



Issue 9

All About The Chinese Space Programme

GO TAIKONAUTS!

龙腾太空

July 2013



Tiangong 1 Revisited

Learning to Operate a Space Station,
with a Grand Vision in Mind



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Tiangong 1 Revisited

Learning to Operate a Space Station, with a Grand Vision in Mind

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SIMBOX on Shenzhou 8

On 31 October 2011 at 22:58 (CET), the Chinese spaceship Shenzhou 8 was launched into Earth orbit on a "Long March" rocket from the Chinese Jiuquan Satellite Launch Centre in Inner Mongolia. Shenzhou 8 carried the experiment facility SIMBOX – developed and built in Germany – housing altogether ... page 26

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The Odd One Out Might Soon be Thumbing its Nose

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Editor's Note

As planned, this issue of Go Taikonauts! is focused on the Shenzhou 10 mission, China's fifth manned space flight and the second visit to the Tiangong 1 space laboratory. Here we have four articles about this mission or related to the Chinese human space programme. The cover story starts with an overview of the mission, highlighting the eye-catching space lecture, and ends with an informative review on the ambitious space station plan. The most interesting message in this article, originally revealed by the Chief Designer of the Chinese human space programme in a paper published earlier this year, is the station's extension plan with three more pressurised modules and design considerations for accepting foreign-built or jointly-developed hardware. It, indeed, gives us a huge space for imagination!

There is also a report on activities of Liu Yang, the first Chinese woman in space, who was in Vienna, during the Shenzhou 10 mission. Our team member Jacqueline Myrrhe had a chance to talk with Liu Yang face-to-face in Austria's capital. In this report, you will read not only the interview with Liu Yang, but also about her personal character and charm. Another interesting report was written by a Chinese tourist who witnessed the Shenzhou 10 launch at the launch site itself. It gives us an opportunity to understand from a different angle how ordinary Chinese people see the space programme of their country. For those more interested in research and technical details, there is a comprehensive review, provided by the German Aerospace Center DLR, on the SIMBOX experiment carried out in space during the unmanned flight of the Shenzhou 8 spacecraft in 2011. The experiment was considered quite successful, paving the way for further German-Chinese cooperation on future Chinese manned missions including those on the planned Chinese Space Station.

International space cooperation is a constant topic. An article on international cooperation provided by Ferdinand Huber discusses the topic in general. It should give you some kind of insight and inspiration. Within just three weeks in late May and early June, on two sides of our planet, there were two gatherings of people who are looking for more understanding and communication on China and space. They were the 5th CSA-IAA Conference on Advanced Space Technology in Shanghai and the British Interplanetary Society (BIS)'s annual Chinese-Soviet Space Symposium in London. We have reports on both events. You will find that new information revealed in the Shanghai conference quite interesting and Go Taikonauts!'s presence in London having a good niche.

In the gallery of this issue, besides the Shenzhou 10 mission pictures, we bring you some photographs and graphics published for the first time in English language media. Take a look at these: a close-up photo of the Chinese docking mechanism, a detailed (unofficial) diagram of Shenzhou and Tiangong by Dietmar Roettler, the great (unofficial) 3D rendering of the planned Chinese Space Station (CSS) by Adrian Mann. Hope you like them!

(Chen Lan)

Imprint

Go Taikonauts! e-Magazine

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Chinese Space Quarterly Report

April - June 2013

by Chen Lan

Highlights

- More details of Long March 6 revealed. Larger Long March 6A planned.
- Structural construction of major facilities in Hainan launch site completed.
- China's super engine made first verification test on component level.
- New phase of Beidou construction will start next year.
- Shenzhou 10 mission concluded successfully. 60 million students took part in space lecture.
- Chinese Space Station to extend to six modules after 2020. International modules welcomed.
- Chang'e 3 started final major testing before launch.
- Sino-US joint comet exploration proposed. US silent on joint Mars mission.
- China and ESA plan joint science mission around 2020.
- China launched a sub-orbital rocket, alleged to be a high orbit anti-satellite test.

Launch Event

After a silence of more than four months at three Chinese launch sites, a CZ-2D vehicle lifted-off at 12:13 on 26 April from the Taiyuan Satellite Launch Centre. The rocket successfully placed four satellites into two different orbits. The satellites include China's first civil high-resolution Earth imaging satellite GF-1 (or Gao Fen, meaning: high resolution) and three CubeSats - the 1 kg NEE-01 Pegaso from Ecuador, the 2 kg CubeBug from Argentina, and the 4 kg TurkSat-3USat from Turkey. The three CubeSats were deployed 15 minutes after main engine shutdown by the ISIPOD CubeSat dispenser, developed by Innovative Space Logistics (ISL) of The Netherlands. Unfortunately, on 22 May, NEE-01 Pegaso was hit by a piece of debris from a Soviet upper stage and lost control.

No more than six days later, on 2 May at 0:06, China launched another satellite. It was the ChinaSat 11 (or ZX-11) comsat launched by a CZ-3B from Xichang. The DFH-4 based ZX-11 is the heaviest and most powerful comsat China has ever built and launched. It weighs 5,234 kg, has 5 antennas and 45 C- and Ku-band transponders.

On 11 June at 17:38, the highly anticipated Shenzhou 10 manned spacecraft was launched from Jiuquan by a CZ-2F rocket, sending three taikonauts, Nie Haisheng, Zhang Xiaoguang and Wang Yaping into space. It was another textbook launch and set a new record for the shortest period between two consecutive Chinese manned space launches – a little less than one year.

Launch Vehicle

On 20-23 May, the 5th CSA-IAA Conference on Advanced Space Technology was held in Shanghai. A presentation by SAST revealed more details of the CZ-6 vehicles it is developing. For the first time, a picture of the CZ-6 on a mobile launch vehicle was shown. CZ-6 needs only 7 days for launch preparation. It also revealed an enhanced model, the CZ-6A with strap-on boosters capable of putting 4 tonnes into SSO. The presentation also indicated the date of CZ-6's maiden flight in 2015, confirming a delay of about one year. It was previously expected to fly in 2014. The latest report about its development was in April about completion of an isolation layer installation on a liquid oxygen tank of its first stage. In the conference, SAST also introduced a new upper stage called TY-1. It uses storable

propellant capability and will be re-ignitable more than once to deploy satellites quickly and in different orbits.

CZ-7 is also a model with fast progress and is expected to fly in 2014. In April, a report reveals that the first oxidizer tank of its strap-on booster was completed and delivered. Material procurement for the CZ-7 engineering model was already on the way. However, there are also rumours floating about that its maiden flight has also been delayed to 2015.

Although CZ-5 encountered serious problems, it continues to make progress. Its first stage oxygen tank passed a critical test - the low temperature static load test - in Tianjin.

In Wenchang, Hainan Island, it was reported that structural construction of major facilities has been completed, paving the way for equipment installation. It was a major milestone since the ground breaking of the Wenchang Satellite Launch Centre in 2009. On 20 June, the port near the new launch centre welcomed the Yuanwang 21 rocket transportation ship. The ship was commissioned on 29 November 2012 and delivered on 6 May this year by the Jiangnan Shipyard, Shanghai.



A strap-on booster of CZ-5, developed by SAST, was hoisted for the first propulsion system test. (credit: China Space News)

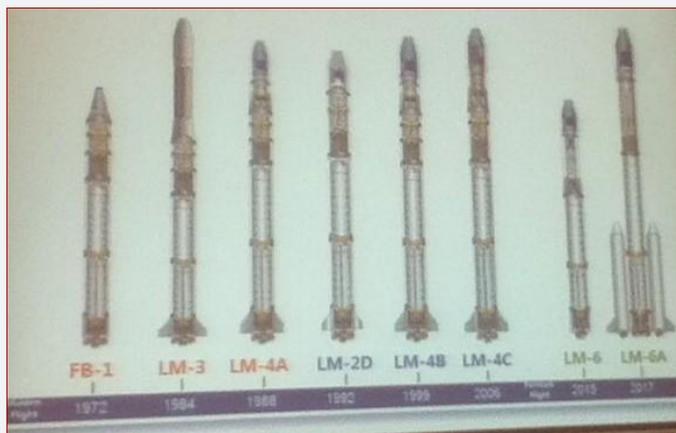
Once put into use, the new launch site will be managed by the Xichang Satellite Launch Centre (XSLC). This does not imply that XSLC will be shut down immediately. It is expected to continue to launch satellites until the toxic old Long March is finally phased out. On 2 May, XSLC announced in a media interview, that it will increase its annual launch capability from 9-10 to 15 launches per year. A new modernised satellite testing hall will also be built. The Pad 3 will also be upgraded and is expected to be completed in October 2014, enabling larger CZ models to be launched. Currently the Pad 3 supports only CZ-3A.

Propulsion

In late May, the first strap-on booster of the Long March 5 was transported to Beijing and hoisted to the vertical at the test stand. On 29 June at 15:30, it made a successful test-firing lasting 3 minutes. It was the largest static test-firing of a rocket propulsion system in Chinese space history. The Long March 5 booster is developed by SAST. The 3.35 m diameter rocket has a length of 27.6 m and dry weight of 14 tonnes. Its two YF-100 engines are able to provide a thrust of 240 tonnes.

In contrast, the successful Long March 6 first stage test-firing on 4 April went relatively unnoticed. It was the second time the Long March 6 has made such a test.

A more noticeable test was on a much smaller scale. In late May, the gas gimbaling installation on the 500-tonne liquid oxygen and kerosene engine made a successful hot test-firing. It's a major progress, marking that the 500-tonne engine project has basically completed concept analysis, key technology study and determination, and entered the phase of component design, manufacture and testing. The 500-tonne engine is developed for China's future manned lunar rocket. The Institute 11 of the 6th Academy of CASC (AAPT) is responsible for its pre-study and pre-development. Its full-scale development, along with the manned lunar landing project, is still in the planning stage. The government approval, or disapproval, is expected later this decade.



A slide shown in the 5th CSA-IAA Conference on Advanced Space Technology revealed an enhanced CZ-6 model (on the right). (credit: Go Taikonauts!)

Satellites

In mid-May, the 4th Annual Conference of Satellite Navigation of China was held in Wuhan. Some information about the future plan of the Beidou Navigation System was revealed during the conference by Chinese media:

- The first 3-4 experimental satellites of the next generation, global navigation system will be launched next year with new Chinese-built atomic clocks on board and new signal designs and frequency.
- Four back-up satellites for the current regional navigation system have been planned. Two of them will be built and launched as early as possible. The other two will be stored on the ground as emergency replacements.
- The first space-based Beidou terminal has been tested and verified and will soon be used on future Chinese spacecraft. It was also revealed that Beidou receivers will be tested and used in civil aviation flight and it is anticipated that they will be adopted to the standards of the International Civil Aviation Organization (ICAO) by 2015.

In this quarter, there were several news reports about China's meteorological satellites. China's first generation polar weather satellite FY-1D, launched on 15 May 2002, has worked normally in orbit for 11 years, exceeding the designed 2-year working life by 9 years. Later in May, the second generation polar weather satellite FY-3A, launched on 27 May 2008, exceeded the 5-year mark in space, 2 years more than its designed 3-year working life. Both satellites show that China's satellite technology has reached a new level.

Meanwhile, development of new meteorological satellites made progress. The third FY-3 (also the first operational FY-3) completed thermal vacuum testing in early June. The operational FY-3 has several improvements including 5 new high-performance equipment items and 4 upgraded ones, increased data storage and data transfer rate, increased end-of-life power supply from 1,180 W to 1,500 W, and longer working life from 3 years to 5 years. The new satellite will be launched in the second half of 2013. Development of another new generation meteorological satellite, the FY-4 geostationary satellite, is also on track. It was reported that electrical testing of



The two launch towers in Wenchang Satellite Launch Centre have been topped-off. The photo was taken around end of May. (credit: Sina.com)

its verification model has started in SAST.

Besides weather satellites, there were also reports on the status of a few other in-orbit satellites. Up to mid-April, China's second oceanic satellite, HY-1B, had worked for more than 6 years, 3 years more than its designed working life. China's first single-board nanosat, TT-1 (Tiantuo 1) worked normally for more than one year while its designed working life was only one month. TT-1 is equipped with the AIS (Automatic Identification System) that has collected more than one million messages from ships since its launch. Based on this data, China's first global AIS data map was generated. TT-1 also provided support for emergency rescue during the Shenzhou missions. At the end of May, CASC announced that the XY-1 (Xinjishu Yanzheng, or new technology validation) satellite, invested and developed by CASC itself, has completed its mission and achieved all desired objectives. On 18 April, the ZY-1 02C resource satellite was formally delivered to its customer, the Ministry of Land and Resource, after nearly four months of in-orbit testing.

In late June, CAS held a review meeting on the second batch of background projects for its Strategic Pioneer Programme on Space Science. Four projects, the Einstein Probe, the Extragalactic Earth-like Planet Exploration, Global Water Circulation Observation Satellite, and Advanced Space-based Solar Observatory, were reviewed. The first batch of background projects selected in June 2011 are: MIT (Magnetosphere-Ionosphere-Thermosphere Coupling Mission), SPORT (Solar Polar Orbit Radio Telescope), XTP (X-ray Timing and Polarisation) satellite and the Space Millimetre-wave VLBI Satellite. They will become follow-up missions after the currently approved 5 missions in the Strategic Pioneer Programme.

As concerns these background projects, pre-development and reviews have already been underway. A review was held on 16-17 April on XTP's scientific objectives. On 26-27 June, a joint XTP-GRAVITAS workshop by CAS and the International Space Science Institute Beijing (ISSI-BJ) was held in Beijing. The Max Planck Institute for Extraterrestrial Physics (MPE) and other six international research organisations participated in the workshop. GRAVITAS is an European space science mission. Scientists from MPE were also invited to the MIT project. On 20 June, the MIT payload review and working plan meeting was held in Beijing.

Approved projects in the Strategic Pioneer Programme on Space Science also made progress. A test of the HXMT (Hard X-ray Modulation Telescope) space – ground data link was successfully completed in Sanya, Hainan Island, during 20-23 April. On 26 April, it was announced that the Dark Matter Exploration Satellite (DMES) has completed the prototype development and formally entered the phase of engineering model development. Other approved projects include the SJ-10 microgravity satellite, the Quantum Science Satellite, and the Kuafu mission.

Manned Space Flight

The Shenzhou 10 mission was largely a repetition of the Shenzhou 9 flight of last year. Its main tasks included an autonomous docking on 13 June and a manual docking on 23 June, and scientific experiments performed inside of Tiangong 1. Of course,

this mission had more tasks included than its predecessor, the highlights of which were as follows:

- The mission lasted for 15 days, including 13 days inside the Tiangong 1. In comparison, the Shenzhou 9 mission lasted 13 days.
- On 20 June at 10:00, the crew carried out China's first and the world's second "space lecture" from Tiangong 1. 60 million students in China watched the live broadcast via CCTV. To make it successful, the crew, the ground team, as well as a team of teachers from middle schools, prepared for it for about one year. 2.9 kg of specially designed teaching aids were carried to space and used in the 45-minute lecture. Wang Yaping, the 33 year-old female taikonaut, China's second after Liu Yang, was the teacher of the lesson. It received quite good feedback nationwide. It is also worth noting that the video quality in the live broadcast was very stable and clear, showing impressive progress of China's communication technology.
- During the second day in Tiangong 1, the crew replaced its soft floor with a new hard floor carried into space by the Shenzhou 10 spacecraft. In the Shenzhou 9 mission last year, the soft floor was found problematic. It was difficult for the taikonauts to maintain a stable attitude with foot restraints on the soft floor.
- After undocking for re-entry, the Shenzhou 10 vehicle made a 180-degree fly-around above the Tiangong 1 mini station on 26 June. Unfortunately there have been no Tiangong 1 photographs taken from the Shenzhou 10 released publicly. A video clip from CCTV shows that another 180-degree fly-around below the Tiangong 1 was also likely performed before the first docking on 13 June. Previously expected r-bar rendezvous and docking was not seen in this mission.

On 26 June at 9:54, the Shenzhou 10 re-entry capsule landed safely in Inner Mongolia. Ground cameras and cameras on helicopters captured the whole sequence from re-entry to landing. The landing location was reportedly at 110°21'25.6E, 42°19'44N, well within the expected landing ellipse. But strong winds dragged the capsule a long distance before the parachute rope was cut.

The conclusion of the Shenzhou 10 mission marks the end of an important phase in China's manned space plan. Work for the next phases has already started. On 22 May, at a meeting in Beijing, CMSEO (CMSA) released a list of pre-study projects for the manned space programme. Possible contractors including CASC, CASIC, CAS and 23 universities attended the meeting. Zhou Jianping, Chief Designer of the manned space programme, and Wang Zhaoyao, Director of CMSEO, attended the meeting.

Although details of the above list were not made public, a paper by the Chief Designer about China's ambitious space station plan was published in the March issue of the Manned Space Flight journal, revealing a lot of interesting new information:

- The addition of three more modules after 2020 is considered. The Station will support six crew members.
- China welcomes international cooperation for new modules, including independently developed and launched modules, or co-developed modules.
- The cargo ship can be configured as fully-pressurised, half-pressurised or non-pressurised. It will also be able to launch small modules with a length of 4.5 m and a diameter of 3 m



which can be developed by international partners.

- A test vehicle of the core module will be launched before 2020 to test fundamental technologies. If it works well, it will become the core of the station. If not, an improved core module will be launched to form the Chinese Space Station (CSS).
- ISS-like large flexible solar panels at the end of two experiment modules were confirmed. Solar panels at the core module will be relocated to the tips of the experiment modules at a later stage by the robotic arm.

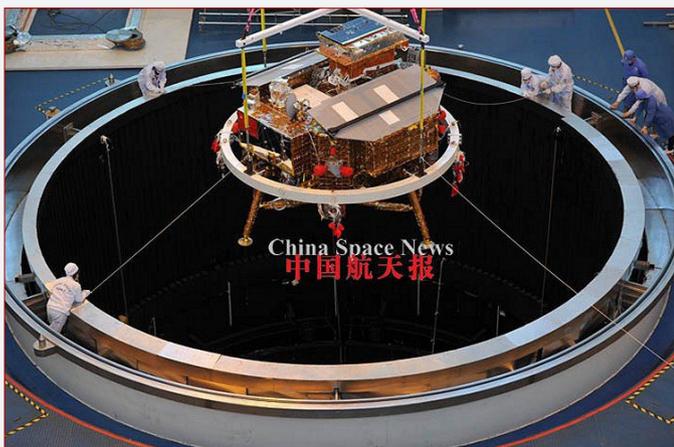
This ambitious station plan is not only on paper. Progress has already been made on ground. In mid-May, the Institute 805 of SAST has reportedly completed the development of 5 key technologies for the flexible solar panel for the future station. In mid-June, it was reported that the assembly facility for large spacecraft in Tianjin was completed. The same report also hinted that China's future space station module's weight and diameter will be 22 tonnes and 4.5 m, larger than that of ISS and Mir. In March, a new organisation under ACC (Astronaut Centre of China), the Astronaut Health Centre, was established. Its objective is announced to support long-term space flight as long as 180 days.

