

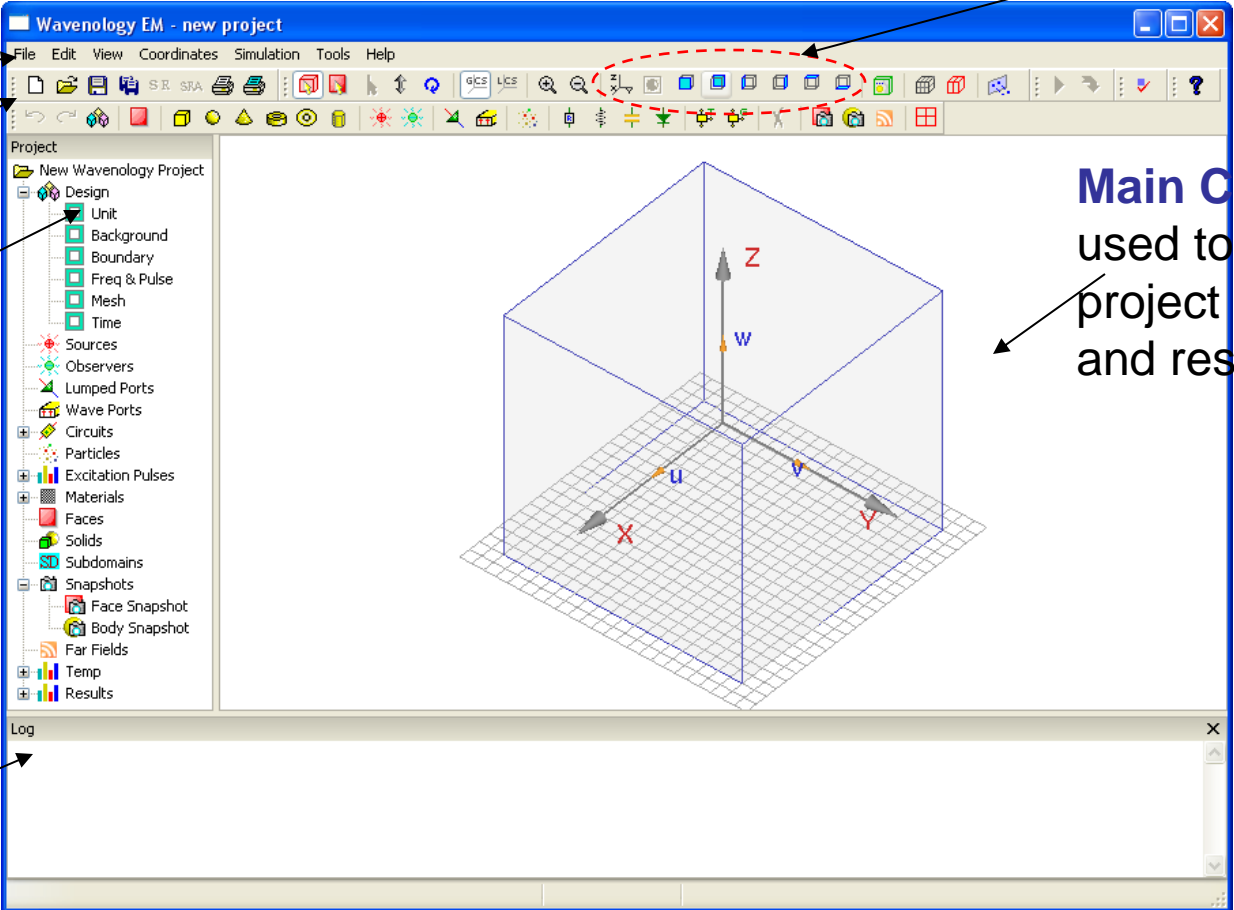
Wave Computation Technologies (WCT)

Software: Wavenology EM-PIC

March, 2013

General Use of the Wavenology EM-PIC

- **Start the program**
 - Click **Start** → **All Programs** → **Wavenology** → **Wavenology EM** to start the program.
- **After started, main frame is shown.** Tool buttons for Different views



The screenshot shows the Wavenology EM software interface. The window title is "Wavenology EM - new project". The menu bar includes File, Edit, View, Coordinates, Simulation, Tools, and Help. The toolbar contains various icons for file operations, simulation, and viewing. A red dashed oval highlights a group of tool buttons. The main canvas displays a 3D coordinate system with X, Y, Z axes and a grid. The left sidebar shows a project tree with categories like Design, Sources, Circuits, Materials, and Results. The bottom status bar is labeled "Log".

Menus → **Tool buttons**

Tree items: *most useful*, are used to design the project and control all the project elements. Try click, right click, or double click these items.

Log: is used to show information and status

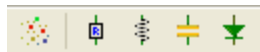
Main Canvas: is used to show the project design and results.

- **Open an project example**

- Click menu: **File** → **Open Project**, choose an particular project file from the popped up dialog.
- All the project filenames have an extension of “.wnt”, e.g. Tube.wnt .

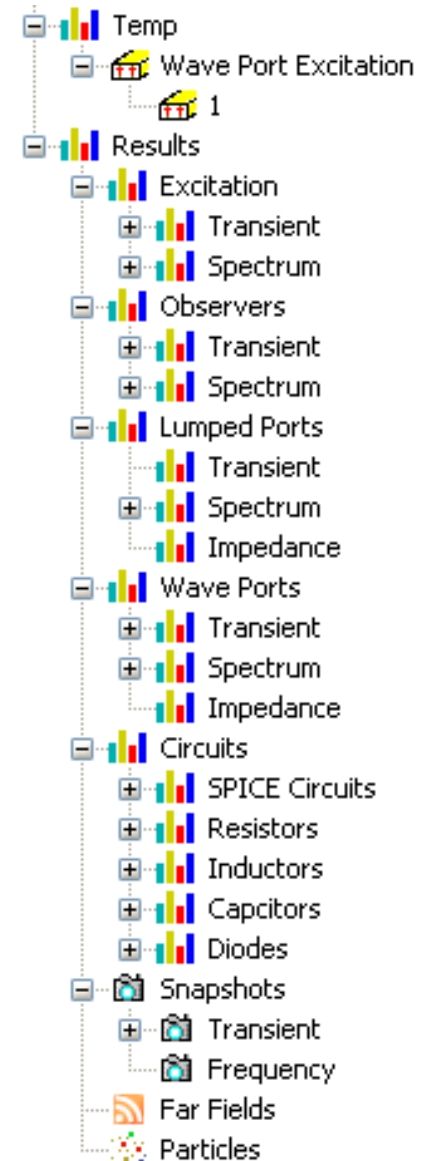
- **Review the project**

- Double click the tree items to review the corresponding project elements. For example, to see the waveguide pattern (if it is defined), double click the corresponding guide under the tree item: **Temp** → **Wave Port Excitation**. (Try the example of Tube.wnt.)
- If the tree item is collapsed, please expand it first by clicking the left ‘+’ sign.
- To see the loaded particles, please click the particle tool button



Particle tool button

- **Simulate the project**
 - Click menu: **Simulation** → **Simulate**.
- **View the results**
 - After simulation, all the results can be obtained by double clicking the corresponding tree items under the tree item **Results**. Sometimes new windows will pop up to show the results. Sometimes the results are shown on the main canvas.

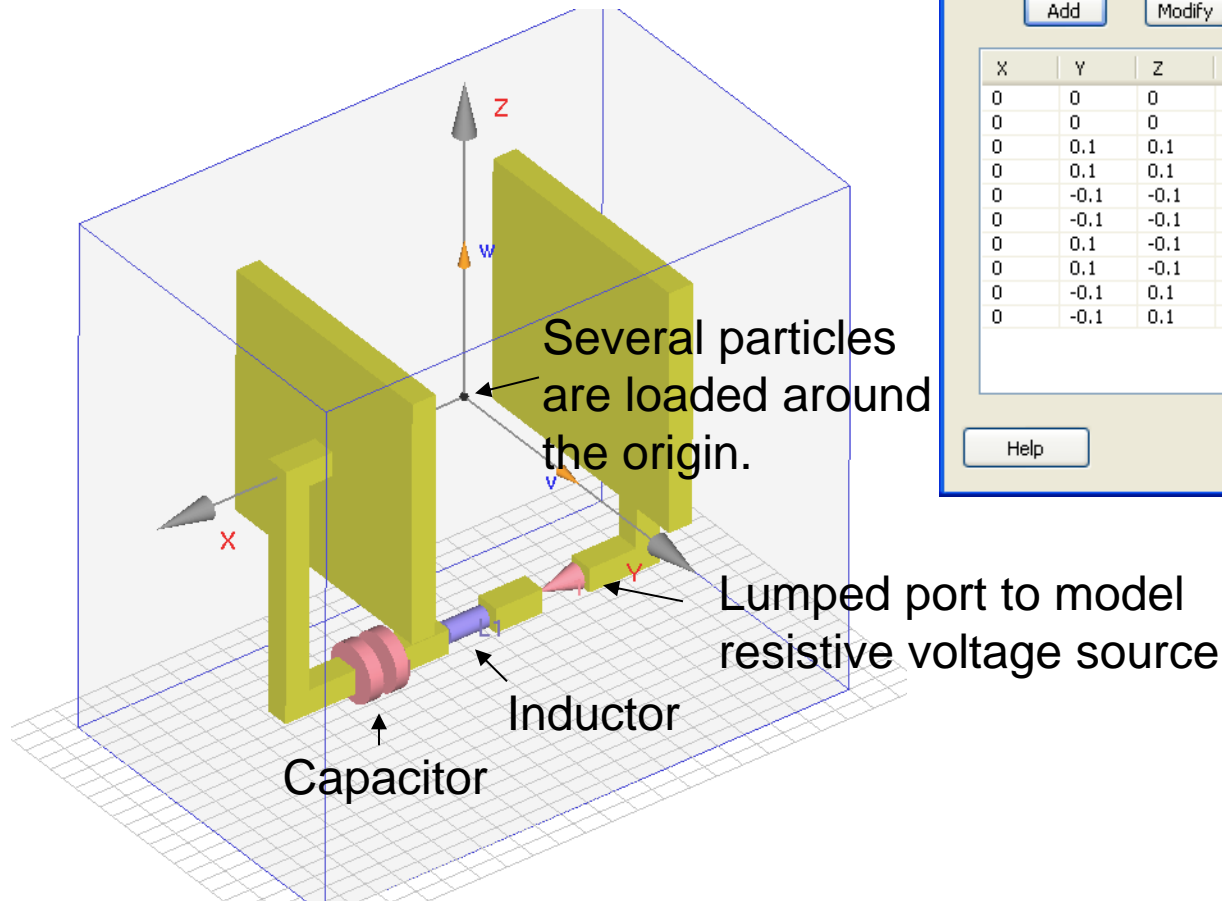


Illustrated Examples

- 7 Examples are provided.
 - Two plates: /Examples/TwoPlates/TwoPlates.wnt
 - CRT: /Examples/CRT/CRT.wnt
 - Tube: /Examples/Tube/Tube.wnt
 - RCS: /Examples/RCS/RCS.wnt
 - Spirals: /Examples/Spirals/spirals.wnt
 - Traveling wave tube: /Examples/TWT/twt.wnt
 - CRT_Spiral: /Examples/CRT_Spiral/CRT_Spiral.wnt
- Please note that: to get exactly same pictures as shown in the slides, rotation, zoom, or different views may be required.

