EE 735: ASSIGNMENT 5 REPORT

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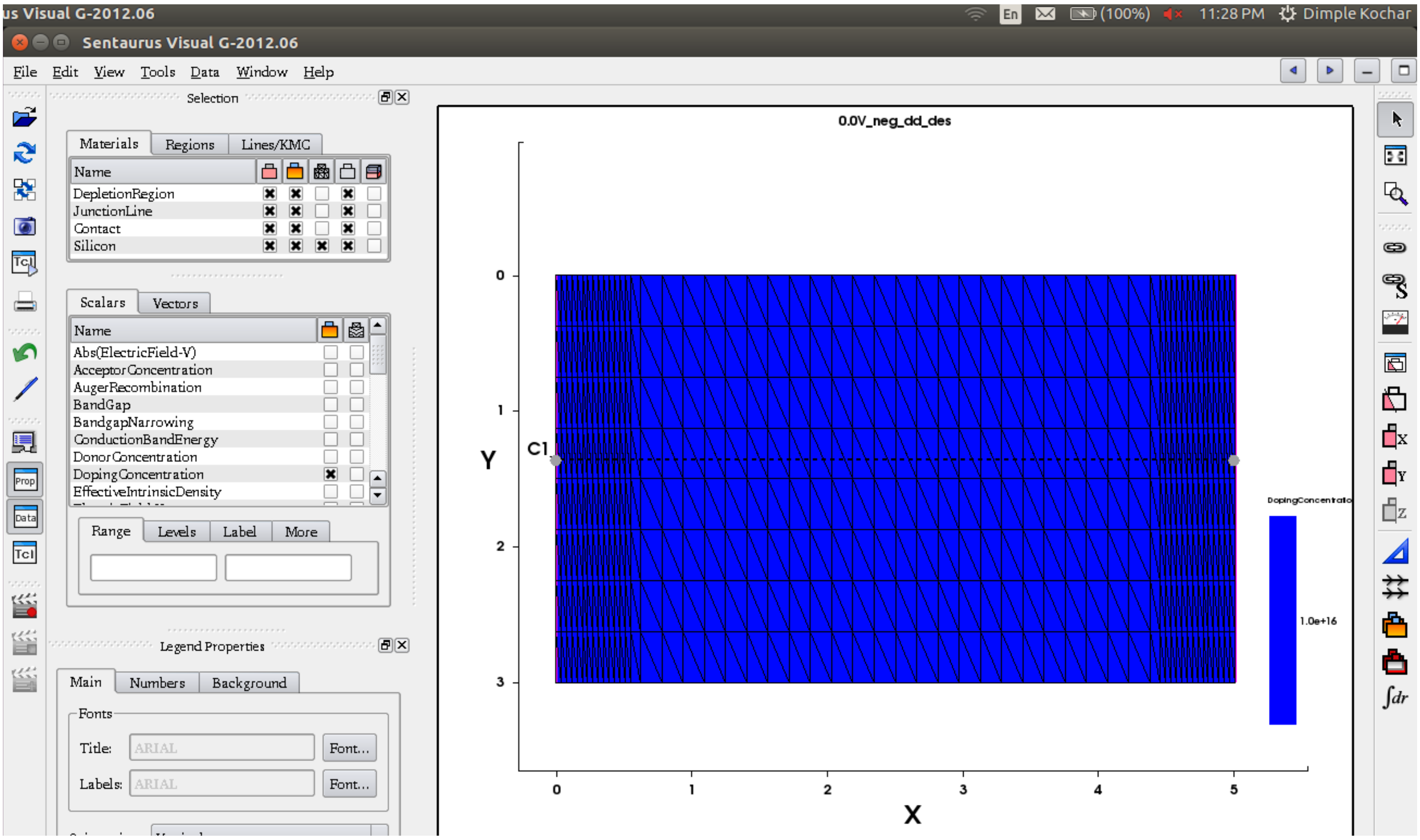
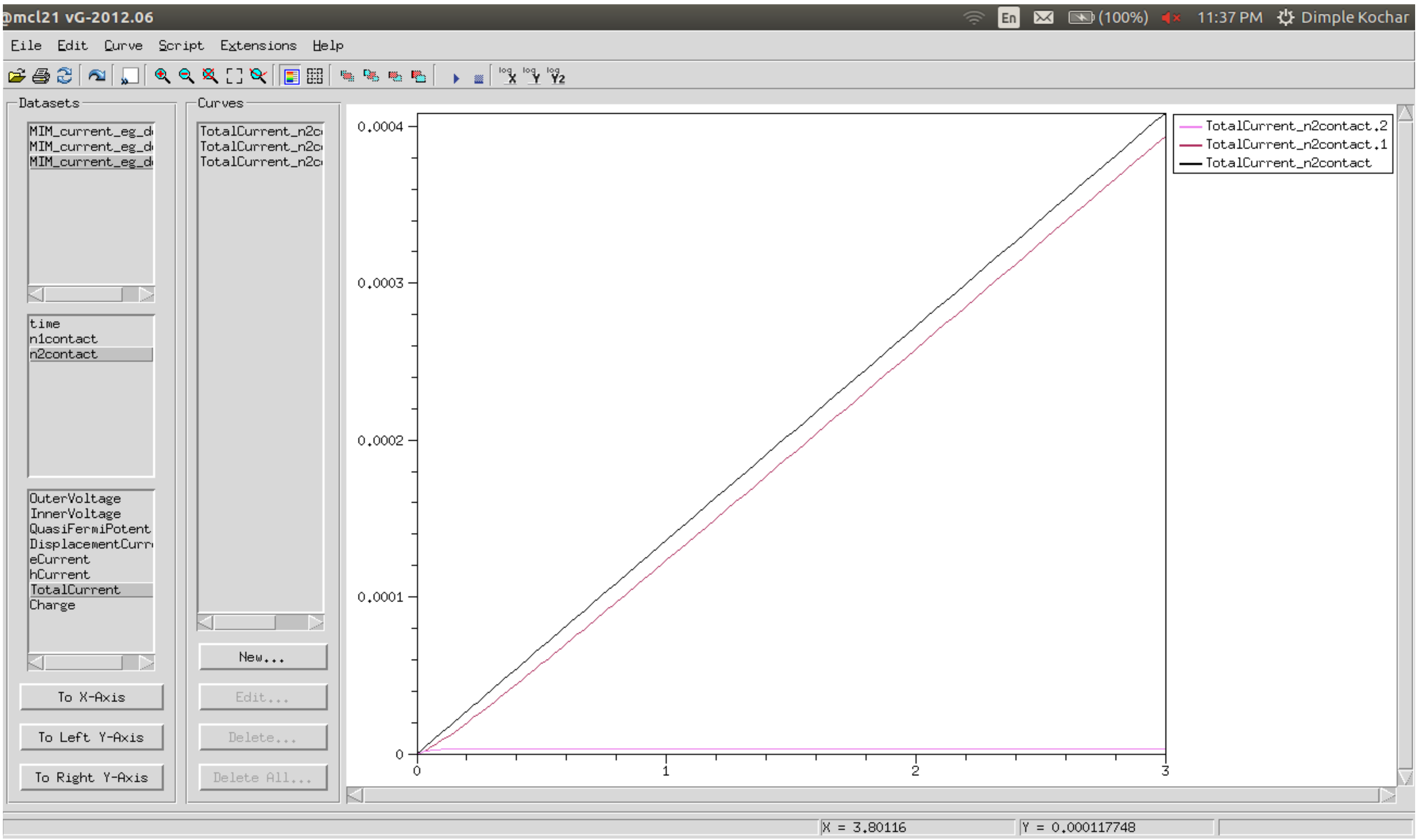
ROLL NO.: 16D070010

Q1.

