6 - 1 Operation Status of HIRFL in 2012

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Since 2012, HIRFL has 7009 machine hours, including 823.1 h for the machine preparation and 783.6 h for the machine commissioning due to beam change, 259.3 h for equipment failure period, 4288.4 h for experiment target time, 695.2 h for machine study. Several different operation modes are included, 1242 h for the independent operation of SFC; 2538.5 h for operation of the combination of SFC+SSC; 1062 h for operation of the combination of SFC+CSRm, 2166.5 h for operation of the combination of SFC +CSRm+CSRe; and 159.4 h is other time.

In 2012, HIRFL provided 21 different types of heavy ion beams for various experiments, among which, 10 kinds of heavy ion beams with different energy were first commissioning beam. The typical ion beams provided by HIRFL in 2012 are listed in Table 1.

In 2012, different types of experiment were completed on HIRFL including 2302.67 h of beam time for physical experiments; 563.67 h for heavy ion tumor therapy, biological experiment and beam test, etc; 1439.08 h for research of material irradiation and single event effect; 695.2 h of beam application for the machine study. Table 2 shows summary of the HIRFL operation time.

Table 1 The typical ions beam provided by HIRFL in 2012

Index	Beam	SFC		SSC		CSR		Time
		Energy (MeV/u)	Current (μA)	Energy (MeV/u)	Current (μA)	Energy (MeV/u)	Current (μA)	
1	$^{86}Kr^{20+}$	3.63	4.4		264～476	700	2012.1.9	
2	$^{18}O^{6+/8+}$	5.361	2.9	60	0.34			2012.1.11
3	$^{84}Kr^{17+/26+}$	2.345	5	25	0.23			2012.1.20
4	$^{19}F^{7+}$	6.6	1.7					2012.2.18
5	D	10	5					2012.2.23
6	$^{12}C^{4+/6+}$	7	6			200,400	800	2012.3.12
7	$^{40}Ca^{12+}$	5.17	2.5					2012.3.17
8	$^{40}Ca^{13+}$	6.975	1.7					2012.3.23
9	$^{40}Ca^{12+/18+}$	6.17	1.6	70	0.075			2012.3.25
10	$^{12}C^{4+/6+}$	7	2.6	80.55	0.18			2012.4.2
12	$^{12}C^{4+/6+}$	7	6			165～350	1600	2012.4.20
13	$^{18}O^{6+/8+}$	7	4			305.41	1600	2012.5.2
14	$^{40}Ar^{12+/16+}$	6.17	4.5	70	0.23			2012.5.13
15	$^{209}Bi^{31+}$	0.911	0.42	9.5	0.04			2012.5.29
16	$^{20}Ne^{7+}$	6.17	5					2012.6.10
17	$^{18}O^{6+/8+}$	6.17	5	70	0.4			2012.6.24
18	$^{40}Ca^{12+}$	4.9	1.5					2012.7.5
19	H^{+}	21.5	※					2012.9.15
20	$^{86}Kr^{17+/26+}$	2.345	3	25	0.26			2012.10.16
21	$^{112}Sn^{26+/35+}$	3.7	2			391.56 etc.	500	2012.11.1

Using the SECR+SFC+CSR complex, HIRFL operation team successfully commissioned $^{112}Sn^{26+/35+}$-3.7 MeV/u beam with maximum energy of 391.56MeV/u, the beam current exceeded 350 eμA (Fig. 1). $^{112}Sn^{26+/35+}$ is the most heavy ion beam available presently in IMS(isochronous mass spectroscopy) experiment at HIRFL-CSRe. The beam from SFC passed through stripping foil to increase charge state from 26+ to 35+, the beam intensity at injection point of CSRm is only 0.4 eμA, after effective accumulation and acceleration, the number of particles extracted to target reached 4×10^{7}.

Table 2 Distribution of HIRFL operation time in 2012

Operation time distribution	Time (h)	Percentage (%)
Total operation time	7009	100
Failure time	259.3	3.7
Preparation of beam	1606.7	22.92
Other time	159.4	2.28
Target beam time	4983.6	71.1
Nuclear physics	2302.67	46.05
Irradiation	1439.08	28.78
Biophysics and cancer therapy	563.67	11.27
Machine study	695.2	13.9

Furthermore, a new setting of ISO mode with tr=1.302 is designed and tested at CSRe. This setting reduced the required energy for IMS experiments to about 80% of previous setting with tr=1.395.

The resonant Schottky pickup was installed at the CSRe and beam tests were performed successfully. The test result, given in Fig. 2, shows it is very sensitive and powerful, even one particle could be detected. It is obvious that with this resonant pickup we can increase substantially our experimental performance.

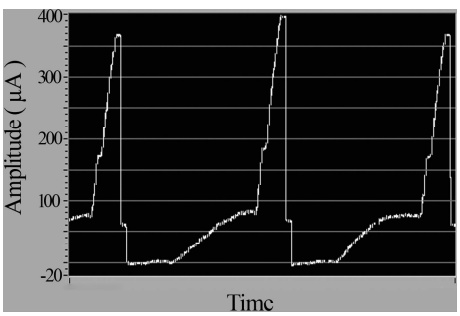

Fig. 1 CSRm beam current signal of DCCT of CSRm.

Fig. 2 Beam spectrum of resonant Schottky pickup in CSRe.

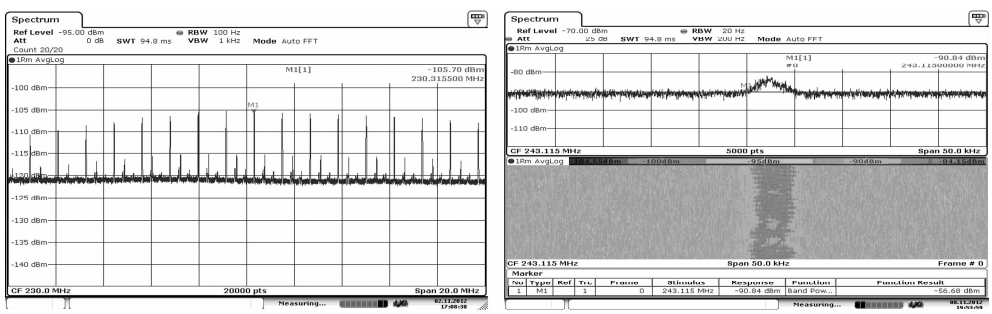

Fig. 3 Beam measurement with the slotted pickup in CSRe.

A novel type of forward coupler slotted strip-line pick-up/kicker to be installed inside the 2.35 m long bending magnet had been developed successfully for CSRe stochastic cooling and verified by beam experiment. For CSRe stochastic cooling pickup, it is the perfect structure. The following work will aim to solve the impedance mismatch effects and improve its performance.