Status of Activities Related to EPICS and Accelerator Control in China

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EPICS Collaboration

RICOTTI Tokai, 8 Dec 2004

Outline

- Introduction

- EPICS Status in China
    - SSRF LINAC
    - BEPCII
    - HLS
    - CSNS

- References and Special Thanks

Introduction

- Started in the middle of 1990s
  - IHEP started EPICS research around 1995
  - HLS started from 1996
  - The first EPICS seminar was hold in IHEP at 1997
  - IHEP got the EPICS license at Jan. 1997
  - HLS got the EPICS license at Jan. 1997
  - SSRF got the EPICS license at 1998

Outline

☐ **Introduction**

☐ **EPICS Status in China**

   ■ SSRF LINAC (Materials are provided by Associate Prof. Jianguo Ding)

   ■ BEPCII

   ■ HLS

   ■ CSNS

☐ **References and Special Thanks**

Status in SSRF LINAC
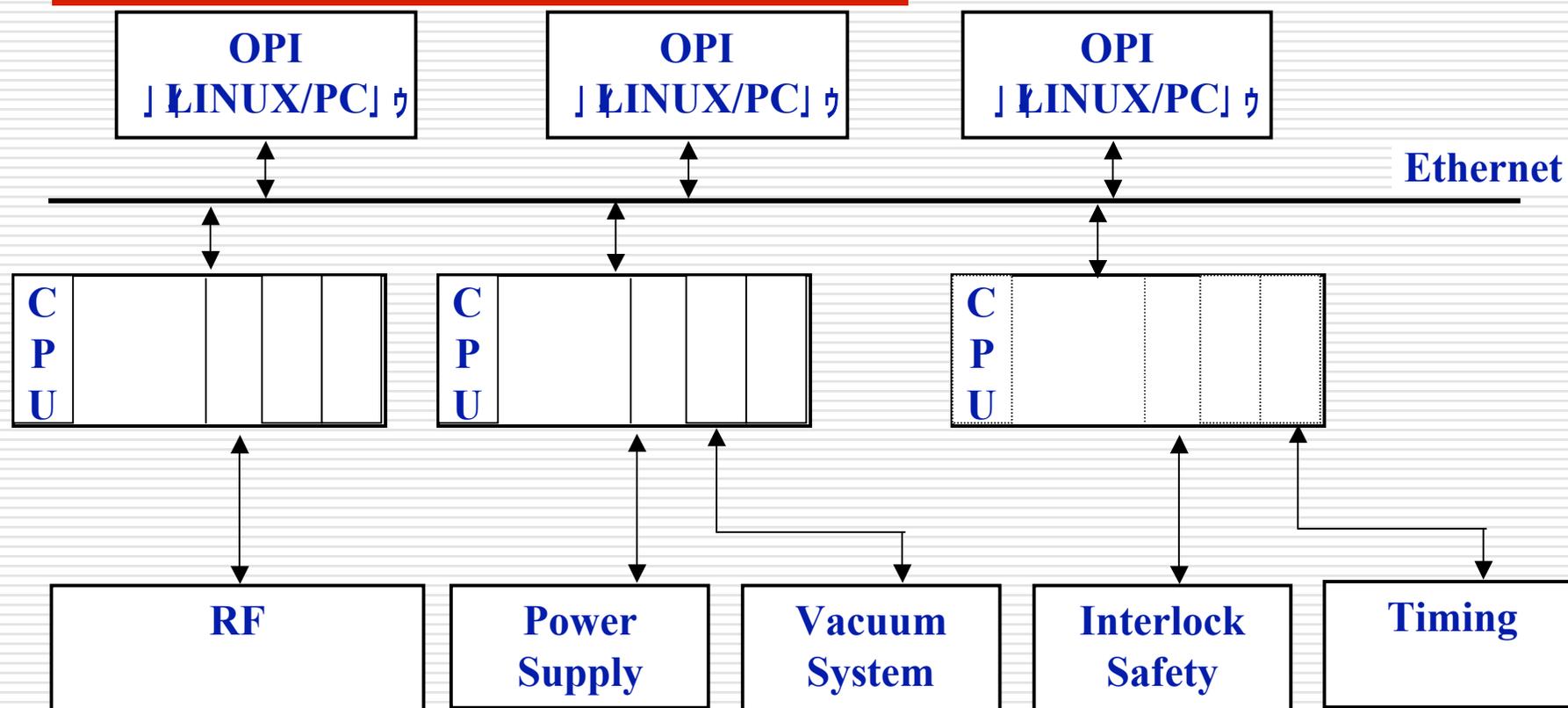## -- Introduce

- SSRF project
  - Intermediate energy 3rd generation SR light source
  - Suspended for almost 2 years from 2001
  - Formal approval by Government at Jan. 2004
  - Control System will be based on EPICS
- 100 MeV LINAC
  - Approval in 2002
  - Now under constructing
  - Commissioning started at the beginning of Nov. 2004
  - Will be upgraded to 300MeV for FEL (?)

Status in SSRF LINAC
-- Structure of Control System

OPI 「LINUX/PC」	OPI 「LINUX/PC」	OPI 「LINUX/PC」

Ethernet

CPU			

CPU			

CPU			

RF	Power Supply	Vacuum System	Interlock Safety	Timing

Status in SSRF LINAC -- Tools

- EPICS Base: 3.13.10 upgrading from R3.13.1
- OPI OS: Linux
- IOC OS: Tornado1.0.1/vxWorks5.3.1
  - Development Platform
    - 3 SUN Ultra10 with Solaris2.6
    - 1 SUN Ultra60 with Solaris2.7
- EPCIS Tools:
  - BURT
  - ALH
  - StripTool
  - ChannelArchiver
  - EDM 1-10-0 /MEDM/DM2K
  - Capfast/VDCT

Status in SSRF LINAC
-- System Configuration

- ☐ 5 subsystems
  - ■ Power Supply, Vacuum, RF, Timing and interlock, Beam Diagnostics (Labview, non-EPICS)
- ☐ 3 OPIs
  - ■ PC with Linux Redhat 9
- ☐ 3 IOCs
  - ■ 2 Motorola MVME2302
  - ■ 1 Motorola MVME162
- ☐ 12 Controllers
  - ■ 2 A-B SLC 500, 1 A-B PLC 5, 6 A-B 1794 DeviceNet
  - ■ 2 Industrial Pack (IP) Modules, directly VME I/O

Status in SSRF LINAC
-- Record Types

☐ Total: ~1,500 Records

■ Ai, Ao, Bi, Bo, Mbbi, Mbbo, Subroutine

Subsystem	Equip.	PVs					
		AI	AO	BI	BO	MBBI	MBBO
Gun	1	8	1	4	1	1	1
RF	9	41	16	12	5	1	1
Modulator	1	9	0	10	4	0	0
P.S.	46	45	45	90	45	0	0
Vacuum	20	52	16	92	82	8	8
Other	2	-	-	16	8	-	-
Total	79	157	86	216	1145	10	10

