Investigating the Use of Control System Studio at APS Beamlines

An Eclipse Plug-in Perspective

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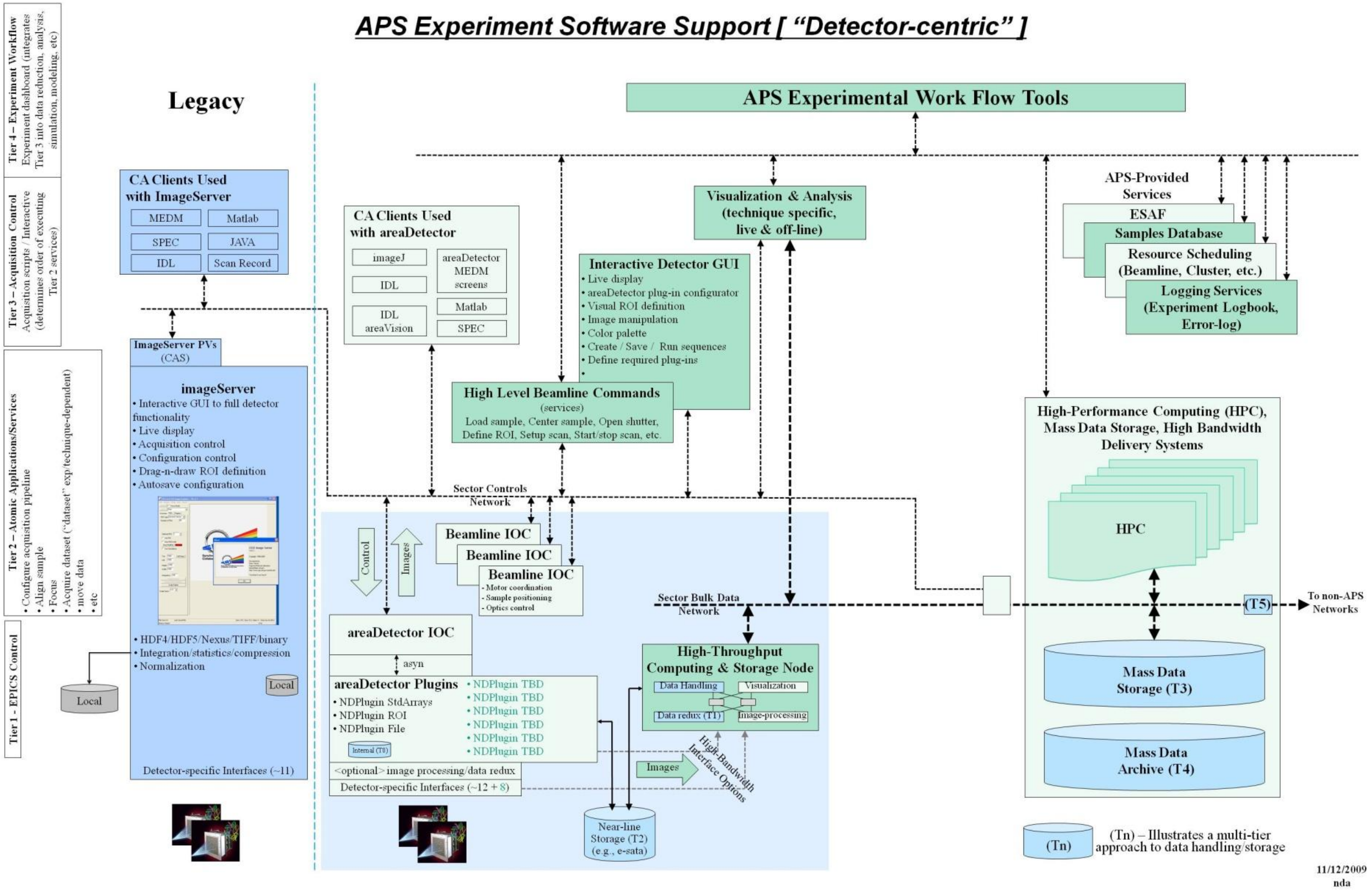
Advanced Photon Source

Software Services Group

Motivation

- We would like to develop an application to control area detectors using Mark Rivers' *areaDetector*.
- We would like to look at the path beyond MEDM
- Don't want this to be just another set of MEDM screens
- This will involve more than just CSS (e.g., GDA, ties to analysis)
- Need to look at setup, collection, monitoring, and the handoff to analysis

The big picture



APS Experiment Software Support ["Detector-centric"]

Tier 4 – Experiment Workflow
Experiment dashboard (integrates Tier 3 into data reduction, analysis, simulation, modeling, etc)

Tier 3 – Acquisition Control
Acquisition scripts / Interactive (determines order of executing Tier 2 services)

Tier 2 – Atomic Applications/Services
- Configure acquisition pipeline
- Align sample
- Focus
- Acquire dataset ("dataset" exp/technique-dependent)
- move data
- etc

Tier 1 - EPICS Control

Legacy

CA Clients Used with ImageServer
MEDM | Matlab | SPEC | JAVA | IDL | Scan Record

ImageServer PVs (CAS)

imageServer
- Interactive GUI to full detector functionality
- Live display
- Acquisition control
- Configuration control
- Drag-n-draw ROI definition
- Autosave configuration
- HDF4/HDF5/Nexus/TIFF/binary
- Integration/statistics/compression
- Normalization

Local

Local

Detector-specific Interfaces (~11)

CA Clients Used with areaDetector
imageJ | areaDetector MEDM screens | IDL | Matlab | IDL areaVision | SPEC

APS Experimental Work Flow Tools

Visualization & Analysis (technique specific, live & off-line)

Interactive Detector GUI
- Live display
- areaDetector plug-in configurator
- Visual ROI definition
- Image manipulation
- Color palette
- Create / Save / Run sequences
- Define required plug-ins
-

High Level Beamline Commands
(services)
Load sample, Center sample, Open shutter, Define ROI, Setup scan, Start/stop scan, etc.

