Shanghai Deep UV-FEL Control System

Control Group

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SDUV-FEL Control System

- Introduction
- System Design
- Device control
  - Power supply control
  - Vacuum control
  - Microwave control (Phase shifter, modulator…)
- Timing and Interlock
- Others

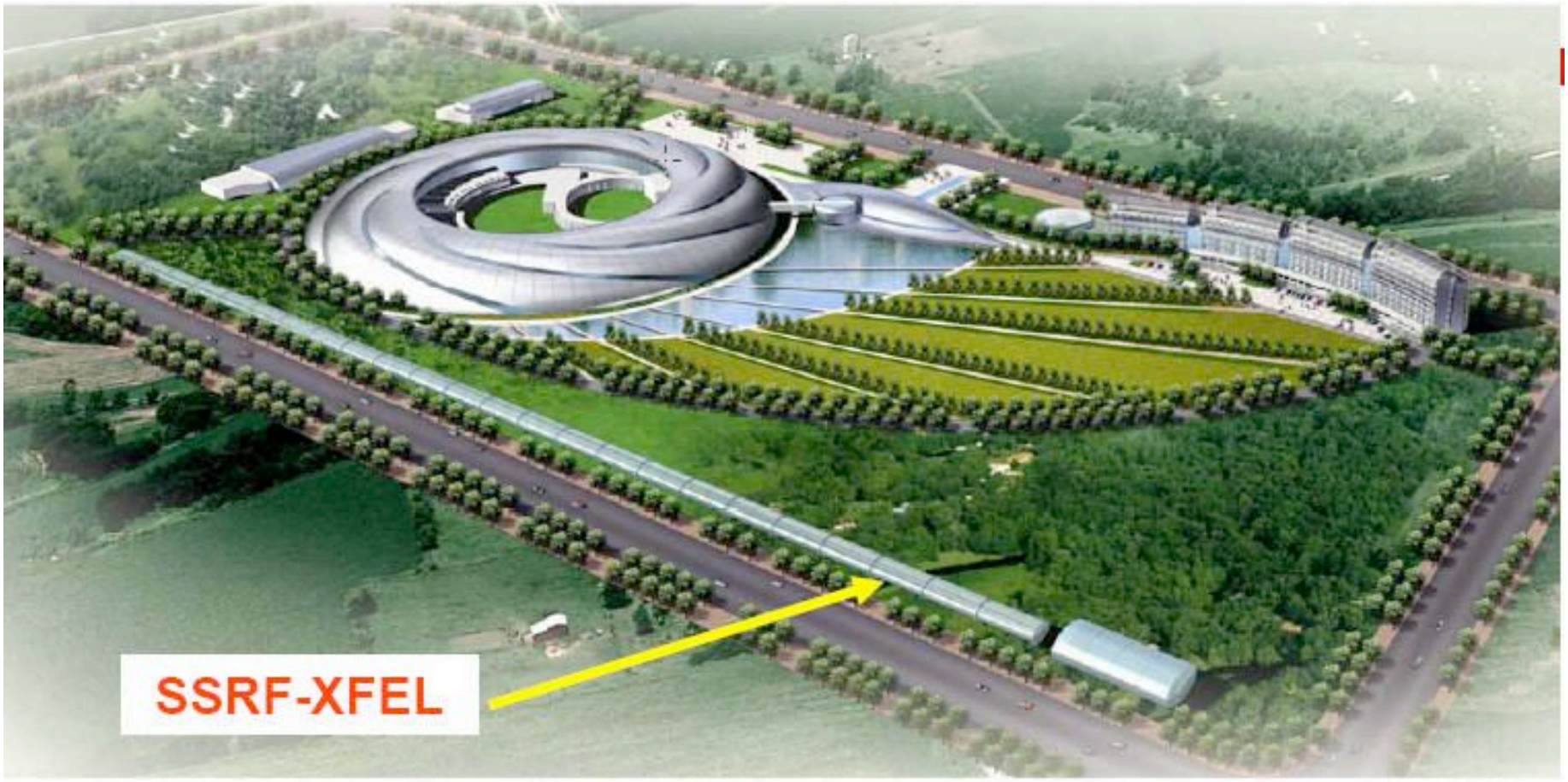
Introduction

- SDUV-FEL is pre-search of chinese hard X-ray FEL
- There are several FEL facilities is under construction
  - LCLS (Linac Coherent Light Source)
  - EURO-XFEL
  - SCSS(SPring-8 Compact SASE Source)
- SDUV-FEL control system is an extended system based on 100Mev linac control system
  - Keep no change to those old devices which existed in 100Mev
  - New devices will be added in through extended cards/buses
  - Almost all of new devices can use the control method in SSRF
- Total system can be separated to following sub systems
  - Injector sub-system
  - Linac sub-system
  - Undulator sub-system
  - Timing and interlock sub-system

Normal Operation of SDUV FEL

Parameters	Value
Seed laser wavelength	1048 nm
Seed laser duration	10 ps
Electron beam duration	2 ps
Electron bema energy	160 MeV
Peak current	300 A
Normalized emittance	6 mm-mrad
Local energy spread	5×10^{-5}
Modulator period length	50 mm
Modulator length	0.80 m
Modulator gap	Alterable
Radiator period length	25 mm
Radiator length	9.00 m
Radiator gap	10 mm
Radiator resonant wavelength	262 nm

