

Non-invasive Bunch Shape Monitoring for high current LINACs*

B. Zwicker^{1,2}, P. Forck¹, P. Kowina¹, O. Kester^{1,2}

¹GSI, Darmstadt, Germany; ²Goethe Universität Frankfurt, Germany

Introduction

Within the FAIR-Project a proton LINAC is scheduled as a new injector for the SIS18 synchrotron at GSI. The p-LINAC is proposed to achieve a high design value of 70 MeV and 70 mA current in addition to a compact construction. A new designed detector for the longitudinal ion distribution with a phase resolution up to 1° of 353 MHz is foreseen for efficient longitudinal matching of the accelerating structure.

Operating Principle

Several tests have been performed with an already existing **Bunch Shape Monitor BSM** at the UNILAC. The BSM prototype is schematically shown in Fig. 1. It is a non-invasive device based on detection of secondary electrons, which are liberated by the interaction of the beam ions with the residual gas. These electrons are accelerated towards an aperture by an external electrostatic field of 3 kV/cm. An electrostatic energy analyser together with an rf-deflector restrict the secondary electrons in transversal and longitudinal direction leading to a spatial distribution. By resolving the spatial distribution a direct image of the bunch shape is obtained.

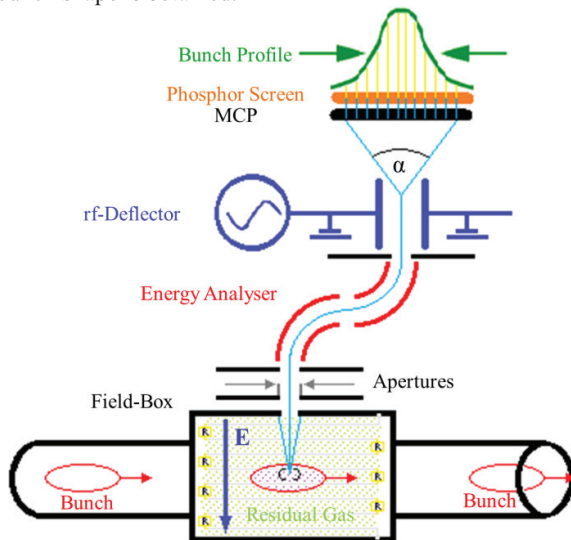


Figure 1: Schematic illustration of the BSM [1].

Results

Successful bunch shape measurements have been obtained with this monitor in 2012. With the BSM it was possible to measure different longitudinal profiles with a width ranging from 440 ps up to 1200 ps as shown in Fig. 2 and Fig. 3. These profiles were taken at identical beam parameters except for the bunch length, which was

manipulated by a bunching cavity in order to test the BSM. The general functionality of this detection scheme is clearly demonstrated, but an unexpected high background was observed, which calls for further investigations. Due to this background and low signal level a bunch shape measurement with typical statistics as of Fig. 2 or Fig. 3 need 128 beam pulses which takes 20 minutes.

The experimentally confirmed phase resolution of the BSM is about 2° at 108 MHz, which corresponds to 51 ps. This level is sufficient to enable reliable bunch shape determination. Intense particle tracking simulations are ongoing to understand and improve the limitations of the actual design and further beam-based tests are planned for 2013 in the UNILAC.

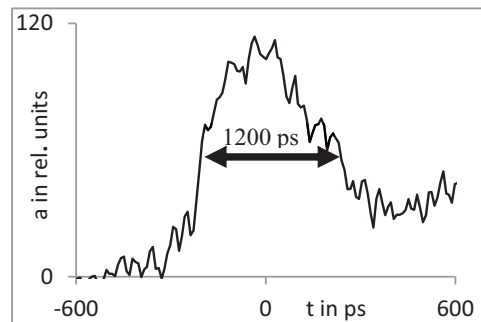


Figure 2: Focused bunch profile [2]. The beam parameters are: U^{28+} , $I = 100 \mu\text{A}$, $t_{\text{pulse}} = 180 \mu\text{s}$, $P = 5 \cdot 10^{-6} \text{ mbar}$

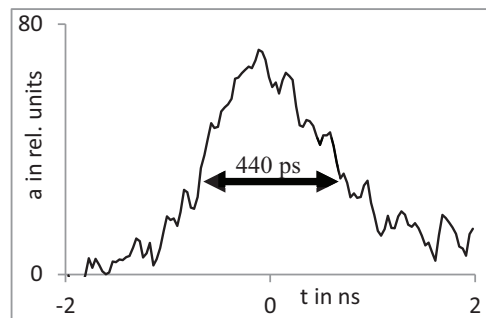


Figure 3: Stretched bunch profile [2]. The beam parameters are: U^{28+} , $I = 100 \mu\text{A}$, $t_{\text{pulse}} = 180 \mu\text{s}$, $P = 5 \cdot 10^{-6} \text{ mbar}$

References

- [1] P. Forck, "A non-intercepting Bunch Shape Monitor at GSI-UNILAC", ABI Workshop, Kreuznach, Germany December 2008.
- [2] B. Zwicker and P. Forck, "A Bunch Shape Monitor for high current LINACs", Bunch Shape Monitor Workshop, Lund, Sweden, February 2013

*Supported by EU-Project CRISP, WP3 T1 Non-intercepting bunch shape monitors.