mctOptics Documentation

Release 0.1

Argonne National Laboratory

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CHAPTER

ONE

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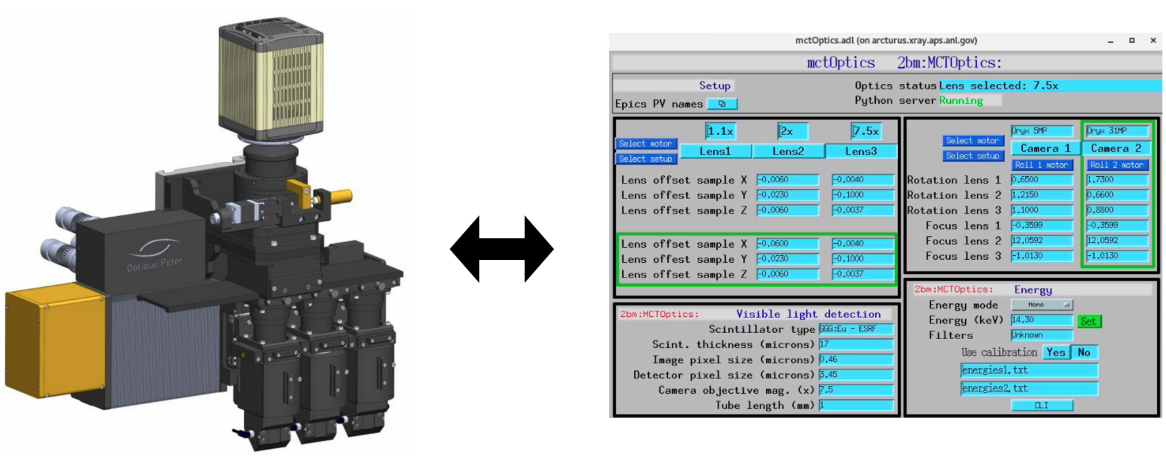
1.1 About

mctOptics is an EPICS IOC supporting the Optique Peter systen installed at beamline 2-BM of the Advanced Photon Source.

