LATEST RESULTS ON PORTABLE X-BAND LINAC DEVELOPMENT

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1. INTRODUCTION

Efficiency of X-band portable linacs for various applications has been substantially improved. Advanced design and some improvements to the existing MINAC provided encouraging experimental results using 1.5 MW magnetron.

Two additions to the existing product line are made and/or considered. MINAC-5 and MINAC-8 characteristics are summarized in the following Table:

Table. Parameters of MINAC-5 and MINAC-8

PARAMETER	UNITS	MINAC5	MINAC8
Maximum Energy	MeV	6	9*
Maximum Current	mA	110	100
Nominal Energy	MeV	5	7.6
Nominal Current	mA	100	80
Linac RF Length	m	0.4	1
Max.DoseRate@1m	R/min	600	1000
AverageBeamPower	W	520	700
Approx.HeadWeight	kg	20	30

* - Smooth regulation from 4 to 9 MeV

Presented data are based on both design and experimental numbers. Some values are predicted using the experimental results. As the previous models MINAC -4, MNAC-6 and MINAC 1.5, both linac heads do not use any external focusing.

2. X-BAND MAGNETRON

Testing of the linacs was performed using a PMX1100 magnetron, which was characterized prior to the experiments (Fig.1 and 2). It was found that the device is capable of delivering 1.8 MW at 90 A.

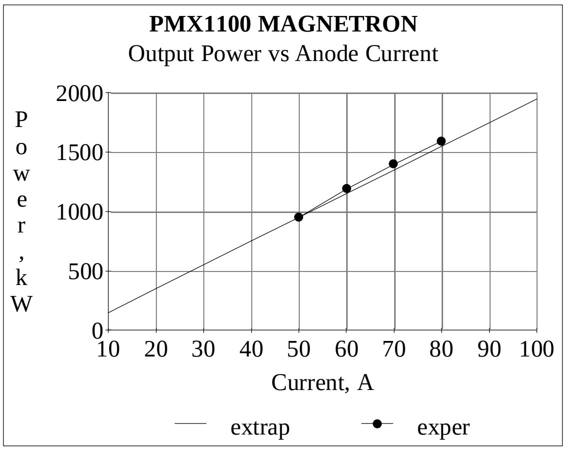

Fig.1

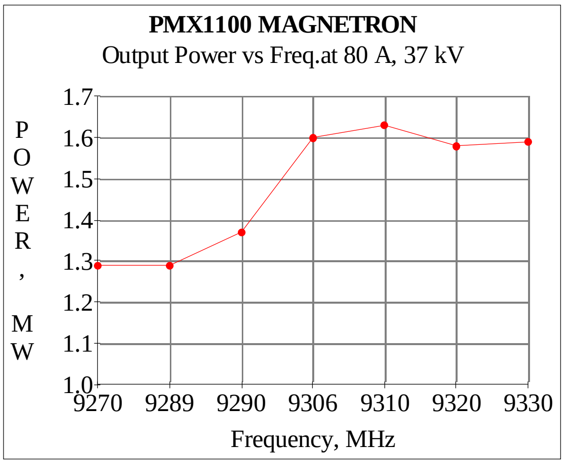

Fig.2

3. 5 MEV 100 mA LINAC

The tested linac has performed using only 0.4 m active RF length. It was built under a contract with SPC, USA.

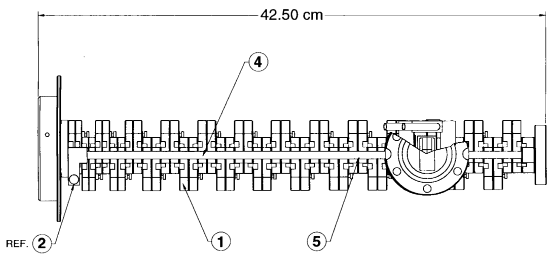

Fig.3 View of shortened 5 MeV 100 mA section

For the first test, we did not pay too much attention to the accurate pulse shaping looking for general performance characteristics (Fig.4). The accelerator has demonstrated very stable and reliable performance. The most encouraging result, from our prospective, is that our calculated and experimental results were in excellent agreement.

Fig.5 represents beam energy measurements made using a multi-plate Faraday Cup. Calculated and extrapolated load lines plotted using data shown in Fig.5 is presented in Fig. 6. A predicted dose rate at 1 m at maximum current of 110 mA should reach 550 R/min compared to approximately 300 R/min for the standard MINAC 6. Characteristics of the latter are shown on the same Figure for a comparison.

