



Processing service of optical frames for the formation of high-precision observations of asteroids and satellites

LEMUR IS:

One of the best software for automatic multithreaded data processing of astrometric and photometric optical observations.

Implemented as a service and independent standalone/local/built-in/corporate software.

High level of data processing automation due to the many years of formalized experience of astronomy professionals and amateurs, customers and developers.

Relieves the observer's stress by removing the operations such as manual frames comparing for objects detection, and much more.

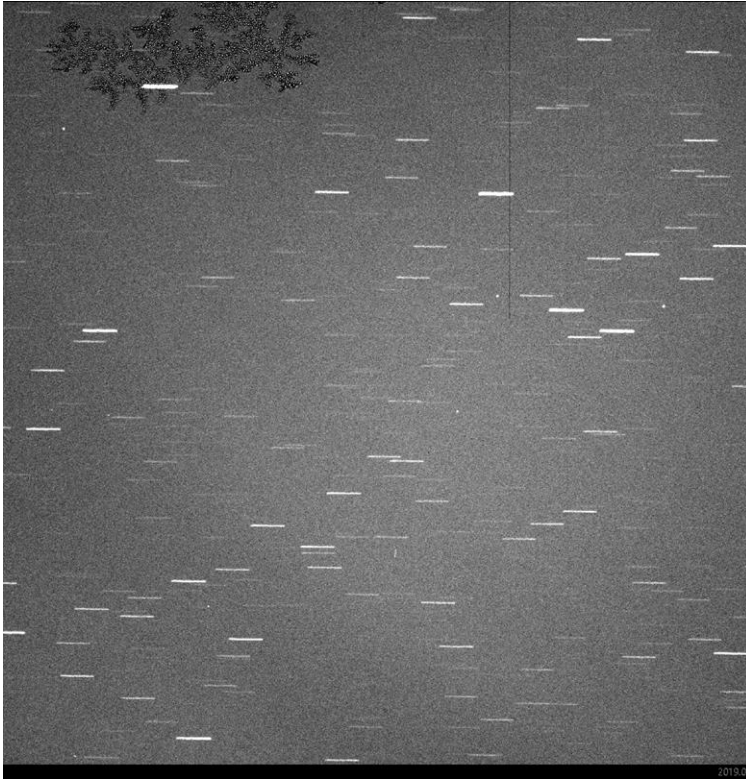
LEMUR CAN:

Organize automatic detection of moving objects and light curves on frames from many telescopes of the observatory!

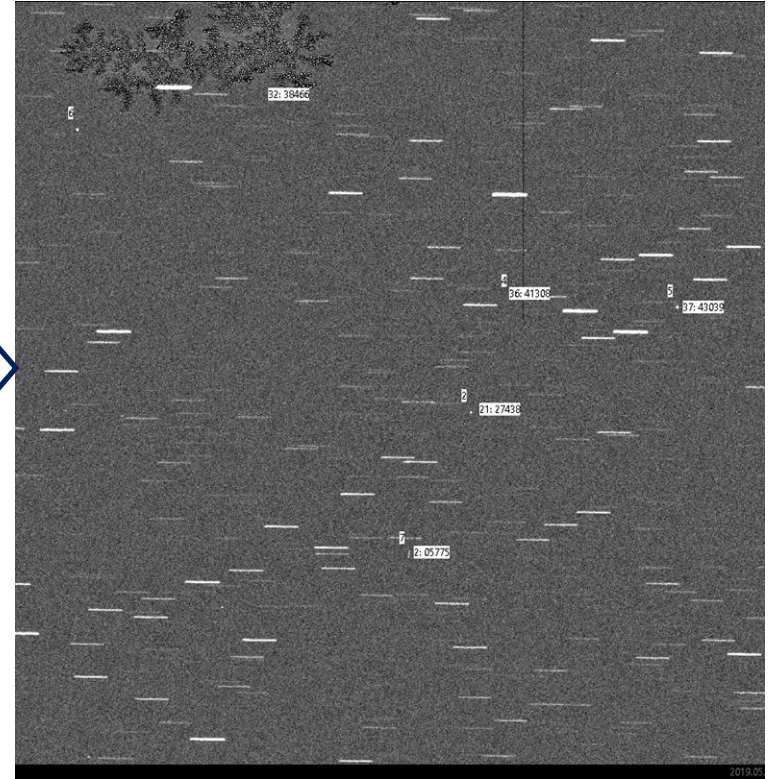
Help create a moving object detection service for processing frames of amateur astronomers!

Automate your observational astronomy tasks!