**2 years old, see reference 1

Status in SSRF LINAC
-- Man Power

- Total 7 persons
  - 5 persons related EPICS
- Others:
  - 2 students

Status in SSRF LINAC -- OPI (1)

Power Supply and

Modulator Control
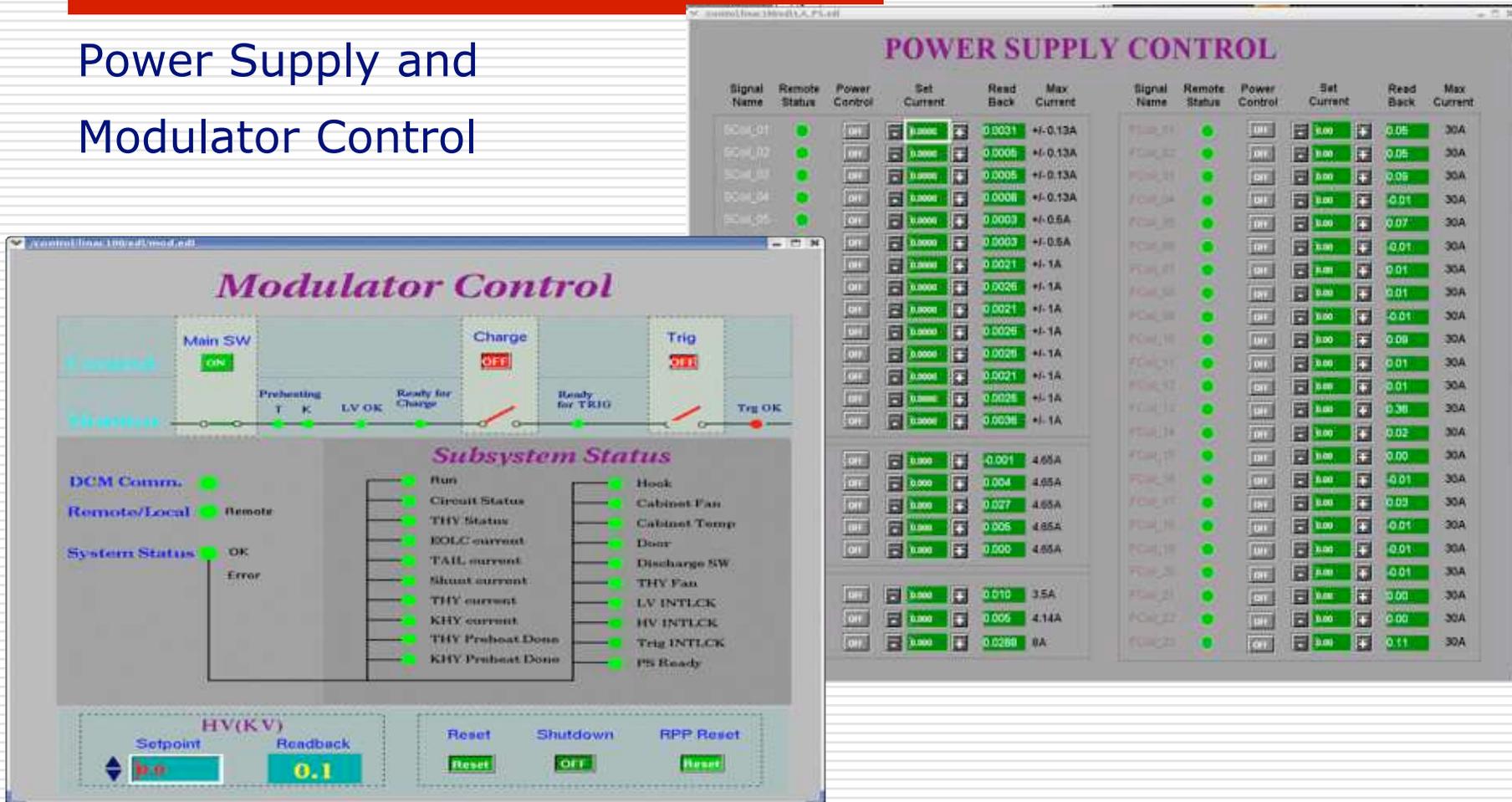
Status in SSRF LINAC
-- OPI(2)

Phase Shifter and
Amplifier Control

Status in SSRF LINAC
-- OPI(3)

Gun Monitor and
Vacuum Control

Status in SSRF LINAC
-- OPI(4)

Vacuum Device Control

Status in SSRF LINAC
-- Central Control Room

Status in SSRF LINAC
-- CRT Monitor

Status in SSRF LINAC
-- Rack of IOC, Trigger, Timing and B.M.

Status in SSRF LINAC
-- Power Supply Room

Status in SSRF LINAC
-- Work Hard

Outline

□ **Introduction**

□ **EPICS Status in China**

   ■ SSRF LINAC

   ■ BEPCII (Materials are provided by Prof. Jijiu Zhao)

   ■ HLS

   ■ CSNS

□ **References and Special Thanks**

Status in BEPCII
-- Introduction

- ☐ BEPCII Control System
  - ■ Based on EPICS
  - ■ R&D has been done in DEC. 2003
  - ■ Development started in Spring of 2004
  - ■ Under construction and in good progress
- ☐ System data of BEPCII
  - ■ 1729 devices (930 at BEPC)
  - ■ About 20,000 channels (4,500 at BEPC)

Status in BEPCII
-- Control System Structure

RF Local   Vac. local   PS local

Ethernet

PS IOC   Vac.IOC   RF IOC

......