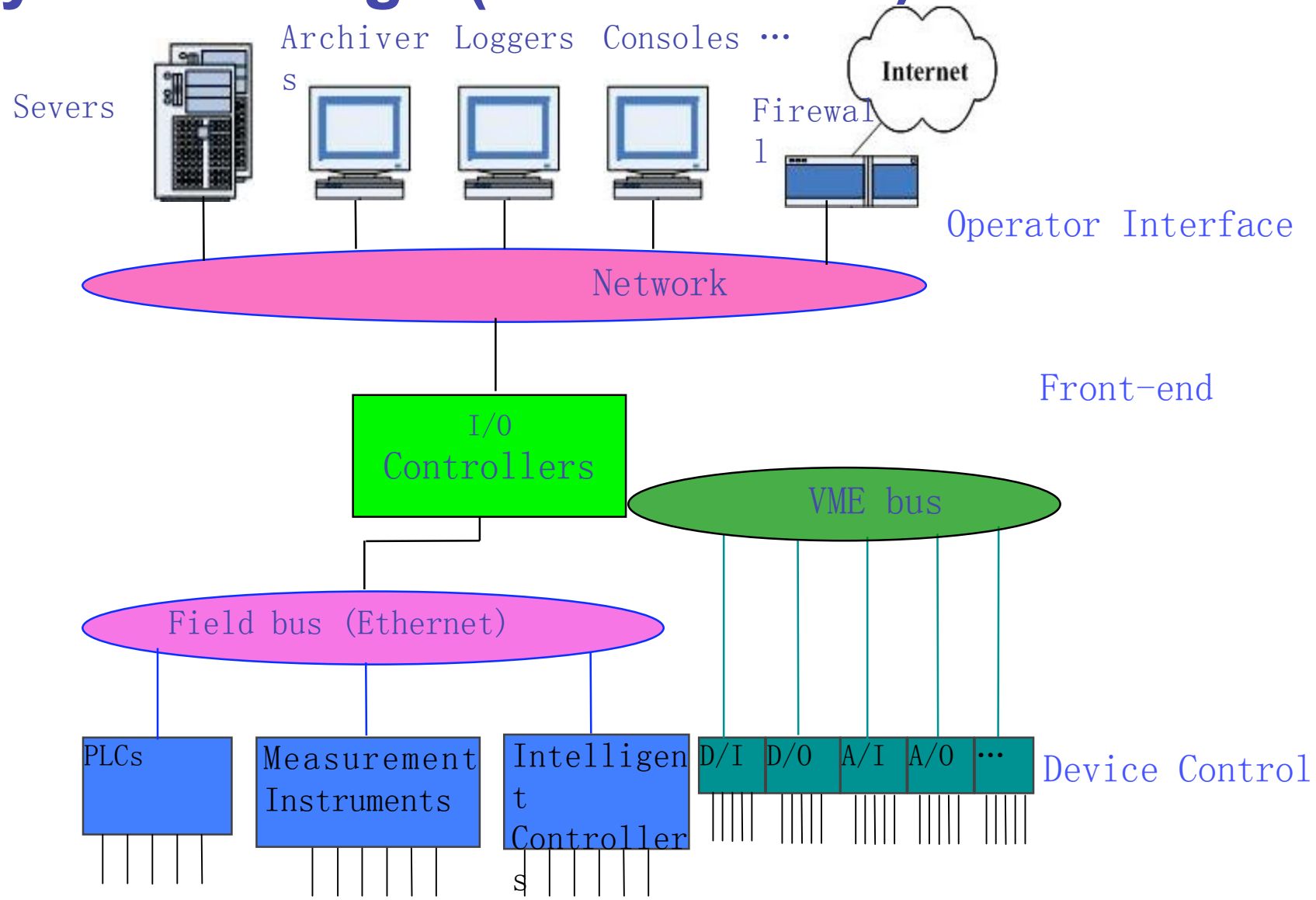
Future Plan



System Design

- SDUV-FEL control system is a distributed system based on “Standard Model”
- OPI Layer
- Front-end Layer
- Device control Layer
  - Ps controller
  - Vacuum controller
  - Pump ps controller
  - PLC, etc.
- Network/filedbuses
  - LAN, DeviceNet, serial, etc.
- As we upgrade from the old control system, we obey the rules “use old devices as much as possible”

System Design (Architecture)



System Design (Hardware)

- 1 EPICS file/data server
  - FTP Server
  - NTP Server
  - NFS Server
  - Data Archiver
  - Running soft IOCs
- 4 OPI computers
  - Including original 2 Desktops
- 7 IOCs
  - Including original 3 servers, add 4 new VME7050
- Device controller
  - Already 1 PLC (For vacuum interlock)
  - Add 2 new I/O modules
  - Other device controllers are maintained by other groups

System Design (Software)

- OS
  - OPI: Scientific linux
  - IOC: vxWorks 5.5.1
  - EPICS Server: Scientific linux
- EPICS base
  - base 3.14.8.2 / 3.14.9
- OPI Interface
  - edm
- Other tools
  - StripTool, AlarmHandler, Channel Archiver, etc.

