7 MAY 2023

THE FINAL FRONTIER FLASH

Developments & Analysis
of the Space Domain

ISR UNIVERSITY

SFA
SPACE FORCE ASSOCIATION

In This Issue

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Catalog

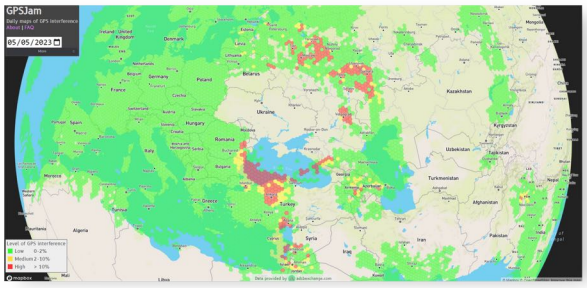
Russian GPS Jamming Effects on UKR HIMARS

6 May 2023: CNN report details Russian Electronic Warfare, specifically GPS Jamming, effects on the accuracy of the 83km range HIMARS rocket system. One drone pilot on the Eastern front described the jamming of the mobile HIMARS as "significant," and something he hadn't seen in his area before last November, several months after the HIMARS first arrived in Ukraine at the beginning of the summer.

HIMARS in Field Training Exercise

- Russia has been thwarting US-made mobile rocket systems in Ukraine more frequently in recent months, using electronic jammers to throw off its GPS guided targeting system to cause rockets to miss their targets.
- Ukrainian military officials, with US assistance, have had to come up with a variety of different workarounds
- Ukraine has received 18 American HIMARS to date and the US has committed to sending 20 more. Other NATO allies have donated 10 Multiple Launch Rocket Systems, according to the State Department.
- The US has also helped the Ukrainians locate the Russian jammers and destroy them – a "high priority" effort, according to a secret Pentagon document that was part of a trove allegedly leaked by Airman Jack Teixeira. "We will continue to advocate/recommend that those jammers are disrupted/destroyed," the document says, "to the maximum extent possible."
- GPS jamming can affect other "smart" US munitions like the precision-guided Excalibur artillery shells fired from Howitzers and air-dropped bombs called JDAMs.
- Four of nine extended-range JDAMs used by Ukraine missed hitting Russian targets, possibly due to jamming.
- Depending on the location and strength of the jamming, a rocket can still successfully hit with significant damage. In addition to GPS guidance, the rockets have inertial navigation systems that are not susceptible and remain accurate, though not as precise as when guided by GPS coordinates.

JDAM Assembly



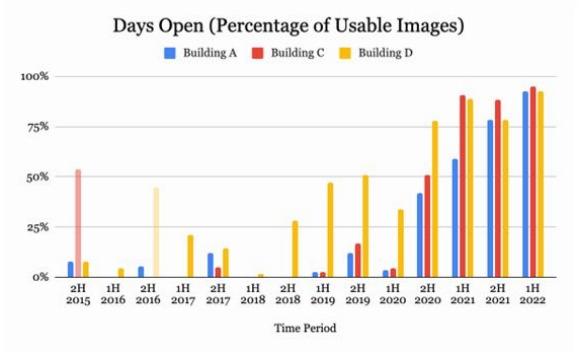
"GPSJam" for 5 May 2023

- As of Feb 2023, Ukraine had expended approximately 9,500 HIMARS rockets.
- Russia's use of electronic warfare has not been nearly as widespread as expected but they have made use of it since the beginning of the war.
-With Russian units largely stalled on the Ukrainian frontlines and stuck in defensive positions, Russian forces have made increasing use of their jamming systems to counteract the HIMARS.
-More broadly, Russia has been employing GPS jamming more frequently in its own cities, likely as a result of successful long range Ukrainian attacks. GPS issues were first spotted by the monitoring system GPSJam, which uses data from planes to track problems with the satellite navigation system.

ASAT Development Activity at China's Korla Facility

1 May 2023: Black Sky released a report showing a pattern of engaging foreign satellites with directed energy weapons at Korla East Test Site.

