ESTANDAR: POLIMA PIPELINE DATA REDUCTION

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The program e*standar* reduces polarized and unpolarized standard stars to obtain the *instrumental polarization and the reference position angle of POLIMA*. Also can reduce a single point object after characterizing the instrument.

To run the program you will need to have the following files in your directory:

BIAS.dat	:	contains the files for bias images.
FLAT.dat	:	contains the files for flat images.
RAW.dat	:	contains the files of raw images.
UnPol.dat	:	contains the data for unpolarized standard stars.
Pol.dat	:	contains the data for polarized standard stars.
files.dat	:	contains the dates and time of creating BIAS.dat and RAW.dat

To run the program you should type

estandar <U,P,O> <name> <filter>

where *U*, *P*, or *O* describes a polarized standard star, unpolarized standard star or a study object, respectively; *name* is the name of the standard star (five characters as given in Table 1 and Table 2) and *filter* is the filter used on the observations. If you need to modify some labels form the files fits header use the command *modhead* provided; for exmaple *modhead file.fits object bdp64* set label object to bdp64. If not argument is given modhead will display the value of that lalbel.

You should first reduce the unpolarized standard star to determine the instrumental polarization since the polarized standard star will need that the instrument polarization contribution be subtracted from the data.

Programs needed:

gcc	:	Gnu C Compiler (or other C compiler)
cfitsio	:	Library for reading and writing data files in FITS.
xpaget	:	Linux routine to retrieve data from one or more XPA server.
ds9	:	SAO astronomical imaging and data visualization application.
nrutil.c	:	Utilities for Numerical Recipes
makefile	:	Makefile

For the moment, you can reduce only data for Marconi and ESOPO CCDs.

TABLE 1 High Polarization Standar Star

Highpol. Std	5 Char	RA (2000)	Dec (2000)	V-mag
BD+64d106	bdp64	00 57 36.7	+64 51 27	10.3
HD 236633	h2366	01 09 12.3	+60 37 41	9.2
HD 7927	h7927	01 20 04.9	+58 13 54	5.0
BD+59d389	bdp59	02 02 42.1	+60 15 27	9.1
HD 236954	h2369	02 13 37.3	+59 10 15	9.4
HD 19820	h1982	03 14 05.4	+59 33 48	7.1
HD 23512	h2351	03 46 34.2	+23 37 27	8.2
HD 25443	h2544	04 06 08.1	+62 06 07	6.8
HD 245310	h2453	05 36 23.0	+21 11 11	9.0
HD 251204	h2512	06 05 05.7	+23 23 39	10.3
HD 43384	h4338	06 16 58.7	+23 44 27	6.3
HD 154445	h1544	17 05 32.2	-00 53 32	5.6
HD 155197	h1551	17 10 15.6	-04 50 03	9.2
HD 155528	h1555	17 12 19.9	-04 24 09	9.6
HD 161056	h1610	17 43 47.0	-07 04 46	6.3
HD 183143	h1831	19 27 26.5	+18 17 45	6.9
Hiltner 960	hi960	20 23 28.4	+39 20 56	10.6
VI Cyg 12	vicyg	20 32 40.9	+41 14 26	11.5
HD 204827	h2048	21 28 57.7	+58 44 24	7.9

TABLE 2. Zero Polarization Standar Star

Zeropol. Std	5 Char	RA (2000)	Dec (2000)	V-mag
Beta Cas	becas	00 09 10.7	+59 08 59	2.3
HD 12021	h1202	01 57 56.1	-02 05 58	8.9
HD 14069	h1406	02 16 45.2	+07 41 11	9.0
HD 21447	h2144	03 30 00.2	+55 27 07	5.1
G191B2B	g191b	05 05 20.6	+52 49 54	11.8
HD 94851	h9485	10 56 44.2	-20 39 52	9.2
GD 319	gd319	12 50 04.5	+55 06 03	12.3
Gamma Boo	gaboo	14 32 04.7	+38 18 30	3.0
BD+332642	bdp33	15 51 59.9	+32 56 54	10.8
HD 154892	h1548	17 07 41.4	+15 12 38	8.0
BD+32d3739	bdp32	20 12 02.1	+32 47 44	9.3
BD+28d4211	bdp28	21 51 11.1	+28 51 52	10.5
HD 212311	h2123	22 21 58.6	+56 31 53	8.1
Zeta Peg	zepeg	22 41 27.7	+10 49 53	3.4

REDUCTION OF DATA FROM POLIMA

The reduction of data consist of 5 steps

STEP 1: Reading BIAS files.

