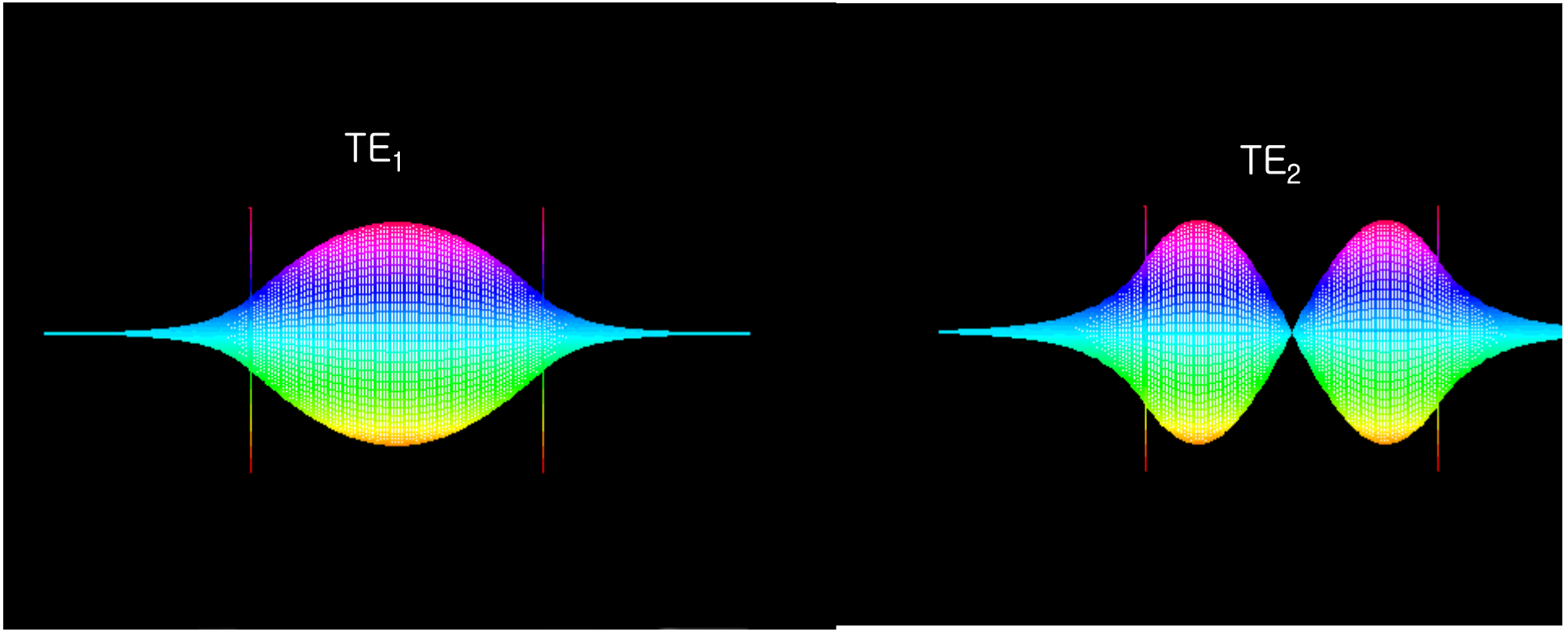
Lect. 13: Dielectric Waveguide (2)

E(y) profile: n_1=1.5, n_2=1.495, d=10μm, λ=1μm



Lect. 13: Dielectric Waveguide (2)

