All About The Chinese Space Programme

Go TAIKONAUTS!

龙腾太空

Issue 25 | June 2019

Landspace's Huzhou manufacturing facility. credit: LandSpace

Content

Chinese Space Quarterly Report
July - September 2018
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SPACE TRANSPORTATION

CZ-5
The China Academy of Launch Vehicle Technology (CALT) reported that it is studying a lunar mission profile comprising the launch of the crewed lunar spacecraft with a CZ-5B into LEO. The crew vehicle would rendezvous with the lunar lander lifted by a CZ-9. The spacecraft combination would then proceed for trans-lunar injection. Also, two versions of a new generation crewed spacecraft are being developed. CZ-5B's first flight is planned for mid-2019.

CZ-8
On 2 July, the China Aerospace Science and Technology Corporation (CASC) performed a hot-fire test of a new 2 m-diameter, solid-fuel motor and its servomechanism system to be used for the CZ-8 boosters. Latest information indicates that solid boosters on CZ-8 have been replaced by liquid fuelled boosters in order to realize resuablity. It is unclear what will be the new use of this solid motor in development. CZ-8's first flight is currently planned for late 2020.

CZ-9
On 18 September, at the World Conference on Science Literacy 2018, Li Guoping, Director of the Department of System Engineering of China National Space Administration (CNSA) said that the first launch of the heavy-lift CZ-9 (140 t to LEO / 50 t to Earth-Moon transfer orbit) is planned for 2028, two years earlier than previously reported.

Regulations on commercial activities

He also mentioned that China promotes the cooperation between government and social capital and will improve government procurement of commercial aerospace products and services. A new regulation regarding rocket launchers will be released shortly. Furthermore, China supports open and shared commercial space launch sites.

SmartDragon 1 - Jielong 1
On 31 July, CASC unveiled its micro rocket Smart Dragon No.1, under development by Chinarocket Co. Ltd., a CASC subsidiary. This solid-fuel rocket, the first in the Smart Dragon series, is designed to lift payloads of around 150 kg weight and 1.1 m (width) x 1.5 m (height) size. The rocket can be readied for launch within 24 hours and it can be manufactured within six months after order.

Yuanwang 7
On 14 August, Yuanwang 7 left the port of Shanghai for its first Indian Ocean maritime space monitoring and control mission.

Launch Opportunities
In mid-August, CALT offered spare capacity on seven of its rocket launches: 100 kg P/L capacity on the CZ-5 GEO flight, planned for the end of 2018; capacities between 9 kg and 1,000 kg into SSO or LEO on five CZ-11 and CZ-2C launches in 2019; 1.8 t payload capacity on the CZ-8 into SSO in 2020.

Yuanwang 7 on cruise. credit: China Internet

CASC Milestone Plan
At the beginning of September, CASC published a plan for becoming a world-class aerospace enterprise between 2020 and 2030, and supporting China's near-term aerospace projects, including the construction of an unmanned Moon research station and national defence programmes. In the second stage between 2030 and 2045, CAST will significantly contribute to China's transformation into a major space power by supporting economic, scientific, technological and military development.

MANNED SPACE FLIGHT

CSS
At the beginning of July, the Director of China Manned Space Engineering Office (CMSE) Yang Liwei, told media that the nation is accelerating the timetable for its space station construction. The core module Tianhe is planned for launch in 2020 and the two experiment modules for 2021 and 2022 respectively. Its operational lifetime is 10 years. In 2021 and 2022, 3-4, maybe 5, crewed missions and several cargo spacecraft are planned. Extended astronaut recruitment for those missions is under way. 13 payload racks will support 30 research projects in eight areas, including space astronomy, space life science and biotechnology, microgravity fundamental physics and space materials. China plans "large-scale scientific experiments on space application projects". Once the main modules are in place, the optical telescope module will be sent into the same orbit.

By mid-August, the first test of the propulsion system for the CSS experiment module has been successfully completed in West Shanghai. The propulsion system is developed by the Shanghai Institute of Space Propulsion under the Academy of Aerospace Propulsion Technology (former "Institute 801" under SAST, now under AAPT), a CASC subsidiary. The academy already developed the propulsion systems for the Shenzhou vehicles, Tiangong 1 (TG-1), Tiangong 2 (TG-2), and Tianzhou 1. The tests were conducted over 2 hours following an 8 step-procedure which covered all in-orbit working conditions of the module, including failure simulation. The CSS will be equipped with 36 thrusters, each weighing 10 kg and with a 15 year lifetime: 4 thrusters adjust the operation orbit and 32 adjust the flight attitude.

On 31 August, the United Nations Office for Outer Space Affairs (UNOOSA) and the China Manned Space Agency (CMSA) have decided to extend the closing date for proposal submission in response to the 1st Announcement of Opportunity (AO) for flying space experiments on-board the CSS by one month until 30 September 2018. The preliminary selection is shifted to 31 December and the final selection and notification to 30 June 2019.

At the beginning of August, a Call for international cooperation experiments on the CSS was issued by CAST and CMSA. CAST established a committee of 14 Chinese space science experts under the lead of academician Bao Weimin, to solicit, review and select experiments submitted by scientists from the global research community. Preferred fields of interest are physics, material sciences, in-space manufacturing, astro-chemistry and bioengineering. The review and selection process will be made in accordance with international norms and universal practices. CMSA is responsible for the final selection.

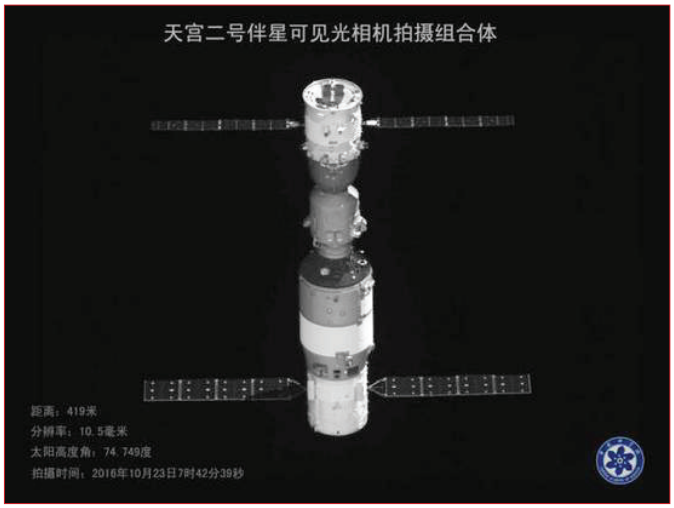
To stimulate interest among the young, the Youth Programme of Scientific Education Experiment on the CSS, was launched at the beginning of 2018. This special programme targets primary

and middle school students from around the world. In a first step, nearly 200 youth education experiments were collected nationwide, and a preliminary list of 30 projects was released.

Tiangong 2

On 15 September, CMSA announced that TG-2, launched exactly two years ago, has exceeded its designed life span of 24 months but remains in orbit for conducting scientific tasks and testing operations.

At a press briefing 11 days later, on 26 September, Lin Xiqiang, Deputy Director of the CMSE told media that the TG-2 Management Committee had decided on 20 September to manually deorbit the module after July 2019. He also confirmed that the module is operating in a near-circular orbit at an average height of 400 km. It is functioning nominally, is in good condition and is used for further tasks. The high-resolution, multi-spectral imager and the 3D microwave imager provide Earth observation and geological data for research and disaster relief, and in support of local economies in Ningxia and Yunnan provinces. Zhu Zongpeng, TG-2 Chief Engineer, stressed that the space lab has many built-in safety control modes to deal with emergencies and ensure its safe decommissioning. In case of loss of signal by Chinese ground controllers, TG-2 would rely on an auto-pilot system for safe guidance. During the re-entry process, engineers will monitor 300 parameters.



An image taken at a distance of 419 m and sent back by an accompanying satellite shows Shenzhou 11 (top) and Tiangong 2 (bottom) on 23 October 2016. credit: Photo/CCTV

TG-2 Atomic Clock

The Chinese Academy of Sciences reported at the end of July, that the atomic clock on board of TG-2 has lost during its two years of in-orbit operation the equivalent of only one second in 30 million years. The ultra-precision is based on laser-cooled cold atom technology, allowing for long-term stability, thanks to the operation of the clock in the microgravity environment of space.

Astronaut Training

On 27 September, the 10th anniversary of China's first and only EVA, astronauts at the China Astronaut Research and Training Centre have been training in the neutral buoyancy pool in preparation for 6-hour spacewalks as may be expected during the CSS assembly. China's astronaut training is intense, relying on repetition to perfect the work flow and reduce the margin for error.

Yang Liwei in Minsk: Chinese Yuri Gagarin

From 9-15 September, the 31st Planetary Congress of the Association of Space Explorers took place in Minsk, the capital of Belarus. During a press conference, Yang Liwei told the media agency BelTA that space exploration is the common goal of humanity. Despite different development levels of space technology in different countries, all countries are cooperating. This is very important for future progress. Yang Liwei said that he is often called "Chinese Yuri Gagarin" and that he feels honoured by that. He reiterated that all countries are invited to take part in the CSS project.

Looking back at the Shenzhou 5 mission

Yang Liwei, Director of CMSE, and China's first taikonaut gave a vivid account of his experiences during the historical mission with Shenzhou 5. He also recalled very tense and dangerous moments of his flight. During launch, he had to endure violent vibrations for 26 seconds. "During that 26 seconds, I thought I'd die.", he told media in January 2018.

In another report, Yang Liwei likened Shenzhou 5 to a tractor and Shenzhou 11 to a limousine: "When Shenzhou-5 was orbiting the Earth in 2003, I could communicate with the ground controllers only 15 percent of the time. When Jing and Chen were in space in 2016 they could communicate with the ground for 85 percent of the flight. They could watch news programmes, use mobile phones, send messages to the ground and log on to the internet."

Photo gallery on China's progress in manned space missions with some rare and artistic shots. (Note: The captions are in German language only. source: german.china.org.cn)

LUNAR AND DEEP-SPACE EXPLORATION

Moon

Li Guoping, Director of the Department of System Engineering of CNSA, said at the World Conference on Science Literacy 2018 on 18 September in Beijing, that China is planning four missions within the 4th phase of CLEP, China's lunar exploration programme. The Chang'e 4 (CE-4) mission to the lunar far-side is already part of the 4th phase. The other missions are a sample return mission and two lander missions: one at the lunar South Pole and one at the North Pole. The South Pole exploration aims at studying the age of the lunar soil, and the composition of the solar wind's isotopes hydrogen, carbon, helium and oxygen; while the North Pole expedition aims at finding out whether ice exists in permanently shadowed areas.

After that, China is considering setting up a scientific research station on the Moon and implementing more robotic and human lunar exploration missions in the future.

Li Guoping also confirmed the launch of China's first Mars mission for 2020, reaching Mars after a 10-month-long journey in 2021. A second Mars mission will be a Mars Sample Return mission, planned for 2028.

Chang'e 4

During a press conference on 15 August, the CE-4 lunar lander and rover were introduced to the public. The rover, similar to its predecessor, the Yutu rover on Chang'e 3, is a rectangular box with two foldable solar panels and six wheels. It is 1.5 m long, 1 m wide and 1.1 m high. Additionally, it has adaptable parts and an adjustable payload configuration to deal with the complex terrain on the far-side of the Moon, the demand for communication via relay satellite, and the specific scientific objectives. The four scientific payloads include a panoramic camera, infrared imaging spectrometer and radar measurement devices, for investigating the Moon's surface, lunar soil and structure. The lander will host the Lunar Lander

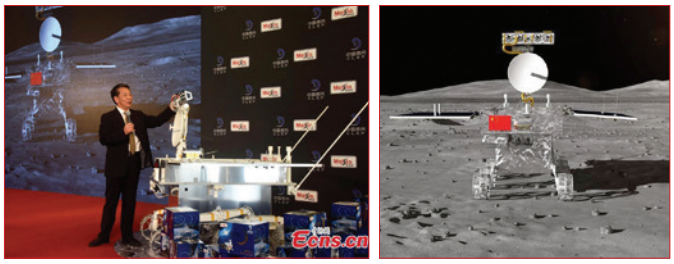
Neutrons and Dosimetry (LND), a neutron dosimeter, developed by Kiel University in Germany and the rover the Advanced Small Analyser for Neutrals (ASAN), an energetic neutral atom analyser provided by the Swedish Institute of Space Physics (IRF). The Netherlands-China Low-Frequency Explorer (NCLE) and a small lunar optical imaging detector developed by King Abdulaziz City for Science and Technology (KACST) are mounted on the relay satellite.

The global public will have a chance to name the rover with the winner to be announced in October 2018.

Chang'e 2

High-resolution, close-up photos of asteroid Toutatis, taken at a distance of 770 m by an on board-camera of CE-2 during a close fly-by of Toutatis with a relative velocity of 10.73 km/s on 13 December 2012, allowed scientists to study the topographical features of the asteroid, showing it has two lobes, including a small "head" and a large "body."

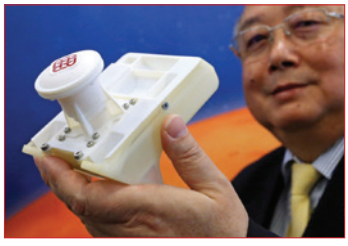
Researchers from the Purple Mountain Observatory of the CAS and the United States concluded that Toutatis might have formed from the merger of two smaller asteroids. They also investigated how Toutatis rotates in space and revealed its geological characteristic - consisting of mainly rubble - and that the impact craters on its surface could be 1.6 billion years old.



Wu Weiren, Chief Engineer of China's lunar exploration programme CLEP, talks about the CE-4 rover (right) at an event in Beijing, on 15 August 2018, where China kicked off a global contest to find a name for it. (photo: China News Service/Sun Zifa)

Mars 2020

Hong Kong Polytechnic University (PolyU) and CAST signed an agreement on 22 August to jointly develop and build a 380 gramme, wide-angle (120 degree horizontal and vertical) "Mars Landing Surveillance Camera" for China's first Mars probe in 2020. The Mars mission will host 10 cameras in total. The PolyU camera has to be tested for very high impact shock since it will be mounted on the top of the lander and is supposed to monitor the operational status of the Mars rover, including its deployment. The device needs to cope with temperatures ranging from -70°C to 90°C and will feature low image distortion optics. Professor Yung Kai-Leung, PolyU's Professor of Precision Engineering, likened it to putting the camera for nine months into a fridge and throwing it from a building onto the street and expecting it to function straight away. The 20-person camera team aims for readiness by 2019 and hopes for spin-offs in medical robots and industrial engineering. PolyU has a tradition in Mars camera development for ESA, Russia and the lunar camera on CE-3 as well as the upcoming CE-4 mission.



Professor Yung Kai-Leung, the Chair Professor of Precision Engineering at Hong Kong Polytechnic University, with a prototype of the camera. credit: Dickson Lee/SCMP-South China Morning Post

On 2 September, CCTV reported that the Tianying 6 (Skyhawk 6) sounding rocket was launched from Xinjiang to conduct four full-scale parachute tests of the Mars supersonic parachute. To simulate the thin Martian atmosphere, the parachute was successfully deployed from heights between 44 and 54 km, providing valuable aerodynamic data and verifying subsystems.

On 17 October, the subsurface detection radar for the Mars 2020 mission was tested from an air balloon at the China Aviation Association Hengshui Aviation Flight Camp.

SCIENCE

On 4 July, the Chinese Academy of Sciences (CAS) announced at the National Space Science Centre (NSSC) in Beijing Huairou Science City that the Strategic Priority Space Science Programme (Phase 2) has officially kicked off with the development of a group of 4 satellites in the next 5 years:

- **E**instein-**P**robe (EP) for X-ray and Black Hole research,
- **A**dvanced **S**pace-borne Solar **O**bservatory (ASO-S) for solar research and space weather,
- **S**olar wind **M**agnetosphere **I**onosphere **L**ink **E**xplorer or SMILE for the research on solar wind and the Earth magnetosphere, and the
- **G**ravitational Wave High-energy **E**lectromagnetic **C**ounterpart **A**ll-sky **M**onitor (GECAM) for the search for electromagnetic signals of gravitational waves.

Because of the historic detection of gravitational waves by the US-American LIGO project in February 2016, GECAM was accelerated in selection and development and is already in the Phase A study phase with advanced technical mission readiness, while the other three are in the engineering phase.

The Priority Programme also includes conceptual studies, intensive studies, pre-research, space science mission planning and data analysis, etc.

The **E**nhanced **X**-ray **T**iming and **P**olarimetry Mission (eXTP) is among the six major background projects under intensive research. eXTP, China's next-generation X-ray observatory for studying black holes and neutron stars in unprecedented detail, is included as a high priority and large space science mission. The programme will be fully funded through China's 13th Five-Year Plan and aims for launches in around 2025.

For a detailed report on China's space science programme and an overview on all space science missions, please, refer to GoTaikonauts! issue no 24.

Gravitational Wave Research

The Sun Yat-Sen University in Guangdong Province announced on 30 July that it will build a ground simulation system for space-based gravitational wave observation. It will provide a complete simulation environment and new research methods for China's research on space-based gravitational wave observation. The ground simulation system, with an estimated investment volume of more than 1 billion RMB (146.6 million USD), will be built on the university's campus in Shenzhen. It is part of the gravitational wave research project "Tianqin" initiated by Sun Yat-Sen University in 2015. With an estimated cost of 15 billion RMB, Tianqin would be carried out in four stages over 20 years, ultimately launching three high-orbit satellites to detect the waves. The Sun Yat-Sen University has already constructed several parts of the research infrastructure for the Tianqin project at its Zhuhai campus.

