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Wavelength Separation on Dielectric Interface Based on Angular and Lateral Displacement

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Introduction 1

- When Gaussian light beam is incident on a dielectric interface, it shifts from geometric optics predications. These shifts with planar or corrugated interfaces are known as non specular shifts which have been investigated by many researchers from the beginning of the last century till now [1]. Further, many applications based on these shifts have very interesting practical implementations [2].
- In this work, the Gaussian light beam wavelengths separation with planar or corrugated interfaces is studied using beam propagation method (BPM). It is found that the displacement for the reflected beams at planar interface is larger than the displacement at the transmitted beams. However, the separation in the transmitted beams in corrugated interface is larger than the reflected fields. Therefore, the suggested technique can separate the two wavelengths in different optical paths successfully. Additionally, the obtained results are in good agreement with the theoretical predictions and significant improvement over the previously published results [3-6].

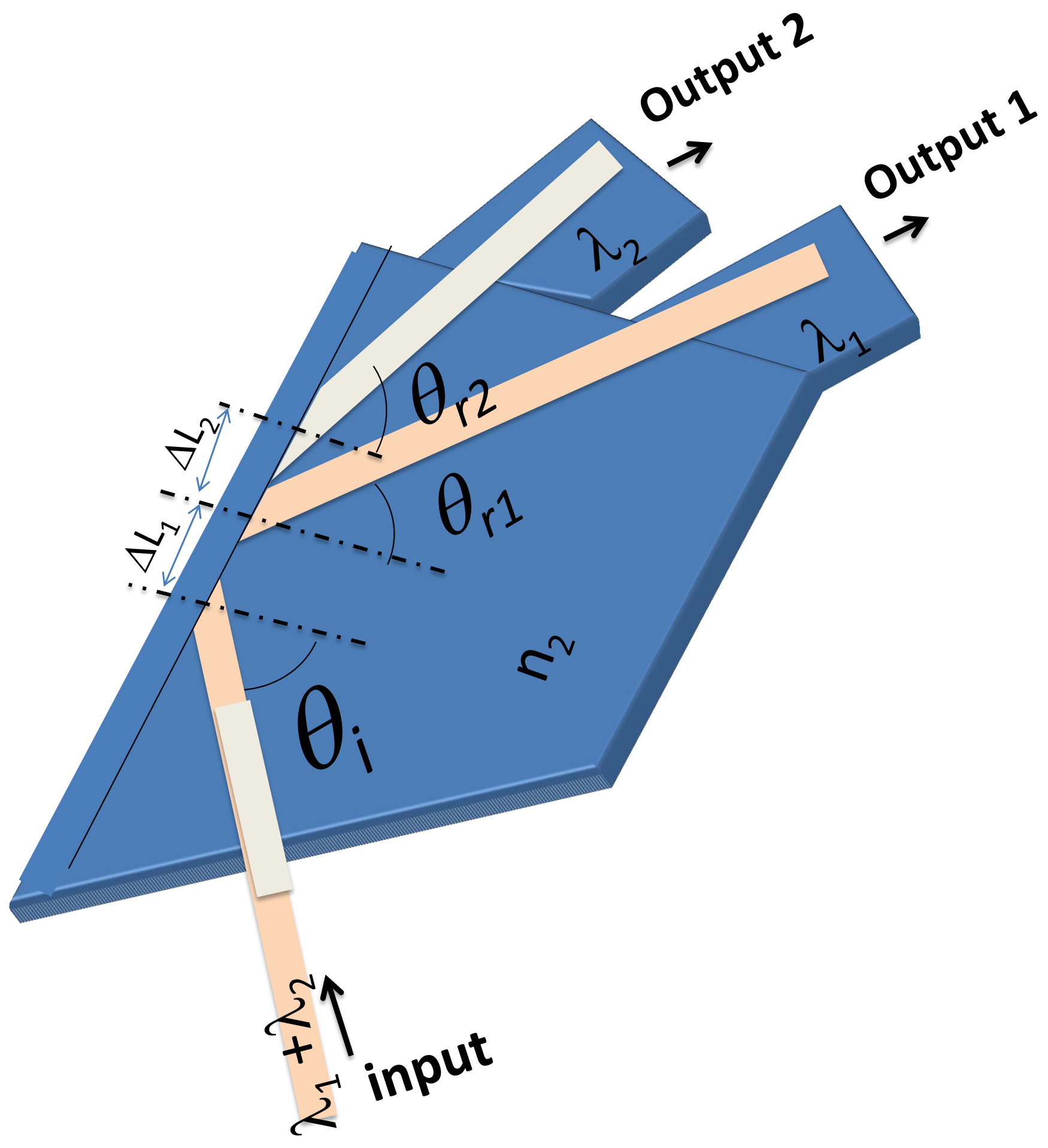

Fig. 1. Illustration of the considered dielectric waveguide. The incident light beam consists of two wavelengths λ_1 and λ_2. The output light beam is separated to two wavelengths due to lateral and angular shift at the dielectric interface., each one can guided to its own waveguide.

Design and Simulations 2

- The fast Fourier transform based beam propagation method (FFT-BPM) is used to simulate the proposed device [7].
- The input parameters are chosen as: n_2 = 1.94 and surrounded by air (Fused Quartz-air interface).
- The lunching beam wavelengths in free space are λ_1=1.33 µm and λ_2=1.55 µm.

