Lemur LookSky – User Guide

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1. General information

LookSky – is a new cross-platform version of the frames viewer of the **Lemur** software for automated satellites, asteroids and comets discoveries in a series of CCD-frames.

The main features of **LookSky** are the following:

- visual analysis of the moving objects (satellites, asteroids and comets) detected in automation mode by **Lemur** software;
- deleting the false objects (it is necessary to pay attention to the previously unknown objects);
- hand measuring of the objects (satellites, asteroids and comets) that were not detected in automation mode;
- tuning visualization parameters (brightness, contrast, palette...);
- work with the list of processed series, generate a report for the entire list of series;
- creation and sending the reports.

After the successful processing of a series of frames by **Lemur** software perform start of **LookSky**. To do this, launch the executable file accordingly to the operating system: «**LookSky.exe**» (Windows) or «**LookSky**» (Linux).

2. Loading data

By uploading data we mean uploading a series (or several series) of processed frames. In this case, it is necessary to select the folder with the processed frames, inside such folder all the meta-data with the result of processing (directories of moving objects, configuration file, etc.) should be located.

It is also possible to load individual frames (which have not been processed), but the main functions of the program will not be available.

2.1. Initial user settings

During the first launching of **LookSky** (figure 1) perform the initial user settings. For this open **LookSky** settings by menu «*File → Profile LookSky*». The following settings are available: localization settings, saving of the parameters and windows position, automated objects searching and loading from the active series.

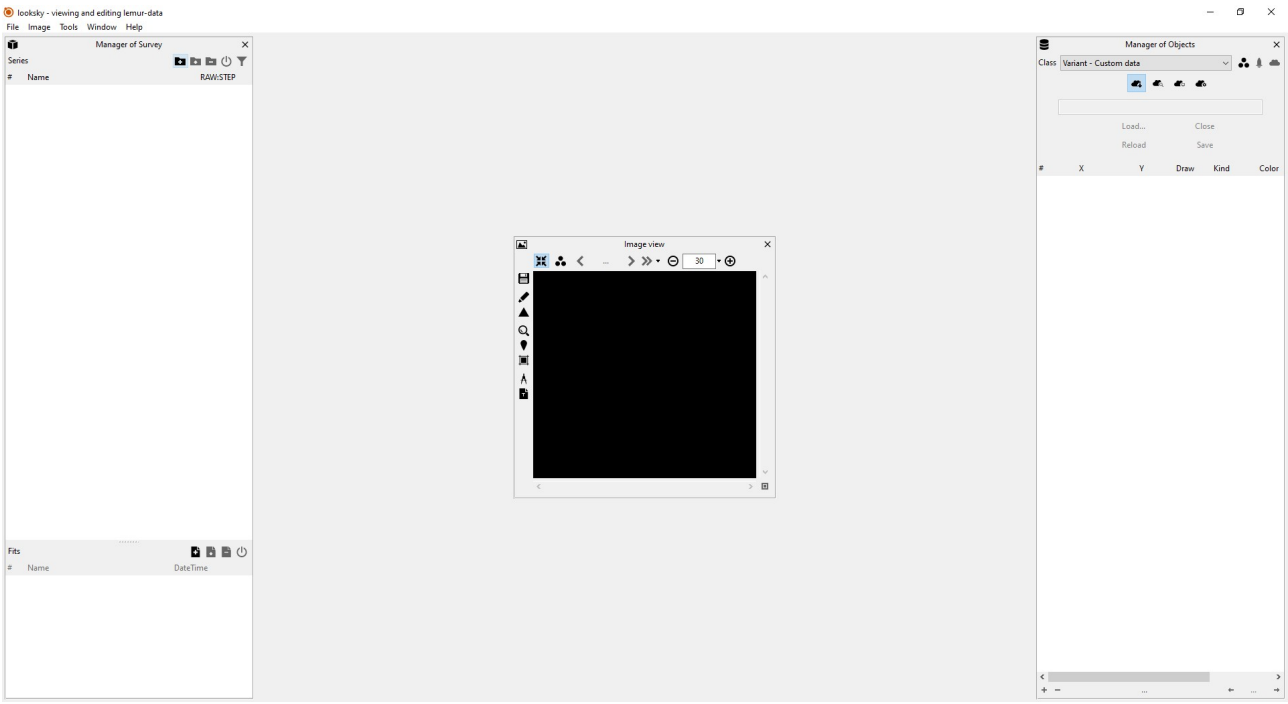

***Figure 1. LookSky** during the first launching*

2.2. Series loading

After initial user settings load the series of frames processed by **Lemur** software using menu «*File → Open series…*», or use the "Open Series..." button in the "Manager of survey" window. If you select the "Open series (recursive search...)" button - it will be possible to open all the series that will be located inside the specified folder. In the appeared dialog window find and select the folder with the processed series of frames. The loading process may take several seconds.

