

The SSRF MPS

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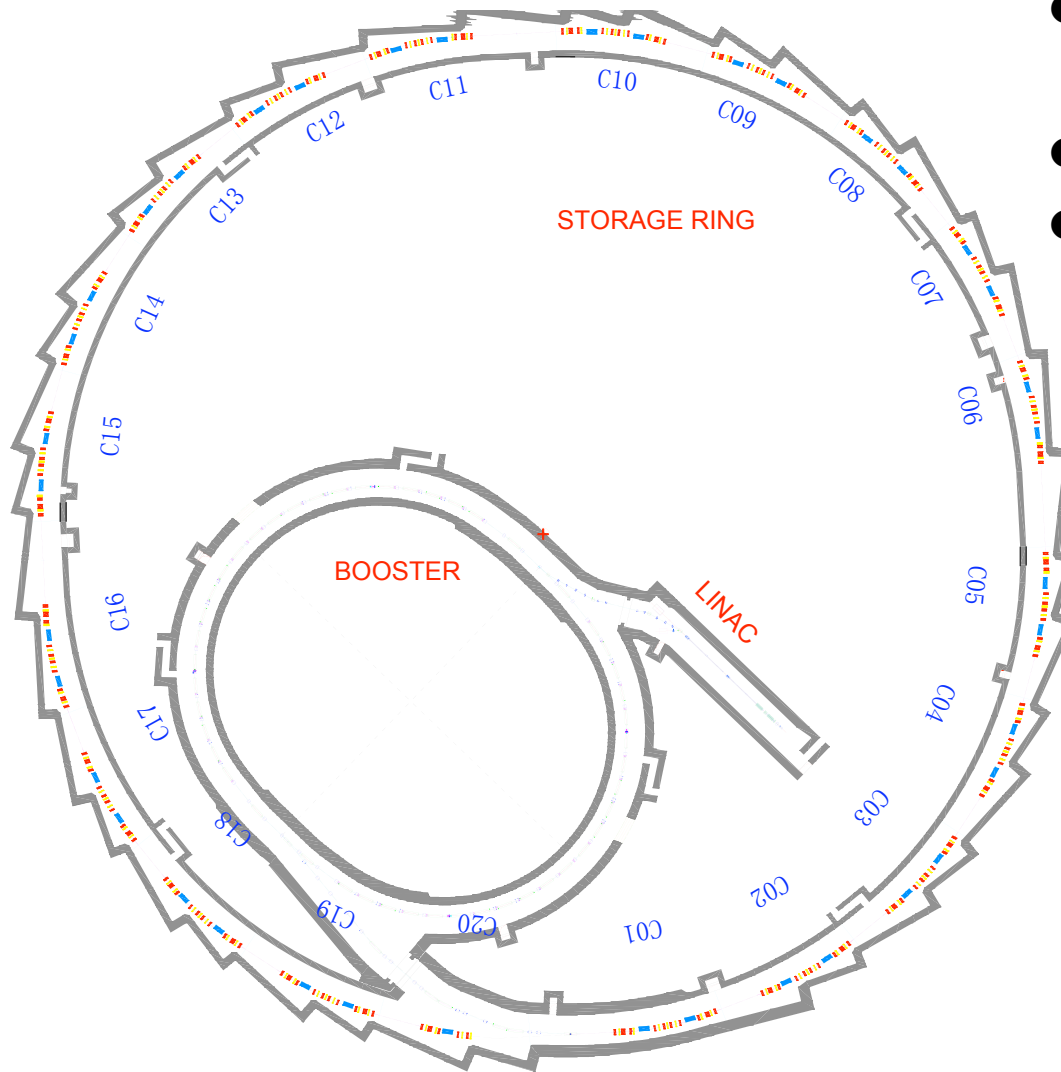
■ SSRF MPS introduction

MPS (Machine Protection System) is one kind of dedicated system which is designed to ensure safe operation of a large scale machine such as a synchrotron radiation facility.

SSRF (Shanghai Synchrotron Radiation Facility) is a third-generation of synchrotron radiation light source. The energy of storage ring is 3.5GeV, and the current is 300mA. Up to now, SSRF is the biggest scientific platform for science research and technology development in China.

SSRF is consists of three division: accelerator division, beam line division, public service division. The MPS we introducing here only concerns MPS works of accelerator division.

