Retrofitting of a non-invasive Bunch Shape Monitor for GSI LINACs*

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Introduction

Within the FAIR-Project a proton LINAC [1] is scheduled as a new injector for the SIS18. A non-invasive Bunch Shape Monitor (BSM) is foreseen to determine the longitudinal bunch structure with a phase resolution of 1°, with respect to the 325 MHz acceleration frequency. It is intended to ensure proper longitudinal matching of the accelerating structures. The presented device is based on the creation of secondary electrons by the ion beam passing a section of high local nitrogen pressure. The secondary electrons are accelerated by an external driving potential towards a time-resolved imaging system to obtain the bunch time structure [2].

Compensation of Beam Deflection

The applied driving potential has unwanted effects on the ion beam. For an 11.4 MeV/u beam with an applied voltage of -31 kV the beam deflection goes up to 0.7 mrad (for protons) according to CST based calculations. For the present monitor location at the transfer channel a significant fraction of the beam is lost [3]. To overcome this flaw, two additional electrodes have been designed and build to fit in the existing vacuum chamber. To design an appropriate electrode geometry a field simulation was performed, using CST finite element code.

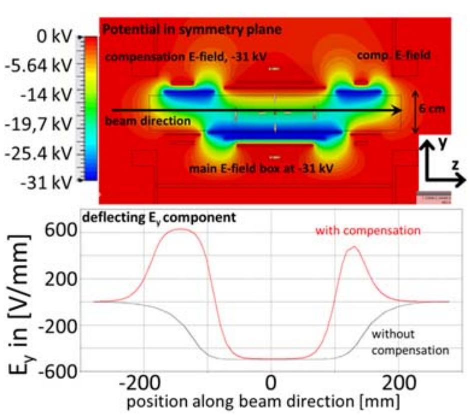

Figure 1: The upper image shows a CST simulation of the potential distribution at the symmetry plane along the beam axis. The lower image shows a calculation of the E-field along the beam axis.

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The most advanced design for optimal compensation is an additional Field-Box with the same geometry split in the middle into two and to put one in front and one behind the original Field-Box. Due to the lack of available insertion space inside the BSM vacuum chamber, this solution is not an option. A more sophisticated design based on CST simulations was chosen, which stays as close as possible with the optimal layout (see Fig. 1). Finally the selected design is a compromise of two contrary objectives, namely achieving a sufficiently homogeneous high field strength with a fixed voltage of -31 kV and leaving enough space in a symmetry axis coaxial to the beam axis, at least 55 mm in diameter (iris size in front of the BSM). This does forbid two capacitor plates with a fixed distance. For sufficient compensation the distance between the capacitors plates is below 40 mm which allows a maximum field strength of 620 V / mm in comparison to the Field-Box with 420 V / mm. In addition the capacitor plates are bended in the middle to allow the beam free pass within a 60 mm diameter (see Fig. 2).
The achieved compensation at 5 mm around the beam axis is about 99 %, decreasing with distance to the axis. Within a 40 mm diameter the deflecting is still suppressed by 90 %, which corresponds to a remaining deflection angle of 0.07 mrad.

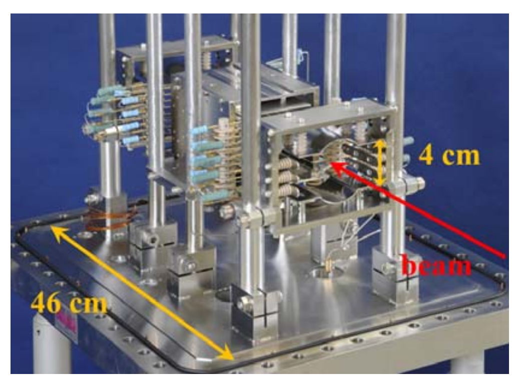

Figure 2: Two compensation electrodes installed in front and behind of the original Field-Box, the red arrow indicates the beam path.

References

[1] L. Groening et al., LINAC'12, Tel-Aviv, THPB034, p. 927
[2] P. Forck et al., DIPAC'05, Lyon, p. 48 ,
[3] B. Zwicker et al.,IBIC'13, Oxford, MOPC36