Inter-Agency Space Debris Coordination Committee

State Space Agency of Ukraine

TEST OBSERVATIONS OF THE COSMOS-1408 DEBRIS BY UKRAINIAN OPTICAL SENSORS IN FEBRUARY 2022

IADC41

12-15/06/2023

Dr. O. Kozhukhov

BACKGROUND

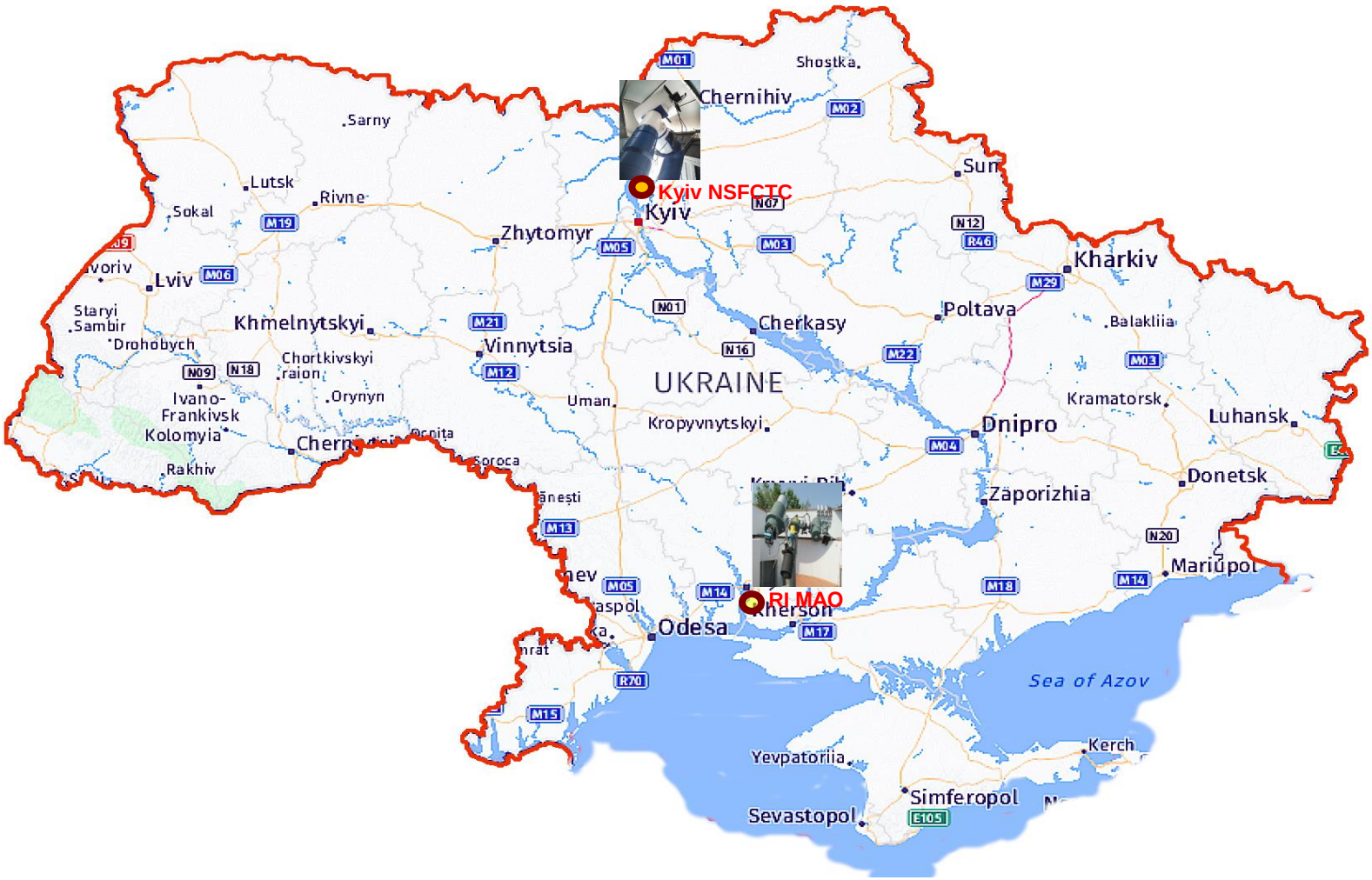
1. Fragmentation of the COSMOS-1408 satellite as a result of a Russian anti-satellite missile hit on November 15, 2021.

2. IT39.2, leader - Fabrizio Piergentili.

OBJECTIVES

Evaluation of the capabilities of optical sensors and observational techniques for observing relatively small fragments in LEO.

SENSORS



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OEOS-2

	OEOS-2
Aperture, cm	30
Focal length, m	0.3
Camera (Sensor)	QHY-174M GPS (Sony 1/1.2" CMOS IMX174LLJ / IMX174LQJ)
Sensor size, pix	1936x1216
Pixel size, μm	5.86
Scale without bining ("/pix)	4.01
FoV (deg^2)	2.89 (130'x80')
Mount	Modified German with direct drive
Max. slew rate, deg./s	Up to 10
Mechnical tracking	Yes

