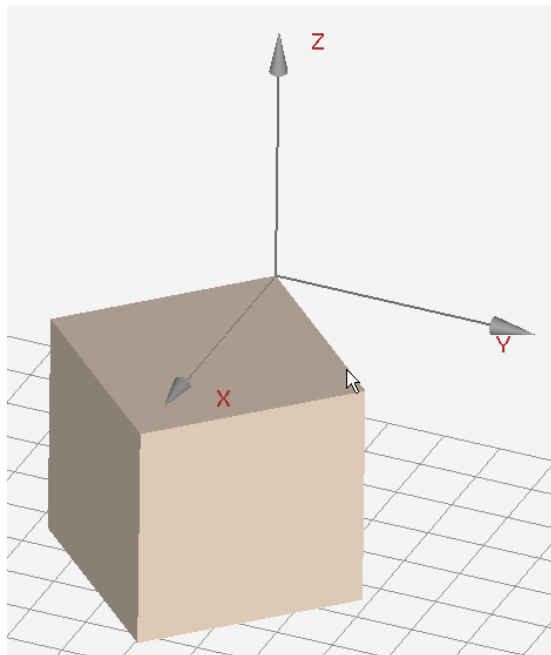
# Faces – Cover from Curves (2)

- Select the bounding curve
- Click the “Cover from Curves” button
- A face will be created as shown
- User can also modify the bounding curves after the face is created, and the new face will be updated based on the modified curve



# Solids – Box

- Box is defined by specifying the lower and upper corner
- Box also has its own local coordinate system
- User has to specify the local u and v axis



**Box Creation** ✖

Name  Material

Transparency

0 0 100

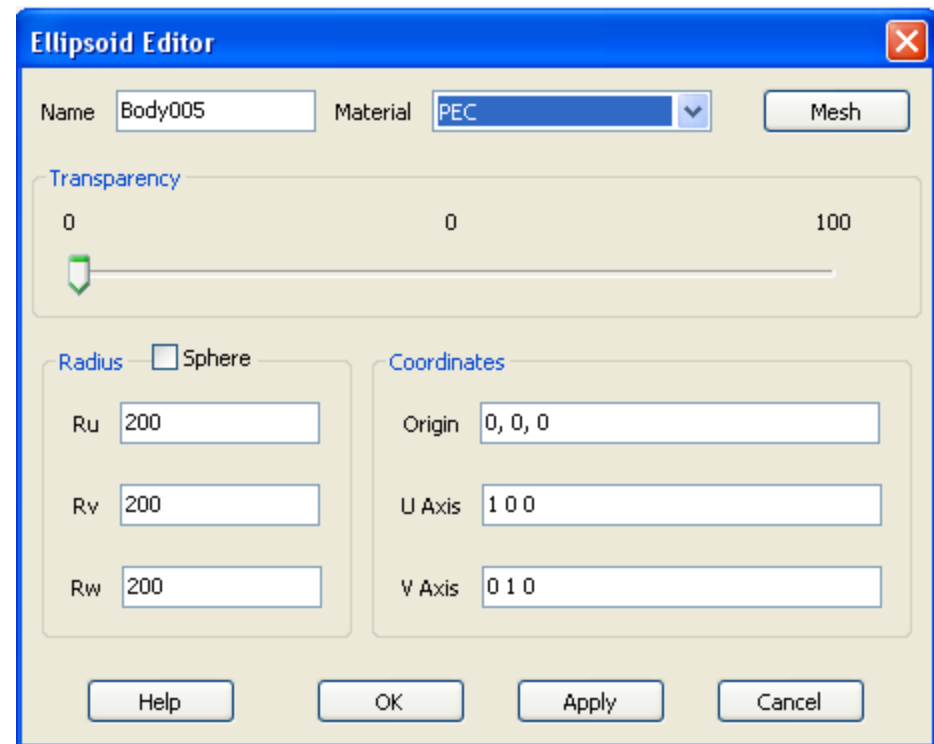
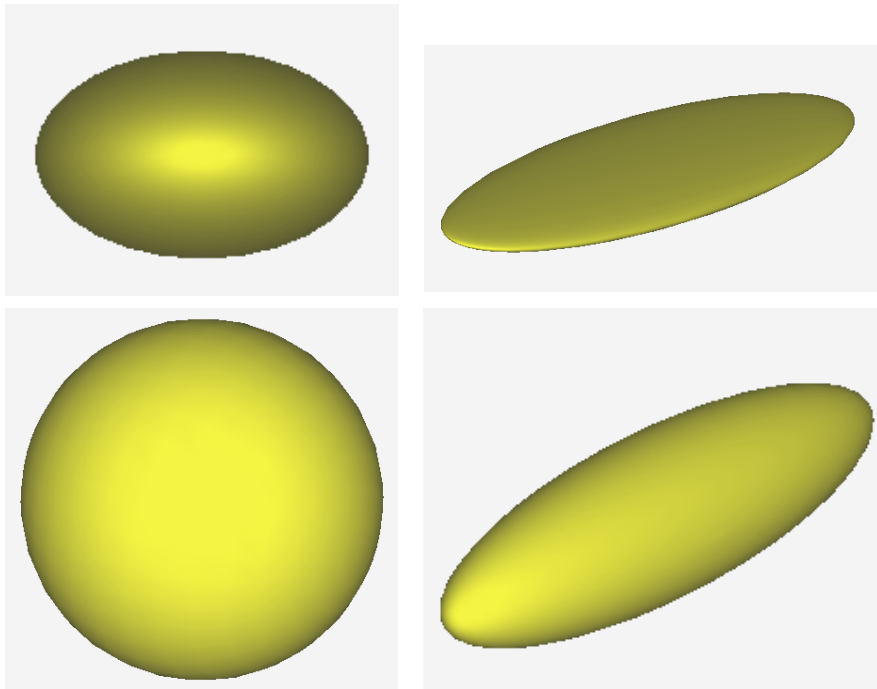
Box Parameters

Lower Corner	<input type="text" value="0, 0, 0"/>	LCS Origin	<input type="text" value="0, 0, 0"/>
Upper Corner	<input type="text" value="100, 100, 100"/>	U Axis	<input type="text" value="1, 1, 0"/>
		V Axis	<input type="text" value="1, -1, 0"/>



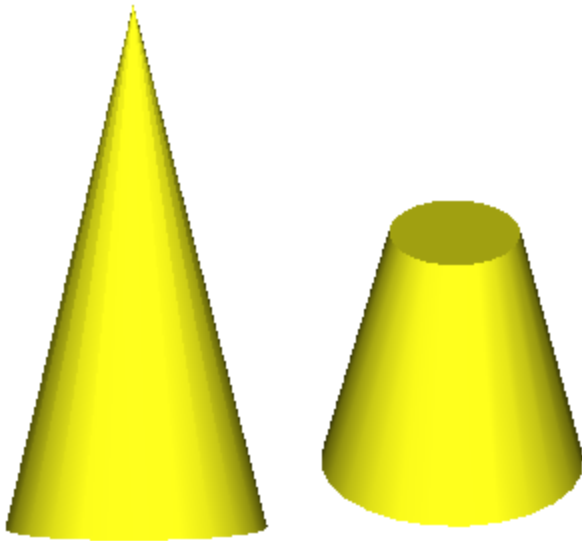
# Solids – Ellipsoids

- Ellipsoids can be created by specifying 3 radius  $R_u$ ,  $R_v$  and  $R_w$
- For sphere, simply check the “Sphere” box



# Solids – Cones

- Cones are defined by specifying height, top and bottom radius
- User also needs to specify the bottom center and Z-Axis to position the cone



Cone Creation
✕

Name  Material

Transparency

Use LCS

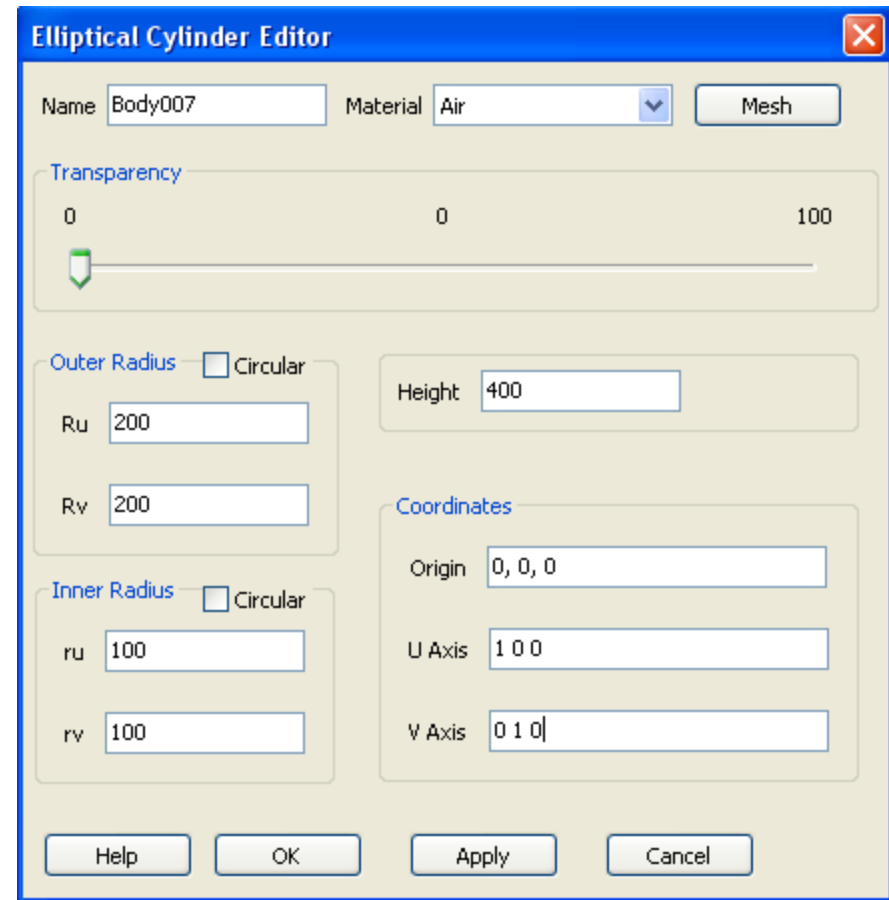
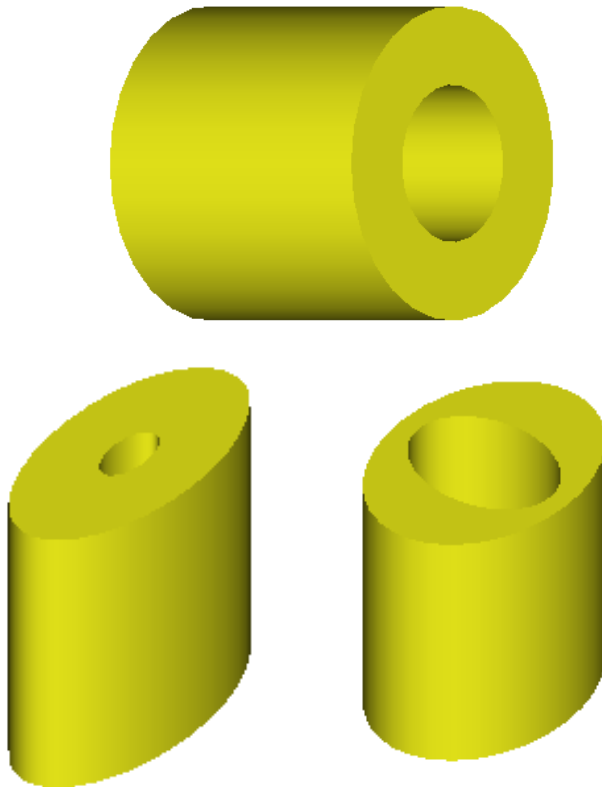
Bottom Center  Bottom Radius

