# OmniSim Examples

Modelling
Small Ring Resonators

RingResonators.prj

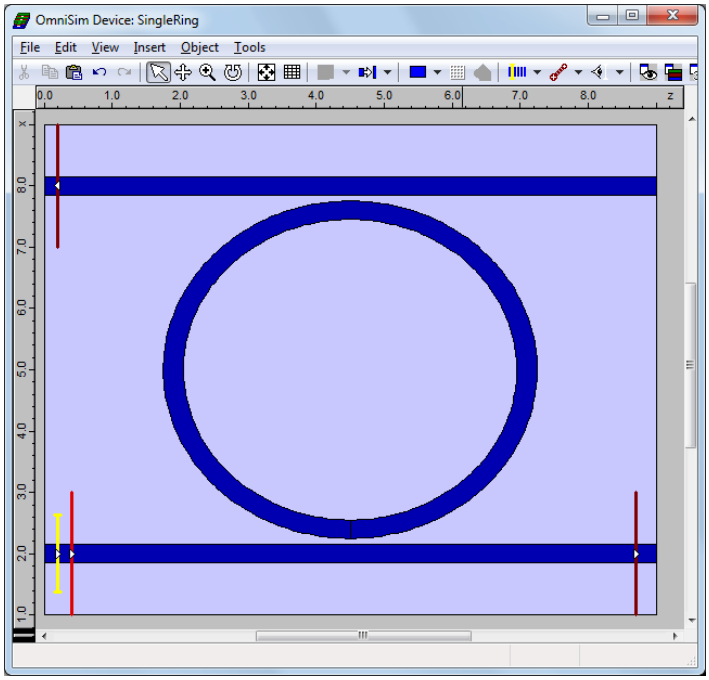
# Modelling Small Ring Resonators with OmniSim

## 1. Modelling a resonator with a single ring with the 2D FDTD Engine

In this first example we are going to use the 2D FDTD Engine to calculate the response of a ring resonator with a single ring and two diametrically opposed bus waveguides. FDTD stands for Finite Difference Time Domain.

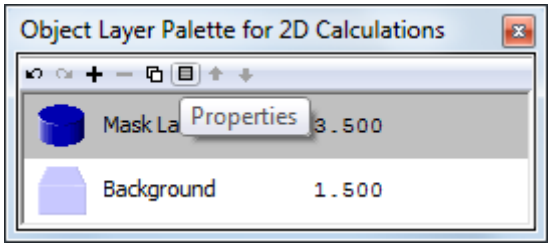
➢ Open the project RingResonators.prj in OmniSim and double-click on "Single Ring".

The OmniSim Device will open, showing you the layout of the ring resonator.




A single ring resonator with two bus waveguides designed in FIMMPROP

➢ Go to the menu and select /View/Object Layer Palette for 2D calculations.




This palette tells you how the structure is defined for 2D calculations. In this case the dark blue areas have a refractive index of 3.5 and the pale blue background has a refractive index of 1.5.

The yellow line is a mode excitor from which the fundamental TE mode of the bus waveguide will be launched as a temporal pulse. The red lines are sensors, which will monitor the field during the calculation. Near the excitor is "SensorInput", at the end of the same bus waveguide is "SensorThrough" and opposite in "SensorDrop".

We will now run a 2D FDTD calculation on this structure.

