SESAME's Control System Status

Fall 2014 EPICS Collaboration meeting
22/10/2014

Presented by:

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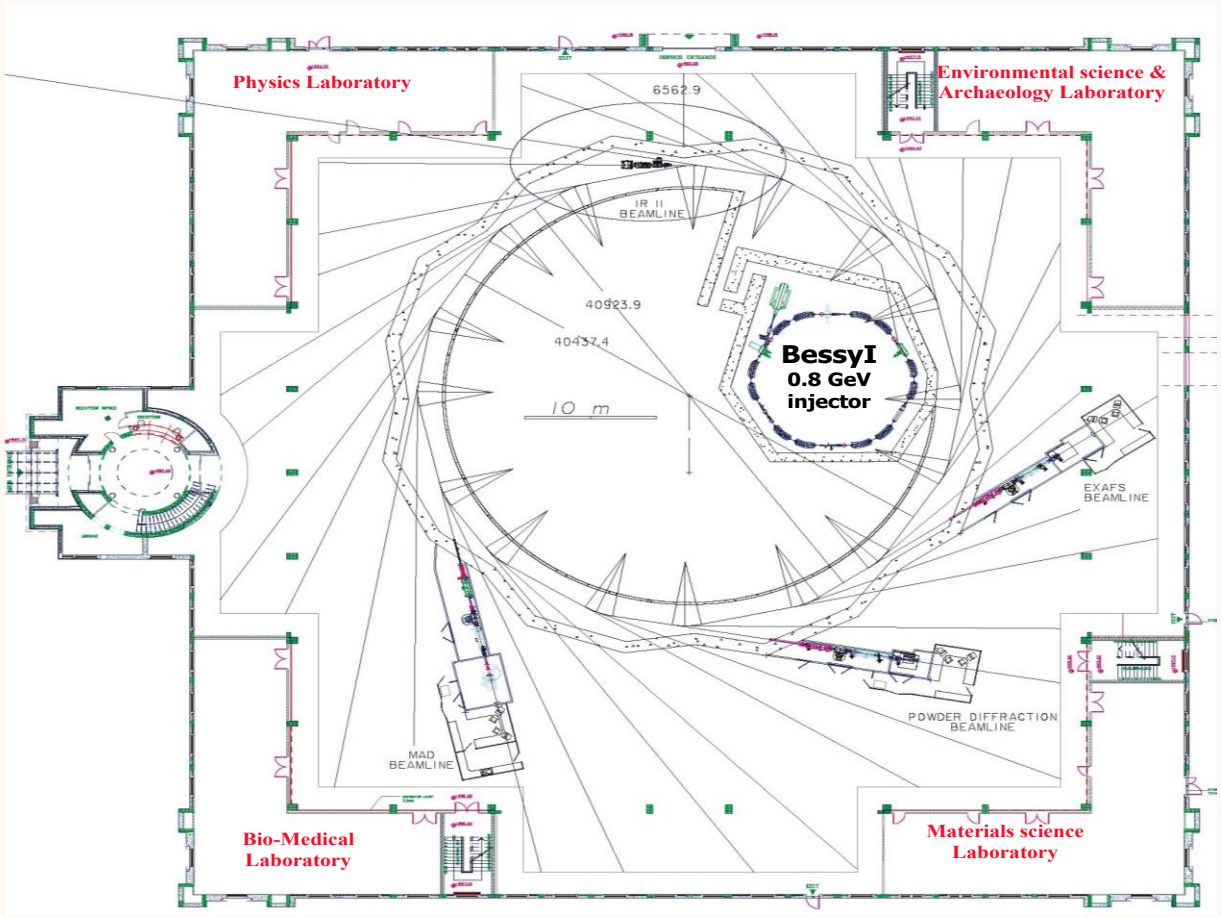
What is SESAME?

- SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East)
- First international 3rd generation Synchrotron Light Source in the Middle East region
- Under construction near Amman (Jordan)
- Expected to become operational in 2016

SESAME-Members:

Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestine, Turkey



Energy; *2.5 GeV*

Circumference; *133m*

Emittance; *26 nm-rad*

12 Insertion Devices

13 Bend Magnet beam lines

Maximum beam line length; 37m

12 straight sections are available for IDs with lengths up to 3.9 m

Space for future full energy injector in the main ring tunnel

- **SESAME's injector (Microtron and Booster Ring) have been commissioned**
- **Commissioning of the storage ring is expected in 2016**

Control Group

Ibrahim Saleh

Abdallah Ismail

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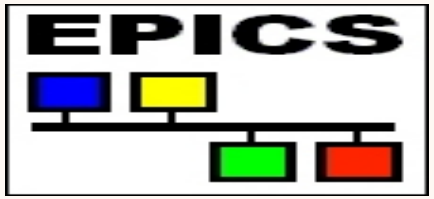
Control System Status

Outline:

- Overview
- Infrastructure
- Booster Control System
- IOCs Development
- Clients Development
- Archive System
- Alarm Handler
- Future Work

Overview

- Control System Implementation uses (EPICS) base 3.14.12



- Clients are implemented using a custom build of Control System Studio (CSS) based on V.3.16

- Servers are implemented as EPICS Input/Output Controllers (IOCs)

- Soft IOCs (Linux Machines)
- Hard IOCs (Libera, VME)

Overview

- Siemens S7 PLCs are used for the machine interlocks

- Allen Bradley PLC is used for the Personal Safety System (PSS).

- Git version Control System is used to track development & documentation

- Development and administration platforms use Scientific Linux 6.4

Infrastructure

- **Twelve virtual servers** reserved to run the following:
  IOCs, Archiver, Alarm Handler, GIT Repository,
  Elog server, Bugzilla, Wiki server and File transfer servers

- All workstations and servers have been migrated to **Scientific Linux 6.4**

- All clients, servers, and controllers are connected to an isolated **machine network.**

- A version control system is used to track development using **GIT.** Separate repositories exist for: IOCs, clients, documentation, required software packages and CSS

Infrastructure

- Issues tracking (including bugs and tasks) is done using **Bugzilla.**

  Any group may submit a bug/task for any other group

- **ELOG** is used by operators to write information during the commissioning, which makes it easy for other people to access this information through a Web interface, browse entries, search, download files, and optionally add, update, delete or comment on entries

- **MediaWiki** server has been recently installed. Documents will be transferred to this wiki to enable easy access