FAST

Since its test operations began in September 2016, the research team at the Five-hundred-meter Aperture Spherical Telescope (FAST) has identified 43 pulsars.

Because the visits to FAST's exhibition centre and viewing platform have become very popular, the local government has restricted the number of tourists to the site to 2,000 per day to improve the protection of the core zone against signal interference.

At an astronomy forum organised by National Astronomical Observatories of China (NAOC) and the Purple Mountain Observatory, held in Xuyi County, Jiangsu Province, the Chief Scientist of FAST, Li Di, confirmed that the telescope will start formal operation and will be open to Chinese astronomers in 2019.

At the forum more than 300 astronomy experts from around the world discussed the future development of astronomy.

China Built the World's Largest Telescope. Then Came the Tourists.

A report by Sarah Scoles of "Wired" is investigating the question whether the world's largest telescope FAST can coexist with a nearby buzzing tourist location, the new Pingtang Astronomy Town. Scoles' article is a descriptive account of the general situation around FAST and how China's ambition in advancing astronomical science may play out.

Unravelling hidden universe with Chinese wisdom - a portrait of Chang Jin, Chief Scientist of Wukong

When Chang Jin graduated from the University of Science and Technology of China and started working at the space astronomy lab in the Purple Mountain Observatory in Nanjing in 1992, he was surprised to find that Chinese space astronomy was a blank sheet. "I felt like I was working in a car factory where no car had been produced," Chang, now Chief Scientist of China's Dark Matter Particle Explorer (DAMPE), recalled. Chang Jin grew up in a poor village in Taixing County, east China's Jiangsu Province. Any resource, be it food or money, was precious. "In my father's last days, he worried that if our satellite failed, the money wasted would be equivalent to the total income of tens of thousands of families in our hometown," said Chang. "That's why I work with extreme caution. We must succeed. We cannot waste the state's research money."

Large aperture optical mirror

The Changchun Institute of Optics, Fine Mechanics and Physics of the CAS has developed a high accuracy 4 m-aperture silicon carbide aspheric optical mirror for astronomical observation. The mirror has a weight of 1.6 tonnes. The silicon carbide used in the production process provides more stability to the surface of the mirror, allowing for greater accuracy at 20 nanometres.

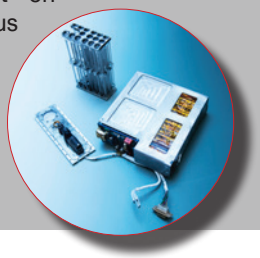
The 4 m mirror. credit: Xinhua

Seed Bank for Cultivation in Space

On 9 August, the first national space cultivation seed research centre and laboratory was established in Yangling National Agricultural Demonstration Zone in Shanxi Province, aiming at combining astronautics with agricultural sciences. It is an initiative by "Space Biology", a technological consultancy with the China Academy of Space Technology, in cooperation with a local plant cultivation company. China has a long tradition of sending seeds on retrievable space craft and recently also on manned missions into space. Starting with FSW-9, launched on 5 August 1987, which carried crop seeds of pepper, wheat and rice, scientists at the Yangling Demonstration Garden for Modern Plant Introduction and Breeding have been working on space breeding technology for more than 30 years and have conducted more than 70 space breeding experiments, sent more than 6,000 seeds into space, of which more than 230 have been successfully selected, including for crops, vegetables and flowers. The principle is that in the space environment, seeds may undergo mutation and after returning to Earth, the mutated seeds are the starting point for breeding new varieties with a higher quality and yield. During their time away from the planet, extreme conditions such as high radiation, increased the mutation rate to more than 1 per cent, compared with the rate of one in 200,000 on Earth. Mutations in space change the DNA without importing outside genes. That makes space seeds different from genetically modified seeds and allows to speed up the cultivation of high-quality seeds, reducing the time from eight years to four years.

The centre, which also serves as a space seed breeding lab, will protect the returned seeds, conduct further selection and test them on Earth. The researchers in Yangling have been tasked by the National Forestry and Grassland Administration to send 20 varieties of trees into space and select mutated ones to cultivate quality tree seedlings for the Three-North Shelter Forest Program, which places forest windbreaks in North, Northwest and Northeast China to green those arid and semi-arid regions, arresting the expansion of the Gobi Desert.

On board of the recoverable FSW-9, back in 1987, a parcel-sized European hardware was also flown, Europe's very first closed-loop life-support experiment to fly in space. It was developed by France's CNES space agency and MATRA space company and represents an important precursor for ESA's current Micro-Ecological Life Support System Alternative (MELiSSA) programme. The FSW-9 experiment flew for five days to see how the algae grew in weightlessness. Two types of microorganism - algae dependent on oxygen and exhaling carbon dioxide, plus cyanobacteria dependent on carbon dioxide and exhaling oxygen - were placed in the glass vials, their mutually-dependent growth in weightlessness supported by nutrients and light, the latter supplied by a small light bulb.



Sun observation

Chinese scientists have put forward a novel idea to put a telescope, the Earth and the Sun in a straight line. Using the Earth to cover the sun, would make the observation of a total solar eclipse in space possible and have a longer and more accurate observation time for studying the source of solar storms. The team calculated the best place for the telescope was close to the second Lagrange point (L2) of the Sun-Earth system, about 1.4 million km from the Earth. The idea however faces technological challenges, such as power supply. Cooperating with scientists from the University of Science and Technology of China and the Innovation Academy of Microsatellites of the CAS, Luo Bingxian, a researcher at the National Space Centre CAS, took the idea to a contest of innovative future technologies, where it was selected as one of 30 winning projects.

MICIUS

At the end of August, the 8th International Conference on Quantum Cryptography took place in Shanghai – and for the first time in China. 500 leading global scholars and experts in the field of quantum communication and cryptography participated in the conference.

At the conference, Pan Jianwei, Chief Scientist for the Micius quantum satellite (also known as: QUESS), told the audience that two members of his team went to Italy's Space Geodesy Centre in Matera to prepare the world's third intercontinental quantum communication test. The Italian colleagues received a training on how to track Micius and learn its parameters for the upcoming test.

Pan Jianwei also stressed that his team is open to working with more institutions in other countries, and to share the expertise

in quantum communication. He confirmed that cooperation with Japan and the United States is under discussion. Micius lifetime is designed to be 2 years.

Asteroids

At the World Conference on Science Literacy 2018 on 18 September in Beijing, Chinese scientists have appealed to further strengthen international cooperation in space exploration, aiming to reduce the risk of near-Earth objects colliding with Earth. Ouyang Ziyuan, a CAS academician and first Chief Scientist of China's lunar probe project, pointed out the potential threat by small celestial objects and noted that modern space technologies are capable of defending Earth from their threat. He called on the scientists from around the world to cooperate to monitor near-Earth asteroids.

SATELLITES

Hongyan Constellation

At the Hunan Commercial Aviation Space and Marine Equipment Forum held on 19 July in Changsha, Hunan Province, it was announced that the first test satellite for the 300-satellite Hongyan constellation will be launched by the end of 2018. The Hongyan LEO constellation is built for worldwide communication services.

Satellite Fengyun-2H

On 28 July, FY-2H reached its new position at 79°East (drifting from 94°E to 79°E) where the 2-month in-orbit testing phase started. FY-2H was shifted to 79°E to provide custom-made services for countries along the "Belt-and-Road", to the Member States of the Shanghai Cooperation Organisation (SCO) and to several Arab countries.

Satellite Fengyun-3D

At the end of August FY-3D finished its in-orbit testing and - with all functions performing satisfactorily - was ready for operations. The 2nd generation, polar orbiting meteorological satellite FY-3D will operate jointly with FY-3C.

Fengyun Emergency Support Mechanism

On 25 September, experts from Shanghai Cooperation Organization (SCO), the World Meteorological Organization (WMO), and Asia-Pacific Space Cooperation Organization (APSCO) met at the Beijing headquarters of China's Meteorological Administration (CMA) to discuss FY-2 satellite data reception, data applications, and the need for technical exchanges. Kazakhstan, Kyrgyzstan, Pakistan, Russia, Tajikistan, Uzbekistan, Afghanistan, Iran, Mongolia, and Sri Lanka were included as users of the Emergency Support Mechanism for International Users of FengYun Meteorological Satellites in Disaster Prevention and Mitigation (FYESM).

Fengyun Data Sharing

The China Meteorological Administration (CMA) has rolled out the trial data management system for the FY Meteorological Satellite Data and FY Meteorological Satellite Basic Data Catalogue 2018 to enable open access to the observation data of 16 instruments on FY-2, FY-3, and FY-4 and for sharing the resulting applications.

Sanya Satellite Constellation Programme

On 14 August, the Sanya Institute of Remote Sensing approved technical plans for its commercial Satellite Constellation Programme with three optical satellites in the 1st phase and one in the 2nd phase, to be launched in the 2nd half of 2019. The programme also includes two hyperspectral satellites and two SAR satellites by 2021, intended for remote-sensing over the South China Sea. The network will provide data services for navigation, fisheries and emergency rescue.

Luojia 1

Scientists from the Institute of Remote Sensing and Digital Earth of the Chinese Academy of Sciences (CAS) assessed the potential of Luojia 1's night time light imaging capacity with a 130 m-resolution to measure artificial light pollution. It was found that Luojia 1 can provide high dynamic range images as well as fine spatial details under artificial night time light.

NAVIGATION – BDS-Beidou

Love navigated by Beidou

10 years ago, on the occasion of the 40th anniversary of the founding of the China Academy of Space Technology (CAST), Cui Bo a young Beidou engineer wrote a poem dedicated to those involved in space exploration. Wang Lu, a Beidou payload engineer recited his poem at the anniversary ceremony. This is how those two young Beidou engineers met, fell in love and how their two lives joined together. Young space engineers like Wang Lu and Cui Bo are representative for a team where the average age is 36.

The industry associated with China's Beidou navigation system has seen an annual growth of 20 percent since 2009, and is expected to reach 400 billion RMB (58.5 billion USD) by 2020, Beidou spokesperson Ran Chengqi said during a forum held in Mianyang, Sichuan Province. Beidou's value chain in 2017 in China was reported as being worth 250 billion RMB.

TELECOMMUNICATION

During the telecommunications trade exhibition CommunicAsia at the end of June in Singapore, satcom companies China Communication Technology Satcom (CCT), Zhongshan Tatwah Smartech (Tatwah), and APT Satellite, spoke during a panel discussion about their ambitions and business models. They are all looking for expansion under challenging conditions. One option is to turn to the satellite operation business or support the communication needs of the Belt-and-Road countries, in particular in Southeast Asia.

During a panel discussion at the 17th Asia Pacific Satellite Conference APSAT 2018 in Jakarta, Indonesia, Yao Fahai, Vice President of China Satcom, announced that after the launch of the first one, two more HTS satellites will follow in 2021 and 2022. He also confirmed that China Satcom is following the international trend in building and operating HTS and LEO constellations, despite some doubts about the viability of a business model for such constellations.

Commercial Launch Service
Sky and Space Global

Telecommunication company Sky and Space Global signed a Memorandum of Understanding (MoU) with China Great Wall Industry Corporation (CGWIC) for the launch option of a 200-nanosatellite constellation in 2020. Before entering into formal contract negotiations, Sky and Space reserved the right to assess CGWIC's capabilities in meeting the technical and operational launch requirements.

Both companies are also looking into other joint opportunities for the Chinese market involving Sky and Space's nanosatellite services.

In June, Sky and Space signed a binding MoU with the Beijing Commsat Technology Development Co. related to China's IoT market.

Apstar 6C

CGWIC has completed the in-orbit delivery of the Apstar 6C comsat to Hong Kong-based APT Satellite Co. Ltd. on 7 August 2018. After launch on 4 May, LEOP operations were conducted, including five apogee and perigee engine firings. Apstar 6C was positioned at the designated orbital slot in GEO for in-orbit testing. Tracking and control operation of the satellite was transferred to the APT ground station at Taipo, Hong Kong, from where the remaining tests were conducted as of 14 May. Apstar 6C reached its final GEO position at 134°East on 29 May. On 4 June 2018, all tests were finished and a comprehensive in-orbit test report was submitted to the customer. The Apstar 6C

Signature ceremony to celebrate the successful in-orbit delivery to the customer of the Apstar 6C satellite. credit: CGWIC

satellite in-orbit acceptance review (IOAR) was held successfully and the satellite ownership was transferred to APT Satellite. The DFH-4-based comsat has a design lifetime of 15 years. It will provide communication and satellite broadcasting services across the Asia-Pacific region, and will support the Belt-and-Road Initiative (BRI).

ADVANCED TECHNOLOGY

Satellite Maintenance Space Tug

Science and Technology Daily reported in mid-July that an CASC affiliated academy is busy with research and development work for an in-orbit satellite transport tug, capable of moving satellites that have run out of fuel or failed to enter their pre-set orbit. Instead of refuelling, the carrier vehicle would use a robotic arm to berth with the target object, provide attitude control assistance and then carry it to the desired orbit. After task completion, the service spacecraft would undock and autonomously fly to the next satellite in need of assistance or repair. The space tug, mainly intended for comsats in GEO, would have an operational lifetime of 15 years. Hu Di, Chief Designer of the 5 t tug space ship, thinks that this technology can be easier implemented than satellite refuelling, being ready in approximately two years for launch on a CZ-3B. The communication satellite Zhongxing 9A (ZX-9A) launched in June 2017, would have been a candidate on which to apply the new technology. ZX-9A failed to reach its planned orbit. However, after two weeks and ten orbital manoeuvres, the satellite reached its final position, using a large amount of the on-board fuel and consequently shortening the satellite's lifetime.

New model for sea level pressure information

Scientists from NSSC proposed a new method to obtain high temporal and spatial resolution sea-level air pressure data through remote sensing observation. They verified the method by using observations from the U.S. weather satellite Suomi NPP (Suomi National Polar-orbiting Partnership). The satellite data were fed into an estimation model which was assessed by in-situ buoy measurements. Weather buoys and merchant ships are the traditional sources of sea level pressure information.

Asteroid Capture and Mining

Li Mingtao, a researcher at NSSC participated in a contest of innovative future technologies, held in Shenzhen, Guangdong Province, by proposing the idea of asteroid capture and landing on Earth. The process could start with a spacecraft carrying a huge bag to be wrapped around a small asteroid and push it into the vicinity of Earth. It would then unfold a heat shield, slow the re-entry speed, and control it to safely land in an un-inhabited zone. For that, many key technologies are needed. Li estimated that the asteroid catcher would not be ready before 2029, with the first target object be brought to Earth in 2034. To analyse the feasibility of the plan, Li's team studied a small asteroid of 6.4 m diameter, weighing several hundred tonnes and more than 100 million km away from Earth.

Currently, Li is working with space engineers at the Qian Xuesen Laboratory of Space Technology, under CASC, to draw up a plan for a satellite constellation on a heliocentric Venus-like orbit. The satellites will be used to search for and analyse small near-Earth objects with a diameter of around 10 m.

A research team at the School of Physical Science and Technology at the ShanghaiTech University developed a low-cost, high-efficiency method called 'cerium photocatalysis' to convert methane into liquefied fuel, such as rocket propellant fuel. The scientists found that cerium salts can initiate a sunlight-catalysed reaction. They tested a catalyst combination of cerium and alcohol, which can convert methane into fuel at room temperature, with no need of heat or condensation. Cerium is abundant and inexpensive in China. The new catalyst costs 18,000 RMB (about 2,650 USD) per tonne, what is 1/10,000 of the price of traditional metal catalysts.

COMMERCIAL SPACE

iSPACE

By the end of June, iSpace (Space Honor Technology, Interstellar Glory) completed a series A financial round led by Matrix Partners China, the Chinese affiliate of the U.S. venture capital fund that has also invested in Baidu Inc. and Didi Chuxing. 10 domestic funds contributed as well, accumulating iSpace's total financing to 600 million RMB (90.4 million USD) within one year. The money will be used for research and development of launcher vehicles, liquid oxygen methane engines, construction of iSpace's assembly base and the expansion of its team.

At the same time, the company is preparing for a sub-orbital launch of its Hyperbola 1Z experimental rocket. The mission is needed for technology testing of the Hyperbola 1, iSpace's carrier rocket, planned for its premier flight in 2019, with three more on the commercial launch manifest. In parallel, iSpace has begun the development of Hyperbola 3, a larger rocket with nine 15 t-thrust, liquid-propellant engines, and a first launch not earlier than 2020.

top photo: iSpace sends a suborbital rocket into space at 13:00 BJT from the Jiuquan Satellite Launch Centre, on 5 September 2018. credit: Xinhua/Wang Jiangbo

left photo: Hyperbola 1S, iSpace's carrier rocket short before its launch in April. credit: China Daily

Suborbital Launch

On 5 September, at 13:00 BJT, iSpace launched its sub-orbital single-stage rocket SQX-1Z (Shuang Quxian 1Z = Hyperbola 1Z) from the Jiuquan Satellite Launch Centre (JSLC). SQX-1Z flew for more than 450 s and reached a peak height of 108 km. The rocket carried three payloads (actually cubesats but since they did not reach orbit, "satellite" is a misnomer) for two Chinese companies: ZeroG Lab and ADA-Space. All were released at the maximum altitude, and while two test "satellites" followed a suborbital trajectory, the third one parachuted to Earth. According to iSpace, all three "satellites" were intended for recovery. More details in the section: LAUNCHES

ONESPACE

In preparation of the first mission of its OS-M1 rocket, OneSpace successfully tested the first stage rocket motor of its M-rocket series on 4 July.

In August OneSpace confirmed that a payload has been arranged for its first orbital mission, planned for the end of 2018.

