Selected LCLS Matlab GUIs User Guide

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1 Overview

The programs Emittance GUI, Wirescan GUI, Correlation Plot GUI, Tcav GUI, and Profmon GUI described within this document are high level Matlab applications for the LCLS electron beam diagnosis. They use EPICS channel access and less frequently AIDA data server to communicate with the accelerator hardware to perform their respective tasks. These graphical user interfaces have a couple of common features summarized below. The rest of the document describes procedures to use the individual programs.

Common Features

Save Saves the present data. The file name is automatically generated from the application, measurement type, and date and time as HEADER-PV NAME-YYYY-MM-DD-HHMMSS.MAT. The file location is automatically taken from the date of the measurement time as $LCDATA/MATLAB/DATA/YYYY/YYYY-MM/YYYY-MM-DD.

Save As Like Save, but a dialog window lets the user choose a different file name and location.

Load Opens a dialog box with the present day's data folder (if exists) to let the user pick a .MAT file. The user has to make sure that the respective file was created with the same application, otherwise it will crash. Due to a Java bug, the dialog might fail and the button has to be invoked several times.

Export Creates a new figure window and plots the current data in it. This figure can then be modified and saved or printed from the figure menu.

-> Log Book Creates new figure window with Export and prints the figure in the electronic logbook queue. The data is saved with Save.

Config Load Loads some or most of the program settings from the program's configuration file.

Config Save Saves some or most of the program settings to the program's configuration file.

Start ... Starts the measurement process.

Abort ... Aborts the current data acquisition. If multiple programs are running in the same Matlab window, all of htem will be stopped. After a program crash, the Start button has to be reset with Abort.

2 Emittance GUI

Scope

This graphical user interface (Fig. 5) for Matlab enables the measurement of the projected and slice emittance of the LCLS electron beam at various OTR/YAG beam profile monitors and wire scanners using a multiple screen scan or a scan with varying quadrupole strength. The software displays the measurement results and can save and load the measurement data. Program settings can be saved and retrieved in a configuration file.

Usage Procedure

1. Start program. On the LCLS Home Screen open USER Dev Displays and then select Emittance GUI or type `emittance_gui` in a Matlab session.

