MAGNETIC COUPLED BEAM POSITION MONITOR FOR THE FLASH DUMP LINE.

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Introduction

A new diagnostics section before the beam dump has been installed at FLASH [1]. It comprises components to a new beam position monitor (BPM). The beam exits the vacuum system through a special window before reaching the dump. Its position must be measured here to verify the proper operation of the beam in the dump. A beam pipe been connected to the window to the dump.

The cross section of the beam-pipe in front of the beam dump is an octagon, as shown in Figure 2. The distance between two opposite pipes is 537 mm. Such a setup is a step in an area of 0.14 m².

This field is valid without the beam. To include a second current, introduced with f(t)=β(t). This direction of the current is parallel to the z axis.

Analytical solution

The magnetic field of a beam with current $I$ is given by the Biot-Savart law as

$$\mathbf{B}(x, y, z) = \frac{\mu_0 I}{2\pi} \cdot \hat{r} \times \mathbf{A}(x, y, z)$$

with $\mu_0$ the vacuum permeability and $r$ the distance to the zero in cylindrical coordinates. The beam current can be expressed as

$$I(x, y, z) = \int_{A(x, y, z)} I(x, y, z) \, \mathrm{d}A$$

The magnetic field with a horizontal offset can be described by a coordinate transformation for a second magnetic field component $\mathbf{B}_2(x, y, z)$.

$$\mathbf{B}_2(x, y, z) = \mathbf{B}(x, y, z)$$

Here the beam offset has been removed from the numerator so that the distance $\sigma$ will result in the sensitivity. One can see the voltage strongly depends on the beam length. The amplitude is located on the beam length and depends on the plane. To measure the position in a plane, introduce two opposite wires with a beam current and calculate the resulting amplitudes.

The beam measurements were done during the 9 mA study-run. During this time the bunch length was about 200 ps and the beam was simulated at DESY. The results of the simulations are included with a bunch length of 660 ps and an offset of 10 mm for two opposing sensors. Figure 4: The difference-over-sum as a function of beam offset. This is comparable to a BPM with the same pipe diameter and a wall diameter of 20 mm, which results in $d_{offset} = 0.022$ mm.

Summary

A BPM introduced directly in front of the FLASH beam dump. The BPM is positioned outside of the vacuum system in an atmosphere. A magnetic coupling BPM has been developed to avoid the detection of the signals from the in-vacuum electrodes. The detection of an electric coupled BPM is in the bunch charge current and is a function of the bunch length. The BPM is measured between the beam dump and the magnet. The results of the simulations are in very good agreement, even so it is difficult to distinguish the lines. The slope at large offsets is transferred to the simulation tool CST [4]. The beam is simulated in the BPM and the signals are measured in the BPM. The beam current is measured in the BPM and the results are compared with the simulation and the non-linearity at large offsets. The slope at $v_0 = 0$ is determined using the simulation method. Here only the vertical component of the magnetic field contributes to the sensitivity.

References