In the same month, OneSpace secured 43.6 million USD in a Series B financing. This fourth round of financing was led by CICC Jiatai Equity Fund, followed by FinTrek Capital. China Merchants Venture Capital, Qianhai Wande Fund and Qianhai Wutong M&A Fund added to their previous investment. In total, OneSpace received 116 million USD from domestic agencies since August 2015. The company plans for an annual production capacity of around 50 rockets by 2020.

On 24 August, OneSpace conducted a second and third stage separation test for its OS-M orbital rocket.

Suborbital Launch

On 7 September, at 12:10 BJT, OneSpace launched its OS-X1 suborbital rocket from the Jiuquan Satellite Launch Centre. This was the second launch of a OS-X type rocket after the first launched on 17 May, reaching an altitude of 40 km. The flight lasted 265 s. More details in the section: LAUNCHES

After the September-launch, a video sequence recorded by the cameras of the Jilin 1 satellite emerged on the web, showing the rocket taking off from the launch pad at JSLC.

Young entrepreneur's rocket dream takes off - a portrait of OneSpace's CEO Shu Chang

Shu Chang led the employees at OneSpace - the first private enterprise in China licensed to design and make carrier rockets - in the successful production of a small rocket launched in mid-May. The success generated a wave of media reports about Shu and his company, with many articles calling the Beijing start-up China's answer to SpaceX. Shu said he does not fear rivals in the industry and hopes that more space start-ups will join the sector.

LANDSPACE

Zhuque 2 (ZQ-2)

At a press event in the National Aquatic Centre (the "Water Cube" of the Beijing 2008 Olympic Games) on 5 July, LandSpace's CEO and founder Zhang Changwu, gave an update on the company's strategy, plans and scope of rockets. He outlined the development and production process of the ZQ-2 rocket and explained that the design of the ZQ-2 (a methane and liquid-oxygen-powered rocket) was completed in June. The construction of the rocket's key components has begun. The rocket will go through a series of ground tests until the end of 2019, meaning that ZQ-2 can be ready for its premier flight in 2020.

He also informed about the opening of its R&D centres in Beijing and Xi'an and the completion of the rocket manufacturing facility in Huzhou. The production capacity for the Huzhou establishment was stated to be 30 launch vehicles and 200 engines per year by the early 2020s. LandSpace Chief Technology Officer, Kang Yonglai, elaborated on the challenges of the launch market and how LandSpace will meet them: explaining that it usually takes more than 20 days and more than 200 staff for a traditional liquid rocket to finish transporting, constructing, and range testing. The ZQ-2 rocket will be able to shorten this process to 7 days with a maximum of 20 staff by using a series of new technologies including automatic loading, unmanned horizontal rocket transportation, hold-down and release system, and control system automated testing. The rocket will be economically viable, re-usable and mass-produced. The plan for the future is to develop the larger versions of a three-stage ZQ-2A, B and C. LandSpace Senior R&D Engineer Yuan Yu said that the company is planning a three to four-year development timeline for the 80 t engine. LandSpace confirmed its plan for

LandSpace presents the ZQ-2 rocket specifications. credits: Tianyi Lan/LandSpace

the first launch of the solid-fuel, three stage ZQ-1 rocket by September, delivering a CCTV satellite into orbit.

See our report about a tour of the Huzhou manufacturing facility in March 2019 on pages 15 to 19.

LandSpace completed the final assembly of its solid propellant rocket on 20 August for a scheduled fourth-quarter launch from JSLC, aiming for the first Chinese private-sector orbital launch. The three-stage solid propellant Zhuque 1 rocket will carry the small "Future" satellite for space science and remote sensing for the state broadcaster CCTV.

On 26 September, LandSpace sent its first rocket, the Zhuque 1 (ZQ-1), three-stage solid rocket, on its way from its assembly facility in Xi'an to JSLC to prepare for launch the next month.

On the same day LandSpace tested the combustion chamber for its 80 t-thrust Tianque 12 methane-liquid oxygen rocket engine, which will be used for the ZQ-2 launch vehicle.

At the end of September, the case of a Chinese rocket scientist's resignation sparked public debate. Xi'an Aerospace Propulsion Institute applied on 20 May for arbitration at a local labour dispute arbitration agency in order to retain Zhang Xiaoping, a Deputy Director of rocket design in Xi'an, who took up a position at LandSpace. Zhang was involved in national key programmes, and his former employer argued that he knows confidential information and should undergo formal processes before leaving. Weibo blogger Zi Zhuzhang decided to publish on WeChat a legal document from the Xi'an institute, dated 17 September, which stated that Zhang Xiaoping was a crucial expert for the development of the 500 t kerosene-liquid oxygen engine for the CZ-9 heavy-lift rocket and other engines, including throttleable engines. Zi Zhuzhang asked publicly: "Why are talents that can directly influence China's Moon landing be left to languish at the bottom of state-owned enterprises?" The article prompted a lively debate on social media where the Chinese public and media urged that state-owned research institutes should reflect on its management and the way they evaluate and retain talent.

S-Motor

S-Motor, a space start-up backed by Shenzhen Oriental Fortune Capital Co., Ltd. and HIT Robot Group, completed the design of its first-stage solid rocket engine.

OCE Technology

Irish company OCE Technology, a software developer and supplier for radiation-hardened chip-level components for use in the aerospace and high-reliability sectors, has secured an investment of 200,000 Euro from Chinese stock market-listed Zhuhai Orbita Aerospace Science and Technology in return for a small share in OCE.

Zhuhai Orbita supplies OCE already with components and OCE in return supplies parts to the Chinese space programme. Tony

Cahill, Vice-President of sales at OCE, said the investment will help spur its next stage of growth, expanding to the U.S. The firm is in "early stage" talks with SpaceX and other private companies in the U.S.

Expace

At the beginning of September, CASIC's subsidy Expace concluded testing and transport preparation of its second Kuaizhou 1A (KZ-1A) solid-fuelled rocket (first launch in January 2017). On 9 September, KZ-1A left Yichang in Hubei Province by train for the JSLC for launch preparation with the Centispace 1-S1 smallsat. The rocket took off from Jiuquan at 12:13 BJT on 29 September.

More details in the section: LAUNCHES

JSLC

The first ever two launches of private rockets from the Jiuquan Satellite Launch Centre was reflected in Chinese media as a concrete measure toward implementing the strategy of Military-Civilian Integration and that it is a concrete embodiment of the commercialisation of China's aerospace industry. Jia Lide, Director of a planning department of JSLC told media that the strategy of military-civilian integration aims to bring "standardised management and orderly guidance" to domestic private commercial aerospace launches, which will be further included in a unified national management system. JSLC has allocated a new area on its territory, dedicated to commercial activities.

4th CCAF – China (International) Commercial Aerospace Forum

After the enormous success of the previous year's event, the 4th China (International) Commercial Aerospace Forum CCAF, took place from 26 to 28 September in the Wuhan International Expo Centre. For the first time the forum stretched over 3 days. The first two days were reserved for presentations by national and international space experts. The conference was accompanied by a 5,000 m^2 exhibition which was open throughout all three days.

INTERNATIONAL COOPERATION

APSCO – Asia-Pacific Space Cooperation Organisation

The Graduation Ceremony for 15 students of the MASTA2016 and Course Completion Ceremony of MASTA2017 was held on 29 June at the Beihang University in Beijing. MASTA (Master of Space Technology Applications) is one of the regular education and training activities of APSCO.

2nd Summer Camp of APSCO SSS Project

The Second Summer Camp, co-organised by APSCO, hosted by Middle East Technical University (METU) in Ankara, and supported by TUBITAK-UZAY (TUBITAK Space Technologies Research Institute in Ankara), kicked-off on 30 July in Ankara, Turkey. Over 40 participants from all APSCO Member States, and 15 more local students joined the three-week long course.

The Summer Camp is an associated activity of APSCO Student Small Satellite Project, carried out by APSCO annually since 2017. The camp included training in project feasibility and concentrated on the development of detailed technologies in the micro/nano satellite subsystems, which included Electronic Power Systems, Tracking & Communications, Attitude Determination and Control System, Structure & Mechanism, Thermal Control, unit/subsystem manufacturing and hands-on training in testing. Therefore, most of the courses took place in test facilities. Participants were divided into eight groups working under the guidance of mentors. After each course, a presentation on selected topics was made by selected members of each team during the entire programme. On 17 August, the grand Closing Ceremony was held in METU.

Group photo after the successful conclusion of the 2018 APSCO Summer Camp. credits: APSCO

Four IGMA (International GNSS Monitoring and Assessment) stations have been installed in four of the APSCO Member States in July, August and September: in Kasetsart University, Thailand; Middle East Technical University, Department of Geodetic and Geographic Information Technologies, Turkey; New Mongol Institute of Technology, Mongolia; and SUPARCO Multan Space Research Station, Pakistan. The installation work was connected with training on operations and maintenance. After the successful acceptance, the four stations started transmitting the observed data to the Data Centre. Data will be shared by all APSCO Member States for scientific research and study.

ARABIC Countries

In a speech at the opening ceremony of the 8th ministerial meeting of the China-Arab States Cooperation Forum in the Great Hall of the People in Beijing on 10 July, Chinese President Xi Jinping reiterated that China and Arab states should co-build the "Belt and Road" space information corridor and promote space cooperation. The Beidou navigation system and meteorological remote sensing satellite technologies should forge ahead to serve Arab states development.

BELARUS

During a meeting between the Deputy Economy Minister of Belarus Alexander Chervyakov, and CASC's Vice President Zhang Jianheng, at the end of July in Minsk, the establishment of a CASC research centre at the Chinese-Belarusian Industrial Park Great Stone was discussed. Previously, on 26 March, CASC signed a letter of intent to become a resident company at the Great Stone industrial park, which is situated 25 km from Minsk.

Sergei Kilin, Deputy Chairman of the Presidium of the National Academy of Sciences of Belarus (NASB), confirmed at end of August, that China and Belarus are regularly discussing possible joint projects including a joint satellite. He did not disclose details but confirmed that negotiations are ongoing. Earlier, the Chairman of the Presidium of NASB, Vladimir Gusakov, told Belarusian media that Belarus invited China to cooperate on a joint satellite. This project will be ready after the current satellite cooperation project between Belarus and Russia or in parallel with it.

BELT AND ROAD

At the end of August, the Aerospace Information Research Institute (AIR) under CAS announced that its agricultural remote sensing monitoring platform, CropWatch, has provided information services to 147 countries and regions. CropWatch uses remote sensing and ground observation data to assess crop growth, yield and related information at global and national scales. AIR is also hosting the Digital Belt and Road Programme, to extend its service to the Belt-and-Road countries which are often lacking those agricultural and food security data.

At the 4th International Symposium on Earth Observation for Arid and Semi-Arid Environments, in Xining, the capital of Qinghai Province, AIR stated that it has supported Mongolia, Kenya, Sri Lanka, Venezuela, Cambodia, Kyrgyzstan, Kazakhstan, Nepal, Thailand and Belgium to install virtual ground stations. The stations are capable of receiving near-real time data from China's remote satellite ground stations which get data from the HuanJing-1A (HJ-1A), HuanJing-1B (HJ-1B), Landsat-8 and Proba-V satellites.

BRAZIL

CNSA and the Brazilian Space Agency (AEB) celebrated the 30-year anniversary of their joint space programme, the Sino-Brazilian Terrestrial Resource Programme, at the Chinese

Embassy in Brasilia on 29 August. The two parties announced their sixth project, the CBERS-4A (China-Brazil Earth Resources Satellite) remote sensing satellite. Starting next year, the CBERS-4A will obtain continuous aerial images for environmental monitoring as well as deforestation, the effects of natural disasters, expansion of agriculture and cities and will collect a host of other data. The cost of the satellite is estimated to be 28.6 million USD for each country. No charge will be imposed on the distribution of the satellite imagery and is free for use by academics and students.

One part of the CBERS cooperation programme is the postgraduate studies programme for Brazilian students at the Beijing University of Aeronautics and Astronautics (BUAA), already accomplished by three groups of Brazilian students. The Regional Centre for Space Science and Technology Education in Asia and the Pacific (RCSSTEAP-China), which was inaugurated at the BUAA in 2014, has offered scholarships for Brazilian students in the Master's and PhD programmes in space technology. These programmes are financed by China.

EGYPT

On 13 August, Egypt and China signed a grant worth 45 million USD for the EgyptSat-2 project for remote sensing applications. The grant was signed by Egyptian Minister of Investment and International Cooperation Sahar Nasr and the Ambassador of China to Egypt Song Aiguo, in the presence of the Minister of Higher Education Khaled Abdel Ghafar and representatives of the National Authority for Remote Sensing and Space Sciences.

An initial grant of 23 million USD was given in 2016. Sahar Nasr stressed that the project aims at transferring Chinese satellite manufacturing and operation technology to serve research projects and remote sensing and is relevant in the context of the establishment of the Egyptian space agency. Investment relations between the two countries are progressing as Chinese firms in Egypt now rank first in the fields of information technology, electricity, communication and transport. The agreement includes the training of a number of Egyptian cadres in China on remote sensing, and to construct a satellite ground control centre in the Egyptian space city. The Chinese Ambassador emphasised that Chinese investments in Egypt will progress, and that the satellite project will contribute to Egypt's regional leadership in the field of space and scientific research.

ESA

From 16-18 July, a CNSA-ESA workshop on Chinese-European Cooperation in Lunar Science took place in Amsterdam, The Netherlands. ESA and CNSA (LESEC - Lunar Exploration and Space Engineering Centre) used this meeting to explore common and synergistic areas of lunar science interest and expertise in Europe and China, and discussed the potential for future cooperation in the area of lunar exploration. The workshop provided inputs to be considered as CNSA and ESA continue to explore options for cooperation. The programme and abstract book can be downloaded from ESA's website:
https://www.cosmos.esa.int/documents/1611606/0/programme_abstracts_ESA_CNSA_2018.pdf

On 20 July, ESA published an Open Invitation To Tender for a "Lightweight Secondary Structure: Support to Chinese Space Station Design": "As part of discussions between CMSA/ESA on cooperation on the CSS, 3 Working Groups (WGs) have been established to identify and develop cooperation topics in the areas of astronaut, infrastructure and utilisation. In the area of the Infrastructure WG, starting from the design of an ISS rack, an evolved light secondary structure design was studied in order to accommodate approximately 500 kg of equipment using less than 1/3rd of the equivalent ISS rack mass. This activity was performed by TAS-I (Thales Alenia Space-Italy) as an evolution of the EDR (European Drawer Rack) Mk II rack design and resulted in very promising results with respect to launch mass savings. The proposed design included use of composite honeycomb panels, protruded beams and structural foams. As a result, CMSA has asked ESA to continue in the definition of the secondary structure of CSS EM1 EVA airlock. Within export control/ITAR constraints, the activity will consist in providing technical support to CAST, in charge of the development of the CSS on behalf of CMSA. This initial phase will consist only of remote technical support in the area of the lightweight secondary structure by CAST, derivation of test plans and finalisation of test reports, in close cooperation with CAST. Manufacturing and testing of the initial test articles will be done by CAST. ESA may provide small test items for technical evaluation. In the course of 2018 and 2019 ESA will further coordinate with CMSA in order to define a proposal for cooperation on the CSS with the objective of obtaining flight and utilisation opportunities. Depending on its maturity, a proposal may be presented as part of the E3P Programme Proposal for Period 2 for the Ministerial Council 2019."

FRANCE

Planetary Scientists share experience in cooperation with Chinese colleagues

Maurice Sylvestre is a French planetary scientist working at the Institute for Research and Planetary Astronomy in Toulouse, France. He is involved in the development of a chemical-sensing camera for China's 2020 Mars mission. He was also part of the team which built the Éclair payload on board the French-Chinese SVOM satellite. Eric Niller from Wired online portal talked to Maurice Sylvestre and James W. Head, an US planetary scientist about their experiences in cooperation with China.

NAMIBIA

On 5 July in Windhoek, China donated meteorological equipment worth 2.4 million USD to Namibia: 10 sets of manually operated weather observation systems; five sets of automated weather systems; workstation software, operating system; meteorological communication system; FY-3 meteorological satellite data collecting and processing system and the FY3-3 meteorological satellite information processing and application system.

RUSSIA

Agreements

Roscosmos space corporation and CNSA signed a number of agreements on space cooperation during a summit between the Presidents of both countries, Putin and Xi, at the beginning of June in Beijing. The agreements followed a memorandum signed on 3 March on Russian-Chinese cooperation in the exploration of the Moon and outer space, and the creation of joint orbital groups.

Roscosmos – CNSA working meeting

As part of the preparations for the 19th Meeting of the Russian-Chinese Sub-Commission for Cooperation in Space Exploration later in September in Beijing, Roscosmos and CNSA held several rounds of talks on 4 and 5 July in Moscow. The following topics were discussed:

Space Station

On 4 July, a CNSA delegation discussed the possibility of creating a jointly-run orbital station. China is interested in Russia's experience with long-duration space flights and the construction of large space projects.

Rocket Technology

Roscosmos has plans to cooperate with China on a variety of space-related projects, including the creation of a super-heavy rocket, necessary to lift large components into LEO or for deep-space exploration.

Russia China comsat constellation

The Chinese delegation proposed to Roscosmos to consider the creation of a joint, global, multi-level satellite

communications system, similar to the OneWeb satellite constellation or Starlink. The system could consist of about 1,000 spacecraft located in low, medium and geostationary orbit. Each side would contribute half of the constellation and cover 50 % of the costs.

Earth Observation

A session of the Russian-Chinese working sub-group for cooperation in the area of remote sensing of the Earth took place on 5 July. Both sides agreed remote sensing is a major area of Russian-Chinese space cooperation and in line with the overall Russian-Chinese cooperation programme for space exploration in the period 2018-2022.