Korla North and South Hangars with Roofs Retracted



- Satellite imagery from geospatial intelligence company BlackSky has uncovered a pattern of behavior at the Korla East Test Site that is consistent with China's development of technology to disrupt, destroy or hijack foreign satellites.
- Satellite images of Korla East Test Site featuring two laser gimbals with supporting infrastructure, housed within separate hangars with retractable roofs, to the north and south of the compound, reveal that this site holds ASAT weapons. The evidence suggests a pattern of opening the hangars to operate the ASAT lasers around solar noon, the time when foreign imaging satellites are most active.
- According to satellite tracking data for a sample of days within the observation period, a large number of satellite companies orbited within line of sight of the Korla facility during active ASAT periods, including SpaceX's Starlink communications satellites, and constellations of commercial geo-imaging satellites that include the companies Spire and Planet Labs. National military satellites may also have been in the region during this time.
-The ASAT located at Korla East Test Site are laser directed-energy weapons that have multiple uses ranging from dazzling and disrupting a satellite's communications and optical sensors, to heating a target for a separate engagement with heat-seeking missiles, or even directly destroying satellite components.
- The period around solar noon is the optimal time for capturing and collecting images of the ground to avoid the blocking effects of shadows. Most image collection in the commercial industry occurs in this time, and the uptick in activity at the Korla East Testing Site at this point suggests the use of the ASAT to engage with this class of satellite.
-The data also showed a rise in the percentage of hangar openings for the northern ASAT weapon later in the day. It is possible that this corresponds to a rise in activity for satellites without publicly logged orbits, such as military and national government satellites.
-China built the Korla site in 2003 but much of its activity since 2005 remains undocumented. Korla is managed by Unit 63655 of the People's Liberation Army – Strategic Support Force (PLA-SSF), which is in charge of research on lasers and optics, very large stratospheric airships and high-powered microwaves.
- China also operates the Bohu facility in Xinjiang, which satellite imagery shows may have been built in 2002 and became operational in 2004, suggesting that China's anti-satellite laser program may already be two decades old. Like Korla, Bohu hosts research about lasers and optics, giant stratospheric airships and high-powered microwaves. Unit 63655 of the PLA-SSF also manages the facility.

China Commercial Sea Launch Coming 2023

28 Apr 2023: Chinese rocket startup Orienspace is moving towards a debut launch from a sea platform in 2023. The Gravity-1 rocket will launch from a mobile sea platform developed as part of sea launch facilities developed at Haiyang in Shandong province before the end of 2023.

Watch Orienspace Promotional Video.

Orienspace Factory & Hardware

- Gravity-1 consists of three solid stages and four side boosters. The rocket will have the capability to lift a payload of 6,500kg to low Earth orbit (LEO), or 3,700kg to a 700km sun-synchronous orbit (SSO).

-When completed, Gravity-1 will be China's and the world's most capable all-solid orbital launch vehicle. Gravity-1 will also have the greatest lift capacity of operational rockets in China's budding commercial space sector so far.

- Space Pioneer's Tianlong-2—China's first privately operated liquid propellant rocket to reach orbit—set the current commercial record earlier this month. Tianlong-2 is capable of carrying 2,000kg to LEO.

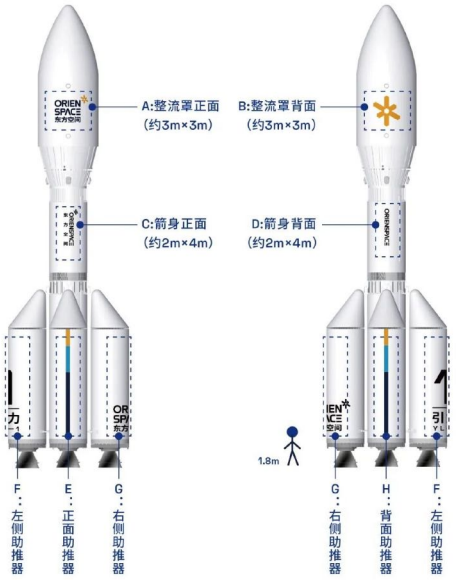
Orienspace & CGST Sign Agreement

- Orienspace signed a contract with Changguang Satellite Technology Co. Ltd., (CGST) April 17 for the launch of a number of Jilin-1 Gaofen-05 series spacecraft. The series will be the fourth generation of remote sensing satellite for CGST.

- At the end of 2022 CGST announced that it planned to expand its under-construction Jilin-1 constellation from a planned total of 138 satellites to 300.

-Orienspace also signed a strategic cooperation agreement 22 Apr with Aerospace Hongtu, under Piesat Information Technology Co. Ltd. Aerospace Hongtu is building a synthetic aperture radar satellite constellation and recently saw four of its satellites reach orbit aboard a Long March 2D.

-Orienspace's Medium and Large-scale Launch Vehicle Assembly Integration Test Center is expected to come online mid-year. It will eventually be capable of producing a total of 20 medium and large launch vehicles per year.



Long March 9 Development Update

21 Apr 2023: China is planning to make a fully reusable version of the Long March 9, a rocket designed to launch infrastructure and deep space missions. Presentations at events marking China's national space day in the city of Hefei, Anhui province revealed plans for a fully re-usable version similar to the SpaceX Starship. Watch great LM-9 update video.

- China is now targeting 2033 for first flights of a three-stage Long March rocket powered by numerous full flow staged combustion methane engines on the first stage, capable of carrying 50 tons to lunar transfer orbit, or 35 tons when the first stage is recovered.

-The initial version will be 114m long, have a mass at liftoff of 4,400 tons and generate 6,100 tons of thrust.

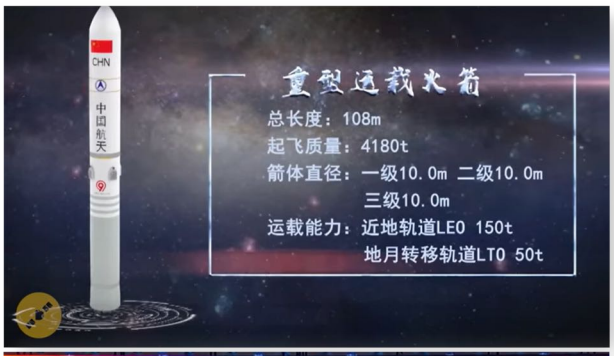
-This will be followed by a two-stage variant capable of carrying 150 tons of payload to low Earth orbit (LEO), or 100 tons when landing the first stage. A fully reusable, 80 tons to LEO variant will be the ultimate objective, expected to fly in the 2040s.

