All About The Chinese Space Programme

Go TAIKONAUTS!

龙腾太空

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Qian Xuesen Library and Museum in Shanghai. credit: GoTaikonauts!

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expected publishing date: March/April 2018

Chinese Space Quarterly Report
April - June 2017
by Jacqueline Myrrhe

SPACE TRANSPORTATION

TIANZHOU 1

On 20 April, at 19:41 Beijing Time (BJT), (11:41 UTC) the Long March 7 Y2 (CZ-7 Y2) rocket launched from the Wenchang Space Launch Centre (WSLC) on Hainan Island with China's first cargo spacecraft, Tianzhou 1. The freighter is 10.6 m long and has a maximum diameter of 3.35 m. Its maximum take-off weight is 13.5 t, with a payload capacity of 6.5 t (including 2 t fuel). Tianzhou (TZ) has a 0.48 ratio of cargo capacity to the total weight of the spacecraft. Chinese space craft designers used new alloys and carbon fibres to achieve the low structural weight. Reliable cargo transportation is essential for the future Chinese Space Station (CSS).

TZ-1 mission profiles included a triple docking with the orbiting Tiangong 2 (TG-2) space lab (length: 10.4 m, max. diameter: 3.35 m, weight: 8.6 t), a triple re-fuelling, conducting 10 experimental (mostly remotely operated) projects and a controlled re-entry.

TZ-1 began to approach TG-2 automatically on 22 April at 10:02 BJT and had first contact with the space lab at 12:16 BJT. The 1st automated docking was successfully completed at 12:23 BJT at an altitude of 393 km above the Earth, that corresponds to the orbital altitude of the future CSS. After the 1st docking, aerospace engineers tested the control ability of the cargo spacecraft for the two spacecraft. Docking was followed by a two-month-long joint flight, the longest tandem flight so far achieved by China.

The main task of TZ-1 is the test of the propellant re-fuelling technology. On 27 April, at 19:07 BJT (11:07 UTC), the 1st 5-day-long re-fuelling procedure was successfully concluded. China became capable of in-orbit re-fuelling, after Russia, Europe and the U.S. have demonstrated this technology before. Each re-fuelling procedure took 29 steps divided in five stages and lasted several days each time. The 1st one took five days.

The 2nd in-orbit re-fuelling was accomplished within 2 days on 15 June at 18:28 BJT.

TZ-1 separated from TG-2 on 19 June in the morning and remained 5 km behind the space lab for 90 minutes. Then, mission control sent the command to TZ-1 to fly around the space lab from behind and position itself at 5 km in front of TG-2. During that manoeuvre, both space craft turned in semicircles. The aim of the 2nd docking was to test the docking procedure from a different direction. It was completed on 19 June at 14:55 BJT.

The photo taken on 17 April 2017 shows the rocket fairing of the Long March-7 Y2, housing the Tianzhou 1 cargo spacecraft.
credit: Xinhua/Ju Zhenhua/www.news.cn

Current International Cargo Capabilities
Progress: 2.23 t – re-fuelling capability
ATV: 7.67 t – re-fuelling capability
HTV: 6 t (1.5 of which is unpressurised)
Dragon: 3.31 t
Cygnus: 2-3.5 t

On 21 June, in the morning, TZ-1 cargo spacecraft undocked from the TG-2 space laboratory again and begun a 3-month independent flight. The undocking sequence started at 9:17 BJT and took about 30 minutes. TZ-1 operated in an orbit of around 390 km.

After ground control sent the commands for TZ-1 3rd rendezvous and docking at 17:24 BJT, the manoeuvre was accomplished with a fast-docking procedure within 6.5 hours, late on 12 September at 23:58 BJT.

The 3rd re-fuelling was completed on 16 September.

TZ-1 started separation procedures from TG-2 on 17 September at 15:29 BJT and finalised the manoeuvre at 16:15 BJT.

After 5 months in orbit, the Tianzhou 1 de-orbit started on 22 September by firing the cargo craft's thrusters twice to initiate the decay. The ground control team gave the command at around 18:00 BJT. TZ-1 re-entered and burned up in Earth's atmosphere. The remaining pieces fell into a designated sea area over the South Pacific.

Long March-7 Y2 carrier rocket, with Tianzhou 1 on top, takes off from Wenchang Space Launch Center, watched by thousands of spectators.
credit: Xinhua/Ju Zhenhua/www.news.cn

Long March 5 - CZ-5

After its transport from the factory to the harbour in Tianjin, the second Long March 5 (CZ-5 Y2) carrier rocket (payload capacity for LEO: 25 t; for GEO: 14 t) left on 24 April (China's National Space Day) by special rocket-carrying ships from the port of Tianjin for Wenchang at Hainan Island. The CZ-5 rocket arrived 6 days later, on 1 May. At WSLC it was assembled, tested and prepared for the launch

The Tianzhou 1 mission was used for a host of scientific and technological projects, such as:

TECHNOLOGY
- Release of Silu 1 (Sichouzhilu 1 - Silk Road 1) 3U cubesat on mission day 104. Silu 1's signals were received on the ground right after release.
- Testing of an advanced navigation, guidance and control device and new domestic-made components.
- In-orbit verification of the key technology for active vibration isolation for maglev.

SCIENCE
- Research on key technologies of the two-phase system experimental platform with the objectives to create a technical foundation for: solving the engineering difficulties of space-efficient heat transfer and research into evaporation and condensation under a microgravity environment.
- Verification of key technologies for non-Newtonian gravitational experiments, e.g. in-orbit tests of the performance of a high-precision electrostatic suspension accelerometer.
- Life science study "Effects of microgravity on cell proliferation and differentiation". The study comprises eight sub-projects which were all remotely controlled and operated for 30 days.

Below are details about four of the set of life science experiments:

CKIP-1 study

School of Chinese Medicine of Hong Kong Baptist University (HKBU).

Team lead: Prof Lyu Aiping and Prof Zhang Ge.

The study aims at the understanding of the bone loss mechanism in space, in particular the effect of the CKIP-1 gene on bone formation under microgravity. The CKIP-1 gene in osteoblasts (bone forming cells) could specifically interact with Smurf1 genes in the cells to inhibit cell activity, causing the slowing or hindering of bone formation during ageing and support the development of glucocorticoid-induced osteoporosis. The process is accompanied by the mass growth of osteoclasts (bone-resorbing cells), causing bone structure to change. Osteoblasts, in which CKIP-1 genes were silenced, were taken on board the TZ-1. The researchers were monitoring remotely the effects of CKIP-1 on osteoblasts.

Testing of medicine to treat bone loss

Center for Synthetic and Systems Biology at Tsinghua University.

Team lead: Chen Guoqiang.

The experiment investigates the effect of 3-hydroxybutyric acid (3HB) in preventing osteoporosis. For that, osteoblast cell samples treated and not treated with 3HB were compared. Pre-cursor experiments, simulating the micro-gravity environment, have been conducted on the ground. Scientists hung up mice by their hind legs to keep them restrained, and found that those given 3HB had normal bones, while those without 3HB suffered serious bone loss. The aim is to test the effect of the medicine in a real space micro-gravity environment.

Embryonic stem cells and embryoid bodies of mice

Institute of Zoology of the Chinese Academy of Science.

The aim of this research is to remotely observe the process of proliferation and differentiation of embryonic stem cells and embryoid bodies of mice in space. In parallel, experiments will be conducted on the ground to compare the results. In previous ground experiments simulating micro-gravity conditions, the differentiation ability of mouse embryonic stem cells was enhanced. The key gene, responsible for this change and the molecular signalling pathway could be identified. The research team conducted a series of space life science experiments on China's recoverable satellites SJ-8 and SJ-10 and hope to continue the study on the future Chinese Space Station. The ambition is to culture functional tissues, such as heart, kidney, liver and spleen tissues.

Induce the differentiation of human embryonic stem cells into germ cells

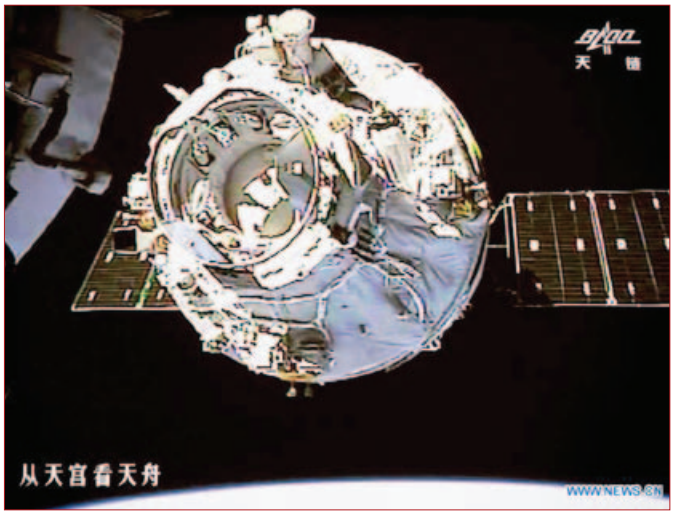
Medical Faculty of Tsinghua University.

Team lead: Prof Keh-Kooi Kee.

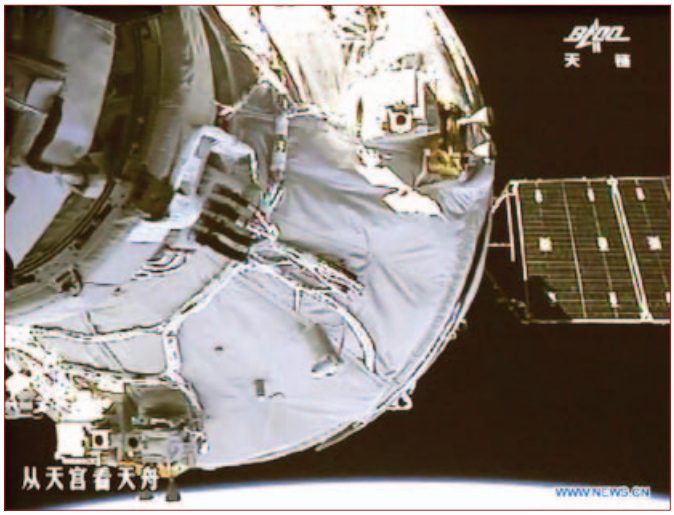
The experiment's objective is to induce the differentiation of human embryonic stem cells into germ cells within 30 days. During this process, the basic development and maturation of germ cells in the micro-gravity environment, and the developmental potential of human embryonic stem cells will be studied. To what extent the human embryonic stem cell can differentiate in space is still unknown.

Tianzhou launch sequence.
credit: Xinhua/Ma Yan/www.news.cn

The graphics shows the procedures of Tianzhou 1 automated docking with Tiangong 2 on 22 April 2017.
credit: Xinhua/Lu Zhe/www.news.cn



The photo taken on 22 April 2017 at the Beijing Aerospace Control Center shows the Tianzhou 1 cargo spacecraft moving towards the orbiting Tiangong 2 space lab for the automated docking. credit: Xinhua/Wang Sijiang/www.news.cn



On 22 April 2017 the Tianzhou 1 cargo spacecraft docks for the first time with the Tiangong 2 orbital module. The automatic docking was successfully completed at 12:23 BJT. credit: Xinhua/Wang Sijiang/www.news.cn

of the Shijian-18 communication satellite. On 26 June, the CZ-5 together with its integrated payload was transferred vertically from the assembly hall to the launch area at Wenchang Space Launch Centre. The same day, the State Administration of Science, Technology and Industry for National Defense (SASTIND), set the launch window for between 2-5 July.

Air Launch

The Airspace Industry Corporation of China (AICC) signed an agreement with the Ukrainian aeroplane manufacturer Antonov Airlines in May to use the world's biggest airplane, the AN-225 Mriya for air launch activities. AICC intends to modernise the AN-225 in order to carry heavier satellites on the back of the aeroplane and launch them from a height of 12 km to space. The first contacts with Antonov started already in 2011.

SATELLITES

China's Landsat network of remote sensing satellite ground-stations that cover all of China's territory and 70 percent of Asia passed its final acceptance test on 31 May. The network's data receiving centre is headquartered in Beijing and is connected to 3 ground stations to where the Landsats transmit their data: one in the Miyun district, a suburb of Beijing, one in Kashgar in Xinjiang Uygur Autonomous Region and one in Sanya in Hainan Province. The network will be used to support various remote-sensing systems, especially for the western part of the country and the South China Sea.

MANNED SPACE FLIGHT

ASTRONAUTS

At the beginning of June, Yang Liwei, China's first astronaut and Deputy Director of China Manned Space Agency (CMSA) announced for late 2017 a new taikonaut selection of 10 to 12 recruits - including two female candidates. The new phase of China's space exploration programme is calling for the next generation of astronauts. According to Yang Liwei, more consideration will be given to aerospace engineers and other experts from the civil sector. In the future, taikonauts will be selected every four years. Yang Liwei confirmed that preliminary studies for a manned lunar programme are ongoing and that it will not take long to get official approval and funding so that potentially, Chinese astronauts could land on the Moon by around 2030.

By the end of April, Wang Zhaoyao, Director of CMSA announced that China plans to conduct at least 4 manned space missions from 2019 to 2022 for the assembly of the 60 t Chinese Space Station (CSS). Chinese astronauts are currently training for the space station era with extended stay in space of 3 to 6 months or even longer. The flight of Tianzhou 1 was the last one before beginning the CSS assembly. The construction of the CSS requires about a dozen launch missions, starting with the placement of the core module in 2019, followed by Tianzhou 2 cargo freighter and two launches of two experiment modules.

TIANGONG 1

The Permanent Mission of China to the United Nations (UN) sent on 10 May 2017 a 'Notification by China on the future re-entry of Tiangong-1 (international designator 2011-053A)' to the Secretary General of the UN to announce the re-entry of Tiangong 1 for the time between October 2017 and April 2018. The note states that China keeps a close track of the decay and will, "fulfil its responsibilities in terms of monitoring and making information publicly available... China will also … make information on Tiangong-1's orbital status and other related information available in real-time through the website of the China Manned Space Agency" (http://en.cmse.gov.cn/col/col1763/index.html).

