OAK RIDGE National Laboratory

Alarm System

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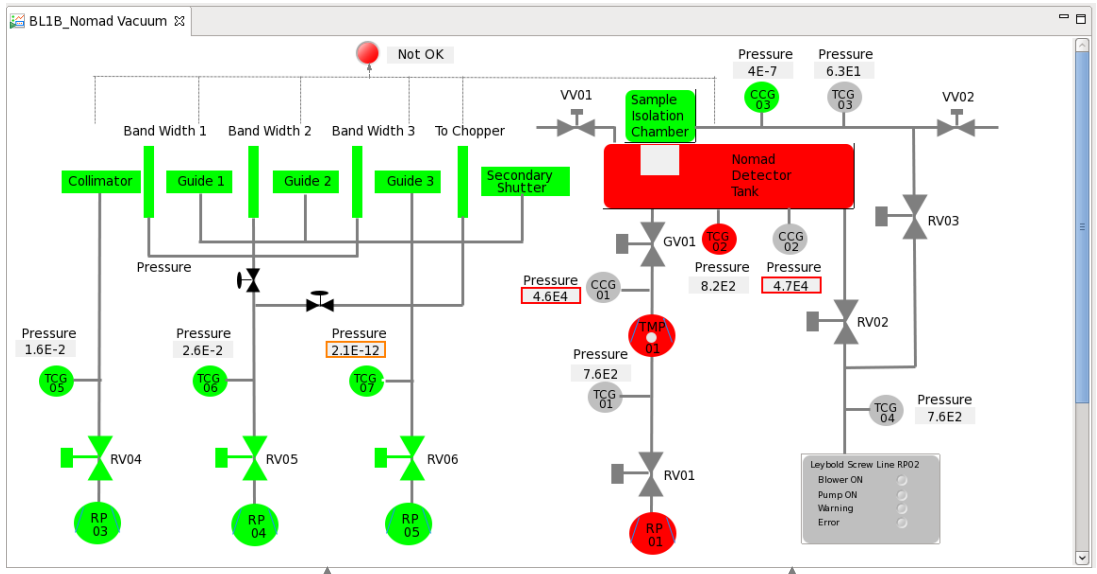
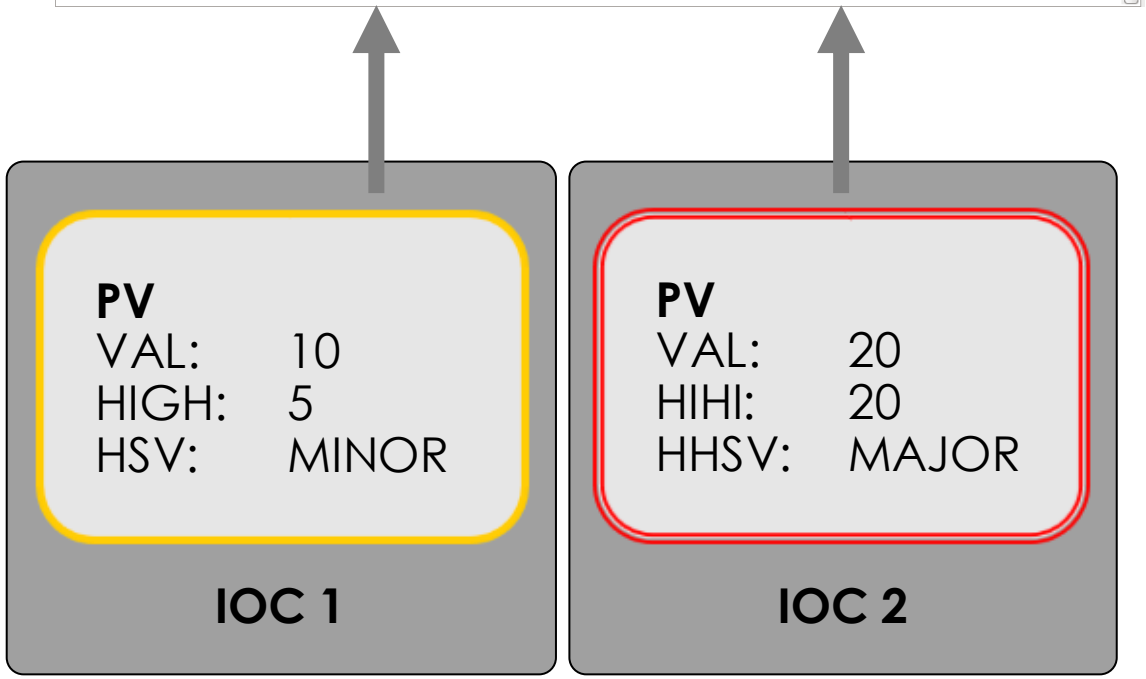
U.S. DEPARTMENT OF ENERGY

