Beam Radiation and Conditions Monitoring Project

Description of projects for students

Title: Monitoring of the arrival time of beam 1 and beam 2 with the BPTX with respect to the CMS clock

Project Description:

A capacitive beam pickup ("BPTX") is install in the LHC at ±175m from the CMS interaction point. The picked-up signal, corresponding to the passing of each of beam 1 and beam 2, is received in the electronics service area of CMS. The signal is analysed using an oscilloscope-based readout and used to measure the arrival time difference between two colliding bunch pairs, and the difference in the arrival time between each beam and the CMS clock. The CMS clock is derived from the LHC clock generated by the RF system in point 4 of the LHC, and sent to CMS via optical fibres of about 3.5km in length. The CMS clock is essential for the CMS detector readout, since it determines the timing reference for the readout of the sub-detectors for a particular 25 ns bunch crossing.

The real-time monitoring of the arrival time difference between the two beams is important since this gives feedback to the LHC about the longitudinal position of the two beams with respect to the centre of the CMS detector. The monitoring of the difference between in the arrival time of the beams with respect to the CMS clock is important, because any drift in the clock, will imply an increased probability of an incorrect bunch crossing assignment of the readout of a particular sub-detector.

Project Goals:

- Monitor the drift of the CMS clock with respect to the arrival time of each beam for a given LHC fill.
- Investigate the sources of the short time scaled drift, by correlating any drift with the LHC beam or RF parameters
- Estimate environmental effects that could result in a phase shift of the arrival of the LHC clock, such as temperature.
- Understand the time resolution of the BPTX scope based readout chain
- Monitor the long-term stability of the CMS clock, by comparing the BPTX based analysis, with the results of any timing drift from the sub-detectors.

In addition to the above tasks, a student with a strong interest in fast timing signals, signal processing, electronics and beam instrumentation, can work on an upgrade to the present scope based BPTX electronics. A master's thesis can be proposed on this subject, depending on the particular interest of the student.