LUNAR AND DEEP-SPACE EXPLORATION

On 27 April, SASTIND, held a first expert committee meeting to discuss the next steps as well as the next lunar missions and their objectives within the national lunar exploration programme.

LUNAR HABITAT

A lunar habitat simulation study started on 10 May at the University for Aeronautics and Astronautics (BUAA) in Beijing. Eight Chinese volunteers, split into two groups, are the crews for the Yuegong 1, (Lunar Palace 1) long-term, self-contained space mission in a sealed, 160 m^2-sized lunar environment cabin with no interference from outside. The first crew of four, two men and two women, entered Yuegong 1 on 10 May to stay in the cabin for 60 days. They will be replaced by the second group, also two men and two women, who will stay there for 200 days. After that, the first group will return for the remaining 105 days. This second simulation involving the Bioregenerative Life Support System (BLSS), is code-named "Yuegong 365". A first successful 105-day trial was conducted in 2014.

CHANG'E 4

During the Global Space Exploration Conference GLEX2017 at the beginning of June in Beijing, it was revealed that a 3-kg mini-ecosystem will be send on-board the Chang'e 4 lunar mission to the surface of the far side of the Moon. The 18 cm-tall cylinder, will carry potato seeds and silkworm eggs to be incubated. The idea is that silkworms will hatch and create carbon dioxide, while the potato plants will generate oxygen. It is planned to livestream the growth of the plants and insects. The research team is led by the Chongqing University.

CHANG'E 5

During GLEX2017 at the beginning of June in Beijing, the landing site for the Chang'e 5 lunar sample return mission was revealed. Chang'e 5 is expected to land in the region of Mons Rümker, Liu Jizhong, Director of China Lunar Exploration and Space Engineering Center of the China National Space Administration (CNSA) told the audience. Mons Rümker is an isolated volcanic formation located in the northwest part of the Moon's near side.

ESA's Mission Operations Centre ESOC in Darmstadt, Germany confirmed at the end of May that it will provide LEOP (Launch and Early Orbit phase) and landing phase operations support for the Chang'e 5 lunar sample return mission in November, through its 15 m-antennas in Kourou (French Guyana) and on Maspalomas (Canary Island). China will also follow the mission phases with its own ground stations as back-up and will have ground support staff co-located at ESOC.

Future robotic lunar exploration

Future lunar missions are planned to focus on the South Pole region of the Moon in the search for water in permanently shadowed regions.

Manned Moon Mission

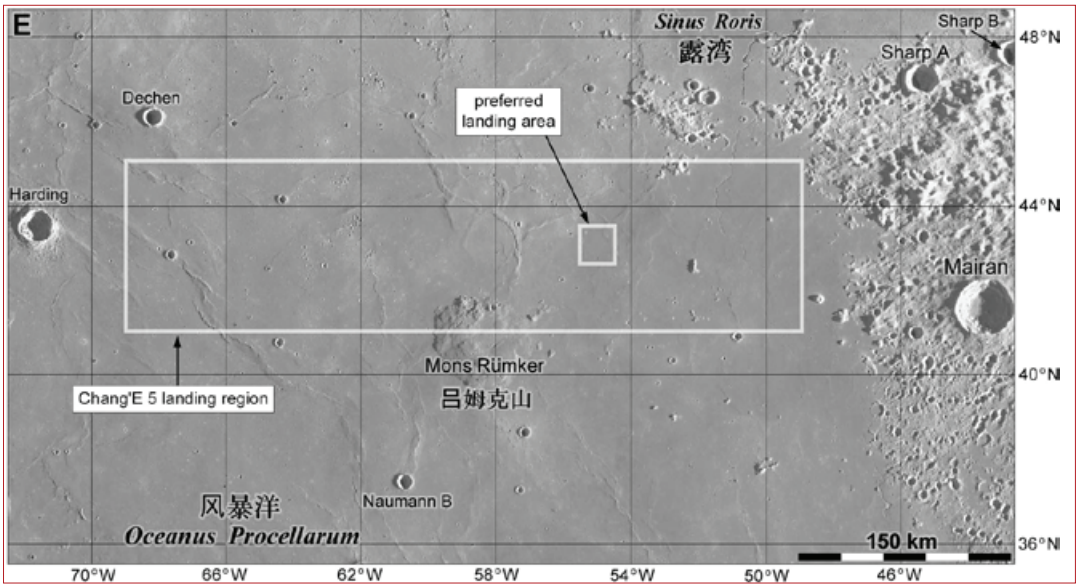
Wu Yansheng, General Manager of China Aerospace Science and Technology Corporation (CASC), disclosed at GLEX2017, that China is working on a manned lunar landing concept. A potential mission could consist of a manned spaceship, a propulsion vehicle and a lunar lander. The crewed vehicle and the lunar lander will be sent separately into circumlunar orbit.

COMMERCIAL SPACE

Venture firm Matrix Partners China has joined a 100 million RMB (14.5 million US$) A series-financing for Tianyi Space Research Institute (Spacety), based in Changsha, Hunan province. Existing investors Northern Light Venture Capital, and Cash Capital, a venture capital unit under state-owned Chinese Academy of Science Holdings, also participated in the round. Founded in 2016, Tianyi Space Research Institute is one of the first microsatellite start-ups established after the opening up of the commercial aerospace market to private enterprises. It is focussing on research and development of small-and-mini-sized commercial aerospace systems, and has provided flexible and efficient space experiment and technical identification services at affordable prices.

The four volunteers before entering the Lunar Palace 1 on 10 May 2017. credit: Xinhua/Ju Huanzong

View inside the Lunar Palace 1, located at Beijing University for Aeronautics and Astronautics (BUAA): credit: Xinhua/Ju Huanzong



Mons Rümker with the proposed landing area for Chang'e 5. credit: xingguo zeng, wei zuo, zhoubin zhang, yuxuan liu, chunlai li - National Astronomical Observatories of China / NASA / LROC-NAC / http://lroc.sese.asu.edu/images/gigapan

On 24 April 2017, China's 2nd National Space Day, construction work began on China's first commercial space industry centre in Wuhan, the capital of Hubei province. The Wuhan National Space Industry Base aims to attract at least 100 enterprises involved in the space industry before 2020 and generate 30 billion RMB (4.36 billion US$) in annual gross product by then. China Aerospace Science and Industry Corporation (CASIC) is the main investor. The centre will occupy an area of 68.8 km² in the Xinzhou district. Expace Technology, a subsidiary of CASIC that provides commercial launch services, will invest 1.7 billion RMB to build production and assembly plants for solid-fuel carrier rockets for commercial launches. The CASIC Second Academy will invest 300 million RMB to construct a research, development and manufacturing complex at the centre to make small satellites.

Mons Rümker is an irregular volcanic mountain of 70 km diameter in the north-western region of the Oceanus Procellarum at the Moon's near side. It's numerous volcanic domes reach up to 1.1 km in height. Oceanus Procellarum has been the landing region for the robotic missions Surveyor 1 and 3 as well as Luna 9 and 13 and for the manned Apollo 12 mission.
Until today, crucial knowledge about the formation of the Earth's celestial companion is missing. Samples taken by Chang'e 5 and returned to Earth could help to fill the knowledge gap. Material from the region of Oceanus Procellarum, a vast expanse of dark basalt, is supposed to be rich in eruptive magma, and therefore would be younger - less than three billion years - than the rocks returned by the Apollo astronauts, originating from rather geological similar regions of the same age. Chang'e 5 Moon samples could support the determination of the Moon's age, its early volcanism and could even help to better estimate the age of Earth-like planets such as Mercury, Venus and Mars.

CASC has teamed up with other government-owned companies for a 150 billion RMB (21.78 billion US$) fund to invest in new technologies. The innovation-focused fund will target an array of high-tech sectors, including aerospace, quantum communications, 3-D printing and robotics.

China Great Wall Industry Corporation (CGWIC), a subsidiary of China Aerospace Science and Technology Corporation (CASC), and Indonesia PT Palapa Satelit Nusa Sejahtera (PSNS) signed a contract for the Indonesia "PALAPA N1" communication satellite project on 17 May in Jakarta, Indonesia. CGWIC is responsible for in-orbit delivery of the PALAPA N1 satellite, which will be developed based on the DFH 4 bus and launched by a Long March 3B launch vehicle from the Xichang Satellite Launch Centre. CGWIC is providing a package solution with the products and services including the satellite, launch service, ground system, insurance and financing support. The PALAPA N1 satellite is developed by China Academy of Space Technology (CAST), a sub-ordinate to CASC. PALAPA N1 will provide broadcast and broadband services across Indonesia and will be finally positioned at 113°E to replace PALAPA D.

Tian Yulong, Secretary General of CNSA, said at GLEX2017 beginning of June in Beijing that in the last two years, more than 10 commercial companies have been engaged in microsatellite research and development and about 100 have worked on the development and use of LEO satellite data. For lunar and Mars exploration, a favourable environment for middle- and small-sized enterprises needs to be created so that enterprises can become the main force of technical innovation.

Beijing-based Commsat Technology Development Co Ltd. announced the installation of 60 satellites in six different orbits, about 600 km above the Earth from 2018 to 2020. The costs are estimated at 1.5 billion RMB (220 million US$). The constellation is designed to collect real-time data for industries including the heavy machinery and logistics sectors. Commsat confirmed that it has applied for communication licences at the Radio Communication Office within China's Ministry of Industry and Information Technology. It is also planning to build some of the satellite ground stations in countries and regions involved in the Belt and Road Initiative, and provide them services.

Commsat plans to deploy more than 800 such satellites. Already by the end of this year or early next year, Commsat intends to launch a low-orbit entertainment satellite, equipped with a special high-tech camera, to transmit pictures to Earth. Customers will be able to download an app, allowing them to combine selfies taken with their mobile phones with real-time space pictures taken by the satellite camera, creating a so-called 'space selfie' collage.

First Chinese experiment on ISS

A SpaceX' Falcon 9 launched on 3 June from the Kennedy Space Center in Florida and berthed to the ISS on 5 June, that delivered a 3.5 kg Chinese life science experiment by the School of Life Science of the Beijing Institute of Technology (BIT) to the Station. The experiment investigates how the DNA code for the human immune system is affected by a prolonged stay in the space environment, marked by higher radiation. The transport was arranged and managed by the Houston-based private company NanoRacks, which also provides its on-board hardware for the installation of the experiment to the power supply of the U.S.-American segment of the ISS where U.S. astronauts are taking care of the experiment twice a week for 20 days. The agreement between NanoRacks and BIT was signed in 2015.

TOURISM

A Space Dive project, operated by Space Exploration Inc. and the Space Dive Organising Committee, was launched recently in Beijing as China's first near-space programme. The project aims at near-space tourism/aviation sports but also at collecting data and dust samples in near-space to facilitate the research and development of China's aerospace industry. Potential customers can rise to the Earth's stratosphere in a helium balloon and return on a parachute.

SCIENCE

During an asteroid exploration forum in Beijing on 8 May, Ye Peijian, a leading specialist in deep-space exploration at the China Academy of Space Technology (CAST), said that China will study ways to send robots or astronauts to mine suitable asteroids and transport the resources back to Earth. In the long term, resources from asteroids could be used to build facilities in space or to provide materials to support interstellar travel, he said. Also, asteroids can be used as bases for interstellar exploration. For an asteroid expedition, large-thrust electric propulsion systems, long-endurance power technologies, a satellite-based navigation system and sampling devices would be needed. China plans to conduct at least one asteroid exploration mission between 2020 and 2025.

A fund of 160 million RMB (23.3 million U.S.$) was set up jointly by the National Natural Science Foundation of China and the Chinese Academy of Sciences on 23 May to support the further development of 4 recently launched space science satellites, as

well as advanced scientific research. With each side sponsoring half of the investment, the fund will last from 2017 to 2020. The 4 satellites are the Dark Matter Particle Explorer Satellite DAMPE-Wukong, the retrievable scientific research satellite SJ-10, the quantum communication satellite QUESS-Micius and the Hard X-ray Modulation Telescope HXMT satellite.

Chinese scientists reported on 15 June a successful transmission of “entangled” photon pairs from the Quantum Experiments at Space Scale (QUESS)-Micius satellite in a 500-km orbit to two ground stations on Earth over 1,200 km apart,

This satellite-based technology opens up prospects for practical secure quantum communications and fundamental quantum optics experiments at distances previously inaccessible on the ground.

SASTIND confirmed on 16 June, that China will launch 4 space probes before 2021. Those are:

- The China-Italy Electromagnetic Monitoring Experiment Satellite for the investigation of phenomena related to earthquakes from space - expected for launch in August 2017.
- The China-France Oceanography Satellite (CFOSat) for studying ocean-surface wind and waves is planned for launch in 2018.
- The first Mars probe including an orbiter, lander and rover in one mission - foreseen for 2020.
- The SVOM (Space-based multi-band astronomical Variable Objects Monitor), an astronomical satellite to study gamma rays and provide data for research in dark energy and the evolution of the universe, jointly developed by China and France, is projected for 2021.

TIANGONG 2

28 seeds out of 150 from an over 5,000-year-old cypress in Huangling County, China’s northwest Shaanxi Province have germinated by the end of May, after being taken into space by Chinese astronauts on the SZ-11 mission and kept at the TG-2 lab from 15 September to 18 November 2016. The sprouting project began on 15 May, and another 150 seeds that had not gone into space were germinated at the same time in a comparative study.

FAST

On 24 May, the China National Astronomical Observatories under the Chinese Academy of Sciences, signed an agreement with the government of Gui’an New District in southwest China’s Guizhou Province to build a data processing centre for the Five-Hundred Metre Aperture Spherical Radio Telescope (FAST). The FAST Data Center would have 100 Petabytes of data storage and a computing power of 1,000 TFLOPS. It is estimated to cost 160 million RMB (23 million U.S.$) and to cover an area of 4 hectares near the FAST telescope.

