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THE INTEGRITY FLASH

Analysis of Developments in the Space Domain

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ISR UNIVERSITY

SPACE FORCE ASSOCIATION

In This Issue

China Launches High Speed Laser Test System

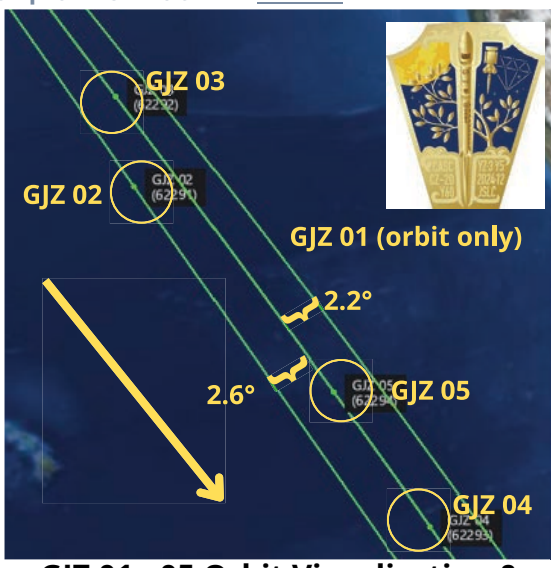
12 Dec: China launched a Long March-2D with 5 satellites for the High-speed Laser Diamond Constellation Test System (62290-62294) from Jiuquan. According to official sources, the five satellites entered the planned orbits. The launch included the Yuanzheng-3 restartable upper stage which China used to deploy the satellites into 3 orbital planes. Launch Video.

- The YZ-3 upper stage fired multiple times to put these 5 satellites into 3 different orbital planes. All are inclined 59.9° but have different RAAN (orbit twist) values.
  - GJZ 01 (62290) deployed to an ~1,160.6 x 1,142.5km altitude with 59.9° inclination. RAAN is 114.5°.
  - GJZ 02 (62291) is deployed to an ~ 812 x 799km altitude with 59.9° inclination. RAAN is 109.7°.
  - GJZ 03, 04 & 05 (62292-94) are co-planar. Altitudes vary slightly and relative positions are evolving. Altitudes are ~988 x 973km with a 59.9° inclination. These satellites are higher than GJZ 02 and lower than GJZ 01. RAAN is 112.3°, which places the satellites 2.2° west of GJZ 01 and 2.6° to the east of GJZ 02.

- Chinese media announced that the satellites were of flat-panel design: "The…high-speed laser Diamond Constellation Test System is another…application of the Gongda satellite flat-panel satellite platform." The rendering on the Mission Success board seemed to confirm this assessment.

- Blaine Curcio's China Space Monitor:
  - The 5 "High Speed Laser Diamond Constellation" satellites (were) built by Harbin Institute of Technology (HIT) commercial spinoff HITSat.
  - HITSat (was) founded in December 2020, and has now built ~15 satellites at an industrial base in Harbin, in China's Northeast.
  - As a manufacturer HITSat is emerging as a highly competent and relevant player, having built and launched 12 satellites this year for multiple customers including the AirSat constellation (based in Shandong) and the Xi'an Aerospace

Per Andrew Jones: Inter-satellite laser link capabilities would be highly applicable to China's megaconstellation projects, the national Guowang constellation, and the Shanghai-backed Qianfan/Thousand sails constellation. Inter-satellite laser links could mitigate China's limited global ground station coverage — an issue that is apparent in its reliance on onboard space situational awareness capabilities.



GJZ 01 - 05 Orbit Visualization & Mission Patch (spaceaware.io)

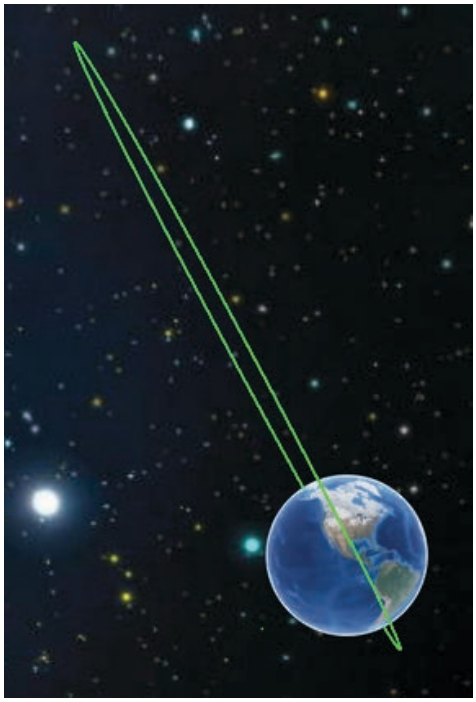
Launch Success Announcement with Depiction of Test Satellite (nasaspaceflight.com)

Harbin Institute of Technology Factory (chinaspacemonitor)

