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# EPICS Implementation in VEC & SCC

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## Basic Attributes of an Accelerator Control System

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- Robust Control Architecture
- Modular Design
- Facility for modify and expand in a scalable way
- Fulfill the operators need



# EPICS Implementation for Room Temperature Cyclotron

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- Power Supply Control
  - Ion Source
  - Trim Coils
  - Main Magnet and Beam line Magnets
- Vacuum System
- LCW System



## EPICS Implementation for Superconducting cyclotron

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- Deflector Conditioning and operation
- Cryogenic Plant Control
- Substation Control
- Vacuum System
- LCW System
- Beam Diagnostic



## What is EPICS?

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EPICS is an abbreviation for:

Experimental Physics and Industrial Control System

- Collection of Software tools and applications
- *A Control System Architecture*
- Collaboration



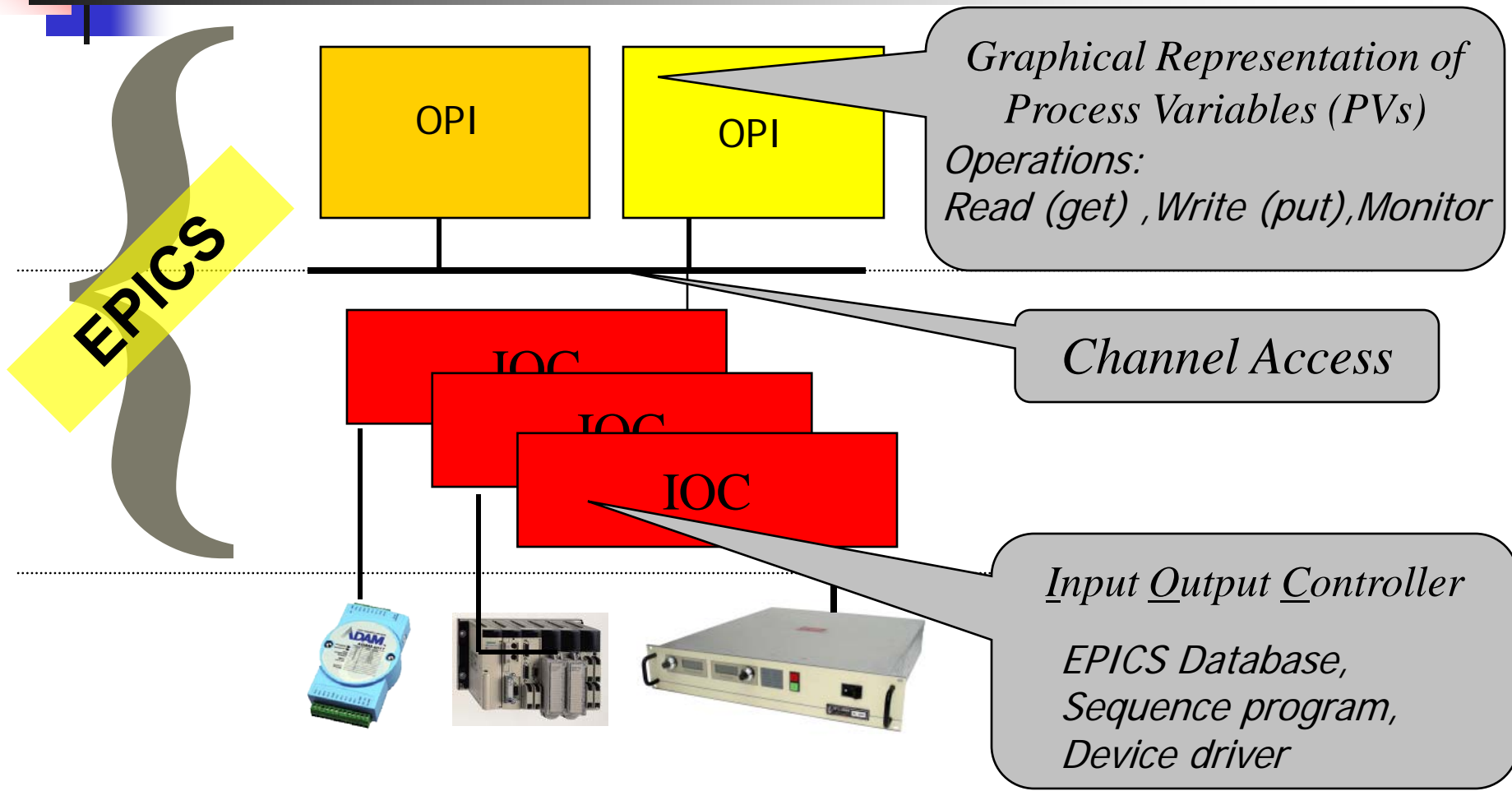
## What does it do?

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**Provides the functionality of almost any typical Distributed Control System (DCS)**

- **Remote Control & Monitoring of Technical Equipment**
- **Data Conversion/Filtering**
- **Closed Loop Control**
- **Access Security**
- **Alarm Detection/Reporting/Logging**
- **Data Trending/Archiving/Retrieval/Plotting**
- **Automatic Sequencing**
- **Modeling/Simulation**
- **Data Acquisition**
- **Data Analysis**

# EPICS Architecture





## Channel Access

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- Network Transparent software bus
- OPI don't need to know anything except PV name to communicate
- 3 Stage operations

