Observations of selected man-made objects with Ukraine Network of Optical Stations and obtained results in 2012 – 2022 years

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Content

- UMOS members, objectives, statistics of observed objects.
- Telescopes and image sensors.
- Methods for digital tracking.
- Software for image processing and calculations of orbital elements.
- Online catalogue of orbital elements.
- Conclusions.

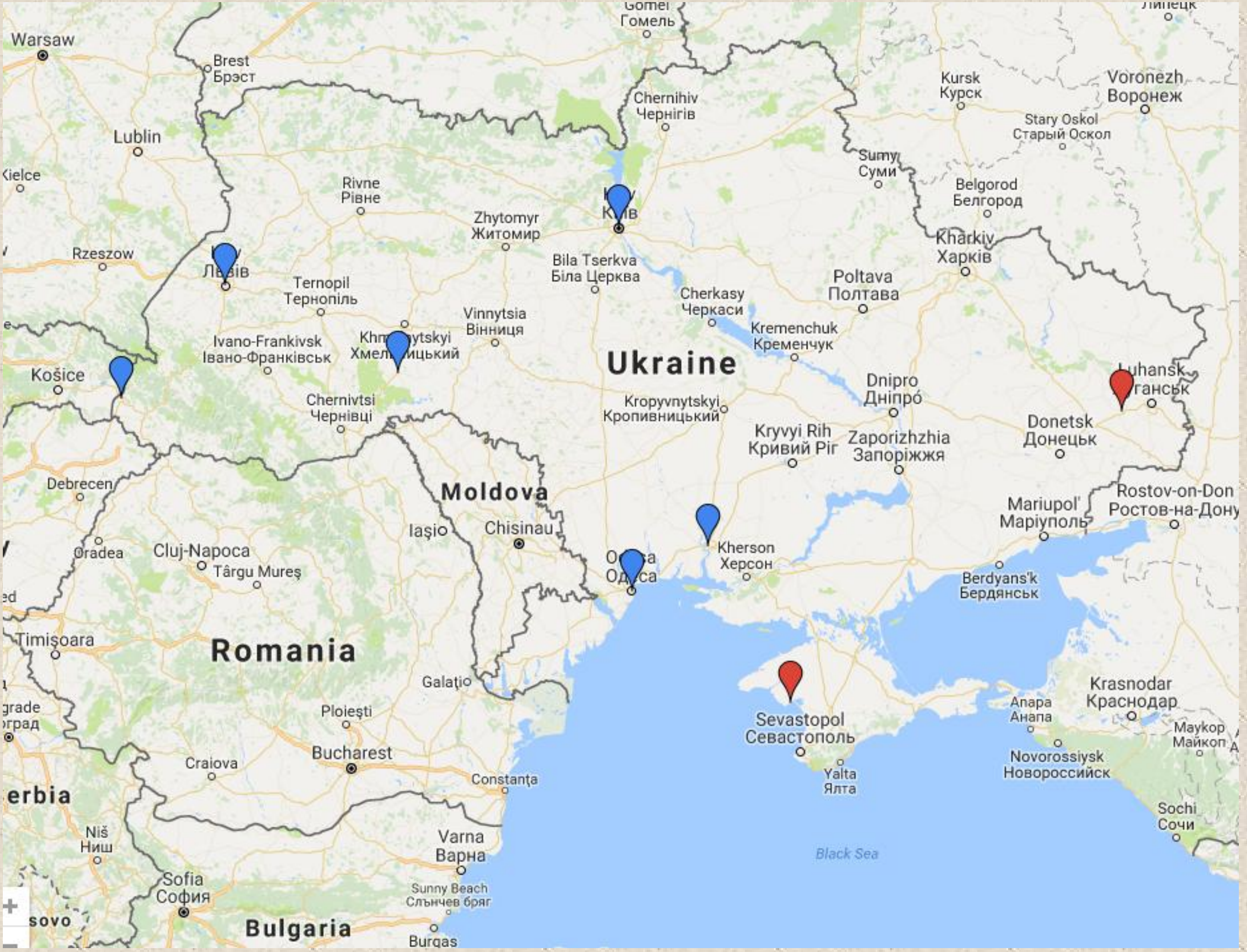
Ukraine Network of Optical Stations
(UMOS - ukrainian abbreviation)

The UMOS was created in 2012 on the initiative of astronomical observatories, the National Academy of Science, the State Space Agency.

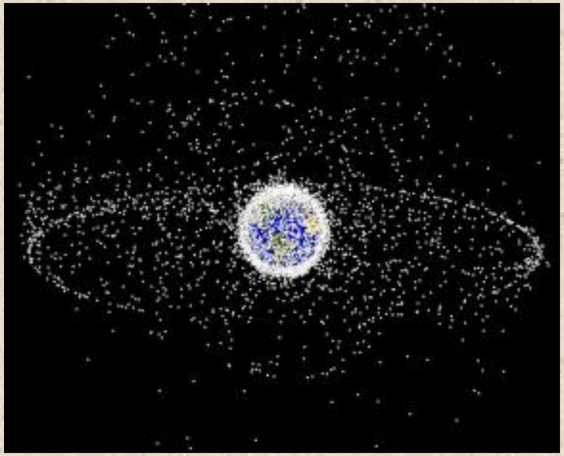
The UMOS members are as follows:

- ✓ Main Astronomical Observatory;
- ✓ Mykolaiv Astronomical Observatory;
- ✓ Astronomical Observatory of Odesa National University;
- ✓ Astronomical Observatory of Lviv National University;
- ✓ Space Research Laboratory of Uzhhorod National University;
- ✓ Donetsk National University;
- ✓ National Space Center.

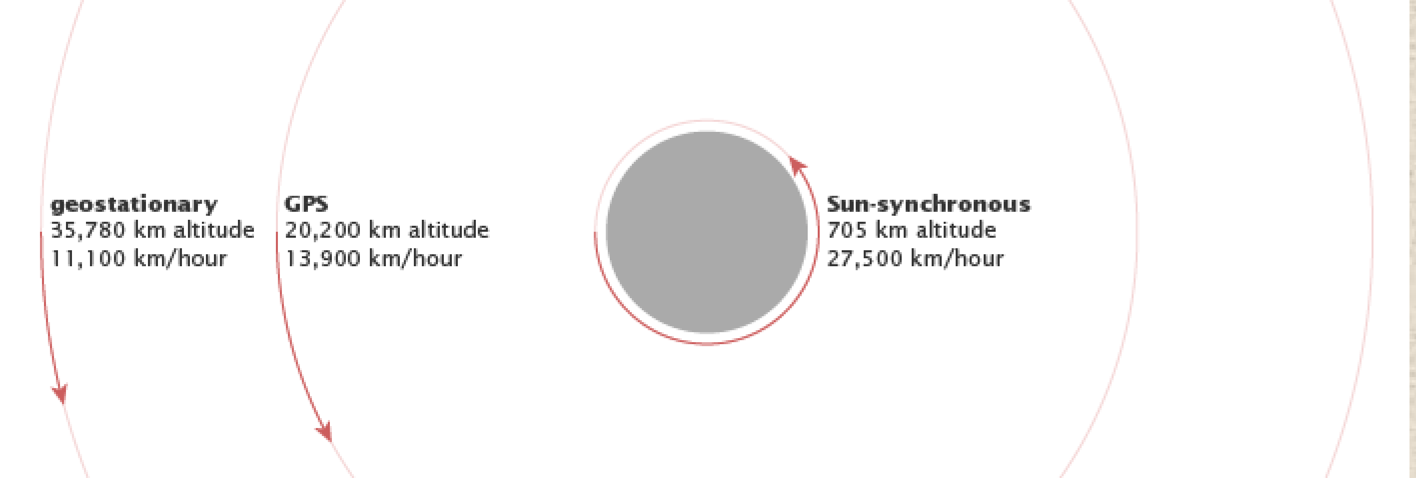
Ukraine Network of Optical Stations (UMOS)



Objectives of the UMOS:

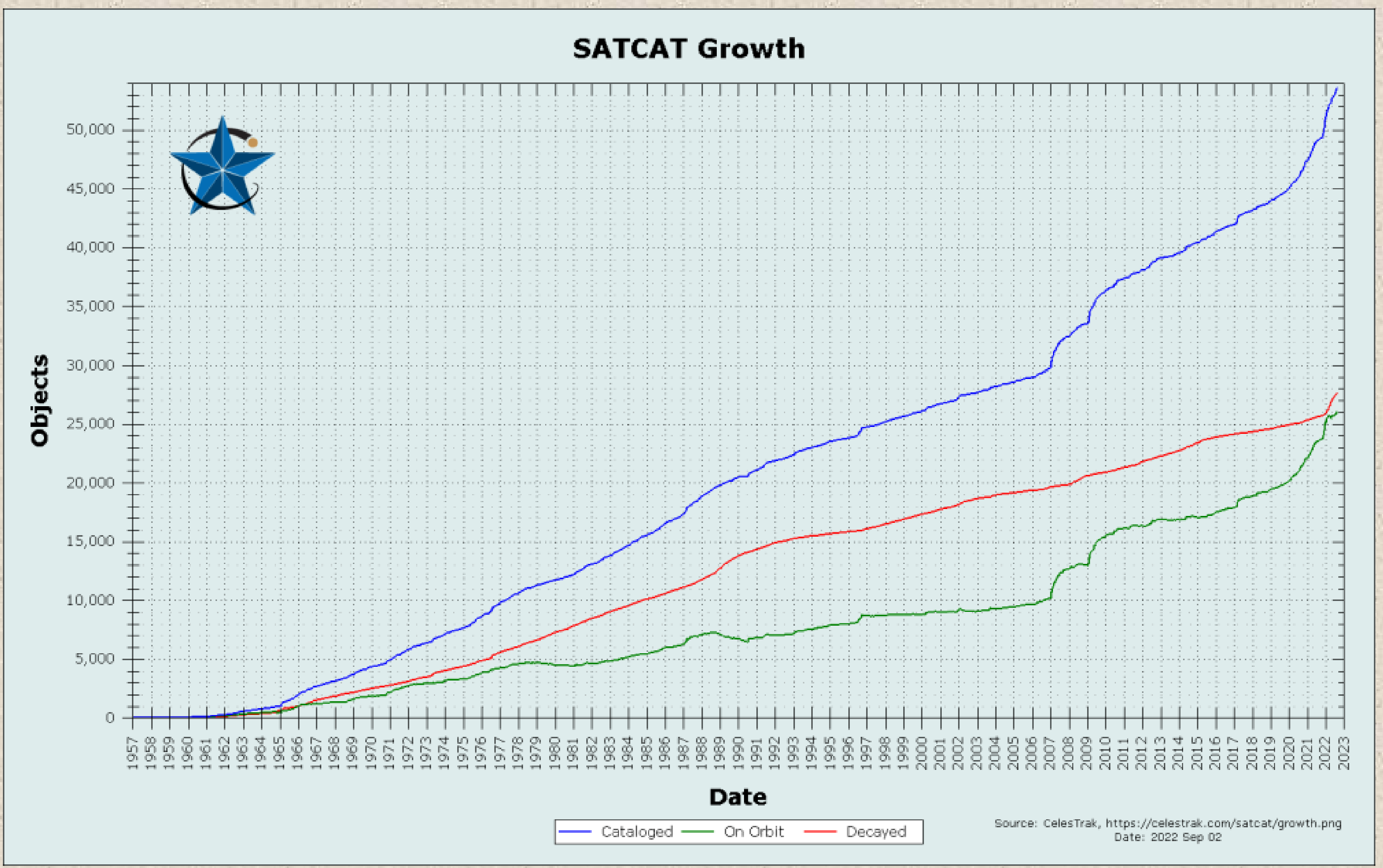


- ✓ regular observations of the selected man-made objects;
- ✓ improvement of motion models;
- ✓ development of algorithms for data processing.



NASA illustration by Robert Simmon

1957 – 2022



https://celestrak.org/satcat/growth.png

Selected man-made objects observed in 2012-2022 years:

- **operational space vehicles in low orbits: ~ 400 satellites, including 100 satellites in Sun-synchronous orbits,**
  minimum size: 30×30×30 cm
- **space debris in low orbits: ~ 500 objects**
  minimum size: 10×10×10 cm
- **navigational space vehicles: ~ 50 satellites**
  GPS, GLONASS, Galileo, Beidou
- **geostationary communication satellites: ~ 150 satellites**

Year: 2011, objects: 7, orbits: 15
Year: 2012, objects: 105, orbits: 271
Year: 2013, objects: 120, orbits: 379
Year: 2014, objects: 127, orbits: 808
Year: 2015, objects: 110, orbits: 351
Year: 2016, objects: 49, orbits: 87
Year: 2017, objects: 137, orbits: 750
Year: 2018, objects: 123, orbits: 403
Year: 2019, objects: 81, orbits: 527
Year: 2020, objects: 198, orbits: 890
Year: 2021, objects: 176, orbits: 1134
Year: 2022, objects: 34, orbits: 206

TOTAL: ~ 1100

~ 4% of objects in orbit from SatCat (DoD of USA)

Telescopes and image sensors

Telescopes for observations of objects in low Earth orbits (LEO)

UMOS station	Objective	F/D (mm)	FoV, deg	Observation mode	Photo
Kyiv	Helios 40	85/56	4.3 × 3.2	Digital tracking	
Odesa	Maksutov	2000/500	0.18×0.14	Mechanical tracking	
Mykolaiv	Tair 11A	135/48	2.6 × 2.0	Digital tracking	
Lviv	Jupiter-9	85/56	4.2 × 3.2	Digital tracking	
Uzhgorod	Jupiter-9	85/56	4.2 × 3.2	Digital tracking	

All telescopes are installed on alt-azimuth mount and equipped with 1/2" interline transfer CCD image sensor - WATEC-902H2 (752×582, 8.6×8.3 μm) without photometric filters.

Telescopes for observations of objects in Medium and Geostationary Earth Orbits

Mykolaiv,

Maksutov + Alta U9000

D≈ 0.28 m, F≈ 1.5 m

FoV≈ 1.3° x 1.3°

Mykolaiv,

Maksutov + Alta U9000

D≈ 0.5 м, F≈ 3.0 м

FoV≈ 0.7° x 0.7°

Mykolaiv,

Refractor + Alta U9000

D≈ 0.23 m, F≈ 0.8 m

FoV≈ 2.6° x 2.6°

Lviv,

? + SXV-9M

D≈ 0.25 m, F≈ 1.25 m

FoV≈ 0.4° x 0.3°

Uzhhorod,

Takahashi BRC250M + Alta U9000

D≈ 0.25 m, F≈ 1.268 m

FoV≈ 1.6° x 1.6°

Odesa,

Maksutov + Alta U9000

D≈ 0.28 m, F≈ 1.5 m

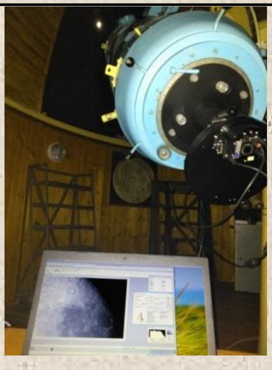
FoV≈ 1.3° x 1.3°

Kyiv, Celestron 1400 XLT

Shmidt-Cassegrain + SBIG ST-8XME

D≈0.35 m, F≈3.9 m

FoV≈ 0.2° x 0.1°



Lviv, AZT-14

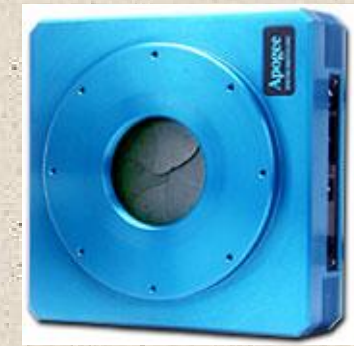
Reflector + Trius SX-35

D≈ 0.48 m, F≈ 7.8 m

FoV≈ 0.26° x 0.17°

Image sensors

Apogee Alta U9000



CCD: KAF-09000

Array Size, pixels: 3056 x 3056

Pixel size: 12 x 12 microns

Imaging area: 36.7 x 36.7 mm

Three telescopes in Mykolaiv are equipped with Apogee Alta U9000.

Watec - 902H2

1/2" B/W interline transfer CCD

Number of effective pixels:	752 x 582
Pixel size, microns	8.6 x 8.3
Max exposure, ms	20
Half-frames per second	50

Five telescopes are equipped with Watec - 902H2.

