THE KUTI-20 ACCELERATOR FIRST STAGE ADJUSTING

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The KUTI-20 is a collective heavy ions accelerator being constructed in Dubna. Today the adjusting works on the first stage of the accelerator are finished. First results of its adjusting are given in this paper.

THE ACCELERATOR FIRST STAGE TOTAL SCHEME

The accelerator KUTI-20 systems are presented on fig.1: injector "SILUND" with a

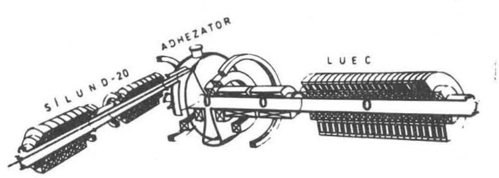

fig.1

power system, ADGEZATOR - the electron-ion ring generation and formation system, LUEK - the electron ring induction accelerating sections. The general view of the accelerator is given on fig.2.

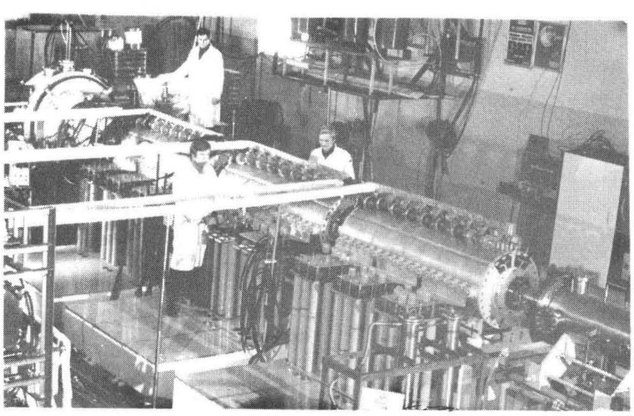

fig.2

SILUND is the electron induction accelerator. The plasma cathode is used as the electron source. It is combined with the first accelerating section. The beam accelerating sections are composed of the inductors with a ferrite as a work ferromagnet. A thyratron with a system of power formation and amplification using non-linear elements serves as the accelerating power generator. The electron beam transporting along the acceleration cannal is being making by the solenoid type magnetic system. The accelerator permits to accelerate the electrons up to 2.5 MeV with the current 800 A. A characteristic current pulse entering the Adgezator is given on fig.3.

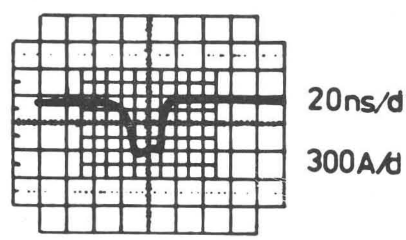

fig.3

ADGEZATOR. The electron beam is injected in the chamber of the Adgezator on the radius 40 cm with the help of the special inflector. The magnetic field is chosen accordingly the radius of injected electron orbit - 35 cm. The pulse correcting device, compensating the transversal particles oscillation velocity is placed on the quarter period of the radial betatron oscillations. After the corrector the beam is captured without oscillations on the orbit with the 35 cm radius. On fig.4 the time process of the electron current capture is shown. As it can be seen from the oscillogram the electron current capture coefficient on the orbit is about 70%. This value depends on magnetic field quantity and the corrector's pulse, especially its trailing edge and can go up to 80%. To illustrate the resonance influence (field index n=0.25) on fig.5 the capture oscillogram in condition of the resonance crossing is given. As this takes place the capture coefficient is near the zero. The Adgezator magnetic system is made in such a manner that during the ring compression from 35 cm to 3.5 cm the dangerous resonances are not crossed. Nevertheless the eddy-current in the walls of the vacuum chamber influences on the resonance of the beam. The ring compression process with the switching on in serie magnetic field systems is given on fig.6. The beam disturbances are well seen on the fall times when the following system is switched on. To evaluate the level of these disturbances we examined in detail the ring cross-section dimentions at different radii. We examined them by the synchrotron radiation distribution in the ring cross-section. The fig.7 demonstrates such a distribution at 4 cm radius. Such a cross-section examination has shown that when the systems are well adjusted the dimentions change according to the adiabatic lows and there are no considerable deviations.