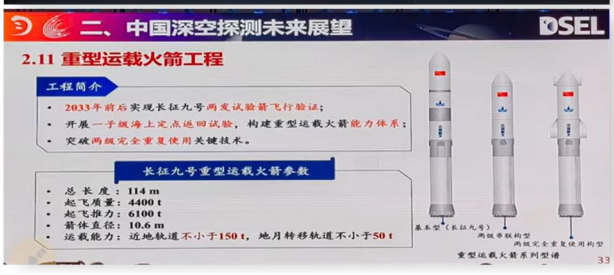
-China had previously aimed to debut an expendable Long March 9 rocket using 500-ton-thrust kerosene-liquid oxygen engines around 2028-2030.

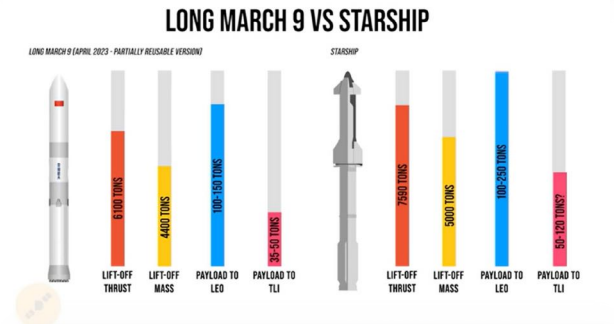
-The Long March 9 project has evolved in the last couple of years from an initial expendable, more traditional Long March-style rocket kerosene-fueled rocket featuring a 10-meter-diameter core and four 5-meter-diameter boosters presented in the early 2010s, to a single stick versions powered variously by kerosene or methane engines. CALT announced late last year that plans for an expendable version had been scrapped and that the structural design had been finalized.

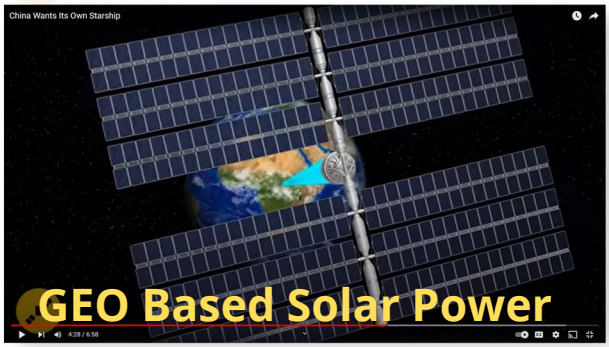
-The future Long March 9 has been touted as useful for launching components for a space-based solar power station in geostationary orbit. Reusable super heavy-lift rockets could make the related launch costs much more manageable.

-China is also developing the Long March 10 which could have a first flight around 2027 and could, with a pair of launches, be able to send a crew to the lunar surface before the end of the decade.



