User Manual for QALMA

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August 17, 2017

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1 Getting Started

QAMLA requires Matlab installed on a computer with Signal processing toolbox, Image processing toolbox and Symbolic math toolbox. The software can be downloaded for free from our github repository http://github.com/mrmushfiq/qalma. The user can follow the simple procedures below to install QALMA,

1. Open MATLAB, click Set Path ->Add with subfolders
2. Navigate to the directory where you unzipped QALMA. Select the 'qalma' folder and click OK.
3. Click save
4. To start QALMA main GUI (Fig 2.), type in the Command Window:
   qalma

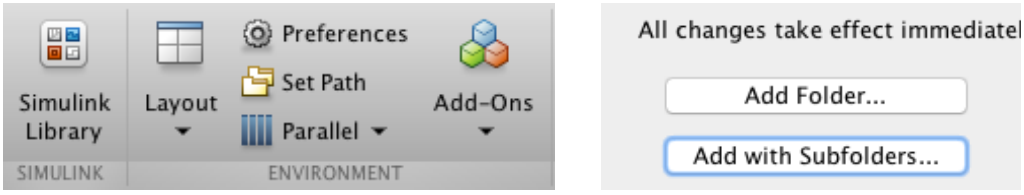

Fig. 1: Installation

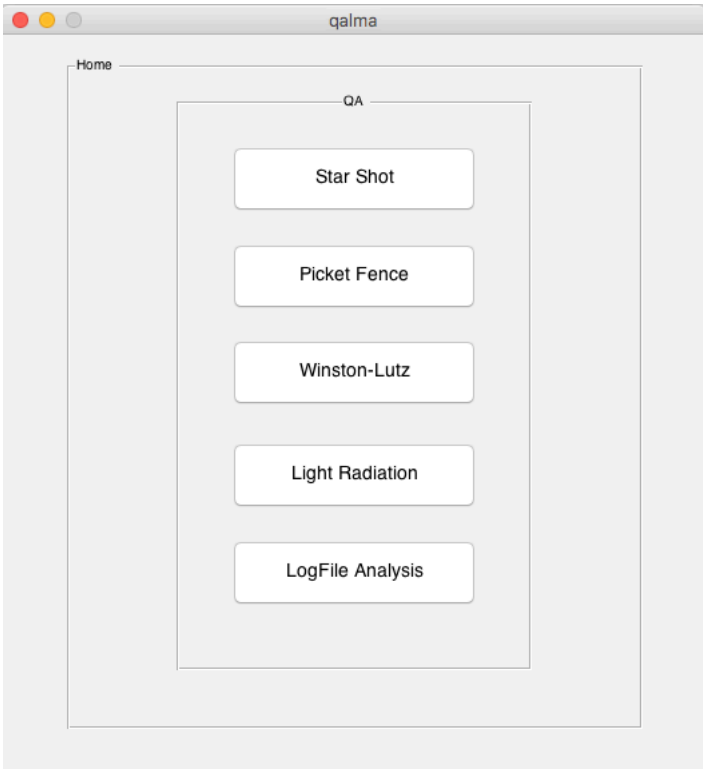

Fig. 2: QALMA Main Window

2 Star Shot Analysis

QALMA star shot module comes with both automatic and manual mode. Star shot images are assumed to have a lower intensity branches than the background. In case, the branches have higher intensity than the background, the image is needed to be inverted (section 2.3).

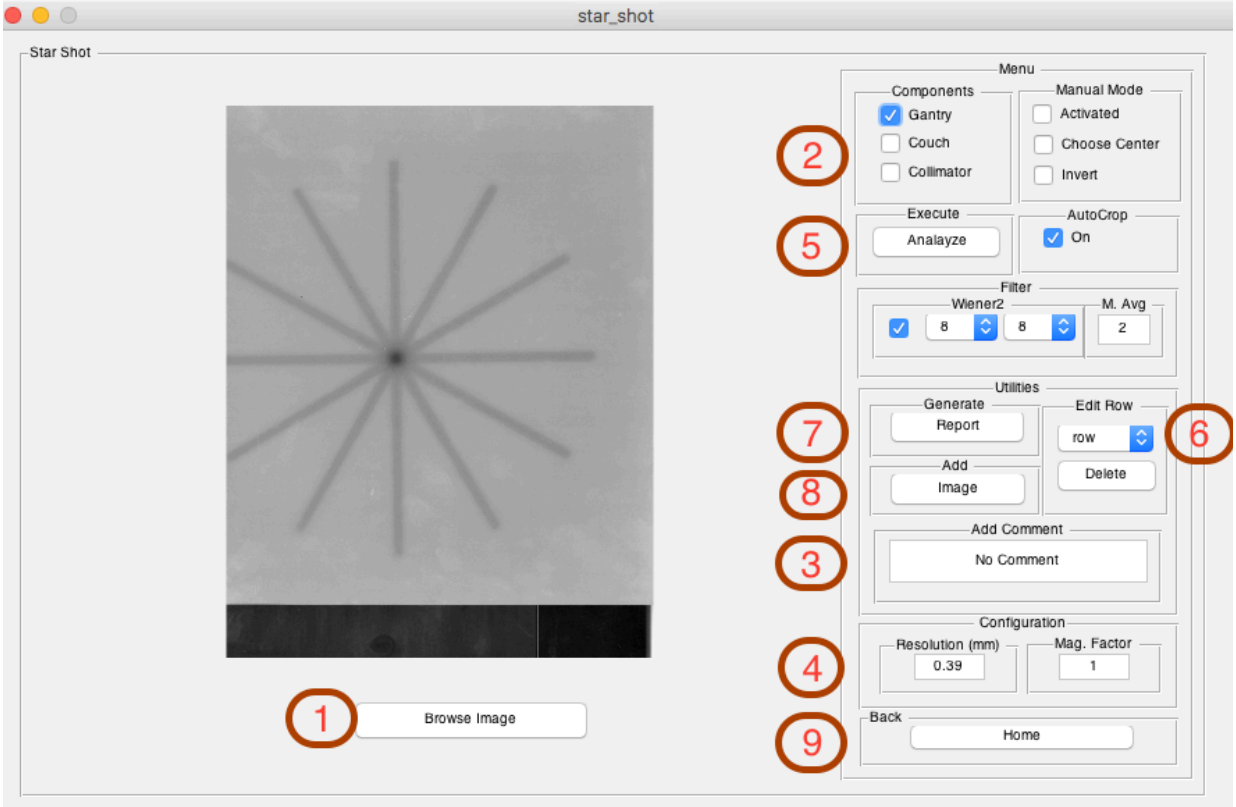

Fig 3: QALMA star shot window

2.1 Automatic Mode

QALMA Star Shot module be opened from the main window or simply type ‘star_shot’ in the MATLAB command window. Next, the user can follow the procedure below:

1. Click the “Browse Image” and load ‘img_star_shot.tif’ from the ‘samples’ folder provided with the package.
2. Select whether the image belong to either Gantry, Couch or Collimator.
3. Add comment if you have any.
4. Check Configuration. Check your film manufacturer manual to find the resolution. To get the result in pixel, simply input ‘1’ for the ‘Resolution’.
5. Click ‘Analyze’.
6. Select the row and click ‘Delete’ if you want to remove a trial.
7. Click ‘Report’ to generate a pdf report in the current working directory. To save file in another directory or in a different format, please select ‘File’ from menu and click ‘save as’.