➢ Go to the menu and select /Tools/Calculator/FDTD Calculator…

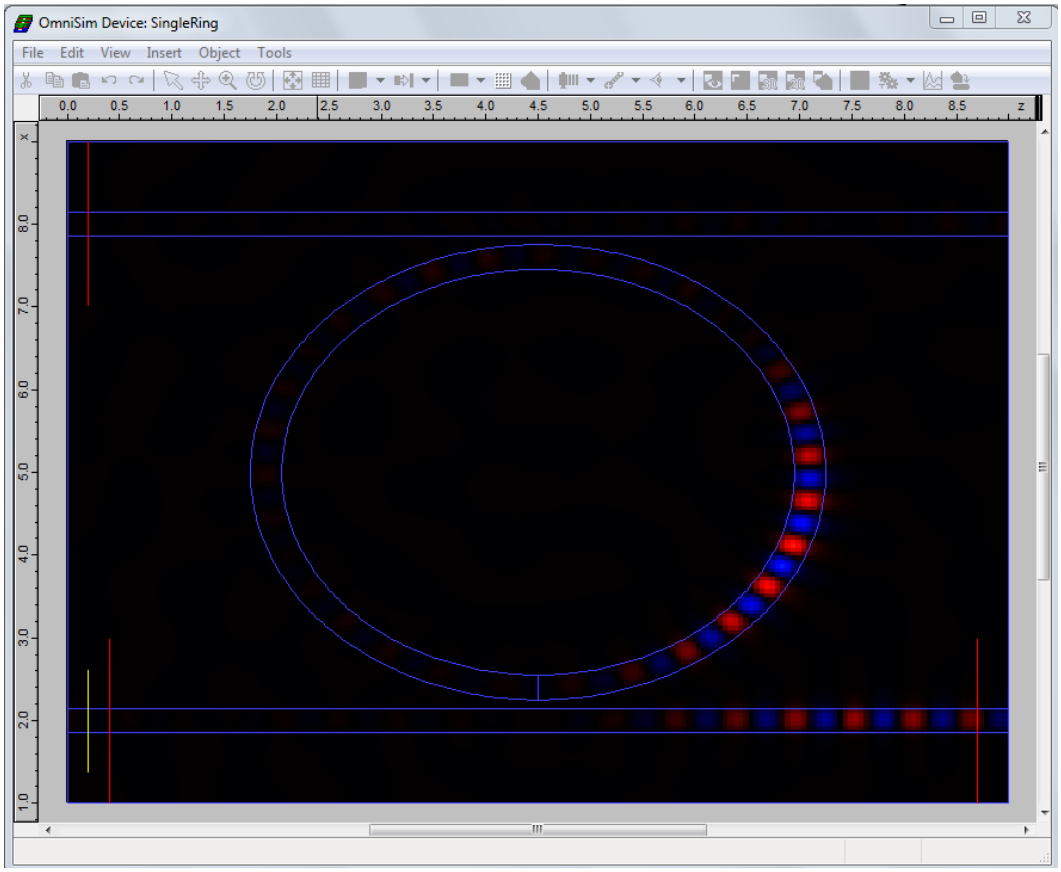
➢ If you are working on a computer with multiple CPU cores, go to the "SMP" or "Cluster/SMP" tab. Make sure that "SMP (No cluster)" is selected in the drop-down menu and select your computer in the

list, then click on the "+" button until it is disabled to add enable as many CPU cores as available for the calculation.

- Before starting the calculation, go to the "Controls" tab.

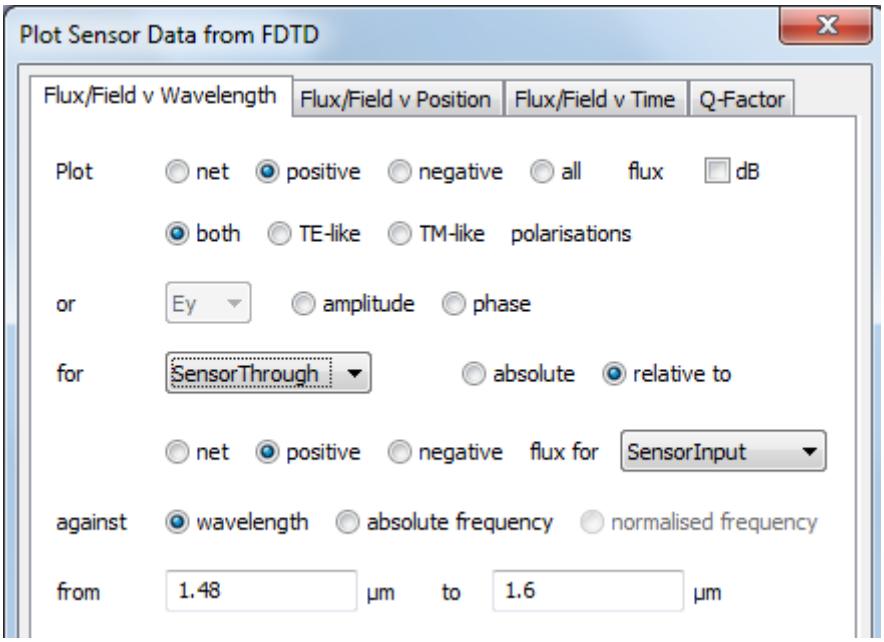
OmniSim allows you to plot the field and intensity evolving in the time domain during the calculation.

- Select "Show Hy every 256 steps".
- Click on **Calculate** to launch the FDTD calculation. The Hy field profile will be plotted every 256 steps, allowing you to see the pulse moving around the ring.