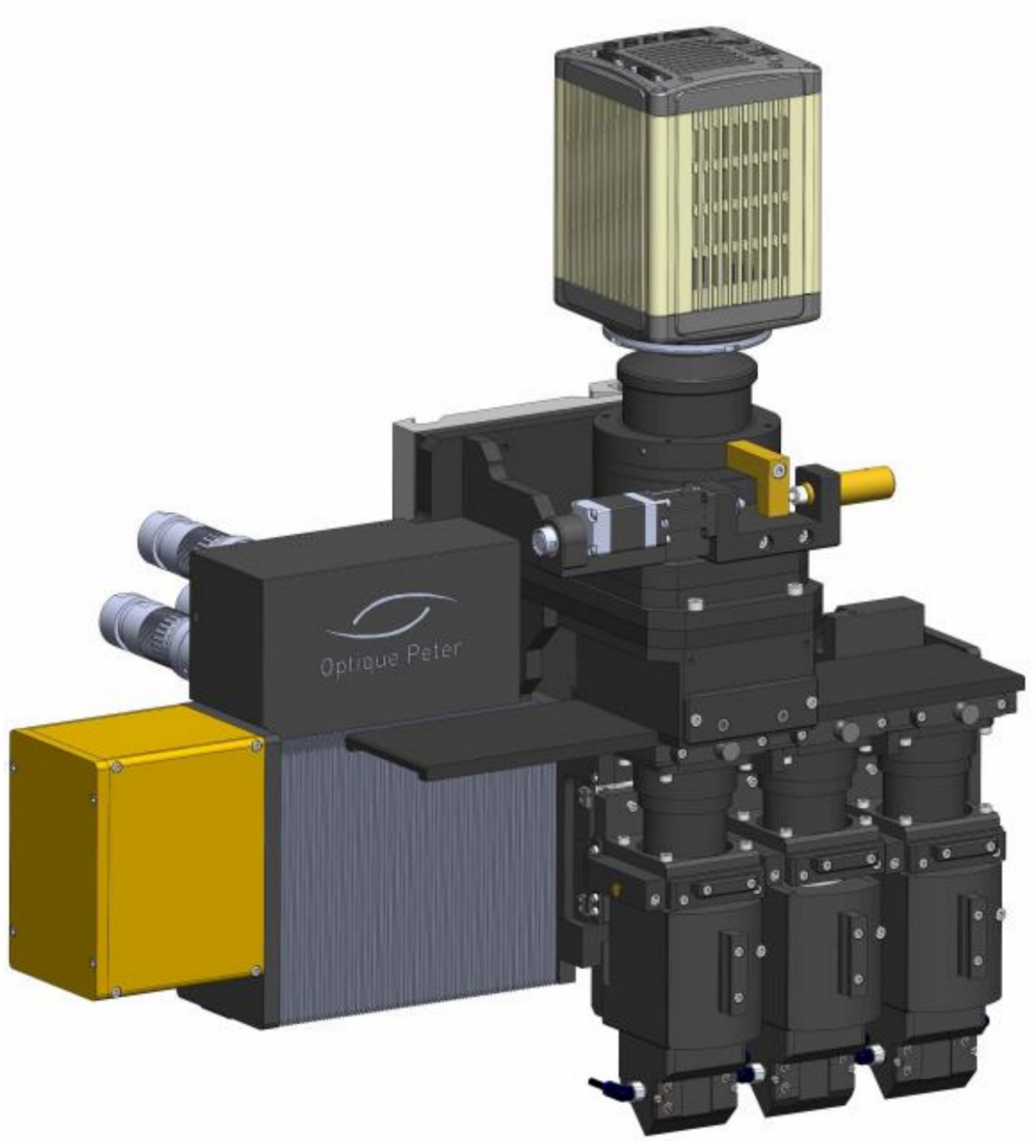


1.2 Instrument

1.2.1 Optique Peter

Triple Objective

At beamline 2-BM we use a Triple Objective Microscope produced by Optique Peter



Detailed information of the instruements are:

1. Test Report
2. User manual
3. Manuals
4. Specs
5. Reference documentation

Lens	Lens Mag	motor position (specs)	ref on lens 1 (specs)	ref on lens 1 (aligned)
0	10 x	121.5942	59.6099	59.0151
1	5 x	61.9841	0.0000	-0.3690
2	1.1 x	2.3006	-59.6835	-59.6865

