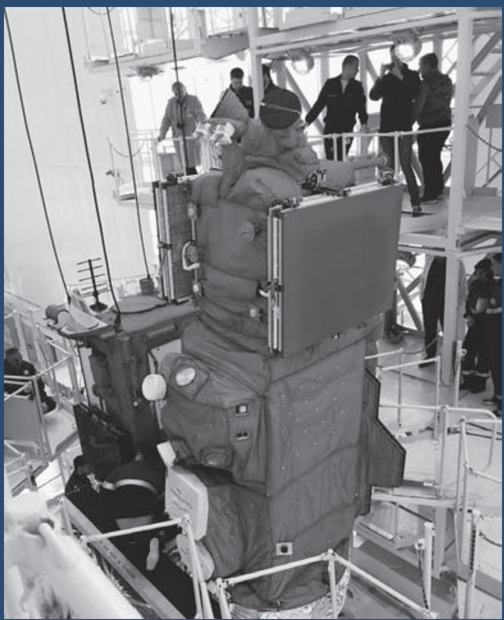
SPACE CHRONICLE

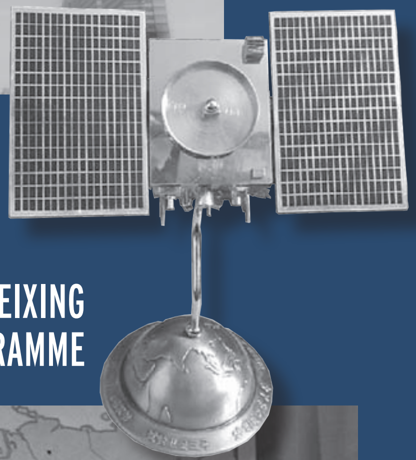
A BRITISH INTERPLANETARY SOCIETY PUBLICATION

Vol. 71 No.1 2018



SPEKTR AND RUSSIAN SPACE SCIENCE

MONUMENTAL STATUES TO LOCAL LIVING COSMONAUTS



CHINA'S SHIYAN WEIXING SATELLITE PROGRAMME

FIRST PICTURES OF EARTH FROM A SOVIET SPACECRAFT

REPORTING THE RIGHT STUFF? Press in Moscow During the Space Race

SINO-RUSSIAN ISSUE

ISBN 978-0-9567382-2-6

JANUARY 2018

Submitting papers to SPACE CHRONICLE

Space Chronicle welcomes the submission for publication of technical articles of general interest, historical contributions and reviews in space science and technology, astronautics and related fields.

GUIDELINES FOR AUTHORS

- As concise as the content allows – typically 5,000 to 6,000 words. Shorter papers will also be considered. Longer papers will only be considered in exceptional circumstances and, at the discretion of the Editor, may be split into parts.
- Source references should be inserted in the text in square brackets [X] and then listed at the end of the paper.
- Illustration references should be cited in numerical order in the text as 'Fig.X'; those not cited in the text risk omission.
- Captions must be labelled with their Fig. number and should be as short as possible.
- **Illustrations should be:**
  — colour or mono, but should be as close to print resolution (300 dpi) as possible.
  — poor-quality illustrations may compromise the acceptance of paper for publication.
  — images embedded in Word documents may be acceptable, but the Editor reserves the right to request separate image files from the author prior to publication.
- Responsibility for copyright clearance rests entirely with the author.
- Submission of papers for consideration should be sent by email to **chronicle@bis.space.com** as a Word document or editable PDF file, along with any separate image files.
- If a paper is accepted for publication, the author will be asked to sign a License to Publish form. This can be downloaded at *www.bis-space.com/wp-content/uploads/2012/08/WebsiteLicense.pdf*

Authors will receive a complimentary copy of the issue in which their paper appears.

We respectfully ask authors to adhere to these guidelines. Failure to do so will result in the delay of acceptable papers for publication.

Our full Guidelines for Authors can be downloaded from **www.bis-space.com**

FRONT COVER (1) Preparing *Lomonosov* for launch; (2) Statue of Yang LiWei as if an Apsara, Húludǎo; (3) Model of *Shiyan Weixing* 3 satellite; (4) First picture of Earth taken by a Soviet spacecraft; (5) Frank Bourgholtzer with the crew of Voskhod 2.

From the editor

DURING THE WEEKEND of June 3rd and 4th 2017, the 37th annual Sino-Chinese Technical Forum was held at the Society's Headquarters in London. Since 1980 this gathering has grown to be one of the most popular events in the BIS calendar and this year was no exception. The 2017 programme included no less than 17 papers covering a wide variety of topics, including the first Rex Hall Memorial Lecture given by *SpaceFlight* Editor David Baker and the inaugural Oleg Sokolov Memorial Paper presented by cosmonaut Anatoli Artsebarsky.

Following each year's Forum, a number of papers are selected for inclusion in a special edition of *Space Chronicle*. In this issue, four such papers are presented together with an associated paper that was not part the original agenda.

The first paper, *Spektr and Russian Space Science* by Brian Harvey, describes the Spektr R Radio Astron radio observatory – Russia's flagship space science project. Since its launch in 2011, Spektr has provided a wealth of new information on the universe – although this has gone largely unreported in western countries.

In the second paper, *Monumental Statues to the Local Living Cosmonaut*, Andrew Thomas provides a personal guide and context to statues in the home towns of cosmonauts living in Russia and in the Peoples' Republic of China.

In *Reporting the Right Stuff?*, journalist Dominic Phelan returns to the early Soviet space program to explore the battles between the Kremlin censor, Soviet pressmen and Moscow-based foreign correspondents who attempted to report the truth behind cosmonaut propaganda myths.

Phillip S. Clark presented a paper at the very first Technical Forum in 1980 and has continued to do so for almost four decades. In this issue, he describes China's *Shiyan Weixing* satellite programme, reviewing the launches of these "test satellites" that have taken place since 2004 and using orbital analysis in an attempt to explain their missions.

The final paper, *The First pictures of Earth from a Soviet spacecraft*, by Bart Hendrickx, is a fascinating complement to those from the 2017 Forum describing the final two unmanned test flights of the Vostok spacecraft in March 1961. Although each one carried a camera, their photographs were not released at the time since they were primarily intended to demonstrate the potential of orbital reconnaissance at a time when the Soviet military was growing increasingly frustrated with long delays in the USSR's spy satellite programme.

These varied and informative papers highlight the commitment and depth of research that characterise the Technical Forum. I would like to extend my thanks to the authors for their outstanding contributions to this issue, and to all the speakers and participants at the 2017 event. Appreciation is also expressed to Gill Norman and the BIS team for supporting the Forum each year.

The programme for the 2018 Forum, to be held at the Society Headquarters on June 2nd and 3rd 2018, is currently being finalized. A selection of papers from that event will be published in the next Sino-Chinese *Space Chronicle* in early 2019.

David J. Shayler, FBIS
Guest Editor   Coordinator & Co-Chair, BIS Sino-Chinese Technical Forum.

Editor John Becklake **Production** MP3 Media **Promotion** Gill Norman **Office** BIS, Arthur C. Clarke House, 27-29 South Lambeth Road, London, SW8 1SZ, UK

Telephone +44 (0)20 7735 3160 **Fax** +44 (0)20 7582 7167 **Email** chronicle@bis-space.com
Website www.bis-space.com

Distribution *Space Chronicle* is distributed worldwide by mail and may be received by annual subscription or purchase of single copies. It is available through membership of the British Interplanetary Society at much reduced rates. Subscription details for members, non-members and libraries are available from the above address.

Space Chronicle is a publication that promotes the mission of the British Interplanetary Society. Opinions expressed in signed articles are those of the contributors and do not necessarily reflect the views of the Editor or the Council of the British Interplanetary Society. Security clearance, where necessary, is the responsibility of the author.

Published by the British Interplanetary Society. Registered Company No: 402498. Registered Charity No: 250556. Printed by Latimer Trend, Estover Road, Plymouth, PL6 7PY, England.

SPACE CHRONICLE
A BRITISH INTERPLANETARY SOCIETY PUBLICATION

Vol. 71 No.1 2018

Contents

OUR MISSION STATEMENT

The British Interplanetary Society promotes the exploration and use of space for the benefit of humanity, connecting people to create, educate and inspire, and advance knowledge in all aspects of astronautics.

Contributors

Brian Harvey is a writer and broadcaster on spaceflight who lives in Dublin, Ireland. He has a degree in history and political science from Trinity College and an MA from University College Dublin. His first book *Race into space – the Soviet space programme* (Ellis Horwood, 1988), was followed by over a dozen more on the Russian, Chinese, European, Indian and Japanese space programmes (Praxis/ Springer). His books and extracts from them have been translated into Russian, Chinese and Korean.

Andrew Thomas is a member of the BIS, a creative writer and a radio "ham" who has spoken with Jean-Pierre Haigneré aboard Mir and organised an ARISS contact between Leicester schoolchildren and the ISS in April 2003. In 2010 he completed an MA thesis entitled "Kultura Kosmosa: the Russian Popular Culture of Space Exploration". Now in retirement, he has joined the Department of Politics at de Montfort University, Leicester, where he is working on a PhD with the working title "Popular Participation in Space Exploration in China and its Mediation to Soft Power".

Dominic Phelan was born in Dublin, Ireland, in 1972, and since 1996 has worked as a freelance writer. His articles on the history of astronomy and spaceflight have appeared in SpaceFlight and Astronomy Now, and he contributed a chapter on Soviet lunar plans during the Moon race for Footprints in the Dust (University of Nebraska Press, 2010). He is the Editor of the 2013 Praxis/Springer title Cold War Space Sleuths: The Untold Secrets of the Soviet Space Program which, for the first time, reveals the inside story of the amateur 'spies', many of them regular presenters at the BIS Forum, who monitored the Soviet space program during the Cold War.

Phillip S. Clark presented a paper at the very first Technical Forum in 1980 and traditionally has delivered the final presentation at most of the subsequently meetings. Since 1969 Phil has focused on Soviet/ Russian and Chinese spaceflight, and has been a space consultant for many years. The author of the popular 1988 book The Soviet Manned Space Programme he has regularly published papers in JBIS and SpaceFlight.

Bart Hendrickx is a long-time observer of the Soviet/Russian space programme and has regularly written on the programme's history for British Interplanetary Society publications during the last twenty years. He is also co-author, with Bert Vis, of the book Energiya-Buran: The Soviet Space Shuttle, published by Springer/Praxis in 2007. Since the beginning of 2015, he has acted as Executive Secretary of the Belgian branch of the Society.

Guest editor

David Shayler attended his first forum in 1983, has presented regularly since then, and from 2012 became Coordinator and Co-Chair of the event. He created Astro Info Service in 1982 to focus his research and writing and was elected to the BIS Council in 2013. David is the author of more than 26 titles on human spaceflight, including cooperative works on the Vostok era and Soyuz with the late Rex Hall, and the Cosmonaut Training Center with Rex and Bert Vis. He is currently working on an update to his Soyuz book and a history of Russian space stations planned for 2021 – the 50th anniversary of Salyut. (www.astroinfoservice.co.uk)

Space Chronicle, Vol. 71, pp.1-40, 2018

Spektr and Russian space science

BRIAN HARVEY

Spektr is Russia's flagship space science programme and indeed its most successful space science mission since the time of the Soviet Union, although it is virtually unknown outside Russia and some scientific circles in the field of radio astronomy. This paper will review the current Spektr programme and briefly set it in the broader context of current Russian space science.

1 Description of Spektr series

Spektr was designed as a successor to the Soviet 'great observatories' of the late Soviet period: *Astron, Kvant, Gamma* and, the most successful, *Granat*, which operated until 1999. From then on, though, the only deep space astronomy mission was ESA's successful Proton-launched Integral (2002), on which Russia had 25% observing time. Spektr was designed to cover the electromagnetic spectrum and put Russia into the forefront of deep space observing, matching Europe and the United States [1].

Spektr was originally approved by the Council of Ministers in 1980 as a series working in the radio, ultraviolet and gamma wavebands. This was unfortunate timing, for it coincided with the first period of contraction of the national programme as a whole. No funding was allocated until initial start-up funding of R200m in 1997, again bad timing because of the collapse that year of the ruble. The programme was then redefined to use not Proton launchers but the less expensive Soyuz 2 or Zenit 3 with the upper stage *Fregat* and NPO Lavochkin's new *Navigator* platform. The running order was defined as Spektr R (Radioastron); Spektr RG (Röntgen Gamma); Spektr UV (Ultra Violet); and Spektr M (Millimetron). The individual spacecraft have since been multiply redesigned as the original equipment designed for them became outdated or exceeded warranty.

The first, Spektr R was conceived by Nikolai Kardashev, Leonid Matveyenko and Gennadiy Sholomitsky, their idea being to use a high altitude space telescope in collaboration with ground telescopes to achieve long base lines equivalent to a radio telescope of tens of thousands of kilometres in diameter, to reach high angular resolution. Kardashev was and is Russia's leading radio astronomer, born Moscow 1932, studied under Iosef Shklovski (1916 - 1985) and made his name in the 1960s for studying quasars. He was an early writer (1963) on extraterrestrial civilizations and devised a scale for assessing their technical capacities. An observing program of 500 objects was drawn up in the PN Lebedev Physical Research Institute of the Academy of Sciences by academician Kardashev, covering quasars, star and planet forming regions, interstellar plasma, black holes and active galactic nuclei. Spektr R scientists hoped that it would analyze the signals from distant galaxies and Lavochkin's then director Georgi Polischuk, voiced the opinion that it might even detect radio signals from distant civilizations.

A precursor 10m diameter radio telescope was first tested on the Salyut 6 orbital station in 1979 by Vladimir Lyakhov and Valeri Ryumin. The formal order to commence Spektr R was issued by President of the Institute of Space Research (IKI) Roald Sagdeev on 18th July 1981. In its original design, the 3,295kg Spektr R was designed to unfold a 27-blade or petal radio telescope dish and orbit from 10,000km to as far out as 390,000km. It was also fitted to carry a solar wind science payload called Plasma F to take, in the course of its orbital path, 32 samples a second of the solar wind, ions and energetic particles so as to determine their small-scale structure, bulk, velocity, density and temperature.

The next, 2,647kg Spektr Röntgen Gamma (RG), was conceived by *Kvant* astrophysicist Academician Rashid Sunyaev and would be the first-ever Russian mission to Lagrange 2 (L2) point some 1.5m km from Earth. The mission was reduced to two x-ray telescopes: the 800kg German extended Röntgen Survey with Imaging Telescope Array, called eROSITA, from the Department of Extraterrestrial Physics of the Max Planck Institute (0.2 - 12keV band) and the Russian ART-XC telescope (5 - 30keV band). The mission will start with eROSITA making a whole-sky survey of up to 100,000 galaxy clusters which will take four years, followed by pointed observations for three years, while ART-XC will make a census of black holes. The aim was to find what is suspected to be

Nikolai Kardashev.

Paper originally presented to the BIS Soviet/Russian/Chinese forum, June 2017.

a hidden population of hundreds of thousands of supermassive black holes and to continue the work of *Granat* with x-ray bursts, weak x-rays, supernova outbursts, black holes, neutron stars and hot gas in galaxies, as well as find exploding stars and detect x-rays swirling around massive black holes. It was expected that Spektr RG would find numerous hitherto-obscured black holes and low surface brightness objects. Some hoped that as many as 3.2m active galactic nuclei and 86,000 clusters would be found and provide fresh knowledge of binary systems, anomalous pulsars and supernova remnants. This would be important for the studies of the evolution of the universe over time and the role of mysterious 'dark energy' in this process. A predecessor of the Russian ART-XC telescope, called MVN (Russian abbreviation of the 'Monitor Vsego Neba' or All-Sky Monitor) was intended to fly to the International Space Station prior to the launch of the main observatory. It is dedicated to an all-sky survey in x-rays, so that a diffuse x-ray background can be studied with high precision. Although the role of the MVN has been outlined in detail, its current status is uncertain [2].

Spektr RG attracted some European funding in the 1990s, but with no Russian hardware appearing, the Europeans withdrew, Russia providing the Proton rocket to launch Integral by way of compensation and Spektr RG was effectively dead in 2002. Roskosmos revived the project in 2005, leading to a formal agreement with Germany in 2007. On top of endless Russian delays, there was an unexpected European one in 2013 when the electronics of eROSITA had to be replaced. Hopes that the mission would fly improved when the ART telescope arrived at Lavochkin in December 2016 and the eROSITA arrived from Germany in January 2017. There was then a further complication. By late 2016, there were only two Zenits left in Baikonour. The one scheduled for Spektr RG ran out of warranty and the other one was contractually tied to an Angolan communications satellite, so at this late stage Roskosmos moved the spacecraft to a Proton DM-3, despite reservations on the part of both German and Russian scientists. The actual Proton would not be available for a further nine months, so the launch was rescheduled for the period spring 2018. Then in May 2017 a further delay was announced due to problems with the BRK radio system, pushing the launch back to September 2018. Speaking in June 2017, Rashid Sunayev was optimistic that the mission would make it possible to draw up a map of the universe, with millions of sources, including three million black holes and 100,000 galaxy clusters [3].

The next, Spektr UV, Ultra Violet, also called the World Space Observatory, will have a 1.7m mirror to gather information on the physics of the early universe, galaxies, hot stellar atmospheres, cool stars, the intergalactic environment, interstellar and solar system dust, gas clouds, active galactic nuclei and distant planetary atmospheres. Weighing 2,250kg, it will orbit from 500km to 300,000km above the Earth. Appointed as project manager was Boris Shustov, head of the Institute of Astronomy at the Russian Academy of Sciences, who promised that the telescope would be one of the most important of the decade and held out the hope that it would detect and explain large quantities of dark matter. Spektr UV's elongated orbit will give it a considerable advantage and up to 20 times greater resolving power than the Hubble Space Telescope. First Russian government funding arrived in 2004. The project's slow progress was halted in 2014 due to the crisis in Ukraine which removed the availability of a Zenit and immediately affected parts due from the United State and Britain which were sanctioned. There was talk of putting back the launch to 2024 or even of cancelling the project, but the switch to a Proton block D was announced and funding and processing resumed in 2016 with a view to a launch in 2022.

Rashid Sunayev.

The last, Spektr M, M for Millimetron, because this satellite will search the heavens in the 4 to 20mm wavelengths, looking especially for leftover radiation from the big bang. According to Nikolai Kardashev, it will search for the first objects in the cold universe, more than 11bn years old, starting across the galactic plane and we should expect images of black holes 100 to 1,000km across and then supermassive black holes in disks 1bn km across, as well as blazars, micro-blazars and micro-quasars; characterization of interstellar dust, which he believes to be polycyclic acromatic carbons; and even the identification of wormholes and multiverses (a development of the ideas of Shklovsky) [4]. It will have the ability to search for terrestrial type planets to characterize their atmospheres, as well as dark matter, interstellar cloud, megamasers, pre-galaxies and learn how the universe was originally formed. It may even be able to listen for signals from extra-terrestrials, calculated many years ago by Kardashev to be most likely on the 1.5mm band.

Spektr M will carry a 12m diameter dish antenna and will operate in a highly elliptical orbit. The telescope will be cooled to 4ºK for three years and then 50ºK for the next ten and will have a pointing accuracy of 1 arc second. In an important change in data handling, the scientific data on Spektr M will not routinely be transmitted directly to Earth. Instead, all the scientific results will be assembled in a large memory bank on the satellite itself. Scientists will connect to the internet, contact the satellite, preview the data in which they are interested and download it. Data that are not downloaded in two years will be automatically cleaned off the memory to make way for new information. Design was concluded in 2010 and construction began in ISS Reshetnev in Krasnoyarsk under Lavochkin supervision in 2014. Launch is scheduled over 2026 after Spektr UV. Spektr M will require a Proton launcher so that it may reach an intended destination of L2. It is planned to undertake both single dish and VLBI observations. The single dish will provide one arcsecond resolution, while the long baseline will provide microarcsecond resolution. Eleven foreign observatories will participate. In summary, the future schedule is:

Spektr RG	September 2018
Spektr UV	2022
Spektr Millimetron	2026.

2 Spektr R mission – description

Spektr R finally left Earth at 6.31am on 18th July 2011, the Zenit 3 putting it in an original orbit of 177- 447km. Its orbit was then raised by a series of burns by the versatile *Fregat*, the first to 444-3,711km and then the final intended eccentric orbit of 1,045 - 332,728km, 51.5°, 11,527min. The trajectory was a challenging one for no Russian upper stage had flown such a profile before. The *Navigator* bus was also quite new, having been introduced earlier that year by Elektro L in 2011. Confirmation that the mission was on course came when the spacecraft was observed soon after separation by an optical telescope in New Mexico.

The launch took place 20 years to the day since the programme was ordered! Spekr R brought with it a plaque to commemorate the achievements of the first radio astronomer, the American but subsequently Australian resident Grote Reber (1911-2002). The most tricky phase, the deployment of the antenna, was accomplished despite some initial worrying hiccups and the other instruments soon activated, except for the magnetometer which failed. First light - the constellation Cassiopeia - took place on 27th September [5]. To describe the spacecraft in more detail, Spektr R is designed to cover the following wavebands so as to achieve multi-frequency synthesis:

K 22,232MHz, with seven sub-bands over 18,372 to 25,112MHz
C 4,832MHz, with 110MHz bandwidth
L 1,664MHz, with 60MHz bandwidth
P 324 MHz, with 16MHz bandwidth

There is a significant overseas contribution to its equipment. as follows:

India	P-band Low Noise Amplifier
Australia	L-band Low Noise Amplifier and receiver
Netherlands and Germany	C-ban receiver
Finland, then USA	K-band receiver
ESA	Antenna tests
Canada	Data recorder

For orientation, the spacecraft uses three star sensors. There are twelve hydrazine thrusters for orientation and course corrections. Signals pass through receivers, then formatters and are transmitted to the ground at 142 MB/sec at 15 GHz at 40w (apogee) or 4w (perigee) on a 1.5m antenna. The two principal tracking stations are the 22m Puschino radio telescope just south of Moscow and the 43m radio telescope at Green Bank, West Virginia. Angular resolution is a millionth of an arcsecond, many magnitudes greater than the Hubble Space Telescope. A hydrogen maser provides the ultra-high frequency stability needed for the VLBI observations. All sources are investigated first at medium resolution before more detailed measurements are made. Mission control is divided between Bear Lake, Moscow and Ussuryisk in the far east. Data are sent to both the Lebedev Institute in Moscow and the Max Planck Institute in Bonn.