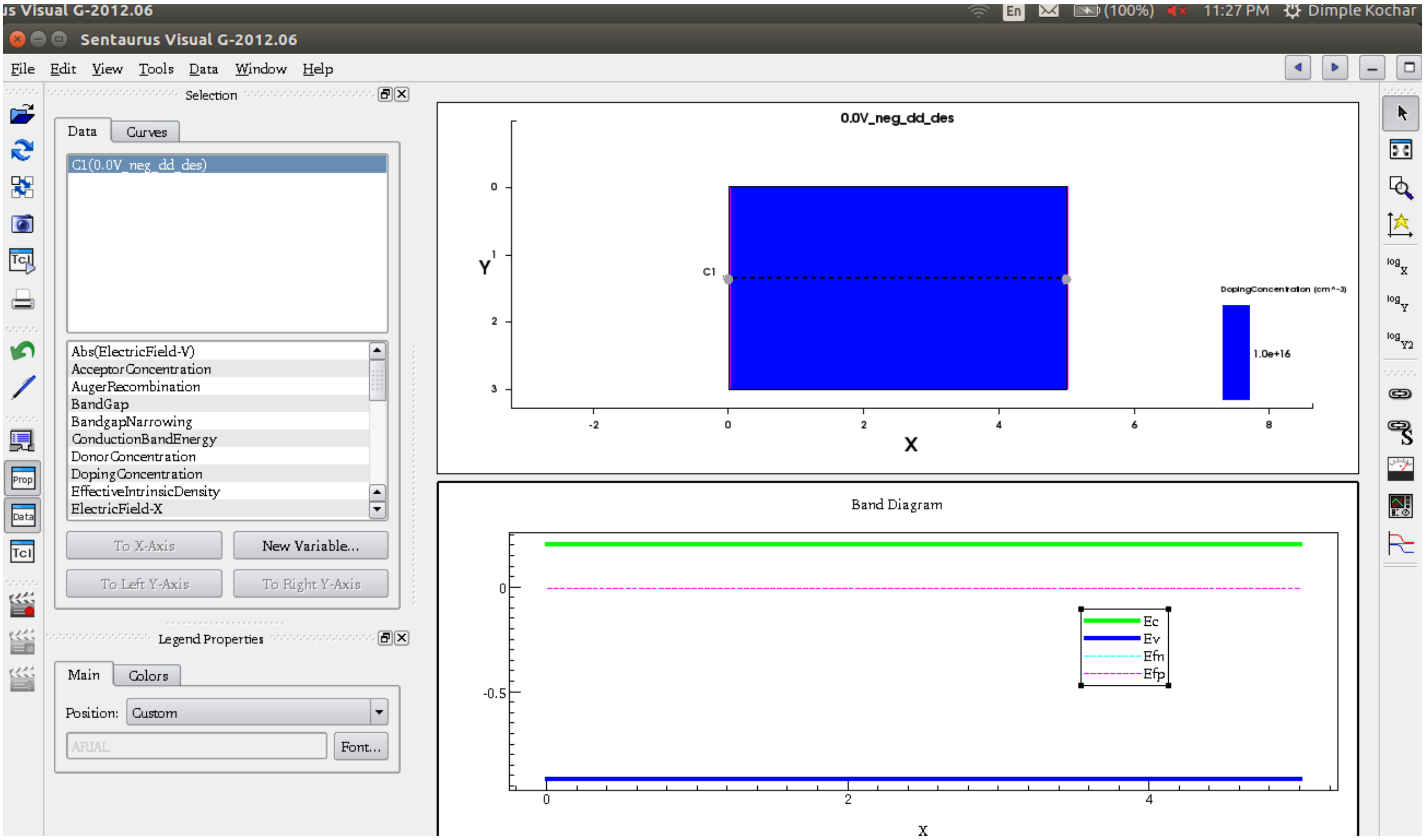
Device structure:

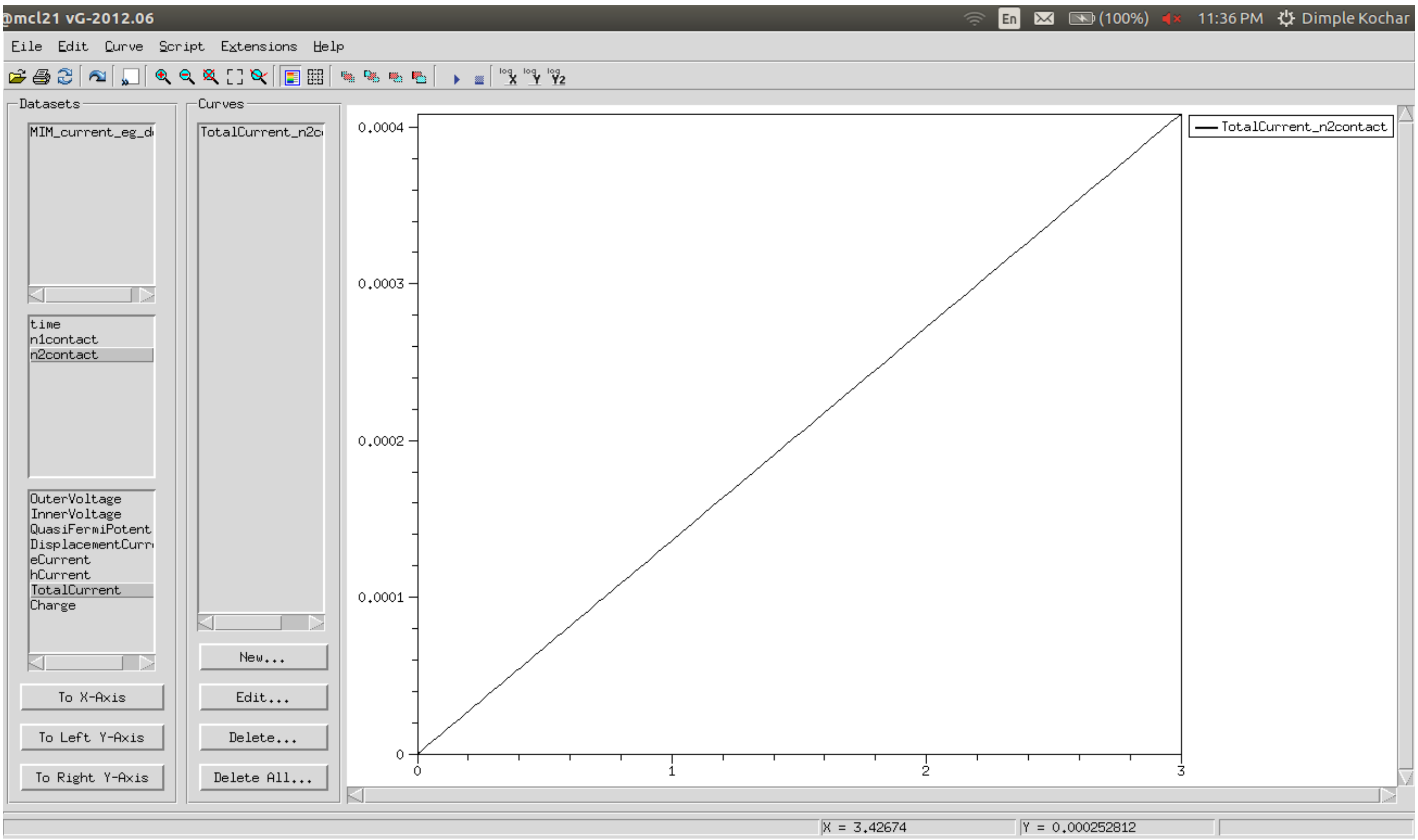




All 3 currents

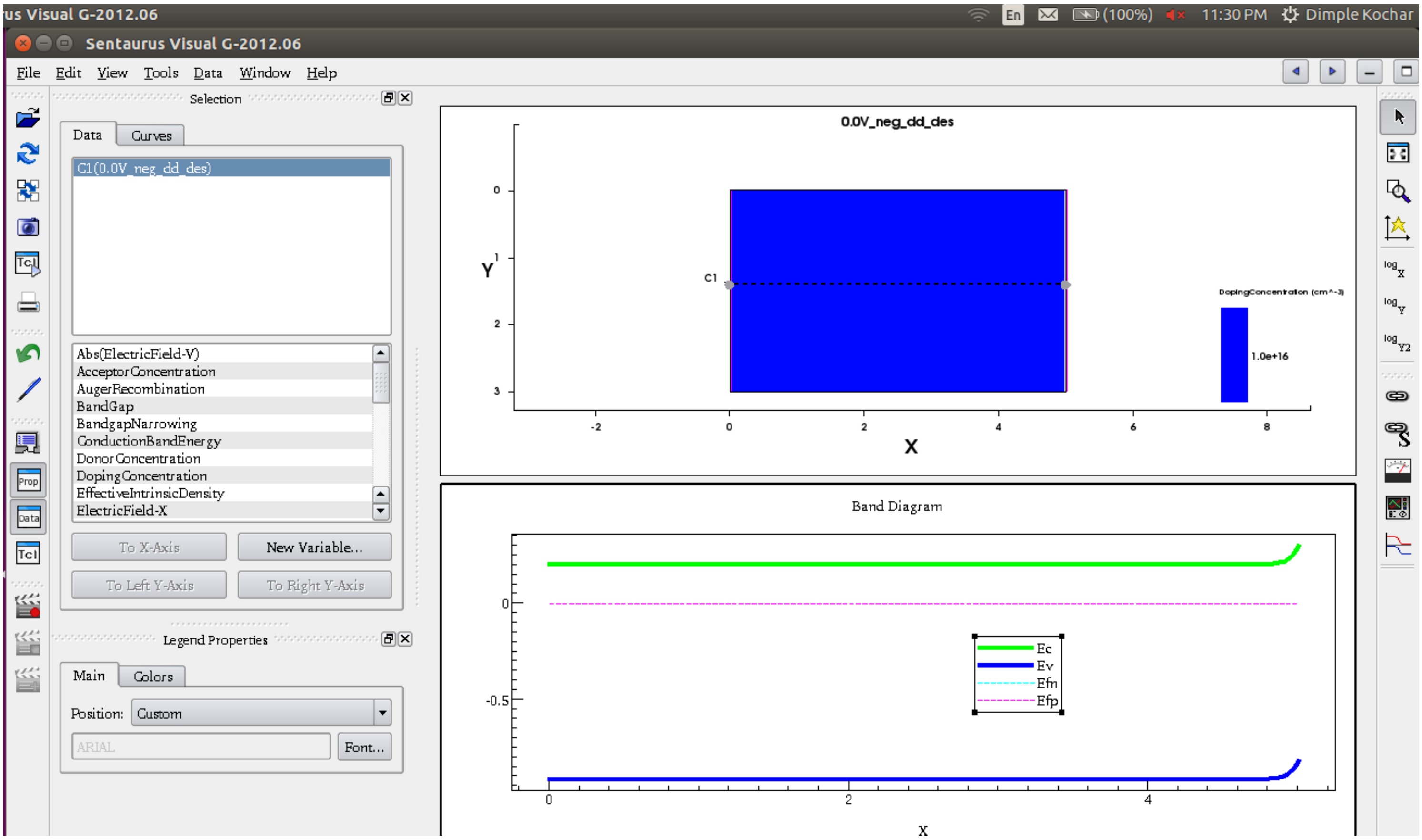
Q1 a) both contacts are ohmic

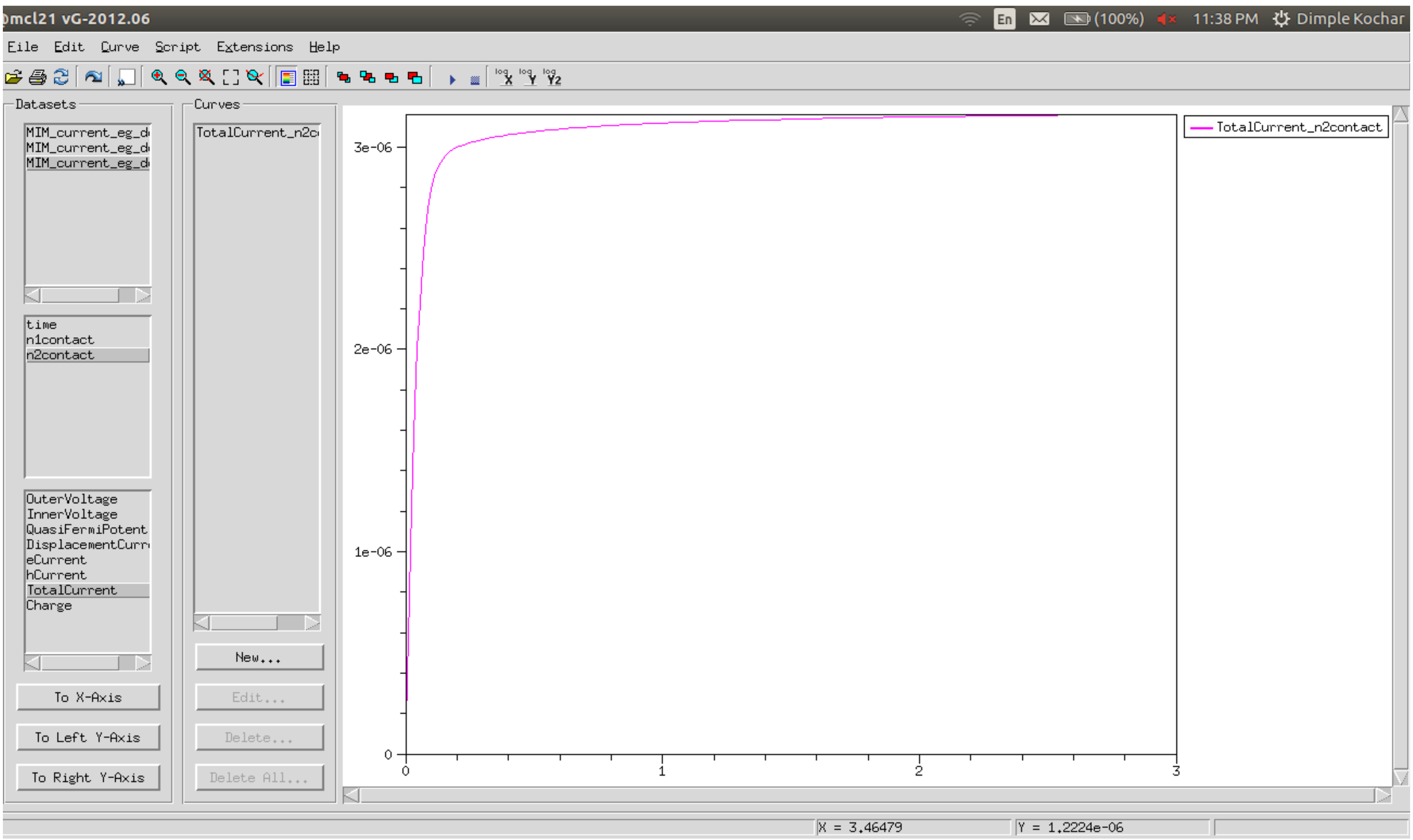




We have a simple bar with two ohmic contacts. Thus, it follows ohm’s laws. Hence, I is proportional to V.