With FLIR Oryx ORX-10G-51S5M-C

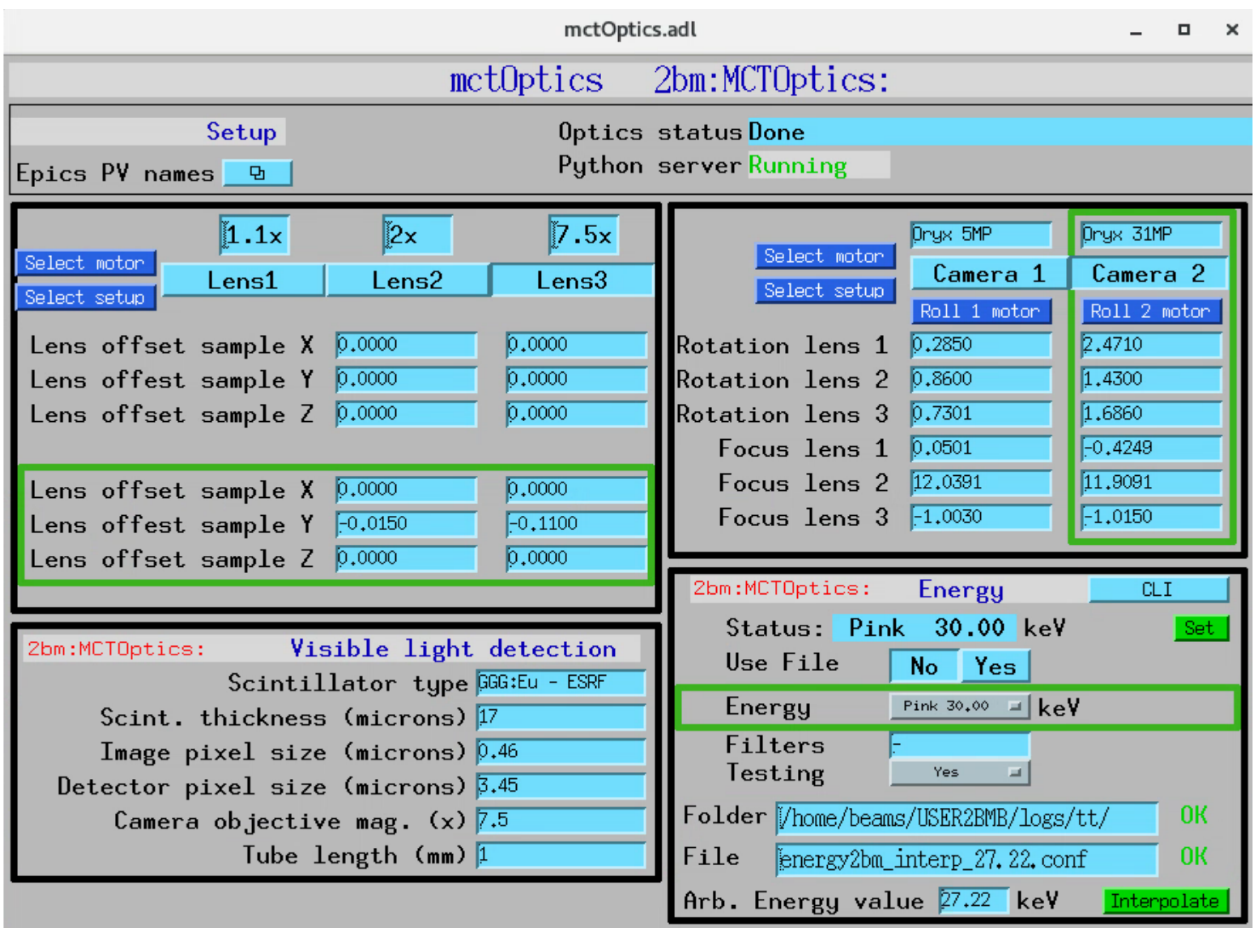
Lens	Lens Mag	Pixel size (m) (specs)	Pixel size (m) (meas.)	Pixels (H)	Pixels (V)	Detector pixel size (m)	H filed of view (mm)	V filed of view (mm)
0	10 x	0.35	0.350787	2448	2048	3.45	0.84	0.71
1	5 x	0.69	0.699447	2448	2048	3.45	1.69	1.41
2	1.1 x	3.14	3.125830	2448	2048	3.45	7.68	6.42

Scintillators:

Lens	Lens Mag	Scintillator material	Scintillator thickness (m)
0	10 x	LuAG	25
1	5 x	LuAG	50
2	1.1 x	LuAG	100

1.3 Usage

Objective and camera change can be accomplished by simply selecting the desired magnification and the camera in the user interface selector of the main **mctOptics** control screen:



When changing lens/camera, **mctOptics** is also correcting for minor miss-alignment of the instrument visible light optics so that sample point of interest stays in the center of the image at each lens change. **mctOptics** also keeps the rotation axis aligned with the detector columns and each lens/camera change by rotating the camera.

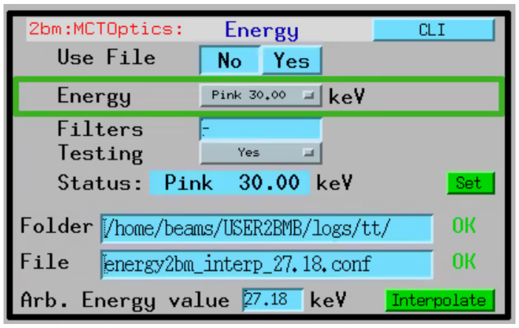
This capability allows for step-zoom-in during a tomographic measurement and shown in this video

The required lens offset sample x, y, z and the lens offset camera rotation are very reproducible and can be determined once when the instrument is first installed.

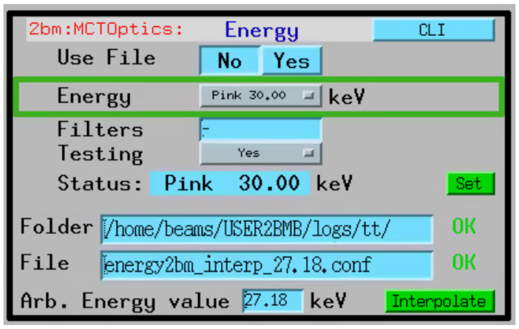
1.3.1 Energy change

The beamline x-ray energy change is managed by the energy cli python library.

