RESULTS OF THE ECR ION SOURCES OPERATION AT THE FLNR (JINR) CYCLOTRONS.

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Abstract

In the report the main results on production of ion beams from the ECR4M and DECRIS-14-2 ion sources will be presented. Many of the elements required for acceleration at the FLNR cyclotrons are available in the solid state. For production of these beams the evaporator and MIVOC technique were used. In the report the main emphasis is given to production of ions of enriched isotopes, such as ^{26}Mg, ^{48}Ca, ^{58}Fe.

1 ECR4M ION SOURCE.

The most time consuming experiments at the U400 cyclotron were the experiments on synthesizing of new superheavy elements. The beam time distribution of the source operation (including the tuning of the source and cyclotron) during the 1999 and 2000 years is shown in Figure 1.

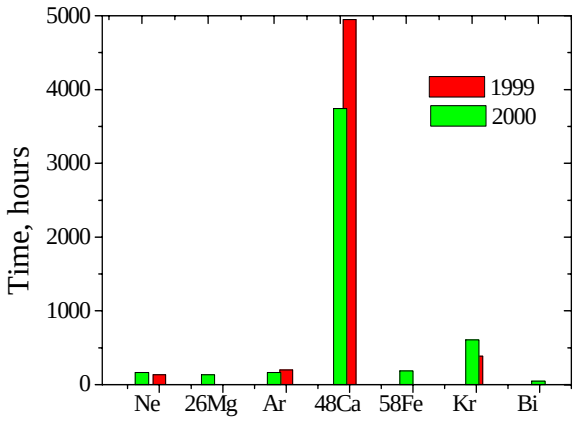

Figure 1: Beam time distribution of the ECR4M operation in 1999 –2000.

For the experiments an intense ion beam of ^{48}Ca was required from the ECR4M source. The plot of the target current during one of the runs at the cyclotron in July 2000 is shown in Figure 2. The current of $^{48}Ca^{5+}$ at the entrance of the injection channel constitutes about of 40 – 50 eμA. An average calcium consumption for this run constitutes about of 0.7 mg/h. During the 1999 – 2000 years 88 calcium samples were used.

New isotopes accelerated at the U400 during 2000 year were ^{26}Mg and ^{58}Fe.

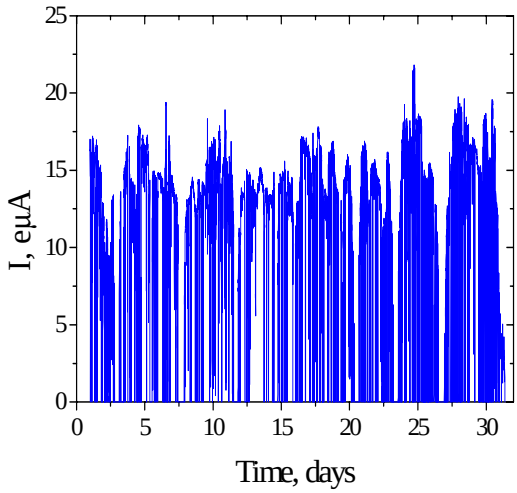

Figure 2: Plot of ^{48}Ca current on the target during the irradiation.

The same technique of the solid substance feed into the ECR source (microoven and hot screen) was used for production of the ion beam of the enriched isotope ^{26}Mg. Metallic magnesium was recovered from magnesium oxide using the same method and installation as for calcium. Up to 40 eμA of $^{26}Mg^{3+}$ were produced from the source that was sufficient for the experiments on chemistry of the element 112. The material consumption was about 0.75 mg/h. The spectra of ^{26}Mg ions is shown in Figure 3.

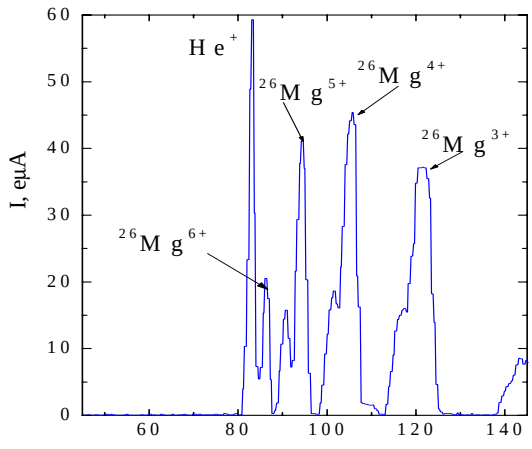

Figure 3: The spectra of ^{26}Mg ions

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During the operation with high vapor pressure solids like Li, Mg, Ca the stable ion source operation is influenced by the additional heating of the oven by u.h.f. and plasma. The measurements of the oven temperature as a function of u.h.f. power and oven position were performed at the ECR4M source. For the measurement of the oven temperature the dependence of the tungsten wire resistance vs. temperature (see Figure 4) was used. The oven was powered by voltage stabilized power supply and the changes of resistance and then the temperature of the oven were determined at different oven positions and u.h.f.power. The results of measurements are summarized in Figure 5. A zero position of the oven corresponds to the end of biased tube.

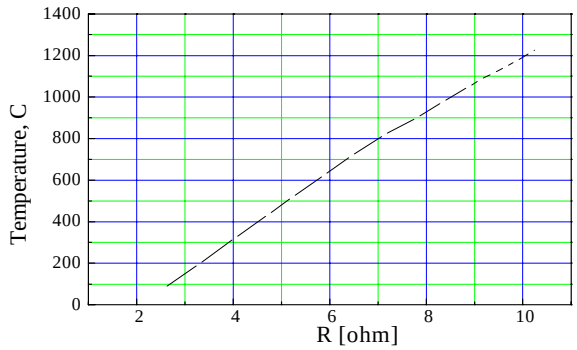

Figure 4: The resistance of the tungsten heater as a function of temperature.

