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Potential Impacts of Glare and IR Emissions from Solar Power Technologies

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Overview

- Introduction
- Glint and Glare Analysis
- Thermal Emissions Analysis
- Summary

Introduction

- **Multiple agencies are interested in evaluating potential safety impacts from emerging energy technologies**
  - Air Force
    - Impact on training missions at Nevada Test and Training Range
  - FAA
  - California Energy Commission
    - Solar power plant Applications for Certification
  - National Academies – Transportation Research Board
    - Synthesis Report on “Investigating Safety Impacts of Energy Technologies on Airports and Aviation”

Air Force White Papers

- **Series of white papers covering renewable energy technologies (PV, CPV, CSP, etc.)**
  - Potential impacts include the following:
    - Ground-based and airborne radar interference
    - Radio frequency interference
    - Glare impact on pilots and sensors
    - Infrared emissions (“thermal signature”)
    - Overflight restrictions
    - Sonic overpressure

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- Thermal Signature Analysis
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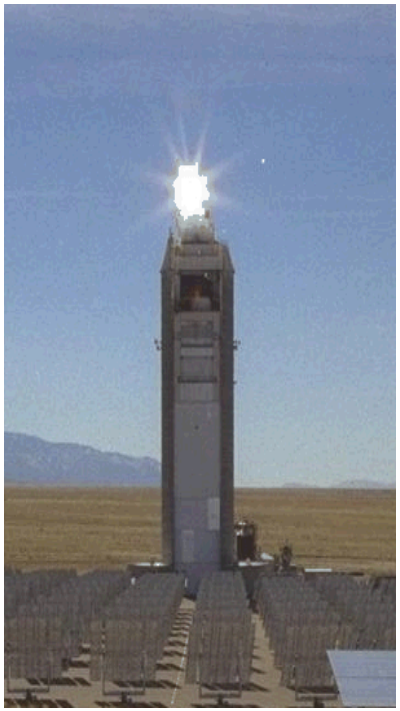
Introduction

- **Glint and glare may cause unwanted visual impacts**
  - Glint is momentary flash of light; glare is more continuous source of excessive brightness
  - Visual impacts range from flash blindness to retinal burn
- **Need quantified analysis of glint/glare to reduce uncertainties associated with visual impacts of CSP installations**
  - Industry, military, government agencies (e.g., California Energy Commission, Transportation Research Board)

Examples of Glint/Glare

Solar One
(10 MW_e power tower, Daggett, CA)



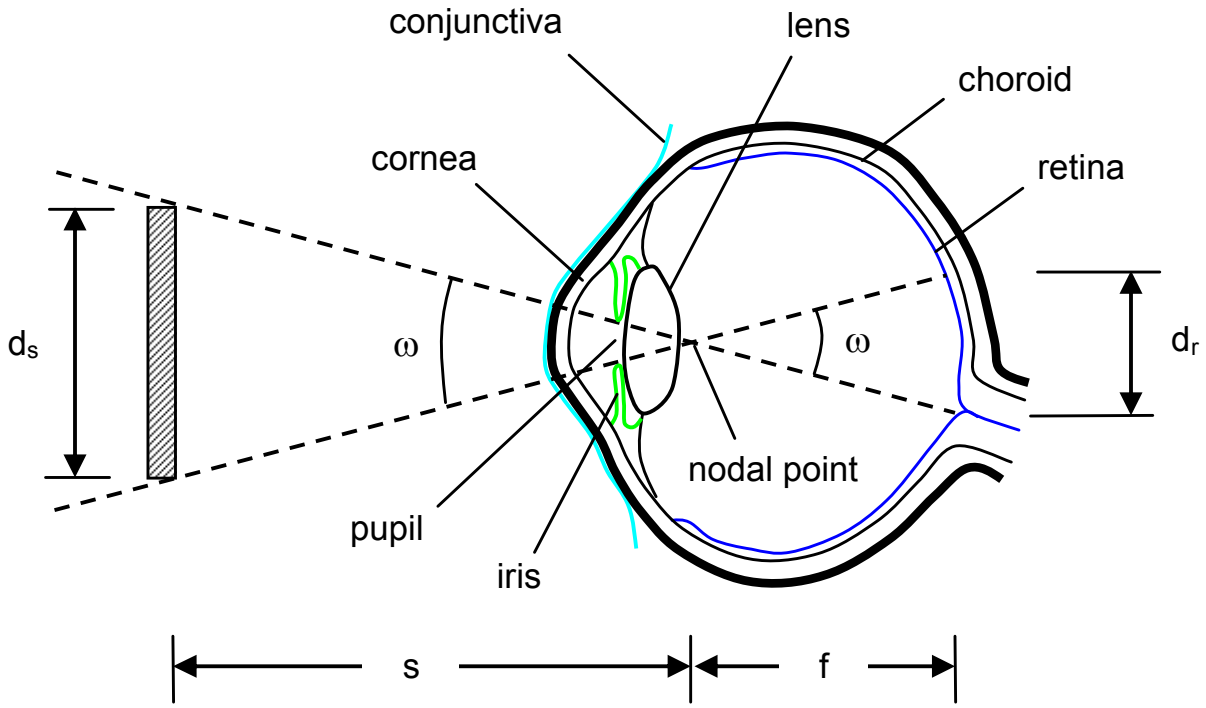
Central Receiver Test Facility
(SNL, NM)

