areaDetector: What's New?

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Outline

- Last areaDetector update was October 2019 at ICALEPCS
- 2020 collaboration meeting talk was an overview for beginners
  - 4 Releases of areaDetector and ADCore since 2019 talk
    - R3-8 through R3-11
- Major new features of these releases
- Important new driver developments
- New viewer

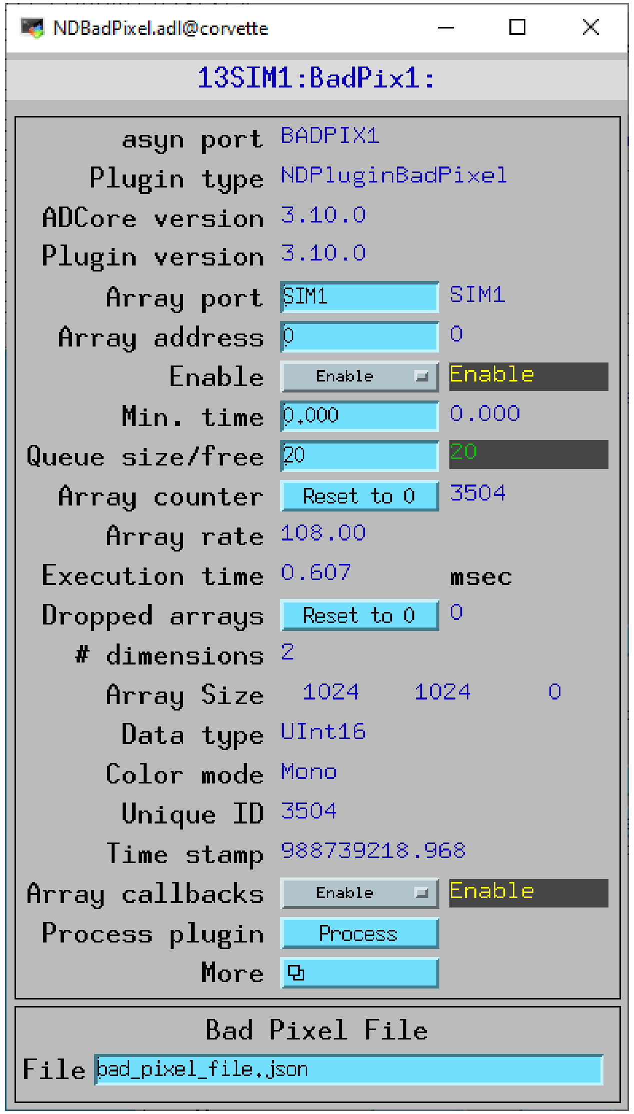
NDPluginBadPixel

Replaces bad pixels in an NDArray. Supports 3 different replacement mechanisms:

- Set: The pixel value is set to a user defined value.
- Replace: The pixel value is replaced by the value in a nearby pixel [ΔX, ΔY].
- Median: The pixel value is replaced by the median value of $[2N_x+1],[2N_y+1]$ nearby pixels.

List of bad pixels is specified in a JSON file like this (red comments not in file):

```
{ "Bad pixels" :
  [
    {"Pixel" : [200,100], "Set" : 0},           Replace with 0
    {"Pixel" : [300,100], "Set" : 1000},        Replace with 1000
    {"Pixel" : [400,100], "Set" : 2000},        Replace with 2000
    {"Pixel" : [200,200], "Replace" : [1,0]},   X+1, Y+0
    {"Pixel" : [300,200], "Replace" : [-2,0]},  X-2, Y+0
    {"Pixel" : [400,200], "Replace" : [1,-1]},  X+1, Y-1
    {"Pixel" : [200,300], "Median" : [1,1]},    3x3 median filter
    {"Pixel" : [300,300], "Median" : [2,1]},    5x3 median filter
    {"Pixel" : [400,300], "Median" : [3,3]}     7x7 median filter
  ]
}
```



NDBadPixel.adl@corvette

13SIM1:BadPix1:

asyn port	BADPIX1	
Plugin type	NDPluginBadPixel	
ADCore version	3.10.0	
Plugin version	3.10.0	
Array port	SIM1	SIM1
Array address	0	0
Enable	Enable	Enable
Min. time	0.000	0.000
Queue size/free	20	20
Array counter	Reset to 0	3504
Array rate	108.00	
Execution time	0.607	msec
Dropped arrays	Reset to 0	0
# dimensions	2	
Array Size	1024 1024 0	
Data type	UInt16	
Color mode	Mono	
Unique ID	3504	
Time stamp	988739218.968	
Array callbacks	Enable	Enable
Process plugin	Process	
More		