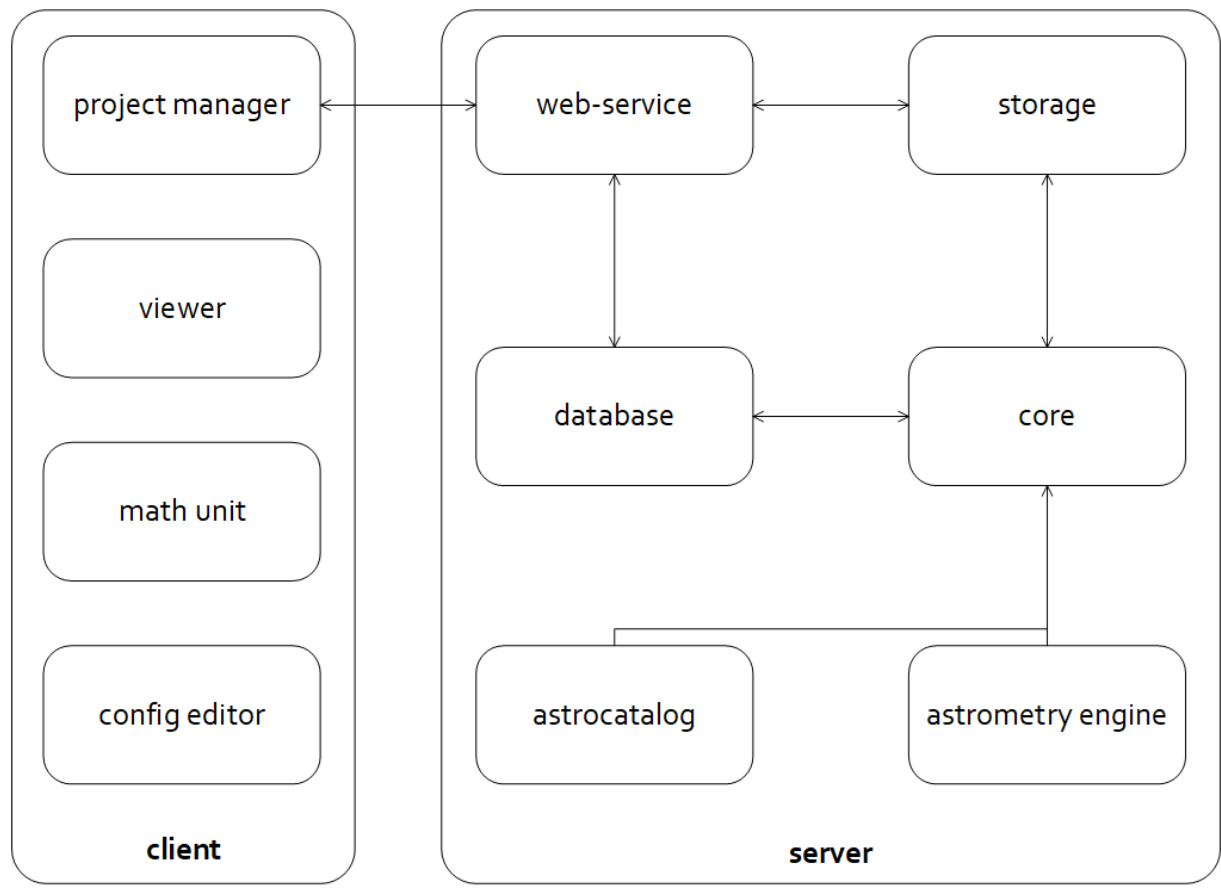
Raw frames

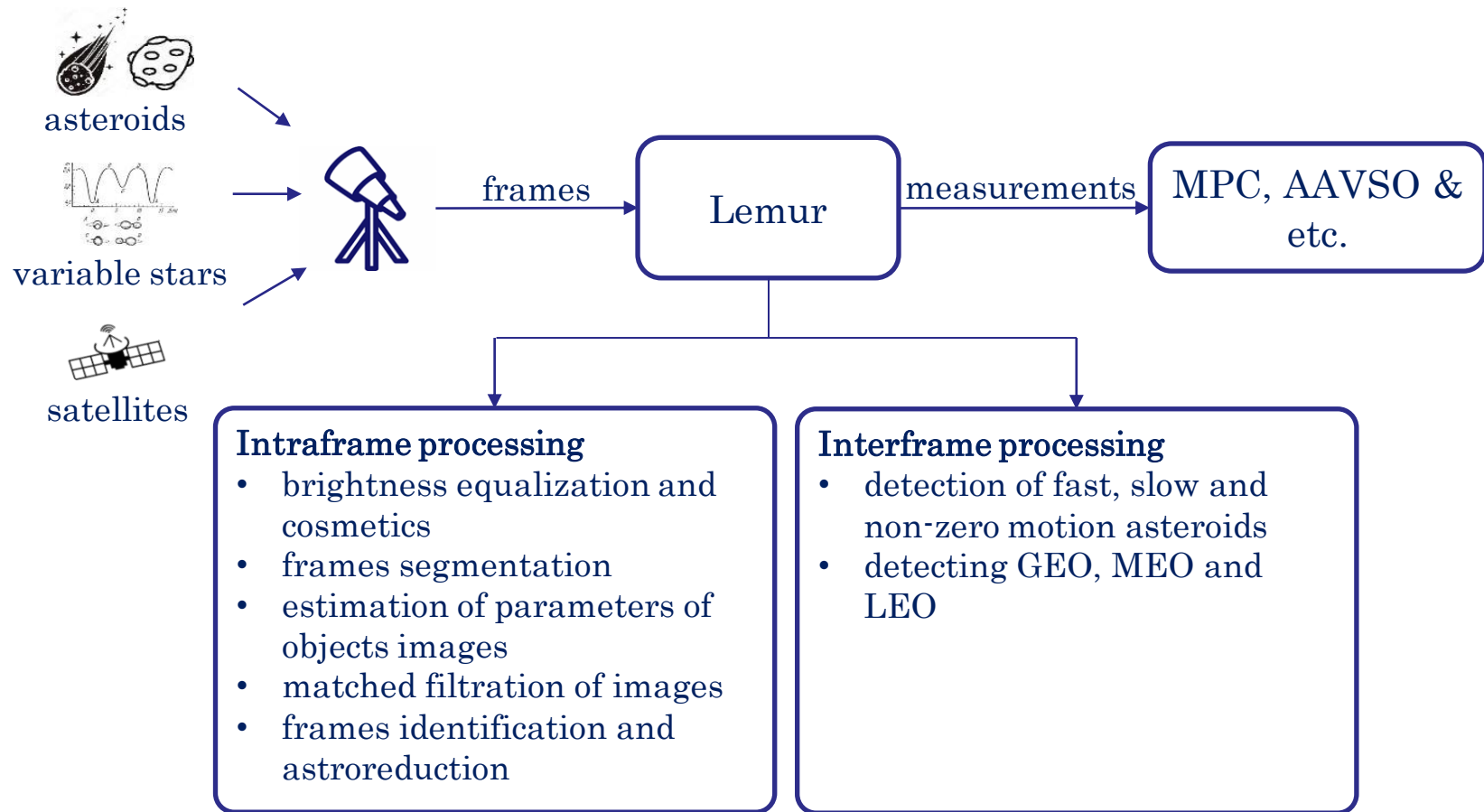


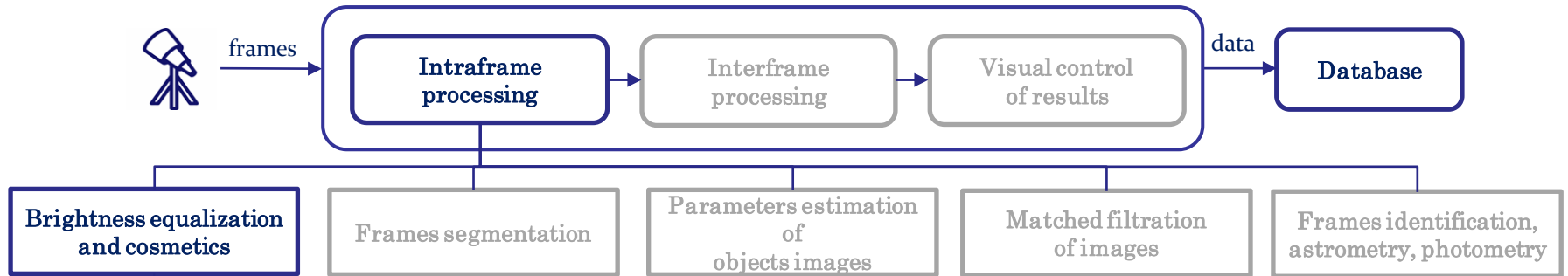
Satellites detected



Lemur architecture







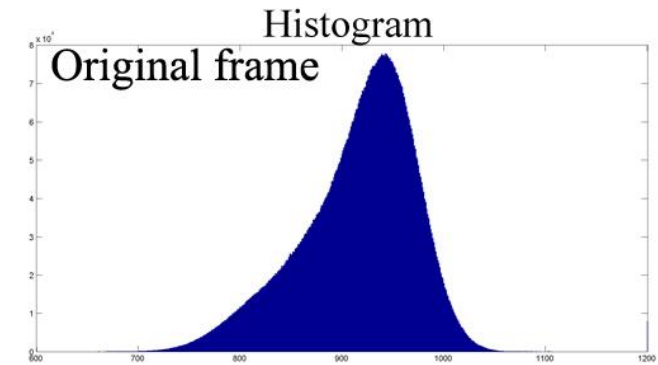
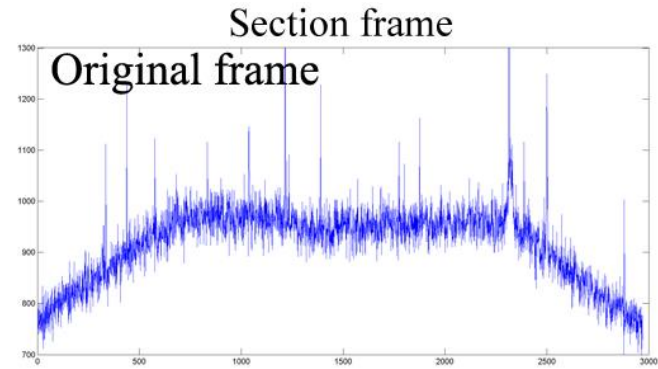
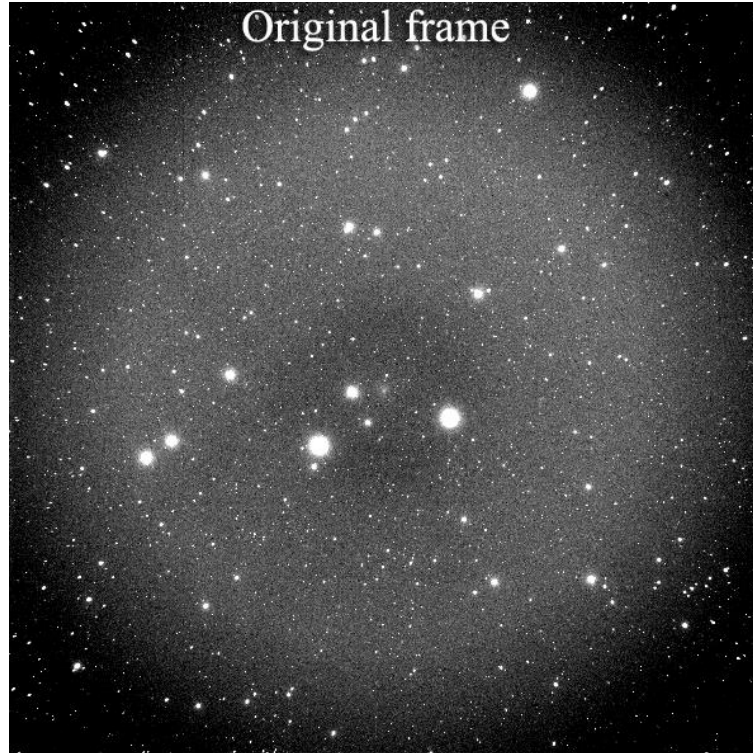
compensates uneven sensitivity and defects of the CCD-camera;

eliminates spurious illumination from extraneous light sources (lights, passing cars), as well as uneven illumination of the frame at “dawn” or near bright stars;

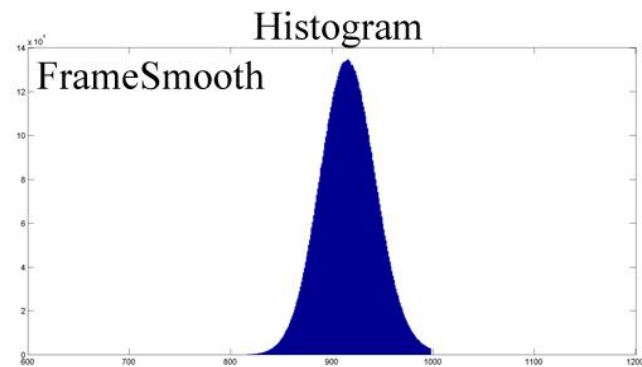
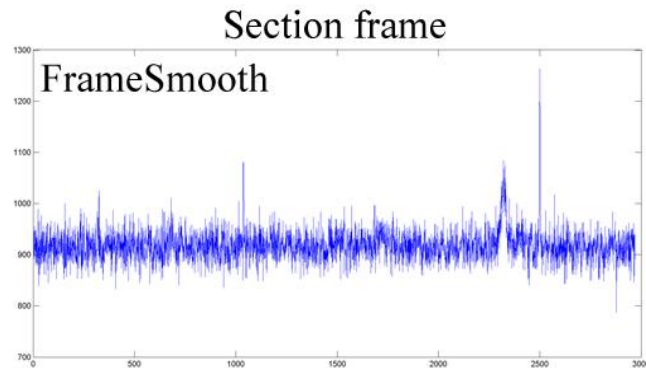
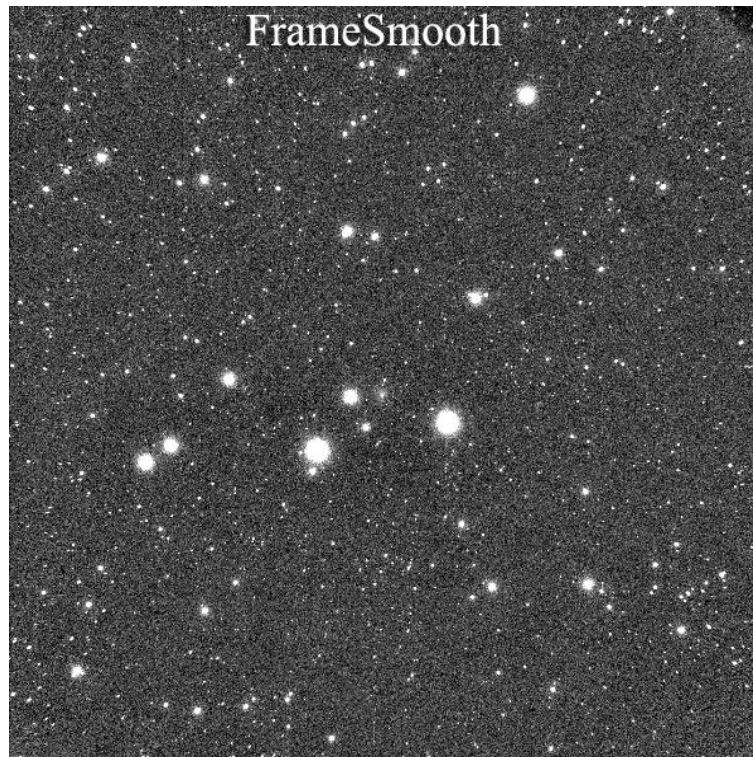
allows to dispense with flat frames;

the use of aligned in brightness frames significantly reduces the errors in detection and parameters estimation of objects images.

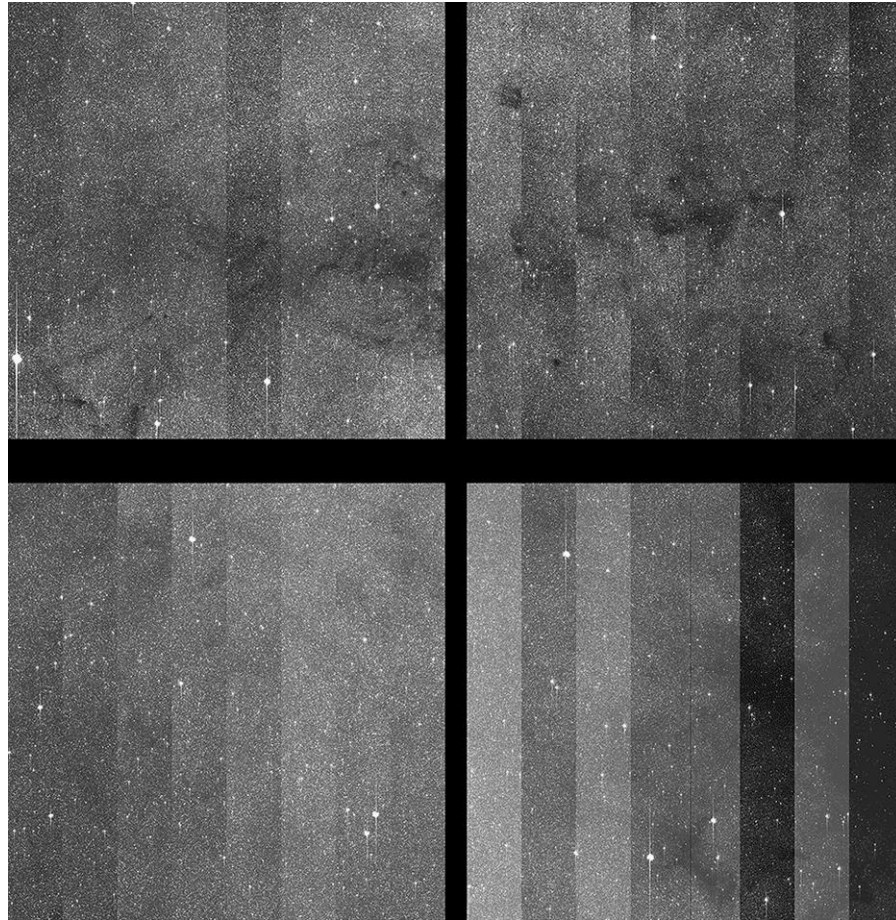
Brightness equalization of digital images



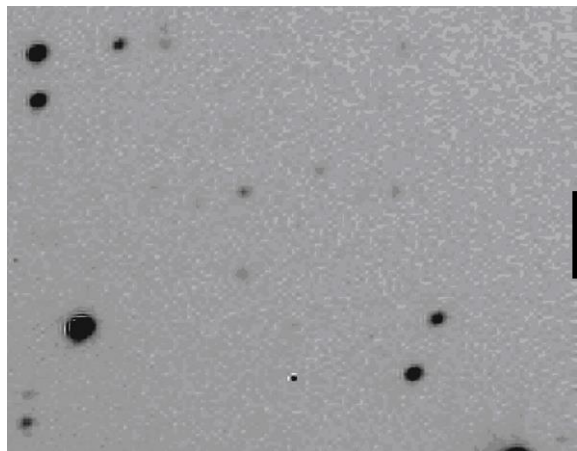
Comparison of alignment results with Lemur (FrameSmooth) and MaxImDL



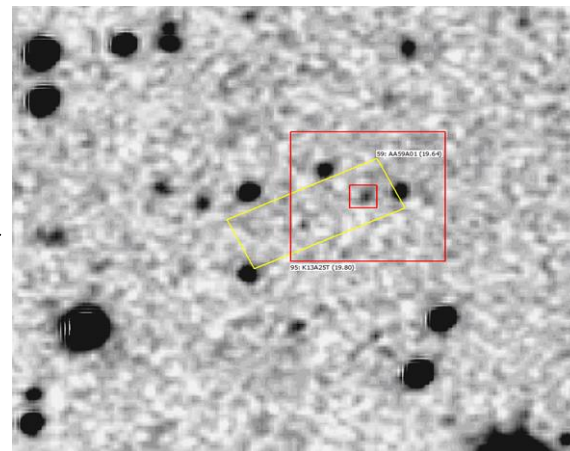
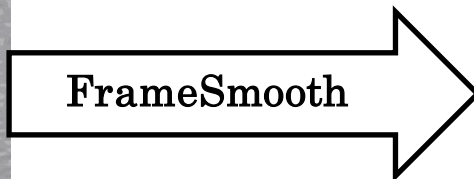
Brightness equalization of multi frames



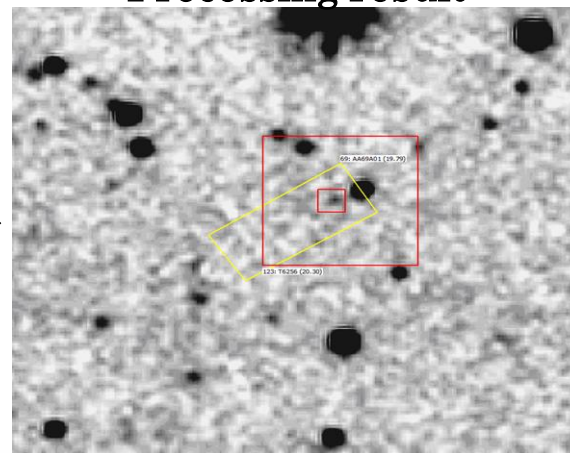
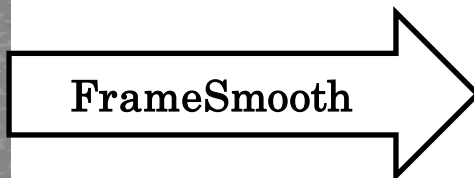
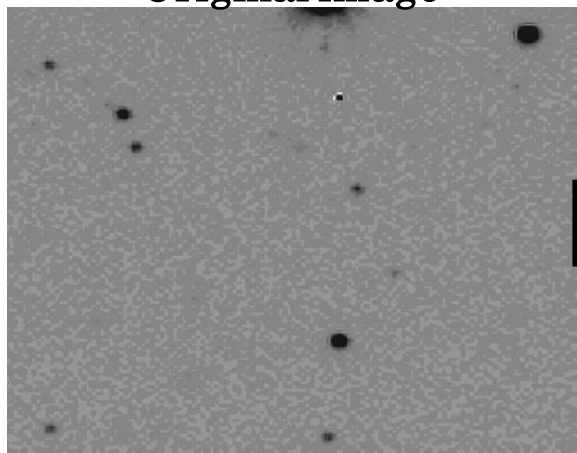
Brightness equalization of multi frames

