

THE EPICS COLLABORATION MEETINGS  
2024 SEP16-20 SNS

# Digital Cameras For Beam Diagnostics @APS



Suyin Grass Wang  
APS

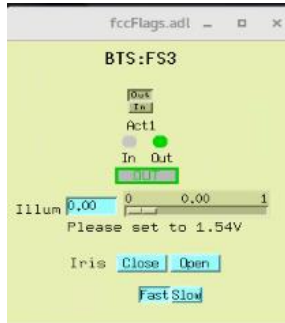
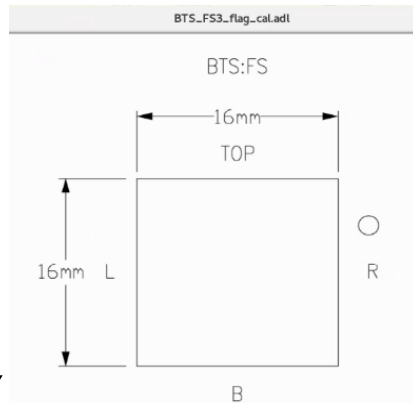
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# Simplify the Control System with Digital Cameras

- APS has been using framegrabber with analog cameras for the Beam Diagnostics
- Some flags come with a mask for beam size calibration, and a pinhole for the image orientation
- Some flags come with a motor to move the lens, with the lens moved, the real time calibration could be handy
- Upgrading happens to be a great chance to simplify the control system



Analog multiplexer

sdds

medm

ImageJ

adxv



APS Video AutoRoute

Frame grabbers

View Image

sequence program

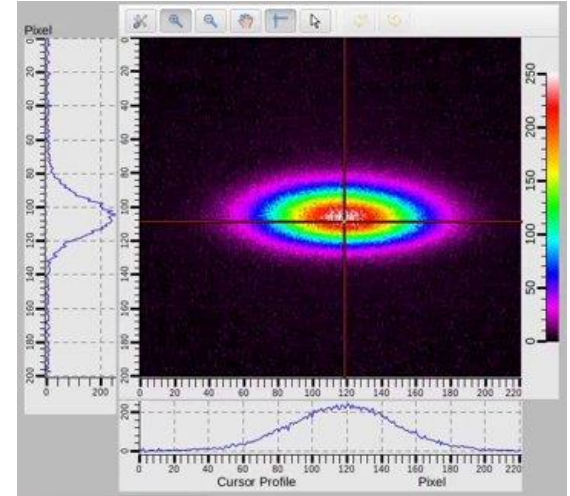
# Digital Camera IOC Setup

- All Camera IOCs share one ioc folder and Display screens
- The USB cameras connecting to a workstation, and the ioc runs on the workstation (ioc2xxx)
- The GigE cameras connecting to a PoE network switch and runs on a VM (sioc2xxx)
- FLIR cameras
  - USB
    - GS3\_U3\_23S6M
  - PoE GigE
    - BFS-PGE-13Y3M-C
    - BFS-PGE-13Y3C
    - BFS-PGE-88S6M
    - BFS-PGE-19S4M
    - BFS-PGE-70S7M-C
- MODULE
  - AREA-DETECTOR
    - \$(AREA-DETECTOR)/ADCore
    - \$(AREA-DETECTOR)/ADSupport
  - ADGENICAM
  - ADARAVIS
  - NDDRIVERSTDARRAYS
  - BASE
  - SEQ
  - BUSY
  - SSCAN
  - CALC
  - AUTOSAVE

```
/C2/iocs/camera
├── B1
│   ├── bin
│   │   └── linux-x86_64
│   ├── configure
│   │   ├── 0.Common
│   │   └── 0.linux-x86_64
│   ├── db
│   ├── dbd
│   ├── FlirApp
│   │   ├── db
│   │   ├── op
│   │   └── src
│   ├── iocBoot
│   │   ├── ioc2bslmcam1
│   │   ├── ioc2bslmcam2
│   │   ├── ioc2pslmcam1
│   │   ├── ioc2pslmcam2
│   │   ├── ioc2s38cam1
│   │   ├── ioc2s38cam2
│   │   ├── ioc2s38cam3
│   │   ├── ioc2s38cam4
│   │   ├── sioc2bslmcam3
│   │   ├── sioc2bslmcam4
│   │   ├── sioc2btsfs3cam1
│   │   ├── sioc2btsfs4cam1
│   │   ├── sioc2btsfs5cam1
│   │   ├── sioc2camtest
│   │   ├── sioc2ctlcam01
│   │   ├── sioc2leafs4cam1
│   │   └── sioc2s35cam1
│   ├── lib
│   │   └── linux-x86_64
│   ├── opi
│   │   ├── adl
│   │   └── bob
└── logs
```