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

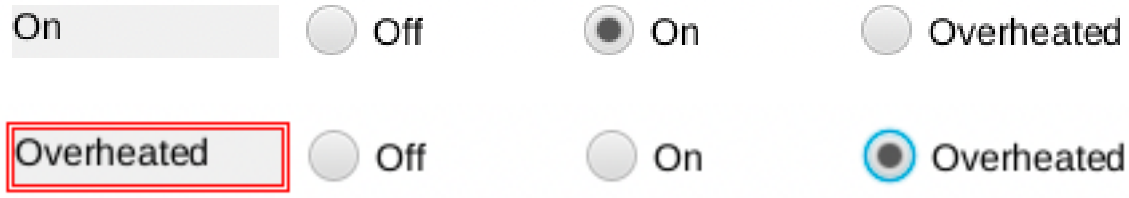
Display Tools

- Typically indicate alarm state via border and/or color

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")
}
```

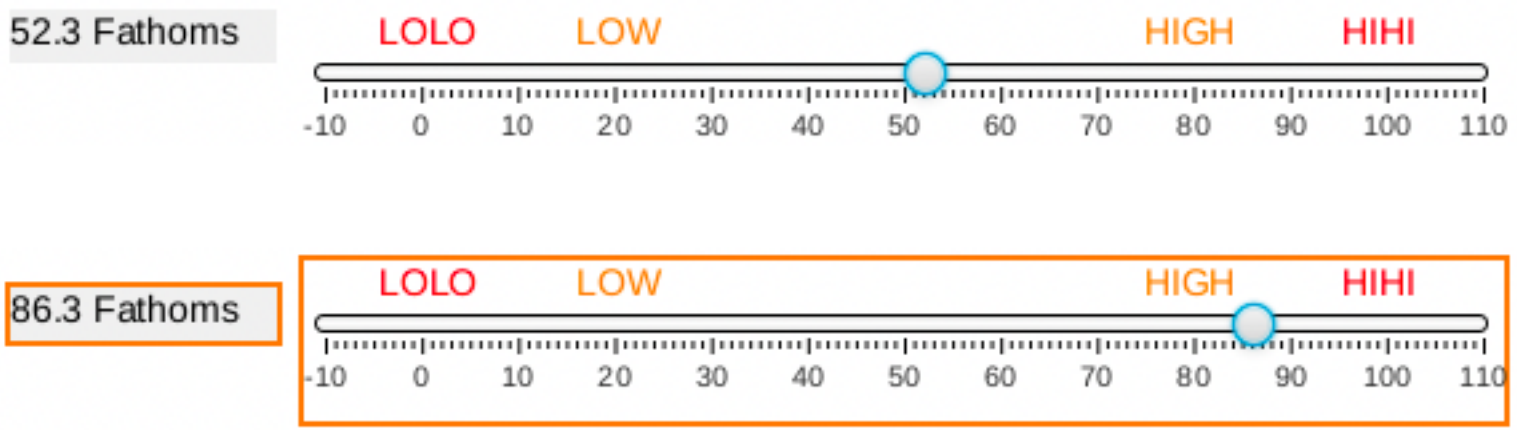

```
record(mbbi, "states")
{
    # Alarm states
    field(TWSV, "MAJOR")

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



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")
}
```

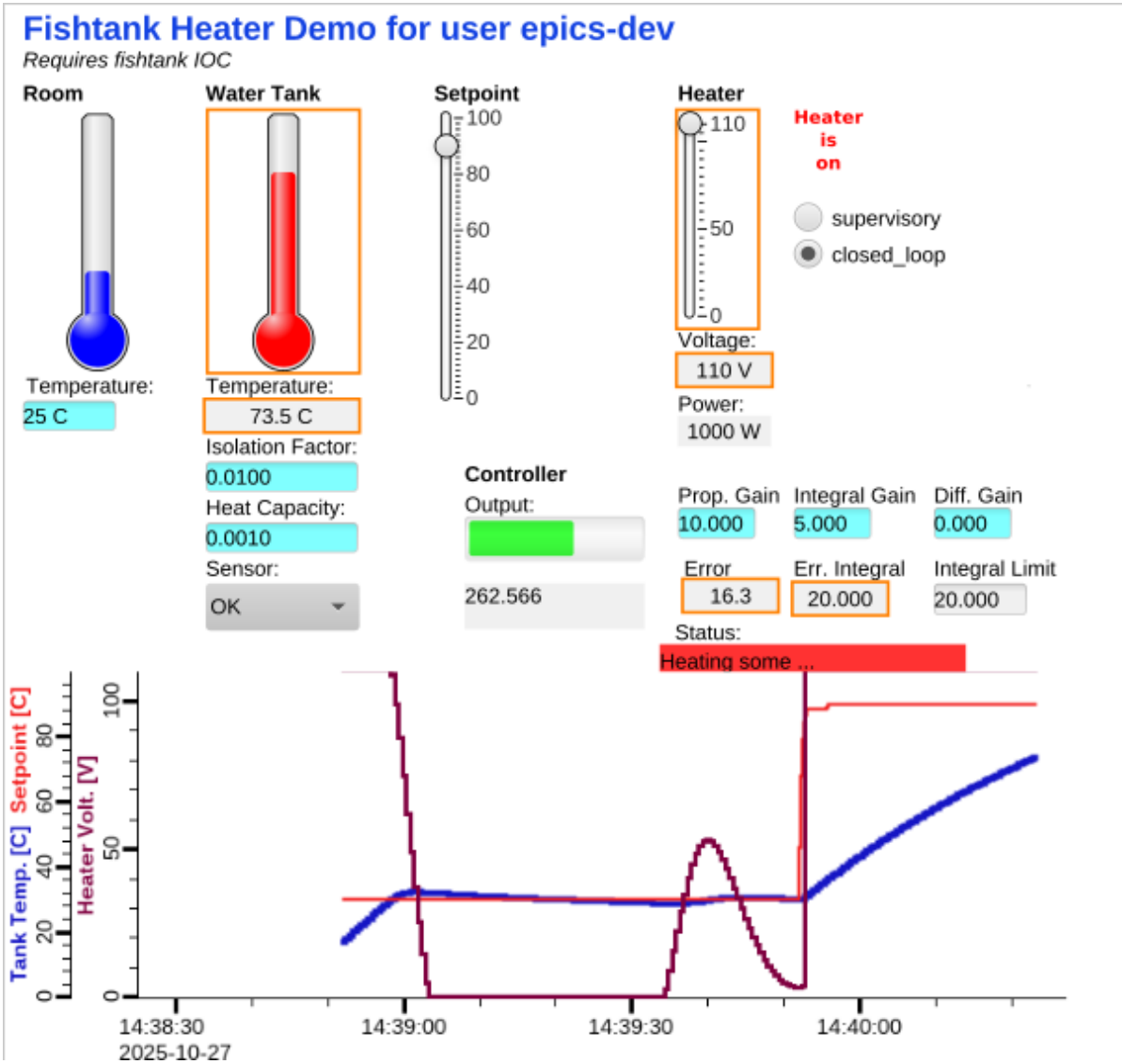
Don’t do this

