Control System Studio

- CSS -

Alarm Handling

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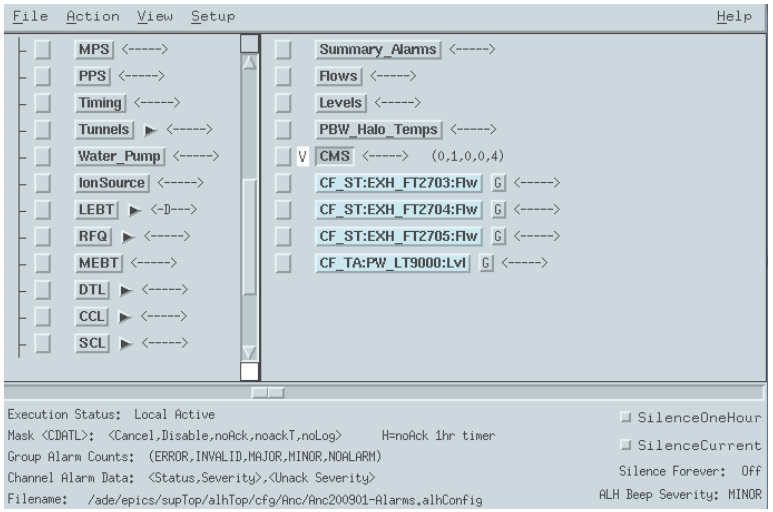
Previous Attempts at SNS

ALH; manual “summary” displays; generated soft-IOCs + displays



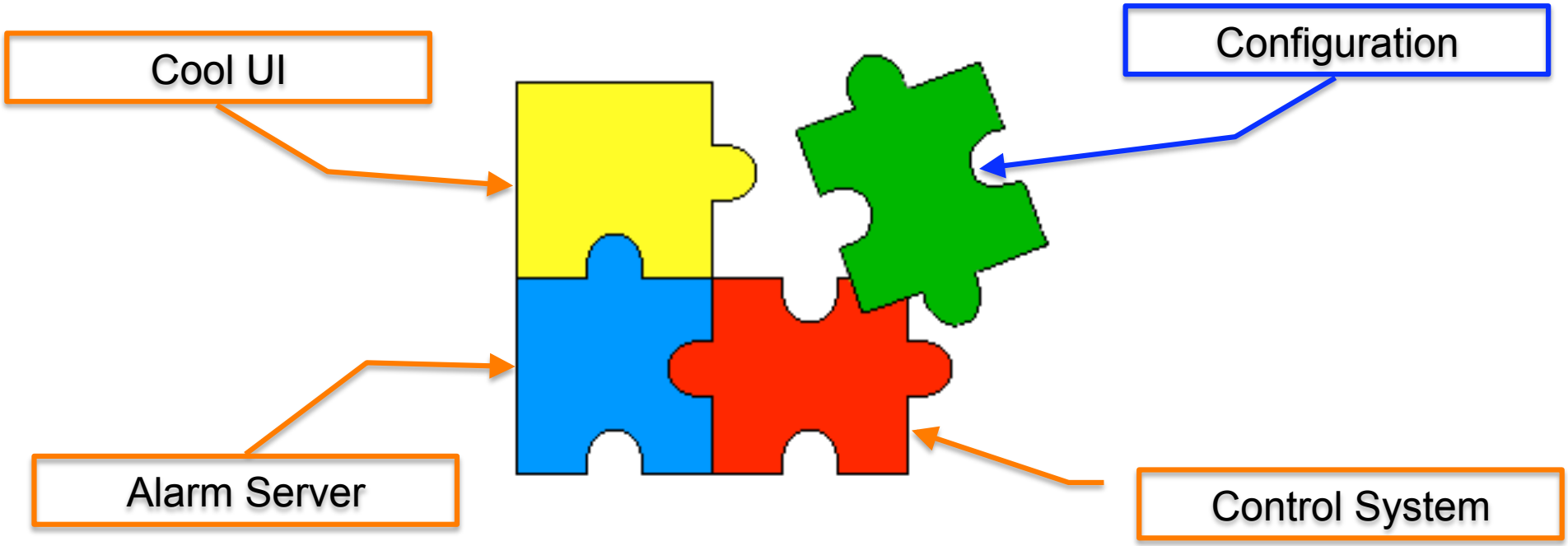
Issues

- GUI
  - Static Layouts
  - N clicks to see active alarms
- Configuration
  - .. was bad ➔ Always too many alarms
  - Changes required contacting one of the 2 experts, wait ~days, restart CA gateway, hope that nothing else broke
- Information
  - Operator guidance?
  - Related displays?
  - Most frequent alarm?
  - Timeline of alarm?

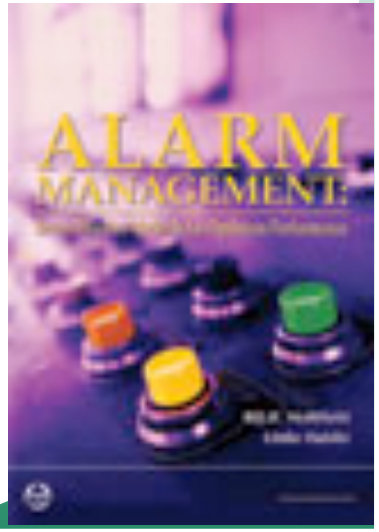
Now: Best Ever Alarm System Tool

Yes, alarms are always a little scary…

Alarm System Components



1. What you see
2. Technical details
3. How to use it



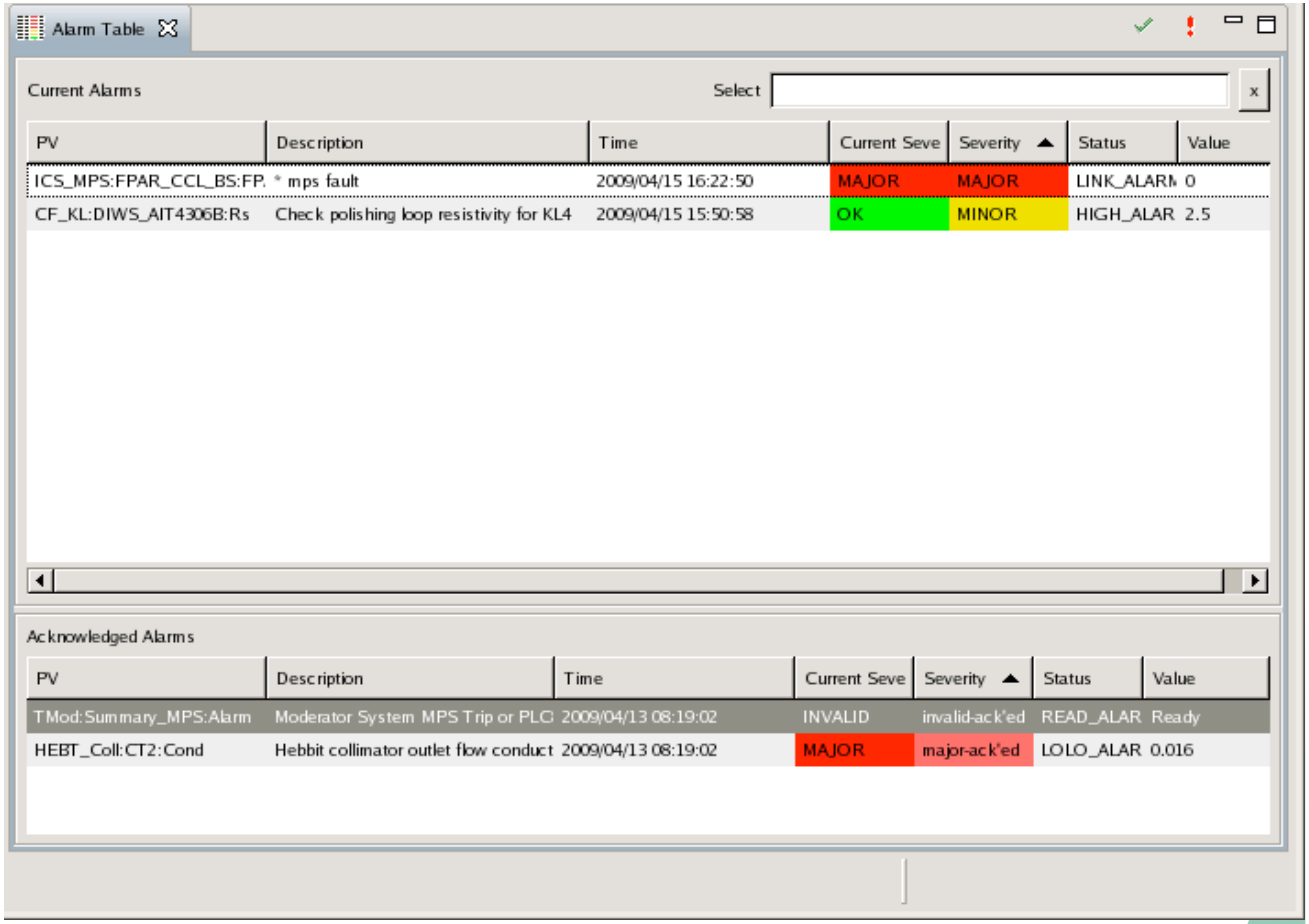
B. Hollifield, E. Habibi, "Alarm Management: Seven Effective Methods for Optimum Performance", ISA, 2007

