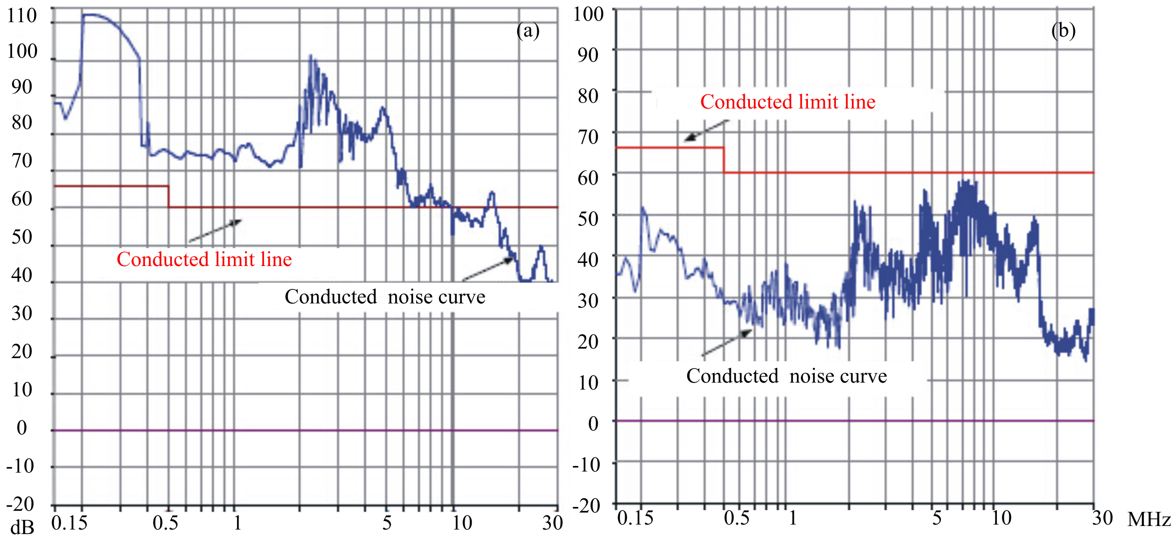

Fig. 4 (color online) Conducted noise of CSRe power supply PS42Q2.
(a) Noise before improvement. (b) Noise after improvement.

6 - 21 Primary Design of Beam Dynamics on Compact C-band Electron Linear Accelerator for High Energy Electron Radiography

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At the beginning of 2014, the Institute of Modern Physics started to develop the research of high energy electron radiography towards high energy density state/inertial confinement fusion diagnostics. One of the important topics is the electron linac specification for the high energy density target imaging system. A C-band electron Linac was selected in order to meet the specific requirement of beam dynamics parameters and achieve a compact design, which is designed to work at the frequency of 5.712 GHz

The high radiography requires high-energy, short-pulsed and small emittance electron bunches, which can be achieved by the better compression property of C-band electron Linac. Accordingly we designed a compact C-band electron Linac and carried out beam dynamics studies optimization. The beamline of C-band electron Linac was designed shown in Fig. 1.

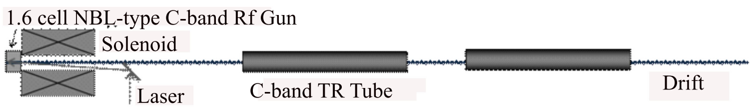

Fig. 1 Beamline of C-band electron Linac.

Beam dynamics parameters simulation has been carried out using the particle tracking code for the C-band electron Linac consisting of a 1.6-cell BNL-type RF gun, optimized solenoid with 4 pancake coils and two C-band traveling-wave cell. The beam dynamics parameters that are optimized include the beam RMS size horizontal emittance, and position of entering the booster. An accelerating field of 100 MeV is required to obtain 5.75 MeV beam energy at the exit of the RF Gun. We used the 4 pancake coils mode with different solenoid field Mu-factor from 0.900 to 1.233 and center position of magnetic field from 21.37 to 26.37 cm, and compared their beam dynamics parameters, with the goal of operating at an optimized injection phase of 22° ~ 25°. Table 1 shows beam dynamics parameters before and after optimization.

Table 1 Beam Dynamics Parameters.

Input parameters	
Bunch charge/nC	0.5
Bunch radius/mm	1
Half width of Gaussian/(°)	1.5
Injection phase/(°)	vary from 22 to 25
Average field of RF Gun/(MV/m)	100
Parameters after optimization	
Multi of $B_{solenoid}$	1.033
Center position of $B_{solenoid}$/cm	23.37
Injection phase/(°)	22.2
position of entering the booster & Z_{min} of $[X_{rms}]$/cm	127.87
Beam RMS size/mm	0.54
Horizontal Emittance/(mm· mrad)	1.07
Beam energy/MeV	80.30

6 - 22 Radiation Safety Report of HIRFL in 2014

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The total operation time of HIRFL is 7 272 h in 2014, and the user beam time is about 4 964.5 h(from 21st Dec.2013 to 21st Dec. 2014). 3 749 h for physics experiment, 332 h for life science research, 883.5 h for material science and single particle effect research, and 235 h for machine research. There are 24 heavy ions beams were provided by HIRFL in 2014. The highest ions energy provided is 487 MeV/u, and the maximum accumulated ion intensity is 1 000 μA.

Environment radiation level was measured with TLDs which were placed in the yard institute around HIRFL, 15 sites of radiation level show no difference with environment background level of Gansu provinc[1]. Furthermore, environmental neutron and gamma dose was monitored by 3 environment radiation monitoring stations continuously, no abnormal data had been found in 2014. Environmental radiation dose of neutron and γ ray had been measured with portable dose meter four times a year. The measured results show no difference with background(Table 1).

Table 1 Environment dose surrounding HIRFL.

Location	Direction	Distance/m	Neutron dose rate/(nSv/h)	γ dose rate/(nSv/h)
Experimental hall door	South	10	23.1	88
The north gate of IMP	South	50	7.05	103
2# building	East	5	29.2	85
6# building	Northwest	5	13.3	90
	West	5	20.5	81
	Southwest	10	10.1	74
	Northeast	5	920.0	176

Measuring time: March 26th, 2014; beam: 70MeV/u$^{40}Ar^{8+}$ at RIBLL1; survey: FHT762 neutron dosimeter, BH-3013B γ dosimeter.

The external dose received by workers mainly due to the residual radiation after the accelerator was shut down. Maximum surface dose rate had been measured in 2014 is 4 mSv/h on the SFC deflector surface. To reduce the external dose of workers, adequate cooling time, and reducing the operating time is essential.

291 persons accepted individual dose monitoring in 2014, and the results are shown in Table 2. The annual collective effective dose was 34.92 mSv. 35 of them are less than 0.1 mSv. The highest individual dose was about 1.49 mSv, which was under the dose limit (20 mSv) of national standard.