

Display Builder Tutorial

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Changes

- Mar. 2024 More display screenshots
- Jan. 2019 USPAS: Initial version
- Jan. 2020 Class file details

Display Builder

- Operator Interface Editor and Runtime
- Builds on ideas from EPICS edd/dm, medm, edm, ..
- Very compatible with CS-Studio 'BOY'
- Started ~2015 in CS-Studio/Eclipse, now in CS-Studio/Phoebus

BL4A User Motors

Sample & Detector

	Destination Pos	Current Pos	Status	Scan
SANGLE	0.5000 deg	0.5012 deg	●	Scan
SampleX	-8.9618	-8.9618	●	Scan
Beam Stop	0.0362 mm	0.0362 mm	●	Scan
Sample Changer	Undefined	-87.0008 mm	●	Scan
DANGLE	13.0000 deg	13.0015 deg	●	Scan

Slits - Collimation

	Destination Pos	Current Pos	Status	Scan
S1Width	0.500 mm	0.501 mm	●	Scan
S2Width	3.000 mm	2.996 mm	●	Scan
S3Width	0.500 mm	0.500 mm	●	Scan
S1Height	30.000 mm	29.998 mm	●	Scan
S2Height	30.000 mm	30.010 mm	●	Scan
S3Height	40.000 mm	40.000 mm	●	Scan

Slits - Background

	Destination Pos	Current Pos	Status	Scan
SSHWidth	0.000 mm	0.000 mm	●	Scan
LSlit4	-1.0092 mm	-1.0145 mm	●	Scan
TDetSlit	0.0539 mm	0.0521 mm	●	Scan
LDetSlit	-0.1279 mm	-0.1276 mm	●	Scan
RSlit4	-58.5160 mm	-58.5165 mm	●	Scan
BDetSlit	0.0438 mm	0.0455 mm	●	Scan
RDetSlit	-4.9926 mm	-4.9927 mm	●	Scan

Stop Motors

SampleX Mode
SampleX->HexaX

Phoebus (on bl12-dassrv1.sns.gov)

Instrument Status

- Beam Power (kW): 1.500000
- Primary Shutter: ●
- Secondary Shutter: ●
- Acquisition Software Status: ●
- Data Reduction Status: ●

Proposal Information

- Proposal #: IPTS-21677
- Proposal Title: Commissioning-TOPAZ
- Team Members: SXW,FCT,FTE,JIU (XCAMSUCAMS)

Run Information

- Scan Status: idle
- Run Status: idle
- Run Number: 31017
- Run Time: 2051.1 s
- Total Neutron Counts: 20017936
- Count Rate (counts/s): 0
- Total Proton Charge: 0.4585 C
- Beam Monitor 1 Counts: 2280665
- Beam Monitor 2 Counts: 1599739

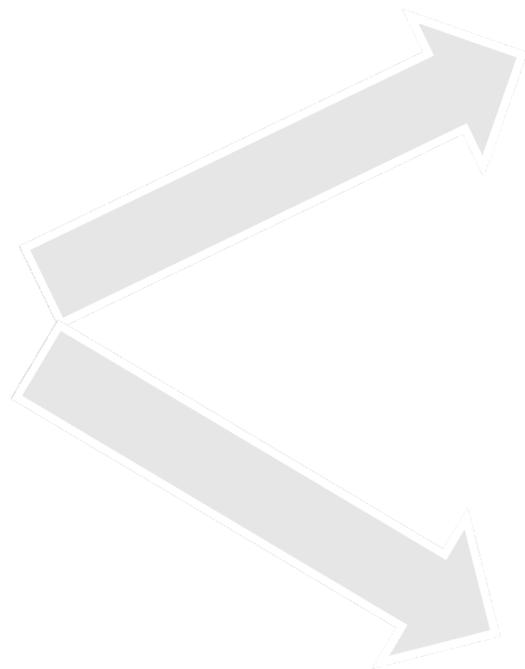
Main Detector XY Plot (4x4 Binned)

Min: 400, Max: 185, Mean: 238.375, Total: 68652, Rate: 0 e/s

ID	Created	Name	State	%	Runtime	Finish	Command	Error
105	11:11:07	/tmp/20...	Aborted		02:04:30	13:15:38	-end-	Aborted
104	09:53:50	/tmp/20...	Aborted		01:16:45	11:10:35	-end-	Aborted
103	09:45:09	/tmp/20...	Aborted		00:02:02	09:47:12	-end-	Aborted
102	09:40:58	/tmp/20...	Aborted		00:02:26	09:43:25	-end-	Aborted
101	09:39:11	/tmp/20...	Aborted		00:01:08	09:40:20	-end-	Aborted
100	09:36:27	/tmp/20...	Aborted		00:02:18	09:38:45	-end-	Aborted
99	09:33:13	/tmp/20...	Aborted		00:02:57	09:36:11	-end-	Aborted
98	09:26:30	/tmp/20...	Aborted		00:04:16	09:30:47	-end-	Aborted
97	09:24:02	/tmp/20...	Aborted		00:01:35	09:25:38	-end-	Aborted

Scan Server Heap: 66.8 / 1024.0 MB (6.5 %), Non-Heap: 87.5 MB

Same Tool, different Results



Examples: SNS Accelerator

SNS Central Control Room

Sep 13, 2018 10:56:05

Power on Target
1398 kW

Foil Image

937 Turns

Energy: 1010 MeV

Rep Rate

59.9 Hz

Beam To

Target

Shutter Status

1B NOMAD	2 BASIS	3 SNAP
4A Magnetism	4B Liquids	5 CNCS

12-Hr Power on Target

Target Image

RTBT30 Beam Size

Diagnostics

Video Foil Monitor

Secondary

Camera Setup

Camera Select: Primary, Secondary

Overlay: On, Off

Primary Lamp: Off, On, Off

Primary Insta-View: Off, On, Off

Secondary Lamp: Off, On, Off

Secondary Insta-View: Off, On, Off

Calibrate: Off, On, Off

Neutral Density Filter

Primary	Secondary
100% (blank)	100% (blank)
25%	25%
100% (blank)	100% (blank)
25%	25%

Horizontal

Amplitude: 3756.96

Mean: 39.75 mm

Std.Dev.: 1.03 mm

Offset: 1.81 mm

Slope: 0.00

Area: 0.00

Vertical

Amplitude: 3970.58

Mean: 37.92 mm

Std.Dev.: 0.75 mm

Offset: 1.85 mm

Slope: 0.00

Area: 0.00

Primary Camera Image:

Plunge: 113.70

Foil: 800.00

SNS E&RF Main Monitor

09/13/18 10:56:48

Power on Target
1377.20 kW

EF&RING Mag. Health RFQ Fields Click LEDs for Detail

Rep Rate

59.9 Hz

Avg Current

27.5 mA

Availability

Current Shift

Max Achievable: 99.91%

Running Total: 99.79%

Previous Shift

Total: 99.51%

RFQ	MEBT				DTL						CCL				
CAV RFQ	1	2	3	4	1	2	3	4	5	6	1	2	3	4	
MOD RFQ	1	2	3	4	RFQ	M3	M5	M1	M2	M3	M4				
XTMR RFQ					X1	X2	X3	X4	X5	X6	X1	X2	X3	X4	

Recent Downtimes

Start	End	Duration
2018/09/12 16:52:10	2018/09/12 16:54:25	0.0
2018/09/12 13:21:46	2018/09/12 13:22:37	0.0
2018/09/12 13:10:16	2018/09/12 13:14:01	0.1

Fault not found

2018/09/12 13:21:46 2018/09/12 13:22:37

Ring Mag EKkick08_CT fault

2018/09/12 13:10:16 2018/09/12 13:14:01

SCL LLRF HPM22a fault

MPS Latest MPS Fault

Sep 13 2018 10:48:32 RFQ_LLRF:HPM1:FPAR_MEBT_B5

Chain Chassis (Col, Row)

MEBT RFQ_HPRF1A (1, 8)

E&RF Systems

E&RF WIKI

ELOG

HPRF Main HVCM Main LLRF Main

XMTR	Modulator	Cavities																								
01	03	SCL 01	01a	01b	01c	02a	02b	02c	03a	03b	03c	04a	04b	05	07	SCL 05	04c	05a	05b	05c	06a	06b	06c	07a	07b	07c
09	11	SCL 09	08a	08b	08c	09a	09b	09c	10a	10b	10c	11a	14	15	SCL 14	11b	11c	12a	12b	12c	12d	13a	13b	13c	13d	
17	18	SCL 15	14a	14b	14c	14d	15a	15b	15c	15d	16a	16b	20	21	SCL 18	16c	16d	17a	17b	17c	17d	18a	18b	18c	18d	
22		SCL 21	19a	19b	19c	19d	20a	20b	20c	20d	21a	21b				21c	21d	22a	22b	22c	22d	23a	23b	23c	23d	

More Accelerator Examples

Created by Operators:

SCL RCCS/Cool 1 X

MAIN | CCL | SCL Vac | LEDP | Vacuum | SCLHB

SCL Module 1	SCL Module 2	SCL Module 3	SCL Module 4	SCL Module 5	SCL Module 6	SCL Module 7	SCL Module 8	SCL Module 9	SCL Module 10	SCL Module 11
CCG01001 1.43E-7	CCG02001 7.25E-8	CCG03001 9.22E-8	CCG04001 6.09E-8	CCG05001 3.75E-7	CCG06001 9.11E-7	CCG07001 6.52E-8	CCG08001 2.25E-7	CCG09001 7.04E-7	CCG10001 8.69E-8	CCG11001 1.72E-6
IP01001 6.89E-9	IP02001 4.98E-10	IP03001 4.18E-10	IP04001 4.85E-10	IP05001 5.79E-10	IP06001 5.11E-10	IP07001 4.12E-10	IP08001 4.21E-10	IP09001 4.99E-9	IP10001 1.01E-8	IP11001 4.91E-10

RF Water Heaters: MB1-MB11

Cryo: MB1-MB11

Magnets: QH00-QV11

Interlocks: SCL Zone 1, 2, 3 QMCS PS Interlock

Created by Controls Engineer:

CCL Water Overview Page

MAIN | DTL Water | SCL Water | EXIT

Interlocks: CCL1 Cool, CCL2 Cool, CCL3 Cool, CCL4 Cool, QMCS Cool, CCL1 RCCS, CCL2 RCCS, CCL3 RCCS, CCL4 RCCS, QMCS WS, CCL DI

CCL RCCS Module 2 Water Skid

RF Water Return | RF Water Supply

ValveState: Close | Overfill: ON

Mode: Auto

FT3-FT1: -5.78 GPM

FT1: 241.84 GPM

FT2: 236.06 GPM

PH1: -0.5 pH

TK-1: NOT LOW

FT4: 3.93 GPM

RE-1: 18.7 Mohm-cm

RE-2: 15.0 Mohm-cm

CV1: 23.11 % HX Flow

CV2: 99.62 % open

CV3: OPEN

Mode: MAN

PMP-1: ON

Speed %: 96.5

57766.1 Pump Run Hrs

Mode: AUTO

Facility Water: 5.25 degC

Facility Chilled Water Supply

Facility Chilled Water Return

TT1-TT2: 14.61 degC

TT3-TT4: 164.133 kW

TT5-TT6: 0.49 degC

TT7-TT8: 2.88 degC

TT9-TT10: 21.90 degC

TT11-TT12: 21.92 degC

TT13-TT14: 21.74 degC

TT15-TT16: 13.230 kW

Skid Shutdown Status: NOT_SHUTDOWN

Related Displays: External Apps, PLC and Rack Status, PLC FM Scaling, LLRF RCCS Interface

SEP 17, 2019 14:56:42

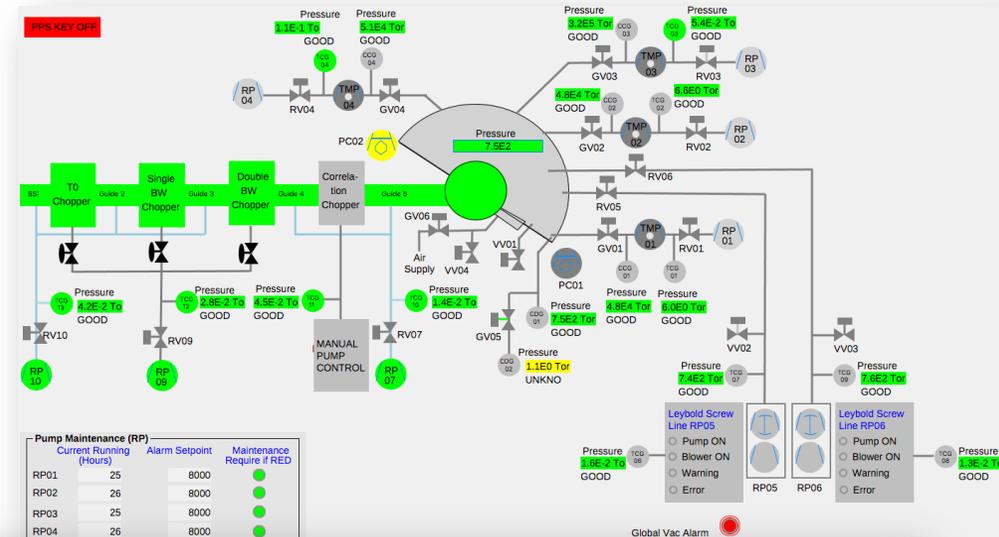
Examples: SNS Beam Lines

Accelerator Mode: Target Power: 1398.96 kW Charge: 2.309E-5 C Energy: 1010.228 Mev Rate: 59.9 Hz

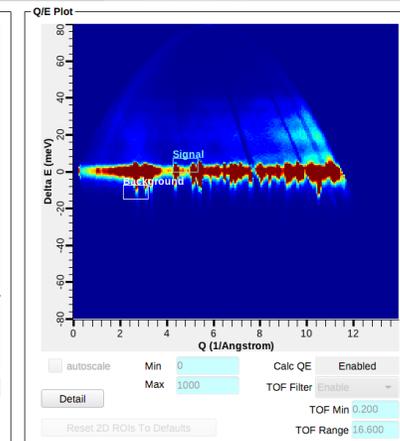
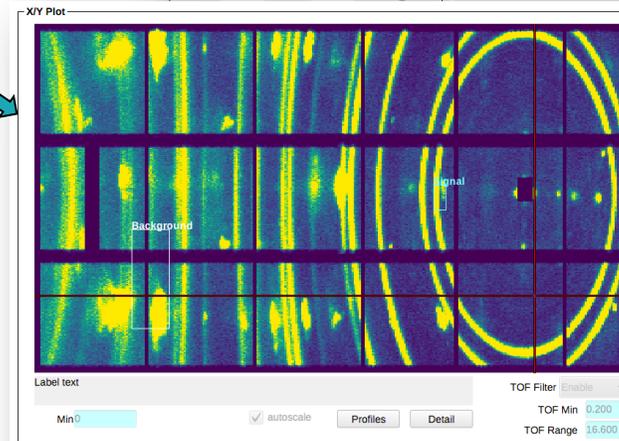
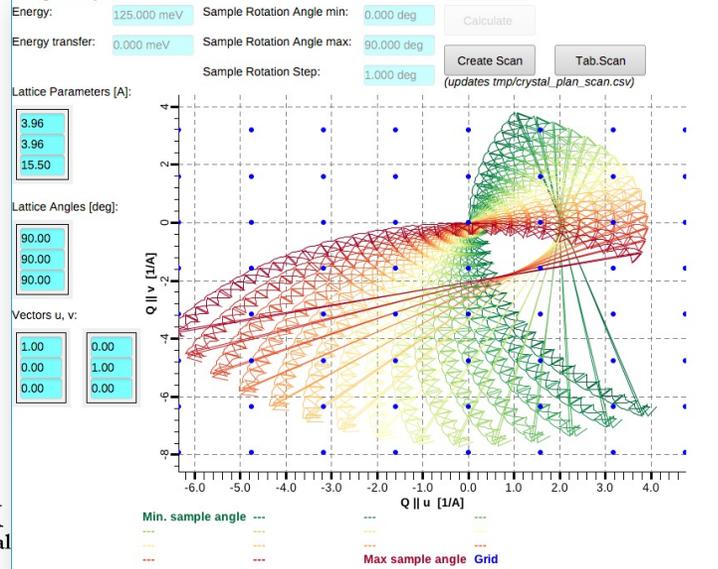
HFIR

