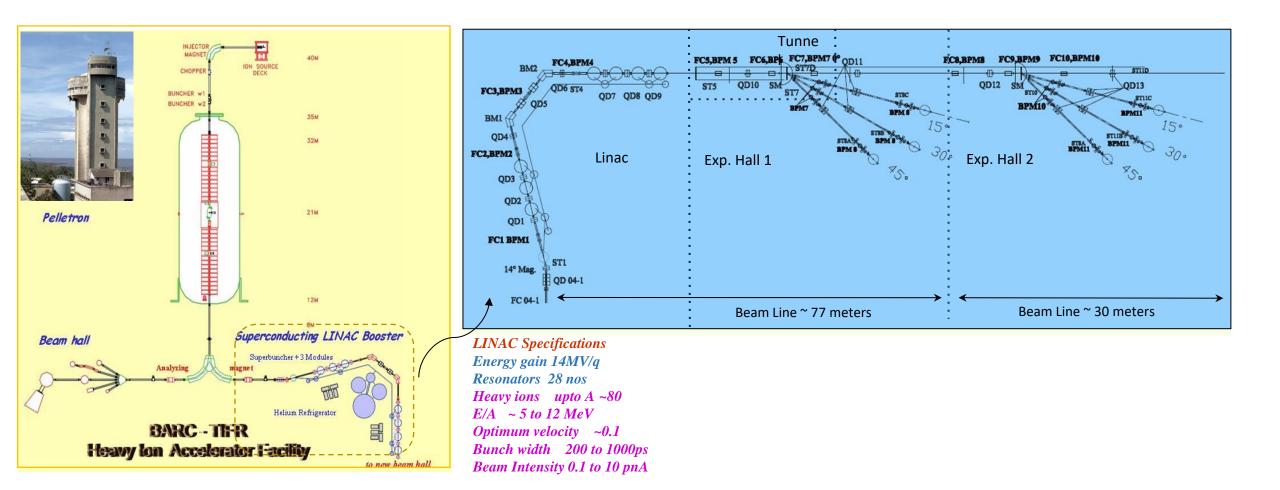
### EPICS based Linac Beam Transport & Diagnostic System

**Catarina Rozario** Pelletron Linac Facility, TIFR Mumbai

# Pelletron Linac Facility at TIFR Mumbai



### **Existing LINAC Control System**

6.5E 7

- RF Control System CAMAC hardware JAVA Beam Transport System -JAVA
- Beam Diagnostic System JAVA
- Cryogenic Control Station –Qt
- Vacuum Monitoring System -LabVIEW
- Slit Controller- EPICS Qt