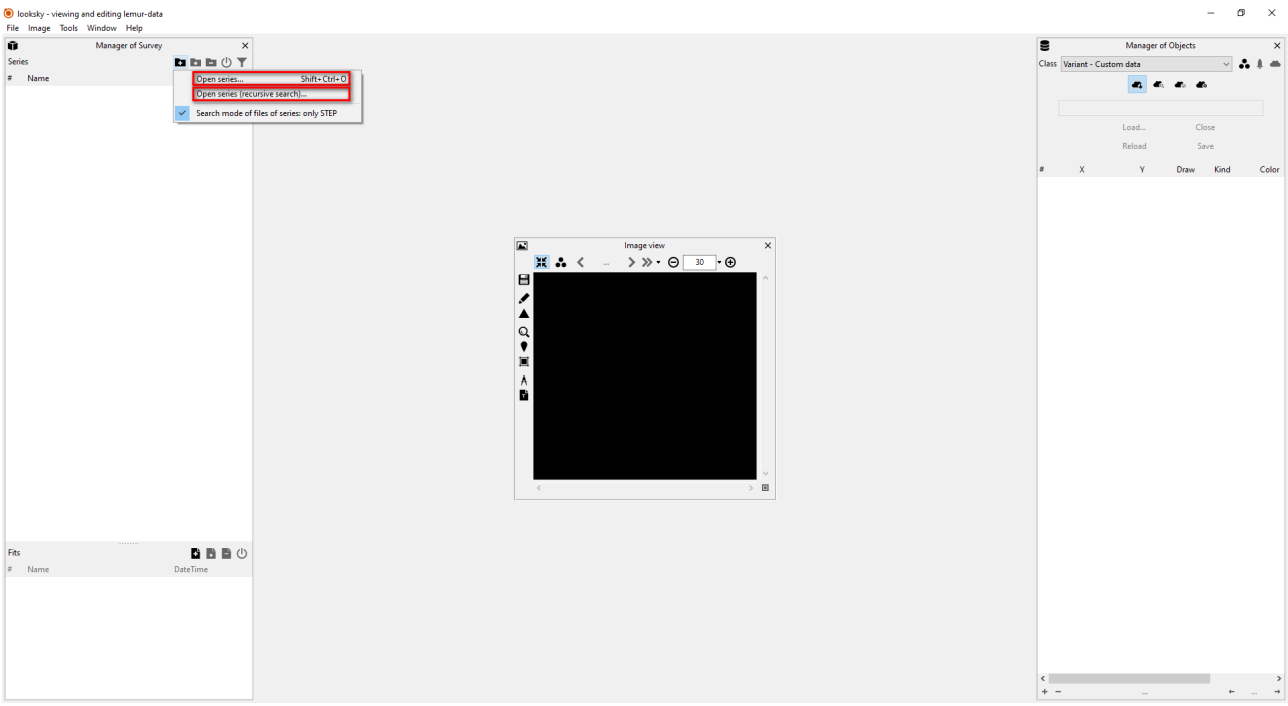

***Figure 2. LookSky** open series*

After loading the series of frames the activation window will appear (figure 3).

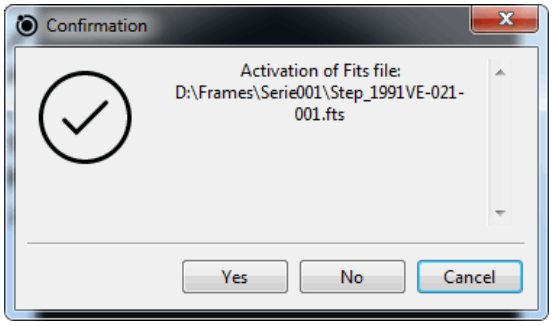

***Figure 3.** Activation window*

Select «Yes» button for the frame activation from loaded series.

3. Main windows

3.1. Main windows

After loading one or more series, the appearance of the program may look as shown in Figure 4. There are three main windows in the program:

Manager of Survey - the window for displaying and managing the list of loaded series.

Image view - the window for displaying frames, setting visualization parameters, centering frames by stars, etc.

Manager of Objects - the window for displaying the space objects (satellites, asteroids (comets)), which were found during processing, and the objects loaded from the catalog of the minor planets center and the tle-catalog of the satellites.

You can set position and size of all windows in the program according to the used monitor to increase usability (figure 4).

More details below.

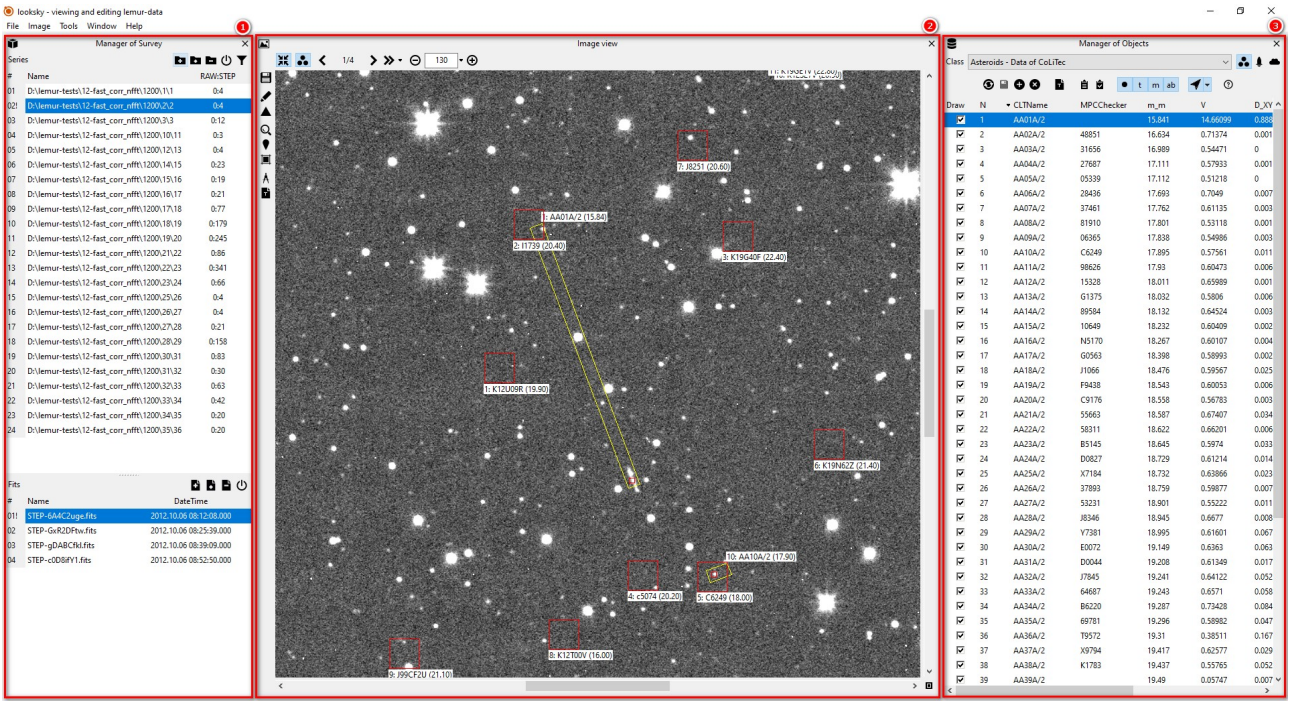

Figure 4. *Main windows*

3.2. Manager of Survey

Marker "1" - select the folder with the processed frames. You can select only one series (Open series...), or select to open several series (Open series (recursive search)...).

Marker "2" update the series in the list. This function can be useful when new frames appear in the folder, or to cancel changes made by the user in the list of objects.

Marker "3" close the series.

Marker "4" - sign of the active series, pay attention to the "!" sign.

Marker "5" - area of the window, in which you need to click the left mouse button, in order to go to this series.

