

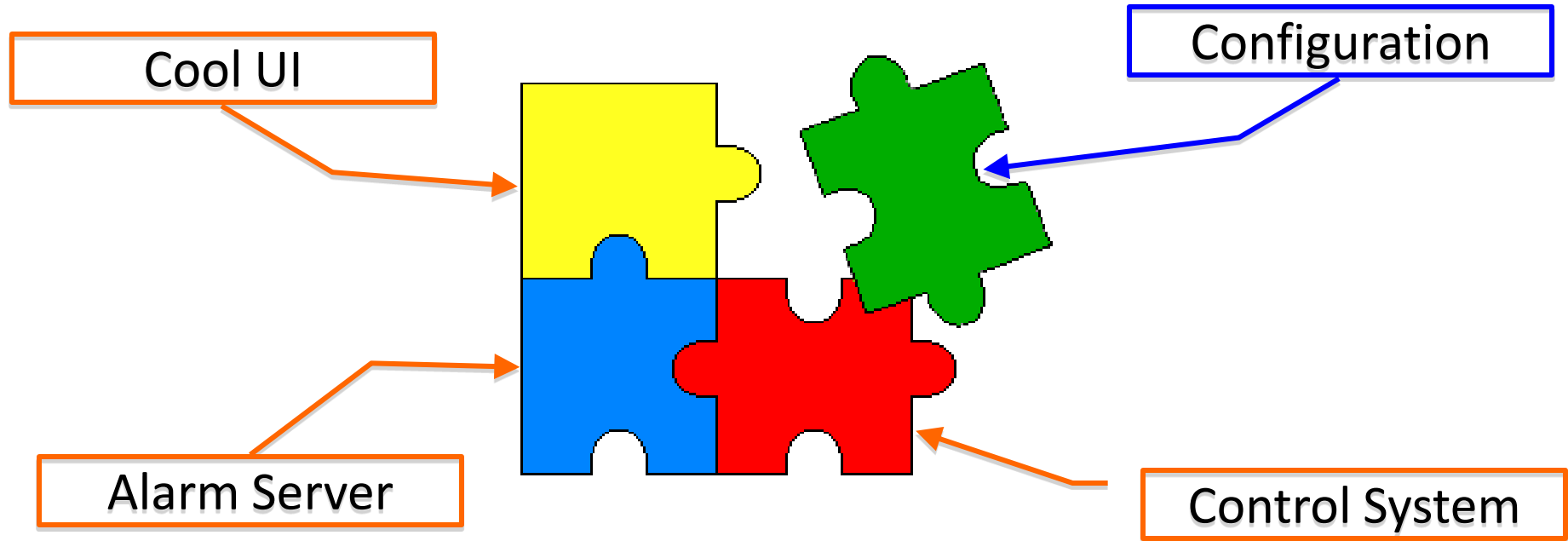
Best Ever Alarm System Toolkit

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BEAST

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ICALEPCS 2009,
Kobe, Japan,
Oct 2009

Alarm System Components

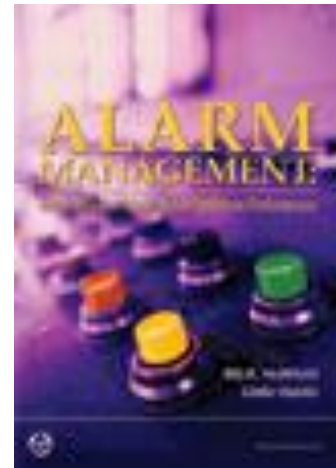


This talk: Alarm System Technology

See also:

"Alarms Philosophy", Karen White (this conference)

B. Hollifield, E. Habibi, "Alarm Management: Seven Effective Methods for Optimum Performance", ISA, 2007



Previous Attempts at SNS, Inspiration

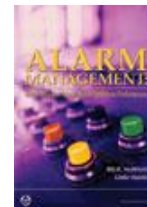
EPICS “ALH”, Generated soft-IOCs and EDM screens

- Old technology
- Static UI layout
- N clicks to see (some of the) active alarms
- **Configuration** changes were hard (so config. was left in bad shape)

DESY Alarm System

Matthias Clausen, “Alarm Management System”, PCaPAC, Oct 2008, Slovenia and “Managing Alarms ... the CSS Way”, this conference

- ✓ Modern technology, linked into Control System Studio
- Different infrastructure: LDAP vs. RDB
- How does a PV turn into an alarm?



Ideas from “Alarm Management: ...” book

- Need multiple views of alarms
- Alarms must have guidance, links to related displays
- Need tools to monitor alarm rate, stale alarms, ...
to continually improve **configuration**

New End-User View: Alarm Table

Acknowledge one or multiple alarms

- Select by PV or description
- BNL/RHIC type un-ack'

Sort by column

All current alarms

- active
- ack'ed

Optional:
Voice Annunciation



PV	Description	Time	Current Seve	Severity	Status	Value
ICS_MPS:FPAR_CCL_BS:FP	* mps fault	2009/04/15 16:22:50	MAJOR	MAJOR	LINK_ALARM	0
CF_KL:DIWS_AIT4306B:Rs	Check polishing loop resistivity for KL4	2009/04/15 15:50:58	OK	MINOR	HIGH_ALAR	2.5

PV	Description	Time	Current Seve	Severity	Status	Value
TMod:Summary_MPS:Alarm	Moderator System MPS Trip or PLC	2009/04/13 08:19:02	INVALID	invalid-ack'ed	READ_ALAR	Ready
HEBT_Coll:CT2:Cond	Hebbit collimator outlet flow conduct	2009/04/13 08:19:02	MAJOR	major-ack'ed	LOLO_ALAR	0.016