Lunar and Deep-Space Exploration

In late May, ground control reconfigured the Chang'e 2 deep-space probe. Its high-pressure gas path had been closed and its telemetry switched to omni-directional mode. Future work will be focused on long lifecycle assessment of onboard equipment, autonomous flight capability and long-range interplanetary telemetry verification. It was 350 million kilometres from the Earth in late May and is expected to reach the 500 million kilometre mark on 14 July.

In mid-May, Chang'e 3 started its final major testing, the thermal vacuum test, in the KM-6 test chamber. The testing was expected to last about 40 days. Launch of the Chang'e 2 lunar lander, expected at the end of the year, will become the most noticeable space mission in 2013 after the Shenzhou 10 mission.

Qi Faren, former Chief Designer of Shenzhou spacecraft, told



Chang'e 3 in thermal vacuum testing (credit: China Space News)

Chinese media that China's next Mars probe after the ill-fated Yinghuo 1 is expected to fly between 2015 and 2020. A tri-asteroid fly-by mission was also planned for around 2020. However, both missions need the government's approval and funding. In May, Ye Peijian, Chief Designer of the China's Lunar Exploration Programme, urged through Chinese media that the government has to make a decision as soon as possible, because flight opportunities for Mars exploration occur only once every two years otherwise it will be too late for a 2015 launch.

Interestingly, an announcement by the British Interplanetary Society for a lecture on 3 April disclosed a proposed joint Chinese-American two-spacecraft comet exploration. The veteran space probe ISEE-3/ICE will be NASA's contribution that will fly through the tail of comet Wirtanen in December 2018 by a lunar gravity-assist manoeuvre. There is no mention of China's probe and also no confirmation from Chinese media. The speaker Robert Farquhar is from Johns Hopkins University in the U.S.A.

Spacenews.com had a report on 29 May from Shanghai carrying a different message. During the 5th CSA-IAA Conference, its reporter Eric Johnson was told by a Chinese official who asked not to be identified, that China has informally approached NASA about a possible joint Mars landing, with no results so far. At the CSA-IAA Conference, China presented an ambitious deep-space roadmap involving most of the planets within the orbit of Saturn. It was similar to the plan revealed in the same conference two years ago (please, see the 5th CSA-IAA conference report in this issue and the report in the Issue 2 of Go Taikonauts!).

International Cooperation

To further promote international cooperation in the field of human space flight, the International Cooperation and Exchange Centre of CMSA (China Manned Space Agency) was founded on 19 April. The centre is run by China Great Wall Industry.

The 9th ESA-China Space Science Bilateral Meeting kicked-off in Palermo, Italy on 2 May 2013. The two delegations introduced ESA's ongoing space science programmes and CAS's Strategic Pioneer Programme on Space Science. Both parties discussed in detail the joint call for a cooperative space science satellite mission around 2020 and reached an in-depth understanding of further actions. A Minutes of Meeting was signed by both parties to promote further cooperation in the upcoming year. The 10th ESA-China Space Science Bilateral Meeting will be held in China in 2014.

On 10 April, the Canadian Space Agency hosted senior representatives from 11 space agencies from around the world for a meeting of the International Space Exploration Coordination Group (ISECG) to exchange information regarding interests, plans and activities in space exploration. CNSA representatives attended the meeting.

On 12 June, just one day after the Shenzhou 10 launch, the first female taikonaut, Liu Yang attended the 56th Committee Session of United Nation's COPUOS (Committee on the Peaceful Uses of Outer Space) in Vienna. Liu Yang also participated in a COPUOS panel discussion, dedicated to the 50th anniversary

of the first woman in space, Valentina Tereshkova, who was also present. Liu Yang gave a summary of her mission and was answering questions from the COPOUS delegates. On 13 June, in the Vienna Museum for the History of Nature, Liu Yang made a remarkable and passionate call for international space cooperation and again answered questions from the audience.

In addition, a five-day international workshop on human space technology in Beijing, from 16 to 20 September 2013 is being organised by the United Nations Office for Outer Space Affairs (UNOOSA) in cooperation with the China Manned Space Agency (CMSA) as part of the Human Space Technology Initiative (HSTI) under the framework of the United Nations Programme on Space Applications.

Pakistan is set to become the fifth Asian country to use China's domestic satellite navigation system which was launched as a rival to the US global positioning system, a report on 18 May said. Thailand, China, Laos and Brunei already use the Chinese system, which currently consists of 16 operational satellites, with 30 more due to join the system, according to the English-language China Daily.

Commercial Space

It was reported on 17 June that Thales Alenia Space has selected a SpaceX Falcon 9 rocket to launch Turkmenistan's first telecommunications satellite after being blocked by new U.S. export rules from shipping the satellite to China for launch. China and Thales Alenia signed the contract to launch the satellite using China's Long March 3B in December 2011.

It was a set-back to the Chinese commercial space sector. But there was also progress made in this quarter. On 15 April, the Cambodian Prime Minister Hun Sen visited CAST. It was revealed that China has signed a contract with Cambodia on an in-orbit delivery of a comsat. On 28 May, China Great Wall signed a US\$ 215 million contract with SupremeSAT of Sri Lanka for the design, manufacture and launch of the SupremeSAT-II satellite. The targeted launch date is mid-2016. The agreement was signed in China in the presence of President Mahinda

Rajapaksa and President Xi Jinping, during the recent visit of Sri Lankan President to China.

Meanwhile, execution of signed contracts was on track. In mid-May, Bolivia's first comsat, the Tupac Katari, completed stacking of its three modules in CAST. It was reported on 6 June by Prensa Latina that construction of the satellite was concluded and it had entered a testing phase prior to its launch in December.

By mid-April, design work of the LaoSat-1 has been completed. The LaoSat project has been delayed for more than three years. To secure its orbit slot and provide service as early as possible, Laos is inviting bidders to sell a second hand in-orbit comsat to move to the 126E slot with a budget of less than 10 millions USD.

Interestingly, despite controversy and debate, the Pentagon will continue for another year the lease of a Chinese commercial satellite to provide communications for its Africa Command. The use of China's Apstar-7 satellite will be extended under a \$10.7 million lease through the government solutions unit of a U.S. company, Harris CapRock Communications, the Pentagon said on 15 May in an e-mailed statement.

Space Policy, Space Education and Misc.

On the night of 13 May, numerous witnesses from Sichuan, Hubei, Hunan to Hong Kong observed a significant UFO event. Videos and photos appeared on the internet just minutes later. It was subsequently reported by the Chinese official media that it was a "high altitude sounding rocket", launched by CAS from Xichang Satellite Centre that reached a point "above 10,000 kilometres". As a research sounding rocket, its launch site and trajectory were quite unusual. There was also much less information disclosed about this test. As a result, many speculated that it was a new anti-satellite missile test targeting MEO or even GEO satellites.

In comparison, a sounding rocket launched on 5 April from the CAS sounding rocket base in Hainan Island had detailed reports in the Chinese media. During its 8-minute flight, the TY-3 sounding rocket reached an altitude of 191 kilometres and released 1 kg of Barium powder.

(Chen Lan)

Tiangong 1 Revisited

Learning to Operate a Space Station, with a Grand Vision in Mind

by Chen Lan



A Repeated Mission

Shenzhou 10 was originally planned as the only manned mission to rendezvous and dock with the Tiangong 1 space laboratory. However, due to the smooth and successful Shenzhou 8 unmanned docking mission in 2011, China decided to give up the second unmanned Tiangong 1 docking mission and let Shenzhou 9 be the first manned mission to visit the space lab. Shenzhou 10 then became the back-up of Shenzhou 9. As is now known, the Shenzhou 9 mission in 2012 was also very successful, and thus there was no need for a back-up mission. This accomplishment raised an important question - what would be the objectives of the Shenzhou 10 mission?

It was reasonable to speculate that Shenzhou 10 would test a new mission profile, or new technologies planned for later missions. For example, r-bar rendezvous and docking, or fast-track docking similar to what the Soyuz spacecraft performed recently, as well as an EVA from the station, were all talked about on the internet. But as the launch day came closer and closer, it became clear that the Shenzhou 10 mission would be a repetition of Shenzhou 9, with only a few new objectives. In fact, China defined the Shenzhou 10 mission as “an application mission on Tiangong 1” to further verify and mature existing technologies and to accumulate experience on space station operation. Also, the technical status of both the launch vehicle and the spacecraft had no major changes. According to Chinese space officials, the Shenzhou spacecraft had already been “type certified” and will be produced in a limited quantity for future missions within this decade.

CMSA announced on 28 February 2013, that Shenzhou 10 would be launched in early June and that the flight would last 15 days. The agency also revealed that a female taikonaut would join the crew. On 31 March, the Shenzhou 10 spacecraft completed its final test in CAST and was transported to Jiuquan by two Ilyushin 76 military transport planes. One month later

on 20 May, the CZ-2F (Y-10) rocket arrived in Jiuquan after three days of train travel. On 3 June, the CZ-2F – Shenzhou 10 combination rolled-out from the vertical assembly building and arrived at Pad 921 after a 1.5 kilometre journey taking one hour and 15 minutes. It was exactly one year ago on similar dates that the Shenzhou 9 mission did the same things, making Shenzhou 10 look more like a replay of the previous mission. Also, exactly as in Liu Yang’s case one year ago, Wang Yaping was one of the hottest topics related to this mission that the media paid most attention to. As expected, Wang Yaping’s presence in the crew had been widely reported a year ago already, but the official announcement came only on the last day before launch.

On 11 June 2013, at 17:38:02, with a burst of fire at its tail, a CZ-2F rocket rose slowly from Pad 921 at the Jiuquan Satellite Launch Centre, leaving in its wake a huge cloud of brown smoke. It ascended faster and faster into the dark blue sky, until unseen by the naked eye. But ground optical and infrared telescopes continued to track the rocket, and we were able to view the whole launch sequence on television. At T+123 seconds, the escape tower was jettisoned. Then, at T+155 seconds, the four strap-on boosters separated, followed by first stage separation 2 seconds later. The nearly simultaneous separation of the boosters and the first stage took place only with the improved CZ-2F vehicle since 2011. At T+213 seconds, the shroud was jettisoned and then at T+574 seconds, the spacecraft separated successfully. A little more than two minutes later at T+765 seconds, live video from the spacecraft showed the smooth deployment of the solar panels. The launch of the Shenzhou 10 manned spacecraft, the fifth manned launch in Chinese space history, was claimed a success in the Mission Control Centre in Beijing by General Zhang Youxia.

In space, the three taikonauts, including Nie Haisheng who was on his second space venture, quickly threw themselves into their work that would last for the next 15 days.

Running the Station

In similarity with the Shenzhou 8 and 9 missions, it took the Shenzhou 10 spacecraft about two days to chase and approach the Tiangong 1 space laboratory. The crew spent the Dragon Boat Festival in space, where they ate a special version of Zongzi (rice dumpling), a traditional food for the festival. Also, as in the two previous missions, the first rendezvous and docking of the flight was done autonomously. The spacecraft switched to autonomous mode for a docking at 10:48, 13 June Beijing Time. After passing through a series of parking points, contact occurred at 13:11 and docking was completed at 13:18. At 16:17, the hatch of the Tiangong 1 was opened by taikonaut Nie Haisheng. Nie then entered the Tiangong 1, followed by Zhang Xiaoguang and Wang Yaping. When all the three were in Tiangong 1, they stood side-by-side facing the camera, and waved their hands in a greeting to the ground. It reminded us of what happened one year ago and felt like an imitation show.

Nothing wrong in saying it was a repeated mission.

Tiangong 1 has been in space now for almost two years, or strictly speaking more than 21 months. Its designed working life is two years. There were concerns about ageing components, degraded air quality, and possible bacterial reproduction within the mini station. Though remote monitoring showed nominal data readings, there were still precautions taken to protect the taikonauts. Before Nie Haisheng floated into the Tiangong 1, he used a portable air detector to make sure that the air inside the Tiangong 1 would not harm the crew during their 13-day stay. Fortunately, there was no sign of harmful substances in the air. It seemed that there were also no other problems found during their two-week residence. Knowing the status of an ageing spacecraft and keeping it up and running is important for future long duration space flights. The experience the Shenzhou 10 crew obtained was definitely valuable.

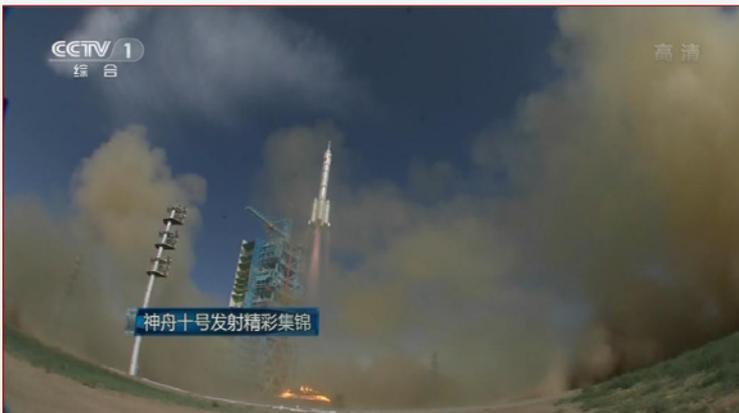
The first job for the crew in Tiangong 1 was to replace the "floor". In the Tiangong design, to make it easy to identify the simulated "up" and "down", one side of the interior was defined as a "floor" and was coloured brown. The original floor was

made of soft material, but the experience of the Shenzhou 9 crew proved that this may have been a mistake. Videos taken during the Shenzhou 9 mission show that, with foot restraints on the soft floor, the taikonauts had difficulty in keeping a stable attitude, especially when walking. The Shenzhou 10 spacecraft carried newly-designed hard floor plates to the Tiangong 1. On the morning of 14 June, just less than 20 hours after entering Tiangong 1, the crew had completed the replacement of the floor, which, from the video, appeared to be very easily and rapidly completed. It was the first time for an in-orbit Chinese spacecraft to replace a major component. It can be seen as China's first ever "space repair" operation which has historic significance.

Except for the "space lecture" on 20 June and the manual re-docking on 23 June, there seemed to be little novelty and excitement during the 13-day Tiangong occupation, in contrast with the Shenzhou 9 mission of one year ago. There was only "routine work" such as equipment checkout, scientific experiments on which not much detail was reported, and routine communication, as well as daily personal activities. On 23 June at 8:26, the Shenzhou 10 vehicle, under manual control of the

Shenzhou 10 launch. A screen-shot from an HD video taken by a camera very close to the launch pad. (credit: CCTV)

Strap-on boosters and first stage separation. (credit: CCTV)



Crew returned to Tiangong 1 after one year. They were greeting ground control just after entering the mini station. Please note, it was still with the yellow soft floor. (credit: CCTV)

Crew in space lecture inside the Tiangong 1. Nie Haisheng was preparing the mass measurement experiment. Please note, that floor inside the module had been replaced with that made of a white-coloured hard material. (credit: CCTV)

crew inside, un-docked from Tiangong 1. After separation of the two spacecraft, it retracted to a certain distance, believed to be similar to that in the Shenzhou 9 manual docking, which was about 400 metres distance. It then started re-approaching the space lab under the manual control of Nie Haisheng and with the assistance of Zhang Xiaoguang and Wang Yaping. At 10:00, the docking rings contacted each other, and at 10:07, locking finished and hard connection was established. The crew then re-opened the hatch of Tiangong 1 and returned to the space lab. There were no abnormalities reported during the re-docking operation. This was the sixth space docking by China. It has become almost routine.

At mid-night on 25 June, the crew started preparations for their return. They moved all required equipment and important items into the Shenzhou capsule. Their final activity inside the Tiangong 1 was a farewell ceremony. They expressed their appreciation and gratitude, in verbal and sign language, to those involved in the programme and the people supporting the space programme. At 5:07, they closed the hatch of Tiangong 1 and returned to their seats in the Shenzhou 10 re-entry capsule.

The un-docking for re-entry happened at 7:05. The Shenzhou 10 vehicle then made a 180 degree fly-around above the Tiangong 1 mini station. It was completed smoothly, but unfortunately there were no Tiangong 1 photographs taken from the Shenzhou 10 publicly released. China made the first spacecraft fly-around during the Shenzhou 7 mission, when the BX-1 satellite flew around the Shenzhou 7 vehicle in an approximately 90 degree arc. The Shenzhou 10 fly-around was one more step towards future complicated space station operations, in which spacecraft docking or re-docking to docking ports at different locations will become routine. In addition, a video clip from CCTV shows that another fly-around below the Tiangong 1 was also likely performed before the first docking on 13 June. But the previously expected r-bar rendezvous and docking was not seen in this mission.

On 26 June at 8:07, the Shenzhou 10 re-entry capsule landed safely in Inner Mongolia. Ground cameras and cameras on helicopters covered the capsule's complete trajectory from re-entry to landing. The most impressive feature was a video captured by the infrared camera showing a complicated sequence of a series of parachute deployments. The landing location was reportedly at 110°21'25.6E, 42°19'44N, well within the expected landing ellipse. But strong winds dragged the capsule a long distance before the parachute rope was cut. The three taikonauts egressed the capsule about two hours later, a little bit longer than in previous missions.

Space Lecture

The most significant and most widely reported event during the Shenzhou 10 mission was the space lecture on 20 June. Though the space lecture was not the first in the world, it was the first time for the Chinese space planners to include an educational programme in a manned space mission. China had previously launched the XW-1 student satellite in 2009, and sent a few student experiments onboard FSW recoverable satellites. But all previous activities were only extra-curricular activities that involved a very limited number of students. The space lecture from Shenzhou 10 however, would have an audience of around

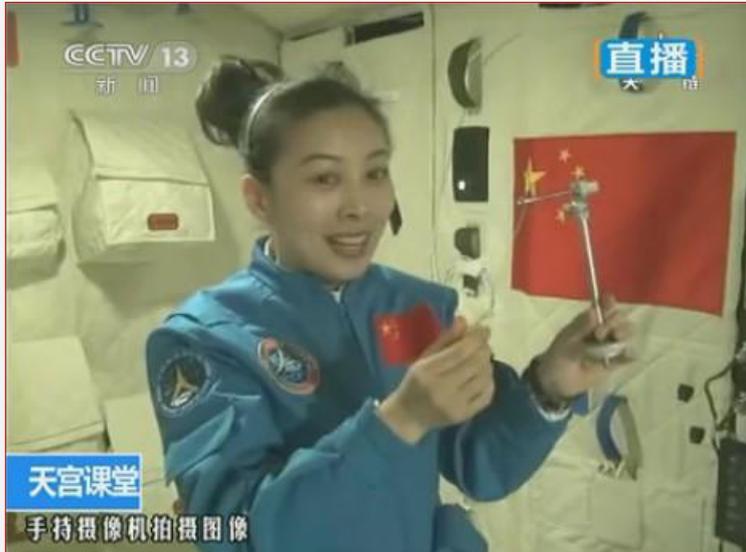
60 million students from all over China, because the Ministry of Education of China ordered all preliminary and middle schools, about 80,000 in total, to re-arrange their schedule for all the students to watch the live broadcast on 20 June. It was mandatory. Schools in some places had to re-schedule their middle school admission examination which is the most important examination for a preliminary student after 5-years of study.