Image sensors for observations in GEO (Lviv)

Starlight Xpress SXV-M9	Starlight Xpress Trius SX-35
	
CCD: Sony ICX423AL	CCD: Kodak KAI11002
Array Size, pixels: 752 x 582	Array Size, pixels: 4032 x 2688
Pixel size: 11.6 x 11.2 microns	Pixel size: 9 x 9 microns
Imaging area: 8.72 x 6.5 mm	Imaging area: 36.3 x 24.2 mm
Filters: Astrodon B,V,R	Filters: Astrodon U,B,V,R,I

National Space Center

Station Sazhen-S

- Refractor + Sony **CMOS** X174LLJ

D≈ 0.3 m, F≈ 0.3 m

Wide FoV≈ 2.1° x 1.3°

- Reflector + FLI ML 16070

D≈ 0.5 m, F≈ 8.0 m

Narrow FoV≈ 14.5' x 9.5'

LEO, MEO, GEO

Station #1

Newton, D≈ 0.5 m, F≈ 1.9 m

- FLI ML 16070

Wide FoV≈ 64.8' x 43'

- **CMOS** IMX174LLJ

Narrow FoV≈ 20.7' x 13'

MEO, GEO

Station #2

Refractor, D≈ 0.3 m, F≈ 0.3 m

- FLI ML 16070

Wide FoV≈ 6.9° x 4.6°

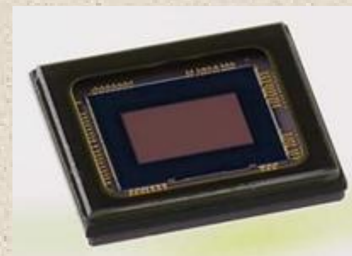
- **CMOS** IMX174LLJ

Narrow FoV≈ 130' x 80'

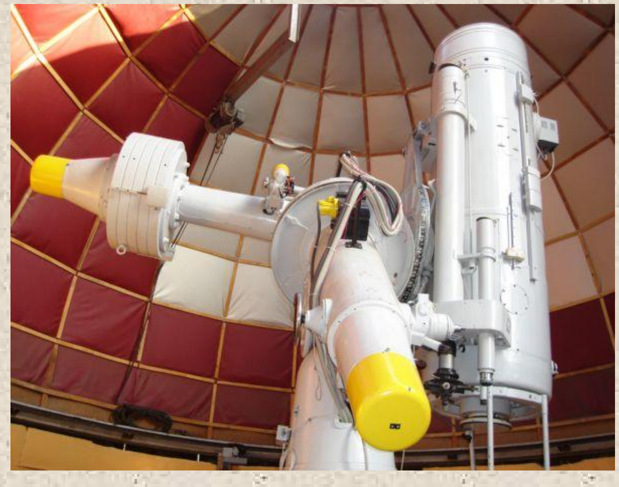
LEO, MEO, GEO

All image sensors were upgraded in 2016-2019 years.

Image sensors of the National Space Center

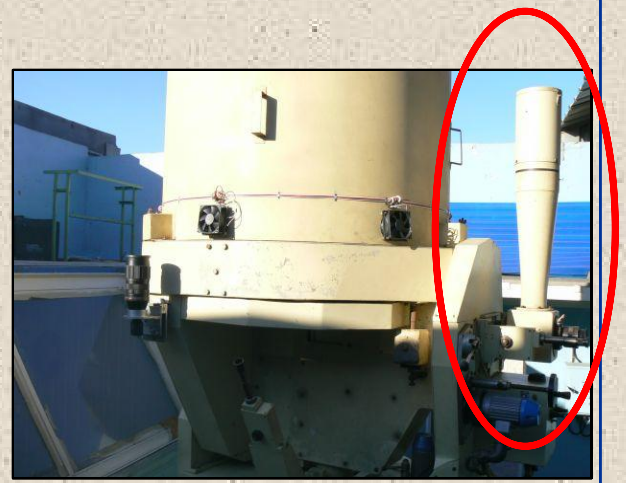
Sensor - On Semi	Camera: FLI ML16070	Sensor - Sony	Camera: QHY174GPS
			
CCD:	KAI-16070	CMOS:	IMX174LLJ
Array Size:	4864 x 3232	Array Size:	1920 x 1200
Pixel size:	7.4 x 7.4 microns	Pixel size:	5.9 x 5.9 microns
Imaging area:	35.9 x 23.9 mm	Imaging area:	11.3 x 7.1 mm
Three telescopes of the NSC are equipped with FLI ML16070.		Three telescopes of the NSC are equipped with QHY174MGPS.	

Telescopes located on the temporary occupied territory of Ukraine



Evpatoria
Newton (AZT-8)
D≈ 0.7 m, F≈ 2.8 m

Evpatoria
Reflector (AZT-28)
D≈ 0.5 m, F≈8.0 m



Alchevsk
Refractor (guide)
D≈ 56 mm, F≈ 85 mm

Methods for digital tracking

Methods for digital tracking

➢ **Combined method by using full frame CCD, rotation stage, angle encoder.**

Point-like images of a man-made object and reference stars are obtained at consequent time moments by using a rotation stage. The method was developed and implemented in Mykolaiv for digital tracking of man-made objects in MEO. Patent of Ukraine for utility model #116724.

➢ **Combined method of frame summation by using CCTV camera.**

Point-like images of a man-made object and reference stars are obtained by using image processing of video stream in the real time. Patent of Ukraine for utility model #118001:

- developed in Mykolaiv for digital tracking of man-made objects in LEO;
- implemented in Mykolaiv, Kyiv, Lviv, Uzhhorod.

➢ **Combined method using full frame CCD in drift scan mode and frame mode.**

Point-like images of a man-made object and reference stars are obtained at consequent time moments by using drift scan mode and frame mode. The method was developed and implemented in Mykolaiv for digital tracking of man-made objects in HEO and GEO.

The telescope is always stationary during exposure time. No mechanical tracking. Astrometric accuracy and precision are not affected by telescope tracking error.

Combined method for digital tracking of man-made objects in MEO

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УДК 520.02, 520.072, 520.075

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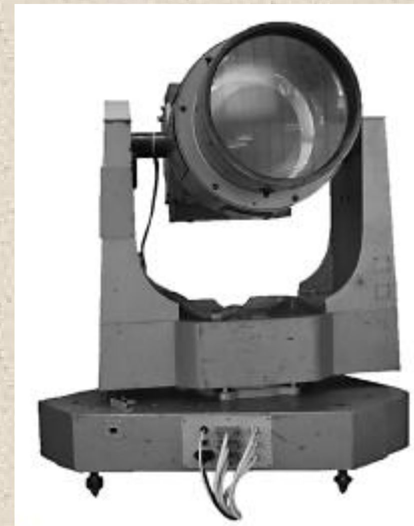
МОБИЛЬНЫЙ КОМПЛЕКС ТЕЛЕСКОПОВ НИИ НАО ДЛЯ НАБЛЮДЕНИЙ ОБЪЕКТОВ ОКОЛОЗЕМНОГО КОСМИЧЕСКОГО ПРОСТРАНСТВА

Рис. 1. Внешний вид комплекса телескопов МОБИТЕЛ: *а* — укрытие телескопа, *б* — транспортируемая платформа с телескопами



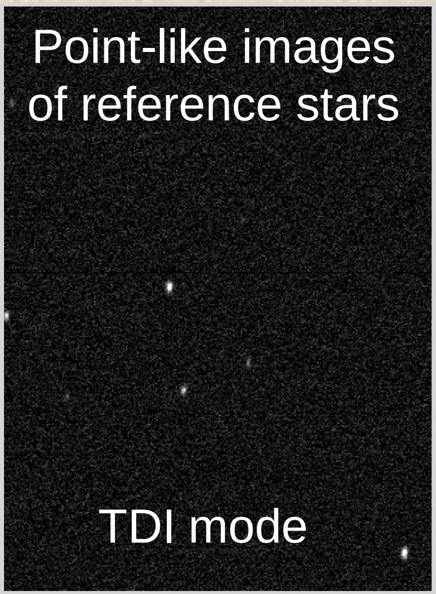
Поворотная платформа. Поворотная платформа (ПП) представляет собой механическое устройство с приводом для вращения ПЗС-камеры вокруг оптической оси объектива [2]. ПП (рис. 5) включает в себя: шаговый двигатель *1*, датчик *2* угла поворота, платформу *3* с червячной передачей. Одним фланцем ПП крепится к тубусу телескопа, ко второму фланцу ПП крепится ПЗС-камера *4*. В состав комплекса МОБИТЕЛ входит две поворотные платформы, установленные на телескопах КТ-50 и АФУ-75.

Рис. 5. Поворотная платформа

Algorithm for digital tracking of man-made object (MMO) in MEO:

(0) Telescope is pointed at equatorial coordinates of MMO for a given time moment.
(1) CCD operates in time delay and integration (TDI) mode to obtain images of reference stars.
(2) Rotation stage installs CCD columns parallel with a trajectory of MMO motion.
(3) CCD operates in TDI mode to obtain a point-like image of the MMO.
(4) Rotation stage installs CCD columns parallel with trajectory of apparent stellar motion.
(5) Repeat step (1).

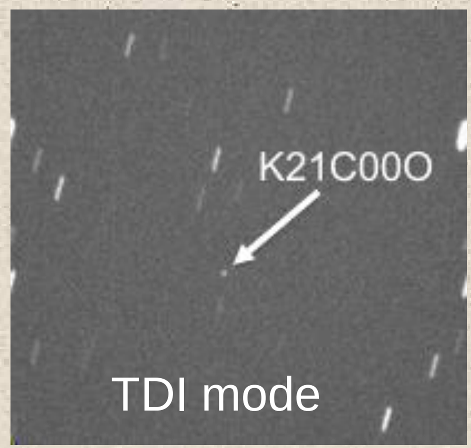
(1)



(2)

motorized rotation stage

(3)

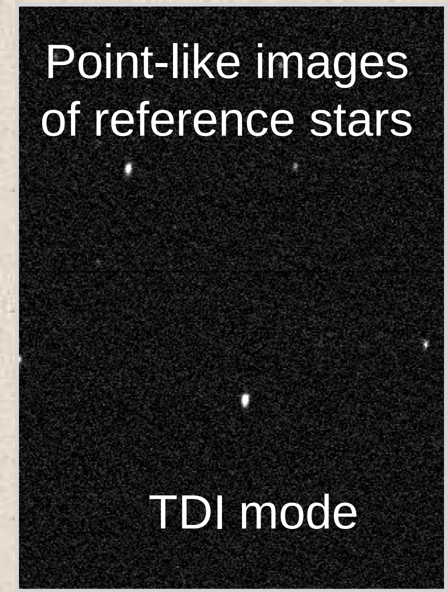


Point-like image of MMO or asteroid

(4)

motorized rotation stage

(5)

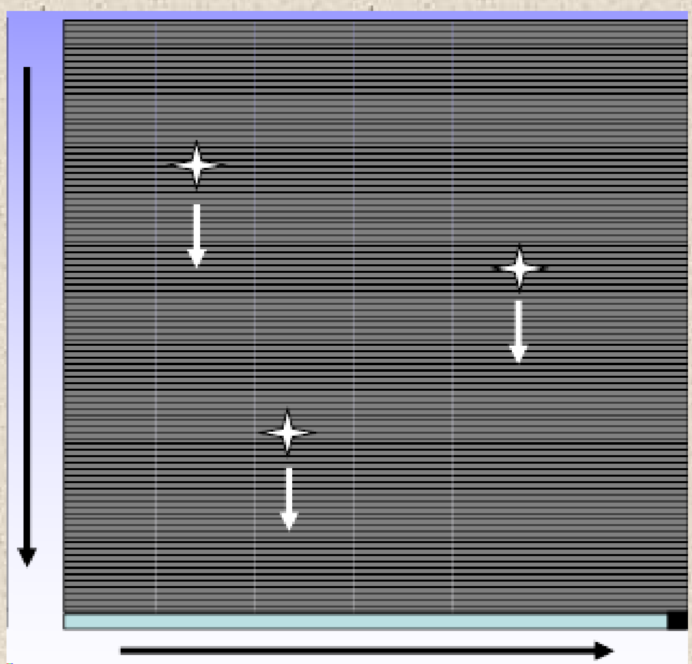


The telescope is stationary during all five steps. No mechanical tracking.
Astrometric accuracy and precision are not affected by telescope tracking error.

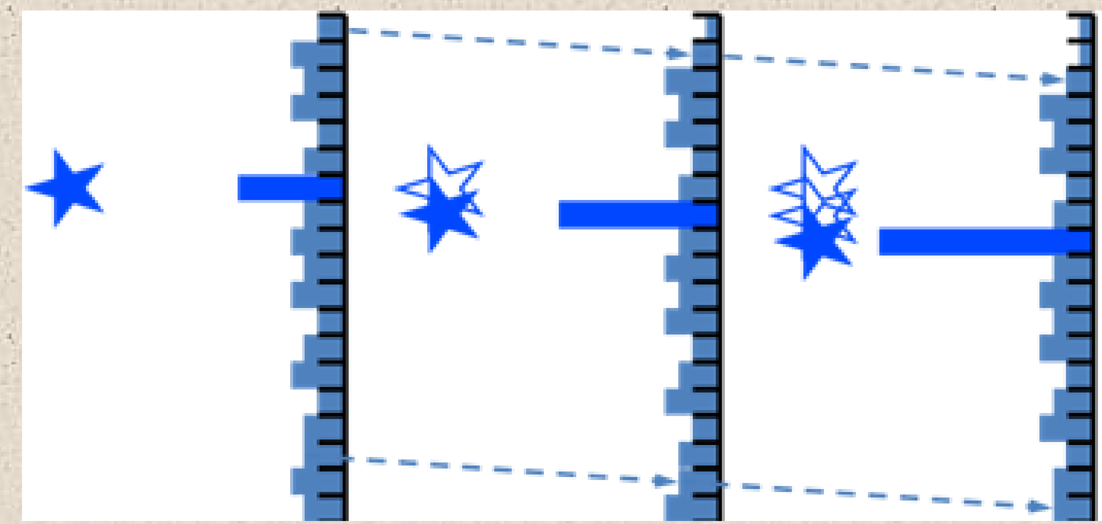
Algorithm for reading out of CCD rows in TDI mode

1. All rows are shifted down one row to match drift rate of reference stars or man-made object.
2. The last row is read out through horizontal register.
3. Repeat steps 1 and 2.

parallel shift



horizontal register



TDI mode:

- images of reference stars or man-made object (MMO) are drifting in the focal plane with different rates;

- CCD rows are shifted to match the apparent motion rate of reference stars or MMO.

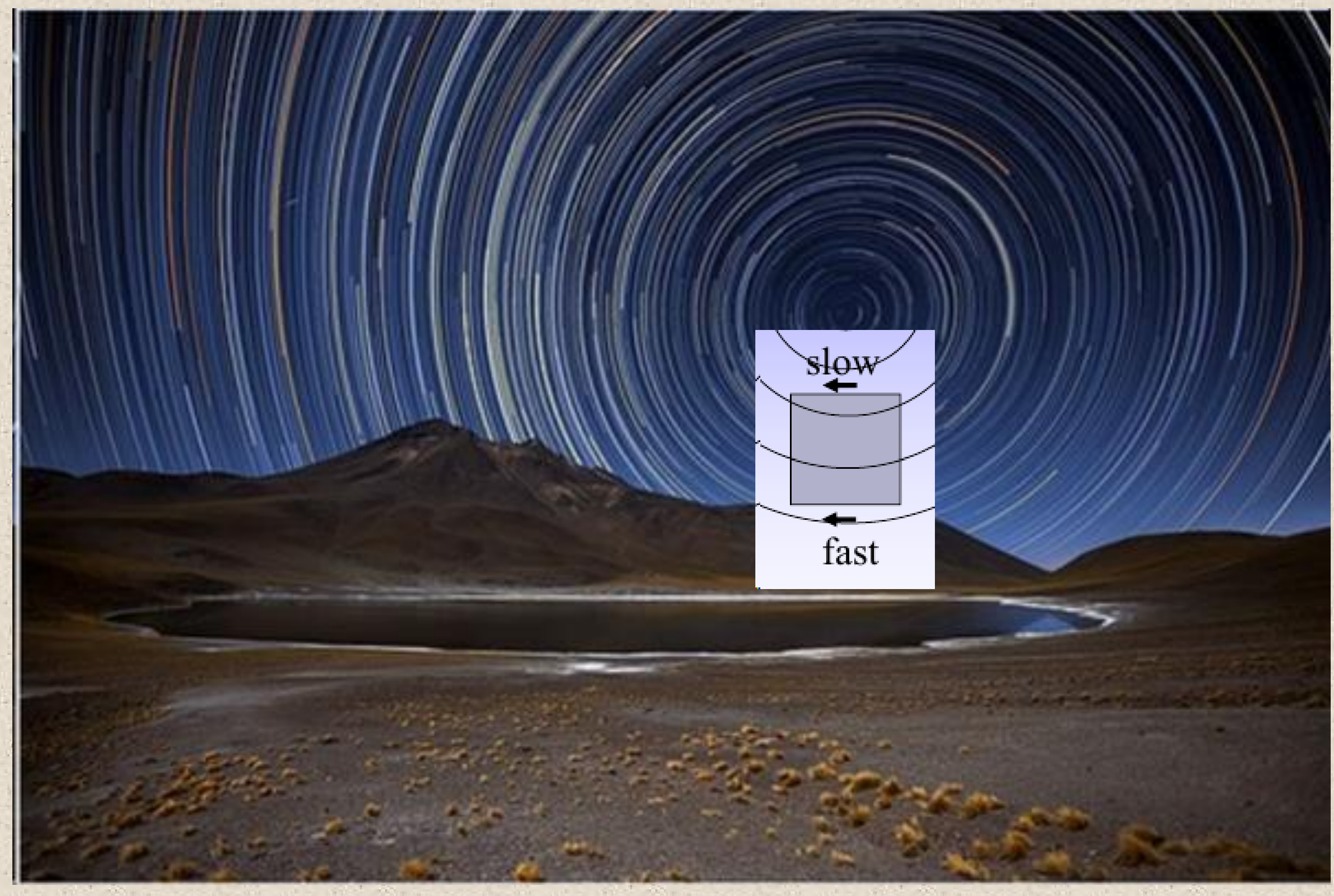
Patent of Ukraine for utility model #116724
«Method for Observing Space Objects»

Advantages of combined method
for digital tracking of MMO in MEO:

- consistent astrometry over wide field;
- astrometric solution is linear in pixel coordinates;
- positional accuracy and precision are not affected by telescope tracking error.

