INVESTIGATION THE ACCELERATION SYSTEM OF ISOCHRONOUS CYCLOTRON ON MODELS

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The acceleration system (AS) is intended for the acceleration of H^- -ions up to 80 MeV and operates at the second harmonic of ion revolution 41.2 MHz. The requirements and conceptual design of AS is described at [1,2]. But due to complicated geometry of AS the accuracy of calculation is not axeed value of $\sim$ 4-5% and for a that reason it was decided to build the models of AS. For the AS investigation it was produced 6 modifications of the models.

The models were made of two-side copper-clad plastic, usually used for printed-circuit boards. One side of the covering was used as a current conductive surface of AS, and the other one was used for soldering the stiffening plates. This made possible to manufacture large surfaces of plastic plates of 2 mm thickness. The models were made knock-down. The knock-down design of the model enables to do easily the modifications of the AS geometry and to investigate alternative versions of AS. The resonace volume of the model was feeded by generator G4-158 by using coupling capasitor $\sim$ 0,1 pF. The typical value of the voltage is about 1–5 V and the resonance curvent was measured by using standart voltmeter V7-17.

The main purpose of the modelling was an exact determination of the stem length so that the difference between the AS frequency and the designed value does not exceed 0,5%. The another interesting problem was determination the sensitivity of the frequency detuning under the variation the AS geometry. The derivatives of the frequency detuning under variation the parameters of the AS $k = \Delta f_0/\Delta p_i$ and $k_1 = \Delta f_0 \cdot p_i/f_0 \cdot \Delta p_i$ are presented at the table.

Table

Sensitivity of the frequency detuning under the variation of the AS geometry

P_i	l	b	h	c	A	a	e	g
$\Delta f_0/\Delta p_i$ KHz/mm	87	48	52	630	310	120	19·Δe	3,8·Δg
$\frac{\Delta f_0 \cdot P_i}{f_0 \cdot \Delta p_i}$	0,46	0,53	0,07	0,61	0,94	0,03	-	-

The geometrical parameters P_i are as follows:
stem length $l = 210$ mm, stem width $b = 430$ mm, stem height $h = 60$ mm, dee aperture (at $r = 0$) $a = 30$ mm, distance between the chamber lids $A = 126$ mm, dee-liner gap $c = 33$ mm, dee displacement from the median plane e (at normal position $e = 0$), dee sag at the centre g (at normal position $g = 0$).

On the model it was investigated also the effect of the acceleration voltage drop along dee. This effect results in the reduction the energy gain at the final energy. It was taken care for the minimization $n(R) = U(R)/U(0)$, where $U(R)$ and $U(0)$ are the acceleration voltage at given radius and a maximum radius respectively (see Fig.). To minimize the value n it

