LERF RF User Guide

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I. Standard Controls and Information

1. CPUs and IOCs

JLab Cryomodule Number	*LCLS-II Cryomodule Name*	*CPU Node Name**	*EPICS IOC Name**
1	ACCL:L1B:0200	lcls-llrfcpu01	sioc-l1b-rf01
2	ACCL:L1B:0300	lcls-llrfcpu02	sioc-l1b-rf02

**CPU Node Name is referred to as <cpuname>in the commands shown below.*
EPICS IOC Name is referred to as <iocname> in the commands shown below.

2. Chassis IPs

These are the IP addresses used in the LLRF internal network. They are the same for each cryomodule.

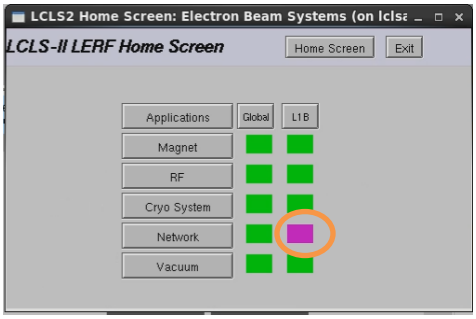
Rack	*Chassis*	*IP*
Cavities 1-4 (aka Rack A)	RES	192.168.0.100
Cavities 1-4 (aka Rack A)	RFS1 (cavities 1,2)	192.168.0.101
Cavities 1-4 (aka Rack A)	RFS2 (cavities 3,4)	192.168.0.102
Cavities 1-4 (aka Rack A)	PRC	192.168.0.103
Cavities 5-8 (aka Rack B)	RES	192.168.0.200
Cavities 5-8 (aka Rack B)	RFS1 (cavities 5,6)	192.168.0.201
Cavities 5-8 (aka Rack B)	RFS2 (cavities 7,8)	192.168.0.202
Cavities 5-8 (aka Rack B)	PRC	192.168.0.203

PRC=Precision Receiver Chassis
Reads cavity probe signals
RFS=RF Station
Provides RF drive; reads forward , reverse, detune signals
RES=Resonance/Interlock Chassis
Controls tuners; performs interlock logic

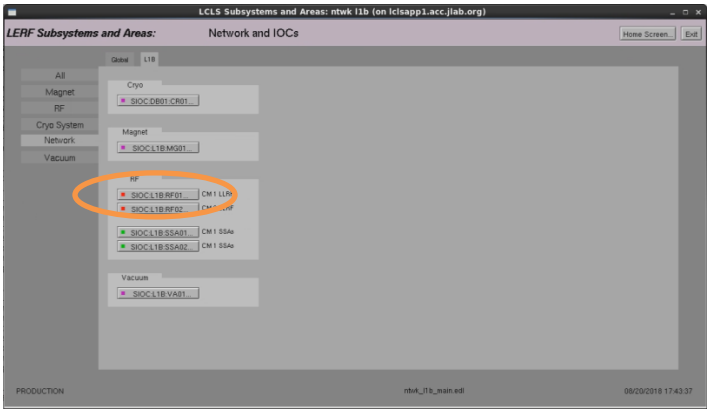
3. Start/Restart the EPICS IOC

1. Log into LERF workstation or server
   (lcls01/2/3/lclsapp1 with individual user id)

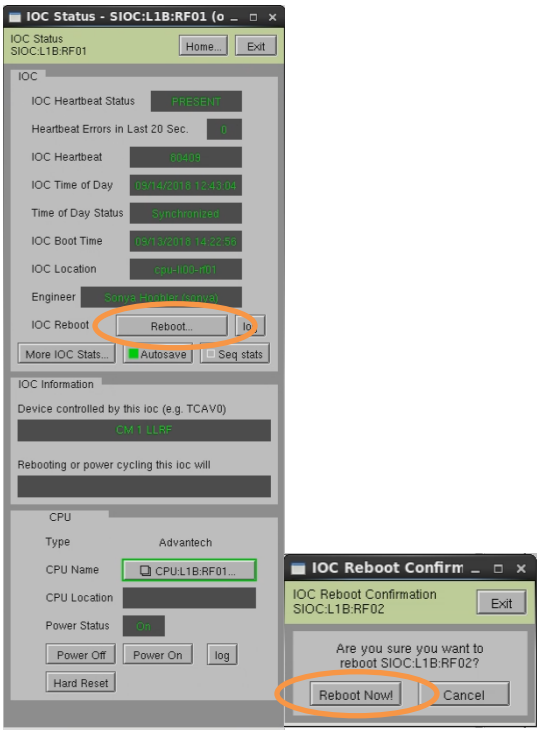
2. Type lerfhome&



3. Click on box intersecting Network and L1B



4. Click on IOC of interest

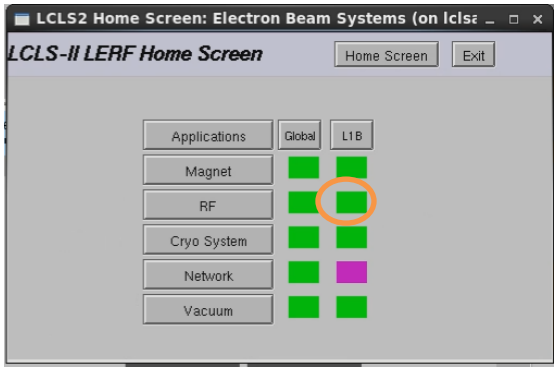


5. Click on ‘Reboot’. Then click on ‘Reboot Now!’

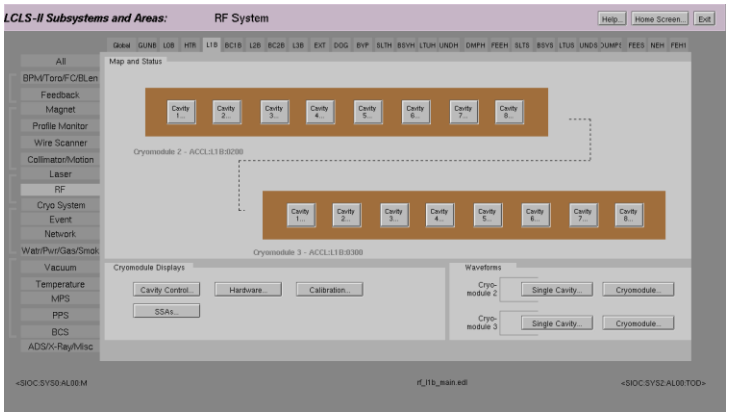
4. View RF EDM screens

a. Log into LERF workstation or server (lcls01/2/3/lclsapp1 with individual user id)

