

THE INSTALLATION OF TPS BOOSTER VACUUM SYSTEM*

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Abstract

The booster of Taiwan Photon Source (TPS) is designed for 3GeV full energy injection ramped up from 150MeV. It is a synchrotron accelerator of 496.8m. The major vacuum system is elliptical tube made of SUS304 stainless steel. The inner cross section is 35*20 mm with 0.7 mm thickness. The elliptical tubes were chemical cleaned and ozonated water cleaned before installation. The bending tube was assembled and aligned into dipole magnet at laboratory. The BPM support and pumping chamber support was aligned with 0.3 mm deviation. The BPM chamber and pumping chamber was assembled firstly. The elliptical tube and bellows was installed to connect BPM, pumping chamber and bending chamber. The cold cathode gauge and TMP was mounted on pumping chamber. The pressure data and residual gas analysis will be described in the paper.

INTRODUCTION

The booster of Taiwan Photon Source (TPS) is a synchrotron accelerator and designed for 3GeV full energy injection ramped up from 150MeV. It is 496.8 meters in circumference and concentric with the electron storage ring in the same tunnel. The vacuum system is divided into six super-periods. Nine bending chambers (two of length 0.8 m and seven of length 1.6 m) and ten beam position monitor in one lattice period.

EPLLIPTICAL TUBE

All TPS booster vacuum chamber was made of SUS304 stainless steel. The major vacuum chamber is elliptical cross section of 35x20 mm. It could satisfy beam stay clear and the cross section of magnet. [1] The thickness of elliptical vacuum chamber is 0.7mm for reducing eddy current. The elliptical tube was extruded from circular tube with suitable size at factory in Tainan. The tolerance of straightness deviation is 2.5mm in 4 meters. The total length of booster elliptical tube is about four hundred meters and the number of tube is about one hundred and fifty. The elliptical tubes with 2.7 to 3.3 meters are over fifty percent. The longest length is about 4.4 meters.

The elliptical tube was cut to correct length by wire electrode cutting. The straightness should be checked again before cleaning. Figure 1 is the picture of cleaning elliptical tube. After chemical cleaning, the elliptical tube was welded with flange by micro TIG welding. The tube should pass the leakage checking and ozonated water

cleaning. [2][3] The process is that immerse the tube into 30ppm ozonated water for thirty minutes. After dry the elliptical tube with flange, it package into aluminium foil bag for installation.

The bending chamber for dipole magnet bent from straight elliptical tube. Check the curvature and size of elliptical tube by mould. It became qualified bending chamber with the same cleaning process and welding flange. CF35 stainless steel circular chamber replaced the elliptical tube in the long straight section without magnet. The CF35 circular chambers also clean by 30ppm ozonated water before installation.



Figure 1: Stainless steel elliptical tube cleaning.

INSTALLATION

The elliptical bending chamber was installed inside the dipole magnet at laboratory. The support for bending chamber was mounted on the bottom part of dipole magnet and aligned. The bending elliptical tube was mounted on the support and installed into the TPS tunnel with the dipole magnet.

For reducing the effect of ferromagnetic materials on the electron beam, the aluminium support was adopted. Most of booster vacuum system support was mounted on the inner wall of TPS tunnel. After the support was

installed, it would be aligned by laser tracker. The deviation for support of BPM chamber is less than 0.1mm and it of pumping chamber and long straight tube is less than 0.3mm.

After the support was aligned, the BPM chamber and pumping chamber could be installed on the support. The pumping chamber connected with bending chamber by formed bellows which welded on the both side of pumping chamber. The suitable elliptical tube was installed to connect BPM chamber with pumping chamber and bending chamber. After the vacuum chamber in the electron beam direction was installed, angle valve, invert magnetron gauge and sputter ion pump could be mounted on the pumping chamber. After sputter ion pump was installed, the vacuum system should pump down as soon as possible in order to reducing exposing time.

PUMPING DOWN

There are four to six pumping chamber between two gate valves. After booster vacuum system including two gate valves was completely installed. At least two turbo molecular pump with mechanical pump was mounted on the pumping chamber to pump down. The pumping down curve for one section of TPS booster vacuum system was shown as Figure 2. The IMG1 to 3 is from upstream to downstream. The molecular turbo pump was mounted on pumping chamber with IMG1 and IMG3. The illustration of this period of vacuum system was showed as Figure 3. The distance between two pumping chambers is about eight meters. The pressure of pumping chamber without turbo molecular pump is about one magnitude higher than it with turbo pump.

The ultimate pressure without starting sputter ion pump is about 5×10^{-8} mbar. In accordance with the result of booster vacuum system prototype, the pressure could reach 5×10^{-9} mbar after starting sputter ion pump and it could reach 3×10^{-10} mbar after system bake out.

The mass spectrum from a residual-gas analyzer shows in Figure 4. The major residual gases are water vapor,

hydrogen, carbon monoxide, carbon dioxide and hydrocarbons.

FUTURE WORK

The installation of TPS booster vacuum system is almost complete. The deviation of elliptical long straight tube was higher than expected after installation. Additional supports need to be mounted on elliptical tube for reducing deviation.