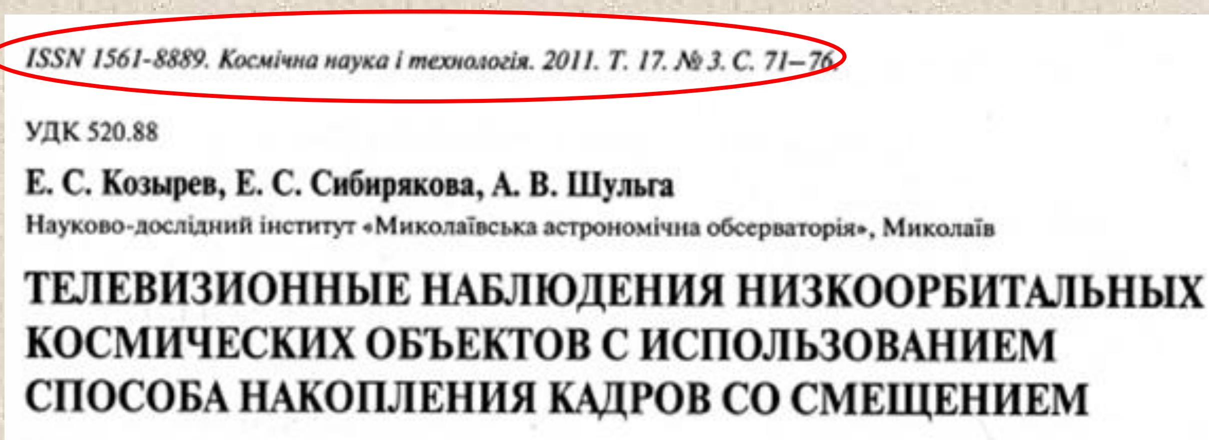
Disadvantages of combined method for digital tracking of MMO in MEO:

- method introduces some image distortion to PSF far from equator;
- row must be read out and written at the same time.



By A. Duro/ESO - http://www.eso.org/public/images/potw1631a/, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid≈50432301

Method for digital tracking of MMO in LEO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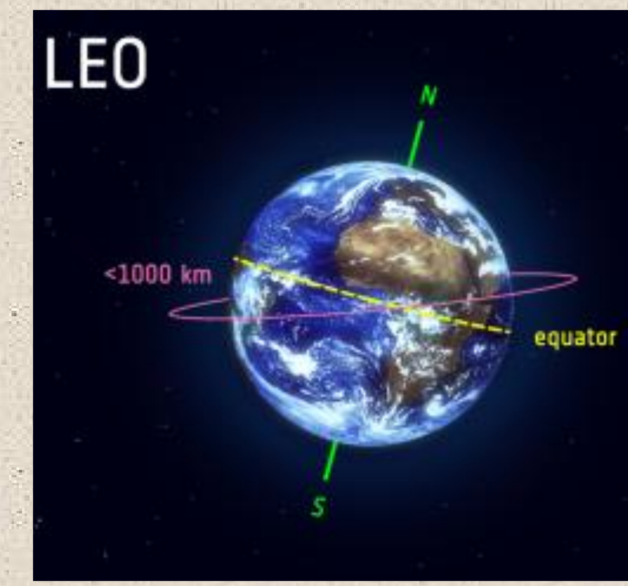
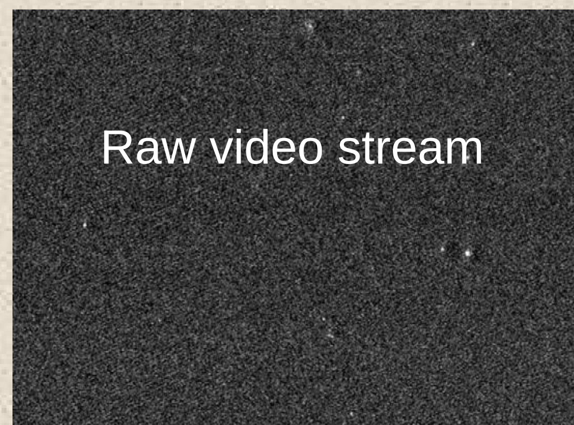
ТЕЛЕВИЗИОННЫЕ НАБЛЮДЕНИЯ НИЗКООРБИТАЛЬНЫХ КОСМИЧЕСКИХ ОБЪЕКТОВ С ИСПОЛЬЗОВАНИЕМ СПОСОБА НАКОПЛЕНИЯ КАДРОВ СО СМЕЩЕНИЕМ



- ✓ CCTV camera is used for frame summation with shifting.
- ✓ The more number of added frames, the more exposure time.
- ✓ The exposure time is only limited by period when the object passes 1° track in FoV due to non-linear trajectory. Longer than 1° track may distort the point-like image.

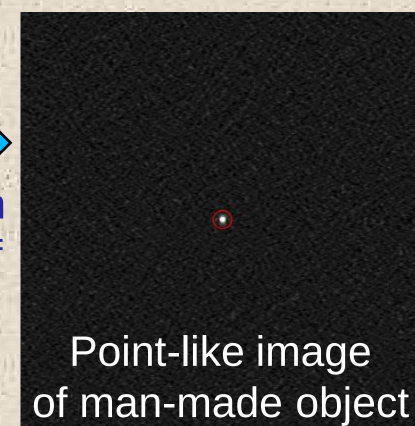
2 images

Summation and shift of frames in real time

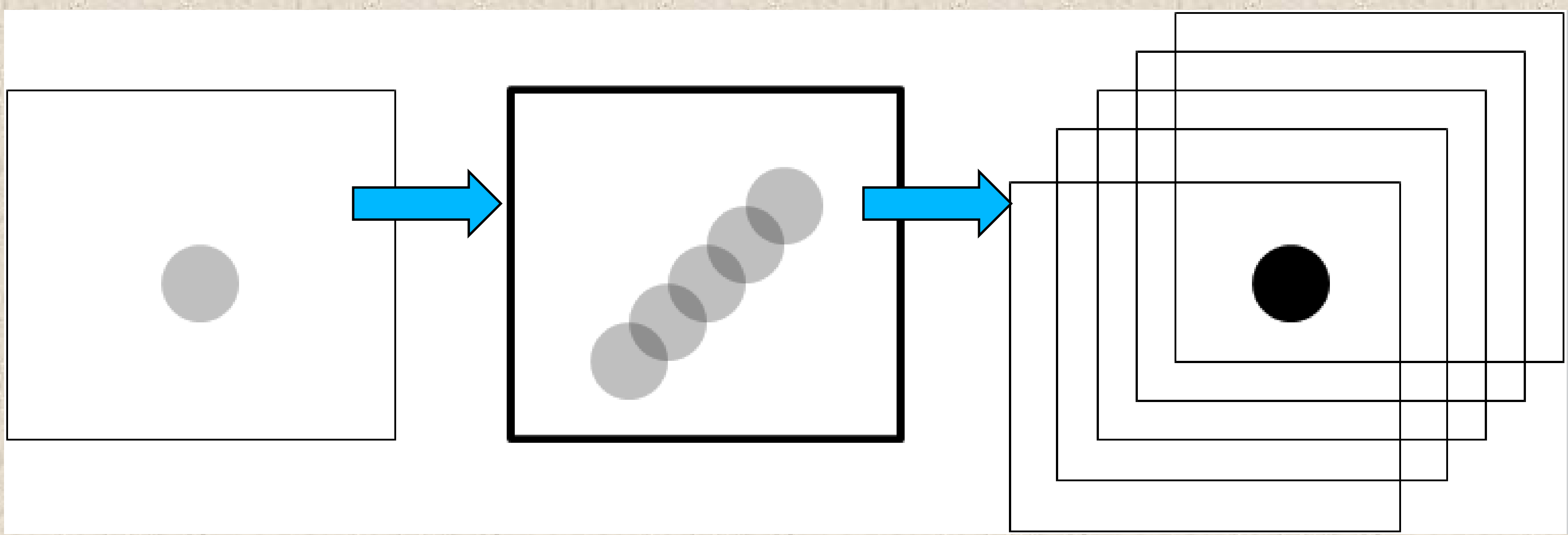


5-9 images

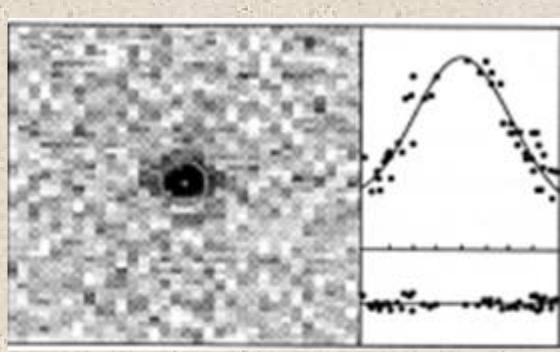
Summation and shift of frames in real time



Method for digital tracking of man-made objects in LEO

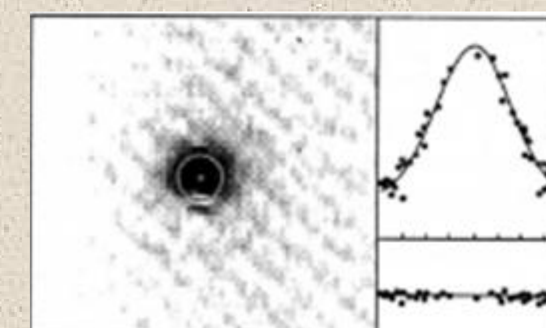


a) one frame b) many frames c) frames are shifted and summed



one frame, SNR ≈ 13

D≈ 47 mm
F≈ 85 mm
WATEC LCL 902H
25 frames/s
FoV≈ 4.3° x 3.2°



sum of 31 frames, SNR ≈ 72

The telescope is stationary during exposure time. No mechanical tracking.
Astrometric accuracy and precision are not affected by telescope tracking error.

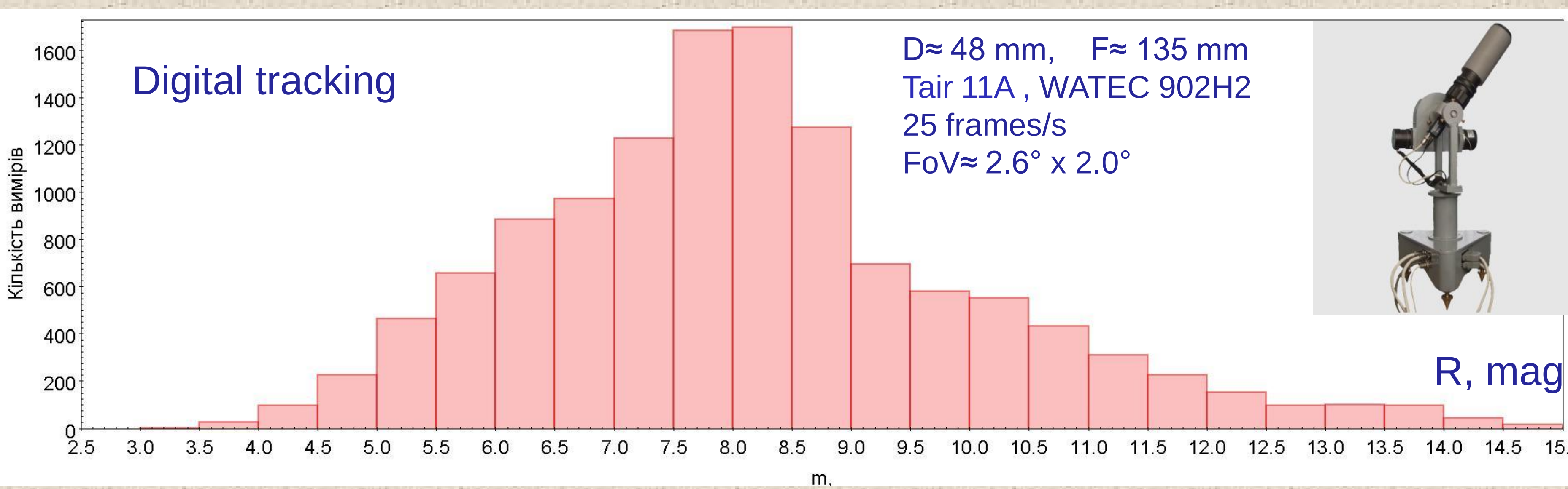
Patent of Ukraine for utility model #118001
«Method for Observing Objects in Low Earth Orbits and Reference Stars»

Algorithm for digital tracking of man-made objects in LEO:

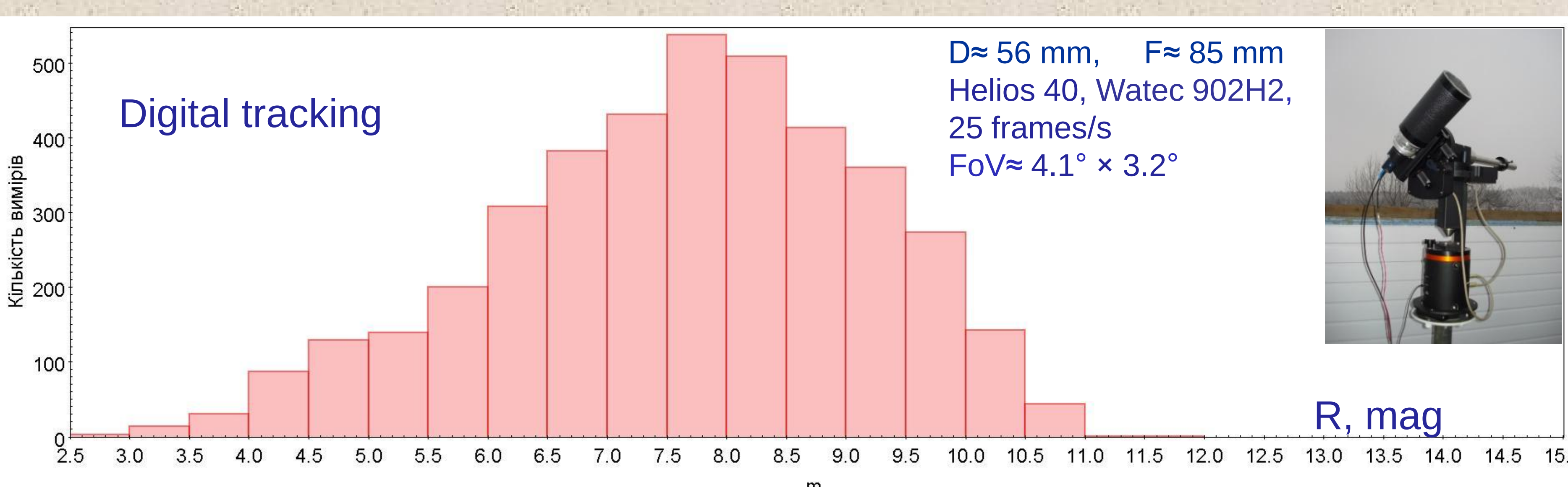
1. Ephemerides for MMO are calculated before observations by using the orbital elements from initial TLE files.
2. Telescope is pointed using the calculated ephemerides.
3. CCTV camera starts a raw video stream at a defined time moment.
4. Software shifts and sums digital frames to create images of reference stars and MMO by using the same video stream but different coordinate shifts.
5. If the same MMO is still visible, then repeat steps (1…4).
6. If the same man-made object is not visible, then repeat steps (1…4) for another object.

During a single orbit path, it is possible to repeat steps (1…4) up to five times, depending on visibility conditions of the same MMO.