STEP 2: Reading FLATS files.

STEP 3: Reading IMAGES files.

STEP 4: Calculating the best aperture for photometry.

STEP 5: Photometry for images at 0, 45, 90 y 135 degrees.

STEP 6: RESULTS.

Example:

STEP 1: Reading BIAS files.

On the first step you will read and combine the bias images. The program will show the result image on a separated *ds9* windows as it shows in Figure 1.

The program will display

Check combined BIAS image
Hit RETURN when finish.

To continue with the next program step hit return.

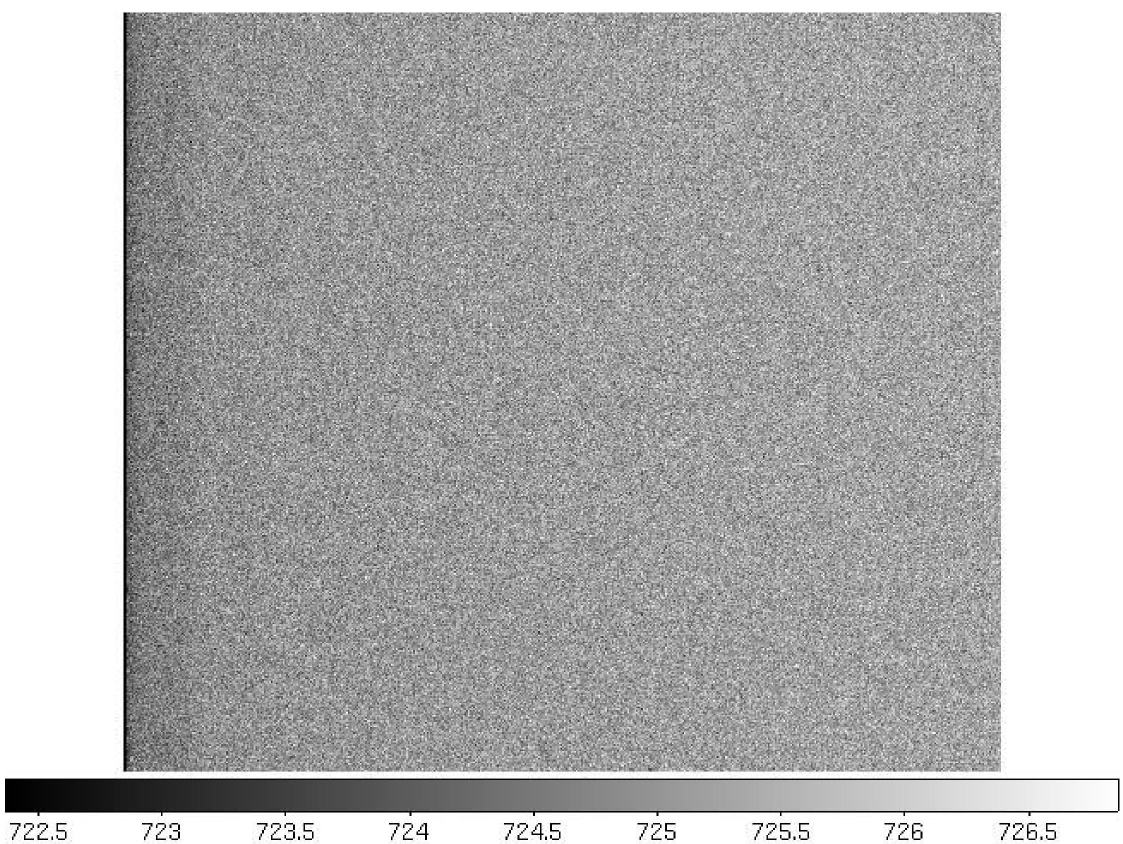

FIGURE 1. Combined image of the bias images listed in the file BIAS.dat.

STEP 2: Reading FLATS files.

Next, the program will read the images of the flat fields for all the polarizer angles and combine the images for the flat fields at polarizer position of 0, 45, 90, and 135 degrees.

Then the program will show, in a ds9 window, the combination of all the flat field images in a color image that will show the region of interest free of vignetting where all the statistics and data reduction will be made.