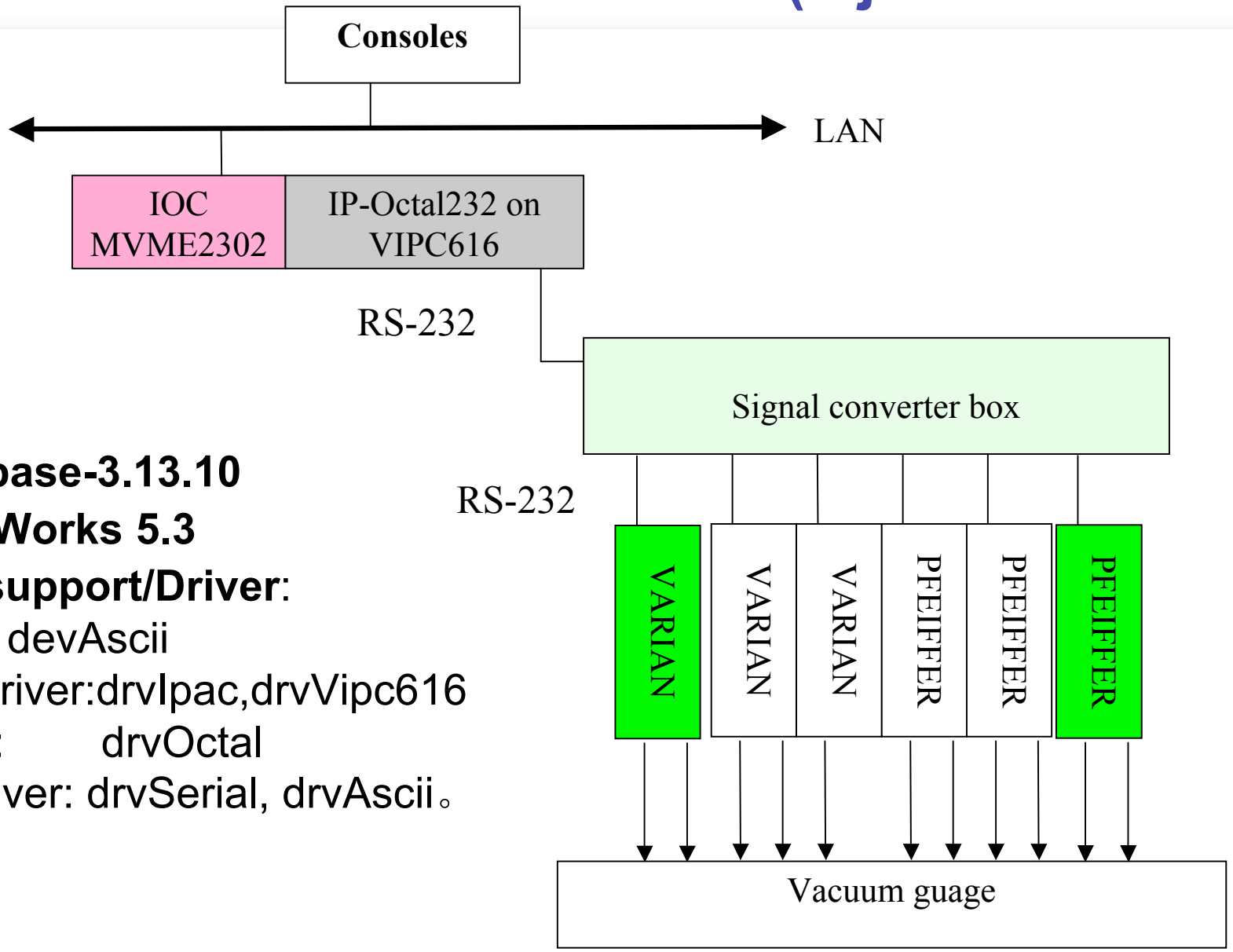
Device Control (Magnets Power Supply)

- Power supply of Injector and linac
  - Old power supplies are kept to be used
  - Some new homemade digital power supplies are added
- Magnet's power supply in undulator
  - Takes new homemade digital power supplies
- Two types of PS, two types of interfaces in our system
  - DeviceNet
  - Ethernet

Device Control - Vacuum Monitor

- Main part of injector and linac
  - Keep the same control method of 100Mev in injector and Linac
  - Add two vacuum gauges (1 Varian, 1 Pfeiffer), control in the same way as above
- Udulator
  - 6 vacuum gauges (one leybold, others undefined)
  - Controlled through Ethernet