National Solar Thermal Test Facility
(SNL, NM)

Kramer Junction
(150 MW_e parabolic trough, Mojave Desert, CA)

Glare Analysis

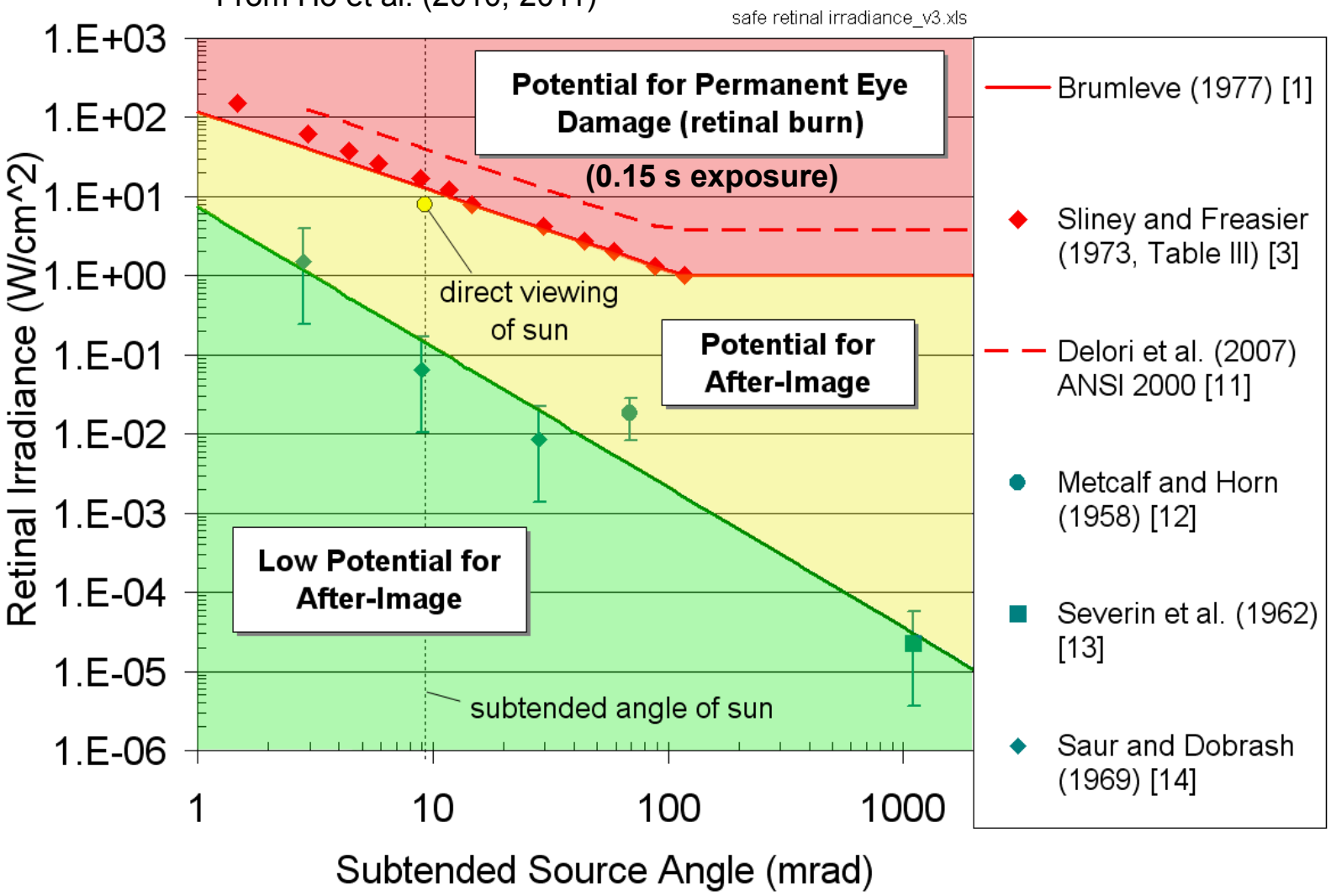
Retinal Irradiance



