

Simulations of a quadrupolar pick-up at GSI SIS-18*

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Introduction

This report presents the simulation results for an asymmetrical capacitive pick-up installed at GSI SIS-18. In the past, it was used as BPM (Beam Position Monitor) and is planned to be used for measuring the transverse beam size oscillations at SIS-18. The main goal of this project consists in estimating the properties of the pick-up and evaluating its usage as a quadrupole signal monitor. Due to the fact that the bunch for the SIS-18 operation is long compared to the pick-up electrode, first simulations have been performed with the electrostatic solver of the simulation software CST EM Studio to estimate the pick-up properties [1]. Now, to study the pick-up behavior in the frequency range of interest for GSI, some simulations have been performed using the PIC solver of CST PS (Particle Studio) [2] and the results are presented in this report.

Simulations and Results

The pick-up design used for the simulations is shown below in Fig. 1

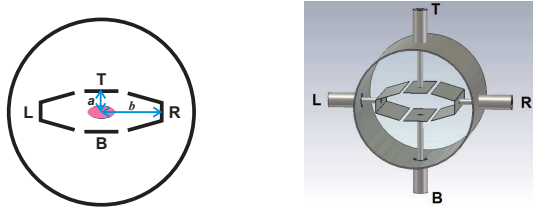


Figure 1: **Left:** front view of the pick-up design, $b = 100.3$ mm, $a = 35.3$ mm; **right:** perspective view of the pick-up from CST PS.

The quadrupolar signal Ξ for the traditional diff-over-sum method is given by $(U_R + U_L - U_T - U_B)/(U_R + U_L + U_T + U_B)$, where U_R , U_L , U_T and U_B are the amplitudes of the FFT signal voltages induced on the respective pick-up plates. Since the frequency range of interest for a typical SIS-18 operation is between 10 kHz and 10 MHz, a high terminating resistor of 1 M Ω was connected at the output of each electrode to obtain a low 3 dB cutoff frequency of the plate. The simulation was carried out, as mentioned in the introduction, using CST PS, with a PIC solver in the frequency range of $DC \leq f \leq 200$ MHz.

On the above diagram in Fig. 2, one can see that, the greater the horizontal beam size σ_x , the greater the

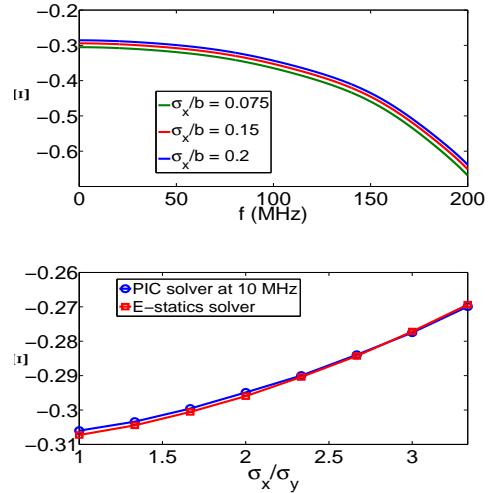


Figure 2: Quadrupolar signal Ξ for a centred beam; **above:** Ξ as a function of frequency; **below:** Ξ as a function of the horizontal beam size σ_x ; $\sigma_y/b = 0.075$, $b = 100.3$ mm

quadrupolar signal in the whole frequency range, as expected. Furthermore, one can see that, in the frequency range of interest (10 kHz \dots 10 MHz) the quadrupolar signal is almost constant; the maximal deviation of $\Xi(f)$ (10 kHz $\leq f \leq 10$ MHz) from the value of Ξ at 10 MHz is in the order of around 0.21%. The lower picture in the above figure shows the quadrupolar signal at 10 MHz for different values of σ_x/σ_y . One can state a good agreement between both solvers; the maximal relative deviation of the PIC solver results from the electrostatic ones is around 0.4%.

Conclusions

The simulations for an asymmetrical pick-up have been investigated in this project. One has seen that, in the frequency range of interest for GSI, the pick-up behaves capacitively. Moreover, there was a good agreement between the PIC and electrostatic results. In conclusion, one can say that, for beams, whose longitudinal extent is much larger than the electrode length, the pick-up properties, like for instance the sensitivity, can be estimated very good electrostatically; this has the advantage that the simulation time is very low compared to that of the PIC solver.

References

- [1] Joel A. Tsemo Kamga, et al., *GSI Scientific Report 2013*.
- [2] CST AG, “CST Particle STUDIO”, www.cst.com

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