The Design and Commission of Vacuum System for CYCIAE-230 Superconducting Cyclotron

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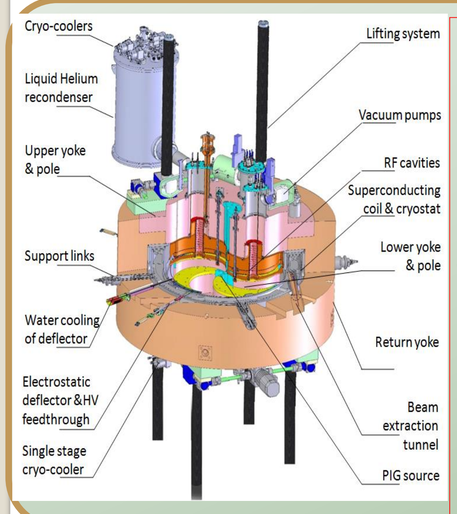
Abstract

In this paper, the design and installation and commission of CYCIAE-230 superconducting cyclotron main vacuum system's equipment are described. The pressure in the particle acceleration chamber should be better than 1 x 10^{-6}mbar. The main technical features of the accelerator vacuum system are that the main magnet cover plate with diameter 3.12m are used as a part of the main accelerator chamber, 8 magnetic poles, 8 high frequency resonators, and 2 sets of striper targets and 2 sets of radial targets are installed in the main accelerator chamber, resulting in technical difficulties such as large surface gas load, virtual leakage, strong leakage of magnetic flux at the installation position of vacuum equipment (up to 2000 gauss) ,high inner ion source load and so on. The main vacuum system is designed using 9 sets of TMP with magnet shields installed on the valley of magnet poles, which also used as RF cavity.



Challenges for Vacuum System of CYCIAE-230 :

✓ Shared with RF used the same cavity for exhaust.

✓ The strong residual magnetic for TMPs

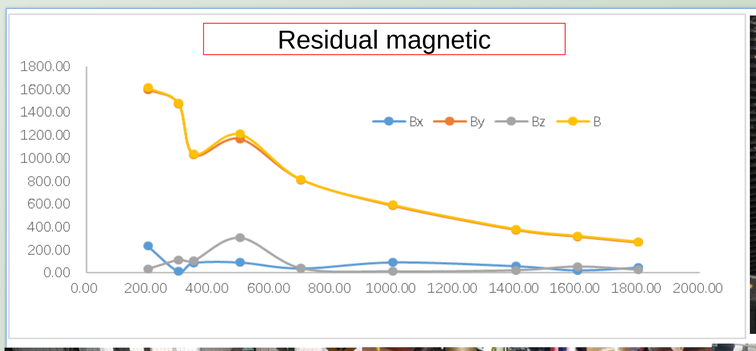
✓ Inner Ion source.

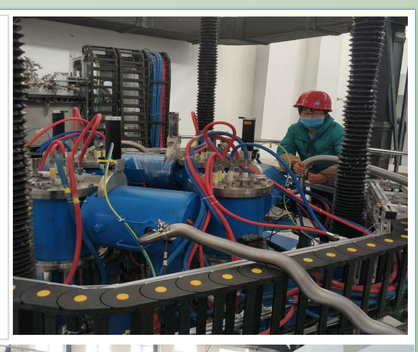
✓ Thousands of internal welds in vacuum chamber

Technical requirements for Vacuum System of CYCIAE-230:

- Static pressure is better than 1×10^{-6}mbar, Dynamic pressure better than 5×10^{-5}mbar
- Clean, oil-free vacuum system
- The overall leakage rate is less than 2×10^{-11}mbarl/s

Development of CYCIAE-230 vacuum system



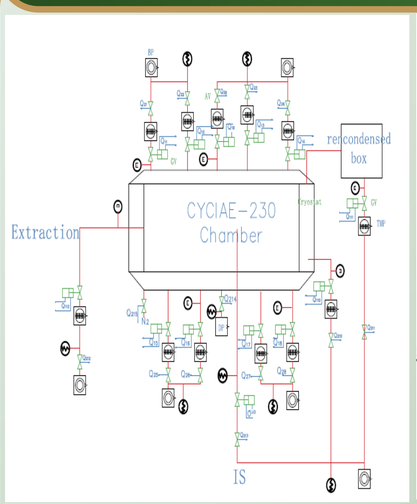


All the parts of CYCIAE-230 superconducting cyclotron are tested while processing, ensuring that the leak rate of every components and seals meet the design requirements.

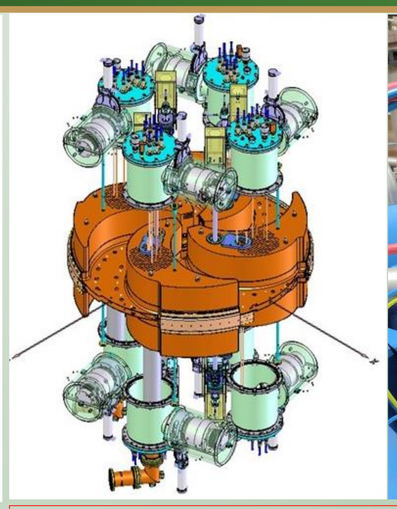
Static pressure of CYCIAE-230 accelerator chamber

CYCIAE-230 vacuum system has been successfully developed, static pressure is better than 5.6 x 10^{-7}mbar, and the dynamic pressure is better than 5 x 10^{-6}mbar, which is better than the design. And It has been in stable operation for more than two years.

