中国科学院高能物理研究所
INSTITUTE OF HIGH ENERGY PHYSICS
CHINESE ACADEMY OF SCIENCES

Design of the HEPS FOFB System Based on an ATCA Platform

Guo-Dong Gao
HEPS FOFB Work Group
2025-09-17

CONTENT

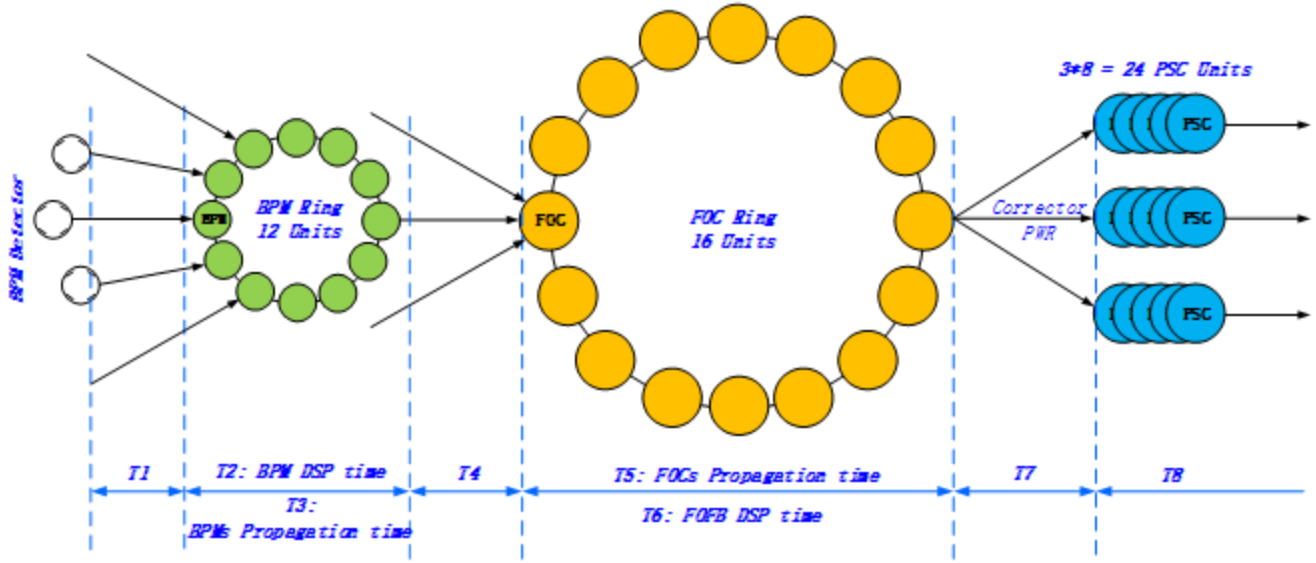
1. Introduction to the HEPS FOFB system
2. Hardware of FOFB Controller Based on Customized ATCA
3. System Integration and Testing
4. Summary

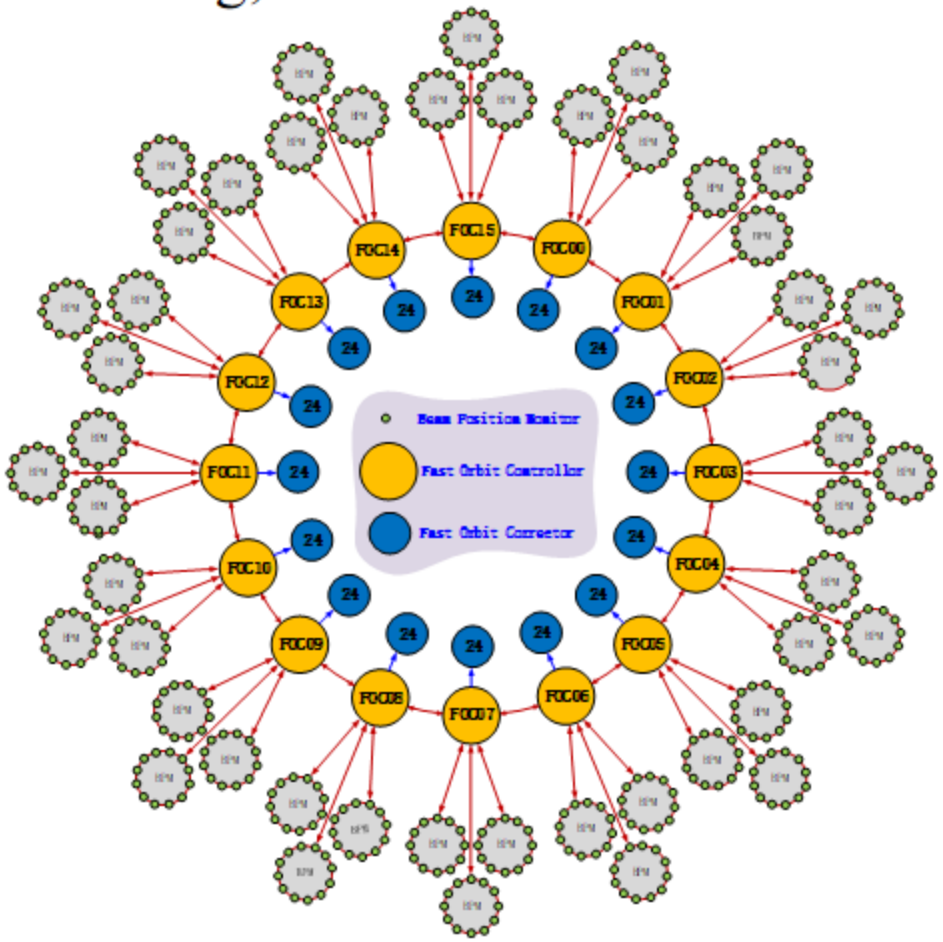
1, Prime introduction to the HEPS FOFB system

