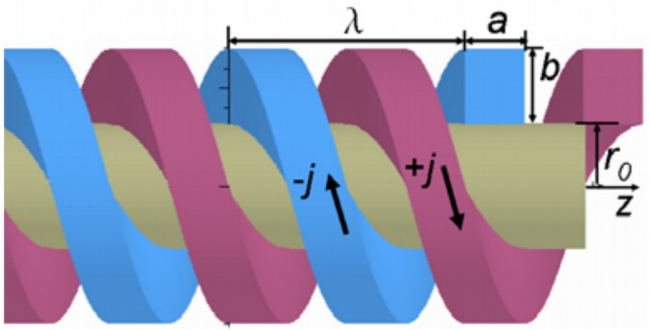
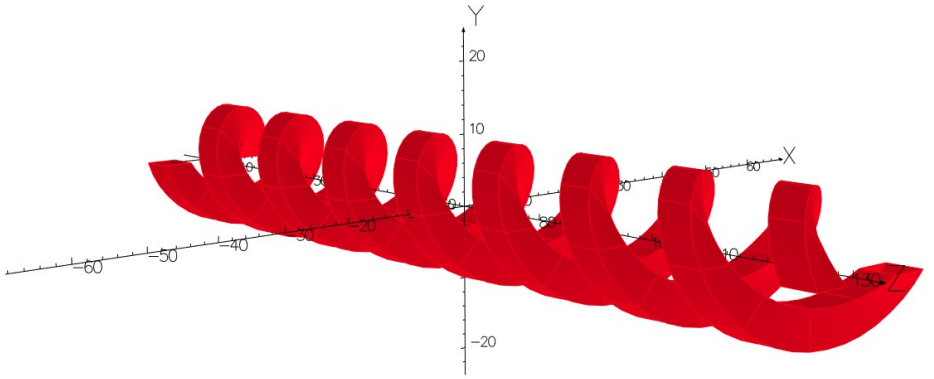