Example 1: Two Plates

- After loading the Examples/TwoPlates/TwoPlates.wnt project, the **geometry** is shown on the main canvas.



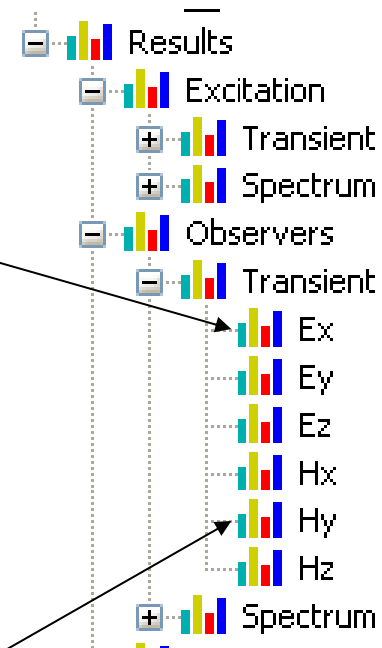
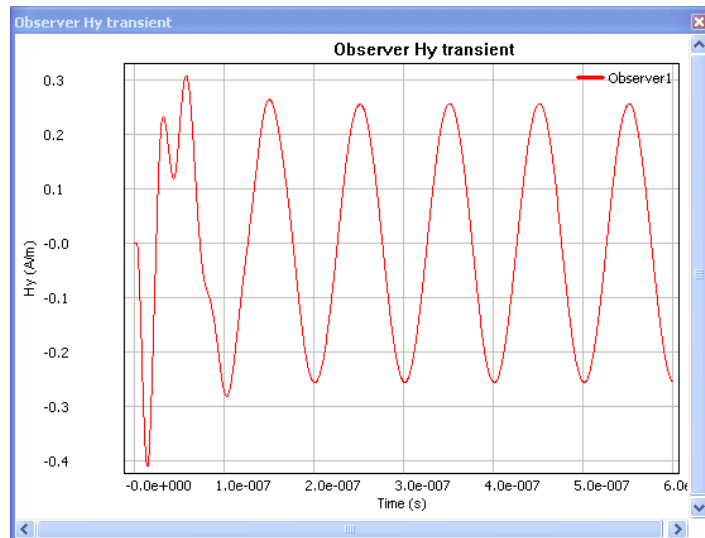
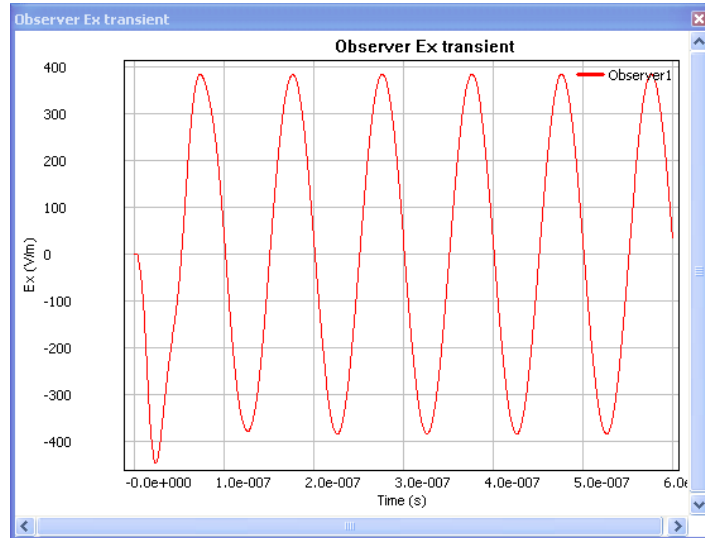
Particle Loading

Add Modify Delete Clear Add from file

X	Y	Z	Vx	Vy	Vz	Charge (Q)	Mass (m)
0	0	0	0	0	0	1.602e-017	9.109e-029
0	0	0	0	0	0	-1.602e-017	9.109e-029
0	0.1	0.1	0	0	0	1.602e-017	9.109e-029
0	0.1	0.1	0	0	0	-1.602e-017	9.109e-029
0	-0.1	-0.1	0	0	0	1.602e-017	9.109e-029
0	-0.1	-0.1	0	0	0	-1.602e-017	9.109e-029
0	0.1	-0.1	0	0	0	1.602e-017	9.109e-029
0	0.1	-0.1	0	0	0	-1.602e-017	9.109e-029
0	-0.1	0.1	0	0	0	1.602e-017	9.109e-029
0	-0.1	0.1	0	0	0	-1.602e-017	9.109e-029

Help OK Apply Cancel

- Observed Field at Origin



• Trajectories of Particles

Adjust particle style and size

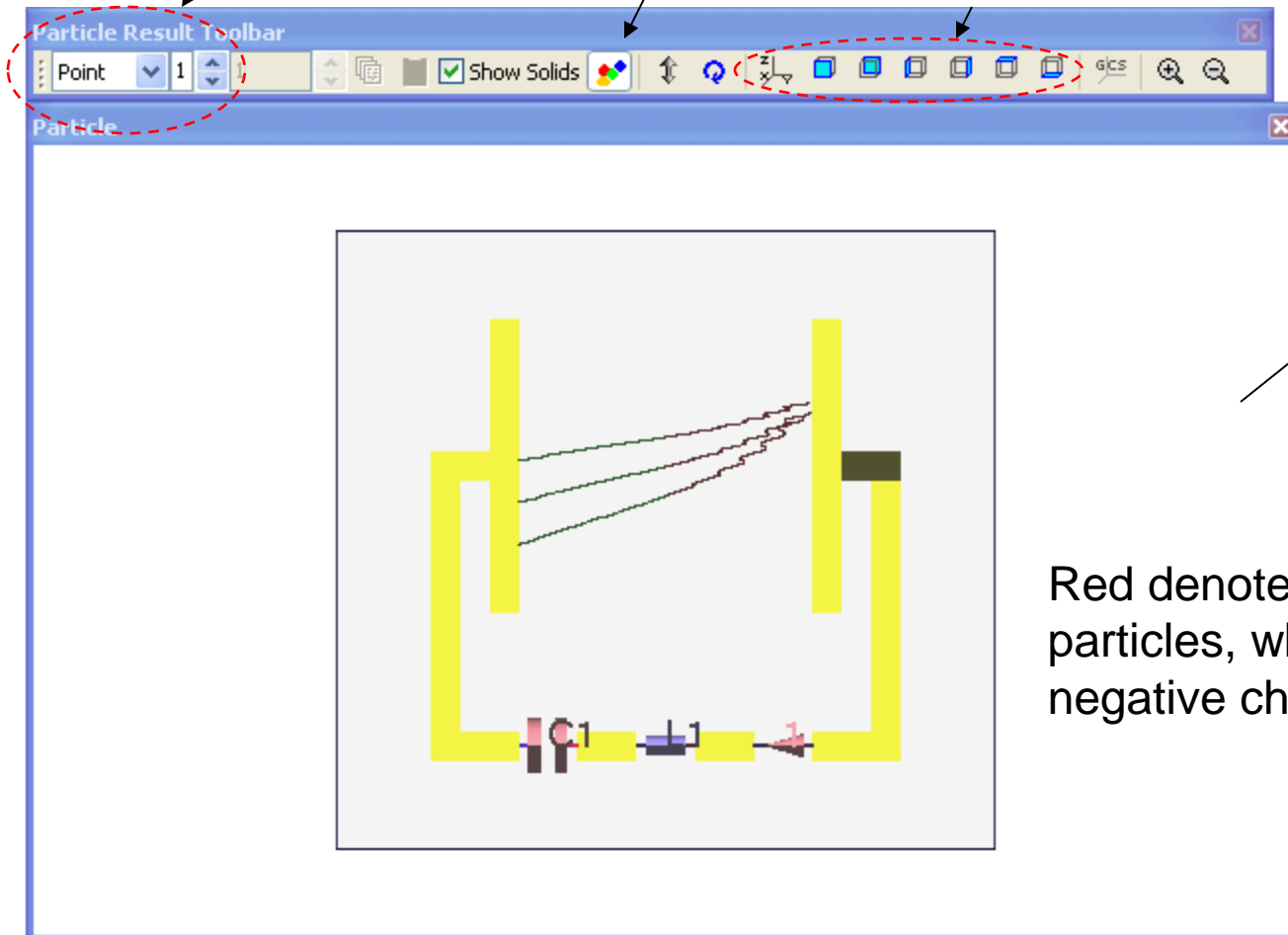
Show all particles' trajectories

Different views

- Results
 - Excitation
 - Observers
 - Lumped Ports
 - Wave Ports
 - Circuits
 - Snapshots
 - Far Fields
 - Particles

