ELEC 4700

Assignment 3

Monte-Carlo/Finite Difference Method

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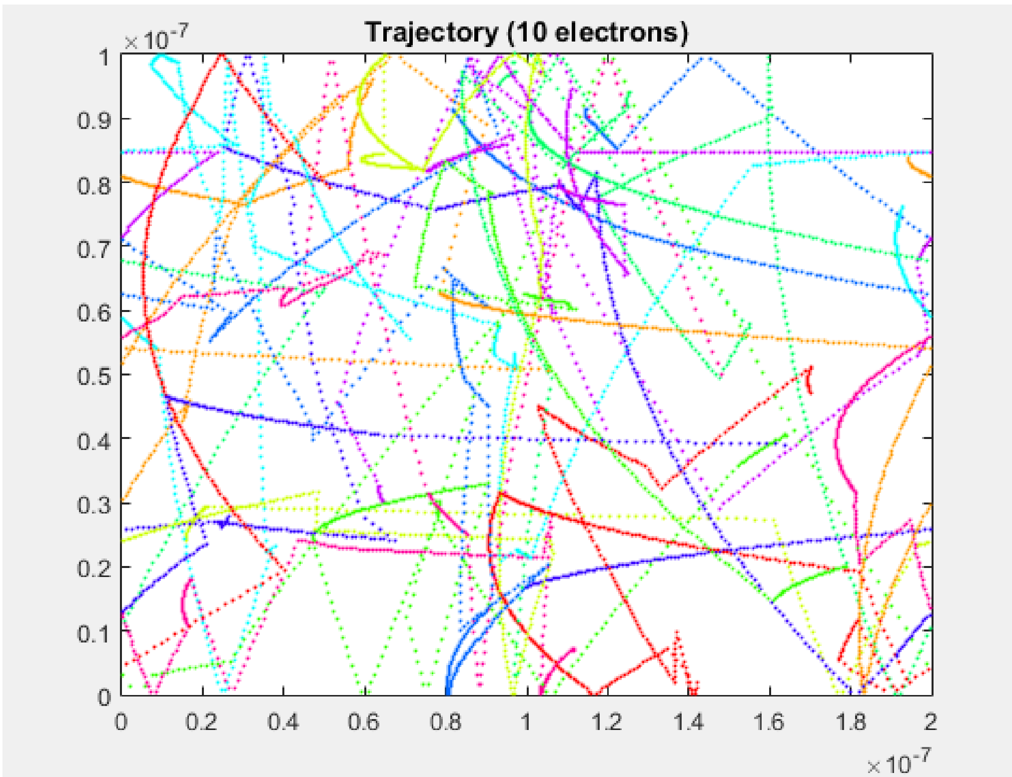
1 Monte-Carlo

a. The field is calculated in MATLAB as 2.5 x 10^6 or 2.6 MV/m.

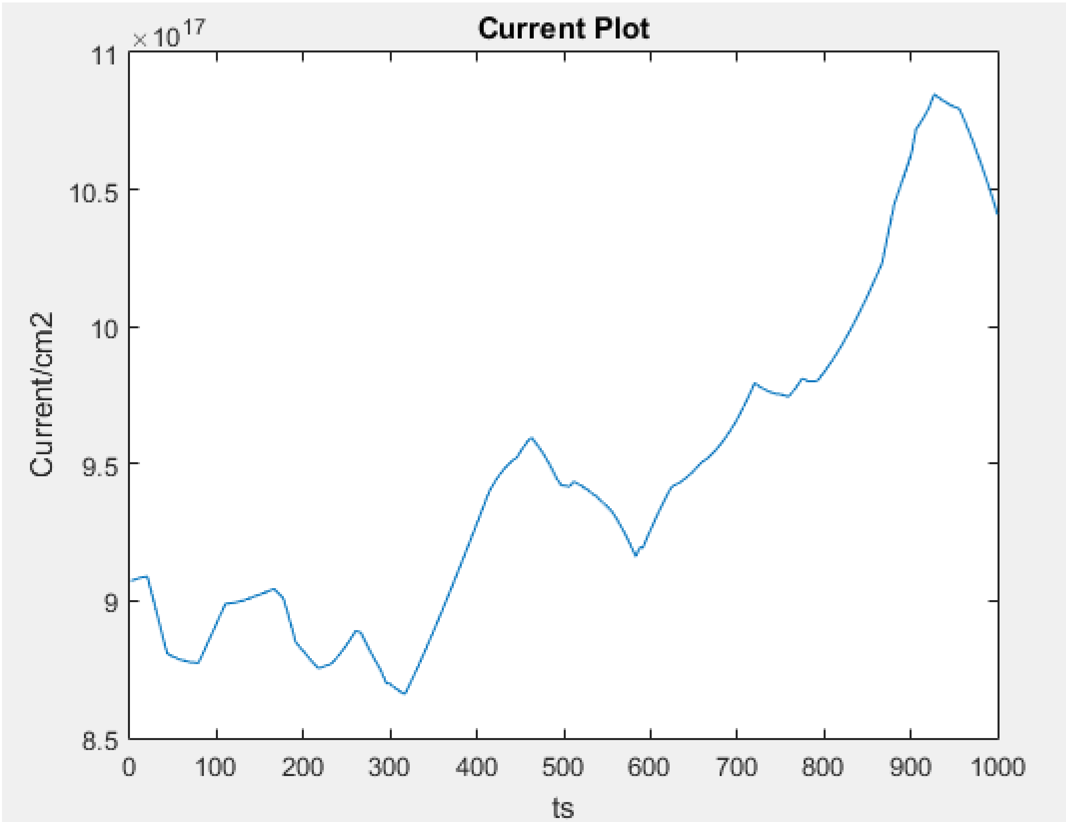
b. The force due to this field is calculated in MATLAB as 4.01 x 10^{-13} N.

