

BEAM DYNAMICS SIMULATION ABOUT THE DUAL HARMONIC SYS-TEM BY PYORBIT

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Introduction



After reaching the designed beam power of 100 kW, The China Spallation Neutron Source (CSNS) has an update plan (CSNS-II) to increase the beam power to 500 kW (3.9e13 ppp), which means much stronger space charge effect will occur. To alleviate space charge effect, a dual harmonic RF system will be used for longitudinal painting to increase the bunching factor and the linac energy will be increased from 80 MeV to 300 MeV.

PyORBIT, which is developed at SNS, is used as the major simulation code to study the beam dynamic involved the space charge effect with and without the dual harmonic RF system in RCS of CSNS. To meet the requirement of simulation in acceleration process, some code modification is made. In order to verify whether the modified code is suitable for CSNS, a series of experiments are carried out to compare with the simulation results. Besides the modification made for acceleration process, some changes of the dual harmonic RF cavity model also need to be made to meet the needs of the changing voltage ratio between the second harmonic and the fundamental harmonic RF.



Benchmark under single harmonic RF

Momentum off-set (%)	RCS transmission (%)	BF	BF	PF	PF
		(measured)	(simulated)	(measured)	(simulated
-0.17	97.2	0.2503	0.2401	0.802	0.815
-0.19	98.2	0.2606	0.2495	0.834	0.835
-0.21	97.2	0.2704	0.2691	0.863	0.860

Longitudinal parameters with different momentum offsets are measured as Table. BF and PF in Table are the average values of bunching factor and momentum filling factor from 1200 to 1400 turn and the measured PF is gotten by tomography method.



The RCS transmission under different longitudinal parameter combinations is shown as Figure. The picture in lower right corner is the beam loss distribution under the bunching factor of 0.28 and the momentum filing factor of 0.86. The designed momentum acceptance of RCS is 1%, and the corresponding momentum filling factor is about 0.82 at 2 ms.



From left to right, they are: **r** = **0.5;r** = **0.5 and -0.2% momentum offset; r** = **0.8 and -0:2%. momentum offset.** r is the voltage ratio between the second harmonic and the fundamental harmonic RF. Simulation parameters is from J-PARC's experiment with 181MeV injection energy at storage ring mode.

Simulation under dual harmonic RF



A new cavity module has been added to the code, which can be simulated by a given voltage and energy change curve. The simulation results of beam distribution in phase space in 500 turn and 3000 turn are shown in Fig. 4, the variation of beam distribution with longitudinal parameters can be reflected.

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China Spallation Neutron Source