

STATUS OF SSRF CONTROL SYSTEM

SSRF Control Group

Shen liren 2009/2/13

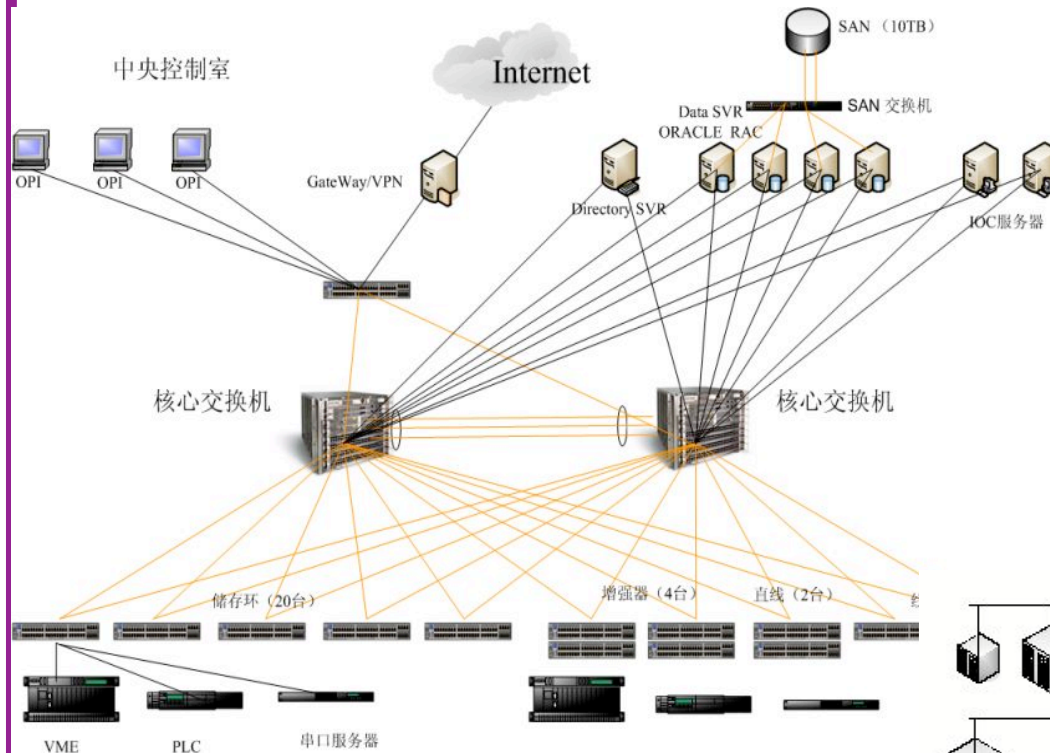


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Shanghai Institute of Applied Physics, Chinese Academy of Sci

Introduction

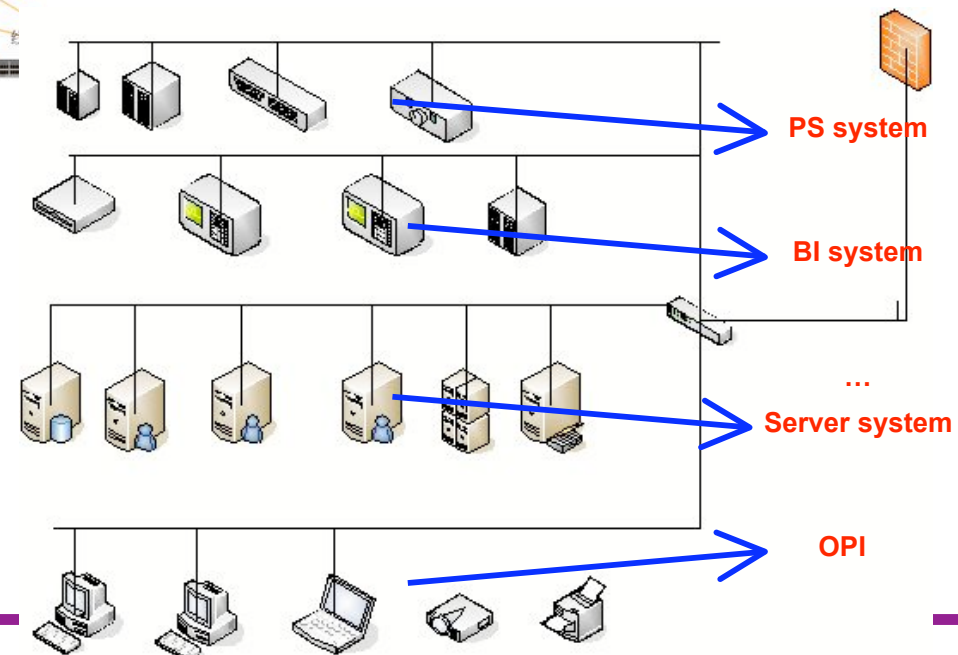
- Shanghai Synchrotron Radiation Facility (SSRF)
 - Third-generation of synchrotron radiation light source
 - SSRF consist of a 150MeV LINAC, a booster and a 3.5GeV electron storage ring.
 - Beam current 300mA
 - Minimum emittance 4 nmrad
 - Lifetime >10 hours.
 - By using advanced insertion device, photon energy range is from 0.1 to 40keV
- SSRF control system is EPICS based control system designed for light source
 - Hardware (including network)
 - Software
 - Subsystems
- Inserting devices

Control System Network



- 1G Ethernet with 3 layer switcher
- backbone reach 2G.
- Full Network manage ability
- Remote access and monitor
- Backbone redundancy design to ensure reliability
- Isolated from office network
- VPN access (Nokia hardware)

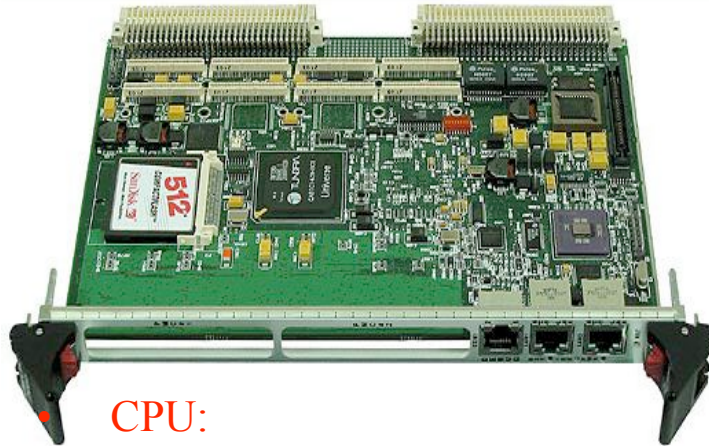
- Sub system division by VALN
 - 10.30.X.X/24
- Static 3 layer route table
- Access List table for access control
- Can be extended easily in future



Hardware

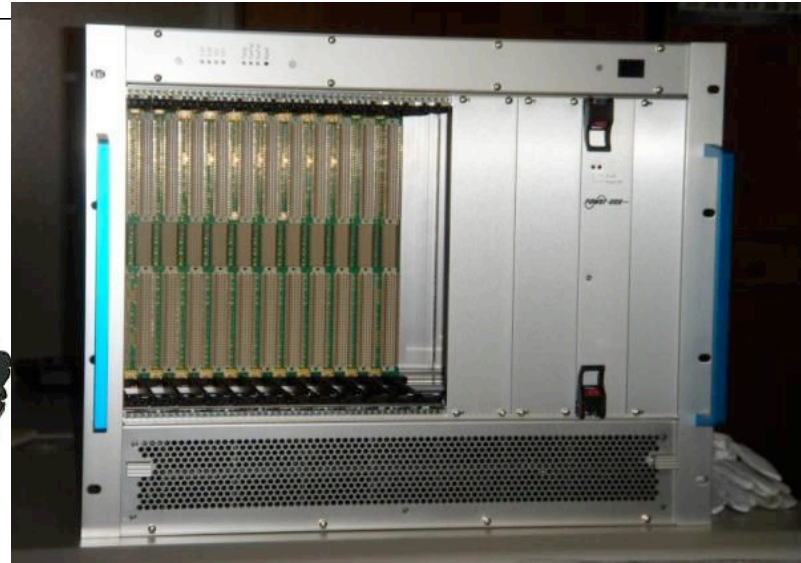
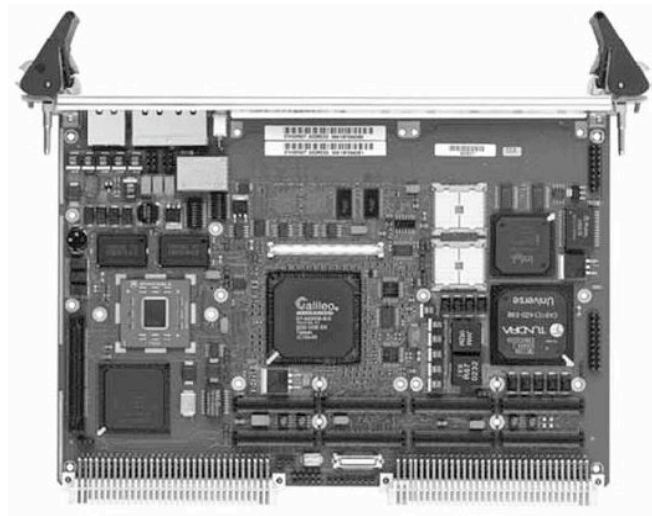
- Not so much VME devices are used in SSRF
 - GE VME7050
 - Motorola MV5500
- PLCs are widely used (Subsystems&PPS)
 - Yokogawa FM3
 - SIEMENS S7-300
- Various kinds of serial devices
 - Vacuum, Power supply, motor controller, etc.
- All of devices are connected via Ethernet
 - Serial/Ethernet converter box (Moxa Nport5610)
- These make our system clean and simple

VME System



CPU:

- Motorola MV5500
- GE VMIVME-7050



VME 64X crate
by Elma

4U 7Slots
9U 12 Slots

Crate status can
be monitored by
Ethernet or serial
port



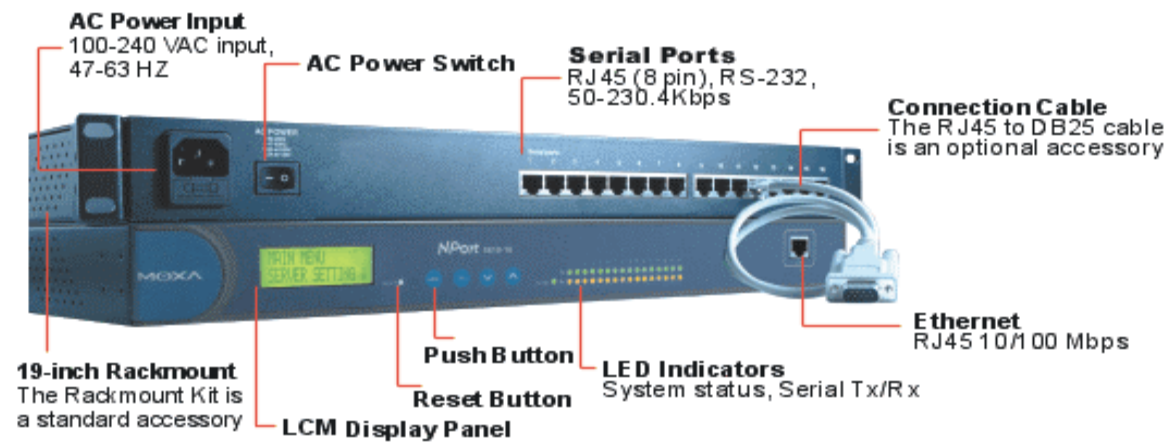
Can be
monitored with
PV names
(NetDrv)