Spektr R is very much intended as an international project using Very Long Baseline Inferometry (VLBI) with stations in Tidbinbilla and Parkes, Australia; Chile, China, Effelsberg, Germany; Robledo, Spain; India; Usuda, Japan; Korea, Mexico, Hartebeesthoek, South Africa (which is especially important for southern perigees); Yevpatoria, Crimea; and the United States, where in August 2013, Green Bank joined. VLBI radio astronomy between the USSR and the USA dated to 1969, when Green Bank was also involved. Other ground telescopes joined the mission as the science programme expanded, such as Jodrell Bank in Britain and up to 40 have been involved altogether.

There were annual Announcements of Opportunity (AOs) and observers with telescopes in these countries were invited to participate by sending proposals for observing time to the programme committee, with about 10hr observing time available per day. Continuous observing time for any single target varies between 1hr and 20hr. Spektr R had a significant programme of outreach to the global scientific community, with publication in English of a 37-page user handbook, regular newsletters (31 published so far) and website on which all the scientific papers arising are published. The newsletter is co-authored by Nikolai Kardashev and his colleague Yuri Kovalev. Updates were also published in the Lavochkin journal, *Vestnik*.

3 Spektr R – operations

Spacecraft check out took until the end of September 2011. Tests of the antenna took until mid-November. The Early Science Programme (ESP) of experimental observations lasted from February 2012 to June 2013, followed by the routine phase.

Spekr R had a five-year lifetime which it has long since exceeded. Tracking the orbit accurately has been a demanding aspect of flight operations and the main system used is laser ranging with reflectors, signals being beamed up from the northern Caucasus and the Observatoire de la Cote d'Azur in Grasse in southern France, assisted by optical observations and even sightings by amateurs, which are welcomed. The first orbit check was undertaken by the Cote d'Azur station on 15th November 2011, which made 875 laser range measurements over 35min to an accuracy of 10cm.

Spektr R's orbit was subject to lunar perturbation, so the apogee could vary between 280,000 to 350,000, but the perigee between 80,000km and an alarming 659km, the average period being nine days, but it was one calculated to ensure 22hr sunlight for the solar panels per day. It soon became clear that perturbations of the orbit, combined with the influence of the sun on the telescope, could bring Spektr R back into Earth's atmosphere as early as 2013. Accordingly, orbital corrections were carried out on 22nd February (300sec) and 1st March 2012 (332sec) with a total ΔV of 3m/sec to raise the orbit by 55,000km [6].

Spektr R's progress was marked at the five-year point by a commemorative poster by IKI. By autumn 2017, Spektr R had exceeded its original planned five year operational lifetime, but the principal threat to its operations came not from equipment wearing out but again from orbital dynamics. Trajectory analysis late 2016 found that it would be in darkness more than two hours a day from January 2018 and that its orbit would decay that June. The Keldysh Institute calculated how an engine firing could lift the orbit to make it safe until 2021. The institute also considered moving Spektr R to 700,000km away from Earth but adjudged as too high the risk that it might fall into the moon's sphere of influence and crash there. Spektr R still had 80% of its fuel remaining and even if with a firing would still have 70% for future course adjustments. On 16th July 2017, the engines were fired for 290.3sec, giving the mission a new lease of life.

4 Scientific programme

Nikolai Kardashev listed the principal scientific targets as being:

- Active Galactic Nuclei (AGN) and supermassive black holes
- Regions of star and planet formation

- The interstellar medium
- Dark matter and dark energy
- Megamasers, magnetars, pulsars.

The science programme was structured as follows:

- Early Science Programme (ESP) (February 2012 - June 2013), exploring scientific possibilities, focussed on 80 AGN sources and six star-formation regions (e.g. Orion KL, Cepheus A)

- Key Science Programme (KSP) (July 2013-June 2014) to focus on those areas of greatest scientific impact, with an open invitation for proposals and decisions taken in the Max Planck Institute in Bonn over 3-4 December 2012; and

- General Observing Time (GOT).

Yuri Kovalev explained that the early mission was to do an AGN survey so as to try to find ultra-compact AGNs on baselines longer than five Earth diameters. Once these AGN sources were identified, they then moved on to brightness and temperature measurements. Different scientists associated with the project had their own shopping list of targets. Kovalev's early targets were pulsars, blazars and masers [7]. Blazars are small-scale structures, in effect quasars with their jets pointing toward Earth, which inflates their apparent brightness. For Sandor Frey, the priority was to zoom in on the high redshift universe, quasars, the most powerful sources at the edge of the universe, whose jets were bending on a massive scale and undergoing structural changes [8].

For the KSP, 31 proposals were made by 160 scientists from 18 countries, the principal ones being from Russia, 34; Australia, Germany and USA (20 each) and the outcomes were presented at COSPAR, Moscow in August 2014. The second programme ran from July 2014 to June 2015, the third from July 2015, the fourth from July 2016 to June 2017 and fifth programme commenced in July 2017 to run to June 2018. This fifth programme involves 11 projects on maser spots, interstellar turbulence, pulsars, AGN temperatures, star formation and gamma ray production.

The first full set of coordinated VLBI measurements, also called interference fringes, were made on 25th November 2011 of quasar 0212+735 using telescopes in Svetloe and Zelenchuskaya in Russia, Yevpatoria in Crimea, Effelsberg in Germany. This quasar was chosen because of its brightness and compactness [9]. This was followed by observations of BL Lacertæ which coincided with a flaring event (later observations found its twisted structure and mapped its magnetic field) [10]. Next were observations of the giant pulses from the Crab nebula. Then observations were turned toward the maser within the Cassiopeia A supernova remnant, pulsar B0950+08. These observations were initially focussed on testing the telescope and calibrating it against previous investigations, for example against Vela, one of the oldest (1968) and best-known pulsars.

In practice, scientific results came quite quickly. Although the AGN survey was intended to principally to look for high-temperature objects and select promising targets for follow-up, it found brightnesses two magnitudes higher than set by Compton as the theoretical limit [11]. Observations of the Crab pulsar and the star-forming region Orion KL (the Orion nebula well-known to amateur astronomers) 420 mpc away found water and hydroxl masers and later, water masers in Cepheus A where there is a young cluster of massive stars [12]. The Crab pulsar presented a real challenge to understand, because it was emitting signals at an astonishing 30 times a second, faster than its own rotation [13].

Here are some highlights of the observing programme.

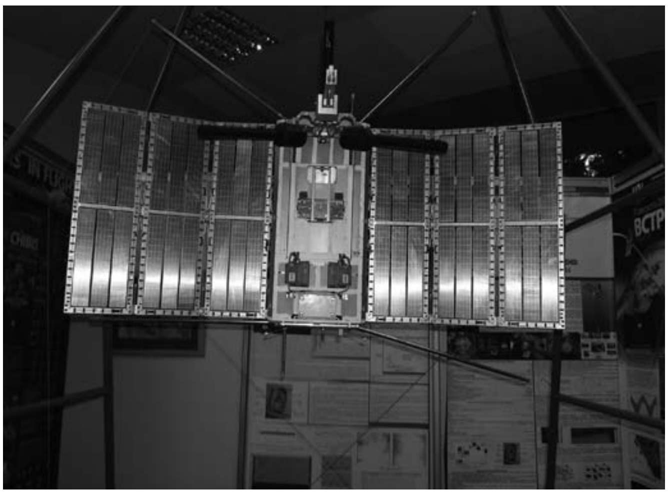
- The first image of a rapidly variable active galaxy (0716+714) was made in summer 2012 as a result of 24hr observations from Russia and China on baselines up to 5.2 Earth diameters, imaging its jet base of width 0.3 parsec and brightness of $2x10^{12}$ K [14].

- Jets are a feature of AGNs and observations from 25 ground stations made of radio source 3C84 in over 22hr in 21-22 September 2012 were the clearest ever and used 25 ground stations. This showed that this jet had a complex structure, curved trajectory and a counter-jet [15]. The southern blazar PKS 1954-388 was detected on baselines of 6.2 Earth diameters and was closely studied at radio and gamma ray energies [16].

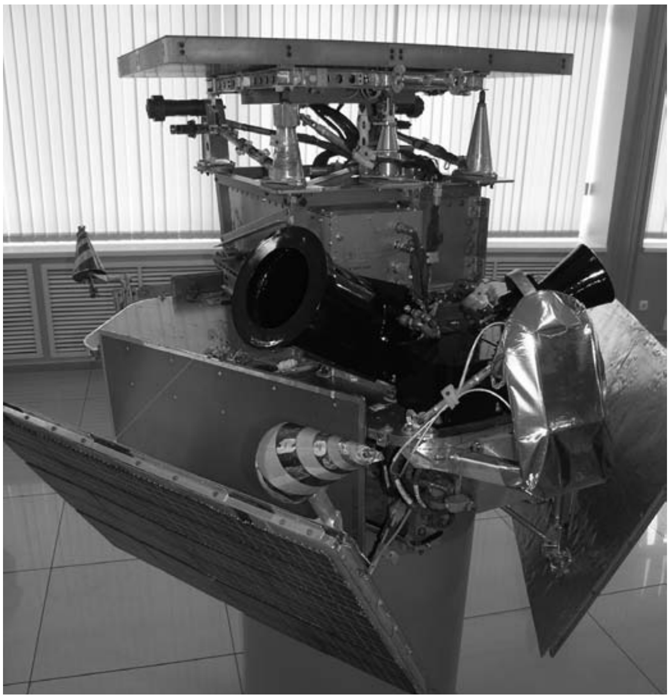
- Pulsar research was undertaken in order to better understand the effects of scattering in the interstellar medium. Thirteen have been observed so far. A 2013 example was pulsar B1933+16 in the arm of Saggitarius at 3.7kpc but these observations were at least as valuable for learning about the inhomogeneities of plasma in the interstellar medium in its line of sight [17]. For example, the image of pulsar B0329+54 in Orion shows not a single point source, but how it is broken up by plasma turbulence in the interstellar medium (ISM) and its scattering effect. Comparing many pulsars from different points makes it possible to map these inhomogeneities, suggesting connections with the spiral arm structure of our galaxy [18]. A study of pulsar B1919+21 found two screens of plasma, one at a near 0.13pc, another much further at 440pc [19]. Examination of B0329+54 and others suggested three dust areas - in the spiral of the Milky Way, a cavity 300pc from the Sun and much closer, 10pc from the Sun [20].

- In March 2015, the first detection of a water megamaser emission from a galaxy was reported (NGC 4258, also known as M106 spiral galaxy) 7.6 mpc away in Canes Venatici with maser spots around a supermassive black hole [21]. Water masers were also found in star forming regions W49N in the arm of Perseus; and W3 IRS5 [22].

- The heat of the inner jet of quasar 3C273 was estimated at 10 trillion degrees, exceeding previous recorded estimates suggesting a theoretical temperature limit of 100 billion degrees [23]. Kardashev himself described this as 'hard to explain'.



Chibis small scientific satellite



Zond PP.

Since then, though, serious concern has arisen that the effects of scattering of the interstellar medium can affect the apparent measured brightness temperature, especially at the lower temperatures [24].

- Magnetic fields have been mapped around distant objects, such as high-redshift quasar 0642+449 and its supermassive black hole and BL Lacertæ [25].

Overall the main scientific gains have been in obtaining precise and mapping images of these objects and their size; following brightness and temperature variations and structural changes (e.g. jets); and giving indications on the location and nature of interstellar dust. Finally, it is also worth noting that significant results have been obtained from the Plasma F instrument suite, giving Russia its first on-orbit data on the Earth's magnetosphere since Interball since 2000, with measurements of solar wind, energetic particles, the interplanetary shock wave, helium content in the solar wind, plasma fluctuations in the magnetosheath and small-scale fluctuations in the solar wind [26].

Other space science missions

Apart from Russian space science carried out on the ISS and planned for the moon (Luna 25-9), Venus (Venera D) and Mars (Exomars), other Russian space science projects in recent years have been small in scale.

With the conclusion of the Cosmos programme, with its two buses, the DS and AUOS and the Intercosmos programme (the Interball mission being the last), Russia was left without a structured programme of small scientific satellites that matches, for example, the American Explorer programme. The most the programme could do was three small scientific satellites, Tatiana 1 and 2, also called the *Universitetsky* series and Chibis M. The first Tatiana was a 30kg satellite launched on a Cosmos 3M with Cosmos 3414 Parus on 20th January 2005; the second, for radiation, cosmic rays and the magnetosphere was launched on Soyuz 2.1.b on 17th September 2009; and Chibis M, 40kg, launched from the ISS on 25th January 2012, to study sprites. It decayed 16th October 2014. Scientific results from all three missions have been published [27].

In an attempt to achieve economies of scale with smaller spacecraft, the Russians devised a standard set of spacecraft buses in the 1990s, of which the *Navigator* used for Spektr and Elektro was one. The others were *Karat* (Lavochkin design bureau) and *Kanopus* (VNIEM design bureau). *Karat*, also called missions MKA-FKI, was used twice for MKA-FKI PN 1 and 2, though four other missions were projected (MKA-FKI PN3 *Konus*, for gamma bursts; MKA-FKI PN 4 *Strannik*, as a magnetic fields precursor to *Resonans*; MKA FKI PN 5 *Arka* (solar observatory, not to be confused with the long-promised *Arktika* series for arctic monitoring); and MKA FKI PN6 *Monika*)[28]. The two launched were:

- MKA FKI PN 1 Zond PP launched July 2012 with Kanopus V to study ocean salinity, circulation and climate dynamics. Zond PP carried a panoramic radiometer, hyper-spectrometer (*Pribor*), multi-spectral camera and video camera. Although results were obtained, the mission was curtailed, for its computer failed on 5th June 2013;

- MKA FKI PN2, *Relek* (also called the Relek experiment, which stands for relativistic electrons) later named *Sergei Vernov,* launched 8th July 2014 on Soyuz 2 with Meteor M-2. It was a 250kg satellite to study space weather and the radiation belts, but lasted an even shorter period, failing that year's end. This was designed to follow the Koronas F solar observatory and carried three DRGE scintillator detectors, a telescope, photo-multipliers and magnetic field sensor. The first scientific results were published in 2016 [29].

There were evidently many problems with *Karat*, built by NPO

Mikhail Panasyuk

Lavochkin, and the bus was discontinued by the Academy of Sciences on 14th March 2014, but allowing *Relek* to fly. Apparently, the bus had proved to be too expensive and the scientists were encouraged to move their experiments onto other, larger spacecraft.

There were results from the missions, despite the short lifetimes. The *Sergei Vernov* was directed by veteran physicist Mikhail Panasyuk who announced the first results at COSPAR 2014 in Moscow in August, by which time a GB of data had been received and it was monitoring solar flares in November. Both missions were described in Lavochkin's *Vestnik* [30].

The most noteworthy in the past year is *Lomonosov*. The original *Lomonosov* was a star-mapping project in the 1980s, but this became redundant once a full star atlas was compiled by Europe's Hipparcos. The present mission has no connection to that planned then, its name coming from the Moscow State University named after Mikhail Lomonosov.

Lomonsov may be called a middle-size mission, for it weighs in at 625kg, has eight instruments and uses the *Kanopus* bus. It had originally been scheduled for a Dnepr launch but when that was no longer available after the Ukrainian crisis, it was allocated a Soyuz 2.1a and Volga upper stage on its maiden flight from the new Vostochny cosmodrome with a secondary payload, the Aist 2D.

Lomonosov was developed by the Nuclear Physics Institute of Moscow University with the Skobeltsin Nuclear Physics Institute and Sternberg Astronomy Institute to study ultraviolet light flashes (TUS), transient luminous events, sprites (following Chibis), gamma bursts (BDRG), electric and energy release events in the atmosphere (UFFO), with a test of a high-speed instrument to detect space junk and asteroids (ShOK). Images from ShOK were published quite promptly. Publication of results of this and other missions suffered a setback in August 2016, when COSPAR 2016 in Istanbul was cancelled, but some will presumably be re-directed to other outlets.

Future

The latest space science plans show, aside the Spektr missions:

- The planned lunar missions (Luna 25-9) over 2019-2024;
- Venera D, now back in planning with the United States, for a lander, orbiter and kite (Venus Atmosphere Manoeuvrable Platform (VAMP));
- Exomars, the joint mission with Europe, now set for launch on 24th July 2020;

Preparing *Lomonosov* for launch.

- *Boomerang* (second Phobos sample return), 2024. This will now be competing with the September 2024 departure of the Japanese French MMX mission to retrieve Phobos samples, due back 2029;
- *Resonans* (three satellites), a long-standing magnetospheric mission following *Interball* in the 1990s, approved but without a scheduled launch date;
- *Arka*, despite the cancellation of *Karat* [31].

Acknowledgements

My thanks go to David Jauncey in Australia for his paper Jauncey, David: *Radio Astron, space VLBI and international cooperation*; and for his review and subsequent comments on the first draft of the paper.

Launch of *Lomonosov* from Vostochny.

References

1. For a more detailed history of Spektr, see Anatoly Zak's account on www.russianspaceweb.com.
2. Revnivtsev, M.G. 'Measurements of the cosmic x-ray background of the universe and the MVN experiment', Astronomy Letters, vol 40, §11, 2014.
3. 'Russian Spektr RG mission to identify 3m black holes after 2018 launch', Space Daily, 15 June 2017.
4. Kardashev, Nikolai Presentation, Moscow, COSPAR, August 2014.
5. Newsletter 1
6. For a description of the Spektr R mission and the orbital manoeuvres arising therefrom, see Zak, Anatoly: www.russianspaceweb.com.
7. Kovalev, Yuri & Kardashev, Nikolai 'Space VLBI mission RadioAstron: development, specifications and early results. Proceedings of Science, 040, 2012. Maser stands for 'Microwave Amplification by Stimulated Emission of Radiation'. The main theoretical work was undertaken in 1952 by Nikolai Basov (famous for the Cosmos 97 Molekularni mission) and Alexander Prokhorov, who were later awarded the Nobel prize for physics. They are used here in two senses. First, masers are used as timekeeping devices for clocks. Second, masers are the natural emission of super-radiant radiation and are indicative of water, hydroxl, methanol, formaldehyde and silicon monoxide, especially in star-forming regions. They can be especially strong in AGNs, where they are called megamasers.
8. Frey, Sandor 'Zooming in on the high-redshift universe', Presentation, COSPAR, Moscow, 2014.
9. Newsletter 10.
10. Gomez, Jose et al 'Probing the innermost regions of AGN jets and their magnetic fields with Radioastron - imaging BL Lacertae', The Astrophysical Journal, 817, 2016; Newsletter 11, 12, 16.
11. Sokolovsky, Kirill 'RadioAstron early science programme space-VLBI AGN survey: strategy and first results', Proceeedings of Science, undated.
12. Newsletter 27, 18, 12.
13. Rudnitsky, A.G. 'The Crab pulsar', Presentation, COSPAR, Moscow, 2014.
14. Kardashev N. et al 'Radio Astron - a telescope with a size of 300,000km - main parameters and observational results', Astronomy Reports, 2013, vol 57, §3, Newsletter 16.
15. Newsletter 29.
16. Edwards 'Proceedings of the Astronomical Society of Australia, vol 34', 2017.
17. Newsletter 29.
18. Popov, M.V. et al 'Distribution of inhomogeneities in the interstellar plasma in the directions of three distant pulsars from observations with the RadioAstron ground-space interferometer', Astronomy Reports, vol 60, §9, 2016.
19. Shishov, V.I. et al 'Interstellar scintillations of PSR B1919+21: space ground interferometry'. MNRS, 18 May 2016.
20. Andrianov, Andrey et al 'Study of scattering material with RadioAstron VLBI observations'. Proceedings of Science, EVN 2014, 064.
21. Newsletter 27.
22. Newsletter 27, 19, 29.
23. Kovalev, Yuri et al 'Radioadstron observations of the quasar 3C273 - a challenge to the brightness temperature limit', Astrophysical Journal Letters, 820, 2016.
24. Johnson, Michael et al 'Extreme brightness temperatures and refractive substructure in 3C273 with RadioAstron', Astrophysical Journal Letters, vol 820, 2016.
25. Lobanov AP et al 'RadioAstron space VLBI imaging of polarized radio emission in the high-redshift quasar 0642+ 449 at 1.6 GHz', Astronomy & Astrophysics, 583, 2015.
26. Zelenyi, Lev et al 'Plasma F experiment - three years of on-orbit operation', Solar System Research, 2015, vol 49, §7.
27. Garipov, Gari et al 'UV radiation from the atmosphere - results of the Tatiana satellite measurements', Astroparticle Physics, vol 24, §4-5, 2005; Garipov, Gari et al 'Global transients in ultraviolet and red-infrared ranges from data of Universitetsky Tatiana 2 satellite', Journal of Geographical Research: Atmospheres, vol 118, 2013; Slominska, Kinga et al 'Scientific results of atmospheric phenomena with JEM-EUSO', monograph; Zelenyi, Lev et al 'The academic Chibis M satellite', Kosmicheskiye Issledevoniya, vol 52, §2, 2014; Dolgonosov, Maxim et al 'VHF emission from lightning discharges recorded by Chibis M microsatellite', Presentation, Moscow, COSPAR, 2014.
28. MKA = Malorazmernie Kosmicheski Apparat. PN = payload.
29. Myagkova, Irina et al 'Dynamics of electron fluxes in the slot between radiation belts in November - December according to the data of the Vernov satellite', Kosmicheskie Issledovaniya, vol 55, §1, 2017; Panaskyuk, Mikhail et al 'Experiment on the Vernov satellite - transient energetic processes in the Earth's atmosphere and magnetosphere'. Part I, Description of the experiments; part II, first results. Kosmicheskiye Issledovaniya, Vol 54, §4, §5, 2016; Myagkova, Irina et al 'Electron flux variations at altitudes of 600-800km in the second half of 2014 - preliminary results of experiment using RELEC equipment on board the satellite Vernov', Kosmicheskiye Issledovaniya, vol 54, 12, 2016.
30. Gordienko, ES et al 'Zond PP, Relek small spacecraft ballistic, navigation and flight control', Vestnik, 32, 2/2016.
31. The dates for the Spektr, Luna, and Boomerang missions were given by Zelenyi, Lev in 'The legacy of Sputnik', remarks made at conference in Moscow, 3rd October 2017, to mark 60th anniversary of the launch of Sputnik.

