ELEC 4700 Assignment 3

Monte-Carlo/Finite Differemce Method

David Bascelli

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Chapter 1. Electrons in Uniform Electric Field

a)

If a simple uniform gradient, we can assume E=V/rSo if voltage = 0.1 V and r = 200 nm, then E= 500 kV/m

b)

F = qE, q = charge of electron = 1.60217653e-19 C, Thus F = 8.01E-14 N

c)

a = m0/F, m0 = mass of electron = 9.10938215e-31 Thus a = 7.2974e-44 m/s^2

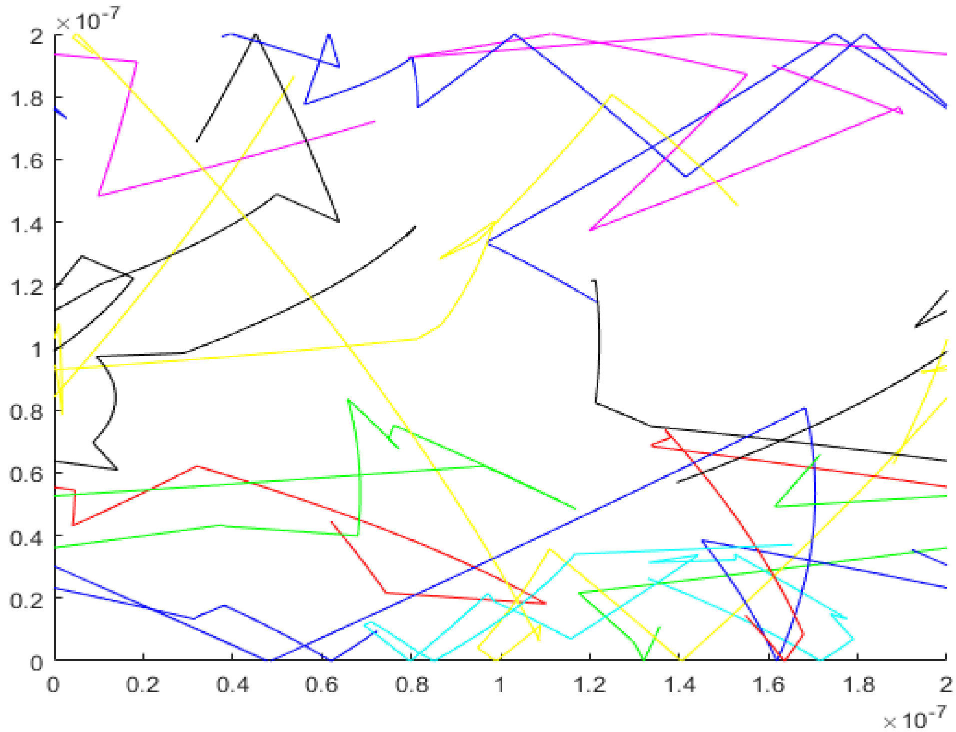

Figure 1.1. Path of Electrons in Uniform Electric Field

d)

With electrons moving in all directions, the drift velocity is the net movement of electrons in a certain direction. It is the directional average velocity. It is calculated using the formula : Vdrift = sum(V)/N, I = q*Cd*Vdrift. The current starts out near zero, as the inital speed is just random thermal velocity. The drift velocity then increaes as the electric field causes the electrons to accelerate in one direction. As the electron velocity reaches equalibrium then current then stabalizes

