# A Novel Wavelength Detection Method Based on Wavelength Absorption in Silicon


K. Zhang[1], Y. Audet[1]

1. École Polytechnique de Montréal, Montréal, QC, Canada


**Introduction**: A new filter-less method of detecting the spectrum based on wavelength absorption in silicon is proposed. Wavelength dependent absorption coefficient produces a unique excess carrier distribution [1]. Thus the wavelength spectral information can be obtained by measuring the photon generated electron-hole pairs as a function of depth.

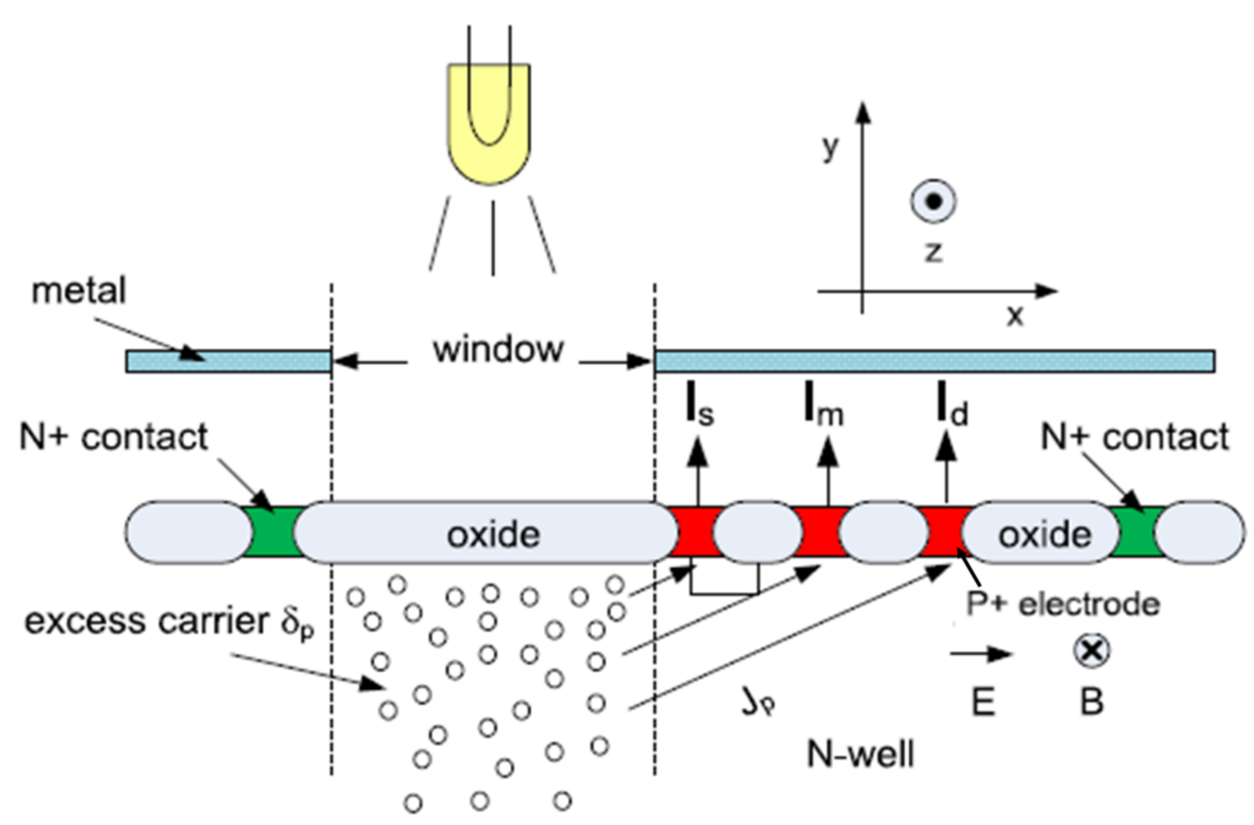


**Figure 1**. The schematic figure of the detection principle

**Theoretical Calculations**: We use the steady-state continuity equation to describe the carrier behavior under the constant incident illumination [2].

$$D_p \frac{d^2\delta_p(|y|)}{dy^2} - \frac{\delta_p(|y|)}{\tau_p} + g_p = 0$$

In order to collect the excess holes, we create an electric field and apply an external magnetic field to control hole transportation [3].