Marker "6" - open (add a frame).

Marker "7" - frame update.

Marker "8" - close the frame.

Marker "9" - is the sign of the active frame, which is currently displayed.

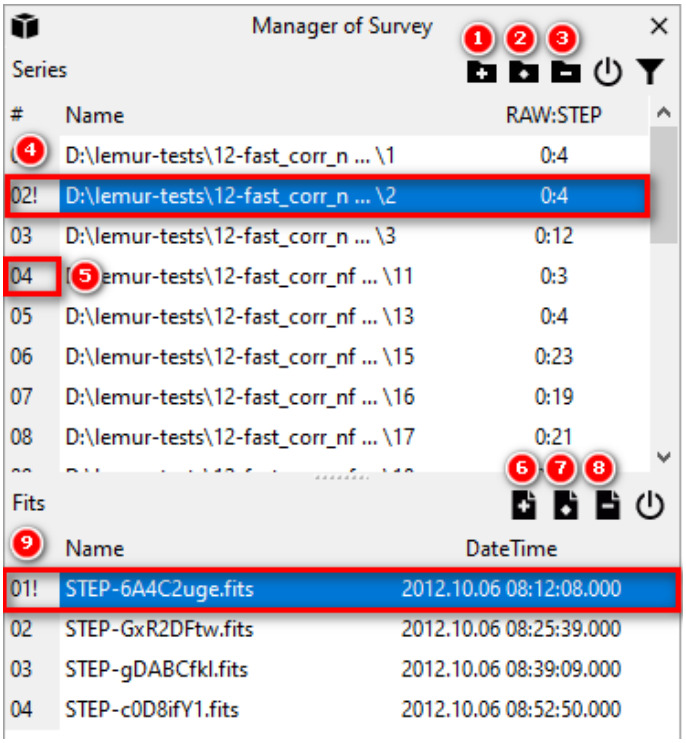

Figure 5. *Manager of Survey*

3.3. Image view

This window is for displaying frames. It contains the control buttons described below (see figure 6):

Marker "1" - is a button to turn on the frames centering by stars. It is recommended to turn on the "centering" mode when viewing slow objects captured in diurnal tracking mode, e.g. asteroids/comets. When viewing fast objects, for example satellites, it is recommended to turn off this mode.

Marker "2" - enable/disable all displayed information.

Marker "3" - rewind frame by frame.

Marker "4" - blinking all frames of the series. Next to the button there is a drop-down menu where you can select the blinking time and the ability to rewind frames with the right and left mouse buttons (try it, it is convenient).

Marker "5" - control the frame display scale. Next to the button, there is a drop-down menu, where you can select the scale of 100% and "fit into the screen".

Marker "6" - save images in bmp or gif formats.

Marker "7" - adjusting the display parameters - brightness, contrast, palette...

Marker "8" - set the orientation of the axes of the displayed frames.

Marker "9" - activate the magnifier.

Marker "10" - opening the information panel of pixel coordinates.

Marker "11" - opening the panel of the displayed area of the frame. It may be convenient when working with very large frames.

Marker "12" - opening the window for manual measurement of angular coordinates and magnitude of objects on the frames of the series. More details about this function will be described in a separate section.

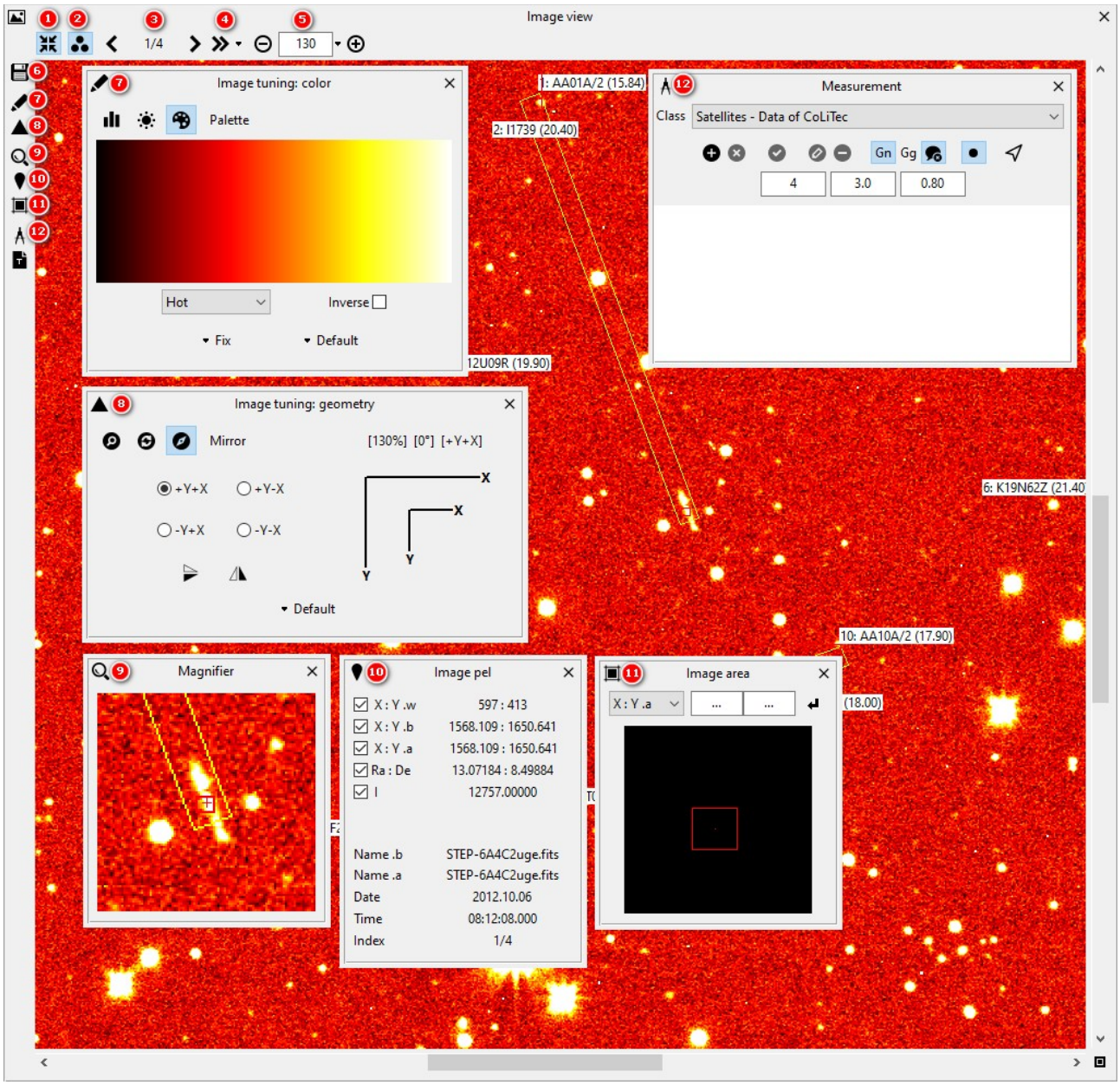

Figure 6. *Image view*

3.4. Manager of Objects.

After successful series loading and activation the list of detected moving objects (satellites, asteroids or comets) will appear in «*Manager Objects*» window.