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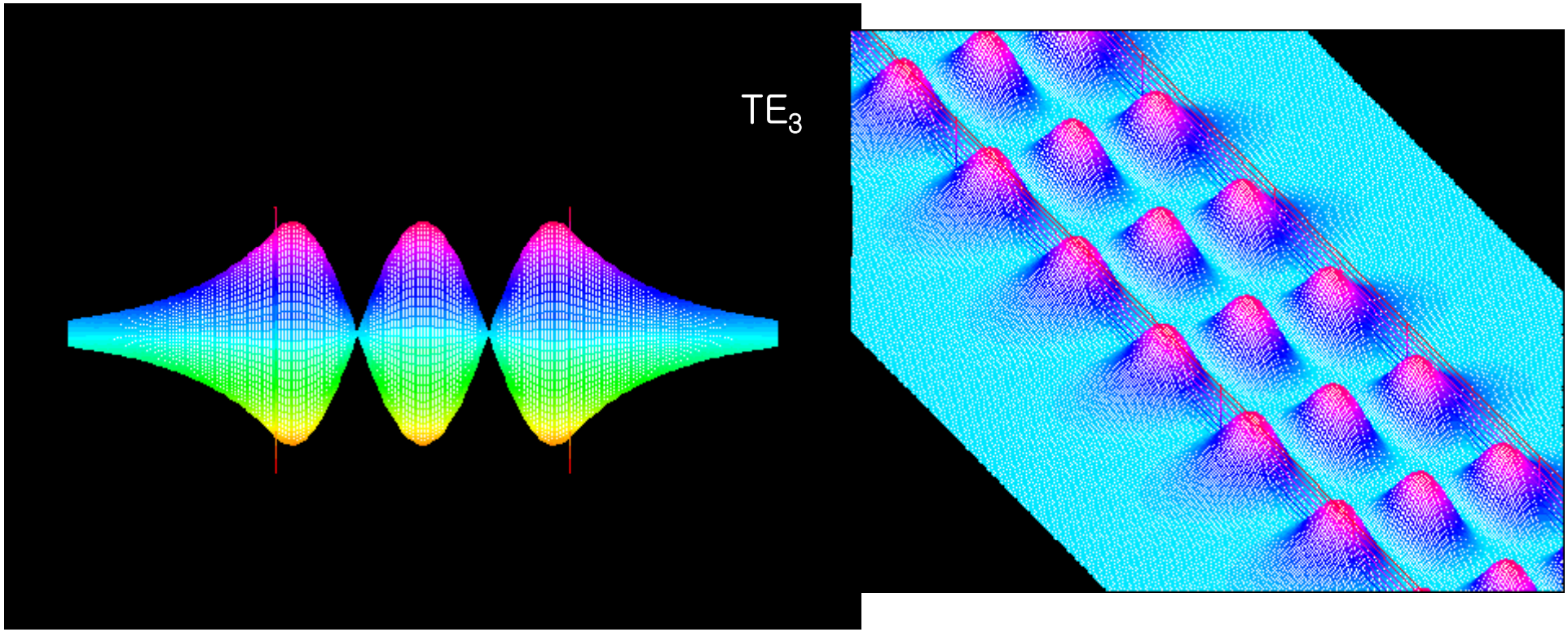


Lect. 13: Dielectric Waveguide (2)

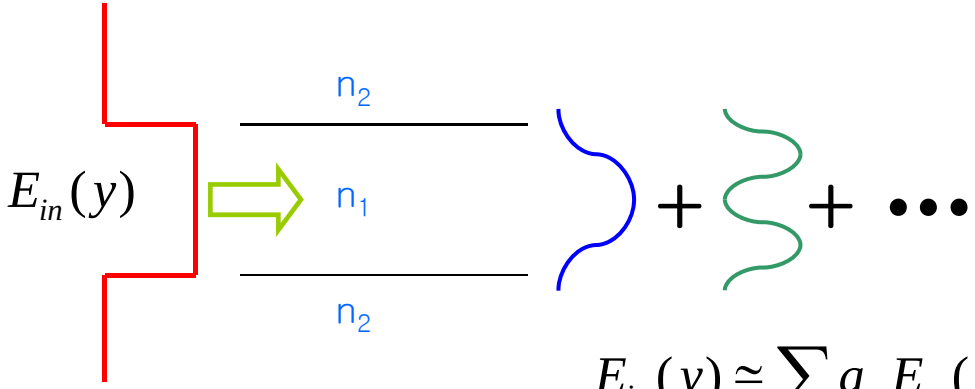
Wave is not entirely confined within core: Confinement factor

$$\Gamma = \frac{\text{Power inside core}}{\text{Total Power}} = \frac{\int_{y=-\frac{d}{2}}^{y=\frac{d}{2}} |E(y)|^2 \, dy}{\int_{y=-\infty}^{y=\infty} |E(y)|^2 \, dy}$$

For higher modes, how does Γ change?

