# Producing FPN Correction Frames with Pilot

This document guides you through creating Fixed Pattern Noise (FPN) correction frames suitable for use by the libflipro API using the `FPROMERGE_ALGO_REF_FRAME` algorithm. The final results of this process are two files:

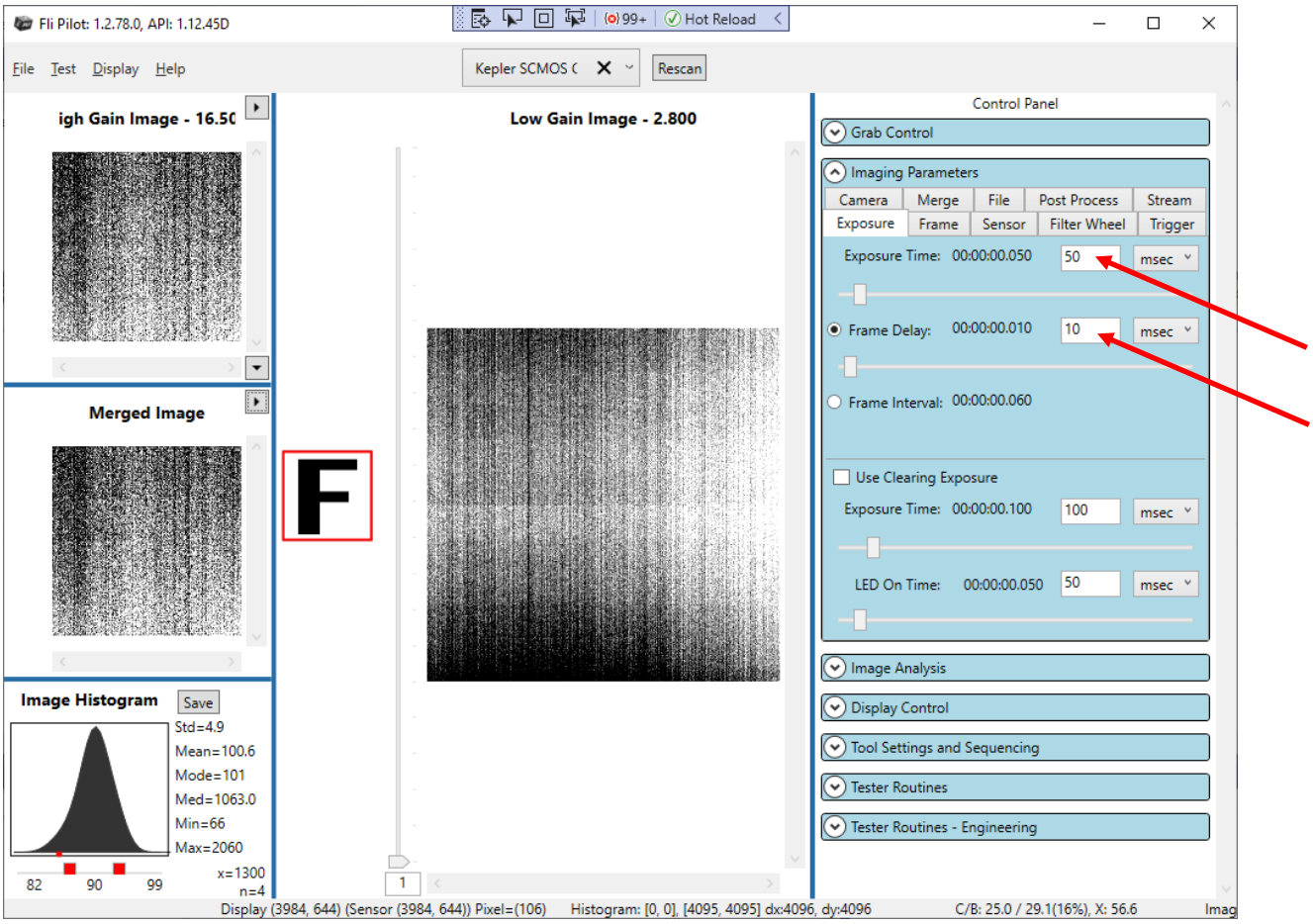
1. A Dark Signal Non-Uniformity (DSNU) correction. This is referred to as the 'Additive' data in the API.
2. A Photo Response Non-Uniformity (PRNU) correction. This is referred to as the 'Multiplicative' data in the API.

