

Alarm System

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Alarm Fields in EPICS Records

```
# bi, bo
record(bi, "binary")
{
    # Alarm states
    field(ZSV, "MINOR")
    field(OSV, "MAJOR")

    # Display niceties
    field(ZNAM, "Marginal")
    field(ONAM, "Hopeless")
}
```

Marginal Hopeless

Marginal Hopeless

```
record(mbbi, "states")
{
    # Alarm states
    field(TWSV, "MAJOR")

    # Display niceties
    field(ZRST, "Off")
    field(ONST, "On")
    field(TWST, "Overheated")
}
```

Off On Overheated

Off On Overheated

Alarm Fields in EPICS Records

```
# ai, ao, calc, calcout, longin, longout, ...
record(ai, "analog")
{
  # Alarm limits
  field(HIHI, "100")
  field(HHSV, "MAJOR")

  field(HIGH, "80")
  field(HSV, "MINOR")

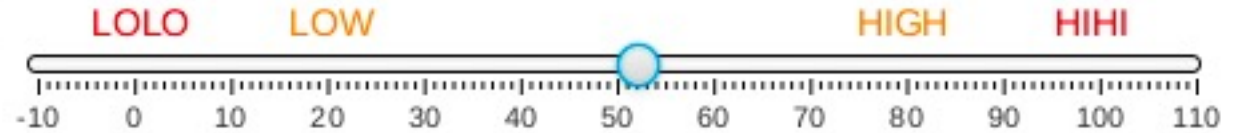
  field(LOW, "20")
  field(LSV, "MINOR")

  field(LOLO, "0")
  field(LLSV, "MAJOR")

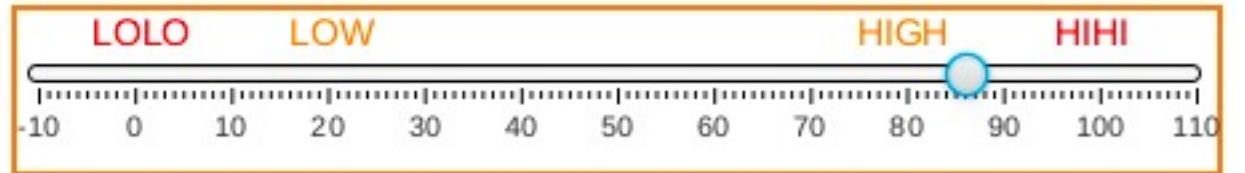
  # Alarm hysteresis
  field(HYST, "5")

  # Display niceties
  field(HOPR, "110")
  field(LOPR, "-10")
  field(EGU, "Fathoms")
  field(PREC, "1")
}
```

52.3 Fathoms



86.3 Fathoms



For historic reasons, need to set both
a) one or more alarm threshold
b) corresponding severity

Alarm Fields in EPICS Records

Perfectly fine

```
record(ai, "only_hihi")
{
    field(HIHI, "100")
    field(HHSV, "MAJOR")
}
```

```
record(ai, "only_high")
{
    field(HIGH, "80")
    field(HSV, "MINOR")
}
```

```
record(ai, "only_low")
{
    field(LOW, "10")
    field(LSV, "MINOR")
}
```

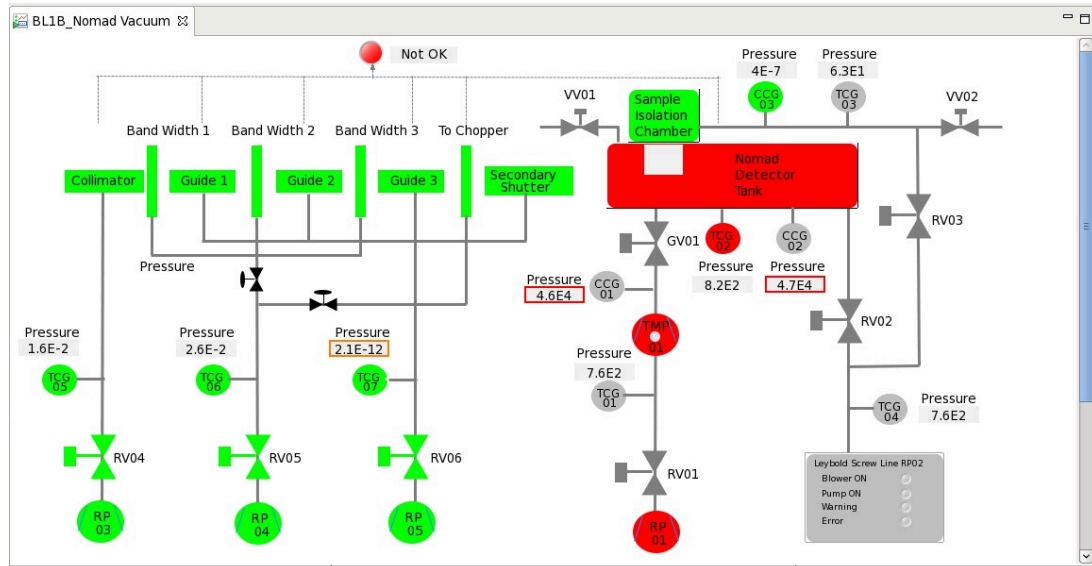
Don't even think about it

```
record(ai, "high_as_hihi")
{
    field(HIGH, "100")
    field(HSV, "MAJOR")
}
```

```
record(ai, "odd_order")
{
    field(HIHI, "100")
    field(HHSV, "MINOR")

    field(HIGH, "80")
    field(HSV, "MAJOR")
}
```