PLCs and Nport5610



- Serial to Ethernet converter

MOXA NPort
5610-16



Software

- The SSRF control system is composed of EPICS toolkits
 - base v3.14.8.2/3.14.8.10
 - extensions
 - Cross-compile environment
- OS
 - Fedora core 7 (mainly)
 - Ubuntu server 8.10/ CentOS5.2/ Scientific Linux
- OPI
 - EDM
- High level physics application
 - Matlab v2007a
 - MCA/LabCA
 - Accelerator Toolbox (AT) & middle layer was adopted

EPICS Development Platform

- Two servers
 - HP Rack PC Server 580GG4, Xeon 3.0G/8G RAM/300G SCSI HD
 - One Master, the other Slave
 - NIS/NTP/NFS
 - RSYNC backup
 - Local yum update/PXE server
- EPICS environment
 - OS
 - Linux FC7/Kernel 2.6x/GCC 4.xx
 - EPICS base
 - 3.13.9/3.14.7/**3.14.8.2**/3.14.10
 - Extensions
 - Edm/medm/SDDS/Archiver/Sequencer/etc.
 - Cross-compiler environment
 - Vxworks 5.5.1
 - Monta-vista linux gcc3.4

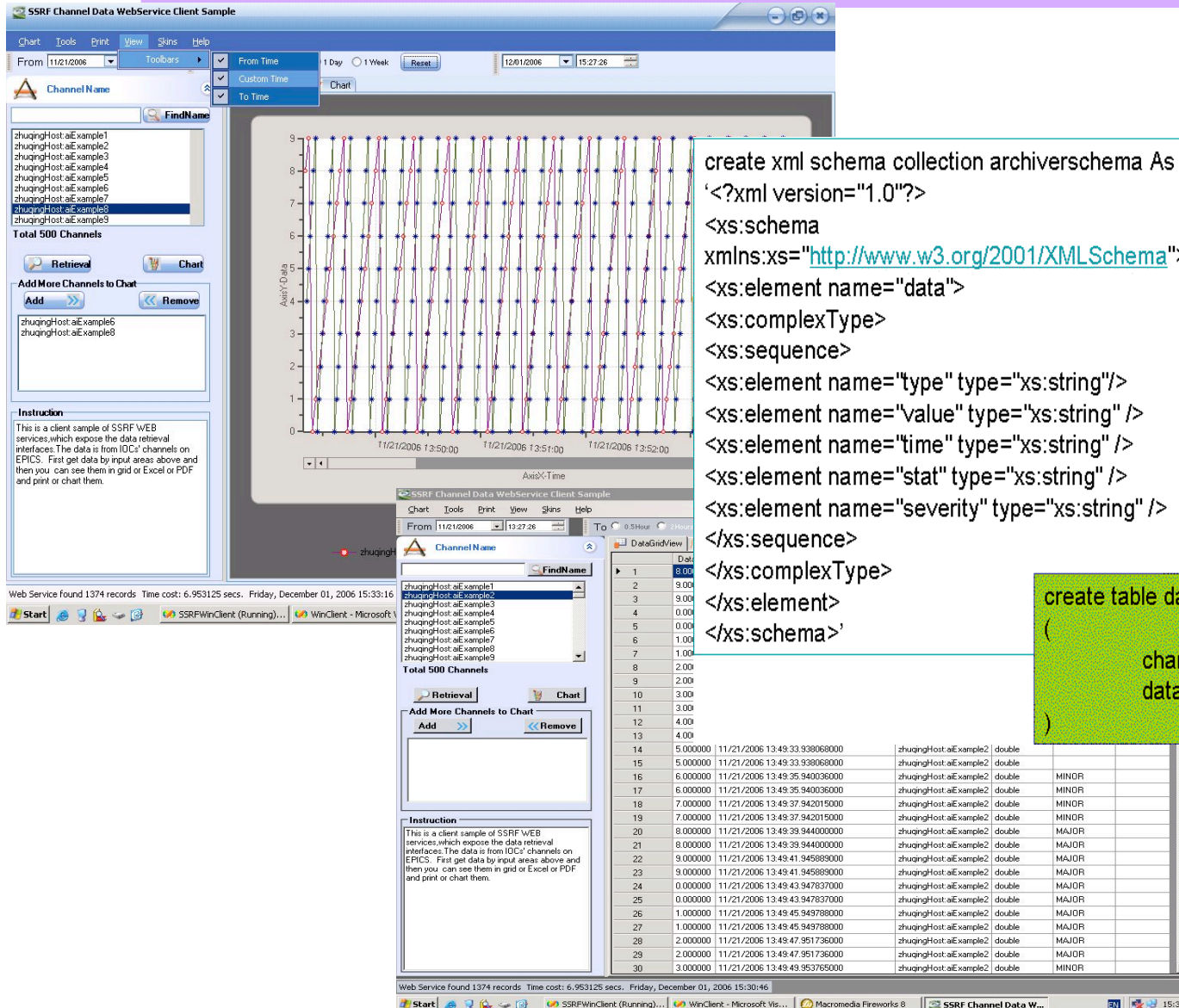
EPICS Drivers/Records

- EPICS Drivers
 - 5-10 types of new serial device drivers are modified based on netDev
 - Yokogawa Plcs uses netDev
 - Simens PLC uses driver from PSI
 - Stream device driver are used for several kinds of serial devices
 - Modbus driver from EPICS website
 - VME device drivers are copy from device manufactures or other labs
- Records
 - Bi/bo
 - ai/ao
 - Mbbi/mbbo
 - Subrutin/gensub
 - Waveform
 - Caculate
 - fanout

Data Archive and Analysis Tools

- Distributed archive engine with center relational database
- Native XML data type with xml schema for data storage
- Developed a data retrieval system based XML Web Services to access the archived data.
- The system included bottom layer interface and interface applicably for accelerator physics as well as client samples exemplifying how to use the interface.
- Tools for users that can browse, retrieve and plot data
- By the client samples, user can development their own application.
- **Memo: not be used now, just in test progress**

Data Archive and Analysis Tools



The screenshot shows the SSRF Channel Data WebService Client Sample interface. It features a menu bar (Chart, Tools, Print, View, Skins, Help), a toolbar, and a main display area. The main display area is divided into a chart area (top) and a data grid area (bottom). The chart area shows a line graph with multiple data series plotted against time. The data grid area shows a table of data with columns for Channel Name, Time, and Severity. The interface also includes a search bar, a list of channels, and various control buttons.

```

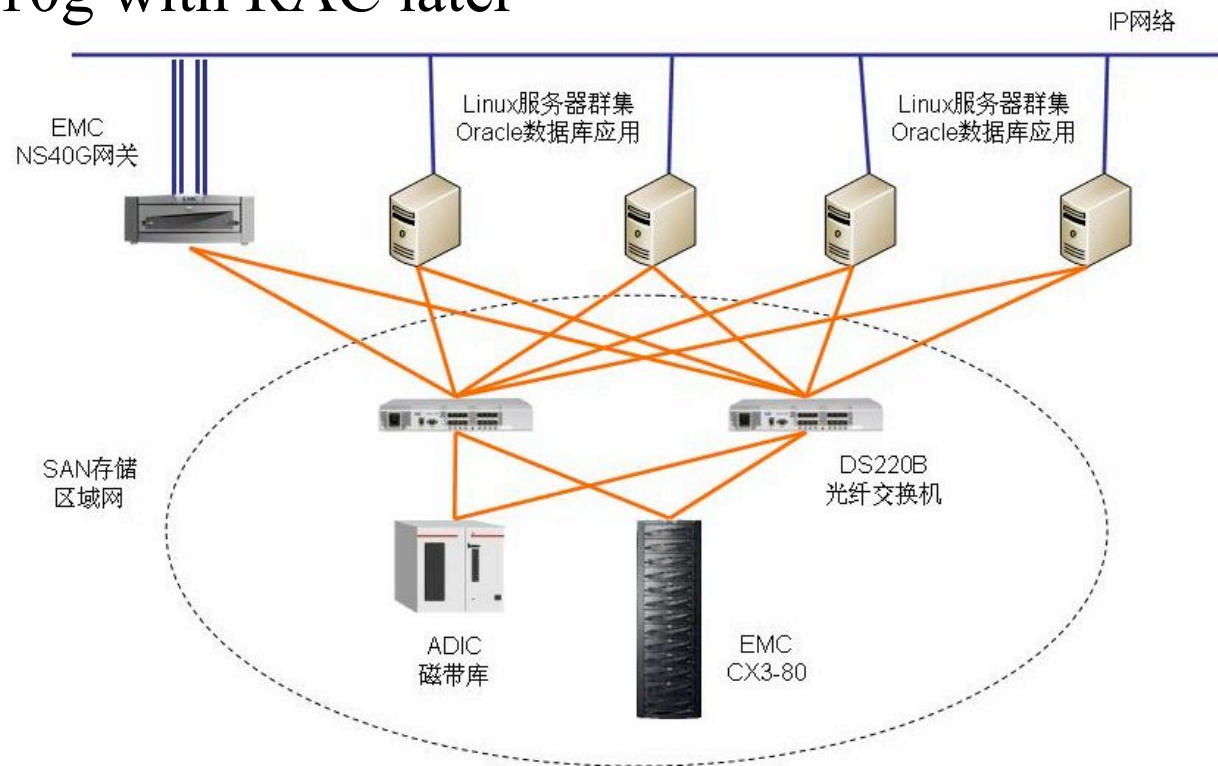
create xml schema collection archiverschema As
'<?xml version="1.0"?>
<xs:schema
xmlns:xs="http://www.w3.org/2001/XMLSchema">
<xs:element name="data">
<xs:complexType>
<xs:sequence>
<xs:element name="type" type="xs:string"/>
<xs:element name="value" type="xs:string" />
<xs:element name="time" type="xs:string" />
<xs:element name="stat" type="xs:string" />
<xs:element name="severity" type="xs:string" />
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>'
    
```

create table channel
(channelID int primary key,
channelname varchar(50) not null,
infoxcol xml not null)

create table data
(
channelID int primary key,
dataxcol xml(archiverschema) not null
)