Sector Controls Network

Control

Images

Beamline IOC

Beamline IOC

Beamline IOC
- Motor coordination
- Sample positioning
- Optics control

areaDetector IOC

asyn

areaDetector Plugins
- NDPlugin StdArrays
- NDPlugin ROI
- NDPlugin File
- NDPlugin TBD
- NDPlugin TBD
- NDPlugin TBD
- NDPlugin TBD
- NDPlugin TBD
- NDPlugin TBD

Internal (T0)

<optional> image processing/data redux

Detector-specific Interfaces (~12 + 8)

Sector Bulk Data Network

High-Throughput Computing & Storage Node
Data Handling | Visualization | Data redux (T1) | Image-processing

Images

High-Bandwidth Interface Options

Near-line Storage (T2) (e.g., e-sata)

APS-Provided Services
ESAF
Samples Database
Resource Scheduling (Beamline, Cluster, etc.)
Logging Services (Experiment Logbook, Error-log)

High-Performance Computing (HPC), Mass Data Storage, High Bandwidth Delivery Systems

HPC

(T5)

To non-APS Networks

Mass Data Storage (T3)

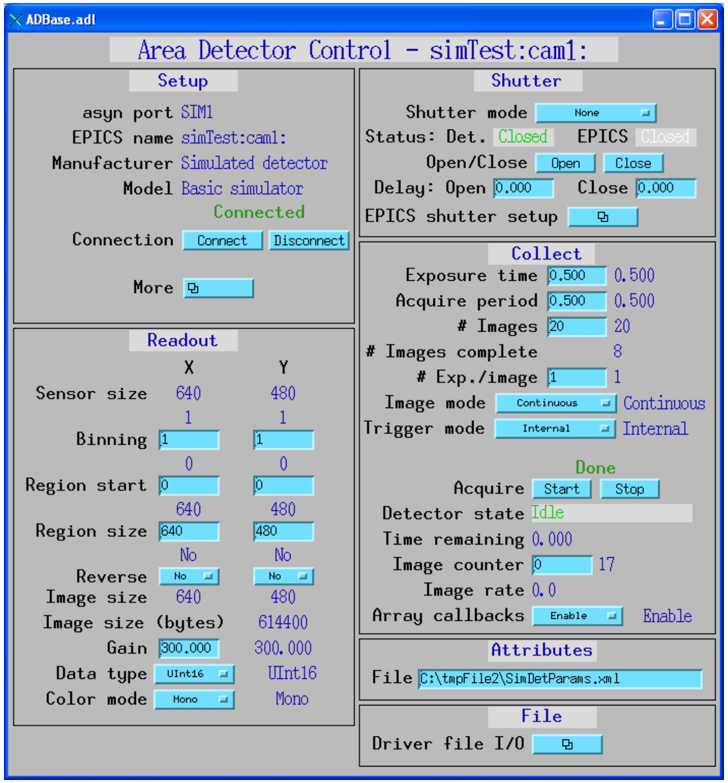
Mass Data Archive (T4)

(Tn) (Tn) – Illustrates a multi-tier approach to data handling/storage

11/12/2009
nda

BOY (Best OPI Yet) - ORNL

Can we produce the same kind of control screens?



Area Detector Control - simTest:cam1:

Setup

asyn port SIM1
EPICS name simTest:cam1:
Manufacturer Simulated detector
Model Basic simulator
Connected
Connection Connect Disconnect
More

Readout

	X	Y
Sensor size	640	480
Binning	1 1	1 1
Region start	0 0	0 0
Region size	640 640	480 480
Reverse	No No	No No
Image size	640	480
Image size (bytes)		614400
Gain	300.000	300.000
Data type	UInt16	UInt16
Color mode	Mono	Mono

Shutter

Shutter mode None
Status: Det. Closed EPICS Closed
Open/Close Open Close
Delay: Open 0.000 Close 0.000
EPICS shutter setup