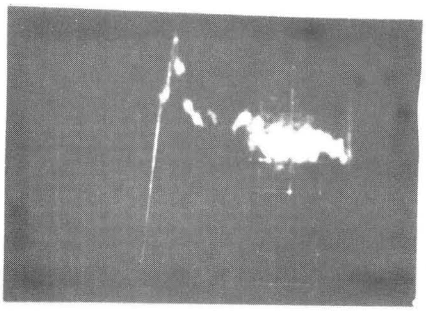

fig.4

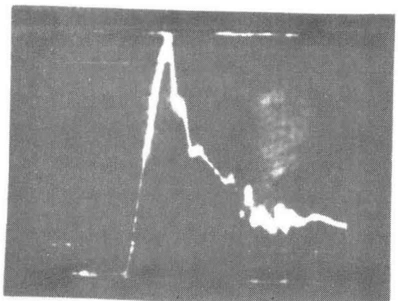

fig.5

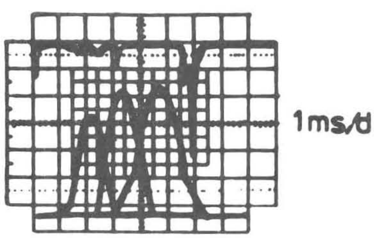

fig.6

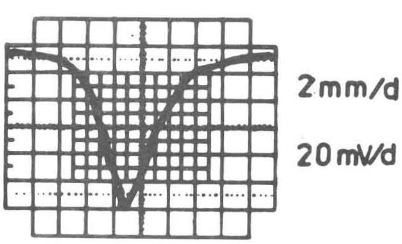

fig.7

The ring ion component is produced by the directed neutral beam from the laser radiated target. The control of the atoms ionization process in the ring was made by the bremsstrahlung. The fig.8 represents the bremsstrahlung during the compression process. The most complicated in the process of the ring extraction along the axis of the accelerator is the resonance $\nu_r = 1$ crossing. Even in condition of good self-focusing ring when we have minimal amplitudes of first azimuth harmonic of the magnetic field, the radial drift of the ring is observed (fig.9). The resonance crossing time influence on the drift amplitude during the extraction have been examined. For this we have created a magnetic field well at the extraction region by the additional coil. The well decreasing time could be different. The investigations have shown that for the time $\leq 5\,\mu s$ the drift is not more than 2 mm. That means that the first harmonic amplitude is about 10^{-3}. In the work regime the additional coil well removed at the times $\sim 0.1\,\mu s$ what permitted besides the fast resonance passage to make the synchronization of the ring extraction, that is necessary for the further acceleration in the induction sections.

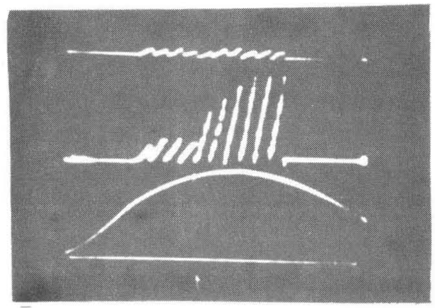

fig.8

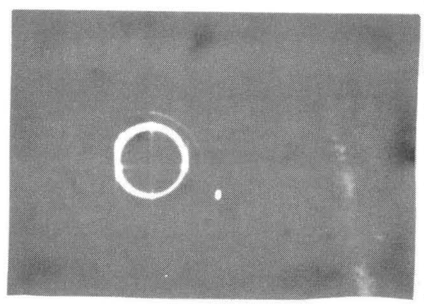

fig.9

<u>PRIMARY RING ACCELERATION</u> is realized in the gradient field of the accelerating solenoid. The plot of the solenoid magnetic field is given on fig. 10. It's seen that the mean-gradients $\frac{dH}{dz}$ don't exceed the admissable values and are 0.23 T/m. The principal parameters of the ion beam have been measured after the acceleration magne-

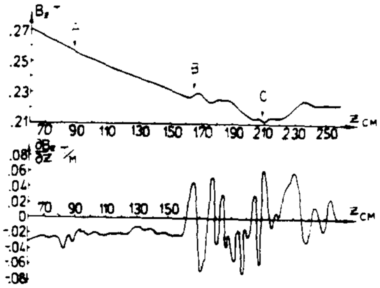

fig.10

tic system. We have done the separation of components and measured the angular and energetic characteristics of the ion beam. The main parameters of the ion beam are given in table 1.

TABLE 1.

Energy		1.7±0.2 MeV/nuc.
Ions velocity	$\beta_{\parallel}$	=0.06
	$\beta_{\perp}$	=1.5 10^{-3}.
Emittance		(6±1) mradcm.
Energy spread	$\Delta E/E$	(5±1) 10^{-2}.

These measurements permitted to formulate the principal conditions for induction section parameters. In particular the magnetic field along the accelerator should be 1.3 T , the magnetic field gradient should be not more than 0.30 T/m. The accelerating magnetic field in sections is taken equal to 10 kV/cm.

