PHY 542

COMPUTATIONAL EXERCISE #1 – PHOTO-INJECTORS

Diktys Stratakis

Exercise: Familiarize yourself with the ASTRA code

1. First you want to initiate the laser beam and sent it to the cathode.
2. So, please open the file *atf2_laser.in*. Set the number of particles to 2000 and make sure that the rms pulse length is set at 2 ps (sig_clock) and charge is at 100 pc = 0.1 nC (Q_total). Later you can change these parameters as you wish.
3. Please run the program *generator*. It will send the laser to the cathode and produce the electron distribution for you.
4. Type *generator atf2_laser.in* to execute the program
5. You have created your electron distribution at the cathode (should match the FNAME in your input deck)
6. Look at the command window: What is the transverse beam emittance? What is the beam size? What is the average energy? Please record those numbers.
7. Now you will track the electron beam through the photo-injector. So please open the file *atf2_linac.in*. Make sure the distribution matches the file you have created.
8. Check the COMPENSATION SOLENOID and make sure LBFieLD=.T. T means ON and F means OFF. Note that MaxB(1)=0.10 is max field of the magnet and S_pos(1)=0.00 is the starting position. So if 0 it means it starts at the cathode.
9. Type *astra atf2_linac* to run ASTRA (suggest to leave ZEND at 0.5 m). If successful, a number of text files are created. How many particles are lost? How many go through?

10. Run *fieldplot atf2_linac.in* and look at the cavity and solenoid fields. What is the rf gradient at the cathode? What is the magnetic field on the cathode? What is the maximum value of the magnetic field?.
11. Now run *lineplot*. Look at the transverse emittance and rms beam size and rest of the parameters. What is the beam energy at the exit of the gun? What is the emittance?
12. For fun, change the rf gradient and see what happens. You gain more energy?
13. Bring back the rf gradient at 110 MV/m.

Photo-injector optimization:

1. Space-Charge Effect: Turn off space-charge by setting LSPCH=F. Run ASTRA. Record the final emittance and rms beam size. Now please turn space-charge on. Record again the numbers. What do you see now? Can you explain the result? Run the program postpro by typing *postpro atf2_linac* and look at the transverse phase-space. Is it an ellipse as we discussed in the lecture?
2. Run ASTRA with solenoid on and off. Check the rms beam size gain. What do you see? Record the emittance at the end of the channel and the peak value of the magnetic field.
3. Vary the magnetic field peak value (MaxB within 0.1-0.5 T) and record the bunch size emittance at the gun exit each time. What do you see? Make sure LBFieLD=.T
4. Make a plot of the emittance and position vs. the peak magnetic field. Find the optimum value of the field that you think works best. Can you explain why?
5. If you have time, feel free to run simulations for different bunch charges. For example what happens when Q=800 pC?