c. The acceleration due to the electric field is calculated in MATLAB as 1.69 x 10^{18} m/s^2.



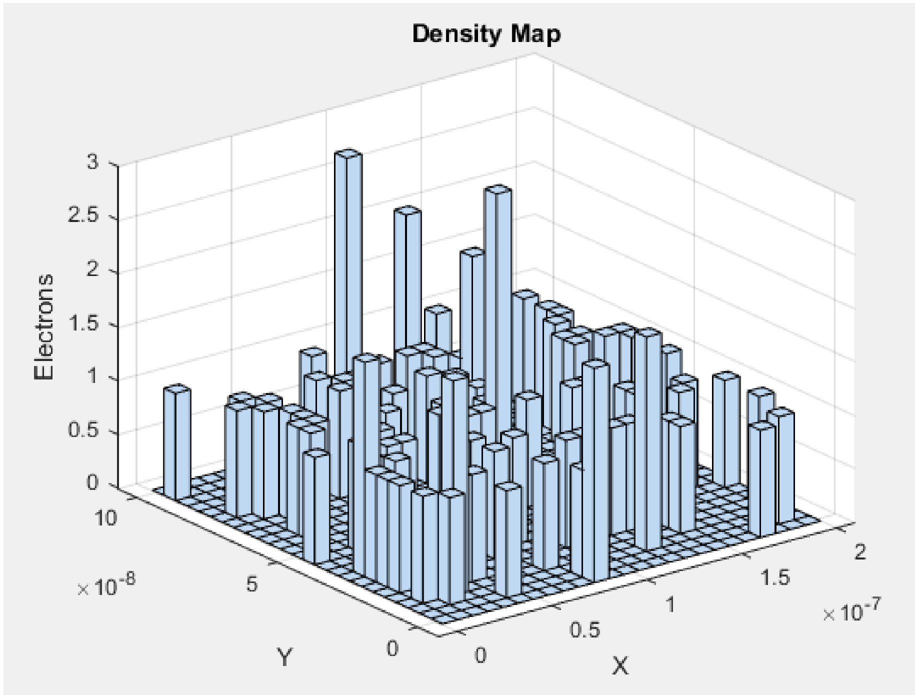
d. I = q * EC * mu * e. field / area
where q is the charge of an electron, EC is the electron concentration provided, mu is the average velocity/e. field, e. field is electric field and area is the area of the semiconductor region under simulation.