Search using UDP Broadcast

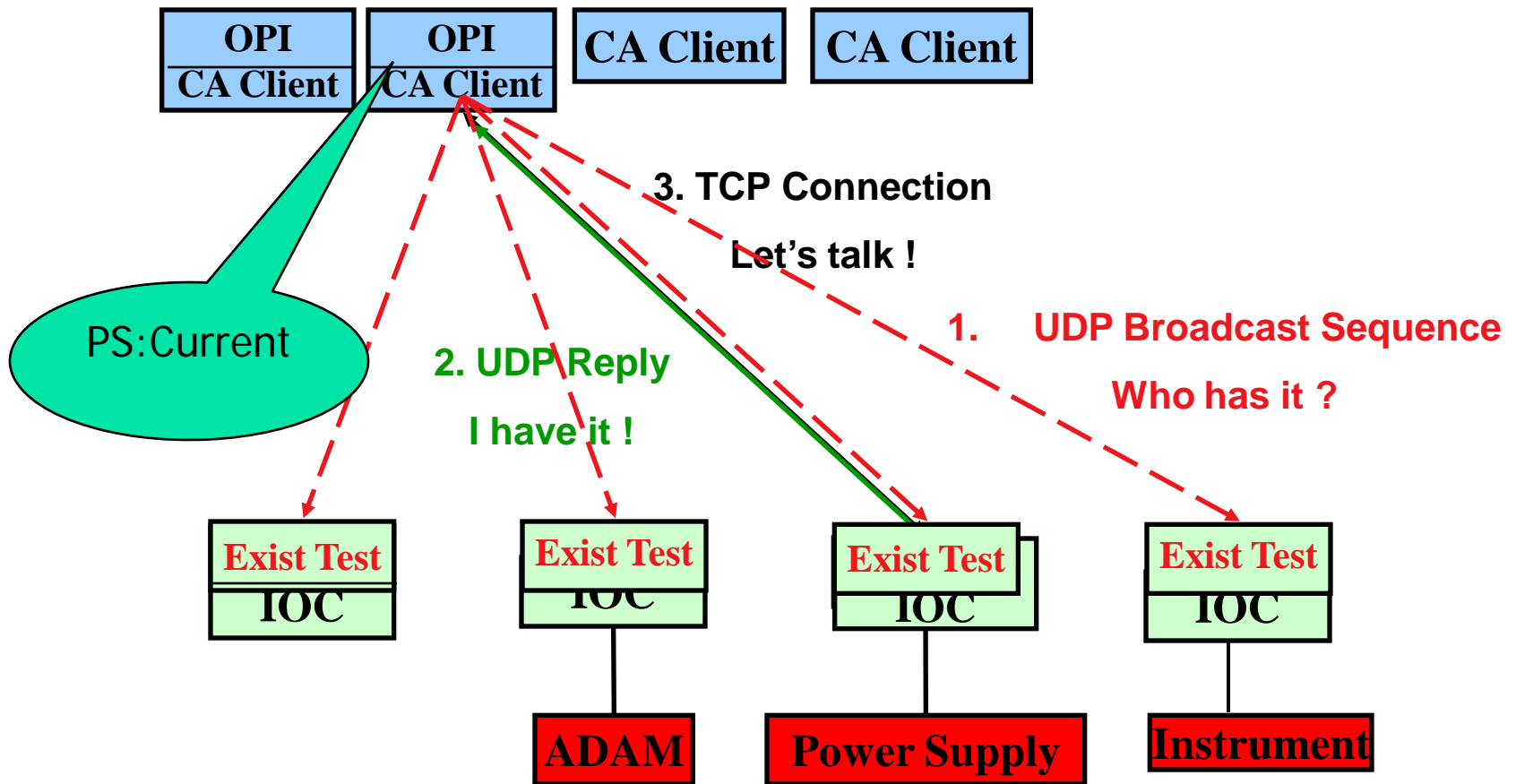
Confirmation by UDP

Talk (get, put monitor) via TCP



# Channel Access

## How it works?

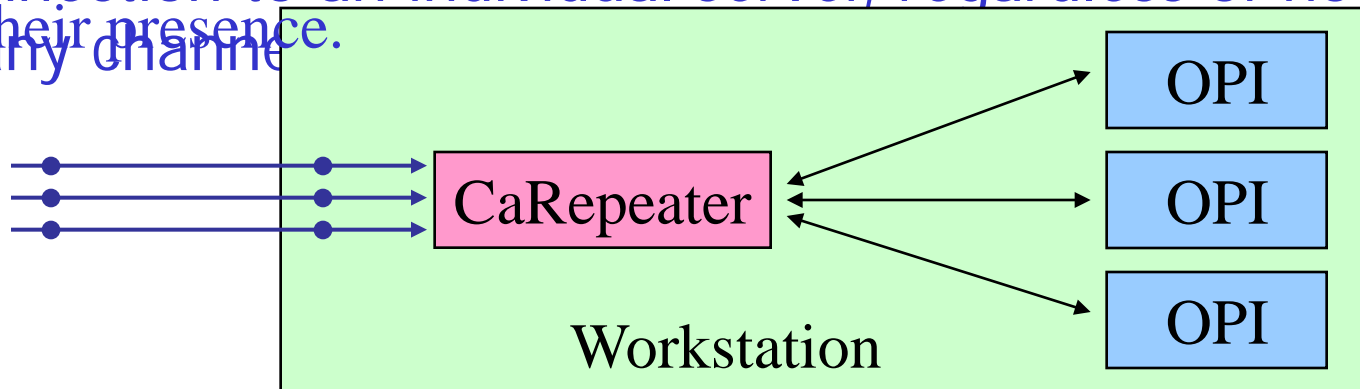


## More Channel Access Concepts

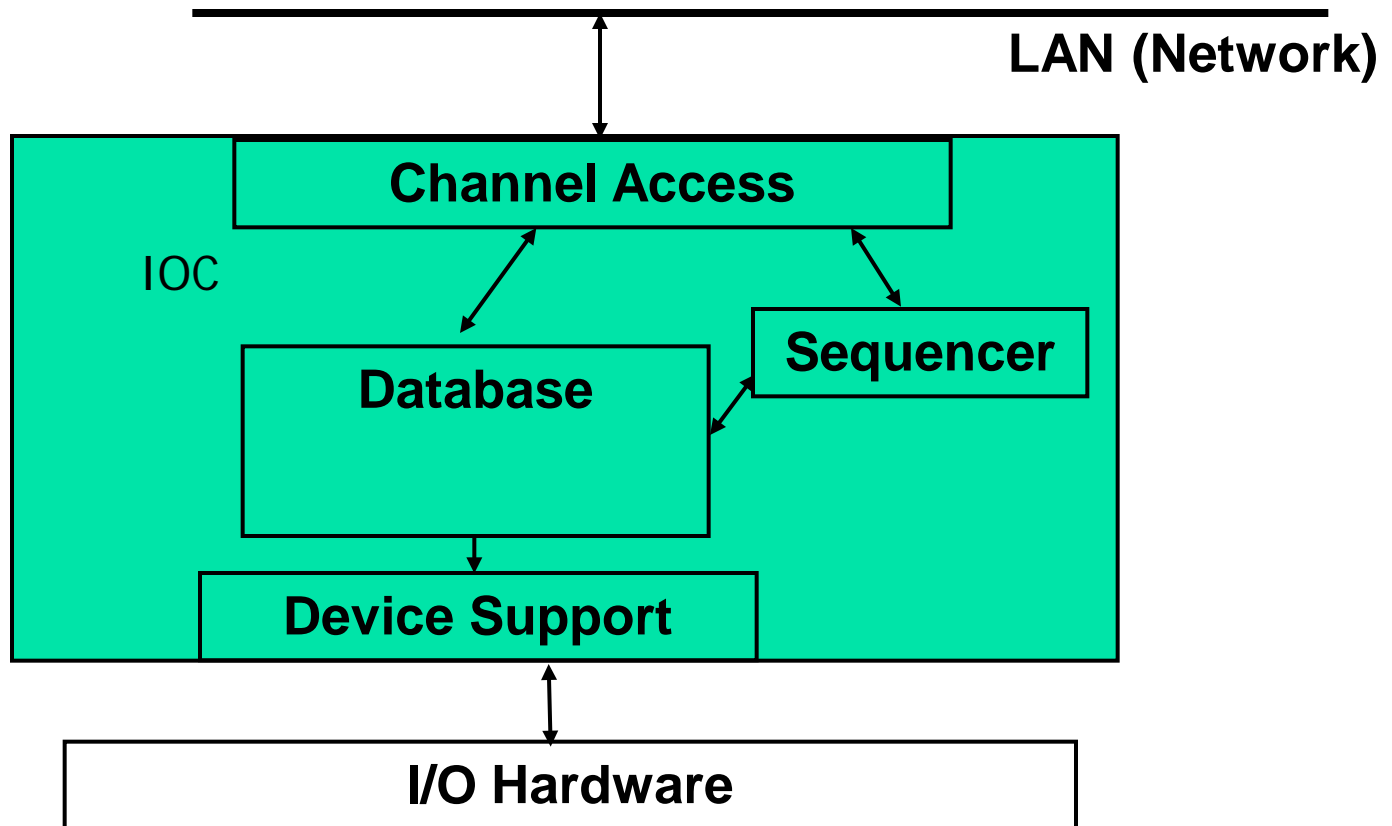
### Virtual CaRepeater

#### Server Beacons:

- Virtual circuits minimize number of TCP connections used between clients and servers
  - Server broadcasts are not guaranteed to go to every process on a workstation