Device or low level control system

Central control room

Local control area
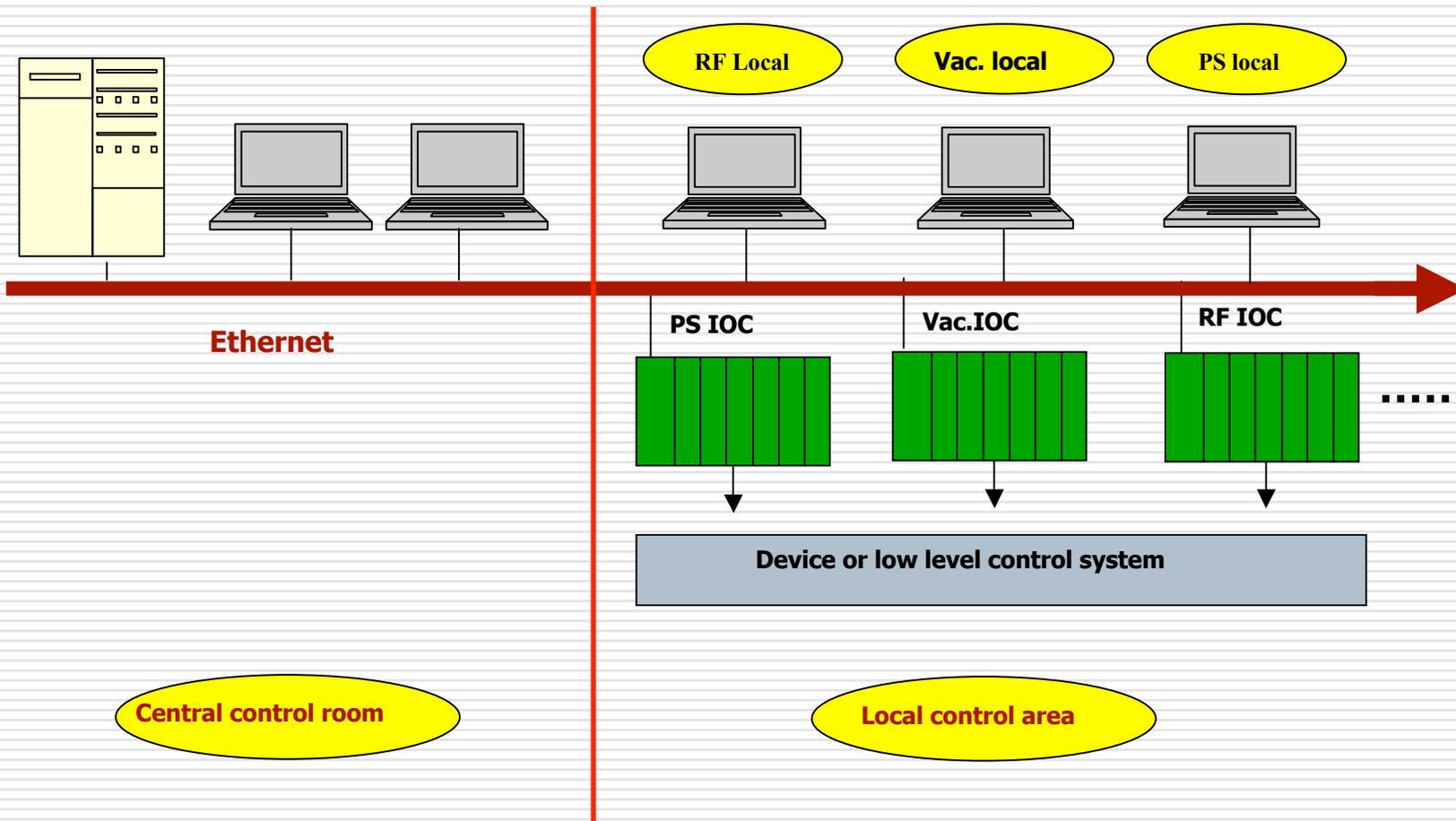
Status in BEPCII
-- Tools

- EPICS BASE R3.13.8
- OPI OS: Solaris 2.8, Linux/PC
- IOC OS: Tornado2.0/vxWorks5.4
- Third Tools:
  - Labview, Tcl/tk, etc.
- EPICS Tools:
  - ALH
  - VDCT
  - SNL
  - Channel Archiver
  - MEDM/EDM
  - SAD

Status in BEPCII
-- System Configuration

- 7 subsystems
  - Power Supply, RF, Vacuum, Beam Diagnostic, Injection, LINAC, Interlock
- OPI
  - SUN Solaris BLADE 2000, some Linux PCs
- 31 IOCs:
  - 22 MVME5100s for transport lines and storage rings
  - 7 MVME5100s for Timing Systems
  - 2 MVME2431s for LINAC
- Local Controller
  - Fieldbus: CANbus, ControlNet
  - RS-232
  - PLC: AB-PLC, S7-PLC(Siemens)

Status in BEPCII
-- Driver Development

- ☐ PS control
  - ■ PSC/PSI (From SNS) interface for Chopper PS
  - ■ VME - IP Carry board/IP modules for Corrector PS
  - ■ VME-CAMAC for TL PS control
- ☐ Vacuum control
  - ■ VME - ControlNet for Vacuum and Cryogenic control
  - ■ VME - RS232
- ☐ Linac control
  - ■ VME - CANbus
- ☐ RF Control
  - ■ Developed by Thomcast company

Status in BEPCII
-- Number of devices and channels

Device	Num.	AI	AO	DI	DO	WF	other	Sum
Power supply	399	399	399	1596	798			3192
Vacuum	517	957	398	814	994		488	3651
Injection kicker	8	8	16	40	4	4		72
Radio frequency	7	72	35	180	50	4		341
Beam diagnostic	459	864		80	80	6		1030
Injector Linac	325	559	198	228	198	36		1219
Summary	1715	2859	1046	2938	2124	50	488	9505

** 2 years old, See Reference 3

Status in BEPCII
-- Present Status

- ☐ Power Supply
  - ■ prototype has been done in Dec. 2003
  - ■ Supported Functions: On/off, settings/readings, status monitor
- ☐ Event timing system
  - ■ New design finished in May 2004
  - ■ Software design began in September
  - ■ now software analysis is under way
- ☐ Vacuum
  - ■ prototype has been done
  - ■ collecting pressure and data of I.P. to IOC with RS-232
- ☐ Cryogenic control
  - ■ Communication software between IOC and PLC has been done

Status in BEPCII
-- Present Status (Cont.)

- RF
  - Klystron system is testing
- Injection control for Kicker Power Supply
  - Driver and application are developing
- Linac
  - Use SNL to carry out the ramping
  - Use EDM and TCL/TK to build OPI
  - Have been put into use in Nov. 2003
- High level application -- SAD
  - all of source and most of data file from KEKB In Jan. 2003
  - Built on SUN workstations
  - Main panel transfer from KEKB
  - Good collaboration between KEKB and IHEP

Status in BEPCII
-- Man Power

- ☐ Total 16 persons
  - ■ 12 persons related to EPICS
- ☐ Others:
  - ■ 7 doctoral candidates

Status in BEPCII
-- OPI (1)