■ SSRF accelerator layout



- Storage ring: circumference 432m
20 cells
- Booster: circumference 180m
- Control system are based on EPICS

■ MPS concerns

- Vacuum system
- Power supply system
- RF system
- Injection and extraction system
- Gate valve
- Vacuum component temperature
- Cooling water temperature and flux

MPS is an interlock system connecting to these systems.

■ Interlock signals in MPS

● Temperature signals (PT100, 3 wire)

- vacuum component temperature
- cooling water temperature

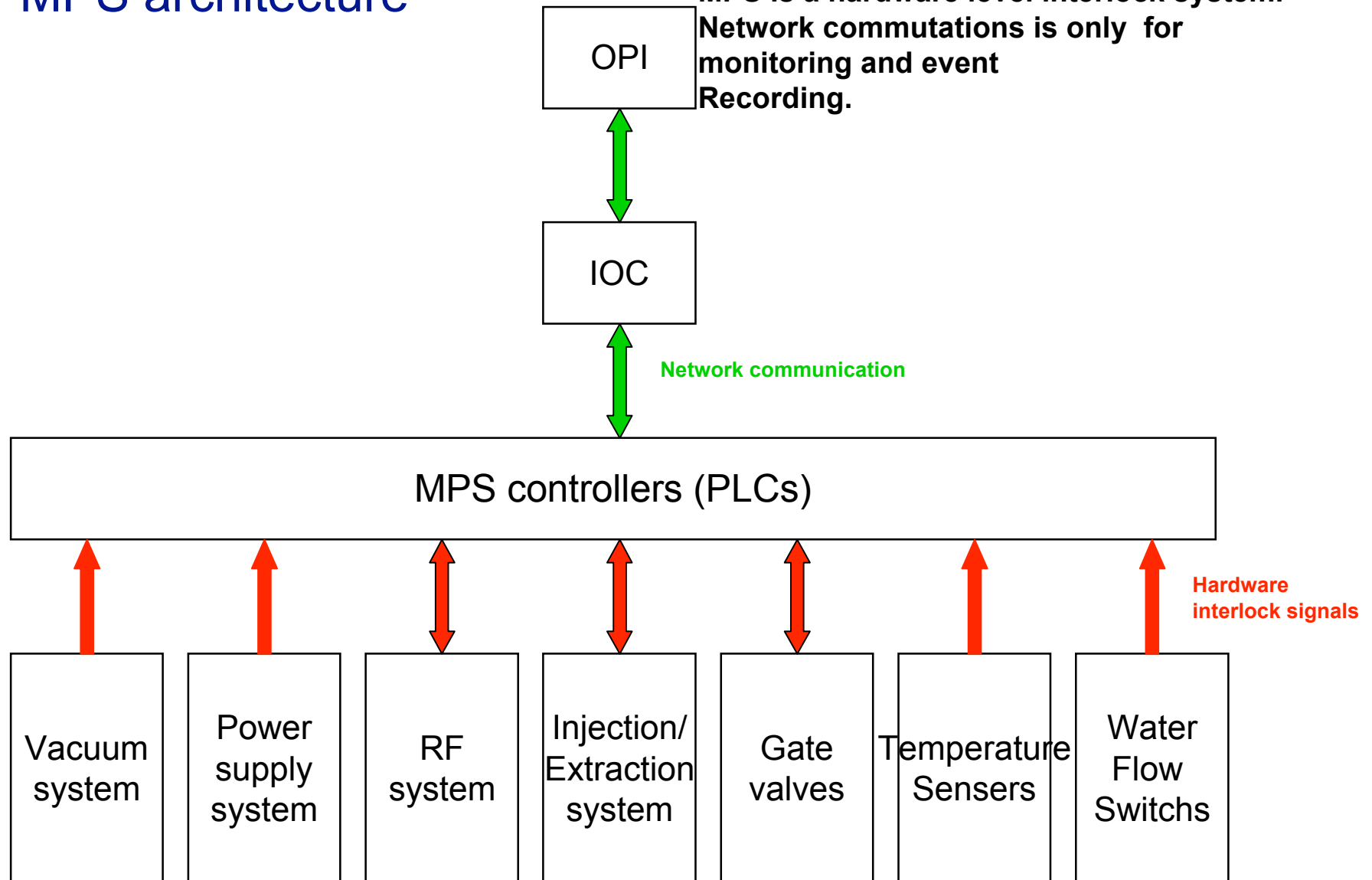
● Switch signals

- vacuum warning/alarm
- gate valve open/close status
- water flow switch
- system/device status
- system/device permit

