

Mar
2021

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खंड : 46 अंक : 60 24 मार्च 2021

Vol.: 46 Issue : 60 24 March 2021



रक्षा विज्ञान पुस्तकालय
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79 projects worth Rs 8,201 crore taken up by DRDO in last three years

By Ch Sushil Rao

Hyderabad: The Defence Research and Development Organisation (DRDO) took over 79 projects worth Rs.8,201 crore in last three years.

The Defence Research and Development Organisation took up projects directly pertaining to development of new defence equipments i.e. Cruise Missile, Anti-Ship Missile, Surface-to-Air Missile, Air-to-Air Missile, Extended Range Anti-Submarine Rocket, Mounted Gun System, Ammunitions, Electronic Warfare System, Radars, Torpedoes, and High Endurance Autonomous Underwater Vehicle.

Some of the DRDO developed systems which are likely to be available to India's defence forces during 2021-23 are--ASTRA Missile, Anti Drone System, Satcom devices by 2021, QRSAM, ADFCR, Helina, ADTCR, Guided Bomb, and Nag by 2022, NGARM and SAAW by 2023.

Many DRDO developed technologies such as Battle Field Surveillance Rader (BFSR), Joint Venture Protective Carbine (JVPC) Jammers, 5.56 mm Rifle, 40 mm Under Barrel Grenade Launcher (UBRL), Oleo Resin (OR) Grenade etc are being utilized by the State Police departments.

DRDO has developed upgrades to some of the systems including Arjun Mk-1A, Akash-NG, Light Combat Aircraft Mk-1A, Medium Power Radar-Extended Range, PINAKA- Extended Range, Guided, Electronics & Communication System for Unified Mission Computer for SU-30 MKI aircraft, Internal EW System for MIG-29 Upgrade Aircraft, and EW systems for Naval platforms.

<https://timesofindia.indiatimes.com/india/79-projects-worth-rs-8201-crore-taken-up-by-drdo-in-last-three-years/articleshow/81656500.cms>

The BrahMos: Potential buyers, competition and hurdles

With India determined to develop itself as a hub of defence manufacturing, how it handles the sale of the BrahMos would be an important factor in its potential emergence as a net provider of regional security in the Indo-Pacific

By Harsh V. Pant and Javin Aryan

Earlier this month, India and the Philippines signed the “Implementing Arrangement” on defence material and equipment procurement. This agreement lays the groundwork for sales of defence systems, such as the highly anticipated export of the BrahMos cruise missile, through the government-to-government route. As the Philippines’ Secretary of National Defence publicly acknowledges the archipelagic country’s intention of purchasing the missile, and the Navy Chief calls it the ideal weapon, a potential export deal moves one step closer to reality. This deal will be of great significance for multiple reasons, and even though the procurement process is progressing steadfastly, there still lie many challenges ahead.

The trajectory

Research and development of the BrahMos cruise missile systems began in the late 1990s. Manufactured by BrahMos Aerospace Limited, a joint venture between India’s Defence Research and Development Organisation (DRDO) and Russia’s NPO Mashinostroyeniya (NPOM), this is the first supersonic cruise missile to enter service. Capable of flying at a speed of Mach 2.8 (almost three times the speed of sound), it has a range of at least 290 km.



Traveling with such velocity means that it would be difficult for air defence systems utilising surface-to-air missiles to intercept the BrahMos while making it easier for it to target and neutralise advanced fighter jets like the Chinese J20 moving at less than Mach 2 speeds. Even so, efforts to increase the speed and range of the missile in its next iterations are underway, with a goal of achieving hypersonic speeds (at or above Mach 5) and a maximum range of 1,500 km. India gaining membership of the Missile Technology Control Regime (MTCR) in 2016 has played a major role in the development of these capabilities.

Traveling with such velocity means that it would be difficult for air defence systems utilising surface-to-air missiles to intercept the BrahMos while making it easier for it to target and neutralise advanced fighter jets like the Chinese J20 moving at less than Mach 2 speeds.

Early naval and land variants of the BrahMos were inducted into service by the Indian Navy in 2005 and the Indian Army in 2007. Subsequently, an air-launched variant was successfully tested in November 2017 by the Indian Air Force from its Sukhoi-30 MKI fighter jet, giving the missile a dominating presence in all three domains.

These advanced and powerful capabilities of the BrahMos not only augment the strength of the Indian military but make it a highly desirable product for other countries to procure as well. Exporting the system, hence, has been on the agenda for more than a decade. Doing so would boost the credibility of India as a defence exporter, help it meet the target of US\$ 5 billion in defence exports by 2025, and elevate its stature as a regional player. Countries such as Vietnam, the Philippines, Indonesia, Thailand, Singapore, the United Arab Emirates, Argentina, Brazil, and South Africa have so far shown an interest in acquiring the systems.

The sale to the Philippines

The implications of the Philippines becoming the first country to import the BrahMos could be wide-ranging and consequential in the Indo-Pacific. For starters, it would caution China, with whom the Philippines has been engaged in a territorial conflict in the South China Sea, and act as a deterrent to Beijing's aggressive posturing. Indeed, this is why China has been wary of ASEAN countries acquiring defence systems like the BrahMos. Further, taking lessons, other nations threatened by Chinese belligerence may come forward to induct the BrahMos into their arsenal, thereby boosting India's economic, soft, and hard power profile in the region and providing the Indo-Pacific with a strong and dependable anchor with which they can protect their sovereignty and territory.

Missile	BrahMos	YJ-12	X-51A Waverider (under flight testing)
Country of Origin	India, Russia	China	USA
Launch Platform	Land, Air, Sea	Land, Air, Sea	Air
Range	290 - 500 km	300 - 380 km	740 km
Speed	Mach 2.8	Mach 2 - 3.2 (increases with launch altitude)	Mach 5.1

Sources: YJ-12, X-51

Taking lessons, other nations threatened by Chinese belligerence may come forward to induct the BrahMos into their arsenal.

Roadblocks ahead

The government of India has prioritised making the country *Atmanirbhar* in the defence manufacturing sector and establishing itself as a major defence exporter. The Philippines, on the other hand, has decided to buy the BrahMos out of geopolitical and strategic necessity. Nonetheless, two major roadblocks still remain for the BrahMos to be delivered to Manila.

The first roadblock is the US's Countering America's Adversaries Through Sanctions Act (CAATSA). Passed and signed into law in 2017, the Act aims to sanction individuals and entities who engage in a "significant transaction" with a listed entity. So far, Turkey and China have been penalised under CAATSA for purchasing the S-400 Triumf air defence systems from Russia. NPO Mashinostroyeniya (NPOM), which owns a 49.5 percent stake in BrahMos Aerospace Limited, is one of the listed Russian entities. And since 65 percent of the components, including the ramjet engine and radar seeker used in the BrahMos, are reportedly provided by NPOM, the export of the missile systems may attract sanctions. Remarkably, the US, of which India is a major defence partner, has maintained ambiguity over whether it will introduce sanctions over India's acquisition of the S-400, licensed production of the AK-203 assault rifle, and export of the BrahMos. Hesitant of being sanctioned themselves, countries may shy away from purchasing the BrahMos. There is, however, an excellent case for India to receive a waiver from CAATSA, especially vis-à-vis the BrahMos that can help contain a confrontational China.