Current working directory can be found by typing ‘pwd’ in the command line.

8. Click ‘image’ if you want to analyze another image.
9. Go to QALMA main window by clicking ‘Home’.

2.2 Manual Mode:

QALMA can be used in automatic mode most of the time. In case, the software cannot detect even number of legs it will pop a massage to the user to choose an initial point. To activate the manual mode, the user must check the checkboxes ‘Activated’ and ‘Choose Center’. Then click somewhere in the image, preferably around the center. Rest of the procedure is same as the automatic mode.

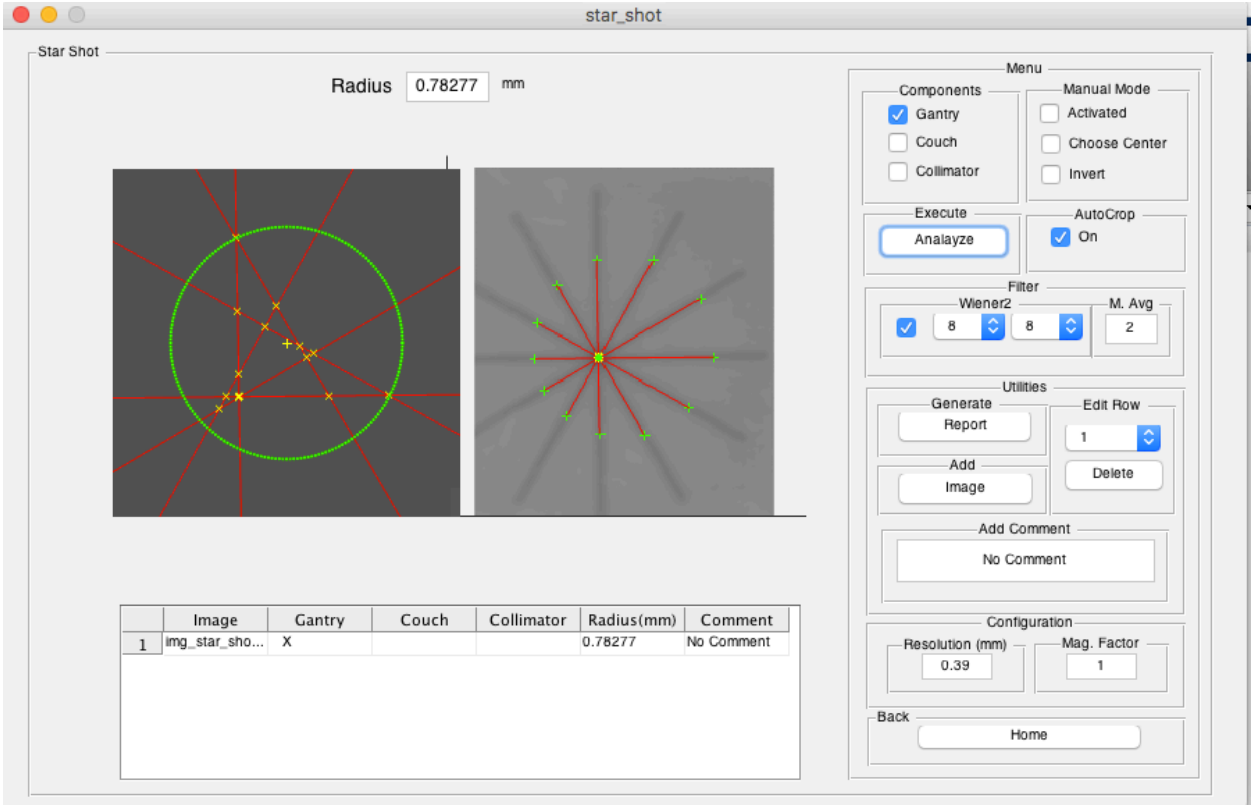

Fig 4: QALMA Star Shot Analysis

2.3 Inverting Images:

Image provided with the QALMA package has branches with lower intensity. If you have an image with higher intensity branches than the background check the boxes for ‘Activated’ and ‘Invert’. Before processing the image QALMA will invert the image automatically.

2.4 Miscellaneous:

In case, the software is not detecting the branches as shown in the result (fig. 4) and the radius of the circle is not as expected, the user must try changing the parameters of 'winer2' and 'moving average' filers.

Auto crop is on by default. Uncheck 'Auto crop' if you don't want to trim the edges of the image.

3 Picket Fence

QALMA Picket Fence window can be opened by clicking the 'Picket Fence' button from the main window or simply type 'picket_panda' in command window.

