Control System for BARC-TIFR Pelletron

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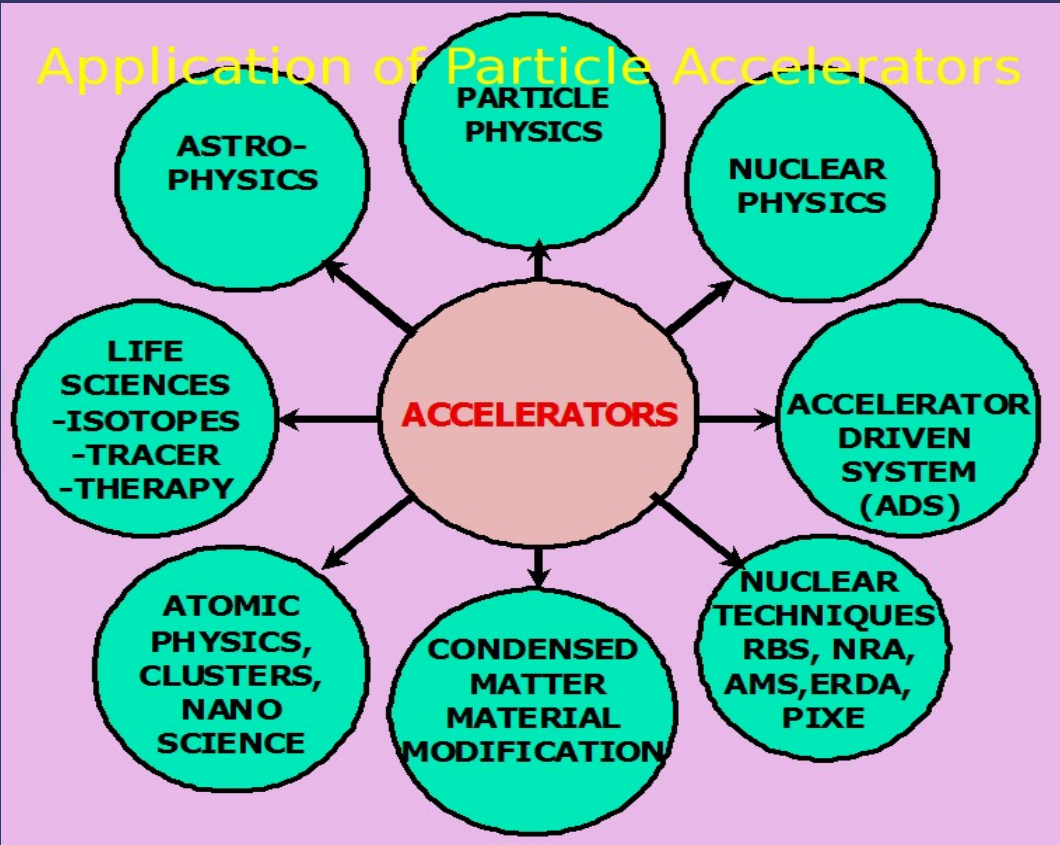
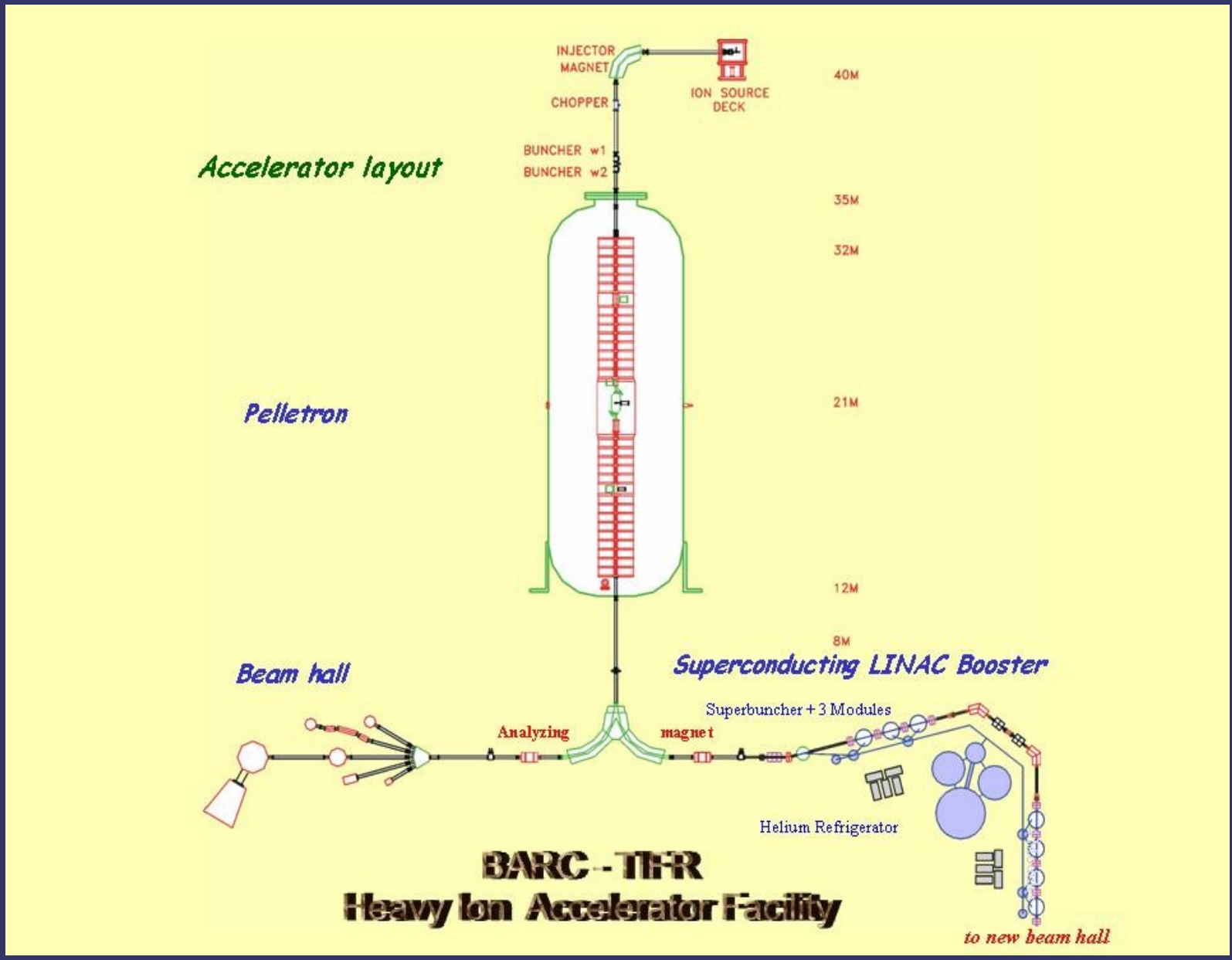
PCaPAC 2012, VECC Kolkata , India