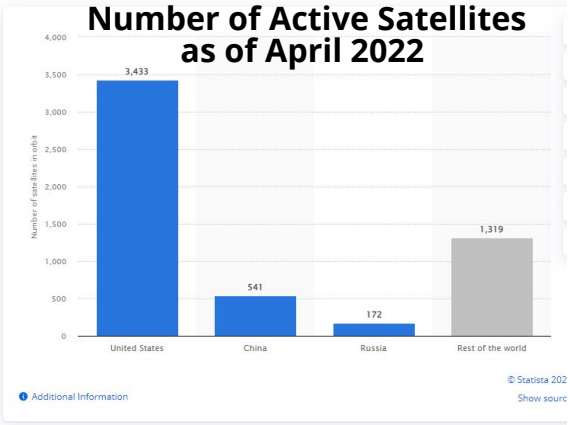




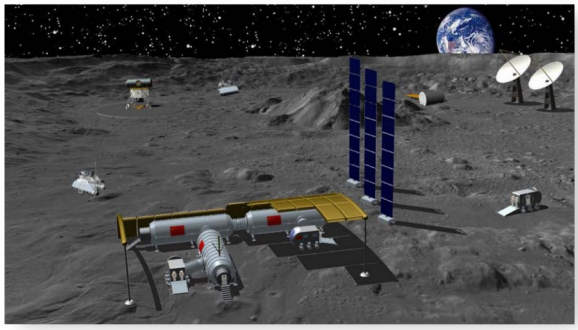


Space Race? A look at China v US Capabilities

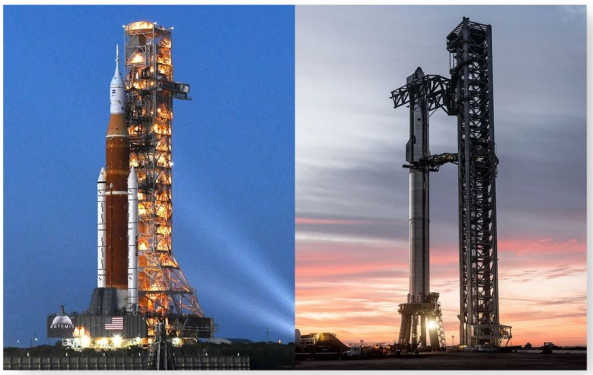
24 Apr 2023: Space Review posted an analysis by Svetla Ben-Itzhak (a professor who studies space and international relations) which takes a comparative look at the space capabilities between China and the United States. Bottom line: We are currently in a state of a complex hegemony: one nation, the US, is still dominating in key space capabilities, and this lead is further amplified by a strong network of partners.



- In several key areas, the US is far ahead not only of China, but of all other spacefaring nations combined.
- In 2021, the US space budget was roughly US$59.8 billion. China has been investing heavily in space and rocket technology over the last decade and has doubled its spending in the last five years. But with an estimated budget of $16.18 billion in 2021, it is still spending less than a third of the US budget.
-US also leads significantly in the number of active satellites. Currently, there are 5,465 total operational satellites in orbit around Earth. The US operates 3,433, or 63% of those. In contrast, China has 541.
-In 2021, for instance, China attempted 55 orbital launches, four more than the US. The total numbers may be similar, but the rockets carried very different payloads to orbit. The vast majority—84%—of Chinese launches had government or military payloads intended mostly for electronic intelligence and optical imaging. Meanwhile, in the US, 61% of launches were for nonmilitary, academic or commercial use, predominantly for Earth observation or telecommunications.
-A major point of difference between the US and China is the nature and number of international collaborations.
-The US government has signed 169 space data sharing agreements with 33 states and intergovernmental organizations, 129 with commercial partners and seven with academic institutions.
-China also has allies that help with space, most notably Russia and members of the Asia-Pacific Space Cooperation Organization, such as Iran, Pakistan, Thailand, and Turkey. China's collaborators are, however, fewer in number and have far less developed space capabilities.
-In 2019, Russia and China agreed to jointly go to the Moon by 2028. Their future International Lunar Research Station is "open to all interested parties and international partners," but, to date, no additional countries have committed to the Chinese and Russian effort.
- Since 2020, 23 nations have joined the US-led Artemis Accords.



International Lunar Research Station Rendering



India Releases New Space Policy

24 Apr 2023: Namrata Goswami posted an article on the Space Review in which she provides highlights of India's recently released national space strategy. Spoiler alert: the primary focus is on the commercialization of space, and ensuring that it is the private sector that takes the lead in building end-to-end space systems. Here is the entire policy document (11 pages).

- The new strategy directs ISRO to "undertake studies and missions on in-situ resource utilization, celestial prospecting and other aspects of extra-terrestrial habitability." ISRO will move out of manufacturing of space systems, and instead focus only on the R&D side. Manufacturing and operations will be turned over to the private space sector.

-ISRO will make access to remote sensing data widely available, and the agency will concentrate on developing human spaceflight technologies as well as support a sustained human presence in space.

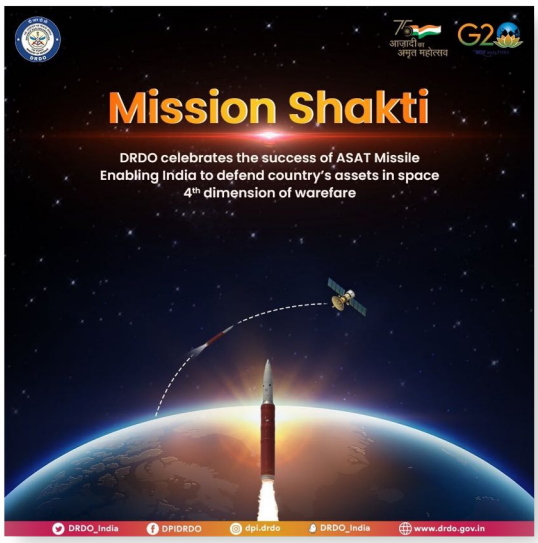
-The Indian National Space Promotion & Authorisation Centre (IN-SPACe) will function as the single-window authorization center for both public and private sector space activities. It will include launch, operation, in orbit slots, re-entry of space objects, and the dissemination of Earth observation data.

-The major gamechanger is India's stand on space resources. India will encourage its private sector to engage in the extraction of space resources by creating the enabling policy and regulatory structures for it.

-The 2023 space policy document offers no in-depth details on India's national security space architecture.

-The role of commercial space in augmenting space warfare capabilities was specified by Chauhan (India's Chief of Defense Staff) when he stated that "as seen during the Russia-Ukraine conflict by SpaceX and Maxar, had unfolded a new area in the war on convergence...This combined with the intense race towards militarization of space has resulted in the battlespace becoming expanded and the very nature of warfare is at a major cusp of transformation."

