THE ALBA VACUUM SYSTEM: INSTALLATION AND COMMISSIOINING

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Abstract

The mechanical installation of the booster synchrotron of ALBA started in January 2009 and finished by having the system under vacuum in April 2009. The preparation of the booster vacuum system for the installation (partial assembly with the pumps and instrumentation, bakeout, etc) started already in September 2008. For the storage ring, the main mechanical installation was done from May to September 2009. The average pressure in the booster synchrotron is in the range of low 10^{-9} mbar and in the storage ring is in the low 10^{-10} mbar. The preparation of the installation, the installation and the present performance will be presented in this contribution. The first round of the booster commissioning took place at the end of 2009 and the beginning of 2010. The first data of the booster vacuum system commissioning are presented as well.

THE BOOSTER VACUUM SYSTEM INSTALLATION AND COMMISSIONING

The booster vacuum system design and installation is described in [1] and [2], respectively.

The preassembly and bakeout was done in the lab. and then the chambers were placed in the tunnel where they were aligned before being connected to each other. Once one sector (between two gate valves) is placed, it was pumped down and leak tested. Following the final assembly of the complete system, the ion pumps were powered.

The pressure readings just before the commissioning were in low 10^{-9} mbar range. During the commissioning stage of the booster, the energy of the beam was ramping and during the ramping there was an increase in the gauges pressure reading. However for the first operation of the RF cavity, the pressure increased into the levels of the valves interlock (1.10^{-6} mbar), that was due to the fast ramping of the power of the RF cavities to 45 kW. In general the booster vacuum system performed within the expectations during the period of commissioning.

Figure 1 shows the graphical user interface of the vacuum system which has been used during the commissioning of the booster and Figure 2 shows the pressure reading from the gauges around the booster before, during and after the commissioning stage.

Few problems were faced during the booster assembly and bakeout; one of the main issues was that during the assembly of the vacuum chamber, it was observed that some of the unit cell vacuum chambers (around 30% of the 31 chambers) were leaky (all at the same position), due to this, the chambers were sent back to the manufacturer for re-welding. Only one chamber was found leaky after the bakeout and movement to the tunnel. Another issue which has been found is that there was an induced noise on the reading of the Pirani gauges during the ramping of the magnets of the booster, into a range which was trigging the interlock of the cold cathode gauges, during the commissioning of the booster, the Pirani readings were removed from the interlock chain, and following this the issue was studied and all the gauges will be grounded and also ceramic breakers will be introduced into the booster at several places.

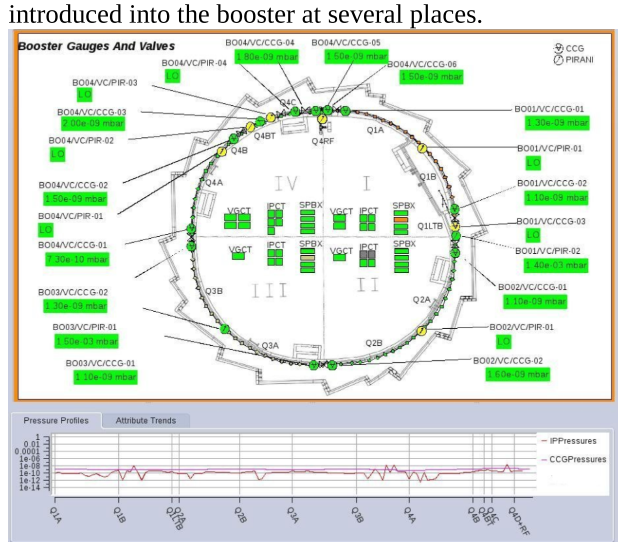

Figure 1: the graphical user interface of the booster vacuum system, just before commissioning.

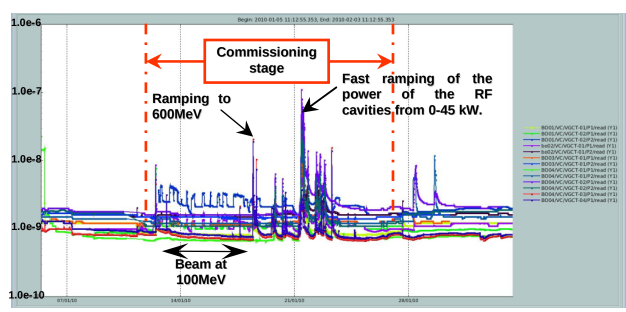

Figure 2: the pressure values for the booster before, during and after commissioning.

THE STORAGE RING VACUUM SYSTEM STATUS AND INSTALLATION

By February 2009, all the vacuum chambers needed for the installation of the storage ring were delivered and all the components and tools needed for the installation were ready by March 2009.

Several test assemblies were performed in 2008; however, the first test assembly of the storage ring vacuum system using the real storage ring vacuum chambers and the final assembly tools was done on April 2009. The test was successful and the procedure was validated, this gave the green light to commence the assembly of the storage ring.

The storage ring is divided into 16 sectors of 11 m long for the matching cells and 13 m for the unit cell. Between the sectors the long and the medium straight sections are located. Each sector was assembled in the clean room together with the ion pumps, gauges, valves…etc. Following this the sector was leak tested, RGA scan was performed, dimensional check for the whole sector, BPM test…etc. Following this the whole sector was connected to a strong back which is a supporting structure, and moved under vacuum to the 14 m long bakeout oven. Inside the oven the sector was leak tested again then baked up to 200°C, during cooling down (at 120°C), the ion pumps were flushed, the RGA was degassed and the NEG pumps were activated, then the sector was allowed to cool down to room temperature. The whole sector with the structure were transported under vacuum to the girders where it was connected to the supports (which have been aligned prior to the movement of the sector), following this the ion pumps were turned on and RGA scan was performed to assure the good vacuum of the sector.