Collect

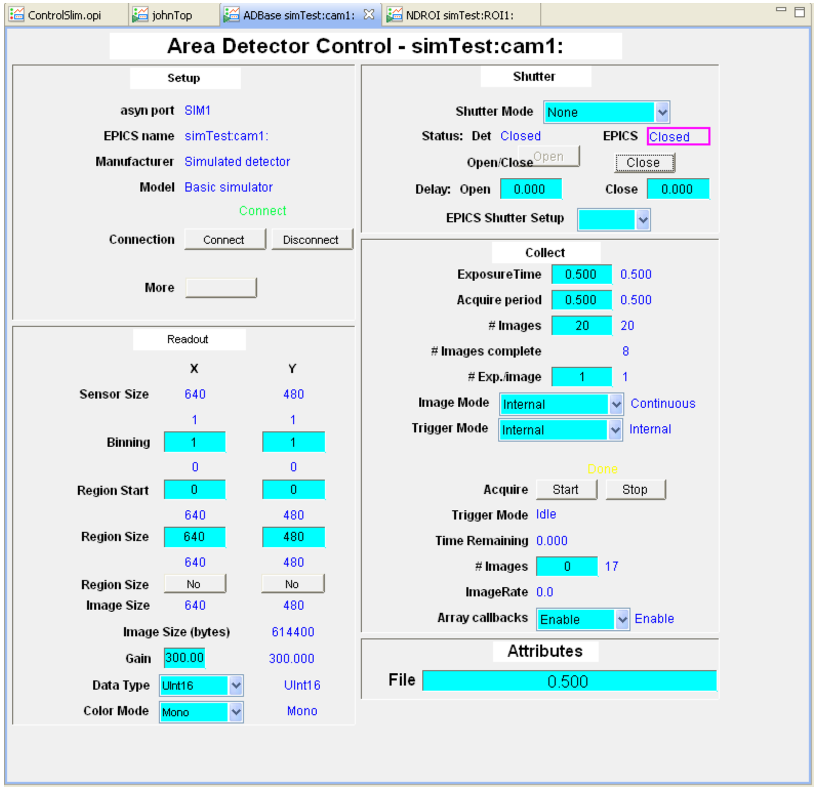
Exposure time 0.500 0.500
Acquire period 0.500 0.500
Images 20 20
Images complete 8
Exp./image 1 1
Image mode Continuous Continuous
Trigger mode Internal Internal
Done
Acquire Start Stop
Detector state Idle
Time remaining 0.000
Image counter 0 17
Image rate 0.0
Array callbacks Enable Enable

Attributes

File C:\tmpFile2\SimDetParams.xml

File

Driver file I/O



Area Detector Control - simTest:cam1:

Setup

asyn port SIM1
EPICS name simTest:cam1:
Manufacturer Simulated detector
Model Basic simulator
Connect
Connection Connect Disconnect
More

Readout

	X	Y
Sensor Size	640	480
Binning	1 1	1 1
Region Start	0 0	0 0
Region Size	640 640	480 480
Region Size	No	No
Image Size	640	480
Image Size (bytes)		614400
Gain	300.00	300.000
Data Type	UInt16	UInt16
Color Mode	Mono	Mono

Shutter

Shutter Mode None
Status: Det Closed EPICS Closed
Open/Close Open Close
Delay: Open 0.000 Close 0.000
EPICS Shutter Setup

Collect

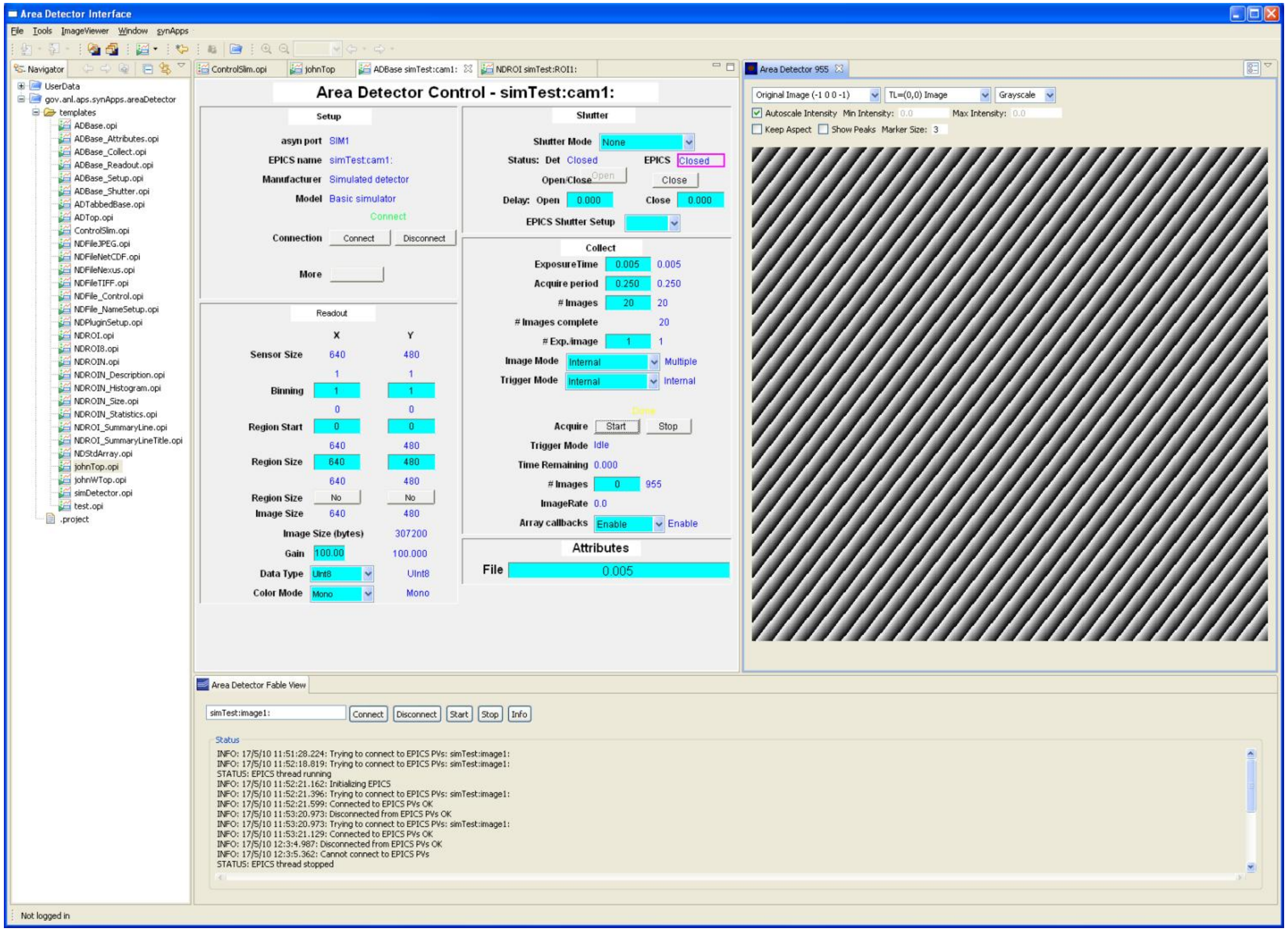
ExposureTime 0.500 0.500
Acquire period 0.500 0.500
Images 20 20
Images complete 8
Exp./image 1 1
Image Mode Internal Continuous
Trigger Mode Internal Internal
Done
Acquire Start Stop
Trigger Mode Idle
Time Remaining 0.000
Images 0 17
ImageRate 0.0
Array callbacks Enable Enable

