THE LNLS RF SYSTEM

D. Wisnivesky°, C. Pardini
Laboratório Nacional de Luz Síncrotron - LNLS/CNPq
Cx Postal 6192, 13085-970 Campinas S.P. Brazil
° also IFGW/ UNICAMP

Abstract

The RF system for the LNLS storage ring [1] has been design, built and commissioned. The system delivers 60 kW CW at 476 MHz. The transmitter comprises a 160 kW, 25.5 kV dc power supply, auxiliary control and protection circuits. The amplifier is a commercial TV klystron with external cavities. A coaxial wave-guide system delivers the power into a single cell RF cavity. In this paper we make a description of the low power amplifier chain and control loops, the high power system, the cavity and the operation during the storage ring commissioning phase.

1. INTRODUCTION

The LNLS synchrotron light source, is design to operate with beam energies in the range of 1.15 to 1.37 GeV. A single cell cavity tuned at 476 MHz is installed in the storage ring. The RF system was specified and designed to deliver 55 kW at the cavity input coupler (produced by a 62 kW CW Klystron), which permits to store a beam current of 200 mA @ 1.15 GeV and, 100 mA @ 1.37 GeV. The RF system main parameters are:

Maximum power:	62 kW CW
Frequency:	476.003 MHz
Effective cavity shunt impedance: ($P=V^2/2R_S$)	3.4 MΩ
Unloaded Q:	41000
Peak cavity voltage :	500 kV
Revolution frequency:	3.216 MHz
Harmonic number:	148

2 RF POWER SYSTEM

2.1 Transmitter

The power plant comprises a dc power source which supplies 25.5 kV @ 6 A with a 1% voltage regulation to the power amplifier. The amplifier is a Philips Klystron model YK 1265 with 4 external cavities tested at 62 kW with a 36 dB gain and 43% efficiency. The high voltage regulation compensates for slow line voltage variations corresponding to 5° in the relative phase between the master generator and the klystron output. A fast phase shifter, acting on the drive circuit reduces the relative phase to less than 1°.

2.2 Low Power RF

A schematic diagram of the low power RF driver and of the different control loops is shown in fig. 1.

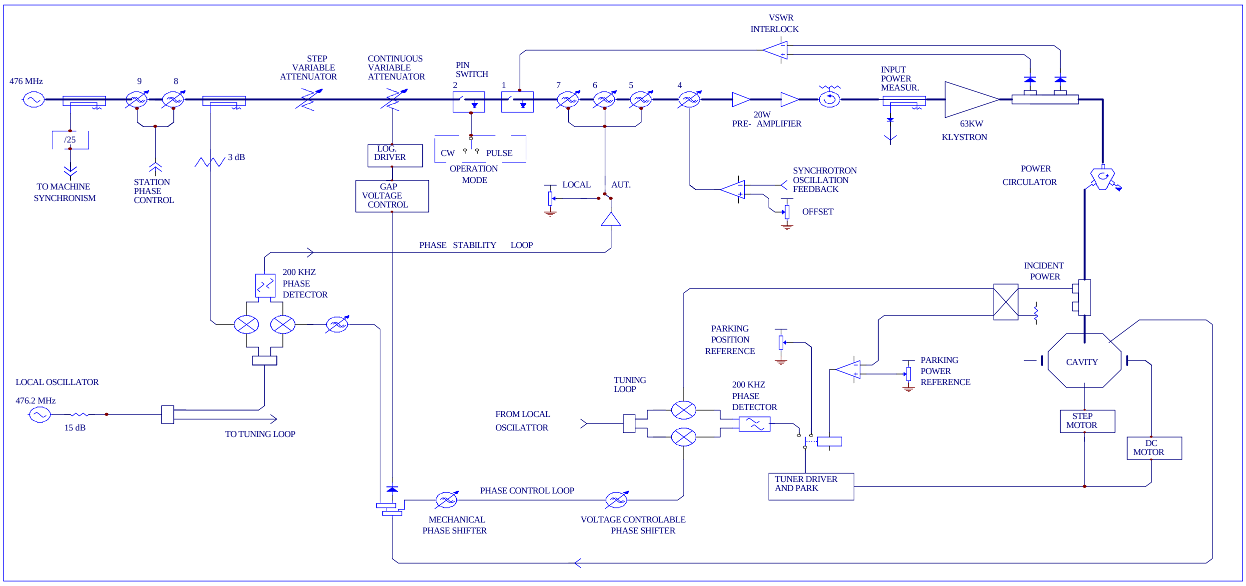

Figure 1: schematic diagram of the RF system.

The power input is generated from a high stability, low noise master oscillator with a frequency of 476.006 MHz, a linac sub-harmonic. The frequency generator can be adjusted locally or remotely from the computer control. From the master generator, using a series of frequency dividers, a 19.04 MHz signal for the general machine synchronism is produced. A chain of electronic controlled phase shifters, attenuator and amplifiers is used between the master oscillator and the Klystron input to control the phase and amplitude of the RF delivered into the cavity. There are 2 separate heterodyne phase loops. The first one keeps the difference between klystron and master phases within 1°. The loop amplification has a unit gain band width at 1 kHz, it corrects the 720 Hz power supply ripple and is well below the synchrotron frequency at 32 kHz. A second loop is used to compensate the cavity temperature drift and beam loading. It compares the cavity voltage phase with the klystron current phase and acts, via a step motor, on the cavity plunger and on a dc motor that can change the longitudinal dimension of the cavity. The combined action of both tuning circuits is required in order to permit a relatively fast increase of RF power into the cavity during the ramping process of beam energy. The cavity voltage is controlled by means of an amplitude loop that monitores and compares it with the gap voltage reference, the result acts on an electronically controlled variable attenuator which corrects the klystron driver. Fig 2 gives a general view of the amplifier and control panels.