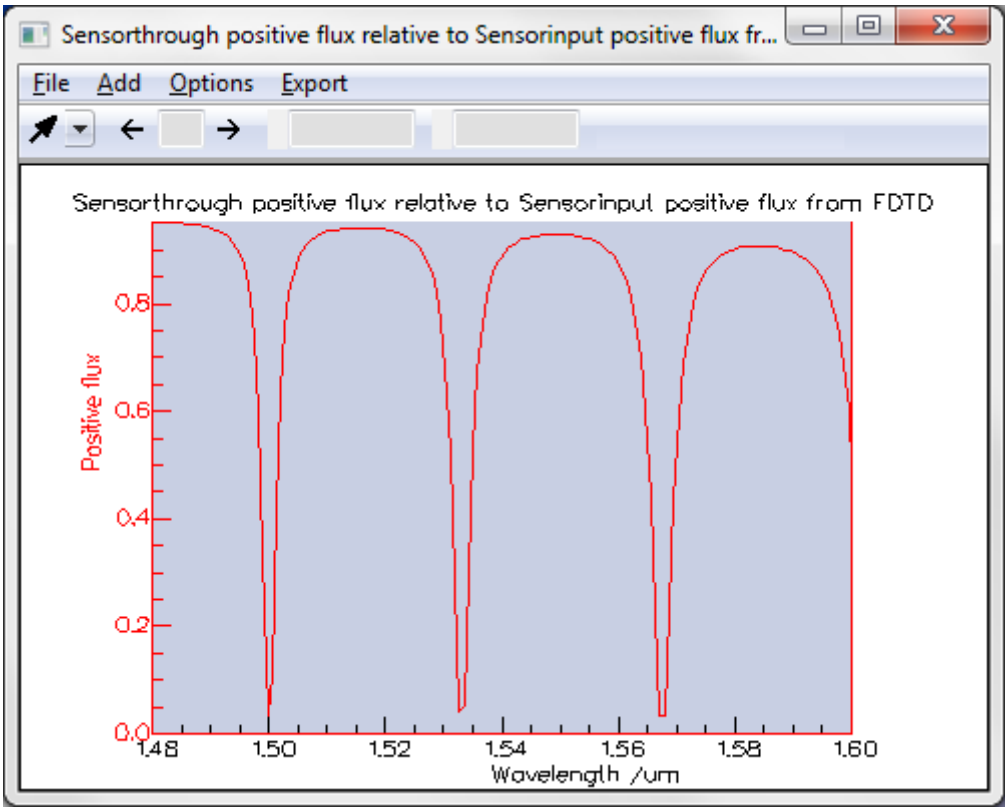

During the calculation you can select other field components or the intensity, adjust the brightness and the plotting rate. If you want to speed up the calculation you can set the plotting rate to "none". From this panel you can also easily record videos of your FDTD calculation.

- Once the calculation is complete, click on **Close**.
- In the OmniSim Device, go to the menu /Tools/Sensor/Plot Data…
- In the tab "Flux/Field v wavelength", select the "positive flux for both polarisations for SensorThrough relative to the positive flux for SensorInput against wavelength from 1.48 to 1.6um".

