

Home Exercises – Monday – Beam Position

1. A button BPM has a diameter of 24 mm , the beam pipe of circular cross-section has 49 mm diameter.
 - a. Assume the electrodes are oriented along the horizontal and vertical planes.
 - i. What is the sensitivity in mm^{-1} of the BPM in the beam pipe center? (use the simple approximation given in the lecture)
 - ii. The beam moves only horizontally ($y = 0\text{ mm}$). At which beam position the error exceeds 5 % if no non-linear corrections are applied?
 - b. The button capacitance was measured to be $\sim 9\text{ pF}$.
 - i. What is the 3 dB cut-off frequency of the equivalent high-pass circuit?
 - c. A Gaussian bunch of 10^9 fully stripped lead ions Pb^{82} passed the button BPM pickup with relativistic velocity $\beta \approx 1$, the bunch length is $\sigma \approx 300\text{ mm}$.
 - i. What is the 3 dB cut-off frequency of the bunch spectrum?
 - ii. What is the approximate peak-peak voltage measured with an oscilloscope of $50\ \Omega$ input impedance, cable losses and dispersion ignored. Calculate the signal voltage by using an analytical approximation and plot the waveform.
 - iii. Compare the result with the exact solution by solving the convolution integral of the inverse Fourier transform numerically to get $v_{\text{button}}(t)$ (You will need your computer, please using the software tools you are familiar with. This task is a bit more time consuming! Again, please plot the waveform $v_{\text{button}}(t)$)