To produce these files in pilot, you must first capture the appropriate Dark Frames, Flat Field Frames, and potentially Dark Flat Field (DFF) Correction Frames.

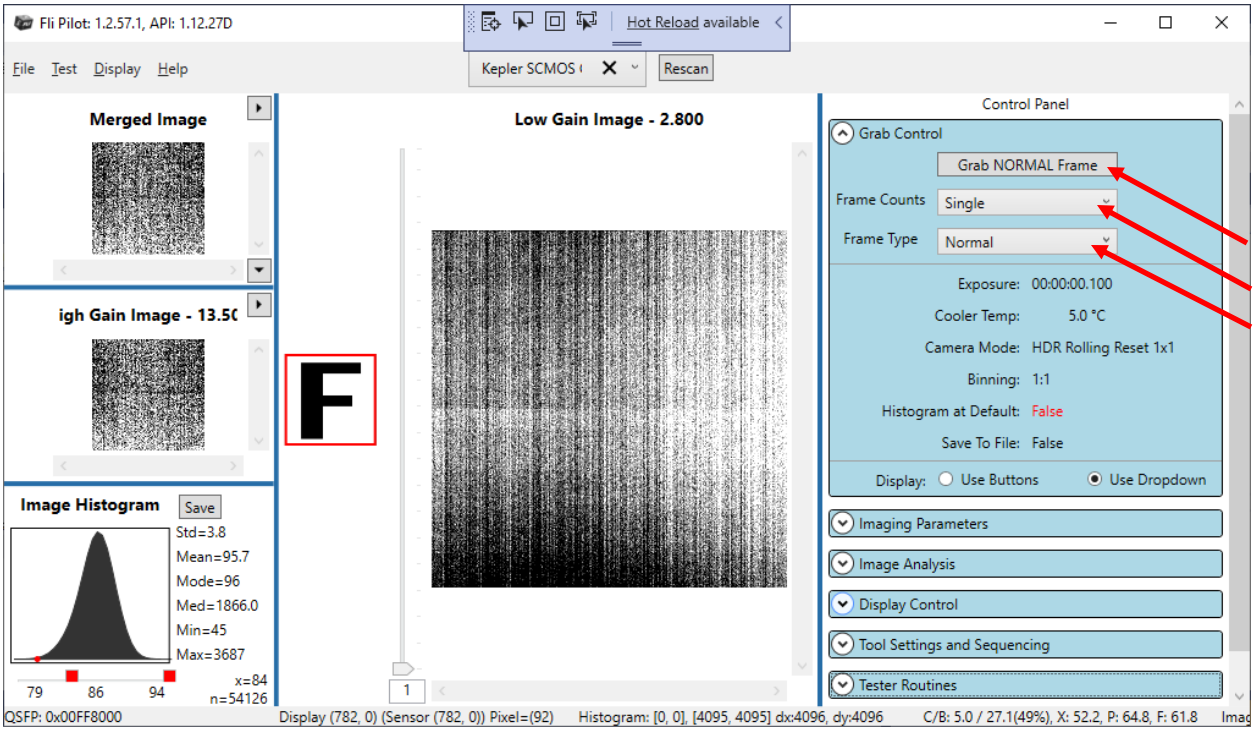
## Capturing The Dark Frames

To take the Dark Frame image, simply cover the lens so no light can reach the sensor.

Using Pilot set the Exposure Time and Frame Delay (or Frame Interval) to the same settings you will use for taking your actual images. This is under the Imaging Parameters drop down on the Exposure Tab as shown below.

