

CHERENKOV CONVERTER FOR LARGE DYNAMIC RANGE, HIGH SENSITIVITY DETECTORS FOR USE ON WIRE-SCANNERS

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ABSTRACT

We are developing a wire-scanner with a dynamic range of 10^6 or larger. In addition to the large dynamic range (LDR), high sensitivity is very desirable so that measurements can be made with a small amount of beam or small duty cycle beam. This high sensitivity requirement makes photo multiplier tubes (PMT) the preferred detector. Low dark current PMTs have maximum quantum efficiency in the visible wavelength range. We describe a converter where Cherenkov radiation (CR) is used to generate visible photons from electrons and positrons that are present due to wire-beam interaction. Also described is an optical system that collects and couples the CR into an optical fiber that delivers the visible photons to the PMT outside of the accelerator area, reducing background. The high directivity of the CR is used in a way that, when CR in the radiating medium is generated by particles not directed from the wire-beam interaction point to the converter, the CR is not coupled into the optical fiber and therefore does not create background for the wire-scanner measurements.

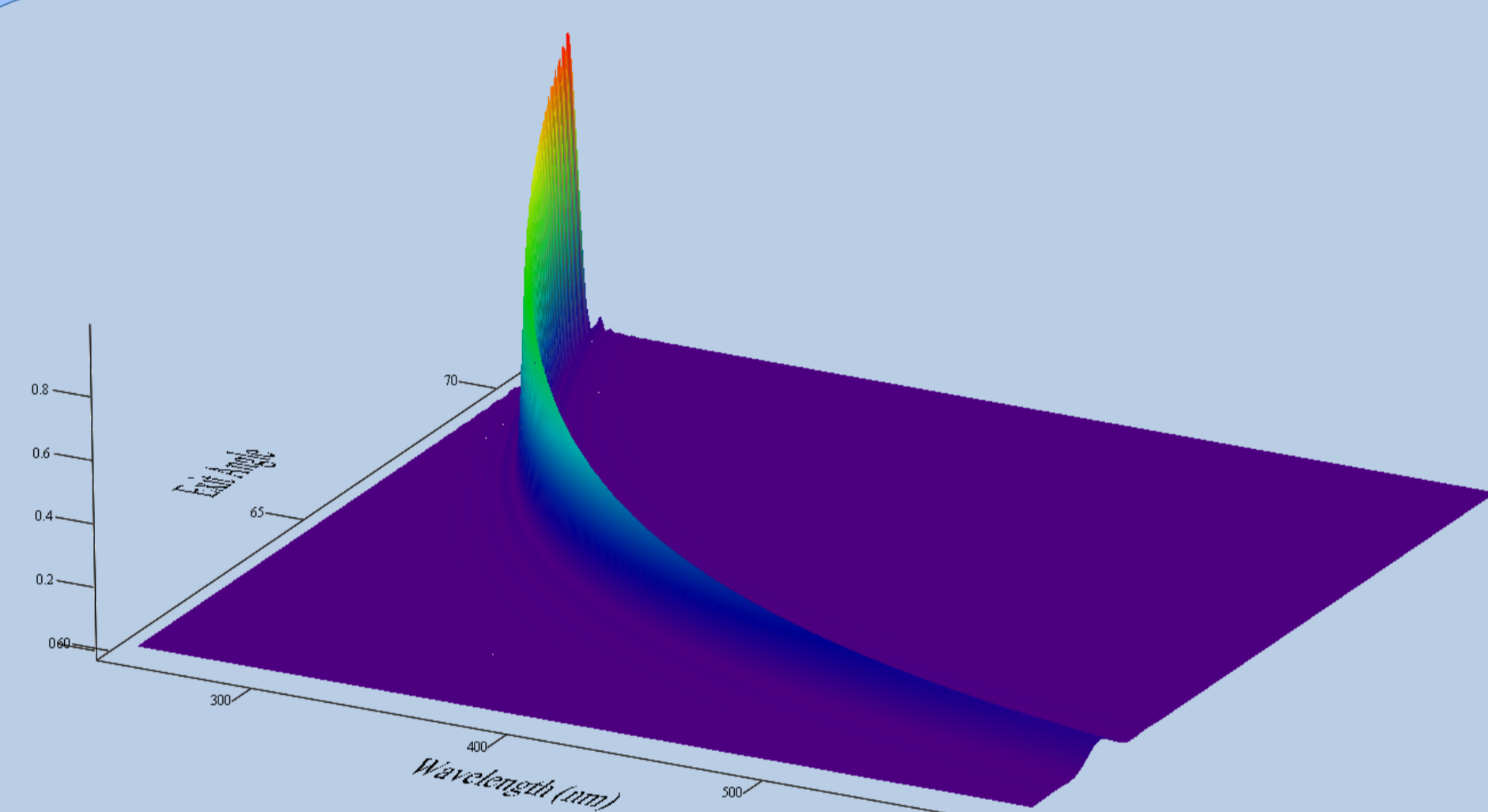


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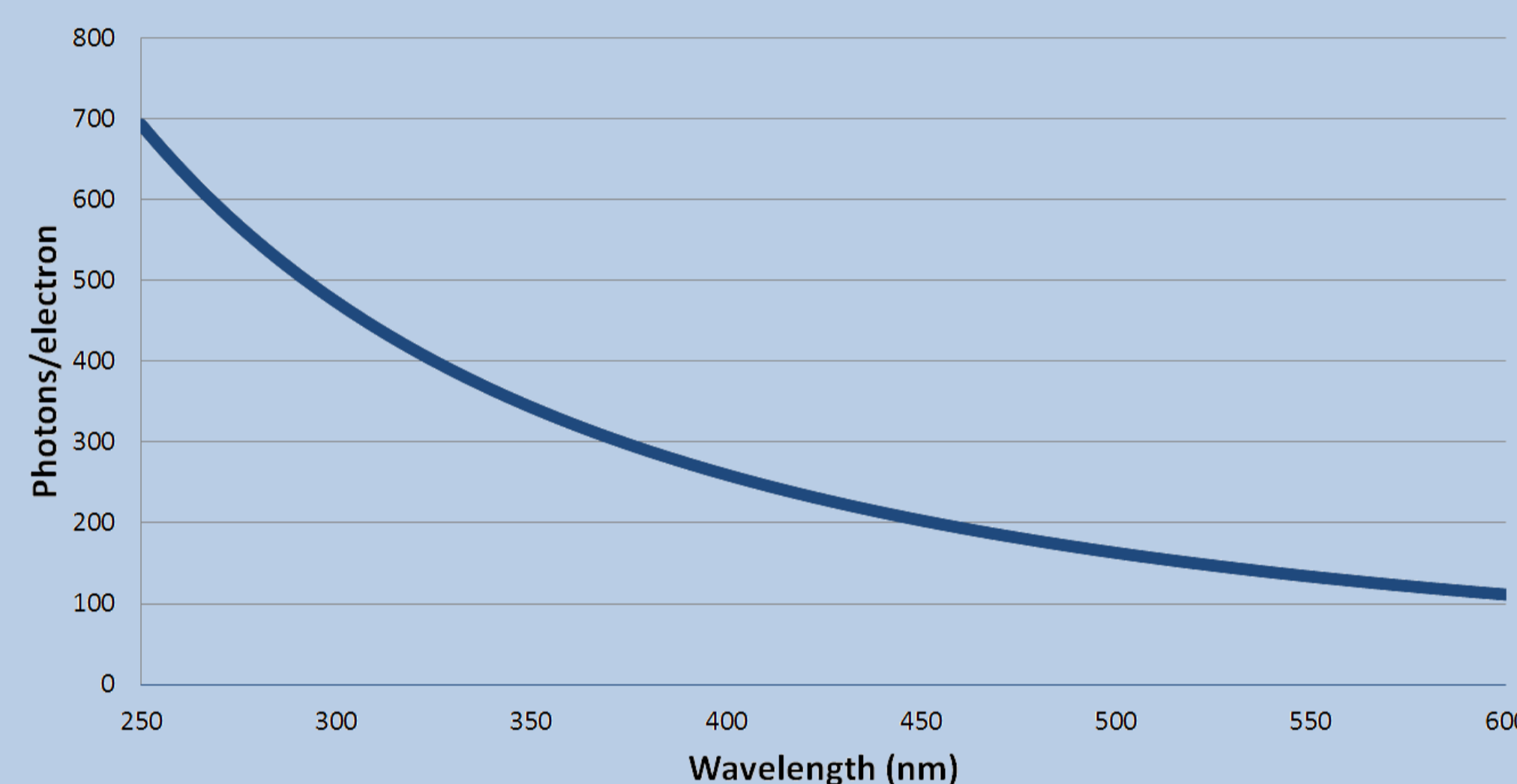
$$\frac{d^2N}{d\Omega d\lambda} = S_{CR} = \left(\frac{\alpha \cdot n(\lambda) \cdot L^2}{\lambda^3} \right) \cdot \sin^2(\theta) \cdot \left(\frac{\sin(k \cdot \pi)}{k \cdot \pi} \right)^2$$