1. What you see

Alarm GUI used by Operators

What you see: Alarm Table

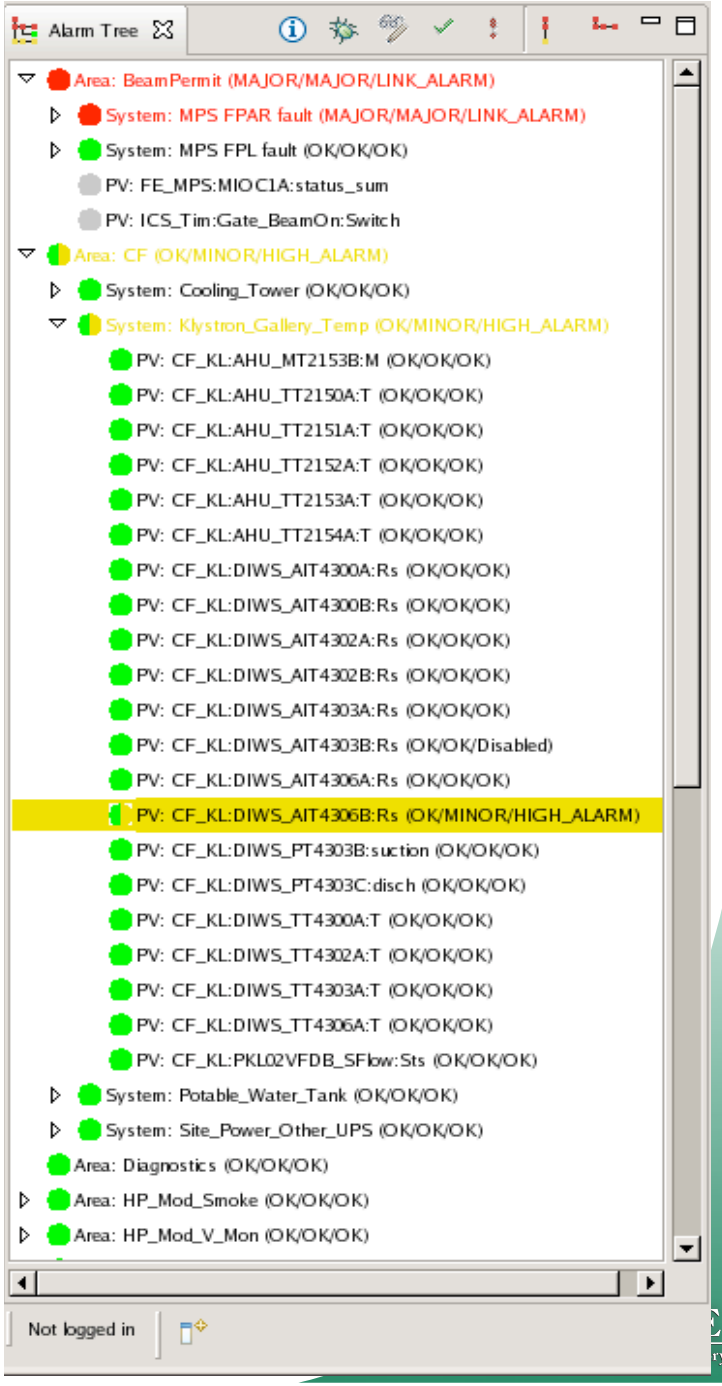
- All current alarms
  - new, ack'ed
- Sort by PV, Descr., Time, Severity, …
- Optional: Annunciate



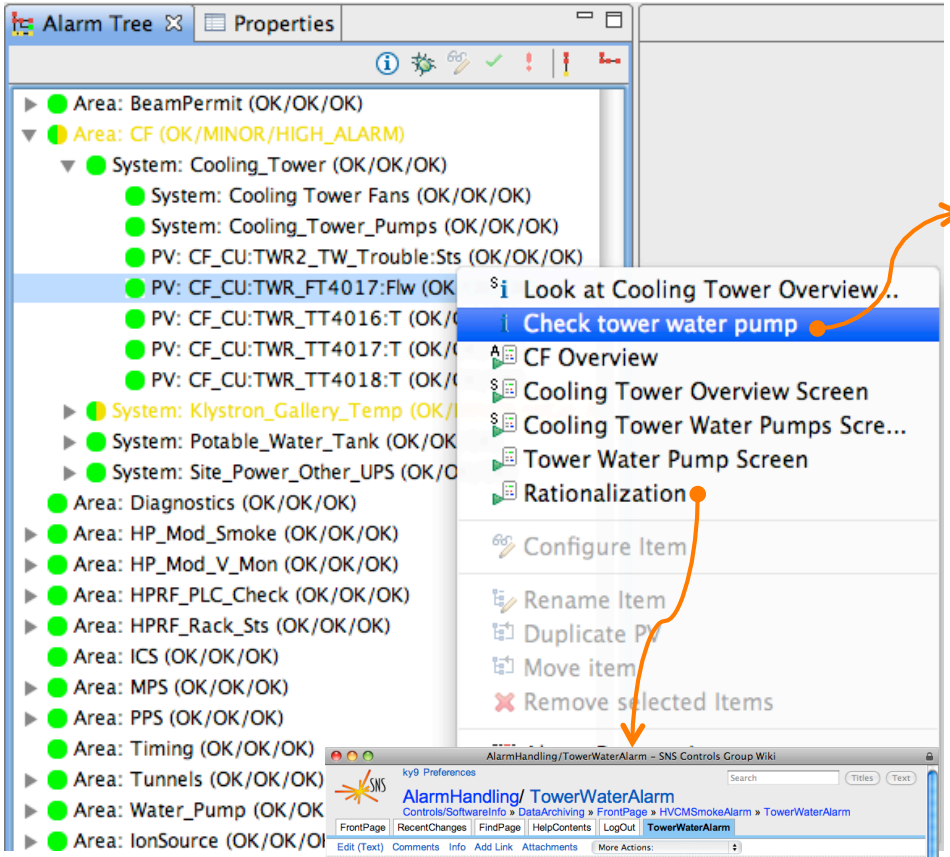
- Acknowledge one or multiple alarms
  - Select by PV or description
  - BNL/RHIC type un-ack'

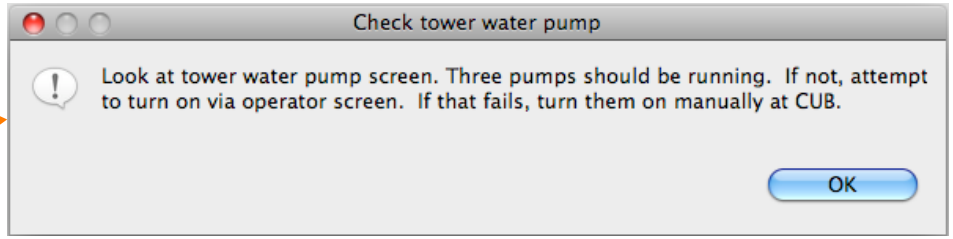
Another View: Alarm Tree

- All alarms
  - Disabled, inactive, new, ack'ed
- Hierarchical
  - Optionally only show active alarms
  - Ack'/Un-ack' PVs or sub-tree



Guidance, Related Displays, Commands





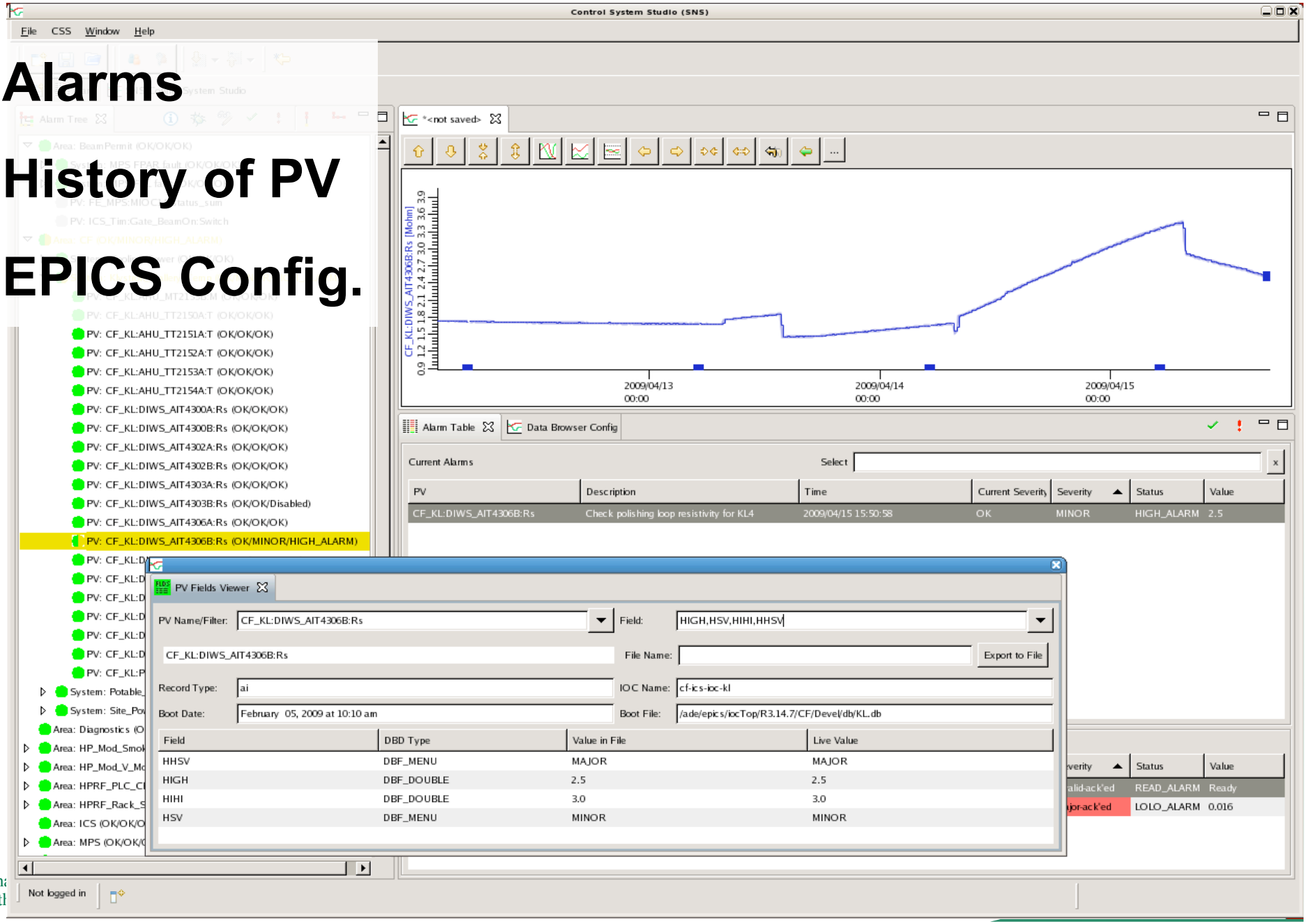
- ☑ **Basic Text**
- ☑ **Open EDM/OPI screen**
- ☑ **Open web page**
- ☑ **Run ext. command**

