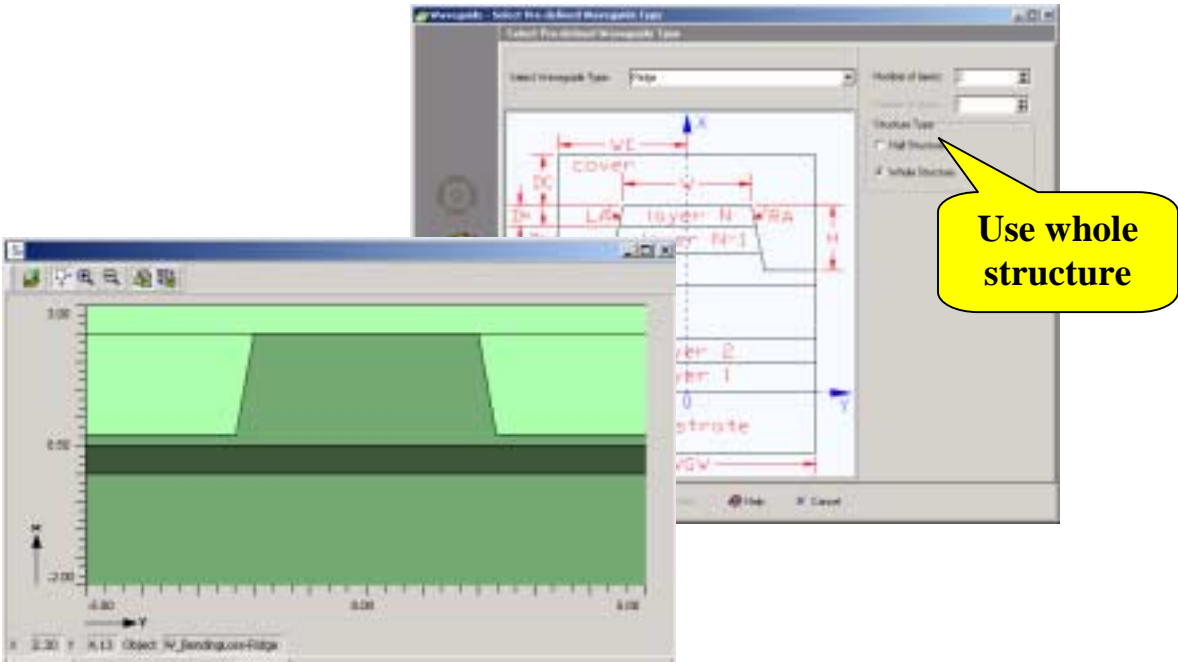


# Bending Loss Calculation

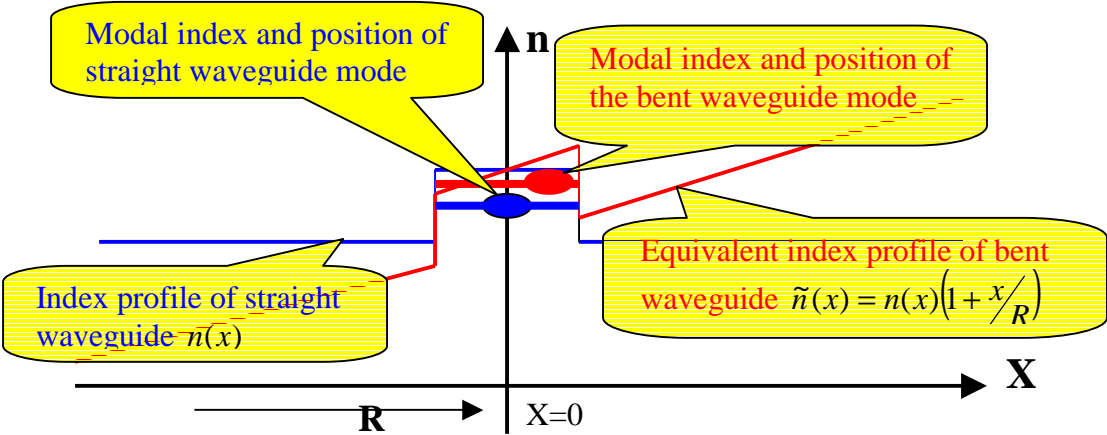
## Setup

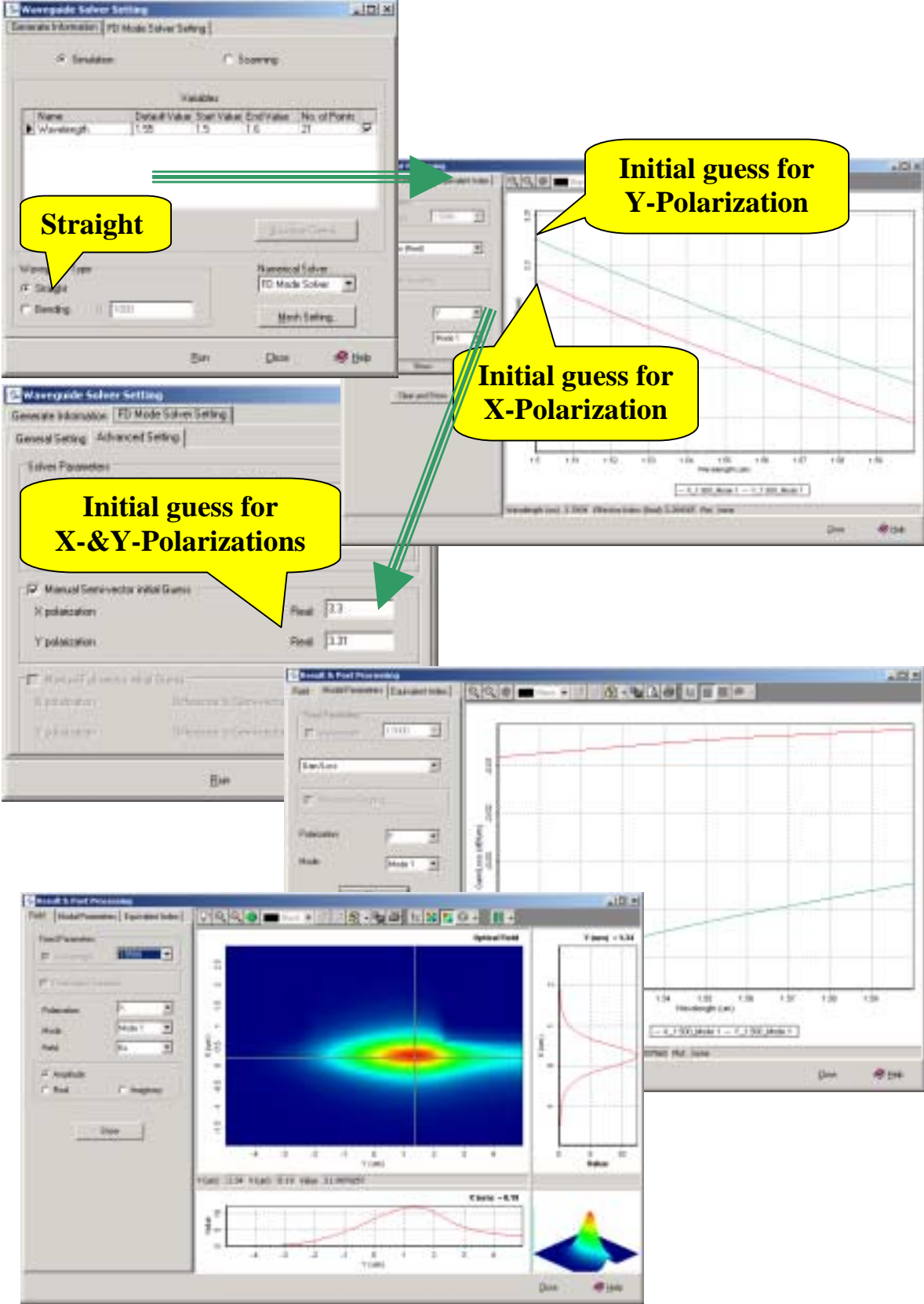
The bending mode of any waveguide structure can be calculated in APSS waveguide. The bend breaks the symmetry of the waveguide and the half structure advantage cannot be taken in bending mode calculation.