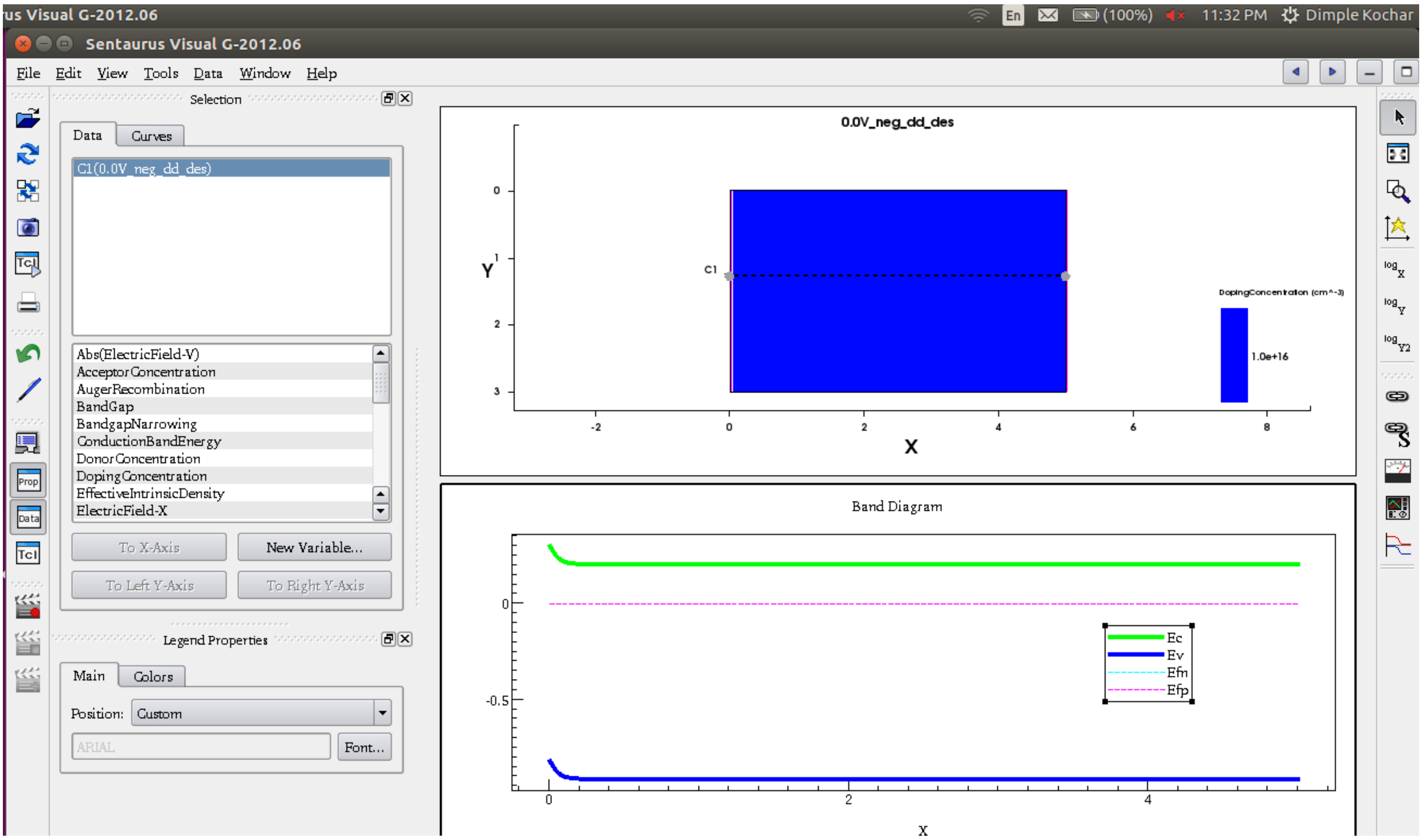
b) left contact is ohmic and right contact is schottky (φ_B = 0.3 eV)

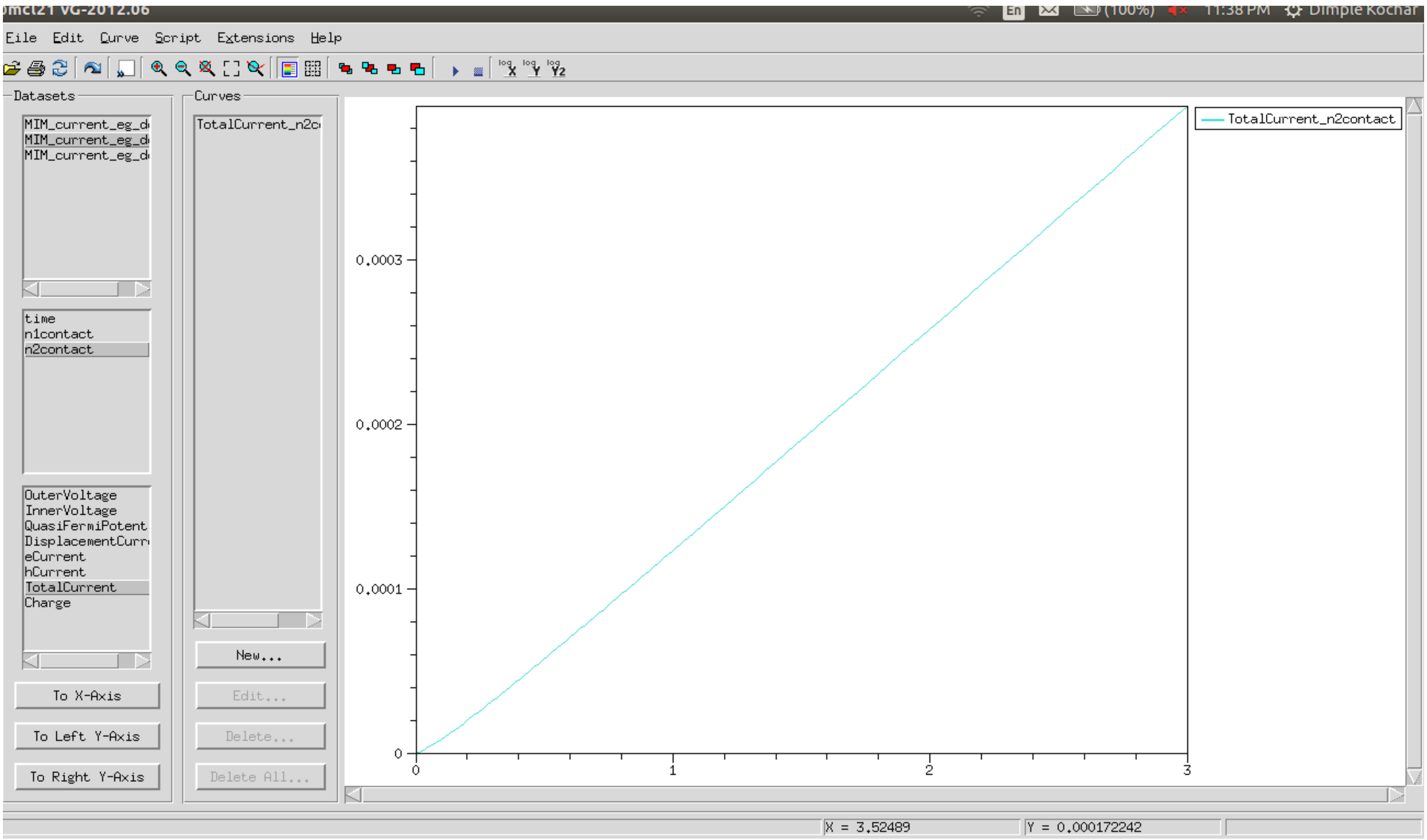




This is basically application of negative voltage at the schottky contact i.e. reverse biasing. Hence, current increases initially and then saturates with increasing voltage.