The space lecture was initially proposed as early as before the Shenzhou 9 flight. Due to potential risks of the first manned docking mission and lack of time for preparation, it was moved to the Shenzhou 10 project. To guarantee the success of the first ever space lecture, preparation work began in September 2012. A request for proposals was sent to schools and various organisations. A team of teachers selected from middle schools was formed to assist in the preparation. At the end of 2012, the content of the lecture was determined and Wang Yaping was chosen to give the lecture. The lecture included five physics experiments and a few back-up experiments. To complete these experiments in space, 2.9 kg of special teaching aids were designed, manufactured and tested. Meanwhile, Wang Yaping underwent a series of training sessions on the experiments, teaching skills and even psychology. Rehearsals were also made. On one occasion, Wang Yaping even tried to give the lecture to the children of her neighbours.

On the morning of 20 June, even before Shenzhou 10 entered Chinese territory, the large classroom in the Affiliated Middle School of China People's University had already been filled with students. It was the main classroom on the ground for the space lecture that was connected to the Tiangong 1 through the Beijing Aerospace Flight Control Centre. Two other schools in Zhejiang and Jiangxi Provinces also served as ground classrooms. Students in these ground classrooms were able to ask questions directly to the Shenzhou 10 crew. There were also representative students from schools in minority areas, and also in Hong Kong and Macau. The lecture was broadcast live by CCTV and its web site. The audience included not only 60 million students, but also many other people from all over the world.

Around 10:00, the lecture was started by two physics teachers in the Beijing classroom. A short video about space was played. At 10:04, the Shenzhou crew appeared on the large screen. Wang Yaping and her colleagues, Nie Haisheng, the assistant in the lecture, and Zhang Xiaoguang, the cameraman, greeted the students and started China's first space lecture. To show weightlessness in space, Nie demonstrated his Kung Fu - sitting in a meditation position in the air - while Wang pushed him away easily with a gentle touch. Then Wang Yaping conducted five experiments:

- **Mass measurement:** There was a mass measurement device in Tiangong 1. Nie Haisheng "sat" on it and then he was pulled by string with a constant force to the wall. An optical device measured the velocity of the seat and elapsed time and calculated the acceleration. Using Newton's Second Law ($F = m \times a$), the mass was then calculated. Wang explained the principle after Nie's demonstration. The device showed that Nie's weight was 74 kg.



The rest of the five physical experiments of Wang Yaping (clockwise): simple pendulum, gyros, water film, and water ball. (credit: CCTV)



- **Simple pendulum:** The Beijing classroom teacher first demonstrated the simple pendulum on the ground. Then Wang Yangping fixed a simple pendulum at the table before her and touched the pendulum. It started an endless rotation. The TV screen showed the two pendulums with different behaviours side-by-side. Wang explained that without gravity, there is no force to pull down the pendulum which, on Earth, makes it swing when pushed.
- **Gyros:** Wang demonstrated a gyro's behaviour in space to show the principle that a spinning gyro can maintain its direction by itself. Wang put two gyros in mid air, one was spinning and the other not. When touched by a finger, the non-spinning gyro started to rotate slowly, but the spinning gyro kept just moving, with the direction of its axis unchanged.
- **Water film:** Wang Yaping put a ring that looked like a magnifying glass into a water bag. When she moved it out slowly, a water film was formed inside the ring. She tried to swing it. The water film bulged-out but never broke. Wang explained the principle that surface tension plays the major

role in the absence of gravity.

- **Water ball:** Wang had taken out an injector and used it to inject more water into the water film. It became larger and larger and finally became a perfect ball. She then injected coloured water into the ball, and the colour quickly filled the ball. Its principal, Wang explained, is similar to the previous one, that when there is no gravity, no force from any direction acts on the ball and surface tension plays the major role that makes it perfectly round.

After conducting the experiments, Wang Yaping answered five questions from students. The whole lecture lasted about 45 minutes. Wang Yaping's performance was remarkable. People were impressed with her nice voice, normative Mandarin and approachability. Feedback from schools and the public showed that it was a very successful lecture. The high video quality of the live broadcast also contributed to the success. During the lecture time from around 10:00 to 11:00, Shenzhou 10 passed over China but most of the transmission seemed to come through the Tianlian data relay satellite. The live video had a fine resolution and

was very stable, showing China's space digital communication technology has made great progress and continues to advance. On the third day of the Shenzhou 10 mission, the world's first space educator Barbara Morgan who gave the first space lecture during an STS mission in 2007 sent a letter to Wang Yaping. "On behalf of teachers and students around the world, I send you greetings of honor and love as you orbit our Earth and prepare to teach your lessons from space" said Barbara in the letter. She reminded Wang to take time to look out the window as "China and all of this world are beautiful". On 20 June, the same day of the space lecture, Wang Yaping replied to Barbara from Tiangong 1. "My colleagues and I are very happy to receive your letter in space..... Today we completed the space lecture smoothly and shared the beauty and wonder of space with Chinese students. Hope you and all teachers in the world may enjoy it when watching it" she said.

Tiangong 2 Confusion

After completion of the Shenzhou 10 mission, Tiangong 1 was to raise its orbit and switch to the "long-term management mode". It was reported earlier this year that Tiangong 1 was still in perfect condition and has enough remaining fuel to complete its planned mission. Some experts in the media hinted that it would be able to continue its operation even after the new Tiangong 2 was launched. This possibility triggered a string of speculation on how these two mini stations could work together. The most-discussed topics were the docking of two Tiangongs to form a space train, or a single Shenzhou to visit two stations to perform equipment transfer (the scenario of Soyuz T-15 that visited the Russian Mir and Salyut 7 stations). However, all these speculations have been proven inaccurate once more and more Tiangong 2 information came out.

It has now been made clear that Tiangong 2 will be the last single-module space station or space laboratory before introduction of the modular space station planned for around 2020. The planned Tiangong 3 vehicle has been cancelled according to the latest plan. Insiders revealed during the annual session of the National People's Conference in March, that Tiangong 2 will test space refueling with a cargo ship launched six months after the space lab. There was an official announcement at the Shenzhou 10 post-mission news briefing that the Tiangong 2 space laboratory will be launched around 2015.

Zhou Jianping, Chief Designer of the Chinese manned space programme disclosed more details about Tiangong 2 in a paper published in March 2013. According to Zhou, Tiangong 2's objective is to test and verify key technologies for the future space station. Two vehicles, the manned Shenzhou 11 spacecraft and the first cargo ship will visit it. These missions will be used to test in-orbit maintenance and conduct microgravity experiments, validate flexible solar panels, perform space refueling, and make other key technology verifications.

The cargo ship is an important component in the Tiangong 2 programme. Its development is based on the Tiangong 1 module. Similar to Tiangong 1, it has a diameter of 3.35 m and includes two segments, the propulsion segment and the cargo segment. The cargo part can have three configurations: fully-pressurised, semi-pressurised and non-pressurised. Such a design provides the capability to send large external payloads

to the station, to support independent experiments after cargo delivery, and launch small station modules with maximum length of 5 m, diameter of 3 m and mass of 5 tonnes. The Chinese cargo ship has an up-mass capability of 6.5 tonnes and can download 6.0 tonnes. Its maximum launch mass is 13.5 tonnes. The cargo vehicle is expected to be launched by the in-development CZ-7 from Wenchang Satellite Launch Centre, also under construction on Hainan Island.

With new information revealed and confirmed, an important question has arisen. According to the plan China previously announced, the Tiangong 2 would be based on the back-up vehicle of Tiangong 1 with slight modification. Its mass is around 8 tonnes and it will still be launched by a CZ-2F. While Tiangong 3 has a totally new design with two docking ports (one at each end) and a mass of 13 tonnes, which means it has to be launched by the CZ-7. The cargo ship docking and refueling would be performed on the Tiangong 3. Now, there is no Tiangong 3. Does this mean that Tiangong 2 will be based on the Tiangong 1 back-up or just be renamed Tiangong 3?

There are three scenarios for the Tiangong 2 space lab:

- The original 8-tonne version: This version would test refueling using one port. Modification or enhancement has to be done at the docking port to support refueling. The space lab will be unmanned when its only docking port is occupied by the cargo ship. As a result, dry cargo transfer is unexpected. It will not rely on the readiness of CZ-7 or the new launch site in Hainan.
- The re-designed 8-tonne version: With an additional docking port added, it could be visited by a Shenzhou and a cargo ship at the same time. This possibility would need a tunnel inside the service module, meaning a total re-design of the spacecraft and extensive modification of the Tiangong 1 back-up model. Although it has no reliance on the new launch vehicle and launch site, the large amount of re-designing and modification work needed would make it difficult to meet the schedule of a 2015 launch.
- The 13-tonne version: This is just a renamed Tiangong 3. This is a reasonable speculation. But the problem is it needs the CZ-7 to be ready for operational launch by 2015. As the maiden launch of CZ-7 has very likely slipped into 2015, it is risky but still possible.

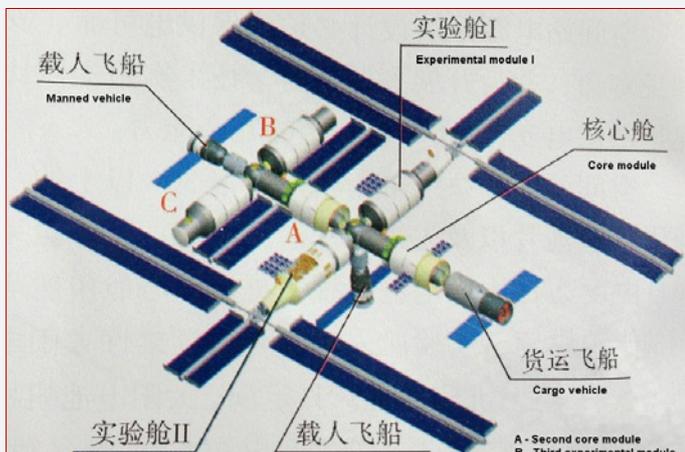
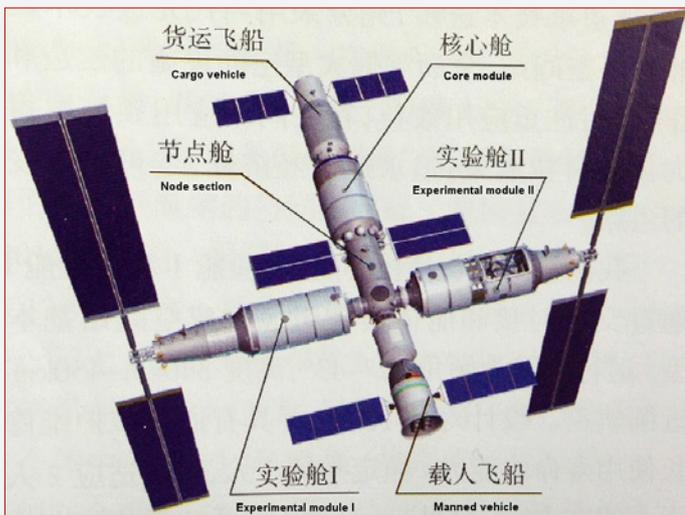
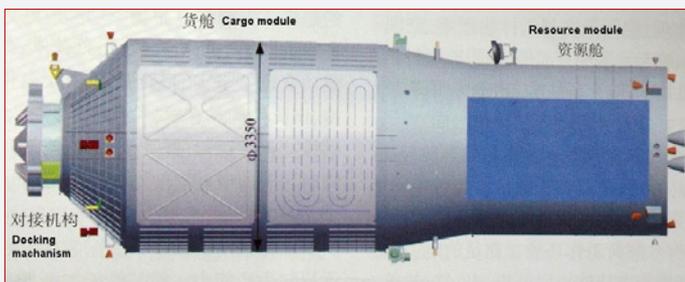
The answer to the above question will be provided in the next two years. If it has to be judged now, based on China's conservative approach on the manned space programme, the first scenario has the best chance.

The Great Station of China

Zhou Jianping's paper has a lot of new information about the future Chinese Space Station (CSS) to be completed around 2020. It has the most detailed description ever revealed on the station design that can be highlighted as follows:

- The station consists of three pressurised modules, the core module, the experiment module 1 and the experiment module 2, with two pairs of large solar panels at their ends. The three modules will be launched by CZ-5B from Hainan

Go TAIKONAUTS!



Illustrations in Zhou Jianping's paper (from top): the cargo vehicle, basic configuration of the station, a transitional configuration with only the second core module and relocated solar panels, and final "extended configuration" of the station. (credit: Zhou Jianping)

and put into an orbit with an inclination of 42-43 degrees and an altitude of 340-450 kilometres. It will have 90 cubic metres of free interior volume for crew activity, and is able to be permanently occupied by a crew of three.

- The core module consists of the resource section (service section), a habitation section and a node section. The node section has two docking ports (forward and nadir), two berthing ports (port and starboard for two experiment modules) and an EVA hatch (zenith). There is also a docking port at the aft of the module. The core module will be responsible for the station's centralised control and management. The node will also be the air-lock during the construction phase and will become the back-up air-lock once the experiment module 1 is docked which will then provide the main air-lock.
- The experiment module 1 consists of the resource section, the pressurised section and the air-lock. Besides scientific experiment facilities, it will play the role of the core module back-up for station control and management, and will serve as storage space.
- The experiment module 2 consists of the resource section, the pressurised section and the non-pressurised section installed with a large astronomical telescope.
- There will be a large robotic arm on the core module and a smaller one on one of the experiment modules. They can work independently and can also be combined to work as an elongated arm. Station modules docked at the forward or nadir ports will be transferred to lateral ports by the robotic arm.
- There is a pair of solar panels on each module. The one on the core module has one degree of freedom, while those on the experiment modules are large flexible panels with two degrees of freedom. They can be replaced during the station lifecycle. The energy conversion efficiency of the solar array will be above 30%, thanks to triple-junction GaAs cells. There will be a unified power grid on the station of 100 Volts.
- Attitude control will rely mainly on control moment gyroscopes (CMGs) with assistance of thruster jets. Orbit maintenance will use electric thrusters.
- A regenerative environmental control and life support system (ECLSS) will be used. Improved noise control as compared to Mir and ISS is projected, and a new type of EVA space suit will be developed for use on the station.
- The planned working life of the station is not less than 10 years, and interfaces for future extensions have already been taken into account from the beginning.

The station will be built-up in three phases. The first phase will start with the launch of a test vehicle of the core module in 2018, together with several manned and cargo vehicles. If the test module performs well over the two-year period to 2020, and passes the required assessments, it will then become the operational core module and the station will be constructed around it. If it falls short of the required performance, an improved core module will be launched around 2020 to become the backbone of the station. The plan of the test vehicle may probably explain why the Tiangong 3 has been cancelled. It will take over part of the tasks previously assigned to the Tiangong 3, such as the regenerative ECLSS. At the same time, the rest of the Tiangong 3 tasks will be moved to the Tiangong 2,

e.g. cargo vehicle docking and re-fueling. As a result, there will be no reason to develop a totally new, complicated and costly 13-tonne vehicle for just one mission. In fact, the current plan is the most cost-efficient approach, consistent with the philosophy in the Chinese manned space programme from the beginning, that is “less missions, large technology advance”.

In the second phase, two experiment modules will be launched, docked to the core module and moved to the lateral ports at the node section of the core module. Manned and cargo vehicle visits are also planned. The second phase is expected to be completed around 2022, marking the completion of the Chinese Space Station (CSS).

The third phase, as revealed by the Chief Designer in his paper, is the extension phase of the station that is most interesting. It is envisioned to extend the station to six modules and to have a capability between a Mir-class space complex and an ISS-class space station. The extension plan includes:

- The second core module with a docking node, providing redundant station control and management and more docking ports.
- Two more experiment modules docked to the second core module.
- Solar panels at the core module will be relocated to the tips of the experiment modules to guarantee enough power supply for the extended station.
- As many as four large exposure platforms. Two will be attached to two experiment modules. The other two will be installed at the location of the solar panels on the core module after they are relocated.
- The extended station is able to accommodate a crew of six for long duration flights.
- A maximum mass of 180 tonnes (believed to include at least one cargo vehicle and two Shenzhou vehicles).

Another interesting message delivered in Zhou Jianping’s paper is that China welcomes a wide range of international cooperation on construction of the Chinese Space Station (CSS). The extended design has already considered possible new modules provided by international partners. They can be built and launched by the partner, or co-developed with China and launched by China. The Chinese cargo vehicle is also able to deliver a 5-tonne class jointly-developed small module to the station. Foreign visiting vehicles, joint flight, mutual rescue operation, foreign or joint developed scientific payload/experiment on the station or on cargo ships, as well as data sharing, are all considered and welcomed.

In the next decade, the ISS will enter its extended utilisation phase, a commercial space station by Bigelow may orbit the Earth, new government and commercial transportation vehicles

will also be in service. With the joining of the Chinese Space Station (CSS) with links to the others, space in Low Earth Orbit will become much more exciting.

New Challenges

The Shenzhou 10 mission has demonstrated that China has matured its human space transportation system and the capability to build and operate a mini space station. China has almost completed two steps of its three-step manned space plan which was drawn up in 1992. In step 2, EVA, rendezvous and docking, and mini orbital station have all been realised. The Shenzhou 10 mission has now paved the way for a much larger, permanently human-occupied space station to be built at the end of this decade, the third and final step in the original plan.

However, as China’s society becomes more and more open and the public has more and more influence on the government’s decision-making process, the expensive manned space plan will probably face challenges. One event during the Shenzhou 10 mission represented such a trend. Chinese media questioned the credibility of official data on Wang Yaping’s age and Nie Haisheng’s weight, because the previously released Wang’s birthday (in 1978) contradicts with her CV released before the flight (1980), and Nie’s weight measured in the space lecture (74 kg) was in conflict with the earlier official data of 67 kg. Although both questions were well explained in the post-mission news briefing; that Wang’s 1978 birthday was from an earlier incorrect media report and Nie’s weight error is a result of weight change over many years, it is still symbolic indicating more and more pressure on the space programme from the public in future.

It looks like Chinese space officials have realised that this type of pressure is increasing. During the Shenzhou 10 mission, official media reports have been intentionally reduced. In the CCTV live launch broadcast, it was not until about T-10 minutes that in-cabin video was shown. In comparison, during all recent Shenzhou launches, TV stations covered crew ingress and in-cabin preparation all the way. The two docking events which occurred on 13 July and 23 July respectively, had no live TV coverage either. Newspapers and web sites also reduced coverage of the mission with Wang Yaping’s space lecture as the singular exception. Nevertheless, is this a good way to cope with such issues? It’s an important question.

