

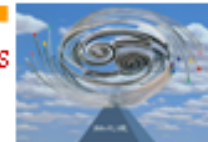


Prototype of Ion Source Control System at CSNS

Control Group IHEP

Gang Li

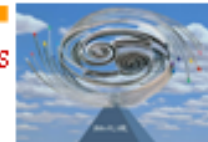
2010-3-2



Outline



- I. The design of ion source control system
- II. Test components of ion source control
 1. Power supply: High Voltage PS、DCS60E、Arc DC and Arc AC etc.
 2. Vacuum system: pump(Varian **Turbo-V 3K-T System**), vacuum gauge, gate valve etc
 3. Other component or function: thermocouple, mass flow controller, interlock, PPS, etc
- III. Commissioning
- IV. other

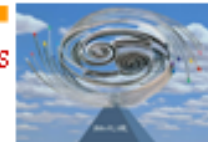


一、 The design of ion source control system



1、 Requirement

- (1) run as a standalone system
- (2) local and remote control capabilities
- (3) it is electrically isolated and filtered from electrical devices
- (4) It can incorporate MPS(machine protection system), PPS and Timing system

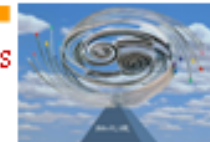


一、 The design of ion source control system



2、 Components

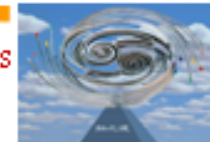
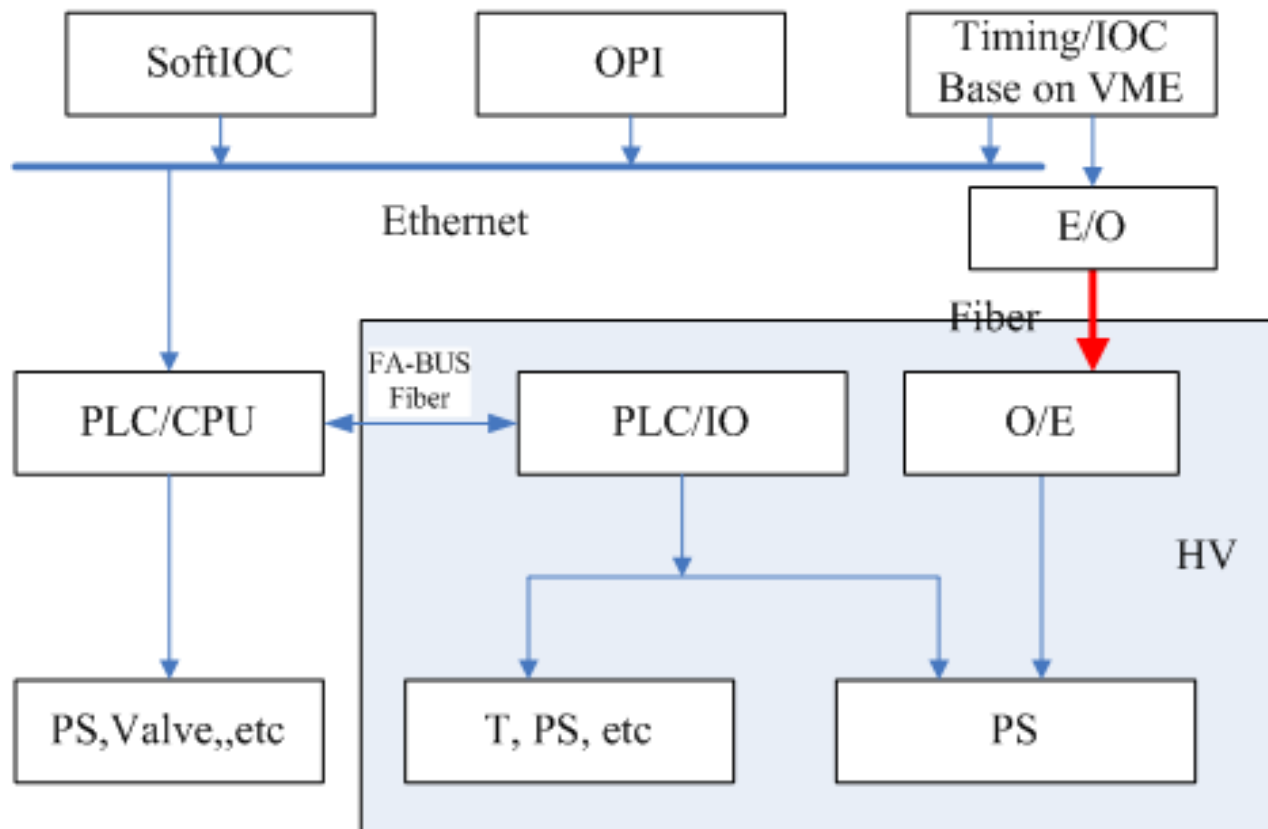
- power supply system
- vacuum system
- dangerous gas alarming system
- Temperature control
- Timing system
- air-cooling system
- water-cooling system
- etc



