#41 Production and manipulation of intense ion beams with an ECRIS in afterglow mode

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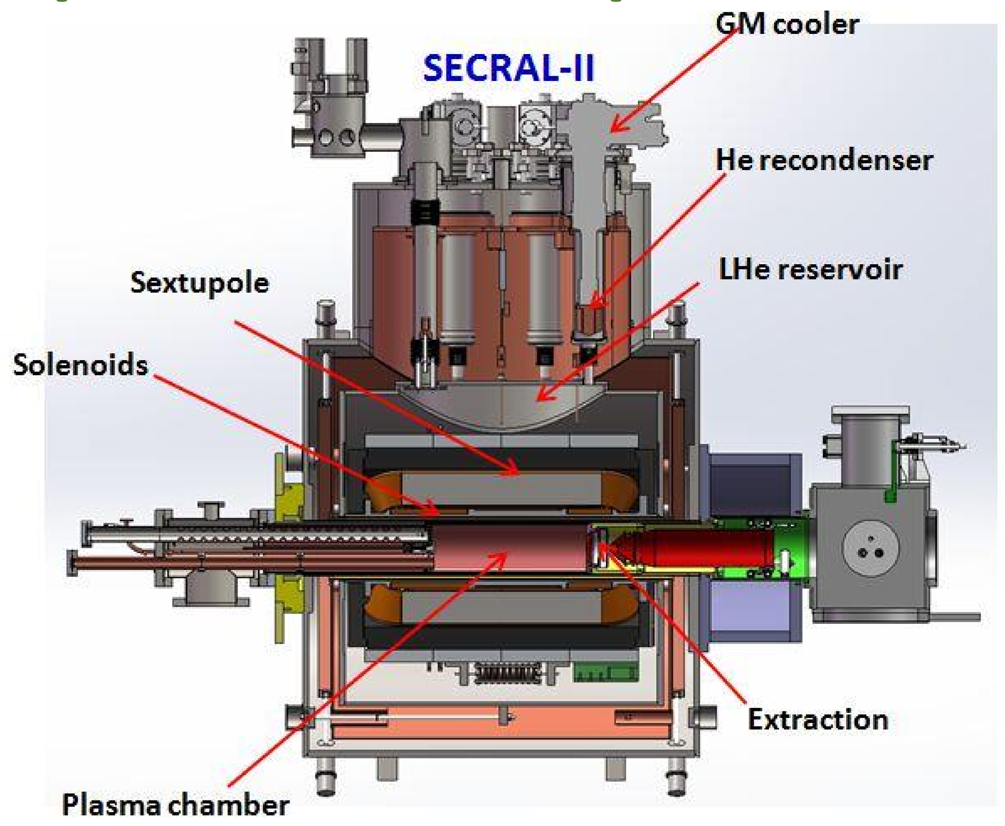
Abstract

