ACCELERATION UNIT OF POSITRON LINAC

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§1 Introduction

The positron generator linac was proposed to the exclusive source accelerator for producting positron beam injected into the Accumulation Ring. This construction started in FY 1982 and will be completed by the end of FY 1984.

The positron generator linac is constructed on a site by the west-side of the PF injector. The generator linac is housed into two storied building of about 90 m long. The whole power sources are equiped on the second floor, the accelerator guides and other some components are also equiped on the ground floor. The concrete partition between the ground and the second is the thicness of 1.5 m, and it was prepared for the radiation shield.

The generator consists of an electron linac, a positron source and a positron linac. Such a conversion target as the positron source is set up in front of the positron linac.

The generator also consists of 6 acceleration units. Intense beam emitted from an electron gun is accelerated by the energy of about 200 MeV into 3 units in the front and is collided with a conversion target, and the divergent positron beam radiated from the target is focussed on axis by strong focussing coils and is also accelerated by the energy of about 250 MeV into 3 units in the rear. The sketch map of generator layout is shown in Fig. 1.

A single unit of the generator was designed as its acceleration per unit increased about 30 % than that of the PF injector linac. A long accelerator guide was developed for accomplishing its purpose.

§2 Acceleration units

6 acceleration units are arranged along a beamline and are named from the upstream for the downstream the unit P-1, ·····, P-5 and P-6.

The 3 units (P-2, P-3 and P-6) are the regular structures and the remainning 3 units (P-1, P-4 and P-5) are indevidually the irregular.

The irregular unit (P-1) is composed of a prebuncer (0.3 m), a bunccher (1.5 m), a short accelerator guide (2 m), and a long accelerator guide (4 m).

The other irregular units (P-4 and P-5) are also composed of two short accelerator guides and a long acceleralerator guide, and those arrangements are the contrary order with each orther. The regular units as shown in Fig. 2 are formed by being put straight two long accelerator guides.