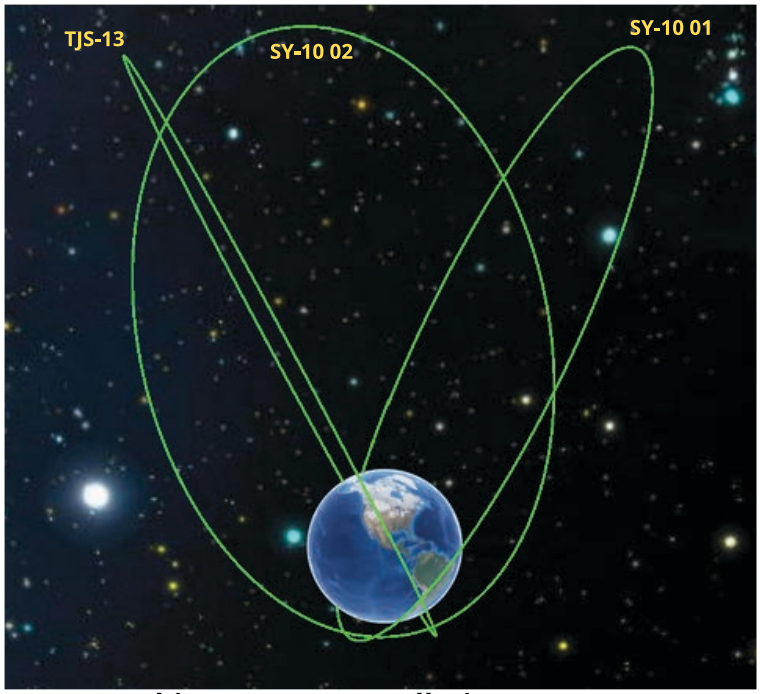
TJS-13 Finds a Home: Welcome to HEO

18 Dec: China placed its TJS-13 (62188), launched on 3 Dec 2024, into a Highly Elliptical Orbit (HEO) with an apogee of 38,675.8km, a perigee of 1,687.8km and an inclination of 63.4°. Hopefully this inclination catches your attention as it is the famed "Molniya" orbit (more details on this orbit from Jack Anthony in next article). TJS-13 is the first TJS satellite not in GEO and joins Shiyan-10 01 (49258) and Shiyan-10 02 (54878) as China's only HEO satellites…all three are in Molniya orbits with an inclination of 63.4° and an argument of perigee of 270°.

- TJS-13's HEO orbit supports the rumor (see 8 Dec 2024 Flash) that the satellite would perform the Missile Warning (aka Early Warning) mission.
- HEO satellites are great for providing communications or remote sensing (missile warning) over one of the hemispheres…to date all HEO satellites have had their apogee over the Northern Hemisphere.
- Due to the nature of their orbits TJS-13, SY-10 01 and SY-10 02 will have long dwell times over the northern hemisphere providing the ability to observe missiles launching from the Northern Hemisphere and heading over the North Pole.
- HEO satellites are also good for providing communications in the Arctic region (where GEO satellites struggle) and this is a possible mission, but I think it unlikely as none of the Chinese landmass is in the Arctic. It could be useful to provide communications support to Chinese shipping and other facilities in the Arctic region, but I believe the more likely mission is Missile Warning.



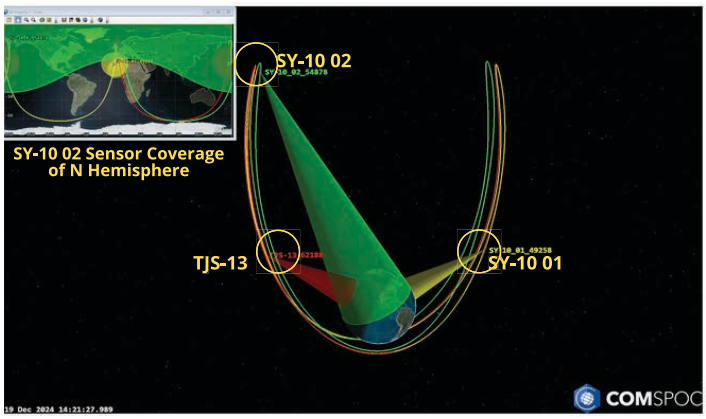
TJS-13 in Highly Elliptical Orbit (HEO). HEO Provides Long Dwell Time at Apogee (Northern Hemisphere) (spaceaware.io)



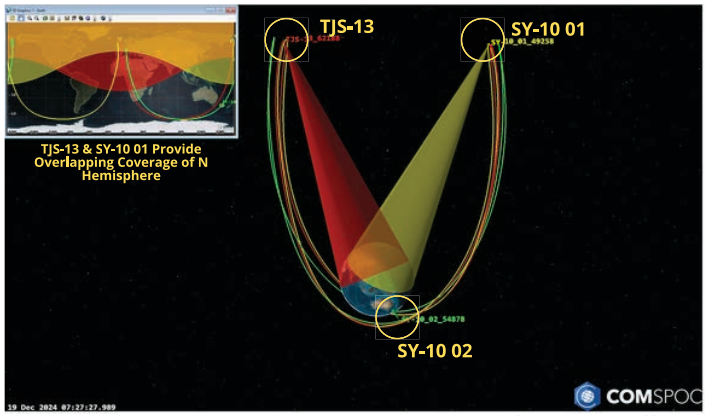
China's HEO Constellation: TJS-13, SY-10 01 & SY-10 02 (spaceaware.io)

TJS-13 In HEO (continued)

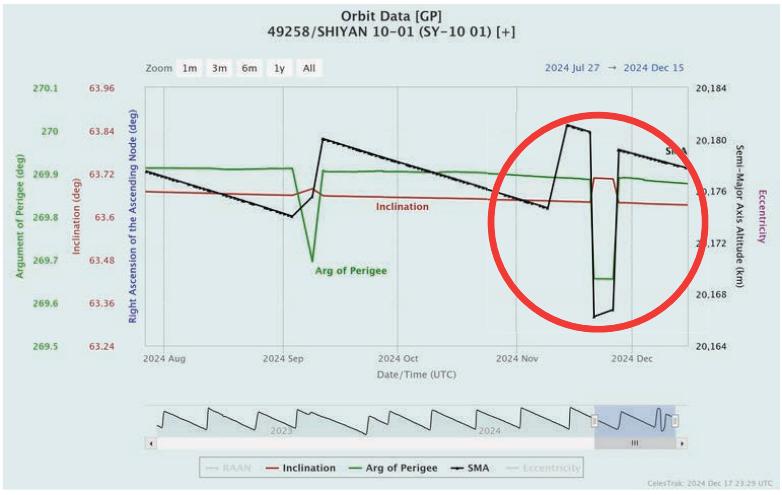
- It appears that China has deliberately synchronized the orbits of TJS-13 and SY-10 01.
- With just SY 10-01 and 10-02 on orbit China had 24-hour coverage, but only from one satellite at a time…either the spot over the UK or over Kamchatka.
- With the addition of TJS-13, for 12 hours/day both spots are occupied. China has gone from 1-satellite coverage all day long to 2-satellite coverage ½ the time and 1-satellite coverage ½ the time.
- Probably a good bet that a future TJS satellite will head to HEO and synchronize with SY-10 02.
- Taking a look at their orbital history it appears as if SY-10 01 performed some unusual maneuvers between 20-27 November 2024 (TJS-13 launched the following week on 3 December). On ~ 20 Nov SY-10 01 dropped 14.3km of SMA, from 21-26 Nov it regained ~0.5km of SMA and then 26-27 Nov it regained ~12.4km of SMA. Going back to 2022 I could find no other similar maneuver in SY-10 01's history.