FOFB system framework

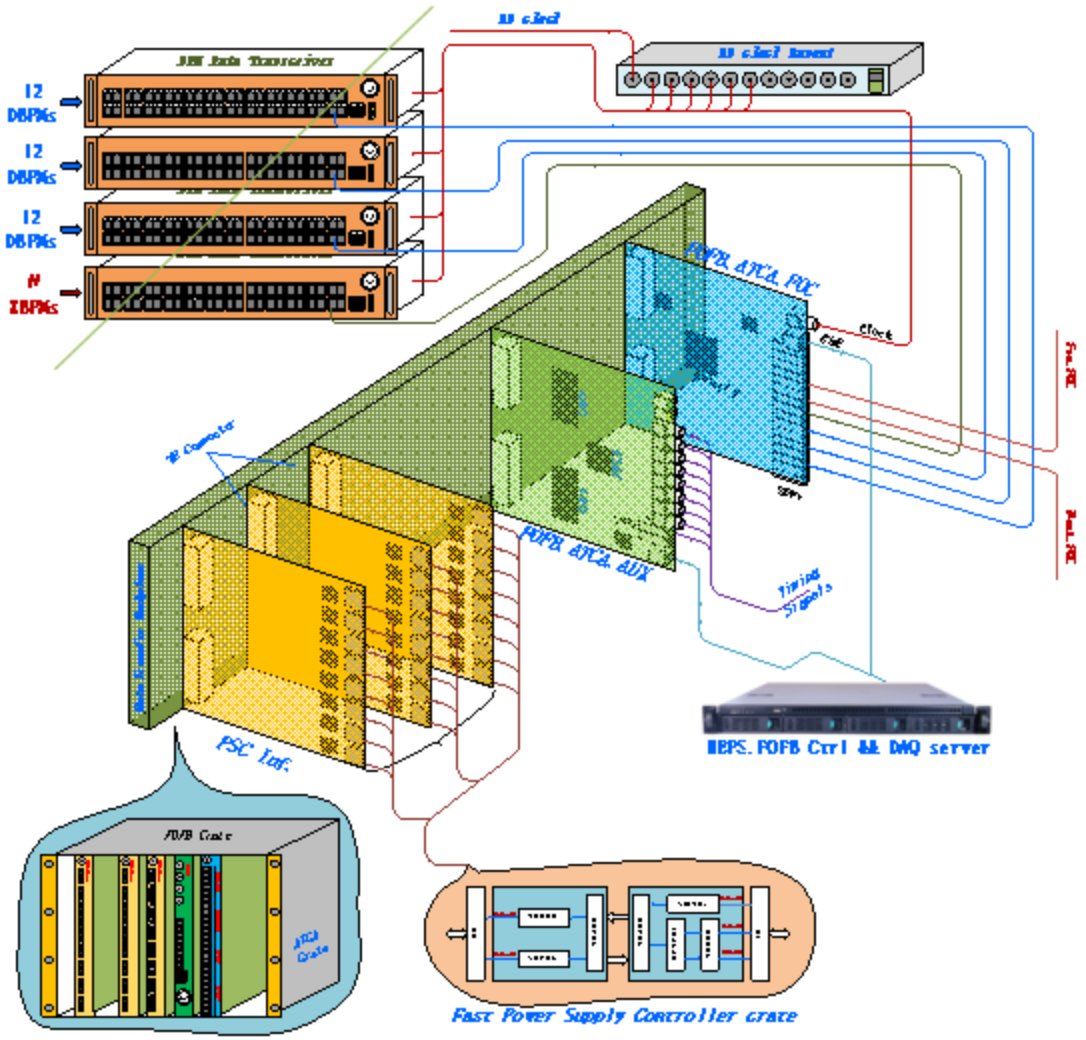
FOFB system framework

- "Ring-Star-Ring" structure
  - For each BPM station, construct all 12 BPMs to a BPM ring;
  - Connecting adjacent 3 BPM rings to 1 FOFB unit.
  - Link all 16 FOFB units to 1 large FOFB ring.
  - Connecting 1 FOFB unit to 3 FC PSC units.





