

Illumination with Engineered Diffusers™

RPC Photonics' Engineered Diffusers™ can be customized to spread an input beam in general fashion, depending on the operating conditions and application requirements. In this note we review some of the typical ways the light distribution is defined and two common illumination conditions, versus angle and at a screen.

Illumination modes

Intensity, or more accurately, radiant intensity, is defined as the power per unit solid angle emitted by the diffuser into a given direction. One can imagine a detector being moved along an arc centered on the diffuser as illustrated in the diagram below.

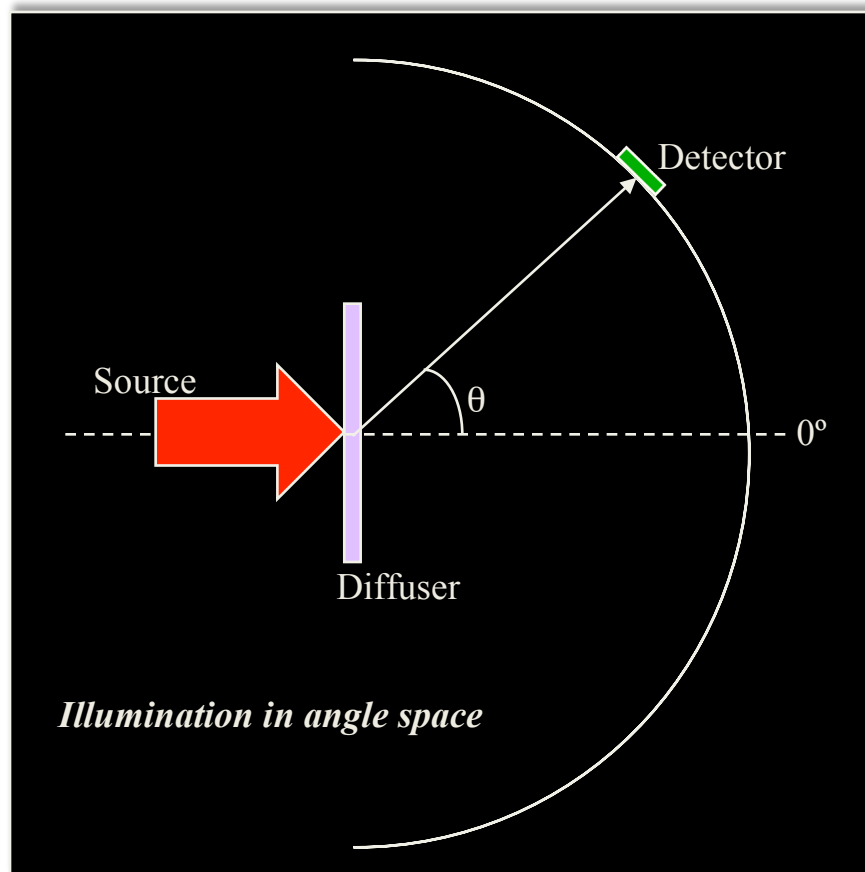


Figure 1: Illumination in angle space (intensity).

The detector has a certain angular extent, which defines how much light is captured at each angle.

Another common scheme requires the diffuser to illuminate a screen, as shown below.

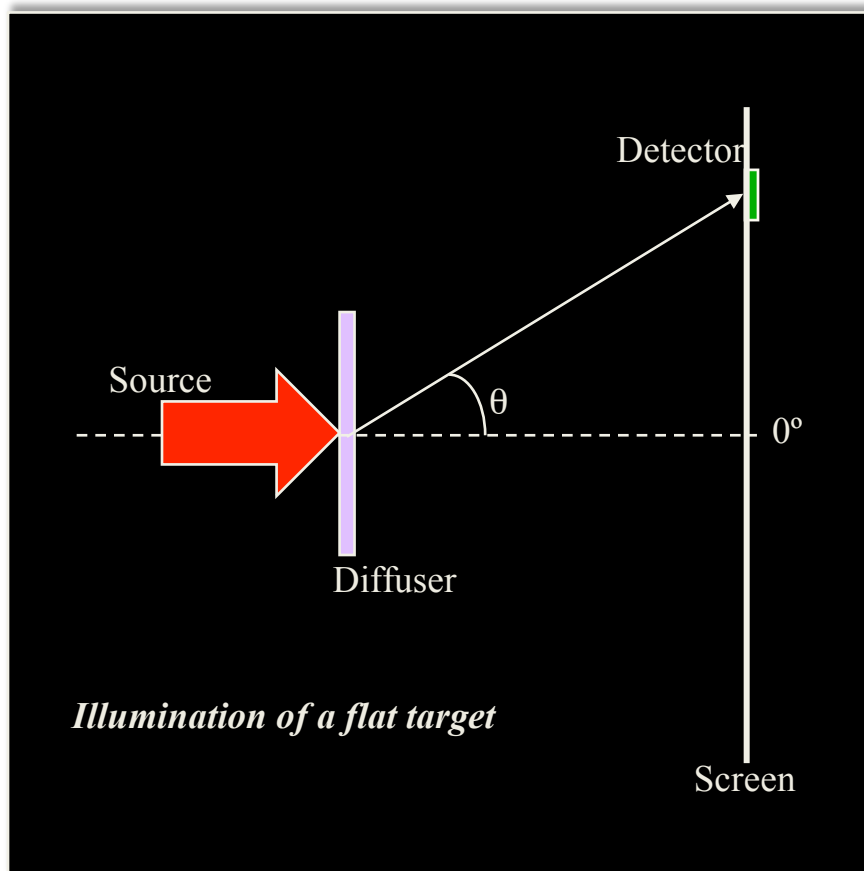


Figure 2: Illumination of a flat target/screen (irradiance).