Magnet

Controller

• Motor Controller for Coupler – EPICS Qt

Steerer

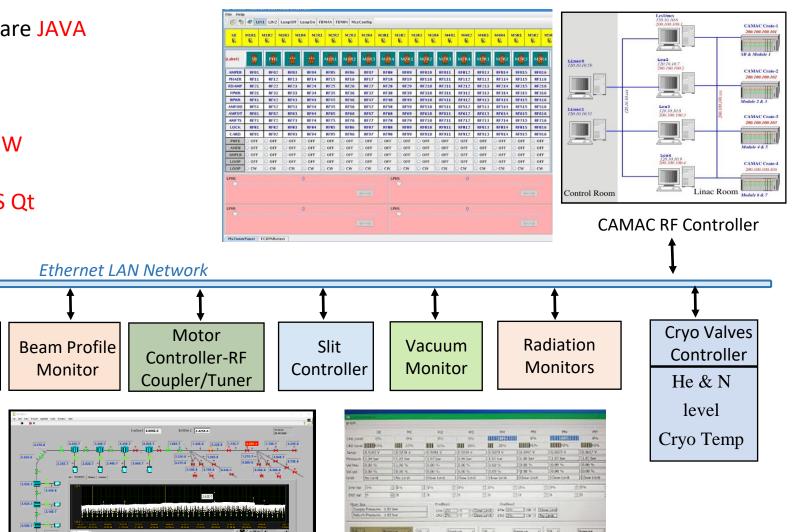
Controller

Faraday Cup

Controller

Radiation Monitors -LabVIEW

280,591

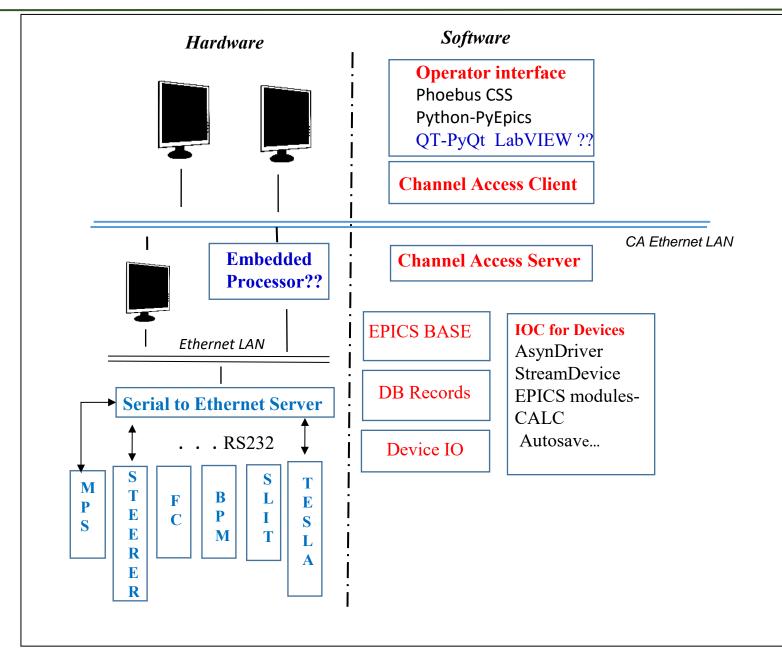


9 200 400 500 800 1,000

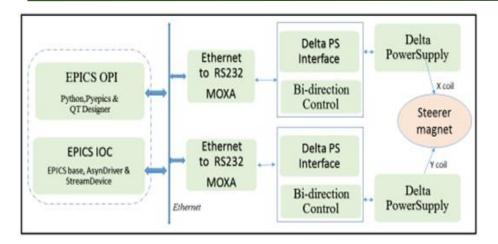
OPPO F19

3 200 400 M00 RUQ1,000

### **EPICS – Hardware Software Layout**



### **Development of Steerer Control using EPICS**



#### Implementation

EPICS IOC: Runs on Linux PC.

DB and Protocol files using Delta SCPI

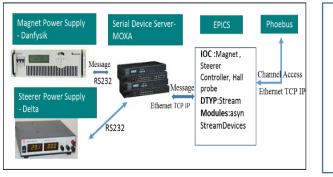
EPICS OPI: PyEpics: Interface for CA library to Python

QT Designer tool was used for creating GUI for python App *Limitations*: Expertise to write, diagnose the python support code

	DELTA PANEL – 🗆 😣
File Edit Help	SELECTED: MS2Y
R EEHS	<u> </u>
16888	
R MS1X R	F MS1Y F
EHER F MS2X F	HIH F MS2Y F
R MS3X D	R MS3Y D
R MS4X D	R MS4Y D
R MS5X D	R MS5Y D
R MS6X D	R MS6Y D
R MS7X D	R MS7Y D
X CONTROLLER	Y CONTROLLER
○ F ○ M ● C	○ F ○ M ● C
<< (A) >> (D)	<< (Left) >> (Right)