There are four lists of space objects available in the program (see figure 7):
Asteroids - Data of CoLiTec - a list of asteroids (comets) which were detected by the program during frames processing. This list can contain both real objects (which can be identified with MPC catalog, or not if they are new objects) and false detections.

Asteroids - Data of Minor Planet Center - list of asteroids (comets) that were downloaded online from MPC service.

Satellites - Data of CoLiTec - the list of satellites, which were detected by the program during frames processing. This list can contain both real objects and false detections.

Satellites - Data of SSA Catalog - the list of satellites that were written to the configuration file by the observer before the processing. See the Lemur.ConfigManager manual for details on how to load the catalog of satellites into the configuration file.

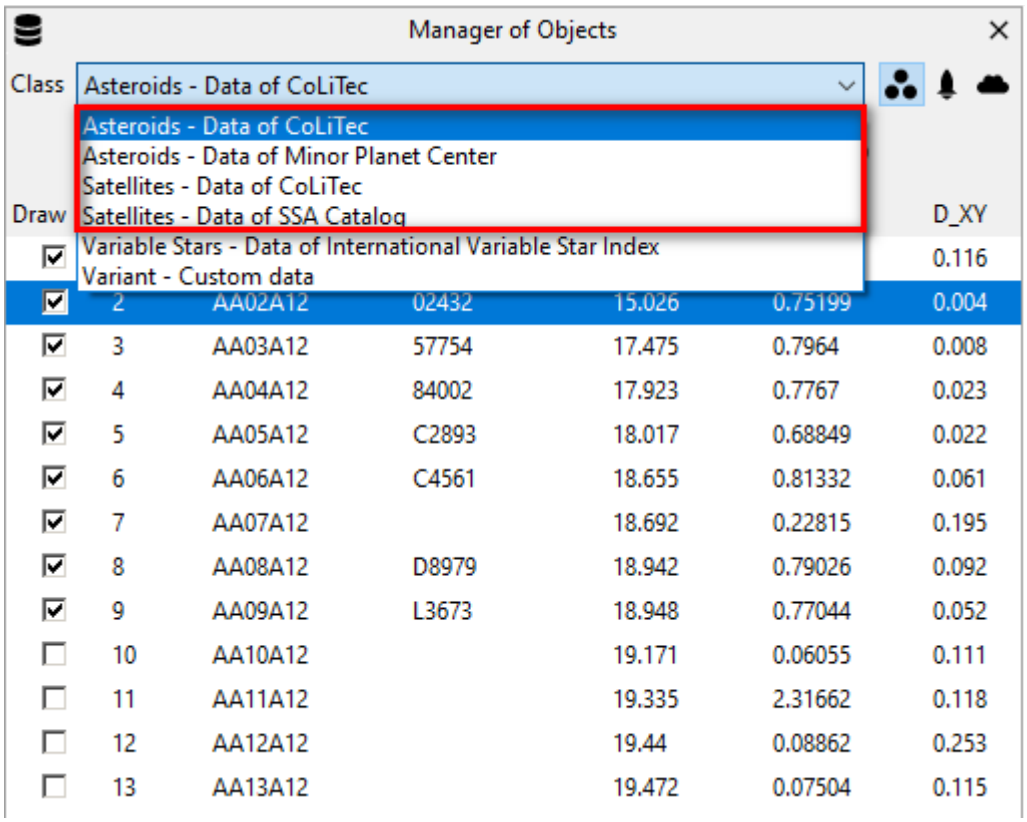

Figure 7. *Selecting a list of space objects*

Manager of Objects – features.

The Manager of Objects window has a set of functions that help the observer to select, analyze the result of the automatic search for objects and generate reports with measurements.

The functions are described below (see figure 8):

Marker "1" - selection of the list of space objects.

Marker "2" - button to enable/disable the display of data on objects on the frame.

Marker "3" - data update.

Marker "4" - saving the results of editing the list of found objects. By pressing this button, the state of the enabled/disabled checkboxes next to each object in the list is saved. Generally, switched off checkbox means that this object is false (or you just have to disable its display, so it won't interfere with viewing of other, close objects). Keep in mind that a report with measurements will not be generated for the object next to which the checkbox is disabled.

Marker "5" - start the window of manual measuring of angular coordinates and magnitude of the object.

Marker "6" - list clearing.

Marker "7" - call the dialog box of report formation - only by selected object.

Marker "8" - call the dialog box of report forming for all objects in the list, opposite to which the checkbox is enabled.

Marker "9" - enabling/disabling the display of objects on the frames.

Marker "10" - enable/disable the display of "yellow" strobes - the area of objects movement.

Marker "11" - enable/disable the display of the object marker.

Marker "12" - enable/disable the display of the object number.

Marker "13" - setting parameters when navigating between objects. Scale - to scale the frame when selecting an object in the list. Nearest frame - switch to display the nearest frame, which has a measurement for the selected object.

Marker "14" - open the text file with objects.

Marker "15" - checkbox to enable/disable the display of the object. Keep in mind that the report with measurements will not be generated for the object next to which the checkbox is disabled.

Marker "16" - an example of identification and non-identification of the object with the catalog.

Marker "17" - header of the displayed parameters. By clicking the right mouse button you can select the desired set of columns.