FOFB system Hardware Unit



- **FOFB Unit Components**
  - **FOFB.ATCA.BackPlane**
  - **FOFB.ATCA.FOC**
  - **FOFB.ATCA.AUX**
  - **FOFB.ATCA.PSC_Interface**
  - **FOFB Server for control and DAQ Op.**
  - **RF clock Fanout module**
  - **BPM data Transfer module**
    - **Used for BPMs data reassemble and forward function.**

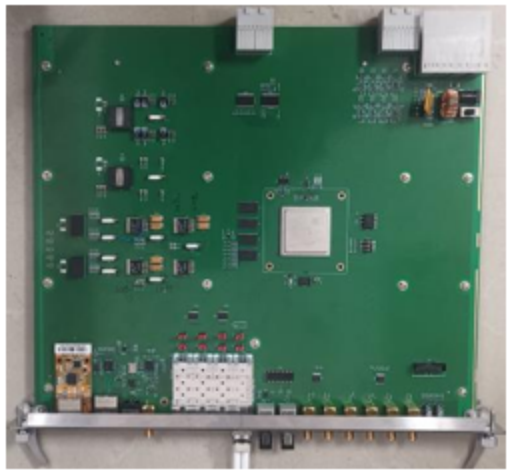
2, The construction progress of the FOFB system

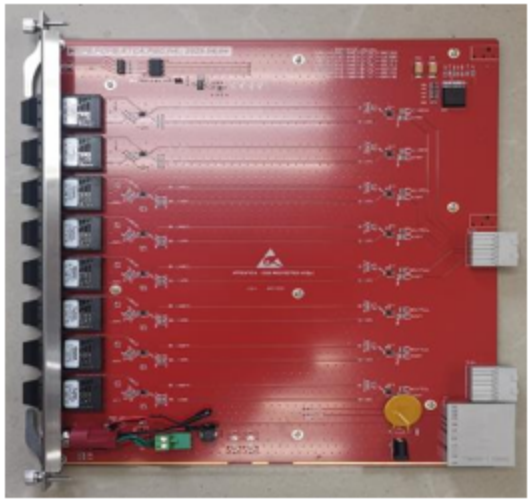
Job list

- Function module Mass production and Testing
- Function module installation
- Cabinet cable installation
- Communication testing
- Timing signal testing
- FOFB data acquisition work
- FOFB temperature monitor function design
- Fan speed adjustment for ATCA crate

Complete the mass production and testing

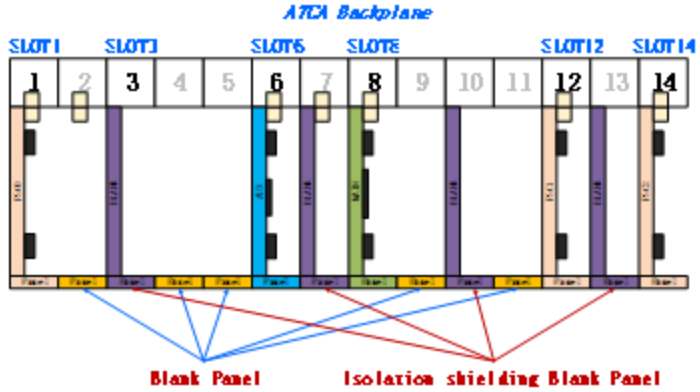
- FOC module (20 PSCs)
- AUX module (20 PSCs)
- PSC_Inf. Module (60 PSCs)

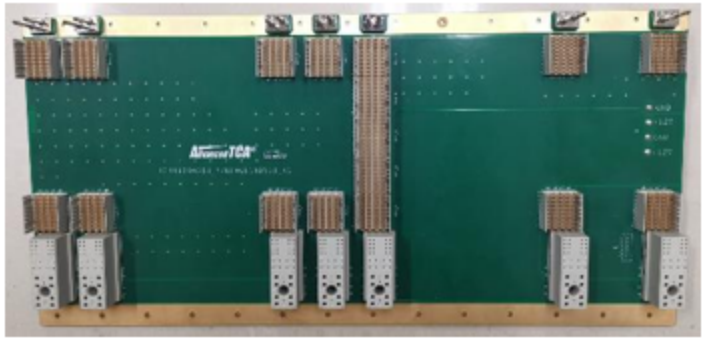




Function module installation

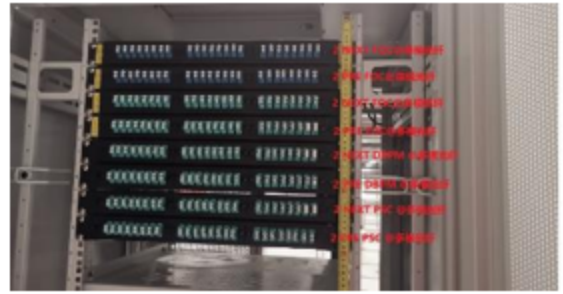
- Intelligent PDU with Remote Control Capabilities
- 1-8 power splitter for RF clock fanout logic
- ATCA function module
  - FOC module
  - AUX module
  - PSC module