$$\mathbf{J_p(B)} = \mathbf{J_p(0)} - \mu_p^*(\mathbf{J_p(B)}\times\mathbf{B})$$

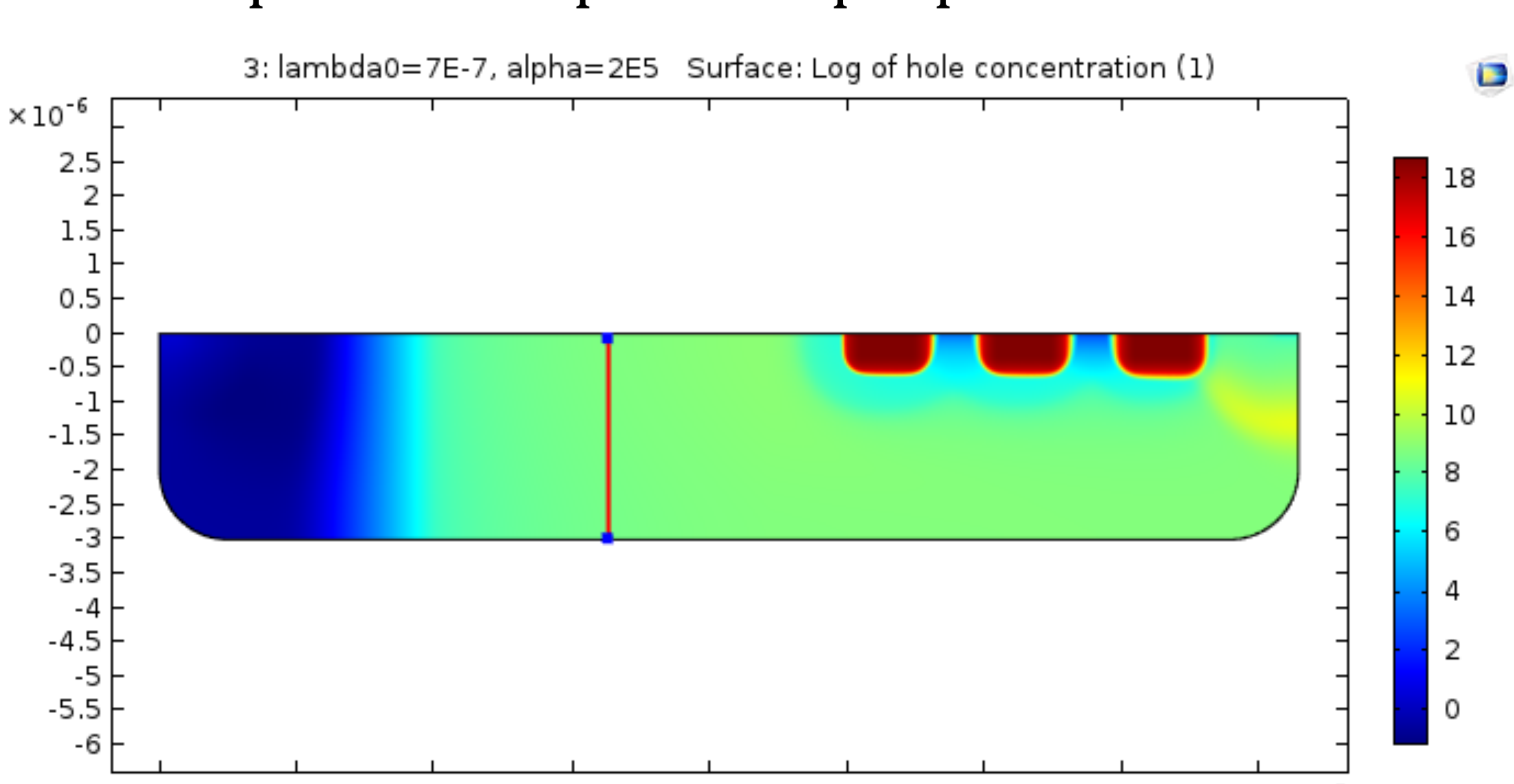


**Figure 2**. COMSOL model of the proposed wavelength detector figure

**Results**: Each wavelength has unique excess carrier distribution at the same incident power. An external magnetic field increases the measured current and improves the detection sensitivity. The measured current comes from a certain depth around 0.9um.

