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Limitations of assuming a circular Gaussian flux density distribution for a heliostat image

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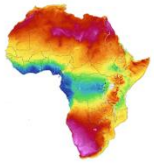
Solar Thermal Energy Research Group (STERG)



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17 July 2014
Stellenbosch, South Africa

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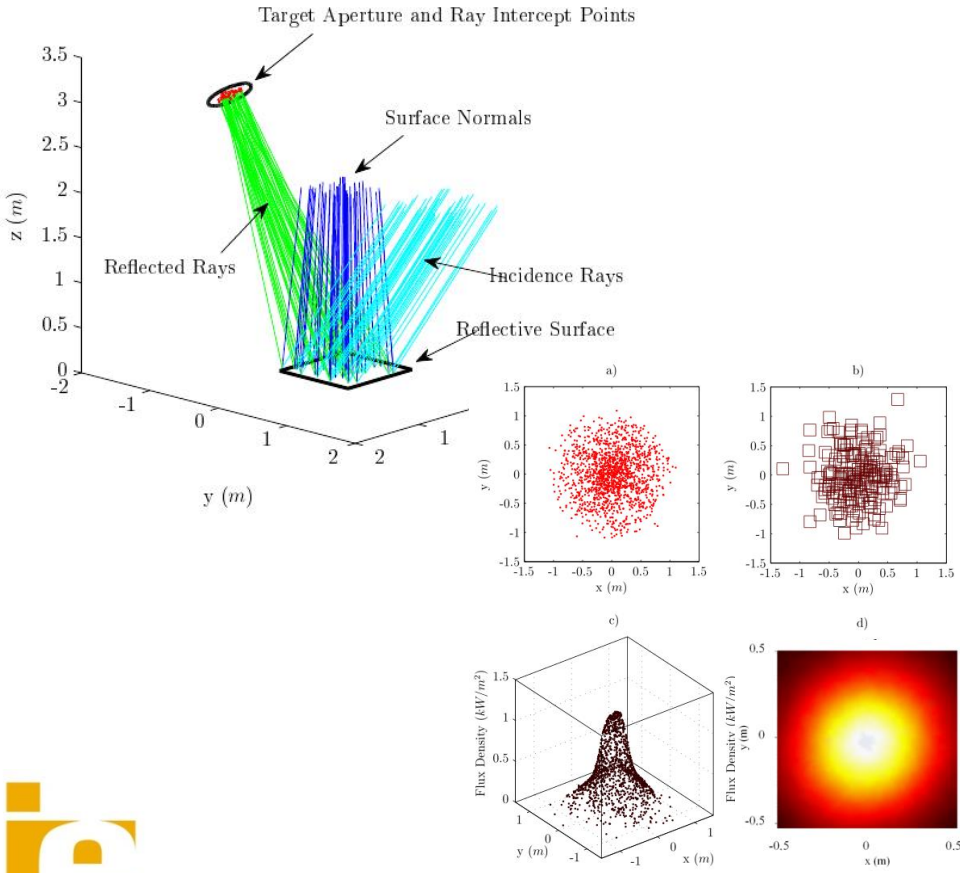
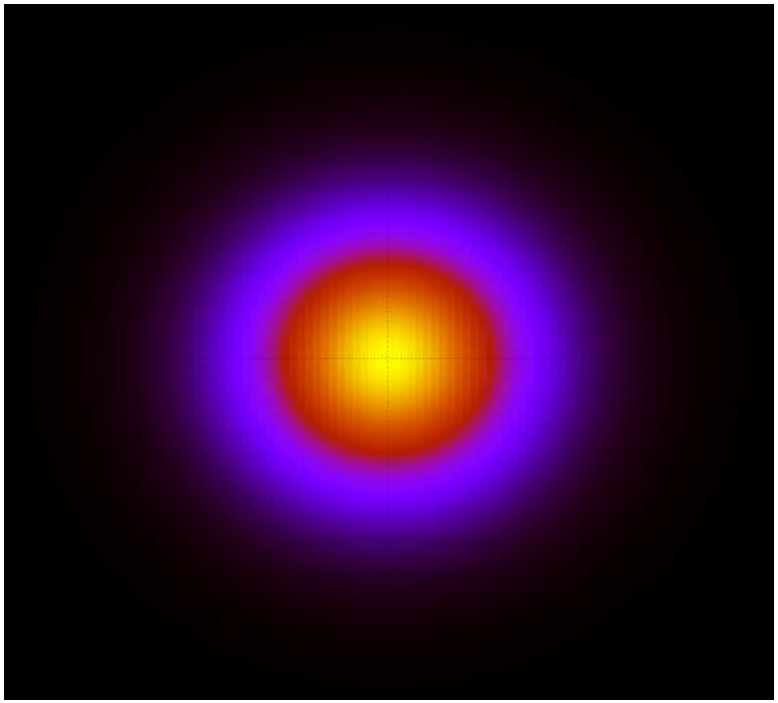
Why assume a circular Gaussian distribution?

