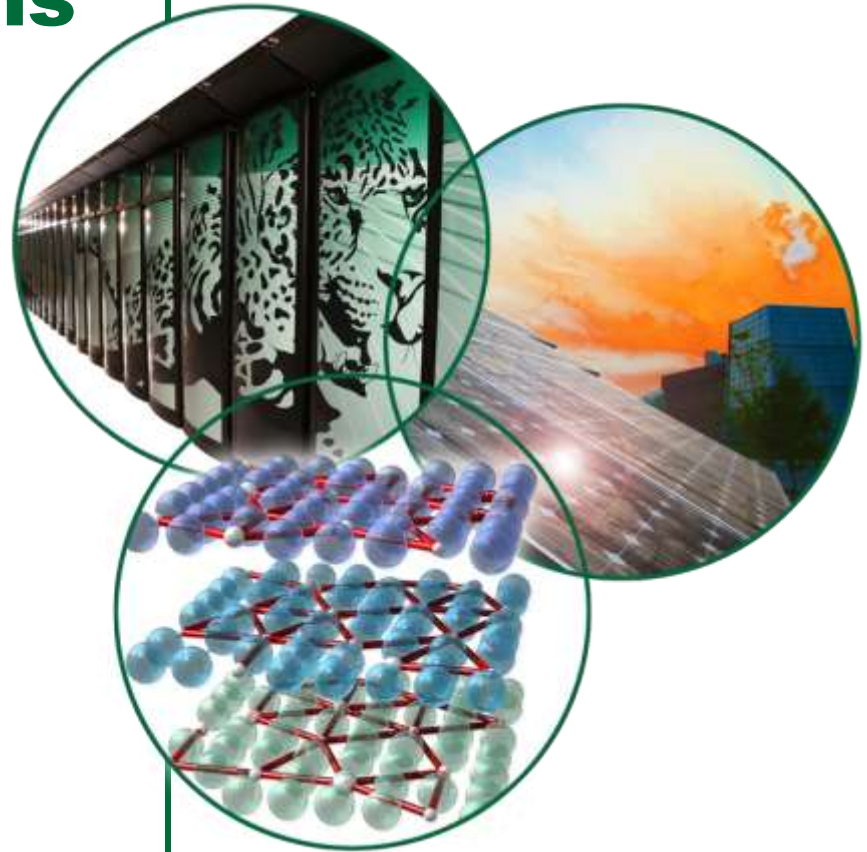


# Control System Performance and Plans

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# Outline

- **Scope**
- **Performance and Goals**
- **Upgrades and Plans**

# Scope

- **Instrumentation and Controls, Timing, Machine Protection, Personnel Protection**
  - Accelerator
  - Cryogenics
  - RF and Ion Source Test Facilities
  - Target
  - Instrument PPS
  - Conventional Facilities
- **Large, highly distributed EPICS based system**
- **PLC based PPS**