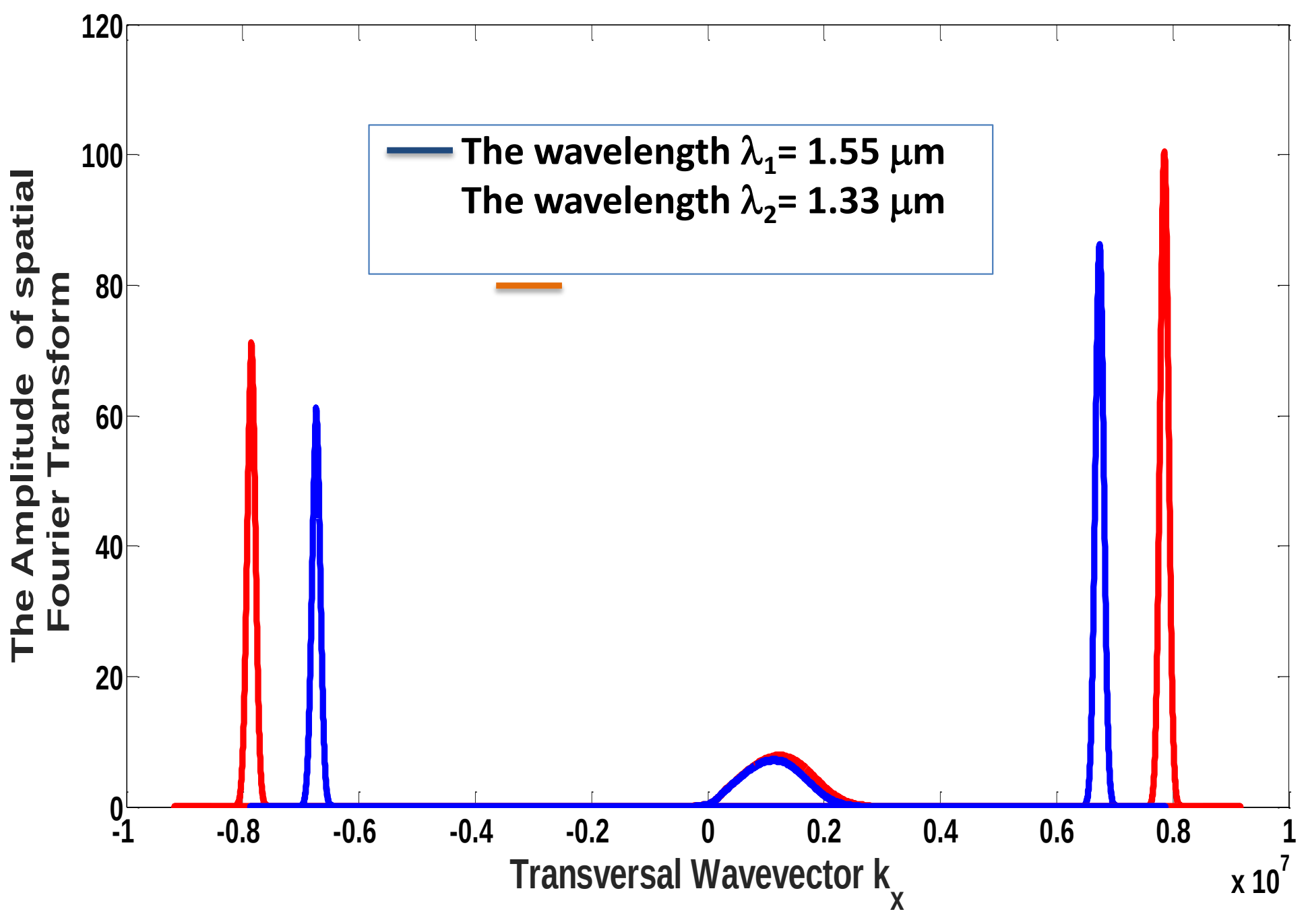

Fig. 2: The input field and output field spectrums containing the two wavelengths 1.55 µm and 1.33 µm.

In planar interface case.

- As shown in Fig. 2, the locations of the two wave vectors are located at k_{xi_1} = 6.739 µm^{-1} and at $k_{xi\ 2}$= 7.854 µm$^{-1.}$
- The calculated values for the wave vectors are matched with input simulated spectrum.
- Figure 3 shows the total output field at the two wavelengths.
- The beam peak is separated into two peaks at different wavelengths. This separation increases as the propagation distance increases.
- The separation for the reflected beams is greater than the separation of the transmitted ones.
- The separated beams can be guided into different paths (like optical fiber or other waveguide).

