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.

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

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

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

**Cherenkov Generation Optics**

**Quartz Window**

**Aluminum Window**

**Water Cell**

**Cherenkov Generation Cell**

**Photons Created as a Function Exit Angle and Wavelength**

**Photons Generated in a 100mm Long Water Cell**

**Exit Angle as a Function of Energy and Refractive Index**

**Distribution on Optical Fiber Input Plane**

**Ideal Alignment**

**0.35mrad Misaligned**

**Gated Integrator Circuit and Board**

Work supported by DOE Contract DE-AC05-06OR23177 and by BES Early Career Research Grant.