TITLE: Results of Verification Tests of CALFOC

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ABSTRACT

The purpose of this test is to verify that the pipeline process "calfo" performs photometric calibration and correction of geometric distortion of normal and spectrographic images according to the requirements of SE-06. In order to simplify the test verification and to speed up the test process, the tests were performed on two separate sets of images: one set was used to test photometric corrections the second to test geometric corrections. The "calfo" problems which were discovered in the test were corrected, and the revised version of "calfo" installed on the science cluster and on FOCA.
1 Introduction

The normal flow of calibration procedures for normal images includes:

1. Dark count subtraction
2. ITF correction
3. Dezooming of zoom format pixels
4. Uniform detective efficiency correction
5. Absolute detective efficiency correction
6. Geometric correction

The normal flow of calibration procedures for spectrographic images includes:

1. Dark count substraction
2. ITF correction
3. Dezooming of zoom format pixels
4. Spectrographic detective efficiency correction
5. Geometric correction

The detailed descriptions of these steps are given in FOC-017 Instrument Science Report.

2 Photometric Correction Test Procedures

The test verification procedure was written by G. Heaps for the FOC RSDP test in IDL and performs the same calibration steps. The procedure was checked in RSDP test 2. In calfoc test the set of input images were corrected by "calfoc" and by the IDL procedure. The results of "calfoc" calibrations are compared to the results of IDL calibrations by computing the ratio between the images. If the images are the same the ratio of all non-zero pixel values must be the same and equal to one.

2.1 The Input images

The observation test set consisted of 19 simulated image files, one for each mode listed in Table 4 of the FOC Handbook. The instrument configuration flags, formats, and indicators are set in the observation images by the RSDP generic conversion procedure. In the test, the RSDP test 2 image files are used. A detailed description of the test data is given in the FOC-033 Instrument Science Report. All 19 images were supplied to calfoc as if they had arrived from generic conversion.

2.2 The reference files

The reference files included BAC, ITF, UNI, ITF and DE corrections. The absolute detective efficiency correction values were taken from the input image headers. For spectrographic mode the UNI files were used as SDE files. A detailed description of the reference files is given in the FOC-033 Instrument Science Report.

2.3 Test results for photometric correction

The test revealed a few problems. A copy was made of calfoc.x, and the problems were corrected in this copy in order to continue testing.

2.3.1 Normal imaging

Problem 1:
CALFOC in the present modification recognizes the reference file names
only in lower case. The RSDP input image headers contain reference file
names written in upper case.
Resolution:
Added calls to convert reference files from upper to lower case in the
procedure get_cal_files. Added - call strlwr( tstring )

Problem 2:
Calfoc processes the normal pixel image 512x1024 as a full image.
The background reference files and DE files for normal pixel have
1024x1024 image sizes. If the image has an offset the results do not
match the results calculated by the IDL program.
Resolution:
The "define MAX_NSAMPS" statement was changed from 512 to 1024.
This is used only to set image offset in a BAC and DE images.

Problem 3:
The log message reports a zoom format as a normal. The zoom_mode variable
was not set at the time when the procedure log_image is called.
Resolution:
Procedure call log_image moved after call get_cal_files.

Problem 4:
In a zoom mode the sample beginning and line beginning are calculated
as follows:

\[
\begin{align*}
sampbeg &= (FOC_SAMPBEG(i_foc) + 1)/2 + FOC_SOFF1(i_foc) \\
linebeg &= (FOC_LINEBEG(i_foc) + 1)/2 + FOC_SOFF2(i_foc)
\end{align*}
\]

Resolution:
The zoom mode affects only sampbeg, so the line:

\[
\text{linebeg} = (FOC_LINEBEG(i_foc) + 1)/2 + FOC_SOFF2(i_foc)
\]

for linebeg should be deleted.

After the above changes calfoc performed the calibrations on all 19
files correctly.

2.3.2 Spectrographic mode

Problem #1:
Memory is not allocated for g_foc.
Resolution:
Add the following line near the begining of xcalspg:

call salloc (g_foc, SZ_FOC_COORD, TY_STRUCT)

Problem #2:
If geo correction is omitted no value was assigned to g_foc.
Resolution:
Copy the value of the pointer t_foc to g_foc following the line
that copies the image name:

call strcpy( t_image, g_image, SZ_FNAME)

\[
g_foc = t_foc
\]

Problem #3:
There was an attempt to read an invalid line from an image.
Resolution:
Geo_v is an array of values which point to the next line of the image
to be read or written; these values must be initialized to 1.
Insert the following two lines before while loop:

call amovkl( long(1), pho_v, IM_MAXDIM)
call amovkl( long(1), geo_v, IM_MAXDIM)
Problem # 4:
Erroneous message "starting BAC and ITF correction for" in the case that BAC and ITF are not performed.
Resolution:
Change the print line after "INITIAL PHOTOMETRIC CORRECTION" to
   sprintf (text, SZ_PATHNAME, " starting a processing for %s")
Add a line in the BAC path:
   sprintf (text, SZ_PATHNAME, " starting BAC processing for %s")
Add a line in the ITF path:
   sprintf (text, SZ_PATHNAME, " starting ITF processing for %s")
After all changes calfoc performed spectrographic calibrations correctly.

3 Geometric correction test procedures

3.1 Introduction

In rough outline the test procedure was as follows: Create a test image, add features to the image at known positions, run calfoc, and measure the positions of the features in the geometrically corrected (.c1h) image. This worked correctly except for one problem discussed below. Only a few modes were tried, but the code in calfoc for geometric correction is essentially independent of the mode. Both normal imaging mode and spectrographic mode did have to be tried because these are done in separate sections of calfoc. Normal mode pixels and zoom mode pixels were both tried, even though dezooming is done before geometric correction.

One test was made (f/96, normal pixels) of reseau location in a flat field. The filetype as specified in the header of the reseau model file created by the rsdpmodx task was 'RESEAU MODEL', and calfoc complained that it should have been 'MOD'. This appears to be a problem with rsdpmodx rather than calfoc.

3.2 The test procedure

The tasks listmarks, distort, and addspots are defined in the directory
FOCA::disk$datatal:[gbcal.phiraf.gtest]. These tasks are referred to below.

The testimx procedure in focutility was used to create a fake FOC image with a uniform value of 10. The option to add reseau marks was not used. Each image created was 512 samples by 1024 lines. The modes tested were F96 and F48 normal pixels and normal imaging, F96 zoom mode, and F48 normal pixels and spectrographic mode.
(Nota: The version of testimx on FOCA puts XD1_1 etc in the group parameter block instead of CD1_1 etc. The latter were added as header parameters.)

Two lists of x,y coordinate pairs were needed. One list was for positions of reseau marks (which did not need to be actually on the image), and the second list was for "star" positions on the image. The listmarks task creates ASCII files with positions on a uniform rectangular grid.

The distort task was run on each of the two coordinate lists. The task read the list, changed the coordinates according to a certain distortion function, and wrote an output list with the modified coordinates. The distortion consisted of a rotation by about 0.01 radian and a stretching of the distance R from the center by the factor (1 + 5e-5*R), where R is in pixels. The total displacement amounted to 10 or 15 pixels near the corners.
The addspots task was then used to add (in-place) a "star" image to the test FOC image at each x,y position in the list of distorted star positions. If the x,y coordinates happened to be integers, the value (10 for these tests) was added to a single pixel with those coordinates. In general, values would be added to up to four adjacent pixels such that the centroid of the values would be at the x,y position. In some cases we also added spots (with a value of -10) at the distorted reseau positions as well, just as an aid when viewing the geometrically corrected images. The undistorted positions (both reseau and star positions) generated by listmarks were all integer coordinates, so in the geometrically corrected image the spots should have been centered on pixels.

The following steps were used to create an image with FILETYPE = 'GEO' for input to calfoc. The rgenx task in the focgeom package was run on the list of reseau positions and again on the list of distorted reseau positions, each time producing a table containing those positions. The rsdpgeox task in the focutility package was then run to convert those two tables to a GEO file. (When running rgenx, if the number of rows is not equal to the number of columns, it is important to set the values of those parameters correctly. Rgenx cannot recognize the error, and calfoc then crashes with an "adjustable array dimension error".)

The cloadrdspx task was used to specify the name of the GEO file and that geometric correction was to be performed. Pixel splitting was also specified if the pixels were zoom mode.

Calfoc was run. This was a test of geometric correction only, but calfoc produces an output image (.coh extension) from the photometric correction section anyway and then reads that image when performing the geometric correction. The .coh image was irrelevant to the current test and was therefore ignored.

The resulting .clh & .cld files were copied to the science cluster, and the autoloc task in the locate package was run to find the locations of the "stars" which had been added to the image. For normal mode pixels the positions were good to about 0.05 pixel except near the edges of the image, where the errors were up to 0.2 or 0.3 pixel. For zoom mode pixels the errors were often a half pixel in the x coordinate but only 0.05 or so in the y coordinate. I believe this is a problem with autoloc rather than with calfoc.

3.3 Problem

The one problem that was encountered during geometric correction was in procedure xcalspg, which is for spectrographic mode. In the call to imsetr and the two calls to imseti, the first argument should be t_im instead of g_im.

4 Time requirements

On an unloaded VAX 785 calfoc took 287 CPU seconds (7 min 50 sec elapsed time) to process one 512 x 1024 image. The mode was f/96, normal pixels. The following corrections were applied: dark count subtraction (BAC), intensity transfer function (ITF), relative detective efficiency (UNI), absolute DE, and geometric correction (GEO).

5 Suggestions for code improvement

There are few minor changes that can be made to improve calfoc.
5.1 The procedure chan_ext

The change file extension can be rewritten to use standard IRAF routines.

```plaintext
call imgcluster(infile,temp,SZ_FNAME)  #check file and save in the temp
  nchar =fnroot(temp,newimage,SZ_FNAME)  #get root name
  call strcat(ext,newimage,SZ_FNAME)    #add new extension
```

5.2 The procedures xcalspg and procedure xcalimg

The line

```plaintext
call amovr( Memr[g_buf], Memr[p_buf], naxisout)
```

can be deleted.

Instead of do loop operators the standard IRAF vector operators should be used. For example to multiply two lines of images use:

```plaintext
call amulr (Memr[tpt], Memr[g_buf], Memr[p_buf])
```

5.3 Error checking

Calfoc checks the type of reference files. We think this is not very informative. For example, the BAC file must have a filetype of BAC, and a UNI file must have a filetype of UNI.

The generic conversion part of RSDP is responsible for the correct selection of the reference files based on flags and indicators and should select the proper files. But the files may be out of date or not verified or provided by the user. This kind of information may be useful to keep track of image calibration.
Description of problem:
When processing an image in spectrographic mode a number of problems showed up.

Problem assessment:
(YF 1988.10.26) (1) Memory was not allocated for g_foc in procedure xcalspg.
(2) If geometric correction is omitted, no value was assigned to g_foc.
(3) The array geo_v was not initialized. Geo_v points to the next line of the image to be read or written and must be initialized to 1.
(4) Erroneous message "starting BAC and ITF correction for ..." in the case that BAC and ITF corrections are not performed.
(5) In the section for geometric correction, the first argument in the call to imsetr and in the two calls to imseti should be t_im instead of g_im. This resulted in an adjustable array dimension error.

Resolution:
(YF 1988.10.26)
(1) Add the following line near the beginning of xcalspg:
call salloc (g_foc, SZ_FOC_COORD, TY_STRUCT)
(2) Copy the value of the pointer t_foc to g_foc following the line that copies the image name:
call strcpy (t_image, g_image, SZ_FNAME)
g_foc = t_foc                # new line Y.F.
(3) Insert the following two lines
    call amovkl (long(1), pho_v, IM_MAXDIM)  # new line Y.F.
    call amovkl (long(1), geo_v, IM_MAXDIM)  # new line Y.F.
(4) Modify the message regarding BAC or ITF corrections.
(5) (PEH 1988.10.26) Change the first argument from g_im to t_im.

Description of problem:
In a zoom mode image the sample beginning and line beginning are calculated as follows in get_cal_files:

    if ( ZOOM_MODE(caldat) == YES ) {
        # convert to image pixels
        sampbeg = (FOC_SAMPBEG(i_foc) + 1)/2 + FOC_SOFF1(i_foc)
        linebeg = (FOC_LINEBEG(i_foc) + 1)/2 + FOC_SOFF2(i_foc)
    }

Problem assessment:
(YF 1988.10.26) The zoom mode affects only sampbeg, so the line for linebeg should be deleted.

Resolution:
(YF 1988.10.26) The line:
linebeg = (FOC_LINEBEG(i_foc) + 1)/2 + FOC_SOFF2(i_foc)
was deleted.
SPR # 248  1988.10.26  CLOSED  Yuri Frankel  Incorrect message for zoom

Package/task:
stdas.foc.focutility.calfoc

Description of problem:
The log message reports a zoom format image as a normal format image.

Problem assessment:
(YF 1988.10.26) The zoom_mode variable was not set at the time when the procedure log_image was called.

Resolution:
(YF 1988.10.26) In procedure calfoc, call log_image after calling get_cal_files.

SPR # 247  1988.10.26  CLOSED  Yuri Frankel  Incorrect offset within in

Package/task:

Description of problem:
Calcfoc processes the normal pixel image 512x1024 as a full image. The background reference files and DE files for normal pixel have 1024x1024 image sizes. If the image has an offset the results are not correct.

Problem assessment:
(YF 1988.10.26) MAX_NSAMPS, which is used only to set image offset in BAC and DE images, should be changed from 512 to 1024.

Resolution:
(YF 1988.10.26) The "define MAX_NSAMPS" statement in calfoc.x was changed.

SPR # 248  1988.10.26  CLOSED  Yuri Frankel  Case-sensitive file names

Package/task:
stdas.foc.focutility.calfoc

Description of problem:
calfoc recognizes the reference file names only in lower case. The RSDP input image headers contain reference file names written in upper case.

Problem assessment:
(YF 1988.10.26) In the short term we should convert file names to lower case.

Resolution:
(YF 1988.10.26) Added calls to convert reference files from upper to lower case in the procedure get_cal_files:
call strlwr (tstring)  # added to change to lower case