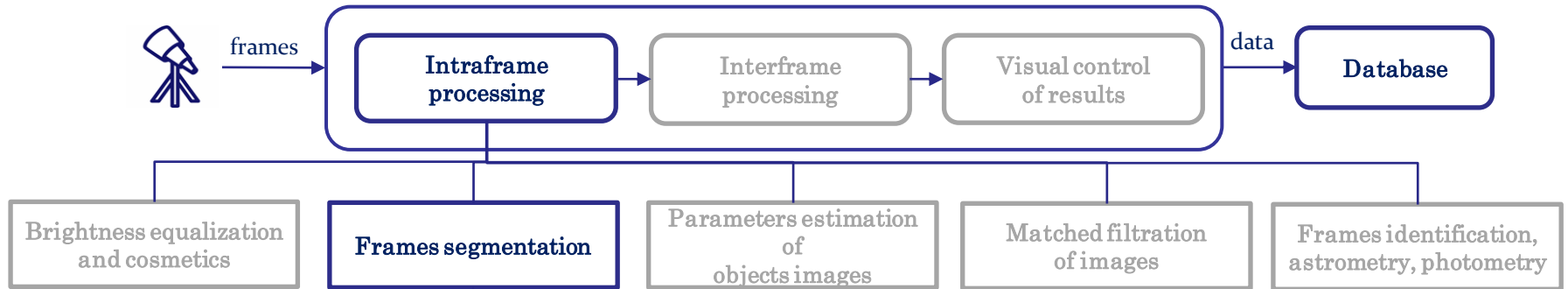


Original image

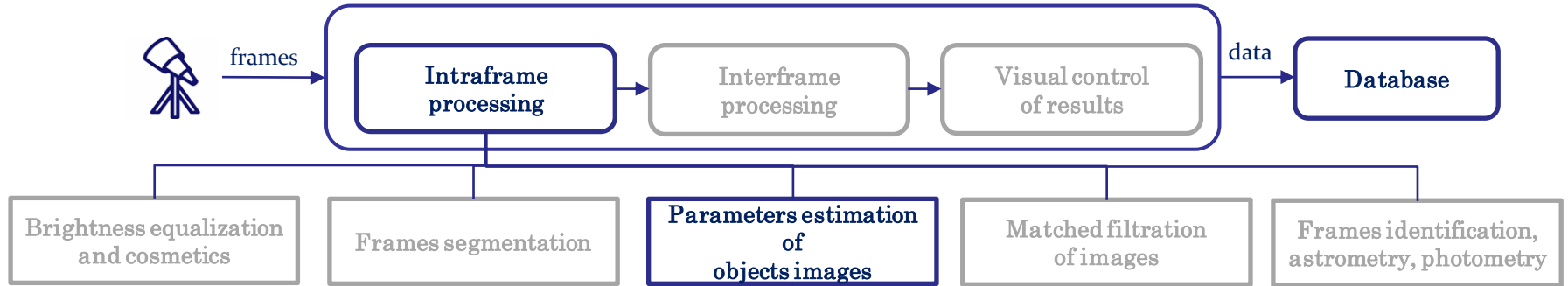


Processing result





- determines the set of CCD-camera pixels which correspond to the objects images in frame;
- uses a complex of classical and original segmentation methods with their adaptive automatic selection for each frame and segment in it;
- classifies objects images into “circular/extended”, and also selects “anomalous pixels”;
- forms segments for objects with small size and for images of large stars with diffraction stretches;
- forms segments for super-extended objects.



— determines the exact rectangular coordinates of objects, instrumental brightness, signal-to-noise ratio, length and other image parameters;

— analytical parameters estimation of point and stroke images of objects before and after the matched filter;

— parameters estimation of the objects images with an analytically undefined profile before and after the matched filter;

— instrumental brightness estimation of circular and extended images, as well as images of objects with an analytically undefined profile.

Parameters estimation of object's image in CCD-frames

Computational method for determining the objects position in CCD-frames

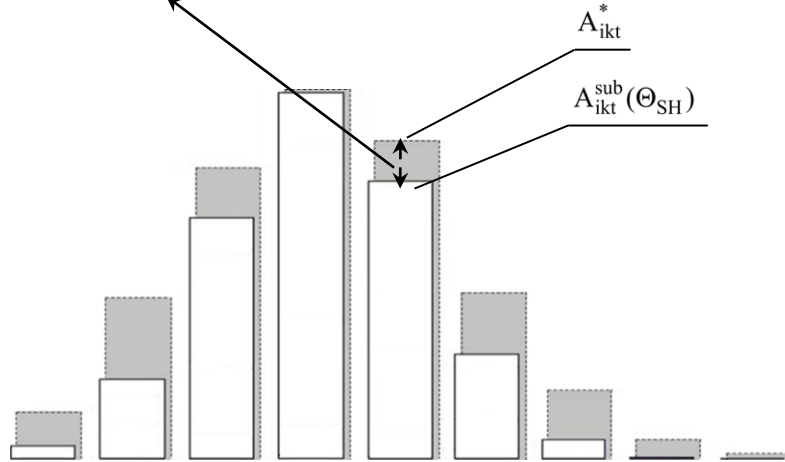
Quality criterion for determining the position of object's image:

$$F_{\Delta AGI}(\Theta_{SH}) = \sum_{i,k}^{N_{SIFP}} \left(A_{ikt}^* - A_{ikt}^{sub}(\Theta_{SH}) \right)^2 \xrightarrow{\Theta_{SH}} \min$$

Minimum sum of squares of deviations
between experimental and model brightness of pixels
in the intraframe processing area

$$\Delta A_{SH(i,k)} = A_{ikt}^* - A_{ikt}^{sub}(\Theta_{SH}) \quad (4)$$

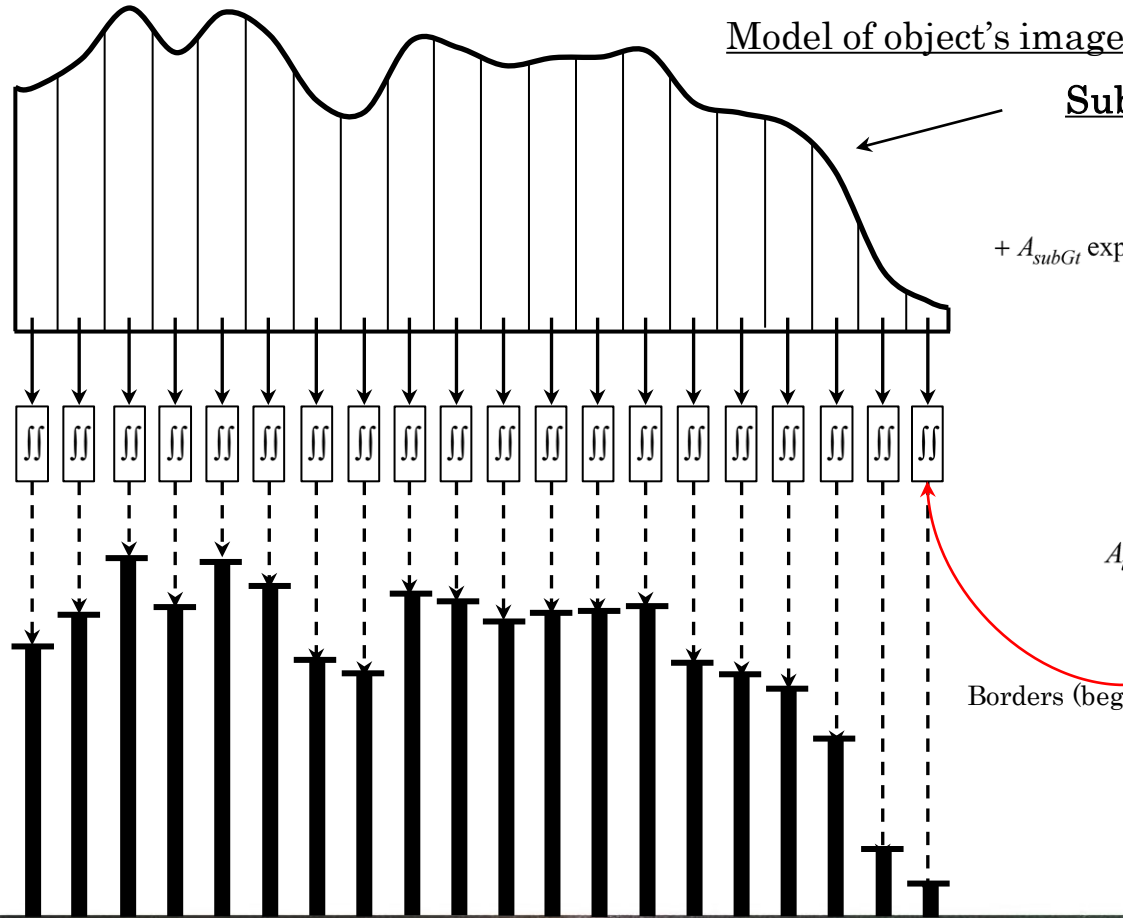
Deviation between experimental and
model brightness of pixel



Real and model object's image

- real object's image
- model of object's image
- Θ_{genr} - vector of estimated parameters
- A_{ikt}^* - experimental brightness of pixels
- $A_{ikt}(\Theta_{genr})$ - model brightness of pixels

Subpixel Gaussian model of extended images of object



Subpixel model of extended image of object:

$$f_{\tau}^{sub}(x_{it}, y_{kt}, \Theta_{\tau}^{sub}) = C_{residual}^{sub} + A_{subGt} \exp\left\{-\frac{1}{2\sigma_{subGt}^2} \left[(x_{it} - x_{\tau}(\Theta_{\tau}^{sub}))^2 + (y_{kt} - y_{\tau}(\Theta_{\tau}^{sub}))^2 \right]\right\}$$

Model brightness of ik-th pixel in subpixel model of image:

$$A_{ikt}(\Theta_{\tau}^{sub}) = \int_{x_{bi}}^{x_{ei}} \int_{y_{bk}}^{y_{ek}} \int_{\tau-\Delta/2}^{\tau+\Delta/2} f_{\tau}^{sub}(x_{it}, y_{kt}, \Theta_{\tau}^{sub}) dx_{it} dy_{kt}$$

Borders (beginning and end) of ik-th pixel in CCD-matrix by coordinates x and y :

$$\begin{aligned} x_{bi} &= x_{it} - \frac{\Delta_{CCD}}{2}; & y_{bk} &= y_{kt} - \frac{\Delta_{CCD}}{2}; \\ x_{ei} &= x_{it} + \frac{\Delta_{CCD}}{2}; & y_{ek} &= y_{kt} + \frac{\Delta_{CCD}}{2}. \end{aligned}$$

Subpixel Gaussian model of extended images of object

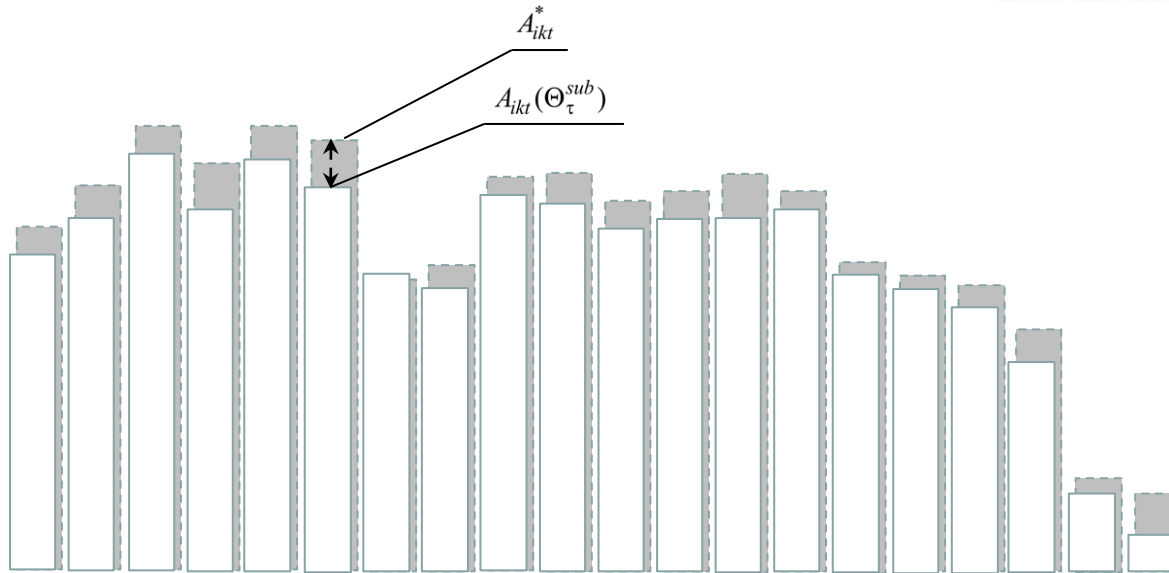
Quality criterion for determining the position of object's image:

$$F_{\Delta A_{\tau}}(\Theta_{\tau}^{sub}) = \sum_{i,k}^{N_{IPS}} \left(A_{ikt}^* - A_{ikt}(\Theta_{\tau}^{sub}) \right)^2 \xrightarrow{\Theta_{\tau}^{sub}} \min$$



Minimum sum of squares of deviations
between experimental and model brightness of
pixel in the intraframe processing area

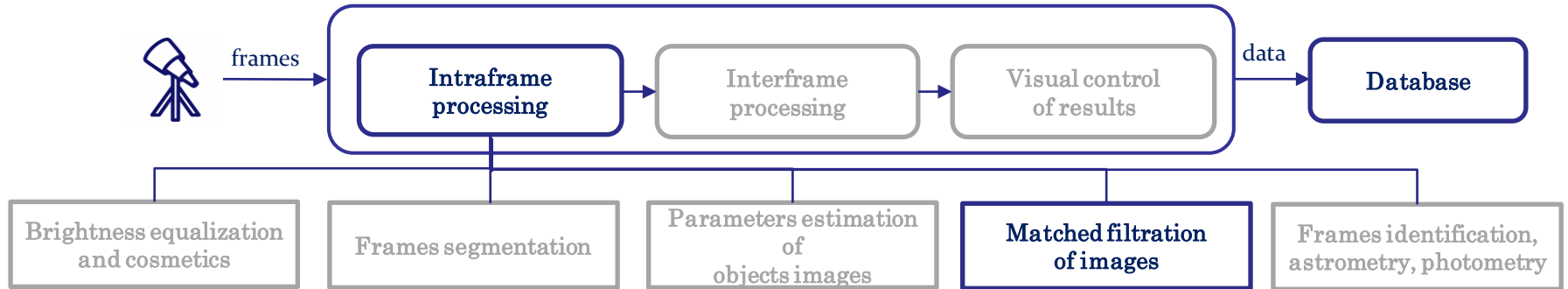
$$\Delta A_{SH(i,k)} = A_{ikt}^* - A_{ikt}(\Theta_{\tau}^{sub})$$

Deviation between experimental
and model brightness of pixel



Real and model object's image

-  – real object's image
-  – model of object's image
- Θ_{τ}^{sub} – vector of estimated parameters
- A_{ikt}^* – experimental brightness of pixels
- $A_{ikt}(\Theta_{\tau}^{sub})$ – model brightness of pixels



— selects images of faint stars and objects;

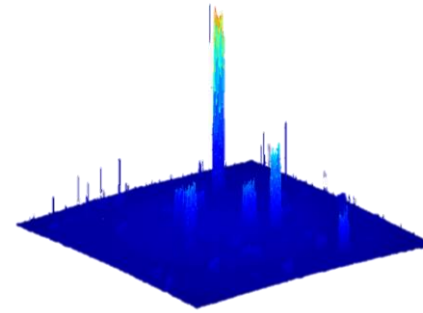
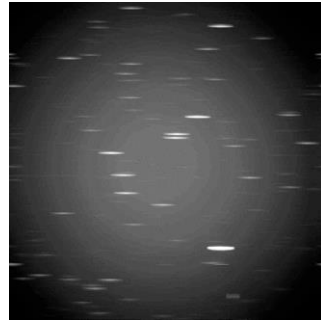
— reduces the number of false objects;

— matched filtration is implemented for images of objects: point (frames with diurnal rotation), stroke and with an analytically undefined profile (frames without diurnal rotation).