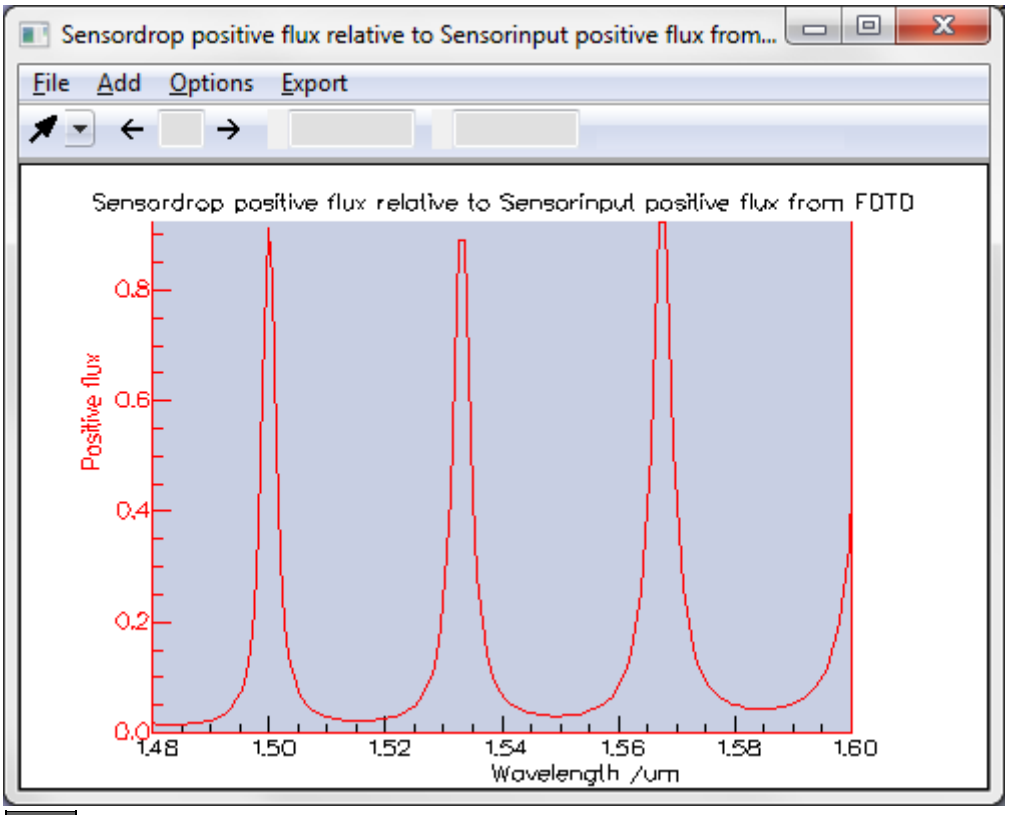



➢ Click on **Plot**.

The following plot will appear.




You can plot the same thing for the "SensorDrop":




- Click on **Close** and close the OmniSim Device window.

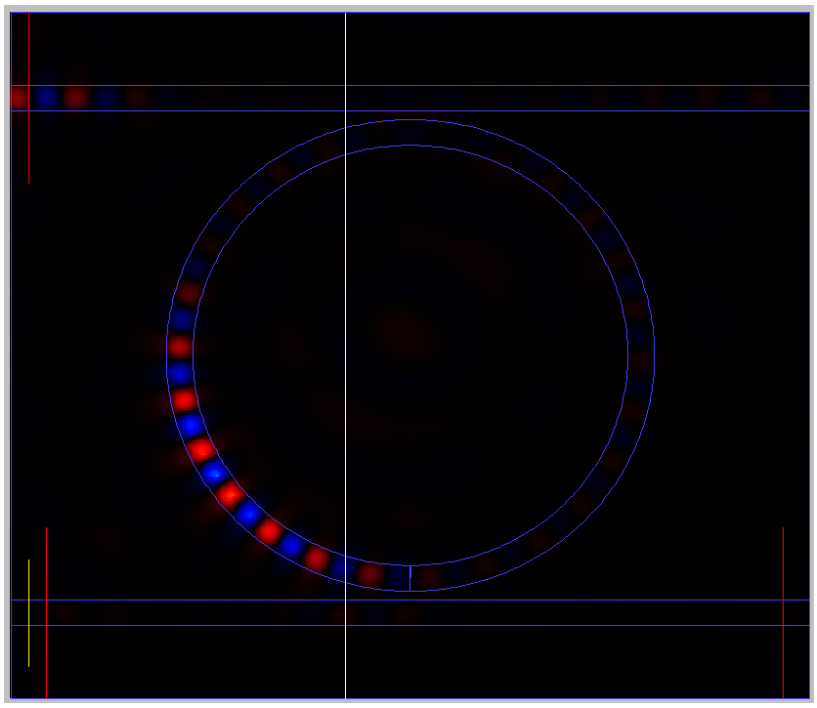
## 2. Modelling a resonator with a single ring with the 2D FETD Engine

Now we are going to use the 2D version of the FETD Engine – FETD stands for Finite Element Time Domain, and in 2D the method relies on a triangular mesh. FETD is generally slower than FDTD however it converges more quickly and can provide much more accurate results.

- In the Device "Single Ring", go to the menu and select /Tools/Calculator/FETD Calculator…
- If you are working on a computer with multiple CPU cores, go to the "SMP" or "Cluster/SMP" tab. Make sure that "SMP (No cluster)" is selected in the drop-down menu and select your computer in the list, then click on the "+" button until it is disabled to add enable as many CPU cores as available for the calculation.
- Before starting the calculation, go to the "Controls" tab.