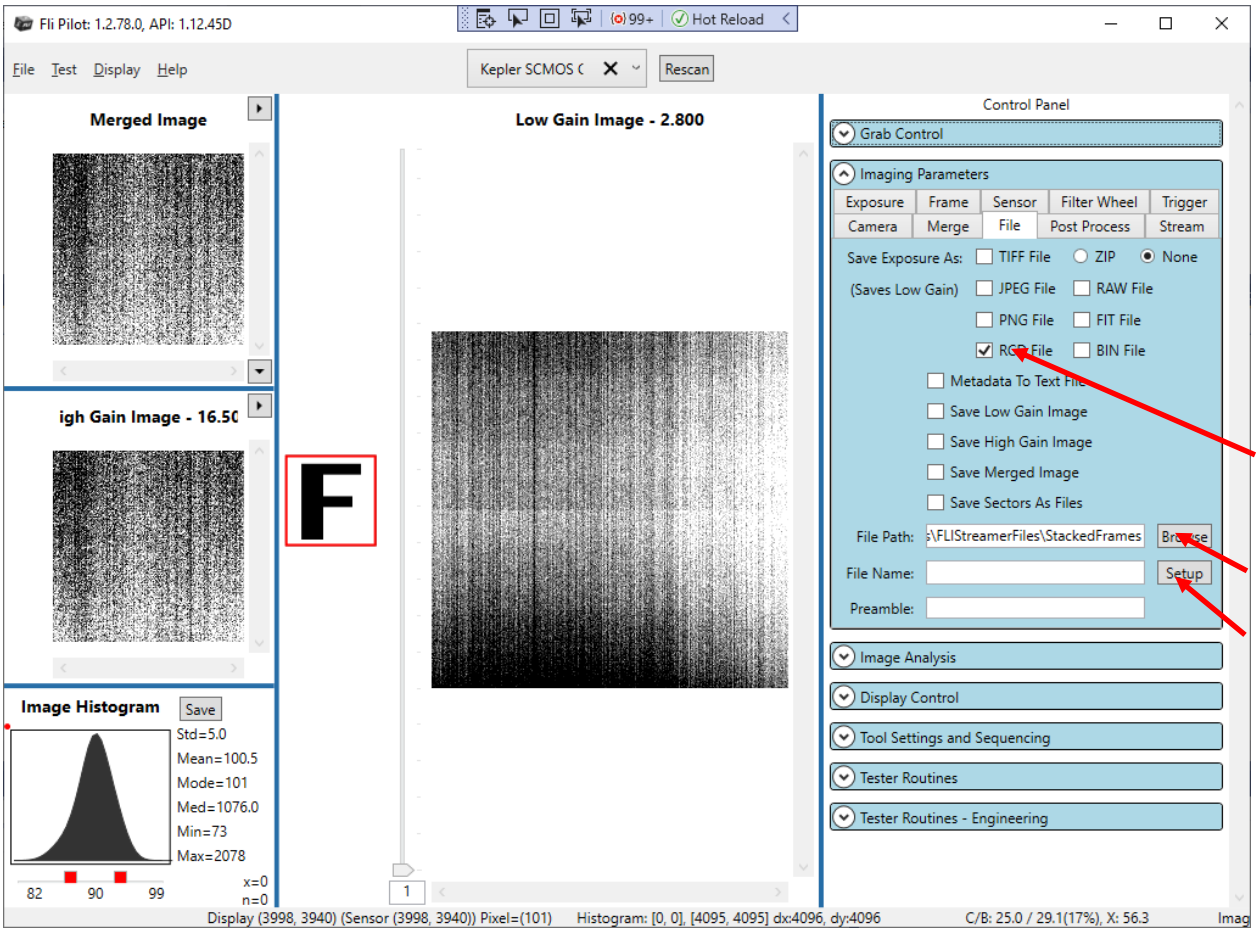



Next, use the **Grab NORMAL Frame** button to capture the image as shown below. The Frame Counts drop down should be set to '**Single**', and the Frame Type drop down should be set to '**Normal**'. To save the image to a file, use the File->Save As… menu drop down to select an appropriate file name and directory location (e.g. `DarkFrame1.rcd`).