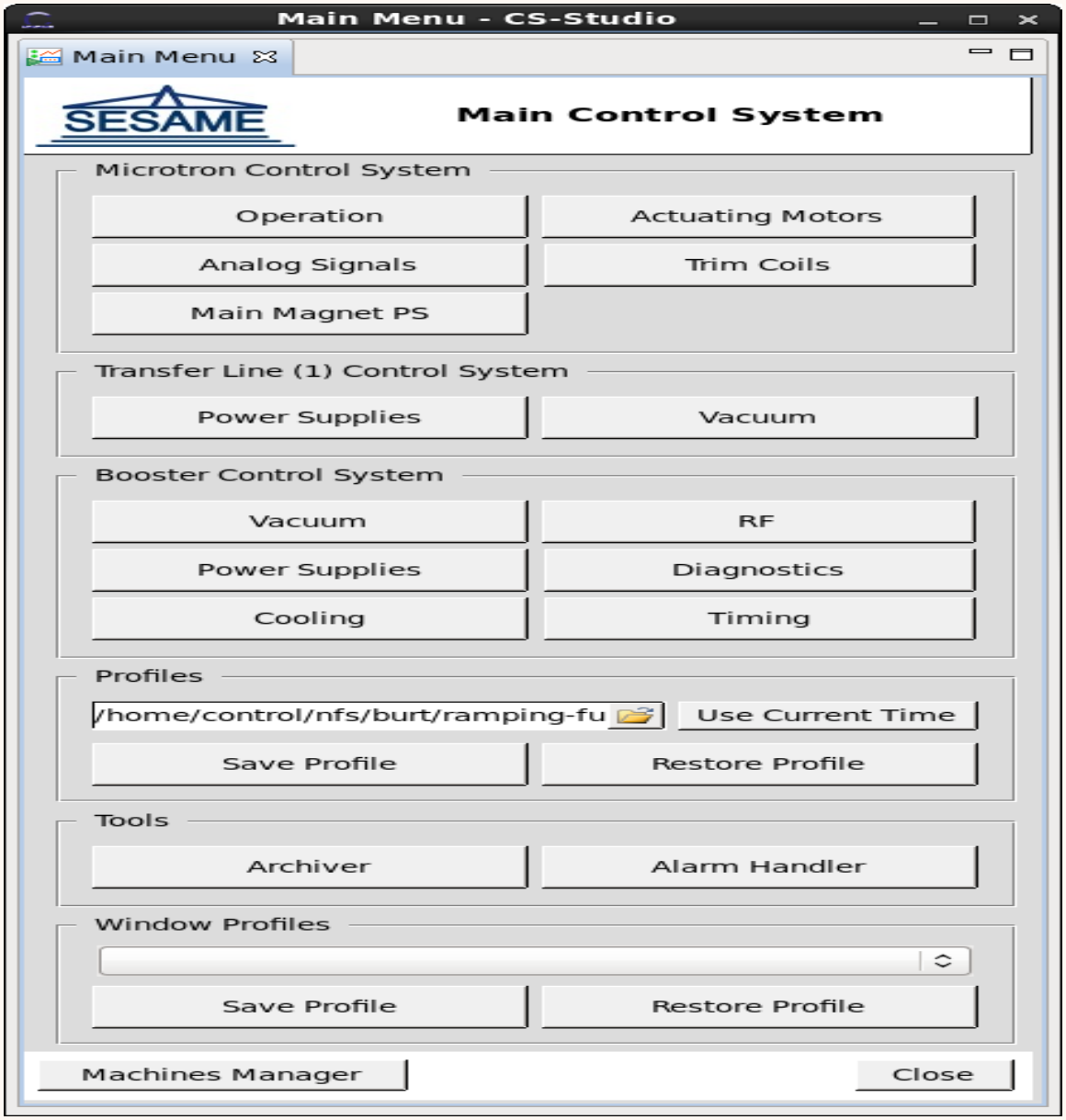
Booster Control System

General Architecture

Booster Ring

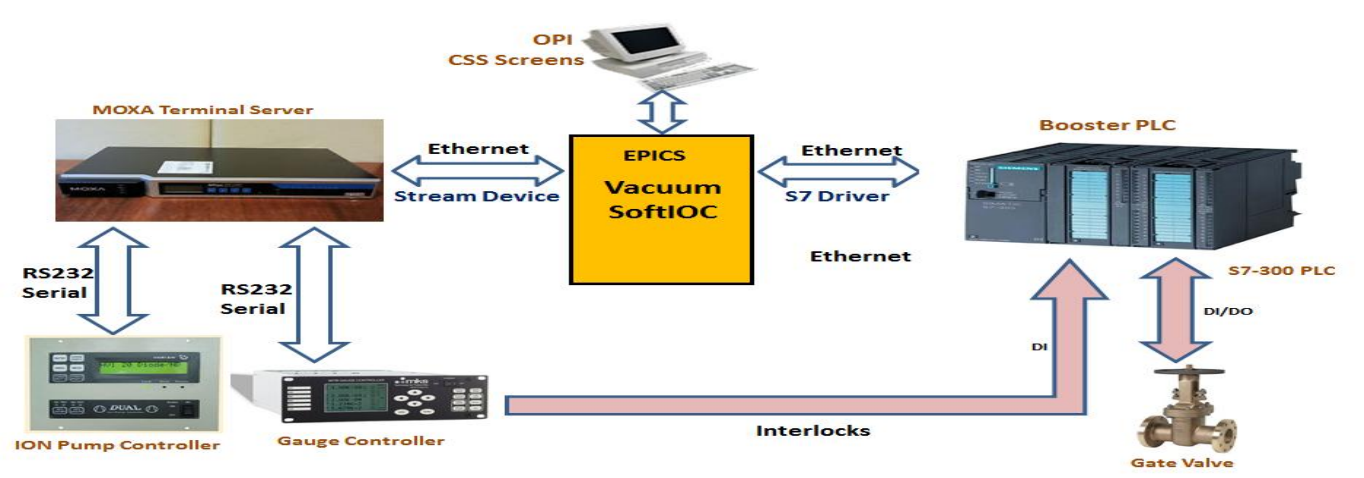
Booster Control System

- Vacuum
- Power Supplies
- RF
- Diagnostics
- Cooling
- Timing
- PSS

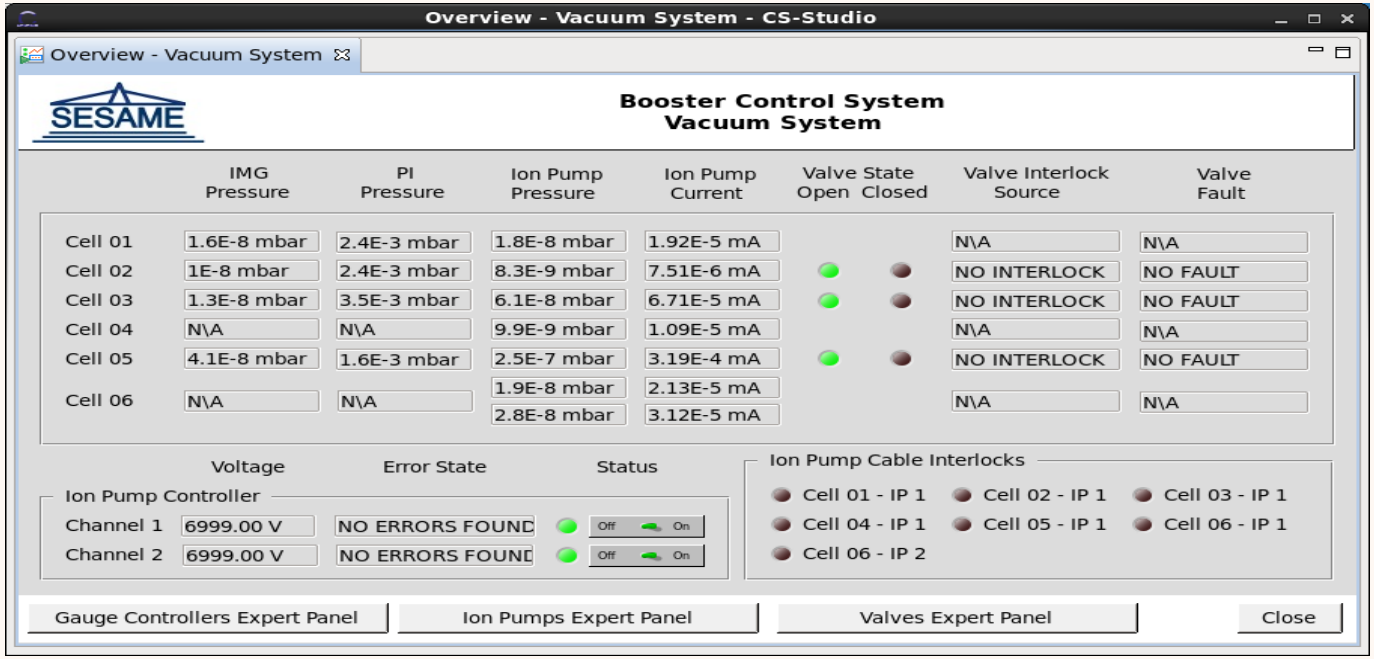


Main CSS OPI

Booster Control System - Vacuum



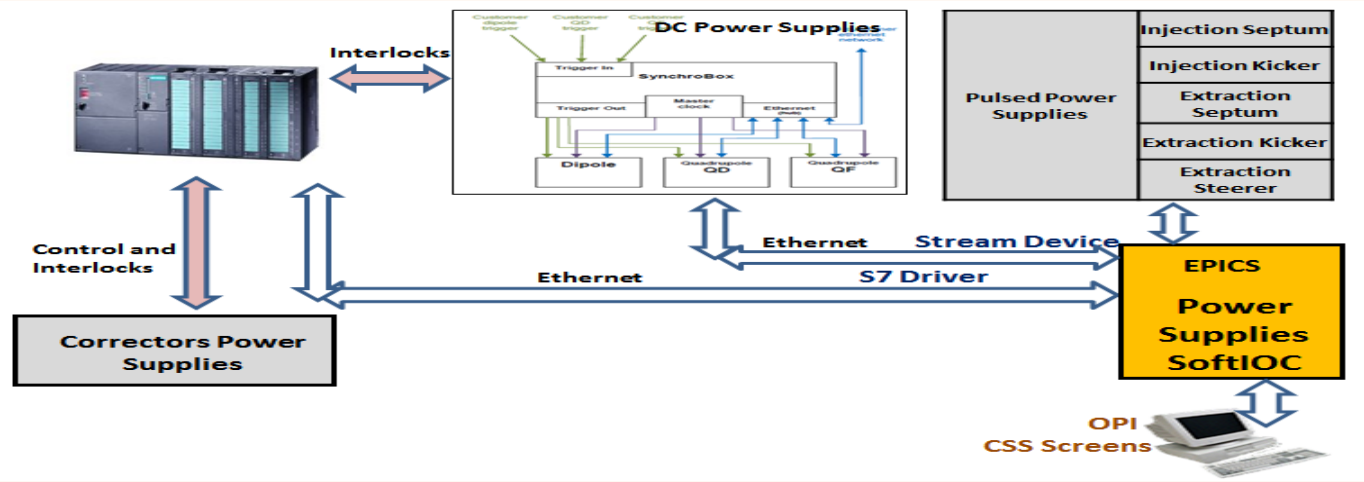
Vacuum Control Architecture



Vacuum Main OPI

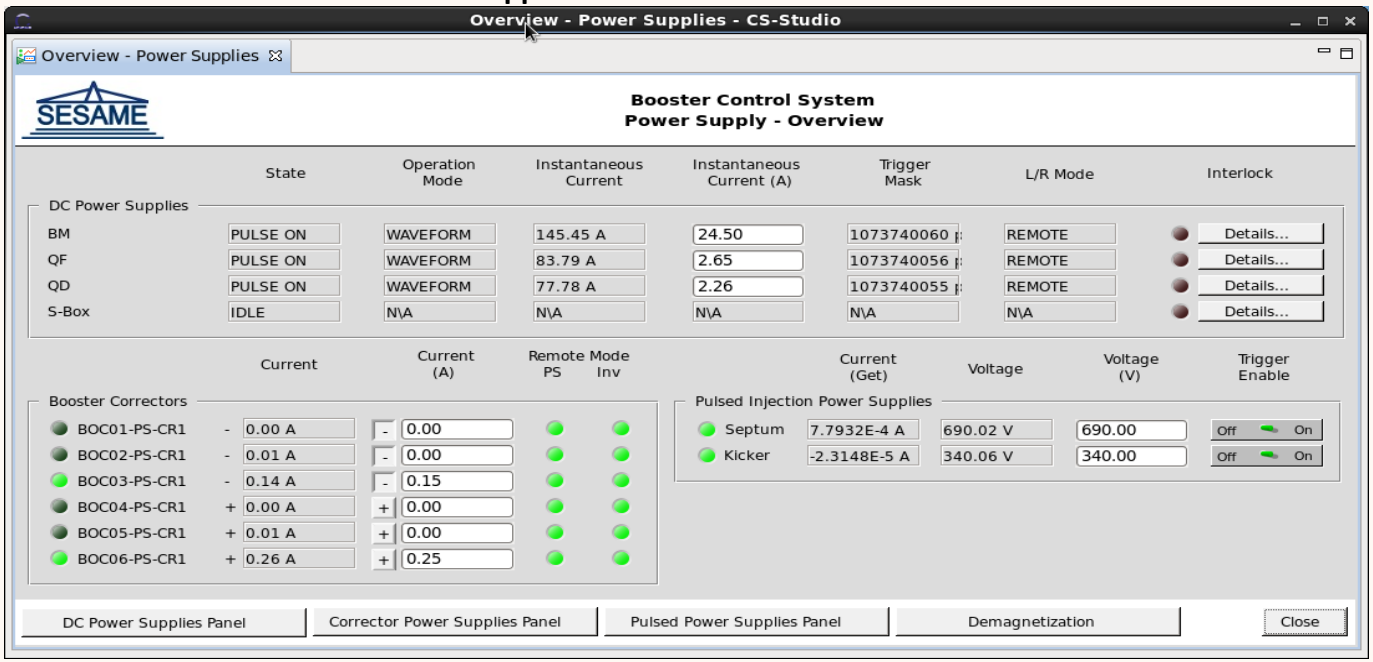
Vacuum Rack