$$k = \frac{L}{\beta \cdot \lambda} \cdot (1 - \beta \cdot n(\lambda) \cdot \cos(\theta))$$

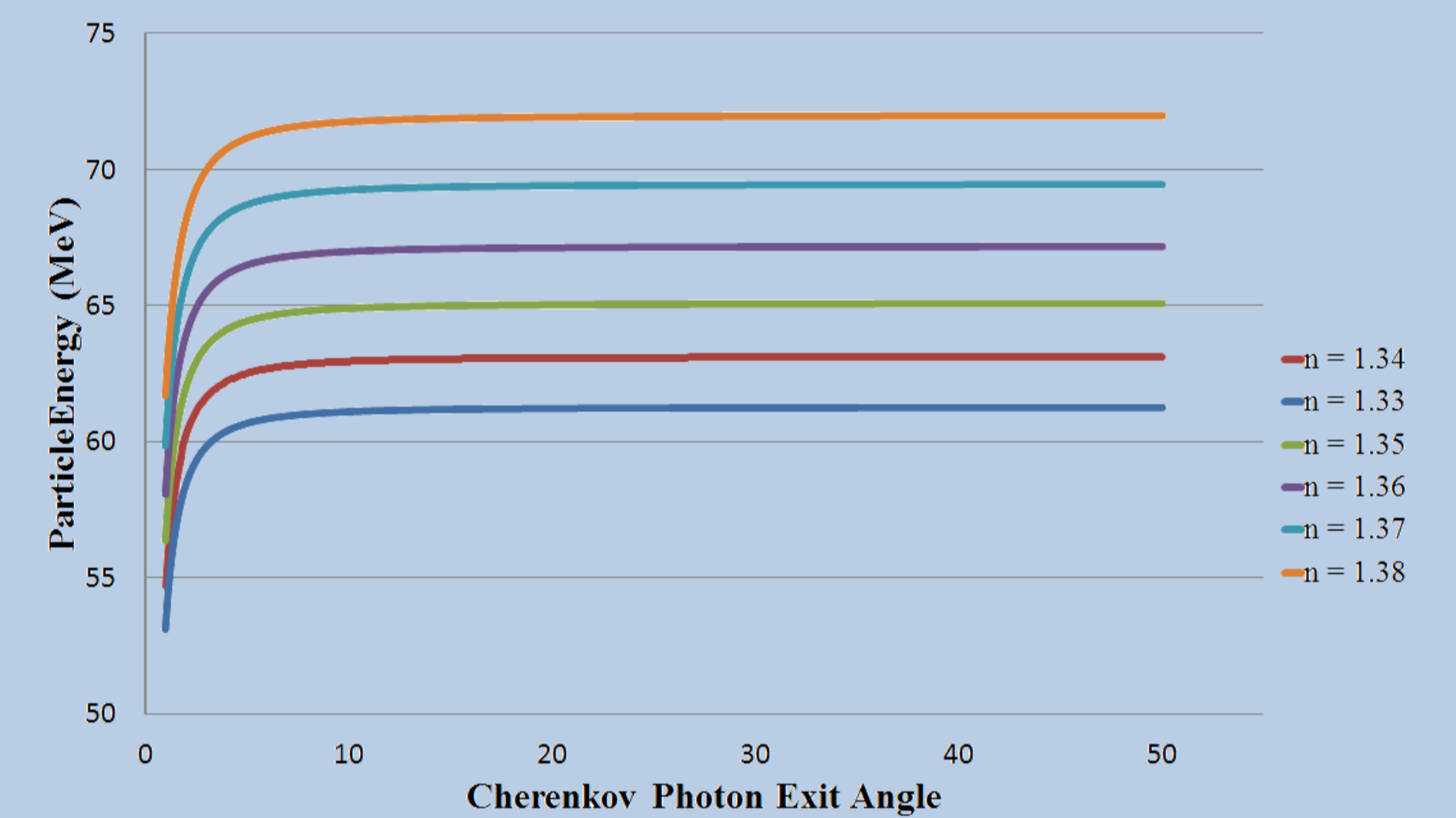
From the Frank-Tamm Formula - Number of Cherenkov Photons Generated per Unit Angle per Unit Wavelength



