All About The Chinese Space Programme

Go TAIKONAUTS!

龙腾太空

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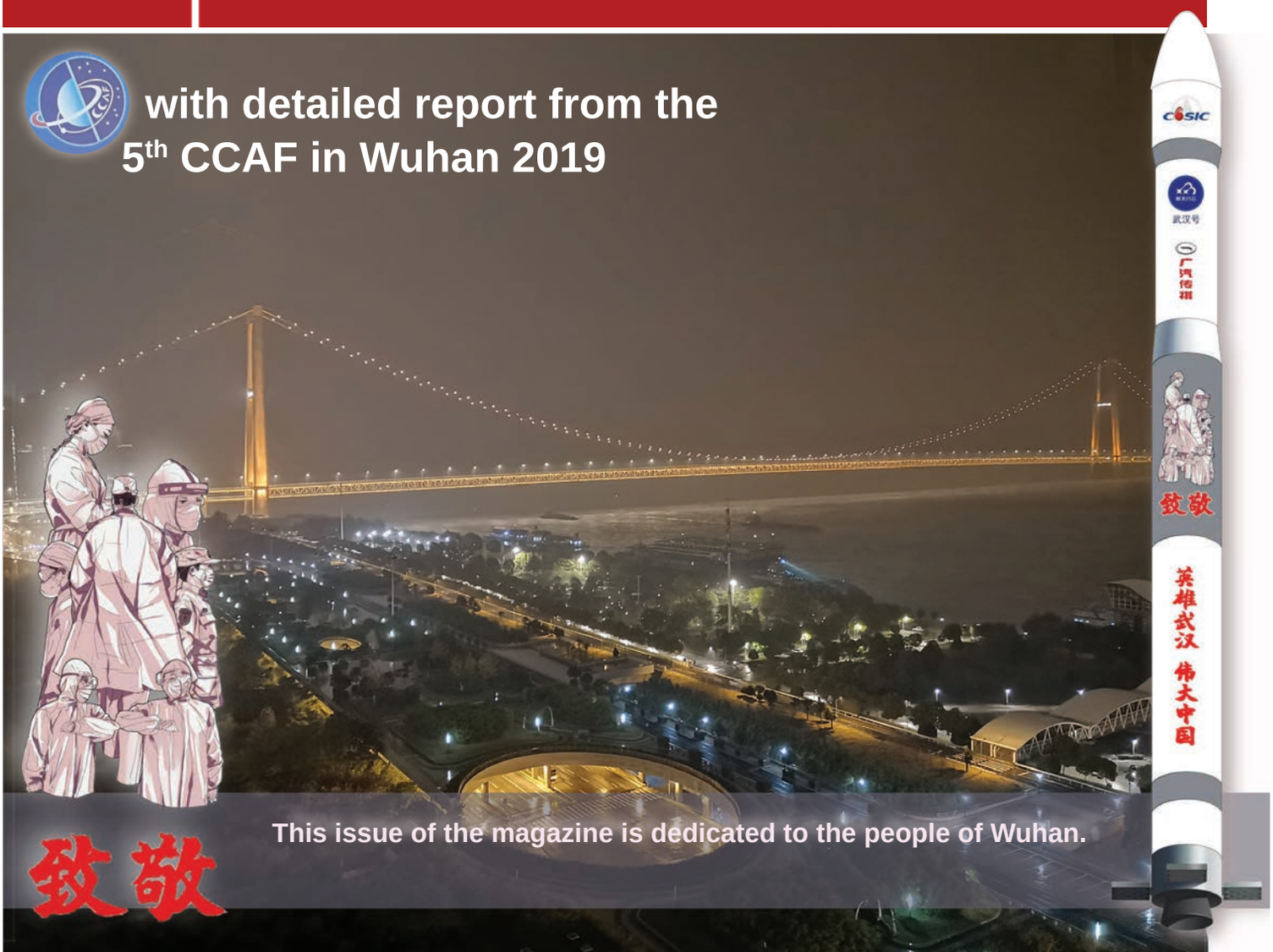
with detailed report from the 5th CCAF in Wuhan 2019



Credit: GoTaikonauts!/ExPace/CASIC/WeChat: yun-Gloria, zhangxiaoyun@leobit.com.cn

Content

Chinese Space Quarterly Report
April - June 2019
by Jacqueline Myrrhe, Chen Lan

SPACE TRANSPORTATION

CZ-3A
On 31 May, the China Academy of Launch Vehicle Technology (CALT) delivered a new Long March 3A payload fairing with a diameter of 4.2 m. The core components were manufactured domestically from polymethacrylimide (PMI). PMI is a light and stable material with high heat-resistance and noise cancelling capabilities, but showing at the same time a high radio compatibility, enabling smooth reception and sending of radio signals by the spacecraft or satellite. Previous payload fairings of 5 m diameter were built with imported materials.

Meet the Ace team of China's carrier rocket family

The "Ace team," comprising the Long March-3A, 3B, and 3C, have been the launch vehicles for almost every Geostationary Transfer Orbit (GTO) launch over the years, setting a record for the shortest time interval of 16 days between two launches. It took 18 years for the Long March 3A series to complete the 50th launch, and only about seven years to accomplish the 100th, with a success rate rising from 96 to 98 percent. What's more, the team responsible for the mission has halved from 300 to 150 people thanks to the mature production line and proficient operational flow.

CZ-5B
The Long March-5B rocket is in production and undergoing tests for engine reliability. Its first flight is expected for the first half of 2020. The CZ-5 is needed for the launch of the CSS modules.

Yuanwang space tracking vessels
In 2019, the Yuanwang (YW) fleet is planned to operate for more than 700 days at sea to support more than 30 upcoming space launches.

Yuanwang 2
After 40 years of tracking space missions on the world's oceans, the newly-retired vessel YW-2 took up a new mission in the field of science education. On 28 April, YW-2 was donated to the municipality of Jiangyin, in east China's Jiangsu Province. YW-1 is also retired, leaving YW-3, 5, 6 and 7 in the fleet of ocean-going space tracking ships.

Yuanwang 3
On 5 May it was reported that YW-3 had returned to port after finishing the monitoring mission for the launch of a Beidou 3 satellite.

On 8 June, YW-3 set sail again, leaving from its port in the Jiangsu Province for the southern Pacific Ocean. It was the 2nd satellite tracking mission of the ship in 2019, and the 52nd since its start of operation 20 years ago. Before departure, the crew underwent a mission-specific training and tested extensively all facilities.

On 18 June 2019 at 15:09 UTC (23:09 BJT), YW-3 crossed the Equator and continued sailing towards the southern Pacific Ocean.

Yuanwang 5
YW-5 left its home port on 5 May for the Indian Ocean.

Yuanwang 6
YW-6 began its first overhaul at the end of April at Jiangnan Shipyard in Shanghai, the vessel's first major maintenance after it was commissioned in 2008. The aim of the maintenance being to improve the ship's power system and to enhance the operability of on-board equipment.

Yuanwang 7
YW-7 departed from its home port in Jiangsu Province on 1 May for the Pacific Ocean, starting its 11th tracking mission since 2016 and the 1st of 2019. Before setting sails, the crew underwent emergency training and extensive mission planning.

On 10 June YW-7 returned after completing its 41-day long maritime space monitoring mission, supporting the sea launch of CZ-11 and of the Beidou DW45 satellite. The modernisation of the YW-7 vessel and upgrades to the software made it possible to extend its classic task of flight tracking to certain functions of a mission control centre.

MANNED SPACE FLIGHT

CSS – China Space Station
During the China National Space Day, it became known that the Experiment Module I "Wentian" and Experiment Module II "Mentian" for the CSS were under final assembly while the core module "Tianhe" was almost ready, undergoing space environment testing. Tianhe is scheduled for launch in 2020. The initial configuration of the CSS with three modules in T-shape and a mass of 66 t, could be extended to 180 t if required. This enlarged configuration would be able to accommodate 3-6 taikonauts. Also, the initial design lifetime of 10 years can be extended further by maintenance.

CSU (Technology and Engineering Centre for Space Utilisation; formerly: GESSA) has made breakthroughs in key technologies for the 16 internal experiment racks, and a test version of the experiment rack in the core module is almost finished. At about 1.8 m high, 1 m wide and 900 cm deep, each rack weighs less than 500 kg. They are smaller and half the weight of the ISS racks.

For the utilisation of the station, 100 international cooperation proposals have been received, and about 30 have passed the initial evaluation. The next round of selection - the national AO for CSS utilisation - was open from 1 July to 31 August 2019 on the website *www.cmse.gov.cn*.

The preliminary selection for astronaut candidates has concluded.

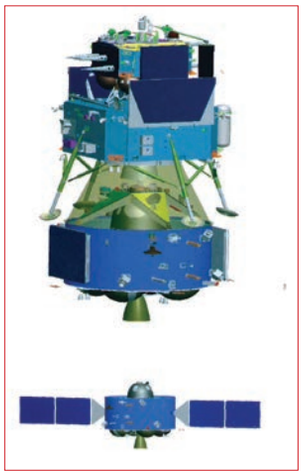
LUNAR AND DEEP-SPACE EXPLORATION

CHANG'E 4 mission
For a detailed overview on the operations during lunar day 4-6, see on page 17-18.

left: Yuanwang 2. Credit: Xinhua

right: Yuanwang 3 antenna. Credit: Xinhua

CHANG'E 6



Schematic of the Chang' e 6 probe. Credit: CNSA

On the occasion of the data handover ceremony to the foreign science teams contributing to the CE-4 mission on 18 April in Beijing, Liu Jizhong, Director of the Lunar Exploration and Space Engineering Centre of CNSA, announced the opportunity for international participation in the Chang'e 6 (CE-6) lunar mission. CE-6 is the back-up mission for the Chang'e 5 (CE-5) lunar sample return mission. CE-5 is currently scheduled for launch by the end of 2019. CE-6's landing location and detailed mission profile is depending on the outcome of the CE-5 flight. The CE-6 orbiter and lander will each reserve 10 kg for instruments, to be selected from national academic organisations, private enterprises and foreign scientific research institutions. France's National Centre for Space Studies CNES said in March that Chang'e 6 would carry French experiments.

Asteroid mission

Liu Jizhong also detailed the mission profile and objectives of China's first asteroid sample mission. Although still under discussion and not approved by the government, the preliminary plan calls for a 10 year-long, multiple-destination mission. The 200 kg probe, would first fly to the near-Earth asteroid 2016HO3 (also known as Kamo'oalewa), orbit and observe the object and then land for a sample collection. After the sample is stored, the return capsule will fly back to Earth and land while the main probe will continue its flight to Mars and beyond to rendezvous with Comet 133P/Elst-Pizarro, a main asteroid belt object which also has the asteroid designation 7968 Elst-Pizarro. The space probe instruments will be designed for exploring its morphology, surface composition and internal structure.

The spacecraft will be able to host 66.3 kg of scientific payloads, comprising 8 instruments including a medium-field of view colour camera, thermal radiation spectrometer, visible infrared imaging spectrometer, multispectral camera, detection radar, magnetometer, charged particles and neutral particle analyser, as well as a dust analyser. Once approved, the project could be ready within 5 years. Applications deadline was 31.08.2019.

Lunar Palace Isolation Study

What's it like to work in isolated space for 200 days?

Yi Zhihao, 28, still sometimes gets emotional when thinking about his volunteering experience living in a self-contained lab in early 2018. "It's incredible, I really did not expect to be able to make it for 200 days," Yi said. His group, along with another one, broke a world record by working rotations at a bio-regenerative life support system in Beihang University in Beijing for a combined 370 days. The Yuegong 1 (Lunar Palace) simulation study attracted world-wide attention.

Lunar South Pole Research Station

Zhang Kejian, Head of CNSA said during the opening ceremony of China's Space Day in Changsha that China aims to build a scientific research station in the South Pole region of the Moon and aims to realise a manned lunar exploration mission in about ten years. Shaoshan, the hometown of China's late leader Mao Zedong, will be one of the permanent storage centres of the lunar samples. He also mentioned in his speech that China plans to launch its first probe to explore Mars in 2020.

MARS

Mars 2020 mission

During a lecture at the Nanjing University of Aeronautics and Astronautics on 11 April, Sun Zezhou, Chief Designer for the Chang'e 4 lunar and future Mars probe said that the preparations for the Mars mission to be launched in 2020 and arriving on Mars by 2021 are going according to plan. The flight hardware has entered the final assembly and testing phase. The Mars rover is similar to Yutu 2 but twice as heavy, at around 200 kg. It will have a better mobility than YT-2 and improved autonomous navigation and control capability.

By the end of May, the Mars 2020 mission spacecraft was undergoing integration. The Academy of Aerospace Propulsion Technology AAPT completed testing of a variable thrust engine, capable of 7,500 N of thrust, which will provide the majority of deceleration for the landing.

Scientist Robert Zubrin on Why China Should Go to Mars

In March, Robert Zubrin, an US-American aerospace engineer and founder of the Mars Society visited several cities in China to mark the establishment of the Mars Society's first chapter in the country. He also attended LinkSpace's successful test launch of a reusable rocket prototype. Media outlet Sixth Tone spoke to Zubrin in Beijing to discuss China's spacefaring companies, the country's lunar and Mars missions, and the future of the space exploration. Zubrin also emphasised how impressed he was with the confidence of the young people at LinkSpace.

SCIENCE

GRANULOGY Microgravity Research

The international microgravity research project Space Grains, by a team from France, Belgium, Germany, Spain, China, and other partners, studies the dynamics and the statistical mechanics of an ensemble of particles that dissipates due to collisions. The experiments focus on clustering mechanisms, thermal fluctuations, convection, segregation and physical phenomena related to excited granular systems.

Within the Space Grain investigation, the GRANULOGY (Granular media in low-gravity environment) project is a cooperation between Europe (ESA – European Space Agency) and China (CMSA/Technology and Engineering Centre for Space Utilisation CSU (formerly: GESSA); Chinese Academy of Sciences; Institute of Physics - IOP).

The kick-off meeting of the GRANULOGY project was held in January 2019 in ESA-ESTEC in The Netherlands. A joint ESA-CSU GRANULOGY project meeting took place on 7-8 May 2019 in ESTEC. The GRANULOGY experiment hardware is being tested during several parabolic flight campaigns and will be installed later on into the European Drawer Rack on the International Space Station (ISS).

First Photo of a Black Hole

Shanghai Astronomical Observatory (SAO) coordinated 16 Chinese researchers who contributed to the efforts of a global science team for capturing the first-ever image of a supermassive black hole at the centre of the distant galaxy M87. Chinese scientists participated in the observations in Spain and Hawaii and made contributions to computer modelling and data analysis. Shen Zhiqiang, Head of SAO held a press conference on 10 April, 21:00 BJT (13:00 UTC) in Shanghai which was coordinated with press conferences by other colleagues in other cities all around the world.

SAO is China's leading institution in the area of very-long-baseline interferometry, which was the technique used for the black hole image. However, no Chinese telescope was directly involved in the observations by the global array of eight ground-based radio telescopes (EHT - the Event Horizon Telescope) coordinated for the imaging of the black hole.

Tianma

The 65 m "Tianma" radio telescope won the 1st price at the 2018 Shanghai Science and Technology Awards on 15 May. Tianma's data contributed to the precise calibration of the final data for the first image of a black hole. Tianma's high sensitivity has also

Tianma antenna. Credit: GoTaikonauts!

played an indispensable role in determining orbits for China's Moon mission. The telescope will also support the precision orbital calculations for China's first Mars mission in 2020.

International Cooperation in Space Science

The first working summit between the China Manned Space Office (CMSA) and the European Space Agency ESA was held at the European Space Research and Technology Centre (ESTEC) in The Netherlands. Representatives and scientists from 10 working teams have shared the latest developments regarding the bilateral space cooperation projects and agreed to further boost cooperation in the area of manned space science and applications. The cooperation started in 2012. In April 2017, the two sides announced a joint programme to select space cooperation projects, and by 2018, the first group of 10 projects had been approved by both sides.

FAST - Five-hundred-meter Aperture Spherical radio Telescope

On 1 April, a tightened ban on radio equipment and electromagnetic devices went into effect in the core silence zone of the FAST telescope. It is part of a newly-revised regulation. FAST's total quiet area includes a 5 km core zone, a 5 to 10 km intermediate zone and a peripheral zone stretching from 10 to 30 km. Violations can result in fines up to 30,000 RMB (around 4,500 USD) up from previously 5,000 RMB (around 750 USD). China Daily also reported that "the three counties closest to the FAST site have all adjusted their economic and social development plans" and that "Guizhou also scrapped a planned airport in Luodian county out of concern of possible electromagnetic interference."

Aerial photo of FAST taken on 27 August 2019. Credit: Xinhua/Ou Dongqu

Scientists from China and ESA worked and took a group photo in the High-bay of the Erasmus Building at ESA's European Space Research and Technology Centre in The Netherlands in April 2019. Credit: Cao Qian/CMSEO

SATELLITES

Haiyang-1C (HY-1C) and Haiyang-2B (HY-2B)

The Ministry of Natural Resources announced that the ocean observation satellites HY-1C and HY-2B have completed their in-orbit commissioning on 29 June. Both were launched in autumn 2018 and have a designed operational life of 5 years. HY-1C has special sensors for determining the ocean colour and water temperatures. HY-2B can detect marine dynamic parameters such as global sea surface wind fields, wave height and sea surface temperature.

World Meteorological Congress (WMC) - Fengyun International Cooperation

During the 18th WMC from 3-14 June in Geneva, Switzerland, China's support for enhancing global meteorological capabilities, especially for island nations and African countries was recognised. China contributes its state-of-the-art meteorological service system and data of its Fengyun (FY) series of meteorological satellites as well as training courses for meteorological experts at its Nanjing University.

China Meteorological Administration (CMA) has undertaken efforts to reinforce the international application of FY meteorological satellites, which includes the FY-2H satellite, filling the gap of observation data captured by meteorological satellites over the Indian Ocean, and the establishment of the Emergency Support Mechanism of FENGYUN Satellite (FYESM).

FYESM - Emergency Support Mechanism for International Users of Fengyun Meteorological Satellites in Disaster Prevention and Mitigation

FYESM was set up in April 2018. It is open to international users who made a request after being hit by extreme events such as typhoon, heavy rain, severe convection, forest or grassland fire and sand and dust storm. After the mechanism is activated, CMA will manoeuvre on-duty Fengyun satellites to initiate highly frequent observations of a given area at an interval of up to 5 minutes, processing and generating images and quantitative products, which are provided through such channels as CMACast, internet, FTP, public cloud and direct satellite broadcasting, to be used for disaster mitigation and relief in a timely fashion. In less than one year, 14 Belt-and-Road countries, including Iran, Algeria, and Mongolia, have been officially affiliated with FYESM. From September to October in 2018, in response to super typhoons Mangkhut and Yutu, Vietnam and the Philippines applied three times to activate FYESM. As of September 2018, there are 18 authorized FYESM users and 9 registered FYESM users.

- **Survey**

China conducted a survey asking 81 nations about their needs for meteorological data. 22 countries raised interest in the monitoring of rainfall, drought, dust storms, heavy fog and

lightning, in addition to training in Fengyun (FY) meteorological satellite data analysis, remote-sensing applications and data collection. Based on the outcome of the survey, China will offer customised data services for disaster prevention through its FY satellites for countries along the Belt-and-Road region. According to international disaster databases, losses and damage caused by disasters – mainly by meteorological disasters – occur in the Belt-and-Road territories about two times more often than compared to the global average. Additionally, there are many blind-spots regarding meteorological observation in this region.