$\lambda = 32.5$ cm

$r_0 = 4.5$ cm

$b = 5$ cm

$a = 5$ cm

$j = 1.101$ kA/cm$^2$

$B_0 = 0.15$ Tesla

N=4 periods

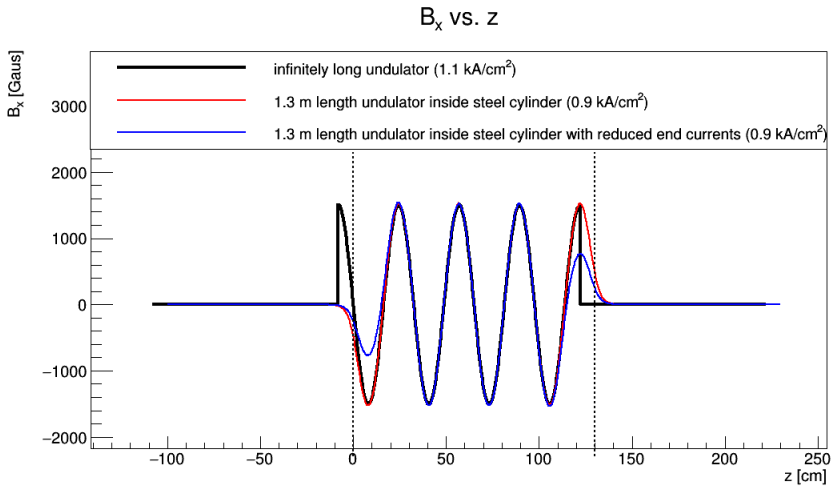
L = 1.3 m

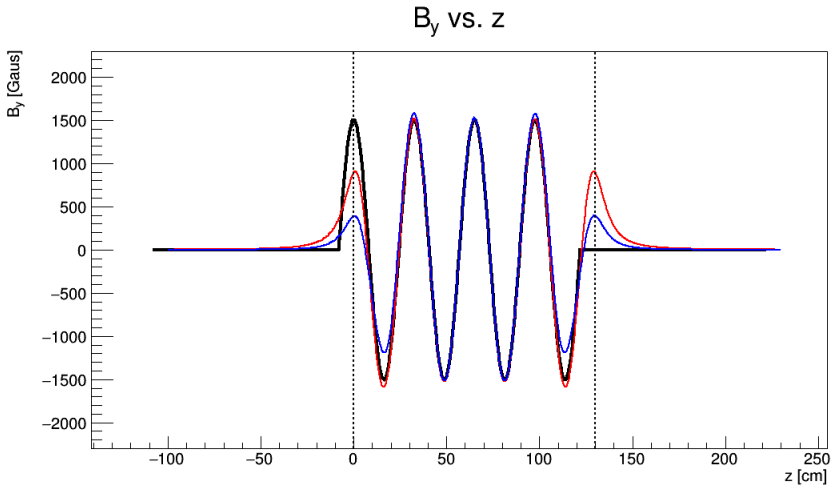
Inside steel cylinder

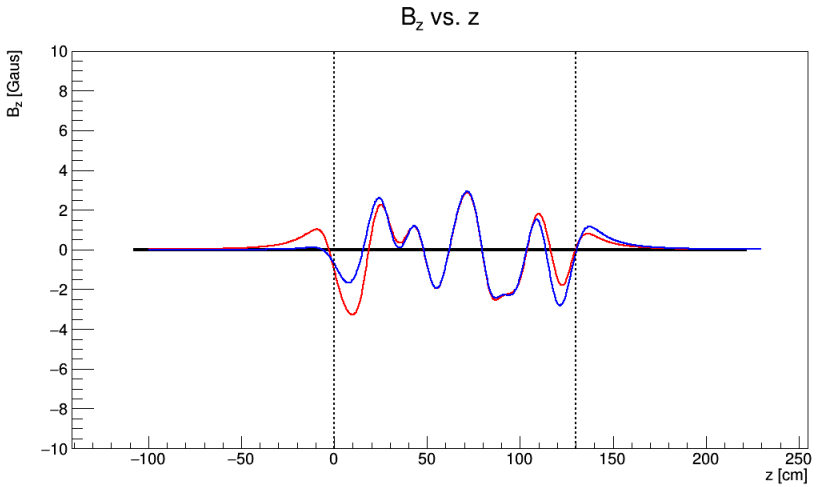
$j = 0.908$ kA/cm$^2$

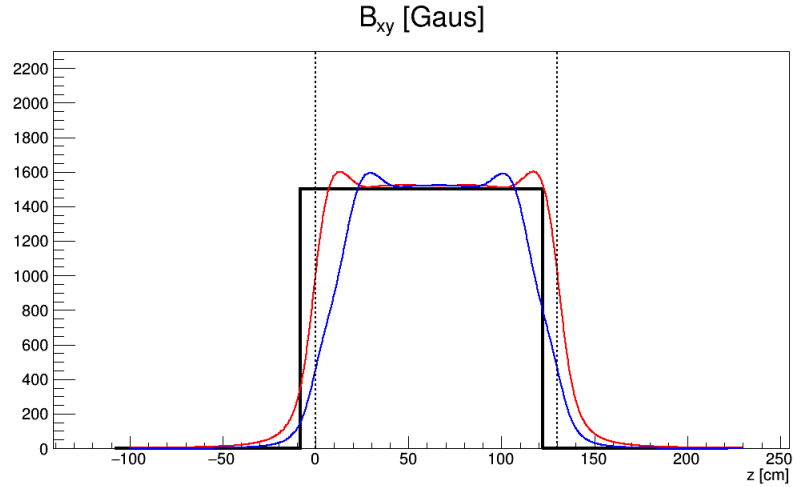
$B_0 = 0.15$ Tesla

# Magnetic field profile



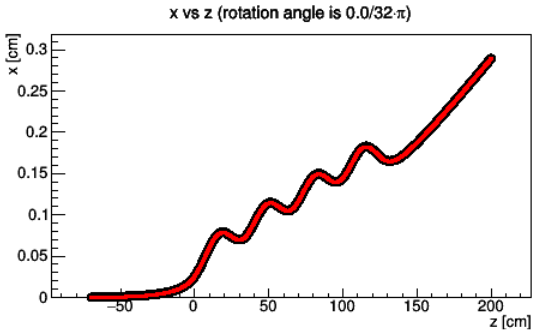



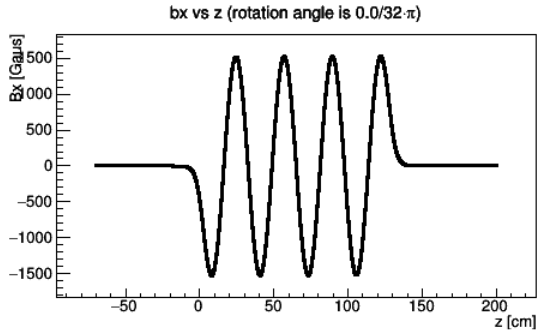



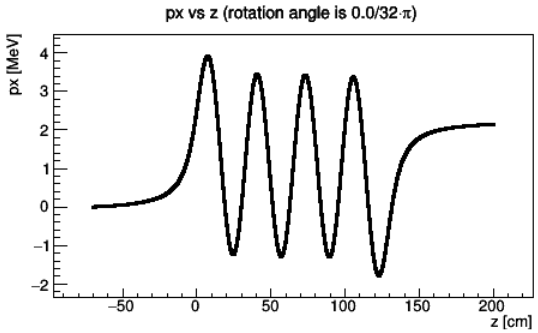
# Tracking method validation

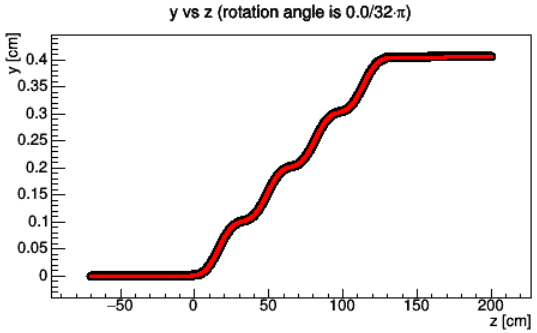