Another View: Alarm Tree

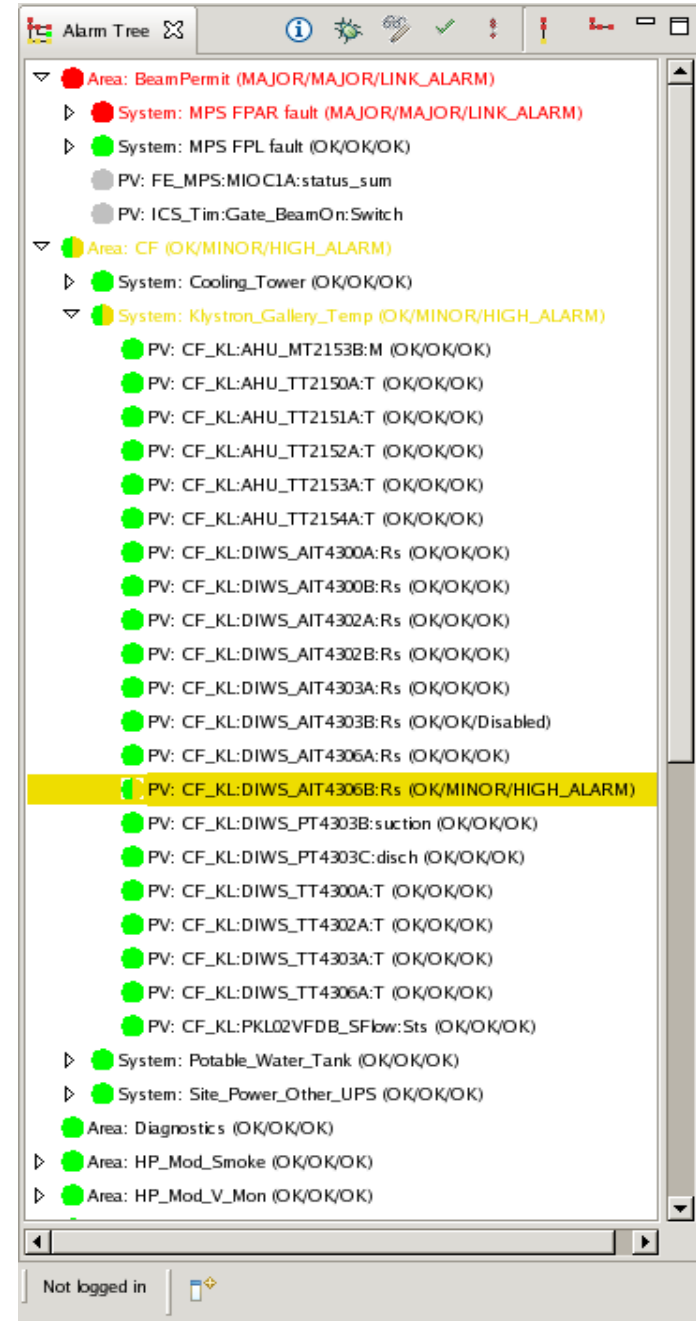
See complete configuration

- Active, ack'ed, inactive, disabled

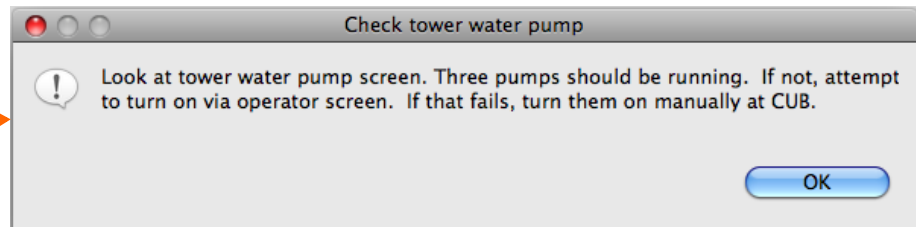
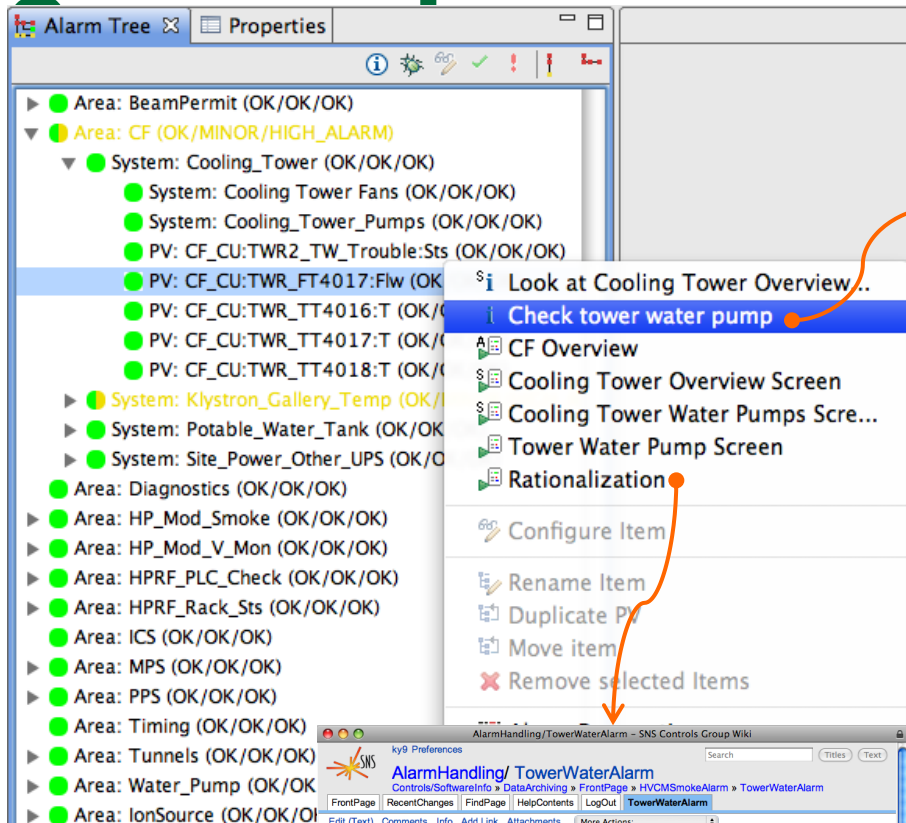
Hierarchical