一、 The design of ion source control system



3、 control structure



二、Test of front components



GAMMA 电源测试 PLC 配置图

PS	CPU	AI	AO	DI	DO	Eth
0	1	2	3	4	5	6

其中：

AI (2: Im, Vm), AO (2: Ic, Vc), DO (1: IntLok), DI (1, GateSta)。

AI 接线说明：

所有 AI 输入均配置为差分输入，提高抗干扰能力（共模干扰），是否增加数字滤波，在 EPICS 内还是 PLC 内？

DO 接线说明：

IntLok: NC (常闭 0) ->正常；置“1” ->紧急切断电源

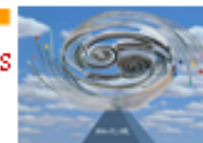
DI 接线说明：

GateSta: 门状态 (常开“0”) ->门打开，不能加 HV；闭合，置“1” ->可以加 HV

电缆颜色和针脚为对应关系：

8 芯电缆： 白色 黑色 红色 蓝色 粉色 浅蓝 绿色
3 4 6 7 8 9 10

移去 2 和 3, 5 和 6, 9 和 10 之间的短路片（电源接线端子默认连接的短路片）。



二、Test of front components

Vac_Pump System 测试 PLC 配置图

PS	CPU	AI	AO	DI	DO	Eth
0	1	2	3	4	5	6

其中：

AI (2: PI, PumpSpeed), AO (0), DO (6: StaStp, IntLok, SpeSet, SofSta, Purge, Vent), DI (3: Fault, SetPoi, R3NC)。

AI 接线说明：

所有 AI 输入均配置为差分输入，提高抗干扰能力（共模干扰），是否增加数字滤波，在 EPICS 内还是 PLC 内？

DO 接线说明：

由于该设备本省接口具有光电隔离功能，需要 24V 供电，其中 StaStp 和 IntLok 信号已经提供两个连接端子，故不再增加中间继电器。其他四个信号共用 Pin-15 引脚，故需要增加一个继电器，通过 PLC 控制继电器线圈的吸合或者断开来控制设备，其 24V 电源使用自身提供信号源 Pin-9 引脚（2009-1-21 补充说明）。

DI 接线说明：

设备的继电器触点输出，直接挂接 24V 电源，连接到 PLC 的 DI 模块即可。

电缆颜色和针脚为对应关系：

8 芯电缆（标签）：	白色	黑色	红色	蓝色	粉色	浅蓝	绿色	黄色
	1	2	3	4	5	6	7	8
8 芯电缆（无标）：	白色	黑色	红色	蓝色	粉色	浅蓝	绿色	黄色
	9	10	11	12	13	14	15	空