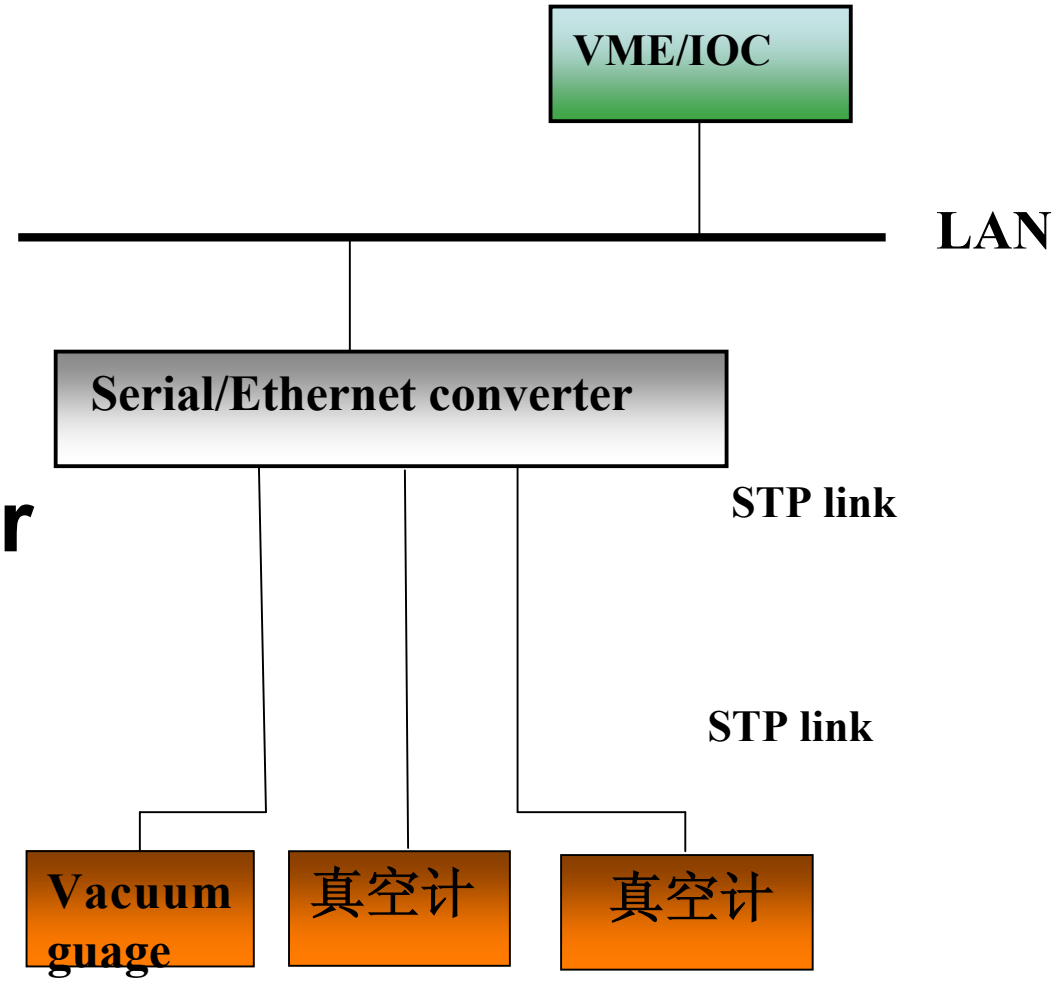
Device Control - Vacuum Monitor (Injector and Linac)



- **Epics: base-3.13.10**
- **O.S: vxWorks 5.3**
- **Device support/Driver**:
  Support: devAscii
  Carrier driver:drvIpac,drvVipc616
  IP driver: drvOctal
  Serial driver: drvSerial, drvAscii。

Device Control - Vacuum Monitor (Undulator)