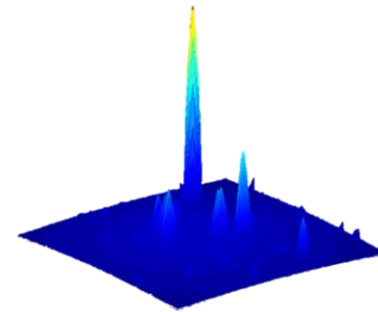
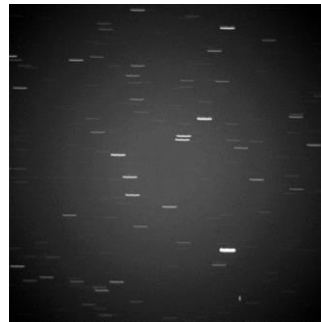
Matched filter for extended images of objects

Matched filter for extended images of objects for CCD-frames taken without the diurnal tracking

Frame with extended objects



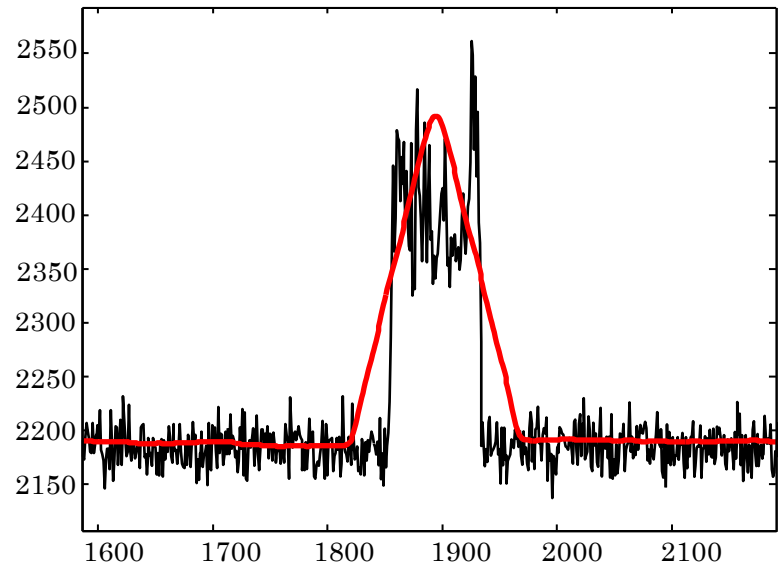
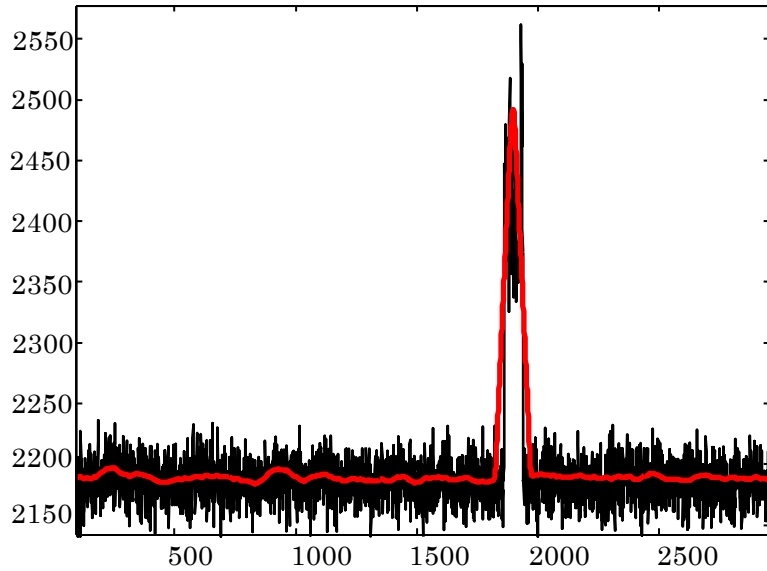
Processing result of matched filter



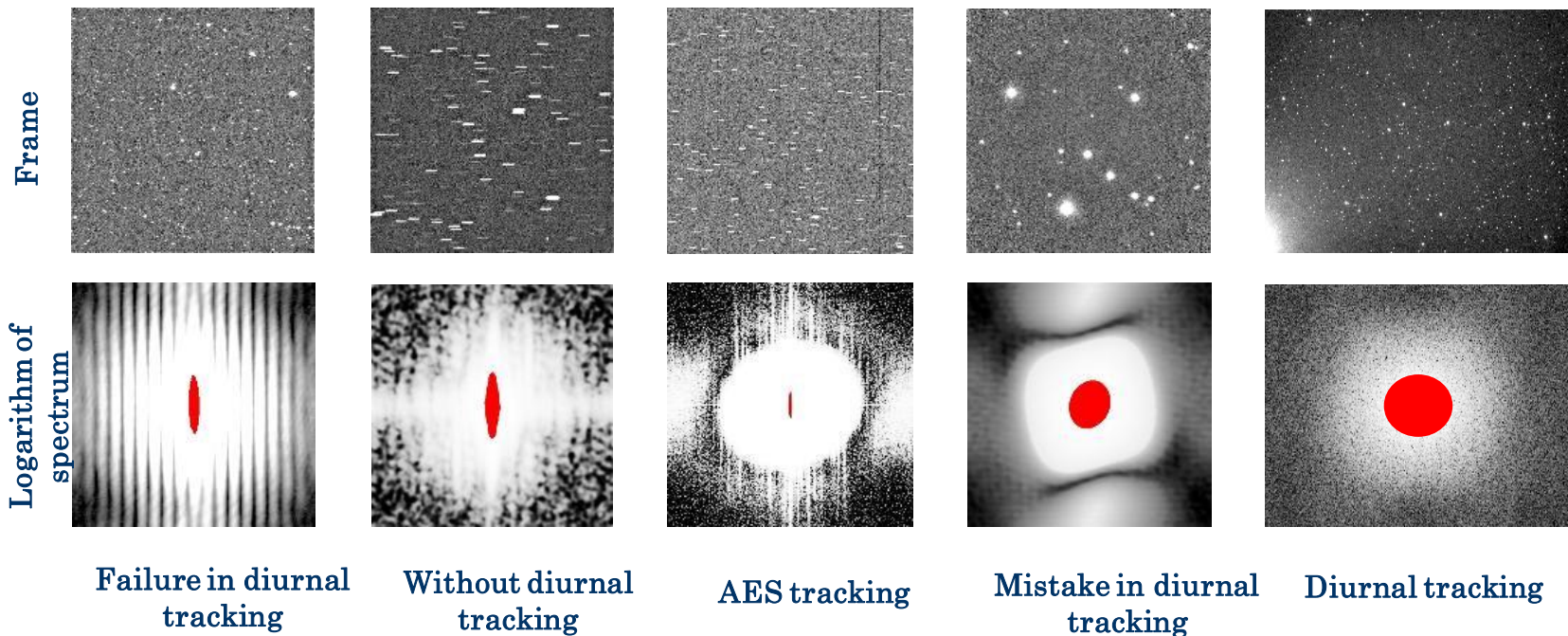
2D

3D

Cross-section image of object before and after applying the matched filter for extended images of object



Examples of CCD-frames and their spectrums with extended images of objects



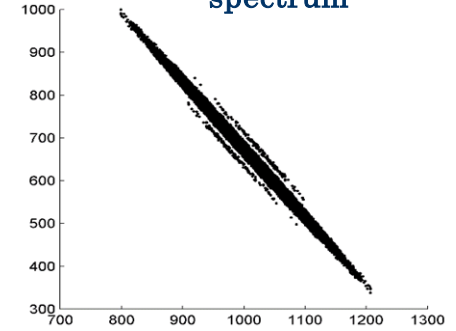
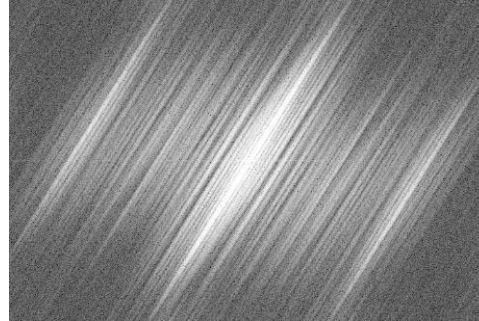
Examples of CCD-frames and their spectrums with extended and point images of objects

Frame

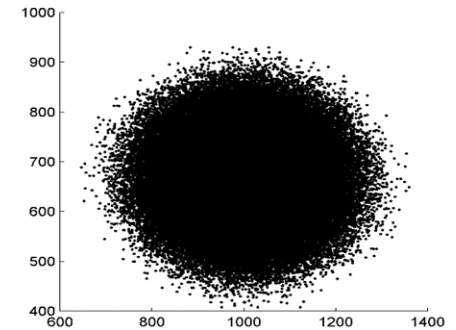
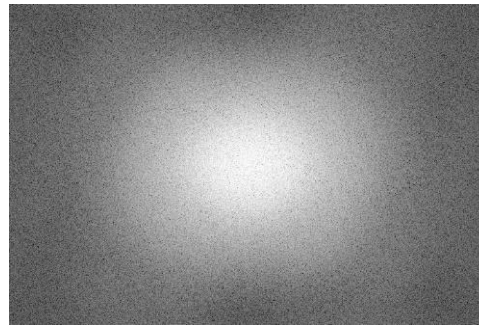
Spectrum

The brightest harmonics of spectrum

Frame with extended images of objects



Frame with point images of objects

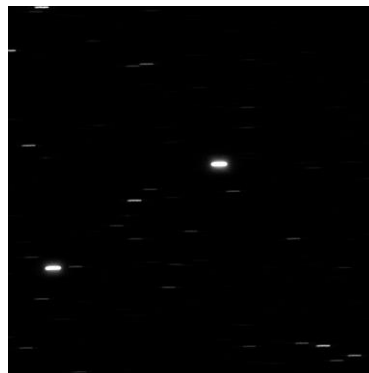


GSO frames addition with stars strokes subtraction

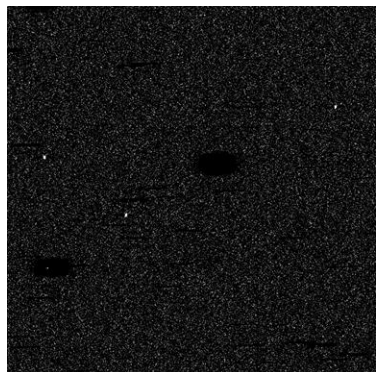
GEO 35815, 38245, 32050



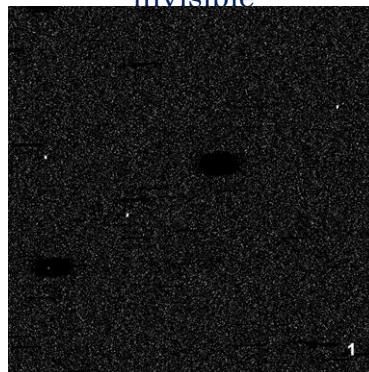
Raw frames



Frames with stars, GSO are invisible



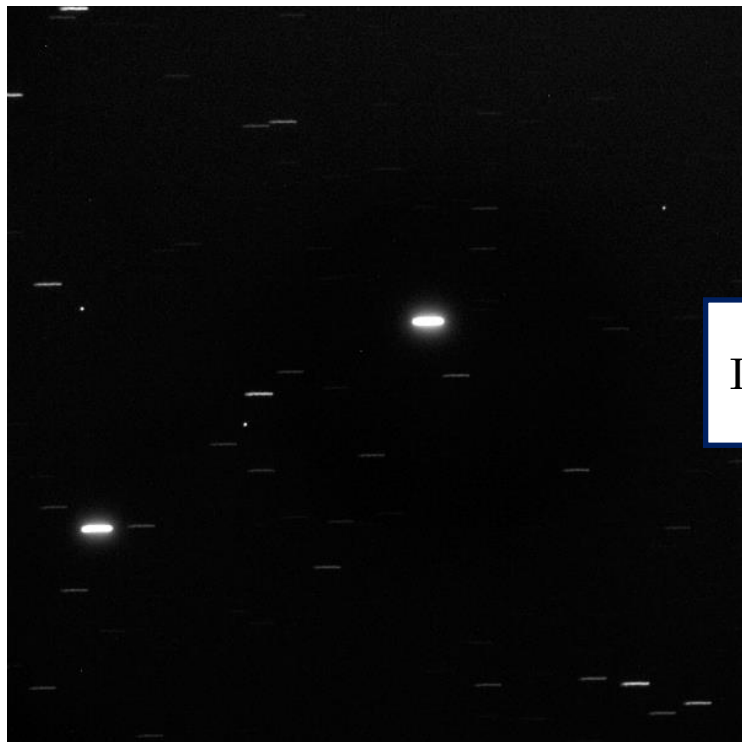
Frames with GSO without stars



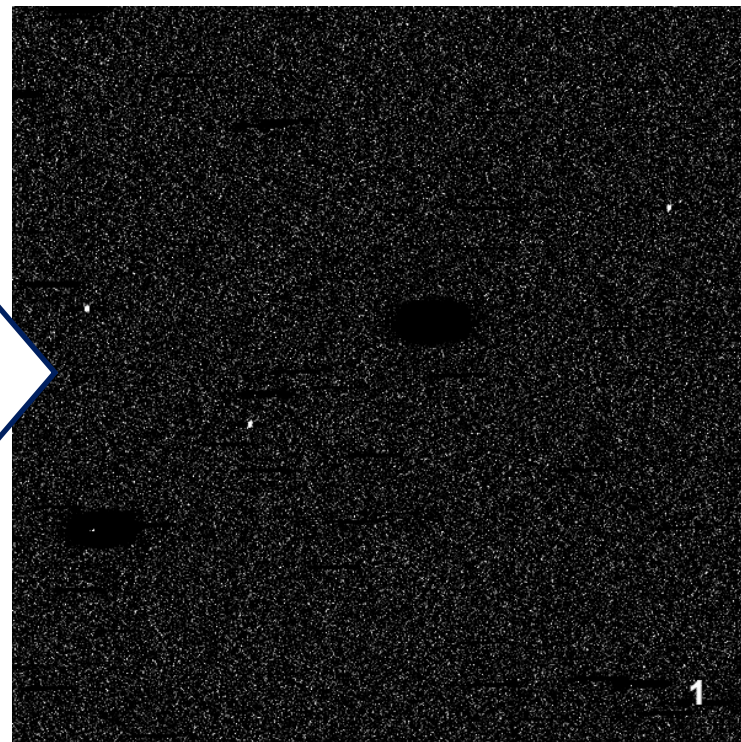
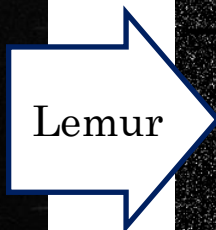
Frames addition

