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COMMISSIONING OF THE 200 MeV INJECTOR LINAC FOR THE OXFORD INSTR.-IBM SYNCHROTRON LIGHT SOURCE

P.Letellier, G.Meyrand, C.Perraudin, A Setty,
D.T.Tran, D.Tronc, V.C. Kempson°, J.A. Uythoven°

General Electric - CGR MeV
BP 34, 78530 Buc, France
°Oxford Instruments Limited
Osney Mead, Oxford OX2 0DX, England

ABSTRACT

A 200 MeV linac has been built by GE-CGR MeV as injector to the compact, superconducting synchrotron/storage ring light source, being built by Oxford Instr. for IBM. The commissioning of this machine has been completed end of February. This paper will remind the salient features of the linac and give the results obtained during the commissioning tests.

INTRODUCTION

A 200 MeV electron linac has been selected for the injection of electrons into the compact superconducting synchrotron being built by Oxford Instr. for IBM. The choice of linac as injector and 200 MeV as injection energy was dictated by many factors. Linac is known, indeed, as the best means to conserve the beam brightness and high injection energy will ensure low emittance and increase beam lifetime. However, linac is often reproached as of high cost and great length. The design of the linac we are going to discuss below is aimed to optimize the system with regard to these two aspects.

DESCRIPTION

The linac has been described and its design discussed elsewhere [1][2].The general layout is shown in Fig.1 . We want only to point out here two most important features:

1. The 6 meter long accelerating structure is chosen to fit with a commercially available tube, the 37 MW TH2100 klystron of Thomson which is now upgraded to 45 MW. This choice leads presently to a standard unit of 100 to 120 MeV. The field gradient still remains reasonnable enough to forsee a future upgrading when higher power klystrons become available.

2. The preinjection part is designed as short as possible. To this aim , the subharmonic buncher is placed as close as possible to the electron gun and the optics of this latter is studied taking into account the effect of the subharmonic rf-field. The 3 GHz buncher also follows at a minimum distance required by the dynamics. Its output energy is chosen high enough so that electrons could be injected into the first accelerating structure without need of further focusing. The first cavity of the buncher is shaped in order to provide self-focusing.The role of the static magnetic field therefore is only to compensate the different regimes of space charge. For beam radial adaptation, an einsel lens is provided between the buncher and the first accelerating structure.

Figures 2 and 3 show the preinjection and the accelerating sections.The total length of the linac is 14 m.

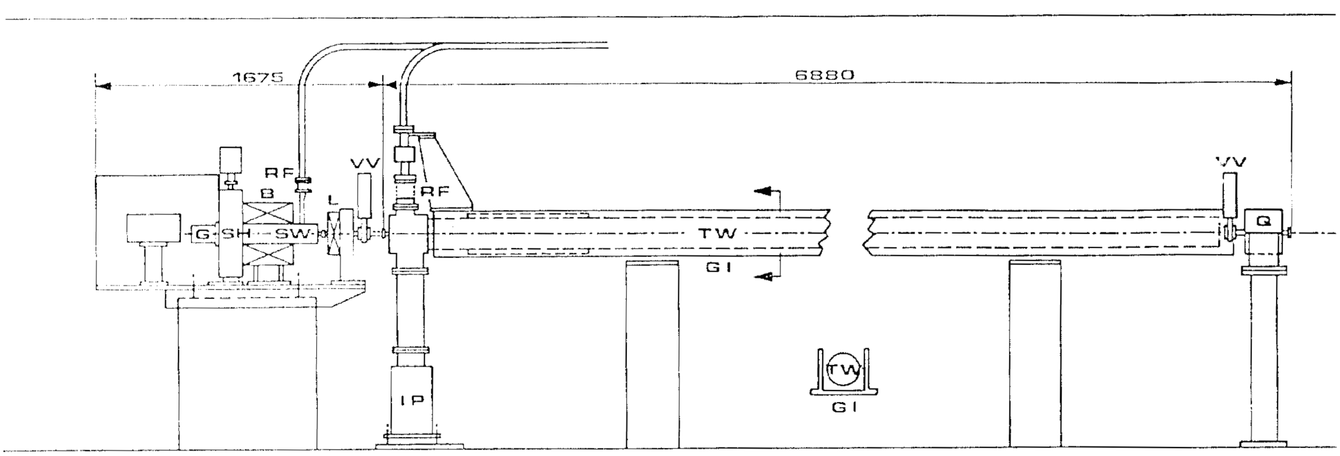

Fig. 1. General layout of the preinjection and the first accelerating section.