So far, China's FY satellites have provided data and products for 47 countries along the Belt-and-Road region. All the 22 respondents said they wanted to install the application software platforms for weather forecasting, as well as climate and environment monitoring through FY satellites.

• 18th World Meteorological Congress - 18th WMC

China is supporting African countries in building their meteorological infrastructure and service capacity, as well as providing meteorological satellite information and programmes to other World Meteorological Organisation (WMO) members.

At the 18th WMC, the strategic shift to the integrated application of Earth observation data from terrestrial, maritime and atmospheric remote sensing data was endorsed, enabling a holistic view of the planet Earth and an interdisciplinary approach to the challenges of climate change.

• WMC electorates for Chinese experts

During the 18th WMC, Ms. Liu Yaming, Administrator of CMA, was elected as a Member of the WMO Executive Council. Mr. Shun Chi-Ming, Director of Hong Kong Observatory (HKO) was elected as Deputy President of the Commission for Weather, Climate, Water and Related Environmental Services and Applications.

• Fengyun - International Cooperation Mozambique, Oman, South Africa, Namibia

During the 18th WMC, CMA signed a number of Fengyun (FY) satellite application cooperative agreements with the meteorological authorities of Mozambique and Oman regarding FY satellite data ground reception systems and application platform development, emergency support services, technical exchanges, and training.

The Head of CMA, Liu Yaming, also met with the leaders of the South African Weather Bureau and the Namibia Meteorological Service, exchanging ideas and reached a preliminary consensus on establishing bilateral cooperative mechanisms, constructing meteorological infrastructure, applying FY meteorological satellites, and personnel training.

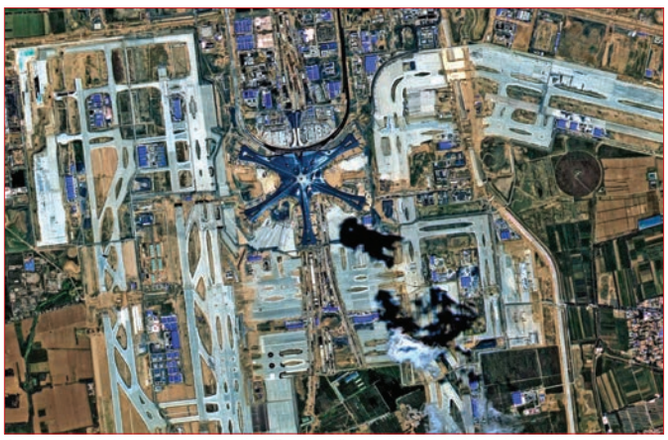
African countries have been hit by the tropical cyclone "Kenneth" at the end of April. The Emergency Support Mechanism for International Users of Fengyun Meteorological Satellites in Disaster Prevention and Mitigation (FYESM) was activated and CMA National Satellite Meteorological Center (NSMC) provided FY-2H and FY-3D data to forecast the cyclone and provided meteorological support for Mozambique's disaster relief efforts via Fengyun satellites.

• Fengyun - International Cooperation Kyrgyzstan

On 13 June, during Chinese President Xi Jinping's state visit to Kyrgyzstan, representatives from both sides signed an agreement between CMA and the Ministry of Emergency Situations of the Kyrgyz Republic on Cooperation in Fengyun Meteorological Satellites Services. The agreement aims at promoting bilateral meteorological scientific cooperation, supporting further FY satellites applications and improvement of disaster forecasting. Both sides will conduct pragmatic cooperation in FY satellite data transmission, reception and sharing, satellite remote sensing application platform construction, FY product development and application, emergency support services, personnel training, and technical exchanges.

Gaofen Applications

The State Administration of Science, Technology and Industry for National Defence (SASTIND) has signed a cooperation agreement with the city government of Qingdao, to promote applications of the Gaofen remote sensing satellite data in marine environmental monitoring, maritime rights and interests, maintenance and disaster prevention. For that purpose, a centre for high-resolution Earth observation will be established in the port city of Qingdao to provide satellite data assistance for marine science and technology innovation.



A high-resolution camera on the Gaofen 6 satellite took this photo of the new Beijing Daxing International Airport. Credit: Gaofen/China Daily

NAVIGATION

BEIDOU Interface Control Document

For the convenience of global users to use the BDS open service signal B1I, the "BeiDou Navigation Satellite System Signal In Space Interface Control Document - Open Service Signal B1I (Version 3.0)" was released on 26 February 2019. It can be downloaded from the web: *http://en.beidou.gov.cn/SYSTEMS/Officialdocument/201902/P020190227601370045731.pdf*

2nd Beidou Cooperation Forum between China & Arab countries

The 2nd Forum on Beidou Cooperation between China and Arab Countries was held under the theme "Cooperation, Application, and Service" in the Tunisian capital of Tunis on 1 and 2 April. (The 1st took place on 24 May 2017 in Shanghai). The 2019 forum introduced measures and initiatives that will increase the use of China's Beidou navigation satellite system (BDS) and its applications in the Arab world and in the Middle East. The conference also served the exploration of long-term mechanisms for international cooperation and exchanges, making the forum an important multilateral platform for deepening China-Arab cooperation on satellite navigation and promoting application of the BDS in Arab countries. During a dedicated "testing and experience activity", Beidou applications and service products for traffic management and agriculture were demonstrated.

The forum was attended by more than 200 Chinese and Arab officials, experts and business people. Several agreements were signed on furthering cooperation on the BDS. BDS has already been applied in Tunisia, Algeria, Kuwait and Sudan in areas such as precision agriculture, telecommunication, maritime monitoring and disaster relief. On the average, 8 Beidou satellites can be seen in Arab countries, providing a positioning accuracy of 10 m.

One outcome of the forum is that China will offer 5 scholarships for BDS studies. 18 short-term training courses have been offered since 2012 on Global Navigation Satellite System (GNSS) inside and outside China. Already 800 people received training and some Chinese experts were sent to Tunisia, Egypt, Sudan, Morocco, Algeria and other Arab countries to provide training courses on BDS.

Another outcome was that China and Arab countries will set up a permanent secretariat to the Forum to improve the forum mechanisms.

The 3rd China-Arab States BDS Cooperation Forum will take place in 2021 in China.

Special connection between China and Arab nations

Sharing the heritage of the ancient Silk Road, China and Arab states are natural partners for the "Silk Road Economic Belt" and "21st Century Maritime Silk Road". By adding the space dimension, the Space Silk Road would form an information and space corridor comprising a vast network of undersea cables, satellite networks and terrestrial links.
Taking energy cooperation as the main axis, infrastructure construction and trade-investment facilitation as the two wings, and the three major high-tech fields of nuclear energy, space satellite and new energy as the breakthrough, the two sides have formed the "1+2+3" cooperation pattern for jointly building the Belt-and-Road-Initiative (BRI).

"Declaration of Action on China-Arab States Cooperation under the Belt and Road Initiative", signed on 10 July 2018

Ran Chengqi (left), Director General of the China Satellite Navigation Office, shakes hands with Mohamed Ben Amor, Secretary-General of Arab Information and Communication Technologies Organisation, at a statement signing ceremony during the second China-Arab States BDS Cooperation Forum in Tunis, capital of Tunisia, on 1 April 2019. Credit: Xinhua/Meng Tao

A self-driving tractor equipped with the BeiDou Navigation Satellite System (BDS) runs along the planned routes via remote control during the second China-Arab States BDS Cooperation Forum in Tunis, capital of Tunisia, on 1 April 2019. Credit: Xinhua/Meng Tao

White Paper on Navigation Industry

On 15 May, the Global Navigation Satellite System (GNSS) and LBS (location-based service) Association of China released a White Paper on the Development of China's Satellite Navigation and Location Services Industry (2019). China's satellite navigation and location services industry achieved a total output value of 301.6 billion RMB (about 43.93 billion USD) in 2018, up by 18.3 % from the previous year. The industry's core sectors, which are directly related to the development and application of the satellite navigation technology, reported a value output of 106.9 billion RMB, corresponding to 35.44 % of the industry's total. Of this core sector, 80 % were related to BDS. Over 80 million sets of domestic BDS terminal products had come into service by the end of 2018. Close to 700 million terminal products, including smartphones, have the BDS compatible chips installed. There are 14,000 enterprises and institutions in the field of satellite navigation and location services in China, with more than 500,000 employees. Chinese satellite navigation and positioning products have entered markets in more than 100 countries, among which are 30 countries and regions along the Belt-and-Road territory.

10th China Satellite Navigation Conference

From 22-25 May, the 10th China Satellite Navigation Conference took place in Beijing. Under the theme “Navigation, 10 Years and Beyond”, seminars, presentations and exhibitions were held, discussing the technologies and applications of the GNSS, as well as the latest progress made in the Beidou navigation system.

Representatives of the satellite navigation system authorities of China, the United States, Russia, and the European Commission presented the latest progress and development plans of their respective satellite navigation systems. The conference also held forums on the industrialisation of applications, on policies and regulations, standards and intellectual properties. A joint forum with the Institute of Navigation (ION) of the United States, a coordinated development forum with the TD industry association, and a Beidou industrial park development forum with some industrial parks were also included in the programme. Other Beidou related forums discussed topics such as intelligent network cars, digital agriculture, high fusion, intelligent Olympic Winter Games.

More than 3,000 delegates attended the conference. At the navigation exposition, BDS's chips, modules, antennas and terminals were shown. During the conference it was confirmed that China will launch 6-8 new satellites of the Beidou Navigation Satellite System (BDS) in 2019.

- **Expert publication on Satellite Navigation**

Another outcome of the conference is the introduction of an open-access, free-of-charge, international English-language journal called "Satellite Navigation". The publication will focus on the latest theoretical development and technical applications in the field of satellite navigation. It will publish original papers and reviews on areas including satellite navigation signal processing, anti-jamming methods, satellite orbit determination and geoscience. The journal is coordinated by the Aerospace Information Research Institute of the Chinese Academy of Sciences (CAS) and Springer Nature, expected to be published officially in October 2019.

- **Beidou Chip**

Since April, a new high-precision baseband chip for BDS is in production and was publicly introduced in Beijing on 20 May 2019, in the run-up to the 10th China Satellite Navigation Conference in Beijing. Called "Lyra-II", the chip supports all civilian signals from the Beidou 3 satellites, and according to the chip's developer Beijing UniStrong, it is the first of its kind in the world. The company spent more than 50 million RMB over the last two years on the chip development and holds the independent intellectual property rights.

2nd BeiDou Satellite Navigation Application Expo

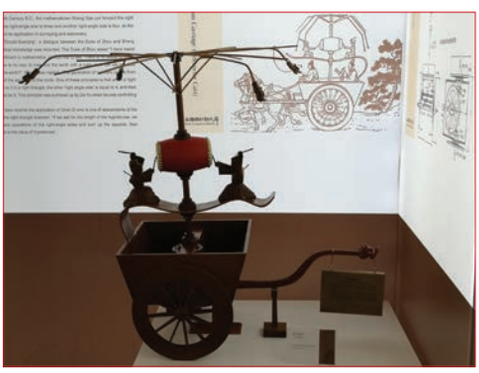
The 2nd China (Nanjing) Beidou Satellite Navigation Application Expo and Beidou Summit Forum took place from 4-6 June in Nanjing. During the forum, attended by 30 satellite navigation experts, it was re-iterated that Beidou 3 is expected to be completed in 2020, with a total of 35 satellites. Earlier it was reported that by then, the market value of Beidou applications is likely to exceed 2 trillion RMB. An accompanying 3-day navigation exposition attracted 200 exhibitors and 5,000 expert visitors.

Beidou Exhibition at the UN

From 11-21 June, the China Satellite Navigation Office showed the exhibition "From Compass to Beidou" at the Vienna International Centre of the UN in Vienna, Austria. It ran in

parallel with the 62nd session of the Committee on the Peaceful Uses of Outer Space, COPUOS. The models and information boards explained China's 5,000 years of history in the area of navigation. After the exhibition closed, China donated the two models of an ancient Chinese odometer carriage and a south-pointing chariot to the United Nations Office for Outer Space Affairs (UNOOSA) in Vienna.

The South-pointing chariot was used in ancient China to indicate the southern direction, functioning as a kind of compass. However, the pointing was not driven by magnets rather by a mechanically operated gear. This required to adjust the pointing arm of the chariot into the southern direction before using the vehicle for a journey. Credit: GoTaikonauts!



The "li-recording drum carriage" or odometer cart was used in ancient China for measuring the travelled distance. One "li" equals to 500 m. The wooden figure, driven by a mechanical gear, would strike the drum when one li was traversed. A person sitting in the cart would note down how often the drum was struck. Credit: GoTaikonauts!

TELECOM

Commercial TV Service for Rwanda

During a ceremony on 24 May 2019 in Rulindo District, central Rwanda, the Chinese Embassy in Rwanda handed over a China-funded satellite television project to the Rwandan government. The project will provide 6,000 households in 300 villages across Rwanda with access to digital television, as part of the ongoing long-term “Access to Satellite TV for 10,000 African Villages Initiative”. The houses were equipped with a satellite dish, a high definition set-top box and accessories while 900 public institutions were connected through a satellite projector TV system and 32-inch television sets.

During the 6th Ministerial Conference of the Forum on China-Africa Cooperation 2015 (FOCAC) in Johannesburg, South Africa, Chinese President Xi Jinping announced 10 cooperation plans among which was also the project “Access to Satellite TV for 10,000 African Villages Initiative”.

The project was implemented by StarTimes, a privately-owned Chinese electronics, media and satellite TV company with a strong presence in Africa, under the supervision of the Chinese Embassy in Rwanda and the Rwandan Ministry of Local Government. The “Access to Satellite TV for 10,000 African Villages Initiative” was launched in Dowa District in Malawi in August 2018. In January this year, the project was implemented in 1,000 villages in Nigeria.

compare: QR 1/2019; GoTaikonauts! 27, p. 9 “Satellite TV Service for Nigeria”

China Satcom for Initial Public Offering

Spacewatch Asia-Pacific reported that China Satcom (as CASC subsidiary) is aiming for a 1 billion RMB Initial Public Offering in June 2019. By doing so, China Satcom is responding to the Chinese government call to use private capital for investments. China Satcom's unit Hong Kong APT Satellite is already listed at the Stock Exchange. This new move would bring the rest of the operations to the stock market via the Shanghai Stock Exchange.

APPLICATIONS

Green Great Wall

The objective of the "Three-North Shelter Forest Programme", also called "Green Great Wall", is the plantation of a 4,500 km long forest belt along the northern parts of China by 2050. For that, the Yangling Seeds Corporation in Shaanxi province is cultivating plants from space-flown seeds. Experts count on this "space breeding technology" to improve the characteristics of ordinary seeds and breed plants able to resist the dry climate in northwest China. Seeds which have experienced mutations due to space radiation and are cultivated back on Earth can halve the breeding circle. In the past three decades, more than 6,000 seeds have been sent into space on Chinese recoverable satellites, resulting in some 230 species ranging from crops to herbs used for Chinese traditional medicine. The next new-generation recoverable satellite is planned for launch in 2021.

Drinking Water Environmental Protection App

The Chinese Ministry of Ecology and Environment developed a drinking water source enforcement app which integrates satellite remote sensing images, water environment problems spotted by satellite, water protection zone spatial data, water environment problems found by provincial and communal authorities and law enforcement data, and sends lists with environmental problems to law enforcers at the scene to guide their work. The remote sensing can also be used in making electric and visual files for water source protection zones after matching the satellite remote sensing images and the ground situation.

ADVANCED TECHNOLOGY

Heat-resistant Material

A team of scientists at Central South University in Hunan Province, developed a new heat-resistant material for hypersonic aircraft which can endure for several hours a temperature over 3,000°C caused by atmospheric friction during a flight at a speed of Mach 5-20. The China-made new material is a composite of ceramics and refractory metals, with low density and high malleability. It has been used for products in a variety of fields including aviation, space exploration, shipbuilding and national defence with an application potential for engines, space rockets and nuclear reactors.

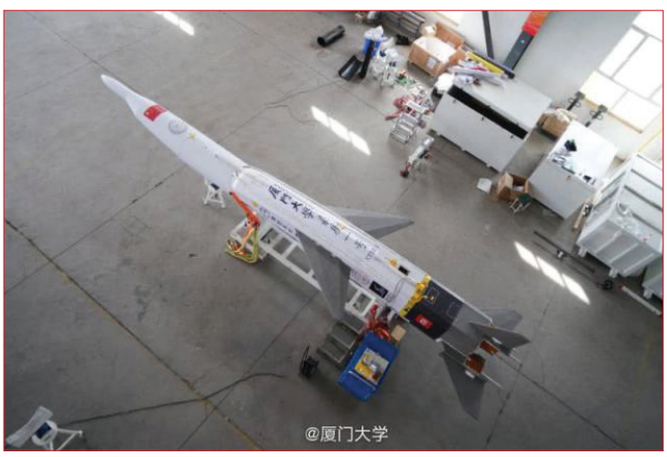
Hypersonic Airplane-Rocket Hybrid

The Xiamen University in East China's Fujian Province jointly developed with Beijing-based company Space Transportation the hypersonic airplane-rocket hybrid, Jiageng 1. Its length is 8.7 m, the wingspan is 2.5 m and the take-off mass 3,700 kg. During a first successful test flight on 23 April, the winged vehicle achieved a speed of 4,300 km/h, travelling at a maximum altitude of 26.2 km. After flight manoeuvres to “reproduce real flight conditions and conduct aerodynamic tests”, Jiageng 1 landed at the designated site in the northwest Gobi Desert aided by a parachute. Some details of the test, including the distance travelled, are classified because the project was partly funded by the military, according to the project team.

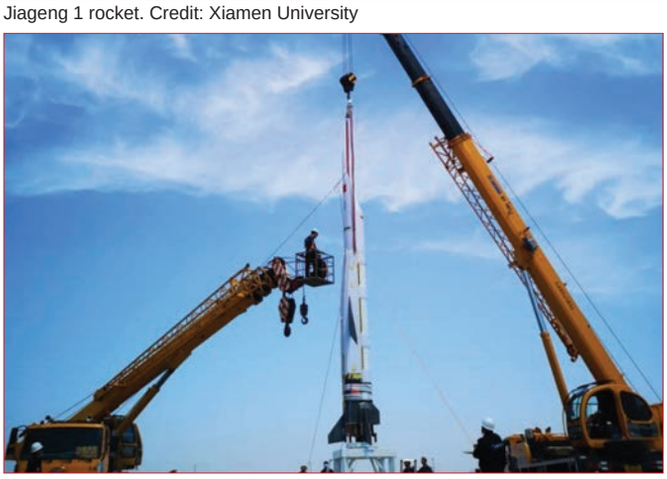
The flight served for testing the performance of the hypersonic test payload with a so-called dual (or: double) wave rider design incorporating the Xiamen Turbine Ejector-Ramjet Combined Cycle (XTER) propulsion system, designed by Xiamen University, and a turbine-based combined cycle (TBCC) engine. Existing hypersonic rocket design functions by using the compression lift created by its own shockwave to gain a high-speed lift-to-drag ratio. However, the “dual wave rider” design of the Jiageng 1 uses two shockwaves - one under its fuselage, and the other in the air-inlet duct for its ramjet engine to boost its speed to possibly Mach 4 to 6. This specific "double wave rider configuration" was designed by the university's School of Aeronautics and Astronautics. It makes the transition from supersonic to hypersonic speed more smoothly, creates more lift and allows further distances and using less fuel. The flight also verified the hypersonic vehicle's recovery and reuse technology.

The test was part of the university's project to try to quintuple the current speed of civil aircraft to achieve global direct access within two hours.

The test vehicle was named after Chen Jiageng, the business tycoon better known as Tan Kah Kee, who founded the university in Xiamen, Fujian province, in 1921.