Prototype of Power Supply Control

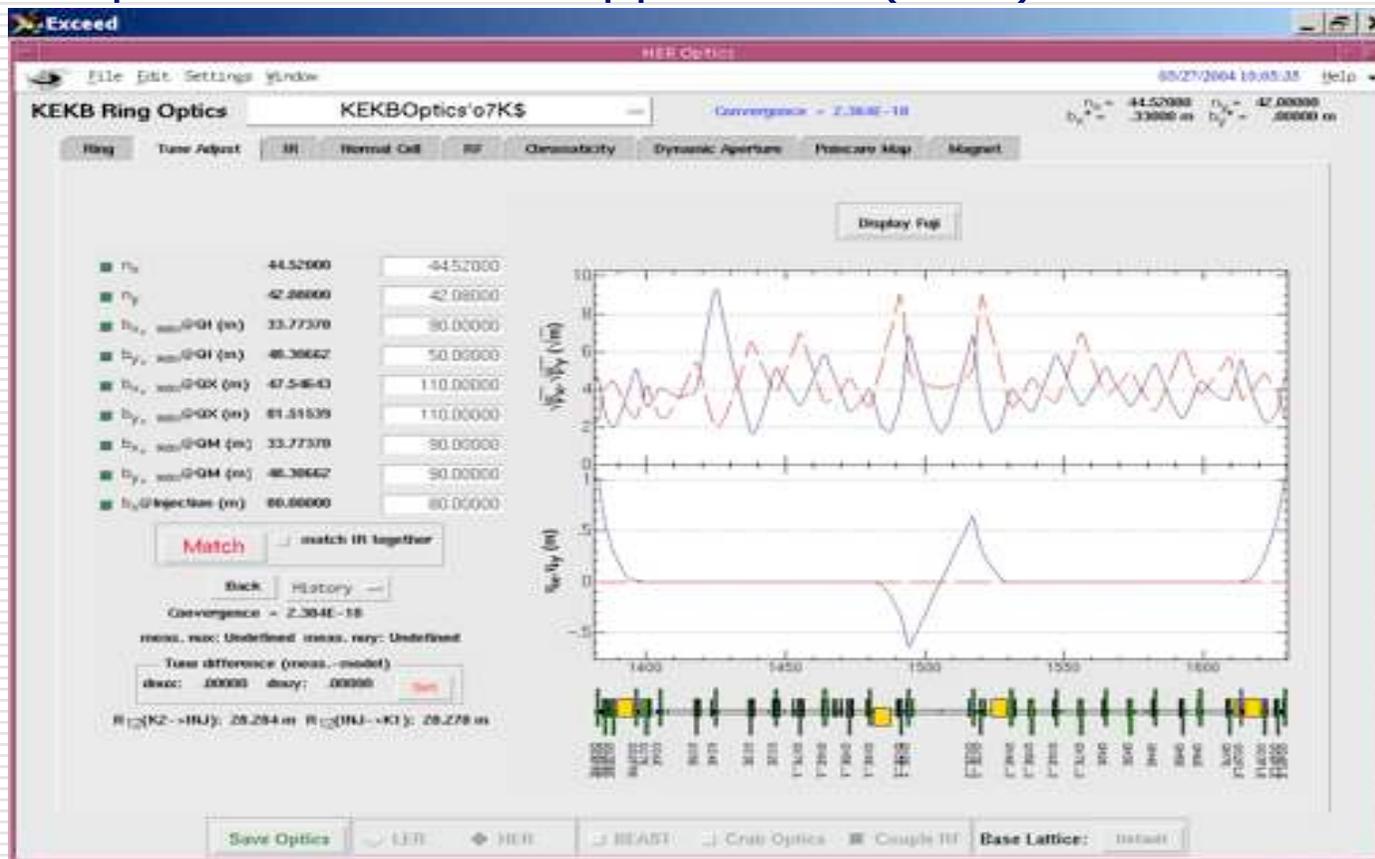# Status in BEPCII
-- OPI (2)
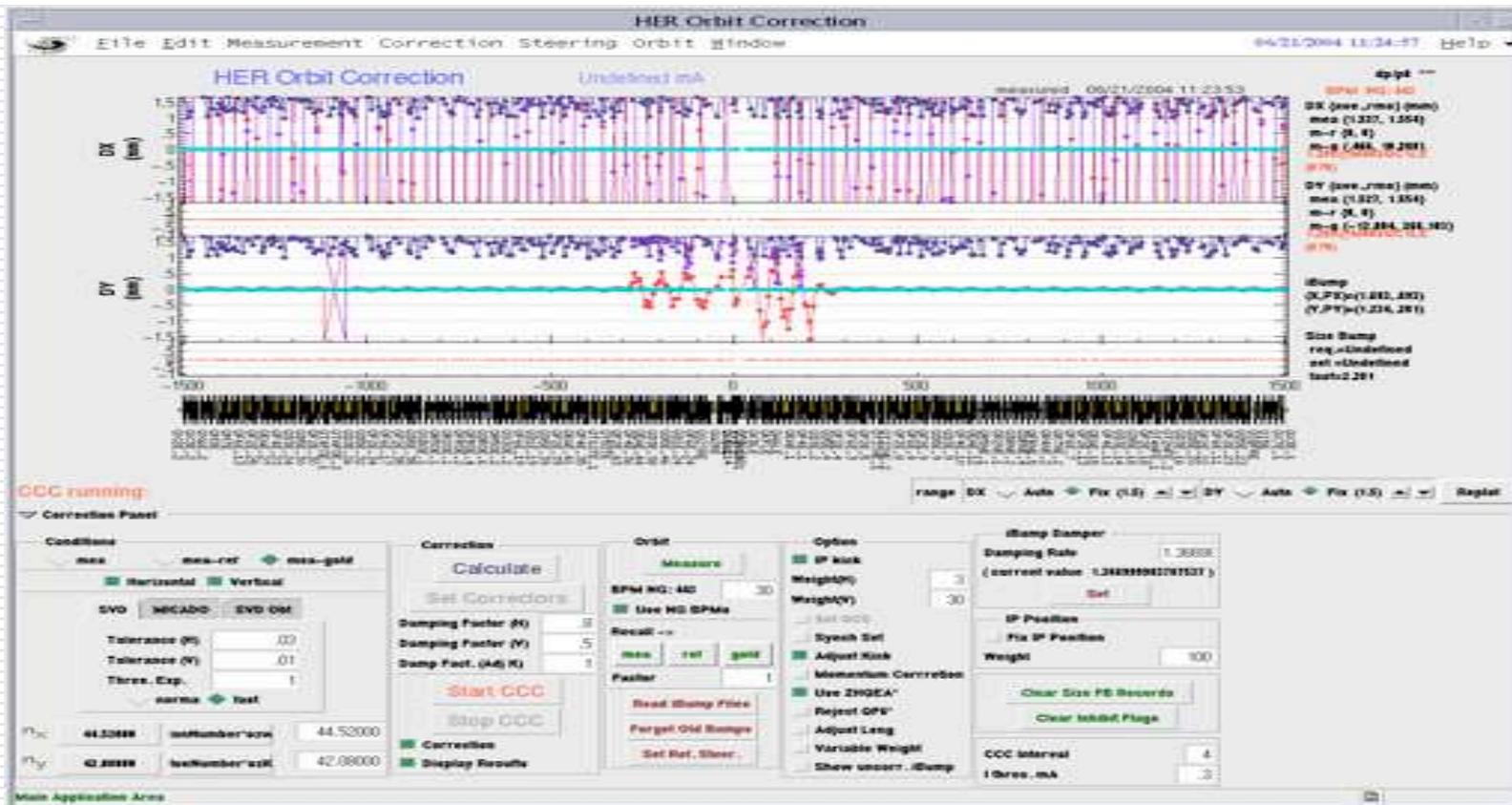
LINAC Power Supply Control