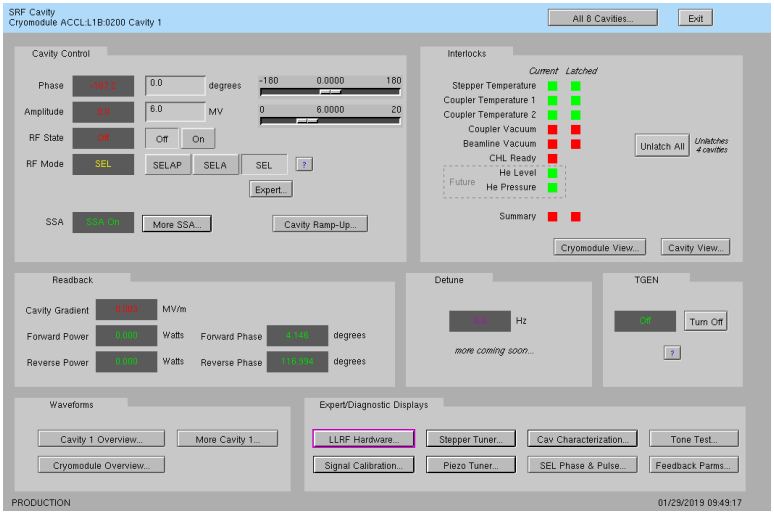
b. Type lerfhome&



c. Click on box intersecting RF and L1B



L1B Overview Display



Single Cavity Display

5. Initialize/Checkout LLRF Hardware

Needed after power outage, hardware swap, etc.

a. Click on Hardware… (from either L1B Overview or Single Cavity display—see above).

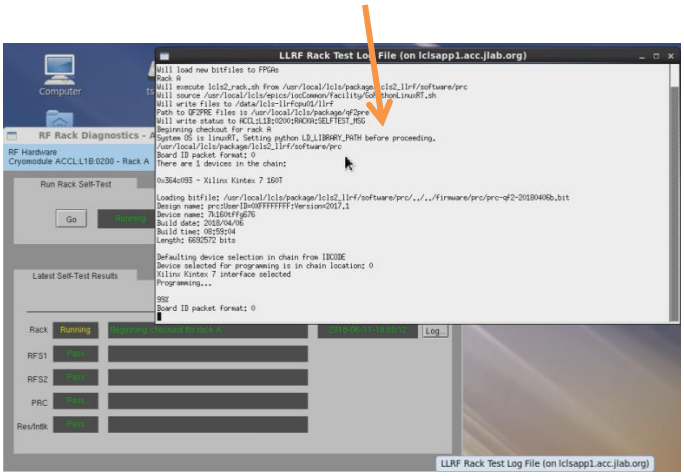
b. For appropriate rack (A or B), open display labelled Rack Hardware Init and Test…

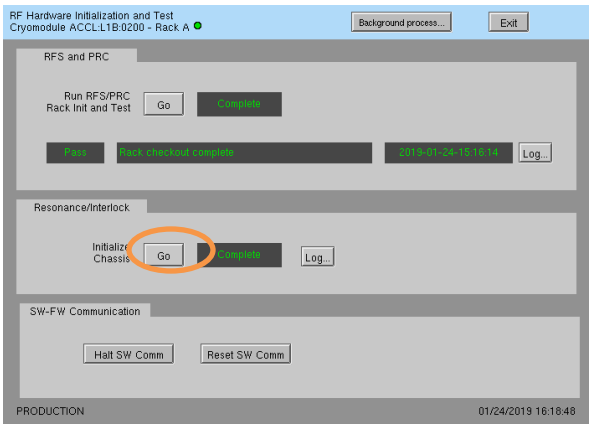
c. Execute RFS/PRC initialization and checkout. Click Go

(The script will disable and then re-enable communication with EPICS.)

To view the rack test script output, click on Log…

It will open an xterm window and display the script output as it progresses.

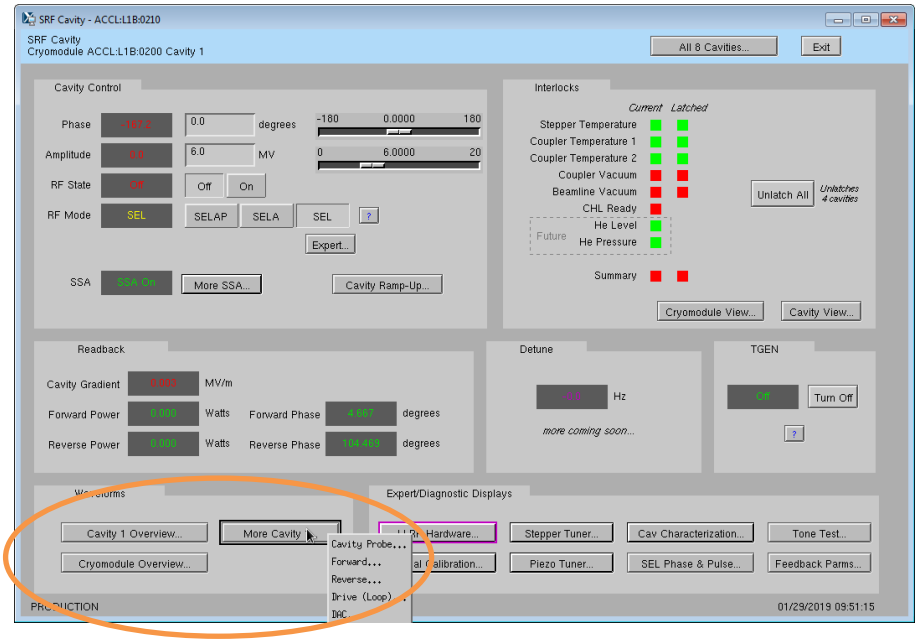




d. Initialize RES chassis. Click Go

(The script will disable and then re-enable communication with EPICS.)

6. View RF Waveform Plots

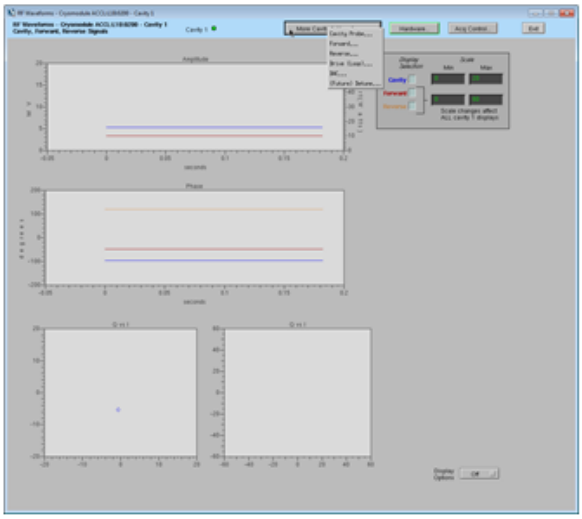


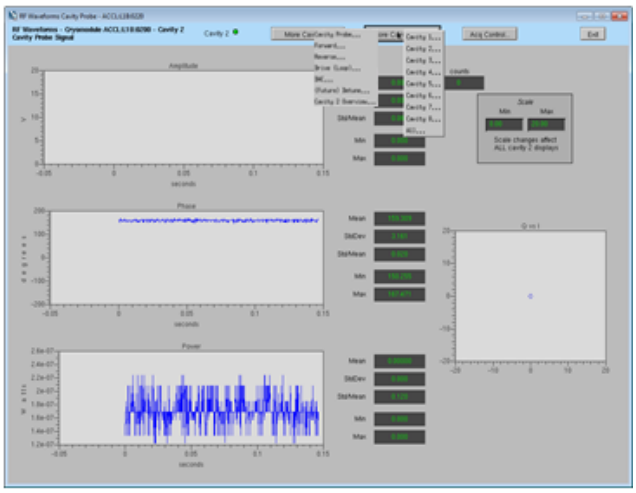
Cavity Overview -- Cavity, Forward, Reverse signals for single cavity

