JonJu Tech Ltd.

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Title: Alignment of a Collimated Beam with a Circular Target of the Same Diameter

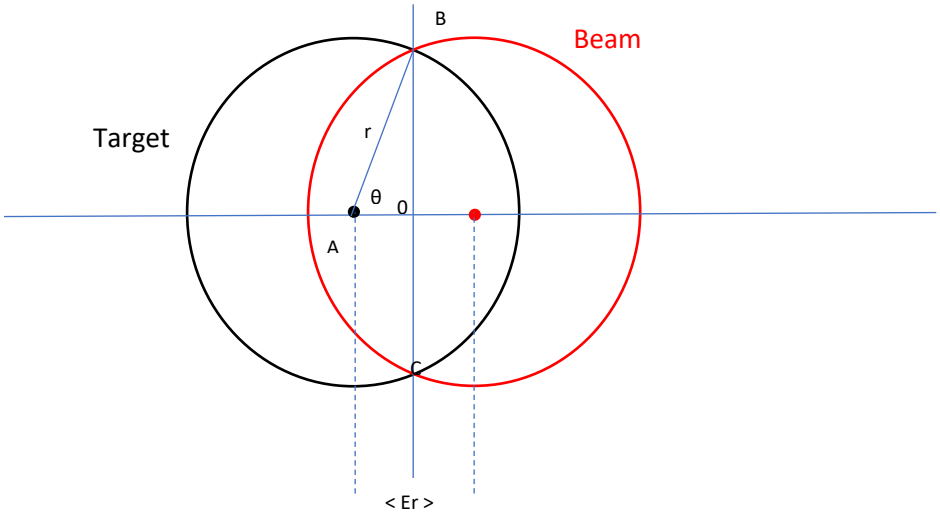
1. Introduction

Significant errors can occur when a beam of light is shone at a target of the same diameter, i.e., the centre of the circular target is not aligned with the centre of the light beam. The following theory derives the equation upon which this depends. The conclusion contains an example.

2. Theory

This simple derivation quantifies the effect of a beam slightly missing its target, and therefore the accuracy that must be demanded of an alignment system.

If the target beam and the target are perfectly circular and of the same diameter the illustration below graphically shows the misalignment.



$r.\cos\theta = Er/2$

$\theta = \cos^{-1}(Er/2r)$

The sector of the target circle that covers half of the beam covered area, Z, is given by the area of that sector minus a rectangle, as below:

$$Z/2 = (\theta/\pi).\pi r^2 - r^2\sin\theta\cos\theta = \theta r^2 - r^2\cos\theta\sin\theta$$

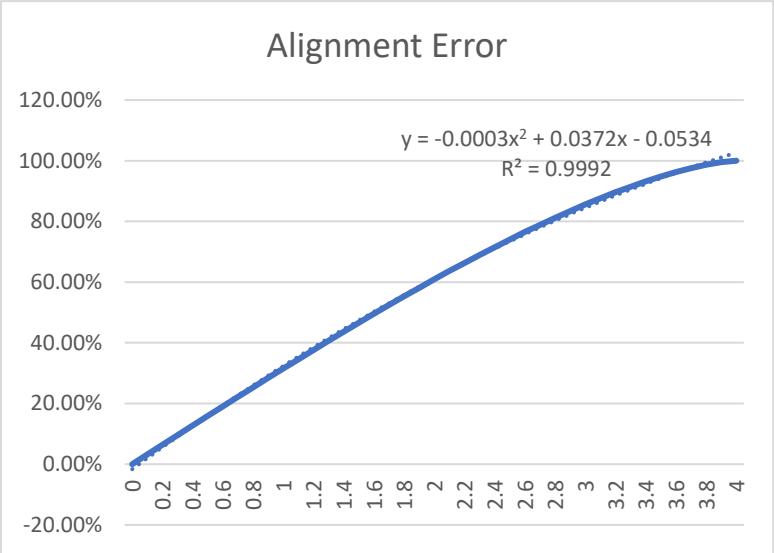
$$Z = 2r^2 [\theta - \sin\theta\cos\theta]$$

Z is the area successfully covered by the beam. Therefore, the per unit area efficiency of beam coverage, μ, is:

$$\mu = Z/\pi r^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

therefore, the area missed $1 - \mu$.

3. Results and Conclusion



The graph below shows the effective area missed against beam centre misalignment for a 4mm collimated beam. An error as low as 0.2mm can result in over 6% of the target not being hit by the beam. If this increases to 1mm, the error is over 30%.