GSO frames addition with stars strokes subtraction

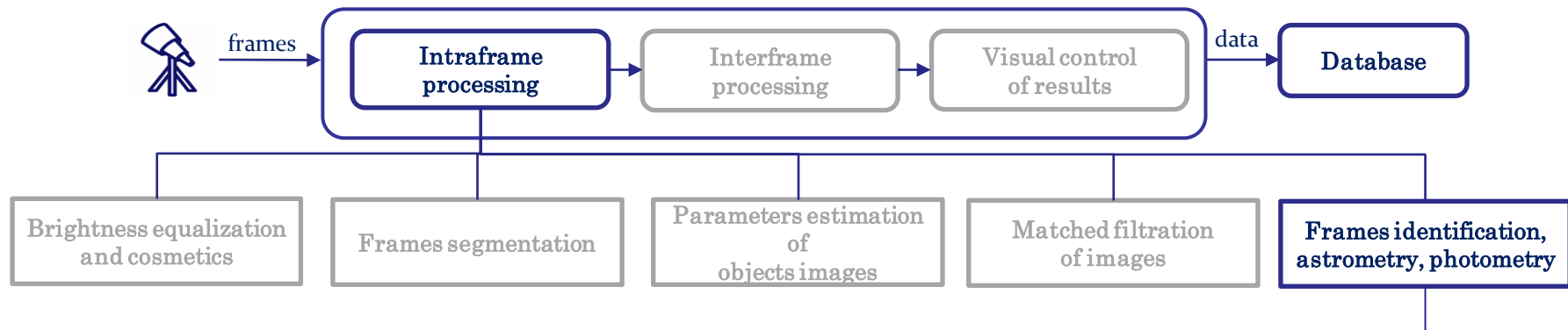
GEO 35815, 38245, 32050



Raw frames



Frames addition



— finds the correspondence between stars images in frame and data of modern star catalogs;

— forms a catalog of objects motionless in a series of frames;

— establishes an analytical relationship between the rectangular frame coordinate system and the ICRS;

— photometry: establishes an analytical connection between instrumental brightness and brightness in the selected star catalog;

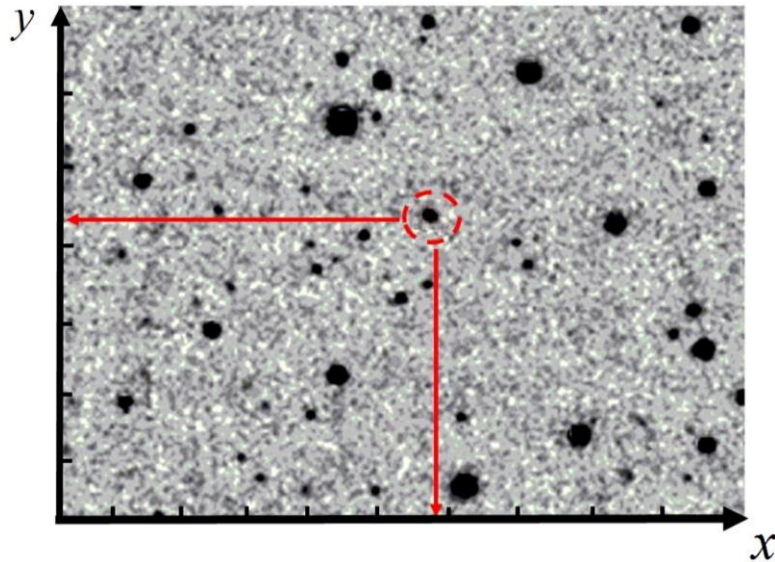
— linear, cubic and fifth degree astrometric reduction models are available;

— automatic selection of astrometric reduction model is implemented;

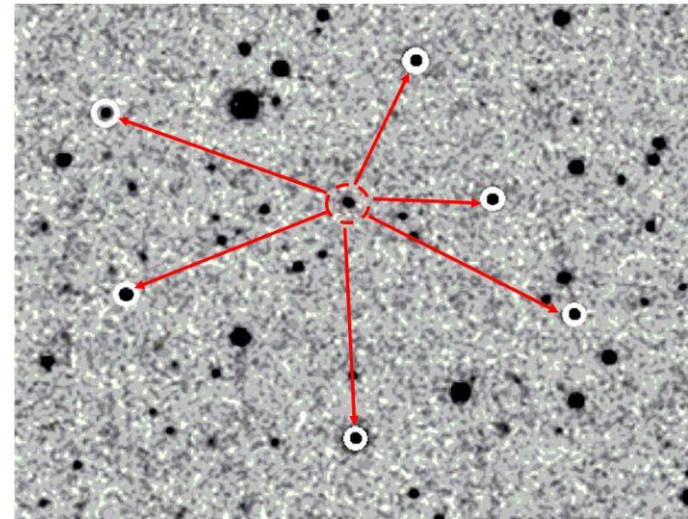
— robust automatic selection of reference stars is implemented.

Selection of reference stars in digital images

Determination of objects angular position in space according to data from images



a) absolute method



b) relative method

Frames identification with stellar catalogs and astrometry

Identification of measurements in frame with measurements from stellar catalog

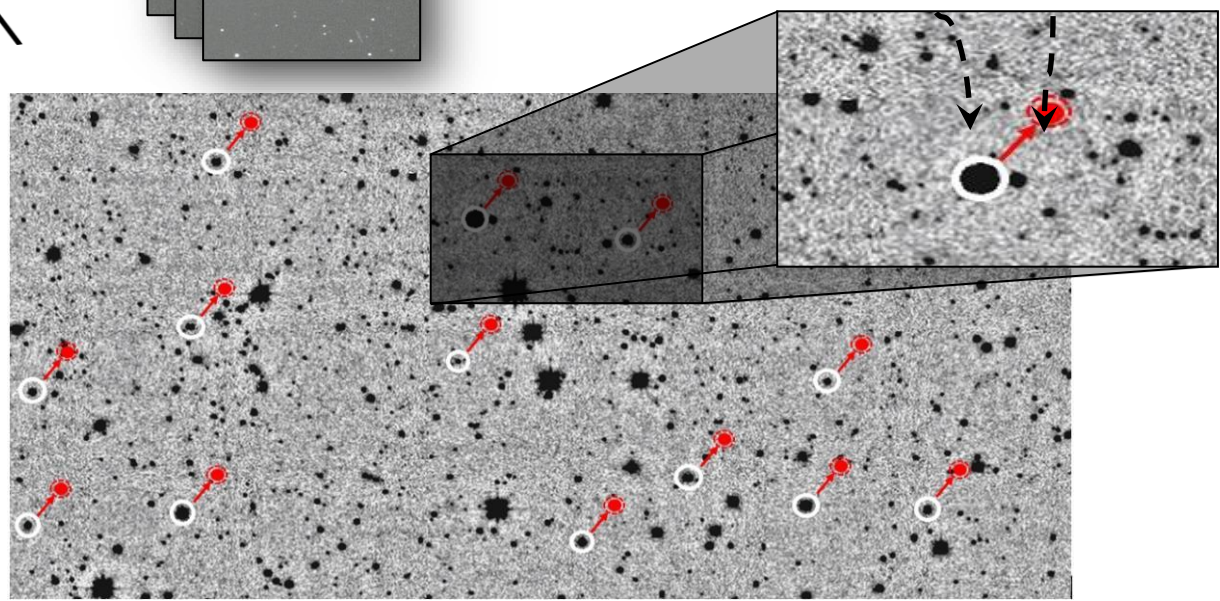
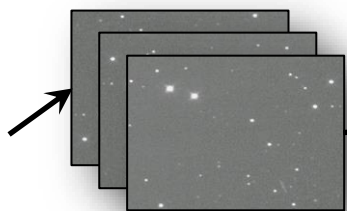
$$\Omega_{nfr} = \{Y_{1nfr}, \dots, Y_{infr}, \dots, Y_{Qnfr}\} \quad (1)$$

$$Y_{infr} = \{A_{infr}; \chi_{infr}\} \quad (2)$$

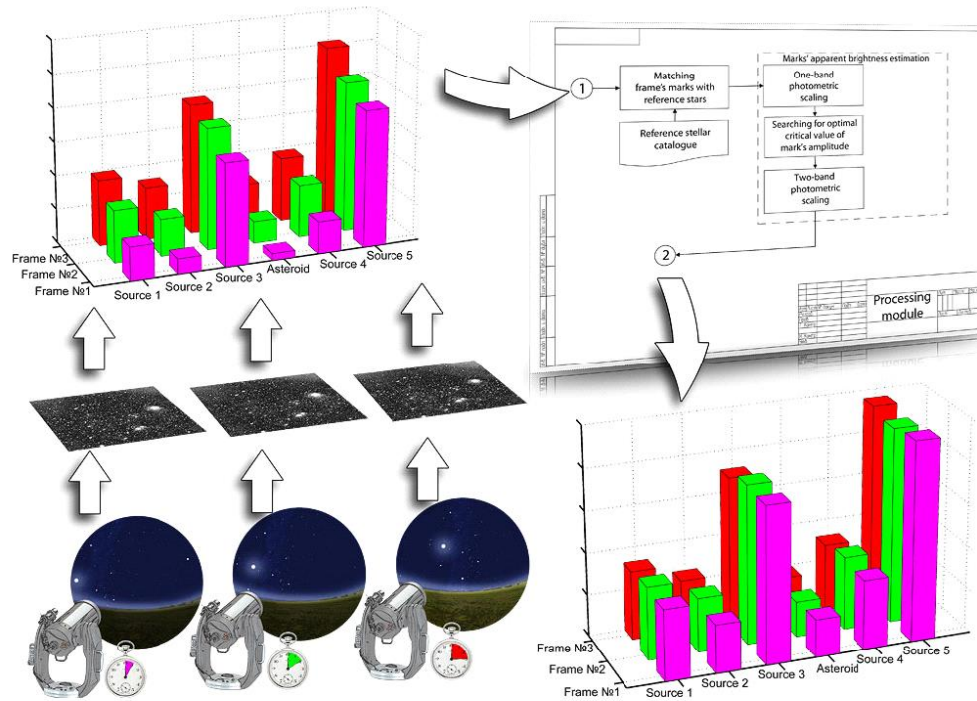
$$\Omega_{cat} = \{\hat{\theta}_{catj1}, \dots, \hat{\theta}_{catjn}, \hat{\theta}_{Qcat}\} \quad (3)$$

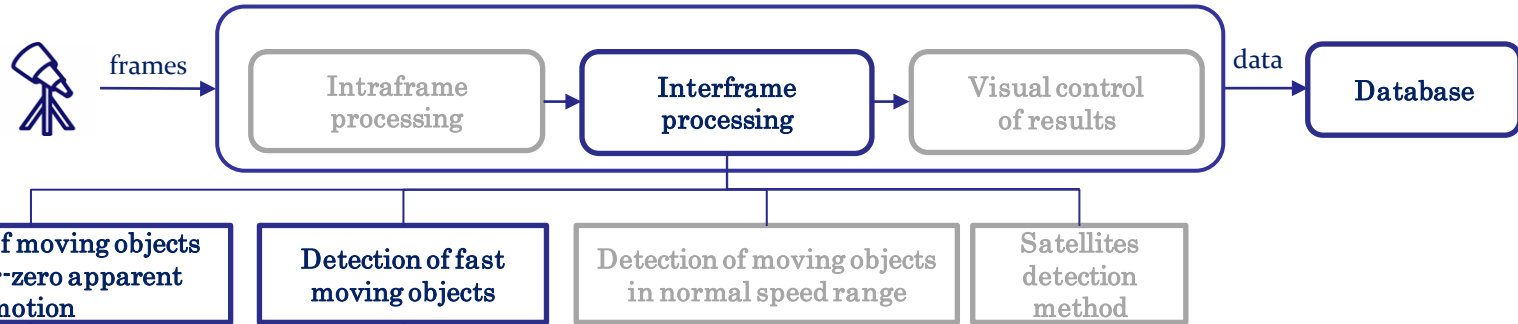
$$\hat{\theta}_{catjn} = \{\hat{\theta}_{j1}, \hat{\theta}_{j2}, \dots, \hat{\theta}_{jM}\} \quad (4)$$