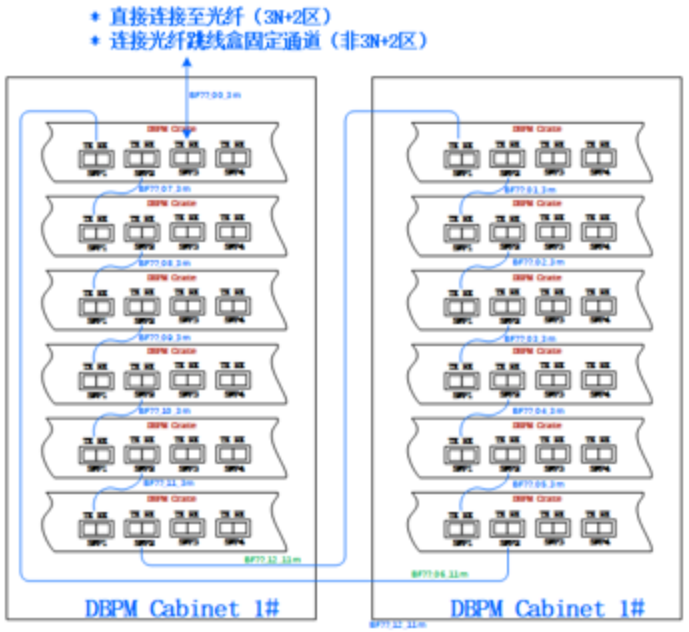


Cabinet cable and fiber installation

- Fiber and Cables connection



DBPM Fiber daisy-chain connection



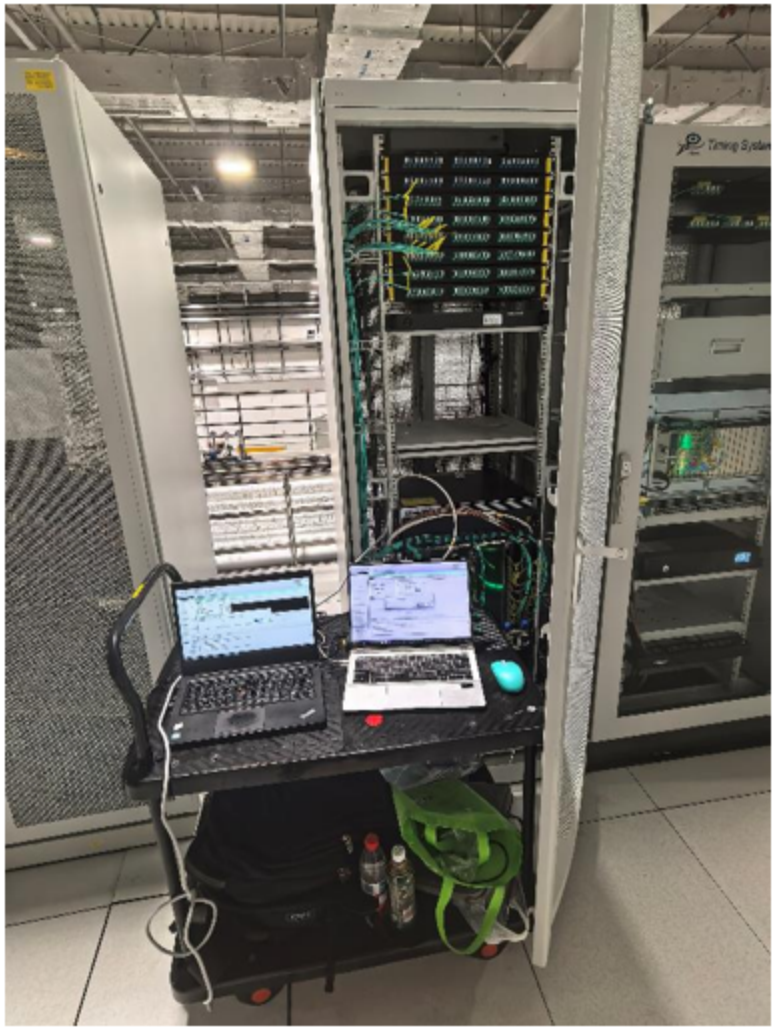
DBPM Cabinet

FOFB Cabinet

FCPS Cabinet

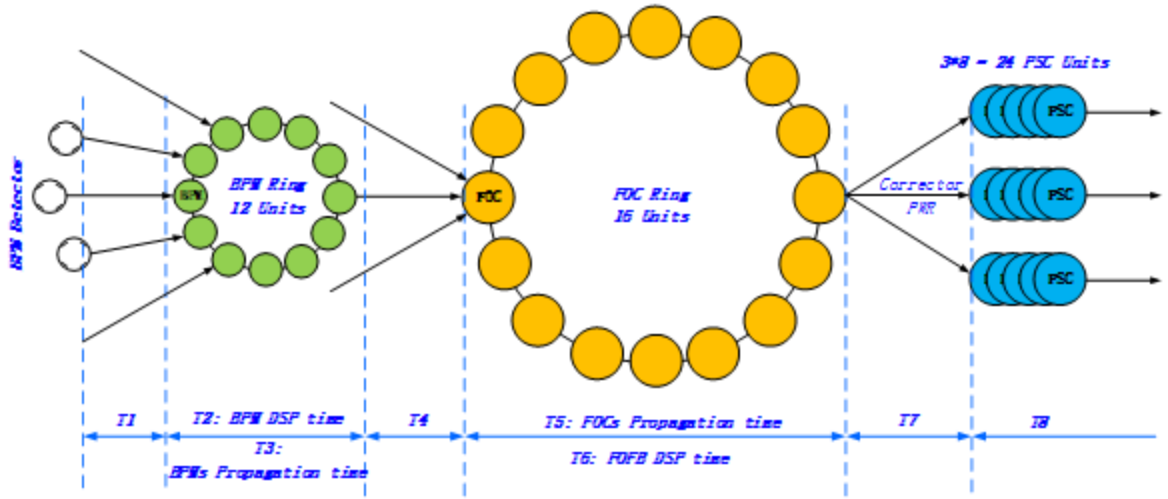
Communication testing

- Communication testing
  - From DBPM to FOFB
  - From FOFB to FCPS
  - Timing signal control test
  - Parameter setting test
  - FOFB data acquisition test
  - Temperature information monitor
  - ……



BPM data transmission

- Complete program updates for all BPM
- BPM position data frame output based on TRIG_FA signal at 22kHz
- At present, BPM loop testing for each substation has been completed, and communication testing for the entire BPM loop will be conducted in the next two days



FCPS data transmission

- Complete program updates for all FCPS controller
- Before each FOFB system startup, it is necessary to obtain the network setpoint as the initial value given by FOFB. Therefore, before startup, I must ensure the normal operation of the FCPS receiving channel. I have created this interface to detect the communication status of all FCPS.