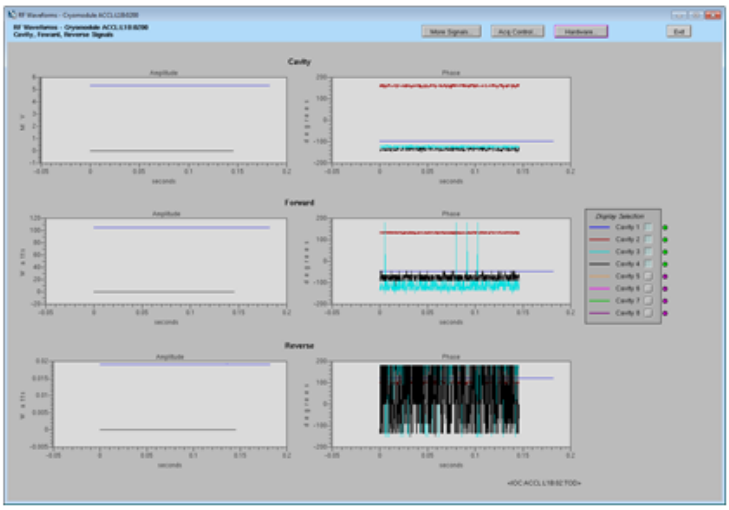
Cryomodule Overview -- Cavity, Forward, Reverse signals for all 8 cavities

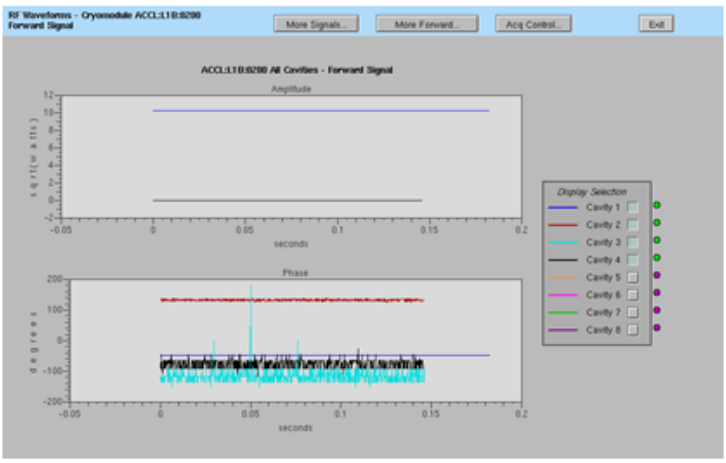
More Cavity -- Drop-down menu for single-cavity single-signal screen

From those screens, you can navigate to other cavities, other signals, or display a single signal for all 8 cavities. Example screenshots:

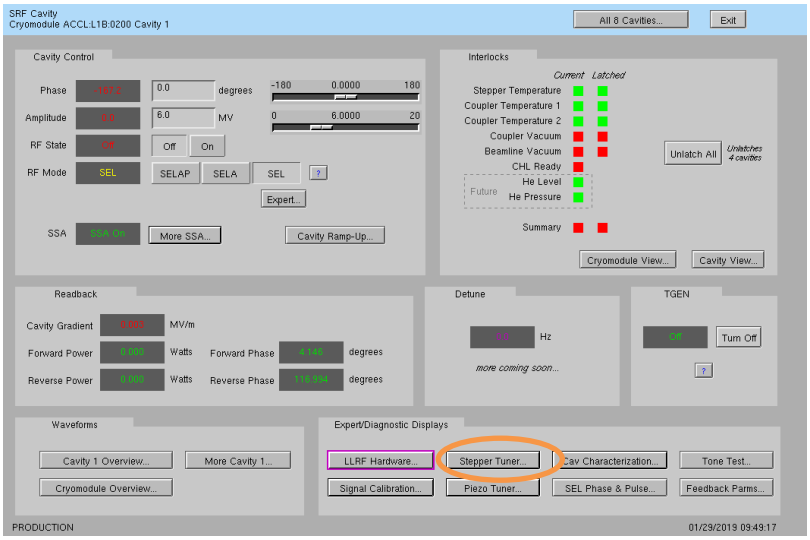




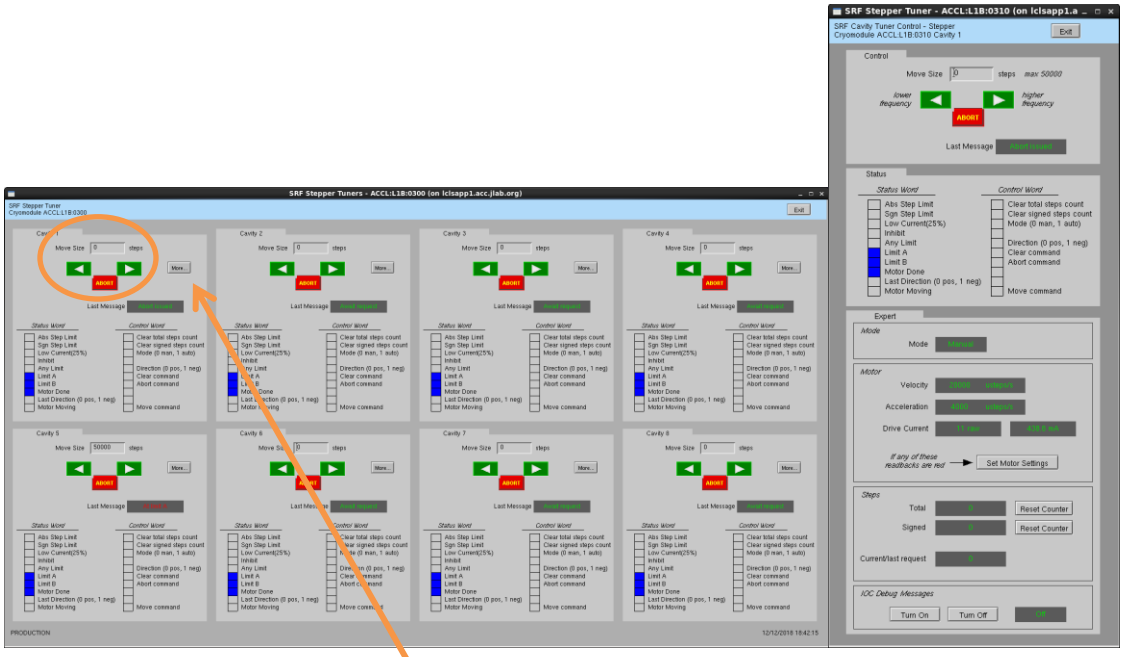

Cavity
Forward
Reverse


RF Waveforms - Cryomodule ACCL:L1B:0200
Forward Signal
More Signals...
More Forward...
Acq Control...
Exit
ACCL:L1B:0200 All Cavities - Forward Signal
Amplitude
sqrt(watts)
seconds
Phase
degrees
seconds
Display Selection
Cavity 1
Cavity 2
Cavity 3
Cavity 4
Cavity 5
Cavity 6
Cavity 7
Cavity 8