2. Select Linac region IN20, LI21, LI28, or LTU.

3. Select measurement method Multi Screen or Quad Scan.

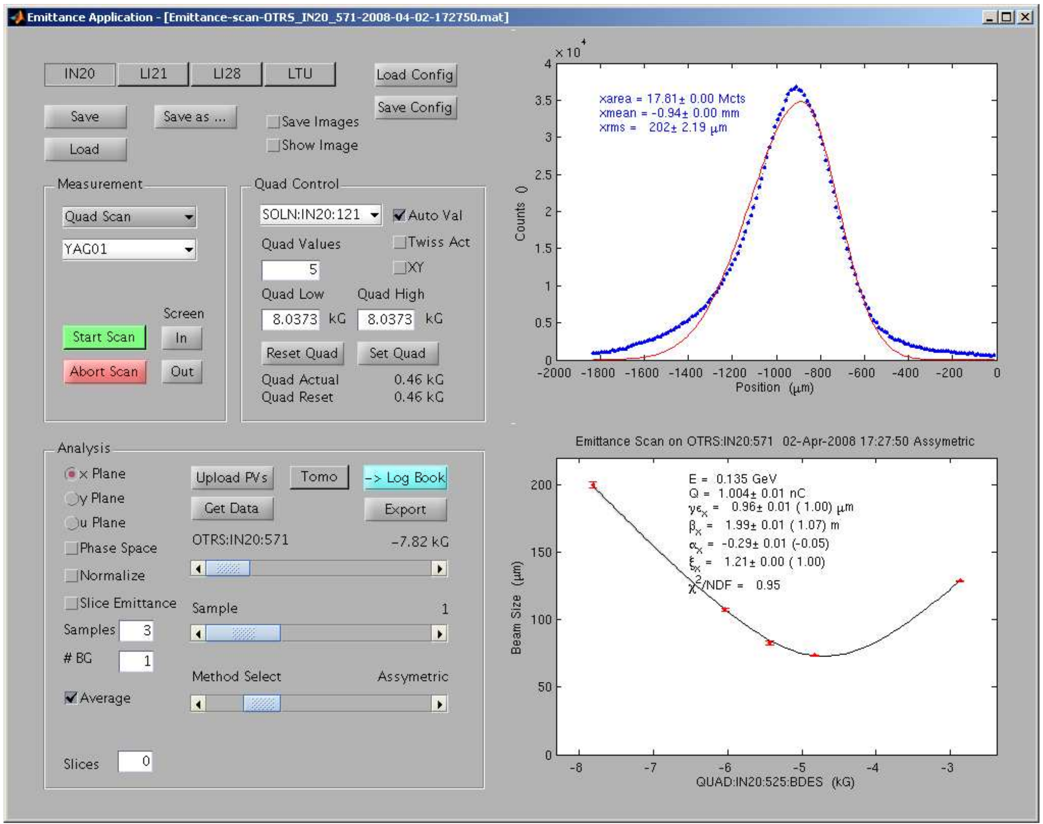

Figure 1: Graphical user interface for emittance measurement.

4. Select measurement location, YAG/OTR screen or wire scanner.

5. For a quadrupole scan, select the quadrupole to scan and the scan range for that quadrupole. The config for the program stores the quad name and its range for each screen, so the selection at program start should be useful.

6. If the quadrupole selection or range was changed and deemed permanent, save the present configuration with Save Config.

7. Select Auto Val if desired. This calculates the quadrupole settings for optimal phase advance for the selected plane. It uses design Twiss parameters unless Twiss Act (from last measurement) is checked. Check

XY to optimize for both planes.

8. Check if the Quad Reset value corresponds to the actual value in the control system.
9. If a wirescan is requested, select the plane, x Plane or y Plane.
10. For a slice emittance measurement, select the number of Slices and the slice window size SliceWin. 2.5 (in multiples of the beam size) is usually a good value. Select the desired emittance plane x/y Plane. The slicing is done in the perpendicular direction. All the slicing related parameters can be changed after the measurement as well.
11. For YAG/OTR screen measurement, select the number of images (Samples) per quad setting or screen location. Depending on beam stability, 5 to 10 shots are reasonable. Select number of background shots (#BG); 1 shot is usually sufficient.
12. Start the acquisition with Start Scan.
13. If the measurement was successful, the program will display a new emittance measurement.
14. After a quad scan, check if the Quad Actual value equals the Quad Reset value.
15. If the measurement has to be aborted use Abort Scan.
16. If the program crashed, press the Abort Scan button to enable new scans. If a quad scan was aborted, check the quad actual and press the Quad Reset button if necessary.
17. Play with the Average, Phase Space, and Normalize check boxes and the Method Select slider until happy with results.
18. After a slice measurement, use the Slice Emittance checkbox to display a slice summary plot. Play with Slices number and window size SliceWin until happy. Each change however can take a long time to process.
19. If the emittance is below 1um, press the ->Logbook and Save buttons.
20. If the emittance is above 1um, increase effort.

21. Subsequent scans. If the program doesn't respond to Start Scan, press the Abort Scan button and try again.

22. If at start of quad scan the actual quad value in the control system differs from the Quad Reset value stored in the program, a dialog box will appear and inform the user of the situation. Depending on the cause of the discrepancy two different actions are recommended. If the actual value is wrong because the quad was left at an undesired value due to a program crash or abort, choose to keep the Quad Reset value and the quad will be set to the nominal value after the scan. If the actual value was deliberately changed to obtain a different matching since the last quad scan, choose to discard the Reset Value and take the present value as the new Reset Value.

3 Correlation Plot GUI

Scope

This graphical user interface (Fig. 2) for Matlab enables the measurement of any number of Epics process variables (Read PV) as a function of one or two control variables (Control PV). The results can be plotted against each other in any combination and various fit functions can be applied to the results. The measurement data can be saved and loaded and the sprogram settings can be saved and retrieved in user specified configuration files. The program can also launch other programs for profile monitors, wire scans, and emittance measurement to get the respective data. Beam synchronous acquisition is also available if the process variable supports this feature.

Usage Procedure

1. Start program. On the LCLS Home Screen open USER Dev Displays and then select Correlation Plots GUI or type `corrPlot_gui` in a Matlab session.