STATISTICS AND ORBITAL PARAMETERS

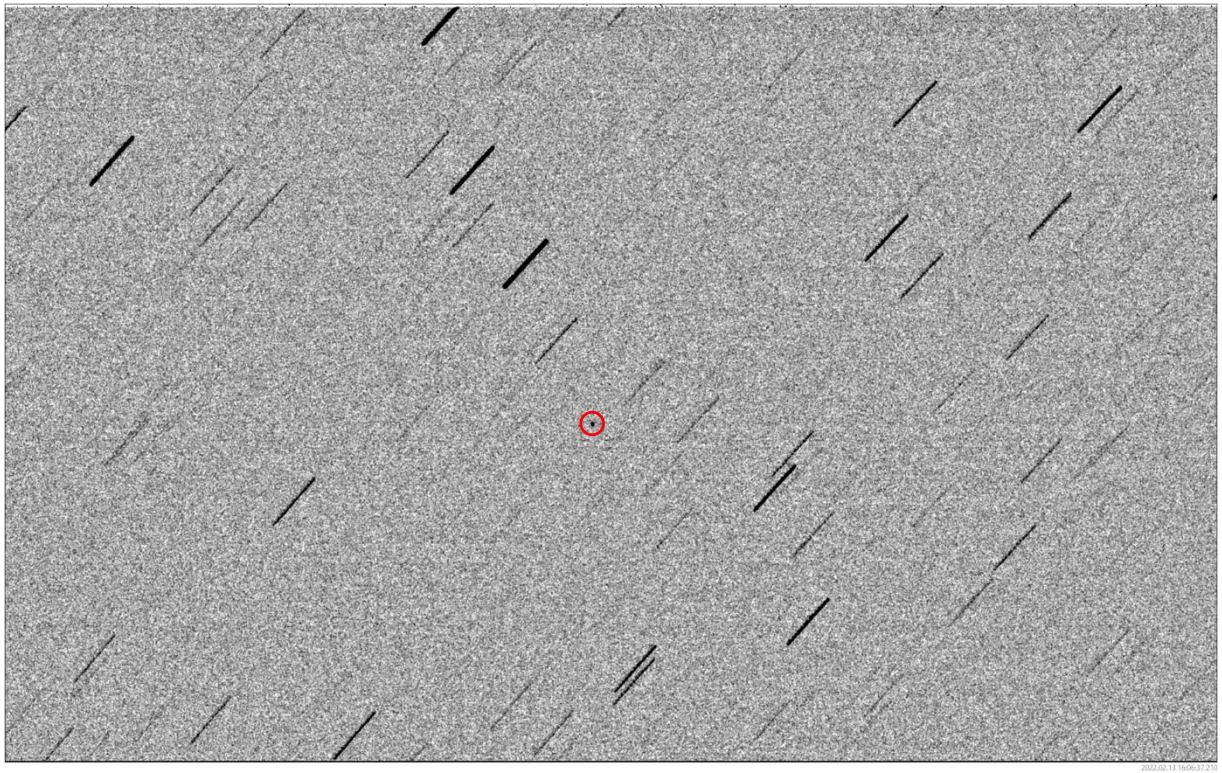
The main statistics of the observations for OEOS-2

USSPACECOM ID	COSPAR ID	Number of observations	USSPACECOM RCS
49528	1982-092-R	133	SMALL
49540	1982-092-AD	88	MEDIUM
49582	1982-092-BX	137	SMALL
49634	1982-092-EB	115	SMALL
49635	1982-092-EC	120	SMALL
49662	1982-092-EH	100	MEDIUM

Main orbital parameters of objects for an epoch close to the observation epoch