Stellar catalogs



Estimation of asteroids apparent brightness by its signals amplitude

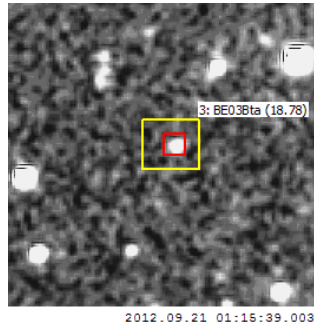




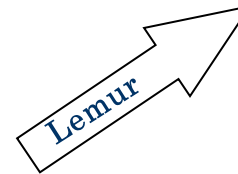
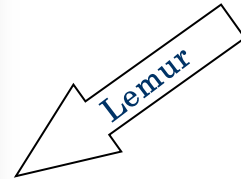
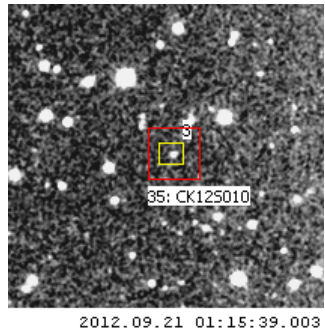
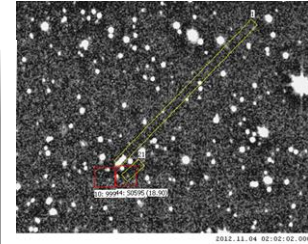
Detects objects with almost imperceptible visible movement (commensurate with errors in position estimation of objects), including objects approaching the Earth at large distances.

detects objects with images blurred by their own motion;
discovers NEO when they are approaching the Earth

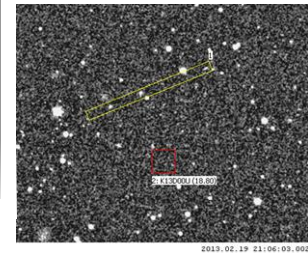
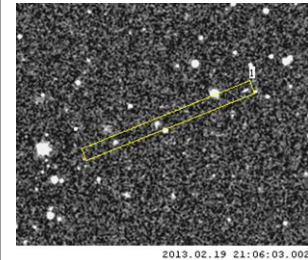
Lemur can detect both very slow and very fast moving object



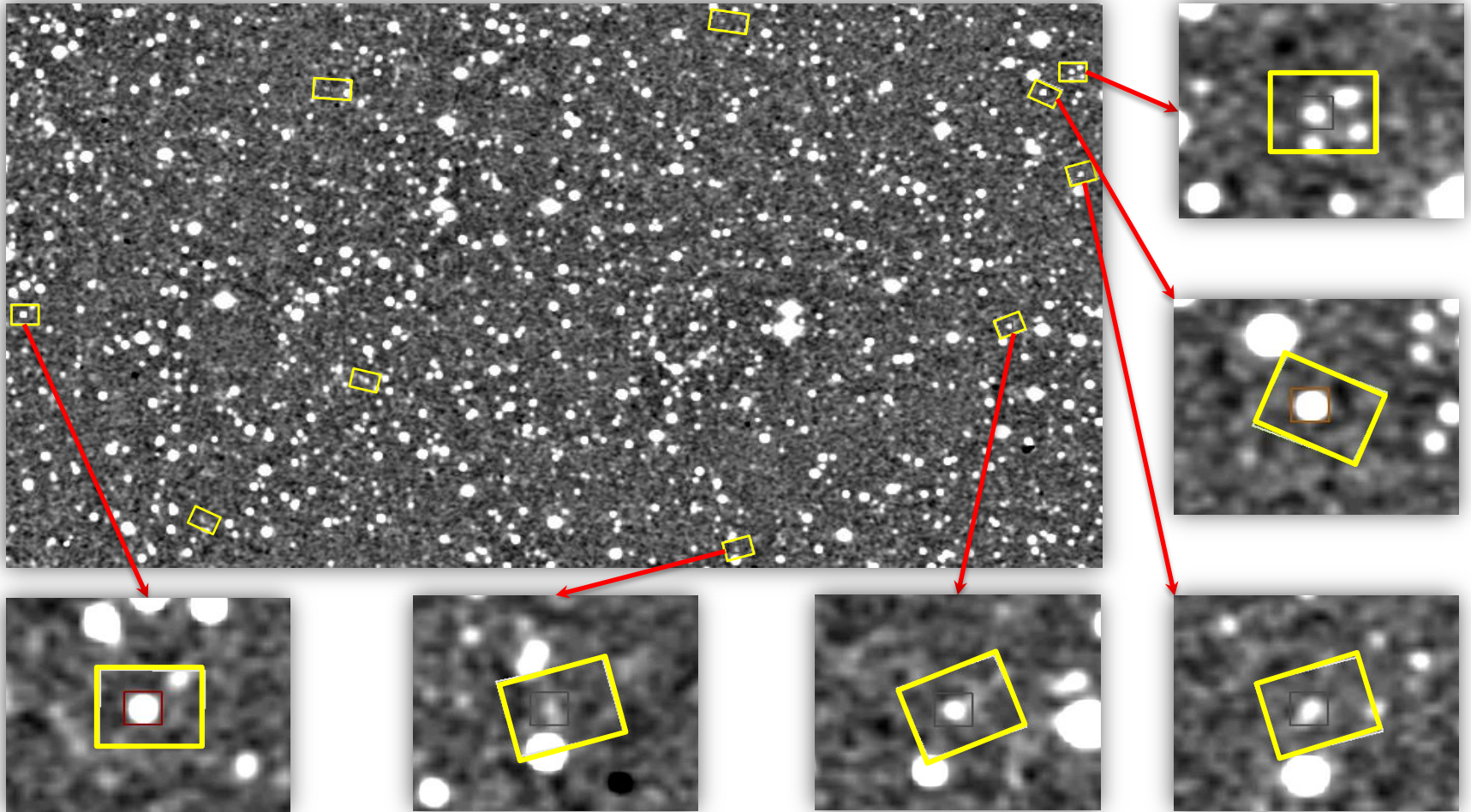
You can see the real images, where Lemur discovered famous comet ISON. On these frames comet is practically not moving between frames. The size of comet about 5 pixels, but it moved only 3 pixels from first to fourth frame.



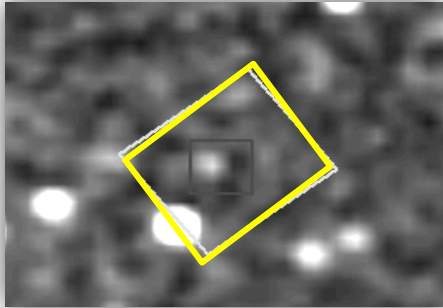
Lemur can detect faint fast moving objects (FMO) by their tracks.



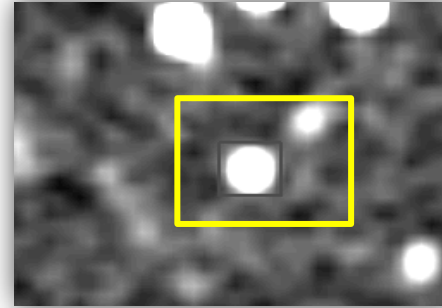
Lemur can detect both very slow and very fast moving object



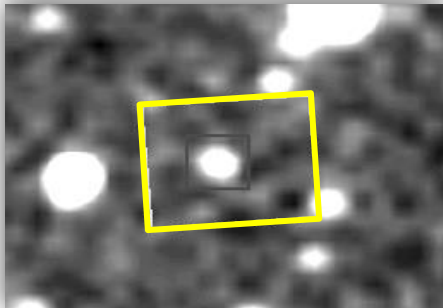
Lemur can detect both very slow and very fast moving object



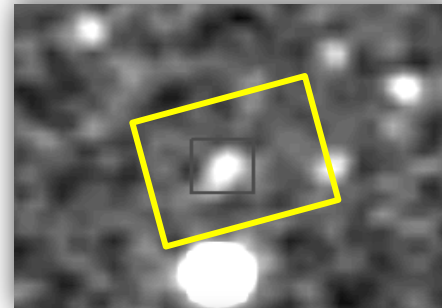
Brightness, mag	19.48
V, arcsec/min	0.282
Vra, arcsec/min	0.212
Vde, arcsec/min	0.186
V, pix/frame	0.921
Vx, pix/frame	0.705
Vy, pix/frame	0.591
S, pix/series	2.763



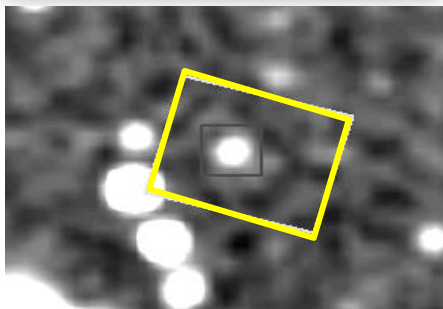
Brightness, mag	17.45
V, arcsec/min	0.451
Vra, arcsec/min	0.441
Vde, arcsec/min	0.094
V, pix/frame	1.467
Vx, pix/frame	1.441
Vy, pix/frame	0.274
S, pix/series	4.401



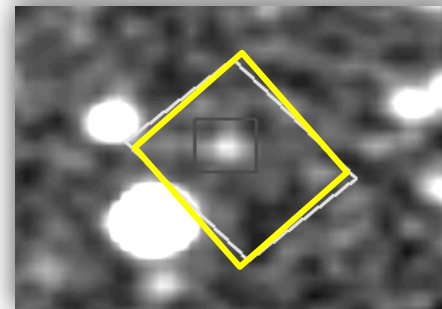
Brightness, mag	17.88
V, arcsec/min	0.360
Vra, arcsec/min	0.358
Vde, arcsec/min	0.036
V, pix/frame	1.175
Vx, pix/frame	1.171
Vy, pix/frame	0.091
S, pix/series	3.525



Brightness, mag	19.11
V, arcsec/min	0.515
Vra, arcsec/min	0.494
Vde, arcsec/min	0.144
V, pix/frame	1.683
Vx, pix/frame	1.626
Vy, pix/frame	0.433
S, pix/series	5.049



Brightness, mag	18.85
V, arcsec/min	0.400
Vra, arcsec/min	0.318
Vde, arcsec/min	0.241
V, pix/frame	1.305
Vx, pix/frame	1.056
Vy, pix/frame	0.766
S, pix/series	3.915

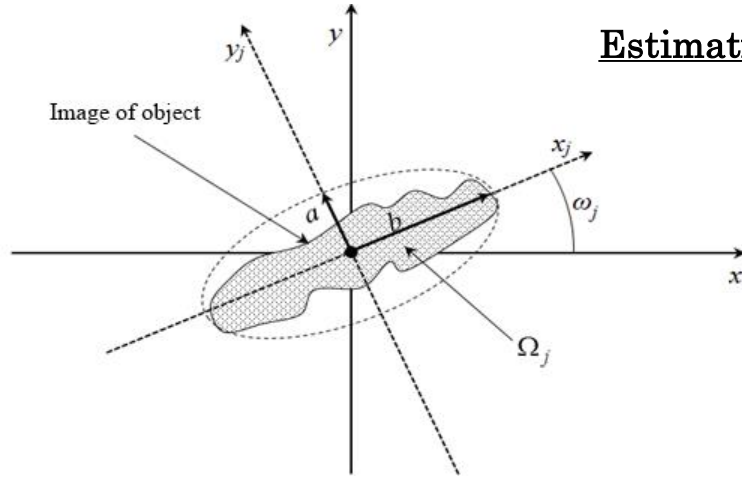


Brightness, mag	19.64
V, arcsec/min	0.638
Vra, arcsec/min	0.434
Vde, arcsec/min	0.468
V, pix/frame	2.084
Vx, pix/frame	1.378
Vy, pix/frame	1.564
S, pix/series	6.252

Method for detection of extended images of objects

Selective signs of extended images of objects during intraframe processing

Estimation of elongation and orientation of object's image

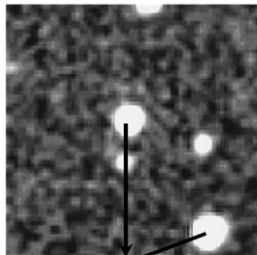


Eccentricity estimation:

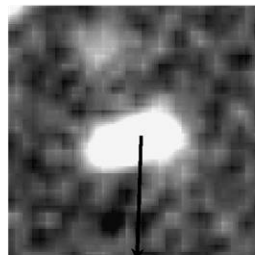
$$\varepsilon_j = \frac{m_{20} + m_{02} - \sqrt{(m_{20} - m_{02} + 4m_{11}^2)}}{m_{20} + m_{02} + \sqrt{(m_{20} - m_{02} + 4m_{11}^2)}}$$

Inclination angle of object:

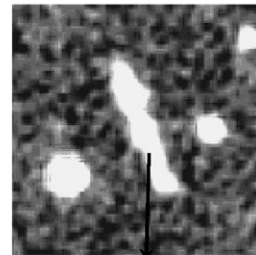
$$\omega_j = \frac{1}{2} \arctan \frac{2m_{11}}{m_{20} - m_{02}}$$



$\varepsilon = 0.0$



$\varepsilon = 0.8$

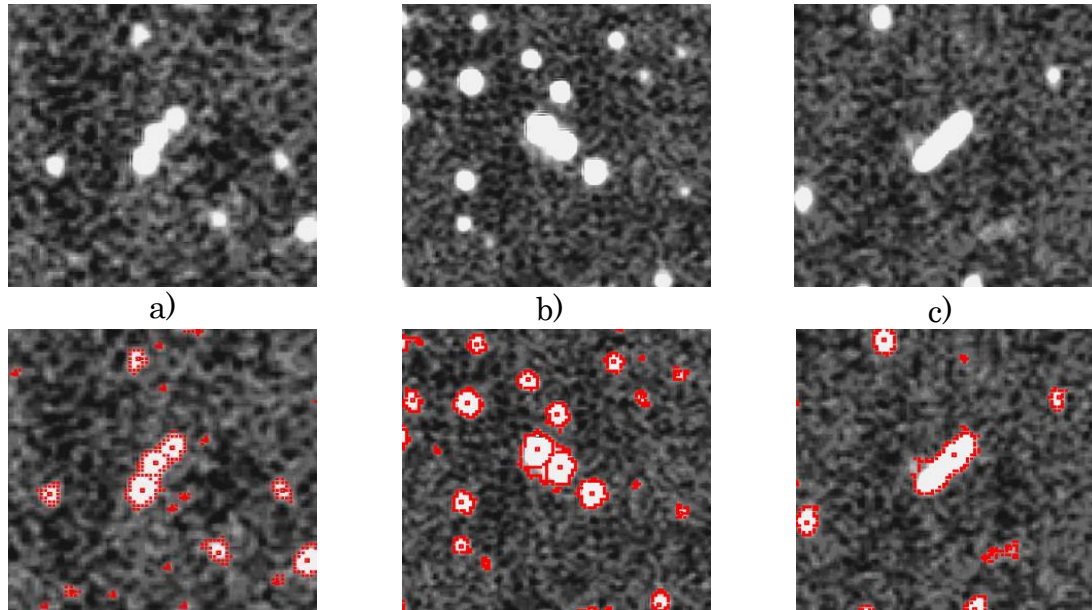


$\varepsilon = 1.0$

Examples of objects images (from point to long)