OPERA tracking

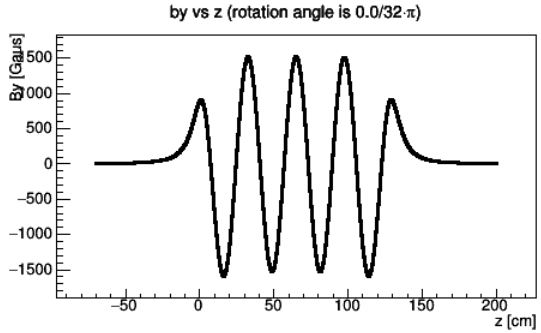
My Runge-Kutta tracking

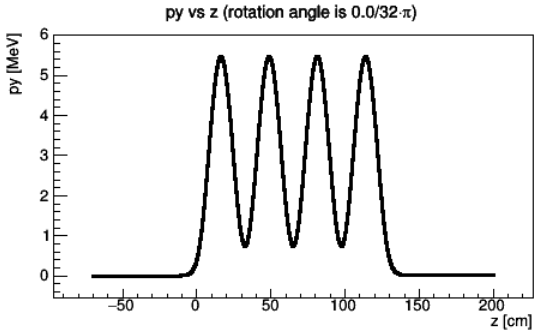


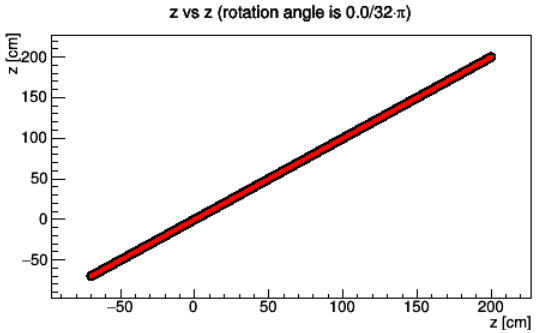



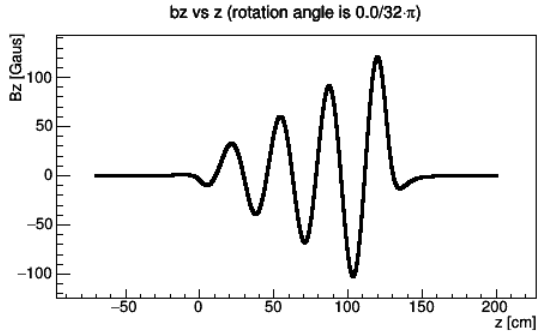



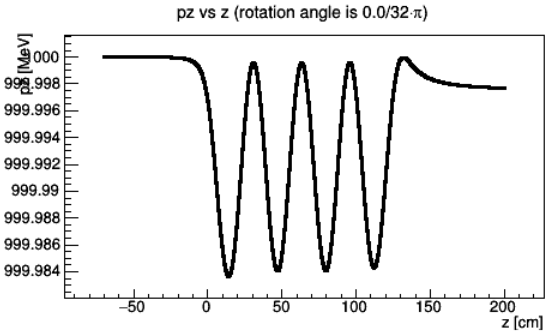



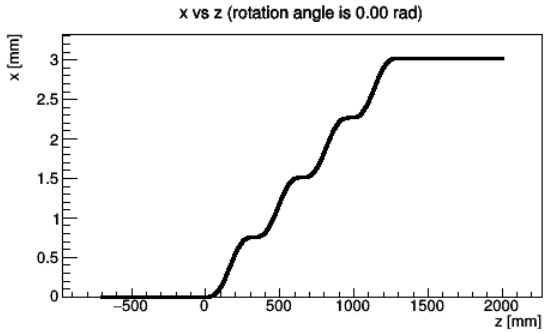



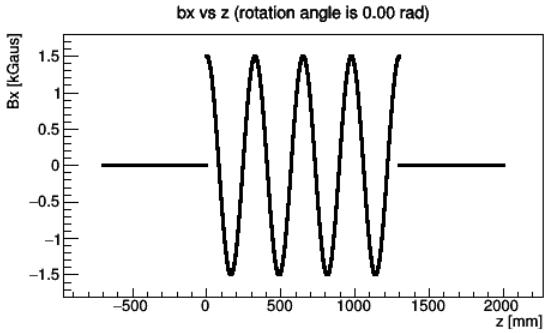



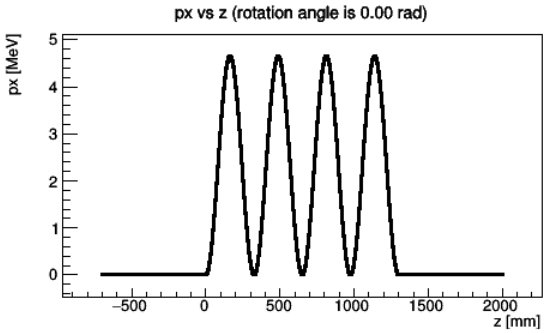



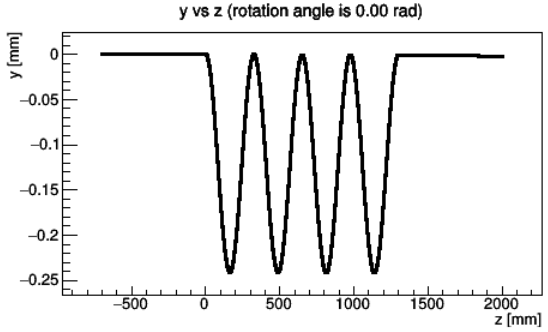



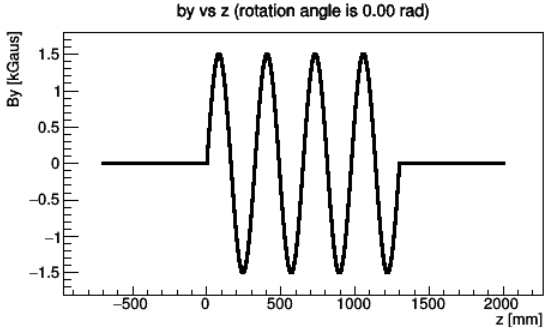
# 1 GeV electron trajectory in infinitely long undulator field