Hierarchical:
Including info of parent entries

Merges Guidance etc. from all selected alarms

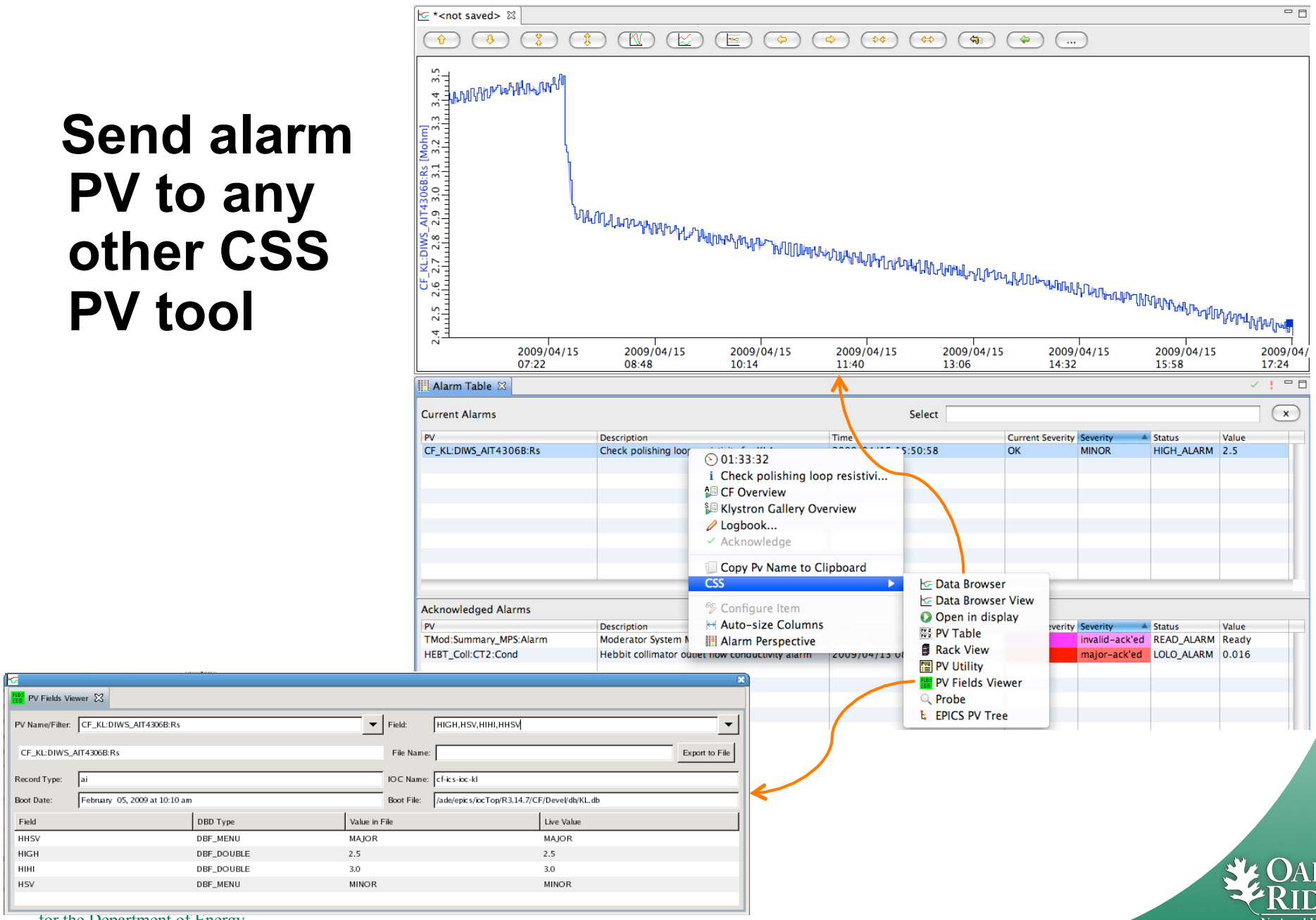
Integrated with other CSS Tools

- ☑ Alarms
- ☑ History of PV
- ☑ EPICS Config.

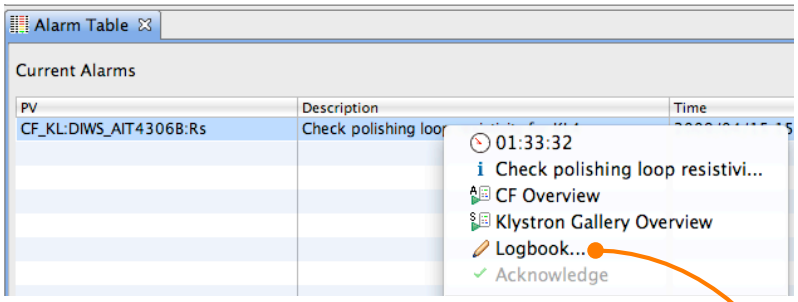


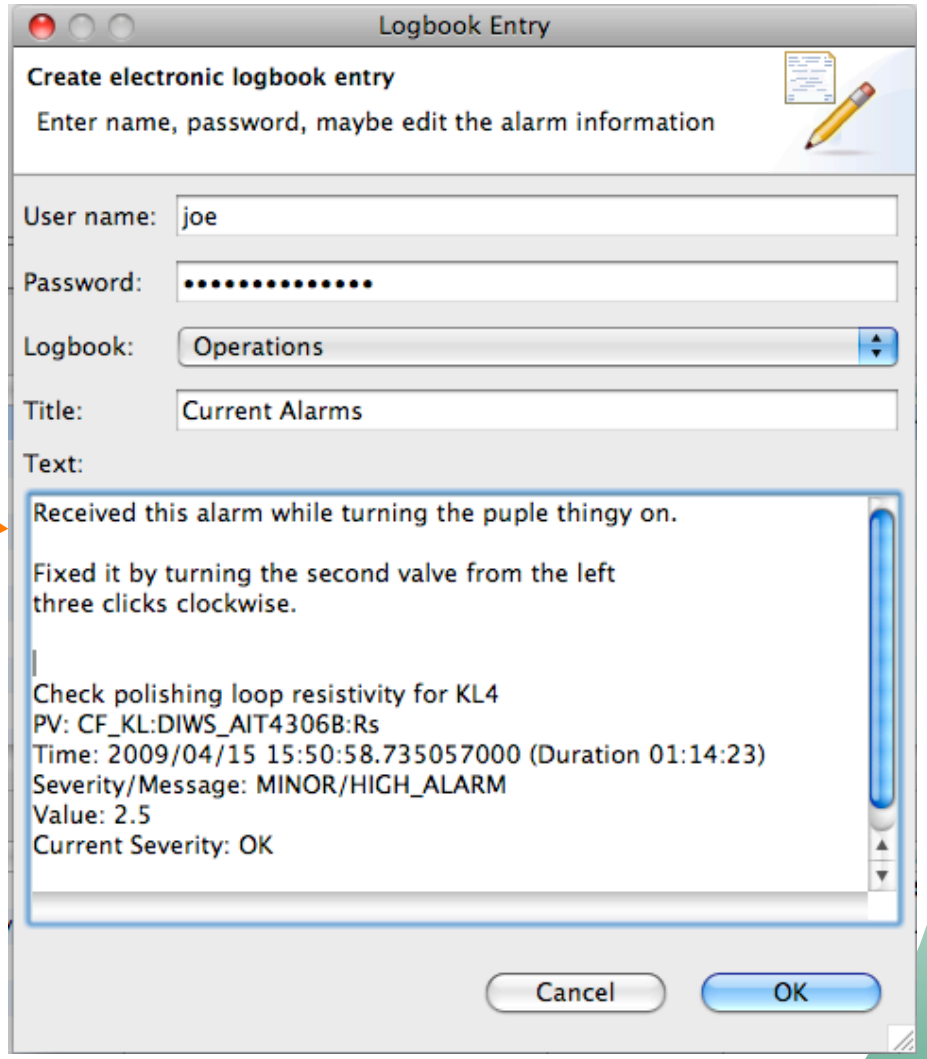
CSS Context Menus Connect the Tools

Send alarm PV to any other CSS PV tool



E-Log Entries





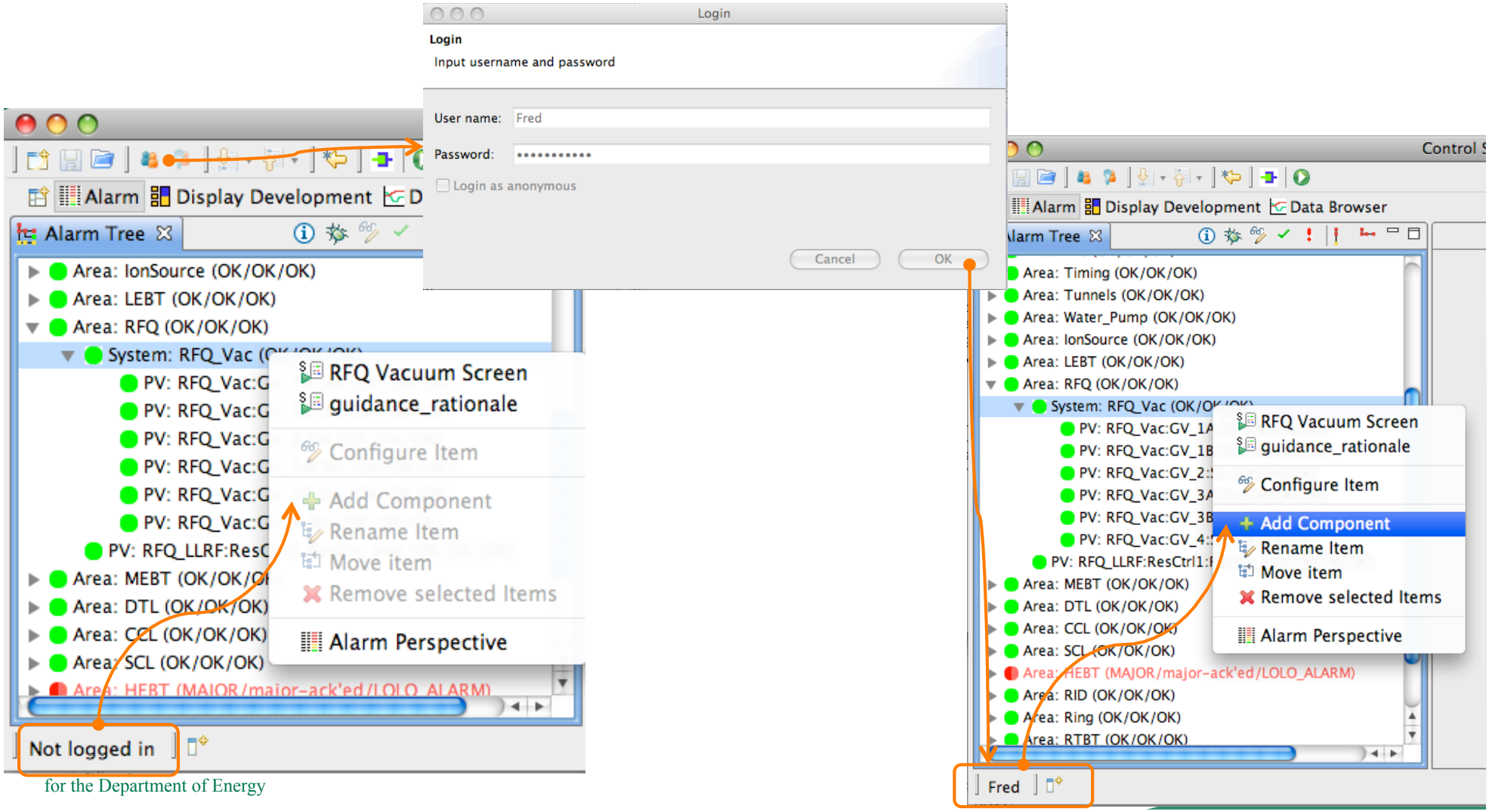
- **"Logbook" from context menu creates text w/ basic info about selected alarms. Edit, submit.**

