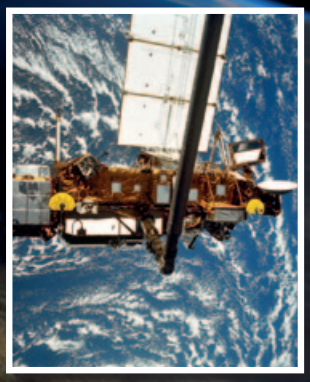
INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SPACE SAFETY

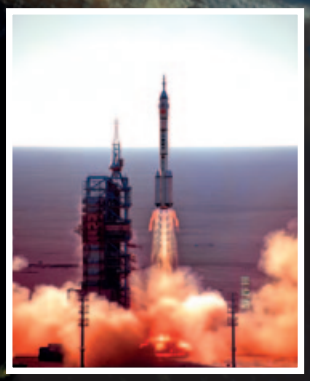
ISSF INTERNATIONAL SPACE SAFETY FOUNDATION

# Space Safety Magazine©

Issue 2
Winter 2012



## Revisiting the Liability Convention



## China's foundations in space

INTERNATIONAL® SPACE UNIVERSITY

**ISU SYMPOSIUM 2012 SPECIAL**
**Sustainability of Space Activities**

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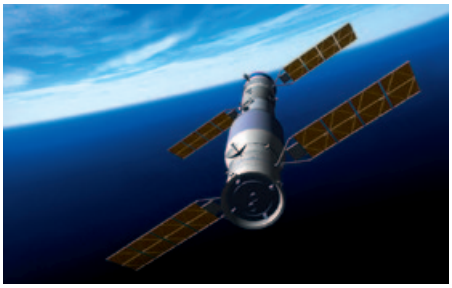



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**SPECIAL**

**SUSTAINABILITY OF SPACE ACTIVITIES**







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INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SPACE SAFETY

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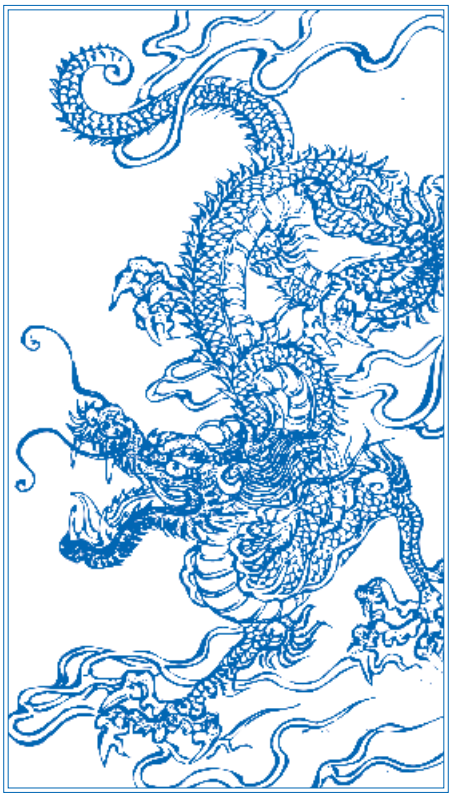
# Cooperating with China: Space Safety is the Key!

China's space activities and intentions are seen by some military analysts as not sufficiently transparent, and the dual-use nature of most space technology compounds the uncertainties and slows down cooperative efforts. However, cooperation among all spacefaring nations is essential to ensure safety and sustainability of space operations. Confidence and communication with China could be developed through a high profile and mutually beneficial program. Such a program could be the development and demonstration of orbital rescue capabilities.

Back in 1990 an International Spacecraft Rendezvous and Docking conference was held at the NASA Johnson Space Center. The purpose was to explore the need and international consensus for establishing a set of common space systems design and operational standards which would allow docking and on-orbit interoperability in case of emergency. The attributes for such international standards were summarized as follows:

a) each party could implement them with their own systems and resources;
b) cooperation in such standards does not require subordination (i.e. one party does not have to buy parts of the system from another);
c) success of one project or project element is not required to ensure success of the other;
d) no one standard requires subordination to another standard;
e) the functional requirements of the standard can be implemented with a number of alternative technologies, since the definition of the standards does not require the transfer of technology.

In 2008, the objective of developing orbital rescue capabilities was restated by the US Congress in the NASA Authorization Act of that year (H.R. 6063). In fact, Sect. 406, "Exploration Crew Rescue", stated that: *"In order to maximize the ability to rescue astronauts whose space vehicles have become disabled, the Administrator shall enter into discussions with the appropriate representatives of spacefaring nations who have or plan to have crew transportation systems capable of orbital flight or flight beyond low Earth orbit for the purpose of agreeing on a common docking system standard"*.



**The Chinese dragon, symbol of Chinese culture and Chinese folk religion.**
Credits: Nyo – Wikipedia

In 2010, the international docking system standard (IDSS), based on the original androgynous docking system (APAS) developed in the seventies as part of the Apollo-Soyuz Test Program, finally became a reality through the initiative of the countries participating in the International Space Station program. Although China was not involved in this standardization effort, the Chinese had already chosen as docking system for their Shenzhou vehicle and for the Tiangong-1 space station a variant called APAS-89, which is the same used on the International Space Station (ISS) and is compatible with the new international docking standard. The Chinese docking system was successfully demonstrated on-orbit in 2011 with a robotic mission. In 2012 further docking tests will be performed by Shenzhou-9 and 10, one of which will have at least one taikonaut on board. Following Tiangong-1, a more advanced space laboratory, dubbed Tiangong-2, will be launched in 2013 followed by Tiangong-3 in 2015.

In the coming years two space stations will be orbiting Earth, the ISS and the Chinese Tiangong, thus making possible for the first time an orbital rescue system. A cooperative program can be launched to implement such capability on the model of the International Submarine Escape and Rescue Liaison Office (ISMERLO) launched in 2004 to *"establish endorsed procedures as the international standard for submarine escape and rescue using consultation and consensus among submarine operating nations."* As for submarines, so too in space must the delay between an accident and rescue attempt be short. Furthermore the institutionalized contacts and increased transparency engendered by such cooperative orbital rescue would fit with broader trends toward increasing openness and could constitute an important confidence-building mechanism for wider cooperation in making space operations safe and sustainable.

According to the Chinese calendar, 2012 is the year of the Dragon, a symbol of action, energy, leadership, vitality and the ultimate auspicious symbol of success and happiness. May the celestial Dragon bring good luck to all space programs, and cooperation with China.

**Tommaso Sgobba**
IAASS President

# Psychology of Space Exploration

## Contemporary Research in Historical Perspective

By Merryl Azriel


**Edited by Douglas A. Vakoch**
**NASA, 2011**
**hardcover, 264 pp., illus.**
**ISBN 978-0-16-088358-3**
**US$27.00**

Published under the NASA History series in July 2011, the book explores the current thinking on psychological issues affecting space flight experience, analyzes the history of behavioral studies relating to space and publishes original research on the therapeutic effects of photographing Earth from space and managing negative interactions. The book was edited by Dr. Douglas A. Vakoch, a licensed psychologist in the state of California, professor of Clinical Psychology at the California Institute of Integral Studies and director of Interstellar Message Composition at the SETI Institute.

This publication takes place at a time when a crewed Mars mission is under scrutiny, and more attention is focusing on the ability of astronauts and cosmonauts to withstand the psychological pressures of an 18-36 month space mission. The recently completed Mars 500 experiment, focusing on the effects of isolation and limited and uniform society in a confined living space, is an example of an analog environment, discussed extensively in Dr. Sheryl L. Bishop's Chapter 3 "From Earth Analogs to Space: Getting There from Here".

Analog studies are a fundamental tool in psychological research on long duration space missions because of the lack of statistically significant numbers of astronauts and cosmonauts who have endured extended stints in space. Bishop points out the need to assess analogs specifically from a behavioral perspective. As an example, she questions the appropriateness of Palmer Station, Antarctica, as a psychological analog, where researchers spend the majority of their time conducting their experiments in solitary, in stark contrast to the ISS, where crew members are challenged to find time away from their colleagues at any time of day or night.

The book explores the history of Psychology in the space programs of the United States and former USSR. According to the authors, US reluctance to permit psychologists to gather data on astronauts' performance, for fear of tarnishing NASA's image and "Right Stuff" veneer, is slowly changing, but the US has a long way to go before reaching norms established by the USSR in using psychological methods not only to screen cosmonaut candidates, but also to monitor their performance on an ongoing basis, utilizing techniques such as voice analysis during space missions. Other national agencies, notably ESA and JAXA, have followed Russia's lead in this regard.

In Chapter 4, "Patterns in Crew-Initiated Photography of Earth from the ISS", Julie A. Robinson, Office of the ISS Program Scientist in NASA JSC, and her collaborators present original research exploring the therapeutic effects of crew-initiated Earth photography on crew psyche. Although often reported anecdotally, this is one of the first times objective research in this arena has been presented. The authors particularly raise the question of what substitute activity may be appropriate for deep space missions in which crew will have no view of Earth or any other planet for months at a time.

Noticeably missing from Psychology of Space Exploration is any discussion related to sexuality. Especially on long duration missions, this is an issue that is bound to arise, yet space agencies seem reluctant – at least publicly – to investigate and discuss the subject at all. In this regard Psychology of Space Exploration toes the mark.

**NASA astronaut Tracy Caldwell Dyson observing Earth from the Cupola module of the International Space Station. Earth observation and crew-initiated photography of Earth from the ISS is regarded as therapeutic for ISS crews.** - Credits: NASA

By Carmen Felix

# Five Hundred Days in Isolation

Mars500 is an international space analog study that simulated for the first time a full duration round trip to Mars. Based in Moscow, the study was conducted by ESA and Russia's Institute of Biomedical Problems. The project started back in 2007 with a short simulation to test the facilities and operational procedures. The first long term study was conducted successfully in 2009, with a crew of six members spending a total of 105 days isolated. The goal was to prepare for the 520 day isolation study, which was ultimately conducted June 2010 to November 2011.

During the mission, two Europeans, one Chinese, and three Russians were hermetically isolated in a spaceship mockup. They were monitored and their psychological, medical, and physical signs were recorded. We met Diego Ürbina, a 28 years old Italian-Colombian electronics engineer and space science specialist who took part in the experiment, to discuss how this experience will help the scientific community to prepare for a real mission to Mars.

"The human factor is one of the keys that needs to be fully understood before undertaking a human mission to Mars," Diego told us. Prolonged isolation in a confined environment far away from Earth is a condition that has never been experienced: Mars500 tried to recreate it on Earth. "To deal with isolation, we kept busy as much as we could," says Diego, "we tried to balance time alone and with the crew, exploiting the scarce communication channels with the exterior to their full extent."

> "We had to be more autonomous and make decisions that are usually made by Mission Control"

The crew had a daily routine to perform, just like astronauts and cosmonauts on the International Space Stations, but no real-time communication: "We had to be more autonomous and make decisions that are usually made by Mission Control," says Diego. Emergency response was part of the training: "two of the members were doctors who could take care of almost any medical problem in case of a health emergency," Diego explains. "They had telemedicine equipment, but in case of life threatening conditions of one crewmember, the mission would have been over for him, and for the rest of the crew he would have 'died' for the purpose of the simulation."

On one occasion the Mars500 crew experienced what they thought to be a real emergency: the complete loss of electrical power. "We weren't expecting it, so the psychologists registered the real reactions of the crew to such an emergency," says Diego. "Even if we weren't directly trained for this specific situation, we had a checklist of tasks to be performed immediately," he recalls. "This, together with pre-mission teamwork training and respect for chain of command helped us to quickly do what had to be done." After the situation was under control, Diego and the crew found it hard to believe that the emergency was part of a simulation: "Hiding 'bad news' to avoid stressing the crew is not something unheard of," he adds, recommending, on the contrary, a policy of complete transparency. "It is crucial that the crew does not get divided and that they can have a quick reaction even in an emergency that can suddenly happen in the middle of the most monotonous situation imaginable," he concludes.

On November 4, 2011, the Mars500 crew finally went back home, leaving a legacy of medical data on how the crew bodies and minds dealt with isolation. "Mars500 gave us a lot of empirical insight in how to deal with such an extreme situation, and helped us to formulate guidelines for prolonged manned deep space missions," says Diego. How far into the future is an actual mission to Mars? "Our current technological capabilities are adequate for a mission beyond low Earth orbit in the next few years," says Diego, "it could happen soon if international collaboration consolidates." What could be improved in a Mars500 follow-up? "I'd make it happen in space".

