

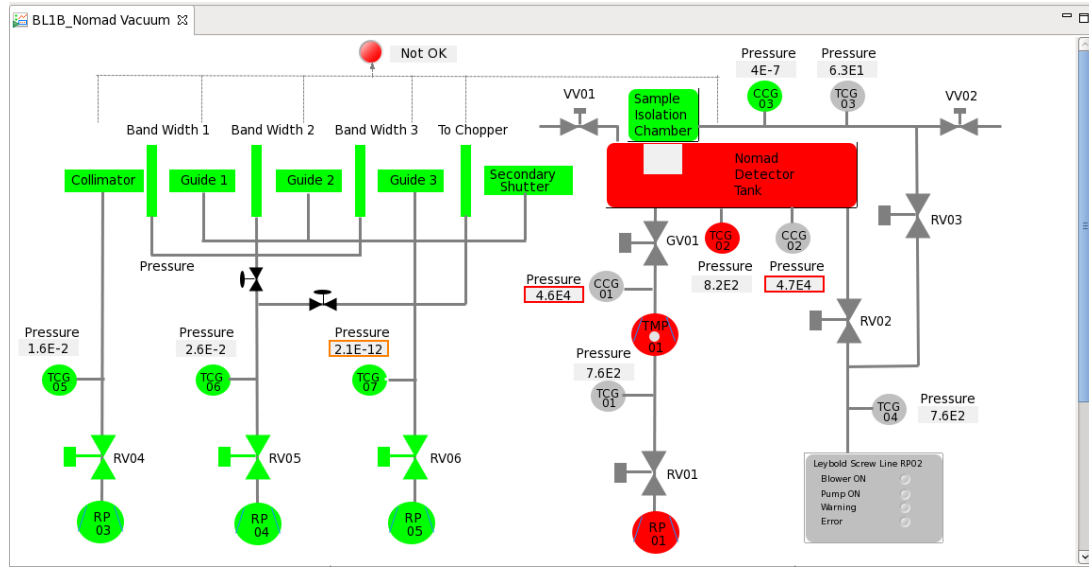
Alarm System

July 2026

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ORNL is managed by UT-Battelle, LLC for the US Department of Energy

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

- Typically indicate alarm state via border and/or color

PV
VAL: 10
HIGH: 5
HSV: MINOR

IOC 1

PV
VAL: 20
HIHI: 20
HHSV: MAJOR

IOC 2

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 Marginal Hopeless

Hopeless Marginal Hopeless

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

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

On Off On Overheated

Overheated Off On Overheated

/ics/examples/22_alarms/alarms.db and [alarms.bob](#)

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")

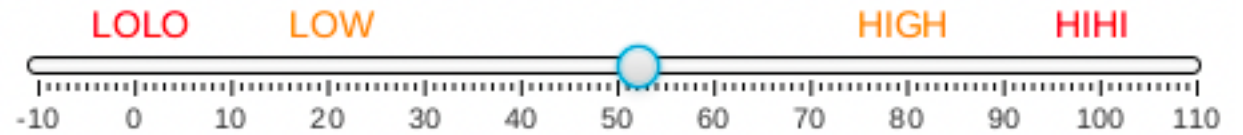
  field(LOW, "20")
  field(LSV, "MINOR")

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

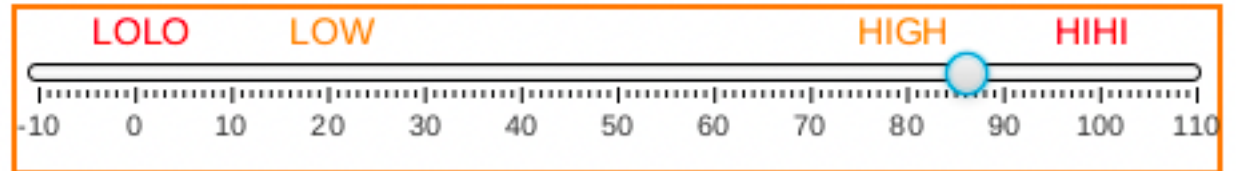
  # Alarm hysteresis
  field(HYST, "5")

  # 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

/ics/examples/22_alarms/alarms.db and [alarms.bob](#)