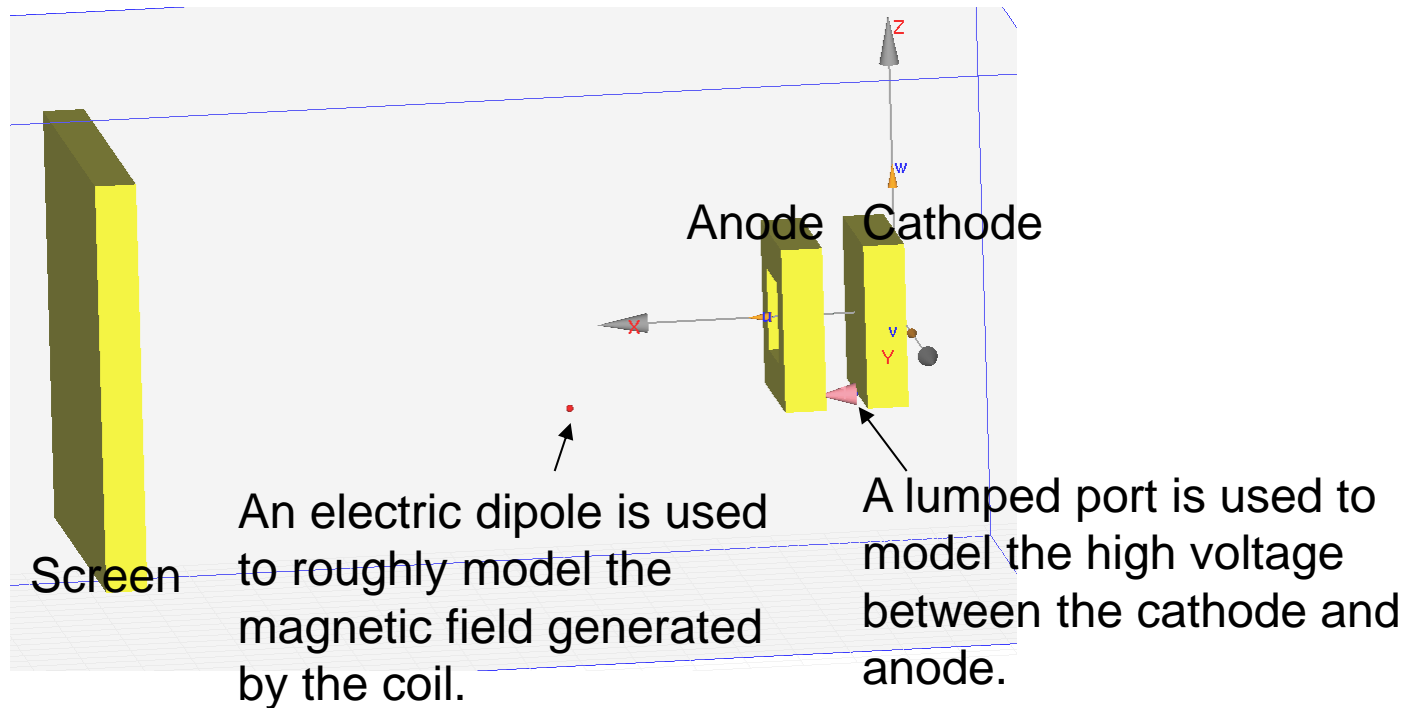
Double click here to see particle results.

Red denotes positive charged particles, while green denotes negative charged particles.

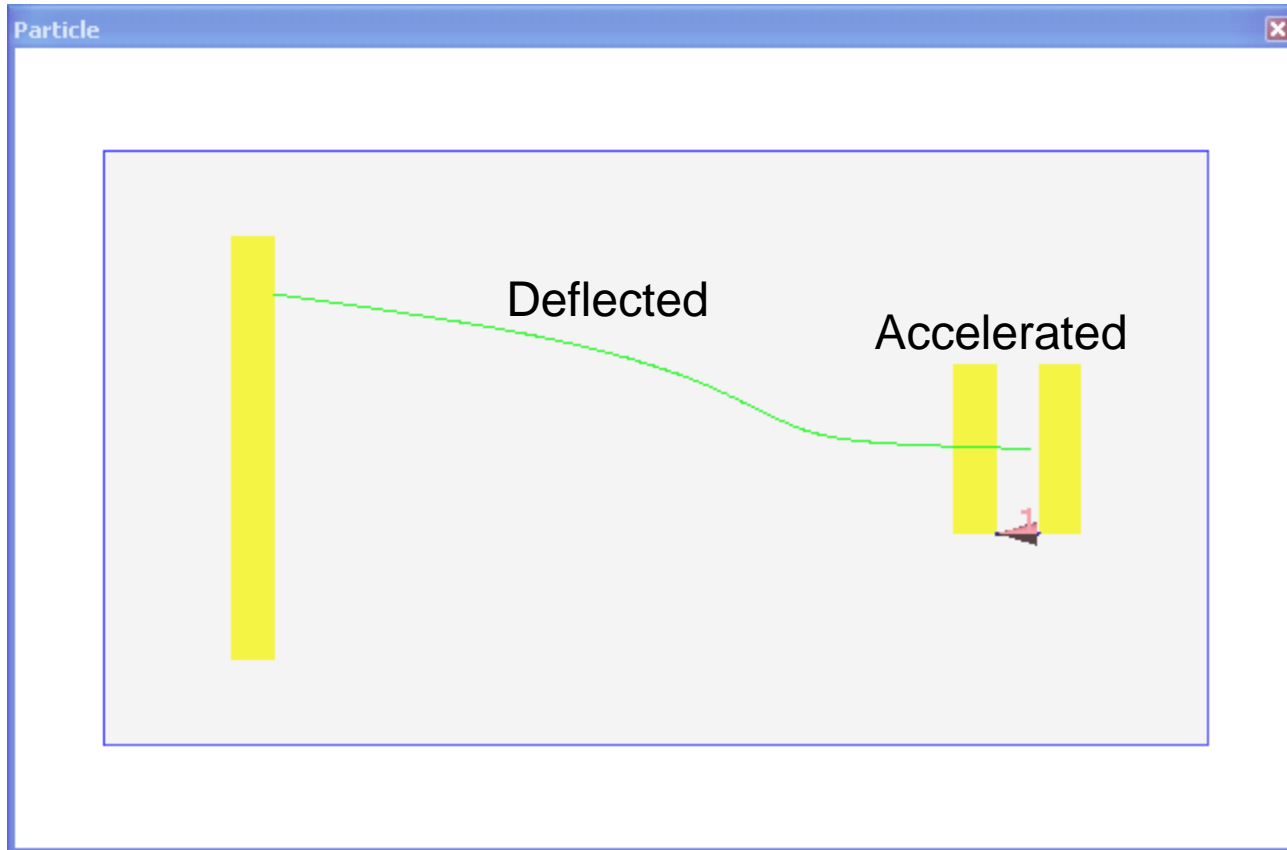


Example 2: A Simple Model For CRT

- After loading the Examples/CRT/CRT.wnt project, the **geometry** is shown on the main canvas.

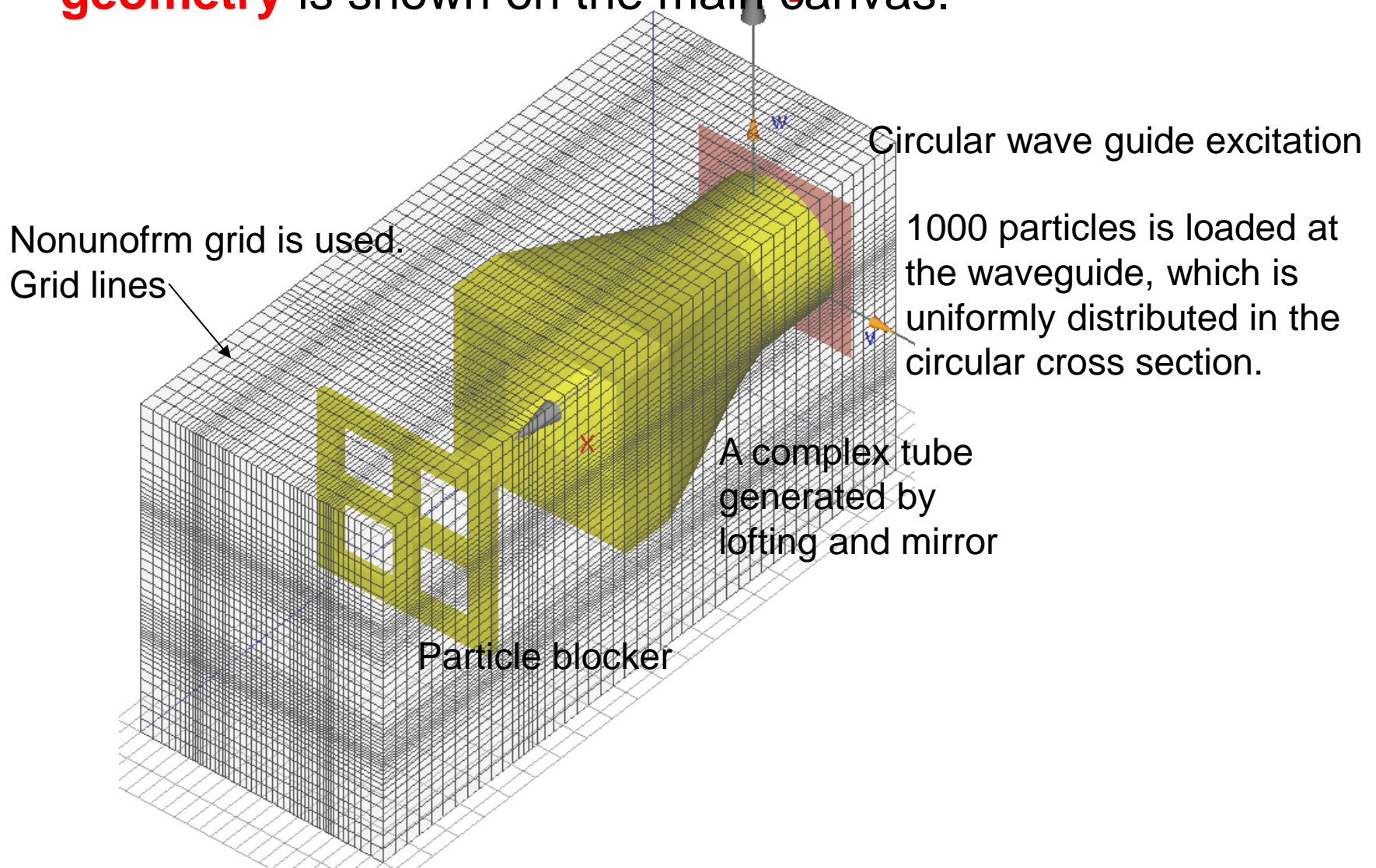


- Trajectory of a particle



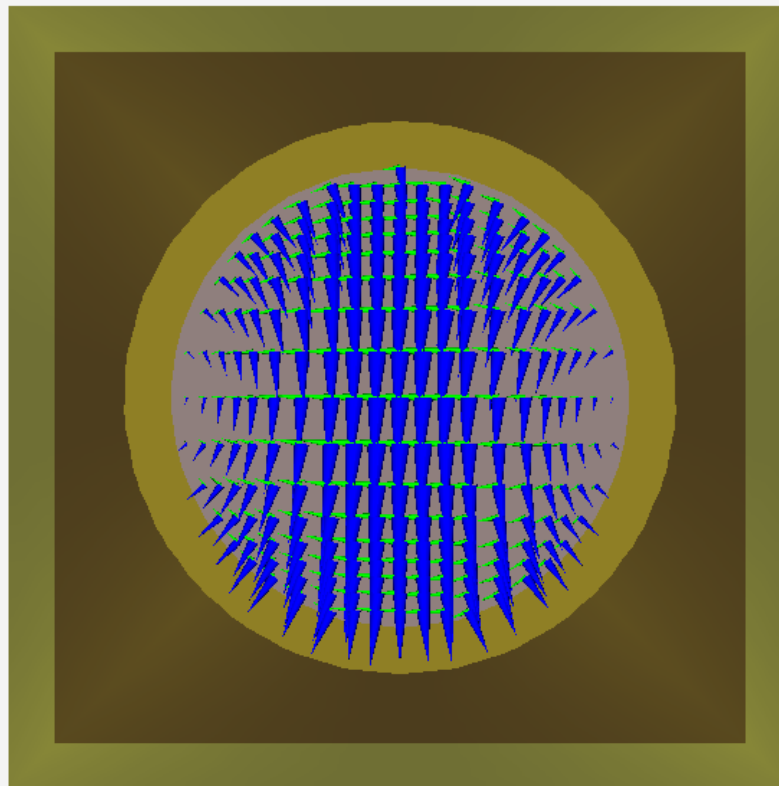
Example 3: Tube

- After loading the Examples/Tube/Tube.wnt project, the **geometry** is shown on the main canvas.