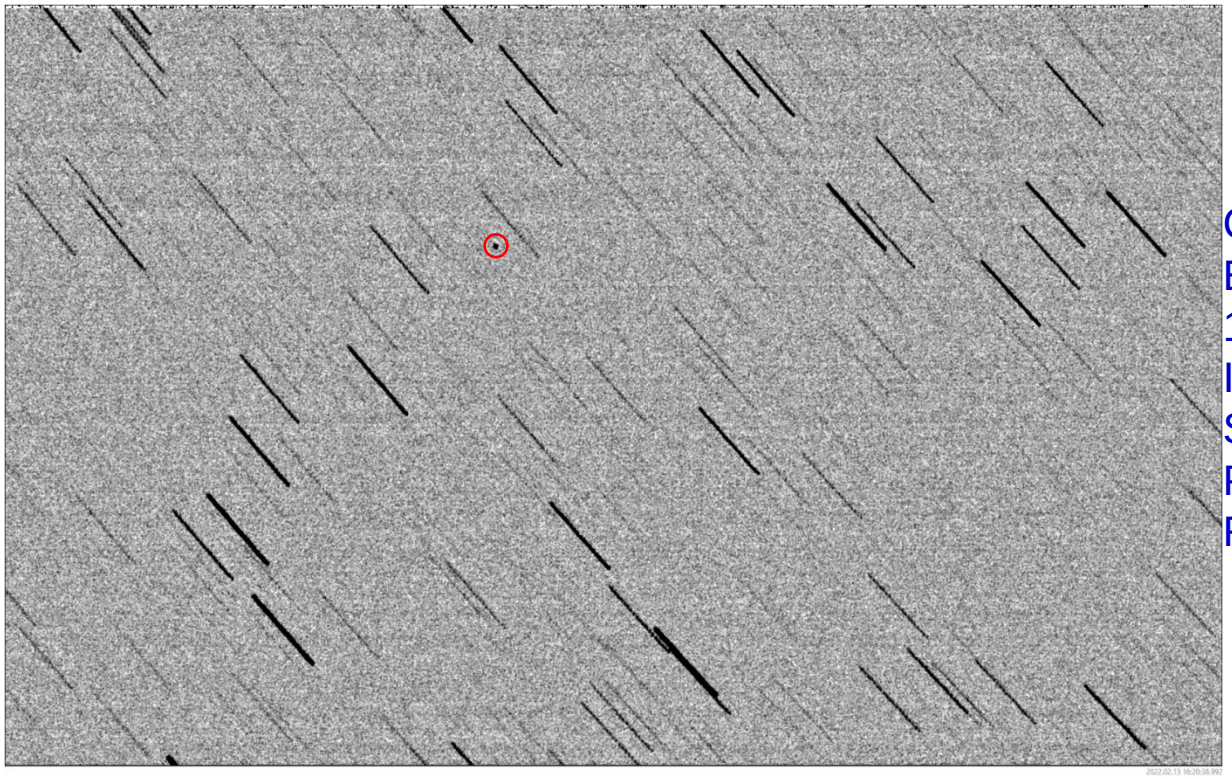
USSPACECOM ID	49528	49540	49582	49634	49635	49662
Epoch (UTC)	2022-02-12 11:34:18	2022-02-12 17:25:03	2022-02-12 11:04:00	2022-02-12 17:47:43	2022-02-12 10:51:29	2022-02-12 17:47:11
Inclination	82.978°	83.107°	82.940°	83.410°	82.938°	83.430°
Semi-major axis, km	7 122	6 999	6 976	6 901	7113	6875
Apogee, km	1 075	798	744	586	1011	540
Perigee, km	413	444	451	460	458	454