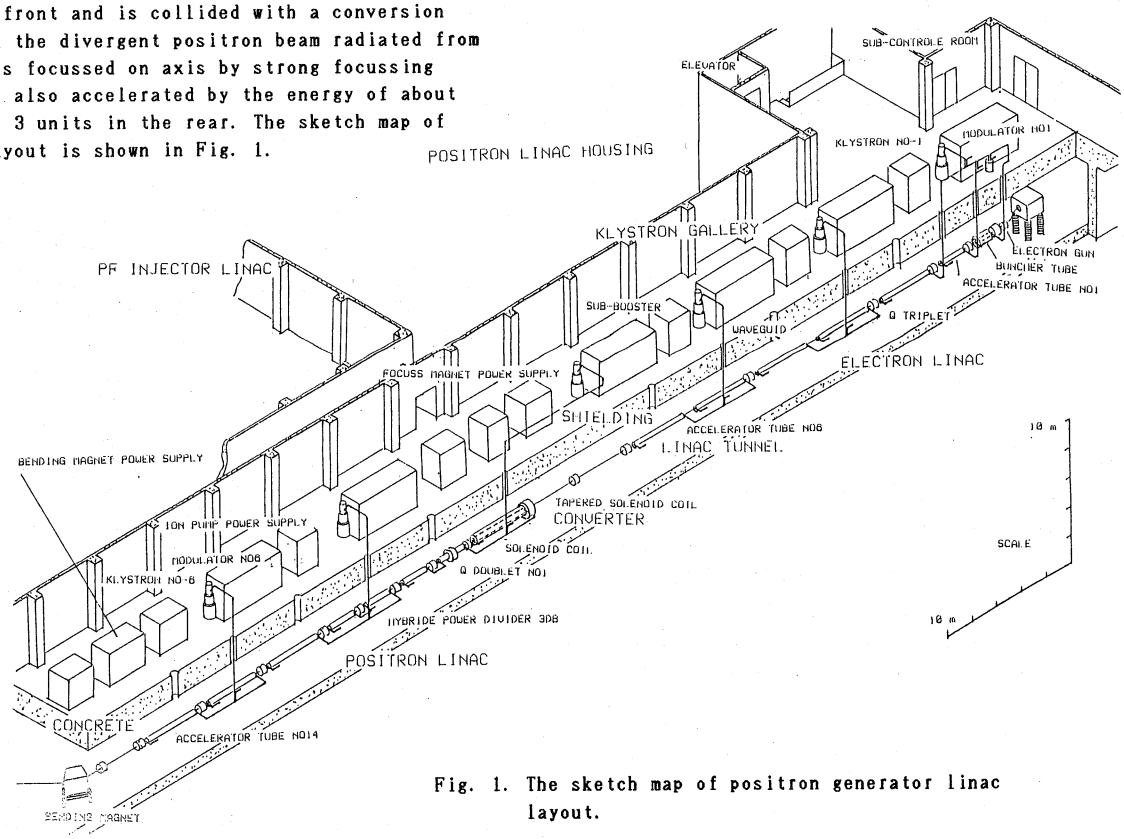

Fig. 1. The sketch map of positron generator linac layout.

The basic component parts of the unit consists of accelerator guides, waveguide components and alignment components, vacuum manifolds and ion pumps, beamducts and some supporting stands.

The basic structure of the unit was designed as microwave power supplied from a klystron is separated into two branches with a hybrid divider and its divided powers are supplied to two long accelerator guides with two waveguides. Both ends of a long accelerator guide is supported with two large stands, its middle point is also supported with a small pole stand. In order to simplify the alignment, each supporting stand is individually installed a light axis detecter which is used itself to be a reference point, and those detectors are easily aligned by use of a laser light beam.

The special broad supporting stands in the units (P-1 and P-4) are prepared for setting up various focussing coils on those stands, and the upper racks of those stands are made of casting aluminum metal for avoiding magnetic field distortion as much as possible.

A feeding power loss into a basic waveguide system was estmated -0.5 DB from the klystron to the entrance of each accelerator guide.