# Performance

**Our job is to provide **reliable** control systems that meets the needs of our operations and engineering customers**

**How are we doing?**

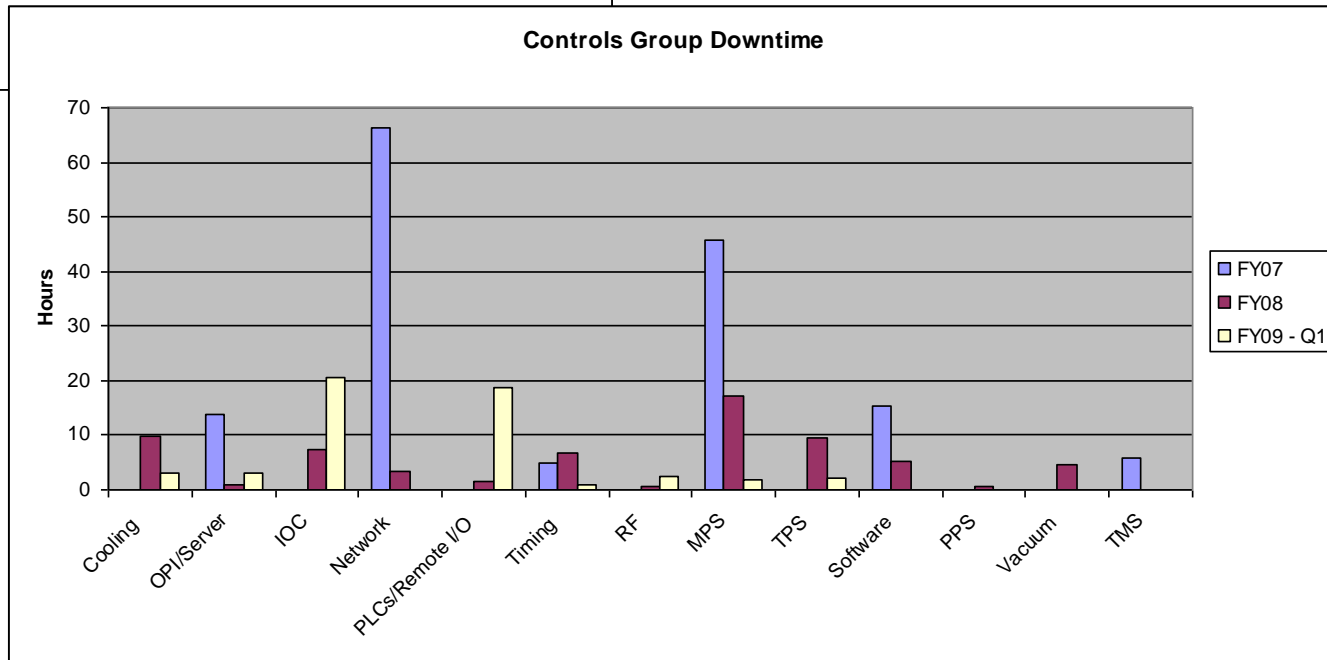
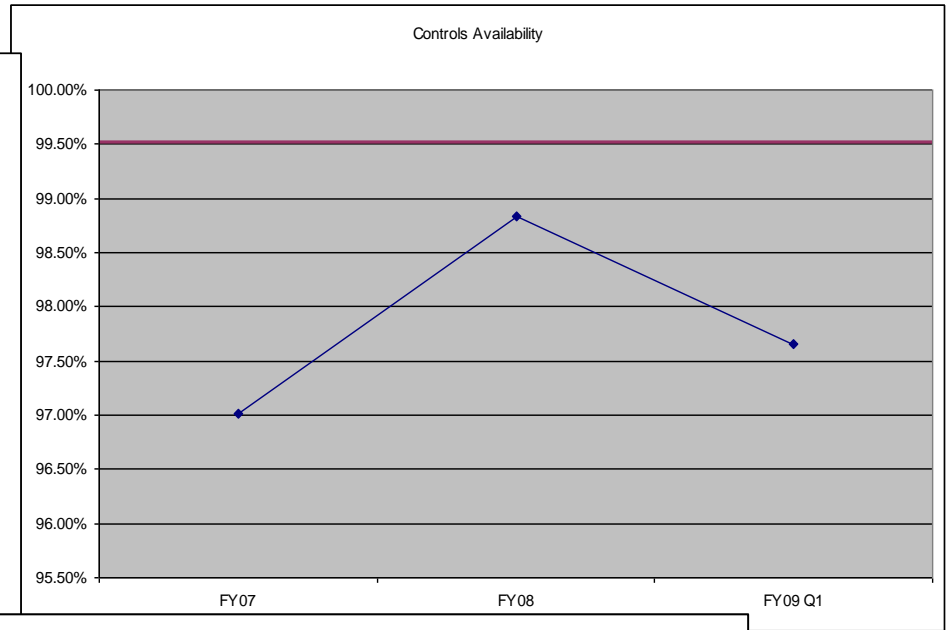
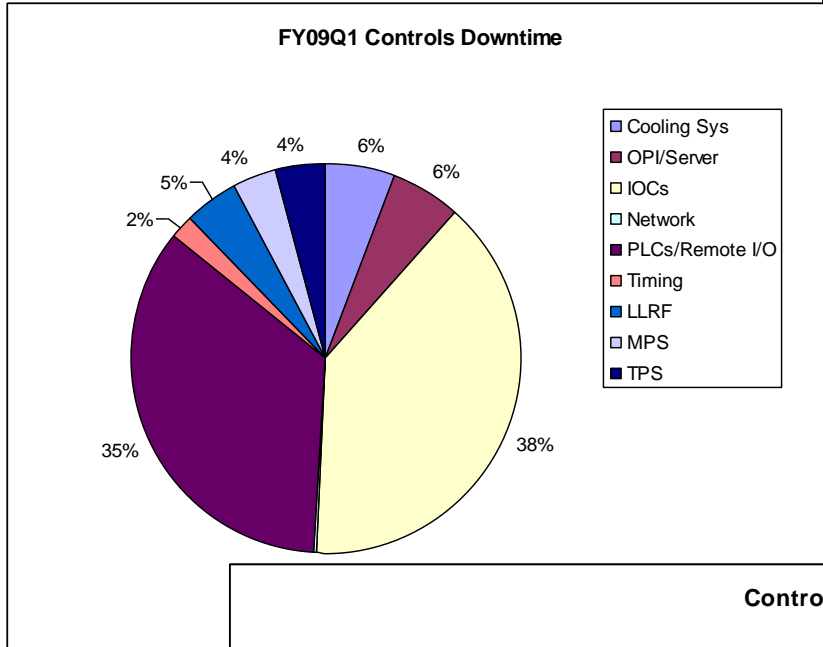
# Beyond Availability