- Optionally only show active alarms
- Ack'/Un-ack' PVs or sub-tree

Users choose to display
table and/or tree



Guidance, Related Displays



- ✓ View Guidance Texts
- ✓ Start related displays (EDM)
- ✓ Open Web pages
- ✓ Run ext. commands

Hierarchical:
Including info of parent entries

Merges Guidance etc. from all selected alarms

Alarm PV: CF_CU:TWR2_TW_Trouble:Sts

Purpose of Alarm

Indicates insufficient tower water problem, either flow or elevated temperature or pump failure.
Flow (5500gpm) and temperature limits are fixed in the PLC. For changes see contacts listed below.

Operator Guidance

Look at tower water pump screen. There should be 3 pumps running. If not, attempt turn-on via operator screen.
If that fails, turn them on manually at CUB. If all fails, call contacts listed below.

Failure Consequence

MAJOR consequence: Beam will be off for 12 hours, cold box will trip, ...
TODO: List the top 3 critical items and response times in each case to avoid shutdown.

Operator Response Time Available

Usually less than 5 minutes in order to prevent further temperature increase.
TODO: Response time depends on beam power. How should this be factored into response?

Contacts

Water System Mechanical Engineers: Greg Irby, Jerry Ferguson Control System Contact: Frank Brantley

CSS Integration: Alarm → Data Browser

1. Context menu: Alarm Duration, Guidance, Displays, ...
2. Select Data Browser for PV in alarm
3. View history, annotate

The screenshot displays the CSS Alarm Tree on the left and the Alarm Table on the right. The Alarm Tree lists various areas and their associated PVs, with the 'MEBT_CHOP:PS_2:V' PV highlighted. The Alarm Table shows a list of current alarms, with the 'MEBT_CHOP:PS_2:V' alarm selected. A context menu is open over the selected alarm, showing options like 'Check MEBT PS 2 Chopper', 'MEBT Chopper PS 2 Screen', 'Logbook...', 'Acknowledge', 'Copy Pv Name to Clipboard', and 'CSS'. The 'CSS' option is highlighted, and a sub-menu is visible showing 'Data Browser', 'Data Browser View', 'PV Table', 'Rack View', 'PV Utility', 'PV Fields Viewer', 'Probe', and 'EPICS PV Tree'. The 'Data Browser' option is selected, and a 'Data Browser View' window is shown in the bottom right corner.

Alarm Tree:

- Area: BeamPermit (MAJOR/major-ack'ed/LOLO_ALARM)
 - PV: FE_MPS:MIOC1A:status_sum (MAJOR/major-ack'ed/LOLO_ALARM)
 - PV: ICS_Tim:Gate_BeamOn:Switch (MINOR/minor-ack'ed/LOLO_ALARM)
- Area: CF (MINOR/MINOR/HIGH_ALARM)
- Area: Diagnostics (OK/OK/OK)
- Area: HP_Mod_Smoke (OK/OK/OK)
- Area: HP_Mod_V_Mon (OK/OK/OK)
- Area: HPRF_PLC_Check (OK/OK/OK)
- Area: HPRF_Rack_Sts (OK/OK/OK)
- Area: ICS (OK/OK/OK)
- Area: MPS (OK/OK/OK)
- Area: PPS (OK/OK/OK)
- Area: Timing (OK/OK/OK)
- Area: Tunnels (OK/OK/OK)
- Area: Water_Pump (OK/OK/OK)
- Area: IonSource (OK/OK/OK)
- Area: LEBT (OK/OK/OK)
- Area: RFQ (OK/OK/OK)
- Area: SCL (OK/OK/OK)
- Area: HEBT (MAJOR/major-ack'ed/LOLO_ALARM)
- Area: RID (OK/OK/OK)
- Area: Ring (OK/OK/OK)
- Area: RTBT (OK/OK/OK)
- Area: Target (INVALID/invalid-ack'ed/READ_ALARM)
- Area: Test (OK/MAJOR/HiHi_ALARM)
- System: LLRF (OK/OK/OK)
- PV: Instr_BmLn:XXSTATE5216A:Sts (OK/OK/OK)
- PV: RFQ_Vac:Pump2:Pressure (OK/MAJOR/HiHi_ALARM)
- PV: RFQ_Vac:Pump3:Pressure (OK/MINOR/HIGH_ALARM)
- PV: RFQ_Vac:Pump4:Pressure (OK/MINOR/HIGH_ALARM)
- PV: RFQ_Vac:Pump5:Pressure (OK/MINOR/HIGH_ALARM)
- PV: RFQ_Vac:Pump6:Pressure (OK/MINOR/HIGH_ALARM)

Alarm Table:

PV	Description	Time	Current	Severity	Status	Value
RFQ_Vac:Pump2:Pressure	Demo pump 2	2009/03/17 16:48:10	OK	MAJOR	HiHi_ALARM	9.0
RFQ_Vac:Pump6:Pressure	Demo pump 6	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump5:Pressure	Demo pump 5	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump4:Pressure	Demo pump 4	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump3:Pressure	Demo pump 3	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
FE_MPS:MIOC1A:status_sum	MPS Beam permit	2009/03/17 16:46:28	MAJOR	MAJOR	LOLO_ALARM	2
ICS_Tim:Gate_BeamOn:Switch	Beam awf	2009/03/17 16:46:27	MINOR	MINOR	STATE_ALARM	Shift
CF_KL:DIWS_AIT4303B:Rs	CF_KL:DIWS_AIT4303B:Rs	2009/03/17 16:10:06	MINOR	MINOR	HIGH_ALARM	18.5
MEBT_CHOP:PS_2:V	mebbit chopper power supply one voltage fault	2009/03/17 16:10:06	MAJOR	MAJOR	LOLO_ALARM	0.0

