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Analysis of a digital beam phase control system

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At GSI a closed loop beam phase control is planned, which will be used to damp coherent dipole oscillations of particle bunches. The system is based on a DSP System for high-precision phase and amplitude detection, which was also developed at GSI based on commercial DSP, ADC and DAC modules and is also applied for cavity synchronisation.

A special digital filter with variable pass band is used to convert the beam phase signal to an adequate correction signal for the accelerating RF-voltage. In order to get a proper correction signal the digital filter eliminates noise but it amplifies phase oscillation signals in the matched bandwidth of the synchrotron frequency of the individual accelerated particles. The filter blocks slow variations of the beam phase to allow changes of the synchronous phase without fixing it to a predefined value.

Anyhow the implementation of this digital filter seems to be straightforward and the realisation does not spend much computational power.

Taking into account limited computing power and given signal processing delays as well as noise on analogue cables the loop stability limit is determined by simulation. Influence on beam loss and longitudinal phase space plots can be given. In future the beam phase control will reduce emittance blow up during accelerating in SIS18/12.

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