SY-10 02 Reaches Apogee as TJS-13 & SY-10 01 Near Perigee (COMSPOC)



TJS-13 & SY-10 01 Arrive at Apogee Providing 2-Satellite Coverage of N Hemisphere. SY-10 02 Nearing Perigee (COMSPOC)

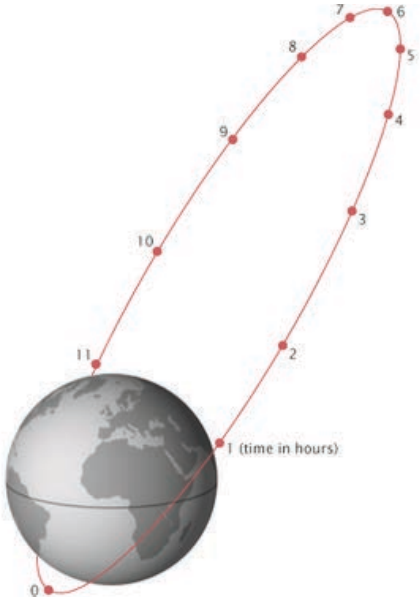


Unusual SMA Changes for SY-10 01 20-27 Nov 2024 1 Week Prior to TJS-13 Launch (celestrak.org)

Jack's Astro Corner Revisit: The Molniya Orbit

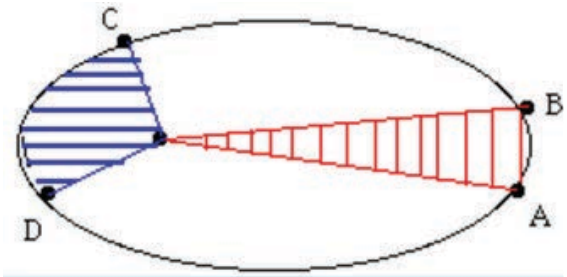
Friend of the Flash, Jack Anthony, wrote about the Molniya orbit in a couple of his "Jack's Astro Corner" articles. For those who might need a refresher I give you the following excerpts from the 3 July and 17 July 2022 Final Frontier Flashes.

Let's take a closer look at the HEO orbit like this and introduce Kepler's Second law of orbital motion. OK, see the tick marks with elapsed time in hours. These show position in the orbit every 1 hours. Notice that this HEO satellite whizzes by perigee area in less than 2-hrs. From perigee to reach apogee for this orbit takes 6 hrs. What Kepler's Second Laws says is if you made a triangle type figure it sweeps out "equal area in equal time." Thus, you are slowest at apogee and fastest at perigee. I call the HEO orbit the "hang time" orbit. Do you see that the "hang time" above the northern hemisphere is more than 10 hours.



The central gravitational force of the Earth is what makes satellites orbit the Earth. We assume a spherical Earth and that's pretty good for starters. But in reality, it's not a spherical point source of gravity. The Earth has oblateness, that is it's squished a little and football shaped, wider at equator and shorter to the poles. Can't really see it, but this is true. This causes some additional forces to be put on an orbiting satellite. The biggy Earth oblateness effect is called the J2 effect. It has an effect mostly the right ascension of the ascending node (RAAN) (twist) and the Argument of Perigee (defines where the closest approach to Earth is). You can get a constant change over time in those orbit elements; it's called a secular perturbation. The equation that determines the motion of perigee due to J2 can be solved to find the inclination where perigee will not drift. There are two specific inclinations where the rate of change of perigee movement due to J2 is zero. Holy cow, now that can be helpful. The answer is 63.4 and 116.6 degrees and it's called the critical inclination. Remember the HEO orbit? Well, if you launched into 63.4-degree inclined orbit and had perigee positioned in the southernmost part of your orbit, then it would not drift away from there and rotate away from this southernmost point. That's helpful for keeping the "hang time" part of the orbit (apogee) over the northern hemisphere.

Kepler's Second Law says says that a line running from the sun to the planet sweeps out equal areas of the ellipse in equal times. This means that the planet speeds up as it approaches the sun and slows down as it departs from it.



Illustrating Kepler's 2nd law: segments AB and CD take equal times to cover.

China Launches TJS-12

20 Dec: China launched a Long March 3B with the Tongxin Jishu Shiyan (TJS)-12 (62374) from Xichang. According to official sources, the satellite has entered the planned orbit and will be used for satellite communications, radio and television, data transmission, other services and tests of related technologies. TJS-12 is NOT likely to join TJS-13 in HEO. Launch Video.