In this case the energy profile as a function of angle is generally referred to as “irradiance”.

There are a few things one should notice in relation to these two illumination schemes:

1. For illumination in angle space the detector is generally pointed towards the source. Therefore the angular range defined by the detector is always the same for any given observation angle.

- So, for example, if the diffuser produces uniform intensity over a $\pm 40^\circ$ range, an observer would see the same amount of energy anywhere within this range anywhere on the measurement arc.
2. In the illumination of a screen of flat target the detector is parallel to the screen. In this case, the total amount of energy captured by the detector depends on the angle of observation and gets smaller as the angles increases or decreases away from the origin. Consequently, to produce uniform illumination at a screen more energy needs to be directed towards the edges compared to the amount of energy at the origin.
 3. Based on items 1 and 2 above, it is clear that a diffuser designed to operate in a given mode of illumination will behave differently when used in a different mode. For instance, a diffuser that produces uniform intensity (versus angle) does not produce uniform irradiance (at a screen). Similarly, a diffuser that uniformly illuminates a screen (uniform irradiance) does not provide uniform intensity (in angle space).

Uniform illumination

At RPC Photonics Engineered Diffusers™ are generally defined in terms of their intensity profile, that is, the energy distribution as measured in angle space, Figure 1 above. For example, most of RPC Photonics' standard diffusers are designed to provide uniform illumination in angle space. As a result, unless the diffuser angle is small enough, these diffusers cannot provide uniform irradiance, or uniform illumination of a flat target or screen, as in Figure 2.

Example of diffusers operating under these two modes are shown below:

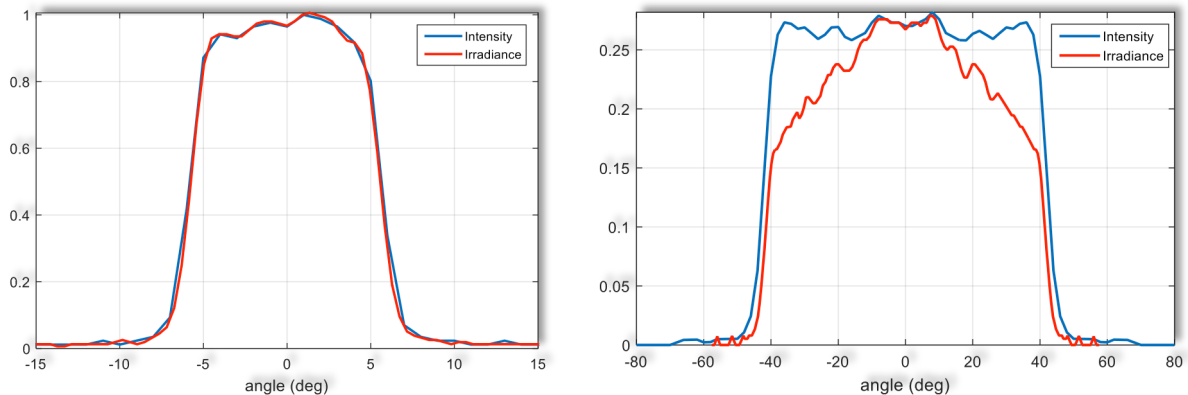


Figure 3: Two diffusers (10°, left, and 80°, right, full-width) designed for uniform illumination in angle space and their performance at a flat target.

To illuminate a flat target with a more uniform light distribution the amount of energy measured in angle space needs to increase with angle. This kind of intensity profile is often referred to as a “batwing” profile. An example is shown in Fig. 4 below.

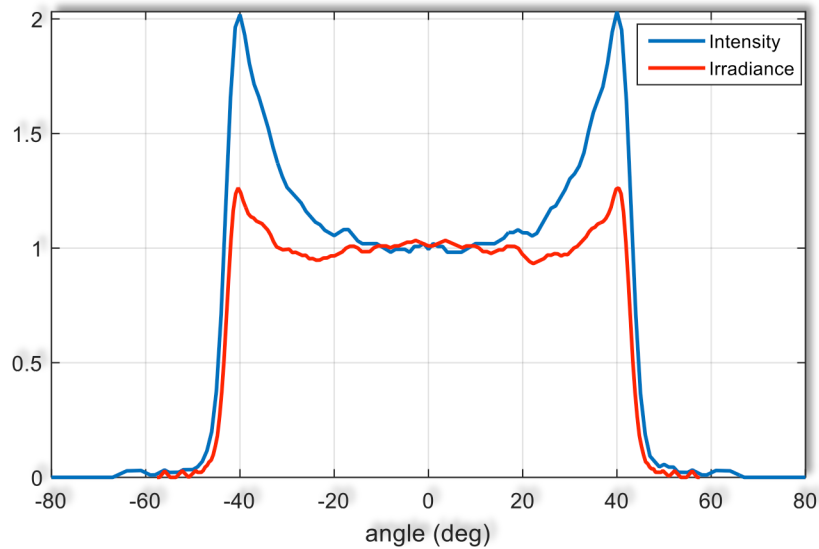


Figure 4: A batwing diffuser (blue line) directs more energy towards wide angles compared to the center. As a result, it provides more uniform illumination at a flat target, or uniform irradiance.

The concept of a batwing diffuser is very general and not all batwing diffusers will produce uniform illumination of a target. If the intensity peak is much higher than the center, for example, it would create a ring pattern. As a consequence, it is important when specifying a certain diffuser to describe how it operates, whether in angle space or coordinate space, and what kind of light distribution is required.

RPC Photonics has the ability to control the intensity profile of its Engineered Diffusers™ for operation in any illumination mode that is required, whether they have uniform intensity, uniform irradiance, or another custom distribution.