BL-1A USANS Shutter: Run Run: Run Scan: Running TO Chopper: Main IPSS: IPSS	BL-1B NOMAD Shutter: Run Run: Idle Scan: Finished TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-2 BASIS Shutter: Run IPSS: IPSS	BL-3 SNAP Shutter: Run Run: Idle Scan: Finished TO Chopper: Main IPSS: IPSS	BL-4A MRef Shutter: Run Run: Idle Scan: Aborted TO Chopper: Main Choppers: IPSS	BL-4B LRef Shutter: Run Run: Idle Scan: Finished TO Chopper: Main Choppers: IPSS
BL-5 CNCS Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-6 EQ-SANS Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-7 VULCAN Shutter: Run Run: Idle Scan: Finished TO Chopper: Main Choppers: Detector IPSS: IPSS	BL-9 CORELLI Shutter: Run Run: Run Scan: Paused TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-10 VENUS Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-11A POWGEN Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS
BL-12 TOPAZ Shutter: Run Main: Main IPSS: IPSS	BL-13 FNBP Shutter: Run Main: Main Choppers: Choppers IPSS: IPSS	BL-14B HYSPEC Shutter: Run Run: Idle Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-15 NSE Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-16B VISION Shutter: Run Run: Run Scan: Running TO Chopper: Main Choppers: Vacuum IPSS: IPSS	BL-17 SEQUOIA Shutter: Run Run: Idle Scan: Aborted TO Chopper: Main Choppers: Detector/nED IPSS: IPSS
BL-18 ARCS Shutter: Run Run: Idle Scan: Failed TO Chopper: Main Choppers: Vacuum IPSS: IPSS					

Summaries: SE Case, CMF, NCL, Gateways, ODH, Instruments Data



Single Crystal Planner



X-Y ROI

	Min	Max	Mean	Total	Total +/-	Rate
Signal	11	363	116.194	22774	150.911	0 e/s
Background	0	1425	71.161	160824	401.029	0 e/s
S/B	0.000	0.255	1.633	0.142	0.001	0.000

Q-E ROI

	Min	Max	Mean	Total	Total +/-	Rate
Signal	44	8996	778.156	105051	324.116	0 e/s
Background	6	2090	182.778	24675	157.083	0 e/s
S/B	7.333	4.304	4.257	4.257	0.030	0.000

Data Collection

Total Counts	4890418	0 e/s
Proton Charge	4.0063559E-1 C	
Beam Power	1402537 Watts	
Data Collection State	Idle	
Data Collection Pause	Not Paused	

Q-E Axes & ROI Position Details

	ROI Start	ROI Size	Start	End	Bin Size	
Q Signal	4.268	1.067	Q Axis	0.0000	13.9396	0.0697
E Signal	0.000	7.500	E Axis	-80.0000	80.0000	0.8000
Q Background	2.134	1.067				
E Background	-15.000	7.500				

More Beamline Examples

Camera Control

Exposure Time (s): 180.000
 Binning: 1
 ADC Speed: 1.00 MHz
 Shutter Mode: AUTO
 Camera State: Idle
 Start Stop

Cooling

Cooler: On
 Temperature: -60.000
 Status: Stabilized at set pt

Motors

Motor	Readback	Position	Left/Move/Right	Limits
Lift Table	831.0 mm	531.0 mm	STOP	
Short Axis	80.0 mm	80.0 mm	STOP	
Long Axis	132.5 mm	132.5 mm	STOP	
Large Rotation T	90.0 deg	90.0 deg	STOP	
Detector Table	225.0 mm	225.0 mm	STOP	Enabled
Small Rotation T	181.4 deg	181.4 deg	STOP	
Camera Vert	70.0 mm	70.0 mm	STOP	

CT Scan (Camera Scan)

Configuration: Start 0 End 182 Step 0.650
 Device: Large Small Rot. Table
 Exposure: 180.000 Delay 0 sec Simulate?
 File Name: Turbine_CT Next File # 280
 Directory: /home/controls/cgl/data/Tuesday/Turbine_4_CT
 File name: Turbine_CT
 Status: 90.0 deg Scan Active
 Camera: Idle
 Last file: J130109_Turbine_CT_0180_181.350_0279.tif

Console

ID	Created	Name	State	%	Runtime	Finish	Command	Error
153	2013-01-08 17:54:24	Rotation Scan: Turbine_CT	Finished - OK		14:35:06	08:29:31	- end -	
152	2013-01-08 17:38:07	Rotation Scan: Turbine_CT_test	Finished - OK		00:15:35	17:53:42	- end -	

Centering Control & Status

Mode: None
 Status Calibration Complete
 XY Clock 338 399
 XY Pos 338 389
 Active Error Settings
 Progress: No centering mode. Can freely re-position crosshairs.

Camera & LED

Start Stop 3006 Hz
 Camera Status: Acquire
 X-Ray Yes/No: Vacuum
 I/FID Control: On Off
 LED Status: 14 s
 Video Viewer Camera Export

Save JPEG Image

File Path: /tmp/...
 File Name: Matt
 Next File Index: 2
 Save Image

Sample Positioning Motors

Base1 10.1661 mm	Sample1 5.6379 mm
Base2 10.3785 mm	Sample2 5.1554 mm
Base3 10.3793 mm	Sample3 5.7751 mm
Omega 75.0020 deg	Phi 0.1120 deg

Select Sample & Set File Name

Current Sample: Gd Loaded Cement
 File name: DF
 Sub Folder Name: March16_2018 (optional)

Align Sample Using the Saved File

File: /data/IPTS-19969/raw/alignment_calibration/20180314_5_Gd_TBP_top
 Please go to tab 2 to manually align a sample. Align Using File

Collect Sample Data

Rotation Start Angle: 0.17
 Rotation End Angle: 181.00
 Rotation Step Size: 0.34
 Number of Images per Step: 1
 Exposure Time: 40.00 sec
 Collect Data

Collect Open Beam Data

Move Sample Away Collect Open Beam Data
 If move manually: please follow the shutter operation procedure.
 Number of Images: 10

Collect Dark Field Data (Optional)

Collect Dark Field Data
 Please follow the shutter operation procedure to close the shutter first.
 Number of Images: 20

Stop Motors and Scans Auxiliary Settings

Instrument Motion Axes

Motion Axis	ix	iy	iz
Motor Direction	Negative	Negative	Negative
Current Position	38.49	28.76	35.36
Sample Origin	52.30	27.56	40.00

Sample Coordinate System Vectors

	ix	iy	iz
Delta-Weld(+)	1.00	0.20	0.50
Delta-Thickness(+)	-0.40	1.00	0.40
Delta-Length(+)	-0.42	-0.60	1.08

Sample Dimensions

Plate Thickness (mm)	6.00
Delta-Weld Extent + (mm)	70.00
Delta-Weld Extent - (mm)	40.00

Example Point

Delta-Weld	0.00	sx	52.30
Delta-Thickness	0.00	sy	27.56
Delta-Length	0.00	szs	40.00

Use Current Position Use Sample Origin
 Reset Camera
 3D View (Rotate: Drag; Pan: Ctrl-Drag; Zoom: Shift-Drag)

Browse the Examples

- Start CSS/Phoebus
- Your setup might have a menu entry
 - File, Top Resources, Examples
- If not, or if you'd like to inspect and edit the examples
 - Applications, Display, Examples, Install Example Displays

Tab
Hover mouse,
open Context Menu,
Close

Example Display
Push any of the buttons

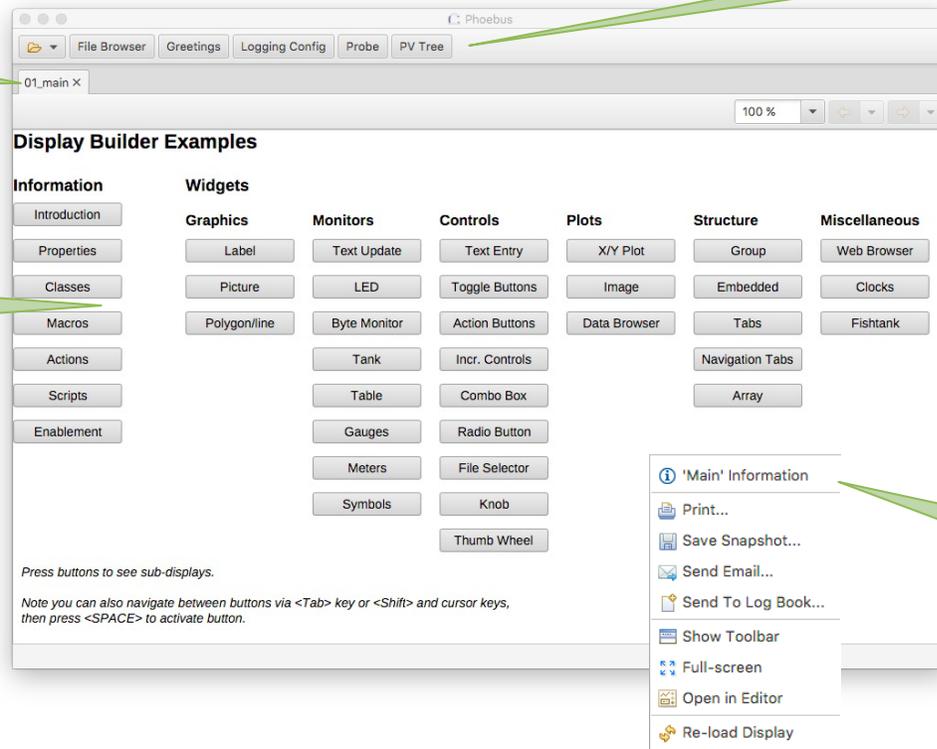
Main Application Toolbar
Menu Window, Show Toolbar

Display Runtime Toolbar
Context Menu Window,
Show / Hide Toolbar

Navigate back/forward
also via Alt-Left, Alt-Right cursor keys

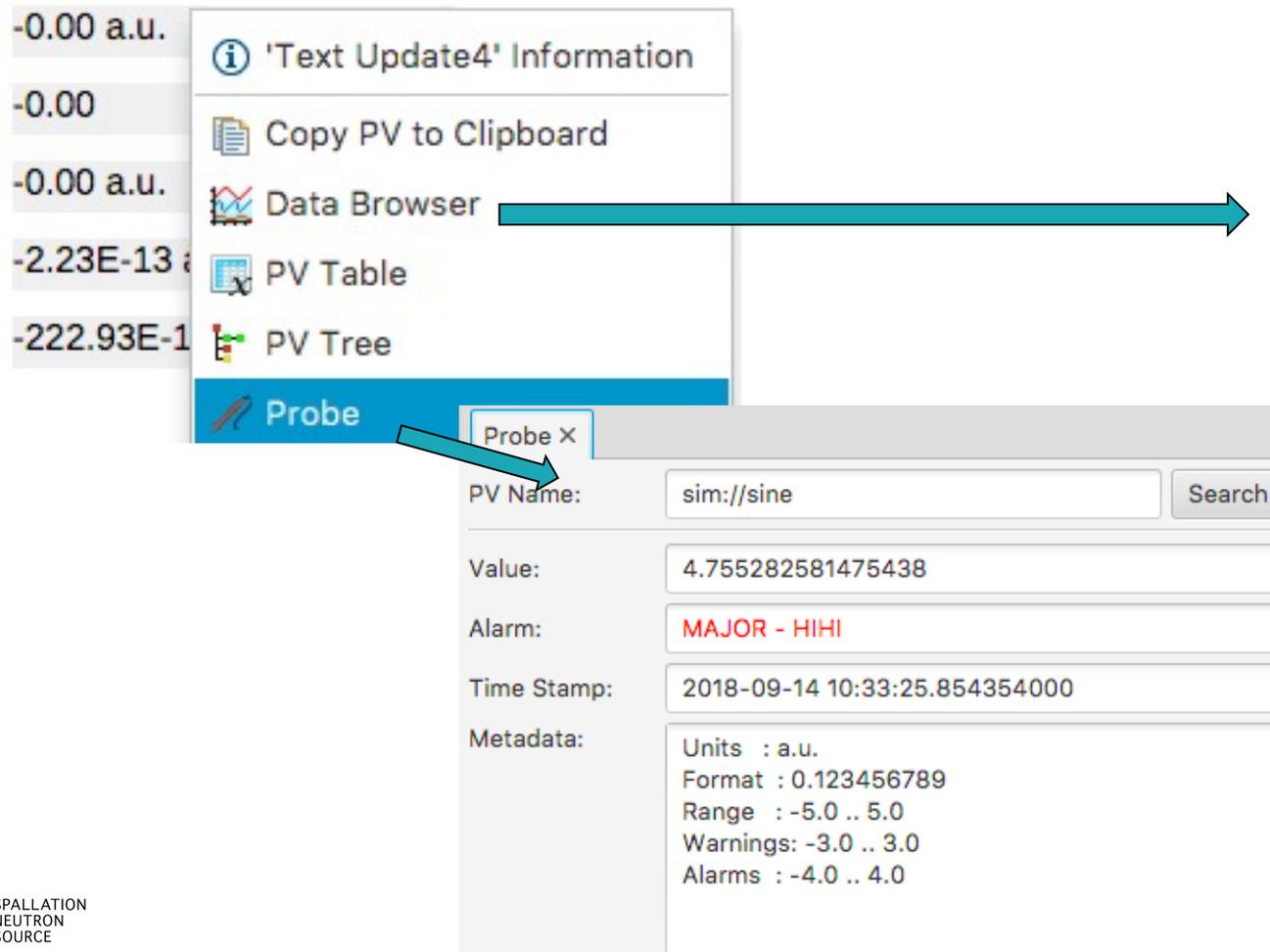
Zoom
to view large control room displays on
office computer

Context Menu
Details change with widget
on which menu was invoked



Send PV to other Tools

Context menu opens other tool with PV



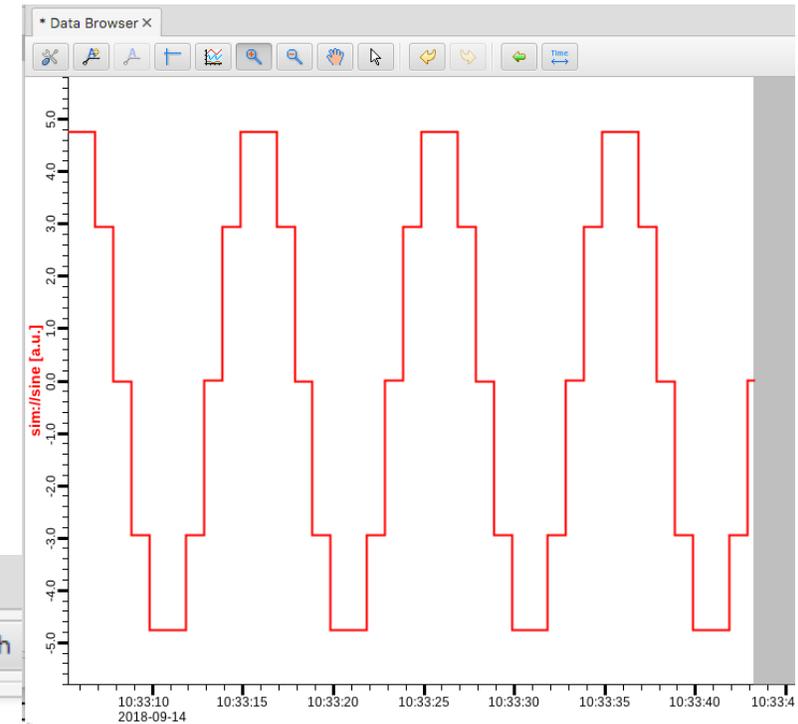
The screenshot shows a context menu for a PV value. The menu items are:

- 'Text Update4' Information
- Copy PV to Clipboard
- Data Browser
- PV Table
- PV Tree
- Probe

The 'Data Browser' option is highlighted with a blue bar, and a blue arrow points from it to the 'Data Browser X' window. The 'Probe' option is also highlighted with a blue bar, and a blue arrow points from it to the 'Probe X' window.