7. Control Stepper Motor Tuner

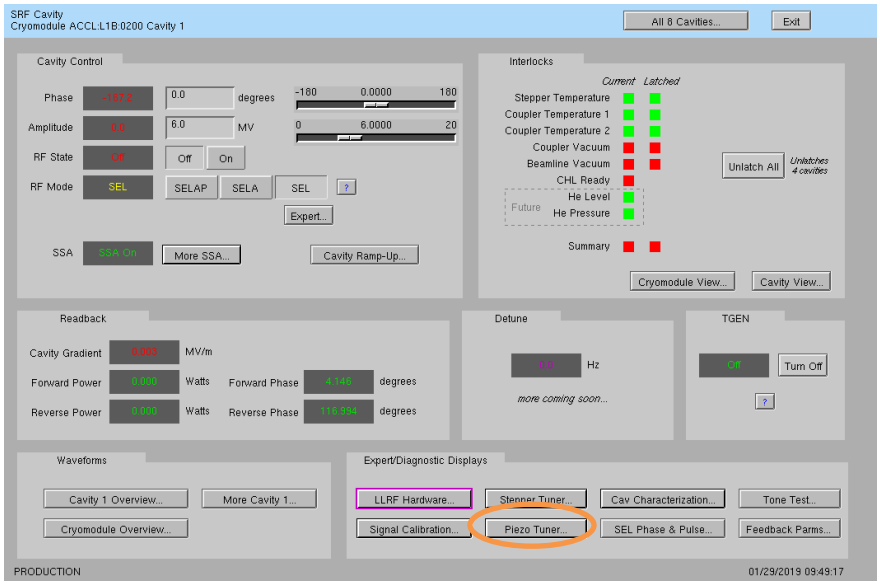


a. Click on Stepper Tuner…

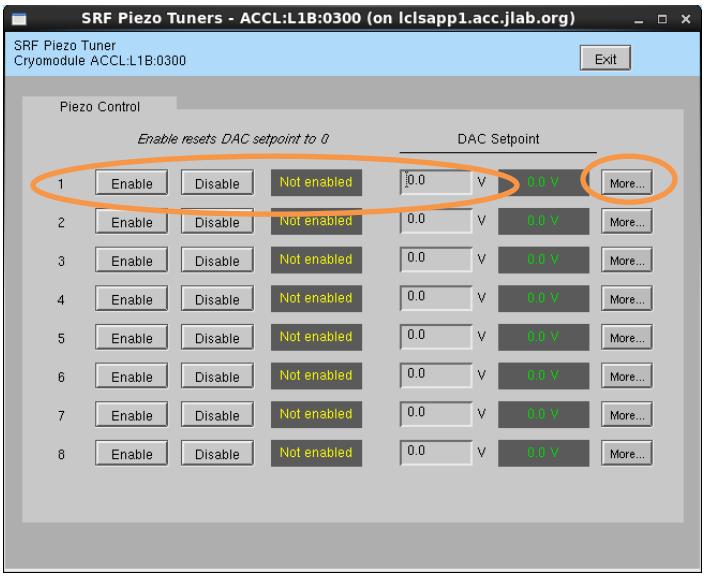


b. 8-cavity screen. From here you can enter number of steps and then click the green arrow to go in one direction or the other. (Relationship between direction and frequency is not yet known.) Click More… for single tuner screen

8. Control Piezo Tuner

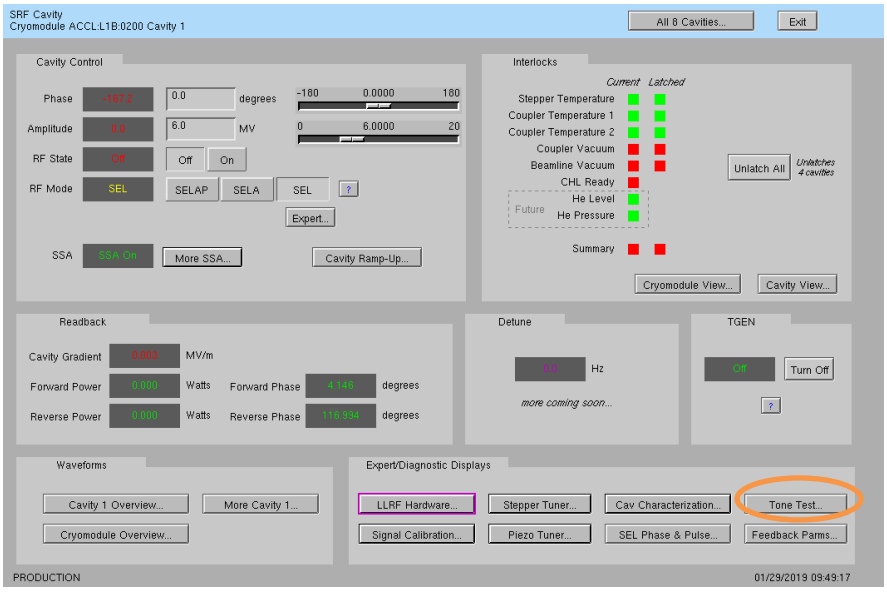


a. Click on Piezo Tuner…

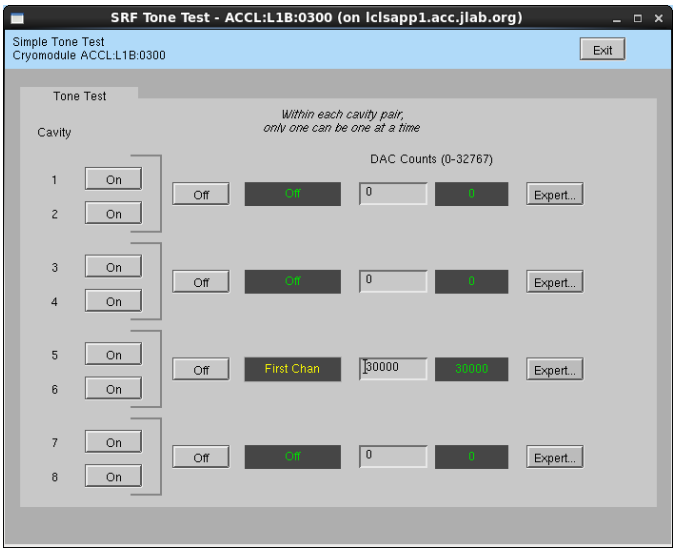


b. 8-cavity screen. From here you can enable the piezo tuner and enter a DC DAC voltage. Click More… for single piezo tuner screen