Ray Tracing



Circular Gaussian



Where do we use it?

- Plant performance
- Field layout optimisation
- …
- …
- Aiming Strategy Optimisation
- Flux Density Distribution

  - Salome 2013
  - Basarati 2014
  - Solgate Project 2005
  - and in STERG
    - Landman
    - Grobler

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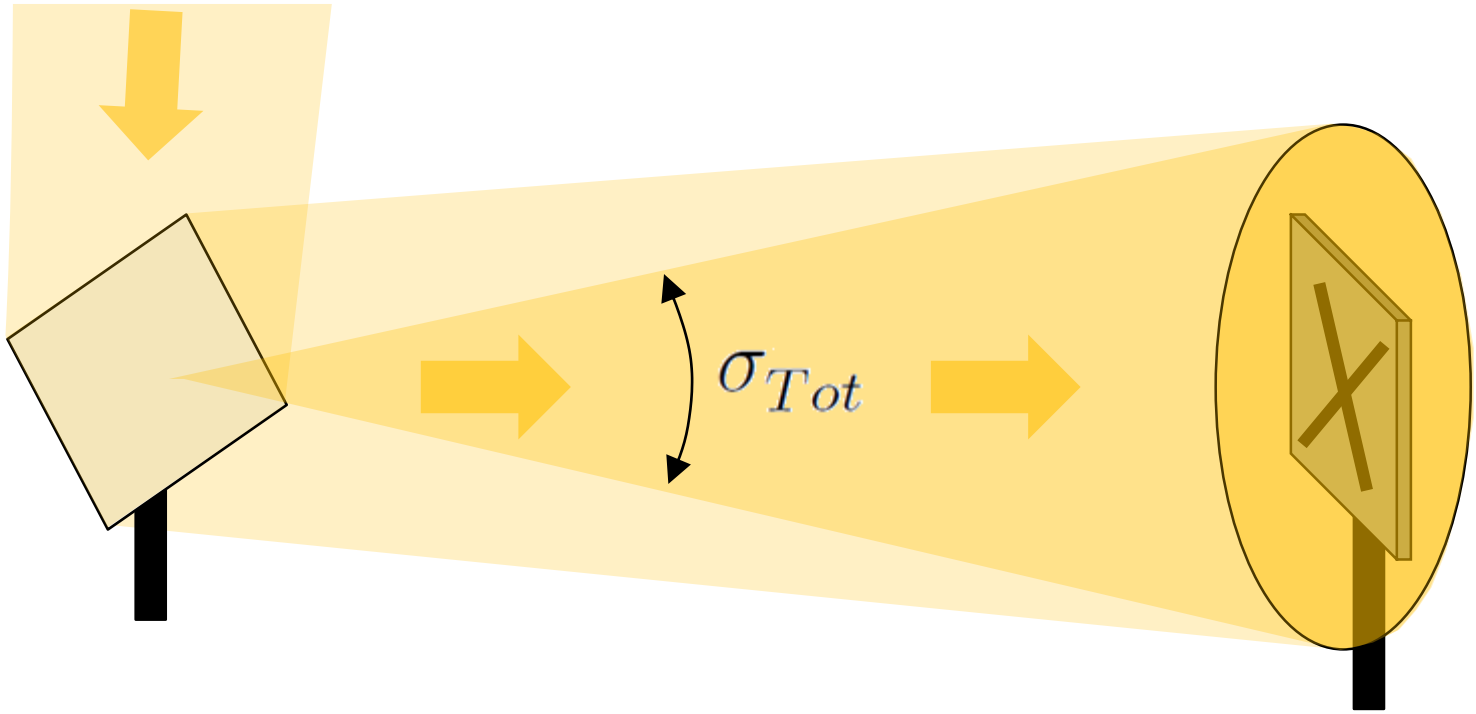
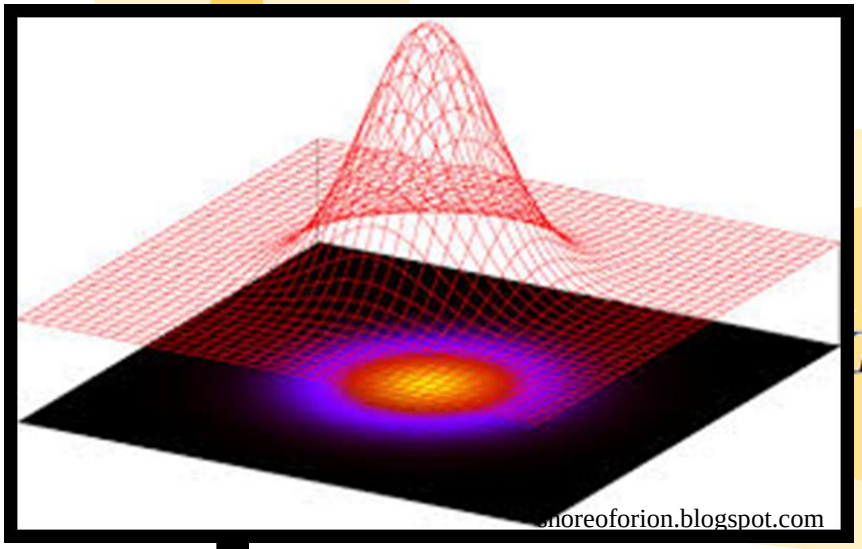
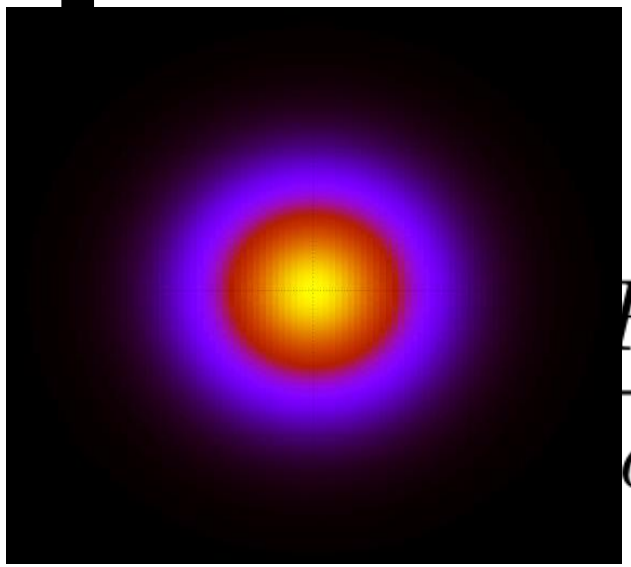
Total Beam Dispersion Error