49528



COSPAR designator: 1982-092-R
Epoch (UTC) 2022-02-12 11:34:18
Inclination 82.978°
Semi-major axis 7 122 km
Perigee x Apogee 413 x 1 075 km
RCS: **Small**

49540

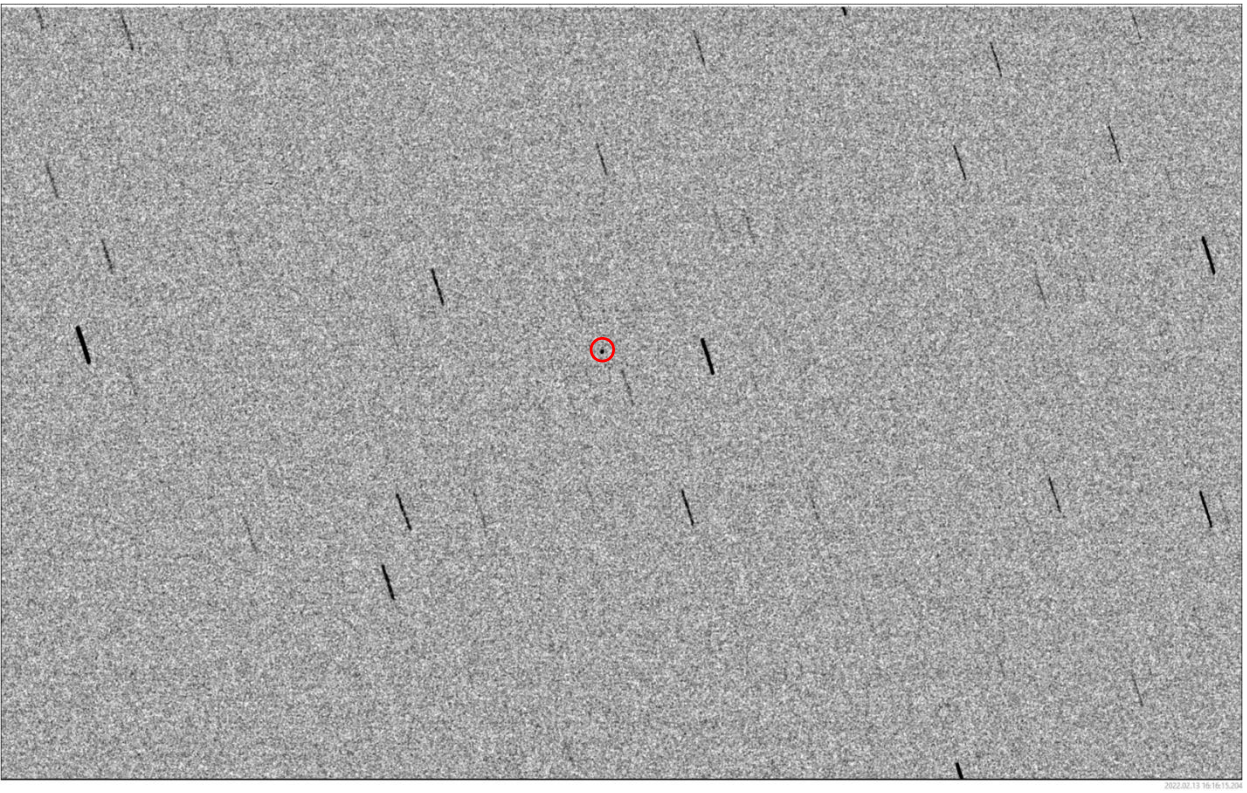


COSPAR designator 1982-092-AD
Epoch (UTC) 2022-02-12 17:25:03

Inclination	83.107°
Semi-major axis	6 999 km
Perigee x Apogee	444 x 798 km

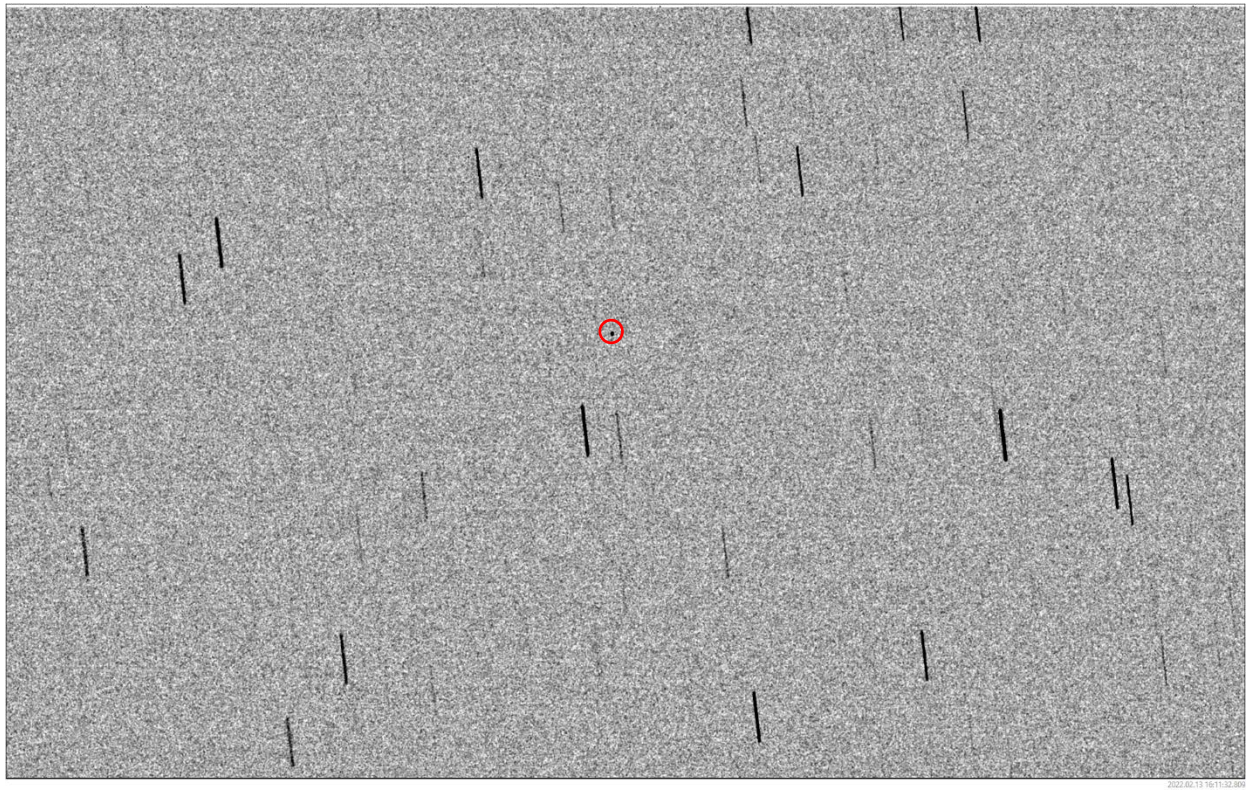
RCS: **Medium**

49582



COSPAR designator 1982-092-BX
Epoch (UTC) 2022-02-12 11:04:00
Inclination 82.940
Semi-major axis 6 976 km
Perigee x Apogee 451 x 744 km
RCS: **Small**