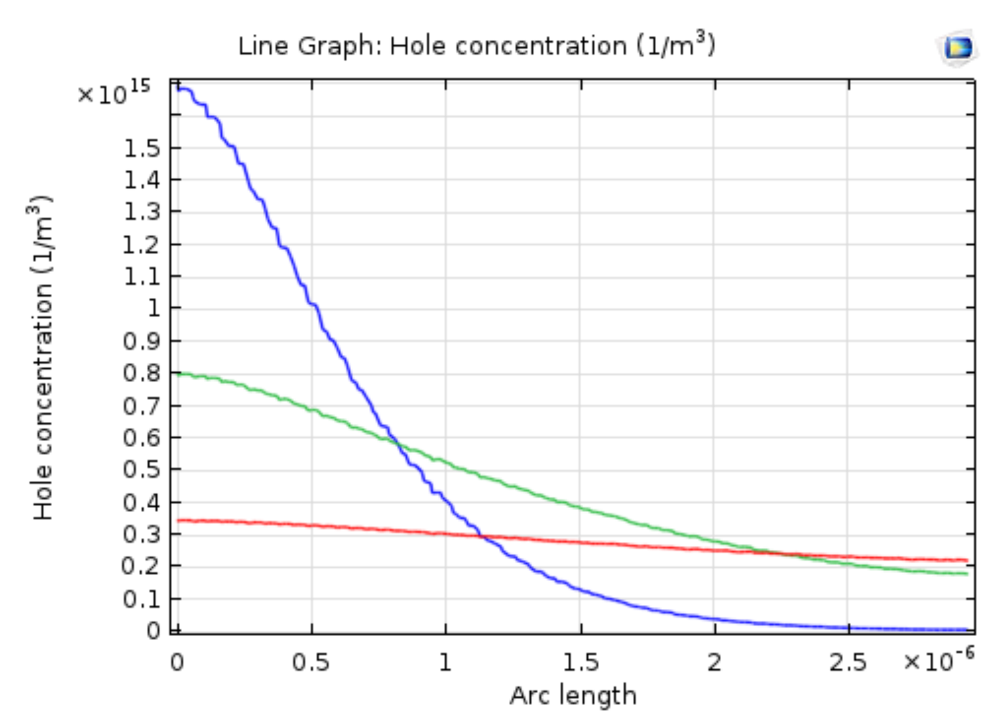


**Figure 3**. Excess hole concentration Vs depth without magnetic field

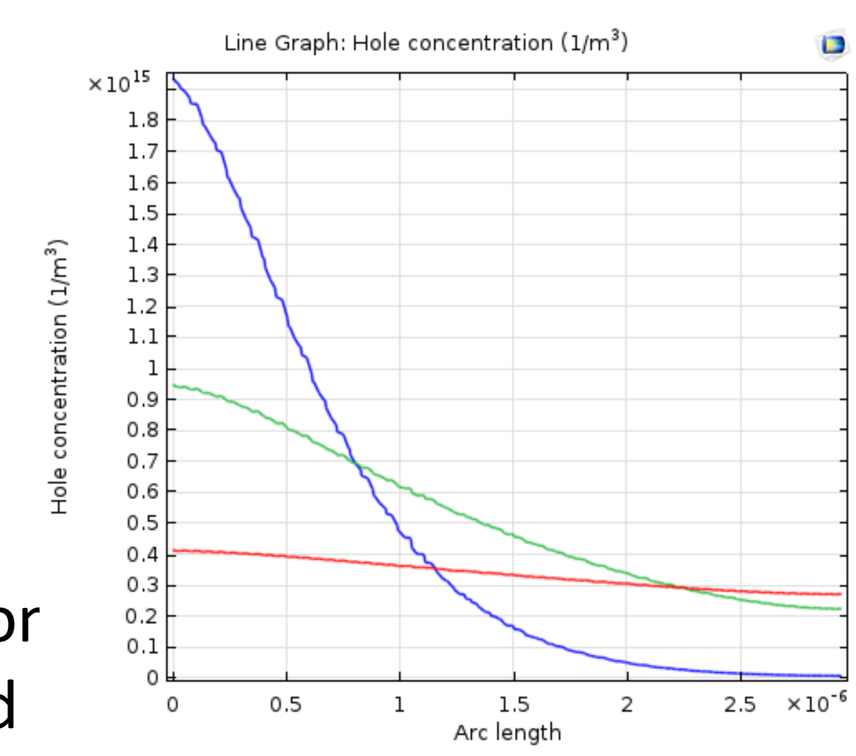


**Figure 4**. Excess hole concentration Vs depth with magnetic field

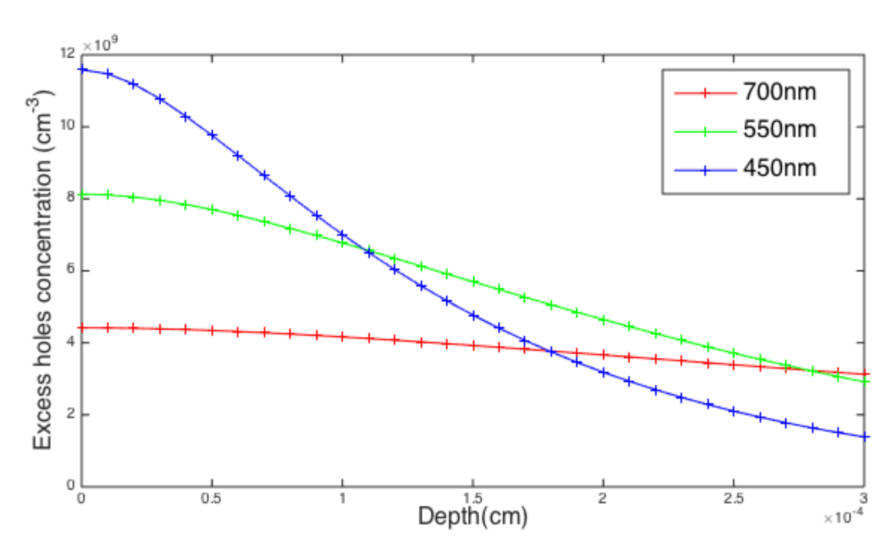


**Figure 5**. MATLAB calculation result

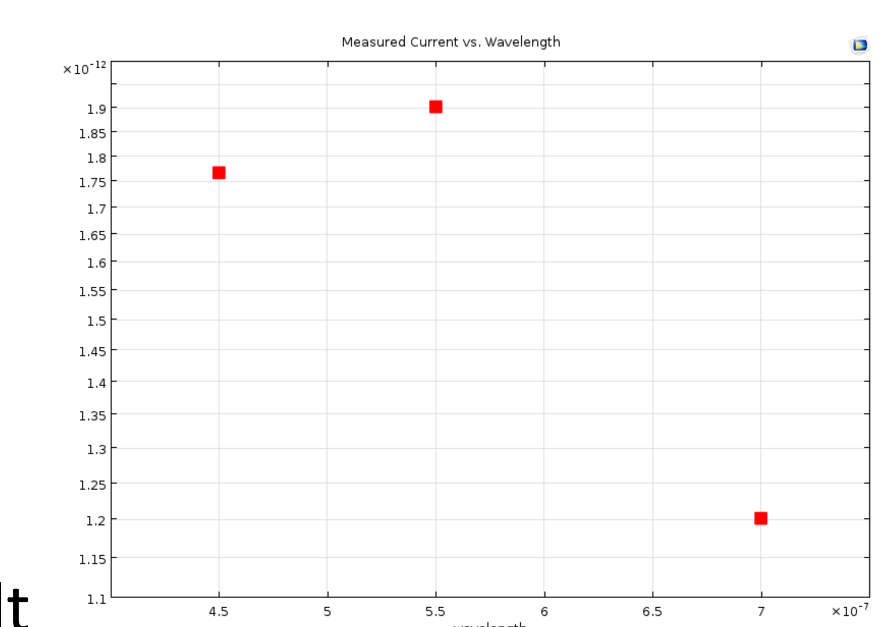

**Figure 6**. Middle P+ electrode current

**Conclusions**: A COMSOL model and MATLAB calculations validate the detection principle. More modeling results need to be compared to experiments before concluding on the performance of this novel highly integrated spectrometer device.

## References:


1. D. K. Schroder, Semiconductor Material and Device Characterization, 2nd ed. New York: John Wiley & Sons, 1998.
2. S. K. B. B. J. Streetman, *Solid State Electronic Devices*, 6th ed. Pearson Prentice Hall, 2006
3. H. P. Baltes and R. S. Popovic, "Integrated semiconductor magnetic field sensors," *Proc. IEEE*, vol. 74, no. 8, pp. 1107–1132, 1986.