Database

- The hardware platform using SAN & database server cluster
- Now we have tested on the MS SQL Server 2005 and will transfer to Oracle 10g with RAC later



e-Log

- Based on center database system
- Using Web2.0 Blog system
- Support RSS
- Integrated with uniform authentication system



Subsystems

- Three part of control system:
 - Linac, Booster, Storage Ring
 - PS, Vacuum, Modulator, e-gun, Microwave, Transport Line (injector/extract), Timing, MPS, RF
- Some subsystems statistics

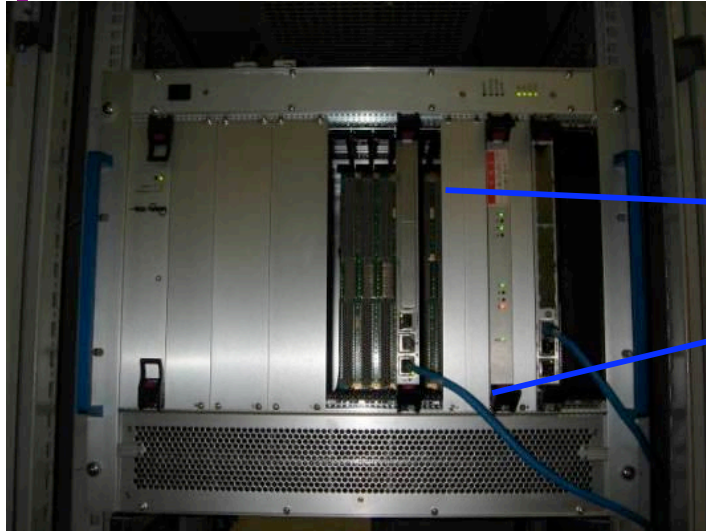
System	Devices	IOCs	PVs
PS	585	26	60000
Vacuum	730	25	23000
MPS	25	3	16000
Timing	16	16	540

PS Control

- Over 550 magnet power supplies are used at SSRF
- All PS are digital controlled
- 2 types of digital controllers
 - SINAP self-developed digital PS controller
 - LINAC, Booster and Transport Lines
 - PSI designed digital controller (Purchased from DLS Co., Ltd)
 - Storage Ring and the Booster Ramp PS
- Performance of stability and reliability has been proved since SSRF commission



Storage Ring PS Control



Booster PS control

Magnet	Switch	Setpoint	Readback	Status	Magnet	Switch	Setpoint	Readback	Status
BS-CV-01	Power	102CVPS	102CV	102CVPS-01	BS-CH-01	Power	102CHPS	102CH	102CHPS-01
BS-CV-02	Power	102CVPS	102CV	102CVPS-02	BS-CH-02	Power	102CHPS	102CH	102CHPS-02
BS-CV-03	Power	102CVPS	102CV	102CVPS-03	BS-CH-03	Power	102CHPS	102CH	102CHPS-03
BS-CV-04	Power	102CVPS	102CV	102CVPS-04	BS-CH-04	Power	102CHPS	102CH	102CHPS-04
BS-CV-05	Power	102CVPS	102CV	102CVPS-05	BS-CH-05	Power	102CHPS	102CH	102CHPS-05
BS-CV-06	Power	102CVPS	102CV	102CVPS-06	BS-CH-06	Power	102CHPS	102CH	102CHPS-06
BS-CV-07	Power	102CVPS	102CV	102CVPS-07	BS-CH-07	Power	102CHPS	102CH	102CHPS-07
BS-CV-08	Power	102CVPS	102CV	102CVPS-08	BS-CH-08	Power	102CHPS	102CH	102CHPS-08
BS-CV-09	Power	102CVPS	102CV	102CVPS-09	BS-CH-09	Power	102CHPS	102CH	102CHPS-09
BS-CV-10	Power	101CVPS	101CV	101CVPS-10	BS-CH-10	Power	101CHPS	101CH	101CHPS-10
BS-CV-11	Power	101CVPS	101CV	101CVPS-11	BS-CH-11	Power	101CHPS	101CH	101CHPS-11
BS-CV-12	Power	101CVPS	101CV	101CVPS-12	BS-CH-12	Power	101CHPS	101CH	101CHPS-12
BS-CV-13	Power	101CVPS	101CV	101CVPS-13	BS-CH-13	Power	101CHPS	101CH	101CHPS-13
BS-CV-14	Power	101CVPS	101CV	101CVPS-14	BS-CH-14	Power	101CHPS	101CH	101CHPS-14
BS-CV-15	Power	101CVPS	101CV	101CVPS-15	BS-CH-15	Power	101CHPS	101CH	101CHPS-15
BS-CV-16	Power	101CVPS	101CV	101CVPS-16	BS-CH-16	Power	101CHPS	101CH	101CHPS-16
BS-CV-17	Power	101CVPS	101CV	101CVPS-17	BS-CH-17	Power	101CHPS	101CH	101CHPS-17
BS-CV-18	Power	101CVPS	101CV	101CVPS-18	BS-CH-18	Power	101CHPS	101CH	101CHPS-18
BS-CV-19	Power	101CVPS	101CV	101CVPS-19	BS-CH-19	Power	101CHPS	101CH	101CHPS-19
BS-CV-20	Power	101CVPS	101CV	101CVPS-20	BS-CH-20	Power	101CHPS	101CH	101CHPS-20

Booster Ramping Control

Booster Ramp PS Control

Magnet	Switch	Path	Waveform operation filename	Download	Status	Power Status	Error State
B-01	Power	/home/system/waveform	waveform.bin	download	Unknown	On	OK (0x00)
B-02	Power	/home/system/waveform	waveform.bin	download	Unknown	On	OK (0x00)
GD-01	Power	/home/system/waveform	waveform.bin	download	Unknown	On	OK (0x00)
GF-01	Power	/home/system/waveform	waveform.bin	download	Unknown	On	OK (0x00)
SD-01	Power	/home/system/waveform	waveform.bin	download	Unknown	broken link	MAIN_RELAY (0x2)
SF-01	Power	/home/system/waveform	waveform.bin	download	Unknown	On	D_ISOLATION_NOT_C

Current Graphs:

- B-01 Current: 53.003
- B-02 Current: 140.518
- GF-01 Current: 76.670
- SD-01 Current: -0.001

/home/dingjt/bsopi/powerB.edl

\$(psname)

Power: Power (psname):STAT

Current: Set Current \$(psname):S Actual \$(psname):I

Data:

- Minimum Current: \$(psname):I10A
- Maximum Current: \$(psname):I10A
- DC Link Voltage: \$(psname):VDC1
- Load Voltage: \$(psname):VLO1
- Current Ref/Readback diff: \$(psname):IDF

Digital Input:

- Master Relay: \$(psname):DI1S
- Current Transducer: \$(psname):DI1S
- Rack Water: \$(psname):DI2S
- Interlock: \$(psname):DI3S
- Ventilator: \$(psname):DI4S
- Chasis Door: \$(psname):DI5S
- Load Water: \$(psname):DI6S
- Load Temperature: \$(psname):DI7S

Device State:

- PWM Output: \$(psname):DO1S
- Power State: \$(psname):DO1S
- ADC Check: \$(psname):DS2S
- Comm Frame Check: \$(psname):DS3S
- Comm Timeout: \$(psname):DS4S
- Digital Input: \$(psname):DS5S
- Command Execution: \$(psname):DS6S
- Operation Prior: \$(psname):DS7S

Raw Value:

- DI STATE:
- DI MASK:
- DEV STATE:

Current Graph

Booster PS Control



/home/dingjg/bsopi/ht_ps.edl

Booster-to-Ring PS control

Magnet	Switch	Setpoint	Readback	Status
HT:CV-01	Power	H01CVPS-	H01CVP	S:H01CVPS-01:
HT:CV-02	Power	H01CVPS-	H01CVP	S:H01CVPS-02:
HT:CV-03	Power	H01CVPS-	H01CVP	S:H01CVPS-03:
HT:CV-04	Power	H01CVPS-	H01CVP	S:H01CVPS-04:
HT:CV-05	Power	H01CVPS-	H01CVP	S:H01CVPS-05:
HT:CH-01	Power	H01CHPS-	H01CHP	S:H01CHPS-01:
HT:CH-02	Power	H01CHPS-	H01CHP	S:H01CHPS-02:
HT:CH-03	Power	H01CHPS-	H01CHP	S:H01CHPS-03:
HT:CH-04	Power	H01CHPS-	H01CHP	S:H01CHPS-04:
HT:CH-05	Power	H01CHPS-	H01CHP	S:H01CHPS-05:
HT:QUAD-01	Power	H01QPS-	H01QPS	PS:H01QPS-01:\$
HT:QUAD-02	Power	H01QPS-	H01QPS	PS:H01QPS-02:\$
HT:QUAD-03	Power	H01QPS-	H01QPS	PS:H01QPS-03:\$
HT:QUAD-04	Power	H01QPS-	H01QPS	PS:H01QPS-04:\$
HT:QUAD-05	Power	H01QPS-	H01QPS	PS:H01QPS-05:\$
HT:QUAD-06	Power	H01QPS-	H01QPS	PS:H01QPS-06:\$
HT:QUAD-07	Power	H01QPS-	H01QPS	PS:H01QPS-07:\$
HT:QUAD-08	Power	H01QPS-	H01QPS	PS:H01QPS-08:\$
HT:QUAD-09	Power	H01QPS-	H01QPS	PS:H01QPS-09:\$
HT:QUAD-10	Power	H01QPS-	H01QPS	PS:H01QPS-10:\$

LA-PS:H01FCS-13 Details

LA-PS:H01FCS-13

Power

Power **ON**

Current

Set Current: 17.555 Actual: **17.61 Amps**

Data

Minimum Current: 0.000 Amps

Maximum Current: 55.000 Amps

DC Link Voltage: 412.998 Volts

Load Voltage: 15.228 Volts

Current Ref/Readback diff: 0.056 Amps

Digital Input

Master Relay: **ON**

Current Transducer: **FAULT**

Rack Water: **FAULT**

Interlock: **OK**

Ventilator: **OK**

Chasis Door: **FAULT**

Load Water: **FAULT**

Load Temperature: **OK**

Raw Value

DI STATE: [Progress bar]

DI MASK: [Progress bar]

Device State

PWM Output: **ON**

Power State: **OK**

ADC Check: **OK**

Comm Frame Check: **OK**

Comm Timeout: **OK**

Digital Input: **OK**

Command Execution: **OK**

Operation Prior: **OK**

Raw Value

DEV STATE: [Progress bar]

Current Graph Close

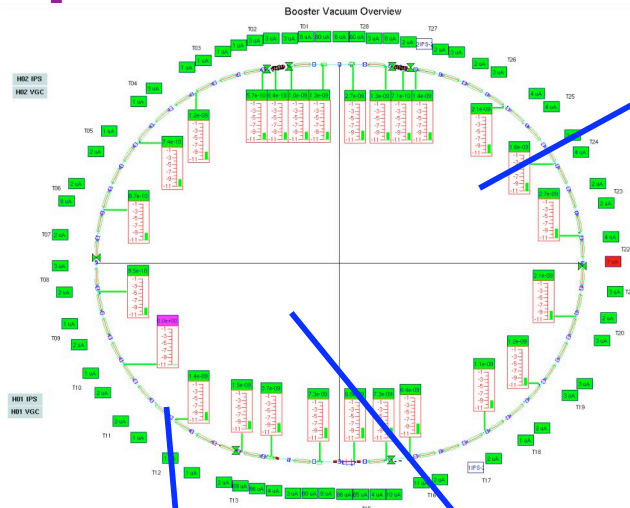
Vacuum Control

- Most devices are based on serial port
 - VARIAN Multi Gauge
 - JJJvac Sputter Ion Pump Power Supply
 - VAT valve
 - RGA (Residual Gas Analyzer)
 - Etc.

