TRANSVERSE MATCHING TECHNIQUES FOR THE SNS LINAC*

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Abstract

It is crucial to minimize beam loss and machine activation by establishing optimal transverse matching for high intensity linear accelerator such as the Spallation Neutron Source linac. For matching DTL to CCL, there are four wire-scanners installed in series in CCL module 1 as proposed in [1]. A series of measurements was conducted to minimize envelope breathing and the results are presented here. As an independent approach, Chu et al is developing an application based on another technique by estimating rms emittance using the wire scanner profile data [2]. For matching MEBT to DTL, a technique of minimizing rms emittance was used and emittance data show that tail is minimized as well.

INTRODUCTION

The Spallation Neutron Source (SNS) accelerator system is designed to accelerate intense proton beams to energy of 1-GeV, delivering more than 1.4 MW (upgradeable to 2 MW) of beam power to the neutron production target [3]. Being a high intensity linac, a primary concern is potential damage and radio activation of accelerator components resulting from uncontrolled beam losses. A major source of loss is beam halo that intercepts the bore of the linac. It is important to accomplish adequate level of transverse matching between sections of linac.

During the previous commissioning runs, matching of the Medium Energy Beam Transport (MEBT) to the Drift Tube Linac (DTL) was performed. For this, the technique of minimizing rms emittance was successfully applied [4]. This technique is totally model independent.

For the purpose of transversely matching DTL to CCL (Coupled Cavity Linac), four wire-scanners are installed in series in CCL module 1 as proposed in [1]. During the warm linac commissioning up to CCL module 3, this technique was tested and the results are presented here.

MATCHING DTL TO CCL

We used the rms beam size of the Gaussian core as a measure of beam size. Measured beam profiles usually contain some level of tail or halo as shown in Fig. 1. We performed a Gaussian fit to the measured beam profile and obtained its beam size σ. From the initial wire-scanner measurement, we obtained the input beam Courant-Snyder parameters β and α, and the beam emittance ε. These parameters and emittance were obtained by fitting the beam envelope from the Trace3D code to the measured beam size from the wire-scanners. The matching quadrupole gradients are obtained using the Trace3D code.

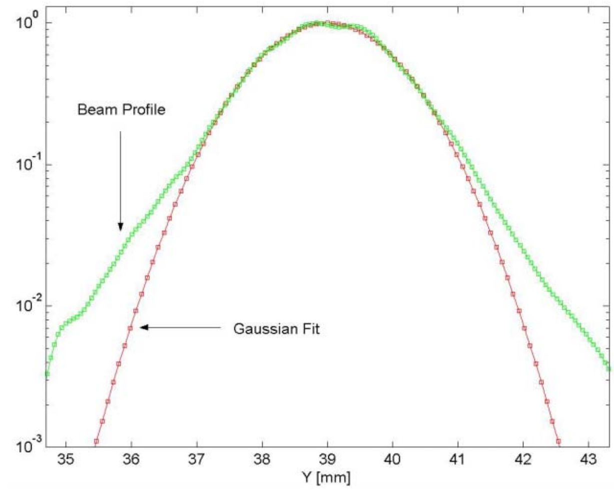

Figure 1: Plot of beam profile obtained from wire-scanner measurement. Over-layed is the profile of Gaussian fit.

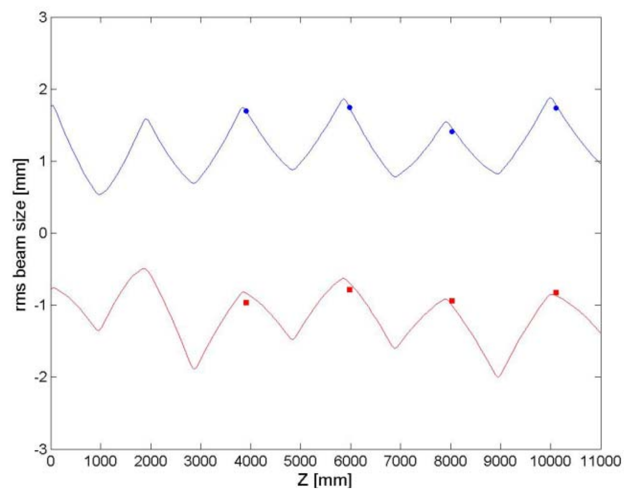

Figure 2: Plots of beam profiles. Solid lines are plots of beam size σ [mm] from the Trace3D program and dots are wire-scanner measurement data.