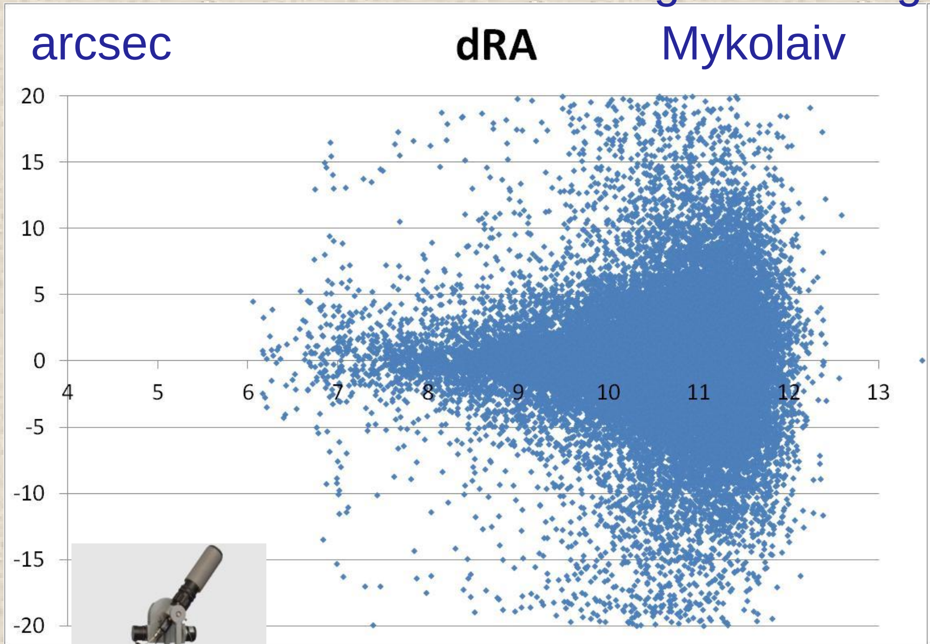
12538 images of 177 objects in LEO obtained with TV telescope in Mykolaiv in 2018

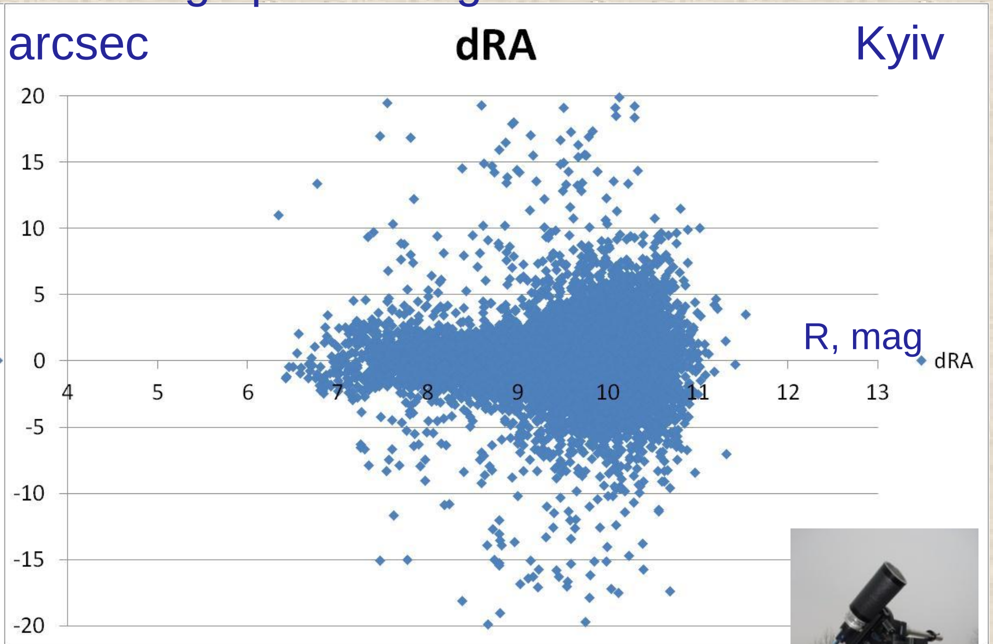


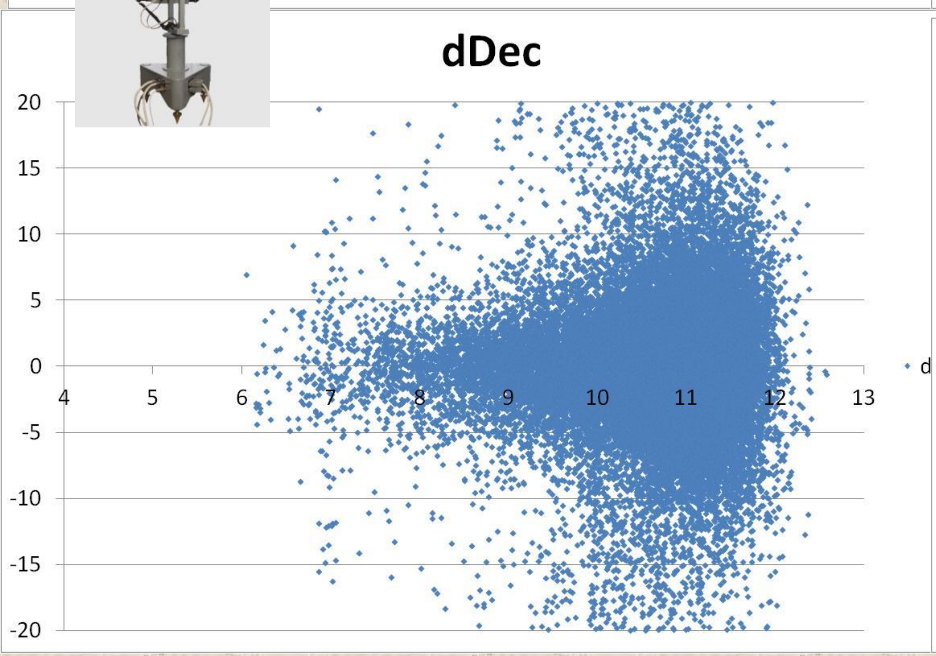
4005 images of 114 objects in LEO obtained with TV telescope in Kyiv in 2018

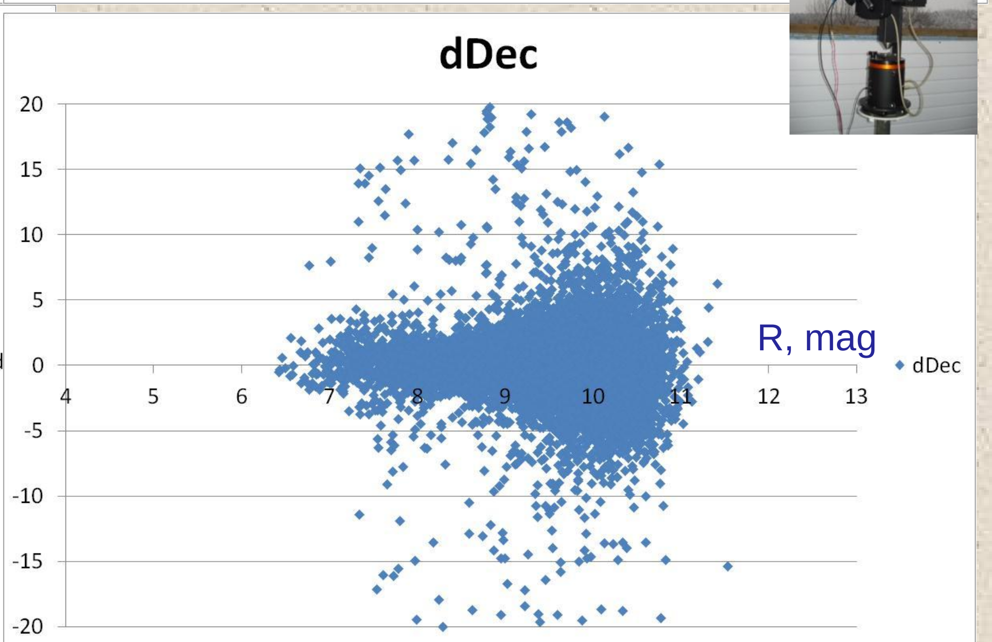


Residuals of (O-C) for positions of reference stars in RA and DEC after digital tracking and image processing



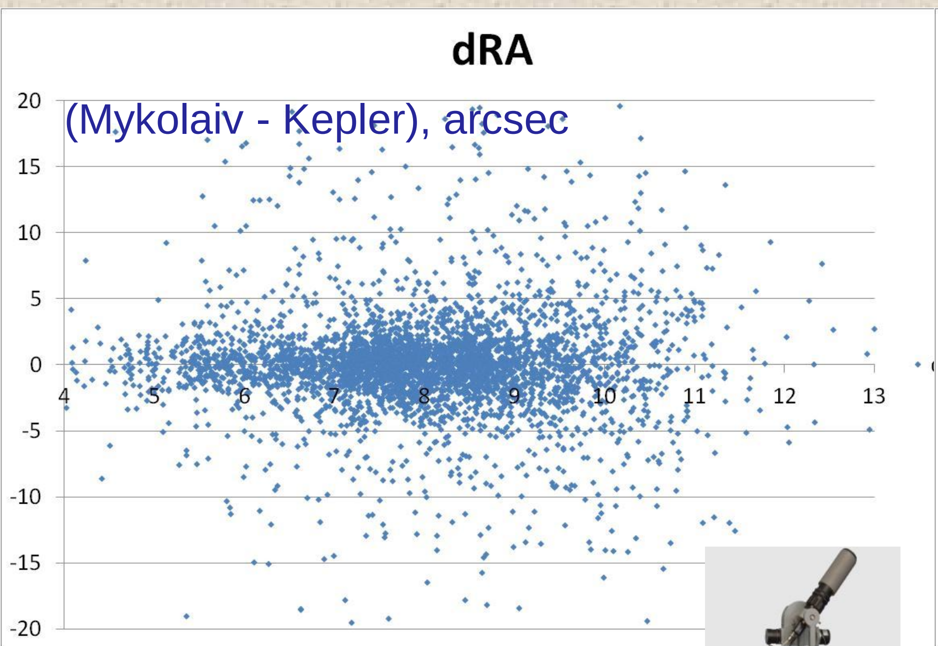


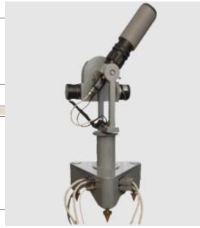


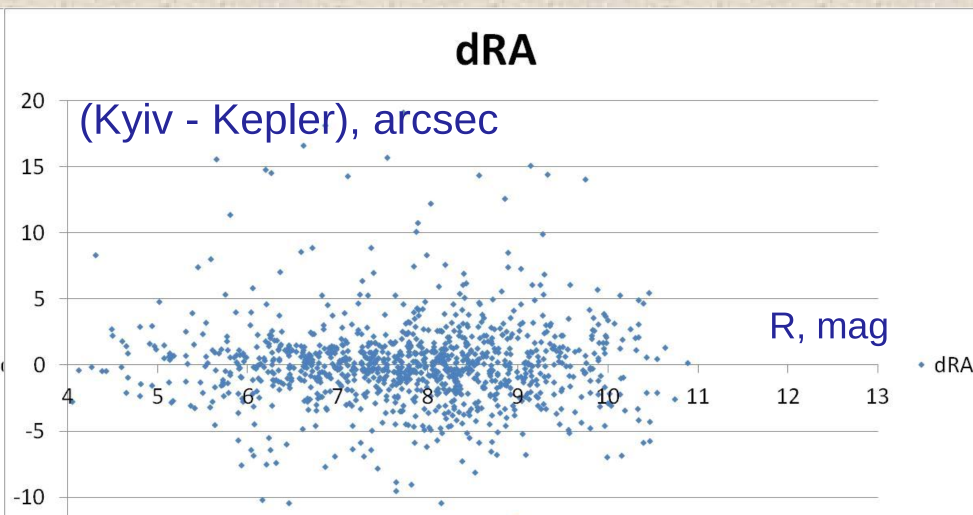


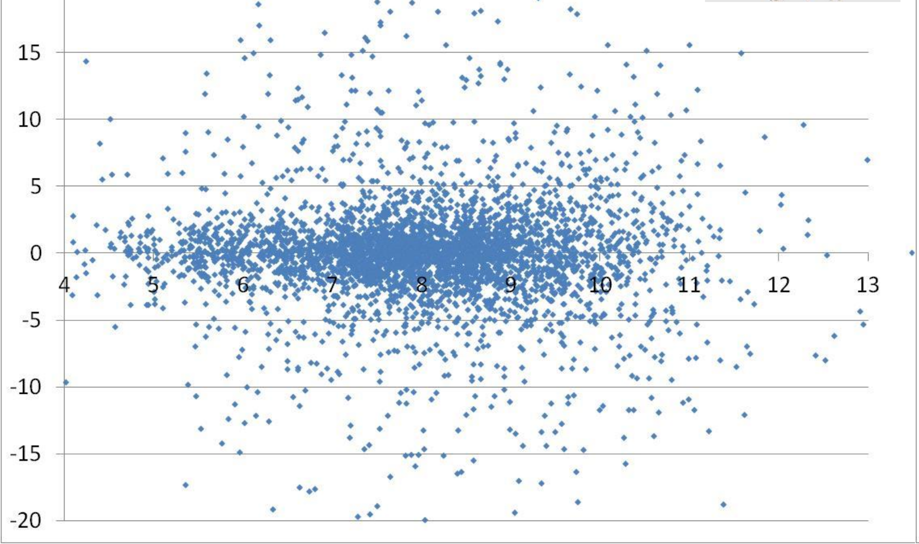
Residuals of (O-C) for 177 objects in LEO, 12538 positions in RA and DEC

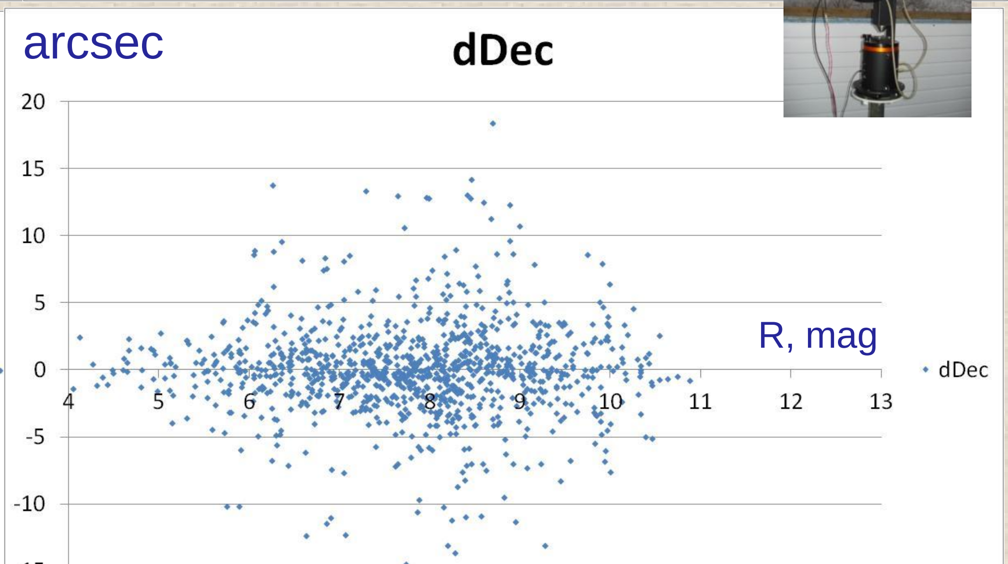
Residuals of (O-C) for 114 objects in LEO, 4005 positions in RA and DEC