```
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

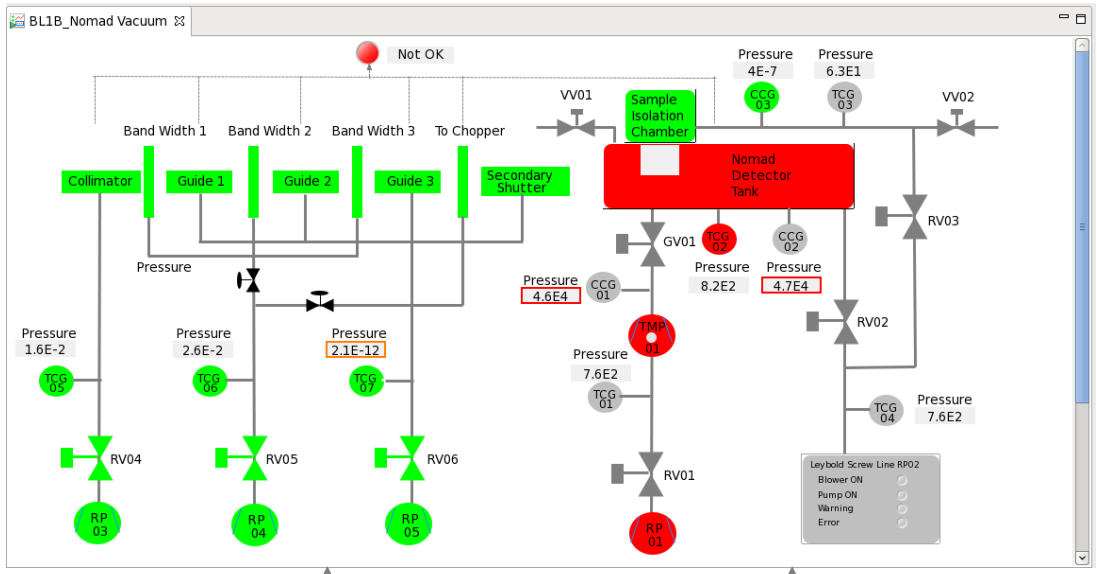
Fishtank

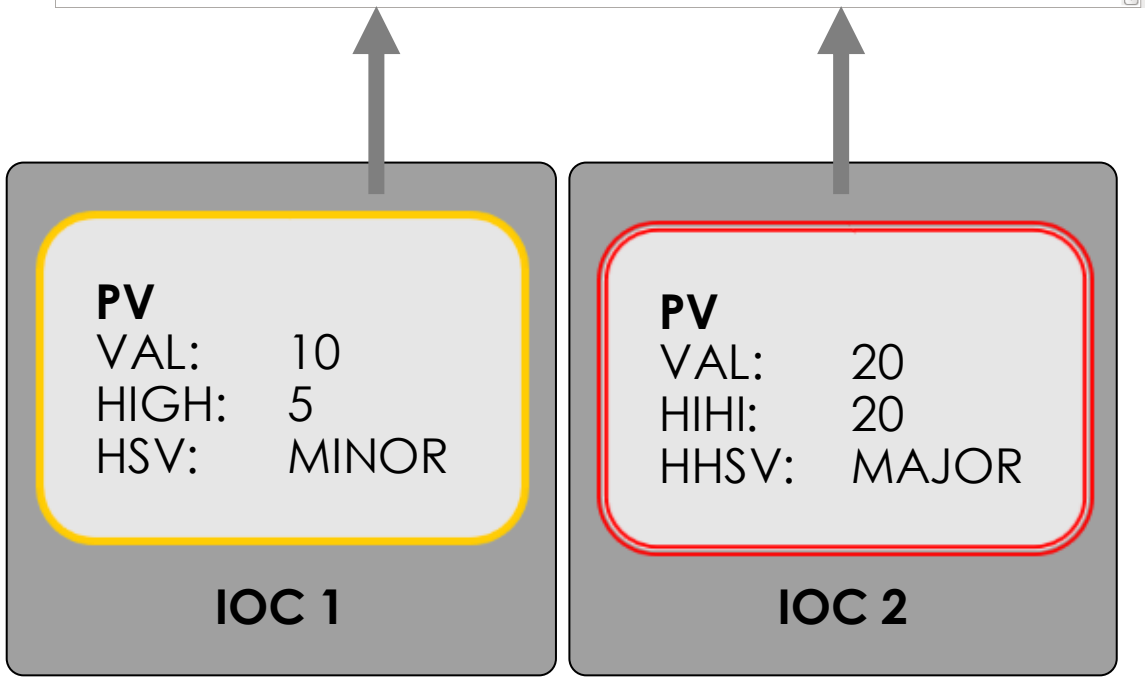
- Is tank temperature above 70 C or below 0 C a good alarm?
- Is heater at 110 V a good alarm?