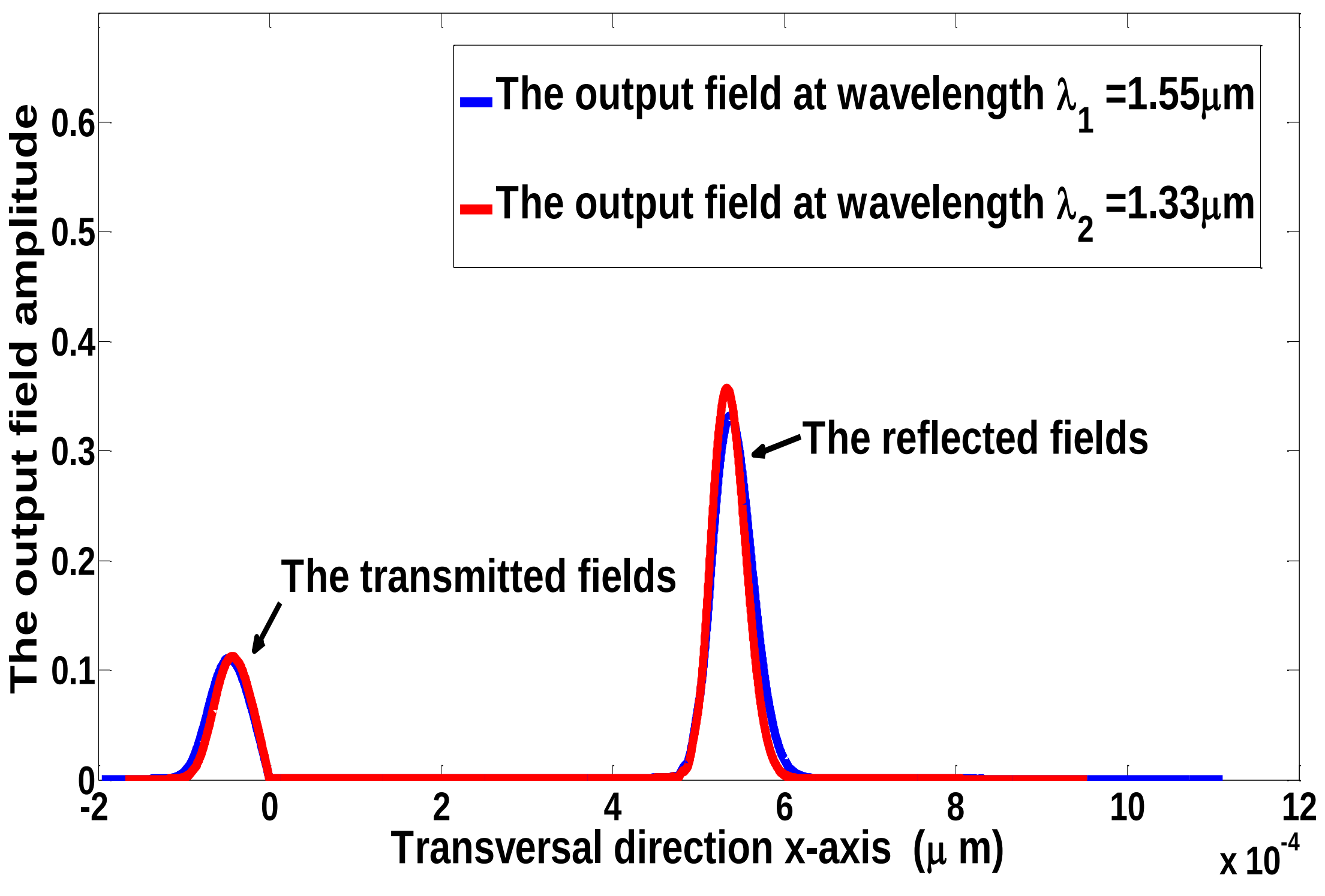

Fig. 3: The total output field, show separation between two Gaussian beams at wavelengths 1.55 µm and 1.33 µm at planar interface.

In corrugated interface case.

- The corrugation is square wave pitch, each pitch depth is 30 µm and pitch depth is 60 µm.
- Figure 4 reveals the total output field at the two wavelengths, as shown the Gaussian beam peaks are separated by a distance.
- The separation increased as the propagation distance is increased.
- The total transmitted and reflected fields can be controlled by adapting the corrugation pitch depth and width.