9. Drive Cavity With Simple Tone Signal



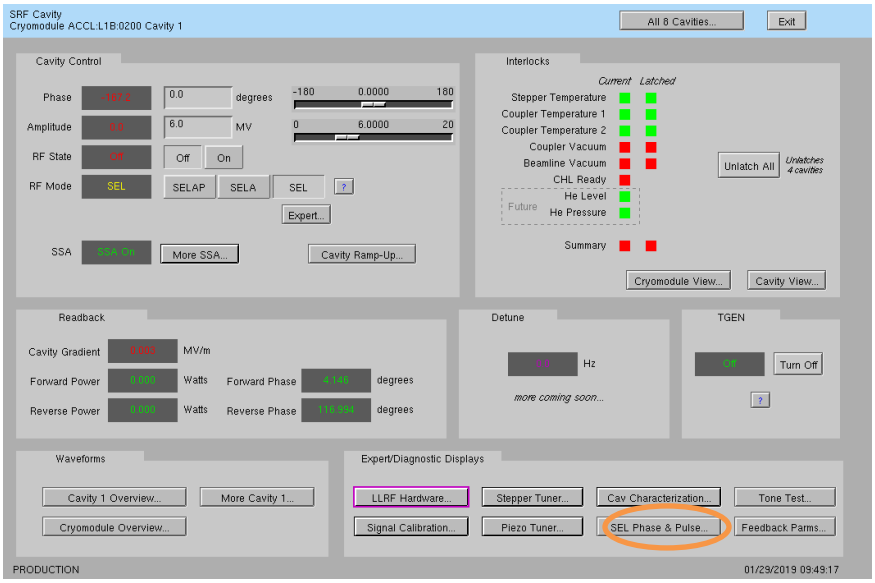
a. Click on Tone Test…



b. Turn desired cavity ‘On’, then enter number of DAC counts…

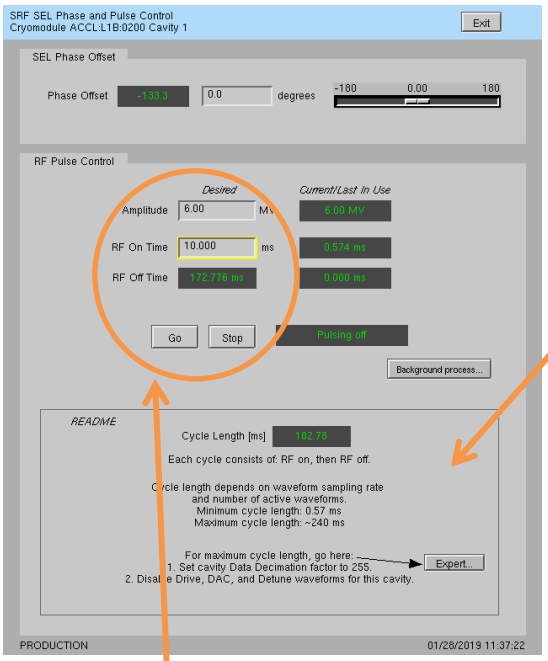
c. When done, click ‘Off’

10. Run RF In SEL Pulsed Mode



a. Click on SEL Phase & Pulse…

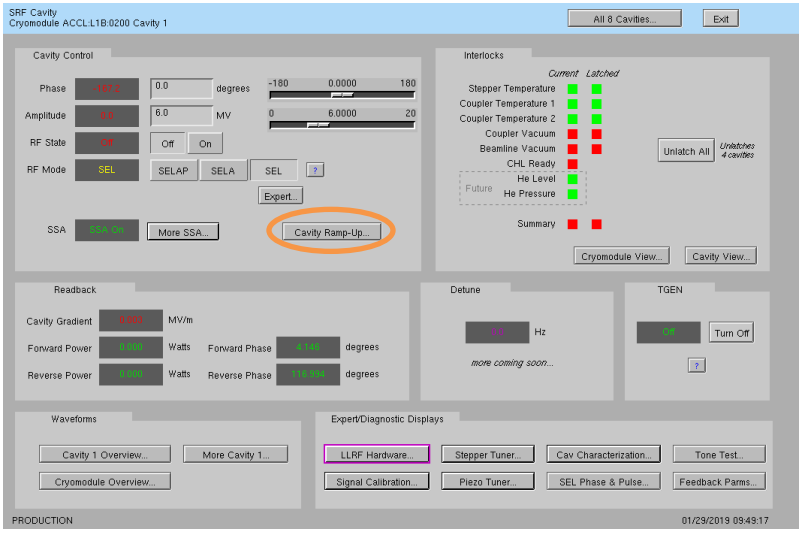
The settings/options for pulsed mode are more complicated than you'd think. It's a good idea to read the README at the bottom of the screen.



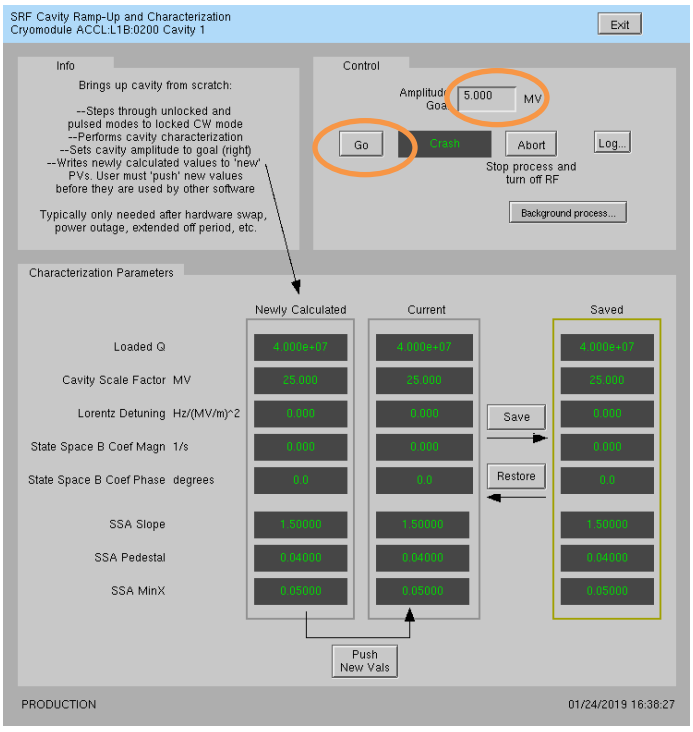
b. Enter desired amplitude (settings will be 'yellow' if they do not match Current/Last In Use)
c. Enter desired RF pulse length
d. Click Go
e. When done, click Stop
f. To update amplitude or time settings, enter new values and then click Go again

11. Ramp Cavity to CW/SELAP and Perform Cavity Characterization

This is used to bring up a cavity 'from scratch' or if there is some need to re-characterize the cavity/SSA. You do not need to run this every time you turn a cavity on.