Table 1: Input beam parameters

	X plane	Y plane
ε [mm-mrad]	0.343	0.351
β [m]	4.18	0.677
α	-3.55	0.536

Table 1 lists the input beam parameters to the CCL module 1 at 35mA. ε_x=0.343 and ε_y=0.351 were obtained for the normalized rms emittance. These are the

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normalized rms emittance [mm mrad] of the equivalent uniform beam distribution having the same rms beam size as the beam profile.

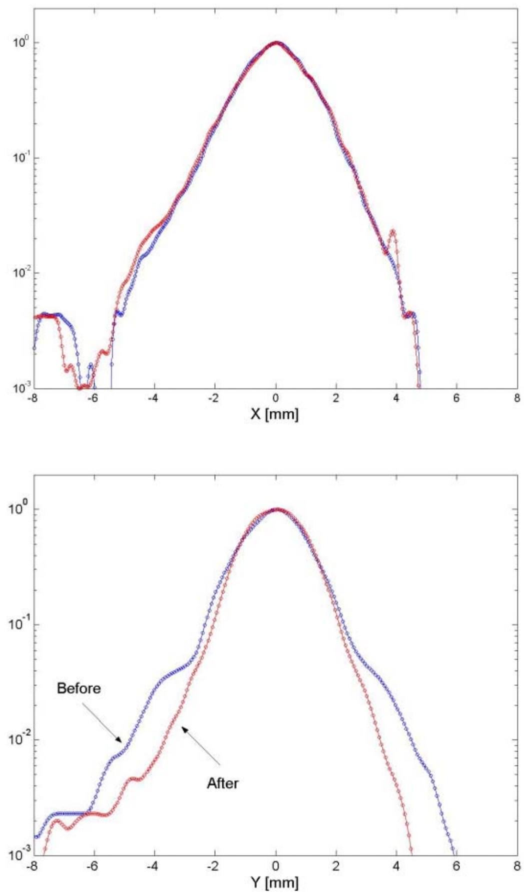

Figure 3: Plots of beam profile in X (top plot) and Y plane (bottom plot) from the wire-scanner in CCL module 1. The blue line is the profile before matching and red line after matching.

The plots in Fig 3 were obtained from the wire-scanner 108 after the 8th cavity of the CCL module 1. Blue lines are profiles before the matching and red ones after the matching. Reduction in tail is observed in Y plane, while there is little change to the tail in X plane.

One of the complications was the halo produced in the upstream part of the linac. We sometimes observed that the core of beam profile deviates from Gaussian. It is important that adequate level of matching is maintained in the upstream linac.

Further study and measurements will be conducted during the next beam commissioning runs.

CONCLUSION

A study of transverse matching of DTL to CCL was performed. The preliminary result shows the emittance reduction in both planes. This technique appears to be promising. Further study will be performed during the next beam commissioning runs.

REFERENCES

[1] Dong-o Jeon and J. Stovall, J. Proc. of the 2003 Part. Accel. Conf. (Portland, 2003), p. 2652.

[2] C. Chu et al, “Transverse beam matching application for SNS”, in these proceedings.

[3] J. Wei et al, Proc. of the 2001 Part. Accel. Conf. (Chicago, 2001), p. 319.

[4] D. Jeon et al, Proc. of the 2004 European Part. Accel. Conf. (Lucerne, Switzerland, 2004), p. 1536; D. Jeon et al, Proc. of the 2003 Part. Accel. Conf. (Portland, 2003), p. 2652.