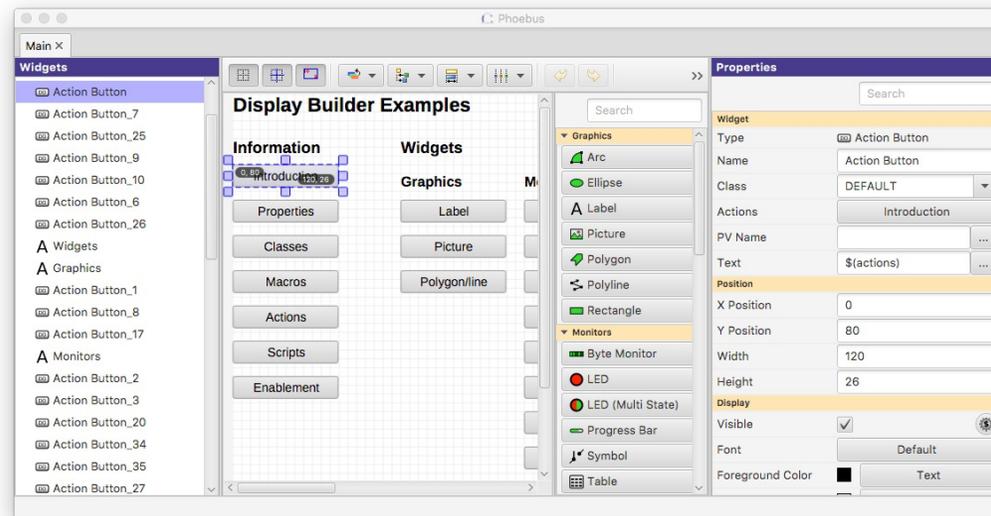
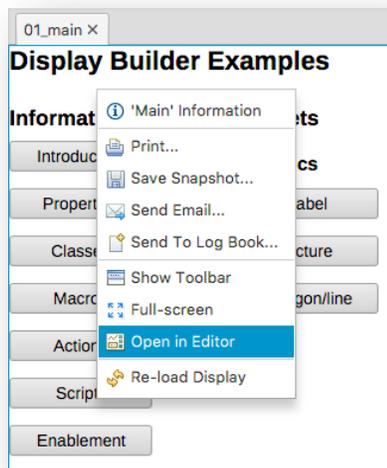
The 'Probe X' window displays the following information:

PV Name:	sim://sine	Search
Value:	4.755282581475438	
Alarm:	MAJOR - HIHI	
Time Stamp:	2018-09-14 10:33:25.854354000	
Metadata:	Units : a.u. Format : 0.123456789 Range : -5.0 .. 5.0 Warnings: -3.0 .. 3.0 Alarms : -4.0 .. 4.0	

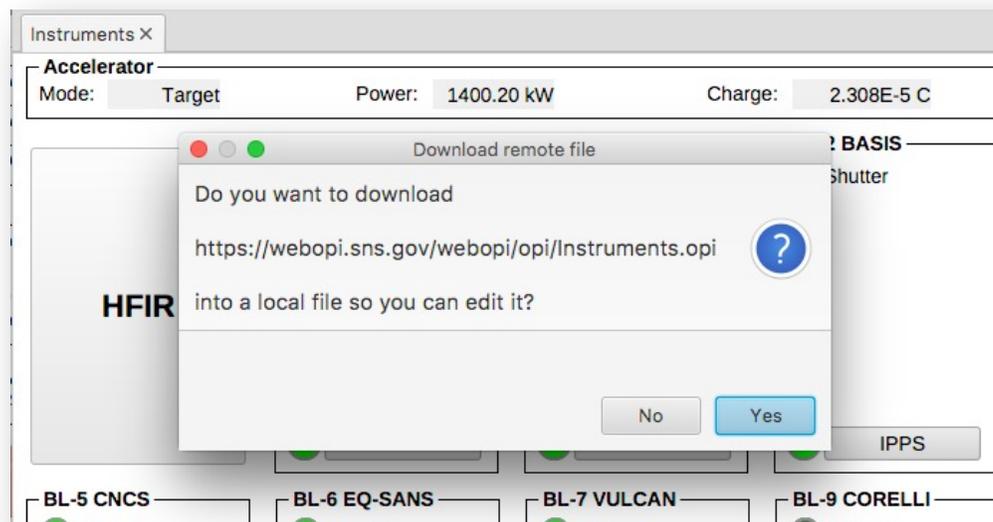


Open Existing Display In Editor

- Context menu can open any display in Editor



- Downloads remote files



Create New Display

Menu Applications, Display, New Display

- Enter a name with .bob file extension

Save & Execute the Display

Property Panel
Edit properties of
selected widgets

Main Editor Area

Select Widgets

Move, resize widgets

Ctrl-C, V, X to copy, paste, delete (⌘ on Mac)

The screenshot shows the LabVIEW 'New Display' dialog box. The 'Widgets' list on the left contains 'A Label', 'A Label_1', '0.0 Text Update', and 'A Label_2'. The 'Main Editor Area' in the center displays a grid with the text 'Some Value: sim://sine Some comment.' and a 'sim://sine' widget. The 'Properties' panel on the right shows settings for the selected '0.0 Text Update' widget, including Type, Name, Class, PV Name, Position, and Display options.

Editing a Display

Selecting Widgets

- a) Click single widget
- b) Ctrl-click to add widget (⌘ on Mac)
- c) Drag 'rubberband' around widgets
- d) Click or Ctrl/ ⌘ click in widget list

Widget Palette

Drag widget into editor

- or -

- 1) Select Widget Type
- 2) Draw rectangular area in display

Quick Edit

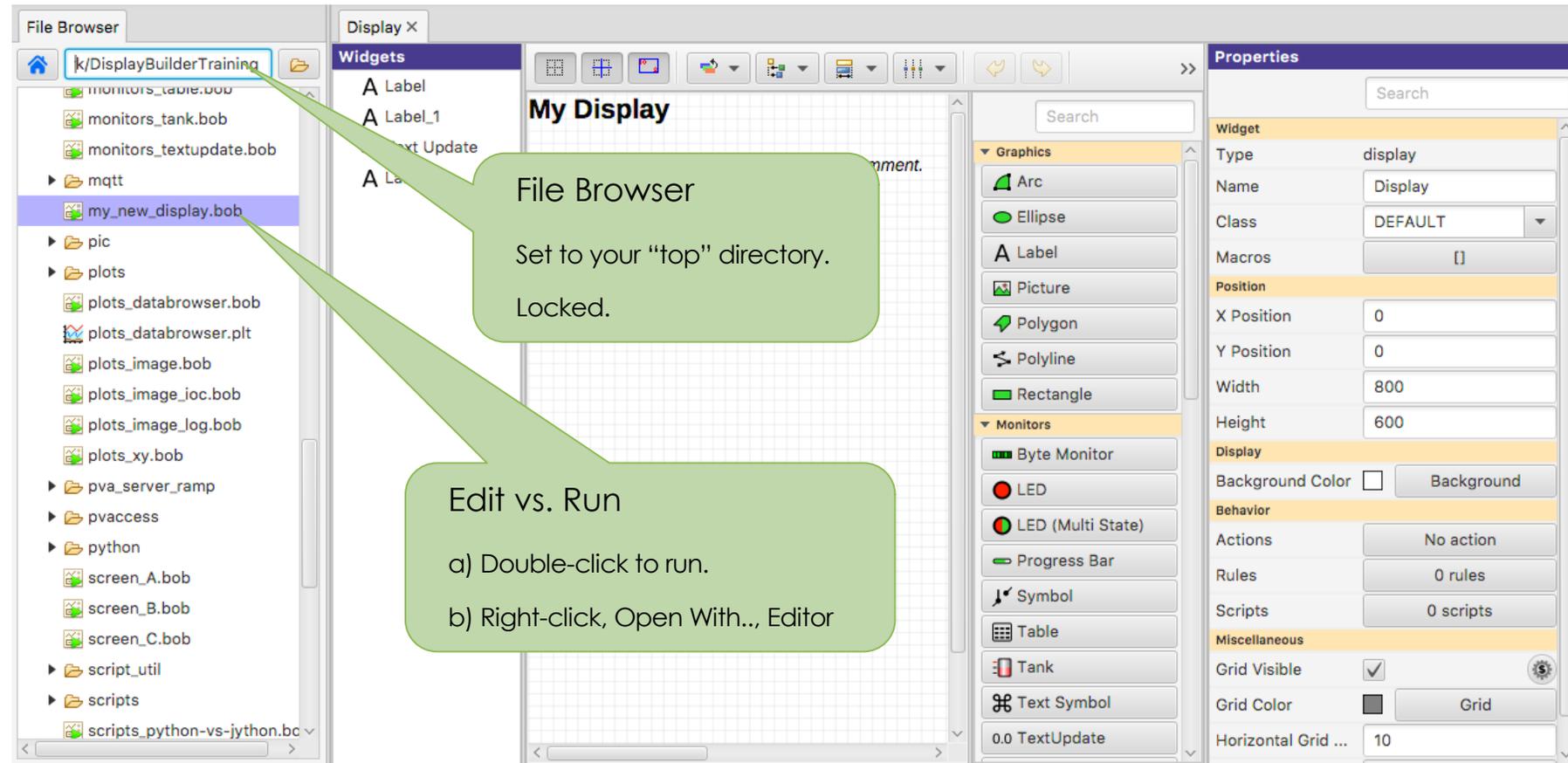
Double-click widget to

- a) Edit text of Label
- b) Edit PV of widgets that use a PV

The screenshot shows the LabVIEW 'My Display' editor. On the left, the 'Widgets' list contains 'A Label', 'A Label_1', '0.0 Text Update' (selected), and 'A Label_2'. The central display area shows 'Some Value: sim://sine Some comment.' with a blue selection box around the 'sim://sine' widget. The 'Widget Palette' on the right lists various widget types under 'Graphics' (Arc, Ellipse, Label, Picture, Polygon, Polyline, Rectangle) and 'Monitors' (Byte Monitor, LED, LED (Multi State), Progress Bar, Symbol, Table). The 'Properties' panel on the far right shows settings for the selected '0.0 Text Update' widget, including its name, class, PV name, position, and display options.

Suggested Setup for Editing

- Pick a top directory, for example where you installed the example files
- Open Applications, Utility, File Browser
 - Set it to your top directory
 - On file browser tab, open context menu, “Split Horizontally”, then “Lock Pane”
- Menu Window, Save Layout As..
 - “Editing”
- Menu Applications, Display, New Display
 - Create new file in your top directory



Keep It Simple

1. Add a Widget
2. Enter Label's Text or Widget's PV Name
3. Done

Basic Number:	-4.76 a.u.
Disconnecting channel:	<sim://intermittent>
Basic Text:	AAAAA

At Runtime, widget will

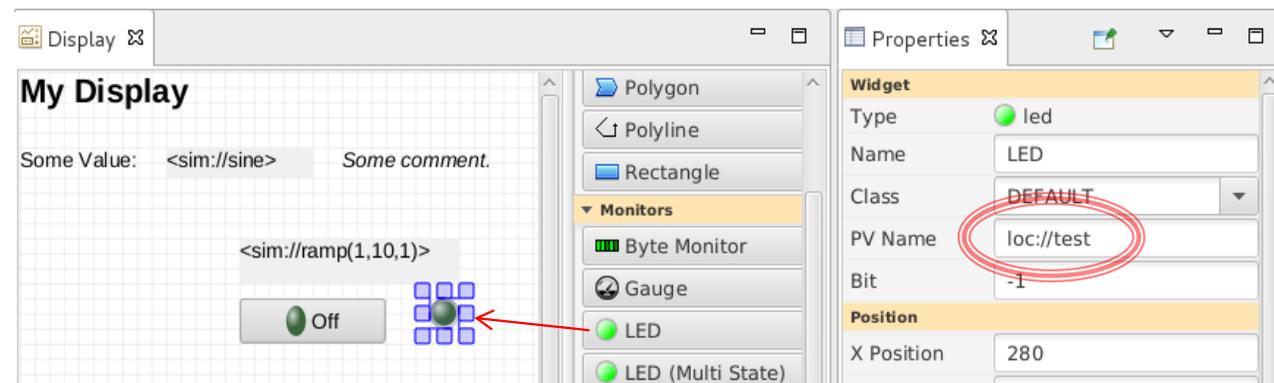
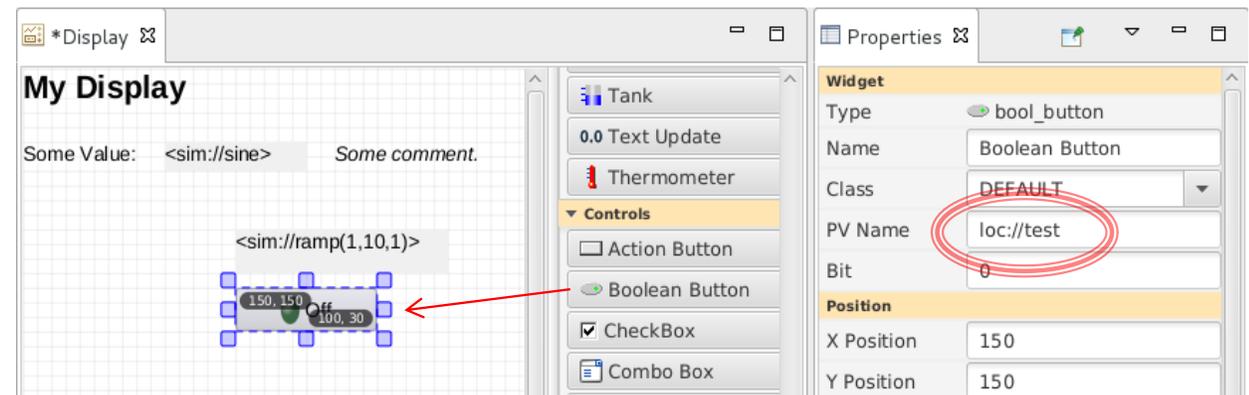
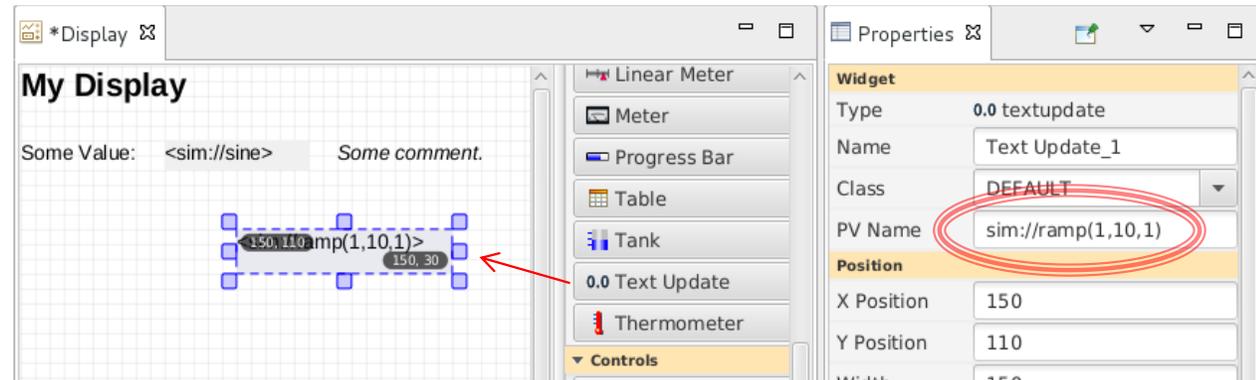
- ✓ Show PV's value, formatted, with units
- ✓ Indicate alarm, disconnect
- ✓ Show tool-tip with PV name and value
- ✓ Combo options read from Enum PV, slider range from numeric PV
- ✓ Disabled when 'control' widget has no PV write access

