ELEC 4700 Assignment 1

Monte-Carlo Modeling of Electron Transport

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Part 1: Electron Modeling

1. What is the thermal velocity V_{th}? Assume T = 300 K.

$$Effective\ Mass = 0.26 * electron\ mass = 2.37 \times 10^{31}$$

$$Thermal\ velocity = \sqrt{\frac{2 \times Boltzmann\ constant \times Temperature}{effective\ mass}} = 1.87 \times 10^{5}\ m/s$$

2. If the mean time between collisions is τ_{mn} = 0.2 ps what is the mean free path?

$$Mean\ free\ path = Mean\ time\ between\ collison \times V_{th} = 3.74 \times 10^{-8} m$$

3. 2D Plot of particle trajectory

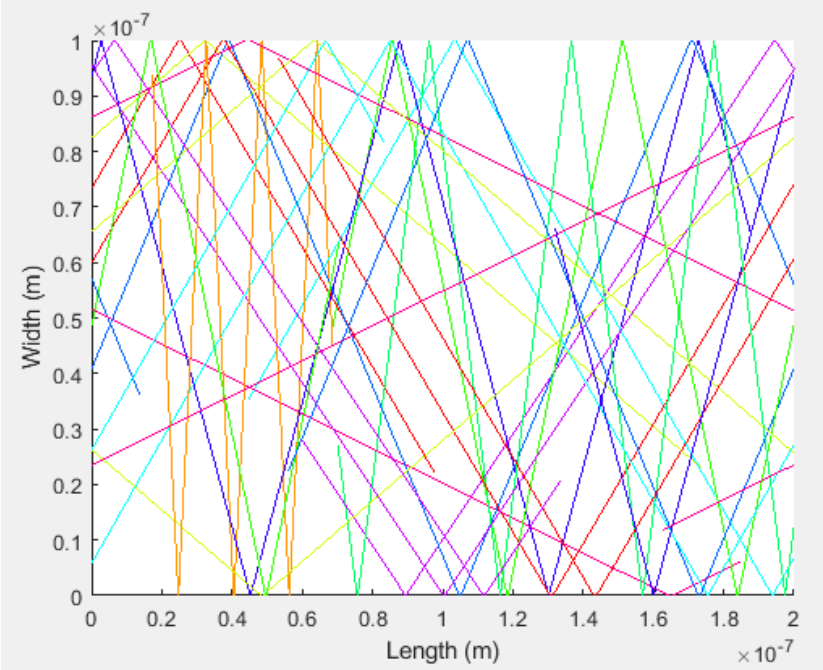

Figure 1 2D Plot of particle trajectory

4. Temperature plot

$$Mean\ Temperature = \frac{V_{th}^2 \times effective\ mass}{2 \times Boltzmann\ constant} = 300K$$

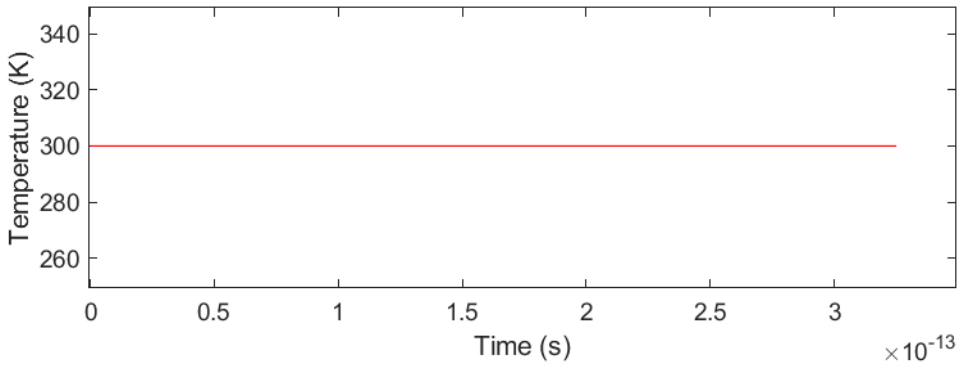

Figure 2 Average Temperature plot

Part 2: Collisions with Mean Free Path

1. Assign a random velocity to each of the particles at the start. Use a Maxwell-Boltzmann distribution for each velocity component. Ensure that the average of all the speeds will be V_{th}. Plot the distribution in a histogram