2. Pre-defined measurement. If the measurement setup has already been saved as a configuration file, use Load Config.

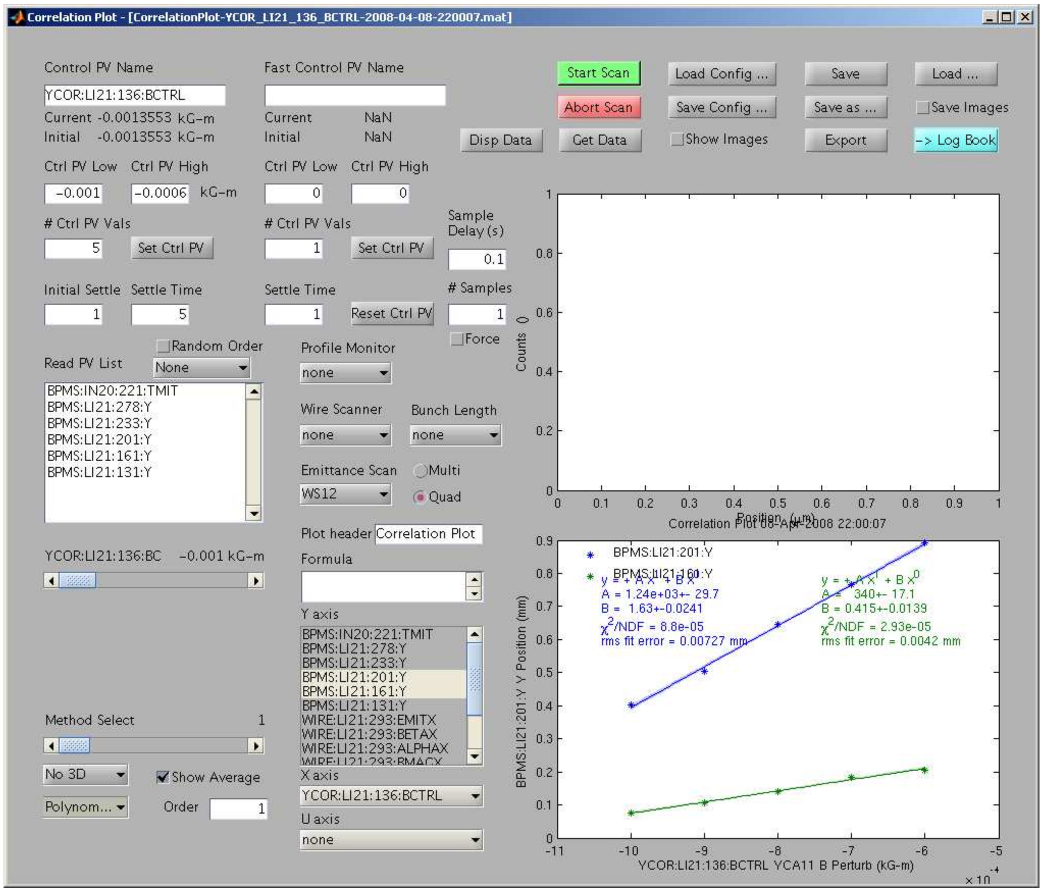

Figure 2: Graphical user interface for correlation plots.

3. Time plot. If the evolution of measurements over time is to be taken, leave both the Control PV and Fast Control PV fields empty. All other settings for the control PVs will have no effect.

4. Standard plot. This is the measurement of the read PVs as a function of one control PV. Enter the name of the process variable into the Control PV Name field. If the name is a valid PV, its present value will be displayed as Current and Initial. The values will be NaN if the PV is invalid.

5. 2D plot. This is the measurement of the read PVs as a function of

two control PVs. Enter the name of the slow process variable into the Control PV field and the fast variable into Fast Control PV Name.

6. To scan an SLC magnet enter the EPICS BDES PV as stypeSECT:PRIM:UNIT:BDES. This will trim the magnet using stypeAIDA.

7. Enter the range for the control PV into the respective Ctrl PV Low and Ctrl PV High fields.

8. Enter the number of set points for the control PV into # Ctrl PV Vals. If two control variables are entered, the total number of setpoints will be the prroduct of both # Ctrl PV Vals fields.

