Contribution ID: **218** Type: **not specified**

SPPC longitudinal dynamics design

Tuesday 10 April 2018 17:59 (1 minute)

After the discovery of Higgs boson in LHC of CERN, Chinese scientists immediately proposed a plan to build next generation colliders – CEPC&SPPC. SPPC (Super Proton Proton Collider) is the second phase of this project to explore new physics beyond the standard model. The key design goal for SPPC is to reach 75 TeV in center of mass energy with a circumference of 100 km. As an important part of the SPPC study, longitudinal dynamics has been specially considered, which is based on the requirements for luminosity and its upgrade. A set of self-consistent beam and RF parameters has been given to reach the goal RMS Bunch length 7.55cm at 400MHz. But there are two main constraints: Intra-beam scattering and beam instabilities, which limit the longitudinal emittance. The instability bottlenecks associated with longitudinal dynamics are loss of Landau damping and transverse mode coupling instability (TMCI). To relieve the restrictions of beam instabilities, a higher harmonic RF system (800MHz) has been studied. The results indicate that both transverse and longitudinal impedance threshold have been improved to a certain degree, and the bunch length becomes shorter, which is beneficial to luminosity. Therefore, for SPPC RF system, injection capture using 400MHz, acceleration and physics run using 800MHz will be recommended. And the corresponding injector chain parameters match has been designed, which is identified to be self-consistent. Besides, to overcome the difficulty from beam instabilities, a dual harmonic RF system has been put forward to use, which maybe extremely improve the longitudinal impedance threshold while keeping the goal bunch length 7.55cm.

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Session Classification: Poster session

Track Classification: FCC-hh ACC