- **We also meet the needs of our customers by**
  - **Implementing upgrades or adding new features to existing controls**
  - **Providing controls for new or upgraded systems in other areas**
  - **Improving tools and interfaces that customers use to interact with the Control System**
  - **Providing tools for Data Management**

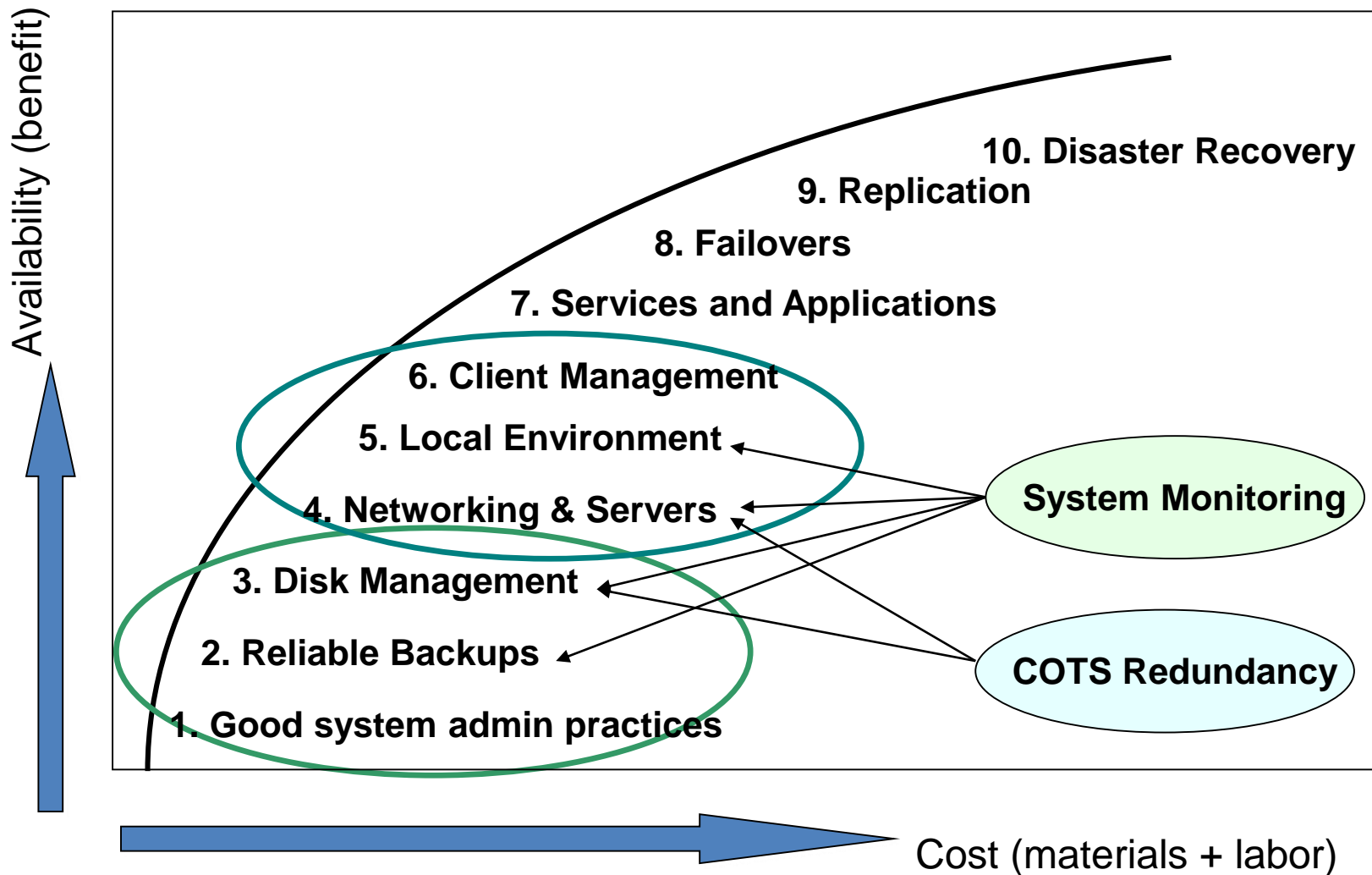
# High Level Goals

- **Improve availability – long term goal = 99.5%**
- **Continue to implement improvements and new systems as needed to support machine ramp-up and new instruments (including AIPs)**
- **Deploy new Archiver and Alarm Handler**
- **Continue to increase use of RDB based configuration**
- **Configuration Control – especially needed for Software**
- **Bring documentation up to date**
  - **Assets in DataStream, including Spares**
  - **As-builts**
  - **Establish regular PM schedules**