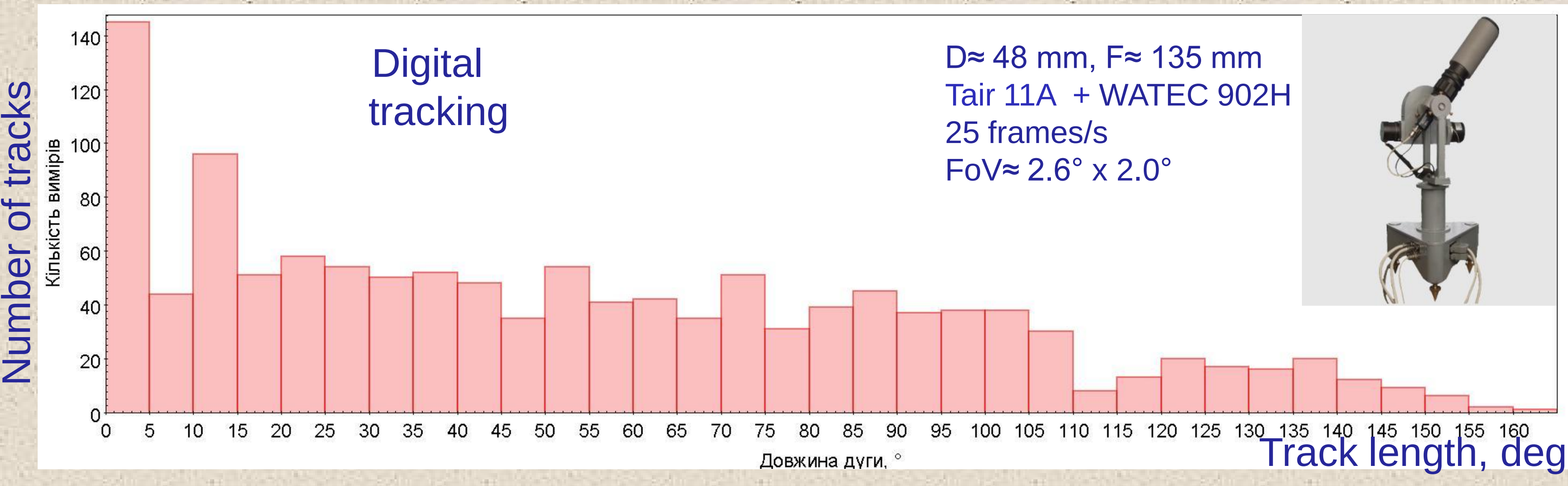




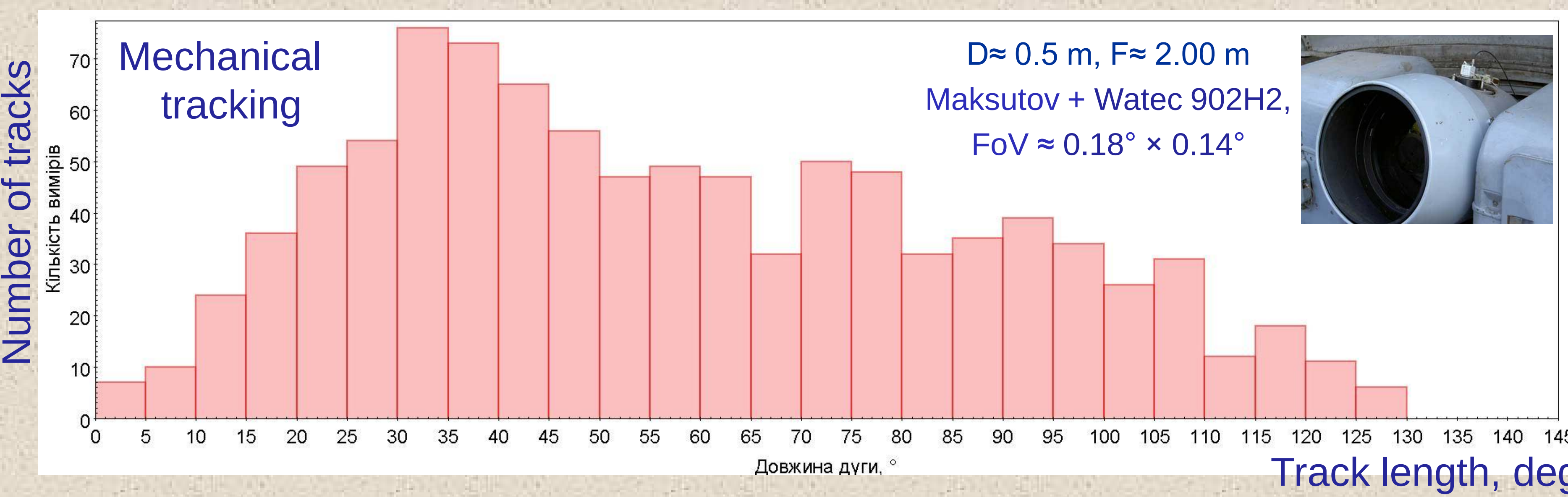


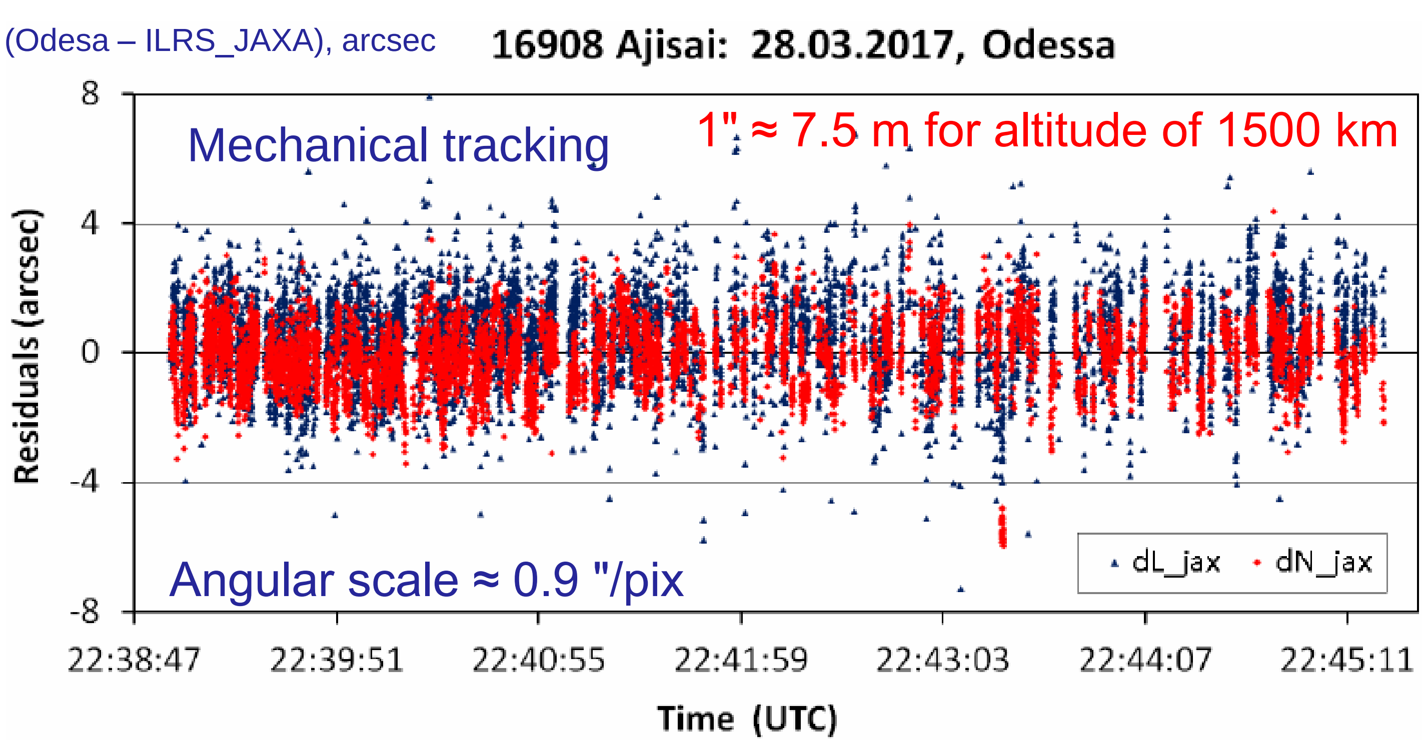
10 arcsec ≈ 50 m for altitude of 1000 km in LEO

843 images of 177 objects in LEO obtained with TV telescope in Mykolaiv in 2018



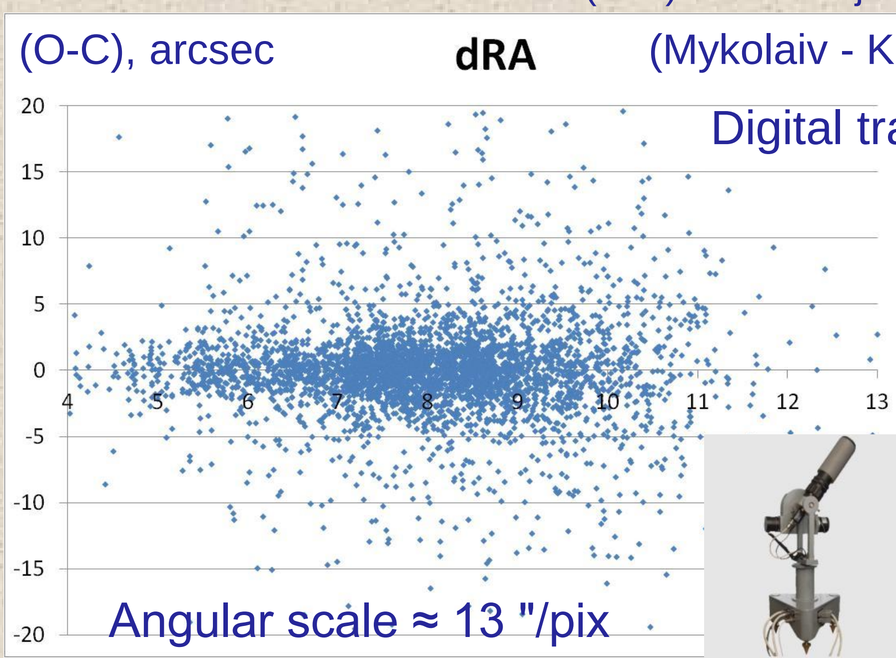
967 images of 151 objects in LEO obtained with KT-50 telescope in Odesa in 2018





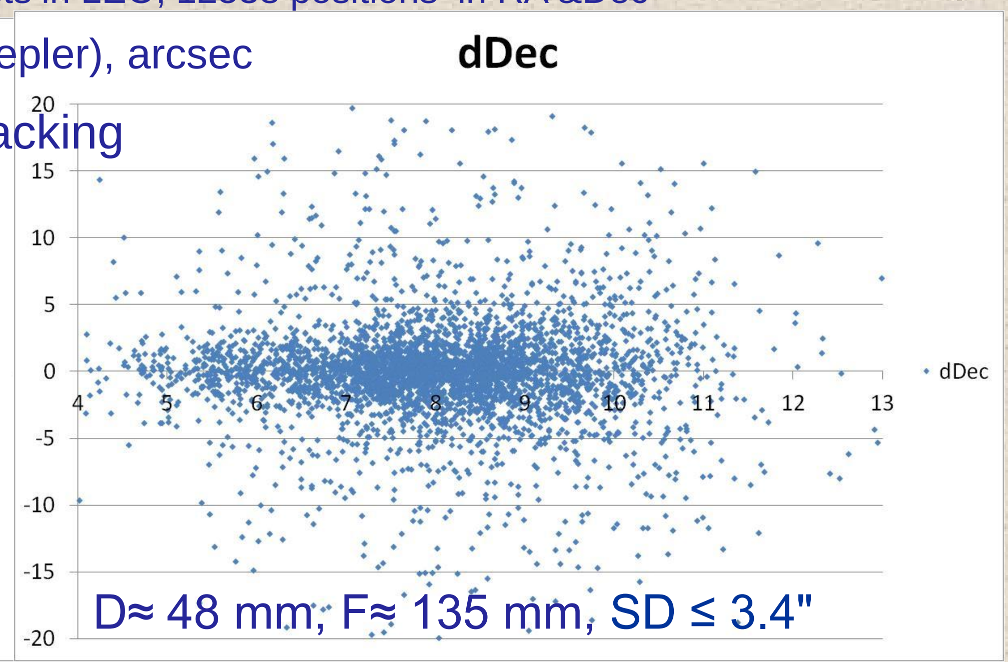
D≈ 0.5 m,
F≈ 2.00 m
SD ≤ 1.4"

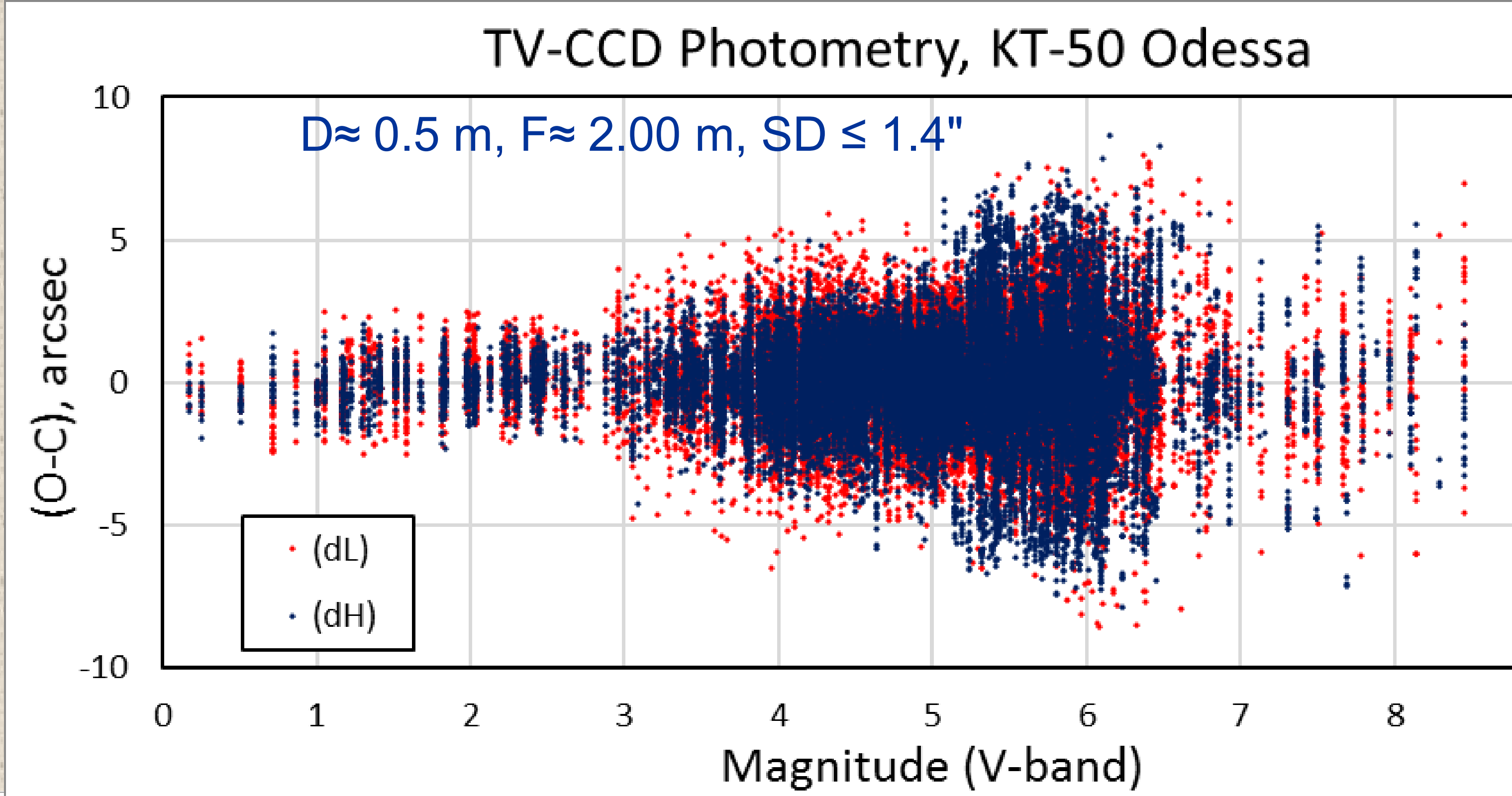
Residuals of (O-C) for 177 objects in LEO, 12538 positions in RA &Dec