c) left contact is schottky (φ_B = 0.3 eV) and right contact is ohmic

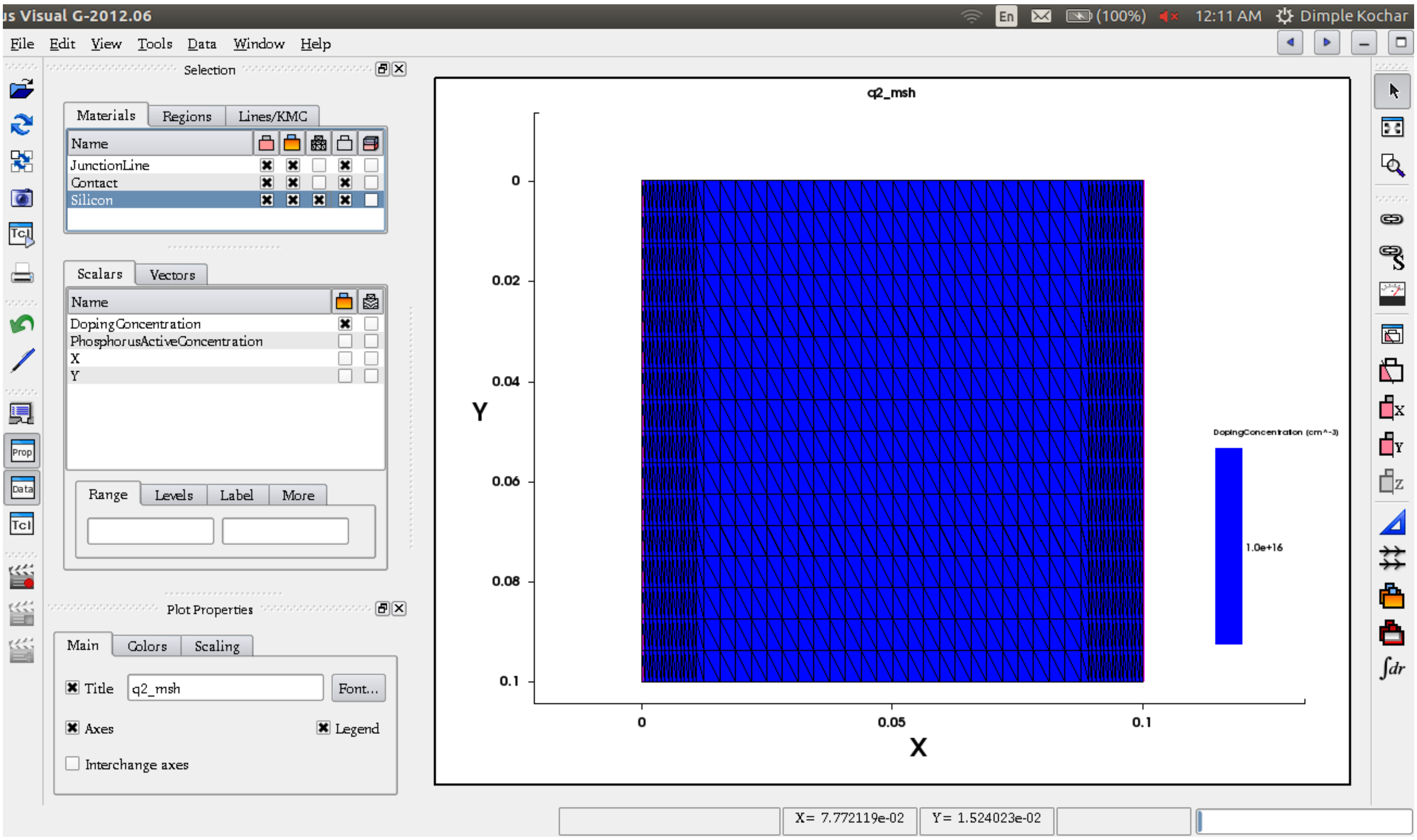




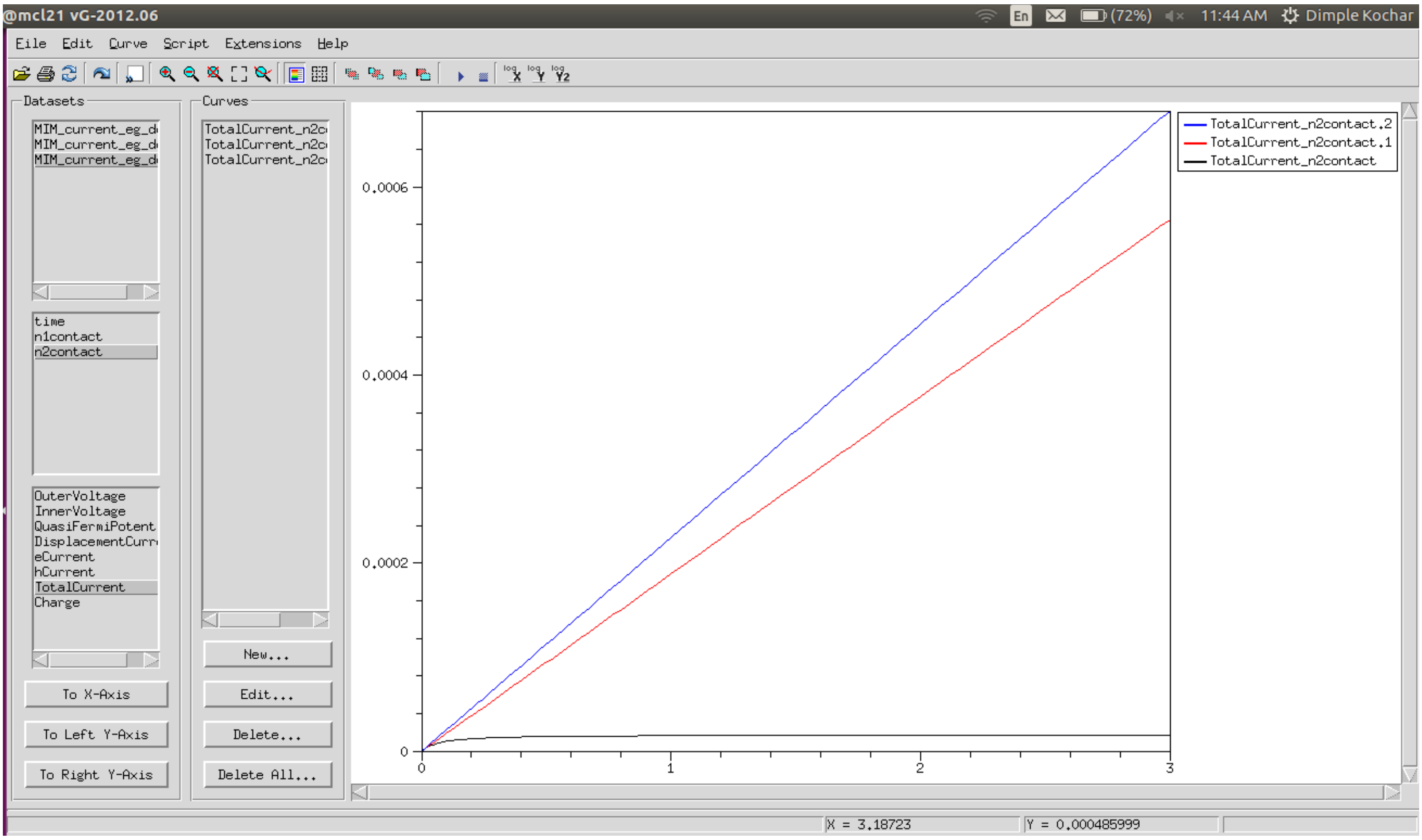
The schottky barrier is under a forward bias as opposed to part (b) where it was in reverse bias. As voltage increases the barrier height decreases. At lower voltages, the IV curve is exponential but as voltage increases the barrier height is very small and hence, it becomes almost like part (a). So we see that the IV curve is increases almost linearly with voltage.