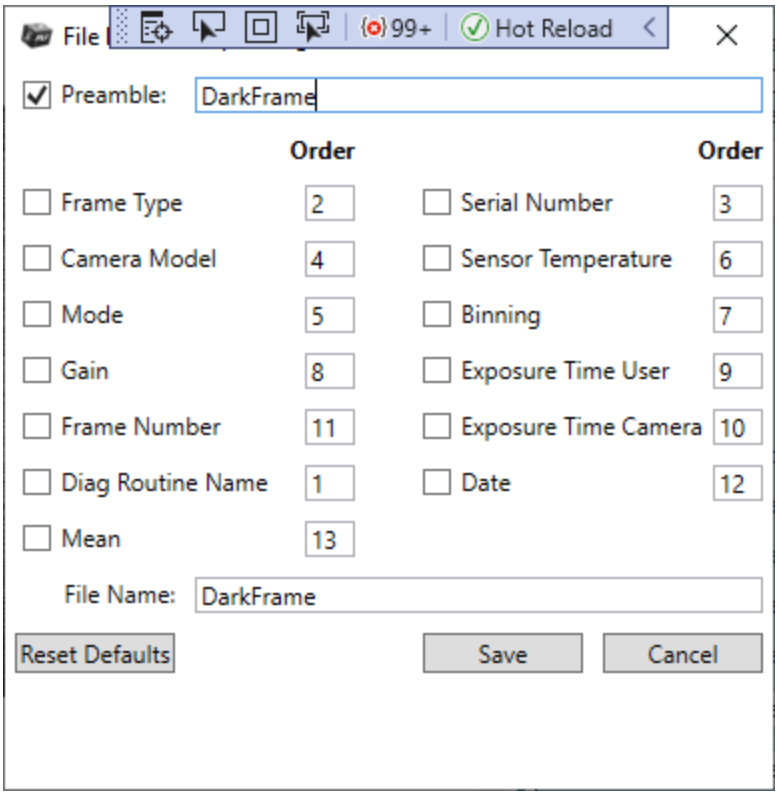



**Advanced:** You can take multiple Dark Frame images here if you like. The final step to create the reference frames will 'stack' them and use the average. This will give you better image quality results. Just name each file differently when you save it (e.g. DarkFrame2.rcd, DarkFrame3.rcd, etc.). If you are trying this for the first time, using a single file will give you reasonable results and ensure you have the process correct.

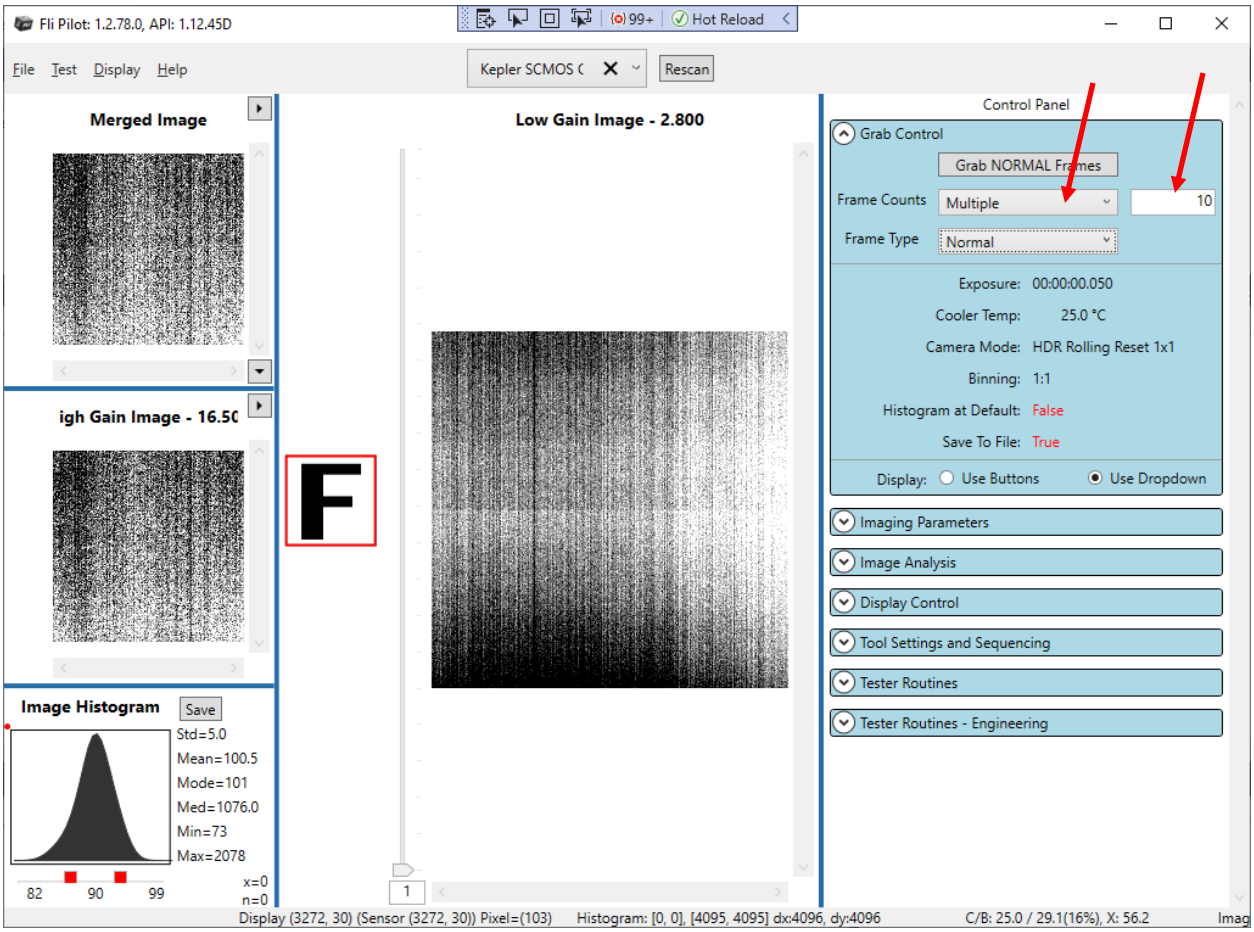
To create as many dark frames as you want for stacking and averaging, you can configure Pilot to do the work for you. First, on the **Imaging Parameters** drop down on the **File** Tab, check the **RCD File** checkbox. Then click the **Browse** button next to the File Path text box and select a location for the saved files.