Co

二、Test of front components



温度闭环开关量输出测试 PLC 配置图

PS	CPU	AI	DO	AI	DI	Eth
0	1	2	3	4	5	6

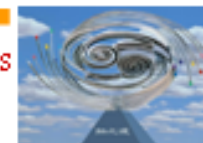
接线说明：

简易接线方式，DO 使用外接继电器输出，控制自耦变压器输出的两个端子。

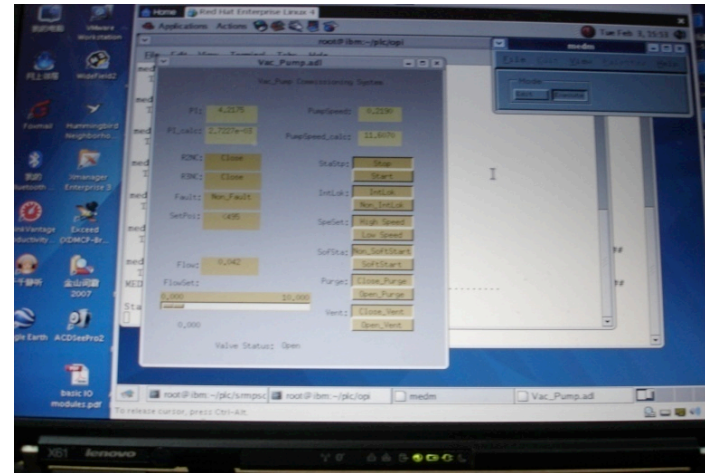
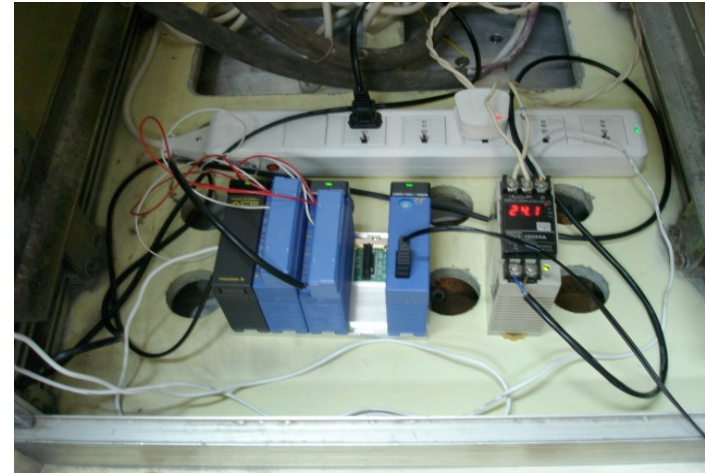
考虑到今后控制、维护方便，自耦变压器的 AC220 输入端将通过继电器控制其开关，且增加高温联锁保护。

继电器开关控制模式，为窗口控制或类似迟滞回线控制，即当温度高于上限（179），断开自耦变压器输出，温度低于下限（178.5），闭环自耦变压器输出，当温度在两者之间则保持上一次工作状态。

如温度变化范围在 1 度内，则继电器在 1 次/6 分钟完成一次开启、闭环动作。若温度变化范围在 0.5 度内，则 1 次/2 或 3 分钟执行一次继电器开启、闭合动作。

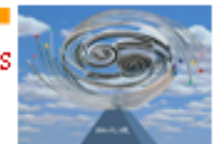


二、Test of front components



Control Group

Institute of High Energy Physics
Chinese Academy of Science



三、Commissioning

PLC-离子源控制系统信号表2009-07-23.xls [兼容模式] - Microsoft Excel

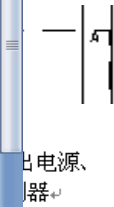
设备信号表 | PLC通道信号表 | 电缆信号表 | New电缆信号表 | Sheet3

0# Low Level Voltage Platform									
PS	CPU	AI	AO	DI	DO	Eth	FA-Bus	FA-Bus	
0	1	2	3	4	5	6	7	8	

Cont

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 【
 门禁电缆：七芯
 左门：红蓝；右门：黄绿；串接：紫黑
 】

DCS-PM 电源		
PM Shu	紫白紫-标日白	31:25-26
PM LocRem	紫白紫-红黑红-红黑黑	31:27-28
PM Im	绿白白-棕白棕	23:05-06
PM Vm	粉白粉-棕白棕	23:07-08