- Each client will have exactly one active and open TCP connection to an individual server, regardless of how many channels
- Clients make a TCP connection to it when they start up
- These messages are sent out periodically to announce their presence.



# Input Output Controller (IOC)



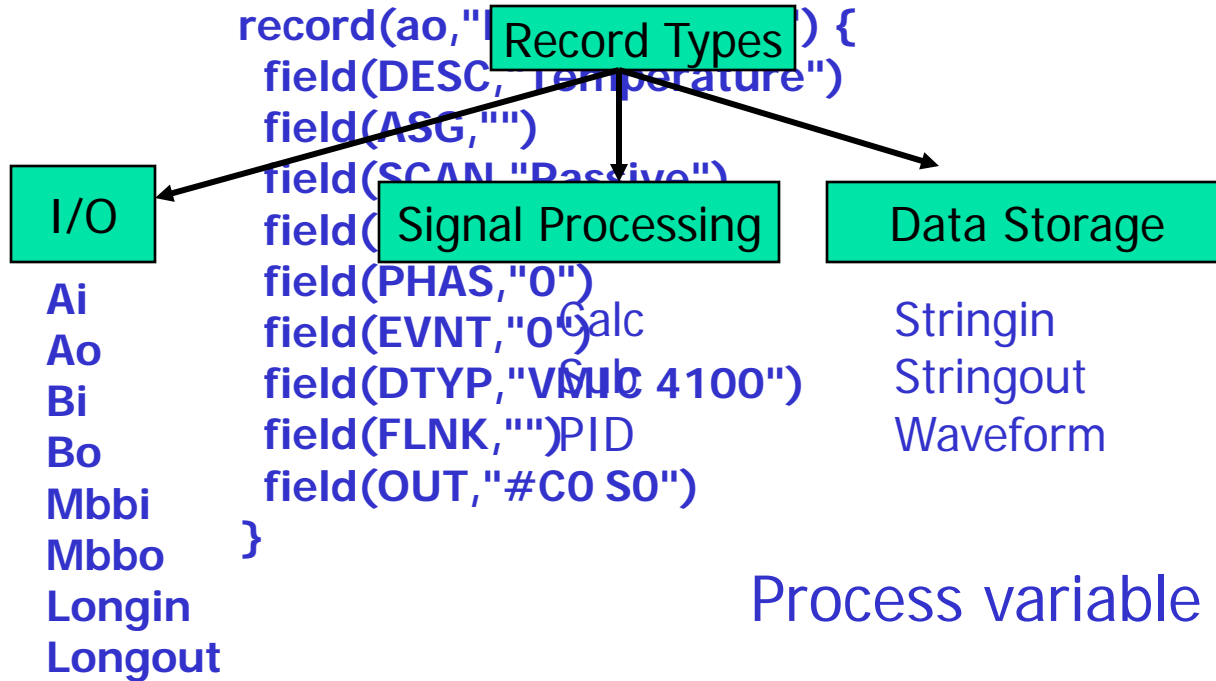


## EPICS Database

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- Collection of records
- Records are application-specific
- Memory-resident