$$\sigma_{Tot}^2 = \sigma_{sun}^2 + \sigma_{astigmatism}^2 + \sigma_{BQ}^2$$

Gaussian Flux Image

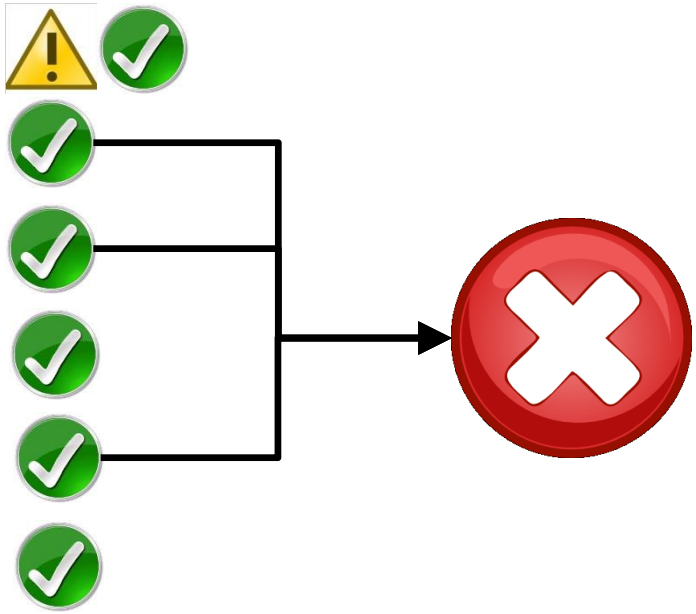




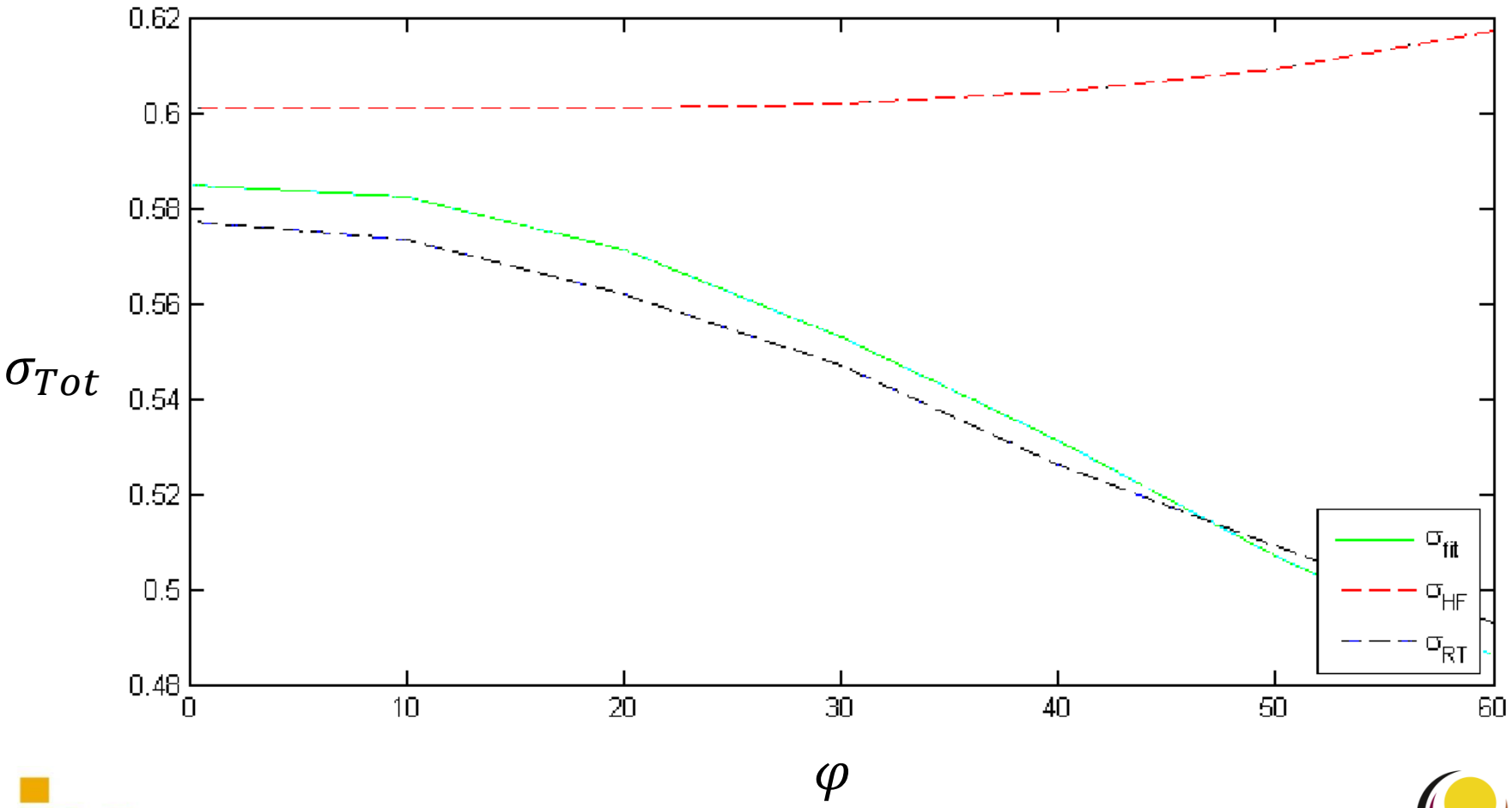
$$Tot$$

$$\frac{P_h}{\sigma_{Tot}^2} \exp\left(\frac{-r^2}{2\sigma_{Tot}^2}\right)$$

- Sun shapes
- Surface Slope Errors
- Incidence angle
- Receiver incidence angle
- Focal Ratio
- Aspect Ratio



