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Incorporating Canting Strategies into HFCAL Modelling

STERG Symposium -18 July 2013 W. Landman & P. Gauché











- Canting
- Astigmatism
- HFCAL Model
- Facet Variations











ATS 150 Heliostat

(4th generation)

E

Carpe Diem Solar: HelioCa 16





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





- Currently 3 canting strategies
 - all with predefined profiles
 - potentially a cost-free improvement (Buck, 2009)
- Modelling and optimisation is computationally expensive
 - requires approximately 10Mio Rays (Buck, 2009)









• Analytical model that assumes the image is a circular normal distribution

$$F(r) = \frac{1}{2\pi\sigma^2} e^{-\frac{r^2}{2\sigma^2}}$$

- Accurate to within 9% (Collado, 2010)
- Limited to a spherical profile











$$h = \frac{2(D - \overline{D})\cos\phi}{r_{s,canting}} \left| \frac{r_{s,canting}\sec\phi}{2} - d \right| + \frac{2\overline{D}\cos\phi}{r_{s,facet}} \left| \frac{r_{s,facet}\sec\phi}{2} - d \right| + \beta_s d$$

$$w = \frac{2(D - \overline{D})}{r_{t,canting}} \left| d - \frac{r_{t,canting} \cos \phi}{2} \right| + \frac{2\overline{D}}{r_{t,facet}} \left| d - \frac{r_{t,facet} \cos \phi}{2} \right| + \beta_s d$$

$$\sigma_{astigmatism} = \frac{\sqrt{(h^2 + 2hw + w^2)}}{8d}$$









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(Buck, 2009)

(Noone, 2011)

















Small plant of 1568m² mirror area













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- •Canting mechanism was incorporated into the HFCAL model
- •Allows greater model flexibility and accuracy (10%)
- •Number of facet focal lengths can be reduced
- •Smaller facets improve optical performance
- •Flat facets are not acceptable in small scale plants









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• HFCAL

Adapted HFCAL Model <= Fast Analytical Model

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• Off-axis canting with various number of profiles

SolTrace Validation

-2

Experimental Validation

±6%

Yearly Performance Model Validation

• Optimisation for flux intensity

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Day After Manufacture

3 Months After Manufacture

- •Cost free performance adaptations are possible
- •Will however require a characterisation system to cant (can't use the sun)
- •Larger systems can allow for less accurate heliostats at low R
- •Perimeter rigidity is important
- •Facets are being investigated

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