Lect. 13: Dielectric Waveguide (2)

Partitioning of input field into different guided modes.



$$E_{in}(y) \cong \sum_m a_m E_m(y)$$

For a_m, use the fact that $E_m(y)$'s are orthogonal.

$$\int E_{in}(y)E_m(y)dy \approx \int \sum_n a_n E_n(y) \cdot E_m(y)dy$$

$$= \int a_m {E_m}^2(y)dy$$

$$\therefore a_m = \frac{\int E_{in}(y)E_m(y)dy}{\int {E_m}^2(y)dy}$$

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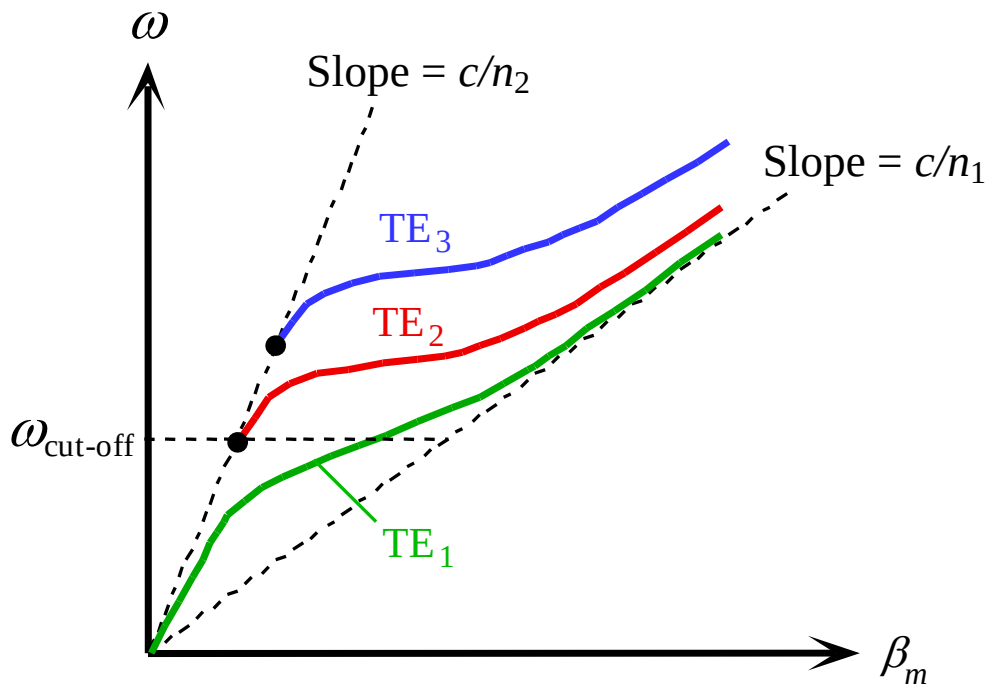
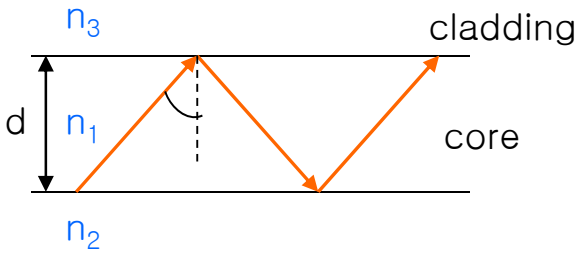


Group velocities are different for different modes => modal dispersion
Need a single-mode waveguide in order to avoid signal distortion.
How do you design a single mode waveguide?

Lect. 13: Dielectric Waveguide (2)



$$V = k_0 d (n_1^2 - n_2^2)^{1/2}$$

(Normalized k)

$$b = \frac{\left(\beta / k_0\right)^2 - n_2^2}{n_1^2 - n_2^2}$$

(Normalized β)

$$a = \frac{n_2^2 - n_3^2}{n_1^2 - n_2^2}$$

(Asymmetry factor)

b–V diagram for TE mode