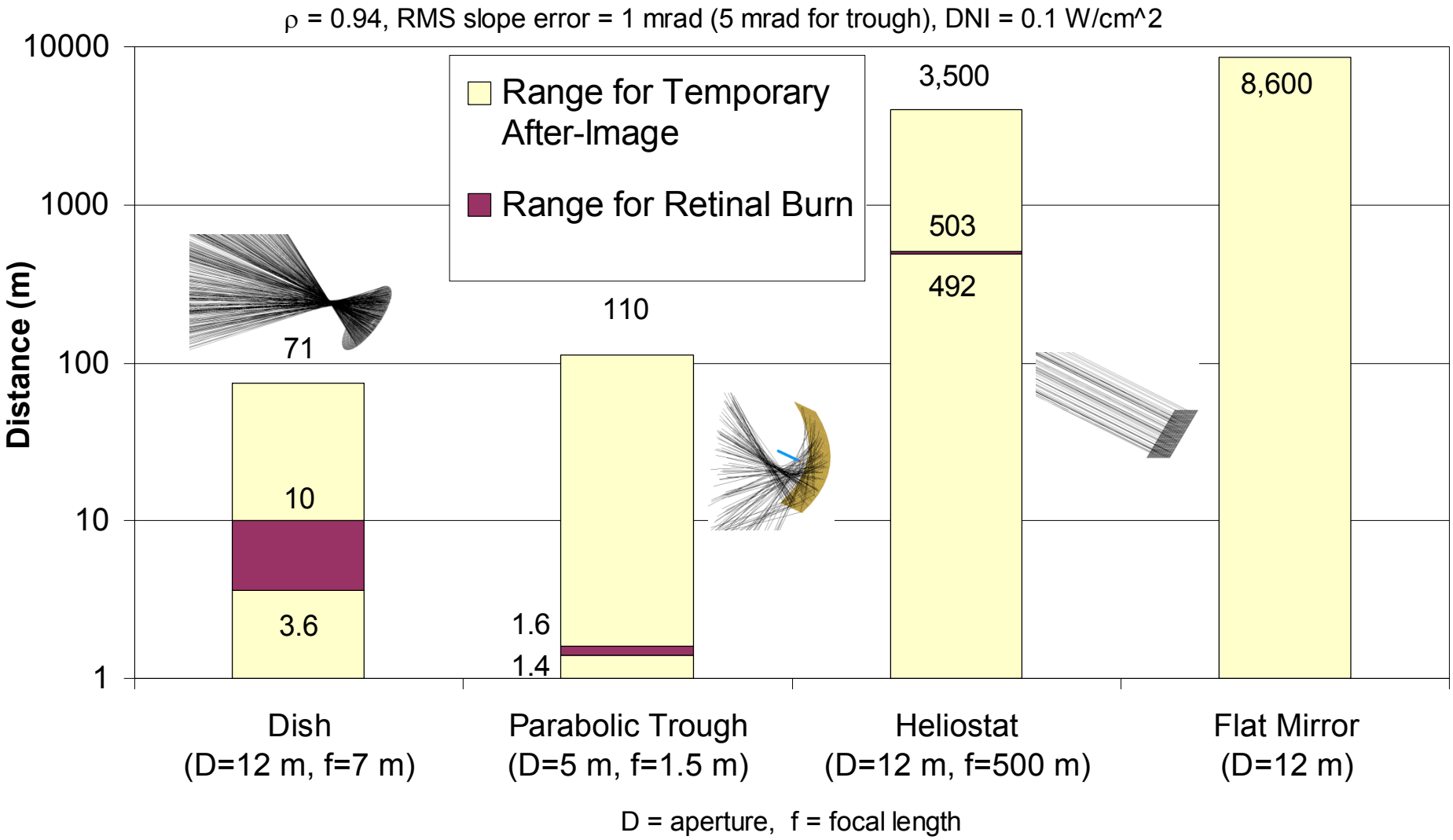
- **Need to calculate**
  - Power entering eye
    - Function of irradiance at the cornea (front of eye)
  - Subtended angle of glint/glare source