# Extra Feature with CSS-Phoebus

- Local PV in CSS-Phoebus for color-range of image, so each user can use the color range of their choice while looking at the same image
- Using rules to adopt the camera with different image size



Special Thanks to  
Kaz Gofron for the great help of Script and Rules

# Diagnostics Camera With Calibration Mask

- Using ROI1 to match the mask size
- Utilized the CSS Phoebus feature for Real time ROI modification by hand-dragging the ROI box position and size to align the mask
- Add new database for
  - Mask size and unit
  - Calibrated value for
    - Image size
    - X-axis PV
    - Centroid, Sigma, and Cursor from NDPluginStats
    - Users can choose profile unit between pixel or calibrated unit

**Calibration**

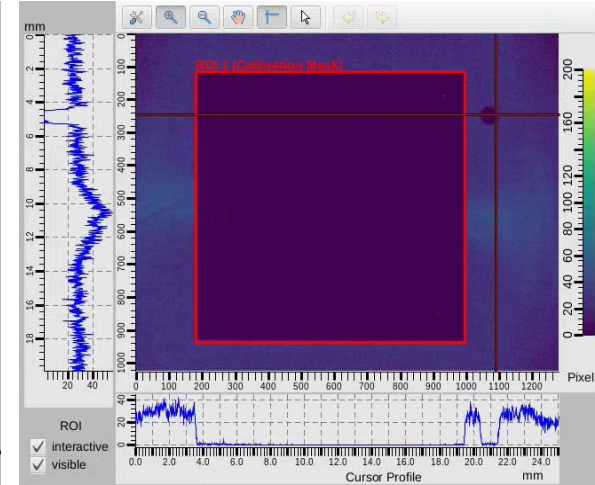
Original Pixel  
Calibrated Egu

**Step 1: Set the Mask Size**  
Mask X size / unit  
16.000 mm  
Mask Y size / unit  
16.000 mm

**Step 2: Set ROI matches the Mask**  
ROI X      ROI Width  
180      817  
ROI Y      ROI Height  
116      823

**Calibration Result:**

X Scaling	Mask X size
Factor =	16.000 mm
	817 pixel
	ROI Width
Y Scaling	Mask Y size
Factor =	16.000 mm
	823 pixel
	ROI Height



Sigma Y	295.8Pixels =	5.453	mm
Centroid Y	512.1Pixels =	9.439	mm
Cursor Y	84Pixels =	1.548	mm

The screenshot shows the TestCam software interface. At the top, it is connected to a digital camera. The main window displays a grayscale image of a mask with a red ROI1 box labeled "ROI1 Calibration Mask" and the text "CTLCAM1" overlaid. The interface includes various control panels for triggering, collection, background and scale, and calibration. The calibration section shows the mask size (20.000 mm) and ROI dimensions (176 x 848 pixels).

