6 - 29 Design of Ceramic Vacuum Chamber

Yang Weishun

Ceramic material is inorganic, non-metallic, solid, and inert. Alumina ceramic (Al_2O_3) is a kind of important engineering and structural ceramic that has been widely applied in many fields due to its unique high strength, good excellent high-temperature mechanical and electrical insulation properties. However, ceramic is difficult and expensive to fabricate into components with large scales and complex shapes. By joining ceramics to metals, it is possible to combine the respective advantages of ceramics and metals. Active metal brazing has been considered one of the most effective joining methods owing to its simplicity, high bonding properties, and good repetitiveness, as well as its perfect adaptability in terms of joint size and shape.

A ceramic-friendly design is necessary to reliably integrate the ceramic into the overall system. It must be noted that ceramics have a low number of slip systems. Unlike metals, they do not possess any plastic deformation capacity for stress relief, which leads to spontaneous crack propagation. The occurrence of tensile stresses is critical for ceramics, particularly.

To reduce eddy current effect in high-frequency magnetic field, the ceramic tubes are used in accelerators. By using a ceramic-friendly design, we developed runway section ceramic vacuum tube as shown in Fig. 1. Its thickness is 8 mm. The tensile stresses and bending stresses are transferred to the metal, while the ceramics can be exposed to high compressive stresses. The appearance of ceramic vacuum tube is shown in Fig. 2. The structural design shows high gas tightness and mechanical strength. Its leakage rate under metal seal is 5.0×10^{-8} Pa·L/s. The deformation at room temperature is almost zero.

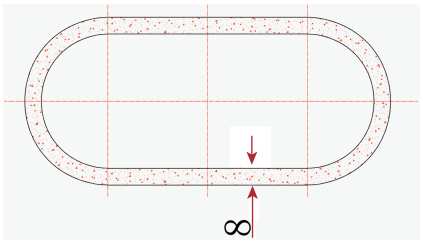

Fig. 1 (color online) Schematic of runway section.

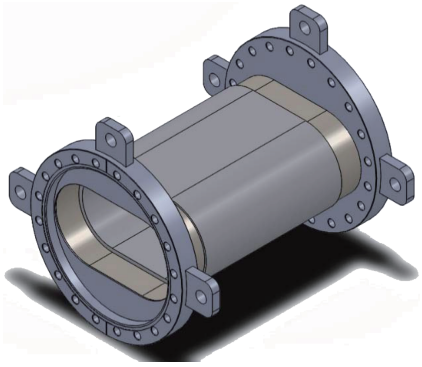

Fig. 2 (color online) Appearance of ceramic vacuum tube.

6 - 30 Work Progress of Slow Control Group in 2016

Wang Yanyu

In 2016, through the efforts of all the members in Slow Control Group in IMP, we had got several good results in HIRFL-CSR control, monitor and alarm system. In HIRFL-CSR operation and maintenance area, our group is in charge of the running and maintains of several accelerator state monitor and alarm systems such as the water leakage detection system, the water pressure/temperature monitor system, and magnets temperature monitor system, vacuum detection, ion source control system, and so on. Main achievements in HIRFL maintenance and other research work are listed below:

(1) **Design of Dose monitor and gate control system for personal safety in HIRFL-CSR.** For personal protection purposes, the slow control group designed a dose monitor system and a gate control system for the radiation protection group in HIRFL-CSR. The hardware design of these two controllers is based on TI's MSP430F169 mixed signal processor and the GUI design is based on C++. Up to now, the dose monitoring system has been successfully applied in Linac and RIBLL1, and the gate controller is applied in the HIRFL-CSR personal safety interlock system. These two systems are stably running since installed in Aug. 2016.

(2) **Upgrade of Electronic Cooler Control System in HIRFL-CSRm.** This work realized some important device control in electronic cooling equipment, including the current and voltage read of the HV power, voltage set, slight tuning function, the leakage current curve show and the temperature, magnetic switch state monitoring

function. The alarm threshold setting function and the overvoltage interlock function are designed to make the whole control system run stably and reliably.

