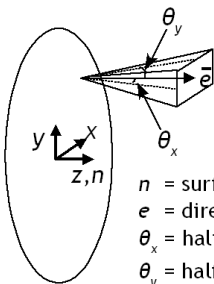


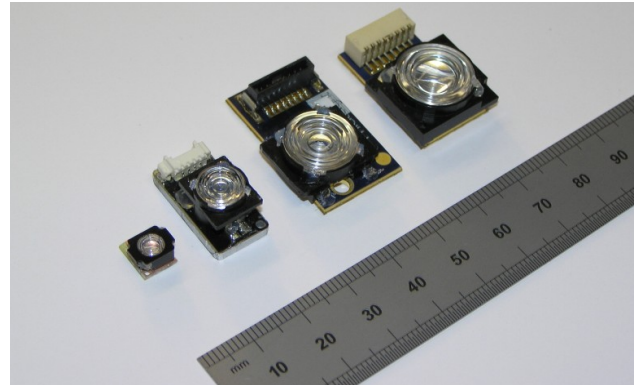
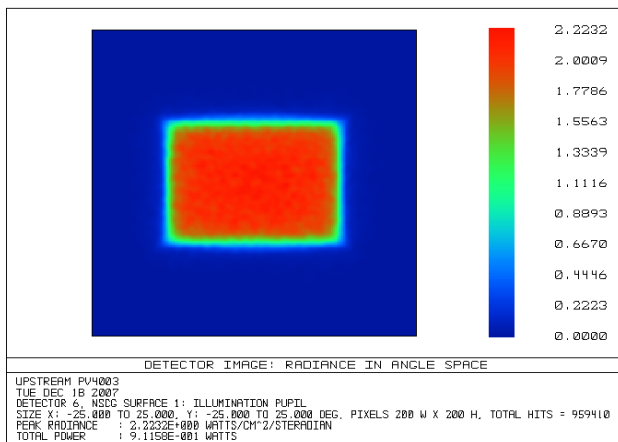
PhotonVacuum™ Technology

PhotonVacuum™ technology is an advanced optical illumination technology for LED based projection displays. It makes it possible to collect all the light from the LED die, which leads to the best possible lm/W ratio. By integrating several optical functions into one etendue preserving component the technology enables the superior performance in the smallest size.

The technology provides all-in-one illuminator including light collection, beam forming and homogenization functions, and resulting uniform and rectangular illumination. Each point at the output of the PhotonVacuum™ component emits light with a rectangular cone. The output is telecentric with solid beam in both spatial and angular space. The diameter and the opening angles of the illumination are adjustable for various projection optics.



n = surface normal vector of PV output
 e = direction vector of rectangular cone of light
 θ_x = half angle in x-direction
 θ_y = half angle in y-direction



Advantages:

Superior lm/W Ratio: Collects All the Light

- Collects the light emitted from the LED die to the whole hemisphere ($\pm 90^\circ$)
- Works equally well with both encapsulated LED dies (Luxeon, ZLED) and non-encapsulated LED dies (OSTAR, Luminus Devices)

Ultra Small Size: All-in-One Illuminator

- Integrates light collection, beam forming and homogenization functions into one component
 - 3x5x5mm³ with 1mm² non-encapsulated LEDs
 - 4x8x8mm³ with Luxeon K2/ ZLED P4
 - 8x15x15mm³ with Luminus PT54
- Minimizes the whole projector engine size by allowing LED die to be placed very close to or at the illumination pupil position

Preserved Etendue

- The etendue of the output beam is equal to the etendue of the source
- The output beam is spatially and angularly solid without etendue increasing holes

High Collection and Guiding Efficiency

- Provides up to 80% efficiency from the LED die to the microdisplay imager

Minimized Engine Losses

- Spatially the output of the PhotonVacuum component is circular with uniform irradiance, which provides optimum match to the projection lens pupil
- Angularly the output of the PhotonVacuum component is rectangular, which provides optimum match to the microdisplay shape

Good Uniformity

- Provides uniformity better than 85% inside the illuminated rectangular

Important Notice

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UPSTREAM

Upstream Engineering Oy is a Finnish optics company supplying optical designs and modules for the world smallest LED based accessory and integrated projector devices. Products are based on unique **PhotonVacuum™** illumination technology, which enables the best optical performance in the smallest size. The technology can be used also for other LED applications, where small size and superior light collection efficiency are important parameters.

For more information: www.upstream.fi



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