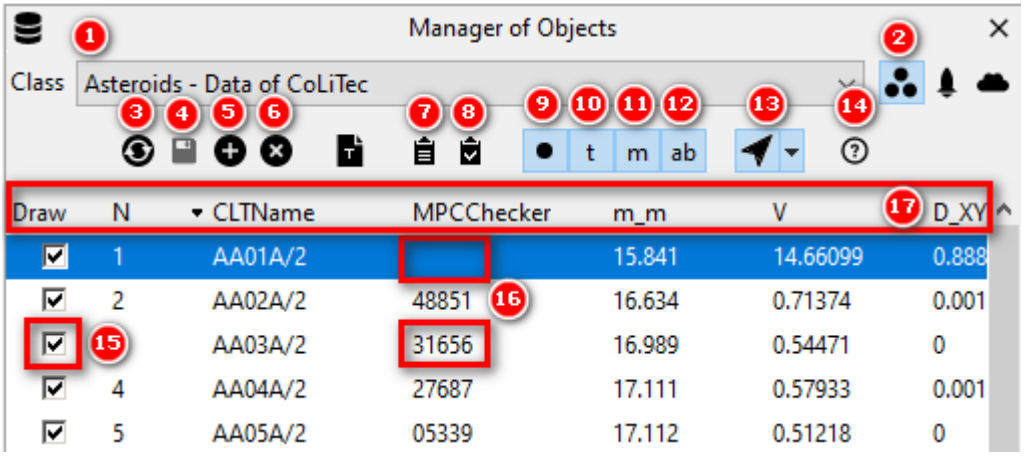

Figure 8. *Manager of Objects features*

4. Visual analysis of found moving objects

This visual analysis of found moving objects is necessary to select real objects from false detections.

To perform visual analysis, depending on the processing (asteroids or satellites), select the required list of objects in the Manager of Objects window - "Asteriods - Data of CoLiTec" or "Satellites - Data of CoLiTec".

Then enable frame blinking (section "3.3 Image view", marker "4").

Left-click on the object in the "Manager of Objects" window and the display area in the "Image view" window will move to the selected object. For your convenience, set the "Use a navigation on a frame" option (section "3.4 Manager of Objects", fig. 8, marker "13").

Use your eyes to judge, if the object is real or false. If the object is false, uncheck the box in the "Draw" column next to the object.

Pass in this way through the whole list of found objects.

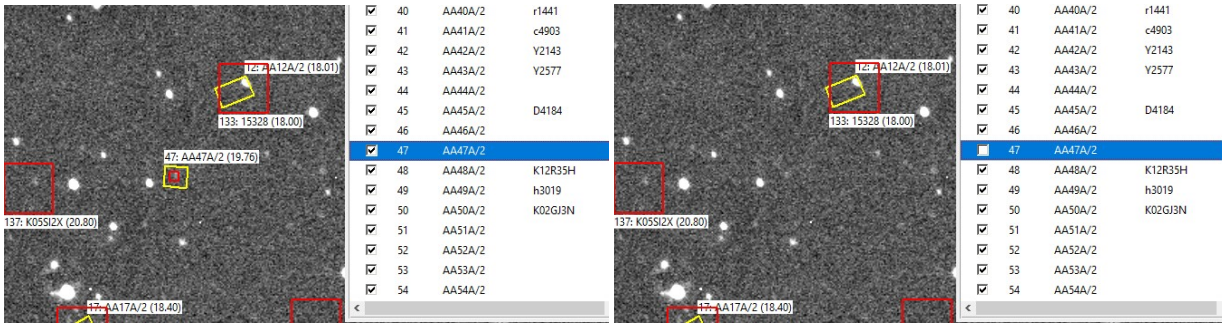

Figure 9. *Removing a false object*

You can also use data from the Minor Planet Center (MPC) catalog to control the quality of automatic detection of moving objects by the Lemur software. To do this, select the tab "Asteroids - Data of Minor Planet Center" (Figure 7) and check each object that is in the catalog list. In the case of satellite frames processing, it is necessary to select the tab "Satellites - Data of SSA Catalog" (Figure 7) to control the quality of automatic detection. If any objects were not detected, the program has a function of manual measurement of objects.

Figure 10 below shows the types of strobes displayed:

Yellow rectangular strobe is an asteroid (comet) that was detected by the program in automatic mode (or by a manual measurer). The inscription next to the yellow strobe shows: the serial number of the object in the list, the internal designation of the object, the average value of the object's magnitude estimate.

The red square is the display of the asteroid (comet) from the MPC catalog. The inscription near the red strobe shows: the serial number of the object in the list, the designation of the object in the MPC catalog, the catalog value of the object in the MPC catalog.

Accordingly, if two strobes, yellow and red, are adjacent, it means that the program has found the known object in the MPC catalog (example "marker-1").

If the object is in the MPC catalog, i.e. there is a red strobe, but there is no automatic detection (no yellow strobe), then, such object was not found. The reasons for this can be different - too weak object, the image of the object on many frames overlapped with the image of the stars, errors in the program... (example "marker-2").

Example "marker-3" - in this case shows false detection by the program, but be careful, in your case it can be a new object!