Booster Control System – Power Supplies



Power Supplies Control Architecture

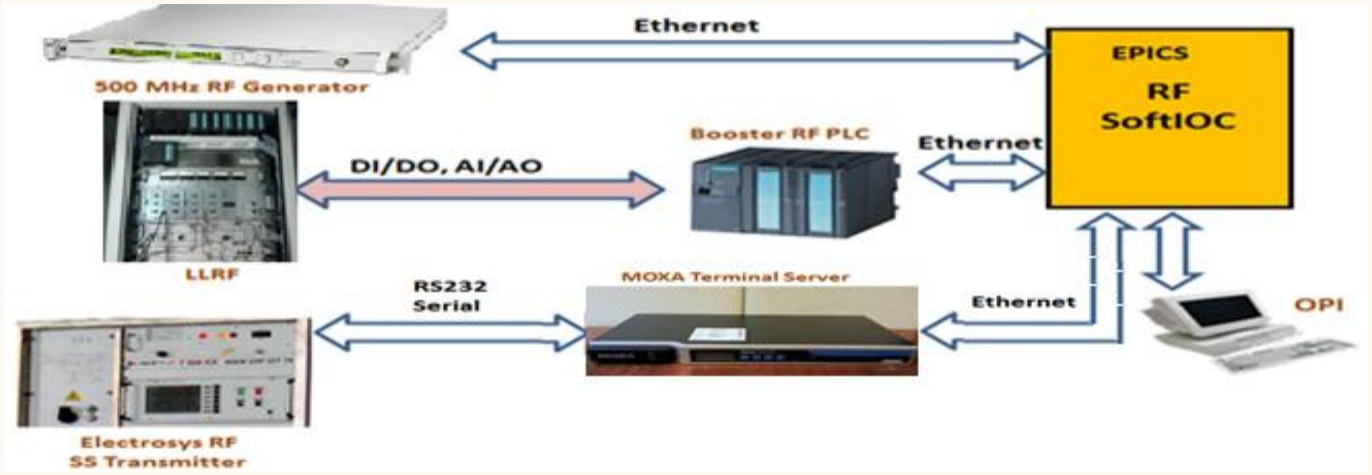
DC Power Supplies



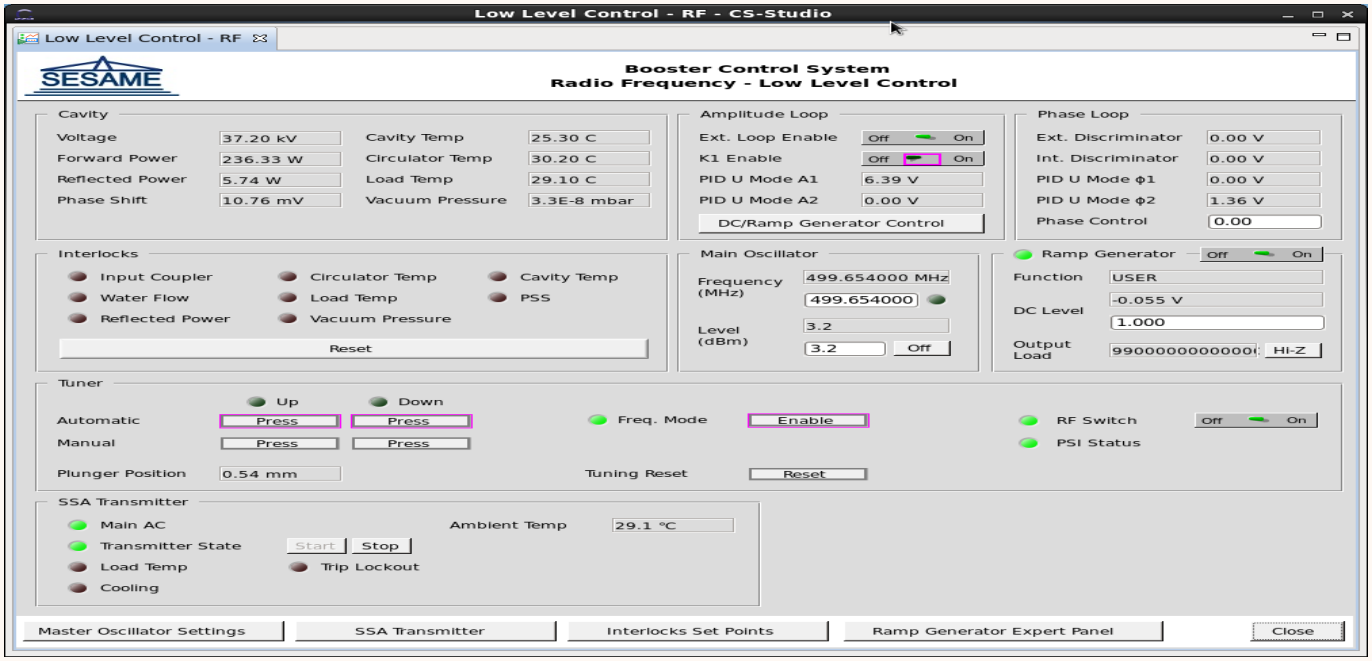
Power Supplies Main OPI

Power Supplies PLC

Booster Control System - RF



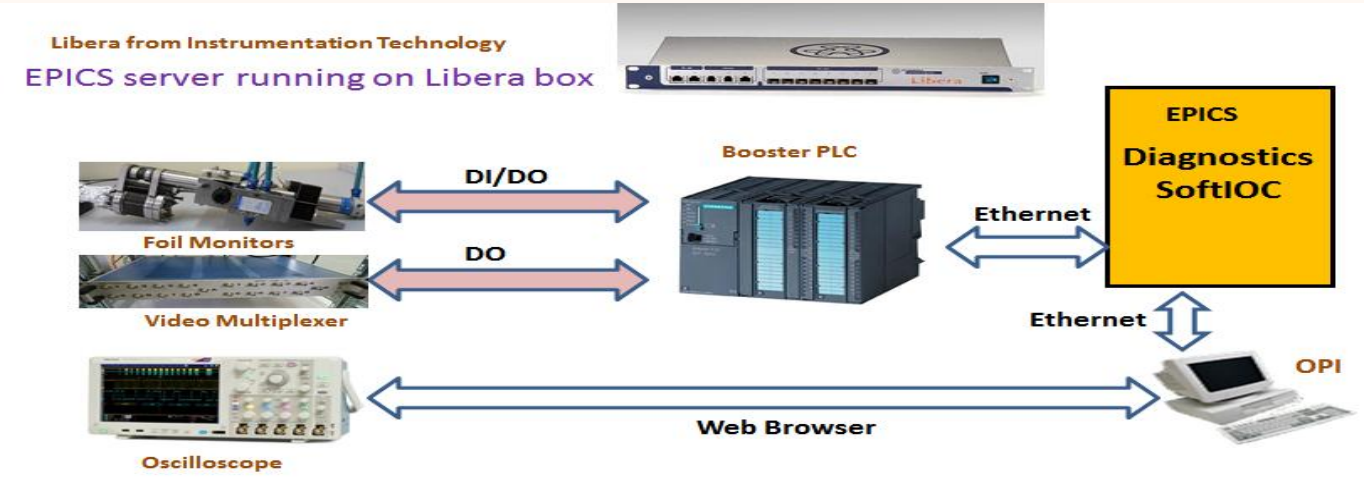
RF Control Architecture



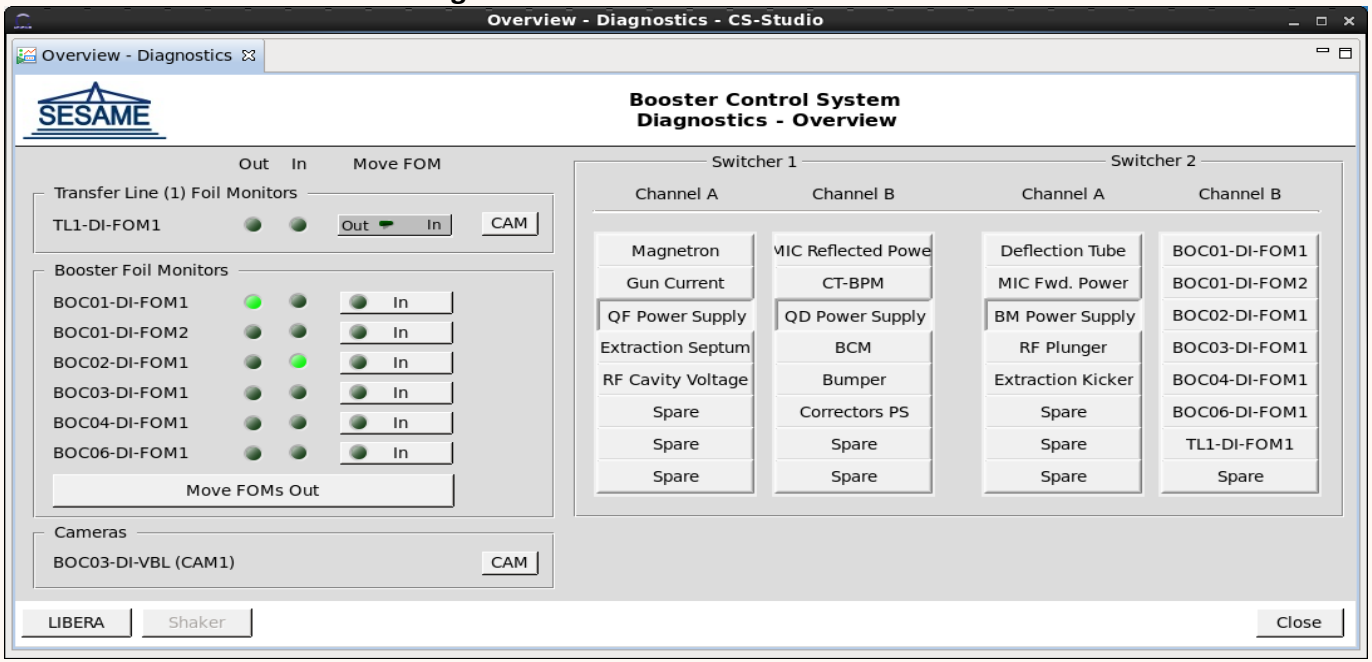
RF Main OPI

LLRF Rack

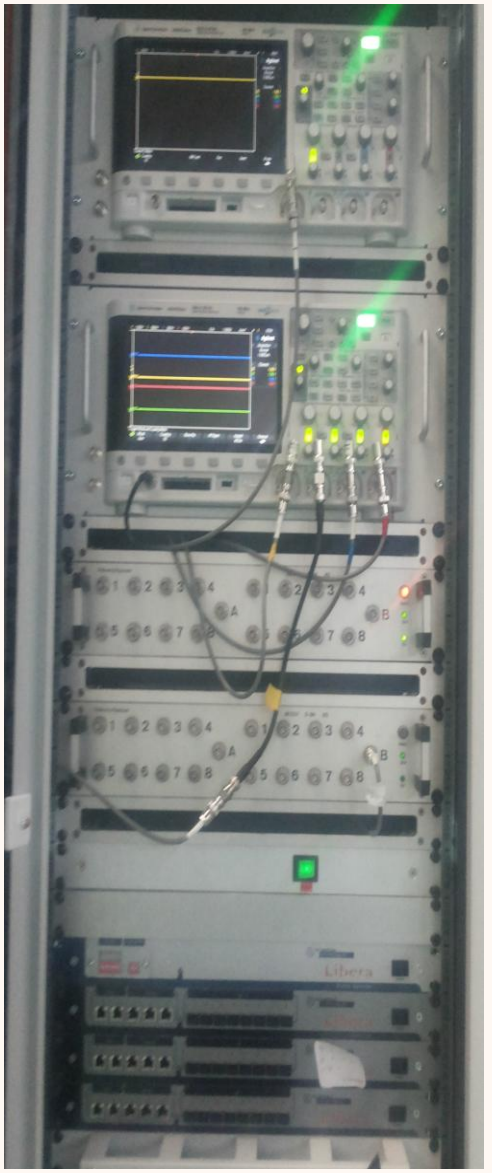
Booster Control System - Diagnostics



