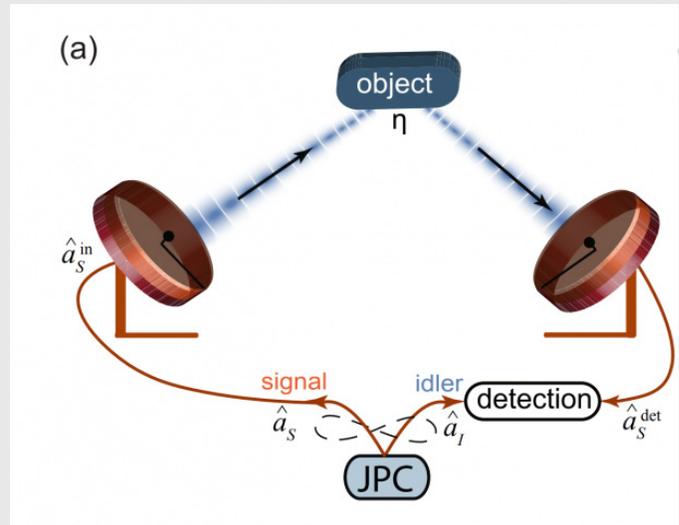


# AOC ISSUE REPORT

## UNDERSTANDING QUANTUM RADAR | OCT 2019

In the summer of 2019 Shabir Barzanjeh and his colleagues at the Institute of Science and Technology Austria used entangled microwaves to create the world's first quantum radar. What is a quantum radar, and what are the implications for the development of this technology?

In the simplest terms, the concept is to create a stream of entangled visible-frequency photons and split it in half using a superconducting device called a Josephson parametric converter. The first photon (signal photon) goes through a conversion to microwave frequencies and is beamed toward the object of interest just like a normal radar system. The second photon (idler photon) is stored. When the signal photon arrives after its interference (echo/reflection) with the object of interest, it is converted back into photons and compared with the idler photon, creating a signature that reveals how far the signal photon has traveled.<sup>i</sup>



This “quantum entangled pair” interacts in a process called quantum illumination, where information about one particle’s environment can be inferred by studying the other particle.

A classical radar functions by transmitting a directional beam of radiation (generally between 3 MHz and 40,000 MHz), and then utilizing a receiver, reflections of that pulse are detected, which allow for the calculation of location and speed of the object of interest.

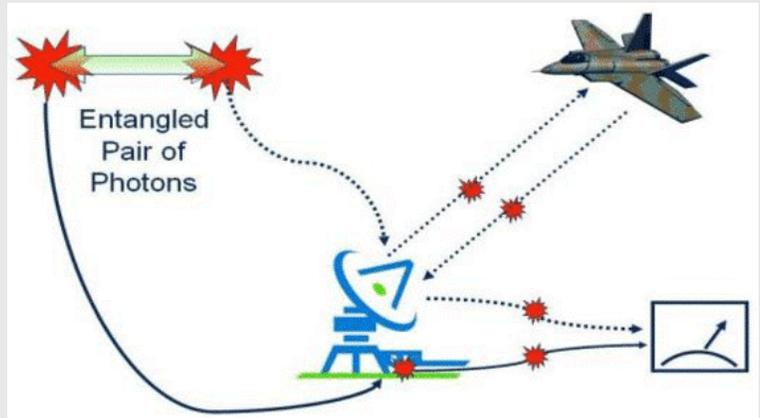
Overcoming or defeating a radar system has been achieved by jamming the radar and also in the last decades utilizing stealth technology (also known as low observable technology) to reduce the radar signature of aircraft – from covering aircraft with radar-absorbent material to designing aircraft shape to minimize the radar cross section.

A quantum radar, should it be successfully developed, would offer significant benefits and improvements from a traditional radar. First, quantum radars will not need to emit the level of energy of a traditional radar – effectively 9-10 orders of magnitude lower power. Traditional radar must use powerful transmitters because the background noise is always significant (generally around 1,000 microwave photons at any instant). A quantum radar (again, if developed) will be able to filter out this noise because it is operating at the single photon level - the signal and idler photons are similar/matched, and the system is seeking to compare the two.<sup>ii</sup> Thus, the lower power levels would make a quantum radar more difficult to detect. Additionally, quantum radar

offers precision that traditional radar does not. It could offer the ability to determine an aircraft's shape, speed, and size.

There has been significant theorizing and public concern that quantum radar would neutralize the advantages of stealth. In 2016 the China Electronics Technology Group Corporation (CETC) reported that it has tested a quantum radar with the capability to detect stealth aircraft at a range of 62 miles.

Most do not believe the Chinese claim, because the great challenge to build a functional quantum radar is that of de-coherence. This is the loss of "quantumness," or coherent entanglement of the photon pairs, as the transmitted photon passes through a lossy medium, such as the atmosphere.<sup>iii</sup>



Much remains to be discovered and developed, but should a functional quantum radar be built, it would provide a higher resolution image, and it would also create challenges of detecting the radar because it would operate at much lower power levels. Given that, many scientists agree that the anti-stealth claims of quantum radar are exaggerated, yet there is still more that we need to learn.<sup>iv</sup>

And like any new technology, it must be developed, and that requires significant investment. According to Seth Lloyd, a professor of mechanical engineering and physics at the Massachusetts Institute of Technology, a prototype quantum radar could be five to ten years away: "There is still some fundamental science to be done, but in a couple of years it will no doubt have more applied engineering that can turn it into a real technology – all contingent on funding."

<sup>i</sup> <https://www.technologyreview.com/s/614160/quantum-radar-has-been-demonstrated-for-the-first-time/>

<sup>ii</sup> Ibid

<sup>iii</sup> Haystead, John, "Quantum Radar See the Light," *Journal of Electronic Defense*, July 2018, p. 25.

<sup>iv</sup> <https://eandt.theiet.org/content/articles/2019/04/could-quantum-radars-expose-stealth-planes/>