49634

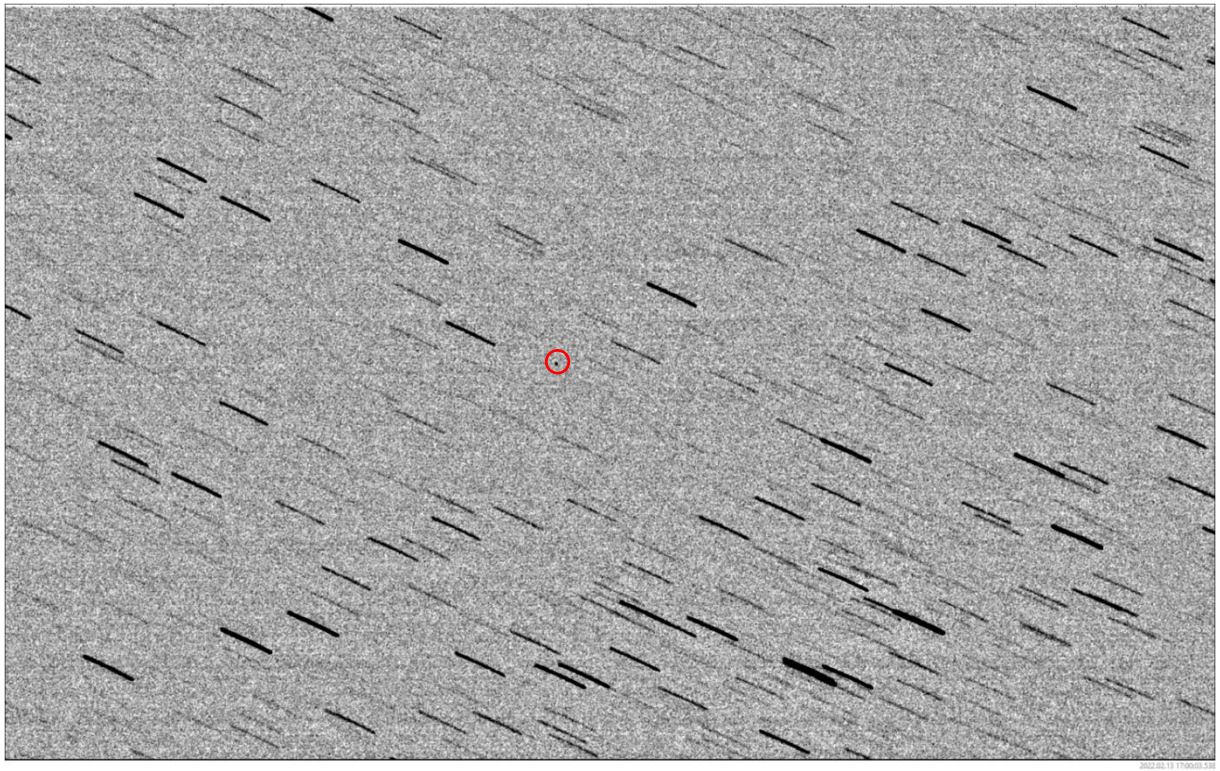


COSPAR designator 1982-092-EB
Epoch (UTC) 2022-02-12 17:47:43

Inclination	83.410
Semi-major axis	6 901 km
Perigee x Apogee	460 x 586 km

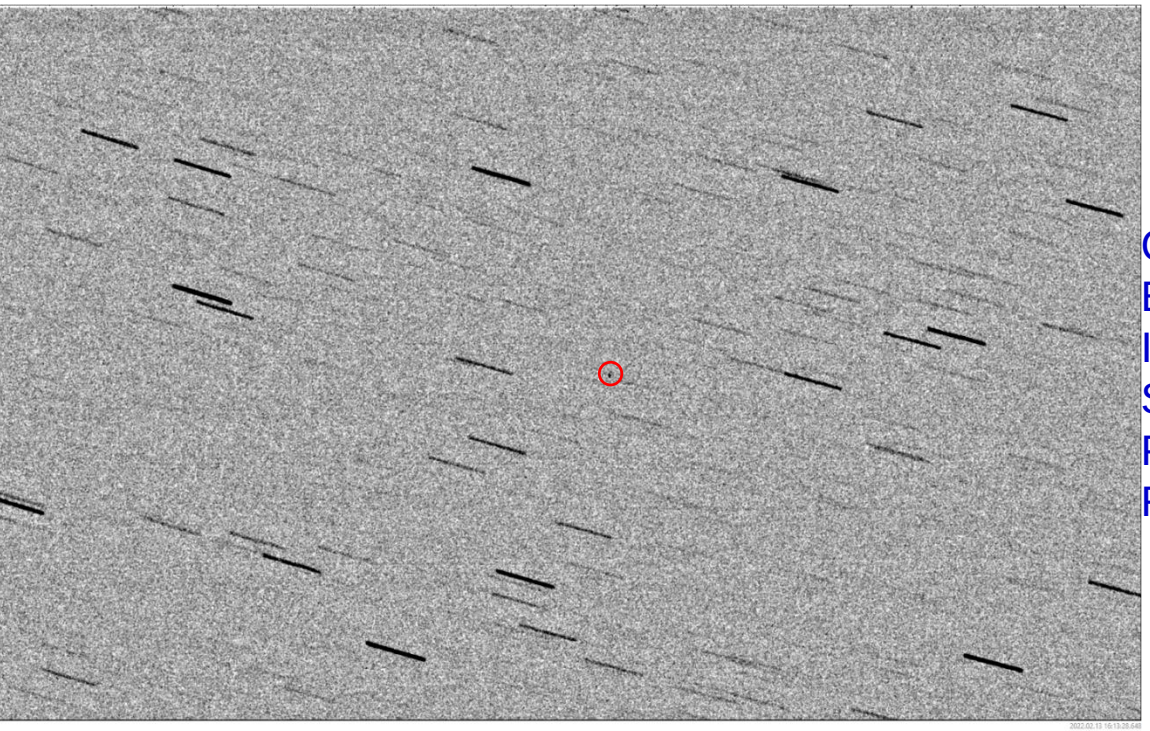
RCS: **Small**

49635



COSPAR designator 1982-092-EC
Epoch (UTC) 2022-02-12 10:51:29
Inclination 82.938°
Semi-major axis 7 113 km
Perigee x Apogee 458 x 1 011 km
RCS: **Small**

49662



COSPAR designator 1982-092-EH

Epoch (UTC)	2022-02-12 17:47:11
Inclination	83.430°
Semi-major axis	6 875 km
Perigee x Apogee	454 x 540 km