EPICS PVs carry Values with Alarm Information



No alarm, MINOR, MAJOR

- Analog records: LOLO, LOW, HIGH, HIHI limits
- Binary records: 0 or 1 state may alarm

Display Tools

- Indicate alarm state via border

PV
VAL: 10
HIGH: 5
HSV: MINOR

IOC 1

PV
VAL: 20
HIHI: 20
HHSV: MAJOR

IOC 2

What if nobody is looking at the screen at the time?

Alarm System Idea

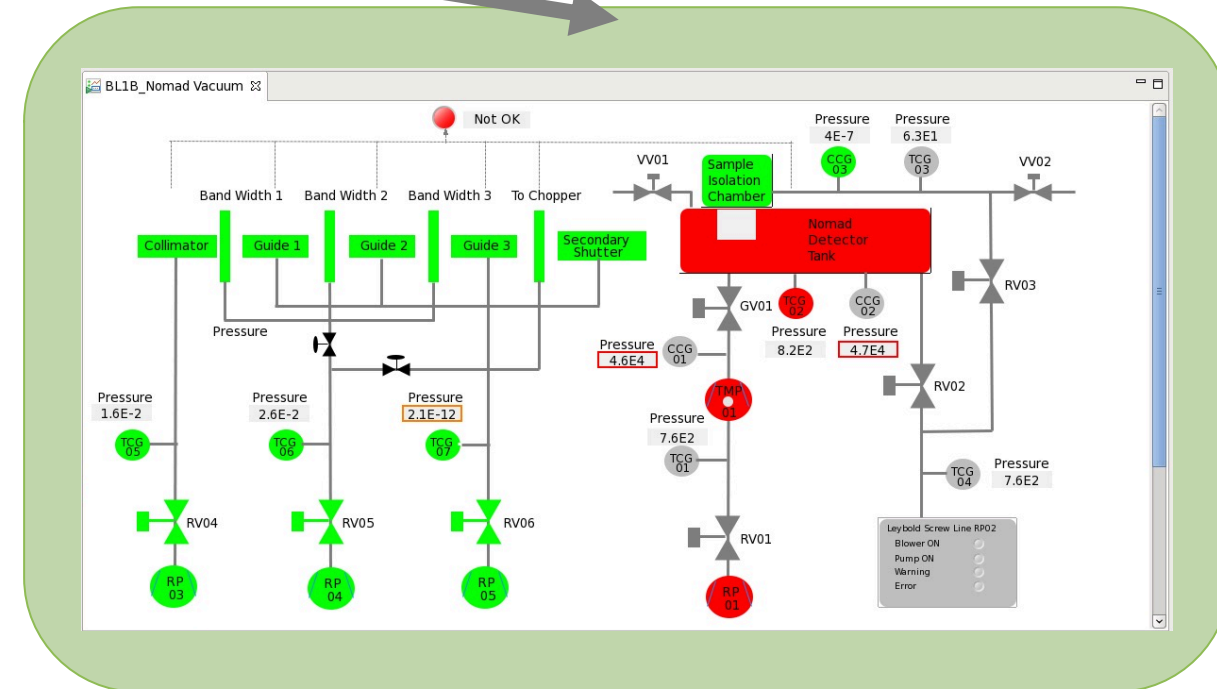
Alarm System

- 1) Indicate alarms
- 2) Detail: Which PV? When? What value?..
- 3) Guidance
- 4) Related Displays
- 5) Keep alarms until acknowledged & cleared

“Check XYZ.
Try opening ABC.
Call Fred.”