**Connection**  
Connected  
Reset Camera

**Trigger**  
Mod Off  
Source Software

**Collection**  
Acquire busy Acquiring  
Detector state Acquire  
Status  
Image rate 100.00  
Exposure time 0.010  
Frame rate 99.514  
Acquire Start Collecting

**Background and Scale**  
Background On/Off Disable  
Scale On/Off Disable  
Scale value 1.00  
Offset value 0.00

**Medm Screens**

**Port to Pva1**  
Color Map VIRIDIS  
Color Range 200.000

**Calibration**  
Original Pixel  
Calibrated Egu

**Step 1: Set the Mask Size**  
Mask X size / unit 20.000 mm  
Mask Y size / unit 19.000 mm

**Step 2: Set ROI matches the Mask**  
ROI X ROI Width 476 857  
ROI Y ROI Height 176 848

**Calibration Result:**  
X Scaling Mask X size 20.000 mm  
Factor = 857 pixel  
ROI Width  
Y Scaling Mask Y size 19.000 mm  
Factor = 848 pixel  
ROI Width

**ROI**  
 interactive  
 visible

**Proc1** **ROI1**

**TestCam:Stats5:ProfileThresholdY\_RB**  
Sigma Y 299.9Pixels = 6.720 mm  
Centroid Y 571.7Pixels = 12.809 mm  
Cursor Y 784 Pixels = 17.566 mm  
Skewness Y 0.053  
Kurtosis Y -0.981  
SigmaXY -0.053

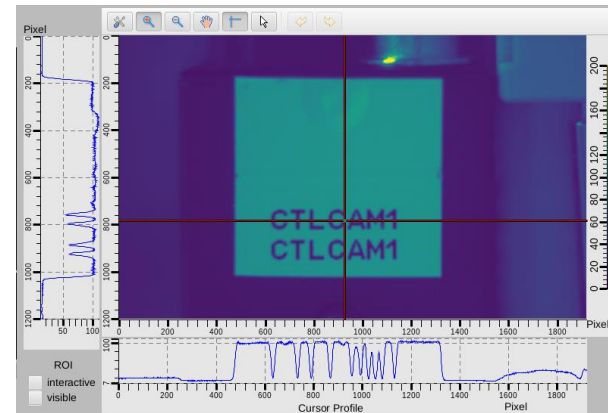
**TestCam:Stats5:ProfileThresholdX\_RB**  
Sigma X 449.0Pixels = 10.479 mm  
Centroid X 987.4Pixels = 12.809 mm  
Cursor X 925 Pixels = 21.587 mm  
Skewness X 0.131  
Kurtosis X -0.497  
Eccentricity 0.144