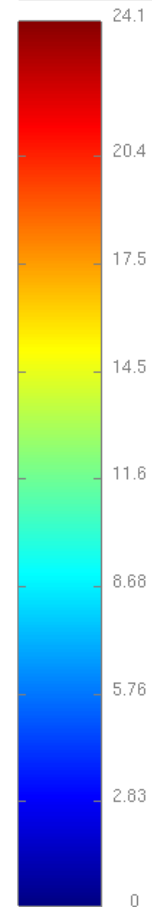


- Wave port excitation: the eigen pattern

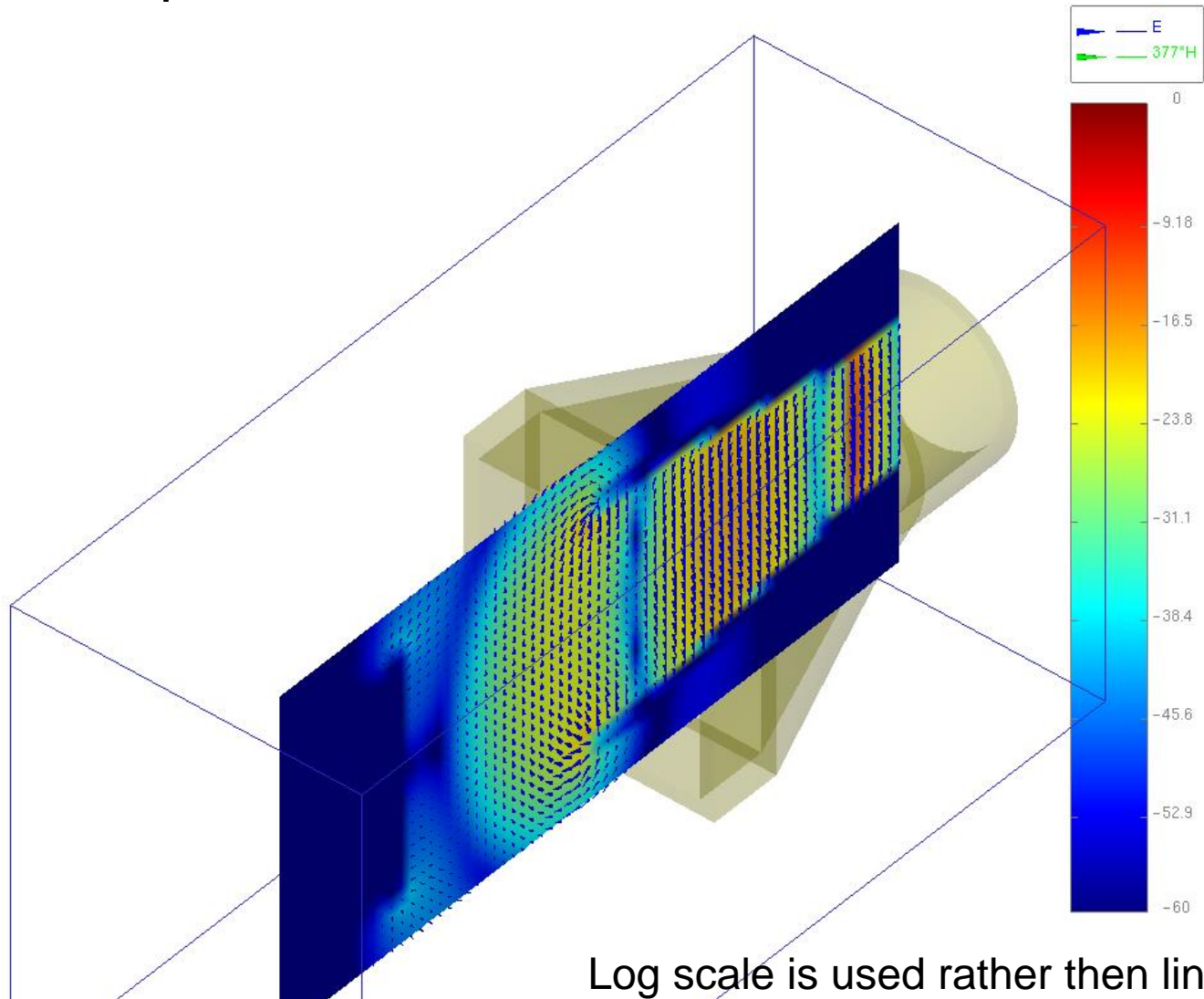
Mode Type: TE
Beta=0.967859 (1/m), Alpha=0 (1/m)
Wave Impedance:815.789+j0 (ohm)
Port Location: X=-0.5
Freq: 100 MHz
max Etrans.: 23.551+j0 (V/m), phase: 0
max Htrans.: 0.028869+j0 (A/m), phase: 0



— E
— 377*H

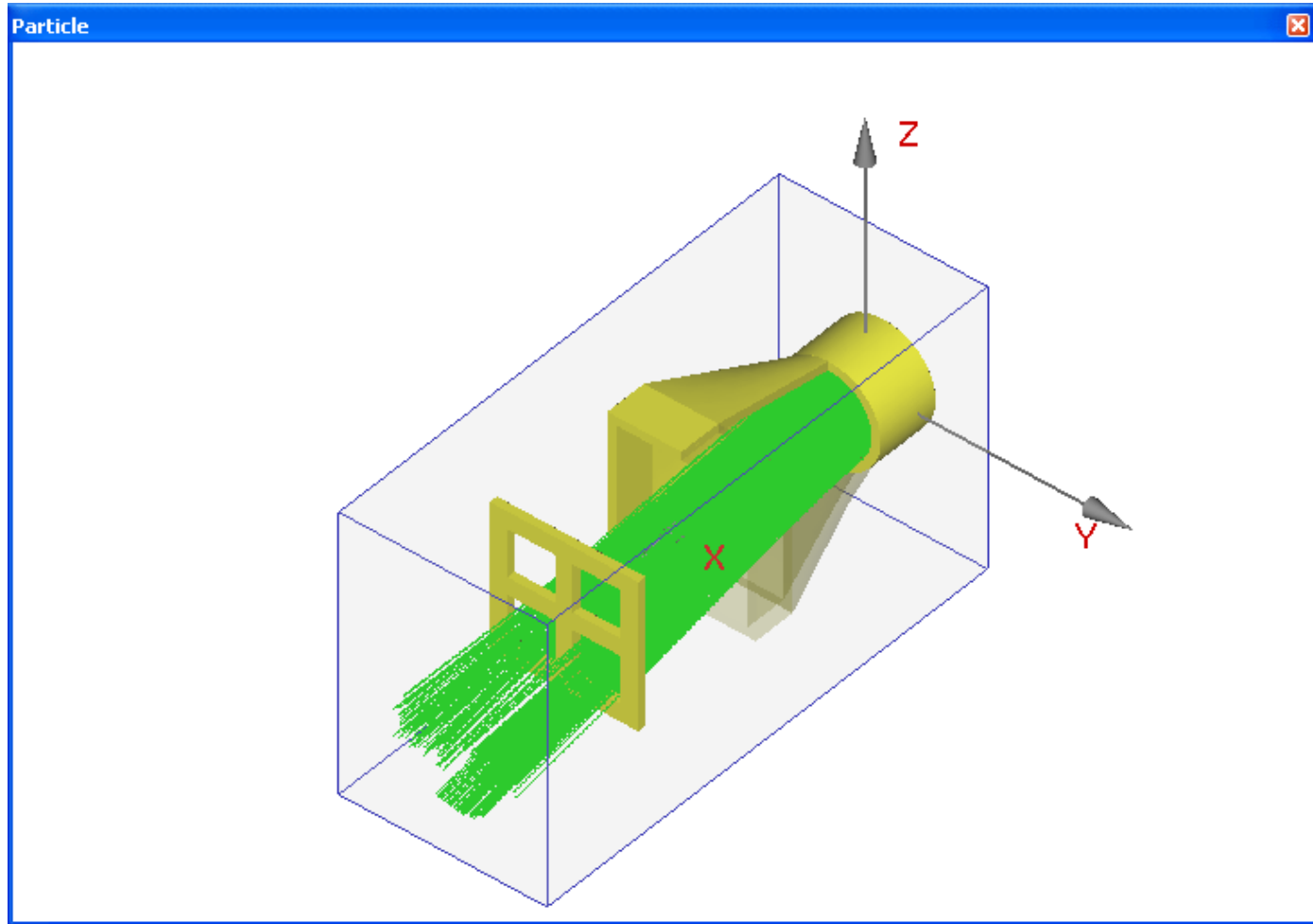


- A field snapshot at a cross section



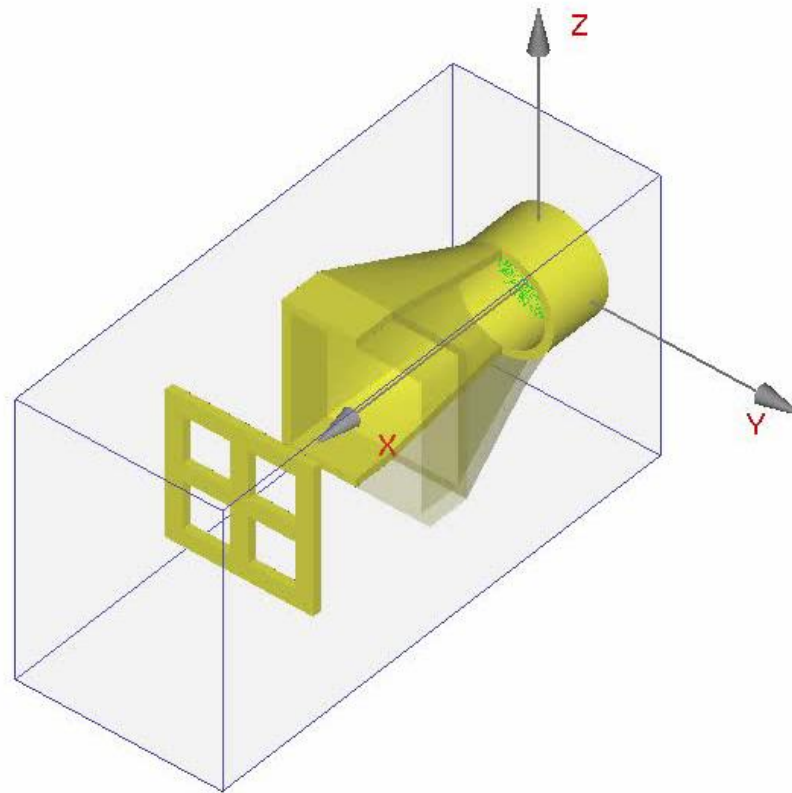
Log scale is used rather than linear.

