10 MeV PROTON LINEAR ACCELERATOR AT SWIERK

T. Niewodniczański
Institute of Nuclear Research
Swierk by Warsaw
Poland

The described accelerator was designed and self made in the Center of Nuclear Research at Swierk by Warsaw. The accelerator was foreseen for basic and applied research in low energy nuclear physics.

The accelerating structure is of the Alvarez type with $L_n = \beta_n \lambda$ and g_n/L_n = const = 0,25. The structure was checked by the numerical calculations using modified Martini-Warner method. The parameters of the focusing channel of the linac have been chosen from the compromise between the maximum value of phase space acceptance and the technically admissible values of field gradient in the quadrupole lenses. The compromising value of cos μ was found to be equal to 0,45 for the FDDF system. The corresponding values of radial noninvariant acceptance and emitance are equal to 100 mm.mrad and 30 mm.mrad respectively.

The injector is of the conventional Cockroft-Walton type with RF ion source, The injector accelerating tube consists of 14 sections with a gradient of 0,55 MV/m. The quality of 515 keV beam can be observed and measured with two pairs of remotely controlled slits. The beam itself is matched to the entrance of the linac with aid of a pair of correction coils and two quadrupole triplets.

Steel vacuum vessel contains copper resonator loaded with 40 drift tubes mounted each on two stems. The quadrupole lenses inside drift tubes are d.c. supplied through water cooled pipes with high current. The field gradient in the lenses varies from 4985 G/cm at the begining to 928 G/cm at the end of the resonator. The cavity.is equiped with 12 flat tuners, 4 of which can be remotely adjusted during the machine operation.

The RF system consists of three power generators strongly coupled to the cavity and one pre-exciter. The generators use EIMAC 4W 20000 A tubes. RF pulse length is 1000 μs and the repetition rate can be varied from 1,5 to 12,5 pps synchronous with the power supply. Electric field distribution along the axis of the accelerator cavity was measured using the perturbation method. After corrections the final variations of the field lay within the limits $\pm$ 5% /including tilt/.

Vacuum system contains self made oil diffusion pumps operating with liquid nitrogen baffles. The pressure in the vacuum vessel is $4 \cdot 10^{-7}$ Tr.

The first beam from accelerator was obtained on the 15th January 1970 and the work on machine improvement is continued. The present beam pulse intensity /July 1970/ is of order of 400 μA without the buncher.

Main accelerator parameters

Particles energy	W = 9,7 MeV
Resonance frequency	f_o = 193,25 MHz
Number of drift tubes	N = 40 + 2 $\cdot$ 1/2
Injection energy	W_i = 515 keV
Synchronous phase	$\varphi_s = -30^o$
Radial acceptance	100 mm.mrad
Focusing structrure	FDDF, cos μ = 0,45
Cavity length and diameter	l = 5524 mm 2R=1077mm
Q value of the cavity	Q = 58 000
RF pulse length	1 000 μs
Pulse repetition rate	1,5 ;3,1 ; 6,2 ; 12,5 pps

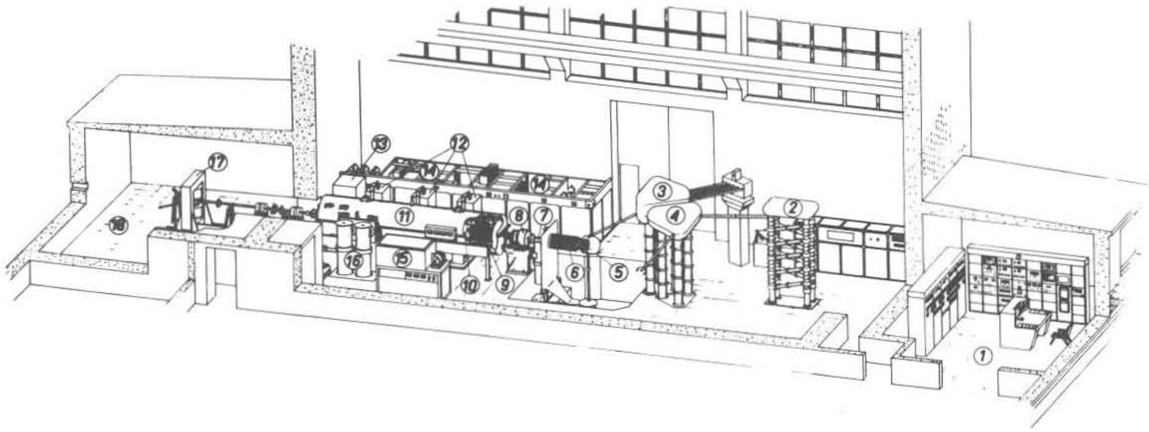
RF pulse power	P = 700 kW
Accelerating rate	E_0 = 2,24 MV/m
Vacuum pressure	$4 \cdot 10^{-7}$ Tr

Acknowledgments

The work reported is the result of a joint effort of the group headed by the author which consisted of: E.Dziura, W.Grabowski, J.Januszewski, Z.Kozłowski, A.Kucharczyk, S.Kuliński, B.Ludkiewicz, Z.Mazur, A.Mekler, S.Myśliński, M.Pachan, L,Sawlewicz, J.Sura, C.Weychert.