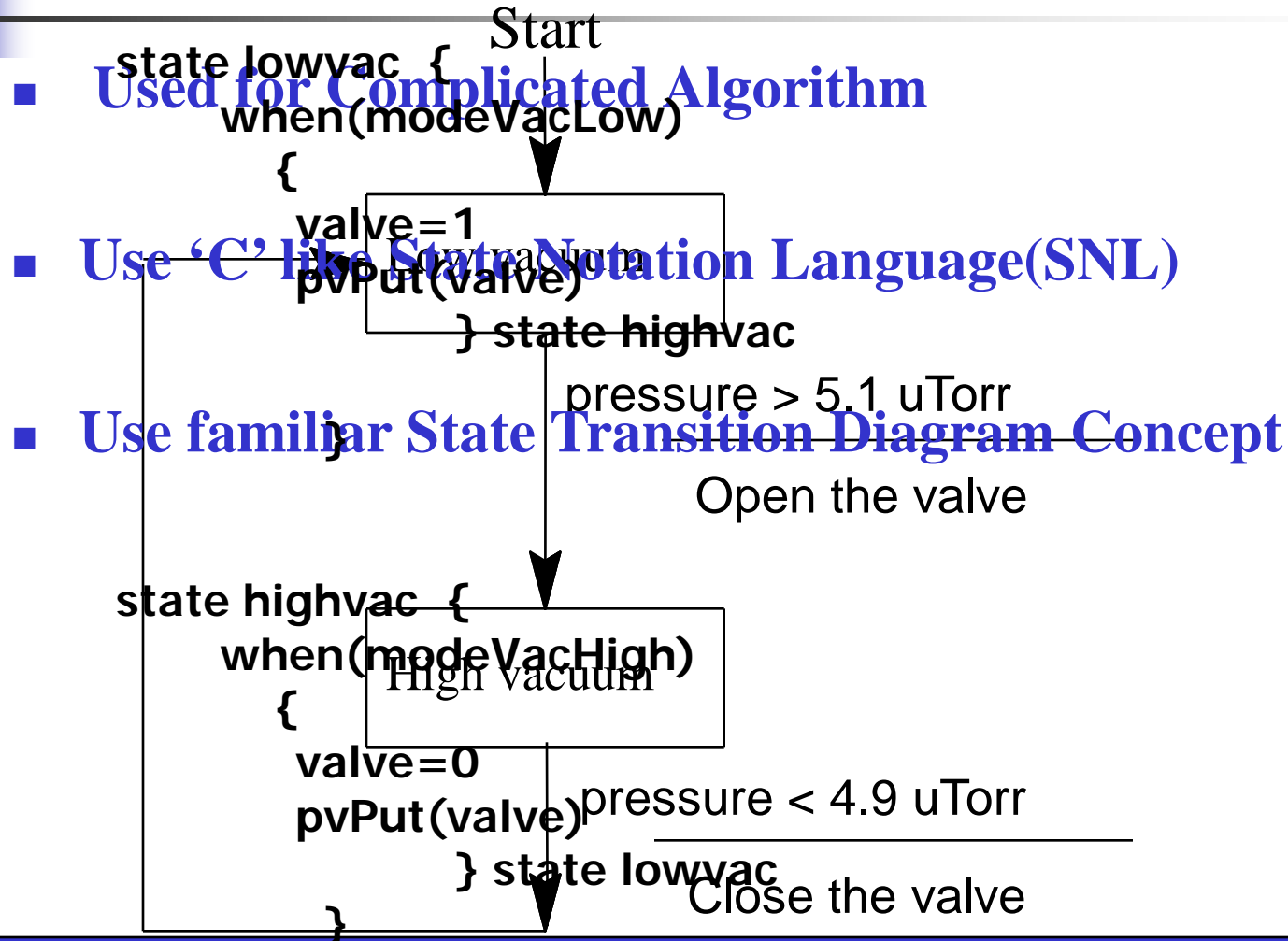
# EPICS Database



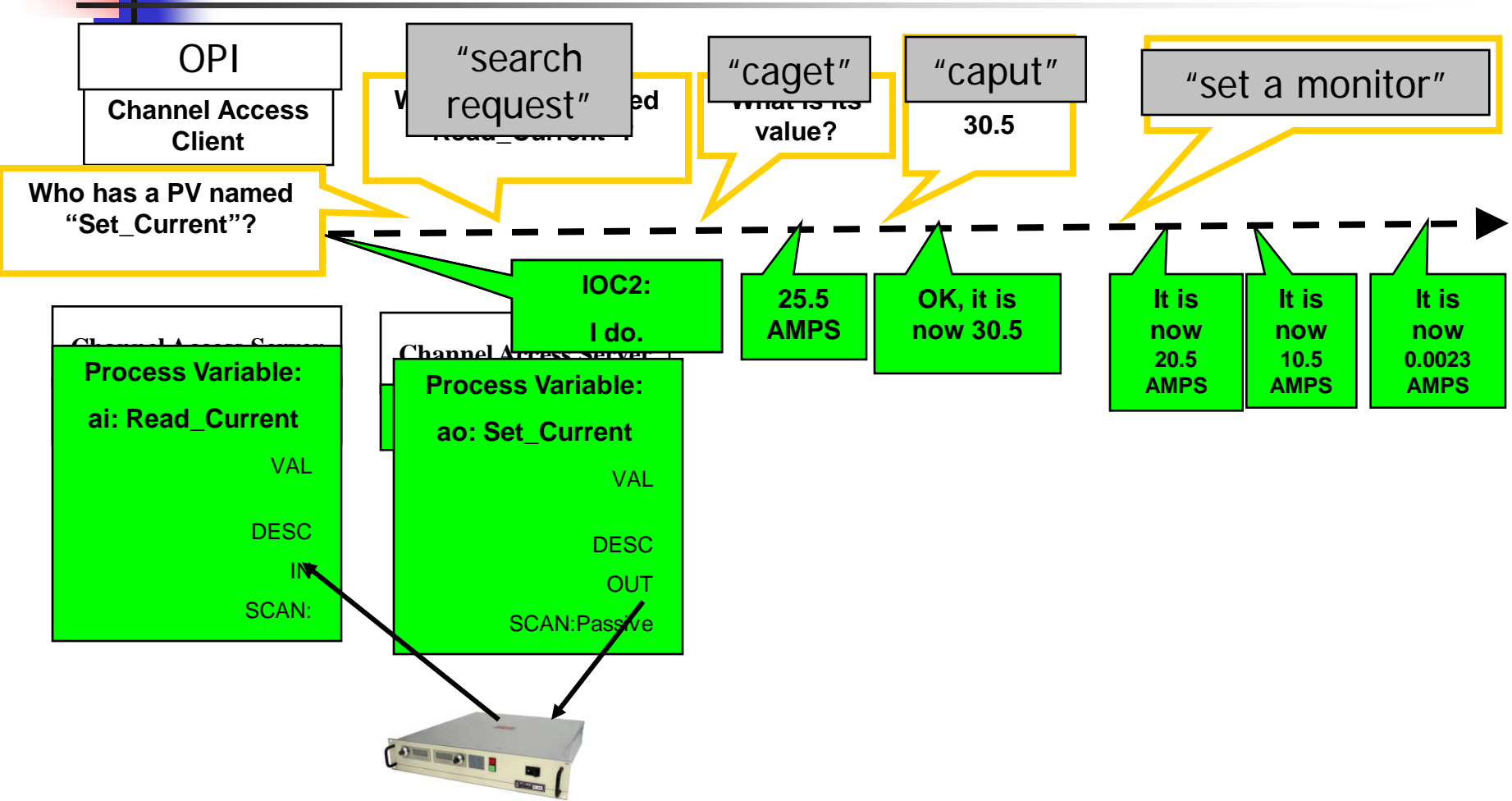
Process variable = record.Field

Example : DemandTemp.SCAN

## Sequence program



# Working principle of EPICS in a single slide



# How fast is EPICS?

- Can be fast or slow, it depends how you use it!

## Some Benchmarks\*

Machine	OS	CPU	Speed	Rec/sec	%CPU
MVME167	vxWork	68040	33MHz	3,000	25
MVME	vxWork	PPC604	300MHz	20,000	20
MVME510	vxWorks	PPC750	450MHz	100,000	25
PC	Linux	PII	233MHz	10,000	27
PC	Linux	P4	2.4GHz	100,000	18

- Have to use the correct tool for the job
- Ultimately speed depends upon hardware also
- Database design and periodic scanning effect *apparent* system speed

\* Extrapolated from benchmark figures courtesy of Steve Hunt (PSI) and L.Hoff, (BNL)





## Features of EPICS

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- It is free
- It is Open Source
- There is a lot of expertise available close by
- It is Portable to many OS-Processor architecture



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# EPICS Implementations

# Room Temperature Cyclotron: Power Supply Control

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- Total 39 Power Supplies.  
2 Ion Source; 16 Trim Coil; 1 main magnet; 20 beam line
- some of these require simultaneous operation
- Operation of each Power Supply