Diagnostics Control Architecture



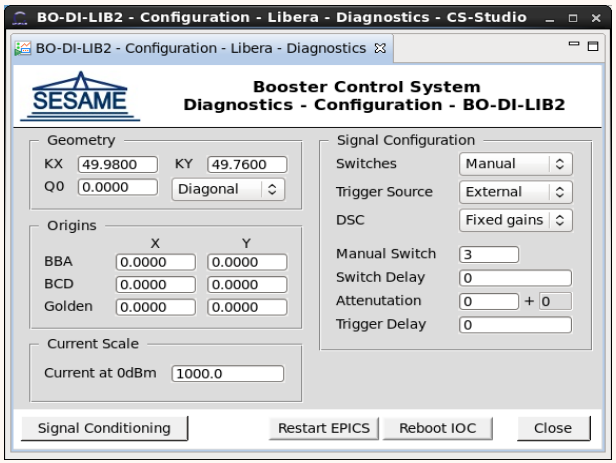
Diagnostics Main OPI

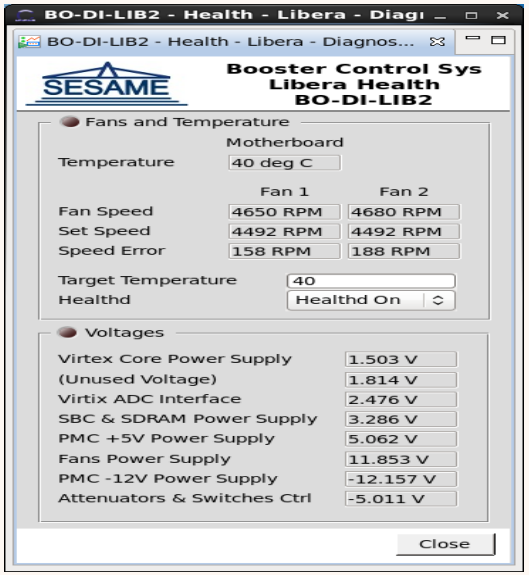


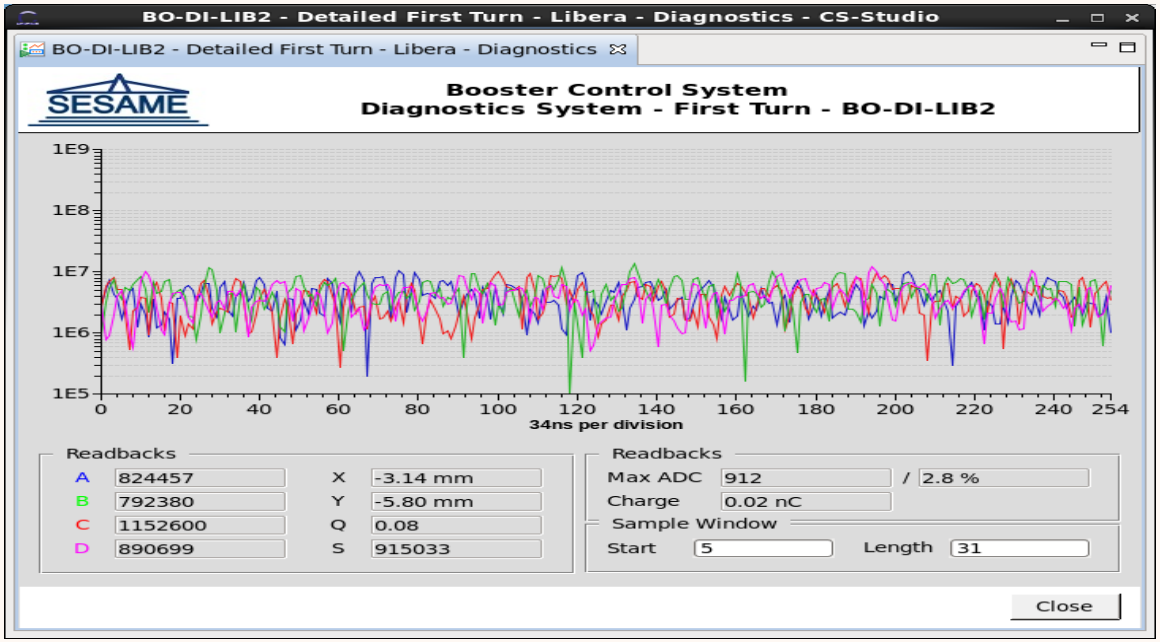
Diagnostics Rack

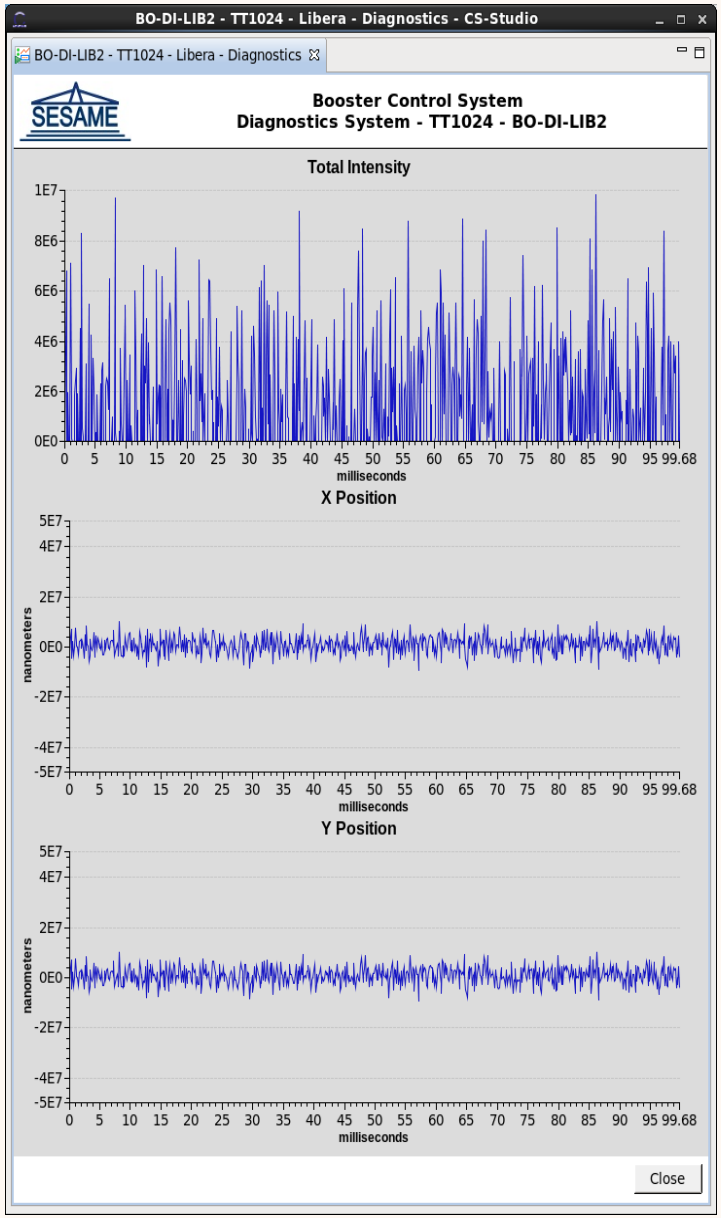
Booster Control System - Diagnostics

- **New CSS Libera Screens**

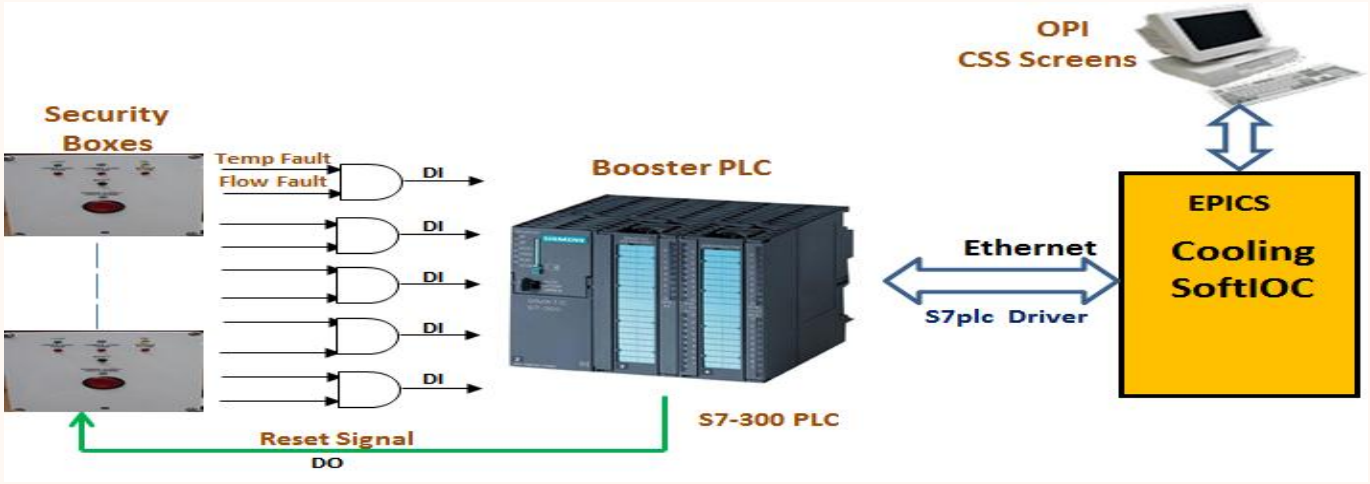




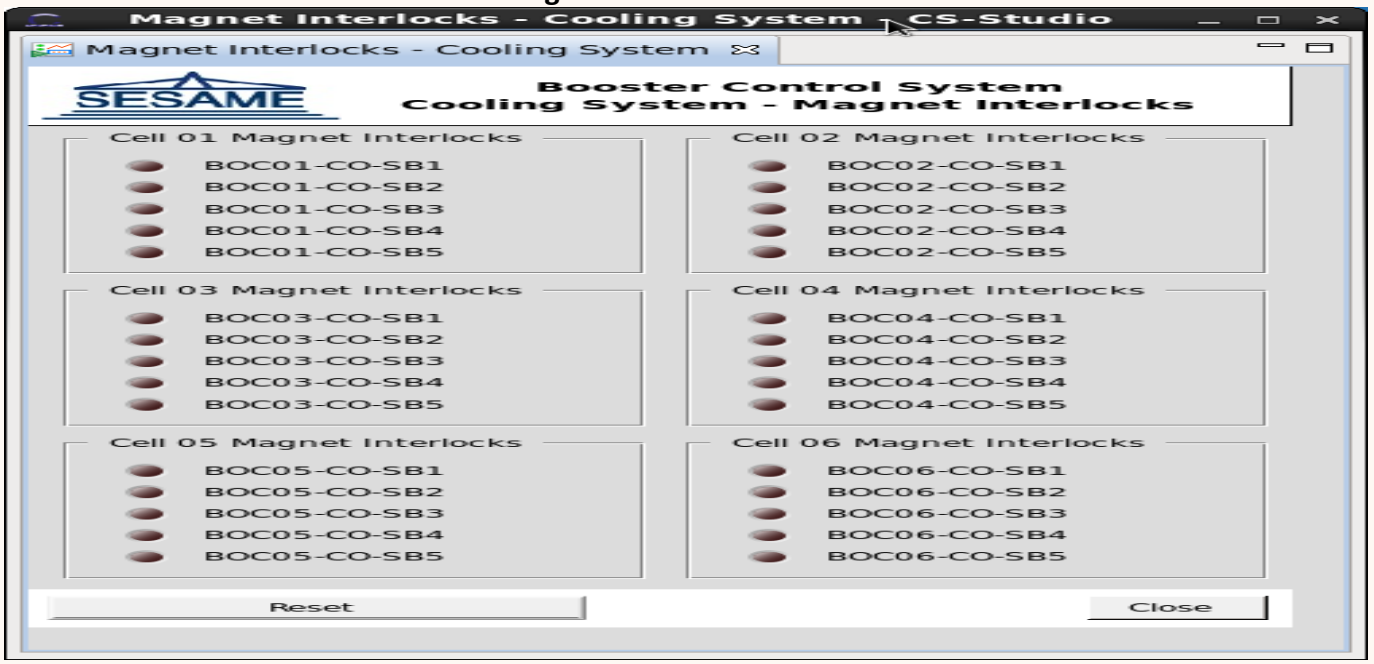




Booster Control System - Cooling



Cooling Control Architecture