Particle Accelerator

- Device that accelerates a beam of fast-moving, electrically charged atoms (ions) or subatomic particles.



BARC-TIFR PLF



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Control System and Data-acquisition System

Sensors > convert physical parameters to electrical signals.

Signal conditioning Electronics>sensor signals into a form to be converted to digital

ADC> signals to digital values.

- Both DAQ and Control system will have data acq and control
- In Data acquisition system we need to set the detector biasing and other setting requiring control (Static)
  Acquired data need to be stored for future analysis
  Large data buffering and fast transfer is required
  EX: LAMPS(CC2000,FERA, ECC), PHAST (MCA)
- In control system control is always dynamic
  acquired data is mostly of interest at the time
  Data can be stored for machine diagnostics and history/trend

Accelerator Control System

- Control system couples the operator to the accelerator.
- The Control System has to suit the plant not the reverse.
- The structure of the control system should reflects that of the plant.
- Ideally, each unit of the plant should have its own controller, interacting with the controllers of the other, related units, mirroring their physical interaction.

Demands of Accelerator Control System

- Remote Control
- On-line Monitoring and Control
- Audio Visual Alarm
- Interlock for machine protection
- Multiple Operator Consoles
- Reliable,Integration,expandable,Configurable
- On line machine configuration
- Different modes of operation(Normal,Diagnostics & Commissioning)

Scope

- Sensors and actuators
- Instrument controllers(Intelligent, Simple)
- Front End Instrumentation
(CAMAC,VME,PXI,PCI,cPCI)
- Digitzation units ADC,DAC,DI/O,Special purpose units
- Operator front end units (CRO,PC graphics, Panel Meters, Knobs, Buttons)

Scope

- Field Bus (Fieldbus is a generic-term which describes a new digital communications network which will be used in industry to replace the existing 4 - 20mA analogue signal.)
  Profi-Bus,serial Highway,RS232/422/485
  Current loops,SIB,Ethernet
- Communication Bus
  Ethernet,Telephone lines,W-lan
- Messaging Protocol/Middlelayers
  OPC,MOD-BUS,RPC,CORBA,Proprietorial
- Communication Protocol
  TCP/IP,Proprietorial
- Software Environment
  OS,Programming Language,Tools

Architecture of Control System
System Architecture

Starting from monolithic (Single layer) architecture the control system has matured to multilayer architecture. multilayer model can be further classified as centralized and distributed architecture. Monolithic architecture can fit itself only in centralized architecture of control system.

- Centralized
- Distributed
  - Geographical
  - Functional
  - Systematic
  - Mixed

Both are having different merits

Centralized:

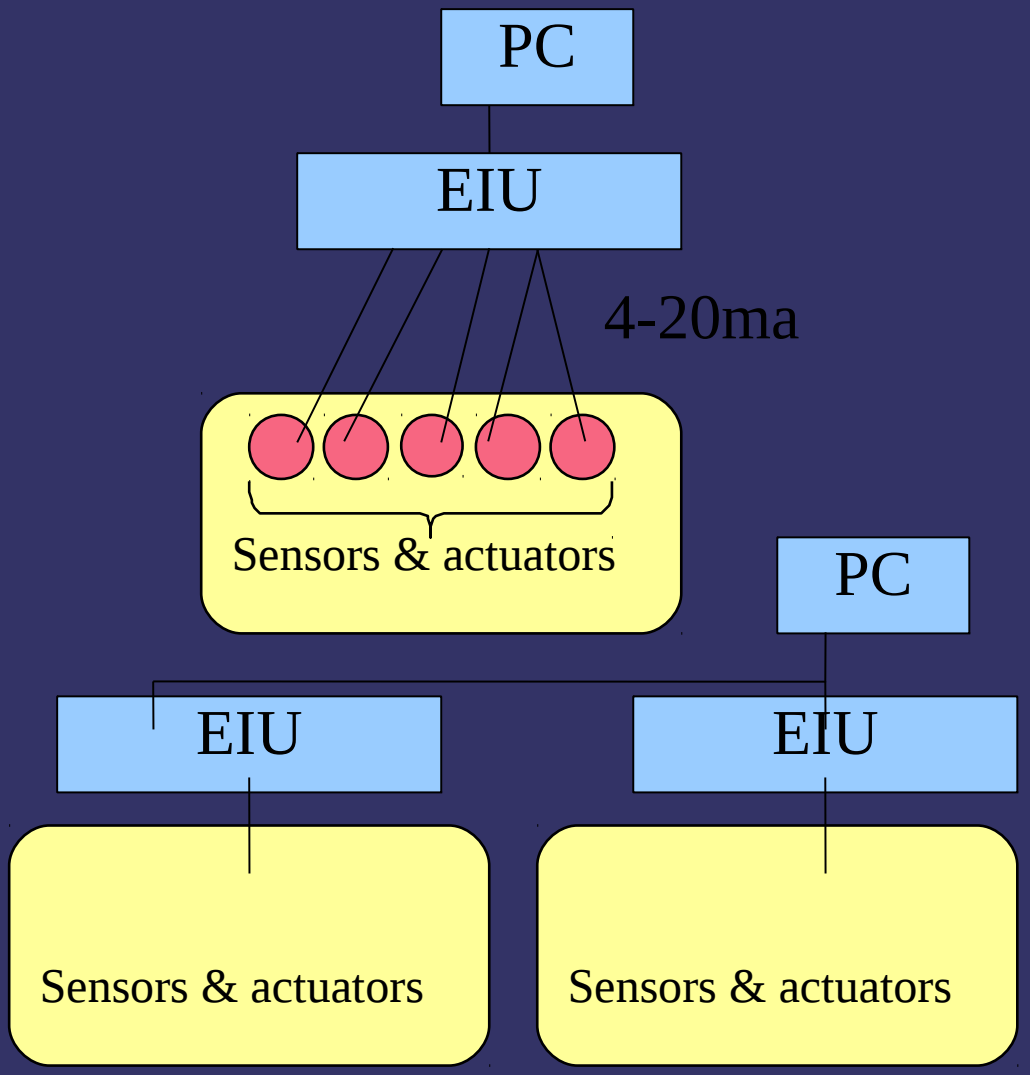
- Simple system
- Easy to meet different Constraints
- Difficult to realize for a developing system
- Reliability can be achieved by putting Standby system

Distributed:

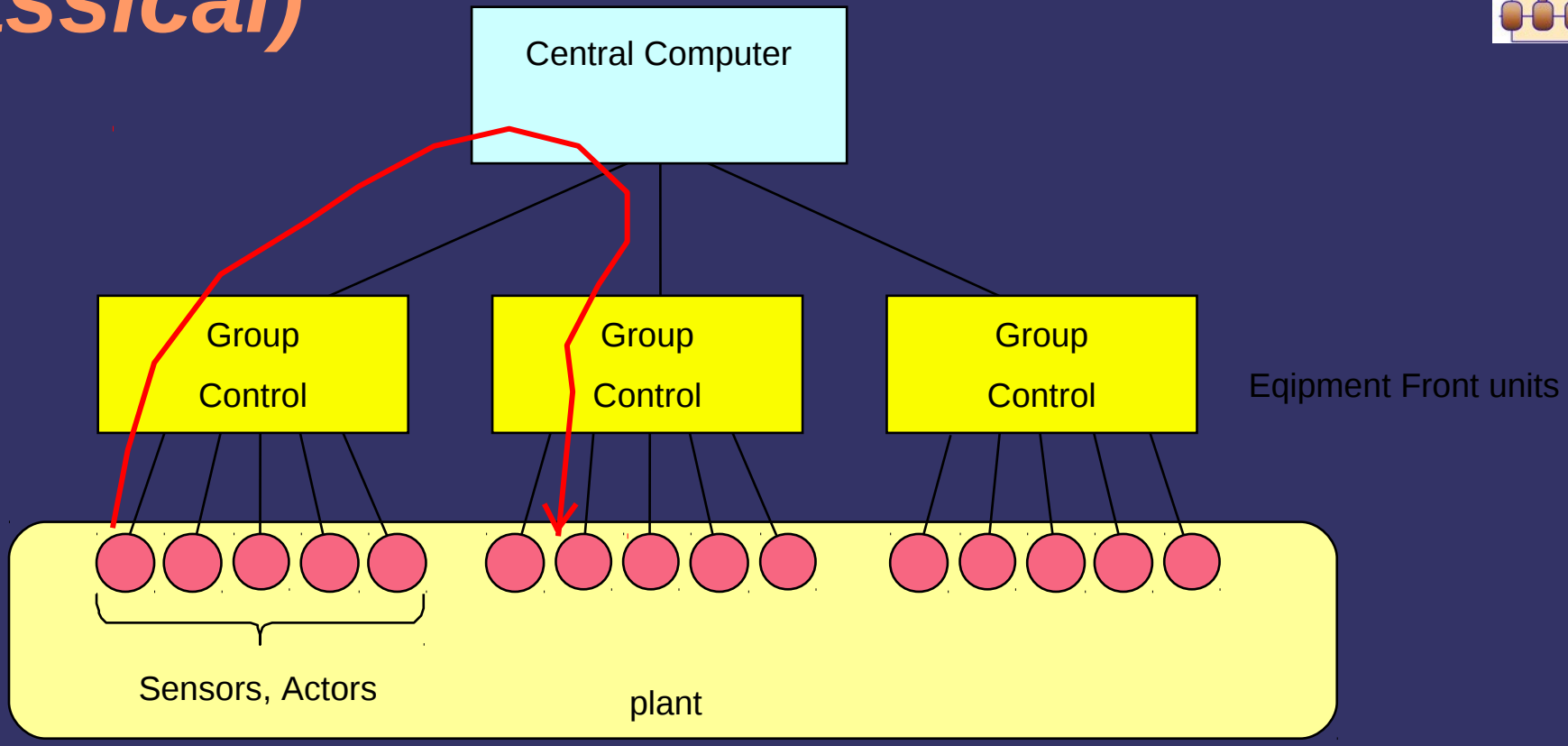
- More nearer to Real life domain
- Highly suitable for developing Machines (Extensibility)
- Inherent reliability is incorporated

