50 years ago Man reached the stars

April 12th is a key day in the history of space exploration: in 1961 Yuri Gagarin was the first man in space, and in 1981, John Young and Robert Crippen entered orbit in the first re-usable space craft. In this article we will remember both events, with particular attention to the achievement of the Russian cosmonaut.

The modern space age began in 1957, when, on 4th October, the Soviet Union announced, via Radio Moscow, that they had launched the first artificial satellite into orbit; Sputnik-1. The event was reported to the international scientific community, that, shortly before, had proposed to the more technologically advanced Countries, the launch of an artificial satellite, to commemorate the International Year of Geophysics (1st July 1957 - 31 December 1958). Both the United States and Soviet Union made efforts to meet the challenge, but it was the USSR that eventually took everyone by surprise.

12th April 1961 launch of Vostok-1 with Yuri Gagarin onboard.

The initial public worry that such a satellite, equipped with an explosive warhead, could have struck any part of the Earth's surface, soon transformed into the expectation that it would not be long before a human being would go beyond the terrestrial atmosphere to reach space.

Before that could happen it was necessary to gain experience with launches, the determination of vehicular orbits, communication systems and also methods of re-entry and recovery. Nothing could be left to chance if a human life was at stake.

The first step was to send a living thing into space to see if it could survive the stress of the launch, the large accelerations and decelerations and weightlessness. The Soviet technicians therefore designed a capsule capable of holding a dog. The first attempt was with Sputnik-2 carrying the dog Laika, that, however, died after just three orbits due to irregular heart beat induced by the stress of the launch, and overheating of the capsule due to a malfunctioning heat regulator.

In any case, there was no recovery plan for Sputnik-2, so Laika's fate was sealed from launch.

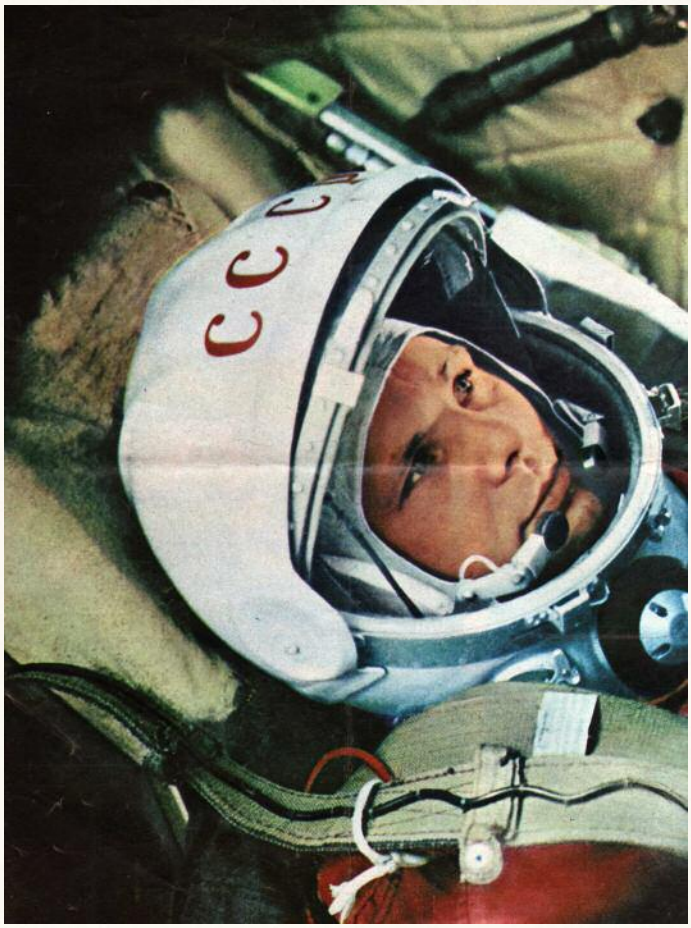
The story of Laika caused a certain amount of public outrage, and in the end technicians were pushed into designing methods of recovery for those test animals that would come after Laika. In fact, many dogs, tortoises and other animals were launched into orbit, and apart from a few accidents, almost all were returned safely to Earth.

At the same time as these test flights, a vehicle able to carry a man into space was being developed, and four years of experimentation and flights with animals and mannequins passed before the first step towards the stars was eventually made.

Yuri Alexeyevich Gagarin

On March 9th 1934, Alexei Ivanovich Gagarin and Anna Timofeyevna gave birth to Yuri, the third of four children (Valentin, Zoya and the younger Boris). His parents worked in the kolchoz (an agricultural cooperative of the time) in Klushino near the city of Gzhatsk in Smolensk. The second world war and the presence of the German forces impacted on family life, first under the Nazi sword but later freed by the advance of the red army. The father and two older brothers, after the liberation of Klushino served in the Soviet armed forces. In this period Yuri witnessed two heroic acts by Soviet pilots that were

fighting the Germans: a LaGG which crashed to the ground while its pilot ejected and parachuted to the ground, and a Yak, which, after taking hits on its wings, managed to land in a field near their house.
When the medal-covered pilot stepped out of the cockpit Yuri was extremely impressed. As he remarked later, *"Us youngsters understood immediately the price that was to be payed for those military decorations. We wanted to become fearless pilots. We had a feeling like nothing we had felt before"*.
Gagarin completed six grades at secondary school, where he showed a particular passion for mathematics and physics. He then went to a technical school to learn how to work in a foundry. At the same time he read of the works of Konstantin Tsiolkovsky, pioneer of Russian astronautics.
After a year and a half of study at the technical school he transferred to Saratov to begin four years of technical training, and during the last year was able to join a flying club. Here he began to realise his dream of becoming a pilot. -



Yuri Gagarin photographed inside Vostok-1. [Epoca-Novosti]

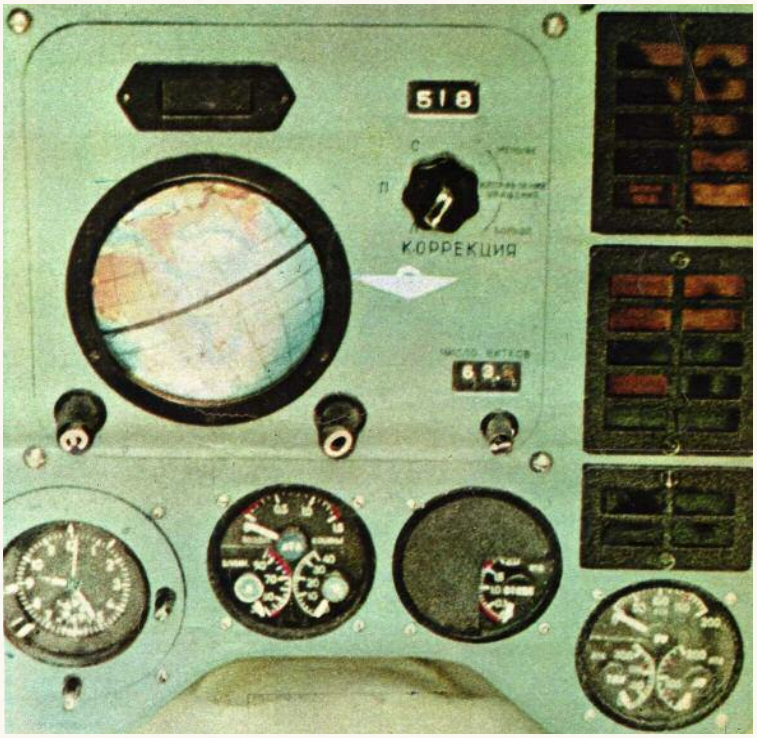
Yuri made his first solo flight in 1955. He was often praised for his skills as a pilot, particularly for his soft landings. *"He will be an excellent pilot"*, his instructor and mentor, Dmitri Pavlovich Martyanov, said. At the same time he trained with parachute jumps, a skill that would later be useful during his cosmonaut training.
On the suggestion of Martyanov, Gagarin signed up to the Soviet air force at the Orenburg flying school, where he learned to fly MiGs.
Here he met Valentina (Valya) Ivanovna Goryacheva, a pretty girl he married in November 1957, the same day he was awarded, with all honours, his military pilot's license as a lieutenant of the Soviet Air Force.
As later said by the leader of the Russian cosmonauts, Karpov, *"Yuri felt calm, sure of himself, happy and optimistic. Valya is marvelous! She helps Yuri in any situation and shows an extraordinary mix of self-control and courage; a perfect astronaut's wife"*.
His first assignment was at an arctic

Photo taken during one of the training phases during which the reactions of the cosmonaut were measured. [Epoca-Novosti]

base, and during his first flight Gagarin watched a beautiful display of the aurora borealis. His training and flying ability allowed him to become, almost straight away, a test pilot.
While he was stationed at the base, the Soviet Union launched Luna-3, the first probe to circle the Moon and photograph the dark side.
The planned first flight of a human being was approaching, and Gagarin decided to apply to be a cosmonaut.
Obviously the application was welcomed, and he was soon put through a series of careful medical tests, including psychological tests and evaluation of his resistance to stress.
Thereafter, the process turned to the evaluation of the reaction of the human body to the conditions encountered in space. After this long process of selection his name was inserted into the list of pilots chosen to become cosmonauts.
On the day of his twenty-sixth birthday Gagarin returned home and announced to his wife that he would have to prepare for space flight, and that they would have to transfer to Zvyozdny Gorodok (Star City), the complex built just outside Moscow for the training of cosmonauts.
During this period of training the doctors would say, *"Your limit is not the stratosphere!"*. Always resolute in any critical situation, he never lost his sense of humour. During his free time he did various sports, such as swimming, fishing and hunting, and he loved to be in the company of good friends.
His family, nonetheless, were always in his thoughts during training. In fact, during one of the first tests of weightlessness involving the manipulation of objects, he said, *"Here I am, a fully grown man and future cosmonaut playing with a golden sphere and a bottle of drinking water. If only my little girl (his first child Lenotchka) could see her father with these toys...!"*.
During physical training, Gagarin experienced an acceleration of 13g in the centrifuge, and as part of the psychological training, spent 24 hours in a room with no light or sound. Instructors described him as a man who could provide useful suggestions, always sure of his own capabilities, so much so that it was difficult if not impossible to put him

Food packages used during the Vostok missions. [Epoca-Novosti]

in difficulty, and also gifted with a very lucid mind and fast reactions.
When rumours of the first launch began to circulate and his name was ever more associated with the subject, one night his wife Valya asked him, full of worry and anxiety, *"Why you?"*.
She understood perfectly what it could mean, but accepted the situation, something that can be considered an act of heroism for a mother of two young girls. The following morning, courageous and decisive as ever, she said, *"If you're sure of yourself, go! Everything will be fine!"*.



The cockpit of Vostok. The globe shows the point over which the capsule is passing; the knob at the top was used to control the trim of the capsule; the counter immediately above shows the number of revolutions made. The dials at the bottom show, from left to right, the time, altitude, speed and external temperature. Under the clock to the left there was a camera that filmed the cosmonaut for the entire duration of the flight. [Epoca-Novosti]

Galotchka, his second girl, was born at the start of 1961, and on his last day at home before the historic flight (while his wife was out shopping) he had to change her nappy.
Gagarin later told how while he was changing the nappy he was playing with her, and said ironically, *"What an inconsiderate little girl, her father is about to go into space and she dirties her nappy!"*.
These glimpses of family life show what a sociable and lovable man Gagarin was as a father and husband, a role he played with the same determination and responsibility that he showed during the various phases of pilot and cosmonaut training. This character made him popular among his training colleagues, doctors and the officials involved in the technical training of the candidate cosmonauts and the selection of the final name.
At the end of the selection process, a special group of 20 people were selected, subsequently reduced to 6, that Sergei Korolev, head of the Soviet space program, liked to call, "Young Eagles".

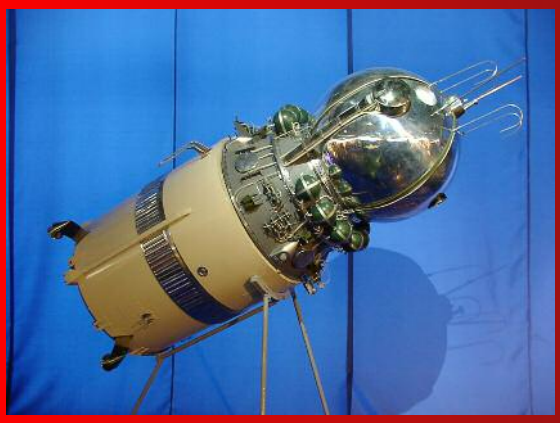
The flight that changed history

The official announcement of the name of the cosmonaut chosen to make the first manned flight into space was made on 11 April 1961, one day before the launch. The announcement was clearly at the level of the officials in charge of the space program, rather than at an international level.
Gagarin was informed privately a couple of days earlier, on 9th April.
The evening before the launch Gagarin left in a flight from Star City to Tyuratam-Baykonour, from where the historic leap towards space was to be made. He was calm, the two little girls were already in bed, the sky was clear after light rain and the stars shone. It almost seemed as though the night expected something special.
Korolev, head of the Soviet space program, and the man who chose the

name of the first cosmonaut, was very impressed by Gagarin; saying, *"During the days of preparation before launch, when anyone would have been anxious and stressed for what was about to happen, he just stayed calm, full of spirit and radiant like the Sun"*.
During an interview released just before the flight, Gagarin, in response to the question, *"Are you happy to go into space?"*, replied, *"Sure! Throughout history, every time that Man has embarked on a journey of discovery he has always been happy"*. On 12th April, at 9:07 Moscow time, Yuri Alexeyevich Gagarin (code name for communications: Kedr) was launched aboard the Vostok-1 capsule (Vostok means "orient"). Radio Moscow immediately broadcast the news: *"Today, 12th April, saw the first flight into space of a craft carrying a man. The astronaut is major Yuri Gagarin"*.
Other announcements followed in which the capsule was described, as well as the orbit and the physical conditions of the astronaut. Throughout the world feelings of awe and admiration spread for the man that had dared to go beyond the confines of the Earth and enter the so-called "fourth environment": space.

Photo of the control centre, with the image of Gagarin that was transmitted constantly during the flight. [Epoca-Novosti]

After 108 minutes, including the phases of launch and re-entry, Gagarin returned to Earth. He spent 89 minutes and 34 seconds in orbit (one complete orbit), with a maximum distance from the surface of 327 km and a maximum velocity of 28,260 km/h.
During the flight, Gagarin never took control of the spacecraft because there were uncertainties about how well the human mind and body would work in conditions of prolonged weightlessness. The Soviet technicians and scientists didn't want to run the risk of the cosmonaut losing control while in space, thus risking a successful end to the mission. In any case there was a key-protected system that would allow manual control by the cosmonaut in case of emergency.
Vostok was equipped with food and

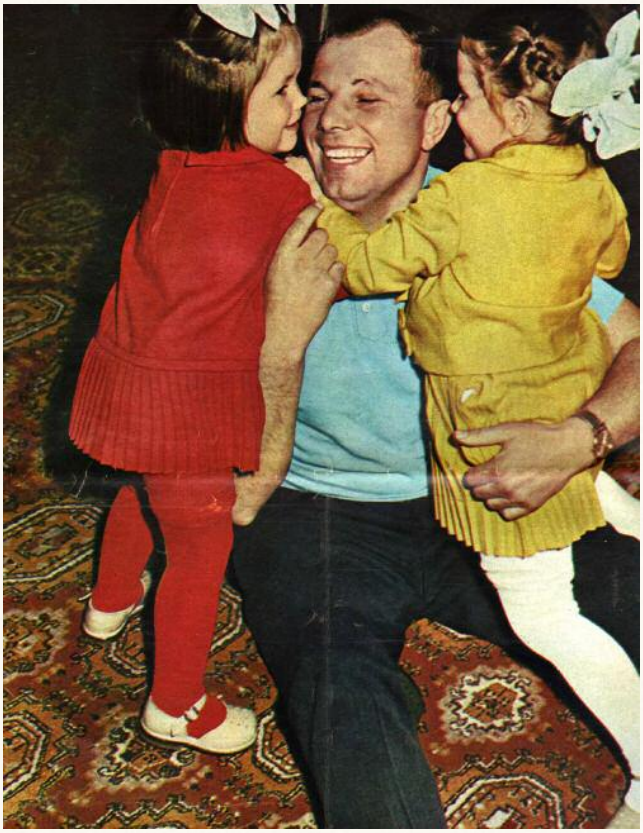


Vostok was made up of two parts: an almost spherical cockpit with three portholes, and a cylindrical service module 2.58 metres long. The service module contained the batteries for electrical power, the motors for orientation control, and the environment sub-system that controlled the living conditions of the capsule.
The cockpit had a diameter of 2.3 metres and the pilot sat on a small ejector seat infront of one of the portholes. The total weight was 4725 kg. The ejection of the seat was automatic at an altitude of 7000 m, after re-entry, and the astronaut descended by parachute.
Vostok-1 (serial number 3KA №3) was mounted on an SL-3 rocket (serial number 8K72K) which was a variant of the feared military SS-6 Sapwood rocket. It was 38.36 metres high and weighed 287.03 tons at launch. The rocket had three stages, with the first made up of four boosters surrounding the second and third stages. The first stage used RD-107 engines, that provided a thrust of 102,000 kg. In effect, Gagarin sat on the nose of an enormous bomb.

drink for a 10 day mission, in case the retro-rockets didn't work to push the vehicle and its occupant back to Earth. The chosen orbit (181 x 327 km inclined by 65 degrees to the equator) would have actually decayed naturally in 10 days, causing a natural re-entry. In the end Gagarin had no problems, *"The capsule reached orbit as planned with a smooth separation from the rocket. I immediately noticed the strange sensation of weightlessness but was able to adapt quickly. I maintained stable and continuous communication with Earth"*. These were some of the comments made by the cosmonaut after the flight. Atmospheric re-entry went normally, but Gagarin had to parachute from an altitude of 7000 metres, because, although the capsule itself was to land with a parachute, the impact velocity would have been too high for its occupant. Despite the high altitude (the temperature at 7000 metres is about -30°C), the cosmonaut, protected by his space suit, enjoyed experimenting with a long free-fall before opening his parachute. He landed near the village of Smelovski, in the same region as the town of Saratov, where he had studied as a boy. It was 10:55 Moscow time. The first to see him, while he was still freeing himself of his parachute, were an old woman, her daughter and a cow. He said, *"I have just returned from a flight in space"*, and was immediately

Official photo of Yuri A. Gagarin. [Epoca-Novosti]

greeted by hugs, applause and hand shakes.
During his official statement after the flight, released on 15th April, Gagarin said, *"On 12th April 1961 the Vostok-1 capsule was placed into orbit with myself onboard... I had a beautiful view of the Earth, it was surrounded by a very distinct blue halo. It had a very smooth transition from pale blue, to blue, to dark blue, to violet until the pitch black of space. A magnificent image"*.
Later he also said, *"Going around the Earth onboard my capsule I was amazed by the view of our planet. People of Earth! Let's look after this precious beauty, not destroy it!"*.



Yuri Gagarin photographed with his two daughters Lenotchka and Galotchka. [Epoca-Novosti]

The last years

After his return to Earth after his historic flight, Gagarin was welcomed triumphantly in Moscow's Red Square, where thousands of people celebrated his achievement.
Thereafter, together with his wife Valya, he became a "world ambassador", and was greeted with the highest honours all over the world. He was also made a deputy of the Supreme Soviet, but continued nonetheless with the training of cosmonauts, becoming commander of the Soviet cosmonauts.
This pleasant new life, however, distanced him from flying and his celebrity status started to bother him. One day, in fact, he said, *"Being a cosmonaut is my profession, and I didn't choose it just to make the first flight"*.
In 1967 he began training for the first flight in the new Soyuz capsule (eventually assigned to Vladimir Komarov, with Gagarin as the reserve cosmonaut). However, due to the fatal accident involving Komarov during the first flight, Gagarin was assigned to the flight of Soyuz-4.
Sadly, he never went into space again. On March 27*th* 1968, during a training flight in a 2-seater MiG-15 UTI with his instructor and director of cosmonaut training, Vladimir Sergheievic Sereghin, he was killed in an accident. The crash happened near the village of Novoselovo. Over the years the reported cause of the accident has seen many variations, but the most likely is probably the close supersonic flyby (10 or 20 metres from Gagarin's plane) by one or two Soviet Sukhoi Su-15-Flagon interceptors. The turbulence caused by this close encounter could have caused a loss of control of the MiG-15, with a

The 12th April 1981 launch of Space Shuttle Columbia with Young and Crippen on-board. [NASA]

subsequent corkscrew and impact with the ground. In honour of his contribution to space exploration a lunar crater was named after him, as well as asteroid 1771.

Korolev later commented, "A good pilot is one who, during one minute of flight, can make a certain number of observations and draw a certain number of conclusions so as to occupy an entire scientific institute for a year. A bad pilot is one who flies for a whole week but provides information only for an hour's work. What was incredible about Gagarin was that in 108 minutes of flight he was able to enrich science with very precious information and conclusions".

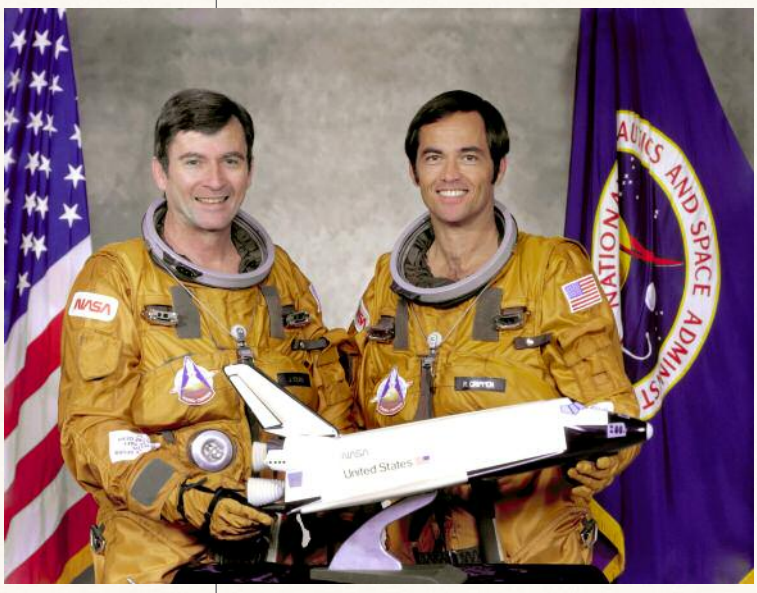
The landing of Shuttle Columbia at Edwards Air Force Base. [NASA]

Space Shuttle 1981-2011

Exactly twenty years after the flight of Yuri Gagarin, a new vehicle, with a quite different design, was launched for its first space mission: the Space Shuttle. This new vehicle was a kind of space plane, a winged vehicle that would take off like a rocket (attached to an external fuel tank and auxiliary boosters, the largest solid fuel boosters at the time), operate in space as a spacecraft, and eventually return to Earth and land like a plane on a runway. The feature that distinguished this craft from all that had come before was the almost complete re-usability.

The launch of the first Shuttle was scheduled for 10th April 1981, but during the count down, about 20 minutes before launch, the onboard computers

signaled a malfunction, and the necessary checks delayed launch by two days.
At 7 o'clock in the morning, Florida time, on 12th April, Columbia took off for its first flight. On board the crew



The crew posing for an official photograph with a model of the spacecraft. [NASA]

consisted of John Young (2 Gemini flights and 2 Apollo flights, including one to the Moon) and Robert Crippen.
A little more than 8 minutes after launch the Shuttle was in a circular orbit at an altitude of 241 km. This was the first of four test flights to verify the systems associated with all phases of a flight.
The only payload was a suite of instruments (Development Flight Instrumentation - DFI), that contained sensors and measurement devices to measure the performance and stresses on the spacecraft during the phases of launch, orbital flight, re-entry and landing. The objectives of the first flight were simply to execute a safe launch and re-entry.
In orbit the various systems were checked and the payload doors were opened both automatically and manually.
During this operation the astronauts noticed that some of the heat resistant tiles that protect the craft from the heat of re-entry were missing.
Fortunately they were not in a critical location and would not have compromised re-entry.
It was later noticed that 16 tiles were missing and 148 had been damaged by the shock wave caused by the ignition of the boosters. This problem was later rectified my modifications to the launch pad and the use of water to suppress the shock wave.
On 14th April, after two days of mission, Columbia re-entered the atmosphere and landed with great precision on runway 23 of the Rogers Dry Lake at the Edwards Air Force Base in California. The Shuttle was then returned to the Kennedy Space Center on 28th April, piggybacked on a Boeing 747 especially modified by NASA for the purpose.
2011 sees 30 years of Shuttle missions, but also the end of flight operations. When this article is published there will remain one programmed mission, STS-134 with Endeavour; while there is still doubt over a subsequent mission, STS-135 with Atlantis. This will probably be the last flight of the Space Shuttle era.

Paolo Laquale, born in 1971 in Altamura, Italy, has been interested in astronautics since the age of 10, when he watched the first Shuttle launch on television. He graduated with a degree in electronic engineering at the Polytechnic of Bari, with a final year thesis completed at the Italian Space Agency's (ASI) Space Geodesy Centre at Matera. He then did a Master's degree in Astronautics and Satellite Science at CISAS at the University of Padua, and a Master's in Remote Sensing at the department of physics at the University of Bari. He worked for "Galileo Avionica" on the LI instrument (Lightning Imager) to be used on the third generation Meteosat satellites. Since then he has carried out research in the field of Remote Sensing at the department of physics at the University of Bari.