(3) **Design of a Digital and Analog Mixed Controller Based on MSP430F149.** In order to meet the requirements of collection the various typeset electronic data which hase signals with relatively slowly speed in the site of HIRFL in IMP, a new controller which is combined with digital inputs outputs(DIOs) and analog inputs outputs(AIOs) was designed. The controller communicates with upper computer by net module or through the port of RS485 which also could place as cascade using. The controller has 4 AIO channels and 8 DIO channels, the Integral Nonlinearity (INL) error of the ADC channels could be better than 0.4% and the INL of the DAC is better than 0.2%. This controller is used as an integrated alarm for several HIRFL state monitor systems.

(4) **Design of a portable multi parameter secondary cosmic ray detector**. One small, low power consumption, portable and fully functional secondary charged particle detector is designed and developed. This detector consists of sensitive detection body, photomultiplier tube, high voltage power supply module, signal conditioning and data processing circuit. It can work at outdoor using a solar battery or vehicle power supply when monitoring the cosmic ray flux at different areas via a network for a long time, and making records of environmental parameters, such as air temperature, humidity and air pressure in these areas as large data sample. This large data sample shall be used in a further study of the correlation between cosmic rays and climate change, biodiversity and genetic variations of animals and plants.

(5) **Water conductivity detection and monitor system.** This is a newly system built which is a cooperation work with the water supply group. Up to now, we have shown 16 water conductivity monitor points of CSR in our interface. In the future, we plan to expand this system to the whole HIRFL area.

(6) **EPICS GUI reform of the water leakage detection and alarm system.** To respond the requirements of general control interface design, we paid a lot effort to reform our water leakage detection system to EPICS structure and used CSS to realize the new interface. This EPICS structure GUI is testing in our lab and will replace the older interface in the near future.

(7) **Realize of the remote switch function for the motor drivers and PLCs in SFC-ES control.** To avoid user operation error and to make user convenience, we designed a remote switch function for the motor drivers. In aids of this function, only when the beam tuning person operates the motors, the motor drives are powered on. And this work also realized the remote reset function of the PLC. This work largely reduces the chance of onsite maintenance and improve the reliably of the control system.

(8) **One Beam Emittance Measurement System for ECR Ion Source.** In order to measure beam emittance of ECR ion source more accurately and reliably, and to display data from different devices on the operation interface uniformly, the double slit motor motion control and the data acquisition of PXI board are introduced in the emittance measurement system, based on EPICS software system.

(9) **Design of a 2×4 synchronous voltage pulse amplifier.** In this work, a kind of synchronous pulse amplifier is designed, which can enlarge the input voltage pulse signal of 3.3 V to 15 V, and the rise time is less than 20 ns. This amplifier has long distance line driver capacity.

In the coming 2017, all members in our group will continue to do HIRFL operation and maintenance work, and also put the necessary studies on the pre-research of HIAF project.

6 - 31 Upgraded Control Software for Electronic Cooler of CSRm

Su Jianjun, Wang Yanyu and Zhang Jianchuan

The architecture, design, and testing of an accurate and usable electronic cooler control software for CSRm are detailed, and the results of its use is presented. The software, based on the Microsoft Foundation Class, was developed following the model-view-controller architecture pattern. On the hardware side, an I-7017R module was adopted for analog-to-digital conversion and an I-7065D module for electronic delay. The communication protocol was analyzed, discussed, and implemented, and the control software was then tested at CSRm with the $^{12}C^{3+}$ carbon beam. The fast reaction time and high-precision data processing exhibited during beam tuning verified the stability and maintainability of the proposed control software.

The control layer receives user commands and analyses them to manage the field equipment. The real-time status of the system will be sent to the data servers, which receive the experimental data acquired by the data-acquisition systems. These data are processed and stored in the experiment database. The system also provides users with data services relevant to the query commands, including data processing. The field devices execute the network commands to connect to the system. Fig. 1 is a flowchart of the system software.