## Initial Guess

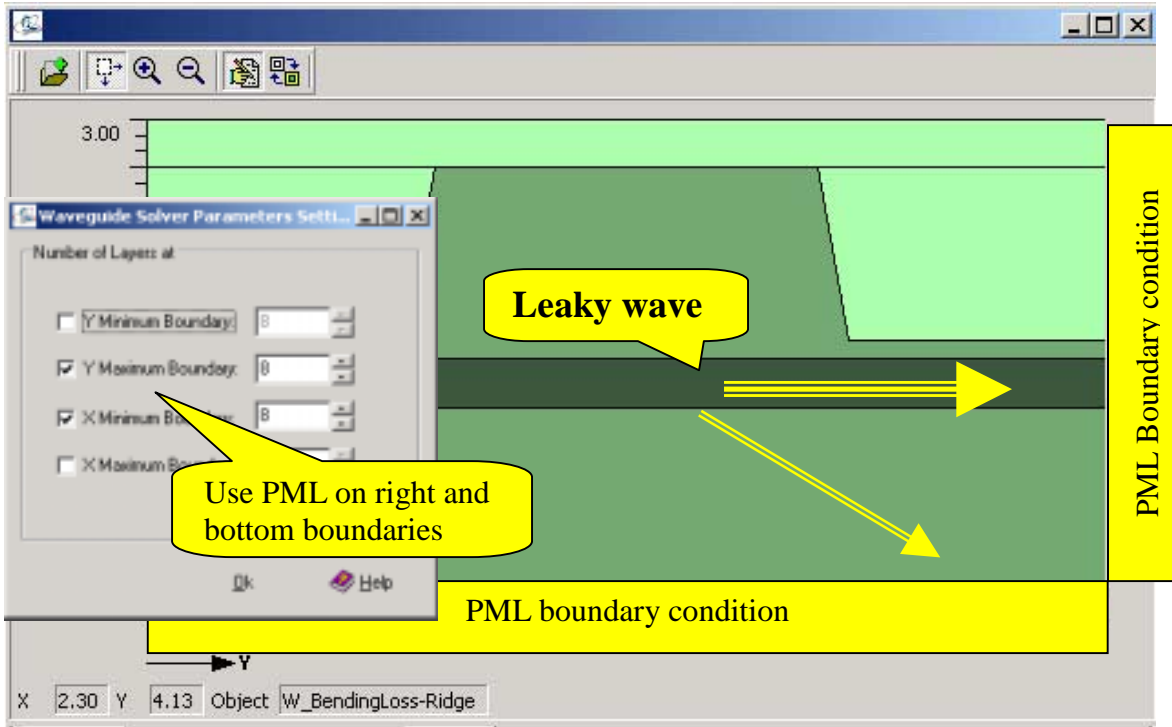
In general, the effective index of the bent mode is slightly higher than the corresponding straight waveguide mode as shown below for a 2D slab waveguide. Therefore, we can Use the effective indices of the straight waveguide mode as initial guesses for bending mode.





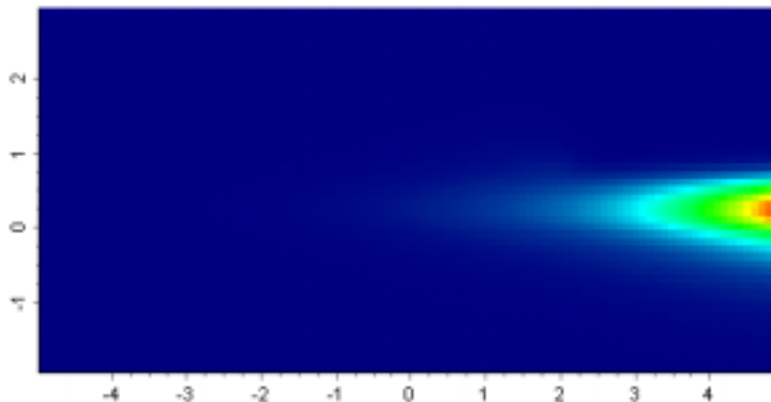
## PML boundary condition

Since the bent center is on the left, the leaky wave mainly propagates towards right. Therefore, right boundary must be PML, and no use of PML on the right side. Some waveguide may also leak into the substrate and bottom, therefore in some cases PML is necessary at the bottom of the structure.



## Lower initial guess

Mode in PML region does appear if the initial guess is too high since the equivalent index of bent waveguide ( $\tilde{n}(x) = n(x)\left(1 + \frac{x}{R}\right)$ ) is higher on the right side, sometimes even higher than the core if R is too small.



## Search for the minimum banding Radius

The bent mode evolves gradually as the bend increase. Therefore, start from larger radius and gradually reduce the radius by using the previous effective indices as the initial guesses for the next calculation is a safer way to obtain the correct bending mode.