Optionally, you can configure File Name prefix and Preamble to contain text or some camera configuration settings (e.g. the exposure time). To do this click the **Setup** button next to the File Name text box and dialogue below will appear. You can type custom text in the Preamble text box at the top (e.g. DarkFrame). Make sure you check the **Preamble** checkbox for it to appear in the File Name. Then select the other items you would like to appear in the file name. Click **Save**.




Now that you have configured Pilot to save the files. You just need to tell Pilot to capture the dark images. Back on the **Grab Control** drop down, set the **Frame Counts** to **Multiple** and type in the number of frames you would like to average in the txt box that appears to the right of the **Frame Counts** selection. Then click the **Grab NORMAL Frames** button to collect the images. The images will be stored in the path you specified on the Imaging Parameters drop down. The files will contain the suffix `_RCDData_xxx.rcd` where '`xxx`' is the number of the file. These files will be used in the *FPN Calculation* section below to create the final output files.


Fli Pilot: 1.2.78.0, API: 1.12.45D
99+
Hot Reload
File
Test
Display
Help
Kepler SCMOS C
Rescan
Merged Image
igh Gain Image - 16.5C
Image Histogram
Save
Std=5.0
Mean=100.5
Mode=101
Med=1076.0
Min=73
Max=2078
82
90
99
x=0
n=0
F
Low Gain Image - 2.800
1
Control Panel
Grab Control
Grab NORMAL Frames
Frame Counts
Multiple
10
Frame Type
Normal
Exposure: 00:00:00.050
Cooler Temp: 25.0 °C
Camera Mode: HDR Rolling Reset 1x1
Binning: 1:1
Histogram at Default: False
Save To File: True
Display: Use Buttons Use Dropdown
Imaging Parameters
Image Analysis
Display Control
Tool Settings and Sequencing
Tester Routines
Tester Routines - Engineering
Display (3272, 30) (Sensor (3272, 30)) Pixel=(103)
Histogram: [0, 0], [4095, 4095] dx:4096, dy:4096
C/B: 25.0 / 29.1(16%), X: 56.2

## Capturing The Flat Field Frames

To capture a Flat Field image, you need to point the camera at a flat field of white such as a blank sheet of paper, or painted white box. Set the Exposure Time to something relatively small (e.g. 50 or 100 msecs). Note this is (can be) different than the exposure time you set up in the section *Capturing The Dark Frames* above.

Then, capture the image the same way as the Dark Frame using the **Grab NORMAL Frame** button in Pilot (shown above). Save this file to a file as above (choose a different file name for example, `FlatField1.rcd)`. As with the Dark Frame images, you can also capture multiple Flat Field images to allow for 'stacking' and averaging.