Bad Pixel File

File bad_pixel_file.json

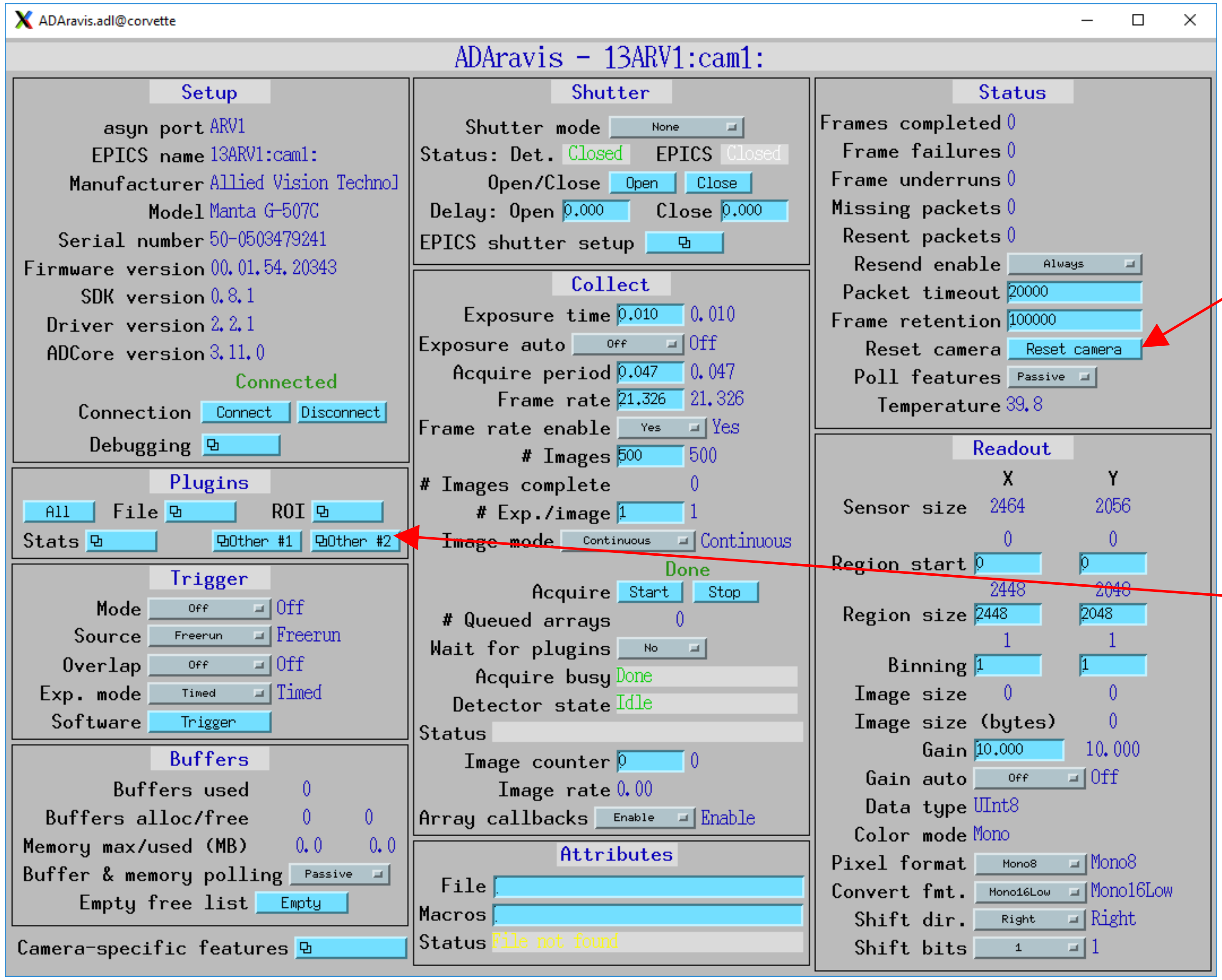
Eliminate Use of shareLib.h from EPICS Base

- Changed code and Makefiles to avoid using shareLib.h from EPICS base.
- Added new header files ADCoreAPI.h and NDPluginAPI.h that are used to control whether functions, classes, and variables are defined internally to the libraries or externally.
- This is the mechanism now used in EPICS base 7.
- Much easier to avoid mistakes in the order of include files that cause external functions to be accidentally exported in the DLL or shareable library.
- Should work on all versions of base, and have no impact on user code.
- Did the same thing for asyn in R4-41.

Recover From Camera Reset Without Restarting IOC

- Some sites want to be able to restart camera without restarting IOC
  - Current EPICS settings should be downloaded to camera after reset
- Implemented and tested with ADAravis
  - Need to implement and test on other camera drivers
- The asynPortDriver disconnect() and connect() methods will be used
  - ADAravis current uses a special ResetCamera record, will be changed
- Uses the autosave **configMenu** feature
  - Manually save an autosave save_set when camera is reset
  - Load the save_set when the reset is complete

Recover From Camera Reset Without Restarting IOC



ADAravis.adl@corvette

ADAravis - 13ARV1:cam1:

Setup

asyn port ARV1
EPICS name 13ARV1:cam1:
Manufacturer Allied Vision Technol
Model Manta G-507C
Serial number 50-0503479241
Firmware version 00.01.54.20343
SDK version 0.8.1
Driver version 2.2.1
ADCore version 3.11.0
Connected
Connection Connect Disconnect
Debugging

Plugins

All File ROI
Stats Other #1 Other #2

Trigger

Mode Off Off
Source Freerun Freerun
Overlap Off Off
Exp. mode Timed Timed
Software Trigger

Buffers

Buffers used 0
Buffers alloc/free 0 0
Memory max/used (MB) 0.0 0.0
Buffer & memory polling Passive
Empty free list Empty

Camera-specific features

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 0.010 0.010
Exposure auto Off Off
Acquire period 0.047 0.047
Frame rate 21.326 21.326
Frame rate enable Yes Yes
Images 500 500
Images complete 0
Exp./image 1 1
Image mode Continuous Continuous
Done
Acquire Start Stop
Queued arrays 0
Wait for plugins No
Acquire busy Done
Detector state Idle
Status
Image counter 0 0
Image rate 0.00
Array callbacks Enable Enable

Attributes

File
Macros
Status File not found

Status

Frames completed 0
Frame failures 0
Frame underruns 0
Missing packets 0
Resent packets 0
Resend enable Always
Packet timeout 20000
Frame retention 100000
Reset camera Reset camera
Poll features Passive
Temperature 39.8

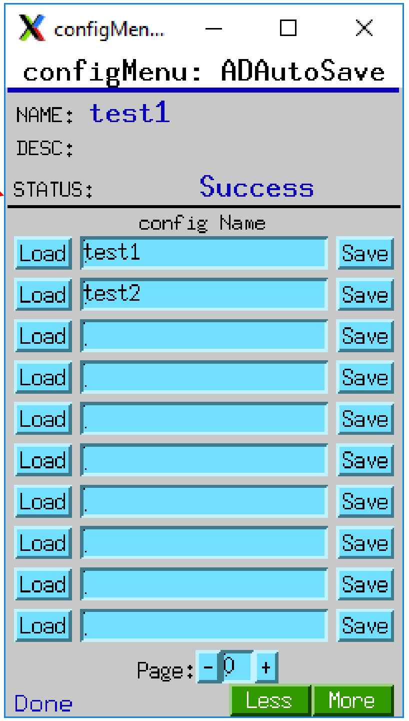
Readout

	X	Y
Sensor size	2464	2056
	0	0
Region start	0	0
	2448	2048
Region size	2448	2048
	1	1
Binning	1	1
Image size	0	0
Image size (bytes)		0