9. Select settle times. The Initial Settle is the number of seconds to wait between setting the control variable(s) to the first set point and taking the data. The Settle Time of the (slow) control PV is the wait time after subsequent set points before taking data. The Settle Time of the fast control PV is the respective wait time after advancing the set point for the fast PV.

10. Select number of samples and sample delay. The # Samples is the number of shots to be taken at each control variable set point. For a time plot, this is also the total number of shots. Enter the (approximate) wait time between samples in the Sample Delay field. This field has no effect is synchronous acquisition is selected.

11. Read PVs. Enter any number of process variables to be measured into the Read PV List field. If any of the names is invalid, no data will be acquired.

12. Additional Matlab measurements. One Profile Monitor, Wire Scanner, and Emittance Scan, and Bunch Length measurement can also be specified to be done along the acquisition of the other read PVs.

13. Select beam synchronous acquisition (BSA). If all read PVs have synchronous acquisition PVs associated with them, i.e., there exist PVs with HSTn appended to the name entered in the Read PV List field, the beam rate ONE_HERTZ, TEN_HERTZ, or THIRTY_HERTZ can be chosen. The Sample Delay value has no effect then. If None is selected, the acquisition is non-synchronous.

14. Select display settings. Use the Y axis, X axis, and (for 2D plots) U axis controls to select in which way the measured data should be displayed. This can also be changed at any time after the acquisition.

15. Label the measurement. Enter a title for the plot into the Plot Header field. This name will be appended by the control PV name and the date and time for the actual plot title as well as for the auto-generated file name.

16. Start the acquisition with Start Acquisition.

17. After each set point, the new data is added to the plot.

18. When the scan is completed, check if the Current value equals the Initial value for the control PVs.

19. If the measurement has to be aborted use Abort Acquisition.

20. If the program crashed, press the Abort Acquisition button to enable new scans. If control PVs where changed, press the Reset Ctrl PV button to put the control PVs back to their initial value.

21. Play with the Show Average, Fit, and 3D controls and the Method Select slider (if any additional Matlab measurements where done) until happy with results.

22. Formulae. If desired, one or more formulae can be entered in the Formula field to be available for display or fitting. The control and read PVs are referenced in the formulae with lower case characters starting at a with the control PVs and then the read PVs. The labeling corresponds to the order of the X axis list without the TIME entry. The operations in the formulae have to be vectorized, i.e. use .* instead of * etc.

23. Save and log data. If deemed worthy for posterity, use Save (with auto-generated file name and folder location) or Save as (with user specified file name and location). Use the ->Logbook button to put the plot into the electronic logbook, which will also save the data.

24. Subsequent scans. If the program doesn't respond to Start Acquisition, press the Abort Acquisition button and try again.

25. Change of acquisition values. If any of the values affecting the stucture of the measurement data (like # Samples or Control PV Name) are changed, a dialog box will appear questioning the user to either save or discard the present measurement, as it will be removed from memory.

4 Wire Scan GUI

Scope

This graphical user interface (Fig. 4) for Matlab enables to perform a wirescan using beam synchronous acquisition for the wire position and the corresponding photomultiplier, as well as toroid and beam position monitor signals. The raw measurement data and the process data are displayed. Corrections for charge fluctuations and beam position jitter can be applied. The software can save and load the measurement data. Program settings can be saved and retrieved in a configuration file.

Usage Procedure

1. Start program. On the LCLS Home Screen open USER Dev Displays and then select Wire Scan GUI or type `wirescan_gui` in a Matlab session.

2. Select Linac region IN20, LI21, LI28, or LTU

3. Select wire scanner.

4. Select Scan Mode. The mode wire scans the wire across the beam in the original way, the mode corr scans an upstream corrector and uses a BPM to infer the beam position at the wire. The mode Step steps the wire slowly through the beam. The number of steps is the value in Scan Pulses divided by 5.

5. Select which wires to scan, x, y, or u Wire. If more than wire is checked, the Scan Pulses will be spread over the accumulated range of all selected wires.