**The Mars500 crew. From left to right, back row: Wang Yue (China), Alexandr Smoleevskiy (Russia), and Diego Urbina (ESA). Front row: Sukhrob Kamolov (Russia), Alexey Sitev (Russia), and Romain Charles (ESA).**

By Morris Jones

# China's Foundations in Space

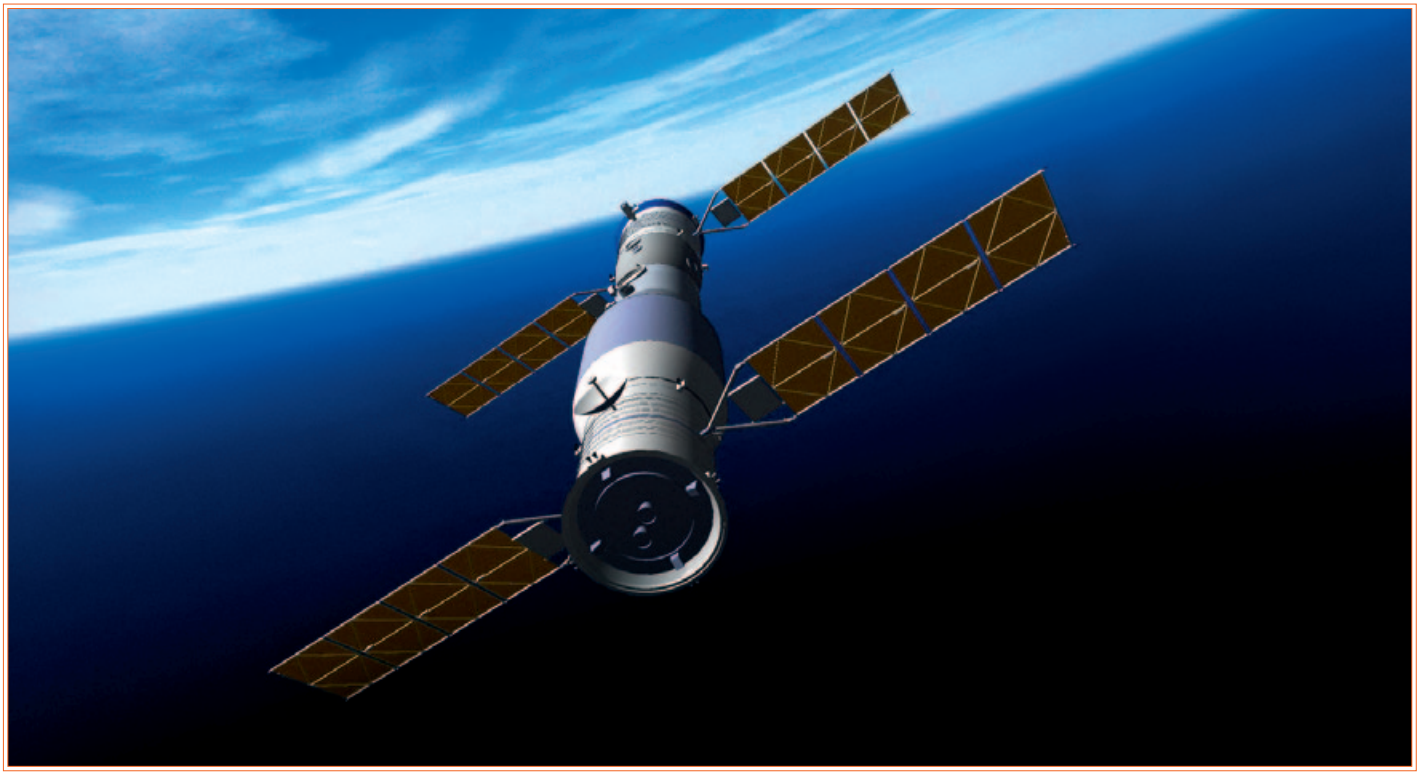
Where is China headed in space? It's a question that's being asked more often than ever before. We have witnessed the launch of China's first space laboratory in the same year that the USA has retired its space shuttle fleet. In 2012, China is expected to launch two teams of astronauts to the Tiangong-1 laboratory, while the US will continue to hitch rides aboard Russian spacecraft for years to come. China has a long way to go before it can truly match the spaceflight capabilities of the US, and its technology base in robotic spaceflight still lags other nations. But it's a solid program that's moving ahead at a steady pace, while some other nations seem to be in retreat.

China has outlined its human spaceflight plans for the near future. The Tiangong program will see three space laboratories placed in orbit this decade. Each one is expected to be more sophisticated than the last. The final laboratory, Tiangong-3, is expected to be a major step forward, and should be capable of receiving multiple spacecraft dockings. Tiangong is a precursor for the ultimate short-term goal, a large modular space station that should be launched around the year 2020. Although this will not match the capabilities of the International Space Station, it will probably exceed the performance of the Russian Mir space station of the last century.

> "China's autonomous approach to the foundations of its program places it in an enviable position"

China is also working on an ambitious lunar and planetary program. Following in the wake of two successful lunar orbiters, China will land its first spacecraft on the Moon around 2013, and deploy a small robot rover. We can expect a repeat of this mission a year or two later, followed by the next major flight around 2017, when a robotic sample-return mission will land. There will probably be a sequel to this mission too. China lost its first Mars probe, Yinghuo-1, when the Russian Phobos-Grunt mission failed to leave Earth orbit in November. But China is already planning more ambitious missions to Mars that will be launched by Chinese rockets.

China is also continuing its strong programs in Earth Observation (often with international partners), as well as navigation and communications satellites. That's what we can expect for the decade ahead. Beyond 2020, the agenda is less certain. But there's one important factor to notice in China's space program. It's very strong on building foundations.



**An artist's rendering of Tiangong, the Chinese space laboratory.** - Credits: Junior Miranda www.astronautix.com

**The launch of Shenzhou-5 on a Long March 2F rocket.** - Credits: AAxanderr/Wikipedia

## China's Independent Access to Space

China has a long history of international cooperation in spaceflight, but it retains control over the most critical elements of its program. China builds and operates its own launch sites, launch vehicles, human spacecraft, space laboratory modules and satellites. These are the foundations of a first-rate space program. Without them, a nation is not completely in control of its destiny in space.

There's a lesson for America and other nations, even those that work in solid international coalitions for spaceflight. The loss or omission of any of these basic foundations is potentially catastrophic, and can place an entire program in jeopardy. The current lack of any indigenous US crew transfer vehicle is shocking, especially when America seeks to continue its major role in the International Space Station.

China's autonomous approach to the foundations of its program places it in an enviable position. It does not need to wrestle with cumbersome international partnerships, but can still gain from other programs when there's a clear advantage.

China is developing a new spaceport at Wenchang on Hainan Island, which will be the nation's most southern launch site. This will allow rockets to gain a greater kick from the Earth's rotation, and also allow the spaceport to be serviced by sea. Wenchang will continue to be supplemented by other major launch sites such as Xichang and Jiuquan, which carry out the bulk of China's satellite launches. Wenchang will play host to China's most ambitious plans in rocketry to date.

The gradual development of the Long March 5 series of modular launch vehicles is another major foundation for China's long-term program. Flying from Wenchang, these rockets will be used to launch China's space station and send larger probes to the Moon and the planets. Launch systems are the first step in any space mission, and a lack of capability is an obvious problem. China's pursuit of advanced rockets gives them the option to pursue a variety of different objectives in space. It is probably fair to say that, behind closed doors, China is already considering how to send astronauts to the Moon. This could be done with an Earth Orbit Rendezvous strategy. A Shenzhou spacecraft could dock in Earth orbit with another rocket stage, possibly launched by a Long March 5 rocket. This would then propel Shenzhou on a circumlunar flight, or possibly an orbital mission. Eventually, it should be possible for Chinese astronauts to land on the surface. The logo of China's Lunar Exploration Program features two human footprints on the Moon. Despite these clues some people still deny that China aspires to human lunar missions!

## China and International Cooperation

The most difficult question centers around China's potential partnership with the US. This is a complex and controversial issue. Right now, there's simply no chance of any serious cooperation. Any change in this will depend on politics, strategic issues, economics, and the overall direction of spaceflight. It seems unrealistic to expect that the two programs will remain totally disengaged forever, but bridging the gap will take time and a lot of work.

China's astronaut corps remains off-limits to foreigners for the moment, but there's a good chance that guest astronauts will eventually fly to China's space station. Where will they come from? It is conceivable that China will invite astronauts from closely allied nations such as Pakistan, and possibly from nearby states in Asia.

The recent successful docking of the Tiangong-1 space laboratory with the uncrewed Shenzhou-8 spacecraft focused global attention on China's space program, showing that China has so much to demonstrate to the world. Sadly, China's obsession with secrecy for much of its space program has hamstrung much of its potential appeal. It has contributed to fears and suspicions of Chinese spaceflight. China's relative lack of openness is also a major barrier to any future cooperation with the US. Opening the program to wider examination would certainly help the Chinese, as well as the world at large: it would make a great space program not only look better, but actually mature and become even greater.

*Dr. Morris Jones is an Australian spaceflight analyst and writer. Views and opinions expressed in this article are those of the author, and do not reflect necessarily those of the IAASS and the ISSF.*

# 5th IAASS Conference USAF General G. A. Feest Opening Speech

By Maj. Gen. Gregory A. Feest

*The 5th Conference of the International Association for Advancement in Space Safety (IAASS), titled "A Safer Space for a Safer World" was held in Versailles, France, on October 17-19, 2011. The conference, attended by space safety experts from 25 countries, covered the major topics connected to space safety, from designing safety into space vehicles to launch range safety, from environmental impacts of space operations to space debris mitigation and removal. The following opening speech was given by Maj. Gen. Gregory A. Feest, US Air Force Chief of Safety.*

**Maj Gen. Gregory A. Feest.**
Credits: US Air Force

> "Safe operation in and through space is one of the main ingredients for economic, commercial and military success"

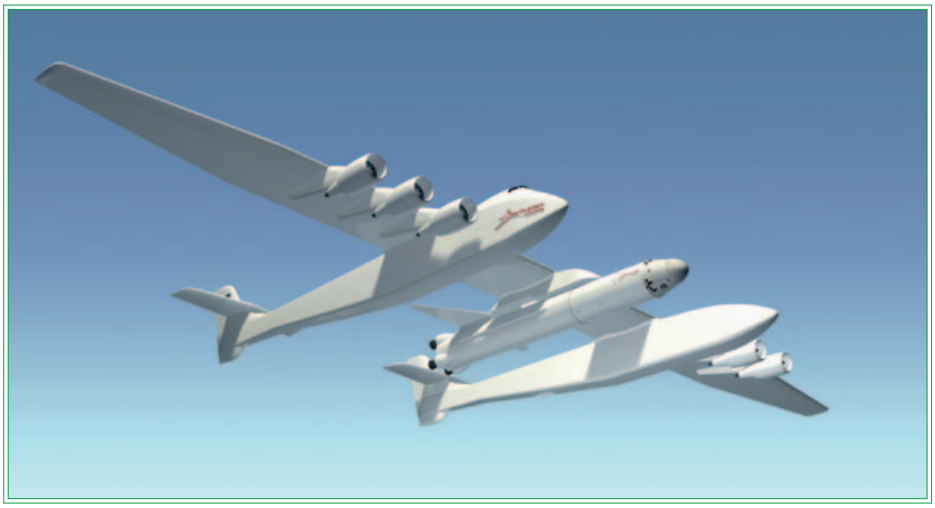
Good Morning Ladies and Gentlemen,

It is my privilege to attend the fifth International Association for the Advancement of Space Safety Conference, and address this distinguished body of scientists and space professionals. On behalf of the U.S. Air Force and the Air Force Safety Center, I'd like to commend the IAASS and its President Mr. Tommaso Sgobba for organizing such an important and dedicated international space safety forum. The IAASS has taken measurable strides in promoting space safety awareness worldwide. Safe operation in and through space is one of the main ingredients for economic, commercial and military success. Thank you all for your unwavering and tireless efforts.

This week, scientists and the space professionals from all over the world are gathered here to network and address many of the prevailing challenges in the space arena. Many of these challenges are complex, multidisciplinary and culturally varied in nature. They include topics in commercial human spaceflight, space communications and global commerce, space nuclear auxiliary power, space debris mitigation and removal, and environmental remediation just to mention a few. Many of these challenges are universal, and require international attention and solutions. Recognizing the mere fact that space is not the providence of any particular nation, I am happy to report that the recent release of several important documents by the United States Government, including the National Space Policy, signed by the President a year ago, the Space Posture Review and National Security Space Strategy, issued by U.S. Department of Defense, and the Space Governance Review, prepared by the Secretary of the U.S. Air Force. These documents encourage greater collaboration among space-faring nations and the safe and responsible use of space. No doubt, such collaboration and partnership foster increasing benefits to national and global economies, security, international cooperation, scientific discovery, environmental protection and overall quality of life on Earth.

## U.S. Air Force's Commitment to Space Safety

I should also highlight the U.S. Air Force's commitment to space safety. Since the Space Safety Division was created at the Air Force Safety Center in 2004, there have been no personnel injuries or deaths associated with a U.S. Air Force space mishap. We continue to develop space safety policy for the U.S. Air Force and have been working toward many of the same goals I'm speaking about today. In fact, my space safety division, who is represented here today, has been collaborating and contributing to the aspirations and goals of IAASS since its inception.



**Hybrid vehicles operating as aircraft and spacecraft as the newly announced Stratolaunch system will soon increase launch and re-entry traffic through the shared airspace.**
Credits: Stratolaunch


**USAF General G. A. Feest presenting at the IAASS plenary session.** - Credits: John Conley

As the commercialization of space and human spaceflight flourishes, the IAASS scientific community should endeavor toward the long-term goal of preserving the continued use of space for all future humankind. This forum is uniquely qualified and equipped to effectively develop and socialize scientifically based safety procedures to ensure the continued safety of space missions. A document similar to principles and safety techniques prepared by the International Civil Aviation Organization is a worthy goal, and would harmonize operational procedures to unify and integrate space surveillance and situational awareness guidelines world-wide, just as the ICAO does for the aviation community.

## Education in Space Safety

We all are excited to observe the development of commercial human space transportation, commercial space stations, and hybrid vehicles operating as aircraft and spacecraft for suborbital flights. These developments will generate in the following decade an increase in space launch and re-entry traffic through the shared airspace. Such tremendous growth in space enterprise, and the crossover with the aviation discipline, demands institutionalizing a formal aerospace safety training and education to our space professionals. Clearly, such training is imperative to maintaining safe air and space, as it is the dissemination to aviation of data of common interest, such as space weather forecast and alerts on falling space debris.

The safety of the aviation operations in the national and international airspace, the safety of launch, on-orbit and re-entry operations, space debris and the sustainability of the space environment, the integration of space and aviation situational awareness, will require space and aviation professionals with a solid background in system safety engineering, and knowledge of space safety regulations and standards. Unfortunately, today aerospace engineering programs do not offer courses in space safety design criteria, methods and safety analyses techniques, space safety regulations and standards. I'd like to commend the IAASS's and International Space Safety Foundation's (ISSF) for recognizing this critical void and their efforts to fill this gap.

This year in Washington DC, the ISSF organized the first workshop on creating an academic certificate program in space safety, proposing to fill the space/aerospace safety educational gap with an initial Graduate Certificate Program. We all expect that world-known experts from academia, space agencies and industry will contribute as faculty and lecturers for the International Institute Space Safety (IISS) educational programs. Space safety systems engineering must be learned not only by those who will begin a specialist career as safety engineers and managers, but also by those who will follow a career in space project management, or in aerospace systems engineering and operations. I am proud to say that my Space Safety Division at the U.S. Air Force Safety Center is championing these educational efforts as well. With our endorsement and support of two U.S. universities, we are already committed to initiate Space Safety programs in conjunction with the already accredited Aerospace and Mechanical Engineering programs next year. Senior Scientists from Space Safety Division contributed with the IAASS to the "Safety Design of Space Operations" textbook, to be published by Elsevier in 2012.

> "All nations have the right to use and explore space, but this right must be met with responsibility"

## Final Remarks

We are living in an exciting and very challenging phase of deep-space exploration. Therefore, we need to promote the responsible, peaceful and safe use of space. All nations have the right to use and explore space, but this right must be met with responsibility. It is my profound hope that for the greater good of space safety, you will come together to collaborate in solving challenges we are facing in space today. Challenges that require international cooperation, like space situational awareness and surveillance, debris monitoring and removal, environmental remediation monitoring and sustainability, and preservation of the space environment. This conference should create a collaborative environment among nations, while preserving the national interests of each, and adopt approaches for safe activity in space. It is our obligation and our responsibility to protect this fragile ecosystem called space, right for the benefit of future generations. My space safety team will continue to partner with you in this endeavor.

I wish you all a productive and enjoyable conference.

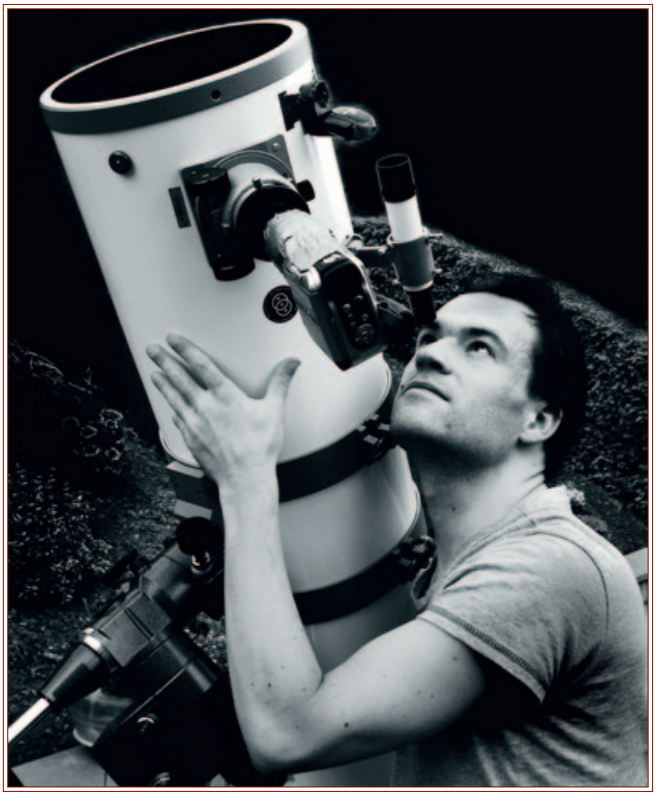
Thank you.

*Maj Gen. Gregory A. Feest,*
*US Air Force*

by Andrea Gini

# Astrophotography and Space Debris

> "In this field it's important to be able to control a telescope by hand and to improve your tracking technique"



**Ralf Vandebergh specializes in manual tracking of small space objects. Note the camera attached to the telescope.**
Credits: Ralf Vandebergh

On November 29, photographs of the stranded Russian probe Phobos-Grunt, lost in Earth's orbit right after launch, began appearing online. Even as ESA and Roscosmos were struggling to regain control of the spacecraft, the images, taken from the ground with an amateur telescope, went viral, ending up in website, newspaper, and press releases all around the world. It was the latest achievement of Ralf Vandebergh, a freelance scientific journalist based in the Netherlands with a passion for astrophotography that dates back to his childhood. We contacted Ralf to learn more about his work, his technique, and his current projects.

## An Early Passion

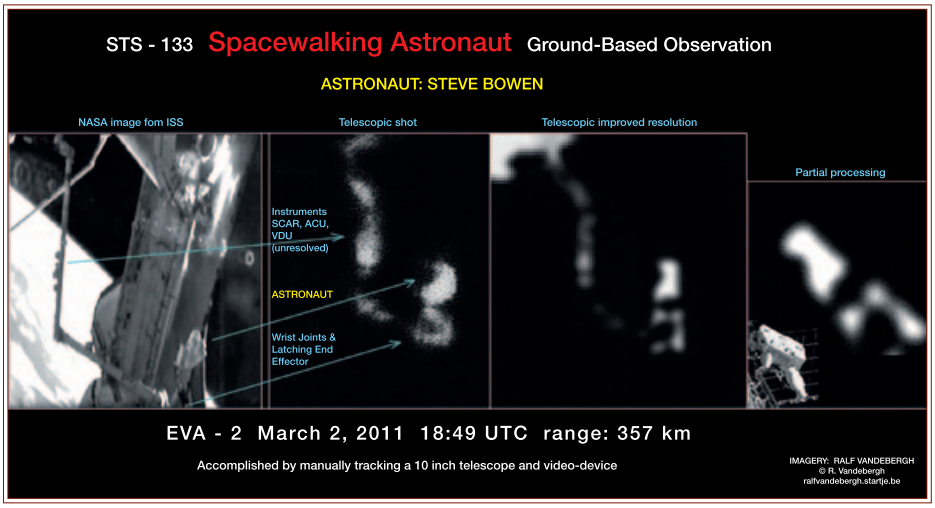
Ralf developed his passion for astrophotography very early: "In 1985 Wubbo Ockels, the first Dutch astronaut, flew on the Space Shuttle," he recalls. "Pass-times were mentioned in the newspaper, so at age 9 I saw my first pass of a Space Shuttle." He then developed his technique throughout the '90s , taking "ordinary" pictures of Saturn: "nobody ever discussed trying to photograph a spacecraft from the ground back then," he explains, "it was just impossible with amateur instruments."

That started to change around the year 2000: "some amateurs, especially in Germany, managed to capture images of the ISS with cheap resources," Ralf says. "In a few months, the technique was developed far enough to allow amateurs to do this, and my old interest in spaceflight picked up again." The equipment used to capture images is actually very affordable: "a classic Newtonian telescope with a 10 inch aperture," explains Ralf. "A normal video camera is mounted on the eyepiece, and tracking is fully manual using a well-aligned tracking scope." Getting a larger telescope is not a priority for Ralf: "In this field it's more important to be able to control a telescope by hand and to improve your tracking technique," he says.

**Beautiful colors reflecting on the ISS. The striking blue color, especially visible on metallic surfaces, is reflected Earth light.**
Credits: Ralf Vandebergh

The first step to capturing a space object image is to check its orbit using software like Calsky, in order to find a favorable pass: "Sometimes it is necessary to compare data from different programs to get better predictions," says Ralf. Once a favorable observing window has been detected, Ralf prepares himself for the appointment by readying the equipment and preadjusting to the correct aim: "I wait for the object, looking at a precise point in the sky," Ralf explains. "When an object is bright like the ISS, you can spot it with the naked-eye," he says, "when it is faint, I use a bright star along the object's path to pick it up." Then, the actual recording starts: "Once the object is in view of the tracking scope at low magnification, I keep it centered on the crosshair as well as I can, and start recording," he says.

A typical session yields hundreds of frames. "I compare as many frames as possible, to see if I can combine some of them to get an improved signal-to-noise ratio," says Ralf. "This technique is widely used in planetary imaging, but it is less effective in satellite imaging because you never manage to capture a large amount of frames in the few useful seconds of a pass." The best ▸▸




**Astronaut Steve Bowen (STS-13) photographed during an EVA. Note the Canadarm, the helmet and the backpack.** - Credits: Ralf Vandebergh

> "One of my best moments was when they sent my images up to the ISS when the STS-119 shuttle crew was up there"

frames are those taken when the satellite is high enough above the horizon: "There is a fast shift in the angle, so the details change their position slightly during a pass," he explains.

## Highlights and Future Plans

Ralf displays some pictures from his collection recorded during STS-119, the Discovery mission which delivered the large Integrated Truss Segment S6. "It was the most successful mission I ever captured," he recalls. "One of my best moments was when they sent one of my images up to the ISS when STS-119 shuttle crew was up there: they just had attached the last big solar panel and I was able to take a picture of it from Earth a few days before they would undock the Space Shuttle and see it for themselves." Another successful image, this time from STS-113, was the picture of astronaut Steve Bowen during an EVA: "in the picture you can see the astronaut 'hanging' from the Canadarm, with details of the helmet and the backpack," he points out.

More recently, Ralf's work achieved exposure with photographs of UARS, ROSAT, and Phobos-Grunt, which ended up in official ESA, DLR and Roscosmos press releases: "It gives much more satisfaction to see your images published in the professional community," he says, "these people look seriously at image content to find the correct interpretation, instead of just surveying them rapidly as most people do."

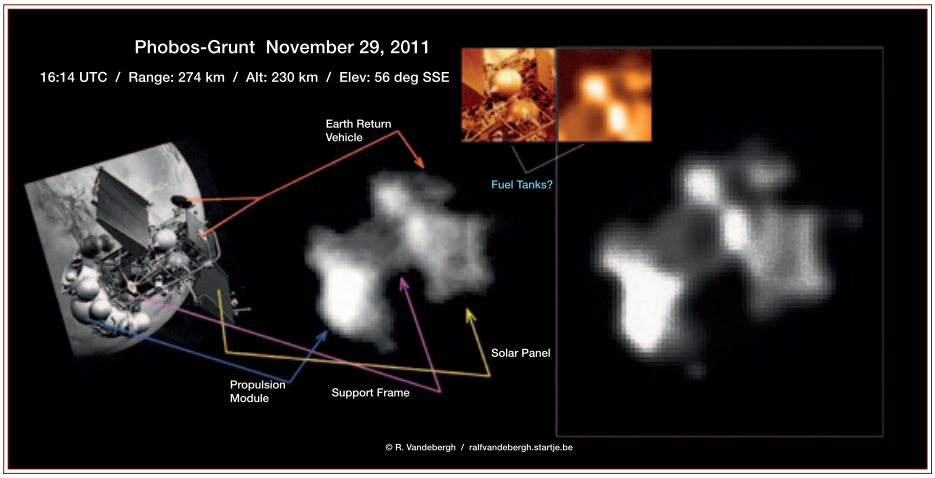
The most interesting part of Ralf's work involves small objects: "Most astrophotographers don't really go beyond ISS imaging," says Ralf. "The ISS is an interesting object, thanks to its size and detail, and it is relatively easy to capture, thanks to its brightness," he explains. "My current interest is trying to register the rotational or tumbling motion of free floating objects such as space debris," he continues, "I would say this has become my specialization, and it is what led me to gain interest in issues of space safety!"

Satellite imaging itself is a very new field: "There are just a few photographers who are doing this," says Ralf, "imaging of smaller satellites is still a very new and pioneering field in astrophotography, and I'm glad to be on the forefront of it, finding ways to push the envelope further every time."

Ralf is currently working on another interesting project: "One of my long-running projects is Cosmos 482, a Russian Venus probe which was lost in an elliptical Earth orbit in 1972," he says. "This probe was part of the Venera series of the early '70s, and it was lost similarly to the more recent Phobos-Grunt," he says. "The project has been running for about 18 months now. I took the first pictures in summer 2010, but not when the probe was in its perigee, so there is margin to get better pictures in the future," he says.

How does Ralf relate with his fellow astrophotographers? "We are a small community," says Ralf, "just a few individuals, and sometimes there is a certain degree of jealousy among amateurs doing the same imaging."

*Ralf Vandebergh is a freelance journalist and astrophotographer based in the Netherlands. To see more of his pictures, visit his website:*
**http://ralfvandebergh.startje.be/**




**The Russian Martian probe Phobos-Grunt. Note the tanks, the support frame and the solar panels.** - Credits: Ralf Vandebergh

By Matthew Van Dusen,
Editor, Txchnologist.com

# Will Anyone Recover Apollo 13's Plutonium?

Somewhere among the jagged trenches of the South Pacific sits a graphite fuel cask containing 3.9 kg of plutonium from Apollo 13. The fate of the radioactive plutonium-238 has long been overshadowed by the successful return of the three NASA astronauts on board the ill-fated mission.

The plutonium was supposed to fuel the System for Nuclear Auxiliary Power, or SNAP-27 Radioisotope Thermoelectric Generator (RTG), designed to power a set of experiments on the lunar surface. But after an explosion crippled the craft and forced the crew to abandon plans of a lunar landing, the plutonium became yet another problem for mission control. Officials from NASA confidently told The New York Times that the biggest risk was that the 40-pound generator might hit someone when it fell to Earth. "It will keep a few fish warm," a NASA official said. The Atomic Energy Commission, on the other hand, conceded the slight possibility that it could become ground into dust and dispersed.

NASA learned its lessons about engineering the fuel casks the hard way: in 1964, the Transit-5-BN mission aborted and the RTG burned up upon reentry above Madagascar, in keeping with its design. Traces of plutonium were found in the area months later. In 1968, the Nimbus B-1 weather satellite was aborted soon after takeoff from Vandenberg Air Force Base and the plutonium from the SNAP-19B2 RTG plunged into 300 feet of water off the California coast, with no release of radiation.

Apollo 13's SNAP-27 fuel, as far as we know, slipped beneath the waves and came to rest 6 to 9 kilometers deep in the Tonga Trench, one of the deepest areas in the ocean. Subsequent testing by the U.S. Department of Energy has shown no spike in background radiation. Not surprisingly, NASA has no desire to go looking for the small cask, even with advances in submersible technology that would make such a mission at least technically feasible. "I don't think that anyone has seriously considered that because of the cost of recovery," said Leonard Dudzinski, a NASA program executive who deals with radioisotope power systems.

**Fred Haise extracts the fuel element for the SNAP-26 RTG during training.** Credits: NASA

**President Nixon (right) presenting the nation's highest civilian award to the Apollo 13 crew (left to right, J. L. Swigert, F. W. Haise, J. A. Lovell).** - Credits: NASA

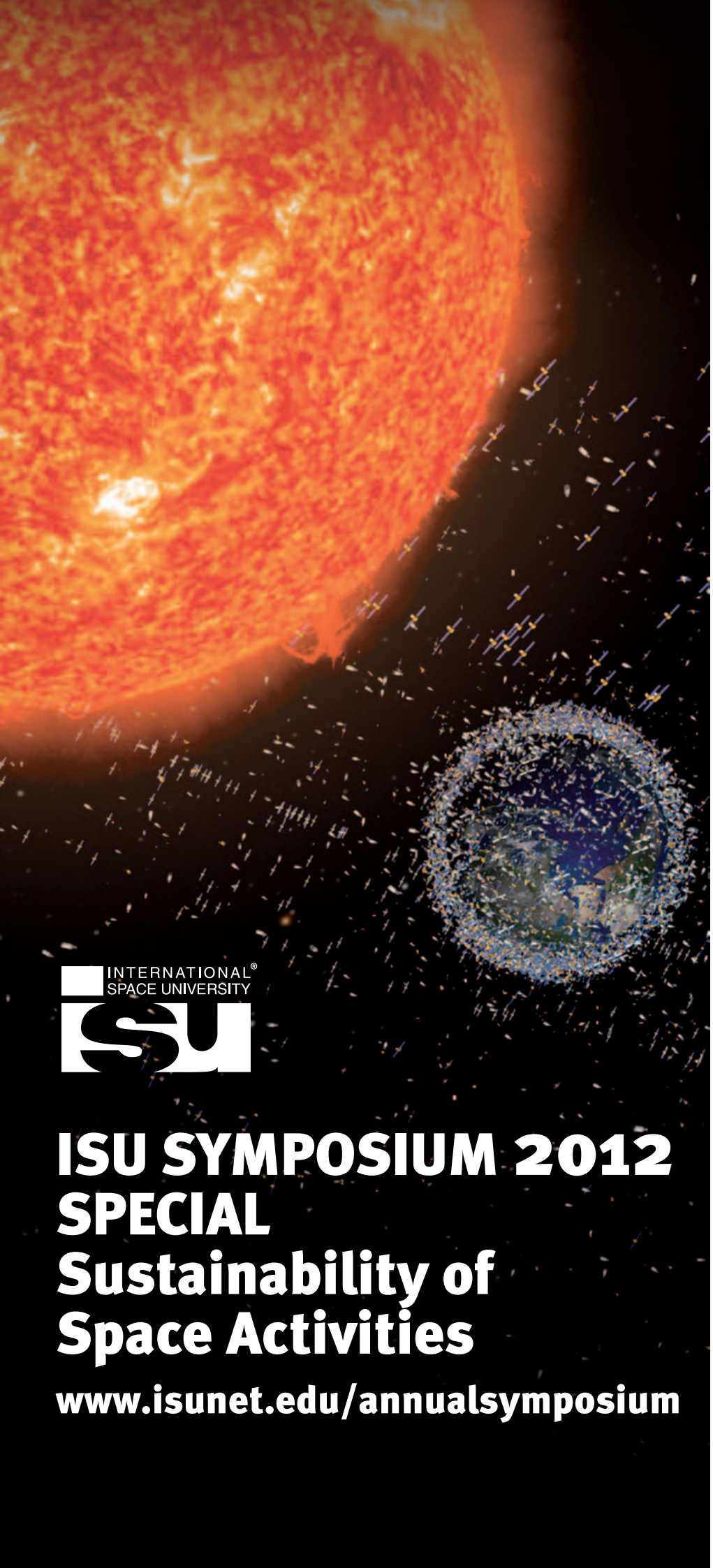
Indeed, NASA is trying to source additional plutonium 238 for its future deep space missions – the U.S. no longer produces the isotope and Russia has proved to be an unreliable source – but the useful life of the Apollo 13's plutonium has expired.

The plutonium poses little danger to the environment: the corrosion resistant cladding should withstand seawater for approximately 870 years, ten times the plutonium's half life. According to NASA, the plutonium itself was in oxide form and was both chemically and biologically inert when it plunged into the ocean.

Over the years, the plutonium cask, far out of sight, has fueled two contradictory positions on the safety of RTGs for deep space missions. For NASA, its safe return to Earth proved the effectiveness of their safety engineering. "We recognize that the Apollo 13 [RTG system] worked," Dudzinski said. "Follow on RTGs were based on that design and improved on that design."

Critics have taken different lessons from the untimely plunges of the RTGs. In 1997, a group of safety experts, including physicist Dr. Michio Kaku, warned that 32 kg of plutonium contained in the Saturn-bound Cassini satellite posed a greater danger than NASA would acknowledge, but ultimately, their warnings did not prevented the mission from happening.

*Matthew Van Dusen is a New York-based journalist. He is the Editor of Txchnologist.com, a publication sponsored by General Electric. Views and opinions expressed in this article are those of the author, and do not reflect necessarily those of IAASS and ISSF, publishers of the Space Safety Magazine.*



INTERNATIONAL® SPACE UNIVERSITY

# ISU SYMPOSIUM 2012 SPECIAL Sustainability of Space Activities

www.isunet.edu/annualsymposium

# Space Sustainability the ISU Way

by Tereza Pultarova

International, Intercultural and Interdisciplinary - the 3Is of the International Space University - is also the philosophy behind the ISU's annual Symposium. This year's Symposium, the 16th since inception, will once again bring together lawyers, economists, engineers, scientists, and other space professionals to discuss a common theme: sustainability of space activities. The Space Safety Magazine paid a visit to the Symposium Organizing Chair, Professor John Farrow, to learn more about the upcoming event.

Sitting in his office surrounded by his favorite satellite models, Prof. Farrow reveals how the idea to create a conference on the grounds of ISU emerged. Although not a faculty member at the time, he knows the story well. The birth of the ISU Masters program in 1995 brought together George Haskell, ISU Vice-President at the time, and Michael Rycroft, a key supporter of the Masters program. "They decided to introduce an international Symposium, which would form part of the students' timetable," explains Prof. Farrow, "the Symposium was intended to attract an international audience to explore a chosen theme."

> *"Space debris is a very topical issue, and a very important one"*

The theme of space sustainability comes from involvement with the working group *"Long Term Sustainability of Outer Space Activities,"* created two years ago within the United Nations Committee on Peaceful Uses of the Outer Space (UN COPUOS). "In the context of space activities, sustainability means sustainable use of outer space for peaceful purposes for the benefit of all countries," explains Prof. Farrow, "It covers things like threats from orbital debris, space weather, deliberate events such as anti-satellite attacks as well as cyber attacks on spacecraft or potential threats that are in space."

These subjects form the backbone of the Symposium session topics.

The issue of space debris and hazards related to uncontrolled space objects has recently received widespread attention. With the reentry of UARS and ROSAT in September and October 2011, and with the reentry of the stranded Phobos-Grunt probe expected by early 2012, space threats are becoming a significant public concern. "It is a very topical issue, and a very important one," says Prof. Farrow, "we looked at space security in a very broad sense four years ago," he explains. "Coincidently at that time, just a few days before we held the Symposium on *Space for a Safe and Secure World*, there was an in orbit collision between two satellites which gave rise to a huge increase of debris in orbit. Since then, the subject of debris has become even more a matter of interest."

The organization of a Symposium is a long and complex process: "we try to vary the topics from one year to another in order to give some variety," explains Prof. Farrow. "It is also important to us that the topics should be of general interest, and that they have an academic content for our students," he says. Sometimes the process is trickier than one might expect: "in the past we've been in the situation that we had to change our topic and even the date of our Symposium in order not to clash with another conference that would steal most of our participants," he says.

According to Prof. Farrow, there is something that sets the ISU Symposium apart: "There is a degree of uniqueness about what we do. Living up to ISU's 3Is philosophy, we try to bring everybody into the same room – the engineers, lawyers, economists – each contributing to and sharing the same common topic," he says. "The unique feature of our conference is that the great majority of our sessions are held in plenary," he adds, "everybody shares, contributes to the ensuing discussion either in the conference center itself, over lunch or during other social activities we organize in Strasbourg, a very beautiful and ancient city that definitely helps to attract more people to our symposia."

*John Farrow, Organizing Chair of the annual ISU Symposium since 2005. Credits: Shripathi Hadigal Rao*

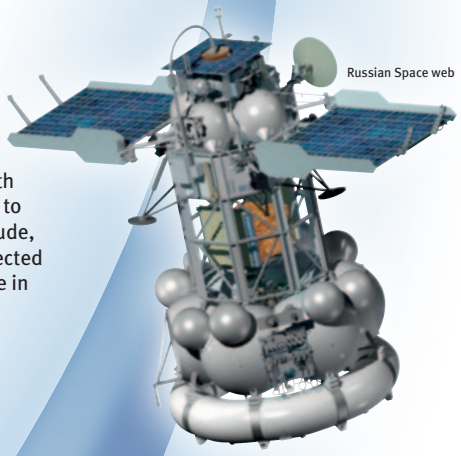
# A Year of Debris

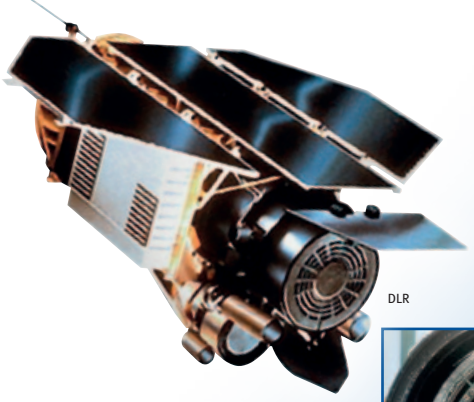
by Megan Kane
Infographic by Kristhian Mason

The Space community has considered space debris a serious threat to space operations, but only recently has the public become aware of the magnitude of threat. The reentry of large space stations, like Skylab on July 1979 or Mir on March 2001, were of course headline news, but ordinary debris have not been thoroughly considered – until now. While only one person has reportedly been hit by a piece of debris returning to Earth, millions learned that there is the potential to be hit by falling debris on a regular basis, as spent rocket stages, satellites, and other space objects fall to Earth every week. The public at large was mainly unaware of this, until two massive satellites came down within weeks of one another – one largely anticipated, one not. And while the year 2011 is reaching its end, the failure of the Russian Phobos-Grunt probe, carrying 10 tons of hydrazine and a capsule of radioactive cobalt, will be a dangerous and controversial opening to a new year in space debris.

## 2012

**November**
**Phobos-Grunt Reentry**
On November 13th, the Russian Martian probe Phobos-Grunt stalled in LEO with its tank filled with 10 tons of hydrazine. Due to its current mass and altitude, the 14.6 ton probe is expected to reenter the atmosphere in mid-January

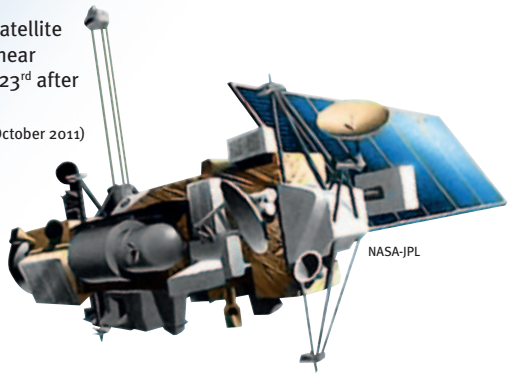

Russian Space web


DLR

**October**
**ROSAT Reentry**
ROSAT, with its massive mirror, reentered Earth's atmosphere over the Bay of Bengal on the 23rd of October after 21 years in orbit.
(DLR)


NASA

**September**
**UARS Reentry**
The 6 ton NASA Upper Atmosphere Research Satellite (UARS) fell to the Earth near midnight of September 23rd after 20 years in orbit.
(Orbital Debris News V15 Iss4, October 2011)


NASA-JPL

**April**
**ISS close call**
On April 2nd, the ISS performed the 12th avoidance maneuver since the start of its life, the 5th maneuver in the last 2.5 years.
(Orbital Debris News V15 Iss3, July 2011)

## 2011

# Familiar Faces

by Merryl Azriel

The 16th ISU Symposium will consist of six sessions covering the topics of International Perspectives, Space Debris, Space Weather, Other Threats (cyber attacks, anti-satellite weapons, and space militarization), Cooperative Approaches to Improvement, and Looking Forward. Several ISU supporters will be presenting their work in February: here are highlights from a few of them.

**Michael Rycroft** of CAESAR Consultancy, a regular lecturer at ISU and resident faculty member from 1995 to 1999, will be discussing the limitations of space weather forecasting today and what the future holds for forecasting not only in near-Earth, but around the Moon and Mars as well.

**Norma Crosby**, Chair of the ESA Space Weather Working Team, attended the SSP in 1992 and served as Assistant SSP Director in 2000. She will be presenting in Session 3: Space Weather, along with Michael Rycroft.

**Jim Burke**, JPL retiree, The Planetary Society representative, and long time supporter of ISU will be discussing ways to avoid a situation in which a disaster results in loss of communication between Earth and the existing satellite network. Along with collaborator **Angela Peura**, George Washington University, he will recommend usage of low technology elements to provide robustness and redundancy that can safeguard existing communications and control systems. They will be presenting in Session 6: Looking Forward and Outward.

**Reinhold Ewald**, ESA astronaut and regular ISU lecturer will support the need for a long term human orbital outpost, such as the ISS, for the sustainability of Space utilization. Together with fellow veteran ESA astronaut **Christer Fuglesang**, Ewald will discuss how the success of ISS has been enabled by its international nature, which provides sustained political support, redundancy, and complementarity, a combination that cannot be achieved by any single actor. Ewald and Fuglesang also see potential for ISS to serve as a planetary mission analog in next generation space mission research. They will present in Session 4: Other Threats to Space Activities.

**Ram Levi**, ISU Space Studies Program (SSP) 2011 graduate and founder of Space Security Facebook page, is currently a research fellow at Yuval Ne'eman Workshop for Science, Technology and Security at Tel Aviv University, along with collaborator **Tal Dekel**. They will address potential cyber attack vectors on satellites and ground stations, review cyber attack case studies and present options for mitigation and avoidance of such vulnerabilities. Their talk will be presented in Session 4: Other Threats to Space Activities. Levi and Dekel will present a poster proposing a National Space Resilience Index to fill gaps in existing indices and provide a holistic view of recoverability of national space resources in case of a disruptive event.

**Jeffrey Apeldoorn**, ISU SSP 2009 graduate now working at OHB-System AG, will present in Session 2: Space Debris, along with an international research team on space mission protection. Strategies discussed will include spacecraft shielding, spacecraft self-protection, mission optimization and redundancy, and options for maintenance and repair of damaged craft. These strategies will be illustrated utilizing specific satellite case studies.

**David Kendall**, Chair of the Inter-Agency Debris Committee and Director of Science in the Canadian Space Agency (CSA), will be Chairing the first Space Debris session. Kendall is a former chair of the ISU Academic Council and served as SSP Director in 1999.

**Joe Pelton**, Vice President of the International Space Safety Foundation, is a former Dean of ISU. He will be speaking in Session 5: Cooperative Approaches to Improved Space Sustainability on space debris remediation efforts. He will propose creation of a monetary fund, paid into by space actors, and paid out to licensed operators authorized to remove Space debris on behalf of current and former Space actors.

**Kai-Uwe Schrogl**, head of ESA Policies Department and former Director of ESPI, will be chairing Session 5. Schrogl is a regular lecturer at ISU and frequently chairs symposia sessions. He is an expert on space traffic management and situational awareness programs.

*Former ISU President Michael Simpsons poses with Michael Rycroft, a key supporter of ISU since its inception. Credits: A. Gini*

*Poster session from ISU Symposium 2007*
*Credits: ISU*

# New Players

by Merryl Azriel

Many more faces, familiar and otherwise, will be presenting their research at the Symposium poster session, which will span the three days of the Symposium. Among these will be three current ISU students – Megan Kane, Christopher Johnson, and Jeffrey Osborne.

**Megan Kane**, a returned US Peace Corps volunteer with an abiding interest in space debris, will present *"Space Debris: A Commercial Opportunity."* "This is an aspect of the space debris issue that has typically been overlooked," said Megan."The commercial sector is becoming more influential and active in the space sector and they will want to protect their investments. It poses some interesting possibilities."

**Christopher Johnson** and **Jeffrey Osborne** will be representing a larger team from ISU SSP 2011 with the topic *"An Interdisciplinary Approach to Human-Robot Cooperation in Mars Exploration"*. "Sustainable space development will have to intelligently balance the flexibility and ingenuity of humans, with robust and sophisticated robotic systems," says Jeffrey, "I am looking forward to connecting with others who are passionate about long-term space development and to see what tools and methods they are pursuing to achieve this." Christopher Johnson, a lawyer by profession, is particularly looking forward to the Symposium's policy discussions. "Space sustainability issues are governed by soft law – and are likely to continue in that vein," said Christopher, "This creates opportunities for development of creative legal tools. There should be some interesting dialogues."

*See these and more speakers at the 16th annual ISU Symposium beginning February 21, 2012.*
*The full program is available at www.isunet.edu/annualsymposium*

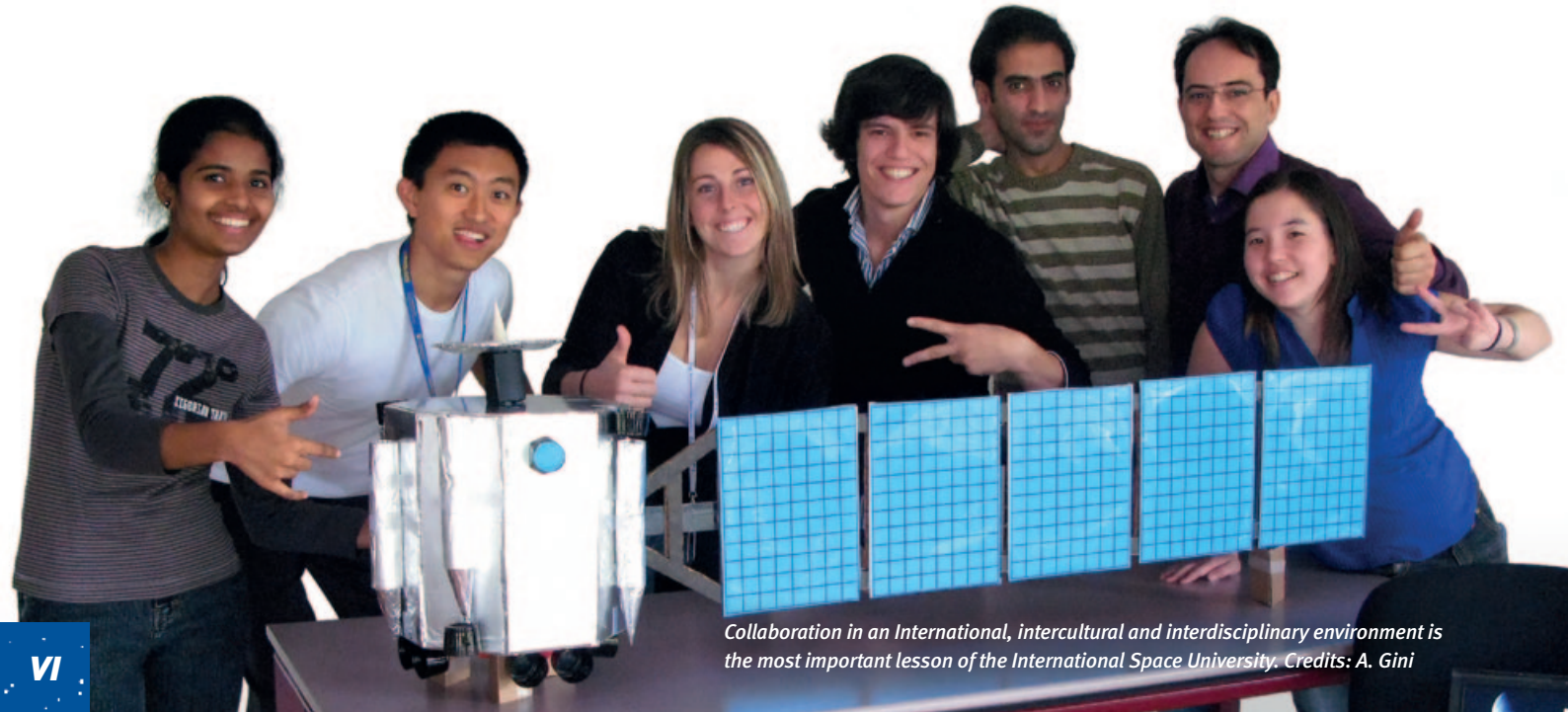
# 25 Years of International Space University

by Tereza Pultarova

It's been almost 25 years since Peter Diamandis, Todd Hawley, and Robert Richards founded the International Space University. Since then, more than 3200 students from over 100 countries have graduated there, and had a chance to start or improve their career in the space business. Based in the suburbs of the beautiful ancient Alsatian city of Strasbourg, ISU is a higher education institute aimed at providing education and training for future leaders of the space industry. The school presents a rather unique approach. During the one year Masters program or the 9 week summer Space Studies Program, students have the opportunity not just to learn about the space industry, but also to experience what the space sector is really about: an international endeavor that requires cooperation of people with different backgrounds, coming from different cultures and speaking different languages. Lawyers, engineers, natural scientists, and economists have to learn to talk to each other, and it is not always easy to overcome the differences in background, method, and mindset. Cultural differences can be subtle and unpredictable, as what in one culture is considered funny may be regarded as offensive in another. Also, overcoming the language barrier requires a lot of effort when for example a Chinese engineer needs to solve a problem together with a Canadian counterpart.

The ISU program is designed to be Intercultural, International and Interdisciplinary, a 3I philosophy that is the essence of the institute. This approach forces humanists to struggle to design a satellite orbit, scientists to put together a business plan, and aerospace engineers to find their way out of legal clauses. The ultimate lesson is that every difficult task is manageable, if you have a team to rely on whenever you feel lost. This experience is priceless: no great space exploration mission would have been accomplished without the enthusiastic cooperation of many people who, just like ISU students, have sometimes felt lost.

The microgravity laboratory, the satellite tracking station, the professional-caliber telescope, and the concurrent design facility all provide opportunities to broaden one's horizons with cooperative hands-on activities. Rocket competitions, robotics workshops, and a number of cultural events – an inseparable part of ISU's student life – are the additional ingredients that bring fun into the experience. And whether one wants to become an astronaut, join the future mission to Mars, start a commercial space flight company, or focus on remote sensing applications to improve life on Earth, everyone believes that space is an ever inspiring domain that opens our eyes and widens our horizons. "The first universities helped to bring mankind out of the Dark Ages and into the Renaissance," said Arthur C. Clark, the legendary science-fiction writer and first chancellor of ISU. "They demonstrated a potential to unshackle the minds and spirits of the people of their time. The International Space University may well become an essential cornerstone in leading humanity ahead in space and on Earth in the century to come." This same belief is what creates a connection among all the space enthusiasts who share the intense, varied, and challenging experience of the ISU program.



*Collaboration in an International, intercultural and interdisciplinary environment is the most important lesson of the International Space University. Credits: A. Gini*

# SSP 2012 Tackles Space Debris

by Merryl Azriel

The Space Studies Program (SSP) is an intensive nine week program designed to teach an intercultural, international, and interdisciplinary approach to the space sector. Held in a different city each year – Strasbourg, Barcelona, and Beijing just to mention a few – SSP2012 will be hosted by the Florida Institute of Technology at their Melbourne campus in partnership with the Kennedy Space Center in Florida USA.

An important part of the SSP curriculum is the Team Project, a comprehensive research project, developed over 4 weeks, covering a contemporary interdisciplinary problem. Of this year's four team projects, one will explore the issue of space debris, with a focus on mitigation and removal. We met Angie Bukley, ISU Dean, Vice President for Academic Affairs and Director of the SSP, to discuss the upcoming SSP and the ISU Symposium.

"The SSP Team Project is a study of space debris in general – mitigation, elimination, and prevention, a holistic view of space debris," said Dr. Bukley. The affinity with this year's Symposium is fortunate, yet accidental: SSP Team Projects are in fact selected eighteen months in advance: "For this particular Team Project it seems most à propos, timely, and lucky," says Dr. Bukley, "we will collect whatever information we can from the symposium and make sure that it gets incorporated in the documentation sent to Florida to be used in the Space Debris Team Project."

The SSP addresses topics in a team environment: thirty to forty participants analyze the problem of the day, research the literature for the current state of the art, and develop a unique solution, often in the form of commercial initiative. Group composition is the most varied: "Young professionals, old professionals, midlevel managers, senior managers, senior engineers," says Dr. Bukley, "some participants are already working in the space industry, while others are looking for a career change." Dr. Bukley was one of the former when she attended SSP in 1993: "I was working at NASA as an engineer," she recalls, "I saw SSP as a great opportunity to study business and management applied to space without a lot of risk." A desire to expand their horizons and to refocus their careers seems to be a common trait among SSP attendees: "that's what most of our participants are coming for," explains Dr. Bukley, "to get an experience in an international, intercultural environment, but also to broaden the range of disciplines with which they're familiar."

> *"I want people to leave with a greater understanding of the problem and motivation to do something about it"*

SSP Team Projects have covered a whole host of topics in the past. Remote sensing applications, robotics, tele-medicine, disaster management, and space traffic management have all been addressed at some point in the SSP's 25 year history. "I was trying to think of subjects we haven't looked at," said Dr. Bukley, "If you go look at the list of former SSP topics it's pretty amazing: when we get Team Project proposals, the Academic Council has to go back and look to see not if we've addressed the topic, but when was the last time we addressed this topic to make sure it's fresh."

It turns out SSP Team Projects are not just academic: "When I was an SSP student, our Team Project was called GEOWARN, a global emergency observation network," says Dr. Bukley, "It actually got funded for a couple of years: I think NASA put well over a million dollars into it," she says. According to Dr. Bukley, It was one of the first times a concerted effort was made to apply space assets to this problem, "Now it's routine: you have a forest fire and JPL provides data to the firefighters; there's a flood, you get remote sensing images to the people on the ground fairly rapidly now."

ISU Team Projects tend to be forward-looking: "It's fun to go back over the years and see that in many cases things are unfolding just the way we had predicted," says Dr. Bukley. Hopefully the symposium will prove to be just as effective. "I want all the people who come to leave with a greater understanding of the problem and motivation to actually go out and do something about it," Dr. Bukley concludes, "that would be a huge accomplishment."

*Angie Bukley, ISU Dean, Vice President for Academic Affairs and Director of the SSP. Credits: Shripathi Hadigal Rao*

# Close Calls on the ISS

by Megan Kane

*International Space Station. Credits: NASA*

In the past 11 years, the International Space Station has been approached many times by fragmented space debris. Sometimes debris have not come close enough to call for precautionary measures, like in November 2011, when the ISS was approached by pieces of the Fengyun 1C satellite, which was destroyed in China's 2007 anti-satellite test. However, five approaches have been deemed threatening and resulted in avoidance maneuvers. Two incidents required retreat of the crew into the Soyuz capsules.

**27 August 2008**
Avoidance maneuver due to fragment from Cosmos 2421 spacecraft.

**12 March 2009**
Retreat to Soyuz Capsules due to fragment of U.S. Delta 2 third stage.

**22 March 2009**
Avoidance maneuver due to fragment of a Chinese launch vehicle stage.

**18 July 2009**
Avoidance maneuver due to fragment of a Russian launch vehicle stage.

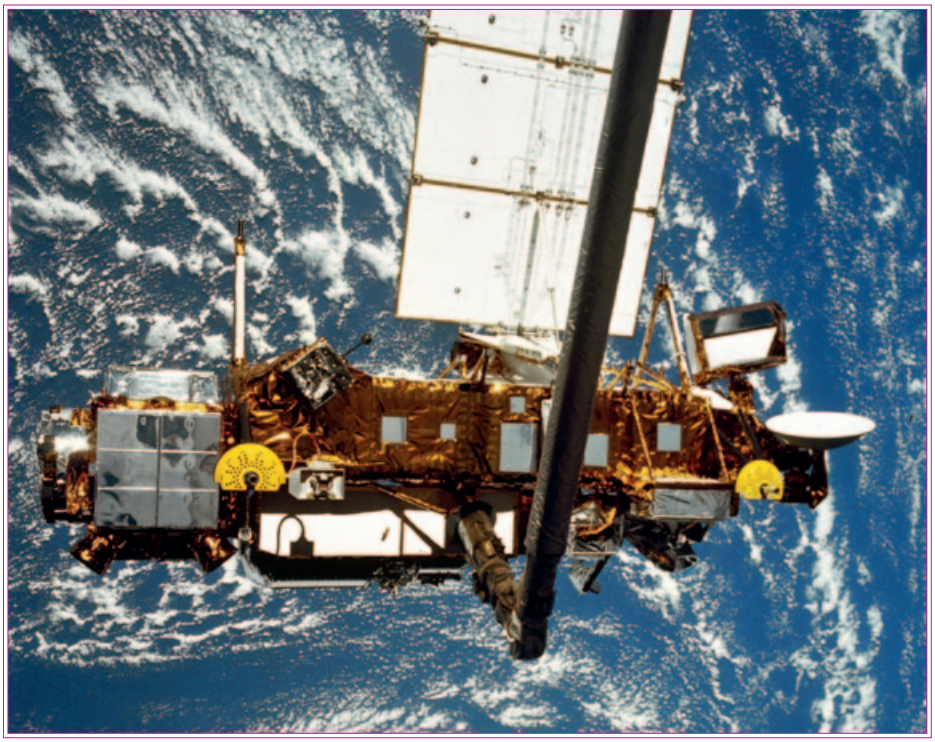
**26 October 2010**
Avoidance maneuver due to fragment of NASA's UARS spacecraft.

**2 April 2011**
Avoidance maneuver due to fragment of Cosmos 2251.

**28 June 2011**
Retreat to the Soyuz capsules from unidentified debris fragment.

By Michael Listner

# Revisiting the Liability Convention

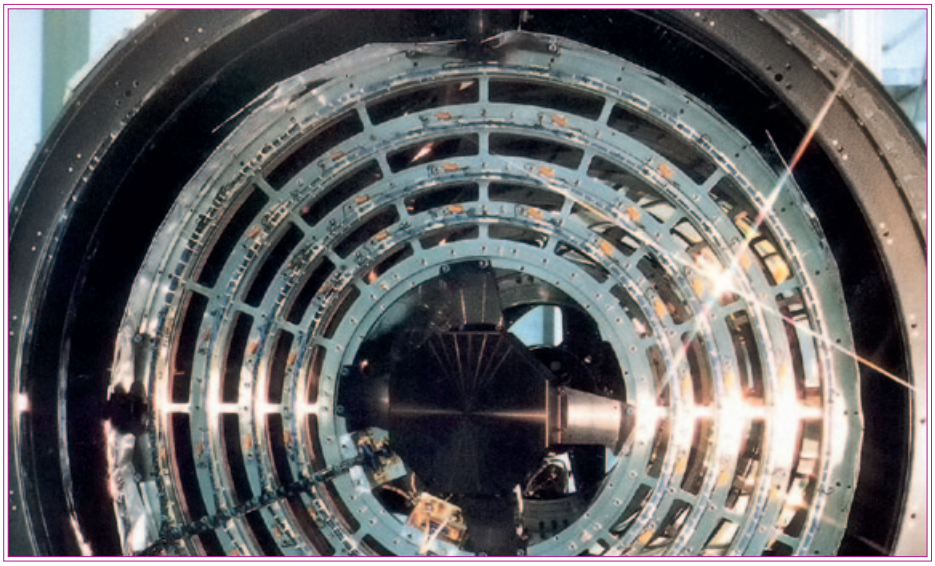


**The massive Upper Atmosphere Research Satellite (UARS), while being released from the Shuttle bay.** - Credits: NASA

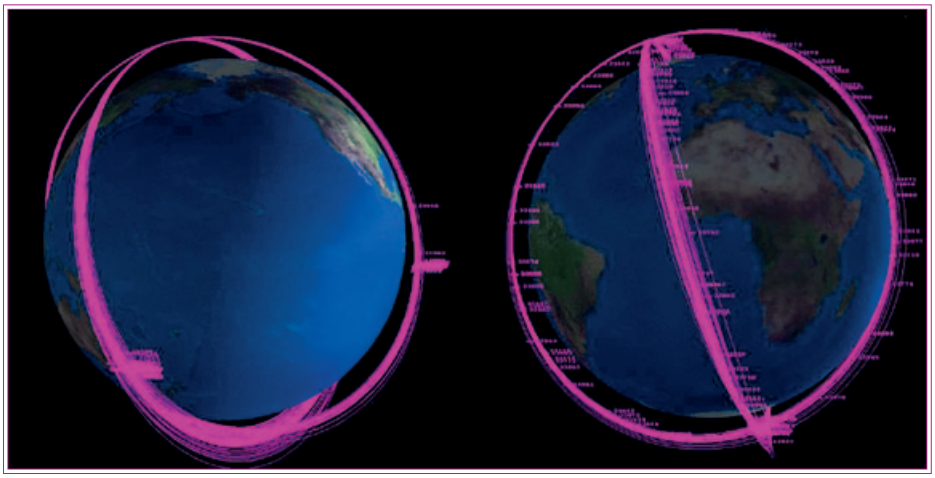
> "The year 2011 will be remembered for several events related with orbital space debris"

The year 2011 will be remembered, among other things, for several events related with orbital space debris. Notable events include several close encounters between the International Space Station (ISS) and orbital space debris, including the remnants of China's 2007 direct-ascent ASAT test. The ISS also had a close brush on July 11th with orbital fragments from the Soviet-era Cosmos 375, a satellite involved in a series of development tests that that led to the deployment of the Istrebitel anti-satellite system through the 1970s and early 1980s.[1] The incidents either did not pose a threat to the ISS, or allowed the time to maneuver the space station to prevent a collision.

Orbital space debris of another nature attracted wide public attention with the reentry of two research satellites within a month of each other. NASA's Upper Atmospheric Research Satellite (UARS) was the first to reenter the atmosphere on September 24th. Up to twenty-six pieces of the satellite were expected to survive reentry, with all of them likely finding a resting place in the Pacific Ocean. The second incident involved Germany's 2.4 tons Roentgen Satellite (ROSAT), which was a collaborative effort between Germany, the United States, and the United Kingdom. The German space agency DLR, was responsible for building the spacecraft, which was launched on June 1, 1990, by the United States on a Delta 6920-X rocket.[2] Thirty-large pieces from the research satellite, including a carbon-fiber composite telescope mount, were expected to survive reentry. ROSAT made an uncontrolled reentry on October 22nd, and the DLR determined that any surviving debris from the satellite fell into the Bay of Bengal.[3]



**The ROSAT system of mirrors, composed by four nesting Wolter mirrors with a focal length of 2.4 meters. Large fragments of this mirror have likely survived reentry.** Credits: MPE



**On the left, positions of the space debris 30 minutes after the Iridium-Cosmos collision; on the right, the debris cloud 10 days later.** - Credits: Jeffrey Lewis

# ROSAT and the Liability Convention

The Liability Convention of 1972 expands upon the principles of liability for damage caused by space objects established in Article VII of the Outer Space Treaty of 1967. It envisions two scenarios where damage might be caused by a space object: the first, which concerns damage to the surface of the earth or to an aircraft in flight; and the second scenario, when damage is someplace other than the surface of the earth, like another space object in orbit, outer space or another celestial body.

The first scenario covers the damage to the surface of the Earth or to an aircraft in flight caused by a space object. It applies a strict liability standard, where a State is held strictly liable for any damage caused by a space object even in the face of circumstances that are outside its control. Under this standard, if more than one State is responsible for the launch of the space object in question, then each one of those States will be held jointly and severally liable for any damage caused, which means that a claimant may pursue an obligation against any one party as if they were jointly liable.

**The ROSAT was equipped with two four-wire Position Sensitive Proportional Counters detectors (PSPC), which have likely survived reentry** - Credits: Max Plank Institute

# Damage to the Surface of the Earth or to an Aircraft in Flight and the First Scenario

The first scenario of the Liability Convention was brought into play by the Canadian government after the reentry and subsequent crash of the Cosmos 954 on January 24, 1978, in the northwest territory of Canada. Diplomatic efforts under the first scenario led to a settlement for the costs of the cleanup and the damages from the crash. If ROSAT's reentry had caused damage by either striking an aircraft or persons or property on the surface of the earth, the first scenario of the Liability Convention would have applied, making the launching State of ROSAT strictly liable. The Registry of Space Objects maintained by the United Nations Office of Outer Space Affairs in Vienna shows that ROSAT was registered per the Registration Convention with the Federal Republic of Germany, listed as the launching State.[4] When determining liability, the Liability Convention is the controlling legal authority, and its definition of "launching State" is used to determine the State or States responsible for a space object.

Article I(c) defines "launching State" as a State which launches or procures the launching of a space object, and/or a State from whose territory or facility a space object has been launched. Under the first test of "launching State", Germany, through its space agency DLR, meets the definition, since it was responsible for procuring and overseeing the launch by NASA and the United States. However, according to ROSAT's entry in the Registry of Space Objects, ROSAT was launched from Cape Canaveral, Florida, which is in the territory of the United States. This meets the second criteria of Article I(c)'s definition, and would have made the United States the launching State of ROSAT along with Germany. Therefore, both the United States and Germany would have been jointly and severally liable under the precepts of the Liability Convention for any damage that ROSAT's reentry might have caused.

# Space objects, orbital space debris and the second scenario

The second scenario of the Liability Convention envisions damage caused by space debris someplace ▸▸

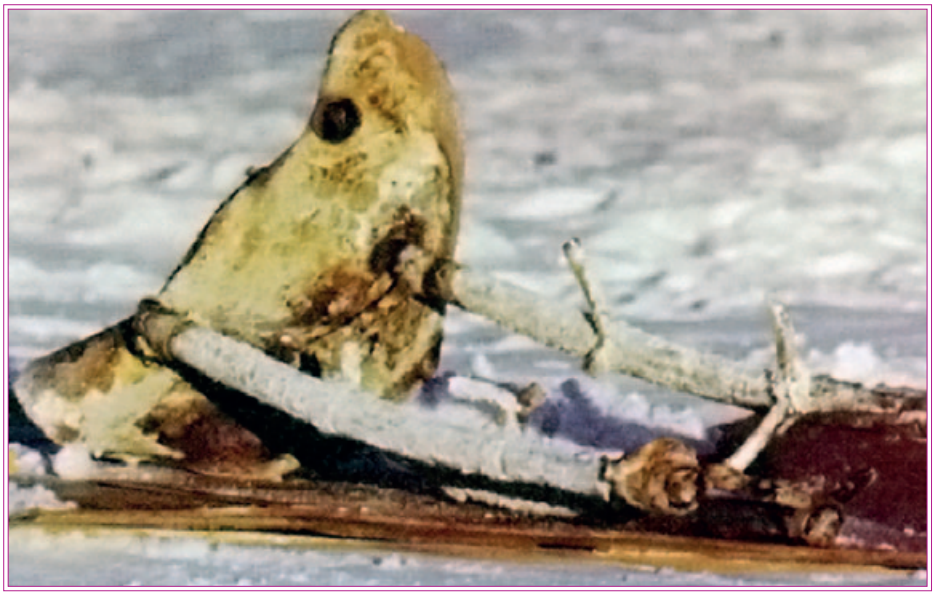
**ROSAT was launched on top of a McDonnell Douglas Delta II on June 1, 1990.** Credits: NASA

**Operation Morning Light cleaned up the radioactive debris of Cosmos 954 in 1978.**
Credits: Royal Canadian Air Force

other than the surface of the earth, like another space object in orbit, outer space or another celestial body. The standard of liability for the second scenario imposes liability only if it can be shown that the damage was due to the fault of the launching State. This theory of liability is similar to the maritime law standard of comparative fault. Under maritime law's comparative standard the percentage of fault and the subsequent liability is apportioned according to the negligence of each party involved to the aggregate liability. Once the percentage of fault for each party is determined, the total amount of damages for the incident will be determined. Each party will be apportioned its damages from the total established damages based on its percentage of fault. This standard of liability is tricky and contentious enough to apply in a maritime or terrestrial situation, but its application to incidents in outer space makes it even more so. The second scenario has never been applied, but the collision between Iridium 33 and Cosmos 2251 over Siberia of February 10, 2009, offered the potential for a case of first impression. No claim for compensation has been filed by the owners of the satellite Iridium LLC or its parent Motorola. If Iridium LLC chooses to pursue a claim, it would be required to demonstrate that the Russian Federation was at fault for the collision. To fully recover, it would also have to show that it was not negligent in its operation of Iridium 33; otherwise its recovery would be diminished by the percentage allocated to it. The circumstances surrounding the incident and the actions taken by the Russian Federation after the incident does not make that task easy. The Russian Federation was quick to point out after the incident that Cosmos 2251 was a derelict satellite incapable of maneuvering, and it correctly asserted that it did not have a legal obligation under international law to dispose of the satellite after it became derelict. It then directed fault for the incident on Iridium LLC's failure to maneuver Iridium 33, which allegedly had sufficient propellant, to avoid the collision. Iridium LLC countered that it did not have an obligation under international law to avoid the collision even if was aware that a collision was imminent. The conflicting information and finger-pointing between the two parties coupled with the lack substantive evidence about the actions of the parties leading up to the collision makes allotting fault complicated at best.

> "Fault would be easier to prove with a fragment from the FY-1C ASAT test striking a module of the ISS"

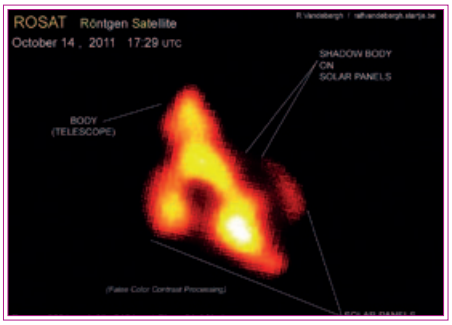
Fault under the second scenario would be easier to prove if the unthinkable occurred with a fragment from the FY-1C ASAT test striking a module of the ISS. Article I (d) of the Liability Convention defines "space object" as "...component parts of a space object as well as its launch vehicle and parts thereof." This means any part or module of a spacecraft or rocket body is considered a "space object" whether it was ejected from a spacecraft or created by an explosion or collision with other space objects. Accordingly, a space object can be as large as an intact satellite or as small as a fragment or screw.



**Radioactive fragment of Cosmos 954.** - Credits: National Resources Canada

**Artist's conception of an ATV reentering the atmosphere. The ATV is deorbited purposely and sunk into the ocean.** - Credits: D.Ducros / ESA

The launching State as defined by the Liability Convention is responsible for each space object created by explosions or collisions as well as additional space objects created by subsequent collisions. Since a launching State is responsible for its space objects, including those created by collisions or explosions, the launching State of the FY-1C fragment (space object) would be liable for any damage it caused. Evidence collected through tracking data and possession of the actual fragment would be significant to determine the identity of the launching State and apportioning fault.[5] However, the fault standard of the second scenario would require the launching State of the ISS module to show that it was not negligent either in maneuvering the ISS to avoid the collision or failing to perform a maneuver that might otherwise avoid a collision. A determination that negligence on the behalf of the launching State of the ISS module in question contributed to the incident would reduce the culpability of the launching State of the FY-1C fragment and any compensation it might owe for damages.




**False-color processing of a picture of the ROSAT satellite, captured with a telescope from the ground.** - Credits: Ralf Vandebergh

## Closing thoughts

As the proliferation of orbital space debris increases, the potential legal issues such as those surrounding UARS, ROSAT, FY-1C, and Iridium/Cosmos will increase as well. The Liability Convention is a well-intentioned document and along with its related space law treaties that make up the body of international space law, forms a necessary backbone for the jurisprudence of outer space.

The current body of international space law, including the Liability Convention, is being overrun by the complexities of international commerce, and particularly the issue of orbital space debris. Proposals for multilateral treaties to supplement the current body of international space law meant to address the issue of orbital space debris beyond the scope of the Liability Convention will be met by the same challenges of interpretation and enforceability that the current treaties face. The key to the success of any future agreements rests in addressing the deficiencies, and reinforcing the veracity of the current body of international space law. Only with that solid foundation to build upon will future proposals be able to address the current problems presented by orbital space debris.

> "The current body of international space law is being overrun by the complexities of international commerce"

## Michael Listner

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(1) See Michael Listner, "*Orbital space debris from Soviet ASAT could collide with ISS*" and "*Soviet ASAT orbital space debris will not threaten ISS*", Examiner.com, July 11, 2011.

(2) Mark Wade, *ROSAT*, Encyclopedia Astronautica.

(3) Nancy Atkinson, "*ROSAT's crash site determined*", Universe Today, October 25, 2011.

(4) *Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space*, ST/SG/SER.E/396, September 14, 2001, p.2.

(5) Under the International Space Station Agreement (IGA), each participating nation retains jurisdiction over the modules it provides to make up the ISS, and each nation reserves the right to pursue individual claims under the Liability Convention.

by Gary Michael Church

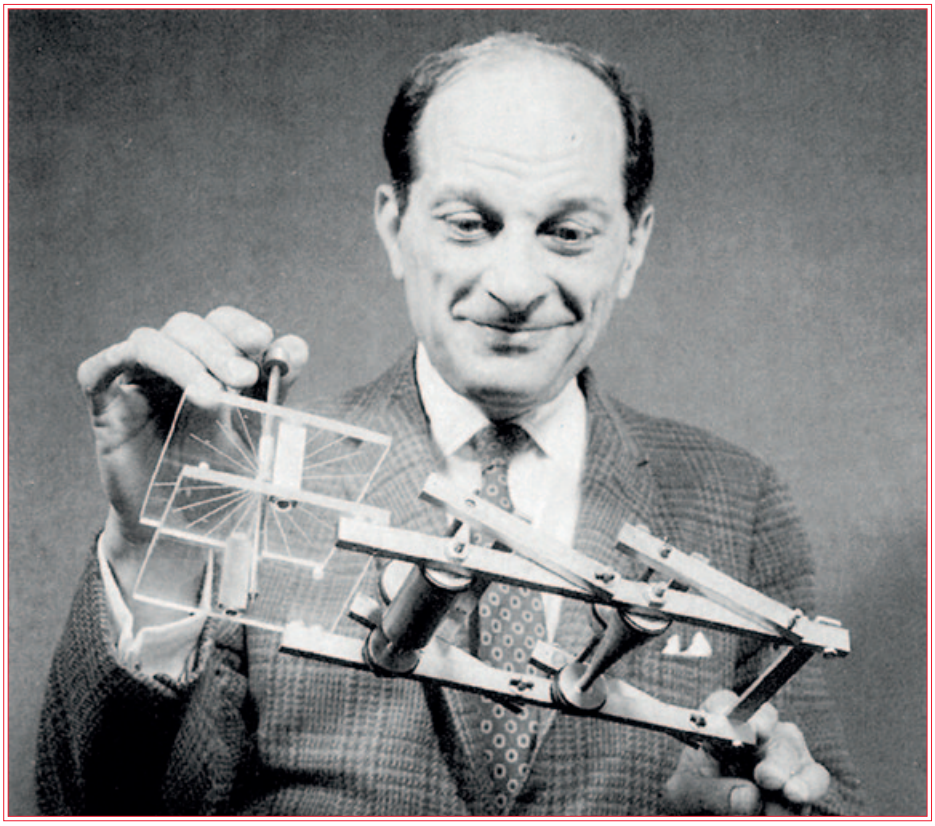
# Water and Bombs

> "Nuclear energy is to the space age as steam was to the industrial age"

Studying the space age, future historians may agree on the significance of a date not generally associated with space flight. July 16th, 1945, was Trinity, the first nuclear weapon test. Stanislaw Ulam, a 36-year-old mathematician who helped build "the gadget" visited ground zero after the test. Ulam later conceived the idea of propelling a spaceship with atomic bombs.

When considering nuclear propulsion, it must be understood that space is not an ocean, even though it's often characterized as one. The distances and conditions are not comparable. Fossil fuels, burned and transformed by steam into mechanical work, would radically change the world in the span of a century and enable the industrial revolution. What is difficult for moderns to understand is not only how limited human capabilities were before steam, but how limited they are now in terms of space travel. Chemical propulsion is incapable of taking human beings to the outer solar system and back within the crew limits of a few years. The solution is a reaction one million times more powerful. Nuclear energy is to the space age as steam was to the industrial age.

Space is not an ocean, and this was the correct lesson drawn by Stanislaw Ulam. While metal can barely contain and harness chemical energy, Ulam thought outside that box by accepting that nuclear energy could never be contained efficiently by any materiall. However, nuclear energy could be harnessed to push a spaceship in separate events to the fantastic velocities required for interplanetary travel, without any containment problems at all, by using bombs.



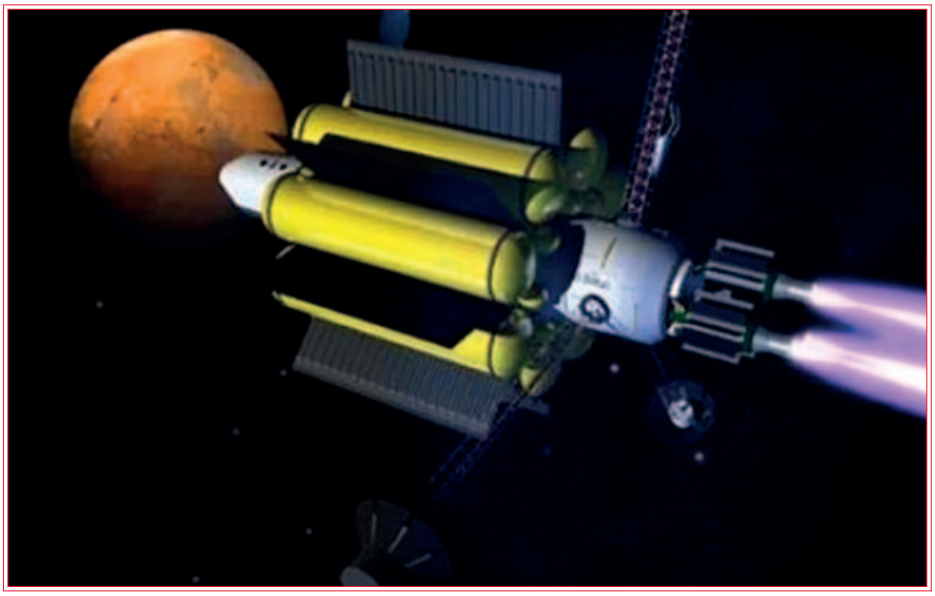
**Stanislaw Ulam, the nuclear scientist who first had the idea of nuclear bomb propulsion.**
Credits: Universidad de Guadalajara

After a half century, atomic bomb propulsion still has no competition as the only available propulsion system for practical interplanetary travel. This fact is almost completely unknown to the public. Physicist Freeman Dyson and weapon designer Ted Taylor on the top-secret project Orion did the first serious work on bomb propulsion. The "unclassified" state of the art in nuclear weapons can direct 80 percent of bomb energy into a slab of propellant, converting this mass into a jet of superheated plasma. A pusher plate would absorb this blast without melting for the fraction of a second it lasts and accelerate the spaceship in steps with each bomb. Perhaps the closest experience to riding in an atomic bomb propelled spaceship would be a set of repeated aircraft carrier catapult launches.

## Space as a Nuclear Industry

In "The Most Powerful Idea in the World: A Story of Steam, Industry, and Invention", author William Rosen theorizes that English patent law was the key enabler of the industrial age by allowing inventors to retain and profit from their intellectual property. In the space age, fears of weaponizing space have had the opposite effect. Ironically, the nuclear industry is not safe on Earth, but deep space seems designed for it.

The space industry is *ipso facto* a nuclear industry. All astronauts are radiation workers. The presence of a small percentage of highly damaging and deeply penetrating particles - the heavy nuclei component of galactic cosmic rays - makes a super pow-



**Artist's conception of a deep space spaceship, using water tanks as radiation shielding.** Credits: NASA

erful propulsion system mandatory.

The great mass of shielding needed renders chemical engines, nuclear thermal, and the low thrust forms of electrical propulsion essentially worthless for human deep space flight. Bomb propulsion is left as the only "off the shelf" viable means of propulsion.

For the foreseeable future, high thrust and high specific impulse to propel heavy shielding to the required velocities is only possible using bombs. The most useful and available form of radiation shielding is water. While space may not be an ocean, it appears human beings will have to take some of the ocean with them to survive.

In the March 2006 issue of Scientific American magazine, Dr. Eugene Parker explained in simple terms survivable deep space travel. In "Shielding Space Travelers", Parker states, "cosmic rays pose irreducible risks." The premise of this statement is revealed when the only guaranteed solution to reducing the risk, a shield massing hundreds of tons, is deemed impractical. Active magnetic shields and other schemes are likewise of no use because while they may stop most radiation, the only effective barrier to heavy nuclei is mass and distance. The impracticality of a massive shield is due to first the expense of lifting hundreds of tons of shielding into space from Earth, and secondly propelling this mass around the solar system. Propelling this mass is not a problem if using atomic bombs; however, another problem arises. There is still the need to escape Earth's gravitational field with all that shielding.

> "The nuclear industry is not safe on Earth, but deep space seems designed for it"

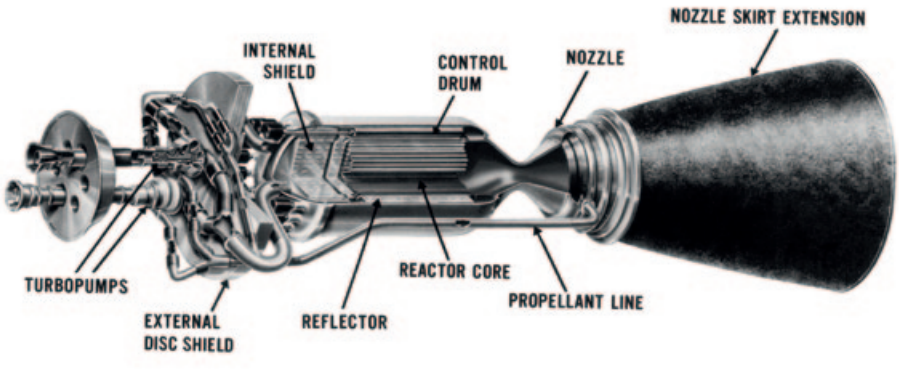
## Water on the Moon

Bomb propulsion is ideal for deep space but cannot be used in Earth orbit due to the Earth's magnetic field trapping radioactive fallout that eventually enters the atmosphere. Not only lifting the shielding into orbit but chemically boosting it to a higher escape velocity away from the Earth is thus doubly problematic.

The situation changed in March 2010, when NASA reported Mini-SAR radar aboard the Chandrayaan-1 lunar space probe had detected what appeared to be ice deposits at the lunar North Pole, an estimated 600 million tons of ice in sheets a couple meters thick. Moon water would allow a spaceship in lunar orbit to fill an outer hull with the 500+ tons of water required to effectively shield a capsule from heavy nuclei. This would enable an empty spaceship to "travel light" to the Moon and then boost out of lunar orbit using atomic bomb propulsion with a full radiation shield. Parker's guaranteed but impractical solution had suddenly become practical. Fourteen feet of water almost equals the protection of the Earth's air column, and this would protect astronauts from all forms of space radiation. With water and bombs, epic missions of exploration to the asteroid belt and outer planets are entirely possible.

