On the Behaviour of Some Quantum Radar Researchers - Supplementary Information

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Abstract: Quantum Radar (QR) represents a significant failure in the global research system. This topic has been studied for over fifteen years, with the production of hundreds of publications, but with no real-word applications nor significant results. Even before any experimental phase, simple evaluations could have shown the lack of effectiveness of QR in all real applications. This "negative" result was ignored, or censored, for a long period of time. This unfortunate situation may be explained by (i) a not adequate evaluation process, (ii) Pareto's analysis of belief, and (iii) some researchers networking. Some examples of the damaging effects of this situation, with particular attention to (iii), are presented in this work.

1. Submissions of some Quantum Radar Papers

1.1. First Case - *Submission to MDPI Sensors Journal*

A manuscript with the main evaluations described in [1], entitled *"On Target Detection by Quantum Radar as a Comparison to Noise Radar"* was submitted on 4 December 2023 to the MDPI **Sensors** Journal by G. Galati and G. Pavan.
The comments by three Referees (*red in Italic*) include the following.

> *The working principle and theoretical validation about quantum radar should be provided. Now, many concepts are much confused. Lack of theoretical analysis and experimental validation. The Authors suggest that no research should have been done at all about quantum radar, which is obviously an absurd statement. On the whole, this paper seems a personal point of view of the Authors, which is occasionally offensive towards solid scientists, and comes a bit too late to be considered as publication. I can't suggest publication.*

In all the Referee's comments, the Authors noticed **the total absence of any objection on the core neither of the work, nor on the concluding quantitative evaluations**.
The only substantial, specific comment are in the following.

> *In 2018 China's Electronic Technology Group Corporation presented the world's first long-range quantum radar worked up to 61 miles out.*

About this statement, there is no evidence or any refereed publication [2], but only some advices and ads on the WEB, e.g.:

https://www.popsci.com/china-quantum-radar-detects-stealth-planes-missiles/

https://www.scmp.com/news/china/science/article/3147309/chinese-team-says-quantum-physics-project-moves-radar-closer.

Moreover, on the same topic, from [3], we read:

"In mid-September 2016, however, researchers from China's Electronic Technology Group Corporation revealed the world's first long-range quantum radar. Each particle this experimental system fires had an entangled partner held back at the sensor. Thanks to the quirky rules of quantum entanglement, anything these emitted particles encountered—including the radar-numbing F-35 — would create an immediate reaction in their entangled partners back at the sensor". Followed by: *"Not everyone was moved by the Chinese experiment. 'They*

didn't supply details that would support their claim, so I conclude they didn't demonstrate what they claimed,' says Seth Lloyd, a mechanical engineer at MIT whose 2008 Science paper set the theoretical foundation for quantum radar. [...] According to Lloyd, anyone hoping to extend quantum radar's range needs to be very clever about how they work around the laws of physics".

Another reviewer's comment is:

> *Recently, the researchers at Ecole Normale Supérieure de Lyon (CNRS) developed a quantum radar that outperforms classical radar by 20% [R. Assouly et al. Nature Physics, 2023].*

This comment is worth of the following considerations.

The CNRS group at Lyon has published (first author R. Assouly) a few papers on the alleged advantage of QR, including: [4] and [5], which are complemented in [6] and [7]. In these papers, aimed to demonstrate a quantum advantage for microwave radar, the joint measurement of the signal and idler microwave photons using a superconducting circuit is described. In the introductory part of [5], it is interesting to read that *".... previous microwave implementations* [...] *have not demonstrated any quantum advantage as probe and idler were always measured independently"*.

In [4] one reads: *"Here we demonstrate a superconducting circuit implementing a microwave quantum radar that can provide more than 20 % better performance than any possible classical radar"*. The remarkable experimental set described in [4], [5] has the target represented by a circulator and a notch filter connected to the sensor by a $12\ m$ long coaxial cable, i.e. at short and fixed distance. The corresponding attenuation κ is very close to the unit and can be reduced to $\kappa = 0.01$ to simulate the absence of the target.

However, in real applications at X-band, κ is the order of 10^{-12} for a target at $1000\ m$ and increases to the order of 10^{-8} for a unitary radar cross section target $100\ m$ away from the radar and to 10^{-4} for a target $10\ m$ away: it is never close to the unit. The related quantum radar performance is evaluated in terms of *"the exponent* $\boldsymbol{\varepsilon}$ *of the error probability"* which has no meaning at all in radar, where the Neyman-Pearson detection criterion (to maximize the probability of detection for a fixed probability of false alarm) is always and everywhere used. Hence, the advantage of a quantum radar over a classical radar is not related to a *"Quantum advantage"*: $Q = \varepsilon/\varepsilon_{classic}$, where, using a pairwise joint measurement of return and idler, it is alleged to be theoretically possible to obtain $Q = 2$. In the experiments described in [4] they got $Q = 1.2$ (i.e., an increase of 20 % w.r.t. the "best possible" classical radar) with $\kappa = 0.03$ (target present) and $\kappa = 0.00032$ (target absent); unfortunately, these values are many orders of magnitude higher than any real radar operation. The error probability exponent (used to define a quantum advantage Q) is related to the single-mode SNR (signal-to-noise ratio) and to the number of modes M by:

$$\varepsilon = \frac{\kappa \cdot SNR}{4} \cdot M$$

where, to get a probability of error $exp(-\varepsilon)$ not close to one, say, less than 0.5, the following inequality shall hold: $\frac{\kappa \cdot SNR}{4} \cdot M > \ln(2)$ i.e. $\mathrm{SNR} \cdot M > 2.77/\kappa$ which, at the distance of $1000\ m$, equals to $2.77 \cdot 10^{12}$, i.e. for $SNR = 20$ (i.e. $20\ dB$), to $M > 1.38 \cdot 10^{11}$, an unrealistic value again.