The program will display:

Check combined flats images at ALL the polarizer position
to define the Region of Interest (ROI) free of vignetting.
The ROI is the area inside the green circle.
Hit RETURN when finish.

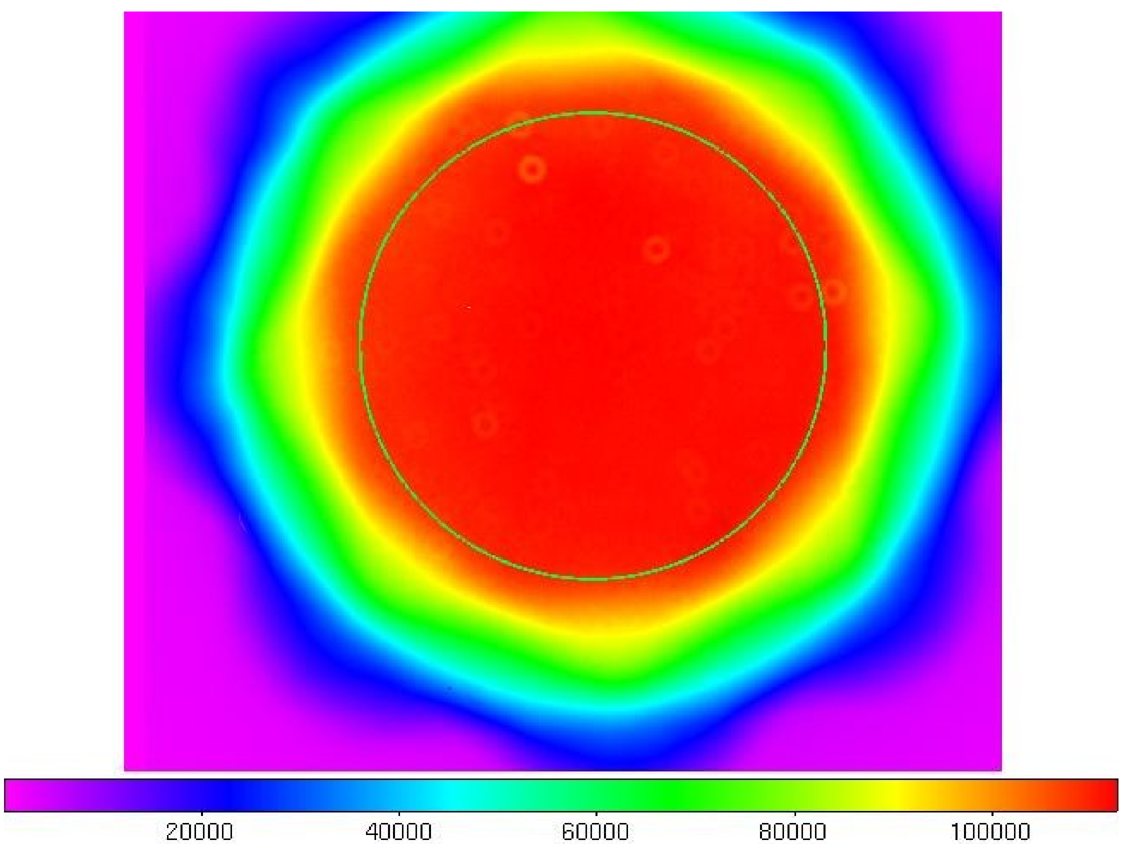

FIGURE 2. Combined images of all the flat field images at all the polarization angles of the polarizer. The Region of Interest (ROI) is the area inside the green circle.

On this ROI, the program will calculate the statistics on the combined images of the flats and bias.

The program will display:

FLAT statistics on the ROI:
Average0 = 21773.19 Standard Deviation0 = 214.28
Average45 = 27883.91 Standard Deviation45 = 309.06
Average90 = 30529.45 Standard Deviation90 = 400.30
Average135 = 30985.85 Standard Deviation135 = 443.04

BIAS statistics on the ROI:
Average = 725.12 Standard Deviation = 0.52

After that the program will show the four combined images of the flats at 0, 45, 90, and 135 degrees.

The program will display:

Check 0 Degrees FLAT image
Hit RETURN when finish.