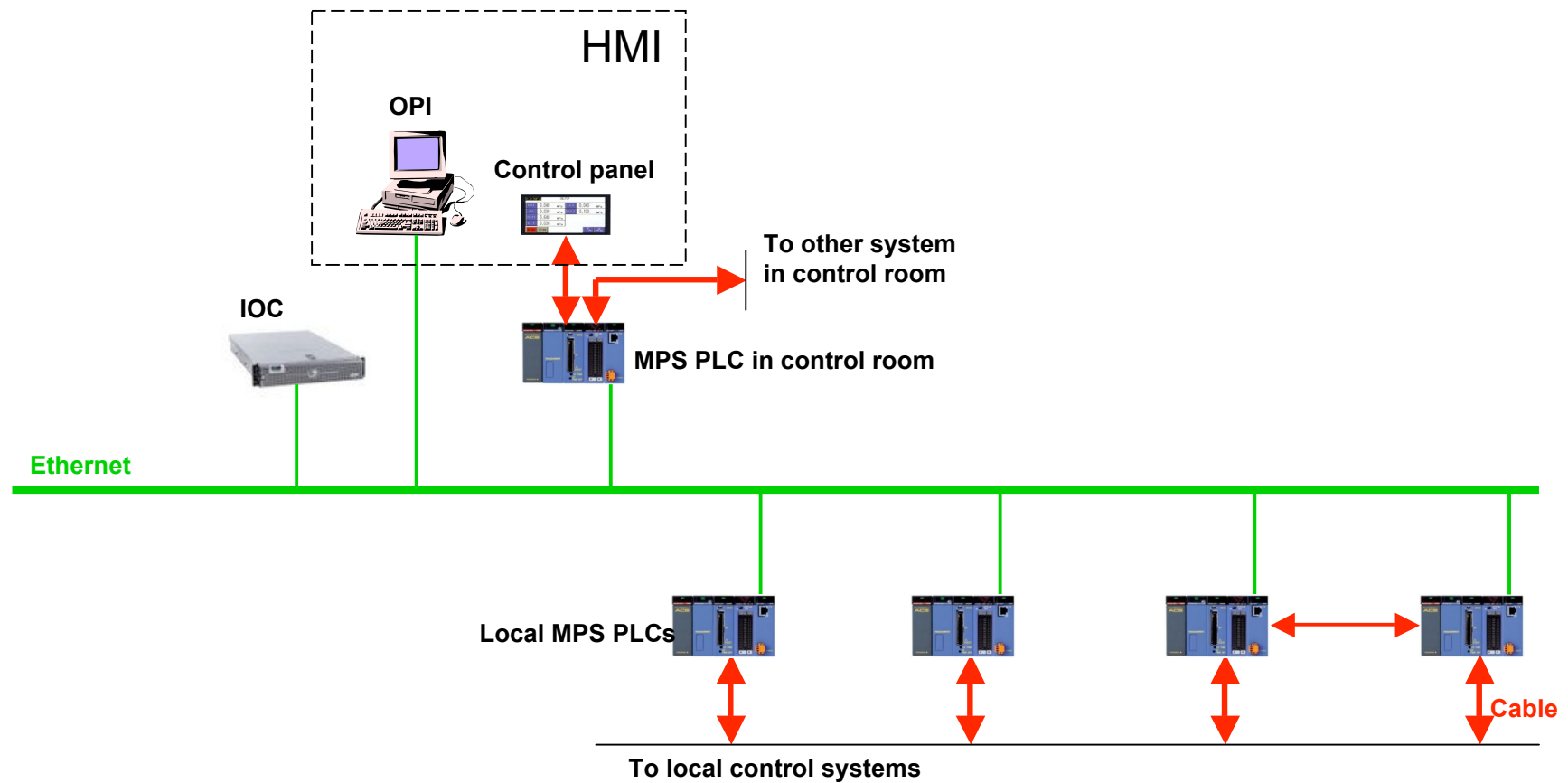
- We choose PLC as MPS controller
 - PLC is the best choice for MPS because
 - The process of interlock is simple
 - interlock signals are large number of ordinary signals
 - need high reliability

■ MPS architecture

MPS controller use high reliability PLCs.
MPS is a hardware level interlock system.
Network commutations is only for monitoring and event Recording.