There are challenges ahead, not only technological but also political and social. Just as in other countries, a sustainable space programme needs the support of the public. The space lecture in the Shenzhou 10 mission was indeed a good effort to acquire public support. Chinese space decision-makers are historically not used to dealing with this, but as China advances more and more, it has to become normal practice in the Chinese space programme. Construction of the Chinese Space Station (CSS) and the intended international cooperation, will definitely push this change, we believe.

My Shenzhou 10 Launch Tour

by Xie Xirui

On 11 June, my family of three came to the Jiuquan Satellite Launch Centre and luckily, watched the Shenzhou 10 launch at the site itself. This short report is to share the wonderful memories with all of you, with best wishes to the Chinese space programme.

Preparation

After the Boss (note: kidding the author's wife) put forward the requirement for the tour, I immediately started work on the mission proposal. Route investigation (frustrating)... schedule planning (headache)... contacting travel agencies (dizzy)... purchase of train and air tickets (that's simple. Money just works). Well, despite all the numerous difficulties, I managed to get everything finally done on 7 June, except for the uncertainty of whether we would be able to watch the launch or not.

The schedule

- 8 June: Jinan to Jiuquan, Train 1085 (9:20 – 17:51 the next day)
- 9 June: Accommodation in Hating Hotel, Jiuquan
- 10 June: Jiuquan to Dunhuang, Train K9667 (2:35 – 7:45)
Visit Sougning Dunes, Crescent Moon Spring and Mogao Grottoes
Dunhuang to Jiuquan, Train K9667 (18:58 – 0:15)
- 11 June: Visit JSLC for the Shenzhou 10 launch
- 12 June: Jiayuguang – Xi'an, Train T194 (7:23 – 23:44)
Accommodation in Longhai Hotel, Xi'an
- 13 June: Hotel to Terminal 3, Xianyang Airport, Xi'an
Xi'an to Jinan, Flight MU2430, China Eastern (11:15 - 12:45)

8 June

Departure! My elder brother drove us to the Jinan Railway Station. We boarded the train #1085, and started a 33-hour long journey.

Clang, clang, clang...

9 June

Continued clang, clang, clang...

At 17:51, we got off the train. My relative asked his relative to come to the railway station to meet us. He then took us to the Hanting Hotel of Jiuquan where we checked in.

Having dinner in a hurry, we went to bed early. At 2:00 in the night, we left to catch the train to Dunhuang due to depart at 2:35. Seeing my relative's relative waiting at the gate of the hotel, suddenly I felt so warmed and touched.

This time, after clanging for 5 hours (only), we arrived in Dunhuang.

10 June

Spectacular Sougning Dunes, beautiful Crescent Moon Spring, mysterious Mogao Grottoes. Dunhuang is really a good place. "Just stay here for long", as my wife said.

Good news came just before we leave Dunhuang: we are allowed to enter the launch centre to view the launch at close distance on 11 June. Thank god! My ancestors are blessing me.

Clanged again for another five hours, we were back in Jiuquan.

11 June

On 11 June at 6:00, we departed from the hotel and headed to the Dongfeng Space City!

Although the name of the launch centre started with the word Jiuquan, to be more accurate, it is located in Ejina Qi, Alashan Meng, Inner Mongolia. It takes about 3-4 hours from Jiuquan City by highway.



View from the top of the Sougning Dunes.



On top of the Sougning Dunes.

all photos: Xie Xirui

all photos: Xie Xirui



View of the Crescent Moon Spring.



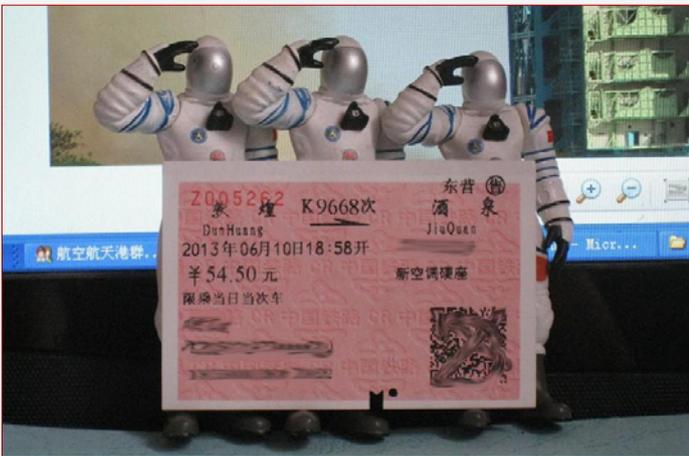
My son took a flight on the Little Bee ultra light aircraft.



The Crescent Moon Spring seen from the Little Bee.



Mogao Grottoes of which I dreamt for more than 30 years...



The train ticket from Dunhuang to Jiuquan.



A wind power plant of huge scale was seen near Guazhou on our return journey.

On the way, we came across a string of Toyota Coaster vans. They were sent to the Dingxin airport to wait for President Xi. After we arrived in the Space City, near the landmark sculpture in the Space City, we met again the motorcade of President Xi. This time, he's inside.

We gathered at 13:50 and then departed for the launch pad! Traffic was controlled at the street before the Wentian Pavilion

when we passed by. Obviously, President Xi was seeing the taikonauts off that time.

Arriving at the launch pad, our first sight was of the vertical assembly building. Finally we saw the Pad 921. Seeing the magnificent combination of the CZ-2F rocket and the Shenzhou 10 spacecraft closely, it's hard to express how excited I was. What a great feeling!

all photos: Xie Xirui



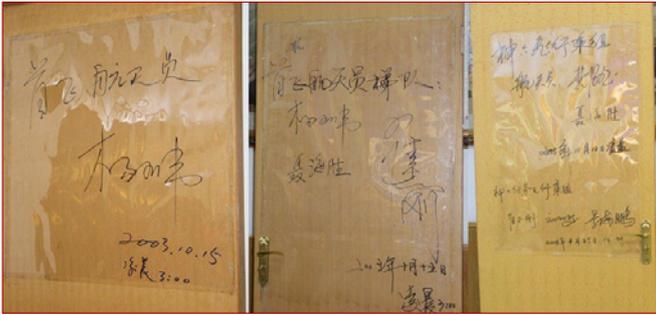
A traffic sign pointing to the launch centre. In fact, there is only one road which makes it hard to go wrong.



The DF-2 missile in the Space City. Most likely it's a true one.



The History Museum of the launch centre.



The door of the room where Yang Liwei stayed on the eve of the Shenzhou 5 mission (left). It was dismantled and displayed here. This was said to be a tradition since the Gagarin era. And the doors signed by the Shenzhou 5 primary and back-up crew (centre) and the Shenzhou 6 and 7 crews (right).

Wentian Pavilion where taikonauts were waiting for departure at the moment the photo was taken.



CCTV was preparing for a live broadcast of the departure ceremony.



Ignition! Lift off! With speed increasing, it climbed higher and higher. The rocket looked stunning in the blue sky.

With excitement and reluctance, I left the launch centre. The MPV ran on Gobi desert under evening sunshine. With a red glow filling the sky, the view was splendid and pleasant. I was still absorbed in the launch that rocked me, without speaking a word for a long time. The great view passing outside the window could not draw me back to reality. At around 10:00 pm, we were back in the hotel. My wife and son both felt that my soul had been left in the Space City. They joked to send me back!

12 June

At 6:00 in the early morning, we left Jiuquan and went to the Jiayuguan Railway Station to take the train T194 to Xi'an.

This time, it clanged for 16 hours. We arrived in Xi'an at 23:41.

13 June

As this trip used up a very short vacation of my son when his school needed to free classrooms for the university and high school admission exams, he had to return to school on 14 June. As a result, our schedule was so tight that we had to have only a glimpse of Xi'an. It was a pity that we missed the Terracotta Warriors, the eighth wonder of the world.

Summary

I think that this trip was very successful in that it realised one of my dreams. Thanks to CCTV! Thanks to the National Meteorological Centre... and most importantly, thanks to the Boss of my family! Without her setting the guiding principles, this trip would still be in the air. My child has gained most from this trip. It not only extended his knowledge and increased his interest in space, but also helped his personal growth. His teachers asked him to make a presentation in his class. Girls now look at him differently.

I saw many visitors from all over the country on the launch site. Some are from space industry. Some are enthusiasts like me. And more are just ordinary people who know nothing about

space which made me confused. But after observing them and talking with them, I understood that they not only came to see a rocket launch for the novelty. Instead, they came to experience the fast progressing of the country's space programme with their own involvement, and to enjoy the happiness and excitement of it. I think this is a coming-together of normal life and the space programme, which, in the past, looked out of reach.

Bless you, China space! Jia You China space!

(The report was originally published on bbs.9ifly.cn in Chinese)

Climbing.



There was only a trail of smoke left in air. The launch was a full success!

The pad 921 before launch. With the umbilical arms already swung away, launch was imminent.



The vertical assembly building.



Lift off.



The Pad 603 and 921 in one photo after launch.

all photos: Xie Xirui

“Let us all together become people closest to the sun.”

China’s First Lady in space is passionately advocating international space cooperation

by Jacqueline Myrrhe

If one wouldn’t know one wouldn’t believe it: this petite lady has become China’s first women in space. If you look at her beautiful face you could easily imagine she is a model, an artist, maybe even a scientist - but an astronaut? If you shake her tiny hand, you do not dare to press too hard fearing you could break her bones. But if she starts to speak you understand: this person has not only got charm and intellect, but also a strong character. Her voice is filling the biggest room, transporting her thoughts clearly and convincingly. Her speech is poetic and inspirational. Seeing her and listening to her is quite an experience. Mid-June she was on stage in Vienna and conveyed an important message to the world.

Liu Yang launched into space 16 June 2012, exactly on the 49th anniversary of Valentina Tereshkova’s space mission, marking China’s milestone achievement of its first female taikonaut. One year on, Wednesday, 12 June 2013, she participated in the first day of the 56th session of the United Nation’s Committee on the Peaceful Uses of Outer Space (COPUOS) within the UN Office for Outer Space Affairs (UNOOSA) in Vienna. She followed the meeting during the morning as an observer. Immediately at the beginning of the session, the Head of Meeting drew attention to her presence, when he congratulated China on the successful launch of Shenzhou 10 the day before.

China’s best Space Ambassador

On the afternoon of that day, Liu Yang took over a more active part in a COPUOS panel discussion, dedicated to the 50th anniversary of the first woman in space, Valentina Tereshkova. Not only Tereshkova herself, but also Roberta Bondar, the first Canadian woman astronaut, Chiaki Mukai, Japan’s first female space flyer, and other respectable female space experts were present.



Liu Yang – model, artist, scientist, astronaut?
credit: Karola Riegler

Go Taikonauts! had the opportunity to talk to Liu Yang in Vienna. Here are her answers.

GoTaikonauts!: Congratulations on your exceptional achievement last year when flying as the first Chinese women into space. Many people all over the world have been following with enthusiasm and good wishes your very successful mission. Now, one year later, do you still remember your days in space? And if so, what left an everlasting memory in your mind?

Liu Yang: Of course I remember. Although it has been one year since then, the experience in space was an unforgettable experience for me. I think it will be remembered in my whole life. Now, that you ask me what is most impressive, I would say, the unique environment and the wonderful feeling experienced in space which is still fresh in my memory. In particular, at the first sight of the Earth, I was stunned by the beauty of our Earth. It made me realise how much I love my planet and our planet is so beautiful.

GoTaikonauts!: What is your current assignment, your work or your duty and what are your professional plans for the future?

After the opening of the afternoon panel by Director-General of the United Nations Office at Vienna Yury Fedotov, Prof. Mazlan Othman, Director of UNOOSA, led the discussion. Liu Yang gave a presentation about her mission and was answering questions from the COPUOS delegates. She concluded her explanations with an outlook to the near-term objectives of the Chinese manned space programme, and stated that the manned space missions are advancing with more flights to come, because China is setting up its own space station which will be open to all nations of the world.

It might not have been intended by the organisers, but it could not have been more symbolic that Liu Yang was sitting on Tereshkova’s right – the future taking its place next to the past.

The next day, Thursday, 13 June, in the Vienna Museum for History of Nature, a public panel discussion included next to Liu Yang, again Chiaki Mukai and Roberta Bondar, but also NASA astronaut Janet Kavandi. The moderation was taken over by Romania’s cosmonaut and President of the Association of Space Explorers, Dumitru Dorin Prunariu. Liu Yang answered numerous questions from the audience but also made a remarkable and passionate call for international space cooperation.

The Message to the World

She started her talk by pointing out that Chinese culture knows many beautiful stories and fairy tales about flying into space. “As you may know, here in the UN-City in Vienna there is the statue of “Nü Wa patching up the sky” which is the symbol of a fairy tale. I loved to listen to those stories but for me they were just fairy tales, beautiful stories.” She continued: “When I was a young girl I had many aspirations of becoming a teacher,



a doctor, but it would never have occurred to me that I would fly into space one day. But life is full of surprises, isn't it? In 1977 I applied to the flight school in China to become a pilot. When I was flying high up in the sky I thought very naively I am flying very close to the sun. But later when I learned about space exploration, I realised that it was the astronauts who are the closest to the sun. In 2009 China initiated the selection and recruitment of female taikonauts. After hearing that news, I applied without hesitation to become the one flying closest to the sun."

Then she used the opportunity to mention the Chinese Shenzhou 10 space mission currently taking place, and wished the crew success. "Everybody knows space exploration is a common aspiration. The path of space exploration is risky and dangerous. This requires significant courage. I hope that every mission is successful, safe and smooth - not only for Chinese missions but for all missions."

At the end of her talk she touched the audience when she called out: "Although China's space programme is moderate it has developed according to plan... In the future there will be more space missions and China will build its own Space Station to provide a sky lab open to everyone. It will be our new home in space. You are welcome to join us! Let us all together become people closest to the sun."

Looking back – searching for the origin

Generally ignored by the West, China's space officials have repeatedly announced that their future space station would be available for global space research projects.

Liu Yang's appearance in Vienna was not the first time that taikonauts have borne witness in front of the UN. Yang Liwei, the first Chinese in space and now Deputy Head of China's Manned Space Agency CMSA, attended the 54th session of the United Nations Committee on

Liu Yang: At the present, I am still involved in space flight activities and continue training. I wish very much I can perform the next mission. I think, my future work will definitely be connected with space flight.

GoTaikonauts!: Will you fly again into space? Regardless, whether you will fly again, would it be a personal wish or dream for you to fly to the International Space Station or would you also like to fly to the Moon or Mars?

Liu Yang: Of course, I would look forward to another space flight. Our Chinese taikonauts are happy to cooperate with astronauts from all over the world. I also wish someday, I may be able to fly to the Moon and to Mars or even planets much farther away.

GoTaikonauts!: Do you think you can promote somehow more space flight opportunities for Chinese women?

Liu Yang: It can be said that the progress of Chinese space technologies has opened a door for Chinese women. I am only the first person to go through this door. I believe that what people have seen with Shenzhou 10 was only the second Chinese women taikonaut. With the development of China's human space technology, more and more women will definitely join the troop of space explorers.

GoTaikonauts!: What do you think you can contribute to the future progress of the Chinese human space flight programme?

Liu Yang: I believe that throughout continued training, we will further explore the universe and develop resources in space. It should be my contribution as a taikonaut. And, I hope to come to space to carry out planetary exploration and even planetary immigration together with other astronauts whether they are from China or other countries. I think it will also be the contribution of the Chinese space programme to the world. Hope that more and more countries to join our Chinese space station.

GoTaikonauts!: What can we expect from the Chinese human space flight programme within the next 10 to 30 years? Will the next human landing on the Moon be a Chinese citizen?

Liu Yang: Just now, in my report I made to the UN today in the afternoon, I explained that in 2020 we will establish our own space station. It will be an open space laboratory. We welcome every country in the world to participate. Of course I personally wished very much that the next person who would be landing on the Moon will be a Chinese... and we could land on the Moon together with foreign friends.

GoTaikonauts!: Thank you very much for giving your time to answer our questions!

Go Taikonauts! wishes to thank **Romana Kofler** of UNOOSA and **He Liang** of the Permanent Mission of the People's Republic of China to the United Nations for arranging the interview opportunity. Also, thanks to Chen Lan and Ping Yen-Henkel for the transcription from Chinese into English.

the Peaceful Uses of Outer Space in June 2011. Already by that time he stated: "China has enormous potential to cooperate with other countries in the field of space development," adding that "China is willing to make positive efforts in this regard. Exchange and cooperation between China and other countries have been effective and will be further strengthened in the future."

A few months later, in September 2011, the Chief Designer of China's Manned Space Flight Programme, Zhou Jianping told Xinhua, that China will turn its future space station into an international platform for space research and applications to share space achievements with partners. This was right after the launch of the Tiangong 1 space lab module when nobody outside China had an idea of how this module might look. Only when 9 months later, in June 2012 the TV transmission from the first manned docking of Shenzhou 9 to that space-something-module were transmitted to the world, astonishment kicked in. Yes - as it turned out - Tiangong 1 is - indeed - a space laboratory! Life is full of surprises, isn't it?

Also worth recalling is that UNOOSA Director Othman was invited by China to watch the launch of Shenzhou 9 from the Jiuquan Satellite Launch Centre. According to the CMSA website, Deputy Chief Commander of China's Manned Space Engineering Project Niu Hongguang met with Prof. Othman on 16 June 2012. During that face-to-face talk he took the opportunity to "highly praise UNOOSA for its years of efforts in advancing global peaceful uses of outer space and promoting international cooperation in space technology. Niu illustrated the tenet of China's manned space engineering project and explicitly expressed that China is willing to actively respond to the initiatives of the United Nations, conduct manned space exchanges and cooperation with more nations in the world, and jointly promote the development of world-wide space technology."

This was reinforced by Wang Zhaoyao, Director of China's



Left: Liu Yang with the Chinese delegation on Wednesday, 12 June 2013, short before the 56th session of the United Nation's Committee on the Peaceful Uses of Outer Space (COPUOS) within the UN Office for Outer Space Affairs (UNOOSA) in Vienna started. credit: Go Taikonauts! **Middle:** Liu Yang working during the 56th COPUOS session. credit: Go Taikonauts! **Right:** The future is sitting next to the past. credit: Go Taikonauts!

Manned Space Agency - CMSA - two days later in Beijing, where Othman travelled to after the launch. In China's capital she also visited the China Academy of Space Technology (CAST), the Astronaut Centre Of China (ACC), and the Beijing Aerospace Control Centre (BACC).

Prof. Othman's visit in 2012 to the astronautical flagship facilities of the Middle Kingdom might be considered the starting point of the biggest international space project in the history of mankind which is about to take shape now.