-The 2023 Indian space policy is a response to these calls for a greater role of the private sector in developing India's civilian and defense space capabilities. It clarifies the role and authority structures of institutions like IN-SPACe, NSIL, ISRO, and DoS. A future space policy document should clarify India's long-term space goals, the capacities being developed to meet those goals, and its military space posture.



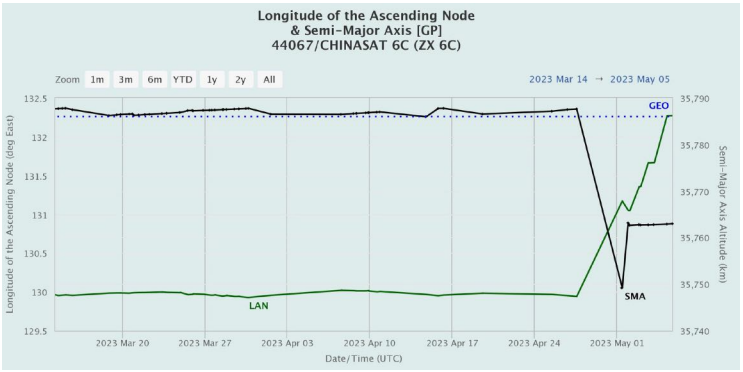
On Orbit Updates: Kosmos-2568 Descending

Kosmos-2568 Update: Russia launched Kosmos-2568 on 29 Mar 2023, and analysts suspected this was the fourth instance of an EO MKA satellite. The previous 3 (Kosmos-2551, 2551 & 2560) all re-entered the Earth's atmosphere 19, 41 and 56 days respectively after launch. After 38 days on orbit it appears Kosmos-2568 is headed towards a similar fate. There have been no known maneuvers and the spacecraft's SMA has declined ~11km (from 336 to 326km).

Steady Decline: Kosmos-2568 SMA

On Orbit Updates: Chinasat-6C

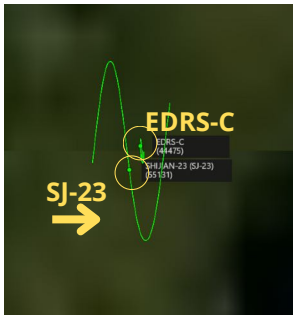
Based on limited observations it appears Chinasat-6C made two maneuvers, first between 27-30 Apr decreasing its SMA 38.4km and initiating an eastward drift and then between 1-2 May increasing its SMA 13.4km. It is currently drifting eastward .23°/day and has moved 2.3° from its previous 130°E location.



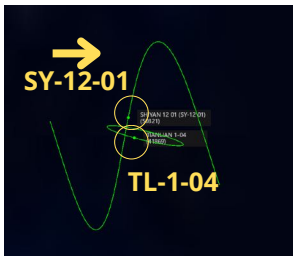
Chinasat 6C provides commercial communications services with twenty-five C-band transponders and supports high-quality and reliable uplink and downlink transmissions of programs for the radio and TV stations and cable TV networks.

On Orbit Updates: SJ-23 & SY-12-01

SJ-23: On 5 May 2023 SJ-23 had a point of closest approach of less than 100kms with the European EDRS-C satellite. SJ-23 has been drifting eastward since 16 Apr 2023. SJ-23 was initially thought of as a likely follow-on to SJ-13, a communications satellite. However, the release of a sub-payload is more indicative of SJ-17, TJS-3 and SJ-21. EDRS C (European Data Relay Satellite C) is one component of the European data relay system.