Space Chronicle, Vol. 71, pp.1-40, 2018

Monumental Statues to the Local Living Cosmonaut

A case study of Kaliningrad (Russia) and Húludǎo (China)

ANDREW THOMAS Department of Politics and Public Policy, de Montfort University, Leicester

This study draws on photographic field visits to statues of living cosmonauts (and their surrounding sites) in Kaliningrad in Russia, birth or home city of cosmonauts Alexi Leonov, Victor Patsaev and Yuri Romanenko, and Húludǎo (葫芦岛) in Liaoning province, Peoples' Republic of China, home town of China's first Hángtiānyuánm (航天员), Yang Liwei (杨利伟). Theories of Monumentalism and Socialist Realism are discussed as they are visible influences on the statues and settings; changes in the presentation of the statue in Kaliningrad following the creation of the Russian Federation are noted; and some features of the complex setting at Húludǎo are explained. The paper draws extensively on the author's photographs of these monuments taken in 2013 (Kaliningrad) and 2016 (Húludǎo) and reproduced here.

Introduction

The task set for this paper is to examine the ætherial qualities of two public monuments to living space explorers in their home cities, and to extract from a visit to each of them a public narrative about space travel. The monuments, which taken together exhibit similarities and differences, are considered both from the point of view of the agencies who commissioned and built the monuments, and of the general public, who interact with this narrative in a daily discourse, and a discourse about space exploration.

Both references to the explorer, in Kaliningrad and Húludǎo (葫芦岛), stand in a complex setting which give a context to the achievement of the people represented. The monument in each case therefore consists of these two components: a personal reference and its constructed context. These monuments are the product of authoritarian Socialist countries (USSR and China), and each has a local counter-narrative.

Perspective

These monuments are described as physical structures which were visited with some cultural experience and expectations. They are in public space and so they were photographed extensively and in close detail. As sculptures they are capable of conveying meaning, as a text is "read" into a narrative. This narrative is conveyed into a discourse within that society as people absorb and react to the conveyed meaning.

The cultural narratives are constructed deliberately to convey a particular set of meanings in to public discourse. There they stand with other narratives, such as public statements, news reports, television shows, magazines, model spacecraft, commemorative stamps, and other ephemera, which together form the public discourse of space exploration in Russia and China.

Methodology

In order to understand these intentional narratives, a methodology is required to move from the raw experience of the monument.
It is possible for an account of public sculpture to be given ad hominem – that is, the account is accepted because of the identity (and by implication, the learning) of its author. But Yanow [1] considers that "Organizational spaces are significant to human meaning-making and therefore to organizational practices, and interpretive methods provide ways of studying them."

In this paper, the example of Yanow is followed, as she writes [2]:

> The author who is writing about experience-near research needs to show that he or she was, in fact, close to the experience, whether as observer or participant. The focus of interpretive research is on meaning to the actor in the situation, and the researcher as participant stands in for that actor to some extent. Although this might seem to require first-person narration and even a confessional mode, it can be accomplished otherwise through third-person thick description, the layering of interwoven and interrelated material that characterizes ethnographic research.

In this paper, the author illustrates with photographs taken by himself in 2013 and 2016, and hopes to contribute a "thick description" along the lines set out by Kopytoff [3]:

> In doing the biography of a thing, one would ask questions similar to those one asks about people: What, sociologically, are the biographical possibilities inherent in its "status" and in the period and culture, and how are these possibilities realized? Where has the thing come from and who made it? What has been its career so far, and what do people consider to be an ideal career for such things? What are the recognised "ages" or periods in the thing's "life", and what are the cultural markers for them? How does the thing's use change with its age, and what happens to it when it reaches the end of its usefulness?

The narrative initiated by the monuments starts with a text as defined by Yanow [4]

> I will treat organizational buildings and built spaces as texts… *Text* focuses on hermeneutic processes, that is, what meanings, made by whom, and with what consequences and conflicts. The focus is on the setting that is "read" and on its "writers" and "readers".

This approach in summary considers"…built spaces as texts that are read by multiple audiences (readers) who sometimes make meanings of those spaces which were not intended by their organisational or architectural designers." This gives space for the creation of counter-narratives.

Orientation: Kaliningrad

Kaliningrad is the Western-most oblast of modern Russia, bordered by Lithuania and Poland. To consider the place within an Astropolitik [5], at a position of –54.7104° N, 20.4522° E, the sub-satellite point is not below the orbital track of the International Space Station or previous Soviet manned missions (Orbital Inclination 51.6 degrees). However, the Tracking Ship *Cosmonaut Victor Patseav* is moored at the Museum of the World's Oceans, and at the time of the visit in 2013 the "laboratory" on board was still in use[1]. It is the home city of cosmonauts Alexi Leonov, Victor Patsaev and Yuri Romanenko,

It has a sad and violent history as the German city of Königsberg bombed heavily by the British and subsequently liberated by the Red Army in 1945.

The monument is set in a small public square off Prospekt Mira adjacent to a large public park, the square being in use by the public at the date of the visit (Fig. 1). Immediate in its impact is a large circle, set against a bright sky, inscribed (author's translation)[2]:

> "The humankind will not remain on the earth for ever but fighting with light and space will first burst the boundaries of the atmosphere and then will conquer the whole space of the solar system."

The monument as a whole site was renovated in 2005-6 by a Lithuanian architect [6] in a project which he calls[3] "The Monument to Cosmonauts and the Symbolism of the Rising Sun". He records that the statue has as "its author sculptor B. V. Edunov (25.10.1921 – 02.05.1982) He is the author of the main monuments "The Mother Russia" and "Kalinin" in Kaliningrad". Set into the walls of the square are cast iron plaques reminiscent of the work of Friedrich Rogge (1898-1983) which commemorate each home cosmonaut by name, text, and bust.

As Vysniauskas records,

> "The image of the rising sun which directly associates to the awakening, ascension and life was chosen as the main symbol of the conception. Choosing the time – approximately 5a.m. in the summer period, when the sunbeams come out of forests and mountains, was the way to express it. The sun is about to rise but still invisible with its light on the horizon and moving clouds. Such an image is created on the monument's pedestal made of a mosaic of colour glass with an objective to recreate the range of natural colours. The rising sun, moving clouds reflecting the light of the sun and, above that - a rocket which is blasting off and a man-cosmonaut standing in the centre…"

Kaliningrad: narrative and counter-narrative

Yamolsky [7] considers that, in relation to Socialist monuments:

> Traditionally, monuments are erected in areas that are maximally open and accessible to view…most often in the squares formed by street intersections, or on an elevated spot. Pragmatically, this is motivated by the fact that, by its very nature, a monument is intended to be admired, contemplated, and worshipped. In reality, however, monuments rarely become objects of a genuine cult or even of admiration. In the urban landscape, as a rule, their perception is automatized and they virtually disappear from the field of vision. Moreover, their positioning often violates the golden rule of the street's visual text: the obligatory placement of the object at – or slightly above – the passer-by's eye level, a rule that advertisements invariably follow. The high pedestals that long dominated the architecture of monuments render the memorials almost

[1] Antenna Description downloadable from: http:// www.andythomas.eu
[2] Человечество не останется вечно на земле, но в погоне за светом и пространством сначала робко проникнет за пределы атмосферы, а за тем завоюет все околосолнечное пространство. К.УЕ. Циалковский.
[3] Miesto aikštės su paminklu „Kosmonautams" rekonstrukcijos projekto paruošimas ir įgyvendinimas. Kaliningradas. Rusija.

Figs.1 and 2 The Kaliningrad Monument (*above*) and Soviet pin-badge (*right*).

> indiscernible from up close. Easily visible from afar, they appear to fade from the field of vision as one approaches them.

He adds [8] that:

> A [Socialist] monument is not so much meant to imitate one or another person as it is to express the idea of not being subject to time, of extrahuman temporality, of ahistoricity.

But is this an adequate description of the monument? Metz [9] describes the alienation of his fictional self on experiencing the monument in Kaliningrad (author's translation):

> Kant, the philosopher who made the cosmos, was the greatest Köningsberger. The Cosmonauts, his brethren in spirit, are the greatest thing that has brought Russian Kaliningrad. They also have their own monument, where my Prospekt Mira crosses with Uliza Leonova. Leonow, the spacewalker, balances the narrow circle of his orbit, stretching out his arms, as if greeting a new universe. He has stripped off the cosmonaut's helmet. The sun is always to his back, Kaliningrad is forever to his feet. Almost every day I walk or pass the monument and look fascinated at Leonow. Then we meet up in orbit and shake our hand.

Sezna considers in these terms [10] that in Kaliningrad it is appropriate to be aware of the City's modern history:

> Two dominant representational strategies were employed by the State to incorporate Köningsberg into the space of the Soviet Union. One was to create a local history of the Kaliningrad oblast. The other was to attempt to integrate this territory into the general history of the Soviet Union.

These are special circumstances, as Vysniauskas records [11]:

> "The cosmonauts themselves planted little trees next to the monument in the square; in 30 years' time they grew big. Sadly, the people and the town did not manage to see that monument. The institution responsible for the protection of monuments and local authorities also forgot this masterpiece and this monument turned into a place where tramps and drunkards used to come for warmth at the rear of the monument at sunrise and where pupils and students used to gather for a smoke in the daytime. From all the good in the square only a broken bench, a pavement with uneven and broken flat stones…"

At the time of the visit, some of the new coloured tiles had been covered artistically, or as graffiti, with repeated images on stickers, and it was evident from printed posters pinned to the cosmonauts' trees that the square was in use as a rendezvous for political protest. These are newer counter-narratives than its previous use as a haven for drunks.

Sezna [12] discusses these special circumstances of Kaliningrad further and notes that:

> "A clash between 'what is' and 'what is demanded' was characteristic of Soviet society as a whole in the period of 'stagnation' (1972-85)…In Kaliningrad, this overall crisis was deepened by a local schism between the shallow official history of a peripheralised city, and a 'remembered' centrality of the place in European history."

Kopytoff [13] addresses the commoditization of things, and considers how cultural conventions singularise monuments:

> "In every society, there are things that are publicly precluded from being commoditized. Some of the prohibitions are cultural and upheld collectively. In state societies, many of these prohibitions are the handwork of the state, with the usual intertwining between what serves the society at large, what serves the state, and what serves the specific group in control. This applies to much of what thinks of as the symbolic inventory of a society: public lands, monuments, state art collections, the paraphernalia of political power, royal residences, chiefly insignia, ritual objects and so on. Power often asserts itself symbolically precisely by insisting on its right to singularise an object, or a set or class of objects."

The USSR did commoditize the Kaliningrad monument in that a Soviet era pin-badge, inscribed "Earthlings to conquerors of space", could be bought at a collectors' market even after the demise of the Soviet Union (Fig. 2).

---

[4] Kant, der Philosoph, der den Kosmos vermaß, war der großte Königsberger. Die Kosmonauten, seine Brüder im Geiste, sind das Großte, was das russische Kaliningrad hervorgebracht hat. Auch ihnen gehört ein eigenes Denkmal, dort wo sich mein Prospekt Mira mit der Uliza Leonowa kreuzt. Leonow, der Weltraumspaziergänger, balanciert dort den schmalen Kreis seiner Umlaufbahn entlang und streckt die Arme aus, so als begrüße er ein neues Universum. Den Kosmonauten helm hat er abgestreift. Die Sonne steht immer in seinem Rücken, Kaliningrad liegt auf ewig zu seinen Füßen. Fast täglich gehe oder fahre ich an dem Denkmal vorbei und sehe fasziniert zu Leonow auf. Dann treffen wir uns oben in Orbit und schütteln uns die Hand.

Orientation: Húludǎo (葫芦岛)

In our astropolitical sense, this city is located at position: 40.7110° N, 120.8369° E. Because the inclination of Shenzhou-4 was 42.4 degrees, the monument is approximately at a sub-satellite point below spacecraft. It is the home city of China's first Hángtiānyuán (航天员), Yang Liwei (杨利伟).

The monument as a whole is contained within the "Feitian Square"飞田广场 [14] and forms a complex site at a traffic junction, illuminated at night, as shown in Fig.3. It contains a copper sculpture of Liwei, several brightly-coloured arms set on a master carving granite relief, nine pillars of stone, 14 steps and a 1:1 bronze copy of the return capsule model. It was commissioned by the municipality and created by the Chinese Association of Sculpture, lead sculptor being Cheng Yunxian with six other sculptors.

The coloured arms are striking both in daytime and when illuminated at night. They are set in bright standard colours of yellow, red, blue and green. They are said to be in the shape of the character 飞 fei 'to fly' but they are elongated and lack the two small strokes to the right of the character. As coloured streamers they could stand for rocket exhaust or convey movement as if they were the peacock decoration or long sleeves and lances in Chinese opera. However, they inspire the first character of 飞天 feitian 'apsara', evoking the long scarves of the lady apsaras from Dunhuang.

The Feitian monument rewards visitors who cross the roundabout with detail in the scripts which are easily visible from below, but not from the other side of the road from the monument. Both close and distant views are provided by this accessibility.

Embossed on the master carving is "Feitian Square" in gold Traditional characters and around it are images of flight, astronomy and space travel in China. Around this is a semicircle of tall slim cylinders depicting space events, with texts engraved in Seal, Traditional and Simplified characters, in various fonts. Fig.4 shows a tribute to the Apollo 11 mission – "Moon America Apollo eleven" (月亮美国阿波罗十一).

The four days of the mission are symbolised by steps upwards and 14 sets of steps around the monument symbolize the "Shenzhou" mission around the Earth flying 14 orbits.

Húludǎo (葫芦岛): Narrative and counter-narrative

Clunas, in his comments about Chinese paintings, notes that [15]: In considering the increasingly global audiences involved in constructing "Chinese Painting" in the twentieth century, we need also

Fig. 4 Yang LiWei as if an Apsara

Fig. 3 Feitian Square at night.

[as well as "the autonomy and expression of the artist's subjectivity] to take into account the visibility of that Chinese painting to, for example, a Soviet audience, as in the major Chinese exhibition at the Tretyakov Gallery in Moscow in autumn 1950, or the Chinese participation in the "Art of Socialist Countries" exhibition held in Moscow in 1958-1959. The official discourse around this very explicitly emphasized the plurality of styles in the "socialist camp", aiming to refute directly accusations from the West that the creativity of the individual and the specifics of national styles were suffering suppression under socialism (Reid, 2000 p107)[5].

Wenfang [16], in criticising the application of the Frankfurt School's analysis of mass media, seeks a peculiarly Chinese characteristic:

> "…Chinese scholars should break through what is Western and base themselves on China and the contemporary scene, and particularly China's practical development in the current transitional period. Academically consistent with the practical development of contemporary China is a new three-dimensional spiritual pattern consisting of level of thought, value concepts, and Chinese characteristics".

While it is appropriate to consider the influence of the Socialist style on the monument in Húludǎo (葫芦岛), it is therefore also necessary to be alert for Chinese characteristics.

The roundabout containing the monument includes small beds of flowers and shrubs. A foreman or work unit leader spoke up with pride about the local man.

Looking up at the statue of Yang Liwei (杨利伟), squinting against a bright sky, his shoulders are surprisingly thin, and his head, not encased in a helmet, quite small. But his boots are prominent, as is the box containing his portable ventilator. This perspective is confirmed by printing a plastic 3-D model from photographs taken below the statue.

The direction faced by Yang LiWei appears to be towards the ascending node of his spacecraft. From a particular angle, the coloured lengths appear behind the statue of Liwei as if he were himself an apsara (Fig. 5).

But discounting this allusion to the lady apsara, referring to them disparagingly as "painted ladies", a counter-narrative was expressed by a resident of Húludǎo (葫芦岛), who said that as he drove towards the intersection he saw first three large bananas, followed by, as he drew nearer, a statue of a boy with a box of grenades.

[5] Reid, S (2000): "The Exhibition "Art of Socialist Countries", Moscow 1958-9, and the Contemporary Style of Painting. In: Reid, S and Crowley, D (eds): *Style and Socialism*. Berg, Oxford.

Discussion

In developing the "thick layer" of explanation, Kopytoff [17] generously asks us to be open about cultural bias:

> "Behind the extraordinary vehement assertions of aesthetic values may stand conflicts of culture, class and ethnic identity, and the struggle over the power of what one might label the "public institutions of singularisation."

It appears that the Kaliningrad monument is not entirely explained by its socialist origins, but requires the thicker description to be more sensitive to the city society in which it is located.

Merging, in both the cases of Kaliningrad and Húludǎo (葫芦岛), the local identification of the space explorer with the City is not atemporal, but rooted firmly in the present continuous, and therefore in these two cases it is the progress in space exploration, not limited to that progress under Socialism that is being conveyed, not "a stable atemporality" [18]. Here we see the affectionate and proud references to the space voyager and to the local space.

Conclusion

This interpretive account of monuments to living space travellers in their home cities describes two very different monuments but which share some common characteristics.

It is important to consider not only how the monuments are meant to be viewed, but also, as best we can, how they are viewed in the society in which they have been constructed.

Both monuments originate from Socialist societies. They are not colossal, but by including their constructed context their ground area is very large. They are complex in their overall structure, containing many visual and written references. They are accessible and accessed locally.

The authoritative narrative presented by these monuments extends the meaning of the monument from the individual local space traveller to progress in space exploration over time. This is a socialist message, but it is not one of stable atemporaility or ahistoricity.

Fig. 5 Tribute to Apollo 11 - "Moon America Apollo eleven" (月亮美国阿波罗十一)

There are also irreverent counter-narratives arising from the monument: a space for drunks or a set of bananas. These are additional meanings arising from the general public who interact with the official narrative and create a discourse.

The interpretive approach continues the development of counter-narrative by allowing the visitor to see and propose some additional meaning by virtue of their sub-satellite point.

The principles of socialist design show a sensitivity to local circumstances, including an ambiguous if not split collective history and a local pride and affection.

In Kaliningrad, it may be the contested history of the city which leads to a lesser Socialist message, but in both cities by design the dominant narrative is that of space exploration. The local hero has become an icon of this narrative.

Acknowledgements

This paper was written within my study of policy narratives of the Chinese space programme. Dr Jonathon Rose and Dr Steven Griggs of the Department of Politics and Public Policy, de Montfort University, commented on an early draft of this paper. I am also grateful to the comments from Angela Reich who guided me through Chinese calligraphy. Staff at the British Library found the Chinese account of the statue at Húludǎo; Staff at the Confucius Institute, de Montfort University, helped in the translation of simplified and Traditional Characters; and Students at King's College London introduced me to friends and their hospitality in Húludǎo. My thanks to them all; all errors and omissions are mine.

References

All internet access as at May 2017.

1. Yanow, D (1998): Space Stories: Studying Museum buildings as Organizational Spaces While Reflecting on Interpretive Methods and their Narration. *J. Management Enquiry* 1998 7:3 pp215-239. p236
2. ibid, p234.
3. Kopytoff, I (1986): The Cultural Biography of Things: Commoditization as Process. Chapter 5 in Appadurai, A (ed): *The Social Life of Things*. CUP. p66
4. Yanow, op. cit., p217.
5. see Dolman, CE (2001): *Astropolitik: Classical Geopolitics in the Space Age*. Routledge.
6. http://www.ricardasvysniauskas.lt/LT/menu/ricardas-vysniauskas
7. Yampolsky, M (trans. J Kachur) (1995): In the Shadow of Monuments: Notes on Iconoclasm and Time. In: Condee, N (ed) (1995): *Soviet Hieroglyphics in Late Twentieth-Century Russia*. Indiana UP. p98
8. Yampolsky, op.cit., pp93/4
9. Metz, A (2005): Kosmonaut in Kaliningrad – Entdeckungreisen durch das Universum Ost. Westkeruez-Verlag GmbH Berlin. Pp71/72
10. Sezna, O (2002): Problems of identity in Kaliningrad. In: Crowley, D , and Reid, S (eds): *Socialist Spaces: sites of everyday life in the Eastern Bloc*. pp47-64. Berg. p51
11. http://www.ricardasvysniauskas.lt/LT/menu/ricardas-vysniauskas
12. Sezna, op.cit., p62
13. Kopytoff, op. cit.,p 73
14. http://en.artron.net/news/news.php?piecespage=2&newid=37969&column_id=62 http://www.people.com.cn/GB/keji/1056/2811889.html
15. Clunas, C (2016): Chinese Painting and Its Audiences. *A W Mellon Lectures in the Fine Arts*, Volume 61. Princeton UP. p216
16. Wenfang, Y (2015): A "Symptomatic Reading" of the mass Culture Critique and its implications for the Reconstruction of contemporary Chinese Literary theory. *Social Sciences in China* 36:3 pp175-185. DOI 10.1080/02529203.2015.1062241. P182
17. Kopytoff, op. cit., p73
18. Yampolsky, op. cit., p104.