ADVANCED TECHNOLOGY

China achieved progress in its decade-long research and development of re-usable horizontal take-off and landing spacecraft, and has completed tests of key components, including engines, Liu Shiquan, Deputy General Manager of CASIC, said at GLEX 2017 beginning of June in Beijing. Researchers at the China Academy of Launch Vehicle Technology (CALT) are looking in the development of a combined-cycle aerospace vehicle that would make use of a combination of conventional turbine engines, ramjet and rocket engines. Such an aeroplane-space vehicle would take-off from an airport runway by firing the conventional aircraft turbine engines before switching to ramjet propulsion in the higher atmosphere until reaching near-space where rocket engines take over. Reusable lift-body launchers will be developed in three stages - rocket-engine partial reusable vehicle, rocket-engine full reusable vehicle and combined cycle-engine reusable vehicle.

In contrast to existing concepts, the new Chinese spaceplane would be operating as a true runway-to-space-to-runway vehicle. The aim of the development is to transport people or cargo into orbit and to have a launch vehicle which is easy to maintain, can fly at lower cost and with a higher frequency. A first test flight is planned for 2019/2020.

For the time period around 2030, a single-stage-to-orbit version with a one-day turnaround on the ground is envisioned.

INTERNATIONAL COOPERATION

APSCO

From 8-13 April 2017, an APSCO delegation (Asia-Pacific Space Cooperation Organisation) with experts from the China Academy of Science (CAS) visited Iran for a Hosting Site Survey at the proposed Iranian site for the Small Multi-Mission Satellite (SMMS) Project. China, Thailand, and Iran are working on a joint SMMS, devoted to civilian remote-sensing and communications experiments.

On 21 April, Dr. Li Xinjun, the Secretary-General of APSCO, Mr. Xu Yansong, Division Director for International Affairs of CNSA and Ms. Charis, Project Manager of Education and Training and Database Management Department of APSCO visited the National Satellite Meteorological Center (NSMC) of China Meteorology Administration.

APSCO and NSMC discussed the possibility to build a cloud-based meteorological satellite data sharing framework under the guidance of CNSA. The data sharing platform could support the internationalisation of FY-3 and FY-4 meteorological satellites on the above-mentioned platform. China could also support the software development for the APSCO Member States in order to directly receive the data.

On 10 May, the Secretary-General of APSCO, Dr. Li Xinjun, and Vice-President of the Northwestern Polytechnical University (NPU) Xi’an, Dr. Zhang Weihong, signed an Agreement for Cooperation on Degree Education Programmes at APSCO’s Headquarters in Beijing. Both sides welcomed the prospects of long-term cooperation especially in Degree Education Programmes for space technology and the prospects of cooperation on research and development in space technology and applications. They agreed to take up the discussion on the development of Space Curricula for APSCO Member States.

On 18 May, Dr. Li Xinjun, Secretary-General of APSCO and Prof. Lin Zhongqin, President of Shanghai Jiao Tong University (SJTU) signed a contract on the cooperation for the APSCO Student Small Satellite (SSS) Project (SSS-2A CubeSat). The signature ceremony was held at APSCO’s Headquarters in Beijing.

The 3-year APSCO SSS project aims at training students and faculties from APSCO Member States in the full-circle of satellite engineering through hands-on practical training from satellite design up to the flight model construction. SJTU’s

expertise will help in the development of space education systems in the participating countries as well as to enhance the capacity building of universities in space technology development for senior undergraduates and above levels in both aspects of knowledge and engineering practices. Already in January, APSCO signed a cooperation agreement with Beihang University Beijing.

BEIDOU

The 8th China Satellite Navigation Conference (CSNC2017) took place from 23-25 May 2017 at the National Shanghai Center for Exhibition and Convention in Shanghai, China.

The first forum on BeiDou cooperation between China and Arab countries was held on 24 May in Shanghai. The forum included training sessions and an exhibition of the uses of the BeiDou Navigation Satellite System (BDS). It will become a long-term mechanism for satellite navigation cooperation. The same day, a declaration on BeiDou cooperation between China and Arab countries was signed, helping Arab countries benefit from China's BDS by providing policy support for satellite navigation cooperation on both sides.

BRICS

Russia's Deputy Prime Minister Dmitry Rogozin has instructed Roscosmos to look into the possibility of operating the International Space Station (ISS) in cooperation with partners in the BRICS group (Brazil, Russia, India, China and South Africa). Russia wants to be prepared for the time when the current ISS agreements run out.

ESA

Tian Yulong, Secretary General of CNSA, said during the 33rd Space Symposium in Colorado Springs, U.S., at the beginning of April, that China and ESA are discussing potential collaboration on a human outpost on the Moon and other possible joint endeavours. An ESA spokesperson confirmed that ESA hopes to get the possibility for analysis of lunar samples brought back by Chang'e 5, and also have a European astronaut flying to the Chinese Space Station in the future.

European Commission

One of the 8 QB50 satellites, launched by India's Polar Satellite Launch Vehicle (PSLV) C38 on 23 June, belonged to China's National University of Defence Technology. The NUDTSat carried an Ion/Neutral Mass Spectrometer. The QB50 project is funded by the European Commission and managed by the von Kármán Institute in Brussels, Belgium. (also see section: LAUNCHES)

FRANCE

During GLEX2017, the Head of French Space Agency CNES, Jean-Yves LeGall met Tang Dengjie and Wu Yanhua, the Administrator and Vice-Administrator of CNSA, as well as Xiangli Bin, Vice-President of CAS, to review progress on the two French-Chinese satellite programmes, the CFOSat (China-French Oceanography Satellite), planned for launch in 2018, and SVOM (Space-based multi-band astronomical Variable Objects Monitor), to be orbited in 2021.

GERMANY

During GLEX2017, representatives of the China Manned Space Agency CMSA and the German Aerospace Centre DLR discussed cooperation within the framework of the Chinese Space Station CSS but also exchanged information on China's lunar and Martian missions. Further talks were held with the National Space Science Center and the German Embassy in Beijing.

INDIA

Sun Weigang, Chief Engineer of CASC said during GLEX2017 in Beijing that China is willing to cooperate with India in space programmes but the governments have to decide the extent of collaboration. He added that directors of space agencies from both sides have met and discussed cooperation, stressing that there are many potential areas for that. India did not participate in GLEX2017. However, India and China cooperate within the BRICS satellite programme.

BELT and ROAD

China Telecom Global is determined to expand its data centre business across the Belt and Road region. It signed an agreement with UK data centre owner Global Switch and Chinese data centre operator Daily Tech. The three companies plan to jointly expand into new markets by offering data centre, network and systems integrations services to provide to international customers access to a global network, cloud computing service solutions and a series of value-added services.

On 23 April, an Aerospace Innovation Alliance was established in Xi'an, capital of northwest China's Shaanxi Province to promote innovation and cooperation on space exploration under the Belt and Road Initiative.

The coalition consists of 48 national and international universities, research institutes and academic organisations, focusing on exchanges for space innovation and joint training of expert professionals.

The Chinese Society of Astronautics and Xi'an-based Northwestern Polytechnical University initiated the project.

RUSSIA

During the 33rd Space Symposium at the beginning of April in Colorado Springs, U.S., Tian Yulong, Secretary General of CNSA told media that China and Russia have established a joint committee under each Prime Minister's responsibility. Future cooperation will be focusing on space debris observations and management, launch vehicle, joint development and exploration projects. Both countries are already closely engaged in the areas of remote sensing and satellite cooperation and are working on the BRICS satellite constellation for Earth remote sensing.

During GLEX2017, Xu Yansong, the Head of the Department for International Cooperation of CNSA said that China and Russia are discussing options for cooperation in each other's lunar exploration programmes which could be at the system level or the overall stage. It was also said that cooperation on Russia's lunar missions Luna-Resurs (Luna 26/27) and Luna-Grunt (Luna-29) actually exist. The lunar orbiter Luna 26 is planned for launch in 2020, the lander Luna 27 for 2024 and the lunar sample return mission Luna 29 for 2024.

China has invited the Russian Space Agency Roscosmos to take part in a project for the construction of the planned CSS, revealed the Head of the Roscosmos State Corporation for Space Activities Igor Komarov at the Le Bourget Airshow 2017 in France. Komarov added that nothing concrete has yet emerged.

U.S.

U.S. Strategic Command Commander Gen. John Hyten said at the 33rd Space Symposium in Colorado Springs, U.S. that he would like to have an agreement with Russia and China to share space situational awareness data.

UNOOSA Director Simonetta Di Pippo said in her speech on 24 April at the Northwestern Polytechnical University in Xi'an:

"China has been an active member of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) since joining in 1980, and has hosted since 2010 a UNOOSA office for the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). And, in 2014, the Regional Centre for Space Science and Technology Education in Asia and the Pacific was inaugurated at the Beihang University in Beijing.

In 2015 UNOOSA and the China National Space Administration signed an Agreement through which Chinese satellite Earth Observation data will be available to support the United Nations in the areas of disaster management and disaster risk reduction.

In addition, just last year we signed an agreement with the China Manned Space Agency to provide opportunities to United Nations Member States, particularly developing countries, to conduct space experiments on-board China's space station, as well as to potentially provide flight opportunities for astronauts and payload engineers. China also makes contributions in the area of space law, and the Office and China have just this week announced our strong commitment to ongoing cooperation. And China contributes to the activities of UNOOSA with other ways and means.

These examples demonstrate how wide-ranging and holistic China's contributions are to the work of UNOOSA and our goal of bringing the benefits of space to humankind. Please let me take this opportunity, on this important day of celebration, to express my deep appreciation for China's support of the Office."

UNITED NATIONS

Upon invitation of the Government of China, the UN Office for Outer Space Affairs (UNOOSA) Director Simonetta Di Pippo, visited China on the occasion of the launch of Tianzhou 1. UNOOSA and China reiterated their shared commitment to the peaceful exploration and use of outer space, as well as underlining the significant contributions that space activities can make to sustainable development. Joint activities are in the area of Earth Observation Data and technical support, access to China's future space station, and support to the UN Platform for Space-based Information for Disaster Management and Emergency Response. Ms Di Pippo conducted bilateral meetings with CNSA and CMSA to discuss a number of ongoing and planned joint activities and projects. Ms. Di Pippo also visited other space facilities and institutions in Beijing and participated in activities to celebrate the National Space Day of China at the Northwestern Polytechnical University in Xi'an. In her speech, Simonetta Di Pippo underlined that in the years since becoming a space faring nation in 1970, China has contributed substantially to international cooperation in the peaceful exploration and use of outer space, also providing essential support to the work of UNOOSA. The Director emphasised that currently, China is, the first contributor, counting both cash and in-kind contributions, to the activities of the UN Office.

EDUCATION

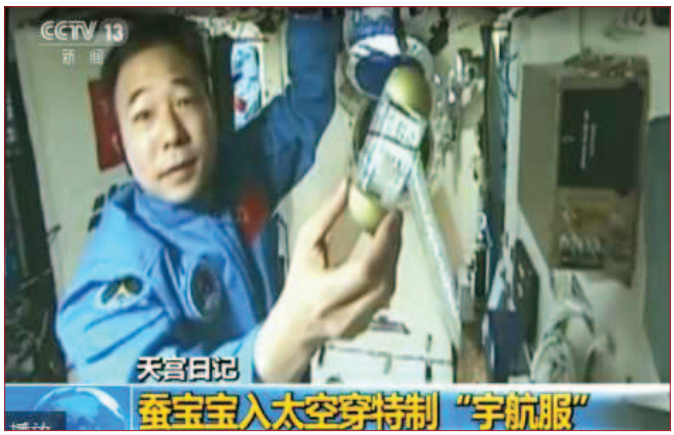
Taikonauts Yang Liwei, as well as Shenzhou 11 crew members Jing Haipeng and Chen Dong, visited the Christian and Missionary Alliance Sun Kei Secondary School in Hong Kong on the occasion of the 20th anniversary of the city's handover to China on 14 April. Students from this school proposed the silkworm experiment for Shenzhou 11 last October. The taikonauts told the students, that the experiment was successful, with 5 of the 6 silkworms having their cocoons spun, with the initial conclusion being that the silk spun in space was stronger than that on Earth. The silk worms were conserved in the fridge on board Tiangong 2 before they would turn into moths. The worms remained dormant until follow-up experiments would be done after return to Earth.

The 3 taikonauts had a few more meetings with school students in Hong Kong. They encouraged the students to discover the universe as 'proud Chinese'. Yang Liwei told them, the recruitment of astronauts from Hong Kong, Macau and Taiwan was being considered.

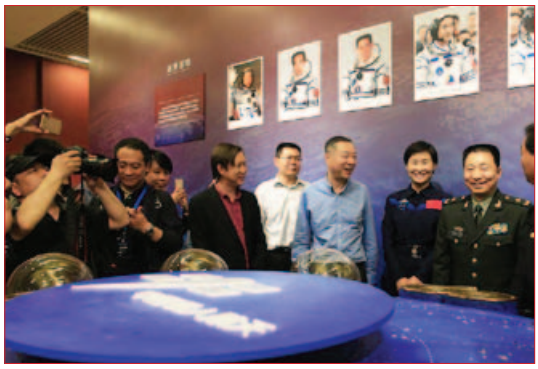
Another activity on the occasion of the 20th anniversary of the city's handover to China was a government competition, themed: "When I'm 20". Children were asked to design a poster to share their thoughts of what life will be like when they enter their 20s. Space topics and travelling into space has been an often-reflected feature in the kid's art works.

China National SPACE DAY on 24 April

China's 2nd National Space Day focused on how space technology can further economic and social development on Earth. Astronauts and scientists from China held talks and exhibitions opened to showcase advances in space exploration. The major event town this year was Xi'an, capital of northwest China's Shaanxi Province and home to more than 200 aerospace research centres and enterprises.