Remarkably, the US, of which India is a major defence partner, has maintained ambiguity over whether it will introduce sanctions over India's acquisition of the S-400, licensed production of the AK-203 assault rifle, and export of the BrahMos.

The second issue pertains to financing. A regiment of the BrahMos, including a mobile command post, four missile-launcher vehicles, several missile carriers, and 90 missiles, reportedly costs around US \$275 million (INR 2,000 crores). Ravaged by the COVID-19 pandemic, many countries who are interested in the BrahMos would find it difficult to purchase it. The cost of the systems has been a major hurdle in moving forward to reach a deal with the Philippines and Vietnam. To remedy this, India has offered US\$ 500 million and US\$ 100 million lines of credit to Vietnam and the Philippines, respectively. Also, the Philippines is thinking of

purchasing a smaller profile of just one battery of the BrahMos, consisting of three missile launchers with 2-3 missile tubes each.

Additionally, India should also be mindful of the competition it faces from other manufacturers and exporters. Case in point, Vietnam was said to be in talks with Russia to procure missiles similar to the BrahMos at a potentially lower cost. As New Delhi looks to put more of its indigenous defence products — such as the Akash air defence systems, Astra air-to-air missile, and HAL Dhruv utility helicopter, on the market — it should focus on developing a streamlined and efficient export regime.

With India determined to develop itself as a hub of defence manufacturing, how it handles the sale of the BrahMos would be an important factor in its potential emergence as a net provider of regional security in the Indo-Pacific.

<https://defenceview.in/the-brahmos-potential-buyers-competition-and-hurdles/>

Defence News

Defence Strategic: National/International



Press Information Bureau
Government of India

Ministry of Defence

Tue, 23 March 2021 3:18PM

Inauguration of Extension of Naval Jetty Phase-II at Naval Wharf, Haddo

A major Naval project of 'Extension of Jetty' at the Naval Wharf was inaugurated by Vice Admiral SR Sarma, Chief of Materiel of Indian Navy, on 22 March 2021. Rear Admiral Suraj Berry, Chief of Staff, HQ Andaman and Nicobar Command and Shri TN Krishnamoorthy, Chief Engineer, Andaman & Lakshadweep Harbour Works were present for the event.

The 230 meter long jetty is one of the larger marine infrastructure projects being undertaken at Andaman and Nicobar Command both in terms of magnitude and technical complexity. The jetty will enable mooring alongside of the Floating Dock and will significantly boost the ship berthing and maintenance capability of the Tri Service Command. The project was completed within stringent timelines of just about three years despite restrictions due to the nationwide Covid-19 lockdown in 2020.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1706897>





पत्र सूचना कार्यालय
भारत सरकार
रक्षा मंत्रालय

Tue, 23 March 2021 3:18PM

नौसेना गोदी, हद्दों में नौसेना जेटी चरण-II के विस्तार का उद्घाटन

भारतीय नौसेना के चीफ ऑफ मीटिरियल वायस एडमिरल एस सरमा ने .आर.22 मार्च 2021 को नौसेना गोदी में नौसेना की प्रमुख जेटी विस्तार परियोजना का उद्घाटन किया। इस अवसर पर अंडमान और निकोबार कमान मुख्यालय के चीफ ऑफ स्टाफ रियर एडमिरल सूरज बेदी तथा अडमान और लक्षद्वीप पत्तन के चीफ इंजीनियर श्री टीकृष्णामूर्ति उपस्थित थे। .एन.

230 मीटर लम्बा जेटी अंडमान और निकोबार कमान में चलाई जा रही बड़ी मरीन संरचना परियोजना है।

यह जेटी तैरते बंदरगाह के साथ लंगर को सक्षम बनाएगा और ट्राई सर्विस कमान की जहाज बर्थिंग तथा रखरखाव क्षमता को महत्वपूर्ण रूप से प्रोत्साहित करेगा। 2020 में देशव्यापी कोविड-19 लॉकडाउन के कारण प्रतिबंधों के बावजूद यह परियोजना तीन वर्षों की समय सीमा में पूरी की गई है।



<https://pib.gov.in/PressReleasePage.aspx?PRID=1706972>

Maritime, air defence theatre commands to be announced by June 2021

*The Indian military is finally shedding its imperial past,
paving a way for tri-services theatre commands*

By Shishir Gupta

New Delhi: When Prime Minister Narendra Modi addressed the Combined Commanders Conference at Kevadia in Gujarat on March 6, the first signs of joint manship among the three services were more than evident. The Indian Air Force commanders were wearing Indian Army's combat disruptive camouflage uniform to signal joint spirit and Indian Navy commanders were in their dark grey disruptive camouflage gear.

While PM Modi impressed on joint manship and synergy among the forces, the three services led by the Chief of Defence Staff (CDS) meant business as if spurred by the 100-day eyeball to eyeball stand-off with China's People's Liberation Army (PLA) in east Ladakh. "It was not a business conference of the past. The commanders were told to be battle-ready at all times with the inter-services silos showing signs of breaking and giving way to new military reform," said a senior commander.

PM Modi's address not only charged up the commanders but also has speeded up the process of creation of theatres commands with the announcement of key maritime theatre command and air defence command expected by June this year. The maritime and air defence command will be raised by the 75th year of Indian Independence.

The fact is that the PLA's aggression against India in east Ladakh has really made the Indian military much more responsive and ready for battle than ever before. When the Indian Army was standing up to PLA in Galwan, Gogra-Hot Springs and Pangong Tso, the air force was aggressively patrolling the skies and the navy was harassing Chinese warships with submarines as far as the Gulf of Aden. This posture continues with the navy now questioning each Chinese survey ship, trying to map the Indian Ocean in the name of the mineral and heavy metals survey.

While the IAF is awaiting its next instalment of Rafale fighters from France, the navy is preparing to receive its first of the 24 MH-60R Seahawk multi-role helicopters from the US this year. Called a "ship on a ship" the Seahawk helicopter is a command and control machine proficient in anti-submarine warfare with torpedoes, anti-surface warfare with Hell-Fire missiles and functions as an attack helicopter at sea in a special operations role. The navy will also get six more Boeing P8I, known for anti-submarine warfare, anti-surface warfare and ship interdiction, from the US. "The Indian Navy, henceforth, will project force in the entire Indo-Pacific. The time has come for deployment as the era of naval diplomacy is over," said a senior Admiral.

The new-found attitude of the Indian Army is exemplified by its XIV Corps Commander Lt General PGK Menon, who meets his Chinese counterparts on equal footing if not more. With all the aggressive attitude of a Sikh Regiment soldier, Lt Gen Menon has asked his troops to patrol up to designated points on the Line of Actual Control (LAC) and be prepared for the worst-case scenario. The same mood prevails all along the LAC.

Another attribute of the fundamental changes taking place within the Indian military establishment is accountability from the Military Engineer Services and looking at the Indian



Air Chief Marshal RKS Bhaduria donning Indian Army camouflage in spirit of joint manship at the combined commanders conference at Kevadia in Gujarat.

private sector and not only the Defence Research and Development Organisation (DRDO) for the completion of the Aatmanirbhar Bharat mission. In this context, DRDO is being questioned on delays in the development of weapon systems as well as indigenous content in the proven systems like Brahmos missile, Arjun tank and Tejas fighter. The Indian armed forces finally have decided to shrug off their imperial baggage and are prepared for a more professional tri-service future.