Reporting the Right Stuff?

The Press in Moscow During the Space Race

DOMINIC PHELAN

During the Cold War the Soviet Union did everything possible to control press coverage of its space programme. Unfortunately for the Kremlin over fifty Moscow-based foreign correspondents were still able to 'scoop' some of its carefully stage-managed cosmonaut propaganda.

A 27-year-old Nicholas Daniloff arrived Moscow in 1961 to work for legendary *United Press Internationad (UPI)* bureau chief Henry Shapiro – a veteran reporter who had lived in the Soviet Union since the 1930s and had excellent contacts.

Although Daniloff was born in Paris and raised in the United States, he was from an aristocratic 'White Russian' family and had a genuine interest in the culture. Unfortunately he found his new assignment mainly consisted of busy days in the office monitoring Soviet newspapers and television for items to rewrite as *UPI* 'wire copy'. He estimates 75-80% of western reports from Moscow during the 1960s originated in the Soviet media.

Correspondents who wanted to make a reputation for themselves had to get out of the office and find independent sources – a rare commodity during the Cold War. The fact that Nicholas Daniloff's grandfather had been a wartime general on Tsar Nicholas II's staff didn't make this any easier.

"On Mondays, Wednesdays and Fridays, I was seen as hostile. On Tuesdays, Thursdays and Saturdays, I was seen as friendly or at least understanding!" he half-joked [1].

Ironically, Soviet Premier Nikita Khrushchev offered a rare glimpse behind the official façade because his own enthusiasm for spaceflight – one of his few propaganda successes against the west – made him especially talkative on the subject. Western reporters literally stalked him around Moscow, notebooks in hand, waiting for a revealing quote.

"Spaceflight was very important to Khrushchev because it made the USSR look like a very modern, technological state – which was a misperception," recalled Daniloff. "The USSR gave space a high priority – it was a 'Guns over Butter' sort of thing."

For decades press dispatches had been directly censored at the central telegraph office before transmission to the west. In early 1961 Khrushchev allowed news bureaus install their own private 'telex' machines, so they suddenly had uncensored communications with the outside world [2].

Unwanted Headlines

In the run-up to Yuri Gagarin's historic spaceflight on 12 April 1961, Moscow was so 'electrified' with rumours of the flight that western journalists heard them. *UPI's* Henry Shapiro was even confidently reporting on 10 April that his own 'reliable but unofficial sources' were telling him it had already taken place [3].

This paper was presented at the British Interplanetary Society Sino-Russian Technical Forum held on 3-4 June 2017.

DOMINIC PHELAN COLLECTION

Nicholas Daniloff after his *KGB* release.

A similar report by Dennis Ogden of the British communist newspaper *The Daily Worker* caused the Soviets the most trouble. Although he should have needed little controlling – he regularly played cricket with exiled spy Guy Burgess! – his story was published on 12 April and wasn't just for western consumption. As his newspaper was one of the few western newspapers allowed on sale in Moscow, it appeared on newsstands around the city on the very morning Gagarin was launched.

Soviet journalist Leonid Finkelstein remembered seeing the headline and was in the process of checking it out with his own sources when the first news of Gagarin broke. He later learned those responsible for allowing *The Daily Worker* on sale were sacked, whilst Ogden had to leave the country the following year [4].

BBC correspondent Reginald Turnill attended Gagarin's first press conference but felt the event was solely organised to humiliate the western press. A delegation of Soviet nurses was paraded past them first and they then had to listen to them all laughing at the mocking answers given to their questions [5].

Soviet journalists also caused problems for the authorities. Astronomer Alla Massevich had been drafted in to monitor their output but her own ignorance of the fact that Gagarin's landing by personal parachute was top secret information led her to approve its use in several newspapers. She was soon relieved of her censoring job and full details of the landing weren't revealed for another ten years [6].

KGB Manipulation

When cosmonaut Andrian Nikolayev was launched aboard Vostok 3 in August 1962, western correspondents were astonished to hear their sources tell them a second cosmonaut would be launched the following day. As this simply seemed impossible, they dismissed it as 'Soviet banter' (or a joke) and missed the scoop [7].

"In the 1960s, and later, fear of KGB harassment and repression was a constant element of Soviet life," recalled Daniloff. "There were no scientific sources other than official press conferences. Soviet newsmen, especially at TASS, got advance notice of spaceflights and would pass on some info but only occasionally. I had a source at the Novosti press agency who gave me some stuff about Tereshkova being unlikely to fly again [8]."

He filed his 1964 exclusive about Valentina Tereshkova being medically disqualified after a Caesarean but later discovered his source was a KGB man feeding him harmless stories to gain his trust. Luckily, their friendship had cooled after the man tried to pressure him into revealing the source of another more sensitive political story. Anyone doubting the compromised position a correspondent could find himself in only needs reminding that Daniloff was arrested during a second 'tour of duty' in the 1980s and only released as part of a classic Cold War spy swap!

Another source suspected by the western press pack of having KGB connections was Viktor Luis. Although employed as a 'stringer' by many news outlets in Moscow, he was widely believed by them to be used to leak information the Soviets wanted known. These KGB sources were disparagingly termed 'Nursemaids' (*Nyanka*) by western correspondents.

In mid-March 1965 Henry Shapiro rushed into the *UPI* office after one of his sources (his assistants knew never to ask who) told him a spaceflight was days away and would see one of the cosmonauts conduct the first spacewalk. Although details were hazy, the source revealed it was a two-man crew and one of them would leave the spacecraft using a "special capsule" – which we now know was probably a reference to Voskhod's unique throw-away inflatable airlock. Daniloff wrote-up the story and transmitted the *UPI* scoop to the west 24-hours before Alexei Leonov and Pavel Belyayev were launched [9].

After their historic mission the Novosti press agency approached NBC television correspondent Frank Bourgholtzer with an offer of an exclusive interview with the Voskhod 2 cosmonauts. A New York TV crew were dispatched to record it and even asked amateur artist Leonov to illustrate the broadcast with his own drawings. When Leonov asked them to bring along some hard to find 'Magic Marker' pens, the Americans arrived with six dozen for the surprised cosmonaut [10].

Perhaps unfamiliar with western interview techniques, the cosmonauts convinced themselves they were really talking to a secret delegation sent by NASA. In his 2004 autobiography *Two Sides of the Moon* Leonov repeats the claim [11].

"Our meetings with the delegation took place in the offices of a Soviet press agency", he wrote. "At first I thought the delegates were American journalists but I soon realised that they were not, that they were specialists from NASA…They sat asking questions for hours and hours. They recorded the interviews, and filmed them with several cameras under special lighting. I do not believe that what NASA learnt from us during those discussions was put in a

NBC

Frank Bourgholtzer with the Voskhod 2 crew.

drawer and forgotten."

When NBC's 'The Man Who Walked in Space' was broadcast on American television on 14 May 1965 it was watched by millions - including astronaut Ed White, who admitted footage of Leonov's spacewalk helped him learn how to float around in orbit [12].

Moscow Isolation

The Kremlin tried to isolate Moscow-based correspondents by only announcing the first details of new missions via its TASS office in London. By the time details filtered back to them, their editors had already published without waiting for their expert opinions.

Often the only advantage they had was an ability to read ten Soviet daily newspapers and as many 'provincials' as they could get their hands on. Stories that might have been censored in the capital often appeared in these obscure publications. Henry Shapiro delegated this task to his Russian wife Ludmilla, who spotted a reference to the first multi-man Voskhod 1 crew in a provincial newspaper before it flew [13].

Ironically, she had a real-life 'Deep Throat' source inside the Soviet space establishment as her cousin was Yuri Pobedonostsev – a rocket engineer who had been sent to Germany after the war to study captured V2s. She later admitted he told her nothing for fear of revealing state secrets.

According to Daniloff, the correspondent who best exemplified the classic 'beat reporter' in Moscow was Theodore Shabad of *The New York Times*. Born in Berlin in 1922, he moved to America aged 16 but had also learned Russian to keep in contact with his father in the Red Army. Shabad was a trained geologist – something colleagues believed helped him find good academic sources [14].

"He was not a trained journalist (but) worked on the *Times* copy desk before going to Moscow," remembered Daniloff. "He made an effort to connect with Russians and attended dissertation defences at Moscow University and elsewhere."

Shabad's biggest 'scoop' came after attending the wedding reception for cosmonauts Tereshkova and Nikolayev in November 1963. Told by Russian friends that two of the guests were 'top secret' rocket engineers, Shabad learned they were named Sergei Korolev and Valentin Glushko. He obtained file photos under those names from TASS and wrote his exclusive two years before the Soviets officially admitted Korolev's existence [15].

Sometimes the Soviets had to be embarrassed into admitting a western news story. This happened during the homecoming parade for the Soyuz 4/5 cosmonauts in January 1969, when a lone gunman opened fire on the motorcade in an assassination attempt on Premier Leonid Brezhnev. Although a driver was killed and several cosmonauts injured, it took repeated questions from the foreign press pack before the Kremlin finally admitted it happened [16].

The Soviet Press

Unlike the western press, Soviet journalism played a central role in the Soviet propaganda machine. Official space correspondents like Alexander Romanov, Evgeny Riabchikov and Yaroslav Golovanov might have been given unprecedented access to a top secret military project but they always knew they were simply there to portray cosmonauts as living examples of Marxist-Leninist ideology – even if they knew otherwise. Their articles were censored at a special office on Moscow's Molodyozhnaya Street but it became a bureaucratic nightmare involving the submission of multiple forms and copies of articles [17].

Youth newspaper *Komsomolskaya Pravda* space correspondent Yaroslav Golovanov had given-up a promising rocket engineering career for journalism to be closer to his heroes. Although his twenty-two million readers ensured close access to all the leading space personalities, he soon grew disillusioned.

"It was very difficult for me to work because I knew much more than I was able to write," he admitted in 1990. "Soviet journalism is journalism between the lines. If you could not say something directly, you could still write for clever readers [18]."

Before a manned mission Soviet pressmen were given special envelopes containing the photographs and biographical details of the new crew but weren't allowed to open them until told. This didn't stop them telling western friends when the packages arrived on their desks [19].

Lars Bringert of the Swedish newspaper *Dagens Nyheter* got these tip-offs and passed them onto others in the western press [20].

American Joseph Galloway found a way to verifying these tip-offs when he discovered a Russian friend had a neighbour involved in manned rocket launches. When this friend was asked by the neighbour to collect his mail, Galloway correctly guessed the engineer had flown down to Baikonur for a launch [21].

Escaping the Censor

One of the few Soviet pressmen to escape censorship was Leonid Finkelstein. He defected during an official visit to London in 1966 but discovered nobody believed his insider view of the Soviet space programme. Westerners simply didn't believe the United States could beat the USSR to the Moon and his book *The Russian Space Bluff* (1971) wasn't published until after the triumph of the Apollo 11. He remained in Britain under the pseudonym 'Leonid Vladimirov' and became a well-respected broadcaster on BBC World Service radio.

Nicholas Daniloff swapped Moscow for Washington D.C. in 1965 and also decided to write a book on Soviet spaceflight. Between 1968 and 1972 he researched it part-time at the Library of Congress, interviewing émigrés and space experts such as Frederick Durant and Charles S. Sheldon.

"When you are in Washington, of course, the slant is going to be US positive," said Daniloff. "I did on one occasion go to the CIA for a briefing on Soviet space activities. Needless to say, nothing classified was alluded to [22]."

The Kremlin and the Cosmos was published in 1972 and sold 5,000 copies. "The Soviets later said the book was faulty and lacking in correct information. Not surprising! I did the best I could to scoop-up info but obviously I was an outsider looking in."

By the 1980s things were changing rapidly for the press behind the Iron Curtain. Previously off-limits topics were open to scrutiny; whilst Mikhail Gorbachev's policy of *glasnost* allowed Soviet journalism publish all the 'space secrets' it had known for decades.

The close relationship between the Soviet press and the Kremlin also nearly paid-off with a 'Journalist in Space' mission to the Mir space station. In the mid-1960s, Yaroslav Golovanov had been selected alongside broadcaster Yuri Letunov and *Krasnaya Zvezda*

Cosmonaut Belyayev reading *Paris Match.*

DOMINIC PHELAN COLLECTION

Tereshkova talks to reporters in 1965.

writer Mikhail Rebrov for a similar propaganda flight. That plan had come directly from Chief Designer Korolev, who was disappointed by the bland descriptions given by the cosmonauts and wanted a professional communicator aboard one of his spacecraft. Unfortunately the idea was scrapped after his sudden death in 1966 [23].

Twenty years later the Soviet press were outraged again when the new commercial space agency Glavkosmos offered a 'space tourist' seat to a Japanese journalist. The USSR Union of Journalists organised its own cosmonaut selection process to embarrass the Kremlin into supporting a similar flight by one of its members. It even sent an official delegation to Baikonur to watch the launch of Soyuz TM-8 in September 1989.

Pravda editors asked Mikhail Gorbachev who would fly first but all he could do was diplomatically remind them that the Japanese were already in training. Tellingly, a readers' poll in the newspaper showed 70 percent were opposed to sending the Soviet journalist. Six finalists were announced in May 1990 but the project fizzled out for lack of funds [24].

"To cut a long story short, there has been much talk – but business, as usual, was done by the Japanese," Golovanov lamented.

References

1. Nicholas Daniloff to author, 29 July 2016.
2. Nicholas Daniloff, Of Spies and Spokesmen, Univ. Missouri Press, 2008, pg.91.
3. Henry Shapiro (UPI), "Man in Space Report Electrifies Russia", Vancouver Sun, 10 April 1961.
4. Leonid Vladimirov, The Russian Space Bluff, Tom Stacey Ltd. 1971, pg.102.
5. "Space Miscellany", Spaceflight 21, pg.382, 1979.
6. Slava Gerovitch, Soviet Space Mythologies, Univ. Pittsburgh Press, 2015, pg.94.
7. Reuters, "Soviet Launching 'Joke' Was Lost on Newsmen", The New York Times, 14th August 1962.
8. Daniloff interview, July 2016
9. Nicholas Daniloff, Of Spies and Spokesmen, Univ. Missouri Press, 2008, pg.121.
10. Whitman Bassow, The Moscow Correspondents, Morrow & Co, 1988, pg. 212.
11. David Scott & Alexei Leonov, Two Sides of the Moon, Simon & Schuster, 2004, pg. 122.
12. Glenn E. Schweitzer, Techno-Diplomacy, 1989, p.168.
13. Whitman Bassow, The Moscow Correspondents, pg.253.
14. "Theodore Shabad, A Times Editor and Geographer, is Dead at 65", The New York Times, 6th May 1987
15. Nicholas Daniloff, The Kremlin and the Cosmos, Alfred Knopf 1972 pg.69
16. Nicholas Daniloff, The Kremlin and the Cosmos, pg.199
17. Leonid Vladimirov, The Russian Space Bluff, pg.104.
18. "What's In the Stars for Soviets", The Chicago Tribune, 13th December 1990.
19. Whitman Bassow, The Moscow Correspondents, pg.253.
20. Nicholas Daniloff, Of Spies and Spokesmen, Univ. Missouri Press, 2008, pg.111.
21. Whitman Bassow, The Moscow Correspondents, pg.355.
22. Daniloff interview, July 2016
23. Philip Clark, The Soviet Manned Space Programme, Salamander 1988, pg.30.
24. Gordon Hooper, "The Year of the Journalist", Spaceflight News, pg.18, May 1990.

Space Chronicle, Vol. 71, pp.1-40, 2018

CHINA'S SHIYAN WEIXING SATELLITE PROGRAMME
2004-2017

PHILLIP S. CLARK
Email: phillipclark@btinternet.com

This paper provides an analysis of the satellites which have been launched under the programme name Shiyan Weixing starting in 2004. It provides a summary of what is known and what can be deduced about the satellites from orbital analysis. The two geosynchronous orbit satellites identified as Tongxin Jishu Shiyan Weixing are also reviewed in this paper.

1 Introduction

China used the name *Shiyan Weixing* for the first *Dongfanghong-3* communications satellite which was stranded in a low orbit after the third stage of the maiden *Changzheng-3* (CZ-3) failed to operate properly after reaching a low Earth orbit in January 1984 [1]. That satellite will not be considered as part of this paper, since in that instance "*Shiyan Weixing*" was a cover name used to hide the true nature of the launch.

The proper *Shiyan Weixing* ("test satellite", sometimes translated as "experiment") programme started in 2004 and since that time there have been occasional launches which are discussed in this paper. The satellites have tended to be flown on different CZ-2 variant launch vehicles (one used the CZ-4C vehicle) and they all appear to have been preliminary technology test-beds or demonstrators.

Two other satellites will be discussed in this paper: *Tongxin Jishu Shiyan Weixing* 1 and 2, both launched to geosynchronous orbit using the CZ-3B and which were officially said to be communications satellites. One can argue that this description is true in that the satellites were communicating information to the ground controllers – but that can be said of all operating satellites, of course.

This paper is considered to be a companion to a review of the *Shijian* satellite programme [2].

This author initiated a brief online discussion about the meaning of the names *Shiyan Weixing* and *Shijian*. The three Chinese programmes using the names *Shiyan Weixing*, *Shijian* and *Yaogan Weixing* can be considered to be very approximate equivalents of the Soviet-era Cosmos programme. In the case of Cosmos the programme name was used as a cover for various military satellites, technology test-beds, civil satellite and failed satellites in various programmes (eg, failed *Molniya* communications satellites or deep space missions). The three Chinese programmes can be split as follows, each incorporating satellites with different missions:

Shiyan Weixing – test-of-concept satellites
Shijian – technology development
Yaogan Weixing – imaging and radar reconnaissance satellites

This author has always understood the *Shijian* means "practice" and following an enquiry on the NASASpaceflight.com website the following explanation for the name derivations and meanings was given [3]:

> *Shijian*: if you look at the word separately, *Shi* means "reality" (in the sense of physical reality, things you can touch), and *Jian* means to "implement". Hence, together it means "to implement (theory or idea) into reality".
>
> A related word, *Shiyan* or "experiment", with *Shi* still meaning "reality" and *Yan* meaning "verify". Hence to "verify (theory or idea) in reality". This is used mostly in the "hypothesis-experiment-conclusion" context.
>
> For brand new experiments, it's *Shiyan*. With a different *Shi* meaning "trial" with *Yan* still meaning "verify". This is used mostly in the context of testing a new technology based on know scientific principles. It should be noted, the official description for *Shijian* series is "scientific exploration and technology experiments satellite". With "experiment" being the "trial-verify" type rather than "reality-verify" type.
>
> Why use *Shijian* then you say? Well, remember the program is born during the height of Cultural Revolution, and the name is from one of Mao's essays*. So basically it's the same reason *Dongfeng* (East Wind) is name of the Chinese missile program, and *Changzheng* or "Long March" and *Dongfanghong* ("East is Red") are the names of Chinese communication satellites.

It remains to be seen whether the *Shiyan Weixing* and the related *Tongxin Jishu Shiyan Weixing* programmes will expand or whether they will remain as smaller programmes than the *Shijian* series.

Table 1 provides a summary listing of the satellites which are considered in this paper. Many of the satellites are known to have a second designator. "*Shiyan Weixing*" is the public name for the satellites which is generally descriptive in nature while the alternative names are specific to the programme which each satellite is undertaking. Most of the alternative names have been traced by Igor Lissov and shared on the NASASpaceflight.com Chinese forums [4,5].

2 *Shiyan Weixing* 1 (2004)

The first *Shiyan Weixing* satellite proper was launched on April 18, 2004 aboard a CZ-2C2 launcher: the launch also carried the NAXING satellite. This was the first use of the CZ-2C2 from Xichang, the first polar orbit launch from the site (which is normally used for launches to geosynchronous orbit and beyond) and also the first northerly launch in the Chinese space programme – launches are normally made in a southerly direction.

This paper was presented at the British Interplanetary Society Sino-Russian Technicl Foroum held on 3-4 June 2017.

* The gist of the essay is the following: "All logical knowledge must be put to practice in order to substantiate its truth-value."

TABLE 1: List of Shiyan Weixing Launches

Launch Date	Time UT	Satellite	Launch Site	Launch Vehicle
2004 Apr 18	15:59	*Shiyan Weixing* 1	Xichang	CZ-2C2
2004 Nov 18	10:45	*Shiyan Weixing* 2	Xichang	CZ-2C2
2008 Nov 5	00:15	*Shiyan Weixing* 3	Jiuquan	CZ-2D2
2011 Nov 20	00:15	*Shiyan Weixing* 4	Jiuquan	CZ-2D2
2013 Jul 19	23:38	*Shiyan Weixing* 7	Taiyuan	CZ-4C
2013 Nov 25	02:12	*Shiyan Weixing* 5	Jiuquan	CZ-2D2
2015 Sep 12	15:42	TJSW 1	Xichang	CZ-3B/G2
2017 Jan 5	15:18	TJSW 2	Xichang	CZ-3B/G2

Notes: *Shiyan Weixing* 1 was also known as *Tansuo*. Although the *Tansuo* name has also been applied to *Shiyan Weixing* 2 by some western publications this alternative name was actually assigned to *Shijian* 7. *Shiyan Weixing* 2 was also known as *Qianshao*-1. *Shiyan Weixing* 7 was also known as *Tansuo* 4A/B. TJSW is *Tongxin Jishu Shiyan Weixing*. TJSW 1 was also known as *Qianshao-3* (some reports also use the designator *Chang Cheng* 1) and TJSW 2 was also known as *Huoyan* 1. *Shiyan Weixing* 6 has not been identified through to the end of May 2017.