Monolithic Architecture

- Processing, data and the user interface all reside on the same system as a part of single software program.
- monolithic system are unsuitable to manage the complexity in the system as any mistake done to handle will put the whole system down it is always easier to handle complexity at small level.
- As the operator interface is also an integrated part of the system , it is directly exposed to the operator and any mistake will jam the whole system.
- unsuitable for incremental development during machine commissioning and installation phase as well as up gradation of either machine or control system itself.
- Difficult to add new features to the system



Centralized Control Architecture (classical)



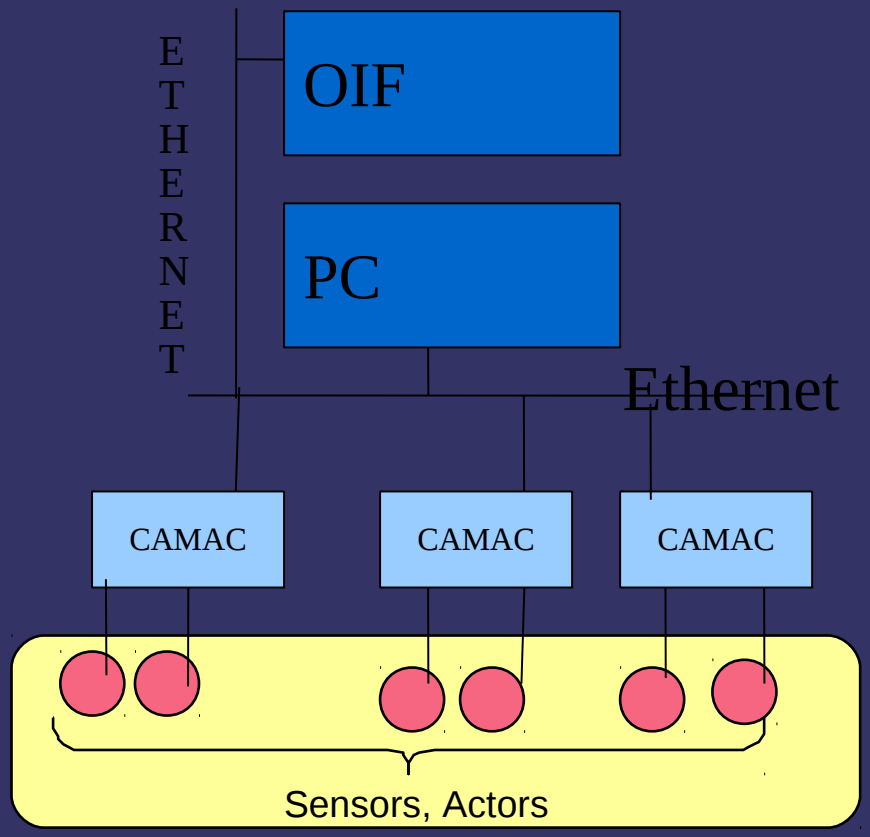
Classical, hierarchical, centralized architecture.

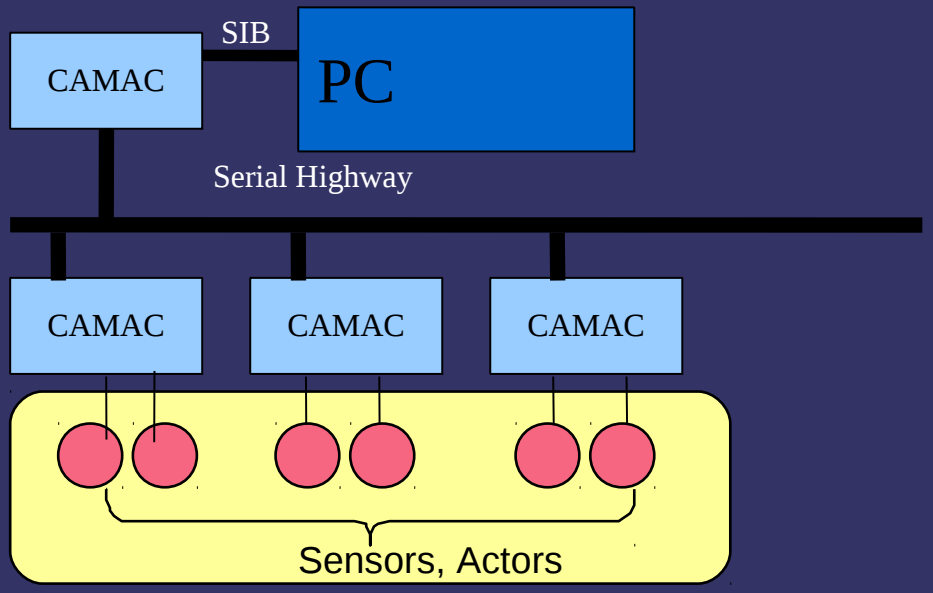
The central computer only monitors and forwards commands to the EFU's