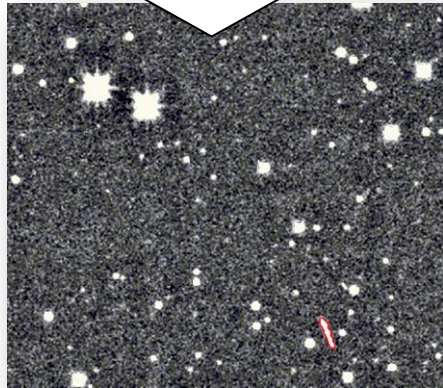
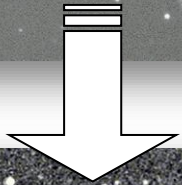
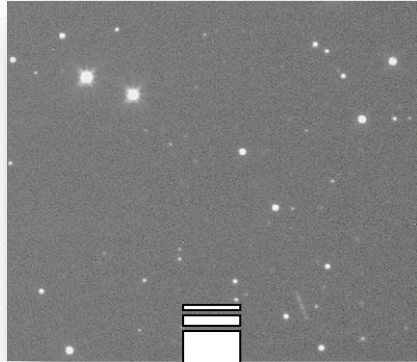
Method for detection of extended images of objects

Checking the belongings of extended images to objects from internal catalog with appropriate rejection (rejection of images of close stars)



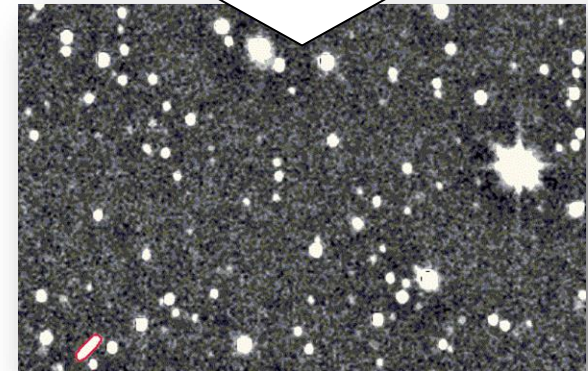
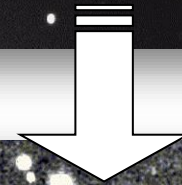
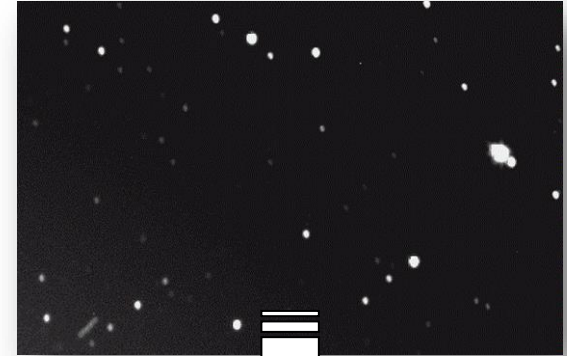
Extended images of objects

Working examples of proposed method for detection of extended images of objects



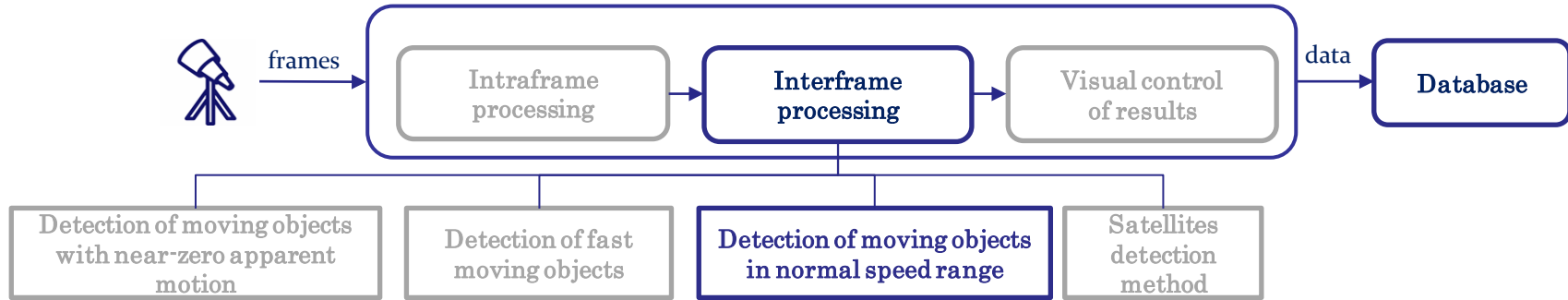
Characteristics of object
1:

frame	X_1	Y_1	ε_1	ω_1
1	2557	284	0.9	135.0
2	2637	200	0.9	130.6
3	2707	127	0.9	137.9
4	2779	53	0.9	131.7



Characteristics of object
2:

frame	X_2	Y_2	ε_2	ω_2
1	1575	1655	1.0	120.7
2	1539	1559	1.0	111.0
3	1503	1465	1.0	116.6
4	1467	1366	1.0	114.2



detects and discovers comets, asteroids and satellites in automated mode;

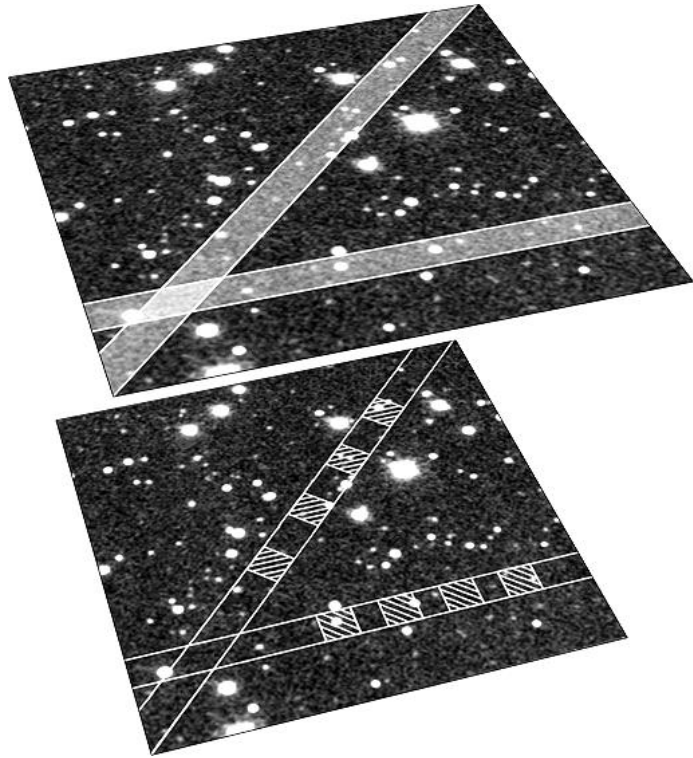
uses the method of light collecting, which allows energy accumulation of the objects images along trajectories with unknown parameters, which provides high quality detection in telescopes with small aperture;

works at low thresholds and allows to see very faint and hardly observable objects, for observation of which by traditional methods it is necessary to increase the observing potential in several times;

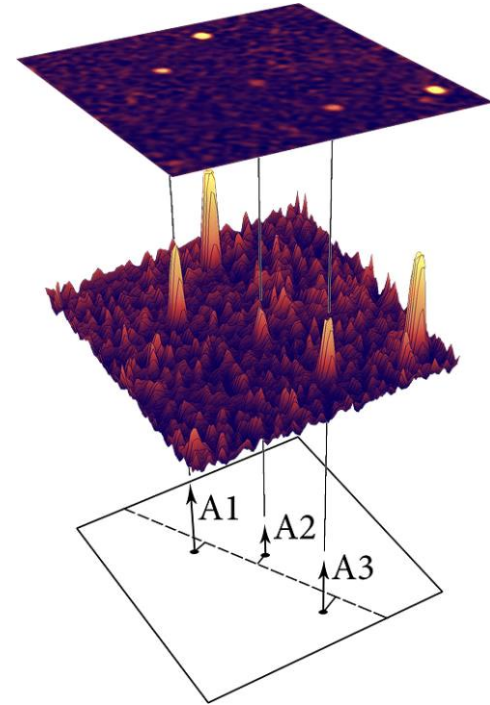
software has a linear complexity with the measurements number per frame, which allows working at low thresholds and detecting a motion against the background of 5000 false measurements and 20,000 stars.

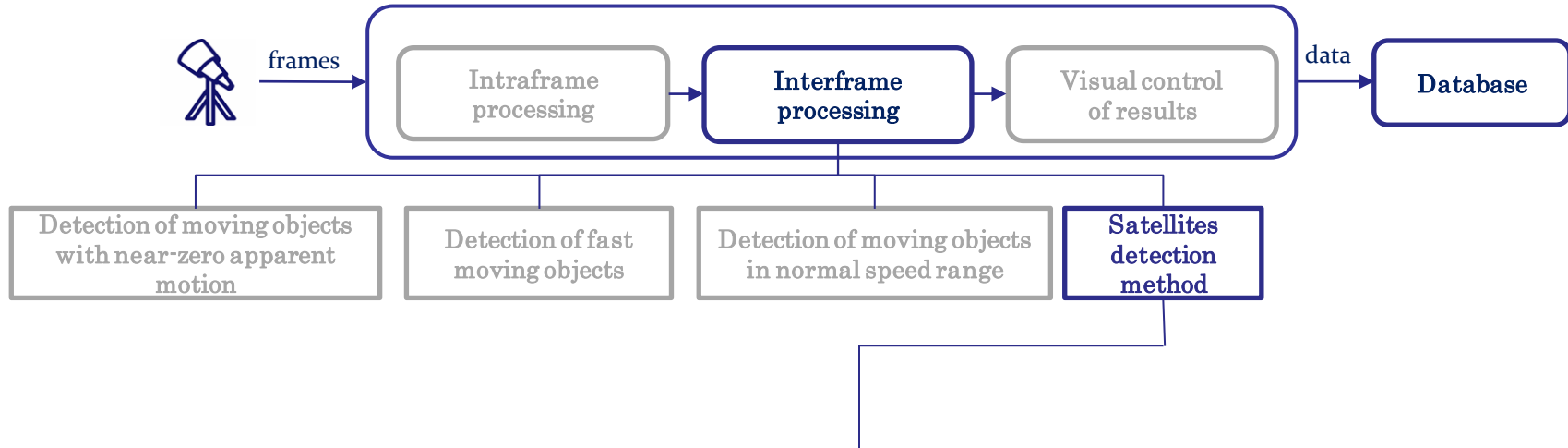
Detection of slow and fast moving objects

Algorithm for moving object detection



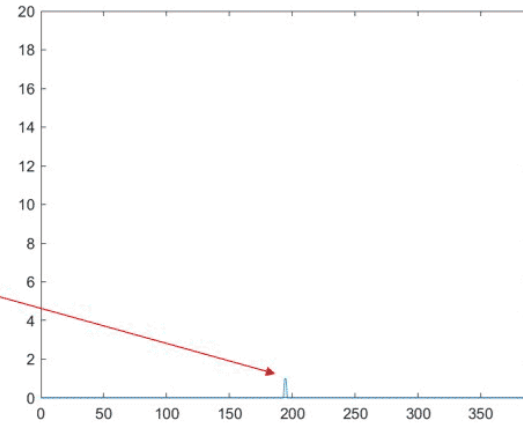
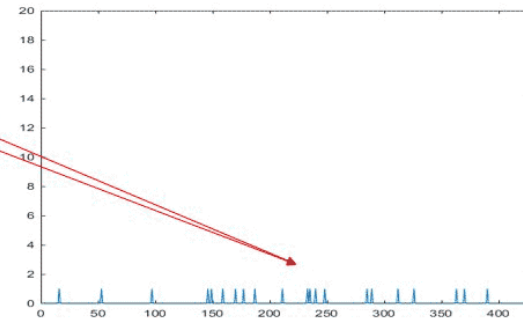
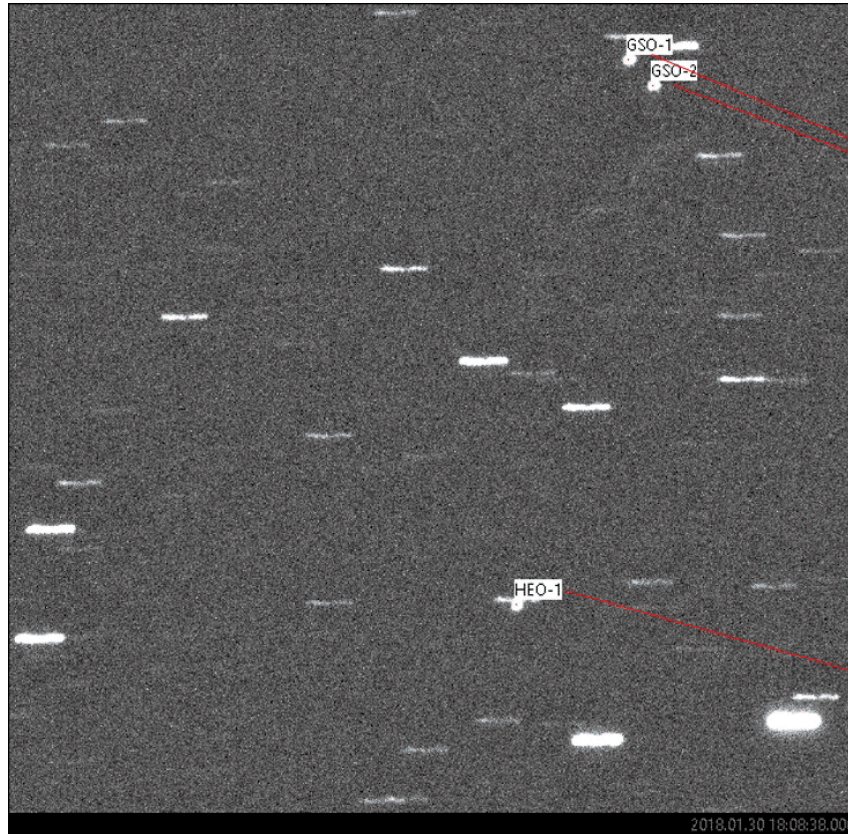
Lemur





Detects satellites with geostationary orbit or high-elliptical orbit on frames with stars background like as strokes made by fixed mounting telescope. Detects satellites with low (LEO) and medium (MEO) Earth orbit.