File Applications Window	v Help					
[Edit] Display × LINAC Ste	erere Interface × * [Ed	it] LINAC Steerere Inte	rface × [Edit] Display ×			
8 8 1 1		• 🧳 👒 10	0 % 🔻		Properties	
					Search	'n
q			p	Search	Widget	
	LINAC Steerer Inter	face		▼ Graphics	Туре	led
MS04X <ms4x:< td=""><td><t< td=""><td>MS04Y <ms4y:< td=""><td>R <ms4y:5 _<="" td=""><td>Arc</td><td>Name</td><td>LED_52</td></ms4y:5></td></ms4y:<></td></t<></td></ms4x:<>	<t< td=""><td>MS04Y <ms4y:< td=""><td>R <ms4y:5 _<="" td=""><td>Arc</td><td>Name</td><td>LED_52</td></ms4y:5></td></ms4y:<></td></t<>	MS04Y <ms4y:< td=""><td>R <ms4y:5 _<="" td=""><td>Arc</td><td>Name</td><td>LED_52</td></ms4y:5></td></ms4y:<>	R <ms4y:5 _<="" td=""><td>Arc</td><td>Name</td><td>LED_52</td></ms4y:5>	Arc	Name	LED_52
-1004A <10134A.	F M C	<b>13041</b> <101341.		Ellipse	Class	DEFAULT
		_		A Label	Position	40
MS <mark>05X</mark> <ms5x:< td=""><td></td><td>MS<mark>05Y</mark> <ms5y:< td=""><td>R <ms5y:s< td=""><td>Polygon</td><td>X Position Y Position</td><td>73</td></ms5y:s<></td></ms5y:<></td></ms5x:<>		MS <mark>05Y</mark> <ms5y:< td=""><td>R <ms5y:s< td=""><td>Polygon</td><td>X Position Y Position</td><td>73</td></ms5y:s<></td></ms5y:<>	R <ms5y:s< td=""><td>Polygon</td><td>X Position Y Position</td><td>73</td></ms5y:s<>	Polygon	X Position Y Position	73
	F M C		FOMOC	S Polyline	Width	73
MS <mark>07X</mark> <ms7x:< td=""><td>&lt; <ms7x:5< td=""><td>MS07Y <ms7y:< td=""><td>R <ms7y:s< td=""><td>Rectangle</td><td>Height</td><td>34</td></ms7y:s<></td></ms7y:<></td></ms7x:5<></td></ms7x:<>	< <ms7x:5< td=""><td>MS07Y <ms7y:< td=""><td>R <ms7y:s< td=""><td>Rectangle</td><td>Height</td><td>34</td></ms7y:s<></td></ms7y:<></td></ms7x:5<>	MS07Y <ms7y:< td=""><td>R <ms7y:s< td=""><td>Rectangle</td><td>Height</td><td>34</td></ms7y:s<></td></ms7y:<>	R <ms7y:s< td=""><td>Rectangle</td><td>Height</td><td>34</td></ms7y:s<>	Rectangle	Height	34
	FOMOC		OF MOC	Monitors	Display	54
MS08X <ms8x:< td=""><td>&lt; MS8X:5</td><td>MS08Y <ms8y:< td=""><td>R <ms8y:5 td="" 🔶="" 🗖<=""><td>Byte Monitor</td><td>Visible</td><td><math>\checkmark</math></td></ms8y:5></td></ms8y:<></td></ms8x:<>	< MS8X:5	MS08Y <ms8y:< td=""><td>R <ms8y:5 td="" 🔶="" 🗖<=""><td>Byte Monitor</td><td>Visible</td><td><math>\checkmark</math></td></ms8y:5></td></ms8y:<>	R <ms8y:5 td="" 🔶="" 🗖<=""><td>Byte Monitor</td><td>Visible</td><td><math>\checkmark</math></td></ms8y:5>	Byte Monitor	Visible	$\checkmark$
	FOMOC		OFOMOC	led	Font	'Liberation M
MS10X <ms11x:< td=""><td>R <ms11x td="" 🗘<=""><td>MS10Y <ms11y:< td=""><td>R <ms11y< td=""><td>LED (Multi State)</td><td>Foreground</td><td>Text</td></ms11y<></td></ms11y:<></td></ms11x></td></ms11x:<>	R <ms11x td="" 🗘<=""><td>MS10Y <ms11y:< td=""><td>R <ms11y< td=""><td>LED (Multi State)</td><td>Foreground</td><td>Text</td></ms11y<></td></ms11y:<></td></ms11x>	MS10Y <ms11y:< td=""><td>R <ms11y< td=""><td>LED (Multi State)</td><td>Foreground</td><td>Text</td></ms11y<></td></ms11y:<>	R <ms11y< td=""><td>LED (Multi State)</td><td>Foreground</td><td>Text</td></ms11y<>	LED (Multi State)	Foreground	Text
NSTON CIVISITY.	OF OM C			🗇 Meter	Behavior	
				🗢 Progress Bar	Actions	No actions
MS11X <ms12x:< td=""><td></td><td>MS11Y <ms12y:< td=""><td>R <ms12y< td=""><td>J Symbol</td><td>Rules</td><td>No rules</td></ms12y<></td></ms12y:<></td></ms12x:<>		MS11Y <ms12y:< td=""><td>R <ms12y< td=""><td>J Symbol</td><td>Rules</td><td>No rules</td></ms12y<></td></ms12y:<>	R <ms12y< td=""><td>J Symbol</td><td>Rules</td><td>No rules</td></ms12y<>	J Symbol	Rules	No rules
	F M C		FOMOC	III Table	Scripts	No scripts
_				Tank	Tool tip	MS4X:GetD
				₩ Text Symbol		
d			р	0.0 Text Update		
				Thermometer		
				▼ Controls		
				Action Button		

# Control – Linac Beam Transport System



#### **EPICS** database for Magnets

- Current Setting, limits, ranges(C,M,F) of 20 bit value
- Status Interlocks, readback Current
- Control function(on/off, reset)
- Per IOC-Multiple devices
- Dipole Quadrupole Magnets control using Danfysik Power Supply (9100 and 8500)