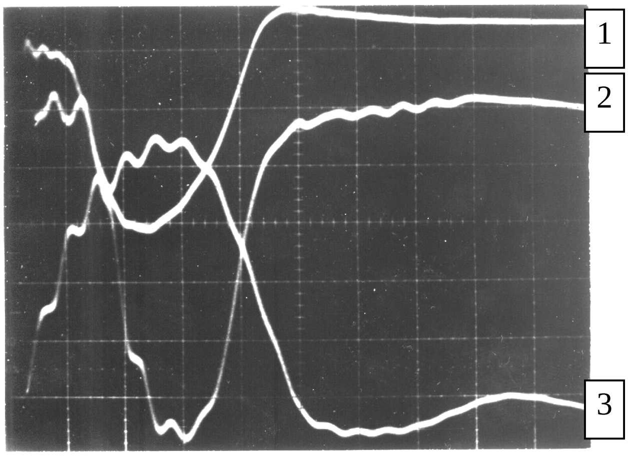

Fig. 4 Experimental results obtained during sction testing:1 - injected gun pulse; 2- accelerated beam current pulse(110 mA), 3- magnetron anode current pulse (90 A)

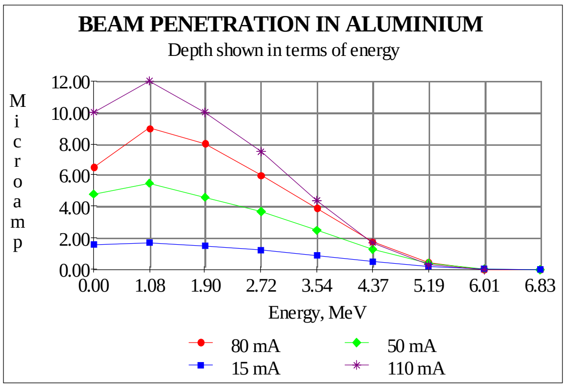

Fig. 5. Information obtained for MINAC-5 using multiplate Faraday Cup.

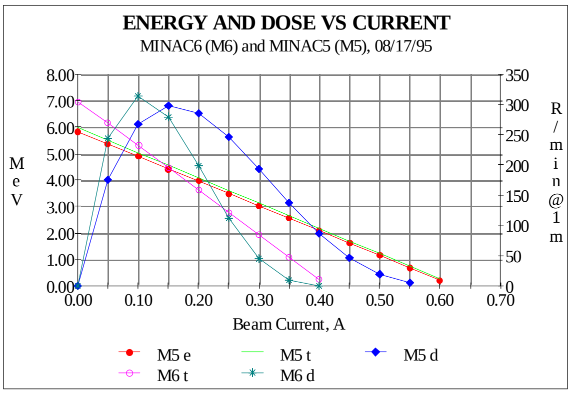

Fig. 6. Comparative characteristics of MINAC-5 and MINAC-6. Dose rate is calculated at 0.0006 duty factor.

4. 8 MEV 80 mA LINAC

Another interesting result was obtained during testing of a prototype of X-band linac designed for intraoperative therapy [1]. We were able to accelerate 100 mA current to energy of approximately 4 MeV using only 50 % of the power, available from the magnetron.

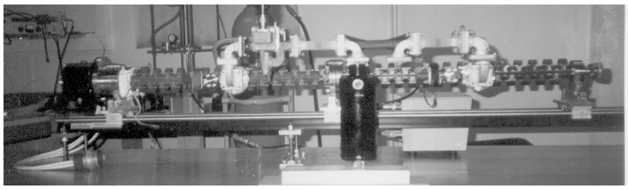

Fig.7 Two-section linac prototype capable of smooth energy regulation from 4 to 9 MeV. Measured beam efficiency of this section exceeded 40 %.

Section utilizes principle of short Alvarez cavities coupled through coupling cavities and microwave structure prototype which first was described and tested in [2, 3, 4] with on-axis cavities and then used in [5] with side coupling cavities. It allowed boosting of bunching efficiency at lower particle velocity in a range 0.1 c to 0.5 c. Additional presentation, describing the approach will be made at LINAC96 [6].

The complete system was tested at low current with both regular and high gradient β=1 second section. Some of the results were described earlier [5].