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 do this

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

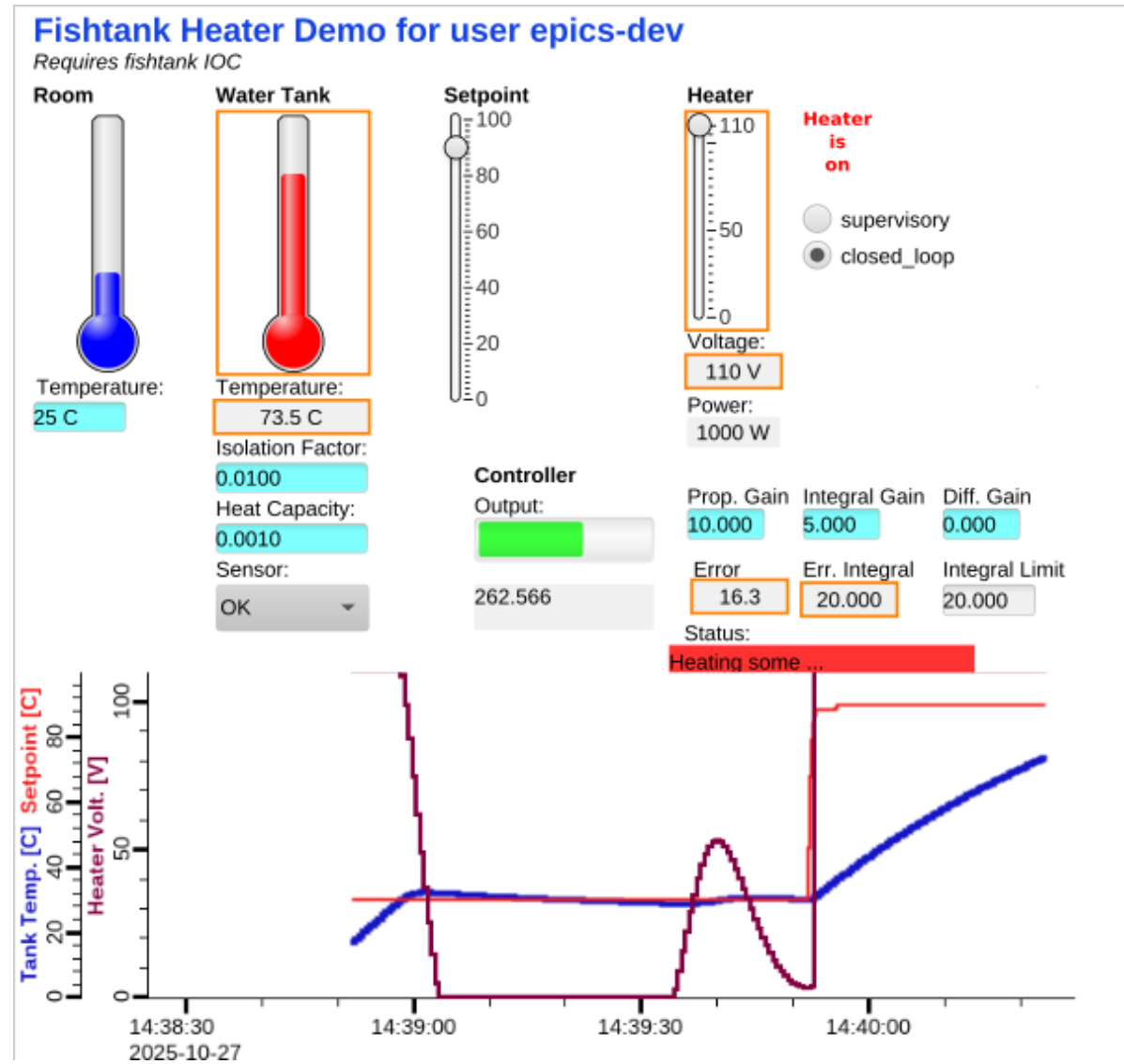
```
record(ai, "odd_order")
{
    field(HIHI, "100")
    field(HHSV, "MINOR")

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

/ics/examples/22_alarms/alarms.db and [alarms.bob](#)

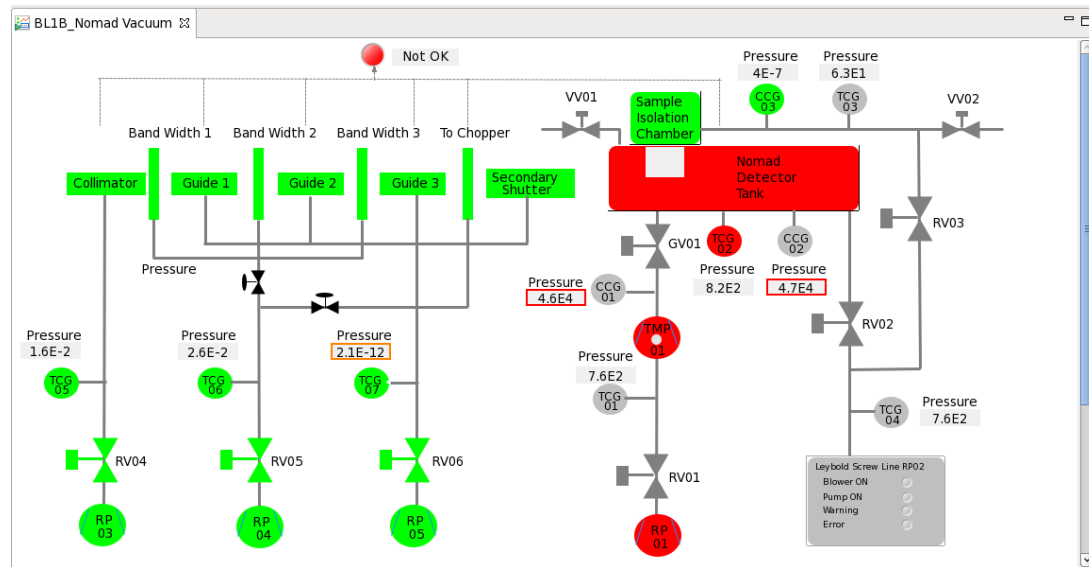
Fishtank