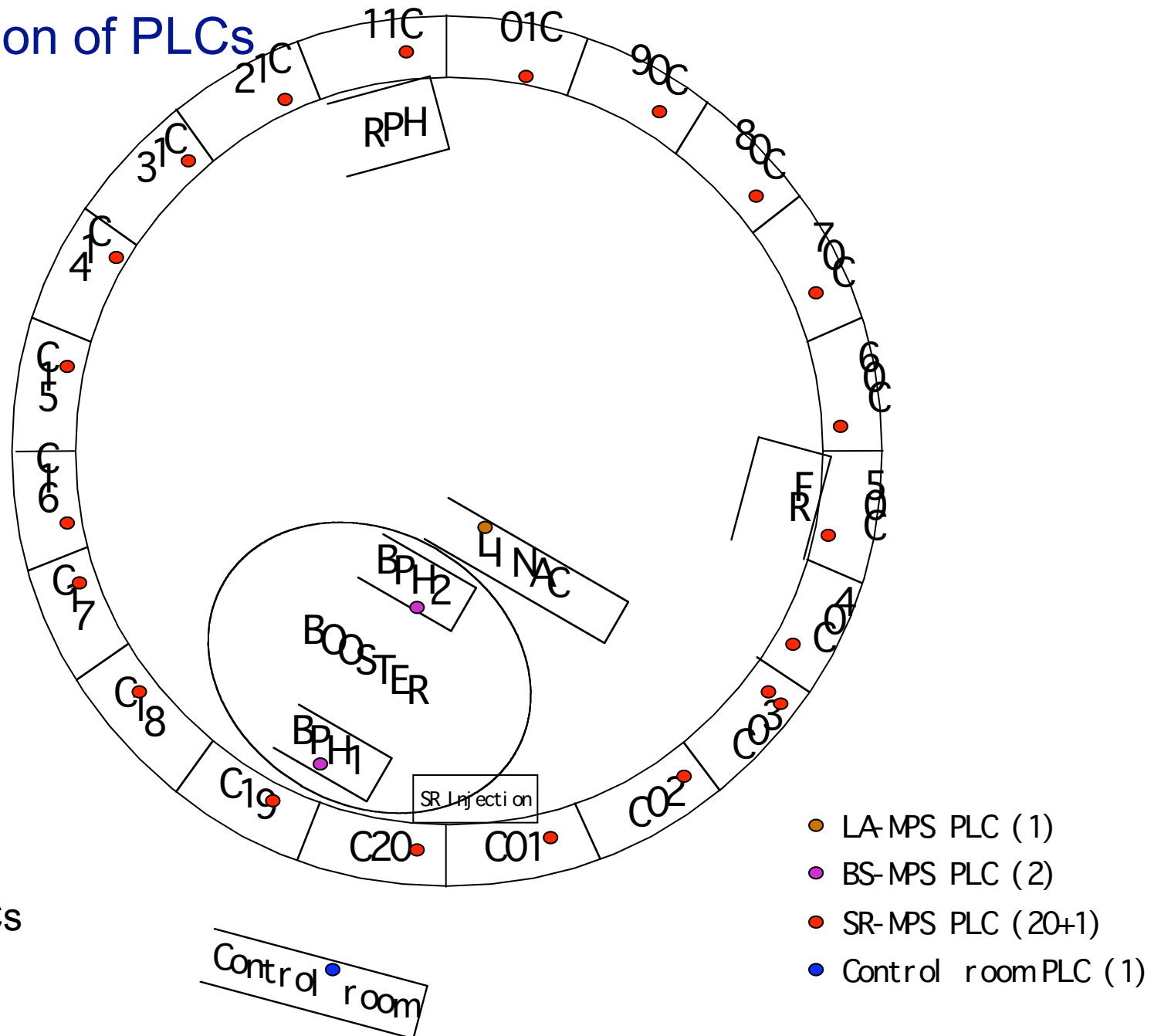


■ MPS is a distribution system



- PLCs are connected to IOC by Ethernet
- We use cable connections for all hardware signals (include signals between PLCs)

■ Distribution of PLCs



Total: 25 PLCs

■ Basic technical specifications requirement

● Response time

- General interlock (not include temperature) : 10-30ms
- Vacuum fast leak interlock (beam line): 1ms
(solve by special device, not include in PLC)

● Reliability

- Insulation interface
- Interface operating voltage: 24V
- Max cable length: 500m (some risk)

