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FrameSmooth

User guide

Version 1.5

2016

1. Common information

Software FrameSmooth - cross-platform module for brightness equalization. It allows processing images with any formats. Module is based on using of filter for brightness equalization, inverse median and nonlinear high-frequency filters. Also it supports using of additional astronomical masterframes (Bias, Dark, DarkFlat and Flat).

Also the feature for converting images in fits format was added.

2. Minimal system requirements:

- **Windows** system from 2000 (32, 64-bit) version or **UNIX** system (32, 64-bit);
- **Processor** frequency no less 1 Hz;
- **RAM** no less 2GB;
- Free space on the hard drive (taking into account the space for temporary files) no less 6GB.

3. Supported file formats

FrameSmooth supports the following file types – *jpg, png, tiff, bmp, gif* и *fits*.

Inverse median filter supports the following file types – *jpg, png, tiff, bmp, gif* и *fits*. *Fits* files of 8 and 16 bits depth.

Nonlinear high-frequency filter supports only *fits* files of any bits depth.

IMPORTANT! The file names and paths to them should not contain cyrillic characters.

4. Windows configuration

Recommended using the latest version of Java 8 ([32-bit](#), [64-bit](#)).

5. Linux configuration

5.1. Verify Java version

Recommended using the latest version of Java 8

Verify Java version. Perform in the terminal the following:

```
java -version
```

If Java version is less than 8, install Java 8. Perform in the terminal the following:

```
sudo add-apt-repository ppa:webupd8team/java  
sudo apt-get update  
sudo apt-get install oracle-java8-installer
```

5.2. Compiler C & C++ update

5.2.1 Compiler C

Verify compiler C version. Perform in the terminal the following:

```
gcc -v
```

If compiler C version is less than 4.8, install gcc 4.8 or higher. Perform in the terminal the following:

```
sudo add-apt-repository ppa:ubuntu-toolchain-r/test  
sudo apt-get update  
sudo apt-get install gcc-4.8  
sudo update-alternatives --remove-all gcc  
sudo update-alternatives --install /usr/bin/gcc gcc /usr/bin/gcc-4.8 20  
sudo update-alternatives --config gcc
```

5.2.2 Compiler C++

Verify compiler C++ version. Perform in the terminal the following:

```
g++ -v
```

If compiler C++ version is less than 4.8, install g++ 4.8 or higher. Perform in the terminal the following:

```
sudo add-apt-repository ppa:ubuntu-toolchain-r/test  
sudo apt-get update  
sudo apt-get install g++-4.8  
sudo update-alternatives --remove-all g++  
sudo update-alternatives --install /usr/bin/g++ g++ /usr/bin/g++-4.8 20  
sudo update-alternatives --config g++
```

5.3. Set the permissions for all FrameSmooth modules:

Set the required permissions (read/write) for the directory with all installed CoLiTec modules. Perform in the terminal the following:

```
chmod -R 700 Path_to_FrameSmooth
```

5.4. Installing ImageMagick library

To process *jpg, png, tiff, bmp, gif* files with help of FrameSmooth you should install ImageMagick library. To download the latest version of ImageMagick library use the following [link](#).

To [install](#) ImageMagick library perform in the terminal the following:

```
tar xvzf ImageMagick.tar.gz  
cd ImageMagick-7.0.3  
./configure  
make  
sudo make install  
sudo ldconfig /usr/local/lib
```

6. Main window:

Access to the program features can be provided through the main window of GUI (fig. 1).

