Simulations (Main Linac & BDS)

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Simulations

- I was initially running simulations using a lattice file, kindly provided by Pierre, with the two bunch compressors (BC1, BC2), the ML and the BDS. However, while it was possible to get the correct bunch length, correct emittance and correct horizontal/vertical bunch size it proved difficult/impossible to get them correct at the same time.

- I instead tried running a simulation of just the ML and BDS, based on the R2016X lattice by Mark Woodley.

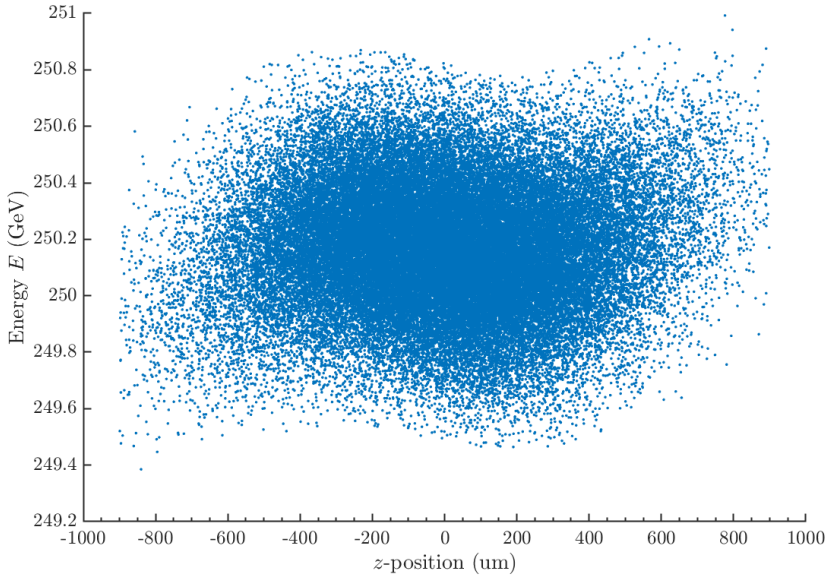
Running with a perfect beamline

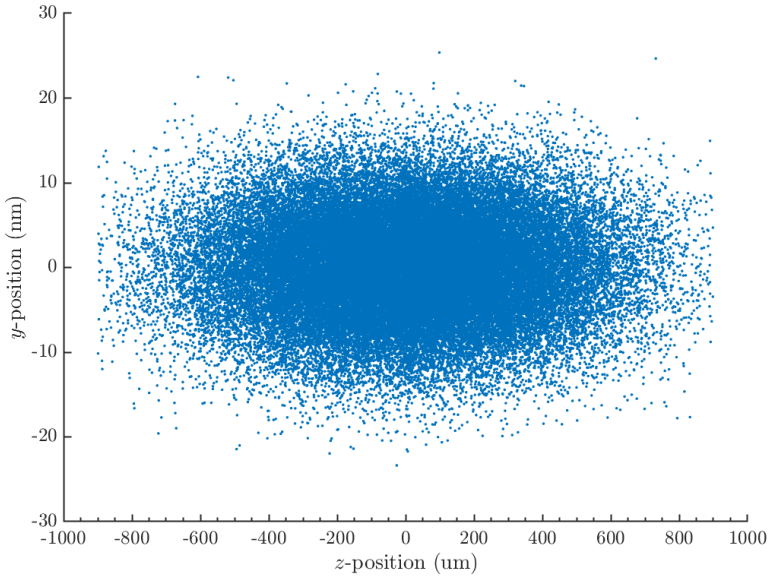
- I verified the lattice was working by tracking the beam with no misalignments, ground motion, or wakefields and was eventually able to get the beam to the IP with the correct bunch size, and with only minimal emittance growth.
- After this, I added back in the wakefield effects (just in the BDS) which made the emittance slightly larger but this effect was very small.
- To further check the simulation I interfaced PLACET with GUINEA-PIG and confirmed that with nominal beam parameters at the IP, I got the nominal luminosity (**$1.76 \times 10^{10}\ cm^{-2}s^{-1}$**)