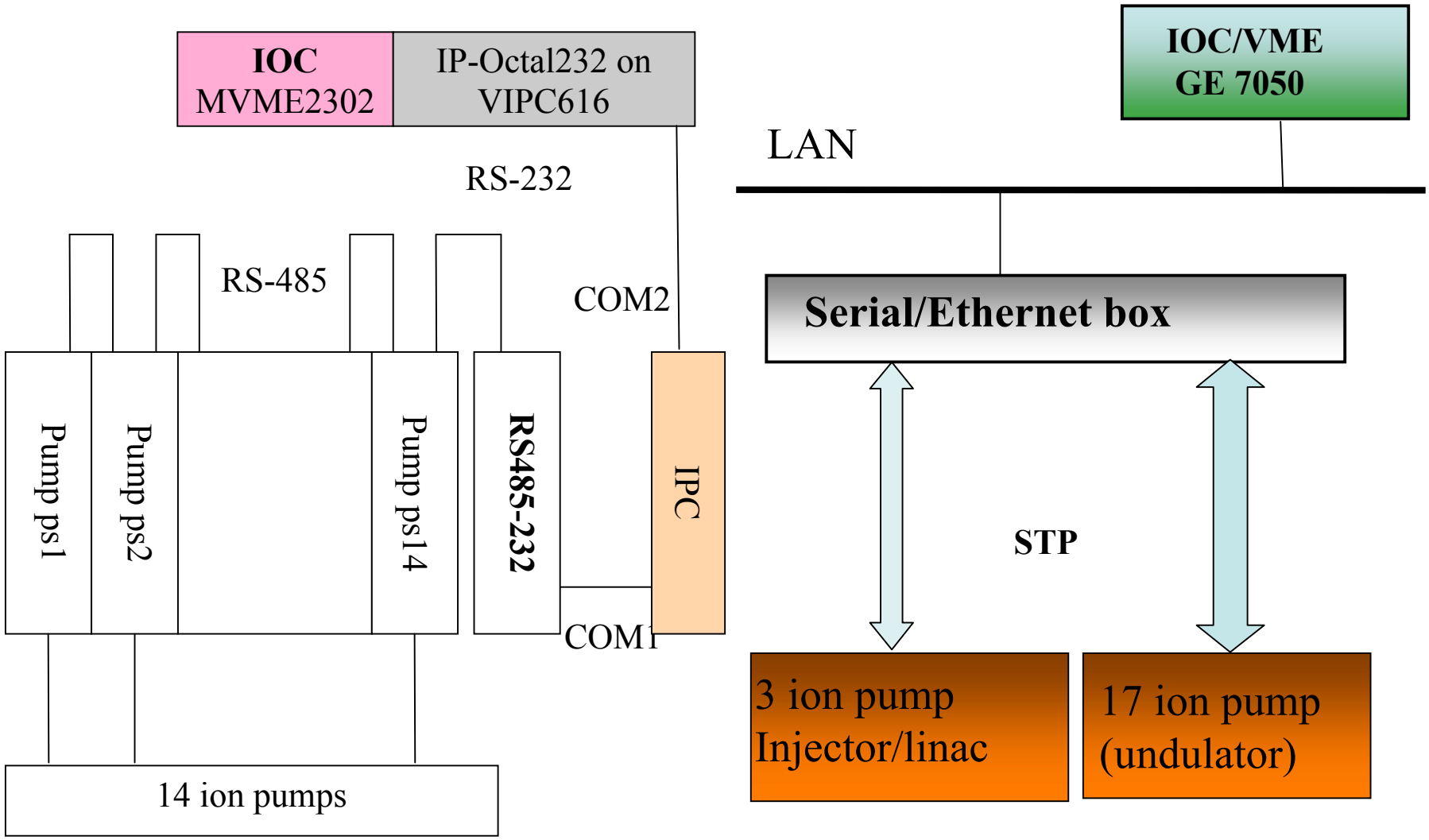
- Epics: base-3.14.8.2
- OS: vxWorks 5.5.1
- Device support/Driver
  - asynDriver
  - streamDriver



Device control – Vacuum Pump

- Injector and linac
  - Keep old RS485 control method of 100Mev control in injector and linac
  - 3 new pump supplies were added and controlled through Ethernet
- Undulator
  - 17 new pump power supplies
  - Controlled through Ethernet