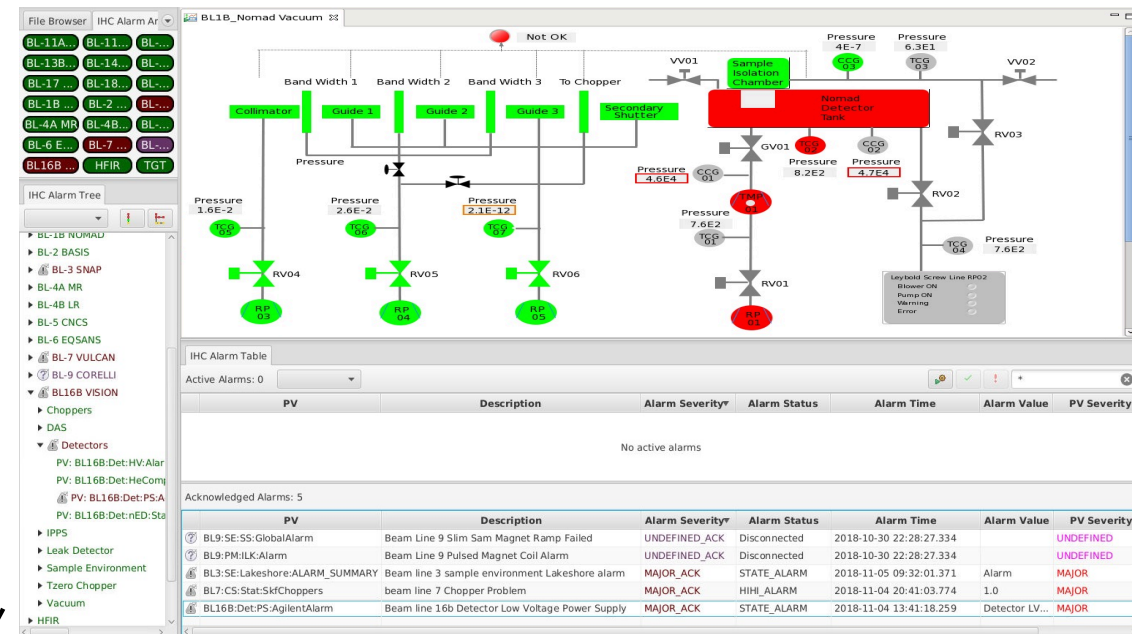
PV
VAL: 20
HIHI: 20
HHSV: MAJOR

PV
VAL: 10
HIGH: 5
HSV: MINOR

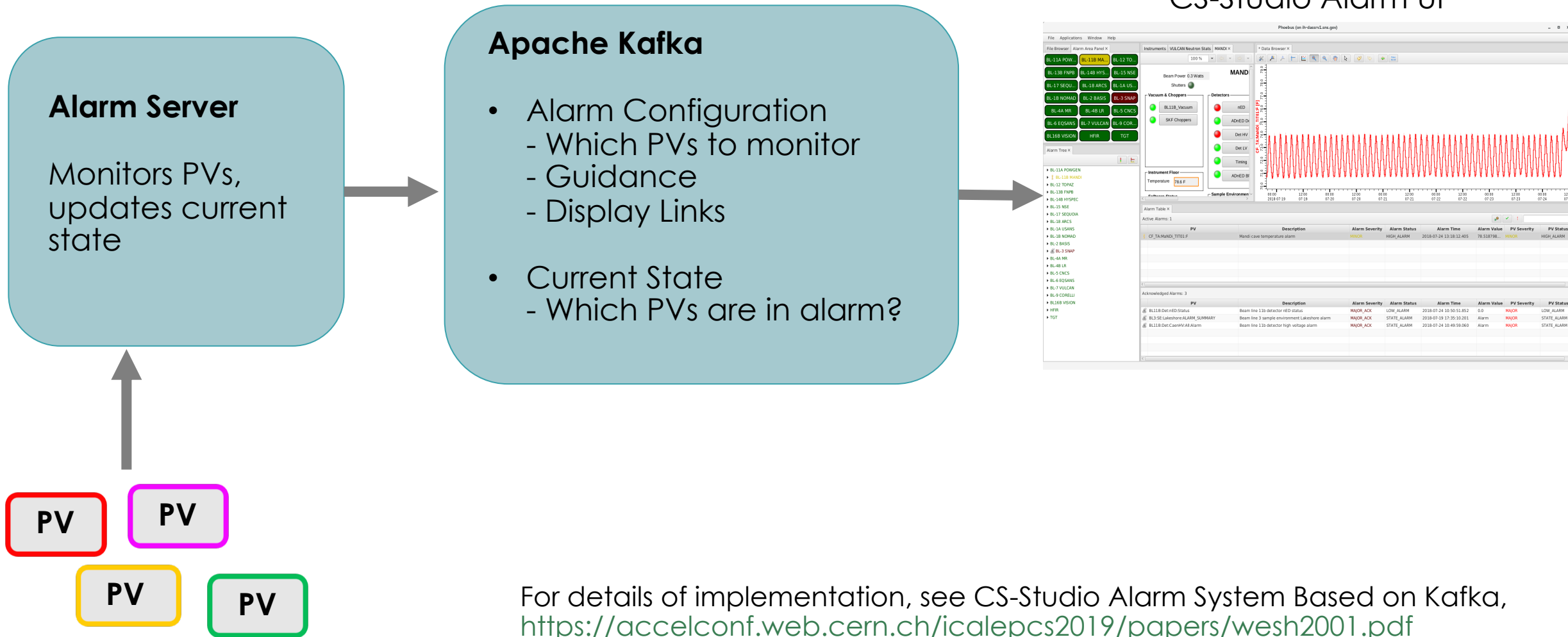


Basic Roles

- System Expert
 - Provide useful alarm levels
 - Explain what to do when alarm happens
- Control System Engineer
 - Configure alarm levels
 - Maybe create new alarm trigger PV
 - Create displays
- Operations Expert
 - Add alarm trigger PV to alarm system, with guidance and links to displays
- Operators
 - Handle alarms, helped by guidance



