Thermodynamic Understanding of Segmented CPC

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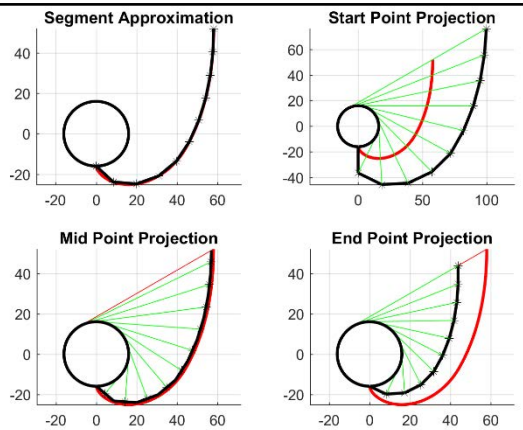
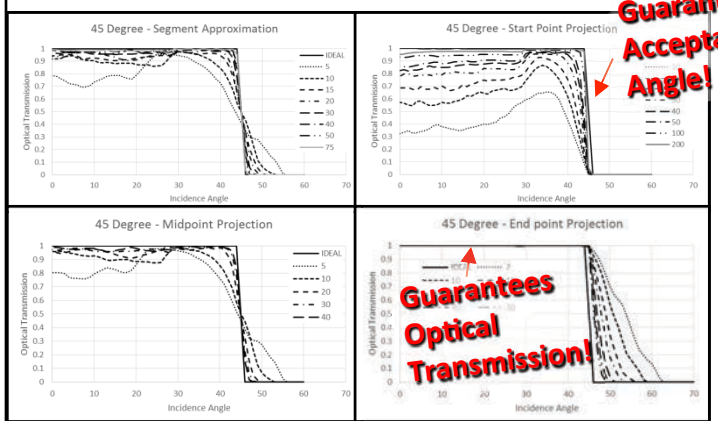
Methods for Approximating CPC Profile

1) Simple segment approximation, where endpoints of segment lie along ideal profile.
2) Projection of segment based on edge-ray principle which can be taken from the start, mid, or endpoint of the segment.



Incidence Angle Modifiers

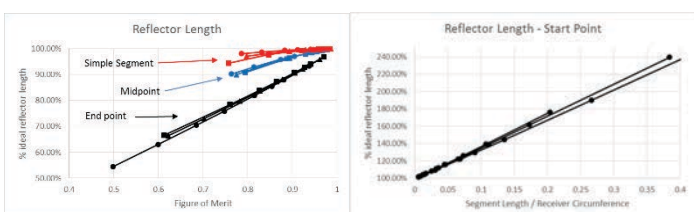


Segment and ***midpoint*** projection accept some outside light and reject some inside light.

End point projection guarantees transmission within acceptance angle

Start point projection guarantees hard acceptance angle cutoff

Reflector Length



Start point projection is impractical for small #'s of segments due to huge reflector length.

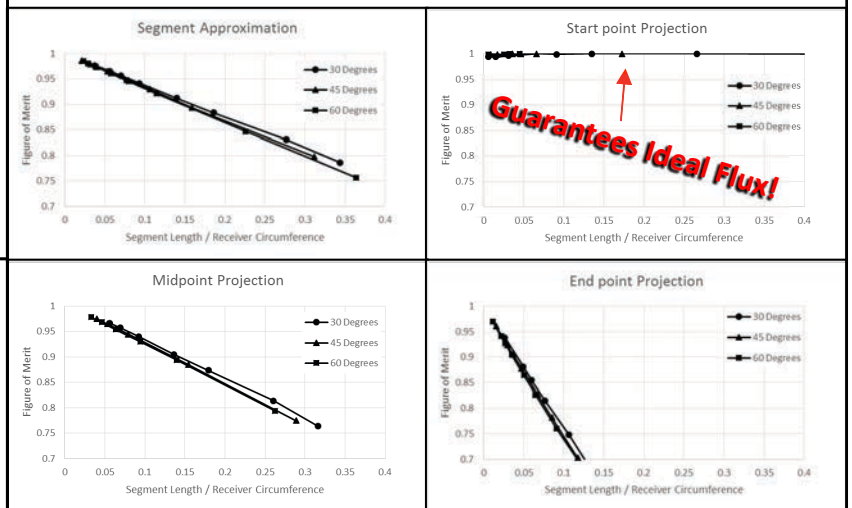
Performance Metrics

Geometric optical efficiency does not have a direct correlation with flux and therefore the geometric concentration can be larger than the theoretical limit of $C_{max} = 1/\sin(\theta_a)$ by having optical efficiencies less than one. We therefore propose the following *Figure of Merit* (FOM), where C is the geometric concentration

$$FOM = C/C_{max} \cdot \int_0^{\theta_a} \eta_m \, d(\sin\theta)$$

ratio and η_m is the modified IAM (mIAM), a function of $\sin\theta$ instead of θ. The entire rightmost term containing the integrals is the modified optical efficiency. The mIAM graph correctly reflects the energy density for different angles according to the cosine effect which weights optical efficiencies at small incident angles more importantly than those at larger incident angles. *The FOM multiplied by the radiation flux at the source is the maximum surface flux achievable at the absorber.*

Figure of Merit vs # of segments



The ideal CPC guarantees both optical transmission and maximum flux. By segmenting the profile, however, we have guaranteed them separately.