STATUS OF THE SOLEIL BOOSTER SYNCHROTRON

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Abstract

SOLEIL is a 2.75 GeV third generation synchrotron radiation facility under construction near Paris [1]. The injection system is composed of a 100 MeV electron Linac pre-accelerator followed by a full energy (2.75 GeV) booster synchrotron. The booster lattice is based on a FODO structure with missing magnet. With a circumference of 157 m and low field magnets (0.74 T), the emittance reaches 150 nm.rad at 2.75 GeV. A flexible and economic ramping switched mode procedure was chosen for the main power supplies cycled up to 3 Hz and a 35 kW-352 MHz solid state amplifier provides the RF power. At present time we are in an intensive equipments test phase and we plan to commission the booster with beam by June 2005.

INTRODUCTION

The lattice has a 2 periods race-track configuration with 22 cells and 4 missing magnets [2]. Injection and extraction magnets will be inserted in the free drift sections. The main parameters are summarized in table 1.

Table 1 : Main parameters of the booster at 2.75 GeV.

Injection - Extraction energy	0.1- 2.75 GeV
RF Frequency	352.202 MHz
Circumference / Period	156.6 m / 2
Max . cycling frequency	3 Hz
Horizontal emittance	1.5 10^{-7} m.rad
Energy spread	6.6 10^{-4}
Energy losses by turn	409 keV
Betatron tunes (ν_x , ν_z)	6.4 , 4.4
Momentum compaction	3.19 10^{-2}
Damping times (τ_x , τ_z , τ_s)	6.3, 5.7, 2.7 ms
Dipoles number / length	36 / 2.16 m
Field min/max	0.027 / 0.74 T
Quadrupoles number / length	44 / 0.4 m
Maximum gradient	10.3 T/m
sextupoles number / length	28 / 0.15 m
Sextupole max strength	16 T/m^2

At present time, the complete ring is already installed in the tunnel (see picture below) except the pulsed elements. The four main magnet power supplies as well as the RF amplifier are installed and are about to be tested.

MAGNETS

A campaign of systematic relative comparison of the integrated field of all the magnets has been done. The dipole spread at max field (0.74 T) is within ±0.15 % that is a factor of 2 below the tolerance (±0.3%). At injection field (0.027 T), the measured spread is enlarged up to low field sensitivity of the bench. The magnets were sorted so that their positioning minimises the induced closed orbit errors. The orbit was reduced by about a factor of 5.

The quadrupoles measured with a rotating coil, exhibit a spread of 100 µm for the magnetic centers and a tilt of 1 mrad min to max. The gradient spread is of 0.1 % (figure 1). All these results are within the tolerances.

Magnetic measurements were performed at 3 Hz on a 2 dipoles and a quadrupole with the first ramped power supply. The measured fields of the magnets during the cycle (1 kHz sampling) were in good accordance with the systematic DC measurement campaign.

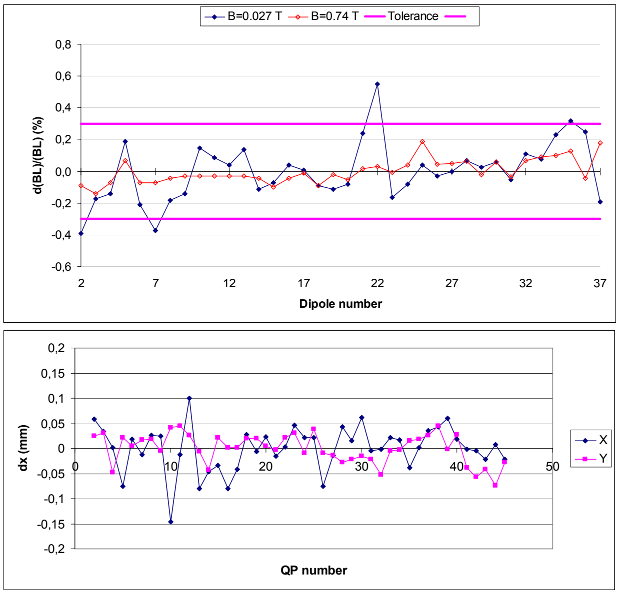

Figure 1: Dipole relative magnetic length spread (up) and quadrupoles magnetic center spread (down).