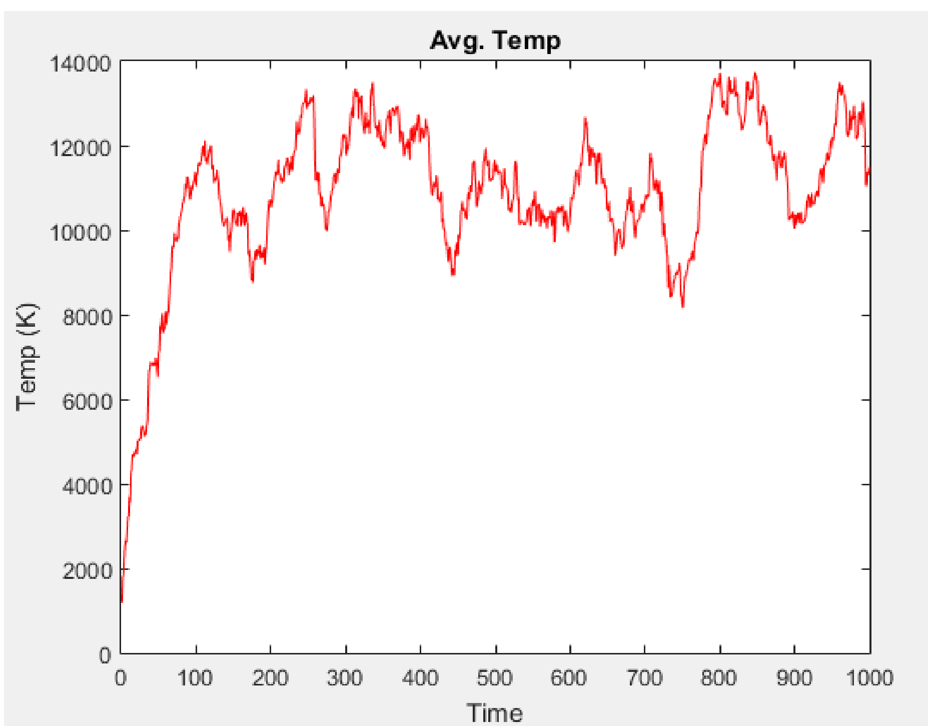
Current plot and comment on next page.



The current appears to steadily increase.

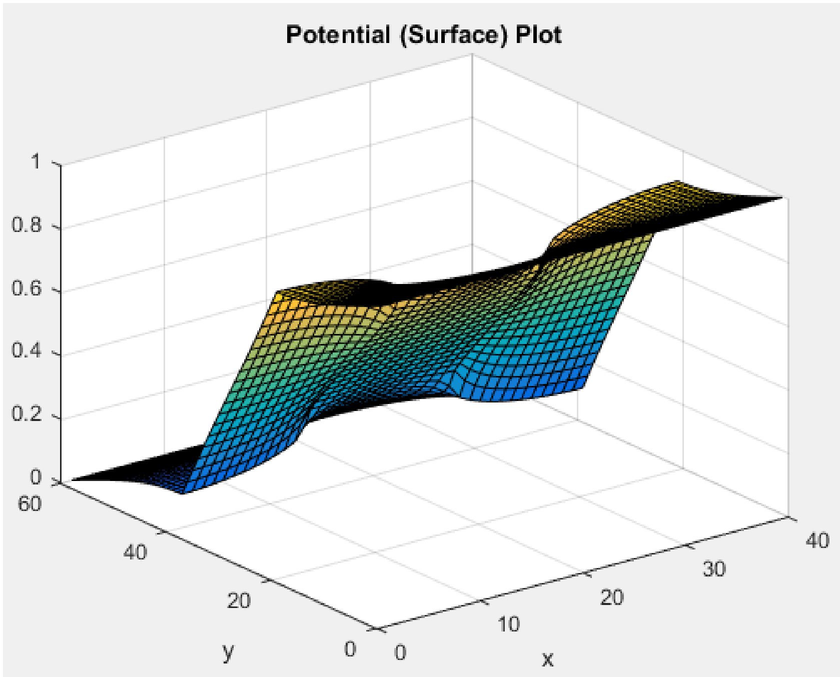
e.


Density Map
Electrons
3
2.5
2
1.5
1
0.5
0
10
5
0
$\times 10^{-8}$
Y
0
0.5
1
1.5
2
$\times 10^{-7}$
X

