# RECENT PROGRESS ON THE DEVELOPMENT OF IRANIAN LIGHT SOURCE FACILITY (ILSF) PROJECT

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*Abstract*

The Iranian Light Source Facility Project (ILSF) is a 3rd generation light source with energy of 3 GeV, a full energy injector and a 150 MeV linac as pre-injector. The stored beam current in top up mode is 400 mA, the beam lifetime is about 7 h, and the average pressure of vacuum chamber is approximately $1.33 \times 10^{-7}$ Pa (1 nTorr). The ILSF storage ring has been designed to be competitive in the future operation years. Some prototype accelerator components such as high power solid state radio frequency amplifiers, LLRF system, thermionic RF gun, storage ring H-type dipole and quadruple magnets, Hall probe system for magnetic measurement and highly stable magnet power supplies have been constructed in ILSF R&D laboratory.

## INTRODUCTION

The construction of a synchrotron is an enterprise that requires international cooperation and very few countries are capable of carrying it out on their own. The synchrotron community is an international community with no borders and the synchrotron scientists share their knowledge and expertise openly and freely. The ILSF project has enjoyed this support from the beginning, in particular the technical groups of ILSF were trained by famous scientists in the field of accelerator. The ILSF conceptual design was completed under the direct supervision of several notable synchrotron scientists which advised ILSF for the completion of its conceptual design report, and various seminars have been conducted at IPM and ILSF with the participation of synchrotron scientists from around the world. The First Meeting of ILSF Machine Advisory Committee was held on 7-9 June 2015 at IPM. The goal was to receive a final approval for the design of the lattice of ILSF magnets and advice on the optimization of the next stages of the basic design of the ILSF synchrotron. On the basis of the previous design, the storage ring was based on a Five-Bend Achromat lattice providing a very low horizontal beam emittance of 480 pm-rad. The ring was consisting of 100 pure dipole magnets, 320 quadrupoles and 320 sextupoles. But now base on the new design which is the outcome of MAC meeting, its horizontal beam emittance reduced to 286 pm-rad. The major outcome of this meeting was some modification to bending magnets of storage ring in order to reduce the natural emittance to lowest value as 275 pm.rad, freezing the lattice design and entering to a new phase of project which is basic design. According to the plan, within 22 months (started from April 2016) more than 3200 technical documents will be provided and after that detail design and some procurements will begin to start. Figure 1 shows the distribution of documents for each discipline

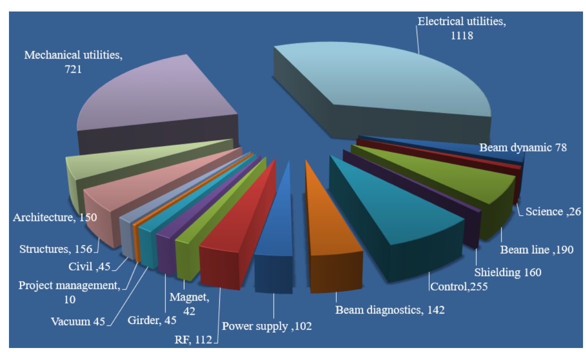


Figure1: Distribution of 3267 documents for ILSF basic design.

## STORAGE RING SPECIFICATIONS

The new storage ring lattice's consists of 20 five-bend achromats separated by 7 m straight sections for IDs. Each of the achromats consists of three unit cells and two matching cells. The unit cells have a 3.9° bending magnet, while the matching cells at the ends of the achromat have a 3.15° bending magnet. Three dimensional drawing view of one achromat. The matching cells contain dedicated quadrupole doublets in order to match the achromat optics to the ID in the straight sections. Since the vertical focusing is performed by the gradient dipoles, dedicated quadrupoles are, apart from ID matching; only required for horizontal focusing [1]. Main specifications of the designed ring and its optical functions in a super period are given in Table 1.