- Trajectories of the particles



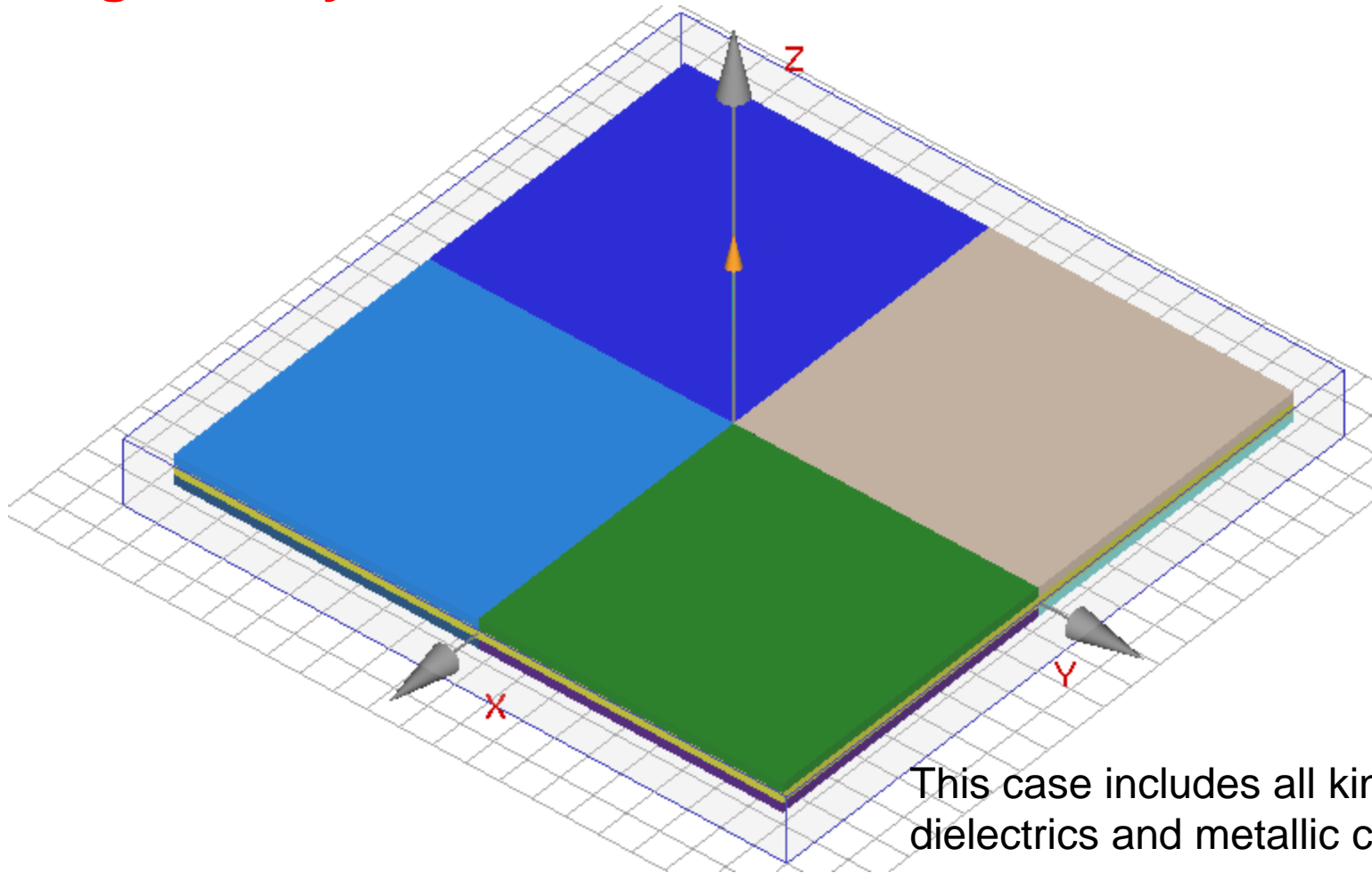
- Movie of the particles

Make a movie.



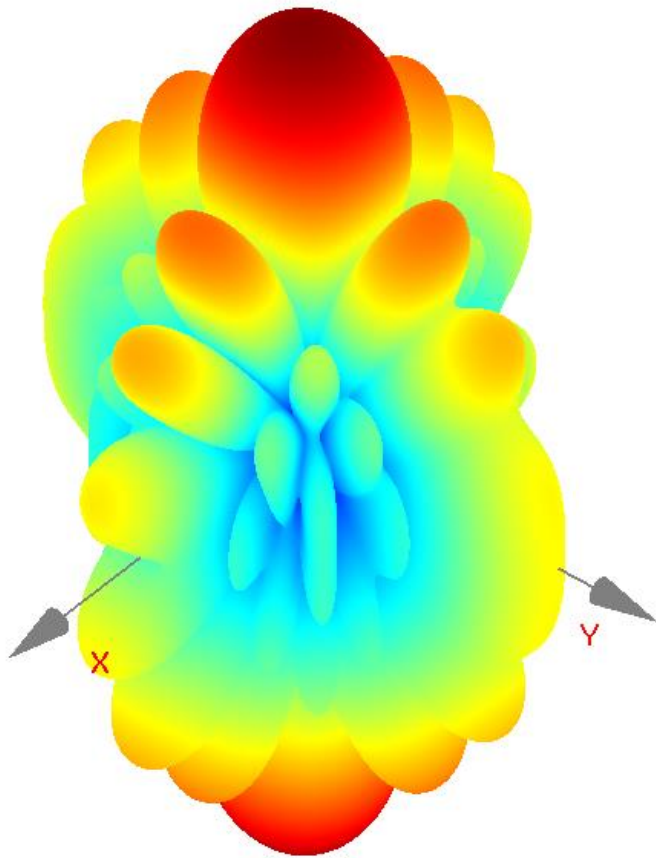
Example 4: a pure EM case: RCS

- After loading the Examples/RCS/RCS.wnt project, the **geometry** is shown on the main canvas. Rader corss

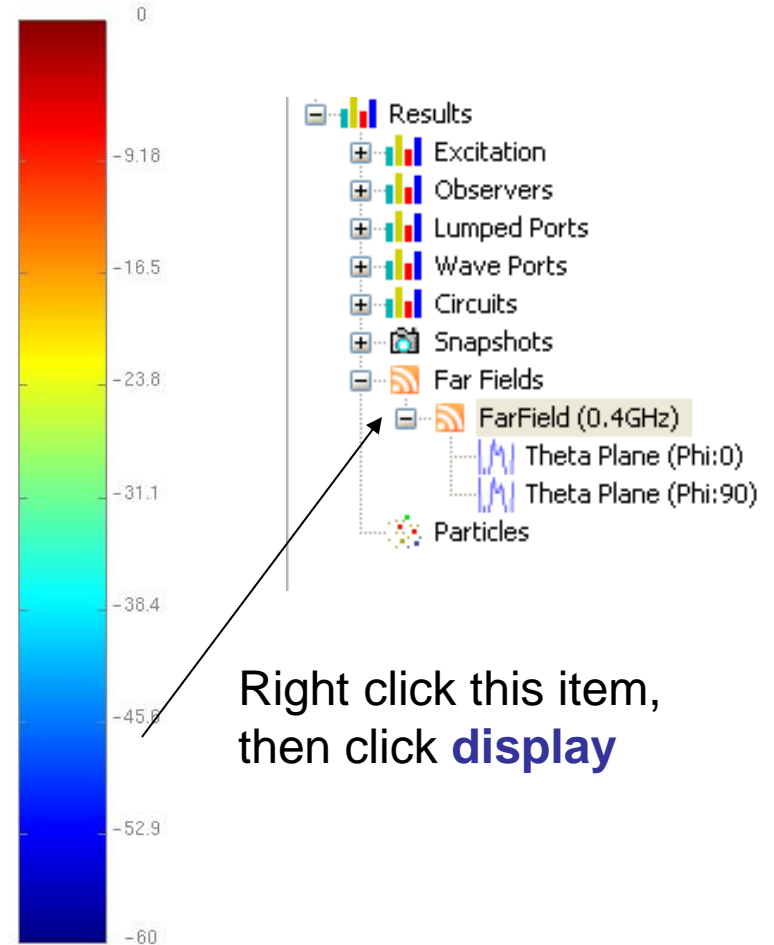


This case includes all kinds of dielectrics and metallic conductors.