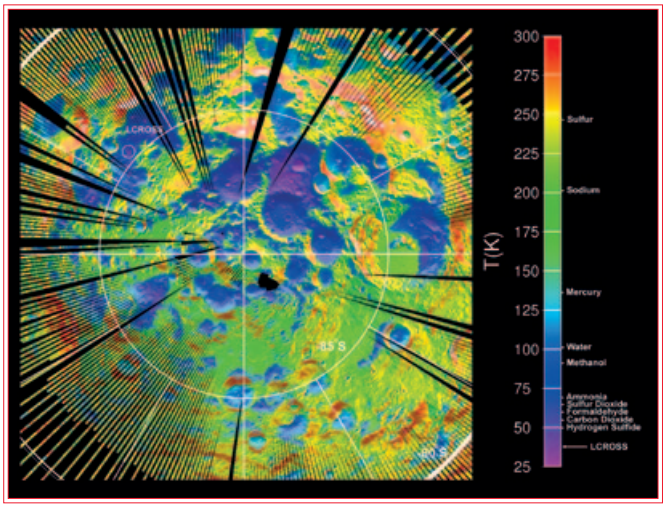
## Artificial Gravity

There are other challenges to long duration beyond earth orbit human space flight, but the solutions have been known for many decades. Zero gravity debilitation causes astronauts to weaken and permanently lose bone and bone marrow mass. The most practical solution, theorized since the early 1930's, was investigated in 1966 during the Gemini 11 mission. A 100-foot tether experiment with the capsule attached to an Agena booster was successful in generating a small ▸▸




**The Nuclear Engine for Rocket Vehicle Application (NERVA), which was successfully tested in the late '60s, demonstrated that nuclear rockets could be feasible and reliable tools for deep space exploration.** - Credits: NASA

> "With water and bombs, epic missions to the asteroid belt and outer planets are possible"




**A surface temperature map of the lunar south pole, showing several intensely cold impact craters that could trap water ice and other icy compounds commonly observed in comets.**
Credits: NASA

amount of artificial gravity by spinning the two vehicles. Equal masses on the ends of a tether can efficiently generate centrifugal force equal to 1G. The concept is to "split the ship" when not maneuvering under power, so the 500+ tons of shielded capsule is on one end and the rest of the craft of equal mass is reeled out on the other end of a thousand foot or more tether. Looking out through 14 feet of water, the crew of such a spaceship would view a slowly rotating star field.

Equipment to enable a closed cycle life support system, providing years of air and water, is now available in the form of plasma reformers and facilitated by tons of water in which to grow algae or genetically modified organisms. With Earth radiation, Earth gravity, and air and water endlessly purified on board, crews can push their psychological limits as far out into the solar system as the speed of their atomic spaceships allow.

## A Problem of Funding

As of 2011, there are zero prospects for funding a long duration beyond earth orbit mission. Using atomic bombs to propel spaceships around the solar system would cost as much as several major U.S. Department of Defense projects combined. However, there is a completely valid military mission for atomic bomb propelled spaceships. Planetary protection became an issue in 1980, when the Chicxulub impact crater in Mexico was assigned blame for the mass extinction of the dinosaurs.

The human race needs to be protected, but not only from random impacts that could strike the Earth at any time. In April of 2010 physicist Stephen Hawking warned of alien civilizations posing a threat to humanity. Comets purposely crashed into a planet to wipe out the majority of indigenous life and prepare for the introduction of invasive alien species may be a common occurrence in the galaxy. Before readers scoff, they might consider towers brought down by jetliners, the discovery of millions of planets, and other recent unlikely events.

At this time self-defense is the only valid reason to go into space. Protecting our species from extinction is the ultimate moral high ground above all other calls on public funds. President Ronald Reagan in his 1983 Star Wars speech said, "I call upon the scientific community who gave us nuclear weapons to turn their great talents to the cause of mankind and world peace." The best insurance for our species is to establish, in concert with a spaceship fleet, several independent self-supporting off world colonies in the outer solar system. The first such colony would mark the beginning of a new age.

*Views and opinions expressed in this article are those of the author, and do not reflect necessarily those of IAASS and ISSF, publishers of the Space Safety Magazine.*

**References:**
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**Artist's conception of a nuclear pulse powered spacecraft.**
Credits: Rhys Taylor - www.rhysy.net

By Maite Trujillo

# Suborbital Safety: A new IAASS Technical Committee

**SpaceportSEA (Spaceport at South East Asia), the new facility for commercial suborbital spaceflight that will be built in Malaysia.**
Souce: SpaceportSEA

In May 2011, a new IAASS "Suborbital Safety" technical committee was created to contribute to the advancement on the field by addressing the technical and regulatory challenges of the emerging suborbital spaceflight industry. This technical committee is chaired by Andy Quinn and Maite Trujillo, active contributors to the field, and it is formed by experts and vounteers working in Government organizations, Industry and Academia around the world.

## The Suborbital Space Race

The suborbital industry is showing real progress in terms of development and there are many companies competing in the race to achieve suborbital experimental flights and subsequent commercial operations. Companies involved in the suborbital domain have experienced many challenges in their endeavours to win this new "space race", ranging from difficulties with obtaining investment, problems with technical solutions and with regulatory issues. We can only judge the progress of some of the leading suborbital companies by the milestones they have achieved, whether in winning business contracts or to actual test flights.

Armadillo Aerospace appears to be progressing well and they are one of three companies using a vertical take-off/vertical landing approach. Armadillo Aerospace will operate in the United States under the FAA-AST Launch License approach. Masten Aerospace and Blue Origin also are developing VTVL systems. All three are designed for autonomous operation with a ground-based vehicle operator as a back-up. EADS-Astrium is developing their suborbital aircraft (SoA) under an EASA certification approach and intends to operate from Singapore for its initial operations. This aircraft-style of space-plane is one of the reasons for forming the technical committee; because it requires novel approaches in determining safety criteria and licensing or certification. Another space-plane model is the Spacelinq in the Netherlands. Both of these SoA have jet turbine engines for normal take-off and powered landing and a rocket propulsion system for the suborbital part of the flight.

The progress of Virgin Galactic has been well documented, as they continue with their SpaceShipTwo test schedule, having undertaken a 'drop-test' from the Mother-ship WhiteKnightTwo with successful deploy of the 'feathered' configuration. The SpaceShipTwo rocket has not been air-tested as of yet. Finally, XCOR moves on with the development of their Lynx vehicle, which carries one passenger and one pilot, powered by the Reusable Launch Vehicle (RLV) from the Spaceport's runway all the way up to the engine cut-off altitude of about 40 to 50 km, with the common ballistic microgravity coast to apogee and back through re-entry. The variety of approaches is what makes this industry so exciting, while at the same time requiring the formulation of proper guidelines and best practices.

# Suborbital Technical Committee: Purpose and Goals

The purpose of the new Suborbital Safety Technical Committee is to focus on the emerging technical issues as the industry develops towards regular suborbital operations. The goal is to contribute to the development of suborbital industry guidelines and best-practices towards a global harmonization on the various challenges facing the industry today. The technical issues that will be addressed cover definition and harmonization of safety criteria and possible certification approaches, as well as providing guidance on system safety engineering practices from design to operations. Crew and passenger health & safety considerations as well as spaceport planning and operations are also within the scope of the terms of reference of this technical committee.

# New Commercial Spaceports

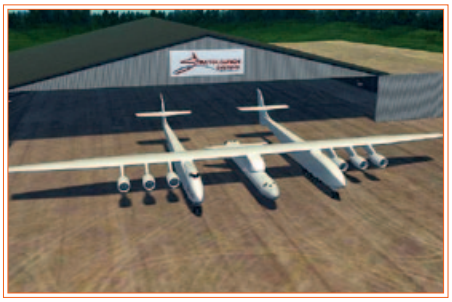
New commercial spaceports are being developed, either by extending existing airports with extra facilities and certifications, or by developing totally new infrastructures similar to airport, with runways and terminals to support passengers and other commercial payloads including scientific experiments. The two major and most known spaceports being developed are Spaceport America and Mohave Air and Space Port in the USA. Other spaceports outside the USA include Caribbean Spaceport on Curacao Island, Spaceport SEA in Malaysia, plus some proposal for Sweden and the UAE.

The emergence of these new commercial spaceports at multiple locations around the world creates the needs of a global air and space traffic management and spaceport safety standards, and explains the significant roles the IAASS suborbital safety technical committee can play.

# Technical Committee Members

The TC members have been selected from within the industry or are interested in working in the industry. The TC aims to harness member's expertise on suborbital-specific issues to be able to provide best practice and guidelines based on appropriate and rationalised methods. The SSTC will learn from lessons in the sister orbital domain and also engage with other orbital-based committees when appropriate.

**For further information:**
**Andy Quinn (andy.quinn@iaass.org) or**
**Maite Trujillo (maite.trujillo@iaass.org)**



**Artist's conception of the new Stratolaunch air-launch system.**
Credits: Scaled Composites

# Stratolaunch Announces Air-Launch System

Paul Allen announced on December 13 that he would develop a revolutionary aircraft-launched space transportation system consisting of 3 main components: a carrier aircraft, designed by Scaled Composites; a multi-stage booster, designed by SpaceX, carrying a 6-ton payload; and a mating and integration system, developed by Dynetics, which will define the interface between aircraft. If successful, the Stratolaunch system would allow for reduced cost and increased reliability and safety for missions to low earth orbit.

Read the full story:
**http://bit.ly/stratolaunch**

# Shenzhou-8 Completes Docking Mission

The reentry module of China's unmanned Shenzhou-8 capsule returned to Earth on November 17. Launched November 1st atop a Long March 2F rocket, Shenzhou-8's primary mission was to perform China's first ever on-orbit rendezvous by docking to the Chinese Tiangong-1 space station. The completion of the unmanned docking test flight represents an important step in the Chinese manned space program, which aims to establish a manned space station by 2020. Shenzhou-8 carried SIMBOX, an incubator of 25 Kg with nearly 40 biology experiment units, developed by a European consortium lead by German Space Agency DLR.

Read the full story:
**http://bit.ly/shenzhou_8**

# Space Debris Makes it to Hollywood

After countless scientific studies and governmental proposals on how to handle the intensifying problem, the issue of space debris is making its way to the Silver Screen. Director Alfonso Cuaron is currently editing the movie Gravity, which features Sandra Bullock and George Clooney as two surviving astronauts trapped inside the remote space station is damaged after a collision with a piece of space junk. The movie is expected to be released the next November, and is already considered one of the most anticipated events in the cinema industry for next year. According to insiders, instead of focusing on action, the movie will explore the boundaries of space psychology, human consciousness and modern "weird physics" discoveries about space and time.

Read the full story:
**http://bit.ly/gravity_movie**

# First Ever Graduate Course in Space Safety Announced

The University Of Southern California Viterbi School Of Engineering has announced the first ever graduate-level course in space safety. Entitled Safety of Space Systems and Space Missions, the course is designed to teach engineers and program managers how to design systems that will meet human rating certification standards. It will focus on systems engineering of human spaceflight craft, building on real-life experience from the past 50 years in space. Michael Kezirian, a safety engineer with The Boeing Company and Fellow Member of IAASS, is to teach the course. The textbook used will be Safety Design for Space Systems, sponsored by IAASS and published by Butterworth-Heineman, edited by Gary Eugene Musgrave, Axel (Skip) M. Larsen, and Tommaso Sgobba.

Read the full story:
**http://bit.ly/graduate_course**

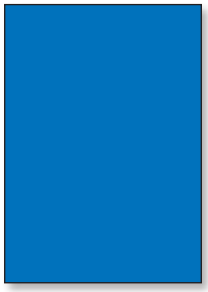
# Boris Chertok Dies at 99

Boris Chertok, a Russian rocket engineer who played a pivotal role in designing navigation and control systems for the Soviet space program, including the rocket that launched the first ever artificial satellite into orbit, died in Moscow on Wednesday of pneumonia. He was 99. "It's difficult to think of any major event in the Soviet space program that he didn't contribute to," said Asif Siddiqi, a history professor at Fordham University. Chertok's contributions to the Soviet space program first culminated in the launch of the R-7, the world's first Intercontinental Ballistic Missile (ICBM) in 1957. A modified R-7 was also used to launch Sputnik-1, the first artificial satellite to orbit the Earth. Chertok held his post for more than 20 years, and served as the primary designer of control systems for Vostok, Voskhod, and the hugely successful Soyuz vehicle.

Read the full story:
**http://bit.ly/boris_chertok**

**Artist's impression of the Shenzhou-8 - Tiangong-1 complex.**
Credits: Junior Miranda www.astronautix.com

# Advertising Placement



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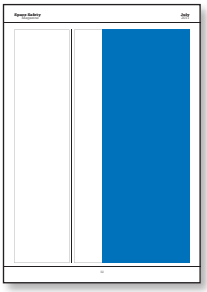

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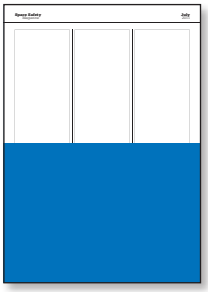

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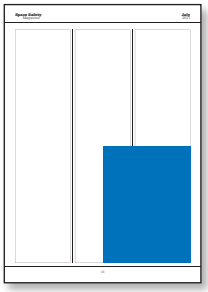

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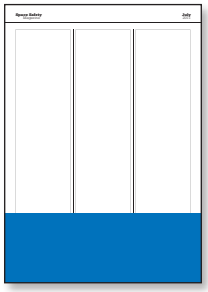

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**ADVERTISING**

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# A new Portable Power Supply for Columbus

KAYSER ITALIA is a Small Medium Enterprise (SME), a private independent aerospace system engineering company, owned by Dr. Valfredo Zolesi's family, incorporated in 1986. In a modern building, the company has 5,000 sq. meters of property, organized into offices, meeting rooms, conference room, laboratories, clean room, manufacturing, inspection and integration area, and an User Support Operation center (USOC) for the support to the execution of experiments with astronauts on board the ISS. Since the beginning up to 2010, KAYSER ITALIA has participated to 50 space missions with 79 payloads. all of them completed with full scientific, technical, economic and programmatic success.

The staff consists of 40 high specialized engineers, with expertise in electronics, aeronautics, mechanics, thermodynamics, physics, computer science, optics and molecular biology. Their design and manufacturing capabilities, joined with a deep engineering background, have allowed the participation of the company both as prime-contractor as well as sub-contractor to many European Space Agency (ESA) and Italian Space Agency (ASI) programmes, especially in the area of life science (biology and human physiology). The payloads developed by KAYSER ITALIA have been flown on the Russian capsules Bion, Foton, Progress, Soyuz, on the Shuttle Transportation System (STS), on the Japanese HTV module, on the European ATV module, on the Chinese Shenzhou-8, and on the International Space Station (ISS).

The company is certified ISO 9001, and the personnel is qualified for manufacturing of electronic circuits and harness, and for their inspection, in accordance with ESA standards.





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