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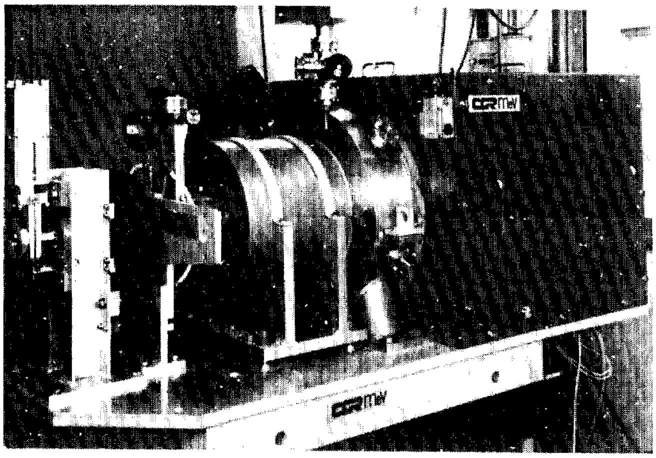

Fig. 2. The preinjection section.

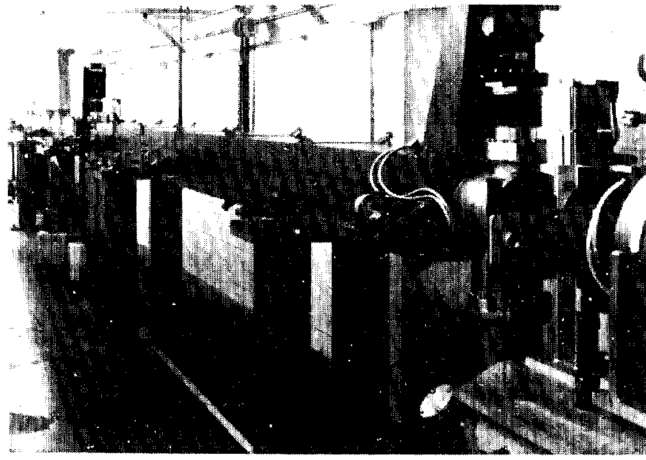

Fig. 3. The two accelerating sections.

TEST RESULTS

A typical set of results obtained during the the commissioning is given in Table 1.

Table 1.

Beam parameters :	
Energy (MeV)	200.
Peak current (direct)(mA)	70.
Peak current (analyzed)(mA)	
. in $\Delta E/E = \pm 0.5\%$	51.
. in $\Delta E/E = \pm 0.25\%$	32.
Beam pulse (nS)	120.
Repetition rate (Hz)	10.
Emittance (80 % beam width)	
. horizontal (πmm mr)	1.
. vertical (πmm mr)	0.4
RF-System :	
Frequency (GHz)	
. fondamental	3
. subhamonic	0.5
Number of klystrons	2
Power per klystron (MW)	35
Electron gun :	
Type	Triode
High voltage (KV)	45

The energy and energy spread were measured using a 40° analyzing magnet with a motorized slit at 2m down stream.The system is designed such that a slit width of 13.6 mm corresponds to an energy deviation of 1 %. A quadrupole doublet is placed between the accelerator output and the magnet. The curves shown in Fig.4 represent beam currents measured behind a slit of 6.8 mm as functions of the magnet current, for two different current settings of the quadrupole doublet. One can deduce an an output energy of 200 ± 1 MeV with a FWHM energy spread of 2.5 to 3%. More precise measurements are given in Fig.5 and 6 with the slit set respectively at 13.6 and 6.8 mm. they confirm the results obtained from Fig.4.

Beam pulse profiles are shown in Fig.7 and 8. In Fig.7, the current detection is achieved using a pair of capacitive electrodes followed by a four port combiner-splitter.The subharmonic structure is apparent. In Fig.8 the signal comes from the target.One observes the average component of the pulse as well as the 500 MHz component. This latter however, due to the unknown attenuation of the cable and the rather narrow bandwidth of the scope, can not be taken as the exact value.

Emittances were measured following the method used at SLAC [3]. Measurement was carried out by varying the focal length of the quadrupole lens and recording, for each current setting and at a given distance, the beam profile. This latter was obtained by exposure of a glass plate during 5 minutes.The beam density was afterwards digitized with a densitometer, scanning being made using an aperture of 0.1 mm. The emittance was determined for each plane, from five measured profiles combined 3 by 3 [4]. The values given in Table 1. have been calculated using the 80% beam width (defined as the distance at which the beam density drops to 20% of the maximum value). The 20% density is calibrated by another exposure during 1 minute.

The linac has been also tested with no rf-power in the second section. No beam loss was found . A detoriation of energy spread was observed as expected. This effect will be analyzed latter on.

CONCLUSION

The commissioning has been completed end of February. The measured performances fit well with the designed ones. They appear to be sensibly better than the actually guarantied ones.

We acknowledge the hospitality and the helpful assistance of our colleagues from Oxford Instr. during the installation and the commissioning of the machine. Our thanks go especially to Drs. M. Wilson, V. Kempson and J. Uythoven. We are in debt to J.Uythoven who helped us carrying out the emittance measurement and computation.