# Performance



# Availability Index\*



\*Adapted from Blueprints for High Availability)



# Availability

- **FY08 showed good improvement**
- **Recent rash of PLC failures**
- **Working with Cryogenics Group to improve controls**
- **General plans**
  - **Continue to strengthen infrastructure – servers, COTS redundancy**
  - **Build development network to improve ability for realistic testing prior to deployment**
  - **Remove external dependencies**
  - **Software configuration control (need QA manager)**
  - **Evaluate COTS hardware MTBF and upgrade as needed**
  - **R&D on use of redundancy for PLCs, IOCs**
  - **Increase use of RDB based configuration**
  - **Improve documentation, manage spares**

# Challenges – Availability - PLCs

- **Allen Bradley Control Logix PLCs used extensively throughout SNS Control and Protection Systems**
- **Experienced a variety of PLC module failures over the last 2 months, all impacting cryogenics controls**
  - **12/31/08 – Ethernet module – led to 2K coldbox trip – 16 hours downtime**
  - **1/3/09 I/O module**
  - **1/15/09 Analog Input module**
  - **1/30/09 Binary Output module**
- **Replaced one processor in target controls that failed several times but always recovered on reboot**
- **Prior to these problems, we have had 2 processor failures that were attributed to flaws in manufacturing by Allen Bradley**
- **Working with Allen Bradley to determine the cause of recent failures, assess the risk associated with our current inventory and implement reliability improvements**

# Challenges – Availability – Cryogenics Controls

- In addition to PLC problems, we have recurrent loss of communication between a cryo IOC and PLC
  - Has occurred at least 4 times in 2 months
  - First time led to 2K coldbox trip
  - Recently observed intermittent power problem to this crate
- Impact of a failure in cryogenics control system has more severe consequences than failures in other areas
- Cryo and controls engineers identified improvements to ensure systems “fail safe” to avoid damage to equipment (implementation in progress)
- Performing tests to verify systems operate as expected in the event of a failure
- Fabio plans to conduct formal Failure Mode Analysis to identify other improvements (Controls will participate)
- Conduct code reviews for critical areas to ensure proper error checking and exception handling are employed based of FMA

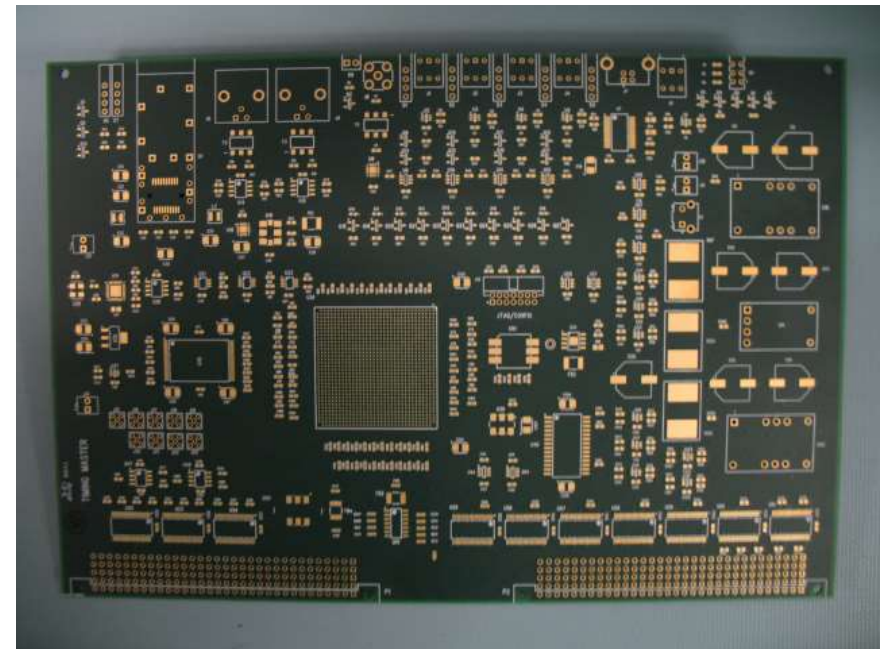
# Progress & Plans

- **Controls Hardware**
- **Process Controls**
- **Infrastructure**
- **IOC Software**
- **Protection Systems**
- **System Tools**

# Controls Hardware

- **MPS – Availability Improvements**
  - To reduce trips due to noisy inputs
  - To prevent unnecessary front end trips
- **LEBT Chopper AIP – Custom FPGA Controls**
- **Timing AIP**
  - Addresses obsolescence and reduces complexity
  - Three new FPGA boards