Extend the First Display

- Drag a “Text Update” from the palette
 - Enter PV name “sim://ramp(1, 10, 1)”. Note PV name auto-completion popup.



- Add “Boolean Button”
 - PV name “loc://test”
- Add “LED”
 - PV name “loc://test”. Note name in PV History.
- Execute the display
 - Toolbar Button or Context Menu

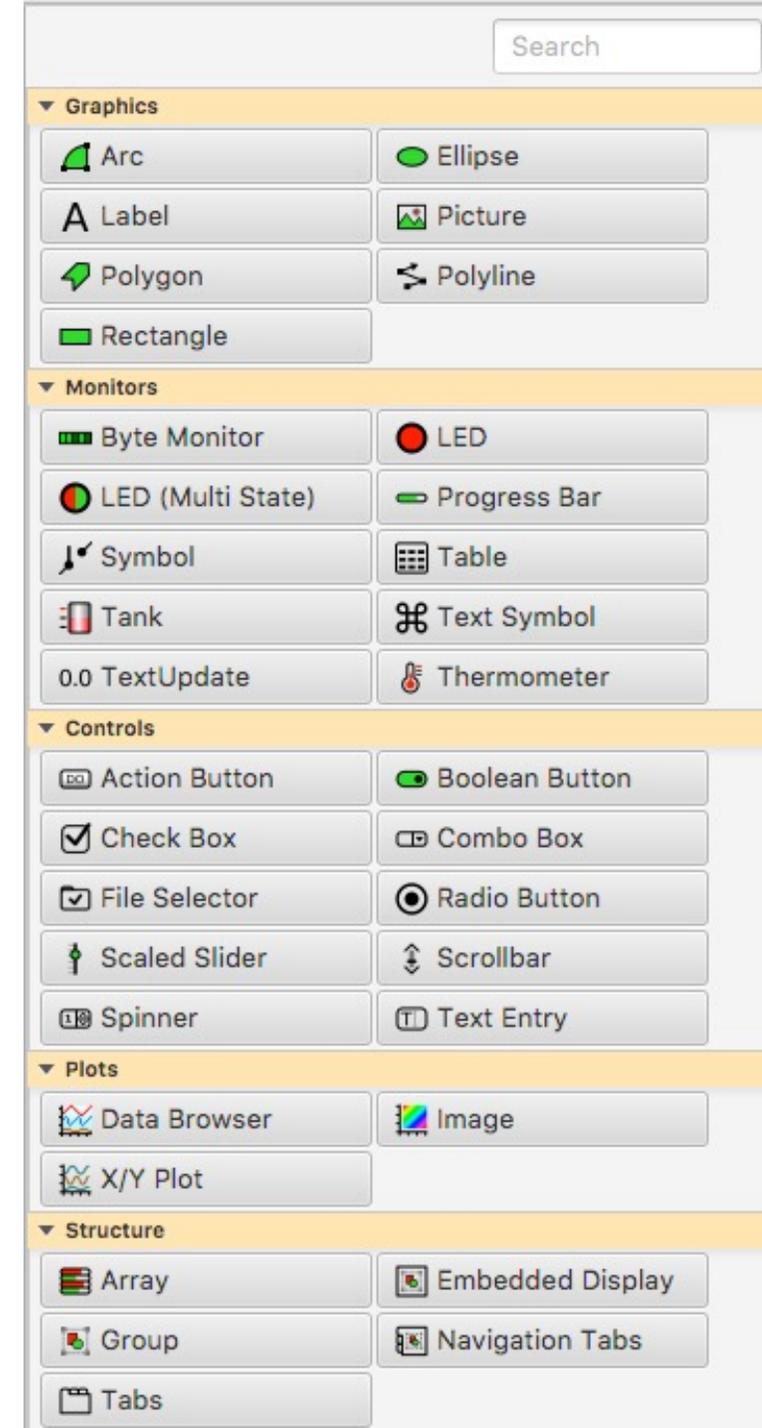


PV Names

- `ca://some_pv_name`
 - EPICS Channel Access PV
- `some_pv_name`
 - Typically same, since “ca://” is the default
- `sim://sine`
 - Simulated PV. See auto-completion hints
- `loc://x(4)`
 - Local PV. See auto-completion hints
- `pva://x`
 - EPICS pvAccess

Widget Palette

- Shows all available widgets
 - Enter name for "Search"
 - Hover mouse for description
 - Drag -or- Select & Rubberband
- Categories
 - Graphics show static label, picture, ..
 - Monitors update based on reading a PV
 - Controls read a PV and can write to the PV
 - Plots tend to read from one or more (waveform) PVs
 - Structures group widgets, embed sub-displays



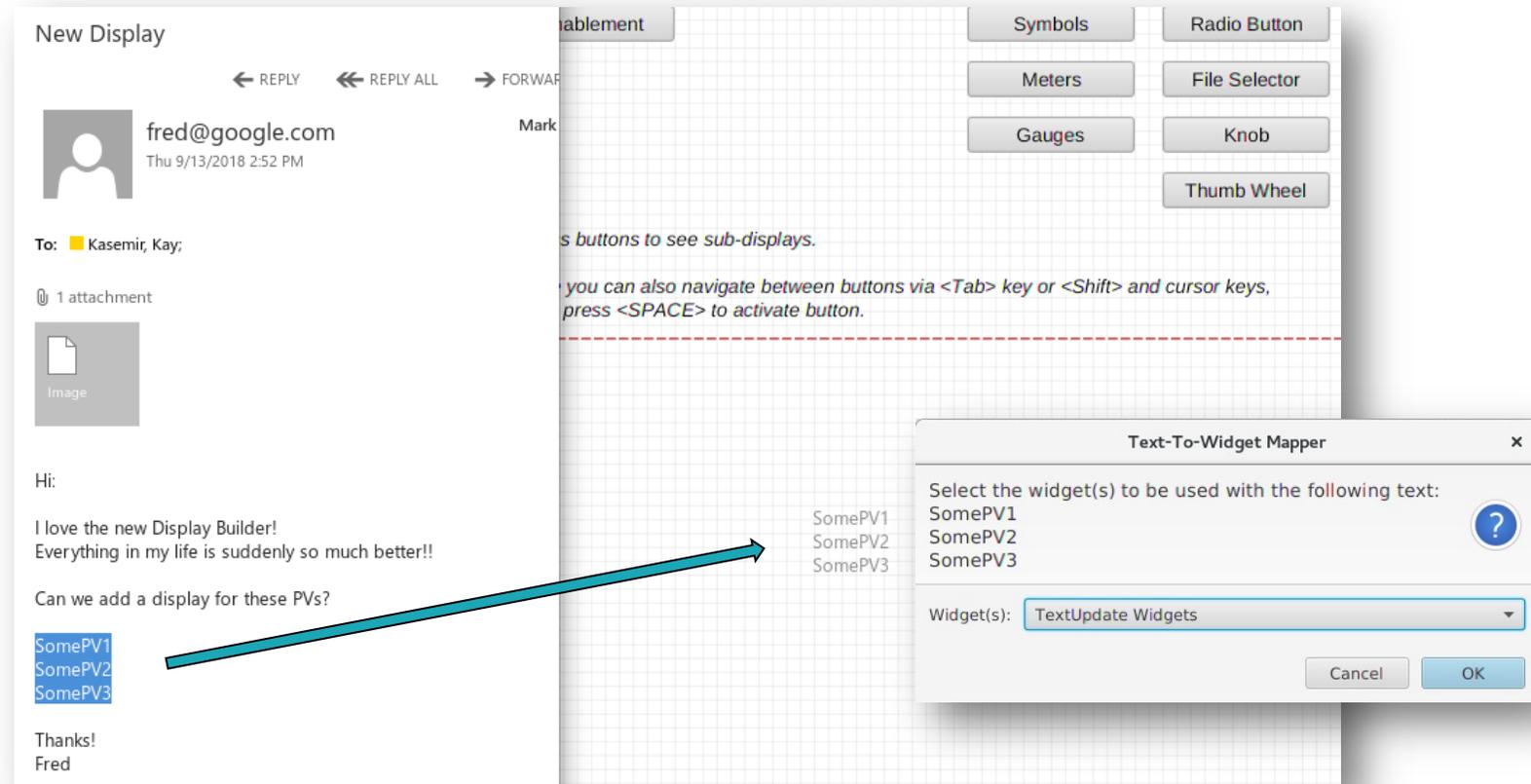
Create Widgets via Drag/Drop from other Apps

Email with list of PVs?

- Drag that text into Display Editor
- Select widget type

Supported:

- Text → Label
- Text → PV Widget
- Image File → Picture Widget
- *.bob File → Embedded Display Widget



Manipulating Widgets

Snap to Grid

.. Other Widgets

Show Coordinates

Order Front/Back

Align

Size

Widget List

Select widgets

Rename Widgets

View/change their order.

Widgets

- A Label
- A Label_1
- A Label_2
- LED
- 0.0 Text Update
- ▼ Group
 - Boolean Button
 - 0.0 TextUpdate

My Display

Some Value: 100, 50

Some comment.

Group

Off

138, 148

Distribute

Selected Widgets Tracker

Move or resize selected widgets

Display Properties

Click on display background to select no widget for editing overall display properties

- Name
 - Shown in Tab
- Macros
 - Used by all widgets in this display
- Grid size
 - Can aid with placing widgets

Properties	
Search	
Widget	
Type	display
Name	Display
Class	DEFAULT
Macros	[]
Position	
X Position	0
Y Position	0
Width	800
Height	600
Display	
Background Color	<input type="checkbox"/> Background
Behavior	
Actions	No action
Rules	0 rules
Scripts	0 scripts
Miscellaneous	
Grid Visible	<input checked="" type="checkbox"/>
Grid Color	<input type="checkbox"/> Grid
Horizontal Grid Step Size	10
Vertical Grid Step Size	10

Widget Properties

Select one (or more) widgets to edit their (common) properties

- Search
 - To find desired property
- PV Name
 - Most important property for most widgets

Details depend on the widget type

The screenshot shows a 'Properties' panel for a widget. The panel is organized into several sections:

- Widget:** Type: 0.0 TextUpdate; Name: Text Update; Class: DEFAULT; PV Name: sim://sine.
- Position:** X Position: 100; Y Position: 50; Width: 100; Height: 20.
- Display:** Visible: ; Font: Default; Foreground Color: ; Background Color: ; Transparent: ; Format: Default; Precision: -1; Show Units: ; Horizontal Alignment: Left; Vertical Alignment: Top; Wrap Words: ; Rotation: 0 degrees.
- Behavior:** Actions: No action; Rules: 0 rules; Scripts: 0 scripts; Tool tip: \$(pv_name)\$ (pv_value); Alarm Border: ; Interactive: .
- Miscellaneous:** Border Width: 0; Border Color: .

Common Widget Properties

Defaults tend to be reasonable:

- Format with precision set by PV
- Show units provided by PV
- Alarm-sensitive Border
- Fetch Items (Combo, ...) from PV

Instead of changing them,
maybe the PV needs to be updated?

Still, can be adjusted as needed for the display.

The screenshot shows the 'Properties' panel for a widget. The widget is identified as '0.0 TextUpdate' with the name 'Text Update' and class 'DEFAULT'. Its PV Name is 'sim://sine'. The 'Position' section shows X Position: 100, Y Position: 50, Width: 100, and Height: 20. The 'Display' section includes: Visible (checked), Font (Default), Foreground Color (black), Background Color (ReadBackground), Transparent (unchecked), Format (Default), Precision (-1), Show Units (checked), Horizontal Alignment (Left), Vertical Alignment (Top), Wrap Words (checked), and Rotation (0 degrees). The 'Behavior' section shows: Actions (No action), Rules (0 rules), Scripts (0 scripts), Tool tip (\$(pv_name)\$ (pv_value)), Alarm Border (checked), and Interactive (unchecked). The 'Miscellaneous' section shows: Border Width (0) and Border Color (black).

Predefined "Named" Colors and Fonts

Use whenever possible!

Name	Text Update_4
Class	DEFAULT
PV Name	sim://sine
Position	
X Position	191
Y Position	351
Width	170
Height	20
Display	
Visible	<input checked="" type="checkbox"/>
Font	Default
Foreground Color	Text
Background Color	ReadBackground
Transparent	<input type="checkbox"/>
Format	Default
Precision	-1
Show Units	<input checked="" type="checkbox"/>
Horizontal Alignment	Left
Vertical Alignment	Top
Wrap Words	<input checked="" type="checkbox"/>
Rotation	0 degrees

Position	
X Position	191
Y Position	91
Width	170
Height	20
Display	
Visible	<input checked="" type="checkbox"/>
Font	Default
Foreground Color	Text

Font – Select a predefined font and/or customize it.

