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Nano-second time scale measurements of the particle arrival times

Mitigating the micro-structure of the spill can be achieved by adjusting the machine settings or manipulating the beam properties. At SIS18, spill smoothing was commissioned by changing the longitudinal distribution of the circulating beam with RF cavities. Tune scan slow extraction was performed using two different frequencies for the RF cavities: bunching was performed at roughly 4.85 MHz (4 circulating bunches) or roughly 81.44 MHz (with 90 circulating bunches). The arrival times of particles were measured using a plastic scintillator (BC400). The analogue signal from the photomultiplier was converted to a logic signal by a 300 MHz discriminator and then characterized by the Time-Digital-Converter (TDC, CAEN V1290N), which recorded the timestamps of each individual particle with a time resolution of about 50 ps for the TDC only. The time structure of the particle arrival times with respect to the RF cavity and particle intervals with respect to each other were analyzed. For the 4.85 MHz low RF frequency, the standard deviation σ of the distribution of particle arrival times with respect to the RF cavity is about 6 ns, which is significantly shorter than for circulating bunches. In addition, a variation of σ and a drift of the centre of approximately 5 ns were observed along the extraction. These are typical values also observed previously. For the extraction with a higher frequency RF of 81.44 MHz the corresponding σ is about 2 ns. In addition, the shape of the distribution of particle arrival times changes significantly during the extraction. A possible reason for this change could be the excitation of the synchrotron-betatron resonance.

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