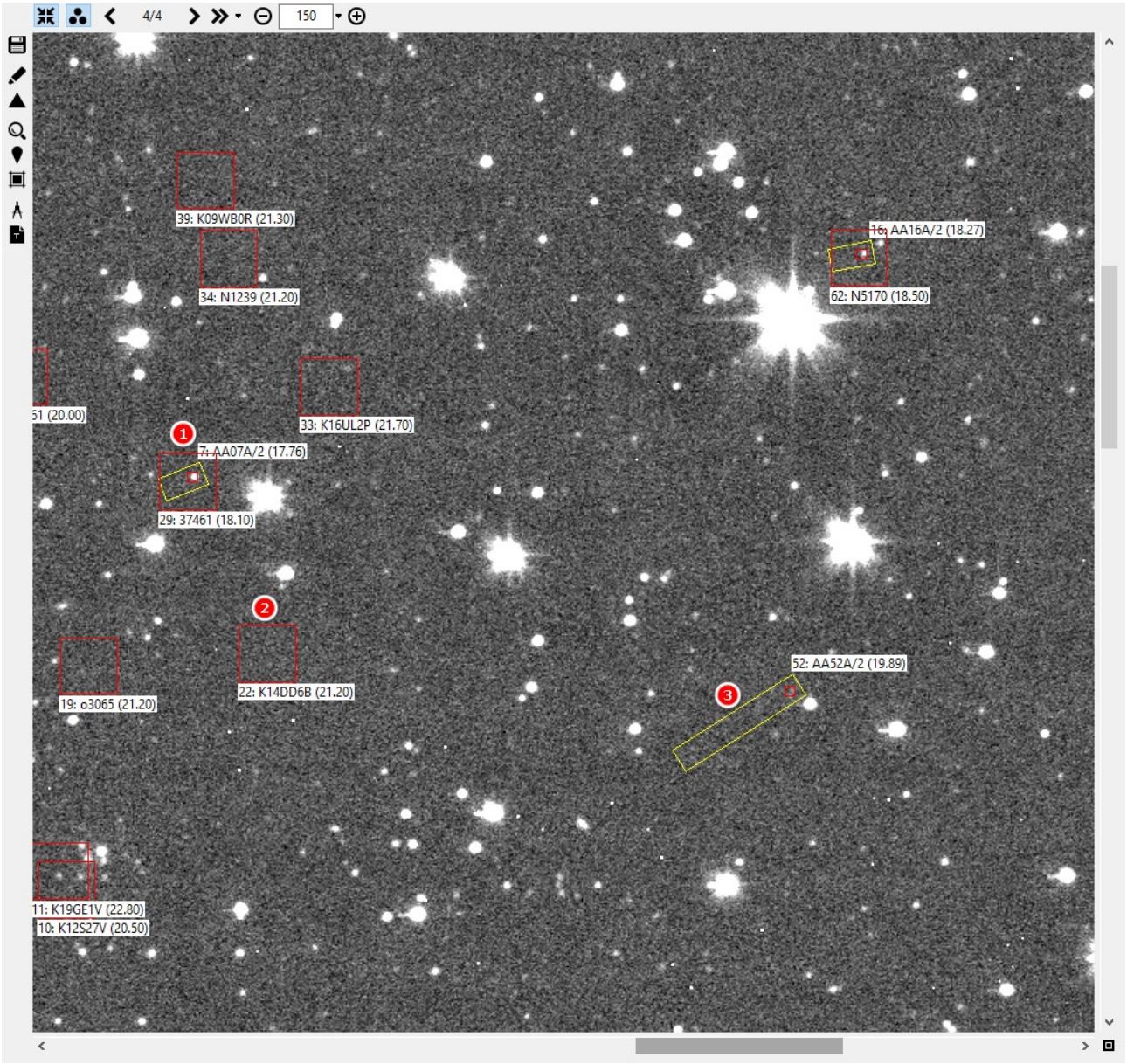

Figure 10. *Description of displayed strobes*

5. Hand measuring of the objects

In case if some objects (asteroids/comets or satellites) were not detected by **Lemur** software and there is only one red (MPC) selection of these objects you should perform the hand measuring of all not detected objects. To do this, use «*Tools → Hand Measurer*» menu.

The measuring of the object's image in the current frame can be perfomed by clicking on Ctrl+LMB. Measure the required object on each frame, you can do this by using the frame navigation buttons or by turning on the frame blink button.

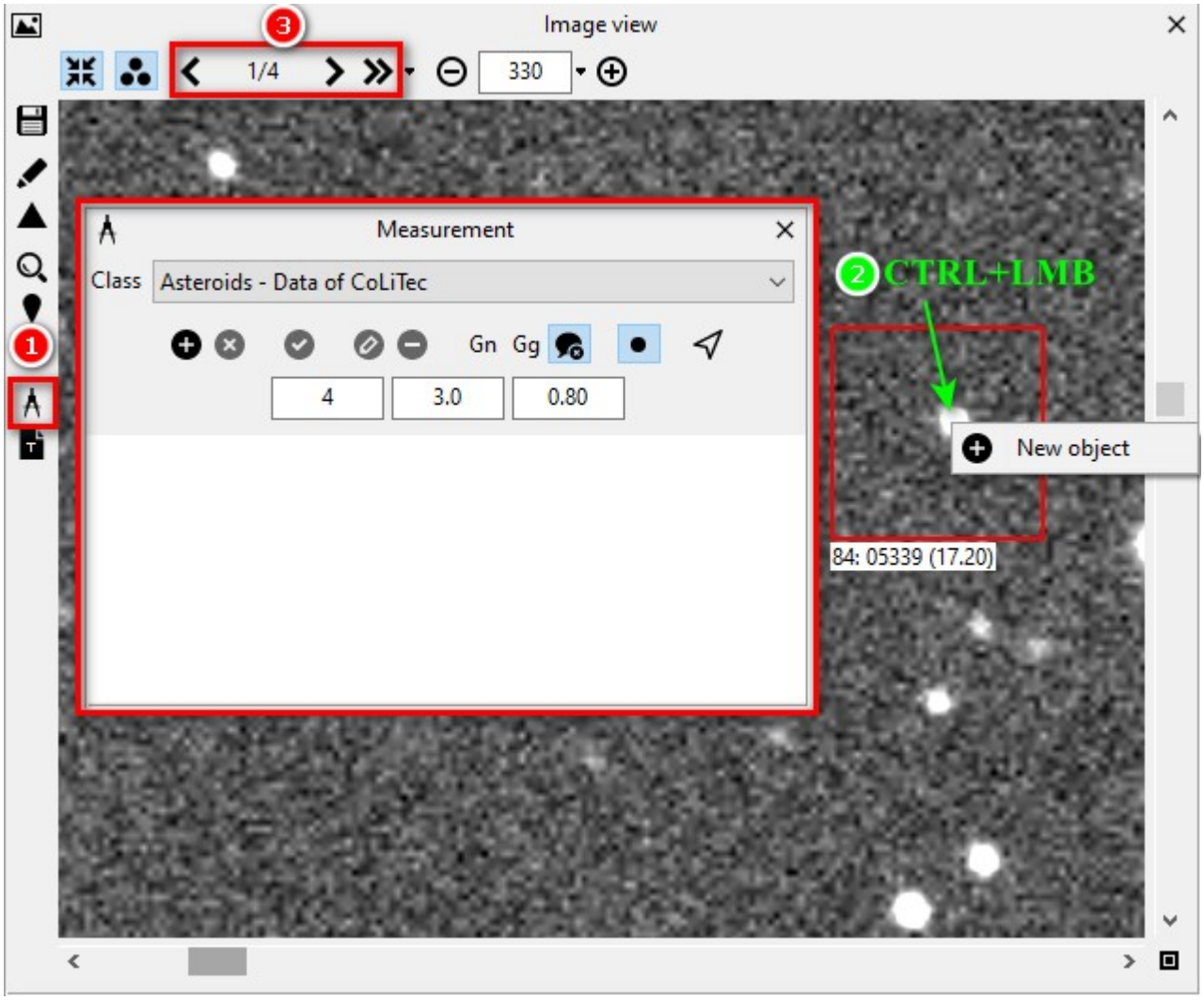

Figure 11. *Hand measuring of the object*

After getting all the measurements, click the " Make object " button, and this new object will be added to «*Asteroids - Data of CoLiTec*» list, or to the «*Satellites - Data of CoLiTec*» list, depending on the type of the measured object (figure 12).