**New Timing Master replaces  
20 custom VME boards**



# Process Controls

- **SCL vacuum controls AIP ~80% complete (5 of 8 zones)**
  - Replaces dated custom modules with standard PLCs
- **Converted proprietary CUB chillers controls to EPICS**
- **Supported Instruments**
  - HVAC controls design for BL13 & 14B
  - BL5 argon purge controls
- **Improvements to Electrical Power Monitoring System**
- **FE vacuum controls upgrade**
- **Ion Source Test Stand vacuum control system**

# Infrastructure

- **Basics**
  - New backup system – Daily automated tape backups of servers
  - Patching Linux systems
  - Maintaining spare components and systems for servers
- **Warm Standby Servers (3) – maintain a mirrored copy of critical servers**
- **Warm standby network switches installed and configured for cryogenic network systems**
- **ICS clustered Oracle servers**
  - Will allow us to remove accelerator dependence on ORNL IT network and machines for RDB

# Infrastructure - Plans

- Evaluate use of servers to reduce number and complexity, manage growth and usage
- Investigate clustering for critical (file) servers
- Implement uniform system monitoring



# IOC Software

- **Errant beam Controls**

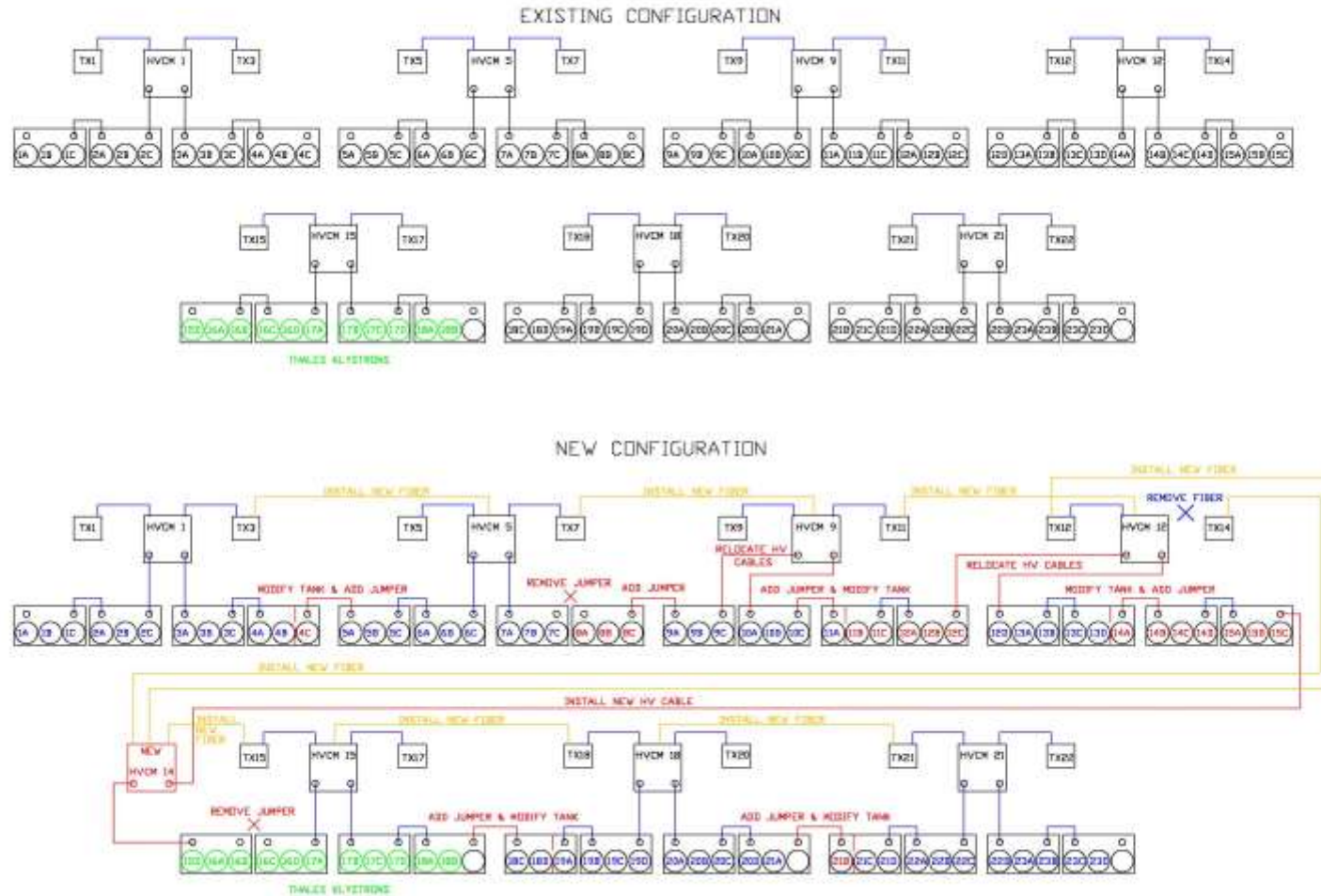
- Injection kicker waveform monitoring system deployed
- Extraction kicker waveform monitoring installed, being tested