6. Choose number of beam pulses for scan in the Scan Pulses field.

7. Select appropriate range for the wire scan with the Inner and Outer fields.

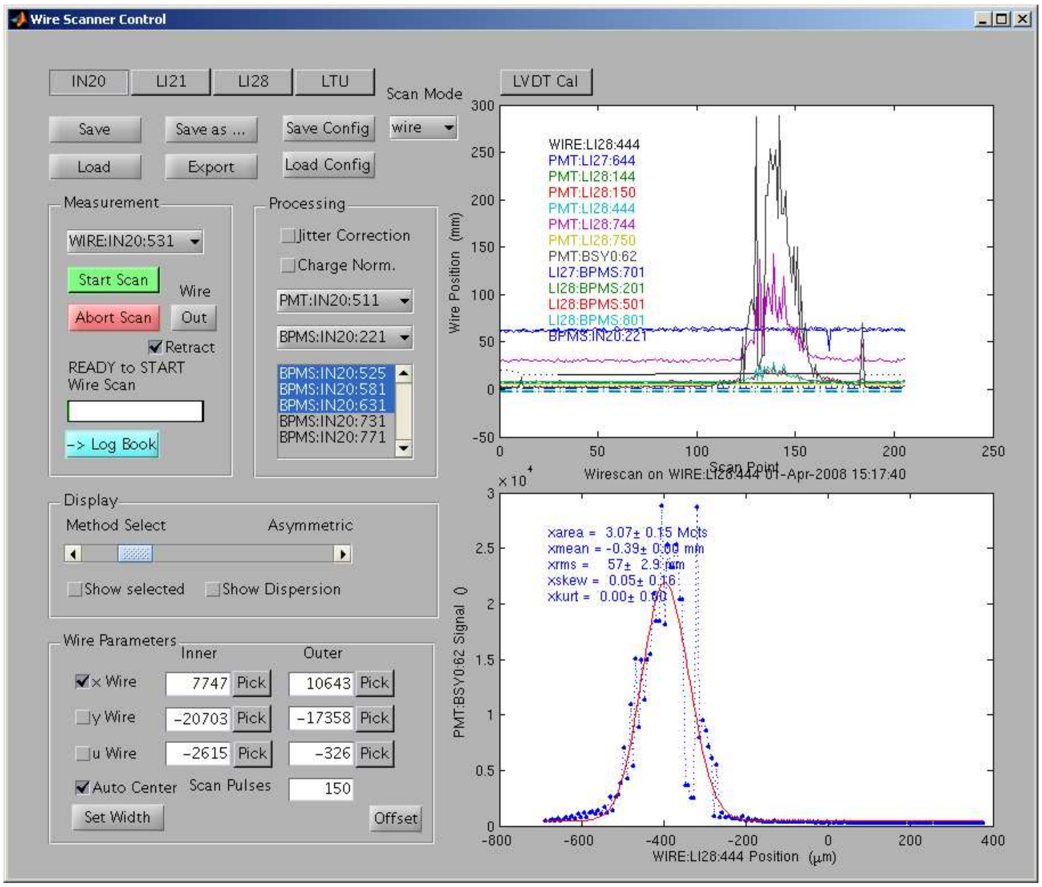

Figure 3: Graphical user interface for wire scans.

8. Alternatively, check Auto Range to center the present scan range Inner, Outer onto the current beam position for all wires on the selected wire scanner. If checked, this centering will occur prior to any new wire scan.

9. The settings in the Wire Parameters panel except for Auto Range all correspond to EPICS PVs and are managed by the control system.

10. Start the acquisition with Start Scan.

11. If the measurement was successful, the program will display a new wire scan.

12. If the measurement has to be aborted use Abort Scan. If this doesn't work, CTRL-C the program.

13. If the measurement was unsuccessful, i.e. the program crashed, or was aborted by CTRL-C, press the abort scan button to enable new scans.

14. Select a proper photomultiplier, toroid, and BPM. The respective selection for each wire scanner is stored in the configuration file and can be updated with Save Config and retrieved with Load Config.

15. Play with the Jitter Correction and Charge Norm. check boxes and the Method Select slider until happy with results.

16. If the wire scan is noteworthy, press the ->Logbook or Save buttons.

17. Subsequent scans. If the program doesn't respond to Start Scan, press the Abort Scan button and try again.

5 Profmon GUI

Scope

This graphical user interface (Fig. ??) for Matlab enables to retrieve and display live images from profile monitor and laser cameras. The software can save and load the image data.