Z Axis  Top Radius

Height

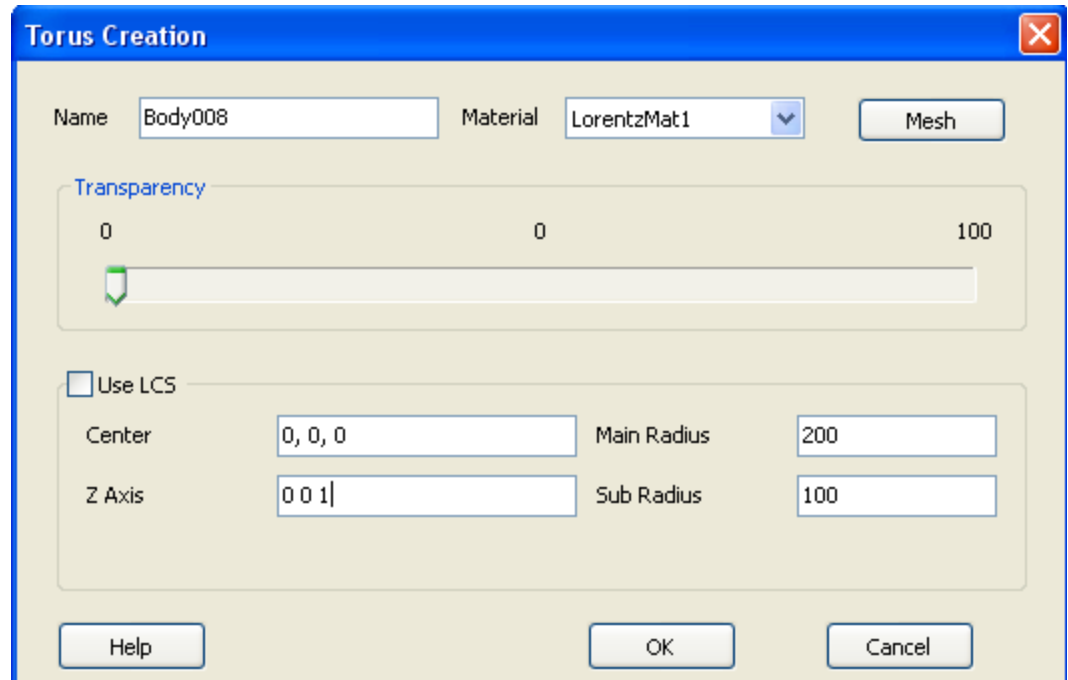
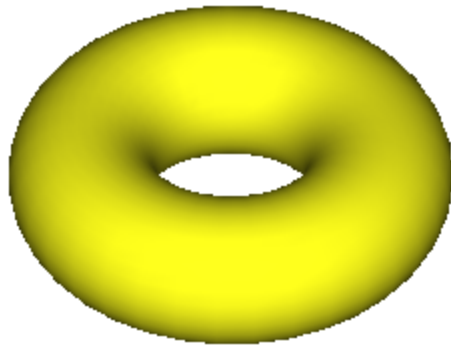
# Solids – Elliptical Cylinders

- Elliptical cylinder is defined by specify the inner and outer radius
- Change Ru and Rv of inner and outer radius to create elliptical shapes



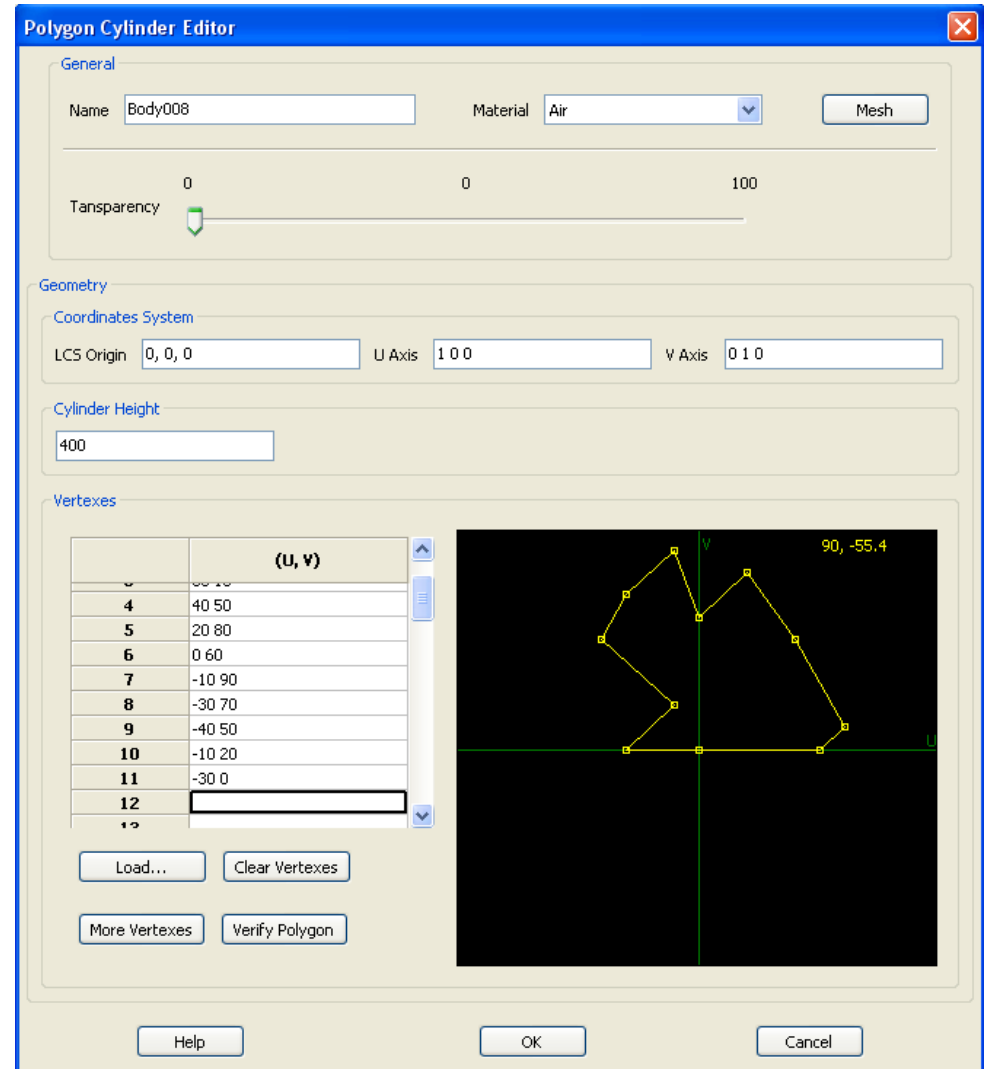
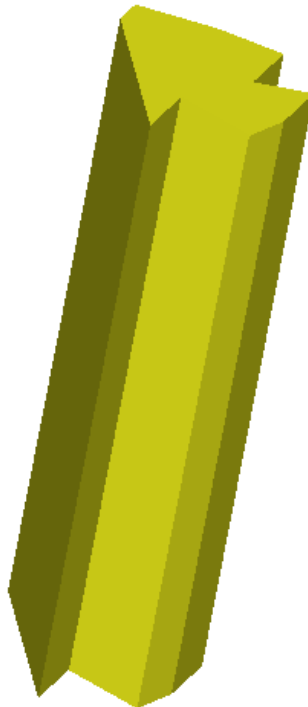
# Solids – Torus

- Torus is simply defined by giving main and sub radius



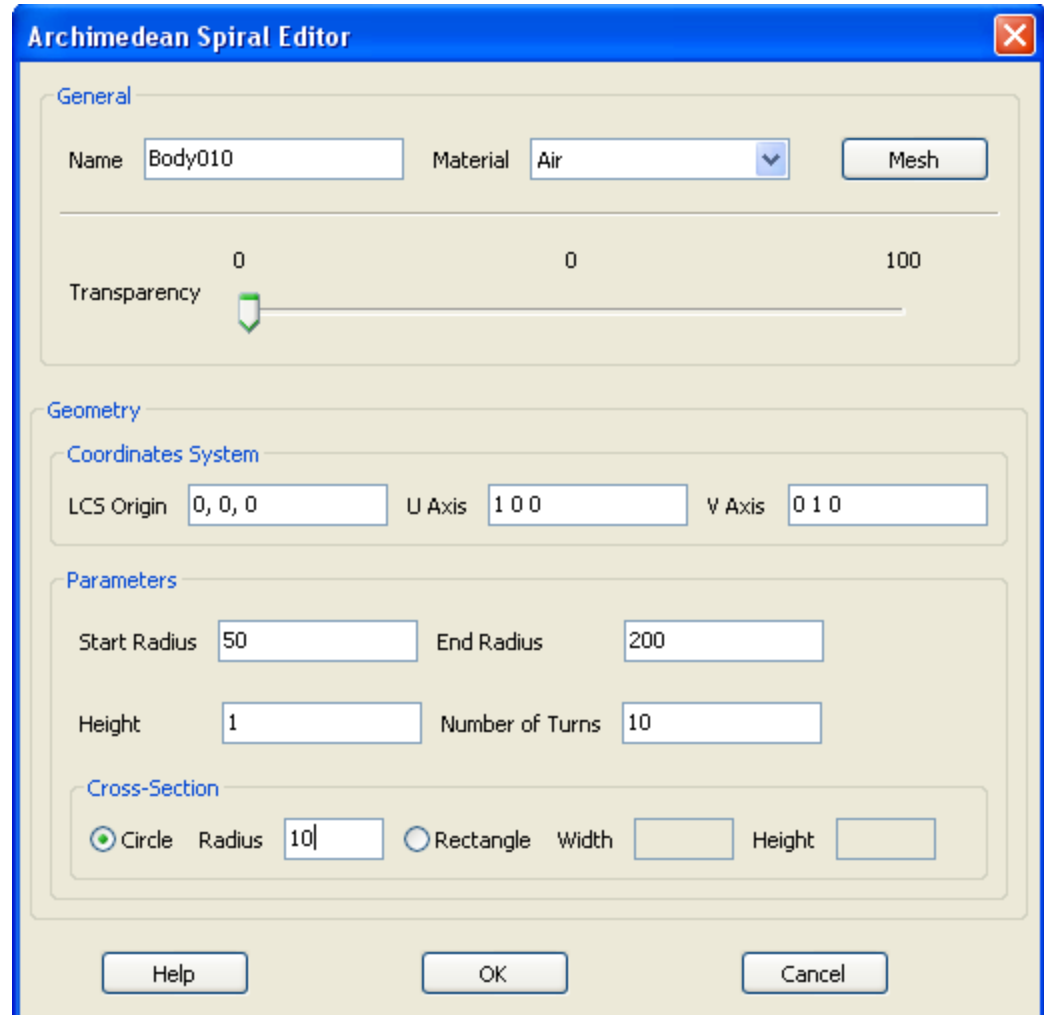
# Solids – Polygon Cylinder

- User can create polygon cylinders by drawing the polygon curve and the cylinder will be created based on the defined curve