三、Commissioning

/home/luyh/ioncontrol/opi/HVTest082610.edl

Ion Source_HV Control

EXIT

Water Flow_Status				FS1 ●	FS2 ●	FS3 ●	FS4 ●	Pump	
Gas Control and Vacuum		Vac_HV		7.0469e-06 Torr	HV_R1NO ●	HV_R2NO ●	HV_R3NO ●	LV	
		Vac_LV		2.5704e-11 Torr	LV_R1NO ●	LV_R2NO ●	LV_R3NO ●	IntLok ●	
		H2 Flow	<input type="text" value="0.000"/> SCCM	44.580 SCCM	H2 Alarm: ●	H2 Flow IntLok: ●			
Arc DC&AC		DC ●		Vm 21.4000 V Irb 0.2150 A Im 0.2110 A	RegSta: ●	Vac_IntLok: ●			
		Current	<input type="text" value="0.000"/> A		Loc/Rem: ●	ExtOn: ● <input type="text" value="On"/> <input type="radio"/> <input type="text" value="Off"/> ●			
On/Off		AC ●		Vm 8.5400 V Irb 2.2450 A Im 2.1200 A	RegSta: ●	Vac_IntLok: ●			
		Current	<input type="text" value="0.00"/> A		Loc/Rem: ●	IntLok: ●			
PV Valve		DV Voltage		Vrb -21.6390 V Vm -22.9635 V	PV_Vac ●				
		PV Voltage	<input type="text" value="-20.00"/> V	PVrb 128.6400 V PVm 127.3950 V	ExtOn ●	<input type="text" value="On"/> ● <input type="text" value="Off"/> <input type="radio"/>			
		PVc	<input type="text" value="130.00"/> V						
Magnet PM		Current	<input type="text" value="8.00"/> A	8.00 A	VI_Mode: <u>I_mode</u>	Loc/Rem: <input type="radio"/> Local <input checked="" type="radio"/> Remote	ShuDown: <input type="radio"/> ShutDown <input checked="" type="radio"/> OK		
		Voltage	<input type="text" value="35.00"/> V	18.84 V	OVP_M: <u>Ok</u>				
DM		OVP	<input type="text" value="40.00"/> V		Fault_M: <u>Ok</u>				
		Current	<input type="text" value="12.00"/> A	11.45 A	VI_Mode: <u>V_mode</u>	Loc/Rem: <input type="radio"/> Local <input checked="" type="radio"/> Remote	ShuDown: <input type="radio"/> ShutDown <input checked="" type="radio"/> OK		
Voltage		Voltage	<input type="text" value="0.000"/> kV	Vm: -0.005 kV	Vac_IntLok: ●	Over Current: ●	TimingOn: <input type="radio"/> TimeOn <input checked="" type="radio"/> TimeOff		
		Sta/Stop:	<input type="text" value="vc U/D"/>		Status: ●	Over_Voltage: ●			
Extract		Start	<input type="radio"/>			Loc/Rem: ●			
		Stop	<input checked="" type="radio"/>						
Reset									
Temperature		Boiler	<input type="text" value="180.00"/> Degree	180.57 Degree	Boiler_Out1: ●				
		Transport_1	<input type="text" value="280.00"/> Degree	280.32 Degree	Transport_1_Out1: ●	Transport_1_Out2: ●			
Switch ON/Off:		Transport_2	<input type="text" value="280.00"/> Degree	271.83 Degree	Boiler_On: <input type="text" value="0.20"/>	Boiler_Off: <input type="text" value="0.30"/>			
		Anode	<input checked="" type="radio"/>	349.44 Degree	Tranp1_On: <input type="text" value="0.20"/>	Tranp1_Off: <input type="text" value="0.30"/>			
		Cathode	<input type="radio"/>	254.99 Degree	Tranp2_On: <input type="text" value="2.00"/>	Tranp2_Off: <input type="text" value="3.00"/>			
		Source Body	<input type="radio"/>	349.80 Degree					