Jiageng 1 rocket. Credit: Xiamen University


Xiamen University stages a test flight of a hypersonic vehicle. Credit: Xiamen University.

COMMERCIAL SPACE

COMMERCIAL Companies

By the end of 2018, China had 141 registered commercial space companies of which 90 % are privately owned and the other 10 % are state-owned businesses with often more than 10 years of operations. Approximately, half of the 141 enterprises are based in Beijing, another bigger part in Shaanxi province. A report by FutureAerospace counted among those 141 companies, 36 satellite manufacturers, 22 satellite launching companies, 39 satellite operators and 44 satellite application companies. 13 out of 39 satellite launches in 2018 were related to commercial activities, placing 36 satellites into space. The overall investment into the commercial space sector in 2018 amounted to 3.57 billion RMB, mainly in the field of launchers and satellites. 20 plans exist for satellite constellations, of which 14 are planned by commercial companies. Until 2025, Chinese enterprises plan to send 3,100 commercial satellites into space, and the commercial satellite market will reach a volume of 13.6 billion RMB, while the commercial launch market is expected to account for 17 billion RMB.

Guidelines for Commercial Space Launch Actors

With official approval on 30 May, SASTIND and the Equipment Development Department of the Central Military Commission publicly released a guideline document for commercial space actors in China on 10 June. The guidelines, welcomed by the space entrepreneurs, set standards for rocket technology research, space launcher development, testing of launch vehicles, safety, confidentiality and export control, as well as rules for the use of governmental launch sites, and the handling of rocket propellants. The document also outlines the requirements for commercial companies with respect to qualifications and the range of its businesses.

Also, under the new rules, Chinese private space companies are banned from building any kind of “weapons capable of attacking.” Observers of the Chinese private space sector stated that most of China’s rules are similar to those applied to American companies.

Commercial Rocket Branding

- **Great Wall Motors**

WEY, the new SUV brand of Great Wall Motors together with the China Space Foundation and China Academy of Launch Vehicle Technology (1st Space Academy) entered into a strategic cooperation during China Space Day 2019 and agreed to name the first Chinese sea-launch rocket CZ-11 WEY. This was the first occasion that a rocket, built by a state-owned company, was named after a commercial brand. The project focusses on the application of space technology in the automobile industry and includes the set-up of the first “joint technology innovation centre” between the space and automobile industry, inaugurated on 24 April. WEY hopes to realise new breakthroughs in research and development as well as in manufacturing. One first result of the cooperation between WEY and the space industry was that the WEY VV6 Space Commemorative Edition entered the market at the same time the launch took place on 5 June. *compare also with section: LAUNCHES*

1st sea launch by China. Credit: China DailyZhu Xingxin/Weibo

Liu Yanzhao, Executive Vice President of WEY brand, said that based on the current exterior design, WEY will draw inspiration from aerospace aerodynamics technology to improve its cars’ fuel economy and driving experience with a lower drag coefficient. Also, materials used for the SUV are taking advantage of the high-strength, high-stiffness and lightweight materials that are typically applied in aerospace machinery.

Until the end of April 2019 250,000 WEY SUV models were sold. Insiders assume that naming a satellite or a rocket usually costs 5 to 10 million RMB, staying below the rocket's overall launch cost. The CZ-11 launch cost is around 5.3 million USD.

• Chutian

On 24 April, during the Space Day of China in Changsha, CASIC Rocket Technology Company and Wuhan Science and Technology Bureau signed a contract to name one of the next Kuaizhou rockets "Kuaizhou-Chutian" (KZ-1A Y7). This is the first time the Kuaizhou vehicle received a naming sponsor. The KZ-1A Y11 was named Womendetaikong (Our Cosmos).

• Chang'an Automobile

At the beginning of June, Chinese car manufacturer Chang'an Automobile Co. Ltd. announced its support to private rocket company iSpace by naming the rocket for the planned July-launch after its passenger car brand Oushang. It is a response to the government's 2014 call to businesses to help the development of the nation's commercial space industry. The company stated if the launch succeeds it would provide funds of 10 million RMB (1.5 million USD).

• Tmall Douyu 666

In December 2018, on the occasion of the 10th anniversary of Tmall, the Tmall International Satellite, developed and manufactured by Beijing Jiutian Micro Satellite Technology Development Company, was launched from Jiuquan launch centre. Also, the Douyu 666 satellite, named after the internet company Douyu took off. This was the first commercial satellite named after a live broadcast platform, and Douyu was the first Hubei enterprise, sponsoring a satellite name.

Launch Opportunities with CGWI

China Great Wall Industries regularly publishes on its website payload opportunities on its Long March rocket flights. The status from May 2019 included 14 offers for the 2020-2021 time period and in different launch configurations (as a shared ride, as a dedicated mission or within a cluster) were available. Potential customers can raise their interest via CGWI's service e-mail: *launchservice@cgwic.com*

LANDSPACE

• Hot Test Firing

Following a successful power pack test in March, Landspace completed the assembly of the liquid methane-liquid oxygen rocket engine TQ-12 for its new Zhuque 2 (ZQ-2) launcher in the manufacturing factory in Huzhou. The engine is based on a modular and integrated design.

From 13 to 17 May, Landspace completed four successful full-system hot test firings of its 80-t methalox engine TQ-12. The run on 17 May was the longest and lasted 20 sec. The engine performed a stable and rapid initial start and shut down.

The company released photos and videos of the test runs at its test range, located near to the Huzhou manufacturing base. Landspace stated that their TQ-12 engine ranks number three after SpaceX's Raptor and Blue Origin's BE-4, and is larger than CASC's 60-t methalox engine prototype derived from the cryogenic engine YF-77. The TQ-12 engine has a sea-level thrust of 67 t and a vacuum thrust of 76 t. A future vacuum model will increase the thrust to 80 t.

In the last decade of July, Landspace successfully tested its TQ-12 liquid oxygen methane engine with a maximum test time of 100 sec. During the hot firing test run, the engine started and shut down as expected with measured performance data exceeding the design indicators. The engine's overall plan, startup and shutdown procedures, nozzle laser welding, high-efficiency turbo pumps, turbo pump fluid dynamic pressure seals, new valve dynamic seals and other innovative technologies have been fully evaluated, and the 100-t liquid rocket engine test bench has been verified.

Zhang Changwu, founder and CEO of Landspace, confirmed that the mass production of the TQ-12 engine and the ZQ-2 carrier rocket will begin later in 2019 in Huzhou. As of 2022, the annual production capacity of the Huzhou production line will be about 15 ZQ-2 rockets and 200 TQ-12 engines. The first flight of the ZQ-2 is expected by 2020.

Landspace's TQ-12 engine. Credit: Landspace

• Launch Agreement

On 25 April, at the 2nd Belt-and-Road Forum in Beijing, Landspace signed a cubesat launch contract with Open Cosmos of UK and another one with D-Orbit of Italy. The Memorandum of Understanding (MoU) with Open Cosmos values 100 million RMB (approx. 15 million USD), but is a non-exchange of funds deal. It gives Open Cosmos launch opportunities via Landspace's rockets while Landspace will advise potential customers to use Open Cosmos platforms when launching with Landspace.

LINKSPACE

After the successful, first untethered launch and landing test of its RLV-T5 tech demonstrator on 27 March (reaching 20 m), Linkspace demonstrated on 19 April a second, longer and higher low-altitude launch, reaching 40 m. The RLV-T5 demonstrator safely landed within 30 seconds. Linkspace reported that the 8.1 m tall and 1.5 t heavy RLV-T5 achieved a greater landing accuracy. For the near future it is planned to reach a height of 1,000 m, by 2020 of 100 km and an orbital launch in 2021. The 20 staff Linkspace team has started the research and development of the RLV-T6 sub-orbital reusable rocket and aims at completion by the end of the year. Once the reusable rocket is operational, Linkspace targets a price of 30 million RMB (4.48 million USD) per launch.

China's rocket start-ups go small in age of 'shoebox' satellites

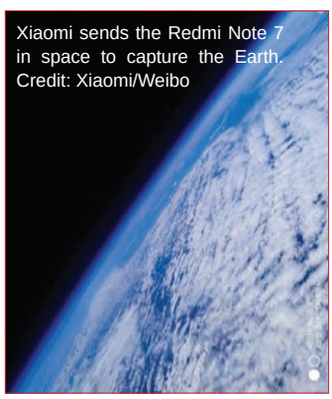
When the Beijing-based company's prototype, called NewLine Baby, successfully took off and landed last week for the second time in two months, no tether was needed. The 1.5 t rocket hovered 40 m above the ground before descending back to its concrete launch pad after 30 seconds, to the relief of 26-year-old chief executive Hu Zhenyu and his engineers – one of whom cartwheeled his way to the launch pad in delight.

Wuhan National Aerospace Base

On 24 April, the ground-breaking ceremony for the Satellite Industry Park was held at the Wuhan National Aerospace Base. The satellite facility with a smart production line for more than 100 satellites annually should become operational by 2020. The production is mainly for CASIC's Hongyun communication satellite constellation.

Mobile Phone in Near Space

In a marketing stunt, the Xiaomi Europe team sent the latest smartphone, the Xiaomi Redmi Note 7, on a hydrogen balloon to an altitude of 33,375 m where the device endured temperatures of -58°C and an atmospheric pressure of 1 kPa. The 48 Mpixel rear-facing camera on the phone was commanded to take photos of the Earth.



Xiaomi sends the Redmi Note 7 in space to capture the Earth. Credit: Xiaomi/Weibo

The mobile phone survived the near-space experience, proving the high quality of the hardware.

The Technical Choices of China's NewSpace Launcher Companies in 2019

The article looks at the technical choices of Chinese NewSpace start-ups regarding propulsion technology and expendability/ reusability, and what this reveals of their understanding of the commercial launch market. At the time of writing, we are entering the 5th year of China's "Open Up Policy" in the space industry, which has enabled private capital to flow into space companies and triggered the emergence of a large number of start-ups. Among these newcomers are approximately 15 launcher-focused companies (according to our latest Space Infographics mapping), all hoping to provide satellite launching services to the world within 1-3 years.

Chinarocket – Smart Dragon

On 3 April CALT reported that the engine test of the Smart Dragon 1 (SD-1) was concluded, paving the way for its first launch in the first half of 2019.

Space Cloud Cubic data platform

CAS introduced on 26 June in Shenzhen a data platform tailored to the needs of the commercial space industry, developed by CAS Tianta Co. Ltd. The Space Cloud Cubic platform offers services for data management, storage, and computing. CAS Tianta and Alibaba Cloud, the data intelligence branch of Alibaba Group, have signed a framework cooperation agreement in joint development of products and services under the Space Cloud Cubic platform.

Sky Mirror

The 54th Research Institute of China Electronics Technology Group Corp in Shijiazhuang is developing a space-based air traffic surveillance network, called Sky Mirror, capable of tracking and reporting the location of in-flight airplanes in near real-time. The system will consist of LEO satellites, which receive and transmit the ADS-B (automatic dependent surveillance-broadcast) signals from planes in-flight, independent from the coverage of the flight path through ground stations. Sky Mirror's first test satellite with ADS-B receivers is scheduled for launch by a CZ-11. 8 more satellites will follow until 2021 to form a regional system covering the Asia-Pacific region. Improvements are still needed in the number of adequately equipped satellites in space and the communication between satellites.

INTERNATIONAL COOPERATION

BRAZIL

On 24 May 2019, at the invitation of the Director General of the National Space Science Centre NSSC Wang Chi, the President of the Brazilian Space Agency (AEB) Carlos Augusto Teixeira de Moura paid an official visit to NSSC. Based on the ongoing solid bilateral cooperation for the projects China-Brazil Earth Resources Satellite and the China-Brazil Joint Lab for Space Weather, both sides discussed future initiatives. A preliminary consensus was reached on cooperation and exchanges in the field of space science. The Brazilian delegation also visited the research facilities in NSSC, e.g. the Electron Accelerators & Low Energy Ion and Electron Calibration System Facilities, the Concurrent Design Facilities as well as the Space Science Mission Facility.

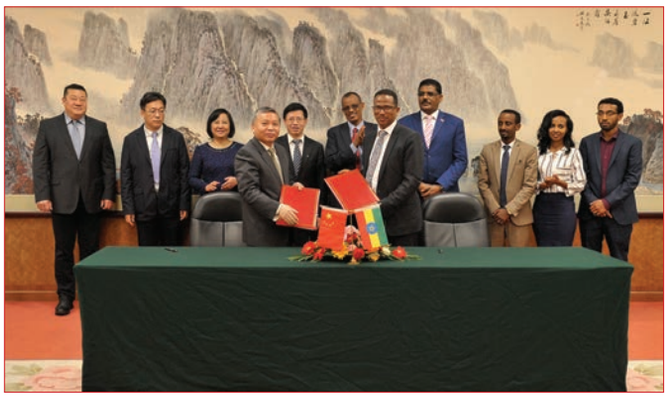
EUROPE - China Meteorological Administration CMA

From 9-10 June, the Administrator of CMA Liu Yaming visited the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, United Kingdom and held talks with Florence Rabier, Director-General of ECMWF. Liu Yaming was briefed about the work of the centre, the Copernicus Project, numerical weather prediction strategies, and visited the high-performance computing centre. Both sides exchanged ideas about pragmatic bilateral cooperation.

ETHIOPIA

On 22 April, Zhang Kejian, Director of CNSA, together with Wu Yanhua, Deputy Director of CNSA met in Beijing with Ethiopia's Minister of Innovation and Technology, Getahun Mekuria and the Director of the Ethiopian Space Science and Technology Institute, Solomon Belay.

The two sides exchanged views on follow-up bilateral space cooperation, and signed the Agreement on Cooperation in the Field of Space Activities between CNSA and the Ministry of Innovation and Technology of the Federal Democratic Republic of Ethiopia.



Zhang Kejian and Getahun Mekuria exchange documents. Credit: CNSA

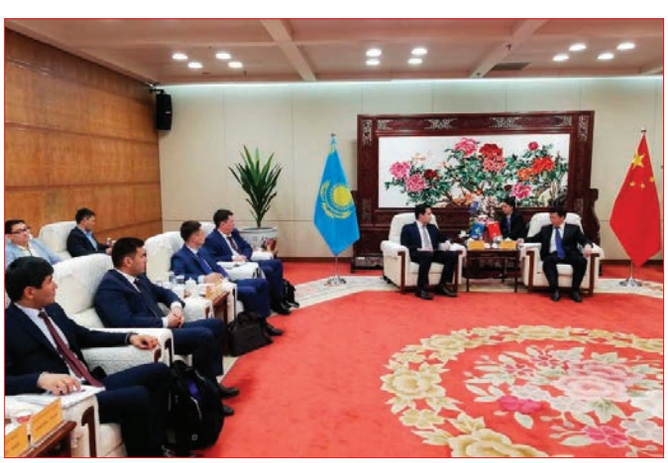
On 27 May, the Director General of the Ethiopian Space Science and Technology Institute Solomon Belay and the Deputy President of China Rocket Co. Ltd., Han Chinping signed in Addis Ababa an agreement to jointly build a telecom satellite. This project, starting in June 2019, will become the second satellite cooperation project. The first one, the Ethiopia's Multi-Spectral Remote Sensing Satellite ETRSS-1, is planned for launch by the end of 2019.

EUMETSAT, FRANCE

Wu Yanhua, Vice Administrator of CNSA, Jean-Yves Le Gall, President of CNES and Alain Ratier, Director-General of EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites), signed a cooperation agreement on 18 June 2019 (during the Paris Airshow) for the use of data delivered by the Chinese-French Oceanography Satellite (CFOSat) launched on 29 October 2018. EUMETSAT will distribute data from the satellite's payload to its 30 Member States and the European Centre for Medium-Range Weather Forecasts in near-real time and perform additional processing of the data once the CFOSat data stream will be operationally available as of autumn 2019. This service will help improve the accuracy of weather forecasts and aid understanding of climate change.

KAZAKHSTAN

End of May, the 2nd meeting of the Kazakh-Chinese Working Group for Cooperation in Space Activities was held in Beijing. The Deputy Chairman of the Aerospace Committee of the Kazakh Ministry of Digital Development, Defense and



Kazakh delegation in Beijing. Credit: www.inform.kz

Aerospace Industry, Malik Olzhabekov, held negotiations with CNSA Deputy Administrator Wu Yanhua. Both sides discussed areas of cooperation in satellite technology applications and in the development of scientific programmes. The Kazcosmos delegation visited the China Centre for Resources Satellite Data and Application and the 5th Academy.

Representatives of the Kazakh Ministerial Centre of Space Communication met with their colleagues from ChinaSatcom to discuss electromagnetic compatibility of the Kazakh and Chinese communication satellites. The Kazakh specialists of the Ministerial Centre of Space Communication also discussed with China Great Wall Industry Corporation cooperation opportunities in the field of communication satellites.

PAKISTAN

Amer Nadeem, Chairman of the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), participated in the opening ceremony of China Space Day in Changsha, Hunan province on 24 April. He told Chinese media that Pakistan intends to send one of their astronauts to China's space station by 2022. He hopes that the agreement on the matter will be signed very soon, so that Pakistan can start selecting suitable candidates. Parts of the astronaut training will be done in China. Nadeem also mentioned that Pakistan and China will further enhance cooperation on several space projects focusing on satellite networks.

On 28 April, CNSA Director Hao Chun and SUPARCO Chairman Amer Nadeem, signed in Beijing a cooperation agreement for scientific and technological experiments, astronaut training, along with manned space applications. Under the agreement, CNSA and SURPARCO will establish a jointly chaired China-Pakistan Space Committee to address future cooperation.

RUSSIA

China and Russia have agreed on joint lunar exploration. Yu Guobin, Deputy Director of the Chinese Lunar and Space Exploration Engineering Centre, told Russian media at the end of April, that both countries are evaluating the options for joint lunar exploration in 2023 through the Russian Luna 26 orbiter mission and the Chinese Chang'e 7 mission. The launch of Luna 26 almost coincides with that of Chang'e 7. This would open opportunities for simultaneous observations and data sharing. Expert teams of the two countries are involved in discussing the specific details.

SOUTH AFRICA - Square Kilometre Array SKA

On 24 June, on the side-lines of the Forum of China-Africa Cooperation (FOCAC) Coordinators' Meeting in Beijing, South Africa's Minister for International Relations, Naledi Pandor, signed a partnership agreement with her Chinese counterpart, Wang Yi, State Councillor and Minister of Foreign Affairs. The bilateral agreement serves as a framework for Chinese entities to partner with South African institutions for work on the SKA project and is a commitment to fully participate in the building of the radio telescope. The agreement includes an MoU between the South African Radio Astronomy Observation (SARAO) and the National Astronomical Observatory of China together with the Chinese Academy of Sciences regarding the Radio Astronomy Research Exchange Programme, for the training of graduates from South Africa in China.

Shanghai Cooperation Organisation SCO Summit in Bishkek

On 13-14 June 2019, the 19th annual Summit of the Council of Heads of State of the SCO was held in Bishkek under Kyrgyzstan's chairmanship during the 2018-2019 time period. The SCO consists of 8 Members (China, Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, India, and Pakistan), 4 observers (Afghanistan, Belarus, Iran, and Mongolia), and several dialogue partners (Azerbaijan, Armenia, Cambodia, Nepal, Turkey, and Sri Lanka).

The summit resulted in the signing of the Bishkek Declaration of the SCO's Heads of State Council. The press communique, issued at the end of the summit, stated: "The Member States note the importance of keeping outer space free from weapons and the top-priority importance of unfailingly complying with the current regulatory-legal framework that stipulates the exclusively peaceful use of outer space. They praise the work of the Group of UN Government Experts for reviewing and submitting recommendations on substantive elements of a legally binding international document for preventing an arms race in outer space and also stipulating reliable guarantees for the no first placement of arms in outer space." Russia will chair the 20th SCO summit in 2020.