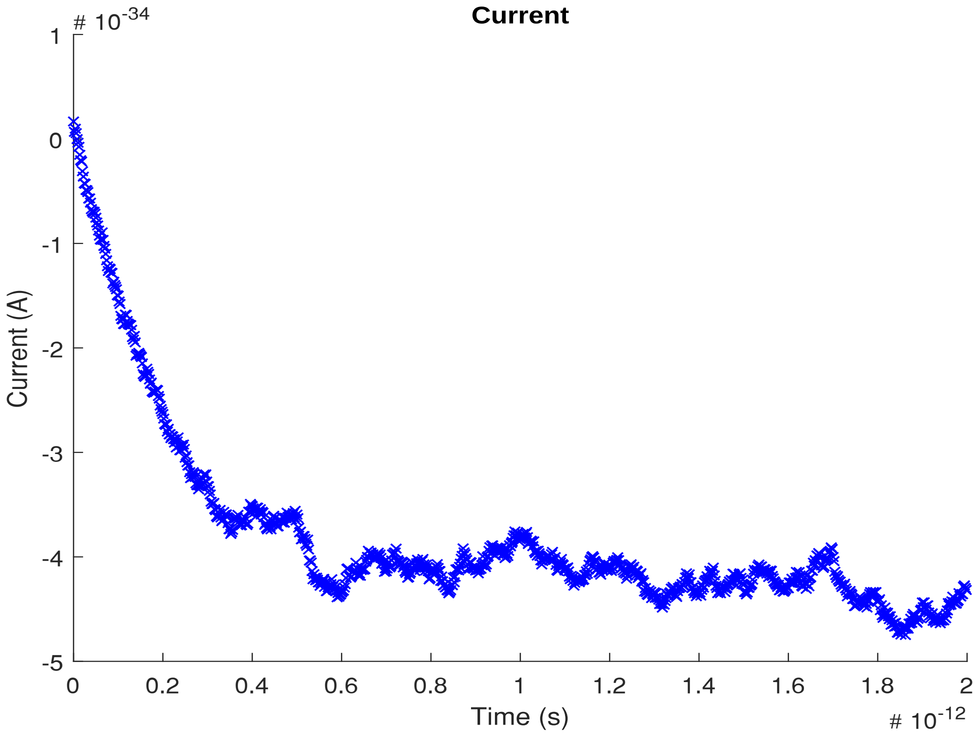

Figure 1.2. Electron Current

e)

