FK concentrator outdoor measurements

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FK concentrator overview

Optimal spectral design

Latest measurement results

Conclusions
Köhler integration

- Two-stages design where input/output stage forms image of a preferred object point onto a point of the output/input stage
- Canonical example: two identical lenses imaging a point source at infinite (plane wavefronts) onto each other
Köhler integration in the FK

- Advanced concentrator using LPI-proprietary 4-channel Köhler homogenization
- POE folds image the sun onto SOE folds, which in turn image the POE folds onto the square solar cell
Köhler integration in the FK

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FK compared to other Fresnel concentrators

• Higher Concentration-acceptance product (CAP): for a fixed minimum acceptance angle, the FK can concentrate more

*includes sun finite size, optical losses, and MJ cell photocurrent
FK features

- Optical depth reduced with respect to other Fresnel systems (0.85<\(f\#\)<1.2)
FK features

- High concentration
- High optical efficiency
- High spatial and spectral irradiance uniformity on the cell (high cell efficiency and long-term reliability)
- High acceptance angle (preserves high efficiency at array level)
- Low cost optics

Ventana™ Optical Train:
A complete off-the-shelf optics solution by Evonik and LPI using acrylic POE
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Spectral transmission issue

- Solar cell junctions are series-connected, the goal is keeping balanced photocurrents for bottom, middle and top sub-cells
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- Solar cell junctions are series-connected, the goal is keeping balanced photocurrents for bottom, middle and top sub-cells.
- Best performance is achieved when the concentrator considers spectral characteristics of both sunlight and solar cell.

**AM 1.5 spectrum containing a power density of 900W/m²**

**3J solar cell EQEs (Source: www.emcore.com)**
Spectral transmission issue

- A careful optical design and good choice of optical materials maximize energy production throughout the year

\[ J_{sc,k} = \int S(\lambda)T(\lambda)\text{EQE}_k(\lambda)d\lambda \]

\[ I_{sc} = \min\{I_{\text{sc, top}}, I_{\text{sc, mid}}, I_{\text{sc, bot}}\ \}

Solar spectrum \( S(\lambda) \)

Concentrator optical transmission \( T(\lambda) \)

\( \text{EQE}_{\text{top}}(\lambda) \)

\( \text{EQE}_{\text{mid}}(\lambda) \)

\( \text{EQE}_{\text{bot}}(\lambda) \)
Spectral irradiance issue modelled

Tracker angle = 0º

FK overview – Spectral design – Measurements - Conclusions

Spectral irradiance issue modelled

Tracker angle = 0.6°

Spectral irradiance issue modelled

- Optical efficiency (%)
- Electrical power (%)

Silo

- Top Cell
- Middle Cell
- Bottom Cell

FK

- Top Cell
- Middle Cell
- Bottom Cell

FK overview – Spectral design – Measurements - Conclusions
FK concentrator overview
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Spectral irradiance issue measured

- Measurements confirm the models