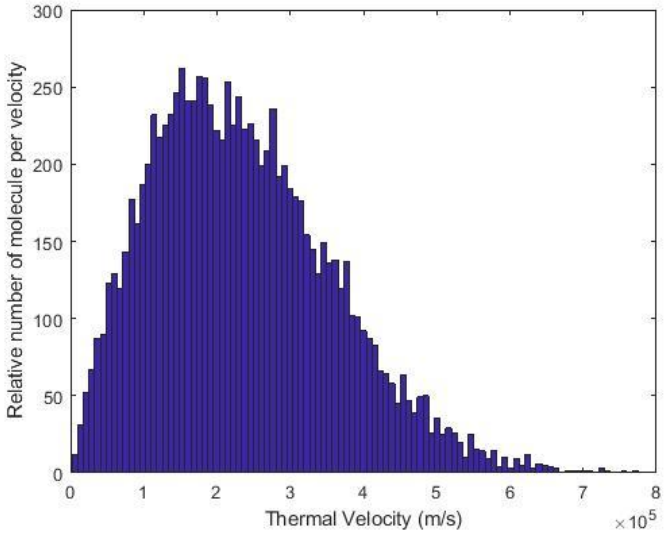

Figure 3 Maxwell-Boltzmann distribution for each velocity component of electrons

2. 2D Plot of particle trajectory

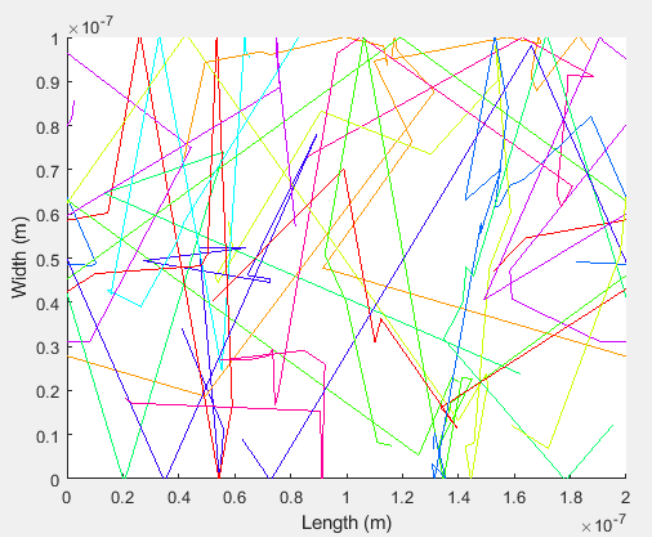

Figure 4 2D Plot of particle trajectory

3. Temperature Plot

   The average temperature in the region has a slight fluctuation around 300 K

4. Mean free path and τ_{mn}

