# UPGRADE PLAN OF SYNCHROTRON RADIATION SOURCE AT HIROSHIMA SYNCHROTRON CENTER, HIROSHIMA UNIVERSITY

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*Abstract*

There is a plan to upgrade of the present synchrotron radiation source covering with the wavelength range of VUV to the low emittance storage ring with same wavelength range for a long time at Hiroshima Synchrotron Radiation Center, Hiroshima University. We have made two plans up until now. One is based on the design of MAX III storage ring at Lund University, Sweden. The other is the design of a storage ring introducing a concept of the torus-knot. Now we are studying these designs the next our upgrading project comparing with each other, and are also considering the possibility of other designs. We will soon make the detail specifications for the next our light source and proceed to make the detail designs of it and developments for related components.

## INTRODUCTION

We are promoting to investigate the materials science, especially solid state physics, using the synchrotron radiation with the wavelength range from the ultraviolet to soft x-ray at Hiroshima Synchrotron Radiation Center (HSRC), Hiroshima University [1, 2]. HSRC was established at 1996, and since then, various researches for the materials science are carried out using a compact synchrotron light source of the racetrack-type with the energy of 700 MeV. There are, however, strong requirements for the major upgrade of the light source from users, because precise and detailed measurement techniques using the synchrotron radiation has been dramatically developed in the recent years. Especially, there is a request to upgrade the light source with a low emittance beam and availability to use of multiple beamlines having each undulator.

As such a situation, accelerator group at HSRC has been proceeding studies for the design of a compact storage ring with a low emittance for a long time. Here we show the summary of the two designs of low emittance ring which have been studied in detail, and prospects of our activities.

## DESIGN OF MAX III TYPE RING

The design concept and its proof of MAX III at Sweden made a great impact on the design of a compact storage ring. Thus, three types of a ring design, which are a conventional DBA ring [3 - 6], a ring based on UVSOR-upgrade at the Institute of Molecular Science, Japan [4, 7], and a ring based on MAX III [8], were deeply considered at HSRC, and then, the design based on the MAX III type ring was studied in detail due to the most compactness [9]. As the results, it has been designed that a storage ring has the beam energy of 700 MeV, the circumference of 40 m, eight long and short straight sections in total, and the emittance of 14 nmrad. It has also been designed to have an injector consisting of a linac and booster synchrotron with FODO lattice to make possible to operate in top-up.

The basic concept of this design is a quite similar to the MAX III, but it has two types of length of 3.4 m and 2 m in the straight sections for the effective use of the limited space. An injector septum, accelerating cavity and kickers are installed at the short sections, and undulators are at the long sections. As the results, it is possible to make more compact keeping with needed functions. To make a stable operation in top-up, newly installation of a linac and booster synchrotron is needed. Thus, the injector system will be installed on the underground structure inside the storage ring. The underground structure will also save the space for the radiation shielding.

## DESIGN OF TORUS-KNOT TYPE RING

For the purpose to make more challenging and original design for the compact storage ring, the torus-knot ring has been recently studied at HSRC [10]. Due to the application the torus-knot concept into a design of the storage ring, it is possible to increase the orbit length up to over 130 m and a number of the straight sections up to eleven on the same construction area of above MAX III type ring. Furthermore, applying the multi-bend structure, it is possible to achieve the emittance of 8.1 nmrad with the energy of 700 MeV keeping an achromatic property at the straight sections.

On this design, however, a lot of magnets should be installed into the small space due to the multi-bend structure packed into a small construction area. Considerations for the installation and working space of an rf-cavity, injector components, vacuum components, and cabling are needed in detail. Due to the dense installation of various components, the interference of the leakage field must be also considered in detail.

## PROSPECTS

We are now reviewing above two designs in detail. Also we are researching other designs for a compact storage ring for the VUV wavelength range. For example, we are considering the possibility of the achromat structure on the straight sections as possible as compact space based on the unification of the combined function magnets

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which is the fundamental concept at the MAX III. If the small space design is achievable, it would be realized a low emittance storage ring with the energy of 700 MeV and the circumference of less than 50 m. In this case, the ring structure would be quite simple with the low emittance and achromatic straight sections.

Although the accelerator group at HSRC has just started the reconsideration on the upgrading design of the VUV light source, we have to determine the detailed design of the storage ring and realize it as soon as possible because of the strong requirements to make a low emittance beam and multiple uses of the undulator beamlines from the user community of the VUV radiation. For this purpose, we are considering not only the performance of the light source, but also the feasibility of the construction including its budget. Also we will study the developments for related components in parallel.

## CONCLUSION

The two preceding designs for the upgrade of the light source at HSRC are briefly summarized. Also we are now researching other possibilities to make a low emittance ring with a simple structure for the future upgrading.

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