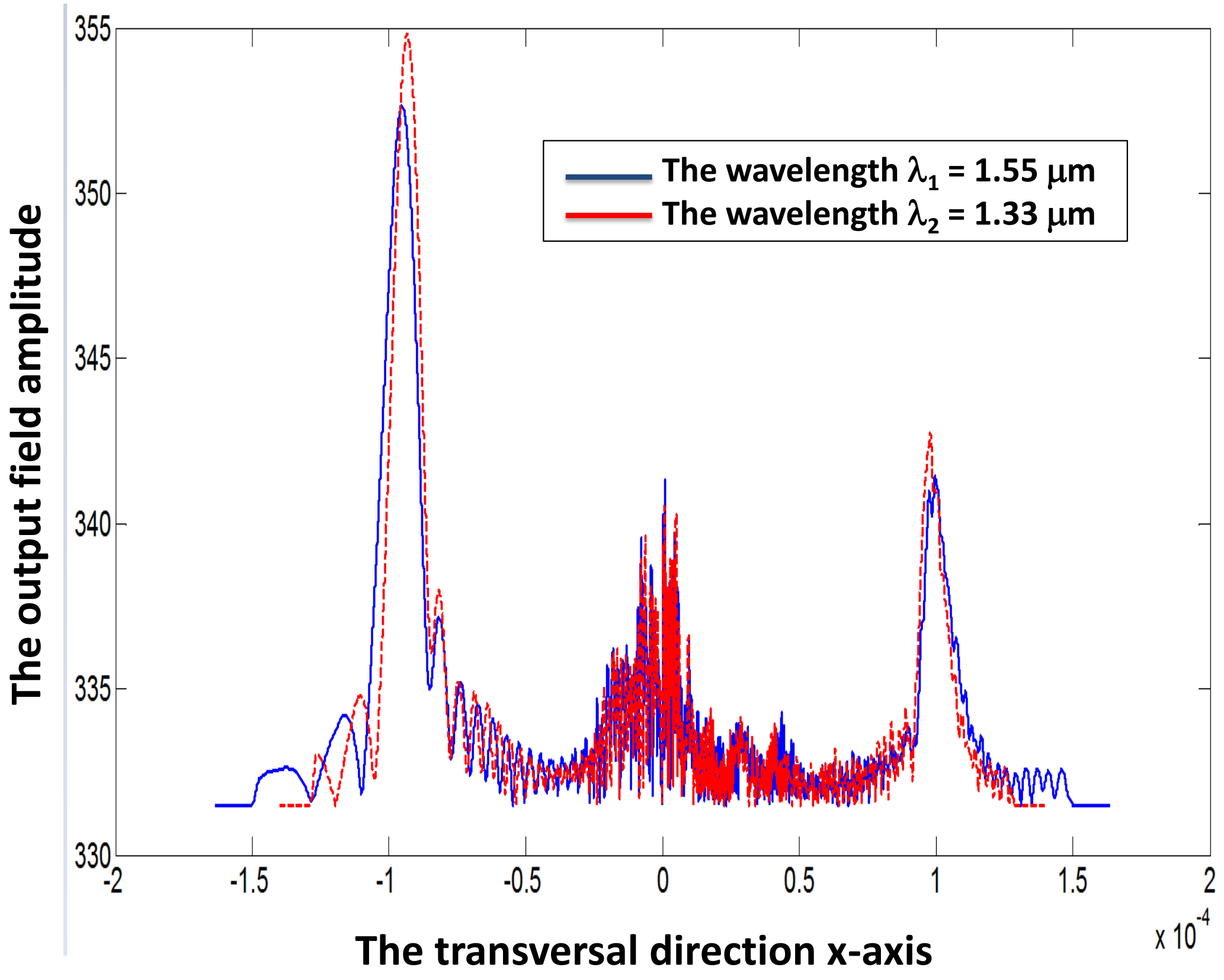

Fig.4: The total output field, show separation between two Gaussian beams at wavelengths 1.55 µm and 1.33 µm at corrugated interface.

- Figure 5 gives the output spectrum for the total field, The reflected spectrums are located at $k_{xr\ 1}$ = - 6.735 µm^{-1} and at $k_{xr\ 2}$ = -7.864 µm^{-1}.
- The transmitted spectrum is located at $k_{xt\ 1}$ = - 6.735 µm^{-1} and at $k_{xt\ 2}$ = -7.822 µm^{-1}.