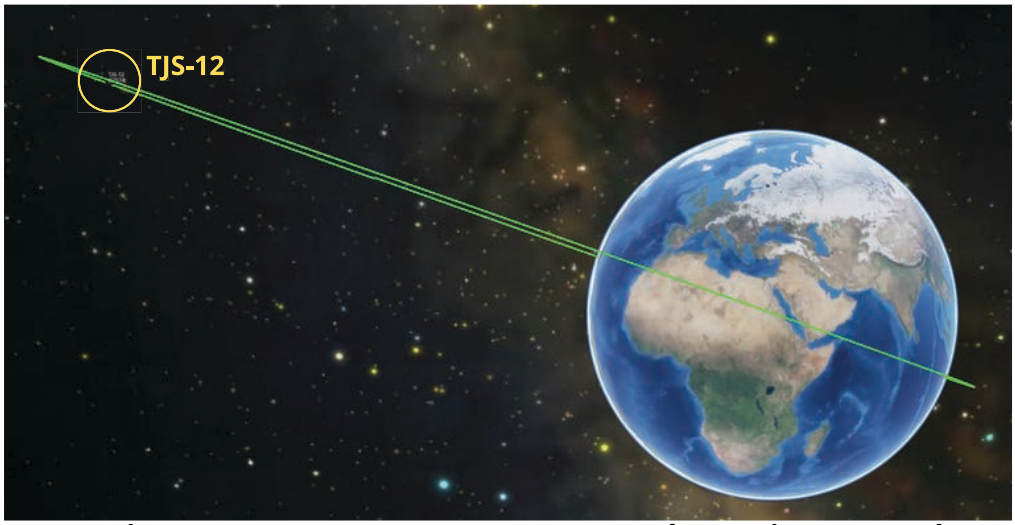
- As is typical for the TJS satellites, China has not released any details related to the spacecraft or its mission.

-TJS-12 is currently in Geostationary Transfer Orbit (GTO) and if it follows previous TJS missions to GEO will likely remain in GTO for ~7-10 days.

- TJS-12's flight profile differs from that of the TJS-13 (62188) mission which resulted in a HEO placement.

- Initial observations of TJS-12 show the satellite in a 28.4° inclined orbit with an SMA of 17,991km.
- By comparison the initial observations of TJS-13 placed the satellite into a 51.0° inclined orbit with an SMA of ~20,144km.
- The inclination and SMA for TJS-12 is similar to other GEO based satellites launched from Xichang using the LM-3B. For comparison I looked at the three Hulianwan Gaogui (HG) "high orbit internet satellites China launched in 2024.
  - HG-1 (59069) had an initial inclination of 27.7° and SMA of 18,033km.
  - HG-2 (60327) had an initial inclination of 26.7° and SMA of 17,999km.
  - HG-3 (61503) had an initial inclination of 28.4° and SMA of 17,986km.

-Based on these comparisons, TJS-12 is heading to the Geostationary Belt and is not partnered with TJS-13. I do expect another HEO based TJS satellite in the future.



TJS-12 in GTO (21 Dec 2024). Apogee = 35,795km Perigee = 193.9km Inclination = 28.4° (spaceaware.io)

LM-3B with TJS-12 Lifts Off from Xichang (nasaspaceflight.com)

TJS-12 Launch Patch (Left) and Mission Patch (right). (nasaspaceflight.com)

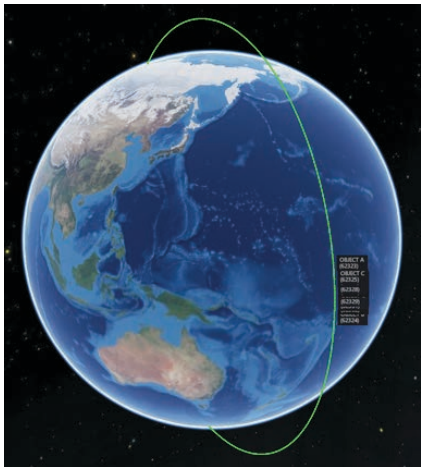
China Launches LM-5 with 10 Guowang pLEO Satellites

16 Dec: China used its most powerful rocket, the Long March-5B Y6 with a Yuanzheng-2 upper stage to launch the first group of 10 SatNet LEO (Guowang) satellites from Wenchang. Official sources noted "the satellites successfully entered the predetermined orbit and the launch mission was a complete success." Launch Video.

- All 10 satellites are currently in a ~1,110 x 1,094km orbit with an inclination of 86.5°. There are slight variations in the satellites altitudes and their positions relative to one another are evolving.
- Per Chinese news sources: Guowang plans to launch a total of 12,992 satellites. 6,080 will be in an extremely low orbit of 500 to 600km; the other 6,912 satellites will orbit at 1,145km.
- US Space Force 18th Space Defense Squadron confirmed the satellite count at 10 objects soon after launch.
- Per Andrew Jones Report:

  - Shanghai Academy of Spaceflight Technology (SAST) confirmed the success of the launch two hours after liftoff. Aboard were the satellite Internet low-orbit 01 satellite group, according to SAST, revealing no information about the number of satellites, nor basic details such as their orbits, satellite mass and manufacturer.
  - Guowang aims to provide global communications coverage from low Earth orbit and is seen as a response to Starlink and other constellations. Despite the ostensibly civilian focus of the Guowang constellation, the availability of details regarding the project is limited.
  - Guowang plans first became known in 2020 through filings for just under 13,000 satellites with the International Telecommunication Union. The constellation is managed by the China Satellite Network Group Co., Ltd., or China Satnet, established in April 2021…China Satnet will need, according to ITU regulations, to launch half of the 13,000 satellites by 2032.
  - A domestically controlled satellite network ensures China's strategic independence from foreign providers like Starlink. The Chinese military also noted the value of that system from the early days of Ukraine's response to the Russian invasion of the country in 2022.
  - China is leveraging the Long March 5B, originally designed to launch the country's space station modules and a crew spacecraft for lunar missions, to launch its megaconstellations, along with an enhanced Long March 8 rocket expected to debut next year. Commercial actors will also play a role.