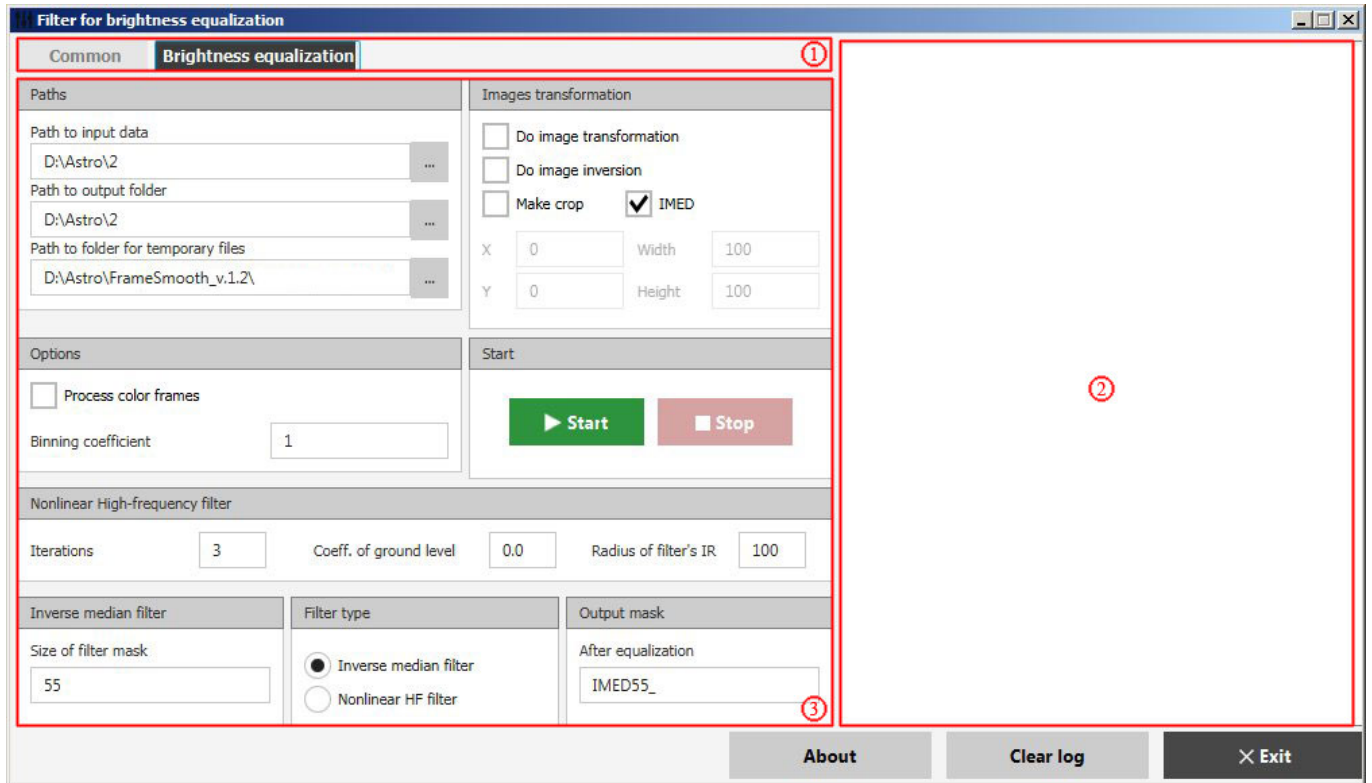


Fig. 1. Main window: 1 – tabs; 2 – Output window with text information (processing log); 3 – tab area to set parameters.

7. “Common” tab (fig. 2):

1. “*Configuration file*” – Save\Load configuration file (*Save as* \ *Load*);
2. “*Language choice*” selection field of the language interface;
3. In field “*Others*” optionally set:
 - “*Delete temporary files*” – removing of temporary files (recommended);
 - “*Use additional frames*” – usinf of additional tabs to process with master-frames (9 section).
 - “*Threads count*” – select the number of processor cores that will be available to the program.