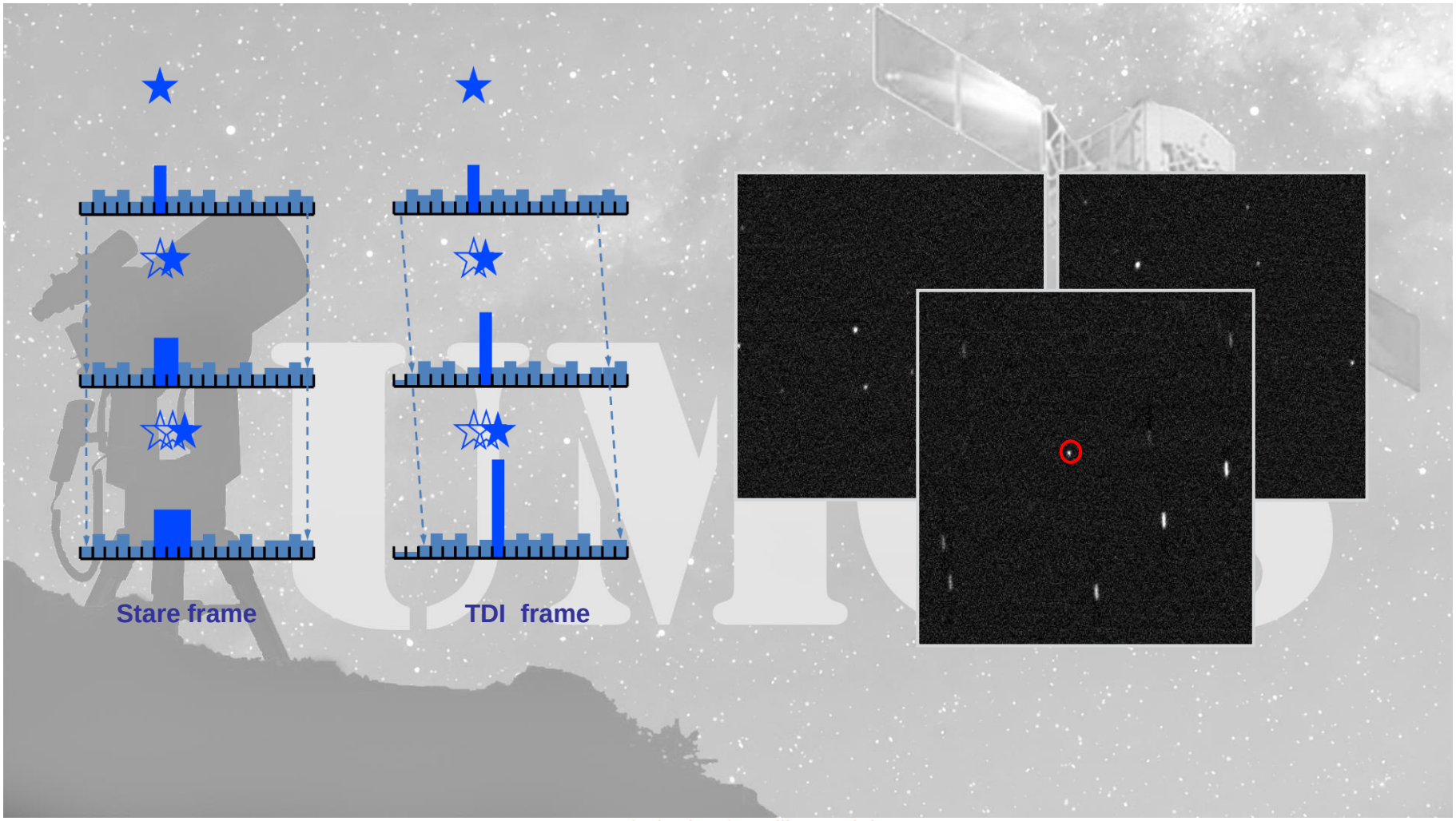
RCS: **Medium**

FAST ROBOTIC TELESCOPE OF MAO

	FRT
Aperture, cm	30
Focal length, m	1.5
Camera (Sensor)	Apogee Alta U9 (ON Semi KAF-09000)
Sensor size, pix	3056×3056
Pixel size, μm	12
Scale without binning ("/pix)	1.6
FoV (deg²)	1.96 (1.4°×1.4°)
Mount	Alt-azimuth
Max. slew rate, deg./s	20
Mechanical tracking	No

OBSERVATION TECHNIQUES

Time delay and integration (TDI) mode with rotation stage (RI MAO)



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

STATISTICS AND ORBITAL PARAMETERS

The main statistics of the observations for FRT

USSPACECOM ID	COSPAR ID	Number of observations	USSPACECOM RCS
04-Feb-2022			
49522	1982-092-K	3	MEDIUM
49530	1982-092-T	6	MEDIUM
49531	1982-092-U	3	MEDIUM
49535	1982-092-Y	1	MEDIUM
49537	1982-092-AA	1	MEDIUM
49538	1982-092-AB	1	MEDIUM
49541	1982-092-AE	7	MEDIUM
49576	1982-092-BR	1	MEDIUM
49590	1982-092-CF	2	MEDIUM
49626	1982-092-DT	1	MEDIUM
49653	1982-092-EW	1	MEDIUM
49694	1982-092-GP	2	MEDIUM
49707	1982-092-HC	2	SMALL
49723	1982-092-HU	2	MEDIUM
49784	1982-092-JA	1	SMALL
49787	1982-092-JD	1	MEDIUM
49789	1982-092-JF	1	MEDIUM
49822	1982-092-KD	1	MEDIUM
50010	1982-092-QW	1	MEDIUM
50026	1982-092-RN	1	MEDIUM
11-Feb-2022			
49530	1982-092-T	1	MEDIUM
49694	1982-092-GP	4	MEDIUM