Gain 10.000 10.000
Gain auto Off Off
Data type UInt8
Color mode Mono
Pixel format Mono8 Mono8
Convert fmt. Mono16Low Mono16Low
Shift dir. Right Right
Shift bits 1 1

Required Steps

1. Power cycle the camera
2. Wait for camera to finish initializing, then press the "Reset camera" button on the ADAravis screen
3. ADAravis can now control the camera again, but many camera settings will no longer match the EPICS values.
4. Open configMenu screen from Plugins/Other #2



configMen...

configMenu: ADAutoSave

NAME: test1
DESC:
STATUS: Success

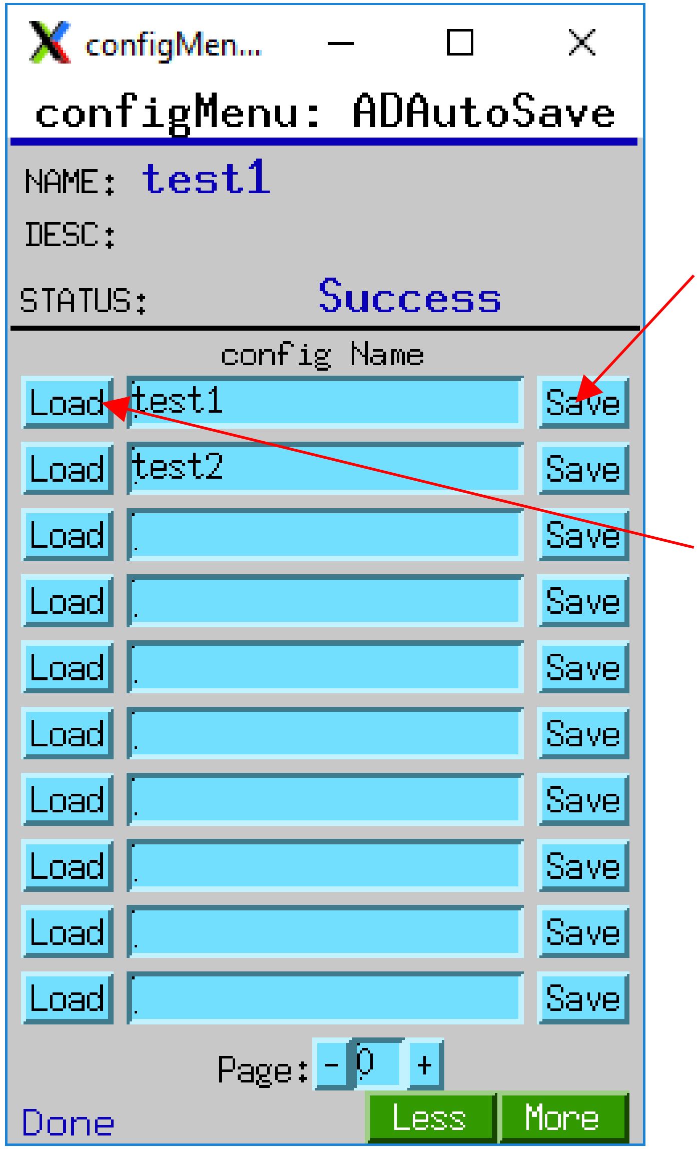
config Name

Load	test1	Save
Load	test2	Save
Load		Save
Load		Save
Load		Save
Load		Save
Load		Save
Load		Save
Load		Save
Load		Save

Page: - 0 +

Done Less More

Recover From Camera Reset Without Restarting IOC



configMen...

configMenu: ADAutoSave

NAME: test1

DESC:

STATUS: Success

config Name

test1

test2

Page: 0

Required Steps

5. Name the configuration to be saved (e.g. test1)
6. Press Save button for the configuration you want to save.
   - Saves all of the camera and plugin settings to a file called ADAutoSave_test1.cfg.
   - Creates a backup of the current settings before creating the new file with a name like ADAutoSave_test1.cfg_210628-133135 encoding current date and time.
7. Press the Load button for the same configuration you just saved.
   - Downloads all of the EPICS camera settings to the camera.
   - Also sets all of the plugin settings to the same values you just loaded, so they should not actually change.

- This tool can also be used to save multiple configurations with different settings, for example different binning or camera.
  - Provides a convenient way to then reload these configurations at a later date.
- This mechanism is not specific to areaDetector, can be used with any EPICS device that is reset.

64-bit Integer Support

- NDArray now supports NDInt64 and NDUInt64 data types
- NDAttribute now supports NDAttrInt64 and NDAttrUInt64 data types
- All standard plugins were modified to handle the new 64-bit NDArray and NDAttribute data types
- These file plugins can now write NDArray data types NDInt64 and NDUInt64, and NDAttribute data types NDAttrInt64 and NDAttrUInt64:
  - NDFileHDF
  - NDFileNexus
  - NDFileTIFF
- NDFileNetCDF cannot write the 64-bit integer data types because the netCDF3 "Classic" data model does not support them.
- 64-bit integer TIFF files cannot be read by ImageJ, but they can be read by IDL.
- ntndArrayConverter converts NDInt64 and NDUInt64 to the equivalent pvData "long" and "ulong".

