K500 operations and development

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Introduction

During the 2007-2008 reporting period a total of 34 different beams, including 14 newly developed beams, were used for experiments. There were a total of 42 beam tunings not counting multiple tunes of beams for the SEE program. The SEE program will be treated separately.

Ion Sources

During the January shut-down ECR1 was opened for examination and cleaning, and it was discovered that another small spot of damage had developed in the aluminum wall of the plasma chamber directly on a plasma flute. The plasma flutes overlap the poles of the hexapole, so the damage likely occurred at a weak place in the magnetic field of the hexapole. Over time this process accelerated as the excess plasma-heating of the spot heated the weak area of the underlying permanent magnet material causing its field to become even weaker in this region.

Measuring the field at the wall at the position of the damage and comparing it to the value measured after the hexapole was assembled revealed that there was an original field minimum at this position located at the joint between two blocks of permanent magnet material and that this minimum was now lower. The damaged area is almost identical to another spot noted in 2002 and repaired by replacing a hexapole bar in January of 2004. The new spot is not at the midpoint of the hexapole as before, but 4.0” closer to the injection end of the source.

Because the axial confinement field reinforces three of the poles of the hexapole at each end of the ion source, the plasma flutes of an ECR ion source form a three-pointed star on the injection end and a three-pointed star on the extraction end. The two stars are rotated by 60º with respect to one another, and they extend along the cylindrical walls of the plasma chamber and overlap by a few inches at the midpoint. In order to spare the hexapole further heating at the damaged position the axial magnetic field of ECR1 was reversed. This rotates the three flutes of each plasma star by 60º. To match the star on the injection end, the injection end plate with its microwave feed and the steel plug, which accommodates this feed, were both rotated by 60º. After this field reversal ECR1 has continued to perform well.

In March of 2007 ECR2 had been moved to a position above the K150 cyclotron so that it could provide beams for the K150. During the summer ECR2 was turned on again but without the power supply for the biased plate or lead shielding and only supplied low charge state beams.

Cyclotron Beams

New beams of ^{12}C at 10 AMeV, ^{14}C at 12 AMeV, ^{19}F at 26 AMeV, ^{27}Al at 30 AMeV, ^{32}S at 10 and 40 AMeV, ^{47}Ti at 30 AMeV, ^{56}Fe at 10 AmeV, ^{63}Cu at 10 AMeV, ^{78}Kr at 35 AMeV, ^{86}Kr at 15

AMeV and at 35 AMeV and ^{124}Sn at 26 AMeV were developed. For ^{47}Ti a foil of the isotopic material was spot-welded onto the flat side (facing into the source) of a non-isotopic titanium sputter target. Later in a source-only trial an isotopic foil was folded and spot-welded to a stainless-steel wire support. This worked well, but the sputtering occurred on only one side of the material. A vacuum feed-through capable of 360º rotation will be tried next with this isotopic target.

Operations

For the period April 1, 2007 through March 31, 2008, the operational time is summarized in Table I, while Table II lists how the scheduled time was divided. There were three major repairs that

Table I. 2007-2008 Operational Time

Time	Hrs.	%Time
Beam on target	5967.25	**76.5**
Tuning, optics, set-up	77.00	**1.0**
Beam development	345.50	**4.4**
Scheduled maint.	440.50	**5.6**
Unscheduled maint.	967.75	**12.5**
Idle time	1.00	**0.0**
Total	**7801.00**	**100.0**

Table II. 2007-2008 Scheduled Beam Time.

Time	Hrs.	%Time
Nuclear physics	1690.00	**25.7**
Nuclear chemistry	1253.50	**19.1**
Atomic physics	308.00	**4.7**
Outside collaboration	0.00	**0.0**
Outside users	3131.50	**47.7**
Beam development	181.50	**2.8**
Total	**6564.50**	**100.0**

caused significant loss of time. In August helium-refrigerator problems caused a loss of over four days of beam time, followed in September by a water leak of a dee stem internal to the K500 that resulted in 3.5 days of lost beam time. Finally, after the January shut-down the helium refrigerator did not perform up to specification and finally failed in the last days of February. The entire month of March was lost to what has been determined to be contamination of the helium with moisture. As a consequence the unscheduled maintenance for this year represents a much higher percentage of time than for previous years.