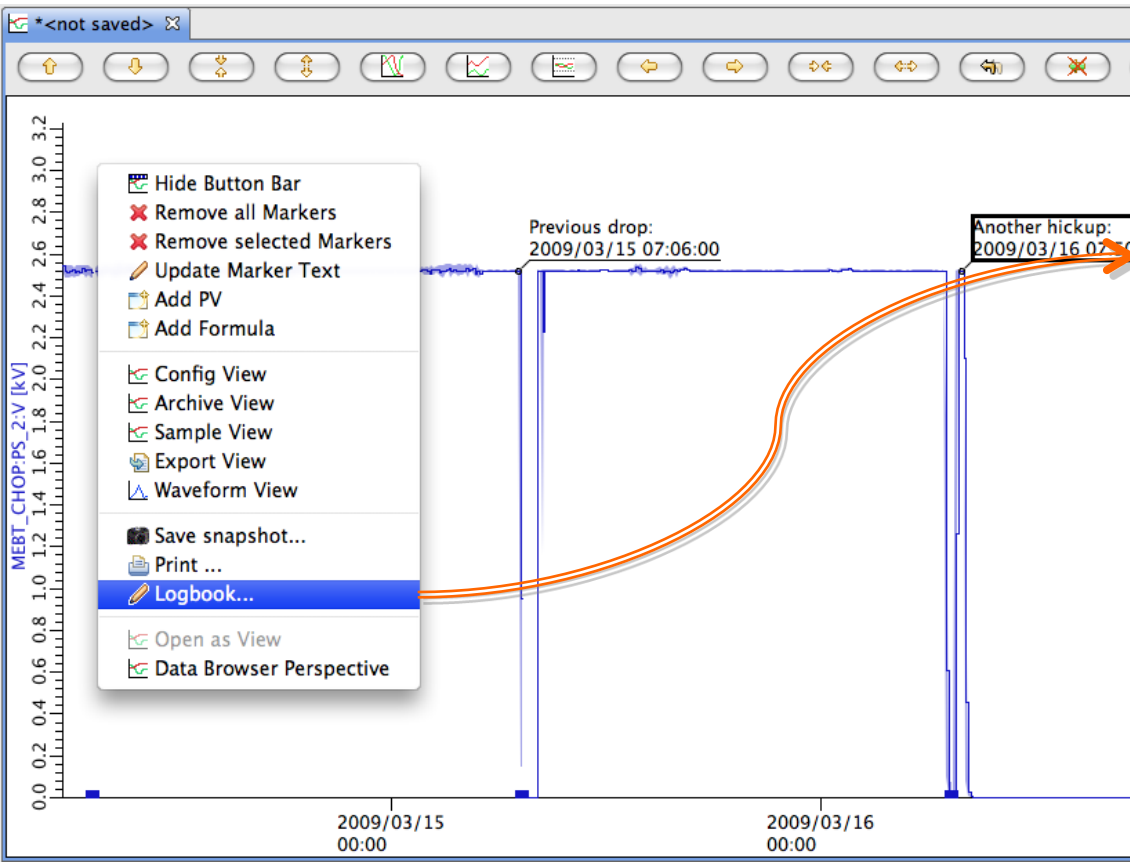
MEBT_CHOP:PS_2:V [kV] History:

Previous drop: 2009/03/15 07:02:54

Another hiccup: 2009/03/16 07:55:42

Data Browser → Electronic Logbook

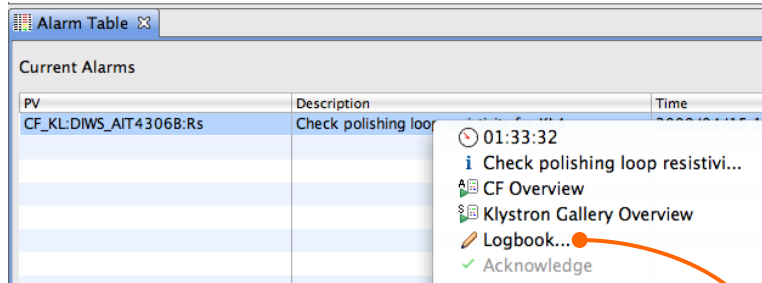
After inspecting alarm PV's history, post commented plot to E-Log



The screenshot shows the 'Logbook Entry' dialog box. It has a title bar with standard window controls. The main area contains the following fields and text:

- Create electronic logbook entry**
- Enter user, password, maybe edit text. Snapshot of current plot will be attached.
- User name:** Fred
- Password:** (masked with dots)
- Logbook:** Electrical Systems (dropdown menu)
- Title:** Data Browser Snapshot
- Text:**
 - Just got another chopper trip. This time was different, though, because we did this and not that, while before we tried that and not this.
 - Called Jim who suggested to wiggle the blue cable before resetting
 - Attached image was created by Data Browser
- Attached Image...** (placeholder for a screenshot of the plot)
- Buttons:** Cancel, OK

Directly from Alarm to E-Log



- **“Logbook”**
from context menu
creates text w/
basic info about
selected alarms.
Edit, submit.

The screenshot shows a window titled "Logbook Entry" with the subtitle "Create electronic logbook entry". Below the subtitle is the instruction "Enter name, password, maybe edit the alarm information". The form contains the following fields:

- User name:
- Password:
- Logbook:
- Title:
- Text:

Received this alarm while turning the puple thingy on.

Fixed it by turning the second valve from the left three clicks clockwise.

