Simulation program to describe charge transport in diamond sensors

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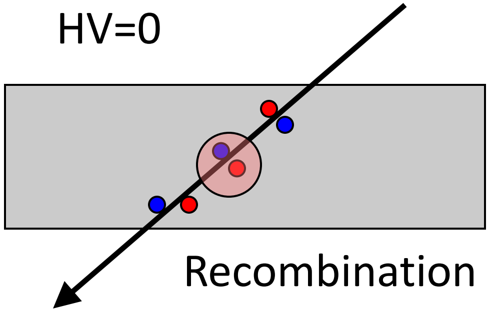
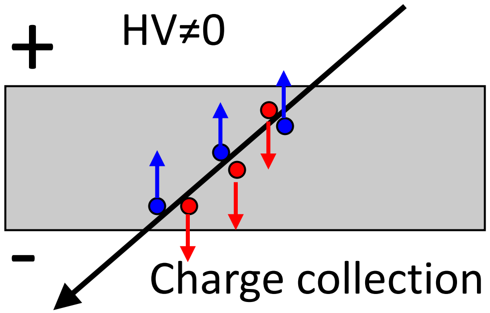
Charge creation



HV=0

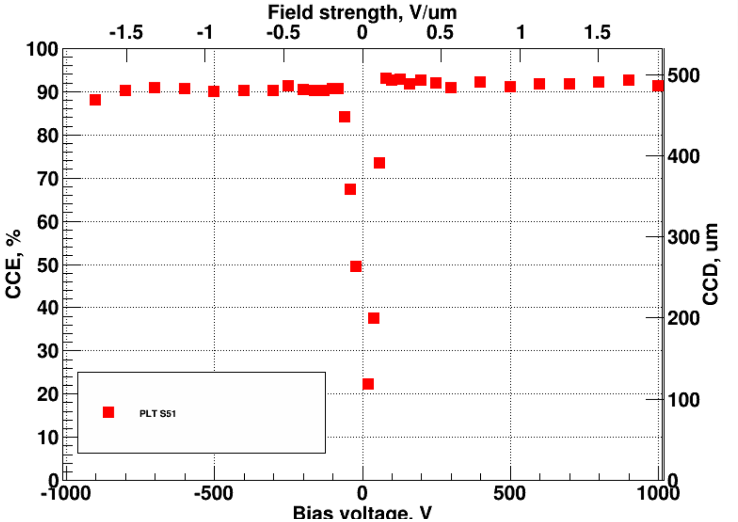
Recombination

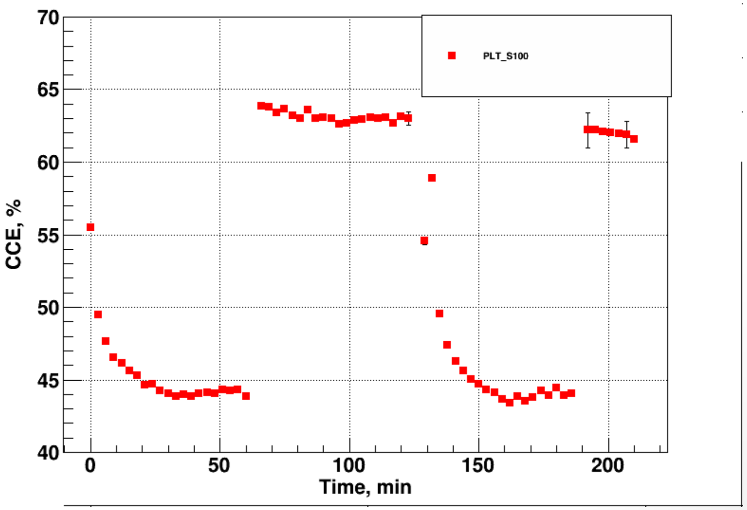


+ HV≠0

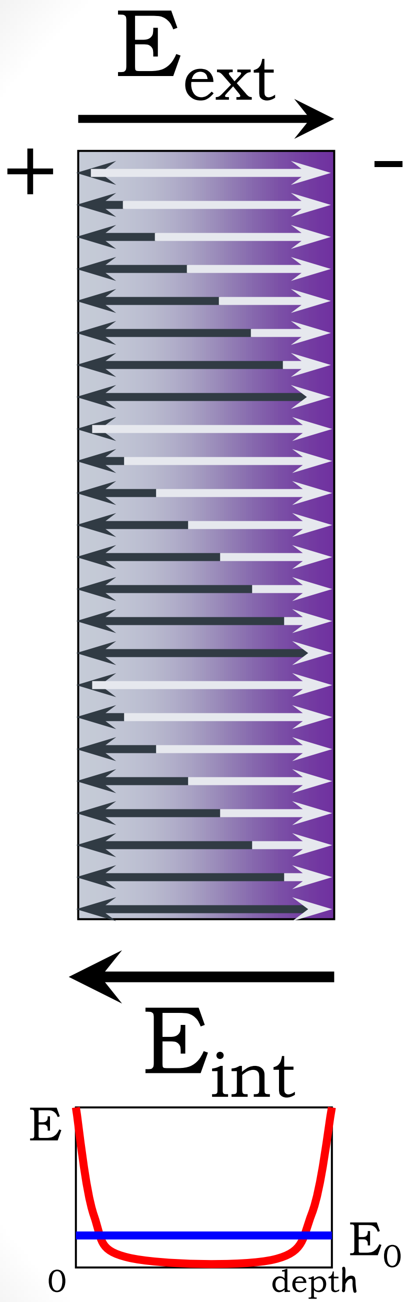
–

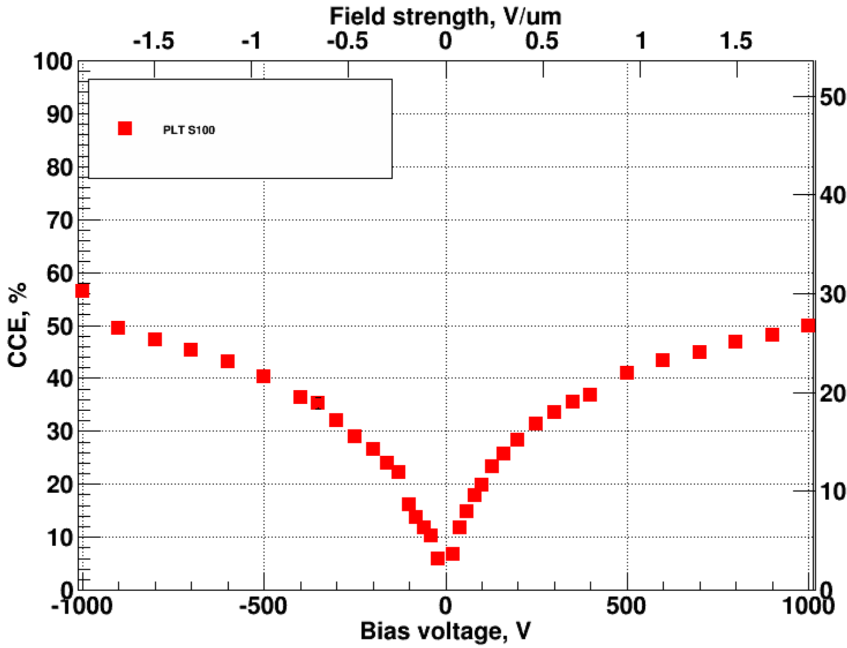
Charge collection





Damaged diamond



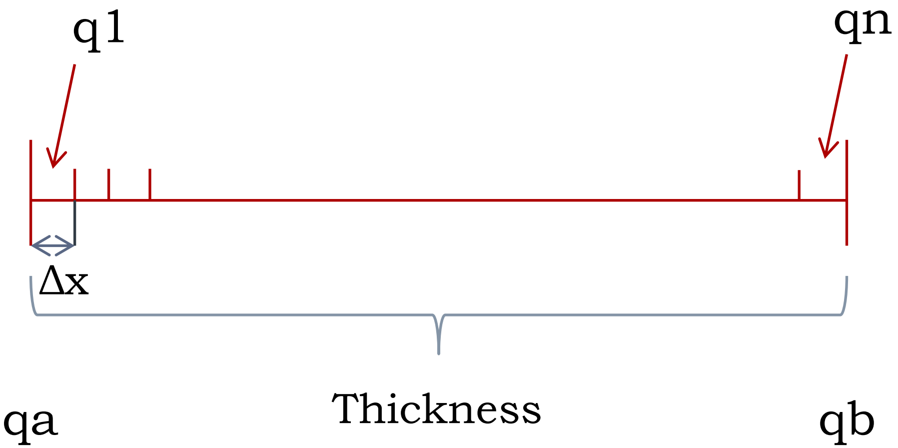


Simulation program

- Goal:
  - Create a simulation program to describe a polarization effect and charge transport in diamond.

Input data:	Result of the program:
Thickness; Applied voltage; Trap concentration; Hole and electrons cross section; Trap lifetime; Flux; Hole and electrons effective masses.	CCE; Current; Space charges; Effective capacitance; Internal electric field.

Calculation of internal electric field



$$E_j = \frac{1}{2\mathcal{E}_0\mathcal{E}_d}\left[\sum_{i}^{i<j} q_i - \sum_{i}^{i>j} q_i + q_a - q_b\right]$$

Charge transport