Attributes

File 0.500

Throw together an example app

Mix elements from CSS with our own plugins



- UserData
- gov.anl.aps.synApps.areaDetector
  - templates
    - ADBase.opi
    - ADBase_Attributes.opi
    - ADBase_Collect.opi
    - ADBase_Readout.opi
    - ADBase_Setup.opi
    - ADBase_Shutter.opi
    - ADTabbedBase.opi
    - ADTop.opi
    - ControlSlim.opi
    - NDFileJPEG.opi
    - NDFileNetCDF.opi
    - NDFileNexus.opi
    - NDFileTIFF.opi
    - NDFile_Control.opi
    - NDFile_NameSetup.opi
    - NDPluginSetup.opi
    - NDROI.opi
    - NDROI8.opi
    - NDROIN.opi
    - NDROIN_Description.opi
    - NDROIN_Histogram.opi
    - NDROIN_Size.opi
    - NDROIN_Statistics.opi
    - NDROI_SummaryLine.opi
    - NDROI_SummaryLineTitle.opi
    - NDStdArray.opi
    - johnTop.opi
    - johnWTop.opi
    - simDetector.opi
    - test.opi
  - .project

Area Detector Control - simTest:cam1:

Setup

asyn port SIM1
EPICS name simTest:cam1:
Manufacturer Simulated detector
Model Basic simulator
Connect
Connection Connect Disconnect
More

Readout

	X	Y
Sensor Size	640	480
	1	1
Binning	1	1
	0	0
Region Start	0	0
	640	480
Region Size	640	480
	640	480
Region Size	No	No
Image Size	640	480
Image Size (bytes)		307200
Gain	100.00	100.000
Data Type	UInt8	UInt8
Color Mode	Mono	Mono

Shutter

Shutter Mode None
Status: Det Closed EPICS Closed
Open/Close Open Close
Delay: Open 0.000 Close 0.000
EPICS Shutter Setup

Collect

ExposureTime	0.005	0.005
Acquire period	0.250	0.250
# Images	20	20
# Images complete		20
# Exp./image	1	1
Image Mode	Internal	Multiple
Trigger Mode	Internal	Internal

Done
Acquire Start Stop
Trigger Mode Idle
Time Remaining 0.000
Images 0 955
ImageRate 0.0
Array callbacks Enable Enable

Attributes

File 0.005

Original Image (-1 0 0 -1) TL=(0,0) Image Grayscale
☑ Autoscale Intensity Min Intensity: 0.0 Max Intensity: 0.0
☐ Keep Aspect ☐ Show Peaks Marker Size: 3

simTest:image1:

Status

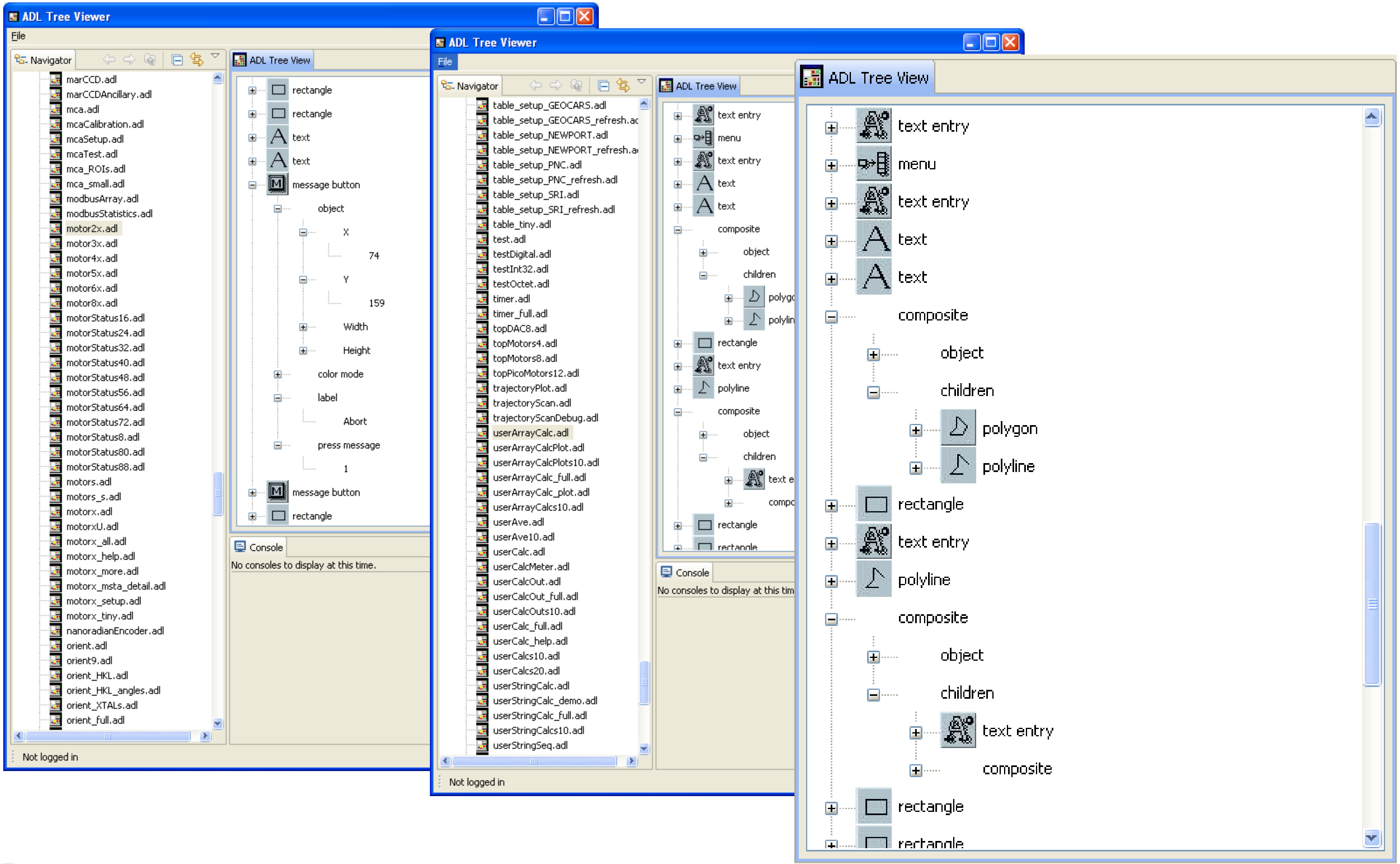
```
INFO: 17/5/10 11:51:28.224: Trying to connect to EPICS PVs: simTest:image1:
INFO: 17/5/10 11:52:18.819: Trying to connect to EPICS PVs: simTest:image1:
STATUS: EPICS thread running
INFO: 17/5/10 11:52:21.162: Initializing EPICS
INFO: 17/5/10 11:52:21.396: Trying to connect to EPICS PVs: simTest:image1:
INFO: 17/5/10 11:52:21.599: Connected to EPICS PVs OK
INFO: 17/5/10 11:53:20.973: Disconnected from EPICS PVs OK
INFO: 17/5/10 11:53:20.973: Trying to connect to EPICS PVs: simTest:image1:
INFO: 17/5/10 11:53:21.129: Connected to EPICS PVs OK
INFO: 17/5/10 12:3:4.987: Disconnected from EPICS PVs OK
INFO: 17/5/10 12:3:5.362: Cannot connect to EPICS PVs
STATUS: EPICS thread stopped
```

How will we convert all the MEDM screens?

- Write a converter
  - ORNL had the start of an EDM->BOY converter
    - Still somewhat primitive
    - Ties between the conversion and the data model
  - DESY had an ADL->SDS converter
    - Fairly complete
    - Ties between ADL parsing and the data model
    - Could see a clean way to cut the tie between parsing and the data model
- Start with the ADL->SDS converter
  - Cut the strings between parsing the ADL file and the SDS model
  - Create an adlParser plugin (org.csstudio.utility.adlParser)
    - Most of this was LIFTED from the ADL->SDS converter (org.csstudio.utility.adlConverter).
    - Took out references to SDS in the parser
    - Should be able to use this parser for all converters (ADL->SDS & ADL->BOY)
  - Create an ADL->BOY converter (org.csstudio.opibuilder.adl2opi)
    - Use the parser
    - Convert to the BOY data model (fairly straightforward)
    - Dump the file