References

1. Collective work "10 MeV Proton Accelerator "Andrzej" at Swierk", Report INR No 1187/FLAP/PL /1970/
2. S. Kuliński "Note on Numerical Calculations of Linear Accelerator Cavities", paper presented to the 1970 Proton Linear Accelerator Conference, Batavia p.....
3. J. Sura "Choise of Parameters of the Focusing Channel for the Proton Linear Accelerator 10 MeV in Swierk", Report INR No 750/SLBAL/PL /1966/
4. J.Sura "Phase Motion of Protons in a Proton Linear Accelerator with a Perturbated Axial Field", Report INR No 640/SLBAL/E /1965/
5. E.Dziura "Radial Acceptance of 10 MeV Proton Linear Accelerator in Swierk, Report INR No 834/SLBAL/PL /1967/
6. E. Dziura "Beam Matching Between 510 keV Proton Injector and 10 MeV Linear Strong Focusing Accelerator",Report INR No 875/SLBAL/PL /1967/
7. J. Sura "Longitudinal Tolerances in the Accelerating Structure of the 10 MeV Swierk Proton Linear Accelerator" Report INR No 790/SLBAL/PL /1967/
8. M. Pachan "Running-up of 10 MeV Proton Linear Accelerator at Swierk" paper presented to the 1970 Proton Linear Conference, Batavia, p....



1 - control room
2 - high voltage generator
3 - ion source supply
4 - 1000 c/s power generator
5 - ion source
6 - injector accelerating tube
7 - injector vacuum pumps
8 - buncher
9 - drift tubes
10 - resonator
11 - vacuum tank
12 - RF power generators
13 - RF pre-exciter generator
14 - pulse modulators
15 - freon refrigerator
16 - tank vacuum pumps
17 - bending - analyzing
18 - target area

Fig. 1. General view of the 10 MeV proton linear accelerator at Swierk.