ADGenICam 64-bit Integer Support

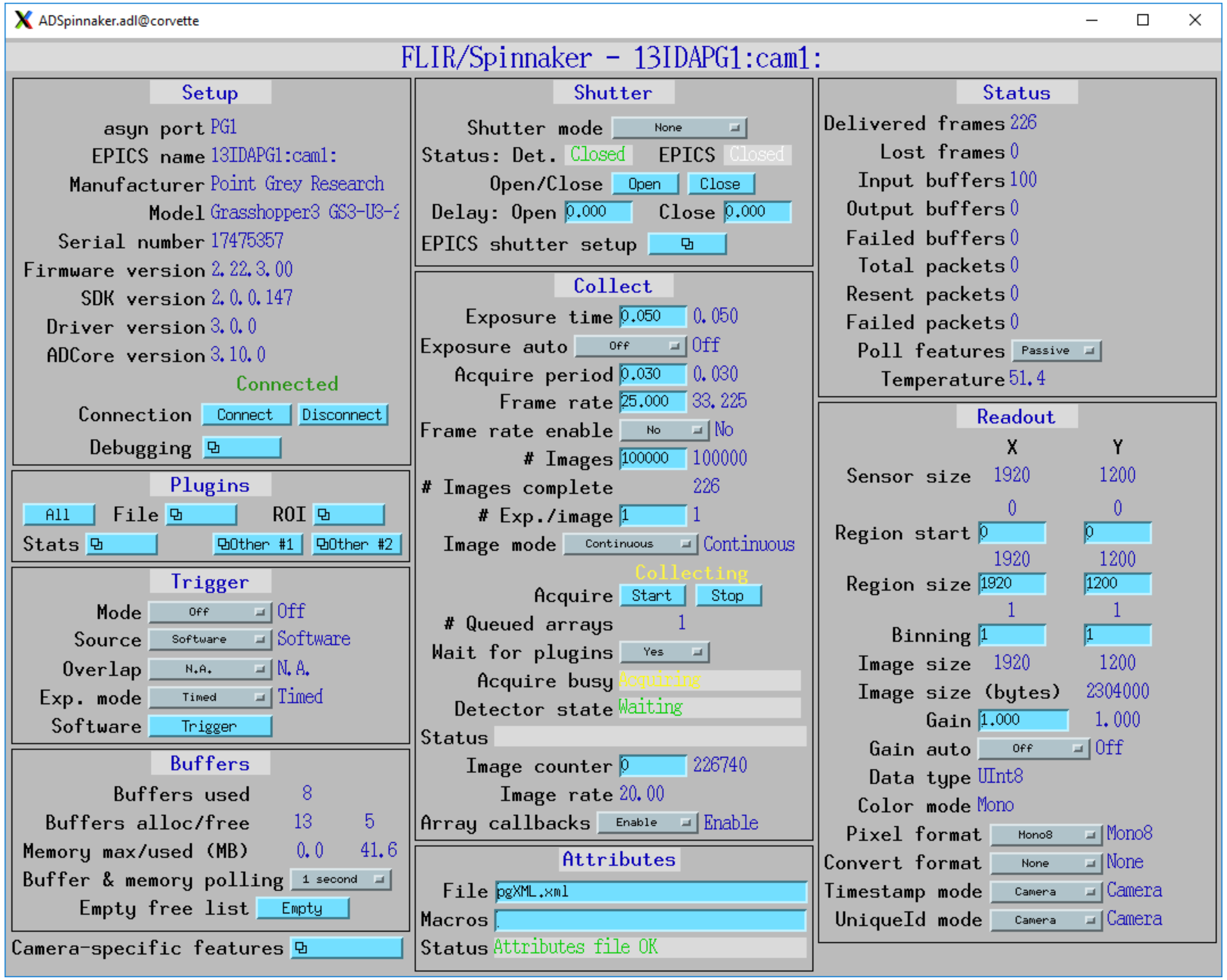
- ADGenICam integer feature support changed from 32-bit integers to 64-bit integers, which is what the GenICam standard specifies.
- Requires asyn R4-38 which adds asynInt64 support for the ai, ao, longin, and longout records. With EPICS base 3.16.1 and later (including EPICS 7) int64in and int64 out records can be used for these features.
- On older versions of base ai and ao records must be used, which limits exact representation of the features to 52 bits.
- Added --devInt64 option to makeDb.py to create int64in and int64out records for GenICam integer features.
  - If this option flag is not used then ai and ao records are created for these features.
- The --devInt64 flag is recommended if running on EPICS base 3.16.1 or later, including EPICS 7.

Other ADGenICam Enhancements

- Added support for Mono12p and Mono12Packed formats
  - These pack 2 12-bit pixels into 3 bytes,
  - Reduces network bandwidth by 25% compared to 2 16-bit pixels
  - ADGenICam provides new decompressMono12Packed() and decompressMono12p() methods to unpack the data to 16-bit pixel values in the driver.
  - Optional 4-bit left-shift operation so data fills full 16-bit range, like some vendors SDKs.
- Improvements to allow the asyn parameter datatype and the GenICam feature datatype to be different. Specifically, one can be an integer and the other a double.
  - Needed for the areaDetector Gain feature (double) on GenICam cameras that don't implement the GenICam Gain feature (also a double), but rather only implement the GainRaw or GainRawChannelA features (both are integers).
  - Some older Allied Vision Technologies/Prosilica cameras require this.

ADSpinnaker

- New driver for FLIR/Point Grey cameras
- Uses the FLIR Spinnaker SDK
- Inherits from ADGenICam
- Runs on Windows
- Runs on Linux
  - GLIBCXX ≥ 3.4.21
  - Ubuntu 18, Centos8, etc. (not RHEL 7)
- Replaces ADPointGrey



ADSpinnaker.adl@corvette

FLIR/Spinnaker - 13IDAPG1:cam1:

Setup

asyn port PG1
EPICS name 13IDAPG1:cam1:
Manufacturer Point Grey Research
Model Grasshopper3 GS3-U3-2
Serial number 17475357
Firmware version 2.22.3.00
SDK version 2.0.0.147
Driver version 3.0.0
ADCore version 3.10.0
Connected
Connection Connect Disconnect
Debugging

Plugins

All File ROI
Stats Other #1 Other #2

Trigger

Mode Off Off
Source Software Software
Overlap N.A. N.A.
Exp. mode Timed Timed
Software Trigger

Buffers

Buffers used 8
Buffers alloc/free 13 5
Memory max/used (MB) 0.0 41.6
Buffer & memory polling 1 second
Empty free list Empty

Camera-specific features

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 0.050 0.050
Exposure auto Off Off
Acquire period 0.030 0.030
Frame rate 25.000 33.225
Frame rate enable No No
Images 100000 100000
Images complete 226
Exp./image 1 1
Image mode Continuous Continuous
Collecting
Acquire Start Stop
Queued arrays 1
Wait for plugins Yes
Acquire busy Acquiring
Detector state Waiting
Status
Image counter 0 226740
Image rate 20.00
Array callbacks Enable Enable