THE ACCELERATION SECTIONS (LUEK-20)

The first acceleration stage is composed of 3 acceleration sections. Every section has 18 identical inductors. The inductor scheme is shown on fig.11. In the body (1) two permalloy cores are fixed (2). The leading magnetic field is forming with the help of coils (3) placed in the cores (4 coils in every core). The ceramic vacuum tube with 130 cm diameter is placed in the inductor. The transformer oil is dopped into the section. It serves as the isolator and heat carrying agent.

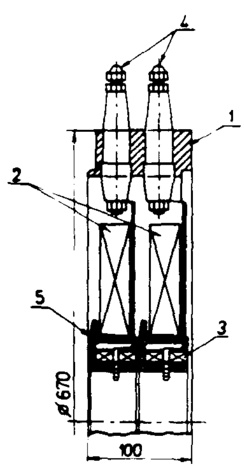

fig.11

Between the section and for the accelerating sections and solenoid jointing, special transitional sections were made for the pumping-out and ring observing. The transient zones have also the coil systems of the magnetic field for the elements jointing with a necessary accuracy of the field. All magnetic system elements are powered by the current pulse with the help of a serie of thyristor commutators. The field formation results for the transient sections are presented on fig.12.

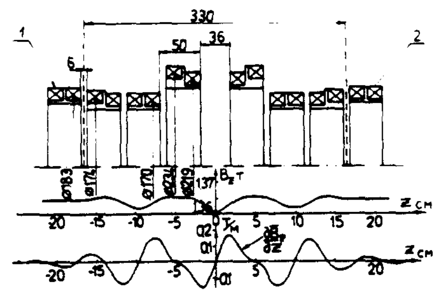

fig.12

PULSE MODULATOR is made with the use of non-linear schemes of power amplifying by the electro-magnetic energy compression in time. The modulator is destinate to power one accelerating section and to create the acceleratind field strength 10 kV/cm. A standart hydrogen thyratron is used as the commutator. The modulator construction is shown on fig.13. where N°1 is a commutator, 2 - storing capacity, 3 - preliminary power amplification cascade, 4 - final amplification and formation cascades, 5 - non-linear sharping lines, 6 - inductor. The principal modulator scheme is given on fig. 14.

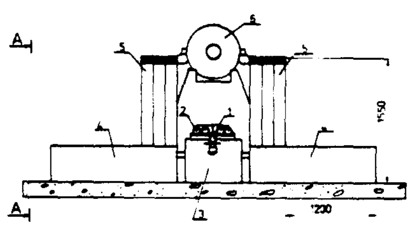

fig.13

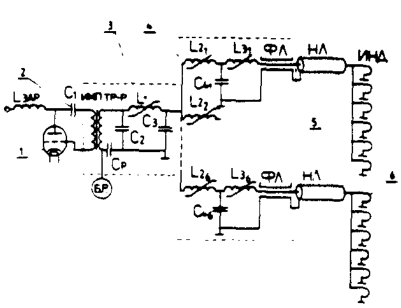

fig.14

The modulator adjusting results have shown that:

1. the output voltage of the modulator with the load 0.5Ω is U_L = 50 kV,
2. current in the load I_L = 100 kA,
3. pulse duration - 80 ns.

One inductor load characteristics (R_L= = 4.5Ω) is given on fig.15.

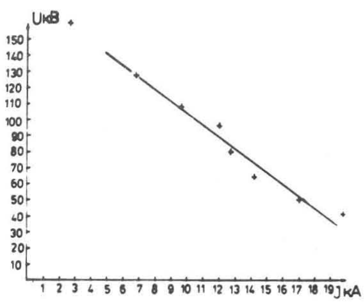

fig.15

The experiments on the ring acceleration in the first stage sections has been performed. First experiments have shown that for the chosen parameters of the magnetic field the electron ring passes through the sections with the radius R = 4.5 cm (see fig.16).

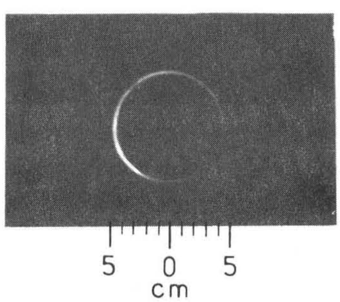

fig.16

The ring velocity measurements by the flying time has shown that the energy increase of the ring longitudinal movement per one section is 1.7 - 1.8 MeV, that corresponds to the field strendth in the induction sections 10 kV/cm.

So, preliminary results of the acceleration system adjusting have shown that the parameters correspond to these designed.

L I T E R A T U R E

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