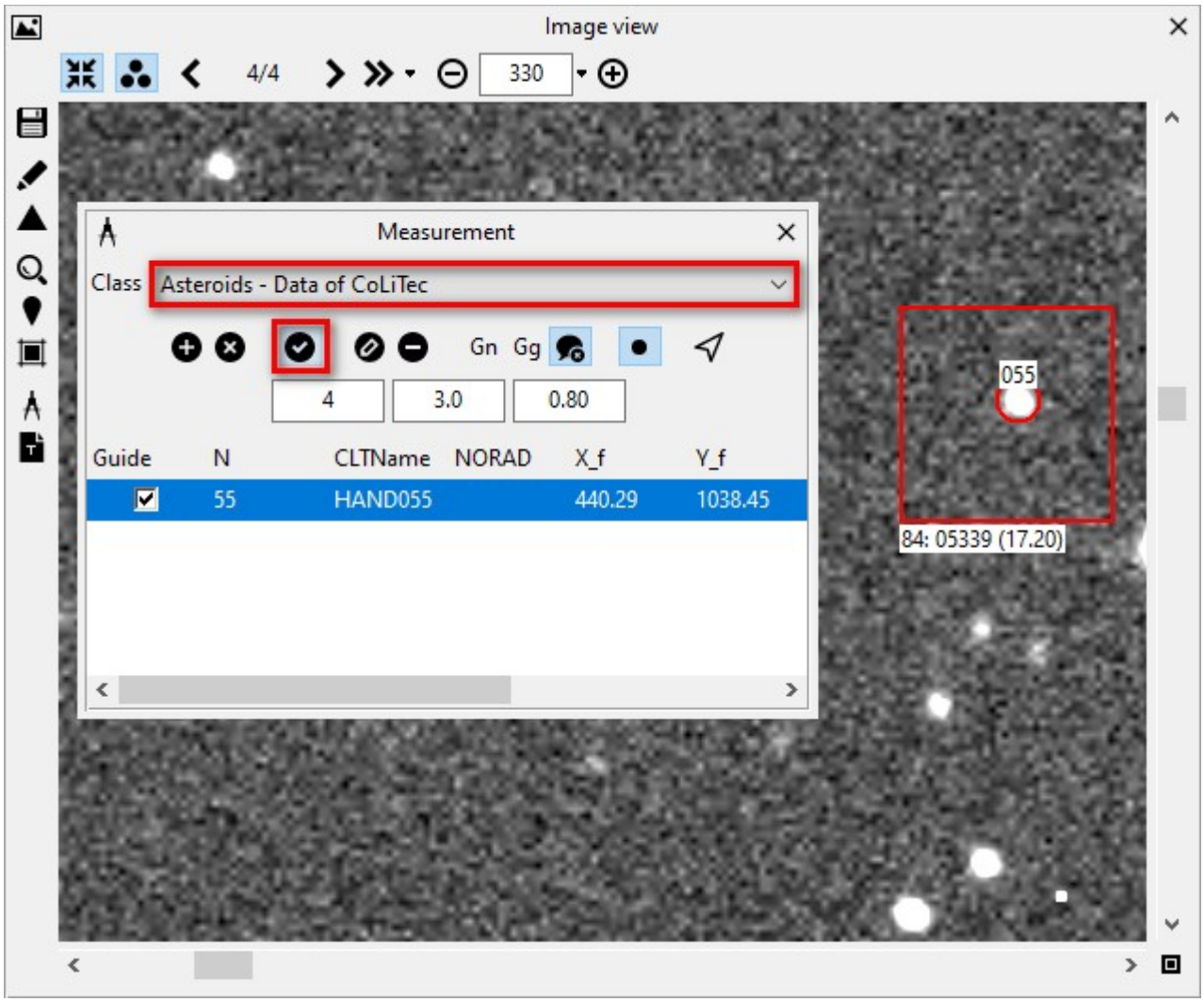

Figure 12. *Creating an object*

The functions of the manual measurement window are described below.

Marker "1" - selection of the type of object to be measured (asteroid/satellite).
Marker "2" - add the object to the list for measurement.
Marker "3" - delete the object from the measurement list.
Marker "4" - make an object.
Marker "5" - add a measurement of the object.
Marker "6" - delete the measurement of the object.
Marker "7" - activation of mode Gn - auto tracking on "one frame" - it means that the search of the image of the object on the next frame will be made relative to the coordinates obtained on the current frame. It is advisable to turn on this mode when measuring satellites that were tracked by the telescope.
Marker "8" - switching on mode Gg - auto tracking on "two frames" - this means that the search for an object image on the next frame will be made relative to the coordinates obtained on the two previous frames.
Marker "9" - enabling the notification of measurement errors.
Marker "10" - switching on the display of measurements.
Marker "11" - activation of navigation, frame centering relative to the object.
Marker "12" - search radius relative to the predicted coordinates (used in Gn and Gg modes).
Marker "13" - minimum OSR value of the object.
Marker "14" - smoothing coefficient (used in Gg modes).