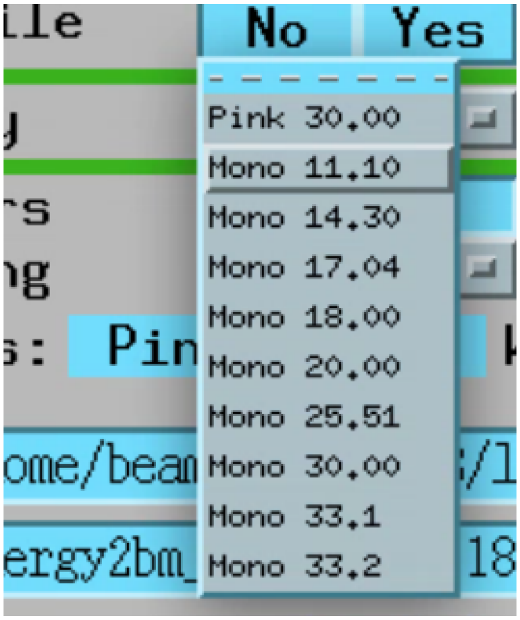
For user operation the **energy cli** is called from the mctOptics user interface:



The DMM energy change operates in two modes. The first uses pre-stored energy calibration files. To select this mode set to "No" the "Use File" button:

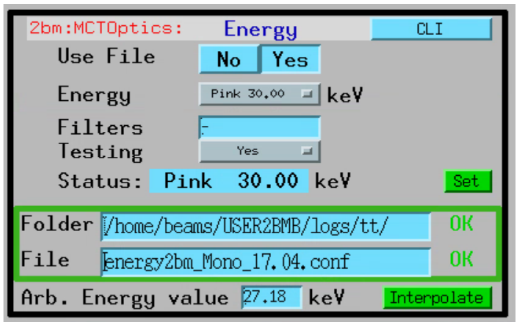


Then you can select any available energy from the drop down list:



Once the desired energy is selected press the “Set” button to move the DMM.

The second mode allows the use of arbitrary configuration files. You can enable this mode by selecting “Yes” in the “Use File” button:



In this example we are setting the DMM to 17.04 keV using the **energy2bm_Mono_17.04.conf** configuration file. Press the “Set” button to move the DMM to this energy.

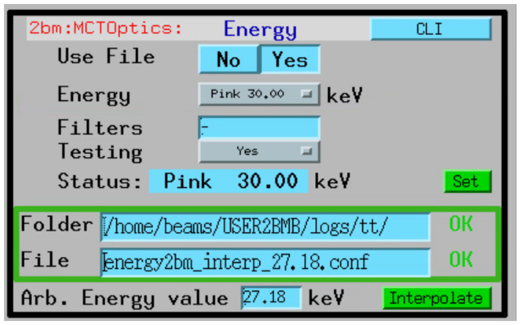
You can create new configuration files with the energy cli by moving the DMM to a known energy, i.e. using calibration foils, and storing that DMM positions in a new config file with:

```
[user2bmb@arcturus,42,~]$ energy save --mode Mono --energy-value 27.00
```

in this case a new config file called **energy2bm_Mono_27.0_2022-11-03_23_26_17.conf** is automatically generated and it can be used by updating the “Folder” and “File” entries in the user iterface.

Finally, if you want to set the DMM to an arbitrary energy that is not a calibration point, let’s say 27.18, you can use the “interpolate” function. To do so, enter an abritrary energy within the energy calibrated range, in our case between 11.10 and 33.20 keV, in the user inteface.

The intepolation function will create a config file for 27.18 keV by intepolating linearly all DMM positions between the 2 closest calibrated energies. For 27.18 keV, the intepolation will occur using 25.51 and 30.00 keV. Once the new energy2bm_interp_27.18.conf is generated, its name will be automacally copied in the “File” entry of the user interface. To move the DMM to this energy press the “Set” button.



More information on how to operate the mctOptics user inteface is here.

1.4 Demo

mctOptics allows for step-zoom-in during a tomographic measurement and shown in this video.