The statement by Deng Yibing, Director of China's Astronaut Research and Training Center, after the successful landing of the Shenzhou 10 crew can be considered as the last one in a string of hints. Xinhua reported on its website, that during a press briefing in Beijing, Deng "called for international cooperation to promote the development of manned space technologies." He shed light on the fact that "China has long been pushing for international cooperation in the manned space programme under the principles of mutual respect, equality and mutual benefit, as well as of transparency and opening. China has long been paying great attention to exchanges and cooperation between Chinese astronauts and their international counterparts and is willing to help train astronauts for other countries."

Not a closed club

The Shenzhou 10 mission, clearly, was another step in the preparation of the Chinese Space Station (CSS). In contrast to the International Space Station (ISS) currently in orbit and operated by the US, Russia, Canada, Japan and Europe, the CSS will not become a closed club.

After 2020, by the time when the ISS is facing an uncertain perspective, China's future orbital outpost is planned to be operational. As Liu Yang stressed in Vienna: "It will be our new home in space." Moreover, the CSS would not only be at other space nations disposal, but also at the disposal of non-space fairing nations, which might not even have a space programme nor a space agency – not today. This concept is warmly supported by the United Nations. UNOOSA initiated in 2010, under the framework of the United Nations Programme on Space Applications, a project dedicated to technology development in the area of manned space programmes, the so-called "Human Space Technology Initiative – HSTI". The core of this programme is to build space skills in countries currently without a space programme – which means in the majority of the current 74 UNOOSA Member States.



Left: During the afternoon panel discussion of the 56th COPUOS session, dedicated to 50 years of Women in Space. credit: Go Taikonauts! **Right:** Where ever Liu Yang was going, she was surrounded by space enthusiasts asking for her signature or approaching her to get a photograph taken together with her. After the inauguration of the UN photo exhibition "50 Years of Women in Space" Liu Yang joined the Members of the Chinese Permanent Mission at the United Nations in Vienna for a group photo. credit: Go Taikonauts!



After arrival in the Tiangong 1 space lab, Liu Yang found a present which was left for her by the ground staff preparing the lab for the launch into space. (left) In return, Liu Yang also manufactured a gift for the crew coming after her to Tiangong. (right) Being asked what she left in the lab, Liu Yang explained: "I would like to leave it to the second Chinese women in space to reveal the secret. But I can give you a small hint. I have left in Tiangong 1 for the next crew two of my hand-woven gifts. The one was woven by myself and the other one was made jointly by me and my other two crew members. Everybody knows, space exploration is a common aspiration. The path of space exploration is risky and dangerous. This requires significant courage. I hope that every mission is successful, safe and smooth - not only for Chinese missions but for all missions. These two gifts are my best wishes and blessings. The secret will be unveiled in the next few days." credit: Go Taikonauts!

June 2012 - Laying the foundation. Prof. Othman is meeting Niu Hongguang Jiuquan Satellite Launch Centre (left) and Wang Zhaoyao, Head of China's Manned Space Engineering Office, in Beijing (right). credit: CMSA



To realise this in practice, China has offered to UNOOSA its future Space Station. Mazlan Othman, introduced this idea end of May in Brussels, during the Space Policy Round Table "Cooperation vs. Competition", jointly organised by the Secure World Foundation and Women in Aerospace Europe. She explained: "Human Space Technologies: We are not here to compete with the International Space Station, but what we are paid to do is to harness the opportunities available, offered by the ISS, for developing countries. Again, we promote international cooperation between Member States in order to benefit from the ISS, mainly. But of course we are also working with China. Because we know that by 2018 the plan in China is to have a Space Station which would be fully operational by 2020. So China has offered to us to carry out experiments. And maybe, m-a-y-be they even have a module ready where international cooperation can happen."

Othman should be the "right stuff" to bring such a project to life. In the past, she not only initiated a satellite programme in her home country Malaysia, but translated that experience into a similar, but much more extensive UN project after she became UNOOSA's Director. (Compare interview with her in GT! No 8). The highly successful "Basic Space Technology Initiative – BSTI", aimed at building capacity in basic space technology for countries without such expertise. The activities focussed on small satellites and their applications in support of sustainable development. After the successful implementation of BSTI, the new HSTI initiative is just another "small step" on the road to the future.

In similarity with this precursor project, the Human Space Technology Initiative is also supporting capacity building, but this time in manned technologies, and in particular in non-traditional



Dumitru Prunariu - first Romanian in space: "I can give you a statistic from my country. In the school of my grandchildren 10 % of the parents asked the school managers to organise Chinese language lessons after the official school lessons - 10 % requested that! I am sure that they do not know yet that China will be in a few years open for international space flights... but indirectly we prepare for that." credit: Karola Riegler



In honour of Valentina Tereshkova's milestone achievement as the first woman in space, the United Nations featured a photo exhibition dedicated to her space mission and the role of women in space exploration. This photo taken during the opening of the exhibition shows female space travellers united from four countries and three continents to celebrate what has bound them together: space exploration. From the left: Chiaki Mukai, Valentina Tereshkova, Roberta Bondar, Liu Yang, and UNOOSA Director Mazlan Othman. credit: Go Taikonauts!



space countries. It is based upon the three pillars:

International Cooperation to promote international cooperation in human spaceflight and space exploration-related activities;

Outreach, to promote increased awareness among Member States on the benefits of utilising human space technology and its applications, and last but not least on

Capacity-building, to build capacity in microgravity science education and research.

To discuss the programme further, UNOOSA is currently preparing jointly with the CMSA, a workshop in Beijing – just one week before the who’s who of astronautics will meet in China’s metropolis for its annual get-together, the IAC, the International Astronautical Congress. UNOOSA and CMSA will make use of the days before the IAC to exchange information on the latest developments and future plans of human space flight and space exploration, to create awareness on the benefits of human space technology and its applications, to promote the capacity on microgravity research and education, and to identify the potential opportunities for new space-faring and emerging countries to participate in space exploration-related efforts. Most importantly, the workshop will also discuss the potential cooperation opportunities in the context of HSTI activities to promote human space technology and its applications to benefit mankind.

China on the other hand, is still going further. A paper, published in March by Zhou Jianping, Chief Designer of the Chinese Manned Space Programme, once again, is stressing the aspect of international cooperation. Moreover, China is offering potential partners to build their own space module and dock them to the Chinese Space Station CSS. Chen Lan is elaborating the details of that project in his article “Tiangong 1 – Revisited”, to be found in this newsletter.

But life is full of surprises! On 19 April 2013 CMSA, backed by the China Aerospace Science and Technology Consultant Co. Ltd., founded the International Cooperation and Exchange Centre, a permanent support organisation in Beijing aiming at international cooperation research and consulting in the area of manned spaceflight. The tasks of the



The Story of Nü Wa

On 21 November 2012, on the occasion of the 25th anniversary of the Montreal Protocol on substances that deplete the ozone layer, a statue donated by Chinese artist Professor Yuan Xikun, Patron for Arts and Environment for the United Nations Environment Programme (UNEP) was revealed in the United Nations Headquarters in Vienna. The plaque on the monuments says: "Sky-patching" is a Chinese mythological story dating back to ancient times. Warfare had caused a hole in the sky, so Goddess Nüwa refined 36,500 five-colour stones to heal the sky, saving her people from the catastrophe. The sculpture "Sky-patching Goddess Nüwa" aims to mobilize global action to preserve the ozone layer, counter climate change and protect human beings."

credit: UNEP/ UNIDO/UN Vienna

office are defined as the promotion of the cooperation and exchange work of CMSA, the realisation of international cooperation strategy and policy research, the coordination of work in international manned space cooperation projects, and to build the foundation for international cooperation.

Director Wang Zhaoyao put particular emphasis on the expectation, that “the newly-founded centre should follow the development trend of international manned space, focus on the long-term development of China’s manned space work, improve their expertise, raise the awareness of service, play the supporting role in expertise, thus making the centre a think tank for the international cooperation and exchange.”

As of today it is pure speculation, but it might seem feasible, that China could also offer astronaut training opportunities to developing countries, a feat we have seen with the INTERCOSMOS programme during the better days of the Soviet Union. Sure, it remains speculation, but what is seriously preventing Beijing from becoming the astronaut training centre of the United Nations? Life has always been and will remain to be full of surprises!

It is not a secret that China would have liked to join the ISS programme. Conservative forces in the US, next to Russia the most important partner in the project, have blocked that until today. Also tragic was the exclusion of China from the European satellite navigation programme Galileo – again a consequence of political pressure from the US. Remarkable was how China then subsequently established its own, indigenous satellite navigation system and now continues with the autonomous and persistent mounting of a space station project of moderate dimension, but open to the nations of the world.

In times of fading space budgets not only in the US but also in Europe, Canada and Japan, while facing the unprecedented Chinese space offers, the West might feel like getting a resounding slap by China - but of course the Chinese way.

Provided the West would be less preoccupied in being busy with itself, the West could come up with some creative ideas, or even surprises, which would avoid that the future of manned space exploration might take place without the US and Europe.

The Odd One Out Might Soon be Thumbing its Nose

How China could benefit from its enforced international isolation in space affairs

by Ferdinand Huber

China has so far been largely excluded from international cooperation when it comes to the conquest of space. This has not kept China from successfully pursuing its space ambitions. On the contrary, far from being a hindrance, international isolation has forced China to develop much of its own technology. In times when economic austerity severely cuts space programmes in the West down to size, turning to China for cutting-edge technology for future missions might be inevitable. And because Beijing, unlike the West, might not be so picky about who gets to board its future space station, the benefits that China could reap from its space programme could go far beyond the scientific-technological horizon.

When the Shenzhou 10 mission with three taikonauts on board blasted-off on 11 June this year, Chinese media hailed the event as the “coming of age” of China’s space programme. The Shenzhou 10 crew carried China’s space dream of turning the country into a space power, said President Xi Jinping at the Jiuquan Satellite Launch Center in Inner Mongolia.

The Shenzhou 10 mission was China’s longest space endeavour yet. Altogether, the three taikonauts spent 15 days in space. Besides conducting a number of scientific experiments and giving a live video lecture about the physical anomalies of zero-gravity to students back home, the crew got a chance to practice automatic and manual docking manoeuvres – an important skill for the operation of China’s planned space station which is supposed to come into service in 2020.

Chinese media miss few chances to reiterate how fast China’s space programme has gotten to where it is today. With its first manned space flight dating back only ten years, China is now one of only two nations worldwide, along with Russia, that can take humans into space at all, after NASA scrapped its Space Shuttle programme in 2011.

China has been forced to go much of that way alone, being barred from direct cooperation with NASA by US law, or being pushed out of the joint Galileo programme with the EU after Washington strong-armed Brussels. China takes pride in not having been discouraged by these setbacks – indeed, quite the opposite. After being kicked out of Galileo, instead of relinquishing its wish to have access to a global positioning system independent of the US-run GPS, it went ahead to develop its own, known as Beidou/Compass. And while the Europeans are still meddling with test satellites, Beidou has already started providing basic regional services in December of last year.

The same holds true for China’s space station dreams. Being blocked from participating in the International Space Station (ISS) programme, China set its mind on developing its own space outpost. It has done so with utter determination. According to China’s state-run Xinhua news agency, 700,000 researchers have contributed to the country’s space programme. According to the Associated Press, China has spent over \$6bn on its space programme in the period 1992-2012, “chump change” compared to NASA’s budget of almost \$17.8bn for 2012 alone.

But China is making good use of its funds. In addition to the Beidou, Tiangong 1 and Shenzhou missions, China has embarked on robotic Moon and Mars exploration, and is working on plans to send a robotic probe to a near Earth asteroid. It

wants to launch at least 9 robotic missions into deep space before 2030, and is planning to send humans to the Moon and Mars or a near Earth asteroid before 2050, says Chen Jie, Chief Engineer at China Aerospace Science and Technology Cooperation (SAST).

Despite all these achievements, experts agree that China has a long way to go before its technology matches that of the United States or other established space nations. Nonetheless, the constant push for space technologies can benefit China in many ways.

For one, space technologies are known to create spin-offs for other areas. At a time when China is seeking to restructure its economy to move up the value chain from producing cheap labour-intensive goods, technological input from the space sector could come in more than handy.

Also, space is a market that China has only begun to tap. “China’s satellites have begun to enter the world market,” Guo Xiaobing, a space policy researcher at the China Institute of Contemporary International Relations told the Hong Kong-based South China Morning Post. The research firm Euroconsult estimates the space industry market at \$145bn over the next 10 years.

Apart from satellites, China’s successful Shenzhou missions have also been effective advertising for its launcher technology. When Yang Yugang, engineer at the China Aerospace Science & Industry Corporation (CASC), the main contractor of China’s space programme, presented the company’s products at the 5th CSA-IAA conference in Shanghai in May, a delegate from India was so impressed that he instantly asked if the technology was up for sale.

Furthermore, space technology “Made in China” could open the door to international space cooperation with the West, especially the US, which China has been seeking and has been denied for years. “Today, the NASA’s Orion programme does not include China,” said Jean-Michel Contant at the same conference in Shanghai. Mr Contant is Secretary General of the IAA, an organisation dedicated to enhance international cooperation in space. “The Orion programme has a timeframe of 15 to 20 years and it doesn’t cover all aspects of, let’s say, Mars exploration,” Contant went on to say, “Enough time for countries like China to develop something that the US isn’t developing. NASA has no Mars lander, for example, why could China not develop one?” If Chinese products worked well and were compatible, Contant hopes economic and scientific necessities might trump current political resentments that impede cooperation with China today.



The Shenzhou 10 mission brought China another step closer to filling one of the voids the established space nations have left open. Successful docking, as displayed by the Shenzhou 9 and 10 crews, is an essential prerequisite for operating a future space station, as China is planning to do. It's supposed to go into service in 2020, the year the ISS is set to be de-commissioned. If things go according to plan, China will then be the only nation with a functioning space station in low Earth orbit - and it's planning to make the most out of it. Immediately after the return of the Shenzhou 9 capsule in 2012, the Head of the China Manned Space Agency, Wang Zhaoyao, was quoted in the Chinese media as saying that "Other countries are welcome to carry out joint experiments aboard the country's future space station," specifically naming astronaut selection and training, joint flights and space medical research. "We will respond positively to the initiatives of the United Nations Office for Outer Space Affairs (UNOOSA), and share with other countries our technological achievements and application results", Wang told the China Daily.

At a recent Space Policy Round Table, organised by Women in Aerospace Europe and the Secure World Foundation in Brussels, UNOOSA-Director Mazlan Othman confirmed China's pledge to open its future space station to UNOOSA Member States through UNOOSA mechanisms. This is a chance that especially many developing countries have been waiting for. "Many African countries want to expand their satellite-based activity to something more, especially Space Life Science," says Jean-Michel Contant of the IAA. "Take Nigeria for example.

They are developing their own roadmap and programme for Space Life Science." And Contant is convinced that research in this field would propel African Life Science to the forefront. With China's pledge to openness and cooperation in space, countries like Nigeria might get a better chance to pursue their goals.

Cooperation in space would also suit China's interests on the ground. China's increasing interest in Africa, seeking resources and markets, has been well-documented for years. A move to open its space station to African nations could further enhance its position and strengthen its involvement in Africa.

It would be the logical next step in China's long-standing policy towards Africa. "In the past [i.e. during the Cold War, ed.], China championed the cause of the Third World and in fact saw itself as the leader of the developing world, against the two superpowers," says Russell Ong, lecturer of China's foreign relations at the School of Oriental and African Studies in London. "China's intention to share the use of a permanent space station with developing nations can be regarded as an extension of the earlier policy, albeit a less forceful and less explicit one." Through cooperation in space, Ong believes, China would increase its soft power and "enhance its ties with the developing world and also elevate its status in the eyes of the international community in general."

On a larger scale, Ong's take on China's move to open its space station to the developing world could also hold true for the country's space programme as a whole: "It reflects China's aspiration to global power status in the long run."

The author, Ferdinand Huber, is a free-lance journalist for TV, radio and online media. He studied at the School of Oriental and African Studies in London, UK as well as International Business and Cultural Studies in Passau, Germany. Since 2012 he lives in China and reports for several media from China and South-East Asia.

SIMBOX on Shenzhou 8: German-Chinese Cooperation in Biomedical Space Research

by Dr. Markus Braun,

German Aerospace Center (DLR), Space Administration, Microgravity Research and Life Sciences, Bonn, Germany



Dr. Markus Braun – SIMBOX Project Manager for the German Aerospace Centre DLR. credit: DLR

Fundamental biological and biomedical experiments addressing the effect of microgravity on plants, nematodes, bacteria, cancer and immune cells, as well as on a miniature ecosystem, and the crystallisation of proteins were to be answered. In the meantime, most of the results are available, and several papers have already been or are just being published in renowned scientific journals.

“Figuratively speaking, SIMBOX has been a leap over the Great Wall that has opened up a completely new partnership in human spaceflight for Germany,” said Dr. Gerd Gruppe, Executive Member of Board of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) responsible for Space Administration. “Our new partnership with China provides German scientists with additional research opportunities in space. We have high expectations in this new cooperation and especially concerning the results of SIMBOX, like the microgravity-induced changes in human immune and cancer cells and other organisms. I do not see this as a competition with our proven long-term cooperation partners, the United States and Russia, but rather as a complement.”

Summary

On 31 October 2011 at 22:58 (CET), the Chinese spaceship Shenzhou 8 was launched into Earth orbit on a “Long March” rocket from the Chinese Jiuquan Satellite Launch Centre in Inner Mongolia. Shenzhou 8 carried the experiment facility SIMBOX – developed and built in Germany – housing altogether 17 biomedical Chinese, German and joint research experiments. This mission was a milestone in several respects: For the first time in the Shenzhou programme – the heart of the Chinese manned space programme – on the way to a Chinese Space Station, China was cooperating with a foreign space agency, namely with the German Aerospace Center (DLR). Also, this mission prepared the construction of the Chinese Space Station by performing for the first time, rendezvous and docking manoeuvres with the module Tiangong 1 launched a few weeks earlier. On 17 November, Shenzhou 8 landed in the Gobi desert after a successful flight. SIMBOX was recovered and brought back to Beijing where the experiment samples were handed over to the scientists for further analysis in their home laboratories.



Dr. Gerd Gruppe, DLR’s Director for Space Administration, during the press conference on 28 October 2011 in Bonn, a few days before the launch of SIMBOX. credit: GoTaikonauts!

SIMBOX/Shenzhou 8: German-Chinese Cooperation in Biomedical Space Research

In 2008 the German Aerospace Center DLR and the Chinese Manned Space Agency CMSA (the former China Manned Space Engineering Office CMSEO), signed a framework agreement about cooperation in Space Research – the basis for the SIMBOX/Shenzhou 8 project. About 3 years later, on 31 October 2011, Shenzhou 8 was launched on a “Long March” rocket into orbit for a 17-day mission carrying onboard the German SIMBOX experiment facility. SIMBOX - a combination of an incubator and a centrifuge - contained 17 experiments: 6 German, 9 Chinese and 2 joint Chinese-German experiments. Fundamental questions were to be answered: What causes the immune deficiency of astronauts in space and how can we prepare and strengthen our immune system for such or similar conditions? Does an ecosystem work in microgravity? How do organisms like bacteria, plants and nematodes sense the direction of gravity and how do they behave in or adapt to the absence of gravity. Scientists from



Roll-out of the Shenzhou 8 rocket at the Jiuquan Satellite Launch Centre in China’s North-East. credit: DLR



The complete set of prepared experiment containers before integration into the SIMBOX payload. credit: Astrium

the universities of Erlangen, Hohenheim, Magdeburg, Tuebingen, Hamburg, Freiburg, and from the Charité Berlin, as well as from 7 Chinese research institutions, participated in the project to find answers to these questions. In the meantime, most analyses are now completed, and the first papers are being published in scientific journals. This article provides an overview of results that have been presented at a post-flight meeting in Germany in 2012, and highlights the political dimension of this project.