UNOOSA-CNSA

Lunar Cooperation Agreement

During the China Space Day 2019 in Changsha, UNOOSA and CNSA signed a lunar exploration cooperation agreement. UNOOSA Director Simonetta Di Pippo told Chinese media in Changsha: "Also, UNOOSA just signed a framework agreement with China, allowing UN Member States to participate in its scientific missions for the exploration of the solar system. It will bring scientists from all over the world to work together, which will bring a lot of innovation."

A request for information on this subject sent to UNOOSA by the end of January 2020, stated: "The MoU is to cooperate in expanding the benefits of, and access to data from, China's lunar and deep-space exploration missions to the international community. In particular, UNOOSA and CNSA will work together to encourage countries to actively participate in China's lunar and deep-space missions and promote the development of technological capabilities and scientific progress in these fields at the global level, in line with UNOOSA's mission to bring the benefits of space to all of humankind. The MoU is in the initial phase and we are currently exploring how to best leverage this cooperation."

Signature Exchange Ceremony in Changsha. Credit: GoTaikonauts!

UNOOSA and CMSA announce winners of opportunity to fly experiments on board the China Space Station

At a side event of the 62nd session of the Committee on the Peaceful Uses of Outer Space (COPUOS) on 12 June 2019, the United Nations Office for Outer Space Affairs (UNOOSA) and the China Manned Space Agency (CMSA) announced the winners of their joint opportunity to conduct experiments on board the China Space Station (CSS). 6 winning projects were selected, and 3 were conditionally selected.

The 9 projects involve 23 entities from 17 countries including Belgium, China, France, Germany, India, Italy, Japan, Kenya, The Netherlands, Norway, Mexico, Poland, Peru, Russian Federation, Saudi Arabia, Spain and Switzerland. The

research topics are covering the fields of aerospace medicine, space life sciences and biotechnology, microgravity physics and combustion science, astronomy and other emerging technologies.

Also compare our report in GoTaikonauts! issue no. 25, pages 24-28

USA

Reuters reported on 27 June, that the U.S. and China are aiming for a bilateral meeting on civil space matters this autumn in the U.S. The topics of concern include "being a responsible actor in outer space" and "China's philosophy of commercial space activities".

VENEZUELA

Venezuela's President Nicolas Maduro said on 24 May while visiting the exhibition of innovations and technologies of the Venezuelan Armed Forces, that the country plans to launch its own system of nanosatellites with support from Russia and China. China has assisted in the launch of three Venezuelan satellites in the past.

EDUCATION

Mars Base Jinchang

After opening in October 2018, the Mars-themed tourist and educational facility C-Space Project Mars Base 1 simulation habitat, in the Gobi Desert outside Jinchang, Gansu Province, was used for the first time on 17 April by a group of 100 school students for a 5 hour-long project course. The C-Space Base is situated 40 km from Jinchang. The facility consists of nine interconnected modules, including a greenhouse, a control room and an air-lock.

It is a project by Jinchang Star Universe Culture & Tourism Investment Co, a Chinese media company, in cooperation with the Gansu administration.

It is planned to invest 2.5 million RMB over the next years to extend the area to 67 km^2 and attract 2 million visitors by 2030. The camp has contact with the Astronaut Centre of China (ACC) to look into the option of using the facility for astronaut training purposes. In the neighbouring Qinghai-Tibet plateau, a first Mars “village” simulation facility was opened in March.

Mars Base Jinchang (also called: C-Space Project Mars Base 1)
Aerial view of the C-Space Project, a Mars simulation base in the Gobi Desert in Jinchang, Gansu Province, China. The base opened officially on 17 April 2019 with the aim to educate and provide an environment for youths and tourists to experience life on planet Mars.

Inside view of Mars simulation base in Gansu
Another photo gallery with aerial and close-up photos of the recently opened Mars Base 1 in the barren, windswept hills of Jinchang City, in Northwest China’s Gansu Province.

China Focus: Exploring life on Mars in the Gobi desert
The Mars base made international headlines when it started trial operation and welcomed more than 100 local students on a five-hour tour on 17 April.
Since then, Mars Base One has received over 500 visitors, mainly teenagers, from across China who yearn to take a peek at the futuristic base before its official opening later this year.

Mars Base Jinchang photo gallery

International Talent Training

Two Venezuelans, two Pakistanis, one Cambodian, one Russian, one Belarusian and one Kazakh engineer are taking part in a satellite design, operation and maintenance course at the Shenzhou Institute in Beijing, a training programme hosted by the China Academy of Space Technology. The aim is to train outstanding foreign students to become space industry engineers capable of developing and manufacturing satellites on their own, thus enabling their countries to build their respective space industries and explore space.

Edgar Moreno Pena (front), a space industrial engineer from Venezuela, attends a course with fellow students at the Shenzhou Institute in Beijing. Credit: China Daily

MISCELLANEOUS

During the **62nd session of the Committee on the Peaceful Uses of Outer Space of the United Nations** from 12-21 June 2019 in Vienna, China made three technical presentations:

Status and Future Prospect of China Deep Space TT&C Network, presented by Li Haitao: http://www.unoosa.org/documents/pdf/copuos/2019/copuos2019tech45E.pdf

Introduction to China Space Foundation, presented by Wang Cheng: http://www.unoosa.org/documents/pdf/copuos/2019/copuos2019tech29E.pdf

China Space: Realizing the Sustainable Development Goals, presented by Jiang Hui: http://www.unoosa.org/documents/pdf/copuos/2019/copuos2019tech22E.pdf

Paris Airshow 2019

As an expression of the importance China's space industry attaches to its relations with the European space industry, China Aerospace Science and Technology Corporation (CASC) participated in the Paris Airshow 2019. CASC showcased models of the CZ-7, together with CZ-8, CZ-6 and CZ-11, at their booth.

CHINA NATIONAL SPACE DAY 2019

United Nations/China Forum on Space Solutions
http://www.unoosa.org/oosa/en/ourwork/psa/schedule/2019/2019-un-china-forum-on-spacesolutions.html

Detailed Programme and Presentations (accessible via the link in the PDF document):
http://www.unoosa.org/documents/pdf/psa/activities/2019/UNChinaSymSDGs/Detailed_Programme_with_links_to_presentations_-_as_delivered_06052019.pdf

Impressions from the 2019 edition of China Space Day in Changsha by Jean Deville who attended the International Commercial Space Symposium.
https://china-aerospace.blog/2019/04/28/impressions-on-the-2019-edition-of-china-space-day-in-changsha/

China National Space Day 2019

The central event for the China National Space Day 2019 took place from 23-29 April in Changsha, the capital of Hunan Province. Many events, conferences and workshops run in parallel during this week-long celebration, e.g. the 2019 China Earth Observation Business Summit on 25 April with 300 participants, the China-Europe Earth Observation Symposium, the Sino-Russian Lunar

Exploration Symposium, to name only a few.

CNSA signed agreements on space cooperation with the UN Office for Outer Space Affairs, Turkey, Ethiopia and Pakistan's SUPARCO. 12 cooperation agreements with an investment volume of 20 billion RMB were signed between 23 enterprises or institutions.

Signature Ceremony for the agreement between CNSA and SUPARCO. Credit: GoTaikonauts!

Space Achievement Exhibition

The multiple events were accompanied by a Space Achievement Exhibition, covering an area of 11,000 m^2 and displaying exhibits of three main topics: Aerospace Achievements, China's and Foreign Commercial Aerospace, and Aerospace Science Popularisation. Also shown were commercial aerospace technologies and products in the aerospace industrial chain, aerospace industry integration and application achievements, models of space hardware such as the Shenzhou 11 re-entry capsule, the "Feitian" spacesuit, the Chang'e 4 lunar probe with the Yutu 2 rover and Queqiao relay satellite or space cultural relics, simulation models, and interactive exhibits utilising VR/AR/3D, touch-screen and other advanced technologies. Also present at the exhibition was the Hunan Geographic Information Industrial Park, including the China Centre for Resources Satellite Data and Application, and Jusfoun Big Data Information Group. The Hunan Geographic Information Industrial Park comprises 89 geo-information-based enterprises and institutions and platforms such as Geospatial Big Data Application Centre, the Innovation and Entrepreneurship Base, ChinaRS (Hunan) Science Park, the Hunan Geographic Town and the Geographic Information Industry Park Incubation Centre.

Commercial Space Forum

During the Commercial Space Forum on 23 April, which also ran within the National Space Day celebrations in Changsha, it was announced that CNSA will soon introduce rules and guidelines to regulate commercial rocket manufacturing, test-flights and launches. **Wu Yanhua**, Deputy Director of the CNSA pointed out that commercial space companies can count on governmental support in creating a solid foundation for the healthy development of the sector. It is in the government's interest to improve the governmental procurement processes of commercial aerospace products and services, to innovate government service models, and to guide private capital and social forces to participate in related aerospace activities.

Changsha Exhibition. Credit: China Daily

Poster for China Space Day 2019. Credit: Yang Quan

He also confirmed that the creation of a national space law has been included in the legislative plan of parliament, and could be introduced in the next 3-5 years. Commercial space companies must strictly follow state regulations on safety and confidentiality to protect national security. The law will require private entities to seek permission before undertaking research on related technologies and products. It will also focus on safety concerns, especially regarding solid-fuelled rockets that contain high-risk propellants and chemicals.

Huang Zhicheng, an expert in space technology, told Chinese media that the national space legislation should address safety concerns in the development of the commercial space industry, stressing that rockets are technically missiles. Since the space sector is a very technology-intensive industry with a high entry threshold, safety is of concern. It is in the nature of commercial companies that they are driven by profits. Laws setting standards for research and development can prevent enterprises from taking risks or ignoring safety concerns in favour of maximizing profits. Additionally, unqualified companies should not be able to enter this industry.

Zhang Yulin, former Deputy Commander of China's manned spaceflight project, promoted the establishment of an economically viable Earth-Moon space transportation system for extending manned spaceflight activities from LEO, via GEO, to the Earth-Moon environment. The development of a new generation of carrier rocket, advanced spaceflight technologies for manned exploration are the prerequisites for manned exploration of the Moon. In particular GEO is becoming increasingly more important in the space economy for the installation of large-scale space solar power stations and other infrastructures. (also see: Report on 5th CCAF on pages 24 to 31)

CNSA released the "2019 China National Report on High-Range Satellite Applications" (Business Application Volume), focusing on the specific areas of remote sensing business support. The application of the business process initiates the era of commercialisation of China's remote sensing satellite applications.

Hunan Aerospace Industry Development Symposium

During the Hunan Aerospace Industry Development Symposium on the 24 April, agreements for the establishment of research and incubation centres for space industry manufacturing, satellite applications with various government agencies, universities, and local enterprises in Hunan province as well as launch agreements, were signed.

United Nations/China Forum on Space Solutions: Realising the Sustainable Development Goals

Co-organised by the United Nations Office for Outer Space Affairs and the China National Space Administration, the United Nations/China Forum on Space Solutions: Realising the Sustainable Development Goals took place from 24 to 27 April

in Changsha. The forum comprised a 3 day-programme filled with presentations not only from China but also from many players from all over the world.

CNSA Deputy Director Wu Yanhua told the audience of the forum that China will promote international space cooperation to make concrete contributions to sustainable development goals set by the United Nations. He stressed: "China is to build a new type of cooperative and win-win relationship with other space agencies and international organisations around the world, to jointly enhance the role of space industries in facilitating sustainable development." As examples he mentioned the utilisation of data from Chinese Earth observation satellites for the Belt-and-Road Spatial Information Corridor, the utilisation of the Chinese Fengyun satellites for weather monitoring, the use of the Beidou Navigation Satellite System, and the promotion of commercialisation and application of space technologies.

For more details, see our report about the events in Changsha in GoTaikonauts! issue no. 25, page 20-23

In addition to the central event in Changsha, a series of country-wide conferences and events took place.

China marks Space Day - Photo gallery.
Credit: Xinhua

CHINA SPACE DAY in Macao

The local Education and Youth Affairs Bureau (DSEJ) and the Science and Technology Development Fund have invited approximately 400 middle school students to participate in the celebration of the China Space Day, which took place on 24 April at the Macao Science Center.

The Wandering Earth - a brief review

Christopher Hudspeth of BuzzFeed watched the Chinese science-fiction blockbuster on Netflix. He was quite impressed with what he saw.

Micius Quantum Foundation Award

The newly founded Micius Quantum Foundation, based in Hefei, awarded the Micius Quantum Prize for 2018 and 2019 to 12 international scientists for their ground-breaking academic contributions to the fields of quantum computation and quantum communications. Each laureate received 1 million RMB.

The aim of the non-profit organisation is to promote development of quantum information science and technology. The awards ceremony was held on 20 September.

Space Science in China

Chinese space scientists are starting to play an increasingly important role in the international space community. Despite the fact that China's space science still lags behind many of its international peers in the US, Japan, EU in a number of areas, space scientists in China are optimistic that the nation's role can and will be bigger. One reason to be hopeful is the successful dark matter space mission, "Wukong". There are similar Western missions but they were launched in the 1970s and based on the technology of the time. For example, the BGO (Bismuth Germanate Oxide) calorimeter on the Wukong Dark Matter Particle Explorer far exceeds any other satellite-based detector in terms of accuracy today. Still, the Chinese space science community remains critical about the national industrial system's incapacity of developing high-grade, precision and advanced industrial products for astronomical endeavours. There is not yet enough experience to take a leading position in the international context. China's space industry leads the world in terms of scale, but lags behind in terms of sophistication. The scientific development leadership also appears to be uneven. Due to China's late-starter status, Chinese scientists' access to global science projects such as the Atacama Large Millimeter/sub-millimeter Array in Chile is limited. The SKA (Square Kilometre Array) project is the first significant global initiative in the field of space science in which China became involved and has been playing an important role from the beginning. China's capacity to bring funding and talent, whose complementary work can be vital to lead researchers. Although China's financial envelope for research and development in fundamental science doubled from 41.2 billion RMB (6.5 billion USD) in 2011 to 82.3 billion RMB in 2016 there is still a long way to go to match the US total basic research budget which exceeded 38 billion USD in 2018.

The U.S.-China Commission released a report entitled **"China's Pursuit of Space Power Status and Implications for the United States"**. This report examines China's space goals and national space strategy; its progress toward those goals, including an examination of China's progress in its advanced launch vehicle, long-term crewed space station, and lunar exploration programs; and the primary entities involved in setting and implementing its space policy. Finally, the report assesses the implications of China's space program for the United States and its continued leadership in space.

LAUNCHES

2019-023A
20 April 2019 - 14:41 UTC (22:41 BJT)

launch site: Xichang Satellite Launch Centre, LC3
launcher: Chang Zheng 3B CZ-3B/G2 (Y59)
payload: Beidou 3IGSO-1 (Beidou 44), Beidou DW44

The new Beidou 3 satellite, also named Beidou 3-I1Q or Beidou 44, is the 44th satellite of the BDS satellite family and the first BDS-3 satellite in a 55° inclined circular geosynchronous Earth orbit. The hybrid constellation design, with 3 groups of satellites in different orbits, is characteristic for BDS and enables a higher number of visible satellites in the Asian-Pacific Region, consequently improving the service. Since the end of 2018, BDS provides a position accuracy of 10 m globally and 5 m in the Asia-Pacific region.
The CASC-built Beidou 44 is a box-shaped satellite with dimensions of 2.25 x 1.0 x 1.22 m. Based on the DFH-3B bus, it is equipped with two solar panels generating at least 4,000 W. The launch mass is 4,600 kg, the payload mass 450 kg. The IGSO satellites operate via a phased-array antenna and two S/L- and C-band parabola antennas. The main navigation signals are transmitted in the B1-range at 1.57542 GHz (the same as the GPS-L1C- and Galileo-E1 signals). The satellite's active operational life is 10 years.
According to the Xi'an Satellite Control Centre, Beidou DW44 conducted four orbital transfers and entered its operational orbit on 26 April. After in-orbit tests, the satellite will work with 18 other BDS-3 satellites in intermediate circular orbit and one in geosynchronous Earth orbit.
The launch was the 100th for the CZ-3B.

2019-024A
2019-024B
29 April 2019 - 22:52 UTC (30 April - 06:52 BJT)

launch site: Taiyuan Satellite Launch Centre
launcher: Chang Zheng 4B CZ-4B
payloads: Tianhui 2 Group 01 Satellite 01
Tianhui 2 Group 01 Satellite 02

Chinese authorities responsible for airspace closure announced this early morning launch on very short notice and not as is usually done, days in advance. Xinhua reported that the two Tianhui 2 satellites will be used for scientific experiments, land resource survey, geographic survey and mapping. No additional details about the spacecraft were released. The three precursor satellites of the Tianhui 1 series, launched between 2011 and 2015, were used by the PLA.

2019-027A
17 May 2019 - 15:48 UTC (23:48 BJT)

launch site: Xichang Satellite Launch Centre, LC2
launcher: Chang Zheng 3C CZ-3C/G2 (Y16)
payload: Beidou DW45, Beidou-2GEO8 (Beidou-45)

Beidou DW45 is the 4th BDS-2 backup satellite of the Compass series and the 45th satellite of the BDS satellite family since the beginning of system construction in 2000. Beidou DW45, to be placed in GEO, is based on the DFH-3 bus, built by CAST. The 3,060 kg satellite has a box-shaped body of the dimensions 2.2 x 2.0 x 3.1 m.
Two solar panels deliver 2,150 W. It is also equipped with two parabolic antennae and a navigation antenna platform. The navigation signals are transmitted at the frequencies of 1.20714 to 1.561098 GHz. Communication signals use S- and C-band. The active lifetime of Beidou DW45 is 8 years.
Over the last years, BDS-2 has improved the positioning accuracy from 10 to 6 m. The BDS-2 system and BDS-3 system will jointly provide services before October 2020, and after that the BDS-3 will mainly take over.

2019-F04
22 May 2019 - 22:49 UTC (23 May - 06:49 BJT)

launch site: Taiyuan Satellite Launch Centre, LC9
launcher: Chang Zheng 4C CZ-4C
payload: Yaogan 33

The launch of the remote sensing Yaogan 33 satellite failed. While the 1st and 2nd stages of the rocket worked nominally, the 3rd stage did not. Monitoring data showed that the 3rd stage and satellite debris have fallen back to the ground. China has started an investigation in this launch failure.

The airspace warnings, released by the Chinese government ahead of the launch, also included information on the drop zones for the booster stages. From that it was concluded that the rocket was heading for a polar, sun-synchronous-type orbit of 615 km in height and an inclination of 97º.

Official reports said that the satellite was intended to be used for remote Earth observation, scientific experiments, agriculture and disaster management.

2019-032A 2019-032C 2019-032E 2019-032G
2019-032B 2019-032D 2019-032F 2019-032H
5 June 2019 - 04:06 UTC (12:06 BJT)

launch site: Tairu/Yellow Sea - sea launch
launcher: Chang Zheng CZ-11H, CZ-11H barge
payloads: Tianxiang 1 (Zhongdian Wangtong 1A)
Xiaoxiang 1-04
Bufeng-1A (BF-1A)
Tianqi-3 (Xingzhi Jiaoyu 1)
Bufeng-1B (BF-1B)
Jilin-1 Gaofen 03A
Tianxiang 2 (Zhongdian Wangtong 1B)
Liangshan 1

China succeeded with its first sea launch from a modified drilling rig in the Yellow Sea off the coast of Shandong province, placing two technology experiment satellites and five commercial satellites into a 560 x 585 km x 45.0º orbit. All seven payloads were Made in China. The 110 x 80 m platform "Tairu" is not self-propelled and was therefore towed by the two tug vessels, Beihei Jiu 101 and Beihei Jiu 118, to its position at 121.19ºE, 34.90ºN. Tairu is owned and run by a Chinese maritime engineering company.