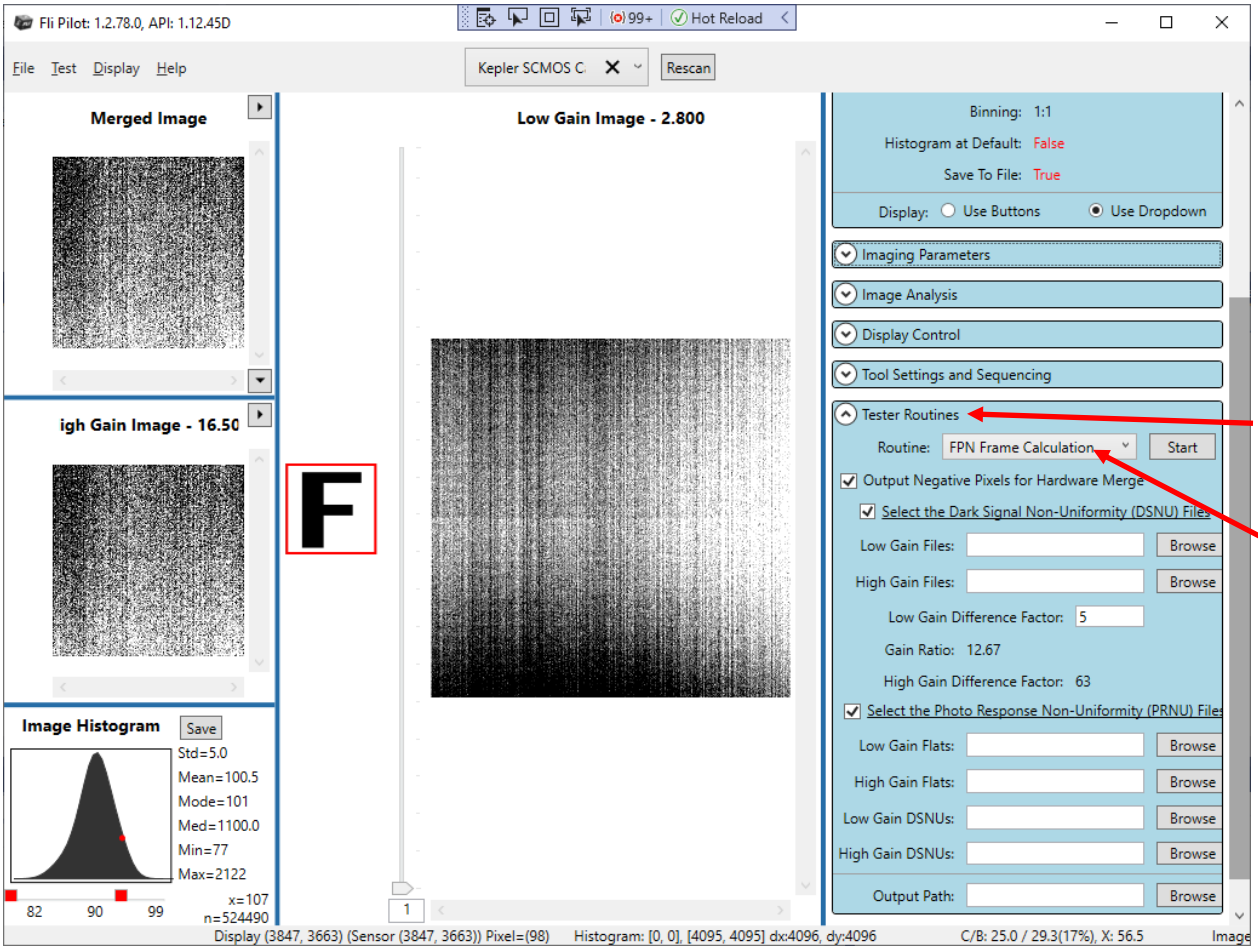
## Dark Flat Field Correction Frames

As of Pilot version 1.2.78, you also have the ability to correct the Flat Field images. Previous versions of Pilot did not have this feature so if you have an older version of Pilot, you can skip this section. These frames are called Dark Flat Field (DFF) Frames

These frames will correct the Flat Field prior to use in the FPN calculation below. They are Dark Frames taken with the same exposure time as the Flat Field frames. The Dark Frames you captured initially for correction were taken with the exposure time set to the time for your actual image capture. So, to capture these DFF correction frames, use the same exposure settings you used for the Flat Field Frames and cover the lens so no light can reach the sensor. Then, just capture the images the same way as you did for capturing the Flat Field Frames using the **Grab NORMAL Frame** button. Again, you can capture a single image, or multiple depending on your needs.