1.5 Install directions

1.5.1 Build EPICS base

> **Warning:** Make sure the disk partition hosting ~/epics is not larger than 2 TB. See tech talk and Diamond Data Storage document.

```
$ mkdir ~/epics
$ cd epics
```

- Download EPICS base latest release, i.e. 7.0.3.1., from https://github.com/epics-base/epics-base:

  ```
  $ git clone https://github.com/epics-base/epics-base.git
  $ cd epics-base
  $ make -sj
  ```

1.5.2 Build a minimal synApps

To build a minimal synApp:

```
$ cd ~/epics
```

- Download in ~/epics assemble_synApps.sh
- **Edit the assemble_synApps.sh script as follows:**
  1. Set FULL_CLONE=True
  2. Set EPICS_BASE to point to the location of EPICS base. This could be on APSshare (the default), or a local version you built.

  For mctoptics you need

1. ASYN=R4-37
2. AUTOSAVE=R5-10
3. BUSY=R1-7-2
4. XXX=R6-1

You can comment out all of the other modules (ALLENBRADLEY, ALIVE, etc.)

- Run:

```
$ assemble_synApps.sh
```

- This will create a synApps/support directory:

```
$ cd synApps/support/
```

- Edit asyn-RX-YY/configure/RELEASE to comment out the lines starting with:

```
IPAC=$(SUPPORT)/
SNCSEQ=$(SUPPORT)/
```

Warning: If building for RedHat8 uncomment **TIRPC=YES** in asyn-RX-YY/configure/CONFIG_SITE

- Clone the mctoptics module into synApps/support:

```
$ git clone https://github.com/tomography/mctoptics.git
```

- Edit configure/RELEASE add this line to the end:

```
MCTOPTICS=$(SUPPORT)/mctoptics
```

- Edit Makefile add this line to the end of the MODULE_LIST:

```
MODULE_LIST += MCTOPTICS
```

- Run the following commands:

```
$ make release
$ make -sj
```

1.5.3 Testing the installation

- Edit /epics/synApps/support/mctoptics/configure to set EPICS_BASE to point to the location of EPICS base, i.e.:

```
EPICS_BASE=/APSshare/epics/base-3.15.6
```

- Start the epics ioc and associated medm screen with:

```
$ cd ~/epics/synApps/support/mctoptics/iocBoot/iocMCTOptics
$ start_IOC
$ start_medm
```

1.6 mctOpticsApp EPICS application

mctOptics includes a complete example EPICS application, including:

- A database file and corresponding autosave request file that contain the PVs required by the mctoptics.py base class.
- OPI screens for medm
- An example IOC application that can be used to run the above databases. The databases are loaded in the IOC with the example substitutions file, mctOptics.substitutions.

1.6.1 Base class files

The following tables list all of the records in the mctOptics.template file. These records are used by the mctoptics base class and so are required.

mctOptics.template

This is the database file that contains only the PVs required by the mctoptics.py base class mctOptics.template.

TomoScan and Camera PV Prefixes

Record name	Record type	Description
(P)(R)Camera0PVPrefix	stringin	Contains the prefix for the detector 0, e.g. 2bmbSP1:
(P)(R)Camera1PVPrefix	stringin	Contains the prefix for the detector 1, e.g. 2bmbSP2:
(P)(R)OverlayPlugin0PVPrefix	stringin	Contains the prefix for OverlayPlugin 0, e.g. 2bmbSP1:Over1:
(P)(R)OverlayPlugin0PVPrefix	stringin	Contains the prefix for OverlayPlugin 1, e.g. 2bmbSP2:Over1:
(P)(R)OverlayPlugin1PVPrefix	stringin	Contains the prefix for FilePlugin 0, e.g. 2bmbSP1:HDF1:
(P)(R)FilePlugin0PVPrefix	stringin	Contains the prefix for FilePlugin 1, e.g. 2bmbSP2:HDF1:

Lens Sample X-Y-Z PV Names

Record name	Record type	Description
(P)(R)LensSampleXPVName	stringin	Contains the prefix for LensSampleX , e.g. 2bmS1:m2
(P)(R)LensSampleYPVName	stringin	Contains the prefix for LensSampleY, e.g. 2bmb:25
(P)(R)LensSampleZPVName	stringin	Contains the name for LensSampleZ, e.g. 2bmS1:m1