Roscosmos and CNSA "agreed to hold before 1 October 2018 a joint experiment for testing the Russian and Chinese ground stations to raise the quality in assessing remote sensing data of their satellites." Furthermore, both sides noted the effective interaction in the mutual provision of Earth remote sensing data from Russian and Chinese satellites under the International Charter on Space and Major Disasters upon the onset of emergency situations on the territories of Russia and China.

"The sides also discussed the results of the work of the sub-groups in the sphere of Earth observation, space debris and in the area of the space-related electronic components base whose sessions had been held earlier in Moscow.", Roscosmos stated.

Lunar Exploration

The working meeting also decided that the programme of Russian-Chinese cooperation in outer space for the period 2018-2022, that is already in place, will include lunar exploration projects.

Russia and China consider joint lunar station

At the beginning of October, the Head of Roscosmos, Dmitry Rogozin, said on Russia's TV Channel One: "China is a serious partner. I don't rule out that as soon as we agree the outlines of our lunar programme with the Americans, that within our manned lunar programme it is likely to work of a research station on the Moon's surface together with our Chinese partners. They can be equal partners already in the coming years."

Hainan Russia-China Space Cooperation Centre

The government of the southern Chinese province of Hainan is inviting Russian agencies, enterprises and higher educational institutions to cooperate in the sphere of aviation and space exploration. Governor Shen Xiaoming told the Russian news agency TASS on 11 July: "If Russian higher educational establishments, research centres, R&D institutes and enterprises operating in the sphere of cosmonautics and aviation are ready to cooperate with us and, given the large number of projects, we are ready to create a joint China-Russia centre for cooperation in space and aviation technologies. We are ready to allocate a land site for creating such a centre."

Rocket Engines

Russia will strengthen cooperation with China by supplying its rocket engines to China, Hu Bin, Counselor of the Department of Treaty and Law at China's Ministry of Foreign Affairs, told Russian media outlet Sputnik on 12 September on the side-lines of the first UN Conference on Space Law and Policy, which took place from 11 - 13 September 2018 in Moscow. "China and Russia are very good friends, and all cooperation, bilateral cooperation should extend to space. We take it as a very good initiative," Hu said. The official added that space cooperation between Russia and China could comprise research and engineering, including rocket engines.

Multilateral Space Arms Control Treaty

On 28 August, the representative of the Chinese Foreign Ministry, Hu Bin, called for the adoption of a multilateral agreement for the control over arms in space to ensure peace and security. China tries to accommodate the concerns of the US regarding the current version of the Multilateral Space Arms Control Treaty. Hu added that in order to persuade the United States to join the treaty, it would be necessary to discuss a common interest. But even if the United States refuses to join the initiative, other countries will still have an international legal framework to regulate the use of arms in space.

Vostochny Spaceport Cooperation

Alexander Molchanov, Deputy General of the Vostochny spaceport, said the new spaceport facility is very important to Russia. Russia is now looking forward to starting a series of aerospace cooperation projects with China, not only those related to the new spaceport, but various forms of aerospace exchanges as well.

China partner country of MAKS-2019 air show

Russia invited China to become a partner country at the International Aviation and Space Salon MAKS-2019 which will take place at the end of August 2019. China accepted the proposal, Russian Industry and Trade Minister Denis Manturov told reporters.

Cooperation in rocket and engine manufacturing

By the end of September, Roscosmos said in a press release that Russia and China have signed a protocol on cooperation in space rocket and engine manufacturing, as well as lunar exploration projects. The Russian-Chinese Sub-Commission for Cooperation in Space Exploration met on 28 September in Beijing for its 19th working meeting in preparation for the regular meetings of heads of government. The session ended with the signing of a protocol in which the two parties agreed to take further steps to seek rapprochement in implementing joint projects for building space vehicles and rocket engines, for lunar and deep space exploration, remote sensing of the Earth, satellite navigation, creating a base of electronics components for the space industry, and low orbit mobile communication systems and space debris monitoring.

Group photo of Rogozin's visit in CAST.

credit: Roscosmos

19th session of subcommittee on space cooperation of the Russia-China Intergovernmental Committee.

credit: Roscosmos

Qian Xuesen Exhibition in Moscow

At the beginning of September, a joint exhibition about Sino-Russian aerospace cooperation was held in Moscow, jointly sponsored by the Qian Xuesen Library at Shanghai Jiao Tong University and the Moscow Aviation Institute.

SWITZERLAND

On 10 September, Yu Xinwen, Deputy Administrator of the China Meteorological Administration (CMA) met with Renato Krpoun, Head of Swiss Space Office (SSO) in Beijing. They introduced

their satellite developments and discussed how to carry out scientific and technological cooperation on satellite payloads. SSO and CMA have been involved in scientific cooperation for the development of Fengyun satellite instruments. The two sides will continue to maintain close exchanges and explore more opportunities for scientific research cooperation.

USA

According to Yan Yihua, President of Division E: Sun and Heliosphere of the International Astronomical Union (IAU), the observation range of the ground-based Chinese Spectral Radioheliograph (CSRH) and NASA's recently launched Parker Solar Probe to study the Sun will overlap, and it is possible that the two will cooperate for future specific scientific tasks. CSRH is situated in Ming'antu, a radio quiet region in north China's Inner Mongolia Autonomous Region. It consists of 100 antennas with different frequency spectra covering an area of 10 km^2.

EDUCATION

Liu Cixin, author of The Three-Body Problem participated in a conference on the popularisation of Space Science in mid-September in Beijing. Liu called for more independent innovation and invention in science and technology. Science fiction, combined with education and greater science literacy, can contribute to China's technology push. An executive at the Xi'an CAS Star, an incubator for start-ups founded under the auspices of the Chinese Academy of Sciences, stressed that NASA space centres in the US are open to the public, and China should support a similar 'open-door-policy' for its national space institutes to promote the overall affinity for science.

Chinese rocket models on display in Malaysia

The China Science and Technology Museum donated six models, four of the Long March rocket family, the Chang'e 3 lunar lander and Yutu lunar rover to the Space Exploration Gallery in Malaysia's northern state of Penang. Malaysian Finance Minister Lim Guan Eng, who personally supported the donation when he was the Chief Minister of Penang two years ago, thanked the Chinese side in his speech at the ceremony on 4 August. He said that the Malaysian government values its relations with China and will continue to support the China-proposed Belt-and-Road Initiative. Chinese Consul-General in Penang Lu Shiwei, said the six models symbolise the good relations between the two countries and will further strengthen the bond.

MISCELLANEOUS

New TV series on China's nuclear and space programme

A TV serial based on China's "Two Bombs, One Satellite" project, began airing on Beijing Satellite TV and the video streaming site Tencent Video in August. The 43-episode "The Glory and the Dream" follows the development of a group of friends from their graduation from college to becoming skilled engineers at a rocket research centre in Southwest China.

During the 7 year-long work on the series, the producers acquired original footage of missile launches from the 1960s and 1970s. The drama was shot in Sichuan province at several locations which were once factories manufacturing components and parts for rockets and missiles. The drama received praise from critics and audiences alike and was among the top three highest-rated TV programs.

Prevention of arms race in outer space

Assistant Foreign Minister Zhang Hanhui called for joint efforts from the international community to explore effective ways to prevent an arms race in outer space. During a two-day international symposium jointly held by China, Russia and the United Nations (UN) in Beijing, he introduced four proposals on outer space security.

First, the international community should agree on applicable norms and principles on outer space.

Second, countries should pursue a common, comprehensive, cooperative and sustainable security and build a new type of international relations.

Third, countries should enhance international cooperation on the peaceful use of outer space.

Fourth, countries should improve the outer space governance system and address challenges brought about by the deteriorating environment of outer space.

60 representatives from 20 countries including Brazil, South Africa, India, Pakistan, Germany, France, Italy, the Republic of Korea and Japan as well as the UN and Chinese and international think-tanks attended the workshop.

6th High-Tech Expo China

The 6th High-Tech Expo was held in Mianyang Science and Technology City from 6 to 9 September 2018.

Around 10,000 national and international guests from industry, members of the inter-ministerial coordination group of Mianyang Science and Technology City and representatives of investment and financing institutions attended the 70,000 m^2 exhibition, themed: "Military-Civilian Integration, Technological Innovation, Openness and Cooperation".

The China BeiDou Application Conference ran in parallel and industry professionals, scholars and experts in the sector of BeiDou development and application exchanged ideas on the technology and application of navigation, remote sensing, communications and other satellite systems to promote the sharing and comprehensive utilisation of satellite data.

PEOPLE

In mid-July it became known that Hao Chun, former Deputy Director of China Manned Space Agency, has been appointed as the Director of the Agency.

Meet Miao Jian - the woman technician devoted to China's aerospace industry

Miao Jian was born in Shanghai in May 1977. As the Chief Technician of the National Master Skills Studio, she has been involved in the development and production of key components for launch vehicles, tactical weapons and spacecraft. Miao has devoted herself to the aerospace industry for 23 years. She said: "As a frontline skilled worker, I may not know which spaceships the precision-machined parts I made will ultimately be used on, but I still feel proud to be a member of the country's space missions. I do know that my efforts will contribute to the reform and development of China's space industry."

ON A SIDENOTE

SpaceNews reported that SpaceX President and Chief Operating Officer Gwynne Shotwell, participating at the Air Force Association's annual symposium on 17 September, answered the question of whether she is worried about national security space threats from China or Russia: "As the President of SpaceX I am concerned about the competition coming from China and Russia because they're backed heavily by their governments. As an American citizen I worry more about China than Russia." On the number of Chinese space launches in 2018 she commented: "I was hoping to beat the Chinese this year. It does concern me that China is flying 40 times this year. And it's not for commercial customers. They have very few commercial customers. So what in the world are they doing? The fact that I'm not beating them is a shame. The fact that they're launching 40 times is something we should all be worried about." Shotwell also commented on how China acquires space capabilities: "They innovate in a different way, they go after ideas, they stick to a plan, and their pace is much faster."

LAUNCHES

2018-056A
2018-056B
09 July 2018 - 03:56 UTC (11:56 BJT)

launch site: Jiuquan Satellite Launch Centre, LC 43, Pad 94
launcher: Chang Zheng CZ-2C/SMA
payloads: PRSS-1 / PakTES-1A

The CZ-2C, upgraded with an SMA upper stage, launched the two Pakistan payloads PRSS-1 and PakTES-1A. Because of delays in the delivery of the satellites, the launch, originally planned for March 2018, was rescheduled for July.

During launch, the smaller of the two, PakTES-1A (Pakistan Technology Evaluation Satellite), was protected by a cover, looking similar to the SYLDA dispenser system, used for double launches on the Ariane rocket. PakTES-1A is a technological Earth observation satellite, built in cooperation between SUPARCO and Space Advisory Co. South Africa. It is a cube-shaped satellite of 285 kg mass with two foldable solar panels and one mounted on the satellite's body. The satellite is equipped with medium-resolution cameras whose data will be used for land survey, forestry, urban development and the monitoring of glaciers. On 15 July a first image, a so-called "global picture" was published. Between 11 and 14 July, PakTES-1A raised its orbit by 30 km to 610 km SSO. A second PakTES satellite is under development.

The main payload, PRSS-1 (Pakistan Remote Sensing Satellite 1), was developed and built by DFH Satellite Co. Ltd., CAST. The box-shaped satellite is based on the CAST 2000 platform. It is equipped with two solar panels (600 W), has a mass of 1,200 kg and a life time of 7 years. PRSS-1 was sent into sun-synchronous orbit at an altitude of 640 km. The high-resolution data from the panchromatic camera (1 m) and the multi-spectral imager (4 m) with a swath width of 60 km will be used for Pakistan's territorial resource investigation, environmental protection, disaster monitoring and management, crop yield estimation and urban planning as well as the China-Pakistan Economic Corridor and the Belt-and-Road Project. Xinhua reported that the cameras are among the best remote sensing cameras ever built in China. Each camera has independent image processing, storage and transmission capability. PRSS-1 has an information security design, and the data can be encrypted.

The project is part of the PRSS-1 Satellite System Programme Contract signed between CGWIC and SUPARCO on 20 April 2016. CGWIC was responsible for the in-orbit delivery, the Ground Control System and a Ground Application System, and provides in-orbit tests, on-site support, training, and launch insurance. Chinese and Pakistani engineers have cooperated closely during the satellite development. French space experts were invited to supervise the manufacturing of key parts. PRSS-1 is the replacement for Badr 2, launched in 2001. After hand-over, the satellites are operated by SUPARCO.

2018-057A
09 July 2018 - 20:58 UTC (10 July 2018 - 04:58 BJT)

launch site: Xichang Satellite Launch Centre, LC 2
launcher: Chang Zheng CZ-3A
payload: Beidou 2 IGSO-7 (Beidou 32, Beidou-2 I7)

Just 17 hours after launching from Jiuquan, a Beidou navigation satellite (Beidou-2 I7, Beidou 32, Beidou 2 IGSO-7) took-off from Xichang and was placed into geosynchronous orbit at an altitude of about 35,786 km, inclined by 55°.
It is the 32nd satellite of the Beidou system, and the last of the 2nd generation - although an upgraded one. It will replace another soon-to-be retired satellite in inclined GEO. Beidou-2 I7 is based on the DFH-3B satellite bus, equipped with deployable solar panels, a phased array antenna for navigation signals, a laser retroreflector and a rubidium clock. The 1.900 kg, 1,8 x 2,2 x 2,5 m-sized satellite was built by CAST and has an operational life of eight years. Beidou-2 I7 has a navigation payload, transmitting in four Beidou-L-bands at 2,4835 to 2,500 GHz highly time synchronised signals. The PRN code is C16. There were reports saying that the launch was advanced from 19 July, however, the reasons are unknown. Beidou 2 satellites provide regional services, while 3rd-generation Beidou 3 satellites are part of the global coverage constellation.

2018-062A
2018-062B
29 July 2018 - 01:48 UTC (9:48 BJT)

launch site: Xichang Satellite Launch Centre, LC3
launcher: Chang Zheng CZ-3B/YZ-1
payloads:
Beidou 3-M9 (Beidou 33)
Beidou 3-M10 (Beidou 34)

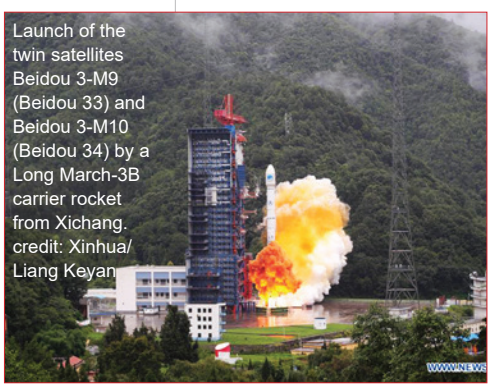
Beidou 33 and 34, also known as Beidou-3 MEO-5 and MEO-6 are the 9th and the 10th Beidou 3rd generation satellites and also the 33rd and 34th of the overall Beidou navigation system. Beidou 33 will operate in Slot C-7 and Beidou 34 in the Slot C-1 of plane C in medium circular Earth orbit, at an altitude of around 21.528 km with a 55° inclination.
They were built by CAST in Beijing. The satellite bus's dimensions are 2.25 x 1.0 x 1.22 m. Each satellite has a mass of 1,014 kg and a life time of 12 years. The phased array antenna for navigation signals is completed with two deployable solar panels and a laser retroreflector for high-precision location determination. The PRN codes were given with C23 and C24.

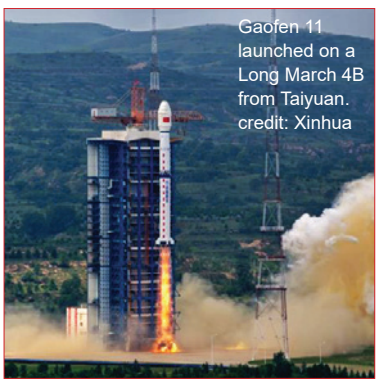
2018-063A
31 July 2018 - 03:00 UTC (11:00 BJT)

launch site: Taiyuan Satellite Launch Centre, LC9
launcher: Chang Zheng CZ-4B
payload: Gaofen 11

Gaofen 11, an optical remote sensing satellite, is part of China's CHEOS-Programme, a high-resolution, multiple

The PRSS-1 is China's 1st optical remote sensing and commercial satellite for Pakistan and the 17th CAST-satellite for an overseas customer. The experimental science satellite, PakTES-1A, developed and built by Pakistan, was sent into orbit on the same rocket. credit: China internet


Launch of the twin satellites Beidou 3-M9 (Beidou 33) and Beidou 3-M10 (Beidou 34) by a Long March-3B carrier rocket from Xichang. credit: Xinhua/ Liang Keyan


Gaofen 11 launched on a Long March 4B from Taiyuan. credit: Xinhua

platforms Earth observation system, supporting land survey, urban planning, road network design, agriculture, and disaster relief. Its data with a resolution of under one metre will also be used for the Belt-and-Road Initiative. Built by CAST, the box-shaped satellite has two solar panels and features a telescopic objective. No other details became known.

2018-067A
2018-067B
24 August 2018 - 23:52 UTC (25 August - 07:52 BJT)

launch site: Xichang Satellite Launch Centre, LC 3
launcher: Chang Zheng CZ-3B/YZ-1
payloads:
Beidou 3-M11 (Beidou 35)
Beidou 3-M12 (Beidou 36)

The two new generation Beidou 3 navigation satellites are M11 and M12 (also: Beidou 3 MEO-12 and Beidou 3 MEO-11) for medium Earth orbit at around 21,500 km and an inclination of 55,5°. They are the 35th and 36th of the overall Beidou system and were built by the Shanghai Innovation Academy for Microsatellites of the Chinese Academy of Sciences (formerly: SECM). Each satellite has a launch mass of 1.030 kg. Its operational life is 12 years. They are equipped with a laser inter-satellite link, enabling high precision (mm-dimension) and an inter-satellite communication speed of 1 Gbps. There is also a SMS payload integrated for global search and rescue operations. The twin satellites are the second pair for plane C, operating in Slot C-2 and C-8. They were give the PRN code C26 and C25. After in-orbit-tests, they will work together with 10 other, already operational, Beidou 3 satellites.

