Exercises Week 1 PIC/MC

Exercise 1 *Take a look at the contents of the file* `pic_example.cpp`. *Try to identify the components in the PIC/MC scheme in figure 3. How and where in the code is the current calculated?*

Exercise 2 *Compile* `pic_example.cpp`. *Run the code and compare the results with the structure of the discharge in figure 2 in terms of for example the electric field or potential. What happens if you change the length of the discharge? Also look at the effect of the initial number of particles and the weight of the simulation particles.*

Exercise 3 *Make an estimate of the mean free path of the particles and their collision times. Check to see if the requirements for grid-size and time step are satisfied.*

Exercise 4 *Try changing the secondary electron emission coefficient. What is the effect of the secondary electron emission?*

In the code the voltage over the discharge is fixed. This is not very realistic. To reproduce the current voltage characteristics of a real discharge we need to add an electrical circuit.

Exercise 5 *Assume a circuit consisting of voltage source and a single resistor in series with the discharge tube. Make an estimate of which values of the voltage source and of the resistor are expected to yield a stable discharge.*

Exercise 6 *Add code to simulate an electrical circuit consisting of a fixed resistance in series with the electrodes of the discharge. Use the estimated values for the resistor and voltage source from the previous exercise.*

If you examine the output for the current you will notice a fair amount of noise.

Exercise 7 *List some possible remedies to reduce this noise.*

Reducing the noise by adding more simulation particles has the disadvantage of increasing computation time. To filter out the noise we introduce an under-relaxation factor for the current. This has the effect of taking a running average of the current, weighted with an exponential decay function in time.

Exercise 8 *Modify the code which calculates the current so that it uses an underrelaxation factor. (Perhaps add a hint on the value).*

Exercise 9 *Recompile the program and run it. Try different total voltages and comment on the output. Under which conditions does the discharge reach a steady state?*