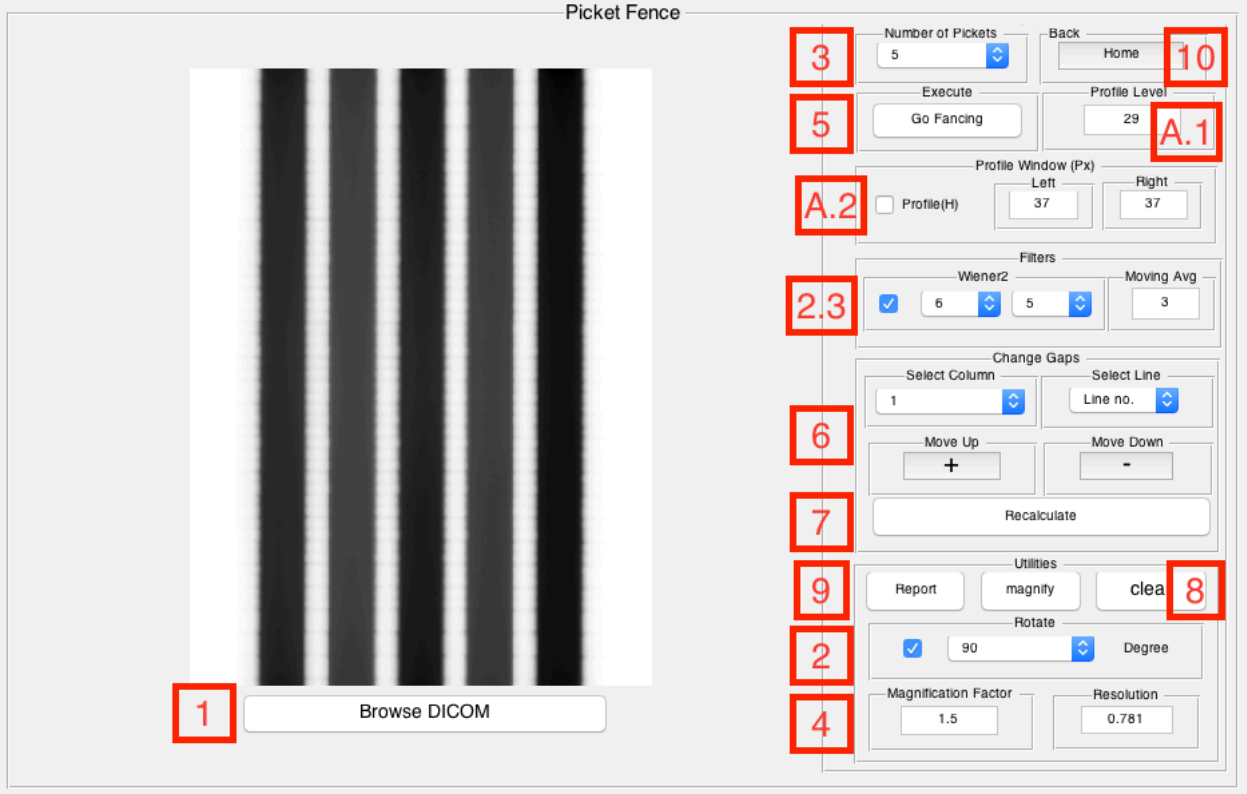

Fig. 5: QALMA Picket Fence window

3.1 Analysis:

Picket fence analysis can be performed simply by following the procedure below:

1. Click the “Browse DICOM” and load the image ‘img_picket_fence.dcm’ which can be found in the ‘samples’ folder provided with the QALMA package.
2. QALMA expects the pickets to be vertical. If the image has horizontal pickets, it must be rotated. The image provided with the package has horizontal pickets. So, check the box and select 90 Degree.
3. Select the number of pickets you want to analyze.
4. Check the Magnification factor and the resolution of the imager.
5. Click ‘Go Fancing’. A cursor will appear. Choose the pickets one by one from left to right. The user must click the horizontal centers of the pickets as shown in the figure 6. The yellow markers show the chosen centers of the pickets. QALMA will finish the analysis by detecting the leaf position and edges. The gaps are located using the green lines and the position of the leaves are shown using red ‘*’. Couple of figures will be opened. Unless Profile (H) and Profile (v) is checked, please wait till the figures close by themselves.
6. If you want to adjust the positions of the leaves, at first choose the column (bank position) and line number. Then click ‘+’ or ‘-‘ to move a line up or down.
7. Finally, ‘click recalculate.
8. If you want to restart the process with the same image click ‘Clear’.
9. Generate a pdf report at the current working directory by clicking ‘Report’. To save file in another directory or in a different format, please select ‘File’ from menu and click ‘save as’.
10. Go back to QALMA main window by clicking ‘Home’.

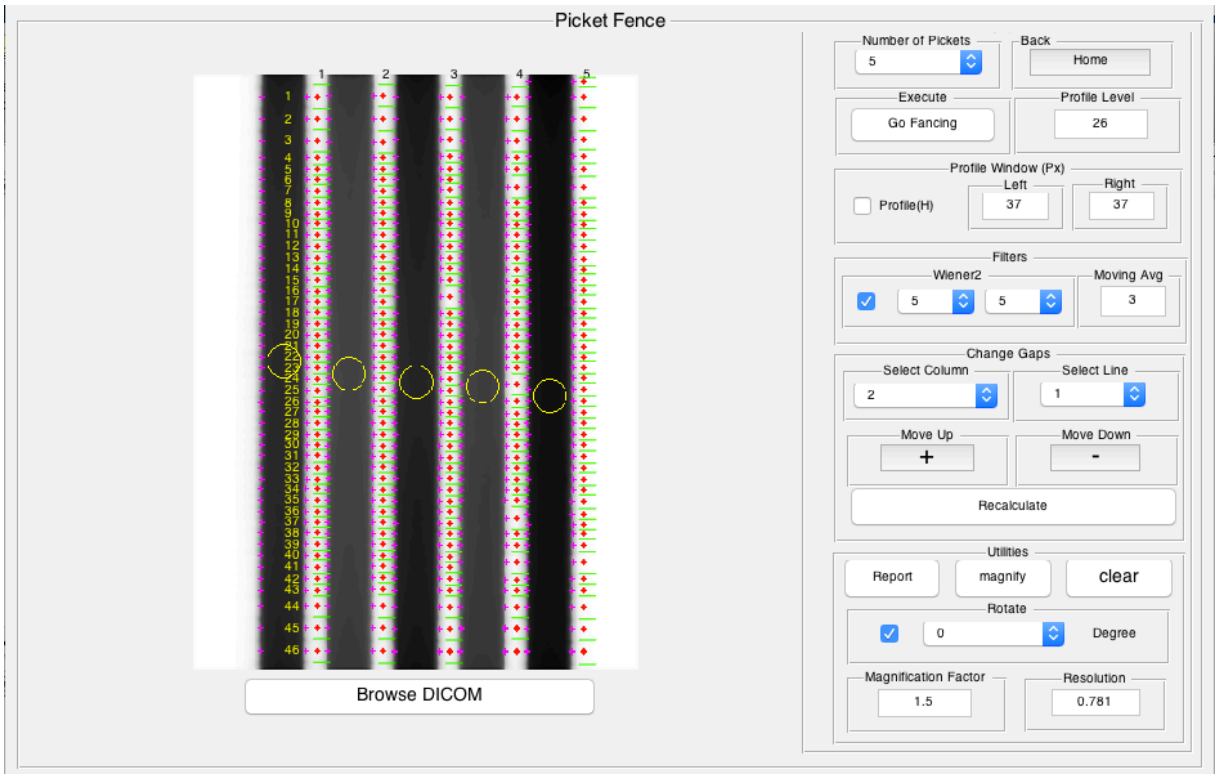

Fig. 6: Picket fence analysis.