Potential Impacts

From Ho et al. (2010, 2011)



Distances for Retinal Burn and Temporary After-Image



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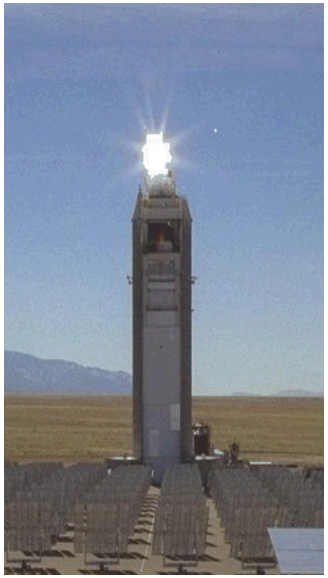
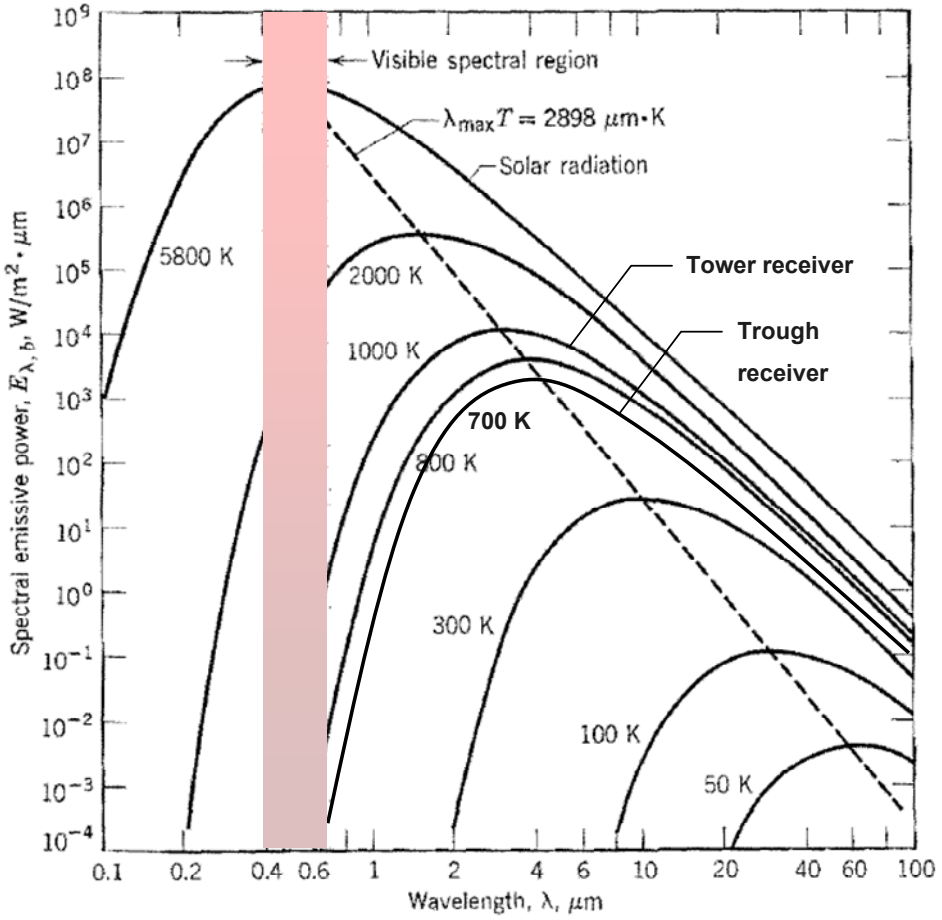
Infrared Emissions

- **Heated objects can emit infrared radiation that may interfere with infrared sensors**



Spectral Emissive Power



Spectral blackbody emissive power as a function of wavelength and temperature (adapted from Incropera and DeWitt, 1985).

