

Proposal for a 3rd Generation National Iranian Synchrotron Light Source

Javad Rahighi

Institute for Studies in Theoretical Physics and Mathematics School of Physics, Tehran, Iran

Abstract:

The Institute for Research in Fundamental Sciences, IPM, has been given the go ahead to establish a major research center in Iran for multi disciplinary research. The facility will include a 3rd generation light source for promoting science and technology in the field of accelerators and applications of synchrotron radiation.

The preparation of the conceptual design report has been funded by the Iranian government and will be executed under the authority of the president of the Institute for Research in Fundamental Sciences, IPM, Tehran, Iran.



The location of the facility will be close to the Iranian capital city, Tehran and site selection from a few different locations is underway. The conceptual design report has to be finished at the end of 2011.

The present draft design is a 3GeV, 3rd generation light source with a circumference of about 300 m and an emittance of 3.6 nm-rad providing light for research from the infra-red to X-rays region up to 10 keV and beyond.

As initial beamlines, we plan for a protein crystallography beam line as well as SAXS and WAXS beamlines for material science research,

UV/VUV/SXR, photoelectron spectroscopy and photon absorption spectroscopy, IR spectroscopy and EXAFS.

Various technical groups which include beam optics, power supply, radio frequency, Mechanics, Vacuum, Magnets, Beam diagnostics, control, Radiation Safety, cooling and civil engineering have been formed. Initial steps towards completing a conceptual design of the project are taken.

Major decision making are performed by the interim council consisting of many Iranian scientists and authorities.

The Accelerator Complex

Storage Ring

In modern synchrotron light sources like DIAMOND, SOLEIL and ALBA with energy of 3 GeV, the emittance is in the range of 3 to 5 nmrad and around 40% of the circumference are available for straight sections. This should also be the case for the Iranian Light Source. For the injection straight a length of roughly 8m is required for the installation of the spectrum and the 4 kickers. For beam dynamic reasons the periodicity of the storage ring should be between 4 and 6 or higher. At the injection straight a relative high horizontal beta function is needed (roughly 10 to 15 m/rad). All the other straights should be devoted to the installation of the insertion devices.