LM-5B Prepares to Lift Off from Wenchang & Patch (nasaspaceflight.com)



Guowang Constellation as of 19 Dec 24. Expect Satellites to Disperse in coming weeks (spaceaware.io)

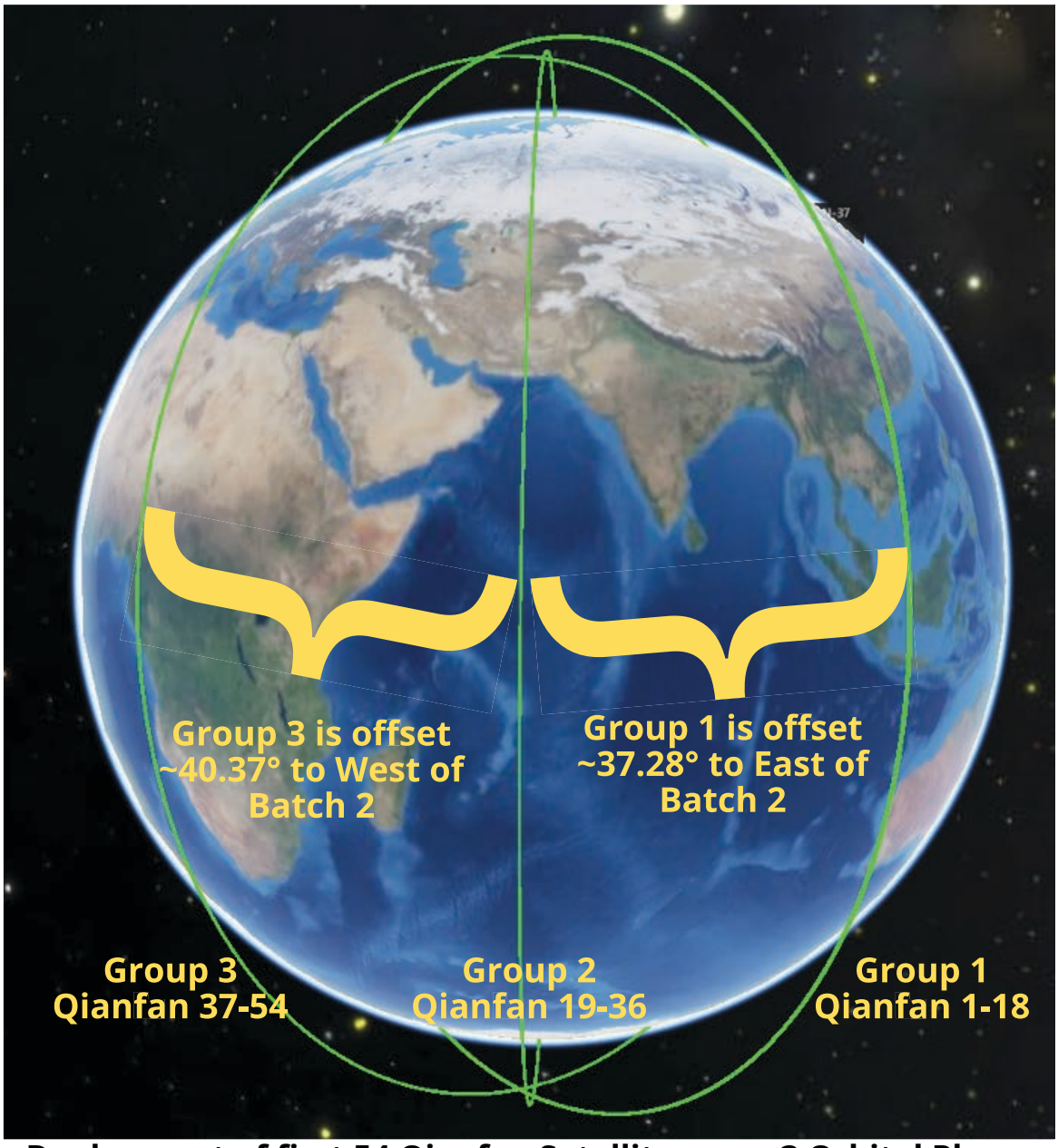
China has placed the Guowang satellites into a similar orbit as the 54 Qianfan satellites it has launched over the past 2 months. Guowang has an ~50km higher SMA (1,105.6 vs 1,068.5) and is inclined 2.5° less than Qianfan (86.5° vs 89°). Starlink satellites orbit at 550km or about half of what China is using for Guowang and Qianfan.

Update on China's Qianfan (Thousand Sails) Constellation

21 Dec: We now have orbital information on the third batch of 18 Qianfan satellites (Qianfan 37-54 <62238-62255>) China launched on 5 Dec 2024. Below is an initial analysis of the deployment.

-All of the Qianfan satellite orbits are inclined 89°. However they are not all co-planar as there is a RAAN offset. All three launches used a Long March-6A. There may be a 4th launch in 2024.

- Group 1: Qianfan 1-18 (60379-60396) launched on 6 Aug 2024, and most appear raised their SMA from ~810km to 1,070km. All satellites remain co-planar. RAAN is 335.87°.
- Group 2: Qianfan 19-36 (61552-61569) launched on 15 Oct 2024, and some have raised their SMA to ~850km while others remain at ~810km. This is consistent with what we observed during the first 2 months of the Qianfan 1-18 satellites. All satellites remain co-planar. RAAN is 118.59°
- Group 3: Qianfan 27-54 (62238-62255) launched on 5 Dec 2024, and all are orbiting near their initial deployment SMA of 810km. All satellites remain co-planar. RAAN is 78.22°