Usage Procedure

1. Start program. On the LCLS Home Screen open USER Dev Displays and then select Profmon GUI or type `profmon_gui` in a Matlab session.

2. Select profile monitor or laser camera from pull down menu.

3. Start live image with Start or get a single image with Single.

4. The image acquisition can be stopped with pressing the the Start button, now labeled Stop.

5. If the image is noteworthy, press the ->Logbook or Save buttons.

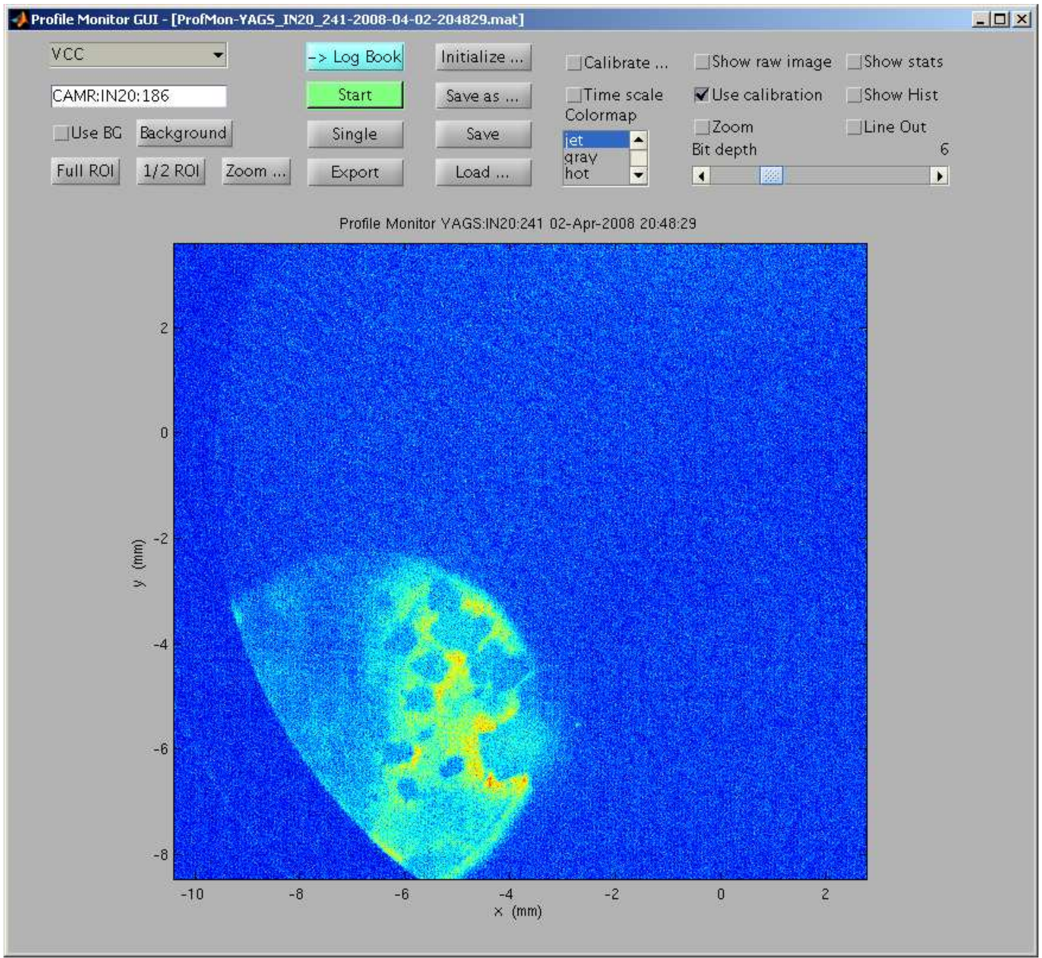

Figure 4: Graphical user interface for profile monitors.

6 Tcav GUI

Scope

This graphical user interface (Fig. **??**) for Matlab enables the measurement of the bunch length of the LCLS electron beam at various beam profile monitors as well as the calibration of the transverse cavity on the respective screen. The software displays the measurement results and can save and load the measurement data. Program settings can be saved and retrieved in a configuration file.