Lens Focus PV Names

Record name	Record type	Description
(P)(R)Lens0FocusPVName	stringin	Contains the prefix for Lens0Focus, e.g. 2bmb:m2
(P)(R)Lens1FocusPVName	stringin	Contains the prefix for Lens1FocusPVName, e.g. 2bmb:m3
(P)(R)Lens2FocusPVName	stringin	Contains the prefix for Lens2FocusPVName, e.g. 2bmb:m4

Camera rotation PV Names

Record name	Record type	Description
(P)(R)Camera0RotationPVName	stringin	Contains the motor PV name for Camera0Rotation , e.g. 2bmb:m7
(P)(R)Camera1RotationPVName	stringin	Contains the motor PV name for Camera1Rotation , e.g. 2bmb:m8

Optique Peter camera selector

Record name	Record type	Description
(P)(R)CameraSelect	mbbo	Camera selector for Pos0 and Pos1 position
(P)(R)CameraSelected	mbbi	Camera selector status for Camera0 and Camera1 position
(P)(R)CameraPos0	ao	Motor position for the Camera0
(P)(R)CameraPos1	ao	Motor position for the Camera1
(P)(R)CameraName0	ao	Camera label for Pos0, e.g. Adimec
(P)(R)CameraName1	ao	Camera label for Pos1, e.g. Flir
(P)(R)CameraMotorPVName	stringin	Contains the camera motor PV name, e.g. 2bmb:m5

Optique Peter camera rotation

Record name	Record type	Description
(P)(R)Camera0Lens0Rotation	ao	PV storing Camera 0 Lens 0 rotation value
(P)$(R)Camera0Lens1Rotation	ao	PV storing Camera 0 Lens 1 rotation value
(P)(R)Camera0Lens2Rotation	ao	PV storing Camera 0 Lens 1 rotation value
(P)(R)Camera1Lens0Rotation	ao	PV storing Camera 1 Lens 0 rotation value
(P)(R)Camera1Lens1Rotation	ao	PV storing Camera 1 Lens 1 rotation value
(P)(R)Camera1Lens2Rotation	ao	PV storing Camera 1 Lens 2 rotation value

Optique Peter lens focus

Record name	Record type	Description
(P)(R)Camera0Lens0Focus	ao	PV storing Camera 0 Lens 0 focus value
(P)(R)Camera0Lens1Focus	ao	PV storing Camera 0 Lens 1 focus value
(P)(R)Camera0Lens2Focus	ao	PV storing Camera 0 Lens 2 focus value
(P)(R)Camera1Lens0Focus	ao	PV storing Camera 1 Lens 0 focus value
(P)(R)Camera1Lens1Focus	ao	PV storing Camera 1 Lens 1 focus value
(P)(R)Camera1Lens2Focus	ao	PV storing Camera 1 Lens 2 focus value

Optique Peter lens selector

Record name	Record type	Description
(P)(R)LensSelect	mbbo	Lens selector for Pos0 and Pos1 position
(P)(R)Camera0LensPos0	ao	Motor position for the first lens
(P)(R)Camera0LensPos1	ao	Motor position for the second lens
(P)(R)Camera0LensPos2	ao	Motor position for the third lens
(P)(R)LensName0	ao	Label for Pos0, e.g. Lens0
(P)(R)LensName1	ao	Label for Pos1, e.g. Lens1
(P)(R)LensName2	ao	Label for Pos2, e.g. lens2
(P)(R)LensMotorPVName	stringout	Contains the lens motor PV name, e.g. 2bmb:m1

Detector image cross

Record name	Record type	Description
(P)(R)CrossSelect	mbbo	

Optique Peter lens 1 offsets

Record name	Record type	Description
(P)(R)Camera0Lens1XOffset	ao	
(P)(R)Camera0Lens1YOffset	ao	
(P)(R)Camera0Lens1ZOffset	ao	
(P)(R)Camera1Lens1XOffset	ao	
(P)(R)Camera1Lens1YOffset	ao	
(P)(R)Camera1Lens1ZOffset	ao	