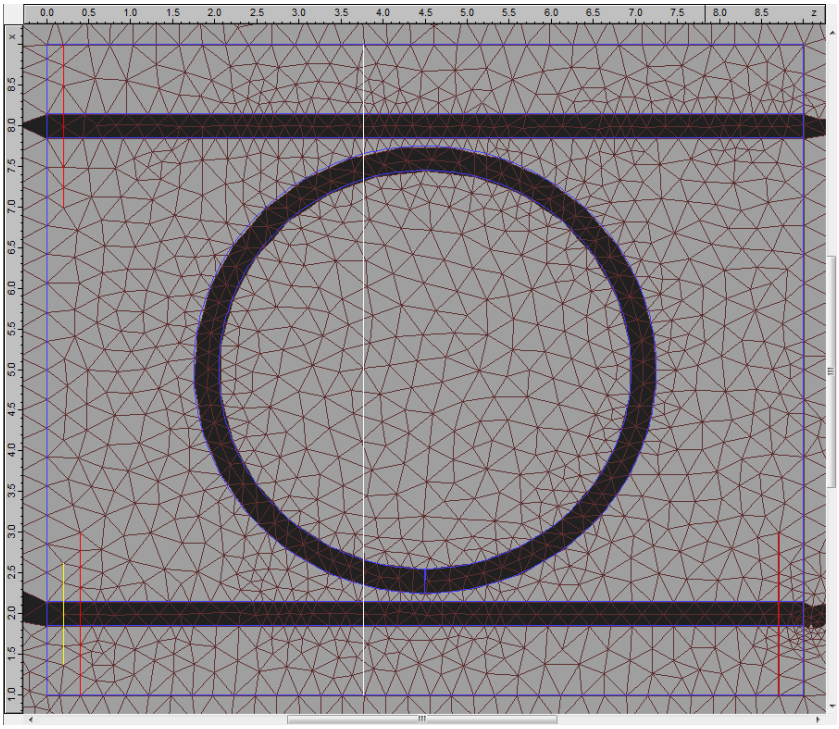
OmniSim allows you to plot the field and intensity evolving in the time domain during the calculation.

- Select "Show Hy every 256 steps", enable "bipolar", disable "show mesh" and set "plot factor resolution" to 4.0.
- Click on **Calculate** to launch the FETD calculation. The Hy field profile will be plotted every 256 steps, allowing you to see the pulse moving around the ring.



You can modify "plot resolution factor" to plot the fields more or less finely; setting this parameter to a small value will allow you to generate the plots more quickly.

- Click on RIX to display the refractive index distribution and the mesh.

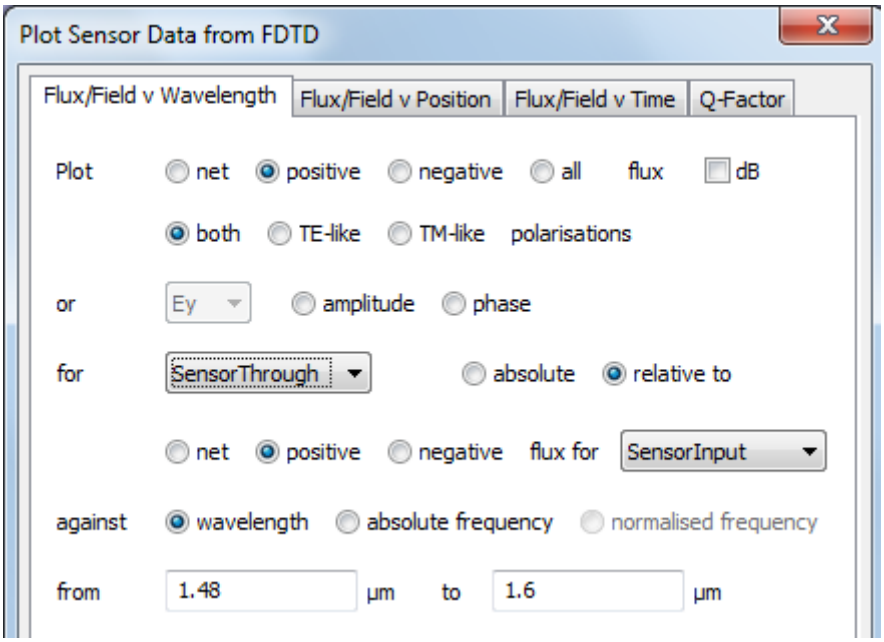


During the calculation you can select other field components or the intensity, adjust the brightness and the plotting rate. If you want to speed up the calculation you can set the plotting rate to "none" or display the RIX distribution. From this panel you can also easily record videos of your FETD calculation.

The calculation time is rather longer than FDTD so if you want you can click on **Stop** and skip the rest of this section, as it is very similar to what is done in the FDTD example.