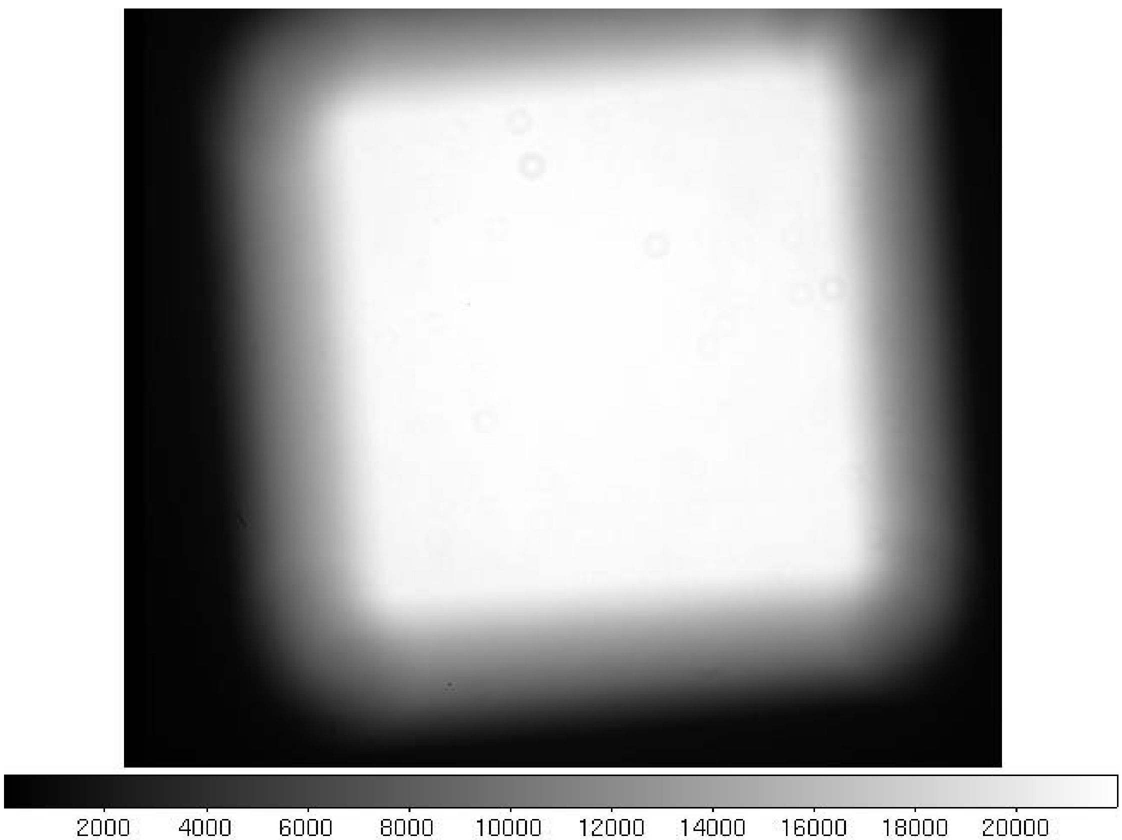

FIGURE 3. Combined image of all the flat field images are zero degrees of position of the polarize prism.

Subsequently, you will find the same suggestion for the other flat fields.

STEP 3: Reading IMAGES files.

Next the program will read the images indicated in the RAW.dat and will be corrected by bias and flat field.

STEP 4: Calculating the best aperture for photometry.

In this step the program will try to get the best aperture for the photometry.

The program will display.

Choose the circular aperture for OBJECT.
Hit ENTER when finish.

In a *ds9* window will display the image at zero degrees with an aperture, green circle(see Figure 4). Drag the region to the object, clicking and holding down the left button of the mouse.