Implementation



For details of implementation, see CS-Studio Alarm System Based on Kafka, <https://accelconf.web.cern.ch/icalaptops2019/papers/wesh2001.pdf>

Initial Setup

<https://github.com/ControlSystemStudio/phoebus/blob/master/app/alarm>

1. Install Kafka (typically as Linux service)
2. Check that “Accelerator” config exists

```
cd /ics/tools  
./list_topics.sh  
./monitor_topics.sh Accelerator
```

If nothing shown:

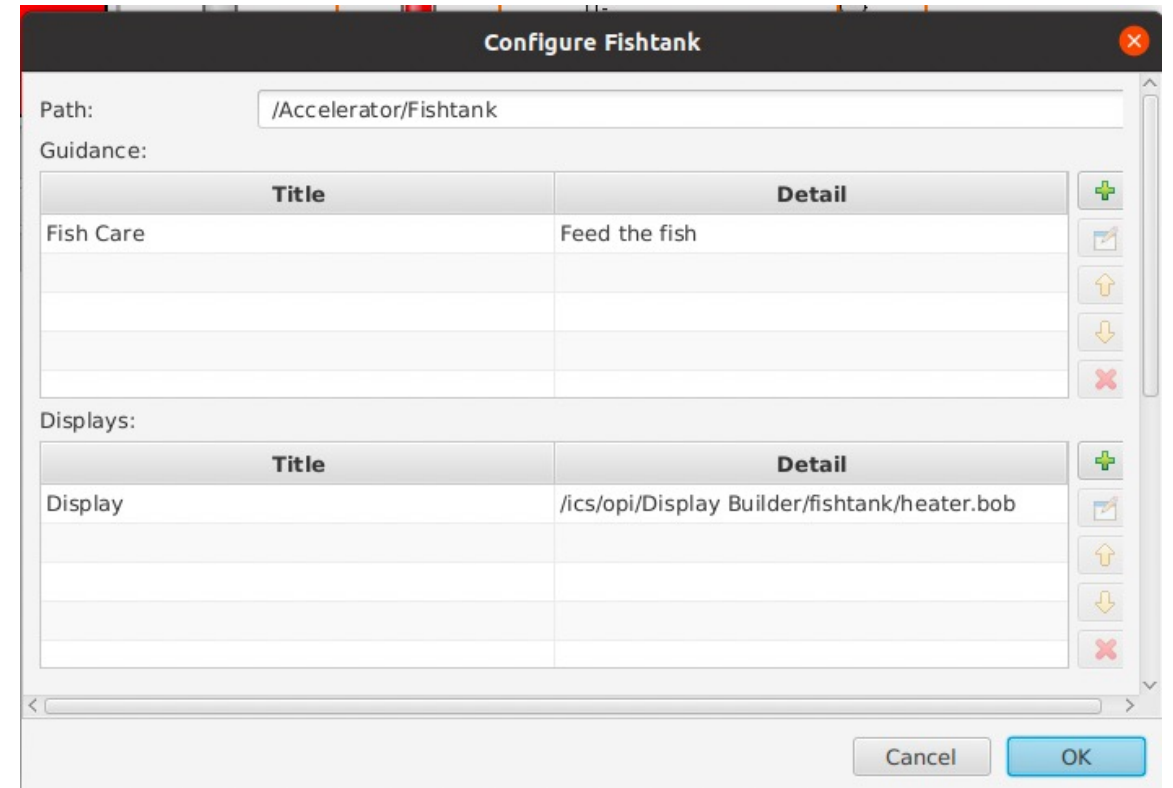
```
./create_alarm_topics.sh Accelerator
```

3. Start alarm server (typically also as Linux service)

```
cd /ics/tools/alarm-server-  
./alarm-server.sh
```

Configuration for 'Fishtank'

- Open CS-Studio Applications, Alarm, Alarm Tree
- Right-click, Add Component
 - Node "Fishtank"
 - Add Guidance and Display link



Configuration ...

- Right-click on new “Fishtank”, Add Component

- PV** “training:heat_V”

- Description**

 - Anything’s better than the PV name

- Specific **Guidance** and Displays

 - Should have guidance. Otherwise, why is this an alarm?

- Enabled? Latch? Annunciate?