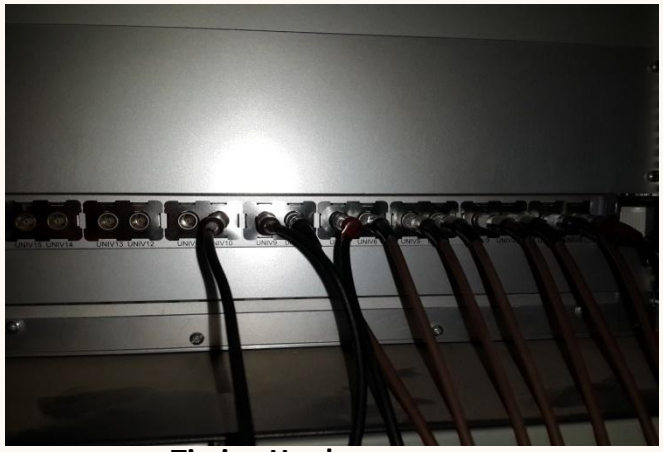


Cooling Main OPI

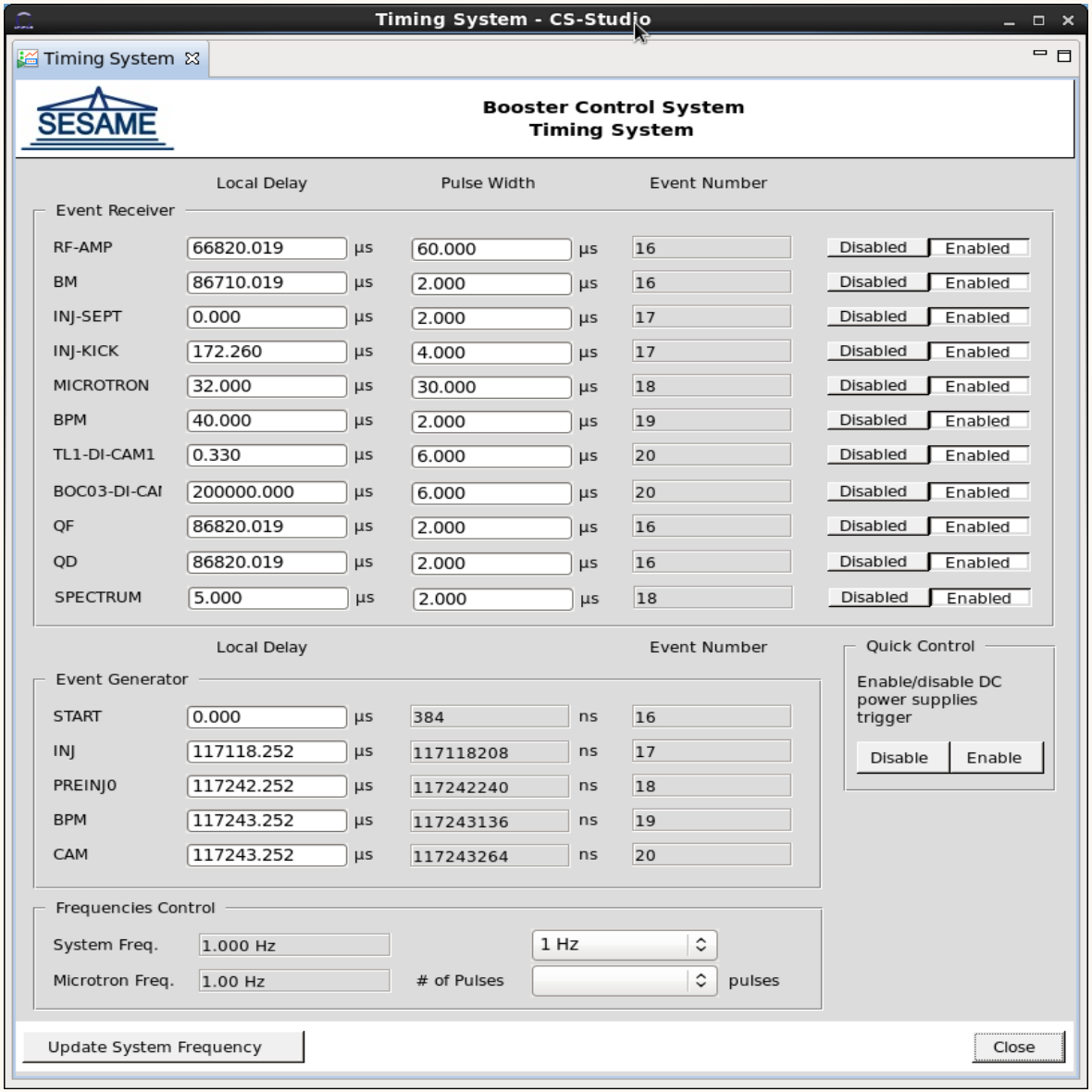
Cooling Rack

Timing Control System

- VME Crate from PSI
  - One EVG card
  - One EVR card



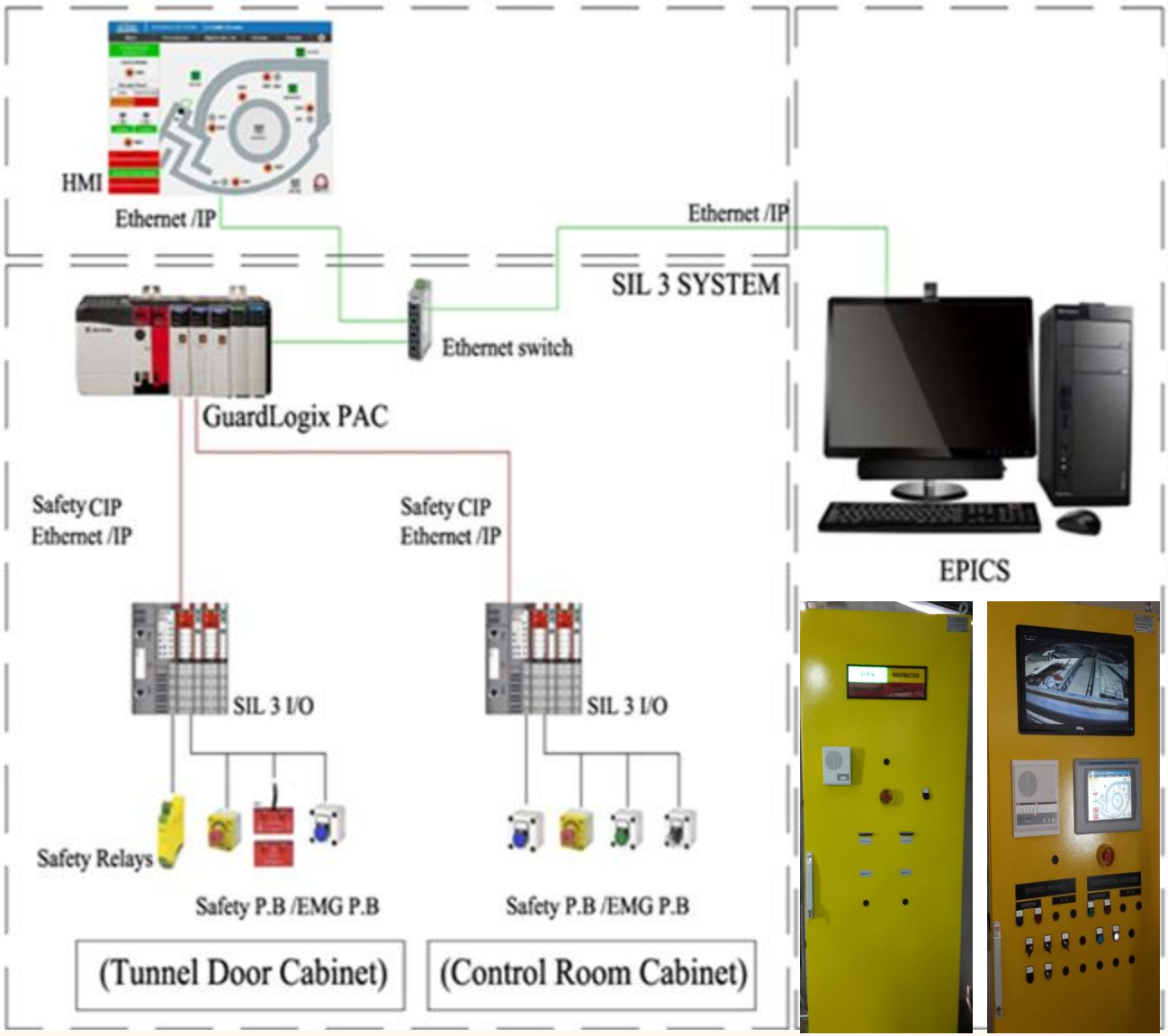
Timing Hardware



Timing Main OPI

PSS Control System

- **EtherIP** driver/device support module interfaces Allen Bradley Guard Logix safety PLC via Ethernet to EPICS IOC
- The PSS IOC monitors the safety interlocks and showing them on the CSS