- Steerer magnet control using Delta PS
- Hall Probe Monitoring
- Implemented 20+ IOCs for 50 devices
- Configured Phoebus CSS Save & Restore tool user defined PVs by snapshot

Beam and energy configuration file – Boron 11 +4, 50 MeV

	CS-Studio			V ^ 0			
Fie Ap	plications Window Help						
File Brows	er X LINAC Steerere Interface X	811-50Mev+4 H	215 12oct202	1-09.30 ×			
3 0 6							0 0 0
Selected	PV	Description	Timestamp	Value	Alarm	Saved Value	Saved Value T
V	MS4X:SetREVPWD_ONOFF		2024-08-1		NVAL.	1	2023-10-11 21:
V	MS4Y:SetREVFWD_ONOFF		2024-08-1		NVAL.	0	2023-10-12 10:3
1	MSSX:SetREVPWD_ONOFF		2024-08-1		INVAL.	0	2023-10-11 21-5
V	MS5Y:SetREVFWD_ONOFF		2024-08-1		NVAL.	0	2023-10-11 21:5
V	NS7X:SetREVPWD_ONOFF		2024-08-1		1572	1	2023-10-11 21-
1	MS7Y.5etREVFWD_ONOFF		2024-08-1		INVAL.	0	2023-10-11 21-5
V	MS8X:SetREVPWD_ONOFF		2024-08-1		INVAL	0	2023-10-11 21-5
V	MS8Y:SetREVFWD_ONOFF		2024-68-1		INVAL	0	2023-10-12 10:
1	MS10X-SetREVFWD_ONOFF		2024-08-1		RVAL.	0	2023-10-11 21:
1	MS10Y:SetREvFWD_ONOFF		2024-08-1_		INVAL	0	2023-10-11 21:
1	MS11X-SetREVFWD_ONOFF		2024-68-1		INVAL.	1	2023-10-11 21-5
1	MS11Y:SetREVFWD_ONOFF		2024-08-1		NVAL:	0	2023-10-11 21:
V	MS4X:Seti_con		2024-08-1		10/21	0.0	2023-10-11 21:5
V	NS4Y:SetI_con		2024-08-1		INTAL_	13770.0	2023-10-11 22:0
1	MSSX:SetI_con		2024-08-1		NVAL	0.0	2023-10-11 21:5
1	MS5Y.Seti_con		2024-08-1		NVAL.	0.0	2023-10-11 20:
1	NS7X:Seti_con		2024-08-1		NVAL.	00	2023-10-11 21:5
~	MS7Y.Seti_con		2024-08-1		WAL.	0.0	2023-10-11 21-
V	MS8X:SetLcon		2024-08-1		INVAL.	0.0	2023-10-11 21:5
V	MS8Y:Seti_con		2024-08-1		INVAL	11972.0	2023-10-11 22:0
1	MS10X Set con		2024-68-1		15795	0.0	2023-10-11 21:5

			CS-Studio	
File Applications	Window Help			
Edit] LED × [Edit] [	Display × LINAC Steere	ere Interface × Display	×	
LIN	AC BeamLine M	Magnet Control		
2DX41 16 A •	QDY41 16 A .	QDX9 24 A •	QDY9 25 A o	BM1 0.499297 T
DM14 59 A •		MSX5 0.00 •	MSY5 0.00 .	BM2 0.466543 T
QDX1 20 A •	QDY1 20 A .	QDX10 20 A •	QDY10 19 A o	SM2 0.156708 T
QDX2 20 A •	QDY2 28 A .	SWM1 -1 A O		SM1 0.003797 T
QDX3 20 A •	QDY3 20 A •	MSX7 0.00 •	MSY7 0.00 .	
QDX4 20 A o	QDY4 20 A O	QDX11 22 A O	QDY11 22 A 👩 🏧	1
BM1 58 A •	BM2 58 A •	MSX8 0.00 0	MSY8 0.00 .	l,
QDX5 18 A •	QDY5 20 A O	QDX12 20 A •	QDY12 20 A o	1
QDX6 25 A •	QDY6 26 A O	SWM2 26 A •		
MSX4 0.29 O	MSY4 0.00 0	MSX10 0.00 0	MSY10 0.00 •	1
QDX7 26 A O	QDY7 23 A O	QDX13 20 A •	QDY13 20 A o	1
QDX8 27 A o	QDY8 31 A O	MSX11 0.00 0	MSY11 0.00 0	
LINAC-X HALL 1	& 2 -X			
MSX5 ODX10 SH	M1 MSX7 QDX11 M	SX8 00X12 MSX10 0	DX13 MSX11 GPPX	
tione gonze en	ing noni gonag in		onto nontra ont n	
QDX10 Ready	NLK ON/OFF 20 A	RS ON	196725 📫 🔍	F 🔘 M 🖲 C
0 10000	20000 30000 4		000 70000 800	
MPS Magnet FR	se DC DC MPS	Earth Door Therma		■ 4
	AND ACCOUNTS AND AND AND A			
LINAC -Y HALL1	0.0 V			
MSY5 QDY10 SW	IM2 MSY7 QDY11 M	SY8 QDY12 MSY10 Q	DY13 MSY11 GRPY	
QDY10	• • 19 A	RS ON	180701 🛟 🤅	F 🔘 M 🖲 C
Ready	NLK ON/OFF		[mmm]mmm]mmm]mmm]	
<u></u>				
0 100000			000 700000 8000	