PELLETRON
Control System Architecture
(Centralized)

- Now

Before





Multilayer architecture

Operator Interface (PC running on Linux or MS Windows)

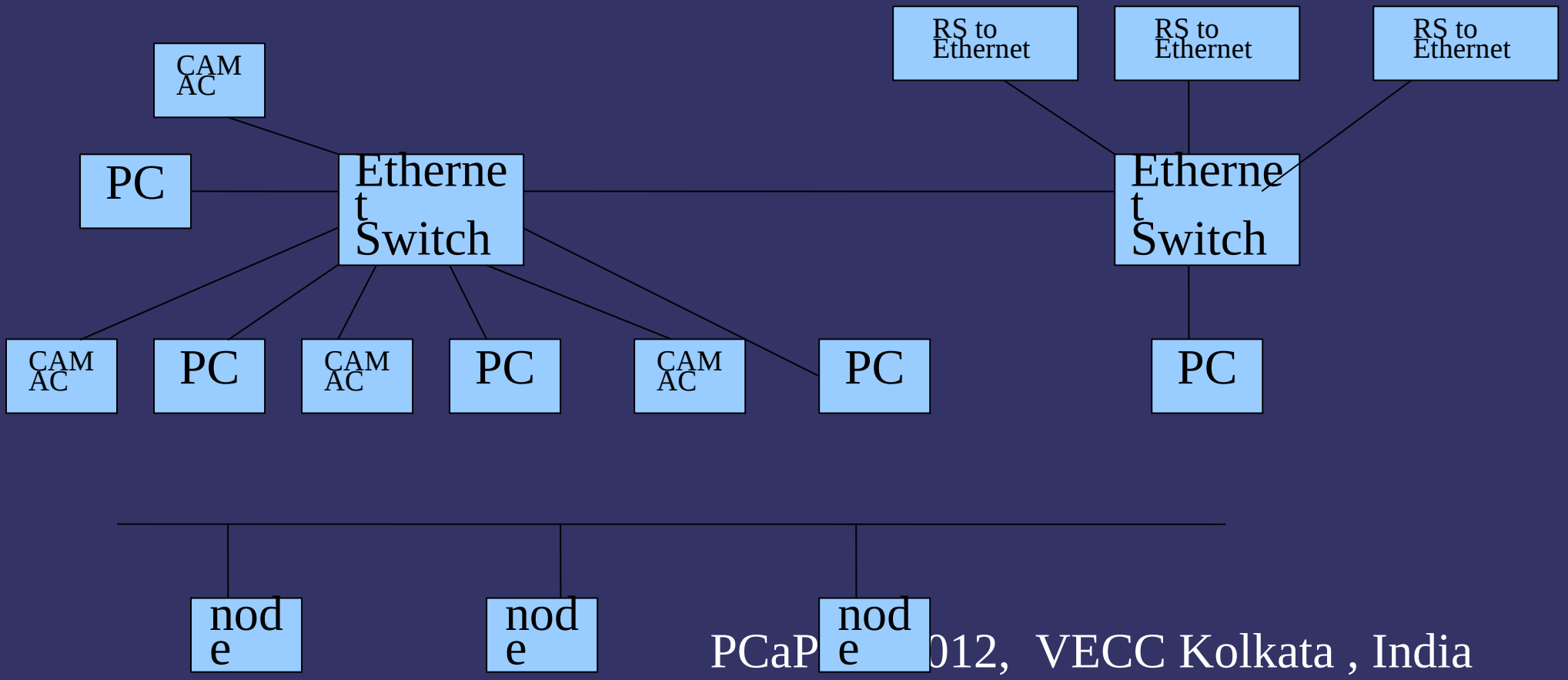
Device control Unit (PC running on Linux)

Equipment interface Unit (CAMAC with ECC)

With ADCs, DACs, DI/DOs

Control System Communication Architecture

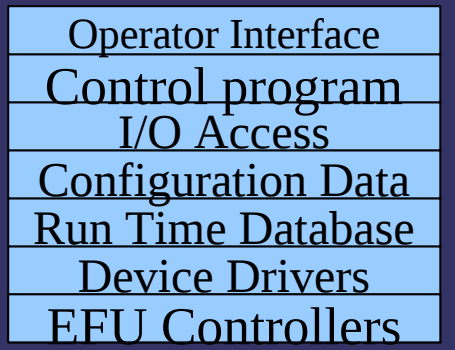
- Standard Control Model is a communication oriented System
- Ethernet can be made more suitable