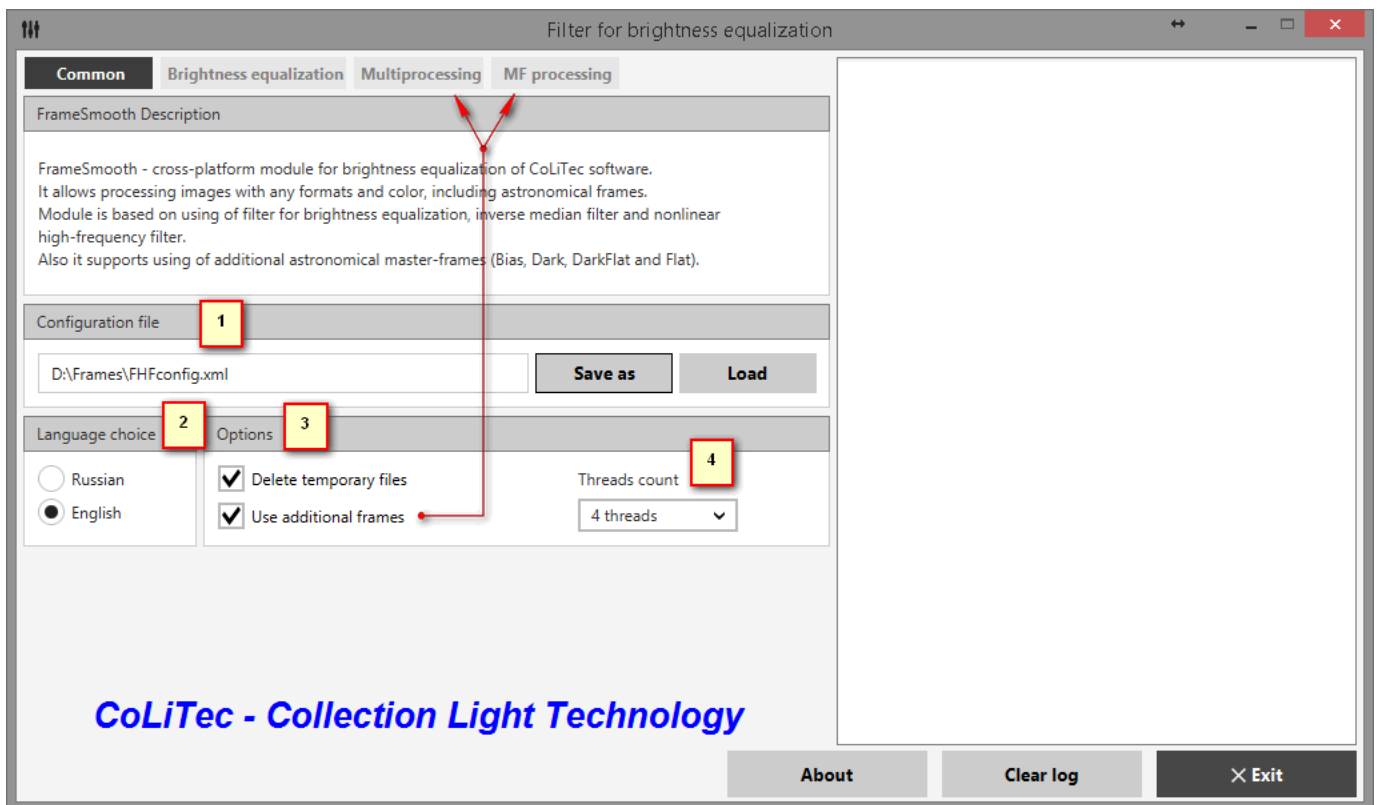


Fig. 2

8. “Brightness equalization” tab

8.1 Settings for the image filtration (fig. 3).

The screenshot shows the 'Brightness equalization' tab in the FrameSmooth software. It is divided into several sections:

- Paths (1):** Three text boxes for file paths. The first is 'Path to input data' (D:\Astro\Samples FITS\2016 08 27 flat\FHF_flat -0), the second is 'Path to output folder' (D:\Astro\Samples FITS\2016 08 27 flat), and the third is 'Path to folder for temporary files' (D:\Astro\Samples FITS\2016 08 27 flat).
- Options (2):** A checkbox for 'Process color frames' (unchecked) and a 'Binning coefficient' input field (1).
- Nonlinear High-frequency filter (3):** Three input fields: 'Iterations' (3), 'Coeff. of ground level' (0.0), and 'Radius of filter's IR' (100).
- Inverse median filter (4):** A 'Size of filter mask' input field (55).
- Filter type (5):** Two radio buttons: 'Inverse median filter' (selected) and 'Nonlinear HF filter'.
- Output mask (6):** An 'After equalization' input field (IMED55_).
- Images transformation:** Three checkboxes: 'Do image transformation' (unchecked), 'Do image inversion' (unchecked), and 'Make crop' (unchecked). A checked checkbox 'IMED' is also present. Below are 'X' and 'Y' input fields (both 0) and 'Width' and 'Height' input fields (both 100).
- Start:** A green 'Start' button and a red 'Stop' button.

Fig. 3

1. In “**Paths**” field following paths can be set:

- “*Path to input data*” – path to the raw files;
- “*Path to output folder*” – path to the output folder of processed files;
- “*Path to folder for temporary file*” – path to the folder for temporary files (used during converting images to fits).

2. In “**Options**” field set modes:

- “*Process color frames*” is used for the processing of graphics file types. It allows you to process a color image channel by channel.

- “*Binning coefficient*” sets the binning factor for reducing the amount of used memory and image processing time.

3. Parameters of Nonlinear High-Frequency filter can be set in “*Nonlinear High-Pass filter*” field:

- “*Iterations*” – number of iterations from 1 to 50;

- “*Coefficient of ground level*” – parameter changes from -3 to 3, recommended value equal zero;

- “*Radius of filter's IR*” – radius of the filter's impulse characteristic from 30 to 500;

4. Parameter of the inverse median filter – mask size “*Size of filter mask*” – can be set in “*Inverse median filter*” field.

The recommended value of the inverse median filter mask size is determined by the expression:

$$d \geq \sqrt{2N} ,$$

where d - window size of inverse median filter;

N - number of pixels (area), which occupies by the bright object on the image.

5. Filter type can be selected in “*Filter type*” section.

6. The mask for filename of the processed images can be set in “*Output mask*” filed.

8.2 Settings for converting images in fits format (fig. 4).

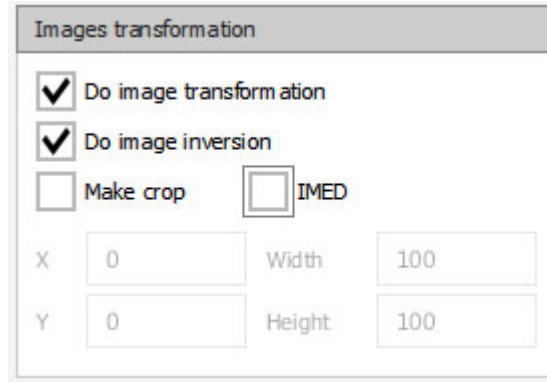


Fig. 4

In the "**Images transformation**" set converting parameters:

- "*Do image transformation*" – activates the converting function;
- "*Do image inversion*" – activates the image inversion function during converting.
- "*Make crop*" – activates the crop creation function. It defines by the coordinates of the upper left vertex, the width and height. Crop parameters set in the text boxes "*X*", "*Y*", "*Width*" and "*Height*".
- "*IMED*" – activates the alignment function of the received file fits.

9. Section «MF processing»

Functionality section for "Manual (individual)" creation and using of the additional master frames.