SIMBOX on Shenzhou 8 – The Experiments

All 17 experiments can be categorised in the following simplified topics:

- Effects of microgravity on immune and cancer cells (3 experiments),
- on bacteria (1 experiment),
- on nematodes (2 experiments),
- on gravity sensing and gravi-responses in plants (8 experiments);
- the two joint experiments addressed crystallisation of medicine-relevant proteins (2 experiments) and
- effects of space conditions on a miniature version of an ecosystem (1 experiment).

Effects of Microgravity on Immune and Cancer Cells

Since the US Skylab mission in the 1960s, it is well-known that the immune system of astronauts is impaired and less effective. The cellular and molecular mechanism underlying this “immune depression” is not understood. Research in this field – embedded in clinical research – is one of the key aspects in the German biomedical space research programme. A wide range of flight opportunities have been used by scientists from the University of Magdeburg, including parabolic plane flights, TEXUS sounding rocket flights, and now also a flight on the Chinese spaceship Shenzhou 8, for conducting experiments in microgravity with the goal to unravel the influence of gravity on the innate and adaptive immune system, and to characterise microgravity-induced changes. Differential gene expression as shown in T-lymphocytes (type of white blood cell providing immunity), and disturbances in the regulation of the cell cycle were also found in monocytes (the ‘big-eaters’ of the immune system): gene expression of ion-channel proteins, cytoskeletal (the scaffolding within a cell) proteins as well as proteins of the regulation of transcription and other important proteins were altered.

The SIMBOX immune experiment was designed to shed light on the changes in human macrophages (a type of white blood cell that ingests foreign material) in long-term microgravity (parabolic flights and sounding rockets provide only short-term microgravity conditions). The scientists reported strongly impaired cytoskeletal patterns leading to impaired migration behavior of the macrophages. In addition to that, a reduced abundance of the protein CD11 was detected which in consequence strongly inhibits the recognition of bacteria. Altogether, this mission provided another important piece in the puzzle of understanding the impaired immune system (i.e. immune depression) – valuable new results also for improving therapies in the long-term for humans on Earth.



Another experiment studied the effect of microgravity on human thyroid cancer cells. These cells show microgravity-induced changes in cytoskeleton apoptosis (also known as ‘programmed cell death’), cell proliferation, growth and differentiation. From space experiments scientists hope to create new cancer therapies in the long-term. For that purpose, factors linked to neoangiogenesis (the formation of blood cells in tumour tissue), and the development of metastases (the spread of cancer from one part of the body to another), are studied in microgravity. When data from

SIMBOX experiments were compared with data from simulation experiments carried out on ground, numerous compliances were found. Human thyroid cancer cells tend to form multi-cellular aggregates in microgravity, so called spheroids, which is an interesting mechanism for tissue engineering. Secretion of certain cytokines (small ‘signaling’ molecules) as well as factors for tumour neoangiogenesis were down-regulated in microgravity, whereas secretion of VEGF-d increased, which seem to indicate a re-differentiation to less aggressive tumour cells.

Pathogenic Bacteria More Aggressive in Space?

Opposing results were obtained from the experiments of Chinese scientists with *Streptomyces* (a species of bacteria). Microgravity caused a series of changes in growth, development and differentiation. Gene expression, production of secondary metabolites (small molecular products of metabolism), and certain bioactive molecules, DNA damage and repair as well as internal cell structures – all these parameters were altered considerably in microgravity. All these effects suggest an increase in resistance against bacteria for bacteria such as *Bacillus subtilis*.

Chinese experiments

Experiment 1

Functional genomic analysis of plant signal transduction and secondary metabolism under microgravity (*Oryza sativa*)
 Institute of Plant Physiology and Ecology,
 Shanghai Institutes for Biological Sciences, CAS, Shanghai
 Principal Investigator: Cai Weiming

Experiment 2

Molecular biology basis of cytoskeleton responding to microgravity in plant cells
 Institute of Plant Physiology and Ecology, Shanghai Institutes for Biological Sciences
 Principal Investigator: Zheng Huiqiong

Experiment 3

Investigation of rice proteomic change in response to microgravity
 Institute of Plant Physiology and Ecology,
 Shanghai Institutes for Biological Sciences, CAS, Shanghai
 Principal Investigator: Sun Weining

Experiment 5

Synergistic effects of space radiation and microgravity on *C. elegans*
 Institute of Environmental Services and Systems Biology,
 Dalian Maritime University
 Principal Investigator: Sun Yeqing (Dr. Huang Lei)

Experiment 6

Effects of space conditions on microbial growth and metabolism
 Institute of Microbiology, CAS, Beijing
 Principal Investigator: Huang Ying

Experiment 7

The study of animal behaviour and development (*C. elegans*)
 Institute of Hydrobiology, CAS, Wuhan
 Principal Investigator: Wang Gaohong

Experiment 8

Studies on development and physiological response of algae in space
 Institute of Hydrobiology, CAS, Wuhan
 Principal Investigator: Hu Chunxiang

Experiment 9

Metabolism of higher plants in space (*Oryza sativa*)
 Photosynthesis Research Centre, Institute of Botany, CAS, Wuhan
 Principal Investigator: Wen Xiaogang

Experiment 10

Gene expressions analyses in plants (*Arabidopsis thaliana*) under microgravity condition
 Institute of Genetics and Developmental Biology, CAS, Beijing
 Principal Investigator: Liu Min

German-Chinese experiments

Experiment 4

Studies on assembly and application of bio macromolecules in space
 Institute of Biophysics, CAS, Beijing and
 Institute for Biochemistry and Molecular Biology, University of Hamburg
 Principal Investigator: Cang Huaixing

Experiment 11

Life support system in a cigarette box
 Institute of Hydrobiology, CAS, Wuhan and
 Institute of Botantics I, Friedrich-Alexander-University Erlangen
 Principal Investigator: Prof. Yongding Liu, Dr. Michael Lebert, Prof. Häder

German experiments

Experiment 12

Molecular adaptation of *Euglena gracilis* in microgravity
 Institute of Botantics I, Friedrich-Alexander-University Erlangen
 Principal Investigator: Dr. Michael Lebert, Prof. D-P Häder

Experiment 13

Differentiation of human neuronal cells in microgravity
 Institute of Physiology, University Hohenheim
 Principal Investigator: Prof. Wolfgang Hanke
 Project website:
<https://membranphysiologie.uni-hohenheim.de/89470?L=1>
 more complete report on the project in German
<https://membranphysiologie.uni-hohenheim.de/89470>

Experiment 14

Influence of microgravity on human thyroid cells
 Department of Plastic, Aesthetic and Hand Surgery, University Hospital Magdeburg
 Principal Investigator: Prof. Daniela Grimm

Experiment 15

Effects of microgravity on the activation and function of human macrophage cells
 Institute of Mechanical Engineering, Faculty of Mechanical Engineering,
 Otto-von-Guericke-University Magdeburg
 Principal Investigator: Prof. Oliver Ullrich

Experiment 16

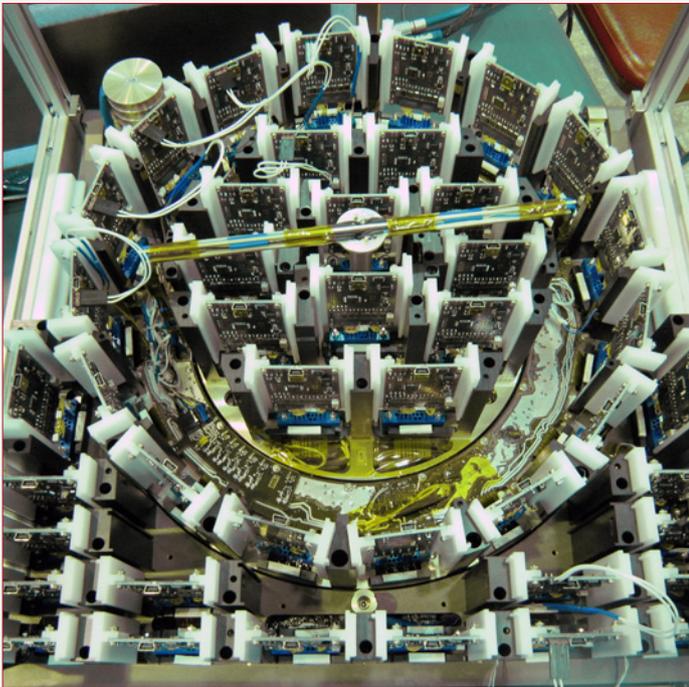
Genomic and protein expressions of plants under microgravity conditions
 Botanical Institute, Physiological Ecology of Plants, University Tuebingen
 Principal Investigator: Prof. Ruediger Hampp

Experiment 17

Analysis of gravity-dependent genes in plants
 Institute for Biology II, University Freiburg
 Principal Investigator: Prof. Klaus Palme



The experiment containers of experiment no. 15, 11, 10, and 9. credit: DLR/Astrium



The SIMBOX interior without experiment containers. Clearly recognisable are the 40 positions for the experiment units and the circular centrifuge that can accommodate 16 containers, while 24 positions are for stationary experiments. credit: Astrium

Nematodes With High Adaptability

Threadworms, especially *Caenorhabditis elegans* (*C. elegans*), are favourable model organisms for developmental biology and space research. The genome of the nematode is well-known and quite small. In SIMBOX, scientists from Wuhan and Dalian investigated behaviour and development. In microgravity, the life cycle and reproduction of the nematodes was not altered, but changes were found on the molecular level. After landing, the behavioral pattern was also analysed and was found to differ considerably from ground controls. Further analyses will clarify the molecular basis of these changes.

Protein Crystals Support Structure-based Design of New Pharmaceutical Components

Gravity and gravity-driven effects like sedimentation, convection and hydrostatic pressure – scientists have argued since the 1970s

– should have a negative influence on several biotechnological phenomena and processes. Crystallisation in microgravity on the other hand, should lead to bigger and more homogeneous crystals, which should allow for a more precise determination of their 3-dimensional structure, promising a diversity of applications and the development of new medicines. Experiments already began on TEXUS sounding rocket flights at the end of the 1970s, and were continued on satellites and space missions including the International Space Station (ISS) and finally on Shenzhou 8. Fourteen different proteins were crystallised in SIMBOX under microgravity conditions, in a joint experiment by scientists from Beijing and Hamburg. The most impressive results originated from crystallisation of lysozyme (a protein that damages the cell membrane of bacteria) isolated from chicken egg-white. Another example is the protein sf0046, which is an enzyme of the purine metabolism of *Shigella* (a genus of bacteria) causing bacillary dysentery. The structural determination for both proteins has been substantially improved. Furthermore, sf0046 crystallised as a tetramer (four sub-units) in microgravity, whereas it forms dimers (two sub-units) on ground. The cause and importance of this modification still needs to be analysed. Long-term goal of these experiments is to design new pharmaceutical drugs against pathogens like antibiotics-resistant bacteria based on structural data.

Gravity-sensing and Signal Transduction in Plants

The SIMBOX plant experiments focused on two questions: How does microgravity affect plants on the molecular level and is photosynthesis, one of the most important processes on Earth, altered in microgravity? Algae, seedlings of *Arabidopsis* (a small flowering plant used extensively as a 'model' in plant biology) and rice, as well as cell cultures of *Arabidopsis* and rice (*Oryza sativa*) were used in the SIMBOX experiments. Altogether, the results showed mostly unaffected morphology, physiology, growth and development. However, changes were found on the ultra-structural and molecular level in the absence of gravity. Scientists detected altered stacking of thylakoid membranes (the site of photosynthesis) in the chloroplasts (these conduct the photosynthesis) of the algae. Nevertheless, the photosynthesis rate in the algae was not changed considerably, whereas in seedlings of rice, photosynthesis activity of photosystem I was reduced by about 30%.

The most extensive studies were conducted to analyse changes in gene expression and the corresponding protein patterns



Check of the experiment containers in the laboratory in Beijing. credit: DLR



Fitting of the payload's inner part with centrifuge and fully integrated experiment containers into the SIMBOX housing – 45 cm wide, 55 cm deep, 30 cm high. The 35 kg SIMBOX hardware is based on Astrium's experience in building the European research facility Biobox, which has proven to be a reliable research tool for microgravity experiments. credit: DLR



After landing, the Simbox was transported by helicopter, airplane and escorted car to the laboratory in Beijing. In the payload integration test centre of the Chinese Space Science Organisation GESSA, the hardware was opened during an official and festive ceremony. credit: DLR

induced by the absence of gravity. Stress proteins, ribosomal proteins (cell units involved in translation), cytoskeletal proteins like actin and tubulin, as well as cell wall proteins were among the proteins that were most strongly affected in microgravity. In cell cultures of *Arabidopsis*, changes were less pronounced as compared to samples collected after only several seconds or minutes of microgravity of parabolic flight manoeuvres or TEXUS sounding rocket flights, which led the scientists to assume that the cells had adapted to the conditions of microgravity in space.

The Miniature Ecosystem Works Well in Space

Plants are not only interesting organisms for research on gravity sensing and signal transduction processes, but they are also the central components of so-called bioregenerative life support systems. Artificial habitats are a pre-condition for astronauts living and working under the harsh and hostile conditions of space. In the past, and currently on the International Space Station, physico-chemical life support systems provide oxygen, remove carbon dioxide and waste and recycle water. A regular (and costly) re-supply of food, water and oxygen from Earth is indispensable. For exploratory long-term missions to Mars or other Solar System planets this concept is no longer viable. Physico-chemical systems need to be complemented or even replaced by biological systems. Our understanding of the underlying mechanisms of bioregenerative life support systems, and especially the knowledge on the influence of gravity on the complex interactions between the organisms involved, is the basis for the development of efficient systems saving launch mass and resources. Such systems have also great potential for terrestrial applications, i.e. for humans living in extreme environments. Therefore, research on bioregenerative life support systems is a major topic in the space programme of several space agencies. Germany has focused on aquatic microalgae-based systems for about 25 years and has gained an internationally recognised expertise in this area.

In a joint German-Chinese SIMBOX experiment, an artificial ecosystem consisting of microalgae and snails was put together, in order to study organismic physiology and the material and energy flow. The miniature ecosystem, not bigger than a cigarette

box, was divided in two compartments separated by a semi-permeable bio-membrane; the uppermost smaller flat chamber was inhabited by the snails, and the lower larger chamber by the microalga *Euglena*. A number of physical and chemical parameters like pH, temperature, and density of the microalgae suspension were measured during the mission. After landing, the snails and microalgae were fixed and analysed in the home laboratories of the scientists. The results show that the smallest ecosystem to have ever been flown in space, had mastered its tasks, keeping both organisms alive for a total of 17 days in space.

Outlook: Potential of the German-Chinese Cooperation in Biomedical Space Research

In September 2012, a workshop was held at the Tegernsee in South Germany. Chinese and German scientists met to discuss results from research under space conditions, and in particular, the results of the SIMBOX experiments which were flown on Shenzou-8. These 17 experiments were recognised as programmatic and political milestones by representatives of CMSA and DLR. This successful scientific space project pushed open a door for a future joint and peaceful utilisation of Chinese space vehicles such as Shenzhou, and the future Chinese Space Station. The partnership offers chances for intensifying scientific cooperation and providing German scientists with valuable flight opportunities, not only for space biology, but also physical and material sciences research. Researchers from the Charité Berlin already participated in a ground simulation test conducted at the Astronaut Center of China (ACC) in November 2012. Chinese subjects tested the newly developed German thermo sensor measuring the human body core temperature. This sensor is currently used by astronauts on the International Space Station. This and several other projects are being discussed by representatives of CMSA and DLR as potential experiment hardware for future missions of the Chinese space programme. A cooperative Chinese-German parabolic flight experiment is being prepared for spring 2014 by scientists from Munich and Beijing working on immunological aspects.

The German-Chinese cooperation in the field of research under space conditions has just begun and is gaining momentum.



A Chinese scientist and Astrium staff are inspecting the experiment sample. credit: DLR

Some personal perspectives - by the SIMBOX scientists

by Hui Qiong Zheng
Experiment 2

Molecular biology basis of cytoskeleton responding to microgravity in plant cells

How did the SIMBOX project contribute to your research?

The SIMBOX was very good for us to get a series of *Arabidopsis callus* samples, including micro-gravity (micro-g), 1g-centrifugation control in space, the ground control and the ground 1g centrifugation samples. The important contribution of the SIMBOX for my experiment was that the culture condition in the EUE was similar, except the gravity, which allowed us to get comparable samples between micro-g and 1g.

What was the most important result of your experiment?

The most important result of my experiment was to find out that in space microgravity, 69 cytoskeleton associated proteins exhibited differential expression in comparison with the ground control; 11 cytoskeleton proteins exhibited differential expression in comparison with the 1g centrifugation in space.

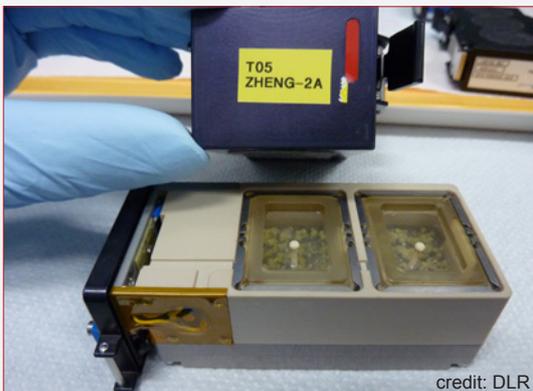
In retrospect, what was the biggest challenge in the cooperation with your German colleagues?

The cooperation with my German colleagues was great and happy in overall, but the difficulty was communication, because of language and far distance.

Was there a particular remarkable event while working together with scientists from Germany?

The particular remarkable events were the following:

- (1) ERD and historical record were very good for us to follow the progress of the project.
- (2) The detailed training file and videos provided to us by the Astrium engineer was good for us to learn how to use the hardware.
- (3) That the ECs and EUEs were numbered, respectively, by engineer was good for us to record the different samples and to avoid confusion.
- (4) Dr. Markus Braun was an important man in this experiment, who gave us a lot of helpful suggestions which enabled the scientists and the engineers to understand each other.
- (5) The cooperation between my group and Mr. Hamp's group was good for designing the space experiment and analysing the results.



credit: DLR

by Huaixing Cang
Experiment 4

Studies on assembly and application of bio-macromolecules in space

How did the SIMBOX project contribute to your research?

