# 3rd GENERATION LIGHT SOURCE PROJECT IN IRAN

Javad Rahighi, Morteza Jafarzadeh, et al
Institute for Research in Fundamental Sciences, IPM, Tehran, Iran

*Abstract*

The Institute for Research in Fundamental Sciences (IPM) is in charge of the establishing the Iranian Light Source Facility (ILSF). This facility will be a 3rd generation 3 GeV storage ring with a circumference of roughly 300 m. The injector will consist of a 150 MeV Linac and a full energy booster synchrotron. The storage ring has a four-fold symmetry with 4 long (7.88m), 16 medium (4.0 m) and 12 short (2.8 m) straight sections. Within the medium straight section there are mini beta values in order to get an optimized flux density for the users. The emittance is in the range of 3 nmrad. The booster synchrotron has a circumference of roughly 192 m with an emittance of roughly 31 nmrad. It is a separated function machine in order to have the maximum flexibility. For both machines it is foreseen to use a 500 MHZ RF-system with normal conducting cavities. The machine will be built within an international collaboration, in which the main components have to be supplied from the international market. The conceptual design report should be completed in 2012; the commissioning of the machine is expected to be in 2020.

## INTRODUCTION

With the advent of several dedicated synchrotron radiation sources since about 1980, synchrotron radiation, as a versatile research tool, has experienced an unprecedented expansion. Today, a large and continuously growing community of researchers representing a variety of disciplines depends on light sources as an essential part of their research programs. In order to meet the demands of cutting-edge research, increasingly advanced synchrotron radiation facilities have been constructed around the world. The number of such synchrotron radiation facilities now exceeds 75 with more than 20,000 users per year; it is predicted that these numbers will continuously grow in the future. The Iranian Light Source Facility (ILSF) is an open project fully complying with the international scientific codes and standards. All the design and progress reports will be presented at local and international conferences and published in international journals accessible to scientists all over the world. In the following sections we will discuss the progress made so far in designing the Iranian Light Source Facility. In the following sections we shall describe the design work concerning the storage ring, booster and pre-injector, magnets, RF systems and power supplies.

## STORAGE RING

The Iranian Light Source is an intermediate 3 GeV storage ring with which should cover the requirements of experimental science in several fields. it has been decided to build a light source with 24 beamlines so as to extend the spectrum of the undulator radiation to 20 KeV. Moreover, a very low-emittance (ε < 5nm-rad) storage ring with a 400 mA beam current and a circumference in the range of 280 m to 320 m. The general layout of the Iranian Light Source Facility (ILSF) is shown in Fig. 1 and the main parameters of storage ring are given in table 1.

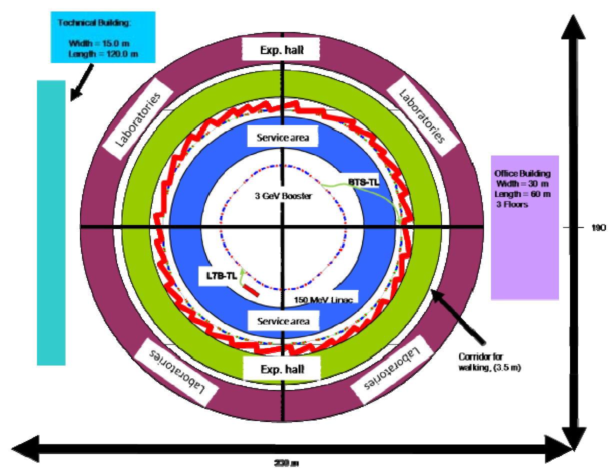


Figure1: General layout of ILSF.

Table 1: Main parameters of the storage ring based on ILSF-Lattice-1

| Parameter | Unit | Value |
|---|---|---|
| Energy | GeV | 3 |
| Circumference | m | 297.6 |
| Number of super-periods | - | 4 |
| Current | mA | 400 |
| Horizontal Emittance | nm-rad | 3.278 |
| Harmonic number | - | 496 |
| RF frequency | MHz | 500 |
| Tune ($Q_x$/ $Q_y$) | - | 18.2656/11.324 |
| Natural energy spread | - | 1.0408E-03 |
| Natural chromaticity ($\xi_x/\xi_y$ ) | - | -34.560/-28.02 |
| Momentum compaction ($\alpha_c$) | - | 7.621E-04 |
| Radiation loss per turn | MeV | 1.0167 |
| Beta function at center of medium straight sections ($\beta_x/\beta_y$) | m | 2.3/1.4 |
| Beam size at center of medium straight section ($\sigma x/\sigma y$) | µm | 156.18/6.84 |
| No. of dipoles | - | 32 |
| No. of quadrupoles | - | 104 |
| No. of sextupoles | - | 128 |
| Dipole magnetic field | T | 1.42 |
| Dipole field gradient (matching/unit) | T/m | -3.83/-5.83 |

Dipole magnets in the storage ring are used to bend the electron beam. Long dipole magnets can have manufacturing flaws that increase the beam emittance. The dipole magnet in a matching cell has the same length as that of the dipoles in unit cells. The gap of dipole magnets in the booster of ILSF is 32 mm. The arrangement of dipole magnets in half a super-period of ILSF-Lattice-1 is shown in Fig.2. Main parameters of dipole magnets are displayed in Table2.