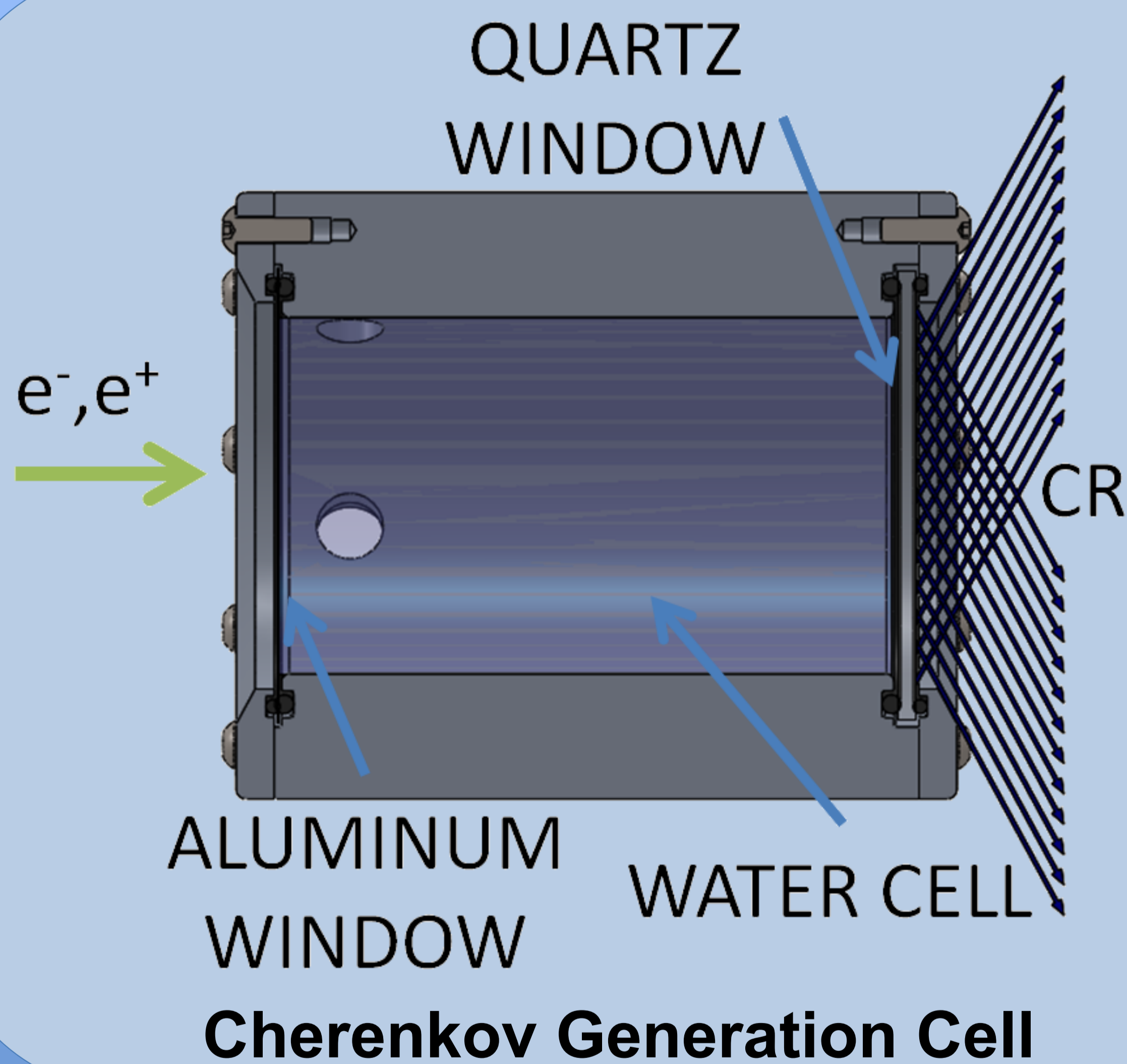
Photons Created as a Function of Exit Angle and Wavelength