The bending chamber at the downstream of extraction Kicker will be replace by elliptical bending tube with cross section 50x20mm. The other vacuum chamber between extraction kicker and septum will also change to dimension of CF63. The vacuum system near extraction and injection section will be bake out.

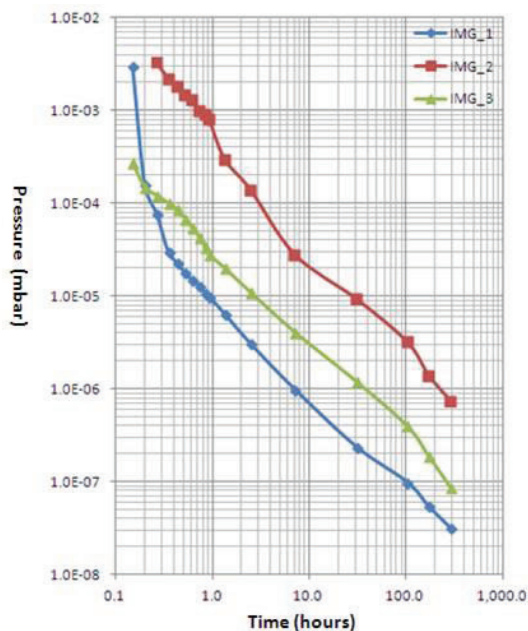


Figure 2: Pumping down curve for one section of TPS booster vacuum system.

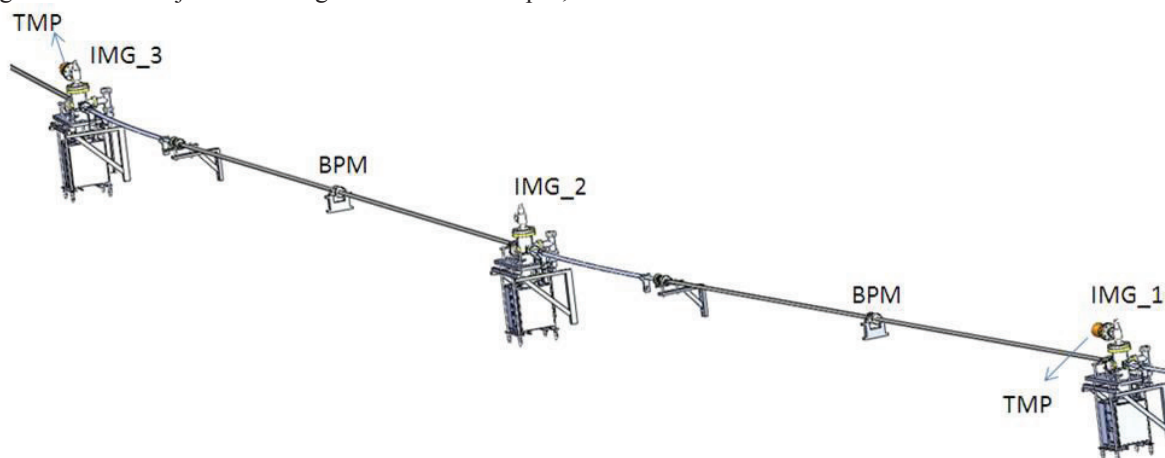


Figure 3: The illustration of TPS booster vacuum system which is the section of pumping down curve.

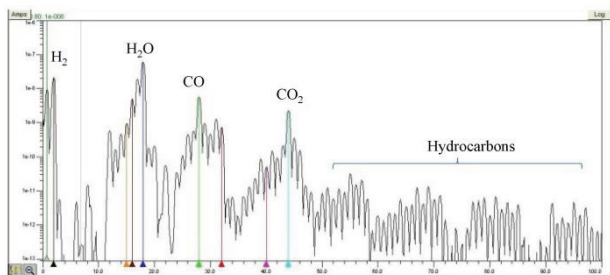


Figure 4: Mass spectrum for one section of TPS booster vacuum system.

CONCLUSION

The booster of Taiwan Photon Source (TPS) is a 3GeV synchrotron accelerator with 496.8 meters in circumference. The major vacuum chamber is elliptical cross section of 35x20 mm and with 0.7mm thickness. The tolerance of straightness deviation is 2.5mm in 4 meters. The total length of booster elliptical tube is about four hundred meters and the number of tube is about one hundred and fifty. After chemical cleaning, the elliptical tube was welded with flange and ozonated water cleaning before package for installation.

The bending elliptical tube was mounted into the dipole magnet at laboratory and installed into the TPS tunnel with the dipole magnet. After the support was aligned, the BPM chamber and pumping chamber could be installed.

The deviation for support of BPM chamber is less than 0.1mm. The suitable elliptical tube was installed to connect BPM chamber with pumping chamber and bending chamber. After sputter ion pump was installed, the vacuum system pumped down for leakage check.

The ultimate pressure without starting sputter ion pump is about 5×10^{-8} mbar. The pressure of pumping chamber without turbo molecular pump is about one magnitude higher. In accordance with the result of booster vacuum system prototype, the pressure could reach 5×10^{-9} mbar after starting sputter ion pump and it could reach 3×10^{-10} mbar after system bake out.

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