Vacuum System of CYCIAE-230



Schematic of CYCIAE-230

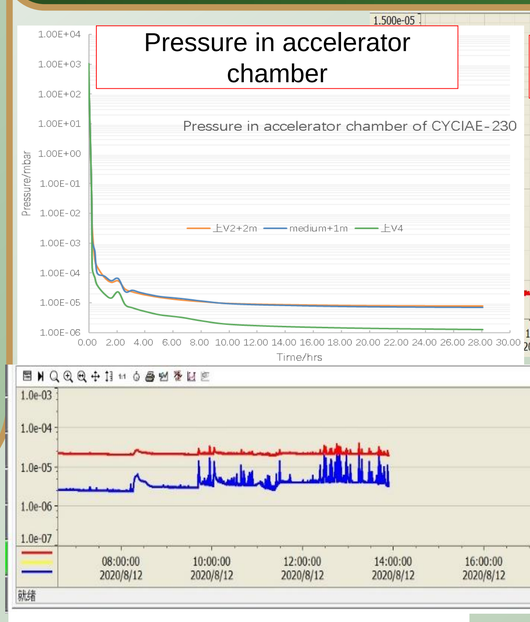


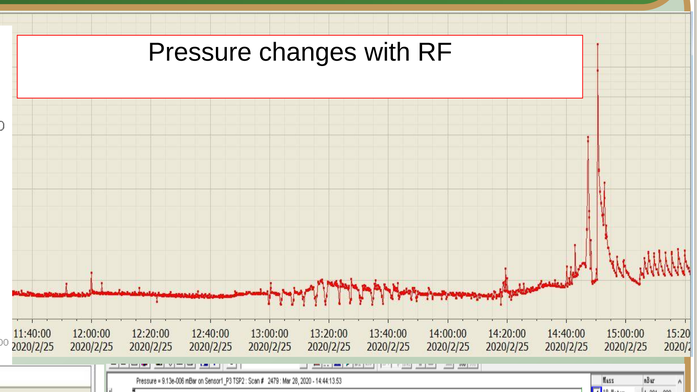
9 TMPs used for main chamber

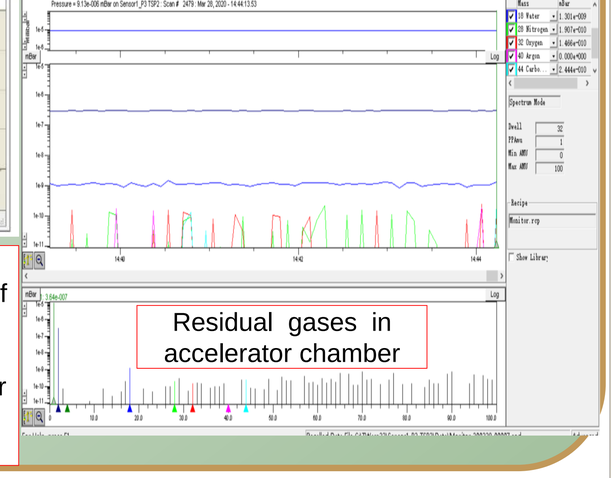
Shield for TMP

To solve the above four technical problems of superconducting cyclotron CYCIAE-230 vacuum system, 8 sets of TMPs with magnet shields are installed on the valley of magnet poles, which also used as RF cavity, 1 set of TMP with magnet shields is installed on the central magnet pole to increase the pressure of central region. The pressure in the particle acceleration cavity is better than 2 x 10^{-6}mbar in 48 hours without ion source. The development and commission of CYCIAE-230 vacuum system will be presented.

The commission of CYCIAE-230 vacuum system







1.950e-05 mBar
3.186e-06 mBar
4.451e-04 mBar

Dynamic pressure of CYCIAE-230 accelerator chamber

Conclusions

The challenges for the vacuum system of Sc cyclotron CYCIAE-230 are as follows: the first one is that the exhaust system and the strong RF system share same magnet valley area; Second strong residual magnetic has to be considered in the design, magnetic field shielding is designed to protect the vacuum equipments;1SCCM gas load for inner ion source also is the challenge for CYCIAE-230 vacuum system. 8 sets of TMPs(1600l/s） with magnet shields are installed on the valley of magnet poles, which also used as RF cavity, 1 set of TMP（200l/s） with magnet shields is installed on the central magnet pole to increase the pressure of central region. After design, development and commission， we has got 5.6 x 10^{-7}mbar and 5 x 10^{-6}mbar separately for static pressure and dynamic pressure. And It has been in stable operation for more than two years.