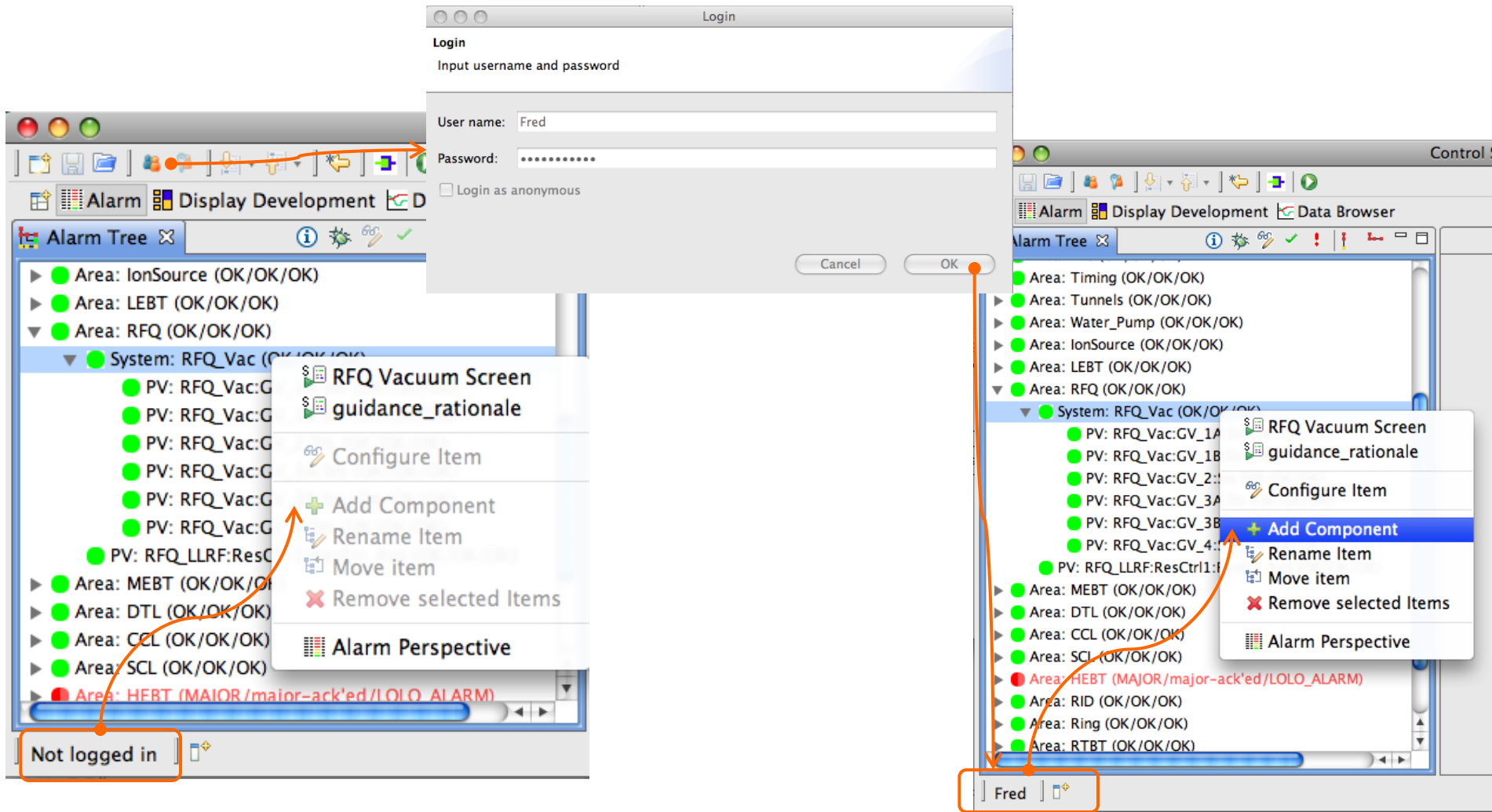
Check polishing loop resistivity for KL4
PV: CF_KL:DIWS_AIT4306B:Rs
Time: 2009/04/15 15:50:58.735057000 (Duration 01:14:23)
Severity/Message: MINOR/HIGH_ALARM
Value: 2.5
Current Severity: OK

At the bottom of the window are "Cancel" and "OK" buttons. An orange arrow points from the "Logbook Entry" window back to the "Logbook..." option in the context menu of the "Alarm Table" window.

Online Configuration Changes

.. may require Authentication/Authorization (LDAP)

✓ Log in/out while CSS is running



Configure PV

- Again online
- Especially useful for operators to update guidance and related screens.

Alarm Item Configuration

Item: Annunciator/RFQ/RFQ_LLRF:ResCtrl1:ResErr_Avg
Configure guidance, related displays, ...

Description: Elevated R F Q resonance error

Alarm Delay [seconds]: 0

Alarm Count [within delay]: 0

Behavior: ☒ Enabled ☐ Latch ☒ Annunciate

Enabling Filter:

Guidance:

Title	Detail
Check and fix resonance error	Check LLRF measurement of cavity residency error.
<Add>	<Add>

Displays:

Title	Command
RFQ LLRF	startedm -m S=RFQ,N=1,TN=
RFQ Chiller	startedm Cool
Rationalization	https://ics-web.sns.ornl.gov/
<Add>	<Add>

Commands:

Title	Command
<Add>	<Add>

ID: 621 Last configured: 2009/04/14 16:46:17

Cancel OK

Edit Row Data

Title: Check and fix resonance error

Details: Check LLRF measurement of cavity resonance error.
Try to reduce error by adjusting LLRF pulse width as per the Daily Order.

