

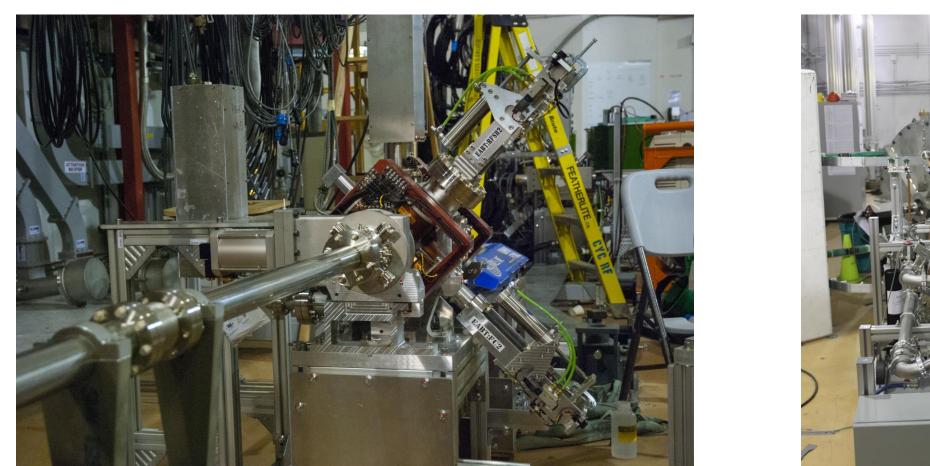
Canada's National Laboratory for Particle and Nuclear Physics Laboratoire national canadien pour la recherche en physique nucléaire et en physique des particules

ARIEL CONTROL SYSTEM AT TRIUMF -STATUS UPDATE

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Abstract

The Advanced Rare Isotope & Electron Linac (ARIEL) facility at TRIUMF has now reached completion of the first phase of construction; the Electron Linac. A commissioning control system has been built and used to commission the electron gun and two stages of SRF acceleration. Numerous controls subsystems have been deployed including beamlines, vacuum systems, beamline diagnostics, machine protect system interfaces, LLRF, HPRF, and cryogenics. This paper describes some of the challenges and solutions that were encountered, and describes the scope of the project to date. An evaluation of some techniques that had been proposed and described at ICALEPCS 2013 are included.



Beam Optics & Diagnostics: VME IO, GallI motors, TCP LAN power supplies

Vacuum & Gas Control: Modbus PLCs

Devices under control	1160
Discrete IO Points	11155
EPICS IOCs	22
IOC Hosts	16
EPICS Device Support types	24

Control system scale



LLRF:CryogenicsTCP LAN + In-houseModbus PLO

Cryogenics and Cold Distribution: Modbus PLCs & Siemens PLCs

Mobile Vacuum Pumping Carts

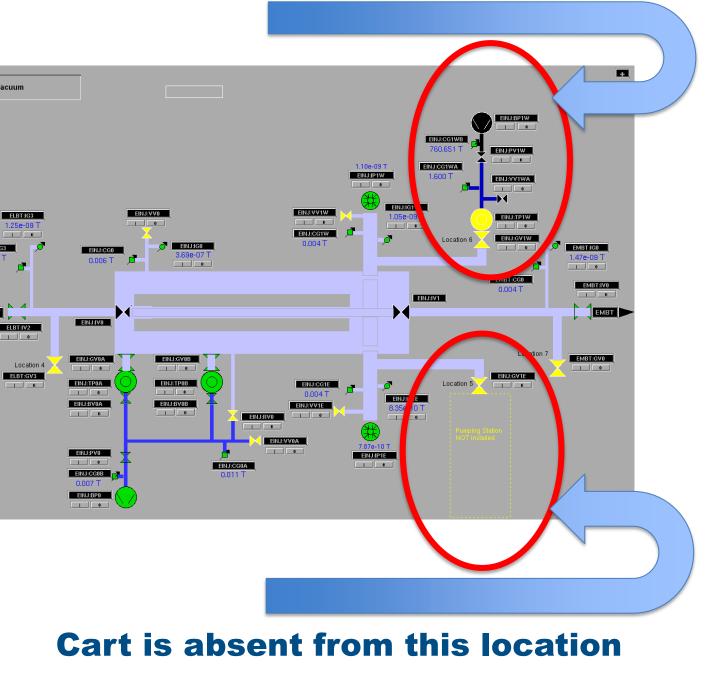
• Turbo Pumps connect any of 27 beamline ports

Linux OS Everywhere

- Automatic detection of connect & disconnect events in PLC
- EPICS EDM displays automatically reflect changing geographic locations of two carts
- Driven by economics and space constraints:
 - 1. Saving of CDN \$27000 vs dedicated PLC IO
- 2. Saving of 10,000 m of cable
- 3. Reduced congestion in cable passageways
- 4. Reduced congestion around beamlines



this location



EPICS IOC hosts use diskless Linux

- Compact In-house Linux 'distribution'
- Customized for local controls requirements
- Follows historical model of diskless vxWorks IOCs
- Permits easy distribution of changes
- Fast loading, small memory footprint
- Currently on x86 PC and x86 VME CPUs