More generally, the alleged 20 % advantage [4], [6] may be misleading: there is no 20 % advantage neither in radar Range nor in accuracy, only in the *"error probability exponent"* which has little to do with the standard probability of detection – for a fixed probability of false alarm.

1.2. Second Case - *Submission to IEEE Access Journal*

A similar version of [1], entitled *"Intrinsic Range Limitations in Microwave Quantum Radar"*, was submitted by G. Galati and G. Pavan on 4 April 2024 to the **IEEE Access** Journal (2024-13218). The comments by Referees (*red in Italic*) include the following (in Bold, the Authors' comments which have been sent on June 17th to the IEEE vice-President for Publication Services and Products).

> *The article does not contribute to the existing body of knowledge in the field of microwave quantum radar as the study is incorrect* **(where and why?)**. *The article does not present any novelty* **(why?)**, *only many sentences taken from valuable publications by other authors* **(where and which ones?)**.
>
> *The discussion about limiting the range of quantum microwave radar is influenced by wrong design considerations* **(where and which considerations?)**.
>
> *The bandwidth limitation applies to classical or noise radars. The bandwidth limitation cannot be applied to microwave quantum radar* **(this is simply false; phase matching - see for instance, our Ref. [41] by Sorelli et al.) is one of the causes of bandwidth limitation)**.

1.3. Third Case - *Submission to MDPI Remote Sensing Journal*

Finally, on 28 May 2024 G. Galati and G. Pavan submitted to MDPI **Remote Sensing** Journal the manuscript *"Range Limitations in Microwave Quantum Radar"* whose substantial content does not differ from the one of Cases 1 and 2.
The manuscript was revised on 4 July 2024 and **published on 10 July 2024 (reference [1]**).

The paper shoved a great interest: on 4 Nov.2025, the article reached 7,677 views (https://www.mdpi.com/2072-4292/16/14/2543). An ensuing paper by the same Authors (Reference [8]) on 5 Nov. 2025 got 11,805 downloads and 31,730 views.

References of Section 1.1, 1.2 and 1.3

[1] Pavan, G.; Galati G. Range Limitations in Microwave Quantum Radar. MDPI Remote Sensing, 2024; 16(14):2543. https://doi.org/10.3390/rs16142543.

[2] Trimble, S. China Shows Off First Quantum Radar Prototype. Aviation Week. https://aviationweek.com/defense-space/china-shows-first-quantum-radar-prototype.

[3] Stockton, N. (2019) 'Quantum Radar - Can quantum entangled photons reveal the shape and location of cloaked military fighter jets? Maybe, but probably not yet'. Available online: https://spie.org/news/quantum-radar.

[4] Assouly R., Dassonneville R., Peronnin T., et al. Quantum advantage in microwave quantum radar. Nat. Phys. 19, 1418–1422 (2023). https://doi.org/10.1038/s41567-023-02113-4.

[5] Assouly R., Dassonneville R., Peronnin T., et al. Demonstration of Quantum Advantage in Microwave Quantum Radar, arXiv:2211.05684, https://doi.org/10.48550/arXiv.2211.05684.

[6] Fadelli I. A quantum radar that outperforms classical radar by 20%, Phys.org - July 20, 2023 Feature, https://phys.org/news/2023-07-quantum-radar-outperforms-classical.html.

[7] Zhuang Q. Quantum advantage on the radar. Nat. Phys. 19, 1384–1385 (2023). https://doi.org/10.1038/s41567-023-02111-6.

[8] G. Pavan, G. Galati and F. Daum " Lessons Learnt from the Rise and Fall of Quantum Radar Research", Academia Quantum, March 2025, https://www.academia.edu/3064-979X/2/1/10.20935/AcadQuant7586.

1.4. Fourth Case - *Submission to Frontiers*

On 20 October 2025 the following paper: *"Suggestions to Improve the Assessment of Research"* by G. Galati, G. Pavan and F. Daum, was submitted to **Frontiers in Research Metrics and Analytics** (Research Assessment), Edited by: Adolfo A. Abadía.

The Reviewer's comments (shown below with the Replies in blue) were favourable.

REVIEWER 1 - 11 Dec 2025

Initial recommendation to the Editor: **Accept in current form.**

Review:

EVALUATION

In this paper, the authors discuss a relevant topic in the current research lying on the weaknesses in the assessment practices using the Quantum Radar as the case of study.

> First, we have found all the comments and suggestions very useful to improve our paper and we wish to thank the Referees for their comprehensive and productive work.

About the discussion:

Although the manuscript offers a timely and highly relevant discussion on the topic of scientific publishing, it returns too frequently to the historical narrative of the case study—namely, quantum radar—while overlooking, or at times mentioning only in passing, the importance of investigating quantum-mechanical systems, models, techniques, and methodologies in an era where quantum theories are still taking shape as they continue to be developed.

> 1) Repetitions have been suppressed.
>
> 2) The rationale for using Quantum Radar as an example has been clearly explained in the Introduction and elsewhere.
>
> 3) The importance of investigating Quantum-Mechanical systems, models, techniques, and methodologies has been stated.

Conclusion

I can see the physical and social interest and innovation of the presented work, worth to be reported. It is always needed and desirable to frame the discussion around the predatory scientific-publishing ecosystem to which researchers are subjected, as well as the overwhelming sea of information in which it becomes increasingly difficult to navigate while distinguishing constructive and reliable material from misleading and deceptive content.

In fact, I believe the manuscript would be strengthened—and made more suitable for publication in Frontiers—if the information regarding the example, namely Quantum Radar, were streamlined and focused specifically on the aspects that directly support the manuscript's central hypothesis.

> The manuscript has been rewritten with the above aim.

Given the exhaustive focus on the Quantum Radar case, I wonder why it is not reflected in the title, why it is mentioned only briefly in the abstract, and why it receives such limited scrutiny in the introduction.

> Title and Abstract have been rewritten.
> New title: *"From the Rise and Fall of Quantum Radar to the Improvements of Research Assessment".*

On the other hand, it is important to underscore that scientific knowledge often emerges in the absence of an immediate practical need or a clearly formulated problem. What is later framed as a 'solution' typically originates from the pursuit of understanding and the attempt to fill conceptual gaps. Moreover, many of the technological advances that underpin modern society historically arose from what the authors describe as 'solutions looking for problems.' Scientific developments frequently lead, directly or indirectly, to technological progress that ultimately benefits society. For this reason, I suggest caution when implying that the quantum-mechanical research currently unfolding in the context of the second quantum revolution is primarily driven by predatory commercial forces. While such pressures indeed exist and merit critical reflection, they do not represent the core motivation for the vast majority of researchers engaged in these fields.

This suggestion is fully accepted, and a related sentence has been added.

Remarks:

The abstract is too brief to reflect the complexity of the manuscript and does not convey the essential elements of the discussion. I recommend strengthening it substantially.

The Abstract was fully rewritten.

The manuscript would benefit from a clearer and more explicitly delimited scope in the introduction, as this would provide readers with a stronger conceptual anchor for what follows.

The Introduction was fully rewritten.

Additionally, the overall structure should be improved by reorganizing sections to enhance coherence and narrative flow. At present, the argumentation is at times fragmented, blending technical details with sociological critique without sufficiently clear transitions, which weakens the internal consistency of the discussion.

The overall structure (Sections, Paragraphs) was fully reorganized.

While the manuscript has the potential to make a meaningful contribution, it requires substantial revisions to strengthen its conceptual clarity, organizational structure, and argumentative coherence.

We believe this revised version to be much clearer and coherent in its arguments.

Final comment:

I believe that once the recommended revisions have been implemented, the manuscript will be well positioned for publication in Frontiers.

Check List

a. Is the quality of the figures and tables satisfactory? **Yes.**

b. Does the reference list cover the relevant literature adequately and in an unbiased manner? **Yes.**

c. Does this manuscript refer only to published data? (unpublished or original data is not allowed for this article type) **Yes.**

QUALITY ASSESSMENT

Rigor: **4/5**

Quality of the writing: **3/5**

Overall quality of the content: **5/5**

Interest to a general audience: **4/5**

Declaration of AI use

Did you use any AI tools to assist you with reviewing this manuscript or writing this report? **Yes**.

Some language details were reviewed with AI assistance:

Excessive sentence length and overly complex constructions:

Several sections, particularly in the Introduction and Section 4, contain sentences that are unnecessarily long and overloaded with subordinate clauses, which hinders readability and weakens the clarity of the argument. Shorter, more focused sentences would significantly improve the manuscript's communicative effectiveness.

Recommendation: Divide the text into shorter sentences, remove redundancies, and reorganize ideas into a more logical sequence.

Example:

"Quantum technologies are proposed since about 1990 as a key element for the world's development…" could be reformulated to avoid the heavy, historic construction.

DONE

Separate technical content from sociological and philosophical discussion.

DONE

Technical explanations are frequently interwoven with sociological critique within the same paragraphs. Distinct separation of these elements, supported by clear transitions, would strengthen the logical structure and improve the coherence of the argument.

Recommendation: Separate both registers into distinct paragraphs and use explicit transitions.

DONE

Example:

In Sections 4.1 and 4.2, technical references are mixed with philosophical assessments without an adequate narrative bridge.

Standardize verb tenses to maintain narrative consistency.

The text exhibits inconsistent shifts between past, present, and future tenses, especially in the historical account of Quantum Radar research. Harmonizing tense usage—past for historical events, present for analysis—would enhance grammatical precision and internal consistency.

Recommendation: Place the historical narrative consistently in the past tense, the conclusions in the present, and any projections in the future.

DONE – Generally the present tense was preferred for better readability.

Example:

Paragraphs describing the stages of Quantum Radar shift between "are," "were," and "will be" without a clear rationale.

Reduce redundancy in the presentation of central themes

DONE

Key ideas such as quantum hype, limitations of peer review, and concerns about bibliometrics are repeated throughout the manuscript. Consolidating these discussions would reduce redundancy and sharpen the manuscript's focus.

Recommendation: Consolidate these points into more concise sections to avoid repetition.

Example:

The notion of "freedom of research" as a misused argument appears repeatedly across different chapters with nearly identical wording.

DONE – Many repetitions have been found and suppressed.

Replace syntactically heavy phrasing with more direct scientific prose.

Several passages rely on grammatically correct but stylistically cumbersome constructions. Adopting a more direct and idiomatic scientific style would improve the manuscript's accessibility while preserving technical rigor.

Recommendation: Replace ornate constructions with more direct syntax and avoid the accumulation of subordinate clauses.

DONE – Many sentences have been shorted.

Example:

Sentences such as "Based on our internationally recognized radar expertise, we have analyzed in detail the financially small case…" could be simplified to improve fluency and readability.

DONE.

********** End of Review 1 **********

REVIEWER 2 - 09 Dec 2025

Initial recommendation to the Editor: **Major revision is required.**

First, we have found all the comments and suggestions very useful to improve our paper and we wish to thank the Referees for their comprehensive and productive work.

Review:

EVALUATION

The manuscript, "Suggestions to Improve the Assessment of Research", presents an extensive narrative arguing that the failures in evaluating the feasibility and merit of quantum radar research exemplify systemic weaknesses in the broader research-assessment ecosystem. It combines a historical review of the quantum radar literature with sociological, epistemological, and policy-oriented arguments.