The launch also marked the first time that a Chinese private company - Beijing Aerospace Satelliteherd Science and Technology - has provided monitoring and tracking service during the launch and flight of a space mission.

Although intended as a technology demonstration, the launch also had a commercial component. The rocket was named "CZ-11 WEY" under an agreement between the rocket manufacturer CALT, China Space Foundation and the automobile producer Great Wall Motors. (*see section: COMMERCIAL SPACE, paragraph: Commercial Rocket Branding*) The CZ-11 has accomplished 6 missions since its first flight in 2015, with this sea launch being its 7th flight with the modified ocean version, to fit the launch hardware on the Tairu platform.

Jilin 1-03A (also: Jilin Gaofen 03A) was built by Chengguang Sat Tech Co., based in Jilin province. The satellite serves remote sensing purposes with a 1.1 m resolution camera. The launch mass was 42 kg. Shortly after launch, the first images of the Los Angeles region in high defnition were released.

Bufeng 1A and 1B (COSPAR objects 032C and E) were built by CAST/Beijing for remote sensing of wind velocities. Both satellites are flying in a tandem configuration. Their data are expected to improve the weather monitoring, observing ocean wind fields and improve typhoon monitoring. Some reports state that they are able to investigate the ocean surface.

Tianxiang 1 and 2 (also: Zhongdian Wangtong 1A and 1B) are 65 kg satellites for the China Electronic Technology Group. While carrying a multispectral camera and ADS-B, they are also testing Ka-band inter-satellite links and a space-based router.

Xiaoxiang 1-04 from SpaceTY (Tianyi Research Institute) is equipped with a 7 m resolution RGB camera for remote sensing and a deorbit sail. The 6U cubesat is also named TY1-04 and XX1-04.

SpaceTY from Changsha works with standardised satellite modules and readily integrated adapters, shortening the satellite assembly time from the previous three months to the current three days and laying the foundation for mass production. In case of requested modifications, the satellite can be disassembled within 24 hours.

Tianqi 3 (also: Xingzhi Jiaoyu 1 or Tao Xingzhi) built by Guodian Gaokeji for the Tao Zhixing Education Foundation is equipped with a camera and an IoT relay payload. The 8 kg satellite is a LEO communication technology mission.

There was also a payload reported, connected to the upper stage (2019-032H). This payload was the **Liangshan 1** (also: Swarmsat 1) satellite which encountered a problem days before launch. It was decided to modify the payload separation software and not to deploy it. As a result, it was launched but not separated from the rocket stage.

CALT plans to develop and construct a coastal port to support seaborne launch missions as well as a dedicated launch platform

A Long March 11 solid-propellant carrier rocket, with a payload of seven satellites, blasts off from a mobile launch platform off Shandong province on Wednesday. Credit: Zhu Xingxin/China Daily

- instead of the current modified one - that will be capable of lifting not only solid-propellant but also liquid-propellant rockets, which can be bigger and stronger than solid-fuel models. The sea launch capacity enables launches from a low inclination for lower cost and from a flexible location meaning that services for the Belt-and-Road Region are possible.

2019-035A
24 June 2019 - 18:09 UTC (25 June - 02:09 BJT)

launch site: Xichang Satellite Launch Centre - XSLC, LC3
launcher: Chang Zheng 3B CZ-3B/G2 (Y60)
payload: Beidou DW46 (Beidou 3 IGSO-2, Beidou-46)

The new Beidou navigation satellite was sent into an inclined geosynchronous Earth orbit. It is the 46th satellite of the BDS satellite family and the 21st satellite of the BDS-3 system. After in-orbit tests, the new satellite will work with those BDS satellites already in orbit to improve the coverage and positioning accuracy of the system.

So far, there are already 18 MEO BDS-3 satellites positioned, one GEO BDS-3 satellite, and two IGEO BDS-3 satellites.

right: Launch of the 21st satellite of the BDS-3 series on 24 June 2019 from Xichang Satellite Launch Centre. Credit: Xinhua/ Guo Wenbin

Ralf Hupertz *and* ***Arno Fellenberg*** *kindly contributed information to the section Chinese Space Launches. Other sources of informations are:*

http://news.xinhuanet.com
http://www.xinhuanet.com/english/list/china-science.htm

AAPT	Academy of Aerospace Propulsion Technology
AEB	Brazilian Space Agency
ASAN	Advanced Small Analyser for Neutrals
AO	Announcement of Opportunity
APSCO	Asia-Pacific Space Cooperation Organisation
BACC	Beijing Aerospace Command and Control Centre
BDS	BeiDou satellite navigation System
BJT	Beijing Time
BRI	Belt-and-Road Initiative
CALT	China Academy of Launch Vehicle Technology, 1st Academy of China Aerospace Science and Technology Corporation CASC
CAS	Chinese Academy of Sciences
CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
CAST	China Academy of Space Technology
CCTV	China Central Television
CE	Chang'e
CFOSat	China-France Oceanography Satellite
CGWIC	China Great Wall Industry Corporation
CLEP	China's Lunar Exploration Programme
CMA	China Meteorological Administration
CMSA	China Manned Space Agency
CMSEO	China Manned Space Engineering Office
CNES	National Centre for Space Studies
CNSA	China National Space Administration
COPUOS	Committee on the Peaceful Uses of Outer Space

https://www.nasaspaceflight.com
http://www.spaceflightinsider.com

CRESDA	Centre for Resources Satellite Data and Applications
CSES	China Seismo-Electromagnetic Satellite mission
CSS	Chinese Space Station/China Space Station
CSU	Technology and Engineering Centre for Space Utilisation
CZ	Changzheng, Long March
DFH	Dong Fang Hong
ECMWF	European Centre for Medium-Range Weather Forecasts
ESA	European Space Agency
ESSTI	Ethiopian Space Science and Technology Institute
ESTEC	European Space Research and Technology Centre
FAST	Five-Hundred Metre Aperture Spherical Radio Telescope
FOCAC	Forum On China-Africa Cooperation
FY	Fengyun
FYESM	Emergency Support Mechanism of FENGYUN Satellite
GEO	Geostationary Orbit
GNSS	Global Navigation Satellite System
GTO	Geostationary Transfer Orbit
HY	Haiyang
IGSO	Inclined Geosynchronous Orbit
ISRO	Indian Space Research Organisation
ISS	International Space Station
JSLC	Jiuquan Satellite Launch Centre
LEO	low Earth orbit
LEOP	launch and early orbit phase

https://spaceflightnow.com
http://www.planet4589.org/space/jsr/jsr.html

LND	Lunar Lander Neutrons and Dosimetry
LRO	Lunar Reconnaissance Orbiter
MoU	Memorandum of Understanding
NCLE	Netherlands-China Low-Frequency Explorer
NSSC	National Space Science Center
OSTP	Office of Science and Technology Policy
P/L	payload
QUESS	Quantum Experiments at Space Scale
RLV	reusable launch vehicle
Roscosmos	Russia's State Space Corporation
RSMC	Regional Specialised Meteorological Centres
SAO	Shanghai Astronomical Observatory
SAST	Shanghai Academy of Spaceflight Technology
SASTIND	State Administration of Science, Technology and Industry for National Defense
SCO	Space Climate Observatory
SCO	Shanghai Cooperation Organisation
SKA	Square Kilometre Array
SMILE	Solar wind Magnetosphere Ionosphere Link Explorer
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
TG	Tiangong
UN	United Nations
UNOOSA	UN Office for Outer Space Affairs
UTC	Coordinated Universal Time
WMC	World Meteorological Centres
WMO	World Meteorological Organisation
YW	Yuanwang
ZQ	Zhuque

Imprint

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Chang'e 4 – Behind the Moon (part 2)

Operations of Lunar Days 4 to 6 on the far side of the Moon

by Jacqueline Myrrhe

4th lunar day: from approx. 28 March to 12 April

After the Yutu 2 rover (YT-2) was stationary from 13-29 March during the 3rd lunar night (from approx. 14-28 March), it woke up on 29 March at 20:28 BJT. Yutu unfolded its solar panels and re-established communications with the Queqiao relay satellite. The CE-4 lander followed on 30 March at 18:14 BJT. Both - lander and rover - were in normal condition and resumed work. During the morning of the 4th lunar day, lasting from 29 March to 1 April, YT-2 travelled 8 m before shutting down to avoid the mid-day heat.

between 2 - 8 April – mid-day standby of 4th lunar day

YT-2 and CE-4 switched to hibernation mode from 2 to 8 April.

During the lunar afternoon from 8 to 12 April, YT-2 explored another 8 m. In total, Yutu traversed 178.9 m until the end of the 4th lunar day. By being operational for the 4th lunar day, it exceeded its projected lifetime by one month.

11 April

During a lecture at the Nanjing University of Aeronautics and Astronautics, Sun Zezhou, Chief Designer of the Chang'e 4 lunar probe and the Mars 2020 probe said the instruments on CE-4 are working nominal and data acquisition is ongoing. The rover is programmed to prioritise safety on the lunar surface and selecting a path, most valuable for scientific research. The calculations to meet those conditions are time-consuming and explain Yutu 2's pace as perceived by outsiders to be "slow". Sun confirmed that the preparations for the launch of Chang'e 5 are ongoing and that development and research work for further missions is underway, including the exploration missions to the lunar poles, paving the way for a future research station on the Moon.

4th lunar night – from approx. 13 to 27 April

On 12 April BJT, ahead of a 4th lunar night, CE-4 powered down at 00:00 BJT and YT-2 followed at 00:38 BJT also on 12 April. YT-2 remained stationary between 12-28 April.

18 April – handover of first science data to foreign teams

First data of the Netherlands-China Low-Frequency Explorer (NCLE) on the Chinese Queqiao satellite were handed over to Taake Manning, Counsellor for Science and Technology of the Dutch Embassy in Beijing on 18 April. He received the data DVD from Zhang Kejian, Director of China National Space Administration (CNSA), on behalf of the Dutch team of the Radboud University Nijmegen in the Netherlands.

The data show that the radio antenna operates as planned. In the next phase, the three still stowed antennas, will undergo a one-month long commissioning before the next recording with partially deployed antennas can start. The actual operation is planned within the next 6 months, when the antennas will be deployed to the full length of 5 m. Because of possible interference with the surface operations of the rover, the low-frequency experiment has to wait until the rover has concluded its exploration. On the same occasion, data DVDs were handed over to the German and Swedish teams. Data from the Lunar Lander Neutrons and Dosimetry (LND) were presented to the University of Kiel, Germany and the data of the Advanced Small Analyser for Neutrals (ASAN) to the representative of the Swedish Institute of Space Physics (IFR) Kiruna, Sweden.

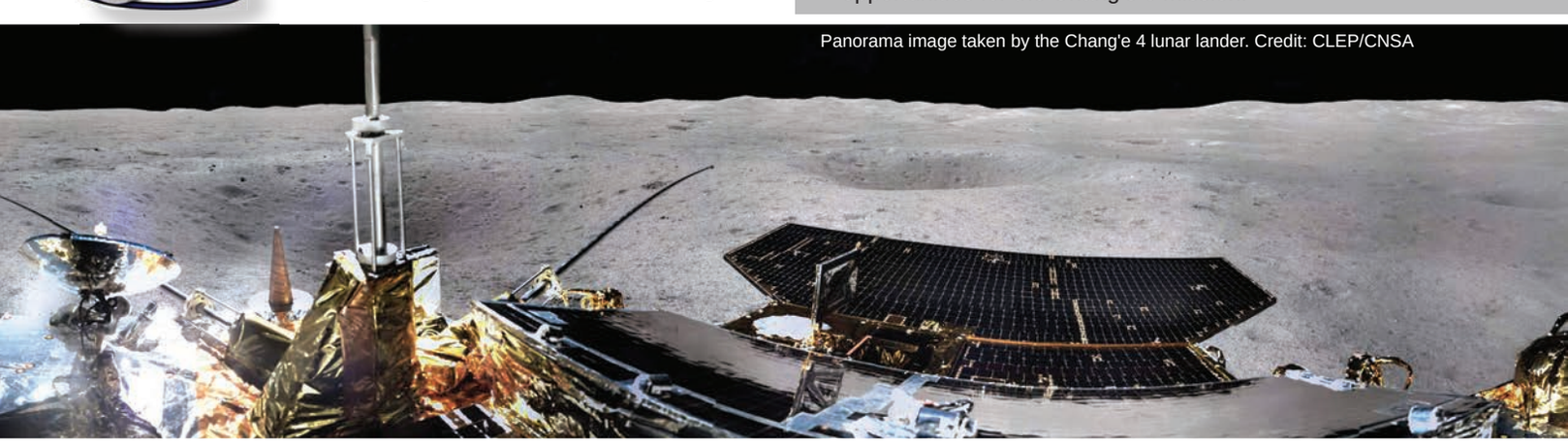
At the data handover ceremony on 18 April 2019. 2nd from left: Wu Weiren, Chief Designer of China's lunar programme, 3rd from left: the Swedish representative, centre: Zhang Kejian, Director CNSA, 3rd from right: Sönke Burmeister, University Kiel, 2nd from right: Wu Yanhua, Deputy Head of CNSA, far right Taake Manning, Counsellor for Science and Technology of the Dutch Embassy in Beijing. Credit: CNSA

GERMANY - Lunar Lander Neutrons and Dosimetry (LND)

Sönke Burmeister, who participated in the development of the German LND payload, recalled the cooperation with his Chinese colleagues as "very effective."

"It's really good experience to work with Chinese partners because they are very effective. We built a nice instrument within a very short timeframe," said Burmeister, a researcher with the Institute of Experimental and Applied Physics of the University of Kiel in Germany. "The instrument has switched on every lunar day. It works properly on the Moon's surface, which proves the collaboration is very fruitful," he said. According to Burmeister, one interesting discovery so far is that the secondary radiation produced by the lunar surface soil is different from the dose previously measured by other probes in lunar orbit. "It is very important for astronauts who will travel to the Moon."

He is also looking forward to participating in the cooperation opportunities for the Chang'e 6 mission.



Panorama image taken by the Chang'e 4 lunar lander. Credit: CLEP/CNSA

NETHERLANDS

"It's not only the cooperation that we have with China in space. We have quite a few programmes in the area of Earth observation, using satellite data for agricultural purposes, for monitoring environmental conditions and so on. Those are the programmes we are very much looking forward to continuing and expanding in the future," Dutch Counsellor for Science and Technology, Taake Manning told CGTN.

Director Liu Jizhong of the Aerospace Engineering Center announced the cooperation opportunity for the Chang'e 6 and asteroid exploration missions, soliciting from domestic universities, private enterprises and foreign scientific research institutions.

25 April

Zhang Lihua, the Chief Designer of the Queqiao relay satellite, reported during the 5th International Symposium on Small Satellite Technology on 25 April in Changsha that Queqiao is in good condition. It needs regular orbit maintenance manoeuvre with each activity consuming 80 grams of fuel. By April 2019 the satellite had nearly 50 kg of fuel left, which enables a 10-year life. Zhang pointed out that the data rate is not very high. Future relay satellites will be able to increase the data transmission either by using a laser communication link or by working from an orbit closer to the Moon.

5th lunar day – from approx. 28 April to 11 May

The exploration operations for the 5th lunar day started on 28 April. The rover woke up at 13:45 BJT on 28 April and the CE-4 lander at 7:40 BJT in the morning of the 29 April. Both were in normal working condition.

The scientific instruments on the lander and rover worked well. A total of 6.6 GB of scientific detection data were sent to the research team for analysis. YT-2 has driven 11.76 m during the 5th day, accumulating a total of 190.66 m.

5th lunar night – from approx. 12 to 26 May

The rover switched to dormant mode for the 5th lunar night at 11:05 BJT on 11 May and the lander at 12:00 BJT the same day. YT-2 remained stationary from 11-27 May.

16 May - first results

The research team from the National Astronomical Observatories of China under CAS published on 16 May 2019 in Nature an article about a first result of the CE-4 mission. The team, led by Li Chunlai, analysed the spectral data of YT-2's Visible and Near Infrared Spectrometer (VNIS) from two locations and found that the lunar soil in the landing area contains olivine, low-calcium pyroxene and a small amount of high-calcium pyroxene which could originate from the lunar mantle deep inside the Moon. This finding could help to determine the lunar mantle composition and the formation and evolution of Moon and Earth.

After analysing the high-res remote sensing images and the hyperspectral data, the researchers believed the materials were ejected during an asteroid impact which formed the 72-km wide Finsen Crater to the northeast of the Von Kármán Crater. During the impact, excavated material from the mantle was consequently blasted into the Von Kármán Crater. YT-2 might be directed to target the material for further investigation. If confirmed, this could become the first time that lunar mantle material is available for scientific study. These findings may have an influence on the selection of the landing site for later lunar missions.

Mid May – Longjiang 2 (2018-045C)

Spanish amateur spacecraft tracker Daniel Estévez (EA4GPZ), predicted mid-May that Longjiang 2 (DSLWP-B) will crash into the Moon on 31 July, after more than one year in operation. Longjiang 2 hosted an amateur radio payload which amateur radio operators on Earth could control to take photos of the Moon. Already on 24 January, Longjiang 2's orbit periapsis was lowered by 500 km in preparation for an impact on the far-side of the Moon.

6th lunar day – from approx. 27 May to 10/11 June

The rover woke up on 28 May at 2:16 BJT and the CE-4 lander at 18:00 BJT the same day.

The neutron radiation detector and low-frequency radio detector on the lander were restarted to conduct scientific tasks including particle radiation observation and low-frequency radio astronomical observation

On the rover, the panoramic camera and science instruments were restarted. All scientific payloads worked well, and about 1,654 MB of data and 237 data files were sent to the research team for analysis. During the 6th lunar day, YT-2 traversed 22.33 m on the far-side of the Moon, bringing it to a total of 212.99 m since the start of operations on 3 January.

During the 6th lunar day, the YT-2 rover encountered a non-specified issue which caused communications interferences and loss of signal between the rover and the Queqiao relay satellite. An analysis by experts indicated that cosmic particles hit one of Yutu's microchips, causing the error. The issue was resolved successfully.