adlParser

Plugin contains an RCP applicaction to examine the detail inside the file



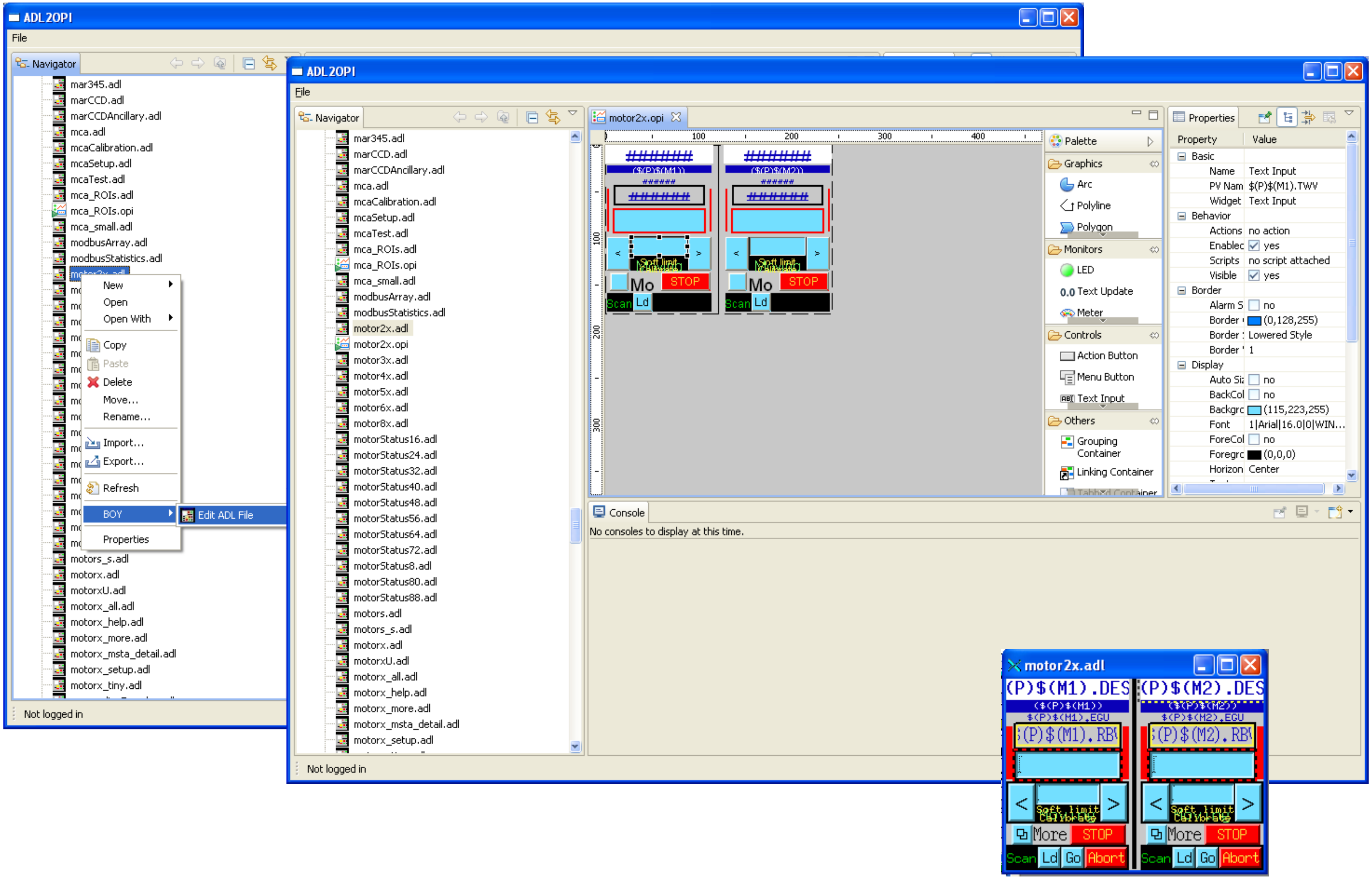
```
ADL Tree Viewer
File
Navigator
marCCD.adl
marCCDAncillary.adl
mca.adl
mcaCalibration.adl
mcaSetup.adl
mcaTest.adl
mca_ROIs.adl
mca_small.adl
modbusArray.adl
modbusStatistics.adl
motor2x.adl
motor3x.adl
motor4x.adl
motor5x.adl
motor6x.adl
motor8x.adl
motorStatus16.adl
motorStatus24.adl
motorStatus32.adl
motorStatus40.adl
motorStatus48.adl
motorStatus56.adl
motorStatus64.adl
motorStatus72.adl
motorStatus8.adl
motorStatus80.adl
motorStatus88.adl
motors.adl
motors_s.adl
motorx.adl
motorxU.adl
motorx_all.adl
motorx_help.adl
motorx_more.adl
motorx_msta_detail.adl
motorx_setup.adl
motorx_tiny.adl
nanoradianEncoder.adl
orient.adl
orient9.adl
orient_HKL.adl
orient_HKL_angles.adl
orient_XTALs.adl
orient_full.adl

ADL Tree View
rectangle
rectangle
text
text
message button
    object
        X
            74
        Y
            159
        Width
        Height
    color mode
    label
        Abort
    press message
        1
message button
rectangle

Console
No consoles to display at this time.

Not logged in
```

```
ADL Tree Viewer
File
Navigator
table_setup_GEOCARS.adl
table_setup_GEOCARS_refresh.ac
table_setup_NEWPORT.adl
table_setup_NEWPORT_refresh.a
table_setup_PNC.adl
table_setup_PNC_refresh.adl
table_setup_SRI.adl
table_setup_SRI_refresh.adl
table_tiny.adl
test.adl
testDigital.adl
testInt32.adl
testOctet.adl
timer.adl
timer_full.adl
topDAC8.adl
topMotors4.adl
topMotors8.adl
topPicoMotors12.adl
trajectoryPlot.adl
trajectoryScan.adl
trajectoryScanDebug.adl
userArrayCalc.adl
userArrayCalcPlot.adl
userArrayCalcPlots10.adl
userArrayCalc_full.adl
userArrayCalc_plot.adl
userArrayCalcs10.adl
userAve.adl
userAve10.adl
userCalc.adl
userCalcMeter.adl
userCalcOut.adl
userCalcOut_full.adl
userCalcOuts10.adl
userCalc_full.adl
userCalc_help.adl
userCalcs10.adl
userCalcs20.adl
userStringCalc.adl
userStringCalc_demo.adl
userStringCalc_full.adl
userStringCalcs10.adl
userStringSeq.adl

ADL Tree View
text entry
menu
text entry
text
text
composite
    object
    children
        polygo
        polylin
rectangle
text entry
polyline
composite
    object
    children
        text e
        compo
rectangle
rectangle

Console
No consoles to display at this tim

Not logged in
```

```
ADL Tree View
text entry
menu
text entry
text
text
composite
    object
    children
        polygon
        polyline
rectangle
text entry
polyline
composite
    object
    children
        text entry
        composite
rectangle
rectangle
```