File servers, user hosts, and Control
Room consoles use Debian Linux
NFS, TFTP (PXE), DHCP and SSH
EPICS extensions: EDM, ALH, StripTool, etc

Development hosts use Debian Linux

- Native compiler toolchain used to build OS components and EPICS components
- Planned cross-native toolchain development to remove development host dependencies

IOC Hosts provide services to Fieldbus Ethernets

- DHCP Servers for Ethernet devices under control
- NAT firewall to expose PLCs to programming tools



EPICS Applications specified in PXE Bootloader configuration

- Bootloader specifies kernel arguments
- Kernel ignores arguments it doesn`t know, but userspace still has access
- Scripts read arguments to configure IOC host and launch IOC applications
- IOC application shells launched in sharable multi-user GNU screen sessions

Automated Generation of Synoptic Displays

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Hockey 🛅 Homefire2 📋 TRIUMF 🤣 Home TRIUMF : 📄 Chrome URLs 🛛 Google 🔓 Google Calendar 🛅 Misc		
TRIUMF/ISAC Device Database V3.0 (user R.Nussbaumer) System: ELINAC Session expires in 58 minutes.		
Orthogonal file elbt_dev_1.cfg		
Device list updated based on config file elbt_dev_1.cfg Place mouse over an implementation module for help		
FCDT1=MCB, NOICON1=YES, PANEL1=elhelmholtzcp.edl	ELBT OPTICS	(1) vt
FCDT3=Include, FILE3=icon_hhcoil.edl, X3=27, Y3=0		
2 ELBT:BUNCH		
DIAG1=YES, FCDT1=Generic		
○ 3 ELBT:XCB0		ELBT:IV2 open shut
FCDT1=MCB, PANEL1=steerercp.edl		-1 0.00
COLOR3=warning, FCDT3=Label, PV3=ELBT:XCB0:POLOK, TEXT3=polarity switching, VIS3=0, X3=500, Y3=8		
○ 4 ELBT:YCB0		-1 0.00
FCDT1=MCB, PANEL1=steerercp.edl		
COLOR3=warning, FCDT3=Label, PV3=ELBT:YCB0:POLOK, TEXT3=polarity switching, VIS3=0, X3=500, Y3=8		
FCDT1=ACTMOT, ICON1=icon_actmot_mcol.edl, MONITOR1=NO, NOCTRL1=NO		ELBT:VS2 Out @T
COLOR3=stateok, DIAG3=NO, FCDT3=Led, LABEL3=Out, LABELX3=175, PV3=ELBT:MCOL0:NEGLIM, X3=140, Y3=7		
FCDT4=Led, LABEL4=@Pos1, LABELX4=260, PV4=ELBT:MCOL0:FOIL1, X4=265, Y4=7	L L	BT:RFSH2 out in
FCDT5=Led, LABEL5=@Pos2, LABELX5=390, PV5=ELBT:MCOL0:FOIL2, X5=395, Y5=7		
FCDT6=Led, LABEL6=@Pos3, LABELX6=515, PV6=ELBT:MCOL0:FOIL3, X6=520, Y6=7		ELBT:FC2 out in
FCDT7=Led, LABEL7=@Pos4, LABELX7=635, PV7=ELBT:MCOL0:FOIL4, X7=640, Y7=7	6 F	LBT:SOL2
0 6 ELBT:RFSH0		-3 0.00
FCDT1=ACT, ICON1=icon_rfsh.edl		
ALIGN3=center, BOLD3=NO, FCDT3=Monitor, HEIGHT3=13, LABEL3=Peak, LABELX3=-60, LABELY3=-2, PV3=ELBT:RFSH0:SCALECUR1, THF		-3 0.00
 ALIGN4=right, BOLD4=NO, FCDT4=Monitor, HEIGHT4=13, LABEL4=Avg, LABELX4=-65, LABELY4=-2, PV4=ELBT:RFSH0:SCALECUR2, THREE 7 ELBT:VS0 		BT:XCB1B
FCDT1=ACTMOT, ICON1=icon actmot vs.edl, MONITOR1=NO, NOCTRL1=NO		1 0.00
COLOR3=stateok, DIAG3=NO, FCDT3=Led, LABEL3=Out, LABELX3=175, PV3=ELBT:VS0:NEGLIM, X3=140, Y3=7		
FCDT4=Led, LABEL4=@Targ1, LABELX4=260, PV4=ELBT:VS0:FOIL1, X4=265, Y4=7		BT:YCB1A
FCDT5=Led, LABEL5=@Targ2, LABELX5=390, PV5=ELBT:VS0:FOIL2, X5=395, Y5=7		
FCDT6=Led, LABEL6=@Targ3, LABELX6=515, PV6=ELBT:VS0:FOIL3, X6=520, Y6=7		BT:XCB1A
0 8 ELBT:FWS0		-5 0.00
DIAG1=YES, FCDT1=Generic		