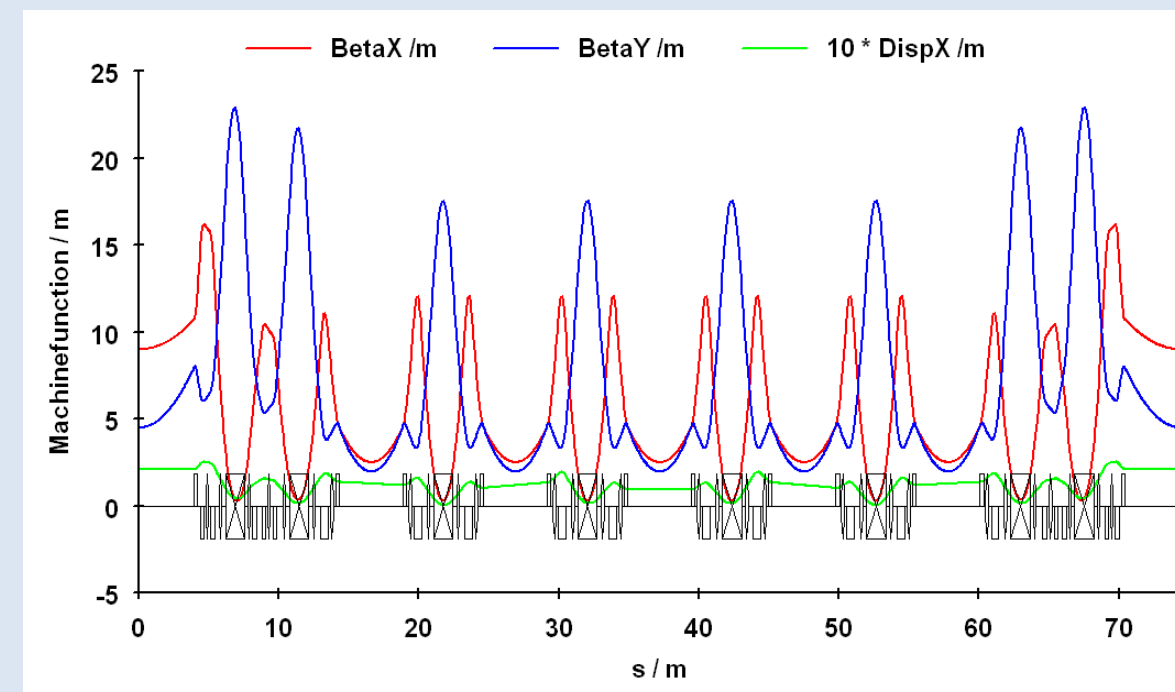


Fig. 1: The first design of a lattice for the Iranian Light Source

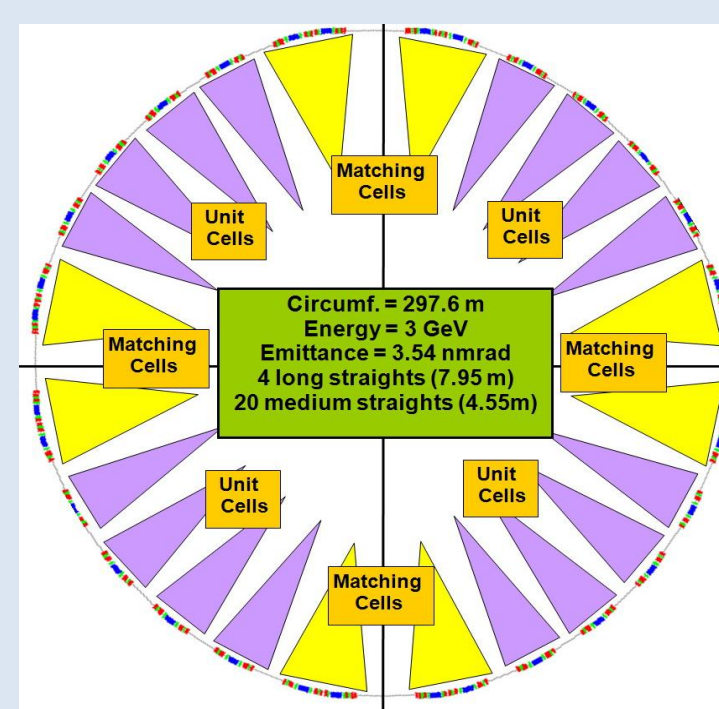
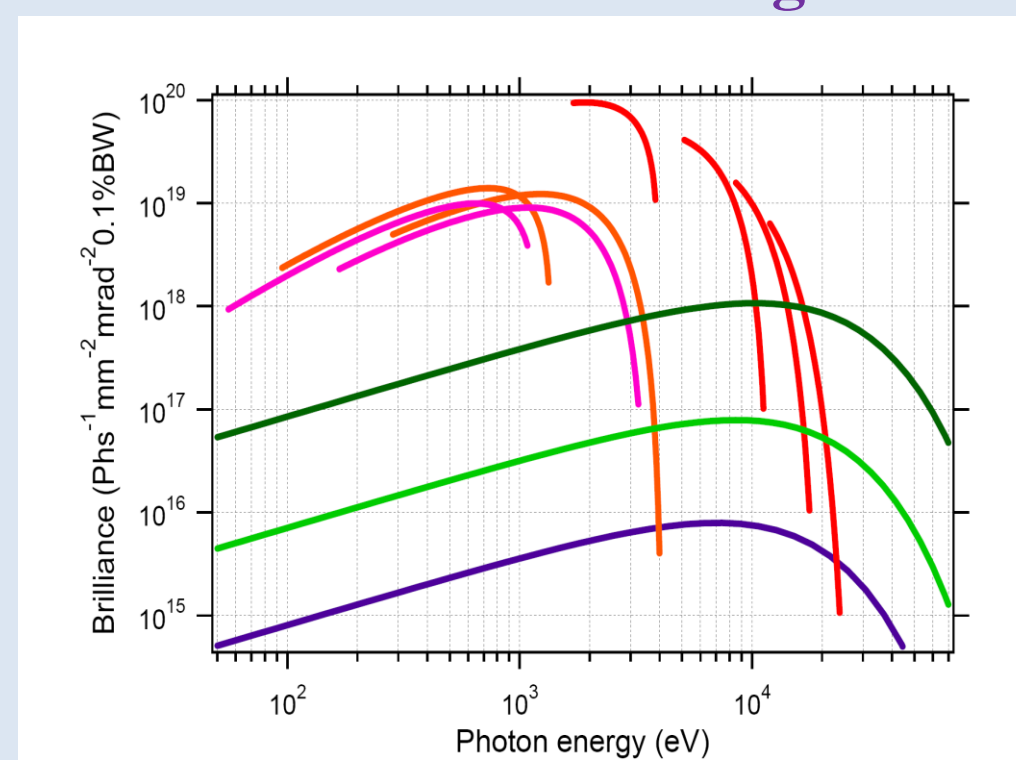