Shiyan Weixing 1 (also called *Tansuo* 1, a name which means "to probe" or "explore") was a microsatellite with a mass of 204 kg, operated and manufactured by the Harbin Institute of Technology. It carries a stereo imaging system for mapping land resources.

NAXING 1 (acronym for *Nami Weixing* – "nano–satellite") was an experimental satellite developed by the Tsinghua University of Beijing to test nanosatellite technology and had a mass of 25 kg. The satellite was used as an educational tool for future Chinese space engineers. The Chinese did not identify the specific experiments which were carried on the satellite.

Table 2 provides the orbital data for the objects from this launch. It will be noted that the debris 2004-012L was not catalogued until about 14 months after launch: it is not known whether this genuinely reflects when the object was first tracked or whether it had been tracked for some time but not transferred to the public listing of objects in orbit until June 2005.

Generally the Chinese do not release detailed photographs of the *Shiyan Weixing* and the only ones which are available are low resolution screen shots from videos of the satellite launches. Fig. 1 is such a screenshot of *Shiyan Weixing* 1 after deployment in orbit [6].

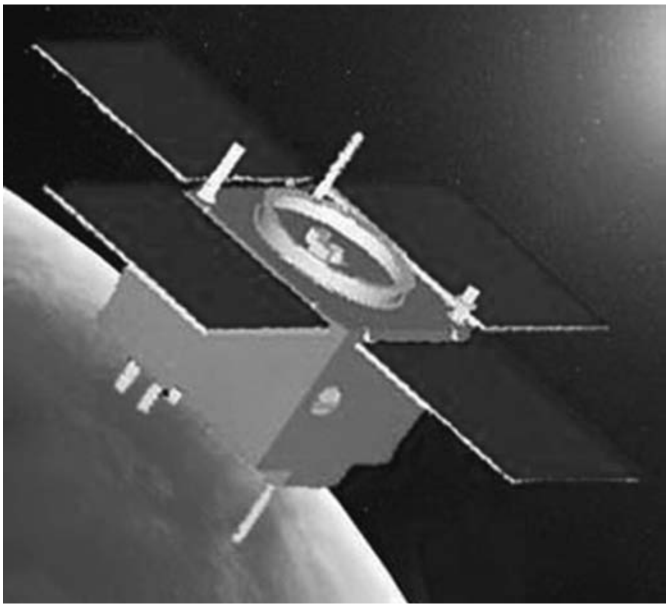


Fig. 1 Representation of *Shiyan Weixing* 1, taken from the deployment animation [6]. No photographs of the satellite are known to be available.

TABLE 2: Objects from the *Shiyan Weixing* 1 launch

International Designator	Name	Orbital Epoch	Inclination (deg)	Period min	Perigee (km)	Apogee (km)	AoP (deg)
		2004					
2004-012A	*Shiyan Weixing* 1	Apr 19.88	97.71	96.84	600	615	317
2004-012B	*Naxing*	Apr 19.88	97.71	96.85	600	615	318
2004-012C	CZ-2C2 second stage	Apr 19.87	97.64	96.30	543	620	263
2004-012D	Launch debris	Apr 20.76	97.72	94.18	351	607	239
2004-012E	Launch debris	Apr 22.75	97.56	98.00	597	729	78
2004-012F	Launch debris	Apr 21.74	97.52	98.49	603	770	69
2004-012G	Launch debris	Apr 21.88	97.89	98.46	608	763	55
2004-012H	Launch debris	Apr 21.91	97.62	97.42	603	668	86
2004-012J	Launch debris	Apr 21.84	97.90	99.47	608	858	50
2004-012K	Launch debris	Apr 21.86	97.82	97.87	595	718	89
		2009					
2004-012L	Launch debris	Jun 22.44	97.81	99.19	602	838	315

Notes: As with all orbital data in this paper, all of the orbits quoted are derived from the Two-Line Orbital Elements. Object 2004-012L is classified as being "Launch debris" even though it was first catalogued more than five years after the launch because the initial orbit would have been similar to 2004-012J.

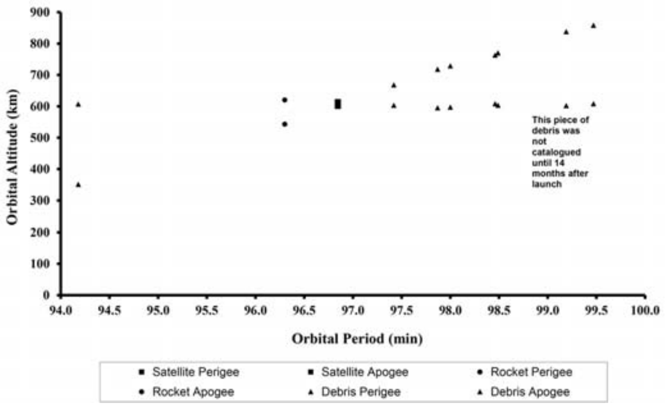


Fig. 2 Gabbard diagram for objects from the *Shiyan Weixing* 1 launch, showing the orbital distribution of the objects.

Fig. 2 is a Gabbard Diagram for the deployment of the objects from this launch. The objects from the launch were clearly separated at an altitude of slightly more than 600 km with most of the objects separating with a posigrade velocity so that their apogees were significantly above the orbits of the two satellites (which are virtually identical). Some of these debris pieces are the four covers for the solid propellant separation motors of the rocket stage, possibly objects F, F, G and K. After the satellites were deployed the rocket stage was given a small retrograde burn which resulted in perigee being lowered. There was also one piece of debris - 2004-012D - which entered a much lower orbit than any of the other objects from the launch.

Fig. 3 is a comparison of the mean altitudes of the *Shiyan Weixing* payloads compared with the altitudes required for a Sun-synchronous orbit. Given a circular orbit the altitude of a Sun-synchronous orbit (SSO) is a function of only the orbital inclination to a first approximation. It will be seen from Fig. 3 that the orbit of *Shiyan Weixing* 1 was higher than that required for a proper SSO.

3 *Shiyan Weixing* 2 (2004)

The second S*hiyan Weixing* satellite was launched in November 2004 and this time there was no second payload carried. As Table 3 shows, the satellite was deployed in an orbit that was higher than that seen for *Shiyan Weixing* 1. Also the distribution of the debris was different for the second launch. Table 3 lists the objects from the S*hiyan Weixing* 2 launch.

The name "*Tansuo* 2" has sometimes been associated with this satellite but this is incorrect: this alternate name was assigned to the *Shijian* 7 satellite. *Shiyan Weixing* 2 was also called *Qianshao*-1 ("outpost") [7].

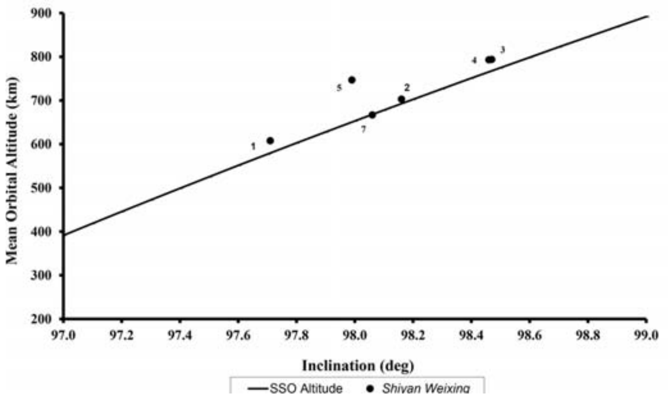


Fig. 3 *Shiyan Weixing* orbits compared to Sun-synchronous orbits: the orbits of the *Shiyan Weixing* payloads are often referred to as being in Sun-synchronous orbits simply because of their orbital inclinations, but as this graph shows only a minority of satellites have actually used such orbits. Most of the satellites are in orbits which are too high to be truly Sun-synchronous.

Shiyan Weixing 2 was launched from Xichang on November 18, 2004 using a CZ-2C2 vehicle. The satellite was said to be manufactured by the Dongfanghong Satellite Company, while the first *Shiyan Weixing* had originated from the Harbin Institute of Technology.

The satellite was said to be conducting Earth observations. Unlike the later *Shijian*-11 missions for which it appears to have been a technology test, *Shiyan Weixing* 2 performed a small orbital manoeuvre on July 4, 2007: this lowered the orbit from having a period of 98.822 minutes to 98.800 minutes. A check has been made for the orbital data for all other objects from this launch in case a cataloguing error resulted in the orbits of two objects being interchanged but this did not happen: the manoeuvre was real.

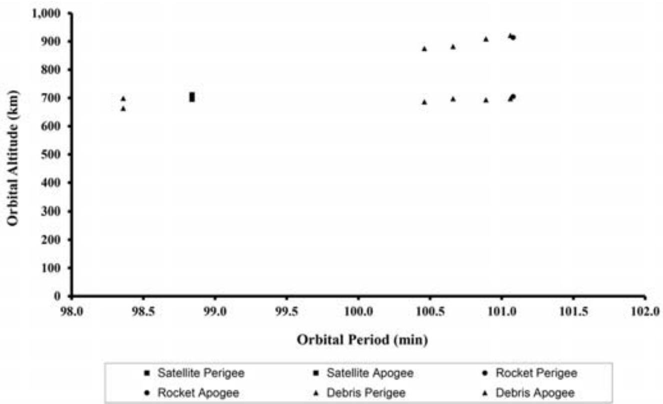


Fig. 4 Gabbard diagram for objects from the *Shiyan Weixing* 2 launch.

TABLE 3: Objects from the *Shiyan Weixing* 2 launch

International Designator	Name	Orbital Epoch	Inclination (deg)	Period (min)	Perigee (km)	Apogee (km)	AoP (deg)
		2004					
2004-046A	*Shiyan Weixing* 2	Nov 18.86	98.16	98.84	695	711	10
2004-046B	CZ-2C2 second stage	Nov 18.87	98.06	101.08	705	914	112
2004-046C	Launch debris	Nov 19.01	98.03	100.89	693	909	76
2004-046D	Launch debris	Nov 19.01	98.35	101.06	697	921	54
2004-046E	Launch debris	Nov 19.35	98.05	100.46	686	875	86
2004-046F	Launch debris	Nov 20.82	98.37	100.66	697	882	57
2004-046G	*Shiyan Weixing* 2 debris	Nov 23.37	98.19	98.36	663	698	221

TABLE 4: Objects from the *Shiyan Weixing* 3 launch

International Designator	Name	Orbital Epoch	Inclination (deg)	Period (min)	Perigee (km)	Apogee (km)	AoP (deg)
		2004					
2008-056A	*Shiyan Weixing* 3	Nov 5.06	98.47	100.75	786	802	306
2008-056B	*Chuangxin* 1-02	Nov 5.20	98.48	100.78	786	805	305
2008-056C	CZ-2D2 second stage	Nov 5.12	98.06	96.11	308	836	351
		2009					
2008-056D	Launch debris	May 28.98	98.74	102.62	755	1,010	11
2008-056E	Launch debris	Jun 10.26	98.49	101.39	718	931	341
2008-056F	Launch debris	Jul 12.00	98.43	100.21	666	871	258
		2010					
2008-056G	Launch debris	Jan 21.41	98.43	102.84	759	1,027	55
2008-056H	Launch debris	Jan 6.94	98.54	103.03	772	1,031	99
		2012					
2008-056J	Launch debris	May 20.01	98.54	103.54	777	1,075	240
2008-056K	Launch debris	May 16.91	98.60	100.38	652	901	83

Fig. 4 shows the distribution of objects from the *Shiyan Weixing* 2 launch. The orbit of the satellite was about 100 km higher than the first satellite. Significantly, the final stage of the launch vehicle entered an orbit with an apogee that was about 200 km higher than that of the satellite: on the first launch the rocket was in a lower-perigee orbit than the satellite. Indeed the rocket was in an orbit that was higher than the four covers for the solid propellant separation motors of the rocket stage which is highly unusual. A few days after launch an object was catalogued in an orbit which was lower than *Shiyan Weixing* 2 and the Satellite Situation Report has tagged this object as being "*Shiyuan* [sic] 2 debris" which is intriguing.

Reference to Fig. 3 shows that *Shiyan Weixing* 2 was in an orbit which was lower than that required for a SSO.

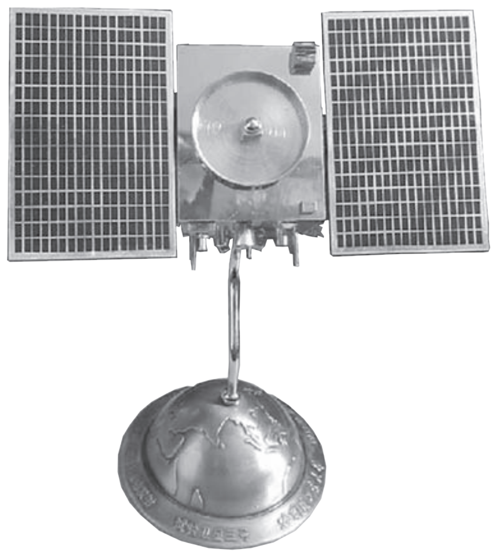
Shiyan Weixing 2 with its alternate designator *Qianshao*-1 appears to have been a direct precursor for the series of *Shijian*-11 satellites, discussed in [2], which had the alternate designation *Qianshao*-2 [8]. Igor Lissov has noted that Lu Annan designed SIGINT payloads for *Qianshao* satellites, and on *Shiyan Weixing* 2 the payload was designated "System 162" [9].

4 *Shiyan Weixing* 3 (2008)

There was a break until November 2008 before the next launch in the periodic *Shiyan Weixing* programme. The third satellite was launched with an experimental communications satellite, *Chuangxin* 1-02 (which had the alternate name *Tainxun* 1), and for the first time the programme saw a launch from Jiuquan and the use of the CZ-2D2 launch vehicle. *Shiyan Weixing* 3 entered a 786-805 km orbit, higher than the first two satellites in the series.

The *Shiyan Weixing* was the first of the new *Ji Shu Shiyan*-1 ("NewTec") satellites manufactured by the Harbin Institute of Technology. The satellite was intended to "carry out in-orbit demonstrations of new technologies and new products" [10]. No further details were made available about the satellite.

Table 4 provides orbital data for the objects catalogued from the launch. It will be noted that additional debris was catalogued in 2009, 2010 and 2012, and therefore a meaningful Gabbard diagram at launch cannot be constructed. A model representing the satellite was displayed and two photographs of this are shown in Fig. 5.



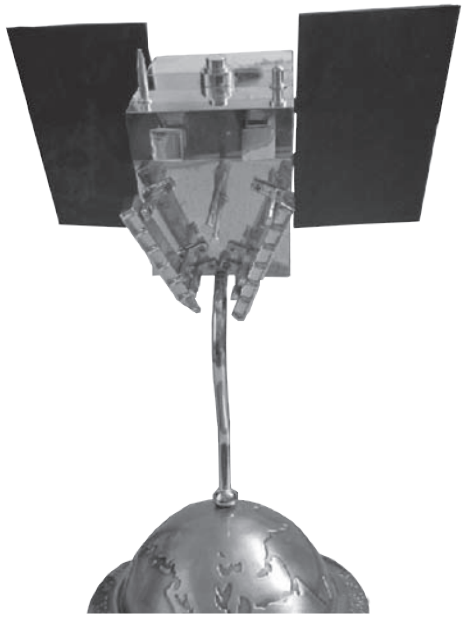


Fig. 5 Two photographs of *Shiyan Weixing* 3 model [11].

TABLE 5: Objects from the *Shiyan Weixing* 4 launch

International Designator	Name	Orbital Epoch	Inclination (deg)	Period (min)	Perigee (km)	Apogee (km)	AoP (deg)
		2011					
2011-068A	Chuangxin 1-03	Nov 20.13	98.47	100.75	787	801	269
2011-068B	Shiyan Weixing 4	Nov 20.34	98.46	100.74	785	802	282
2011-068C	CZ-2D2 second stage	Nov 20.34	98.34	101.31	795	847	214
		2012					
2011-068D	Launch debris	Apr 10.99	98.65	100.43	686	871	213
2011-068E	Launch debris	Apr 10.26	98.42	100.56	680	890	206
2011-068F	Launch debris	Apr 17.49	98.38	100.95	701	906	181
2011-068G	Launch debris	Apr 8.48	98.65	101.80	742	946	194
2011-068H	Launch debris	Apr 4.80	98.57	101.75	731	952	206
2011-068J	Launch debris	May 16.96	98.56	103.65	777	1,085	70

5 *Shiyan Weixing* 4 (2011)

After another gap of three years, *Shiyan Weixin*g 4 was launched in November 2011, and everything about the satellite suggests that it was a follow-on or duplicate of *Shiyan Weixing* 3. The launch time, launch site, launch vehicle and orbital data (see Tables 4 and 5) were virtually identical.

Calculations show that at the end of November 2011 *Shiyan Weixing* 3 was in a near-circular orbit with a period of 100.7614 minutes (admittedly, going to four decimal places is pushing the accuracy of the Two-Line Orbital Elements) while that of *Shiyan Weixing* 4 was 100.7359 minutes. At that time the orbital planes of the satellites were 15.5 degrees apart and the new satellite was approximately 58.5 degrees behind the older satellite in terms of the "longitude around the orbit".

No similar mission has flown through to mid-2017, although it is possible that the technology on these satellites has been applied elsewhere within the Chinese space programme.

6 *Shiyan Weixing* 7 (2013)

The next two *Shiyan Weixing* launches came out of numerical sequence: number 7 was part of a three-satellite launch on June 19, 2013 while number 5 was launched on November 25 the same year: to the end of May 2017 there has been no satellite launched with the designator *Shiyan Weixing* 6.

The Satellite Situation Report has simply identified the satellites from this launch as being "Payload A", "Payload B" and "Payload C" in line with their international designators. Looking at the behaviour or the satellites suggests that the following identities are appropriate:

2013-037A *Shiyan Weixing* 7
2013-037B *Chuangxin* 3
2013-037C *Shijian* 15

Chuangxin 3 (possibly also called *Tansuo* 3) was a small communications satellite: *Shijian* 15 (possibly *Tansuo* 5) is discussed elsewhere [12]. *Shiyan Weixing* 7 might have had the alternate name *Tansuo* 4A [13].

The *Shiyan Weixing* 7 experiments included the testing of a robotic arm. After launch the satellite's orbit was allowed to decay until there were some small orbit-raising manoeuvres during October 15-17, after which a new object was catalogued in orbit: this was named *Shiyan Weixing* 7B in the Satellite Situation Report and reportedly had the alternate name *Tansuo* 4B [13]. The evolution

TABLE 6: Objects from the *Shiyan Weixing* 7 and *Shiyan Weixing* 5 launches

International Designator	Name	Orbital Epoch	Inclination (deg)	Period (min)	Perigee (km)	Apogee (km)	AoP (deg)
		2013					
2013-037A	Payload A	Jul 20.11	98.06	98.08	661	673	26
2013-037B	Payload B	Jul 20.23	98.06	98.15	666	674	35
2013-037C	Payload C	Jul 20.12	98.06	98.12	664	673	40
2013-037D	CZ-4C third stage	Jul 20.11	98.10	96.16	478	671	44
2013-037E	Launch debris	Jul 20.18	98.06	98.12	664	673	41
2013-037F	Launch debris	Jul 20.72	98.05	98.03	656	673	12
2013-037G	Launch debris	Jul 22.62	98.03	98.18	663	680	299
2013-037H	Launch debris	Aug 25.26	98.08	102.22	672	1,055	96
2013-037J	Payload A debris	Oct 19.49	98.05	98.10	661	675	79
2013-068A	Shiyan Weixing 5	Nov 25.14	97.99	99.76	739	755	227
	CZ-2D2 second stage	de-orbited before being catalogued					

Notes: The 2013-037 launch carried three payloads which have been identified as being *Shijian* 15, *Shiyan Weixing* 7 and *Chuangxin* 3, but USSTRATCOM has not identified which satellite relates to which of the international designators A, B and C.

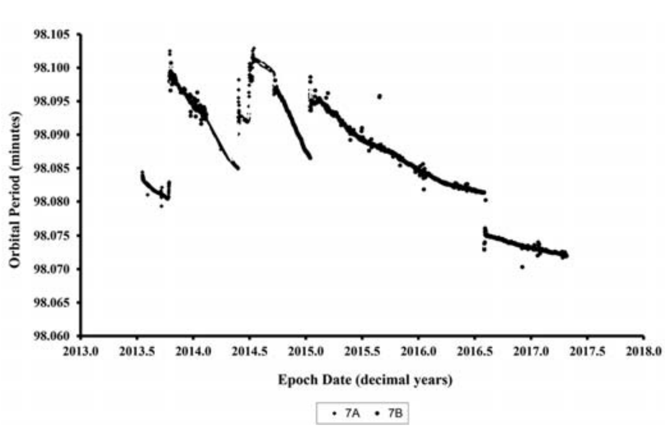


Fig. 6 Evolution of the orbital period of *Shiyan Weixing* 7A and 7B: it will be noted that the orbital period of 7B closely follows that of 7A and indeed the two might be attached when manoeuvres take place.