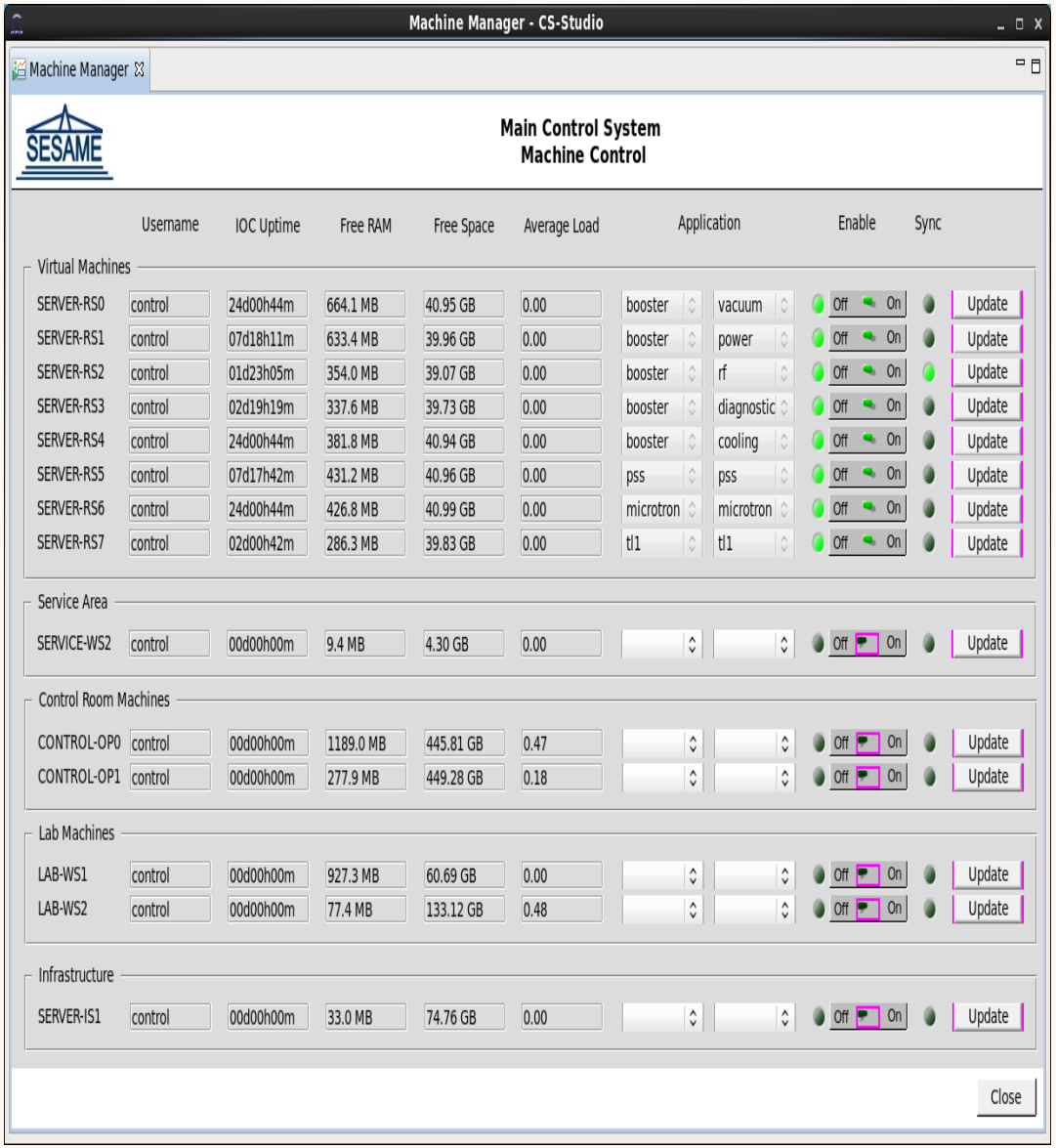
PSS Control Architecture

PSS Cabinets

IOCs Development

➢ IOC Manager

- Enable/Disable the IOCs
- Synchronize IOCs with the version control repository
- Monitor the uptime, free RAM, free space and the average load of the IOCs
- Manage the development machines and other infrastructure servers.



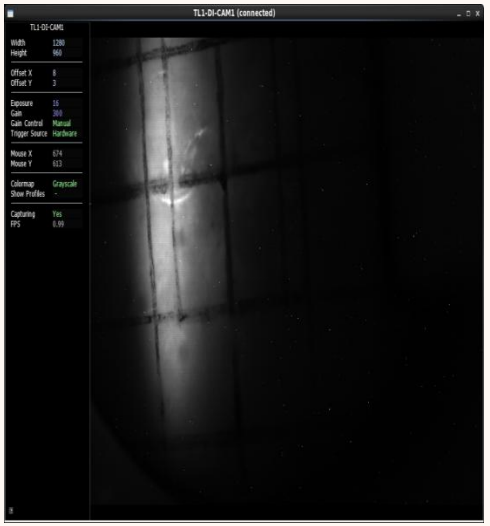
IOCs Manager OPI

IOCs Development

➢ Basler GIGE Camera Driver

- Ace acA1300-30gm GigE camera, no drivers available
- Purpose: Speed up scientific analysis, system integration
  Needed image, gain, exposure, ROI, and trigger control
- Record types: Bi, bo, longin, longout, waveform
- Device support: Asynchronous processing (I/O thread)
- Driver support: One thread per device, message passing
- Device driver: Shared C++ libraries from Basler

Basler GIGE Camera



Beam Image

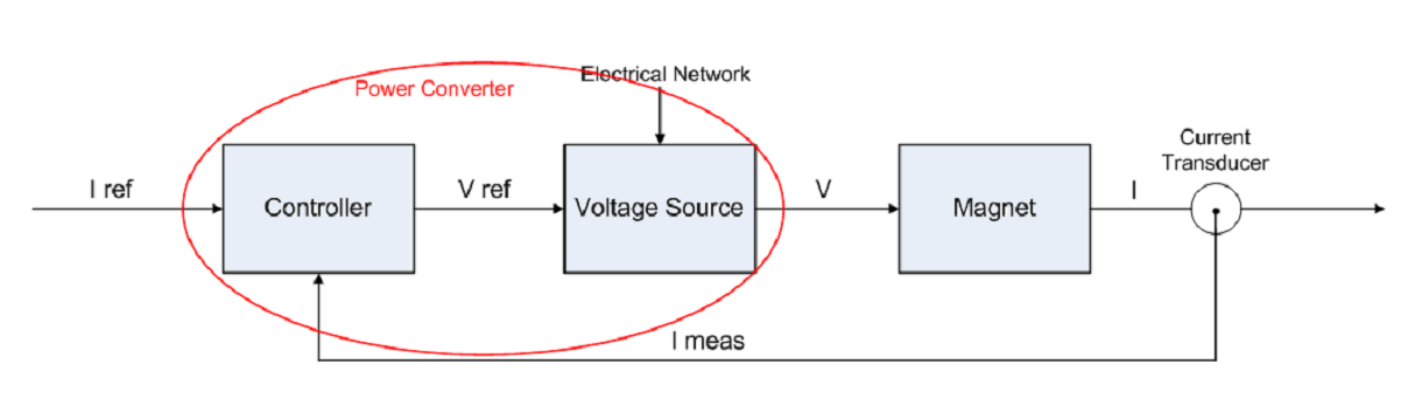
IOCs Development

➢ Storage Ring Power Supplies Control System

- Current controlled power supplies have 2 loops; a fast voltage feedback loop and slow current feedback loop

- We bought a power supply which already contains the voltage feedback loop from industry (Voltage Source)

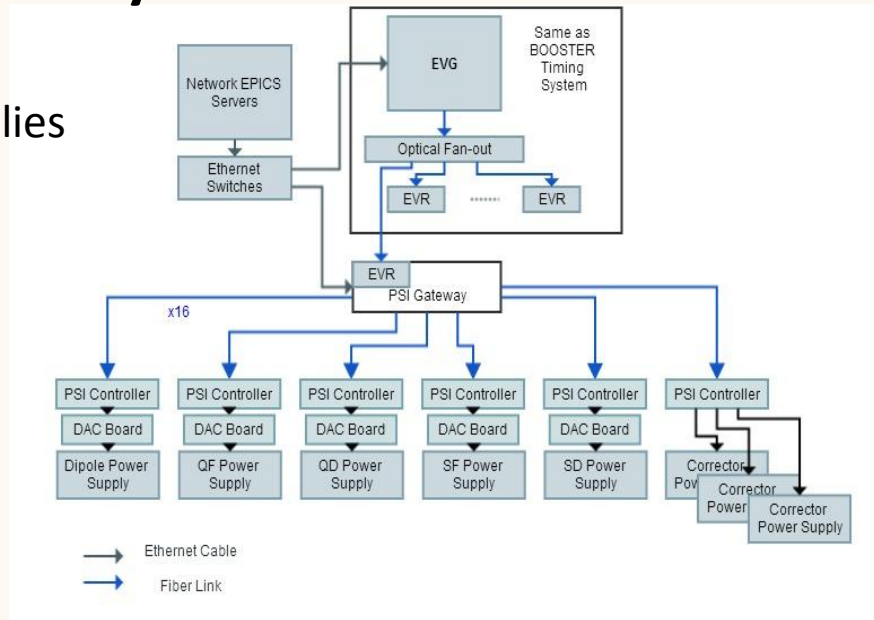
- The current feedback loop is then implemented using PSI power supplies controllers



IOCs Development

➢ Storage Ring Power Supplies Control System

- Control room communicates with gateways
- Gateway distributes commands to power supplies
  - Reference current
  - Waveforms
  - Triggering and synchronization
  - Fast orbit feedback
  - Parameterization
  - Firmware upgrades
- Power supply drives magnet
  - Triggering and tracking repsonse and jitter < 100us
  - Over damped response
  - Settling time within 50ppm < 1ms
  - Phase margin > 60