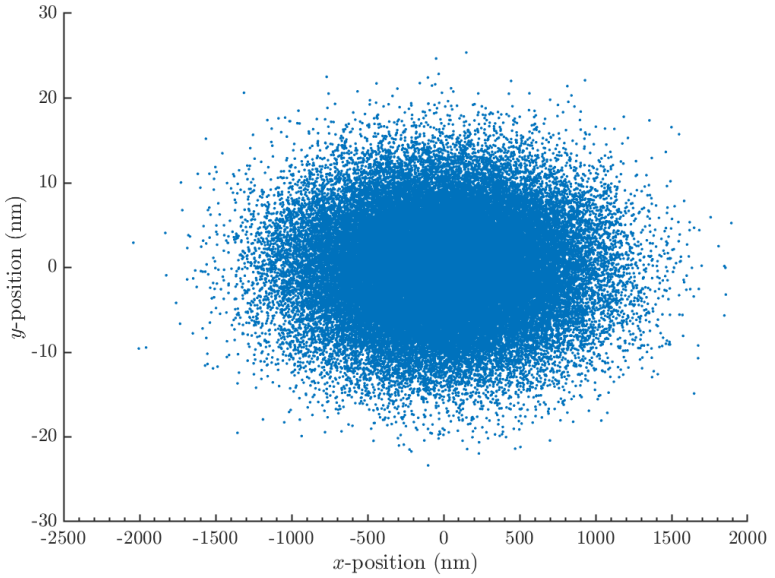
Beam Parameters at the IP (no GM)

- Beam size:
  - $\sigma_x = 477.4$ nm,
  - $\sigma_y = 5.9$ nm,
  - $\sigma_z = 300\ \mu$m
- Energy E = 250.16 GeV

- Energy spread dE = 0.224 GeV
- *x*-offset = 10 nm
- y-offset = 0 nm
- Luminosity = $1.76 \times 10^{34} cm^{-2} s^{-1}$







