The Optical Lever Longitudinal Coupling

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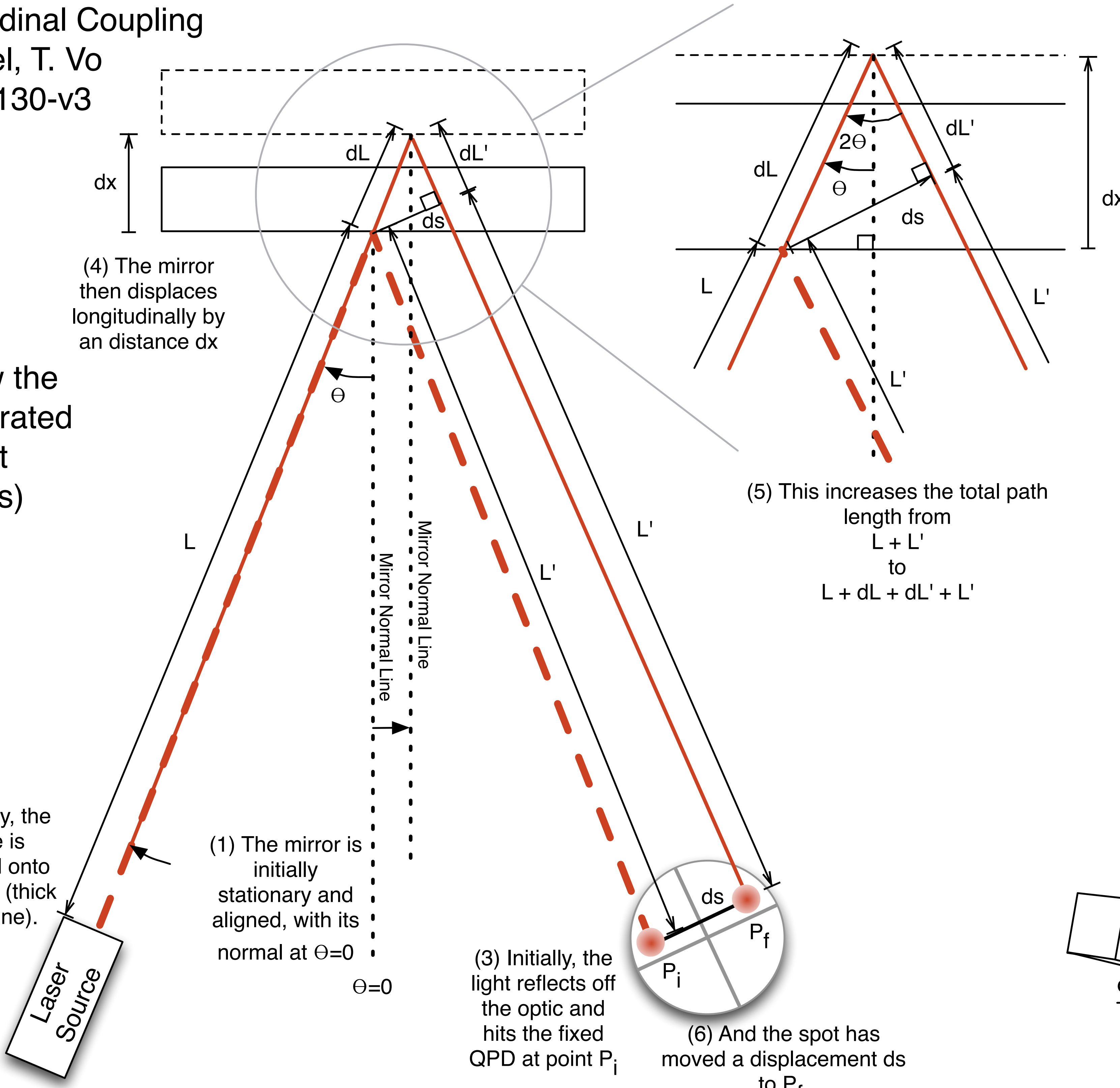
(Follow the enumerated thought process)