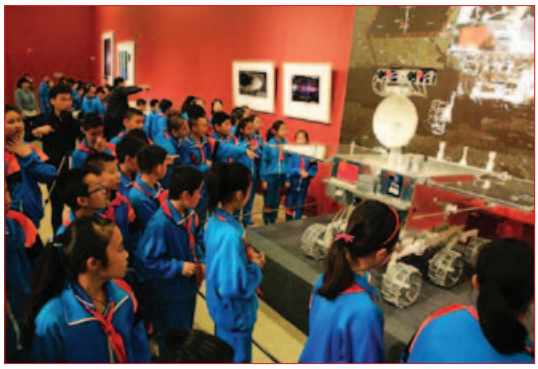


The six silkworms brought into space for experiments on China's Tiangong-2 space lab have begun spinning cocoons. Selected from 4,000 silkworms, the six chosen candidates entered space on 17 October via the Shenzhou 11 spacecraft. credit: CNSA, People's Daily



Chinese astronauts Yang Liwei (right) and Liu Yang (second from right) at the opening of the exhibition in Beijing. credit: China Daily

A survival kit that China's first astronaut Yang Liwei used during his mission. credit: China Daily



Chinese school children visit the space exhibition in the National Museum of China in Beijing. credit: China Daily

Xi'an - Northwestern Polytechnical University (NPU) opened an exhibition displaying the achievements of China's lunar probe, and the BeiDou navigation satellite system. In an effort to promote international space cooperation, the Aerospace Innovation Alliance was founded in Xi'an.

Macao - In the Macao Science Center of the special administrative region, an event for the popularisation of space science among young students was organised. Shenzhou 10 astronaut Wang Yaping, shared her experience of becoming and being an astronaut with 400 middle school students.

Beijing - In the Chinese capital, the one-month long Aerospace Objects Exhibition at the National Museum of China in Beijing was opened. The exhibition shows 63 objects from the collection of the National Museum of China and 10 objects on loan from CMSA. Among the exhibits is an installation which bears the palm prints of China's 11 astronauts who have gone into space to date. (see QR 1-2017 – New Years Gala)
A course about basic knowledge of rockets was offered to all the first graders at Beijing Xicheng Foreign Languages School. The students learned about the origins, structure and flight theory of rockets, the history of China's space industry, and the launching process of the Long March 7 carrier rocket, which lifted TZ-1. In a practical exercise, the students assembled a rocket model which was launched from the school campus.

China Global Television Network (CGTN) introduced a dedicated website to Chinese space activities, called "Destination Space". This multi-media platform provides in an attractive format the latest stories on space in China.

MISCELLANEOUS

In preparation of China's first cargo mission with the TZ-1 cargo space craft, the new generation spacecraft tracking ship Yuanwang 7 started its maritime space monitoring and communication mission on the morning of 10 April, arriving at its position in the Pacific Ocean on 13 April.

Space tracking ship Yuanwang 3 embarked on a 27-day maritime calibration mission beginning of June and returned to its home port in east China's Jiangsu Province on 29 June. The ship is assigned for 6 more maritime space monitoring missions in the second half of 2017, including the launch of the Chang'e 5 lunar probe and BeiDou 3 satellite.

China Aerospace Science and Technology Corporation (CASC), China's main contractor for spacecraft, launcher, missiles and space hardware, exhibited during the 52nd International Paris Air and Space Show.

China's President Xi Jinping has sent a letter of congratulations to the Global Space Exploration Conference GLEX 2017, which opened on 6 June in Beijing. China is willing to enhance cooperation with the international community in peaceful space exploration and development. The letter said that the country has paid big attention to space exploration as well as innovation in space science and technology to create a better future for mankind.

China aims at closer cooperation for renting foreign launch sites to improve launch flexibility, for building international launch sites in equatorial regions, and for developing sea-based launch platforms with other countries, according to Lu Yu, Director of the Science and Technology Committee of CALT.

During the past four years, China's Communist Party assigned senior management of the country's space programme to important political roles in key provinces. Last year, Ma Xingrui, a former General Manager of CASC, became governor of Guangdong, the economically most important province. Xu Dazhe, academic of the International Academy of Astronautics, is governing the central province of Hunan from around the same time. Two years ago, Chen Qiufa, head of China's space programme until 2013, became governor of Liaoning to revive the north-eastern rust-belt province. End of April, former President of CAST, Yuan Jiajun, who was also Head of China's Shenzhou manned space programme, was appointed acting governor of Zhejiang, a business hub and the power base of President Xi Jinping. The rationale behind this is that technocrats are pragmatic minded, not shy of making necessary but unpopular decisions and are not bound to factional allegiances. Accepting political positions significantly reduce their annual income – up to 80 % compared with their industrial salary.

At a ceremony on 8 May, the inner main-belt asteroid No. 456677 was named after Chinese aerospace scientist, Chief Commander and Chief Designer of the Chinese Lunar Exploration Programme CLEP, and academician of the Chinese Academy of Sciences, Ye Peijian. The minor planet was discovered in 2007 by a Chinese team at the Purple Mountain Observatory in Nanjing.

On a side note

Apollo astronauts talk China
In mid-May, at the Humans to Mars conference in Washington, D.C., Apollo 11 astronaut Edwin Aldrin promoted commercial space activities in LEO and stressed that those private industries should combine their activities with that on the planned Chinese Space Station once it is assembled and operational.

A few days later, the "Armstrong Space Symposium" took place at the Ohio State University. During a panel discussion on mankind's next exploration destinations, Apollo 15 astronaut Alfred Worden, told the audience that he thinks there may be a confluence of events in the world today that will predicate another landing on the Moon, but it won't be accomplished by the U.S. He stressed: "I think it might be China." His Apollo 17 astronaut colleague, Harrison Schmitt, did not want to agree to that but admitted that China has ambitious plans for space exploration.

LAUNCHES

2017-018A
12 April 2017 - 11:04 UTC (19:04 BJT)

Launch site: Xichang Satellite Launch Center – XSLC
Launcher: Long March CZ-3B/G2
Payload: Shijian 13 (ZX-16 Zhongxing-16/Chinasat 16)

On 12 April 2017 at 11:04 UTC (19:04 BJT), China launched the Shijian 13 (ZX-16 Zhongxing-16/Chinasat 16) advanced telecommunications satellites on board the Long March CZ-3B/G2 from LC2 of the Xichang Satellite Launch Centre, in the southwest China's Sichuan Province, into geo-transfer orbit.

Shijian 13 was built by the China Academy of Space Technology (CAST) and is based on the DFH-3B satellite bus. The box-shaped, 2.2 x 2.0 x 3.1 m satellite weighs 4.6 t and has two solar panels (min. 1,700 W). Its active lifespan is expected to be 15 years. Different sub-systems such as electric propulsion (Xenon) will be tested. First tests of the so-called LIPS-200 ion thruster unit were already successfully performed on 24 April 2017.

The main goal is the test of a High-Throughput Satellite (HTS) payload that enables ultrafast broadband transmission in the Ka-band frequency with a data rate of 2 Gbit/s. The satellite provides 26 user beams enabling internet access on aeroplanes, high-speed trains, ships and in less-developed regions. Once testing is completed, Shijian 13 will be handed over to China Satcom that will operate the satellite under its designation Zhongxing 16 (Chinasat 16) on its orbital position at 110.5°East covering China's main land and offshore areas.

Another test will be conducted on the high-speed laser communication technology between ground and the satellite. No further information was available on this feature.

2017-021A
2017-021F
20 April 2017 - 11:41 UTC (19:41 BJT)

Launch site: Wenchang Satellite Launch Centre - WSLC
Launcher: Long March 7 (Y2)
Payloads: Tianzhou 1

On 20 April at 11:41 UTC (19:41 BJT), the Long March 7 (Y2) rocket carrier launched from LC201 at Wenchang Satellite Launch Centre, Hainan Island, carrying the unmanned 12.91 t Tianzhou 1 (TZ-1) cargo space craft for docking with Tiangong 2 space module in orbit since mid-September 2016. It was only the second launch of the new CZ-7. Tianzhou, based on the Tiangong design but slightly heavier, is 10.4 m long and has a diameter of 3.2 m. It is equipped with 4 thrusters for orbital manoeuvres and 2 solar panels for power supply.

The secondary payload on this launch was the 4.5 kg Silu 1 (Sichouzhilu 1; Silk Road 1; 2017-021F), a 3U cubesat which was attached to the outside of Tianzhou and ejected from TZ-1 by a spring mechanism later during the mission, on 1 August. Silu 1 is intended for Earth observation and mapping and is the pathfinder for a bigger constellation of 30 satellites. It was built for the Xi'an Institute of Surveying and Mapping.

TZ-1 docked with TG-2 on 22 April, 04:23 UTC and carried out the first refuelling test on 27 April. In total, Tianzhou and Tiangong experienced 3 refuelling operations and 3 dockings. The Tianzhou space craft will become the backbone of re-supply operations for the future Chinese station.

ISS cubesat deployment
98067LP
98067ME
98067MN

On 17, 25, 26 May, 3 Chinese cubesats as part of the QB50 project were "launched" from the ISS.

On 17 May, at 01:45 UTC, the "Phoenix" 2U QB50-TW01 cubesat, built by the National Chen Kung University in Tainan City, Taiwan, was deployed from the NanoRacks ISS CubeSat Deployer NRCSD-11 attached to the JEM RMS robot arm on the Japanese Kibo module of the ISS.

On 25 May, at 08:35 UTC, the "Zidingxiang 1" 2U QB50-CN02 (also called: LilacSat 1) from Harbin Institute of Technology, Manchuria and on 26 May, at 12:15 UTC, the "Aoxiang 1" 2U QB50-CN04 from Shaanxi Engineering Laboratory for Microsatellites in Xi'an were deployed from Nanoracks' NRCSD-12 dispenser.

2017-036Y
23 June 2017

On 23 June, the Indian PSLV-XL rocket launched as secondary payload a series of cubesats among which was the QB50-CN06 "NUDTSat", a 2U technology cubesat of China's National University of Defense Technology. As part of the QB50 project, the experimental cubesat is testing technology and collects data of low mass ionized and neutral particles in the lower thermosphere (O, O2, and N2) and in the upper atmosphere with its Ion/Neutral Mass Spectrometer INMS.

2017-034A
2017-034B
2017-034C
2017-034D
15 June 2017 - 03:00 UTC (11:00 BJT)

Launch site: Jiuquan Satellite Launch Center - JSLC
Launcher: Long March 4B (Y31)
Payloads: Hard X-ray Modulation Telescope HXMT
OVS-1A Zhuai-1A
OVS-1B Zuhai-1B
ÑuSat-3 / Aleph 1-3 "Milanesat"

On 15 June, at 03:00 UTC (11:00 BJT), the Long March 4B (Y31) rocket took-off from LC43 at launch pad 603 of the Jiuquan Satellite Launch Center. The 2.5 t Hard X-ray Modulation Telescope HXMT (2017-034A), renamed 'Huiyan' (Insight) after launch, was sent into an 550 km orbit.

The modern astronomy satellite carries 3 collimator-type telescopes: the high energy X-ray telescope (20-250 keV) with a total detection area of more than 5,100 cm^2, the medium energy X-ray telescope (5-30 keV, 952 cm^2) and the low energy X-ray telescope (1-15 keV, 384 cm^2) covering a broad energy band.

HXMT is based on the CAST-built Ziyuan-2 / Phoenix-Eye-2 bus – a 2.0 x 2.0 x 2.8 m box-shaped body. Additionally, it comprises a payload compartment developed by IHEP and Tsinghua University and two solar panels. The expected lifetime is 4 years.

Data from HXMT will help scientists to better understand the evolution of black holes, gamma-ray bursts, strong magnetic fields and the interiors of pulsars. The observation results could support the use of pulsars for spacecraft navigation and search for gamma-ray bursts corresponding to gravitational waves.

OVS-1A Zhuai-1A (2017-24B); OVS-1B Zuhai-1B (2017-034D); ÑuSat-3 / Aleph 1-3 “Milanesat” (2017-034C)

Along with HXMT, China also launched three remote-sensing micro-nano satellites. Two of them, OVS-1A and the OVS-1B are 50 kg remote-sensing micro satellites from Zhuhai Orbita Control Engineering Ltd. These first two satellites of Zhuhai-1 imaging constellation with video capability for fast “gaze” observation, are expected to improve the monitoring of geographical, environmental, and geological changes across the country, according to the Beijing Institute of Space Science and Technology Information. The Zhuhai-1 satellite constellation, consisting of micro-nano video satellites, hyperspectral satellites and radar satellites, will be completed within the next two to three years.

The 37 kg Milanesat is the 3rd ÑuSat/Aleph 1 imaging payload from the Uruguayan/Argentinian firm Satellogic S.A. for the Aleph 1 constellation of up to 25 satellites. Milanesat’s dimensions are: 400 mm x 430 mm x 750 mm. It is equipped with optical and infra-red cameras, delivering monochromatic images with a resolution of 1 m, infra-red images with a resolution of 90 m and multi-spectral images of 30 m resolution. The satellite operates in a 500 km SSO orbit at a 97.5° inclination.

2017-035A
18 June 2017 - 16:12 UTC (19 June, 00:12 BJT)

Launch site: Xichang Satellite Launch Center - XSLC
Launcher: Long March CZ-3B/G2
Payloads: Zhongxing 9A (ChinaSat 9A; Xinnuo 4; Chinastar 4)

On 18 June, at 16:12 UTC (19 June, 00:12 Beijing Time), the Long March CZ-3B/G2 launched from LC2 of the Xichang Satellite Launch Center XSLC the Zhongxing-9A (ChinaSat-9A; Xinnuo-4; Chinastar-4) direct-to-home broadcasting satellite.

The communication satellite failed to enter the pre-set orbit due to a malfunction of the 3rd stage. The initial burn of the upper stage positioned the satellite into a low parking orbit. The second burn failed to push ZX-9A into the correct GTO Geostationary Transfer Orbit. Through 10 additional orbit correction manoeuvres, Zhongxing-9A could reach its planned GEO position at 101.4°East. The extra fuel needed for that will reduce the expected 15-year operational lifetime.

The CASC-built ZX-9A is based on the box-shaped DFH-4 bus, has two solar panels and a launch mass of 5.1 t. The DFH-4 platform houses 22 Ku-band transponders, three receiver antennas, and two transmission antennas, able of transmitting 150 - 200 TV programmes simultaneously to the 0.45 m antenna of ground users. It is the first Chinese satellite that can transmit radio programmes as well as TV programmes and multi-media communication services via its four 54 MHz and eighteen 36 MHz Ku-band transponders to the entire Chinese territory, Hong Kong, Macau and Taiwan as well as the South China Sea. Satellite operator is China Satellite Communications Co. Ltd. (China Satcom).

