ULTRARELATIVISTIC KLYSTRON-A FUTURE SUPER POWER UHF GENERATOR

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I. INTRODUCTION

At the beginning of work on the 76 GeV Serpuchov accelerator (after 14 October 1967 y.), a presence of HF voltage on accelerating resonators without power tube exiting was marked. This voltage was exited by rotating proton bunches. With proton current aobut 0.1 A and energy 76 GeV, the beam power had gigantis value 7.6 GWt. After an invention of magnetic energy analyser type grouping device, the theoretical and experimental investigations were begun. The initial structural scheme is presented in Figure 1. In 1975 the preliminary understanding have been published [1]. Here at the first time was discussed the problem of gigawatt power consumption by means of many resonators for a feeding resonators of very long linac, the problem of a o- pulse grouping of superrelativistic particle bunches, a problem of high efficiency accelerating such bunches to superrelativistic energy (energy 1¡W¡10 MeV). Many model elements of superrelativistic generator were constructed and made in the decade of 1975–1985—electronic guns, grouping devices, electronoguides with magnetic focusing. During the last decade, due to financial limitations work was narrowed, but namely in this time some important conceptions were suggested.

II.

Maximal electron energy must be lowered to 5-7 MeV, as at higher energy the residual radioactivity will appear. At 5 MeV the current must be about 200 A for the power 1 GWt to be conserved. The caculation shows a grouping length about 30m at energy 5 MeV and only 3.4 m at energy 1 MeV. Therefore the particle breaking can be only to energy 1 MeV and an energy using coefficient is only 83% at initial energy MeV. A consumed by one resonator power must be as high as possible. At the frequency wave length 10 cm a consumed by two outputted resonator power about Pir=20 MWt and a whole power of 34 resonators can be about 680 MWt.

The value Pir at first harmonic current amplitude I1=320 A (due to real grouping coefficient n=0,8) depends on shunt impedance, with equal in this case 400 Ohm. Consequently the amplitude voltage drop will be 130 kV at one resonator and 440 kV at 34 resonators. The efficiency of a voltage using

$$\mathrm{ng} = 1 - \mathrm{We}/\mathrm{Win} \qquad (1)$$

will be about 88% at Win=5 MeV and We=0.6 MeV. but the power efficiency of generator is of course only 68% due to I1=0.8Io. For a UHF power GWt the Win must be 7 MeV.

III.

the bunch parameters 5 MeV and 200 A can easily be provided by means of the Kokroft-Wolton accelerator. The involved improvements—screening every accelerating steps [2], and using an energy feedback [3], give the possibility of having a high efficiency ultrarelativistic bunch source (to 95%). I at the bunch power I GWT the 50 MWt consumption from the electrical net will be real than the efficiency coefficient of ultrarelativistic generation with 680 MWt UHF power will be 680/(680+50)=93%.

IV. CONCLUSION

The concentration of 34 resonators with summ UHF power 680 MWt at 3.4 m length will lead to the inadmissible power dissipation in waveguides in case a feeding the long (1 km) linac resonators. In this case the number generator resonators can be more than 34 (for example 100) and install with distance about 10 m between them with high number passive (untuned) resonators, serving for additional bunches grouping. At the 100 working resonators the power losses at 5.m length guides 0.02*5=0.1 dB (about 1%) will be quite admissible.

References

[1] F.A. Vodopianov, B.P. Murin, Proceedings of Radiotechnical Institute, USSR Academy of Sciences, Accelerators teckhnics, Moscow, 1975, p. 20.

[2] F.A. Vodopianov, SC-techn. Reports of Moscow Radiogtechnical Institute, USSR Academy of Sciences, Moscow, USSR, 1990. p. 105.

[3] F.A. Vodopianov,“MATRESHKA–High Intensity Accelerator of Continuous Particle Beams”. Report PAC-95, TAR02.

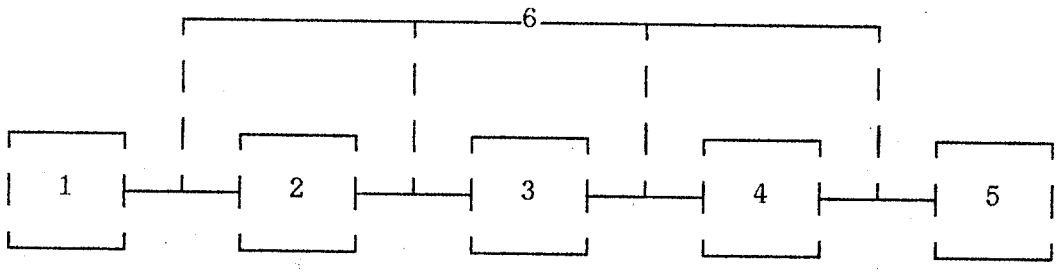

Figure 1. Structural scheme:1 – electron gun; 2 – accelerator; 3 – grouping device; 4 – resonator system; 5 – collector; 6 – electron guide.