/ics/examples/fishtank: st.cmd, heater.bob

EPICS PVs carry Values with Alarm Information





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

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

Alarm System Idea

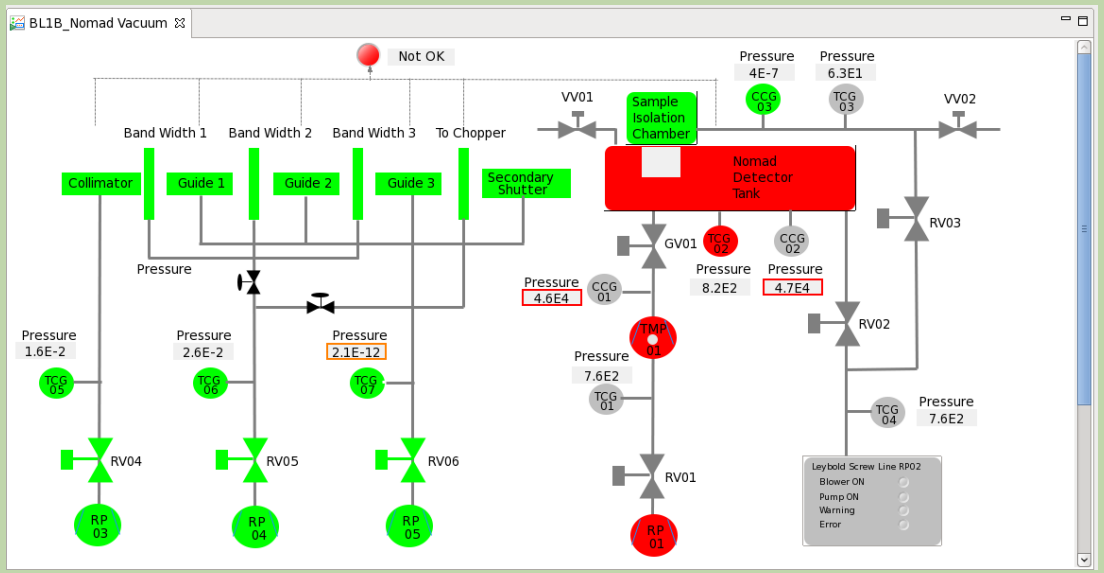
Alarm System

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

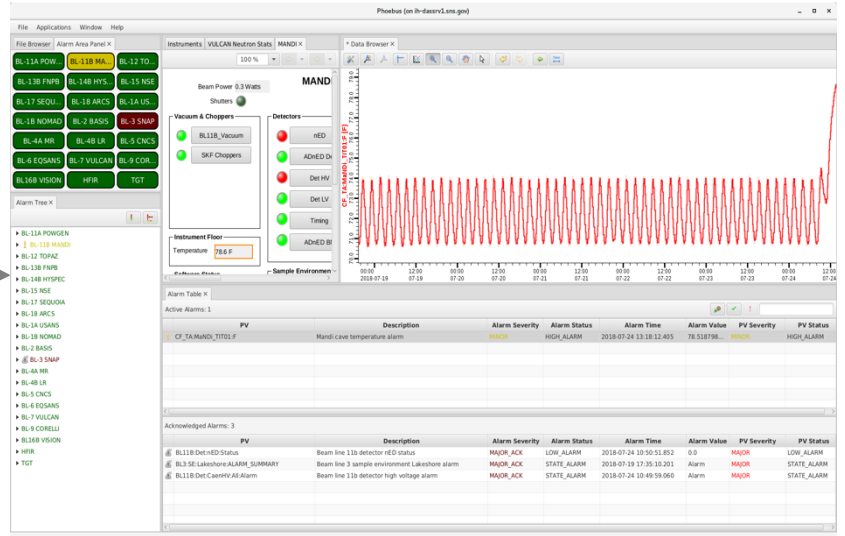
Alarm Server

Monitors PVs, updates current state

Apache Kafka

- Alarm Configuration
  - Which PVs to monitor
  - Guidance
  - Display Links
- Current State
  - Which PVs are in alarm?

CS-Studio Alarm UI



PV PV PV PV

For details of implementation, see CS-Studio Alarm System Based on Kafka, https://accelconf.web.cern.ch/icalepcs2019/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

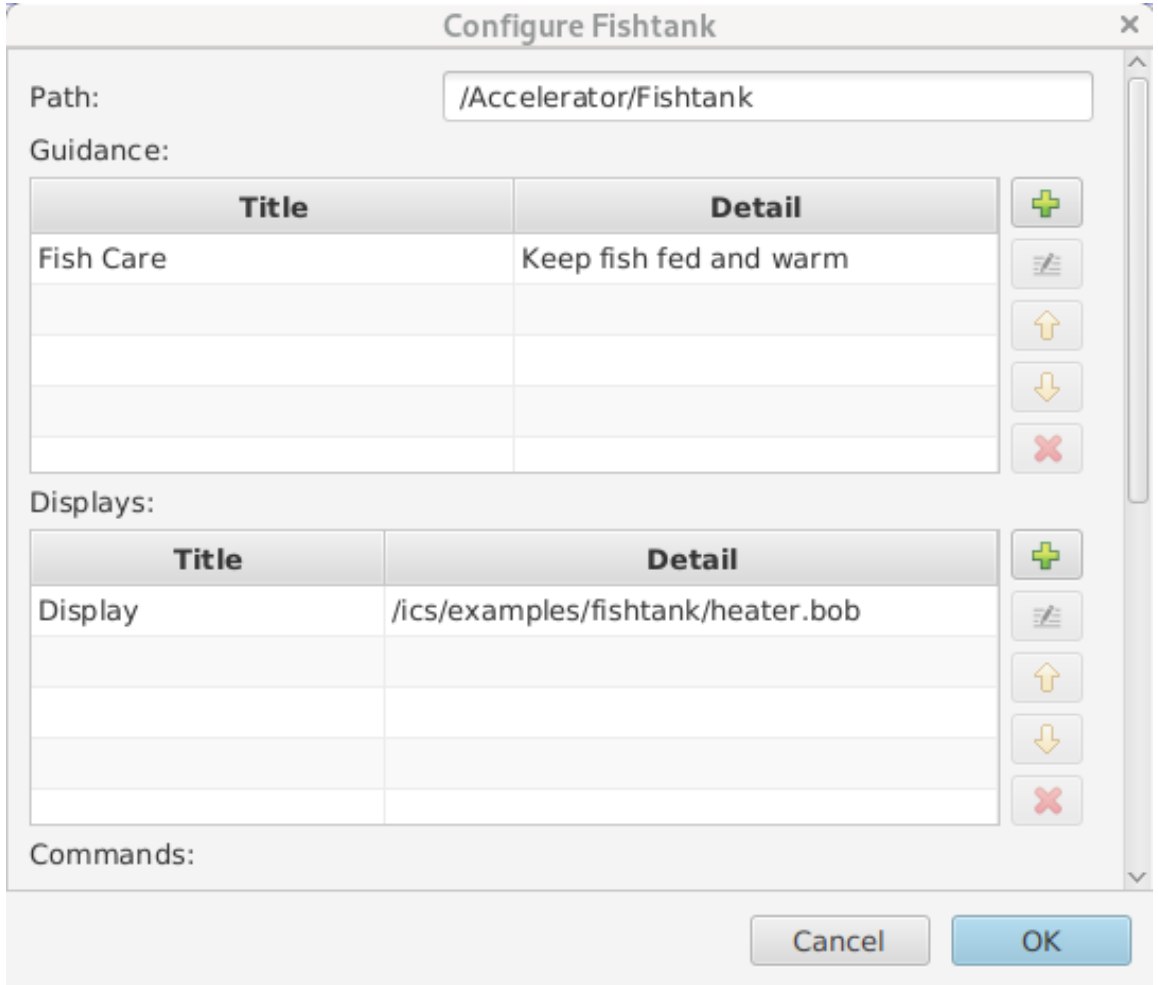
```
cd /ics/tools
systemctl status kafka
./monitor_topics.sh Accelerator
```

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

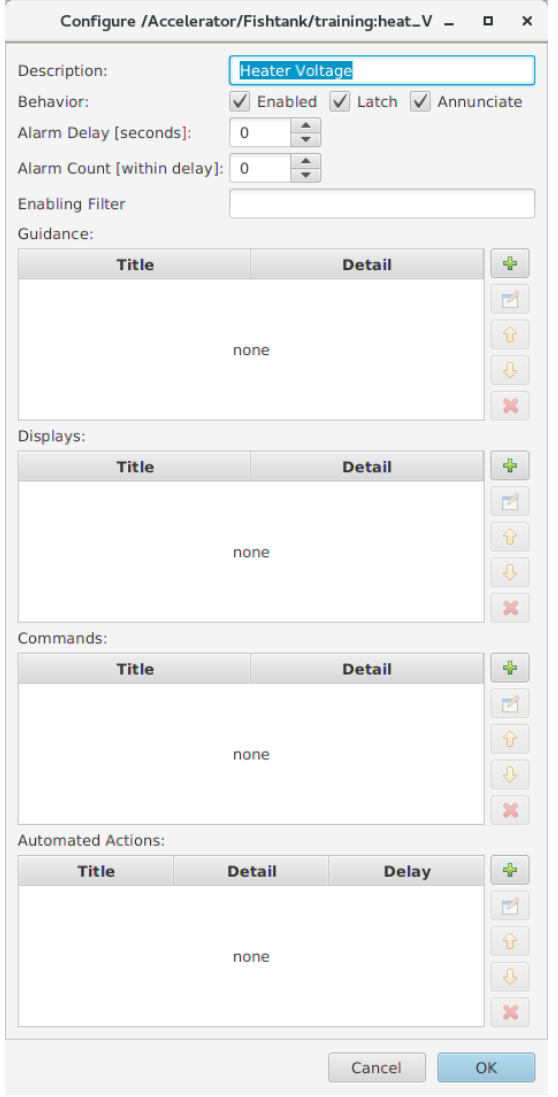
- Right-click on “Fishtank”, Add Component
  - ❑ **PV** “training:heat_V”
  - ❑ **Description**