Ethernet as a Field Bus

Many devices use Ethernet as Control System interface

EDM screens built from web-based configuration tool

Consistent layout and appearance

Easy to maintain

- Extensible Python framework
- Beam Optics & Diagnostics

OPTICS (1)		et 13 14	:09:40			
		· ·				
	pen shut	1				
ELBT:YCB2	0.00	1	-0.0004 A			
	اساب		-0.0004 A			
ELBT:VS2	Out	@Targ1	@Targ2	ELBT:BPM2 @Targ3		
	out in					
	ut in	Pea	6.19e-06 A	Avg -0 A Beam Dump 300W		
ELBT:SOL2	0.00	5	0.0163 A	Deallin Dalling 3004	, 	
	0.00	3	0.0000 A			
	0.00	3	0.0000 A			
ELBD:MB0	0.00	1	0.0004 A			
	0.00	1	-0.0003 A			
	0.00	1	-0.0003 A			
	0.00	5	0.0777 A			
				ELBT:BPM0		
ELBT:FWS0				NOT INSTALLED		
ELBT:VS0	Out	@Targ1	@Targ2	@Targ3		
ELET:RFSHO	out in	Pea	k -0 A	Avç <mark>-0 A</mark>		
		@Pos1	@Pos2	@Pos3	@Pos4	
	0.00	1	-0.0011 A			
	0.00	1	-0.0004 A			
	0.00	40				
			0.0073 A			

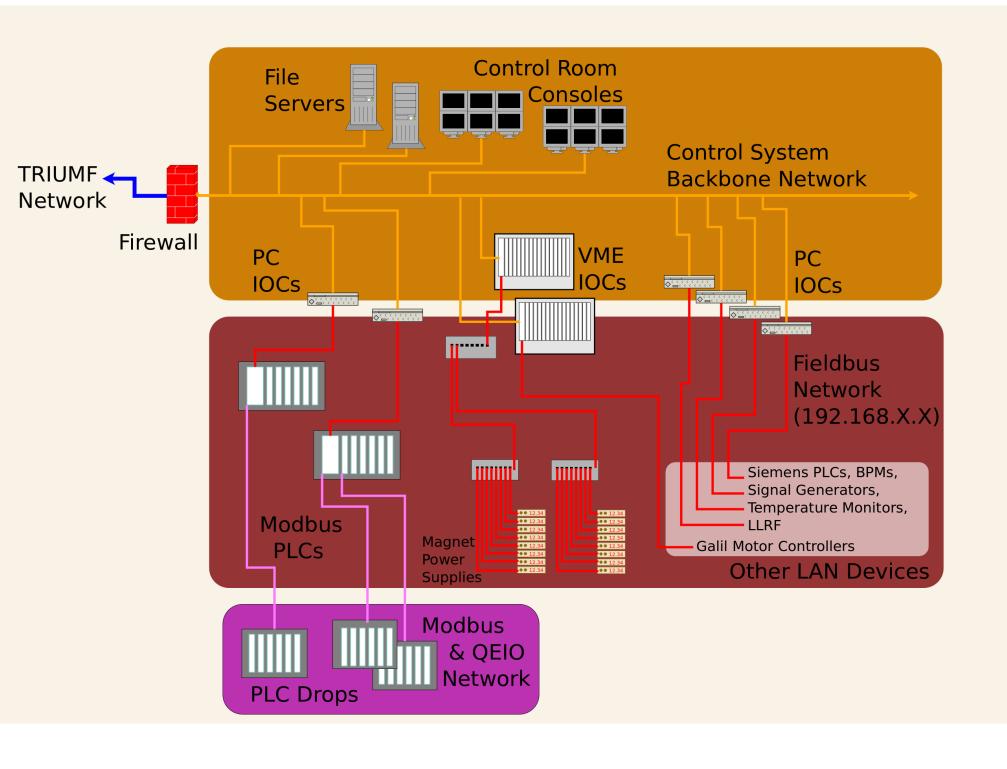
- Three tiers of ethernet:
 - Control System Backbone
 Device Field Buses
 - 3. Modbus PLC Field Buses

Segregation is good
Easier troubleshooting

- Less shared traffic
- Reduced overlap of functionality
- Local administration of LAN IPs

 Linux IOC hosts provide NAT Firewall
 access devices from development network.

 Schneider Unity PLC programming software access to PLCs



ICALEPCS 2015, Melbourne, AU