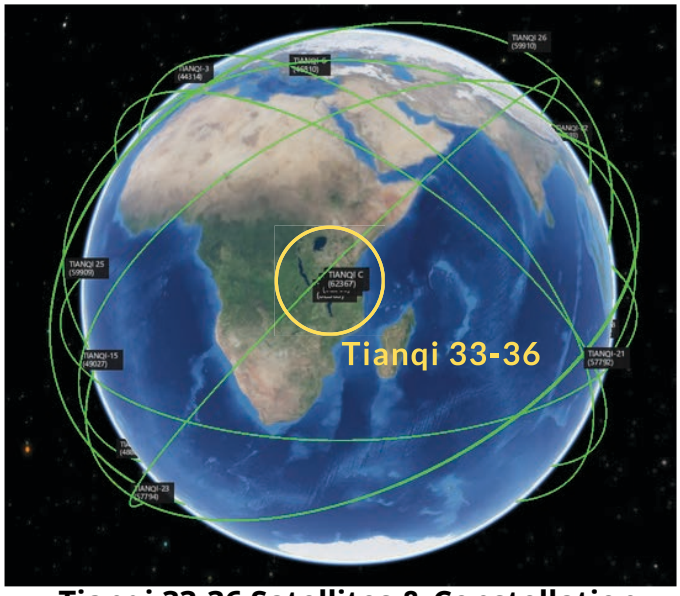


Deployment of first 54 Qianfan Satellites over 3 Orbital Planes Group 3 West, Group 2 Center & Group 3 East (spaceaware.io)

China Conducts Sea Launch of 4 Tianqi Satellites

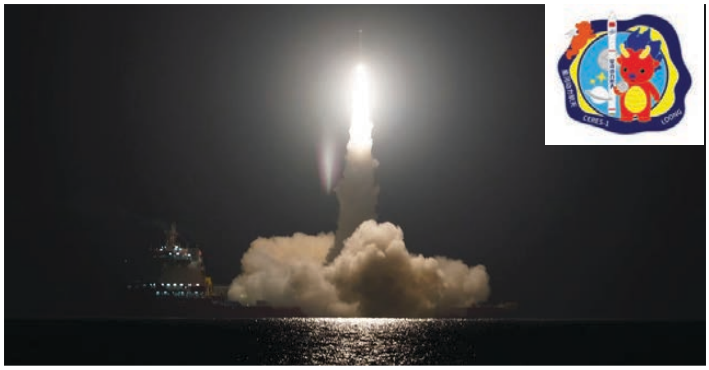
19 Dec: Chinese commercial company, Galactic Energy, completed its fourth successful Ceres-1S sea launch (15 of 16 total launches have been successful). The Ceres-1S launched four Tianqi satellites (Tianqi-33 ~ 36, 62365-68), from a sea platform located near the Shandong Province, China. According to official sources, the satellites have entered the planned orbits and are part of the Tianqi Constellation.

- All 4 of the Tianqi satellites were successfully placed into a 854 x 838km orbit with a 45° inclination. The satellites will likely increase their spacing in the coming weeks.
- The launch brings the total Tianqi constellation to 33 satellites (38 are planned for the complete constellation). The satellites are in a variety of orbits and several appear to have not maneuvered in quite some time.
- The Tianqi constellation will provide low-bandwidth communication to connect Internet of Things (IoT) devices in remote or hard-to-reach locations.
- "The Tianqi LEO satellite constellation is being built and operated by LEO satellite operator Guodian Gaoke Guodian Gaokeji), a Chinese private commercial space company and leading provider of domestic satellite IoT."
- Lu Qiang, chief executive of Guodian Gaoke, told Chinese media last year that the company plans to "expand our services to other fields, including outdoor emergency response and military applications."



Tianqi 33-36 Satellites & Constellation (spaceaware.io)

Ceres-1 Mission Patch (left), Ceres-1 Preparing for Launch (center), Tianqi 33-36 Payload Integration (right) (nasaspaceflight.com)



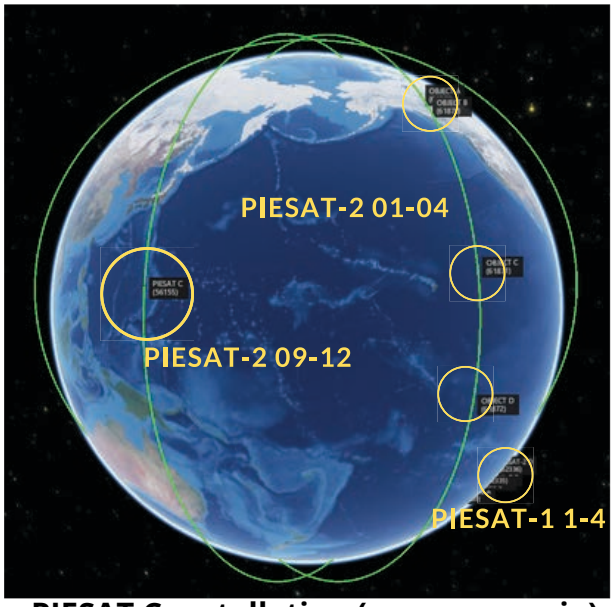
Ceres-1 Launch from (nasaspaceflight.com)

Launch and Stage Drop Locations (nasaspaceflight.com)

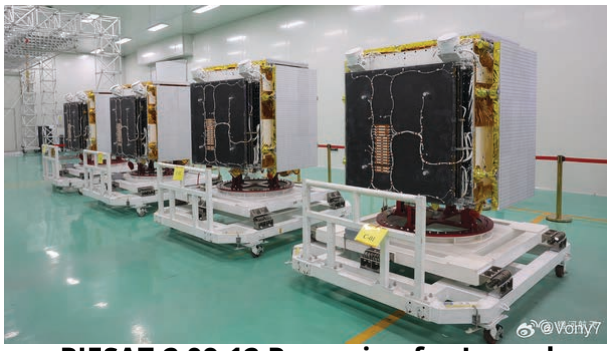
China Launches its 3rd PIESAT SAR Formation

16 Dec: China launched a Long March-2D with four PIESAT-2 satellites (PIESAT-2 09-12 <62333-36>) from Taiyuan. According to official sources, the PIESAT-02 09-12 satellites were designed and manufactured by GalaxySpace and will be "mainly used for synthetic aperture radar (SAR) imaging, with high-precision imaging capability". The PIESAT satellites are intended to cooperatively collect SAR imagery. There are now 3 sets of PIESAT satellites on orbit. Launch Video.