- RCS Pattern

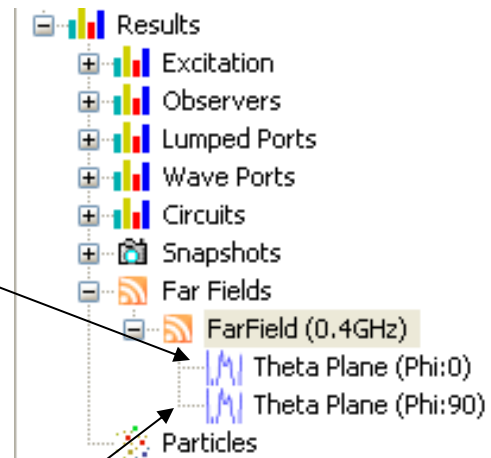
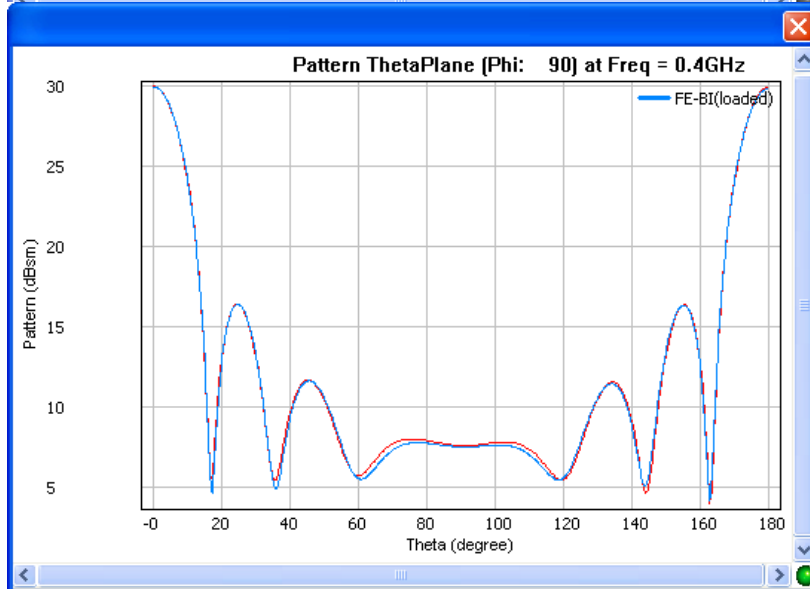
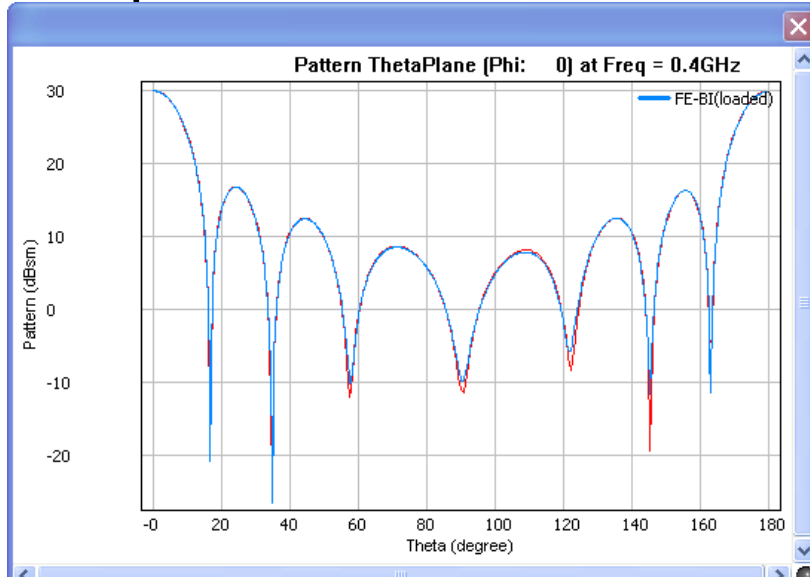


Log scale is used.



Right click this item,
then click **display**

- Compare with loaded reference.



Waveform Setting

Load Curves
Export Data
Export All Data

Interpol. cross sec.

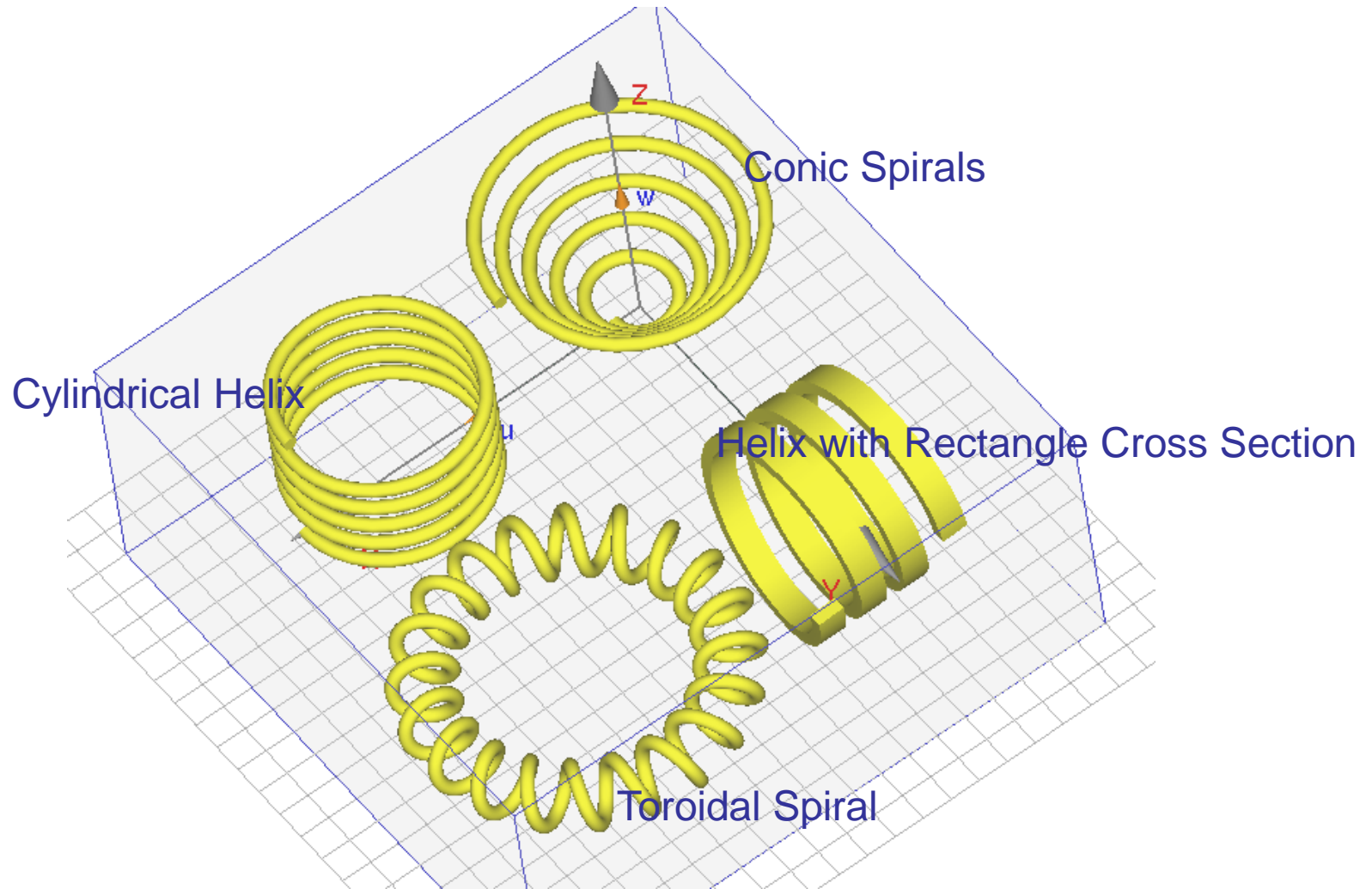
Zoom All

Print
Print to File
Print to Postscript

Wavenology can export results and load reference results to compare by right clicking the results figures.