<https://www.hindustantimes.com/india-news/maritime-air-defence-theatre-commands-to-be-announced-by-june-2021-101616478448044.html>

THE ECONOMIC TIMES

Wed, 24 March 2021

Indigenous light choppers get go-ahead, delivery in 2022

By Manu Pubby

Synopsis

The LUH is a homegrown success story, having demonstrated its capability of operating in all kinds of environments, with a focus on high altitude missions that are essential for maintaining troops on the Pakistan and China border.

India is going ahead with an indigenous light utility helicopter (LUH) after it proved it worth during high altitude operations, including at the Daulat Beg Oldie (DBO) airstrip on the China border. The defence ministry has given the go ahead for placing an order for 12 of the choppers, with developer and manufacturer Hindustan Aeronautics NSE -1.37 % Limited (HAL) expected to deliver the first by August next year.

The LUH is a homegrown success story, having demonstrated its capability of operating in all kinds of environments, with a focus on high altitude missions that are essential for maintaining troops on the Pakistan and China border.



A file image of LUH

HAL Chairman R Madhavan told ET that the letter of acceptance for 12 helicopters – six each for the army and air force – has been received and work has started to produce the aircraft. “The LoA has been received and we plan to deliver the first helicopter by next year. The production facility at Tumkur is ready and we will manufacture the choppers there,” he said.

The LUH order is a boost for the Make in India initiative, given that the chopper has been fully designed and developed in house by HAL, borrowing on the expertise gained by older platforms like the Advanced Light Helicopter.

While 12 helicopters are to be ordered in the first lot, the expected requirement of the LUH within the services is pegged at 185. In addition, India and Russia have also been negotiating a deal for the Kamov Ka 226 helicopters for the army and air force to fulfil the large needs of such type of aircraft. The LUH will progressively replace the Chetak and Cheetah helicopters that operate at impossible heights on the border, including the Siachen glacier. Given its new design, the LUH can carry more than eight times the meaningful payload to the highest helipads in the world, as compared to the Cheetahs.

The indigenous chopper has gone through rigorous trials and tests by the services, including at forward helipads on the border. These include test missions from Leh to both the China and Pakistan borders. It has also demonstrated a flawless flight from Bangalore to Leh, a distance of over 3000 km, in three days without any servicing issues.

<https://economictimes.indiatimes.com/news/defence/indigenous-light-choppers-get-go-ahead-delivery-in-22/articleshow/81638498.cms>

India's military set to get its own version of the iconic US Army Humvee

Mahindras will supply 1,300 of light-specialist vehicles for Rs 1,056 crore

By Ajai Shukla

India's military is set to get its own version of the iconic US Army Humvee, the light tactical vehicle that came to symbolise battlefield mobility.

“Ministry of Defence (MoD) signed a contract with Mahindra Defence Systems Ltd (MDSL) for supply of 1,300 Light Specialist Vehicles (LSV) to the Indian Army, at a cost of Rs 1,056 crore, in New Delhi on March 22, 2021. The induction of vehicles is planned to be completed in four years,” stated an MoD press release on Monday.

“The LSV is a modern fighting vehicle and will be authorised to various fighting units for carriage of medium machine guns (MMGs), automatic grenade launchers (AGLs) as well as anti-tank guided missiles (ATGMs),” said the MoD.

The LSV is indigenously designed and developed by MDSL. It is an extremely agile combat vehicle with all round protection against small arms fire. It is intended to assist small independent detachments in the operational area.

MDSL won the contest in which the MoD invited competitive bids from Indian companies in an open tender. The vehicles that were fielded, including the LSV, were put through gruelling trials under different operating conditions, including high altitude, deserts, and plains.

“LSV is the only vehicle which passed all the field, ballistics, and technical trials,” stated MDSL in a press release on Tuesday.

MDS has indigenously designed and developed the LSV with a modular design that they say “makes it future proof.”

“Also, as the OEM (original equipment manufacturer) of the vehicle, MDS has the necessary IP (intellectual property) and capabilities in all aspects from development of the LSV variants to complete life cycle support,” says MDS.

Mr SP Shukla, Chairman, Mahindra Defence Systems Limited, said, “This contract truly signifies success of the Atmanirbhar Bharat (self-reliant India) initiative. It is the first major contract for the advanced armoured tactical vehicles that are designed and developed by the private sector in India with intellectual property rights within the country. This contract paves the way for large scale adoption of Indian platforms with indigenous capabilities.”

One version of the MDS LSV is already in service with Indian Battalion deployed in UN Peacekeeping mission in Africa. Other friendly foreign countries have also sought details of this vehicle for their operations indicating the export potential of this armoured vehicle developed and made in India.

<https://www.ajaiShukla.com/2021/03/indian-army-to-get-its-own-humvee.html>



The Mahindra light specialist vehicle in UN colours. The firm will supply 1,300 of these vehicles for Rs 1,056 crore

From Scorpio to missile launching armored vehicles – Mahindra to add much needed firepower to the Indian Army

By Younis Dar

The Indian Defense Ministry has signed a Rs 1,056-crore contract with Mahindra Defence Systems Ltd (MDSL) for the supply of 1,300 Light Specialist Vehicles (LSVs) to the Army. The induction of vehicles is planned to be completed in four years.

According to a statement from the ministry, “The LSV is a modern fighting vehicle and will be authorized to various fighting units for the carriage of medium machine guns, automatic grenade launchers as well as anti-tank guided missiles.”

The vehicle is indigenously designed and developed by MDSL. These combat vehicles are extremely agile with all-round protection against small arms fire and will assist small independent detachments which are required to operate this weapon platform in the operational area, the statement adds.

The step is another push by the Narendra Modi government towards self-reliance in defense production, in sync with the ‘Atmanirbhar Bharat’ and ‘Make in India’ initiatives.

According to Mahindra Defence, the Armoured Light Specialist Vehicle (ALSV) is a key product, designed and developed by the company within just 24 months.

“The vehicle has successfully passed rigorous trials conducted by the Indian Army in multiple terrains, operating successfully in temperatures ranging from a scorching 45°C in the Thar Desert to a freezing -15°C in the Himalayas. The vehicle provides a high degree of ballistics protection and excellent maneuverability over rugged terrain.”

The Mahindra LSV is a light armored specialist vehicle built for use by military and defense forces. It’s designed to be a modular type vehicle allowing for efficient maintenance and it can be upgraded or configured in the field for a wide variety of operational roles.

The vehicle provides protected mobility for the front, side, and rear as per STANAG Level I Ballistics and Blast for four crewmembers with a battle load having ample stowage space for arms and ammunition inside the crew compartment and an additional 400 kg of cargo load-carrying capacity. It can also be upgraded to STANAG – II Ballistics.

What makes the armored vehicle stand out is its powerful 3.2 Lts, 215 HP multi-fuel diesel engine with 4/6 Speed Automatic Transmission, 4X4 with front and rear differential locks, 1,000 Kgs payload capacity, self-recovery winch, and high travel all-wheel independent suspension with central type inflation system.

