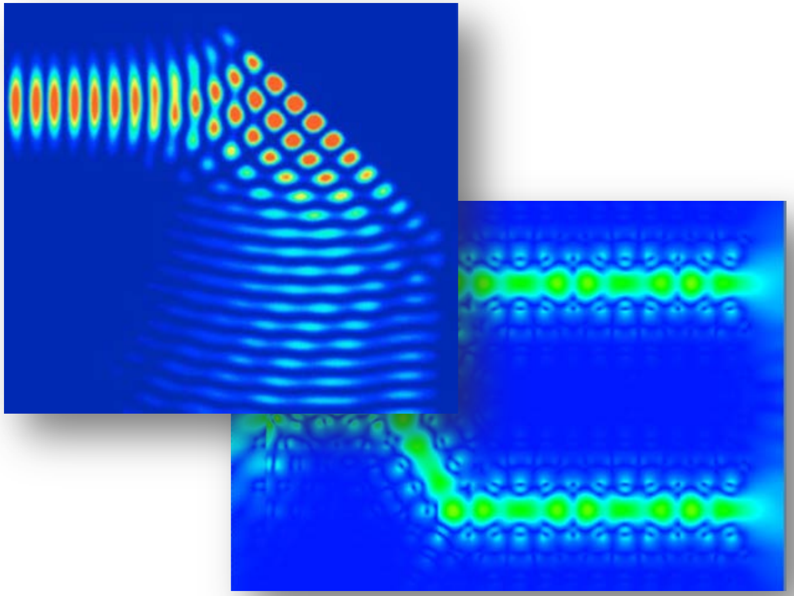

OptiFDTD applications:

Plasmonic waveguide filters with nanodisk resonators

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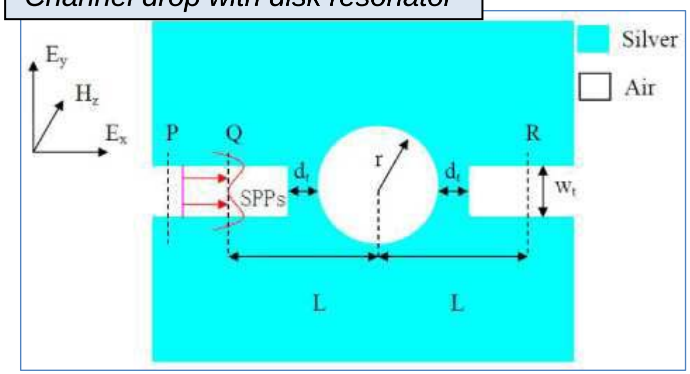
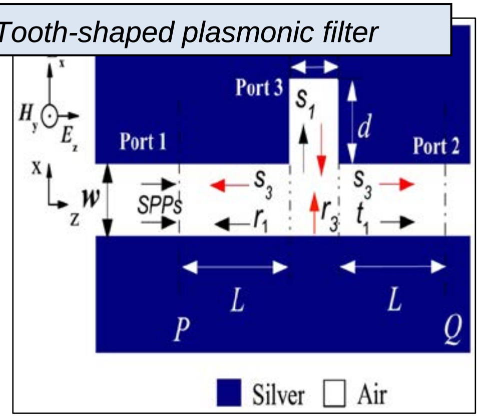
Introduction

- Surface plasmon polaritons (SPPs) are waves trapped on the surfaces of metals owing to the interaction between the free electrons in a metal and the electromagnetic field in a dielectric, and attenuating exponentially in the direction perpendicular to the interface. [1]
- Compared with insulator-metal-insulator (IMI) plasmonic waveguides, the metal-insulator-metal (MIM) waveguide exhibits a strong confinement of light and has an acceptable propagation length for SPPs. [1]
- There are many kinds of plasmonic waveguide filters: tooth-shaped plasmonic waveguide filters [2], channel drop filters with disk resonators [1], rectangular geometry resonators [3] and ring resonators [4].
- There exist two types of plasmonic filters in MIM waveguides, i.e., band-pass and band-stop filters. [1]