Architecture

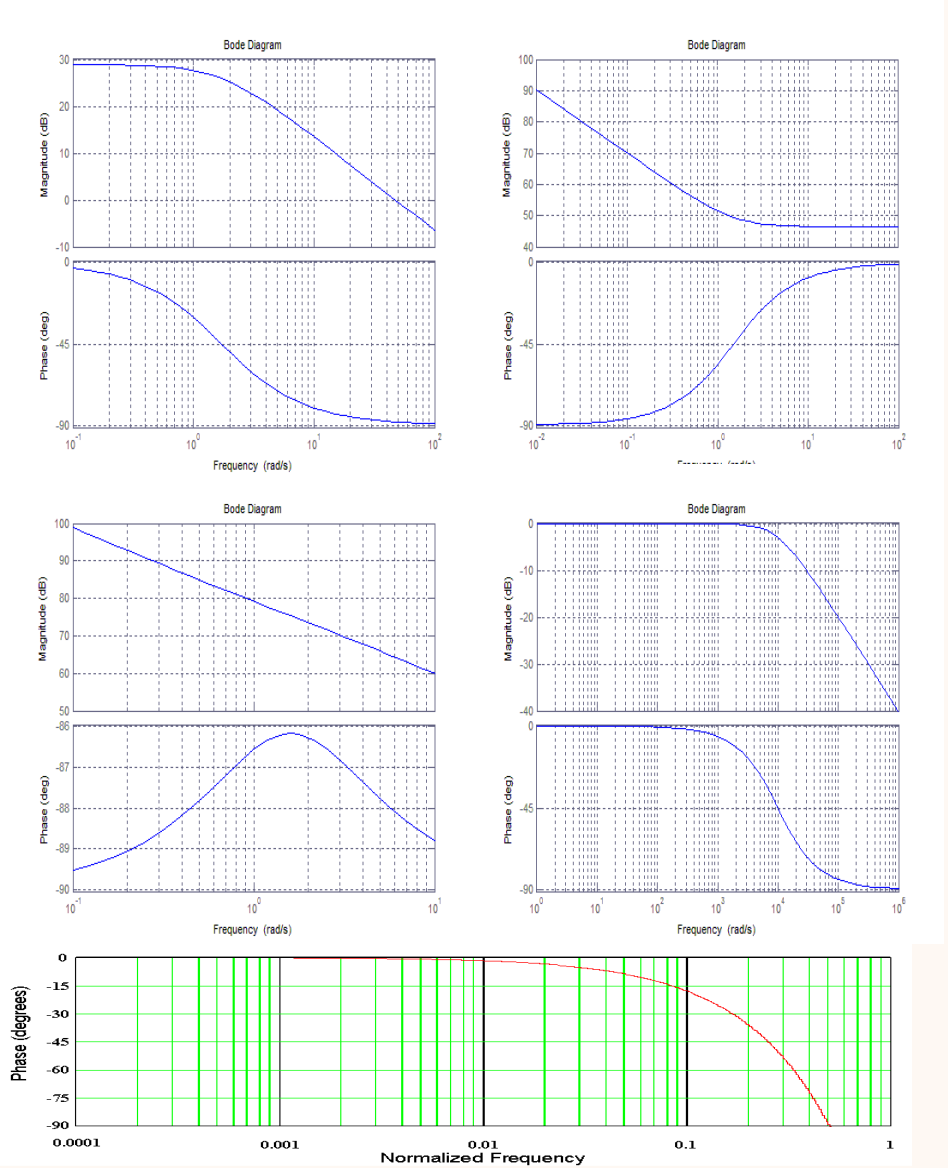
Gateway

Controller

IOCs Development

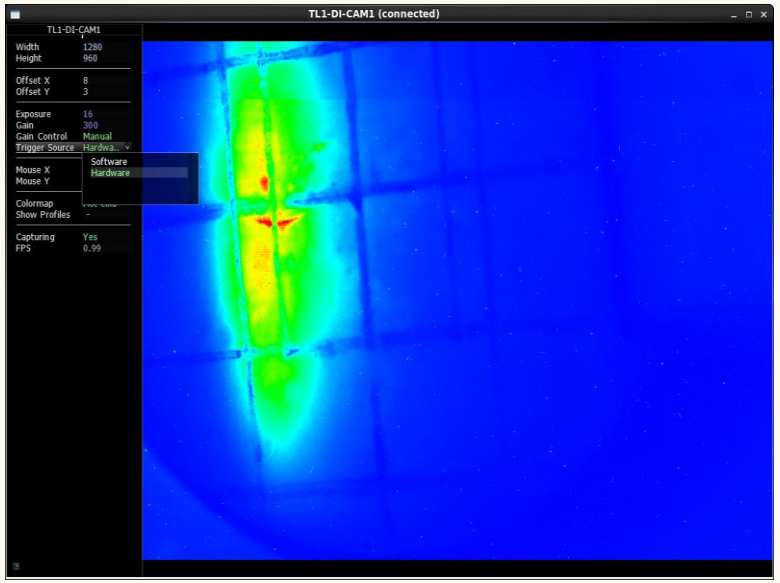
➢ Storage Ring Power Supplies Control System

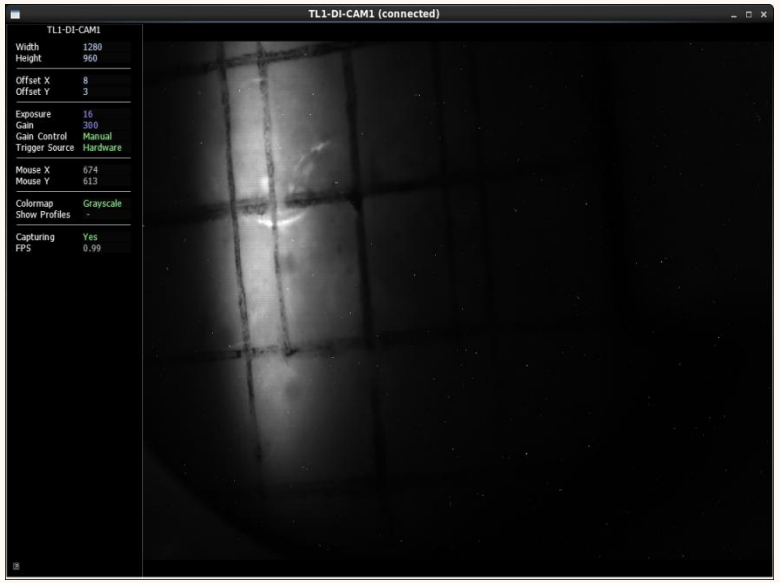
- Controller design requirements
  - Overdamped response
  - Settling time < 1ms
  - Error band < 50ppm
  - Phase margin > 60
- PI Controller design procedure
  - Gp has dominant real pole due to magnet
  - Place zero to cancel dominant pole
  - Place pole at origin
  - Close the loop and set bandwidth
  - Select sampling rate to achieve phase margin
- Design equations:
  - Ki = Wp, 10tau = 1ms, BW = 1/tau, Kp = L.BW, Fs > 4Fc



Clients Development

- **Basler GIGE Camera Client**
  - Uses EPICS client framework
  - Built using C, OpenGL, SDL and AntTweakBar
  - Provide an interface to control basler camera parameters such as: image size, offset, gain, exposure and trigger source
  - Provides different color maps





Camera Client

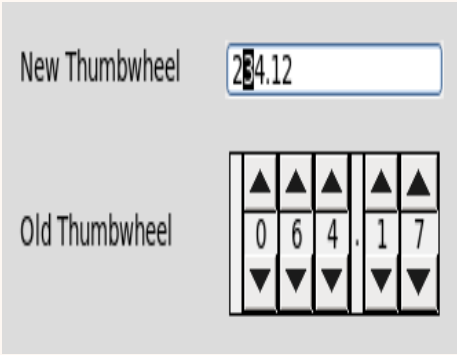
Clients Development

- **SESAME CSS**

  - A custom SESAME build based on CSS v3.16

  - Adding archiver and alarm handler to be integrated with the CSS
  - CSS starts in run-time mode directly without showing the eclipse development windows.

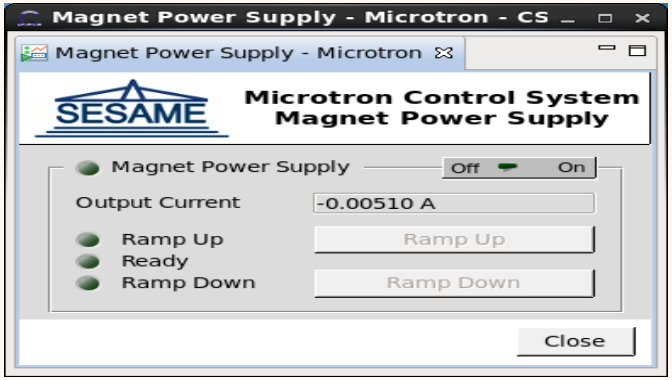
  - Adding a thumbwheel function to the input box widget to provide a compact fine-tunable control to PVs



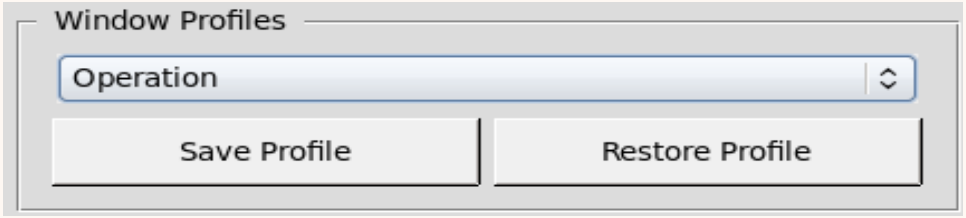
Clients Development

➢ SESAME CSS

- Showing screen names on windows title bar



- Only one instance of identical windows allowed at a time
- Adding window profiles saving and loading to arrange the CSS workspace



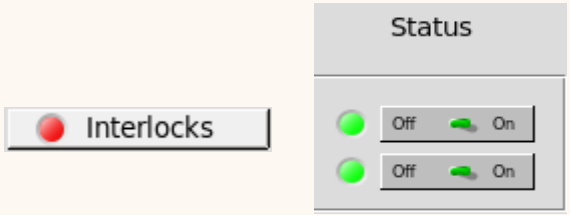
Clients Development

➢ SESAME CSS Standards

All CSS screens follow a standard interface to ease and clarify usage for operators

Examples:

- Color coding LEDs: green LEDs show on/off state, red LEDs show interlock signals, yellow LEDs used for limit switches



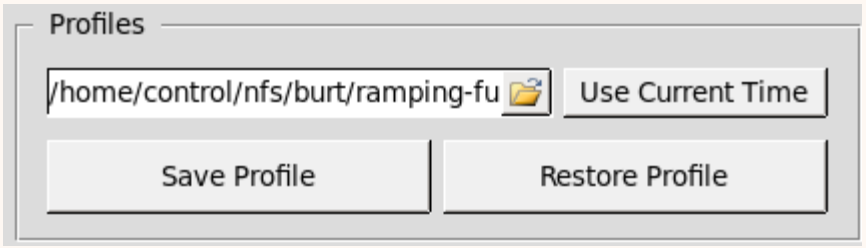
- All reading fields have a gray background, while write-able fields have a white background