- Is tank temperature above 70 C or below 0 C a good alarm?
- Is heater at 110 V a good alarm?



[/ics/examples/fishtank: st.cmd, heater.bob](#)

EPICS PVs carry Values with Alarm Information



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Display Tools

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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

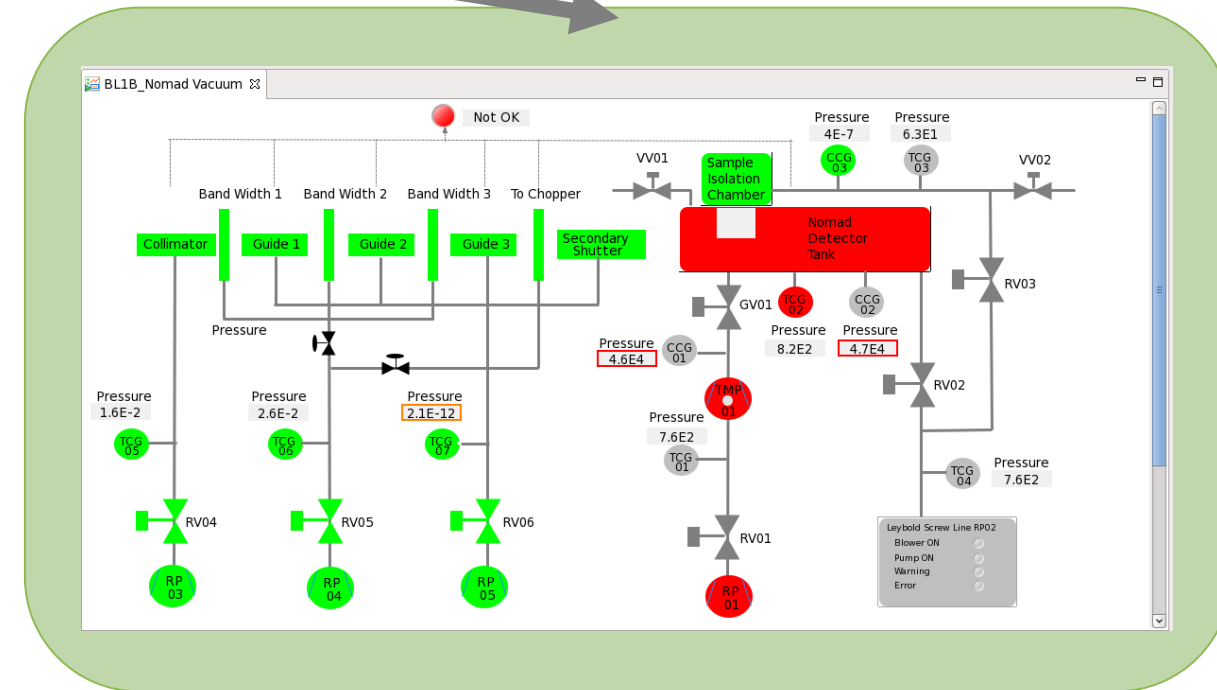
Alarm System