Status in BEPCII
-- OPI (3)

Beam Optics Calculation Application (SAD)

Status in BEPCII
-- OPI (4)

COD Correction Application (SAD)

Status in BEPCII
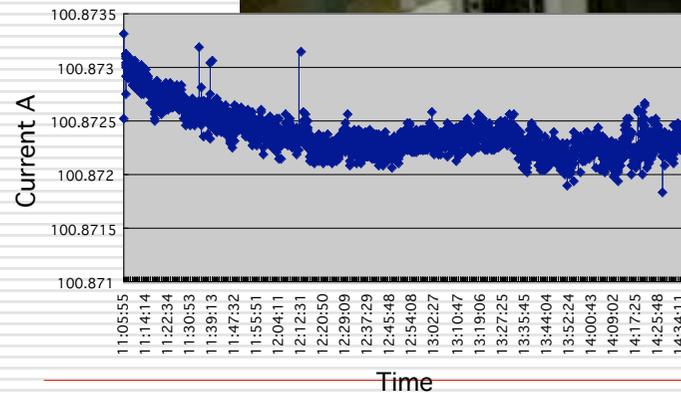## -- MCC and New Console

Status in BEPCII
-- Chopper on-line testing

1# Chopper PS

Accuracy and Stability: 5x10-5

Status in BEPCII
-- Prototype of PS control

Outline

- ☐ **Introduction**

- ☐ **EPICS Status in China**

  - ■ SSRF LINAC

  - ■ BEPCII

  - ■ HLS (Materials are provided by Associate Prof. Gongfa Liu)

  - ■ CSNS

- ☐ **References and Special Thanks**

Status in HLS
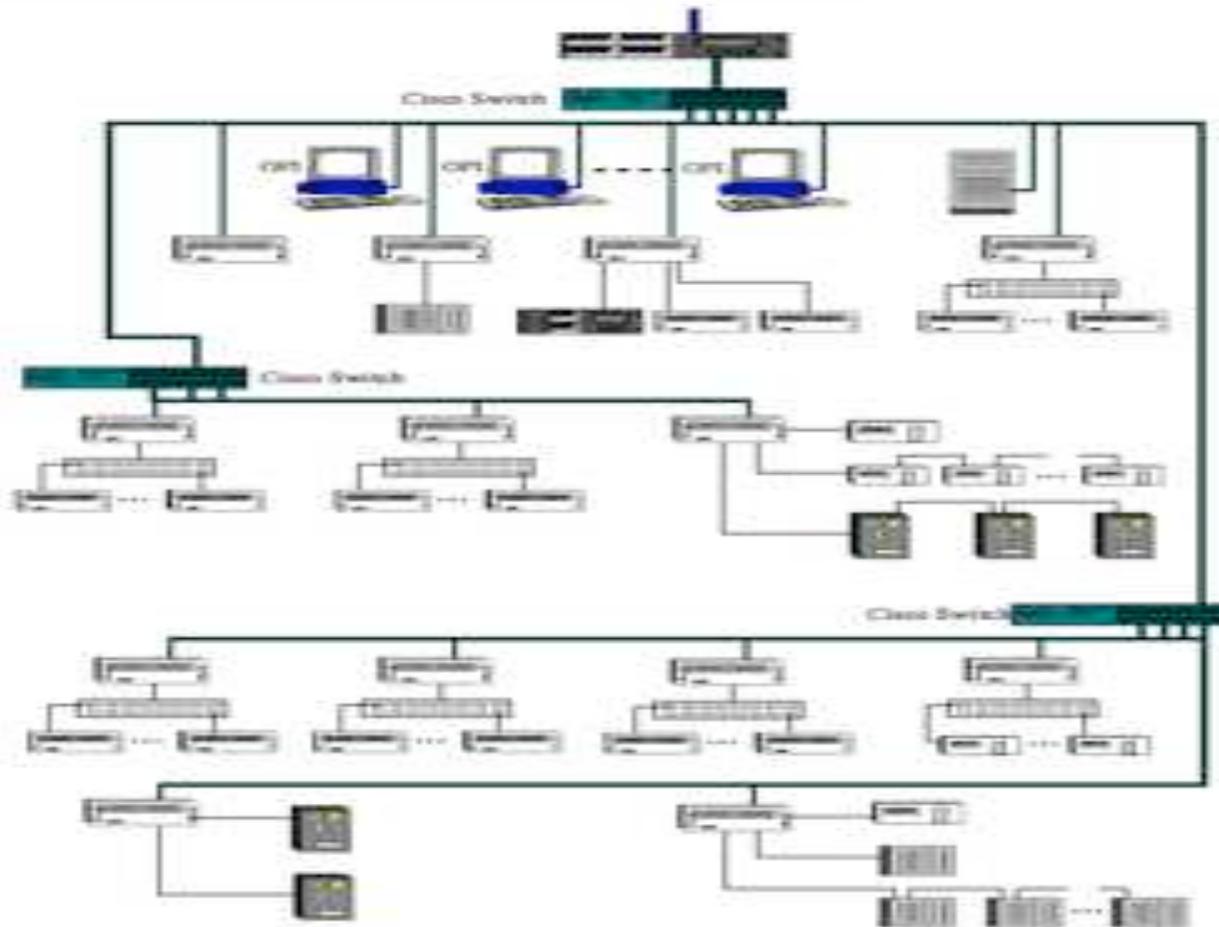## -- Instruction

- HLS
  - 2nd generation dedicated synchrotron light source
  - 200MeV electron LINAC and 800 MeV electron storage ring
- New Control System
  - Phase II started from April 1999 formally
  - Prototype system set up at May 1999
  - First subsystem commissioning at June 2000
  - Last subsystem commissioning at Oct. 2003

Status in HLS
-- New Control System Structure

Status in HLS
-- Tools

- ☐ EPICS BASE R3.13.8, upgraded from R3.13.0.beta12 at June 2003
- ☐ OPI: Solaris7/8; Red Hat7/9; Windows98/2000
- ☐ IOC: Tornado1.0.1/vxWorks 5.3.1
  - ■ Development Platform: SUN/Solaris
- ☐ Third tools: Tcl/tk, PHP, PLC Ladder Software Package, LabView/ActiveX
- ☐ EPICS tools:
  - ■ DCT
  - ■ MEDM
  - ■ SDDS (Closed Orbit Correction)
  - ■ SNL

Status in HLS
-- System Configuration

- 6 Subsystems
  - Power supply, RF, Vacuum, BPM, Interlock, Water
- 21 OPIs
  - 1 Sun Ultra 1, 3 Sun Ultra 10, 1 Sun E250, 2 PC (Linux), 14 PC (Windows)
- 17 IOCs
  - IPC (with Flash Disk)
- 107 Local Controllers
  - 56 IPC (with Flash Disk), 12 PLC, Others, 39