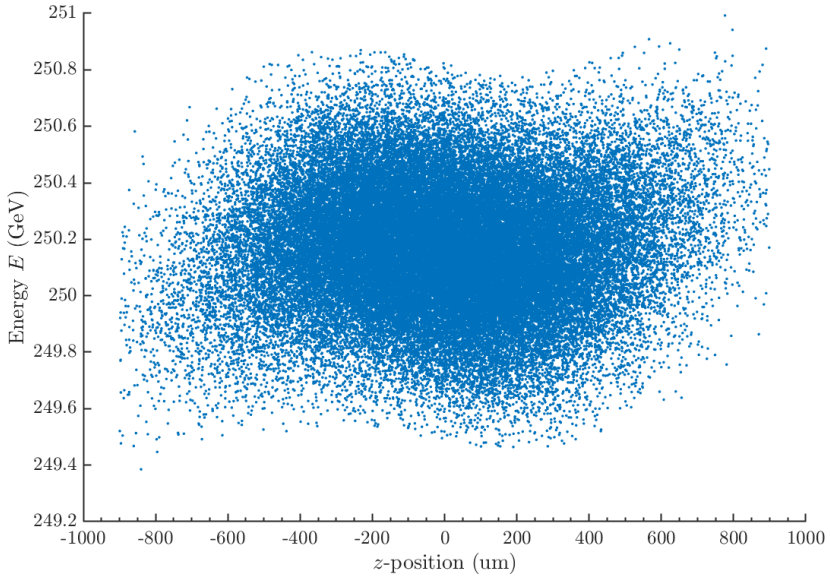
Ground Motion

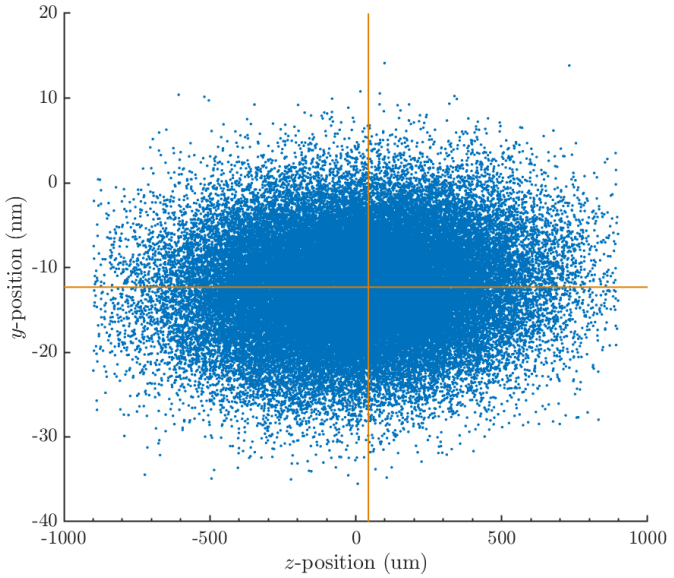
- By adding in 0.2s of ground motion (model K) the luminosity is reduced by up to ~40%, with no feedback running, to approximately $1 \times 10^{34} cm^{-2} s^{-1}$.
- Chet uses a filter on the power spectrum of the ground motion instead of modelling the beam-based feedback systems throughout the machine. I guess ideally I would model the feedback systems explicitly, but that makes the simulation suddenly a lot more complicated.

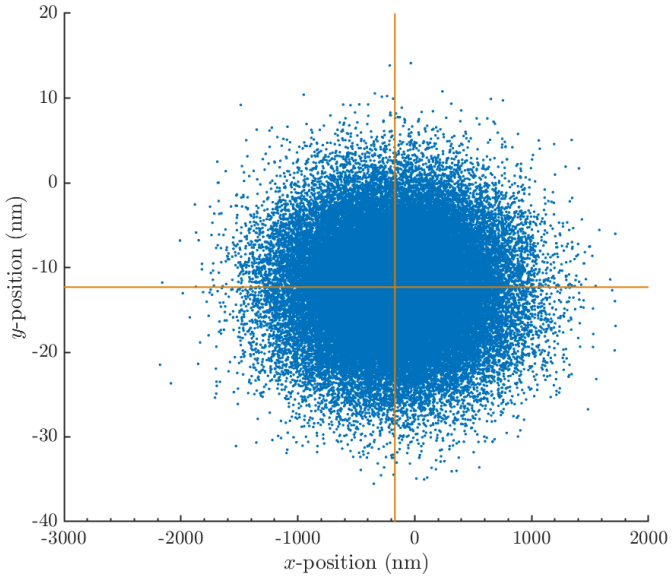
Beam Parameters at the IP (no GM)

- Beam size:
  - $\sigma_x = 478.2$ nm,
  - $\sigma_y = 6.0$ nm,
  - $\sigma_z = 300\ \mu$m
- Energy E = 250.16 GeV

- Energy spread dE = 0.224 GeV
- *x*-offset = 170 nm
- y-offset = 12.3 nm
- Luminosity = $1.02 \times 10^{34} cm^{-2} s^{-1}$







Multi-bunch simulations

- I am currently running single-bunch simulations and it appears Placet doesn't have systems in place to run multi-bunch simulations.
- Pierre's recommendation is to run a single macro-particle as bunch, to allow you to then run 1312 macro-particles as a train. This would not allow for short-range wakefield simulations.
- In this case, this would require separate simulations for the effect of short-range wakefields on the bunch shape and for the effect of ground motion on a train.
- Pierre and Chet are working on a function within Placet to fully model the entire bunch train but they don't anticipate this will be ready before early/mid January.

Summary

- Single bunch simulation with GM and short-range wakefields in the BDS appear to be working.
- Multi-bunch simulations are currently restricted to a single macroparticle per bunch but hopefully this will be sorted early in the new year.
- My next step is to connect my IP feedback model (MATLAB) with the bunch train from PLACET.