2018-068A
07 September 2018 - 03:15 UTC (11:15 BJT)

launch site: Taiyuan Satellite Launch Centre
launcher: Chang Zheng CZ-2C
payload: Haiyang 1C (HY-1C)

HY-1C, the 3rd in the Haiyang series, is an oceanographic satellite.

It carries an medium-resolution optical imager (China Ocean Colour and Temperature Scanner), a multispectral imager for the survey of coastal zones, an ultraviolet imager, a calibration spectrometer and a ship-tracking AIS payload. The sensors can detect chlorophyll and suspended sediment concentrations and dissolved organic matter, supporting fishery and aquaculture, and environmental control. The satellite operates in a 780 km orbit. Already on 13 September first high-quality imagery was released.

HY-1C was developed by the China Spacesat Co., Ltd. under CAST. It is based on the CAST-968 satellite bus - a 3-axis stabilised, box-shaped body of 1,4 x 1,1 x 0,953 m. Two deployable solar panels deliver 510 W. The launch mass is 442 kg, the dry mass 429 kg. The improved operational life is five years. Two more Haiyangs are planned for the end of 2018 and 2019.

2018-072A
2018-072B
19 September 2018 - 14:07 UTC (22:07 BJT)

launch site: Xichang Satellite Launch Centre, LC2
launcher: Chang Zheng CZ-3B/YZ-1
payload:
Beidou 3-M13 (Beidou 37)
Beidou 3-M14 (Beidou 38)

The two Beidou 3 navigation satellites Beidou 37 and 38, also designated as Beidou 3 MEO-13 and MEO-14, were placed into circular medium-Earth orbit at around 21,500 km and inclined by 55.5°. They are the 37th and 38th satellites of the Beidou constellation. For the first time, the standard COSPAS/SARSAT payloads, providing distress alerting and positioning services for global users, were carried on board of the CAST-built navsats. The satellites are similar to those Beidou 3 satellites launched on 29 July. After a series of tests and evaluations, they will work together with 12 BeiDou-3 satellites already in orbit. Beidou 37 has the PRN-code C32 and Beidou 38 C33.

2018-075A
29 September 2018 - 04:13 GMT (12:13 BJT)

launch site: Jiuquan Satellite Launch Centre, Launch Area 4
launcher: Kuaizhou 1A (KZ-1A)
payload: Centispace 1-1S (renamed after launch: Xiangriku 1)

Expace Technology Co. Ltd. launched the second Kuaizhou-1A vehicle with the small, 97 kg commercial communications and navigation technology payload Centispace 1-S1 on board. (in Chinese: Weili kongjian yi hao xitong S1 shiyan weixing (Micro-space 1 System S1 Test Satellite). It was renamed after launch to Xiangrikui 1 (Sunflower One). Centispace 1-1S, intended for testing low-orbit navigation in a 700 km SSO orbit, was built by the Innovation Academy for Microsatellites for Beijing Weilai Daohang Keji YG (Beijing Future Navigation Technology Co. Ltd.). Centispace 1-S1 has a lenghty box-shaped satellite bus with two solar panels. It carries a GNSS receiver for orbit determination and a laser intersatellite comms link.

Shijian 17 (2016-065A)
Jonathan's Space Report (No. 754) referred to observations by David Todd from Seradata (a launch and satellite database service - www.seradata.com). Todd noted that the communication satellite Shijian 17 had conducted several unusual orbital manoeuvres since its launch by the end of 2016. Starting in April 2017, SJ-17 moved from its original position at 163°East via a position at 118°East to 152°East, were it arrived on 23 January 2018. There, its inclination was raised by 4° on 26 January 2018. After that, positions were occupied at 178°West, 40°East, 118°East, 106°East, 103°East and 94°East. On 21 July 2018, SJ-17 reached again 0° inclination and moved then to 80,5° East. Until 31 August 2018 the satellite relocated to 94,1° East were it remained since then.

Suborbital launches

SQX-1Z (Hyperbola-1Z) Shuang Quxian 1Z
5 September - 05:00 UTC (13:00 BJT)
Jiuquan Satellite Launch Centre

After its first suborbital launch on 4 April with Hyperbola 1S from Hainan, iSpace conducted its second test flight with its single-staged Hyperbola 1Z (SQX-1Z) on 5 September from Jiuquan. At the peak height of 108 km, the rocket released three cubesats: TFJR 1 for Zero-g-Lab in Beijing and CDGX 1 and EREBus for ADA-Space in Chengdu. A first orbital test flight with enlarged first stage and the SQX upper stage is planned for the first half of 2019. iSpace said that four launches are on its commercial manifest for 2019.
Also compare section: COMMERCIAL SPACE

OS-X Suborbital
7 September - 04:10 UTC (12:10 BJT)
Jiuquan Satellite Launch Centre

OneSpace launched on 7 September for the second time its solid-fuel OS rocket - this time in the version OS-X1 (Chongqing Liangjiang Star-X1) and from Jiuquan. The first launch was with the OS-X0 on 15 May from a place in North China (Alxa). OneSpace will aim for its first orbital launch in 2019.
Also compare section: COMMERCIAL SPACE

For the list of used sources and abbrevations, please, consult page 19.

LandSpace - Will it be China's SpaceX?

Visit to the LandSpace manufacturing base in Huzhou

by Chen Lan, Jacqueline Myrrhe

Zhuque 2. credit: LandSpace

Chinese NewSpace Leader

LandSpace is China's leading private space company. It has created many "firsts" in China - the first private company to develop space launchers, the first privately funded orbital launch attempt, the first private company to sign a launch agreement with international customers. And on 17 May 2019, comes another first. On that day, LandSpace announced that the company's 80-tonne class methane and liquid oxygen (methalox) engine TQ-12 has completed successful full-system hot test firings. Within one week up to 17 May, the engine made four successful test firings with the longest one lasting a duration of 20 seconds. The company released photos and videos showing the engine and the impressive firing at a test stand located in a mountainous area.

LandSpace claimed that their new methalox engine ranks number three in the world after SpaceX's Raptor and Blue Origin's BE-4. According to LandSpace, the TQ-12 engine has a sea-level thrust of 67 tonnes and a vacuum thrust of 76 tonnes. A future vacuum model will increase the thrust to 80 tonnes. LandSpace's methalox engine project was kicked-off in 2017 with a 10-tonne class gas generator and the thrust chamber test firing at the end of that year and again in March 2018. After that, LandSpace's focus shifted to the 80-tonne engine, and in September 2018 and January 2019, it successfully tested the larger engine's thrust chamber and the gas generator. The fast development led to a semi-system test firing in March 2019, paving the way for the May test firing.

This was another milestone after the Zhuque 1 (ZQ-1) launch last year, and certainly a big news for the Chinese commercial space sector. However, it was very quickly submerged on Chinese media due to overwhelming reports on the U.S. ban on Huawei, which happened the day before. Whilst among the space circle and space fans, the news was quickly spread. LandSpace founder and CEO Changwu Zhang shared the message in WeChat's "Moments" at the first opportunity with only a few words of comment: "80 tonnes, full-system, 20 seconds, world class". Interestingly, Mr. Zhang's WeChat profile photo is an astronaut in spacesuit helmet - Matthew McConaughey, the starring actor of the sci-fi film Interstellar. Does it show LandSpace's interstellar ambition?

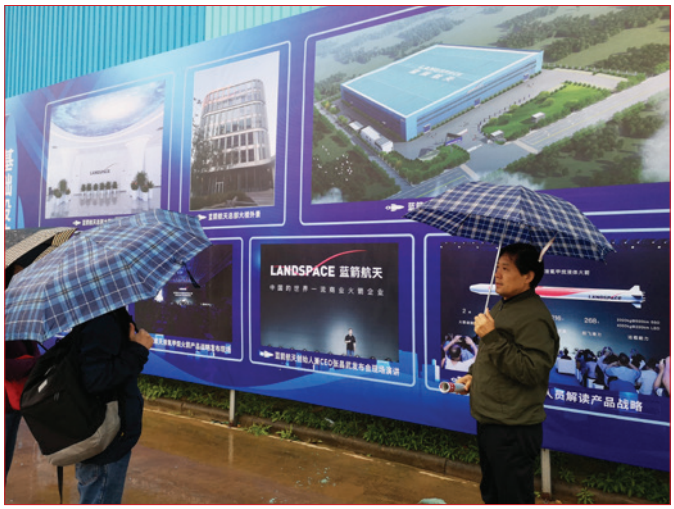
LandSpace is often seen as China's counterpart of SpaceX. But it is not the only one. Nearly a dozen private rocket companies have emerged in recent years. For now, most of them are small and unnoticeable. Even leading companies like LandSpace are still at an early stage. Undoubtedly it is too early to compare them with SpaceX, which however, cannot prevent people from imagining the future. SpaceX was also small and had not launched any real rockets in its first three years. In fact, during a visit to LandSpace's Huzhou facility in March, we have seen more or less the shadow of SpaceX in its early days - dream and passion, failure and success.

The Huzhou Base

The authors have followed LandSpace since its establishment in 2016. In October 2018, one of the authors (Chen Lan) was in Jiuquan Satellite Launch Centre and witnessed the almost successful LandSpace Zhuque 1 launch (see the report in GoTaikonauts! issue no 23). In Jiuquan, LandSpace people talked about their newly-built manufacturing base in Huzhou, Zhejiang Province, a city very close to Shanghai (LandSpace's headquarters and its R&D team are based in Beijing). The idea to visit the base was born at that time. In late March 2019, Jacqueline Myrrhe, another author and member of the Go Taikonauts! team came to Shanghai. It seemed this would be a good opportunity to visit LandSpace's Huzhou Base. Our request through Dr. Shufan Wu, co-founder of LandSpace, was quickly responded to, and the visit was arranged smoothly.

The test of the 80-t methalox engine TQ-12 on 17 May 2019 at Landspace's test range in the Meinyu Mountains, 20 km from Huzhou. credit: LandSpace

Landspace's Huzhou manufacture facility. credit: LandSpace



General Manager Du (r.) explains LandSpace's portfolio. credit: GoTaikonauts!

On 28 March, after about two hours of driving from Shanghai in light rain, we arrived in Huzhou. The company is located at a road in the west of the city where few people tread. There, a modern and generously-sized industrial park is taking shape, giving other, but not only, high-tech companies favourable conditions for their businesses.

The first sight that greeted us, after we turned into the LandSpace campus, was an impressively huge striking blue coloured factory building that we had never anticipated for such a small start-up company. Mr. Du, General Manager of LandSpace's Huzhou Base, welcomed us at the entrance. At first, he brought us to a long billboard on the outside of the building where he - ignoring the rain - unhurriedly briefed us on the base's background and recent development. We noticed that there was a photo of the semi-system test firing just made three days before, which may imply the company's high efficiency.

The inner space of the building was also huge, and to our surprise, mostly empty! The only space related hardware we saw, was the Zhuque 1 solid launcher and its launch platform. Mr. Du told us that the rocket is a mock-up and the platform is the actual one used in the launch last October. The building has a covered area of nearly 30,000 m^2. It will be divided into several sections for different functions such as engine assembly, tank manufacture, rocket assembly and testing, etc. The empty space is reserved for rocket manufacture and assembly, as at the moment there were only activities on engine development. We noticed that at two sides of the building, there are some low partitioned rooms. They later turned out to be offices, conference rooms, workshops, testing rooms and laboratories. The whole team works under one huge roof.

The Zhuque 1 rocket model in the 30,000 m^2 hall. credit: GoTaikonauts!

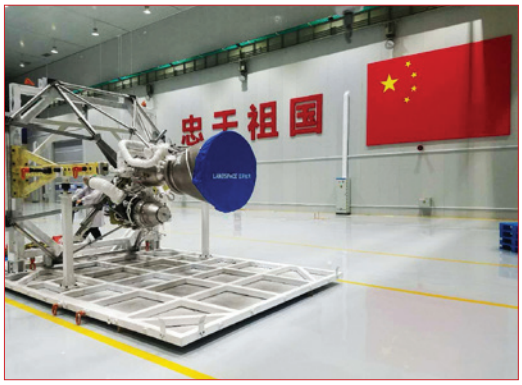
Inside the brand-new manufacturing hall. From the left: Chen Lan, Estella Ding, Jacqueline Myrrhe, Mr. Du. credit: Qin Chun

Mr. Du took us to a conference room and started a well-prepared presentation about the company, the Huzhou Base, and the products they are developing. Du is the type of engineer you would trust straight away, whom you would give without hesitation your best car for repair. His calm charisma, his unruffled way of talking and his sound explanations are convincing and give him the aura of seniority. Before his move to Huzhou he worked in the Academy of Aerospace Propulsion Technology (The 6th Academy of CASC) in Xi'an and was an engine manufacture expert. He joined LandSpace to lead the team in building the engine and the facility, including the factory building converted from an old one once belonging to a bankrupted heavy industrial machinery company, and a newly built engine test stand in the mountains 20 kilometres away, that was claimed as the first and the only one by a private company in China. The construction work started in March 2018, and in August the stand was put into use. Du was quite proud of making it in such a short time. When asked about the possibility to visit the test stand, Du said it was in refurbishment to prepare the full-system engine test planned in June (in fact it was done ahead of schedule). He suggested to us to visit it next time as moving around at the construction site would be difficult on a rainy day.

Ambitious Plans

On 5 July 2018, LandSpace announced the company's overall strategy and planned products in Beijing. The grand launch event was held in the National Aquatic Center, built for the Olympics 2008 and well known as the Water Cube. The company's strategic product Zhuque 2 liquid fueled launcher made its first appearance at the event. Zhuque 2 (or: ZQ-2) is a medium class launcher with a length of 48.8 m, a diameter of

The platform as used for the launch of ZQ-1 in October 2018. credit: LandSpace



left and middle photo: The TQ-12 engine. credit: LandSpace

The fluid flow test stand. credit: GoTaikonauts!

3.35 m, a launch mass of 216 tonnes and a lifting thrust of 268 tonnes. Its first stage has four Tianque 12 (TQ-12) methalox engines and the second stage will be equipped with a single vacuum version of TQ-12 together with an 8 tonne thrust TQ-11 methalox engine as a vernier engine. It is capable of sending 1.8 tonnes of payload into 500 km SSO and 4 tonnes to 200 km LEO. LandSpace has also planned three variants, ZQ-2A, 2B, and 2C, with an additional third stage powered by a TQ-11 and strap-on boosters in number of zero, two and four. They have a length of 55.7 m, a launch mass of 236, 650 and 1,030 tonnes, and a GTO capability of 2.4, 6.7 and 14 tonnes respectively.

LandSpace also released a conceptual design of a two-stage winged space launcher able to send 10 people to the space station or transport 100 people from and to any place on the Earth within one hour. However, the current focus of the company, and also key to its ambitious planning is the methalox engine, something that even CASC has not much experience with. The Institute 11 of CALT once developed a prototype based on the cryogenic YF-77 engine with a thrust of 60 tonnes, but never put it into use. To guarantee success within shortest time, LandSpace selected a conservative design using the traditional gas generator cycle with an impressive specific impulse of 350 s (vacuum) - in comparison, SpaceX's first methalox engine Raptor is a cutting edge full-flow staged combustion cycle engine with specific impulse of 380 s (vacuum).

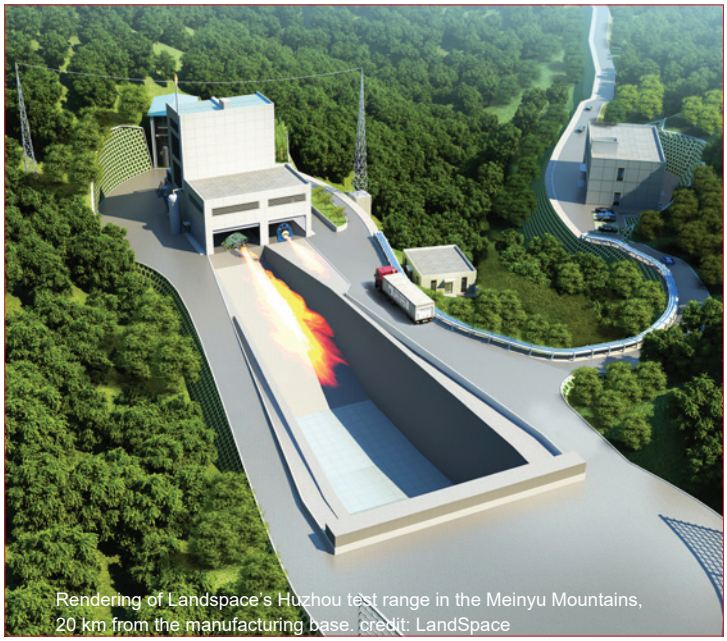
Currently, engine development is also the most important job of the Huzhou Base. Mr. Du showed us the video of the semi-system test firing done three days before. It was a beautiful test firing, though the stand looked simple and preliminary. Since China has so far, no launch site supporting methane propellant, we asked where LandSpace's methalox rockets will be launched? Du answered that they have already been in discussion with the authority to build new facilities at an existing launch site to support launches of methane based carrier rockets. Once built, it will be shared by all state-owned and private launcher companies. He was quite confident that there will be no major obstacles.