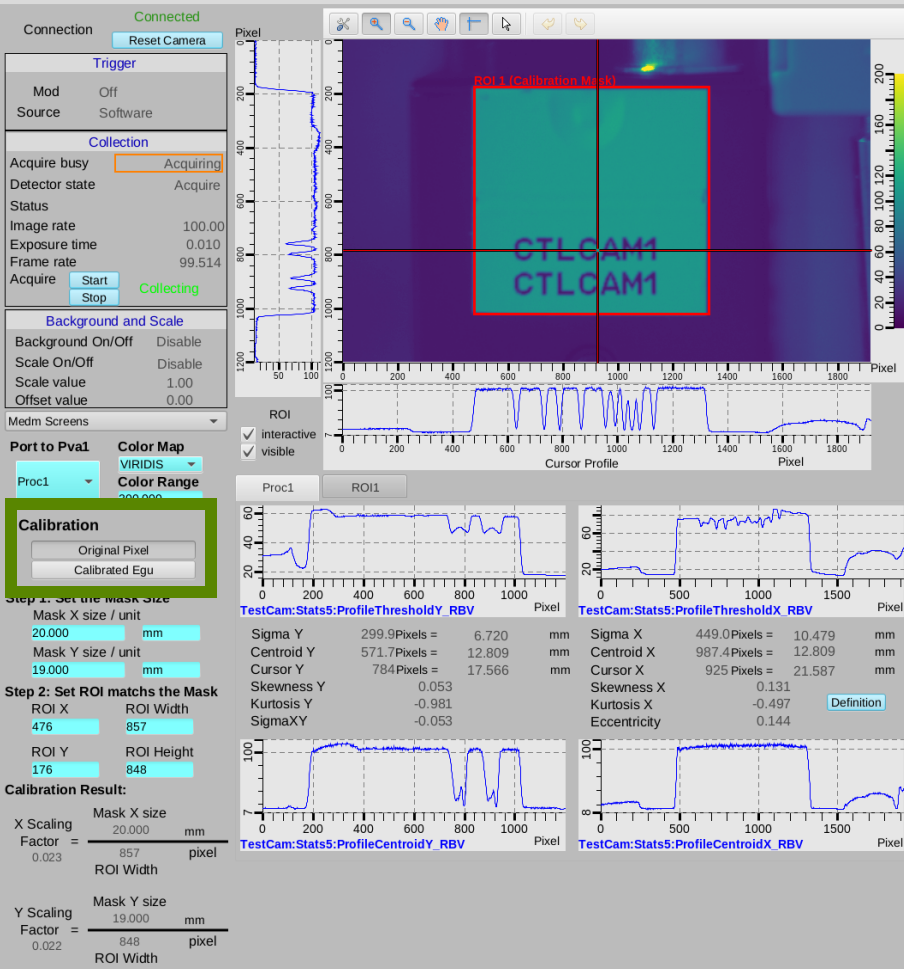
**TestCam:Stats5:ProfileCentroidY\_RB**

**TestCam:Stats5:ProfileCentroidX\_RB**

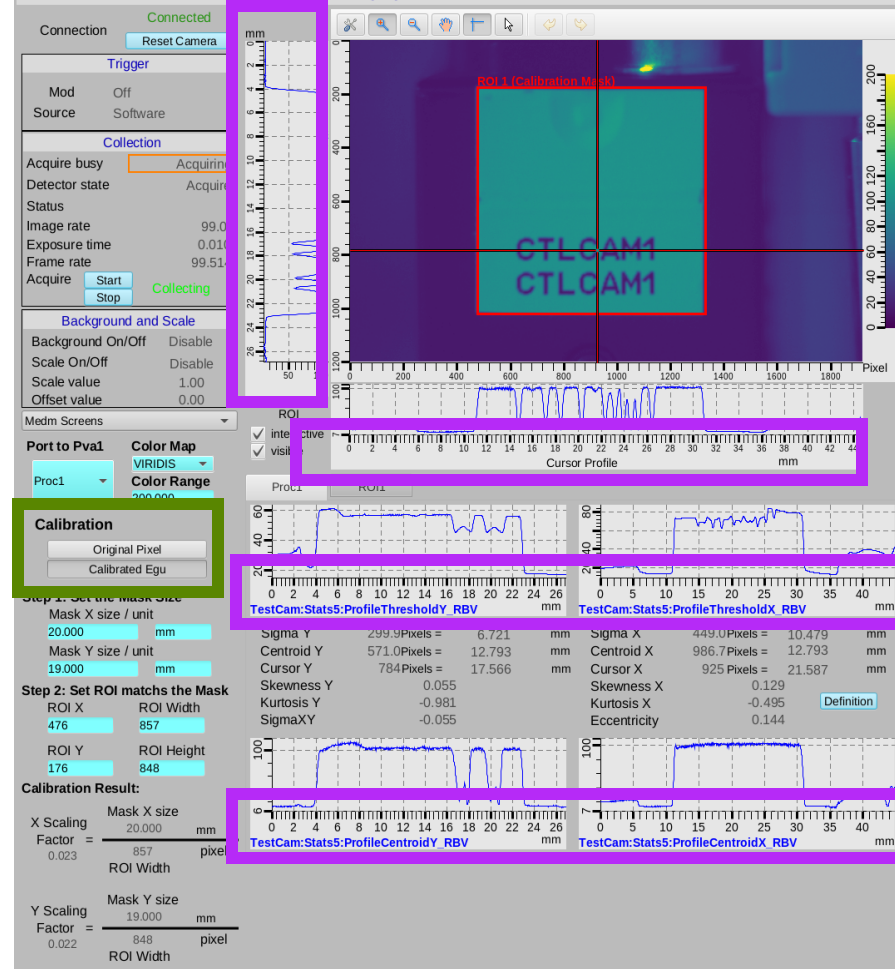
# Calibration Feature

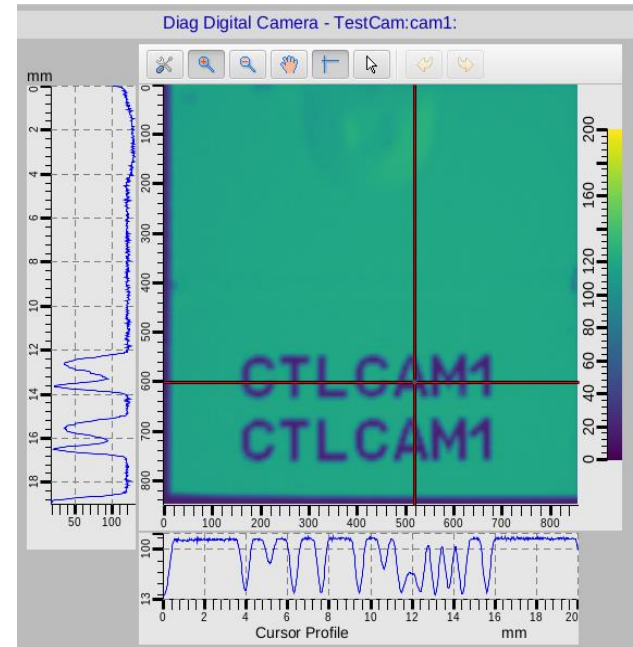
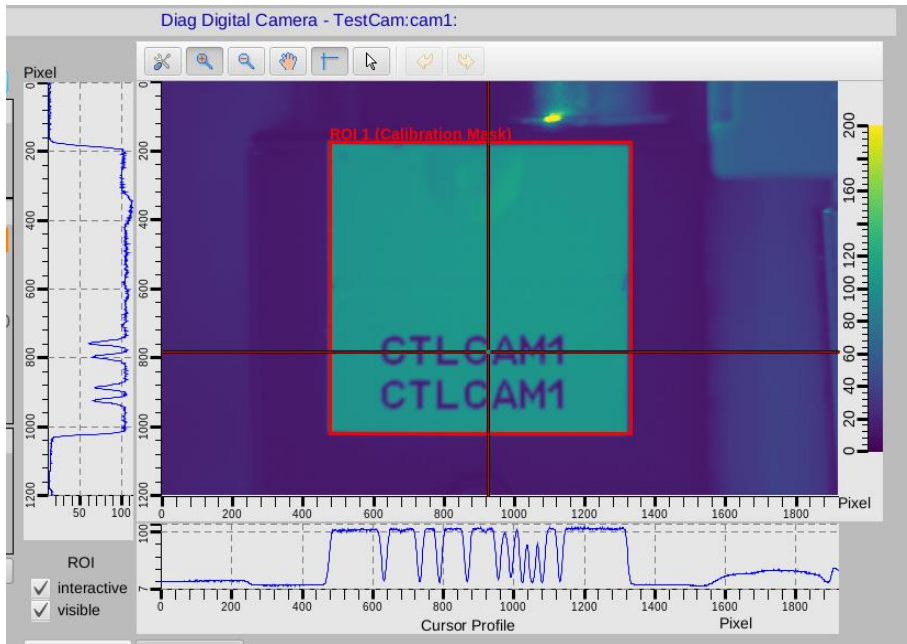
- The example use a 20x19 mm label as a mask
  - Set the mask size by typing the value and unit
- We use ROI1 to set the calibration mask
  - The ROI can be set by dragging the box in the image
  - Or Set the number by typing the value
- Use the check box to change ROI box on the screen, disable to interactive/visible to avoid accidentally change the ROI





Switch the unit of axis for all waveforms by choosing Pixel or Calibrated Egu





Proc1

Port to Pva1  
Proc1

Color Map  
VIRIDIS

Color Range  
200.000

Switch Between ROI view and Proc1 view.  
Note this is also what pip to port Pva1