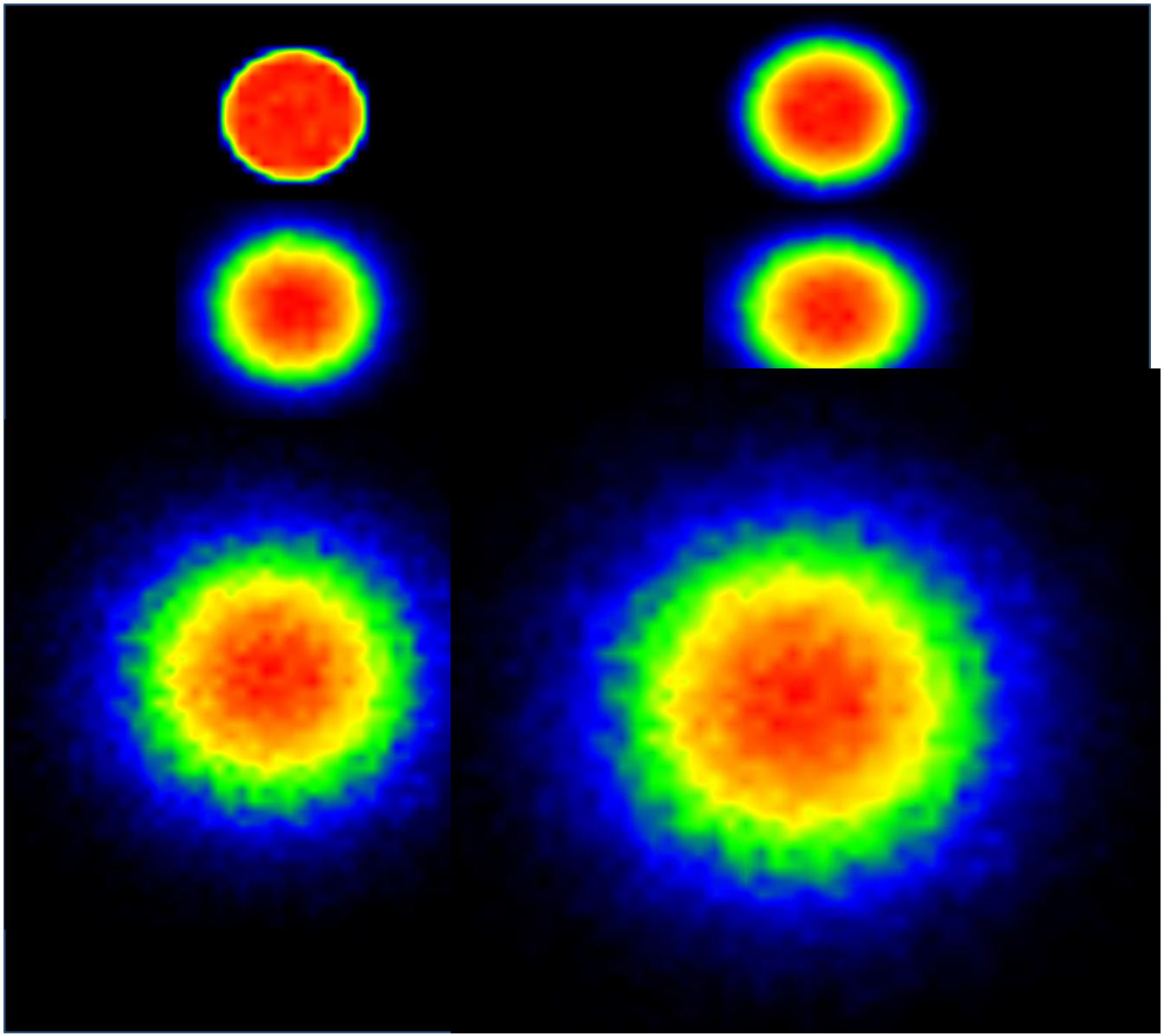
Incidence Angle or φ



σ_{ast}

σ_{ast}

σ_{SSE}



σ_{SSE}

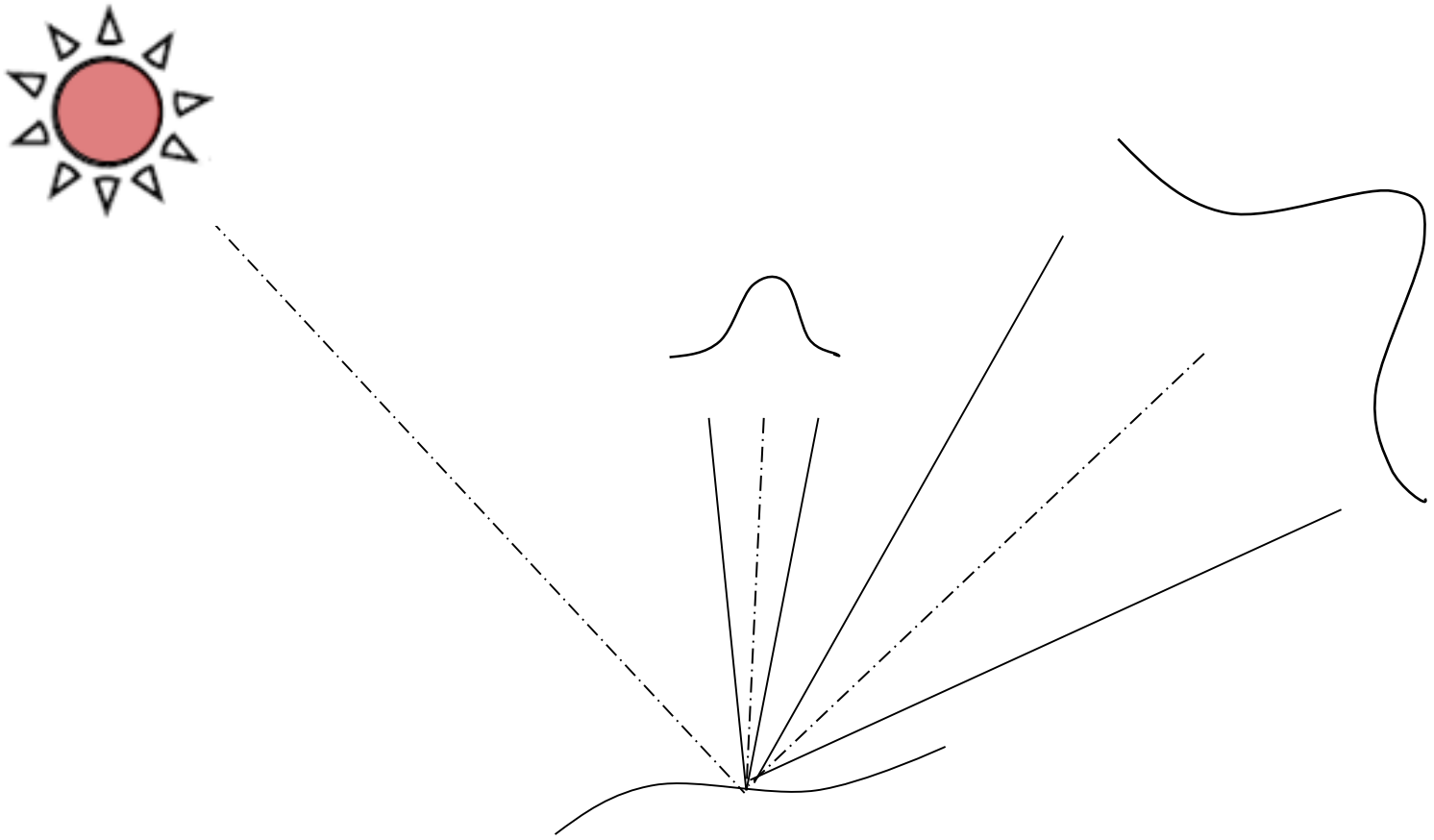
φ