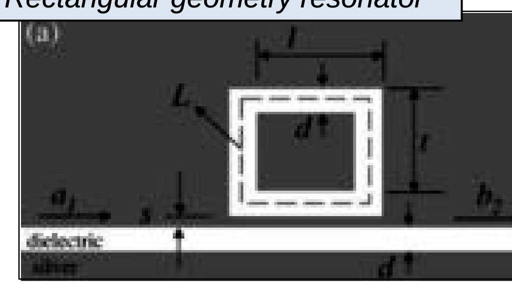
Channel drop with disk resonator



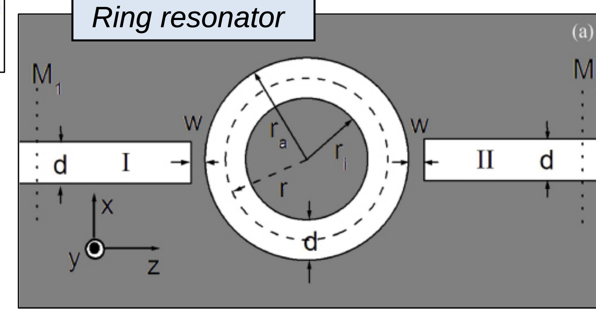
Tooth-shaped plasmonic filter



Rectangular geometry resonator



Ring resonator

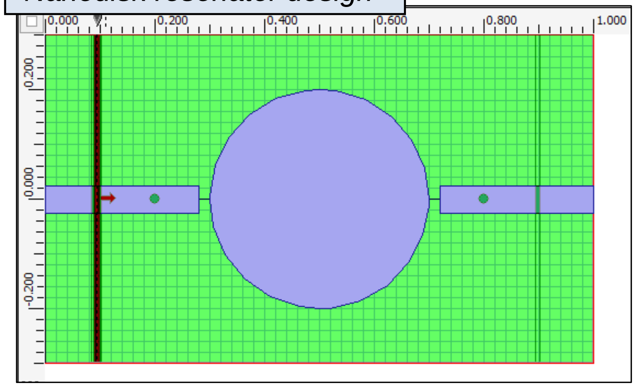


[1] Hua Lu, et al., "Tunable band-pass plasmonic waveguide filters with nanodisk resonators," Opt. Exp. VOL. 18, NO. 17, 17922-17927 (2010)
[2] X. S. Lin, et al., "Tooth-shaped plasmonic waveguide filters with nanometeric sizes," Opt. Lett. **33,** 2874-2876 (2008);
[3] A. Hosseini, et al., "Nanoscale surface Plasmon based resonator using rectangular geometry," Appl. Phys. Lett. 90(18), 181102 (2007).
[4] T. B. Wang, et al., "The transmission characteristics of surface plasmon polaritons in ring resonator," Opt. Express 17(26), 24096–24101 (2009).

