1. INTRODUCTION

Over 150 years since the discovery of the retinal rod and cone photoreceptors in 1834, it has been believed that, both visual and biological effects induced by light would be dependent on those two traditional photoreceptors. However in 2002, through the discovery of a novel photoreceptor in the eye by David Berson et al. [1] views have changed on how human vision system works. The novel photoreceptor, intrinsically photosensitive retinal ganglion cell (ipRGC) is one of the known ~20 ganglion cells in human retina. It has been estimated that of all retinal ganglion cells (RGC), 0.25% are photosensitive ipRGCs [2]. It was found [3] that the novel photoreceptor is responsible mainly for regulating light-induced human biological rhythms (circadian rhythms) by synchronizing body to environmental light/dark-cycle. It has also been proposed [4] to mediate light-induced increase in alertness, pupillary responses, and as a possible target for seasonal depression treatment. This novel photoreceptor may have many consequences for practical applications both in general lighting and lighting for special groups (e.g. elderly, shift workers, patients suffering from seasonal depression) so it has become a great interest of research in the lighting community [5].

However, the characteristics of non-image forming (NIF) visual system differ from the conventional visual system based on cones and rods. The NIF visual system has a higher threshold for activation, requires longer exposures for activation, depends on the location of light source in the visual field, and most importantly has different spectral characteristics with the peak wavelength (λ_{max}=480 nm) shifted towards the blue part of visible spectrum. Given that the spectral characteristics are different with the NIF visual system; conventional photometric illuminance can not be used to quantify the NIF responses in humans. As the temporal characteristics (duration and timing of light exposure) differ from visual system, simple measurement of task illuminance is not sufficient to determine the NIF effective light response for example during normal office work.

Measurement situations with NIF effective lighting can be divided roughly into two categories: measurement in strictly controlled laboratory studies and to field studies and workplace measurements. This work addresses the problems measuring the NIF effective light exposure by means of a literature review in field conditions using a portable head-mounted light dosimeter. However given that the biological effects of given light exposure are not completely unknown, the simple measurement of light exposure is not sufficient to produce new knowledge on the NIF visual system. Both in field and laboratory studies physiological measurements are needed to study the causality between biological effects and light. Within the scope of this work the physiological measures are only briefly reviewed. In reality when designing a dosimeter, the simultaneous measurement of measures such as ERG, EOG, EEG and ECG with light exposure should be taken into account (e.g. electromagnetic compatibility and space/weight restrictions). For a review of the physiology related to light exposure and NIF responses, the Master's thesis of the author is suggested [6].

In this work chapter 2 reviews briefly the circadian photobiology that is needed to understand the needs of the new measurement device needed to quantify the NIF responses. Chapter 3 reviews the literature on existing technologies for measuring NIF effective light exposure and the related measurements such as pupil size, eye tracking, electrical activity of eye, and NIF effective ambient luminosity distribution. In Chapter 4 the possible improvements and cost-cutting methods for the measurement are reviewed with some basic signal-to-noise ratio comparisons.