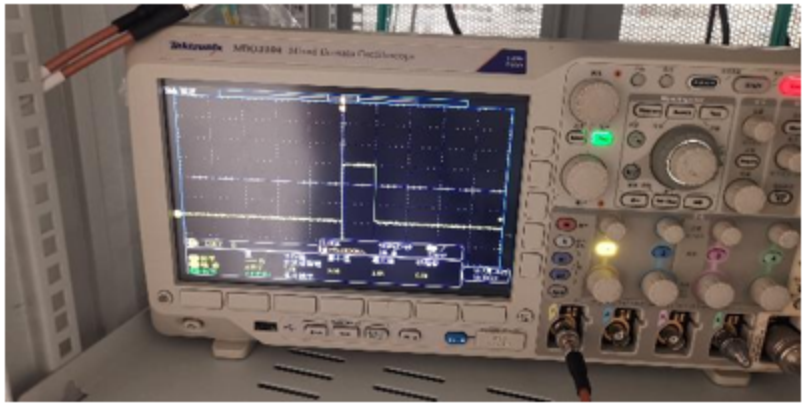
PSC系统状态监控

PSC系统状态监控（绿色:正常，红色:故障，黄色:警告）

	PSC-1	PSC-2	PSC-3	PSC-4	PSC-5	PSC-6	PSC-7	PSC-8	PSC-9	PSC-10	PSC-11	PSC-12	PSC-13	PSC-14	PSC-15	PSC-16	PSC-17	PSC-18	PSC-19	PSC-20	PSC-21	PSC-22	PSC-23	PSC-24
站点1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点7	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点9	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点10	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点11	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点12	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点13	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点14	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点15	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
站点16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Timing signal testing

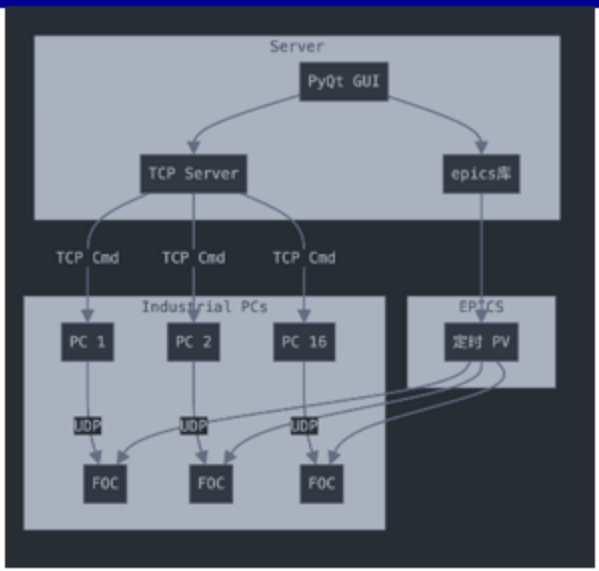
- Timing signal include:
  - TRIG_FA
  - TRIG_START
  - TRIG_STOP
  - TRIG_DAQ