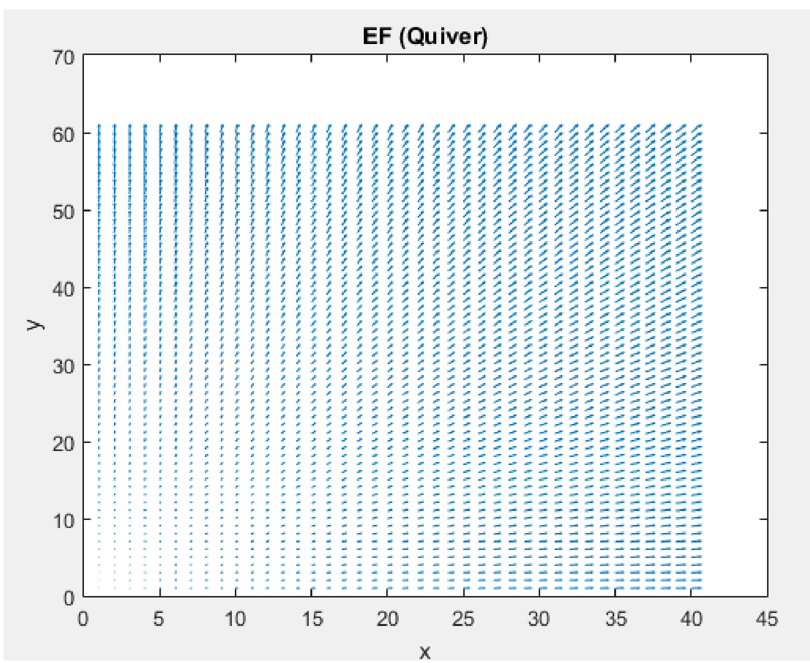

Avg. Temp
Temp (K)
14000
12000
10000
8000
6000
4000
2000
0
0
100
200
300
400
500
600
700
800
900
1000
Time

2 Finite Difference Method

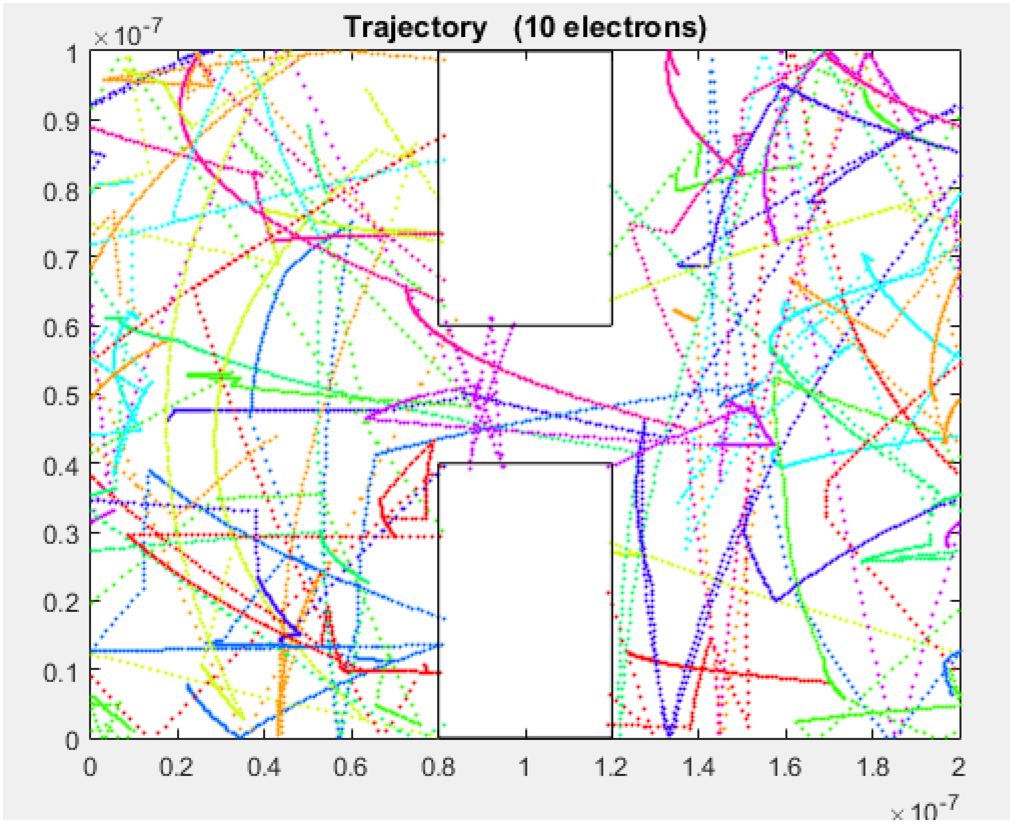
a.



b.



