TRANSVERSE MATCHING OF THE SNS LINAC BASED ON PROFILE MEASUREMENTS*

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Abstract

For a high intensity linac such as the SNS linac, it matters to match adequately to minimize the beam mismatch and potential beam loss. The technique of doing the matching using the wire-scanners in series was employed [1]. It was verified that matching was improved through the matching technique based on the beam profile measurements from wire-scanners in series.

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 of beam power to the neutron production target [2]. 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.

When emittance measurement device is available, minimization of rms emittance proves to be effective in doing the matching as for the SNS DTL (Drift Tube Linac) tank 1 commissioning [3,4].

Alternatively wire-scanners installed in series can be used to do the matching [1]. For the purpose of transversely matching between two different structures of the SNS linac, four wire-scanners are installed in series. During the beam commissioning runs, the matching technique based on beam profile measurements was tested and the results are presented here.

MATCHING SCL TO HEBT

We applied the technique based on profile measurements to matching the Superconducting Linac (SCL) to the High Energy Beam Transport (HEBT). We performed a Gaussian fit to the measured beam profile and obtained its beam size σ. By fitting the beam envelope from the Trace3D code to the wire-scanner profile data, we obtained the input beam Courant-Snyder parameters β and α, and the beam emittance ε, as shown in Fig. 1. Table 1 lists the incoming beam parameters determined above. The solid circles in Figs. 1 and 2 represent the beam profile data from the wire-scanners in the HEBT and the solid lines represent simulated beam profile obtained from the Trace3D code. It should be noted that there is a mild oscillation in the beam core before the beam enters HEBT at Z=8x10^4 [mm]. The blue color represents the x beam size and the red the y beam size. HEBT starts from 8x10^4 mm in the figure and the upstream of that point is the SCL.

With the beam parameters of the incoming beam determined, the matching quadrupoles are optimized using the Trace3D code to do the matching. When the matching routine completes the matching, we change the matching quadrupoles as suggested and subsequent wire-scanner measurement is done as shown in Fig. 2.

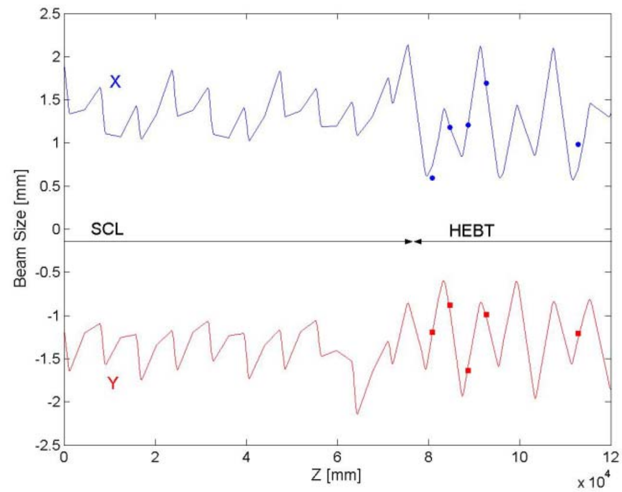

Figure 1: Plots of beam profiles before matching SCL to HEBT. Solid lines are plots of beam size σ [mm] from the Trace3D program and solid circles are wire-scanner measurement data.

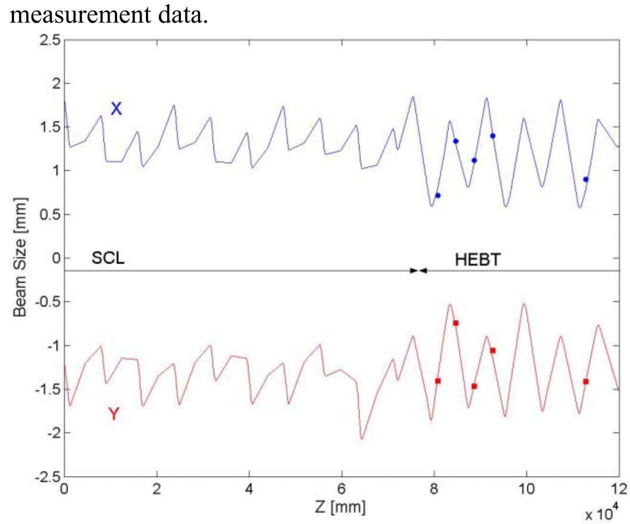

Figure 2: Plots of beam profiles after matching SCL to HEBT. Solid lines are plots of beam size σ [mm] from the Trace3D program and solid circles are wire-scanner measurement data.