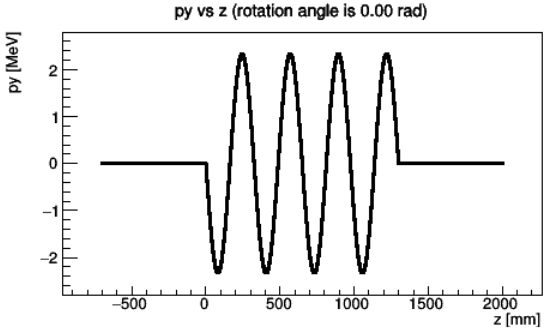


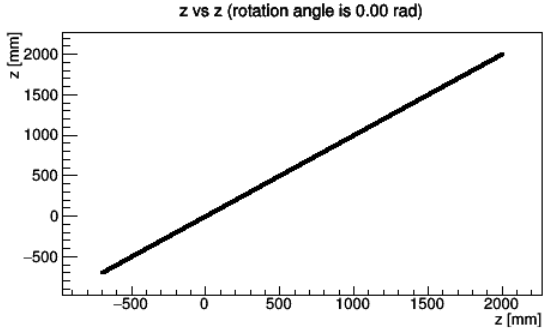



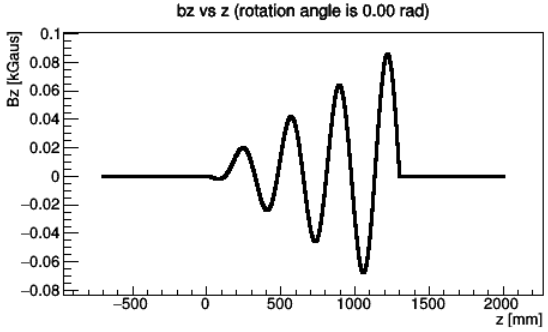



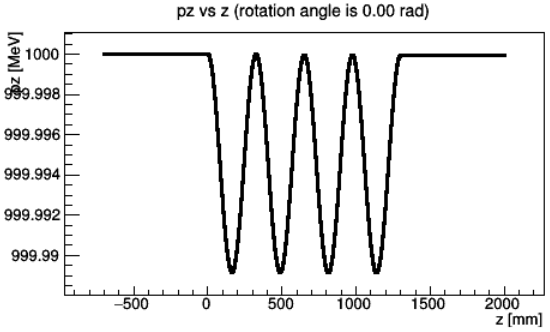



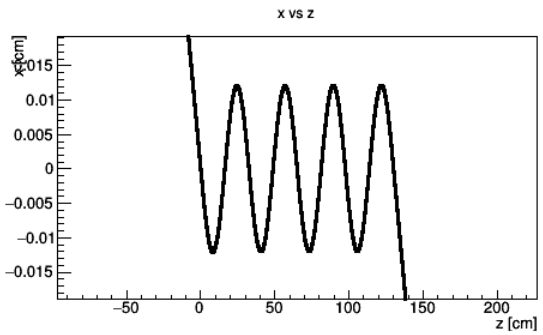



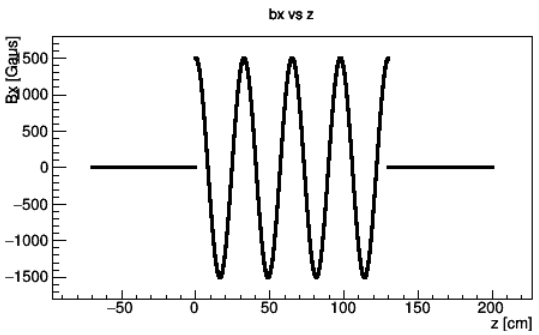



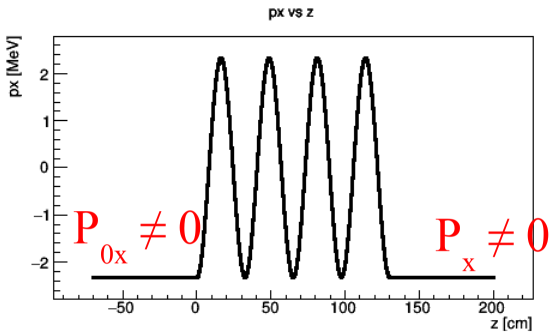



# 1 GeV electron trajectory in infinitely long undulator field

$P_{0x} \sim 2.5$ MeV,
final $P_x \sim 2.5$ MeV,

