Effect of Facet Flatness Variations on Jitter

The flatness of polygon facets will have an impact both on the aberrations in the beam as well as the pointing of the beam. This pointing error results in velocity variations across the scan. A flat facet will produce a reflected beam that moves angularly at twice the rotation rate of the polygon. Variations from flatness will cause the beam to be displaced in angle from the ideal position.

These angular variations in position will become time of flight errors between two points in the image plane. Jitter is a measure of the error in time between a beam traversing the start of scan (SOS) sensor and the end of scan (EOS) sensor as the polygon rotates. The curvature of the facets will cause the time to vary. The surface of the facets can range from convex to concave. A convex facet shape will cause the time of flight between SOS and EOS to increase whereas a concave facet will cause a decrease in time of flight.

It is not the absolute magnitude of the facet flatness that determines the jitter but instead the variation in flatness from facet to facet. If all the facets are equally concave then the actual time of flight will be decreased but there will be no contribution to jitter from the facet curvature

The analysis that follows measures the facet curvature induced jitter between a flat facet and a facet with a given flatness error. If the calculations show that your system is marginal on facet induced jitter it may be possible to specify all facets to be either convex or concave.

In order to calculate the effect on jitter of a given flatness variation you need to know the facet length and the total active scan angle in the system. (see illustration)

The calculation is as follows:

$R = (r2 + h2) / 2h$ and $\sin \Theta = r / R$

Therefore: $\Theta = \sin -1 (2hr/ (r2 + h2))$

Where: h = Surface figure

r = .5 x facet length

Θ = Mechanical facet angle error at one end of scan

Example:

$h = \lambda / 4$ @ 633 nm r = 25 mm

Total optical scan angle is 50 degrees

$\Theta = \sin^{-1}(2(25)(.000158) / ((25)^2 + (.000158)^2))$

$\Theta = .000724$ degrees

If the total optical scan angle is 50 degrees then,

Total mechanical scan angle = 25 degrees

Mechanical half scan angle = 25 / 2 = 12.5 degrees

Jitter = .000724(100%) / 12.5

Jitter = .005792 %