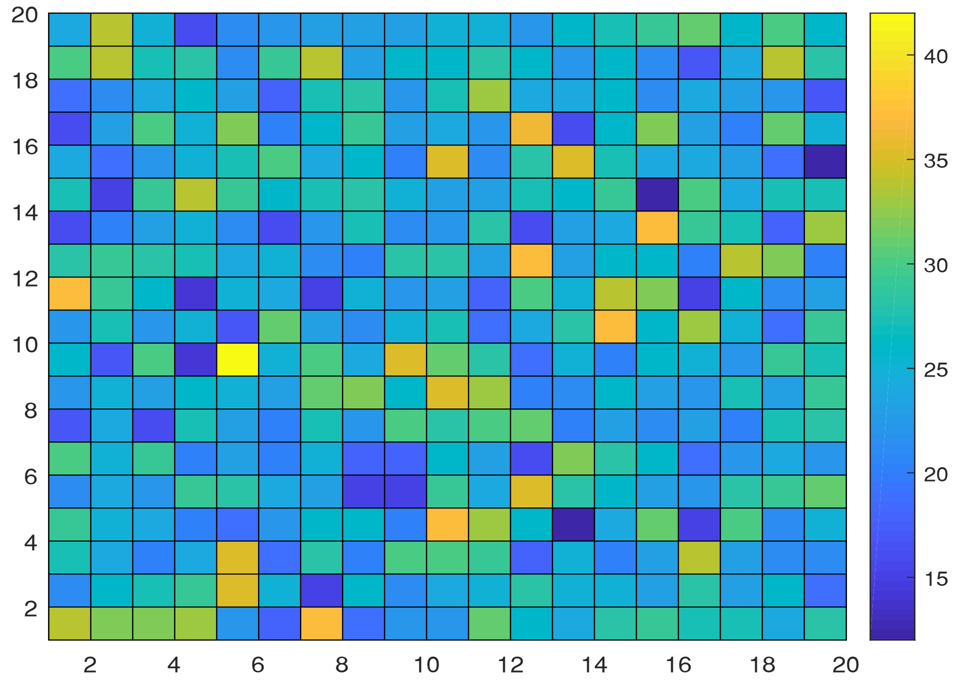

Figure 1.3. Electron Density

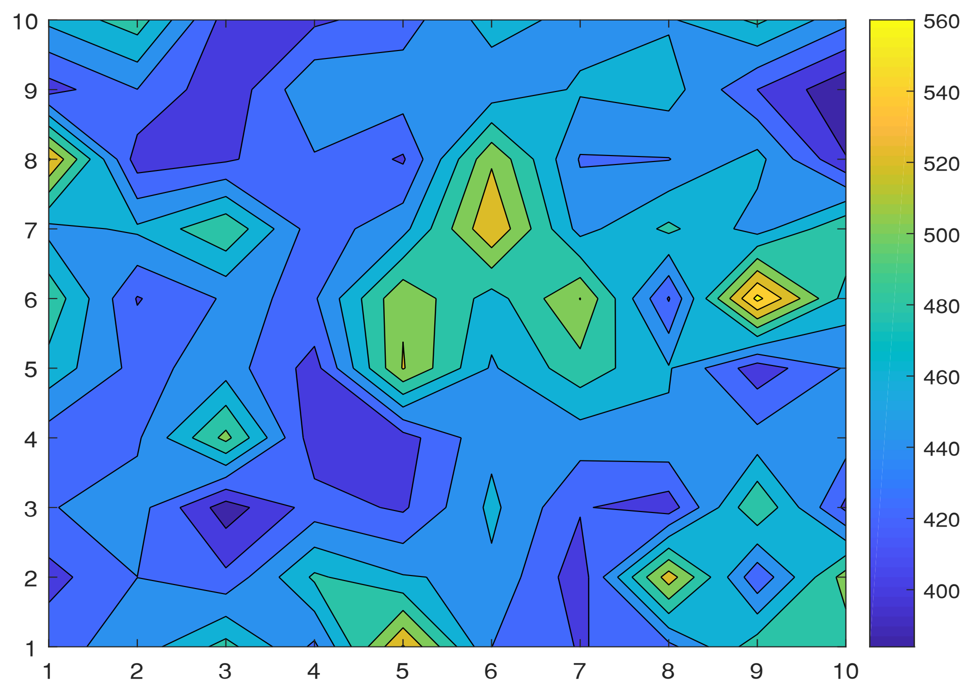

Figure 1.4. Electron Temperature

Chapter 2. Calculation of Electric Field with Bottleneck

a)

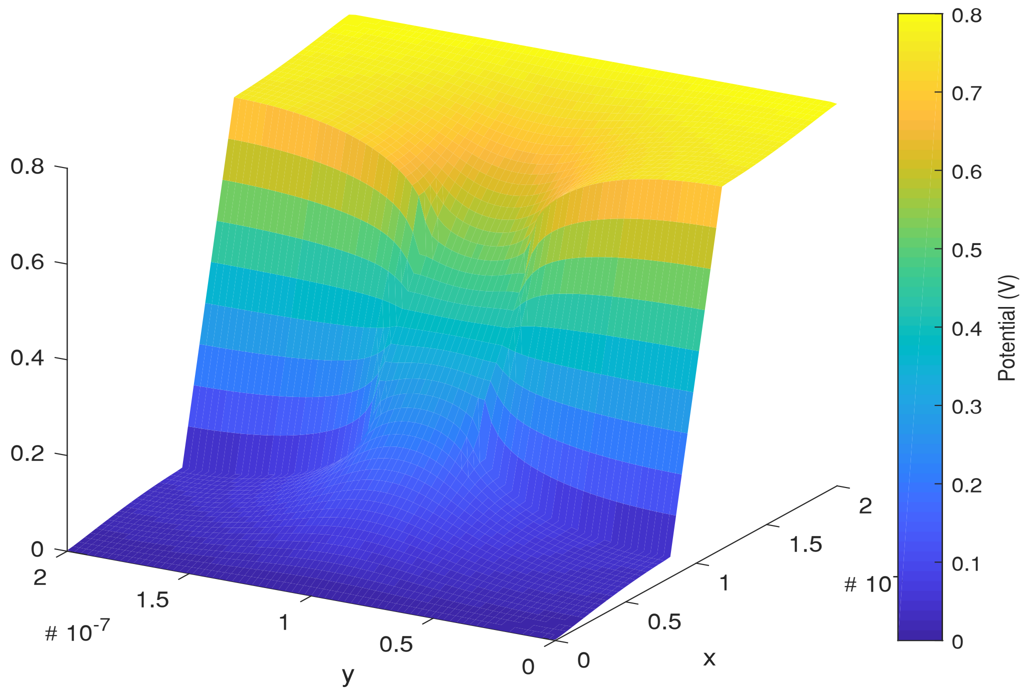

Figure 2.1. Potential of Bottleneck

b)