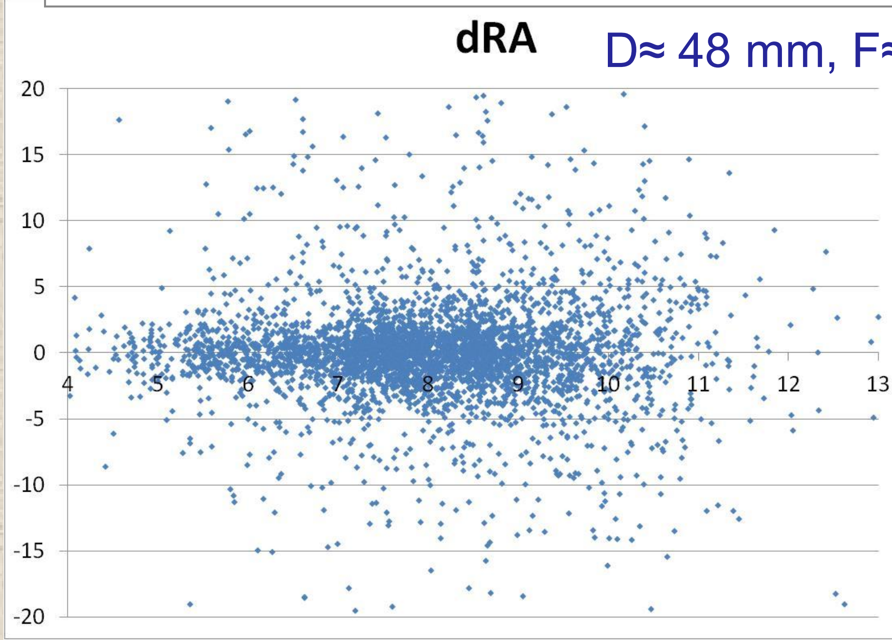
(Mykolaiv - Kepler), arcsec

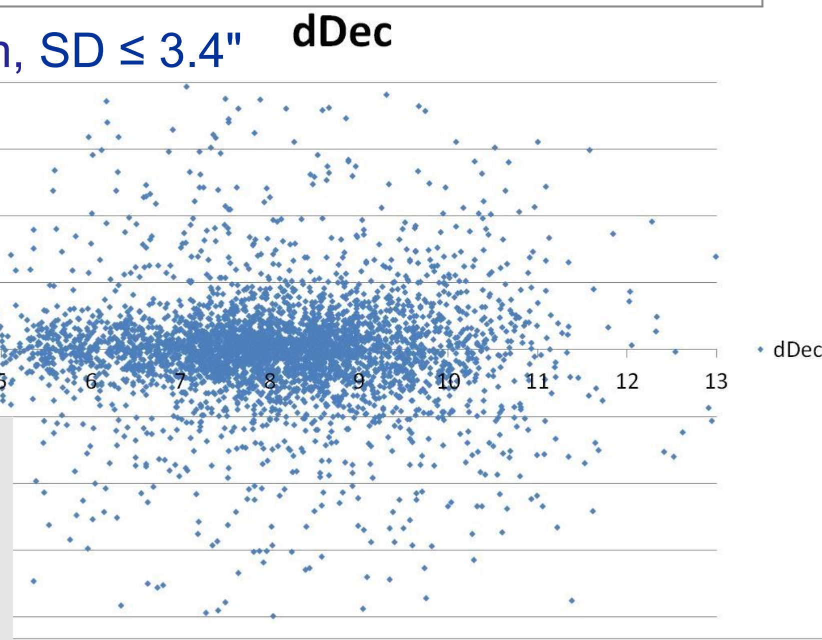
Digital tracking

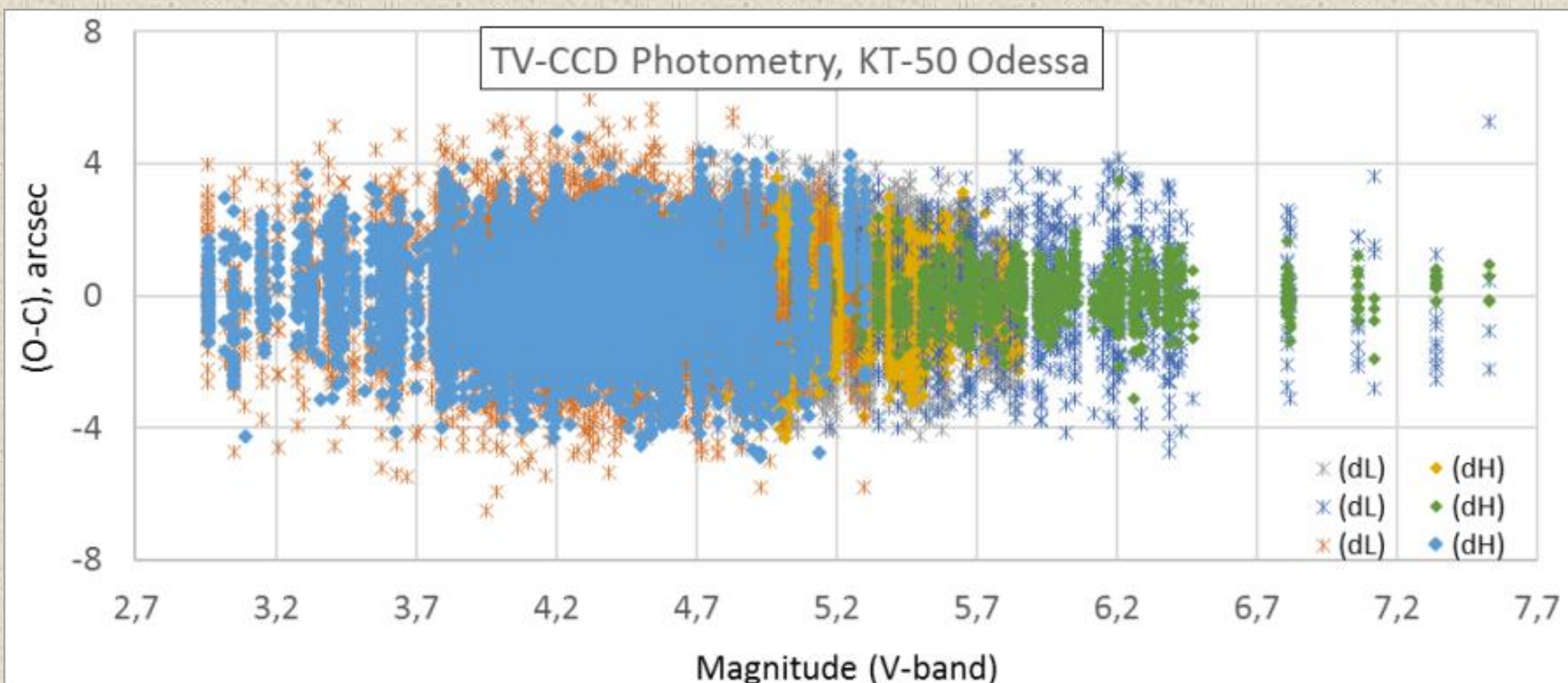


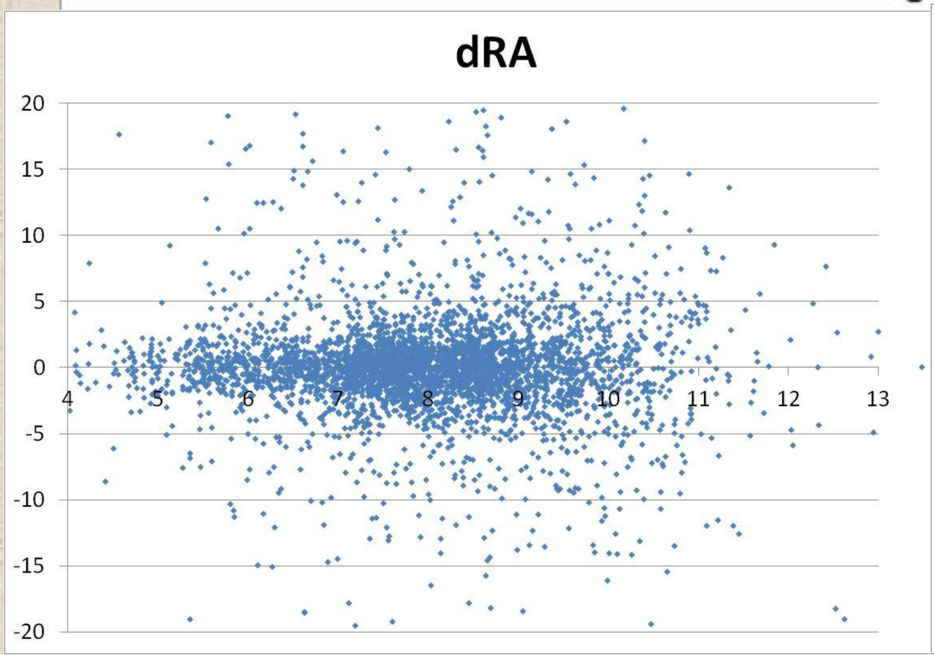


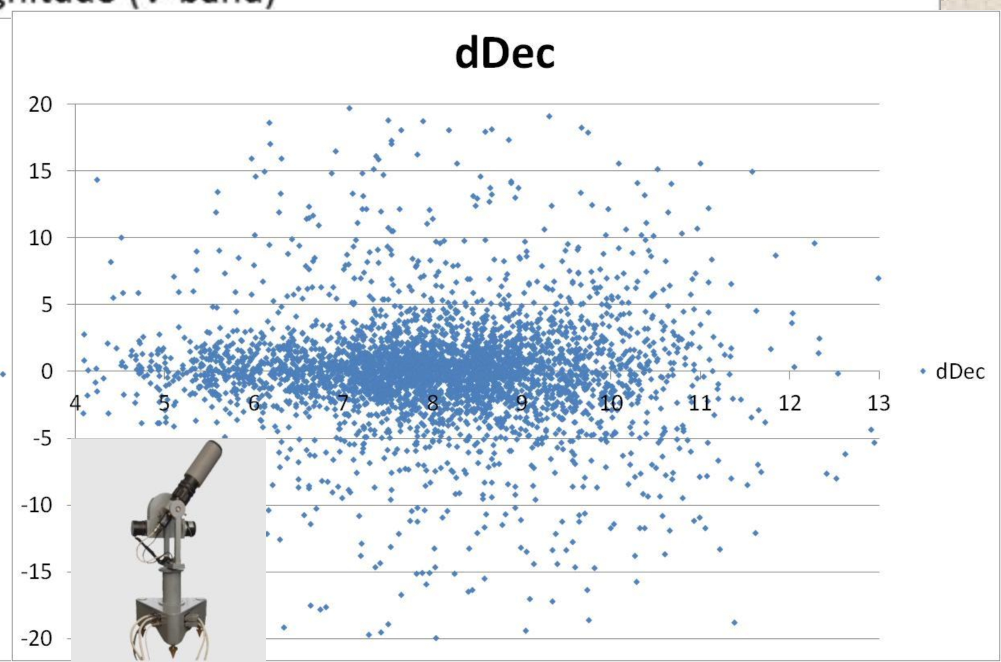
D≈ 48 mm, F≈ 135 mm, SD ≤ 3.4"






TV-CCD Photometry, KT-50 Odessa
(O-C), arcsec
8
4
0
-4
-8
2,7
3,2
3,7
4,2
4,7
5,2
5,7
6,2
6,7
7,2
7,7
Magnitude (V-band)
(dL)
(dH)
(dL)
(dH)
(dL)
(dH)


dRA
20
15
10
5
0
-5
-10
-15
-20
4
5
6
7
8
9
10
11
12
13


dDec
20
15
10
5
0
-5
-10
-15
-20
4
5
6
7
8
9
10
11
12
13
dDec

Method for digital tracking of MMO in GEO using full-frame CCD

КОСМІЧНА ГЕОДЕЗІЯ
ТА ГЕОДИНАМІКА

КІНЕМАТИКА
І ФІЗИКА
НЕБЕСНИХ
ТІЛ том 38 № 2 2022

doi: https://doi.org/10.15407/kfnt2022.02.074

УДК 523.492

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Оцінка точності оптичних спостережень геостаціонарних супутників

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УДК 521.95, 523.44, 521.61

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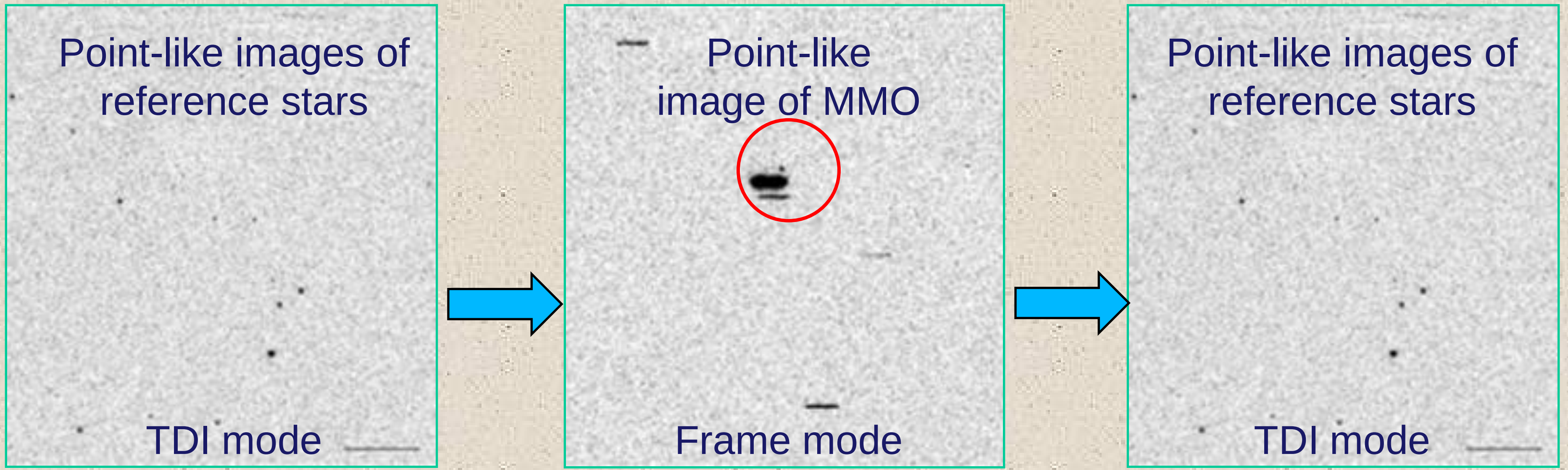
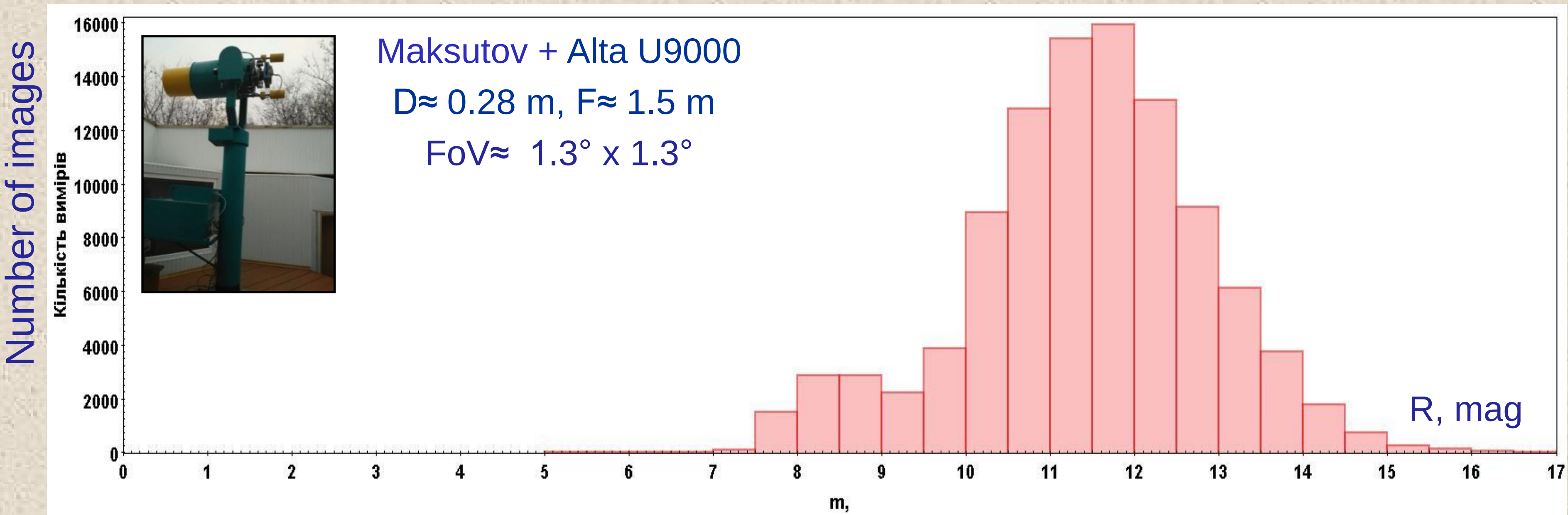
ИССЛЕДОВАНИЕ ТОЧНОСТИ АСТРОМЕТРИЧЕСКОЙ РЕДУКЦИИ ПРИ ИСПОЛЬЗОВАНИИ КОМБИНИРОВАННОГО МЕТОДА НАБЛЮДЕНИЙ НЕБЕСНЫХ ОБЪЕКТОВ



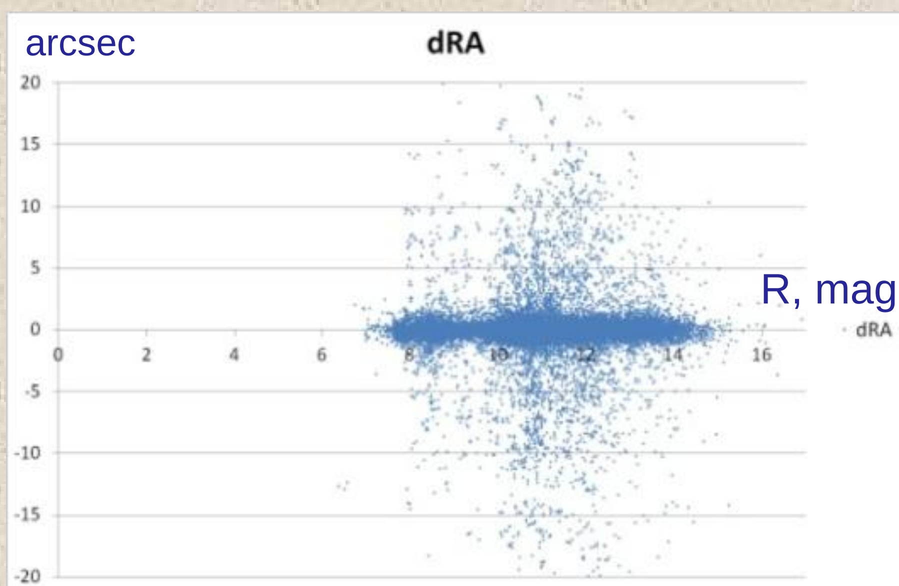
The telescope is stationary during exposure time. No mechanical tracking.
Astrometric accuracy and precision are not affected by telescope tracking error.

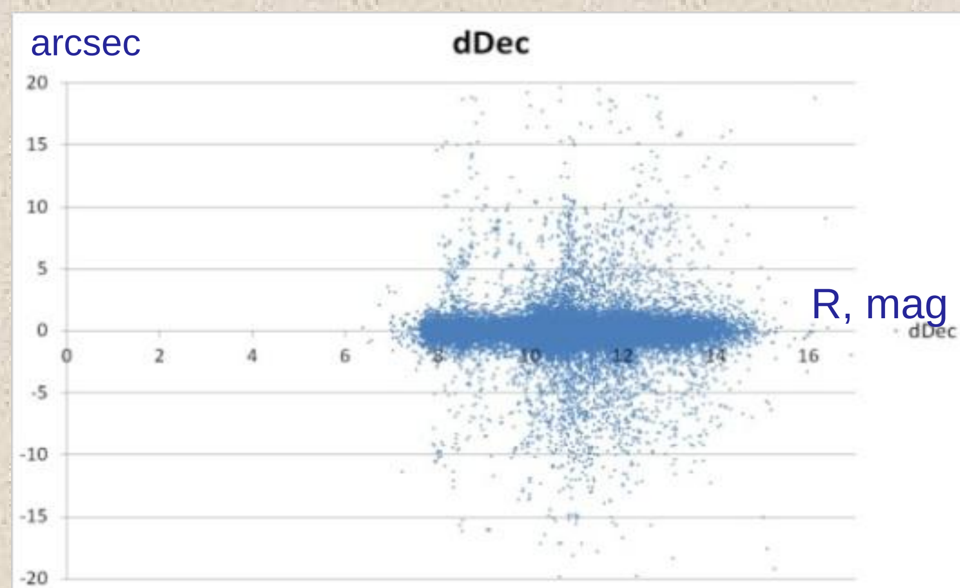
Research Agreement between Shanghai and Mykolaiv Astronomical Observatories in 2021

101683 images of 180 objects in GEO obtained with Fast Robotic Telescope (FRT)