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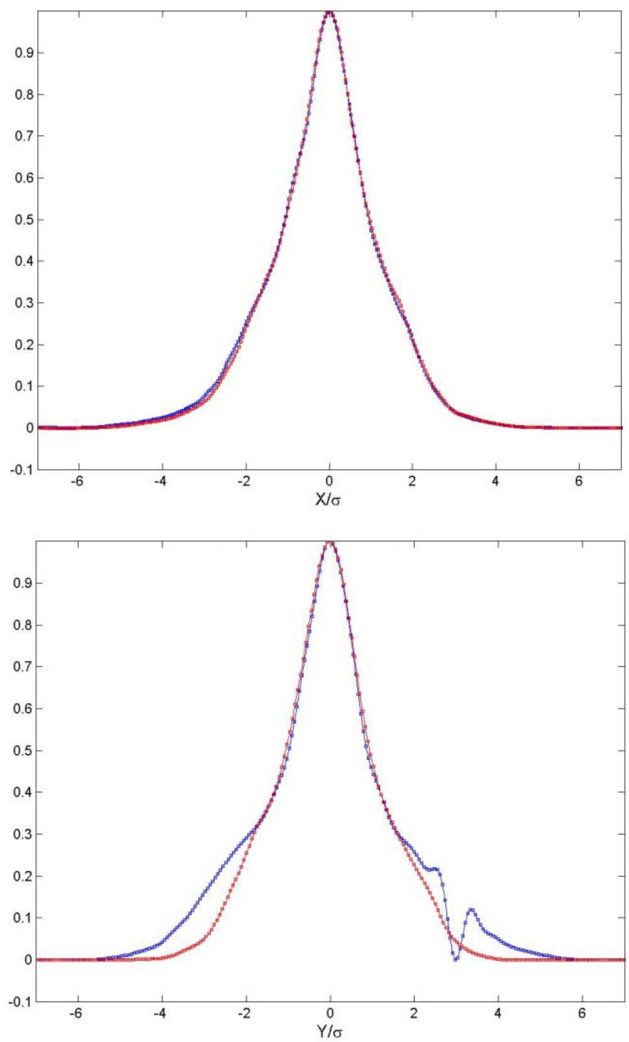

Figure 3: Plots of beam profiles in X plane (upper plot) and Y plane (lower plots). Blue lines are profiles before the matching and red ones after the matching. Reduction in tail is observed in Y plane, while there is little change to the tail in X plane.

Figure 3 illustrates the beam profile change before and after the matching is performed. Reduction in beam tail is observed in Y plane. The glitch in the blue curve of the lower plot is due to the missing beam pulse during the scanning. Further study and measurements will be conducted during coming beam operations.

Table 1: Input beam parameters

	X plane	Y plane
ε [mm-mrad]	0.326	0.345
β [m]	16.05	6.36
α	-1.49	0.112

Table 1 lists the input beam parameters at Z=0 in Figs. 1 and 2. ε_x=0.343 and ε_y=0.351 are the normalized rms emittance [mm mrad] of the equivalent uniform beam distribution having the same rms beam size as the beam profile.

MATCHING DTL TO CCL

The same technique was applied to matching the Drift Tube Linac (DTL) to the Coupled Cavity Linac (CCL). At the end of DTL, the proton beam energy is 86.6 MeV. Figure 4 shows the data before the matching and Fig. 5 the data after the matching. The solid circles in Figs. 4 and 5 represent profile measurements in CCL module 1 and 2. The first four wire-scanners were used by the matching routine. It should be noted that the third wire in x plane was malfunctioning as indicated in the figure. Again the blue color represents the x beam size and the red the y beam size. It is clear that the matching in x plane is improved significantly whereas a slight degradation is observed in y plane. We observe an overall improvement in matching.

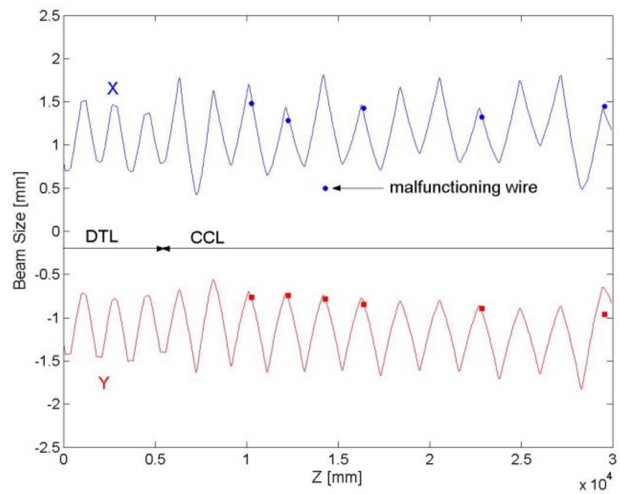

Figure 4: Plots of beam profiles before matching DTL to CCL. Solid lines are plots of beam size σ [mm] from the Trace3D program and solid circles are wire-scanner profile data.

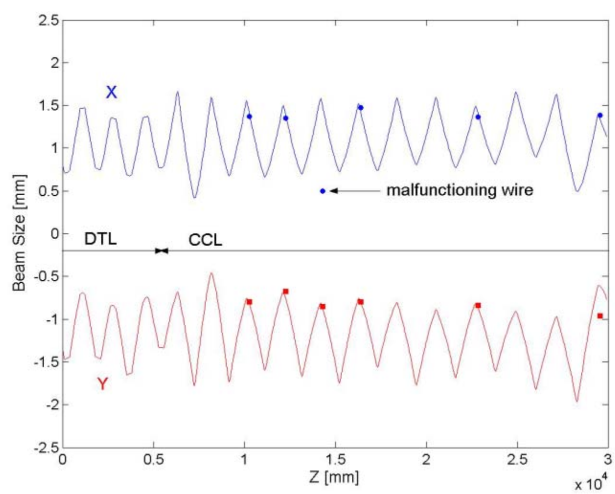

Figure 5: Plots of beam profiles after matching DTL to CCL. Solid lines are plots of beam size σ [mm] from the

Trace3D program and solid circles are wire-scanner profile data.

CONCLUSION

A study of transverse matching of the SNS linac was performed. Positive results were obtained showing that the matching is improved. Further matching study will be conducted for other sections of the SNS linac.

REFERENCES

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