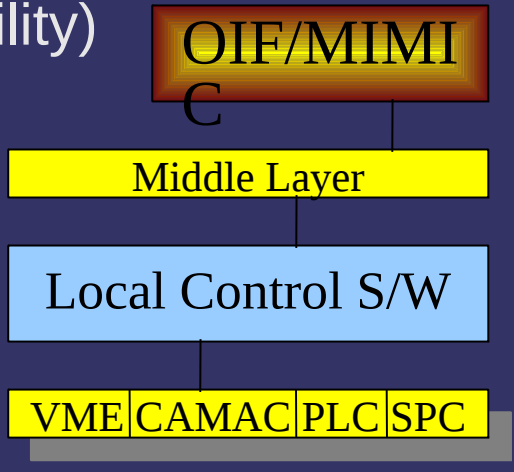


Software Architecture

Common Goals
Portability
Extensibility
Proper Engineering Practices Suitable for R&D Programs

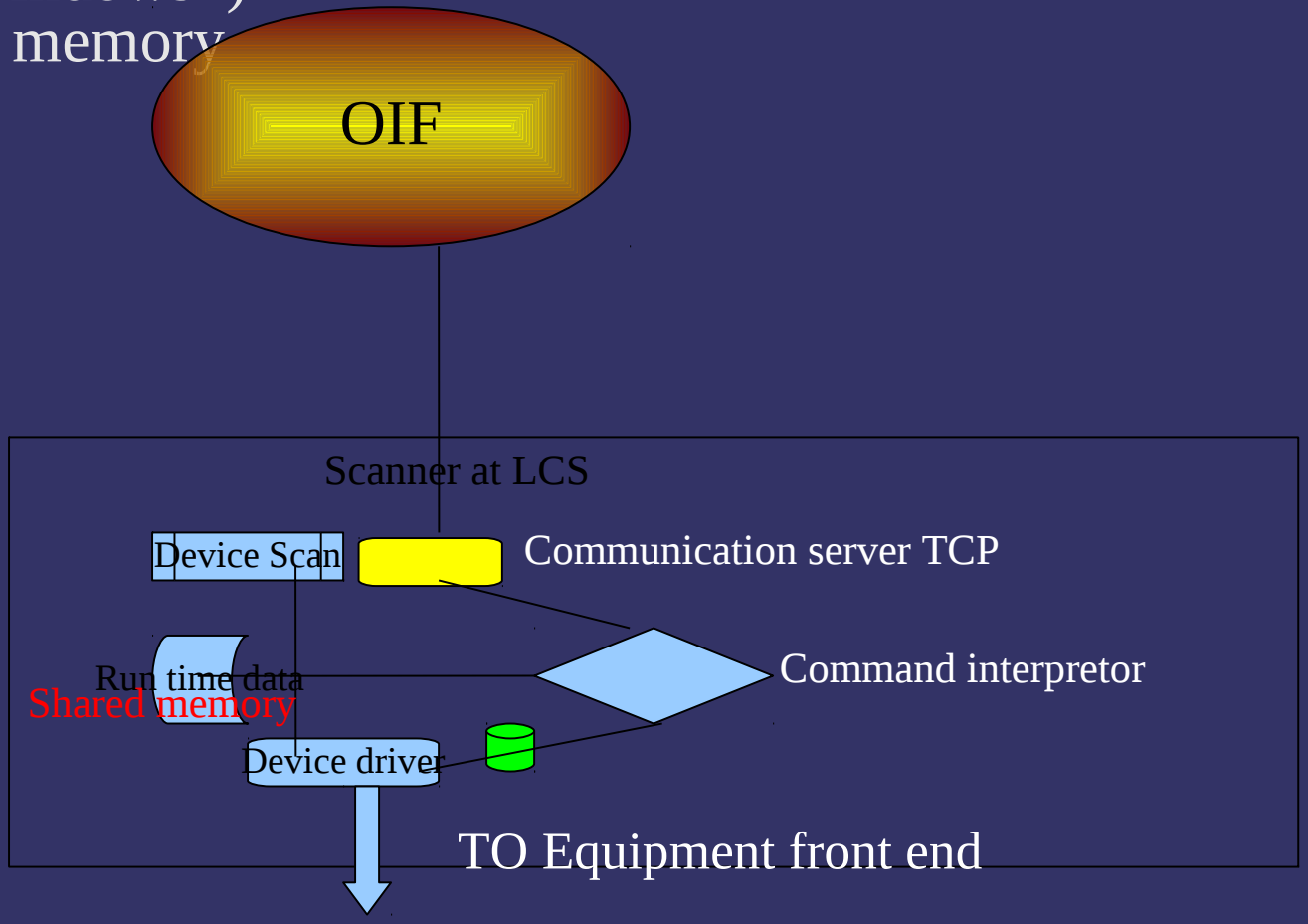
- Single layer (Single s/w program)
  +Inherently fast response time
  +Simple to develop
  -Difficult to handle complexity
  -Difficult to meet reliability & Fault Tolerant
  -Difficult to provide multiple consoles
- Multiple layer (Multiple s/w Programs)
  Hierarichal Control Software
- +Variety of controllers can be selected(Extensibility)
- +OIF/MMIC is independent of lower layer
- +Easy to handle the complexity
- +Incremental Development
- +Reliable and Fault Tolerant
- +Multiple Console and Expandability
- -Requires Specialized Development Team