Cancel OK

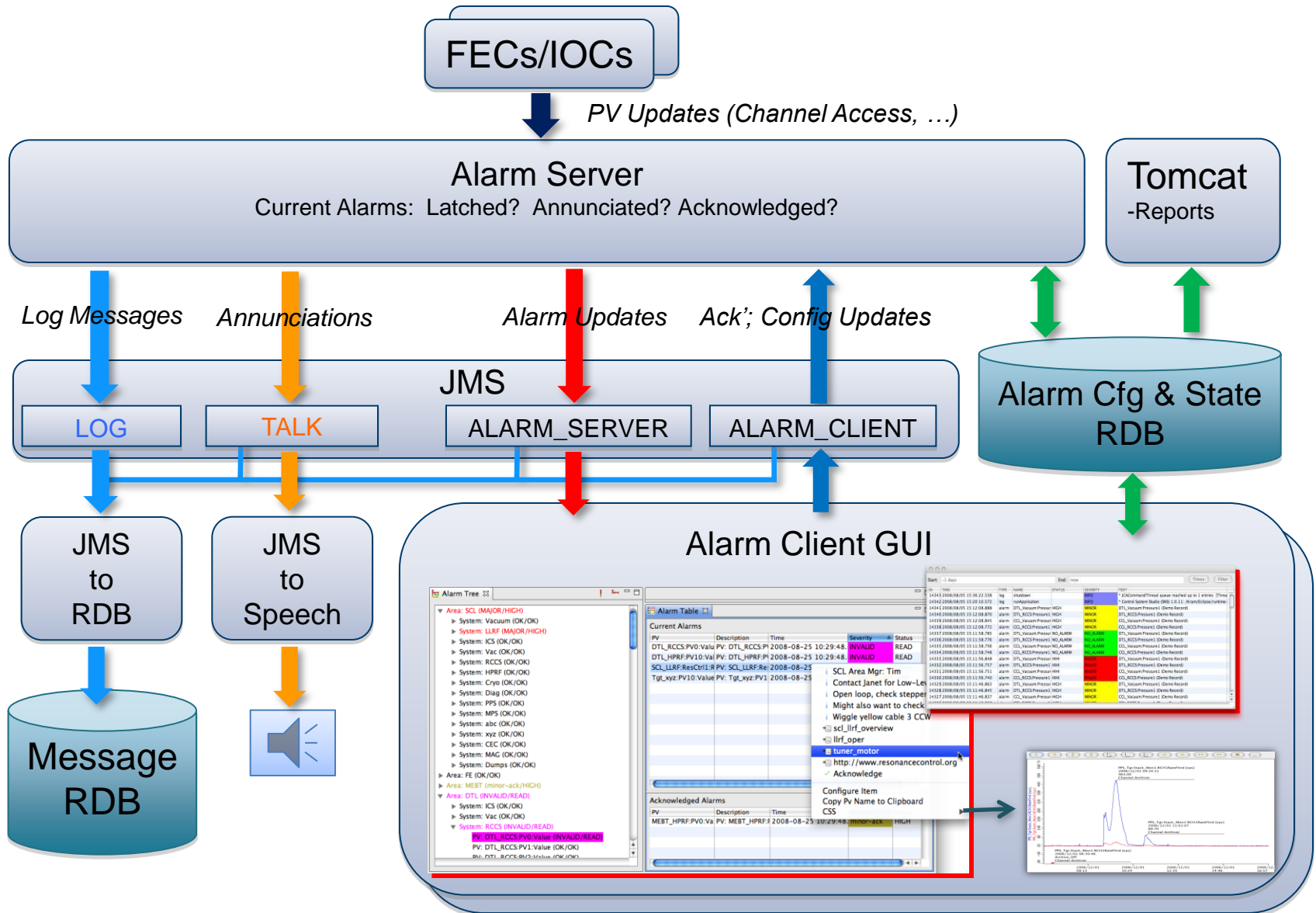
▼ ● Area: RFQ (OK/OK/OK)

▼ ● System: RFQ_Vac (OK/OK/OK)

- PV: RFQ_Vac:GV_1A RFQ Vacuum Screen
- PV: RFQ_Vac:GV_1B guidance_rationale
- PV: RFQ_Vac:GV_2: RFQ Vacuum Screen
- PV: RFQ_Vac:GV_3A RFQ Vacuum Screen