■ PLC modules used in MPS

Module	Type	Specification
CPU	F3SP53-4S	56k steps, 4096 I/O, 16k/16k/32k
Ethernet	F3LE11-0T	10/100M, TCP/IP
DI	F3XD16-3F	16point, 24V, 4.1mA, 0-16ms, solderless terminal
DO	F3YC08-0N	8point, Relay contact, 10ms
DO	F3YD04-7N	4point, Transistor contact, 3ms(ON→OFF)
Temperature	F3CX04-0N	4point, sampling period 0.2s, accuracy 0.1%
Remote I/O	F3LR01-0N F3LR02-0N	10Mbps Fiber-optical
Power supply	F3PU20-0S F3PU30-0S	
Base	F3BU13-0N	

■ I/O signals statistics

	DI		DO		PT100	
	signals	design	signals	design	signals	design
LA MPS	60	80	10	24	4	0
BS MPS	86	128	22	48	0	0
SR MPS	1188	1760	140	260	876	1072
Total:	1334	1968	172	332	880	1072

■ PLC modules statistic

BASIC Modules

	PLC s	BASE	Power supply		CPU	Ethernet	FA-bus	
		F3BU13- 0N	F3PU20- 0S	F3PU30- 0S	F3SP53- 4S	F3LE11- 0T	F3LR01- 0N	F3LR02- 0N
LA MPS	1	1	1		1	1		
BS MPS	2	2	2		2	2		
SR MPS	21	46		46	21	21	42	4

I/O Modules

	F3XD16-3F	3YC08-0N	F3YD04-7N	F3CX04-0N
LA MPS	5	3	0	1
BS MPS	8	4	4	0
SR MPS	111	0	63	268



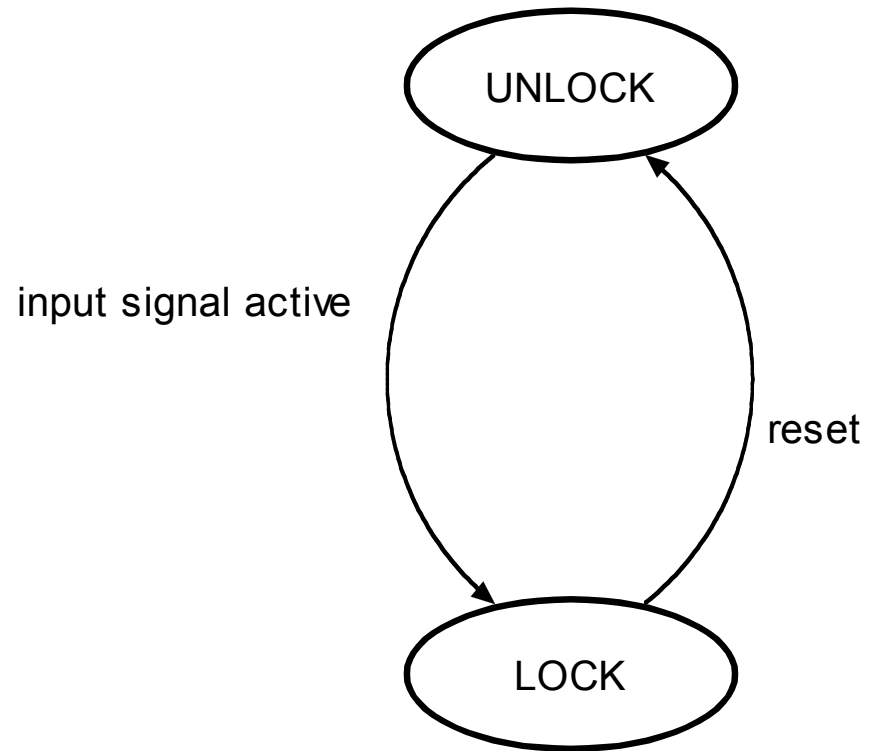
- The PLC programming
 - We wrote six ladder program totally:
 - LINAC, 1 ladder program
 - BOOSTER, 2 ladder programs
 - STORAGE RING, 3 ladder programs



■ The IOC

- We wrote 1 db file for linac MPS, 2 db files for booster MPS and 7 database files in the storage ring MPS ioc.
- The records sum is about 12,000.

- The input signal transaction




We only experienced one small problem:

OPI response time:

only use bi and di response time $\approx 3S$

mbbiDirect instead of bi response time $\approx 1S$

- 
- With the help of Odagiri-san, we add new record type, named status, it can read 64 words data one time, we changed the running database, using the status type records instead of the ai type records. After all this had been done, the problem are solved.



FA-M3 PLCs are stable, easy to use, very good products.