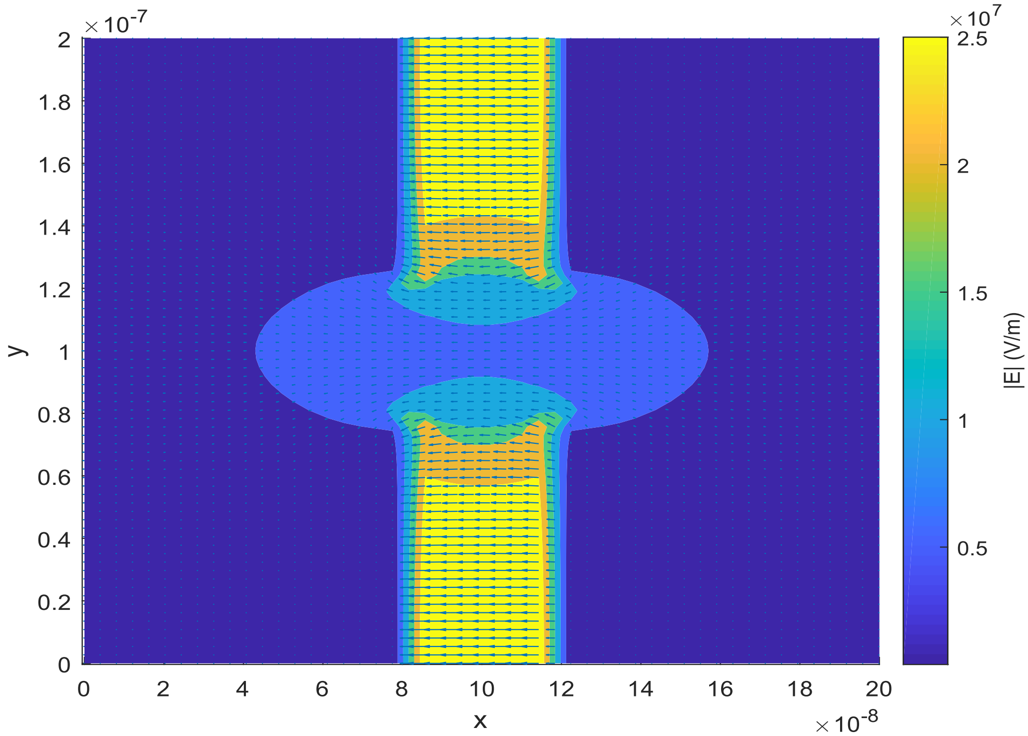

Figure 2.2. Electric Field of Bottleneck

Chapter 3. Electrons in Bottleneck

a)

