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The Design of NBI Experimental Data Processing System

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As a necessary auxiliary heating method, Neutral Beam Injection (NBI) heating technology has high heating efficiency and clear physical mechanism to meet various needs of fusion experiments, so it will definitely become an indispensable key technology in future fusion research. NBI requires parameter tuning and optimization before it can be formally put into operation, so its operational data is of critical importance to experimenters. Undoubtedly, better control, data processing and feedback methods will be of great benefit to the feedback of experimental data and the analysis of experimental results. Inspired by the COntrol, Data Access and Communication (CODAC) system, this paper proposes the design and implementation of a CODAC-based NBI experimental data processing system based on the actual operational requirements. For system design, a three-tier distributed system architecture model of "task processing", "storage processing" and "interaction processing" is constructed based on the Experimental Physical and Industrial Control System (EPICS). In terms of data exchange, a data processing scheme between memories is proposed based on the double buffering algorithm and MMAP technology. In addition, considering the scalability and compatibility of system, a device model is proposed based on EPICS to unify the device abstraction processing format and standardize the subsequent device development. In terms of transmission, a data transmission structure under high-speed sampling is proposed based on TCP/IP protocol. Meanwhile, considering the possible failure state of the system and the storage limitation of EPICS, this system adopts the service model of hot standby dual computer so that it can provide data storage and guarantee services while also providing a platform for system status monitoring and remote services. In terms of system operation, a reasonable concurrency handling mechanism is proposed considering the concurrency exceptions that may be brought by both local and remote operation modes. After testing on NBI testbed, the system showed a significant improvement over the old method in terms of data processing. When the buffer size is set to 1M, the data processing efficiency under the NBI testbed is the highest, which is about 5 times of the previous data processing rate. This system will provide more real-time data processing for NBI experiments and will be used to cope with more complex pulse experiments in the future.

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