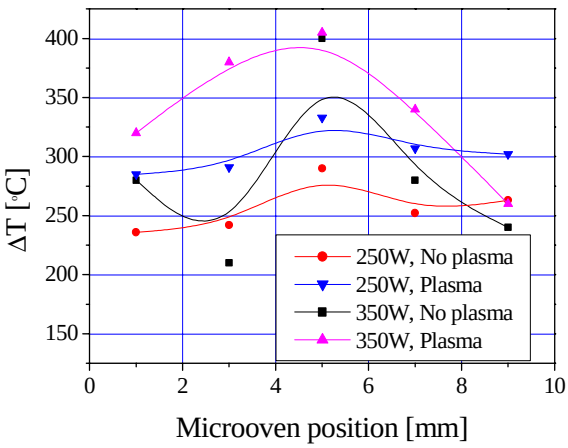

Figure 5: The dependence of temperature increase vs. microoven position for 250W and 350W with and without plasma.

For production of ^{58}Fe ion beam two methods were tested. For the experiments with evaporation technique natural $FeCl_2$ was used. Also it was possible to provide more than required for the experiments on the fission physics 10 eμA of Fe^{6+} from the source (we were able to produce up to 50 eμA), it was practically impossible to provide the stable mode of the source operation. So, we switched to MIVOC technique.

The compound $Fe(C_5H_5)_2$ was prepared from the enriched metallic isotope of ^{58}Fe. The compound was put to the chamber connected to the standard piezoelectric valve.

Due to the low vapor pressure of ferrocen and low conductivity of the standard valve it was necessary to add He as a support gas.

The required intensity of $^{58}Fe^{6+}$ was produced, and the mode of source operation was very stable. During 10 days of experiment we practically did not touched the source. The spectra of ^{58}Fe ions is shown in Figure 6. The material consumption was not measured because we did not open the MIVOC chamber after the experiment.

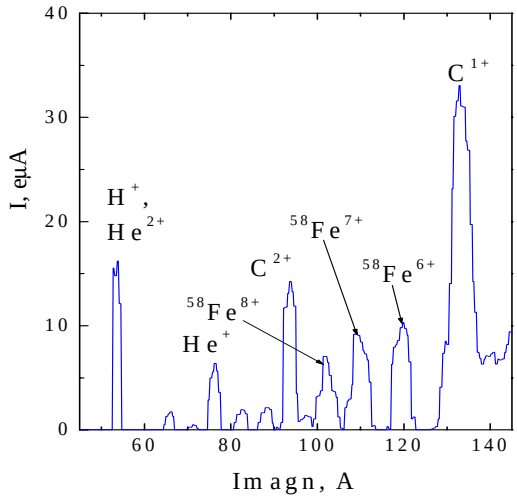

Figure 6: The spectra of ^{58}Fe ions.

After the experiment which was performed in February 2000 a ferrocen was kept in a chamber during a one year. And after preliminary pumping through the piezovalve the chamber was connected to the source in February 2001. The beam of $^{58}Fe^{6+}$ was produced in the same mode of source operation.

2 DECRIS - 2 ION SOURCE.

At the U400M cyclotron the experiments with the secondary beams of ^{6}He and ^{8}He required from the ion source an intense primary beams of $^{7}Li^{2+}$ and $^{11}B^{3+}$. The technique of production lithium and boron beams was already presented in our previous paper [1]. With the injected current of $^{11}B^{3+}$ of 150 eμA the current at the production target was about of 32 – 35 eμA (6 – 7 pμA). Beam time distribution for the DECRIS–2 source in 1999 and 2000 is shown in Figure 7.

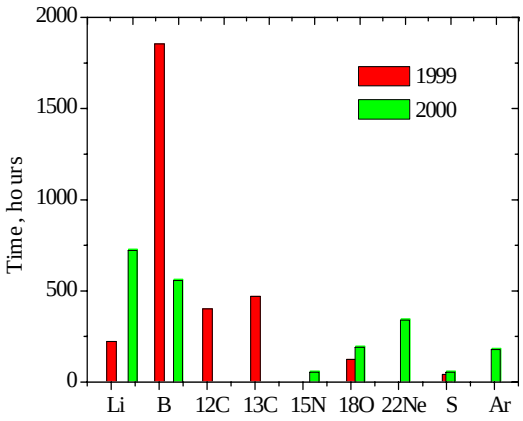

Figure 7: Beam time distribution of the DECRIS – 2 source in 1999 and 2000.

The ions of $^{32}S^{11+}$ were accelerated. The spectra of sulphur ions, produced from SO_2 is shown in Figure 8.

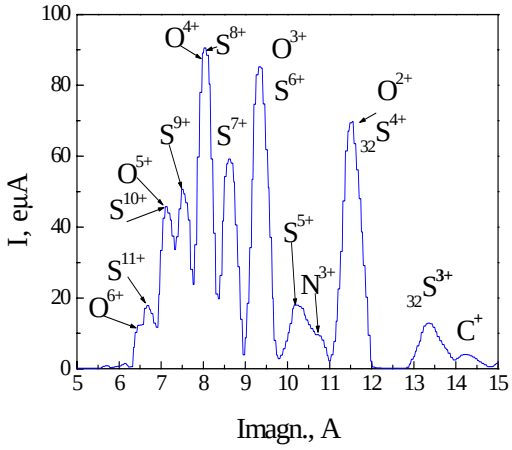

Figure 8: The spectra of sulphur ions.

REFERENCES

[1] V.B.Kutner et al.Rev.Sci.Instr. v.71, N2, Part II, 2000, p.774