- **EPICS support for many upgrade projects led by other Groups and Teams:**

- Support for development of HVCM test stand
- Support for FE, SCL and Ion Source test stand Vacuum upgrades
- EPICS view of PPS
- Rework of RF controls and timing for new HVCM

# SCL Reconfiguration

New Modulator-Klystron HV Cable & Fiber Routing



# Personnel Protection Systems

- **MEBT Beam Stop Mode AIP completed**
  - **Allows the front to run for testing while the rest of the machine is accessible, during extended maintenance periods**
- **Instrument PPS implemented for four new instruments**
- **Scheduling for instruments is “challenging”**
- **Recertify each PPS/IPPS every year**
- **Small team – Crosstraining to ensure all areas are supported**
- **Evaluating redundant PLC system**

# System Tools

- **As tools are updated**
  - Configuration in RDB with web based tools
  - **Control System Studio (CSS)**
    - Facilitates development of interoperable applications
    - Allows data display from multiple sources – transparent to user
    - Big improvement over last generation tools
- **Reusing general purpose code for common functions**
  - JMS – common message service (JAVA)
  - User authentication for configuration control
- **New Archiver and Alarm Handler (BEAST)**
  - Data in Oracle
  - Configuration in Oracle
  - CSS Viewer

# System Tools – Alarm Handler - BEAST

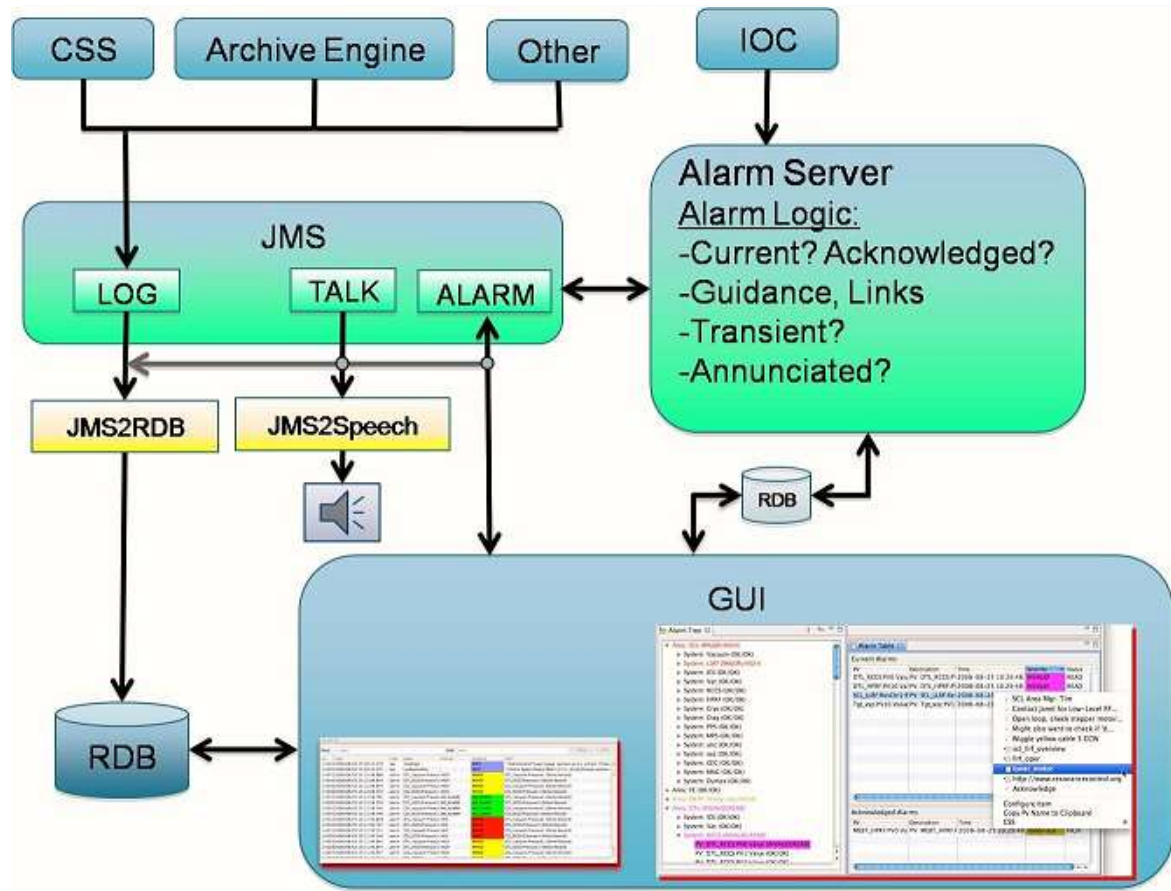
- Recently deployed in Operations
- Audible alarms deployed during last run
- New interface supports both tree view and list view
- View and acknowledge alarms from any console
- Each alarm includes guidance and related display
- Easy to pop up history of any alarm or configuration
- Easy to configure via web interface
- Tools to help determine configuration issues
- Adopted alarm configuration principles based on industry best practices
- Working on configurations with other groups

