OBSERVATION OF A MULTICHANNEL INTERDIGITAL H-STRUCTURE

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The paper presents the experimental results together with their comparison with calculations. The relation between a bunch charge in accelerating channel and a variation of resonant wave-length at asymptotic alternating-phase focusing is derived. Suggested is also a new way for computation of high-frequency characteristics of the accelerating structure taking into account the variation of resonant frequency with constant transversal dimensions of the structure.

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1. THE EXPERIMENT

1.1. THE CALCULATIONS AND EXPERIMENT

The issue involves an analysis of a multichannel accelerating structure (MAS) and a modified MAS (MMAS) based on interdigital cavity working in H_{211} mode and providing acceleration of several intensive beams of heavy ions with total current from several dozens of mA up to several A [1,2].

The experiment was carried out to explore the MAS and MMAS. Q-factors were measured: Q_{MAS}=800±21 and Q_{MMAS}=800±38; operational frequencies: MAS f_{r1}=150 MGz and MMAS f_{r2}=114 MGz. Predicted and measured distributions of field gradient in accelerating channel are presented in Figs.1-3, correspondingly. Also is obtained that the configuration of field gradient in vacuity is the same for both the structures, and the differences in amplitudes make few percents. That may be caused by producing imprecision, some alignment errors, and inaccuracy of measurements.

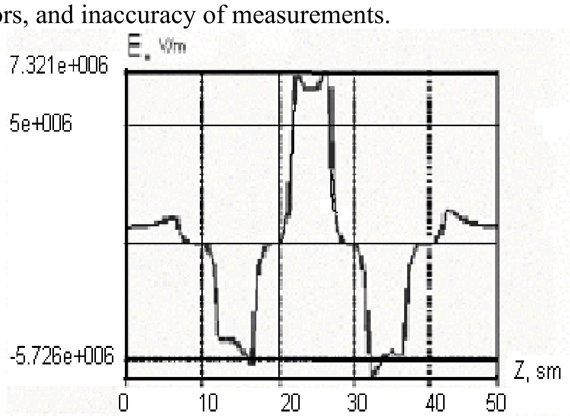

Fig.1. Field gradient distribution in accelerating channel in MAS

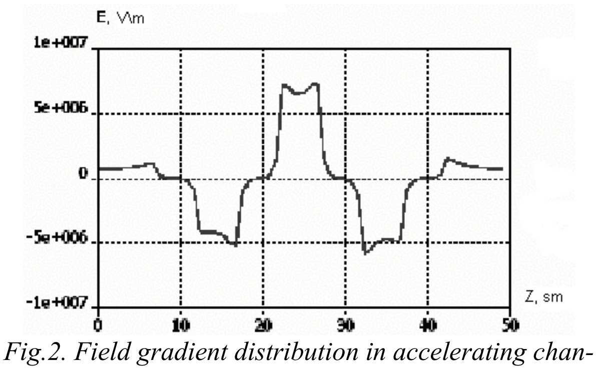

Fig.2. Field gradient distribution in accelerating channel in MMAS

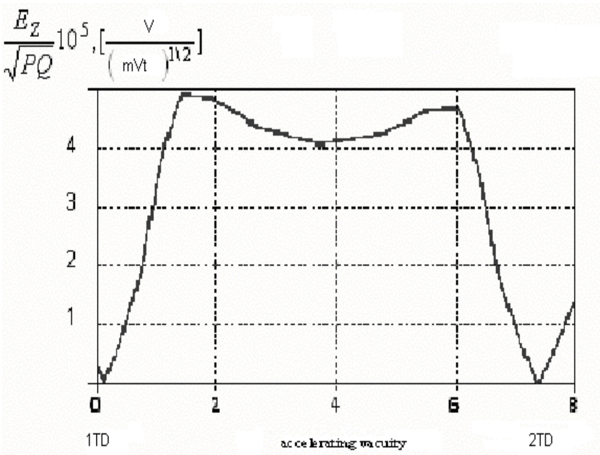

Fig.3. Field gradient distribution in accelerating channel in MAS and MMAS

One should mention that the values of predicted frequency agree well with measured ones (deviation is not worse than 6%) [3]. The results are given in Table.

Predicted and measured frequency

structures	calculations and experiment	quantity		
		frequency, MGz	Q-factors	impedance, MOм/m
MAS	theoretical	145	1021	30.0
	numerical	157		
	experiment	150	800	27.0
MMAS	theoretical	109	1130	24.3
	numerical	118		
	experiment	114	800	23.0

2. THE THEORETICAL CALCULATION

The equations for bunch charge and deviation of resonance frequency relationship have been derived. It is shown that the resonance wave-length growth leads to a bunch charge increase in the MMAS (if compared with the MAS), so the maximum current value could be increased in each accelerating channel of MMAS.

Few allowances were accepted. Bunches are considered to be orb-formed and the orb diameter is equal to the maximum length of the bunch, which in its turn is equal to the length of separatrix (1)

$$a_z = \Delta b_в = \frac{3\varphi_e(1-S)\beta\lambda}{2\pi}, \quad (1)$$

where S is a parameter characterizing charge density in a bunch, φ_e – equilibrium phase.

After several transformations have been performed, the equation describing the bunch charge takes the form

$$Q_в \sim N\sqrt{\lambda} \sim 2\varepsilon_0 E_m R^2 \chi_m, \qquad (2)$$

where χ_m is a function, which reflects the relation between the amplitude of phase oscillations and the bunch characteristics, λ – operating wave-length.

Equations for the currents are:

$$I_{\lim\perp} \sim N\sqrt{\lambda},$$

$$I_{\lim\|} \sim \frac{N}{\sqrt{\lambda}}. \qquad (3)$$

It has been shown [4] that an increase in operational wave-length in MMAS (with constant transversal sizes of the accelerating structure) leads to a calorific losses reduction and to a gain in shunt impedance of the accelerating structure.

$$P \sim \lambda^{-1/2},\ R_{sh} \sim \lambda^{1/2}. \qquad (4)$$

Thus, presented MAS and MMAS systems provide an essential gain in operational wave-length with respect to a single-channel accelerating structure, and also allow increasing of maximal current in every channel of the multichannel structure.

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ИССЛЕДОВАНИЕ МНОГОКАНАЛЬНЫХ Н-СТРУКТУР ШТЫРЕВОГО ТИПА

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Приведены результаты эксперимента, сравнение полученных данных с расчетными величинами. Получено выражение зависимости заряда сгустка в ускоряющем зазоре от изменения резонансной длины волны для ассиметричной фазопеременной фокусировки. Приведены результаты нового способа расчета ВЧ-параметров предложенной структуры с учетом фактора изменения длины волны при постоянстве поперечных размеров ускоряющей структуры.

ДОСЛІДЖЕННЯ МНОГОКАНАЛЬНЫХ Н-СТРУКТУР ШТИРОВОГО ТИПУ

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Наведені результати експерименту, порівняння отриманих даних з розрахунковими величинами. Отримано вираження залежності заряду згустку в прискорювальному зазорі від зміни резонансної довжини хвилі для асиметричного фазозмінного фокусування. Наведено результати нового способу розрахунку ВЧ-параметрів запропонованої структури з урахуванням фактора зміни довжини хвилі при сталості поперечних розмірів прискорювальної структури.