- Numbers of e-h pears
  - $N_{e-h\,pears} = \Phi \cdot 36 \cdot 10^{7}\ \left[\frac{e-h}{m}\right]$
- Numbers of e-h pears per bin
  - $\frac{N_{e-h\,pears}}{thickness/_{NumOfBin}}$
- Charge transport
  - $\frac{N_{e-h\,pears}}{thickness/_{NumOfBin}} \cdot f_{rec} \cdot N_{freeTrap} \cdot \sigma_{cap} \cdot \Delta l + N_{emitted}$
    - $\Delta l = V_{term}\ \cdot\ \Delta t$
    - $V_{term}\ = \sqrt{\frac{3 \cdot k_B \cdot T}{m_{eff}}}$
    - $\Delta t\ = \frac{\Delta x}{V_{drift}}$
    - $V_{drift}\ = \frac{\mu_0 E}{1+\frac{\mu_0 E}{V_{set}}}$
    - $N_{emitted} = N_t \cdot (1 - e^{-\frac{\Delta t}{\tau}})$

CCE and current calculation

$$\underbrace{\underbrace{\frac{N_{e-h\,pears}}{thickness/_{NumOfBin}}\cdot f_{rec}\cdot N_{freeTrap}\cdot \sigma_{cap}\cdot \Delta l}_{N_{min}} + N_{emitted}}_{N_{max}}$$

- $CCE = Q\,\frac{\Delta x}{Thickness}$
  - $Q = N_{min}\cdot e$

- $I = Q_{max}$
  - $Q_{max} = N_{max}\cdot e$

Future plans

- Create a program;
- Create a alternative voltage mode;
- Use traps with different energies.

- Thank you