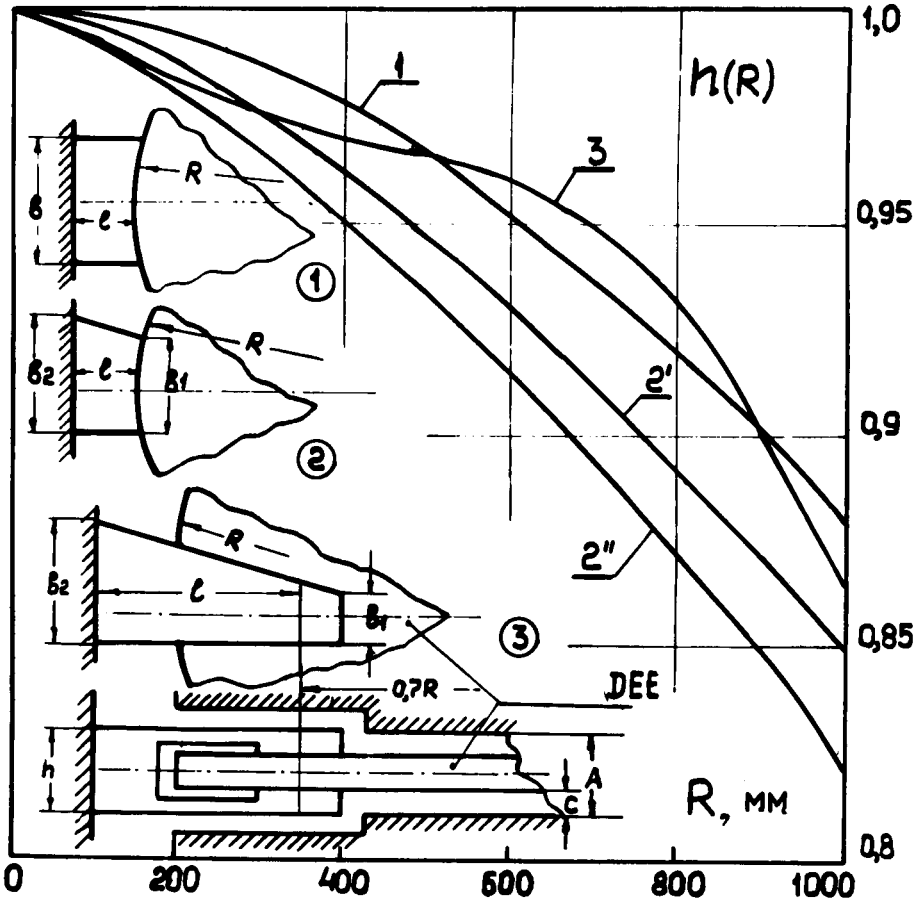

Fig. The voltage drop along the dee for the different form of a stem. *1* — l = 210 mm, b = 430 mm, h = 60 mm; *2* — l = 210 mm, b_1 = 200 mm, b_2 = 500 mm, h = 120 mm; *3* — l = 510 mm, b_1 = 200 mm, b_2 = 500 mm, h = 120 mm

was investigated the different contours of the stem and methods of its connection with the dee under the fixed dee geometry [3] as it is shown on the Fig.

The measurement of $n(R)$ was performed also by using method of the frequency detuning under introduction of the dielectrical sample body at the point of measurement. As it was shown at [4] the frequency detuning is defined by the electric field intensity at the given point. For a measurement of $n(R)$ the thin string was stretched along the dee gap on which 3 mm polysterene ball was moved. The measurement accuracy was about 3-5% and restricted by the electrical field gradient. The results of measurements of $n(R) = [\Delta f_0(R)/\Delta f_0(0)]^{1/2}$ along dee for the three versions of the steam design are presented on the Fig.

On the models it was measured the ranges of the frequency tuning of the tuning capasitor $\Delta f_0/f_0 \sim 2\%$, at the trimmer of the autotuning system $\Delta f_0/f_0 \sim 0,3\%$, as well as an influence of RF probe and RF power input. The measured value of the Q-factor is equal 3500.

The model measurements make available to correct the result of calculation and estimate the error of calculation as 5-10%. The difference between the calculated and experimental

value of the resonance frequency accounts for 6%.

The results of the model measurements form the basis for the techical design of AS.

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EXPERIMENTAL SETUP FOR INVESTIGATION INTERNAL H^-- ION SOURCES

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The experimental setup for investigation internal H^- - ion source was design and manufactured at acceleration department of PNPI. Ion source is one of the principal units of cyclotron. The activity of many cyclotron's systems and characteristics of ion beam depend on parameters and type of the ion source. The ion source of closed type with the electrode configuration of a Philips ionization gauge, discribed by Ehlers[1], was selected as an internal H^--ion source for Gatchina Isochronous Cyclotron (GIC)[2,3]. A schematic diagram of the experimental apparatus is displayed in Fig.1 The internal ion sources operate in strong magnetic field. To model ion source in real size the magnet SP-10A was modified. Gap betveen poles was increased up to 155 mm but bottom and upper walls of the,vacuum chamber,which arranged between poles, were made from magnetic steel, so the magnitude of the magnetic field reaches 13 kGs and corresponds to one in central part of GIC. The ion source, arranged inside vacuum chamber, consist of two cathodes (hot and cold) and cylindrical anode, which axis is parallel to force lines of the magnetic field. The power supply for heating of filament with parameters $U = 5$ V and $I = 500$ A and one with $U = 3$ kV and $I = 10$ A for discharge supporting are used. The two were made by laboratory's members. Special system of calibrated feeding of working gas (hydrogen) was design for creation needed pressure inside ion source. It allowes to regulate gas flow rate Q in the limits from 0.1 to 15 cm^3/min. Vacuum system is assembled on the basis of two highvacuum pumps with effective pumping rate about 2000 l/sec and provides pressure 10^{-7} Torr in vacuum chamber without gas feeding. The extraction of the ion beam from dischage through exit slit in anode to across magnetic field is carried out by the pullers connected with dee. The extraction voltage supplies on pullers and can be as positive for extraction of negative ions so negative for extraction positive one. But there are some difficults with supplying a high positive voltage on dee