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

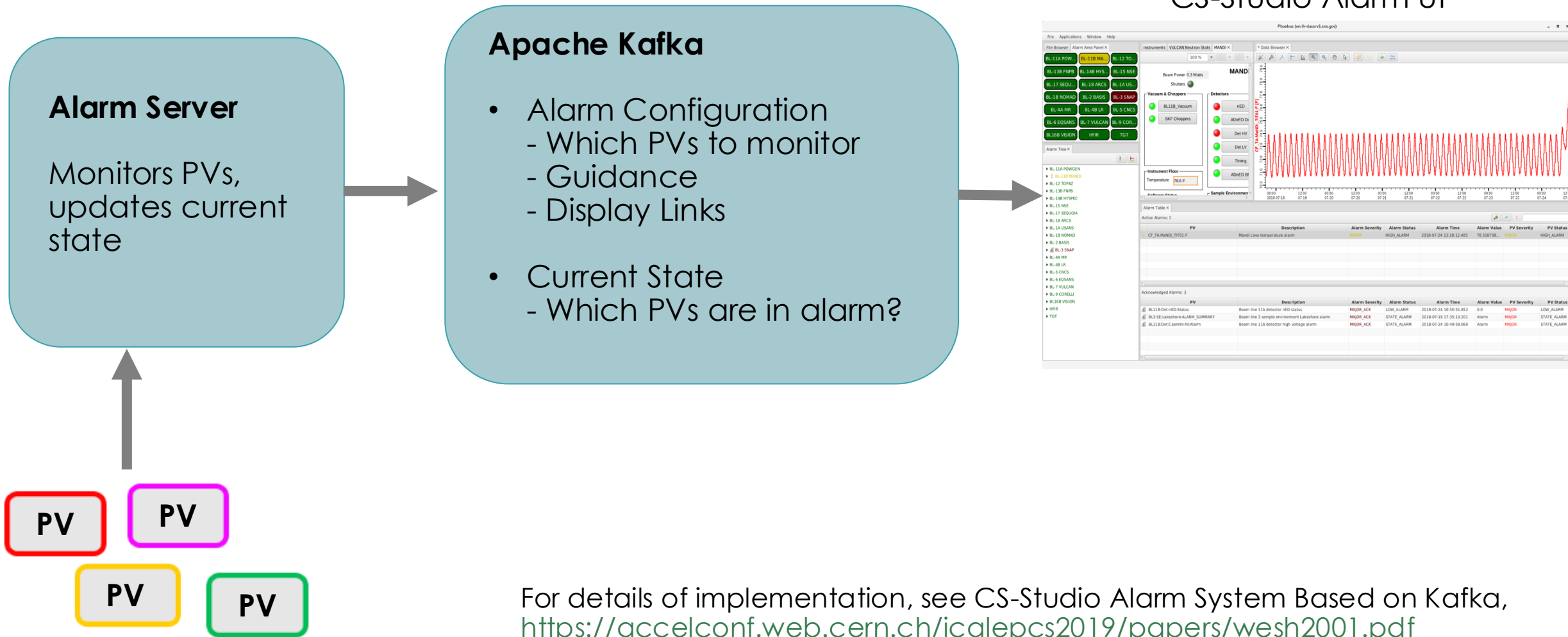
“Check XYZ.
Try opening ABC.
Call Fred.”

PV
VAL: 20
HIHI: 20
HHSV: MAJOR

PV
VAL: 10
HIGH: 5
HSV: MINOR



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

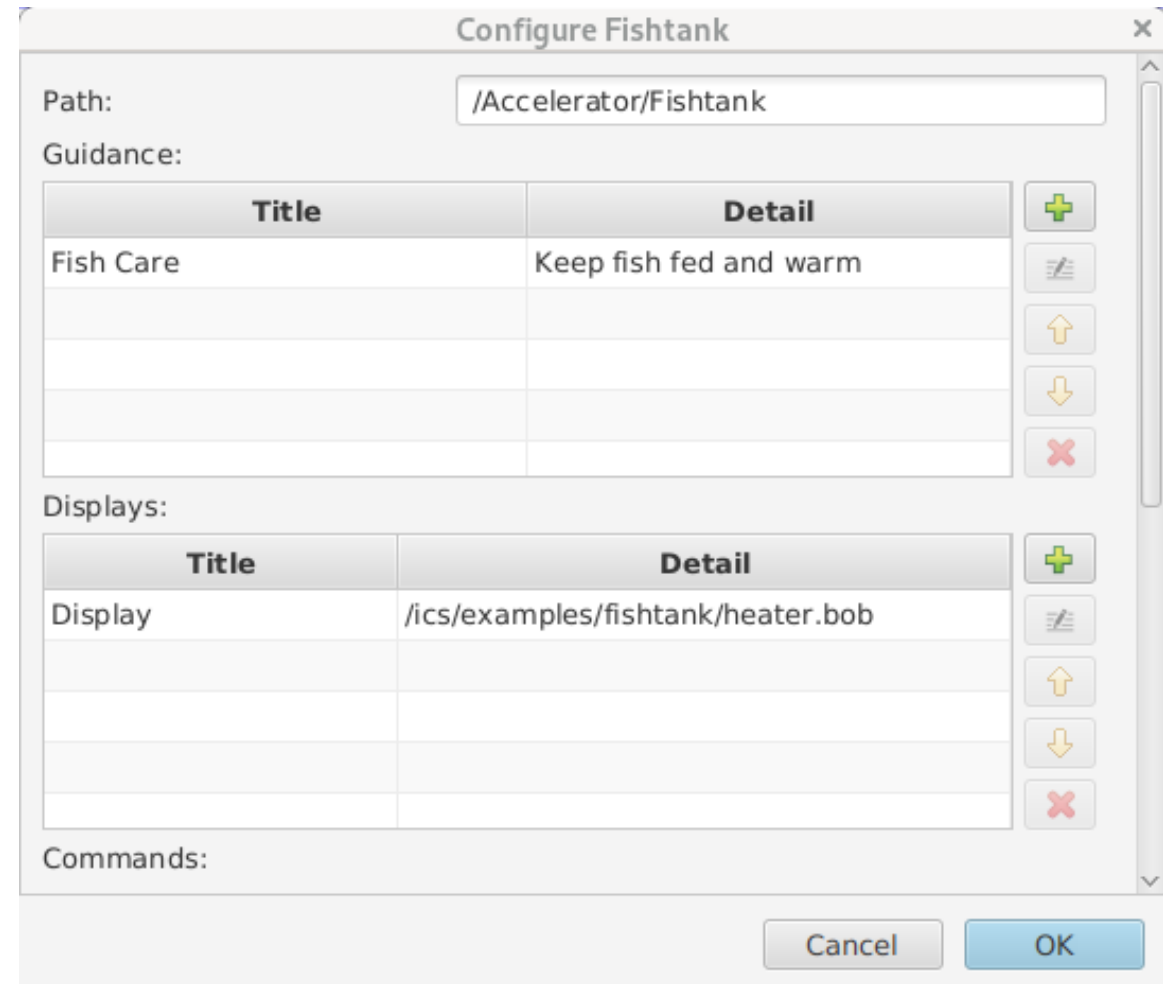
```
cd /ics/tools
systemctl status kafka
./monitor_topics.sh Accelerator
```

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