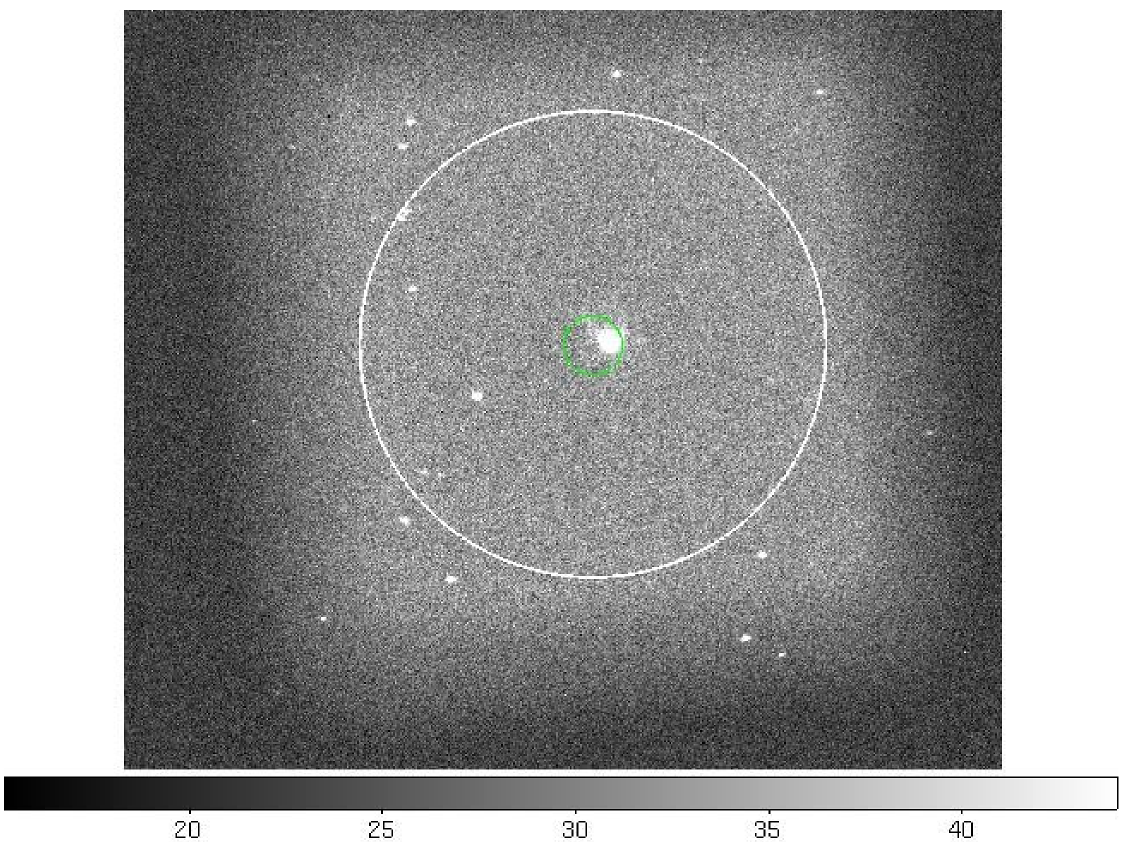

Figure 4. Initial image at 0 degrees for calculating the best aperture for photometry.

If you want to change the size of the aperture, double click on the aperture and a small window will appear. You might change the radius of the aperture typing the value of the new radius and typing return or hitting the *Apply* button.

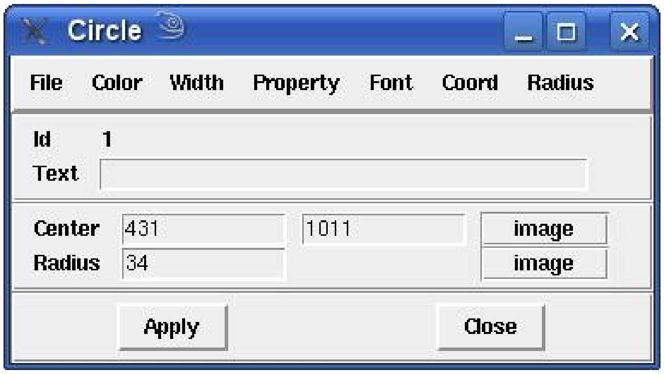

Figure 5. Changing the radius of the aperture.

Next you will be ask to select a region for the sky. Drag the region as before to a representative region of the sky. You will be ask only once for this region of the sky so choose a region the will be the same in the rest of the images. The program will display:

Choose the circular aperture for SKY
Drag the Mouse to the region on the sky and hit ENTER when finish

Drag the region with the Mouse to the sky region and hit RETURN when ready.

The program will calculated the best aperture and all the images and it will say:

Recommended Radius for Photometry = 13 pixels

STEP 5: Photometry for images at 0, 45, 90 y 135 degrees.

In this step will do the photometry for the object

*********** Image at 0 degrees*
Choose the circular region for OBJECT (Hit ENTER when finish

In this case we have choose the object with the radius suggested by the previous step. If you want to change the radius of the aperture see above.