GSO-Hough detection method





— visualization of a series of frames and detected satellites, comets, asteroids;

— automated satellite measuring in a series of frames: it suffices to mark the satellite in two frames, after which its measurements will be done automatically in the remaining frames with ability to control;

— analysis of satellite measurements in a series of frames: visualization of deviations and measurements censoring;

— reports generation with measurements of asteroids and satellites in the international formats;

— initial determination and clarification of satellite orbit elements;

— on-line loading and identification of detected asteroids and comets from MPC data allows to quickly make a decision about the possible presence of new asteroids and comets in series of frames.

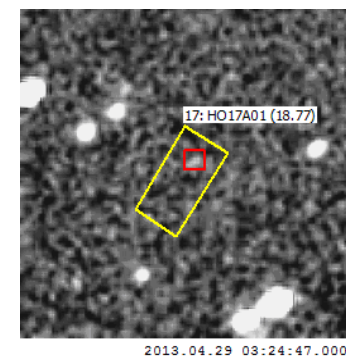
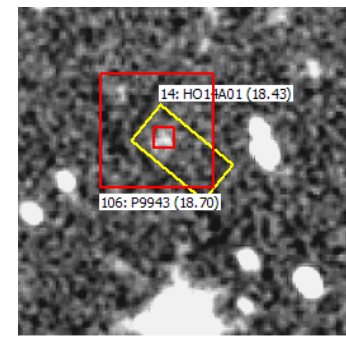
LookSky – visual inspection of asteroids detected

The screenshot shows the LookSky software interface. The main window displays a star field with numerous asteroids labeled with IDs and coordinates. A 'Manager Objects' window is open on the right, showing a table of detected objects. Below the table is an 'Image header' window displaying technical details of the observation.

Draw	N	CLTName	V	Vx	Vy	V_ra
<input checked="" type="checkbox"/>	1	AA01A12	0.71509	4.769	-1.352	-0.68001
<input checked="" type="checkbox"/>	2	AA02A12	13.89876	-33.658	-90.126	4.98601
<input checked="" type="checkbox"/>	3	AA03A12	0.54567	3.17	-2.047	-0.45069
<input checked="" type="checkbox"/>	4	AA04A12	0.12624	0.474	0.741	-0.06905
<input checked="" type="checkbox"/>	5	AA05A12	0.51162	3.354	-1.177	-0.48157
<input checked="" type="checkbox"/>	6	AA06A12	0.58057	3.999	-0.155	-0.57989
<input checked="" type="checkbox"/>	7	AA07A12	0.70404	4.76	-0.849	-0.69277
<input checked="" type="checkbox"/>	8	AA08A12	0.61177	3.911	-1.583	-0.56684
<input checked="" type="checkbox"/>	9	AA09A12	0.8336	-5.322	-1.862	0.79023
<input checked="" type="checkbox"/>	10	AA10A12	0.57512	3.696	-1.389	-0.53787
<input checked="" type="checkbox"/>	11	AA11A12	0.55796	3.415	-1.831	-0.4886
<input type="checkbox"/>	12	AA12A12	0.35124	-1.232	-2.142	0.17907
<input checked="" type="checkbox"/>	13	AA13A12	0.60523	3.861	-1.711	-0.55449
<input checked="" type="checkbox"/>	14	AA14A12	0.53211	3.311	-1.773	-0.47011
<input type="checkbox"/>	15	AA15A12	0.62883	-4.285	-0.664	0.61986
<input checked="" type="checkbox"/>	16	AA16A12	0.58804	3.361	-2.372	-0.4811
<input checked="" type="checkbox"/>	17	AA17A12	0.57948	3.489	-2.125	-0.49255
<input checked="" type="checkbox"/>	18	AA18A12	0.74571	2.708	-4.451	-0.38531
<input checked="" type="checkbox"/>	19	AA19A12	0.64571	4.006	-1.893	-0.58404

```

Image header
Step_201-4-001-001.fits
EXPTIME = 2.400000000000E+002 / [sec] Duration of exposure
EXPOSURE = 2.400000000000E+002 / [sec] Duration of exposure
SET-TEMP = -20.00000000000000 / CCD temperature setpoint
CCD-TEMP = -20.00000000000000 / CCD temperature at start of
XPFSX2 = 12.00000000000000 / Pixel Width in microns (ad
YPFSX2 = 12.00000000000000 / Pixel Height in microns (ad
XBINNING = 1 / Binning level along the X
YBINNING = 2 / Binning level along the Y
NORGSUBP = 0 / Subframe X position in bit
YORGSUBP = 0 / Subframe Y position in bit
READOUTM = 'Normal' / Readout mode of image
IMAGETYP = 'Light Frame' / Type of image
SITELAT = '32 54 12' / Latitude of the imaging loc
SITELONG = '-105 31 42' / Longitude of the imaging loc
JD = 2456206.8686342593 / Julian Date at start of obs
TRAKTIME = 0.7200000034706115 / Exposure time used for aut
FOCALLEN = 1270.7408988171113 / Focal length of telescope
APTDIA = 455.00000000000000 / Aperture diameter of tele
APTAREA = 162597.05930203199 / Aperture area of telescope
SWCREATE = 'Maxim DL Version 5.18 130606 18z9w' / Name of the
the image
    
```



LookSky –visual inspection of satellites detected

The screenshot displays the LookSky software interface, which is used for visual inspection of satellites detected in astronomical images. The main window, titled "LookSky - viewing and editing colitec-data", features a central "Image view" pane showing a grayscale image of a star field with a red and yellow bounding box around a specific satellite. The interface includes several panels:

- Manager Survey:** A table listing survey data with columns for ID, status, and DateTime.
- Image pel:** A panel for image properties, including checkboxes for X:Y.w, X:Y.b, X:Y.a, Ra:De, and I.
- Image area:** A panel for defining the image area, with X:Y.a coordinates.
- Image view:** The main image display with navigation controls (back, forward, zoom) and a magnifier window below it.
- Manager Objects:** A table listing detected objects with columns for Class, Draw, CLTName, m_m, TrMade, and NORAD.
- Image header:** A panel showing FITS header information, including STEP-16908_011222_230317_33_Exposure=50.0ms_0004.fit and various parameters like SIMPLE, BITPIX, NAXIS, etc.
- Manager of Reports:** A panel for generating reports, including SMTP server settings and a list of satellite data.
- Hand Measurer:** A panel for measuring the size of objects, with Class, Draw, and measurement values.

#	N	DateTime
01	S	2017.03.23 01:12:20.731
02	S	2017.03.23 01:12:20.784
03	S	2017.03.23 01:12:20.828
04	S	2017.03.23 01:12:20.877
05!	S	2017.03.23 01:12:20.925

Class	Draw	CLTName	m_m	TrMade	NORAD
Satellites - Data of CoLiTec	1	HAND001	4.832	MANUA	HAND001

```
STEP-16908_011222_230317_33_Exposure=50.0ms_0004.fit
SIMPLE = T / Conforms to FITS standa
BITPIX = 16 / Number of bits per data
NAXIS = 2 / Number of axes
NAXIS1 = 968
NAXIS2 = 608
BSCALE = 1.000000000000 / Data scaling factor
BZERO = 0.000000000000 / Data offset
EXTEND = T / Extension permitted
PCOUNT = 0 / No extra parameters
GCOUNT = 1 / One group
OBSERVER= /
```

StationCode	230317	0112207310	1603253745	-1926353076	0
HAND001	230317	0112207310	1603253745	-1926353076	0
HAND001	230317	0112207840	1603265471	-1926412404	0
HAND001	230317	0112208280	1603276146	-1926578364	0
HAND001	230317	0112208770	1603287136	-1927056664	0
HAND001	230317	0112209250	1603297427	-1927137412	0

Displaying and navigation of astronomical frames with satellites

The screenshot displays the LookSky software interface, titled "LookSky - viewing and editing colitec-data". The main window shows an astronomical image with a red and yellow bounding box around a satellite. The interface includes several panels:

- Manager Survey:** A table listing survey data.
- Image view:** The central display area showing the astronomical image with a zoom level of 70 and a file path of "UF 250317 011220.700".
- Manager Objects:** A table listing satellite objects.
- Fits:** A table listing FITS files.

#	Name	RAW:STEP
01	D:\CoLiTec\1.8.3	0:5
02!	D:\CoLiTec\1.8.3	0:5
03	D:\CoLiTec\1.8.3	0:4

Draw	N	CLTName	m_m
<input checked="" type="checkbox"/>	1	HAND001	4.832

#	N	DateTime
01!	S	2017.03.23 01:12:20.731
02	S	2017.03.23 01:12:20.784
03	S	2017.03.23 01:12:20.828
04	S	2017.03.23 01:12:20.877
05	S	2017.03.23 01:12:20.925

Displaying and navigation of astronomical frames with satellites

The screenshot displays the LookSky software interface, titled "LookSky - viewing and editing colitec-data". The main window shows an astronomical image with numerous white streaks representing satellite tracks. Two yellow rectangular boxes highlight specific tracks in the lower-middle section of the image.

The interface includes several panels:

- Manager Survey:** A table with columns for Series, Name, and RAW:STEP. The first row is selected and highlighted in blue.
- Manager Objects:** A table with columns for Draw, N, CLTName, and m_m. Two rows are checked and highlighted in blue.
- Fits:** A table with columns for #, N, and DateTime. Three rows are listed, with the first row selected and highlighted in blue.

The central image view includes navigation controls such as zoom in/out, pan, and a status bar showing "1/3" and "29".

Series	Name	RAW:STEP
01!	D:\CoLiTec\1.8.3	0.3

Draw	N	CLTName	m_m
<input checked="" type="checkbox"/>	1	HAND001	0.99
<input checked="" type="checkbox"/>	2	HAND002	4.477

#	N	DateTime
01!	S	2017.03.29 20:09:11.000
02	S	2017.03.29 20:09:41.000
03	S	2017.03.29 20:09:56.000

Displaying and navigation of astronomical frames with satellites

The screenshot displays the LookSky software interface, titled "LookSky - viewing and editing colitec-data". The main window shows an astronomical image with several white streaks representing satellite tracks. Four red boxes are overlaid on the image, highlighting specific satellite positions. The interface includes several panels:

- Manager Survey:** Shows a list of survey frames. The first frame is selected: # 011, Name: D:\Frames\VGEO_0-91, RAW:STEP.
- Image view:** The central area displaying the astronomical image with navigation controls (zoom, pan, etc.) and a status bar showing "1/91" and "99".
- Manager Objects:** A table listing satellite objects. The class is "Satellites - Data of CoLiTec".
- Fits:** A list of FITS files with their corresponding DateTime values.

Draw	N	CLTName	m_m
<input checked="" type="checkbox"/>	1	HAND001	5.559
<input checked="" type="checkbox"/>	2	HAND002	6.511
<input checked="" type="checkbox"/>	3	HAND003	6.854
<input checked="" type="checkbox"/>	4	HAND004	5.181

#	DateTime
011	2015.03.26 10:05:05.500
02	2015.03.26 10:05:14.500
03	2015.03.26 10:05:22.500
04	2015.03.26 10:05:31.500
05	2015.03.26 10:05:39.500
06	2015.03.26 10:05:47.500
07	2015.03.26 10:05:56.500
08	2015.03.26 10:06:04.500

Displaying and navigation of astronomical frames with satellites

The screenshot displays the LookSky software interface, titled "LookSky - viewing and editing colitec-data". The main window shows an astronomical image with a yellow rectangular box highlighting a satellite track. The image contains numerous white streaks representing stars or galaxies, and a small white dot within the yellow box. The text "UT 150617 222109.803" is visible in the top left corner of the image.

The interface includes several panels:

- Manager Survey:** A table listing survey data.
- Manager Objects:** A table listing object data, with "HAND002" highlighted.
- Fits:** A table listing FITS file data.

The "Manager Survey" table:

#	Name	RAW:STEP
01	D:\CoLiTec\1.8.3	0.5
02	D:\CoLiTec\1.8.3	0.5
03	D:\CoLiTec\1.8.3	0.4

The "Manager Objects" table:

Draw	N	CLTName	m_rn
<input checked="" type="checkbox"/>	1	HAND001	5.572
<input checked="" type="checkbox"/>	2	HAND002	4.957
<input checked="" type="checkbox"/>	3	HAND003	5.572

The "Fits" table:

#	N	DateTime
01	S	2017.06.15 22:21:09.583
02	S	2017.06.15 22:21:10.591
03	S	2017.06.15 22:21:11.587
04	S	2017.06.15 22:21:12.583

Our immediate goals:

Online and mass photometry.

Implement the TLE service - it will allow the observer to see the data from the NORAD catalog on the processed frames.

To implement the stacking of the frames in the given range of speeds in order to automatically find the super-weak objects of the solar system.

Improving segmentation, fitting, astrometry, and more...

Thank you!

We are ready for the collaboration!

Savanevych
Vadym



[Scopus](#)

[NASA ADS](#)

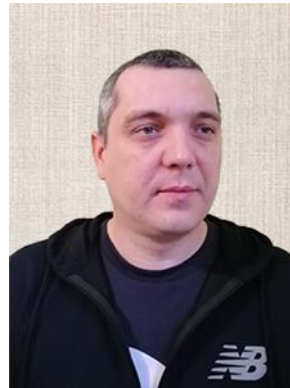
Briukhovetskyi
Olexander



[Scopus](#)

[NASA ADS](#)

Dikov
Yevhen



[Scopus](#)

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Dmytrenko
Artem



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Sergii



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