Fig.2: Principle layout of the storage ring

The length of these straights should be in the range of around 4 m in order to have enough space for the installation of 2 to 2.5 m long insertion devices. The cross section of the stored beam is given by the square root of the emittance multiplied with the beta functions. According to this relationship a small emittance as well as small beta functions are required within the straights. This means a so called “mini beta section” should be designed for the straight sections.

The horizontal as well vertical beta functions should be in the range of 1.5 to 2.5 m/rad. With these conditions a draft version of a lattice for the Iranian Light source has been designed, which is given in the Fig.1. This figure is quadrant of the machine, which means a periodicity of 4 has been chosen. The lattice exists of the two matching sections at the beginning and the end as well the 4 unit cells in the middle of the quadrant (see Fig.2).

Brilliances of the different light sources



Brilliance of the Insertion devices at 400 mA (Blue: bending magnet, light green: multiple wiggler MPW 80 (length 1m), dark green: superconducting wiggler SCW 30 (length 1.8m), red: IVU 21 (length 2 m), pink: EU71 (length 1.7m), orange: EU62 (length 1.7m)

The length of the straight section (required for the injection) is 7.95 m and the length of the 5 straights in a quadrant is 4.55 m. This means the overall length of the straights is 104.5 m which results in 35 % of the circumference. This lattice design results in an emittance of 3.5 nmrad. In order to have a compact arrangements of the magnets a combined function magnets will be used, which makes most of the vertical focusing.

Within the straights there is a mini beta section with the beta functions $\beta(x) = 2.51$ m/rad and $\beta(y) = 1.98$ m/rad. With these values and the above mentioned emittance the cross section of the beam in the middle of the straights is $\sigma(x) = 94.3$ μm and $\sigma(y) = 8.4$ μm . All this values can compete with other modern 3rd generation light sources.

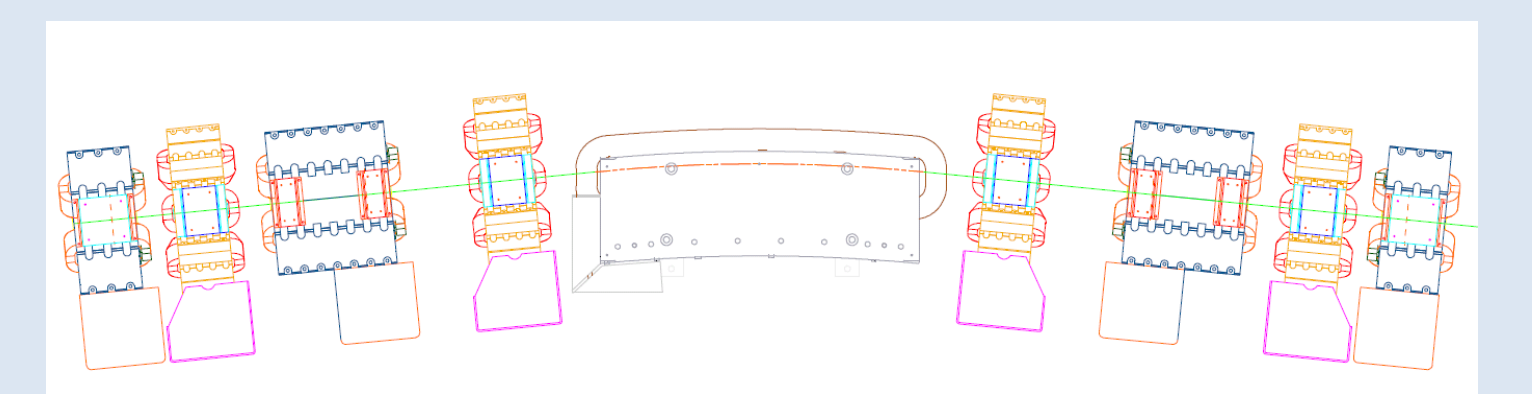


Fig.3: Arrangement of magnets within the unit cell of the lattice, in the middle is the combined bending magnet. (blue: quadrupoles, red: sextupoles)