# New Archiver

- **Running in parallel with old archiver for many months**
- **Cutover for Operations on new Oracle cluster during this outage**
- **New CSS GUI retrieves data from old and new archiver repositories and immediately starts adding new values as they are updated (replaces old archive viewer and striptool)**
- **Capable of 8000 samples per second (4x estimated need)**
- **Easy to deploy viewer from any other CSS application**

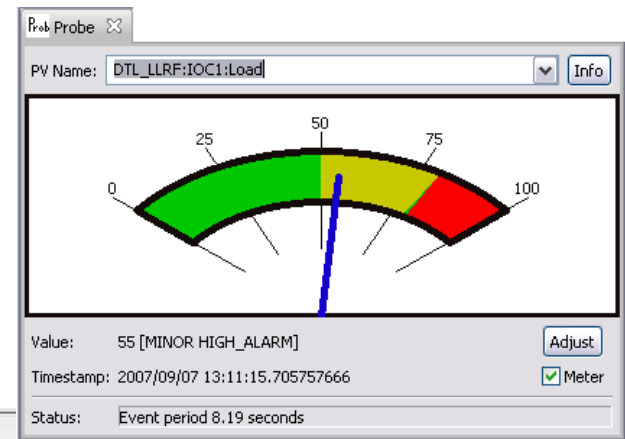
# Control System Studio (CSS)

- Deployed first set of modern, portable control system tools
  - Real-time Data
  - Archived Data
  - Alarm Data
  - Configuration Info
- Integrated
  - Easy transfer of PV names within CSS
  - Easy E-Log entries



# CSS Tools for Real-time Data

- 'Probe' PVs
- Inspect EPICS database links



EPICS PV Tree

PV: SCL\_LLRF:HPM01b:Cryo\_Sts

- ▼ PV 'SCL\_LLRF:HPM01b:Cryo\_Sts' (calc) = 1
  - ▼ INPA 'SCL\_LLRF:HPM01b:Cryo\_Perm' (bi) = OK
    - ▼ INP 'SCL\_Cryo:Cav01b:RFPerm' (calcout) = 1
      - ▶ INPA 'SCL\_Cryo:CM01:L\_P\_OK.SEVR' (calcout) = NO\_ALARM
      - ▶ INPB 'SCL\_Cryo:Cav01b:WinT1.SEVR' (ai) = NO\_ALARM
      - ▼ INPC 'SCL\_Cryo:Cav01b:WinT2.SEVR' (ai) = NO\_ALARM
        - INP '@Cryo\_ICS\_PLCS1 PCS1R05[7]'
      - ▶ INPD 'SCL\_Cryo:Cav01b:8mPipeT.SEVR' (ai) = NO\_ALARM
      - ▶ INPE 'SCL\_Cryo:Cav01b:OuterT.SEVR' (ai) = NO\_ALARM
        - INPF '2'
    - ▼ INPB 'SCL\_LLRF:HPM01b:Cryo\_Perm.SEVR' (bi) = NO\_ALARM
      - INP 'SCL\_Cryo:Cav01b:RFPerm' (calcout) = 1
        - INPC 'SCL\_LLRF:HPM01b:Cryo\_Ovr' (bo) = Oper. [INVALID UDF\_ALARM]



# CSS: Alarm System and Historic Data

- Obtain historic data for PV-in-alarm via mouse clicks
- User can annotate Graph, then send to E-Log

The screenshot displays the CSS Alarm System interface. On the left is the 'Alarm Tree' showing a hierarchy of areas and process variables (PVs). The 'Area: MEBT (OK/MAJOR/LOLO\_ALARM)' is expanded, and several PVs are highlighted in red, indicating they are in an alarm state. The central graph shows the historic data for 'MEBT\_RF: Bnch02: V\_Plt\_PA [W]' from 2008/12/22 16:5:19 to 16:24. The graph shows a power amplifier trip at 16:20:27, followed by a 'Try to recover' period. A red arrow points from the 'Trip!' annotation on the graph to the corresponding entry in the 'Current Alarms' table. The 'Alarm Table' is divided into 'Current Alarms' and 'Acknowledged Alarms' sections.