```
alarm-server
```

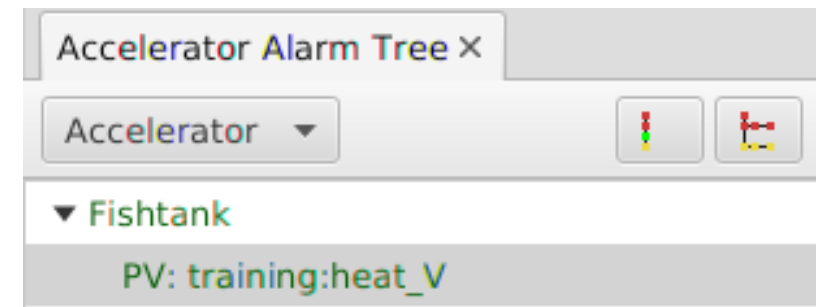
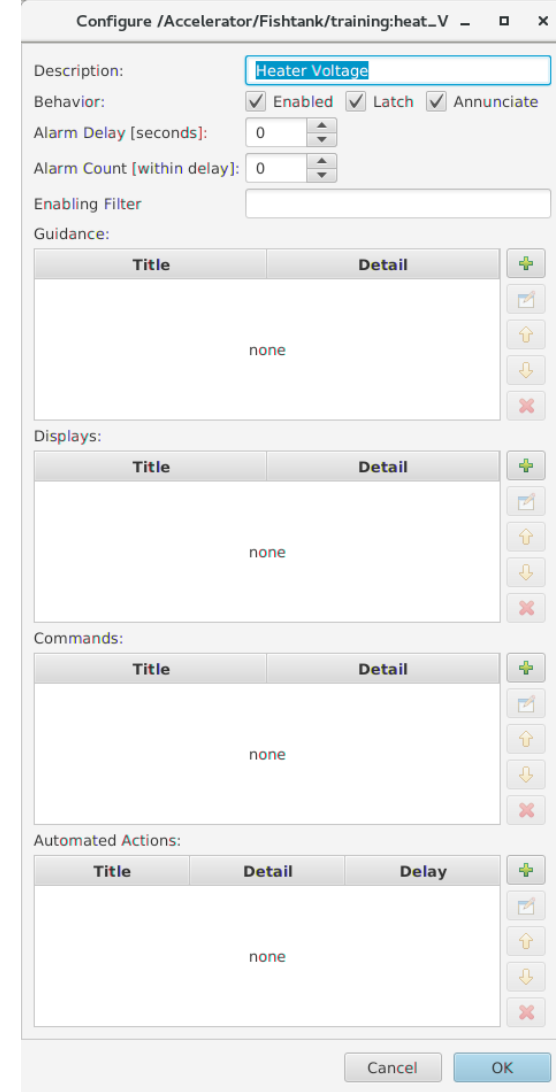
Configuration for 'Fishtank'

- Open CS-Studio Applications, Alarm, Alarm Tree
- Find component "Fishtank"
 - Check Guidance and Display link



Configuration Example

- Right-click on “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 epics-dev:setpoint 72
```