- PLCs
 - Yokogawa FAM3



Vacuum Control GUI



IPS	HV	Current	Pressure	IPS	HV	Current	Pressure
01	6100 V	3 uA	2.300e-08 Pa	17	6200 V	9 uA	6.400e-08 Pa
02	5900 V	2 uA	1.300e-08 Pa	18	6200 V	86 uA	6.600e-07 Pa
03	6100 V	1 uA	9.000e-09 Pa	19	6200 V	85 uA	6.500e-07 Pa
04	6100 V	2 uA	1.300e-08 Pa	20	6100 V	4 uA	4.200e-08 Pa
05	6300 V	1 uA	1.300e-08 Pa	21	6300 V	11 uA	1.100e-07 Pa
06	6100 V	2 uA	1.300e-08 Pa	22	6100 V	11 uA	1.100e-07 Pa
07	6100 V	2 uA	1.300e-08 Pa	23	6100 V	2 uA	1.500e-08 Pa
08	6000 V	2 uA	1.300e-08 Pa	24	6200 V	2 uA	1.700e-08 Pa
09	6300 V	1 uA	6.000e-09 Pa	25	6200 V	2 uA	1.500e-08 Pa
10	6100 V	1 uA	6.000e-09 Pa	26	6000 V	2 uA	2.000e-08 Pa
11	6200 V	2 uA	1.300e-08 Pa	27	6100 V	2 uA	2.000e-08 Pa
12	6100 V	72 uA	7.200e-07 Pa	28	6200 V	3 uA	2.800e-08 Pa
13	6200 V	92 uA	9.200e-07 Pa	29	6100 V	3 uA	2.600e-08 Pa
14	6000 V	4 uA	4.200e-08 Pa	30	6100 V	3 uA	2.800e-08 Pa
15	6000 V	3 uA	3.100e-08 Pa	31	6100 V	2 uA	2.100e-08 Pa

BS-T08-IPS-1

BS-T08-IPS-1

6100 V

3 uA

2.9e-08 Pa

Control

Local/Remote: Remote 4KV OFF

State: Work 6KV ON

BK OFF

Status Readback

Local/Remote: 4KV

State: 6KV

BK

Parameter Set Disable

Start Current (mA):

Work Current (mA):

Baudrate:

IPS No.:

Parameter Readback

Start Current (mA):

Work Current (mA):

Baudrate:

IPS No.:

Booster to Storage Ring Transfer Line - Vacuum

5.7e-10

7.0e-10

4.4e-10

1.4e-09

9.6e-10

Beam Dump Wall SR01C

Pumps: [Stop] [Start] Valves: [Reset] [Close] [Open] IMGs: [Off] [On]

Ring_Vac:SGV_D01

Status: ac:SGV []

Control: [CLOSE]

Fault:

- 90V Fault1- Valve not closed in middle
- 90V Fault2- Valve open when commanded closed
- 90V Fault3- T1 timed out & Valve STILL closed
- 90V Fault4- T2 timed out
- 90V Fault5- Valve closed when commanded open
- 90V Fault6- Valve not open in middle
- 90V Fault7- T3 timed out & Valve STILL open
- 90V Fault8- T4 timed out

Booster H02 VGC Control Panel

Stage	Pressure	Current	Working	Warning	Stop	Start	Stop	Start
T02A02	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A03	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A04	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A05	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A06	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A07	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A08	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A09	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A10	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A11	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A12	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A13	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A14	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A15	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A16	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A17	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A18	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A19	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A20	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A21	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A22	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A23	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A24	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A25	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A26	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A27	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A28	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A29	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A30	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A31	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A32	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A33	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A34	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A35	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A36	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A37	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A38	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A39	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop
T02A40	1.30e-08	0.00e+00	Start	Stop	Start	Stop	Start	Stop

4.9e-10

9.4e-10

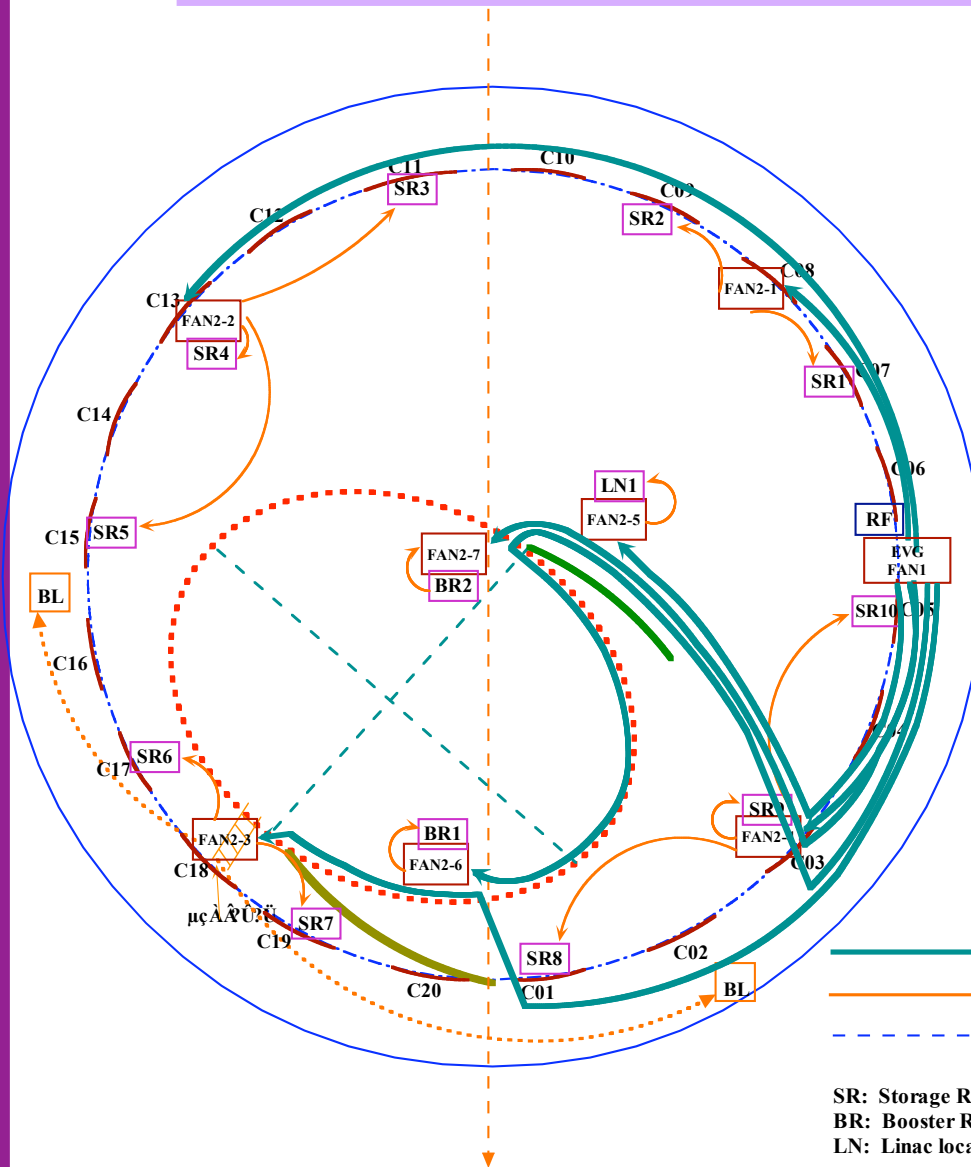
4.8e-10

6.8e-10




Beam Stop Beam Stop Wall

Pumps: [Stop] [Start] Valves: [Reset] [Close] [Open] IMGs: [Off] [On]

The Event Timing System



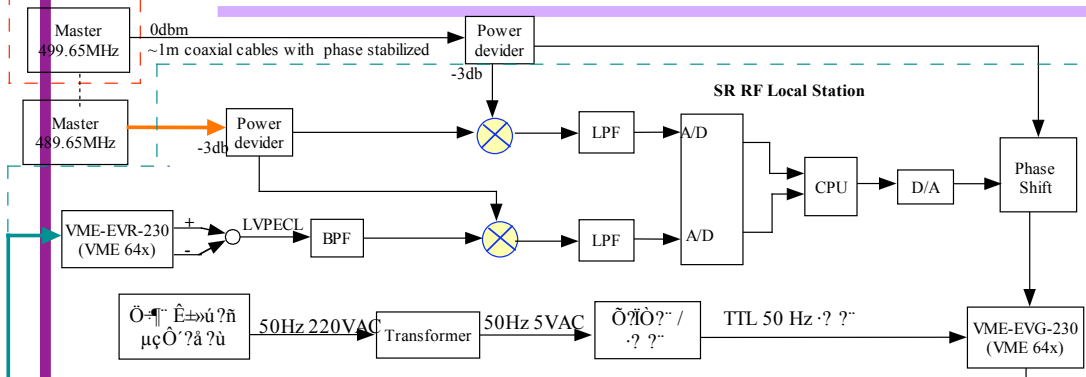
- New event timing system
 - Structure is simple used broadcasting method
 - Low Jitter with distributed RF clock
 - Run on the EPCIS environment, base 3.14.x
 - Easy to extend
- Compact network based on characteristic event system.
- All EVRs are placed on timing crates and BI local stations not being triggered devices
- All trigger outputs integrate with hardware interlocks

 Second level brunches, ~ 250m
 Third level brunches, ~ 60m
 Fourth level brunches (plastic fibers), ~35m
 SR: Storage Ring local station ,assuming 10
 BR: Booster Ring local station ,assuming 2
 LN: Linac local station ,assuming 1



