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THE FIRST RUN WITH ^{32}S RELATIVISTIC NUCLEI AT THE LHE ACCELERATING FACILITY IN DUBNA

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The acceleration of ^{32}S nuclei were first performed at the accelerating facility of LHE. The cryogenic electron-beam ionizer KRION-S was used as a source of ions. The control system of the ionizer was based on fiber-optical communication links and a PC/XT computer. The number of particles captured in the acceleration mode was $(2.2 \div 2.5) \cdot 10^5$ 1/cycle. The stacks of plastic track detectors and photoemulsion chambers were exposed at an energy of 3.65 GeV/u.

The investigation has been performed at the Laboratory of High Energies, JINR.

Первый сеанс с пучками релятивистских ядер серы на ускорительном комплексе Лаборатории высоких энергий ОИЯИ в Дубне

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На ускорительном комплексе ЛВЭ впервые осуществлено ускорение ядер серы ^{32}S. В качестве источника ионов использован криогенный электронно-лучевой ионизатор КРИОН-С. Система управления ионизатором реализована на базе волоконно-оптических связей и ПЭВМ PC/XT. Число захваченных в режим ускорения частиц составило $(2,2 \div 2,5) \cdot 10^5$ 1/цикл. Облучение сборок пластиковых трековых детекторов и фотоэмульсионных камер проведено при энергии 3,65 ГэВ на нуклон.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Works on accelerating more heavier nuclei are being continued at the accelerating facility of the Laboratory of High Energies (LHE) in accordance with the proposal on Nuclotron injector development [1]. The first run of accelerating sulphur nuclei at the Synchrophasotron, LHE using the electron-beam KRION-S was carried out in January, 1933.

The KRION-S research program was begun in 1985 for the development of IBIS technology and for an experimental study of multicharged ionization processes for heavy ions, including U^{82+}. For this purpose it was necessary to provide an electron beam with energies of ~30 KeV and an electron density of ~5.3 A/cm^2. The confinement time should be one second in this case. The electron beam passes through a drift tube which surface has the temperature of liquid helium.

A similar research program was begun on the "SUPER IBIS" installation at the Sandia National Laboratory, USA at that time. In 1988 we realized for the first time electron beams with energies of 80 keV, an electron current of 0.2 A and an electron density of 500 A/cm^2. The confinement time for ions in the ion trap produced by this electron beam was no more than 0.5 s. The ionization factor, namely electron density times confinement time, was below 10^{21} I/cm^2. This ionization factor is sufficient to produce Ar^{18+} ions and corresponding multicharged heavy ions including U^{56+}.

To accelerate sulphur ions at the Synchrophasotron, we have chosen the "beam-foil" method of acceleration as the most optimum one at heavy ion accelerating facilities. This method makes easier the mode of functioning an ion source because substantional increasing of the ionization factor is needed to provide ionization of K-shell.

KRION-S was installed on the high voltage terminal of the foreinjactor of the linac LU-20M. We used fiber-optical links to control the KRION-S from the linac control room. The magnetic field of the superconducting solenoid, electron current, cathode potential, cryogenic temperatures, vacuum, level and potential distribution along the drift tube are indicated on a colour display in the control room.

The parameters of the KRION-S are the following:

— electron beam	— 0.2 A (DC-mode)
— electron energy	— 5 keV
— electron density	— 200 A/cm^2
— ionization factor	— $3\cdot10^{20}$ 1/cm^2
— gas for operation	— H_2S.

The ion beam from the source with an intensity of $5\cdot10^9$ 1/Z and consistivity (S^{14+}~80%, S^{13+}~15%, S^{12+}~5%) was injected into the linac LU-20M tuned for the ratio Z/A = 0.437. After going through a carbon stripper, the accelerated ion beam with another consistivity (S^{14+}~98%,

S^{13+}~2%) was transformed to the ion beam with (S^{16+}~20%, S^{15+}~45%, S^{14+}~30%, S^{13+}~5%). Only nuclei were injected into the vacuum chamber of the Synchrophasotron.

The number of nuclei captured in the betatron mode was $3.7 \cdot 10^7$ 1/Z. An average intensity of sulphur nuclei at final energy 3.5 GeV/u was $3.5 \cdot 10^3$ particles per pulse. The spectrum of the accelerated beam consisted of S^{16+}~70% and O^{8+}~30%. This means that the gas for the ion source had some polutions (~1%). The losses of ions during the acceleration process due to residual gas were estimated as a factor of 20 at $2 \cdot 10^{-7}$ Torr for average vacuum in the chamber of the Synchrophasotron. This vacuum was provided by a cryopumping system.

The experiments have shown a good agreement between the spectrum of ions after «beam-foil spectroscopy» for an ion energy of 5 MeV/u and theoretical predictions. The possibility of stable functioning the IBIS KRION-S and the effectiveness of the «beam-foil» method were shown up during this beam run.

The stacks of plastic track detectors with different targets photo-emulsion chambers and also a number of other targets were exposed to sulphur nuclei accelerated to a maximum energy of 3.65 GeV/u. Experiments on exposure of plastic track detectors are being carried out in the framework of the protocol with the physicists from Siegen University (FRG) during the last few years. These experiments yielded a series of physical results on the study of nuclear collisions, in particular on fragmentation cross sections of ^{16}O nuclei over the range of energies from 1 to 200 GeV/u [2]. The new experimental material will fill up the blanks in data on characteristics of sulphur interactions in the intermediate energy region.

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