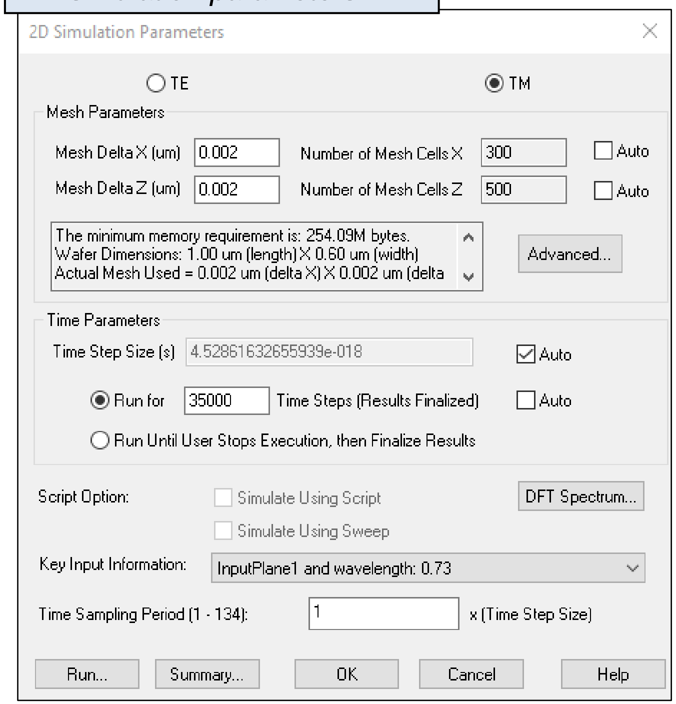
2D FDTD simulation

- TM polarized wave should be chosen to excite the SPPs.
- The Sine-Modulated Gaussian Pulse is used to obtain results over a range of wavelengths of interest.
- The input field transverse is set as a mode field profile (calculated using the mode solver)
- The mesh size should be small enough to study the SPPs.
- For resonators, the simulation time should be long enough to let the field in the time domain decay to a small value when pulse is used.
- The Lorentz – Drude model is used for the dispersion of Silver.