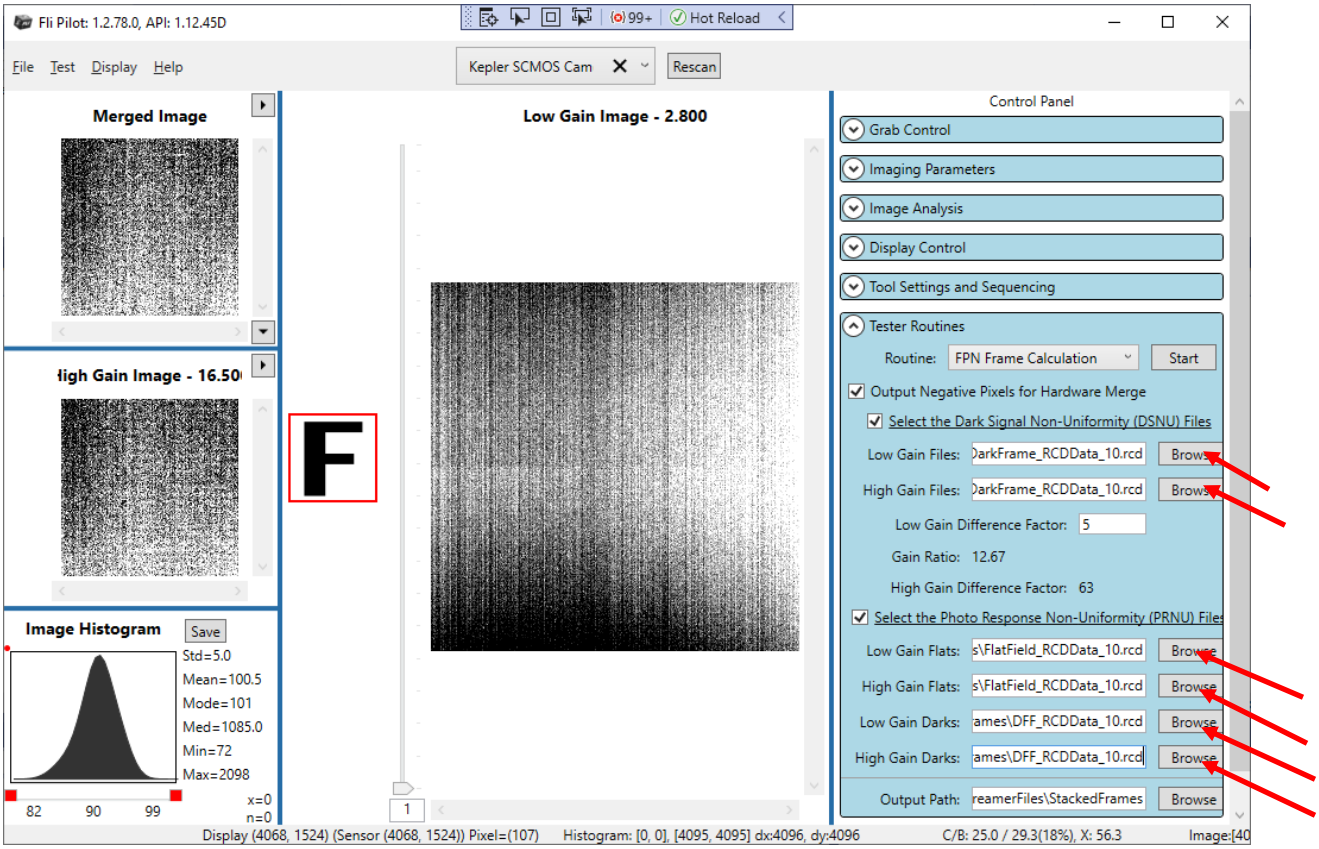
## FPN Calculation

Now that you have captured the Dark Frame , Flat Field, and (potentially) Dark Flat Field Correction frames, you can use Pilot to create the DSNU and PRNU files for merging. Expand the `Tester Routines` drop down near the bottom of the Control Panel. In the Routine drop down, choose `FPN Frame Calculation`.

