FIRST RESULTS OF THE NEW CURRENT PROBE RRL

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The layout of the new probe head RRL is presented. With this new probe, a distortion in the main magnetic field has been discovered. Its influence on the beam and the influence on the beam losses are reported. The possibility of correction using the existing trim coil layout is discussed and an appropriate method to compensate for this field error is proposed.

INTRODUCTION

After the 2002 shutdown, a new probe head has been manufactured for the long radial current probe RRL in the 590 MeV Ringcyclotron. The existing vertical single tungsten wire has been replaced by two silicon carbide fingers, vertically aligned and spaced two millimetres apart (Fig. 1). This new probe head provides additional information about the vertical beam position and consequently about the vertical beam excursions. The scanning path of the probe was not changed. The fingers are moved in radial direction, starting at the extraction position and ending at turn eight [1]. All beam revolutions are scanned, except for the first seven. The new finger probe is able to scan a beam current up to 0.4 mA, which corresponds to 22 % of the actual production proton current of 1.8 mA. This fulfils the operational requirements, since this probe is mainly used during setup and commissioning periods and not for high intensity applications.

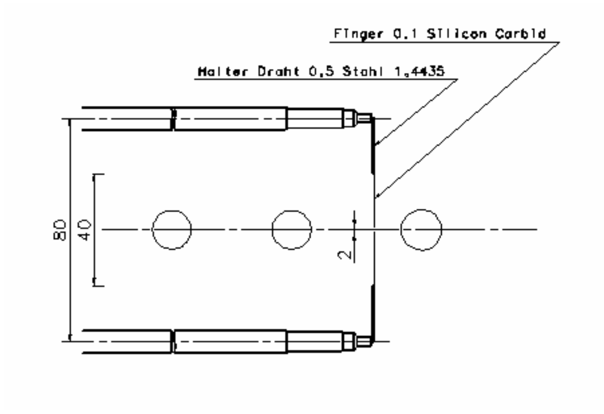

Fig. 1: Geometric layout of the RRL probe head. Distances are noted in millimetres.

VERTICAL BETATRON OSCILLATON

The first measurements with this probe head gave insight into the vertical beam behaviour. As known from measurements with the probes RRI1 and RRI2 located at the injection region of the Ringcyclotron, the beam starts spiralling with almost no vertical betatron oscillation. Measurements with the new probe head confirm this stable beam acceleration up to a kinetic energy of 250 MeV, corresponding to a radius of 3600 mm. The vertical long range movements observed in this section indicate small displacements of the magnetic midplane and/or of the probe guide. Beyond this energy, a vertical betatron oscillation with an amplitude of a few millimetres is excited. This remains unchanged until the beam is extracted.

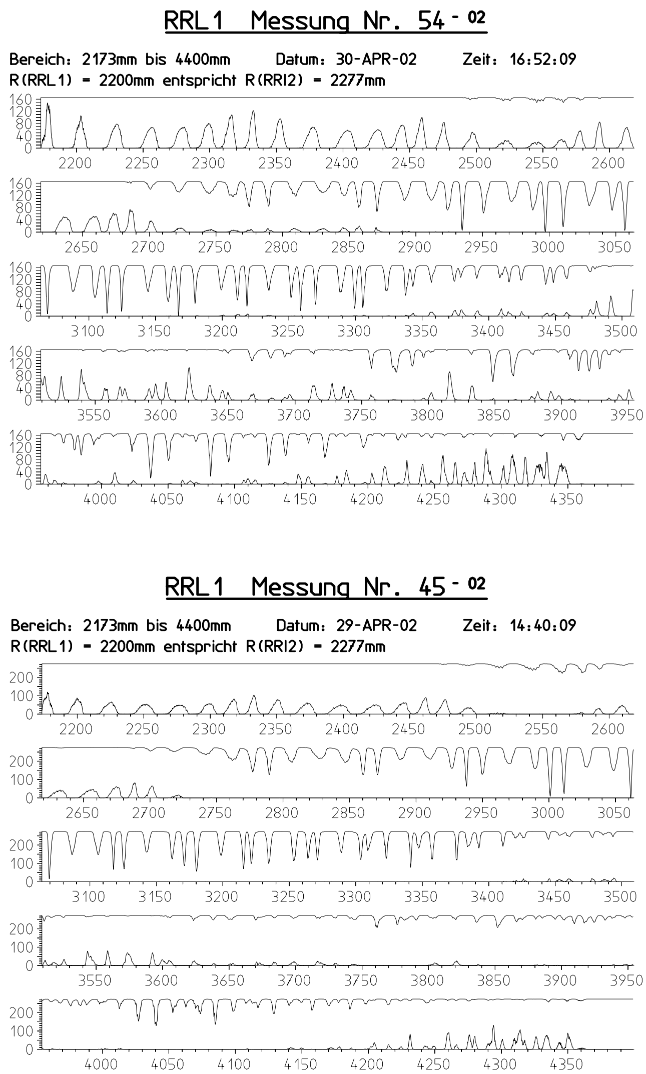

Fig. 2: Plot of RRL Scans. The current deposited on the lower finger is plotted from the bottom upwards, the current on the upper finger downwards from the top. At production conditions (54), an oscillation starts at a radius of 3600 mm. It can be eliminated by appropriate setting of the injection parameters (45).