Status in HLS
-- Detail Lists of Subsystems

subsystem	IOC IPC	Local controller			OPI				
		IPC	PLC	Others	SUN Ultra	SUN Ultra	SUN	PC/Linux	PC/Windows
Ring main mag. PS	3	12		12	1	130	E250	2	w4
Ring corr. Mag.PS	1	8							
Ring vacuum	1			6					
Ring Flag				1					
Injection system			3						
RF	2	1	2	1					
Water system	1								
RFKO	1			2					
Ring octupole mag. PS	1								
Transport line mag. PS	2	20							
Switch mag. PS	1			1					
Kly. focusing coil PS	1	6							
Analysis Mag. PS		1							
Linac vacuum	1			15					
Linac mag. PS	1	8							
Linac Flag	1			1					
interlock			1						
Linac Modu. pulse PS			6						
sum	17	56	12	39	1	3	1	2	14
	17	107			21				

Status in HLS
-- Record Statistics

Subsystems	Record Number
Ring main mag. PS	~400
Ring corr ector mag. PS	~250
Transport line mag. PS	~800
Linac mag. PS	~300
RF	~150
Vacuum	~200
Injection system pulse PS	~50
Flag	~50
Others	~300
sum	~2500

Status in HLS
-- Record Type

- Record type
  - Ai, Ao
  - Bi, Bo
  - Mbbi, Mbbo
  - MbbiDirect, MbboDirect
  - Subroutine,
  - subOut
  - maio
- Self development
  - subOut and maio

Status in HLS
-- Upgrade process

- ☐ May 1999
  - ■ set up a prototype system
- ☐ June 2000
  - ■ First subsystem commissioning (Storage ring main magnet power supply control system)
- ☐ Oct. 2003
  - ■ Last subsystem commissioning (Storage ring Octupole magnet power supply control system)
- ☐ June 2003
  - ■ upgrade EPICS base R3.13.0.beta12 _>   R3.13.8
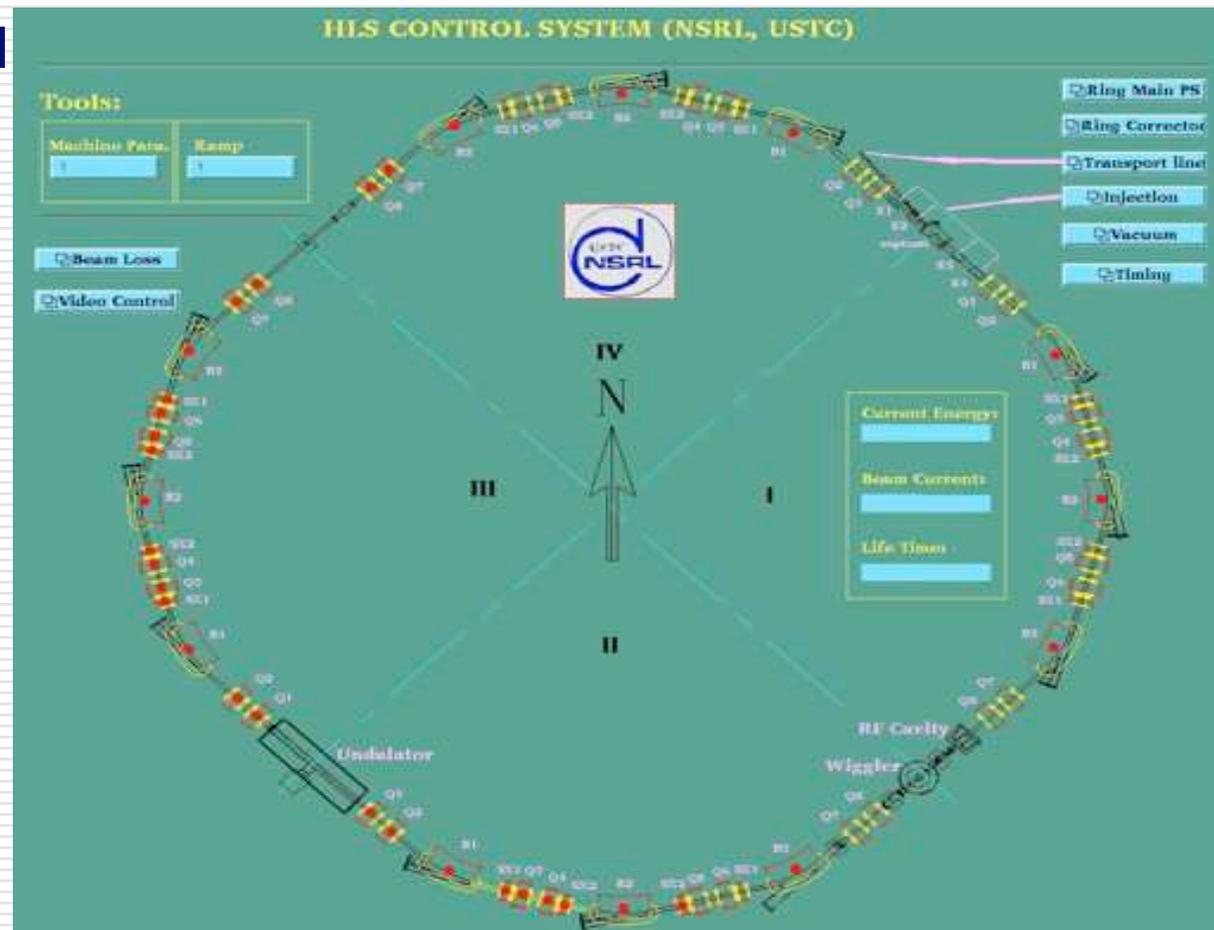
Status in HLS
-- Man Power