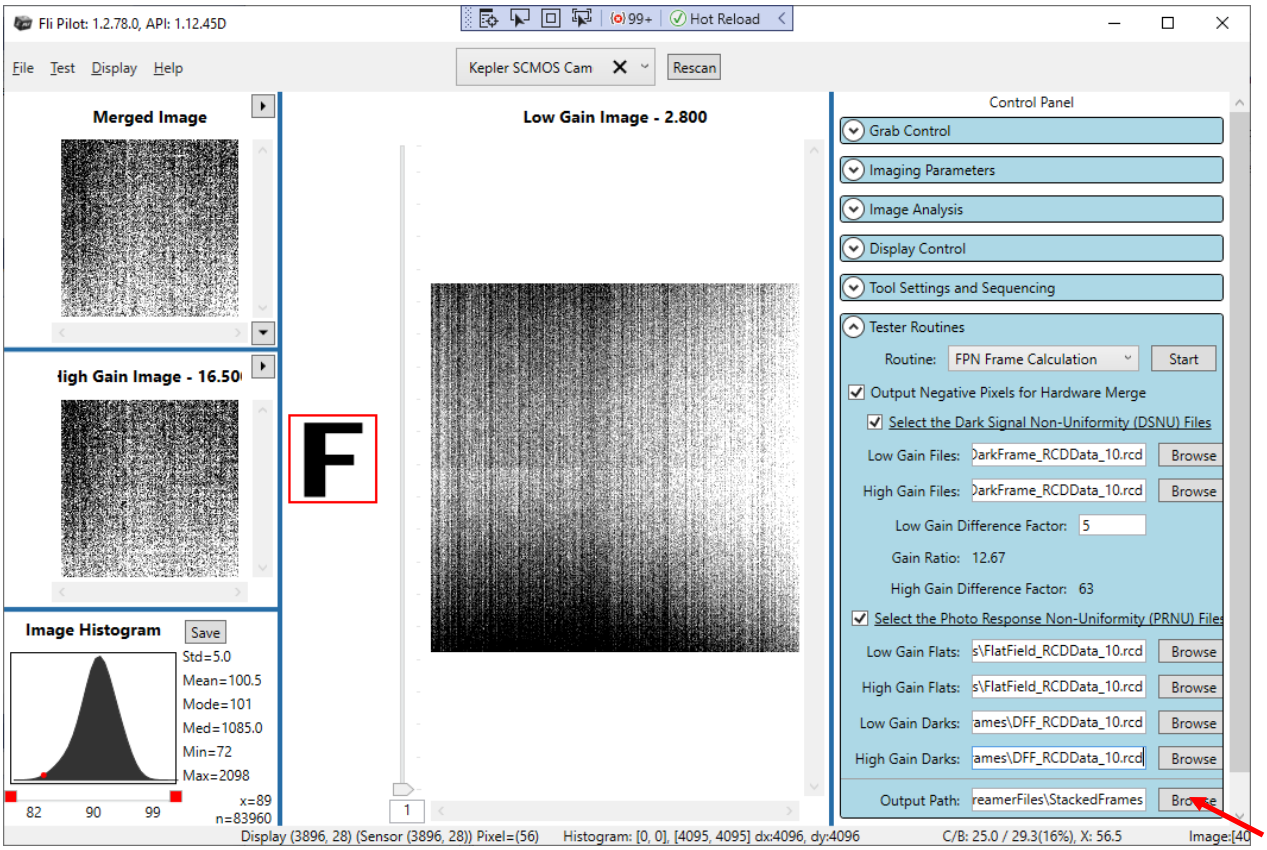


Next, using the **Browse** buttons, locate the files you saved for the Dark Frame and Flat Field images. Note that the same file is entered for both the Low Gain and High Gain files. This is because the `rcd` file that Pilot saved contains both the Low Gain and High Gain image data. For Pilot versions 1.2.78 and later, you also select the Low Gain Darks (i.e. DFF frames) and High Gain Darks using the associated **Browse** buttons. These buttons do not appear on older versions of Pilot.

**Advanced:** If you captured multiple Dark Frame , Flat Field, or DFF frames, you simply select all of the files you created through the Browse button.



Next, choose a location for the resultant DSNU and PRNU files using the **Browse** button for the `Output Path` text box near the bottom.



Finally, you can create the DSNU and PRNU files by hitting the **Start** button next to the **Routine** name. This will produce two files similar in name to the following:

- `DSNU-DarkFrame_RCDData_1.rcd`
- `PRNU-FlatField_RCDData_1.rcd`

These files can now be used for API merging using the `FPROMERGE_ALGO_REF_FRAME` algorithm as described above. For additional information on how to use these files with the API, see the `SimpleAPIMerging.cpp` example in the API documentation.