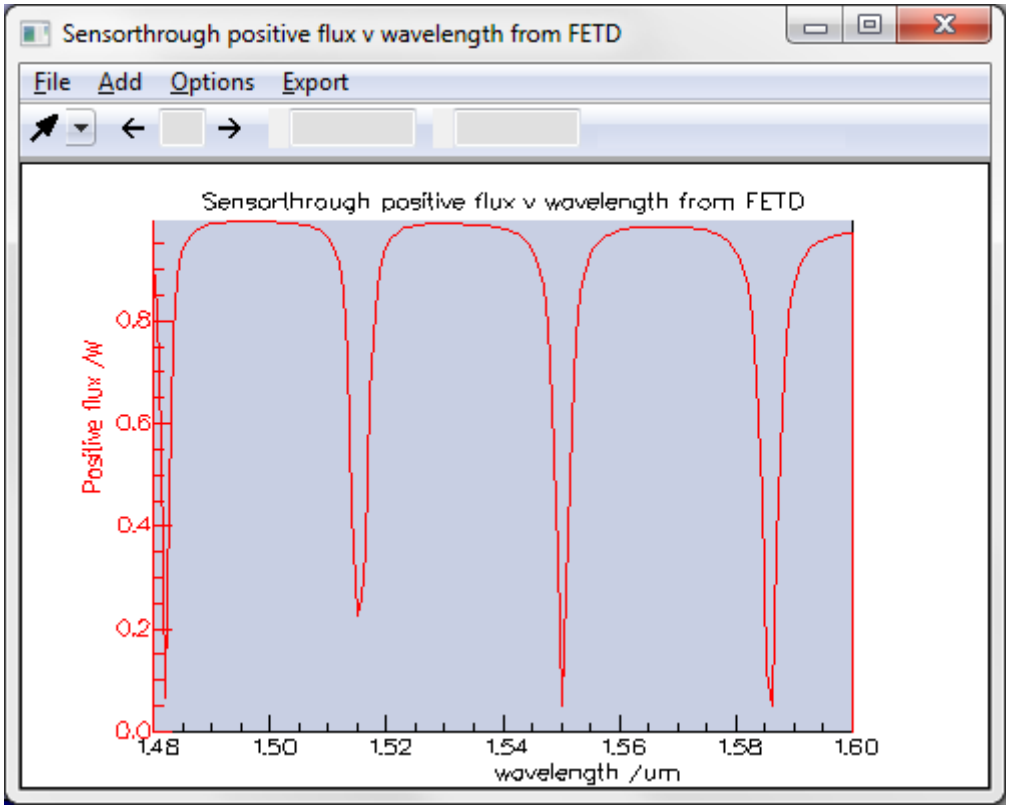
- Once the calculation is complete, click on **Close**.
- In the OmniSim Device, go to the menu /Tools/Sensor/Plot Data…

- In the tab "Flux/Field v wavelength", select the "positive flux for both polarisations for SensorThrough relative to the positive flux for SensorInput against wavelength from 1.48 to 1.6um".