- ☐ Total 5 persons
- ☐ 3 persons related to EPICS

Status in HLS
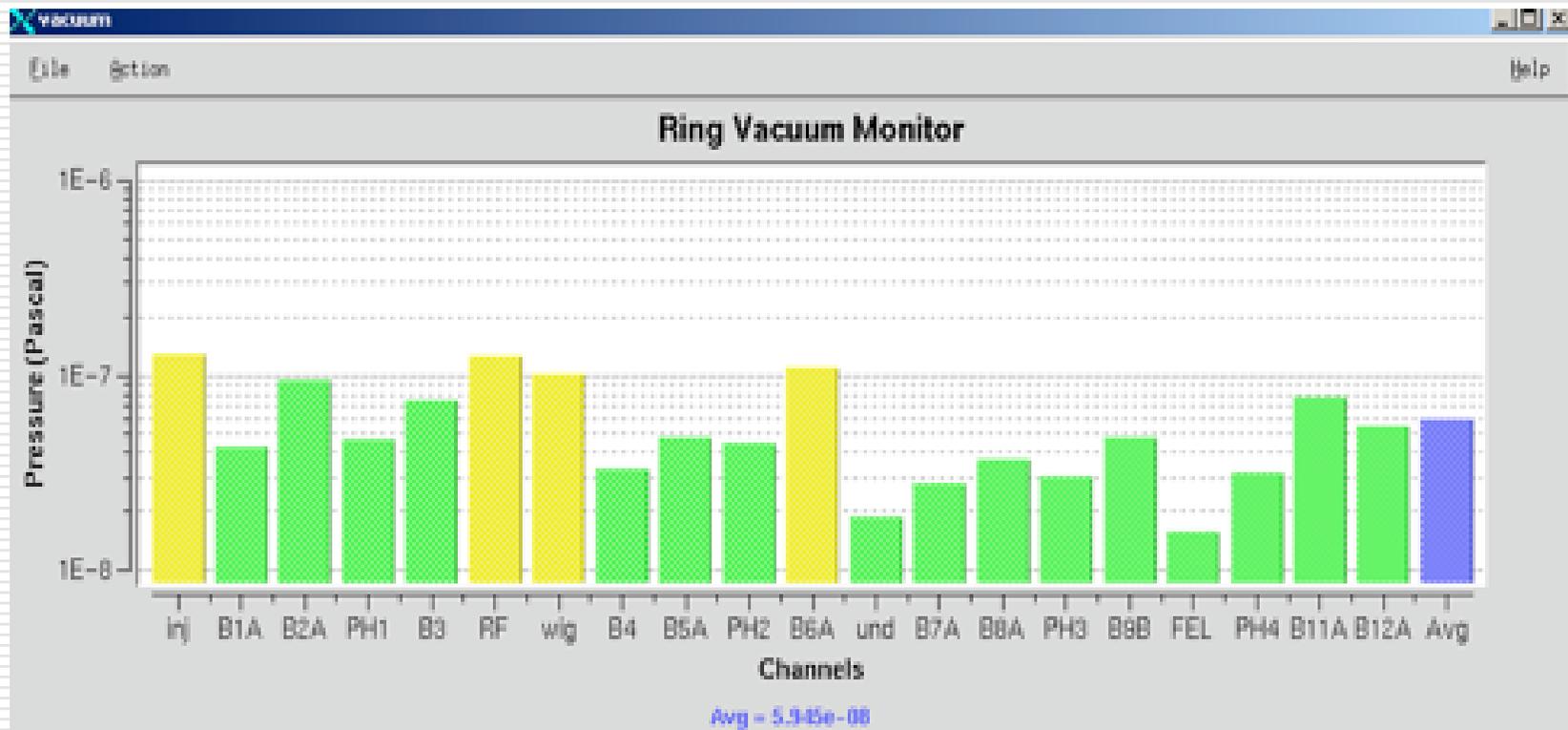## -- OPI (1)

Main Control Panel

Status in HLS
-- OPI (2)

Power Supply Control

Status in HLS
-- OPI (3)

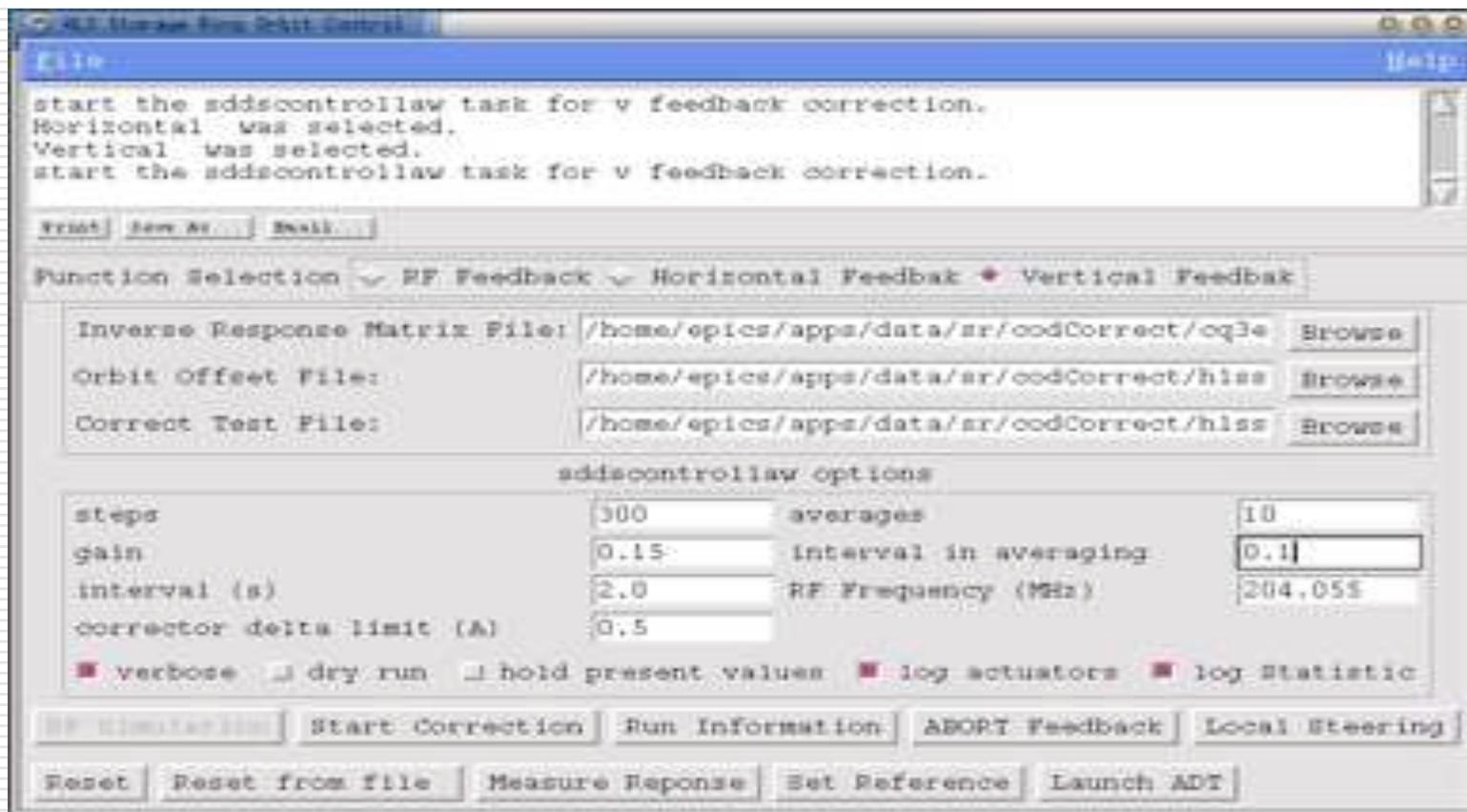Ring Vacuum Monitor

Status in HLS
-- OPI (4)

Ramping Control

Status in HLS
-- OPI (5)

Ring Orbit Control (SDDS)

