**MANUAL FOR IMAGE ANAYLYSER**

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Hi! Do you want to know how to install, run and use this Image Analysis software? Well hopefully this will provide the answers to your questions. If it doesn’t then feel free to email me at:

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This is the first version on my very first GUI so there is bound to be bugs and when you find any please let me know so I can update and improve the software. That being said, I hope this find the Software useful and this Guide informative.

**1 INSTALLATION**

To install, please read the document 'Installation of Python and ROOT for Image Analysis Software.docx'.

**2 RUN SOFTWARE**

To run the code, ensure you have a setup like the one described in the installation document, then from the command line, input:

python Image\_Analyser.py

It worth knowing that the accompanying files you received with the .py script should be kept with the python script, as they are vital for running the code.

**3 FEATURES**

This section describes a bit about all the features you can find in the GUI and why they are included.

**3.1 OPEN IMAGE(S)**

The types of images that can currently be uploaded are 12-bit .raw files (in greyscale) and 8-bit .png (colour or greyscale). You can also mix these files, for example, you can have a beam image loaded from a .png and the background loaded from a. raw file.

In the toolbar across the top of the window there is the option 'Open'. This tab gives you the option to upload and image, a batch of images, a background image and a batch of background images. When you upload one image/background it will be displayed inside the graph section on the ‘Main Page’ tab.

For now the name of the images you upload is important as it is what sets certain parameters in the analysis. The software looks for strings 'YAG-' or 'Virtual Cathode' in the name of the image to know where the image has come from. Therefore do not alter the names of the images initially given to them.

**3.2 SET BACKGROUND(S)**

Loading backgrounds does not have the same restrictions to the name of the file like the image has so can be named however you choose.

**3.3 SAVE DATA**

Along the top toolbar there is ‘Save’ and it offers four options on what to save. By selecting ‘Beam Positions’ you will save analysis results of an image that has just been analysed to a text file. The ‘Image’, ‘X Projection’, and ‘Y Projection’ options will save the respective graphs from the ‘Main Page tab.

**3.4 MAIN PAGE**

**3.4.1 FIND BEAM BUTTON**

Clicking this button runs the analysis of the image you have uploaded using the options and settings you have selected. You do not need to press this button when analysing a batch of images.

**3.4.2 OPTIONS**

To select one of these options you will need to select the check box. Some will update your results instantly and some will require you to re-run the analysis (one such example of the latter is 'Show Original Image' option).

**3.4.2.1 SUBTRACT BACKGROUND**

This option is applied when you run the analysis (click the 'Find Beam' button) and subtracts the background you have uploaded (Section 3.2).

**3.4.2.2 SHOW ORIGINAL IMAGE**

Though the analysis the image manipulated and edited. A copy of the original image is stored and if you wish to view it you can do so by selecting this option.

**3.4.2.3 HIGHLIGHT SATURATED PIXELS**

This option updates instantly and covers the upload image with a translucent image that highlights saturated pixels in green. The default saturation level is set to 4095 which is based on 12-bit .raw file (8-bit .pngs are scaled to match this value), but you can change this level (Section 3.5.1.5). Note: if you wish to view saturated pixels before you’ve run any analysis, ensure you selected the ‘Show Original Image’ option as well, otherwise the code will break.

**3.4.2.4 USE MANUAL CROP**

In the analysis there are two stages that crop the image automatically however these can be bypassed and you can choose you own manual crop of the image. By selecting this option a ‘Region Of Interest’ (ROI) appears. This can be scaled and repositioned over your image so when you run the analysis it will crop the image to what lies within the ROI. Note cropping processes only works on the original image. You cannot re-crop and re-analyse an image.

**3.4.2.5 UNITS IN MILLIMETRES**

This option updates the parameters that are displayed on the 'Main Page'. The default is to show the parameters in units of pixels or pixels^2. By selecting this option you set the units to millimetres. This option also governs what units the parameters will have when and image or batch of images are saved to a text file.

**3.4.2.6 SHOW 1D PROJECTION FITS**

When fitting a BVN function to the image of the beam, estimates of the beams position and size (sigma x and y) are used. These estimates come from fitting Gaussian curves to the X and Y projections of the image. By selecting this option you can view the lines indicating one sigma above and below the mean on each of the projections.

**3.4.2.7 SHOW DIRECT FIT**

In the analysis of the beam there are two methods that are carried out to calculate the beam's parameters. The first if fitting a BVN function to the image and the second is using a covariance matrix. The latter method has been coined the 'Direct Method' it conducts a weighted average of the pixel positions with pixel intensity used as the weight. When you find the beam on your image crosshairs and contour lines are overlaid to show a graphical indication of the fit. The default of this is to show the BVN results, however by selecting this option you can view the direct method's results overlaid on the image instead.

**3.4.2.8 IMAGE COLOUR SCHEME**

This is the list box at the bottom of all the other options. By choosing one of the options in this list you set the colour scheme for the image and background image. Choose whatever colour scheme you like best! Yey for colour! And yes... I am aware the names of my colour schemes are a bit immature, but hey, it's fun.

