STUDY OF A BIPERIODIC SLOW-WAVE STRUCTURE AT MEDIUM ENERGIES

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In the present work charged particle accelerators occupy the important place both in scientific, and in practical applications [1]. The wide spectrum of accelerator applications compels the developers to upgrade existing and to develop new accelerating structures to conform the most full up-to-date requirements in technical and physical characteristics (energy, currents etc.), as well as in practical (e.g. weight and size), including financial and economic ones. The biperiodic, coupling on a π-wave slow-wave structure (BSWS) [2] can serve as one of such versions of the proton linac accelerating structure in the energy range (20-100) MeV ($0.15<\beta<0.45$). In such BSWS quarter wavelength the strip-geometry resonators are as accelerating cells. Coupling resonators are chosen as the quarter wavelength resonators too, but they are made as a loop. These loopback coupling resonators are put in accelerating resonator electromagnetic field symmetry planes.

Shorting metal planes are put in end faces of BSWS. The accelerating resonators are placed at distances of a quarter wavelength ($\lambda_g/4$) from the faces of shorting metal plates. Thus, they are in places of BSWS crests, whereas the loopback coupling resonators are placed in nodes of the BSWS. Accordingly, all coupling resonators are unexcited.

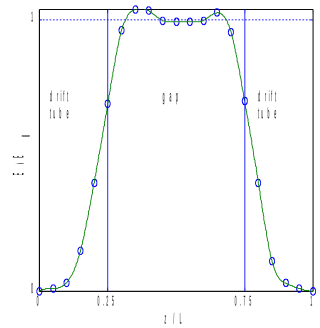

Fig. 1. The electrical field distribution along a gap

The high-frequency accelerating fields in the BSWS are π/2- modes, i.e. the phase shift between neighbouring resonators of link and accelerating resonators is equal to π/2.

In BSWS the interaction of accelerated charged particles with a slow wave is the π- interaction. Therefore BSWS operation is chosen under the standing wave condition as the most practical one.

The measurements of BSWS parameters were carried out on an experimental structure model. There are four copper rings with a diameter D = 201 mm in the model. Two-quarter wavelength accelerating vibrators and one loopback coupling resonator are inside of it. The length L_0 of each ring is equal to a quarter of a wavelength in BSWS and makes 39 mm, so the wavelength is $\lambda_g = 4L_0 = 0{,}156$ m.

The electrical accelerating field distribution (in relative units, E_0 is an electric field strength in the gap middle) on the accelerator axis in the middle gap between two neighbouring accelerating electrodes is shown in Fig.1. The common observed dates are shown in Table 1.

Table 1. Main parameters of investigated BSWS

Resonator length (in BSWS one wavelength is two accelerating vibrators). m, $\lambda_g = 4L_0$	0,156
Total effective length of gaps in the resonator, m, g_{eff}	0,083 5
Working frequency of π- wave, MHz, f_0	475,3
Free space wavelength, m, λ_0	0,631
Phase velocity in BSWS at working frequency of π-mode, β_{ph}	0,247
Energy of accelerated protons, MeV, W	30
Own quality-factor of the half wavelength resonator, Q_1	2975
Own quality-factor of the resonator on one wavelength, Q_2	3854
Quality-factor of the indefinitely long resonator, Q_∞	5514
Displacement of frequency by a metal ball ($r = 2{,}6.10^{-3}$ m), Hz, Δf	99277
Efficiency of a gap, T	0,859
Shunt impedance, MΩ/m, R_{sh}	16,7
The relation of shunt impedance to quality-factor, MΩ/m, R_{sh}/Q_∞	3028
Effective shunt impedance, MΩ/m, Z_{eff}	25,86
Attenuation field constant, mcs, $\tau = Q_\infty/\pi f_0$	3,69
Depth of a skin layer, micron, δ	3
Relation of a wavelength to a diameter, λ_0/D	3

Table 2. A comparison of accelerating structures (given for f = 150 MHz)

Structure	BSWS	Alvarez	H_{111}
R_{sh}/Q_∞, MΩ/m	955		
Z_{eff} , MΩ/m	14,53	29	9
Q_∞	9785	60000 (94475)	
τ, mcs	20	127 (200)	
δ, micron	5,4		

* In brackets the computed values are given.

Thus, the BSWS under consideration should have values Z_{eff} of about (20-27) MΩ/m. It is much higher than the effective shunt impedance of structures with a parallel connection of gaps and is comparable to values Z_{eff} of Alvarez structure at a working frequencies of 150 MHz in the considering energy range being investigated.

REFERENCES

1. CERN Courier. Applying the Accelerator. Special issue. 1995. Vol.35. P.1-25.
2. O.G.Zagorodnov, V.G.Papkovich, N.A.Khizhnyak. An investigation of biperiodic slow-wave structure. Preprint KIPT 93-1.-Kharkov, KIPT, 1993. 19 p. (in Russian).