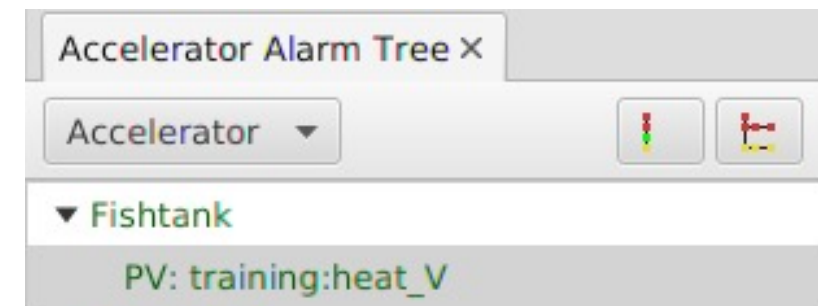
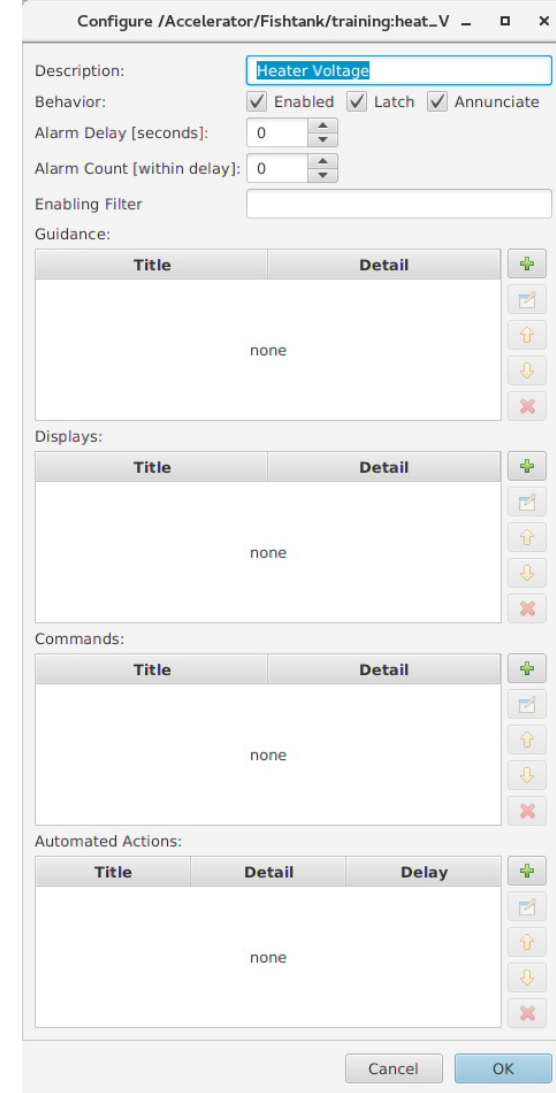
 - Usually: Yes, otherwise: Why bother?

- Delay?

