DESIGN, DEVELOPMENT, CONSTRUCTION AND INSTALLATION OF A CERAMIC CHAMBER FOR A PULSED KICKER AT LNLS STORAGE RING

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Abstract

Following the upgrade of the LNLS injector system with the addition of a 500 MeV booster synchrotron, the storage ring in vacuum ferrite injection kicker magnets started to show overheating due the interaction with high frequency electromagnetic fields induced by the electron beam in large currents. In this paper, we describe the design of a new ceramic chamber for the kickers, which minimize this effect by decreasing the coupling impedance of the kickers and their interaction with the electron beam.

INTRODUCTION

The Brazilian Synchrotron Light Laboratory, LNLS, operates a synchrotron light source consisting of and a 120 MeV linear accelerator injector, a 500 MeV booster and a 1.37 GeV electron storage ring [1, 2, 3]. Since the installation of the booster [4] and a second RF cavity [5] the maximum current able to store increase from 220 mA to 400 mA as continues effort of improving the light source. When large current in few bunches were storage in low energy or large currents at high energy, a overheating (>130°C) can be detected in the vacuum kickers ferrites (see fig. 1), due the interaction with the beam-induced fields. As a poor solution a cooling pipe was installed in the vacuum chamber to keep the temperature as low as possible (water at 8 C).

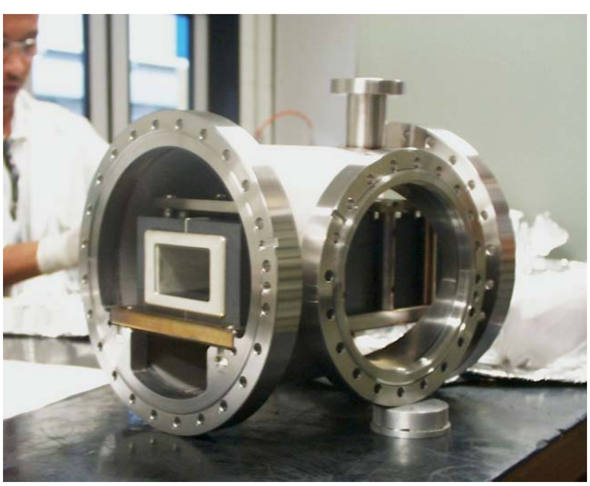

Figure 1: Kicker chamber with in vacuum ferrites.

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CERAMIC KICKER CHAMBER

The solution for this overheating was to substitute the in vacuum kickers for a air kicker with a ceramic vacuum chamber that could be transparent to the pulse magnet fields. A project of a first prototype in house made ceramic vacuum chamber was made with two bellows and an internal metallic coating of Ti. Many difficult with the mechanical quality of the ceramic and Ti coating make to develop a new project with a more details in the production procedure and the materials used on it. The ceramic specified was a 99% Al_2O_3, pressed isostatically and sintered with a length of 300 mm (see fig. 2). The transition to the stainless steel bellows was done with vacuum brazing of a Kovar neck. The resistance was chosen to satisfy different specifications: allow the low frequency pulsed magnet field transparencies, to carry the beam image current, protect external component from the beam fields, minimize power density seen by coating from the ohmic heating from the image current or eddy current from magnetic pulsing. To prevent overheating, 2 fans were installed outside to cool the ferrites.

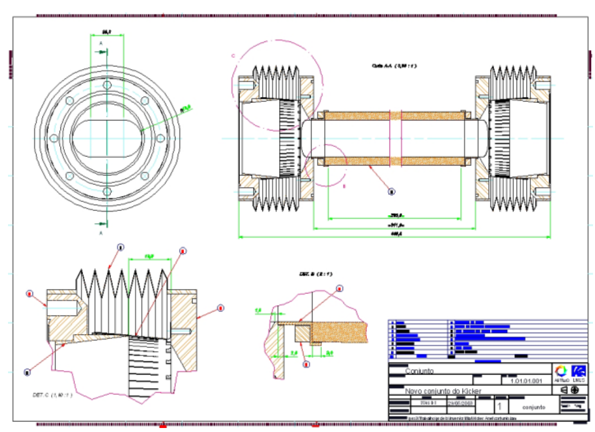

Figure 2: CAD draw final version of ceramic kicker chamber.

The deposition of the coating was made by vacuum thermo evaporation of Ti wire (99.9%) and an oxidation with dry-air. This oxidation was necessary to avoid the behaviour of the resistively change considerably between vacuum and air venting (> 40% near total resistance of 1-2 Ohm). The variation could make a large distortion in the field inside the ceramic. The oxidation protects the metallic Ti from air contamination and decrease the outgassing and photon induced desorption (see fig. 3).

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Figure 3: Kicker ceramic prepared for Ti deposition.

The oxidation with dry-air was in a pressure of 3.10^{-4} mbar during the last 0.3 Ohm to reach the final value of the resistance (between 1 and 2 Ohm). In each step of the construction the brazing and the TIG weld are leak check in the level of 10^{-10} mbar.l/s.