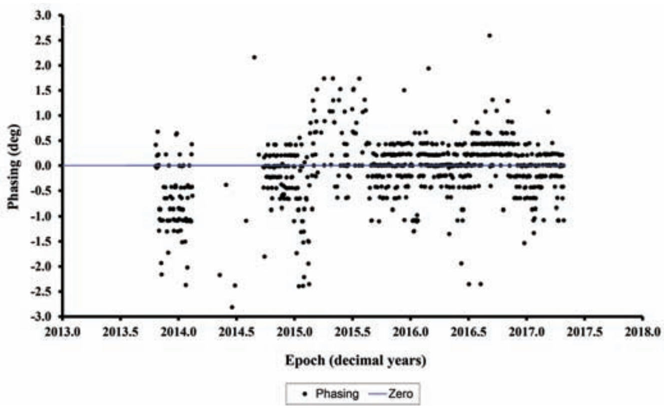


Fig. 7 Phasing of *Shiyan Weixing* 7A and 7B: the phasing is measured as the "longitude around the orbit of 7A minus the longitude around the orbit of 7B". Within the errors that are inherent in the Two-Line Orbital Elements, it is clear that these satellites have remained very close together in orbit.

of the orbital periods of the two objects is shown in Fig. 6, while Fig. 7 shows the angular separation of the two satellites ("phasing") around their orbits.

It will be noted from these graphs that *Shiyan Weixing* 7B regularly followed the orbital manoeuvres of the parent satellite and it never strayed far away from 7A. One might therefore wonder if the two satellites had redocked - with the aid of the robotic arm - when the manoeuvres took place and they were only separate during periods between the manoeuvres.

The applications of such technology could be in both the civil and military fields. It is known that the *Shenzhou* 11 crew tested a robotic arm inside *Tiangong* 2 during their visit to the laboratory. The technology could be applied to a satellite inspector programme within the military programme. It could also see use during the unmanned sample-return missions to the Moon (*Chang'E* 5 and 6) and further into the future Mars sample-return. In addition it could be used on the *Tianhe* core module of the Tiangong space station for the relocation of the two plug-on modules from the forward docking port to the side-mounted berthing ports.

7 *Shiyan Weixing* 5 (2013)

The most recent launch (to mid-2017) in the *Shiyan Weixing* programme came on November 25, 2013 when satellite number 5 was placed into orbit. As previously noted, *Shiyan Weixing* 6 has not been identified. Prior to the launch it had been reported that *Shiyan Weixing* 5 would be a high resolution remote sensing satellite and it would use the (then-) new CAST-100 satellite platform [14].

The satellite was launched into a near-circular orbit (see Table 6) which was higher than the altitude required for a SSO – surprising for a remote sensing satellite. No carrier rocker or other debris were tracked in orbit from the launch: the second stage of the CZ-2D2 had clearly de-orbited itself after deploying the satellite. A representation of the satellite appeared as part of the launch video (Fig. 8).

At one point Igor Lissov tagged this mission as possibly being "*Qianshao*-2" [15] but later believed this to be in error [16].

8 *Tongxin Jishu Shiyan Weixing* 1 (2015)

These days before a Chinese launch takes place western observers are aware of the satellite's name, its intended mission and often its platform, as well as the launch vehicle, launch site and – through

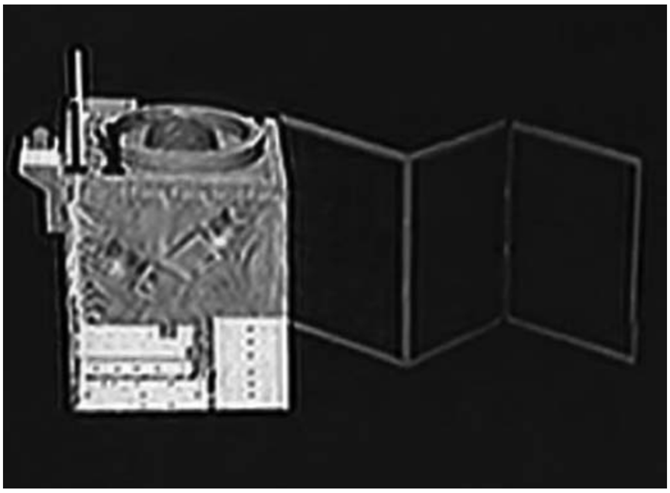


Fig.8 *Shiyan Weixing* 5, as represented in an animation of its deployment in orbit [16].

NOTAMs – the planned launch date and planned launch window. This did not happen in September 2015.

No details of the launch were available before the launch on September 12, 2015. There was speculation on the NASASpaceflight.com web site that the satellite might be part of a programme identified as *Changcheng*-1 ("Great Wall") and it was thought that an early warning satellite was to be launched [18].

On September 11 the NOTAMs for the launch were issued, confirming launch for the next day, with the window being 15:36-16:30 UT.

While there was no official information about the satellite before the launch, there were some rumours that the satellite had the designator "QS-3" – *Qianshao*-3 – the same generic programme name which had been given to low orbit satellites which were undertaking SIGINT work.

After the launch had taken place at 15:42 UT but before the official Chinese announcement there were unofficial reports that the satellite was *Tongxin Jishu Shiyan Weixing* 1 ("communications engineering test satellite") and that it was a "communications technology test satellite" [19]. When the launch was announced by the Chinese it was said that "this satellite is going to conduct experiments on the broadband Ka-band communication technology after it is sent into the preset orbit" [20].

TABLE 7: Objects from the *Tongxin Jishu Shiyan Weixing* launches

International Designator	Name	Orbital Epoch	Inclinatation (deg)	Period (min)	Perigee (km)	Apogee (km)	AoP (deg)
		2015					
2015-046A	TJSW 1	Sep 13.27	27.10	631.70	195	35,823	180
		Sep 23.65	0.18	1,436.06	35,776	35,795	260
2015-046B	CZ-3B/G2 third stage	Sep 12.77	27.05	613.37	182	34,889	179
		2017					
2017-001A	TJSW 2	Jan 5.85	27.47	631.40	201	35,802	180
		Jan 16.93	1.00	1,436.06	35,779	35,793	119
2017-001B	CZ-3B/G2 third stage	Jan 5.78	27.46	602.51	164	34,340	179

Orbital data for the two objects from this launch are given in Table 7. The Two-Line Orbital Elements indicated that the satellite was stationed over approximately 154.5 deg E.

In January 2017 some newly-collated information was posted about the satellite [20]. Manufactured by CAST, the satellite was China's first to carry a large mesh antenna, with a diameter of ~32 metres being reported. Such an antenna would be ideal for SIGINT operations which squares with the use of a *Qianshao* designator.

9 *Tongxin Jishu Shiyan Weixing* 2 (2017)

In December 2016 reports appeared, indicating that a new *Tongxin Jishu Shiyan Weixing* was scheduled before the end of the year. Originally scheduled for December 30 and with NOTAMs available a week before that date, reports appeared to say that the launch was delayed until January 4, 2017. Fresh NOTAMs were issued for a launch window of 15:08-15:45 UT that day, but there was a further delay due to inclement weather. Revised NOTAMs were issued for January 5 with the same launch window limits. Launch took place at 15:18 UT: the orbital data are given in Table 7. The satellite was located over ~107 deg E, based upon the Two-Line Orbital Elements.

Tongxin Jishu Shiyan Weixing 2 was the first geosynchronous orbit satellite to be manufactured by SAST (thus indicating that it was not a repeat of the CAST *Tongxin Jishu Shiyan Weixing* 1 satellite) and it was described as being a "new generation high capacity experimental communications and broadcasting satellite" without reference to the Ka band communications [22], although it was testing "high speed/multi-frequency wide-band data transfer".

Video of the launch control room during the launch showed a monitor which appeared to show a representation of the satellite [23] and a "still" is reproduced in Fig. 9.

Later, some Chinese media referred to the satellite as being *Huoyan*-1 (variously translated as "fire eyes", "steely eyes" and "fire cam") [24]: this would appear to be the programme name and it has been reported that this is China's first geosynchronous orbit early warning satellite.

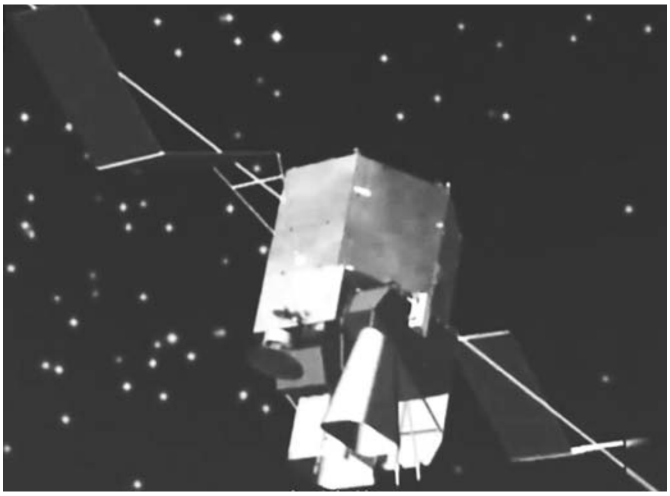


Fig. 9 *Tongxin Jishu Shiyan Weixing* 2 representation from a deployment video [22].

Acknowledgements

Since this paper is primary concerned with orbital details of satellites, it would have been impossible to prepare without the Two-Line Orbital Elements (TLEs). These had been issued originally via the Orbit Information Group (OIG) at the NASA Goddard Space Flight Center, and since early 2005 the data have been issued via the Space-Track website at https://www.space-track.org/. The staff associated with the Space-Track site are to be thanked for the continued access to their data.

The author would like to acknowledge the discussions with Igor Lissov, both online and in private, which have related to the phasings of satellites in orbit.

References

1. Phillip S Clark, "China's DFH-2 and DFH-2A Communications Satellites Programme", JBIS, 54 (2001), pp 129-132.
2. Phillip S Clark, "The *Shijian* Programme": "1 – Inspector Satellites and Other Manoeuvrable Missions" and "2 – ELINT and SIGINT Satellites", both papers to be submitted to *JBIS*.
3. Posting by "Luhai167" (a pseudonym) dated May 11, 2013 on the thread "Long March-4B launch with *Shijian* 16 – Jiuquan – October 25, 2013": available online at http://forum.nasaspaceflight.com/index.php?topic=33139.20 (accessed May1, 2016).
4. "Names of Chinese Satellites" thread at http://forum.nasaspaceflight.com/index.php?topic=20068.0 (accessed March 6, 2017).
5. "*Qianshao* military satellites" thread at http://forum.nasaspaceflight.com/index.php?topic=42403.0 (accessed March 6, 2017).
6. Illustration taken from the *Shiyan Weixing 1* entry on Gunter's Space Page at http://space.skyrocket.de/doc_sdat/sy-1.htm

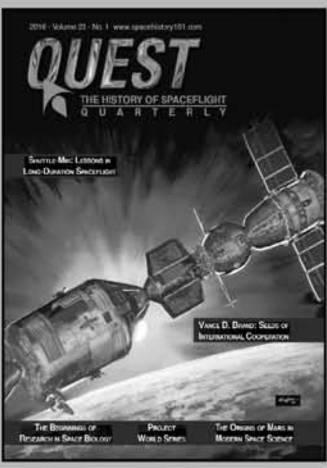
(accessed March 6, 2017).

7. Igor Lissov, posting dated January 12, 2010 on the thread "Names of Chinese satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=20068.msg524405#msg524405 (accessed May 10, 2016).
8. Posting by "Input~2" (a pseudonym) dated January 21, 2017 on the thread "*Qianshao* military satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=42403.0 (accessed March 6, 2017).
9. Posting by Igor Lissov dated February 16, 2017 on the thread "*Qianshao* military satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=42403.0 (accessed March 6, 2017).
10. Posting by "Satori" (a pseudonym for Rui Barbosa) dated November 4, 2008 on the thread "Chuangxin 1 (02) and Shiyan 3": available online at http://forum.nasaspaceflight.com/index.php?topic=14819.0 (accessed March 6, 2017).
11. Posting by "Galactic Penguin SST" (a pseudonym") dated July 14, 2013 on the thread "Chuangxin 1 (02) and Shiyan 3": available online at http://forum.nasaspaceflight.com/index.php?topic=14819.0 (accessed April 28, 2017).
12. Phillip S Clark, "The *Shijian* Programme: 2 – ELINT and SIGINT Satellites", to be submitted to *JBIS*.
13. Igor Lissov, posting dated February 6, 2010 on the thread "Names of Chinese satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=20068.msg524405#msg524405 (accessed March 10, 2017).
14. Posting by "Beidou" (a pseudonym) dated November 18, 2012 on the thread "*Shiyan Weixing 5*": available online at http://forum.nasaspaceflight.com/index.php?topic=30487.0 (accessed March 10, 2017).
15. Posting by Igor Lissov dated February 6, 2016 on the thread "Names of Chinese satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=20068.msg524405#msg524405 (accessed March 10, 2017).
16. Posting by Igor Lissov dated February 16, 2017 on the thread "Names of Chinese satellites": available online at http://forum.nasaspaceflight.com/index.php?topic=20068.msg524405#msg524405 (accessed March 10, 2017).
17. Illustration taken from the *Shiyan Weixing 5* entry on Gunter's Space Page at http://space.skyrocket.de/doc_sdat/sy-5.htm (accessed March 10, 2017).
18. Postings by "Beidou" (a pseudonym) and "Satori" (a pseudonym for Rui Barbosa) on September 2, 2015 on the thread "TJS-1 (*Tongxin Jishu Shiyan-1*)": available online at http://forum.nasaspaceflight.com/index.php?topic=38375.0 (accessed on March 11, 2017).
19. Posting by "Input~2" (a pseudonym) on September 12, 2015 on the thread "TJS-1 (*Tongxin Jishu Shiyan-1*)": available online at http://forum.nasaspaceflight.com/index.php?topic=38375.0 (accessed on March 11, 2017).
20. "China launches communication technology experimental satellite", http://news.xinhuanet.com/english/photo/2015-09/13/c_134618997_3.htm (accessed on March 11, 2017).
21. Posting by "Galactic Penguin SST" (a pseudonym) on January 7, 2017 on the thread "TJS-1 (*Tongxin Jishu Shiyan*-1)": available online at http://forum.nasaspaceflight.com/index.php?topic=38375.0 (accessed on March 11, 2017).
22. Posting by "Galactic Penguin SST" (a pseudonym) on January 5, 2017 at 15:29 UT on the thread "TJS-1 (*Tongxin Jishu Shiyan*-1)": available online at http://forum.nasaspaceflight.com/index.php?topic=38375.0 (accessed on March 12, 2017).
23. Posting by "Galactic Penguin SST" (a pseudonym) on January 5, 2017 at 15:53 UT on the thread "TJS-2 (*Tongxin Jishu Shiyan*-2)": available online at http://forum.nasaspaceflight.com/index.php?topic=41976.0 (accessed on March 12, 2017).
24. Posting by "Galactic Penguin SST" (a pseudonym) on January 7, 2017 on the thread "TJS-2 (*Tongxin Jishu Shiyan*-2)": available online at http://forum.nasaspaceflight.com/index.php?topic=41796.0 (accessed on March 12, 2017).


Volume 20, Number 1
2013
QUEST
THE HISTORY OF SPACEFLIGHT QUARTERLY
www.spacehistory101.com


QUEST
THE HISTORY OF SPACEFLIGHT
QUARTERLY


QUEST
Volume 21, Number 4
2014
www.spacehistory101.com
THE HISTORY OF SPACEFLIGHT
QUARTERLY


QUEST
THE HISTORY OF SPACEFLIGHT
QUARTERLY


QUEST
Volume 20, Number 3
2013
www.spacehistory101.com
THE HISTORY OF SPACEFLIGHT
QUARTERLY


QUEST
Celebrating 50 Years of Human Spaceflight


QUEST
Volume 21, Number 1
2014
www.spacehistory101.com
THE HISTORY OF SPACEFLIGHT
QUARTERLY

First Pictures of Earth from a Soviet Spacecraft

BART HENDRICKX

When the diaries of Air Force General and cosmonaut training chief Nikolai Kamanin were published in the mid-1990s, a puzzling fact came to light about the final two unmanned test flights of the Vostok spacecraft on 9 March and 25 March 1961. These two missions, officially announced by the Soviet Union as the fourth and fifth *korabl-sputnik* ("satellite ship"), were dress rehearsals for Yuriy Gagarin's single-orbit mission on 12 April 1961 and each carried a dummy cosmonaut as well as a dog and various biological specimens. These facts had been announced by the Soviet Union at the time, but judging from Kamanin's diaries, the missions had an additional objective.

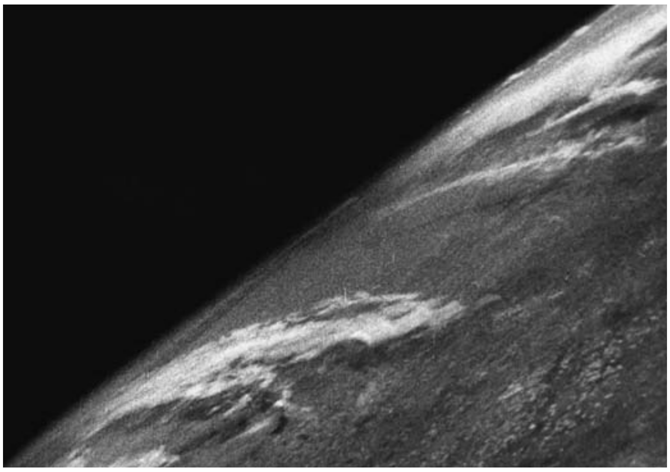
In three separate entries in late March/early April 1961, Kamanin wrote about pictures of the Earth taken from the vehicles while they were flying over Africa and Turkey. He described how he showed the pictures to Air Force Commander-in-Chief Konstantin Vershinin as well as to cosmonauts Yuriy Gagarin, Gherman Titov and Grigoriy Nelyubov (the three candidates for the first flight), who all agreed that "pictures from space will be of great value for reconnaissance purposes".

The reason why the photographs had been kept secret was obvious: their prime purpose had been to demonstrate the possibility of performing reconnaissance from space. An unmanned version of Vostok (later dubbed Zenit) was concurrently under development to perform photographic reconnaissance missions and was scheduled to make its debut later in 1961.

Kamanin's diary entries raised some intriguing questions. The bulky photographic equipment carried by the later Zenit satellites occupied virtually the entire descent module. How could it have been installed on the already crammed korabl-sputniks? Even more puzzling was the fact that the pictures had been taken over Africa and Turkey, regions that the spacecraft overflew as they were making their descent back to Earth. How could they have been properly oriented during this phase of the flight to make the images? Surely Kamanin had got his facts straight when he made those notes? These questions were of more than academic interest, because if the two korabl-sputniks had indeed taken those pictures, they were the first photographs of Earth ever to be made from a Soviet spacecraft. Recent Russian publications have now made it possible to answer these questions and also indicate that the photography experiments were a stopgap measure to appease the Soviet military community after the priority of the Vostok project had shifted from photoreconnaissance to piloted spaceflight.

The First Pictures of Earth from Space

Until the mid-1940s, the highest pictures ever taken of Earth's surface were from the US high-altitude Explorer II balloon on November 11, 1935. Riding in a spherical cabin suspended from the balloon, US Army Air Corps Captains Albert Stevens and Orvil Anderson snapped pictures of Earth from a record altitude of 22 km, high enough to discern the curvature of the Earth. The first pictures of Earth from outside the atmosphere were made from a captured V-2 missile launched by the US Army from the White Sands Missile Range on 24 October 1946 (Fig. 1). Installed in the nosecone of the rocket was a 35 mm motion picture camera developed by Clyde Holliday, an engineer working for the John Hopkins University Applied Physics Laboratory. The camera snapped a new frame every second as the rocket rose to a maximum altitude of 104 km. The camera was smashed when the rocket slammed into the ground minutes later, but the film, ensconced in a steel cassette, remained intact. In all, more than 1,000 Earth pictures were returned from V-2 missiles between 1946 and 1950 from altitudes as high as 160 km.



NASA

Fig. 1 The first picture of Earth from space, taken from a V-2 missile launched on 24 October 1946.

NASA

Fig. 2 First ever image of Earth from orbit, obtained by Explorer-6 in 1959.

The first picture of Earth from orbit was a crude television image of the central Pacific area captured by NASA's Explorer-6 satellite on 14 August 1959 (Fig. 2). The first image to show recognizable

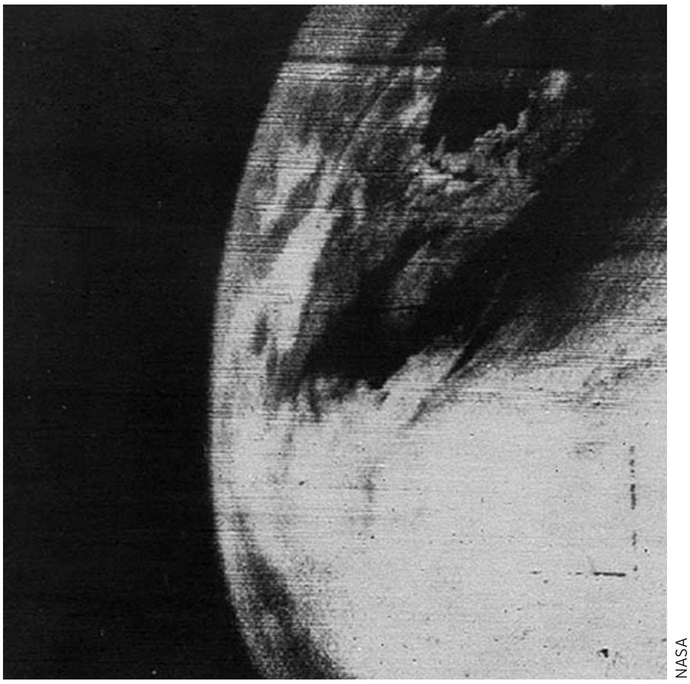


Fig. 3 The first image of Earth taken by TIROS-1 on 1 April 1960.