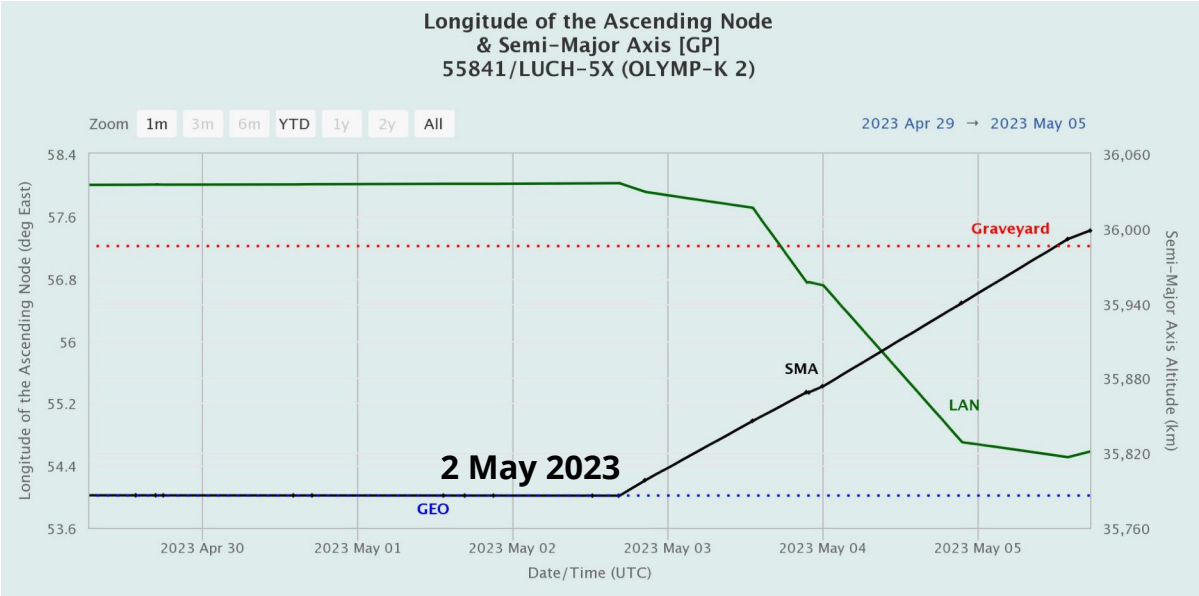


SY-12-01: SY-12-01 had a point of closest approach less than 29kms with the Chinese Tianlian-1-04 relay satellite. SY-12-01 frequently maneuvers and has been drifting east at varying rates since late November 2022. There has been open source comparison with the US GSSAP mission.

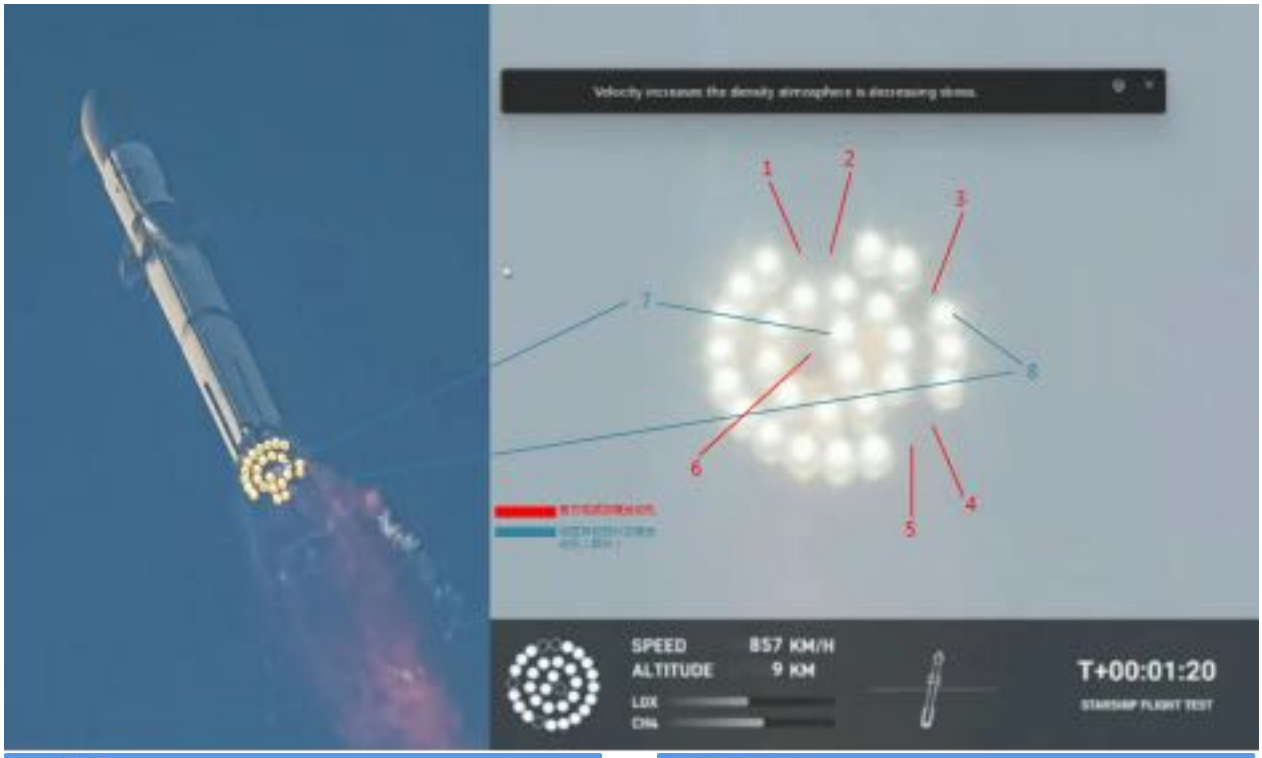


On-Orbit Updates: Luch/Olymp-K2

Luch/Olymp-K2: Between 2-5 May 2023, Olymp-K2 raised its orbit over 200km and is now drifting west. More to follow in coming weeks.



Pics o' the week!



