

K500 operations and development

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Introduction

During the 2021-2022 reporting period a total of 19 different beams, including 8 newly developed beams, were used for experiments, and there were a total of 22 beam tunings for these experiments. The SEE program and the radioactive-beam effort are treated separately in this progress report.

Ion Sources

Three new beams were run using sputtering. Our standard method for producing silicon beams has been to flow the highly explosive gas, silane, into the ion source. A new method, suggested by personnel of the LBL 88" cyclotron lab [1], has now been tested here. A silicon rod of 99.9% enriched ^{28}Si and separately a silicon rod of 90% enriched ^{30}Si were mounted on the rod feed for ECR4 and sputtered into the source. It was found that nitrogen was more stable than oxygen as a support gas for silicon sputtering, possibly because the silicon oxidizes easily. The sputtering voltage ranged from 1.0 to 1.5 kV. In addition a rod of natural ytterbium was used to produce beams of several of the ytterbium isotopes via sputtering into ECR4. The sputtering voltage ranged from 0.9 to 2.5 kV depending on the need for intensity of each isotope.

During this reporting period the ECR1 ion source was dismantled from its position next to ECR4 and repaired by replacing its plasma chamber. The new aluminum chamber had already been fabricated along with the chamber for ECR4 and the new NdFeB permanent magnet bars acquired. All that remained was to install the copper, water-cooling lines in the chamber and then insert the magnet bars. The source was remounted on the K500 injection line along ECR4, but it has yet to be completely reassembled with microwave and gas injection due to the x-ray danger of working close to ECR4 while it is running. However, the source could quickly be brought to operation if required.

Cyclotron Beams

New beams of ^{12}C at 35 AMeV, ^{14}N at 18.5 AMeV, ^{28}Si at 35 AMeV, ^{30}Si at 35 AMeV, ^{83}Kr at 15 AMeV, ^{170}Yb , ^{174}Yb , and ^{176}Yb all at 7 AMeV, and ^{197}Au at 8.7 AMeV were developed for experiments.

Operations

For the period April 1, 2021 through March 31, 2022, the operational time is summarized in Table I, while Table II lists how the scheduled time was divided. Unscheduled maintenance decreased back to a normal level from the last period. Scheduled time for outsider users, exclusively SEE customers increased substantially from the last reporting period.

Table I. 2021-2022 Operational Time.

Time	Hrs	%Time
Beam on Target	6246.5	71.5
Beam Development	77.5	0.9
Scheduled Maintenance	1696	19.4
Unscheduled Maintenance	716	8.2
Total	8736	100

Table II. 2020-2021 Scheduled Beam Time.

Time	Hrs	%Time
Nuclear Physics	1414.5	22.4
Nuclear Chemistry	952	15.0
Outside Collaboration	0	0
Outside Users	3880	61.4
Beam Development	77.5	1.2
Total	6324	100

[1] Janilee Benitez, private communication