Attributes

File pgXML.xml
Macros
Status Attributes file OK

Status

Delivered frames 226
Lost frames 0
Input buffers 100
Output buffers 0
Failed buffers 0
Total packets 0
Resent packets 0
Failed packets 0
Poll features Passive
Temperature 51.4

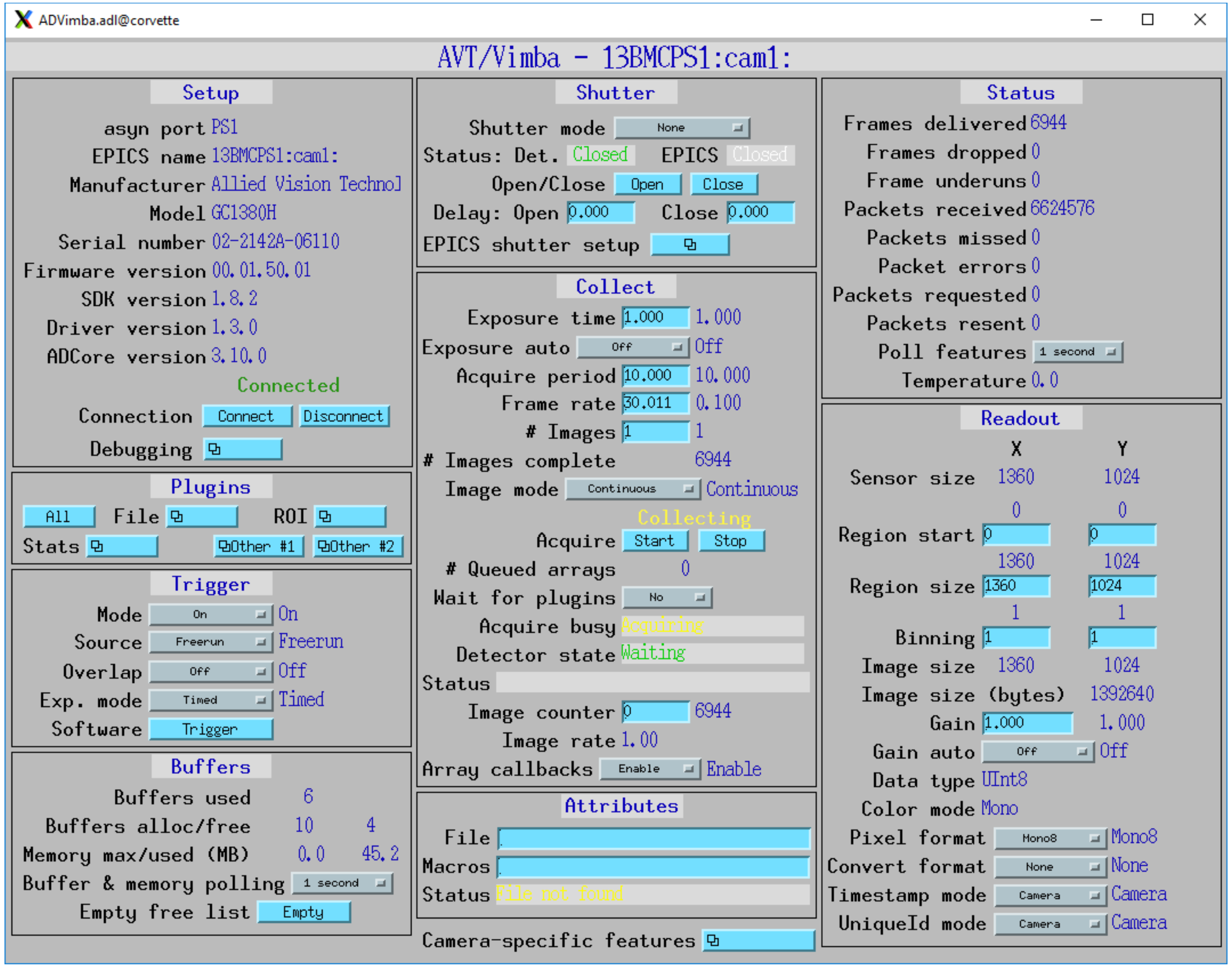
Readout

	X	Y
Sensor size	1920	1200
	0	0
Region start	0	0
	1920	1200
Region size	1920	1200
	1	1
Binning	1	1
Image size	1920	1200
Image size (bytes)	2304000	

Gain 1.000 1.000
Gain auto Off Off
Data type UInt8
Color mode Mono
Pixel format Mono8 Mono8
Convert format None None
Timestamp mode Camera Camera
UniqueId mode Camera Camera

ADVimba

- New driver for Allied Vision Technology /Prosilica cameras
- Uses the Allied Vision Vimba SDK
- Inherits from ADGenICam
- Runs on Windows and Linux
- Replaces ADProsilica



ADVimba.adl@corvette

AVT/Vimba - 13BMCPS1:cam1:

Setup

asyn port PS1
EPICS name 13BMCPS1:cam1:
Manufacturer Allied Vision Technol
Model GC1380H
Serial number 02-2142A-06110
Firmware version 00.01.50.01
SDK version 1.8.2
Driver version 1.3.0
ADCore version 3.10.0
Connected
Connection
Debugging

Plugins

Trigger

Mode On On
Source Freerun Freerun
Overlap Off Off
Exp. mode Timed Timed
Software

Buffers

Buffers used	6	
Buffers alloc/free	10	4
Memory max/used (MB)	0.0	45.2

Buffer & memory polling 1 second
Empty free list

Shutter

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

Collect

Exposure time 1.000 1.000
Exposure auto Off Off
Acquire period 10.000 10.000
Frame rate 30.011 0.100
Images 1 1
Images complete 6944
Image mode Continuous Continuous
Collecting
Acquire
Queued arrays 0
Wait for plugins No
Acquire busy Acquiring
Detector state Waiting
Status
Image counter 0 6944
Image rate 1.00
Array callbacks Enable Enable

Attributes

File
Macros
Status File not found

Camera-specific features

Status

Frames delivered 6944
Frames dropped 0
Frame underuns 0
Packets received 6624576
Packets missed 0
Packet errors 0
Packets requested 0
Packets resent 0
Poll features 1 second
Temperature 0.0