- **Pluggable implementation, not limited to Oracle-based SNS ELog**

Online Configuration Changes

.. may require Authentication/Authorization

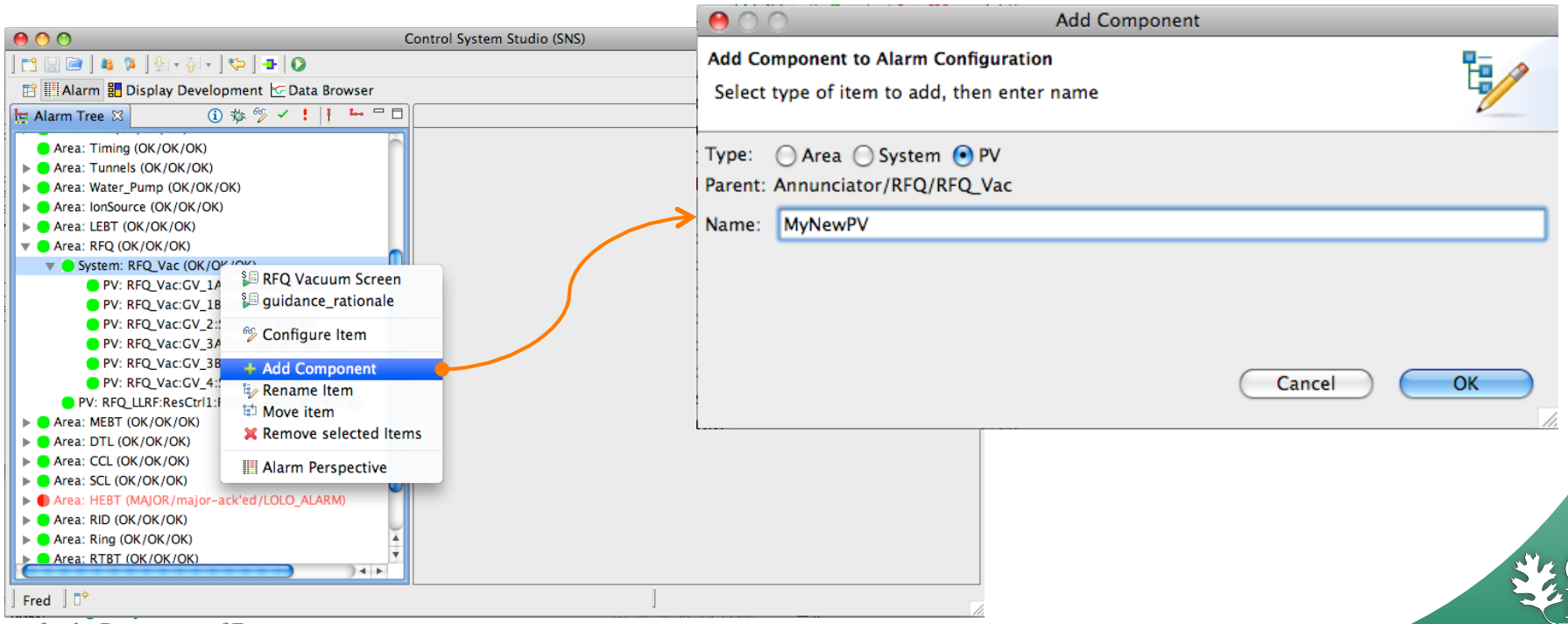
☑ Log in/out while CSS is running



Add PV or Subsystem

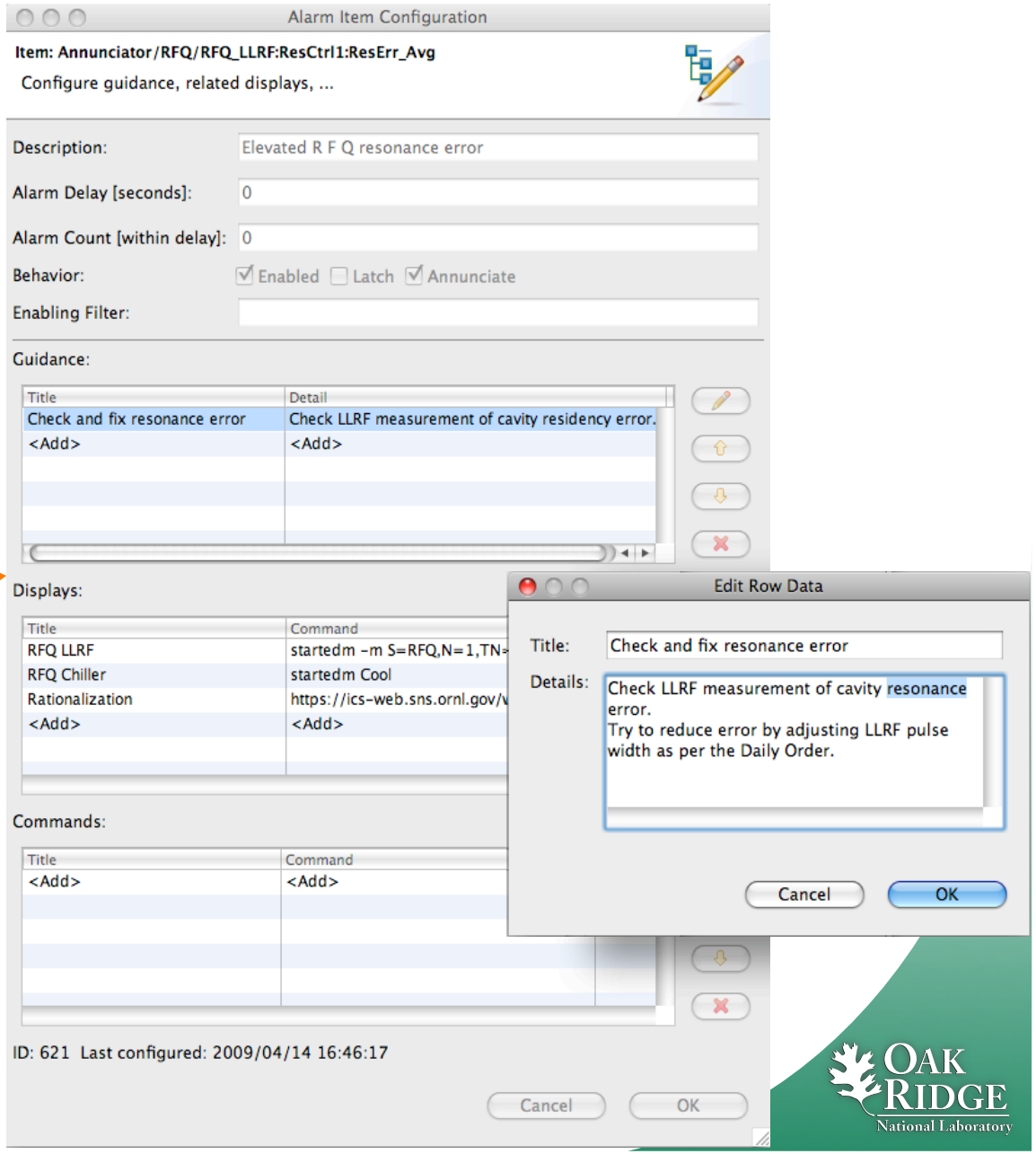
1. Right-click on ‘parent’
2. “Add …”
3. Enter name

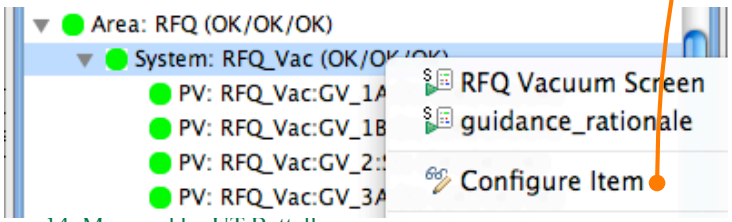
Online. No search for config files, no restarts.