Hardware Schematic

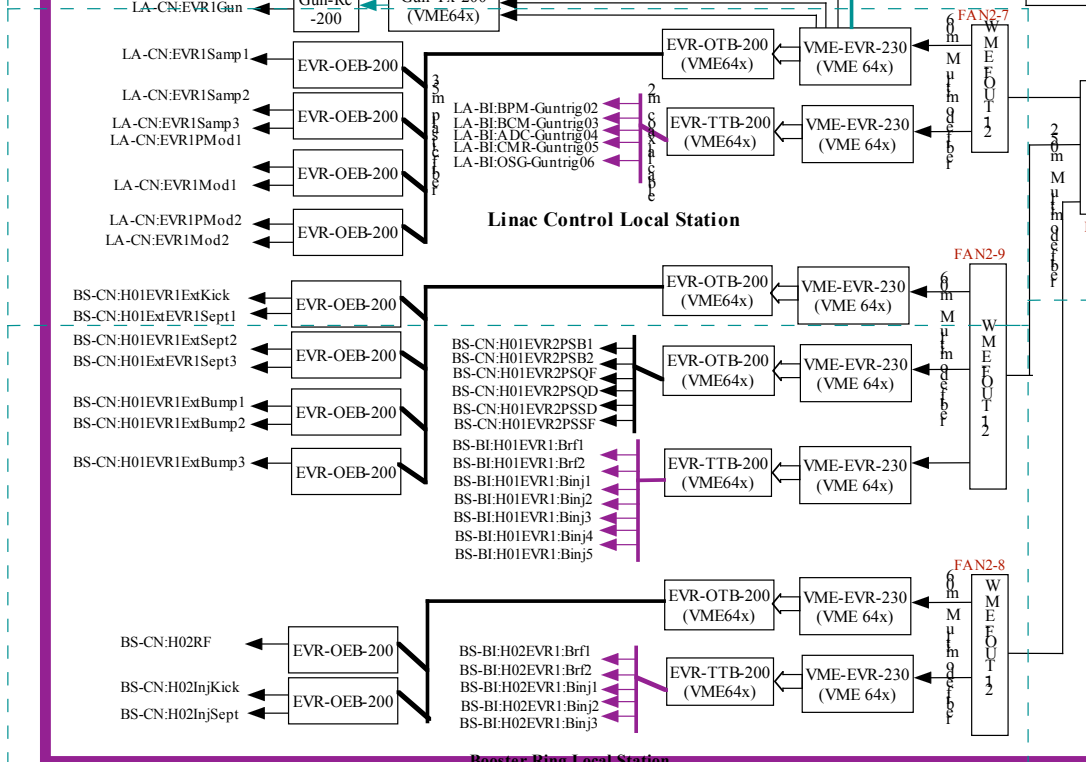
RF Local Station



310m Multimode Fiber



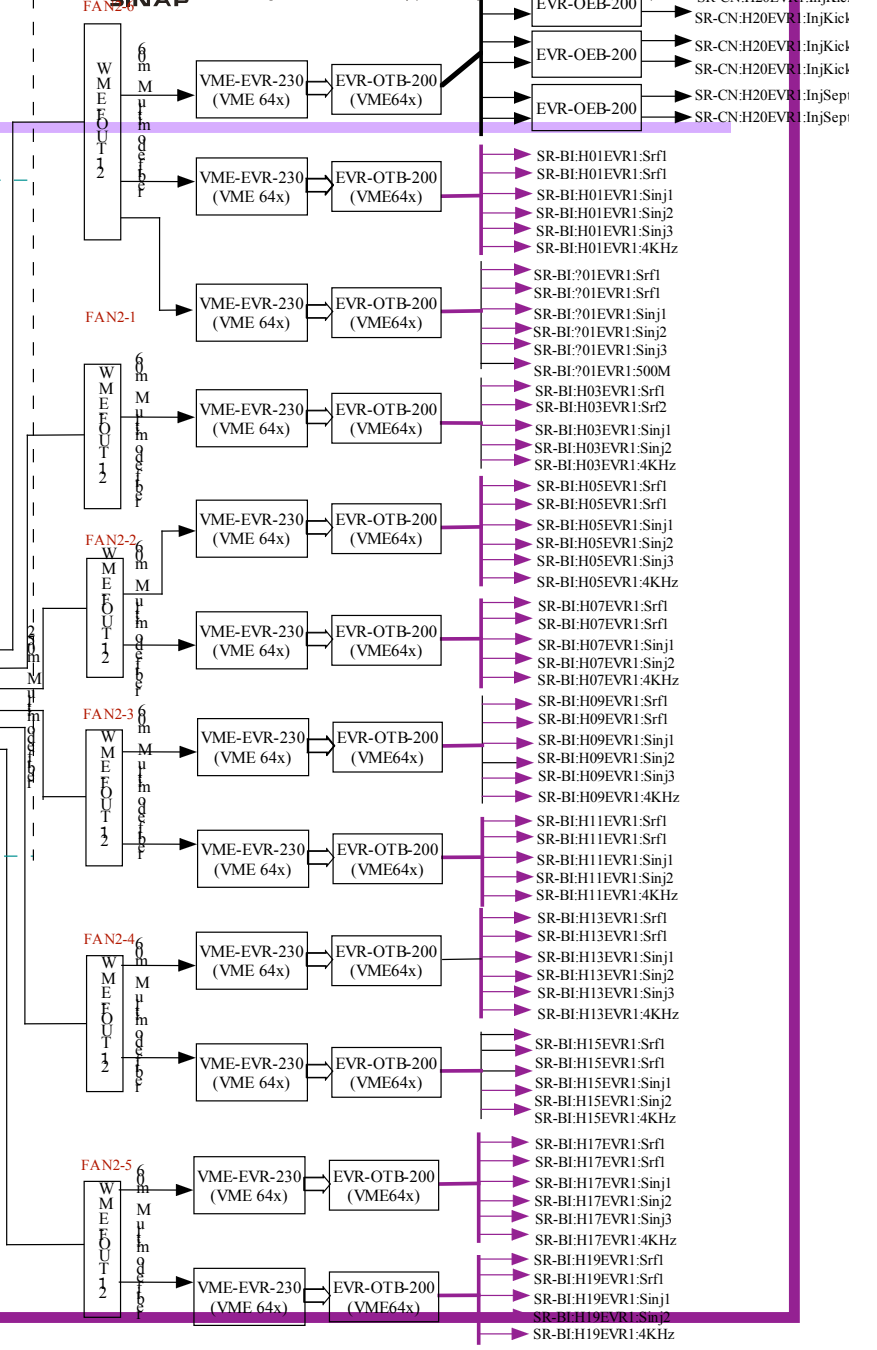
Linac Control Local Station



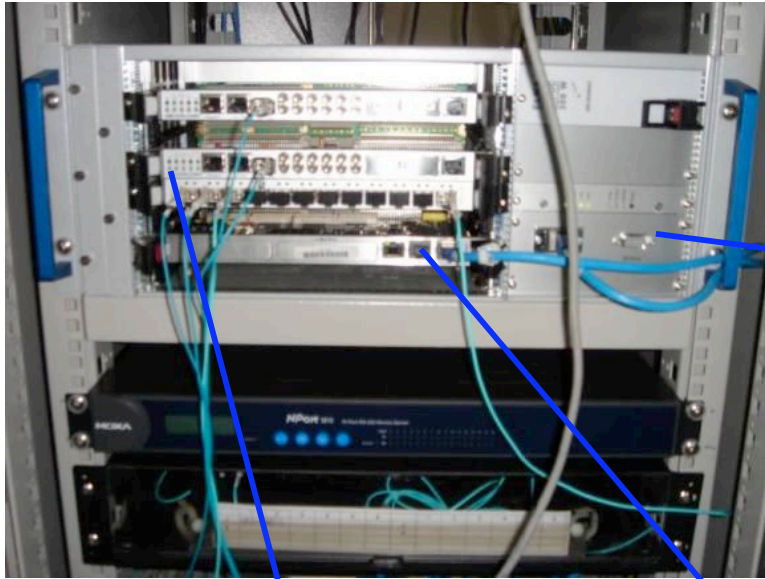
Booster Ring Local Station



Storage Ring Local Stations



Timing System



/home/shen/timingopi/pulseps.edl

Booster Pulse Power Supplies Timing Control

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Inj Kicker	010W	:H02EVRI	BS-CN:H0	0100	:H02EVRI	BS-CN:H0	ON
Inj Septum	011W	:H02EVRI	BS-CN:H0	0110	:H02EVRI	BS-CN:H0	ON

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Ext Kicker	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
Ext Septum1	011W	:H01EVRI	BS-CN:H0	0110	:H01EVRI	BS-CN:H0	ON
Ext Septum2	012W	:H01EVRI	BS-CN:H0	0120	:H01EVRI	BS-CN:H0	ON
Ext Septum3	013W	:H01EVRI	BS-CN:H0	0130	:H01EVRI	BS-CN:H0	ON
Ext Bump1	014W	:H01EVRI	BS-CN:H0	0140	:H01EVRI	BS-CN:H0	ON
Ext Bump2	015W	:H01EVRI	BS-CN:H0	0150	:H01EVRI	BS-CN:H0	ON
Ext Bump3	016W	:H01EVRI	BS-CN:H0	0160	:H01EVRI	BS-CN:H0	ON

EXIT

/home/shen/timingopi/booster.edl

Booster Timing Control

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Inj Kicker	010W	:H02EVRI	BS-CN:H0	0100	:H02EVRI	BS-CN:H0	ON
Inj Septum	010W	:H02EVRI	BS-CN:H0	0100	:H02EVRI	BS-CN:H0	ON
Inj RFTr	012W	:H02EVRI	BS-CN:H0	0120	:H02EVRI	BS-CN:H0	ON
Inj BPM1	010W	:H02EVRI	BS-BE:H02	0100	:H02EVRI	BS-BE:H02	ON
Inj BPM2	012W	:H02EVRI	BS-BE:H02	0120	:H02EVRI	BS-BE:H02	ON
Inj BPM2	012W	:H02EVRI	BS-BE:H02	0120	:H02EVRI	BS-BE:H02	ON

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Ext Kicker	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
Ext Septum3	013W	:H01EVRI	BS-CN:H0	0130	:H01EVRI	BS-CN:H0	ON
Ext Septum2	012W	:H01EVRI	BS-CN:H0	0120	:H01EVRI	BS-CN:H0	ON
Ext Septum3	013W	:H01EVRI	BS-CN:H0	0130	:H01EVRI	BS-CN:H0	ON
Ext Bump1	014W	:H01EVRI	BS-CN:H0	0140	:H01EVRI	BS-CN:H0	ON
Ext Bump2	015W	:H01EVRI	BS-CN:H0	0150	:H01EVRI	BS-CN:H0	ON
Ext Bump3	016W	:H01EVRI	BS-CN:H0	0160	:H01EVRI	BS-CN:H0	ON

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Ext BPM1	010W	:H01EVRI	BS-BE:H01	0100	:H01EVRI	BS-BE:H01	ON
Ext BPM2	012W	:H01EVRI	BS-BE:H01	0120	:H01EVRI	BS-BE:H01	ON
Ext BPM2	013W	:H01EVRI	BS-BE:H01	0130	:H01EVRI	BS-BE:H01	ON
Ext Cavn	014W	:H01EVRI	BS-BE:H01	0140	:H01EVRI	BS-BE:H01	ON