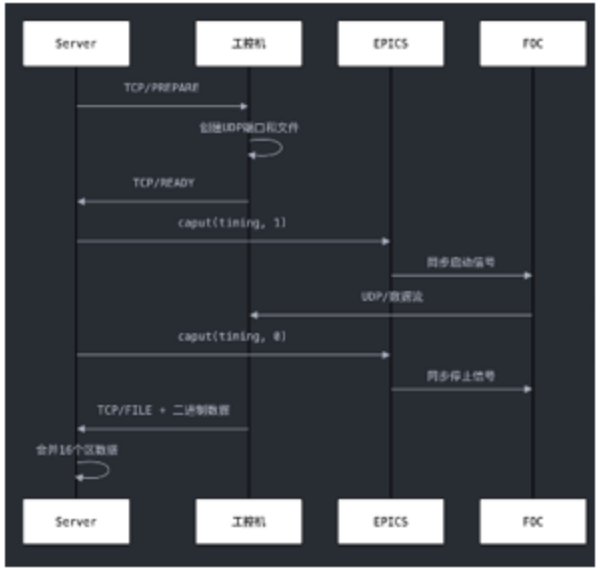


- TRIG_FA: A periodic signal with a frequency of 22 kHz.
- TRIG_START: Controlled by PV, it is used to synchronize the startup of the FOFB system.
- TRIG_STOP: Similar to TRIG_START, it is used to synchronize the shutdown of the FOFB system.
- TRIG_DAQ: Similar to TRIG_START, it is controlled by PV and is used to synchronously initiate the FOFB data acquisition task.

FOFB data acquisition work

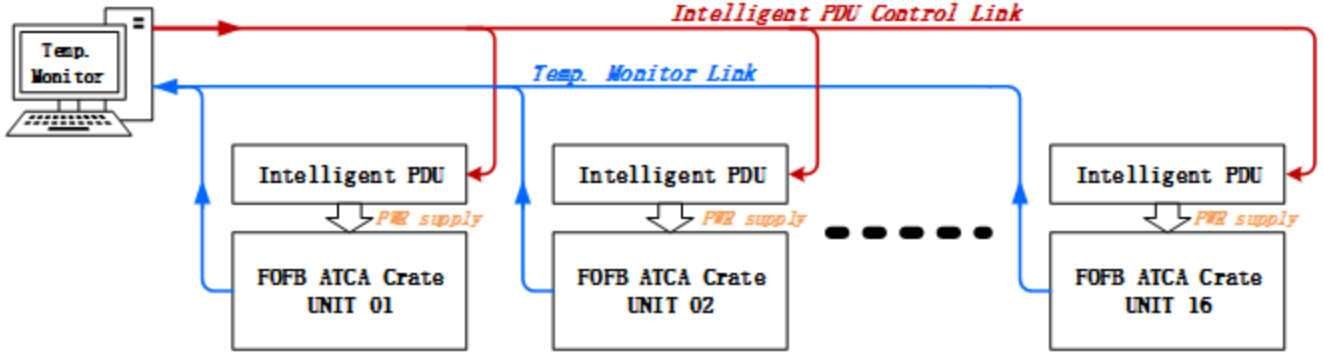
- The significance and implications of this work
  - In accelerator running time, to obtain the synchronized BPM data and setpoints and readback PS data, it is useful for FOFB system analysis
- Main information in FOFB acquisition data
  - DBPM.FA data
  - FCPS setpoints data
  - FCPS readback data
  - Partial parameters of the FOFB controller
- Points of attention
  - All DAQ information must be synchronized, which is controlled by timing signal TRIG_DAQ.

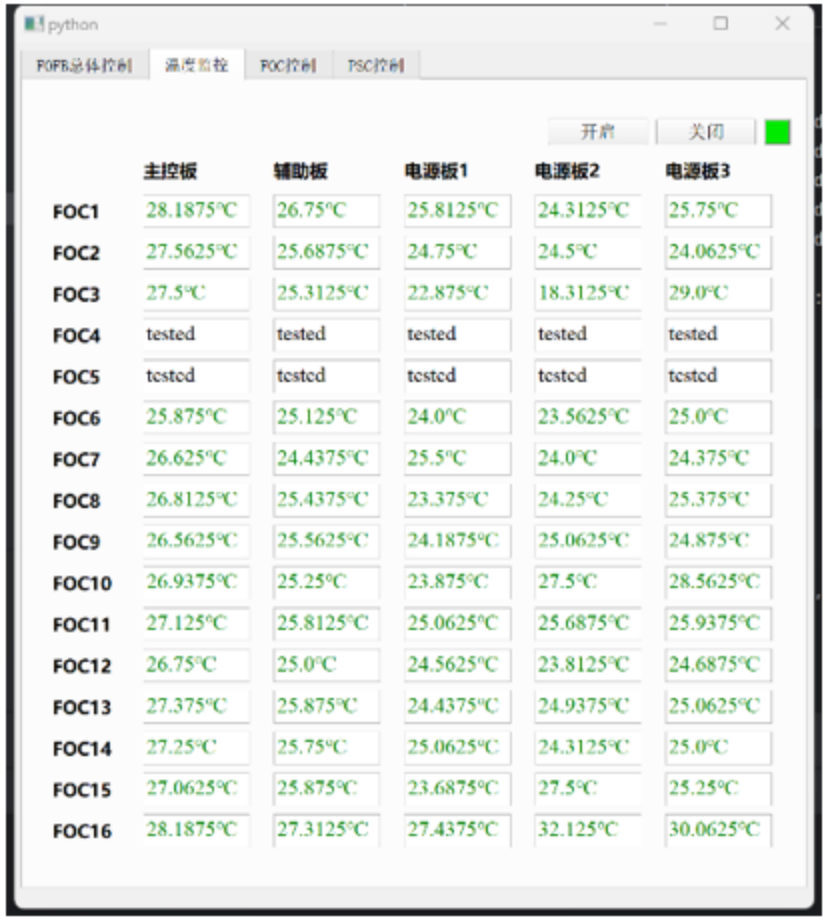




FOFB temperature monitor function design

- It is an important function for FOFB system
  - To monitor and protect the FOFB system.
- Implementation methods
  - In case of abnormal temperature, the FOFB system will be shut down, and the corresponding power supply to the ATCA chassis will be automatically cut off through the Intelligent PDU.