# Solids – Archimedean Spirals (1)

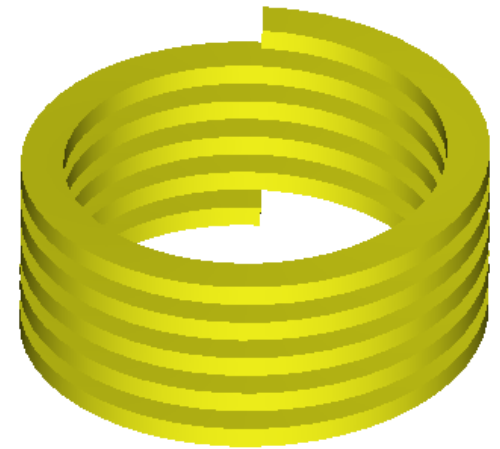
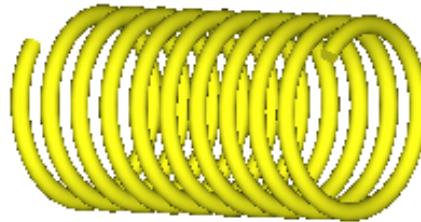
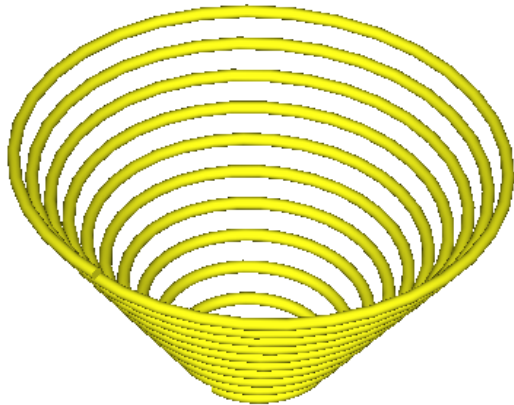
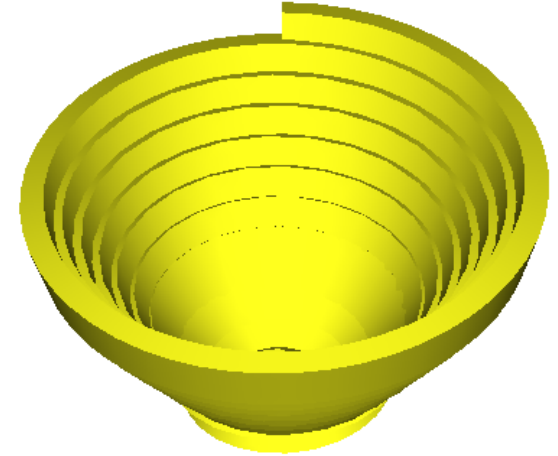
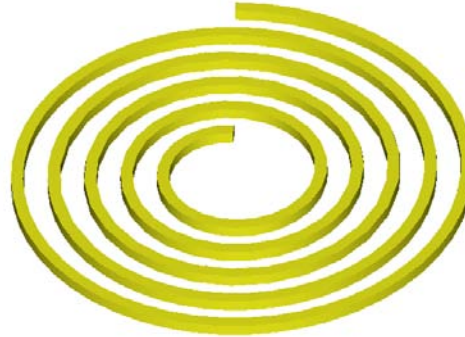
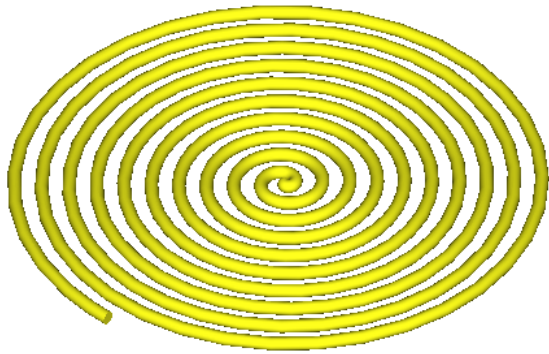
- User can create Archimedean spirals by specifying start/end radius, height and number of turns
- The wire shape of the spirals can also be changed as circle or rectangle
- Modify these parameters will create various spiral shapes



The screenshot shows the 'Archimedean Spiral Editor' dialog box with the following settings:

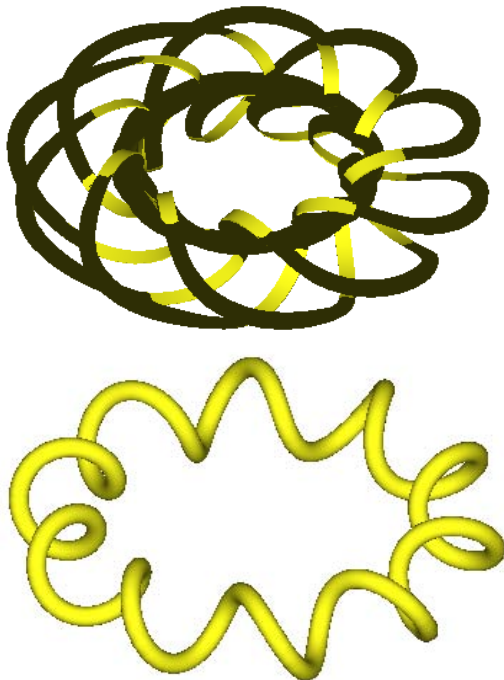
- General:** Name: Body010, Material: Air, Mesh button.
- Transparency:** A slider set to 0.
- Geometry:**
  - Coordinates System:** LCS Origin: 0, 0, 0; U Axis: 1 0 0; V Axis: 0 1 0.
  - Parameters:** Start Radius: 50, End Radius: 200, Height: 1, Number of Turns: 10.
  - Cross-Section:** Circle (selected), Radius: 10; Rectangle (unselected), Width: [empty], Height: [empty].
- Buttons:** Help, OK, Cancel.

# Solids – Archimedean Spirals (2)



# Solids – Toroidal Spirals

- User can create toroidal spirals by specifying start/end radius, height and number of turns
- The wire shape of the spirals can also be changed as circle or rectangle



Toroidal Spiral Editor
✕

---

**General**

Name  Material

---

Transparency  0 100

---

**Geometry**

**Coordinates System**

LCS Origin  U Axis  V Axis

---

**Parameters**

Main Radius  Sub Radius  Number of Turns

---

End Angle (degree)  Initial Phase (degree)

---

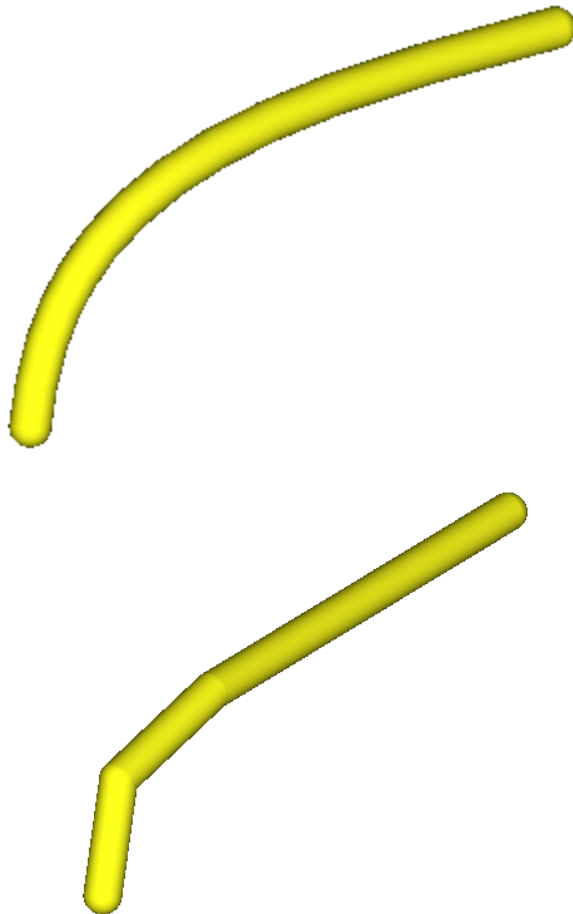
**Cross-Section**

Circle Radius   Rectangle Width  Height

---



# Solids – Bondwires



**Spline Bond Wire Editor**

Name:  Material:

Transparency: 0  100

Path

(x0,y0,z0)

(x1,y1,z1)