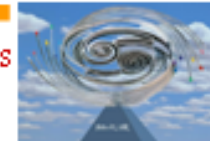
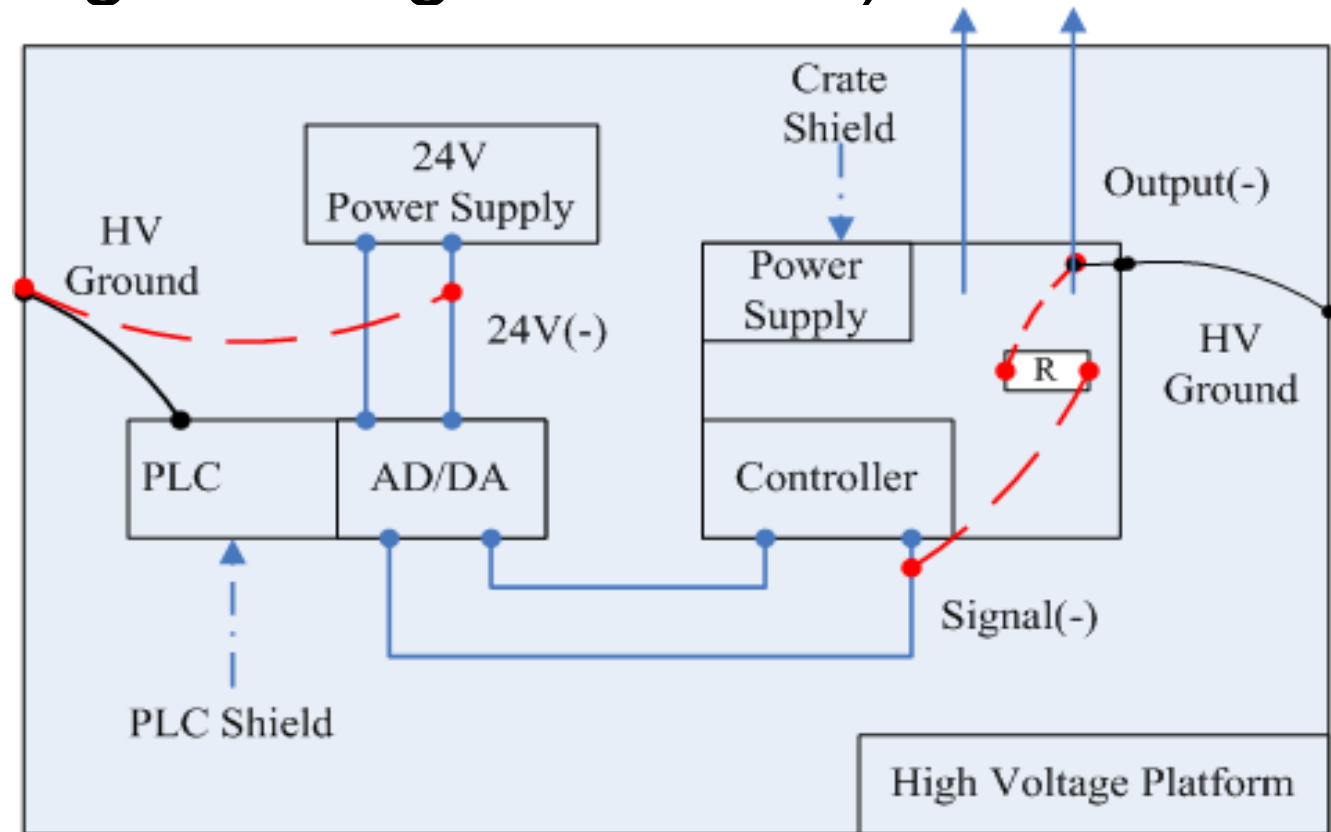


四、Other



1、Ground(High Voltage Platform)

- Signal G
- Output G
- Shield G
- HV G

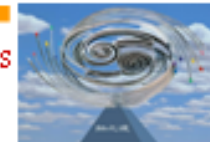


四、 Other



2、 Difficulty and Experience

- ① EMC(Electro Magnetic Compatibility), System stability
- ② Commissioning of homemade PS(“Ground”)
- ③ Interference of Arc DC(Timing signal)
- ④ Interlock distribution of PLC-interlock and hardware interlock
- ⑤ Ramping of accelerating PS
- ⑥



四、 Other



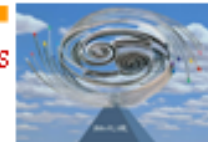
3、 “Opportunity” & “challenge”

Advantage of using EPICS during R&D:

- ① Scientists & engineers accept and use EPICS
- ② Discover question and trouble, and resolve it

Disadvantage:

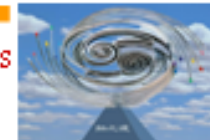
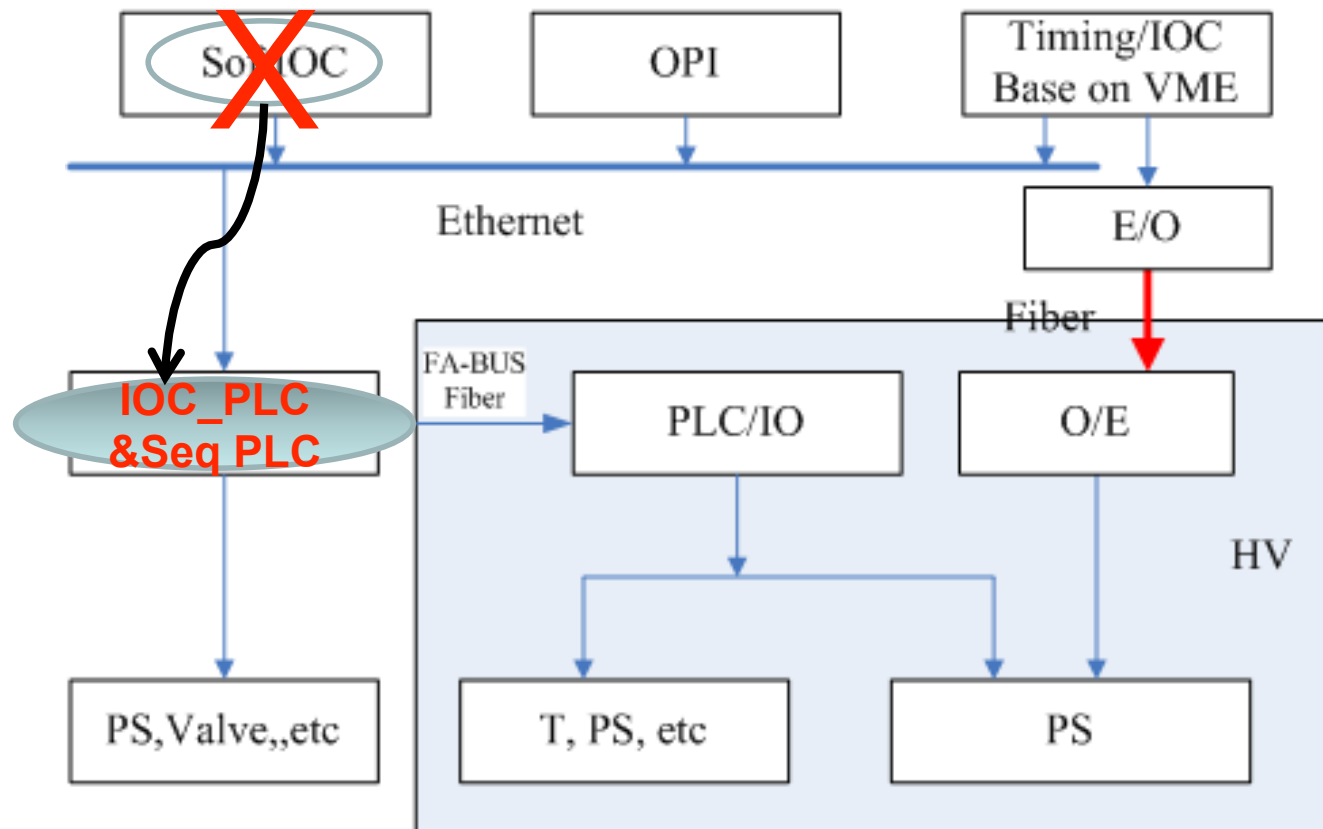
- ① Cost short
- ② Time tightly
- ③ Manpower



四、Other

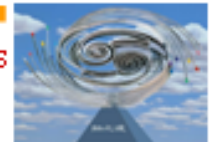


4、”New” Control Structure of Ion Source



五、 Acknowledge

- Thank Odagiri-san for providing the nedDriver of PLC
- Thank Furukawa-san for information of the 16bit AO module(customized module)
- Thank ueno-san for discussion about J-PARC ion source control system
- Thank Jiang geyang and Zhou dayong from SSRF for discussing about the PLC
- Thank ouyang and his team for cooperation during commissioning of the ion source control system
- Thanks Yokogawa electric corporation for a set of PLC
- Many Thanks ...





Thank your for your attention