**3.4.3 PARAMETER DISPLAY**

Below the options on the left-hand side is the parameter display. When the analysis of an image is complete the results are displayed here.

**3.4.4 TEXT OUTPUT**

This text display is just way to keep an eye on all the buttons you will press. It doesn't get saved anywhere, it tells you what you've done or if you need to do something.

**3.4.5 GRAPH DISPLAY**

This is the big section on the 'Main Page'. It displays your uploaded image, background image and projections of the image. By right-clicking on one of the graphs you can export it as an image how you desire. This functionality comes from using the library 'pyqtgraph' so if you want more info on how it works you can always google that. I suggest experimenting with the options in this GUI though, as its fairly intuitive.

**3.4.6 IMAGE STATUS (BOTTOM OF PAGE)**

The two lines at the bottom of the window show the addresses of the image and background image you have loaded into the GUI.

**3.5 SETTINGS**

This section explains what is in the ‘Settings’ tab.

**3.5.1 EXPERT SETTINGS (ES)**

Expert Settings (ES) are settings that allow people like yourself more control on how the analysis and parameters of the beam are conducted and obtained. Each option you can have has a check box next to it to allow you to select that option for when you re-run the analysis.

**3.5.1.1 LOAD AND SAVE ES**

Have a particular setup of ES that you prefer but can't be bothered to re-enter all the particular values every time you run this GUI? No worries! This is your answer. By using the load and save buttons at the top of the ES section to the ‘Settings’ tab you can save the setup you want to use again as a .txt file and load those values at a later date.

**3.5.1.2 MASK**

One of the first image manipulation processing that occurs in the image analysis is to apply a mask that removes parts of the image that are useless. The shape of this mask is that of an ellipse and with this option you can manual set the centre and radii of the ellipse mask. Note: these values are always entered in units of pixels. Automatically and by default, they are read in from the YAG.config file, but using this option this will override those values.

**3.5.1.3 PIXELS TO MILLIMETRES**

Here you can manually change the pixel-to-millimetre ratio that is used to convert the results. By default it is read in from the YAG.config file, but this will override that value.

**3.5.1.4 R-SQUARED THRESHOLD**

When determining if the fits to the image projections are good enough, R-squared values are calculated for each. Usually if those values are above 0.4 the fit parameters are considered good enough to use in the BVN fit method. If not, then estimates using the FWHM are used. This 0.4 threshold can be changed to the value you input here.

**3.5.1.5 SATURATED PIXEL VALUE**

By default the saturated value is set as described in Section 3.4.2.3. However the value can be overridden with this setting.

**3.5.1.6 SIGMA CUT**

To speed up analysis of the image, as much of the image (as reasonable possible) is removed. Therefore the image is cropped using the projection fit parameters. The default is to cut the image to 3\*Sigma in X and Y around the centre of the beam. The multiple of this sigma can be changed with what it inputted for this setting. Be warned though, if you choose a value of sigma that causes a crop beyond the size of the image, it will NOT conduct this crop.

**3.5.1.7 SPECIFIC FILTER**

The fits to the X and Y projections need estimates and the way they are found uses the filtering (smoothing) of the projection. This is done using a moving average, and the number of points the filter averages over can be set here. By default the software selects the best filter between 5, 10 and 20 point moving averages. You can’t average of a non-integer amount of data points so only integer inputs here please.

**3.5.1.8 MANUAL CROP PARAMETERS**

The position of the manual crop option described in Section 3.4.2.4 can be set in units of pixels using this setting.

**3.5.1.8 CUT LEVEL FOR DIRECT METHOD**

The direct method can be improved be ignoring lower intensity pixels. They cause a skew in the resulting parameters, implying a larger beam than what actually existed. This option allows for the setting of a level below which pixels are ignored by the direct method. The input here is a percentage of the maximum pixel intensity and that provided the cut off level.

**3.5.2 BATCH MODE**

This section explains the features available of the ‘Settings’ tab in the ‘Batch Mode’ settings.

**3.5.2.1 LOAD IMAGES**

Use the buttons on this page to load in multiple images and background images to analyse. Running certain batch methods are described in the text in these settings, but the general idea is that you can run with no background image, one background image (used for every image) or run with and equal amount to both. The order of both lists needs to match each other so the image and corresponding background have the same position in their relative lists.

MOST IMPORTANTLY: In batch mode the settings you have selected on the ES and options will be used for all the batch images so be aware of what you have selected.

**3.5.2.2 OUTPUT SETTINGS**

This box contains options to select for what data you want saved. Note: before you analyse a batch of images you MUST enter a valid name for an output text file for this section. This text file will contain the names of the relevant names to the graph images you decide to save.

**3.5.2.3 RUN AND PROGESS**

Final to run the analysis on you images click the ‘Run’ button and track the process of the batch on the progress bar.