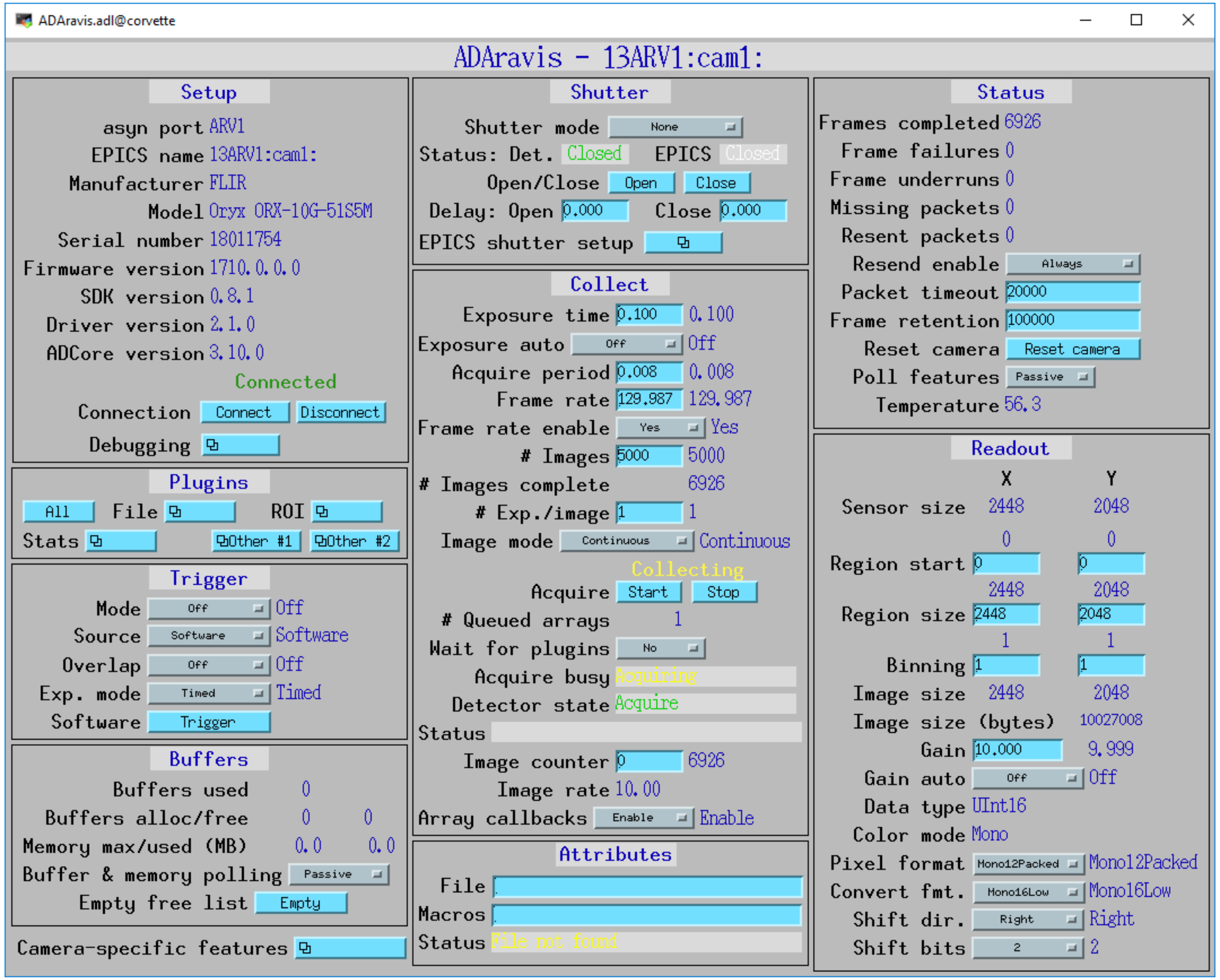
Readout

	X	Y
Sensor size	1360	1024
	0	0
Region start	0	0
	1360	1024
Region size	1360	1024
	1	1
Binning	1	1
Image size	1360	1024
Image size (bytes)		1392640
Gain	1.000	1.000
Gain auto	Off	Off

Data type UInt8
Color mode Mono
Pixel format Mono8 Mono8
Convert format None None
Timestamp mode Camera Camera
UniqueId mode Camera Camera

ADAravis

- New driver for any GenICam GigE, 10GigE, or USB camera
- Uses the open-source aravis SDK
- Inherits from ADGenICam
- Runs on Linux (most versions)
- Replaces aravisGigE



ADAravis - 13ARV1:cam1:

Setup

asyn port ARV1
EPICS name 13ARV1:cam1:
Manufacturer FLIR
Model Oryx ORX-10G-51S5M
Serial number 18011754
Firmware version 1710.0.0.0
SDK version 0.8.1
Driver version 2.1.0
ADCore version 3.10.0
Connected
Connection
Debugging

Plugins

Trigger

Mode Off Off
Source Software Software
Overlap Off Off
Exp. mode Timed Timed
Software

Buffers

Buffers used 0
Buffers alloc/free 0 0
Memory max/used (MB) 0.0 0.0
Buffer & memory polling Passive
Empty free list

Camera-specific features

Shutter

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

Collect

Exposure time 0.100 0.100
Exposure auto Off Off
Acquire period 0.008 0.008
Frame rate 129.987 129.987
Frame rate enable Yes Yes
Images 5000 5000
Images complete 6926
Exp./image 1 1
Image mode Continuous Continuous
Collecting
Acquire
Queued arrays 1
Wait for plugins No
Acquire busy Acquiring
Detector state Acquire
Status
Image counter 0 6926
Image rate 10.00
Array callbacks Enable Enable

Attributes

File
Macros
Status File not found

Status

Frames completed 6926
Frame failures 0
Frame underruns 0
Missing packets 0
Resent packets 0
Resend enable Always
Packet timeout 20000
Frame retention 100000
Reset camera
Poll features Passive
Temperature 56.3