POWER SUPPLIES

Figure 2: Picture of the pulsed dipole power supply (3 Hz, 1 kV, 0.5 kA).

The first 3 Hz quadrupole Power Supply was delivered at the beginning of the year by BRUKER. The dipole power supply is shown in figure 2. Test on a low load (2 dipoles and one quadrupoles in series) have been done. It exhibits a systematic current shift (or delayed) of 1% max and a random variation of 0.1 % max relative to the set points (figure 3). These maximum deviations happen at the injection level where the current is low, and are just within the tolerance on current jitter. We expect an even lower jitter on the real load. The power supplies are now all installed and ready to be tested on their load.

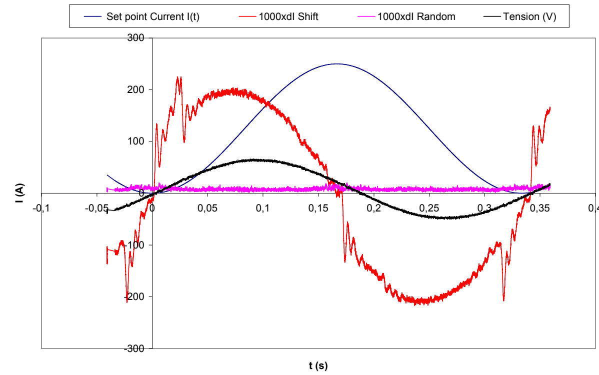

Figure 3: Systematic and random current shift on the 3Hz power supplies.

RF SYSTEM

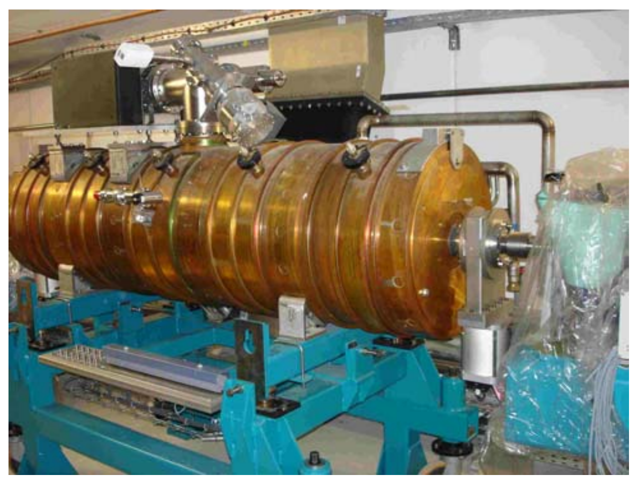

Figure 4: RF cavity in the tunnel.

A 35 kW-352 MHz solid state amplifier power a 5-cell copper cavity of the LEP type, donated by CERN. The complete booster plant, amplifier [3], cavity control & LLES (Low Level Electronic System), was successfully tested up to 30 kW in June 2004. The Cavity is installed in the tunnel (figure 4) and the amplifier will be installed and made operational by the beginning of June.

PULSED MAGNETS

All the injection (1 kicker + 1 septum) and extraction (1 kicker, 3 bumpers, and 2 septa) magnets and power supplies have been designed in-house. The 2 kickers, 3 bumpers and the 2 Eddy current septums have been delivered as well as their power supplies (figure 5).
The extraction active septum will be delivered by mid-may. They will be ready for installation in the tunnel after magnetic measurement by the end of May. A current time profile of the kickers is shown on figure 6. It confirms a rising (and fall) time of 200 ns and a flat top of 300 ns.

Figure 5: Booster bumper magnet.

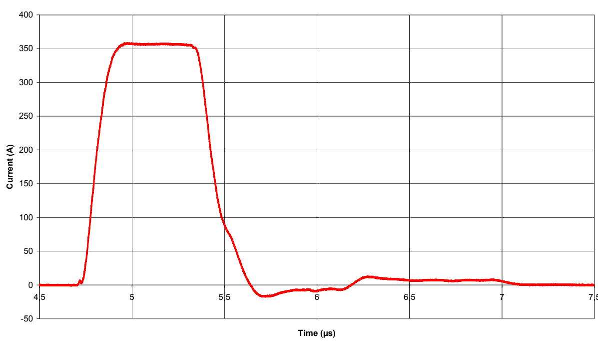

Figure 6: Measured current in the booster kicker magnet.