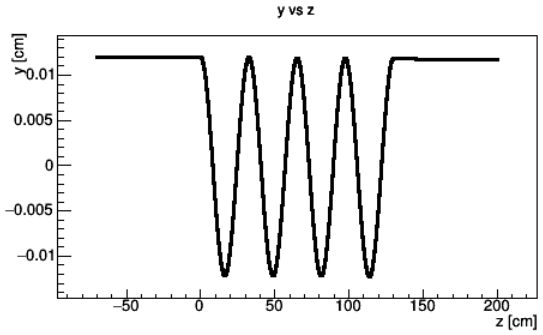


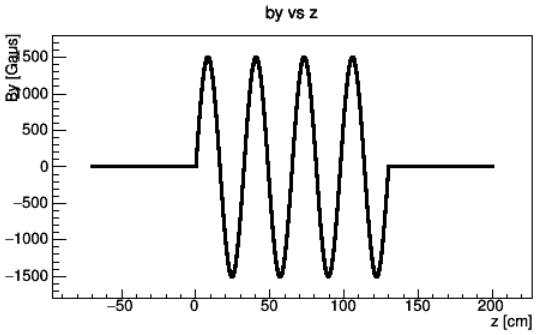



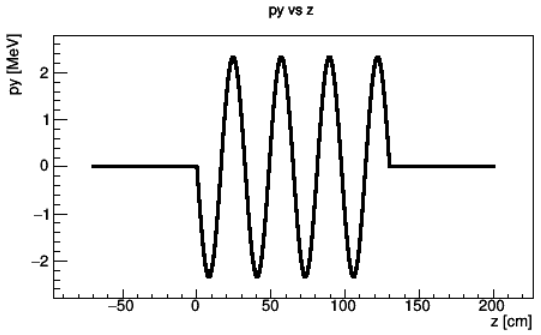



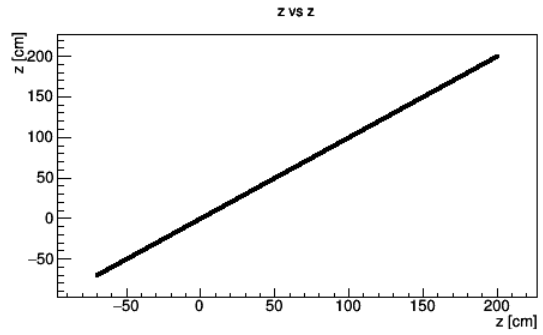

$P_{0x} \neq 0$

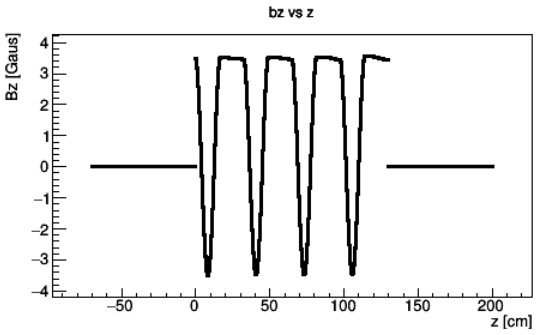
$P_x \neq 0$

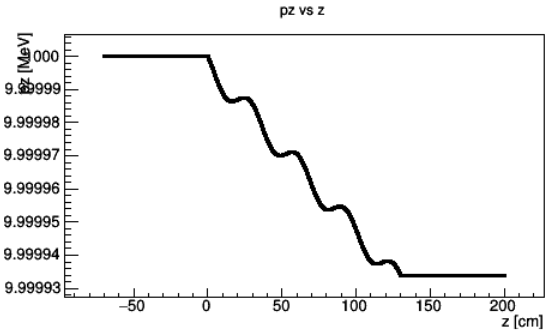


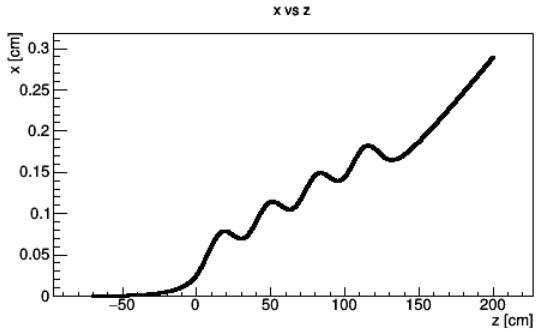



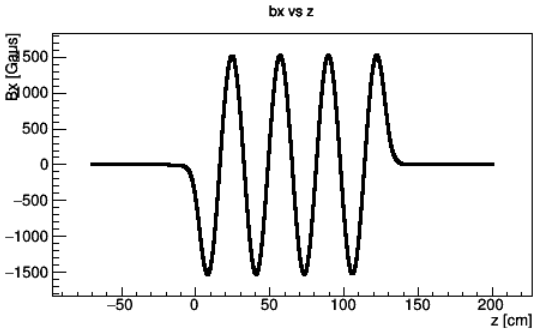



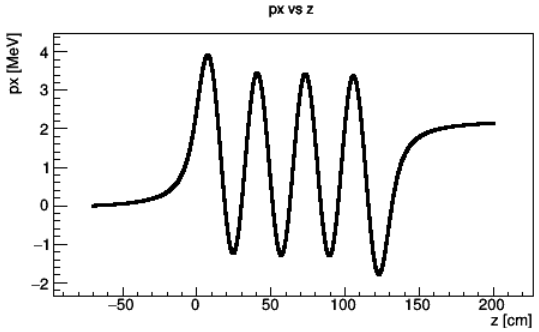