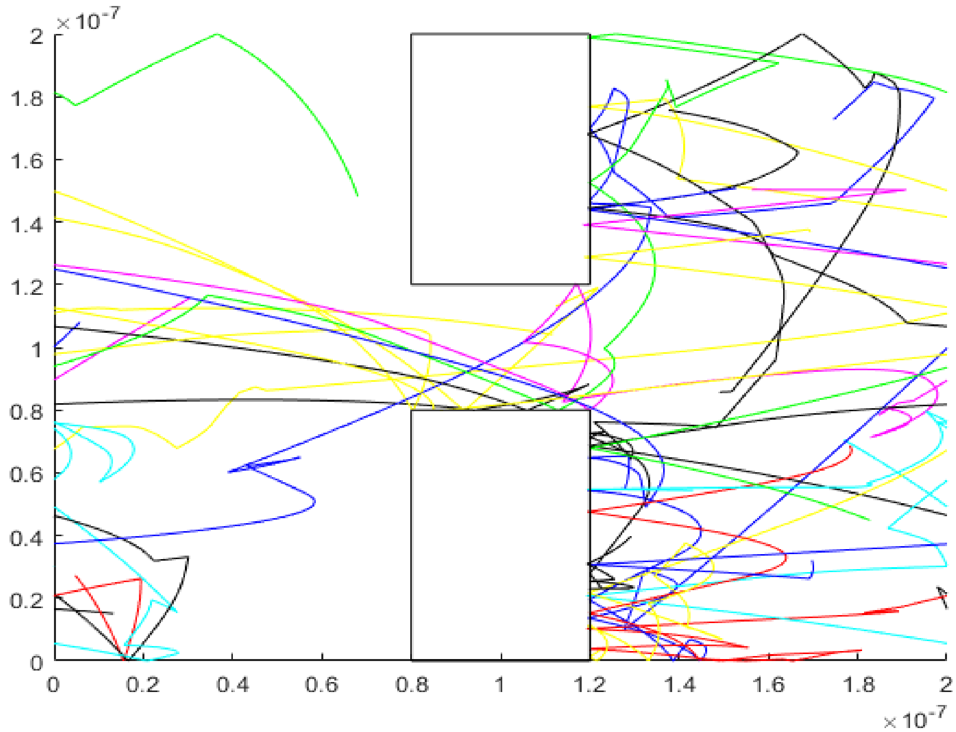

Figure 3.1. Path of Electrons in Bottleneck

b)

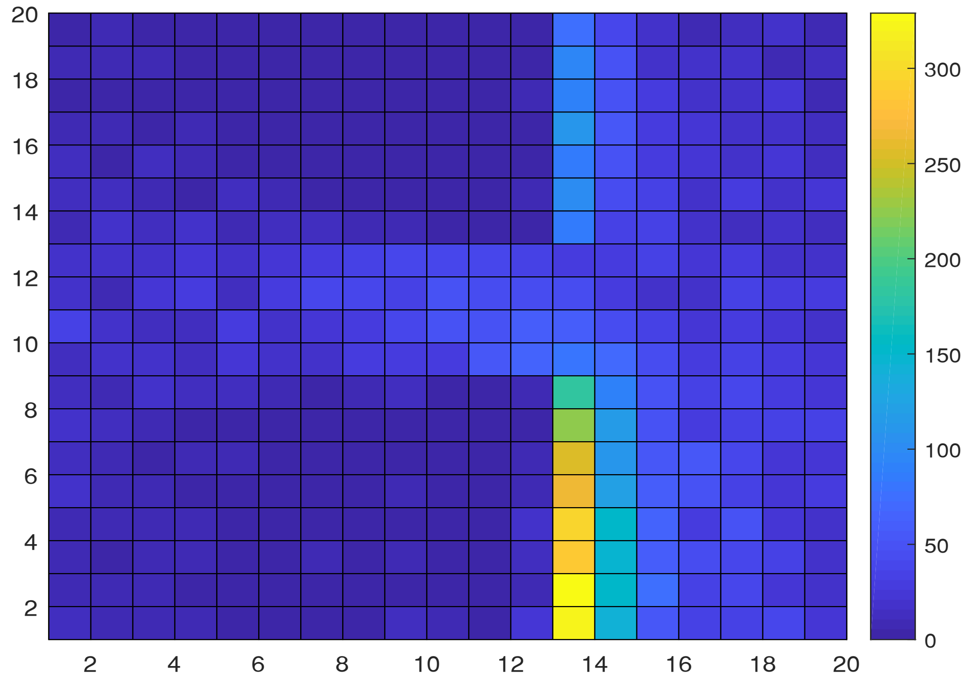

Figure 3.2. Density of Electrons in Bottleneck

Electrons are getting stuck against the right side of the block, this is because they are unable to escape the electric field at that point. In the other direction, electrons are funneled out of the gap. We have higher electron density on thehigh voltage side.

c)

The obvious solution of greater accuracy is smaller grid size, smaller step time, more particles and longer run time. Another improvement would be to allow the electrons to travel through the insulating material, maybe by modeling the insulating area as having an increased mean time between collision.