Preliminary Ionization Efficiencies of ^{11}C and ^{14}O with the LBNL ECR Ion Sources*

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^{11}C ($t_{1/2}$ = 20.3 min) and ^{14}O ($t_{1/2}$ = 70.6 sec) are the first two radioactive isotopes to be developed for the BEARS (Berkeley Experiments with Accelerated Radioactive Species), an initiative to develop a radioactive ion-beam capability at the 88-Inch Cyclotron Facility. These radioactive isotopes were produced either in a N_2 gas target or a boron nitride (BN) target. A 10 MeV proton beam with intensities up to 5 µA from the 88-Inch Cyclotron or up to 30 µA from the medical cyclotron in the Building 56 was used to irradiate the targets. The produced radioactive isotopes were then transferred to the ECR ion sources in a batch mode through a cryogenic trap.

So far high charge states up to fully stripped ion beams of ^{11}C and ^{14}O have been produced with the electron cyclotron resonance ion sources, the LBNL ECR and AECR-U ion source at 88-Inch Cyclotron Facility. Ionization efficiency as high as 11% for $^{11}C^{4+}$ was achieved. Table 1 lists the detailed results for the various charge states of ^{11}C and ^{14}O achieved with the two ECR ion sources. Listed also in Table 1 are the efficiencies for the stable species of ^{12}C and ^{16}O achieved with the AECR-U. Comparison between the stable and radioactive species indicates that there is still room for further enhancing the ionization of these radioactive species.

With further improvements and the completion of the transfer line from the medical cyclotron at Building 56 to the 88-Inch Cyclotron facility, for a target production rate of approximately 1 x 10^{11} atoms/sec, a ^{11}C beam of intensity up to a few x 10^8 ions/sec for experiments can be expected. Similar projections for ^{14}O lead to an initial beam of a few x 10^6 ions/sec.

TABLE 1. Preliminary ionization efficiencies with the ECR and AECR-U ion sources

ION	ECR (%)	AECR-U (%)	AECR-U[a] (%)
$^{11}C^{1+}$	1.1		
$^{11}C^{2+}$	0.7		
$^{11}C^{3+}$	0.4	4	
$^{11}C^{4+}$	0.9	11	24
$^{11}C^{5+}$	0.1	4	14
$^{11}C^{6+}$		2	
$^{14}O^{3+}$	0.4		
$^{14}O^{4+}$	0.4		
$^{14}O^{5+}$	0.45		
$^{14}O^{6+}$		3.6	26.7
$^{14}O^{7+}$		1.2	5.6
$^{14}O^{8+}$		0.4	

[a]Efficiency of stable species of ^{12}C and ^{16}O measured with a calibrated CO leak of flow rate of 9.5 pµA.

Footnotes and References

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