6th lunar night – from approx. 10 to 25 June

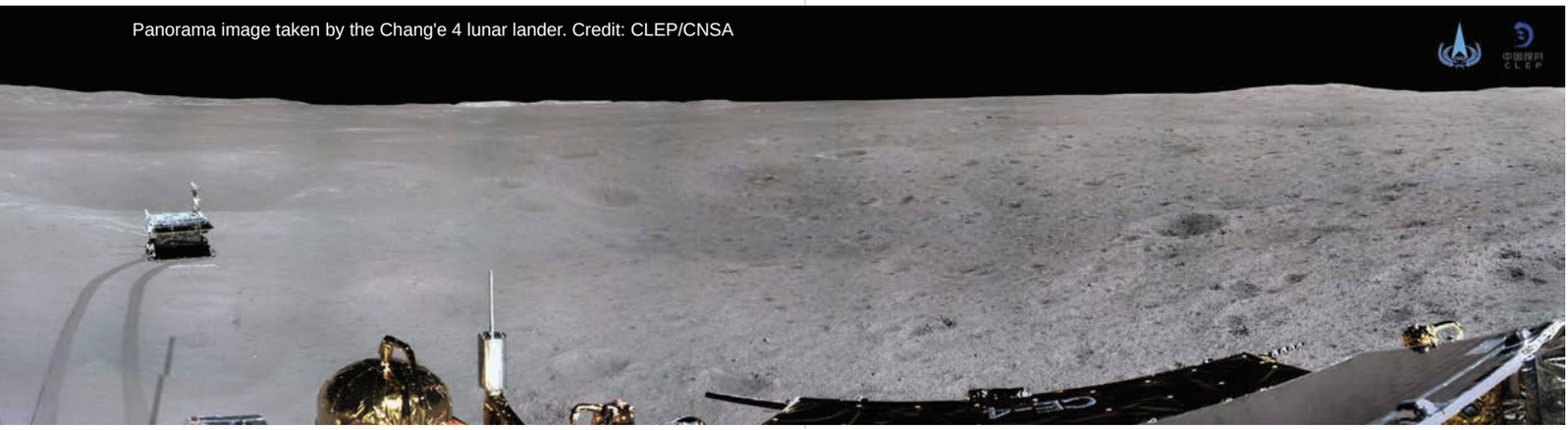
The CE-4 lander switched to dormant mode for the 6th lunar night on 9 June at 22:00 BJT and the YT-2 rover at 23:40 BJT the same day. YT-2 remained stationary from 9-26 June.

7th lunar day – from approx. 26 June to 9 July

YT-2 awoke on 26 June at 13:26 BJT and the CE-4 lander woke up on 27 June at 9:45 BJT. All systems were working nominally.

to be continued in the next issue of GoTaikonauts!

Panorama image taken by the Chang'e 4 lunar lander. Credit: CLEP/CNSA

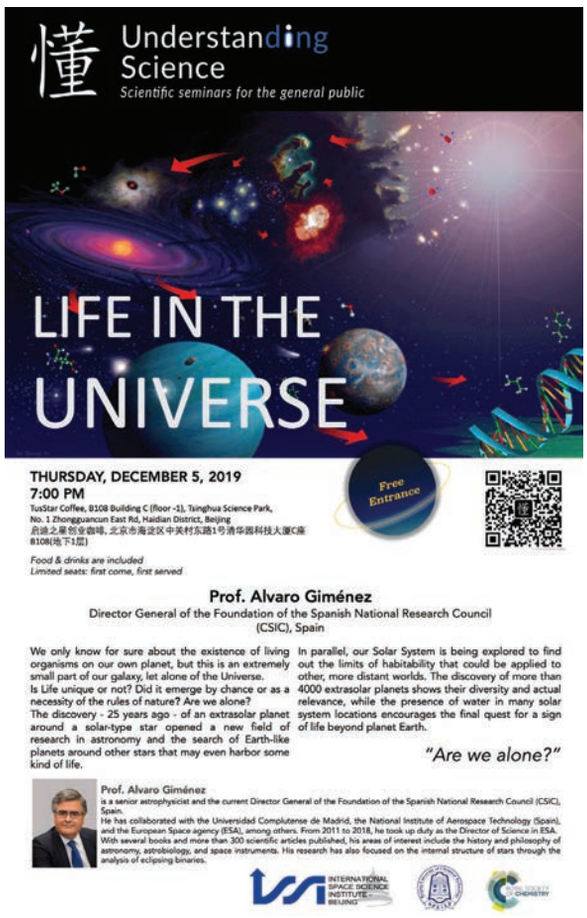


Spreading the Knowledge among Society about Space Science

An Interview with Prof. Álvaro Giménez and Prof. Maurizio Falanga at the Science Seminar "Life in the Universe"

by Iana Grytsenko (Belt & Road Education, www.br-edu.net)

The GoTaikonauts! Team took the opportunity to speak with Prof. Maurizio Falanga, Executive Director of ISSI-Beijing and Álvaro Giménez, Professor for Astrophysics at the Spanish National Council for Scientific Research (CSIC), to discover more about the current challenges and progress in the field of space science. The interview took place during the informative event "Understanding Science Seminar" organised by the International Space Science Institute in Beijing on 5 December 2019.



On 5 December 2019, ISSI-Beijing (ISSI-BJ) - the only partner of the world-renowned space science "platform" of the ISSI-Bern, organised and facilitated a public event for experts from space and science fields and non-experts to reflect on space science-related questions. This meeting was at TusStar Coffee in Haidian District, Beijing, where with a great atmosphere Prof. Álvaro Giménez gave the scientific lecture on "Life in the Universe". After the presentation, the audiece took the opportunity to ask questions.

It should be noted that many people believe that this casual meeting helped to spread the knowledge and achieve a closer integration of science and society.

Álvaro Giménez is Professor of Astrophysics at the Spanish National Council for Scientific Research (CSIC). He works since 17 years for the European Space Agency (ESA) where he served as the former Director of Science at the establishment in Noordwijk ESTEC. Currently he is the Science Policy Coordinator in the ESA Director General's Cabinet in Paris.


Prof. Giménez. Credit: Iana Grytsenko

Professor Giménez, what is your motivation to give a talk in Beijing?

Giving a talk in Beijing is part of my commitment to connect space science with our society in general, and the opportunity offered by ISSI-Beijing during one of my regular visits to China, could not be missed.

How was your talk perceived by the audience?

I think the audience got the main point of the current status of research in the field of astrobiology, and was excited by the new challenges in the search for life beyond the Earth. The questions received after the talk clearly showed the connection with the big questions of science today.

What is your impression of ISSI-Beijing?

ISSI-Beijing is a great initiative for the promotion of international cooperation in space sciences for China. ISSI-Beijing keeps a high level of international standards, allowing upcoming scientists feel like at home, share data and projects.

You have been ESA's Director of Science and you are now Science Policy Coordinator in the Director General's Cabinet. How do you evaluate the chances for closer European space science cooperation? We are aware of the cooperation for Double Star,[1] for the Earth Observation Dragon Programme,[2] for the Chang'e lunar missions[3] and currently for SMILE.[4] However, considering the size and scope of science in Europe and now also in China: Could there be more possible?

I have been personally involved in the developing of cooperation between Europe and China in space sciences, particularly in the SMILE mission which is currently under development. Nevertheless, future cooperation opportunities are possible and looked for. For instance, the European involvement in the Chinese-led Einstein Probe mission[5] has been approved.


Credit: Iana Grytsenko


Prof. Falanga. Credit: ISSI

The social event started with the warm welcome message given by Prof. Maurizio Falanga, Executive Director of ISSI-Beijing (ISSI-BJ).

Prof. Falanga took up duty as ISSI-BJ Executive Director in 2012, right after the establishment of the institute. Since then, he has served a 4-year term from 2012 to 2016 and then from 2017 to 2019 (ad interim). Since he has left office at the end of 2019, we have seized the opportunity to ask him about his experience working at ISSI-BJ.

Which milestone achievements could ISSI-Beijing record during the last years?

I personally identify ISSI-BJ's achievements in two categories. First of all, I am happy to say that ISSI-BJ is currently able to connect with high-level agencies and prominent scientists to promote innovative scientific activities in Beijing. Secondly, in addition to the ISSI-BJ tools which are shared with ISSI in Bern, ISSI-BJ has inaugurated two novel assets, i.e. the TAIKONG Magazine - ISSI-BJ forum-related output - as well as its biennial Space Science School. To be more specific, I deem we have achieved a sustainable development of our organisation which turned it into a reliable and stable institution in the international scientific landscape. As the field of space science research is moving fast, we need to keep up with the pace and make continuous progress to support and promote space scientists efficiently and thus preserve a good reputation.

Considering the big recent successes of Chinese space experts in quantum communication,[6] lunar exploration[7] and dark matter research,[8] what can be expected next? Is China marching ahead of other nations?

I think that the recent successes of China's space research and missions can hardly be compared with the extensive experience gathered by other countries in the space science field, and the reasons why are very simple. China's accelerated programme began in 2003 with the triumphant flight of the Shenzhou 5 and on 29 September 2011, with the launch of Tiangong 1, making China the third country in the world, after Russia and the USA, to possess the capability of sending humans into space independently; nonetheless, ESA and NASA's first space missions trace back to the 1960's. Therefore, both parties have made the most out of the legacy bequeathed by a long line of explorers throughout history, but in the space science field, this has happened at different times.

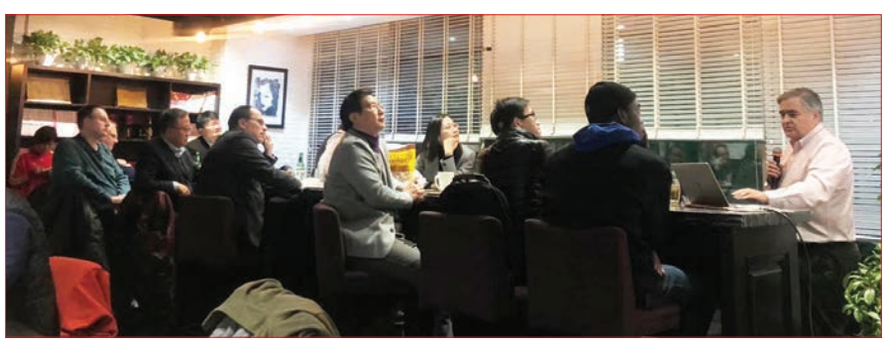
The cornerstone European Rosetta Mission launched its satellite ten years ago to reach and perform a series of manoeuvres around the Comet 67P/Churyumov-Gerasimenko, to go into orbit around and eventually land on it. Furthermore, the Science Programme Committee (SPC) in Europe has been looking for and measuring gravitational waves traveling through space since a long time, opening a completely new window for general relativity testing. For these reasons, I think that the recent progress made by Chinese space programmes cannot be equated with other countries' achievements, e.g. Europe's missions and studies or NASA's six decades of experience. It cannot be denied, though, that China's recent attainments have opened the way to becoming a key player in the space science field, as the country is putting a lot of efforts in space studies' activities and investing a relatively considerable budget in space science programmes, projects, research, and innovation. Moreover, it has proven to be open to international cooperation with Europe in order to achieve common goals, as cost-sharing and joint efforts are important steps to advance in scientific as well as technological research. Thus, China is on the right path to march ahead of other nations in space science programmes.

Would you dare a forecast for the future? With respect to space science, which direction into the future is China going? Which role will international cooperation play?

I think that to become a key player and be able to compete with the main space agencies around the world, significant investments in innovation should be made. They need to find what is the space science to be the first.

In my opinion, the Chinese lunar programme has a clear direction and strong ambitions, thus showing China's super power, but at the same time, such ambitions are also very costly and a bigger role ought to be played by the cooperation with international actors. Even though results in space science are clearly something to be proud of, an equilibrium between national interests and the international framework should be found to not stir up tensions and competition, as space research requires combined efforts and resources to advance and to avoid the too familiar "space race" scenario. Furthermore, joint accomplishments do also considerably increase a country's power and prestige, therefore making an international space station a more valuable asset than a single-country space station.

Finally, one decade of space science research and missions is just the positive beginning of a fruitful journey towards a successful positioning in space. By looking at other country's experiences, it seems to me that coherence, stability, and striving toward a sustainable development constitute the



Prof. Giménez is giving his talk at the "Understanding Science Seminar" at the International Space Science Institute - Beijing on 5 December 2019. Credit: I. Grytsenko

1) The agreement for cooperation on Double Star on 9 July 2001 was signed at the European Space Agency's Headquarters in Paris.
2) The European Space Agency ESA, together with the National Remote Sensing Centre of China (NRSCC) have cooperated in the field of Earth observation application development. Three-year Earth Observation exploitation programme called Dragon (2004 to 2007) focuses on science and applications development in P.R. China using mainly data from the ERS and Envisat missions.
3) A series of successful lunar missions began on 24 October 2007. CNSA has sent a host of spacecraft to the Moon as part of the Chang'e programme, named after the Chinese goddess of the Moon.
4) The Solar Wind Magnetosphere Ionosphere Link Explorer, or SMILE, is a joint mission between ESA and the Chinese Academy of Sciences CAS. SMILE aims to build a more complete understanding of the Sun-Earth connection by measuring the solar wind and its dynamic interaction with the magnetosphere.
5) The Einstein Probe (EP) is a mission of the Chinese Academy of Sciences (CAS) dedicated to time-domain high-energy astrophysics. Its primary goals are to discover high-energy transients and monitor variable objects.
6) China launched the world's first quantum communications satellite on 16 August 2016, officially known as the Quantum Science Satellite (QUESS) https://spectrum.ieee.org/tech-talk/aerospace/satellites/china-launches-worlds-first-quantum-communications-satellite.
7) Chinese Lunar Exploration Programme: China launched the Chang'e 1 robotic lunar orbiter on 24 October 2007 - for exploring the Moon and is investigating the prospect of lunar mining, specifically looking for the isotope Helium-3 for use as an energy source on Earth.
8) Dark matter is composed of particles that do not absorb, reflect, or emit light, so they cannot be detected by observing electromagnetic radiation. The China Dark Matter Experiment was the first experiment to be hosted at China Jinping Underground Laboratory, beginning construction of its shield in June 2010.

key factors to maintaining high-quality programes, together with transparency and info-sharing to promote international cooperation and an eventual restructuring of the space science research organisational framework.

Prof. Falanga, we have spoken to you four years ago. How is progress in the meanwhile - how is the work at ISSI-Beijing going?

Very well, I am very satisfied with ISSI-BJ development and progress in the last years, as it was agile and efficient. Up to now, we have hosted a total of five workshops and published their corresponding books - the last one related to the workshop on “Oscillatory processes in solar and stellar coronae” will be released later this year - 20 Forums and the forum-related TAIKONG magazine issues (TAIKONG means “outer space” in Chinese), 38 International Teams have been approved since 2013, and two Space Science Schools have been organised between 2016 and 2018. Our third one will take place this year.

Last but not least, the participation of the scientific community to our activities has increased steadily over the years, prompting us to strive towards continuous improvement and increasing the visibility of our institute, which we also try to achieve by hosting the Understanding Science seminars for the general public - the thirteenth one took place in December 2019.

The most recent issues of Taikong magazine. Credit: ISSI-BJ

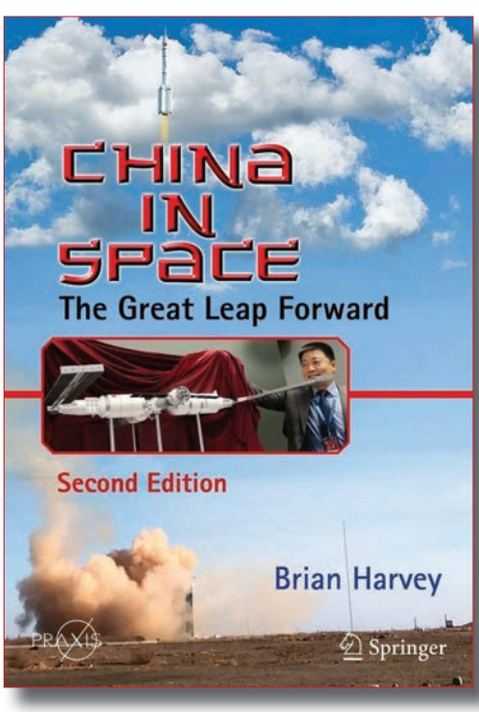
China in Space - The Great Leap Forward

A book review **by Jacqueline Myrrhe**

Reading GoTaikonauts! is good – reading Brian Harvey is better.

China’s space programme became much more transparent and accessible over the last decade. But still, there is no other and in particular no better standard work about China’s efforts in space than “China in Space - The Great Leap Forward” by Irish space author and analyst Brian Harvey.

This comprehensive compendium was published as the second edition at the end of last year. Even for owners of the first edition it makes sense to get the updated book, as much has happened recently and Brian Harvey has stayed on top of those dynamic developments.



No wonder that the first chapter is dedicated to the milestone lunar mission, Chang’e 4. Maybe the biggest value being the chapters about the historical developments which Harvey has traced as a long-time observer and analysed and assembled meticulously for this publication. Not much knowledge about those early beginnings is out there. A look into the book explains it all. But Harvey also covers all currently existing space programmes, from Earth observation, to telecommunications to space science and the manned space flight activities. The author is also not shy in shedding some light on the military applications, about which it is still difficult to get access to reliable information through public content.

All chapters are illustrated with photos and mission tables covering the different fields. Very useful references are the glossary at the end of the book, the timeline of key dates in China’s space programmes, and a detailed list of all Chinese space launches. Extremely useful too are the old-fashioned bibliography and index. Thanks for putting the effort into this indispensable tool for reading and studying.

This complete and thorough description of Chinese space activities makes the book interesting for the person with a general interest in the subject but also for professionals who need reliable information. Most of all, this book is strongly recommended to all those newly-arrived young authors who find it fanciful to write about China’s space programme on the web, but lack the knowledge and the understanding of the context. They can be helped – for the reasonable price of around 35 Euros only.

Education and knowledge about China in Space has never been more affordable and accessible.

China in Space - The Great Leap Forward
Author: Harvey, Brian

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WUHAN 2020

by Jacqueline Myrrhe

Draw a straight line directly west from Shanghai and you will find where Wuhan is located. In the past, this was how I explained where I have been in China after returning to Europe.

Wuhan - until recently to most in the West an unknown name of a central Chinese city but this changed dramatically in January 2020. Wuhan became a household name, and this not for the reasons Wuhan is actually famous for: its incredible friendly people, its modern transport infrastructure, the spacious city architecture or for being home to China's only commercial space industrial park, the Wuhan National Aerospace Industry Base.

However, it was commercial space flight why we from the GoTaikonauts! team have been over in Wuhan 4 times in the last 3 years. Attending the 5th CCAF (China International Aerospace Forum) from 21 to 23 November 2019 meant that we narrowly missed the Corona virus outbreak. So, Corona virus and commercial aerospace - how do we get that together apart from the shared city of origin: Wuhan.

Interestingly, one of the strongest takeaways from the 5th CCAF last year was the optimistic certainty of the young commercial space start-ups that the development of the so-called down-stream sector, the space applications using space data, will make it work for them.

And strangely, China proved this in retrospect by using numerous space resources and applying them as a tool for measures to mitigate the outbreak of the disease. Applications of satellite navigation and positioning, remote sensing and satellite communications became indispensable tools for the front-line workers, be it medical staff, logistic companies, security or other assisting forces.

The possible central role in the use of space tools during the Corona crisis could be played by China's satellite navigation system Beidou Navigation Satellite System (BDS).

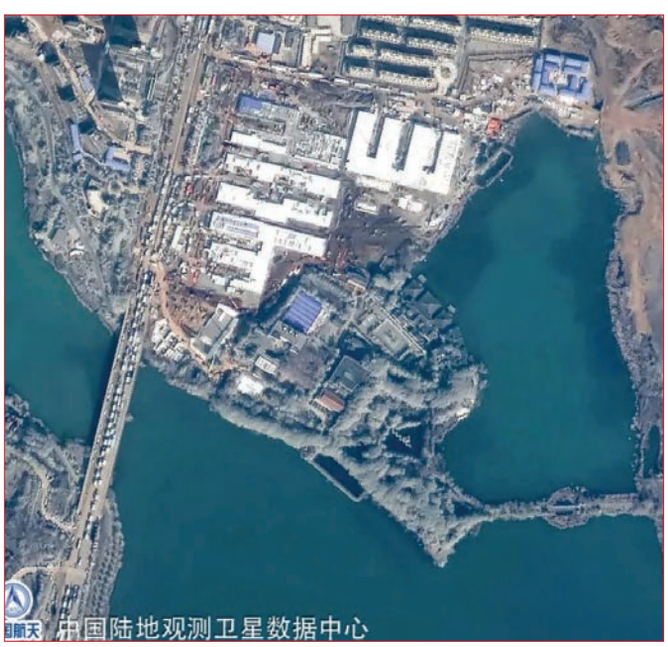
The world looked on with disbelief at photos showing a crowd of excavators digging and levelling criss-cross the ground on a construction site next to Lake Zhiyin. That activity was the starting point after the authorities in Wuhan decided to set up two makeshift hospitals - Huoshenshan (Fire God Mountain) Hospital and later the Leishenshan (Thunder God Mountain) Hospital. Equipment based on the BDS system provided a high-precision positioning service for the construction period.