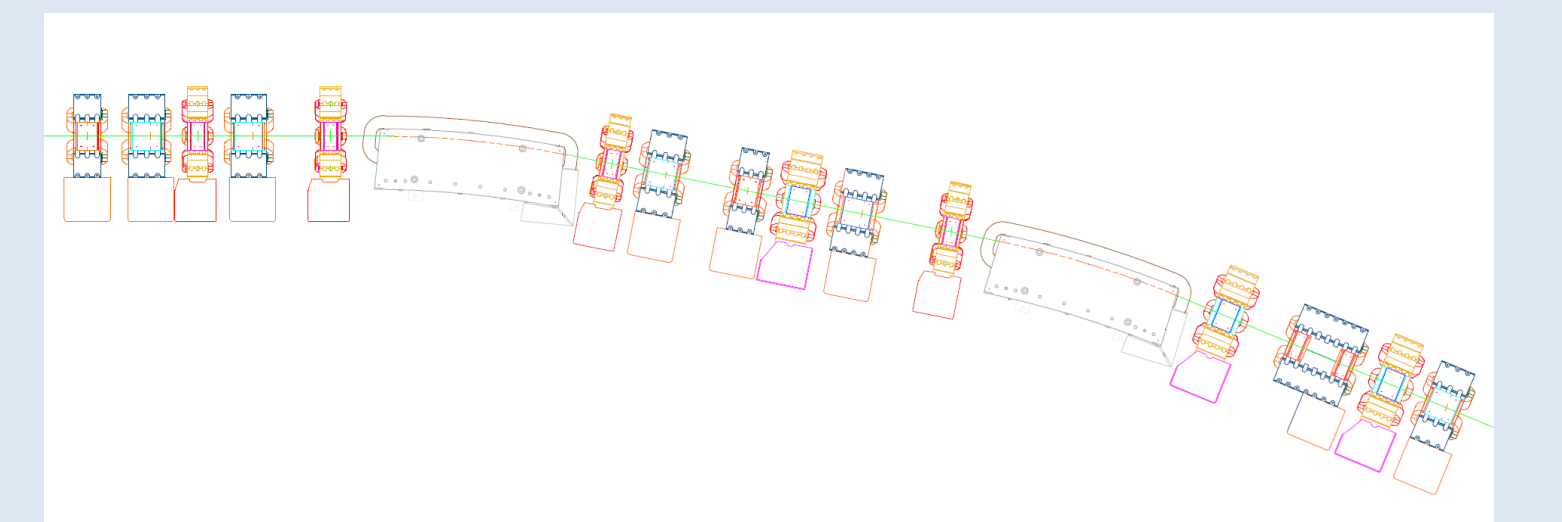


Fig.4: Arrangement of magnets within the matching section of the lattice. In the middle are the bending magnets (blue: quadrupoles, red: sextupoles).

The arrangement of the magnets with the unit cell as well in the matching section are given in Fig.3 and 4. The general parameters of the lattice are given in table 1. This is the first draft version for a lattice of the Iranian Synchrotron Light Source. This lattice has to be optimized and the beam dynamic calculations have to be performed for a good sextuple setting resulting in a sufficient dynamic aperture. For the layout of the booster synchrotron there exist two solutions: A.) to have an extra building or B.) to have it in the same tunnel as the storage ring. There are some pro and cons for each solution. At this stage the solution A will be adapted because in this case one can build up both accelerators separately.

Table 1: The general parameters of the lattice

Parameter	Value	Unit
Beam Energy	3	GeV
Beam Current	400	mA
Circumference	297	m
Bending Radius	7.047	m
Beam emittance, horizontal	3.57	nm
Energy spread	0.104	%
Energy Loss per Turn	1030	eV
Chromaticity, xi_x	-42.86	
Chromaticity, xi_y	-24.15	
RF-Frequency	500	MHz
Bending Magnet Field	1.42	T
Bending Magnet Gradient	6.07	T/m
Critical energy (bend)	8.50	keV
Long straight sections	4x7.95	m
Short straight sections	20x4.55	m
Beam sizes, short straight section	158x45	μm
Beam sizes, long straight section	284x13	μm