Table 2 Main parameters of dipole magnets in ILSF-Lattice-1

| Parameters | Unit | Value |
|---|---|---|
| Magnetic field | T | 1.42112 |
| Length | m | 1.383684 |
| Deflecting angle | Deg. | 11.25 |
| Bending radius | m | 7.047 |
| Gap | mm | ±16 |
| Horizontal Good field region (BE1/BE2) | mm | 7.964/9.780 |
| Magnetic field gradient (BE1/BE2) | T/m | -3.837/-5.839 |
| (BE1/BE2) | $m^{-2}$ | -0.3835/-0.5835 |

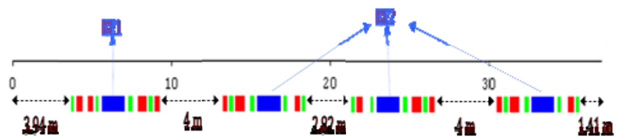


Figure 2: Arrangement of magnets in half a super-period of ILSF-Lattice-1. The blue arrows show the locations of dipole magnets.

## BOOSTER

A full energy 3 GeV booster synchrotron has been designed to boost a 150 MeV electron beam, extracted from the linac, to the target energy of 3 GeV for the proposed third generation light source that will be constructed in Iran (ILSF). The primary goal in the design of the ILSF booster is to deliver a small emittance ($\varepsilon < 30$ nm-rad), while keeping the construction costs as low as possible. . In order to design a lattice for the booster, two configurations for the booster have been considered. In the first configuration, the booster has a circumference of 144m and is placed in a separate tunnel inside the storage ring; in the second configuration the booster has a circumference of 192m and shares a wall with the storage ring's service area.

## PRE-INJECTOR STRUCTURE

Figure 4. shows the lattice layout of the pre-injector at ILSF. The electron gun will probably have a thermionic cathode since it is easier to manufacture, although it may have an RF structure. A focusing solenoid is required right after the electron gun to control the beam emittance.

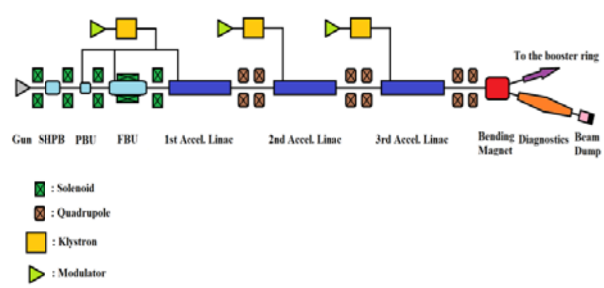


Figure4. Lattice layout of the pre-injector at ILSF.

## MAGNETS

Combined dipole magnets are employed for linear and nonlinear optimization; hence a smaller number of quadrupole and sextupole magnets are required. The sextupole component of the dipole magnets is utilized to help correct the natural chromaticity of booster and optimize nonlinearities. The Primary design of ILSF storage ring Girders is represented in Fig.3.

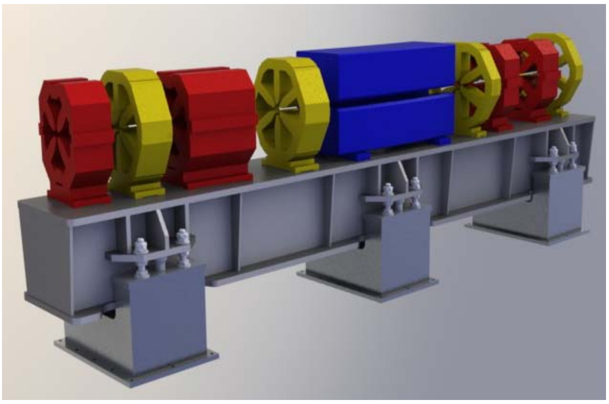

Figure3. Primary design of ILSF storage ring Girders of the Matching Cell.

## RF SYSTEM

RF frequency is one of the main parameters of a synchrotron light source. The choice of RF frequency does not seem straightforward, since it influences in the determination of many other synchrotron parameters. Table3 shows the main parameters of ILSF RF system.

Table3. The main parameters of ILSF RF system

| Parameters | 100MHz RF system |
|---|---|
| $f_{rf}$ (MHz) | 100 |
| E (GeV) | 3 |
| $I_b$(mA) | 400 |
| $Q_s$ | $2.406\times10^{-3}$ |
| $N_c$ | 6 |
| $f_{rev}$(MHz) | 1.0074 |
| A | $7.621\times10^{-4}$ |
| $\tau_s$ (ms) | 5.858 |
| $\tau_y$ (ms) | 4.614 |
| $\tau_x$ (ms) | 3.386 |

## POWER SUPPLY

The ILSF storage ring will be equipped with 32 dipole magnets of two different types. Series connection of the same-type dipoles means that the current flow through every magnet would be the same, thus the generated magnetic field by each dipole would be also identical. To attain this operational condition, two single converters feed the two series-connected strings of dipole magnets. The first circuit consists of a series connection of 24 dipole magnets and its power converter is given in table4.

Table4. Specifications of the power supply for the dipole magnet.

| | |
|---|---|
| AC input power | 3-phase 380 VAC / 780 AAC |
| DC maximum output | 530 ADC |
| DC output voltage | 490 VDC |
| Stability (1 h–8 h) | 20-50 ppm |
| Stability (30 h) | 20-70 ppm |
| Absolute accuracy | 100 ppm |
| Accuracy | 100 ppm |
| Current ripple + Noise | 50 ppm |

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