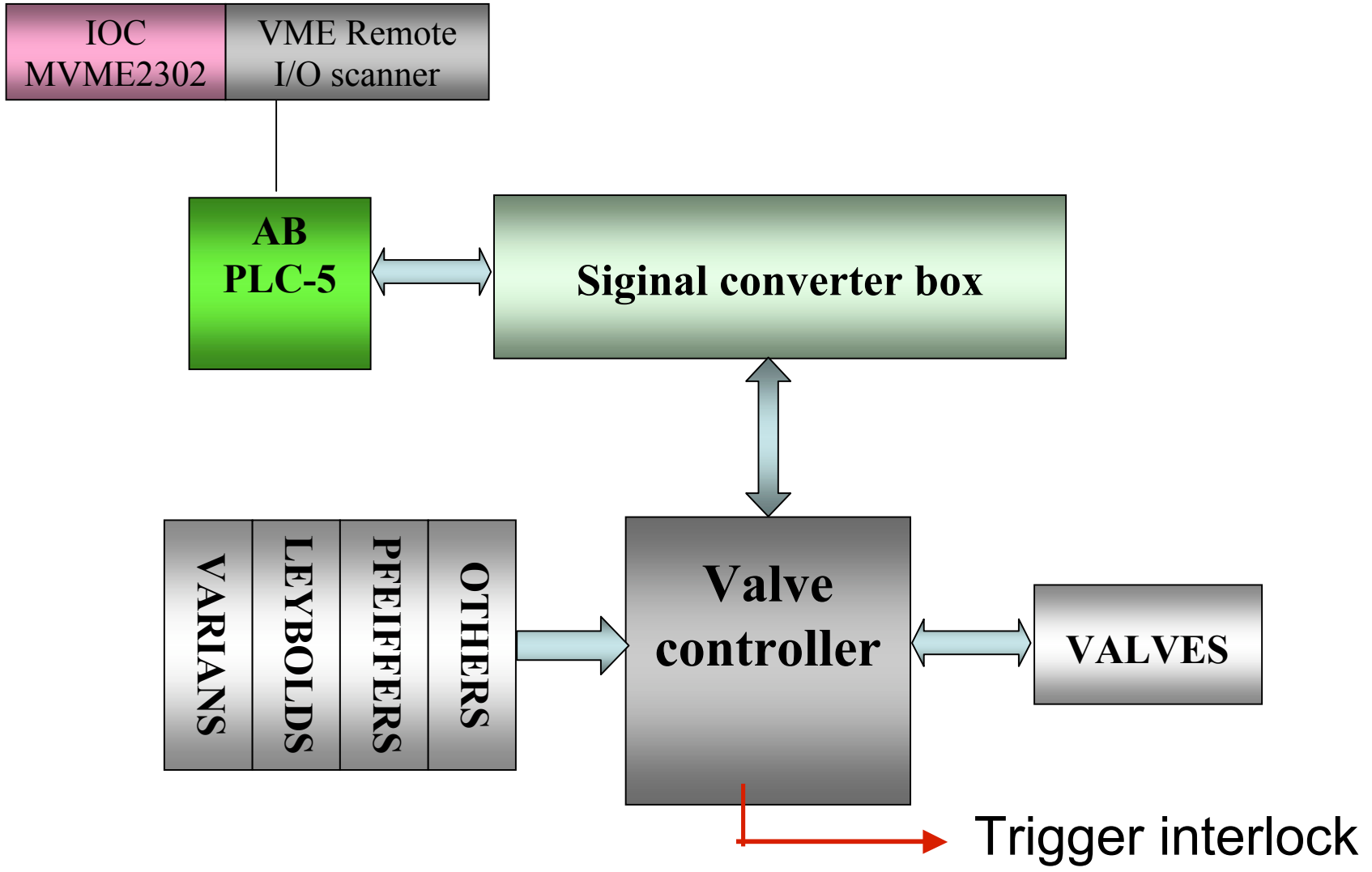
Device control – Vacuum Pump



Device Control - Valve Control

- Use AB PLC-5 to control valves and implement interlock
- There are 3 vacuum parts
  - Injector (valve V1,V2)
  - Linac (valve V2,V3)
  - Udulator (V4,V5)
- When the guage value reaches alarm, relay breaks, PLC output to close valves at both ends
- Comparing with old 100Mev control, 2 modules of 16 channels are added and new control logic was designed
- PLC communicate with VME/IOC based on AB's DCM protocol