After the presentation and a casual talk in the conference room, Mr. Du guided us to a few facilities including the component testing room, the fluid flow test bench, and finally a large clean area where the just-tested engine was under the process of disintegration.

There was a bit of magic and surrealism hanging in the air when watching the engineers counting the screws, sorting the bolts and inspecting the engine parts in this over-dimensioned huge hall, which could easily fit a production line. But for the moment two smaller groups around small tables and a support rack were focused on their precision work. They were not bothered by our visit, did not interrupt their work nor pay any attention to the curious visitors. The one group, busy with the engine casing, was led by a senior engineer assisted by young space experts. The other group, sorting the hardware nuts and bolts, bits and pieces were young and middle-aged engineers. Watching them as a visitor one could not really get the impression that they felt lost in the enormous space, rather they filled the room with dedication and zealous efforts to get the job done.

The base will soon start Phase 2 construction. After completion, it is able to produce 200 engines and 15 launchers per year, said Mr. Du.

Rendering of the Landspace's Huzhou test range, showing the completed site. credit: LandSpace



Rendering of Landspace's Huzhou test range in the Meinyu Mountains, 20 km from the manufacturing base. credit: LandSpace

Right Time, Right Place and Right People

The Huzhou Base and LandSpace's fast progress are impressive. It was unimaginable just a few years ago when people always thought that space is a strictly restricted area by the government, and that space technology is too high and complex to be achieved by private companies. It has to thank the new policies the Chinese government has launched in recent years - more or less under pressure from Elon Musk. The reason behind the emergence of LandSpace is exactly as a Chinese proverb says: right time, right place and right people. LandSpace is one of the first space start-ups in China and it seized the opportunity. This is the right time.

Huzhou City government provided a 200 million RMB fund to support LandSpace's engine and rocket manufacturing plan. It also gave LandSpace free rental of the land and the building, and soon will build an office building and a canteen for Landspace for free use. Zhejiang Province where Huzhou is located, and its adjacent Shanghai, belong to China's most developed economic zone with a matured manufacturing industry chain, which will largely support LandSpace's manufacturing base. This is the right place.

However, Huzhou is only a "small city" for Chinese standards with residential population of 3 million. It has only two colleges and not many high-tech companies. Fortunately, it has enough supply of technical workers and good policies to attract external talents. In LandSpace's Huzhou Base, most people are from large cities like Beijing and Xi'an. And most people are from the so-called "national team" that implies state-owned space organisations and companies. And last, most people are young and have a higher degree. Among them, about ten percent are female, including some in a high technical position, told by Mr. Du. They mostly come to this small city following their dream. Mr. Du is one of them. As one of the eldest in the team, he admitted that joining LandSpace is an adventure but he is very optimistic on LandSpace and Chinese NewSpace. On many occasions, we saw this special expression of passion based on professionalism in Mr. Du's face. He told us that he likes the mix of young and old engineers within the teams. Even more so, he is committed to transfer his experience to the next generation of engineers, "to the rocket scientists of the future" as he stressed. We did not have the chance to contact young people at the base. They all were absorbed by their work. There was no way to get them away from their activities. But what they have achieved already told us without a big explanation is that these are the right people, the "right stuff".

It seems that the launch failure last October has had no impact on the company. Just less than one month after the failure, LandSpace signed the B+ series funding of 300 million RMB. Du said he did not rule-out the possibility to relaunch the solid Zhuque 1, as long as there are requirements, though their focus is now on the Zhuque 2. Now, LandSpace has entered the fast lane. It is definitely the leading private company in China on liquid rocket engine development, and is the one closest to an operational medium launcher. On 26 April, it signed 100 million RMB of agreements with the UK-based Open Cosmos and Italy-based D-Orbit to launch their cubesats.

LandSpace plans to launch their first Zhuque 2 by the end of the next year, 2020. So far, everything seems smooth. But it is still a big challenge for the company. There is still a long way to go to catch up with SpaceX.

A New Space Race

Just one day before our visit to Huzhou, OneSpace, another Chinese NewSpace start-up, launched their first orbital rocket, the solid fueled OS-M, from Jiuquan. Unfortunately, it lost attitude after separation of the first stage. Investigation results released in early April showed that the failure was caused by a gyro malfunction at T+45 seconds. This is the second orbital launch attempt after LandSpace's ZQ-1 launch in last October.

Starting in March 2018, Landspace's Huzhou manufacturing facility and the surrounding infrastructure were built within 8 months. The hall is the biggest manufacture base of a commercial space company in Asia. credit: LandSpace

Mid-March 2019, Landspace released the ZQ-2 development time schedule:

- **March 2019:** Finalising roadmap planning
- **March 2020:** Preliminary design review and start of rocket test model
- **October 2020:** Launcher system assembly
- **November 2020:** System test
- **November 2020:** Pre-shipment review
- **December 2020:** Transport to launch site; launch readiness

In mid-May, Interstellar Glory (also known as i-Space or Space Honor), yet another private rocket company, announced that their first orbital launcher, Hyperbola 1, had completed assembly and will be launched in early June. If it achieves success, Interstellar Glory will win the race and become the first Chinese private company to reach orbit.

LandSpace, OneSpace and Interstellar Glory are not the only players in this race. Galactic Energy, LinkSpace, Deep Blue Aerospace, Space Trek are all developing their engine/motor and rockets. Most companies start with a smaller solid rocket but all have plans of liquid engines. For example, Interstellar Glory is developing a 15-tonne thrust methalox engine that has already completed gas generator and turbo pump tests. Galactic Energy is currently developing a high-thrust solid motor, and has also started development of a 40-tonne thrust (sea level) liquid oxygen and kerosene engine to power their WisdomStart 1 launcher that is within the same class as LandSpace's ZQ-2. LinkSpace, in contrast, follows a different path. Their efforts are concentrated on a reusable VTVL (vertical take-off, vertical landing) rocket. In late March, they successfully launched and recovered their 8-metre long RLV-T5 prototype. The flight lasted 35 seconds climbing to a maximum altitude of 20 metres. It was a milestone, as this was the first free flight of their "large rocket" (all their previous VTVL rockets are mocked by people as "model rockets").

Currently LandSpace is still the most promising one. Ironically, its ambition was shown in an April Fool news. It said that LandSpace and Taobao, China's largest C2C e-Commerce company, are jointly developing two express delivery rockets - one able to complete an intercontinental flight within one hour, and another for 30 km in 30 seconds.

The race is heating up, not only within China, but also outside the country. LandSpace and its domestic competitors, as followers and challengers of SpaceX, all claim that reusability was in their consideration from the beginning. SpaceX may one day feel pressure from these newcomers when their technologies are matured in a few years, which is certain to happen.

From a broader perspective, the race is also part of a much larger race between China and the U.S. Unfortunately, the Sino-U.S.-American trade war is now evolving into a tech war which may permanently change the world order. It will deeply influence China's policy and will speed up the development of independent technologies. What will the incoming race bring? We just hope a mutual-beneficial competition and win-win, instead of a conflict, or even a war.

When we walked out of the building, the rain had stopped. And we always believe that the future is bright.

update from 23 July: *The TQ-12 engine completed a 100 sec full-thrust test run at Landspace's test range in the Meinyu Mountains near Huzhou. The test met all key performance requirements, verifying the engine's quality and structural reliability. Next up are further tests including under extreme working conditions and a long test run.*

update from 25 July:

On 25 July, Interstellar Glory (iSpace) made a successful orbital launch, sending two smallsats into a 300 km orbit. This achievement ended the race about the first commercial launch in China. Interstellar Glory got the glory. However, now the second round is on: aquiring the liquid rocket capability. In this new race, LandSpace is still in the leading position.

Zhū Què, the Vermilion Bird, is one of the four spirits in the ancient Chinese mythology and one of the four symbols for the Chinese astrological constellation, where it is residing over seven "mansions" or positions. Zhū Què is the god of the South, representing fire and summer. The bird's feathers are colored in vermilion - different shades of brilliant and scarlet red.

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

http://news.xinhuanet.com
http://spaceflight101.com/china/
https://www.nasaspaceflight.com
http://www.spaceflightinsider.com
https://spaceflightnow.com
http://www.planet4589.org/space/jsr/jsr.html

AAPT	Academy of Aerospace Propulsion Technology
AO	Announcement of Opportunity
APSCO	Asia-Pacific Space Cooperation Organisation
BDS	BeiDou satellite navigation Systems
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
CBERS	China-Brazil Earth Resources Satellite
CCT	China Communication Technology Satcom
CCTV	China Central Television
CE	Chang'e
CGWIC	China Great Wall Industry Corporation
CLEP	China's Lunar Exploration Programme

CMA	China Meteorological Administration
CMC	China's Central Military Commission
CMSA	China Manned Space Agency
CMSEO	China Manned Space Engineering Office
CNSA	China National Space Administration
CSS	Chinese Space Station/China Space Station
CZ	Changzheng, Long March
DFH	Dong Fang Hong
ESA	European Space Agency
EVA	Extravehicular Activity
FAST	Five-Hundred Metre Aperture Spherical Radio Telescope
GEO	Geostationary Orbit
GNSS	Global Navigation Satellite System
HJ	Huan Jing
HTS	High-throughput satellite
IAU	International Astronomical Union
IGSO	Inclined Geosynchronous Orbit
IoT	Internet of Things
JSLC	Jiuquan Satellite Launch Centre
KACST	King Abdulaziz City for Science and Technology

LEO	low Earth orbit
LEOP	launch and early orbit phase
LIGO	Laser Interferometer Gravitational-Wave Observatory
MoU	Memorandum of Understanding
NAOC	National Astronomical Observatories of China
	NASB National Academy of Sciences of Belarus
NSSC	National Space Science Center
P/L	payload
PolyU	Hong Kong Polytechnic University
PRN	Pseudorandom noise
Roscosmos	Russia's State Space Corporation
SAR	Synthetic Aperture Radar
SQX	Shuang Quxian
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
Tatwah	Zhongshan Tatwah Smartech
TG	Tiangong
UN	United Nations
UNOOSA	UN Office for Outer Space Affairs
UTC	Coordinated Universal Time
ZQ	Zhuque

Imprint

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for issues 1 - 17, the **Go Taikonauts! e-magazine** can be downloaded **on iTunes**:
http://itunes.apple.com/de/app/go-taikonauts!/id454679742?mt=8
for issues 1 - 18, the **Go Taikonauts!** PDF can be downloaded **from the web**:
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As of issue 19 you can subcribe to the printed version.

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Go Taikonauts! print version is issued by:
Initiative 2000 plus e.V.;
Dümperstrasse 5,
17033 Neubrandenburg,
Germany
copies can be ordered via e-mail:
rcspace@t-online.de

printing house:
WirmachenDruck.de
Sie sparen, wir drucken!

pricing

single printed issue:
mailing within Germany: 10 €
mailing outside Germany: 15 €
for consultants/analysts/members of media, space companies, think tanks, space organisations: 100 €

annual subscription of 4 printed issues:
mailing within Germany: 31 €
mailing outside Germany: 42 €
for consultants/analysts/members of media, space companies, think tanks, space organisations: 400 € (including two adverts of 1/3 page)

China Space Day 2019 - A Retrospective

by Blaine Curcio (Orbital Gateway Consulting), Jacqueline Myrrhe

China fascinated the world with a poetic and artistic Space Day poster, connecting cultural heritage with modern technology in a unique way. credit: Yang Quan

The past 5 years have seen two major changes in the Chinese space industry. The industry has become more international, and more recently, it has seen the emergence of a commercial space component. On the international side, China now has a not insignificant share of the global space market, primarily selling to developing countries with Chinese loans, and educating developing country engineers in China. On the commercialisation side, while still in its infancy, the commercial space industry is now represented by dozens of companies that have raised hundreds of millions of US dollars in funding from private sources (though most companies have some combination of private and state funding). Both of these trends were plainly visible in late April in Changsha, Hunan Province. Several different conferences highlighted internationalisation and commercialisation, all of which were clustered around "China Space Day" - an "Earth Day"-type holiday in China whereby nobody stops working, but many people "observe" the holiday.

The Main Event: Pursue Space Dream for Win-Win Cooperation

The Main Event was the official opening ceremony of the China Space Day, held on the morning of 24 April at the Changsha Saint Tropez Hotel, and was sponsored by the Ministry of Industry and Information Technology of China (MIIT), the China National Space Administration (CNSA), and the Government of Hunan Province. Under the headline of "Pursue Space Dream for Win-Win Cooperation" (逐梦航天 · 合作共赢), it included keynote speaker Xu Dazhe, former Head of CNSA and SASTIND and now Governor of Hunan Province, and Yang Liwei, China's first taikonaut. In addition, representatives from several other countries - among them two Russian cosmonauts wishing a Happy China Space Day via video message from the ISS, as well as a representative of Pakistan's SUPARCO broadcasting from Pakistan.

In addition to the international guests attending via video conference, the event itself was attended by almost 800 people, including academicians, staff of the central government and institutions, representatives of the commercial space sectors, foreign guests from international organisations and national

China Space Day in a nutshell

In 2016, the Chinese government set the 24 April, the anniversary of the launch of the nation's first satellite in 1970, as the national Space Day. Taking a modest start in the first three years, the 2019 edition of China National Space day has been a true celebration of China's emergence as a space nation. From 23 to 29 April, more than 350 events took place across the country, ranging from small gatherings of 15 - 20 persons at space companies to events with 200, 500 or 1,000 persons in all major space-related cities, with the biggest event at Hunan University in Changsha, uniting 10,000 participants. After Beijing in 2016, Xi'an in 2017 and Harbin in 2018, the capital of Hunan province, Changsha, was the epicentre of the festivities. Here, the Opening Ceremony of China Space Day set the stage for the other conferences taking place in parallel: the China Space Conference, the International Commercial Space Forum, the Hunan Space Industry Development Symposium, the National Space Achievement Exhibition, the China Earth Observation Business Summit, the China-Europe Earth Observation Symposium, the Sino-Russian Lunar Exploration Symposium, and the United Nations/China Forum on Space Solutions - Realising the Sustainable Development Goals.

The Opening Ceremony was a colourful and spacy stage show. credit: GoTaikonauts!

Greetings from the ISS Expedition 59: Oleg Kononenko and Aleksey Ovchinin. credit: GoTaikonauts!

Taikonaut Yang Liwei is saluting to the audience. credit: GoTaikonauts!

Hunan's space connection

Hunan province is home to Liuyang county, where since for more than 1,400 years fireworks are produced. Today, about 50 % of China's national fireworks production originates in Liuyang. Changsha, the capital of Hunan, is famous for its firework displays on the Orange Island but also for the Mawangdui archaeological site where three tombs were excavated in the 1970s. Tomb 3 contained astronomical recordings including the oldest for comets. More than 2,000 years ago, Qu Yuan wrote a poem in which he sent his "Heavenly Question" to the sky on the banks of the Miluo River, searching for answers he could not find on Earth.

Qu Yuan is asking the heavens. credit: Yana Grytsenko

Taikonaut Liu Boming credit: GoTaikonauts!

Simonetta DiPippo is awarding the youngest participant of the art competition. credit: GT!

space agencies. An estimated 25 % of the audience was international. Notably, France was the "Guest of Honour", with Lionel Suchet, Directeur Général Délégué of the French space agency CNES giving a speech on stage.

When compared to previous editions of China Space Day, the Opening Ceremony of the 2019 edition was markedly more international. Additionally, throughout the stage show, several short videos were played highlighting some of the accomplishments of the Chinese space industry. The production quality of these videos was significantly better than what one might have seen in year's past, with China clearly having an improved understanding of soft power. Videos of Long March rockets taking off, rovers landing on the Moon, and launch control centers with excited scientists were paired with impressively pulse-quickening music, made for an impressive sight.

The whole stage show was very well designed and moderated, with artistic parts, children's performances and heavy light installation, a far reminiscence of the annual spring festival TV show. Perfectly interweaved into the show was a drawing contest organised by the Chinese Aerospace Society and Hunan Education Department. The impressive results of the children's and youngsters' art work were shown in the entrance area and projected onto the screen during the show. UNOOSA Director Simonetta Di Pippo, after giving a keynote speech, requested the organisers that she would like to personally honour one of the youngest prize winners of the competition which turned out to be a 4 year-old girl.

Internationalisation at the United Nations

The biggest difference between

The Director of the Office for Outer Space Affairs, the Administrator of CNSA and the Governor of Hunan Province, among others, opened the China Space Days. credit: GoTaikonauts!

Sustainable Development Goals

The 2030 Agenda for Sustainable Development, adopted by the UN General Assembly in 2015, is the boldest agenda for humanity and the most ambitious anti-poverty, pro-planet agenda ever adopted by the United Nations. Developing countries especially, are in need of innovative approaches and partnerships to facilitate their progress towards achieving the Sustainable Development Goals (SDG). The SDG 17 "Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development" is aiming at multi-stakeholder partnerships as an important means for mobilising and sharing knowledge, expertise, technologies and financial resources. Also, it is generally accepted that the importance and the potential of outer space has not been fully recognised and utilised by the international community.

In its resolution 73/6 of 26 October 2018 on space as a driver of sustainable development, the UN General Assembly emphasised the need to build stronger partnerships at all levels in order to enhance the contribution of space activities for the realisation of the 2030 Agenda and invited the COPUOS (Committee on the Peaceful Uses of Outer Space) to develop a "Space2030" agenda and implementation plan, and acknowledged the importance of global partnership and cooperation among UN Member States, intergovernmental and non-governmental organisations, industry and private sector entities in fulfilling the "Space2030" agenda. COPUOS, at its 61st session, in 2018, agreed to the establishment of a working group on the "Space2030" agenda.