Q2

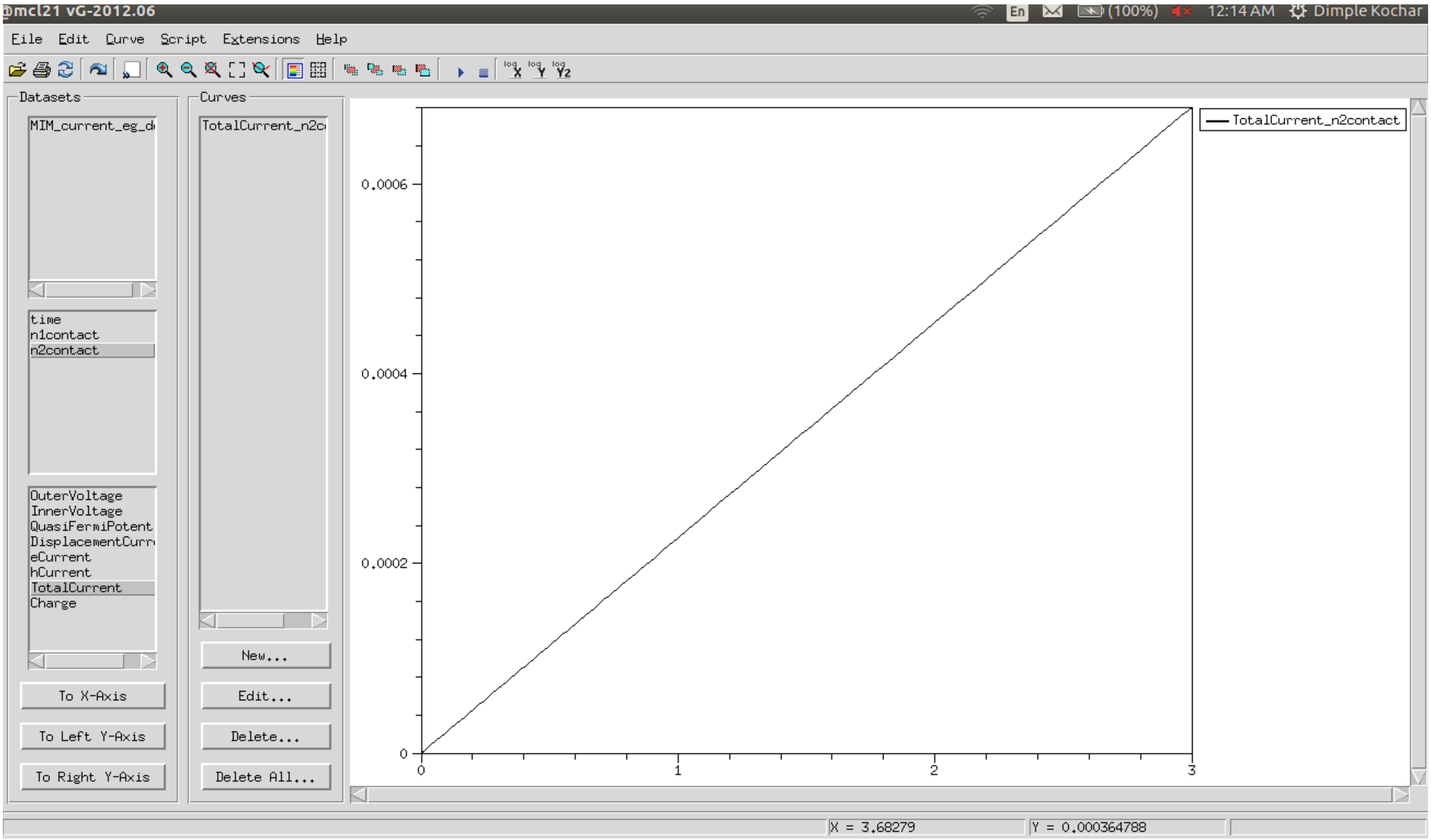
Device structure:



All 3 currents:

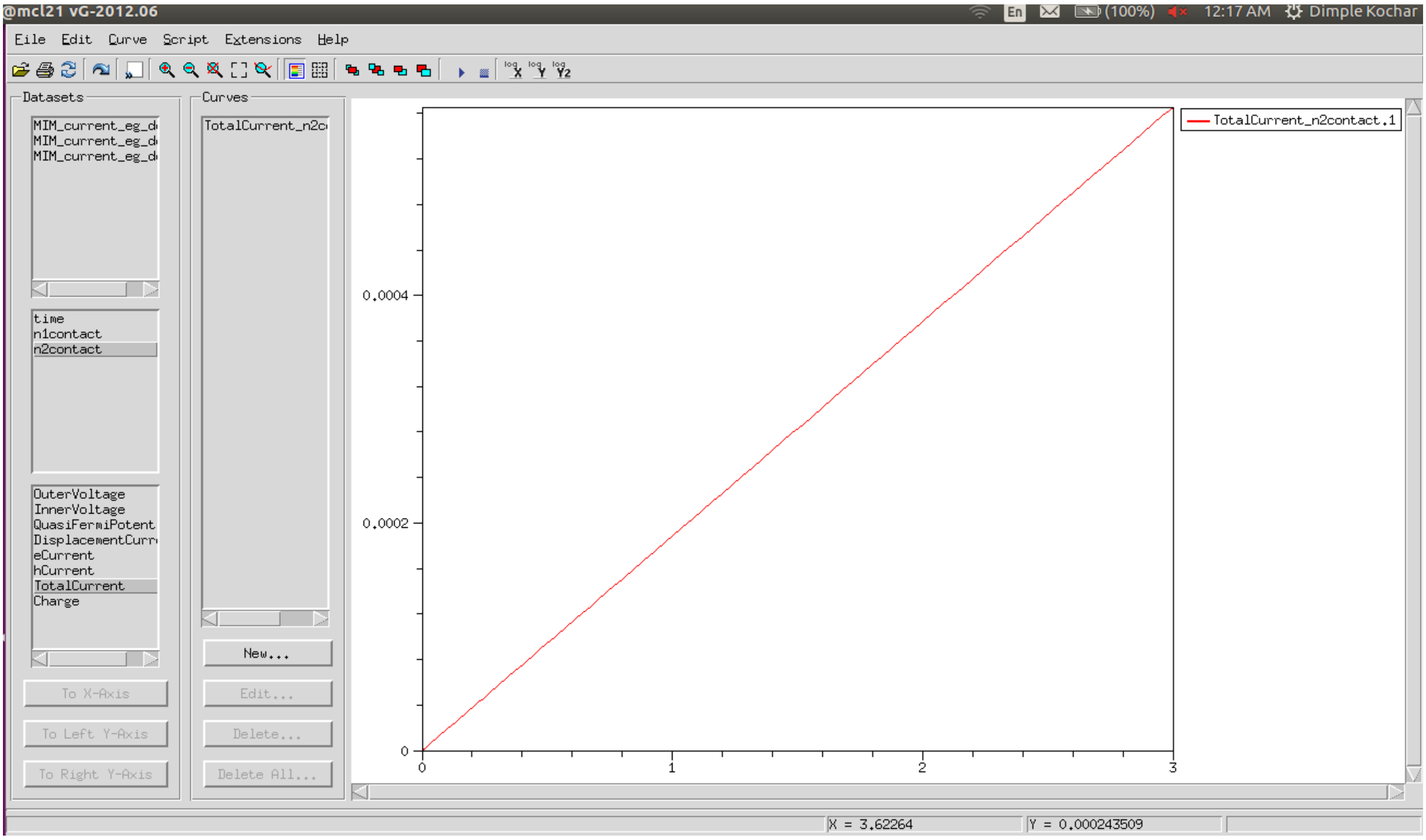


a) constant mobilty



Conductivity is proportional to the product of mobility and carrier concentration. In this model, as mobility is constant, hence conductance is constance. Thus the IV curve is linear.