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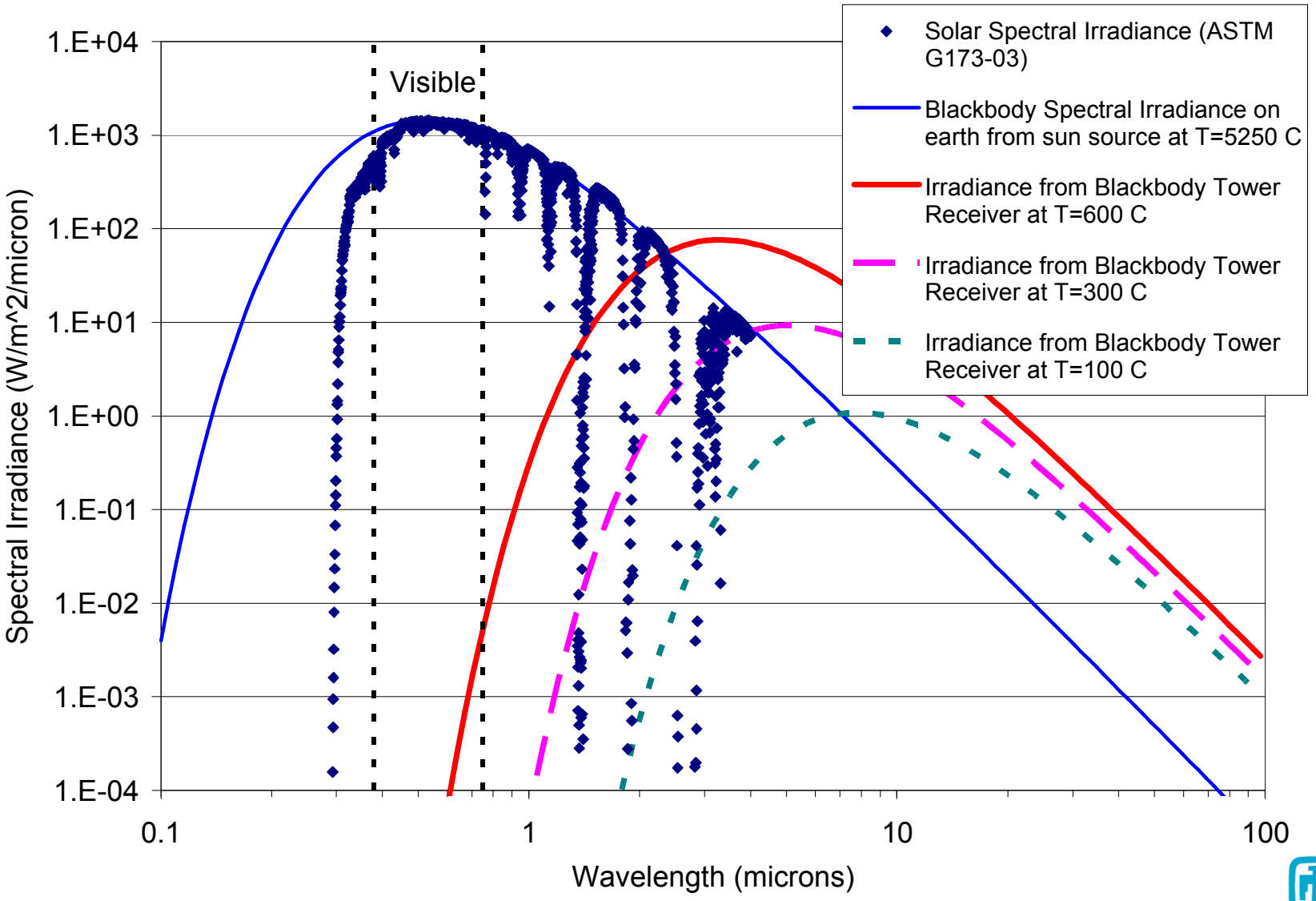
Example of Irradiance Received from Power Tower Receiver at 100 m



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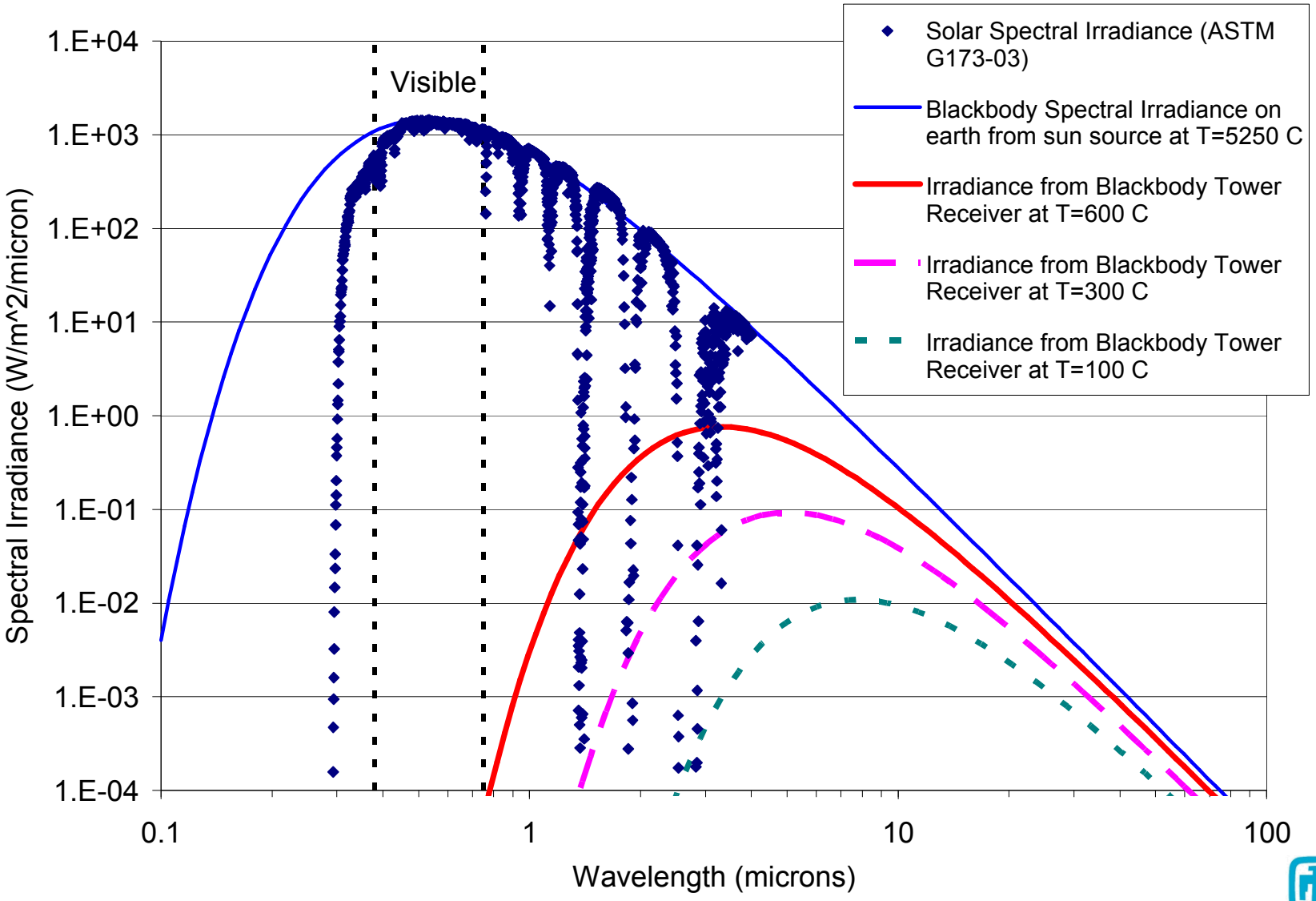
Example of Irradiance Received from Power Tower Receiver at 1,000 m



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Summary

- **Glint and Glare can cause unwanted visual impacts**
  - Analytical models and safety metrics have been developed to quantify glint and glare
  - Models have been validated with test data
  - Web tool has been developed
- **Infrared emissions from heated objects can interfere with infrared sensors**
  - Excel spreadsheet has been developed to determine spectral irradiance from “hot sources”
    - Dependent on temperature, distance, and configuration