Configure PV

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

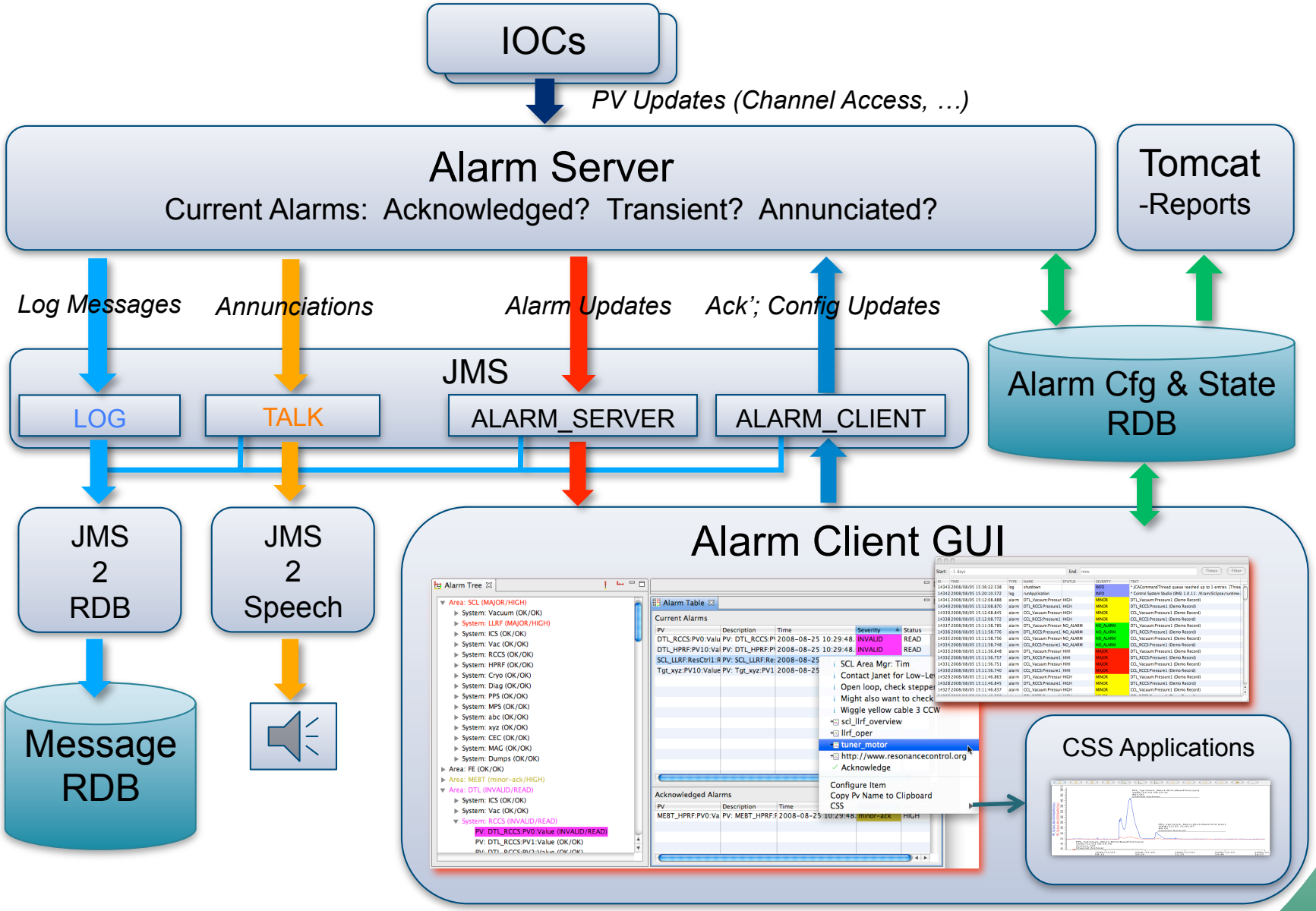




2. Technical details

Behind the GUI;
Tools to monitor performance

Technical View

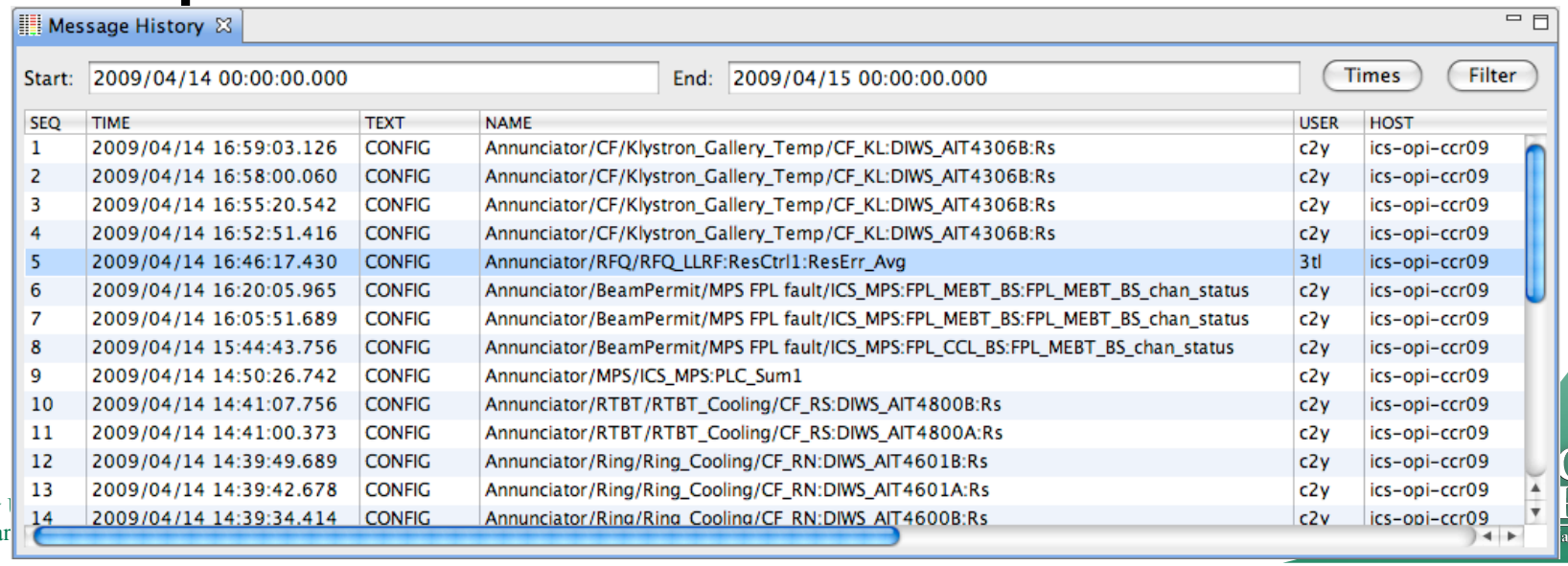


General Alarm Server Behavior

- Latch highest severity, or non-latching
  - like ALH “ack. transient”
- Annunciate
- Chatter filter ala ALH
  - Alarm only if severity persists some minimum time
  - .. or alarm happens >=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
- When acknowledging MAJOR alarm, subsequent MINOR alarms not annunciated
  - ALH would again blink/require ack’

Logging

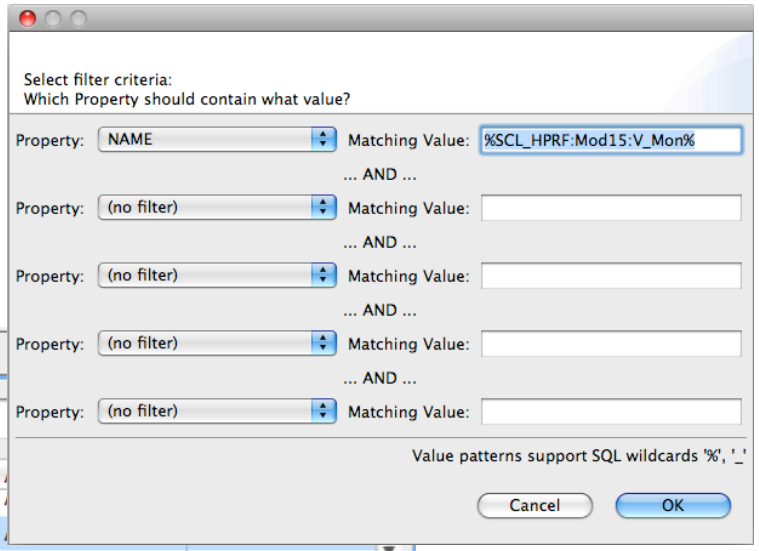
- ..into generic CSS log also used for error/warn/ info/debug messages
- Alarm Server: State transitions, Annunciations
- Alarm GUI: Ack/Un-Ack requests, Config changes
- Generic Message History Viewer
  - Example w/ Filter on TEXT=CONFIG

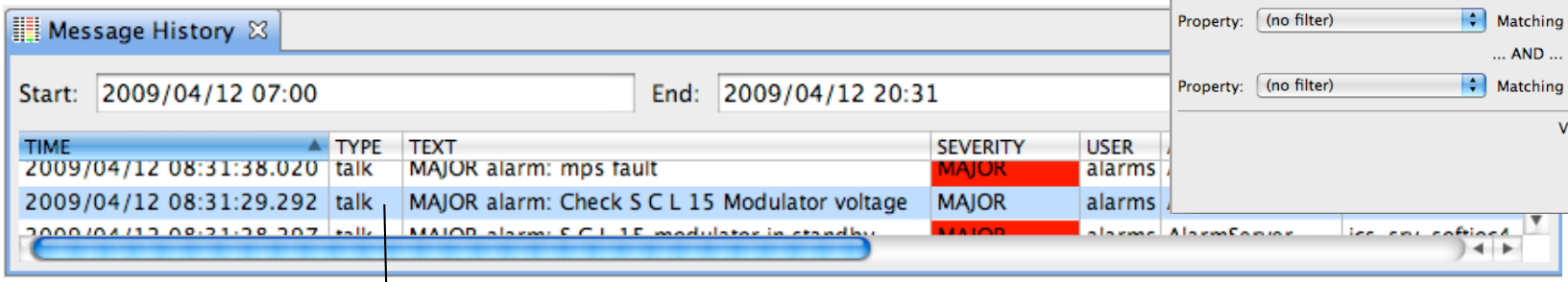


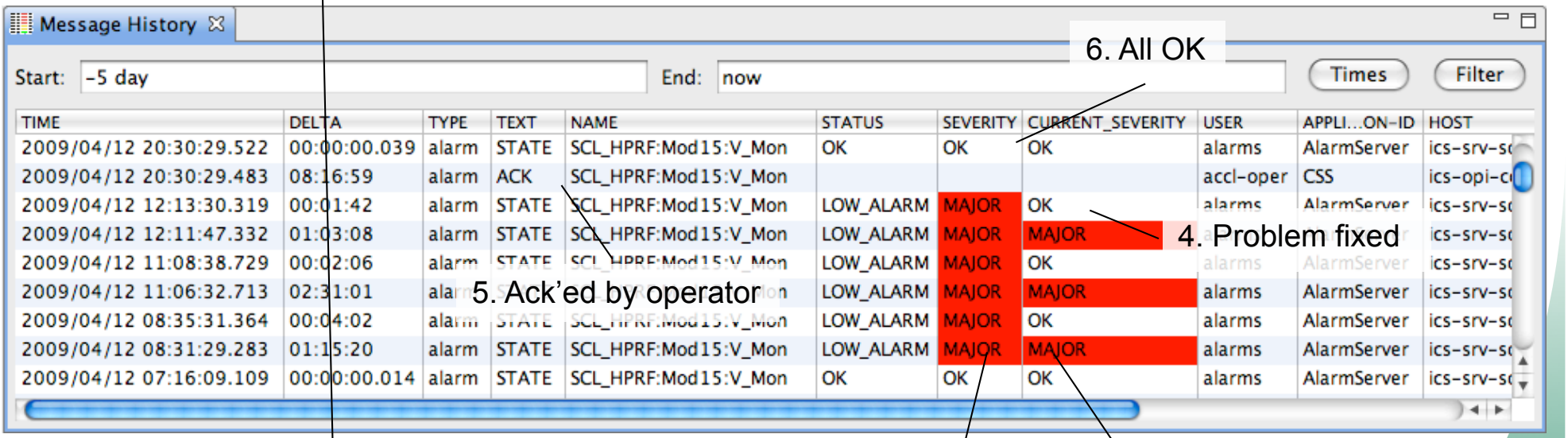
SEQ	TIME	TEXT	NAME	USER	HOST
1	2009/04/14 16:59:03.126	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
2	2009/04/14 16:58:00.060	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
3	2009/04/14 16:55:20.542	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	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	c2y	ics-opi-ccr09