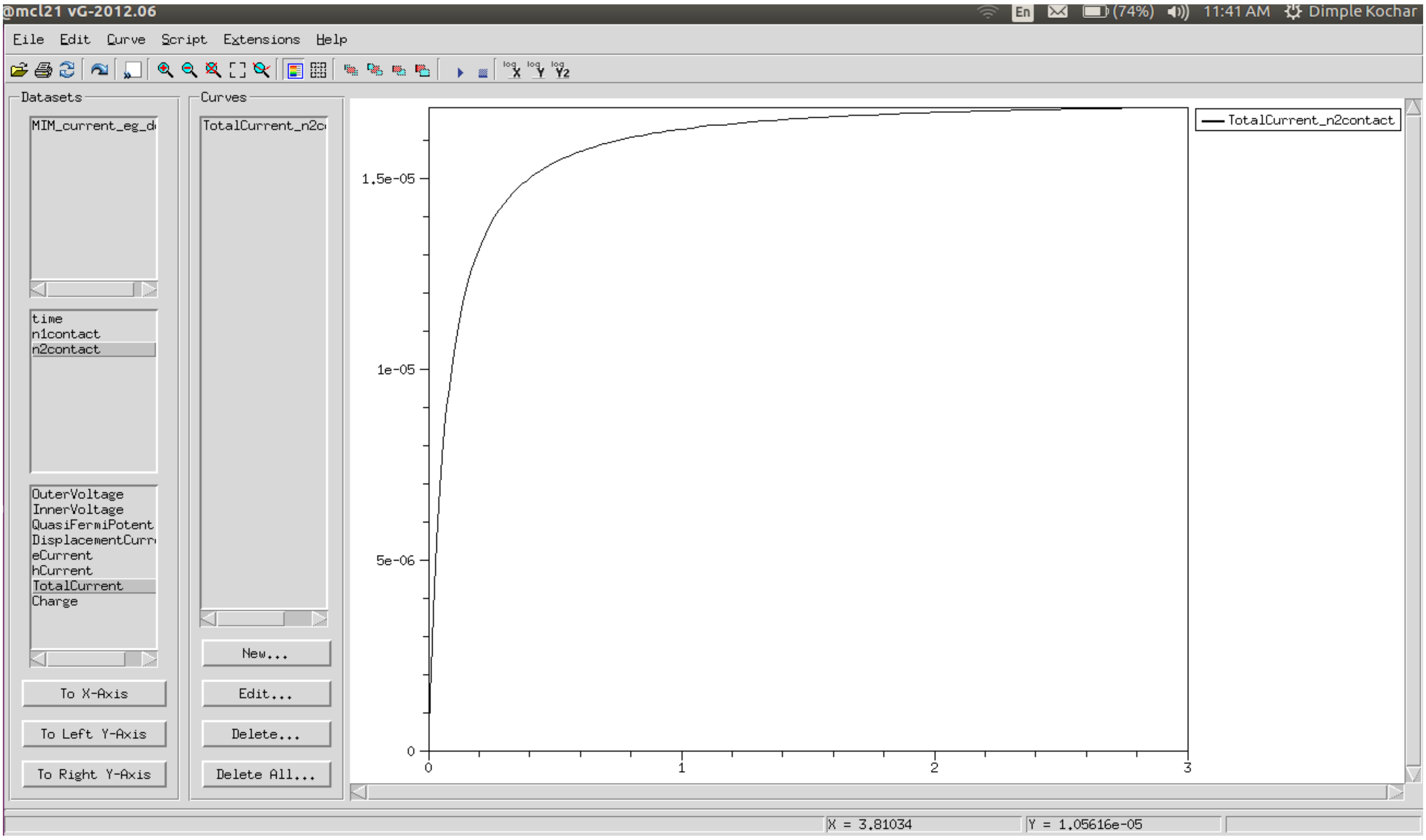
b) doping dependence



The current magnitude decreases as compared to part (a) but the curve is still linear. This is because conductance decreases as mobility decreases. Mobility decreases when we take doping in account using the relation:

$$\mu = \mu_o + \frac{\mu_1}{1+(\frac{N}{N_{\text{ref}}})^{\alpha}}$$

c) high-field saturation

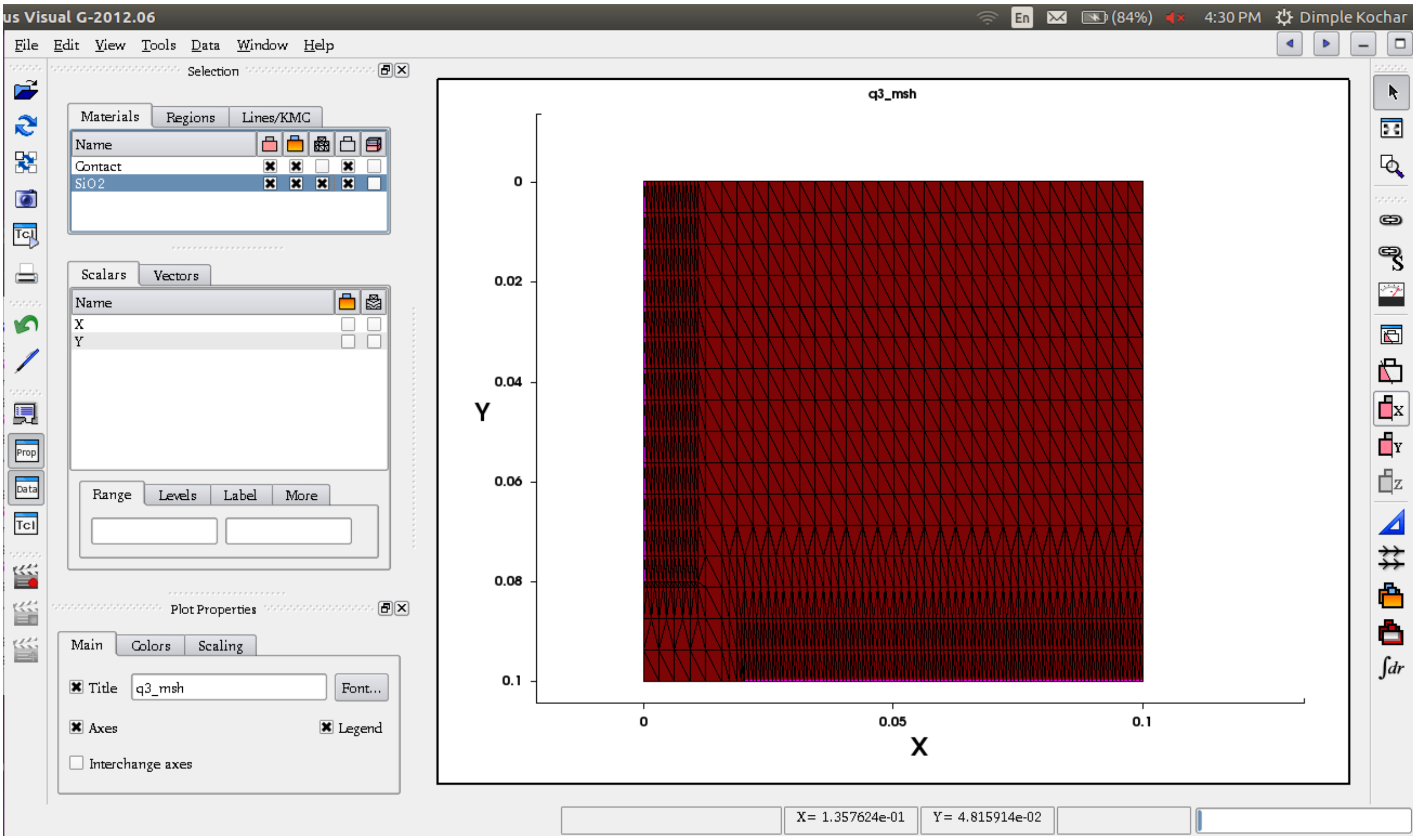


$$\boxed{v = \begin{cases} \dfrac{\mu_{\text{eff}} E}{1 + \dfrac{E}{E_c}} & E < E_c \\ v_{\text{sat}} & E \geq E_c \end{cases}}$$ where $$\boxed{E_c = \frac{2 v_{\text{sat}}}{\mu_{\text{eff}}}}$$ (approximated relation)

At high electric fields, we therefore see a velocity saturation. As current is directly proportional to drift velocity of electrons, hence it saturates as voltage increases.

