K150 Operations and development 2024-2025

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The operation of the K150 cyclotron continued this year, providing beams to the science program, SEE line users, and the astatine-211 production program. For the reporting period 4/24-3/25, we logged 3676 of beam on-target for in-house science experiments, 316 of beam on-target for SEE line testing and 1848 hours of beam development as shown in Table I.

Table I. 2024-2025 operational time for the K150 cyclotron

Time	Hours	% Time
Beam on target (Science)	3676	42%
Beam on target (SEE Line)	316	4%
Beam Development	1848	21%
Scheduled Maintenance	1896	22%
Unscheduled Maintenance	712	8%
Idle	288	3%
Total	8736	100%

The new filament ion source, manufactured by D-Pace Inc. [1], continues to be commissioned after its installation last year. This ion source can provide both positive and negative hydrogen ions as well as positive ^{3}He and ^{4}He ions. The first H- beam from the new filament ion source was extracted in April 2024, and the ion source is functioning well. To date, H^{-} beam intensities extracted from the K150 cyclotron to FC02 of 20 μA have been achieved for energies ranging from 14 to 23 MeV, and beam energies up to 45 MeV have been extracted from the cyclotron. For the $4He^{+}$ beam at 7.2 MeV/u (intended for ^{211}At production), 9μA of extracted beam have been achieved. Details about the continuing commissioning of the new filament ion source are given in a separate report.

The active users of the K150 beams were the light ion guide (LIG) group, Yennello, Folden, Rogachev, Adsley and Bonasera groups. There was one external group, Professor Sobotka from Washington University in St. Louis, that used a beam for an experiment on the MARS beamline to test a new scintillating fiber array detector.

The LIG group run this year was mainly concerned with the production of ^{105}In for the experimental campaign reported in last year's progress report. The operation of the LIG and the CB-ECR was optimized first with ^{106}In, produced from ^{106}Cd(*p*,*n*) with 15 MeV protons from the K150. After this, the proton energy was increased to 22 MeV to produce ^{105}In with ^{106}Cd(*p*,*2n*). Typically, 10-12 μA were used during the nearly 3 week long run. Producing these beams was relatively easy with the newly commissioned D-Pace filament ion source in H- mode. Later in the year, production of new LIG radioactive beams with Pd targets were investigated. These efforts are described in a separate report.

The astatine-211 production program also is continuing to use the beam regularly, usually about once per month. Each beam consisted of $^{4}He^{1+}$ beam at 7.2 MeV/u and with intensities between 6 to 13 μA on target. A typical irradiation of the bismuth production target lasts overnight and has a total run time of 14-16 hours. The beam tune for the ^{4}He beam has become relatively routine and can often be optimized within 4-6 hours. Small improvements to the beam tuning have been made, but often the quality of the beam depends on the overall condition of the cyclotron. It has been observed that the internal vacuum of the cyclotron is critical for the best beam intensity. Efforts are still being made to increase the available extracted intensity beyond 20 μA. In addition to improving the beam tuning from the ECR2 ion source, the He+ ions can also be provided from the new D-Pace filament ion source, and the advantage or disadvantage of using that ion source is being investigated.

Calcium metal ion beams, such as ^{40}Ca, are being developed with ovens in ECR2 and the K150 cyclotron. The development of calcium beam is needed as two groups are requesting intense ^{48}Ca beam, a very rare and expensive isotope, within the coming years.

During the annual maintenance shutdown, the K150 deflector was cleaned and inspected. During this process, the internal calibration of the position of shoes changed slightly, but significantly. New shoe positions for various beams have been developed.

[1] – Positive/Negative Filament Ion Source,Model# ISV.F-100, D-Pace Inc.; https://www.d-pace.com/?e=363