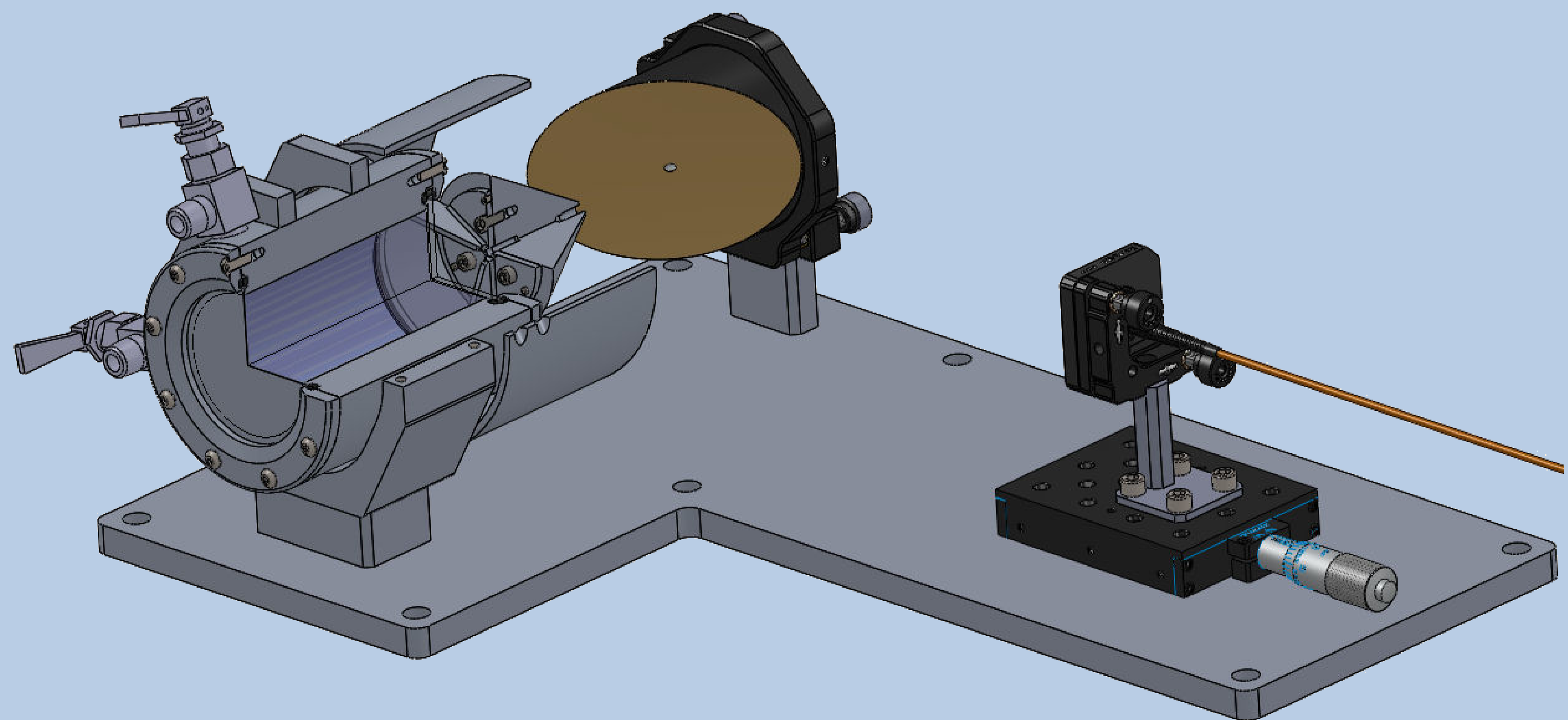
Photons Generated in a 100mm Long Water Cell