Linac Beam Transportation System using EPICS- C. Rozario, et.al. – SEBTA 2024 at BARC Mumbai

# Control – Beam Diagnostic System

20 + Linac Beam Diagnostic units - Faraday Cup (FC), Beam Profile Monitors(BPM) and adjustable X-Y slits communicate through serial port

#### FC

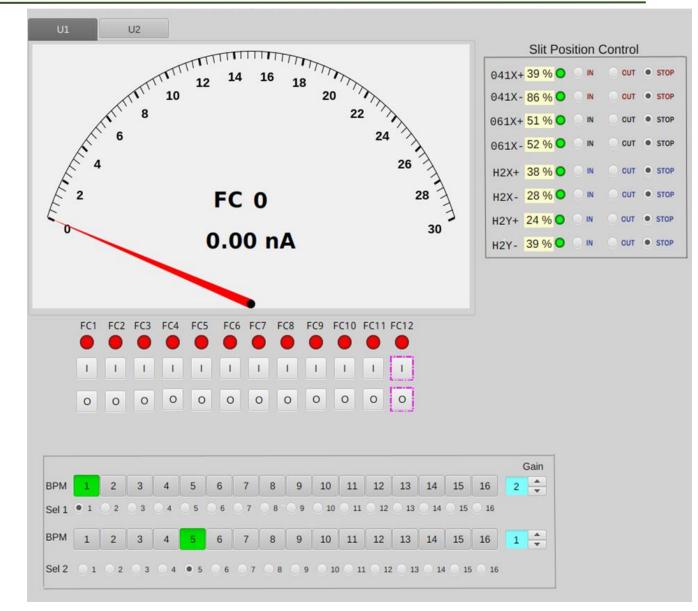
- Measures beam current (0.1nA to 1uA)
- Single packet data
- Records-Calc, mbbo,ai,bi,bo,Compress ..
- Achieved operator friendly dynamic full range meter movement

#### **BPM Selector**

- Scope Display of shape + position of beam
- 2 BPMs can be selected
- Gain selection
- Records-Calcout, mbbo,ao,bo

#### XY Slit

- Adjustment to collimator
- 15mm displacement range
- Controls direction & operation of motor



# Summary

- Tested LINAC Beam Transport System with the Beam, thus, achieved EPICS integration to one phase of our system
- Preliminary testing to validate –Diagnostic System (Beam Profile Monitor, Faraday Cup, Slit controller.)
- Future Plan to integrate are
  - Vacuum System (monitoring of the gauges and gate valves)
  - Radiation Area Monitors
  - Cryogenic Distribution valve controls
  - PLC based Cryogenic Refrigeration
  - PLC based Vacuum Furnace
  - Beam Line Component of Electron Cyclotron Resonance (ECR)

## Summary

- Tested LINAC Beam Transport System with the Beam, thus, achieved EPICS integration to one phase of our system
- Preliminary testing –Diagnostic System (Beam Profile Monitor, Faraday Cup, Slit controller.)
- Future Plan to port these system to EPICS
  - Vacuum System (monitoring of the gauges and gate valves)
  - Radiation Area Monitors
  - Cryogenic Distribution valve controls
  - PLC based Cryogenic Refrigeration
  - PLC based Vacuum Furnace
  - Beam Line Component of Electron Cyclotron Resonance (ECR)

#### Thanks to Prof Vandana Nanal, Prof R Palit and my colleagues at PLF TIFR

#### Special thanks to Mr. Sandeep Malu