A similar betatron oscillation can be introduced by the beam injection line steering element SND3Y. Appropriate setting of this element induces an oscillation with the same phase and inverse amplitude, which is then compensated by the field error. Fig. 2 compares measurements of these two settings. The upper RRL graph (54) shows the situation at production conditions, where the oscillation starts at a radius of

3600 mm. In the lower graph (45), the oscillation generated at injection is fully compensated in the field error region.

INFLUENCE OF TRIM COILS

The region of the detected field error is equipped with two sets of trim coils TR10 and TR11. These devices act as correction elements for field isochronism and thus should not contain any horizontal field component. However, RRL-measurements of the influence of these isochronising trim coils have shown that they could be used to modify the amplitude of the vertical oscillation. An appropriate setting of these coils can even completely compensate the influence of the magnetic field distortion. We therefore had to find out if these coils generate unexpected horizontal field components. The main cyclotron field was isochronised by a set of trim coil currents leaving the coils under examination (TR10 and TR11) unexcited. In addition, betatron oscillation was compensated by appropriate setting of the steering magnet SND3Y as mentioned above. Starting from this situation, the test coils were excited and the influence on the oscillation amplitude was measured. No significant influence was observed. We were able to conclude that the horizontal field component is not generated by trim coils. The cause of the observed effects must be found elsewhere.

The observed influence of the trim coils on the vertical oscillation is probably caused by the fact that they change the vertical focusing properties and as well the path of the beam orbits. This may increase or decrease the number of revolutions in the disturbed field region.

INFLUENCE ON BEAM LOSSES

Although the origin of this vertical oscillation and the influence of the correction coils TR10 and TR11 are not yet fully understood, first studies have been done to examine its influence on beam losses.

Deposit rates on the ionisation monitors; MRI10 and MRI11 for vertical losses and MRI13 – MRI15 for horizontal losses; have been scanned for various SND3Y excitations. The graph in Fig. 3 reveals that there is no direct correlation between the size of the betatron amplitude and the low-loss window for the SND3Y setting. Furthermore, a complete compensation of the error induced oscillation yields a smaller SND3Y low-loss window and an enhancement of the losses. Since these trim coils primarily act as isochronising devices, any changes influence the phase history of the beam and thus raise overall losses. More detailed examinations would require a means of producing horizontal field components without affecting the phase history.

PROPOSED METHOD OF CORRECTION

The correction of the betatron amplitude by means of exciting isochronising trim coils is not recommended for the reasons mentioned above. A more promising approach would be to operate the upper and lower group of trim coils in the region of 250 MeV using separate power supplies. This would allow setting the coil currents in such a way that a horizontal field component results, leaving the isochronism and thus the beam losses untouched. The realisation of this modification is subject to further investigation.

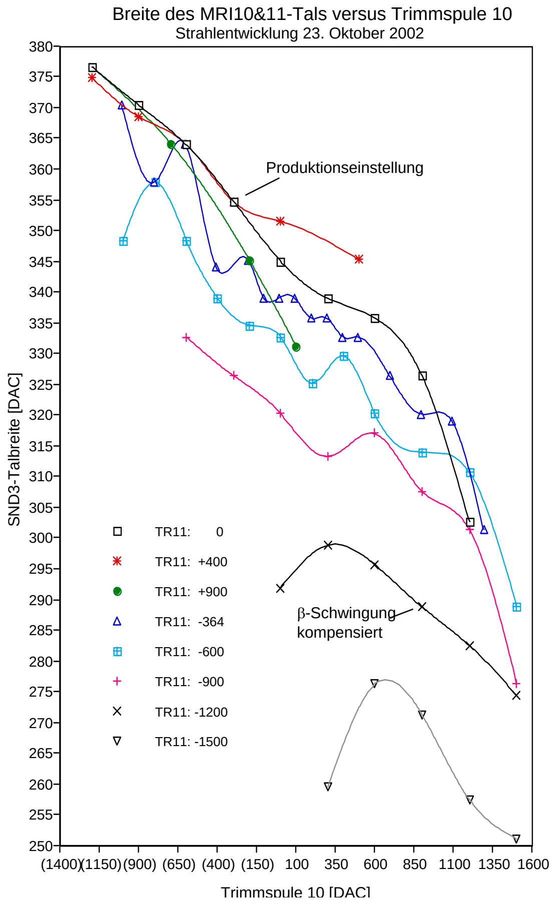

Fig. 3: Low-loss window settings of the SND3Y for. various excitations of the trim coils TR10 and TR11. Terms in brackets are negative.

ACKNOWLEDGEMENTS

The authors acknowledge the control room crew for their patience and constructive help with data taking.

REFERENCES

[1] L. Rezzonico et al., *Diagnostic for High Intensity Beams*, Proceedings of the Beam Instrumentation Workshop BIW-94, Vancouver.