9.1. Master frame creation

To create additional master frames use the following tab:

«MF processing -> MF creation»

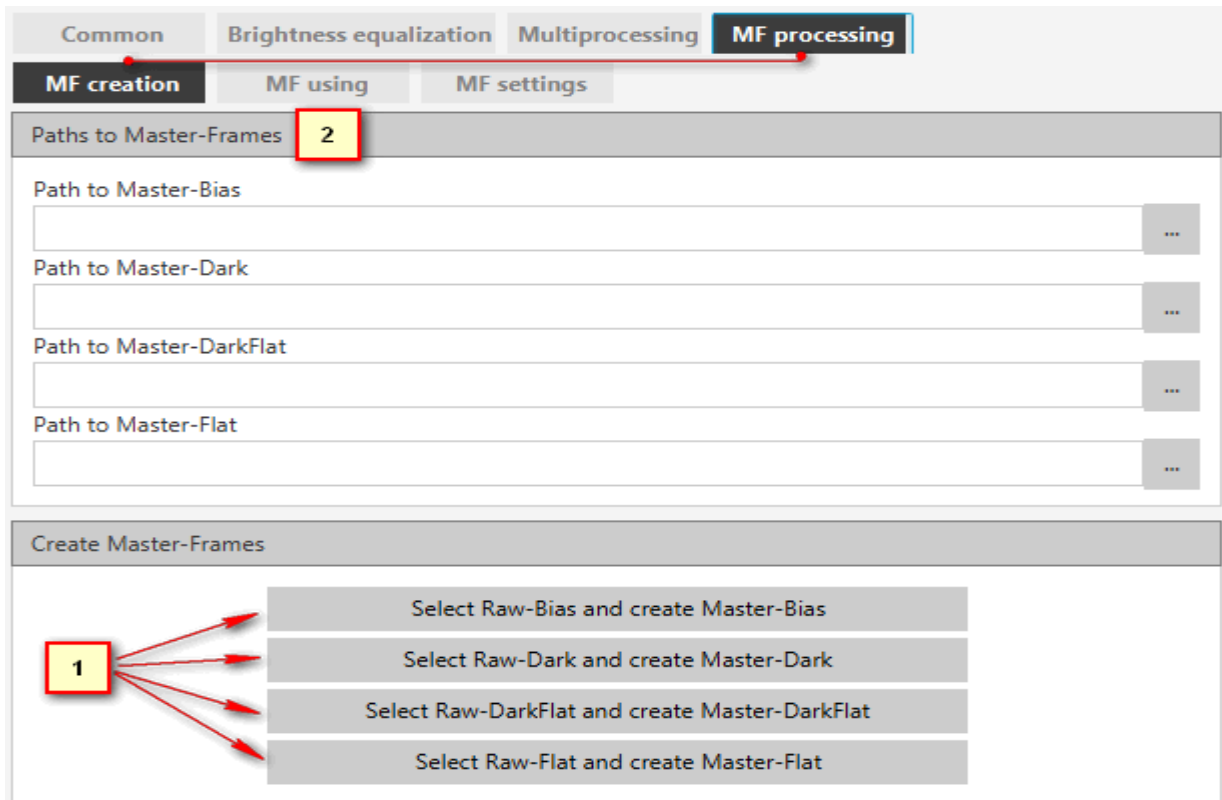


Fig. 5

1. For creation the master frame perform the following (fig. 5 index “1”):
 - 1.1. Master-Bias – click «*Select Raw-Bias and create Master-Bias*» button.
 - 1.2. Master-Dark – click «*Select Raw-Bias and create Master-Dark*» button.
 - 1.3. Master-DarkFlat – click «*Select Raw-Bias and create Master-DarkFlat*» button.
 - 1.4. Master-Flat – click «*Select Raw-Bias and create Master-Flat*» button.
2. Paths of the created master frames will be inserted to the appropriated fields (fig. 5–index “2”):
 - 2.1. For Bias – «*Path to Master-Bias*»

2.2.For Dark – «*Path to Master-Dark*»

2.3.For DarkFlat – «*Path to Master-DarkFlat*»

2.4.For Flat – «*Path to Master-Flat*»

3. If master frames Master-Bias and Master-DarkFlat were created, they will be used for creating the Master-Dark and Master-Flat frames. If necessary, you can download another Master-Bias and Master-DarkFlat. If you want to create a Master-Dark and Master-Flat frames without Master-Bias and Master-DarkFlat frames, you should clean fields «*Path to Master-Bias*» and «*Path to Master-DarkFlat*».
4. The mask for created master frame can be set in «**MF settings**» section.

9.2. Master frames using

To use additional master frames use the following tab:

«MF processing -> MF using»