Logging: Get timeline

- **Example: Filter on TYPE, PV**







6. All OK

4. Problem fixed

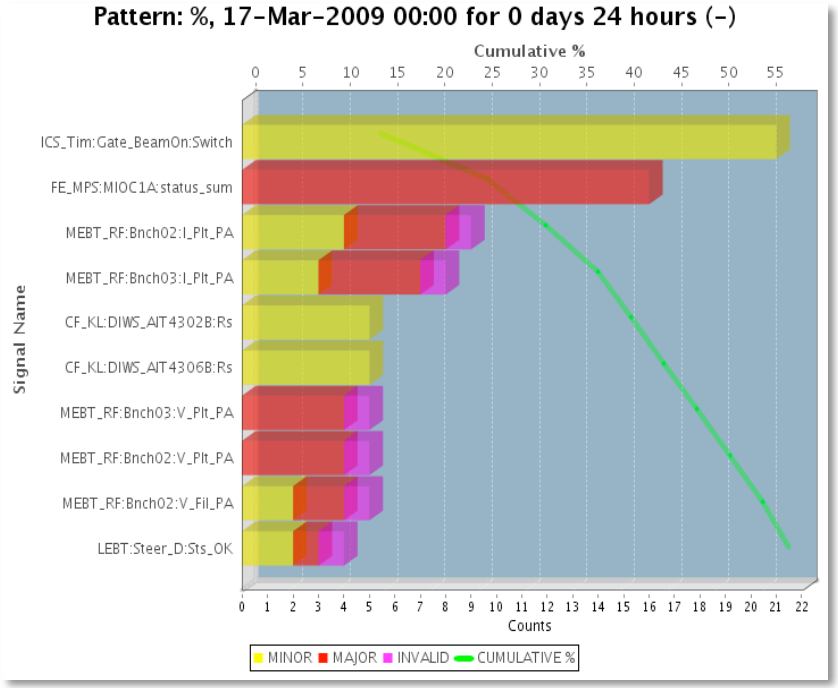
5. Ack'ed by operator

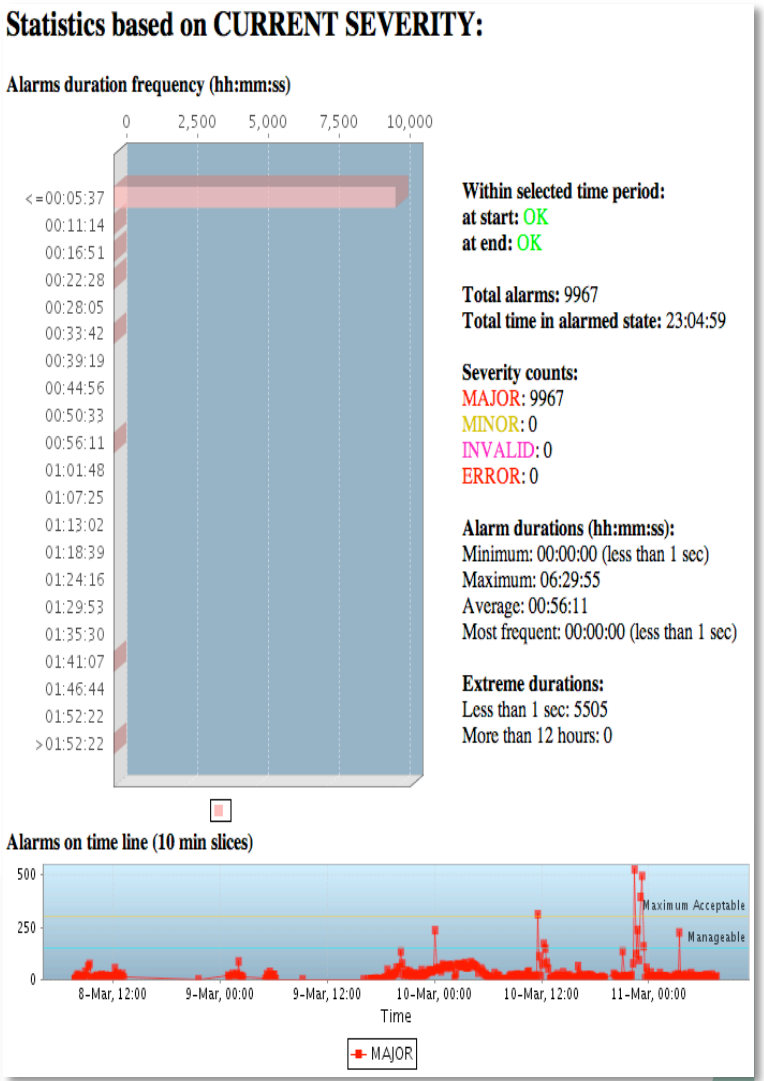
3. Alarm Server annunciates

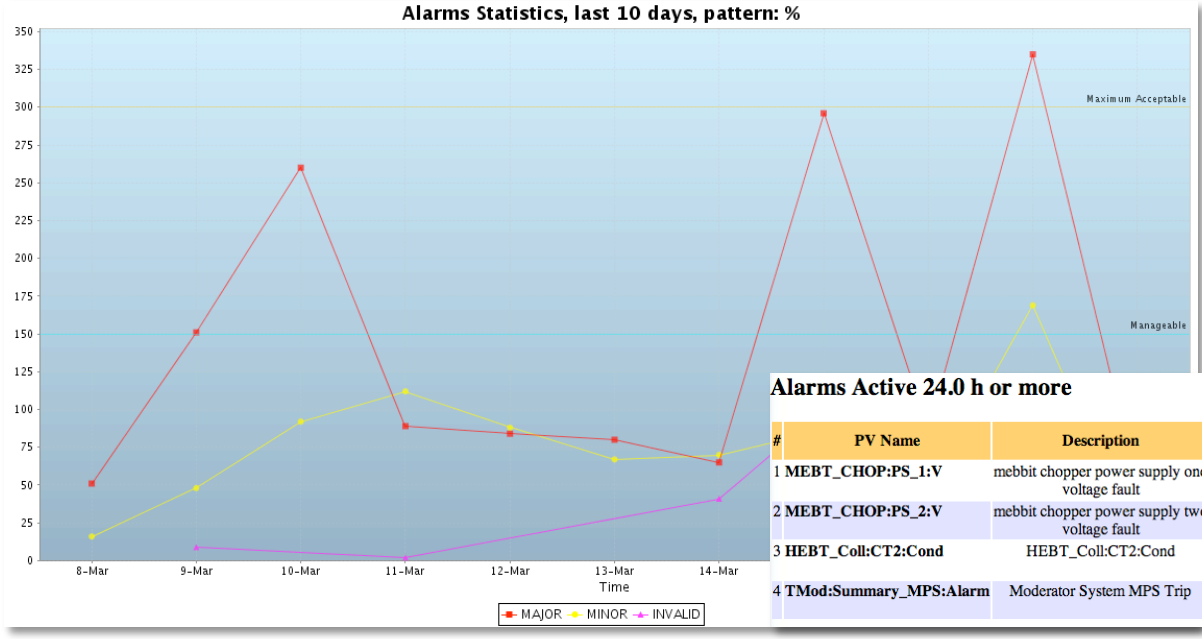
2. Alarm Server latches alarm

1. PV triggers, clears, triggers again

All Sorts of Web Reports







Alarms Active 24.0 h or more

#	PV Name	Description	Path	Alarm Time	...Duration [HH:MM:SS]	Severity	Alarm Message	Current Severity
1	**MEBT_CHOP:PS_1:V**	mebbit chopper power supply one voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
2	**MEBT_CHOP:PS_2:V**	mebbit chopper power supply two voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
3	**HEBT_Coll:CT2:Cond**	HEBT_Coll:CT2:Cond	/Annunciator/HEBT/HEBT_Cooling	2009-03-14 20:22:50	83:53:42	INVALID_ACK	READ_ALARM	MAJOR
4	**TMod:Summary_MPS:Alarm**	Moderator System MPS Trip	/Annunciator/Target/CMS	2009-02-07 09:25:09	934:51:23	INVALID_ACK	READ_ALARM	INVALID

3. How to use it

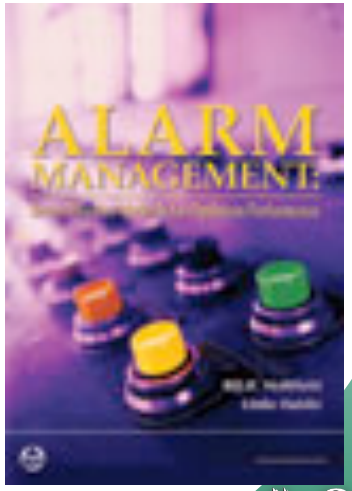
This may be more important than the tools!

Best Ever Alarm System Tools, Indeed

.. but Tools are only half the issue

Good configuration requires plan & follow-up.

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



Alarm Philosophy

Goal:

Help operators take correct actions

- **Alarms with guidance, related displays**
- **Manageable alarm rate (<150/day)**
- **Operators will respond to every alarm**
  (corollary to manageable rate)

What's a valid alarm?

- ***DOES IT REQUIRE IMMEDIATE OPERATOR ACTION?***
  - **What action? Alarm guidance!**
    - **Not "make elog entry", "tell next shift", …**
    - **Consider consequence of no action**

- **Is it the best alarm?**
  - **Would other subsystems, with better PVs, alarm at the same time?**

How are alarms added?

- **Alarm triggers: PVs on IOCs**
  - **But more than just setting HIGH, HIHI, HSV, HHSV**
  - **HYST is good idea**
  - **Dynamic limits, enable based on machine state,...**

  <u>Requires thought, communication, documentation</u>
- **Added to alarm server with**
  - **Guidance: How to respond**
  - **Related screen: Reason for alarm (limits, …), link to screens mentioned in guidance**
  - **Link to rationalization info (wiki)**

Impact/Consequence Grid

Category	So What	Minor Consequence	Major Consequence
Personnel Safety		PPS independent from EPICS?	
Environment, Public		Can EPICS cause contained spill of mercury?	Uncontained spill??
Cost: **Beam Production**, Downtime, Beam Quality	No effect Beam off < 1 sec?	**Beam off <10 min** <$10000	**Beam off >10min** >$10000

- **Mostly: How long will beam be off?**

.. combined with Response Time

Time to Respond	Minor Consequence	Major Consequence
>30 Minutes	NO_ALARM	MINOR
10..30 minutes	MINOR	MAJOR
<10 minutes	MAJOR	MAJOR + Annunciate

- **This part is still evolving…**

Example: Elevated Temp/Press/Res.Err./…

- Immediate action required?
  - Do something to prevent interlock trip
- Impact, Consequence?
  - Beam off: Reset & OK, 5 minutes?
  - Cryo cold box trip: Off for a day?
- Time to respond?
  - 10 minutes to prevent interlock?

- MINOR? MAJOR?
- Guidance: “Open Valve 47 a bit, …”
- Related Displays: Screen that shows Temp, Valve, …

“Safety System” Alarms

- **Protection Systems not per se high priority**
  - **Action is required, but we’re safe for now, it won’t get worse if we wait**

- **Pick One**
  - ☑ **“Mommy, I need to gooo!”**
  - ☐ **“Mommy, I went”**

(Does it require operator action? How much time is there?)