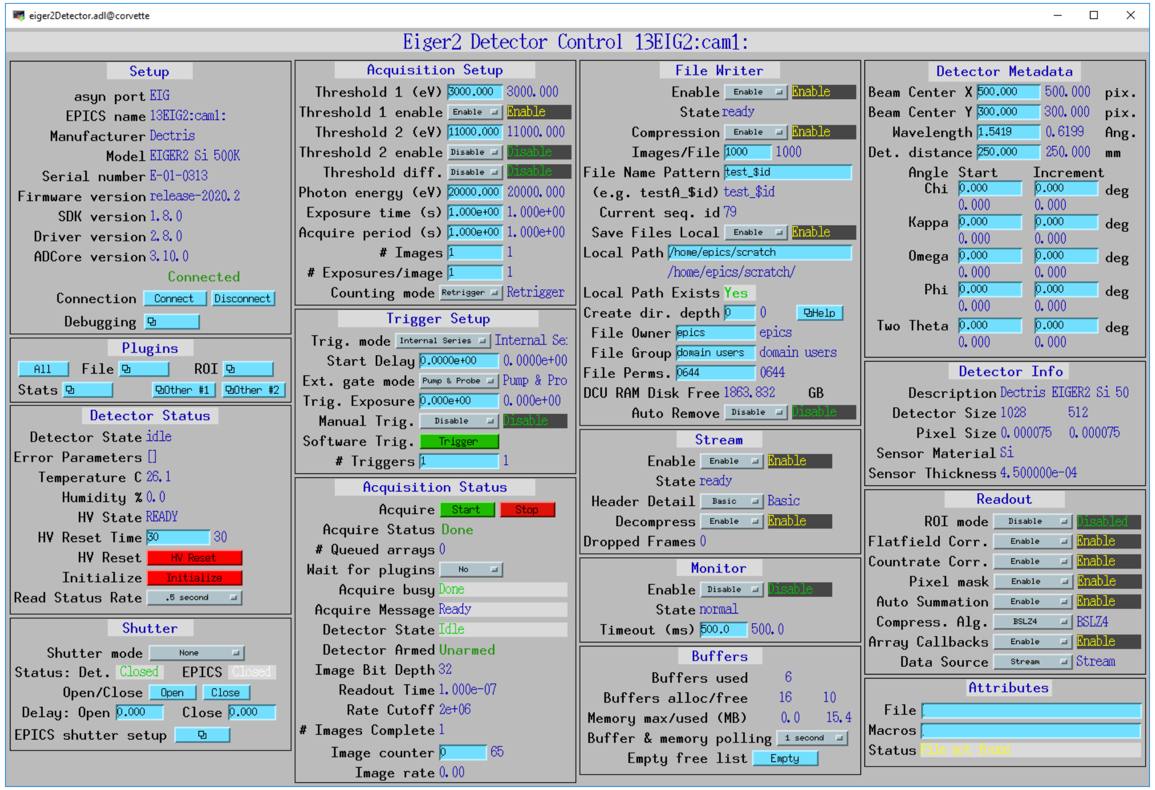
Readout

	X	Y
Sensor size	2448	2048
	0	0
Region start	0	0
	2448	2048
Region size	2448	2048
	1	1
Binning	1	1
Image size	2448	2048
Image size (bytes)		10027008
Gain	10.000	9.999

Gain auto Off Off
Data type UInt16
Color mode Mono
Pixel format Mono12Packed Mono12Packed
Convert fmt. Mono16Low Mono16Low
Shift dir. Right Right
Shift bits 2 2

ADEiger

- Added support for Eiger2 detectors.
  - These use a different version of the Simplon API (1.8.0) from most Eiger1 detectors which use 1.6.0.
  - The Eiger2 detectors also have new features such as 2 energy thresholds rather than just 1.
  - Driver automatically detects which version of the API is in use (1.8.0 or 1.6.0) and what Eiger model is being used (Eiger1 or Eiger2).
- Added support for decompressing bitshuffle/lz4 compressed files on the Stream interface.
- Added StreamDecompress record. This controls whether the driver decompresses the arrays from the Stream interface.
  - If StreamDecompress=No then the NDArrays received by plugins are compressed, with the .codec and .compressedSize fields set appropriately.
  - Useful for passing compressed arrays directly to NDPluginPva (and then to ImageJ) and to NDFileHDF5 since that supports DirectChunkWrite.



eiger2Detector.adl@corvette

Eiger2 Detector Control 13EIG2:cam1:

Setup

asyn port EIG
EPICS name 13EIG2:cam1:
Manufacturer Dectris
Model EIGER2 Si 500K
Serial number E-01-0313
Firmware version release-2020.2
SDK version 1.8.0
Driver version 2.8.0
ADCore version 3.10.0
Connected
Connection Connect Disconnect
Debugging

Plugins

All File ROI
Stats Other #1 Other #2

Detector Status

Detector State idle
Error Parameters []
Temperature C 26.1
Humidity % 0.0
HV State READY
HV Reset Time 30 30
HV Reset HV Reset
Initialize Initialize
Read Status Rate .5 second

Shutter

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

Acquisition Setup

Threshold 1 (eV) 3000.000 3000.000
Threshold 1 enable Enable Enable
Threshold 2 (eV) 11000.000 11000.000
Threshold 2 enable Disable Disable
Threshold diff. Disable Disable
Photon energy (eV) 20000.000 20000.000
Exposure time (s) 1.000e+00 1.000e+00
Acquire period (s) 1.000e+00 1.000e+00
Images 1 1
Exposures/image 1 1
Counting mode Retrigger Retrigger

Trigger Setup

Trig. mode Internal Series Internal Se:
Start Delay 0.0000e+00 0.0000e+00
Ext. gate mode Pump & Probe Pump & Pro
Trig. Exposure 0.000e+00 0.000e+00
Manual Trig. Disable Disable
Software Trig. Trigger
Triggers 1 1

Acquisition Status

Acquire Start Stop
Acquire Status Done
Queued arrays 0
Wait for plugins No
Acquire busy Done
Acquire Message Ready
Detector State Idle
Detector Armed Unarmed
Image Bit Depth 32
Readout Time 1.000e-07
Rate Cutoff 2e+06
Images Complete 1
Image counter 0 65
Image rate 0.00