- Inspect Alarm

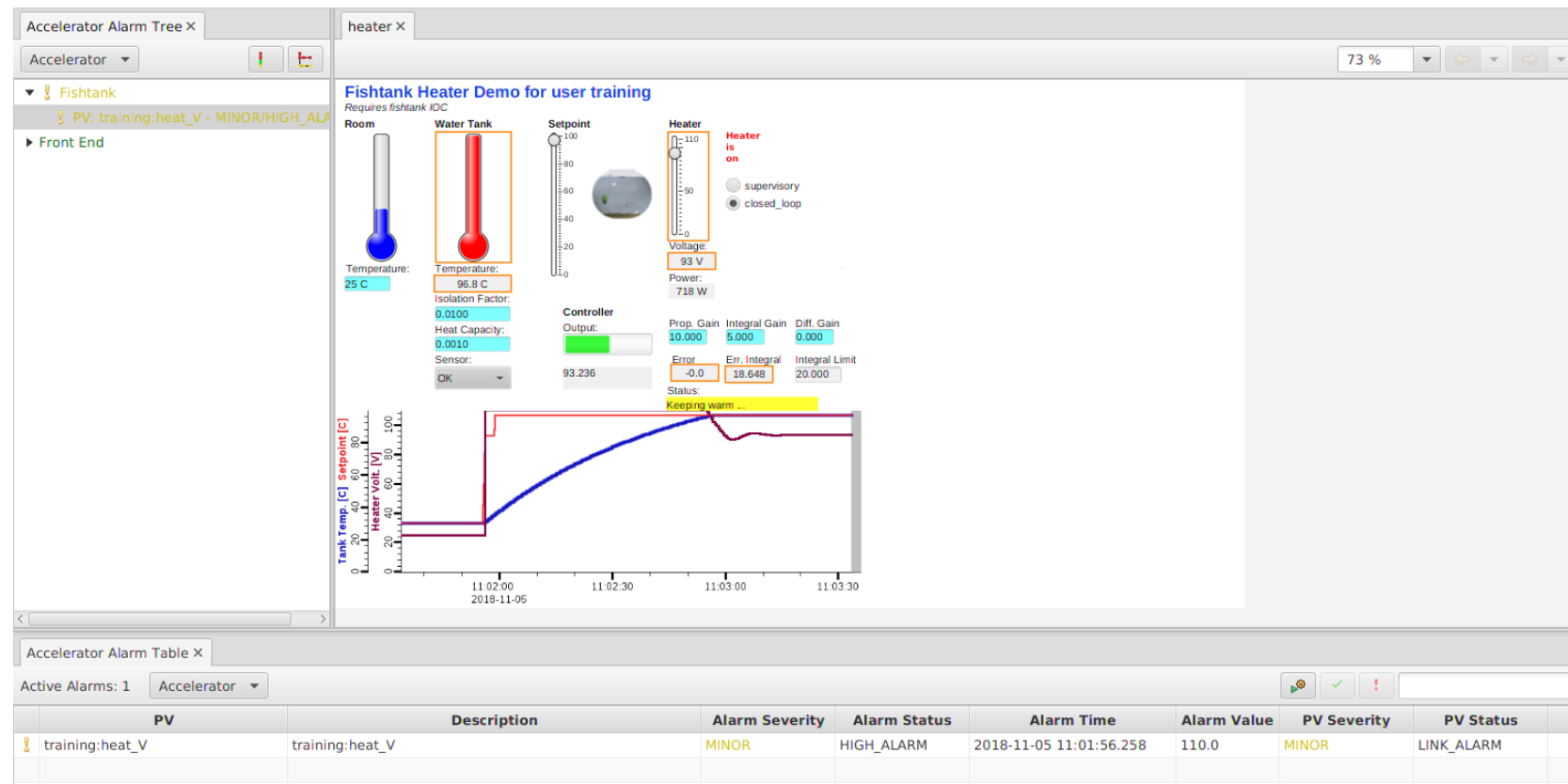
- Watch as alarm is indicated
- Open associated display

- 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

Accelerator Alarm Tree x

Accelerator

- ▼ Fishtank
 - ⚠ PV: training:heat_V - MINOR/HIGH_ALARM (OK/NO_ALARM)
- ▼ Front End
 - ⚠ PV: sim://sine - MAJOR/LOLO (OK/NONE)

93:37:12


- ✓ Acknowledge
- 📄 Copy PV to Clipboard
- 📊 Data Browser
- 📄 PV Table
- 🌳 PV Tree
- 🔍 Probe
- 🔧 Configure Item
- 📄 Rename Item
- 📄 Duplicate PV
- 📄 Move Item
- Enable Alarms
- ✗ Disable Alarms
- ✗ Remove Selected Items
- 🖨 Print...
- 📄 Save Snapshot...
- ✉ Send Email...
- 📄 Send To Log Book...