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
PSB1	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB2	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB3	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB4	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB1	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB2	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB1	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON
PSB2	010W	:H01EVRI	BS-CN:H0	0100	:H01EVRI	BS-CN:H0	ON

EXIT

/home/shen/timingopi/rf.edl

Booster RF Timing Control

	Pulse Width(*8ns)			Pulse Delay(*8ns)			
Inj RFTr	012W	:H02EVRI	BS-CN:H0	0120	:H02EVRI	BS-CN:H0	ON

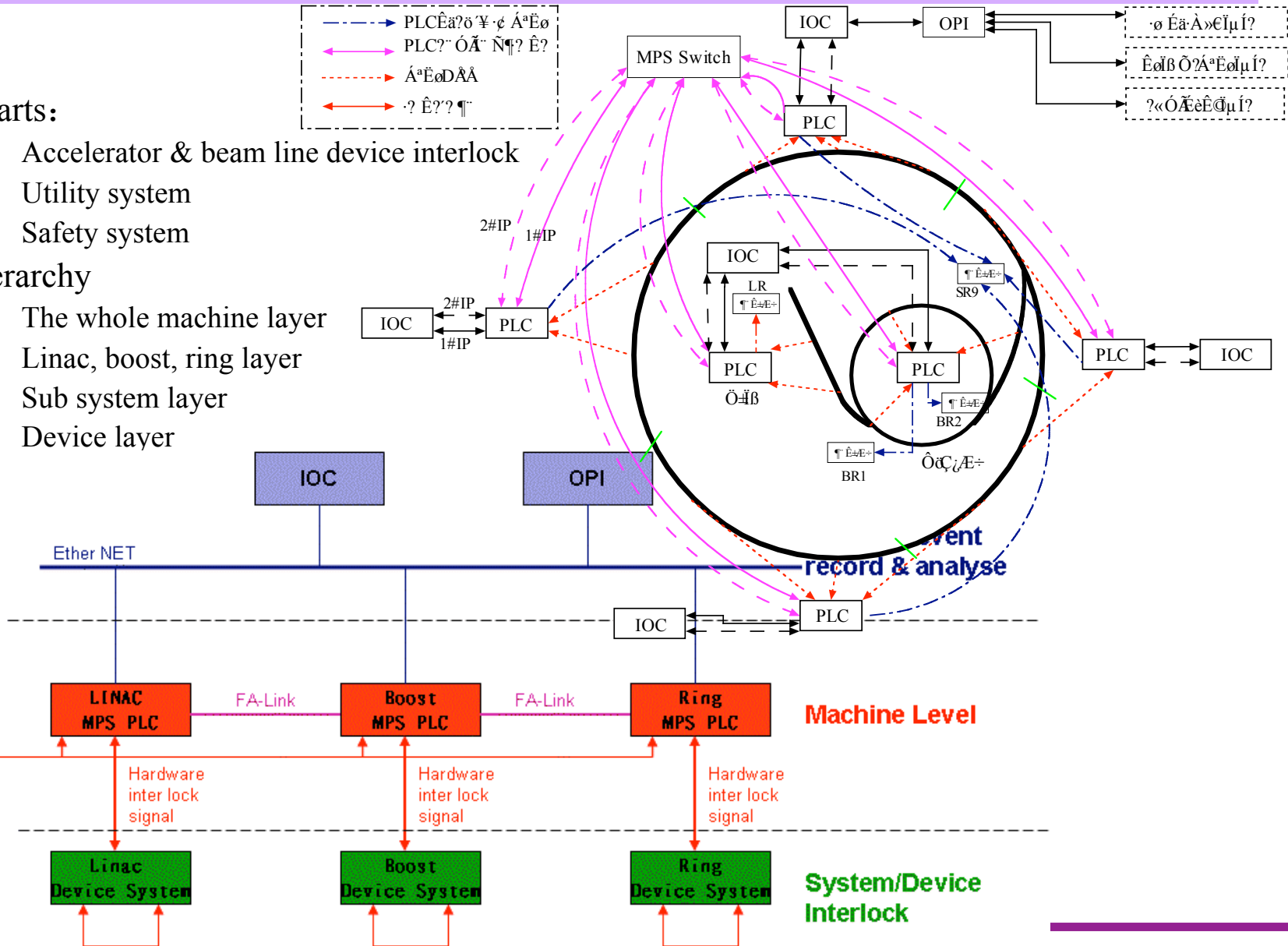
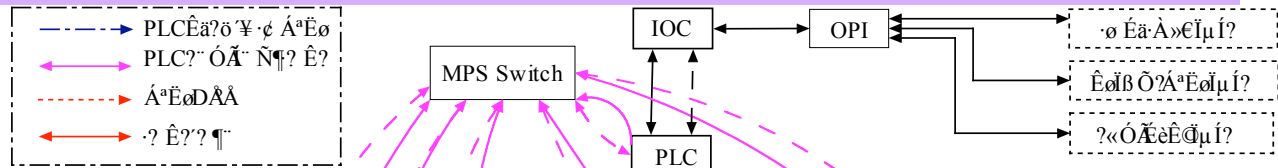
EXIT

Performance

- The RMS jitter of gun trigger relative to RF reference is 10.72ps, which includes the jitter of e-gun and oscilloscope.
- The RMS jitters of other injection and extraction trigger are less than 30ps.
- Performance are satisfied with the requirements of physical design.

MPS

- 3 parts:
 - Accelerator & beam line device interlock
 - Utility system
 - Safety system
- Hierarchy
 - The whole machine layer
 - Linac, boost, ring layer
 - Sub system layer
 - Device layer



MPS GUI



/home/chengh/bs_mps.edi

Booster Machine Protect System

StopH01
DebugModeH01
StopH02
DebugModeH02

Booster System Status				Booster Ring Vacuum Status				LTB Vacuum Status						
Signal	Status	Bypass	Latched	Reset	Signal	Status	Bypass	Latched	Reset	Signal	Status	Bypass	Latched	Reset
B1 power supply status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T01BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	098P	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>
B2 power supply status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T01BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	099P	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>
QF power supply status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T02BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	100P	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>
QD power supply status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T02BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
HT B power supply status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T03BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Injection system status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T05BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Extraction system status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T06BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
RF System status	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T08BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
PPS status 1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T10BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
PPS status 2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T11BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Emergency Stop 1 (to BPH1)	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T13BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Emergency Stop 2 (to BPH1)	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T13BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Emergency Stop 3 (to BPH2)	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T14BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
Emergency Stop 4 (to BPH2)	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>	T15BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T15BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T16BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T17BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T19BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T20BAG	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T22BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T24BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T25BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T27BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T27BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T28BAG1	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					
					T28BAG2	●	<input type="button" value="Bypass"/>	<input type="button" value="Latched"/>	<input type="button" value="Reset"/>					

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

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

Kicker Run Stop

<ul style="list-style-type: none"> ● Trig Ind ● TH Preheat ● MachBox Temp ● Rem Control ● Kicker Fault ● CPS Loc Con ● CPS On/Off ● CPS Interlock ● Outside Interlock 	<ul style="list-style-type: none"> ● Output Ind ● Charge Ind ● CPS Sta ● Door Interlock ● TH Fan ● Ground Sta ● Filana Fault ● H2 Fault ● K Run
---	---

Kicker Voltage(KV)

Setpoint: 0.0 KV Readback: 12.7 KV

Kicker Current(mA)

Setpoint: 0.0 mA Readback: 0.7 mA

Rate: 2.0 Hz

Total Time: 15 Minute

Warming Time: 15 Minute 0 Second

Septum Run Stop

<ul style="list-style-type: none"> ● Trig Ind ● Ground Sta ● MachBox Temp ● CPS Loc Con ● CPS On/Off ● CPS Interlock ● Outside Interlock 	<ul style="list-style-type: none"> ● Output Ind ● Rem Control ● Septum Fault ● CPS Sta ● Door Interlock ● Mage Water ● Mage Temp
--	--

Septum Voltage(KV)

Setpoint: 0.0 KV Readback: -0.0 KV

Septum Current(mA)

Setpoint: 0.0 mA Readback: -1.1 mA

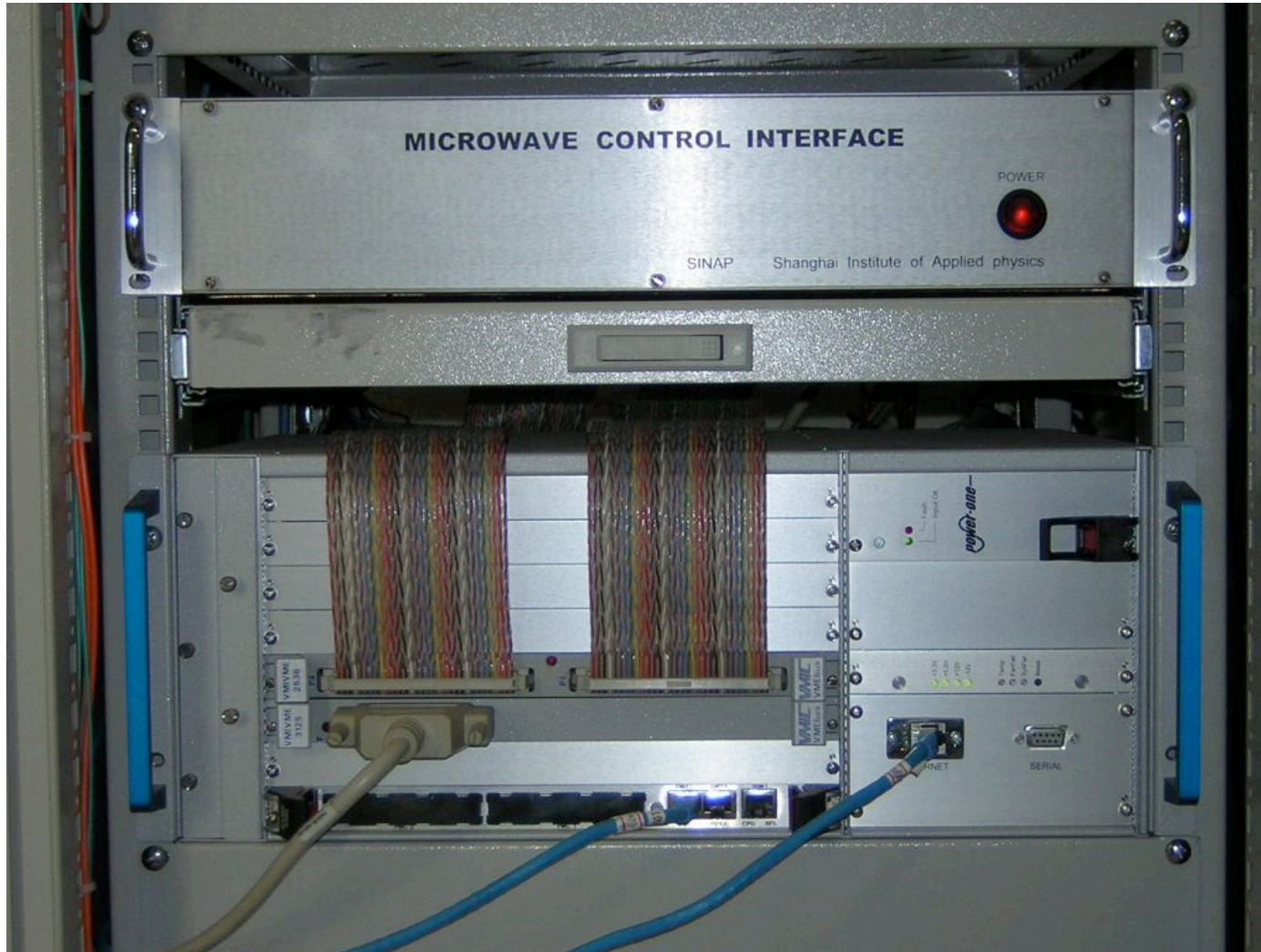
Rate: 2.0 Hz

[shen@bop03:~] zhuqg's 7plc/foc B... shen@bop03:~ edm 1-11-02b /home/shen/edm/BS-1-Control.edi

