

VACUUM SYSTEM FOR THE LNLS 500-MeV BOOSTER SYNCHROTRON

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Abstract

We present a summary of the commissioning and performance of the vacuum system of a 500-MeV booster synchrotron recently built at LNLS as part of a new injector for the LNLS light source. The main vacuum parameters of the synchrotron are pressure below 5×10^{-7} Pa (lifetime of 1-2 hours), no *in-situ* baking, no cooling system, and a short recovery time after ventilation. All parts of the system are made of 1mm thick AISI 316L stainless steel. The chambers were pre-baked before installation.

1 INTRODUCTION

The Brazilian National Synchrotron Light Laboratory, LNLS, operates a synchrotron light source consisting of a 1.37GeV electron storage ring and a 120MeV injector. Here we present a summary of the design, commissioning and performance of the vacuum system of a 500-MeV booster synchrotron[1]. All the system was designed with the following requirements:

- Operation pressure 5×10^{-7} Pa N_2 equivalent at 500 MeV, 70mA and life-time 1-2 hours.
- Residual gas free of hydrocarbons.
- The system must allow new development.
- The accelerator must also operate in storage mode.

Commissioning of the transport line from injector to the booster started in January 2000 and commissioning of the booster started November 2001. Full energy operation was first achieved in December. At present, 40mA of beam dynamic pressure in the system is 4×10^{-7} Pa, the transport line is in the 10^{-6} Pa range and RF cavity shows the

pressure 6×10^{-7} Pa[2]. All parts of the system were opened at least once, during installation, after the pre-baking, which allowed us to check the short recovery time. Today, if any one of the cells of the booster needs ventilation to atmospheric pressure, 6 hours later it is possible to inject. The transport line can be operated after 4 hours of pump down under the same conditions.

2 TRANSPORT LINE FROM INJECTOR

The transport line from the injector to the booster is a tube of 8m longer (fig.1), with 35.1mm of diameter. The dipole chambers were laser cut. A dipole to deflect the beam to the booster was installed in February 2000. At the same time, modifications in the diagnostic system were made to help this injection. The diagnostics were beam position monitors, current monitors and screen monitors. The final pressure, without baking, is 10^{-6} Pa range from the diode 20 l/s ion pump (IP) current.

3 BOOSTER

The booster has 34m of circumference with the major axis with 12.3 m and the minor axis with 7.9m (fig.2). There is a straight section with 2 m for insertion devices. The chambers were designed for easy light extraction, modularity and the mentioned vacuum guidelines. The low thermal load from the beam allowed using stainless steel without a cooling system in the dipole vacuum chambers. The vacuum and magnetic components current in the booster has been achieved. The average space was carefully detailed to include kickers, *septa* (injection, thin extraction and thick extraction) [3], beam

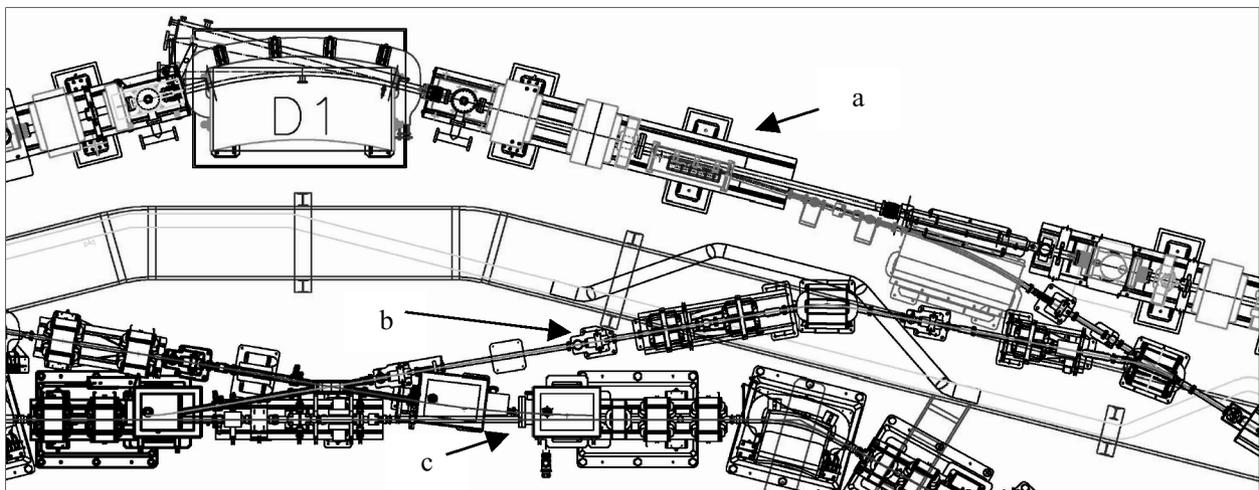


Fig. 1 View of the storage ring (a), transport line from the injector (b), the booster (c).