The LSV can also cruise at a maximum speed of 120 kmph, with an acceleration of 0 to 60 kmph in 12 seconds. The vehicle is capable of going 50 km run-flat system on all five wheels.

As the armed forces in India expand the scope of their operations across the country, the need for personnel protection vehicles is growing. Such vehicles are crucial for the paramilitary and army engaged in offensive roles, patrolling, intelligence gathering, battlefield reconnaissance, and weapon deployment missions.

The estimated requirement of such light armored vehicles for the army is projected at around 4000, with about 1500 light bullet-proof vehicles and 4500 light specialist vehicles. The LSVs are employed by the Indian Army, CRPF, NSG, Marcos, Border Security Forces, and various commando units.

Kalyani M4

Just last month, the Army ordered an emergency procurement of M4 armored vehicles, worth Rs 177.95, to bolster its inventory. The vehicle was tested in Ladakh during the standoff with China and is manufactured by the Pune-based defense company Bharat Forge of the Kalyani group. Although the procurement order is small, the army expects to increase the number of such armored vehicles in the near future.

The Kalyani M4 is a multi-role platform, designed to meet the requirements of the armed forces for quick mobility in rough terrain and in areas affected by mine and IED threats. M4's ballistic and blast protection from up to 50 kg TNT side blast makes it a unique choice for operations in conflict zones.

The vehicle is capable of withstanding the IED or roadside bombs, thanks to its design, built on a flat-floor monocoque hull. The thrust speed of 140 km per hour and the vehicle's ability to carry a payload of 2.3 tons gives the forces a unique advantage in maneuvering inhospitable situations.

Modeled on Paramount's Mbombe 4 armored vehicle, which has seen international success in a number of markets, M4 boasts of next-generation design, advanced technologies, and the highest levels of protection.

The Indian armed forces already use a wide variety of armored vehicles for anti-terror operations in J&K and Naxal areas in multiple states, besides the border patrols. To respond to various contingencies with enhanced maneuverability, survivability, and combat, specialist combat vehicles play a crucial role in the armed forces to neutralize threats quickly.

Some of the prominent armored vehicles include the Renault Sherpa, Mahindra Marksman, Viper, Tata Merlin LSV, Mahindra Armoured MEVA Straton Plus, and other LSV models in use with the Indian armed forces.

The Growing Demand

Due to their unique operational versatility, the demand for light armored vehicles is only expected to grow with changing security scenario in India. The scope of integration of various weapon stations and communication facilities for command control aboard such vehicles lend them crucial value within the armed forces.

They are also deployed for multipurpose activities like recce operations, border patrol, and quick attacks, and ergonomics.

The demand for such vehicles has pushed many firms to innovate and set up R&Ds and ink JVs with foreign defense companies. The private sector is expected to ramp up its armored vehicle offerings to meet the growing requirements of armed forces, with many big players like Mahindra, Tata, Kalyani, and Ashok Leyland already in the fray.

<https://eurasianimes.com/indian-army-adds-mahindra-lsv-to-its-fast-growing-inventory-of-light-armored-vehicles/>

Indian Army signs contract for 1.7 million medals

Soldiers are awarded medals for gallantry and distinguished service among other key landmarks in their military careers

By Rahul Singh

New Delhi: Soldiers will no longer have to buy replicas of medals from the market, with the Indian Army on Tuesday announcing that it has concluded a contract for procuring 1.7 million medals.

Soldiers are awarded medals for gallantry and distinguished service among other key landmarks in their military careers.

Resolving a decade-old problem, the army said it has signed a contract for 17 different types of medals. “Integrated Headquarters of Ministry of Defence (Army) has concluded a contract for procurement of a total of 17.27 lakh service medals of 17 different types,” it said on Twitter.

“The procurement has enabled Indian Army to meet all outstanding demands of service medals in respect of soldiers who have served and are serving in the Indian Army,” the army added.

In contrast to original medals, the replica medals do not have the names of the soldiers and their service numbers engraved on them. For almost 10 years, soldiers have been purchasing medals from the market as the army grappled with the shortage.

Soldiers could just approach shops selling service medals and buy them as per their requirement, an official familiar with the matter said. There was no need to produce any certificate to make the purchase.

Gopinath Bazar in Delhi Cantt is a popular place for soldiers to buy replica medals. Other cantonments in the country also have shops that sell medals and other military items such as uniforms and boots. Soldiers and veterans wear these medals only during ceremonial functions.

While there was no shortage of medals awarded to soldiers for gallantry, the defence ministry’s department of medals had failed to issue other varieties of medals, another official said on condition of anonymity.

In 2016-17, the medals department was saddled with more than 1.4 million medals of various types.

The soldiers, by default, are entitled to a variety of medals after completing a certain number of years in service, serving in difficult areas or taking part in various operations.

<https://www.hindustantimes.com/india-news/indian-army-signs-contract-for-1-7-million-medals-101616530209175.html>



For almost 10 years, soldiers have been purchasing medals from the market as the army grappled with the shortage. (PTI)

Wed, 24 March 2021

South Korea Defence Minister heads to India; Indo-Pacific, Minesweepers, cyberspace, military drills on the agenda

Sources have confirmed to Financial Express Online “The defense Minister of South Korea is arriving in New Delhi on Thursday (March 25, 2021).

Accompanied by senior officers of his ministry the visiting dignitary will meet his Indian counterpart Rajnath Singh, for a ministerial level meeting.”

By Huma Siddiqui

The Defense Minister of South Korea Suh Wook is visiting India later this week to discuss Indo-Pacific, Quad, military to military cooperation, and deeper cooperation in defense production. The two sides will also discuss regional security and multilateral cooperation, and Korean Peninsula.

Sources have confirmed to Financial Express Online “The defense Minister of South Korea is arriving in New Delhi on Thursday (March 25, 2021). Accompanied by senior officers of his ministry the visiting dignitary will meet his Indian counterpart Rajnath Singh, for a ministerial level meeting.”

He is going to be here on a three day visit during which as per sources he is the chief guest at a ceremony which has been planned for the inauguration of the “Indo-Korean Friendship Park” in New Delhi. This park has been established as per the agreement between the two countries in 2019. Due to the global lockdown due to the COVID-19 pandemic everything had to be pushed back, including the visit of the minister.

Indo-Korean Friendship Park

This is a monument which has been created to mark the sacrifice and commitment of Indian troops during the 1950-53 Korean War. According to the data of the government of Korea, during the war, India had sent its 60th Parachute Field Ambulance Platoon of 627 medics. And these medics played a very critical role in taking care of around 220,000 soldiers and civilians. This has been developed by the Indian Army and is in association with the Embassy of the Republic of Korea (ROK) in India and the Korean War Veterans Association.



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India-South Korea Defense Cooperation

Bilateral relations were elevated to Special Strategic Partnership in 2015. And both countries have been in discussions for several military platforms and weapons, especially naval shipbuilding. While South Korea considers India as a key partner in the region, India looks at South Korea a major partner under the ‘Act East Policy’.