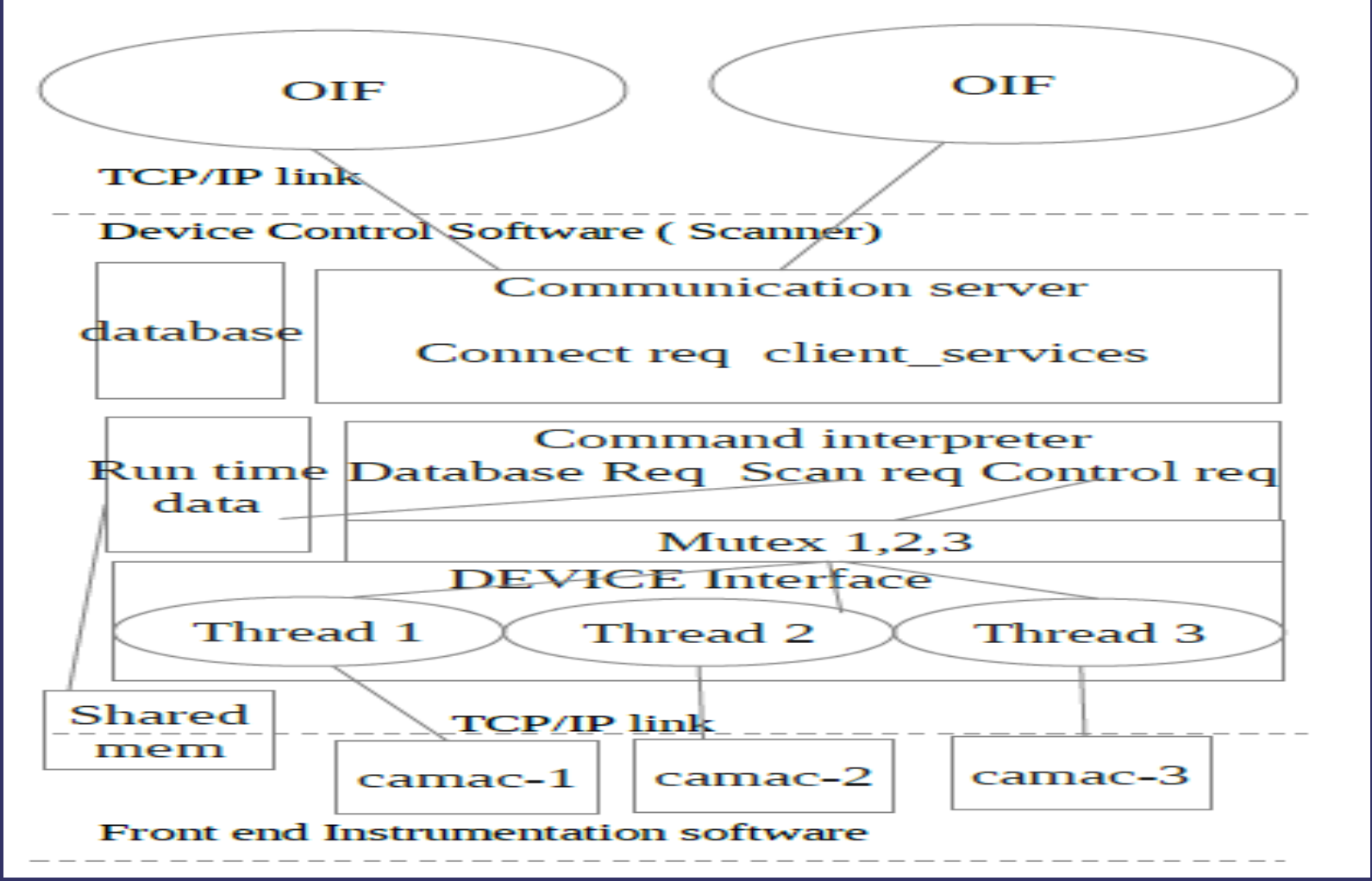




Software Architecture
PELLETTRON

- Multi layer Control s/w (scanner,OIF)
- Equipment Interface Unit :Scanner (LINUX based)
- Opertaor Interface unit OIF (Source code portable on LINUX ,MS-windows)
- d memory




OIF
OIF
TCP/IP link
Device Control Software (Scanner)
database
Communication server
Connect req client_services
Run time data
Command interpreter
Database Req Scan req Control req
Mutex 1,2,3
DEVICE Interface
Thread 1
Thread 2
Thread 3
Shared mem
TCP/IP link
camac-1
camac-2
camac-3
Front end Instrumentation software