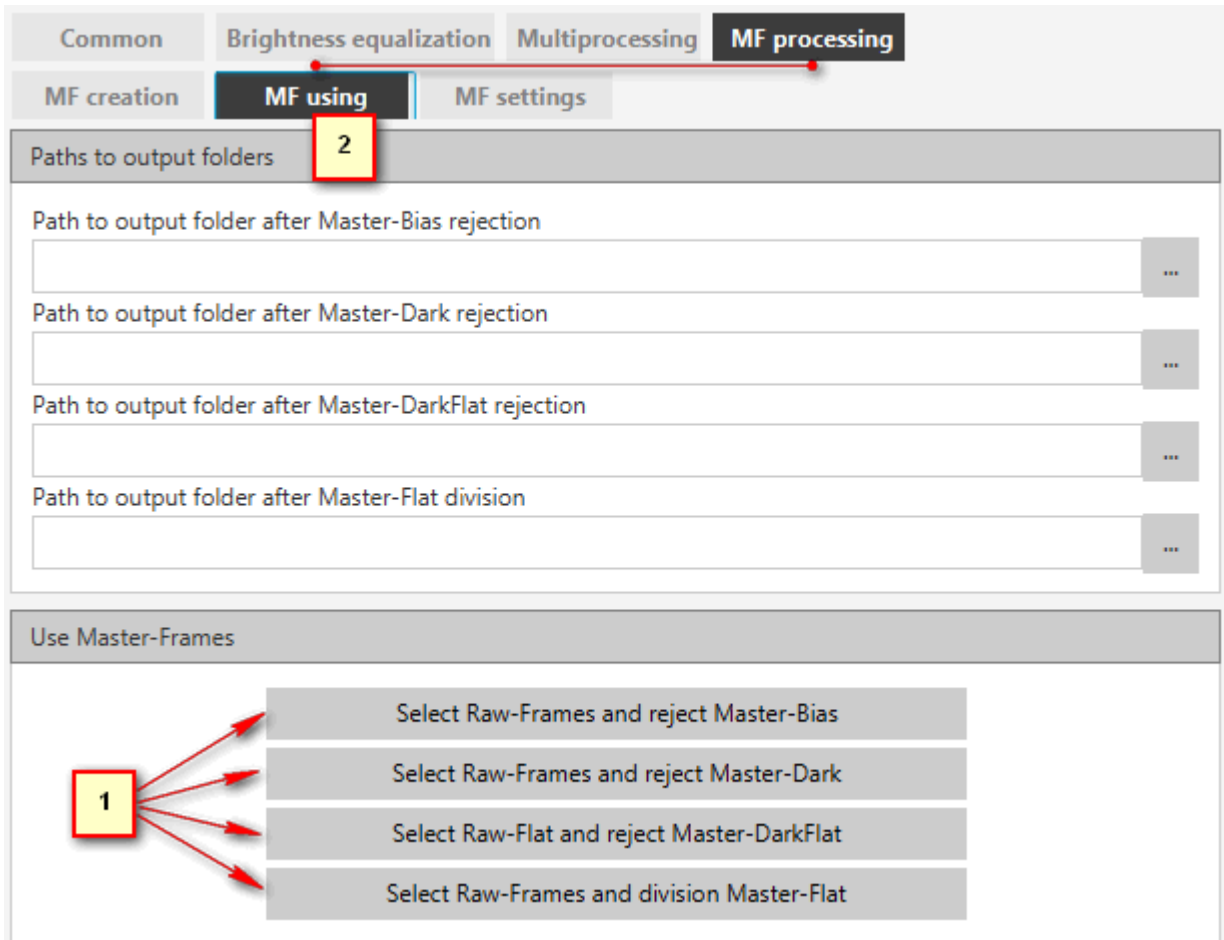


Fig. 6

1. For calibration target (Light) frames the appropriate paths to the master frames should be set in «MF creation» tab.
2. You should specify the output directory where will be saved Light-frames after using the appropriate master frame.
3. Select, according to the index "1", which processing of the Light frames you want to perform.
4. Rejection and division masks for the new names of Light frames after the appropriate master frame using can be set in the «MF settings» section.

9.3. Settings of MF processing

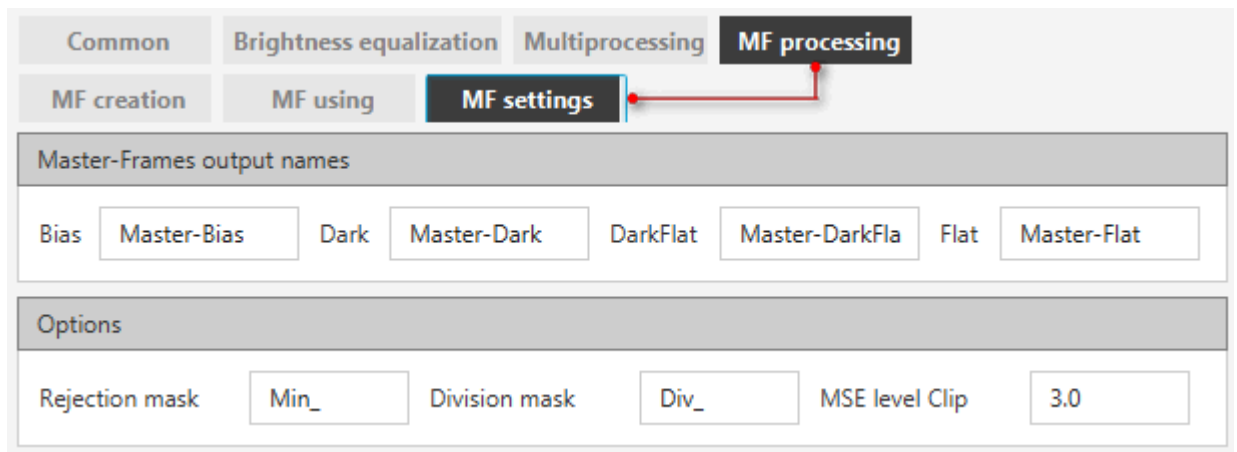


Fig. 7

Parameters description:

1. **Master-Frames output names** pane allows you to specify the names of the master frames for **MF creation** mode.
2. **Options** pane:
 - Rejection mask** – a prefix to the name of the target (Light) frames after the rejection operation;
 - Division mask** – a prefix to the name of the target (Light) frames after the division operation;
 - MSE level Clip** – rejection ratio of pixels in an operation of master frames creation.