Usage Procedure

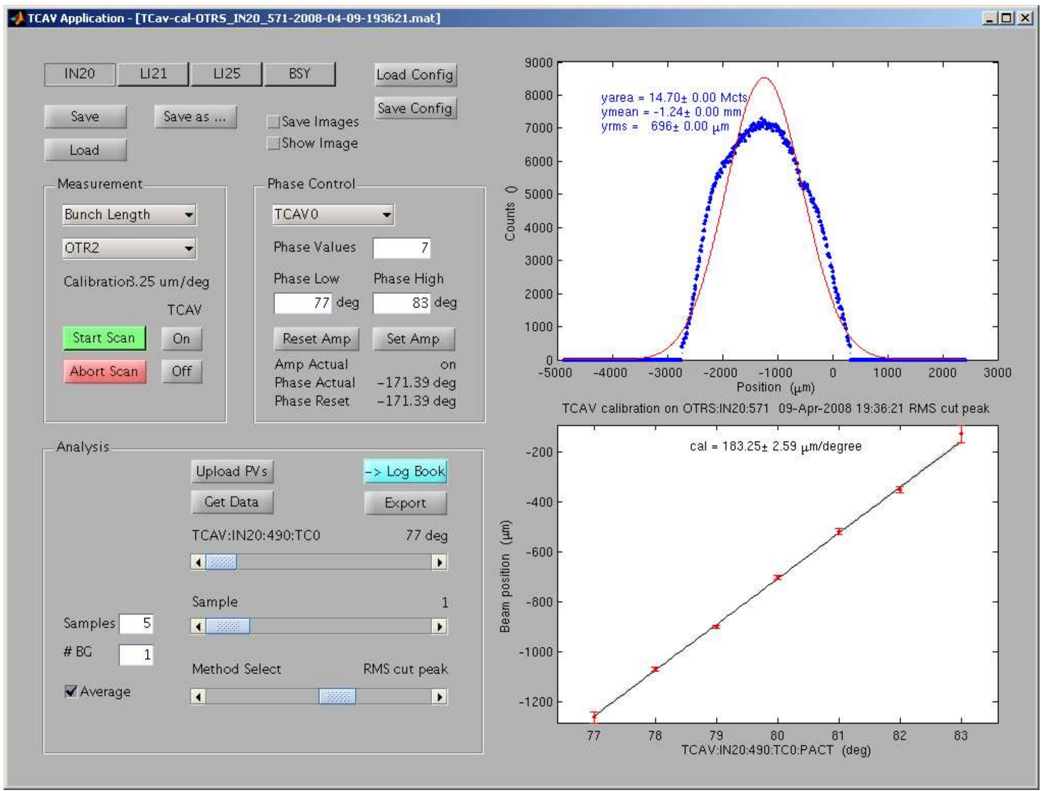

Figure 5: Graphical user interface for bunch length measurement.

1. Start program. On the LCLS Home Screen open USER Dev Displays and then select Tcav GUI or type `tcav_gui` in a Matlab session.

2. Select Linac region IN20, LI21, LI25, or BSY.

3. Select desired mode Bunch Length or Calibration.

4. Select measurement location.

5. For calibration, set the scan range for the transverse cavity. The config for the program stores the range for each screen, so the selection at program start should be useful.

6. If the phase range was changed and deemed permanent, save the present configuration with Save Config.

7. Select the number of images (Samples) per phase or amplitude setting. Depending on beam stability, 5 to 10 shots are reasonable. Select number of background shots (#BG); 1 shot is usually sufficient.

8. Start the acquisition with Start Scan.

9. If the measurement was successful, the program will display a new bunch length measurement or transverse cavity calibration.

10. If the measurement has to be aborted use Abort Scan.

11. If the program crashed, press the Abort Scan button to enable new scans. If a quad scan was aborted, check the Phase Actual or Amp Actual values and press the Reset Amp or Reset Phase button if necessary.

12. Play with the Average and the Method Select slider until happy with results.

13. If the measurement should be kept, press the ->Logbook or Save buttons.

14. Subsequent scans. If the program doesn't respond to Start Scan, press the Abort Scan button and try again.