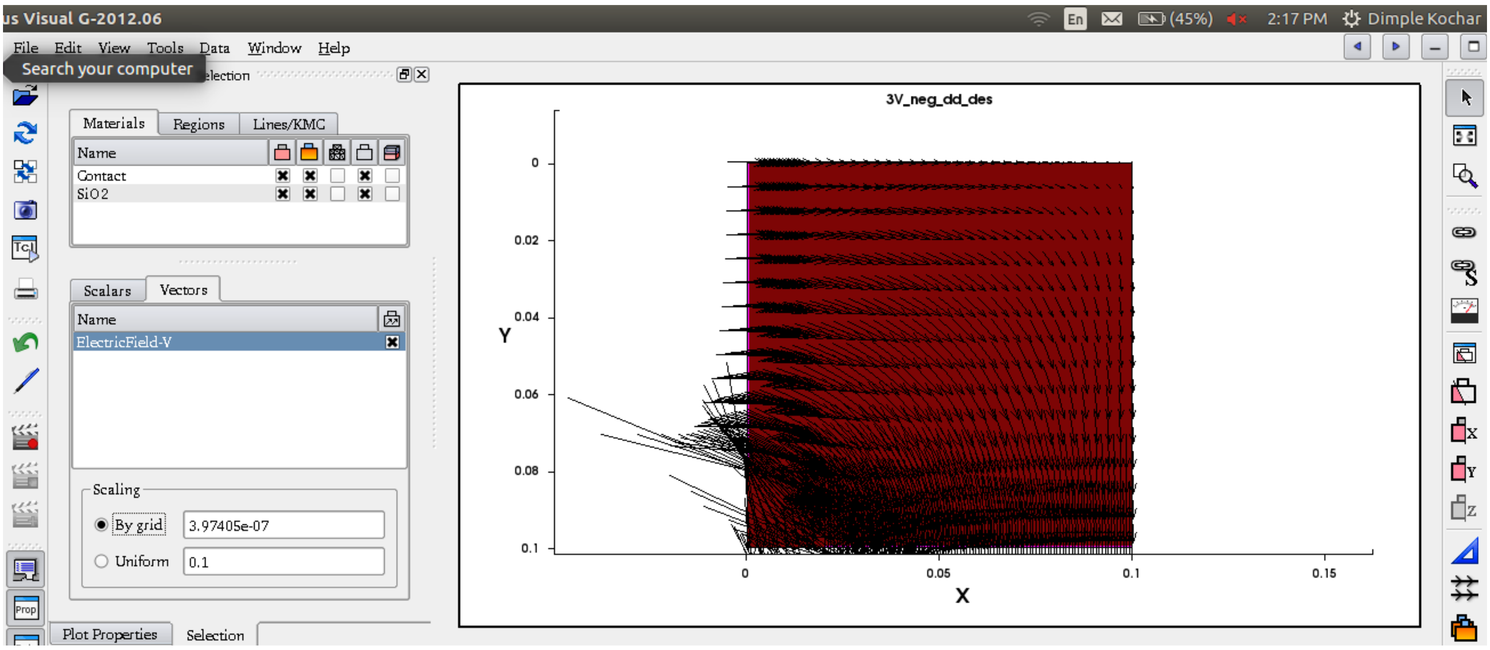
Q3)

Device structure:

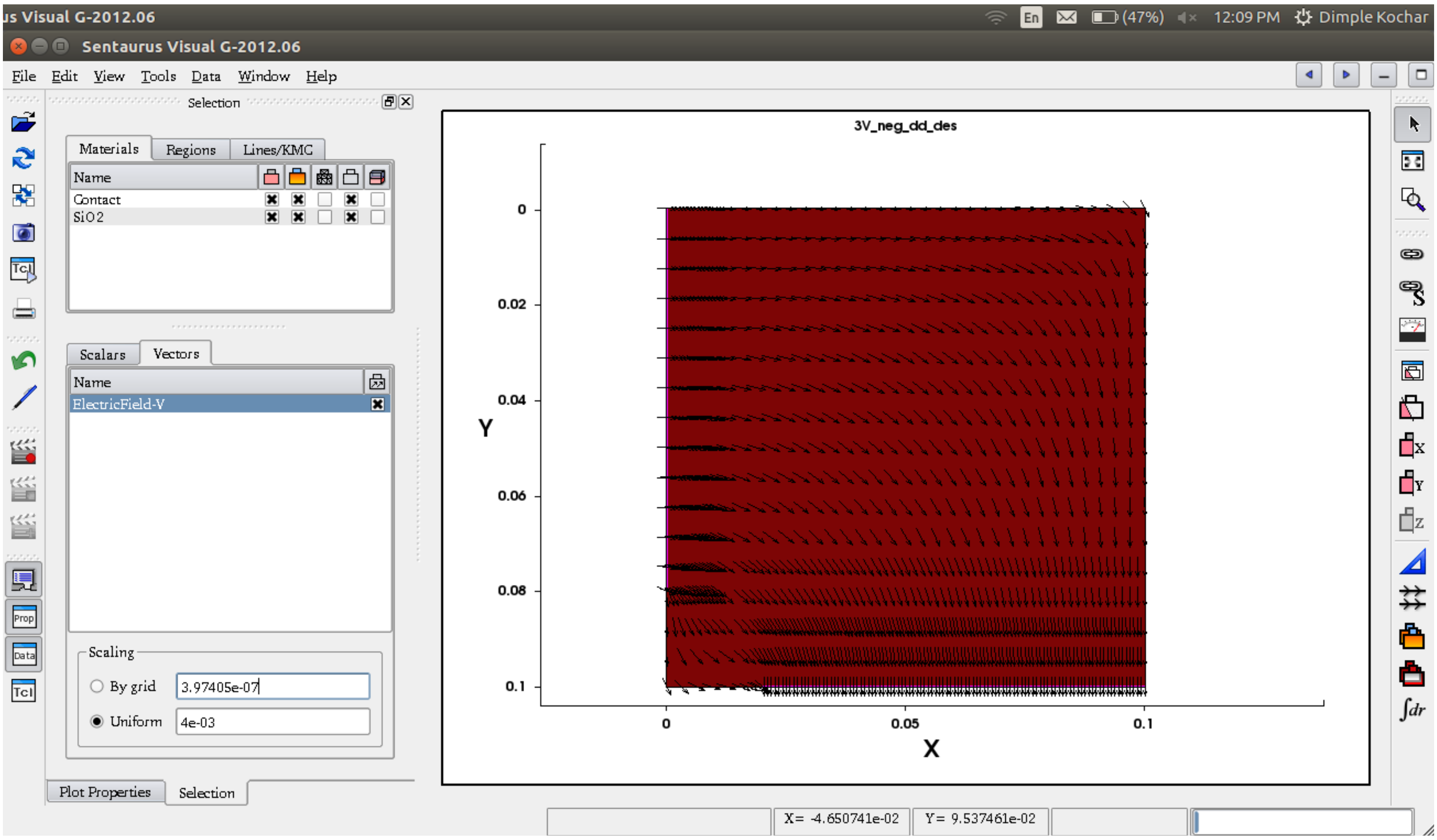


Electric field vector:

By grid scaling:



By uniform scaling:



Current: