

The Retinal Flux Density Meter

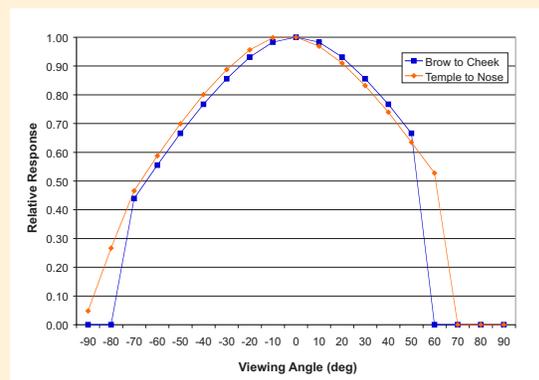
The Lighting Research Center (LRC) has designed and constructed a retinal flux density (RFD) meter. This device can serve as a standard illuminance meter or can measure flux density on the retina, using both photopic (V_λ) and scotopic (V'_λ) spectral responses. In addition, the instrument can determine standard illuminances and RFDs at mesopic levels. Although the prototype device is not yet commercially available, we estimate that a commercial instrument that provides accurate measurements at photopic, scotopic, and mesopic light levels could be manufactured for less than \$1000. Researchers and practitioners could use such device to assess the utility of moving beyond static photopic (V_λ) illuminance levels. Widespread use of these devices might lead to new standards that would improve both energy efficiency and safety.

The RFD meter has the following capabilities:

- Perform photopic and scotopic retinal flux density measurements
- Perform standard illuminance measurements (with baffle removed)
- Calculate mesopic values in real time
- Calculate $V_{10\lambda}$ -weighted values in real time

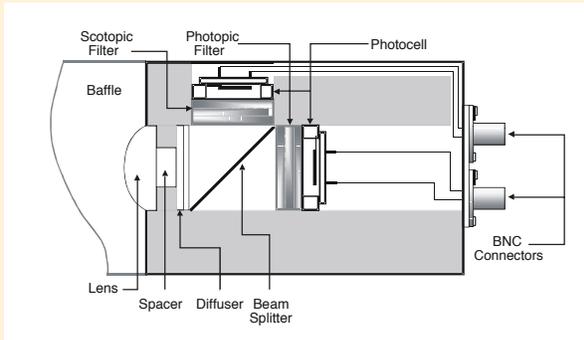
Theoretical Spatial Efficiency

The RFD meter approximates the spatial efficiency of the human eye to determine the total amount of light falling on the retina. The spatial efficiency function of the eye has two components, the cutoff caused by facial structure and the spatial efficiency of the eye itself. The spatial efficiency of the eye was determined through computer modeling.



Retinal spatial response function with facial cutoff. Negative angles represent the directions toward the brow and temple, respectively.

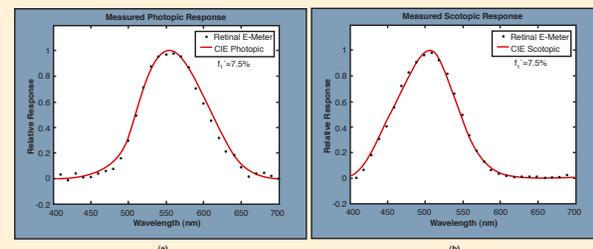
Detector Assembly Design



A schematic diagram of the RFD detector head. This geometry allows for the nearly simultaneous photopic and scotopic measurements.

Spectral Efficiency

The RFD meter uses two separate detectors: one that approximates the CIE V_λ efficiency function and another that approximates the CIE V'_λ efficiency function.



(a) Relative V_λ photopic spectral response and (b) V'_λ scotopic spectral response of the RFD detector along with the corresponding standard functions.

Future Work

Although this prototype proves the concept and value of the RFD meter, some additional work needs to be done to make the instrument commercially viable and more useful to researchers. This work would include increasing the low-end measurement resolution of the device, decreasing its size, and increasing its robustness. For photobiological research, the spectral sensitivity of the RFD meter must match that of the circadian system. With a small amount of additional effort, the RFD meter can be made ready for commercial production.



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