Height

L1

Height Direction

Wire Cross Section

Circle Radius

Square Width

Terminal Shape

Start  Original  Round

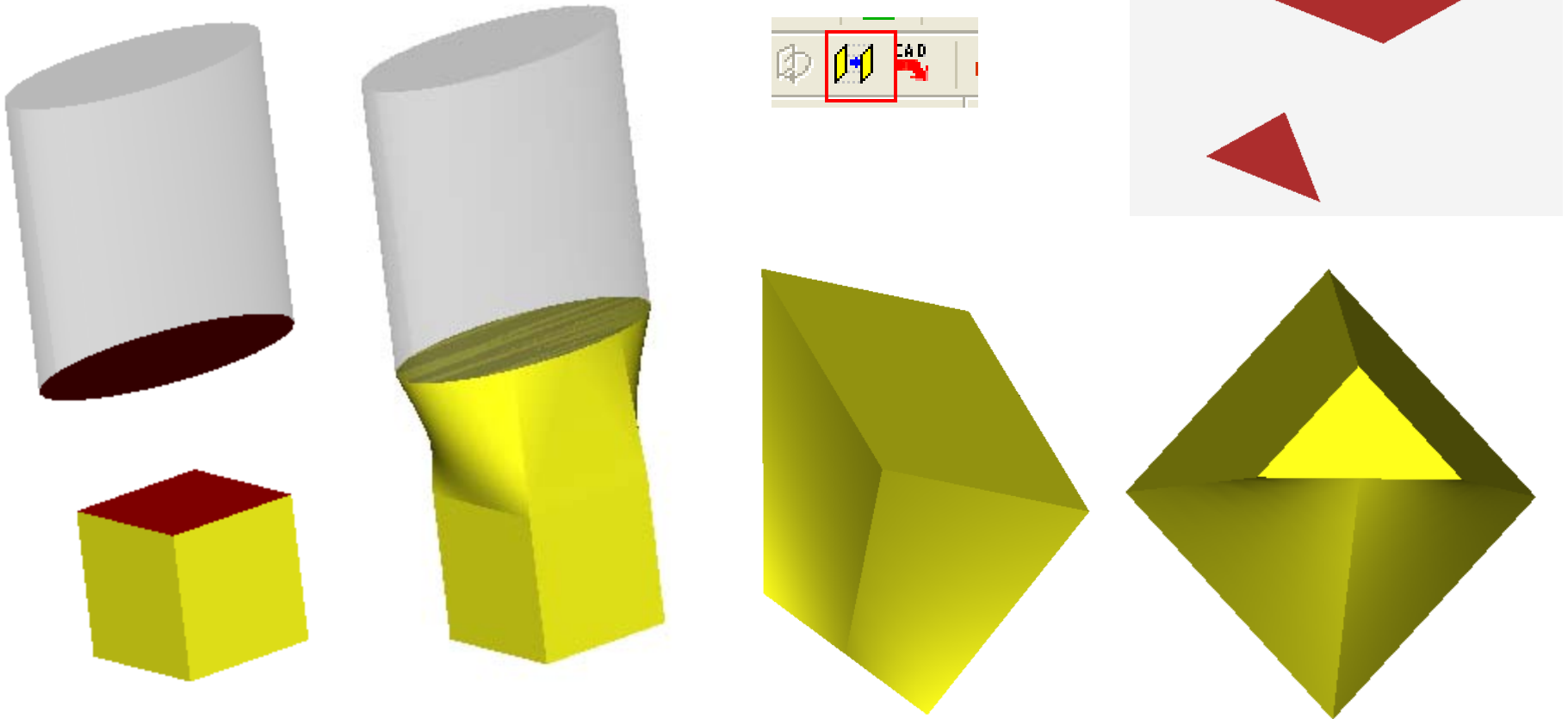
End  Original  Round

# Solids – Sweeping Faces

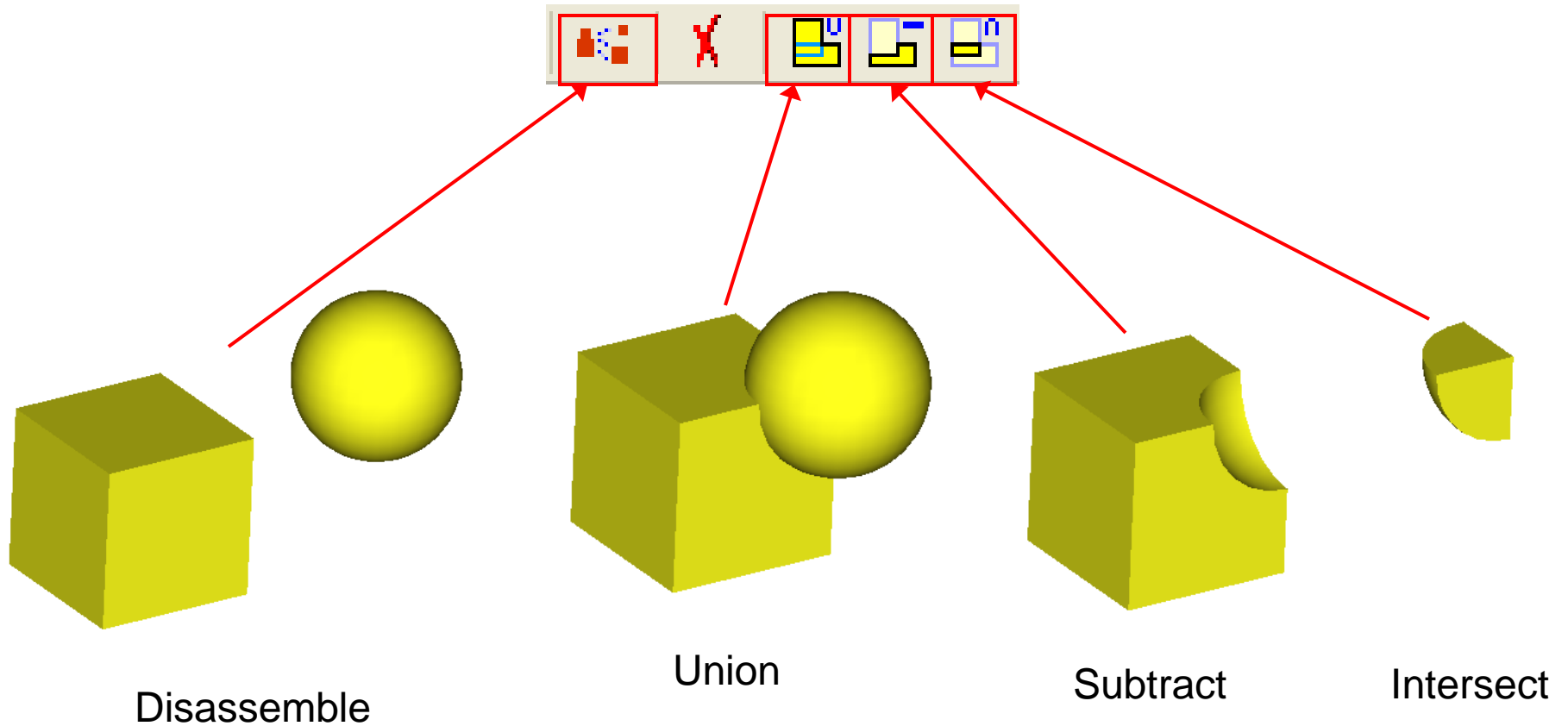
- To create body by sweeping faces
- User has to first define the parent face
- Then define the curve that will be used as the sweeping path
- Then click button “Create body by sweeping face along curves”



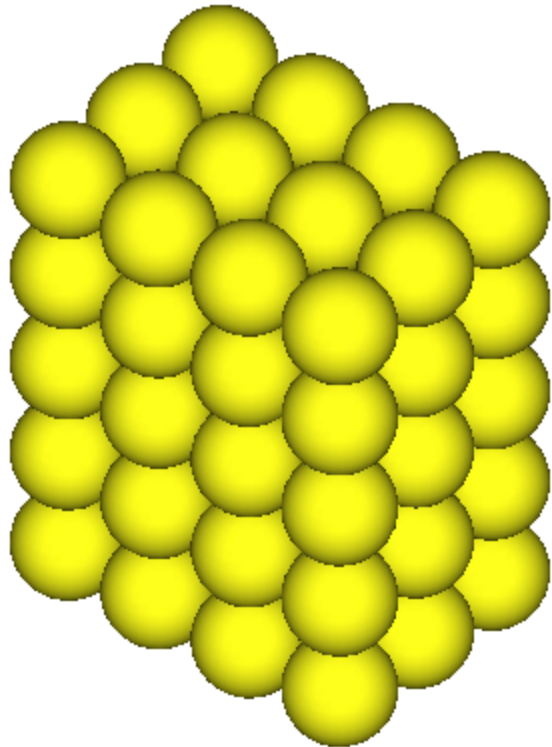
# Solids – Lofting



# Operations – Union, Subtract, Intersect, Disassemble



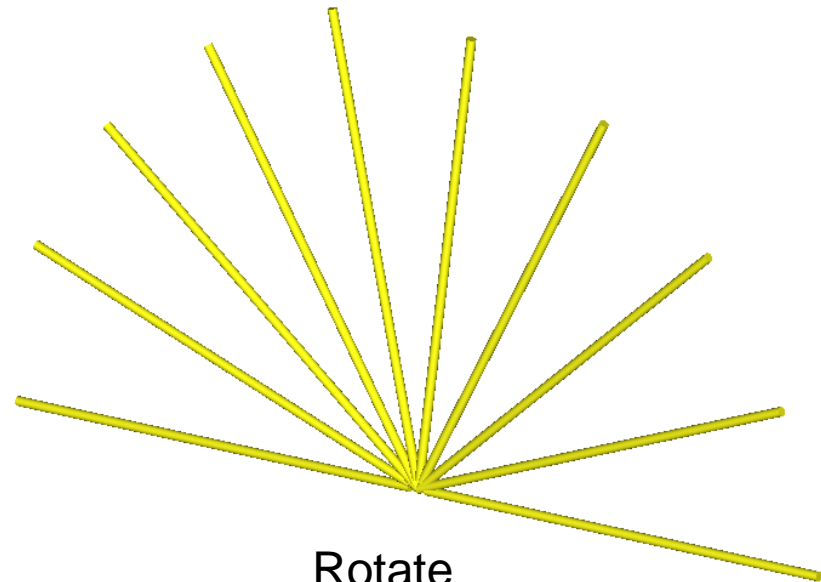
# Operations – Array Copy, Mirror, Rotate



Array Copy



Mirror



Rotate

# Operations – Scale

**Scale** ✖

Scale origin

User defined point in GCS

User defined point in LCS

Individual body centroid

Individual body bounding box center

---

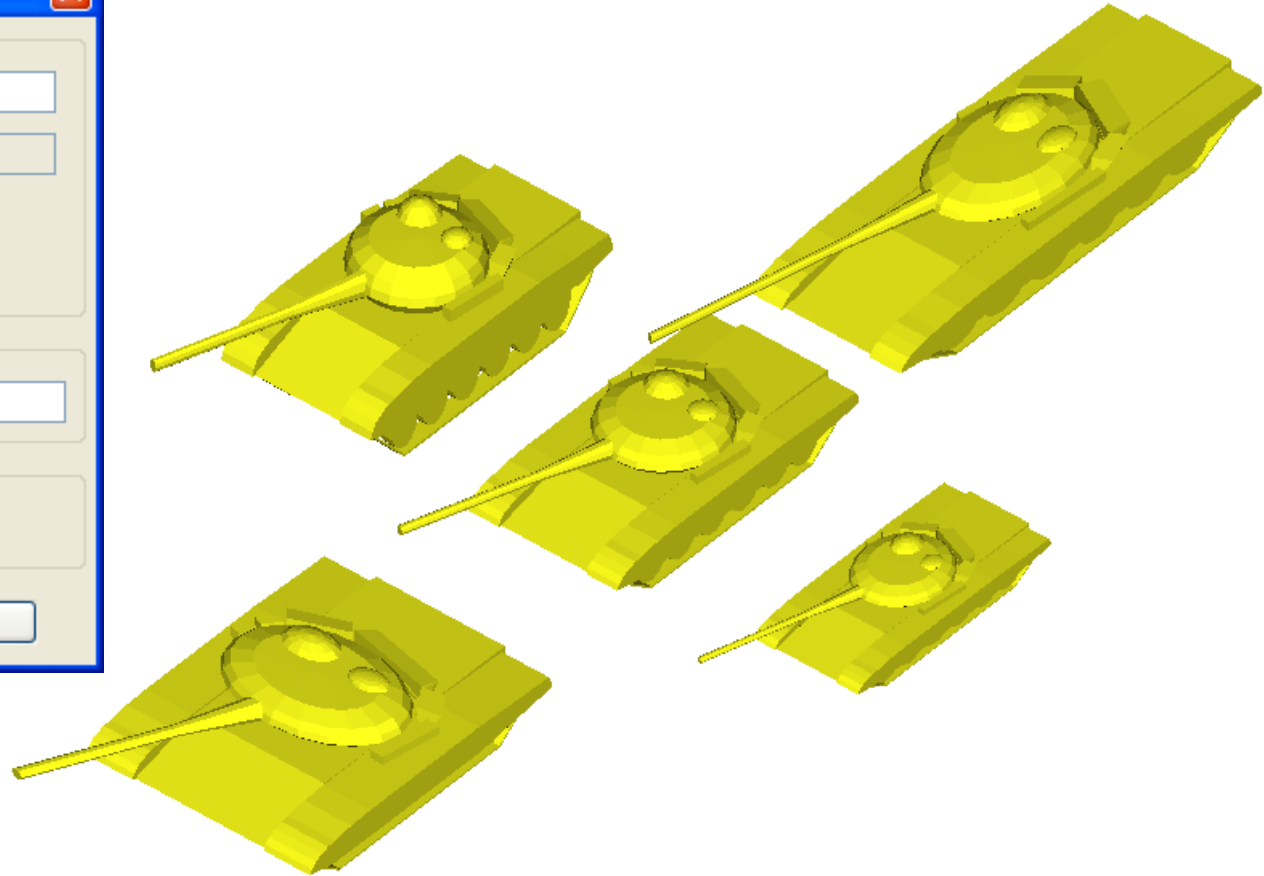
Scale factor  Uniform Scale in all Directions

U  V  W

---

Advance

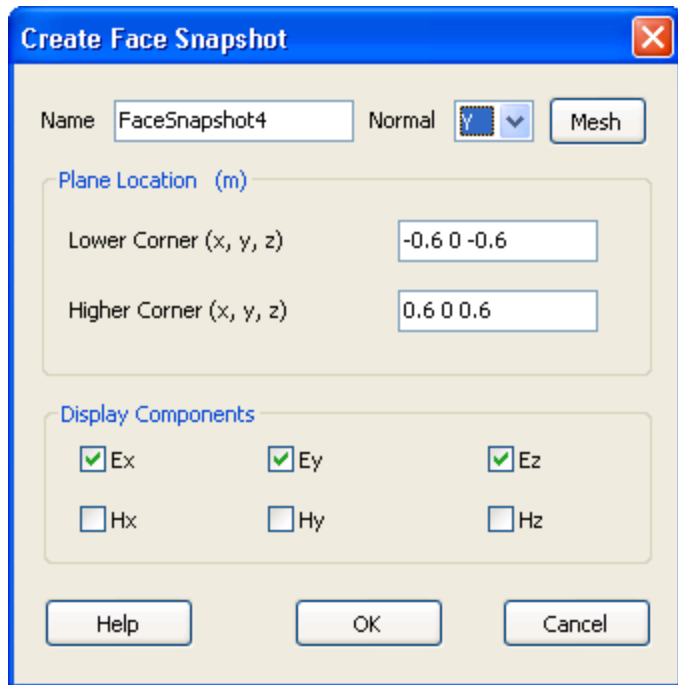
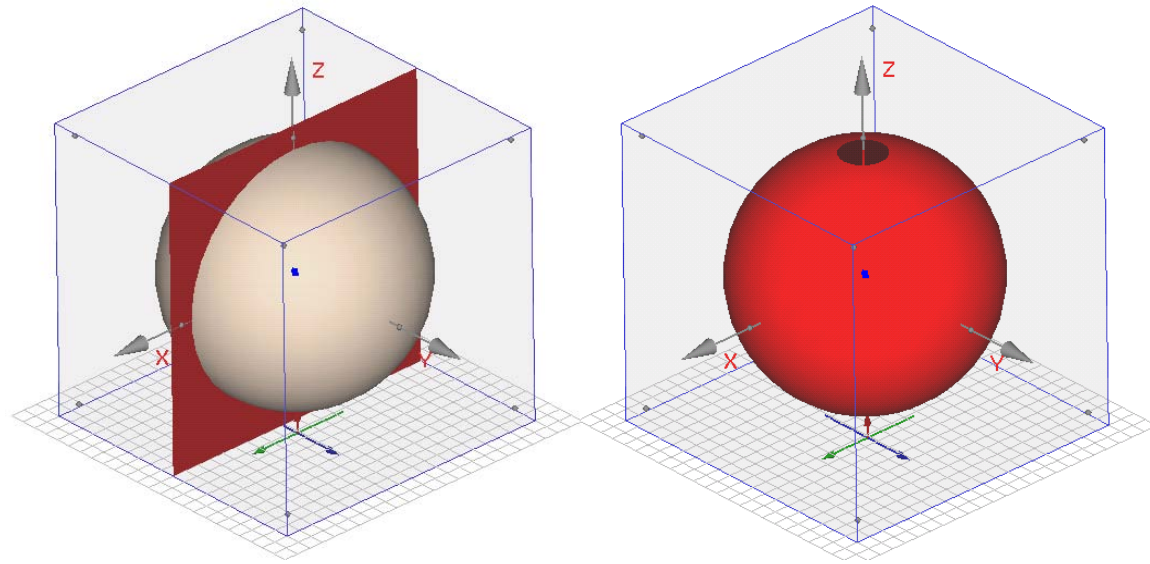
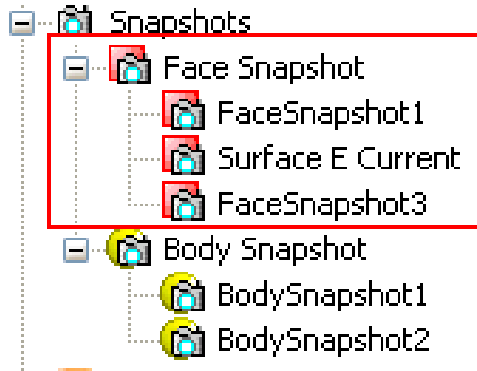
Keep Original    Name



# Result Exploration

- Snapshots
  - Face
    - EM Field on Face Cut
    - EM Field on Object Surface
    - EM Current on Object Surface
  - Volume
    - EM Field on Volume
    - EM Field on Object
- Far Field
  - 3D view of far field pattern
  - Bi-Static RCS at multiple frequencies and different theta and phi planes
  - Wideband RCS at multiple locations
- 2D Curves
  - Observers
    - EM fields and its x, y, z components
  - Lumped Ports and Wave Ports
    - S-Parameters
    - Impedance
    - Incident current and voltage
    - Scattered current and voltage
    - Total current and voltage
  - Circuits
    - Voltage at all nodes
    - Current at all branches
    - Circuit terminal current and voltage
  - All above listed items support both transient and spectral results

# Snapshots Defined on Face

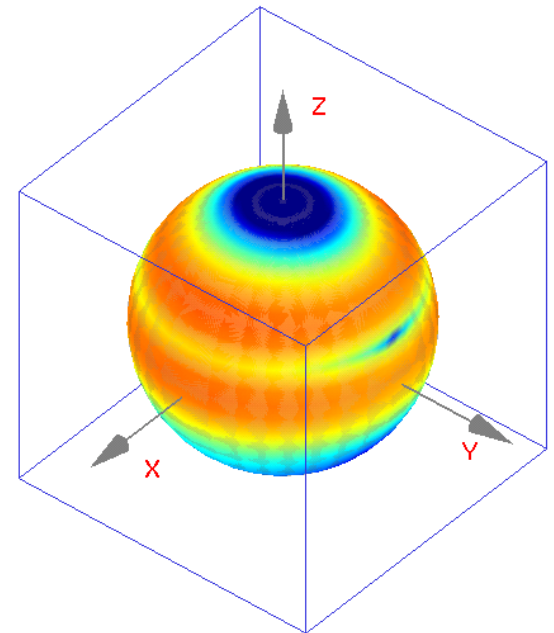
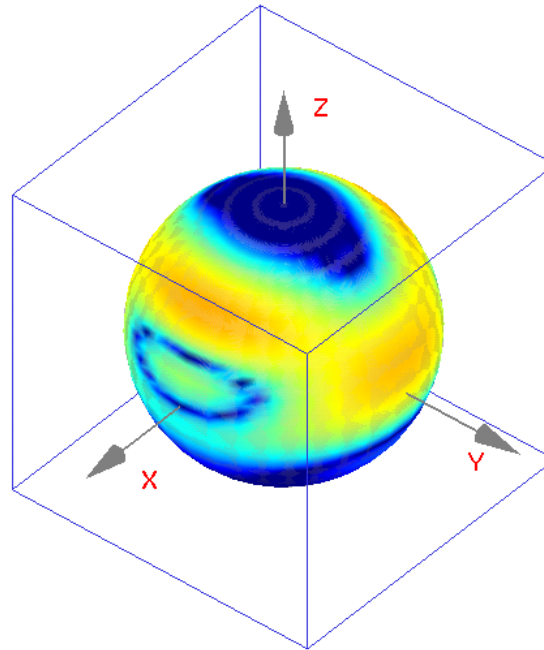
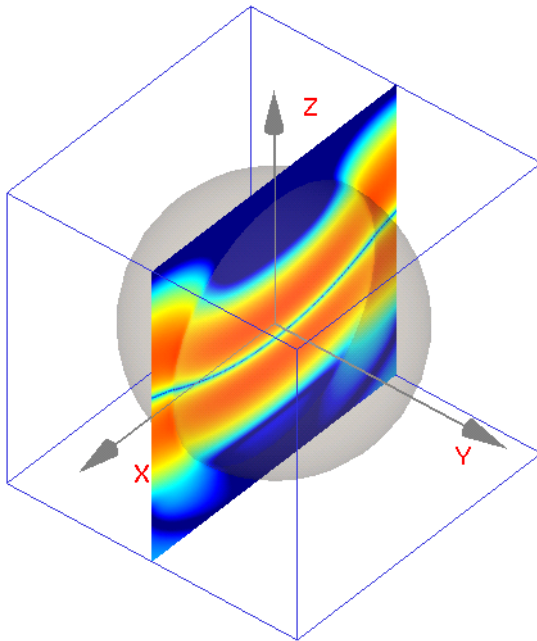
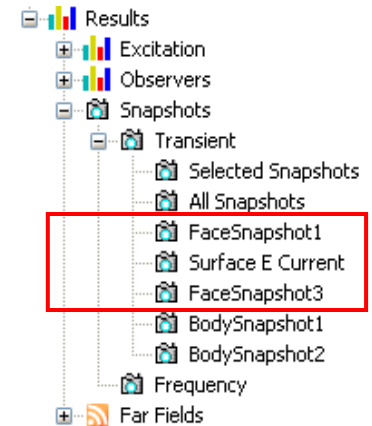


- Can be defined on both face cut and object surface
- User can select the field components (Ex, Ey, Ez, Hx, Hy, Hz) to display

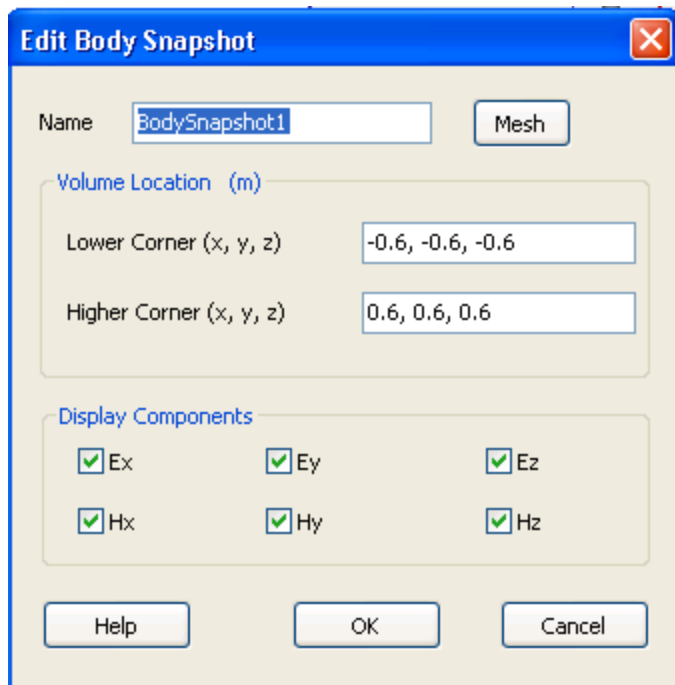
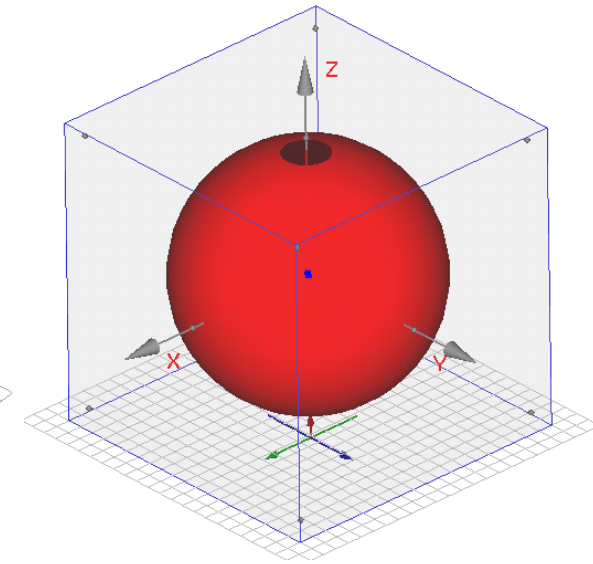
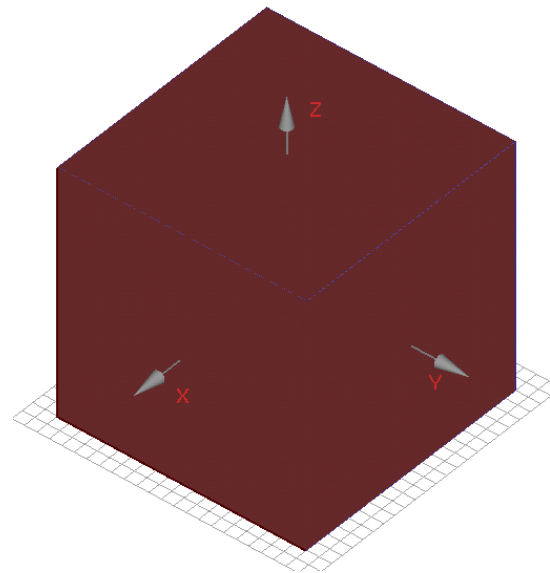
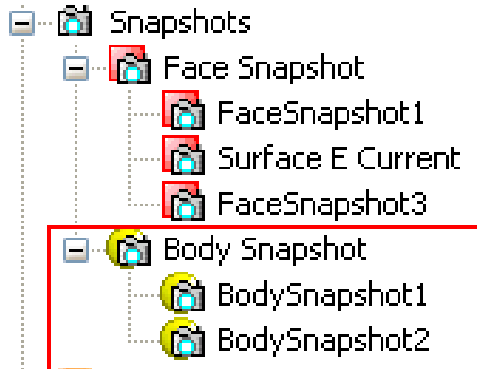


# Snapshots – Face Field and Current

- Left: X component of the E field defined on XoZ plane
- Middle: Electric current J defined on sphere surface
- Right: Total electric field defined on sphere surface