Part 3A: Enhancement

1. 2D Plot of particle trajectory

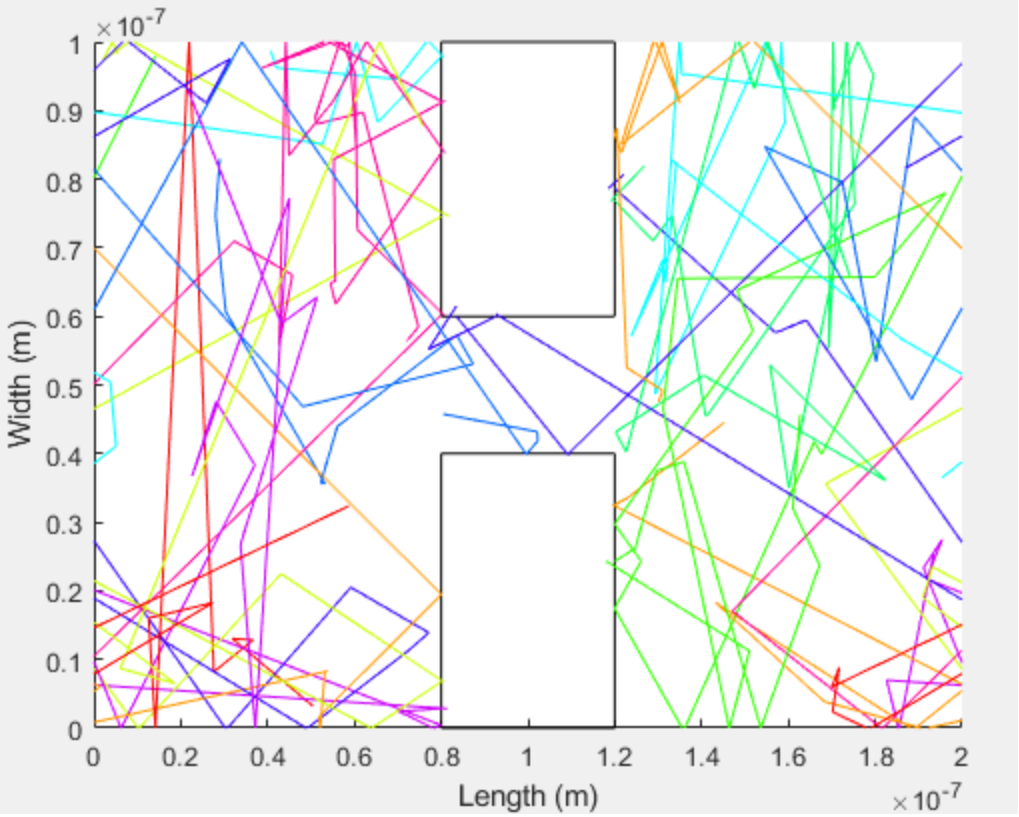

Figure 5 2D Plot of particle trajectory

2. Electron density map

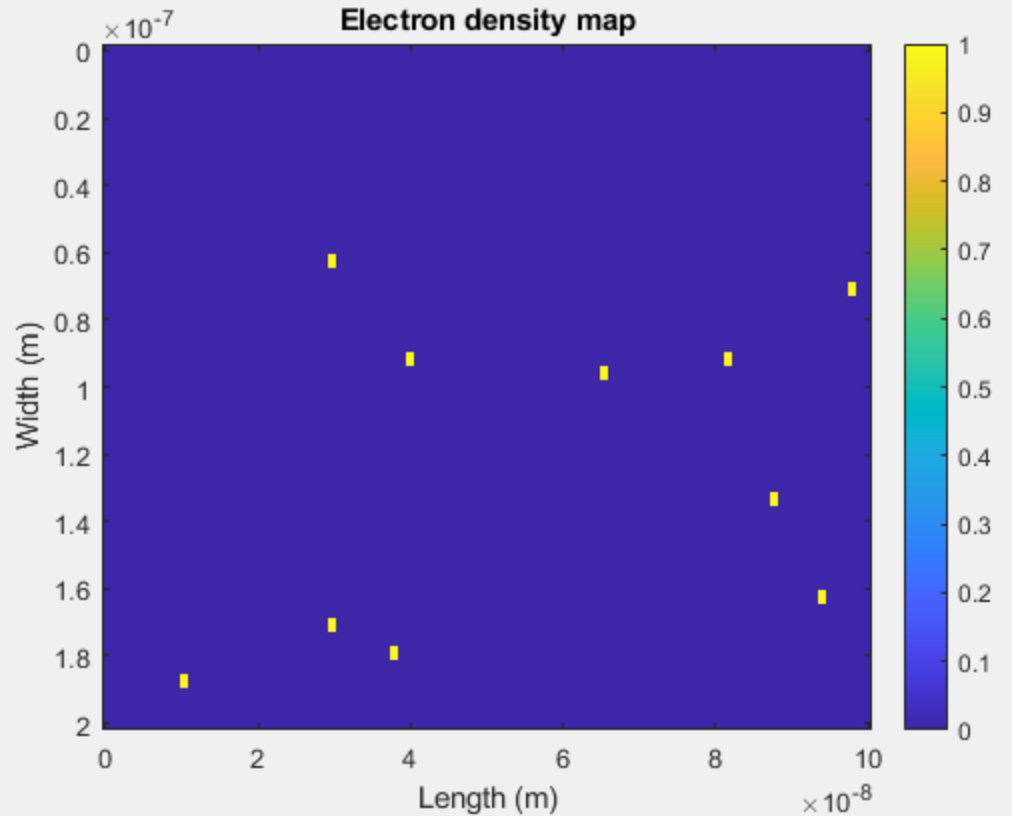

Figure 6 Electron density map

3. Temperature map

Part 3B: Injection

1. 2D Plot of particle trajectory

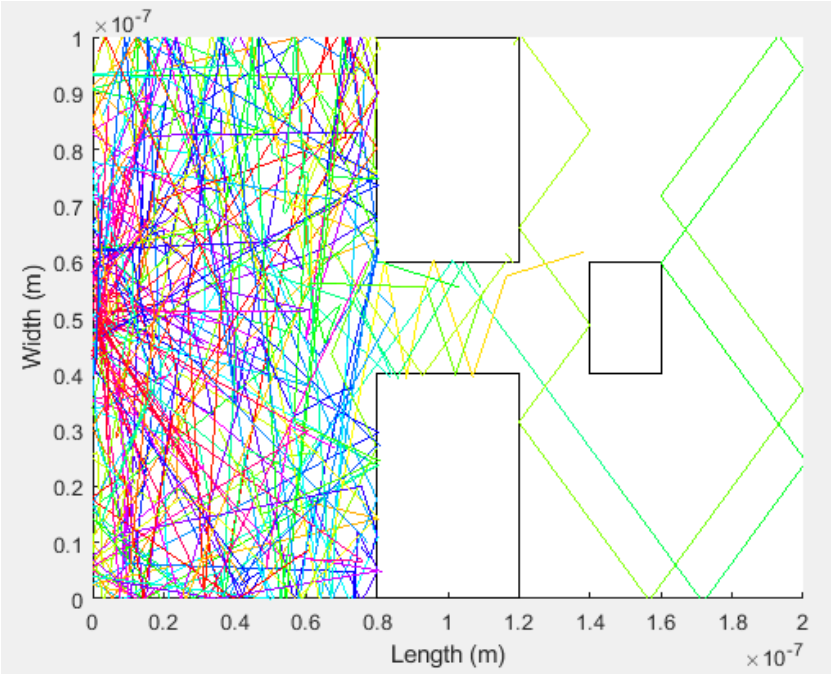

Figure 7 2D Plot of particle trajectory