Based on the results obtained for the first section tested at 100 mA, we have proposed a two section linac with expected characteristics, shown on Fig.8.

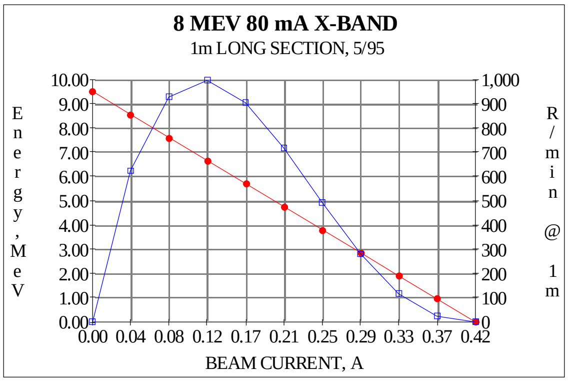

Fig.8 Projected load line and dose rate created by X-ray flux from a heavy metal target measured at 1 m.

Nice and stable operation of the first section encouraged us to propose this 9 MeV linac. Using the predicted energy-current characteristics, one could expect to have dose rate approximately 1000 R/min.

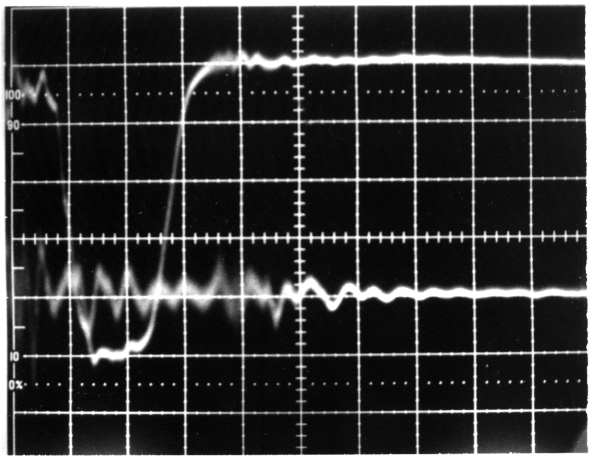

Fig. 9. Peak beam current equal to 100 mA accelerated to 4 MeV in first section of 9 MeV prototype X-band linac.The lower signal represents reflected power at resonance.

The main considered application of this linac is radiography of large and dense objects with equivalent thickness over 300 mm. However, the linac could be used for various other applications. Maximum mass of the linac head without tungsten collimator will be approximately 30 kg (60 lbs) and total length of linac head about 1.2 m.

Both systems could use a standard modulator and control console shown on Fig 10 and 11 below.

Fig. 10. Control Console

5. CONCLUSIONS

Theoretical and experimental study made to improve performance characteristics of existing X-band linac models was completed. Result of the study permits to propose two new linac models, described in the article. MINAC-5 and MINAC-8 will have improved efficiency, output dose characteristics. MINAC-8 could be considered a new approach to the system design and packaging. A new possibility of smooth energy regulation from 4 to 9 MeV will be added.

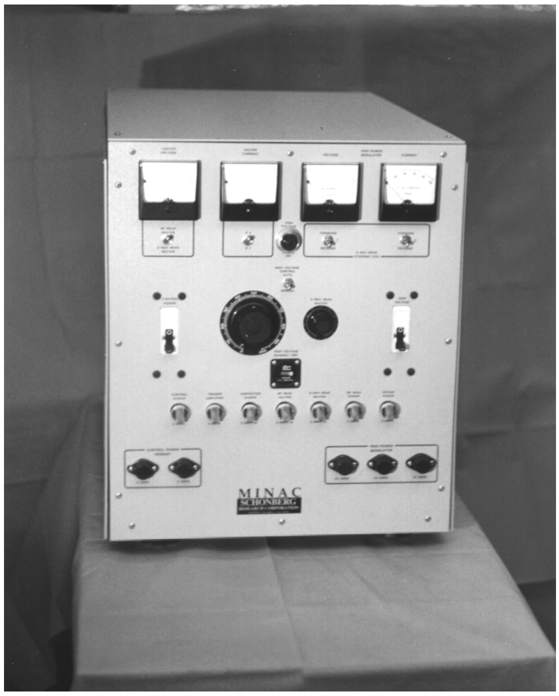

Fig.11. Modulator

6. REFERENCES

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