The topic—improving global research assessment—is clearly relevant for Frontiers in Research Metrics and Analytics. The manuscript is comprehensive and addresses policy suggestions at multiple levels. However, the paper requires major revision to improve clarity, coherence, evidence bases, balance, neutrality, and structure.

Major Strengths

1. Timely Topic: Research assessment, bibliometrics, hype cycles, and quality control are highly relevant issues.

2. Rich Literature Overview: The manuscript cites a broad array of sources from physics, philosophy of science, and research-assessment literature.

3. Concrete Case Study: The quantum radar example is well-developed and shows detailed domain knowledge.

4. Historical and Sociological Perspective: Use of Popper, Feynman, and contemporary critiques provides conceptual depth.

5. Ambitious Proposal: The idea of an international research-evaluation agency (IREO) is bold and may stimulate debate.

Required Revisions

1. The manuscript is overly long, with several digressions (quantum computing, consciousness, New Age claims, cold fusion, etc.) that dilute the core argument. Some sections read as opinion essays rather than conceptual analysis; tightening is necessary. Authors should articulate clear research questions, a clear theoretical framework, and explicit criteria for "research assessment problems."

> The manuscript has been fully rewritten, including Title, Abstract, Introduction, and many parts of the text.

2. Restructure the manuscript to present (This will drastically improve readability and alignment with journal expectations)

1) Introduction
2) Case Study: Quantum Radar
3) Diagnosis of Assessment Failures
4) Review of Literature on Research Assessment
5) Policy Proposals
6) Discussion
7) Conclusion

> DONE: Reorganized according to the above structure.

3. Rephrase evaluative language in a more scholarly, neutral tone. Claims of "improper rejection" by specific journals or platforms must be supported by verifiable documentation, or moved to an anonymized, general discussion. Statements about particular authors "publishing too much" or accusations of inflated signature practices need to be framed carefully—avoid naming individuals unless essential and ethically justified.

> DONE: Many statements have been suppressed or moved to the Supplementary Information (WEB SITE), which contains supporting data and rationale.

4. Expand the proposal into a more structured, evidence-based policy model. The STARs / IREO proposal is interesting but currently lacks:

• feasibility analysis
• governance structure
• operational examples
• comparative analysis with existing bodies
• discussion of risks (bureaucracy, capture, biases)

> DONE: This fundamental part has been added.

6. I recommend that the authors include an evidence-based estimation of the proportion of "non-research" vs. genuine research publications within the targeted domain.

> DONE: A comment on 132 Papers on Quantum Radar has been added.

Since one of the central claims of the manuscript concerns the overproduction of low-value or non-research outputs, providing at least an approximate quantitative estimate—based on definable criteria, bibliometric indicators, or sampling—would significantly strengthen the argument. Even if the estimate is coarse or based on a sample, articulating the methodology and underlying assumptions would increase the credibility and reproducibility of the authors' conclusions. Without such an estimation, the discussion remains largely qualitative and risks being perceived as anecdotal.

> DONE: A short quality analysis of 132 Papers on Quantum Radar has been added.

Check List

a. Is the quality of the figures and tables satisfactory? **Yes.**

b. Does the reference list cover the relevant literature adequately and in an unbiased manner? **Yes.**

c. Does this manuscript refer only to published data? (unpublished or original data is not allowed for this article type) **Yes.**

QUALITY ASSESSMENT

Rigor: **3/5**

Quality of the writing: **3/5**

Overall quality of the content: **4/5**

Interest to a general audience: **4/5**

Declaration of AI use

Did you use any AI tools to assist you with reviewing this manuscript or writing this report? **Yes.**

********** End of Review 2 **********

After submission of the revised version, the following message was sent by Frontiers to the Authors:

Specialty Chief Editor: Zaida Chinchilla-Rodríguez | 29 Dec 2025 | 07:19

Dear Authors,

After reading the original manuscript, the revised version, and the authors' responses to the reviewers, I consider that although the revised version shows some formal and organizational improvements, substantive issues remain insufficiently addressed. Consequently, the manuscript requires a further major revision before it can be considered for publication in the Research Assessment section.

The central concern remains the weak analytical grounding of the manuscript in the contemporary research assessment literature. The paper adopts a predominantly normative and essayistic tone and engages only superficially with key debates such as responsible metrics and the governance of research evaluation, particularly regarding the different uses of evaluation and their consequences. The manuscript should clarify more explicitly its conceptual contribution to research assessment, beyond the specific case examined. Closely related to this issue, the scope and limits of the case study are not clearly defined. The Quantum Radar case is used to derive general conclusions and recommendations, leading to overinterpretation. The manuscript should be explicitly reframed as an illustrative case, from which potentially transferable insights may be drawn, but without claims of direct generalisation.

There is also a clear imbalance between the extensive technical detail devoted to Quantum Radar and the analysis of its relevance for research assessment. The level of technical exposition exceeds what is appropriate for the audience of this section and obscures the central argument. A substantial reduction of technical detail, combined with a stronger focus on implications for research evaluation and governance practices, is recommended.

In addition, the manuscript frequently adopts an evaluative and sometimes accusatory tone, particularly in relation to editorial processes and peer review. This tone does not align with the academic standards of the section and should be replaced by a more neutral and

analytical register, clearly distinguishing between evidence-based observations and interpretative claims. Relatedly, the discussion of research ethics and peer review lacks adequate engagement with the relevant academic literature, weakening the robustness of the argument.
The policy and governance proposals advanced in the manuscript also require clarification. The text does not clearly distinguish between potentially implementable recommendations and more speculative ideas. In particular, the regulatory measures proposed in Section 5.2 are not supported by empirical evidence, overlook longstanding debates on authorship and scientific collaboration, and conflict with current approaches to responsible research assessment, such as those promoted by initiatives like CoARA, which emphasise contextualisation of contributions rather than mechanical regulation. This section requires substantial reformulation or an explicit acknowledgement of its limitations.
Significant methodological concerns also persist. The claim that the bibliographic search on Quantum Radar retrieved 6.1 million items is not supported by a transparent description of the search strategy, preventing assessment of its validity and reproducibility. Similarly, the periodisation of Quantum Radar research lacks a clearly articulated methodological basis and should clarify whether it constitutes an original contribution or a synthesis of prior work. The origin and analytical status of Figure 5 are unclear, as it appears to rely on commercial and consultancy sources without sufficient information on data selection, aggregation, or interpretation, and therefore does not meet acceptable standards of transparency. From a formal and structural perspective, Figure 1 is not appropriately placed in the manuscript and should be relocated to Section 2.6 (Literature and Evaluations on Quantum Radar), immediately after the first reference to the figure, in order to improve narrative coherence. Finally, the manuscript introduces both an International Research Evaluation Organization (IREO/UN) and a STARs committee, but does not clarify the conceptual or functional relationship between them. As presented, the STARs committee largely replicates functions already performed by reviewers, editors, and existing evaluation panels, without justifying its novelty or necessity within current responsible research assessment frameworks. Overall, I consider that only a further substantial revision, focused on conceptual framing, scope delimitation, analytical tone, and methodological transparency, will allow the manuscript to align with the standards and expectations of the Research Assessment section.

A revised version was submitted, accompanied by with the following letter to the Specialty Chief Editor: Zaida Chinchilla-Rodríguez:

To: Frontiers Specialty Chief Editor, Zaida Chinchilla-Rodríguez - Reply to the message on 29 Dec 2025 – Paper "*From the Rise and Fall of Quantum Radar to the Improvements of Research Assessment*"

1) After reading the original manuscript, the revised version, and the authors' responses to the reviewers, I consider that although the revised version shows some formal and organizational improvements, substantive issues remain insufficiently addressed. Consequently, the manuscript requires a further major revision before it can be considered for publication in the Research Assessment section.

REPLY: *We confirm that both Referee's comments were very useful to improve our paper. Concerning the Editor's comments, although only partially agreeing with them, we want to thank the Editor for her suggestions, clearly aimed to further improving our work, as we implemented in the Second (revised) version.*

2) The central concern remains the weak analytical grounding of the manuscript in the contemporary research assessment literature. The paper adopts a predominantly normative and essayistic tone and engages only superficially with key debates such

as responsible metrics and the governance of research evaluation, particularly regarding the different uses of evaluation and their consequences. The manuscript should clarify more explicitly its conceptual contribution to research assessment, beyond the specific case examined.

REPLY: *In the Second version we have more strongly clarified that our conceptual contribution to research assessment, with a Popperian approach, is two-fold : (a) there is at least a case of total, demonstrated "beyond reasonable doubt", failure of the research assessment and there is a reasonable - and statistically strong - suspect that many other exist, (b) the assessment based on bibliometric indexes is* ***not*** *a valuable assessment anymore because of the Goodhart's law and*
because of their too large quantity of publications coped with their decreasing and decreasing quality, at least in the areas where we are able to judge. Hence, new research assessments strategies and related organizations are proposed with a reasonable degree of detail.

3) Closely related to this issue, the scope and limits of the case study are not clearly defined. The Quantum Radar case is used to derive general conclusions and recommendations, leading to overinterpretation. The manuscript should be explicitly reframed as an illustrative case, from which potentially transferable insights may be drawn, but without claims of direct generalisation.

REPLY: *As stated in the above reply and in the Second version, the – finally – deceased – Quantum Radar is not important "per se", it is important as a demonstrated incident in the research assessment/evaluation. Therefore, are not worried about "the risk of over interpretation". The Quantum Radar case is similar to an accident in Air Traffic Control (ICAO, ANNEX 13, Aircraft accident and incident investigation) and every* ***single*** *accident (or incident) calls for a thorough analysis, that is something different from a generalization, as better explained in the Second version.*

4) There is also a clear imbalance between the extensive technical detail devoted to Quantum Radar and the analysis of its relevance for research assessment. The level of technical exposition exceeds what is appropriate for the audience of this section and obscures the central argument. A substantial reduction of technical detail, combined with a stronger focus on implications for research evaluation and governance practices, is recommended.

REPLY: *We only partly agree as, as explained in the above reply, the Quantum Radar is an exemplary case that deserves a due attention. The rationale for technical details is synthetically explained in the Abstract and in the Introduction of the Second version –where we have reduced the technical part and abolished Sections 2.3 to 2.5.*

5) In addition, the manuscript frequently adopts an evaluative and sometimes accusatory tone, particularly in relation to editorial processes and peer review. This tone does not align with the academic standards of the section and should be replaced by a more neutral and analytical register, clearly distinguishing between evidence-based observations and interpretative claims. Relatedly, the discussion of research ethics and peer review lacks adequate engagement with the relevant academic literature, weakening the robustness of the argument.

REPLY: *We do not find accusatory tones to anybody in our text (anyway we deleted some names in the Second version), but we agree on the need for more neutral and analytical register and on distinguishing between observations and interpretations, which we* *implemented in the Second version. Reading again our text, we find that our discussion on research ethics and peer review has sufficient references in the literature. To shorten and to avoid emphasizing some unpleasant practice, in the Second version we have suppressed some parts and we have added/modified other ones.*

6) The policy and governance proposals advanced in the manuscript also require clarification. The text does not clearly distinguish between potentially implementable recommendations and more speculative ideas. In particular, the regulatory measures proposed in Section 5.2 are not supported by empirical evidence; overlook longstanding debates on authorship and scientific collaboration.

REPLY: *Thank you for this comment, we developed and explained in more detail our policy and governance proposals in the Second version. The regulatory measures proposed in Section 5.2 are based on our long-lasting (up to forty years) personal experience as Researchers, Reviewers of many Journals, Editors and Organizers of Conferences. We feel that their formulation does not need for any more empirical evidence and fully agrees with the (often-overlooked) common sense. The need to stop the multiplication of signatures and the firm of papers is clear to any honest worker in today's scientific and technical domain.*

7) …and conflict with current approaches to responsible research assessment, such as those promoted by initiatives like CoARA, which emphasise contextualisation of contributions rather than mechanical regulation. This section requires substantial reformulation or an explicit acknowledgement of its limitations.

REPLY: *We are not aware of specific or particular successes of CoARA nor of any "*responsible research assessment" and are in favour of world-wide regulations (we do not know whether to call them "mechanical" or not) similar to the Standards and Recommended Practices (SARPs) by the International Civil Aviation Organization (ICAO/UN), as better explained in the Second version.

8) Significant methodological concerns also persist. The claim that the bibliographic search on Quantum Radar retrieved 6.1 million items is not supported by a transparent description of the search strategy, preventing assessment of its validity and reproducibility.

REPLY: *We never wrote "*the bibliographic search on Quantum Radar retrieved 6.1 million items". We simply explained, within brackets, what IEEEXplore is : IEEEXplore (the database of the Institute of Electrical and Electronic Engineers, which includes more than 6.1 million items, https://ieeexplore.ieee.org/Xplore/guesthome.jsp).

Anyway, to avoid confusion we delete the unnecessary sentence "which includes more than 6.1 million items".

9) Similarly, the periodisation of Quantum Radar research lacks a clearly articulated methodological basis and should clarify whether it constitutes an original contribution or a synthesis of prior work.

REPLY: *the periodization is an original contribution, anyway it is probably too much emphasized in our work and is much shortened in the Second version.*

10) The origin and analytical status of Figure 5 are unclear, as it appears to rely on commercial and consultancy sources without sufficient information on data selection, aggregation, or interpretation, and therefore does not meet acceptable standards of transparency.

***REPLY:** As better explained in the Second version,* Rows 429-431, *Fig. 5 is the well-known Gartner hype cycle, see for instance* https://en.wikipedia.org/wiki/Gartner_hype_cycle..

11) From a formal and structural perspective, Figure 1 is not appropriately placed in the manuscript and should be relocated to Section 2.6 (Literature and Evaluations on Quantum Radar), immediately after the first reference to the figure, in order to improve narrative coherence.

REPLY: *thanks, we agree on this comment implemented in the Second version, with updating and improving Fig. 1, with adding a new Fig. 2 for enlarging the scope and with suppressing Fig. 3 for the sake of conciseness.*

12) Finally, the manuscript introduces both an International Research Evaluation Organization (IREO/UN) and a STARs committee but does not clarify the conceptual or functional relationship between them. As presented, the STARs committee largely replicates functions already performed by reviewers, editors, and existing evaluation panels, without justifying its novelty or necessity within current responsible research assessment frameworks.

REPLY: *we agree that we did not explain clearly enough these conceptual and functional relations. They are now explained and expanded in the Second version. We write (in the Second version) that we respect the activity* already performed by reviewers, editors, and existing evaluation panels. However, *we clarify that the need for STARs committees arises from the evident presence of critical cases and that STARs are different, in nomination and operation, from Editorial Boards and Referees, which continue to exist in our future vision.*

Related additions and clarifications have been largely added, including the expanded and partly rewritten Sect. 5, Sect. 6 and, finally, Section 7 "Conclusion and Perspectives" where we have also added a few lines on the increasing number of papers produced by Artificial Intelligence generating tools, and some rough cost analysis for STARs.

To enhance the References, we have added Sokal, A. (1998), Perc M. (2025), Kusumegi, K, et al. (2025) and Margolis J. (1967).

FINAL REMARKS

Summing up, we are "statistically" sure that other experts with such a deep background in specific research and technology sectors are able to find in other scientific/technical domains some "evaluation failures" similar to our case. We recognize, in the Second version, that implementing our proposed "hard" (an adjective probably better than "mechanical") regulations and the related structures (STARs, IREO) is a very demanding task, hence the term (im)possible.

However, we find it necessary to try to stop not only the multiplication of signatures and of papers, but also the distortions of people's knowledge and, more important, the misuse of scarce research resources.

Of course, this is our opinion, which could not be accepted but, we feel, shall deserve to be known in the technical-scientific arena and in the research assessment and managing contexts.

FINAL COMMENT BY THE AUTHORS

When revising the manuscript, we have felt necessary to add (Section 5.3) a description of the IREO and of the related critical comments and (Section 7) a short note on the impact of Artificial Intelligence on the publications process.

We wish to thank both the anonymous Reviewers and the Editor for the precise, insightful and constructive comments, which allowed us to improve our manuscript.

Gaspare GALATI, Gabriele PAVAN, Fred DAUM

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Finally, the manuscript was **rejected** by Zaida Chinchilla-Rodríguez with this motivation:

Reason: The content of this manuscript does not meet the standards of scientific quality or rigor required by the journal to be considered for peer review.

Comment: While some formal improvements were noted, the manuscript continues to exhibit significant deficiencies in analytical rigor, an inappropriate use of the case study, and an evaluative tone without sufficient empirical support.

2. Reviews of some Quantum Radar Papers

In 2024, a few manuscripts on Quantum Radar were submitted and reviewed by G. Galati.

2.1. First Case

A submission by the Carleton University (Canada) to IEEE Transactions on Radar Systems, TRS-2024-0223 entitled "Noise-Type Radars: SNR and the Correlation Coefficient" was revised.

Reviewer's comments:

Reviewer: 1

Referee's Comments to the Authors

1) Foreword. The submitted manuscript (MS in the following) is mostly a repetition, with minimal additions/modifications, of already published topics [1-6 in References of the Rewiew 1]. Strangely enough, this submitted manuscript to T-RS is a PDF file joint together (15.4 Mbytes total, 322 pp.) with the Ph.D. Thesis of D. Luong, a document (of course) not analysed here but containing the single, representative sentence at page 31 (or 65/331) that is a critics of a quotation from the celebrated textbook [7 in References of the Review 1] (Section 6.3). There, Skolnik warns against comparing the time-bandwidth product with the Heisenberg uncertainty principle. Luong writes "To start, the quotation appears to be drawing an implicit distinction between quantum particles and the "classical" targets that radars are concerned with. But no such distinction exists, since all targets are made of particles that obey quantum mechanical laws. Furthermore, it is untrue that "in quantum mechanics, the observer does not have control over that waveform". Any reader – with basic knowledge of modern physics and of radar – may easily notice two fundamental errors in this quotation from the Thesis. These errors also affect the MS. First, the MS shows lack of the basic concepts of decoherence and tensor product, which explain why quantum mechanics cannot be conveniently applied to macroscopic objects such as a radar target. Shall be clear to all that the classical mechanics works because the macroscopic world has so many particles that the quantum states decohere and mechanics becomes classic. Quantum states remain pure only in closed systems. Second, the MS shows a lack of understanding the profound difference between waveform generation in Noise Radar (NR) and in Quantum Radar (QR). In the former, either random or, as today's practice, pseudorandom waveforms may be generated and transmitted, generally "tailored", e.g. with a suited PAPR (Peak-to-Average-Power-Ratio) for the radar application [17 in References of the Rewiev 1]. In QR, the waveform is made up by a large number M = BT of Modes each of duration 1/B (remark: B is the radar bandwidth, T is the signal duration), each one with an average number N_s of Poisson-distributed photons (N_s is less than the unit in most QR experiments or design, as at more than four or five photons the quantum effect disappears). Hence, unlike the claims in the MS, the waveforms (natively random in QR) and their control (impossible for QR) are inherently different in the QR and in the NR case.

2) Aim of the manuscript. The manuscript aims to analyse "noise type radars", an alleged (and improper) definition that, according to its Authors, would try to include both Noise Radar end Quantum Radar. The analysis is done in terms of a "correlation coefficient" rho between replica and backscattered signal. This coefficient is allegedly more convenient than the standard Signal-to-Noise Ratio (SNR) for the calculation of detection performance.

3) Comments.

(a) Putting together NR and QR shall be avoided, as it is just a way of confusing the reasoning.

(b) Unlike what claimed in the Introduction of the MS, no significant sensitivity improvement in QR over classical (including Noise) were demonstrated (the Assouly experiments [16 in References of the Rewiev 1] show about 1 dB Quantum Advantage). This is exactly what an unbiased engineer would expect considering that the transmitted power by a QR is $P_t = h \cdot f \cdot N_s \cdot B$

which, for $N_s = 1$, B = 100 MHz, f = 10 GHz (and for the unfortunate very low value of the Planck's constant h), equals to -152 dBW only: three orders of magnitude below the receiver noise, hence useless for radar detection above a few metres, as recognised in the literature after 2020, [8-15, 19 in References of the Rewiev 1].

(c) An important missing element in this MS is the consideration of the orders of magnitude. At page 2 of the MS, and in the ensuing parts, it is claimed that any reference signal is "imperfect" because of its "noise" due to "quantum effects" (Heisenberg's uncertainty principle) and that QTMS radar "adds less noise to the beam splitters thus increasing the correlation between transmitted and reference signals". Hence, the MS introduces a "reference SNR" or "SNR2" which is the basis for its ensuing computations. No effort at all is done in the MS to quantify this SNR2, but from the References, e.g. eqn. (11) of [18] in the References of the manuscript it appears to be related to a form of Heisenberg's uncertainty principle for the I and Q components of a signal: $Var[I]\cdot Var[Q] \geq 1/4$. Which in the symmetric case reduces to $Var[I] = Var[Q] = 0.5$. However, these formulas use units normalized to the Planck's constant. Conversion to standard units shows (again, because of the very low value of h) that the variance of I (and of Q) corresponds to a level well below the quantization noise (even when a very large number of bits is used) and more generally below any measurable quantity in a real radar receiver/processor. Hence, in practice, this "Heisenberg" noise does not exist.

(d) The experimental section has no scientific significance. The reader finds, with much surprise, an unbelievable value (with four significant digits!) of SNR2 = 4.329 dB with no explanation at all on how it was obtained and its precision.

(e) Summing up, all the MS is based on misconceptions and confusion between the quantum world of elementary entities (bosons, fermions and combination of a few of them) and the macroscopic world that includes radars and radar targets.

(f) Some less relevant items are: (i) Incorrect assumptions, e.g. ignorance of the frequency band limitations such as in "we assume that the transmit and reference signals are white noise processes". (ii) Writing errors such as in page 2: I1[n] = j Q1[n], (iii) Unfit terms such as beam splitters (of course, they are absent in radar). (iv) Some nonsense but, anyway, marginal sentences such as, after this formula: "In the quantum context, it is impermissible to combine I and Q voltages into complex voltages of the form $I1\ [n] = jQ1\ [n]$".

References of the Rewiev 1

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[2] Luong, D., Rajan, S. and Balaji, B. "Entanglement-based quantum radar: From myth to reality," IEEE Aerospace and Electronics Systems Magazine, vol. 35, no. 4, pp. 22–35, Apr. 2020.

