

## 8 - 19 Operational Report of On-line Ion Sources in 2022

Feng Yucheng<sup>1</sup>, Zhang Wenhui<sup>1</sup>, Ma Hongyi<sup>1</sup>, Ma Jindou<sup>1</sup>, Zhang Zonghu<sup>1</sup> and Lu Wang<sup>1,2</sup>

<sup>1</sup>Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China;

<sup>2</sup>School of Nuclear Science and Technology, University of Chinese Academy of Sciences, Beijing 100049, China)

In 2022, three on-line ion sources: SECRAL-IILECR4 and LECR3 serviced for HIRFL-CSR accelerator facility normally all year round, and their service time are 4 114.5, 679 and 2 941.5 h respectively, amounting to 7 735 h. There are 22 kinds of ion beams delivered successfully, including 7 kinds of metallic ions, accounting for 39.5% of the total service time. In particular, intense pulsed  $^{209}\text{Bi}^{36+}$  beams were produced with SECRAL-II ion source in afterglow mode and applied for the HIRFL-CSRm. Table 1 summarizes the main information about the ion beams delivered by these three ion sources.

Table 1 Ion beams delivered by ECR Ion source to HIRFL accelerator in 2022.

Equipment	Ion beam	Extraction HV/kV	Ion beam intensity/eμA	Method for metallic ions	Service time/h
SECRAL-II	$^{209}\text{Bi}^{36+}$	19.85	65	LTO*	707.5
	$^{181}\text{Ta}^{35+}$	13.0	20	Sputtering	765.5
	$^{129}\text{Xe}^{27+}$	14.05	300		339.5
	$^{78}\text{Kr}^{26+}$	19.85	250		675
	$^{58}\text{Ni}^{19+}$	19.49	30	IHO**	340.5
	$^{56}\text{Fe}^{17+}$	22.86	50	IHO	663
	$^{54}\text{Fe}^{15+}$	17.71	60	IHO	487
	$^{40}\text{Ar}^{11+}$	19.24	220		136.5
LECR4	$^{209}\text{Bi}^{32+}$	24.35	23	LTO	24
	$^{129}\text{Xe}^{22+/20}$	21.88/24.05	82/95		300/53
	$^{78}\text{Kr}^{15+/14+}$	19.37/20.78	80/115		270/5
	$^{16}\text{O}^{4+/3+}$	14.93/19.88	115/200		7/20
LECR3	$^{86}\text{Kr}^{17+}$	18.89	100		263+412
	$^{40}\text{Ar}^{8+}$	18.70	200		353
	$^{18}\text{O}^{6+}$	17.72	400		736
	$^{12}\text{C}^{5+}$	18.77	35		171
	$^{12}\text{C}^{4+}$	23.07/21.66	200/200		330.5/243.5
	$^7\text{Li}^{3+}$	22.36	50	MTO***	71.5
	$^4\text{He}^{+}$	17.66	300		361

LTO\*: Low Temperature Oven, IHO\*\*: Inductive Heating Oven, MTO\*\*\*: Medium Temperature Oven.

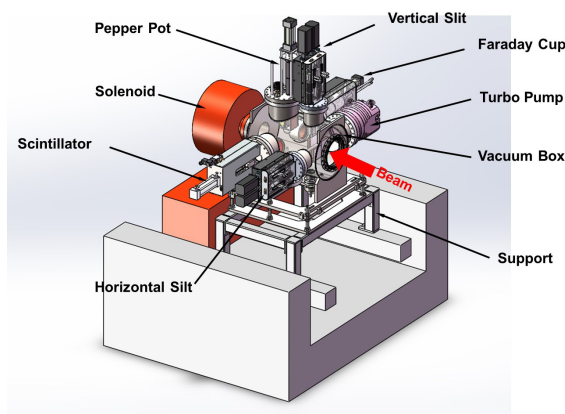


Fig. 1 (color online) Three-dimensional model of the new beam diagnostic system.

In addition, the LEBT of LECR3 ion source was upgraded to enrich the beam diagnostic methods as well as improve the transmission efficiency. Figure 1 shows the three-dimensional model of the new beam diagnostic system. Meanwhile, the location of the diagnostic system was also adjusted based on beam dynamic simulation. In practical test, the transmission efficiency of the  $\text{He}^{2+}$  beam from BL0FC01 to BL0FC02 can reach over 90%, which is much higher than the original situation (about 60%) and thus proves the effectiveness of this upgrade.