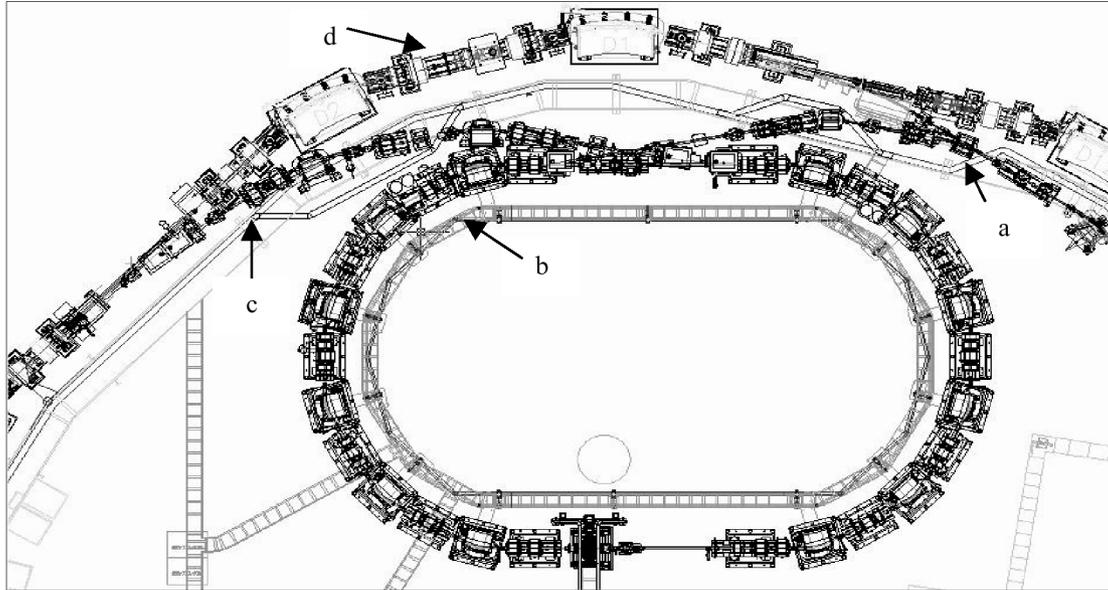


Fig. 2 View of the transport line from injector (a), booster (b), transport line from booster (c) and storage ring (d).

position monitors, button cleaning electrodes, pick ups, radio-frequency (RF) cavity and dipole vacuum chambers, with the sextupoles, quadrupoles, correctors and bending magnets [4]. These constrain let us to choose a CFX NW 50 flange (EVAC) instead of a Conflat® DN 63 standard flange to get the necessary flexibility. The bellows in each side of the dipole vacuum chambers was installed with no shields. The system is pumped by conventional diode 50 l/s IP in the 12 dipole chambers and 300 l/s in the 3 kickers, 3 *septa* and one RF cavity. Cold cathode gauges installed in the kickers, *septa*, RF cavity and one dipole vacuum chamber measure the pressure. The booster has 10 vacuum sector using stainless steel mini-gate valves specially built with CFX NW 50 flanges and the pump down by the low cost DN 40 all-metal angle valve. Chambers were baked for 5 days at 200°C, with a turbo-molecular pump. The dipole vacuum chambers were baked with the ion pumps installed. The kickers and *septa* for injection into the booster and the *septa* for extraction were baked without IP. In the initial commissioning the mean static pressure was 1.8×10^{-7} Pa and pressure during operation was 6×10^{-7} Pa. Until now, can be injected a current of 40mA in 120MeV and ramped to 15mA in 500MeV with cycles of 5.8 sec.

4 TRANSPORT LINE FROM BOOSTER

The transport line from the booster to the storage ring has 13.6 m (fig. 2) and it is a tube with 35.1mm of diameter. We have thick and thin *septa* for injection into storage ring, which also includes beam position, current and screens monitors. The dipole chambers were laser cut. The final dynamic pressure is 10^{-6} Pa range by the current of the 20l/s IP, without any baking in the chambers.

5 STORAGE RING

The storage ring received some modification for the new injection from the booster. The new injection was installed in a straight section including one new kicker, a DCCT beam current monitor and a thin *septum*. The DCCT current monitor was moved from the original section for a new kicker to take its place. After installation no baking *in situ* was done in the chambers. Until now, the performance is 540mA at 500MeV, and 305mA at 1.37GeV with life-time of 6.2h after 30Ah of accumulated charge.

6 CONCLUSION

After installation and initial commissioning, the expected performance of all vacuum booster system was achieved. The mean dynamic pressure of the booster has reached 6.0×10^{-7} Pa at 15mA in 500MeV. The limitation of the lifetime is due to the elastic scattering on the residual gas.

7 REFERENCES

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