Predefined Fonts	Fonts Families
Comment	Liberation Sans
Default	Liberation Serif
Default Bold	Libian SC
Fine Print	LiHei Pro
Header 1	LiSong Pro
Header 2	Lucida Bright
Header 3	Lucida Grande
Oddball	Lucida Sans
	Lucida Sans Typewriter

Style: Regular Size: 14.0

Preview

Example Text

Default Cancel OK

Foreground Color – Select a predefined color and/or customize it.

Predefined Colors	Custom Color
DISCONNECTED	Color: Black
Grid	Red: 0
Header_Background	Green: 0
Header_ForeGround	Blue: 0
INVALID	Alpha: 255
MAJOR	
MINOR	
Off	
OK	
On	
Read_Background	
STOP	
Text	
Write_Background	

original default

Default Cancel OK

Configuring Named Colors, Fonts

```
# -----  
# Package org.csstudio.display.builder.model  
# -----  
  
# Widget classes  
# One or more *.bcf files, separated by ';'   
# Defaults to built-in copy of examples/classes.bcf  
class_files=examples:classes.bcf  
  
# Named colors  
# One or more *.def files, separated by ';'   
# Defaults to built-in copy of examples/color.def  
color_files=examples:color.def  
  
# Named fonts  
# One or more *.def files, separated by ';'   
# Defaults to built-in copy of examples/font.def  
font_files=examples:font.def
```

```
Named colors  
#  
# Format:  
# NameOfColor = red, green, blue [, alpha ] |  
# PreviouslyDefinedNameOfColor  
# with values in 0..255 range.  
#  
# Whenever possible, use named colors in displays  
# instead of arbitrary red/green/blue values.  
  
# ----- Predefined colors -----  
# May be overridden in here  
  
# Alarm related  
OK = 0, 255, 0  
MINOR = 255, 128, 0  
MAJOR = 255, 0, 0  
INVALID = 255, 0, 255  
DISCONNECTED = 200, 0, 200, 200  
  
# Default color for text  
Text=0,0,0  
  
# Default color for 'active' text that's being edited  
ActiveText=255, 255, 0  
  
# Display background  
Background = 255, 255, 255  
  
# .. for widgets that read/write a value  
Read_Background = 240, 240, 240  
Write_Background = 128, 255, 255  
  
# .. for buttons  
Button_Background = 210, 210, 210  
  
# ----- Examples for additional colors -----  
  
# Also show ideas for site-specific guidelines that  
# are required to make sense of the color names.  
  
# Styling  
Header_Background=77,77,77  
Header_ForeGround=255,255,255  
  
# Use alarm colors only when you mean to indicate an
```

```
Named font definitions  
//  
// Entries in this file are read in sequence.  
// A later entry in the file can override  
// an earlier entry in the file.  
//  
// In a production setup, this file may be constructed  
// by concatenating a generic file with a more specific file,  
// and the specific entries would then override generic entries  
// of the same name.  
  
// Format:  
// NamedFont['(' OS ')'] = Family '-' Style '-' Size | '@'PreviouslyDefinedNamedFont  
//  
// Family: Font family name "Liberation Sans", "Liberation Mono", "Liberation Serif"  
// Style: "regular", "bold", "italic", "bold italic"  
// Size: Font height in pixels  
// OS: "windows", "linux", "macosx"  
//  
// Leading/trailing spaces around each element are OK, but if the font family  
// is "Liberation Sans", it has to be typed with just that one space between  
// "Liberation" and "Sans"  
//  
// Examples of named fonts  
//  
// Default = Liberation Sans - regular - 14  
// Default Bold = Liberation Sans - bold - 14  
// Header 1 = @Default Bold  
//  
// Speaking of "Liberation Sans":  
// The display builder includes the "Liberation" fonts  
// from https://fedorahosted.org/liberation-fonts.  
// Their use is encouraged because the resulting displays  
// will always render correctly.  
// When using other fonts, for example "Arial" on Windows,  
// the font might not be available to a display builder  
// runtime that is executing on Mac OS or Linux.  
  
// Predefined fonts that this file could re-define  
Default = Liberation Sans - regular - 14  
Default Bold = Liberation Sans - bold - 14  
Header 1 = Liberation Sans - bold - 22  
Header 2 = Liberation Sans - bold - 18  
Header 3 = Liberation Sans - bold - 16  
Comment = Liberation Sans - italic - 14
```

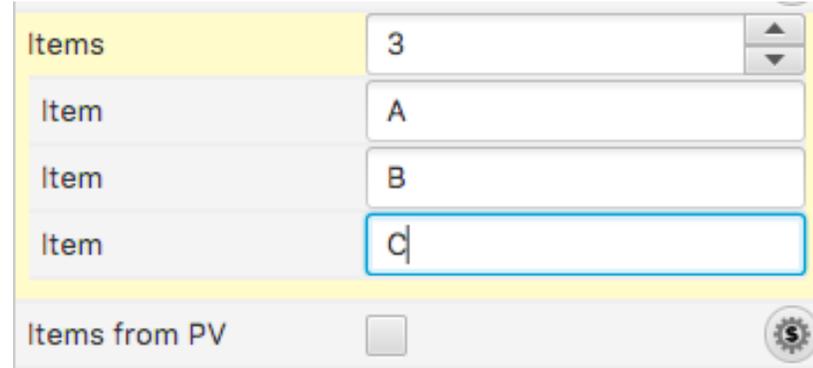
Ideally set at start
of project

Widget Notes

- Text Entry, Text Update:
 - Set Format = String for “long string” waveforms. Default will show array.
- LED, Boolean Button, Checkbox
 - Boolean PV
 - Numeric PV 0 or not 0 (when “Bit” set to default of -1)
 - Bit in a numeric PV (when “Bit” set to 0, 1, 2, ...)
- Multi-State LED
 - Enumerated or numeric PVs
 - Defaults to using state values 0, 1, 2, 3, ..

Widget Notes

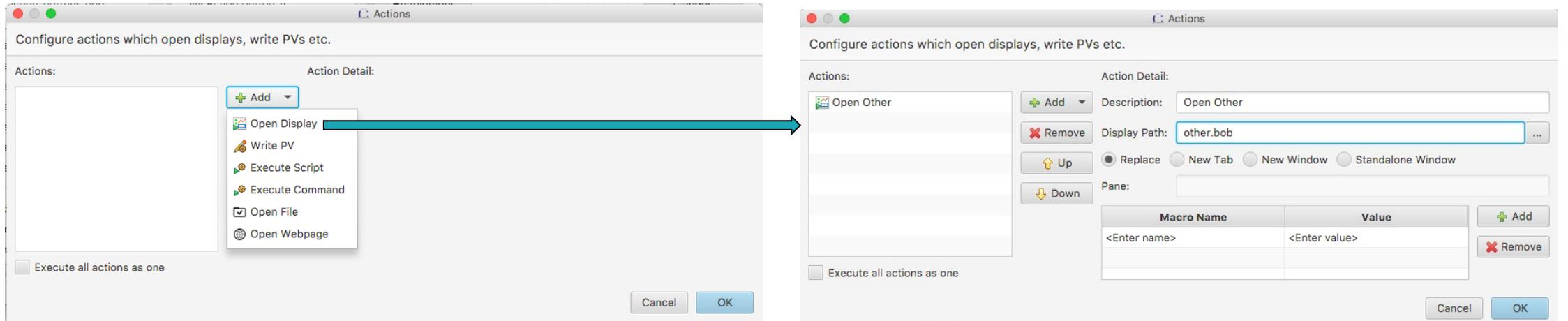
- Combo Box, Radio Button:
 - Best for enumerated PV: Enter PV name, done
 - Alternatively, un-check “Items from PV” and enter items



The screenshot shows a configuration window with a yellow header bar. Below the header, there is a list of items. The first item is labeled 'Items' and has a value of '3' in a text box with up and down arrows. Below this are three rows, each labeled 'Item' and containing a text box with the values 'A', 'B', and 'c' respectively. The 'c' text box is highlighted with a blue border. At the bottom of the window, there is a checkbox labeled 'Items from PV' which is currently unchecked. To the right of the checkbox is a gear icon.

Action Button

1. Add ActionButton
2. Configure “Actions” property, add “Open Display”



3. Run: Clicking button opens the “other” display.

*In principle, any widget can have ‘Actions’.
They appear in the widget’s runtime context menu.
But it’s not obvious to end users that for example a Label will have actions.*

Screen Navigation

- Replace

- Suggested default.
- Allows back/forward navigation as in web browser



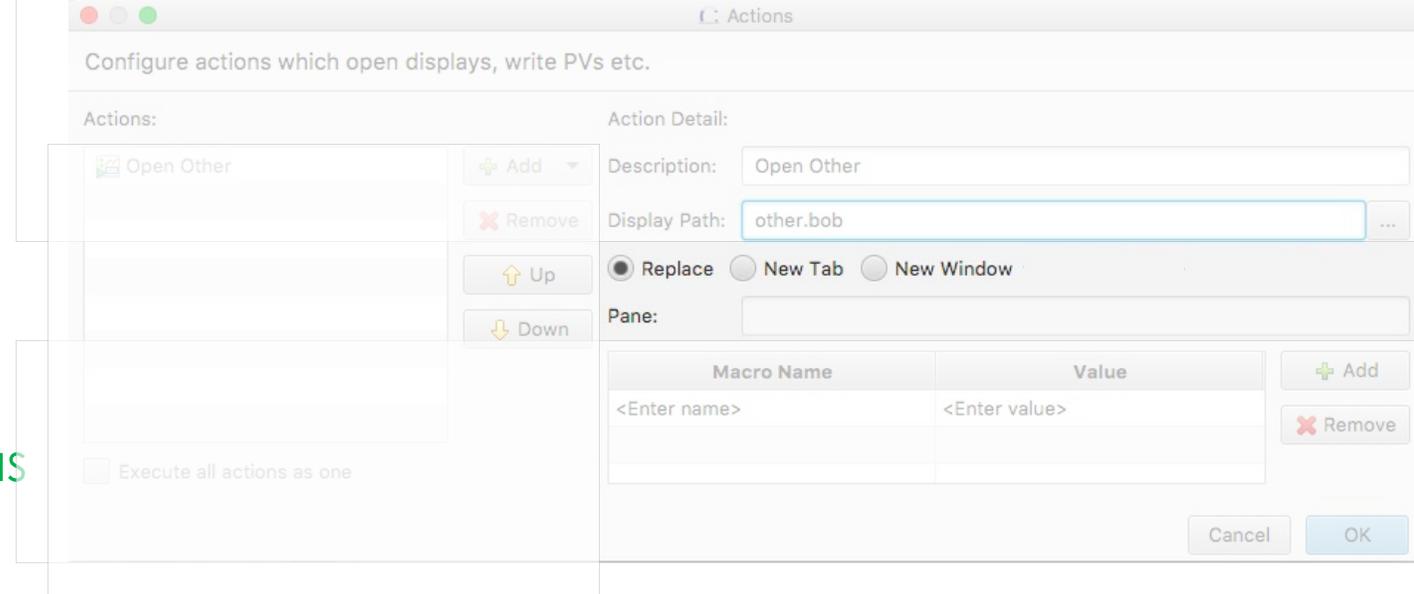
- Minimizes number of open screens

- New Tab

- Opens in new tab
- Allows specific Pane name

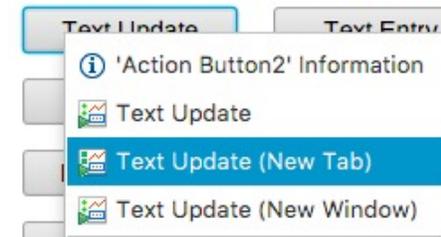
- New Window

- Opens in new window



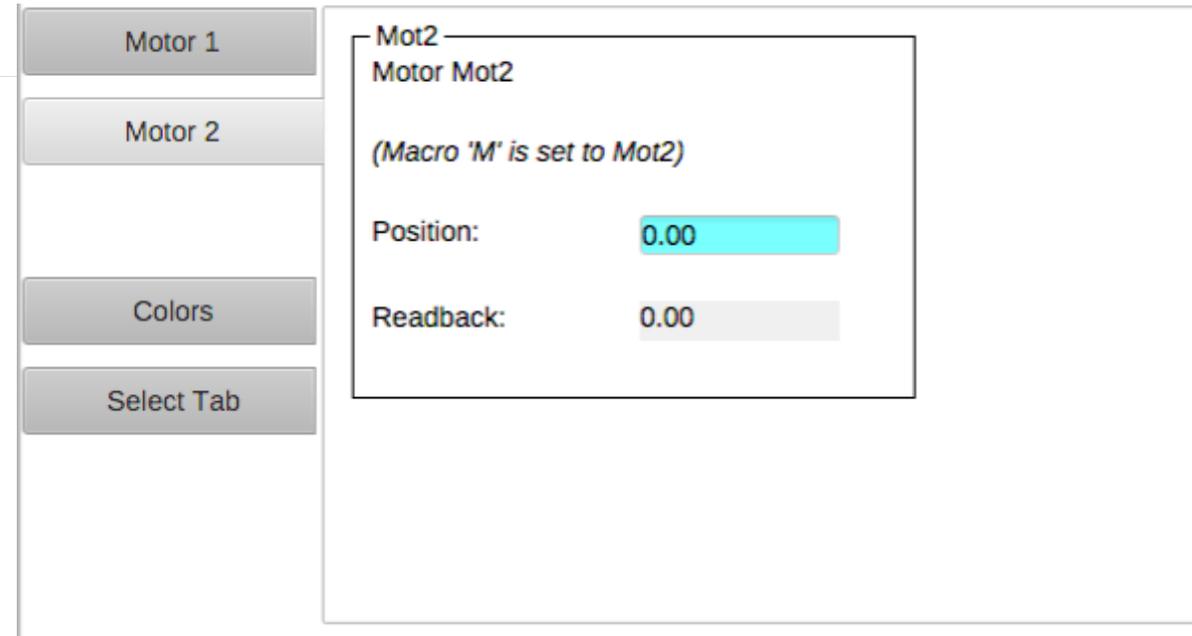
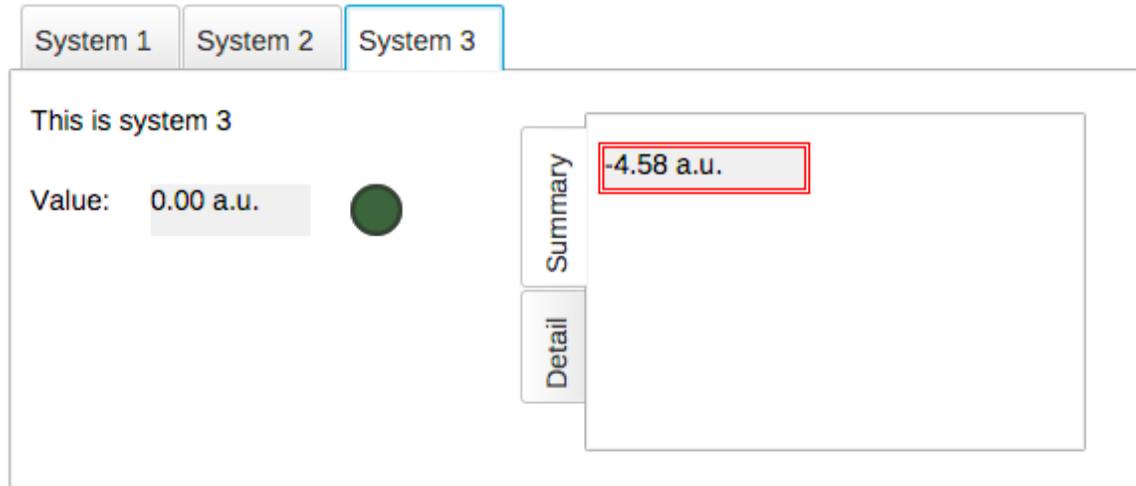
- With “Replace”, can still use