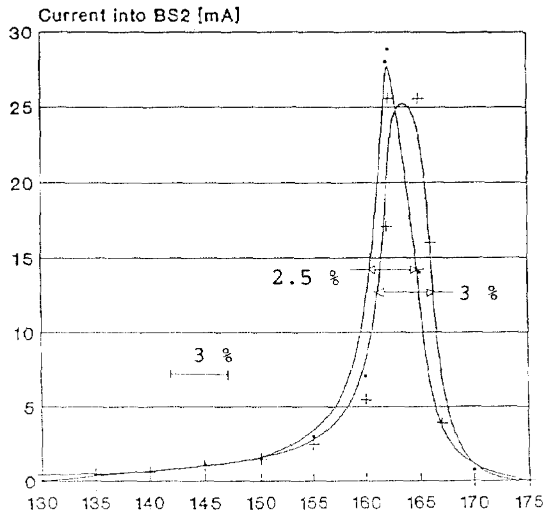

Fig. 4. Beam current (mA) behind a 6.8 mm slit (or 0.5% energy spread) versus analyzing magnet current (A).

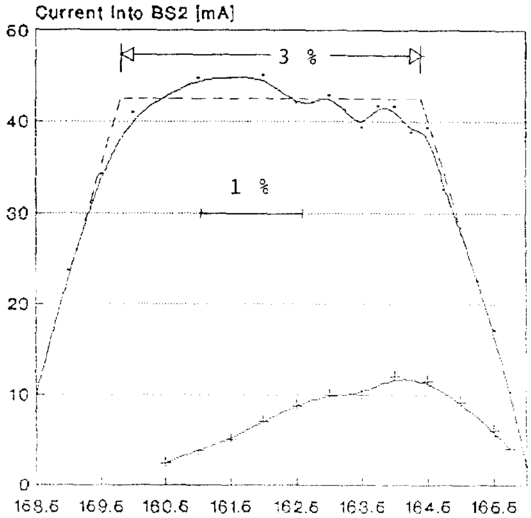

Fig. 5. Beam current (mA) behind a 13.6 mm slit (or 1% energy spread) versus analyzing magnet current.

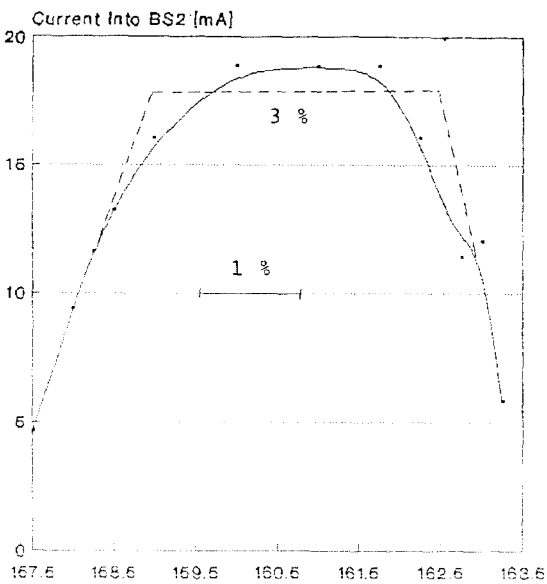

Fig. 6. Beam current (mA) behind a 6.8 mm slit (or 0.5% energy spread) versus analyzing magnet current.

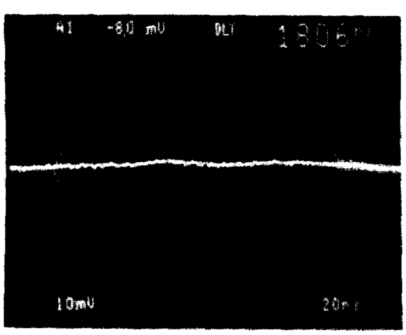

Fig. 7. Beam pulse profile detected with a pair of capacitive electrodes.

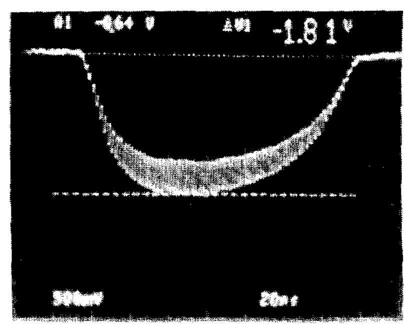

Fig. 8. Beam pulse signal detectexd from the measuring target.

References

[1] D. Tronc, D.T. Tran, G. Meyrand, A.Setty, "Electron Linac Design For Light Source" The First European Particle Accelerator Conference, Roma, Italy, June 1988.

[2] D.T.Tran, "Application of Electron Linacs in Medicine , Food Sterilization and Synchrotron Light Source" Tenth Conf. on Applications of Accelerators in Research and Industry,Nov.7-9,1988,Denton,Texas.

[3] M.C. Ross, N. Phinney, G. Quickfall, H. Shaoee, J.C. Sheppard, "Automated Emittance Measurement in the SLC" SLAC-PUB-4278, March 1987, PAC, Washington, D.C., March 16-19, 1987.

[4] J.Uythoven,"Linac Emittance Measurements" Helios Project Note, HJH 36/1, Feb.89, Oxford Instr. Int. Rep., unpublished.