Yue Yuan, an expert on international relations and space security policies, described in a lengthy report for the webportal, SpaceWatchGlobal, how the experts in Wuhan University's Key State Laboratory of Information Engineering in Surveying, Mapping, and Remote Sensing, analysed the Earth observation data of the last two years collected by the European Sentinel 1 satellite, to assess the chosen piece of land close to the lake. Understanding the data, the expert could conclude that the ground would be stable enough to support the installation of the hospital and its related infrastructure. Additional data from the Chinese Zhuhai 1 hyperspectral satellite and high-resolution images from the Jilin 1 satellite were used to observe the water quality around the construction site. The world was awestruck when Huoshenshan was ready within 10 days! Remote sensing data by the GaoFen-2 satellite delivered the proof in high-resolution, showing the former green land before the start of construction and the view of the finished Huoshenshan Hospital in almost 3 m resolution.

China also introduced other applications which would collect data from multiple databases, fed with terrestrial and space-based information, to indicate in which part of the town a high density of infected people are in quarantine, or where the hot spots are in order to advise the app user which route is the best to avoid those spots. At the same time, the app displays official health alerts or news related to the epidemic sent by the governmental authorities.

Another crucial instrument in the fight against the Coronavirus, Yue Yuan explained, was the Mini Neighborhood app. The user would fill in a questionnaire which gives a preliminary assessment of the state of health of the user. The app registers the address of the user and would log-into the health network so that in case the user is infected, medical staff would either get to him/her or volunteers would bring the user to a hospital. In case of quarantine the neighbours would receive a notification to stay away from this address or offer online neighbourhood support.

Chinese expats in London who rushed back home to Hong Kong before the full outbreak happened in the UK reported on the SCMP web-portal, that during immigration they had to download and activate a location app and were equipped with



top: Gaofen 2 satellite image taken on 29 October 2019 shows the location covered with vegetation where the Huoshenshan Hospital would be built in January 2020. **right:** Another Gaofen 2 image of the construction site of the Huoshenshan Hospital on 31 January 2020. Credit: CASC - China Aerospace Science and Technology Corporation/Gaofen/Weibo/China Internet

an electronic wristband allowing the authorities to localise them during the next two weeks during which they were obliged to stay at home in self-isolation.

Xinhua news also reported that drones based on the BDS and previously in use with the farmers fertilising their fields, have been utilised to spray disinfectant. The local police in Ruichang, east China's Jiangxi Province, used BDS-based drones to patrol crowded places to prevent intensive contacts. The Chinese media outlet Global Times placed some videos online to show that already before the lockdown traffic controllers would let drones equipped with loudspeakers fly over busy crossings or places to spot people not wearing a face-mask to remind them to put them on. On one occasion a female voice would come out of the blue to say for example: "You, dude, with the pink coat on your motorbike! Yeah, it's you! Please, put on your mask." Or also nice: "Hey, handsome guy speaking on your mobile! Where is your mask? Wear your mask!" Or more warmly when a male voice addressed a confused older woman in the region of Inner Mongolia: "You, auntie, this is the drone talking to you. You shouldn't be walking without a face mask. You should better go home to get your face mask and do not forget to wash your hands." Of course, the puzzled grandma made a U-turn to get away from that drone. Most likely she went home…

Though these episodes sound anecdotic, here is the link to the website with the video footage and even a few more examples: *https://www.globaltimes.cn/content/1178119.shtml*

The greatest involvement of the Beidou system of course was in the logistic chain to keep Wuhan supplied with food for the citizens along with materials and equipment for the hospitals. China's Ministry of Transport established a real-time information service with epidemic prevention and transportation advice. This information was distributed to more than 6 million vehicles via the BDS terminals and provided services for the transportation of emergency materials to the most-hit areas, but also gave directions for safe and fast routes on the long-distance motorways. Xinhua also reported that the China Post Group Co., Ltd., had installed 5,000 Beidou terminals on its trunk line vehicles and used the vehicle positioning information to conduct real-time supervision and allocation to ensure timely delivery of epidemic prevention materials. In Wuhan, the BDS-based robots of the e-commerce and logistics company JD.com, delivered medical materials to hospitals and medical isolation venues with high speed.

Chinese state broadcaster CCTV also reported how doctors in the West China Hospital in Chengdu conducted a remote CT scan of COVID-19 patients in a hospital over 700 km away in Ganzi, in the Tibetan Autonomous Prefecture. China's growing 5G network made it possible to transmit the high data volume and let the doctors process the data at a high rate.

Yue Yuan describes in her article for SpaceWatchGlobal, that China Education Television broadcasts learning programs through the ChinaSat-9 satellite, operated by China Satcom, to rural areas lacking any terrestrial internet connections.

Last but not least - an optimistic story about unexpected space technology transfer. Researchers at the Astronaut Centre of China (ACC) came across a posting in a forum on the Chinese Weibo platform where a doctor from the Hubei Maternal and Child Health Hospital in the Optics Valley Campus of Wuhan, asked the Chinese netizens whether they have a proven home-grown recipe for preventing glasses and medical protective goggles from fogging up. The staff from the ACC, reading this question, immediately remembered the anti-fog agents (wipes) for spacesuits the ACC had developed for the Shenzhou 11 mission. China's manned spaceflight programme is not famous for a high flight-rate, which meant that there were no large supplies of these wipes available. Nevertheless, the team at ACC organised some new raw materials and produced 1,000 sets of anti-fog wipes within 24 hours. ACC sent the delivery the next day to the Hubei Maternal and Child Health Hospital where the doctors confirmed that the wipes were extremely useful.

China's response to the Coronavirus was multifaceted. It was very stringent, in a way so rigorous that it frightened the rest of world. But it was effective too. Once the situation in China had stabilised, the virus spread around the world. As the virus does not know borders, the strength of space-based applications is that they not only help to gain a global view on dynamic processes on Earth but also are applicable globally.

China not only bought the world time in getting prepared for the containment of the virus, but also showed which power the interdisciplinary use of data, robotics, and AI, mixed with a bit of common sense and thinking beyond one's horizon can have in helping us to get on with a globalised future.

No matter when the next Commercial Space Forum will take place again in Wuhan – this year or next year – we are looking forward to hear the full story about how space technology helped to overcome COVID-19.

Medical staff at the Hubei Maternal and Child Health Hospital in Wuhan show the packs with wipes for glasses from the ACC in Beijing. Credit: ACC/China Internet/Weibo

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5th CCAF – China (International) Commercial Aerospace Forum

Jointly Building an Industrial Ecology to Lead the Development of Commercial Aerospace

by Jacqueline Myrrhe

There is this saying in the commercial world that the first five years of a business are the most crucial for its survival. On the other hand, five years is not really long, in particular not for big endeavours. So, let's say: It is **only** five years ago that commercial space companies in China entered the scene.

The initial spark set the Chinese government in 2014 with its document no 60 "The State Council's Guidelines on Investment and Financing Mechanism Encouraging Social Investment in Innovation and Key Areas". It allowed the privatisation of high-tech companies, including space. That was a surprise since it meant the monopoly of the space giants CASC, SAST and CASIC would inevitably be challenged. But this policy also encouraged those state giants to buy innovation, services and hardware for a competitive price from the commercial sector. Whether it - indeed - opened up a two-way road of mutual win-win remains to be seen. The second milestone on the way to a sustainable Chinese commercial space industry was set when President Xi Jinping urged further integration of military and civilian undertakings. In January 2017, the Central Commission for Integrated Military and Civilian Development was introduced to lead efforts in this regard. The military-civilian integration is not only limited to the space sector. The intention behind this move is to gain "twice the benefit with half of the investment", meaning taking advantage from dual-use in both ways: re-feeding military high-tech, paid by tax payers money, back into the economic circulation as well as buying cheaper in the commercial world. Ever since, other policies for public private partnerships supported the whole process which saw the emergence of mixed-ownership commercial companies, spin-offs and venture capital supported space businesses.

5 years of commercial space industry in China – basically means: in **only** five years unprecedented progress has been made. Not considering the commercial spin-off Expace with its successful Kuaizhou launches and ChinaRocket with its Jielong launcher, this short time period included already China's first commercial flight, achieved by iSpace in July 2019. And others are to come! Considering the first 5 years of its Chinese existence, commercial space is seen as much as an opportunity as a challenge. This résumé has been the focal point of the 5th CCAF on 19 and 20 November 2019 in Wuhan, organised by CASIC which has been pioneering the development of commercial space from day one.

The 5th CCAF was the 3rd international edition since 2017 and each one of those last three conferences has been different while the purpose of the gathering - offering industry, academia and space agencies a platform to exchange ideas on commercial aerospace development and future perspectives - has remained consistent.

Also, the overall number of around 500 participants remained stable since the 3rd conference, though the atmosphere and the talks have always been unique, year by year. The number of foreigners in 2019 was slightly lower compared to 2018. Roughly 80 foreigners from Russia (many!), Sweden, Switzerland, Ukraine, Japan, the UK, Greece, Germany, the Netherlands, US, Serbia, Turkey, UAE, and France came to Wuhan. Several of them even coming on a frequent basis.

Two factors prevented that the number of international participation in 2019 was higher:

Originally the date for the 5th CCAF was set for end of August. The organisers estimated that if that date would have been kept, roughly 100 more foreign participants would have been able to come to Wuhan.

It was highly unfortunate that at the same time of the Wuhan Forum, other important space conferences took place around the globe:

- SpaceCom Expo on 20 and 21 November in Houston, USA
- SpaceTech Expo Bremen from 19 to 21 November in Germany
- APSCC 2019 Satellite Conference & Exhibition from 19 - 21 November 2019, in Bangkok, Thailand
- 18 to 20 November Zhuhai - International Symposium on the Peaceful Use of Space Technology

Those parallel events occupied many of the leading managers of the commercial space industry. Still, Martin Sweeting, Directors of the Swedish Space Corporation and high-ranking Russian representatives were worthy representatives of the "Western" hemisphere. Considering all of this, Wuhan still saw a significant audience - national and international - and they made soundly the best out of this.

In 2019, the organisers returned to the place of the 3rd CCAF - the Eurasia International Convention Hotel. The hotel and the facilities are very good. However, after the grandiose location for the 4th CCAF in 2018 - the Intercontinental Wuhan Expo - the Eurasia Hotel was on a different scale, although the facilities for conference, exhibition and lunch are ideally located: opposite CASIC's office building and in a business district, easy to access with the metro station in front of the hotel and easy to move around, including short distances to the city centre, the airport, and the Hankou train station.

VIPs arrive at the conference hotel. Credit: GoTaikonauts!

It took a full wall to display the conference programme.

Conference souvenirs: pins and reading marks.

Like always, the first day was buzzing with all the space officials, politicians and VIPs present. The opening speeches were given by the Chinese high-level officials like the Vice Mayor of Wuhan, a representative from the Beijing Ministry of Science and Technology, officials from CMSA, CNSA, CASIC and the China-Russia Committee of Friendship.

Hu Yabo, Executive Deputy Mayor of Wuhan, was the first to welcome the guests, saying that the local government has given its support to the forum since its introduction in 2014 and will continue to do so. He confirmed that the city administration is highly motivated to support the development of the commercial space sector in Wuhan. There is a strong drive for moving the industrial value chain to the high-tech and high-quality end. The Wuhan National Aerospace Industry Base adds to a healthy industrial mix of different innovative and future oriented sectors. In the last five years, more than 60 commercial space companies have started business in China. Wuhan is already today the connecting hub for them. However, by 2035 the city intends to double the number of inhabitants. This explains why even an outsider can recognise that in certain areas in Wuhan whole apartment blocks are not inhabited – waiting for new arrivals. So, please, addressed the Mayor the audience, be welcome to set up your business here in Wuhan! There is certainly no lack of infrastructure.

Despite the success so far, Hu Yabo identified some challenges along the way. The Military-Civil Integration is a two-way road and should be seen as such. He thinks that the military has not yet recognised the full potential of the civil commercial companies, the civil remote sensing satellites as well as its applications. Furthermore, there are still many open questions regarding IP protection. Also, what benefits can Chinese commercial space companies bring to the Belt-and-Road Region? With this food for thought he wished the forum much success.

The representative from the central government, **Zheng Fangneng**, Director of the Department of High and New Technology Development and Industry of the Ministry of Science and Technology echoed many of Hu Yabo's points. He stressed that the technology transfer from the military to the civil society is helping to strengthen the commercial space industry for the global competition in which China can position itself favourably.

An interesting aspect of the 2019 CCAF was the involvement of high-leading representatives from governmental space organisations. At the first sight this might look strange for a commercial space forum, however the speakers from CMSE and CNSA were fully aware of the relevance of commercial space companies for their state-owned organisations.

Deputy Director **Lin Xiqiang** of the China Manned Space Engineering Office emphasised that he is convinced that high-end technology and innovation will derive from the work of the Chinese commercial space sector. In the never-ending course for space exploration and towards our common goals he looks forward to work with all relevant players.

Tian Yulong, Vice Administrator of the China National Space Administration looks at the commercial space industry as a source of growth. Its open and inclusive character will make a new type of industrial ecosystem possible. He pointed out that the drafting of a policy framework is in the making and he realises the urgency of it. Like the speakers before him said, the expectations from the commercial sector are high, as well as the trust in the innovative power of the diverse players. As some example for unprecedented development potential, he pointed out the integration of artificial intelligence, of big data and the conversion of academic results into commercial space products.

Sergey Nedoroslev, the President of the Council on Science and Innovation of the Russian-Chinese Committee of Friendship, Peace and Development conveyed the regards from the members of his organisation. He is convinced that the cooperation between both States will grow stronger and will inevitably involve all areas of the society. Based on a long tradition of close neighbour relations, science and space have always been a fruitful field for progress and development.

Liu Shiquan, President of CASIC, recalled that CASIC initiated the CCAF to provide a platform for business cooperation and trade and to speed up the development of the commercial aerospace industry by seeking the

A display of all exhibitors, speaker's organisations, sponsors and contributors

sustainable support of relevant state administrations and local governments, as well as the extensive attention and assistance from all communities. During the last five years, said Liu, CASIC has focused on the built-up of the production capacity for launcher, satellites and space hardware and promoted the coordinated development of the entire industry chain in a strategic, systematic and innovative way. The reduction of launch costs, the development of satellite constellations and the applications of their data within a new generation of spatial information system which is integrating communication, navigation, remote sensing and ground-based information, laid the foundation for new trends in the commercial space sector. Liu concluded that: "Whoever develops faster and better in commercial aerospace will be earlier to benefit from it, and human society will enjoy more convenience and services brought by space technologies earlier." Information technologies such as big data, and artificial intelligence and the cross-integration of new materials and advanced manufacturing technologies have facilitated disruptive innovation in aerospace technology and enable the shift of China's economy from a high-speed growth to a high-quality growth. CASIC's leadership, so Liu Shiquan, regards it for granted to contribute to this.

Liu Shiquan, also confirmed that the in-orbit testing of the Hongyun 1 satellite concluded successfully - including tests under different weather conditions, and for different business scenarios such as website browsing, video chats and high-resolution streaming services. During the tests, there was no frame loss or buffering, and all functions and indicators met the design requirements.

By the beginning of 2020, users across China will be able to access the demonstration system of the Hongyun Constellation, and they will be able to take advantage of what he described as "Hongyun speed".

In 2020 four more satellites are scheduled for launch and by the middle of the 14th Five-Year Plan (2021-25) the initial configuration of 156 satellites should be in orbit and operational.

Cao Guangjing, the Deputy Governor of the People's Government of Hubei Province confirmed that he and his colleagues are happy to provide any support needed for commercial space industry in Wuhan and Hubei – 24/7 for everyone! He is convinced that the currently under construction satellite control centre will give way to commercial applications and new products.

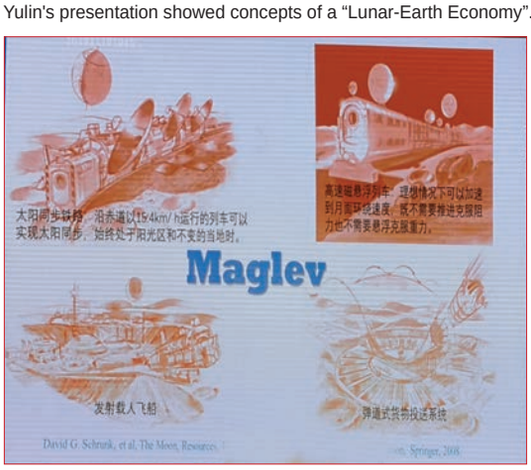
Cao Guanjing is talking. Credit: GoTaikonauts!

Zhao Lihong, the Party Secretary of the District Committee of the Xinzhou District People's Government of Wuhan gave an overview on the status of the construction of the international space city, the living and residential area for the workers and their families of the Wuhan National Aerospace Industry Base. The main road, the Space Avenue is ready, as well as the football park (!) and the school and kindergarten. Until the end of the year, the production facility for the launchers, satellites along with the satellite control centre are expected to be ready. The infrastructure outside the manufacturing is complete anyway.

Zhang Yulin, the former Deputy Commander of the China Manned Space Engineering Agency, mentioned in his talk the new buzzword "Lunar-Earth Economy". Considering that the resources on Earth are limited and the Moon is the nearest destination, it makes sense to include its resources along with those of the Solar System. According to Zhang Yulin, the utilisation of outer space will become a natural move as soon as the capacities in transport, energy and industry are available. Zhang Yulin stressed that the cislunar utilisation is a strategic project to extend the sphere of living for mankind. He showed two interesting technology applications, he proposed to be suited for the Moon: the Maglev technology and tether technology application. (compare: Quarterly Report, section: China National Space Day 2019, page: 13)

A slide of Zhang Yulin's presentation showed concepts of a "Lunar-Earth Economy".

A slide of Zhang Yulin's presentation showed a lunar Maglev concept from the publication: David G. Schrunk, et.al. The Moon, Resources, Future Development and Settlement, Springer 2007



A slide of Zhang Yulin's presentation showed space tether concepts from the publication: David G. Schrunk, et.al. The Moon, Resources, Future Development and Settlement, Springer 2007

Hou Xiufeng, CASIC spokesperson, informed the audience about the readiness status of the production facilities in the Wuhan National Aerospace Industry Base. The smart production line for satellites, allowing batch processing, is expected to be commissioned in 2020. Its initial capacity is 120 satellites per year with a later expansion stage of 240 satellites.

The rocket assembly centre will be ready by the end of 2019. The new facility will support the mass production of rockets. The annual production capacity in the first phase is 20 rockets which will be increased to 50 in the second phase. An innovative assembly process foresees the initial assembly of components which will be tested before joining together for the rocket assembly and final check and tests of the whole launcher ahead of transport to the launch site. Hou Xiufeng illustrated that the Wuhan Base is representing a complete industrial chain of rocket manufacturing, satellite building, ground applications production and other developments.

The Wuhan National Aerospace Base will commission its rocket assembly centre by the end of 2019. The annual production capacity will be initially 20 carrier rockets and up to 50 per year in the second phase. The Wuhan National Aerospace Base will also host a complete industrial chain of rocket manufacturing, satellite building, ground applications production and other development. The advanced satellite production line is expected to be commissioned in 2020 with an annual production output of 120 satellites when working in one shift, and 240 satellites by having two shifts.