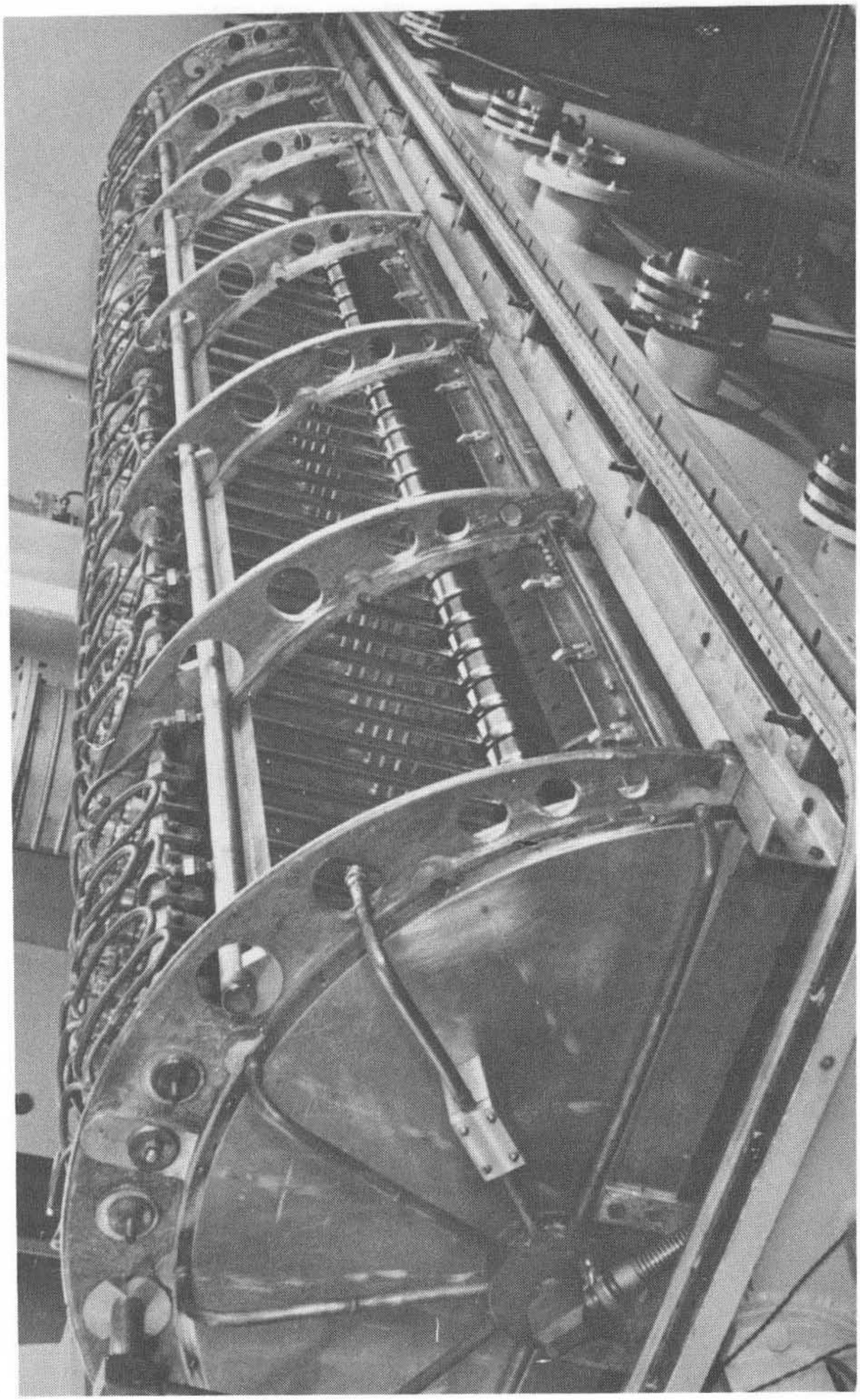


Fig. 2. - Open resonator of the Swierk PLA

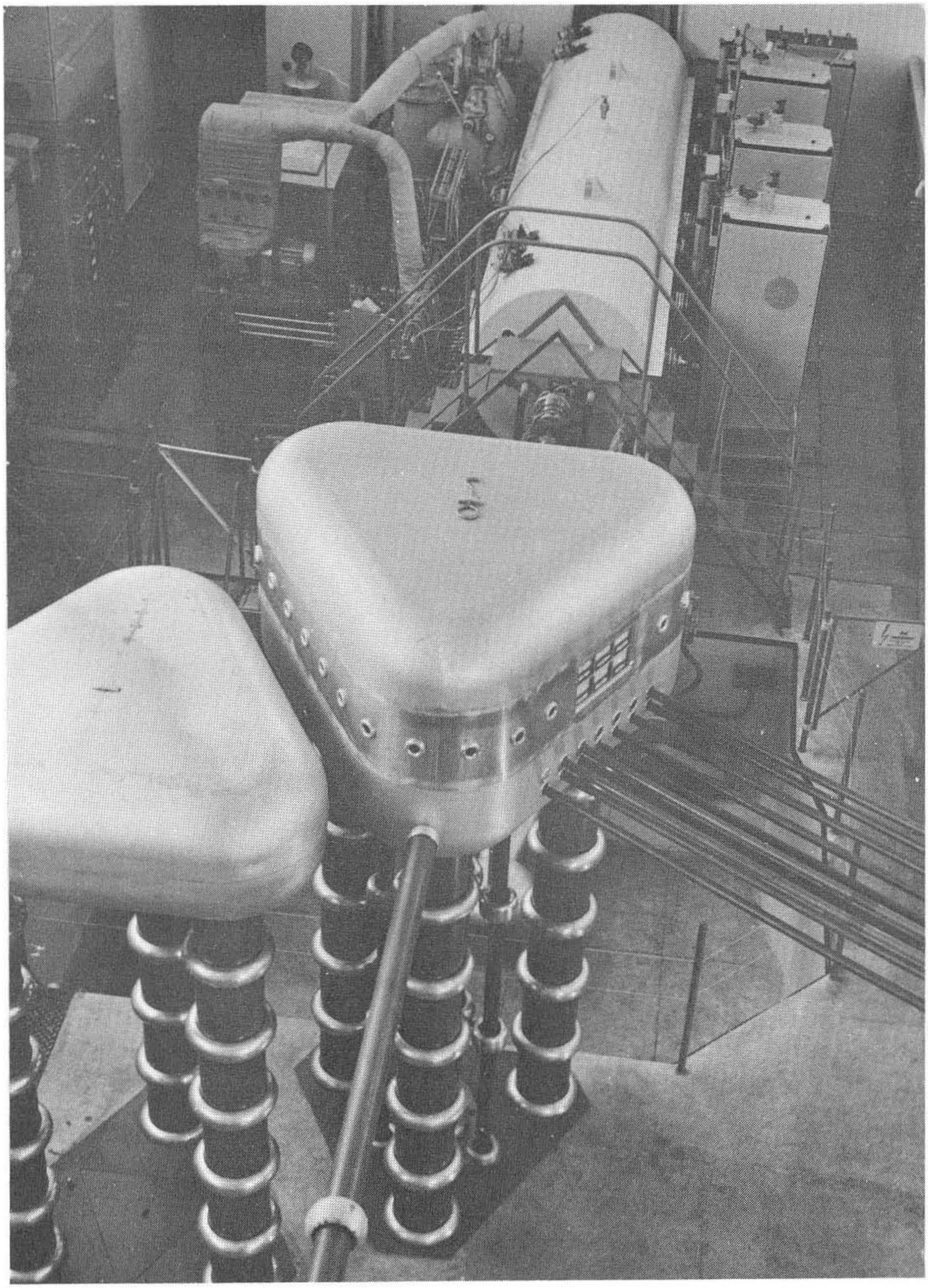


Fig. 3. - Swierk PLA seen from the Cockroft-Walton side.