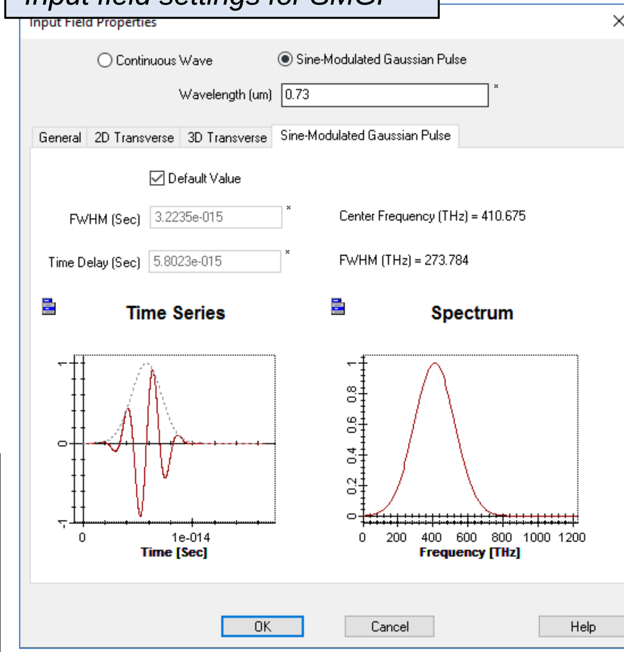
Nanodisk resonator design

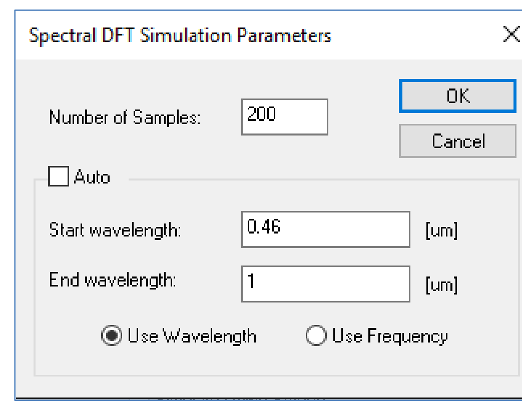


2D simulation parameters



Input field settings for SMGP





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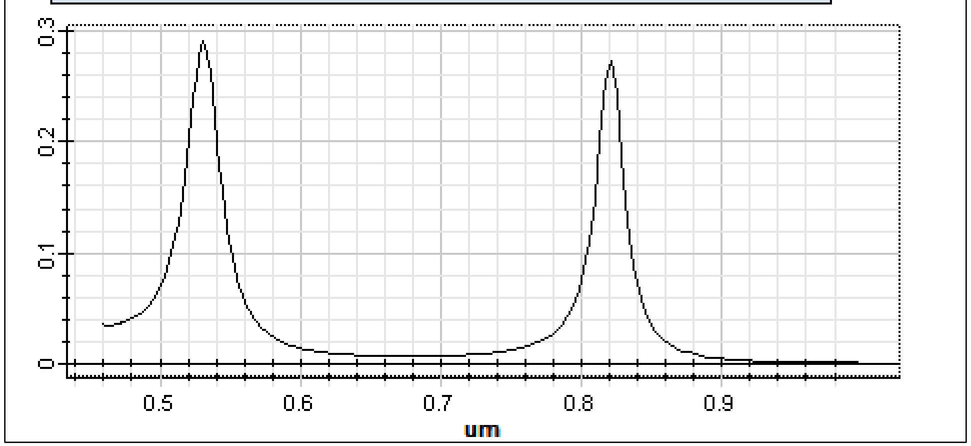
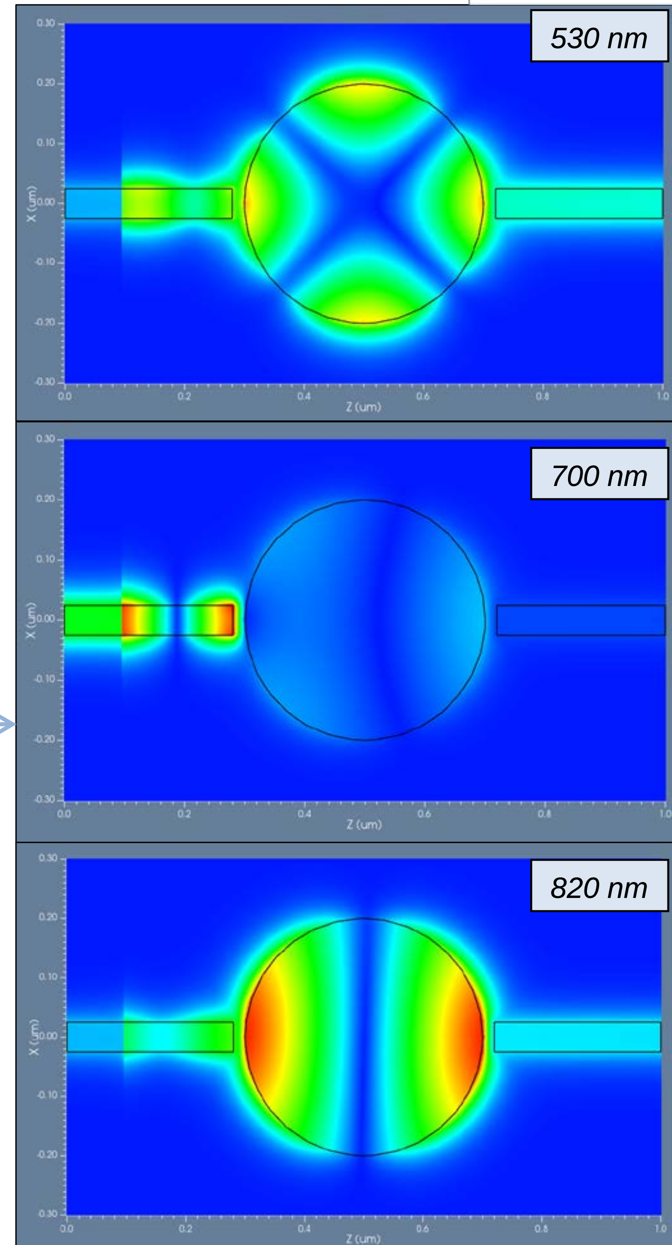
Simulation results

The power spectrum* from the output recorder normalized to the optical source. Two peaks** at wavelength 530 nm and 820 nm are shown.



Corresponding field profiles of **Hz** with wavelengths of 530 nm, 700nm, 820 nm, which exhibits the filtering characteristics.



*Note: From the power spectrum, obtained directly from OptiFDTD, the filter can be demonstrated. The transmission spectrum can also be calculated using the method shown in Ref 1.

**Note: The slight difference in the peak wavelengths (compared to reference) is due to the different metal model used.