

EXTRACTION SYSTEM OF A COMPACT CYCLOTRON

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Abstract

Based on the beam orbit and dynamics simulations, the extraction system of a compact cyclotron is determined, and the beam parameters of the extracted beam are calculated.

INTRODUCTION

HITFiL(Heavy Ion Therapy Facility in Lanzhou) is composed of a compact synchro- tron ,several ion beam lines , three therapy chamber and a cyclotron injector, Fig.1. is a sketch drawing of the HITFiL. The injector of the synchrotron is a compact cyclotron ,it is now under designing at institute of modern physics Chinese academy of science, it is intended to provide carbon ion with charge number 5,the beam intensity will be more than 10 μA ,and the extraction energy is 7Mev/A.The present paper gives the designing of the extraction system of the compact cyclotron and the beam parameters of the extracted beam.

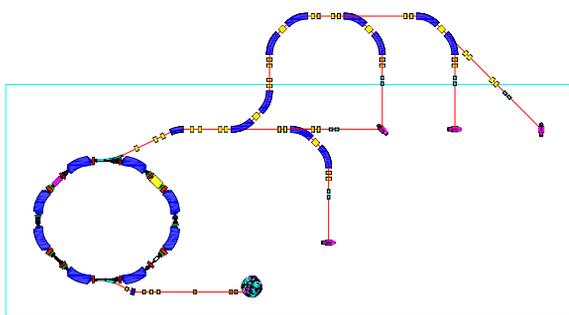


Figure 1: Layout of HITFiL

DESIGNING OF THE EXTRACTION SYSTEM

The designing of extraction system is based on the orbit calculations, the magnetic field used in beam orbit calculation was obtained by a 3D infinite element code, the electric fields used in orbit calculations is an analytical field, Fig.2. is the layout of the reference particle track and extraction elements. The whole

extraction system composed of an electric deflector and a bending magnet. The electric field in the gap is 80.0kV/cm,for that its high voltage electrode will be 80kV, A bump filed be used to enhance the turn distance between extraction orbit and accelerator orbit, it is also helpful for deduce the burden of the deflector.

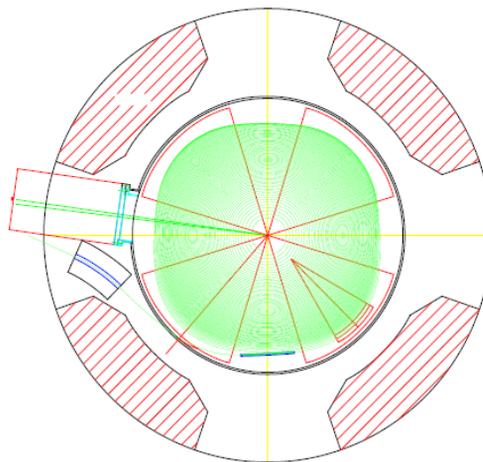


Figure 2: Overview of the cyclotron

Based on the reference particle orbit, extraction elements and it's physical parameter be determined. To obtain higher extraction efficiency and higher beam quality, multi- particle simulation was done, such calculations show that the position of the extraction elements which get from single particle calculations should be optimized.

BEAM PARAMETERS OF THE EXTRACTED BEAM

Extracted beam parameters are obtained based on multi-particle calculation, the initial conditions for such calculations is coming from the injection and center region calculations, The matching point is at the exit of the bending magnet, at this point the beam parameters are as following table, Fig.3. to Fig..5 are the 6 dimensions emittance of the beam, Fig.6.is the dispersion D and D' of the extraction beam.

Table 1: Beam parameters

	β [m]	α	ε [π mmmrad]
H	16.0	-2.77	14.24
V	3.6	-5.46	10.88

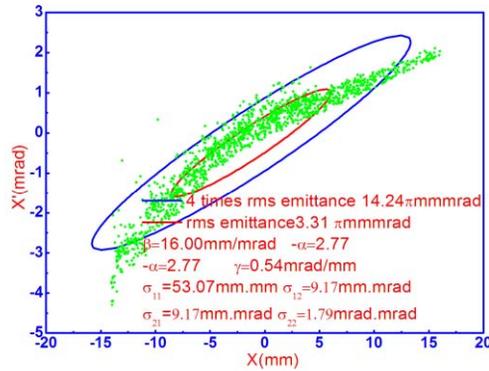


Figure 3: Horizontal emittance

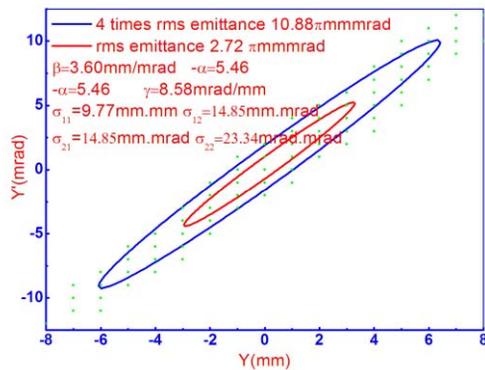


Figure 4: Axial emittance

CONCLUSION

As to now, the design and study of the extraction systems is based on the data from 3D calculations or analytical models. Because the beam is extracted through an area where the magnetic gradient is very high, and due to the strong divergence at horizontal plane and over focusing in axial plane, the beam diverged on both dimensions, but the calculations show the extraction beam may the need, both in beam intensity and beam quality.

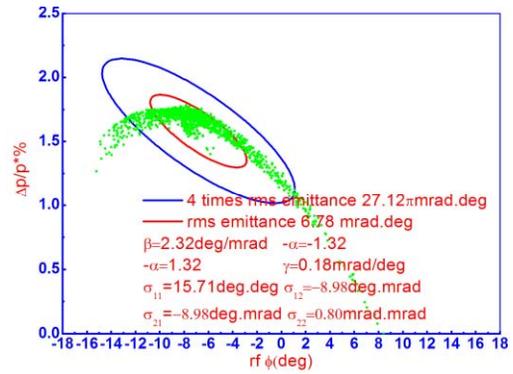


Figure 5: Longitudinal emittance

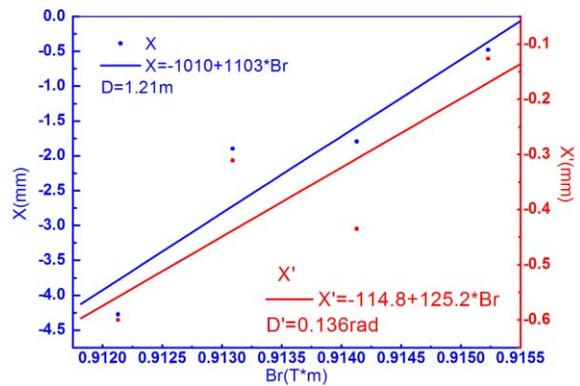


Figure 6: Dispersion at the matching point

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