The two countries have already inked a logistics agreement. This agreement helps the Indian Navy while operating in the Indo-Pacific Region and in interoperability.

When Indian Army Chief visited South Korea

Last year on December 28, 2020, the Indian Army chief Gen MM Naravane visited South Korea. It was a three day visit where he held talks with the top defence brass of the country, and focussed on exploring ways of expanding bilateral military cooperation.

In South Korea Gen Naravane had met the country’s minister for national defence, army chief and chairman of Joint Chiefs of Staff, and had met South Korea’s minister of defence acquisition

planning administration (DAPA) too. He had also visited the Korea Combat Training Centre in Gangwon province and Advance Defence Development (ADD) facility at Daejeon.

Interesting Factoid: His visit to that country took place two weeks after concluding a six-day tour of the United Arab Emirates (UAE) and Saudi Arabia.

The South Korean minister is already in UAE on a four day visit, and he will travel from there to India.

The visit of the minister from South Korea comes following the recently concluded visit of the US Secretary of Defense Lloyd Austin, who had visited that country before heading to New Delhi last weekend.

Will South Korea be QUAD Plus?

Quad had recently concluded the first ever Leaders Summit which was called by the US President Joe Biden. Prime Minister Narendra Modi, Prime Minister of Australia Scott Morrison, and Prime Minister of Japan Yoshihide Suga joined the talks virtually.

This grouping of countries has sent a strong signal to China and has enhanced cooperation among the major maritime powers in the Indo Pacific. And according to experts has worked effectively in an expanded framework of Quad plus (with the inclusion of Vietnam, South Korea and New Zealand) to coordinate policies and responses in dealing with the global pandemic.

Members of the Quad have been focussing on working with the ASEAN keeping ASEAN centrality in mind.

As has been reported earlier by Financial express Online, in recent months there has been interest from countries like the UK, France, and Germany who have come up with their own versions of an Indo Pacific strategy to work together with like minded countries of the Quad in maintaining a rules-based, free and open Indo Pacific.

Quad + ASEAN: They will work towards Blue economy, white shipping agreements, coastal surveillance, offshore patrolling capabilities, maritime drills, Hydrographic services, and information sharing for increased maritime domain awareness.

Defence Projects to be discussed

Once again the South Korean delegation is expected to discuss the \$ 3 billion Self Propelled Air Defence Gun Missile System (SPAD-GMS) deal. This was a deal in which South Korea's Hanhwa Defense had emerged as the lowest bidder after beating the Russian competitor.

Also there could be discussions on the Mine-counter measure vessels (MCMVs) which Indian Navy is keen to procure to fill gaps in the navy's mine warfare capability.

Highly placed sources had recently told the Financial Express Online that it is also open to the idea of leasing the MCMVs to fill the gap until they are built at the Indian Goa Shipyard through Transfer of Technology (ToT), under the 'Make in India' initiative.

These minesweepers are considered vital for keeping the sea lanes safe and are deployed by the navies to help secure the harbours by locating and destroying underwater mines.

India's Act East Policy

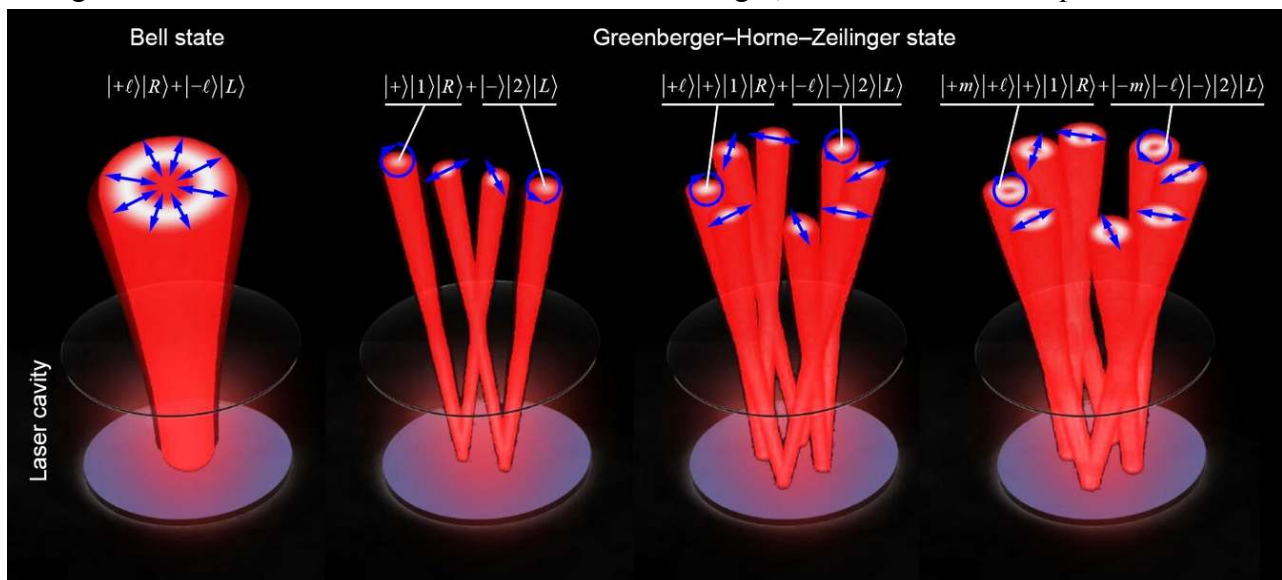
As reported earlier, in 2019, when the defence minister Rajnath Singh had visited South Korea he had invited the top defence majors to participate in various defence projects in India. The companies specializing in military platforms in South Korea are allowed to Transfer Technology as there are no laws to stop the transfer.

<https://www.financialexpress.com/defence/south-korea-defence-minister-heads-to-india-indo-pacific-minesweepers-cyberspace-military-drills-on-the-agenda/2218744/>

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A simple laser for quantum-like classical light

Tailoring light is much like tailoring cloth, cutting and snipping to turn a bland fabric into one with a desired pattern. In the case of light, the tailoring is usually done in the spatial degrees of freedom, such as its amplitude and phase (the 'pattern' of light), and its polarization, while the cutting and snipping might be controlled with spatial light modulators and the like. This burgeoning field is known as structured light, and is pushing the limits in what we can do with light, enabling us to see smaller, focus tighter, image with wider fields of view, probe with fewer photons, and to pack information into light for new high-bandwidth communications. Structured light has also been used to test the classical-quantum boundary, pushing the limits with what classical light can do for quantum processes, and vice versa. This has opened the intriguing possibility of creating classical light that has quantum-like properties—as if it is 'classically entangled.' But how to create and control such states of light, and how far can one push the limits?



A simple laser comprising just two standard mirrors was used to create higher-dimensional classically entangled light, a new state of the art, deviating from the prevailing paradigm of two-dimensional Bell states. The approach combines internal generation, in-principle unlimited in what can be created, with external control, allowing user-defined states to be molded. Shown here are examples of two-dimensional Bell (left) and high-dimensional states (right), including the famous GHZ states. Credit: Yijie Shen, Isaac Nape, Xilin Yang, Xing Fu, Mali Gong, Darryl Naidoo and Andrew Forbes

The prevailing tools for structuring light from lasers is hindered by the complexity of the specialized lasers needed, often requiring customized geometries and/or elements, while the prevailing two-dimensional paradigm of using only pattern and polarization, means accessing two-dimensional classically entangled light, mimicking quantum qubits, 1s and 0s. An example of this would be the well-known quantum Bell states, shown in Figure 1 (left), which as classical light appears as vectorial structured light, combining the two degrees of freedom of 'pattern' and 'polarization.' These two degrees of freedom mimic the two dimensions of the qubit quantum state. To create higher dimensions requires finding more degrees of freedom in a system seemingly constrained to just two.

In their paper "Creation and control of high-dimensional multi-partite classically entangled light," Chinese and South African scientists report on how to create arbitrary dimensional

quantum-like classical light directly from a laser. They use a very simple laser available in most university teaching laboratories to show eight dimensional classically entangled light, a new world record. They then go on to manipulate and control this quantum-like light, creating the first classically entangled Greenberger-Horne-Zeilinger (GHZ) states, a rather famous set of high-dimensional quantum states, shown in Figure 1.

"Theorists have long suggested all the applications that would be possible with such quantum-like light, but the lack of any creation and control steps has prohibited any progress. Now we have shown how to overcome this hurdle," says Dr. Shen from Tsinghua University (present senior research fellow in University of Southampton), the lead author of the paper.

Traditionally, exotic structured light from lasers requires equally exotic laser systems, either with custom elements (metasurfaces for example) or custom geometries (topological photonic based for example). The laser built by the authors contained only a gain crystal and followed textbook design with just two off-the-shelf mirrors. Their elegant solution is itself built on a principle embedded in quantum mechanics: ray-wave duality. The authors could control both path and polarization inside the laser by a simple length adjustment, exploiting what is called ray-wave duality lasers.

According to Prof. Forbes, the project supervisor, "what is remarkable is not only that we could create such exotic states of light, but that their source is as simple a laser as you could possibly imagine, with nothing more than a couple of standard mirrors." The authors realized that the crucial "extra" degrees of freedom were right in front of their eyes, needing only a new mathematical framework to recognize them. The approach allows in-principle any quantum state to be created by simply marking the wave-like rays that are produced by the laser and then externally controlling them with a spatial light modulator, molding them to shape. In a sense, the laser produces the dimensions needed, while later modulation and control molds the outcome to some desired state. To demonstrate this, the authors produced all the GHZ states, which span an eight dimensional space.

Because no-one had ever created such high-dimensional classically entangled light, the authors had to invent a new measurement approach, translating tomography of high-dimensional quantum states into a language and technique suitable for its classical light analog. The result is a new tomography for classically entangled light, revealing its quantum-like correlations beyond the standard two dimensions.

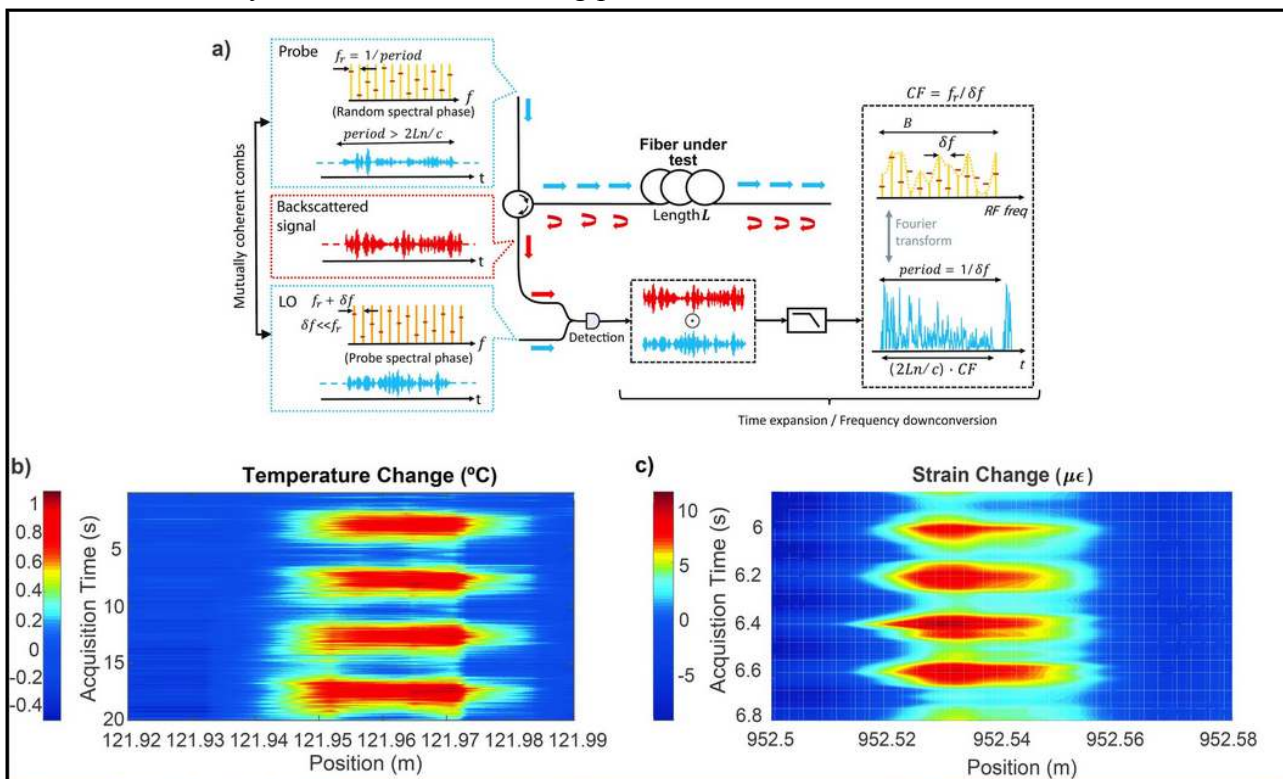
This work provides a powerful approach to creating and controlling high-dimensional classical light with quantum-like properties, paving the way for exciting applications in quantum metrology, quantum error correction and optical communication, as well as in stimulating fundamental studies of quantum mechanics with much more versatile bright classical light.

More information: Yijie Shen et al, Creation and control of high-dimensional multi-partite classically entangled light, *Light: Science & Applications* (2021). DOI: [10.1038/s41377-021-00493-x](https://doi.org/10.1038/s41377-021-00493-x)

Journal information: [Light: Science & Applications](https://phys.org/news/2021-03-simple-laser-quantum-like-classical.html)
<https://phys.org/news/2021-03-simple-laser-quantum-like-classical.html>

Time-expanded phase-sensitive optical time-domain reflectometry

Distributed optical fiber sensing (DOFS) is currently a mature technology that allows 'transforming' a conventional fiber optic into a continuous array of individual sensors, which are distributed along its length. Between the panoply of techniques developed in the field of DOFS, those based on phase-sensitive optical time-domain reflectometry (Φ OTDR) have gained a great deal of attention, mainly due to their ability to measure strain and temperature perturbations in real time. These unique features, along with other advantages of distributed sensors (reduced weight, electromagnetic immunity and small size) make Φ OTDR sensors an excellent solution for monitoring large infrastructures (like bridges and pipelines), especially when considering that their cost scales inversely to the number of sensing points, and its resolution can achieve a few meters.



(a) Working principle of the TE-OTDR technique. The fiber under test is probed by an optical frequency comb with a tooth spacing and a random spectral phase profile. The impulse response of the fiber is encoded on the backscattered signal generated by the propagation of the probe comb. This signal is beaten with a local oscillator, which is another optical frequency comb with the same random spectral phase profile. The LO and the probe comb are composed of the same number of lines, but the line spacing of the LO is slightly higher by an amount δf . The detection stage consists in a balanced photodetector followed by an electrical low-pass filter. The beating between lines of the probe comb and the neighboring lines of the LO comb results in a radiofrequency comb with a tooth spacing that is given by δf . This entails a down-conversion of the optical bandwidth, being the compression factor CF the ratio between f_r and δf . Alternatively, the above process can be understood in the time domain as a large time expansion of the detected signal. (b) Temperature map of a hot point with 2 cm of length measured by the TE-OTDR scheme. A perturbation of 0.2 Hz is recovered. (c) Dynamic strain map around a 4 cm of length obtained by means of the range-extended TE-OTDR scheme. A perturbation of 5 Hz is recovered in this case. Credit: Miguel Soriano-Amat, Hugo F. Martins, Vicente Durán, Luis Costa, Sonia Martin-Lopez, Miguel Gonzalez-Herraez and María R. Fernández-Ruiz

In a new paper published in *Light Science & Applications*, a team of scientists from the University of Alcalá, University Jaume I and the Spanish Research Council (CSIC) presents a novel fiber optic interrogator to conduct Φ OTDR. It is based on a well-known interferometric technique that employs two mutually coherent optical frequency combs. This new interrogator

allows strain and/or temperature sensing with resolutions on the cm scale over up to 1 km range (i.e., it provides >104 sensing points distributed along the optical fiber). In view of the reported results, this approach opens up the door for cost-effective DOFS in short range and high-resolution applications, such as structure health monitoring of aerospace components and wellbore production surveillance, which to date have a prohibitive cost.

The technique presented in the paper, called time-extended Φ OTDR (TE- Φ OTDR), relies on the use of a smartly engineered ultra-dense optical frequency comb to probe a sensing fiber. A weak return signal is then originated by the elastic scattering experienced by the light. This signal is detected by making it interfere with a second comb, which has a bandwidth and spectral phase coding similar to that of the probe, but a different tooth spacing. The result is a multi-heterodyne interference that produces a "time extension" of the detected signals (see Figure). In the frequency domain, this process can be understood as a frequency 'down-conversion' (an optical-to-electrical mapping). In the dual-comb scheme developed for DOFS, both combs are generated from the same continuous wave laser, thanks to a couple of electro-optical modulators driven by a single arbitrary waveform generator.

Some remarkable features of this scheme are: (i) the flexibility in the design of the combs, which allows the user to achieve the targeted performance for the sensor; (ii) the reduced detection bandwidth (in the sub-megahertz regime for centimeter resolution over 200 meters), which is a consequence of the time-extension experienced by the detected signals; and (iii) the capability of maximizing the power injected into the sensing fiber. This last feature is fundamental to carry out real distributed sensing, given the extreme weakness of the elastic scattering phenomenon. By introducing a controlled random phase profile in the generated combs, the peak power of the optical signals can be minimized, while preserving a high average power to improve the sensor's signal to noise ratio. In addition, the encoded phase is automatically demodulated upon detection, requiring no further post-processing.

"The sensing scheme based on a conventional dual-comb scheme allows us to reach cm-scale resolutions over sensing ranges of a few hundreds of meters, while keeping a measurement rate of tens of hertz. In the paper, we also introduce a strategy to significantly extend the sensing range without reducing the acoustic sampling rate. The basic idea is to employ two frequency combs with very dissimilar tooth spacing, so the generated time signals have quasi-integer-ratio periods. This scheme, previously applied to the field of spectroscopy, makes it possible to measure fibers up to 1 km length with a spatial resolution of 4 cm. This means 25,000 individual sensing points along the fiber. This performance improvement is at the cost of increasing to some extent the detection bandwidth (up to a few megahertz), as well as the complexity of the processing algorithm, although still retaining the fundamental advantages of the method."

"The presented techniques expose a completely new operation arena for dynamic Φ OTDR-based sensors, which was limited to fields requiring sensing along tens of kilometers and meter-scale resolutions to arise as a worthwhile solution. The results demonstrated in the paper are a promising step to design distributed sensor providing fast acquisition speed, small detection bandwidth and sharp spatial resolution," they added.

More information: Miguel Soriano-Amat et al, Time-expanded phase-sensitive optical time-domain reflectometry, *Light: Science & Applications* (2021). DOI: [10.1038/s41377-021-00490-0](https://doi.org/10.1038/s41377-021-00490-0)

Journal information: [Light: Science & Applications](https://www.nature.com/journal/41377)

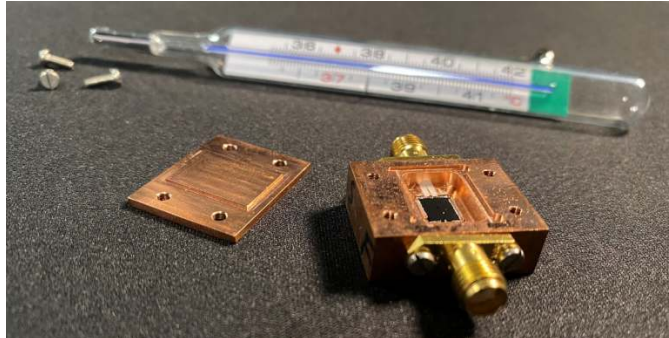
<https://phys.org/news/2021-03-time-expanded-phase-sensitive-optical-time-domain-reflectometry.html>

Novel thermometer can accelerate quantum computer development

By Christian Borg

Researchers at Chalmers University of Technology, Gothenburg, Sweden, have developed a novel type of thermometer that can simply and quickly measure temperatures during quantum calculations with extremely high accuracy. The breakthrough provides a benchmarking tool for quantum computing of great value—and opens up for experiments in the exciting field of quantum thermodynamics.

Key components in quantum computers are coaxial cables and waveguides—structures that guide waveforms and act as the vital connection between the quantum processor and the classical electronics that control it. Microwave pulses travel along the waveguides to the quantum processor, and are cooled down to extremely low temperatures along the way. The waveguide also attenuates and filters the pulses, enabling the extremely sensitive quantum computer to work with stable quantum states.



The new quantum thermometer on a chip, in the foreground. It is probably the world's fastest and most sensitive thermometer for measuring temperature at the cold end of a waveguide at the millikelvin scale, according to the Chalmers researchers. Credit: Claudia Castillo Moreno/Chalmers University of Technology

In order to maximize control over this mechanism, the researchers need to be sure that these waveguides are not carrying noise due to thermal motion of electrons on top of the pulses that they send. In other words, they have to measure the temperature of the electromagnetic fields at the cold end of the microwave waveguides, the point where the controlling pulses are delivered to the computer's qubits. Working at the lowest possible temperature minimizes the risk of introducing errors in the qubits.

Until now, researchers have only been able to measure this temperature indirectly, with relatively large delay. Now, with the Chalmers researchers' novel thermometer, very low temperatures can be measured directly at the receiving end of the waveguide, accurately and with extremely high time resolution.

"Our thermometer is a superconducting circuit, directly connected to the end of the waveguide being measured. It is relatively simple—and probably the world's fastest and most sensitive thermometer for this particular purpose at the millikelvin scale," says Simone Gasparinetti, assistant professor at the Quantum Technology Laboratory, Chalmers University of Technology.

Important for measuring quantum computer performance

The researchers at the Wallenberg Centre for Quantum Technology, WACQT, have the goal to build a quantum computer based on superconducting circuits with at least 100 well-functioning qubits performing correct calculations by 2030. It requires a processor working temperature close to absolute zero, ideally down to 10 millikelvin. The new thermometer gives the researchers an important tool for measuring how good their systems are and what shortcomings exist—a necessary step to be able to refine the technology and achieve their goal.

"A certain temperature corresponds to a given number of thermal photons, and that number decreases exponentially with temperature. If we succeed in lowering the temperature at the end where the waveguide meets the qubit to 10 millikelvin, the risk of errors in our qubits is reduced

drastically," says Per Delsing, Professor at the Department of Microtechnology and Nanoscience, Chalmers University of Technology, and leader of WACQT.

Accurate temperature measurement is also necessary for suppliers who need to be able to guarantee the quality of their components, for example, cables that are used to handle signals down to quantum states.

New opportunities in the field of quantum thermodynamics

Quantum mechanical phenomena such as superposition, entanglement and decoherence mean a revolution not only for future computing but potentially also in thermodynamics. It may well be that the thermodynamic laws somehow change when working down at the nanoscale in a way that could one day be exploited to produce more powerful engines, faster-charging batteries, and more.

"For 15 to 20 years, people have studied how the laws of thermodynamics might be modified by quantum phenomena, but the search for a genuine quantum advantage in thermodynamics is still open," says Simone Gasparinetti, who recently started his own research group and plans to contribute to this search with a novel range of experiments.

The new thermometer can, for example, measure the scattering of thermal microwaves from a circuit acting as a quantum heat engine or refrigerator.

"Standard thermometers were fundamental for developing classical thermodynamics. We hope that maybe, in the future, our thermometer will be regarded as pivotal for developing quantum thermodynamics," says Marco Scigliuzzo, doctoral student at the Department of Microtechnology and Nanoscience, Chalmers University of Technology.

More information: Marco Scigliuzzo et al, Primary Thermometry of Propagating Microwaves in the Quantum Regime, *Physical Review X* (2020). [DOI: 10.1103/PhysRevX.10.041054](https://doi.org/10.1103/PhysRevX.10.041054)

Journal information: [Physical Review X](https://phys.org/news/2021-03-thermometer-quantum.html)
<https://phys.org/news/2021-03-thermometer-quantum.html>

Aspirin may reduce deaths in severe COVID-19

By James Kingsland

- *Many people who are hospitalized with COVID-19 have excessive blood clotting, which can be fatal.*
- *A pilot study of hospitalized patients suggests that a low dose of the anticoagulant aspirin could reduce the need for mechanical ventilation and admission to intensive care, as well as the risk of dying.*
- *A larger clinical study will be necessary to confirm the findings.*

Early in the pandemic, research showed that almost one-third of people with COVID-19 in intensive care experienced potentially fatal complications as a result of excessive blood clotting.

Another study^{Trusted Source} found that many of these patients had unusually “sticky” blood that tended to coagulate easily.

“As we learned about the connection between blood clots and COVID-19, we knew that aspirin — used to prevent stroke and heart attack — could be important for COVID-19 patients,” says Jonathan Chow, M.D., assistant professor of anesthesiology and critical care medicine at the George Washington University School of Medicine and Health Sciences in Washington, D.C.

By “thinning” the blood, aspirin helps prevent the formation of clots, or thrombi, that can block the blood vessels supplying the heart, brain, lungs, and other vital organs.

One widely recognized limitation of aspirin as a preventive treatment is that it leads to a small increase in the risk of bleeding.

Given the low cost of aspirin and the evidence of its overall safety and efficacy in cardiovascular disease, however, Dr. Chow and his colleagues decided to conduct a pilot study of hospitalized patients with COVID-19.

Their analysis suggests that a low dose of aspirin shortly before or after hospital admission is associated with a significantly reduced risk of mechanical ventilation, admission to intensive care, and in-hospital mortality.

At the same time, the researchers found no evidence that aspirin increased the risk of bleeding.

“Aspirin is low cost, easily accessible, and millions are already using it to treat their health conditions,” says Dr. Chow. “Finding this association is a huge win for those looking to reduce risk from some of the most devastating effects of COVID-19.”

In addition to preventing clotting, aspirin reduces levels of an immune signaling molecule or cytokine called interleukin-6 (IL-6) in the blood. The molecule is associated with the immune overreaction, or “cytokine storm,” that can affect people with COVID-19 in intensive care.

The study features in the journal *Anesthesia & Analgesia*.

Study design

The authors emphasize that other researchers will need to conduct randomized controlled clinical trials to confirm their findings.

Their retrospective study analyzed the records of 412 adults with COVID-19 who were admitted to one of several hospitals in the United States between March 2020 and July 2020.

Of these people, 98 took aspirin in the week before admission or during the first 24 hours after admission. The researchers compared the outcomes for these individuals with those for the 314 people who did not take aspirin.

Among those taking aspirin, the median daily dose was 81 milligrams, and the median length of treatment was 6 days.

In their analysis of the data, the researchers accounted for other variables that scientists have shown to affect the severity of COVID-19, including age, sex, body mass index, race, hypertension, and diabetes.

After these adjustments, aspirin use was associated with a 43% reduced risk of intensive care unit admission, a 44% reduced risk of mechanical ventilation, and a 47% reduced risk of dying in the hospital.

While there was no evidence that aspirin increased the risk of bleeding, the authors recommend caution:

“Until a randomized controlled trial of aspirin is performed, it is imperative to exercise cautious optimism and deliberately balance aspirin’s known risks against its potential benefits in patients afflicted by COVID-19.”

Large and small clots

Interestingly, the researchers found no difference in overt thrombosis between the aspirin and non-aspirin groups. Overt thrombosis is the term for large blood clots that show up in standard diagnostic images.

However, they point out that the number of cases of thrombosis in the two groups was low, which limits the statistical reliability of this finding.

In addition, they note that small blood clots, called microthrombi, are difficult to spot without the use of more specialist, nonstandard imaging techniques.

The researchers acknowledge that their sample size was modest and that the study was observational, meaning that it could not prove that aspirin reduced the severity of COVID-19 in hospitalized patients.

The people who took aspirin may have received different medical treatments due to their underlying conditions, for example, which would skew the results.

The researchers were also unable to account for other medications that people may have been taking that could increase their risk of blood clots, such as birth control pills and hormone replacement therapy (HRT).

<https://www.medicalnewstoday.com/articles/aspirin-may-reduce-deaths-in-severe-covid-19#Large-and-small-clots>