10. Multiprocessing section

The functional section is designed for automatic on-line processing of any number of frames that can be formed by different telescopes.

10.1. OLDAS (on-line data analysis system)

The screenshot shows the OLDAS interface with the following components:

- Navigation tabs:** Common, Brightness equalization, Multiprocessing (selected), MF processing.
- Sub-tabs:** OLDAS (selected), Script, Settings.
- Paths section:** Two text input fields with browse buttons (three dots) for 'Path to input folder(s)' and 'Path to processing folder'.
- Options section:** Three input fields: 'Mask' (empty), 'Timeout' (value 10), and 'Refresh' (value 10).
- Start section:** Three buttons: a green 'Start' button with a play icon, a red 'Stop' button with a square icon, and a yellow 'Refresh' button with a circular arrow icon.
- OLDAS status section:** A table with two columns: 'Paths to output folders' and 'Processed'. The table is currently empty, displaying 'No content in table'.

Fig. 8

OLDAS mode performs the following functions:

1. On-line search for frames in the specified input directory;
2. Copy the frames found in the directory for processing;
3. Search for the appropriate master frames (bias, dark, darkflat, flat), if not set by the user;
4. Master frames creation and using;
5. Inverse median filter using.

To start **OLDAS** perform the following steps:

1. Set the **number of cores** (Fig. 2, the pointer 4), that will be available for the program (we recommend to leave at least one core for the needs of other processes). This parameter determines the number of running CLTClone programs, that will be look for the task (frame alignment) (Fig. 8).
2. It is necessary to specify the path to input folder(s) (**Path to input folder (s)**) with frames that are already located in it or will be created (i.e. by telescope during observation) (Fig. 8). The structure of output folders will be the same as the structure of the input folders.
3. It is necessary to specify the path to processing folder (**Path to processing folder**), where frames processing (alignment) will be performed (Fig. 8). Processing folder should be different with the input folder (i. e. `Path_to_processing_folder != Path_to_input_folder (s)`).
4. **«Mask»** parameter - mask of the frame's name that will be selected from «input folder (s)». By default, the mask is empty that means program is looking for all frames (Fig. 8).
5. **«Timeout»** parameter - idle time of the program, in hours. After this time the running program CLTClone will be terminated (Fig. 8).
6. **«Refresh»** parameter - frequency of updating the processing information in OLDAS status window (Fig. 8).
7. Set required parameters in **Multiprocessing -> Settings** tab (described in section 10.3 «*Multiprocessing Settings*») (Fig. 11).
8. **Start \ Stop** buttons - start \ stop OLDAS processing.
9. **Refresh** button - update the processing information (number of processed frames) (Fig. 8).

Note 1 - location of the processed frames.

For example, two user-selected input folders (\ IN_1 \ and \ IN_2 \) and processing folder is set as (\ OUT \), as shown in Fig. 9. The aligned frames will be saved in the processing folder with the same structure of folders. Example in Table 1.

Table 1

Catalog search frames	Frames location	Directory for processing	Aligned frames
\TestFS\IN_1\	\TestFS\IN_1\KIC 2835289\	\TestFS\OUT\	\TestFS\OUT\KIC 2835289\
\TestFS\IN_2\	\TestFS\IN_2\RXJ1803\	\TestFS\OUT\	\TestFS\OUT\RXJ1803\

