

Step by step procedure for designing a slit aperture in OptiScan7.7v0

A slit aperture with a complicated cross sectional shape shown in Figure 1 is designed using the OptiScan program. Described below is a step-by-step procedure starting from initiating OptiScan to viewing the final results.

1) **Initiating OptiScan:**

Open MATLAB 7.7 and select the OptiScan folder titled 'OSCAN77_V0'. In the command window enter 'Startup'. When the OptiScan window opens, click on the 'Open New OptiScan Project'. After naming the project, the main project workspace window opens. Under the 'Accessories' tab click on 'FDTD Calculator'. The 'FDTD Calculator – Main Window' opens.

2) **Defining Computation Domain:**

In the 'FDTD Calculator – Main Window' enter the number of voxels in all three axes and the sampling size of each voxel. This sets the total computational domain size. Chapter 1 in the FDTD User's Manual provides a discussion about voxels. A voxel size of 10nm is adequate for a wavelength 658 nm.

For the design of the slit shown in Figure 1, the following computation domain parameters are used:

x voxel = 1200

x voxel = 3

x voxel = 100

x sampling = 1e-8

x sampling = 1e-8

x sampling = 1e-8

3) **Defining Geometry:**

Click on the 'Edit/View Geometry' button. In the 'FDTD Elements' tab design the geometry of the slit in 3D. To design the slit multiple 'box' elements are required and they are placed in the appropriate location in 3D space to represent the metal, the substrate and the aperture. For further information refer to Chapter 2 in the FDTD User's Manual. Once the design is completed click on the 'OK' button. In the 'FDTD Calculator – Main Window' click on the 'Save Object' button and save the design by creating a new object folder for this particular design in the 'userdata' folder under the main project folder.

The slit design shown in Figure 1 has a 125 nm slit width at the metal – substrate interface and a 120 nm thick aluminum metal layer. It also has a 85 nm deep etching into the glass substrate.

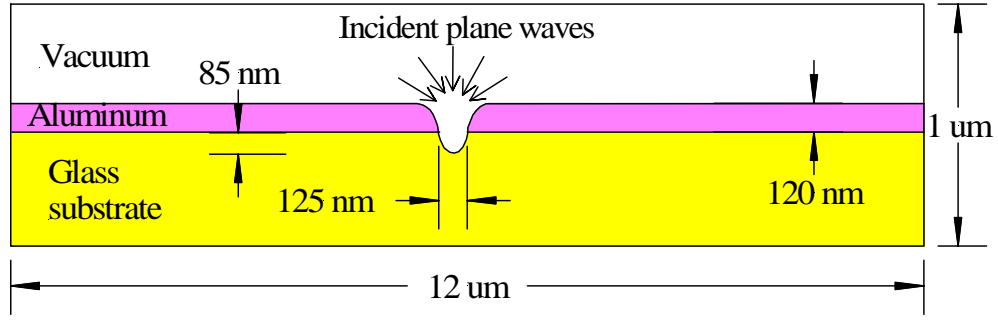


Figure 1. FDTD simulation domain geometry

To design this geometry the following parameters are used:

Element List	Translation	Size	Refractive Index
box	0 0 -6e-8	1 1 1.2e-7	1.53+7.88i
box	0 0 -6e-8	3.45e-7 1 1.2e-7	1
box	0 0 0.5	1 1 1	1.53
box	-1.175e-7 0 0	1.1e-7 1 1e-8	1.53+7.88i
box	1.175e-7 0 0	1.1e-7 1 1e-8	1.53+7.88i
box	-1.275e-7 0 -1e-8	1.15e-7 1 1e-8	1.53+7.88i
box	1.275e-7 0 -1e-8	1.15e-7 1 1e-8	1.53+7.88i
box	-1.27e-7 0 -2e-8	1.05e-7 1 1e-8	1.53+7.88i
box	1.27e-7 0 -2e-8	1.05e-7 1 1e-8	1.53+7.88i
box	-1.27e-7 0 -3e-8	1e-7 1 1e-8	1.53+7.88i
box	1.27e-7 0 -3e-8	1e-7 1 1e-8	1.53+7.88i
box	-1.275e-7 0 -4e-8	9e-8 1 1e-8	1.53+7.88i
box	1.275e-7 0 -4e-8	9e-8 1 1e-8	1.53+7.88i
box	-1.375e-7 0 -5e-8	9.5e-8 1 1e-8	1.53+7.88i
box	1.375e-7 0 -5e-8	9.5e-8 1 1e-8	1.53+7.88i
box	-1.375e-7 0 -6e-8	9e-8 1 1e-8	1.53+7.88i
box	1.375e-7 0 -6e-8	9e-8 1 1e-8	1.53+7.88i
box	-1.375e-7 0 -7e-8	7.5e-8 1 1e-8	1.53+7.88i
box	1.375e-7 0 -7e-8	7.5e-8 1 1e-8	1.53+7.88i
box	-1.475e-7 0 -8e-8	6.5e-8 1 1e-8	1.53+7.88i
box	1.475e-7 0 -8e-8	6.5e-8 1 1e-8	1.53+7.88i
box	-1.475e-7 0 -9e-8	5e-8 1 1e-8	1.53+7.88i
box	1.475e-7 0 -9e-8	5e-8 1 1e-8	1.53+7.88i
box	-1.575e-7 0 -1e-7	4e-8 1 1e-8	1.53+7.88i
box	1.575e-7 0 -1e-7	4e-8 1 1e-8	1.53+7.88i
box	-1.675e-7 0 -1.1e-7	3e-8 1 1e-8	1.53+7.88i
box	1.675e-7 0 -1.1e-7	3e-8 1 1e-8	1.53+7.88i
box	0 0 1e-8	1.25e-7 1 1e-8	1
box	0 0 2e-8	1.15e-7 1 1e-8	1

box	0	0	3e-8	1.05e-7	1	1e-8	1
box	0	0	4e-8	9.5e-8	1	1e-8	1
box	0	0	5e-8	8e-8	1	1e-8	1
box	0	0	6e-8	6e-8	1	1e-8	1
box	0	0	7e-8	4e-8	1	1e-8	1
box	0	0	0	1.25e-7	1	1e-8	1

- 4) **Viewing Geometry:**
Click on the 'Edit/View Geometry' button in the 'FDTD Calculator – Main Window'. Under the 'VRML Viewer' click on the 'Write VRML File'. A VRML file of the designed geometry is saved in the newly created object folder. The designed geometry can be viewed by opening this VRML file. Cortona 3D viewer has to be downloaded to the computer from www.cortona3d.com/cortona to open the VRML file. Repeat step 4 for any desired changes to the geometry.
- 5) **Defining Fields:**
Click on 'Edit Excitations' in the 'FDTD Calculator – Main Window'. Choose the appropriate excitation source (point source or plane wave) and the boundary conditions (PML or PBC) for the model. For a brief introduction to boundary conditions refer to Chapter 3 in the FDTD User's Manual. Enter excitation parameters like field amplitude, direction and wavelength. Chapter 3 in the FDTD User's Manual provides a discussion about the excitation parameters. Once the EM excitation is completed click on the 'OK button.

For the slit design, the following parameters are used:

Excitation – Plane Wave with PBC

$\phi = 0$

$\theta = 0$ through 89 depending on the required angle of incidence

$\psi = 0$ for polarization parallel to the long axis of the slit and 90 for polarization orthogonal to the long axis of the slit.

$a = 1$

$\text{smoothT} = 500$

$\lambda = 6.58e-7$

- 6) **Defining Time Steps:**
In the 'FDTD Calculator – Main Window' enter the desired time step indices whose results are saved under 'Save Vector'. Chapter 3 in the FDTD User's Manual provides a discussion about 'Save Vector'. For the slit design time steps of 2189 and 2190 are saved. Once the EM excitation is completed click on the 'OK button

- 7) **Saving Definitions:**
Once the 'Edit/View Geometry', 'EM excitation' and 'Save Vector' are completed click on the 'Save Object' button and save the entire design in the object folder.

- 8) **Running Simulation:**
Click on the 'Calculation/View Results' button in the 'FDTD Calculator – Main Window'. Under the calculated tab, click on the 'GO!' button to perform the calculation. The progress of the calculation and estimated time are shown in the MATLAB command window. When the 'Simulation Done' entry appears on the MATLAB command window the calculation is completed.

- 9) **Viewing Results:**
After clicking the 'Calculation/View Results' button, click on the 'View Results' tab. Select the appropriate time step, viewing plane and the location of the plane orthogonal to the viewing plane and click 'GO'. The electric and magnetic field components along the three axis are shown in 6 separate windows. Chapter 4 in the FDTD User's Manual provides a discussion on viewing results.