- Context menu



- Control (⌘ on Mac) for tab
- Shift-Control for window

Screen Navigation: Tabs



Tabs

Each tab is in-memory, same *.bob

- Appears immediately when selected
- Uses CPU and memory when hidden

Navigation Tabs

Tab is loaded from separate *.bob when selected

- May need a little time to load
- No CPU and memory when hidden

Macros

- Macros are passed into displays from
 1. Enclosing Group or Tab Widget
 2. Display
 3. Embedded widget container or Action that loaded the display
 4. Phoebus preferences

- To use: $\$(NameOfMacro)$

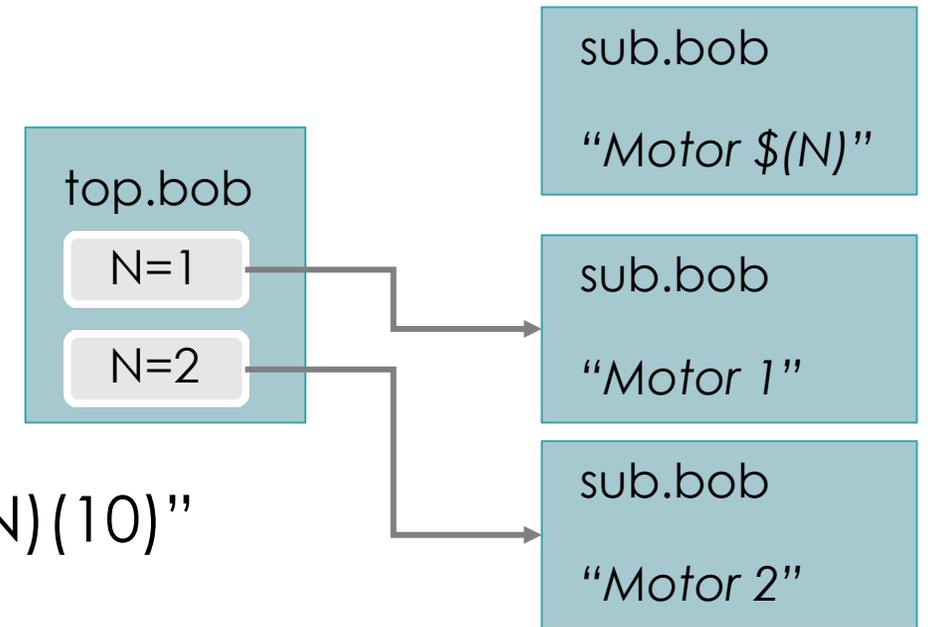
.. or $\${NameOfMacro}$.
EPICS *.db files use $\$(xx)$,
SNL and shell use $\${xx}$,
so we support both conventions.

- Examples:

PV Name:	$\$(PV)$	with PV=TheFullPVName
PV Name:	Motor $\$(N)$	with N=1, 2, 3, ...
Width:	$\$(WID)$	with WID=200
Visible:	$\$(SHOW)$	with SHOW=true

Macro Example

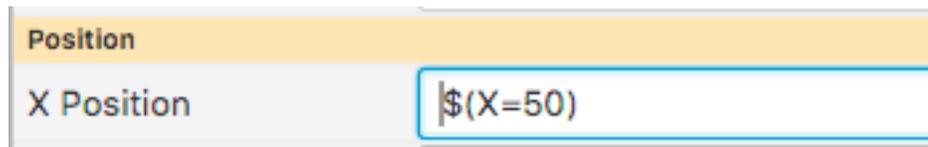
1. Create display "sub.bob"
 - Label with text "Motor \$(N)"
 - TextUpdate with PV "loc://pos\$(N)(10)"
 - ActionButton with PV Name "loc://pos\$(N)(10)" and Action to "Write PV" value 20
 - Copy that button, update to set PV to 30
2. Create display "top.bob"
 - ActionButton with Action to open sub.bob with N=1
 - Copy/paste the button, update to N=2
3. Execute top.bob, press buttons



Macros

- Default values: $\$(\text{MACRO}=\text{default})$

Allows standalone testing without passing values into display



Position
X Position

- To enter macro for Boolean
Press the “\$” macro button

Select valid option from drop-down ...

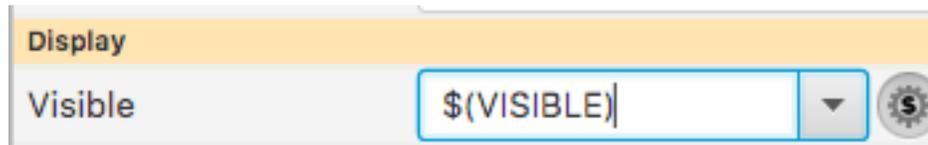
.. or enter a macro



Display
Visible 



Display
Visible 
'Off' Label true
'Off' Color false



Display
Visible 

Macro Fallbacks

When macro is not defined, falls back to

- Widget Properties

- Uses the internal property name shown in tool-tip of Properties view
- Note how tooltip is usually preset to “\$(pv_name)\n\$(pv_value)”
- Action Button has PV Name property.
It’s not used directly as in other widgets with PV name, but in “Write PV” the PV name is preset to \$(pv_name)
- Action Button text is preset to “\$(actions)”

- Java Properties

- \$(os.name)

- Environment Variables

- \$(HOME), \$(USER)

Predefined Macros

\$(DID): Unique display identifier, useful for per-display PVs

loc://x\$(DID)(10)

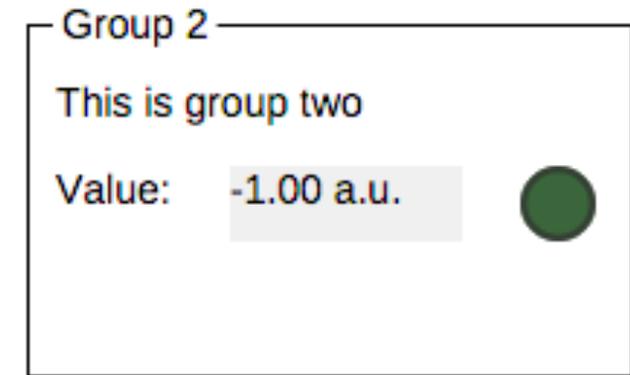
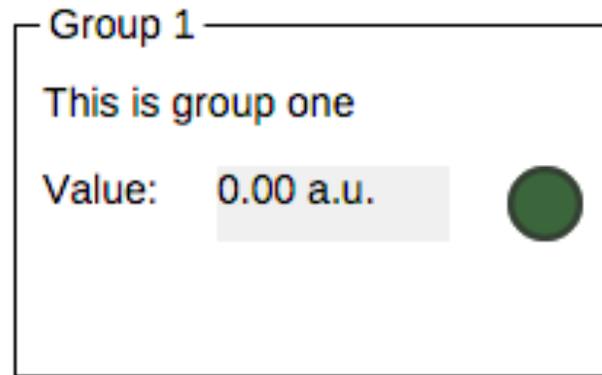
\$(DNAME): Display Name

Group Widget

Contains other widgets

Visual Effect:

- Border, Name



Practical Effect:

- Group can define macros for contained widgets
- Group can be moved, copied/pasted as one unit in editor

Group Widget

1) Add Group Widget

2) Move other widgets inside the Group

Active Group is highlighted

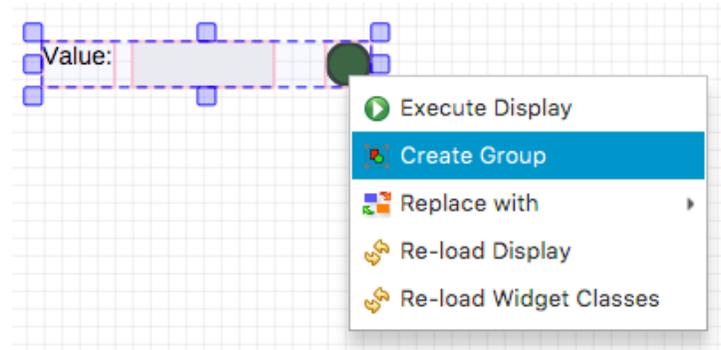
Group Properties

- Name:
Shown in border
- Style:
“Group Box” for named border
- Macros:
Passed to contained widgets

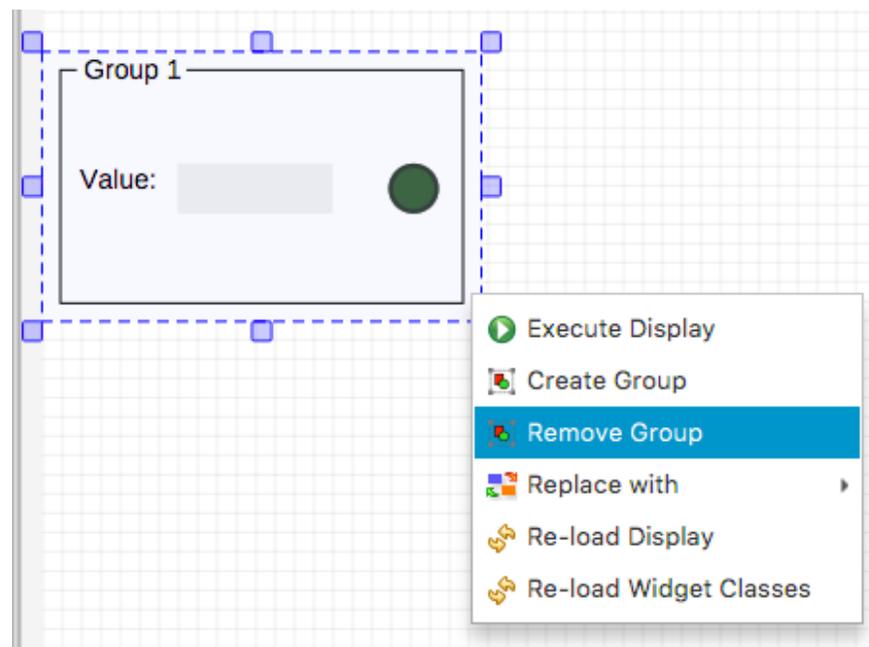
Properties	
<input type="text" value="Search"/>	
Widget	
Type	 Group
Name	<input type="text" value="Group 1"/>
Class	DEFAULT 
Macros	[PV = 'sim://sine', TE...]
Position	
X Position	<input type="text" value="0"/>
Y Position	<input type="text" value="91"/>
Width	<input type="text" value="227"/>
Height	<input type="text" value="140"/>
Display	
Visible	<input checked="" type="checkbox"/> 
Style	Group Box  
Font	Default
Foreground Color	<input type="color" value="black"/> <input type="button" value="Text"/>
Background Color	<input type="color" value="white"/> <input type="button" value="Background"/>
Transparent	<input type="checkbox"/> 
Behavior	
Actions	<input type="button" value="No action"/>
Rules	<input type="button" value="0 rules"/>
Scripts	<input type="button" value="0 scripts"/>
Tool tip	<input type="text"/> 

Group Editing Shortcuts

1. Select Widgets
2. Context menu “Create ..”



1. Select Group
2. Context Menu “Remove..”



Embedded Display

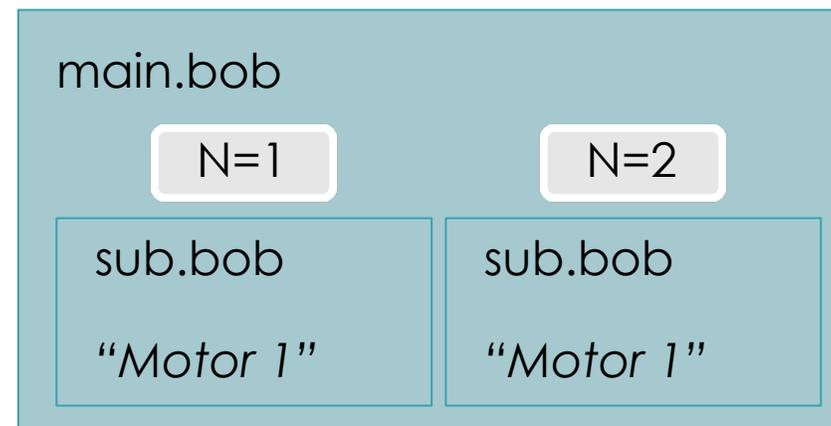
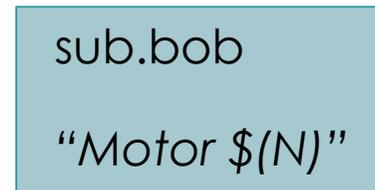
Hosts a complete *.bob file within a widget

Allows composing higher-level displays from smaller displays:

- Per-device *.bob
- Show multiple devices in one display

Embedded Display Example

1. Create display “sub.bob” (or use the one created earlier)
 - Label with text “Motor \$(N)”
 - TextUpdate with PV “loc://pos\$(N)(10)”
2. Create display “main.bob”
 - Embedded Display, File sub.bob, Macros N=1
 - Copy/paste the Embedded Display, update to N=2
3. Execute main.bob



Embedded Display Sizes

a) Embedded Display Size

- Size of the widget that will host the *.bob
- Defined by the widget Width and Height properties

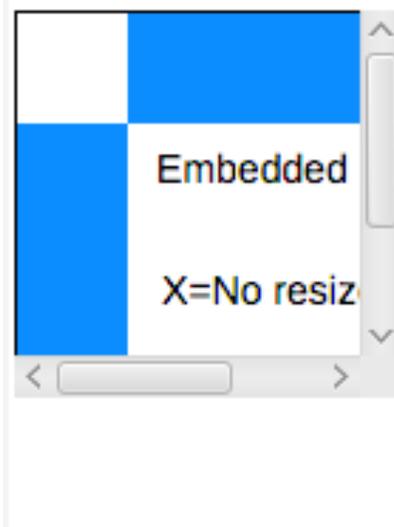
b) Content Size

- Size of the *.bob
- Defined by that Display Width and Height properties

What if those sizes differ?