# Customized Background And Scale Sequence

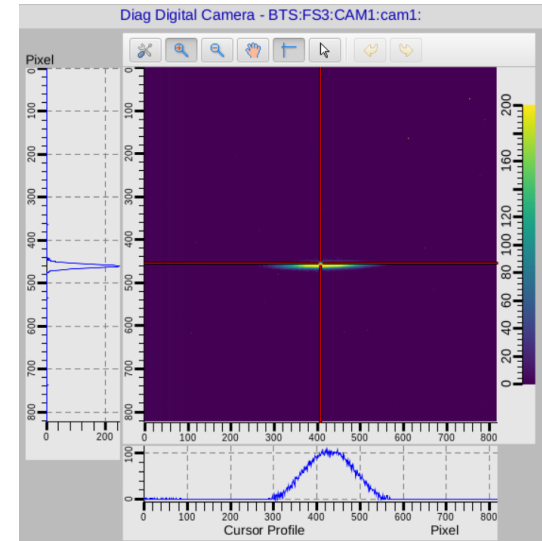
- For the area-detector the background subtraction, the background image must take when no background and scale factor applies
- A simple sequence to
  - save the scale factor, offset, and background status
  - Turn of all off it
  - Took a background image
  - Set all back to saved status

Background Sub and Scale			
Save background	<input type="button" value="Save Seq"/> Invalid	Enable background	<input type="button" value="Disabl"/> Disable
Save Seq button does the following 4 steps automatically		Enable scale/off.	<input type="button" value="Enable"/> <input type="button" value="Enable"/>
1. Latch the function status in Proc1			Scale value <input type="text" value="0.0625"/> 0.0625
2. Disable all functions in the Proc1			Offset value <input type="text" value="0.00"/> 0.00
	3. Wait a second and save the last image as background in the buffer		4. Enable it back to Latched status.

# Add-on feature

- Trigger the camera with selected MRF Event
  - (See Ran Hong's talk)
- Re-connection after a network glitch
  - The ARResetCamera PV in ADAravis module could reconnect the camera
  - The SysReset PV in iocStats module could reboot the ioc after reconnection

ASD Diag Digital Camera Summary							
Trig Select		Screen		Detector state		Connection	
Opt(45)/Align(118)		P-SLM:CAM1:	Acquire	Connected	Connect	Reboot	
		P-SLM:CAM2:	Acquire	Connected	Connect	Reboot	
		B-SLM:CAM1:	Acquire	Connected	Connect	Reboot	
		B-SLM:CAM2:	Acquire	Connected	Connect	Reboot	
Opt	Align	Opt 45	BTS:FS3:CAM1:	Acquire	Connected	Connect	Reboot
Opt	Align	Opt 45	BTS:FS4:CAM1:	Acquire	Connected	Connect	Reboot
Opt	Align	Opt 45	BTS:FS5:CAM1:	Acquire	Connected	Connect	Reboot
Opt	Align	? 38	LEA:FS4:CAM1:	Acquire	Connected	Connect	Reboot
			B-SLM:CAM3:	Acquire	Connected	Connect	Reboot
			S35-SLM:CAM1:	Acquire	Connected	Connect	Reboot
			B-SLM:CAM4:	Idle	Connected	Connect	Reboot

