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*Fri, 05 April 2019*

## **DRDO offers India Netra AEW&C on new platform**

India's Defense Research and Development Organisation has made an offer to the Indian Air Force (IAF) to equip Airbus C-295 aircraft with upgraded Netra airborne early warning and control (AEW&C) system.

On 26 February, India deployed an indigenously-made AEW&C system mounted on an Embraer aircraft in the aerial strike against terror group based in Pakistan-occupied Kashmir making it the first time such a system has been used in combat by the Indian Air Force (IAF). The aircraft guided IAF's 12 Mirage 2000 fighter jets used to bomb multiple camps operated by the terror group.

The C-295 tactical air-lifter will soon be manufactured by Airbus-Tata in India. Airbus C295 Netra on offer to IAF will have same Two radiating planar arrays assembled back-to-back and mounted on top of the fuselage in an active antenna array unit (AAAU) will provide 240° coverage but with improved capabilities, idrw.org reported Wednesday.

Airbus also has an Airborne Early Warning version of C-295 which has a static radar dome to provide a 360 Degrees coverage which DRDO is also ready to offer as a by-product of AWACS INDIA if IAF wants it aircraft in this package.

DRDO already has started testing static radar dome mounted on top of a building to test new radar developed for the AWACS INDIA program.

IAF's long-pending quest to induct two more AWACS based on Israeli Phalcon early-warning radar systems mounted on Russian Ilyushin-76 too has been pending due to the increased price quoted both by Israel and Russia which has forced IAF to solely depend on 3 Phalcon AWACS procured earlier.

Second Netra aircraft is yet to be inducted into IAF due to changes and improvements asked by IAF.

DRDO also plans to offer an Airbus C-295 variant for Maritime Patrol and Anti-Submarine Warfare missions to Indian Navy, the idrw.org report stated further.

[http://www.defenseworld.net/news/24556/DRDO\\_Offers\\_India\\_Netra\\_AEW\\_C\\_On\\_New\\_Platform](http://www.defenseworld.net/news/24556/DRDO_Offers_India_Netra_AEW_C_On_New_Platform)

## **A-Sat missile test shows India's growing offensive capabilities**

*Although A-SAT has a range of 1000 km, the range for test was maintained at 300 km in order to keep other space-based assets safe and avoid debris*

*By Debalina Ghoshal*

New Delhi: The head of American space agency Nasa on Tuesday described India's destruction of one of its own satellites a "terrible, terrible thing" that had created 400 pieces of orbital debris and led to new dangers for astronauts aboard the International Space Station.

On March 27, 2019, India conducted its first ever Anti-Satellite (A-SAT) test under Mission Shakti. During the test, India shot down its own Low-Earth Orbit (LEO) satellite with a ground-to-space missile. That India would test A-SAT capabilities sooner or later was no surprise. Ever since India developed long-range Agni category ballistic missiles, there weren't many doubts about country's progression towards developing A-SAT capability.

The development of A-SAT missile portrays India's growing offensive capabilities and the weapon is a medium to enhance country's space-based deterrence vis-à-vis China and Pakistan. Although A-SAT has a range of 1000 km, the range for test was maintained at 300 km in order to keep other space-based assets safe and avoid debris.

It is crucial for India to develop space-based deterrence especially since China has worked on the same capability. The test would provide an advantage to India in space race and strengthen its conventional and nuclear deterrence.

However, the A-SAT capability has only been tested in LEO and it must prove its mettle at High-Earth Orbit (HEO) that would require further technological sophistication. Moreover, the test was conducted against known satellites in known directions. During crisis, the A-SAT must have the capability to deal with satellites with varied features.

Adversaries could use stealth technologies to prevent their satellites from being detected. Countries like China could also make their satellites look like debris for deception. China's SY-7 has the capability of being maneuvered which implies that India's A-SAT in future would also need to deal with maneuverable satellites.

Conducting A-SAT test at HEO will invite international criticism because such tests could leave large amount of space debris. In 2007, China faced criticism from the United States for its A-SAT test that took place at high altitudes leaving large chunks of debris in space. A NASA administrator has said that India shooting down of one of its own satellites was a "terrible thing" as it created about 400 pieces of orbital debris assessment of the test. However, if you compare it with China, India's test has left much less debris and the International Space Station (ISS) is safe. Moreover, should there be a need, the debris can be maneuvered. The Ministry of External Affairs has confirmed that the remaining debris would also "decay and fall back" onto the earth within weeks because the test took place at low altitude.

The recent test would provide India a greater leverage to voice its opinions in space-related arms control regimes such as Prevention on Arms Race in Outer Space (PAROS). India is already a part of the Outer Space Treaty ratified in 1982 which prohibits testing of weapons of mass destruction in space. In addition, similar capabilities make it easier for India to actively voice on opinion on demilitarisation of space.

While many people may criticise that the A-SAT test will be destabilising in the region, it must be noted that had India not matched its capability with that of China, it would have been destabilising as till now space parity was non-existent between the two countries. India is already working on laser technology and directed energy weapons (DEWs), electro-magnetic weapons and microwave weapons are also on cards under the supervision of the Defence Research and Development Organisation (DRDO).

India's missile defence and A-SAT capabilities constitute India's 'defence by denial' strategy. A perfect offence and defence balance in its military mix would strengthen its deterrence vis-à-vis Pakistan and China as also it would enhance India's diplomatic bargaining power by leaps and bounds.

(The writer is a Non-Resident Fellow with the Council on International Policy, Canada.)  
—(Courtesy: Outlook India)

<http://www.kashmirtimes.com/newsdet.aspx?q=89464>

THE  
**WIRE**

*Fri, 05 April 2019*

## **What does India really hope to gain from the ASAT test?**

*The debris aspect of the ASAT test has received the most media attention in the last week, and deservedly so. However, it isn't the only issue with Mission Shakti. There are at least three more*

*By Arup Dasgupta*

On March 27, during the course of Mission Shakti (Hindi for 'strength'), the Defence Research and Development Organisation (DRDO) used an anti-satellite (ASAT) missile to destroy a defunct satellite in a low-Earth orbit. The missile had been launched from the DRDO's site on Kalam Island, off the coast of Odisha.

The usual claims followed. "India is now a superpower". "We did it in one attempt." "We are the fourth after China but they succeeded after four failed attempts." Setting aside these headlines, it is worth considering the mission's real *shakti*.

To chase down a satellite travelling at 7 km/s and to blast it out of orbit is indeed a fantastic technical achievement. However, ours is a country that can manoeuvre a satellite into orbit around a celestial body. Such precision has already been achieved in the Chandrayaan and Mangalyaan missions. What is new?

Recently, a US-based organisation called the Federation of American Scientists declared that an earlier DRDO test of an ASAT weapon in February 2019 had failed. However, DRDO claimed it hadn't really 'failed' because it had chased down an electronic target correctly.

In fact, the event creates a cloud of debris that could affect future launch plans and low-Earth orbit missions, including Gaganyaan. It should not be forgotten that the debris will include the satellite and the ASAT weapon's uppermost stage.

We are told that the debris will deorbit and burn up in Earth's atmosphere in 45 days. However, in those 45 days, what can happen is anybody's guess. Simple physics says that if the velocity of an orbiting object changes, the object's orbit will also change. So when a satellite is blown up, the debris will suffer a velocity change and some of the debris will actually go into a higher orbit while others will go into a lower one. That is, the debris will create an expanding cloud.

This is now borne out by NASA as well. Its chief Jim Bridenstine said at a townhall meeting earlier this week that small debris from the test had increased risk to the International Space Station (ISS) by 44%. The ISS is in a low-Earth orbit at about 400 km.

It is also notable that the smaller an object is, the lesser the drag it will experience in orbit, and the more time it will take to deorbit. Therefore, the DRDO's claim of 45 days is highly optimistic. It should be remembered that even a microscopic piece of debris can puncture a space vehicle in a critical area because of its high speed.

Then there is the issue of liabilities. What if the debris incapacitates another satellite or launch vehicle?

The debris aspect of the ASAT test has received the most media attention in the last week, and deservedly so. However, it isn't the only issue with Mission Shakti. There are at least three more.

India, officials said, can now "protect" its space assets. These are primarily communication satellites in geosynchronous and geostationary orbits (36,000 km up) and Earth-observation satellites in Sun-synchronous orbits between 700 km and 1,000 km. It is not clear how destroying a satellite in low-Earth orbit gives us the capacity to safeguard these assets.

Satellites in low-Earth orbit are usually surveillance satellites with imaging and electronic intelligence capabilities, and Shakti's abilities are limited to targeting them. (One example of a satellite with the latter toolset is EMISAT, launched on the PSLV C45 mission on April 1.)

Second, officials have also been stressing that the test broke no law. However, space law isn't the only entity India is mindful of; there are also treaties. Perhaps the most overarching one is the UN Outer Space Treaty. It specifically prohibits nuclear weapons and weapons of mass destruction from being placed in orbit. However, it does fail to discuss kinetic bombardment weapons, and India could have used this loophole to conduct the test.

Reconsidering Mission Shakti *de novo* would be great if India could develop an ability to forcibly deorbit rogue satellites – instead of destroying them – thus not creating debris. Even better would be if India could improve its anti-ballistic-missile system to intercept a foreign ASAT missile before it can complete its mission. If so, there would be no space debris but the risk of some pieces of the missile hitting the ground.

Such tactics will also be more useful than A destroying B's satellite in retaliation for B destroying A's. In the end, both countries will just be more blind, and hopefully learn that 'an eye for an eye' does not offer constructive solutions.

Third, both the US and the former Soviet Union tested such weapons during the Cold War; China got into the act in 2007; now India has joined this "elite club". The official line, it appears, is to stand up and be counted when a treaty banning the weaponisation of space is effected.

However, India has suffered at the hands of the Non-proliferation Treaty (NPT), which was created by the haves of nuclear weapons to keep the have-nots as have-nots by insisting they sign the treaty. If it does become a signatory, India will have to throw open its nuclear assets and welcome scrutiny of the purchases and sale of nuclear items – terms to which India has found it can't agree.

In the same vein, China and Russia appear to be on the verge of stationing weapons in space. The US has mooted a 'Star Wars' programme that includes a 'space command'. So the thinking seems to be that India – at least a more gung-ho part of it – shouldn't find itself on the wrong side of the line of a potential future treaty on space weapons.

However, even though India has not signed the NPT, it remains constantly exposed to nuclear blackmail. In the same way, it is not clear what India will gain by becoming a founding member of a 'weapons in space treaty'. Does India want to set up a 'space command'?

*(Arup Dasgupta is the managing editor of Geospatial World and former deputy director of the Space Applications Centre, ISRO)*

<https://thewire.in/space/what-does-india-really-hope-to-gain-from-the-asat-test>

## **A-SAT space debris means no harm to ISS or anyone**

*NASA and Combined Space Operations Centre reportedly  
identified 400 pieces of space from India's A-SAT test*

*By Nirad Mudur*

Bengaluru: Using an interceptor ballistic missile without an explosive warhead and targeting a satellite at low earth orbit of less than 300 Km, ensured that space debris caused by India's March 27 anti-satellite (A-SAT) experiment, named Mission Shakti, may not be as harmful as it is being made out to be. The debris causing 'serious danger' to the International Space Station, raised by NASA Administrator Jim Bridenstine, could be bit too alarmist, Indian space scientists feel.

Experts, like Prof Roddam Narasimha, say that despite NASA administrator Bridenstine raising concerns that India's test had increased the risk to the ISS by 44 percent due to space debris, "there is no such cause for worry". Bridenstine had based his worries on estimates provided by NASA and the Combined Space Operations Centre (part of US Strategic Command).

Interestingly, Bridenstine himself said after his town hall talk on April 1, which was live-streamed by NASA TV when he raised these concerns — as quoted by space.com — "The good thing is (about India's A-SAT mission), it's low enough in Earth orbit that over time this (the space debris) will all dissipate."

Scientists from India's Defence Research and Development Organisation (DRDO), which conducted the March 27 test, and Indian Space Research Organisation (ISRO) have confirmed that the low-earth orbit space debris caused by the test would dissipate within eight days. The debris, they said, will fall to earth, but will burn in the planet's atmosphere.

Compared to that, the 2,000-odd pieces of space debris (several hundreds bigger than a golf ball) caused by the Chinese A-SAT test, conducted on January 11, 2007, are still orbiting the earth as that experiment was conducted at an altitude more than twice that of the Indian A-SAT test — 865 Km above earth.

Prof Roddam Narasimha, Indian aerospace scientist and fluid dynamicist who was Director of the Bengaluru-based National Aerospace Laboratories, downplayed the threat to the ISS, saying: "The altitude at which India conducted the test was below that of the ISS. Yes, there will be debris, and space debris should not be caused, but compared to what other countries (USA, Russia and China) have done this is nothing."

NASA and Combined Space Operations Centre reportedly identified 400 pieces of space from India's A-SAT test. This included 60 pieces which were larger than 10 cm in diameter, and 24 of which were travelling through the orbit of the ISS, which led them to raise the risk rate to ISS by 44 percent.

Prof Narasimha also pointed out that had the DRDO's ballistic missile — developed under India's ballistic defence missile programme — carried an explosive warhead, the explosion could have provided a powerful thrust to the space debris, pushing the debris to a higher altitude.

However, the March 27 test, according the official release, was a "kinetic kill" test, which means there was no warhead used on the missile. It was the sheer velocity (8 Km/sec) of the missile which successfully targeted the satellite, which caused it to disintegrate without causing an explosion.

According to space.com, which reported Bridenstine's livestreamed town hall talk on April 1, he had said describing the Indian test: "That is a terrible, terrible thing, to create an event that sends

debris in an apogee that goes above the International Space Station...And that kind of activity is not compatible with the future of human space-flight that we need to see happen.

“We are charged with commercializing low Earth orbit; we are charged with enabling more activities in space than we’ve ever seen before for the purpose of benefiting the human condition, whether it’s pharmaceuticals or printing human organs in 3D to save lives here on Earth, or manufacturing capabilities in space that you’re not able to do in a gravity well...All of those are placed at risk when these kind of events happen — and when one country does it, then other countries feel like they have to do it as well.”

India’s A-SAT mission was launched from Dr A P J Abdul Kalam Island launch complex off Odisha coast.

<http://www.newindianexpress.com/nation/2019/apr/04/calm-down-a-sat-space-debris-means-no-harm-to-iss-or-anyone-1960068.html>

**hindustantimes**

*Fri, 05 April 2019*

## **The A-SAT test restores the India-China strategic balance**

*India has work ahead to do in developing non-kinetic ASAT technologies that China too is pursuing, as well as ABM technologies*

*By Kanwal Sibal*

The Narendra Modi government’s decision to conduct a live anti-satellite (A-SAT) test was bold and timely. Bold because the political leadership overcame past hesitations and authorised the Defence Research and Development Organisation (DRDO) to conduct it. While the decision was not in defiance of an established discriminatory international regime that circumscribed India strategically as was the decision in 1998 to go nuclear, taking a step that could feed into international concerns about militarisation of outer space required careful consideration.

One such consideration would have been the adverse international reaction to China’s A-SAT test in 2007 conducted at a height of 865 kilometres that produced substantial space debris, which interferes with existing and future space activities and therefore raises international concerns. We have acted more responsibly by conducting our test at a height of 300 kilometres to ensure that the debris generated will fall earthwards within weeks. Most significantly, international reaction to our test (barring Pakistan’s) has not been adverse including US political reaction. More than NASA’s debris-related technical concerns as a space organisation which have been credibly refuted by our space scientists, it is the American government’s reaction that matters. We rightly preferred a kinetic kill instead of “fly-by tests” and jamming to prove the precision of our capability and exclude any ambiguity.

Our test was timely. Unlike our nuclear tests, the international environment for us to take strategic steps to protect our security is more favourable, particularly because of increased strategic understandings with the US. While we have rightly said that our test was not directed against any country, in reality just as we developed nuclear weapon capability to principally deter China, the A-SAT capability also redresses the India-China strategic balance.

China’s strategic antagonism towards us is demonstrated by its cover to Pakistan on our core issue of terrorism by preventing Masood Azhar’s designation as a terrorist by the United Nations Security Council (UNSC) 1267 Committee. China is disdainful of India’s reaction to this and to its opposition to India’s Nuclear Suppliers Group (NSG) membership. It remains unwilling to treat India as a

political equal. China is also highly active diplomatically to thwart India's moves to finally initiate text-based negotiations in the United Nations General Assembly on Security Council expansion. China's bullying tactics against weaker countries as well as global concerns about its threatening cyber capabilities require the development of counters by India.

China is bristling at the US move to raise the Masood Azhar issue in the UNSC as its duplicitous position will be publicly exposed. China's apologists in India, who make the bizarre argument that on this, as well as that of line of actual control (LAC) clarification and NSG membership, India should not have made a public push because these issues are not intrinsically important enough to turn them into a litmus test of our ties with China may have reason to be unhappy because India has not prevailed upon the US, France and the UK to desist from a move that would make us lose China's goodwill unnecessarily.

If China takes an adverse position on Pakistani sponsored terrorism against India (it did not even condemn the 2008 Mumbai attacks), veto our NSG membership on specious grounds, reverse its position on LAC clarification after agreement in 1996, what should be the litmus test then? The Special Representatives mechanism has produced no result despite the confidentiality of discussions. The Chinese lobby in India, always ready to assume guilt towards China, goes as far as to argue that the US-India nuclear deal provoked a natural rebalancing by China towards Pakistan. How the 2013 Belt and Road Initiative and the China-Pakistan Economic Corridor are a consequence of the India-US nuclear deal and have nothing to do with China's grand geopolitical Silk Road strategies spanning the globe as apart of its declared ambition to be at the centre of international governance by 2049 is difficult to comprehend. According to the "tributary thinking" of this lobby, India should defer to Chinese sensitivities and pursue its interests only to the point that China is not upset.

Finally, the A-SAT test was timely because negotiations on Prevention of an Arms Race in Outer Space (PAROS), a treaty to prevent an arms race in outer space, though stalled because of differences between the US, Russia and China, could eventually get concluded. A-SAT technology is also closely linked to Anti-Ballistic Missile (ABM) technology, which makes PAROS negotiations more complex in security terms. India has work ahead to do in developing non-kinetic ASAT technologies that China too is pursuing, as well as ABM technologies. By conducting the A-SAT test, India has avoided repeating the folly of not conducting a nuclear weapon test in time to ensure that its nuclear weapon status was recognised under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). It will now be a key player in drafting any international law on preventing an arms race in outer space.

As against this larger canvas, the fact that the A-SAT test came when general elections are due, and could possibly give some advantage to the ruling party, should be of secondary importance.

Kanwal Sibal is former foreign secretary.

<https://www.hindustantimes.com/analysis/the-a-sat-test-restores-the-india-china-strategic-balance/story-jkn9FsMOE3OqNdD7edCIAO.html>

Fri, 05 April 2019

## Isro to launch 5 military satellites this year to boost 'strategic assets in space'

*By Surender Singh*

New Delhi: Starting 2019 with the liftoff of two surveillance satellites for Defence Research and Development Organisation (DRDO), one of which was used as a target for the ASat missile test + , Indian Space Research Organisation (Isro) is gearing up to launch a slew of advanced military satellites this year that will enhance surveillance capabilities of security forces and boost the country's "strategic assets in space".

Isro is scheduled to launch four new series Risat satellites and an advanced Cartosat-3 satellite. The images from old Risat-series satellites were used to plan the surgical strike in 2016 and the air strike on a Jaish camp in Pakistan's Balakot this year.

In the past, the space agency had launched one or two military satellites a year but its focus has now shifted towards boosting defence assets in space amid heightened tension along the Pakistan border and increased Chinese naval activities in the Indian Ocean.

ISRO chairman K Sivan told TOI, "We are targeting to launch 33 missions, including satellites and rockets, this year. In the middle of May, PSLV-C46 rocket will launch Risat-2B and thereafter in the fourth week of June, PSLV-C47 will launch Cartosat-3. Cartosat-3 is the advanced version with the capability to zoom up to a resolution of 0.2 metre (20 cm), which is considered the best in the world." The resolution of Cartosat-3 will be so refined that it will be able to capture clear images of very small objects like a gun or an enemy bunker. The old Cartosat-2 series satellites had a resolution of only up to 0.5 metre. Sivan said Risat-2BR1 will be launched in July, Risat-2BR2 in October and Risat-1A in November. Risat-2B series is a lighter version of the spy satellite with an X-band synthetic aperture radar that can penetrate clouds and zoom up to a resolution of 1 metre.

The ISRO chief said, "In September, we are going to launch a new series of remote-sensing satellite Geo-Imaging Satellite-1 (Gisat-1) and Gisat-2 in November." Gisat will carry a geoimager with multi-spectral (visible, near infra-red and thermal), multi-resolution (50m to 1.5 km) imaging instruments that will enhance the country's land mapping capabilities. Gisat has both military and civilian use. Till now, old imaging satellites could map a particular area only once in 22 days. With Gisat, military can scan or map an area every other day. The satellite will provide near real-time pictures of large areas of the country under cloud-free conditions.

Besides military satellites, Isro is also planning to launch high-profile Chandrayaan-2 mission and first demonstration test of the mini-PSLV or SSLV this year. Advanced communication satellites like Gsat-20, Gsat-30 and Gsat-32 will also be launched by early next year. Gsat-32 will replace Gsat-6A, which was lost in space after the successful launch due to a communication failure and was meant to mainly serve ground forces.

<https://timesofindia.indiatimes.com/india/isro-to-launch-5-military-satellites-this-year-to-boost-strategic-assets-in-space/articleshow/68713168.cms>

## **Defence Ministry kicks off 50K cr submarine project**

New Delhi: Having received the nod from the Government for manufacturing six submarines in India earlier this year, the Defence Ministry has started the process of issuing expression of interest or global tender expected to be floated in the next four to five weeks. The total cost of the project is about Rs 50,000 crore and the submarines will be built as per the Strategic Partnership model.

The model entails an Indian shipyard in private or public sector forging a joint venture with the foreign original equipment manufacturer (OEM) and then constructing the six conventional diesel-electric submarines known and Project-75 I(P-75I) in India. The Government had cleared the project in January this year.

Giving this information about the process of firming up the tender, sources said here on Wednesday the submarines will be fitted with anti-ship cruise missiles and other lethal weapons. The tender or expression of interest will be issued to leading manufacturers of advanced submarines in four weeks, adding the defence ministry has started the process for selecting both the Indian and foreign defence entities.

They also said an empowered committee appointed in January to implement the mega project has already held consultations with short-listed Indian defence majors including Adani Defence, Larsen and Toubro and state-run Mazagon Dock Shipbuilders Ltd (MDL) as part of the process to identify the domestic partner. The defence ministry has already drafted an Expression of Interest for the procurement, and it has been shared with prospective contenders, they said.

The project will be implemented under the strategic partnership model which provides for joint ventures between Indian private and public firms with foreign manufacturers. The tender for six submarines is a follow on order of the Scorpene submarines project. Six such submarines are now under construction with French collaboration at the public sector Mazagon Dock Limited, Mumbai.

The follow-on order known as P-75I is the second project to be implemented under the strategic partnership model. The first project to get government's nod for implementation under the new model was acquisition of 111 utility helicopters for the Navy at a cost of over Rs 21,000 crore.

Sources said construction of six submarines under Project 75 (I) will provide a major boost to the existing submarine design and manufacturing eco-system in India.

<https://www.dailypioneer.com/2019/india/defence-ministry-kicks-off--50k-cr-submarine-project.html>

## **Japan's Hayabusa2 probe prepares to drop explosives and blast crater in asteroid Ryugu**

Tokyo: Starting 2019 with the liftoff of two surveillance satellites for Defence Research and Development Organisation (DRDO), one of which was used as a target for the ASat missile test + , Indian Space Research Organisation (Isro) is gearing up to launch a slew of advanced military satellites this year that will enhance surveillance capabilities of security forces and boost the country's "strategic assets in space".

A Japanese probe began descending toward an asteroid on Thursday on a mission to blast a crater into its surface and collect material that could shed light on the solar system's evolution.

The mission will be the latest in a series of explorations carried out by the Japanese space agency's Hayabusa2 probe and could reveal more about the origin of life on Earth.

But the task scheduled for Friday will be the riskiest yet of Hayabusa2's investigations, and involves the release of a device filled with explosives.

The "small carry-on impactor," a conical device capped with a copper bottom, will emerge from Hayabusa2 on Friday, after the probe has arrived just 500 meters above the asteroid Ryugu.

The probe will then depart the area, and the impactor is programmed to explode 40 minutes later, propelling the copper bottom toward Ryugu, where it should gouge a crater into the surface of the asteroid that sits 300 million km from Earth.

Hayabusa2 will move away from the area to avoid being damaged by debris from the explosion or the collision with Ryugu.

As it does so it will release a camera slightly above the site of the detonation that should be able to capture images of the event.

The camera should be able to transmit those images, but it is unclear when the first confirmation of the mission's success will come.

It will take two weeks for the probe itself to return to its "home position" near Ryugu after the detonation and impact.

"We are thrilled to see what will happen when the impactor collides with the asteroid," Takashi Kubota, engineering researcher at the Japanese space agency (JAXA), told reporters earlier this week.

The crater could be as large as 10 meters in diameter if the surface is sandy, but a smaller 3 meters across if it is rocky, according to JAXA scientists.

NASA's Deep Impact project succeeded in creating an artificial crater on a comet in 2005, but only for observation purposes.

The aim of the crater on Ryugu is to throw up "fresh" material from under the asteroid's surface that could shed light on the early days of the solar system.

In February, Hayabusa2 touched down briefly on Ryugu and fired a bullet into the surface to puff up dust for collection, before blasting back to its holding position.

The asteroid is thought to contain relatively large amounts of organic matter and water from some 4.6 billion years ago when the solar system was born.

The Hayabusa2 mission, with a price tag of around ¥30 billion (\$270 million), was launched in December 2014 and is scheduled to return to Earth with its samples in 2020.

Photos of Ryugu — which means “Dragon Palace” in Japanese and refers to a castle at the bottom of the ocean in an ancient Japanese tale — show the asteroid has a rough surface full of boulders.

Hayabusa2 observes the surface of the asteroid with its camera and sensing equipment but has also dispatched two tiny MINERVA-II rover robots as well as the French-German robot MASCOT to help surface observation.

At about the size of a large fridge, Hayabusa2 is equipped with solar panels and is the successor to JAXA’s first asteroid explorer, Hayabusa — Japanese for falcon.

That probe returned with dust samples from a smaller, potato-shaped asteroid in 2010, despite various setbacks during its epic seven-year odyssey and was hailed as a scientific triumph.

<https://www.japantimes.co.jp/news/2019/04/05/national/science-health/making-dent-japans-hayabusa2-probe-prepares-blast-crater-asteroid-ryugu/>