a. Click on Cavity Ramp-Up…



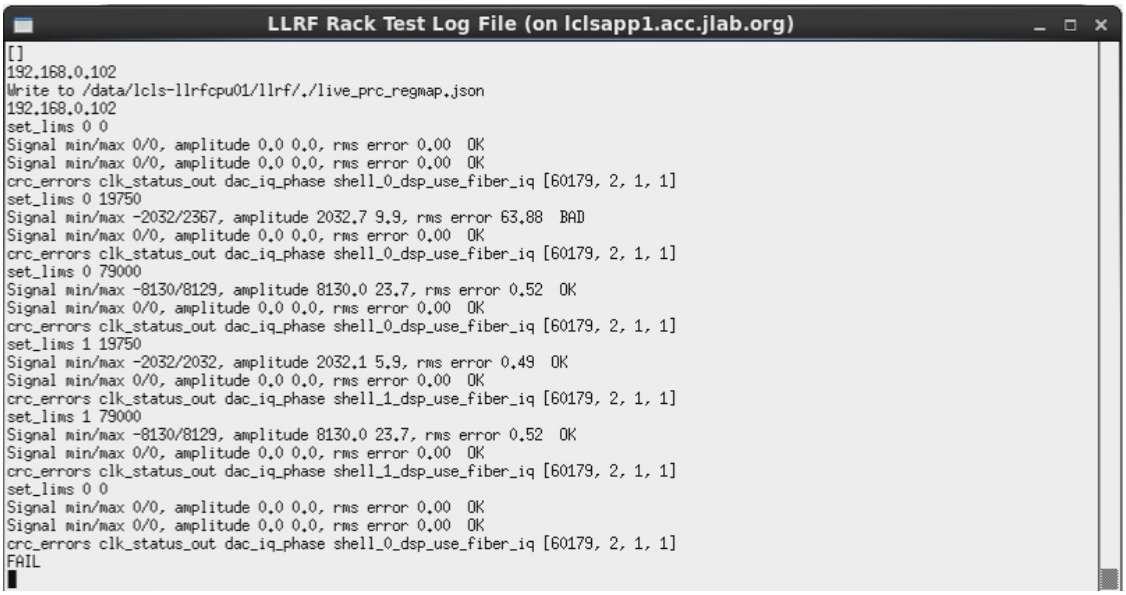
b. Set Amplitude Goal and click Go

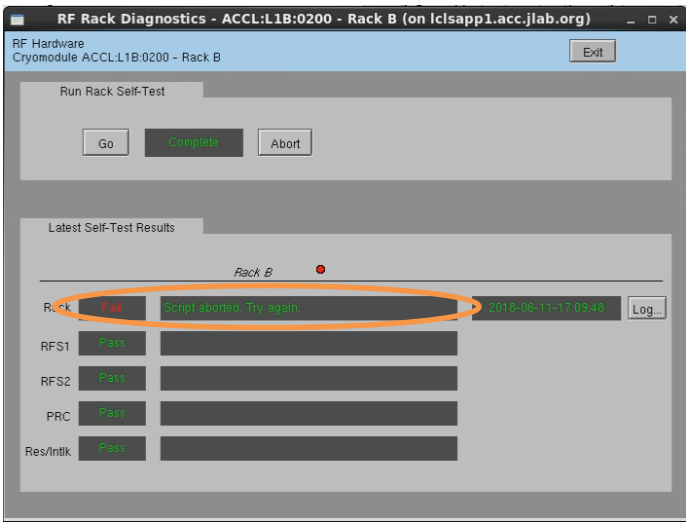
c. Future (not yet done 1/29/2019): the script will write is calculated characterization parameters to the Newly Calculated values on the screen. You can review these and if they seem reasonable, click Push New Vals. You can also save the Current values as a known good set—to possibly restore in future.

II. Occasional Issues

1. Mystery Rack Checkout Error

We occasionally see a problem during the first cryomodule rack A checkout. This is what it looks like:

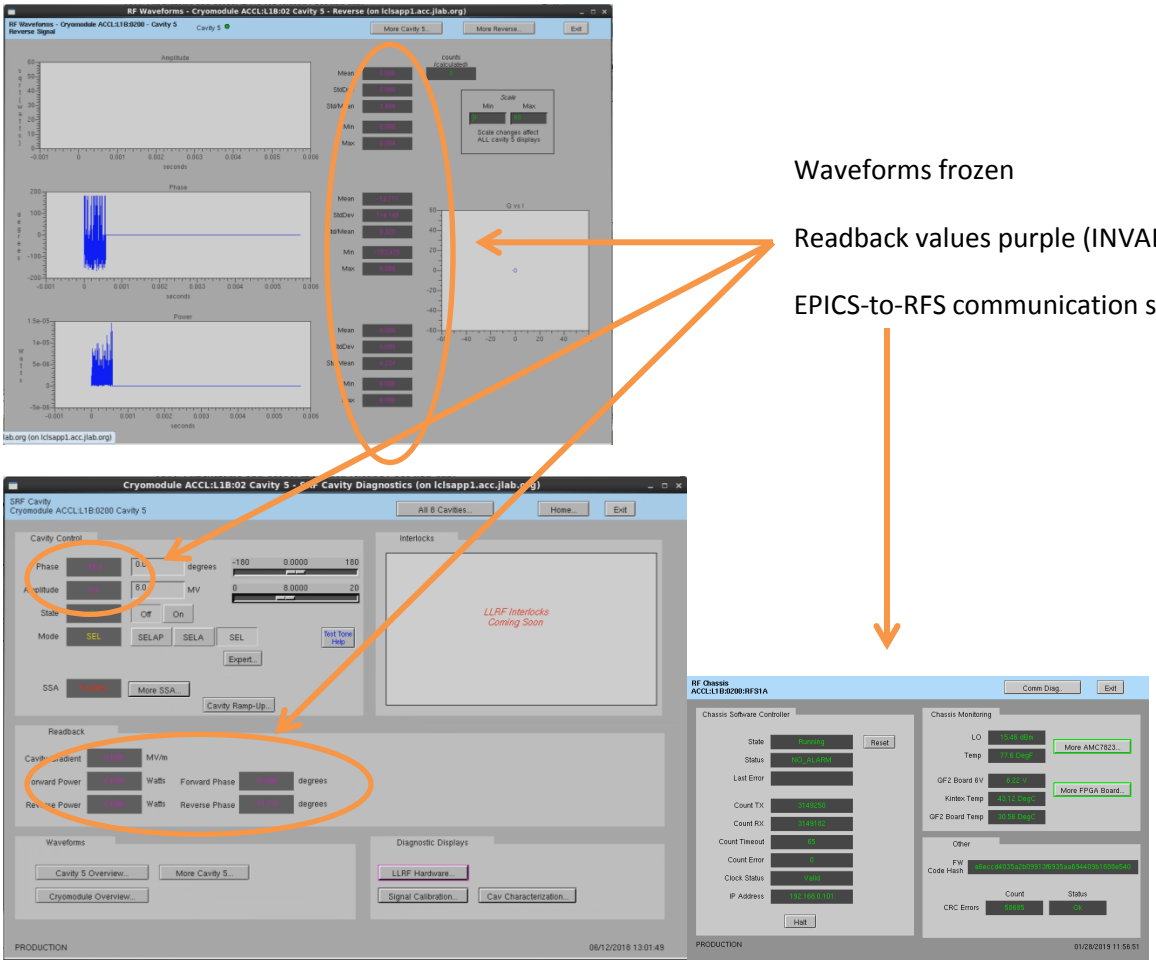




It is an intermittent failure and is not understood. You'll have to simply re-run rack checkout and hope it passes. (We have observed that if the system was previously set up correctly and there has been no outage/hardware swap since, it will probably work fine in spite of this error.)