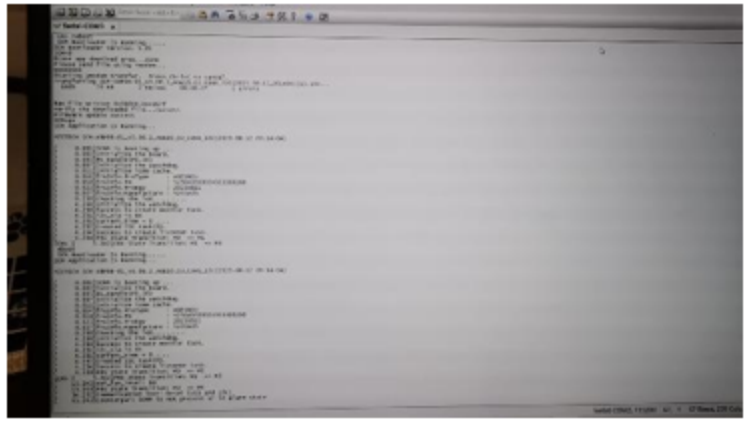
	主控板	辅助板	电源板1	电源板2	电源板3
FOC1	28.1875℃	26.75℃	25.8125℃	24.3125℃	25.75℃
FOC2	27.5625℃	25.6875℃	24.75℃	24.5℃	24.0625℃
FOC3	27.5℃	25.3125℃	22.875℃	18.3125℃	29.0℃
FOC4	tested	tested	tested	tested	tested
FOC5	tested	tested	tested	tested	tested
FOC6	25.875℃	25.125℃	24.0℃	23.5625℃	25.0℃
FOC7	26.625℃	24.4375℃	25.5℃	24.0℃	24.375℃
FOC8	26.8125℃	25.4375℃	23.375℃	24.25℃	25.375℃
FOC9	26.5625℃	25.5625℃	24.1875℃	25.0625℃	24.875℃
FOC10	26.9375℃	25.25℃	23.875℃	27.5℃	28.5625℃
FOC11	27.125℃	25.8125℃	25.0625℃	25.6875℃	25.9375℃
FOC12	26.75℃	25.0℃	24.5625℃	23.8125℃	24.6875℃
FOC13	27.375℃	25.875℃	24.4375℃	24.9375℃	25.0625℃
FOC14	27.25℃	25.75℃	25.0625℃	24.3125℃	25.0℃
FOC15	27.0625℃	25.875℃	23.6875℃	27.5℃	25.25℃
FOC16	28.1875℃	27.3125℃	27.4375℃	32.125℃	30.0625℃

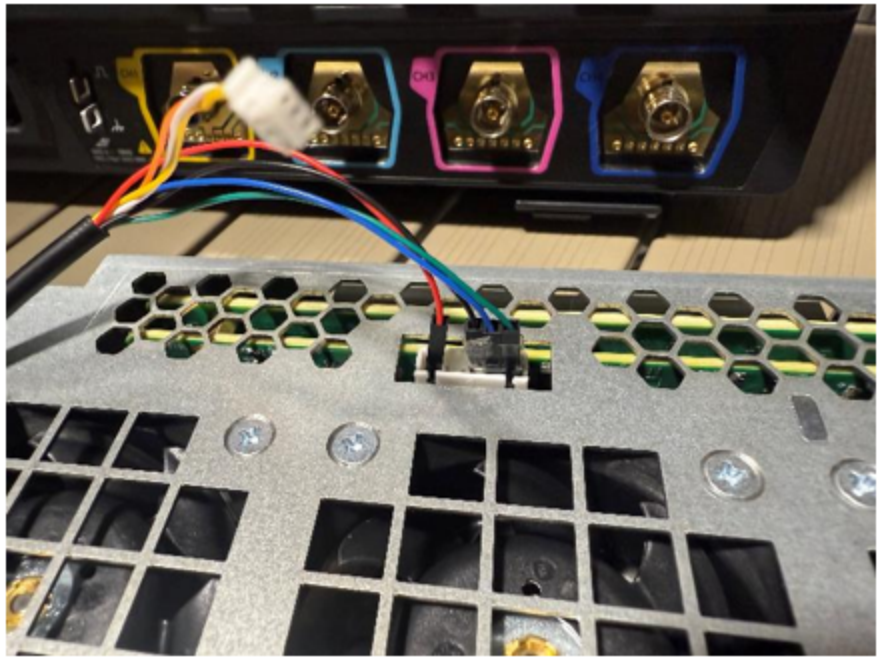
Fan speed adjustment for ATCA crate

- Why is this work necessary
  - Noise reduction in ATCA crate running time
  - Extending the lifespan of the ATCA crate fan is essential for enhancing system reliability.