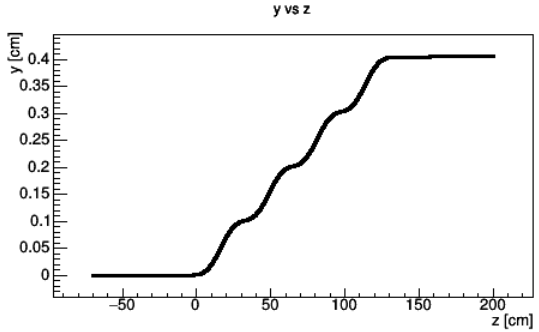



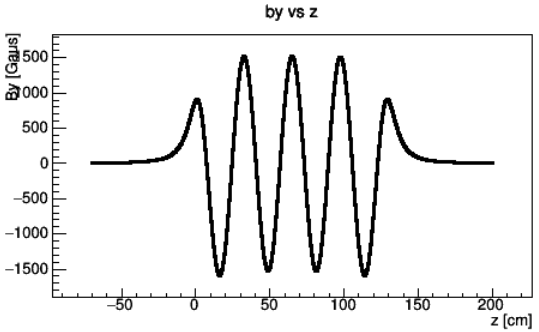
# 1 GeV electron trajectory in 1.3 m long undulator

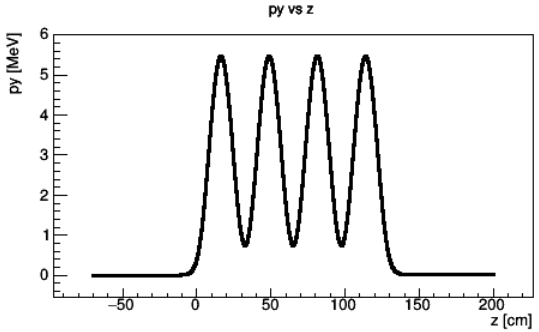


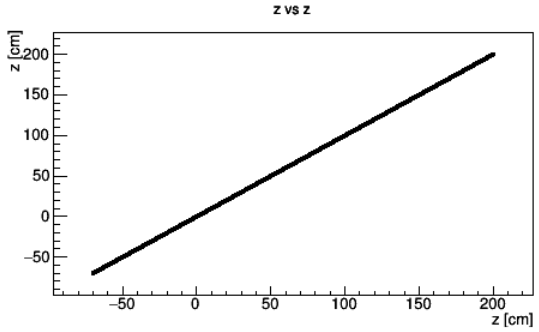



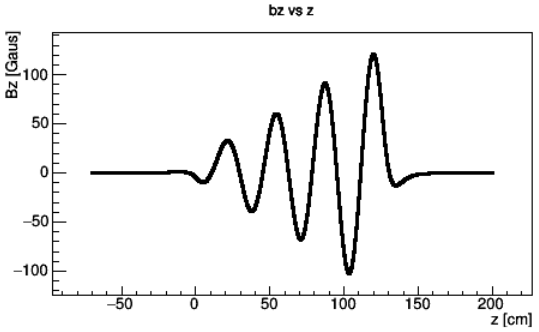



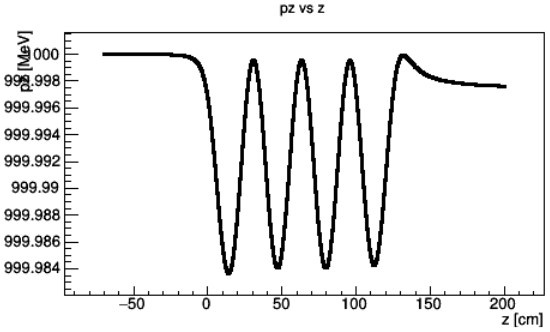



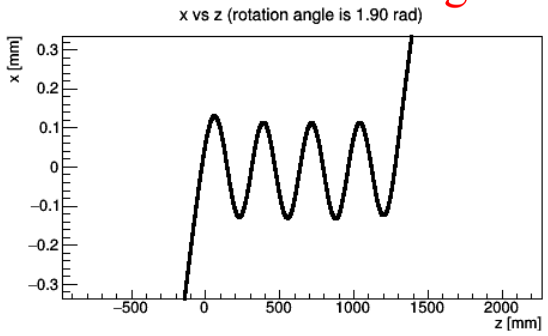



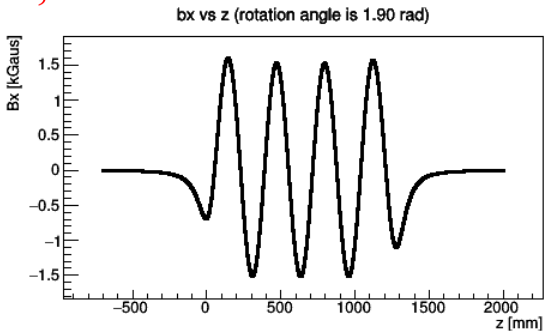
# 1 GeV electron trajectory in 1.3 m long undulator