 - Hack for noisy alarm trigger PVs

- Automated Actions

 - <mailto:fred@google.com>

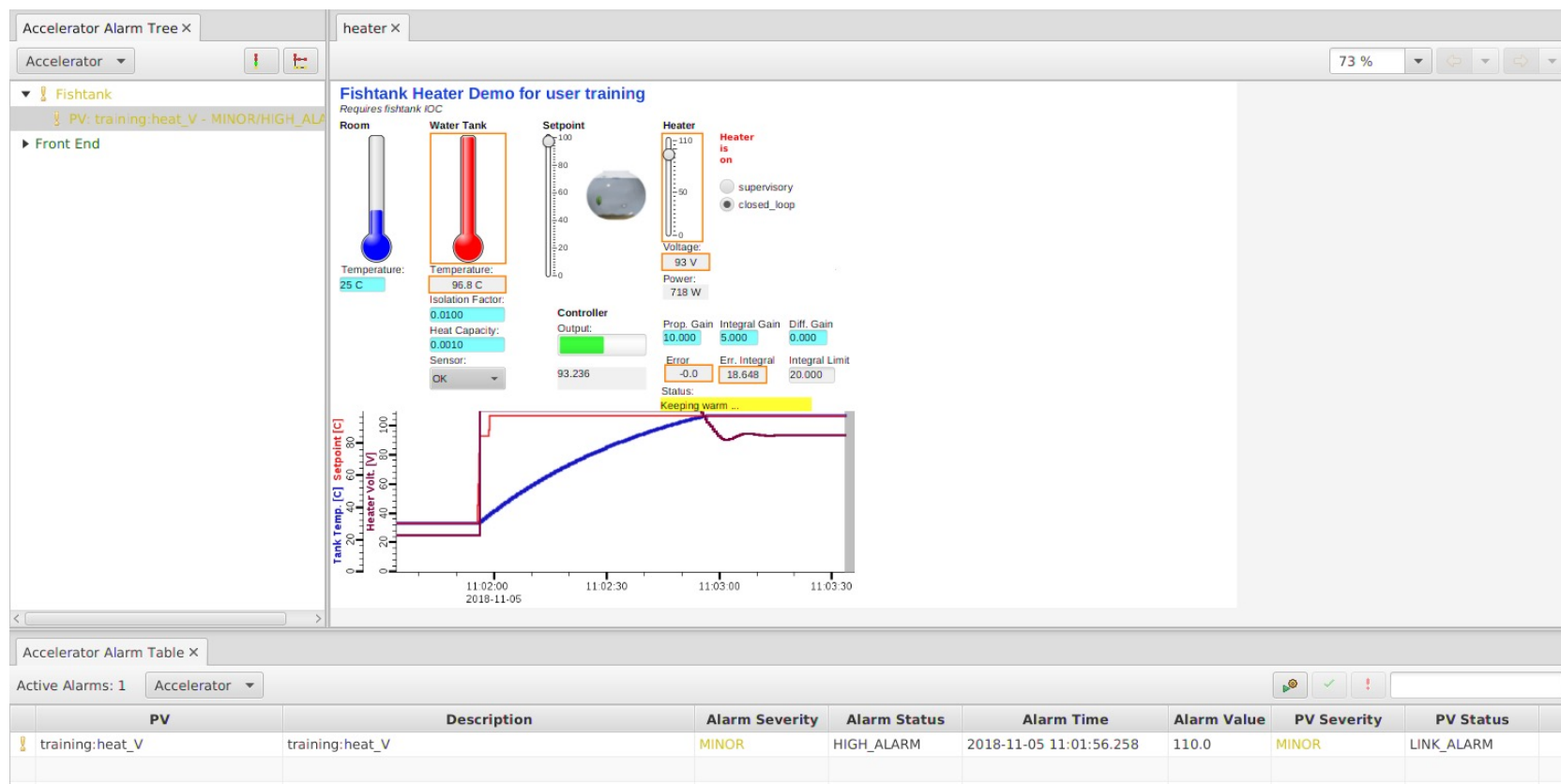


Example Alarm Workflow

- Cause an alarm
caput training:setpoint 60
- Inspect Alarm
 - Watch as alarm is indicated
 - Open associated display
- Handle It
 - Acknowledge
 - Reduce setpoint
 - Clear

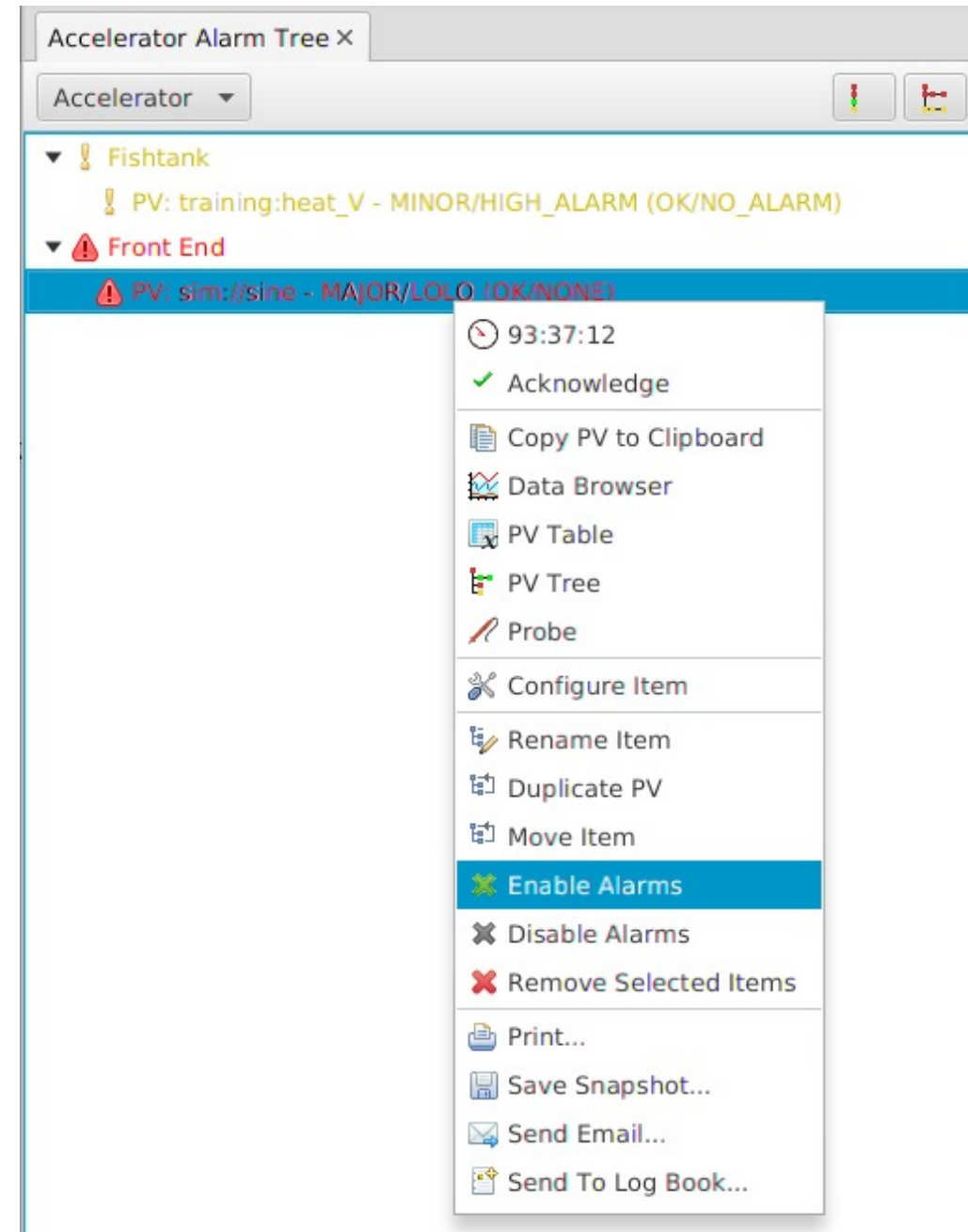
Suggested “Alarm” layout:

Alarm Tree to the left,
Alarm Table at the bottom,
both “locked”



Alarm Tree

- Primary configuration tool
- Hierarchical
 - Guidance, Displays apply to sub-nodes
- Operational useful to
 - Check if numerous alarms originate in the same area
 - Acknowledge or disable complete subtrees




Alarm Table


- Primary operations tool
- Ideally empty
- View/sort/acknowledge alarms
- Open guidance and displays

Accelerator Alarm Table x

Active Alarms: 1 Accelerator

PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity	PV Status
 sim://sine	sim://sine	MAJOR	LOLO	2018-11-05 11:15:39.244	-4.7552825...	OK	NONE

Acknowledged Alarms: 1

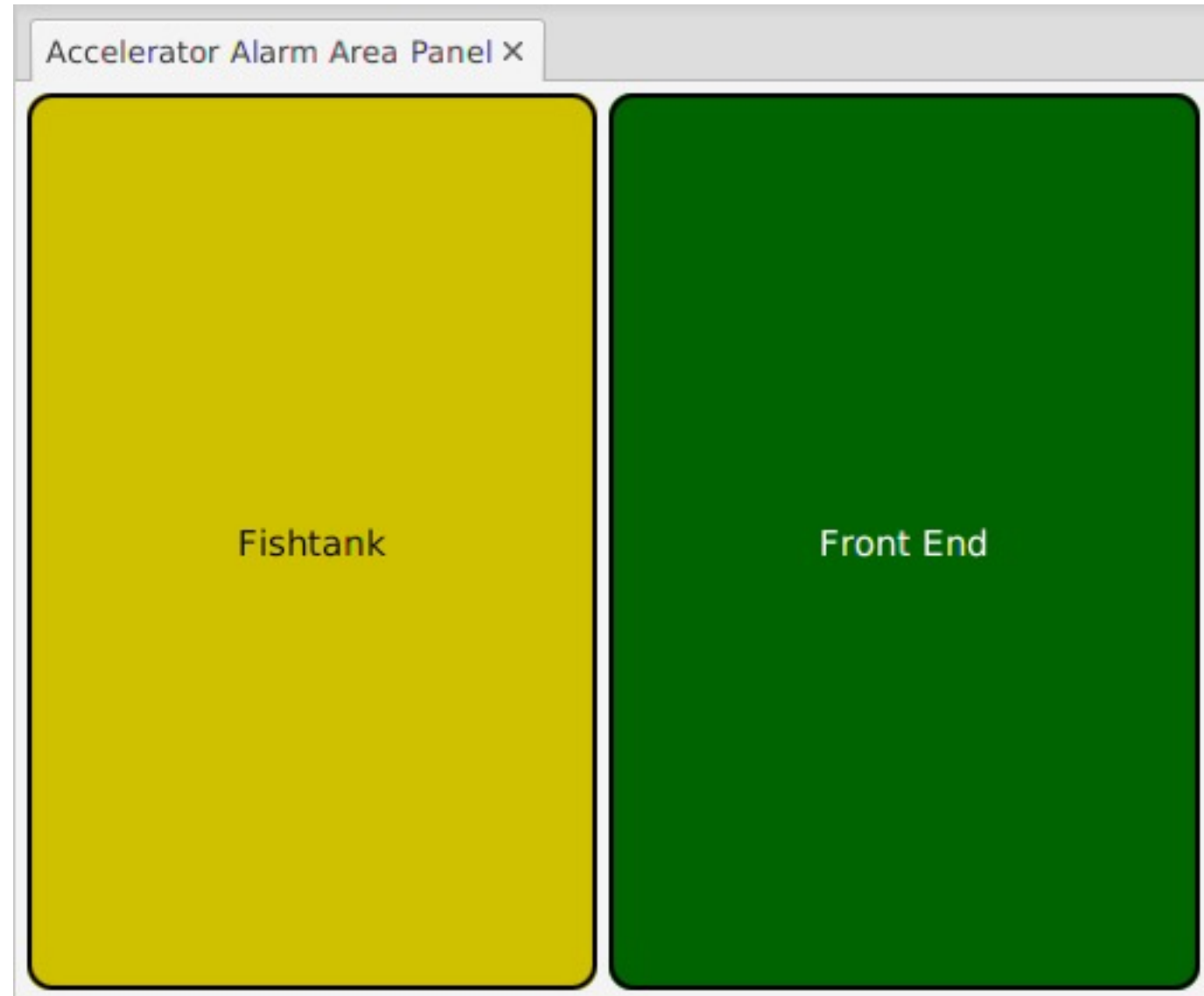
PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity	PV Status
 training:heat_V	training:heat_V	MINOR_ACK	HIGH_ALARM	2018-11-05 11:15:42.257	110.0	MINOR	LINK_ALARM