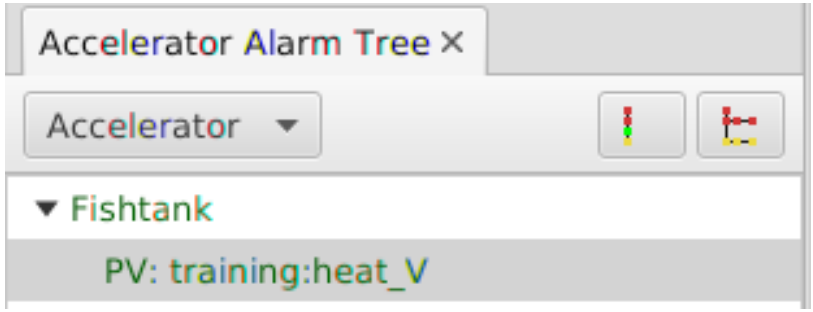
    Anything’s better than the PV name
  - ❑ Specific **Guidance** and Displays

    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

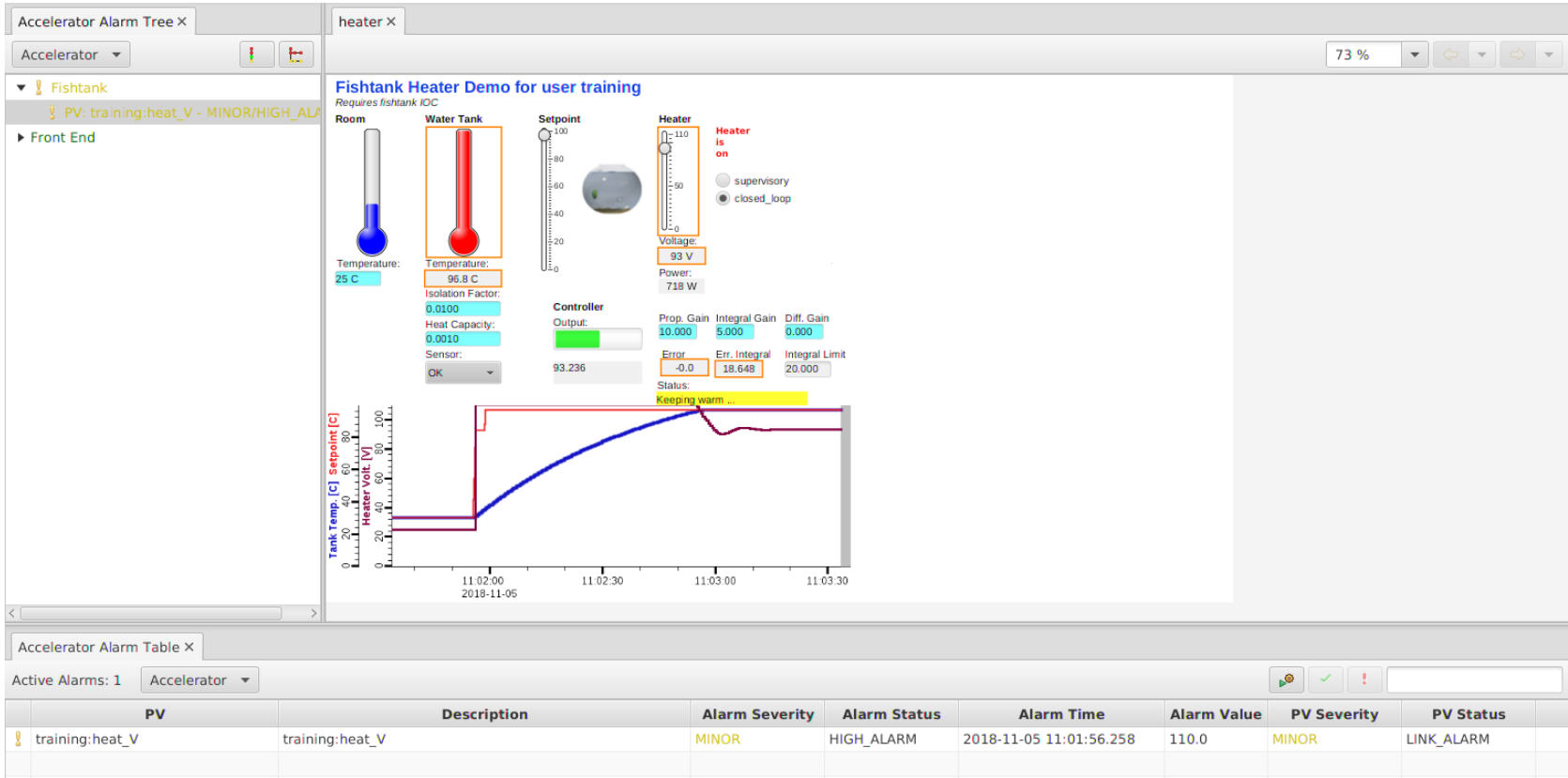
```
caput epics-dev:setpoint 72
```

- Inspect Alarm
  - Watch as alarm is indicated
  - Open associated display
- Handle It
  - Acknowledge
  - Reduce setpoint