RF System

- Linac microwave system is designed by SSRF
- Thales design RF system for SSRF
- Integrated with EPICS system and can be controlled at center control room

Linac RF Control



RF for Booster and Storage Ring



RF Amplifier &
Klystron

Booster 180Kw

Storage Ring
300Kw X 3

Epics IOC
MVME 5500
Hytec I/O boards
Fully Isolated -
Interface

RF and Timing Event Distribution



Master Signal
Generator

RF Signal
Distribution
Unit

Timing & Event
Signal
Generator

Fiber (Om3)
Distribution
Unit

RF GUI

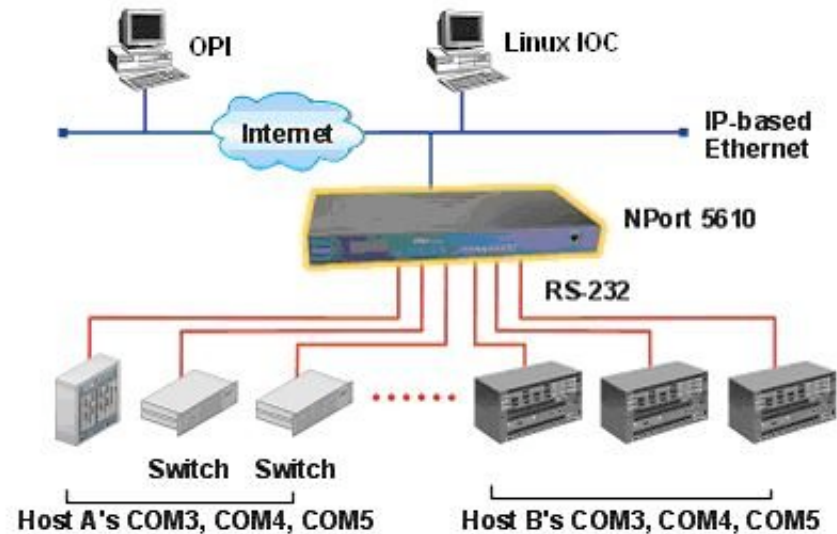
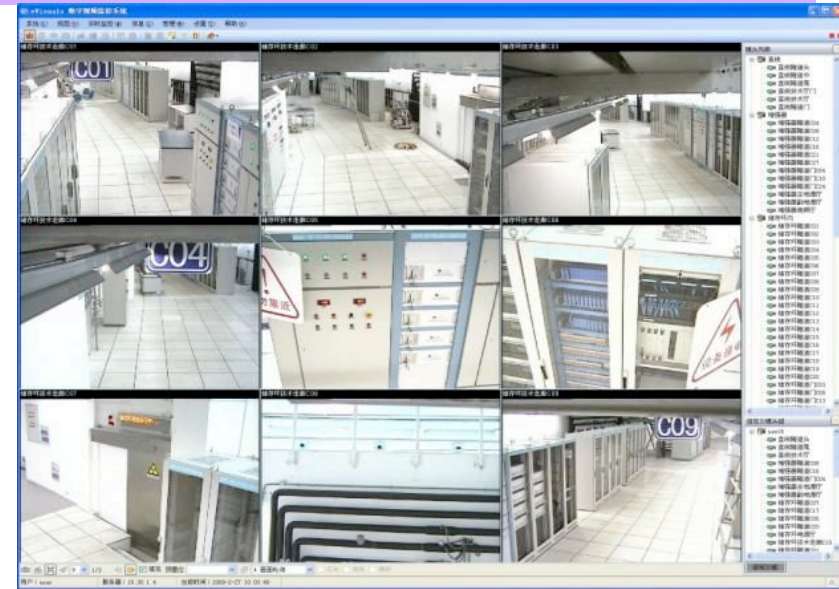
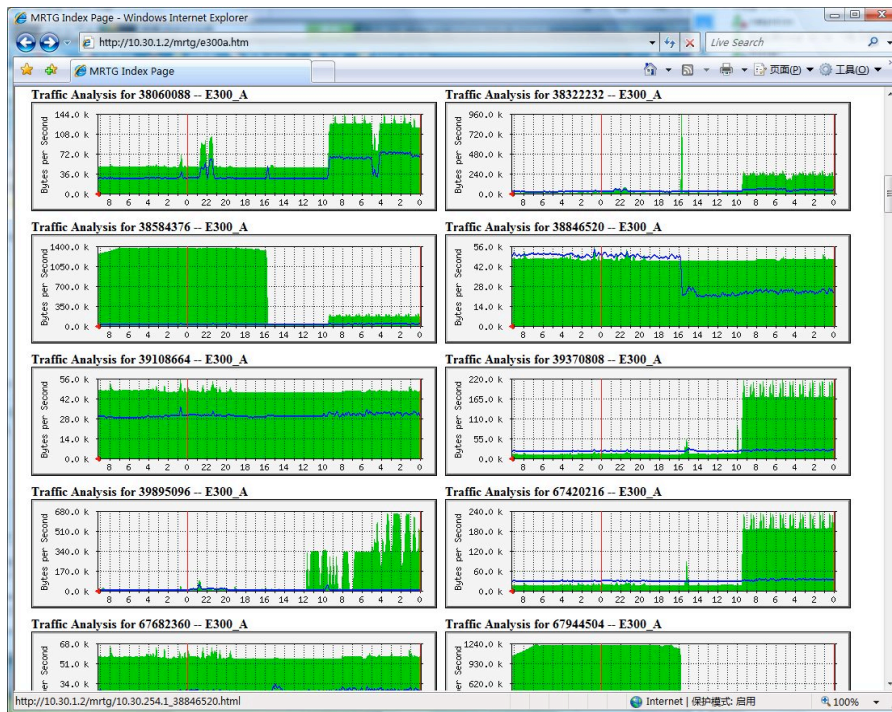


Storage Ring

Booster

Remote Management

- Video & Audio system based on network
- Device management
- Remote monitor: VME ,Switch, UPS etc
 - Based on SNMP
- Email、SMS alarm system (Next)



Center Control Room

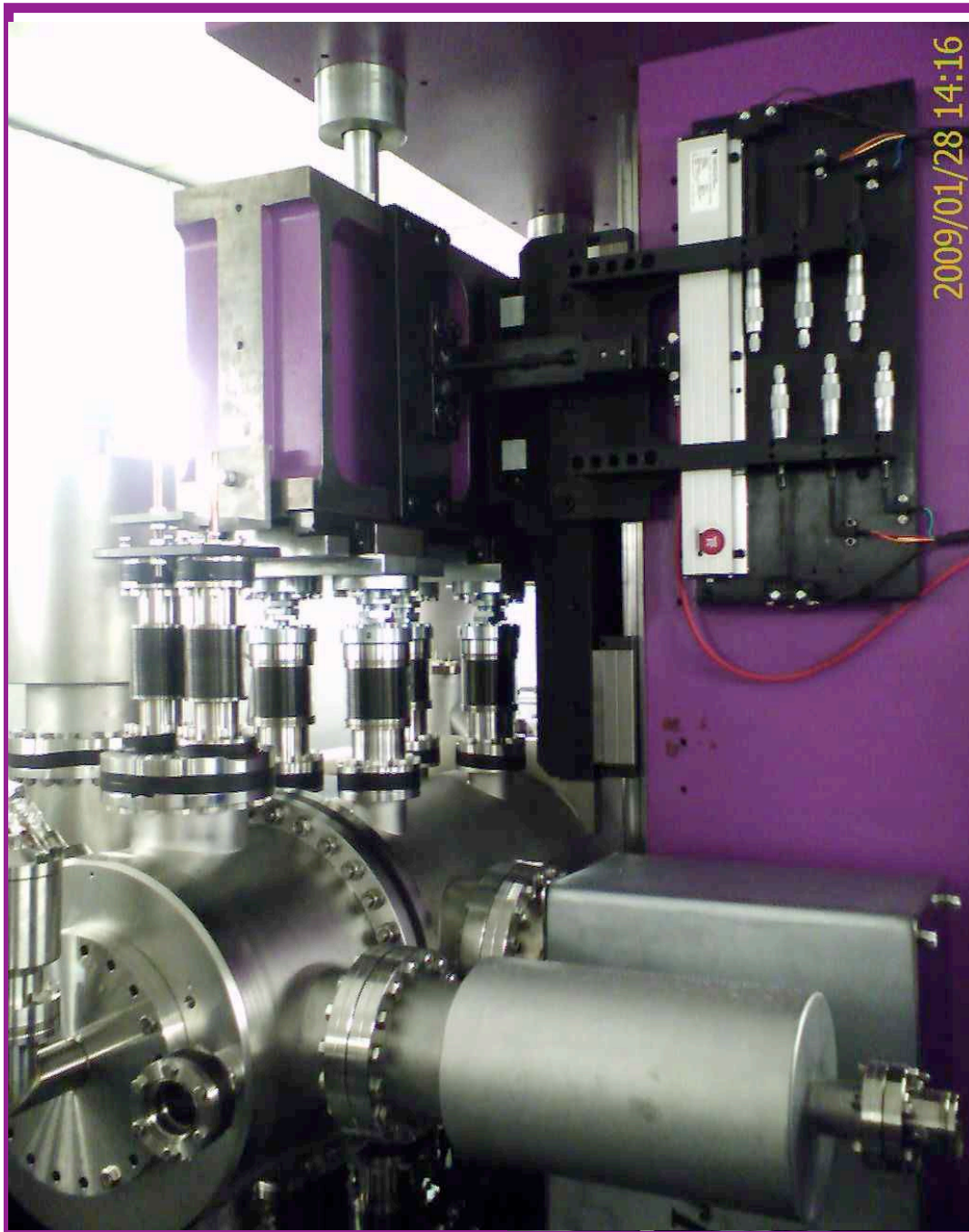
- 18 HP7700 OPI PCs in the Control Room
- All the OPIs run on the Linux Fedora 7 and in ssrf.ac.cn domain.
- OPI system running at control system has uniform runtime environment.
- The edm GUI files are stored on NFS file server and all the client can access it by a start script.



