PRELIMINARY DESIGN OF TRANSFER LINES FOR THE ILSF ACCELERATOR COMPLEX*

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Abstract

There are two transfer lines within the ILSF accelerator complex. The first transfer line (T-line) links the LINAC to booster (LTB) and guides the electron beam from the pre-injector system to the booster. The second line connects the booster to the storage ring (BTS). This paper gives design specification of these two T-lines.

INTRODUCTION

The Iranian Light Source Facility (ILSF) project is a new 3 GeV third generation synchrotron light source which is currently in design stage and will be built in Iran [1-3]. General layout of a possible ILSF accelerator complex surrounded with shielding walls is shown in figure 1. The arrangement of the different accelerators (pre-injector, booster synchrotron and storage ring) is completely different from the other 3rd generation light sources. Some of the light sources like SLS, ALBA and TPS have the booster synchrotron in the same tunnel as the storage ring. Diamond, Soleil and SSRF attached the booster synchrotron to the storage ring. As a design criterion, and to have independent assembling, commissioning, operation and maintenance of the accelerators, they have been designed to be housed in the separate tunnels.

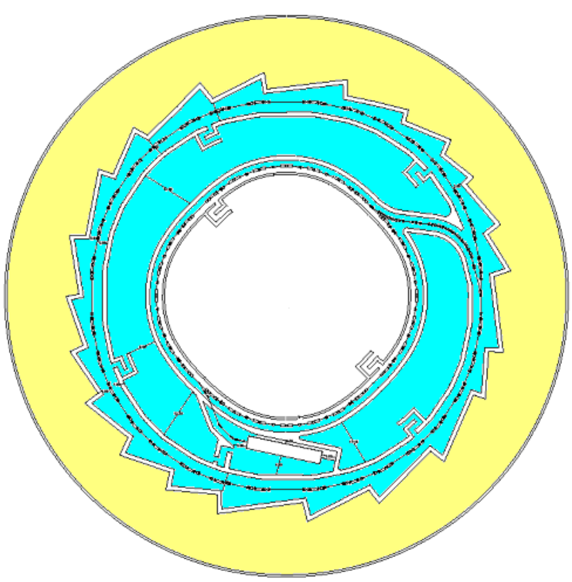

Figure 1. Mechanical drawing of the ILSF accelerators

As seen the booster and storage ring are concentric and the service area is placed between them. Both of booster and storage ring have the symmetry of 4 and with 36 degree rotation regarding to their straight sections. For more information about the ILSF accelerators, the reader is recommended to see Ref. [2-5]

An electron beam produced with an electron gun, is accelerated by a travelling wave linear accelerator (Linac) to the energy of 150 MeV. Then the electrons are guided to the booster synchrotron via Linac to booster (LTB) transfer line and enter into the booster straight section. The booster accelerates the electron beam to the energy of 3 GeV using a radio frequency (RF) cavity with the frequency of 500 MHz. After reaching the target energy, the electron beam is transferred from the booster to the storage ring with booster to storage ring (BTS) transfer line. OPA [6] and ELEGANT [7] simulation tools are employed for the design and lattice optimization.

LINAC TO BOOSTER TRANSFER LINE

The LTB transfer line guides the beam from 150 MeV Linac to the booster synchrotron. The LTB transfer line provides for matching of beam parameters from the exit of the Linac to the booster synchrotron injection septum. Based on the accelerators layout, the booster is turned by 36 degrees relative to the storage ring and for horizontal injection scheme, the LTB does not have vertical bending magnets. It is assumed that the Linac is located between the booster and storage ring inside the service area. In this case the best configuration is having the Linac roughly parallel to a long straight section of the storage ring to save space in the service area. Mechanical drawing of the designed LTB line which links pre-injectors and Linac sections to the booster straight section is depicted in figure 2. The pre-injectors, LTB line, booster synchrotron and surrounding shielding walls are depicted in figure 3. It shows reserved space for Linac, its equipment and the useful space in service area.

*The work is supported by ILSF.

ISBN 978-3-95450-122-9

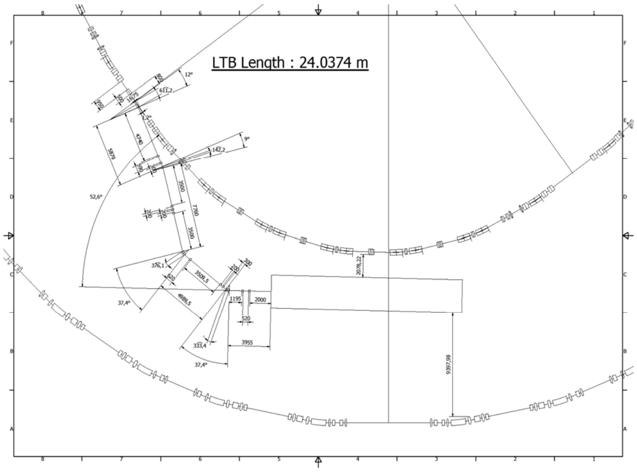

Figure 2. Mechanical drawing of the LTB line.

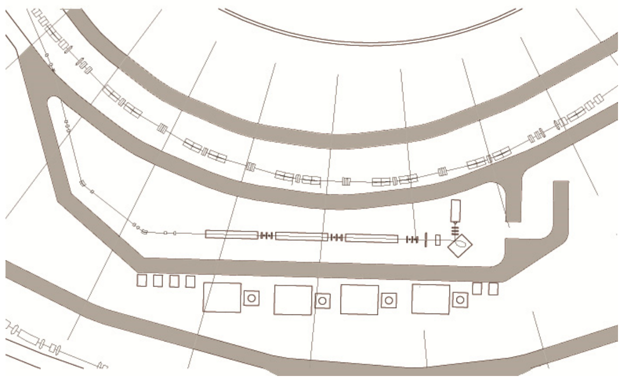

Figure 3. Mechanical drawing of the LTB line including shielding walls.