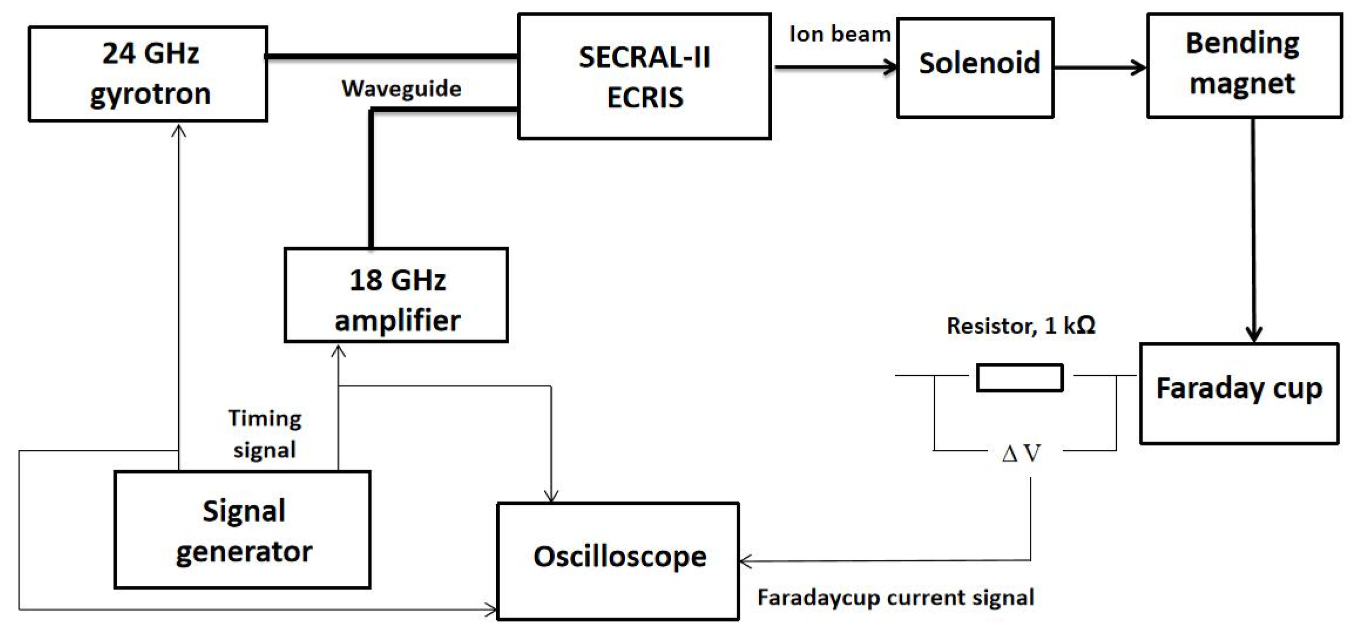
High intensity afterglow beams have been produced with SECRAL-II ion source under double frequency heating (24 + 18 GHz) recently. At a total microwave heating power of up to 8 kW, high intensity ion beams such as 266 eμA of Xe^{34+} and 169 eμA of Xe^{38+} have been produced. In this experiment, we have tried high power double frequency heating, and also changing of the temporal synchronization between the two microwave sources, which was found to have impact not only to the afterglow peak currents, but also affect afterglow peak waveform. Specifically, a prolong of the end time in the second microwave (18 GHz in our case) can decrease the pulse width of beam peak obviously. Overall, this work provides new possibilities for the application of afterglow beams in terms of high peak currents of highly charged ion beams and flexibility in pulse duration.

