LNLS VACUUM SYSTEM COMMISSIONING

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Abstract
The Brazilian National Synchrotron Light Laboratory, LNLS, operates a synchrotron light source consisting of a 1.37 GeV electron storage ring and a 120 MeV injector. A summary of the commissioning and operation performance of the vacuum system for the linear accelerator (LINAC), transport line, RF system and storage ring is presented. The performance of the sub-systems is described including the photon induced desorptions (PID) and the effects on the beam lifetime.

1. INTRODUCTION

Commissioning of the injector LINAC started in December 1995 with and commissioning of the storage ring (at low energy) started on May 1st 1996. Full energy operation has first achieved in August 1996. The description of the vacuum system is given elsewhere (2). At present 10.0 Ah of accumulated beam dose in the storage ring has been achieved. The average dynamic pressure in the LINAC, transport line and storage ring is in the 10^{-7} Pa range, whereas in the LINAC RF system the pressure is in the 10^{-6} Pa range. All parts of the system were opened at least once, during modifications and improvements. This allowed us to check the short recovery time. Today if any one of the 6 cells of the ring needs ventilation to atmospheric pressure, 6 hours later it is possible to inject at low energy without baking. The transport line can be operated after 4 hours of pump down under the same conditions. The most sensitive is the LINAC RF system. The rectangular copper wave guides need baking (400 K, 24 hours) after ventilation. The copper accelerating structures of the LINAC are not bakeable and 24 hours of pump down are necessary after ventilation before operation.

2. LINEAR ACCELERATOR

After 15 months of operation the linear accelerator had to be vented for removing the ceramic RF window near the gun. The window ceramic had been eroded by sparks, developing a leak and turning the LINAC operation unstable. The LINAC had to be vented a second time since we did not have at the time a spare window available. Almost at the same time, the gun cathode had to be replaced and the gun ion pump was replaced by a new 25 l/s model. After this maintenance we used the normal baking procedure in the gun and heated up the LINAC to 333 K using the hot water stabilizing system of the accelerating tubes. The final static and dynamic pressure in the gun reached 2.8×10^{-7} Pa and 6.0×10^{-7} Pa respectively. In the LINAC the static and dynamic pressure are 4.1×10^{-7} Pa and 6.6×10^{-7} Pa, respectively.

3. LINAC RF SYSTEM

The LINAC RF system has no gauges and uses the current in the power supplies for the interlock system. A current bellow 500 μA ($\approx 5 \times 10^{-4}$ Pa) in the ion pump enables the system to work. Each time we opened one of the "arms" of the system, we needed baking for 24 hours at 453 K against a turbo-molecular pump. We tried to condition the system with the RF only, but were a lot of sparks in the ceramic windows and the operation became unstable. In normal operation conditions the maximum current is 10 μA ($\approx 1 \times 10^{-5}$ Pa).

4. TRANSPORT LINE

We have built a new septum chamber very similar to the already installed one but with some improvements, such as providing more space for the injection angle. Changing the chamber took one day. The chamber was not baked it and we used only the beam cleaning capability. A slit was installed to help a better control of the energy dispersion during the injection. The main computer, in the control room, operates the slit.

5. STORAGE RING

The storage ring chambers were baked for 10 days right after installation in April 1996. During the following 4 months of commissioning, the vacuum chamber was opened several times and 3 beam lines were installed. In order to prepare the ring for the installation of the remanding 4 beam lines, the machine was baked again without the NEG activation. After the second baking the ring started to operate without interruptions and the average pressure started to decrease. Figure 1 shows the time evolution progress of the accumulated beam dose at 40 mA and the lifetime of the beam. The lifetime is the time it takes for the current to fall to 1/e of its initial value. During the last month of operation the beam dose increased from 5.4 Ah to 10.0 Ah. In the conceptual