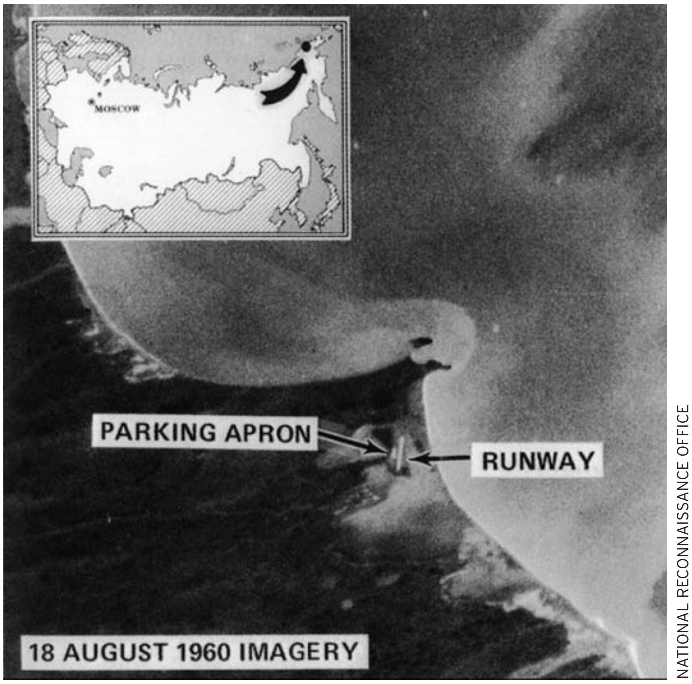


Fig. 4 First Earth image captured by a CORONA spy satellite in August 1960 shows an airfield in the northeast of the Soviet Union.

features was downlinked by NASA's TIROS-1 experimental weather satellite shortly after its launch on 1 April 1960. An outgrowth of a cancelled TV reconnaissance satellite project, TIROS was equipped with two television cameras, one of which transmitted fuzzy images of thick cloud bands over the Gulf of St. Lawrence from an altitude of about 700 km as the satellite neared completion of its first orbit (Fig. 3).

If all had gone according to plan, the distinction of making the first Earth pictures from orbit should have gone to the Central Intelligence Agency's CORONA reconnaissance satellites. Officially announced under the cover name Discoverer, the satellites returned exposed film to Earth in small capsules that were retrieved in mid-air. After a frustrating string of failures that began with the first launch in February 1959, the first satellite that managed to accomplish its mission was Discoverer 14, launched on 18 August 1960. It did become the first spacecraft to return Earth images made with a photographic camera rather than a television camera (Fig. 4). However, the general public didn't get to see them until some were declassified in 1995.

The First Soviet Pictures of Earth from Space

Although the Soviet Union started its own test flights of modified V-2 missiles in September 1948, it would take almost ten years before any of them carried a camera into space. That happened on 16 May 1957, when the first R-2A missile was launched from the Kapustin Yar test range near Volgograd. The R-2A, built by the OKB-1 design bureau under the leadership of the legendary chief designer Sergei Korolyov, was a version of the R-2 missile adapted for a series of flights to conduct biomedical research and study the upper layers of the atmosphere. The main payload for the 16 May 1957 flight was a small cabin carrying two dogs (Damka and Ryzhaya), but also on board was a camera that was activated at liftoff and continued to operate until the rocket reached its apogee at an altitude of 212 km (Fig. 5).

Called AFA-39 (AFA standing for aerofotoapparat or "aerial camera") or A-39, the camera was one in a family of aerial cameras developed by the Krasnogorsk Mechanical Factory (KMZ), which had specialized in such cameras since the Second World War and in the 1950s also began manufacturing the famous Zenit single-lens reflex cameras. Flown on several types of aircraft, it was designed for aerial photography in daytime conditions at altitudes between 500 and 5,000 m and at speeds between 500 and 1,500 km/h (Fig. 6). Technical specifications of the camera are given in Table 1. The initiative to fly the AFA-39 on a suborbital rocket flight is said to have come from Vasiliy Beshenov, KMZ's chief designer of aerial cameras, who later praised Korolyov for having agreed to the experiment despite the high costs involved. Several modifications had to be made to the camera for its rocket flight, more particularly to its timing mechanism and power supply [1].

The Military Roots of Vostok

The 1957 R-2A flights were conducted in the framework of the International Geophysical Year and had been specifically aimed at testing some of the equipment that would be installed on future satellites. In a document written just weeks before the start of the missions, Korolyov had noted that two of the rockets would carry "a special device to photograph the Earth's surface with the aim of using it in the future on an oriented satellite" [3].

At that time early conceptual work was underway on two types of "oriented satellites", an unmanned reconnaissance satellite known as OD-1 that would send back exposed film in a small conical return capsule (like the CORONA satellites), and a piloted vehicle called OD-2 with a large spherical descent module. In late 1958/ early 1959 the OD-1 and OD-2 projects were merged into what became known as Vostok. On the one hand, this was a cost-saving measure. The reconnaissance satellite and the manned vehicle would now both use the big spherical descent module, making it possible among other things to return the expensive photoreconnaissance cameras back to Earth along with the exposed film. On the other hand, this move made it easier to secure funding for piloted missions. While people like Korolyov, inspired by the great Russian spaceflight theoretician Konstantin Tsiolkvoskiy, may personally have been more interested in human exploration of the Solar System than military reconnaissance, justifying a manned space programme on the basis of its propaganda value or scientific merits alone would have hardly been convincing to the military community, which to a large extent controlled the purse strings of the space programme. The nascent Soviet space programme was an offshoot of the missile programme and lacked the clear dichotomy between civilian and military space projects that emerged in the United States with the formation of NASA in 1958.

When Korolyov and other leading space programme officials sent a formal request to approve the Vostok project to the Central Committee of the Soviet Communist Party on 22 April 1959, they did everything to emphasize the military potential of Vostok. The main goals mentioned in the letter were optical reconnaissance, electronic reconnaissance, infrared reconnaissance and pinpointing the coordinates of potential targets. Almost as an aside, the authors of the letter noted that "solving the main technical problems associated with the development of an oriented automatic reconnaissance satellite will make it possible to subsequently get down to the development of an artificial reconnaissance satellite with a person [on board]" [4]. In other words, piloted Vostok flights were presented as an extension of the unmanned reconnaissance missions, with cosmonauts performing the role of orbiting spies. When the Soviet government and Communist Party gave the official go-ahead for Vostok in a decree on 22 May 1959, piloted flights were not even mentioned in the cover letter. It was only in the supplements to the decree that several organizations were assigned to start the development of hardware needed for piloted missions.

The decree called for the development of two different systems to obtain imagery. One, called Ftor-2R, would store exposed film on board for return to Earth and the other, named Baikal, would develop film on board and scan it for transmission to the ground. The prime contractor for the photographic cameras was the Krasnogorsk Mechanical Factory (then called TsKB-393), which was allowed to postpone work on several aerial reconnaissance cameras for the Air Force to give priority to the spy satellite project. The film read-out system was to be built by the VNII-380 research institute in Leningrad [5].

Both film recovery and film read-out systems were concurrently also under development for America's early spy satellites. The CIA's CORONA/Discoverer satellites that began flying in February 1959 used the film-return technique. The film read-out system was ultimately flown only once on an Air Force Samos satellite in February 1961. It was complex in design, had low resolution and could relay only a limited amount of images to Earth due to slow transmission rates. The US would continue to rely solely on film-return spy satellites until advances in CCD technology made it possible to introduce the KENNEN digital spy satellites in 1976.

FEDERALNYY PATRIOTICHESKIY VESTNIK

Fig. 5 The first ever picture of Earth taken from a Soviet rocket.

Evolving Plans for Vostok Test Flights

With military reconnaissance being the prime purpose of Vostok, the original idea was to test some of the camera equipment as soon as possible on the early test flights of prototype Vostok capsules. However, in 1960 these plans gradually moved to the background

ALEKSEI NIKITIN

TABLE 1: AFA-39 Technical Specifications [2]

Weight	8 kg
Lens	Uran-27 100 mm f/2.5
Field of View	54°
Shutter Type	focal-plane curtain shutter
Exposure Times	1/1820, 1/1270, 1/730 s
Frame Rate	0.7 – 2 – 4 – 8 – 16 s
Picture Size	70 x 80 mm
Film Type	Izopankhrom type 17/type 22
Film Width	80 mm
Amount of Film	19 m
Number of Frames	200
Operating Temperatures	-60° to +60°

Fig. 6 The AFA-39 camera.

as the emphasis shifted to the piloted portion of the Vostok project, apparently in response to ongoing developments in America's Project Mercury. Still, as has become clear from newly declassified letters sent to the Central Committee of the Soviet Communist Party, space officials made every effort to portray the piloted portion of Vostok as an integral part of the space reconnaissance programme rather than a stand-alone effort, underlining the future role of cosmonauts as orbiting spies.

The plan to fly reconnaissance cameras on early Vostok test flights was still in effect in a proposed flight schedule sent to the Central Committee on 6 May 1960. By now the prototype version of the spacecraft was known as "Vostok-1", the spy satellite version as "Vostok-2" and the piloted version as "Vostok-3" (not to be confused with the later designators for the first piloted Vostok missions). The schedule called for seven Vostok missions in 1960: two in May without a heat shield (to avert the risk of them landing on foreign territory), two or three Vostok-1 missions before August to test some of the photographic and electronic reconnaissance equipment (thus paving the way for Vostok-2) and two unmanned Vostok-3 missions in the September-December timeframe to test the life support systems and launch emergency escape procedures [6]. The schedule was approved by a government decree on 4 June 1960, by which time the first test mission had already been completed [7].

The hope was that the first imaging equipment to fly would be the film read-out system developed by VNII-380. By late April 1960 that equipment was expected to be ready in May-June 1960 [8]. VNII-380 had gained preliminary experience in the field by building a similar film read-out system for the Luna-3 space probe, which sent back the first images of the Moon's far side in October 1959. Ironically, the first ever images of a heavenly body beamed back by a Soviet spacecraft had been not of Earth, but of its celestial neighbour.

It soon turned out, however, that this schedule was overly optimistic. Not only was the development of the imaging equipment running behind schedule, space officials had also become wary of installing sensitive military equipment on the early test flights. In a letter to the Central Committee on 18 July 1960, only days before the second unmanned Vostok test flight, they explained why:

"Considering the difficulties involved in returning cargo from orbit and the absence of the necessary experience for this launch, no electronic or photographic reconnaissance equipment will be installed on the Vostok-1 satellite to exclude the possibility that the equipment lands on foreign territory in case of an emergency" [9].

Instead, the main goal of the upcoming test flights would be to test the re-entry and landing procedure and gather biomedical data by flying dogs and other biological specimens. However, the authors of the letter still linked the latter objective to the reconnaissance programme, saying the data was needed "to conduct flights of persons on reconnaissance satellites". After a launch failure on 28 July, another korabl-sputnik (officially announced as the second one) was successfully launched on 19 August with the dogs Belka and Strelka on board and returned safely 24 hours later, with the dogs being ejected from the capsule shortly before touchdown as planned. One aspect of the flight applicable to the reconnaissance programme was the presence of a TV camera called Seliger (developed by VNII-380) that radioed TV images of the dogs to the ground. This provided valuable experience for the relay of TV pictures from the spy satellites using the Baikal read-out system.

Bolstered by the success of the Strelka/Belka mission and well aware of progress being made by America in the Mercury project, Soviet space officials decided to move the first manned Vostok flight significantly forward. In another letter to the Central Committee on 10 September, they proposed an ambitious schedule that would culminate with the first manned spaceflight before the end of the year. This would be preceded by two more Vostok-1 missions in October-November and two unmanned test flights of the man-rated Vostok-3A vehicle in November-December. The first flight of the Vostok-2 spy satellite was pushed back from January-February to April-May 1961. Once again the letter's authors made no secret of the ultimate objective of the manned flights. They pointed out that a more powerful launch vehicle scheduled to debut with the launch of the first Soviet Mars probes in September-October 1960 (the 8K78 or "Molniya" rocket) could eventually place into orbit spacecraft weighing 7 to 9 tons, which in their words "opened up new prospects for creating military satellites with a person on board" [10].

The new plans were sanctioned by a government decree on 11 October 1960, but thrown into disarray just thirteen days later when the first R-16 missile of Mikhail Yangel's OKB-586 design bureau blew up on its launch pad at the Baikonur cosmodrome, killing dozens of people. Although not directly related to the Vostok project, this horrible tragedy sent shock waves reverberating through the entire Soviet missile and space programme and dictated a more leisurely and cautious build-up to the first manned space mission, which was now pushed back to 1961. The aggressive schedule put forward in September would probably have been too ambitious anyway even if the R-16 accident hadn't happened.

In a status report on the Vostok project sent to the Central Committee on 16 November 1960, space officials said two more Vostok-1 capsules with dogs were being readied for launch before the end of the year. While presenting these as precursors to the manned flights, they were once again quick to stress their relevance to the space reconnaissance programme: "The development of a reconnaissance satellite with a person on board will make it possible to obtain reconnaissance information [of higher quality] than that received with the help of automatic reconnaissance assets such as the Samos satellites". They reminded their political peers that the first attempted launch in the Samos programme had taken place just three weeks earlier and that the fifteen American Discoverer satellites launched to date had been used to test equipment for Samos (which strictly speaking was not the case since Samos and Discoverer were two independent projects). Unlike Samos, which the Air Force publicly acknowledged as being a reconnaissance satellite, the CIA's Discoverer/CORONA satellites were officially said to be intended for scientific research, but the Russians were all too well aware of their true nature. The letter's authors expressed hope that the construction of the first Vostok-2 spy satellites would be completed in January-February 1961 and added that more advanced reconnaissance cameras were to be developed in 1961 for a more capable spy satellite called Vostok-4 [11].

The new Vostok-1 schedule was authorized by a Central Committee decree on 24 November 1960 [12]. The two missions flown before the end of the year failed to meet all their objectives. The first one, launched on 1 December as the third korabl-sputnik, burned up on re-entry, and the second one failed to reach orbit on 21 December, but did manage to perform a successful emergency landing on Soviet territory.

Flying a Camera on the *Korabl-Sputniks*

Despite these setbacks, the Russians pressed on with preparations for two unmanned test flights of the man-rated Vostok-3A capsule, which, if successful, would clear the way for the maiden piloted mission. Both precursor missions would carry a dummy cosmonaut clad in an SK-1 pressure suit as well as a single dog and various other biological specimens. Since the ejection seat was occupied by the mannequin, the dogs would now land inside the capsule.

While the most urgent goal of Vostok was now to beat America in the race to put the first human into orbit, there was still a way to at least partially satisfy the appetite of military officials who had probably been frustrated to see the reconnaissance role of Vostok take a backseat to its piloted component. Although there was no room on the two Vostok-3A capsules to install the bulky photographic equipment intended for the spy satellite missions (which probably wasn't ready by this time anyway), it would be possible to mount a relatively small camera on one of the portholes and take pictures of the Earth. The resolution would not be very high, but the pictures would still demonstrate the feasibility of performing reconnaissance from space.

The task could be accomplished with the same type of AFA-39 aerial camera that had earlier flown on the R-2A rocket in May 1957 [13]. The initiative for the photography experiment is said to have come from OKB-1's Yevgeniy Ryazanov, who had been closely involved in the development of the R-7 intercontinental ballistic missile and went on to head the spy satellite effort at OKB-1 [14]. It is possible that the idea to install the AFA-39 on an Earth-orbiting spacecraft had originated at the time of the R-2A flight.

It should also be noted that the AFA-39 had been used in a series of experiments conducted in early 1960 by the Moscow Institute of Engineers of Geodesy, Aerial Photography and Cartography (MIIGAiK) to study the feasibility of photographing the Earth's surface from space. The institute had been given this assignment in a wide-ranging government decree on future space projects approved on 10 December 1959. Known internally as "Theme 105-Kh", the work was led by Boris Rodionov, the head of the institute's aerial photography department, and was supposed to be finished in the second quarter of 1960. It involved the use of a Tu-16R reconnaissance aircraft to take pictures of the cities of Gomel (in the Belarus republic) and Sumy (in Ukraine) as well as specially installed photo calibration targets near these cities from altitudes between 500 m and 12 km. The aircraft carried a battery of 17 aerial cameras with different focal lengths and loaded with various types of black-and-white, multispectral, colour and infrared film. Twelve of these were AFA-39 cameras [15].

The best way to test the camera would have been to take pictures of the Earth while the vehicle was in orbit. However, like the first manned mission, the two dress rehearsal missions were supposed to last just a single orbit. Following insertion into orbit, the spacecraft would soon leave the Soviet landmass behind it, cross the Pacific, then skim the southernmost tip of South America before heading out over the Atlantic Ocean and firing its deorbit engine over the west coast of Africa (Fig. 7). The only way to obtain pictures of landmass was to activate the camera as the spacecraft began its descent back to Earth after the deorbit burn. At this point the capsule would not be stabilized, meaning that the camera would have to shoot pictures at random in the hope that at least some of them would show the Earth's surface.

The first of the two capsules, carrying the dog Chernushka ("Blackie"), was launched as the fourth korabl-sputnik on 9 March 1961 and after performing a single revolution around the Earth landed safely about 260 km northeast of Kuybyshev. The AFA-39 camera was subsequently sent to a department of the Soviet General Staff that specialized in space-based reconnaissance. One of the persons involved in processing the film, Leonid Matiyasevich, later recalled:

"We were excited, but also a little worried when the camera with the exposed film was delivered to us. After all, it was the first time in our history that we were to develop unique film of the Earth obtained from space. To be on the safe side, we initially intended to cut the film in small pieces and develop them in a developing tray. But then we decided to develop the whole film at once in a developing spiral … Contrary to all expectations, the film was of good quality and, despite its unusually small format (about 1 : 2 000 000) it contained valuable information on the Earth's surface. In the be-

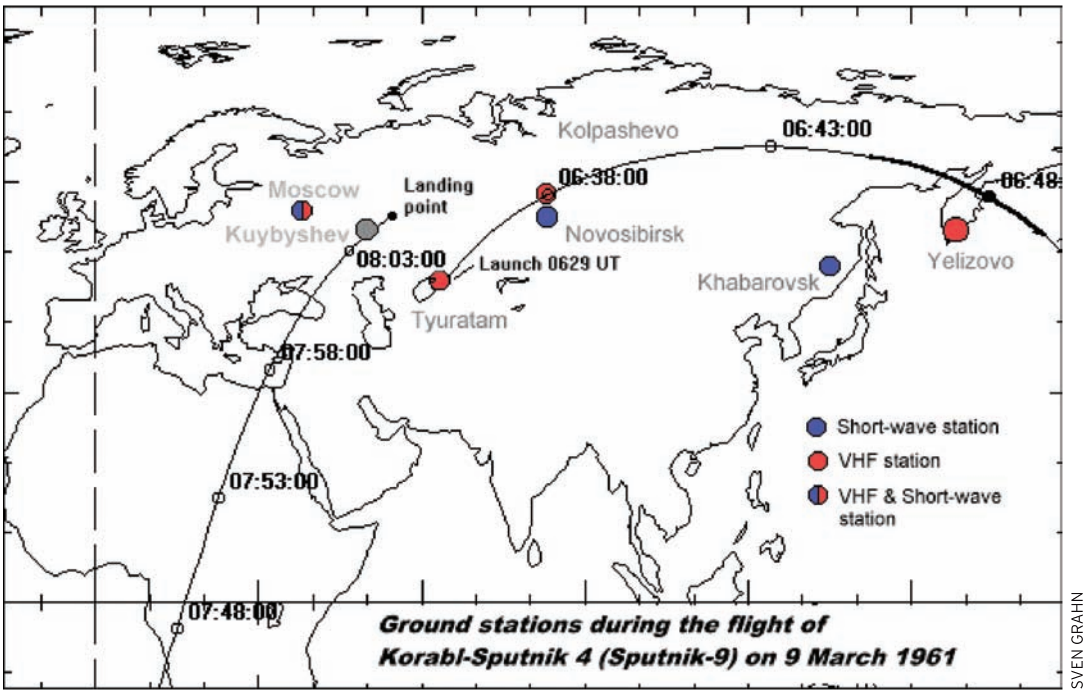
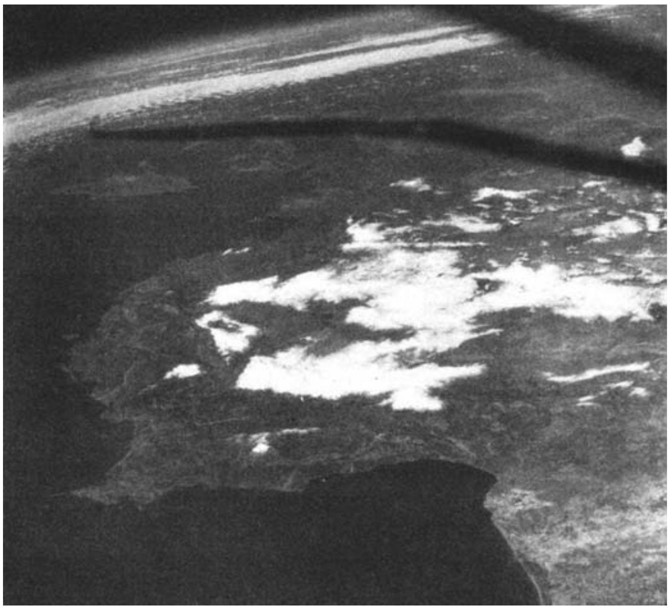


Fig. 7 Ground track of the fourth *korabl-sputnik*.



FEDERALNYY PATRIOTICHESKIY VESTNIK

Fig. 8 Picture of the west coast of Africa taken by one of the Vostok-3A vehicles in March 1961.

ginning of the film we could clearly distinguish the mountain ranges of Africa, then the Mediterranean, the island of Cyprus, Lake Tuz in Turkey… We printed the pictures, deciphered them, made a short description of what they showed and wrote down our conclusions. The main result was that the possibility of obtaining highly informative images from space had been confirmed. We finished our work around midnight and rushed to the Korolyov design bureau in Podlipki, where [Konstantin] Bushuyev and [Yevgeniy] Ryazanov were waiting for us. We gathered in Bushuyev's office. There was no doubt left whatsoever : space-based reconnaissance was possible. The road to launching the first [experimental photoreconnaissance satellite] was open" [16].