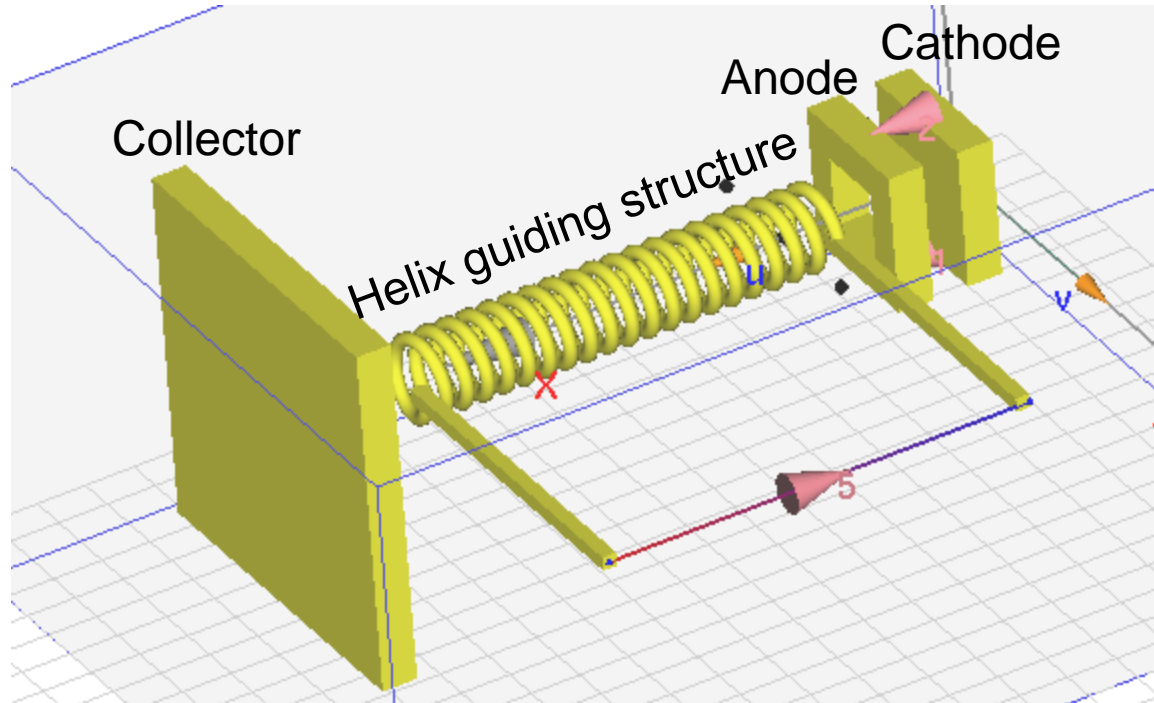
Spirals and Helixes

- Load the Examples/Spirals/spirals.wnt project

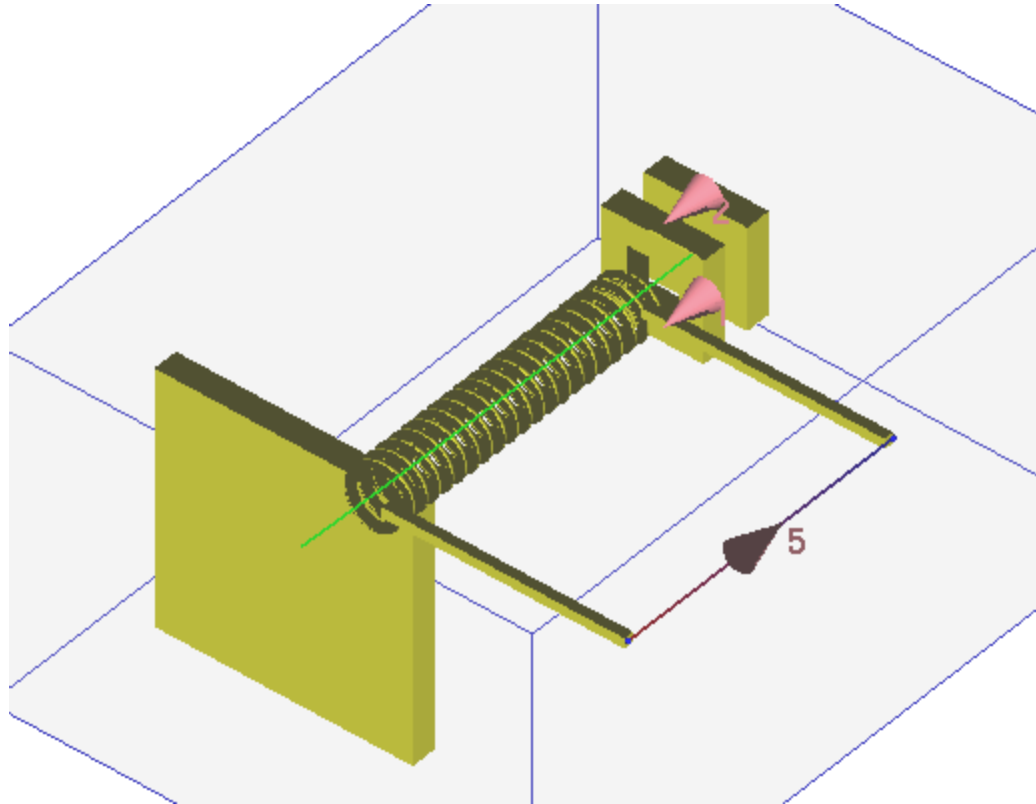


A Traveling Wave Tube

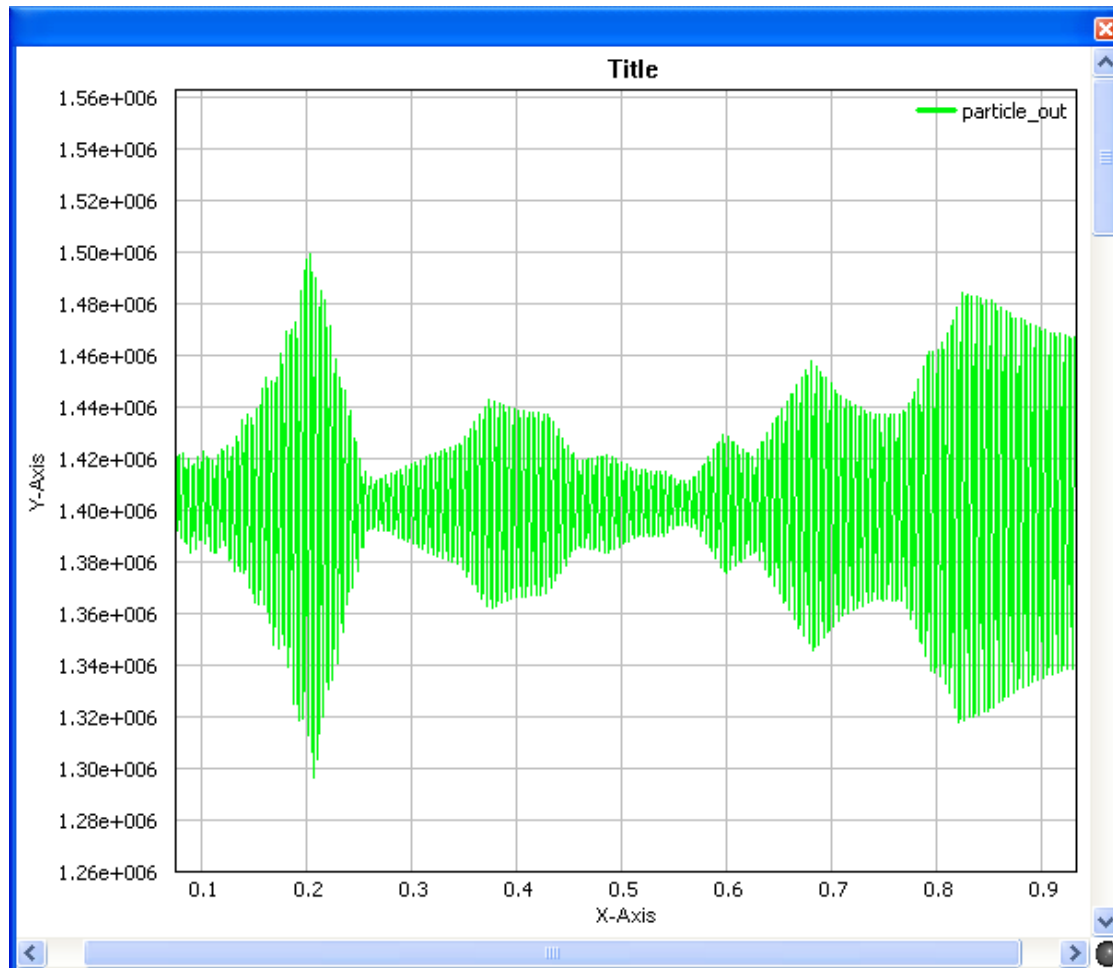
- Load the Examples/TWT/twt.wnt project



- Particle's Trajectory

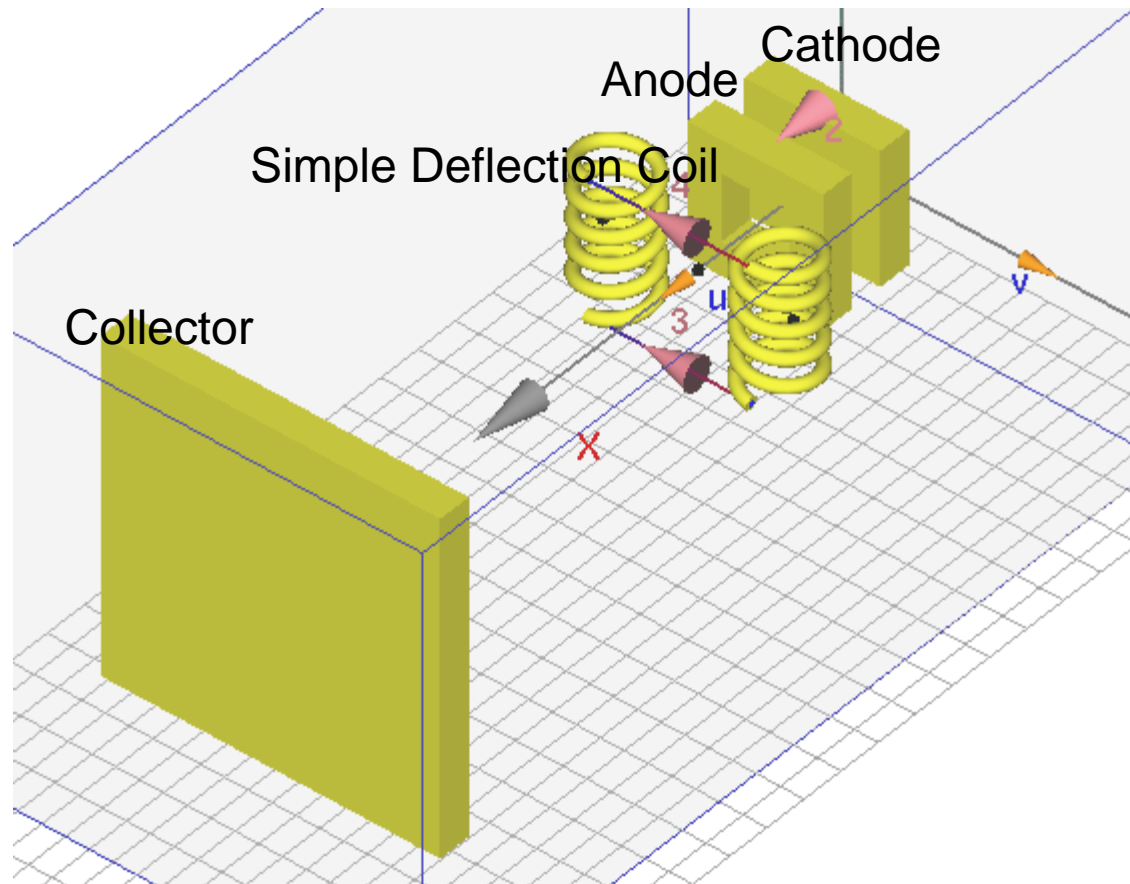


- Velocity Modulation

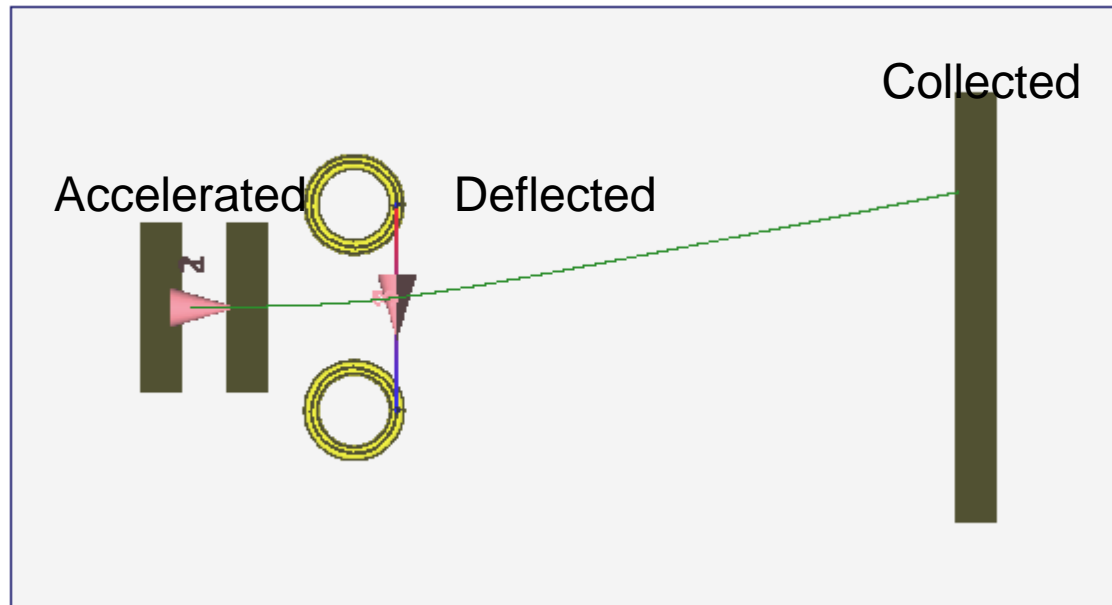


A Simple Model of CRT

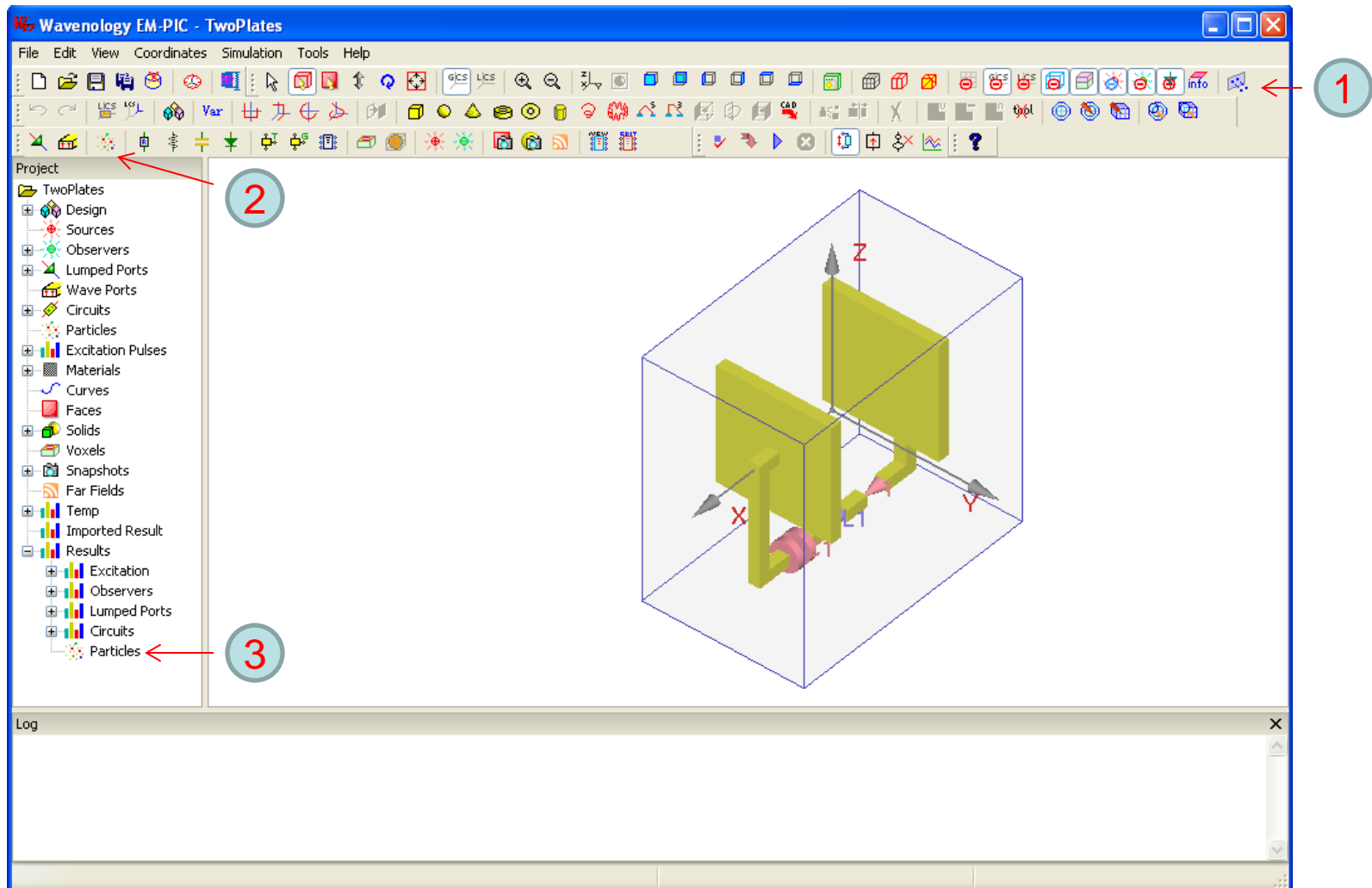
- Load the Examples/CRT_Spiral/CRT_Spiral.wnt project
 - Deflection coil is model by two helix coils.





- Particle Trajectory



GUI Items Related to Particle Simulation

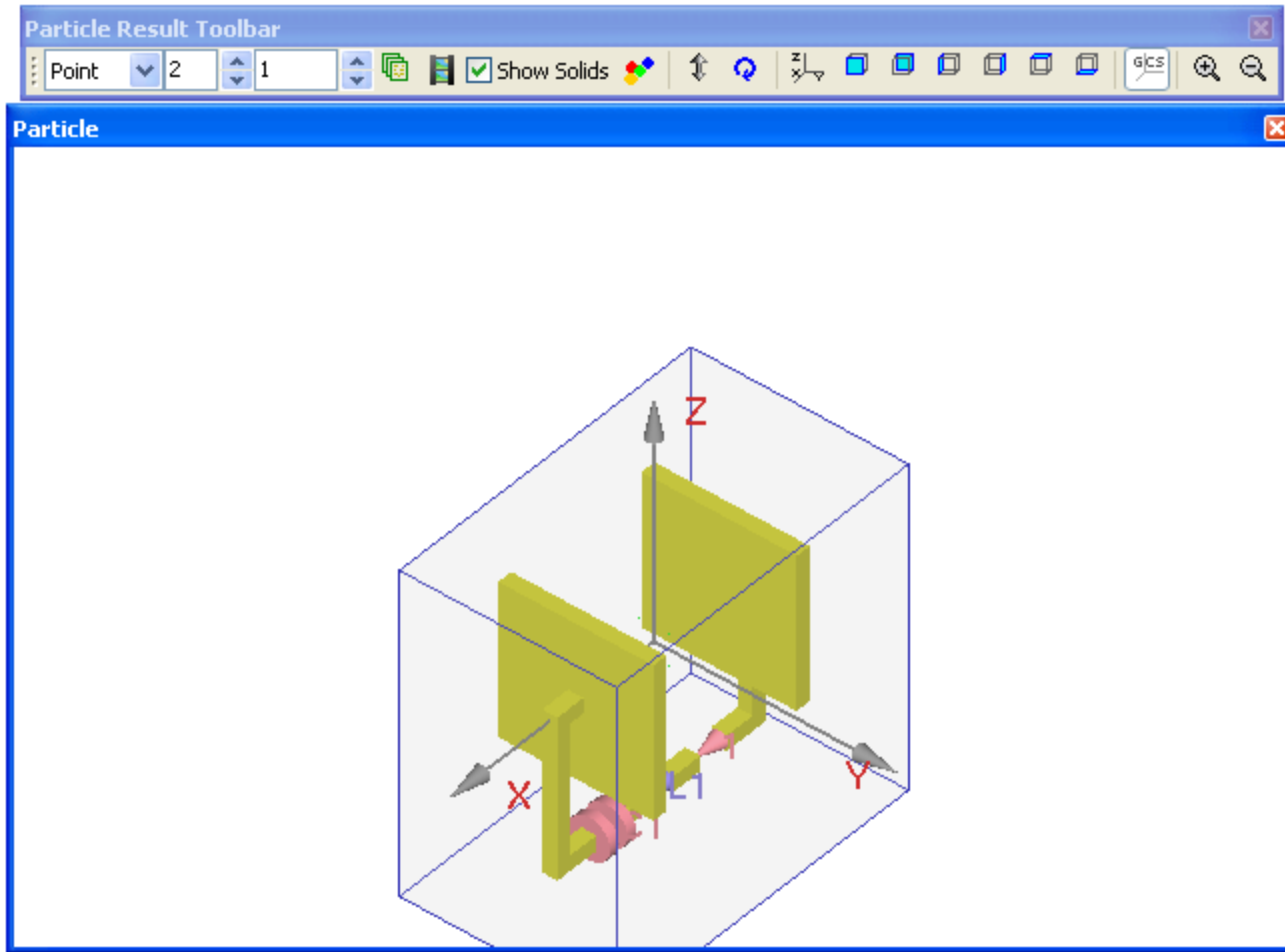


1  Show particle injection position on 3D canvas

2  Define or edit particle injection

3  Particles Simulation result for particle

Browse Simulation Result for Particle



← Toolbar to control result displaying

← 3D canvas that display particle position at different time step

Particle shown as a point or big sphere

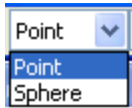
Displayed frame index

Make a movie for particle movement