3.2 Adjusting Profile window (width) and level (center):

If you are using QALMA for the first time for your system, you might need to adjust the parameters, in case the default parameters could not generate expected result (fig. 6).

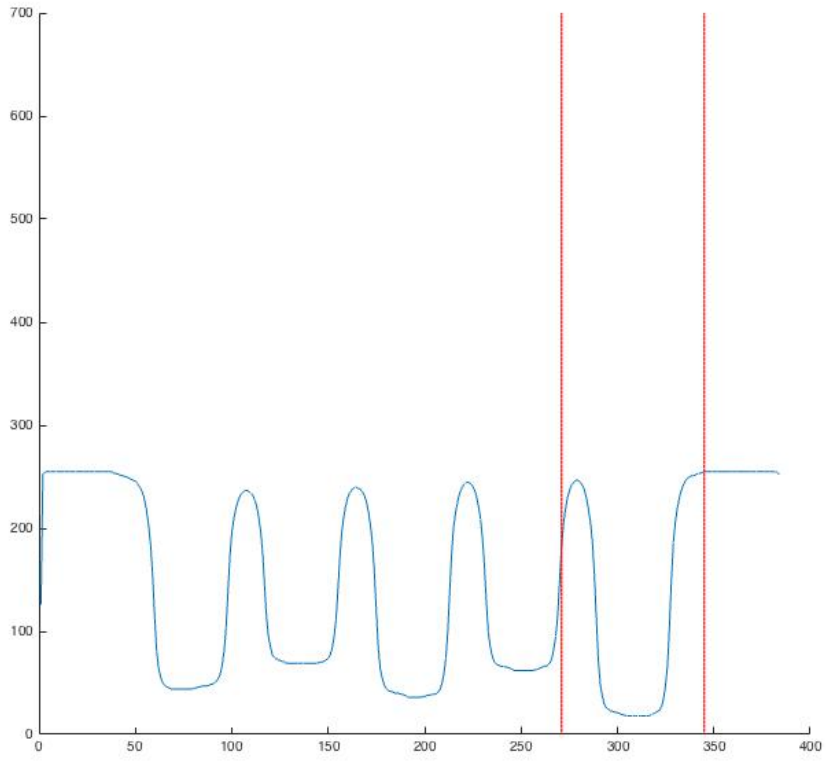

Fig. 7: Adjusting the profile width

A.1: If the position of the center '*' is not located at the at the center (horizontally) of the leaves, then profile level is needed to be changed. Please increase or decrease the default number to shift the '*' to the right or left. Even if the asterisk seems to be at the center, changing the level two or three pixels can drastically improve the result.

A.2: The next step is to adjust the profile window (width). After following the steps 1-5 in section 2.1 check the box 'Profile (H)'. Then an additional window will pop up with a horizontal profile. You can also keep it checked initially which will result in same outcome. As shown in the fig. 7, the two vertical red lines should enclose only one minima. Please, increase or decrease the values at the "Left" or "Right" text boxes on in window to move the change the position of the left and right window. To make these parameter changes permanent please see section 7.

3.3 Adjusting the filters:

Expected results might not be achieved due to the existing noise on the image depending on the quality of the imaging system. The user is expected to try different values of Weiner2 and moving average filters until desired result is achieved (fig. 6).

3.4 Magnify:

A magnification glass will appear once the ‘Magnification’ button is clicked (fig. 8). It can be turned off by clicking the same button again and pressing ‘Esc’ on the keyboard.

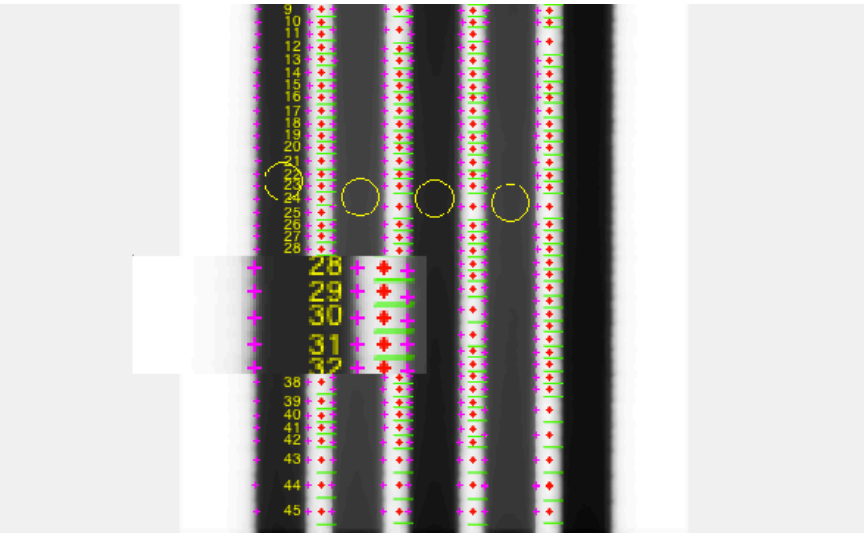

Fig. 8: Magnification glass

4 Winston-Lutz test

Winston-Lutz module can be opened from the QALMA main window or simply typing ‘wl’ in the command window in Matlab. One can perform the test using the following procedure below:

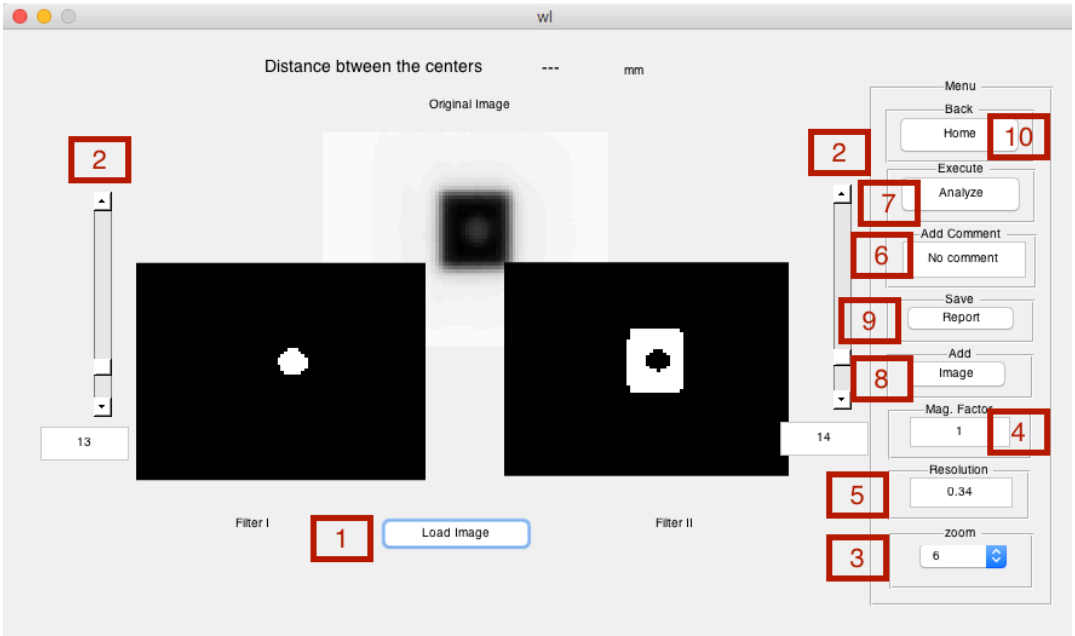

Fig. 9: QALMA Winston-Lutz module

1. Click ‘Load Image’ and select ‘img_winston_lutz.dcm’ from ‘sample’ folder provided with the QALMA package
2. Two binary images will appear on filter I and filter II with two white objects, one of which would be the ball and the other one would be the radiation field with the ball removed from the initial image. The user can use the slider or text box to change the filter parameters to find the appropriate of the objects using trial and error. The example here (fig. 9) shows a proper setting, which will vary for different images.
3. Zooming parameter can be changed to achieve a clear view of the images. Zoomed in view will be shown with the increase of the parameter and vice versa.
4. The default value for the magnification factor is 1, which measures the distance between the centers of the radiation field and the metal ball at the isocenter. Change the magnification factor if the distance is desired to be measured at the EPID.
5. Type the resolution of the EPID which can found at vendor’s manual. Setting the value to 1 will measure the distance in pixels.
6. Add comment if you have any. Comment section can be used to mention the angle and whether the image belongs to the test for Gantry, Collimator or Couch.
7. Click ‘Analyze’ to complete the analysis (fig. 10).
8. Click ‘Add image’ to analyze another image.
9. Generate Report

10. Click ‘Home’ to go the QALMA main window

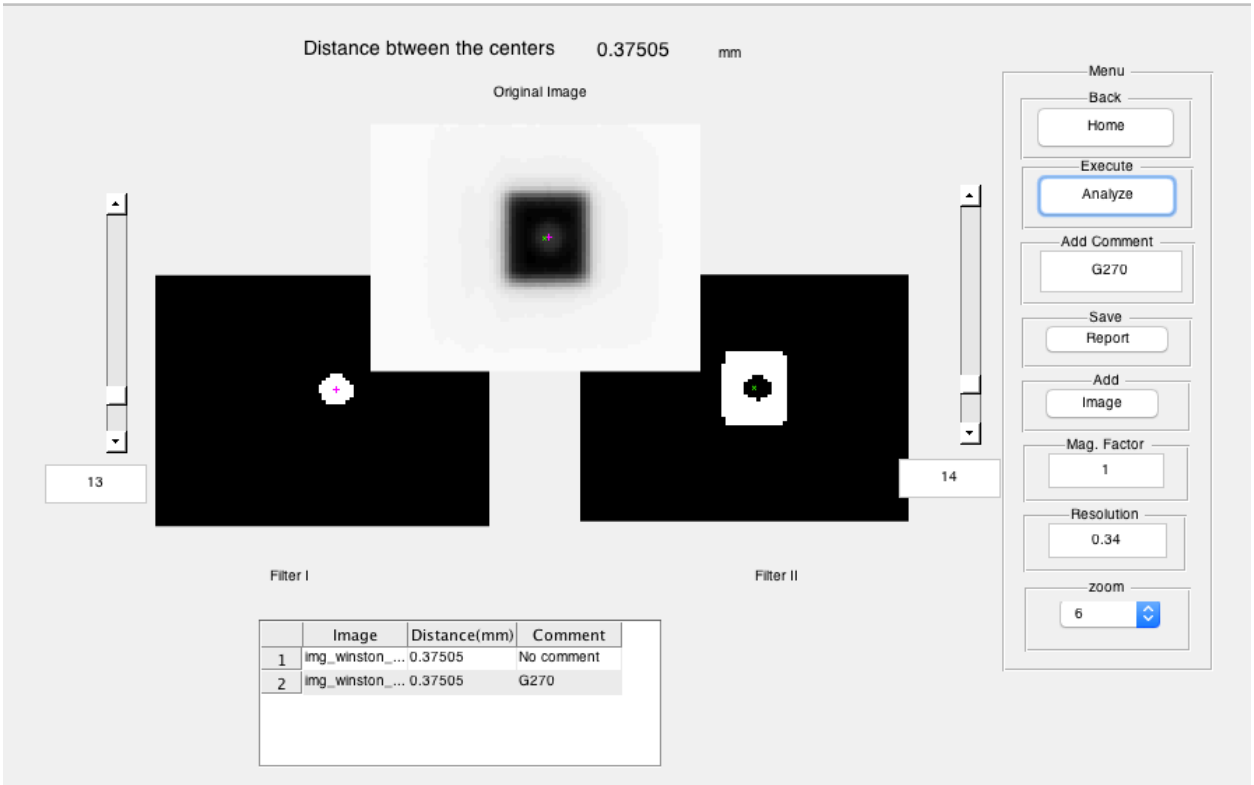

Fig. 10: Winston-Lutz test (Result)

5 Log file analysis

Dynalog analysis or log file analysis module is the simplest of all the modules available in QALMA. It can be opened from the main window or simply by typing 'dynalog' in the command window. The log file analysis can be performed using the following procedures:

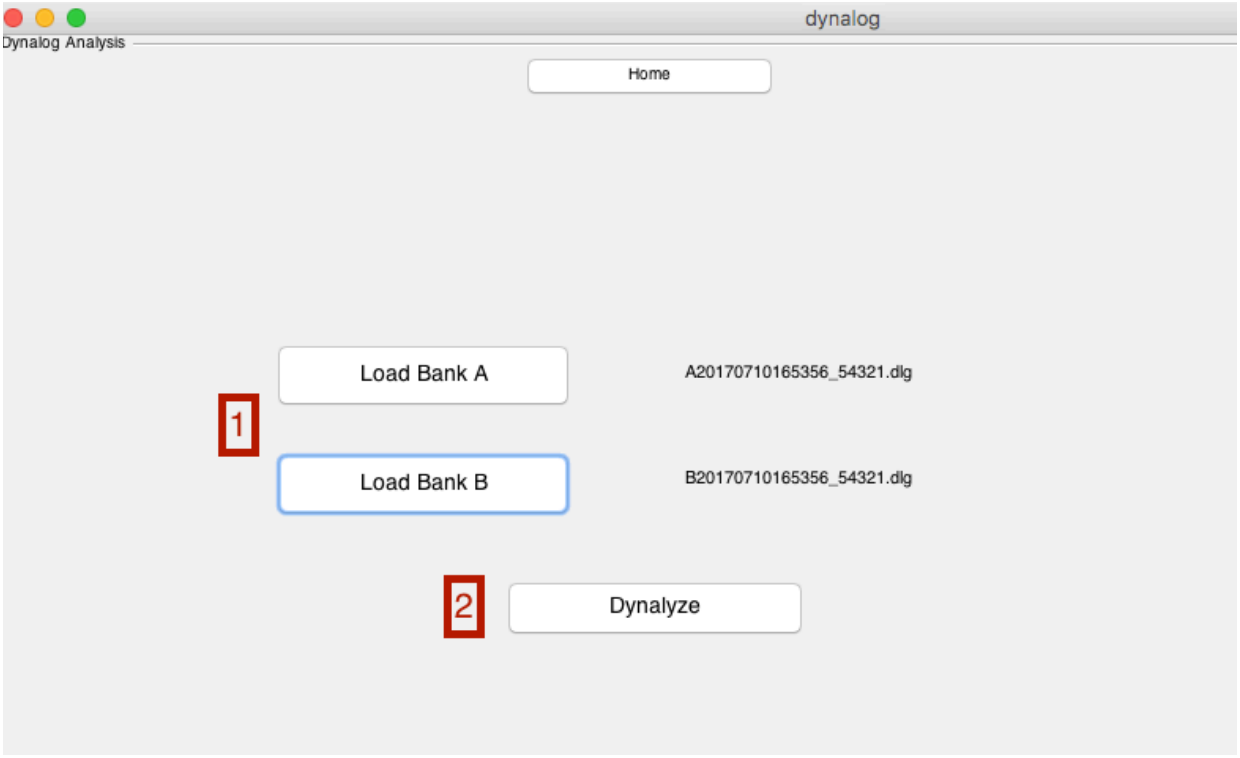

Fig. 11: QALMA Dynalog module (loading files).

1. Load Varian™ dynalog files for bank A and bank B. Two sample files are provided in the 'samples' folder. The user can load 'A20170710165356_54321.dlg' and 'B20170710165356_54321.dlg' files to follow the example (Fig. 11).
2. Click 'Dynalyze' (Fig. 11).
3. Add comments (Fig. 12).
4. Save 'Report' (Fig. 12).
5. Analyze more files (Fig. 12).
6. Click 'Home' to go back to QALMA main window.

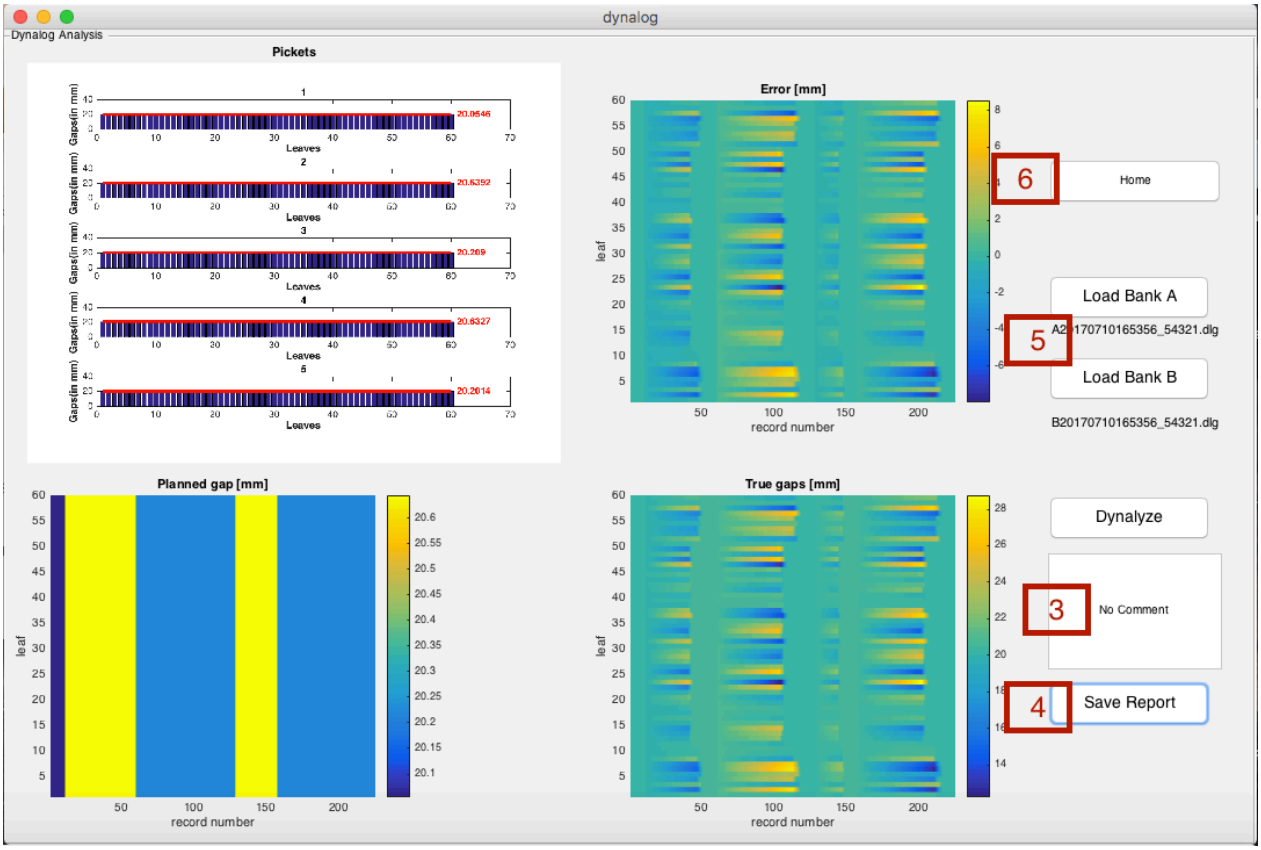

Fig. 12: QALMA Dynalog analysis

Note: The user may need to resize the Dynalog GUI or switch to full screen mode if all the figures don't find in window due to the resolution of the certain computer monitors.