Figure 2: RF amplifier and control panels.

3 RF CAVITY

The RF cavity was purchased from Sincrotrone Trieste (S.T.). It is a one cell, bell shaped cavity, similar to those installed in Elettra, specially designed for the LNLS frequency. Tuning of the cavity is performed by mechanical deformation along the length of the cavity. It has 6 equatorial ports used for the coaxial loop input coupler, vacuum pump, vacuum gauge and pick ups. An additionally port is used for a mechanical plunger to enhance the speed and tuning range. The cavity is provided with 5 separate cooling circuits, while 12 other separate circuits are used for temperature stability of the cavity surface. The cavity temperature is adjusted for HOM free operation following the method developed at S.T. for the Elettra operation. Preliminary studies of the HOM structure of the cavity and the HOM frequency variation with temperature indicates that for the LNLS storage ring, a relatively large range of temperatures, between 40 and 55°C is available for operation free of HOM instabilities, with beam currents up to 200 mA. The cavity temperature control system was designed to allow 0.1 °C temperature stability. Furthermore this same system, together with the mechanical tuning must have a sufficiently fast response to allow energy ramping between 120 MeV injection energy and final storage energy, that is between 5 kW and 36 kW RF power in about 100 s. Fig 3 shows the power plant and the cavity mounted in the storage ring.

4 OPERATION

All components of the RF system have been tested separately before final assembly in the storage ring. The transmitter was adjusted to nominal power operation using a dummy load. Separately, the cavity was conditioned up to 40 kW during several days, until continuous operation in the 10^{-9} mbar range was attained. Injection at 120 MeV requires 4 kW RF power, while for operation at full energy with 500 kV gap voltage and 1.3 coupling factor is achieved with 36 kW dissipation in the cavity walls.

5 CONCLUSIONS

The RF plant and cavity for the LNLS synchrotron radiation ring was constructed, mounted and tested. Operation of the system for the initial commissioning of the machine is presently under way.

6 ACKNOWLEDGMENTS

We like to thank A. Rosa, G. Fragas, A. C. Lira and M. A. Remy for their help in the design and test of several sub-systems of the RF plant. We are grateful to M. Svandlik from S.T. for his help during the construction of the cavity .

7 REFERENCES

[1] RODRIGUES, A. R. D. e al. “LNLS Commissioning and Operation”. In these proceedings.

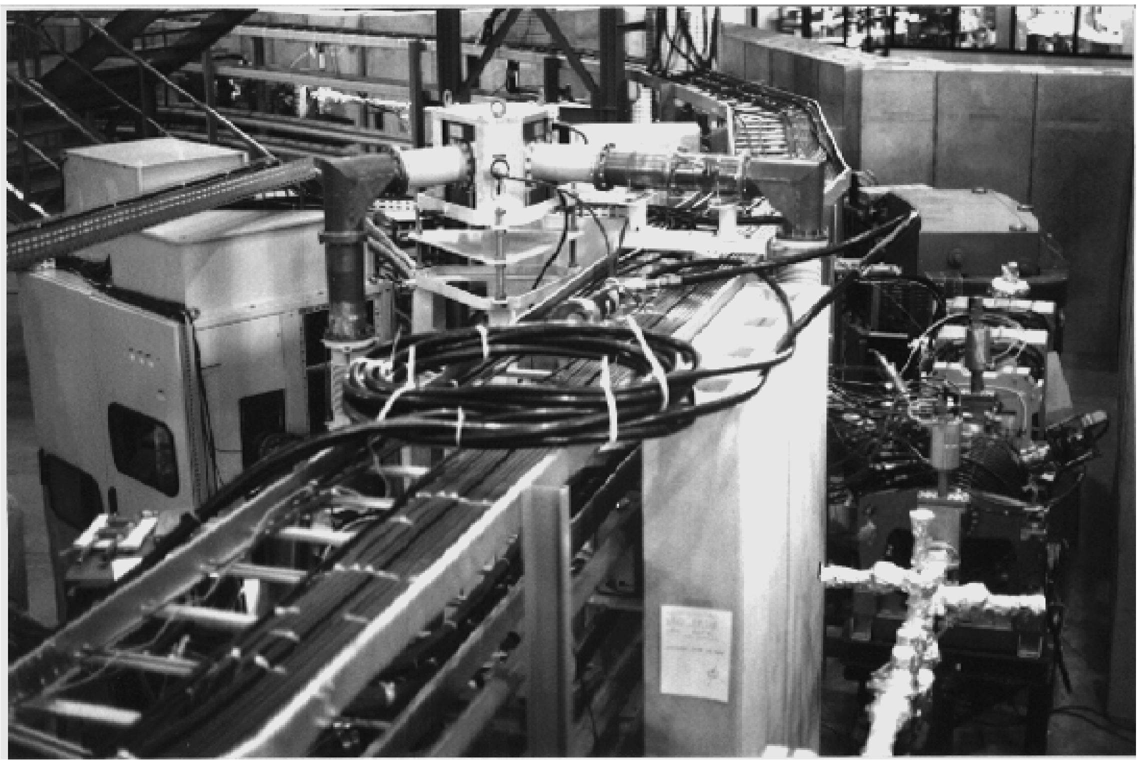

Figure 3: cavity assembly in the the storage ring.