Exercises - Future Circular Collider – Parts 3 & 4

A) Consider Z, WW, and/or ZH running: 264 2-cell 400 MHz Nb/Cu cavities at 4.5 K (COP=300), R/Q=180 Ohm, Q_0=3x10^9, V= 8 MV / cavity ; estimate the **electrical power required for the cryogenics**

B) Calculate the **electrical power required for sustaining 100 MW synchrotron radiation with $\eta_{RF} = 75\%$.**

What would be the power saving from increasing the efficiency to $\eta_{RF} = 90\%$?

C) Now turn to the ttbar running 408 6-cell 800 MHz bulk Nb cavities at R/Q = 600 Ohm at 2 K (COP=1000), Q_0=3x10^{10}, V=23 MV/ cavity; again estimate the **electrical power required for the cryogenics**

D) Possible benefit of Nb_3Sn coating – **For A), but consider Q=8x10^9** instead of 3x10^9; **for C) but now** consider **4.5 K (COP=300) instead of 2 K (COP=1000)**

E) The charge imbalance between colliding bunch pairs cannot be more than a few %. Assume that when the intensity of one bunch has decreased to 97.5% of nominal a small bunch with ~5% of the nominal collider charge is injected on top (top-up injection), assuming the opposite bunch is exactly at nominal intensity in this moment. The injection is alternating between the two beams. With 10,000 bunches **in the Z mode**, and assuming a beam lifetime of 18 minutes, what is the **average bunch injection rate** for both beams together? What will be this average bunch injection rate **at the ttbar energy** with 10 minute lifetime and 60 bunches per beam?

F) Now consider a linac repetition rate of 100 Hz - **how many bunches must be accelerated per linac** pulse at the Z and at the ttbar (the number of bunches should be an integer)?