Experimental setup



Key Parameters

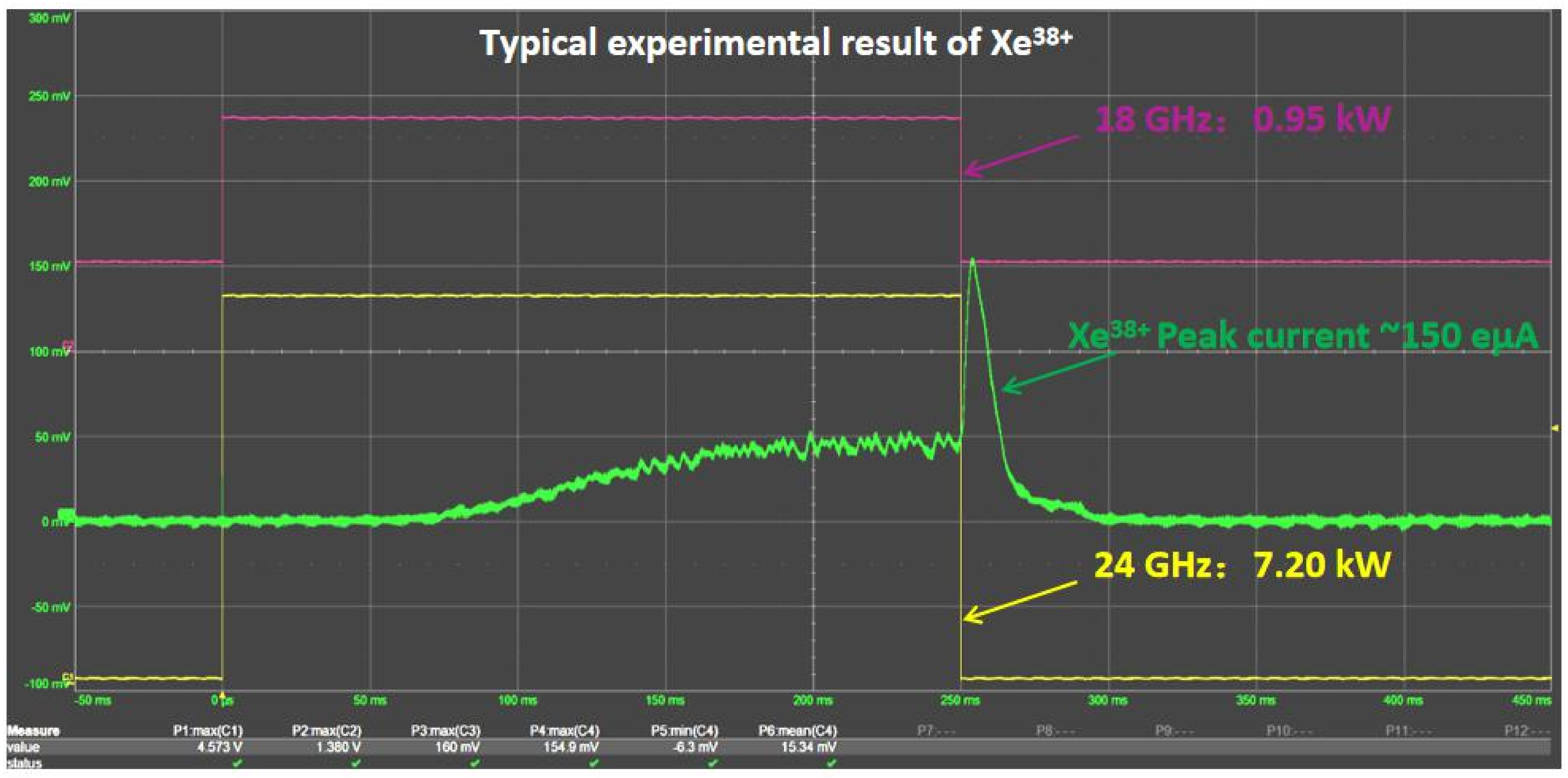
Parameters	SECRAL-II
ω_{rf} (GHz)	18-28
Injection Field Peaks (T)	3.7
Extraction Field Peaks (T)	2.2
Mirror Length (mm)	420
No. of Axial SNs	3
B_r at Chamber Inner Wall (T)	2.0
Coldmass Length (mm)	~810
Warm bore ID (mm)	~142 .0
Chamber ID (mm)	125.0