ABBREVATIONS

3HB	hydroxybutyric acid
AICC	Airspace Industry Corporation of China
AN	Antonov
APSCO	Asia-Pacific Space Cooperation Organisation
ATV	Automated Transfer Vehicle
BDS	BeiDou satellite navigation Systems
BIT	Beijing Institute of Technology
BJT	Beijing Time
BLSS	Bioregenerative Life Support System
BRICS	Brazil, Russia, India, China, South Africa
BUAA	University for Aeronautics and Astronautics Beijiing
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
CFOSat	China-French Oceanography Satellite
CGTN	China Global Television Network
CGWIC	China Great Wall Industry Corporation
CLEP	China’s Lunar Exploration Programme
CMSA	China Manned Space Agency
CNSA	China National Space Administration
CSS	Chinese Space Station
CZ	Long March, Changzheng
ESOC	European Space Operations Centre
FAST	Five-Hundred Metre Aperture Spherical Radio Telescope
GEO	Geostationary Orbit
GLEX2017	Global Space Exploration Conference 2017
GMT	Greenwich Mean Time
GTO	Geostationary Transfer Orbit
HKBU	Hong Kong Baptist University
HTV	H-II Transfer Vehicle
HXMT	Hard X-ray Modulation Telescope
ISS	International Space Station
ISRO	Indian Space Research Organisation
LEO	Low Earth Orbit
LEOP	Launch and Early Orbit phase
NPU	Northwestern Polytechnical University
NUDT	National University of Defence Technology
PSLV	Polar Satellite Launch Vehicle
QUESS	Quantum Experiments at Space Scale
SASTIND	State Administration of Science, Technology and Industry for National Defense
SJ	Shijian
SJTU	Shanghai Jiao Tong University
SMMS	Small Multi-Mission Satellite
SVOM	Space-based multi-band astronomical Variable Objects Monitor
SZ	Shenzhou
TG	Tiangong
TZ	Tianzhou
UN	United Nations
UNOOSA	UN Office for Outer Space Affairs
UTC	Coordinated Universal Time

Ralf Hupertz and Arno Fellenberg kindly contributed information to the section Chinese Space Launches.
Other sources of informations are:
http://news.xinhuanet.com
https://www.nasaspaceflight.com
http://www.spaceflightinsider.com
https://spaceflightnow.com
http://www.planet4589.org/space/jsr/jsr.html

China's 1st National Day of Space Flight on 24 April 2016

24 April 2016 – China sets the course for a space tradition

by Jacqueline Myrrhe

Traditions can come a long way: in 1962 – one year after Yuri Gagarin accomplished mankind's first flight into the cosmos – the Soviet Union declared the 12 April as "Cosmonautics Day" with opulent galas and commemorative events taking place annually. In 2011, the United Nations joined in the Russian celebration and made Cosmonautics Day the world-wide festival of "International Day of Human Space Flight". Earlier though, in 1999, as a result of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space UNISPACE III in Vienna, the most prominent space event on Earth has been introduced. Since then, the week from 4 October to 10 October each year is known as the World Space Week.

And now China has got it right as well: On 24 April 2016, for the first time, China celebrated its National Space Day. This day is the reoccurring anniversary of the launch of the People's Republic of China's first satellite - Dongfanghong 1 - into Earth's orbit on 24 April 1970.

Zhang Yulin. This photo was taken during the Tiangong 2 space operation meeting on 5 December 2017 in Beijing. Credit: CMSA – China

In remembrance of this milestone achievement, on 23 April 2016 the China Manned Space Programme Office held a symposium in Beijing, for which more than a hundred space experts were invited. The conference participants reviewed the development of the countries manned spaceflight activities and looked ahead into the future.

On the sidelines of this gathering, Zhang Yulin, Vice Minister of the Armed Forces Equipment Development Department and Deputy Commander of China's Manned Space Programme gave a rare interview to Chinese media. He spoke about the status of China's manned space programme and about plans for innovation and development for the future.

Zhang Yulin stressed that the decision taken by the Central Committee of the Communist Party of China and the State Council to establish the China Space Day reflects clearly the importance China's government attaches to space and space affairs. The decision for a National Space Day comes rather late in China's 60 years of industrial aerospace development but it comes at the right time when China is heading into a science and technology-based future.

The Vice Minister explained that the manned space programme had used up moderate financial means but the 10 astronauts flown to space until April 2016 have put into action the Chinese dream of flying to space. This has greatly inspired the people and effectively raised China's overall national strength and enhanced significantly China's international image.

Zhang Yulin then listed the tasks for 2016: launch of Tiangong 2, Shenzhou 11 mission, test of key technologies, and first flight of Long March 7. The efforts in 2016 are crucial key steps within the second phase of China's manned space project before the third phase – the construction of the space station – can start. "This year's tasks are difficult, challenging and of great responsibility. But we have the confidence to win, and we will turn the confidence into victory", he stressed and added that the pillars for succeeding are the support by the government, the accumulated experience from Shenzhou 1 to Shenzhou 10 and Tiangong 1, as well as the talented and creative workforce. Nevertheless, it also requires to take carefully chosen steps, attention to quality and good planning to make 2016 a success.

However, what are the plans for the time after the completion of the Chinese Space Station? Zhang Yulin gave a glimpse of that when he said that the completion of the space station will become the starting point to plan a new innovative goal. The research on that is still in the study-phase. But in general, he emphasised, the manned lunar exploration of the Moon and the expansion of that research to the Moon-Earth space is a realistic choice. Such a project would elevate the manned spaceflight programme to a higher ground, in line with the national situation for the great rejuvenation of the Chinese nation. In accordance with President Xi's demand for innovation and the five development concepts (see: next page) introduced by the government and the party, a new manned spaceflight strategy will be worked out, one that will fit in the "Two Centenaries" goal (see: next page) and will be based on the previous achievements, Zhang Yulin added.

In parallel with those efforts, there is a need for holistic innovation which includes the innovation in all aspects of space engineering management and engineering-related key technologies. For that, innovative people are a prerequisite. Zhang Yulin drew attention to the fact that the most precious thing is to train a large number of outstanding talents for the development of science and technology in China. Innovation and development of new manned spacecraft are one side of the medal, the other side is to make great efforts to train innovative talents. And for that, the China National Space Day is a good foundation since its main objective is inspiration and encouragement about space.

Last but not least, Zhang Yulin also touched on the point of commercial activities in the area of manned space flight. He referred to space as the new area for the development of mankind, the new place to work and live. He also made explicitly clear that the meaning of astronautics is to explore new places and to aim for technological break-throughs: "Whether it's a space station or a satellite, we ultimately do these things in order to exploit space resources. Do you want to industrialise? Do you want to support civil-military integration? Do you want to support the development of private economy in space? This is certainly self-evident. For example, satellites - commercial applications are now in the making, and communications, remote sensing and navigation satellites are in commercial use. For the space station, it is necessary to achieve breakthroughs in the manned spaceflight technology, but also to carry out space science applications. In addition, we also need to make

full use of space stations to support mass entrepreneurship and innovation. At the moment the "Internet of Things" is much talked about. Our space station can also be seen as a node in a large network in Earth's orbit. However, this is not the main task for China's manned space project. China's space station is still about to be assembled with an early exploitation phase to follow where the technologies for long-term stays in space will be developed. After maturity, the commercialisation of some applications is possible, although not the subject of the current project, but it can be one direction that we must strive to promote."

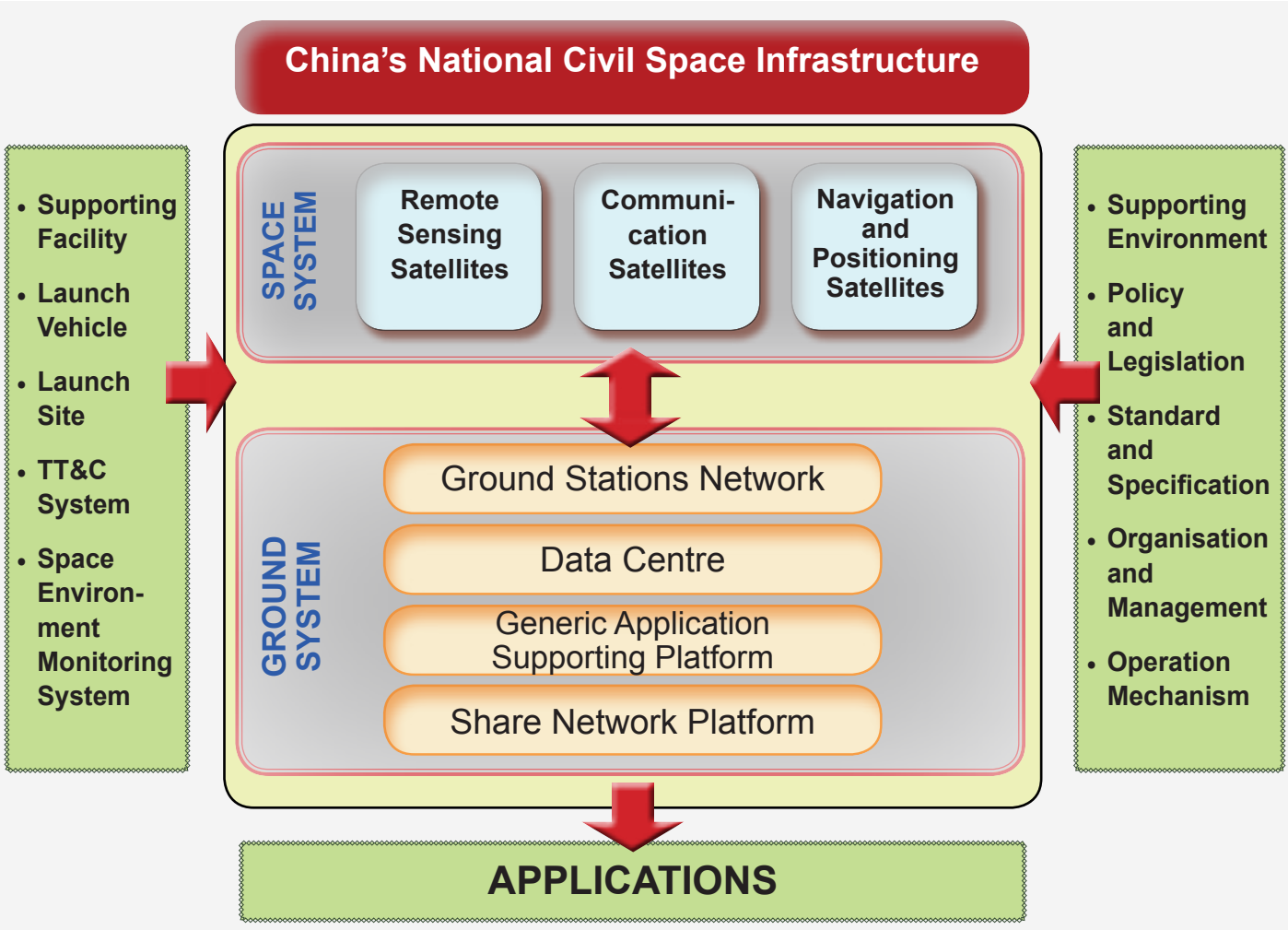
(GoTaikonauts! wishes to thank Yunxia Liu, Cologne, for her help translating the article with the Zhang Yulin interview.)

五大发展理念

The five development concepts: innovation, coordination, green development, opening up, and sharing are designed to facilitate building a "moderately prosperous society in all respects" by 2020.
The five development concepts were mentioned for the first time by the end of October 2015 in the "Proposal for Formulating the 13th Five-year Plan (2016-2020)" which was adopted at the Fifth Session of the 18th CPC Central Committee.

两个一百年

The term "Two Centenaries" refers to two 100-year anniversaries: the founding of the Communist Party of China in 2021 and the founding of the People's Republic of China in 2049.
The "Two Centenaries" is a set of goals advanced by the General Secretary of the Communist Party of China, Xi Jinping, following the 18th National Congress of the Communist Party of China held in 2012. It is the basic foundation for achieving the "Chinese Dream" - a moderately well-off society by doubling the 2010 capita income until 2021 and of becoming a "strong, democratic, civilized, harmonious, and modern socialist country" until 2049.



China's Civil Space Infrastructure is defined as the space-ground engineering facilities that utilise space resources to provide remote sensing, communication broadcast, navigation and positioning, and other products and services. It consists of space system, ground system and their related systems, which are coordinated in function and stable in operation. China's Civil Space Infrastructure possess strategic significance for the overall modernisation and making the society information-oriented and intelligence-oriented. At the same time, it is an important bolster for national security, and an important method to push forward scientific development, transform economic development mode, and realise an innovation-driven society. It possesses strategic meaning for China's modernisation construction to accelerate establishing an open, safe, stable, reliable civil space infrastructure that acts on Chinese people's will, and operates continuously in long term. Efforts are on the way to gradually establish a national Civil Space Infrastructure that is technologically advanced, independent and manageable, rational in layout with global coverage, and consists of satellite remote sensing system, satellite communication broadcast system and satellite navigation and positioning system. It should meet major industrial and regional application requirements; bolster the needs of China's modernisation, national security and the improvement of people's livelihood.

complied from website: http://en.chinabeidou.gov.cn/c/81.html

China's 1st National Day of Space Flight on 24 April 2016

Summary of the State Council Information Office press conference on China's 1st National Day of Space Flight

by Jacqueline Myrrhe

Russia has it, the United Nations has it and now China has embraced it too: an annual day to celebrate space. With the approval of the Central Committee of the Communist Party of China and the State Council, the 24 April was designated as the National Day of Space Flight from 2016 onwards.

China launched its first indigenous satellite, Dongfanghong 1, on 24 April 1970, making it the fifth country to enter the noble club of space fairing nations. Since then, China has made enormous progress in the field of astronautics. The year 2016 marked the 60th anniversary of China's inception of the space industry which contributed to three milestones:

- launching a man-made Earth satellite,
- sending Chinese people into space orbiting the Earth, and
- realising the Chinese millennium dream of landing on the Moon.