After the Linac sections, three dipole magnets are employed in the LTB line to guide the beam to the straight section of the booster. Two of them with the length of 333.40 mm, field of 0.48 T and deflection angle of 18.70 degrees bend the beam positively (clockwise) and the last one with the length of 142.2 mm, field of 0.55 T and deflection angle of 9 degrees gives a negative deflection to the electrons. Matching of the optical functions was performed in six dimensional phase space by the use of several quadrupoles all with length of 120 mm. The required space for the diagnostic line is utilized which makes possible measurement of the beam parameters in the LTB line. Total length of the designed LTB line is 24.0374 m and the optical functions is depicted in figure 4. The designed LTB line has the flexibility of matching optical functions with different launching conditions at the Linac exit to the booster straight section.

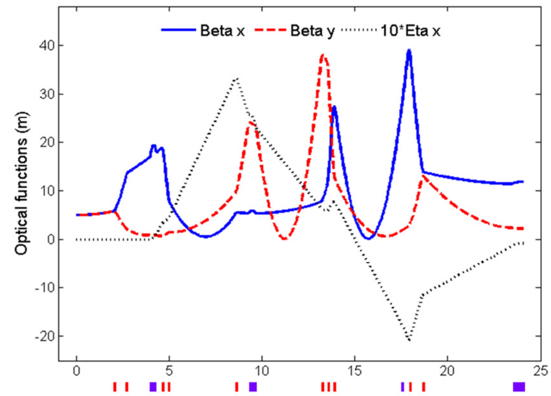

Figure 4. The optical functions along the LTB line with the initial Twiss functions of β_x=β_y=5 m and α_x=α_y=0.

BOOSTER TO STORAGE RING TRANSFER LINE

BTS transfer line links the booster synchrotron to the low emittance storage ring of the ILSF. As mentioned the booster and storage ring have the same center in x-y coordinates but the booster is turned by 36 degrees relative to the storage ring straight section which should be compensated by the BTS line. Due to separate tunnels for the both booster and storage ring and concentricity of them, the BTS needs to meet geometric constrains. In order to extract the electron beam from the booster, an extraction kicker magnet with the length of 850 mm and kick strength of 8.73 mrad is used. The extracted beam is then bent by the use of a septum with a negative deflection angle of 23.5 degrees. For the injection of the electrons into the ring an injection septum with a positive deflection of 24 degrees is employed. To compensate the remaining 36 degrees of deflection between the booster and the storage ring, 4 dipole magnets with deflection angles of 18 degrees and lengths of 1.5 m will be used. One of them causes a negative deflection after the extraction septum and the remaining three dipoles deflect the beam positively prior to the injection septum. Design overview of the BTS transfer line is shown in figure 5.

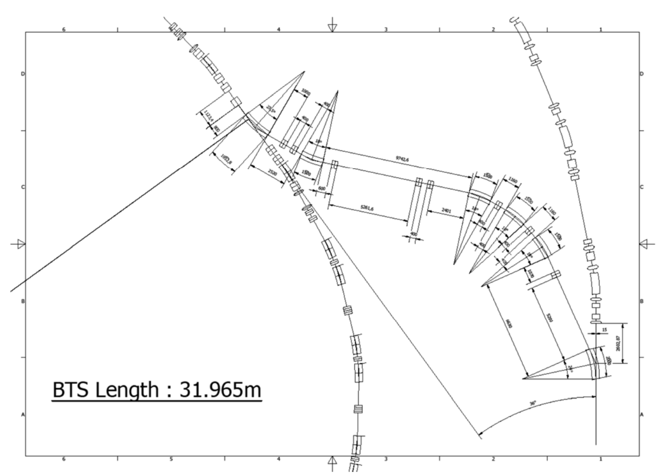

Figure 5. Mechanical drawing of the BTS line.

In addition to the dipoles, several quadrupoles have to be used to match the machine functions of the booster to those of the storage ring. Optical functions at the extraction point from booster and injection point into the ring are given in Table 1. They are shown along the BTS transfer line is in figure 6.

Table 1: Main parameters of the high field ILSF storage ring

	Extraction point	Injection point
β_x/β_y (m)	11.960/2.935	14.003/4.208
α_x/α_y	-0.107/-0.576	-0.013/-0.043
η_x (m)	-0.084	0.247
η'_x (m)	0.0	0.0

Each quadrupole has length of 0.36 m and the total length of the BTS line will be 31.965 m.

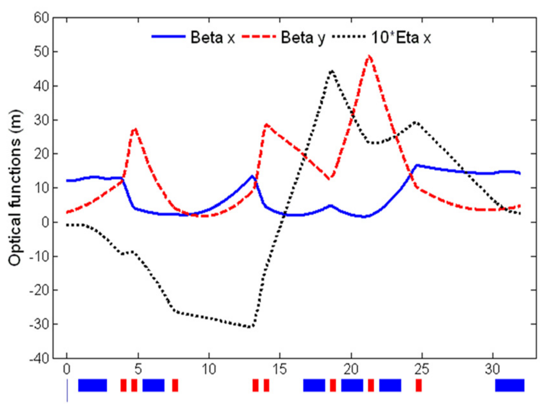

Figure 6. The optical functions along the BTS line with the initial and final Twiss functions given in Table 1.

CONCLUSIONS

Several design criterions have been utilized in design of the T-lines and the preliminary design of them has been presented. They have designed be as short as possible with small number of magnets and to satisfy geometric conditions.

ACKNOWLEDGMENTS

The authors wish to thank Prof. Dieter Einfeld for his helpful discussions.

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ISBN 978-3-95450-122-9