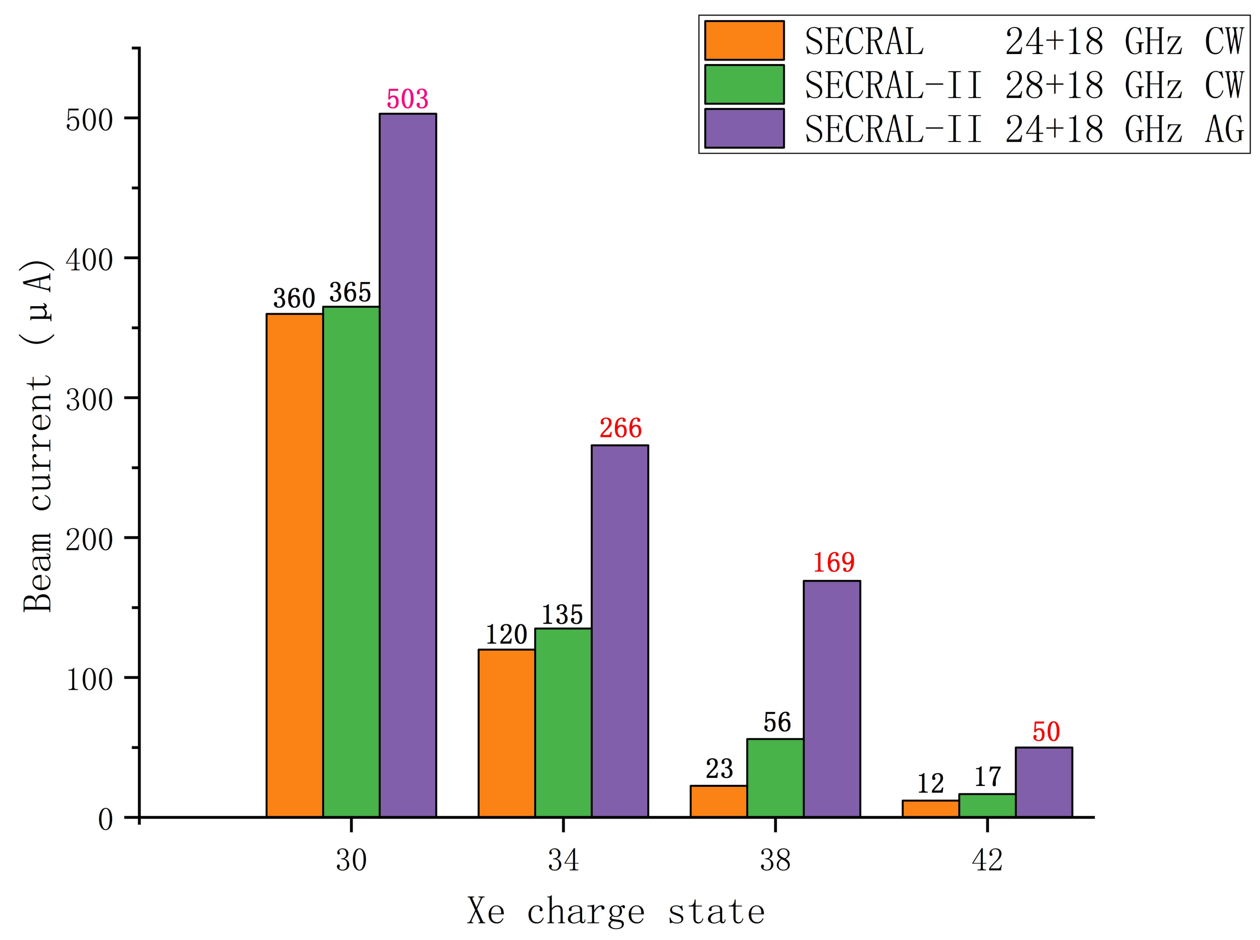


The schematic of experimental setup

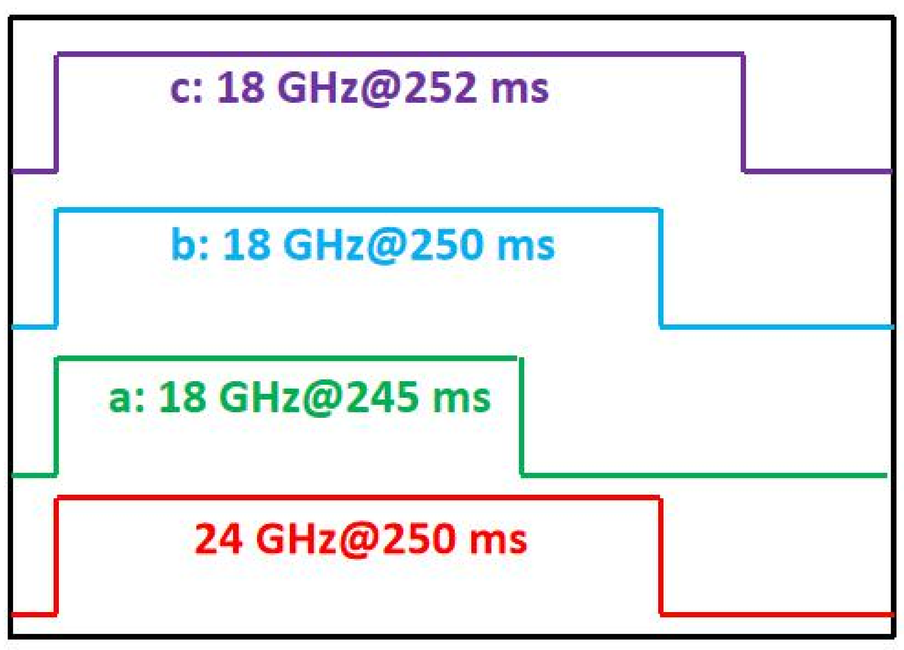
Experimental results

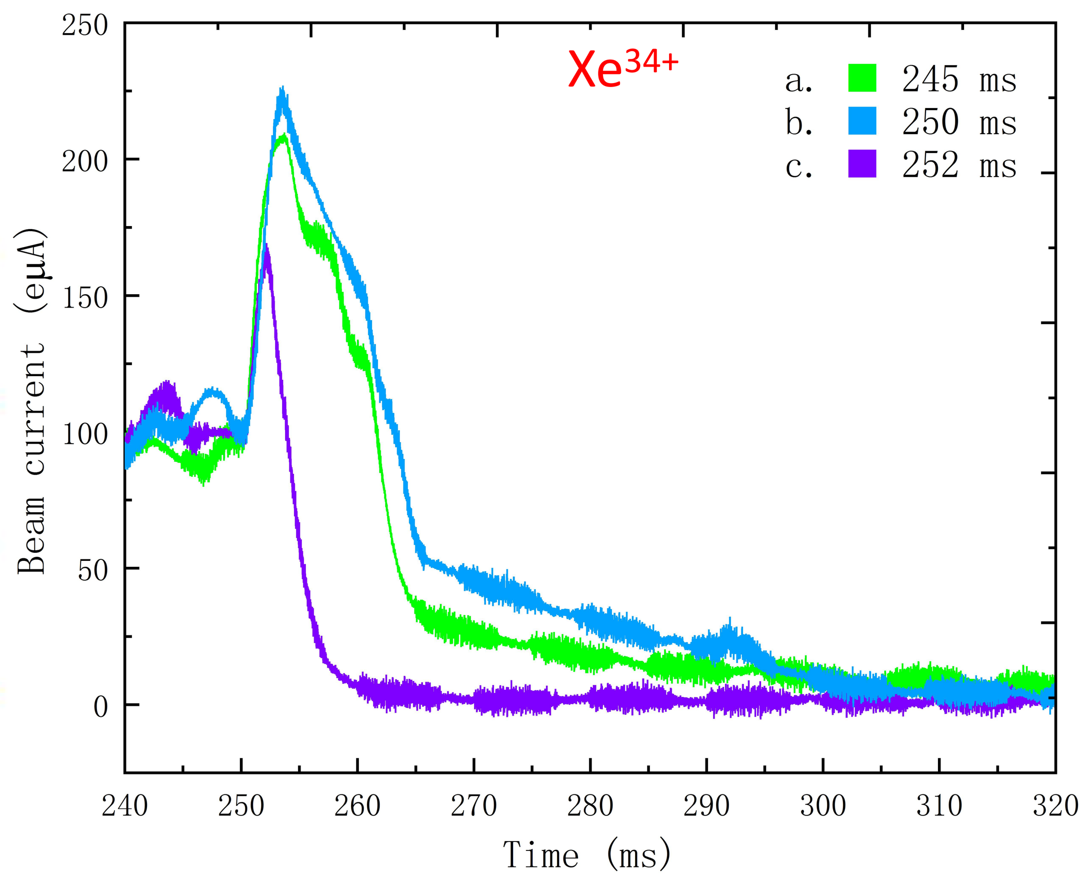
Comparison of xenon beam intensity records between CW and AG mode





Manipulation of afterglow waveform





ion	Delay of 18 GHz microwave (ms)	Peak current (eμA)	Rise time (ms)	Fall time (ms)	1/*e* decay time (ms)
Xe^{30+}	0	425	2.71	17.09	6.22
	+1.5	343	1.60	5.58	2.10
Xe^{34+}	0	226	3.36	13.61	10.45
	+2	168	2.20	6.42	2.63
Xe^{38+}	0	124	3.86	11.61	8.62
	+1.5	92	2.15	4.33	1.64

The experimental results demonstrate that when the pulse width of 18 GHz microwave is shorter (up to 5 ms) than the pulse width of 24 GHz microwave (250 ms), it has little effect on the afterglow waveform; but when the pulse width of 18 GHz microwave is longer (1.5-2 ms) than the pulse width of 24 GHz microwave (250 ms), the waveform is significantly modulated (illustrated above) and further increasing the 18 GHz pulse width will not change the afterglow waveform. The detailed waveform parameters of Xe^{30+}, Xe^{34+} and Xe^{38+} are shown in the above table.

Conclusion

A great enhancement of xenon beam intensity has been achieved on the third generation ECR ion source SECRAL-II operating at two-frequency heating afterglow mode. Compared with the best beam intensity results in CW mode, the gain factor is 1.4~7.5. By changing the temporal synchronization between the two microwave sources, the shape of afterglow waveform can be modulated. Overall, the results of our experiments provide more possibility of the application of afterglow beams.