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

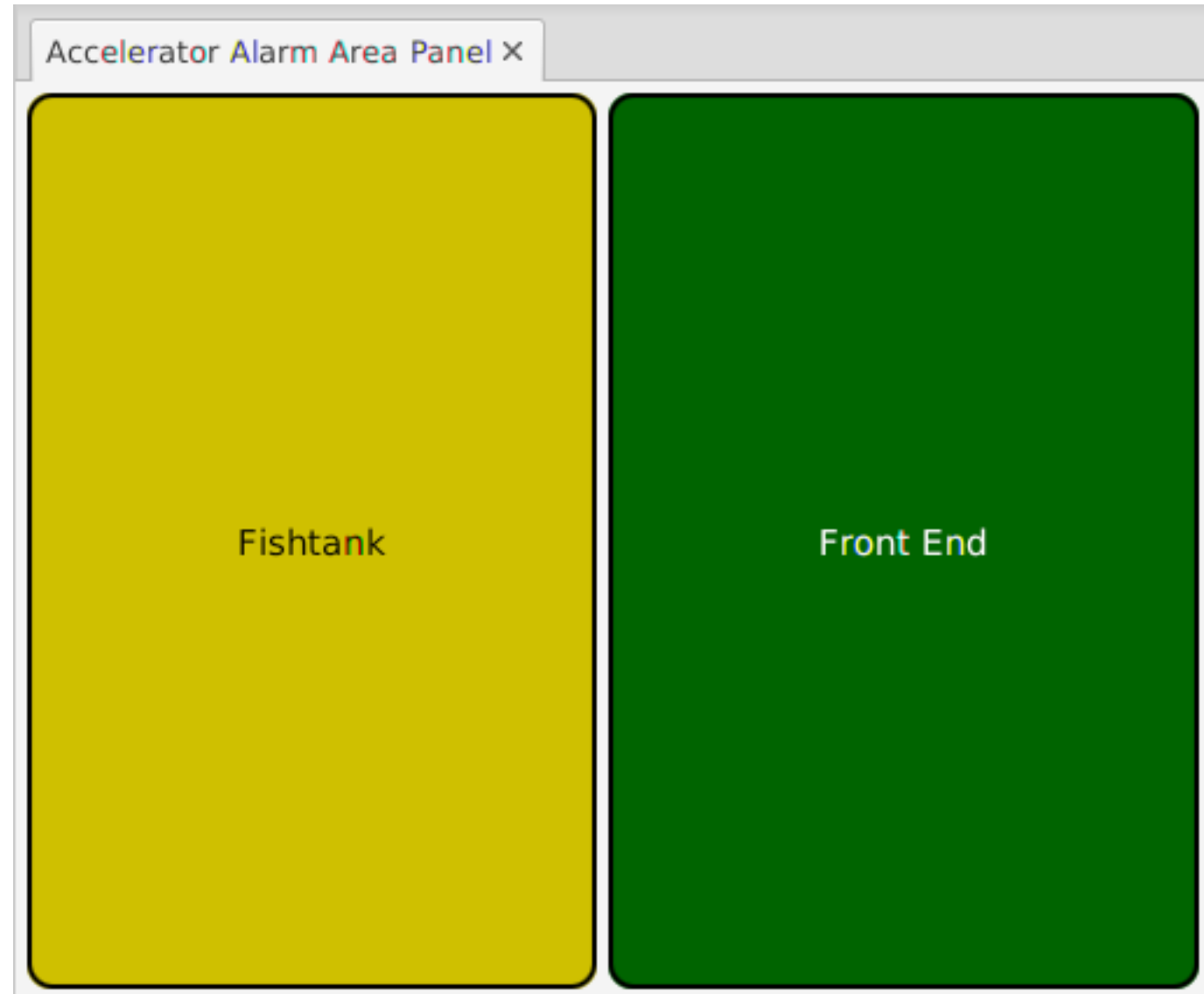
PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity	PV Status
 training:heat_V	training:heat_V	MINOR_ACK	HIGH_ALARM	2018-11-05 11:15:42.257	110.0	MINOR	LINK_ALARM

Alarm Area Panel

Useful for 'Overview Displays'

Indicates
'across the room':

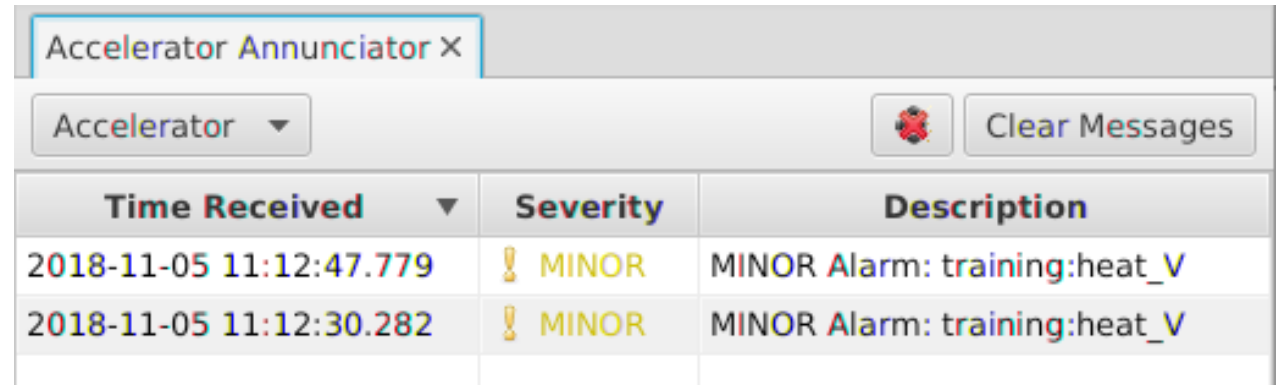
All OK?