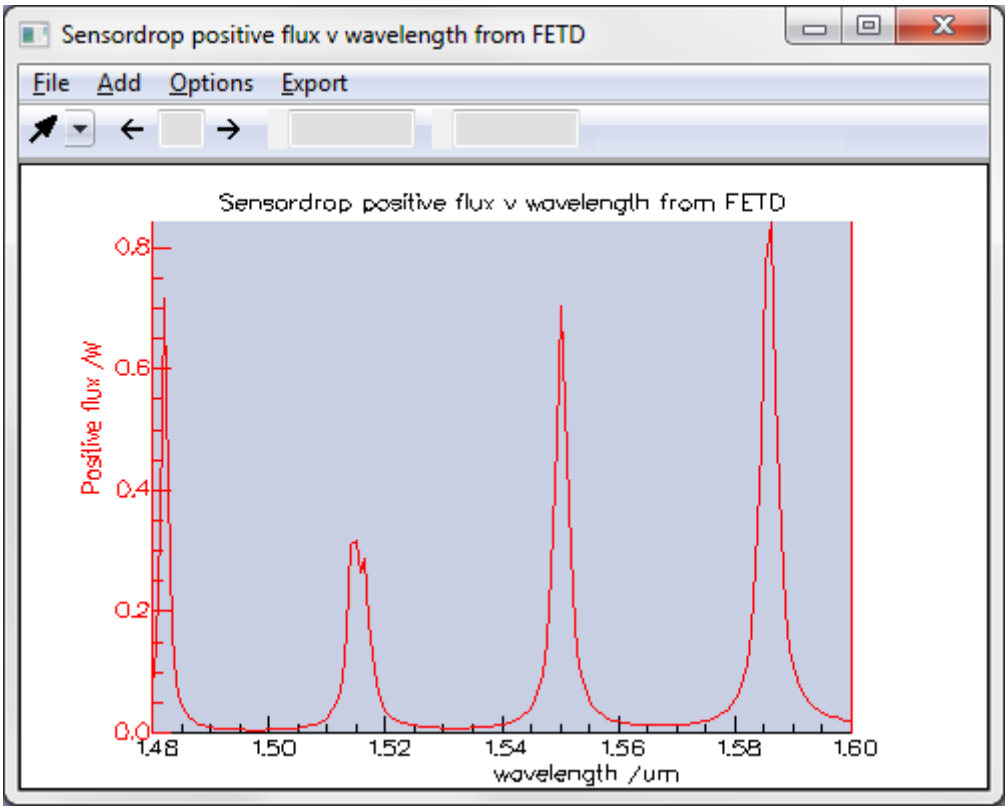



- Click on **Plot**.

The following plot will appear.




You can plot the same thing for the "SensorDrop":




➢ Click on Close and close the OmniSim Device window.

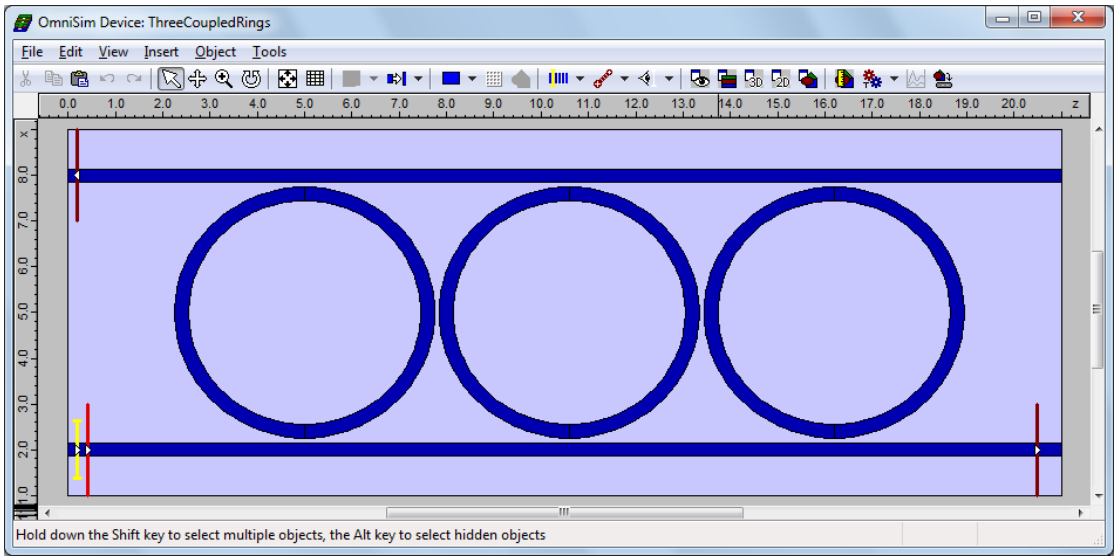
As you can see both FDTD and FETD Engines provide very similar results; the slight discrepancy between the two will disappear as you increase the resolution. You can use the FDTD Engine for fast initial calculations and then switch to the FETD Engine if higher accuracy is needed.

## 3. Modelling a resonator with a three rings with the 2D FEFD Engine

We will now use the OmniSim's 2D FEFD Engine (Finite-Element Frequency Domain) to model a structure with three coupled rings at a few wavelengths. Unlike the FDTD and FETD Engines the FEFD Engine is only available for 2D calculations. This is a frequency-domain engine, so we will only model one wavelength per calculation.