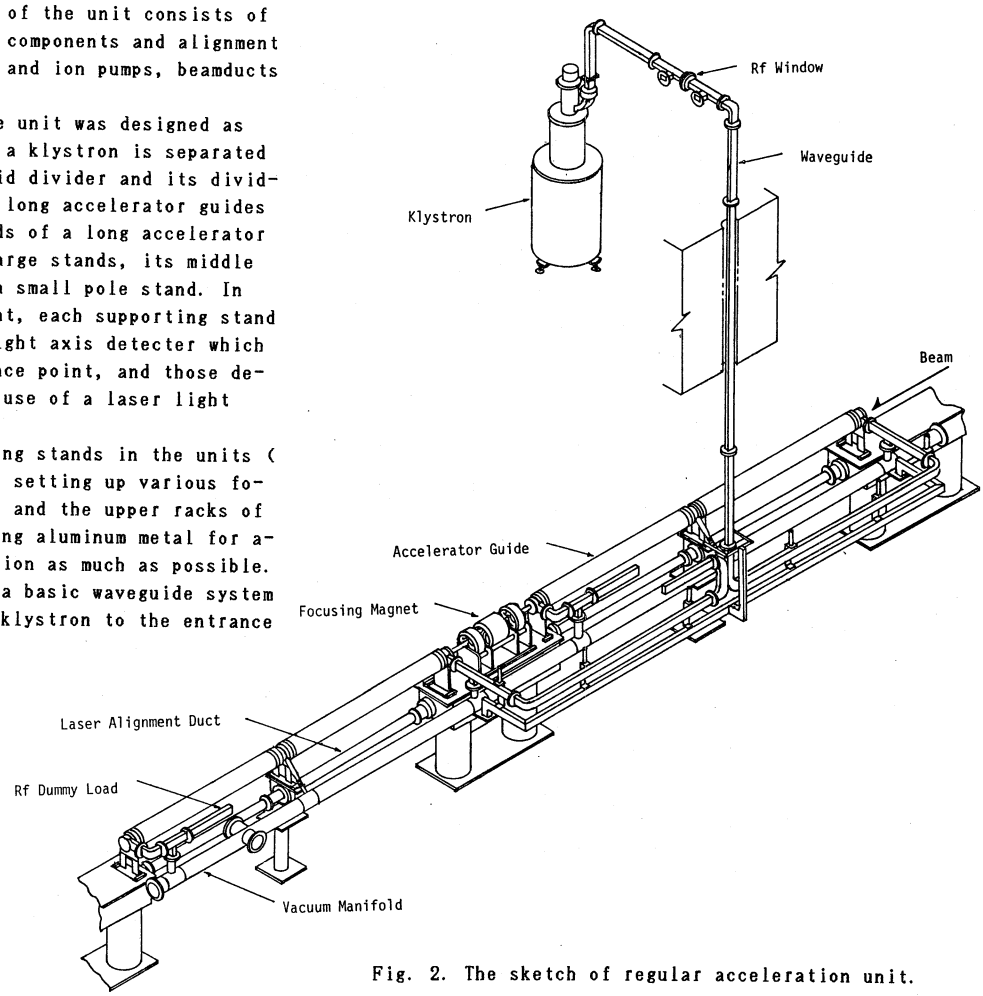

Fig. 2. The sketch of regular acceleration unit.

§3 Accelerator guides

A disk-loaded guide has such structure as alternatively piles up some of disks and cylinders and concrete those outside by electroplating. A short guide of 2 m long is consists of a disk-loaded guide with the 54 cells and two coupling cavities, the coupling cavities are fitted on both the ends of the guide.

A technical development succeeded in manufacturing a 4 m long accelerator guide. The long guide is also composed of two short guides, a buffer guide, and two coupling cavities. The long guide was extended its length by connecting straight a buffer guide and two short guides, and the buffer guide was inserted in a space between those short guides. For evacuating, 16 small holes (5 mm diameter) were bored through the outside wall of the buffer guide. Electrical contacts between those guides are mechanically kept by an arc welding stress by which the guides were welded each other. The connection part shows in detail in Fig 3.

The long guide is designed to obtain the acceler ating energy of 44.3 MeV for the supplied power of 12.

5 MW without beam loading. Consequently, a disk hole diameter at the entrance became 26.12 mm, the diameter gradients are decided on the pitching of 60 microns steps.

Fig. 4. shows electric feild strength and flowing RF power into the long guide without beam-loading calculated along the guide, Fig. 5. shows shunt impedance and group velocity, and Fig. 6. also shows a relation between 2a and 2b.

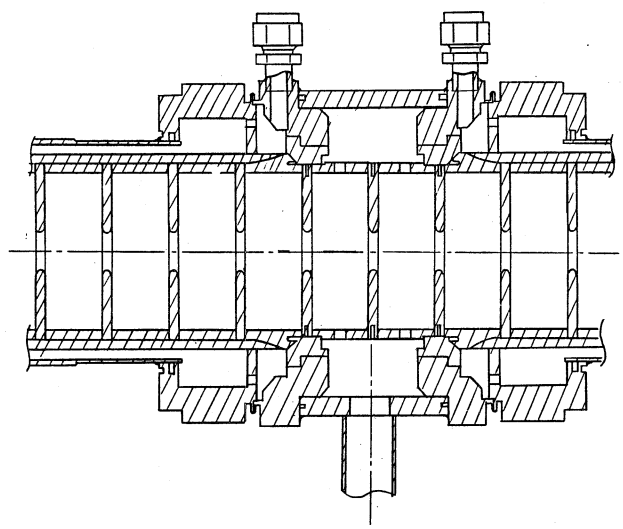

Fig. 3. Section view of connection part for long accelelerator guide with the buffer guide.

Some design parameters for the long accelerator guide are listed in Table 1.

Table 1
Accelerating structure characeristics for positron generator linac

Type of construction	Approximately constant gradient
Operating frequency (MHz)	2856
Number of long accelerator guide	9
Number of short accelerator guide	5
Length of long accelerator guide (m)	3.999
Length of short	
Number of cavities per long guide	110
Number of cavities per short guide	54
accelerator guide (m)	1.982
Phase shift per cavity	2PI/3
Field attenuation	0.685
Shunt impedance for fundamental space harmonic r (megaohrms/m)	60.25-53.67
Group velocity (vg/c)	0.0084-0.0227
Q facter	13500-14290
Filling time (micro-sec)	0.960
Waveguide diametor, 2b (cm)	8.189-8.333
Iris aperture diameter, 2a (cm)	1.976-2.618
Disk thickness (cm)	0.500
Klystrom peak output power rating (MW)	25
Average number of accelerator guides per klystron	4
Average energy gradient at normal operating level (KeV/cm)	11.3