adl2boy

Plugin includes self contained application



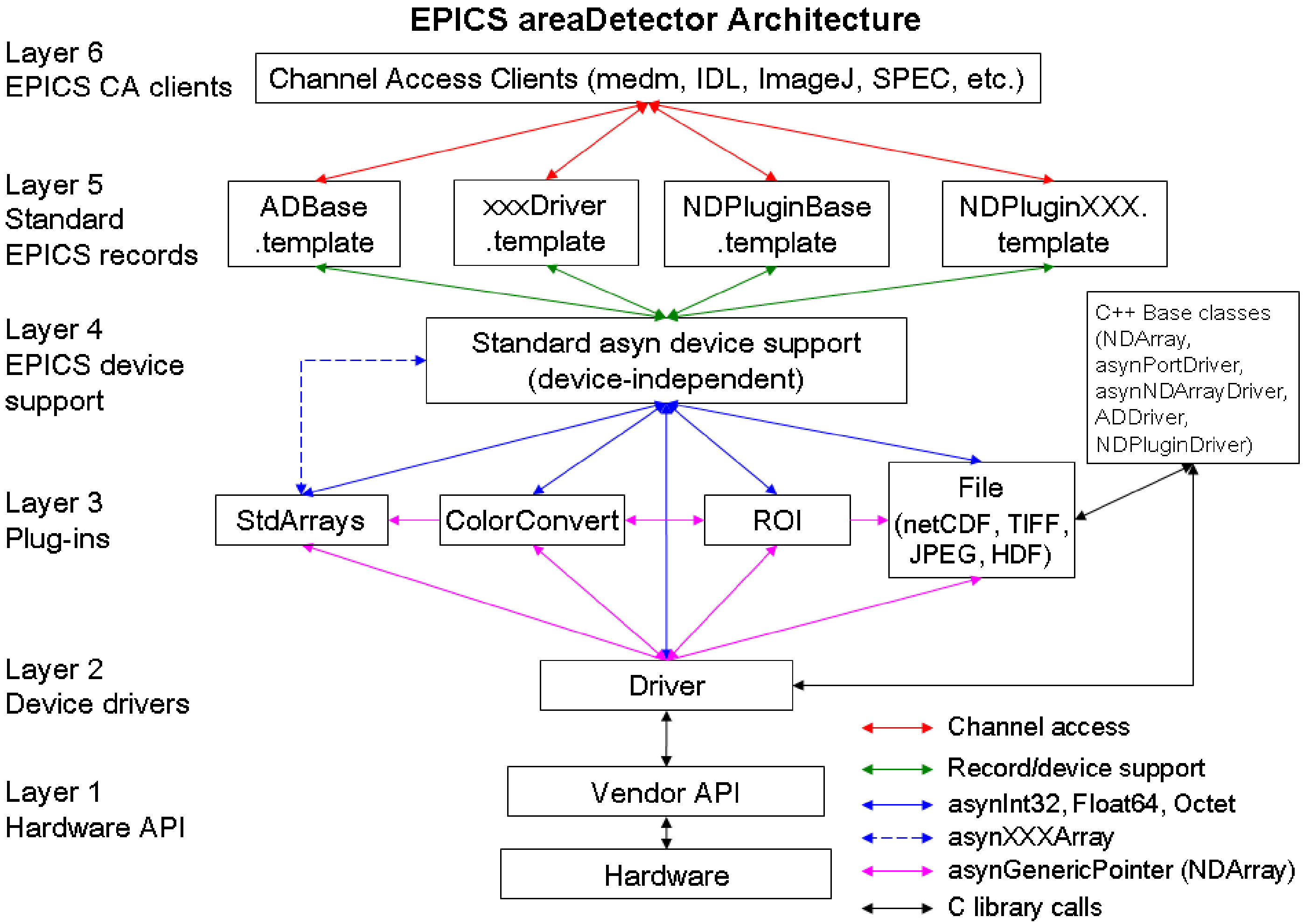
Property	Value
⊟ Basic	
Name	Text Input
PV Nam	(P)(M1).TWV
Widget	Text Input
⊟ Behavior	
Actions	no action
Enablec	☑ yes
Scripts	no script attached
Visible	☑ yes
⊟ Border	
Alarm S	□ no
Border (	(0,128,255)
Border :	Lowered Style
Border '	1
⊟ Display	
Auto Siz	□ no
BackCol	□ no
Backgrc	(115,223,255)
Font	1|Arial|16.0|0|WIN...
ForeCol	□ no
Foregrc	(0,0,0)
Horizon	Center

No consoles to display at this time.

