

# **User manual for program – FITSOVERLAP**

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## Introduction

This program (fitoverlap.pro) is mented for comparison of intensities of magnetogram and H-alpha image, it determines corelation of intensities, of those two types images, or any other type – so in other cases it doesn't need to be magnetogram and H-alpha. For example, you can analyse filaments, prominences, sunpots etc.

Here you can read the manual for program, and at the end of explanation you'll find also example of the process.

Necessary data for program to work properly:

- Main program : **fitoverlap.pro**
- Main program has separated functions that has been written, so also you need to put these function in IDL workspace:
  - radiusfits.pro
  - rotmodfits.pro
  - translatefits.pro
  - resizefits.pro
  - slitrotate.pro
- Also main program uses **mpfitellipse.pro** and it must be in IDL library, so as the, **readfits.pro**, **writefits.pro**, **sxpar.pro** – also those tree functions must be in IDL library.
- And of course you need images that you want to examine in FITS format.

## Main interface

When you have images for analysis, and you see images, first what is needed to determine is whether you can spot one or two points on images for which you are sure that are the same on both images.

If you can see one same spot, than you will use part of the program that is **One point fit**, and if there is two same spots, than you will use second part of the program that is **Two points fit** (as seen on the image at the bottom of the page).

There is also on Main interface button for **slit rotate** and it should be used **only** if the slit on the image that you possess is not vertical, otherwise you don't use this button!

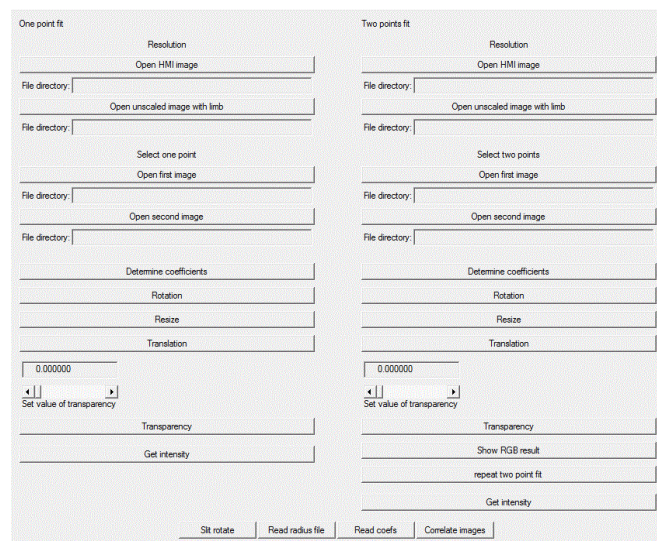


Image 1. Main interface

## Slit rotate

Button on Main interface which is for rotation of slit if it's not vertical, and this procedure must be used before picture analysis. But again, only if the slit on image is not vertical! And also be careful, because Slit rotate – rotate image so that the slit on the image is vertical, and then **overwrite** fits image that you used with rotated one, so be careful not to lose original image that you are analyzing

## One point fit

If you determined one point on your picture that is the same on other picture, you should and must use one point fit, this procedure is on the left side of Main interface. Here is what you need to do :

- First you need to calculate the resolution of the images, with that you will have relation between size of pixel and arc seconds.

## Resolution

Press the button – Open HMI image, then you need to find your HMI image on the computer and open it. HMI – means that you need image that is magnetogram of the Sun.

When you open the image, you will see below, in field – File directory, address of the image, so you'll know all the time which image you opened.

When the image is open, than you need to click with left mouse button on the Solar limb that is seen on the image (15 times), so from those points program is calculating Solar radius. And what is important, in case you put point accidentally somewhere else on image, you can take it back by clicking right mouse button. Also in code you can adjust number of points that you want to use in fitting the Solar limb. Be careful because on same images you can see also the chromosphere, and you need to mark the edge of the photosphere!

And when the resolution is measured, you must know the resolution of the camera from which you took the image for magnetogram (it can be easily found on the internet), in our example is:  $res = 0.5$  pixels per arc second, then you just put that value in the code if it is different.

Then you need to press the button – Open unscaled image with limb, and then you find your image that you want to compare with magnetogram and analyze. Also as on the first button, you need to mark the Solar limb, so you put 15 points on image - click with left mouse button, and also you can take back point by clicking with the right mouse button.