Embedded Display Resize Options

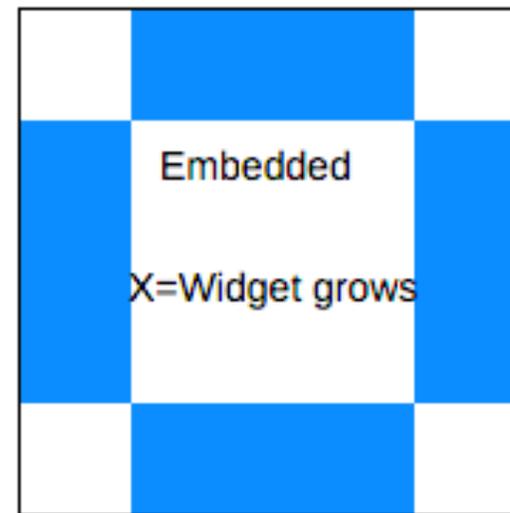
No Resize



Size content
to fit widget

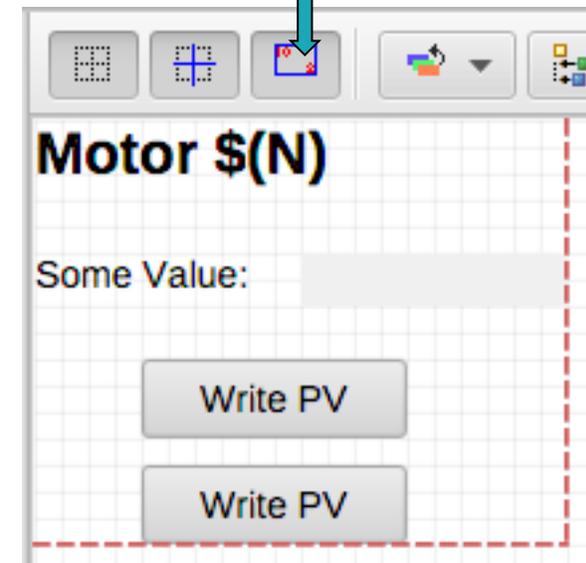
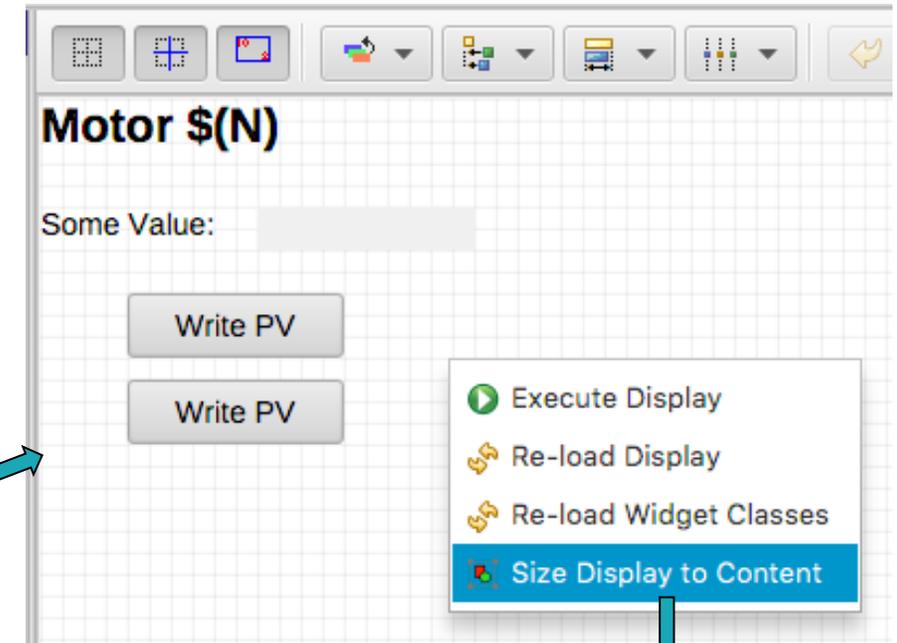
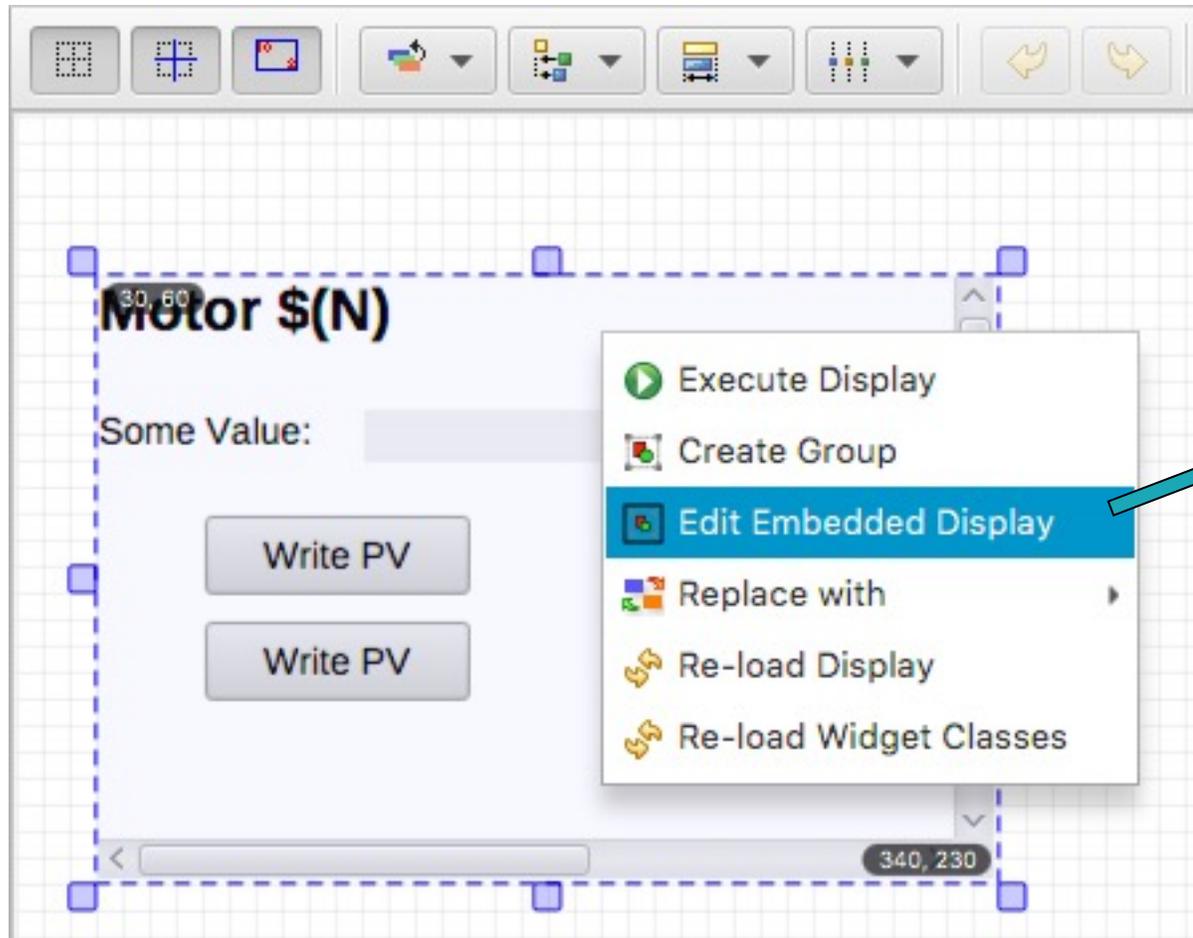


Size widget
to fit
content



- ✓ No Resize usually best. Scrollbars appear as needed.
- Resizing results in odd font sizes or widgets that outgrow their initial space.

Embedded Display Editing



Top Resources

See Help, Preference Settings

```
# -----  
# Package org.phoebus.ui  
# -----
```

```
# Top resources to show in "File" menu and toolbar  
#  
# Format:  
# uri1 | uri2,Display name 2 | uri3,Display name 3  
top_resources=examples:/01_main.bob?app=display_runtime,Example Display | pv://?sim://sine&app=probe,Probe Example | pv://?sim://sine&loc://x(10)&app=pv_table,PV Table Example | http://www.google.com?app=web, Google
```

Start phoebus with “-settings /path/to/my_settings.ini”:

```
org.phoebus.ui/top_resources=/home/controls/displays/main.bob, Start Page |  
http://controls.my.site/displays/main.bob, Start Page
```

- File system: Use NFS or ‘git pull’ to distribute files
- http: All users always see the same set of files

***TO BE
CONTINUED...→***

Many Widgets and Properties

Compared to earlier EPICS display tools,

- **Group Widget** instead of Lines
- **LED** instead of Circle-with-changing-color
- **Tab/Navigation Tabs** instead of buttons, local PVs, conditional visibility,..

Display describes **Meaning**:

- Group of related widgets
- LED for binary PV, not circle that happens to change color

Files with meaning are easier to translate into the next tool

Widget Classes

- Instead of creating a Label with large font, define a “TITLE” class for the Label
- Instead of creating an LED with Orange color, define a “WARNING” LED class

```
# -----  
# Package org.csstudio.display.builder.model  
# -----  
  
# Widget classes  
# One or more *.bcf files, separated by ';'   
# Defaults to built-in copy of examples/classes.bcf  
class_files=examples:classes.bcf
```

Editing *.bcf Widget Class Files

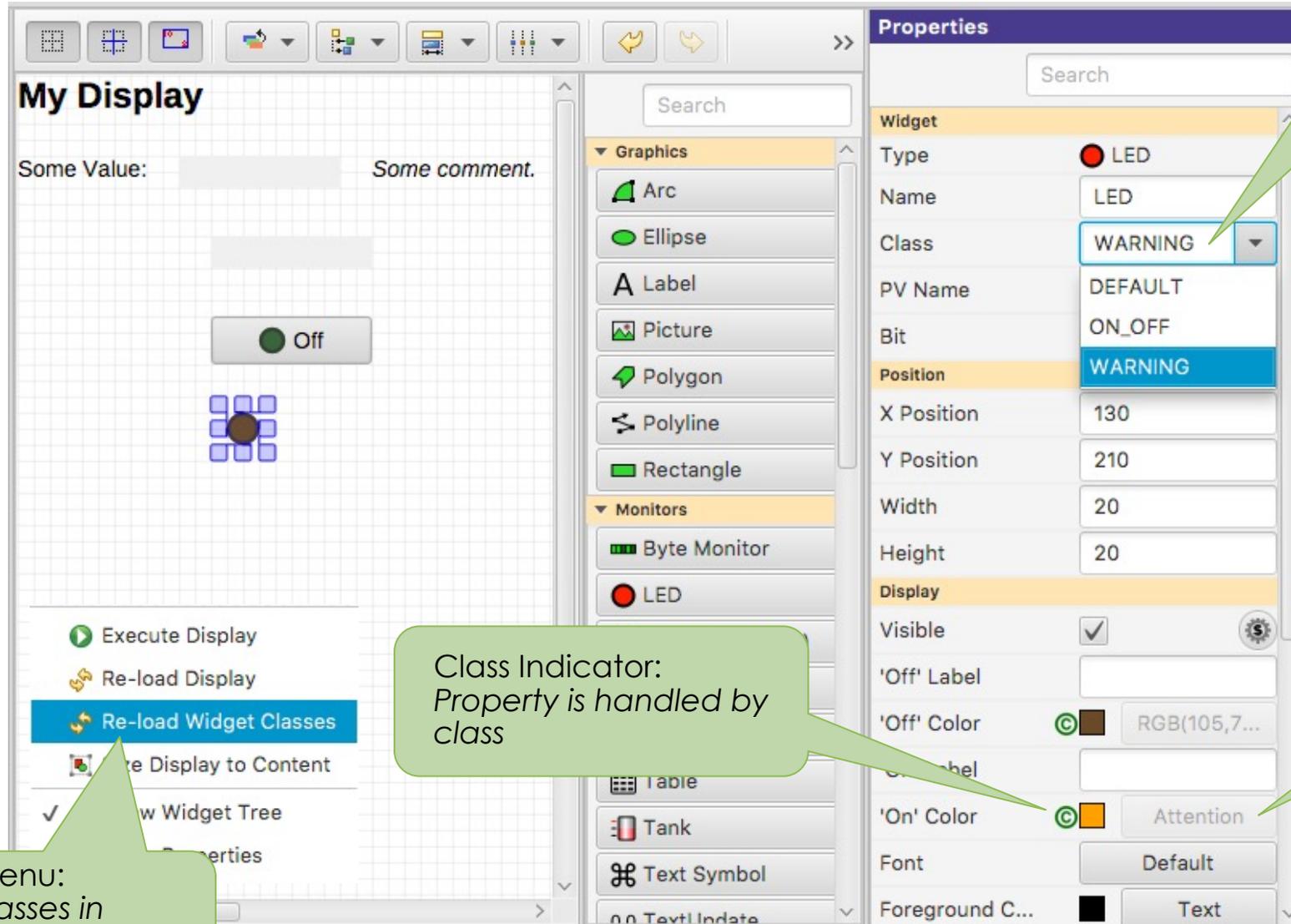
Slightly different editor behavior

Name Defines a widget Class:
'WARNING' LED,
'TITLE' Label,
...

The screenshot shows a software interface for editing widget class files. On the left, a 'Widgets' list contains items like 'TITLE', 'COMMENT', 'ON_OFF', 'WARNING', 'SECTION', and 'A'. The main workspace is a grid where 'ON_OFF' is represented by a green circle and 'WARNING' by a 3x3 grid of blue squares. A text box in the grid explains: 'This file defines widget classes. The 'name' of each widget defines the class. Properties are marked to be included in the class definition.' On the right, a 'Properties' panel is visible, showing settings for a 'LED' widget. The 'Name' is set to 'WARNING'. The 'On' color is set to 'Attention' (orange) and is checked. A tooltip points to this checked property with the text: 'Checked Property: Value becomes part of class definition'. Other properties include 'Type' (LED), 'PV Name', 'Bit' (-1), 'X Position' (120), 'Y Position' (190), 'Width' (20), 'Height' (20), 'Visible' (checked), 'Off' Label, 'Off' Color (RGB(105,74,44)), 'On' Label, 'On' Color (Attention), 'Font', 'Ground Color', and 'Line Color' (RGB(50,50,50,178)).

Checked Property:
*Value becomes part
of class definition*

Using Widget Classes



Select Widget Class

Class Indicator:
Property is handled by class

Disabled:
Cannot change the class-based property

Context Menu:
Re-load classes in case *.bcf is changed while editing display

Class Details

- *.bcf files define widget classes
 - Label of class *TITLE* uses font XYZ
- When editing a *.bob file, classes are applied.
Add Label, select Class *TITLE*:
 - Font is set to XYZ
 - Can no longer change the font
 - File is saved with font=XYZ, marked as “use_class”
- *.bob files use widget classes, if they are defined.
Open a file with Label of class *TITLE*, and
 - a) *TITLE* is a known class:
Whatever that class defines is used. If it sets font=EFG, that'll be used.
 - b) *TITLE* is not a known class:
Using font=XYZ as saved in file.

Compare *.bcf and *.bob to *.css and *.html

*.bcf classes are similar to *.css style settings,

*.bob files are similar to *.html content

a) Have same *.bcf/*.css

→ Display looks the same

b) Use different *.bcf/*.css

→ Display looks as requested in my *.bcf/*.css

c) Have no *.bcf/*.css

→ *.html turns into rubbish, lacking any description of what to look like.

*.bob display looks as seen by last person who edited it,
since the class settings effective at that time are in the *.bob file.