File Writer

Enable Enable Enable
State ready
Compression Enable Enable
Images/File 1000 1000
File Name Pattern test_$id
(e.g. testA_$id) test_$id
Current seq. id 79
Save Files Local Enable Enable
Local Path /home/epics/scratch
/home/epics/scratch/
Local Path Exists Yes
Create dir. depth 0 0 Help
File Owner epics epics
File Group domain users domain users
File Perms. 0644 0644
DCU RAM Disk Free 1863.832 GB
Auto Remove Disable Disable

Stream

Enable Enable Enable
State ready
Header Detail Basic Basic
Decompress Enable Enable
Dropped Frames 0

Monitor

Enable Disable Disable
State normal
Timeout (ms) 500.0 500.0

Buffers

Buffers used 6
Buffers alloc/free 16 10
Memory max/used (MB) 0.0 15.4
Buffer & memory polling 1 second
Empty free list Empty

Detector Metadata

Beam Center X 500.000 500.000 pix.
Beam Center Y 300.000 300.000 pix.
Wavelength 1.5419 0.6199 Ang.
Det. distance 250.000 250.000 mm

Angle	Start	Increment	
Chi	0.000 0.000	0.000 0.000	deg
Kappa	0.000 0.000	0.000 0.000	deg
Omega	0.000 0.000	0.000 0.000	deg
Phi	0.000 0.000	0.000 0.000	deg
Two Theta	0.000 0.000	0.000 0.000	deg

Detector Info

Description Dectris EIGER2 Si 50
Detector Size 1028 512
Pixel Size 0.000075 0.000075
Sensor Material Si
Sensor Thickness 4.500000e-04

Readout

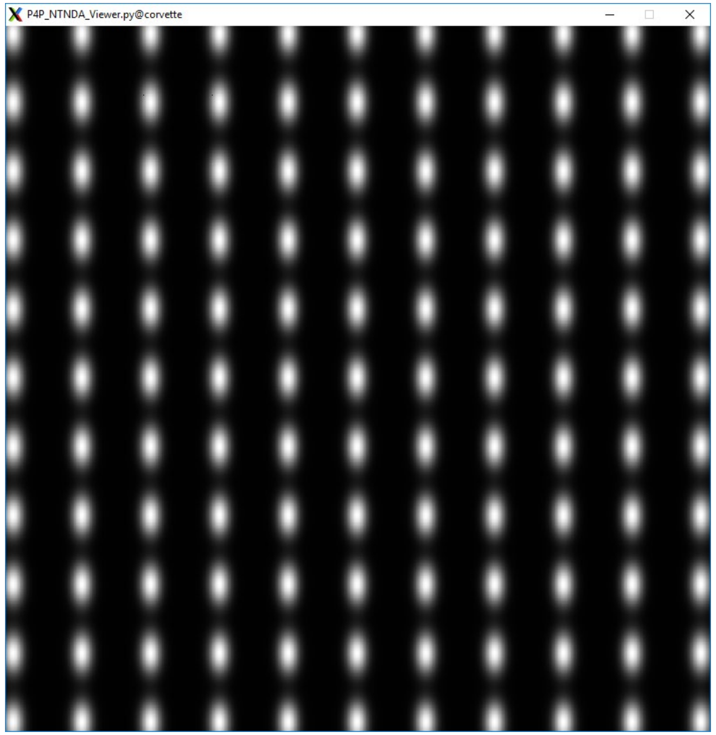
ROI mode Disable Disabled
Flatfield Corr. Enable Enable
Countrate Corr. Enable Enable
Pixel mask Enable Enable
Auto Summation Enable Enable
Compress. Alg. BSLZ4 BSLZ4
Array Callbacks Enable Enable
Data Source Stream Stream

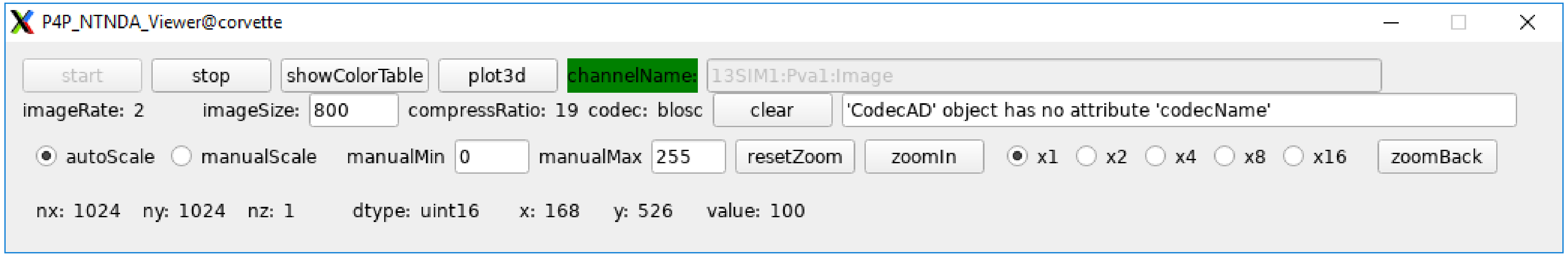
Attributes

File
Macros
Status File not found

PY_NTNDA_Viewer Python Viewer (By Marty Kraimer)

- Python pvAccess viewer similar to the ImageJ (Java) pvAccess viewer
- Features
  - Zoom
  - Scale intensity
  - False color capability
  - Handles compressed NTNDArrays
- Available in ADViewers
- 2 versions:
  - P4P_NTNDA_Viewer.py. This uses p4p.
  - PVAPY_NTNDA_Viewer.p. This uses pvaPy.
  - Both are supported on Windows, Mac OSX, and Linux.
- https://areadetector.github.io/master/ADViewers/PY_NTNDA_Viewer.html





channelName: 13SIM1:Pva1:Image

imageRate: 2 imageSize: 800 compressRatio: 19 codec: blosc 'CodecAD' object has no attribute 'codecName'

● autoScale ○ manualScale manualMin 0 manualMax 255 ● x1 ○ x2 ○ x4 ○ x8 ○ x16

nx: 1024 ny: 1024 nz: 1 dtype: uint16 x: 168 y: 526 value: 100