Avoid Multiple Alarm Levels

- Analog PVs for Temp/Press/Res.Err./…:
  - Easy to set LOLO, LOW, HIGH, HIHI
- Consider:
  - Do they require *significantly different* operator actions?
  - Will there be a lot of time after the HIGH to react before a follow-up HIHI alarm?
- In most cases, HIGH & HIHI only double the alarm traffic
  - Set only HSV to generate single, early alarm
  - Adding HHSV alarm assuming that the first one is ignored only worsens the problem

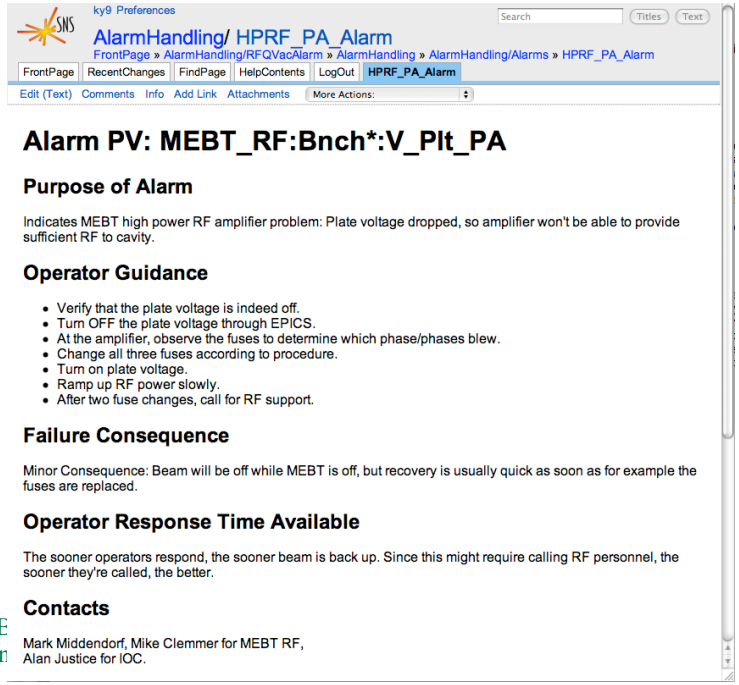
Bad Example: Old SNS 'MEBT' Alarms

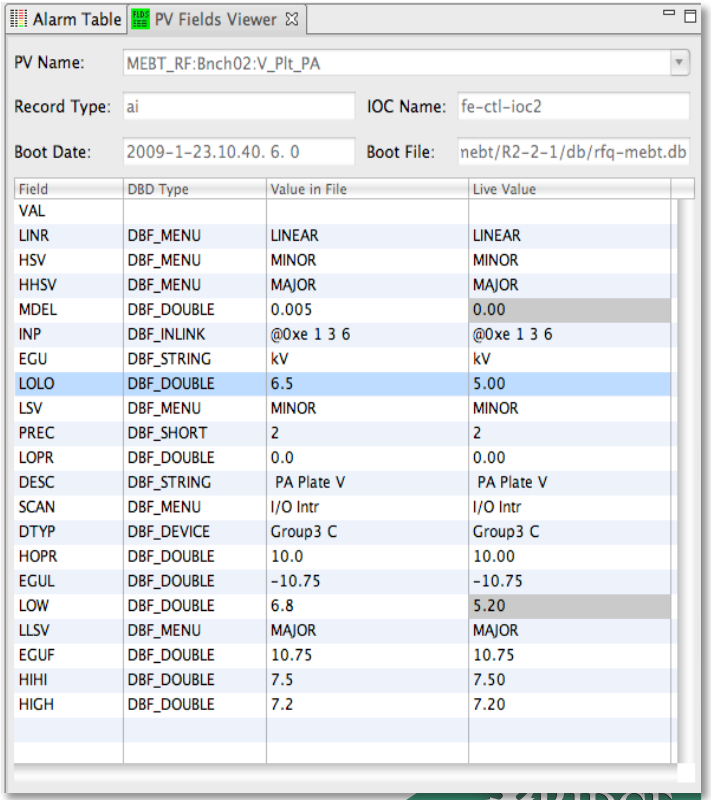
- **Each amplifier trip: ≥ 3 ~identical alarms, no guidance**

#	Date	Type	Name	Severity	TEXT
1	2009-03-16 13:46:20.255	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
2	2009-03-16 13:46:19.962	talk		MINOR	MINOR alarm: MEBBIT two power amplifier trip
3	2009-03-16 13:45:56.241	talk		MAJOR	MAJOR alarm: S C L 18 modulator in standby
4	2009-03-16 13:45:25.963	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
5	2009-03-16 13:45:25.891	talk		MINOR	MINOR alarm: MEBBIT two power amplifier trip
6	2009-03-16 13:45:25.884	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
7	2009-03-16 13:23:09.202	talk		MINOR	MINOR alarm: DTL 3 RCCS CV one valve open limit is exceeded

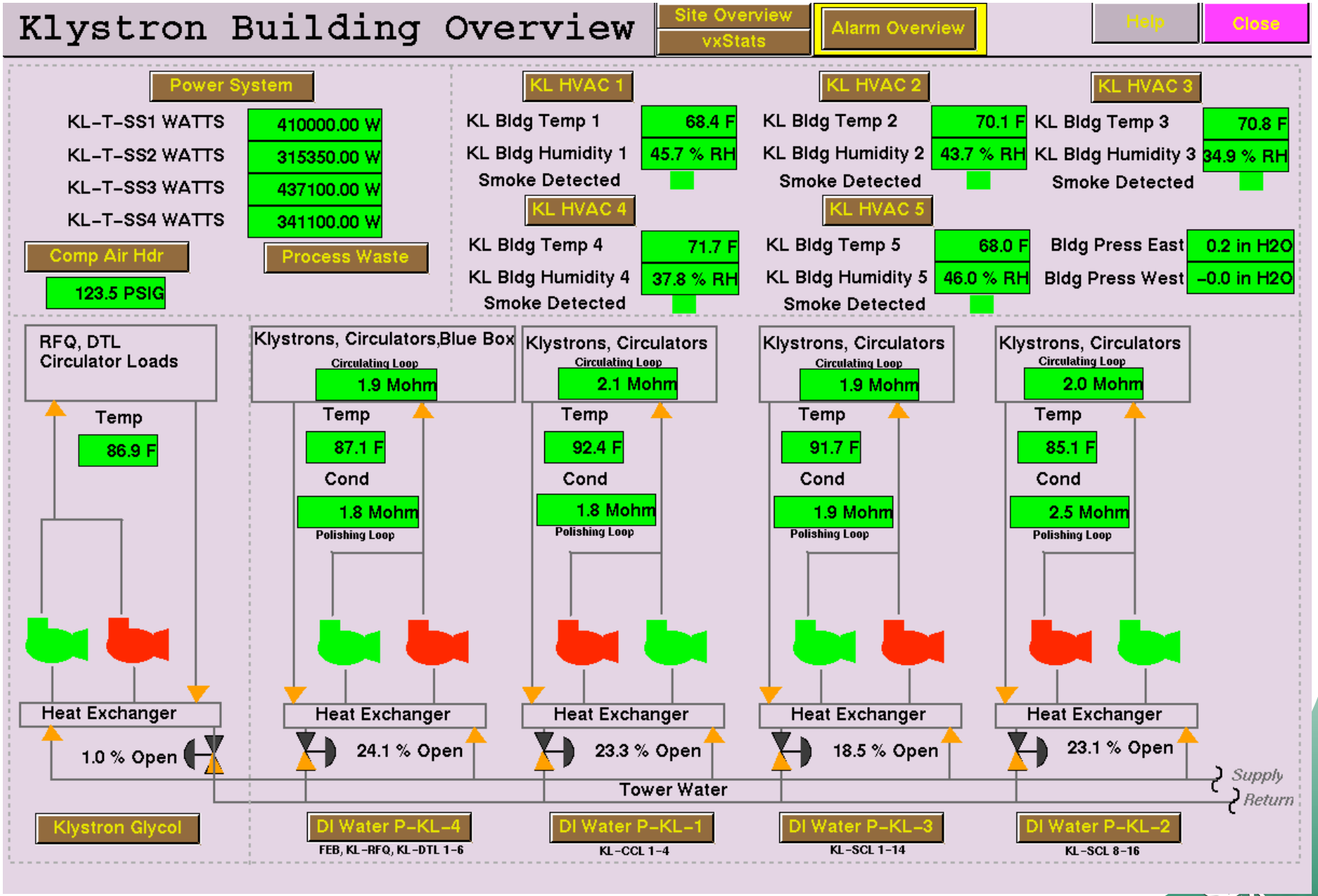
MEBT_RF:Bnch02:V_Plt_PA	MEBBIT two power amplifier trip
MEBT_RF:Bnch02:V_Fil_PA	MEBBIT two power amplifier trip
MEBT_RF:Bnch02:I_Plt_PA	MEBBIT two power amplifier trip

- **Rethought w/ subsystem engineer, IOC programmer and operators: 1 better alarm**

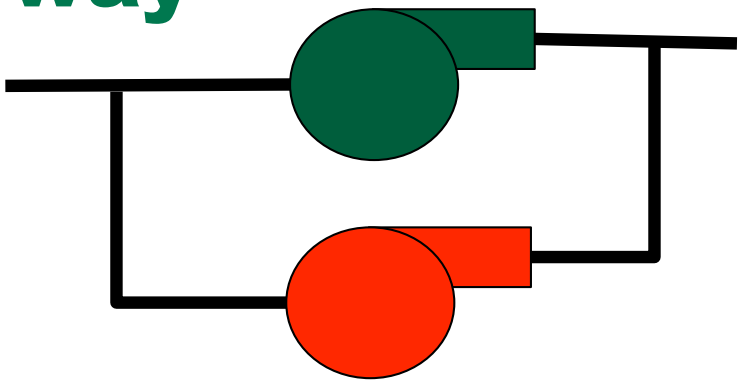




Alarms for Redundant Pumps



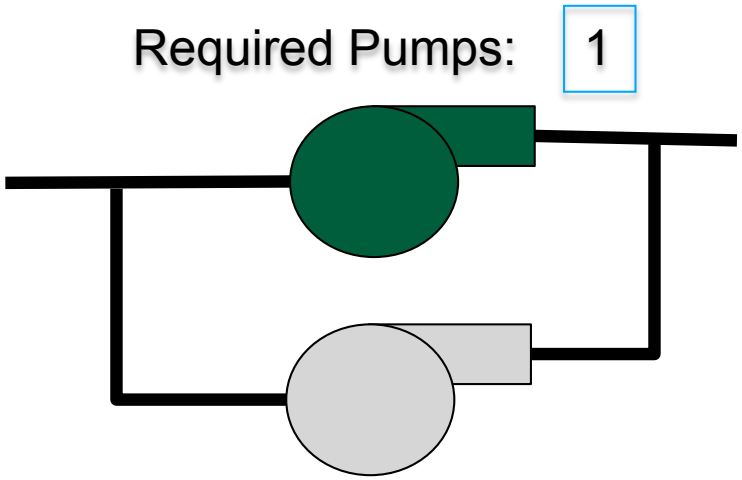
Alarm Generation: Redundant Pumps the wrong way



- Control System
  - Pump1 on/off status
  - Pump2 on/off status

- Simple Config setting: Pump Off => Alarm:
  - It's normal for the 'backup' to be off
  - Both running is usually bad as well
    - Except during tests or switchover
  - During maintenance, both can be off