Alarm Area Panel

Useful for 'Overview Displays'

Indicates
'across the room':

All OK?



Alarm Annunciator

Annunciates the *description* of alarms

Basic “heads up” to check alarm table for details



Accelerator Annunciator X

Accelerator ▼  Clear Messages

Time Received ▼	Severity	Description
2018-11-05 11:12:47.779	 MINOR	MINOR Alarm: training:heat_V
2018-11-05 11:12:30.282	 MINOR	MINOR Alarm: training:heat_V



Accelerator Annunciator X

Accelerator ▼  Clear Messages

Time Received ▼	Severity	Description
2018-11-05 11:12:47.779	 MINOR	MINOR Alarm: training:heat_V
2018-11-05 11:12:30.282	 MINOR	MINOR Alarm: training:heat_V

Alarm System

- Alarm Server monitors PVs, tracks alarms
- Alarm Tree to configure
 - PV?
 - Guidance?
 - Displays?
- Alarm Table, Area Panel, Annunciator to use
 - Acknowledge
 - Open Displays

The screenshot displays the IHC Alarm System interface. At the top, there are tabs for 'ICS Gateway', 'BL16B_Main', and 'Agilent PS x'. Below the tabs is a summary table with columns: Sum, Status, Voltage, Prot. V, Current, Over Voltage, Over Current, Over Temp., and Details. The table lists four power supply units: LV 3V, LV 4V, LV -4V, and HV 13V, all with a status of 'ON'. Below the summary table is a 'Summary Alarm' section showing a red alarm icon, 'Time In Alarm 78553 secs', 'Debounce Time 5', and 'Debounced Alarm' with a green icon. To the left is an 'IHC Alarm Tree' with a hierarchical list of components including BL-11A through BL-16B, HFIR, and TGT. Below the tree is an 'IHC Alarm Table' showing 'Active Alarms: 0' and 'Acknowledged Alarms: 5'. The acknowledged alarms table has columns: PV, Description, Alarm Severity, Alarm Status, Alarm Time, Alarm Value, and PV Severity.

Sum	Status	Voltage	Prot. V	Current	Over Voltage	Over Current	Over Temp.	Details
LV 3V	ON	3.38 V	15.00 V	2.552 A	OK	OK	OK	...
LV 4V	ON	4.43 V	15.00 V	33.247 A	OK	OK	OK	...
LV -4V	ON	- 4.42 V	15.00 V	14.589 A	OK	OK	OK	...
HV 13V	ON	13.31 V	24.00 V	1.985 A	OK	OK	OK	...

Summary Alarm

Time In Alarm 78553 secs

Debounce Time 5

Debounced Alarm

IHC Alarm Table

Active Alarms: 0

PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity
No active alarms						
Acknowledged Alarms: 5						
BL9:SE:SS:GlobalAlarm	Beam Line 9 Slim Sam Magnet Ramp Failed	UNDEFINED_ACK	Disconnected	2018-10-30 22:28:27.334		UNDEFINED
BL9:PM:ILK:Alarm	Beam Line 9 Pulsed Magnet Coil Alarm	UNDEFINED_ACK	Disconnected	2018-10-30 22:28:27.334		UNDEFINED
BL3:SE:Lakeshore:ALARM_SUMMARY	Beam line 3 sample environment Lakeshore alarm	MAJOR_ACK	STATE_ALARM	2018-11-05 09:32:01.371	Alarm	MAJOR
BL7:CS:Stat:SkfChoppers	beam line 7 Chopper Problem	MAJOR_ACK	HIHI_ALARM	2018-11-04 20:41:03.774	1.0	MAJOR
BL16B:Det:PS:AgilentAlarm	beam line 16b Detector Low Voltage Power Supply	MAJOR_ACK	STATE_ALARM	2018-11-04 13:41:18.259	Detector LV...	MAJOR

Suggested Layout with "locked" alarm panels