6 Light Radiation Field Coincidence

The light radiation field coincidence test can be performed using QALMA following the simple procedure explained below. This section is divided in two separate sub-sections: Image acquisition and Analysis.

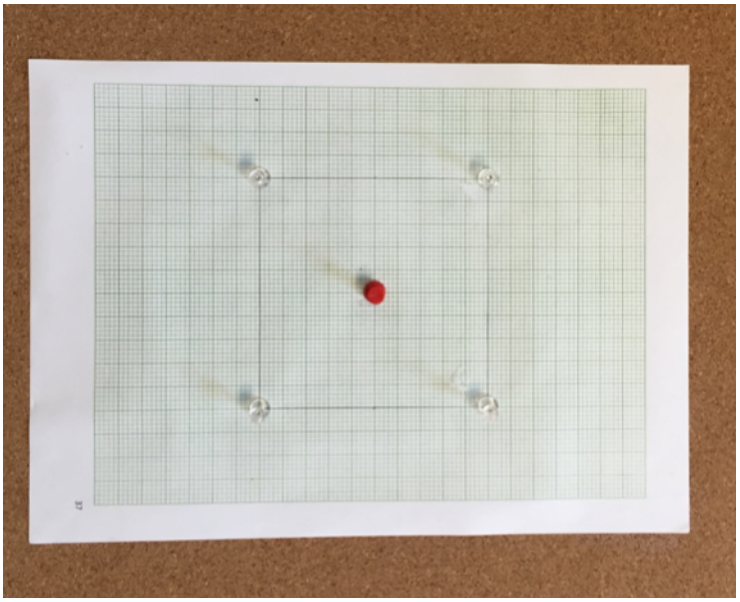

Fig. 13: In-house built phantom for light radiation field coincidence test

6.1 Image acquisition

1. The gantry, collimator and couch were set to 0 degree (IEC convention)
2. The phantom (Fig 13) was built using a graph paper glued on the cork board, four board pins (BBs) at the corners of 10 x 10 cm square and a board pin at the center. The phantom was setup at 100 cm SSD on the table and aligned with the 10 x 10 light field set according to machine parameters.
3. The EPID is brought out so that the source to imager distance (SID) was 150 cm.
4. Energy and the dose rate were selected.
5. An image is acquired for 10 x 10 cm field size.

6.2 Analysis

QALMA light radiation field coincidence module can be accessed from the main window or simply by typing ‘ci’ in the command window. The coincidence can be checked using the following procedure:

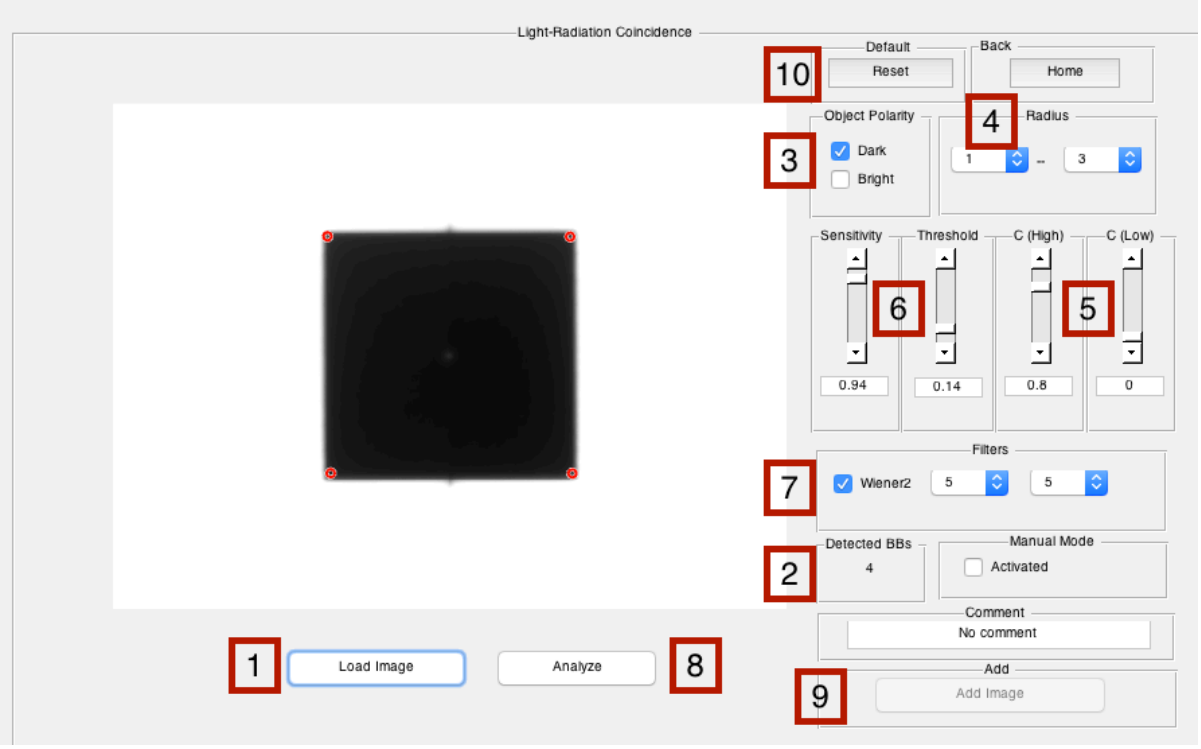

Fig 14: Light radiation field coincidence (automatic mode)

6.2.1 Automatic Mode:

1. Load the image desired to be analyzed. To follow this example, the user can load the provided image 'light_radiation.dcm' from the 'samples' folder. The next step is to adjust the parameters. The default parameters are optimized for the sample image. Four small circles locate the position of the BBs. See Section 7 to make permanents change to the parameters.
2. Check the number of BBs. If it's not 4 then we need to adjust parameters.
3. Object polarity is usually set to dark. For a different contrast where bright objects are to be detected, 'bright' can be checked.
4. Radius should be selected as 1-3 if the procedure explained here is followed for image acquisition using the same phantom. If different BBs or setups are used the radius can be larger.
5. Contrasts: C (High) and C (Low) are adjusted to get a decent view of the BBs or until 4 BBs are detected. However, C (High) should always be larger than C (Low).
6. Sensitivity and Threshold parameters are to be adjusted by 'trial' and 'error' until 4 BBs are detected.
7. Filters can be adjusted if necessary
8. Click 'Analyze'. A red and a green box appear for the inspection of the coincidence and Dice coefficient is shown at the top of the window. The closer the value is to 1, the better the coincidence is.
9. Analyze another image if necessary
10. Click 'Reset' to get the default parameters back.

