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Calculation of NET (Noise Equivalent Temperature) for a Thermal (Black) Pyroelectric IR Detector App Note 13-01

The NET (Noise Equivalent Temperature) is defined as the minimum detectable temperature such that the signal from the detector through the optics is equal to its noise (SNR = 1).

Noise Equivalent Power (NEP) is the minimum detectable power which a detector can measure with a S/N of 1. D Star (D*) is the specific detectivity accounting for the size of the detection element.

When characterizing the NET we must define the optical power on the detector's active area in terms of a minimum temperature difference or ΔT causing that power difference or excitance.

The excitance (MBB814) as a function of temperature and wavelength in the 8 to 14 micron interval from a 300 K BB is found below:

C1 = 3.7413 x 10^{-12}, C2 = 1.4388, T_{bb} = 300 °K, Lower Wavelength 8 x 10^{-4} cm,
Upper Wavelength 14 x 10^{-4} cm, ε = .999

$$MBB814 := \left[\int_{A}^{B} C1 \cdot \left(\frac{1}{L^5}\right) \cdot \left(\exp\left(\frac{C2}{L \cdot Tbb}\right) - 1\right)^{-1} \cdot \frac{C2}{L \cdot Tbb^2} \cdot \frac{1}{\left(\exp\left(\frac{C2}{L \cdot Tbb}\right) - 1\right)} dL \right] \cdot \varepsilon$$

MBB814 = 3.285 x 10^{-6} Watts/cm²

Detector and Optical Considerations

(Typical MWA 4110 1 mm Dia. LTO with Rv and Vn @10Hz 1Hz. BW)

$$Rv := 2500 \frac{V}{W} \quad Vn := .6 \cdot 10^{-6} \text{ V/sqrt Hz.} \quad NEP := \frac{Vn}{Rv} \quad NEP = 2.4 \times 10^{-10} \quad Fnumber := 1.2 \quad dd := .1 \quad Ad := \frac{dd^2}{4} \cdot \pi$$

$$Ad = 0.008 \quad Dstar := \frac{Rv \cdot \sqrt{Ad}}{Vn} \quad Dstar = 3.693 \times 10^8$$

Solving with a SNR of "1" we find the NET

$$NET := \frac{Fnumber^2 \cdot NEP}{MBB814 \cdot Ad \cdot SNR} \qquad NET = 0.0134 \ °K$$

Alternately we can find the NET using Dstar

$$NET := \frac{Fnumber^2}{(\sqrt{Ad}) \cdot MBB814 \cdot Dstar \cdot SNR} \qquad NET = 0.0134 \ °K$$

In conclusion one can see that a typical 1 mm dia. MWA 4110 LTO Pyroelectric detector chopped at 10 Hz. with an F# 1.2 is capable of achieving an NET of 13.4 mK

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