DIAGNOSTICS

All the diagnostics (screens, FCT, DCCT, strip lines and BPMs) have been installed in the tunnel. The fast current and direct current transformer (FCT, DCCT) have been tested together with their TANGO device.

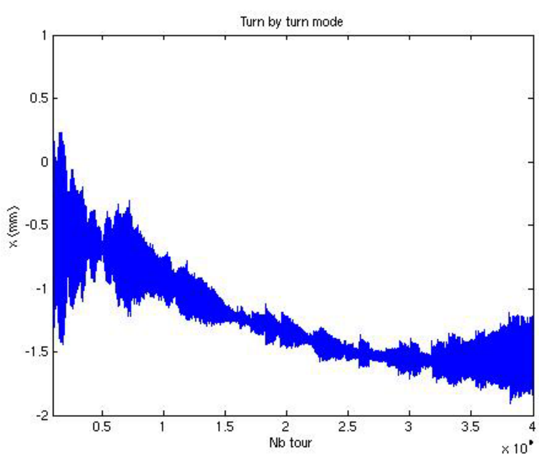

Figure 7: ESRF booster turn by turn orbit recorded with the SOLEIL Libera electronics

A systematic time domain reflectometry on all the BPMs electrodes has been done. All the transverse electrical offsets have also been measured on a bench and recorded. In addition, the Libera modules have been tested together with the TANGO Dserver on the ESRF booster. First turn and turn by turn mode have been operated with success [4]. The figure 7 depicts the first 40000 turns in the ESRF booster.

COMMAND CONTROL

A set of upper level applications has been prepared (GlobalScreen) to control the booster equipments (power supply (figure 8), RF, pulsed elements, synchronisation, vacuum) [5]. They are under test. In parallel low and high level Tango and Matlab applications are in progress.

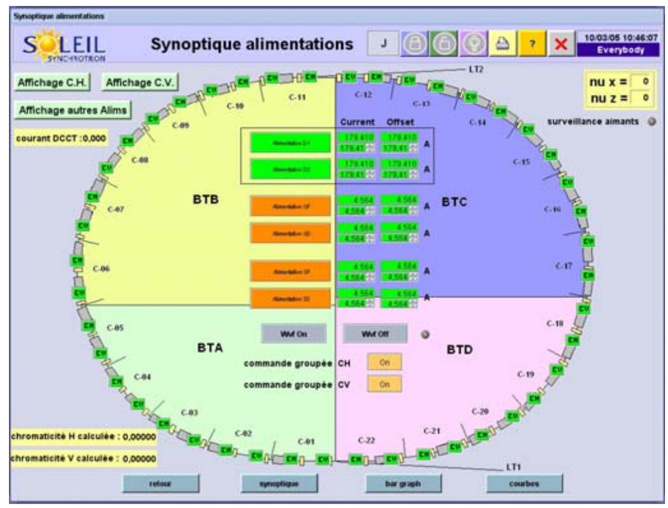

Figure 8: Screen shot of power supplies GlobalScreen driving application

CONCLUSION

As mentioned in the introduction, the booster is installed, aligned and connected in the tunnel. The utilities (water, power, air compressed) will be available early June. We will the start the test phase together with the command control. We plan about a few week tests, in parallel with the linac and the transfer line commissioning. First electrons in the booster are then expected before end of June 2005.

REFERENCES

[1] M.P. Level et al., Progress report on the construction of SOLEIL, these proceeding

[3] P. Marchand et al., Successful RF and cryogenics test of the SOLEIL cryomodule, these proceeding

[4] J.C. Denard et al., Preliminary Tests of a New Kind of BPM system for SOLEIL, DIPAC05

[5] L. Nadolski et al., High Level Control Applications for SOLEIL Commissioning and Operation, these proceeding

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