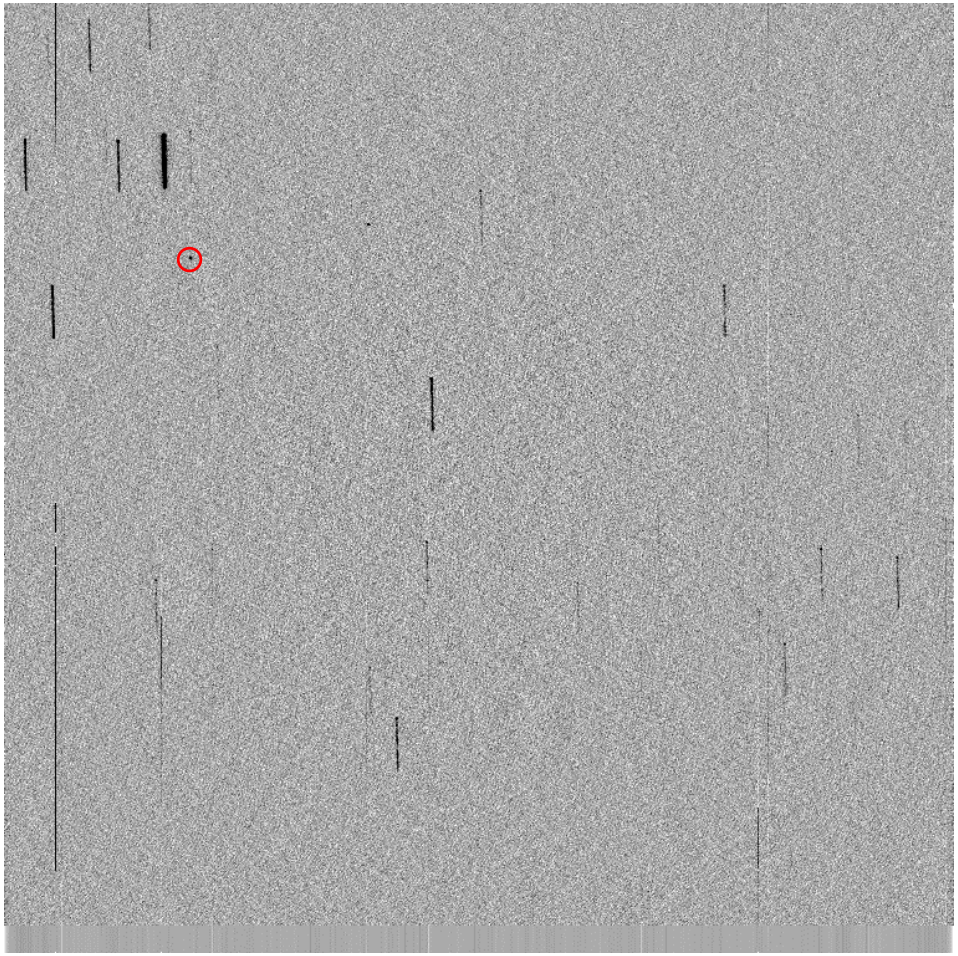
STATISTICS AND ORBITAL PARAMETERS

Main orbital parameters of objects for an epoch close to the observation epoch (FRT observations)

USSPACECOM ID	49522	49530	49531	49535	49537	49538	49541	49576	49590	49626	49653
Epoch (UTC)	2022-02-03 17:19:52	2022-02-03 12:43:32	2022-02-03 17:59:31	2022-02-03 12:38:17	2022-02-03 18:02:16	2022-02-03 17:54:24	2022-02-03 12:16:44	2022-02-03 17:26:56	2022-02-03 18:27:20	2022-02-03 17:57:12	2022-02-03 19:23:44
Inclination	82.579°	83.405°	82.874°	82.562°	82.564°	82.284°	82.808°	82.598°	82.551°	82.561°	82.551°
Semi-major axis, km	6848	6 916	6 883	6 857	6952	6917	6 940	6 857	6 917	6853	6880
Apogee, km	481	622	583	495	651	662	661	518	622	497	543
Perigee, km	459	453	428	463	457	415	463	440	456	452	461

USSPACECOM ID	49694	49707	49723	49784	49787	49789	49822	50010	50026
Epoch (UTC)	2022-02-03 17:31:11	2022-02-03 19:38:58	2022-02-03 21:56:30	2022-02-03 17:53:08	2022-02-03 12:35:04	2022-02-03 12:54:33	2022-02-03 12:29:39	2022-02-03 18:05:18	2022-02-03 18:05:21
Inclination	82.580°	82.723°	81.969°	82.568°	82.574°	82.613°	82.576	82.562	82.577
Semi-major axis, km	6 865	6 838	7 015	6 868	6865	6914	6874	6 872	6838
Apogee, km	511	489	873	513	510	612	534	523	480
Perigee, km	462	431	402	466	464	460	455	465	439