Vacuum Test of Ceramic Chamber

All the ceramic tubes with Ti coating were tested under UHV. During the procedure the value of the resistance, the pressure, temperature and residual gas were analyzed (see fig. 4). The final pressures of each ceramic tube are in Table 1.

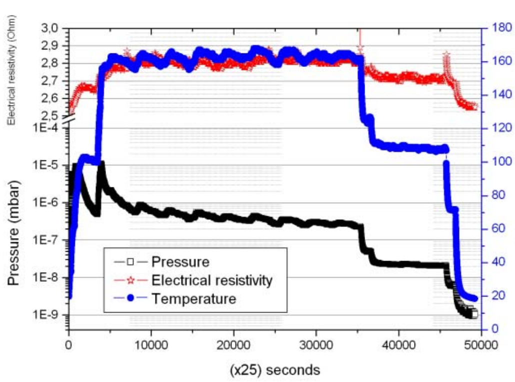

Figure 4: The vacuum test check the stability of Ti coating with temperature.

The baking procedure was made in 200°C during 208h to check the resistance stability with ventilation with dry N_2 at the end of the test. The residual gas in all tubes were mainly H_2, CO and CH_4

Table 1: Final pressure.

Kicker	Pressure
02	$1{,}0.10^{-9}$ mbar
03	$3{,}0.10^{-10}$ mbar
04	$1{,}5.10^{-9}$ mbar

Magnetic Measurement

In order to produce good repetibility of the field a careful magnetic measurement was performed for each group of ferrites and ceramic tubes. The fall, rise and top time were recorded in different currents to check the quality of the field in many energies of the beam. The measurements were in air and room temperature (see fig. 5). The differences of the integrated field are less than 1%.

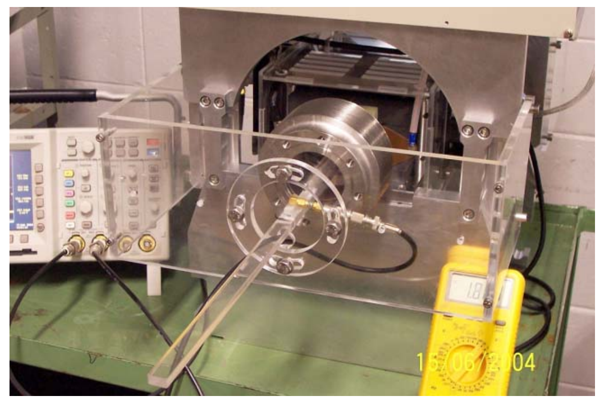

Figure 5: Magnetic measurement for each ferrite and ceramic tube.

Installation and Operation

During the 2004 shutdown the 3 kickers of the storage ring was installed in 2 days, without baking *in situ* (see fig 6).

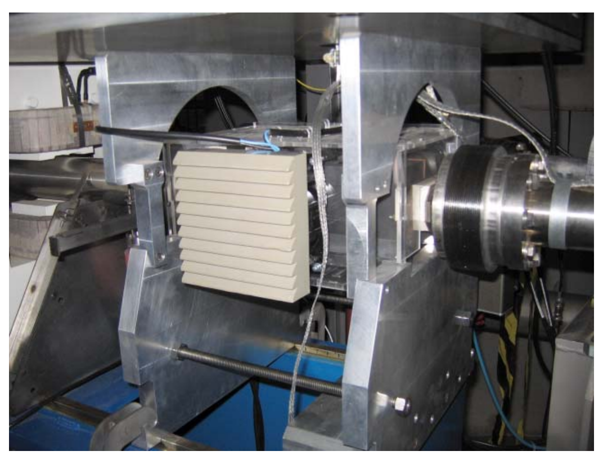

Figure 6: Kicker number 3 installed in the ring with the cooling system for the ferrites.

For the first operation the nominal parameters was set and a efficient capture of the pulse from the booster was obtained. Since the installation no more problems of overheating was observed and the pressure at the sectors reach the same level before in 20 Ah.

CONCLUSION

The project to build in house, a ceramic kicker vacuum chamber was made. All the procedures and measurements to check the parameters of the project were done. The oxidation of Ti coating with dry-air to stabilize the resistance shows a good behaviour in vacuum and after ventilation. The maximum current able to store have no influence in the kickers performance in multi or single bunch mode operation. The substitution of the original in vacuum kicker was well succeeding.

REFERENCES

[1] A.R.Drodrigues et al, *LNLS Commissioning and operation,* EPAC 1996, p.664.

[2] A.R.Drodrigues et al, *Commissioning and Operation of the Brazilian Synchrotron light source,* EPAC 1998, p.811.

[3] P.F.Tavares and J.A.Brum, *The Brazilian Synchrotron Light Source,* these proceedings.

[4] R.H.A.Farias et al, *Commissioning of the LNLS 500MeV Booster Synchrotron,* PAC2001, p.3257.

[5] R.H.A.Farias et al, *Upgrade and Commissioning of the LNLS RF System,* EPAC 2004, p.952..