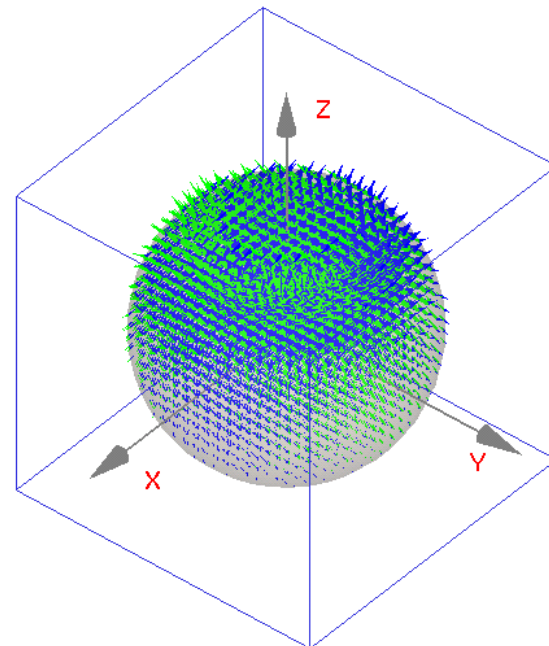
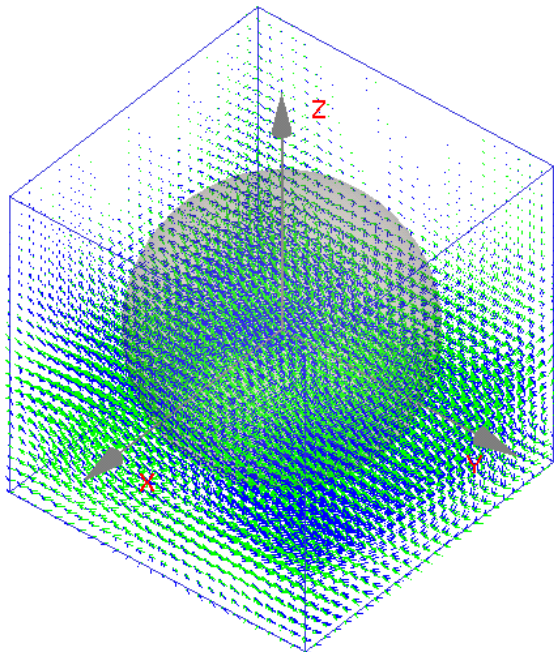
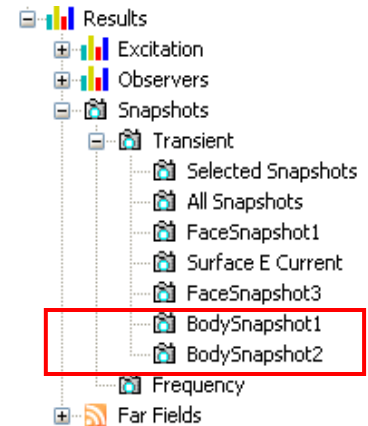
# Snapshots Defined over Volume



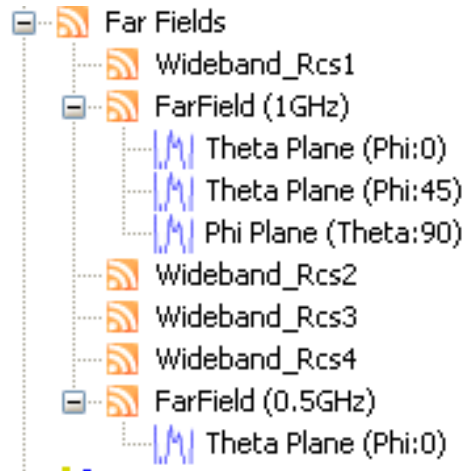
- Can be defined on both computational domain and object volume
- User can select the field components (Ex, Ey, Ez, Hx, Hy, Hz) to display

# Snapshots – Volume Field

- Left: Total E and H field defined over the entire domain
- Right: Total E and H field defined within the sphere

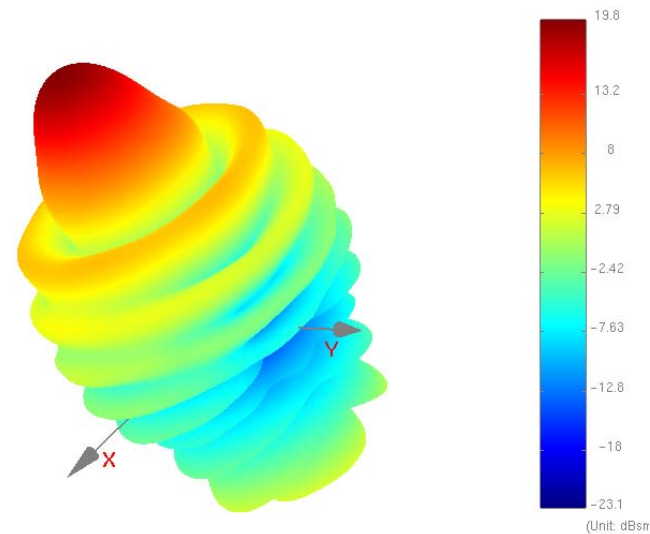


# Far Fields – 3D Pattern

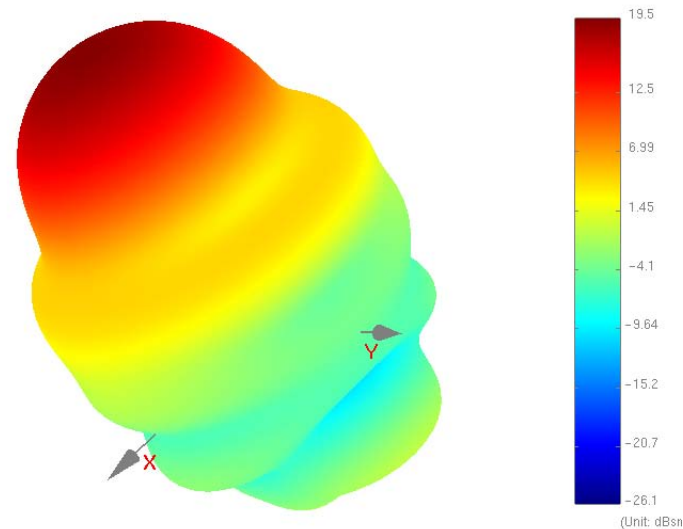


- Simply specify the frequency and the Bi-Static RCS will be automatically calculated after simulation
- The 3D far field pattern can be displayed
- RCS on phi / theta planes can also be calculated
- Wideband RCS at given location can also be calculated

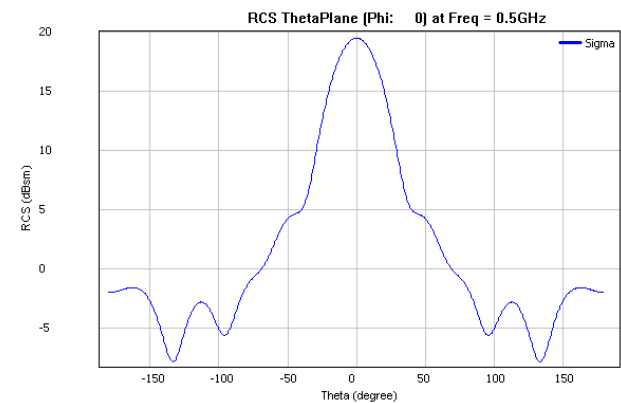
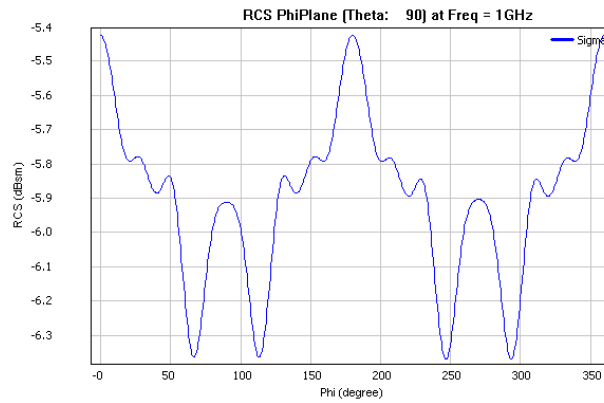
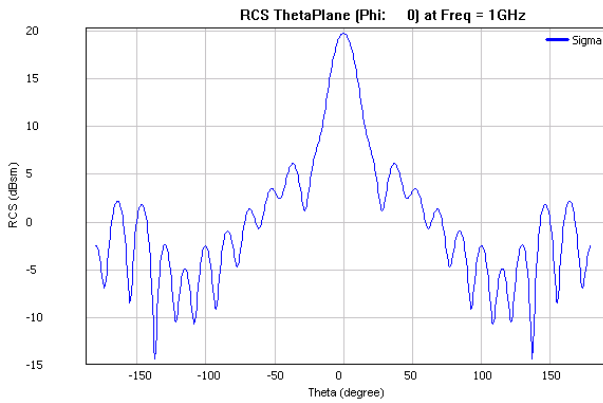
RCS (1GHz)



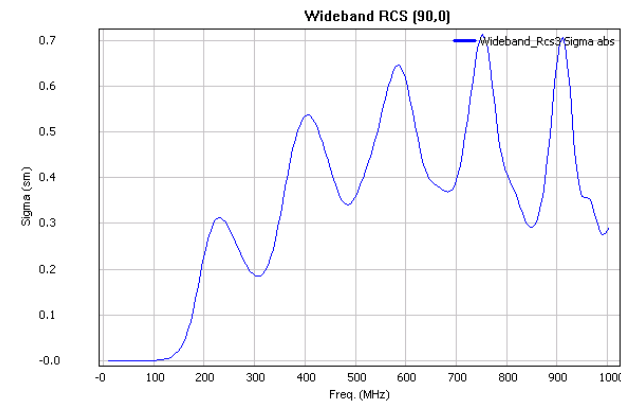
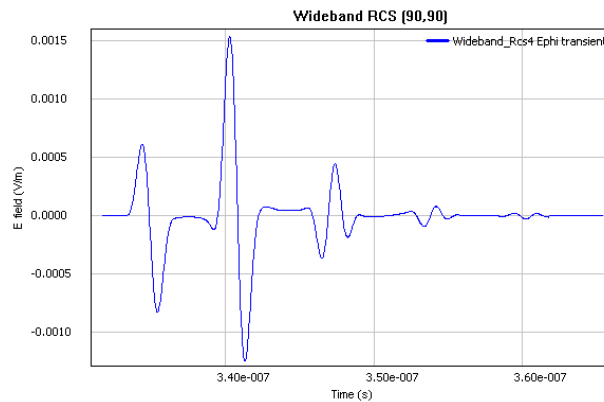
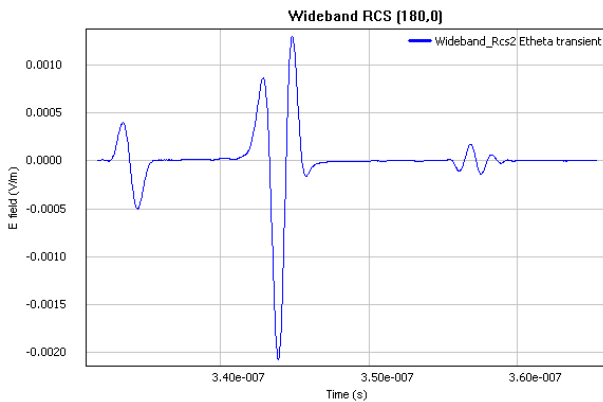
RCS (0.5GHz)