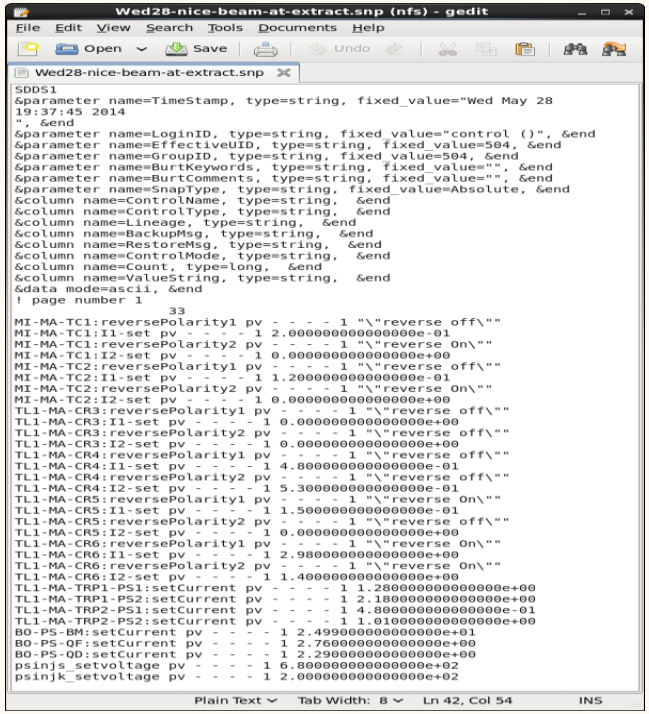
- Tables are used throughout to monitor and control the devices

Clients Development

- **BURT** (Back Up and Restore Tool)

  - Saves machine state and restores it later
  - Uses a network file system to provide saved profiles on all operator's computers

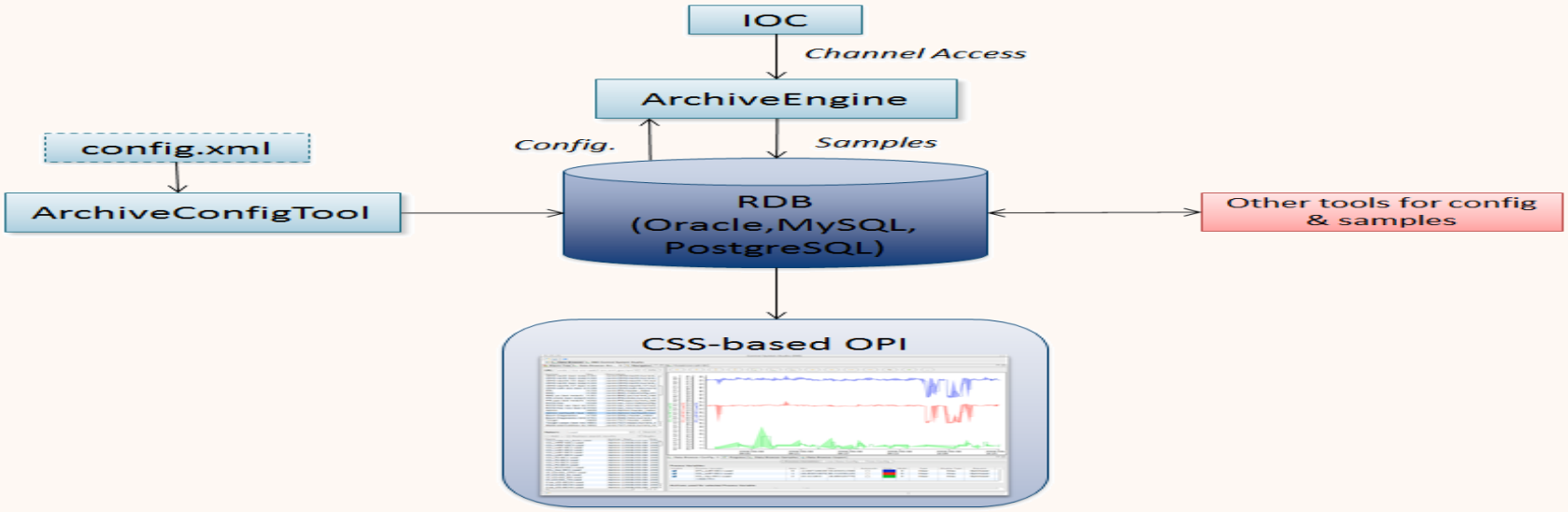




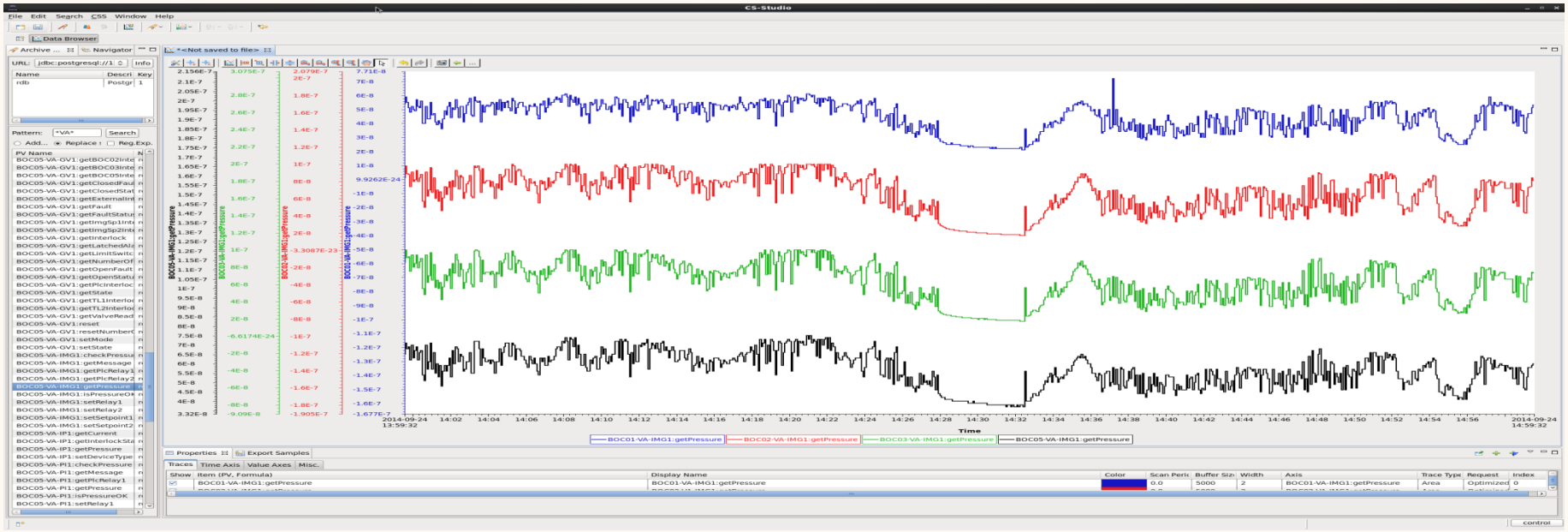
Archive System

- Uses BEAUTY (Best Ever Archive Toolset Yet) Archiver
- Integrates with CSS data browser
- Has ability to specify a time interval
- Show multiple PVs on the same plot
- Uses free PostgreSQL DB
- Installed on a virtual machine with access to EPICS IOCs
- Only PV reading changes are recorded in the database
- All PVs are monitored currently

Archive System



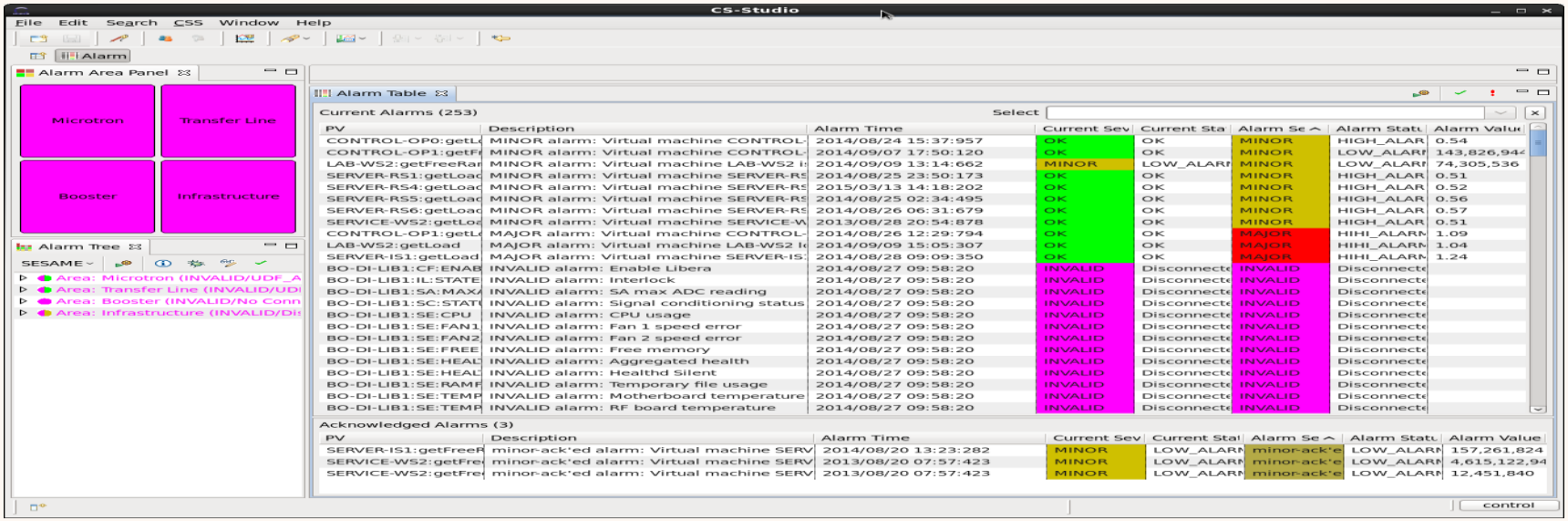
Archiver Architecture



Vacuum readings data browser

Alarm Handler

- Uses BEAST (Best Ever Alarm System Toolkit) Alarm Handler
- Integrates with CSS
- Divides alarms per system
- Alarms can be acknowledged
- Monitors Real-time alarms
- Uses PostgreSQL and Apache ActiveMQ
- Installed on a virtual machine with access to EPICS IOCs
- ANKA alarm creation server is used



Future Work

- Continue the work on the control system of the storage ring's power supplies and other subsystems
- Evaluation of a low cost, high performance controllers to be used in the storage ring control system
- Direct control of the timing system EVG and EVR cards by writing a driver for them and run a soft IOC on one of the Linux workstations

Acknowledgement

- Mark Heron, Diamond Light Source, United Kingdom
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- Elder Matias, Canadian Light Source, Canada
- Igor Kriznar, ANKA, Germany
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Thank You