Simulations of the Position Sensitivity for the SIS18 Capacitive BPM with a Nonstandard Geometry

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Methods and Results

Standard SIS18 Beam Position Monitors (BPM) installed in 12 locations distributed over the SIS18 circumference have typical diagonal-cut geometry [1]. Such geometry allows for position determination with high linearity that, in addition, is independent from the transversal beam shape and homogeneity of the charge distribution. On the contrary, a BPM with a nonstandard geometry, as shown in Fig. 1, shows non-linear readout and is sensitive to higher order moments of the transversal charge distribution. Last feature was intended because this detector, installed in the straight section of sector S04, was initially foreseen for measurements of the quadrupolar Beam Transfer Function [2]. Since this detector is presently used for a Base-Band-tune determination (BBQ-method) [3] a simulation of its position sensitivity was of importance especially for a proper error estimation of the BBQ method.

The simulation was carried out using CST Microwave Studio, with a Time Domain Solver in the frequency range of D$C \leq f \leq 200\mathrm{M}Hz$. The beam was modeled by a stretched wire, whereas a signal propagation was considered as a TEM wave. This approximation is valid also for non-relativistic beams as long as the bunches are much longer than BPM itself. The frequency dependence of the position sensitivity, shown in Fig. 2, was extracted from the scattering parameters as described in [4]. The BPM constants $K_{x,y}$ and electrical offsets in respect to the geometrical center $\delta_{x,y}$ were obtained by a least square fit of the delta-over-sum function [4]. The mean values are:

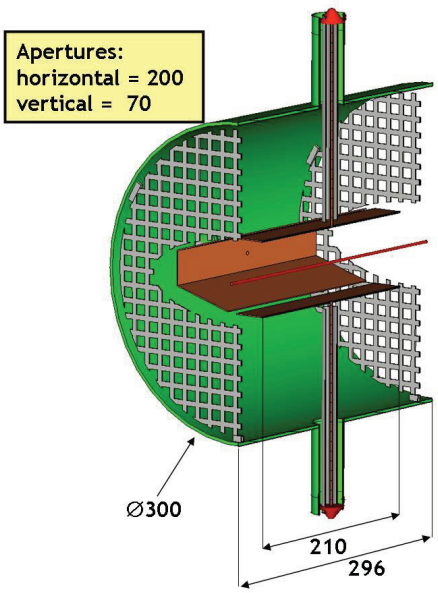

Figure 1: SIS18 BPM with a nonstandard geometry.

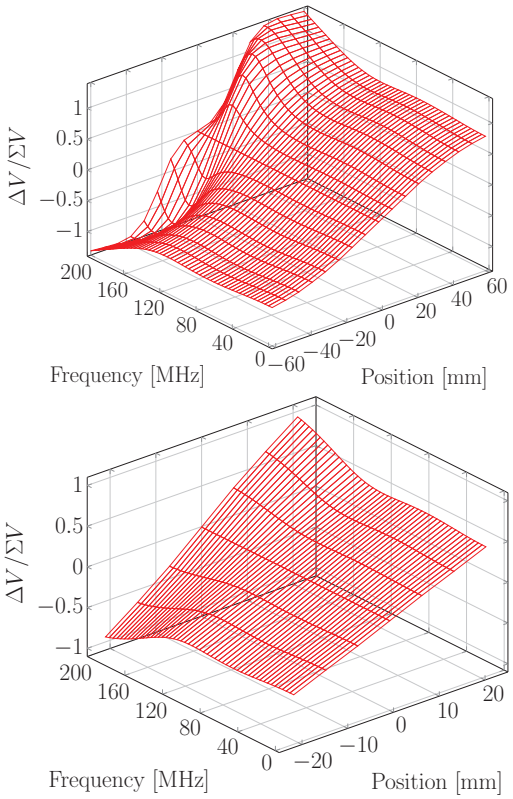

Figure 2: Position sensitivity as a function of frequency for horizontal (top) and vertical beam displacement (bottom).

$\hat{K}_x = 65\mathrm{mm}$, $\hat{\delta}_x = -9 \cdot 10^{-8}\mathrm{mm}$, $\hat{K}_y = 40\mathrm{mm}$, $\hat{\delta}_y = 5 \cdot 10^{-5}\mathrm{mm}$ for horizontal and vertical plane, respectively.

Conclusions

The linearity of the position sensitivity is sufficient for measurements methods like BBQ [3] that base on the spectrum analysis in frequency domain: Within the beam displacement range of nearly 60% of the overall aperture the maximal deviation is in the order of 2.5% for frequencies below 100 MHz. Only at higher frequencies the position sensitivity is strongly effected by resonances which is mostly pronounced for the horizontal plane, see Fig. 2 (top). This, however, is irrelevant for the BBQ method, where interesting frequencies do not exceed 1 MHz.

References

[1] P. Kowina et al., Proc. DIPAC'05, Lyon (2005) p.114

[2] R. Bär, PhD Thesis, Universität Frankfurt, Germany (2000)

[3] R. Singh et al., Proc. of BIW2012, Newport (2012) p.1

[4] P. Kowina et al., Proc. EPAC'06, Edinburgh (2006) p.1022