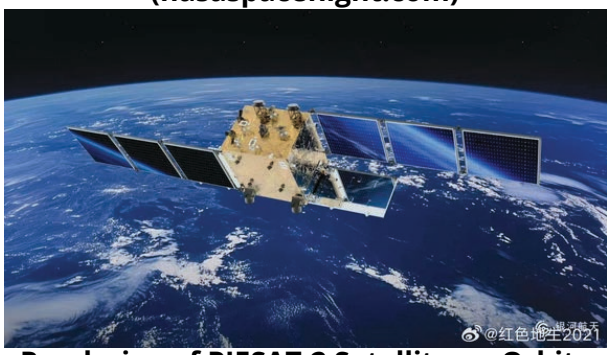
- PIESAT-2 09-12 are in 518 x 533km orbit inclined by 97.5 degrees. These values match the other PIESAT groups.
  - PIESAT-1 (56153-56): launched from Taiyuan on a LM-2D 30 Mar 2023
  - PIESAT-2 01-04 (61869-72): launched from Taiyuan on a LM-2C on 9 Nov 2024. These satellites do not appear to have maneuvered since arriving on orbit.
- PIESAT-1 and PIESAT-2 are X-band radar remote sensing (X-SAR) satellites.
- The PIESAT-2 satellites are part of the "Zhuzhou Constellation" which, when completed, will be composed of 16 small SAR satellites. While not stated, there will be a total of 20 PIESAT satellites on orbit, the first 4 may be considered test spacecraft.
- The 4 satellites in each PIESAT group, consist of one 320-kilogram pivot satellite and three 270-kg assistant satellites. It appears the Pivot Satellite maintains its orbit while the other 3 seem to rotate along its axis. This is consistent with prelaunch renderings. Watch Video.
- The main satellite will act as the transmitter, while the three passive satellites are the receivers.
- The 4 PISAT-1 satellites continuously operate within 1km of one another demonstrating the ability to maintain formation.
- Once the constellation is complete the time interval between two consecutive observations of the same location will be ~2.5 hours.
- To meet the requirements of satellite launch configurations, the Long March 2D rocket used a 3.8-meter diameter composite-material payload fairing for the first time. This fairing offers a larger internal space envelope, allowing for omnidirectional wave transmission.



PIESAT Constellation (spaceaware.io)



PIESAT-2 09-12 Preparing for Launch (nasaspaceflight.com)



Rendering of PIESAT-2 Satellite on Orbit (nasaspaceflight.com)

LM-2D Launch Patch (nasaspaceflight.com)

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AW200 - Analytical Writing
AW300 - Collaborative Analytical Writing
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CT600 - Critical Thinking for Learning Professionals
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TGT215 - Combat Assessment
TGT310 - Weaponeering and Collateral Damage Assessment
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TGT312 - Precision Point Mensuration
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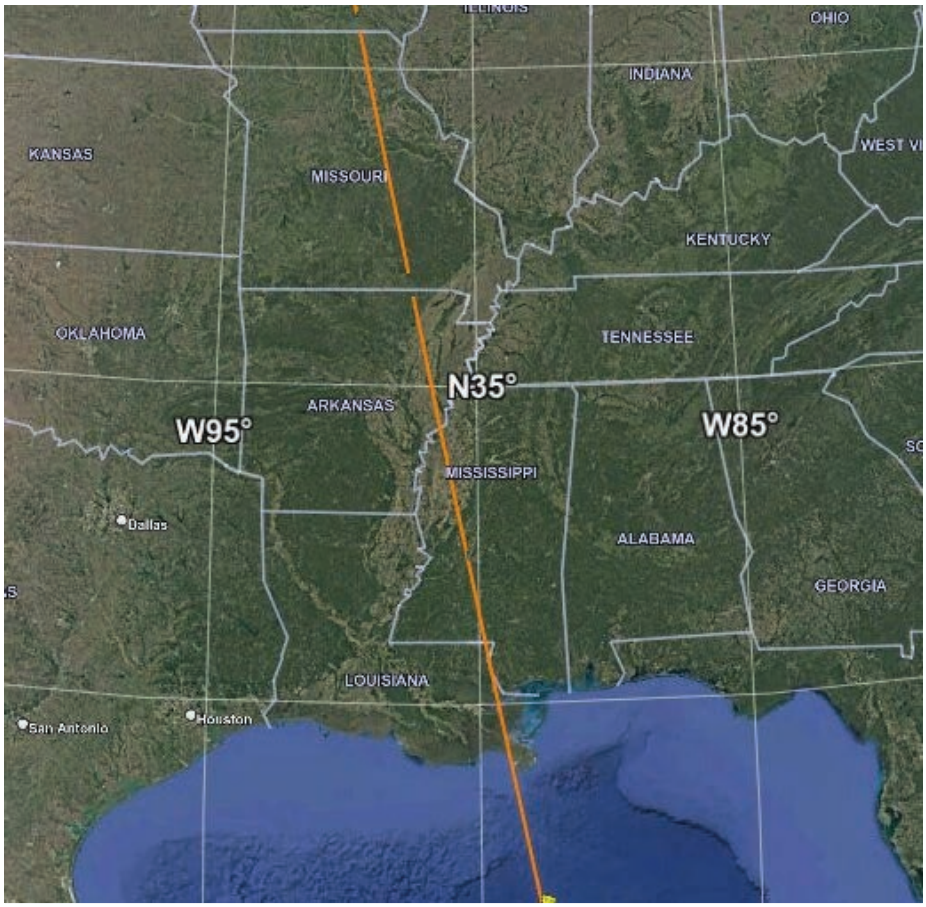
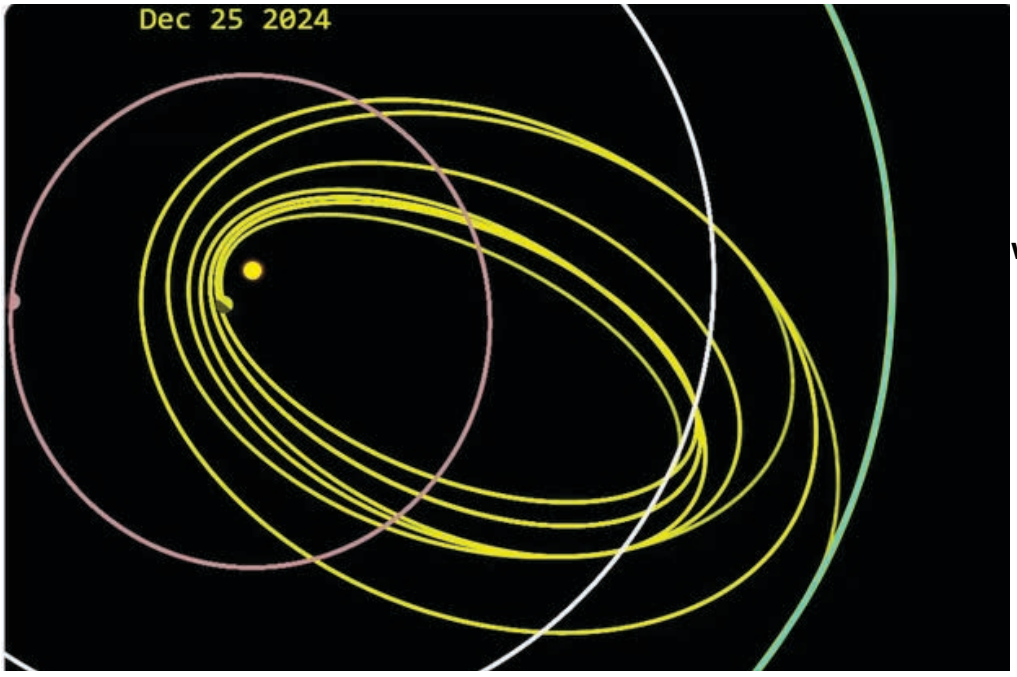
Pics o' the week!