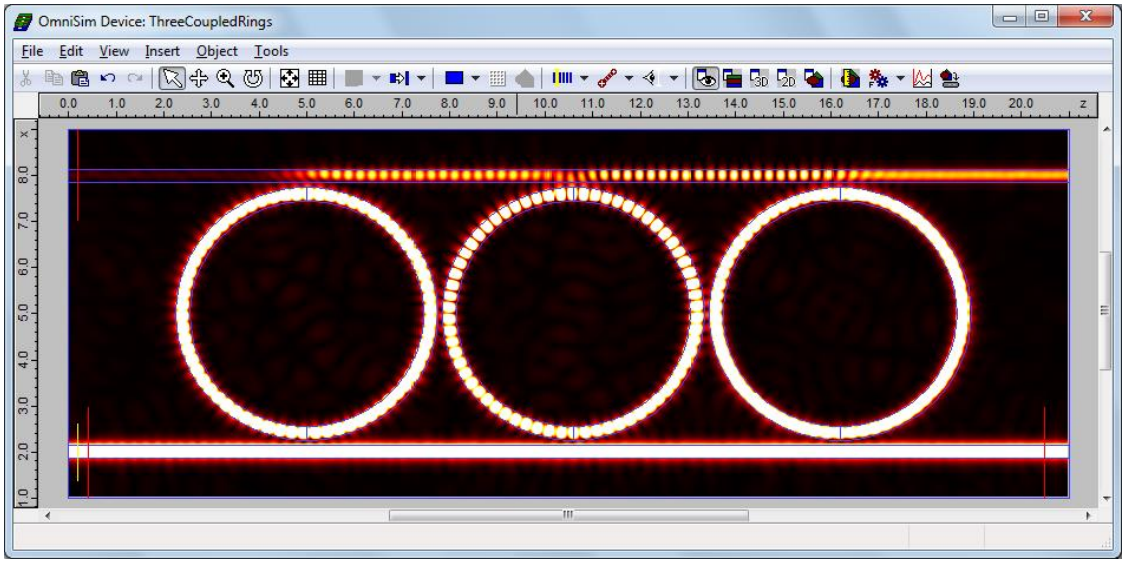
➢ In the project RingResonators.prj, double-click on "Three Coupled Rings".

The structure is very similar to the one with the single ring with two additional rings added to the resonator are now coupled together.




- Go to the menu and select /Tools/Calculator/FEFD Calculator…
- In the "Parameters" tab, set "Wavelength" to 1.40611um.
- In the "Controls" tab, select "Show Hy amplitude".
- Click **Calculate**.

The FEFD Engine is extremely fast and the Hy field should be displayed very quickly.

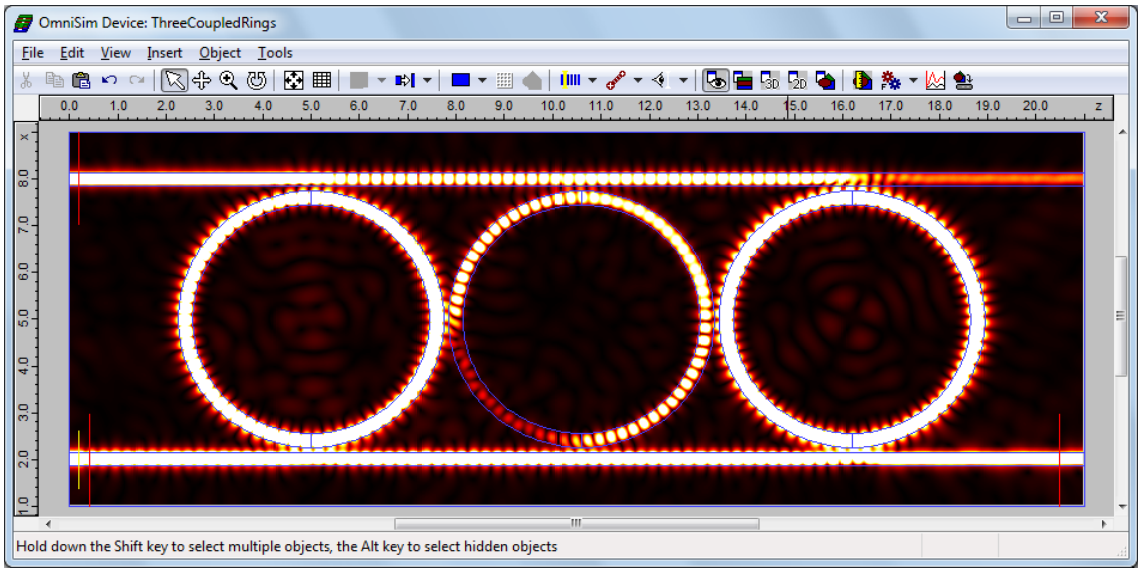



Hy field profile at 1.40611um

- Click **Close**.
- In the OmniSim Device, go to the menu /Tools/Sensor/Calculate Flux …
- Select the "positive flux for SensorThrough relative to the positive flux for SensorInput" and click **Calculate**.

The calculated transmission coefficient is 94%.

- Now perform the calculation for a wavelength of 1.41um. This time you should find that the flux is nearly equally split between SensorThrough and SensorDrop.




Hy field profile at 1.41um