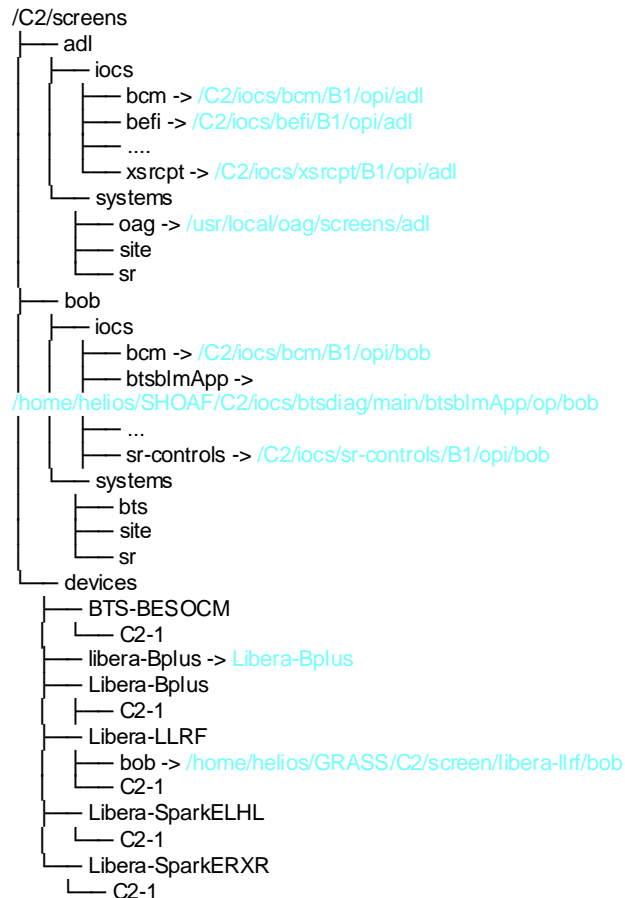
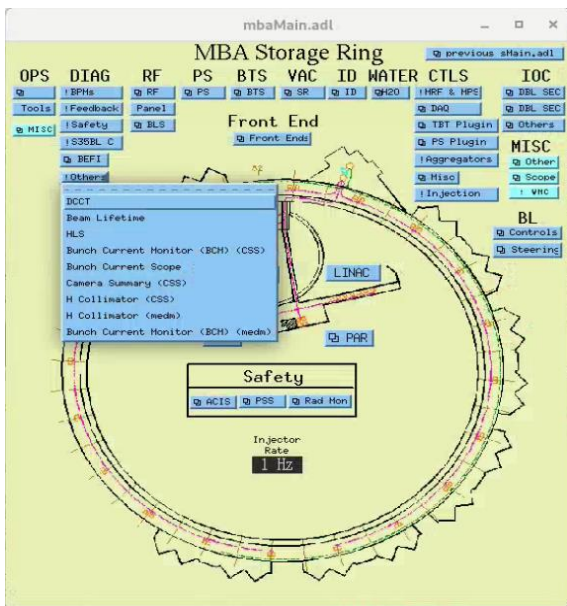


# Hybrid Screen Structure: medm + PhoebusCSS

This allow us to phase in the software upgrade to minimize disruption

- Combination of softlink and git repository
- Individual Engineers push the update to git repository of each EPICS module or IOC
- The each element in the structure softlinks to the opi folders of each EPICS module or IOC

Lingran Xiao  
Ned Arnold  
Andrew Johnson  
Guobao Shen



Andrew Johnson's talk on Tuesday



# THANK YOU!!



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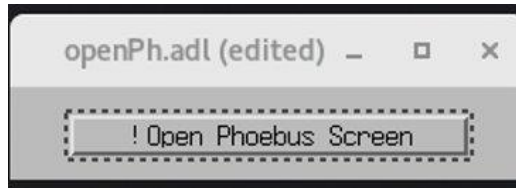
# BACKUP SLIDES



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# Open CSS Phoebus screen from medm

```
"shell command" {
  object {
    x=420
    y=25
    width=17
    height=14
  }
  command[0] {
    label="DLLRF L2"
    name="open-C2-screen -m N=2"
    args="/C2/screens/bob/iocs/Libera-llrf/kn.bob"
  }
  command[1] {
    label="DLLRF L6"
    name="open-C2-screen -m N=6"
    args="iocs/Libera-llrf/kn.bob"
  }
}
clr=14
bclr=51
}
```



There are two way to add apply macro with command line.

1. The official way to call a CSS Pheobus screen from command line is
  - **phoebus.sh -resource file:/path/to/file?MACRONAME=macrovalue**
2. One can use another line
  - **MACRONAME=macrovalue phoebus.sh -resource file:/path/to/file**
  - But if you use env this way, when the phoebus.sh already running, and this command just add a screen the running CSS Phoebus , the env won't kick in.

When put the command line in medm screen or any script, one should use method two to avoid the problem

- The "?" Is a special character in medm
- The work-around would be using a shell script as the medium
  - **phoebus.sh -resource file:\$1?\$2=\$3**
- CTL group has open-C2-screen
  - **open-C2-screen -m macro=value -m macro2=value2 file.bob**