The establishment of the National Day of Space Flight aims at:

- preserving and take forward the Chinese spirit of space flight;
- build China into a leading country in the space industry;
- foster public awareness for science and culture;
- increase young people's interest in science;
- realise the great rejuvenation of the Chinese nation; and
- further exhibit China's determination and faith in the peaceful use of outer space to promote human progress.

The establishment of the National Day of Space Flight shows: The attention paid by both, the Party and the nation, to the space industry, the efforts in the national space programmes, and the importance of innovation.

Under the 2016 motto: "Chinese Dream, Space Dream", the day was accompanied by a series of educational activities held nationwide, including lectures, exhibitions, open-day-events for the public and meetings with experts on campuses.

Xu Dazhe, Vice Minister of the Ministry of Industry and Information Technology (MIIT), Administrator of the State Administration of Science, Technology and Industry for National Defence (SASTIND) and Administrator of the China National Space Administration gave more details on the importance of China's newly introduced National Space Day during the press conference on 22 April 2016 at the State Council Information Office in Beijing:

"I believe that setting the day helps inherit the spirit of space flight, which is a part of Chinese culture and involves the traditional space spirit and the spirit to develop atomic and hydrogen bombs and man-made satellites, and also to develope manned space flight. Marking the day helps carry on the spirit and take it forward.

It helps unite Chinese strength. The dream of spaceflight is a part of the Chinese dream. We shall adhere to the Chinese path of development, carry forward the Chinese spirit and enhance Chinese wisdom.

It helps cultivate the culture of innovation. The Chinese space programme has witnessed a history of independent innovation because no core technology can be bought; we must develop it by ourselves. In these circumstances, we choose a path of self-reliance and innovation.

It also helps promote opening-up and sharing. The space project is huge and complex, demanding international cooperation for exploring the mysteries of the universe for the benefit of mankind. Countries all over the world, especially the big powers, must make joint efforts. I have noticed that countries with a will to become strong nations have invested more in space than they did before. We have been adhering to the principle of the peaceful use of outer space resources and hope to act with wide international cooperation. As I mentioned earlier, China's National Day of Space Flight will become a window for the world to learn about China's space development. We are willing to take the opportunity brought about by this issue to enhance cooperation with our international counterparts."

What is China's National Civil Space Infrastructure?

(question by NHK - Japan Broadcasting Corporation)

Xu: "By 2025, the National Civil Space Infrastructure construction will be completed and the space information application business will be industrialised and developed on a large scale. For the National Civil Space Infrastructure, we plan to establish three major satellite systems: completed remote sensing system, communication and broadcasting system, and the navigation and positioning system in order to serve mankind and people's wellbeing." (see p. 14)

Is there a Chinese SpaceX in the pipeline?

(question by China Radio International)

Xu: "SpaceX recovered the first-stage booster with success. But to be able to re-use and to re-launch the recovered rocket is a long way away. While we respect the courage of SpaceX, having only booster recovery technology is not enough to make low-cost launches or reduce the general cost of astronautics. It requires us to keep working on engineering and technological development as well as change the way we launch rockets. Lowering costs is a pursuit for us in the engineering sector, and in that way we can reduce expenses, making it more affordable. We should learn from our peers their courage in this regard."

How big is China's space budget?

(question by Reuters news agency)

Xu: "Speaking of the budget, China's budget for the space program is on par with its economic growth. In the latest National People's Congress session, we announced the budget, too. Here, I can tell you, friends from the United States, that our budget is far smaller than that of the U.S. government, roughly 1/10 according to some American colleagues' analysis. The figure represents a certain degree of accuracy. That is all that I want to say."

China's 2nd National Day of Space Flight on 24 April 2017

"Tradition is not the worshipping of the ashes but to pass on the flame." *
A Visit to the Qian Xuesen Library and Museum Shanghai

by Dr. William Carey and Jacqueline Myrrhe

The facade of the "Qian Xuesen Library and Museum" in the Huashan Road with the intriguing 3D portrait of the scientist. credit: GoTaikonauts!

Along the Huashan Road, signs show the way to the museum. credit: GoTaikonauts!

24 April 2017 – National Space Day in China. As the major event town for the 2017 celebration, the town of Xi'an was chosen - the capital of northwest China's Shaanxi Province and home to more than 200 aerospace research centres and enterprises. But what to do for commemorating China's achievements in space when you cannot make it to Xi'an because you are just visiting Shanghai – 1,400 km across the epicentre of 2017's National Space Day celebrations?

China's National Space Day was established to raise awareness about the rapidly unfolding national space programme but in its second year of existence, this day is not yet a country-wide activity and it is still less publicly noticed then one would expect. It needs a few more years to become a tradition. However, China's space efforts and its achievements have come a long way, also in Shanghai.

Shanghai harbours the headquarters of significant space strongholds like the Shanghai Academy of Space Technology SAST, with its multiple subsidiaries distributed all over the town, the Shanghai Engineering Centre for Microsatellites (SECM), or the Shanghai Astronomical Observatory with its 65-m "Tianma" radio telescope and another 25-m dish in Sheshan as part of the Chinese VLBI array and the European VLBI Network (EVN), or the cradle of the Chinese space programme – the Laogang launch site in Pudong New Area, just to name a few. Another jewel in the crown of space locations was added 6 years ago. Since 2011, Shanghai is the site of a unique national space attraction: on 11 December 2011, the 100th anniversary of the birth of China's "Father of Missile and Space Programme", Qian Xuesen, the "Qian Xuesen Library and Museum" opened its doors.

Located on the grounds of the 'old' campus of Shanghai Jiao Tong University, the modern building with striking architectural features hosts the exhibition "Qian Xuesen - Scientist of the People".

The building's outside facade shows a 3D portrait of Qian Xuesen which might just be spotted by the attentive visitor since it is neither painted nor embossed, it is an enormous but unexpected sculptural 3D wall mosaic made of brown-reddish differently-shaped 'bricks', which are supposed to reassemble the eroded rock in the Gobi Desert, Qian Xuesen's most important work location. The overall composition results in a pixelated image which is best viewed from distance - a very novel and subtle approach to clearly identify the building.

Everything inside the 3,000-m² building is devoted to one of the most famous alumnus of Jian Tong University. Qian Xuesen studied there in the early 30's before going to the USA, to continue his education first at the Massachusetts Institute of Technology (MIT) then at Caltec under the leadership of Theodore von Kármán.

The museum is a very modern and well-laid out edifice spread over four floors, the first three dedicated to the museum exhibition areas, with the fourth housing the library.

Upon entering the 'welcome lobby' on the first floor, the visitor is faced with a giant representation of a hand-written calculation of Qian, entitled 'Windmill Calculation'. It was apparently part of his work on 'Engineering Cybernetics', a book he wrote while under house arrest in the USA. This work helped to provide the conceptual basis for robotics!

Following the round course, one is first greeted by the bust of Qian. Behind, the most striking element of the museum comes into sight: a retired Dongfeng II ballistic missile mounted on the ground floor, and extending to the upper-most floor in the atrium-like Central Hall. The circular wall of the ground floor shows a large painted mural of a similar missile on a transporter, with Qian Xuesen in conversation with a group of military officers. The mural reassembles an historical photo which was also pictured as a key scene from the biographical movie 'Qian Xuesen'. This combination of a real missile together with the painted mural - including actual sand on the floor – gives a strong feeling of 'being there' when all of

There is the bus stop "Jiao Tong Da Xue – Jiao Tong University" directly in front of the museum. credit: GoTaikonauts!

The museum is open from Tuesday to Sunday. Entrance is free! credit: GoTaikonauts!

* quote by Gustav Mahler, Austrian composer and conductor

this happened – a very effective concept, capturing the audience.

Also, very capturing are the various exhibition rooms. In principal, there are four permanent exhibitions: The Founder of China's Aerospace Industry, Pioneers in Frontier Science and Technology, People's Scientist, and the Success of the Strategic Scientist. But while walking through the floors, the visitor hardly notices the separate sections, he would just follow the flow, carrying the interested person 'seamless' from one room to the next.

The first and second floors contain a selection of material, mostly from Qian himself, which chronicles his life from his early days in China to his exploits in the USA, and subsequent return to China. One of the most impressive things is the sheer range of topics which this man applied his brilliant mind to. A true polymath if ever there was one.

One grainy image that might catch in particular the attention of Shanghainese or true fans of the Chinese space programme: it shows Qian with a group of people behind which was a small tower. This turned out to be of the first sounding rocket launch site Laogang, located outside of Shanghai which the GoTaikonauts!-team had visited a few years ago. (compare: GoTaikonauts! issue no. 13/ August 2014)

For all who still would like to extend their search for knowledge and information, QR codes next to many photos or documents link to websites with further details. Also, the website of the museum offers extensive documents and explanations and on top an online virtual tour for everybody who would like to get a feeling of the exhibition atmosphere or who cannot make it quickly to Shanghai.

All in all, the "Qian Xuesen Library and Museum" is an extremely interesting experience, especially to see the extent of the work Qian performed, but sad to understand that much of it is unknown in the West.

SJTU - Shanghai Jiao Tong University

The Xuhui Campus of Shanghai Jiao Tong University (SJTU) is the only university campus in China that has endured three centuries yet is still in use. Xuhui campus of SJTU is a huge 'museum' per se. The old library, Zhixinxizhai dormitory, Engineering Hall are a few among those buildings that were built in the early 20th century and have witnessed the life and learning time of notable masters in China's history: Qian Xuesen, Li Shutong, Zou Taofen, Huang Yanpei, Wu Wenjun, Zhang Guangdou and others. These buildings are still serving SJTU faculty and students. The 'Qian Xuesen Research Center' of the Shanghai Jiao Tong University is mainly engaged in research on Qian's life and career, his scientific thinking and also other scientists who contributed to the "two-bombs-one-satellite" programme.

(from the SJTU website)

A grandiose welcome to the visitor – the expert himself and his most important work are 'greeting' upon entry to the exhibition area.
credit: GoTaikonauts!

Many displays and information flyer make it easy to find its way through the exhibition.
credit: GoTaikonauts!

address:
Xuhui Campus of Shanghai Jiao Tong University (SJTU)
The city of Shanghai
Xuhui District, Shanghai
No. 1800 Huashan Road
200030, China

For China however, the library is both: it does reflect the aspect of "worshipping of the ashes" with the extensive review of Qian Xuesen's life through unique documents, hardware exhibits, materials and personal items, publicly shown. In total, the affiliated archives comprise 76,000 copies of Qian's documents, manuscripts and books, more than 1,500 historical pictures, and over 700 objects.

But is also "passing on the flame" for it is located at a university campus, inviting everybody who is interested free of charge and offering an educational experience with the library and conference facilities providing an inspirational study place. The exhibition encourages young people to see in Qian's life-long striving for knowledge a role model and: "Keep learning!".

So far, the museum has received over 600,000 visitors, organised more than 300 educational activities and hosted more than 10 guest exhibitions but also went on tours with a selection of Qian Xuesen exhibits to other cities in China as well as to Moscow.

The objective of the national space day movement needs many more people using the opportunity to pay a visit to a space-related location. The "Qian Xuesen Library and Museum" is an ideal place for that. But even better if the Shanghainese space companies would also consider to open their doors to interested visitors.

Obviously, the potential of Shanghai to engage and inspire for space is big and fortunately, Shanghai already offers a surprising number of places to go. For example, the Tianma 65-m telescope in Shanghai's suburb Sheshan…

Website with Virtual Tour:
http://www.qianxslib.sjtu.edu.cn/en/

Opening hours
Tuesday to Sunday: 9:00-17:00
Last entry is at 16:30.

*Note: For more reports on space museums in China, see in GoTaikonauts! issue no 14: "Keep an open mind, and enjoy the differences, that's why you go." by **Robert Hast**, p. 30-31*
*Looking For Space in Hong Kong and Macau by **Morris Jones**, p. 32-34*

In the basement (or ground floor), the panoramic picture shows a scenery from the launch site in the Gobi Desert, which will later become the Jiuquan Satellite Launch Center (JSLC). The ground floor also shows a replica of the control room for missile launches. credit: GoTaikonauts!

Qian Xuesen's work laid the foundation for China's civil space programme. In this exhibition room, the efforts for launching Dongfanghong 1 (hanging from the ceiling) are explained. credit: GoTaikonauts!

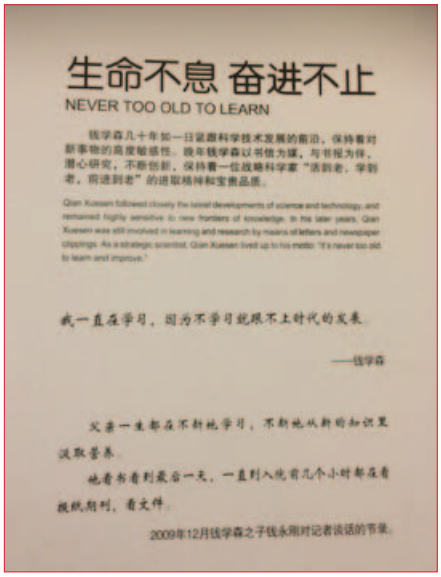
Space flight pioneers - another illustrative painted mural depicts Qian Xuesen's colleague and fellow scientists. credit: GoTaikonauts!

Qian Xuesen was honoured and respected up to the end of his life. China's taikonauts showed him their reverence while visiting. credit: GoTaikonauts!

The steps of missile development up to the Long March rocket launcher. credit: GoTaikonauts!

Many modern and fancy installations introduce the visitors to the academic work by Qian Xuesen. credit: GoTaikonauts!

The liquid-fuelled, 2,500 N twin-engine developed by the 6th Academy of China Aerospace Science and Technology Corporation (CASC) is used for the Shenzhou space craft in case of emergency escape, orbital and return manoeuvring. credit: GoTaikonauts!



