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High-precision clocks and triggers for longitudinal beam measurements in high energy synchrotrons

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High energy synchrotrons, like the Super-Proton Synchrotron (SPS) and the Large Hadron Collider (LHC) at CERN, require high-precision beam synchronous triggers for longitudinal measurements, e.g. to acquire bunch profiles from a wall current monitor pickup. The observation triggering scheme is based on the General Machine Timing (GMT) followed by dedicated trigger units counting the revolution and RF frequency clocks to allow synchronisation to the exact RF bucket. Combined with a programmable fine delay, accurate triggers can be placed at any azimuthal position with a resolution of about 20 ps. The SPS installation is described in detail, including its additional flexibility for measurements at injection, extraction and bunch rotation. The performance and limitations of such an implementation are analysed in terms of jitter with respect to the beam, delay variation due to cable lengths between the clock generation and acquisition with a sweeping revolution frequency. Such varying delays can be compensated with the White Rabbit (WR) technology, and highlights from the recent upgrade in the SPS are presented.

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