One point fit

Resolution

Open HMI image

File directory:

Open unscaled image with limb

File directory:

Select one point

Open first image

File directory:

Open second image

File directory:

Determine coefficients

Rotation

Resize

Translation

Set value of transparency

Transparency

Get intensity

## Select one point

Now, when you press button – Open first image – you need to open image that you are analyzing and on that image select ONE point that you previously determined that it is the same on both images (usually it is sunspot, or some other recognizable object).

Next task is to press button – Open second image – You need to open magnetogram image and before you select ONE point, you must again determine the Solar limb – for Solar radius, so you put 15 points on the Solar edge. Then the picture will reappear and then you select ONE point that is the same on both images.

## Next steps:

Button - Determine coefficients – for coefficients that are calculated before any transformation of the image.

Button – Rotation – you must press this button so that picture can be rotated, and if you are sure that you don't need rotation, then you can skip this button, but it's best if you don't skip because looks can be deceiving.

Button – Resize – For resizing picture so it can be perfect fit on the other image.

Button – Translation – For translating one image to another on specified locations, using point that you selected earlier.

Then you need to overlap two images and see if you selected right spot, and is it a good fit, if you don't like the result then repeat procedure and be more precise.



So for overlapping the images, you set value of transparency from 0.1 to 0.9 choose what you think it's the best, so you could see both images (tips: try 0.3 or 0.4), and then press the button – Transparency – and you will see result. If you are not satisfied, you can again adjust slider value and again press the button Transparency.

Button – Get intensity - When you press this button, program is ready for measuring the intensity from the both pictures, and plots on separate window those intensities (x axis), and position of the intensities on image (y axis). Then you'll get third plot, that has intensity on x axis, and y axis, one is from intensity of H-alpha, and other is from magnetogram.

So press button, then you use image that you get when doing transparency, and click two times with left mouse button on image from where you want to get the intensity.

## Two points fit

If you determined two same points on images, then you can use two points fit part of the program, that is on the right side on the Main interface.

The procedure is similar to procedure of One point fit.

Here is what you need to do :

- First you need to calculate the resolution of the images, with that you will have relation between size of pixel and arc seconds.

**Note:** You do this only once for set of images. If you have previously calculated radiuses (step 1 and 2), you can load the previously saved data from the file named '*radius.dat*' by clicking the button – Read radius file. It's in directory, you have chosen before (at the end of second step). Now you're able to skip first two steps and go to **Select two points**.

## Resolution

Press the button – Open HMI image, then you need to find your HMI image on the computer and open it. HMI – means that you need image that is magnetogram of the Sun.

When you open the image, you will see below, in field – File directory, address of the image, so you'll know all the time which image is opened.

When the image is open, than you need to click with left mouse button on the Solar limb that is seen on the image (15 times), so from those points program is calculating Solar radius. And what is important, in case you put point accidentally somewhere else on image, you can take it back by clicking right mouse button. Also in code you can adjust number of points that you want to use in fitting the Solar limb.

And when the resolution is measured, you must know the resolution of the camera from which you took the image for magnetogram (it can be easily found on the internet), in our example is:  $res = 0.5$  pixels per arc second, then you just put that value in the code.

Then you need to press the button – Open unscaled image with limb, then you find your image that you

want to compare with magnetogram and analyze. Also as on the first button, you need to mark the Solar limb, so you put 15 points on image - click with left mouse button, and also you can take back point by clicking with the right mouse button.

Now you are able to save file '*radius.dat*' which contains measured numbers.

## Select two points

Now, when you press button – Open first image – You need to open image that you are analyzing and on that image select **TWO** points that you previously determined that it is the same on both images (usually it is sunspot, or some other recognizable object). **AND** what is important, you must remember which direction you used for taking those points. It does not matter which direction it is on first image, but must be the same on second image as on the first image.

The image shows a software window titled "Two points fit". It contains the following elements from top to bottom:

- A button labeled "Resolution".
- An input field with the text "Open HMI image".
- A "File directory:" label followed by an empty text box.
- A button labeled "Open unscaled image with limb".
- A "File directory:" label followed by an empty text box.
- A button labeled "Select two points".
- An input field with the text "Open first image".
- A "File directory:" label followed by an empty text box.
- An input field with the text "Open second image".
- A "File directory:" label followed by an empty text box.
- A button labeled "Determine coefficients".
- A button labeled "Rotation".
- A button labeled "Resize".
- A button labeled "Translation".
- A numerical input field containing the value "0.000000".
- A small control with left and right arrow buttons and the text "Set value of transparency".
- An input field with the text "Transparency".
- An input field with the text "Get intensity".