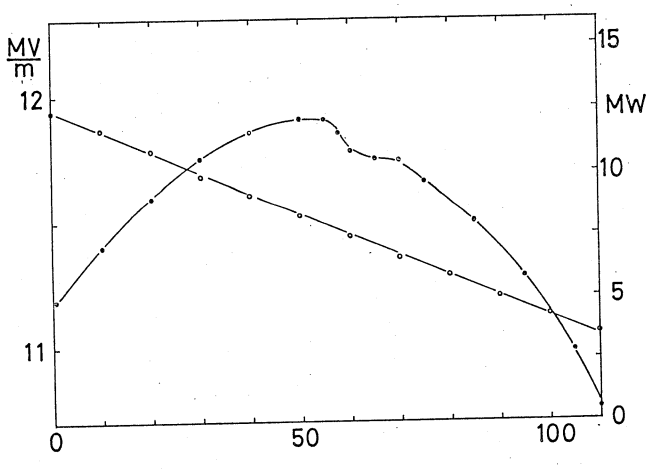

Fig. 4. Electric feild strength and flowing RF power into the long accelerator guide without beam loading calculated on the guide axis.

All of the disk-loaded guides for the PF injector were fabricated with such a material (VMC) as electric copper smilted in a vacuum, however that for the positron generator linac were changed into such a special OFHC as electric copper also smilted in carbon monoxide gas. This change was performed by a judgment based on a reasion that is for cost-cutting in this time and also is for the following became clear after the investigation on the total quantity of outgoing gases released from the melted OFHC, that was the same level as that for the VMC.

The two long guides was installed into the acceleration unit (5-7) in the PF injector, and its running test was executed for the scheduled operation and finished without any trouble.

An accelerating characteristics for the long guide was also investegated duaring its running test, and the measured values of the acceleration energy agreed well with the detailed-calculation results. Two 2 m guides located in the units (P-4 and P-5) are arranged in a series and are electrically connected by a waveguide, and those combined characteristic are almost the same as that of the long guide.

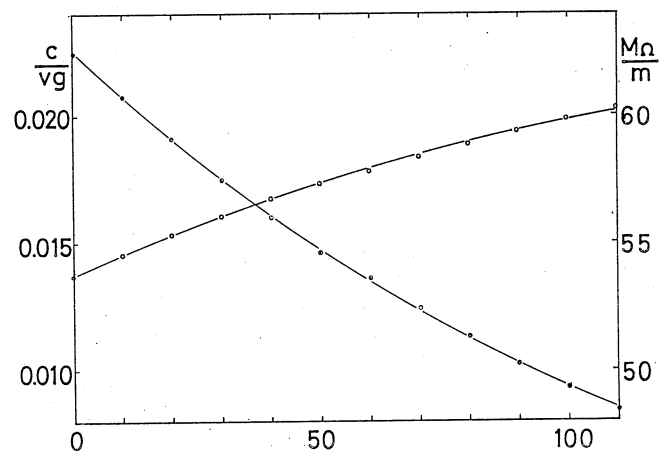

Fig. 5. Shunt impedance for fundamental space harmonic and group velocity located along the long accelerator guide.

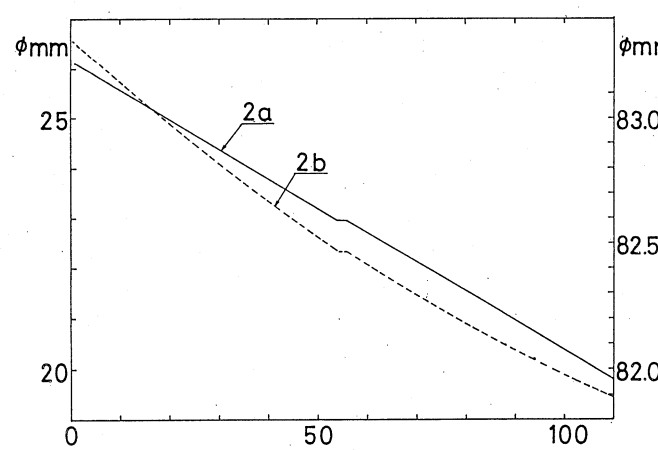

Fig. 6. Relation between iris aperture diameter, 2a and waveguide diameter, 2b, within a long accelerator guide.