Linac MPS PLC and control panel

LA-MPS Control Overview

Linac System Status					MPS Output Signals	
Signal	Status	Bypass	Latched	Reset	Signal	Status
PPS status 1	OK	OK	OK	OK	500M amplifier trigger enable	OK
PPS status 2	OK	OK	OK	OK	3G amplifier 1 trigger enable	OK
Door status of EGUN shield room	OK	OK	OK	OK	3G amplifier 2 trigger enable	OK
Emergency stop 1	STOP	BYPASS	OK	OK	Modulator 1 prepare trigger enable	OK
Emergency stop 2	STOP	BYPASS	OK	OK	Modulator 1 trigger enable	OK
Booster status	OK	OK	OK	OK	Modulator 2 prepare trigger enable	OK
Storage Ring status 1	STOP	BYPASS	OK	OK	Modulator 2 trigger enable	OK
Storage Ring status 2	STOP	BYPASS	OK	OK	EGUN trigger enable	STOP

Vacuum System Status					Microwave System Status					Cooling Water Status				
Signal	Status	Bypass	Latched	Reset	Signal	Status	Bypass	Latched	Reset	Signal	Status	Bypass	Latched	Reset
Gate Valve 1 status	OK	OK	OK	OK	Water conductance status	OK	OK	OK	OK	Water flow SW1	OK	OK	OK	OK
Gate Valve 2 status	OK	OK	OK	OK	K1 water temperature SW1	OK	OK	OK	OK	Water flow SW2	OK	OK	OK	OK
Vacuum warning 1	OK	OK	OK	OK	K1 water temperature SW2	OK	OK	OK	OK	Water flow SW3	OK	OK	OK	OK
Vacuum warning 2	OK	OK	OK	OK	K1 water flow SW1	OK	OK	OK	OK	Water flow SW4	OK	OK	OK	OK
Vacuum warning 3	OK	OK	OK	OK	K1 water flow SW2	OK	OK	OK	OK	Water flow SW5	OK	OK	OK	OK
Vacuum warning 4	OK	OK	OK	OK	K1 water flow SW3	OK	OK	OK	OK	Water flow SW6	OK	OK	OK	OK
Vacuum warning 5	OK	OK	OK	OK	K1 power supply status	OK	OK	OK	OK	Water flow SW7	OK	OK	OK	OK
Vacuum warning 6	OK	OK	OK	OK	K1 reflect power status	OK	OK	OK	OK	Water flow SW8	OK	OK	OK	OK
Vacuum warning 7	OK	OK	OK	OK	K2 water temperature SW1	OK	OK	OK	OK	Water flow SW9	OK	OK	OK	OK
Vacuum warning 8	OK	OK	OK	OK	K2 water temperature SW2	OK	OK	OK	OK	Water flow SW10	OK	OK	OK	OK
Vacuum warning 9	OK	OK	OK	OK	K2 water flow SW1	OK	OK	OK	OK	Water flow SW11	OK	OK	OK	OK
Vacuum warning 10	OK	OK	OK	OK	K2 water flow SW2	OK	OK	OK	OK	Water flow SW12	OK	OK	OK	OK
Vacuum warning 11	OK	OK	OK	OK	K2 water flow SW3	OK	OK	OK	OK	Water flow SW13	OK	OK	OK	OK
Vacuum warning 12	OK	OK	OK	OK	K2 power supply status	OK	OK	OK	OK	Water flow SW14	OK	OK	OK	OK
Vacuum warning 13	OK	OK	OK	OK	K2 reflect power status	OK	OK	OK	OK	Water flow SW15	OK	OK	OK	OK
Vacuum warning 14	OK	OK	OK	OK	Modulator 1 status	OK	OK	OK	OK	Water flow SW16	OK	OK	OK	OK
Vacuum warning 15	OK	OK	OK	OK	Modulator 2 status	OK	OK	OK	OK	Water flow SW17	OK	OK	OK	OK
										Water flow SW18	OK	OK	OK	OK

Accelerator tube temperature



Accelerator Tube Temperature Monitors

No.1 Accelerator Tube Temperature	42.95	C
No.2 Accelerator Tube Temperature	43.13	C
No.3 Accelerator Tube Temperature	43.08	C
No.4 Accelerator Tube Temperature	42.87	C