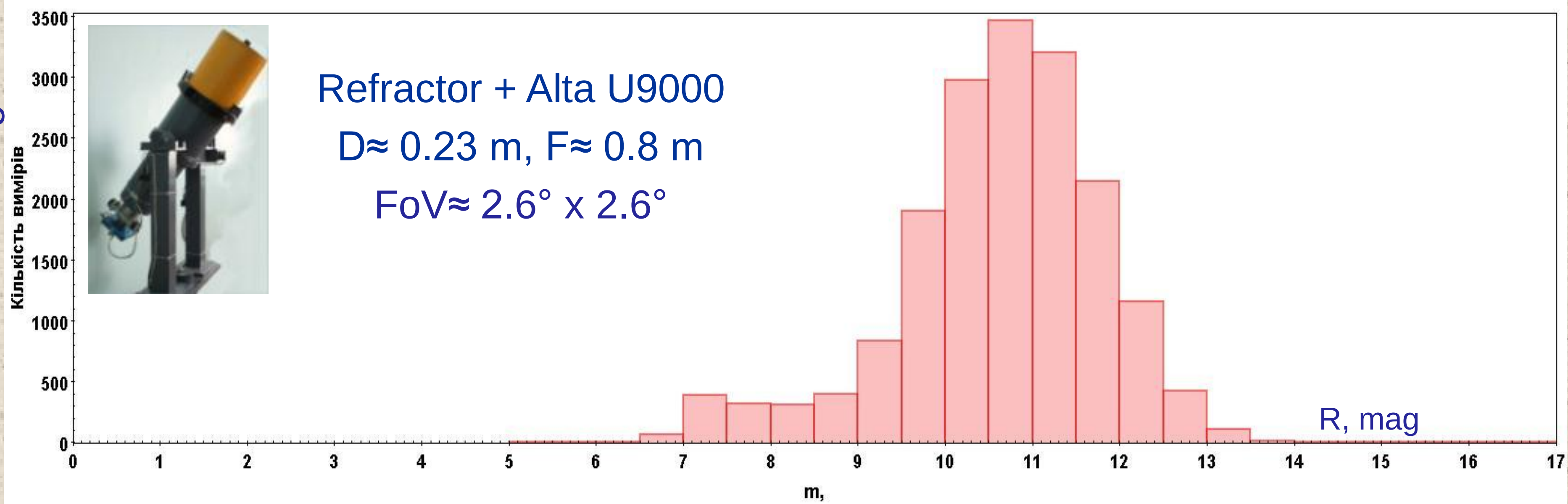
Residuals of (O-C) for 101683 positions of 180 objects in GEO obtained with FRT



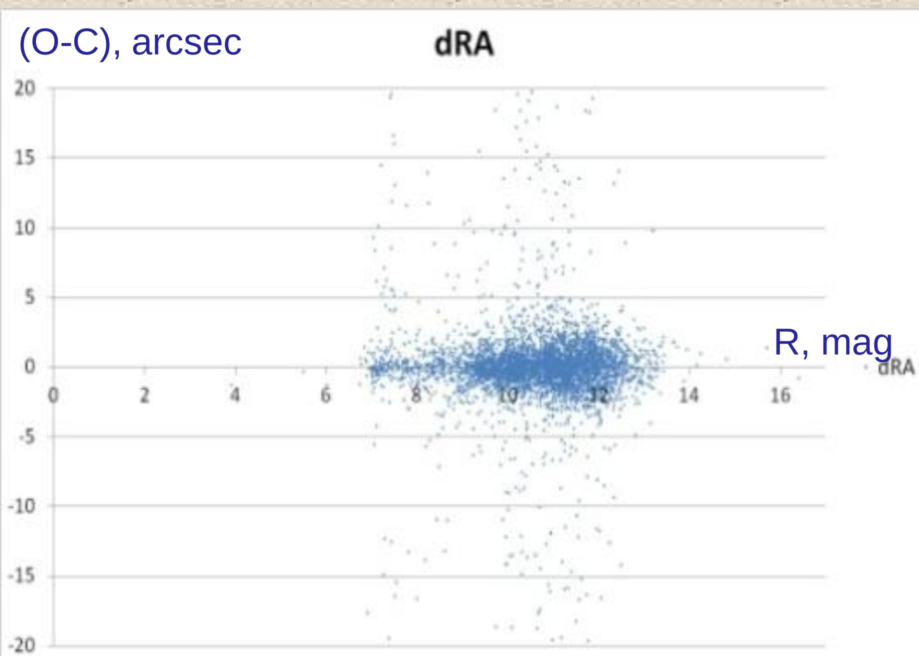


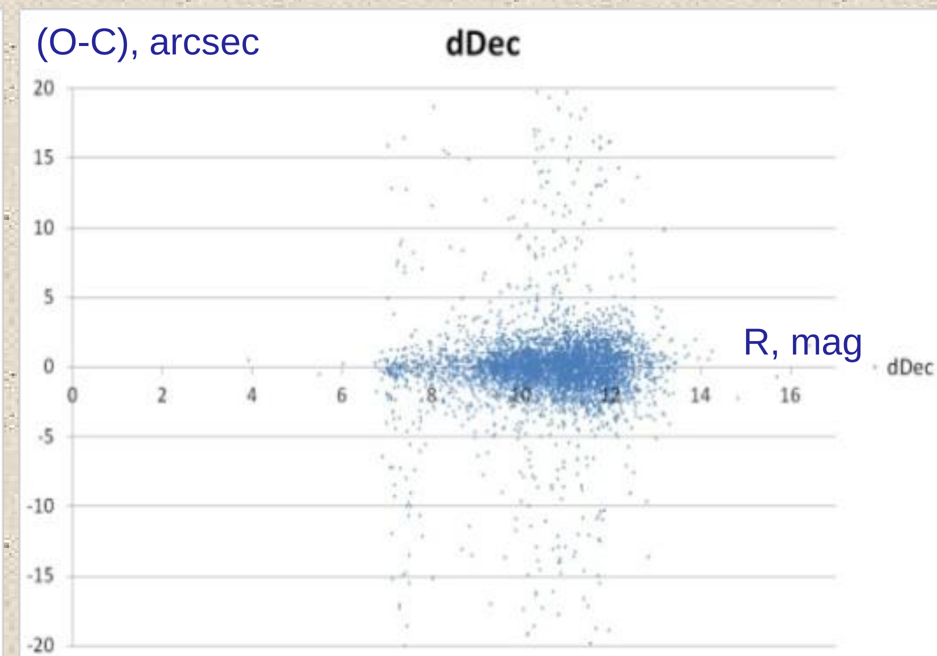
17747 images of 36 objects in GEO obtained with MEZON in Mykolaiv in 2021

Number of images

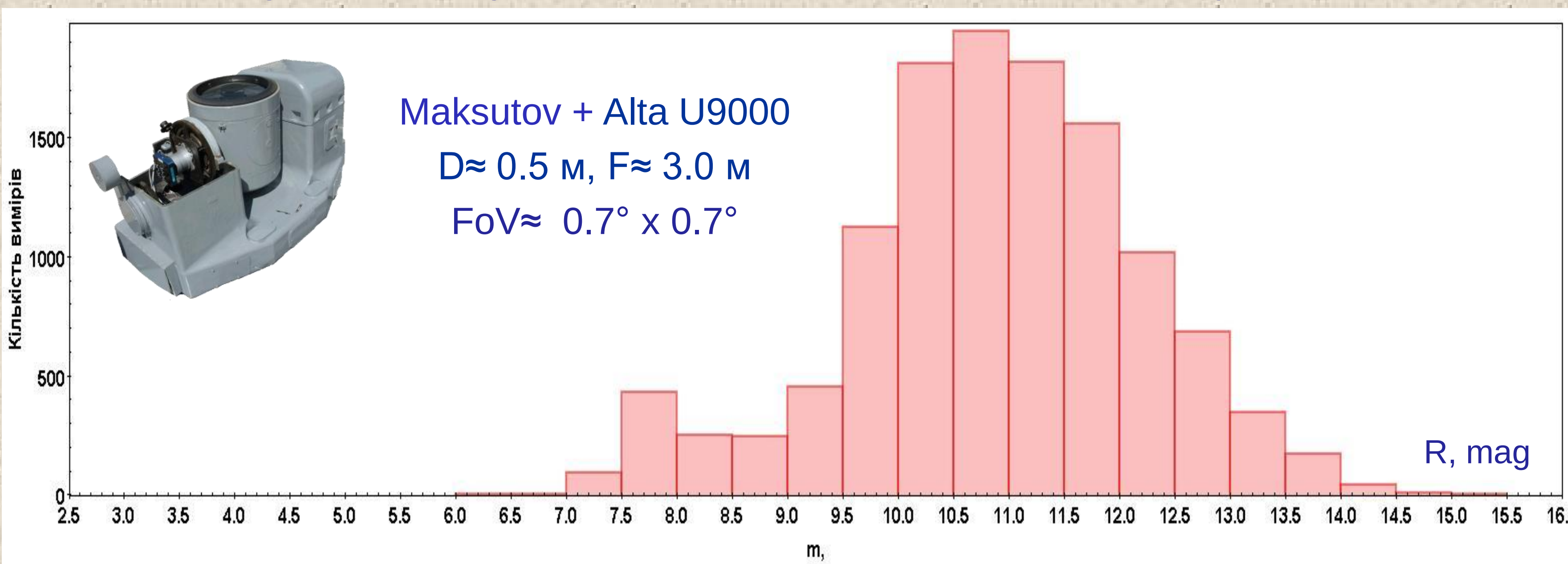


Residuals of (O-C) for 17747 positions of 36 objects in GEO obtained with MEZON

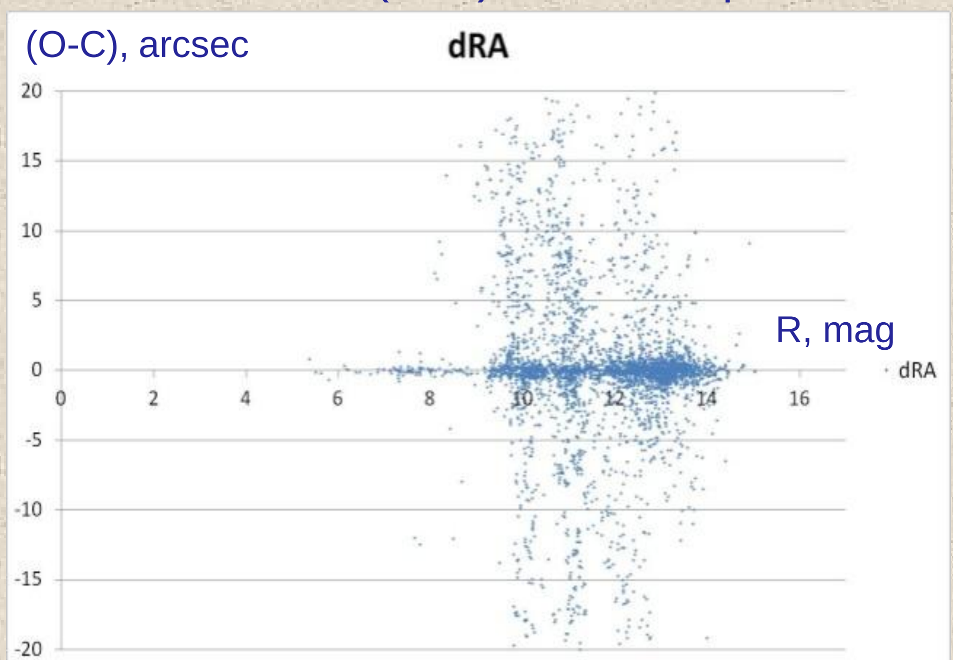


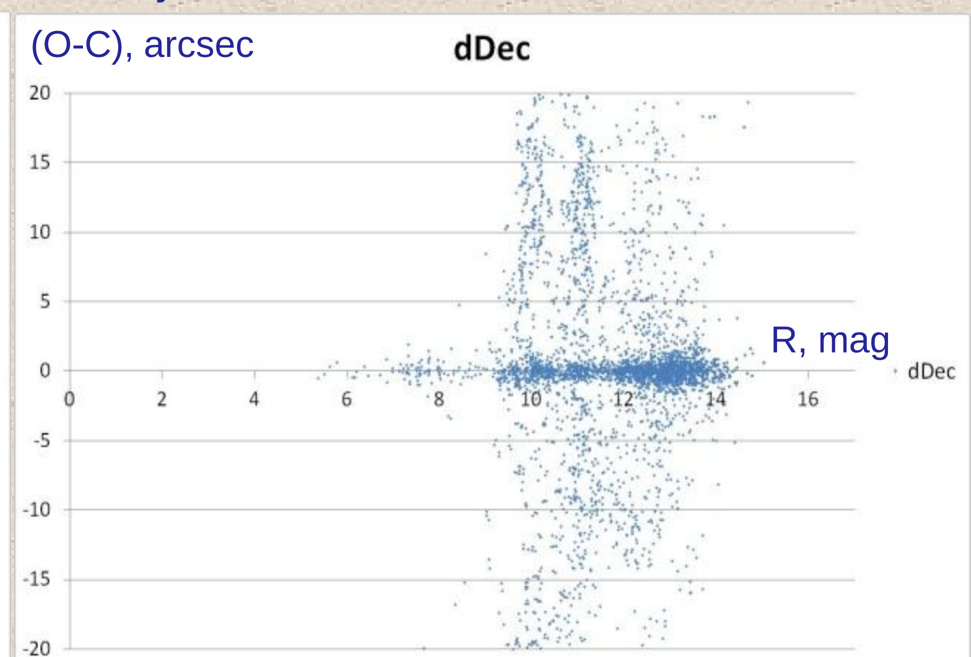


10243 images of 25 objects in GEO obtained with KT-50 in Mykolaiv in 2021

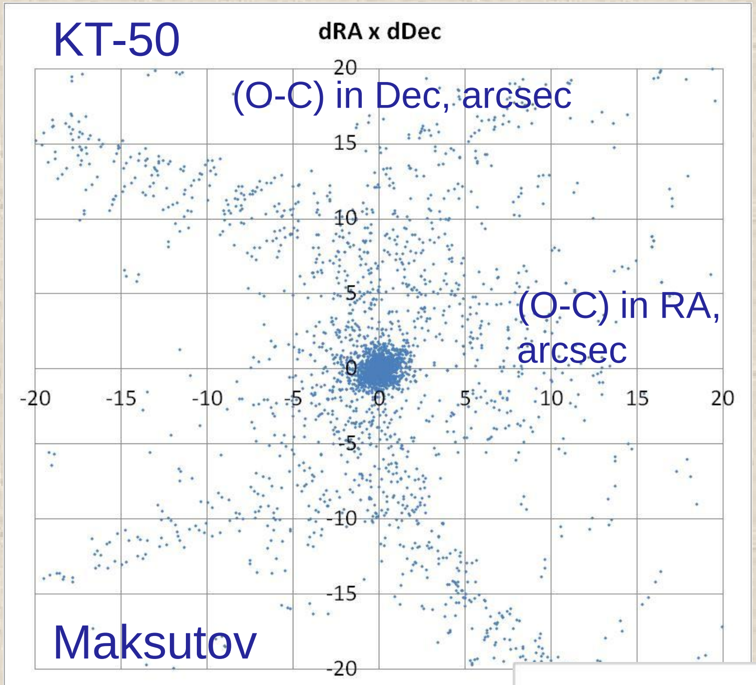


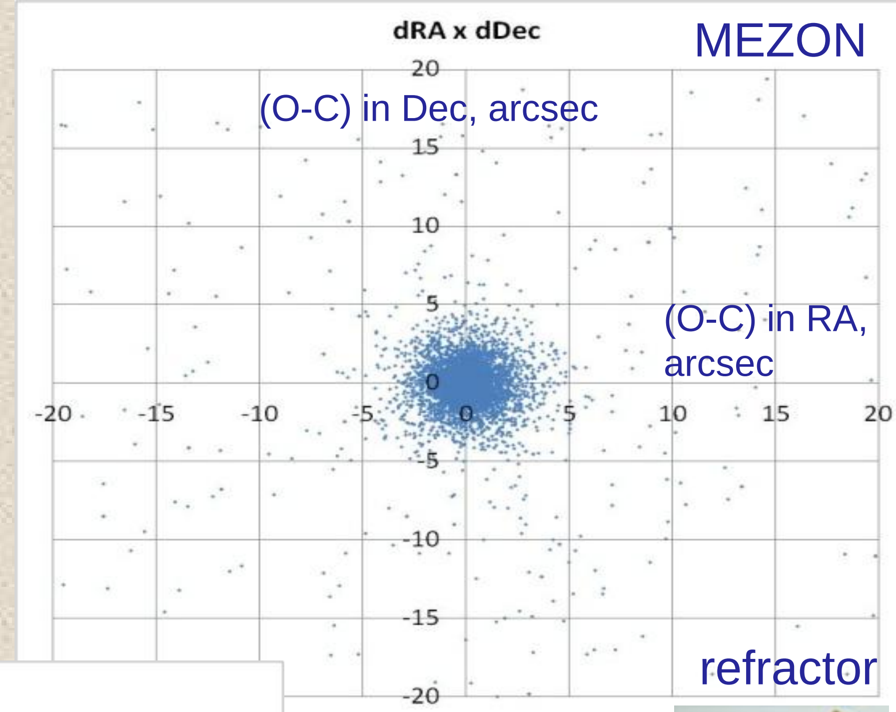
Residuals of (O-C) for 10243 positions of 25 objects in GEO obtained with KT-50