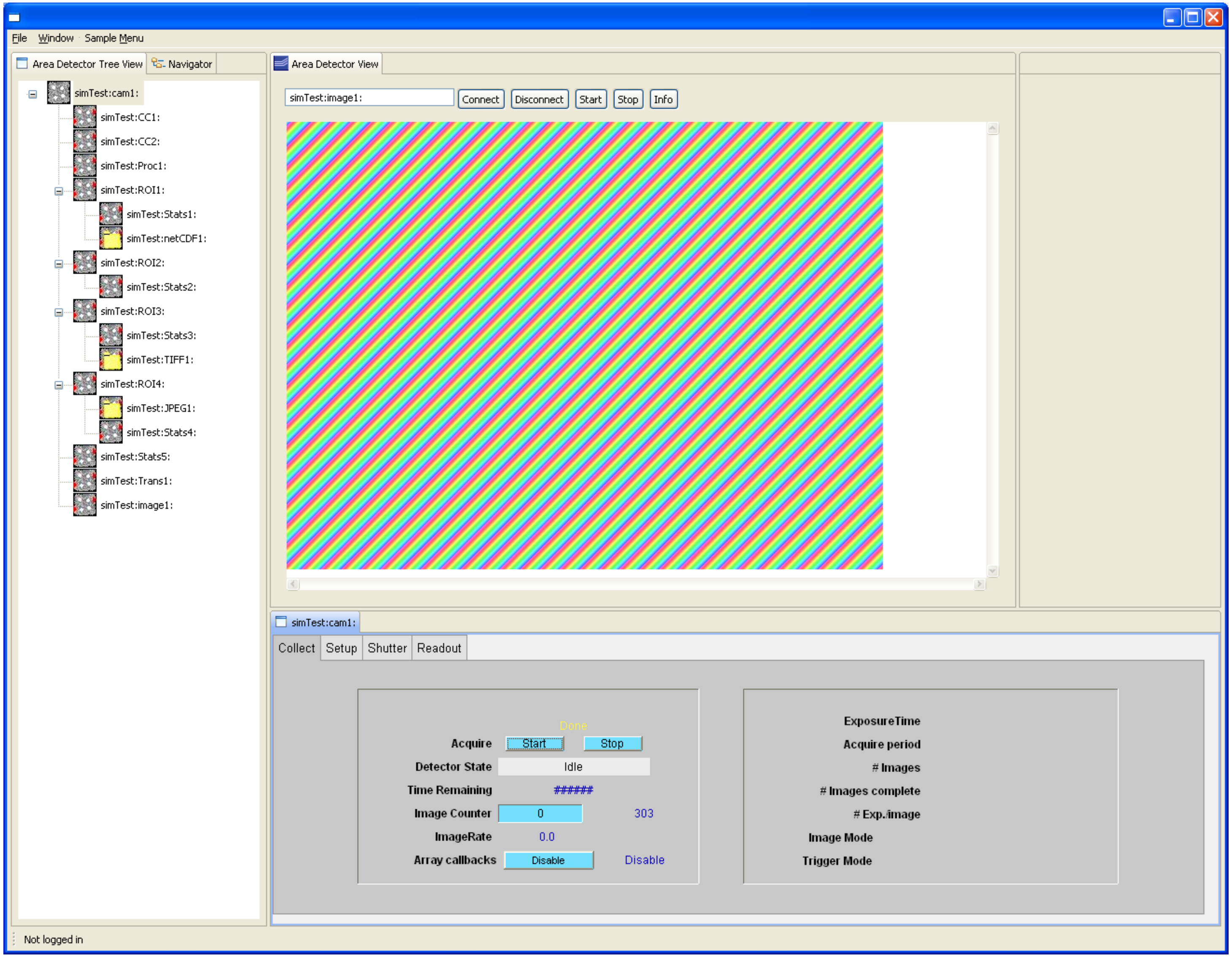
adl2boy – What is missing?

- Byte, Choice Button, Indicator, and Toggle Button – No good matches in BOY, many of these are on wish lists
- No Dynamic properties – this is on the wish list
- No way to specify location for related displays and images
- Some MEDM files (pre version 020200) have attribute sections that follow the widget definition instead of inside of them; These are not currently handled

Taking a bite out of the big picture



Demo application



simTest:image1:

Done

Acquire

Detector State: Idle

Time Remaining: ######

Image Counter: 0 303

ImageRate: 0.0

Array callbacks: Disable Disable

Not logged in

Acknowledgement

- Matthias Claussen et al., DESY and Cosylab, for shepherding CSS
- Kay Kasemir and Xihui Chen, ORNL, for their work on BOY and for their encouragement of the collaboration
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- Ned Arnold for the big picture
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