2019's China Space Day, and those of year's past, was the inclusion of a United Nations Office of Outer Space Affairs event which drew in attendees from many space-faring nations of the developed and developing world.

The United Nations/China Forum on Space Solutions under the motto "Realising the Sustainable Development Goals" was held from 24 to 27 April 2019 in the Wanda Vista Hotel Changsha. It was co-organised by UNOOSA and CNSA in cooperation with the Industry and Information Technology Department of Hunan Province as well as supported by APSCO, the UN Regional Centre for Space Science and Technology Education in Asia and the Pacific (China), the municipal government of Changsha and Hunan University.

The main objective was to bring together space solution providers and users to discuss the needs of countries for space solutions, identify gaps between user needs and space solutions and to forge new partnerships and enhance international space cooperation in support of the SDGs (see textbox).

The forum was attended by 527 participants from 46 nations from all continents: representatives of national, regional and international public and private organisations and institutions, including decision makers from governmental agencies, officials from regional and international agencies, experts from the space community, industry, business and academic communities, policymakers, representatives of the private sector in the space and non-space fields, and civil society.

Already during the Opening Ceremony of the China Space Day, an agreement between UNOOSA and CNSA regarding cooperation on

The introductory note and the presentations made at the forum were made available on the website of the Office, together with the programme of the forum.

Report on the United Nations/ China Forum on Space Solutions on the theme "Realizing the Sustainable Development Goals" - The report was prepared for submission to the 62nd session of the Committee on the Peaceful Uses of Outer Space, held in June 2019.

China's lunar and deep-space exploration was signed by the Director of UNOOSA and the Head of CNSA.

Wu Yanhua, Deputy Director of CNSA stressed that China is determined to contribute its national space activities to the achievement of the SDGs, which includes a 10 item action plan.

Of particular interest was the special session "Win-win cooperation on the Belt-and-Road Initiative Space Information Corridor" where the speakers presented the programmes and opportunities within this project: participation in the construction or the provision of information, communication and navigation services, including space-based information resources and ground information-sharing networks. One of the presentations reflected on the importance of cultivation of space talent and another one on the cooperation within an aerospace innovation alliance under the Belt and Road Initiative. The presentation by Liu Jizhong of CNSA outlined the cooperation opportunities for the Chang'e 6 mission where payloads positions are available and for the asteroid mission, now in planning.

The session titled "Space solutions in support of the Sustainable Development Goals" revealed that accessibility to data was fundamental to data-sharing. The participants were interested in understanding how Earth observation data collected by China could be accessed, including data from meteorological satellites. The option of access to non-commercial data for research purposes through an application process was mentioned, while for larger volumes, bilateral agreements with CNSA were needed.

During the round table discussion on the last day, one of the Chinese representatives spoke about the significant benefits of the Beidou satellite navigation system. It was quite revealing when he explained the importance of the messaging function of the Beidou system for the fishermen on the 40,000 fishing vessels equipped with Beidou. Having the possibility to keep contact with the families while they are fishing on the sea for several days has given them the sense of staying connected, an option which simply did not exist before. Not to mention the fact that in the past five years, the system has helped rescue more than 10,000 fishermen out of dangerous situations. So for the fishermen, Beidou became a second god, a patron saint. Before they enter the sea they pray to the patron of the fishermen to protect them and then they pray that Beidou will function flawlessly.

UNOOSA Director Simonetta DiPippo also mentioned that the Office for Outer Space Affairs was developing the space solutions compendium and the Access to Space for All initiative with a view to making space solutions available to countries.

This was one of the urgent needs addressed by the Nigerian delegate. Any technology transfer on a level playing field would create real progress in Africa. He put it even simpler: Africans would ask: "How can space help me to solve my problems?" The most important criteria is how space can improve daily life according to the needs of the average person.

In the evening of the second conference day, a "matchmaking" event was held, which in a way resembled speed dating. The organisers divided the participants into space solution providers and space solution users. Each user was numbered. Then each provider had to draw a number and met with the participant assigned to this number. Within 10 mins, the users had to explain to the provider what his/her needs are and the provider had to decide whether he/she can offer a matching solution. Then the next round was called. This procedure was a quite innovative way of forging new partnerships between users and providers. The groups also realised that there is a big knowledge gap between users and solution providers. Users were not aware of the available solutions, and providers recognised that more business could be generated when paying attention to users' needs in the development of solutions. The forum participants also raised the point that means should be explored to bridge the gap. At the end of the exercise, a total of 28 match-made letters in which various parties expressed their potential interest in cooperation regarding the Sustainable Development Goals were signed on the spot. UNOOSA had never done such a casual process but the forum participants liked it a lot, even if some speed-dates did not result into a match, but within a couple of hours the attendants knew each other better than before.

A team which matched at the UNOOSA Match-making event. credit: Milan Mijovic

Commercialisation at the Saint Tropez

The Chinese space industry started to commercialise in earnest in 2014, at which time the government partially opened the industry to private investment. Over the past 18-24 months, the pace of private investment has increased dramatically, with company formation likewise ramping up.

As a result, this year's China Space Day included a large commercial space forum held at a separate location from the UN Conference. The forum was hosted by multiple organisations, including Future Aerospace, a Chinese space-related think tank/investor. The forum included several dozen Chinese commercial space companies, with topics including the usual suspects of space commercialisation, new application development, and VC investment into the space industry.

Contracts

During the China Space Day in Changsha, 12 cooperation contracts involving 23 enterprises or institutions and representing an investment volume of 20 billion RMB were sealed.

For example, CASIC Rocket Technology Company and Wuhan Science and Technology Bureau signed a contract to name one of the next Kuaizhou rockets "Kuaizhou-Chutian". This is the first time the Kuaizhou vehicle obtained a naming sponsor. WEY, the new luxury sports utility vehicle brand of Great Wall Automobiles, and China Space Foundation, as well as China Academy of Launch Vehicle Technology (1st Space Academy) concluded a strategic cooperation agreement. The parties 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 in collaboration with a commercial brand. This partnership is the largest single item cooperation project in China's aerospace industry. It focuses on the application of space technology in the automobile industry and includes the set-up of the first "joint technology innovation center" between the space and automobile industries. By this, WEY hopes to realise new breakthroughs in R&D and manufacturing. As the first result of cooperation between WEY and the space industry of China, WEY will launch a VV6 space memorial model.

The discussed issues covered a wide spectrum, such as intelligent launcher capabilities, spacecraft mission planning technology, advanced aerospace materials and manufacturing, aerospace standardisation, etc.

Wu Yanhua, Deputy Head of CNSA noted that the commercial space activities have become an important part of China's overall space sector, and it is time that the actors get legal guidance which supports their specific needs as well as supports an open, fair, and beneficial development of this emerging industry. China's legislative body will soon issue a regulatory framework to enable the healthy development of commercial space and launch activities. Special notice will be given to the involvement of private enterprises in the governmental scientific research landscape, production, testing and operation. At the same time, governmental institutions will be encouraged to include the procurement of commercial services into their planning. Furthermore, the cooperation between government and social/private capital will be promoted.

Wu Zhijian, Chairman of the China Space Foundation, is convinced that China's commercial space development is unstoppable. He thinks that the three main pillars of commercial aerospace of the future will be LEO constellation, space tourism and interstellar mining, with the most important one right now is LEO constellations.

According to him are as much as 49 institutes in the one or the other way engaged in launch vehicles, of those, 8 are governmental enterprises and 41 are private. 10 of the 49 institutes are in Changsha, 12 in Beijing, 11 in Guangdong, and 10 in Xi'an. There are 15 satellite manufacturing companies in China and 10 companies in measurement and control systems. Wu Zhijian addressed five problems, the commercial aerospace sector is currently facing: marketing, government support, innovation, business model, and capital.

Referring to marketing he pointed out that the stress in commercial aerospace is on "commercial". Technology is not a purpose in itself. The market is the goal and this implies that projects of the past are not the business model for the commercial sector. Government support through procurement of commercial aerospace products and services, IP protection, and technology transfer are some of the needed prerequisites for the success of commercial space activities. Innovation is a point that speaks for itself. It also includes to aim for cost benefit otherwise there is no advantage for private space endeavours. Commercial aerospace is a market-oriented business activity. Business is the objective of commercial aerospace, so it must be closely integrated with capital.

Also Sun Weigang, Deputy Director of the Science and Technology Committee of China Aerospace Science and Technology Group Co., Ltd., emphasised that the design of commercial space hardware does not imply the duplication of existing technologies. The ambition of the commercial space sector has to be technological progress and the advancement of space activities.

Surrounding the commercial space forum were, among other events, a VIP dinner that included several prominent Chinese commercial space investors, startups, and think tanks. While the commercial space industry in China remains nascent, the dinner provided an opportunity for various European, Chinese, and North American companies to interact in an informal setting.

On the whole, as compared to previous years, the commercial aspect of the China Space Day conference was markedly larger, with Future Aerospace in particular playing a comparatively big role for a purely private company in its hosting of the Commercial Forum.

The Space Achievements Exhibition

The 11,000 m^2 exhibition showcased four main areas: China and Foreign Commercial Space Industry Enterprises, Space Achievements, Science Popularisation and Earth observation applications. Next to big players such as CASC and CASIC, new space companies ZeroG Lab Space Technology, MinoSpace, Galactic Energy and SpaceTY together with a wide range of enterprises from the geospatial information sector, such as ESRI, GEOVIS and SatImage Information Technology were present. 20 emerging commercial aerospace enterprises showcased their achievements and ambitions. With the Shenzhou 11 capsule and the Feitian spacesuit, original space hardware was also displayed which were complemented by the 1:1 models of the Chang'e 4 lunar lander, the Yutu 2 rover and the Magpie Bridge communication relay satellite.

Space Reaching the Everyday Person

With several significant conferences taking place in Changsha at the same time, this relatively small provincial capital became a sort of "Space City" for the week. During those days, one could see several instances of space being cognizant in the minds of local people.

At a local shopping mall next to the Wanda Plaza Hotel, the authors spotted a sort of "Space Pod", cobranded with SpaceTY - a local smallsat company with total funds raised in the tens of millions of USD - and Pizza Hut. This was spotted in the mid-afternoon, but one could imagine that if it were evening, and families were queueing outside Pizza Hut for their fix of western fare, children would be fascinated by this mysterious Space Pod that has somehow landed in their shopping mall. Conclusion? There are hopefully **a lot** of photos of young children in this space pod on Changsha parents' WeChat moments accounts. This is a great, small-scale way to make the space industry more relevant to everyday people.

The SpaceTY Space Pod in a Changsha shopping mall. credit: Blaine Curcio

In the streets of Changsha. credit: Blaine Curcio

In addition, when driving around town, one could see banners on every light-post showing that this week, in Changsha, was the China Space Day Conference. Interesting was the choice of colours - it is uncommon to see any government-related event without a hint of red. As well, noteworthy is the text: "Pursue Space Dreams for Win-Win Cooperation". The "Win-Win Cooperation" is a favorite phrase of Chinese government and companies when describing projects with other countries. "Space Dreams" is clearly a reference to the "China Dream" (中国梦), a sort of political ideology championed by Chinese President Xi Jinping that aims to restore China to its past glory, hence the "China Dream". These banners were more or less all over Changsha, another promising indication of the extent to which space is becoming more prominent in the lives of everyday people, even if, presumably, the vast majority of people did not stop to take a photo like I did.

The boldest space project for planet Earth: UN-China Space Cooperation

by Jacqueline Myrrhe

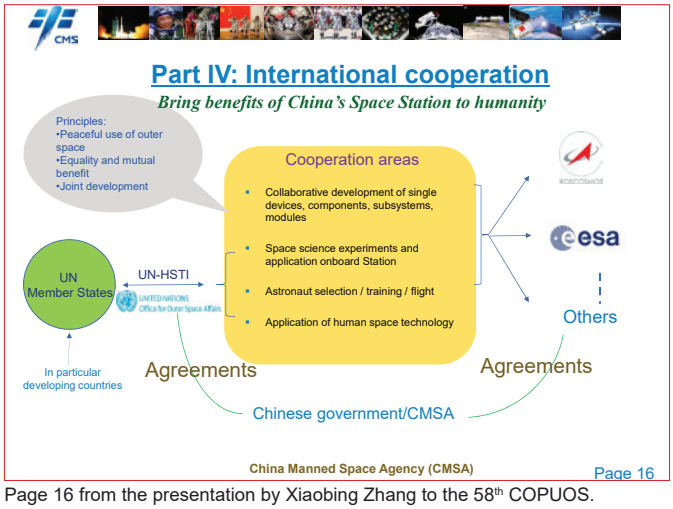
Another breakthrough for China: on 28 May 2018, around 100 participants, most of them high-ranking diplomats attached to their respective national missions to the United Nations, followed the joint invitation by the United Nations Office for Outer Space Affairs (UNOOSA) and the Permanent Mission of China to the United Nations for an event in the noble Park Hyatt Hotel in Vienna. It was not only an invitation for a nice reception but primarily for the ceremonial Announcement of Opportunity (AO) to conduct experiments on-board China's future Space Station. This project, proposed by China to the UN, was incorporated into UNOOSA's Human Space Technology Initiative (HSTI), which gives countries without their own access to space the possibility for participation in space research. For that purpose, UNOOSA has partnered not only with China but with several other countries or organisations. However, the AO for research on the CSS is bold in scope, generous as an offer and unprecedented as an international project. During his brief speech, Shi Zhongjun, China's Ambassador and Permanent Representative to the UN stressed: "The CSS belongs to the world." But also, without explicitly saying it, this ambition was felt, hanging in the air that evening in the Vienna hotel, stretching beyond a new horizon which is only possible through the partnership with UNOOSA: involving nations on a global level. China demonstrated its commitment to becoming a serious and responsible space power - different in style from other space nations and still less technologically advanced as for example NASA - but very firm and committed. Moreover, China is determined to use the CSS as a strong soft-power tool for influencing the development of world politics.

Completely missed by media and the public, Xiaobing Zhang, Deputy Director of CMSA's Scientific Planning Bureau outlined this special cooperation project in his presentation to the 58th Session of the Committee on the Peaceful Uses of Outer Space (COPUOS) at the UN in Vienna in June 2015.

He identified the four intended main cooperation areas as being:

1. Collaborative development of devices, components, sub-systems, modules
2. Space science experiments on-board the Station
3. Astronaut selection / training / flight
4. Application of human space technology

A half year later, on 31 March 2016, UNOOSA and CMSA signed the Framework Agreement and the Funding Agreement between the United Nations and the China Manned Space Agency in Vienna.



Page 16 from the presentation by Xiaobing Zhang to the 58th COPUOS.

In June of the same year, again hardly noticed by outsiders, Wu Ping, Deputy Director General of CMSA, presented the project to the 59th Session of COPUOS at the UN in Vienna. UNOOSA accompanied that with the release of an information note: "Under the agreements, UNOOSA and CMSA will work together to enable United Nations Member States, particularly developing countries, to conduct space experiments on-board China's space station, as well as to provide flight opportunities for astronauts and payload engineers. Both parties will also promote international cooperation in human space flight and other space activities, increase awareness of the benefits of human space technology and its applications, and capacity-building activities in space technology. CMSA will provide funding support to UNOOSA in this regard."

Presentation by Xiaobing Zhang at the 58th COPUOS session in June 2015.

Presentation by Wu Ping at the 59th COPUOS session in June 2016.

Presentation by Lin Xiqiang to the 60th COPUOS session in June 2017.

One year later, Wu Ping's report was reiterated and extended by Mr. Lin Xiqiang, Deputy Director of CMSA's System Technology Division with his presentation to the 60th Session of COPUOS, Vienna.

Finally, on 28 May 2018, the 1st Announcement of Opportunity within the framework of the "United Nations/China Cooperation on the Utilisation of the China Space Station" was launched. China went from intention to action.

Page from the presentation, given by Luc St-Pierre on 4 December during the HSTI meeting in Vienna. credit: UNOOSA

Scan of the signature part of the UNOOSA-CMSA agreement from 31 March 2016.

Shi Zhongjun, China's Ambassador and Permanent Representative to the UN (in 2018) and UNOOSA Director Simonetta Di Pippo. credit: GoTaikonauts!

UNOOSA intends to capitalise on the Chinese space flight expertise to benefit all Member States of the United Nations to whom the programme is open, including public organisations or private entities. Special focus is on developing countries, they "are particularly encouraged to apply", as pronounced in the press release on the occasion of the AO. It is an innovative and future-focused programme to open up space exploration activities to all nations and to create a new paradigm in building capabilities in space science and technology.

The selection process and the implementation was jointly done by UNOOSA and CMSA. China taking over all cost for hardware upload and operations. The development of the experiments having to be covered by the applicant.

There were three possibilities for orbital experiments in the first round of opportunities:

- Conducting experiments inside the CSS by utilising experiment payloads developed by selected applicants.
- Conducting experiments inside the CSS by utilising experiment facilities provided by China.
- Conducting experiments outside the CSS by utilising payloads developed by selected applicants.

The deadline for the first round of application was initially 31 August 2018, but was extended for one month until the end of September 2018.

Until the end of 2018 UNOOSA and CMSA were busy with the evaluation of the proposals and drafting the preliminary selection list. Already on 4 December 2018, Luc St-Pierre, Head of UNOOSA's Space Applications Section, gave an overview on the status of the selection process during the "United Nations Expert Meeting on Human Space Technology - Providing Access to Space".

He explained that a total of 42 applications were submitted from public and/or private organisations based in 27 countries. The science teams came from 60 organisations and were composed of 259 scientists and experts, of whom 200 were male and 59 female. Out of the 42 proposals, 70 % were submitted by public organisations, 7 % from industry and 23 % were joint teams from public and industrial organisations. The 259 team members are from 13 developing countries and 14 developed countries. The scientists are home to 3 African nations, 8 Asian nations, 5 American countries, 10 European countries and from Australia.