Exit Angle as a Function of Energy and Refractive Index

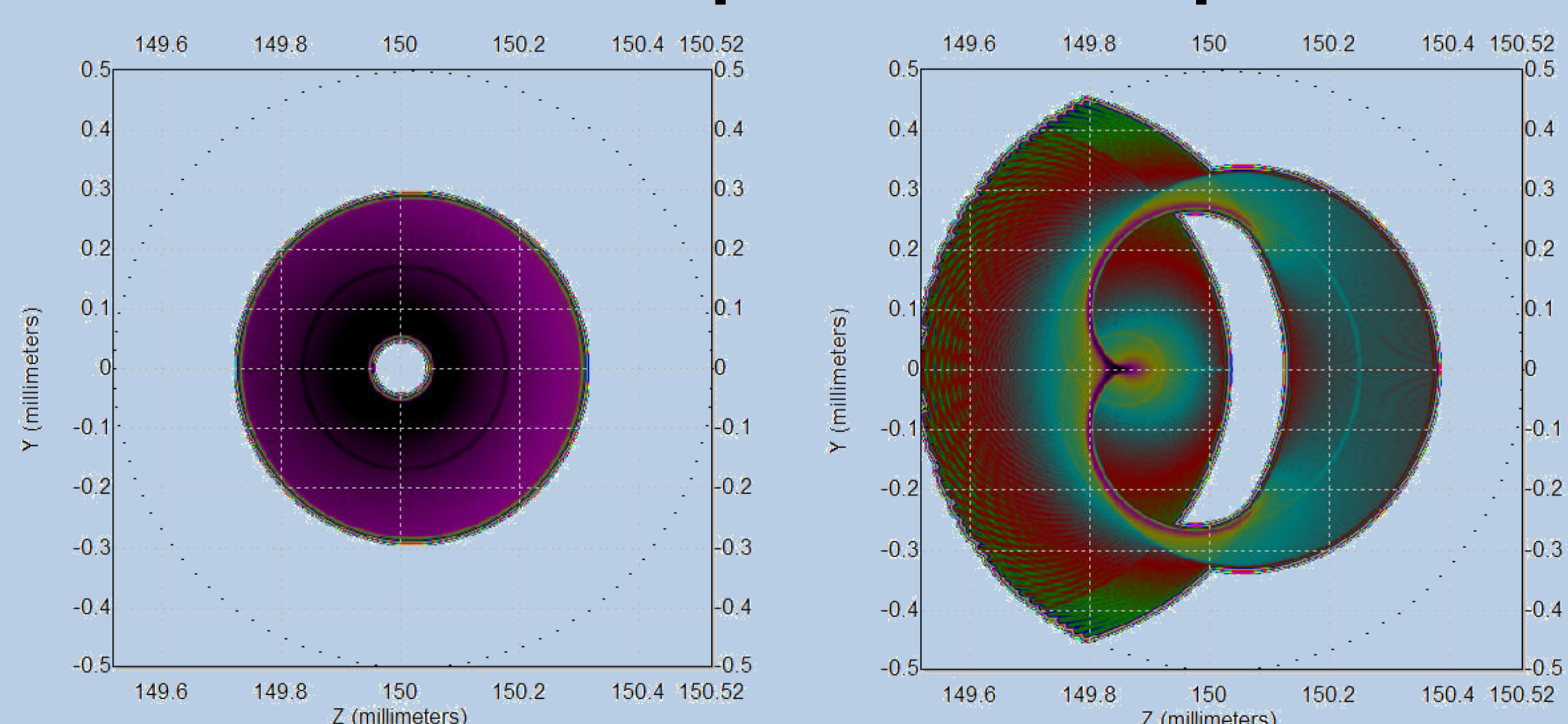


Cherenkov Generation Cell



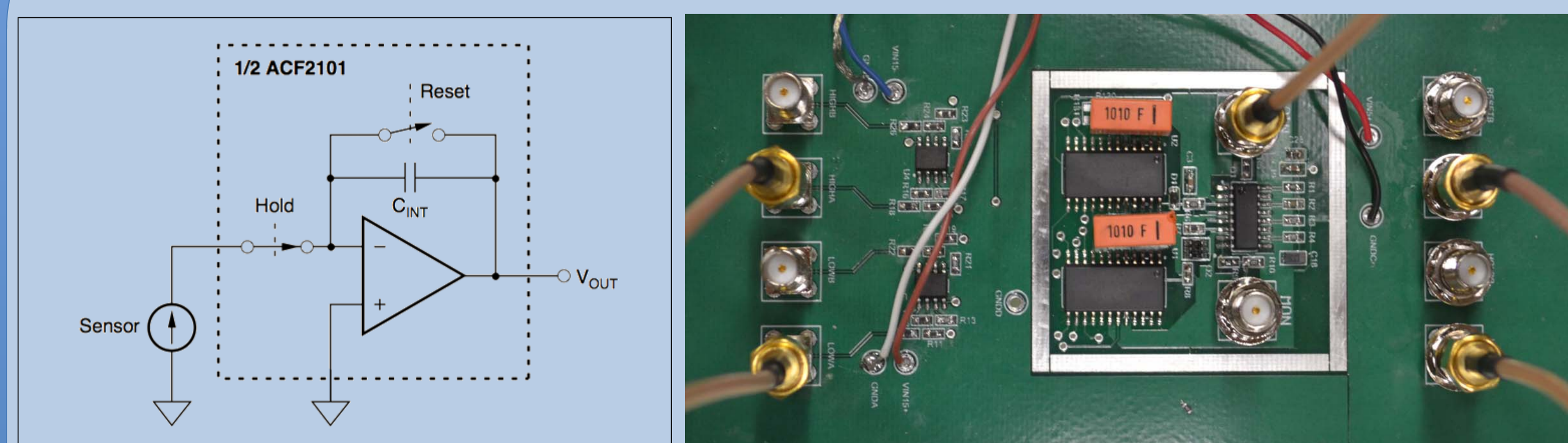
Cherenkov Generation Optics

Distribution on Optical Fiber Input Plane



Ideal Alignment

0.35mrad Misaligned



Gated Integrator Circuit and Board