EXIT

■ Booster MPS PLC and control panel



/home/ssrf/prod/api/edl/mpls/bs_mps_monitor.edl

BS-MPS Control Overview

EXIT

Booster System Status				
Signal	Status	Bypass	Latched	Reset
B1 power supply status	Green	Button	Green	Button
B2 power supply status	Green	Button	Red	Button
GF power supply status	Green	Button	Green	Button
GD power supply status	Green	Button	Green	Button
HT B power supply status	Red	Button	Red	Button
Injection system status	Green	Button	Green	Button
Extraction system status	Green	Button	Green	Button
RF System status	Red	Button	Green	Button
PPS status 1	Red	Button	Red	Button
PPS status 2	Red	Button	Red	Button
Emergency Stop 1 (to BPH1)	Green	Button	Green	Button
Emergency Stop 2 (to BPH1)	Green	Button	Green	Button
Emergency Stop 3 (to BPH2)	Green	Button	Green	Button
Emergency Stop 4 (to BPH2)	Green	Button	Green	Button

Booster Ring Vacuum Status				
Signal	Status	Bypass	Latched	Reset
T01BAG1	Green	Button	Green	Button
T01BAG2	Green	Button	Green	Button
T02BAG1	Green	Button	Green	Button
T02BAG2	Green	Button	Green	Button
T03BAG	Green	Button	Green	Button
T05BAG	Green	Button	Green	Button
T06BAG	Green	Button	Green	Button
T08BAG	Green	Button	Green	Button
T10BAG	Green	Button	Green	Button
T11BAG	Green	Button	Green	Button
T13BAG1	Green	Button	Green	Button
T13BAG2	Green	Button	Green	Button
T14BAG	Green	Button	Green	Button
T15BAG1	Green	Button	Green	Button
T15BAG2	Green	Button	Green	Button
T16BAG1	Green	Button	Green	Button
T17BAG1	Green	Button	Green	Button
T19BAG1	Green	Button	Green	Button
T20BAG	Green	Button	Green	Button
T22BAG1	Green	Button	Green	Button
T24BAG1	Green	Button	Green	Button
T25BAG1	Green	Button	Green	Button
T27BAG1	Green	Button	Green	Button
T27BAG2	Green	Button	Green	Button
T28BAG1	Green	Button	Green	Button
T28BAG2	Green	Button	Green	Button

LTB Vacuum Status				
Signal	Status	Bypass	Latched	Reset
095P	Green	Button	Green	Button
095P	Green	Button	Green	Button
100P	Green	Button	Green	Button

BTS Vacuum Status				
Signal	Status	Bypass	Latched	Reset
HT-1	Green	Button	Green	Button
HT-2	Green	Button	Green	Button
HT-3	Green	Button	Green	Button
HT-4	Green	Button	Green	Button
HT-5	Green	Button	Green	Button