Device Control - Valve Control



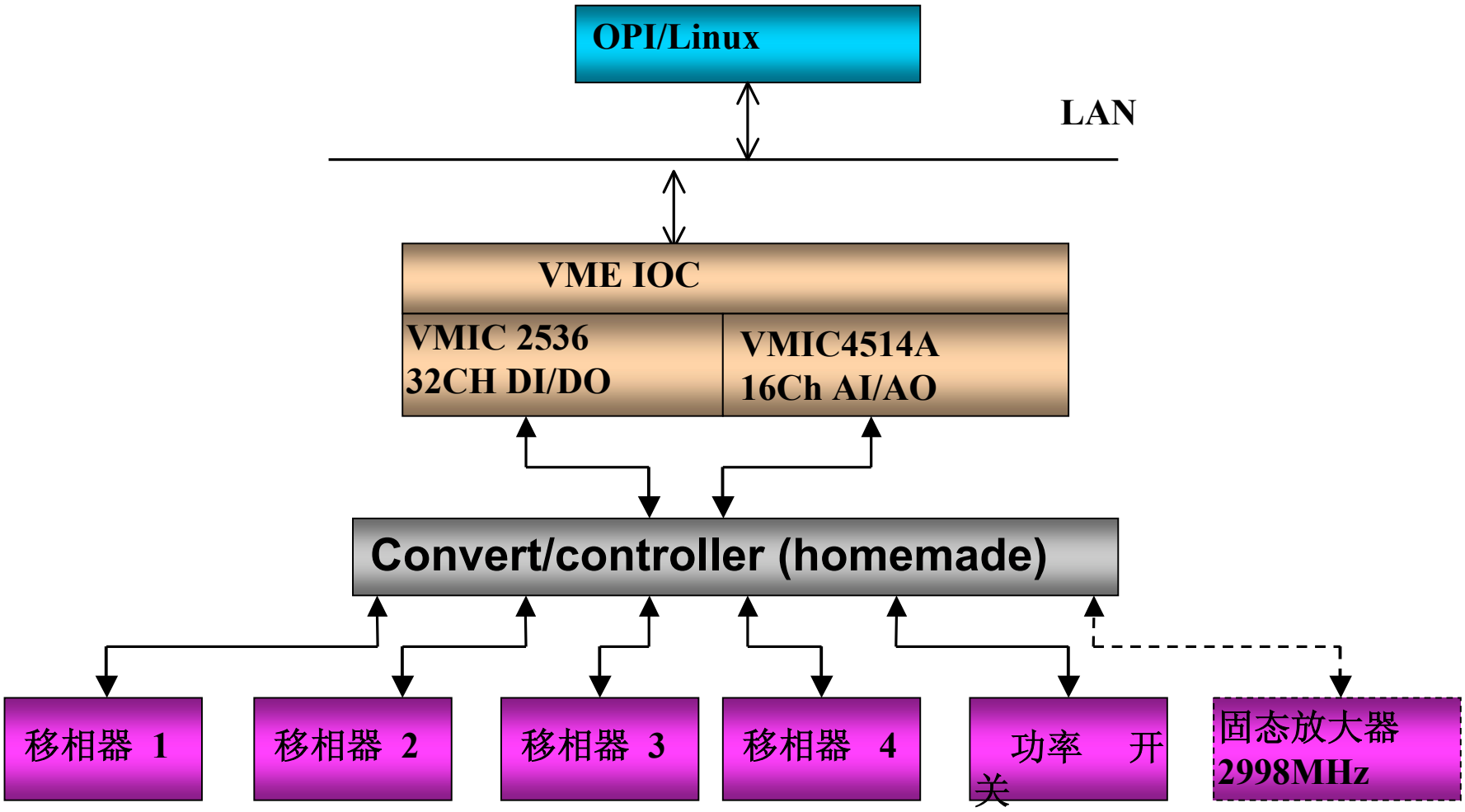
Device Control - Microwave

- One 2856MHz solid state amplifier's control (Has been implemented in 100Mev)
- 4 high power phase shifter, 1 power switch
- 2 modulators (110MW/70MW)

Device Control – Phase Shifter

- Phase shifter (including power switch control) takes DC motors, each motor include
  - motor direction choice
  - Position control
  - Position current read back (0-10v)
- Use 100MeV Linac microwave control's free ports
  - IOC controls motors' digital/analog I/O
  - I/O modules' type is VMIC 2536(32 channel DI/DO)
  - Vmic4514A(16 channels AI/AO)

