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

W.A. Landman, A. Grobler, F. Dinter & P. Gauche
Solar Thermal Energy Research Group (STERG)
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
Total Beam Dispersion Error

\[ \sigma_{Tot}^2 = \sigma_{sun}^2 + \sigma_{astigmatism}^2 + \sigma_{BQ}^2 \]
Gaussian Flux Image

\[ \frac{P_h}{\sigma^2_{Tot}} \exp \left( \frac{-r^2}{2\sigma^2_{Tot}} \right) \]
• Sun shapes
• Surface Slope Errors
• Incidence angle
• Receiver incidence angle
• Focal Ratio
• Aspect Ratio
Incidence Angle or $\varphi$
Surface Slope Errors
Parameter Variation

- Operational/Tangential Plane
- Sagittal Plane
- Incidence Angle, $\phi$
- Surface Normal
- Mirror Rack/Reflective Plane
- Toroidal Misalignment Angle, $\theta$
- Toroid Pre-alignment Angle, $\psi$
- Optical Alignment Angle, $\tau$
Small $\phi$
Large $\varphi$
Conclusions

- CG greatly overpredicts the radial flux density distribution for:
  - High incidence angle
  - SSE $\sim \sigma_{sun}$