φ

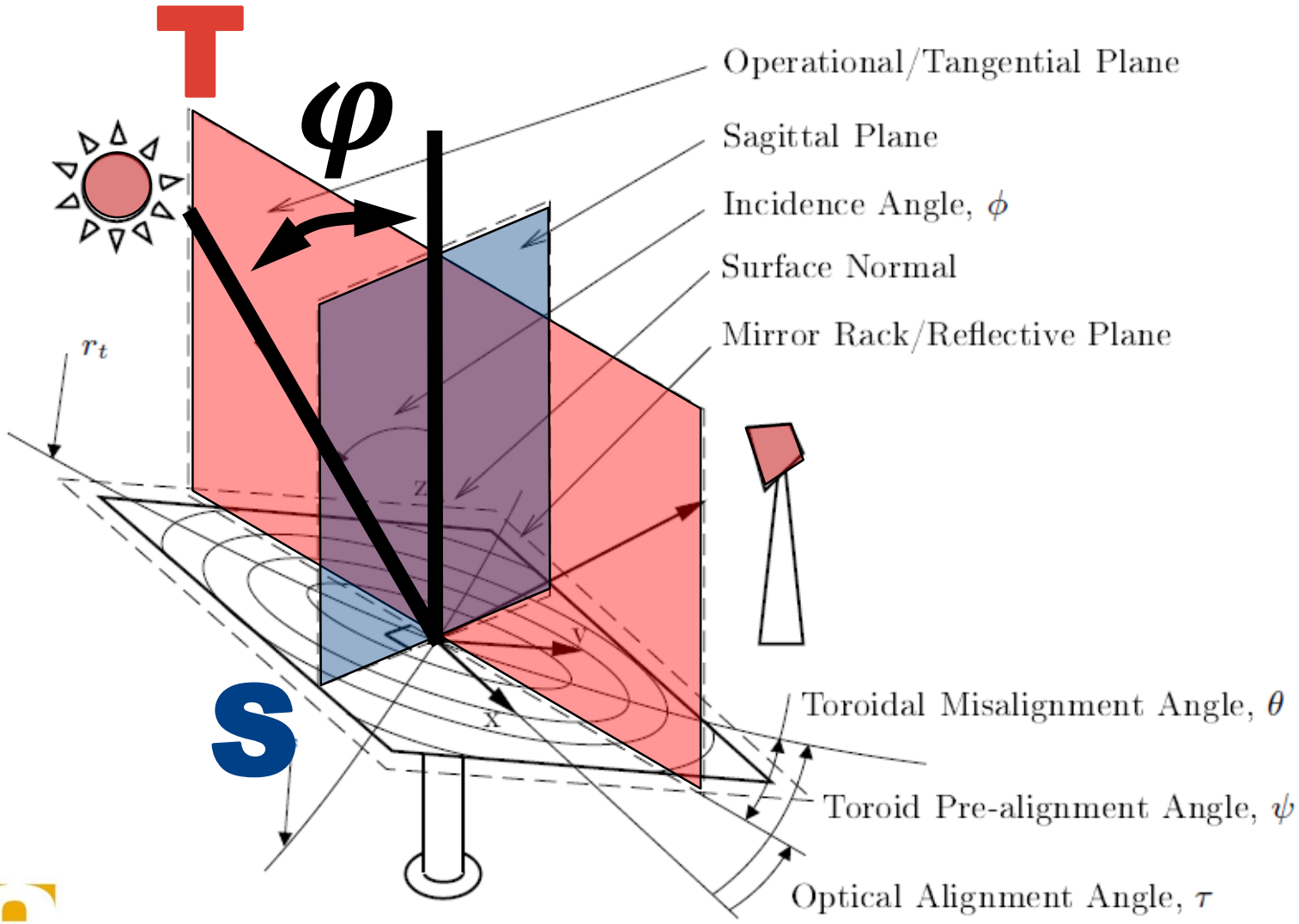
σ_{SSE}

σ_{SSE}

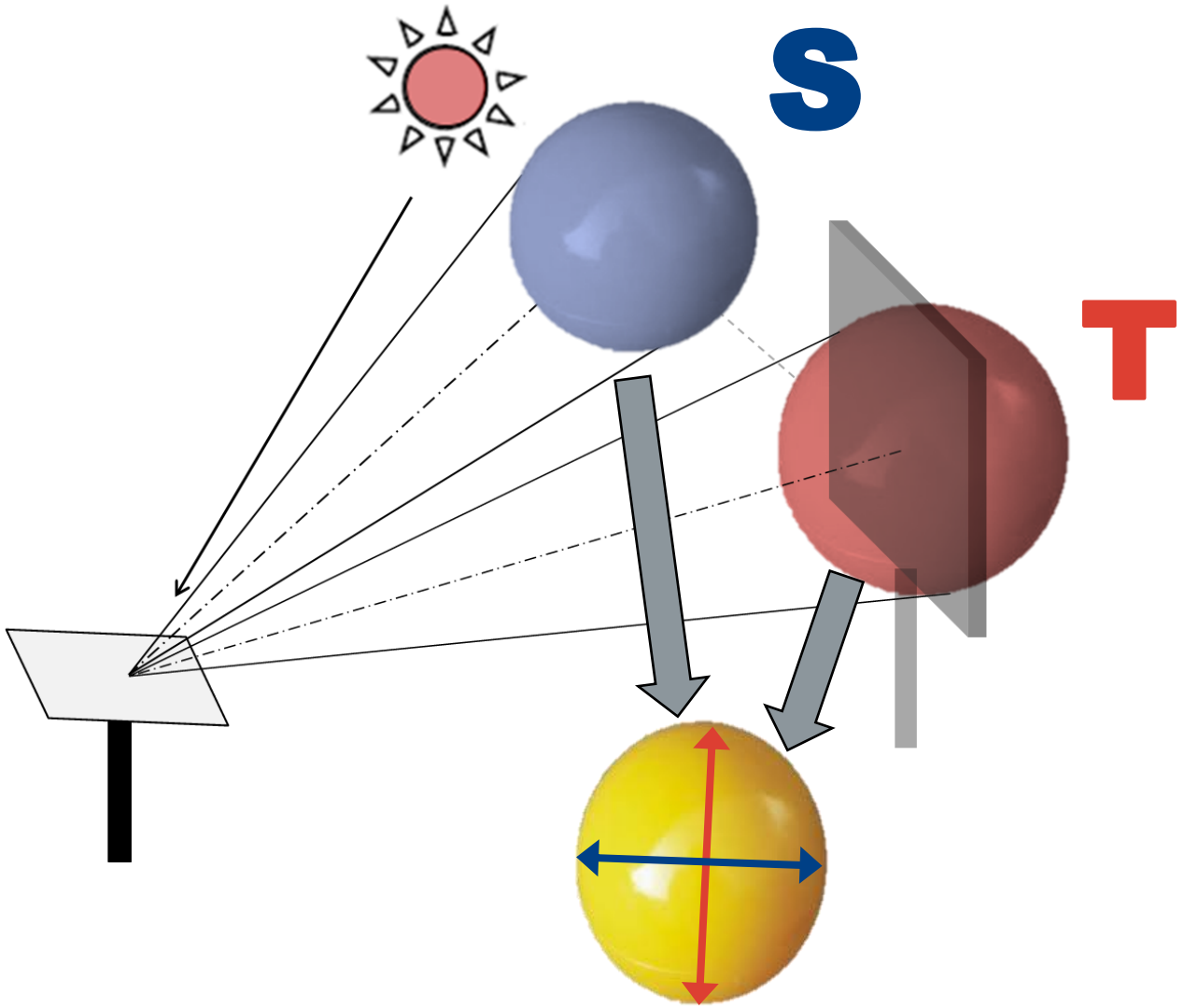
Surface Slope Errors



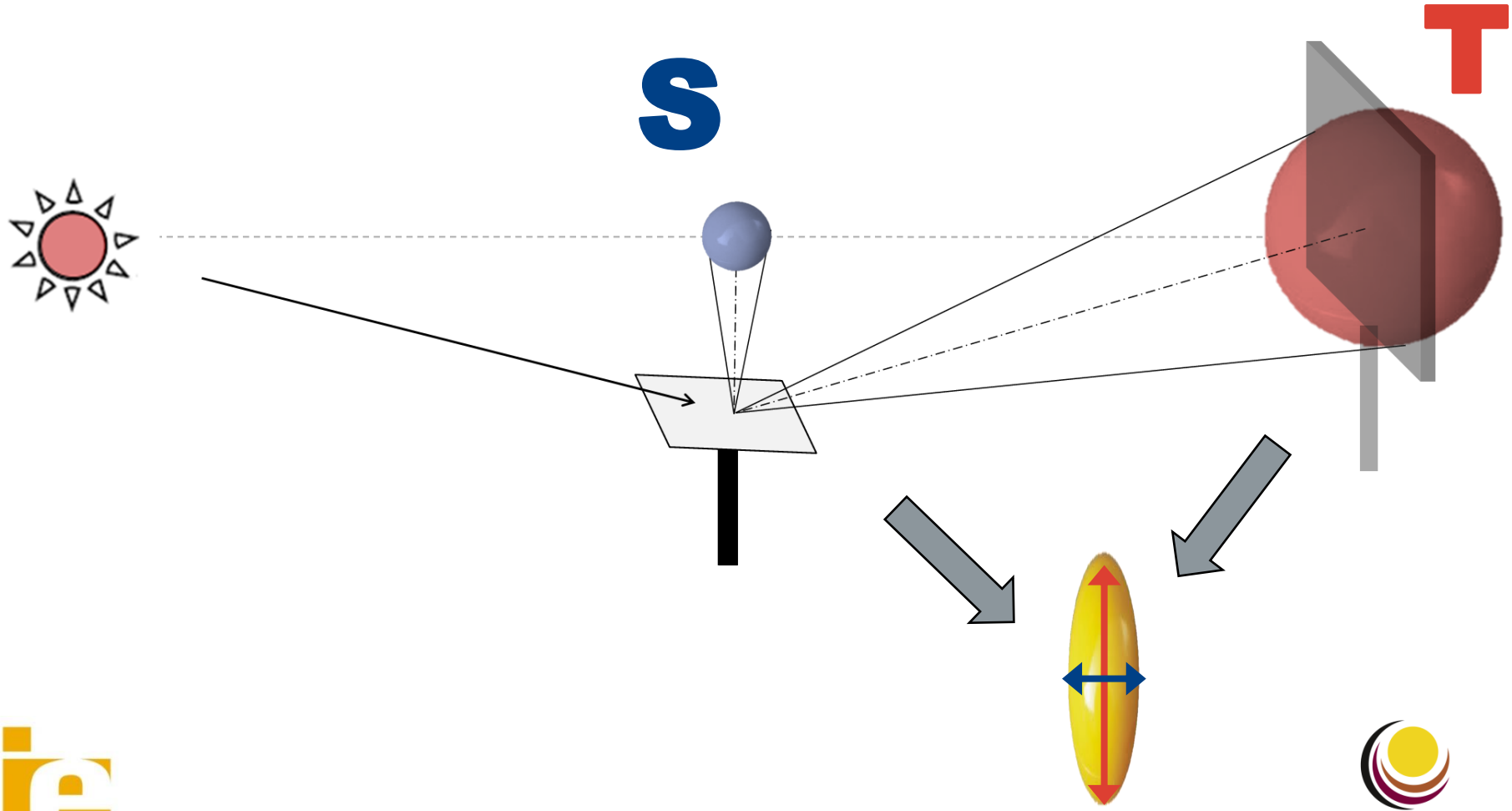
Parameter Variation



Small φ



Large φ



Conclusions

- CG greatly overpredicts the radial flux density distribution for:
  - High incidence angle
  - SSE ~> σ_{sun}

Acknowledgements:

STERG

University of Stellenbosch

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