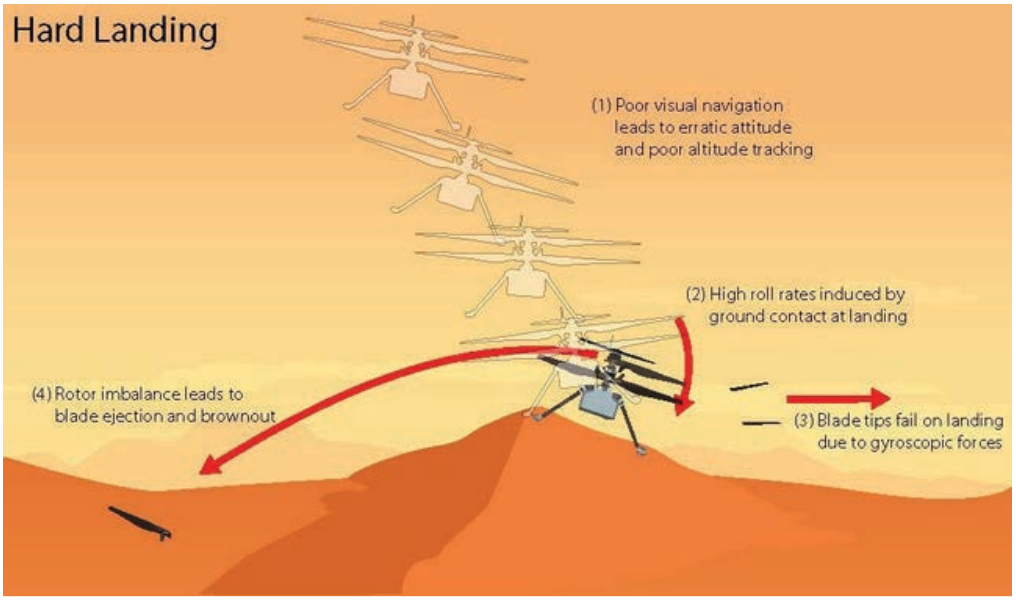


The commercial imaging satellite Superview 1-02, operated by Beijing-based SpaceView reentered above New Orleans at 0408 UTC Dec 22 heading northbound towards MS, AR, MO and was widely observed. Watch Video. (@planet4589.bsky.social via Bluesky)



On Christmas Eve, the #ParkerSolarProbe will make its closest pass ever to the Sun, flying at a record-breaking 191 km/s! It will pass just 6.1 million km above the Sun's photosphere, navigating through the scorching corona.

@tony873004.bsky.social



This graphic, created by NASA/JPL – Caltech, depicts the most likely scenario for the hard landing of the Ingenuity Mars helicopter during its 72nd and final flight on January 18, 2024. According to an accident investigation conducted by JPL and Ingenuity co-designer Aerovironment, high horizontal velocities at touchdown likely resulted in a hard impact on a sand ripple, which caused Ingenuity to pitch and roll, damaging its rotor blades.
@pomerantz.bsky.social

Astroscale's ADRAS-J mission has achieved the closest ever approach by a commercial company to space debris, reaching just 15 meters from a rocket upper stage.
(@astroscale_HQ via X)

Once-in-a-lifetime-shot by Photographers Gong Yurui and Liao Guihe when a bright meteor burned up in the atmosphere while capturing Andromeda Galaxy. (@konstructivizm via X)

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

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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.

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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.

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