On 25 March 1961 the fifth korabl-sputnik, carrying the dog Zvyozdochka ("Little Star"), repeated the performance of its predecessor. A snowstorm in the landing area delayed the recovery of the capsule and its canine passenger for 24 hours, but the mission was declared a total success and set the stage for Yuriy Gagarin's historic mission three weeks later. The AFA-39 camera was once again able to snap a series of pictures of Earth (Fig. 8).

Despite the fact that the two korabl-sputniks had become the first Soviet spacecraft to make such pictures, the photographs were not publicly released, nor was the presence of a camera aboard the spacecraft revealed in the press at the time. This clearly shows that the cameras had been flown to demonstrate the possibility of reconnaissance from space and not for publicity reasons. The pictures didn't have much propaganda value anyway, because America's TIROS-1 weather satellite had already beamed back the first Earth images almost a year earlier. Interestingly, the TASS launch reports on both missions did mention the presence of a TV camera aboard the vehicles (presumably to monitor the behaviour of the dogs), but no in-flight TV images of Chernushka or Zvyozdochka have ever been released. Such images were made public after the Belka/Strelka mission in August 1960.

Behind the scenes Soviet space officials were elated with the quality of some of the pictures and eagerly showed them to their superiors. Four days after the return of the fifth korabl-sputnik, Korolyov proudly showed pictures taken by both spacecraft to Dmitriy Ustinov, the head of the Military Industrial Commission, a body under the Council of Ministers that supervised the missile and space industry. On 31 March General Nikolai Kamanin displayed the pictures to Air Force Commander-in-Chief Konstantin Vershinin, who promised to take them with him to Marshal Andrei Grechko, the Commander-in-Chief of the Warsaw Pact forces, and Marshal Rodion Malinovskiy, the Soviet Minister of Defence. On 3 April Kamanin shared the pictures with cosmonauts Yuriy Gagarin, Gherman Titov and Grigoriy Nelyubov, the three candidates for the first flight, who all agreed on the value of military photoreconnaissance from space [17].

One of the pictures was said to show the Turkish city of Iskenderun (formerly known as Alexandretta) and a concrete runway. Testifying to the accuracy of their flight path, four pictures taken by the two spacecraft were almost identical. Also visible in some of the pictures were strange features that Kamanin called "flying saucers", although they actually resembled what he described as "glasses or vases placed on top of each other". Presumably, this was an optical effect caused by the uncontrolled motion of the spacecraft after the deorbit burn, as a result of which the Sun regularly appeared in the camera's field of view [18]. That spinning motion may have been worsened by a problem that is said to have occurred shortly after the deorbit burn. Writing in his memoirs, OKB-1 veteran Boris Chertok says that on both missions the service module failed to separate from the descent module right after the deorbit burn and that the connection between the two compartments was severed only later by the heat of re-entry. A similar problem occurred during Gagarin's mission and sent his capsule into a violent and potentially life-threatening spin after the deorbit burn. Chertok notes that for reasons he cannot remember the problem was not investigated after the two final korabl-sputnik missions [19]. It is not mentioned in the hitherto published declassified documents on the korabl-sputnik missions.

More AFA-39 cameras would probably have been flown if the Russians had considered it necessary to fly more than two unmanned Vostok-3A test flights. In a declassified document describing changes made to the fourth Vostok-3A vehicle by early July 1961, it is said that equipment and cabling needed only for unmanned missions (more particularly, the AFA-39 and an automatic destruct system that would be activated in case the vehicle was headed for foreign territory) had been removed from the capsule [20].

The fourth Vostok-3A had presumably been configured for an unmanned test mission because initial plans after Gagarin's flight called for another canine mission to pave the way for the second manned flight, which was scheduled to last a full day rather than just a single orbit. That plan was still in place by late May 1961, with the test flight expected in July 1961 [21]. Eventually, mission planners decided to fly the fourth Vostok-3A with a cosmonaut instead, one of the possible reasons being that the Belka/Strelka mission in August 1960 had already demonstrated that the life support systems were capable of sustaining a cosmonaut for 24 hours.

The Long Road to the First Soviet Spy Satellite

Whether the successful photography experiments conducted by the two korabl-sputniks in March 1961 did much to lessen the growing frustration in the military community over the continuing delays in the reconnaissance satellite programme is questionable. The United States had begun launching its CORONA spy satellites in February 1959, at a time when the Soviet Union did not even have an officially approved reconnaissance satellite project. Even by the time that the CORONA programme finally saw its first successful mission in August 1960, the first launch of a Soviet spy satellite was slipping ever further into the future as the most immediate priority of the Vostok project became the need to put a human into orbit before the United States. One of the contradictions in the early Soviet space programme is that despite its organizational connections to the missile programme, more than four years elapsed between Sputnik and the first launch of a military satellite. Apparently, the urge to boost the country's prestige by staging a variety of space spectaculars outweighed the need to keep up with the United States in the military uses of space. By the end of 1960 the Soviet Union had successfully orbited just 9 objects, which, apart from the first three Sputniks, had been either man-related or targeted for the Moon. By contrast, the United States had logged 34 successful orbital launches for scientific research and practical applications such as military reconnaissance, navigation, communications, meteorology and early warning of missile launches.

To add to the frustration in the military community, two major government decrees on space (dated 10 December 1959 and 23 June 1960) had endorsed ambitious plans for a series of unmanned and manned civilian space projects as well as a heavy-lift rocket (the N-1) that had little military value. These projects would gobble up a significant portion of the space budget and threatened to overtax the very same design bureaus and factories that were supposed to produce missiles, military satellites and other military technology. By early 1961 increasing pressure from the military community to revise the priorities of the Soviet space programme was beginning to pay off. On 9 January 1961 the USSR Defence Council, a body chaired by Soviet leader Nikita Khrushchov and established in 1955 to make decisions on key national security issues, ordered a major review of budgets allocated to civilian space projects and called on the design bureaus to shift their emphasis to nuclear missiles, military satellites and missile defence and space defence projects. In response, the Ministry of Defence formulated a plan to cancel and delay a series of civilian space projects and speed up work on a variety of military projects. Most of these proposals were incorporated into a government and Communist Party decree on 13 May 1961, which among other things called for accelerating the manufacture of both unmanned and manned Vostok vehicles by turning over their serial production to a factory in the city of Kuibyshev. In the proposals presented to the Central Committee in the preceding weeks, the manned Vostoks had still been portrayed as an integral part of the reconnaissance programme [22].

By early June the secret code-name of the two types of Vostok-based spy satellites had been changed from Vostok-2 and Vostok-4 to Zenit-2 and Zenit-4, probably because the name Vostok had now been publicly linked to the manned programme [23]. The first attempt to launch a Zenit-2 satellite took place on 11 December 1961, but the satellite failed to reach orbit due to a fault in the launch vehicle's third stage. The first successful launch occurred on 26 April 1962 and was announced by the TASS news agency as Kosmos-4 (Fig. 9). It was not only the first Soviet spy satellite, but also the very first Soviet military satellite to reach orbit. The first Zenit-2 satellites carried both the film recovery and the film read-out system, but the latter was dropped from the payload after just a handful of missions because it did not live up to expectations. Zenit-2 was the first of several generations of Vostok-derived photographic reconnaissance satellites, hundreds of which flew until 1994. Although Vostok cosmonauts would never perform the role of orbiting spies as originally intended, the goal of performing military reconnaissance from a manned platform was eventually accomplished with the Almaz space stations of Vladimir Chelomei's design bureau in the 1970s.

More Firsts in Space-Based Earth Photography

While the Soviet Union had been upstaged by America in taking the first pictures of Earth from space, it did manage to clinch two other firsts in the area of space-based Earth photography. One of those was to make the first images of Earth from a piloted spacecraft. No cameras for Earth photography were on board the Vostok for Gagarin's single-orbit mission (it did carry an automated Seliger TV camera to film Gagarin himself). However, a 35 mm mov-

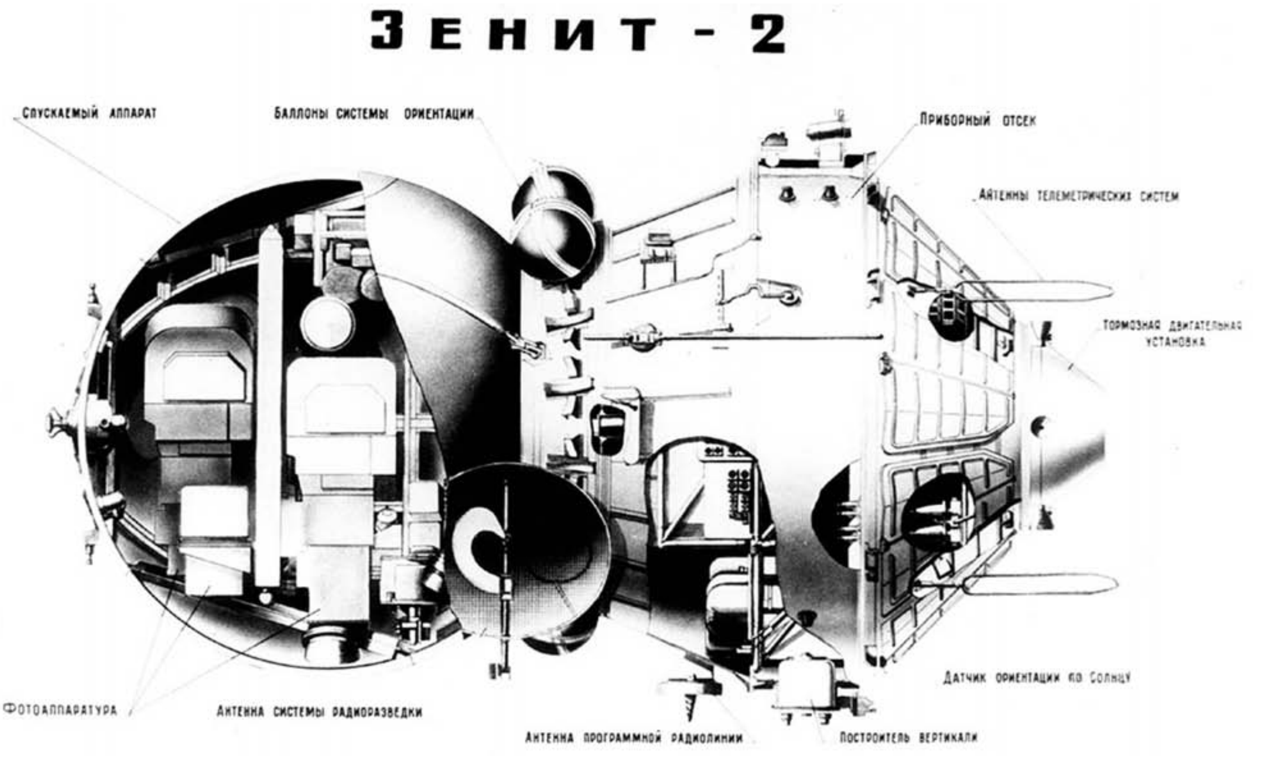


Fig. 9 The Zenit-2 reconnaissance satellite.

RKK ENERGIA

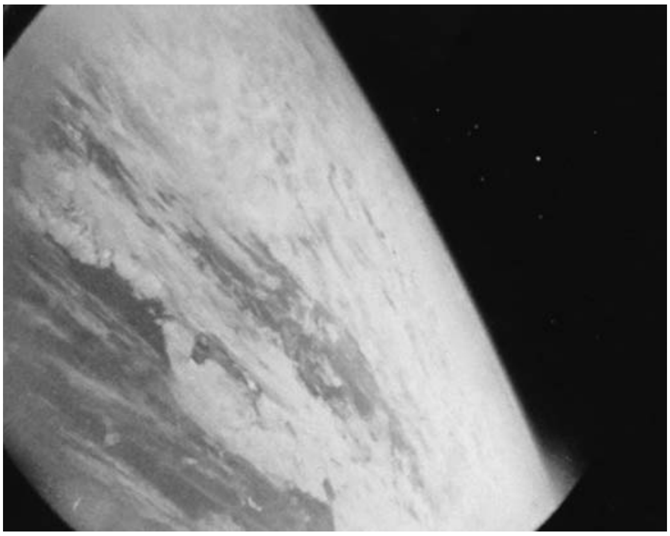


Fig. 10 Shot of Earth taken by Gherman Titov during the Vostok-2 mission.

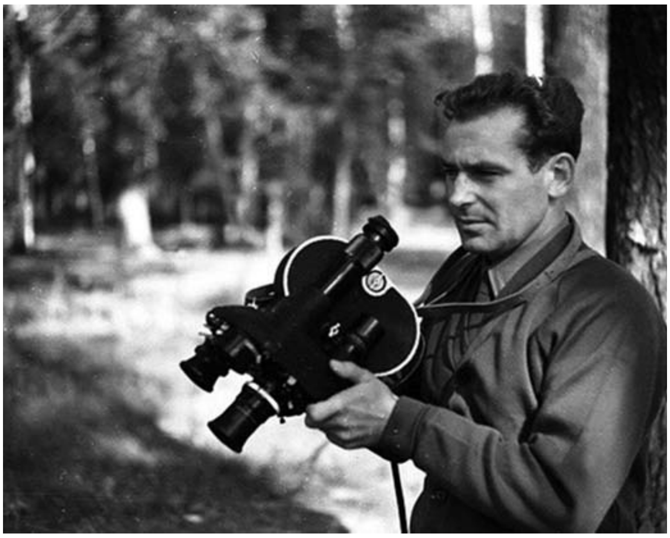


Fig.11 Gherman Titov holding the Konvas movie camera.

ie camera called Konvas was installed aboard Vostok-2 in August 1961 to allow cosmonaut Gherman Titov to shoot images of the Earth. This earned him the distinction of becoming the first photographer in space (Figs. 10 and 11).

Several years later the Russians also obtained the first full view of the planet against the backdrop of space. That honour fell to a Molniya communications satellite launched on 23 April 1966. Besides its main communications payload, it was equipped with a camera system called "Berkut" ("Golden Eagle") consisting of two KR-911 vidicon cameras. These were intended to study the possibility of observing weather patterns from high orbits and were also seen as precursors to similar cameras to be flown on the Oko missile early warning satellites in Molniya-type orbits [24].

On 18 May 1966 Berkut sent back the first fuzzy global images of the Earth as the Molniya satellite reached the apogee of its highly elliptical orbit at an altitude of about 40,000 km. The first NASA satellite to photograph Earth from that vantage point was the geostationary ATS-1 satellite on 11 December 1966. Several months earlier, on 23 August 1966, NASA's Lunar Orbiter 1 had made the first "Earthrise" image from the vicinity of the Moon, a feat not accomplished by the Russians until the Zond-6 circumlunar mission on 14 November 1968.

References

1. R. Fatkhudinov, "The cosmic glory of Krasnogorsk" (in Russian), *Krasnogorye (istoriko-krayevedcheskiy almanakh)*, nr. 15, pp. 81-92, 2011.
2. Specifications taken from: G. Abramov, "Stages in the development of Soviet aerial cameras" (in Russian), http://www.photohistory.ru/1241453447774908.html (Last Accessed 30 September 2017). According to this source the camera was flown on the following aircraft : Su-7B, Su-17, Su-27, YaK-125, YaK-25R, MiG-21F-13, MiG-21R, Su-24, I-1.
3. G. Vetrov (ed.), *S.P. Korolyov i ego delo*, Nauka, Moscow, p.218, 1998. There is no evidence that a camera was also flown on the second R-2A mission.
4. S. Kudryashov (ed.), *Sovetskiy kosmos*, Arkhiv Prezidenta Rossiyskoi Federatsii, Moscow, pp.121-122, 2011.
5. Ibid, pp.123-138.
6. Ibid, pp.191-192.
7. Ibid, p.206.
8. Ibid, p.189.
9. Ibid, pp.267-268.
10. Ibid, pp.285-286. The line about the military uses of manned spacecraft was omitted from a version of the letter released as late as 2008. See: Yu. Baturin (ed.), *Sovetskaya kosmicheskaya initsiativa v gosudarstvennykh dokumentakh 1946-1964 gg,* RTSoft, Moscow, pp.111-112, 2008.
11. S. Kudryashov, op. cit., pp.293-294.
12. Ibid, p.295.
13. The presence of an AFA-39 camera on the first two Vostok-3A vehicles is confirmed in declassified letters of space officials to the Central Committee on 1 March and 14 March 1961. See: S. Kudryashov, op. cit., pp.307-308, 311-312.
14. V. Permitin, "A brief anthology of the history of on-board photographic and film images on the road to exploring the universe" (in Russian), *Federalnyy patrioticheskiy vestnik*, nr. 5, pp.30-43, 2012.
15. S. Kudryashov, op. cit., p.160; B.N. Rodionov, "Facts from the history of scientific research, designs and training of highly-qualified specialists in the area of applied spaceflight at the department of aerial photography of the Moscow Institute of Engineers of Geodesy, Aerial Photography and Cartography (1958-1967) (in Russian), article published on B.N. Rodionov's personal website at http://rodionovbn.ru/PubFaktyIstor.shtml (Last Accessed 30 September 2017).
16. V. Permitin, op. cit.; L. Matiyasevich, *Aerofotorazvedka. Proshloe – nastoyashchee – budushchee*, Poligon-press, Moscow, 2011.
17. N. Kamanin, *Skrytyy kosmos. Kniga 1 (1960-1963)*, Infortekst, Moscow, pp.38-41, 1995.
18. V. Permitin, op. cit., p.35.
19. B. Chertok, *Rockets and People (Volume III : Hot Days of the Cold War)*, NASA, Washington DC, pp. 64-65, 2009. No mention was made of the separation problem in the original Russian-language edition of Chertok's memoirs published in 1997. Chertok claims the fifth korabl-sputnik overshot its planned landing area by 660 km.
20. V. Davydov (ed.), *Pervyy pilotiruemyy polyot (kniga vtoraya)*, Rodina Media, Moscow, pp.136-137, 2011.
21. Ibid, pp.48-51, 116-117.
22. S. Kudryashov, op. cit., pp.298-299, 303-305, 332-333, 337, 389-390.
23. Ibid, p.393.
24. A. Tsytsulin (ed.), *Istoriya kosmicheskogo televideniya v vospominaniyakh veteranov*, NII Televideniya, St.Petersburg, pp.106-109, 2009.

FORTHCOMING LECTURES & MEETINGS OF THE BIS

BRAD GIBSON: WHERE ARE THE ALIENS?!?

8 February 2018, 7pm

VENUE: BIS, 27-29 South Lambeth Road, London SW8 1SZ

Prof Brad Gibson, Director of the E.A. Milne Centre for Astrophysics at the University of Hull, will give a version of his TED talk on galactic habitability and the perils of life in the Milky Way.

Call for Papers

MARS IN THE AGE OF NEW SPACE LAUNCHERS

28 February and 1 March 2018, 9.30am-5.00pm

VENUE: BIS, 27-29 South Lambeth Road, London SW8 1SZ

A two-day symposium to explore the emerging possibilities for human Mars exploration and ultimately settlement, as NASA's SLS rocket approaches its first flight and as competing plans from private industry take shape. Registration open online.

BIS WEST MIDLANDS SPRING TALKS

24 March 2018, 1.45pm-4.30pm

VENUE: The Gardeners Arms, Vines Lane, Droitwich, WR9 8LU

Talks by Rod Woodcock on 'Visits to the Cape between 1971 and 1981', and Terry Ransome on 'To Mars via Kazakhstan Beagle 2'.

Call for papers

CURRENT TOPICS IN ROCKET PROPULSION – AN OPEN SOURCE CONFERENCE

14 April 2018, 9.30am-5.00pm (TBD)

VENUE: Westcott Sports and Social Club (Formerly the V100 Club of the MoD Rocket Propulsion Establishment), Ashendon Rd, Westcott, Buckinghamshire HP18 0NZ

Unclassified rocket propulsion activity at Westcott (the former Rocket Propulsion Establishment and in its day one of the most secretive sites in the UK) is expanding and the government is pushing the space sector as a major economic growth area of the UK economy. To celebrate the increase in activity at Westcott, it has been decided to run an open source conference covering some current topics in near-term rocket propulsion.

Call for Papers

RUSSIAN/SINO FORUM

2 and 3 June 2018, 9.30pm-5.30pm

VENUE: BIS, 27-29 South Lambeth Road, London SW8 1SZ

The BIS is organising its 38th annual Russian/Sino forum; one of the most popular and longest running events in the Society's history. Papers are invited and registration will be open in the New Year.

Call for Papers

SPACE SAFETY AND RESCUE FORUM

5 September 2018

VENUE: tba

Over the past six decades, the development of Space Rescue techniques and technologies, together with the awareness of crew safety, has been at the forefront of human spaceflight. We have seen several major incidents involving issues of safety and rescue, where the lives of the crew have been placed at risk or has sadly resulted in their loss.

As we enter new phases of human space flight development, so emerging technologies will be developed to support crew safety and rescue scenarios encompassing operations from low Earth orbit to the Moon, at Mars, and eventually far beyond.

This Forum will address the history and future potential of both Rescue and Safety in spaceflight and it is hoped will become a regular international Forum hosted by the Society.

If you wish to present a paper in the field of Space Safety or Rescue:
Please email proposals to: info@bis-space.com

SPACE CHRONICLE

A BRITISH INTERPLANETARY SOCIETY PUBLICATION

Vol. 71 No.1 2018