Configure Item

Technical View

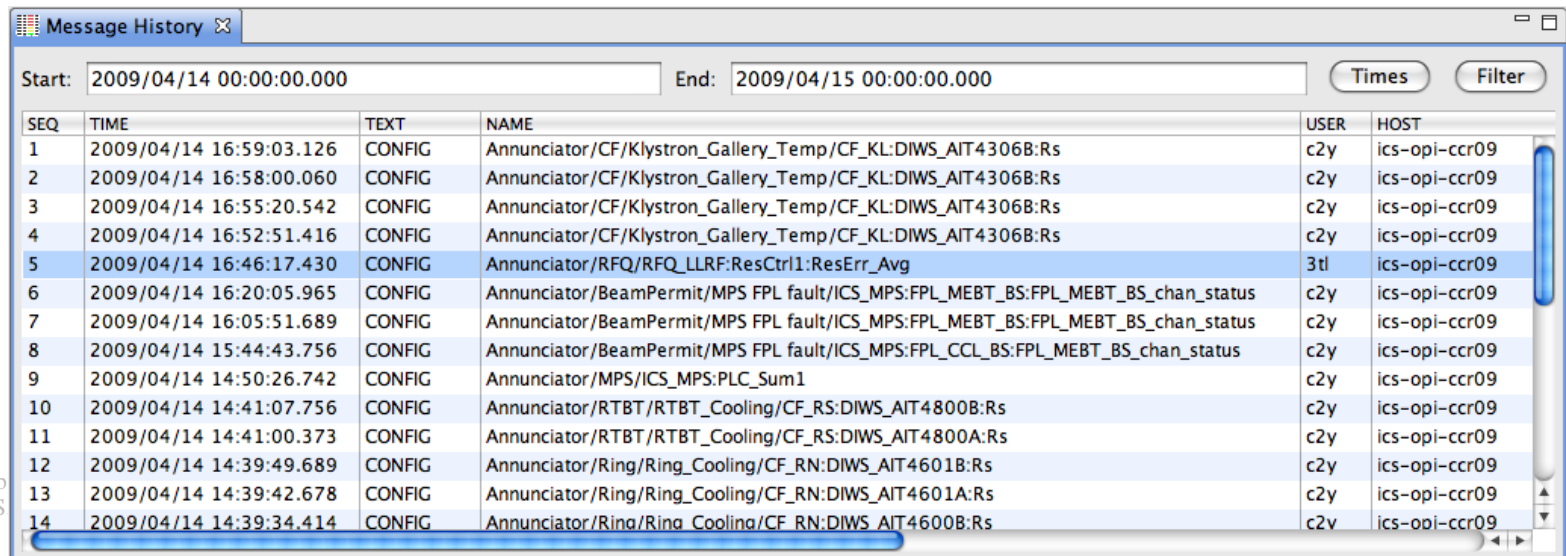


Alarm Server Options

- Latch highest severity, require acknowledgement?
- Annunciate?
- Chatter filter
 - Alarm only if severity persists some minimum time
 - .. or alarm happens $\geq N$ times within period
- Optional formula-based alarm enablement:
 - Enable if “(pv_x > 5 && pv_y < 7) || pv_z==1”
 - ... but we prefer to move that logic into IOC
- “Maintenance Mode”: Invalid PVs don’t annunciate, automatically acknowledged

Logging

- ..into generic CSS log also used for error/warn/info/debug messages
- Alarm Server: State transitions, Annunciations
- Alarm GUI: Ack/Un-Ack requests, Config changes
- Generic Message History Viewer
 - Example w/ Filter on TEXT=CONFIG



The screenshot shows a window titled "Message History" with a search filter set to "TEXT=CONFIG". The window displays a table of messages with columns for SEQ, TIME, TEXT, NAME, USER, and HOST. The messages are sorted by time, showing a sequence of CONFIG messages from 2009/04/14 16:59:03.126 to 2009/04/14 14:39:34.414. The messages are filtered to show only those with TEXT=CONFIG.

SEQ	TIME	TEXT	NAME	USER	HOST
1	2009/04/14 16:59:03.126	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
2	2009/04/14 16:58:00.060	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
3	2009/04/14 16:55:20.542	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
4	2009/04/14 16:52:51.416	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
5	2009/04/14 16:46:17.430	CONFIG	Annunciator/RFQ/RFQ_LLRF:ResCtrl1:ResErr_Avg	3tl	ics-opi-ccr09
6	2009/04/14 16:20:05.965	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
7	2009/04/14 16:05:51.689	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
8	2009/04/14 15:44:43.756	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_CCL_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
9	2009/04/14 14:50:26.742	CONFIG	Annunciator/MPS/ICS_MPS:PLC_Sum1	c2y	ics-opi-ccr09
10	2009/04/14 14:41:07.756	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800B:Rs	c2y	ics-opi-ccr09
11	2009/04/14 14:41:00.373	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800A:Rs	c2y	ics-opi-ccr09
12	2009/04/14 14:39:49.689	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601B:Rs	c2y	ics-opi-ccr09
13	2009/04/14 14:39:42.678	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601A:Rs	c2y	ics-opi-ccr09
14	2009/04/14 14:39:34.414	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4600B:Rs	c2v	ics-opi-ccr09

Logging: Get timeline

Filter on TYPE, PV

Message History

Start: 2009/04/12 07:00 End: 2009/04/12 20:31

TIME	TYPE	TEXT	SEVERITY	USER
2009/04/12 08:31:38.020	talk	MAJOR alarm: mps fault	MAJOR	alarms
2009/04/12 08:31:29.292	talk	MAJOR alarm: Check S C L 15 Modulator voltage	MAJOR	alarms
2009/04/12 08:31:38.307	talk	MAJOR alarm: S C L 15 modulator in standby	MAJOR	alarms

6. All OK

Times Filter

TIME	DELTA	TYPE	TEXT	NAME	STATUS	SEVERITY	CURRENT_SEVERITY	USER	APPLI...ON-ID	HOST
2009/04/12 20:30:29.522	00:00:00.039	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 20:30:29.483	08:16:59	alarm	ACK	SCL_HPRF:Mod15:V_Mon				accl-oper	CSS	ics-opi-c
2009/04/12 12:13:30.319	00:01:42	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 12:11:47.332	01:03:08	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:08:38.729	00:02:06	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:06:32.713	02:31:01	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:35:31.364	00:04:02	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:31:29.283	01:15:20	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 07:16:09.109	00:00:00.014	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc

3. Alarm Server annunciates

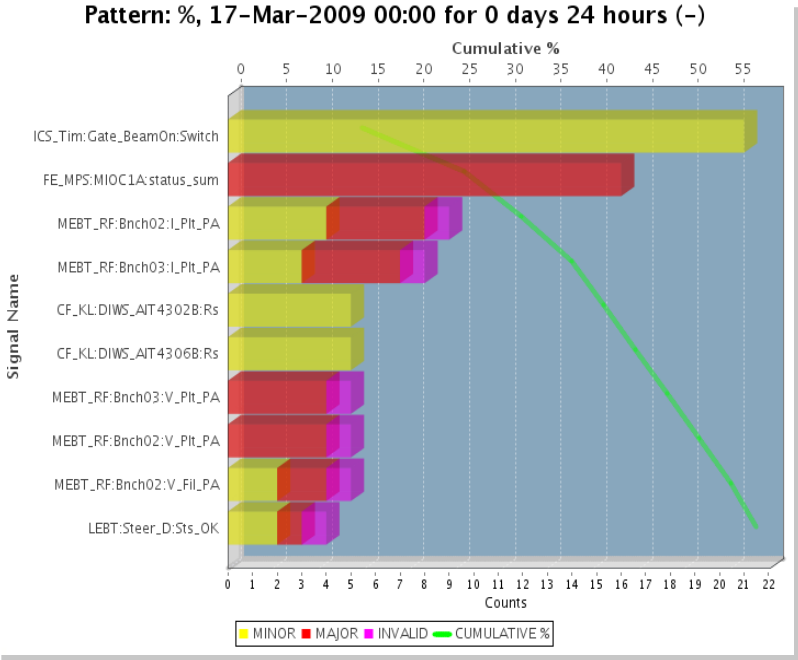
2. Alarm Server latches alarm

1. PV triggers, clears, triggers again

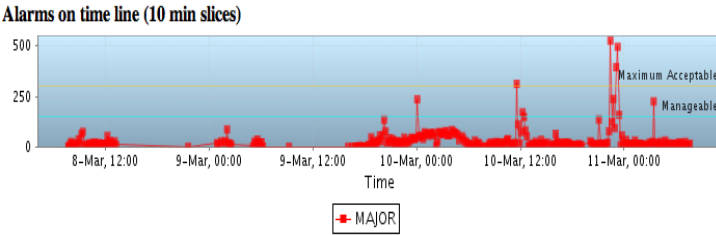
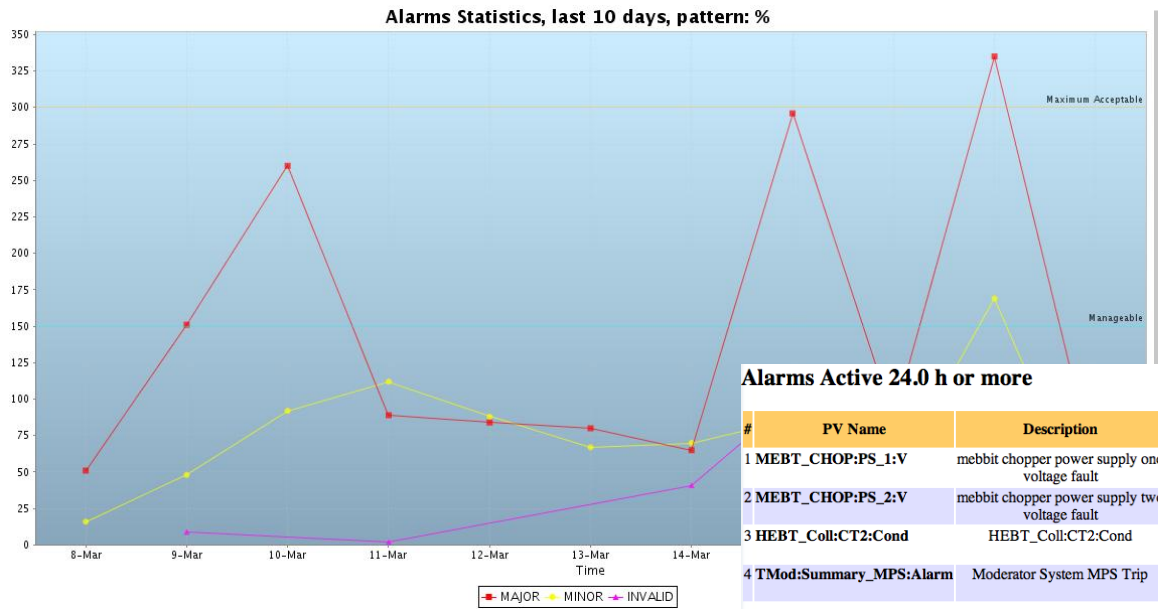
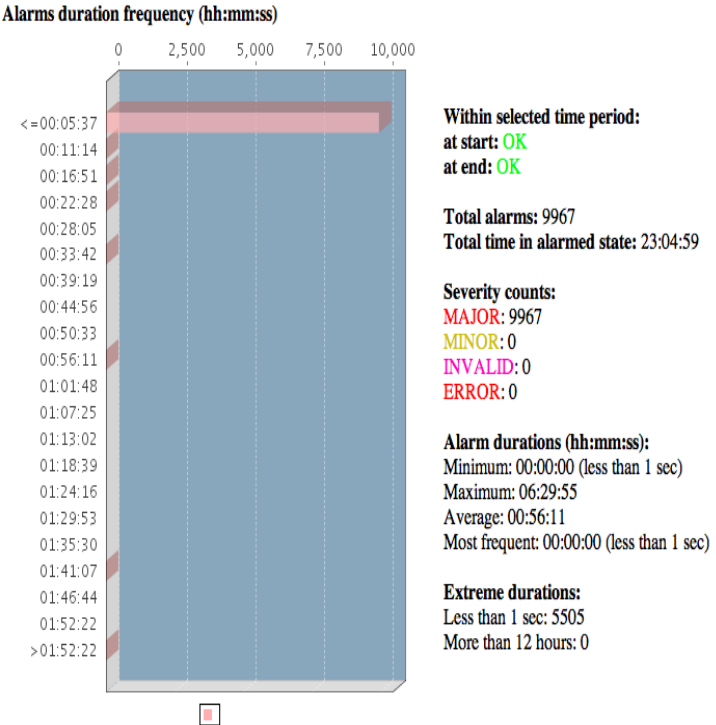
4. Problem fixed

5. Ack'd by operator

Numerous Web Reports



Statistics based on CURRENT SEVERITY:



Summary

- **Tools won't produce a good configuration, but help to improve it**
 - Most frequent alarms?
 - Alarm 'noise'?
- **BEAST operational at SNS since Feb'09**
 - Started with previous ALH setup
 - ~300, no guidance, no related displays
 - Now ~400, all with guidance, rel. displays, links to operational procedures
 - Alarm Server stable through IOC reboots, online configuration changes, Oracle updates
- **Alarm GUI is 'best ever' for SNS**