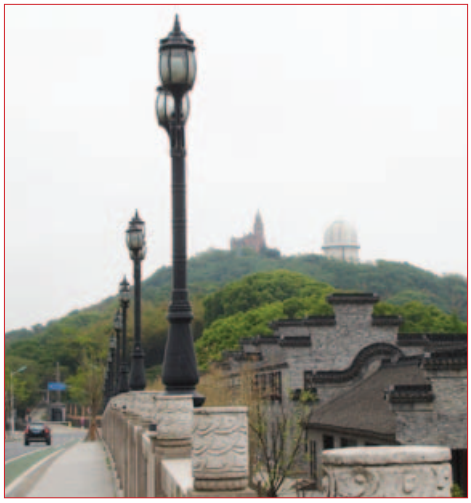
Never too old to learn! Keep learning! This is the message to the students and young visitors of the museum: pass on the flame! credit: GoTaikonauts!

China's 2nd National Day of Space Flight on 24 April 2017

Excursion to Tianma – the Pegasus of Shanghai

A Tour to West Sheshan Mountain and the Sheshan 65-m radio telescope

by Jacqueline Myrrhe



View from the West to West Sheshan Mountain. Credit: GoTaikonauts!

It was for French catholic Jesuits that China inherited a unique scientific sky observation facility, which became the starting point for a wider telescope park supporting today China's unfolding deep-space efforts.

The story starts around the year 1900 when the Jesuits missionaries founded on the picturesque West Sheshan hill top, the highest of a 13 km long hill range, 40 km away from the vibrant port city of Shanghai, the Sheshan Observatory. The West Sheshan Mountain is just 97 m high but it clearly sticks out of the very flat surrounding territory south-west of Shanghai, making it an ideal place for sky observation but also as a befitting, unique religious place: between 1925 and 1935 the Sheshan Basilica of Our Lady of Sheshan was built on the uppermost spot of the hill, just a little bit higher and a bit more central than the earlier established observatory. The observatory with its 40-cm binocular refraction telescope, has been for long the biggest in East Asia. The historic refractor and the old observatory building are now the Sheshan Astronomical Museum, open to the public.

Over the years, the old observatory was rebuilt, modernised, and equipped with a 1.56-m optical telescope which is still operational until today. From 1951 until 1981 is has been China's central time keeper. Only in 1962, Sheshan Observatory, and Xujiahui Observatory - located in a town district in central Shanghai - merged to operate now under the newly founded Shanghai Astronomical Observatory (SHAO). Since 1999, SHAO's administrative headquarters is housed in a modern building in Nandan Road Xujiahui (also called: Zikawei) District, not far from Shanghai Jiao Tong University (SJTU).

But not only this was changed over time: Also, the research facilities of the Sheshan campus saw, under the care of the Shanghai Astronomical Observatory, and being part of the Chinese Academy of Sciences, an impressive growth throughout the recent decades.

Presently, it comprises not only the 1.56-m optical telescope, but also a 60-cm satellite laser ranging (SLR) telescope – both located on the Sheshan hill – and: two state-of-the-art radio telescopes in the close neighbourhood of West Sheshan Mountain.

One of these radio telescopes is the Sheshan 25-m radio telescope (SH25), a landmark in the green countryside east of Sheshan. It was China's first VLBI (Very Long Baseline Interferometry) station when it saw its first light in 1986. The Sheshan 25-m radio telescope is a Cassegrain beam waveguide type antenna, equipped with six receivers at 1.3, 3.6/13, 5, 6 and 18 cm wavelengths and a complete VLBI system.

Its main tasks are data acquisition for high-resolution VLBI astrophysics and high-precision astrometry observations – on national and international level - and playing an integral and significant role as part of the European VLBI Network (EVN) since 1993, contributing to its longest baseline. 13 years ago, the EVN correlator, situated in Dwingeloo, The Netherlands, was connected with Shanghai via high-speed fibre, capable of a maximum data rate of 1 Gbps in real-time mode. The 25-m dish was also used for all four Chang'e lunar missions for VLBI orbit determination.

The latest addition to the Sheshan campus of SHAO is the divine winged horse "Tianma" or "Pegasus" as it would be

View to the administrative and data centre building (left) for the Tianma 65-m radio telescope and a close-up of Tianma's guideway. credit: GoTaikonauts!

The base of the antenna holds this sign with the relevant data about Tianma 65-m radio telescope. credit: GoTaikonauts!

View of Tianma's suspension structure. credit: GoTaikonauts!

View of Tianma's 65-m parabolic receiver dish. credit: GoTaikonauts!

called according to the terminology of Greek Mythology. A few kilometres away from Sheshan hill, in the middle of fertile farmland, the giant among Chinas antennas is scanning the skies. Tianma 65-m radio telescope has been operational since 28 October 2012, the 140th anniversary of the Shanghai Astronomical Observatory. The inauguration at the end of October 2012 was also just in time to support the Chang'e 2' close fly-by of asteroid Toutatis on 13 December 2012 at a distance of 7 million kilometres.

Tianma's total height of 70 m makes it Asia's largest radio telescope and with its 2,650-t weight certainly also the heaviest. It is able to rotate around all its axes. The 1,104 panels of the main reflector are equipped with actuators for adjusting the dish surface via the active surface system. Its operational frequency is between 1 and 50 GHz. Tianma receives radio waves in the L, S, X, C, Ku, K, Ka, Q-band and it is equipped with the Chinese VLBI Data Acquisition System (CDAS). The research with Tianma comprises single-dish observations of radio spectral lines and pulsars to accumulate observational data for the establishment of a pulsar time standard and deep-space automatic navigation. But also, Tianma is part of the European VLBI Network (EVN).

Both radio telescopes, the 25-m telescope and the 65-m telescope, can be operated together as if it were a single dish telescope, improving their performance.

Tianma's construction was a pretty quick feat. The project was approved in October 2008, the foundation laid one year later, construction started in 2010 with the official operations beginning at the end of October 2012. Its main reflector was installed aided by China's first active surface control system which was an in-house development by the SJTU School of Mechanical Engineering.

Looking from afar or from near: The appearance of this white titan is majestic, indeed. Visitors can get close to the parabolic dish and might be able to experience live the antenna's operation when a buzz starts filling the air and the dish slowly starts rotating for pointing onto a new position up in the sky. Standing next to the technical construction made of steel, concrete and metal, and watching it moving, one wonders and is fascinated as to why this mechanical apparatus can see better than the human eye – which does not see anything where the telescope is directed to. It is worth visiting the Tianma radio telescope to get connected with science and technology and to feel a bond with the heavens. Maybe, SHAO will take the effort to offer guided tours soon, to explain its important work with the several telescopes in Sheshan and to inspire many more people. The public outreach potential of Sheshan as an important location for historical and leading current radio astronomy is big. And no study – how intense as it might be – can replace the experience of getting to know the real thing, of seeing a beast like Tianma with your own eyes and touching it with your own hands.

In Sheshan, the infrastructure for more than sporadic visits by space fans on the National Space Day is already in place. It belongs to the Songjiang District of the city of Shanghai. The 40 km distance from Shanghai city centre can be easily bridged with the Shanghai metro Line 9. Sheshan's pleasant

A station map of the European VLBI Network (EVN) with the 65-m Sheshan Tianma indicated as part of the network.
credit: European VLBI Network; http://www.evlbi.org/intro/intro.html

green countryside with its smooth hills became the highly popular Shanghai Sheshan National Tourist Resort with amusement parks, botanical garden, generous hotel complexes, sculpture gardens, replica of a typical English old town as shopping area and for just going out. The variety of things to see and to do is enormous. And so, Shanghainese take advantage of the facilities – but so far – know little about Tianma and its 25-m companion.

Sheshan is perfectly suited for a full day excursion to the locations of the radio telescopes but definitely also to the astronomy museum on the West Sheshan Mountain. It does not need to be National Space Day to make you go.

China's Deep-Space Network

main antennas:

- 66-m Jiamusi, Heilongjiang
- 35-m Kashi, Xinjiang
- 35-m Nuequén, Argentina

4 "receive-only" VLBI stations for orbit determination:

- Beijing-Miyun (50 m)
- Shanghai-Sheshan (65 m)
- Nanshan, Urumqi (25 m)
- Kunming, Yunnan (40 m)

also see GoTaikonauts! issue no 16, p. 22

Note: FAST is not yet ready for deep-space tracking as it is still in its test phase, focusing on astronomical observation. All 18-m dishes, used in the Chang'e 1 and other missions, were not built for deep-space tracking and not considered part of the "deep-space network".

Abbrevations:

EVN: European VLBI Network *(Chinese contributions to the EVN: 25- and 65-m telescopes Shanghai-Sheshan, SHAO; 25-m telescope Nanshan, Urumqi)*
VLBI: Very Long Baseline Interferometry *(VLBI achieves ultra-high angular resolution and is a multi-disciplinary technique for e.g. imaging of extragalactic radio sources, geodesy and astrometry.)*
SHAO: Shanghai Astronomical Observatory

Shanghai Astronomy Museum
Location: on the peak of West Sheshan Mountain, Songjiang District, Shanghai, business hours: 8:30-16:00 / duration of visit 1 - 2 hours

China's Lunar Exploration Programme - touchstone for China's Deep-Space Tracking network

Compared to matured spacecraft and launcher technologies, deep-space telemetry and communication has been a major challenge for China for a long time.

For its first lunar mission, Chang'e 1, launched in 2007, the Unified S-Band (USB) system was still used as the primary TC&C system. Besides tracking stations within China and those in Karachi, Pakistan and Swakopmund, Namibia, as well as the Yuanwang fleet of tracking ships, China's space programme was in urgent need of more overseas stations to have better coverage. Through collaboration with ESA, Chang'e 1 received support from ESA's ESTRACK ground station network including the 35-m station at New Norcia, Australia, the 15-m station in Maspalomas, Spain, and the station in Kourou, French Guiana. But this was still not enough for deep-space tracking. China had to build its own deep-space communication infrastructure from the beginning. The plan was to build a VLBI deep-space network consisting of two existing 25-m antennas in Shanghai-Sheshan and Urumqi, Xinjiang, a newly-built 50-m antenna in Beijing-Miyun and another 40-m antenna in Kunming in southwest Yunnan Province. This was done until 2006. In January 2005, the Shanghai receiver participated in the international joint VLBI observation of the Huygens landing on Titan, which gave Chinese scientists useful experience. In April 2006, the newly established VLBI network consisting now of the existing antennas of Sheshan-Shanghai, Urumqi, and the newly completed antennas in Beijing and Kunming made a successful rehearsal using Europe's Smart 1 lunar orbiter, with support from ESA.

The next lunar mission, Chang'e 2, launched in October 2010. Already before, China started to extend and strengthen its deep-space tracking and communication network. The plan was to complete the projected domestic stations in late 2012 and the overseas stations by 2016. In 2011, China had to use its existing domestic and overseas tracking stations with a maximum antenna diameter of 18 m, supplemented by four VLBI stations for precise angle measurement during the Chang'e 2 lunar mission. Also, the TC&C system had to run at its highest power for the uplink channels. It totally relied on orbit prediction for directing the ground antennas at the spacecraft. Surprisingly, such a system worked well, not only in the 1.5 million kilometres Sun-Earth-L2 mission in 2011 but also in the 7 million kilometres Toutatis fly-by on 13 December 2012.

The success of the Toutatis fly-by was also owed to the newly completed deep-space tracking network. Two large tracking antennas in Kashi and Jiamusi, with a diameter of 35 m and 66 m, and the 65-m Tianma radio telescope for VLBI tracking in Shanghai-Sheshan, entered service ahead of schedule in October 2012. Four telescopes in Shanghai-Sheshan, Beijing-Miyun, Urumqi and Kunming joined the VLBI observation from 26 November to 14 December 2012. It is estimated that VLBI data helped to increase the orbit determination accuracy from 55 m to 11 m. Also, optical observation by three domestic telescopes and two in Hawaii and Chile helped to increase the accuracy of the orbit prediction as well.

So far, the VLBI tracking system has been successfully applied for all four Chinese lunar missions to date: Chang'e 1 in 2007, Chang'e 2 in 2010, Chang'e 3 in 2013 and Chang'e 5T1 in 2014.

However, deep-space missions to Mars or polar Sun orbit require more capabilities. On 10 July 2007, the Chinese government approved the plan to build the world's largest radio telescope, the Five hundred metre Aperture Spherical Telescope (FAST). This huge telescope became operational in September 2016. Since it is focusing on astronomical observation during its testing phase, its capability for deep-space tracking will enhance China's deep-space projects of the future. Other proposals included five new overseas tracking stations in North America, South America, Northern Europe, Australia and Antarctica, and to establish a space-based VLBI network by launching a constellation of tracking satellites.

Chen Lan

Exciting prospects for the future

The Shanghai Astronomical Observatory, in cooperation with national and international partners, undergoes efforts in defining the scientific goals and key technologies of the first space-based Low Frequency Radio Astronomical Observatory and the first space-based VLBI array project in the world.

Also, Tianma will soon be downgraded to become the 2nd largest radio telescope in China. The lead, on a national and international scale, will then be taken by the Steerable 110-m Aperture Radio Telescope (SmART), also known as QiTai radio Telescope (QTT) – currently under construction near the town of Banjiegou in Qitai County, in China's north-western Xinjiang Uyghur Autonomous Region, bordering with Mongolia, Russia, Kazakhstan, Kyrgyzstan, Tajikistan, Afghanistan, Pakistan and India. The site for the new radio telescope was chosen in 2010. It is located in a natural basin, surrounded by 1,900 m high mountain tops, 202 km away from the Nanshan Base with its 25-m radio telescope and 46 km from Qitai town. 2012 was the ground-breaking ceremony and because the project is part of the "13th five-year plan of the Central Government supports for Xinjiang economic and social development planning and construction project", the completion can be expected within the next four years. Like the Nanshan Base, and the Kashi satellite ground station, the Qitai 110-m radio telescope will be operated under the responsibility of the Xinjiang Astronomical Observatory (XAO).