6.2.2 Manual Mode:

Instead of the automatic mode, one can use the manual mode where the user can choose the BBs manually using the following procedure (Fig 15):

1. Check the box ‘Activated’ to activate the manual mode
2. Contrasts: C (High) and C (Low) can be used to get a decent view of the BBs
3. Click ‘Analyze’
4. A cursor will appear on the screen which is used to choose the four BBs one by one. Four blue cross marks are shown at chosen positions. The red and green boxes will appear to inspect the coincidence of the light and radiation fields. Dice Coefficient is shown at the top of the window.
5. Click ‘Reset’ to get the default values for the parameters.

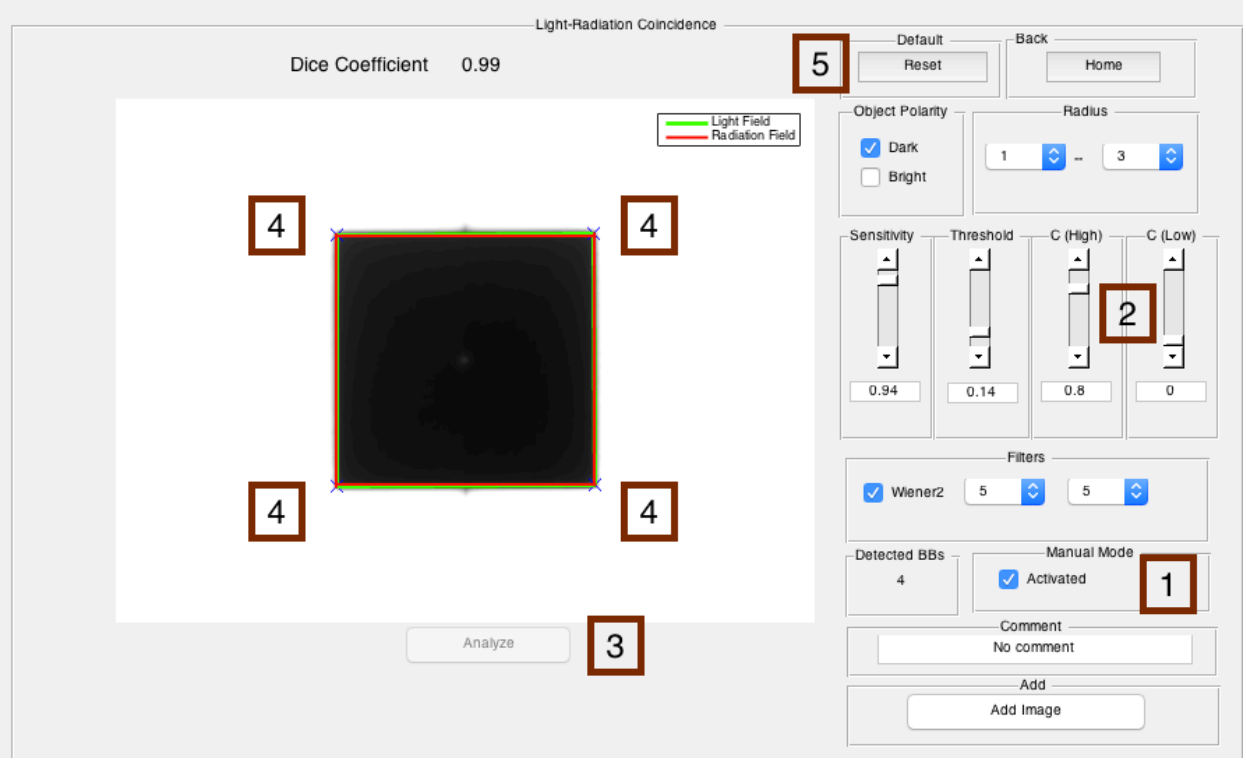

Fig 15: Light radiation field coincidence (manual mode

7 Customizing QALMA

Changing the default parameters in QALMA permanently is simple. They are found in the ‘OpeningFcn’ function in the main .m file of each module. The main files for located in the dedicated folders for each module:

- ~/qalma/star_shot/star_shot.m

- ~/qalma/picket_fence/picket_panda.m
- ~/qalma/winston_lutz /wl.m
- ~/qalma/dynalog/dynalog.m
- ~/qalma/ci/ci.m

Let's try an example:

```
76
77 -    set(handles.smoothing_param,'string','3');
78 -    set(handles.picket_num_pop, 'String',{1:10});
79 -    set(handles.level_txt, 'String', '26');
80
81 -    set(handles.width_left_txt, 'String', '37');
82 -    set(handles.width_right_txt, 'String', '37');
83 -    set(handles.w1_pop, 'String', {1:10});
84 -    set(handles.w2_pop, 'String', {1:10});
85      % set(handles.w1_pop, 'Value', 3);
86      % set(handles.w2_pop, 'Value', 2);
87 -    set(handles.w1_pop, 'Value', 5);
88 -    set(handles.w2_pop, 'Value', 5);
89
90 -    set(handles.rotate_pop, 'String', [0,90,180,270,360]);
91 -    set(handles.rotate_check, 'Value', 1);
92 -    set(handles.rotate_pop, 'Value', 1);
93 -    set(handles.profile_check, 'Value', 0);
94 -    set(handles.wiener_check, 'Value',1);
95 -    set(handles.mag_txt, 'String', '1.5');
96 -    set(handles.res_txt, 'String', '0.781');
```

Fig. 16: Parameters in picket_panda.m

- Open the file ~/QALMA/picket_fence/picket_panda.m on Matlab.
- Find the line "function picket_panda_OpeningFcn(hObject, eventdata, handles, varargin)" which should be found around line 50. All the default parameters are found inside this function (fig. 16).
- Matching the values from the GUI one can easily identify the variable or tags to change the value. Usually *_text is used for a text box, *_pop is used for drop-down menu and *_check is used for checkbox.
- Level or center can be changed by changing 'level_txt'
- Width can be changed using 'width_left_txt' and 'width_right_txt'
- Winer filter parameters can be changed using 'w1_pop' and 'w2_pop'
- Moving average parameters can be changed using 'smoothing_param'
- Rotation degree can be changed by setting 'rotate_pop', 'Value' to 1, 2, 3, 5 or 5 to select 0, 90, 180, 270 or 360 Degree respectively.
- Magnification factor and resolution parameters can be changed using 'mag_txt' and 'res_txt' respectively.