Show particles' position in all frame in 3D canvas (making particle movement path)

Front, back, left, right view, etc.

Zoom in/out



Point or sphere size, range 1-6

Automatically display result frame by frame

Zoom mode

Reset to Angle View

Rotation mode

Show|hide axis

Add or Edit Particle

Modify
selected
particle

Delete
selected
particle

Delete all
particles

Load particles
from a TXT file

X	Y	Z	Vx	Vy	Vz	Charge (Q)	Mass (m)
0	0	0	0	0	0	1.602e-017	9.109e-029
0	0	0	0	0	0	-1.602e-017	9.109e-029
0	0.1	0.1	0	0	0	1.602e-017	9.109e-029
0	0.1	0.1	0	0	0	-1.602e-017	9.109e-029
0	-0.1	-0.1	0	0	0	1.602e-017	9.109e-029
0	-0.1	-0.1	0	0	0	-1.602e-017	9.109e-029
0	0.1	-0.1	0	0	0	1.602e-017	9.109e-029
0	0.1	-0.1	0	0	0	-1.602e-017	9.109e-029
0	-0.1	0.1	0	0	0	1.602e-017	9.109e-029
0	-0.1	0.1	0	0	0	-1.602e-017	9.109e-029

Note: text input file has following format

1. Line start with '%' or '#' is comment line, it will be skipped
2. Each data line should has 8 data separated by ' ' or 'tab'
3. The 8 data in a data line has this sequence:
x_pos y_pos z_pos v_x v_y v_z charge mass