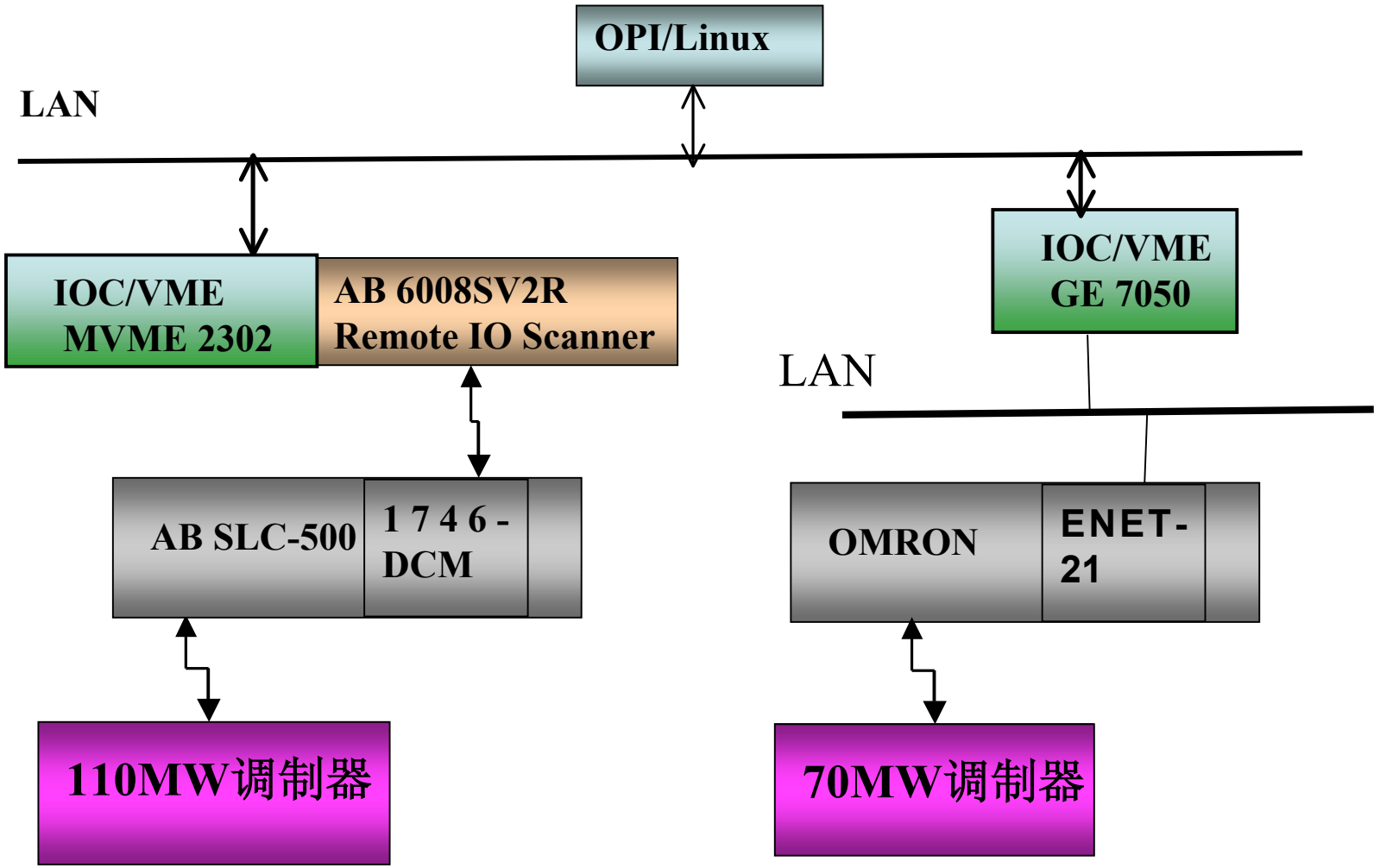
Device Control – Phase Shifter



Device Control – Modulator

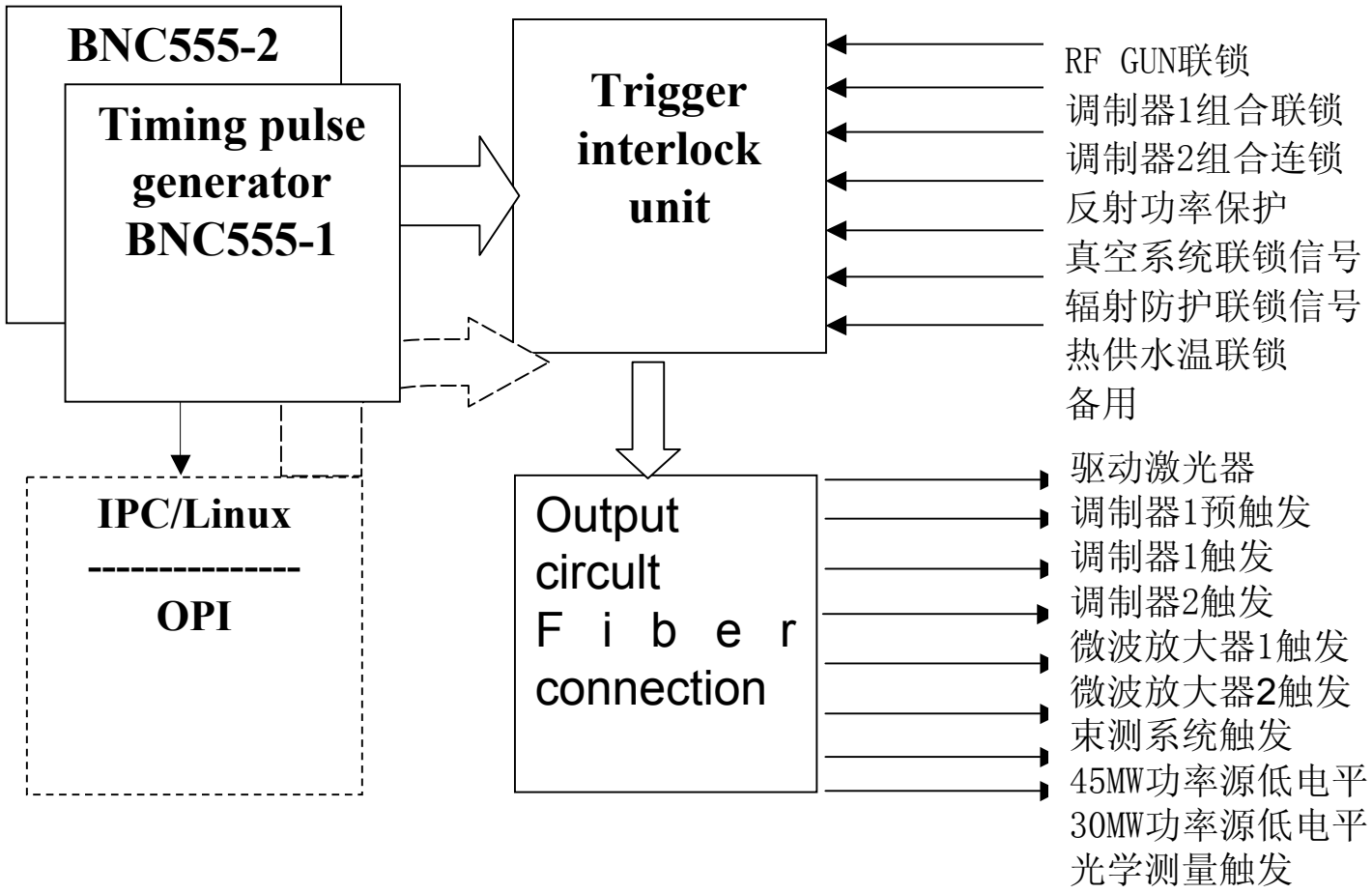
- 110MW modulator (old control system in 100Mev)
  - Local PLC (SLC-500) control with ladder
  - PLC communicates to IOC through Ethernet by 1746-DCM module
- 70MW modular (newly added device)
  - Local Omoron PLC control
  - Communicate to IOC through ethernet
- All control logic/interlock/execute/data acquisition are all finished by local PLC

Device Control – Modulator



Timing and Interlock

- Keep 100MeV design, use BNC company's MODEL 555-8 8 channels digital pulse delay generator



Timing and Interlock - Parameters

- Channels: 8
- Trigger types: Ext Trig, Ext Gate, Int, Single Shot, Burst, Duty Cycle
- Repeat freq: 0.01Hz-1.0 MHz
- Duty factor can be adjusted in each channel
- Output pulse range: CMOS/TTL
- Output pulse polarity can be choosed
- Output pulse width:10ns-100s, resolution1ns
- Output pulse delay:0-100s, resolution1ns
- Rising edge < 5ns

Others

- Network
  - 3 switch hubs locate on central control room, power supply room and device room, consist of local network
- Video/broadcasting system
  - keep old system

Thanks for your attention!

谢谢大家！