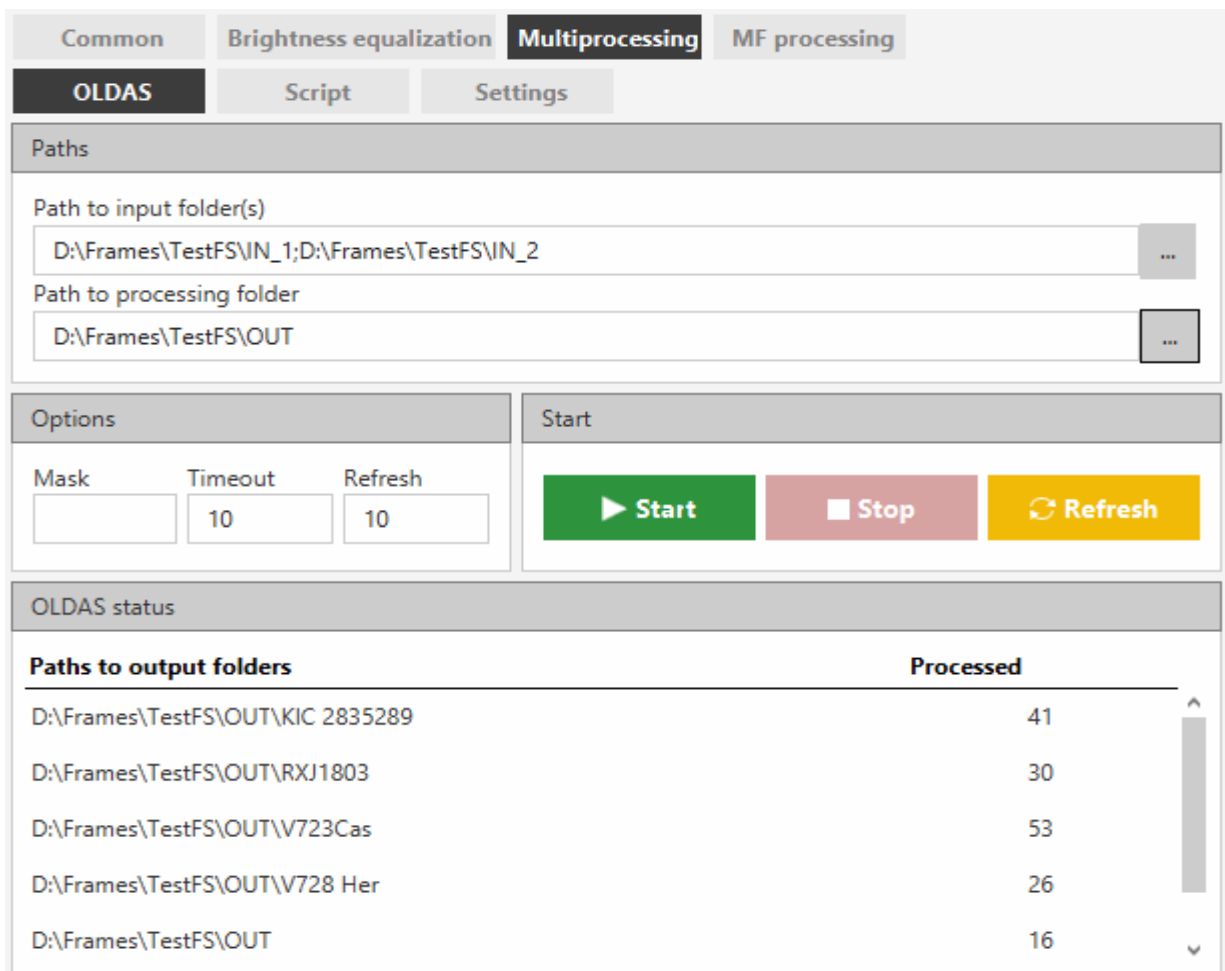


Fig. 9

Note 2 - individual processing parameters for each telescope.

If you want to set "own" parameters for frame of each telescopes, such as window size for inverse median filter, using \ not using some types of master frames, do the following: ("Common" tab -> "Save as" button) with the name, which includes the number (name) of telescope, the same as in the fit-frame header. For example, FHFconfig.xml -> MYSCOPE_FHFconfig.xml. Such individual settings should be saved for the EACH telescope.

10.2. Script

(Alignment by the specified sequence of operations)

Script mode allows to perform the following:

1. Specify list of frames for alignment (Path to input data);
2. Search for the appropriate master frames (bias, dark, darkflat, flat), if not set by the user;
3. Master frames creation and using;
4. Inverse median filter using;
5. Detection and blanking of the bad pixels.

Common	Brightness equalization	Multiprocessing	MF processing
OLDAS	Script	Settings	
Paths			
Path to input data			
<input type="text"/>			
Path to output folder			
<input type="text"/>			
Frames count and detection levels for "hot" and "cold" bad pixels			
Frames count	<input type="text" value="3"/>	Background RMS "Hot"	<input type="text" value="5.0"/>
		Background RMS "Cold"	<input type="text" value="5.0"/>
Script description		Options	
Process flow: 1. Master-Bias, Master-Dark, Master-DarkFlat, Master-Flat creation; 2. Master-Bias, Master-Dark, Master-DarkFlat rejection; 3. Inverse median filter processing; 4. Master-Flat division; 5. Detecting and removing of bad pixels ("hot" and "cold").		<input checked="" type="checkbox"/> Detect bad pixels ("hot" and "cold") Output mask <input type="text" value="Script_"/>	
Start			
<input type="button" value="▶ Start"/>		<input type="button" value="■ Stop"/>	

Fig. 10

To run **Script** perform the following steps:

1. Select images for alignment (Path to input data)
2. Specify processing directory (Path to output folder) - the directory for processed frames (if specified)
3. Set required parameters in the tab **Multiprocessing-> Settings** (see the description of **Multiprocessing-> Settings**) (Fig. 8).
4. Set parameters for bad pixels detection (Frames count - the minimum number of frames on which bad pixel should be detected, RMS HOT, RMS COLD - value of "hot \ cold" bad pixels detection)
5. Set mask for the name of aligned frame (Output mask)
6. Run \ Stop - «Start \ Stop»