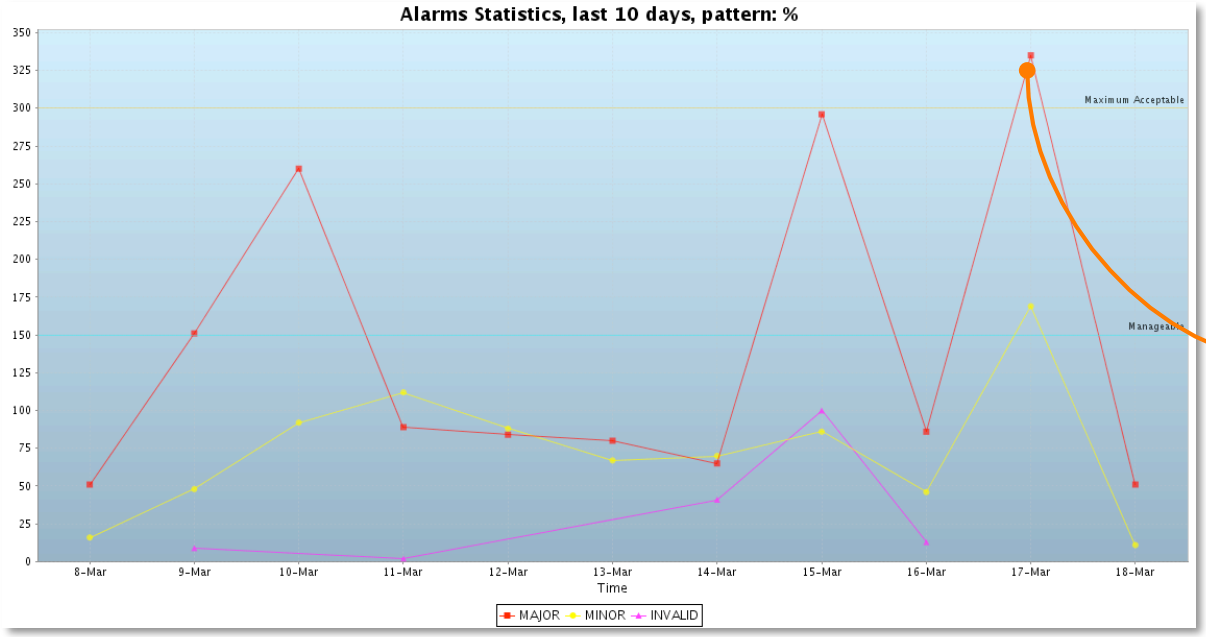
Redundant Pumps

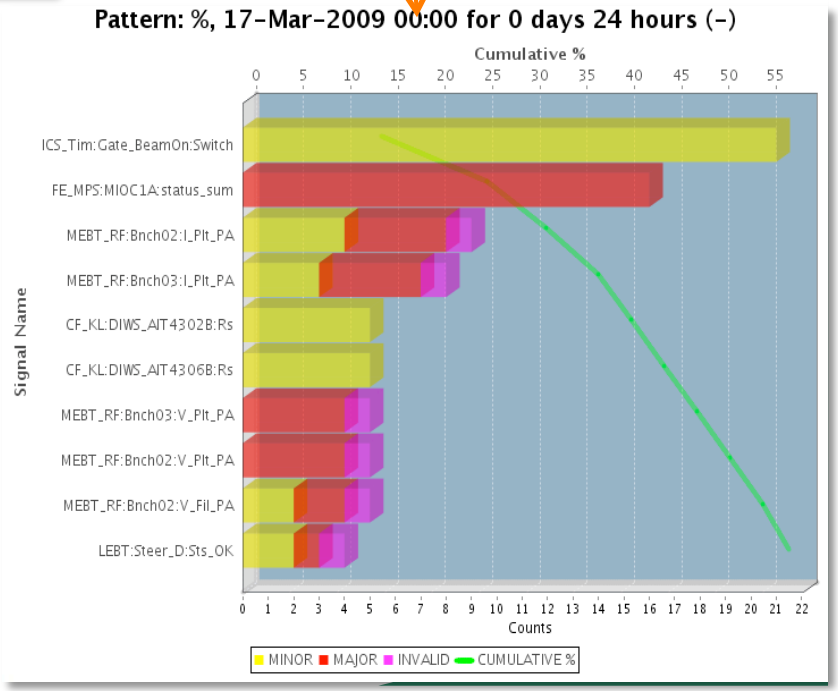


- Control System
  - Pump1 on/off status
  - Pump2 on/off status
  - Number of running pumps
  - Configurable number of desired pumps

- Alarm System: Running == Desired?
  - … with delay to handle tests, switchover
- Same applies to devices that are only needed on-demand

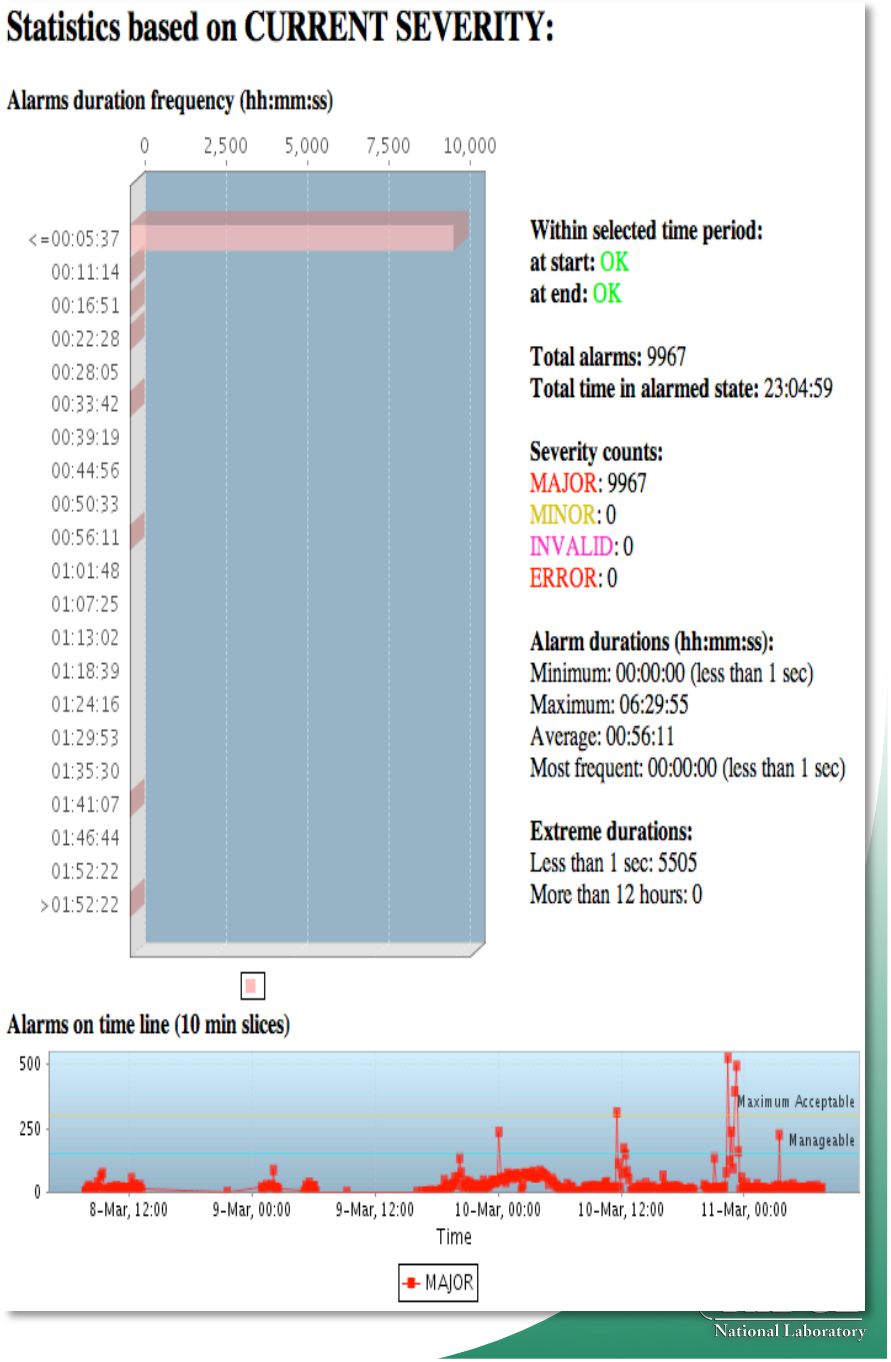
Weekly Review: How Many? Top 10?





A lot of information available

- How often did PV trigger?
- For how long?
- When?
- Temporary issue?
  Or need HYST,
  alarm delay,
  fix to hardware?



Weekly Check: Stale, Forgotten?

Alarms Active 24.0 h or more

#	PV Name	Description	Path	Alarm Time	...Duration [HH:MM:SS]	Severity	Alarm Message	Current Severity
1	MEBT_CHOP:PS_1:V	mebbit chopper power supply one voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
2	MEBT_CHOP:PS_2:V	mebbit chopper power supply two voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
3	HEBT_Coll:CT2:Cond	HEBT_Coll:CT2:Cond	/Annunciator/HEBT/HEBT_Cooling	2009-03-14 20:22:50	83:53:42	INVALID_ACK	READ_ALARM	MAJOR
4	TMod:Summary_MPS:Alarm	Moderator System MPS Trip	/Annunciator/Target/CMS	2009-02-07 09:25:09	934:51:23	INVALID_ACK	READ_ALARM	INVALID

List of disabled alarms matching '%'

#	PV Name	Path	Description	Guidance	Displays	Commands	Latching	Annunciating	Alarm Delay	Chatter Threshold	Config Time
1	FE_MPS:MIOC1A:status_sum	/Annunciator/BeamPermit	MPS Beam permit	2	2	0	no	yes	10 sec	5	2009-04-02 14:14:27
2	ICS_Tim:Gate_BeamOn:Switch	/Annunciator/BeamPermit	Beam awf	1	1	2	no	yes	5 sec	0	2009-04-02 14:14:35
3	CF_KL:DIWS_AIT4303B:Rs	/Annunciator/CF/Klystron_Gallery_Temp	Check polishing loop resistivity for KL2	1	2	0	yes	yes	5 sec	0	2009-03-20 16:27:03
4	HEBT_Coll:PT3:P	/Annunciator/HEBT/HEBT_Cooling	Hebbit momentum dump inlet cooling water pressure alarm	1	3	0	yes	yes	0 sec	0	2009-03-23 14:48:56
5	HEBT_Coll:PT4:P	/Annunciator/HEBT/HEBT_Cooling	Hebbit momentum dump cooling water outlet flow alarm	1	3	0	yes	yes	0 sec	0	2009-03-23 14:51:21
6	CF_RN:DIWS_AIT4601A:Rs	/Annunciator/Ring/Ring_Cooling	Hebbit Ring RTBT magnets DI water circulating loop conductivity alarm	2	3	0	yes	yes	0 sec	0	2009-03-23 15:47:49
7	TGT_He:IOC1:TI_6501_ALM:HiHi_Alarm	/Annunciator/Target/CMS	CMS Helium Temp Hi Hi	1	1	0	yes	no	0 sec	0	2009-03-25 12:15:37
8	TGT_He:IOC1:TI_6501_ALM:Hi_Alarm	/Annunciator/Target/CMS	CMS Helium Temp Hi	1	1	0	yes	no	0 sec	0	2009-03-25 12:16:08

Summary

- BEAST operational since Feb'09
  - Needs a logo
  - For now without BEAUtY
  - DESY AMS is similar and has been operational for longer
- Pick either, but good configuration requires work in any case
  - Started with previous "annunciated" alarms
    - ~300, no guidance, no related displays
    - Now ~330, all with guidance, rel. displays
  - "Philosophy" helps decide what gets added and how
    - Immediate Operator Action? Consequence? Response Time?
  - Weekly review spots troubles and tries to improve configuration