Optique Peter lens 2 offsets

Record name	Record type	Description
(P)(R)Camera0Lens2XOffset	ao	
(P)(R)Camera0Lens2YOffset	ao	
(P)(R)Camera0Lens2ZOffset	ao	
(P)(R)Camera1Lens2XOffset	ao	
(P)(R)Camera1Lens2YOffset	ao	
(P)(R)Camera1Lens2ZOffset	ao	

MCT status via Channel Access

Record name	Record type	Description
(P)(R)MCTStatus	waveform	
(P)(R)Watchdog	calcout	
(P)(R)ServerRunning	bi	

Sync to motor

Record name	Record type	Description
(P)(R)Sync	busy	

Optics information

Record name	Record type	Description
(P)(R)ScintillatorType	stringout	Contains the type of scintillator being used.
(P)(R)ScintillatorThickness	ao	Contains the thickness of the scintillator in microns.
(P)(R)ImagePixelSize	ao	Contains the pixel size on the sample in microns (i.e. includes objective magnification)
(P)(R)DetectorPixelSize	ao	Contains the pixel size of the detector.
(P)(R)CameraObjective	stringout	Description of the camera objective
(P)(R)CameraTubeLength	stringout	Description of the camera objective

Lens name

Record name	Record type	Description
(P)(R)Lens0Name	stringout	Name for Lens0, e.g. 1.1x
(P)(R)Lens1Name	stringout	Name for Lens1, e.g. 5x
(P)(R)Lens2Name	stringout	Name for Lens2, e.g. 10x

Camera names

Record name	Record type	Description
(P)(R)Camera0Name	stringout	
(P)(R)Camera1Name	stringout	

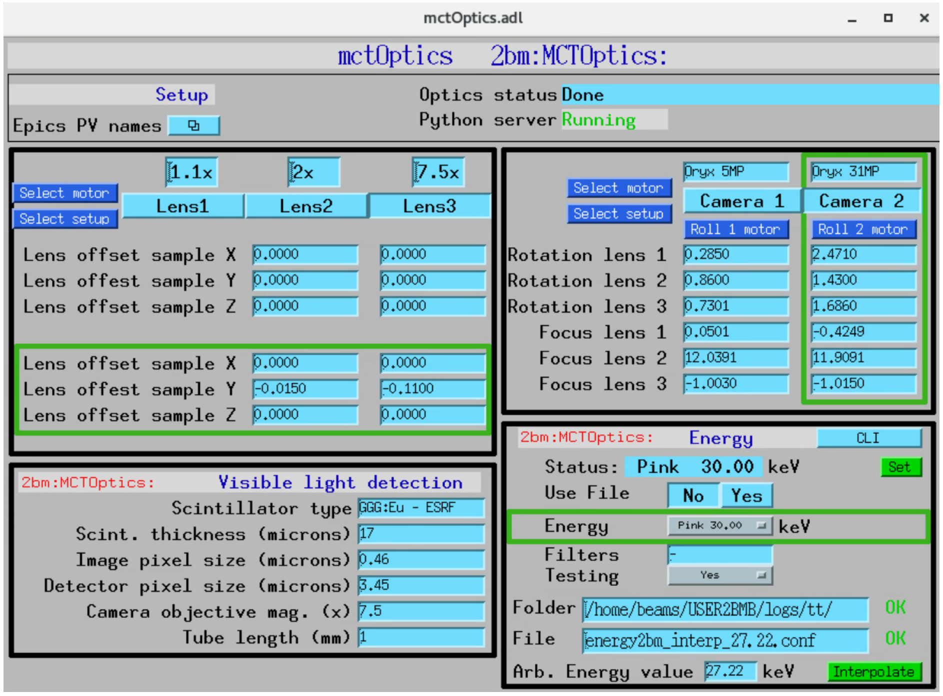
Detector cropping

Record name	Record type	Description
(P)(R)CutLeft	longout	
(P)(R)CutRight	longout	
(P)(R)CutTop	longout	
(P)(R)CutBottom	longout	
(P)(R)Cut	busy	
(P)(R)SuggestedAngles	ao	
(P)(R)SuggestedAngleStep	ao	