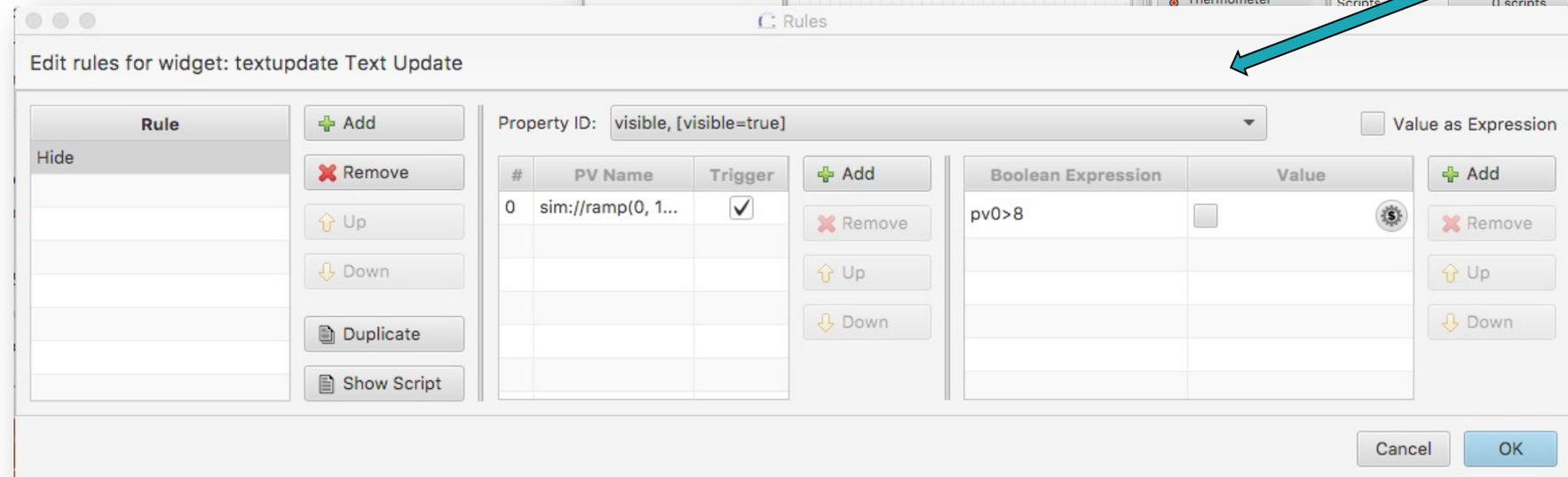
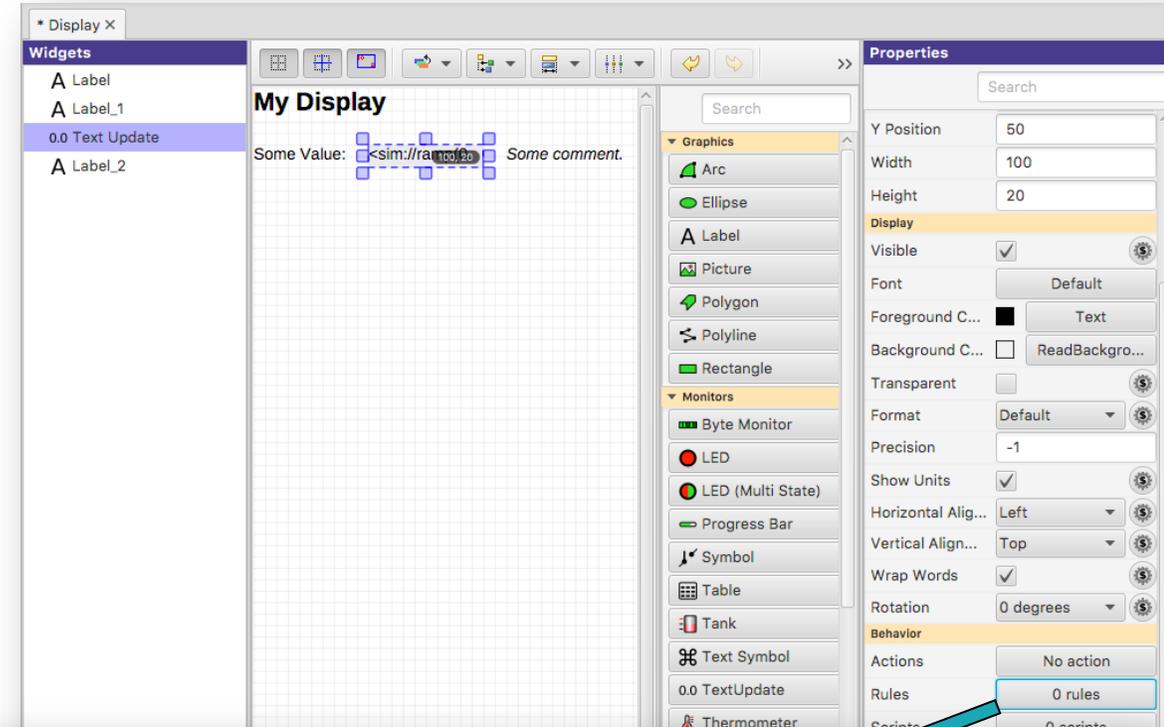
Rules

- Ideally, use widgets' built-in functionality
 - Value of PV displayed in TextUpdate, LED, ..
 - Alarm indicated via Border
- Sometimes useful to for example hide a widget, i.e. change visibility based on a PV
 - Rules can accomplish this
 - .. But functionality may not be obvious to the next person who needs to maintain a display



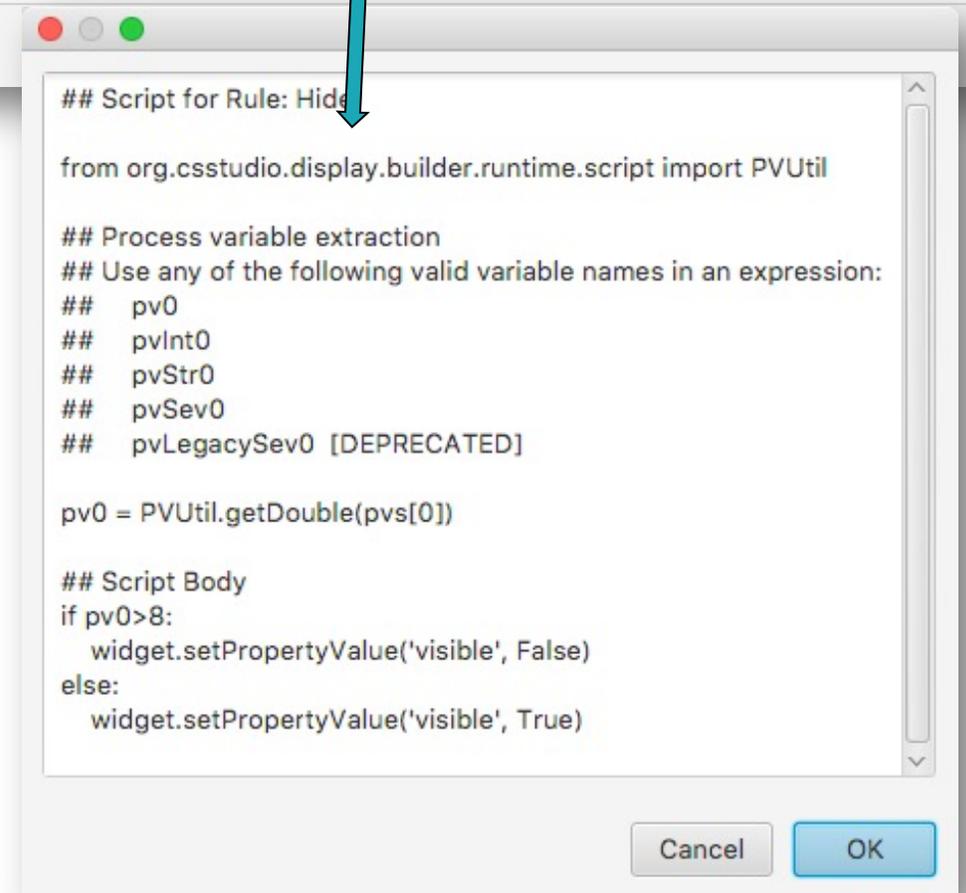
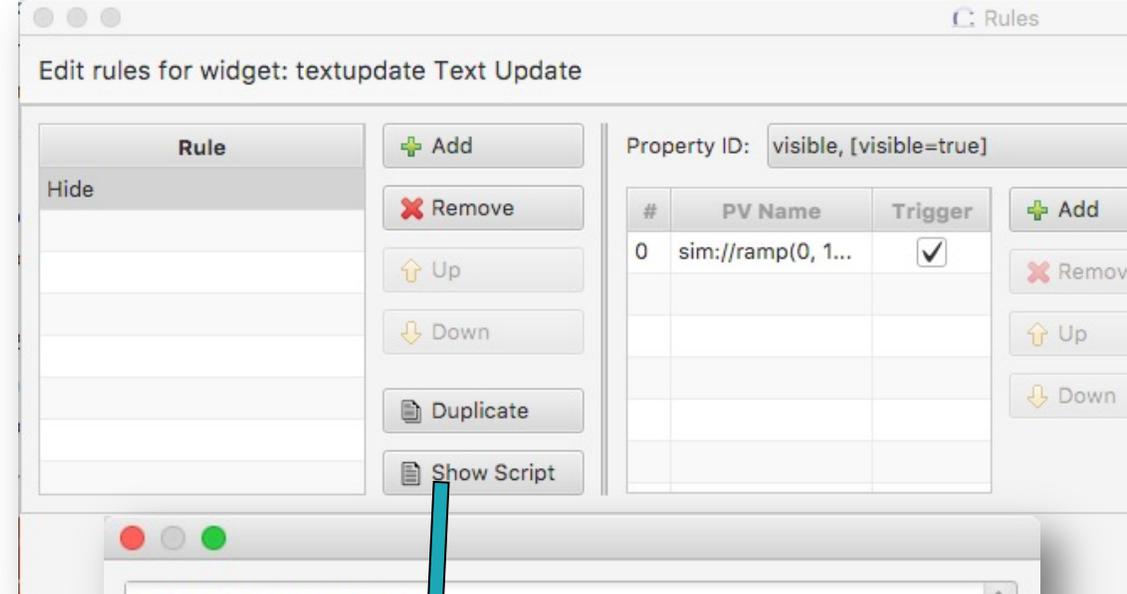
Adding a Rule

- Add TextUpdate widget
- Set PV to sim://ramp(0, 10, 1)
- Open Widget's Rules
- Add Rule, name it "Hide"
- Select "visible" property
- Add PV sim://ramp(0, 10, 1)
- Add Boolean Expression "pv0>8"
- Un-check value
- Run



Rules Detail

- Triggered by at least one PV
 - May use additional non-trigger PVs
- Expressions use pv0, pv1, ..., pvStr0, pvStr1, .. to access PVs' values
- Rule internally converted to Jython
 - Use preview to debug
- “else: ..” sets property to original value



Scripts

- Scripts are attached to a widget
- Triggered by at least one PV
 - May use additional non-trigger PVs
- Invoked with
 - pvs[] – Array of requested PVs
 - widget – The widget
- Script can
 - Read & write the received PVs
 - Set widget properties
 - Locate other widgets in the display
 - Invoke any Java code in the product
 - Be very powerful
 - Result in an unmaintainable mess
- One Script Executor per *.bob file, Runs in background thread
 - Slow scripts do not block the UI
 - One script per display at a time
 - a) Many short-duration scripts
 - b) One that never quits

Rules vs. Scripts

- Both are in the end Jython code
- Both should be the exception.
Plain displays don't need them.
But can be powerful,
replacing separate custom Java/Python/C/C++ applications.
- Prefer Rules because they describe meaning, easier to maintain

When to use a script

- It's simple, well documented, and tremendously improves the UI
- Would be a one-of, specialized, hard to maintain, separate application anyway.
With a script, at least its integrated into the operator UI

Examples:

- Turn scalar PVs into `loc://waveform` for guideline in XYPlot
- Fill display with 50 widgets based on config file, `examples/template_and_script`
- Add information from web service to display

When not to use a script

- It adds logic to the display that should be on the IOC
 - Display should only display PVs and allow user to write PVs.
 - **Display must never do anything**
- You have to ask for help implementing the script
 - If you can't implement it, you can't maintain it, either

Examples

- **Open relieve valve when pressure too high.
Ramp Power Supply.**
 - What if somebody closes the display? Opens two displays?
- **Wiggle something on the display**
 - It's not a video game



Summary

Display Builder is powerful Editor and Runtime with many Widgets, Macros etc.

Keep it Simple

1. Add a Widget
2. Enter Label's Text or Widget's PV Name
3. Done

Sample & Detector

	Destination Pos	Current Pos	
SANGLE	0.5000 deg	0.5012 deg	● Scan
SampleX	-8.9618	-8.9618	● Scan
Beam Stop	0.0362 mm	0.0362 mm	● Scan
Sample Changer	Undefined	-87.0008 mm	● Scan
DANGLE	13.0000 deg	13.0015 deg	● Scan

Slits - Collimation

	Destination Pos	Current Pos		Destination Pos	Current Pos		
S1HWidth	0.500 mm	0.501 mm	● Scan	S1VHeight	30.000 mm	29.998 mm	● Scan
S2HWidth	3.000 mm	2.996 mm	● Scan	S2VHeight	30.000 mm	30.010 mm	● Scan
S3HWidth	0.500 mm	0.500 mm	● Scan	S3VHeight	40.000 mm	40.000 mm	● Scan

Slits - Background

	Destination Pos	Current Pos	
RSlit4	-58.5160 mm	-58.5165 mm	● Scan
BDetSlit	0.0438 mm	0.0455 mm	● Scan
RDetSlit	-4.9926 mm	-4.9927 mm	● Scan

Pump Maintenance (RP)

	Current Running (Hours)	Alarm Setpoint (Hours)	Maintenance Require If RED
RP01	25	8000	●
RP02	26	8000	●
RP03	25	8000	●
RP04	26	8000	●
RP05	128	8000	●
RP06	127	8000	●
RP07	3244	8000	●
RP08	0	8000	●
RP09	3245	8000	●
RP10	3245	8000	●

Pump Maintenance (TMP)

	Current Running (Hours)	Alarm Setpoint (Hours)	Maintenance Require If RED
TMP01	2204	8000	●
TMP02	26	8000	●
TMP03	26	8000	●
TMP04	25	8000	●

X-Y ROI

	Min	Max	Mean	Total	Total +/-	Rate
Signal	11	363	116.194	22774	150.911	0 e/s
Background	0	1425	71.161	160824	401.029	0 e/s
S/B	0.000	0.255	1.633	0.142	0.001	0.000

QIE ROI

	Min	Max	Mean	Total	Total +/-	Rate
Signal	44	8996	778.156	105051	324.116	0 e/s
Background	6	2090	182.778	24675	157.083	0 e/s
S/B	7.333	4.304	4.257	4.257	0.030	0.000

Data Collection

Total Counts	4890418	0 e/s
Proton Charge	4.0063559E+1 C	
Beam Power	1402537 Watts	
Data Collection State	Idle	
Data Collection Pause	Not Paused	

QIE Axes & ROI Position Details

	ROI Start	ROI Size	Start	End	Bin Size	
Q Signal	4.268	1.067	Q Axis	0.0000	13.9396	0.0697
E Signal	0.000	7.500	E Axis	-80.0000	80.0000	0.8000
Q Background	2.134	1.067				
E Background	15.000	7.500				