  → Clear

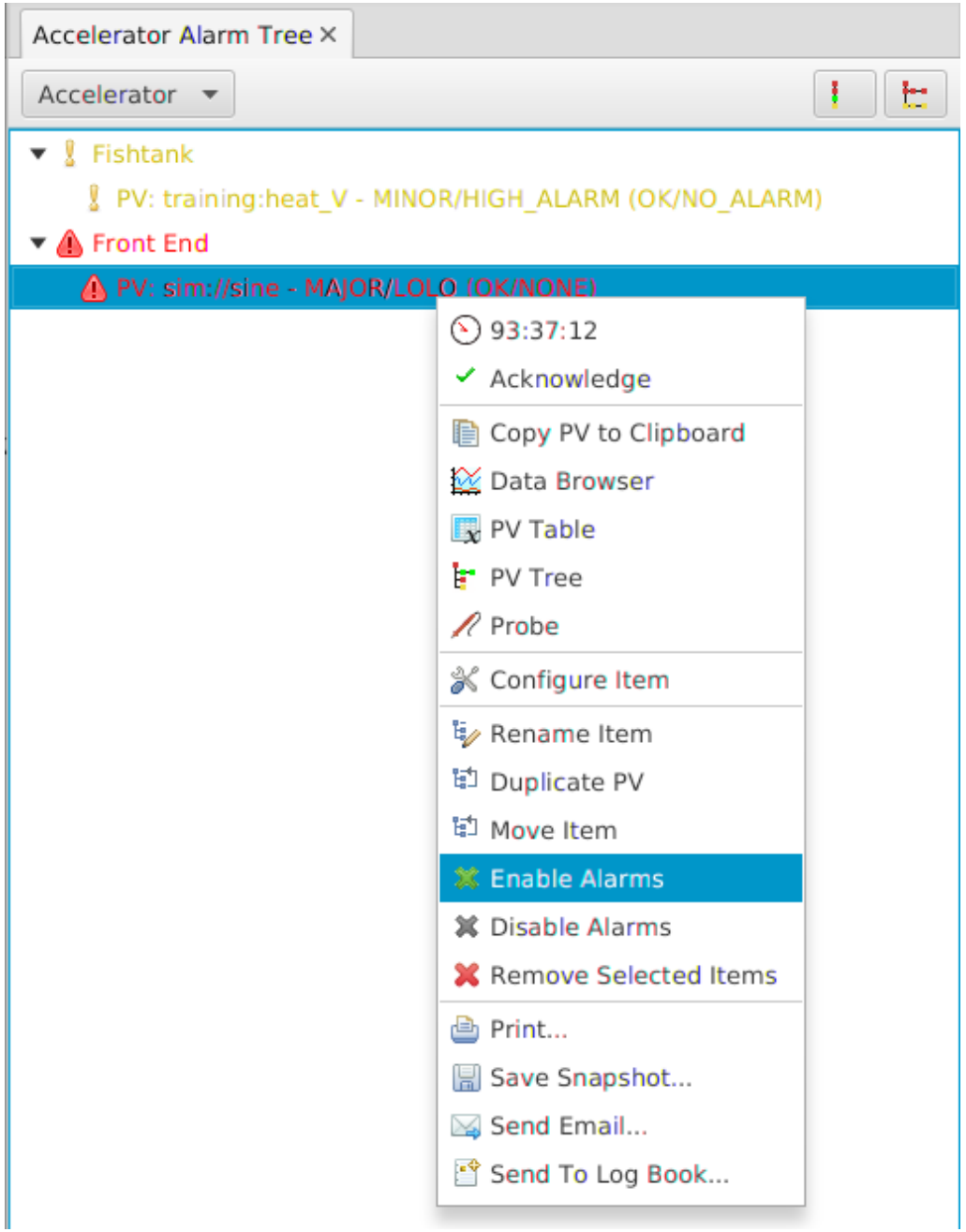
Suggested "Alarm" layout:

Alarm Tree to the left,
Alarm Table at the bottom,
both "locked"