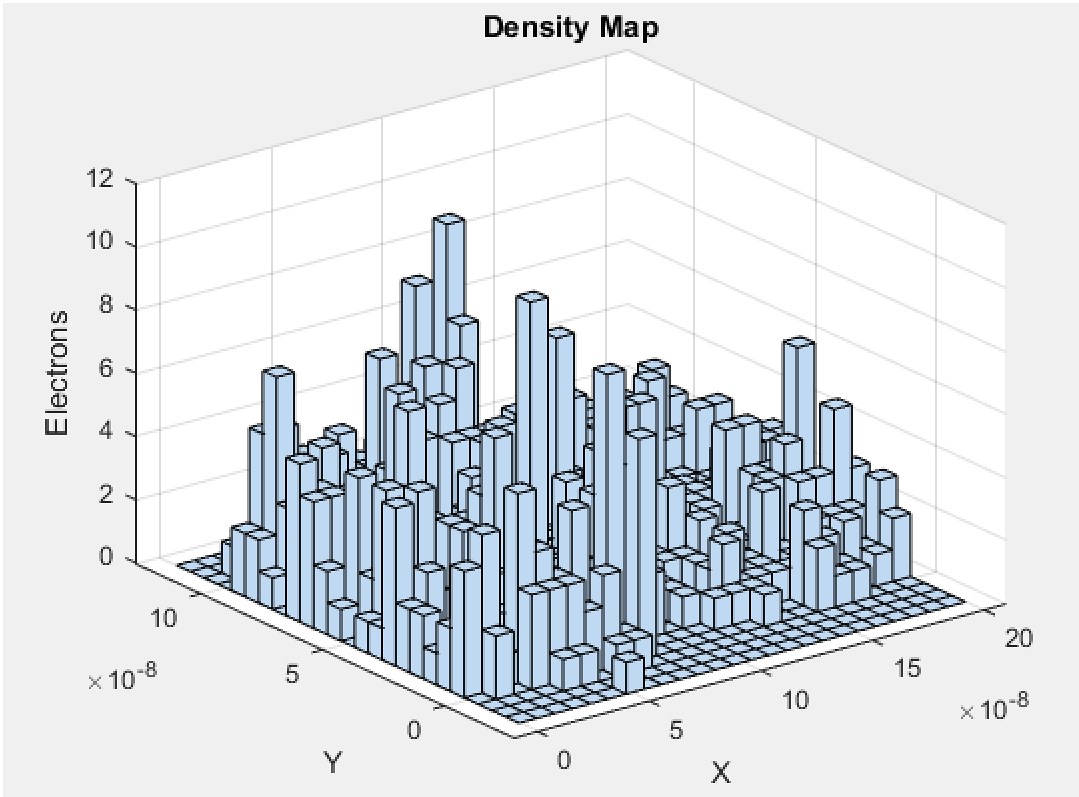
c.



Trajectory (10 electrons)
×10^-7
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
×10^-7

3 Coupled Simulations

a.



The electrons appear to avoid the bottleneck (0.8 <= X <= 12 in the density map).

b. Did not complete.

c. Next steps could include increasing the “intensity” of the simulation in various ways including:

- Increasing the size of Matrix G
- Increasing the number of steps i.e. reducing the step size, or simulation time
- Increasing the number of electrons

References

[1] A. Branicki, “PART1.m,” GH Repository.
<https://github.com/andrewbranicki/assignment3/blob/master/assignment3/PART1.m> 17-Mar-2019.

[2] L. Jones, “Monte Carlo simulation for two dimensional particles in the NVT ensemble-Lennard Jones interaction - MATLAB Central,” Monte Carlo simulation for two dimensional particles in the NVT ensemble-Lennard Jones interaction - [Online]. Available: https://www.mathworks.com/matlabcentral/fileexchange/55266-monte-carlo-simulation-fortwo-dimensional-particles-in-the-nvt-ensemble-lennard-jones-interaction. 15-Mar-2020.

[3] A. Langevin, “Assignment3.m,” GH Repository.
<https://github.com/AdamLangevin/Assignment3/blob/master/Assignment3.m> 17-Mar-2018.

[4] B. Bogosel, “Finite Difference Method for 2D Laplace equation,” *Beni Bogoşels blog*, 27-Oct-2014. [Online]. Available: https://mathproblems123.wordpress.com/2012/10/19/finite-difference-method-for-2d-laplace-equation/. [Accessed: 15-Mar-2020].

[5] B. Kooner, “assignment3.m,” GH Repository.
<https://github.com/baldeepkooner/assignment3/blob/master/code/assignment3.m> 17-Mar-2019.