**TP M2 Grands Instruments: Numerical simulation**

**of plasma acceleration with a PIC code**

**Introduction:**

* **Exercise 1 :**

nc (cm-3) =

E0 (TV/m) =

* **Exercise 2 :**

Lx (μm) =

Lr (μm) =

nx =

nr =

**Section 2.1 : Laser in vacuum**

* **Exercise 3 :**

waist (μm) =

LFWHM (field, fs) =

LFWHM (intensity, fs) =

Center laser (μm) =

xfocus (μm) =

* **Exercise 4 :**

a0 =

I (W/cm-2) =

* **Exercise 5 :**

xR (μm) =

* **Exercise 6 :**

Include a plot of the comparison

**Section 2.2 : Plasma waves**

* **Exercise 7 :**

n0 (cm-3) =

write the asked command here

* **Exercise 8 :**

λp (theoretical, μm) =

λp (simulated, μm) =

* **Exercise 9 :**

Include a plot of the comparison

* **Exercise 10 :**

Include a plot of the comparison for Ex and a plot for the comparison of -Rho.

**Section 2.3 : Laser plasma acceleration with external injection**

* **Exercise 11 :**

Q (pC)=

Rms size along x σx (μm) =

Rms size along y σy (μm) =

Rms size along z σz (μm) =

Energy E (mec2) = Lorentz factor =

Energy E (MeV) =

Relative energy spread δE/E (%) =

Normalised emittance along z εny  (mm-mrad) =

Normalised emittance along z εnz  (mm-mrad) =

Center bunch (μm) =

* **Exercise 12 :**

Include plot showing the plasma wave and the electron bunch

* **Exercise 13 :**

Include a plot with the charge density and the longitudinal electric field Ex

* **Exercise 14 :**

ΔE (mec2)=

ΔE (MeV) =

L (μm) =

Eacc (GV/m) =

Report here all the bunch parameters at the start (timestep = 0) and at the end of the simulation (timestep = 5000). You can copy and paste the output of the script Compute\_bunch\_parameters.py.

* **Exercise 15 :**

Include a plot of the bunch parameters evolution and provide an estimate of the accelerating gradient in GV/m.

* **Exercise 16 :**

Include a plot with the results of the four simulations (charge vs energy gain)

Can you explain why the bunch gains more (or less) energy varying the charge?

* **Exercise 17 :**

Include a plot with the results of the four simulations (delay vs energy gain).

What do you observe and how do you explain it?

* **Exercise 18 :**

Include a plot of the bunch energy spectrum at the start and at the end of the simulation, with a brief comment on the changes you see. Send the script to the instructor.

* **Exercise 19 :**

Include the plot and send the script to the instructor.

* **Exercise 20 :**

Include the plot and send the script to the instructor.