Next task is to press button – Open second image – you need to open magnetogram image and select TWO points that corresponds to points on the other image, CAREFULLY – in the same direction as was on the first image.

### **Next steps:**

Button - Determine coefficients – for coefficients that are calculated before any transformation of the image. (you can save the coefficients after that; if you want to read saved coefficients, click Read coefs and skip this step)

Button – Rotation – you must press this button so that picture can be rotated, and if you are sure that you don't need rotation, then you can skip this button, but it's best if you don't skip because looks can be deceiving.

Button – Resize – For resizing picture so it can be perfect fit on the other image.

Button – Translation – For translating one image to another on specified locations, using point that You selected earlier.

Then you need to overlap two images and see if you selected right spot, and is it a good fit, if you don't like the result then repeat procedure and be more precise.



So for overlapping the images, you set value of transparency from 0.1 to 0.9 choose what you think it's the best, so you could see both images (tips try 0.3 or 0.4), and than press the button – Transparency – and you will see result. If you are not satisfied, you can again adjust slider value and again press the button Transparency.

Button – Get intensity - When you press this button, program is ready for measuring the intensity from the both pictures, and plots on separate window those intensities (x axis), and position of the intensities on image (y axis). Then you'll get third plot, that has intensity on x axis, and y axis, one is from intensity of H-alpha, and other is from magnetogram.

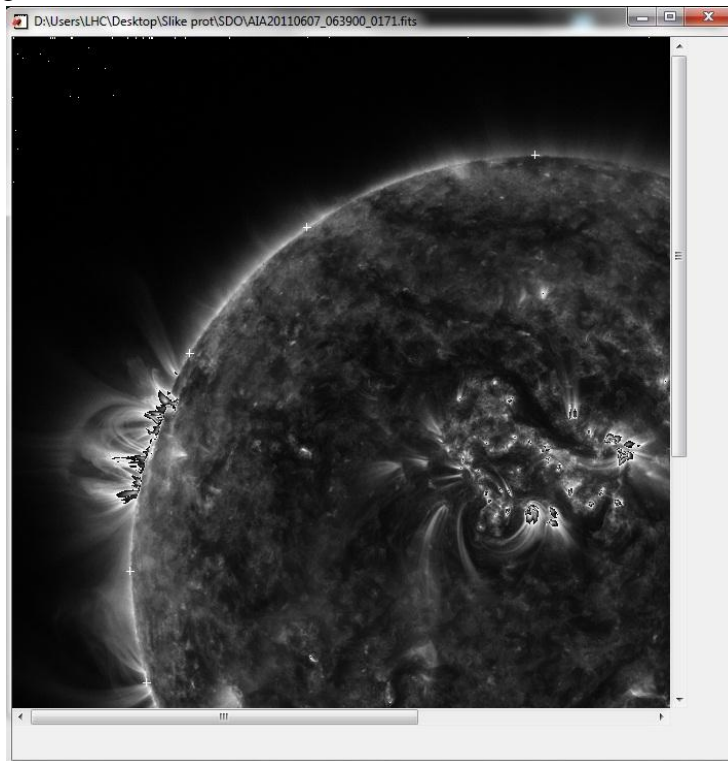
So press button, then you use image that you get when doing transparency, and click two times with left mouse button on image from where you want to get the intensity.

Button – Correlate images – This tells you what's the correlation coefficient of your pictures. Zero pixels (created during previous steps) are omitted.

## EXAMPLE of the Two points fit

Here you can see example of program using Two points fit, so in steps you will see screenshots of the process :

Marking Solar edge:



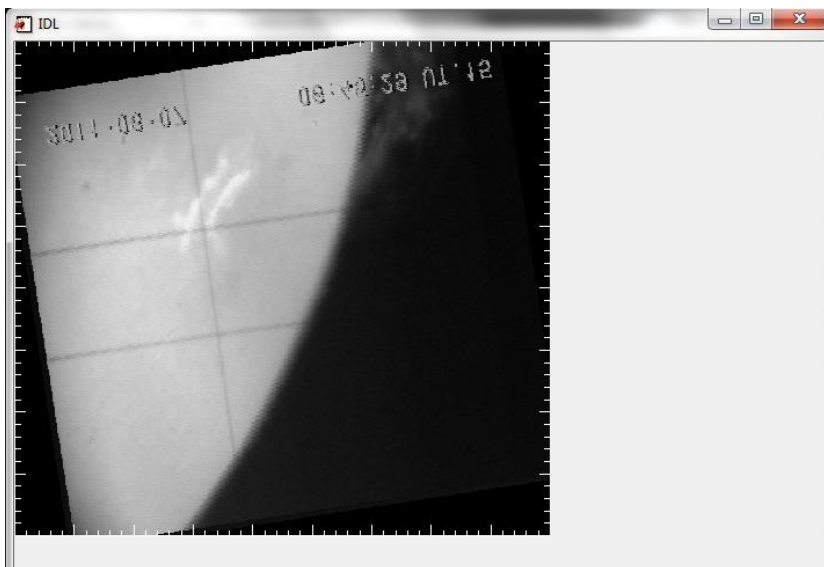
Marking Solar edge, here you can see also the chromosphere, but you need only edge of the photosphere:



Here you can see marked two points on the image with slit, (One on the Sunspot and one on the filament – on the filament I put after black spot just so you can see example, because the cross that mark points is white so it can't be seen otherwise):

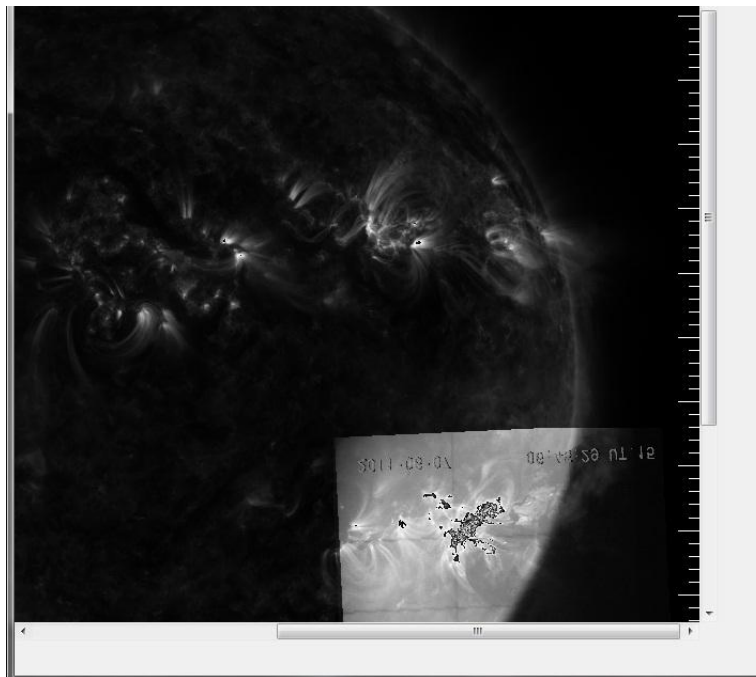


you can see here process of transformation, the picture after rotation and resize:

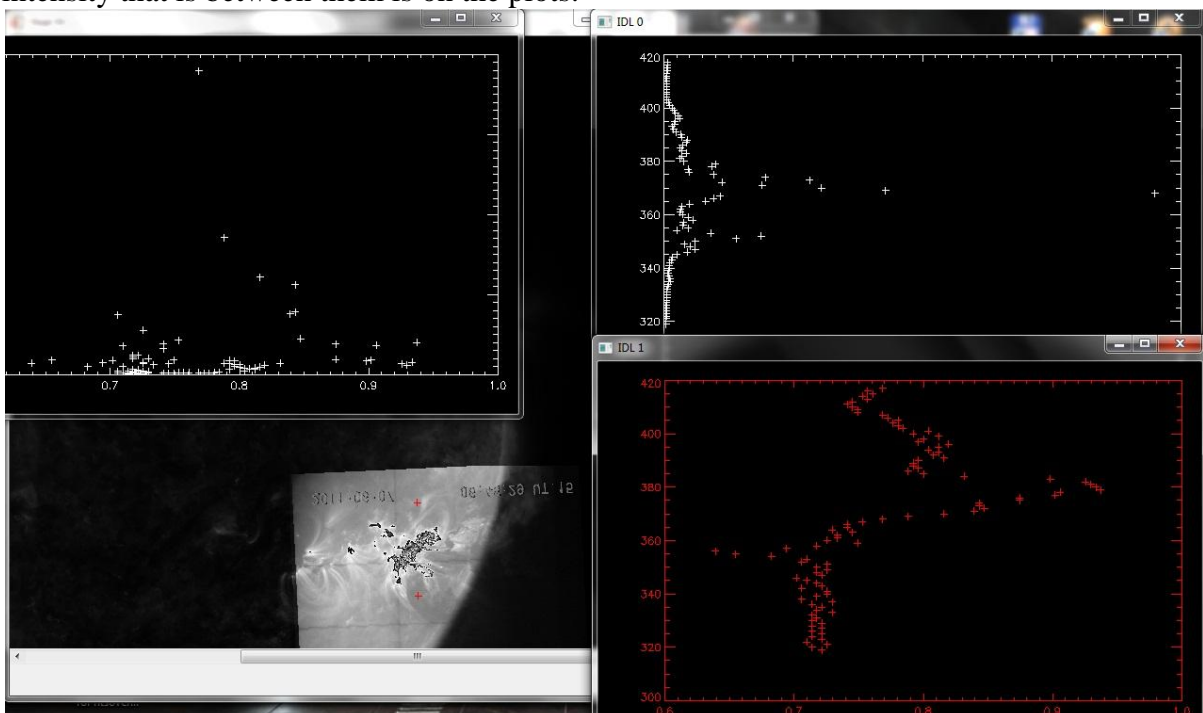




On next image, you can see transparency of two images, and as you can see their limb is fitted correctly when the selected spots are the same on both images. Also there is around image scale that shows arc seconds:



Then after you click on button Get intensity, you mark from which two spots you want the intensity, and then you'll get 3 plots, one for magnetogram (upper right – background image), one for your image (bottom right), and one with the correlation of the intensities on both images (upper left), and also you can see in bottom left, position of two marks, and the intensity that is between them is on the plots:



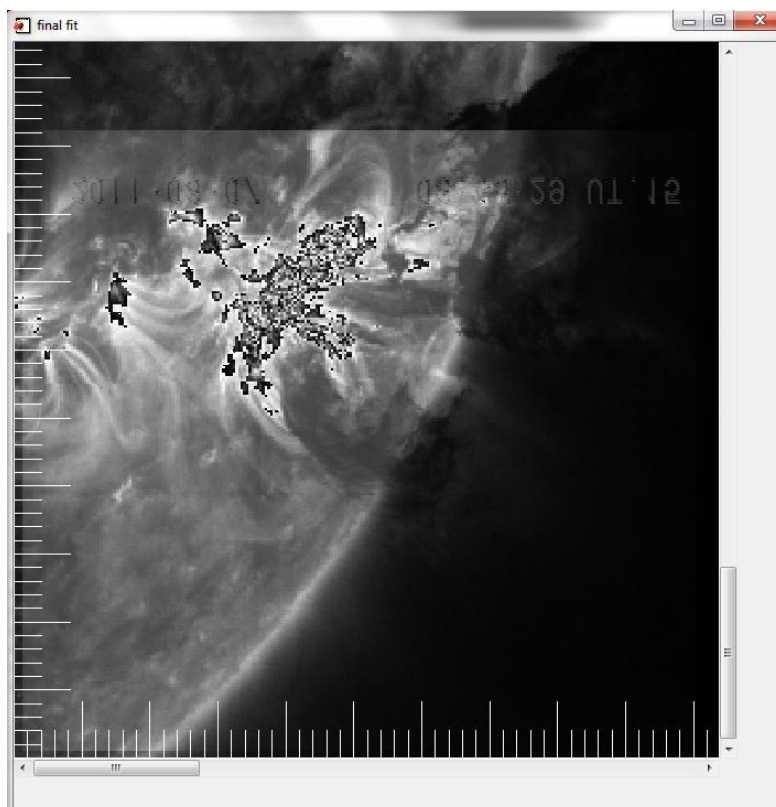
## EXAMPLE of the One point fit

Here you can see example of program using One point fit, so in steps you will see screenshots of the process :

Fist part is the same as for two points, as You've seen it in the previous section. Difference is that you in section select one point, open as first image, and mark One point:



Then open second image - magnetogram and mark the spot, and You need first to mark 10 points of Solar limb, then the image will reappear and then you click on the spot. After coefficients, rotation, resize, translation, set the transparency, and click on the button transparency, You'll get:



Then after clicking on the button Get intensity, you mark two points on the image and you will get the intensity between them.