Setting Current/Voltage

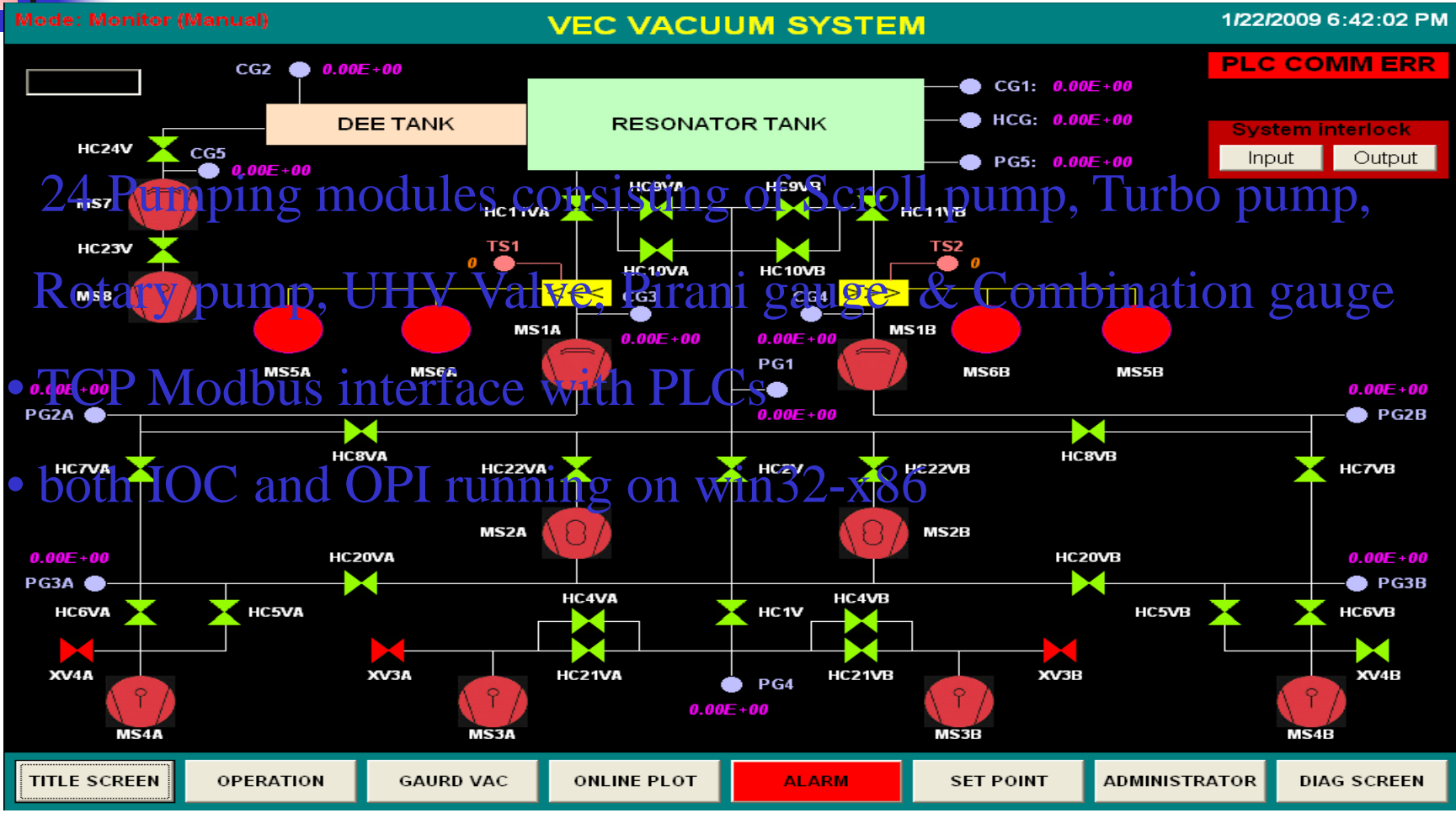
Reading Current/Voltage

Reading Interlock Status

On/Off Control



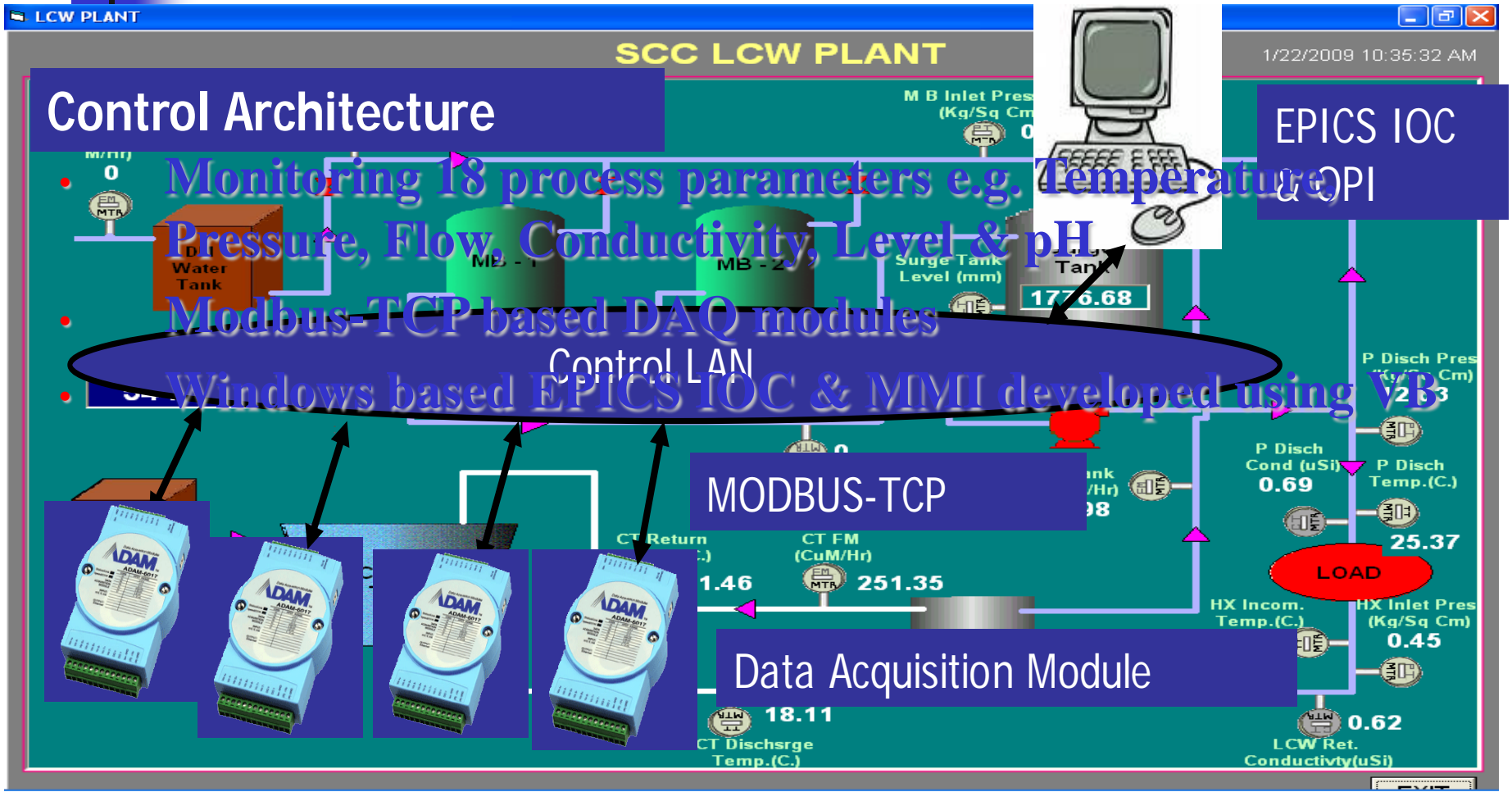
# Room Temperature Cyclotron Vacuum System