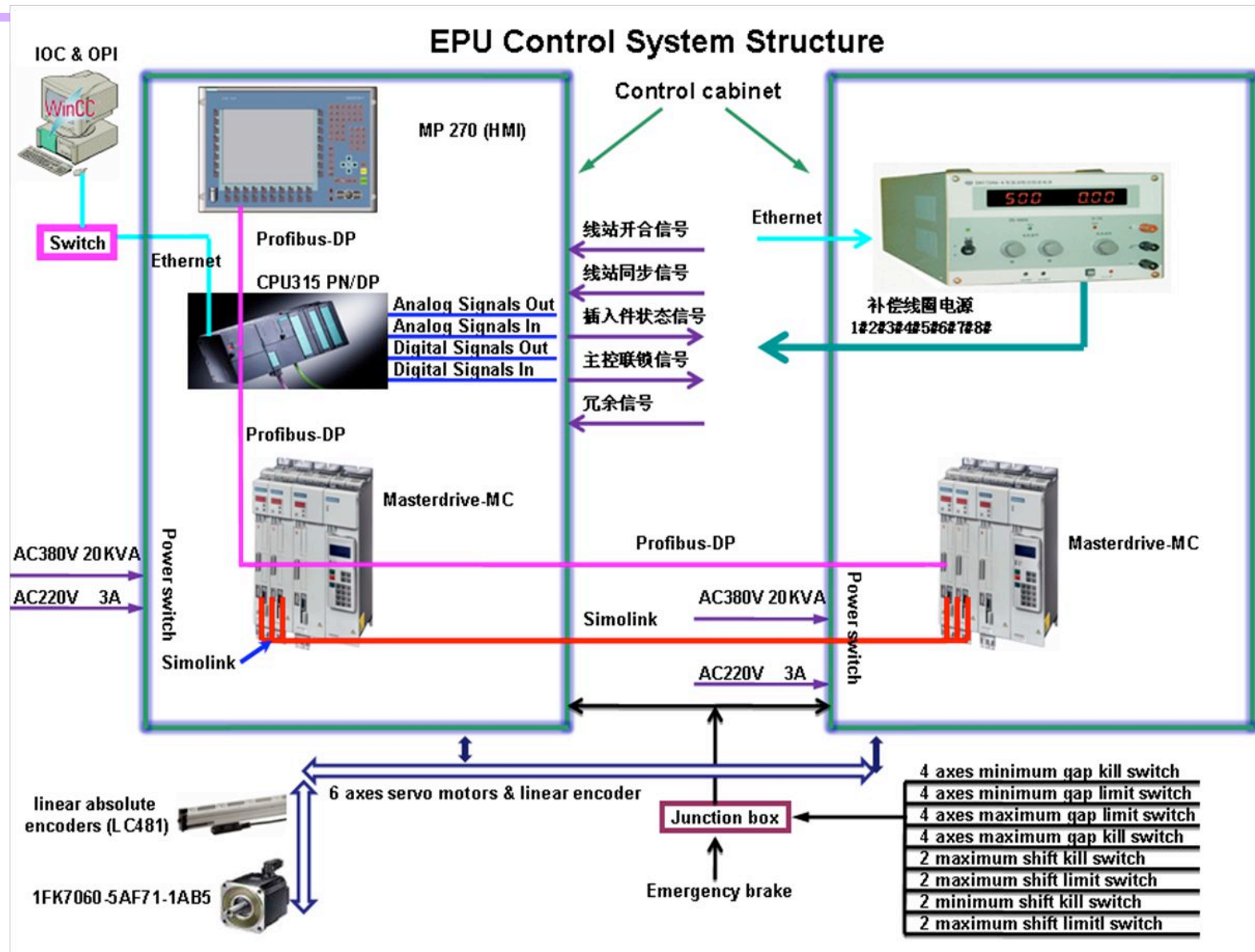
2008/02/27

Inserting Device (ID)

- More than 60 beam lines could be installed in the ring
- 26 of them will be based on insertion devices
- First stage will also include 7 initial beam lines and experimental stations
 - macromolecular crystallography
 - XAFS
 - hard X-ray microfocus
 - X-ray imaging and biomedical application
 - soft X-ray spectromicroscopy
 - diffraction
 - small angle X-ray scattering respectively
- 5 beam lines are based on insertion devices, 2 are based on bending magnets
 - 2 wigglers, finished
 - 1 elliptically polarizing undulator (EPU) , finished
 - 2 in-vacuum undulators (1 finished, 1 will be finished in this month)



Wiggler and EPU control



Embedded EPICS Controller of IDs

- We use embedded EPICS controller to implement ID control
 - DI/DO interfaces
 - 2 Ethernet ports/ 1 RS232 debug ports/PCMCIA wireless card
 - Intel xscale CPU
 - CF card storage support
- Full IOC core
 - Base 3.14.10 cross compile, CF card storage
- Additional programming for converting Ethernet/serial (Full duplex)
- Three types of EPICS applications running on it
 - S7 PLC driver
 - Power supply driver
 - PC Monitor application
- Running stability
 - Kernel version 2.6
 - About 15% CPU loading, several tens of Mega storage
 - Full ioc core supported including sequencer
 - Startup ioc via /etc/inittab

Embedded EPICS Controller

Terminal window: /home/ssrf/prod/opi/edl/insertdevice/ivu_H15_master_monitor.edl

SSRF H15 IVU Control

SR-ID:H15IVU

CPU Heart Beat: 70 (Green dot)

CPU Load: 12.89 % (Yellow dot)

Device	Switch	SetPoint	ReadBack	Stat
H15-PS1	OFF	0.0600	0.0211	Of
H15-PS2	OFF	0.0000	0.0166	Of
H15-PS3	OFF	0.0000	0.0132	Of

Metric	Value	Status
CPU Idle	87.11 %	Yellow
CPU Nice	0.00 %	Yellow
CPU System	3.74 %	Yellow
CPU User	9.15 %	Yellow
Load Avg 1 min	1.51	Yellow
Load Avg 5 min	1.06	Yellow
Load Avg 15 min	2.05	Yellow
Memory Av	127184 KB	Yellow
Memory Used	41080 KB	Yellow
Memory Free	86104 KB	Yellow
Memory Shrd	0 KB	Yellow
Memory Buff	3212 KB	Yellow
Swap Av	0 KB	Yellow
Swap Used	0 KB	Yellow
Swap Free	0 KB	Yellow
Swap Cached	17700 KB	Yellow

```

4805 root      17952 SW  ./...
4806 root      17952 SW  ./...
4807 root      17952 SW  ./...
4808 root      17952 SW  ./...
4877 root      17952 SW  ./...
4878 root      17952 SW  ./...
10758 root     17952 SW  ./...
10759 root     16268 SW  ./...
10760 root     18756 SW  ./...
10761 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
10762 root     16268 SW  ./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
10763 root     18756 SW  ./.../bin/linux-xscale_be/streamApp ./power.cmd
19764 root     18756 SW  ./.../bin/linux-xscale_be/streamApp ./power.cmd
19765 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
19766 root     16268 SW  ./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
19767 root     18756 SW  ./.../bin/linux-xscale_be/streamApp ./power.cmd
19768 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
19769 root     16268 SW  ./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
26166 root      5900 SW  sshd: root@tty0
26172 root      2388 SW  -bash
27581 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
27582 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
30314 root     17952 SW  ./.../bin/linux-xscale_be/s7plc ./st.cmd
  
```

System Information:

- Local Time: Fri Feb 6 10:39
- Boot Time: Tue Feb 3 23:12
- Up Time: 02 days 11:27
- IP Address: 15:9:30:10
- System: Linux
- Release: 2.6.10_dev-iodp42x-arm_xscale_be
- Machine: armv5teb
- Version: #677 Tue Jul 10 03:25:23 CST 2007



```

./.../bin/linux-xscale_be/s7plc ./st.cmd
./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
./.../bin/linux-xscale_be/streamApp ./power.cmd
./.../bin/linux-xscale_be/streamApp ./power.cmd
./.../bin/linux-xscale_be/s7plc ./st.cmd
./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
./.../bin/linux-xscale_be/streamApp ./power.cmd
./.../bin/linux-xscale_be/s7plc ./st.cmd
./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
./.../bin/linux-xscale_be/streamApp ./power.cmd
./.../bin/linux-xscale_be/s7plc ./st.cmd
./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
./.../bin/linux-xscale_be/streamApp ./power.cmd
./.../bin/linux-xscale_be/s7plc ./st.cmd
./.../bin/linux-xscale_be/pcMonitor pcMonitor.script
./.../bin/linux-xscale_be/streamApp ./power.cmd
  
```

Conclusion

- SSRF control system is another successful application of EPICS
- We benefit greatly from other control groups, especially KEKB control group
- Ethernet and netDev (J.Odagiri) make our control architecture simple and clean
- The control system was successful during the machine commissioning, has reached design goal
- We hope can do some enhanced works in the future and contribute to EPICS collaboration



Thanks



主体建筑透视图

Design Parameters

Wiggler

最小磁隙 13 (16) mm
最大使用磁隙 50 mm
最大可拉开磁隙 150mm
最大磁隙调节速度 4 mm/sec
打开磁隙从最小到最大 ~67 sec
打开磁隙从最小到最大工作磁隙 ~19sec
磁隙最小间隙必须有限位开关
通过网络与加速器控制接口
.1 um 绝对值光栅尺
光电限位开关 & 机电刹车开关

- Controller Manages
 - 4 Gap Servo Motor
 - 2 Phase Shift Servo Motor
 - 6 Heidenhain linear absolute encoders
 - 24 Limit and Kill Switches
 - 联锁信号
 - 4 Correction Coils
 - Software Interface
- 2 in-vacuum undulator
 - Step motor
 - Different encoders and so on

EPU:

6个伺服电机 (4个磁隙控制, 2个相位控制)
最小磁隙 ~30 mm
最大使用磁隙 85 mm
最大可拉开磁隙 100mm
最大磁隙调节速度 4 mm/sec
~10 sec Min to Max Gap Time
最小磁隙调节分辨率 $\leq 5\mu\text{m}$
最大磁场极化相位调节速度 30s(从线极化调至圆极化)
相位移动范围 $\pm 55\text{mm}$
磁隙最小间隙必须有限位开关
通过网络与加速器控制接口
.1 um 绝对值光栅尺
光电限位开关 & 机电刹车开关