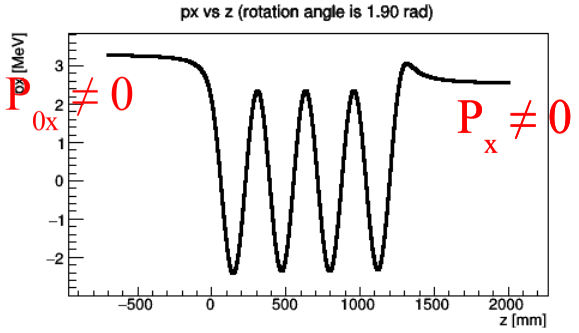
Initial $P_{0x} \sim 3.2$ MeV,

Final $P_x \sim 2.6$ MeV, $P_y \sim 2$ MeV

Undulator rotation angle ~1.9 rad,

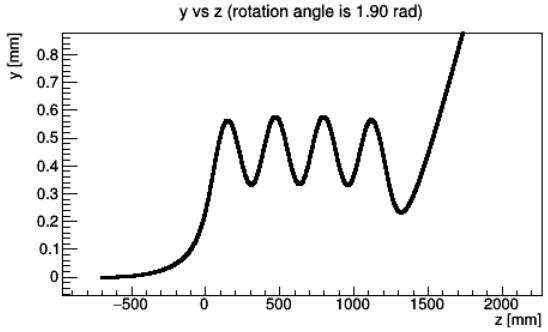


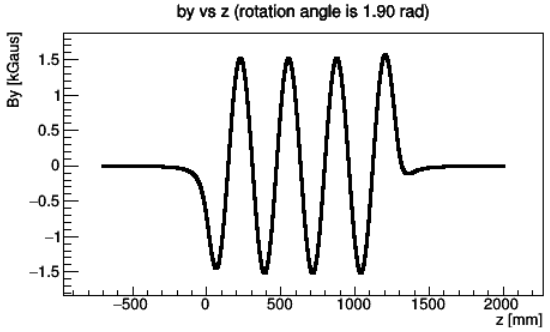



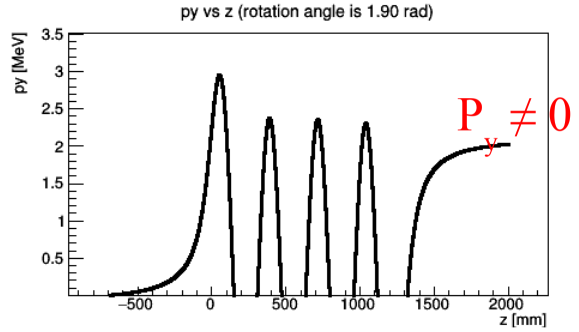




$P_{0x} \neq 0$

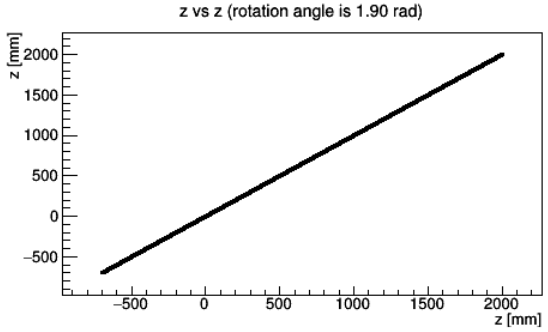
$P_x \neq 0$

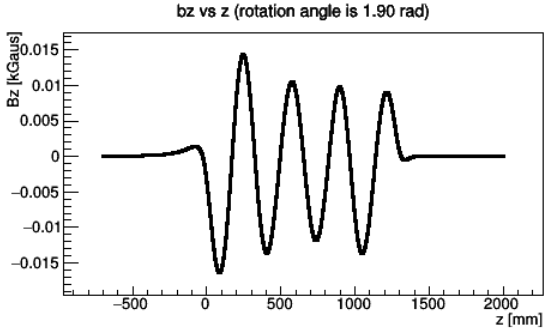


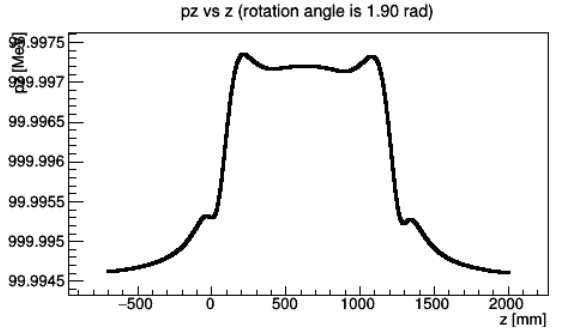




$P_y \neq 0$



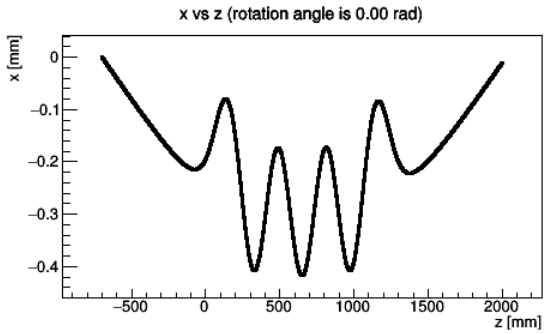



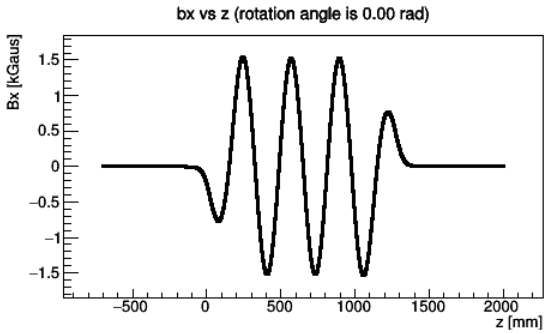
# 1 GeV electron trajectory in 1.3 m long undulator