Alarm Annunciator



Annunciates the *description* of alarms

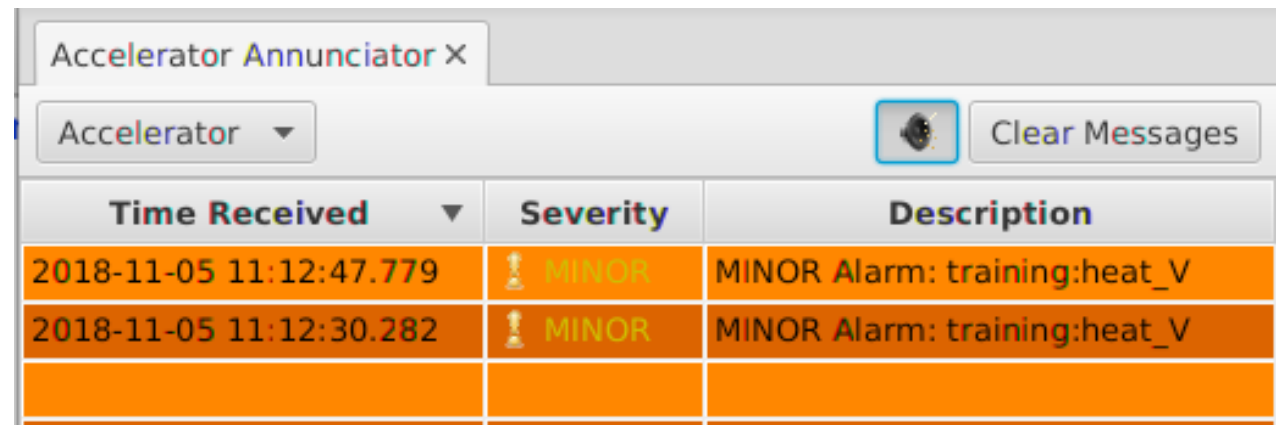
Basic “heads up” to check alarm table for details




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



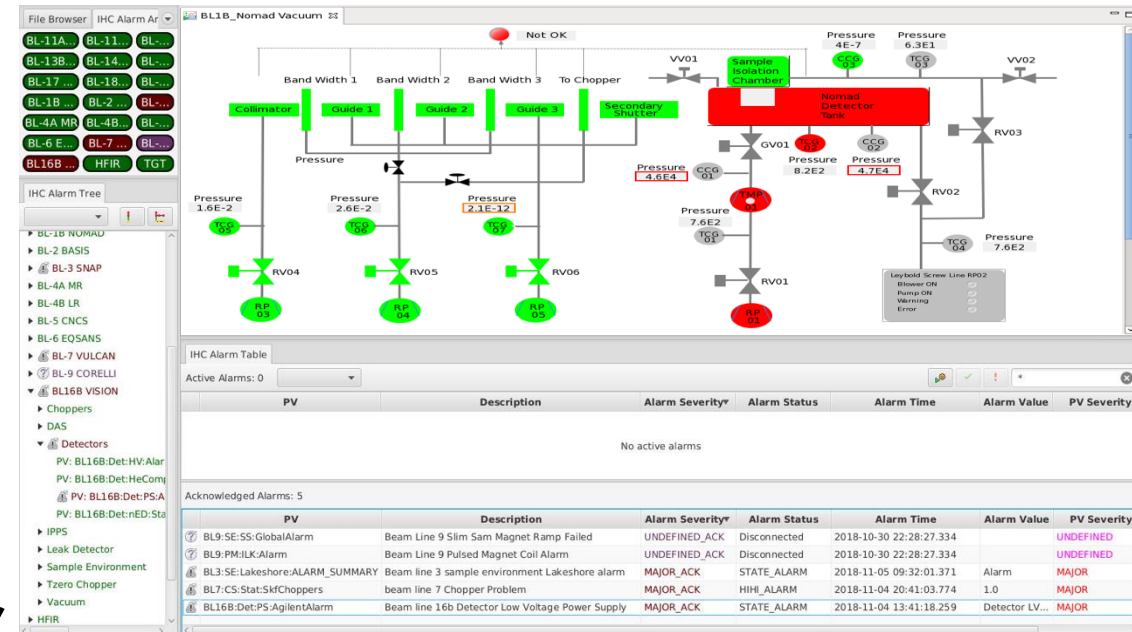
Accelerator Annunciator X

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

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



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 Ar interface. At the top, there are tabs for 'File Browser', 'IHC Alarm Ar', 'ICS Gateway', 'BL16B_Main', and 'Agilent PS x'. Below the tabs is a grid of buttons for various beam lines (BL-11A to BL-16B) and systems (HFIR, TGT). A central summary table shows the status of various power supplies (LV 3V, LV 4V, LV -4V, HV 13V) with columns for Voltage, Prot. V, Current, Over Voltage, Over Current, and Over Temp. Below this is a 'Summary Alarm' section with a red indicator and details like 'Time In Alarm: 78553 secs'. At the bottom, there is an 'IHC Alarm Table' showing active and acknowledged alarms with columns for 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	...

Suggested Layout with "locked" alarm panels

PV	Description	Alarm Severity	Alarm Status	Alarm Time	Alarm Value	PV Severity
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