时 间 (相对起飞0时刻)	事件现象
0~14s	起飞过程（含箭体出塔前后）箭体姿态倾斜明显，火箭在远离塔架方向的起飞漂移量较大。
20s	箭体尾部边缘出现疑似泄漏的气体，同时出现异常亮光。起飞漂移显著，出塔过程中有明显的姿态倾斜。
32s	发动机尾部出现异常亮光，持续至33s消失。在44s~50s时，出现类似的现象，发动机喷流出现爆闪。
1:07（67s）	由飞行影像可见超重推进级发动机出现了6台发动机工作故障，同时伴随呈脉冲状态的异常喷流现象，持续至69s。
1:14（74s）	可明显观察到底部出现6台发动机未工作。
1:20~1:30 （80s~90s）	依据地面光学测量显示已经有6台发动机停止工作。另外中心一台发动机和外圈一台发动机喷口火焰亮度也明显偏弱，据此判断这两台发动机工作处于偏离额定状态的非正常工况。
1:27（87s）	底部外缘某角度方位出现白色气体，与发动机喷流形态及颜色差异明显，逐步发展至91s时可见明显白色气体。90s时，开始有白色雾气喷出，并逐渐扩大，疑似为液氧出现泄漏，至115s时，液氧泄漏形成的白雾已基本遮挡住了发动机的火焰喷流。此时遥测信号显示箭体高度只有11km，箭体速度约266m/s。
1:55（115s）	超重推进级底部发动机出现异常喷流亮光，持续时间1s。
2:00（120s）	火箭尾部靠上方部位有横向火焰喷出，持续约5s，在125s时，发动机尾部火焰突然扩大，疑似出现爆炸。箭体姿态开始滚转。
2:09-2:13 （129s~133s）	由箭载摄像头可以看到显著的姿态变化，角速度较快，呈现发散趋势。
2:20（140s）	箭体姿态开始失稳。
2:44（164s）	姿态持续发散，整箭几乎翻转。
3:08（188s）	飞至最高点39km。
3:59（239s）	随后连续多圈翻滚，高度不断下降，当高度降低至29km时，箭体爆炸解体。

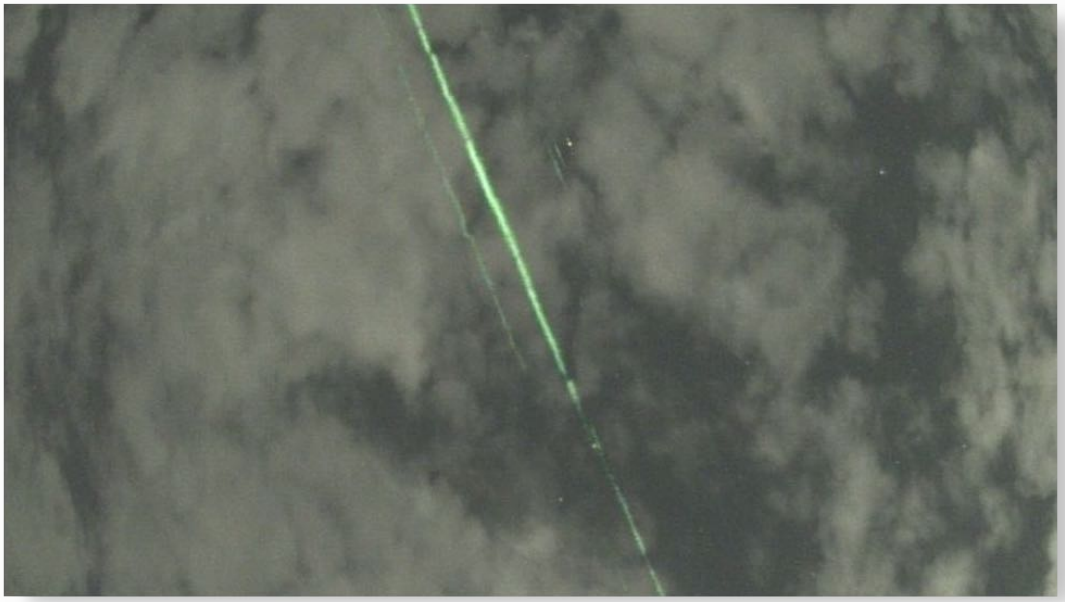
Time (relative to take-off 0 hours)	Event phenomenon
0~14s	During take-off (including before and after exiting the tower), the attitude of the rocket body is obvious, and the take-off drift of the rocket is large in the direction away from the tower.
20s	The tail edge of the rocket body appeared suspected of leaking gas, and abnormal light appeared at the same time. The takeoff drift is remarkable, and the attitude inclination is obvious during the exit.
32s	Abnormal bright light appeared in the rear of the engine, which lasted until 33 s disappeared, and similar phenomenon appeared in 44 s ~ 50s, and the engine jet appeared explosive flash.
1:07（67s）	The mid-flight images showed that six engine failures occurred in the super-heavy propulsion stage, accompanied by abnormal jet phenomena in the early pulse state, which lasted until 69 s.
1:14（74s）	It is obvious that six engines are not working at the bottom.
1:20~1:30 （80s~90s）	According to ground optical measurements, six engines have been stopped for 1 T operation. In addition, the flame brightness of the nozzle of one engine in the center and one engine in the outer ring is also obviously weak, so it can be judged that the two engines are working under abnormal conditions that deviate from
1:27（87s）	There is a white gas at the bottom of the outer edge of a certain angle and direction, and the difference between the shape and color of the engine jet is obvious, and the white gas is gradually developed to 91 s. In the 90s, white fog began to erupt and gradually expanded, suspected to be liquid oxygen leakage, to 115s, the white fog formed by liquid oxygen leakage has basically blocked the flame jet of the engine. The telemetry signal aspect and indication that the height is only 11km and the velocity is about 266m / s.
1:55（115s）	Abnormal jet light appeared in the bottom engine of the super-heavy propulsion stage for 1 s.
2:00（120s）	There was a transverse flame ejected from the upper part of the rocket house, which lasted about 5 s. At 125 s, the flame at the tail of the engine suddenly expanded, and the explosion was suspected. The arrow began to roll.
2:09-2:13 （129s~133s）	The arrow-borne camera can see a significant attitude change, the angular velocity is faster, showing a divergent trend.
2:20（140s）	The arrow began to lose stability.
2:44（164s）	Attitude continues to diverge, the whole arrow almost flipped.
3:08（188s）	"Fly to the highest point 39 km
3:59（239s）	Subsequently, the rocket body exploded and disintegrated when the height dropped to 29km.