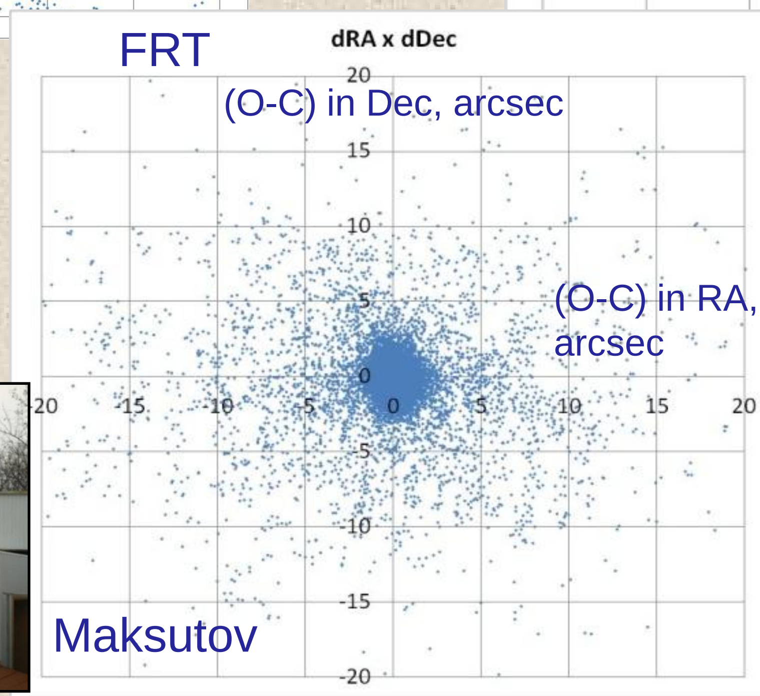




Residuals of (O-C) in RA & Dec for MMO in GEO

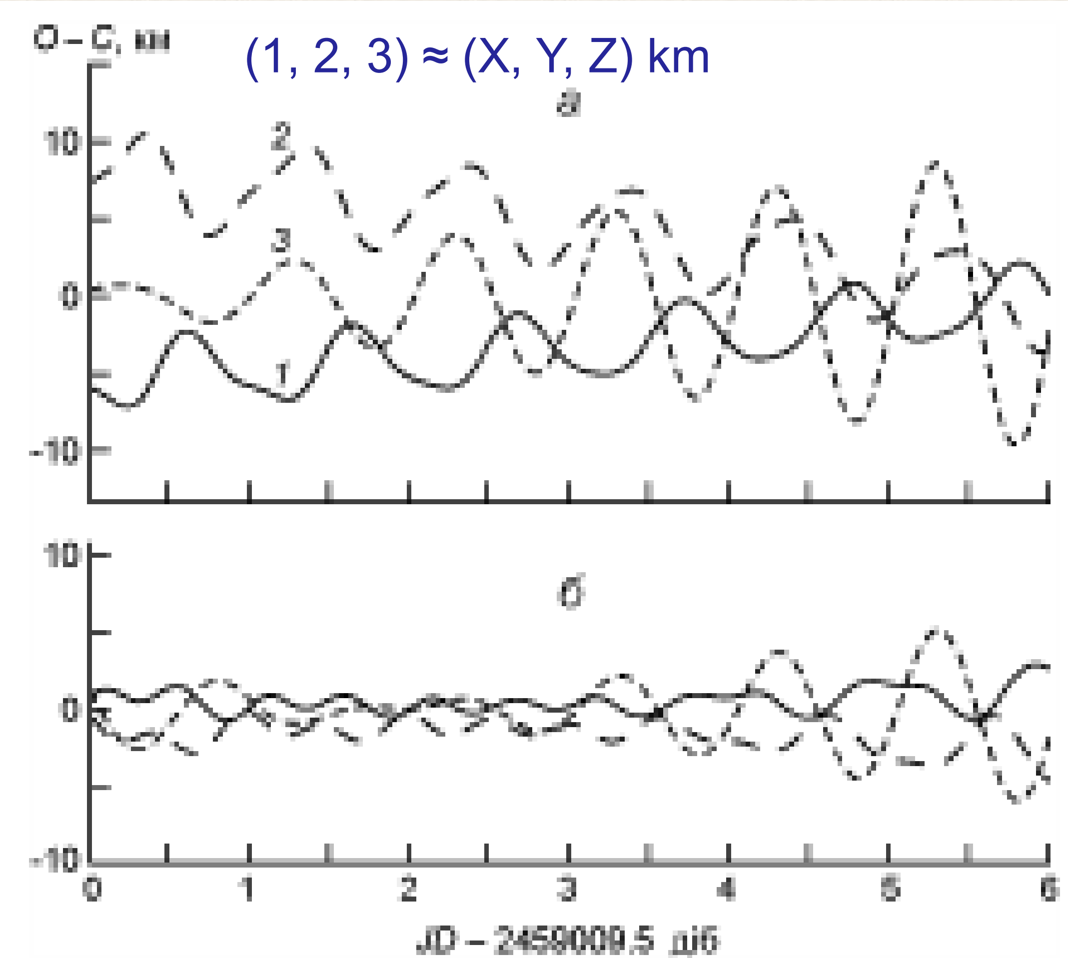






10 arcsec ≈ 1.8 km in GEO

Comparison of 6-day prediction for orbital positions of IRNSS-1F (41384) in GEO



NASA data archive (CDDIS)

UMOS catalogue

JD ≈ 2459009.5 (2020.06.08 12:00 UTC)

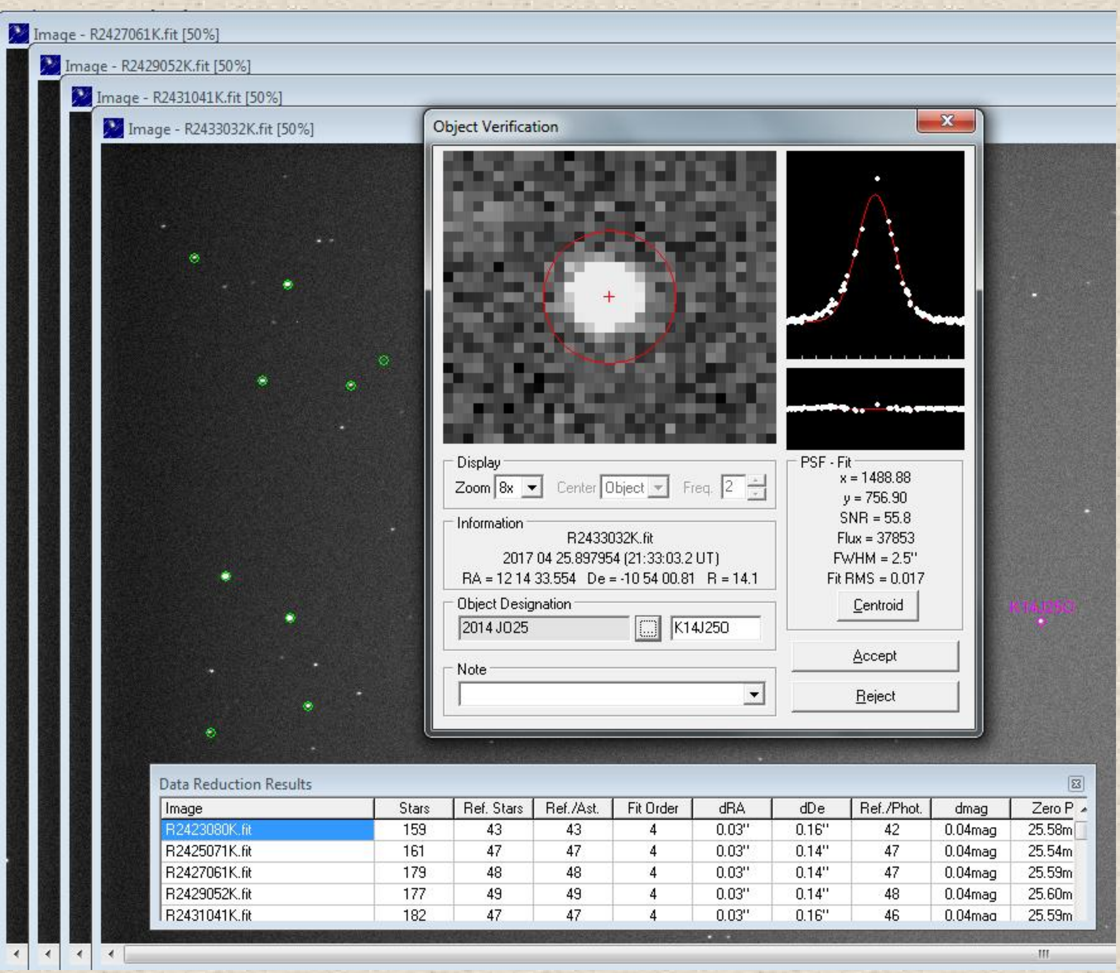
IRNSS-1F is equipped with laser retro-reflectors for range finding measurements.
Laser ranging stations require satellite orbit information in order to point their instrument to the correct location and acquire returns from the retro reflectors. Mission operations groups generate these predicted future orbits from calculated ranging data orbits. Predicted orbit files typically contain orbit information for multiple days.
The Consolidated Prediction Format (CPF) is now used operationally for satellite predictions within the ILRS.

C. Noll, The Crustal Dynamics Data Information System (CDDIS): A resource to support scientific analysis using space geodesy, Advances in Space Research,Volume 45, Issue 12, 15 June 2010, Pages 1421-1440, ISSN 0273-1177,
DOI: 10.1016/j.asr.2010.01.018

Software for image processing and calculations of orbital elements

Algorithm of Image Processing and Astrometric Reductions

Astrometrica sofware http://www.astrometrica.at/



- Calculations of (x, y) coordinates for reference stars by using symmetric Gaussian profile as PSF function.
- Cross-identification of stars using, for example UCAC-4, as reference astrometric catalogue.
- Calculations of equatorial coordinates and stellar magnitudes of MMO by using obtained reference stars.

Software for orbital elements

KeplerOrbita4
2006, Mykolaiv-Odesa, developed by Alexander Bazey
Determination of Kepler orbital elements (a, e, M, ω, Ω, i)

Software for orbit calculations
2014, Mykolaiv-Odesa, developed by Igor Kara
Determination of orbital elements in TLE and CPF formats

Library of space utilities
2017, Mykolaiv-Kharkiv, developed by Valery Yamnitsky
Correction of orbital elements in TLE format

Calculation of orbital elements by using single orbit data.

Algorithm:

1. Correction of satellite positions by using the JPL Planetary and Lunar Ephemeris, DE405/LE405.

2. Calculation of initial orbital elements and state vector of satellites by using Laplace's method.

3. Correction of orbital elements by using analytical model of satellites motion (two-body problem). The model takes into consideration the second zonal harmonic of the Earth and lunar-solar perturbations.

4. Rejection of satellite positions with high random errors by using three-sigma rule.

5. Final corrections by using a numerical model of motion, calculation of osculating orbital elements and state vectors for the mean time of observation.

Calculation of orbital elements by using several orbits obtained with single telescope

Algorithm:

1. Selection of the longest reference orbit.

2. Calculation of orbital elements using the reference orbit.

3. Comparison of orbital elements such as inclination, eccentricity and period of rotation with the SatCat maintained by the US DoD.

4. Inclusion into calculation of the closest orbit.

5. Improvement of state vector by using a method of differential corrections based on a numerical model.

6. Inclusion into calculation of the next orbit.

7. Calculation of orbital elements and state vectors for the mean time of observation.

Online catalogue of orbital elements

http://mao.uran.ua/umos_e/index.php?slab=catalogue

Ukraine Network of Optical Stations

for near-Earth space research

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Catalogue of Satellites

Year: 2022

Show 10 entries Search:

NORAD ID	# of orbits	Table of orbits	Period (min.)	Inclination (deg)	Perigee (km)	Apogee (km)	Int ID	Source	Name	TLE file	CPF file(s)	Current position
23223	26	open	1436.15	12.47	35646.38	35928.93	1994-054A	US	USA 105	open	open	☐
23855	26	open	1436.17	8.63	34264.48	37311.48	1996-026A	US	USA 118	open	open	☐
25336	4	open	1436.11	7.97	35636.60	35936.90	1998-029A	US	USA 139	open	open	☐
26716	2	open	1433.16	11.60	35645.96	35812.46	2001-009B	US	TITAN 4 CENTAUR R/B	open	open	☐
27937	26	open	1436.14	12.64	35626.51	35948.36	2003-041A	US	USA 171	open	open	☐
28352	1	open	101.96	70.88	838.12	864.35	2004-021A	CIS	COSMOS 2406	open	open	☐
28358	13	open	1436.19	0.11	35785.63	35791.05	2004-022A	ITSO	INTELSAT 1002	open	open	☐
28634	3	open	1435.47	11.67	35703.20	35845.35	2005-010F	CIS	SL-12 R/B(2)	open	open	☐
33105	4	open	111.77	65.93	1303.76	1312.10	2008-032A	FR	JASON 2	open	open	☐
33490	11	open	1436.17	6.78	35737.80	35838.35	2009-001A	US	USA 202	open	open	☐

Showing 1 to 10 of 34 entries First Previous 1 2 3 4 Next Last

Select optical station: Alchevs **longitude** **latitude**

Select all sa ... positions (not more than 10)

Select another year of observations:
- Year: 2011, objects: 7, orbits: 15
- Year: 2012, objects: 105, orbits: 271
- Year: 2013, objects: 120, orbits: 379
- Year: 2014, objects: 127, orbits: 808
- Year: 2015, objects: 110, orbits: 351
- Year: 2016, objects: 49, orbits: 87
- Year: 2017, objects: 137, orbits: 750
- Year: 2018, objects: 123, orbits: 403
- Year: 2019, objects: 81, orbits: 527
- Year: 2020, objects: 198, orbits: 890
- Year: 2021, objects: 176, orbits: 1134
- Year: 2022, objects: 34, orbits: 206

Select another year of observations: Submit

Statistics by years

Year	Number of objects	Number of sets	Number of positions	Time of observation	Number of nights
2011	79	271	1558	784	10
2012	325	1859	63351	49049	95
2013	318	2417	48380	52130	108
2014	260	3633	52703	19437	118
2015	315	2381	37600	12605	114
2016	119	606	10540	1341	28
2017	416	3234	63034	3819	123
2018	442	2650	61563	3589	154
2019	374	3102	63102	5924	130
2020	725	5821	117157	142721	160
2021	435	2464	54150	11984	93
2022	34	206			

Conclusions

✓ **Twelve telescopes of five observatories have carried out regular observations since 2012.**

✓ **We developed and implemented two patented methods of observations.**

✓ **We developed new software to calculate Kepler's initial and disturbed orbital elements.**

✓ **We carry out joint observations to solve scientific and applied problems.**

✓ **We developed telescopes, observational methods, software that allow us to obtain a long-term prediction of positions, namely:**

- **for objects in orbits less than 1000 km - up to 3 days,**
- **for objects in mean and geostationary orbits - up to 10 days.**

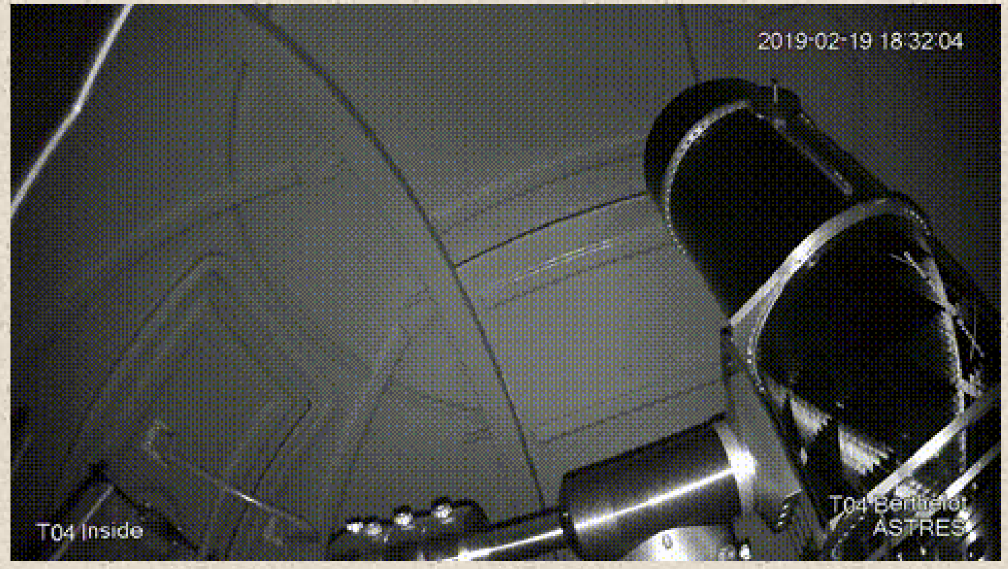
Berthelot Observatory receives MPC observatory code

Berthelot Observatory is a remote observing station of the Astronomical Institute. Built on General Berthelot village, Hunedoara, on a protected area belonging to the Romanian Academy, the observatory is operated in remote mode from Bucharest. Following the *first light* in mid-November 2018, the observatory is currently involved in near-Earth objects photometric surveys and tracking and surveillance activities in the framework of EU-SST programme of the European Commission. The telescope is a RC 14.5'' F/7 Optical Guidance System on a fast, 8°/s, equatorial mount able to track objects on medium Earth orbits. The field of view, using an SBIG STL11000M CCD camera, is of 44'x30'.

Berthelot Observatory successfully concluded the first common European exercise of space surveillance and tracking taking place from 15 to 24 July 2019. Astrometry data for the four assigned targets was provided daily in TDM format.

On December 6th, Berthelot Observatory received the code L54 from the International Astronomical Union's Minor Planet Center (MPC).

Published on: Dec 06, 2019



http://www.astro.ro:8080/news/Berthelot


"People who know what they're talking about don't need PowerPoint."
— Steve Jobs
From Walter Isaacson's book Steve Jobs
THANK YOU FOR YOUR ATTENTION.
HAVE A GREAT DAY!
"The only reason to give a speech is to change the world."
— John F. Kennedy