Tang Yihua, the Vice President of the 1st Academy of China Aerospace Science and Technology Corporation, told the audience that the medium-lift CZ-8, purposely designed for commercial launches, has entered its final assembly phase and is expected to make its first flight in 2020. With its payload capacity of 4.5 t, lower cost and a short production circle it is well suited for the competitive international market. It is expected that 10 annual launches are a reasonable forecast which might double over the years.

ChinaRocket, the commercial arm of CASC, had its successful first launch of the Jielong 1 rocket in July. Tang Yihua, announced that the launches of Jielong 2 can be expected in 2020 and of Jielong 3 in 2021.

China's new commercial carrier rocket to make maiden flight next year

China's new carrier rocket the CZ-8, a medium-lift carrier rocket designed for commercial launches, has entered its final assembly phase and is expected to make its maiden flight in 2020, said Tang Yihua and Zhuang Guojing during the 5th China (International) Commercial Aerospace Forum (CCAF).

Tang Yihua gives his talk. Credit: GoTaikonauts!

In particular revealing was the talk by Venture Capitalist **Yan Jingyu**, Vice President of Galaxy Industry Group. He is responsible for a fund of 20 billion RMB. Among his clients are iSpace and SpaceTY. He gave some insights into the financial support to commercial space companies from his point of view. The majority of new start-ups come from the “national team” (aka: state-owned companies) with a mainly technical background. He thinks they lack management skills, thinking in business models and maintaining networks. He is not always convinced that the newcomers have a solid understanding of the commercial methods needed to survive in this business.

He also took a critical look at the new commercial space companies, pointing to some conflicts (as a commercial company relying on governmental orders), challenges (international marketing) but also mentioning the opportunities (enormous growth potential).

He briefly outlined which factors the Galaxy Industry Group is evaluating when deciding for financing a commercial space company: team background, target customers/market segment, cost control and customer base. Regarding cost control Yan Jingyu is more convinced that savings will be achieved rather by mass production and standardisation then by innovation. He also thinks that the national market could be suitable for solid business models. In particular if commercial space industry is able to provide launch services to the military. Not only him but also other speakers reflected on the situation in the U.S. and take SpaceX’ development as a reference model. It was an interesting revelation that Chinese commercial space entrepreneurs are very carefully studying what is happening in the U.S. commercial space sector.

Yan Jingyu concluded his presentation by saying that the development of the commercial space sector in China is a long-term journey. Nobody is expecting a quick return of investment.

This strong orientation on what the U.S. is doing and that the efforts in the field of commercial space in the U.S. are serving as a role model for Chinese entrepreneurs was echoed by several speakers, not only by Yan Jingyu. Some of them also stressed that the mechanism like seed money from NASA within the COTS programme are not existing in China. Also, the technology transfer for SpaceX and Blue Origin is unique to the circumstances in the U.S. Some managers of the space companies present in Wuhan, especially the younger CEOs, expressed their wish, China should pursue the best practices of the U.S.

Despite concerns that there is not a big enough market for more than one or two commercial launch service providers, all new space companies have different ideas on that.

There is a strong belief that the mastering of low-cost access to space will create unknown markets which can be as simple as advertising or very down to people services. Users, which in the past have chosen for cheaper, non-space solution will be willing to take the space-solution as soon as the price is affordable. And if that would happen, the national market with a population

Yan Jingyu, Vice President of Galaxy Industry Group. Credit: GoTaikonauts!



left: At CASIC's exhibition booth, a model of the Xingyun satellite was presented. The Xingyun constellation for IoT is expected to comprise 156 satellites until 2025. *centre:* Takayuki Kawai (left), Head of JAXA's Strategic Planning and Industrial Promotion Division. *right:* View into the conference hall. Credit: GT!/Yang Yugang/Milan Mijovic

of 1.4 billion has a unknown potential. The critic that the space start-ups have not yet a viable marketing strategy is refuted by those companies by saying that first the core technology has to be ready otherwise no investors are willing to provide funds, and no products can follow.

Some other speakers, in particular of CASIC and the governmental presenters did not miss the opportunity to point out to 2020 which will become a really busy year for China in space, regardless whether it will be commercial or governmental: China is scheduling 30 missions, including the Chang'e 5 lunar sample return mission, the Mars mission, the completion of the Beidou 3 constellation. Also, it was announced that until the end of the year, two IoT satellites for the "Xingyun" LEO constellation of 80 smallsats will still be launched. The Xingyun Project aims at providing low cost communication capacities, complementary to ground-based network in areas with no or weak signals.

In the afternoon - still during the conference programme, the organisers invited the foreign participants (only) for a cocktail reception. It was nicely organised and meant to bring the foreigners together but not all people could get away from the conference immediately since they had to present their talks. But the opportunity for that casual meeting was most welcome and helped to get in closer contact with the other presenters. One cannot overestimate the importance of creating a community, of creating a network, and of staying in contact. The cocktail reception should remain a feature for the years to come and if possible, should include all participants or even grouped by interests. Maybe this in-person activity could be complemented by the set-up of an online community to make it easier to share and stay in contact.

Another interesting activity which could be incorporated into the CCAF is something similar like the B-2-B meetings done at other conferences or the match-making-game of the China-UN forum from April 2019 (see: GoTaikonauts! issue no 25, pages 20-23) which has been a nice example of how common interests can be identified and facilitated (out of the 4 matches GoTaikonauts! made in Changsha, 2 lead to follow-up projects, meaning a success rate of 50 %).

The second day was less busy and followed a normal conference routine. Even the conference poster wall outside the hotel was taken down because the next conference (a medical one) took over the territory. So far for Chinese business efficiency.

Also on the second day, CASIC launched a space-based network ground service platform. That particular workshop took place in Chinese language only and ran in parallel with the conference programme. The full details of this service platform were not obvious, but in summary it can be said that it is an online service platform to make satellite resources more accessible for users. The aim of the platform being to provide integrated satellite resources - communication, navigation and remote sensing - in a user-friendly way. It stores, manages, processes and distributes the data, which is like establishing a satellite "resource pool" for users to select from. The platform is meant to enable the efficient use of the national satellite resources, which are all connected to this platform and are customised to the customers needs.

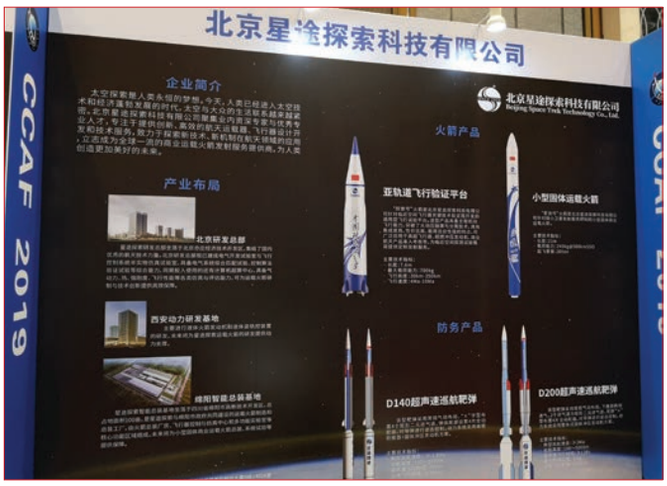
Some Observations

It is always a pity when two sub-fora run in parallel because one has to decide which to follow and which to miss. That left almost no time for visiting the accompanying exhibition. Although the exhibition was not comparable in size to the one in 2018, it is always interesting to have a look and to have an opportunity to get in direct contact with the experts.

In the lead up to the 5th CCAF there was talk by the organisers to include panel discussions on different topics. Panel discussions might not really be a set-up, which Chinese are at ease with. Huo Jia, Vice President of iSpace referred in his presentation to the podium talk between Jack Ma and Elon Musk in September in Shanghai, which he found inspirational and important. Maybe the format of panel discussions could bring a special note to the Wuhan commercial forum, giving it a new and fresh approach, underlining its international atmosphere and would have gotten

Exhibition booth of Chang Guang Satellite Technology Co., Ltd. Credit: GT!

Exhibition booth of MinoSpace. Credit: GoTaikonauts!



The exhibition booth of Beijing Space Trek Technology Co., Ltd. Credit: GT!

the whole event away from the standard PowerPoint talks.

The 5th CCAF showed a strong diversification of the commercial space sector in China, new services and products were presented.

It was obvious that data became an important product, its applications and the services generated out of data not only for China but very much so for the Belt-and-Road region and further on for the African continent. Data without application makes no sense, as one speaker pointed out. It might be very likely that at the next forum, the growing importance of data will become even more prominent. Since there is no other country where AI, 5G, machine learning and data are planned to be strongly combined, super-innovation can be expected from that.

Language remains a problem – also during the conference. Despite a qualified translation service, some details are always lost and the information over the headset comes a little bit later then the slides are shown on the screen. This becomes in particular challenging when the presenter is rushing through the view graphs. Also, more and more Western speakers are able to present in Mandarin… One needs to speak Chinese in China!

Language also remains an obstacle in outreach and PR around the CCAF. For example, rocket manufacturer iSpace produced a brilliant marketing video showing the product portfolio and the direction the company want to go in the future. The same was the case in 2018 when CASIC showed in the exhibition inspiring and high-quality promotional videos. All those features along with the presentations are limited to the view by the audience during the conference. Also, there is always a photographer taking photos of the presenters and a camera recording the presentations. It must be possible to either stream the conference or at least put the presentations and talks online so that interested people around the world could have access to the content. We believe to develop a mature rocket technology is harder to do. Surely, the forum could become better known if a PR strategy could be defined and applied and if that strategy would include targeting the international audience. It made us proud when international participants told us that the only information on the forum they could find was posted on the GoTaikonauts! website but it also made it clear that there is a big potential if outreach activities, even easy ones like having an extended, more detailed conference webpage or blog or community website, could be applied more intensively.

Next Year's venue?

It is undecided as to where the next years venue will be.

The Wuhan National Aerospace Base might be ready in 2020 including a conference centre. The organisers were thinking already this year about tours to the base but in the end decided against it. However, such an opportunity would boost the whole scope of the forum since everybody is curious to see at last the industrial park and hopefully also the interior of the manufacturing facilities.

CASIC, the owner of the new Wuhan satellite industry park within the Wuhan national space industrial base, confirmed during the 5th CCAF that the satellite manufacturing facility will become operational in 2020 and will have an output of annually 120 satellites for general use, each weighing less than a ton. The rocket assembly facility is scheduled to start operation by the end of 2019. Its production capacity will be around 20 rockets a year.

Challenges and Opportunities

Five years is also a good occasion to take stock. So what has the CCAF achieved?

So, far the forum has been drawing from its novelty - now it has to gain profile. The new location in the Wuhan Base could become a significant incentive for conference participants to come along. So, finding a profile might be a hard challenge in a politically difficult arena. But with the Wuhan Aerospace Industry Base, CASIC has a joker in its hand.

From the organisational point of view it might be beneficial to find continuity. During the last three years, each time the organising committee had a different composition. Also, the recent change in management of CASIC has to show that there is the will for consistency.

Provided the challenges are taken up, it can easily be seen that the forum will grow stronger, in particular if the organisers manage to form a close network also among the international community. The average participant might not always be from the higher management of the space sector. To find a balance between experts from the high ranks, medium management and working level will engage a broader spectrum of space experts where each group of specialists can contribute from its point of view. Already in 2019, the classic structure of launcher sub-forum and satellite sub-forum was not strictly applicable because many more experts from the wider "ecosystem" or the so-called "down-stream sector" were present: finances, insurance, supplier, applications. What the organisers have not yet tried is to involve soft-topics, such as outreach, education or art. For that, more international outreach might help.

GoTaikonauts! wishes to thank the organising committee of the 5th CCAF, in particular Prof. Yang Yugang and Zhang Zuotian who did their utmost to make all international guests feel welcome. Without their personal care and support the Wuhan forum would not be same. We hope to meet again in 2020.

The report from the 3rd CCAF 2017 can be found on the GoTaikonauts! website or by scanning the QR code to the left: *https://www.go-taikonauts.com/images/newsletters_PDF/2017_Wuhan_web.pdf*

For the report from the 4th CCAF 2018, please, follow this link or scan the QR: *http://satellitemarkets.com/events/2018-china-commercial-aerospace-forum*

5th CCAF – China (International) Commercial Aerospace Forum

Impressions of the forum by international participants

Helen Tung

Founder,
NewSpace2060

In which function or assignment did you come to the 5th CCAF to Wuhan?
I was invited by Prof. Yang to come and speak at the 5th CCAF. At the time I had spent 6 months working on EU-Japan NewSpace and as I had previously trained NewSpace entrepreneurs, I was very interested in what the start up scene in China was like. At the time I attended as Founder of NewSpace2060 currently I am working as a Senior Associate in a local German-led law firm.

Which topic did you present during the 5th CCAF?
At the 5th CCAF, I primarily focused on the overview of NewSpace and also international events that may be of interest to NewSpace startups in China. For instance, I mentioned the Moon Village Association, the International Aeronautical Congress and other startups for comparison. One of the challenges, at least from my experience is that there is limited time and resources and so for startups, they have to direct their mind on where they want to focus.

The interesting aspect about NewSpace is because the potential is huge, as the technology being developed may be for a totally new purpose or it may be a further development to say small sats, my view is that the scope of a 'customer' is much larger - due to the fact it is still a developing sector. It is wonderful to see how developed some of the NewSpace startups are, in fact I would say it is very impressive. However, if they want to be an international player they have to also be seen and think of ways of how to best partner with other space, non-space businesses.

Did you get feedback on your presentation?
I think the feedback was limited, though then again, that's usually the case with conferences. However, I thought the organisers really wanted to make a great conference inviting many high-level officials and did everything they could to make the speakers and attendees feel good. I think there was ample opportunity to network with local and perhaps more so with international attendees.

What is your overall impression of the 5th CCAF?
I think the 5th CCAF lays a good groundwork to connect key space players on the ground. As you know, China is a large country and so it was good to see people coming in from different regions of China to attend, specifically from Beijing. It was also a wonderful opportunity for me to see Wuhan and know of the many opportunities that are being developed in Wuhan like the Aerospace city that is being envisaged.

Personally, I know of Wuhan as a city that is very strong in international law and as a port city I think that Wuhan has great potential to become a recognised international centre. I guess, like things, it takes time though I think the organisers did an incredible job to compile such a great and diverse programme. For instance, I heard that this is the first time that an insurer was invited to speak and that the market now realises that there is potential for this field as NewSpace startups mature. The fact that the remit of their speakers are expanding is a good indication that the market is maturing too.

Dr. James Kass

Director of
James R. Kass Space Consulting
Den Hague, The Netherlands

In which function or assignment did you come to the 5th CCAF to Wuhan?
I was invited as speaker to the forum.

Which topic did you present during?
The subject of my presentation was *'Harnessing space infrastructure to enable marketable innovative applications'*.
We are currently witnessing an unprecedented increase in the number of satellites launched into orbit whose key goals are facilitating potential commercial services to billions of new and existing users. But even today space infrastructure is very much underused; and when used, the increased potential achieved by combining different space services, such as earth observation, navigation, communication, for B2B and B2C applications, is seldom capitalised.

My paper presented a practical model for facilitating start-ups and SMEs, with the help of space agencies and large companies, to develop cutting-edge potentially commercializable innovative applications that harness space infrastructure as a key part of their solutions. Examples of successful implementation of this model were drawn from the European Space Agency's Business Applications programme. As a member of the inter-directorate task force responsible for designing and setting up this program, I was able to provide first hand examples of projects successfully initiated, as well as current and future domains of potential exploitation.

Did you get feedback on your presentation?
Yes, both at the convention in person, as well as afterwards, confirming that the information garnered was useful and prescient.

What is your overall impression of the 5th CCAF?
My overall impression was very good. The hosts were especially kind to us foreign participants, and did their utmost to be of help to us, and even reserved seats at the front of the auditorium for us. I found the presentations at this forum to be very useful and relevant.

The 2019 motto of the 5th edition of the China (International) Commercial Aerospace Forum was: "Jointly Building an Industrial Ecology to Lead the Development of Commercial Aerospace"

Milan Mijovic

President
SERBSPACE

In which function or assignment did you come to the 5th CCAF to Wuhan?

I have attended the 5th CCAF as the President and the Founder of Serbian Office for Space Sciences, Research and Development (SERBSPACE) as well as Space law Ph.D. student and Air and Space law Research assistant at the Law School Union University in Belgrade.

Which topic did you present during the 5th CCAF?

With great pleasure I have presented and talked about the first South-East Europe Space conference to be held at Science Technology Park, Belgrade, Serbia on 2 and 3 April 2020*, which will include academic, educational and business panel, industry 4.0, technology and innovation session and space and society segment.

SEE Universe 2020 shall gather international and national stakeholders and experts from the domain of space sciences and industry. SERBSPACE believes that this conference will place Belgrade on a global map of innovation and industry 4.0, which shall enable development of national capacities, technology and innovation as well as international cooperation and knowledge exchange, all in service of sustainable development.

Between 100 and 150 participants are expected to attend from national and international universities and organisations, governmental and industry representatives as well as speakers from space agencies and the UN Office for Outer Space Affairs. The conference shall include three thematic sessions: Academia, Industry and Societies.

Did you get feedback on your presentation?

I was very satisfied with the impact my presentation made on the participants of the Forum. My impression was that stakeholders from the Chinese space sector are looking forward to international cooperation as many of them approached me after my presentation and required more information about the SEE Universe 2020 Space conference.

What is your overall impression of the 5th CCAF?

Being for the second time in China in one year, the organisers fullfilled my expectations for the Forum. Being an invited key speaker, the LOC provided my plane ticket and accommodation costs and the entire process went smoothly. I was particularly impressed by the high level of planning of members of the LOC as well as other engaged staff.

I found the punctuality and content of agenda admirable, especially given the outstanding number of participants, presenters and high-level speakers. Several side events were a perfect venue to network and exchange ideas with future partners and colleagues.

Attendance at the Forum was of particular success for me and my Office, given the fact that I had an opportunity to meet representatives from the Chinese aerospace industry sector. Personally, this was a unique opportunity to invite them at the SEE Universe 2020 Space conference which is being organised next year in Belgrade by my Office. In this light, I am glad that I have been able to establish outstanding cooperation with various companies from China and looking forward to welcoming them in Belgrade.

**The interview was given in January 2020. In the meanwhile the SEE Universe Conference had to be postponed.*

P. J. Blount

Postdoctoral Researcher, Faculty of Law, Economics, and Finance, University of Luxembourg
Adjunct Professor, LL.M. in Air and Space Law, University of Mississippi School of Law

In which function or assignment did you come to the 5th CCAF to Wuhan?

I came as a researcher from the University of Luxembourg where I work as part of the team of the SES Chair in Space and Communication Law.

Which topic did you present during the 5th CCAF?

I presented on the need for Space Traffic Manangement in the commercial sector. Essentially I argued that the lack of an STM system for the coordination of responsible space activities is a critical challenge for the commercial space industry. Solving this problem will require a great deal of cooperation among states and private actors, but will be essential to future space operations, especially in light of emerging technologies.

Did you get feedback on your presentation?

Yes, in general it seemed very well received by the participants. This is likely because of the rising interest in STM in China.

What is your overall impression of the 5th CCAF?

It was an enjoyable experience, and an excellent forum for hearing about the commercial industry in China. This is important because Chinese commercial space activities often get overlooked or lumped in with China's civil and military space efforts. The Chinese portfolio of commercial space activities is expanding and the CCAF was an excellent forum for learning about these developments.