# Notes on CVD Diamond Detectors

The energy necessary for the creation of electron-hole pair in diamond is 13 eV.The mobility of charge carriers is higher in diamond than in silicon, for holes it is 2.5 times higher, this allows faster charge collection. The bulk leakage current is very low $\sim 0.2$ pA/mm$^2$ at room temperature. It has a band gap of 5.5 eV and a displacement energy of 42eV/atom. These properties make the diamond radiation hard. It has a low dielectric constant (5.7) and thus low detector capacitance which results in low noise in the front-end electronics. It has a large thermal conductivity (4-5 times that of copper at room temp) this means they can operate without cooling. One disadvantage is the large band gap limits the number of electron-hole pairs created when a particle traverses it.

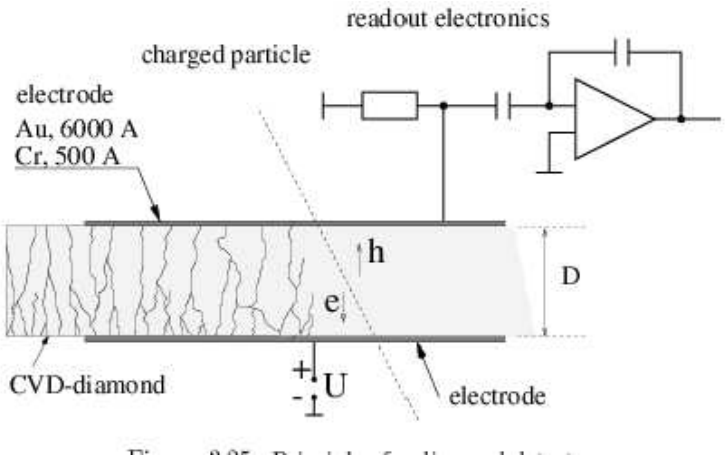


FIG. 1: Schematic of the charge propagation

Principle of a diamond sensor: A charged particle traversing the diamond deposits energy along its path due to Coulomb interaction with atomic electrons. The energy deposited is available to excite electrons from the valence band to the conduction band with subsequent creation of a vacancy (hole) in the valance band. The number of electron-hole pairs is given by $\bar{Q}_{gen} = \frac{eD}{\epsilon_c}(\frac{d\bar{E}}{dx})$, where $\epsilon_c$ is the energy to create an electron-hole pair (13 eV) and $D$ is the sample thickness. The charge carriers in the valance and conduction bands move towards the oppositely charged electrodes because of the potential difference across the electrodes. The distance traveled is limited due to defects states in the and gap. (These defects are the biggest difference between polycrystaline and single crystal diamonds). The average distance traveled for charge carriers is given by the average carrier drift distance. This is inferred from the measurement of the average charge collection distance (measured from the induced charge using $\bar{d} = \frac{\bar{Q}_{ind}}{\bar{Q}_{gen}}D$). The moving charges cause a current between the electrodes which is proportional to average charge collection distance and the particle flux. This induced charge is read out using a charge sensitive amplifier.