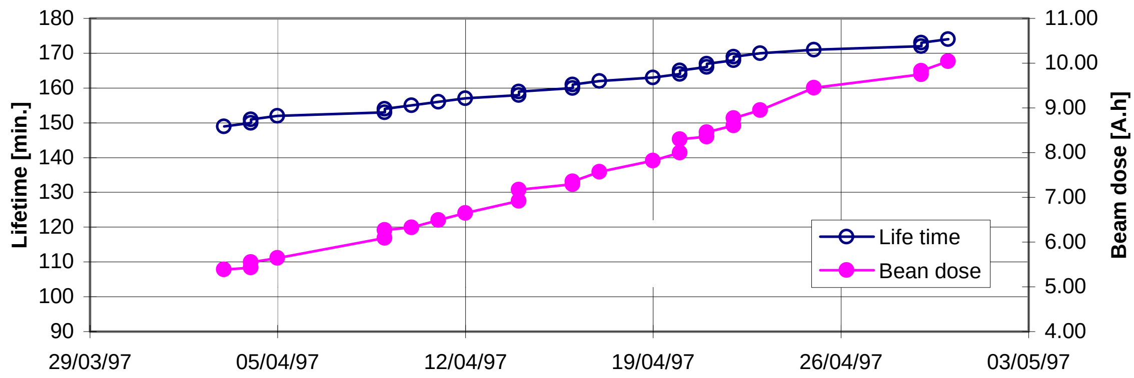

Figure 1: Beam lifetime at 40 mA and the integrated beam dose

design we estimated 100 Ah of beam dose (3,4) to attain the specified lifetime of 7 hours at 100 mA. The averaged pressure readings of the ring are 4 x 10^{-8} Pa without beam, 8 x 10^{-8} Pa at a beam current of 70 mA. This is the dominant factor to the beam lifetime limitation. The pressure rise per unit of electron beam current ($\Delta P/I$), as a function of the bean dose, at pump stations near the bending and a straight section are shown in fig. 2.

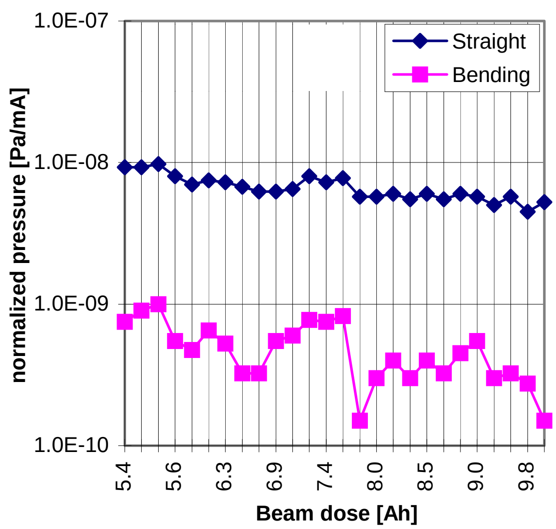

Figure 2: Normalized pressure at bending and straight chambers

The experimental results show that the decrease of the normalized pressure in the bending magnet chamber is only about a fact of 2 lager than the straight section. Since the linear photon power density at the location of bending chambers is many times higher than in the case of the straight section chamber, we have expected a much lager difference rate. We believe the reason of this is the high temperature on the exit port of the bending chamber (430 K). Examining the conceptual design of the bending chamber, we found an inadequate cooling rate on the photon absorber in this position. A new device has been design and a prototype is ready for the test. The design of a wiggler chamber and the new bending chambers for the insertion devices incorporate this detail.

6. CONCLUSION

After one year of commissioning and an accumulated beam dose of 10.0 Ah, the average dynamic pressure has reached 6.0 x 10^{-7} Pa at 40 mA beam current. The limitation of the lifetime is the elastic scattering on the residual gas. This pressure was obtained without NEG activation. The inefficient cooling rate at the bending magnet chambers has been identify and a new cooling device was designed. A new baking with NEG activation will be performance in the next shutdown period, a long with the change of the septum (5).

7. REFERENCES

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