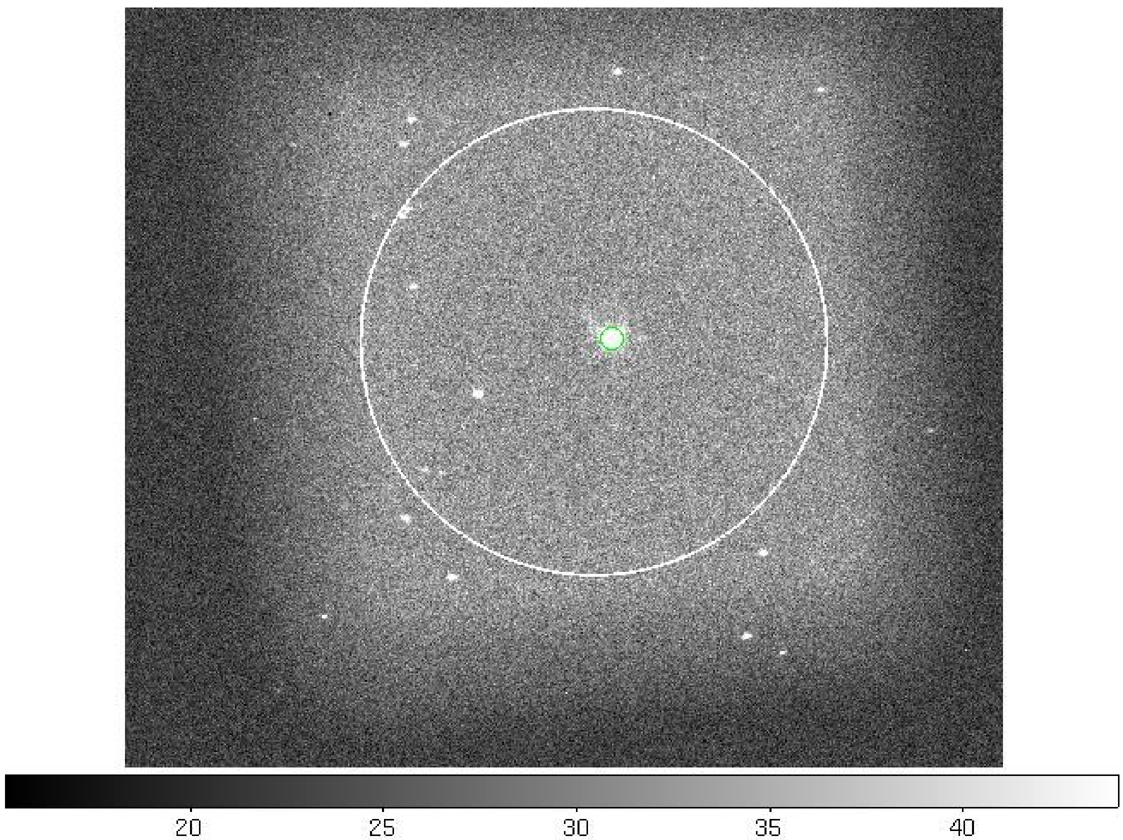

FIGURE 6. Study object.

Then you will be asked for sky.

Choose the circular region for SKY
Drag the circular region to the sky (Hit ENTER when finish).

Drag the region to the sky.