# Far Fields – RCS

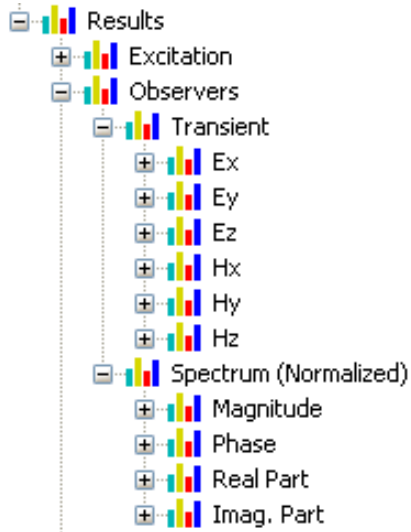


RCS at single frequency

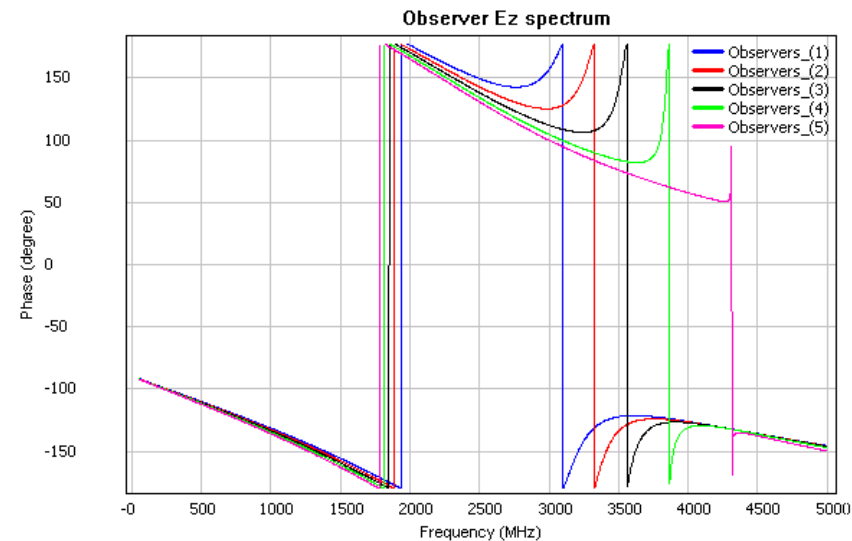
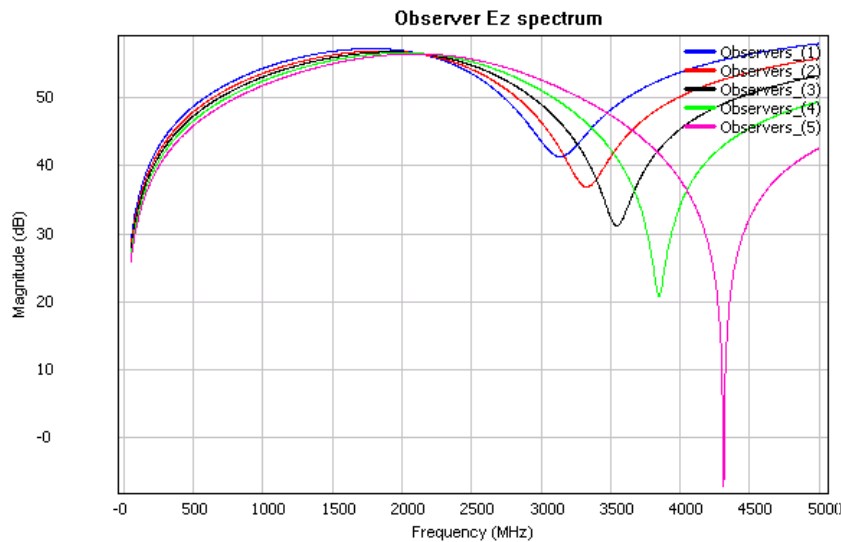
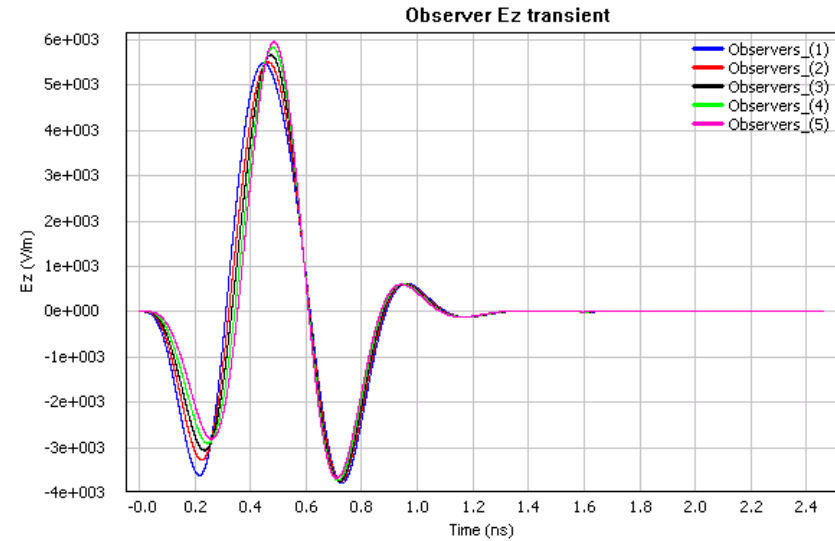


Transient far field and wideband RCS

# Curves – Observers



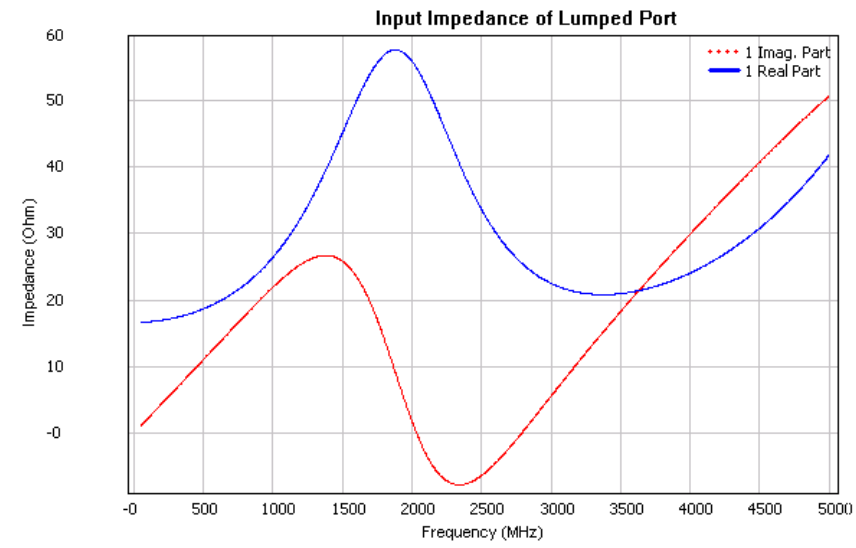
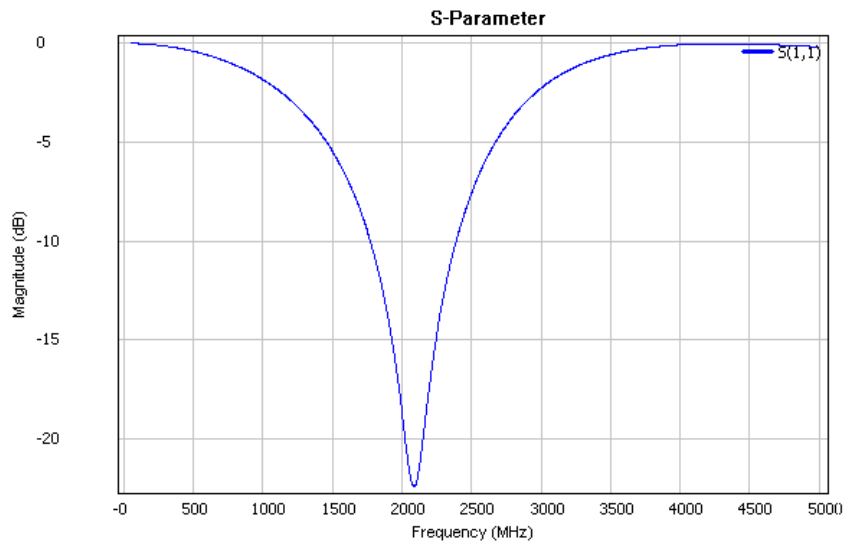
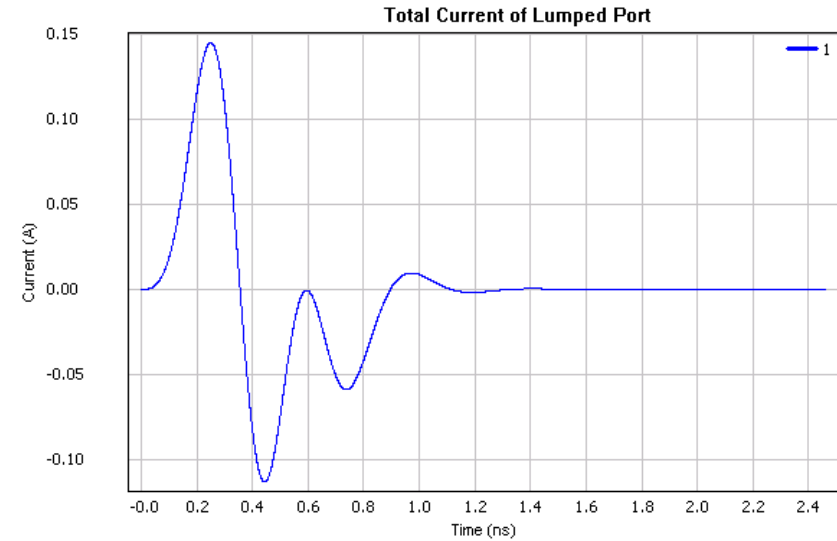
- xyz components of E/H fields
- Transient signals and their spectrums



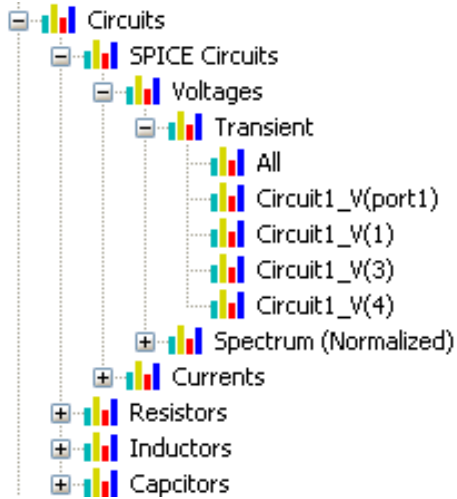
# Curves – Lumped Ports

- Lumped Ports
- S-Parameters
  - Magnitude
  - Phase
  - Real Part
  - Imag. Part
- Impedance
  - Incident voltage
  - Incident current
  - Scattered voltage
  - Scattered current
  - Total voltage
  - Total current

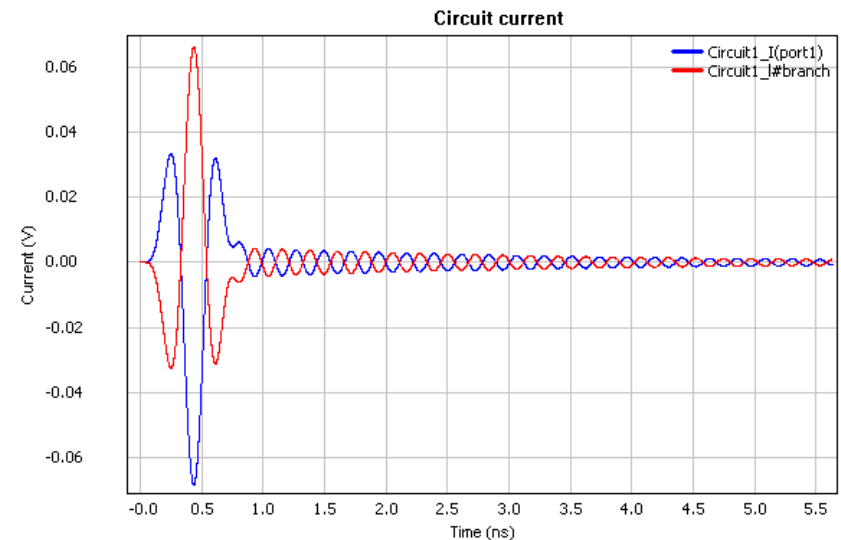
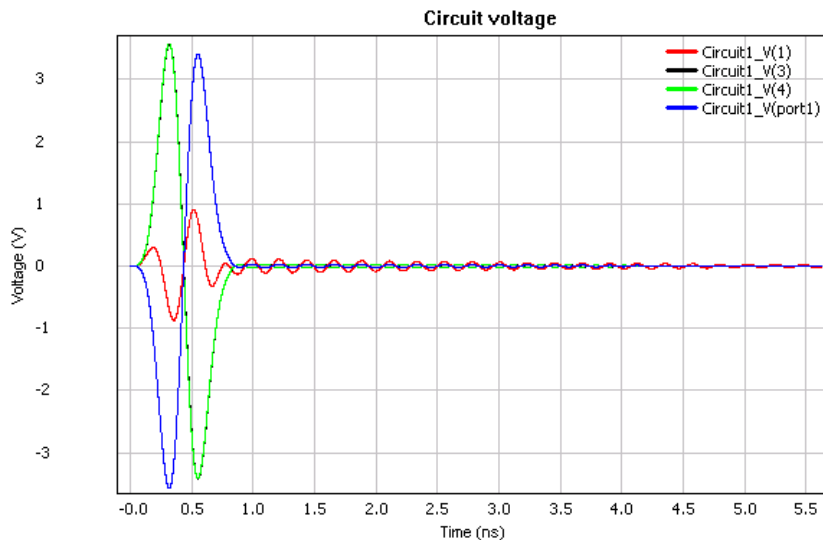
- S-Parameters
- Input impedance
- Incident, scattered, total voltage/current
- Both transient and spectrum