The majority of the proposals, 21 out of the 47 proposals, considered experiments inside the CSS with their own hardware. 13 were ideas for research inside the CSS but the hardware provided by CMSA and 13 suggestions considered experiments outside the CSS.

Also, St-Pierre presented a slide which showed all the components of the HSTI. It included icons for Moon and Mars, although still labelled with a question mark. Nevertheless, this slide seems to be an indication, that UNOOSA Director Simonetta DiPippo has still some creative ideas about the future of her Office… (see interview with Ms Di Pippo on page 27)

Milestones for the Selection of Experiments for Implementation on the CSS

2016 - March:	Framework Agreement and Funding Agreement between CMSA and UNOOSA on the utilisation of the Chinese Space Station.
2018 - 28 May:	1st Announcement of Opportunity within the framework of the "United Nations/China Cooperation on the Utilisation of the China Space Station".
2018 - 31 August:	Deadline for applications.
2018 - 30 September:	Extended deadline for applications.
2018 - 31 December:	Preliminary selection and notification of project teams.
2019 - 21 February:	Announcement of Preliminary Evaluation and Selection.
2019 - 20 April:	Submitting implementation schemes by the teams of the preliminary selection.
2019 - until June:	Final project selection and notification.
2019 - 12 June:	Announcement of the 9 selected experiment projects to be executed on board the CSS for the 1st Cycle.
until the end of 2019:	Negotiating and signing bilateral agreements.

Implementing process of the projects following the signed bilateral agreements between CMSA and selected organisations.
Submission of report 5 months after flight mission.

Page from the presentation, given by Luc St-Pierre on 4 December during the HSTI meeting in Vienna. credit: UNOOSA

On 21 February 2019, UNOOSA and CMSA issued a Preliminary Announcement: "Over the past few months, a total of 42 applications, from organisations in 27 countries, have been received by the United Nations Office for Outer Space Affairs (UNOOSA) and carefully evaluated by around 60 experts from UNOOSA, China Manned Space Agency (CMSA) and international space experts, in line with the eligibility and selection criteria outlined in the first Announcement of Opportunity. Based on the results of the evaluation, a comprehensive preliminary selection meeting was held to shortlist proposals.

The selection exercise for this first cycle has been extremely competitive and after careful evaluation of all the applications by the Project Evaluation and Selection Committee (PESC), 18 applications out of the 42 received have been shortlisted for preparing implementation schemes for the final evaluation and selection, the results of which will be announced in June 2019.

top: Page from the presentation, given by Luc St-Pierre on 4 December during the HSTI meeting in Vienna. credit: UNOOSA

QR Code: Presentation by Luc St-Pierre at the HSTI Workshop in Vienna.

The proposed experiment ideas stretch from simple to complex, from space medicine to astrophysical observations - all reflecting the creativity and commitment of the involved scientists from public and private entities in both developing and developed countries."

The principal investigators of the shortlisted projects were invited to prepare their Implementation Scheme Proposals until 20 April 2019, which 15 of them did. It followed "an in-depth review in terms of technical scheme, implementation feasibility, on board resource requirements, safety analysis, risk analysis, and financial support for their own development".

The final selection was based on this review. On 12 June, between the morning and afternoon session of the running 62nd session of the Committee on the Peaceful Uses of Outer Space in Vienna, a ceremony took place to announce the winners.

As the result of the most comprehensive Announcement of Opportunity in the history of space flight, where all member states of the UN were eligible to apply, 9 experiments were accepted for entering the preparation and implementation process. 6 of the 9 projects were fully accepted, and 3 were conditionally selected with the teams being asked to update their implementation scheme. These 9 projects involve scientists from 23 institutions in 17 UN Member States in Asian-pacific, European, African, North American and South American regions, including governmental organisations, private sectors, and international associations. The involved countries are: Belgium, China, France, Germany, India, Italy, Japan, Kenya, Mexico, Norway, The Netherlands, Peru, Poland, Russia, Saudi Arabia, Spain, and Switzerland.

The announcement of the winners of the joint UNOOSA-CMSA AO for experiments on the CSS. On the panel are sitting from the left to the right: Luc St-Pierre, Head of UNOOSA's Section for Space Applications; Simonetta Di Pippo, Director UNOOSA; Qun Wang, Ambassador of the Permanent Mission of the People's Republic of China to the United Nations in Vienna; Chun Hao, Director General CMSA; Zhou Hui, CASC/CAST Project Manager Europe and Asia.

Wang Qun, the Ambassador of the Permanent Mission of the People's Republic of China to the United Nations and other International Organisations in Vienna was the first panellist to speak at the ceremony. He gave an insight into the political implications of the project by saying: "Today's joint announcement marks the beginning of a new phase of China Space Station cooperation. … The China Space Station cooperation is a vivid manifestation of multilateralism. China firmly upholds multilateralism and the international system with the United Nations at its core. China's space industry needs international cooperation including cooperation within the United Nations framework and it is committed to promoting international cooperation. … China firmly supports UN COPUOS as the prime platform in the peaceful exploration and use of the outer space. We are convinced that by working with the UN and supporting multilateralism, the achievements of China's space development will bring more benefits to the rest of the international community as well."

Hao Chun, Director General of CMSA, stressed in his brief address the overall achievement of the AO and indicated the way forward: "Today we have agreed to have scientists coming from different countries, ethnicities and cultures who will carry out space science experiments on board China Space Station. For the next step, we will support the selected teams to implement their projects and in the meanwhile, in close collaboration with UNOOSA, to further perfect and issue a second cycle of announcement of opportunity."

Wang Qun,
China's Ambassador to the UN in Vienna

"In the future we will continue to enrich these experimental projects, extend platform activities on the Space Station and broaden the scope of cooperation projects."

Hao Chun,
Director General of CMSA

"I believe what we have achieved today is just a nice beginning and there is more and more to come in the future."

Simonetta Di Pippo,
Director UNOOSA

"With CMSA the Office [of Outer Space Affairs] will be creating an environment where the high scientific outcomes of those nine projects and others to come impact the international community. We will work together to create an even more accessible programme for developing countries, helping interested consortia in preparing solid projects through capacity building activities and more tri-partite exchanges."

And UNOOSA Director Simonetta Di Pippo concluded: "After the today's announcement, each team will be formally notified of the selection result. CMSA will invite the winners to negotiate bilateral agreements towards the smooth preparation and execution of their experiment on board the China Space Station.

Congratulations to those nine teams. We trust that they will take full advantage of this unique opportunity. We look forward to the successful results. … My sincere thanks to all involved actors, to CMSA and the government of China."

Director Simonetta Di Pippo was so kind to answer in detail our questions about the importance of the UNOOSA-CMSA project. Please, see the interview on the next page.

I. Fully accepted experiment projects

No. 1: POLAR-2: Gamma-Ray Burst Polarimetry on the China Space Station
Building on the previous investigation on China's TG-2 space lab, this project aims at answering the most important open questions in astrophysics regarding the nature of Gamma-Ray Bursts (GRBs) by using the most promising investigation approach of polarisation measurements allowing to observe even the weakest gamma-ray transients, such as those connected to gravitational waves.
It will be implemented by four institutions from four countries: The University of Geneva from Switzerland, the National Centre for Nuclear Research of Poland, the Max Plank Institute for Extra-terrestrial Physics of Germany, and the Institute of High Energy Physics of Chinese Academy of Sciences.

No. 2: Spectroscopic Investigations of Nebular Gas (SING)
This cooperation between the Indian Institute of Astrophysics, and the Institute of Astronomy of the Russian Academy of Sciences intend to attach an ultraviolet long-slit spectrograph onto the CSS for the observation of nebulae and galaxies.

No. 3: Behaviour of Partially Miscible Fluid in Microgravity
The Indian Institute of Technology and the Université Libre de Bruxelles in Belgium want to study the concentration diffusion phenomenon during local mixing of unmixed liquid caused by temperature change under microgravity.

No. 4: Flame Instabilities Affected by Vortices and Acoustic Waves (FIAVAW)
The Tsinghua University from China and the University of Tokyo from Japan propose to investigate the instabilities of flame edges to get an insight into the fundamental problems of flame stabilisation in microgravity condition.

No. 5: Tumours in Space: Signatures of early mutational events due to space-flight conditions on 3D organoid cultures derived from intra-individual healthy and tumour tissue
This research is a joint effort by four institutions from four countries: the Norwegian University of Science and Technology, International Space University in France, Vrije Universiteit Amsterdam in the Netherlands, and the Belgium Nuclear Research Centre. The science team will look at the effects of microgravity and galactic cosmic radiation (GCR) on mutational signature in the DNA of 3D human organoids derived from intra-individual healthy and colorectal cancer tissue.

No. 6: Effect of Microgravity on the Growth and Biofilm Production of Disease-Causing Bacteria
This project by the Mars Society - Peru Chapter, and the Mars Society - Spain Chapter is looking at the differences between the growth and biofilm production of bacterial colonies grown on Earth and those on board the CSS.

II. Conditionally accepted experiment projects

No. 7: Mid infra-red platform for Earth observations
The National Institute of Astrophysics Optics and Electronics (INAOE) and the Benemérita Universidad Autónoma de Puebla (BUAP) from Mexico would like to install two infra-red (MIR) cameras on the outside of the CSS for the observation of the land and the atmosphere to contribute to hurricane forecasting.

No. 8: Development of Multi-Juction GaAs Solar Cells for Space Applications
A team from the National Center for Nanotechnology and Advanced Materials and the King Abdulaziz City for Science and Technology (KACST) from Saudi Arabia want to expose solar cells on the outside of the CSS to gain data for the improved design and manufacturing of high-efficiency solar cells.

No. 9: BARIDI SANA - High Performance Micro 2-Phase Cooling System for Space Applications
This cooperation between the Sapienza University of Rome in Italy, In Quattro s.r.l. in Italy, and the Machakos University in Kenya intends to investigate the use of an organic and non-toxic cooling agent for the next generation of cooling systems for space applications.

UNOOSA - Gateway to Space

Interview with Ms Simonetta Di Pippo, Director of the United Nations Office for Outer Space Affairs, on the occasion of the United Nations/China Cooperation on the Utilisation of the China Space Station - Announcement of the Selected Experiment Projects to be executed on board the CSS for the 1st Cycle

GoTaikonauts!: Are you satisfied with the results of the selection?

Simonetta Di Pippo: I am very satisfied with the results. The nine selected projects, all collaborative international efforts, involve 23 institutions from 17 UN Member States in the Asia-Pacific region, Europe, Africa, North America and South America. The number and diversity of organisations involved is unprecedented, with proposals coming from governmental organisations, private entities and international associations. Through this initiative, cooperation between nations is being enhanced, links between the private and public sector are being established, and capacity is being developed to leverage space technologies worldwide.

The research areas of the experiments involve space life science, biotechnology, fluid physics, microgravity combustion, astronomy and space technologies. The projects are very innovative and likely to lead in advancing science.

This project highlights the role of UNOOSA as the gateway to space in the UN system and as a capacity-builder. UNOOSA is grateful to CMSA for offering such a possibility to such a diverse group of stakeholders worldwide.

GoTaikonauts!: Which were the objectives UNOOSA attached to this special selection of experiments for the Chinese Space Station? Were these objectives achieved?

Simonetta Di Pippo: For UNOOSA, a key goal of selecting the experiments, and of the initiative with the China Space Station (CSS) in general, is facilitating access to space technologies, in particular for non-spacefaring UN Member States, to enhance their ability to achieve the Sustainable Development Goals (SDGs). A study by UNOOSA and the European Global Navigation Satellite Systems Agency (GSA) found that space-derived technologies have a direct impact on almost 40% of the 169 SDG targets. This percentage does not take into account telecommunications, the inclusion of which would make this percentage much higher.

Despite this huge potential, billions of people all over the world still lack access to even the basic benefits of space technologies. To bridge the gap in capabilities between spacefaring and non-spacefaring nations, UNOOSA launched the 'Access to Space for All' initiative, that enables capacity-building by connecting established and emerging space actors. The initiative offers a wide range of opportunities in microgravity research, satellite development and deployment, in-orbit research and access to laboratories in Low Earth Orbit. This opportunity with the CSS is an exciting addition to the initiative's portfolio.

Partnering with China to open the CSS to all UN Member States is a great example of triangular cooperation to unlock access to the benefits of space for a growing number of countries and their people. The selection of the experiments is a milestone achievement in the development of multilateral cooperation in space research, and in the Office's work of supporting all nations in using space technologies for the SDGs.

GoTaikonauts!: Are you thinking about another Announcement of Opportunity for the Chinese Space Station?

Simonetta Di Pippo: For the time being, it is important that we focus our attention on the successful realisation of the current cycle and project. As a next step, UNOOSA will work closely with

the China Manned Space Agency (CMSA) to explore possibilities for a second call for space experiments on board the CSS.

In general, this first round of the United Nations/China Cooperation on the Utilization of the China Space Station is one element of the Access to Space for All initiative, and our collaboration with CMSA goes beyond this unique programme. With CMSA, the Office will be creating an environment where the high scientific outcomes of those 9 projects, and others to come, impact the international community. We will work together to create an even more accessible programme for developing countries, helping interested consortia in preparing solid project proposals through capacity building activities and more tri-partite exchanges. With this programme and others of the Office, we aim to offer a range of space-based solutions and opportunities that will foster space science in developing countries, from making space science studies attractive to youth to more solid institutions.

GoTaikonauts!: CMSA stated that the March 2016 framework agreement with UNOOSA also includes the opportunity for astronaut training. In this respect, are there any activities ongoing?

Simonetta Di Pippo: Developing an international astronaut programme is another promising area for further exploration under the UN/China Agreement, which includes the objective of promoting international cooperation in human space flight and activities related to space exploration. For the astronaut programme, we need to start with a feasibility study and I anticipate this will require hard and dedicated work by all involved parties before it can be successfully finalised.

GoTaikonauts!: On the side-lines of the 68th IAC, that took place in Adelaide, Australia, you told Xinhua news agency: "We are trying to negotiate in a bilateral way between UNOOSA and Chinese government how we can be part of the Belt and Road Initiative, an important initiative that China is putting forward. Clearly, we are focusing on the space segment, space aspect, space elements of the Belt and Road Initiative." Can you say already something about how this project is evolving?

Simonetta Di Pippo: The Belt and Road Initiative is undoubtedly an important project that China is developing. UNOOSA is currently in discussion with our counterparts in China, specifically CNSA, to determine cooperation areas and plan dedicated capacity building projects along the CNSA Space Information Corridor that will benefit countries along the Belt and Road.

GoTaikonauts!: During your time as Director of UNOOSA, you initiated many new programmes enhancing enormously UNOOSA's portfolio. What is your strategy behind this built-up of capabilities?

Simonetta Di Pippo: The space sector is growing exponentially, with the number of launches increasing fast all over the world, new countries participating in space exploration and private companies entering the sector. In this context of increasing activity, demand for the work of UNOOSA is also growing fast, and we need to consolidate our set up to accommodate this rising interest.

Our portfolio showcases the many different areas of work encompassed by UNOOSA, from space law and global navigation satellite systems to capacity building in fields such as leveraging space science and technology for disaster risk reduction and developing capabilities for space missions.

The Office's new Access to Space for All Initiative, with its portfolio of concrete opportunities for Member States, is at the forefront of our efforts to bridge the space divide among nations. Besides the cooperation with China on the CSS, several innovative projects have been developed under this portfolio, including KiboCUBE, a collaboration with the Japanese Space Exploration Agency that provides opportunities for institutions from developing countries to deploy a satellite into space from the Japanese Experiment Module of the International Space Station. The first round of KiboCUBE enabled a team from the University of Nairobi in Kenya to develop a 1U cube satellite that was successfully deployed from the ISS on 11 May 2018. This was Kenya's first satellite, and the first space hardware deployed under the auspices of the United Nations.

One other example of our expanding portfolio is our Space4Women project, through which we are working to increase the participation of women and girls into space activities and STEM fields. Space4Women is building a platform for women in STEM to connect and interact and for young women entering these sectors to be mentored by role models.

Our increasingly extensive range of programs means that we are better able to achieve our goal of facilitating access to the benefits of space and space-derived technologies for all of humanity.

GoTaikonauts!: Would you like to add something from your perspective what we could convey to our readers?

Simonetta Di Pippo: An important aspect of the Office's mandate is serving as the secretariat of the United Nations Committee on the Peaceful Use of Outer Space (COPUOS). Since its establishment in 1959, COPUOS has been the platform for Member States to develop and maintain the normative framework that governs outer space activities. I would like to highlight the fast growth experienced by the Committee in recent years, both in membership and in the range of topics it covers, which is a testimony to the increasing interest placed by countries on outer space activities and to the value they assign to international cooperation in this field. COPUOS membership has grown from 76 Member States in 2014 to 92 today, with 3 more countries which applied this year, from all levels of economic development and space capabilities. The range of topics discussed at the Committee meeting has progressively expanded and at the same time, UN Member States see in the Office for Outer Space Affairs a source of knowledge for improving their abilities and being more involved at global level in the field.

UNOOSA aims to use its position at the centre of global developments to facilitate progress and international cooperation on all of these issues.

Existing cooperation between China and UNOOSA

1980 - China becomes a Member of COPUOS - the United Nation Committee on the Peaceful Uses of Outer Space

2010 - UN-Spider Beijing Office established

2014 - Regional Centre for Space Science and Technology Education in Asia and the Pacific opens at Beihang University

2015 - MoU between CNSA and UNOOSA on Earth Observation Data and Technical Support