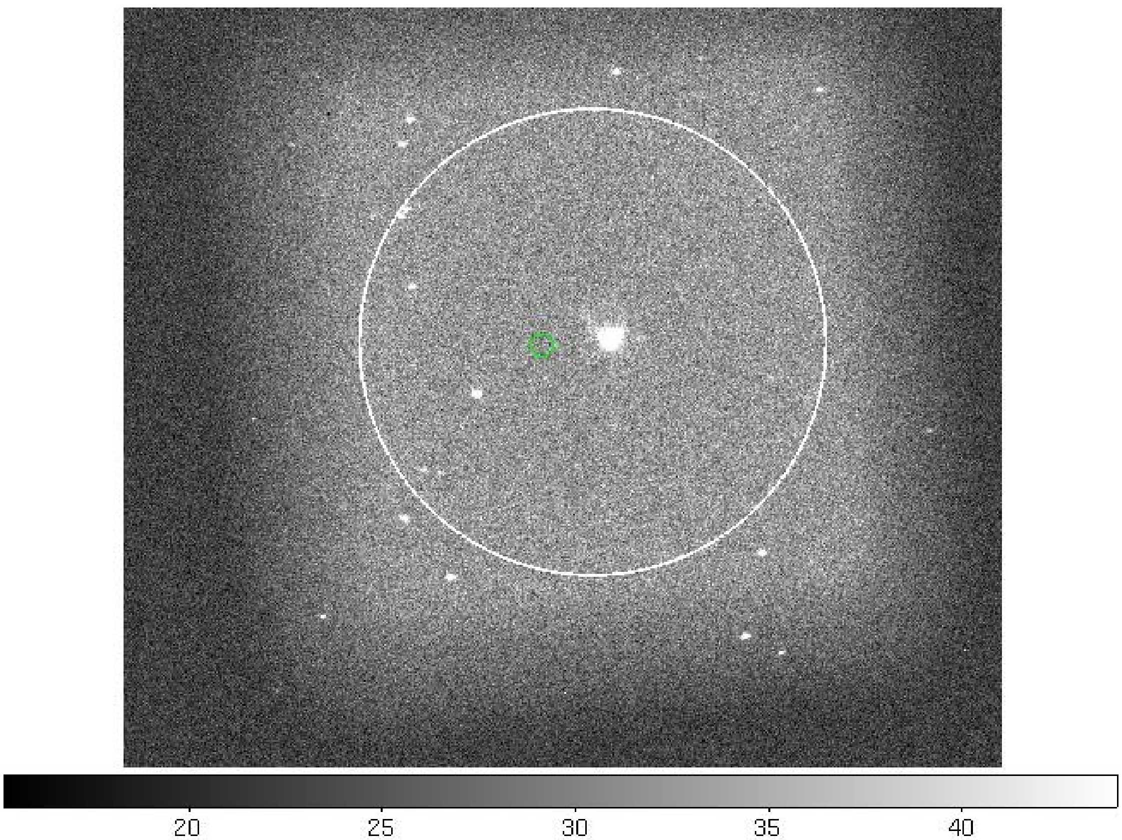

FIGURE 7. Selection of the sky.

For images at 45. 90 y 135 you will be ask to select the region for the study object only. If you are happy with the selection just hit ENTER.

STEP 6: RESULTS.

Fluxes:

Pos	*Object*	*Err_obj*	*Sky*	*Err_Sky*	*S/N*
0	*324731.53*	*598.99*	*17017.49*	*130.45*	*19.08*
45	*323608.55*	*597.41*	*16637.32*	*128.99*	*19.45*
90	*318914.55*	*597.50*	*18482.43*	*135.95*	*17.26*
135	*323657.53*	*606.30*	*21950.65*	*148.16*	*14.74*

SKY TOTAL FLUXES:

I(0,90) = 35499.92 266.40 I(45,135)= 38587.97 277.14

DIFFERENCE = 8.70 Percent

STUDY OBJECT TOTAL FLUXES:

I(0,90) = 643646.08 1196.49 I(45,135)= 647266.08 1203.71

DIFFERENCE = 0.56 Percent

UNPOLARIZED STANDARD VALUES:

Name	*Filter*	*P(%)*	*+/-*	*Theta*	*+/-*	*Comments*
bdp33	*V*	*0.231*	*0.031*	*12.67*	*0.00*	*None*

MEASURED VALUES:

JD	*Name*	*Filter*	*P(%)*	*+/-*	*Theta*	*+/-*
5208.0677	*bdp33*	*R*	*0.703*	*0.134*	*-4.35*	*5.39*

A similar results will be presented for

And the program will finish.

The data will be saved at the the file *Results.dat*

Instrumental polarizaion will be saved at the file *InstPol.dat*
This data will be used for options P and O of the program.

Position Angle of the isntrument will be saved at *Polangle.dat*
This data will be used for option O of the program.

After the first run, at directory *archive* you will have also the following files:

bias.dat
flat.dat
bias.fits
flat0.fits
flat45.fits
flat90.fits
flat135.fits
flat_statistics.dat
files.dat

bias.dat and flat.dat are the files with the files for bias (bias.fit) and flat.dat the files for the flat fields (flat0.fits, flat45.fits, flat90.fits, and flat135.fits)

The file flat_statistics contains the statistic for flats and bias. In this way, if you want to reduce another data for the same flats and bias on the FLAT.dat and BIAS.dat respectively, you will read those files and proceed directly to interact with the program at STEP 3 (Reading IMAGES files).