# Experiment 2

# Wiens Displacement Law

## 1. Objective

This experiment is designed to guide students in understanding Wien's Displacement law using a commercially available incandescent light bulb (60 W) as a source of black-body radiation. A single color optical filter is also introduced for selecting a wavelength in the visible range. AC voltage is used to illuminate the incandescent bulb at different voltages and the corresponding photointensity is measured on a spectrometer. In this experiment students will observe wave length displacement dependence on filament temperature.

## 2. Theoretical Background

We see objects when light is reected from them. At high temperatures, bodies become self luminous and start glowing even in the dark. Radiation emitted by a body due to its temperature is called thermal radiation. All bodies not only emit but also absorb such radiations from their surroundings and finally come into thermal equilibrium. If we steadily increase the temperature we notice that the predominant color shifts from dull red through bright yellow-orange to bluish white heat. This change in color shows that the frequency distribution of the emitted radiation changes with temperature. Since the thermal radiation spectrum strongly depends on temperature, we can easily estimate the temperature of a hot body through the emitted radiation. This is the basis of color thermometry.

In real practice, the radiation emitted by a body not only depends on the temperature but also depends on the material, shape and nature of its surface. Such factors make it dificult to understand thermal radiation in terms of simple physical models, just like dificulties arise in understanding properties of real gases in term of simple atomic model. The 'gas problem' was resolved by introducing an 'ideal gas'. Likewise the radiation problem is solved by introducing the concept of an 'ideal radiator' for which the spectral distribution depends only on the temperature and on nothing else.

Wein's displacement law Wilhelm Wein (1864-1928) deduced that $\lambda_{max}$ at which the spectral radiancy is maximum varies as $1/T$ and the product is a universal constant,

$$\lambda_{max}T = 2{,}898 \times 10^{-3}\,\mathrm{mK}$$

The spectrum of intensity as a function of wavelength for cavity radiation for selected temperatures is sown in Figure (1). The diagram indicates a wavelength shift of the most intense radiation (indicated by the peak) towards lower wavelength as the temperature of the black body increases.

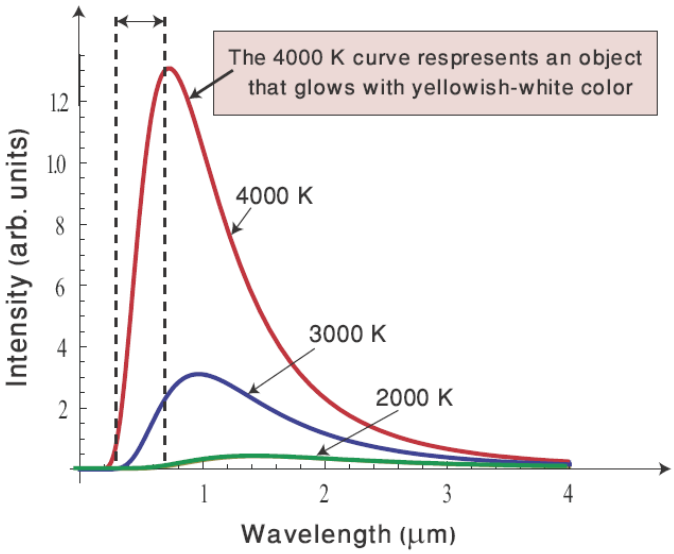


Figure 1: The intensity distribution at various temperatures as a function of wave-length for an ideal blackbody. The arrow shows the region that is approximately equal to the visible range.

## 3. Apparatus/ Materials

1) Computer
2) Variac (0-250 V)
3) Fiber Optic
4) Vernier SpektroVis
5) Tungsten light bulb rated at 60 W, 220-240 V

## 4. Procedure

The experimental setup is shown in Figure (2). Connect a 60W incandescent light bulb to the variac in series. Arrange the Fiber Optic (FO) cable face to the light bulb, then plug the other edge of FO to the Vernier Spectrovis Plus, observe graph which captured in Logger Pro. Observe the spectrum when various voltage. According to Wien's displacement law, please make your own summary!

**Note: Make sure the variac is unplugged when you are making electrical connections. Wear safety gloves. Remember, never touch bare electric wires. It can be fatal.**

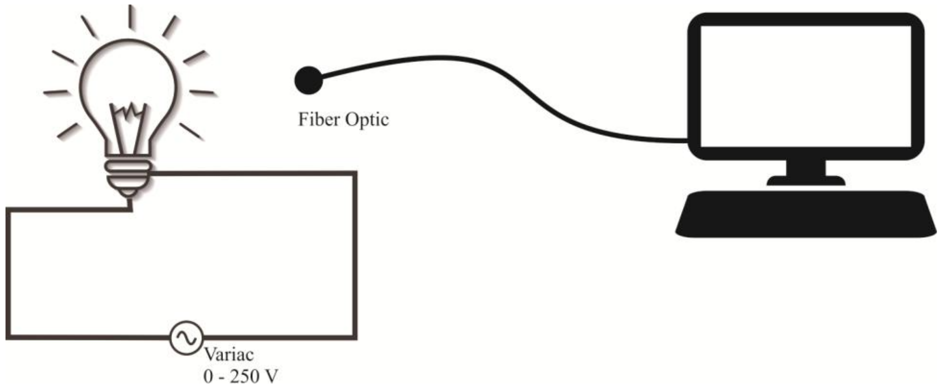


Figure2: The experimental setup