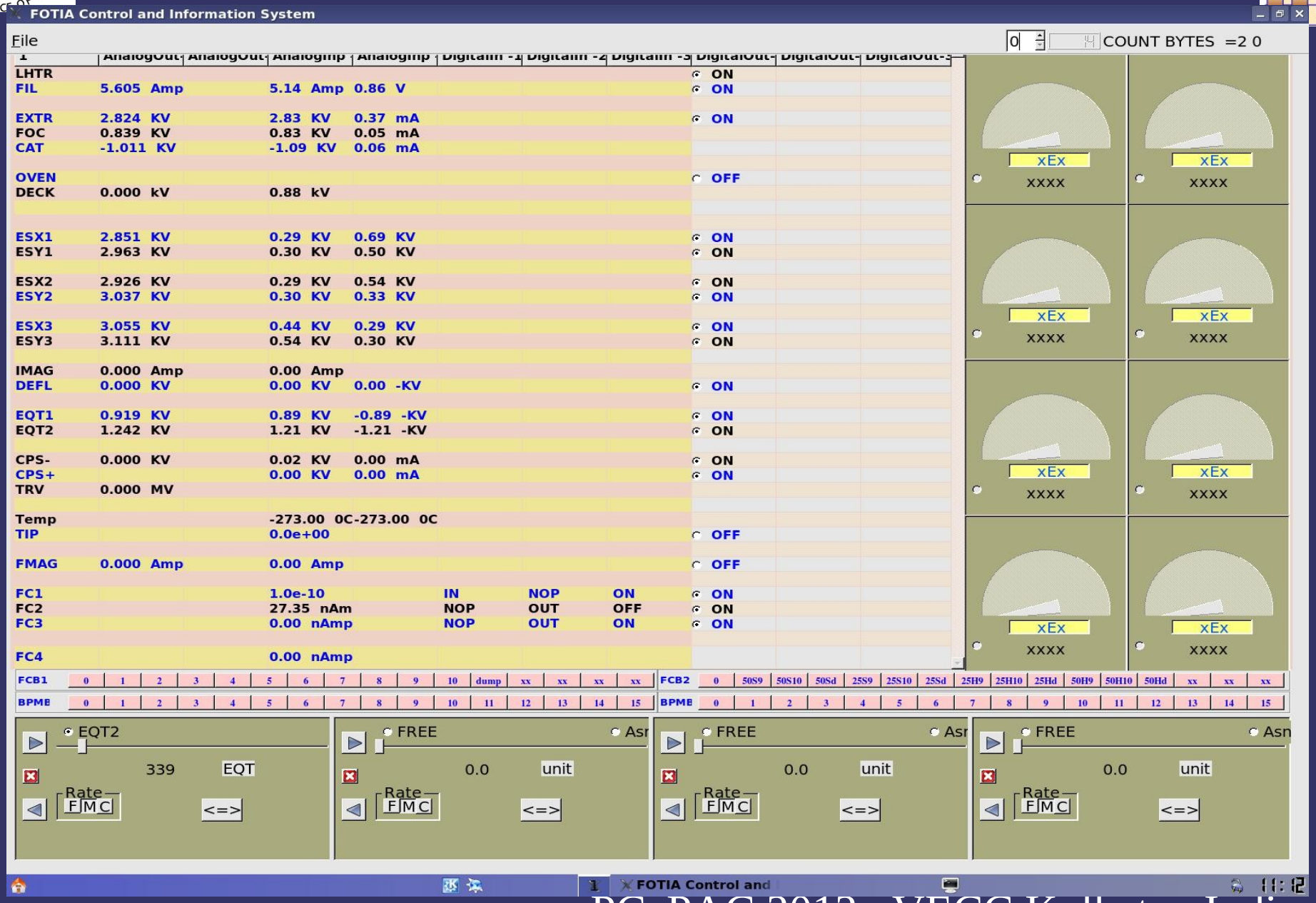
CONTROL Software

- Database Driven System
- Front End Instrumentation unit (QNX RTOS) Runs on ECC
- Device control unit software is POSIX standard Multithreaded software runs on Linux. Is three layer architecture
  Device Interface layer
  Command interperator Layer
  Communication Layer
- Shared memory is used as persistent memory bock

LINUX For Control System

- From long Linux has been in the wishlist for control system
- Security (less prone to virus and malwares
- Stability and Reliability
- Open source and less cost\
- Wide applicability from servers to tiny embedded systems and realtime applications
- Availability of development tools

Pelletron MIMIC



Features

- Configurable pages from database
- Named Pages
- Assignable multi function sliders for analog out control.
- Multiple ways of interaction using mouse and keyboards
- Assignable meters for analog read backs

- Developed in Trolltech's QT 4 which is source code portable on MS windows and linux

PORTABLE API QT

- C++ Based Source code portable API
- Windows, MAC, LINUX/X11/SOLARIS ,EMBEDDED LINUX,QNX,VxWorks
- SIGNALS and SLOTS
- High runtime performance and small footprint
- Gdb and CDB debugger
- Qt Creator IDE can be embedded with Kdevloper and Visual studio
- Version control
- Integrated UI builder
- Epics qt framework (http://sourceforge.net/projects/epicsqt)
- qt.digia.com

SCADA Systems

- Many SCADA systems are available (PVSS, WINCC, PROFICY)
- Unsuitable for accelerators
- EPICS (Experimental Physics and Industrial Control Control System SCADA)
  ANL LANL, ORNL (SNS), SLAC , JLAB (CEBAF), DESY, BESSY,PSI, KEK
  It's free & Open Source
  -The computer can be: - VME based, running vxWorks (only choice until Release 3.14) or RTEMS)
  - PC running Windows, Linux, RTEMS
  - Apple running OSX
  - UNIX Workstation running Solaris

Conclusions & Future Scope

- Are there chances for standardization of control system interface, hardware solutions?
- Would enhance software sharing, reduce resources needed to build the basic system and perhaps result in better solutions
- Specific applications and needs that cannot be standardized will always arise
- Every accelerator has a different flavour
- The tasks are common, the solutions resemble (but are still different)
- Move towards automated tuning
- Use of expert system & A I techniques for better life
- Incorporation of new Technologies (use of cellphones)

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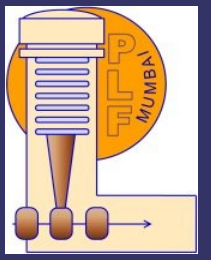
- DR S Kailash Director Physics Group


राष्ट्र की सेवा में परमाणु
BARC
ATOMS IN THE SERVICE OF THE NATION


PLF
MUMBAI

Thank you