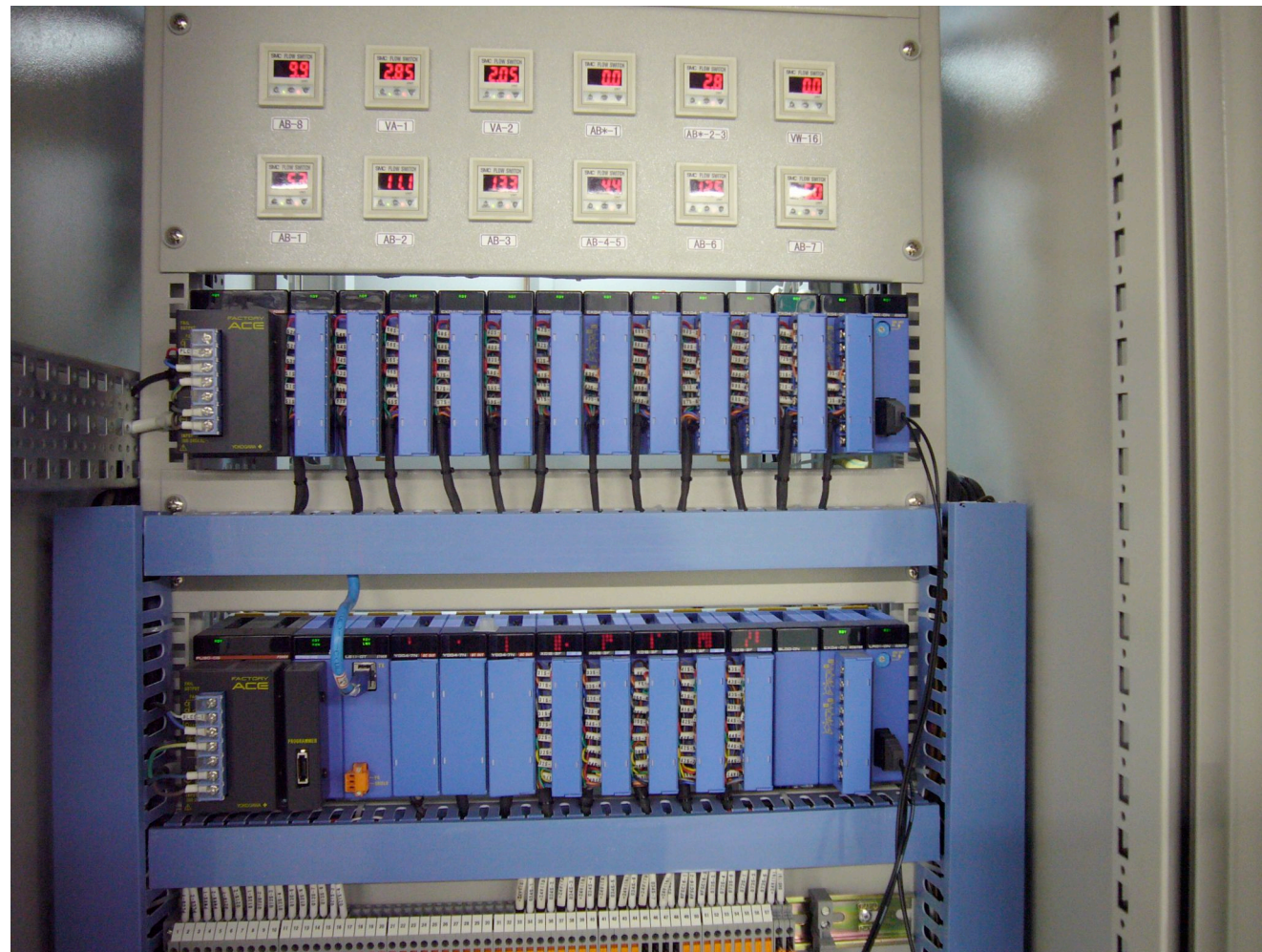
Vacuum Gate Valve Status				
Signal	Status	Bypass	Latched	Reset
LTB	Green	Button	Green	Button
RING-2	Green	Button	Green	Button
RING-1	Green	Button	Green	Button
BTS	Red	Button	Red	Button

MPS Interchange Signals (H01<->H02)	
Signal	Status
BPH1 Output (Stop Gun Trigger)	Red
BPH1 Output (Stop Injection)	Red
BPH1 Output (Stop RF power output)	Red
BPH2 Output (Stop Extraction)	Red

MPS Output Signal	
Signal	Status
Gun Trigger	Red
Injection	Red
RF power output	Red
Extraction	Red

SR Status				
Signal	Status	Bypass	Latched	Reset
SR Status1	Red	Button	Red	Button
SR Status2	Red	Button	Red	Button

- Storage Ring MPS PLC



Storage ring Control panel

The screenshot displays the SR-MPS Master Controller interface, which is divided into several functional panels:

- SR-MPS Master Controller (Top):**
 - Status of Standard Cells:** A table showing the status of 10 cells (C01-C10). Each cell has a status indicator (green, red, yellow) and a 'Detail' button. C01 and C09 show red indicators, while others are green or yellow.
 - Signal:** A section for 'S1 status' with an 'Alarm' indicator (green) and a 'Bypass' button.
- SR-MPS Standard Cell Overview (Middle):**
 - Cell: 2:** A dropdown menu showing the selected cell.
 - Vacu Components Temperature:** A table with two columns of data for various VCTS components (VCTS1-VCTS19). Each row includes Signal, Temperature (Tem), Setting, Readback, Alarm, Bypass, Latched, and Reset buttons.
- SR-MPS Vacuum Overview (Bottom-Middle):**
 - EXIT** button in the top right corner.
 - Table:** A large table with columns: Gauge, Warning, Alarm, Export, Bypass, Latched, Reset. It lists various vacuum components (e.g., 01BAG5, 01BAG6, 01BAG1, etc.) and their corresponding status indicators and control buttons.
- SR-MPS Vacuum Interlock and Gate Valve Control (Bottom-Right):**
 - EXIT** button in the top right corner.
 - Table:** A table with columns: Gate Valve, Interlock, Open, Close, Status, Pressure. It lists 20 gate valves (01GV1 to 20GV2) and their interlock status, along with 'Open' and 'Close' buttons for each.
- Signal List (Left Side):** A vertical list of various signals such as 'RF power output permit', 'SR Injection permit', 'GUN Trigger permit 1', 'BS Extraction Permit1', and 'DC power supply status'.



Thanks!