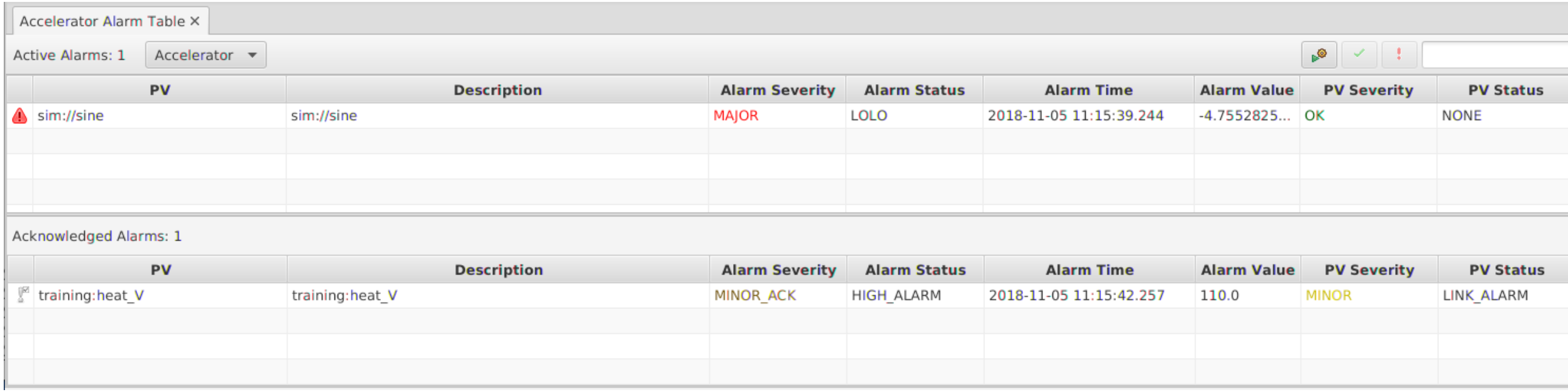
Alarm Tree

- 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



Alarm Table

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

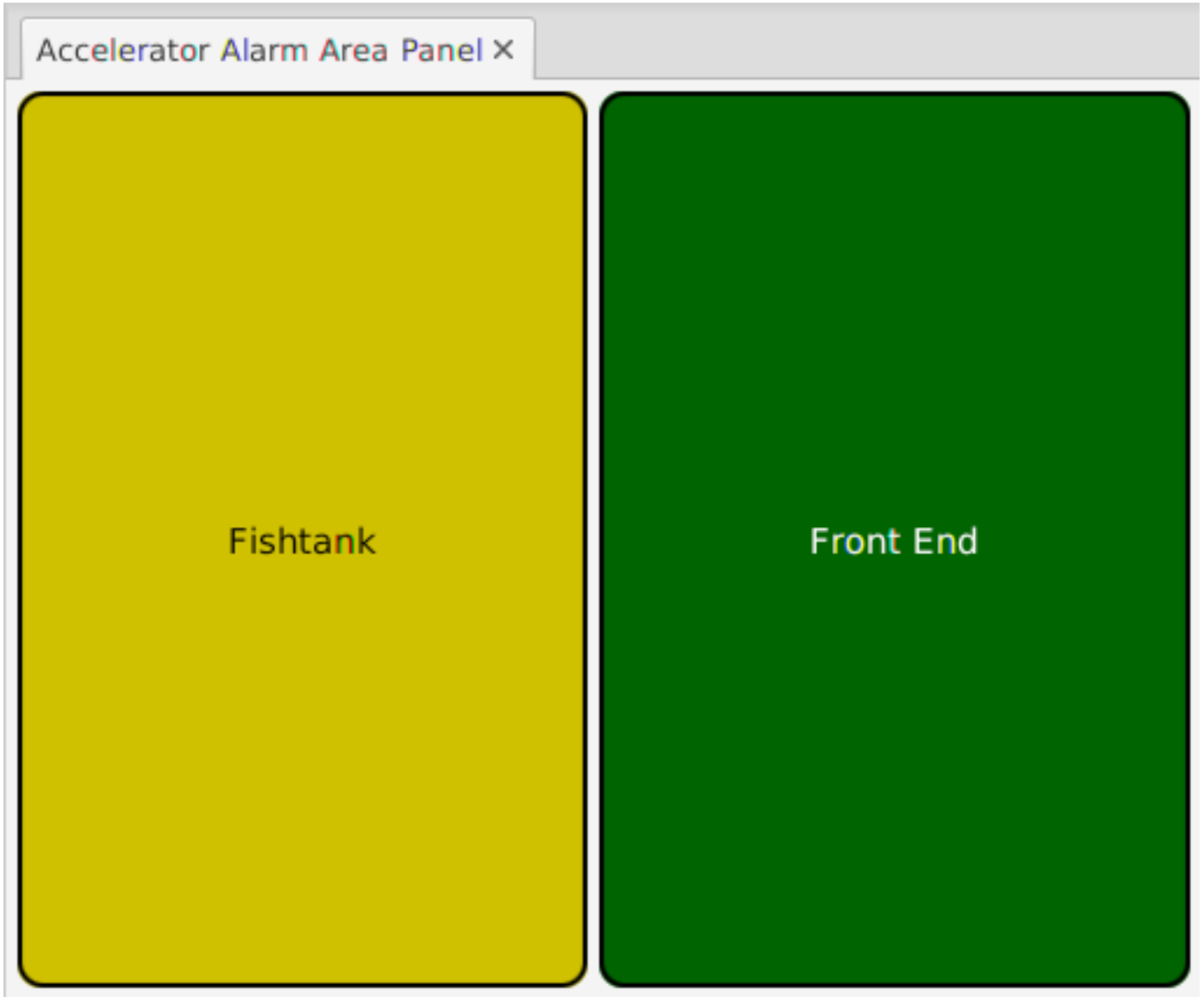


Alarm Area Panel

Useful for ‘Overview Displays’

Indicates ‘across the room’:

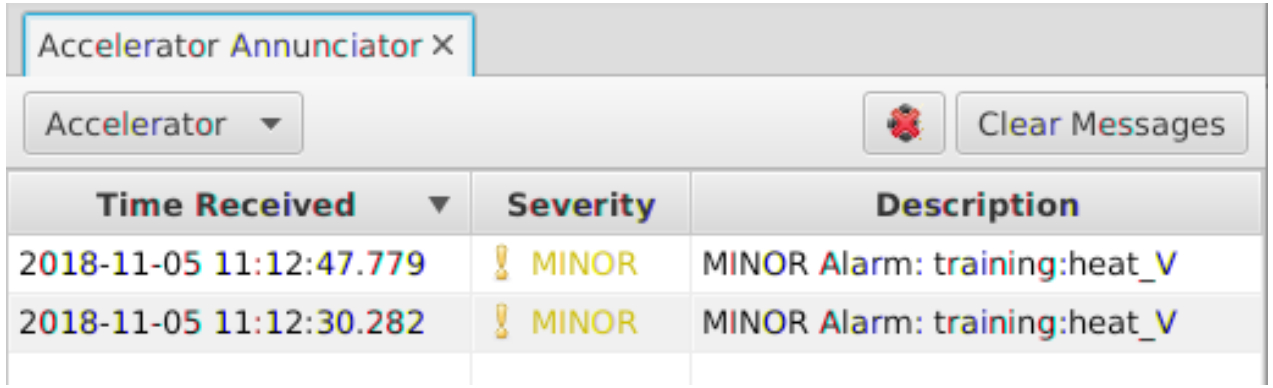
All OK?