The SIMBOX project is very important for space protein engineering, i.e., space protein crystal growth. It provided me with a one-off opportunity for conducting a space experiment. It promoted the cooperation between Germany and China. The concise structure of the SIMBOX hardware reminds me that I should be more careful during the design of the experiment.

What was the most important result of your experiment?

We developed the new crystallisation chamber and improved the Vapour Diffusion method with the aid of the project. And some new phenomena were found during our research.

- (1) The new chamber has the advantages: no power supply, high throughput (EC DEX/II, 120 protein species), same structure for Vapour Diffusion (VD) or Liquid/liquid Diffusion, less consumption of protein (0-10 μ l), less effects of shock/vibration-absorption (no crystal damage during recovery), etc.
- (2) The improvement to the VD method is of high significance owing to the elimination of Marangoni convection. The VD technique chamber can't eliminate Marangoni convection when conducting space experiments which is considered not suitable for space application. Only Liquid/liquid diffusion is "right" for space! However, no biologist cultures protein crystals with Liquid/liquid diffusion method on ground. This conflict prevents the development of space protein engineering heavily.
- (3) We obtained space-grown HEWL crystal with a resolution of 0.116 nm using the new VD chamber, and an Earth-grown one of 0.123 nm.
- (4) We found that the diadenosine tetraphosphate crystals grown in space and on Earth with the Liquid/liquid diffusion method have different structures: the space crystals have P21 or C2 space group, corresponding to structure resolutions of 2.49 Å and 1.99 Å; the ground crystal has C2 space group and resolution of 1.80 Å.

In retrospect, what was the biggest challenge in the cooperation with your German colleagues?

I think the cooperation between the scientists of Germany and China is very effective, as all of them are serious about science research, and respect each other. Maybe our experiment design is not so precise, and there is a lack of accurate measurement instruments, which would influence the results. I hope we can make a wider cooperation in the future if my new research application is approved. And Professor Dr. Christian Betzel is also interested in that.

Some personal perspectives - by the SIMBOX scientists

by Prof. Dr. Wolfgang Hanke / Dr. rer. nat Florian P. M. Kohn

Experiment 13

Differentiation of human neuronal cells in microgravity

How did the SIMBOX project contribute to your research?

We could make new national and international contacts with scientists and industrial partners. The exchange of ideas and the cooperation with many colleagues, sometimes for years in limited lab space, has contributed to an intensive understanding of team work and project management. These experiences are in particular valuable for the two speakers of the project team, Dr. Ulbrich and Dr. Kohn. Both could transfer that experience into their own new project which has been running since 2013 and financed by DLR in my research department at the University of Hohenheim.

What was the most important result of your experiment?

Unfortunately, the flight hardware did not function flawlessly. For our sample, a technical defect caused a reduced rate in the expected cell growth.

Together with the ground control experiment running in parallel it could be shown, that neuronal cells can be well cultivated in the experiment hardware over the period of the mission. The morphological structure of the cells grown under microgravity conditions was similar to the cells grown under normal gravity conditions. At the end, unfortunately, there was not enough cell material for the actually planned detailed analysis. A repetition of the experiment with improved hardware is already in the planning.

In retrospect, what was the biggest challenge in the cooperation with your Chinese colleagues? Was there a particular remarkable event while working together with scientists from China?

One of the biggest challenges was the transport of the required cells and materials to China. Many items passed customs without problems, while some equipment and the cell cultures demanded more effort. Sometimes it was not evident what the actual problem was. Also, it was difficult

to understand the extremely different time periods needed by customs for checking the delivery. Sometimes customs clearance took a few days, but sometimes weeks.

Another example: before the mission we tried to send a water bath, basically a device for controlling the temperature of a water reservoir. The box returned only a few days after sending. It was not opened but we found out that the customs did not accept the transport because in the documentation the word "water" was used and obviously it was not allowed to send "water" to China. So, the box came back without examination of the content. We resent the water bath and we put an additional remark in the documentation that the cargo is not containing "water". That worked fine. Interestingly, the equipment was lost on the way back to Germany and until today it has not arrived.

With respect to cooperation with the Chinese colleagues, I must say, the biggest challenge was the existing shyness on both sides. None of the groups dared to make a start in getting in contact with each other. Achim Schwarzwälder, an engineer from Astrium, had a brilliant idea. Each morning, the groups of scientists were driven by bus to the launch site. One morning, the German scientists entered the bus first. But instead of sitting next to each other like the days before, they spread over the whole bus and left the seat next to them empty. When the Chinese scientists entered the bus, every of them had to take a seat next to a German scientist. The drive took only 15 min but this was the ice-breaker.

More interesting stories and facts, can be found on the website with the mission diary, written and compiled by Dr. Kohn.

Project website:

<https://membranphysiologie.uni-hohenheim.de/89470?L=1>

more complete report on the project in German

<https://membranphysiologie.uni-hohenheim.de/89470>

by Dr. Liu Min

Experiment 10

Gene expressions analyses in plants (*Arabidopsis thaliana*) under microgravity condition

How did the SIMBOX project contribute to your research?

The plant seedlings were growing very strong in the SIMBOX. We got good results from these plants material.

What was the most important result of your experiment?

We carried out whole-genome microarray to screen the transcript profile of *Arabidopsis thaliana* seedlings after three treatments: space microgravity condition (seedlings grown in microgravity

state of space flight of SIMBOX on Shenzhou-8), 1g centrifugal force in space (seedlings grown in 1g centrifugal force state of space flight of SIMBOX on Shenzhou-8) and ground control.

In retrospect, what was the biggest challenge in the cooperation with your Chinese colleagues?

We want to express our acknowledgements for the German scientists. Our cooperation was very happy, we became good friends. We learned a lot from the German scientists.

Some personal perspectives - by the SIMBOX scientists

by Daniela Grimm
Experiment 14

Influence of microgravity on human thyroid cells

How did the SIMBOX project contribute to your research?

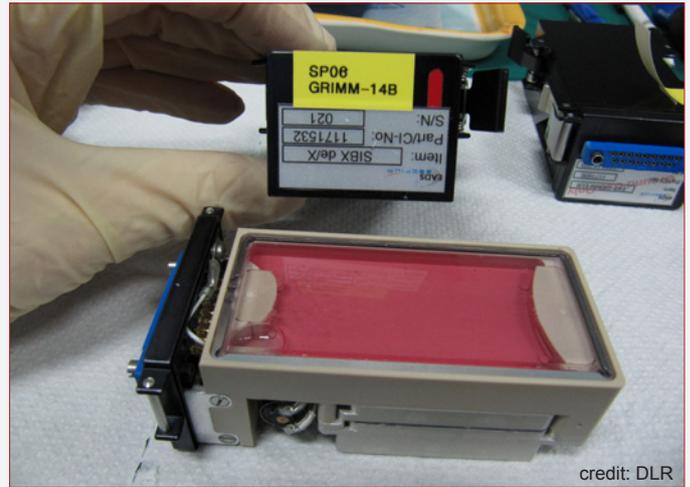
We had the opportunity to investigate human thyroid cancer cells for a longer period in space. The Shenzhou 8 mission was of course a highlight for our research. The experiment went well, all our cells were alive. In the area of cancer research, this experiment was very important for us.

What was the most important result of your experiment?

We received a lot of valuable data. One paper is currently in press in "Biomaterials", another one in preparation.

In retrospect, what was the biggest challenge in the cooperation with your Chinese colleagues? Was there a particular remarkable event while working together with scientists from China?

My team was very happy to be in China. We received laboratory space in the Institute of our friend Associate Professor Chun Yang from Tsinghua University in Beijing. It was amazing to be at the launch site and to see the launch of Shenzhou 8. This was a wonderful moment for us.



credit: DLR

by Prof. Rüdiger Hampp and Dr. Margret Ecke
Experiment 16

Genomic and protein expressions of plants under microgravity conditions

How did the SIMBOX project contribute to your research? What was the most important result of your experiment?

The most important result of the experiment was to gain a first set of molecular data during a long-term exposure (5 days) of plant cells to the conditions of microgravity. Those data enable us to now conduct interesting comparative studies. We can compare the SIMBOX data with data collected during short-term exposures such as typical during parabolic flight campaigns (duration of microgravity 20 s) or during sounding rocket flights (duration of microgravity 6 min). Our first results support the hypothesis that plant cells can adapt very well to the conditions of weightlessness during the course of hours and days and are able to settle into a "daily routine" again.

In retrospect, what was the biggest challenge in the cooperation with your Chinese colleagues? Was there a particular remarkable event while working together with scientists from China?

For the Shenzhou 8 mission, promising experiments from several areas of scientific research were selected. By doing so, the scope of the experiments was highly versatile. Apart from the two cooperation projects there were no overlaps or direct cooperation between the groups. However, we were lucky,

because another group, a Chinese team from Shanghai, also worked with *Arabidopsis* cell cultures, and they also used the same experimental set-up. Because of this, many preparatory experiments could be done directly in China and could be compared with our experience in handling the hardware. Despite the highly diverse requirements for the experiments, the organisation of our work in the laboratory was excellent. A precise analysis of working time and equipment need enabled a smooth and effective working in the lab. The interest in the work of the other groups was very big, what was not only due to traditional politeness and hospitality. It must have been a particular challenge for the Chinese cooking team of the satellite centre in Jiuquan to cook for so many German scientists and to give the Chinese kitchen a European twist. For example, we were offered several dishes with potatoes, meat specially prepared for the European taste or even cake for breakfast, an impossible feature for a Chinese breakfast. The chef observed very well, what and how much we had eaten to analyse what we liked best and to make our stay at the launch site as pleasant as possible. In turn, we really ended up in big difficulties to explain that we are happy with the food because according to the chef's opinion we had always eaten far too little. It was not so easy to convince him that we were eating as much as at home, and it needed the support of a Chinese colleague to explain this fact to the chef and to make everybody happy.

An article in German and English language, describing the project and the SIMBOX hardware extensively can be found on page 6 to 11 of the magazine "Countdown No 17" issue 1/2012 published by DLR.

http://www.dlr.de/Portaldata/28/Resources/dokumente/Publikationen/Countdown/C17_HiRes.pdf

The 5th CSA-IAA Conference on Advanced Space Technology

Trends in the International Space Cooperation with China

by Jacqueline Myrrhe

For the fifth time already, the international conference dedicated to space technology took place in China's Eastern metropolis Shanghai. From 20 to 23 May 2013, a little bit more than 100 space experts met to present and discuss their current work as well as plans for the future. The congress was co-organised by the Chinese Society of Astronautics, CSA, and the International Academy of Aeronautics, IAA. "East meets West" could have been the underpinning motto. Both organisations aim for the promotion of the development of space exploration, and support international exchange in the field of astronautics. While the Paris-based IAA was already founded in 1960 by Dr. Theodore von Kármán, CSA came into play a little bit later. Supported by such large figureheads as Qian Xuesen, Ren Xinmin and Zhang Zhenhuan, CSA was founded in Beijing in October 1979. It is a fortunate circumstance that the two societies have found common ground to call for joint efforts to advance the cause of astronautics.

"... clear emphasis will be made to investigate new international space cooperation with particular attention to the young space countries. Let's hope that this conference will attract more and more foreign participants." With these words, Jean-Michel Contant, Secretary General of the International Academy of Astronautics, announced the 5th CSA-IAA Conference on Advanced Space Technology on the conference's website. Ma Xingrui, President of the Chinese Society of Astronautics expressed his expectations of the conference by saying: "This conference will provide an excellent opportunity for participants to share and exchange ideas and experience on space science and technology. I believe those exchanges will deepen the friendship between the space colleagues from various countries and regions, and promote international cooperation." Three conference days packed with a full programme of presentations and talks, would show that these words were not meant to be empty phrases.

The first day comprised 10 presentations during the plenary session, while on the second day, during parallel-running workshop sessions, a total of more than 90 presentations were given. The third and last day was reserved for a technical visit to the Shanghai Academy of Spaceflight Technology, SAST.

The Spirit of Shanghai

Jean-Michel Contant, Secretary General of the IAA, had the honour of making the conference's opening speech. Under the title "Roadmap and Stepping Stone Approach for Global International Cooperation in Space Exploration for the Next Decades", he drew up an expansive visionary frame which he imagined being filled with truly global space projects, not limited to the current dozen or so, together with the introduction of a few more space-faring nations on the planet. Promoted by the IAA, joint efforts are underway to push for international cooperation on a worldwide level. In preparation for the Heads of Agencies meeting next January in Washington DC, the IAA is collecting inputs for a concept of a comprehensive global roadmap for robotic and human space exploration for the next decades.

Shanghai is just the starting point for a total of 5 conferences, explained Jean-Michel Contant. That roadmap he pointed out, should be accompanied by a catalogue of all global space missions, payloads, and laboratories which would also identify options for cooperation. Particular emphasis is given to the involvement of non-space-faring nations, as well as to the search for complementary national elements in existing international space efforts and to international standards for space hardware and procedures.

With this project the IAA is above all else, concentrating on activities with an engineering and practical background that are not covered by other international space organisations, or other international space exploration coordination efforts, such as the International Space Exploration Coordination Group, ISECG. Also, the IAA has already gained expertise in the involvement of non-space-faring nations. Under the lead of the IAA, the "Space Life Sciences for Africa" project is already running. A project which is a proof of IAA's long-sightedness. Based on a detailed analysis of the African situation, it was possible to show that human space flight can be the driver for terrestrial life sciences, in particular in countries without existing space programmes. The project also demonstrates that it is possible to develop space life sciences education and research activities and programmes for Africa in particular, if there are international partnerships involved. Contant stressed that African leaders recognise that potential and that the IAA has very good experience with their programme in Nigeria and South Africa. And this is just the beginning.

For the remaining time until the end of the year, Jean-Michel Contant highlighted one of the biggest tasks - but also the most promising activity - the preparation of the Heads of Agencies meeting, an international space exploration forum at governmental and ministerial level, to be held next January in Washington, DC. The IAA is going to attach to this high-level get-together, a pre-summit conference on the 9 January. Conference participants for the IAA Space Exploration Conference can make use of a smart package deal, because they are also registered for the summit on the following day. For both parts of the meeting, the focus will clearly be on planetary robotic and human space flight exploration. The IAA is making sure that as many countries as possible participate, including China, and is also paying attention to avoid the confusion which occurred in the past, when Chinese space officials were prevented from getting to the previous IAA 50th Anniversary Heads of Space Agencies Summit, also held in Washington in 2010.

After his talk, one of the Chinese space experts wanted to know from the Head of IAA: What does the IAA consider could be possible Chinese contributions within global space efforts? Contant answered that he would like to see studies led by Chinese space experts, and "to have Chinese ideas everywhere and to have Chinese everywhere". Of course, he would be pleased to see Chinese contributions to the Global Roadmap development, which he explained earlier. He does believe that it can be possible to find complementary elements in existing



international space efforts. For example, the current Orion/SLS programme excludes China, but in the long run, opportunities for China might arise because the programme will go on for quite a while and the political and technological environment is always changing. This means that in the future, opportunities might arise, which today are unthinkable. The same would be true for long-term Mars exploration. Similarly, China could contribute significant support in the definition of cooperation scenarios with an increased number of players, because China has valuable experience in the incorporation and briefing of smaller countries and in particular in non-traditional space players. Contant was not short of ideas for Chinese involvement in the global space scenarios. The summary of this thoughts can be formulated as the spirit of Shanghai: "How to imagine complementary programmes to pave the way for international cooperation for the next decade in advance and independently of today's cooperation scenarios."

China is going Deep-Space

There was another speech during the conference which was also not lacking interesting insights. Chen Jie, Chief Engineer of Shanghai Academy of Space Technology, SAST, spoke about the "Challenge and Innovation in Deep-Space Exploration of China". Starting with an analysis of past, current and planned global deep-space endeavours, Chen Jie summed up China's motivation for deep-space exploration very logically and clearly: "Nowadays, deep-space exploration is one of the most important space activities of mankind, which shows the comprehensive power and innovation capability of a country. It pushes the progress of science, technology and society." Then he continued to outline that China's future ambitions are based on the experience gained with the Yinghuo Mars orbiter YH-1, the Chang'e lunar exploration programme and the Shenzhou human space flight programme. Chen showed a slide presenting a roadmap with 9 (in words: nine) Chinese robotic deep-space missions before 2030. The slide was almost identical to a slide shown in the 2011 conference. Chen Lan, who participated in the 4th CAS-IAA Conference on Advanced Space Systems and Applications in September 2011 has already written about these exploration ambitions in GoTaikonauts! issue no. 2. The new slide of this year's conference had little changes in the wording and also, it looked as if the launch date of the respective missions had been changed from exact years to generic numbers. Although not all missions have been approved and enjoy funding, it is interesting to learn about the Chinese intentions for deep-space.

1. Solar Observatory - it seems to be the long-awaited SST, or Solar Space Telescope that was renamed to Deep Space Solar Observatory recently after its planned orbit changed to the SEL1 point – compare the Quarterly Report in issue no. 7 of GoTaikonauts!
2. Polar area solar observation that might be the SPORT Solar Polar Orbit Radio Telescope;
3. Asteroid rendezvous and touchdown mission;
4. Mars global remote sensing mission which could be a re-flight of Yinghuo 1;
5. Jupiter system probe;
6. Venus global remote sensing and atmosphere floating, which could comprise of a balloon;

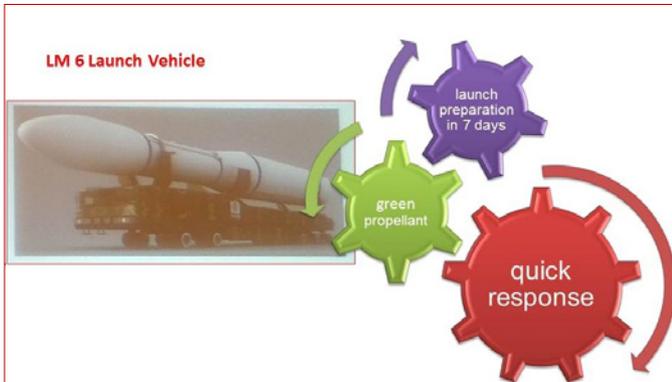
7. Mars mission with regional survey capability - presumably a lander/rover;
8. Mars sample return mission;
9. Asteroid sample return mission.

Chen Jie went on to list conceptual studies for potential human missions in the 2030-2050 timeframe, and long-term missions in the 2050-2100 timeframe. Among these conceptual ideas are human missions to the Moon, Mars or to an asteroid. The study groups at SAST are also looking into human mission scenarios for beyond 2030. Since the recent past has proven that an incremental approach guarantees reliability and continuous progress, this would also be the preferred scenario for future deep-space mission concepts. It includes that during precursor verification missions, new technologies would be tested before a human lunar mission and later, a human Mars or NEO mission, could be attempted. Comparable to other large space nations' plans, Chinese long-term mission concepts are looking at habitation architectures for planetary surfaces, large transfer vehicles and re-usable deep-space vehicles, when mining of NEOs would be considered. It remains interesting that China is thinking about such missions, even if there is no official programme for that to be seen, not yet.