The whole process (from the start of the assembly to the end of the movement to the tunnel) took one single week, all the storage ring sectors were placed into the tunnel in 4 months, with the last sector in place on 1st Sep. 2009.

The straight sections were assembled in the clean room, they were also vacuum tested (leak test and partial pressure test), then they were moved (under atmospheric pressure) using a manipulation support into the tunnel and connected to each sector and aligned, following this the straights were tested and baked in-situ. Figure 3 shows some pictures of the assembly of the storage ring vacuum system and Figure 4 shows a schematic of the assembly and bakeout procedure being followed for the storage ring vacuum system installation.

The RF cavities assembly and bakeout was done in a similar procedure of that of the straight sections, however the RF cavity straight was divided into smaller units (chambers and cavities), which allows easier manipulation and installation; in addition each part was aligned individually then connected. The cavities were baked for one week at 130°C for the cavities themselves and to 180°C for the rest of the chambers and bellows. Figure 5 shows part of the RF cavities installation inside the tunnel.

The pressure inside the vacuum chambers of the sectors, the straight sections and the RF cavities are between mid. to low 10^{-10} mbar range.

The installation of the injection straight has been started in the first week of May 2010, where the kicker magnets, the septum and the chambers in between were placed inside the tunnel, aligned and connected to each other, the in-situ bakeout of the injection straight is scheduled to be the last week of May 2010.

Part of the booster to storage ring transfer line installation was done at the same time with the installation with the RF cavities; however the last part which connects the transfer line to the injection straight is foreseen end of May, once the injection straight bakeout is over.

Figure 3: the installation of the storage ring sectors: a) preassembly and testing in the clean room, b) connection of the strong back, c) the sector inside the bakeout oven, d) bakeout to 200°C inside the oven, e) moving the sector after the bakeout under vacuum into the tunnel with the magnets open, f) placing the sector on the supports on the girder.

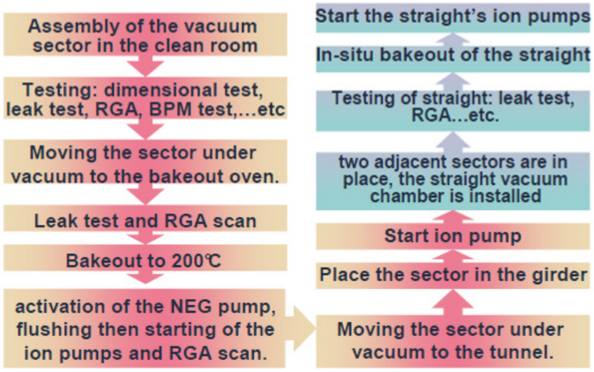

Figure 4: the assembly procedure of the storage ring vacuum chambers.

Figure 5: the RF cavity of the storage ring during the installation inside the tunnel.

During the installation of the storage ring, few problems appeared; one of problems was that some ion pumps high voltage feedthroughs brake after the installation inside the tunnel, the source of the problem is still not clear; however the effect of this problem is very large, as the exchange of the feedthroughs means to vent the sector or the straight and replace the feedthrough, this usually affect the ultimate pressure being achieved before the operation. Another difficulty which faced the installation team at the start of the installation is that during the lowering of the complete sector to the supports, it was necessary to do not only a vertical movement but also in the plane of the beam to avoid some interaction with the coils of the dipole, this movement was dangerous as this give risk of breaking the BPM feedthroughs, the solution was to move the dipole away and after placing the sector, the dipole was placed back into position.

A further problem which affected the final performance of the vacuum system was that the cabling of the ion pumps was not ready when the sectors where placed, due to this, only few ion pumps (around 3 out of 12) in each sector were powered for many months (some sectors for a year), before it was possible to power all of them.

THE FRONT ENDS INSTALLATION

The front end parts have been assembled together with the vacuum components by the supplier of the chambers, however before the assembly of the front end into the tunnel all the parts were leak tested in the front end lab. once they have passed the tests, the front end parts have been moved into the tunnel, where they were aligned then connected to each other, tested again then baked in-situ to 200°C, at the end of the bakeout cycle, the ion pumps were flushed and the RGA was degassed, then the front end was cooled down to room temperature, the average pressure in the front ends is in the low 10^{-10} mbar range. Figure 6 shows the assembly of the front end parts inside the lab., and the installation inside the tunnel.

Figure 6: the assembly of the front end in the lab. and during the installation in the tunnel.

CONCLUSION

The booster vacuum system installation was done first preassembly and bakeout inside the vacuum lab. then the chambers were stored under nitrogen, when the decision to start the mechanical installation inside the tunnel was done, the chambers were put into their final location, align and connect to each other, with this procedure, it was possible to solve the problems earlier and also shortened the installation inside the tunnel by 6 weeks only. The performance of the booster vacuum system before, during and after the commissioning was within the expectations.

The installation of the storage ring vacuum system has been described; it was divided into three main steps, assembly and test in the vacuum lab, bakeout in the oven and movement of the sector under vacuum to the tunnel. The installation went smoothly with only few problems and within the schedule. The description of the front ends installation was also described. The base pressure inside the vacuum chambers of the storage ring and the front ends is in the 10^{-10} mbar range.

ACKNOWLEGEMENT

The authors wish to express their gratitude to the CELLS installation teams who worked as a real team and managed to achieve great results. Very special thanks to the vacuum and front ends team of ALBA who worked hard and efficient to have the vacuum system installed within the expected specifications and ahead of the schedule.

REFERENCES

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[2] E. Al-Dmour et. al. "The Status of the Vacuum System of ALBA Synchrotron", PAC 2009.