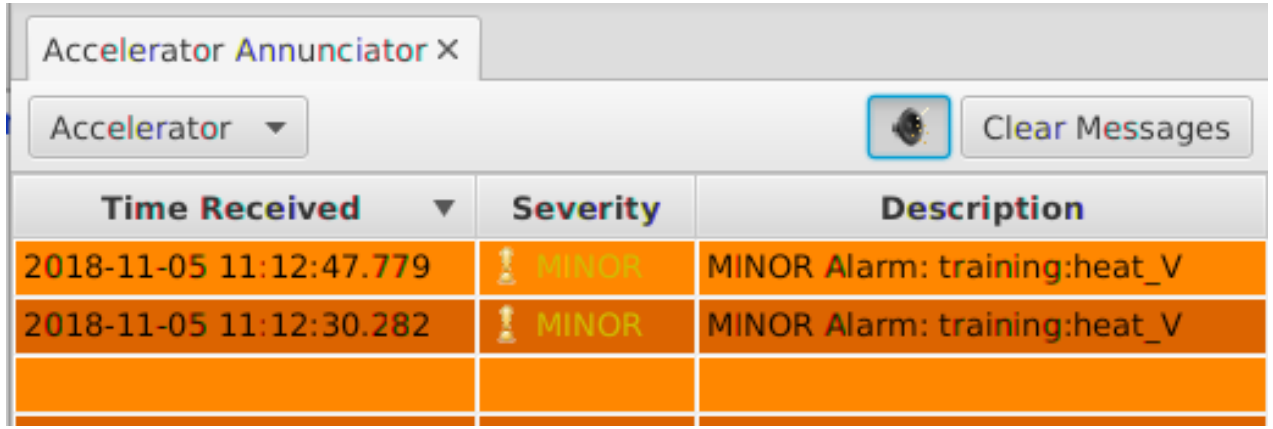


Alarm Annunciator

Annunciates the *description* of alarms

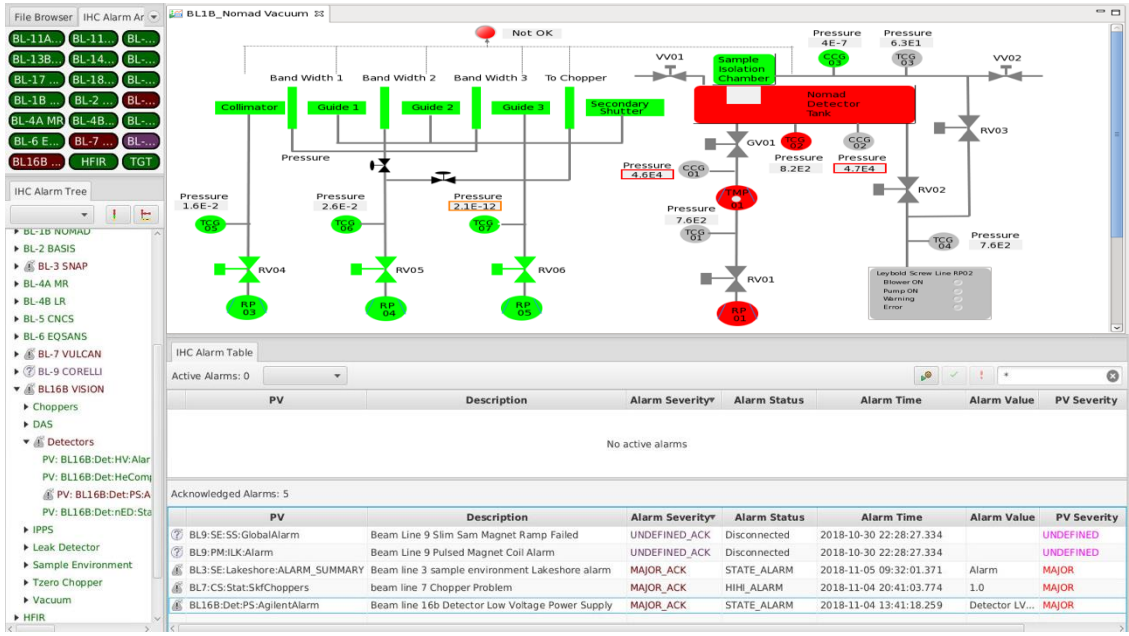
Basic “heads up” to check alarm table for details





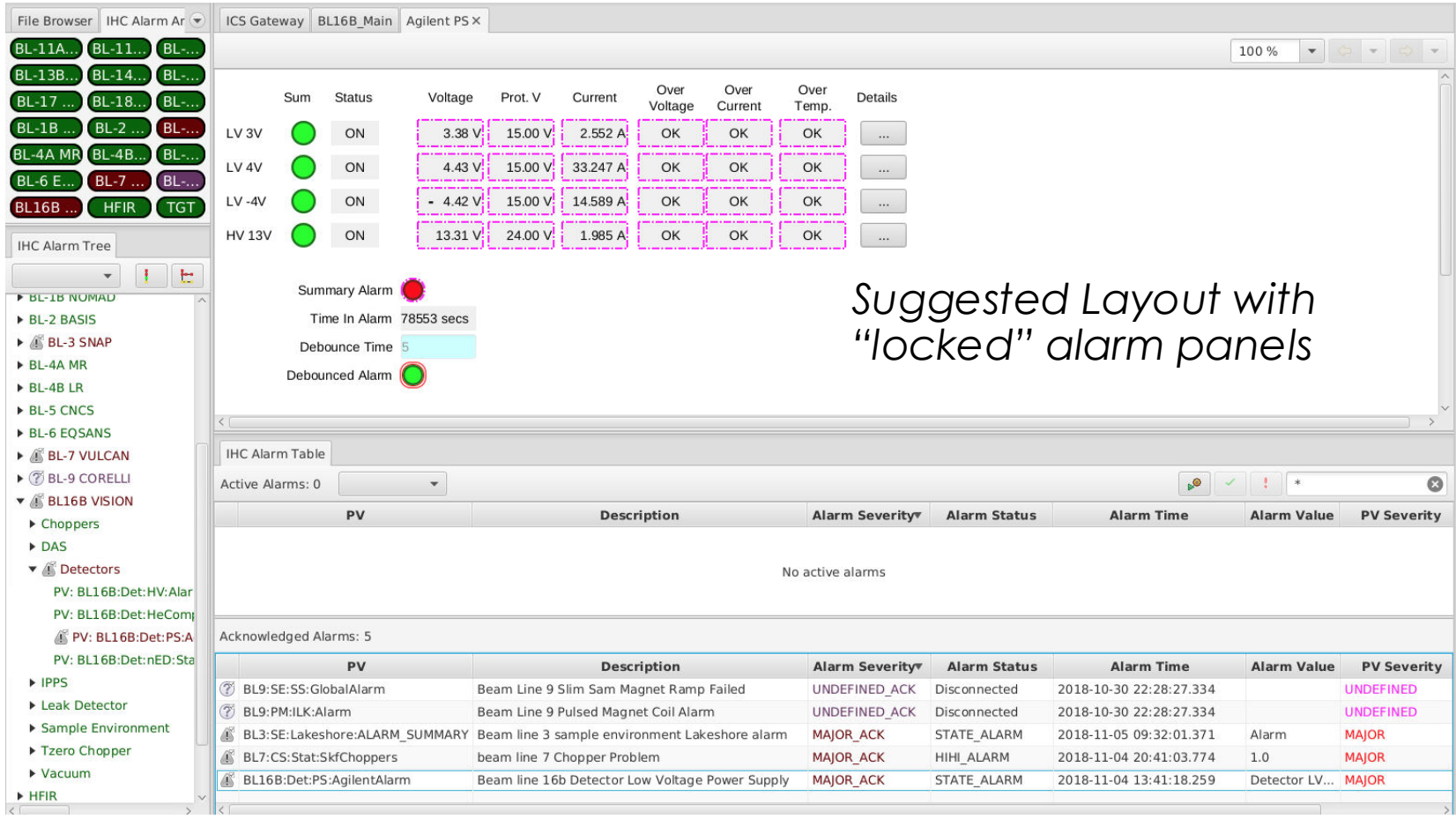
Basic Roles

- System Expert
  - Provide useful alarm levels
  - Explain what to to 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



Suggested Layout with "locked" alarm panels