KHARKOV ELECTRON LINAC AS INJECTOR FOR STRETCHER RING

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Summary

We report on reconstruction design of Kharkov linac. The planned reconstruction envisages a serious upgrading of the linac principal features and construction of a stretcher ring at the linac end-line to achieve higher duty cycle, continuous C.W. operation of the accelerator. This paper describes the base line characteristics of the linac and its future beam parameters.

Introduction

Kharkov electron linac (with $E_{max} = 2$ GeV) was put into operation during 1960-1964. The 20 years research programs have seen 10^5 man-hours of operation. At present linac has a peak energy 1.8 GeV and a peak current 80 mA. Production of high-current electron beams in linac is known to be impeded by beam breakup initiated by interaction with a wave defocusing oscillation EH_{11} in the accelerating section.[1,2] The 2-GeV linac beam intensity increase is accomplished through suppression of the EH_{11} parasitic wave after introduction of radial slits to the waveguide disks in 20 sections, as well as upon improving beam guide focusing and field symmetry in couplers.

Design of Reconstruction

The beam current should be further raised to 300 mA after replacement of 30 sections, those having quasi-constant gradient. The new sections are to increase the injection energy to 2.5 GeV. The average current is raised by operating in 300-600 Hz pulse repetition frequency range.

Parameters of new accelerating waveguides are given in Table 1. The data in parentheses indicates power levels from prospective klystron. One case of the older sections high reliability could be provided only at 30 MW on account of electric breakdown hazards.

Table 1. Characteristics of Kharkov Accelerator Structure

Parameters	Older Section	New Section
Operation frequency, MHz	2797.200	2797.200
Operating mode	$\pi/2$	$\pi/2$ quasi-constant gradient
a/λ ($2a$-disk hole diameter)	0.14	0.11870; 0.1100; 0.1020; 0.0915
Attenuation, Np	0.3	0.807
Shunt impedance, MΩ/m	45	54 (average)
Quality factor	10^4	1.3×10^4
Filling time, μsec	0.39	0.94
Input power, MW	16 (30)	16 (40)
Energy gain per section, MeV	36 (50)	56 (89)
Beam load per section MeV/A	28	70

In order to facilitate the procedure associated with beam breakup hazards four different structures with different disk holes, but equal filling time will be prepared. To reduce the number of different cell types the section consists of four constant impedance assemblies containing 37 identical cell and connected to 5 transition cells.

A 4.3-meter-long prototype section has already been installed (Fig. 1). Beam tests have revealed energy gain per section 56 MeV for 16 MW, which agrees well with theory. No breakdown effects have been recorded. We are planning to run those tests anew at 40 MW next December.

To make the accelerator function in a new mode the design provided for a set of HV pulse modulators placed at each accelerating unit and at the main line power generator. A considerable increase in pulse repetition rate (up to 600 Hz)

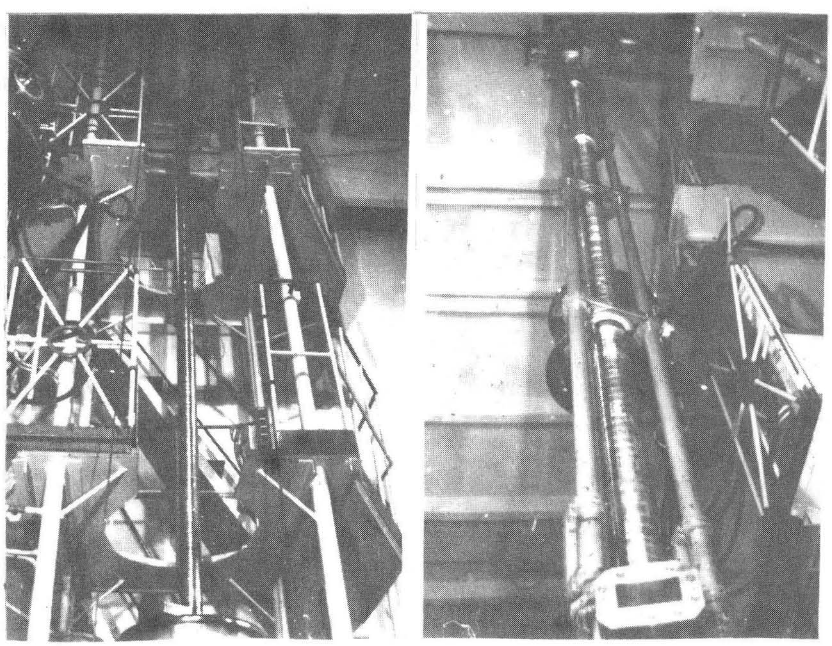

Fig. 1. Prototype Section Output from Vacuum Furnace.

calls for placing additional safeguards on beam control system and klystron units a thyristor voltage regulator will be used to automate modulator controls.

The modulator units are to be distilled water-cooled. All new equipment is to be housed in existing halls, and the modulator operation is monitored both from central and sectional control panels. Table 2 gives the parameters of HV-pulse modulators for accelerating units.

Table 2. Overall Specification of Modulator

Peak beam voltage	280 kV
Peak beam current	260 A
Klystron impedance	1100 Ω
Pulse transformer ratio	1:14
Modulator pulse width	3.5 μsec
Pulse repetition rate	600, 300, 50
PFN input voltage	5-40 kV
PFN impedance	5 Ω
Pulse length, flat top	2.6 μsec
Rise time	0.4 μsec
Fall time	0.6 μsec
Pulse height deviation from flatness	± 0.2%
Pulse amplitude drift:	
long term	± 0.2%/hour
short term	± 0.1%/5-min period
Average power output (max)	100 kW

Table 3. Beam Parameters in Linac

Energy, MeV	500-2500
Pulse current, mA	300
Current pulse width, μsec	1.0
Repetition frequency, Hz	300-600
Energy spread with ECS, %	0.2
Emittance, mm·mrad	0.1

Reduction of the in-beam energy spread will be done by way of adjustable current pulse delay relative to RF-pulse per section[3] plus beam active monochromatization (energy compression).[4]

The linear accelerator reconstruction and stretcher ring erection will have been realized by 1991.

References

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