On 6 February 2018, the final prototype dish for the Square Kilometre Array (SKA) project was revealed in Shijiazhuang, China, by the Vice Minister of the Chinese Ministry of Science and Technology. The 54th Institute of China Electronics Technology Group Corporation (CETC54) was responsible for the structural assembly of the first SKA dish, complemented by components from China, Germany, and Italy.
SKA is an international effort to build the world's largest radio telescope. Africa and Australia will host a vast quantity of radio telescope dishes and low frequency aperture array antennas, with a combined collecting area of one square kilometre. However, 100 organisations from all continents will participate in SKA with the headquarters at Jodrell Bank, UK.

With respect to antennas in China, it remains interesting, seeing intriguing developments unfolding in the future.

TianMa's creator: CETC54 - The 54th Research Institute of China Electronics Technology Group Corporation

CETC54 was the first telecommunications research institute founded by the Chinese government, back in 1952. The institute is located 300 km south-west of Beijing, in Shijiazhuang, the capital of Hebei Province. Over its more than 60 years of development, the institute did not only grow into a facility covering an area of 2 km^2 and employing 6,000 staff, but has also grown into one of the leading comprehensive research institutes in the field of electronics and information.

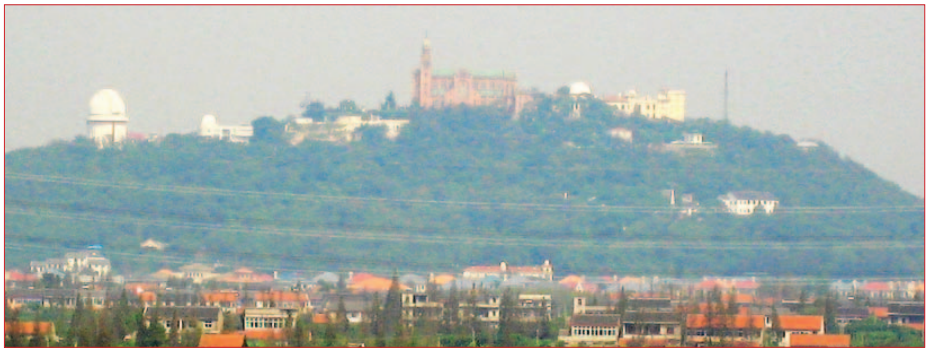
CETC54 runs an educational college with master's degree courses, and it also possesses the largest postdoctoral research centre in Hebei Province. Its establishment in Shijiazhuang comprises research and development centres, a laboratory, manufacturing factories, and a composite materials processing centre.

CETC54 researches, develops, and manufactures equipment for telecommunication, and electronics and information industries. It offers systems, such as emergency command dispatch communication, satellite communication, spectrum monitoring, and public security systems; equipment, including private network switches, satellite communication equipment, and satellite navigation equipment, as well as antenna-, feed-, and composite materials; and components, such as frequency control, precision machining, and customised components. The company also provides technical development and consulting services.

Compiled from content of CETC54 website: http://www.cti.ac.cn/en/

View from the Eastern side of the West Sheshan Mountain. Credit: GoTaikonauts!

The GoTaikonauts! team in front of Tianma 65-m radio telescope.
Credit: GoTaikonauts!



View at the Sheshan hill with the observatory and the Basilica of Our Lady of Sheshan
Credit: 三斤 (CC BY-SA 2.0; https://commons.wikimedia.org/wiki/File:Sheshan_hill_Songjiang_District_Shanghai.jpg)

GLEX2017 - Global Space Exploration Conference - Highlights

by Jacqueline Myrrhe

The 2017-edition of the IAF's (International Astronautical Federation) Global Space Exploration Conference (GLEX 2017) took place from 6 to 8 June 2017 in China's capital Beijing.
The annual gathering of exploration experts from all over the world was jointly organised by the IAF and the Chinese Society of Astronautics (CSA).
China placed a lot of attention on GLEX2017. Surely, being the host comes with the obligation for showing presence and making the event a success. But also, China's long-term strategy for the rejuvenation of the nation has the development of science and technology at its core. Space exploration, space science and space technology are some of the chosen and agreed tools for fulfilling the "Chinese Dream" of becoming a leading nation in the fields of science, technology and economy until 2050.

Therefore, it was a natural move to have GLEX2017 opened by a high-ranking politician. Li Yuanchao, Vice-President of the People's Republic of China, gave the welcome address and brought with him greetings from his boss, Xi Jinping, President of the People's Republic of China. Li read President Xi's words to the delegates which stated: "China has historically attached importance to the space exploration and scientific technological innovations. China is ready to strengthen cooperation with all countries in the world; peacefully study, explore and use space, so that the results of space researches contribute to a better future of humanity." President Xi wanted the conference participants to know that progress in space science and technology will benefit people around the world in the future and that the highest purpose of space exploration as well as innovation in space science and technology is to create a better future for mankind. China wishes to cooperate with all countries on the planet for this goal.

SpaceWatch Middle East COO Torsten Kriening on GLEX2017: "China demonstrated, through many presentations, where they stand, what outstanding achievements they have made in the last decades and where they want to go. In all presentations, international cooperation was praised and was acknowledged as the base for success. However, if the journey to space is faced with difficulties due to the current challenges and circumstances, then China will move forward – with or without the international community."

Below, is a summary of information about the Chinese space programme, revealed at GLEX2017.

SPACE TRANSPORTATION

Lu Yu, Director of Science and Technology Committee at **CALT:**

- Space Transportation system is the foundation of developing space technology.
- China's Long March carrier rockets still have room for improvements.
- Development of a heavy-lift launch vehicle with 140 t to LEO capacity and 50 t to lunar transfer orbit.
- Progress in developing reusable launch vehicles, including tests of parachute landing and propulsion landing.
- CALT welcomes participation in China space activities and commercial launch services.

Wu Yansheng, President of China Aerospace Science and Technology Corporation **CASC:**

- Improvement of space infrastructure and advances in space sciences under the principle of creating peaceful cooperation in outer space.
- Continuation of launch services for other countries, including international commercial launches and satellite-in-orbit-services.
- Work on the Mars 2020 mission is proceeding.
- Conceptual work for a manned lunar landing is on the way (also see: MANNED MISSION TO MOON).

Liu Shiquan, Deputy General Manager of **CASIC:**

- First flight of cargo re-entry capsule expected for 2019.
- New-generation, 3-staged Kuaizhou 11 solid-fuel carrier rocket will launch for first time end 2017 (but was later postponed to the first half of 2018).
- Kuaizhou 11 take-off mass: 78 t, payload capacity for SSO: 1 t; LEO: 1.5 t.

REUSABLE SPACE TRANSPORTATION

Liu Shiquan, Deputy General Manager of **CASIC:**

- Programme for development of reusable (up to 100 times), two-stage to orbit spacecraft, capable of taking off and landing at airports is aiming at low cost, safe, convenient and flexible space transport.
- Flight profile: horizontal take-off from the airport, rising up into the upper atmosphere, in 30 to 40 km height separation of first from second stage with return of first stage hardware to the airport; space craft with second stage proceeds to LEO until mission is accomplished, then re-entry and horizontal landing.
- Spacecraft's key technologies and major parts, including the engine, passed ground tests.
- Payload capacity of 2 t to LEO for human (astronauts or space tourism) and cargo transport (re-supply, satellites, quick response transport services).
- Take-off mass: 100-150 t.

Wang Guoqing, representative: **CASC**

- After 10 years of study, breakthroughs have been achieved in low-cost, reusable space transportation technology.
- Challenges remain in the area of reliability and safety.

CSS - CHINESE SPACE STATION

Yang Liwei, Deputy Director of China Manned Space Agency **CMSA:**

- Construction of 60-t Chinese Space Station (CSS) 'Tiangong' will start in 2019 with completion planned for 2022 and 10 years of life time expectancy.
- Three 20-t modules will be arranged in T-shape: Core Module "Tianhe 1", Experiment Module 1 "Wentian" and Experiment Module 2 "Mengtian" (to either side of the Core Module).
- Experiment modules are installed with advanced multi-purpose facilities for scientific research (life science, biotechnology, microgravity fluid physics and combustion, material science).
- Launcher service: LM-5B for 20-t modules, LM-2F for crew on Shenzhou spaceships, LM-7 for cargo vehicle Tianzhou.
- Average crew size 3 (with up to 6 crew members during rotations).
- For CSS assembly, at least 4 manned spaceflight missions within the next 5 years are planned: Shenzhou 12 (selected from the current 21-strong taikonaut corps) and Shenzhou 13 missions for 2020 with 3-6 months stay in orbit, Shenzhou 14 for 2021 and Shenzhou 15 for 2022.
- Free-flying 2-m space telescope "Xuntian" (Hubble-class observatory), able to dock with the CSS for maintenance, performs large-scale, multi-spectral and spectroscopic imaging for astronomy and astrophysics.

Xu Yansong, International Cooperation Department Director **CNSA:**

- "We have no certainty about the ISS, but we will have our own space station in orbit, and it will be opened for the international community."

MARS MISSION

Wu Yanhua, Deputy Head of the China National Space Administration **CNSA:**

Robotic Mars probe project is progressing, launch planned for 2020.

LUNAR MISSIONS

CHANG'E 3

Lander and Lunar-based Ultraviolet Telescope (scanning the sky for variable stars and in the field of low Galactic latitude) are still operational during the lunar days and communicate with ground stations. The lander hibernates during the Moon nights (equivalent of 14 terrestrial 24-hour periods) but wakes up automatically. It sources its power from solar panels and very long-lasting RTGs. Data from Chang'e 3's telescope and other lunar missions can be accessed via the Planetary Data System of the National Astronomical Observatories of China.

CHANG'E 4

Chang'e 4 payloads includes 11 instruments among them is a 3-kg Mini-Ecosystem (team lead: Chongqing University), an 18-centimeter-tall cylinder will carry potato seeds and silkworm eggs to be incubated while staying on the lunar surface; the silkworms are supposed to hatch and create carbon dioxide, while the potato plants will generate oxygen.

Liu Jizhong,
Director of Lunar Exploration and Space Engineering Center of CNSA:
"China sent out invitations with intent to enhance international cooperation as soon as it started its studies on the Chang'e 4 project and received many responses from other countries. Over a dozen countries have sent us more than 20 cooperation proposals. So far, it has been confirmed that the Chang'e 4 project will include projects from the Netherlands, Germany (University of Kiel, whose scientists developed the Lunar Lander Neutrons & Dosimetry Experiment (LND) experiment), Saudi Arabia and Sweden."

Xie Gengxin,
Chief Designer of the Mini-Ecosystem project:
"We will livestream the development of plants and insects on lunar surface to the whole world."

CHANG'E 5

Liu Jizhong,
Director of CNSA's China Lunar Exploration and Space Engineering Centre:
Announcement of Chang'e 5 landing site in the Mons Rümker region in Oceanus Procellarum, a young volcanic basalt mare in the Moon's NW region.

Sun Weigang,
Chief Engineer, China Aerospace Science and Technology Corporation:
- Confirmed the landing site in the region of Mons Rümker.
- Several Chang'e 5 tests, including simulated launch, landing, take-off and sampling, have been concluded.
- "China is willing to jointly explore the boundless universe and peacefully utilise outer space together with countries all over the world."

CHANG'E X

Liu Jizhong,
Director of CNSA's China Lunar Exploration and Space Engineering Centre:
"China is planning and designing its future lunar exploration programme. We will focus on the South Pole region of the Moon - hot spot of lunar exploration based on international consensus. The research on water and the permanent shadow area of the lunar South Pole region will bring greater scientific discoveries. The lunar exploration concerns all people's life and happiness. All countries should participate in the course and utilise the lunar space in a peaceful and lawful way."

Xu Yansong,
Head of CNSA's Department for International Cooperation:
- China and Russia are discussing options for cooperation in each other's lunar exploration programmes which could be at the system level or the overall project.
- Cooperation on Russia's lunar orbiter mission Luna-Resurs 26, the lunar lander mission Luna 27 and lunar sample return mission Luna-Grunt (Luna-29) actually exist. Launches are planned for 2020, 2021/22 and 2024 respectively.

TAIKONAUT SELECTION

Yang Liwei, Deputy Director of China Manned Space Agency **CMSA:**

Announcement of selection of third generation taikonauts, a group of 10 to 12 persons, two of them women.

Wanted are non-military experts, scientists and engineers, who will fly missions of 3 to 6 months duration.

"Scientific experiments are going to be a major part of the new space station, so we're going to need astronauts who have the right backgrounds."

UNITED NATIONS

Yang Liwei, Deputy Director of China Manned Space Agency **CMSA:**

"China is expanding cooperation with the United Nations in space exploration, and will disclose projects later this year."

(note: So far China agreed with the UN Office of Outer Space Affairs (UNOOSA) on astronaut training and the use of the CSS for UNOOSA Member States.)

MANNED MISSION TO MOON

Yang Liwei, Deputy Director of China Manned Space Agency **CMSA:**

China is in the preliminary stage of its manned lunar programme.

Chinese astronauts could walk on the Moon around 2030.

Official approval and funding for a manned lunar project to be expected soon.

Yang Liwei confirmed that he has never stopped training for a space mission and that he would gab the opportunity in case he would be part of a lunar landing crew: "If I am given the opportunity, no problem!"

Wu Yansheng, President of China Aerospace Science and Technology Corporation **CASC:**

Preparatory work for human lunar mission in the 2030s is ongoing.

Mission would consist of crew vehicle, propulsion space craft, and lunar lander. Crew spacecraft and lunar lander will be launched separately.

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Space Commemorative Banknote and Coin

In December 2015, the People's Bank of China issued 300 million 100 RMB commemorative banknotes and 100 million 10 RMB coins to celebrate China's success in its space programme. Both means of payment show as the main feature the docking of Shenzhou 9 with the Tiangong 1 space laboratory. In the background, China's lunar mission, Chang'e 1 is depicted, while the coin is also illustrated with DFH-1, LM-2F, Yutu and the Moon goddess Chang'e. The graphics on the backside of the banknote symbolise human's technological achievement from bird's flight, via aviation, up to the establishment of a space station.

In total, 2.5 million commemorative albums, containing the banknote and the coin, were released by the People's Bank of China.