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Table 1: Main Parameters of ILSF Storage Ring

| Parameter | Unit | Value |
|---|---|---|
| Energy | GeV | 3 |
| Maximum beam current | mA | 400 |
| Emittance | pm-rad | 275 |
| Circumference | m | 528 |
| Length of straight section | m | 7 |
| Number of straight section | - | 20 |
| Betatron tune (Qx/Qy) | - | 44.20/16.18 |
| Natural chromaticity (ξx/ξy) | - | -108 /-61 |
| RF frequency | MHz | 100 |

## ILSF BOOSTER

ILSF Booster is supposed to work at injection energy of 150Kev and lead the electrons to the ring energy E=3 GeV. It consists of 50 combined bending magnets in 1 type which provide horizontal focusing and correct natural chromaticity in addition to their bending role, 50 pure quadrupole magnets for vertical focusing and 5 defocus-ing quadrupoles for tune adjustment. There are also 20 sextupoles in 2 families, 15 SF for correcting natural chromaticity and 5 SD defocusing sextupoles that each one is placed in each super period to correct eddy current effects. The dipoles are planned to be run in series with a common power supply and due to having one family of quadrupole and one for sextupoles, they will also be connected in series [2].

### *Dipole Magnets of Booster*

ILSF Booster dipole is combined H-type bending magnet having an imposed quadrupole and sextupole components with parallel-ends and a curved yoke; also the yoke can be opened from the middle to facilitate the vacuum chamber placement. The specifications of the booster bending magnets is given in Table 2.

### *Quadrupoles Magnets of Booster*

ILSF Booster has 50 quadrupoles with 18mm aperture, 15 cm length and 28cm ×28cm lamination cross section. The general layouts and length of all the quadrupoles are the same. Main parameters for the ILSF booster quadrupole are given in Table 3.

### *Sextupoles Magnets of Booster*

ILSF Booster has 15 focusing sextupoles with 18mm aperture, 10 cm length and 18cm ×17.4cm lamination cross section.

The general layouts and length of all the sextupoles are the same. Main parameters for the ILSF booster sextupoles are given in Table 4.

Table 2: ILSF Dipole Parameters

| Parameter | unit | Ext/inj |
|---|---|---|
| QTY | - | 50 |
| Bending radius | m | 10.34 |
| Field | T | 0.967/0.0483 |
| Field gradient | T/m | -1.79 |
| Sextupole component | T/m2 | -41.66 |
| Half gap | mm | 11.3 |
| Magnetic length | m | 1.3 |
| Good field region | mm | ±6 |

Table 3: ILSF Quadrupole Parameters

| Parameter | unit | Ext |
|---|---|---|
| QTY | - | 50 |
| Aperture radius | mm | 18 |
| Pole tip Field | T | 0.44 |
| Field gradient | T/m | 24.66 |
| Magnetic length | m | 0.15 |
| Good field region | mm | ±12.5 |

Table 4: ILSF Sextupole Parameters

| Parameter | unit | Ext |
|---|---|---|
| QTY | - | 15 |
| Aperture radius | mm | 18 |
| Pole tip Field | T | 0.04 |
| Field gradient | $T/m^2$ | 440 |
| Magnetic length | m | 0.10 |
| Good field region | mm | ±12.5 |

## RESEARCH AND DEVELOPMENTS

### *Beam Diagnostics*

To monitor closed orbit, it is needed to put 160 BPMs around storage ring of ILSF. To simplify BPM parameters calculation a code was developed by C# to calculate most parameters of BPM like sensitivity, intrinsic resolution and power dissipation vs BW and current. [3]. In order to measure the induced charges on BPM and consequently beam position, a configurable electronic system has been developed for button BPMs readout in the storage ring of Iranian Light Source Facility (ILSF). This system calculates the beam position through the output voltage of BPMs. Output signals of BPMs pass through 500 MHz and 50ohm front-end for noise filtering and also gain control purposes. Then the signal is digitized based on under sampling method by 130MHz ADC for further analysis in FPGA. Safe dynamic range of 0dBm to -90 dBm can be covered by this electronic system with white noise measured to be around -110dBm. Trigger for this electronic is 2-10Hz as Slow data acquisition for Slow orbit feedback system and 4-10 KHz as Fast data acquisition for fast orbit feedback systems. After

Verification of readout system's proper functioning in LAB, final tests were done on the real beam in ALBA (see Fig. 2) which showed precision and resolution of one micro meter [4].

Figure 2: The overall hardware implemented design of BPM system.

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