10.3. Multiprocessing settings

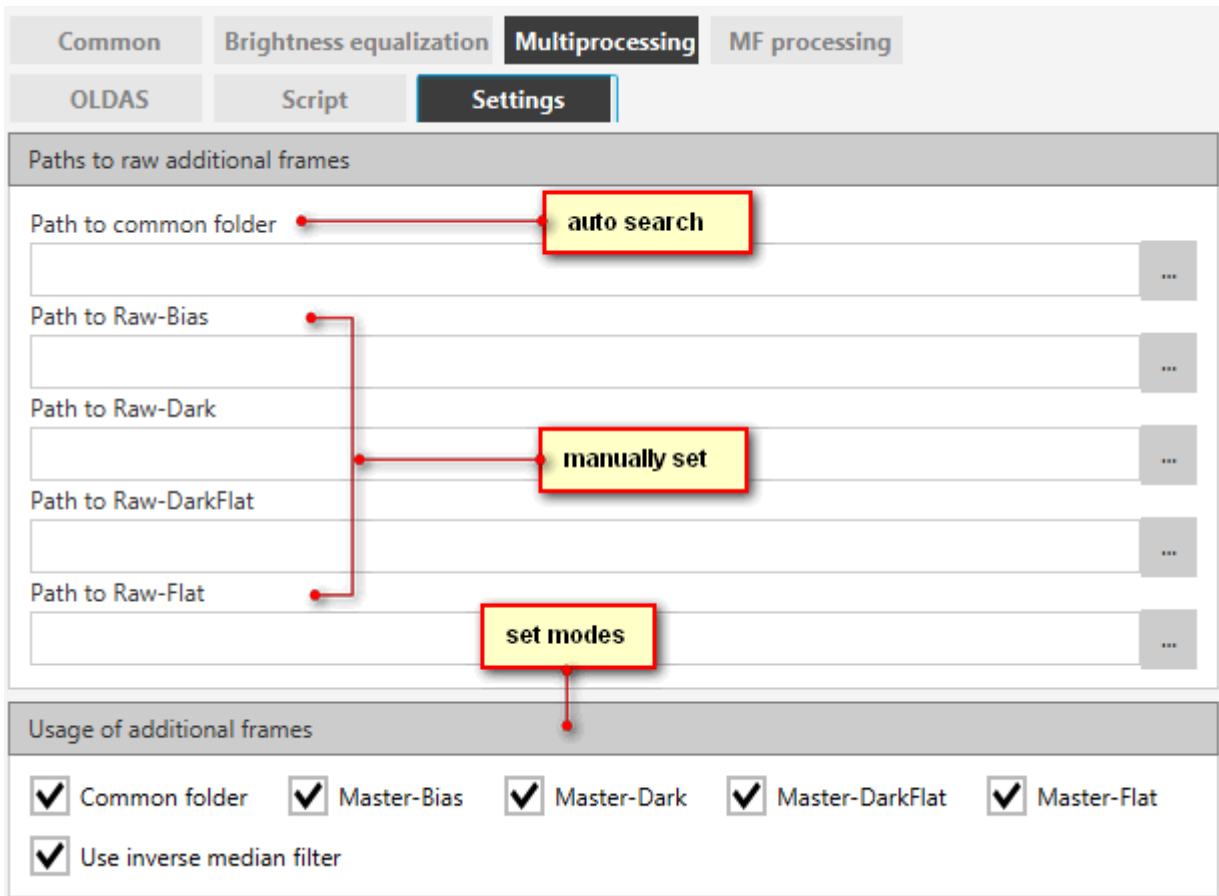


Fig. 11

Parameters description:

1. Automatic search for additional frames. You should specify the directory «Path to common folder», and set «Common folder» checkbox. This directory can contain additional frames of different types and telescopes. Criteria for selection additional frames from «Path to common folder» directory for master frames creation are described below:
 - 1.1. For Bias - frame size, frame type ('IMAGETYP' field should contain a combination of «bias» characters), title of 'TELESCOP' telescope
 - 1.2. For Dark - frame size, temperature ('SET-TEMP'), exposure ('EXPOSURE', 'EXP-TIME', 'EXPTIME'), frame type ('IMAGETYP' field should contain a combination of «dark» characters), title of 'TELESCOP' telescope
 - 1.3. For DarkFlat - the same as for the Dark, but relative to Flat frames

- 1.4. For Flat - frame size, filter type ('FILTR', 'FILTER'), frame type ('IMAGETYP' field should contain a combination of «flat» characters), title of 'TELESCOP' telescope
- 1.5. Time criterion. The group of frames with the time near or early then time of the target frame will be used in processing. For example, the target frame is received on 15.10.2016, there are 20 Dark-frames from 13/10/2016 and 20 Dark-frames from 12/10/2016 in the common folder. So, 20 Dark-frames from 13/10/2016 will be taken for creation of Master-Dark frame.
2. Manual setting of the list of the additional frames. In the fields «Path to Raw-Bias», «Path to Raw-Dark», «Path to Raw-DarkFlat», «Path to Raw-Flat» specify lists of raw additional frames, from which master frames will be created.
3. Setting mode: Set flags:
 - 3.1. «Common folder» - use \ not use the "common folder" for search of the additional frames;
 - 3.2. Master-Bias – use \ not use Master-Bias;
 - 3.3. Master-Dark – use \ not use Master-Dark;
 - 3.4. Master-DarkFlat – use \ not use Master-DarkFlat;
 - 3.5. Master-Falt – use \ not use Master-Flat;
 - 3.6. Use inverse median filtr – use \ not use inverse median filter.