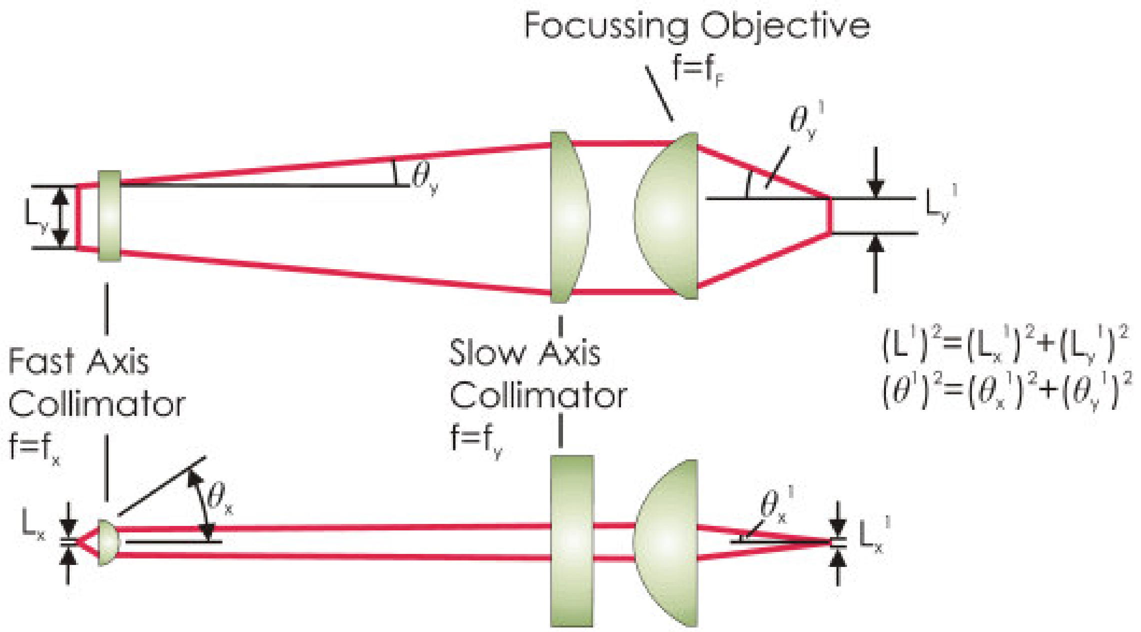
Coupling high-power laser diodes (HPLD) into fibres by beam transformation

Typically, HPLD's exhibit disparate angular distributions of emission with the "fast axis" diverging at about 3 times that of the "slow axis" independent of the length of the emitting junction. To optimally fill the NA of a fibre, this disparity should be eliminated. This is done by beam transformation via anamorphic means eg a symmetric collimator with a prism pair or cylindrical telescope. This approach , however, is limited to anamorphic ratios less than 10:1, typically 4:1. However, if an "aspheric cylinder" lens is used as collimator for the "fast" axis, it is quite easy to achieve anamorphic ratios in excess of 25:1.



Referring to the figure, the following relations can be written down :

$$(L')^2 = (f_F/f_X)^2.[(L_X)^2 + (L_Y/M)^2] \quad \& \quad (\theta')^2 = (f_X/f_F)^2.[(\theta_X)^2 + (M.\theta_Y)^2]$$

where "x" and "y" refer to the "fast" and "slow" axes of the laser diode, and M = fY/fX is the anamorphic ratio. Re-arranging these and assuming that θX /θY <<M<<LY/LX yields :

$$L'.\theta' \cong L_Y.\theta_Y.[1 + (\theta_X/(M.\theta_Y))^2]^{1/2} \quad \text{i.e.} \quad L'.\theta' \cong L_Y.\theta_Y$$

θX is typically 0.25-0.4 and θY lies between 0.07-0.10, their ratio being< 6. For low anamorphic ratios, (θX/(M.θY))≅1, the coupling is poor. This is the case with anamorphic prisms and cylindrical telescopes. For the high anamorphic ratios available from aspheric cylinders, the coupling is good, limited by the slow-axis invariant, LY.θY. The rule of thumb is that the L.θ product at the fibre is never less than that for the device slow axis and this can be used as a simple starting point in the optical design of coupling schemes eg for medical laser modules.

MIOsys Engineering Co info@miosys.co.uk http://www.miosys.co.uk