TRANSMISSION EFFICIENCY STUDY OF SSC

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Abstract

Transmission efficiency of HIRFL-SSC had been studied, found the main reasons of the lower transmission efficiency, and some advices were put forward to improve the transmission efficiency.

INTRODUCTION

HIRFL-SSC is a separated sector cyclotron at IMP(Fig.1.), it was constructed in the 1980's, the first beam extracted from SSC is 50Mev/A $^{12}C^{6+}$ in 1988, from then on SSC has been providing ion beams for 21 years, but the transmission efficiency of SSC is very lower, accelerator physicists at IMP begun to study this problems since1992, then there are four main opinions about which. The first is that the RF voltage of SSC is not reach the designing value. The second is the over trim of magnet. The third is that the designing of injection system had some problem. The forth is that the beam matching between SSC and it's injector cyclotron SFC is bad. The present paper studied those opinions by beam simulations and experiments on SSC.

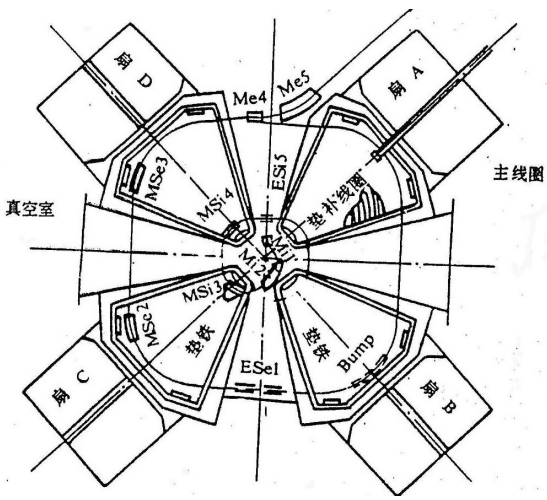

Figure 1: Layout of SSC

LOWER RF VOLTAGE OF SSC

The designing value of SSC RF voltage is 230 kV, as to now, the highest value which the SSC RF system can reach is 180. Some researchers' studies show that for high energy light heavy ions if the RF voltage below 230kV, some particle will hit on the Msi4 or Esi5 for the first accelerate turn, So they point out this is the main reason of lower transmission efficiency of SSC. The authors of the present paper did the same simulations as those researchers did, and got the same results. In our simulations, if the RF voltage is 230 kV the distance between injection beam and first accelerate beam is about 10 mm, and the beam envelope is 8 mm, so there is no beam lose in first accelerate turn, but when the RF voltage bellows 230 kV, there will have beam lost. The above situation is true just for high energy light heavy ions, for other particle beams there is no beam lose even the RF voltage lower than 180 kV. Even for high energy light heavy ions we can increase the distance between injection beam and first accelerate beam to 10 mm by change the location of Msi4 and Esi5. Experiments on SSC verified such moving have the expected effect. So lower RF voltage is not the main reason of lower transmission efficiency.

OVER TRIMMING OF SSC MAGNET

To eliminate the effects of injection elements Mi2 on the main magnet field, some iron was attached on the edge of the magnet sector B and C near Mi2(Fig.1).But the magnet field measurement showed that the iron had a little more than it was needed, such is so called over-trimming. Some researchers thought it is a main reason of the lower

transmission efficiency, they did some simulations under magnetic fields which get from soft edge approximation and included using some techniques the effects of over-trimming, the results show for the high energy light heavy ion beams some particle will lose on the Msi4 or on Esi5 because of the effects of over-trimming. As the researchers pointed out that the over-trimming effects beam patently just for special ions, so should not be the main reason of lower transmission efficiency. And the authors of the present paper use the measured magnetic field do the same simulation as those researchers did, the results show the over-trimming has no effect on beam transmission efficiency, so over-trimming is not the main reason.

DISIGNING PROBLEMS OF SSC INJECITON AND EXTRACTION SYSTEM

The injection and extraction system of SSC designed under soft edge approximation. Some researchers pointed out that the design should be modified under measured magnetic fields, and it is the tradition, also he pointed out the injection beam track is not the optimal one, and the design of Msi4 had some problem, because it sometimes use negative currents, and if the currents is negative the magnetic field inside the magnet channel would be not equality (Fig.2.). The authors agree with this opinion partly, namely the design of injection and extraction system should be modified under real magnetic field. We compared the magnetic field (Fig.2.) which from soft edge approximation or measured ones. We can find there are patent difference at injection and extraction area. And when we use the measured magnetic field do the beam simulation, we find there is a difference about 6mm of beam track between designed one and simulated one in injection, and about 20mm in extraction. We measured the beam intensity and find most beam lost at extraction. Simulations show if we move the extraction elements for property distance, we can increase the extraction efficiency from 40 percent to 80 percent.

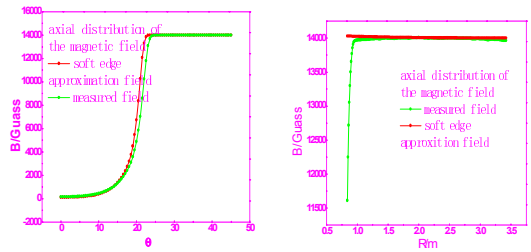

Figure 2: Main magnetic field distributions

BEAM MATCHING BETWEEN SSC AND IT'S INJECTOR SFC

Some researchers pointed out that the beam matching between SSC and SFC is bad, which may be the main reason of the lower transmission of SSC. But when we tune the beam, we found for most beams the injection and accelerate efficiency is very good, so we could not due the lower efficiency to beam matching.

CONCLUSION

The transmission efficiency of SSC is very lower, the main reason is that the injection and extraction system was designed under soft edge approximation and did not modified use real magnetic field. Now to improve the transmission efficiency of SSC, we should simulate the beam under measured magnetic field find the correct locations of the injection and extraction elements, then move the element to the right place.

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