24 Pumping modules consisting of Scroll pump, Turbo pump, Rotary pump, UHV Valve, Pirani gauge & Combination gauge

- TCP Modbus interface with PLCs
- both IOC and OPI running on win32-x86

# Super Conducting Cyclotron LCW System



# Super Conducting Cyclotron Deflector Conditioning and Operation

**Deflector-E1** **High Voltage ON**

**IOC** **OPI**

**Control LAN**

**Discharge current decides the ramp up operation**

**Serial To Ethernet** **RS232** **RS232** **RS232**

**Dark Current Monitoring** **HV Power Supply(E1)** **HV Power Supply(E2)**

**Dark Current Limit(uA)**: 1.00  
**Voltage Limit(kV)**: 35.00  
**Ramp Volt/Rate**: 500  
**Ramp Rate**: 2 second

**Dark Current Limit(uA)**: 4.00  
**Voltage Limit(kV)**: 35.00  
**Ramp Volt/Rate**:  
**Ramp Rate**:

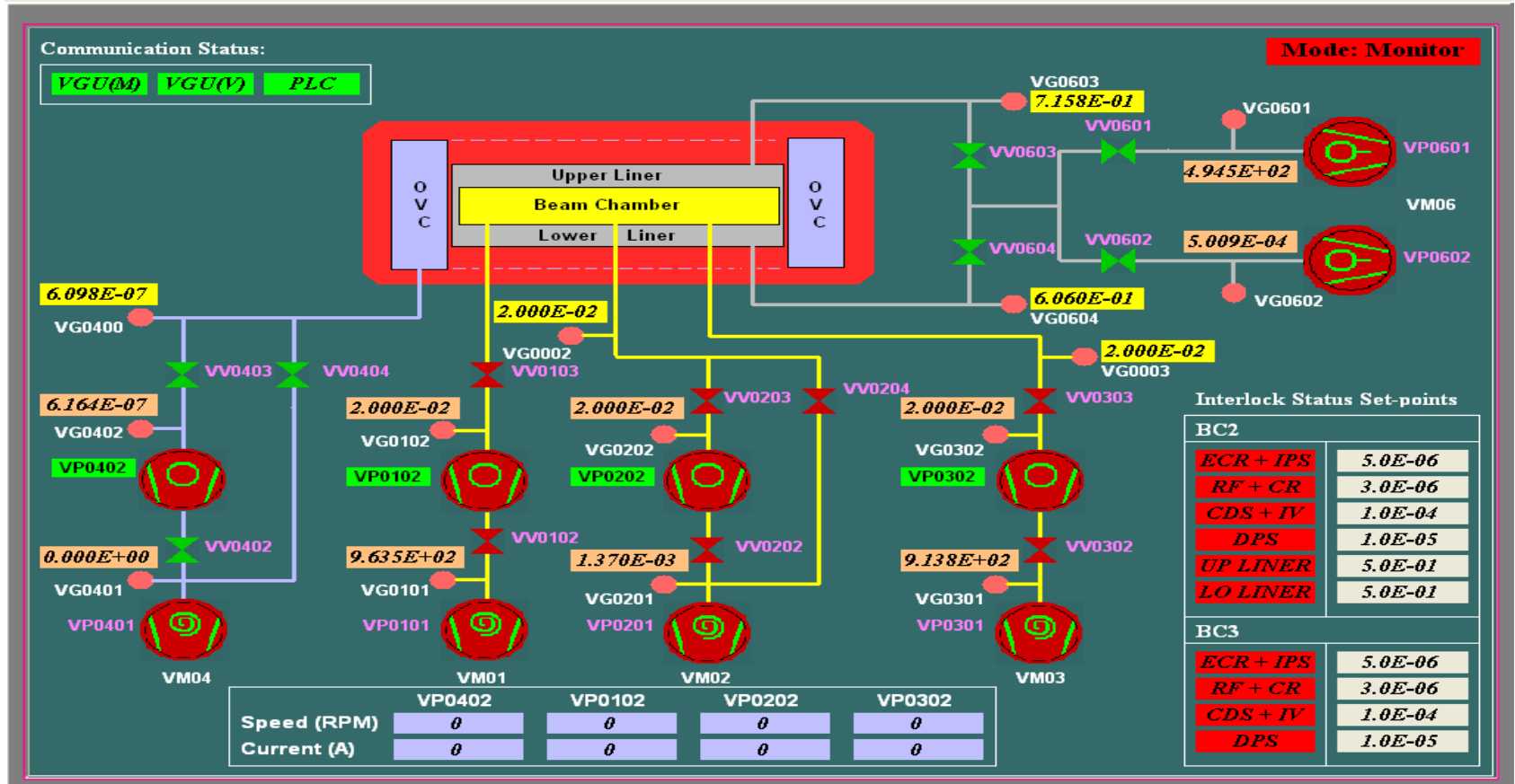
**E1-Voltage(kV)**: 34.57  
**E1-Current(uA)**: 0.00  
**-Dark Current(uA)**: 0.02

**E2-Voltage(kV)**: 34.67  
**E2-Current(uA)**: 0.67  
**E2-Dark Current(uA)**: 2.92

# Super Conducting Cyclotron Vacuum System

SCC MAIN MACHINE VACUUM SYSTEM (User: Engineer)

User Trend Back



# Super Conducting Cyclotron Cryogenic Plant Control System

Alarm Handler: CRYOGENIC\_PLANT\_ALARM

File Action View Setup Help

- CRYOGENIC\_PLANT\_ALARM <-----> (0,0,3,0,30)
  - PNEUMATIC\_AIR <----->
  - TURBINES <----->
  - FAULT <----->
  - STOP <----->
  - CHECK UPS STATUS <-----> (0,1,3,0,3)