PV	Description	Time	Current Sev	Severity	Status	Value
MEBT_RF: Bnch02: V_Plt_PA	MEBT two power amplifier trip	2008/12/22 16:20:27	OK	MAJOR	LOLO_ALAI	0.02
MEBT_RF: Bnch02: I_Plt_PA	MEBT two power amplifier trip	2008/12/22 16:20:28	OK	MAJOR	LOLO_ALAI	0.10

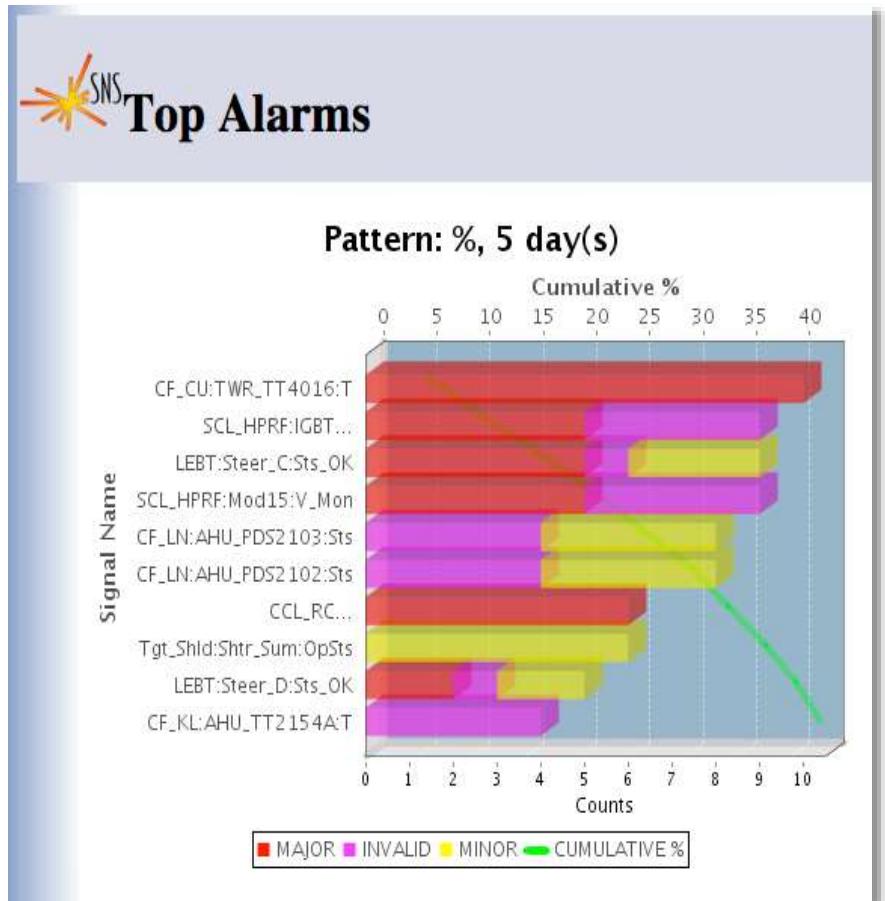
  

PV	Description	Time	Current Sev	Severity	Status	Value
ICS_MPS: PLC_Sum1	M P S P L C fault	2008/12/22 03:05:29	MAJOR	majorack'ed	LOLO_ALAI	0
ICS_Tim: Gate_BeamOn: Sw	Beam off	2008/12/19 18:30:16	MINOR	minorack'ed	STATE_ALAI	Shifted

# Configuration and Performance Info

- Locate IOC and Rack info for PV from RDB
- Various alarm system reports

The image shows two software windows. The left window, 'PV Utility', displays a list of IOCs with 'CCL\_PS:IOC1' selected. Below the list are fields for 'Process Variables' and a table of 'Process Variable' and 'PV' data. The right window, 'Rack View', shows a 'Rack List (Filter):' and a 'Device or Process Variable:' field set to 'CCL\_Mag:DCH110:B'. It includes a 'Device List' table and a 3D rack diagram with components like 'PPS', 'AC DISTRIBUTION', and 'PS'.



# Challenges

- **Attracting and retaining proper skills mix**
- **Balancing workload, setting priorities**
  - **Upgrades and new features**
  - **Supporting Operations**
  - **Improving Availability**
  - **Updating neglected documentation and data management**
  - **Implementing configuration control**
- **Not enough resources to go around**