Maybe it should not be too surprising that the presenter touched on all current innovation trends, such as deep-space communication via X-ray separated from sunlight, autonomous navigation based on the measurement of the spectral red-shift of a celestial body, heavy launch vehicle and common (versatile) upper stage propulsion modules, or RTG and ASRG power systems. However, it was not clear whether these innovations are ear-marked for feasibility studies, or just under observation by China. Maybe the answer to these questions was hinted when Chen Jie, at the end of his talk, revived the spirit of Shanghai by saying: "Powerful countries have the duty to cooperate together to explore the deep-space."

"Made in China" - Launchers for the future

Going into deep-space requires in the first place, a powerful rocket and preferably a flexible family of launchers. Without doubt, China is up for that. In his talk "The progress of SAST's launch vehicle", Lin Jianfeng, the Deputy Director of Research and Development of SAST, the Shanghai Academy of Space Technology, gave a comprehensive overview of the status of rocket development in his Institute. The Chinese government assigned the development of the Long March 6 to SAST, to balance the work of the China Academy for Launcher Technology CALT in Beijing, which is mainly responsible for the LM 5 and 7 design. Although the liquid-propelled boosters of the new generation large launch vehicle LM 5 are manufactured in Shanghai, SAST's new flagships are the Long March 6 and 6A, currently under construction and expected to fly in 2015 and 2017 respectively. For the three-stage LM 6 launch vehicle, SAST's future target lies in the provision of a "green" and high-performance propulsion system. "Green" in this context means the use of an environmentally friendly combination of liquid oxygen and kerosene propellant, a first for a SAST design. Additionally, the new development includes higher reliability, stronger adaptability, an improved payload capability, and at the same time a reduction in launch costs. The most remarkable feature maybe, is the capability to complete



The future Long March 6 launch vehicle on a mobile platform. (credit: SAST)



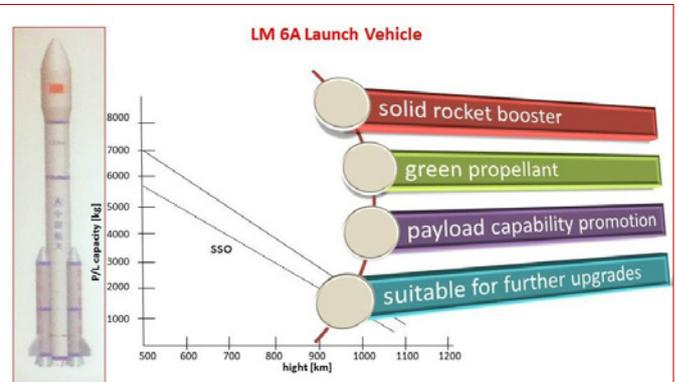
Future targets of the Long March 6A. (credit: SAST)

the launch preparation within 7 days. With a launch capacity of 1 t to a 700 km SSO, the rocket will certainly enjoy a bright future prospective and is going to meet many customers' demands. This might be even more true for the pepped-up LM 6A version equipped with additional solid rocket boosters and green propellant for the second and third stages. In the standard configuration that rocket carrier offers a launch capacity of 4 t to a 700 km SSO, but with the option for further upgrades this version of the Long March rocket will directly challenge Europe's Ariane 6. But maybe this will not happen anyhow, because with LM 6A expected to fly as early as 2017, Ariane 6 might still be sitting on the drawing-board.

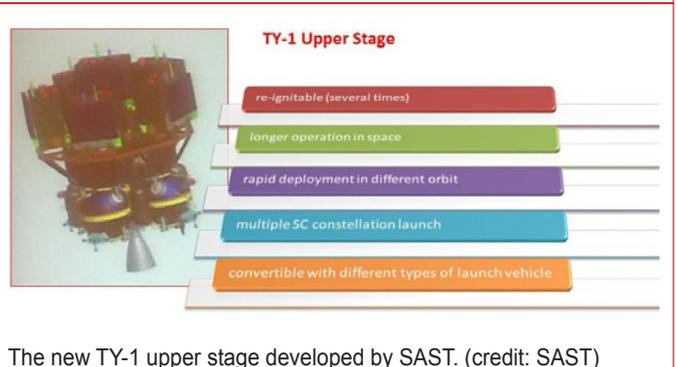
Moreover, SAST is offering its customers 18 months from contract signature to launch, a promise that can only work if bureaucracy is reduced to the necessary minimum.

How much SAST is dedicated to modern, flexible and commercially viable launch solutions was recognisable when the talk came to the new TY-1 upper stage. TY-1 will include features such as storable propellant capability, it will be re-ignitable more than once to deploy satellites quickly and in different orbits, and it will have an extended working lifetime in space. TY-1 will become compatible with LM-2D, LM-4B and the new generation of launchers.

Also, SAST's commitment to space debris mitigation measures, such as the disposal of residual propellant, the disposal of gas cylinders and batteries, and operational debris control, makes the company fit for the next few decades. Already now, after adopting effective mitigation measures of the upper stage, no break-up has occurred during the last 40 missions.



The future Long March 6A launch vehicle as envisioned by SAST. (credit: SAST)



The new TY-1 upper stage developed by SAST. (credit: SAST)

Without hiding his pleasant surprise, Jean-Michel Contant commented on the Chinese expert's talk: "Thank you for this highly interesting presentation and congratulations to your development work which will soon result in a highly flexible range of launchers. This looks very good for the future."

Space for mankind

Once again, the Shanghai conference has confirmed two major trends over the last few years. On the one hand, a certain diversification in space efforts can be observed. More and more smaller players are entering the astronautical stage. The di-poly situation, when just the US and Russia were relevant space nations has now become history. New space powers are welcomed and wanted. On the other hand, the call for extensive international cooperation is getting louder. It even seems that global cooperation is becoming a pre-requisite for any further progress.

Space has always been a driver of cooperation across borders. But today's situation unfolds a completely new dimension. Finally, after more than 55 years of space flight activities, space is demanding more than before, an unavoidable imperative of true global cooperation. It pushes the progress of science, technology and society, as Chen Jie rightly stressed.

The first photos of our planet taken from outer space made us realise how fragile and unique we are and brought mankind emotionally together. Now, the signs of the time might bring mankind also practically together, when the nations of the world realise that they can only care about the Earth, and that we can only progress if we also understand mankind as one unity, acting in a united way. With space exploration as a test case, mankind is forced to mature.

The Chinese-Soviet Space Symposium 2013 of the British Interplanetary Society

by Jacqueline Myrrhe and Bill Carey

Good traditions are worth keeping! As in previous years, in 2013 the Chinese-Soviet Space Symposium organised by the British Interplanetary Society took place in the Society's conference room in London, 27/29 South Lambeth Road. On the 8 June, approximately two dozen space experts, space enthusiasts, and interested people met from 9:30 in the morning to 16:30 in the afternoon to present, inform and discuss the latest developments in the Russian and Chinese space programmes, or to reflect on historical space related topics.

It is an appropriate procedure that the talks given during that symposium usually have a length of around half an hour. This ensures that as many people as possible get the opportunity to present on that day. And another aspect was also true for this year: the speakers covered a wide range of topics.

Starting with a talk by George Spiteri who spoke about what the former Interkosmos cosmonauts are doing now. Remarkably, he was able to identify the status of most of them.

But also Richard Williams' presentation about Soviet and international space stamps gave some good insights into how to "read" the information out of graphical features on space stamps.

Extremely informative was the movie "Russian Connection". This film documented many less known and partly sad facts about the time after the break-up of the Soviet Union, when many cosmonauts and Soviet-Russian space experts offered original space hardware or memorabilia to Sotheby's Space Auction in New York, in 1993 for sale.

As interesting and well researched as always, Bart Hendrickx' presentation on the future of Russia's Manned Space Programme, came up with the latest information from first-hand sources.

Highly entertaining was Bert Vis' attempt to decipher the reasons behind retouched photos from the early years in the Soviet space programme. For example, he did an extensive analysis on the different versions of the famous Sochi photo session of May 1961.

How wide the scope of presentations really went, was impressively shown by Brian Harvey's high quality content presentation. He draw the attention of the audience to a hardly-

known space specialist, Italian Roberto Bartini, who left Italy and settled in the Soviet Union to contribute to crucial space engineering work.

Unfortunately the Symposium did not see any presentation to honour Valentina Tereshkova's anniversary. Also, this year, the majority of talks were on Soviet-Russian space topics. Therefore the two presentations given by the Go Taikonauts! team complemented the overall programme nicely.

Before the lunch break Jacqueline Myrrhe gave an overview on the 5th CSA-IAA Conference on Advanced Space Technology in Shanghai. That overview was extended by an analysis of the trends and tendencies in international space cooperation with China. On both topics, this newsletter has detailed articles which reflect all of the ideas presented in London two months ago.

The last presentation of the symposium day was given by William Carey. He spoke about the British efforts in space cooperation with China. In preparation for this talk, William interviewed several British actors involved in, or planning for, cooperation with China. In one of the next issues of Go Taikonauts! this topic will be covered in more detail.

The annual meeting in London is not only a very friendly get-together of people particularly interested in Soviet or Chinese space projects, but it is also a more than welcome opportunity to exchange the latest information, opinions or thoughts on topics in these areas.

In addition to that, the value of this one day in the British capital is to have the opportunity to talk to other knowledgeable people and learn from each other. As nice and convenient as online tools are nowadays, personal interaction and discussion cannot be so easily substituted.

The British Interplanetary Society is currently planning a special report on the Symposium in its own "Spaceflight" magazine, that should include the abstracts of all presentations including graphics and illustrations.

For next year, the organisers are going for an earlier announcement of the Symposium on their website. However, the date, 7 June 2014 can already now be noted down. Hope to see you in London next year!

Gallery

Shenzhou 10 and the Chinese Space Station



Shenzhou 10 - Long March 2F rolled out on 3 June 2013. (credit: Xinhua)



Shenzhou 10 launched from Pad 921, JSLC at 17:38 on 11 June 2013. (credit: Xinhua)



Solar transit of Shenzhou 10 docked to Tiangong 1, taken from Southern France on 16 June 2013 by Thierry Legault. (credit: Thierry Legault)



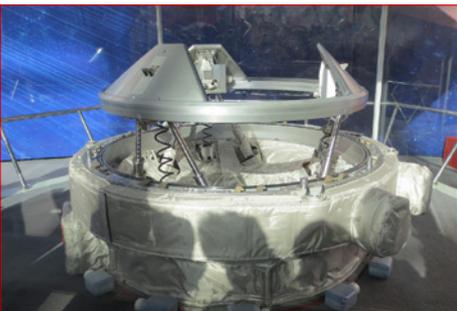
Touchdown! The smoke was from four landing rockets on the bottom of the capsule. (credit: Xinhua)



Overlooking the Shenzhou 10 landing site in Inner Mongolia. A trail behind the capsule on the ground is clearly visible in this photo, caused by being dragged by the parachute. (credit: Xinhua)



The Shenzhou 10 crew sitting in chairs for being photographed after egress. From left to right: Zhang Xiaoguang, Nie Haisheng, Wang Yaping. (credit: Xinhua)



The Chinese docking mechanism, displayed in an exhibition in Shanghai in November 2012. (credit: Go Taikonauts!)



Unofficial 3D rendering of the Chinese Space Station (CSS) from another view angle. (credit: Adrian Mann)

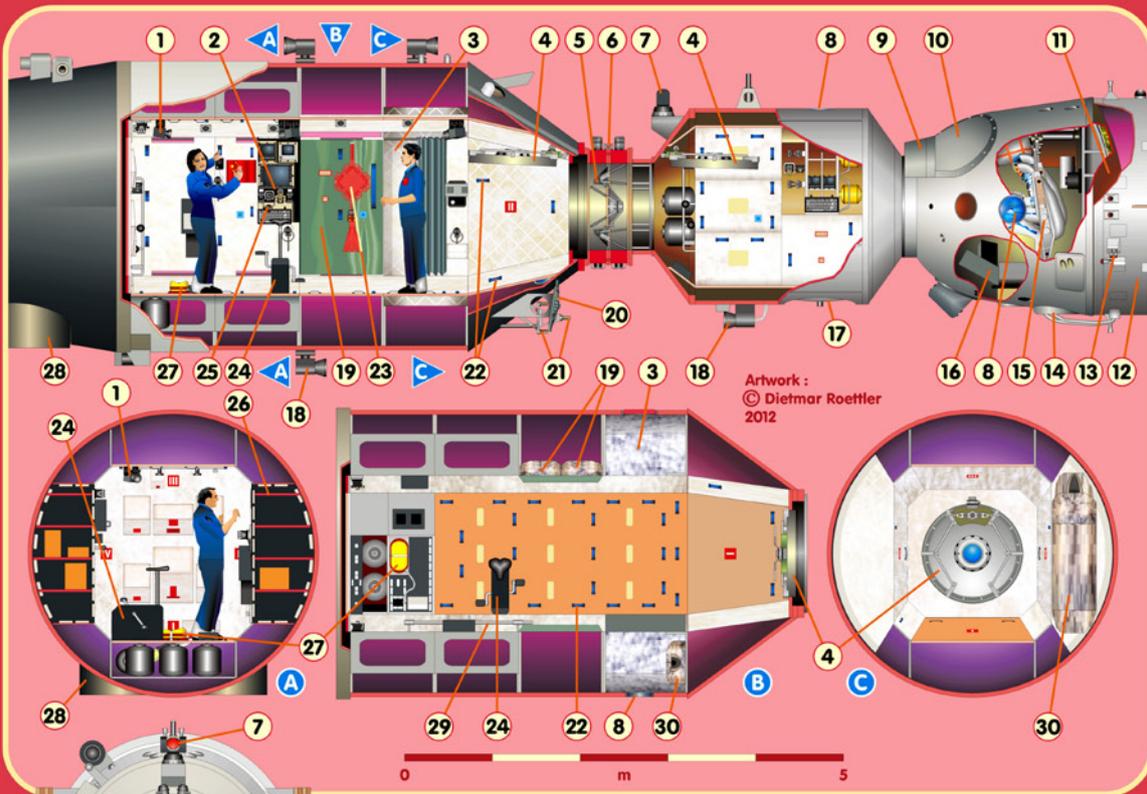


Unofficial 3D rendering of the Chinese Space Station (CSS) - exploded view. (credit: Adrian Mann)

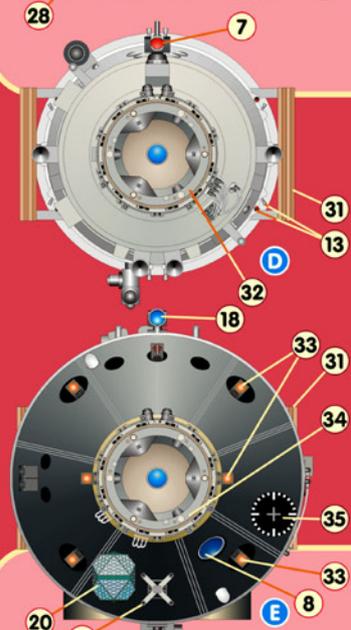
On the next two pages:

Unofficial diagram of Shenzhou spacecraft and Tiangong 1 space lab. (credit: Dietmar Roettler/Raumfahrt Concret)
 Unofficial 3D rendering of the Chinese Space Station (CSS). (credit: Adrian Mann)

For the full format and high resolution of all pictures, please, download and install the Go Taikonauts! iPad Application from the AppStore.

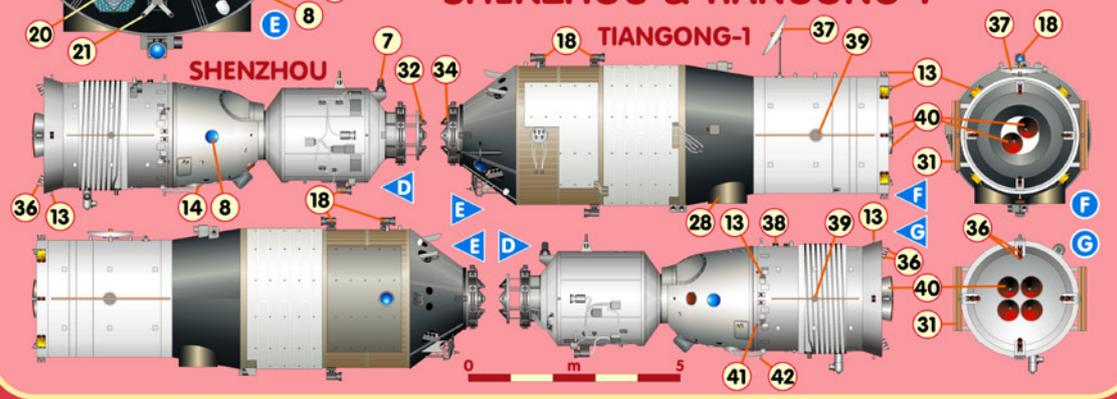


Artwork :
© Dietmar Roettler
2012



- 1 TV camera
- 2 Main computer
- 3 Cabin
- 4 Hatch
- 5 Androgynous docking interface guide petals
- 6 Bolt
- 7 Laser radar
- 8 Porthole
- 9 Aerodynamic parachute compartment cover
- 10 Parachute compartment cover
- 11 Heat shield of Reentry Module (RM)
- 12 Propulsion Module (PM)
- 13 25 N Attitude-control thrusters
- 14 Hermetic connections for supplies (PM to RM)
- 15 Crew seat
- 16 Control panel
- 17 Entrance hatch
- 18 Camera
- 19 2 Sleeping bags (behind curtain)
- 20 Laser radar reflector
- 21 Microwave radar transponder
- 22 Loop handle (hand and feet)
- 23 Knotted symbol for happiness
- 24 Exercise bike
- 25 Headphones of communication system
- 26 Instrumentation shelves
- 27 Foot massage unit
- 28 Hyperspectral camera (10 m resolution)
- 29 Mounting rail (e.g. for cycling)
- 30 Cabin with sleeping bag
- 31 Folded solar panels
- 32 Active docking mechanism
- 33 Target lights for CCD sensor
- 34 Passive docking mechanism
- 35 Docking target (optical aiming)
- 36 150 N Attitude-control thrusters
- 37 Tianlian data relay antenna
- 38 Digital sun sensor
- 39 Solar panel rotary joint
- 40 2500 N Main engine
- 41 150 N Retreating thruster
- 42 120 N Translation thruster

SHENZHOU & TIANGONG-1



page before:

Unofficial diagram of Shenzhou spacecraft and Tiangong 1 space lab. (credit: Dietmar Roettler/Raumfahrt Concret)

below:

Unofficial 3D rendering of the Chinese Space Station (CSS). (credit: Adrian Mann)