WARM EXP OVER SPEED <----->  
COLD EXP OVER SPEED <----->  
WARM EXP BRAKE HIGH TEMP <----->  
COLD EXP BRAKE HIGH TEMP <----->  
WARM EXP INTERSTITIAL PR HIGH <----->  
COLD EXP INTERSTITIAL PR HIGH <----->  
WARM EXP BEARING TEMP TOO LOW <----->  
COLD EXP BEARING TEMP TOO LOW <----->  
WARM EXP ZERO SPEED <----->  
COLD EXP ZERO SPEED <----->  
COLD EXP OUT PR TOO HIGH <----->  
HIGH PR TOO HIGH <----->  
LOW PR SUPPLY TOO LOW <----->  
LOW PR TOO LOW <----->  
DEVAIR TOO HIGH <----->  
SUPPLY POWER FAULT <----->  
INSTRUMENT AIR FAULT <----->  
COLD WATER FAULT <----->  
PURIFIER FAULT <----->

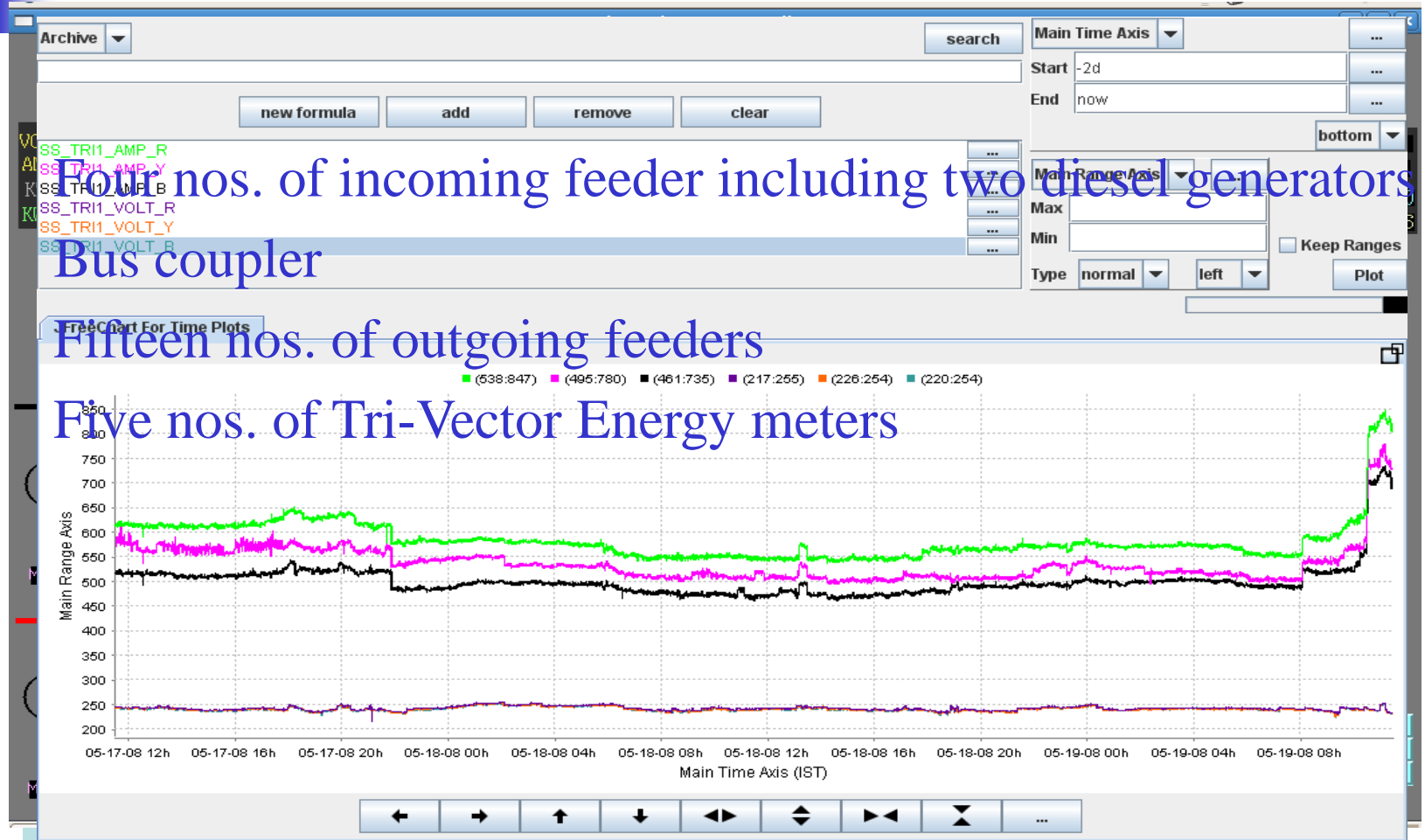
by curio (Status: Local Active)  SilenceOneHour  
Mask <CDATL>: <Cancel,Disable,noAck,noackT,noLog> n=noAck 1hr timer  SilenceCurrent  
Group Alarm Counts: (ERROR,INVALID,MAJOR,MINOR,NOALARM) Silence Forever: Off  
Channel Alarm Data: <Status,Severity>,<Unack Severity> ALH Beep Severity: MAJOR  
Filename: /home/user/epics/alarms/cryogenic.alhConfig

- Helium Liquefier- Refrigerator of 250W @ 4.5K refrigeration capacity for Superconducting Cyclotron
- 16500 litres Liquid nitrogen storage and distributions for Superconducting Cyclotron
- Gas management systems like compressors, gas bags and buffer tanks
- Pneumatic and chilled water systems for the above
- over 500 field input outputs



# Super Conducting Cyclotron Substation

- Four nos. of incoming feeder including two diesel generators
- Bus coupler
- Fifteen nos. of outgoing feeders
- Five nos. of Tri-Vector Energy meters





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## Acknowledgement:

Dr. Debranjana Sarkar

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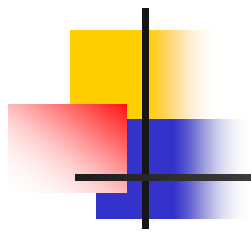
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Shri Anirban De

Shri Umashankar Panda

Shri Niraj Chaddha



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Thank You