Status in HLS
-- Central Control Room

Status in HLS
-- LINAC Control Room

Outline

- ☐ **Introduction**
- ☐ **EPICS Status in China**
  - ■ SSRF LINAC
  - ■ BEPCII
  - ■ HLS
  - ■ CSNS (Materials are provided by Associate Prof. Chunhong Wang)
- ☐ **References and Special Thanks**

Status in CSNS
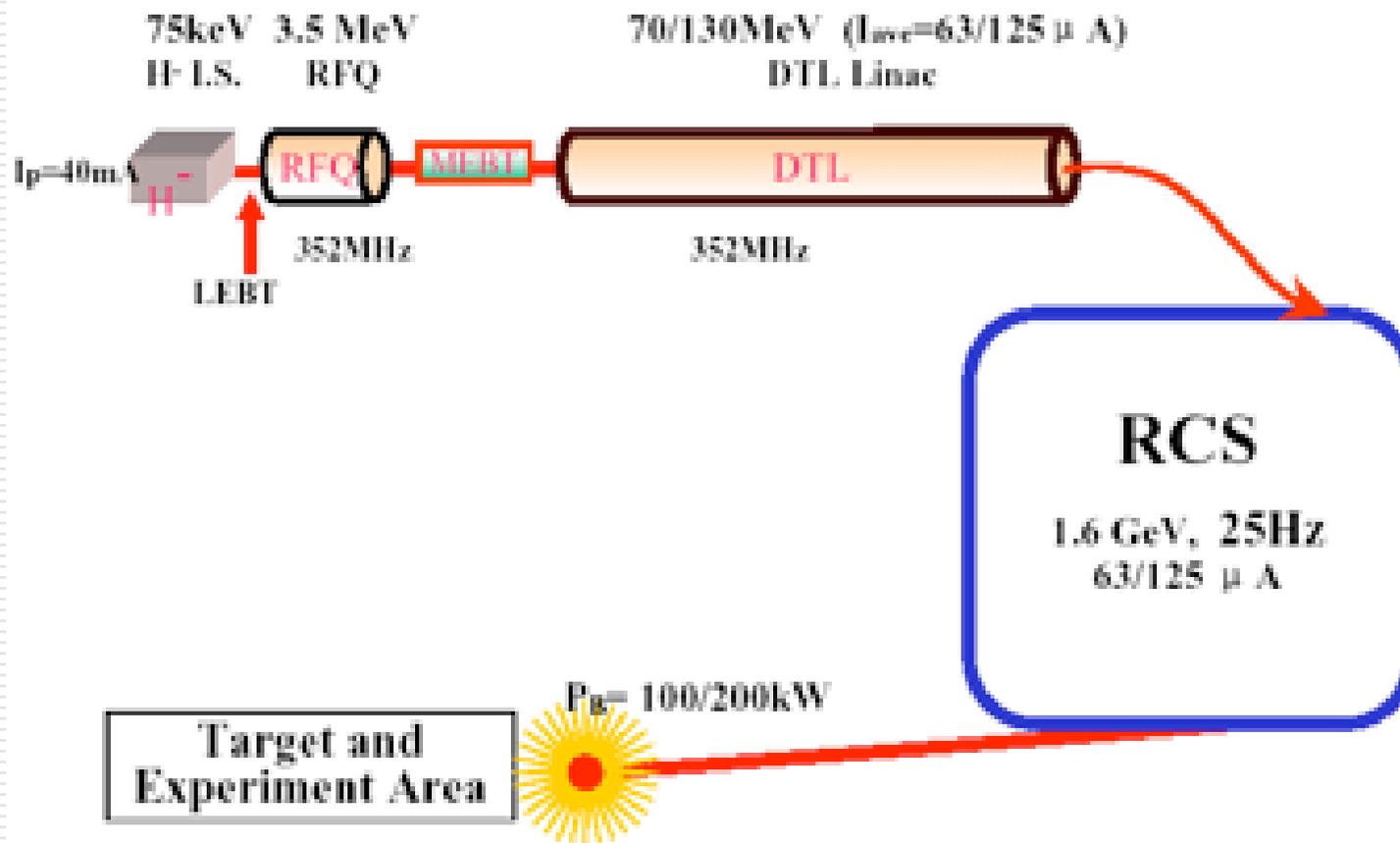## -- Introduce

- **CSNS**
  - China Spallation Neutron Source
  - 100KW, pulsed neutron source
  - 25 Hz repetition frequency
  - A LINAC with lower energy
  - A rapid cycle synchrotron ring with higher energy
- Jointly host by Institute of Physics, Institute of High Energy Physics and CAS
- IHEP response for building the facility
- In the process of R&D

Status in CSNS
-- CSNS Architecture

Status in CSNS
-- Control System

- ☐ Include power supply control, vacuum control, RF control and machine safety protection
- ☐ EPICS based
  - ■ Many people of CSNS have already accepted
- ☐ The preliminary design doesn't yet start.
- ☐ Power supply control prototype has started

Outline

- ☐ Introduction
- ☐ EPICS Status in China
  - ■ SSRF LINAC
  - ■ BEPCII
  - ■ HLS
  - ■ CSNS
- ☐ References and Special Thanks

References

1. Design Reports of SSRF 100 MEV LINAC
   - Songqiang Liu, "CN-T33-100MeV LINAC Control System"
   - Jitang Li, Lifang Zheng, Songqiang Liu, "CN-T38-LINAC P.S. Subsystem Control"
   - Lifang Zheng, "CN-T51-LINAC Modulator Subsystem Control"
   - Shouming Hu, "CN-T53 LINAC RF Subsystem Control"
   - Shouming Hu, "CN-T55-LINAC Timing Subsystem Control"
   - Jianguo Ding, "CN-T57-LINAC Phase Shifter Subsystem Control"
   - Jianguo Ding, "CN-T58-LINAC GUN Subsystem Control"
   - Haifeng Miao, Lifang Zheng, Jianguo Ding, "CN-T63-LINAC Vacuum Subsystem Control"

2. Jianguo Ding, Lifang Zheng, Shouming Hu, Haifeng Miao, Jitang Li, Songqiang Liu,"An EPICS-based LINAC Control System"

References (Cont.)

3. J. Zhao, "Progress of the Controls for BEPCII", EPICS Seminar In IHEP, 20 August, 2002

4. Gongfa Liu, "HLS new control system", EPICS Seminar in Hefei, 4 Mar. 2004

5. Materials of BEPCII are provided by Prof. Jijiu Zhao

6. Materials of CSNS are provided by Associate Prof. Chunhong Wang

7. All photos of SSRF 100MeV LINAC are provided by Associate Prof. Jianguo Ding

8. All photos of HLS are provided by Associate Prof. Gongfa Liu

Special Thanks

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  - Associate Prof. Shouming Hu
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- HLS
  - Prof. Weimin Li
  - Associate Prof. Gongfa Liu

Thank You!