(7) The displacement on the QPD is:

$dL = dx / \cos(\theta)$

$ds = dL \sin(2\theta)$
$\quad = dx \sin(2\theta)/\cos(\theta)$
$\quad\quad [\sin(2\theta)/\cos(\theta) = 2 \sin(\theta)]$
$ds = 2\, dx \sin(\theta)$

(8) This displacement ds is misinterpreted as an angular displacement $d\theta$:

$\Rightarrow d\theta = ds / (2 L)$
$\quad = 2\, dx \sin(\theta) / (2 L)$

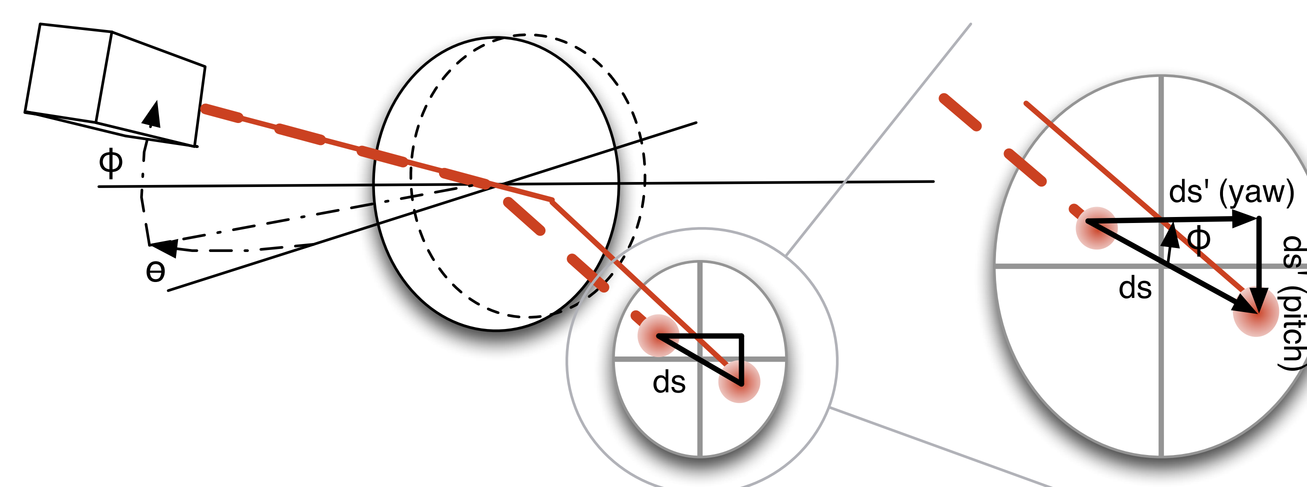
$\mathbf{d\theta = dx (\sin(\theta) / L)}$

(9) This cross-coupling assumes the lever sits on the plane of the vertical Center of Mass, and the QPD crosshairs are aligned to the plane, and therefore yaw-only. If the triangle plane is rotated about the optical axis (e.g. the laser is higher than the receiver), then rotates ds with respect to our pitch and yaw coordinates.

(10) The projection of our ds in pitch or yaw, is merely the component of ds with respect to that angle of rotation, ϕ

$ds' \text{(pitch)} = ds \sin(\phi) = 2\, dx \sin(\theta) \sin(\phi)$
$ds' \text{(yaw)} = ds \cos(\phi) = 2\, dx \sin(\theta) \cos(\phi)$

$\Rightarrow$ **$d\theta' \text{(yaw)} = ds' \text{(yaw)} / (2 L) = (dx / L) \sin(\theta) \cos(\phi)$**
$d\phi' \text{(pitch)} = ds' \text{(pitch)} / (2 L) = (dx / L) \sin(\theta) \sin(\phi)$



Lever arms, L and angles of incidence θ, and ϕ are reported in E1200836