2. Recover Non-Updating EPICS Waveforms

Once in a while, I've seen the EPICS waveform data stop updating. Displays will look like this:



If you see this and nothing else seems to be wrong, try pressing 'Halt', then 'Reset' on the appropriate RFS screen. If that does not recover it, then there is a problem somewhere else.

3. Ping Test

To test if a chassis pings from a CPU:

a. Log into LERF workstation or server
(lcls01/2/3/ lclsapp1 with individual user id)

b. Log into cpu (using CPU Node Name from Section 1):

iocConsole <cpuname>

OR

ssh laci@<cpuname>

(If prompted for login, type 'laci' and hit enter.)

c. Type: ping <ip>

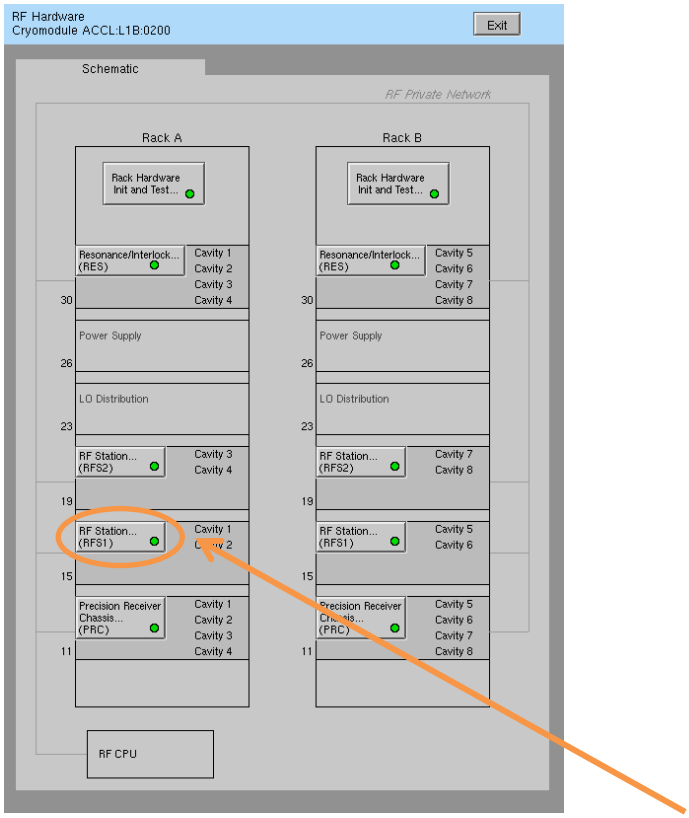
4. View the EPICS IOC Console

a. Log into LERF workstation or server
(lcls01/2/3/lclsapp1 with individual user id)

b. iocConsole <iocname>
c. To exit viewer, press these 3 keys together: Ctrl, a, d.
d. To scroll up in viewer, press these 3 keys together: Ctrl, a, [. Then use arrows to move up/down. To exit scroll mode, press these 3 keys together: Ctrl, a,].

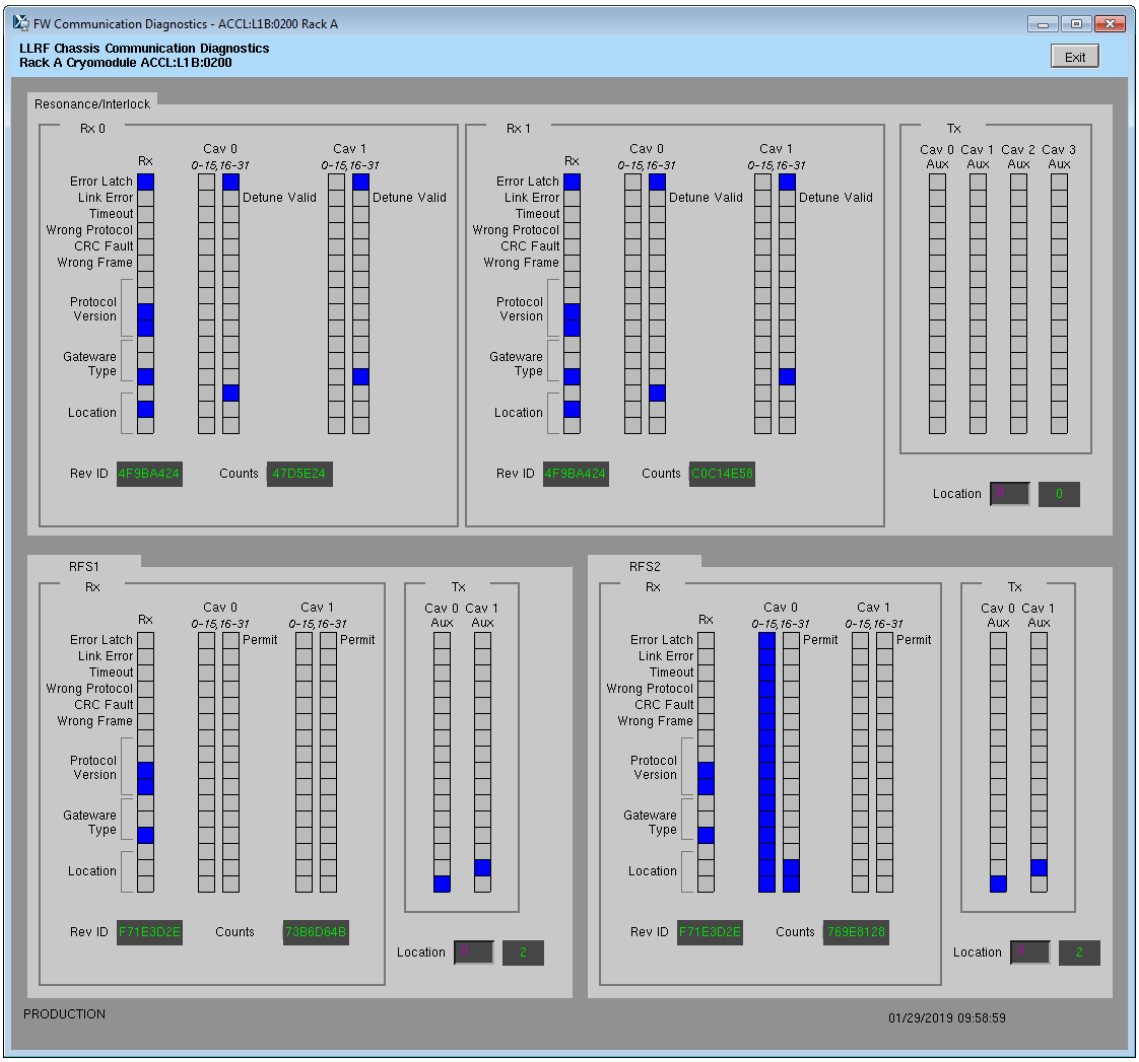
(If you inadvertently kill the ioc, you can restart it using the instructions in section 2.)