CNSA's Assessment of Starship Super Heavy Test Launch

Before it's unfortunate hard landing on the lunar surface, Hakuto-R captured this image of a solar eclipse on Earth.

Coming Soon, LM-7 Resupply Mission to Chinese Space Station

Image from the surface of asteroid Ryugu (Sep 2018). At the time, the asteroid was about 320 million km from Earth.



On 16 Sep 2022, motion-sensing cameras set up by Hiratsuka City Museum curator Daichi Fujii to capture meteors instead caught the laser beams of NASA's ICESat-2 satellite as it passed over Japan. It's the first time the ICESat-2 team has seen footage of the lasers at work in orbit.

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SP310 - Adversary Space Capabilities II

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Continuing Space Education
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SP102 - Introduction to Space
SP103 - Math for Space
SP201 - Space Race 2.0
SP202 - Advanced OrbitalMechanics
SP203 - Joint Planning Process
SP204 - Space Surveillance Network/Object Surveillance & ID
SP301 - Electromagnetic Warfare
SP302 - Cyberspace
SP303 - Anti-Satellite Weapons

Space Specializations - Coming This Fall!
SP400 - Space Operations Planning
SP410 - Rendezvous and Proximity Operations
SP420 - Space Domain Awareness
SP430 - Space Control
SP440 - Space ISR
SP450 - Space Battle Management
SP460 - International SpacePolicy and Strategy
SP470 - Space Acquisitions
SP480 - Intelligence Support to Space

Analytic Thought
AW100 - Foundations of Analytic Writing
AW200 - Analytical Writing
AW300 - Collaborative Analytical Writing
CT100 - Foundations of Critical Thinking & Structured Analysis
CT200 - Critical Thinking for Analysts
CT300 - Advanced Critical Thinking for Analysts
CT500 - Leading Critical Thinkers
CT600 - Critical Thinking for Learning Professionals
CT700 - Critical Thinking for Executives
DA100 - Foundations of Data Analytics
DA200 - The Art & Science of Data Analytics

Cyber
CYBER900 - Cyber Security Strategy
ENG200 - English for Cyber

Faculty Development
FD600 - Facilitation for Learning Professionals
CT600 - Critical Thinking for Learning Professionals

ISR - Analysis
PED100 - Intelligence Planning Cycle
EM110 - Electromagnetic Spectrum Fundamentals
IADS100 - IADS Foundations
IADS200 - Rethinking IADS
IADS310 - Advanced IADS Analysis

ISR - Targeting
TGT110 - Fundamentals of Targeting
TGT210 - Target Development I
TGT211 - Target Development II
TGT212 - Target Capabilities Analysis
TGT213 - Target Force Assignments
TGT214 - Mission Planning & Force Execution
TGT215 - Combat Assessment
TGT310 - Weaponeering and Collateral Damage Assessment
TGT311 - HVI Target Development
TGT312 - Precision Point Mensuration
TGT315 - Targeting Professional

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WHO WE ARE

Integrity ISR employs a diverse group of former military service members, national security experts, and academic professionals to deliver innovative C4ISR, Space & Cyber solutions.

WHAT WE DO

Integrity ISR offers a wide-range of services for multi-domain C4ISR, Space & Cyber strategy, training and operations - enabling operations in any domain under any conditions, from permissive to highly contested and denied environments.

WHY WE DO IT

Our number one priority is to strengthen US national security - increasing US readiness and lethality, building C4ISR, Space & Cyber capabilities for the US and our allies, and fostering increased interoperability for tomorrow's coalition.

WE ARE HIRING!

https://integrityisr.com/careers/

OPEN POSITIONS

SPACE CYBER FUNDAMENTALS INSTRUCTORS (KEESLER AFB MS)

CONTINGENCY INTELLIGENCE NETWORK INSTRUCTOR – MOBILE TRAINING TEAM

INTEGRITY ISR

GLOBAL INNOVATIVE SOLUTIONS FOR C4ISR, SPACE & CYBER STRATEGY, TRAINING, AND OPERATIONS

An Economically Disadvanteged, Woman-Owned Small Business