medm files

mctOptics.adl

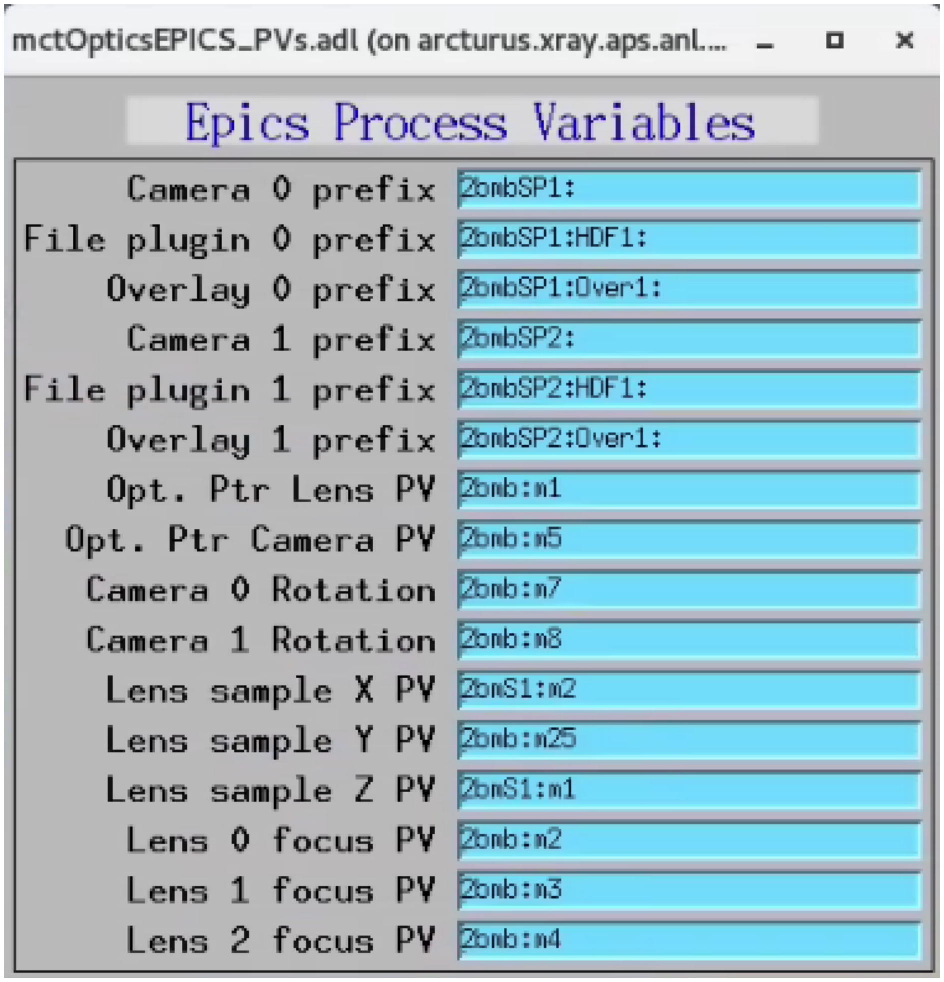
The following is the MEDM screen `mctOptics.adl` during a scan. The status information is updating.



mctOpticsEPICS_PVs.adl

The following is the MEDM screen `mctOpticsEPICS_PVs.adl`.

If these PVs are changed tomoscan must be restarted.


mctOpticsEPICS_PVs.adl (on arcturus.xray.aps.anl...
Epics Process Variables
Camera 0 prefix
2bmbSP1:
File plugin 0 prefix
2bmbSP1:HDF1:
Overlay 0 prefix
2bmbSP1:Over1:
Camera 1 prefix
2bmbSP2:
File plugin 1 prefix
2bmbSP2:HDF1:
Overlay 1 prefix
2bmbSP2:Over1:
Opt. Ptr Lens PV
2bmb:m1
Opt. Ptr Camera PV
2bmb:m5
Camera 0 Rotation
2bmb:m7
Camera 1 Rotation
2bmb:m8
Lens sample X PV
2bmS1:m2
Lens sample Y PV
2bmb:m25
Lens sample Z PV
2bmS1:m1
Lens 0 focus PV
2bmb:m2
Lens 1 focus PV
2bmb:m3
Lens 2 focus PV
2bmb:m4