5. Troubleshoot RFS<->Res/Intlk Communication



a. Open Hardware screen. For the appropriate rack, click on an individual chassis

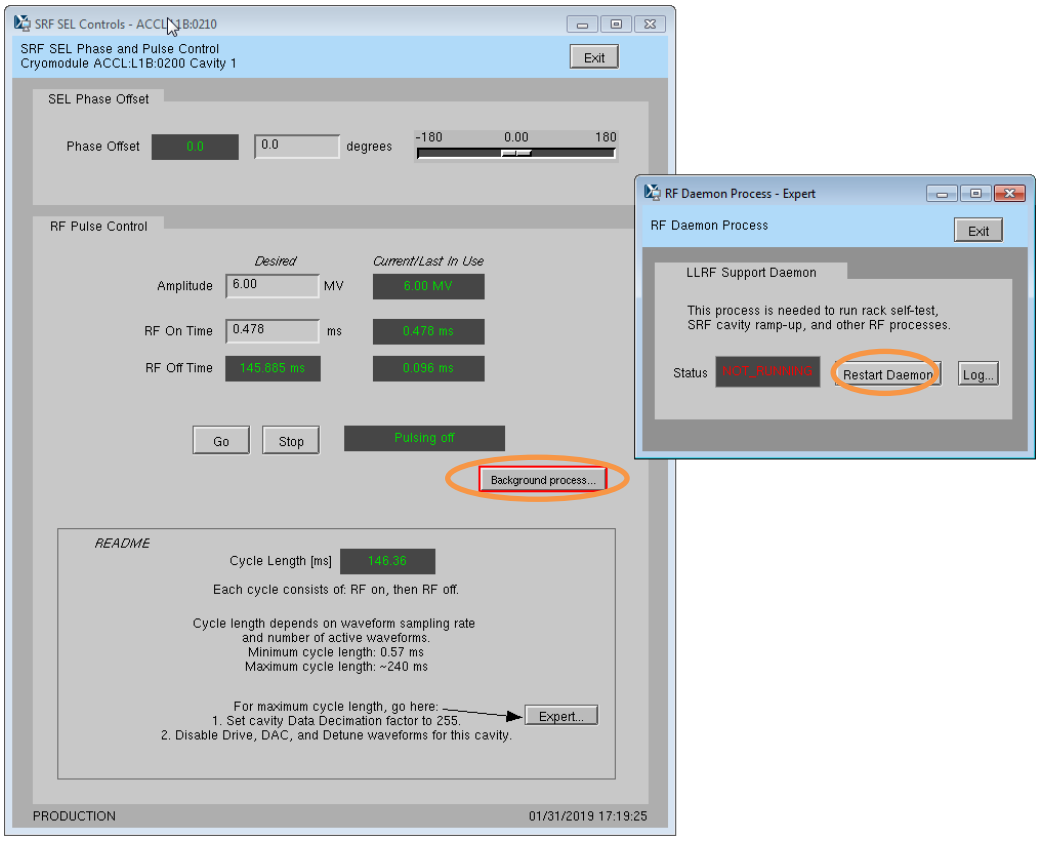
b. Click on 'Comm Diag…'


FW Communication Diagnostics - ACCL:L1B:0200 Rack A
LLRF Chassis Communication Diagnostics
Rack A Cryomodule ACCL:L1B:0200
Exit
Resonance/Interlock
Rx 0
Rx 1
Tx
Rx
Cav 0
0-15,16-31
Cav 1
0-15,16-31
Error Latch
Link Error
Timeout
Wrong Protocol
CRC Fault
Wrong Frame
Protocol Version
Gateware Type
Location
Detune Valid
Rev ID
Counts
Cav 0 Aux
Cav 1 Aux
Cav 2 Aux
Cav 3 Aux
RFS1
RFS2
Permit
PRODUCTION
01/29/2019 09:58:59

6. RF 'Background Process'

Much of the current RF functionality (rack checkout, pulse control, cavity ramp, etc.) is performed by scripts external to the EPICS IOC. This is facilitated by a continuously running background process that is driven by EPICS PVs. This allows us to execute these functions from EPICS PVs on EDM screens—and not have to manually run scripts from the command line.

On every display that relies on this, there is a button titled 'Background process…'. If that process is not running, there will be a red rectangle around it. Click on that button to open a display from which you can start/restart the process. Example:



This process will not successfully launch if the EPICS PVs it relies on are not all online. Both LLRF EPICS IOCs must be on.

III. Expert Operations

These should be rarely/never needed. If you do need to perform any of these operations, please also just send a note to Sonya Hoobler (sonya@slac.stanford.edu) so it's on our radar.

1. Change IP Address of FPGA board (QF2pre)

Avoid two QF2pres with the same IP address on the LLRF internal network at the same time. So if you need to swap IPs between two boards, called X and Y below, you should:

i. Following instructions from Section 6, halt communication between EPICS and relevant chassis
ii. Disconnect X from the LLRF network
iii. Update the IP address for Y (instructions below)
iv. Disconnect Y from the LLRF network
v. Reconnect X to the LLRF network
vi. Update the IP address for X
vii. Reconnect Y to the LLRF network

Instructions to change IP:

a. Following instructions from Section 6, halt communication between EPICS and relevant chassis
b. Log into LERF workstation or server
(lcls01/2/3/ lclsapp1 with individual user id)
c. Log into cpu (using CPU Node Name from Section 1):

iocConsole <cpuname>

OR

ssh laci@<cpuname>

(If prompted for login, type 'laci' and hit enter.)

d. Change directory:

cd /usr/local/lcls/package/qf2pre

e. Execute these commands:

1. python –m qf2_python.scripts.update_spartan_6_configuration –X –t <old ip> -s IPV4_UNICAST_IP=<new ip>
2. python –m qf2_python.scripts.verify_spartan_6_configuration –X –t <old ip>
3. Repeat 1. removing "- X"
4. Repeat 2. removing "- X"

f. Power-cycle chassis
g. Execute command 2 but with *new* IP

h. Execute command 4. but with *new* IP
i. Ping chassis and verify response
j. If board does NOT have AUTOBOOT_TO_RUNTIME set to 1 (and all LERF chassis should have that set), then execute:

```
python -m qf2_python.scripts.reboot_to_runtime -t <new ip> -v
```

k. Perform other checkout if desired/possible. For example, for a RFS or PRC, run prc.py or run rack checkout.

2. Verify QF2-pre Network Settings

From John Jones:
I suggest you disconnect all but one board in the system then work through each board in turn, running:

python -m qf2_python.scripts.verify_spartan_6_image -X -t [CURRENT_IP]
for the bootloader settings and:

python -m qf2_python.scripts.verify_spartan_6_image -t [CURRENT_IP]
for the runtime, and make sure that:

a) The bootloader and runtime images have the same settings for IP and MAC.
b) That they are unique in the overall network.