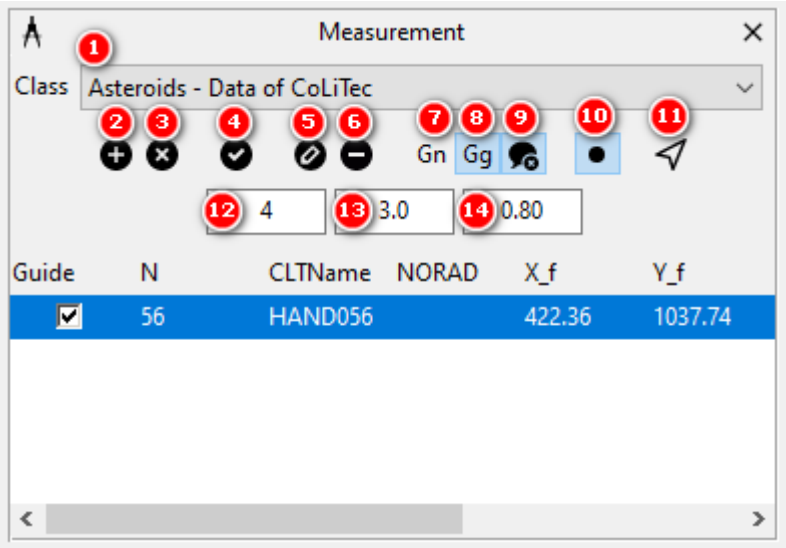

Figure 13. *Manual measurement window functions*

6. Forming a report

Create report after saving the results of work (figure 14).

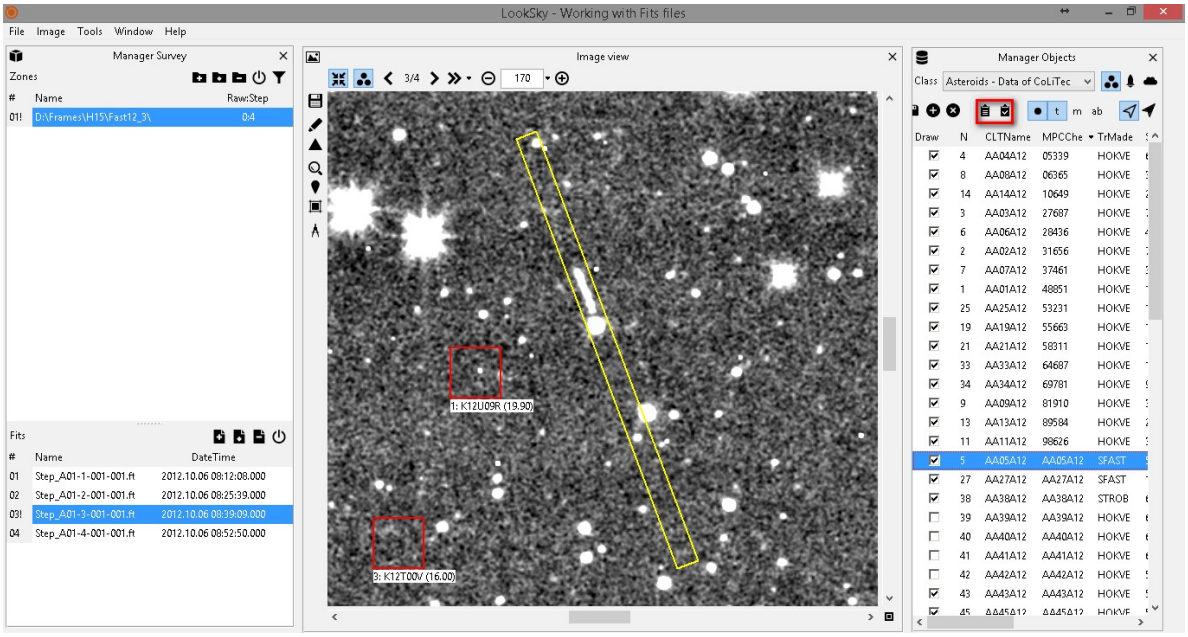

Figure 14. *Report window opening*

IMPORTANT! To send reports from **LookSky** set E-mail settings in «Report/*E-mail settings→ Sender settings*» section and check fields in «*MPC recipient*» section in the settings editor **Lemur Config Manager**. Report also can be saved as text file and sent manually from the preferred mail service.

If several series were downloaded, **LookSky** provides the opportunity to generate a consolidated report for several series (figure 15).

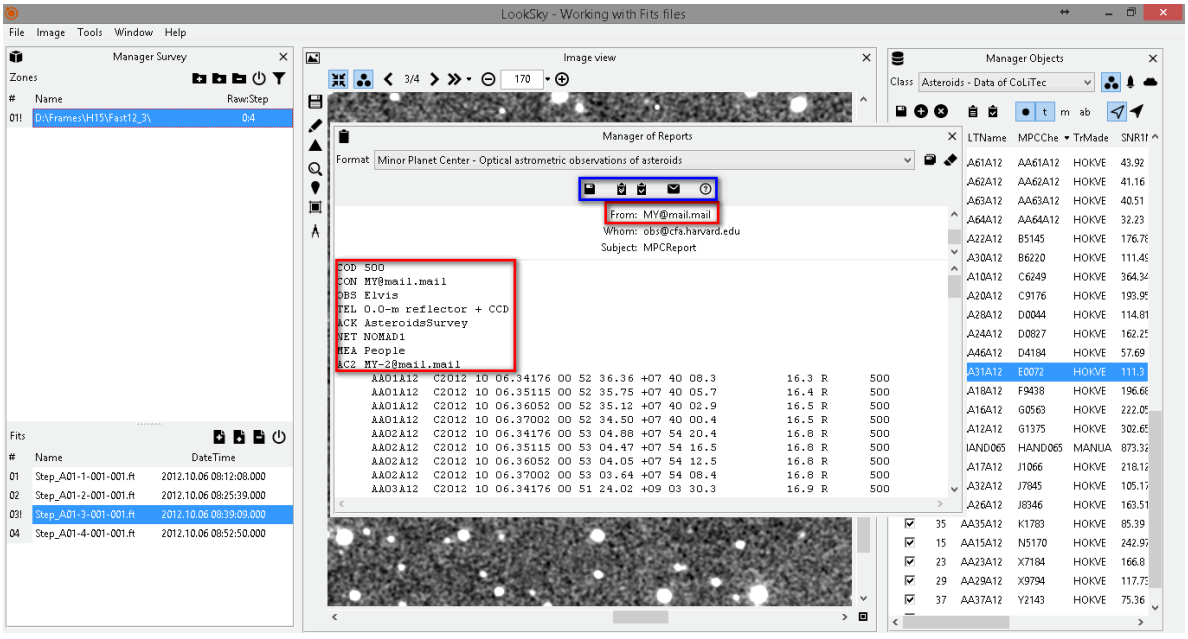

Figure 15. *Report creation for sending*