

Furthermore, the parts drawing of the BRing, SRing, HFRS and beam transport lines has been completed. It is expected to complete most equipment processing by the end of 2023.

## Reference

- [1] Z. Chai, N. F. Wei, J. Q. Jiao, et al., *Vacuum*, 210(2023)111856.

## 7 - 14 Development of HIAF Control and Network System in 2022

Zhang Wei, Yue Min, An Shi, Ge Liang, Zhou Yunbin, Ma Tao, Li Yanlin, Chang Jianjun, Liu Xiaojun, An Jingrui, Wang Pengpeng, Yuan Chao and Wang Baopeng

High Intensity Heavy-ion Accelerator Facility (HIAF) is one of the 16 projects of the 12th Five-Year Plan (2012-2030). It is a next-generation heavy ion scientific research device with international leading level and wide range of subject uses. The task of the control system is to complete the task of overall control, including the overall structure of the control system, the standard of the control system interface, the time system, the database system, the network system. At the same time, the control of the relevant subsystems is completed, including the ion source system, the power supply system, the injection induction system, the electronic cooling and electronic internal target system, the high frequency system and the vacuum system. In 2022, the control group completed some subsystems design, test and hardware product of HIAF (include the timing system, control network, the configuration administration system, SRing Electron Cooler High-end Power Supplies Control System, Time performance optimization for master node, Timing Network Monitoring System).

High-precision timing is the key to precise control of the equipment, which determines the accuracy and precision of the operation of the equipment. Based on the standard time synchronization protocol, we develop a terminal node for the HIAF timing system. The synchronization precision is better than 60 ps and the synchronization accuracy is better than 2 ns. At present, the design, hardware and software have been completed, and the test results show that the synchronization precision of the terminal node meets the design requirements, and the reference trigger output jitter is better than 50 ps. Figure 1 is the picture of the terminal node.

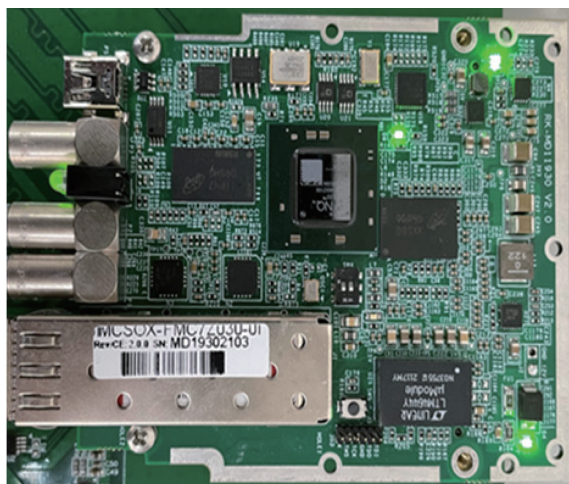


Fig. 1 (color online) Picture of the terminal node.



Fig. 2 (color online) Electronic cooling control hardware.

We completed the software and hardware development of electronic cooling and electronic internal target control prototype. Figure 2 is the Electronic cooling control hardware. The installation of the first ion source SECR2 control system cabinet (2 units) at the front end of HIAF has been completed. HIAF Chopper and Kicker control system hardware has been completed. At presently, we are conducting joint testing work with subsystems. The HIAF control network is designed based on three-level (core, aggregation, access) network architecture, and achieves 40 Gbps backbone network. The access switch adopts the mode of 10 Gigabit uplink and Gigabit downlink to ensure high data throughput. We designed a configuration administration system to manage the configuration and running status of the HIAF Timing System.