49530

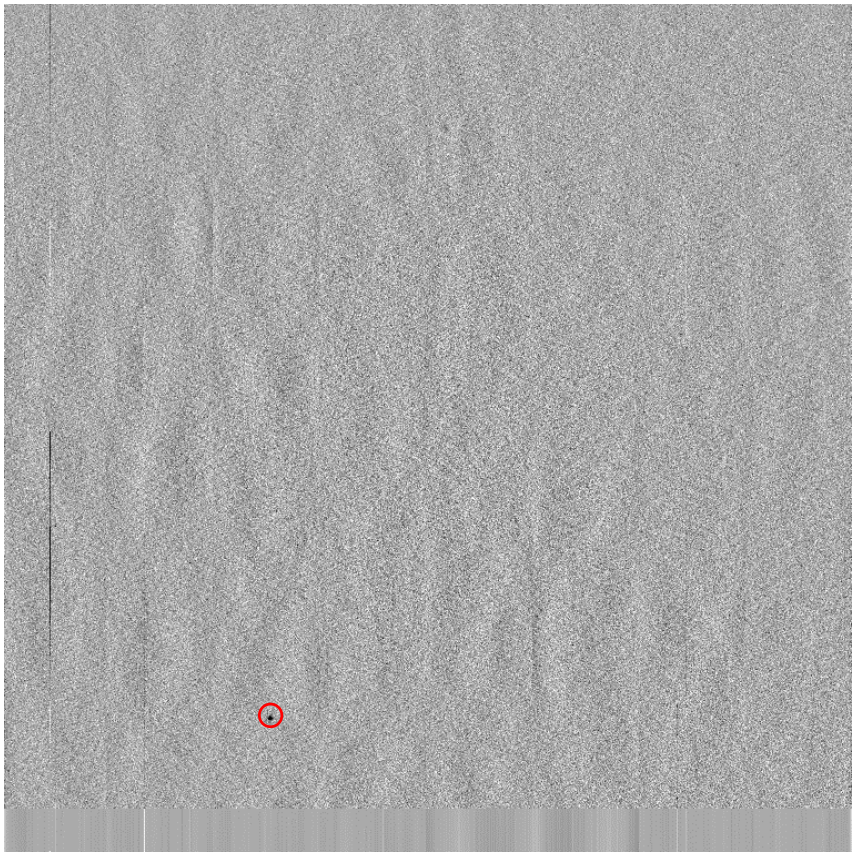


COSPAR designator 1982-092-T

Epoch (UTC)	2022-02-04 12:43:32
Inclination	83.405°
Semi-major axis	6 864 km
Perigee x Apogee	453 x 622 km

RCS: **Small**

49694

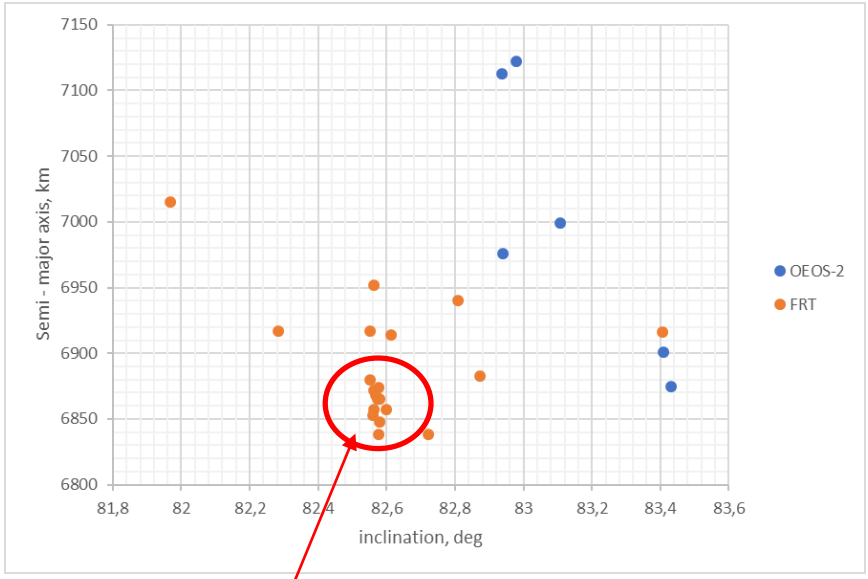


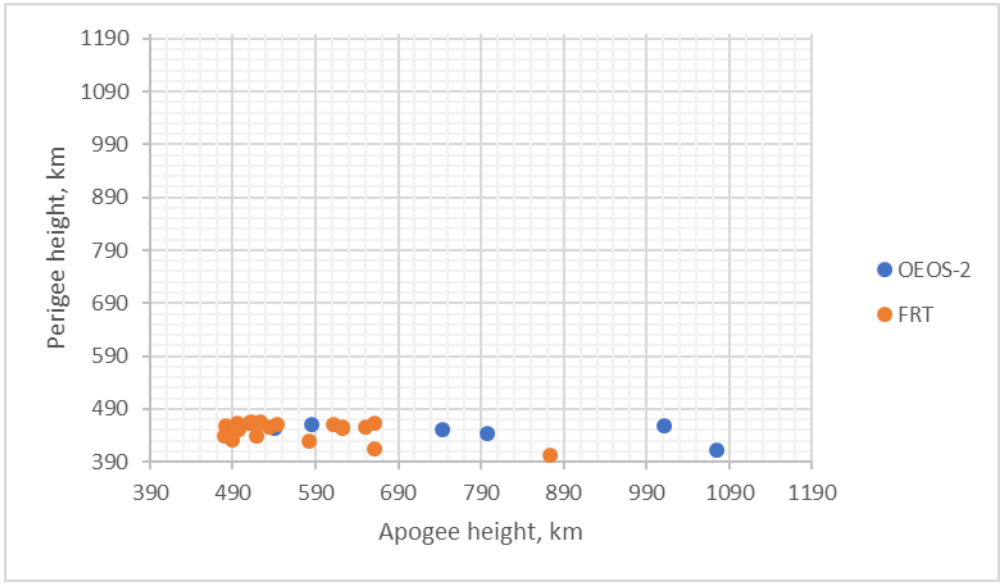
COSPAR designator 1982-092-GP

Epoch (UTC)	2022-02-10 11:33:52
Inclination	82.581°
Semi-major axis	6 864 km
Perigee x Apogee	461 x 511 km

RCS: **Medium**

BRIEF ANALYSIS





The satellite orbit before fragmentation

CONCLUSIONS

Ukrainian optical sensors are able to observe LEO space debris objects with RCS less than 0.1 sq. m. in the presence of relatively accurate ephemeris.

The orbital parameters of a significant part of the observed objects were close to the orbital parameters of the original satellite before the event. It can also be observed that the range of apogee heights is much larger than the perigee heights. These facts are also confirmed by reports of observations by other participants that were made earlier.

In the future, it is necessary to evaluate the capabilities of sensors to observe the consequences of fragmentation of objects on the LEO in the absence of accurate data on the orbits of debris (the first hours and days after the event).

THANK YOU FOR YOUR ATTENTION!