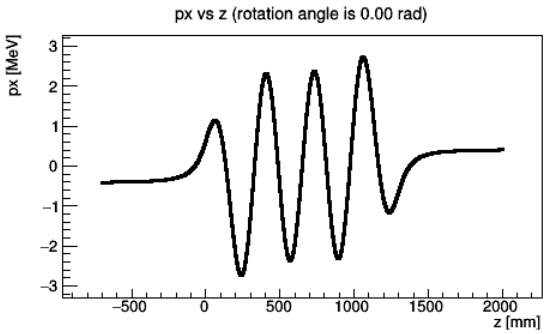
Undulator current = 0.5 I, for the first and last half period

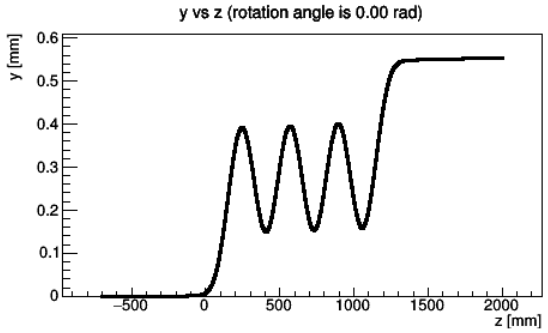
Initial and final $P_x$ ~ 0.4 MeV,

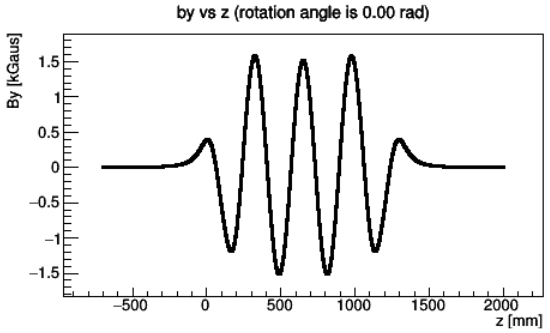
x and y offset

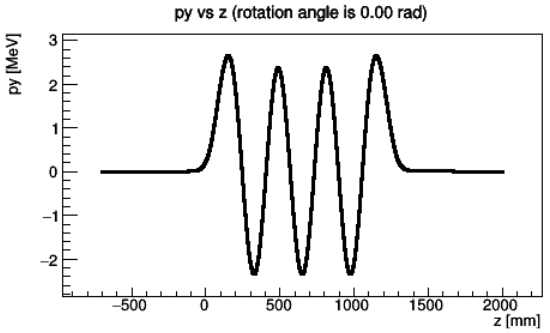


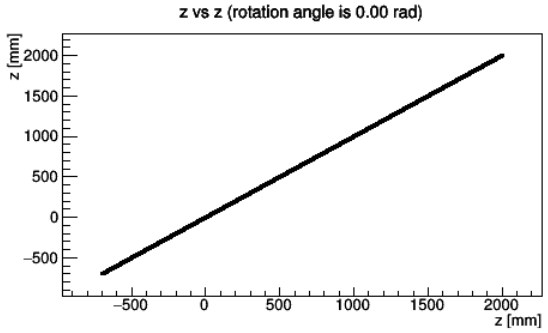



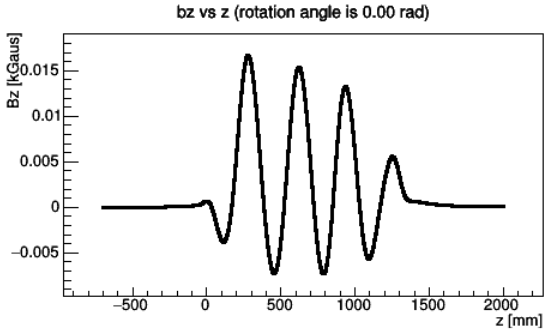



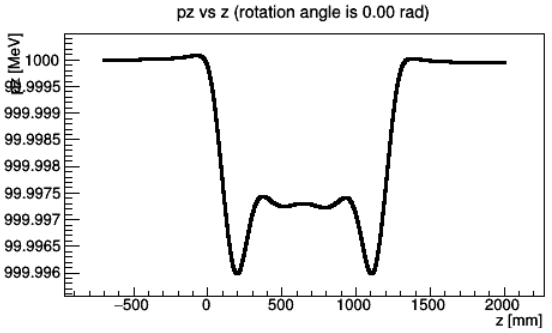



- If $p_{0x}=0$ and $p_{0y}=0 \rightarrow$ the electron trajectory axis is different from z axis, has a few mrad angle.

- We either need to bend the beam before and after the helical undulator to keep it on z-axis,
- Or we have to work with the light and beam which have some angle (and offset) after the undulator