# Curves – Circuits



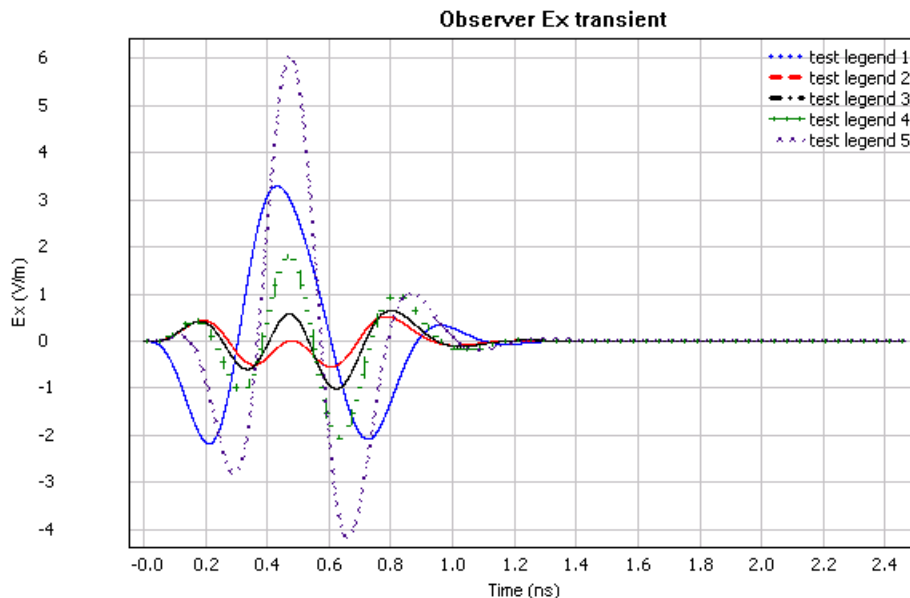
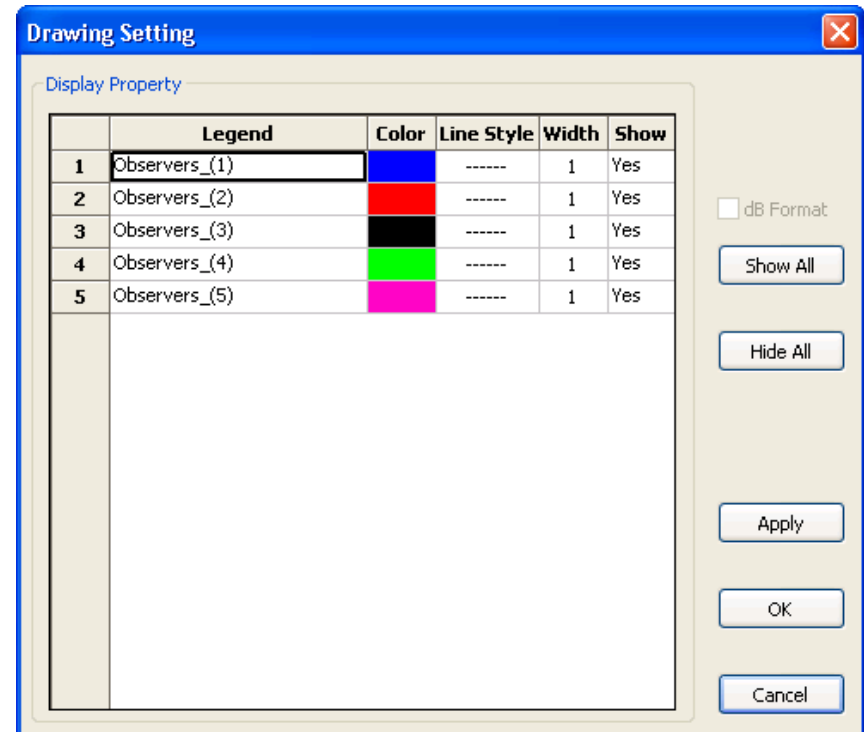
- All node voltages and branch currents of the circuit components will be calculated and displayed
- Both transient signals and their spectrum are calculated





# Curves – Additional Operations

- Legend
- Line color
- Line style
- Line width
- dB format
- Import or export curves
- Zoom in/out
- Save curve to images

**Drawing Setting**

Display Property

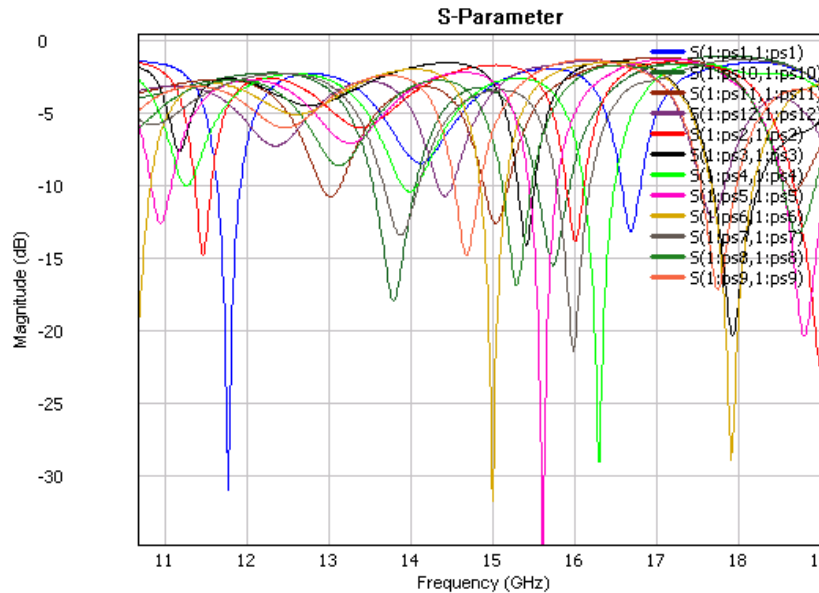
	Legend	Color	Line Style	Width	Show
1	Observers_(1)	Blue	-----	1	Yes
2	Observers_(2)	Red	-----	1	Yes
3	Observers_(3)	Black	-----	1	Yes
4	Observers_(4)	Green	-----	1	Yes
5	Observers_(5)	Magenta	-----	1	Yes

dB Format  
 Show All  
 Hide All  
 Apply  
 OK  
 Cancel

# Additional Features

- Parametric Analysis
- Simulation Manager
- Result Comparison
- Pause and Resume
- Project Backup
- Multi-Threading
- Design Template
- Hybrid Explicit-Implicit Solvers
- Hybrid FDTD-SETD-FETD Solvers

# Parametric Analysis



Simulation Tools Help

- Start Simulation
- Start Parametric Analysis
- Select Solver
- Simulation Options
- Multiple Threads
- Define Farfield
- Observer spectrum
- How to define Multi-Domain ▶
  - Multi-Domain by Grid
  - Multi-Domain by Body
- Edit Parametric Analysis** ▶
  - Select Parametric Results
  - Show Parameters
- Skip clash test before simulation

Edit Select Parametric Results

Source Observer Lumped Port Wave Port Spice

S Parameter

Impedance

Incident Voltage

Transient  Spectrum

Incident Current

Transient  Spectrum

Scattered Voltage

Transient  Spectrum

Scattered Current

Transient  Spectrum

All None

OK Apply Cancel

Edit Parameter Sweeping

List of Parameter Sweeping

Name	From	To	Times
dx	10	13	4
dy	14	16	3

Edit a variable parameter

Name  choose

From  To  Times

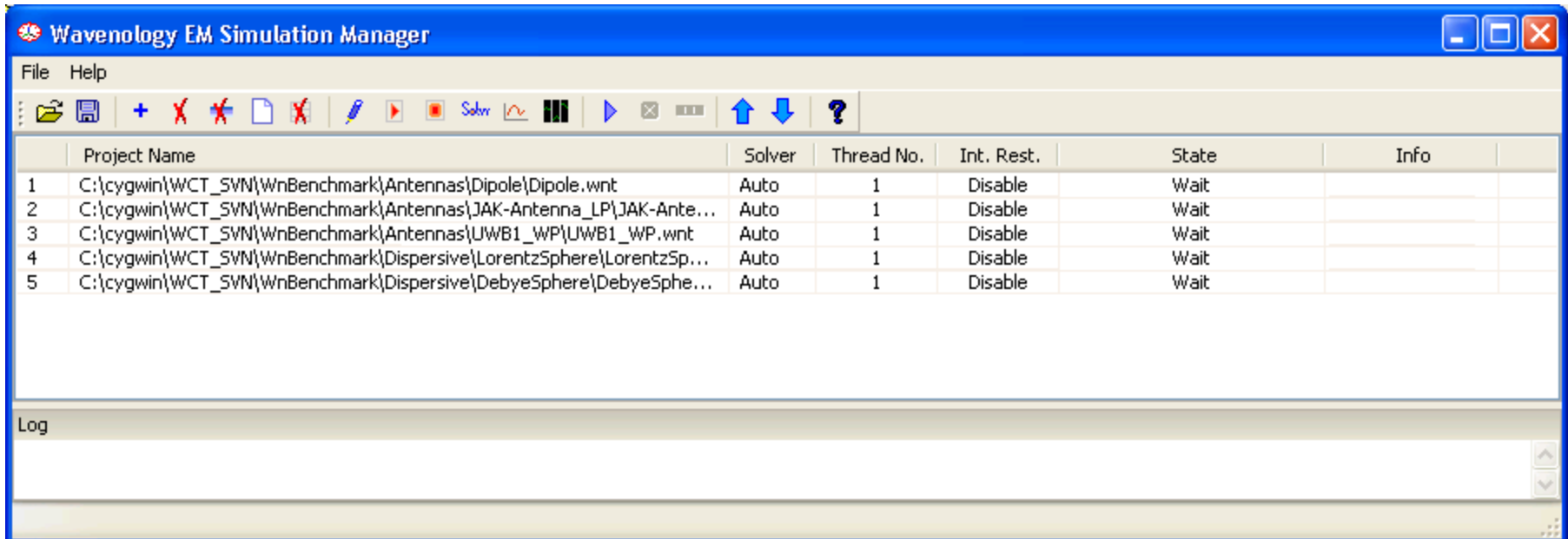
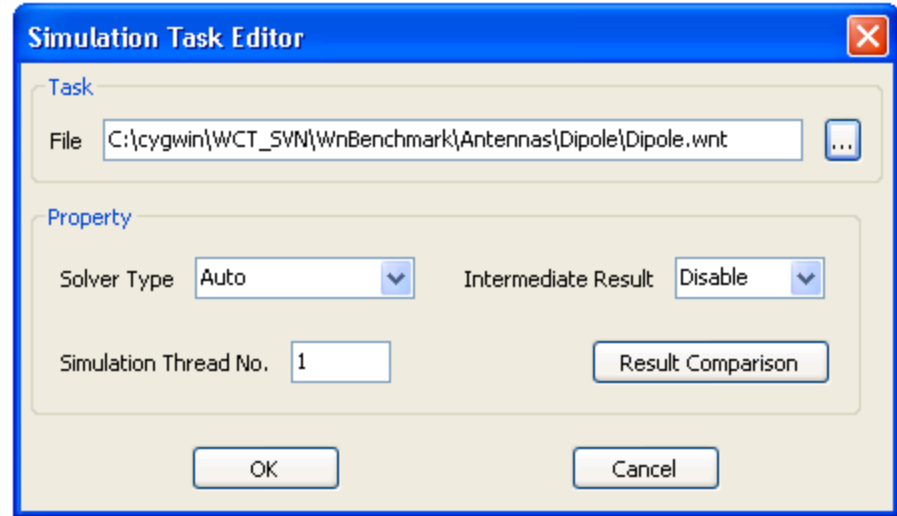
Add Delete Modify

Edit a sequential excitation

New Delete Modify

Help Apply OK Cancel

# Simulation Manager



# Result Comparison