例如设置 90%默认转速：

前下风扇框：set_params 90 3 0 0 0 ICMRoot
后下风扇框：set_params 90 5 0 0 0 ICMRoot
后上风扇框：set_params 90 6 0 0 0 ICMRoot





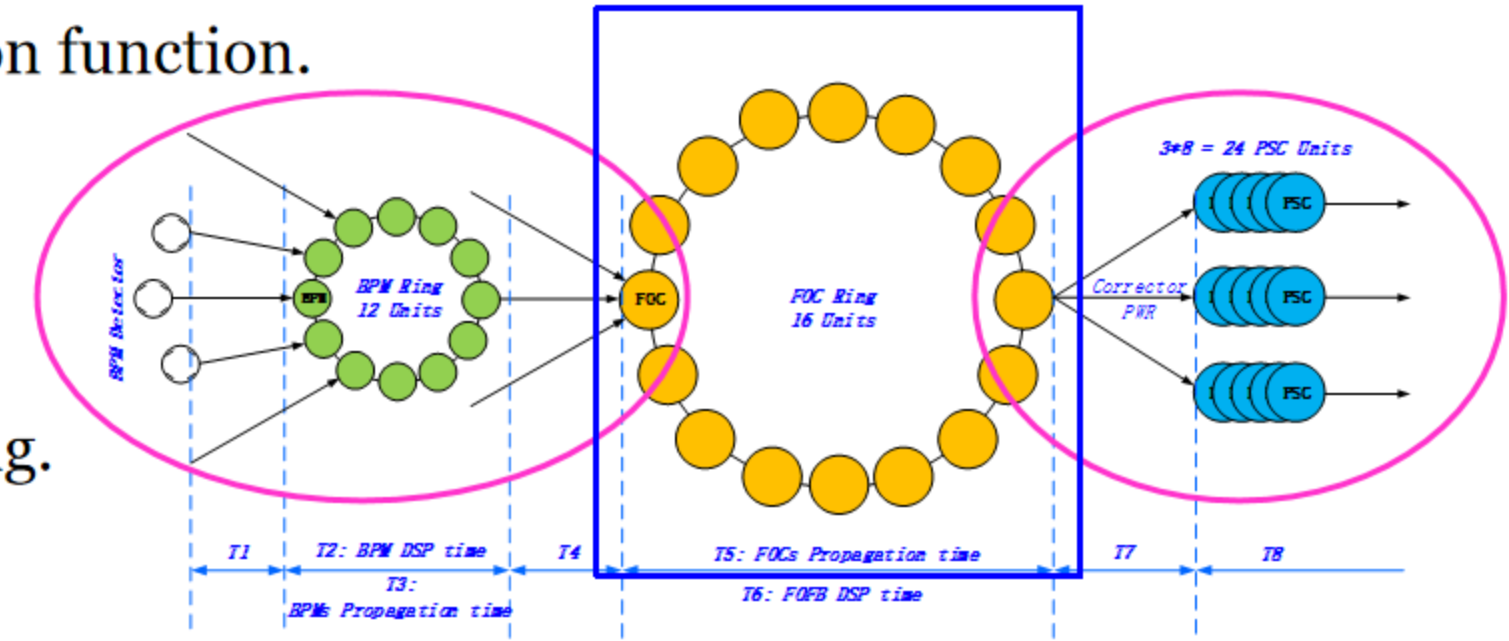
3, FOFB system commissioning plan

FOFB system commissioning plan

- FOFB hardware commissioning without beam
- FOFB Controller software debugging
- FOFB system commissioning with beam

Hardware commissioning without beam

- Communication stability testing from DBPM to FOFB system
  - Checking the data transmission function.
    - DBPM to FOFB
    - FOFB.FOC to FOFB.FOC
    - FOFB to FCPC
  - All BPM data alignment testing.
  - Redundant logic testing
  - And so on.



FOFB Controller software debugging

- Parameter setting and readback function testing.
- Synchronous start and synchronous data reading test controlled by timing signal
- FOFB temperature monitoring and control logic testing.
- Optimization of FOFB Control Interface

FOFB system commissioning with beam

- Testing conditions
  - The beam is in a stable status.
  - Beam is in fixed pattern, and beam current is in a fixed value.
- Testing contents
  - Add a step disturbance to the beam through the FC, then measure the beam position variation by the BPM, and estimate the FOFB open-loop system response time,
  - Start the FOFB system, acquire FOFB data, which includes all FC current setting data and all DBPM.FA data in the HEPS storage ring, to achieve the debugging objectives of the FOFB system through the data analysis.
  - And other contents is under consideration.

4, Summary

- Completed the mass production and testing of all hardware electronics for the FOFB system.
- Completed the installation of all FOFB crates and hardware electronics.
- FOFB electronics hardware is undergoing on-site testing.
- FOFB system commissioning is under consideration

THANK YOU
FOR YOUR
ATTENTION