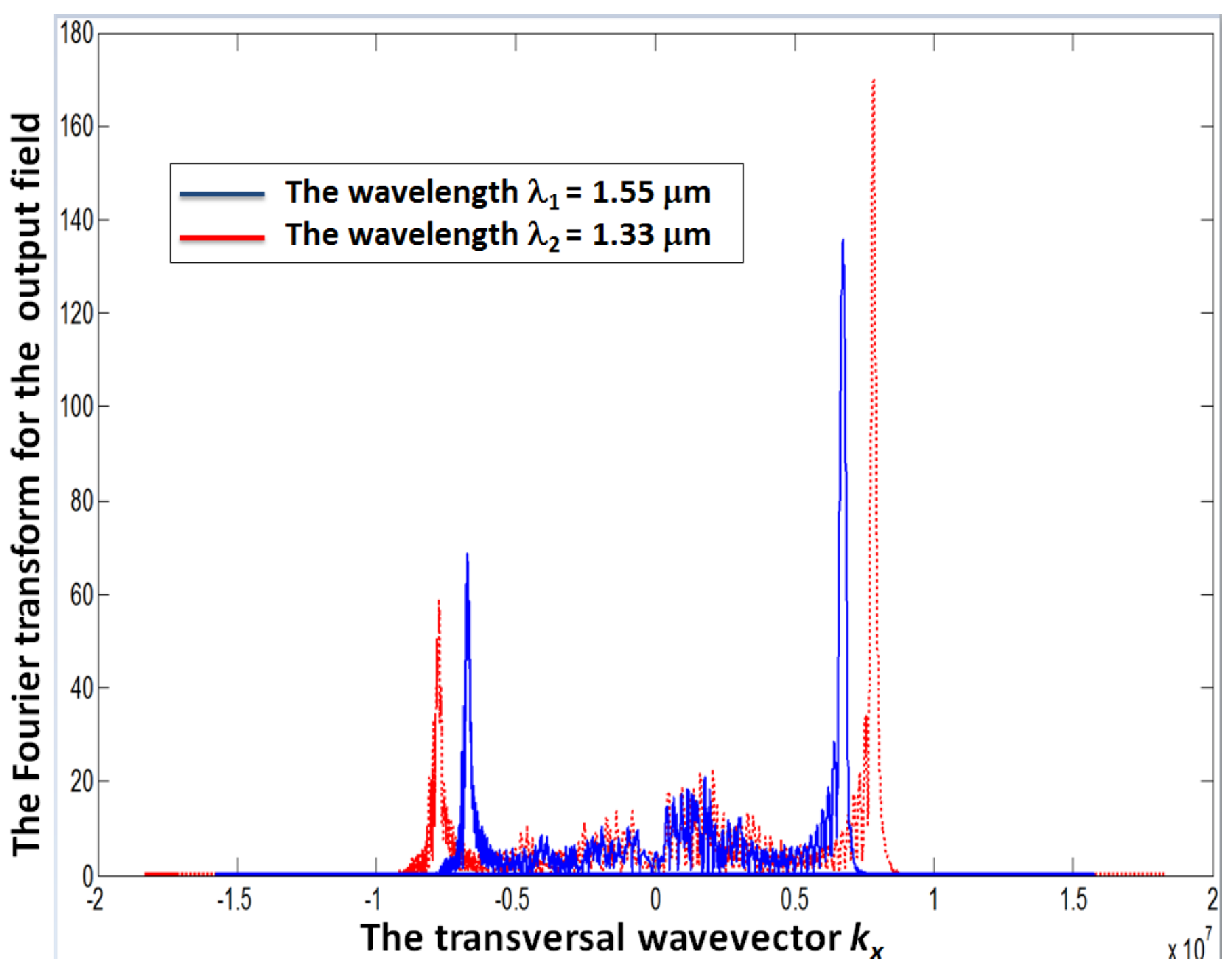

Fig. 5: The total output field spectrum at corrugated interface.

Conclusion 3

This analysis describes the wavelength separation of the Gaussian light beam based on the non specular shifts from the dielectric interfaces. The discussion at different interfaces (planar and corrugated dielectric interfaces) between two homogenous media is presented. The BPM results are matched well with the theory of the non-specular phenomena of the electromagnetic field interaction on a dielectric interface. It is found that the displacement for the reflected beams at planar interface is larger than the displacement at the transmitted beams. However, in corrugated interface, the separation in the transmitted beams is larger than the reflected fields. Hence it can separate the two wavelengths and each one can be guided to its own path like optical fiber.

References 4

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