[3] Luong, D.; Balaji, B.; Rajan, S. Quantum Radar: Challenges and Outlook: An Overview of the State of the Art. IEEE Microw. Mag. 2023, 24, 61–67.

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[7] M. I. Skolnik, Introduction to Radar Systems, 3rd ed. McGraw-Hill, 2001, ISBN 9780072881387. https://drive.google.com/file/d/0B8d0ousCz_COdjJ0eUtJUG9UMGc/view?resourcekey=0-wsuUU040t7A83N_bFK5zdg.
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[16] Assouly, R., et al. (2023) ‘Quantum advantage in microwave quantum radar’. Nat. Phys. 19, 1418–1422 (2023). https://doi.org/10.1038/s41567-023-02113-4.
[17] DePalo, F. et al. Introduction to Noise Radar and its Waveforms. Sensors 2020, 20, 5187. https://doi.org/10.3390/s20185187.
[18] Bourassa, Wilson : “Progress Towards an All Microwave Quantum Illumination Radar” IEEE AES Syst. Magaz. , Nov 2020, pp 58-69 and ArXiv 1607.07908v (26 July 2016).
[19] Wei, Rongyu et al. “Evaluating the detection range of microwave quantum illumination radar.” IET Radar, Sonar & Navigation (2023). DOI:10.1049/rsn2.12456.

End of Reviewer: 1

Reviewer: 2

Referee’s Comments to the Authors

1. Sec. V.A can be omitted (since it is entirely trivial and pedantic).
2. Some statements made about quantum mechanics are too cavalier and need to be sharpened.

    2a. on page 1: "quantum mechanics still forbids perfect copying: the Heisenberg uncertainty principle guarantees that there is noise in the reference signal". These are two subtly different issues. The authors better cite a paper on the "no-cloning theorem" to assert the former point, and then describe how the Heisenberg uncertainty principle enforces no-cloning.

    2b. on page 2: "In the quantum context, it is impermissible to combine I and Qvoltages into complex voltages of the form $I1[n] = jQ1\ [n]$" This seems to be a typo, since even in the classical case, the asserted relation is not generally true.

End of Reviewer: 2

Reviewer: 3

Referee’s Comments to the Authors

1. Noise radars use random signals or noise-like signals as their main probing signal. But the distribution of the probing signal does not have to be necessarily Gaussian. Since the correlation sidelobes of Gaussian noise signals limit the dynamic range of radar, noise radar waveforms

are often tailored (optimized by sophisticated synthesis algorithms) to improve the detection performance (by reducing signal sidelobes). Hence, the assumption and the standardization in the paper that noise radar waveforms have Gaussian statistics is not true. Moreover, the analysis presented in the paper cannot be generalized to all noise radars (what authors call Noise-Type Radars). It can only be valid for noise radars employing Gaussian noise signals. Therefore, I suggest not to use a generalized term such as “Noise-Type Radars” neither in the title nor in the text in order not to be misleading for interested authors.

2. I quote from text “Our result also enables us to prove that, in the appropriate limit, a noise-type noise radar employing matched filtering has the exact same detection performance as a basic radar emitting an unmodulated sinusoidal wave and employing an envelope detector”. There is nothing new in this. It is already known that matched filter compresses the signal so that the signal energy becomes equal to that of a high-power sinusoidal pulse radar. This is why we do pulse compression. More precisely, regardless of the radar type, your analysis is based on detector performance, i.e. signal power vs noise power. Moreover, noise radars suffer from SNR loss due to the intrinsic signal fluctuation (Peak to Average Power Ratio PAPR > 1) (see fig.11 in Galati, G., Pavan, G. & Wasserzier, C. Signal design and processing for noise radar. EURASIP J. Adv. Signal Process. 2022, 52 (2022) **https://doi.org/10.1186/s13634-022-00884-1**). (QTMS radar signal has even worse PAPR ~ 10 - 12). In this respect, the judgement made on noise radar and basic sinusoidal radar in terms of detection performance is not fair.

3. Several typos need to be fixed. In page 2, left column, line 22, the “=” sign must be replaced by “+”. “…complex voltages of the form I_1 [n]=jQ_1 [n]… . In page 2, right column, line 44, the subscript of the latter “Z_1” must be replaced by 2 “…where I_corr, Z_1, and Z_1 are….

4. I quote from your paper “We note in passing that the improvement in QTMS radars over noise radars is really an improvement in $\rho 0$. As was shown in [30], the QTMS radar described in [7] increased the correlation coefficient by a factor of approximately 3 over a comparable NR” According to your paper, I understand QTMS radar has better correlation efficiency than NR. In my opinion, this is not always true. Assuming the pseudo noise signal is generated digitally (Transmit signal goes through DAC-Power Amplifier-Antenna), we have the digital reference (SNR2=>infinity) and in this case, the $\rho 0$ is unity (best correlation efficiency). One can say that the SNR of the transmit signal will eventually deteriorate in the transmitter chain due to the noise contribution and nonlinearity. But, similarly in QTMS radar, Quantum entanglement of signals is lost in the amplification process inside transmitter (assuming reasonable transmit power is utilized for plausible radar range). Thus, the so-called Quantum advantage namely the improvement in the correlation coefficient, is lost under practical implementations.

5. Authors make their evaluation based on real voltages of I and Q rather than the complex form of I+jQ (impermissible in Quantum context as stated in page 2, line 21). In this case, how can Doppler information be extracted from the authors’ approach on estimation of correlation coefficient? In general, complex form of I & Q is utilized in Doppler radars so that phase information is retained in the matched filter output, enabling the calculation of Doppler frequency for moving targets.

End of Review 3

The Associated Editor found a (really, not existant) "potential value” in this very low quality and not interesting manuscript and decided for the option *Accept After Major Revisions* in place of *Reject*.

2.2. Second Case

A submission to IEEE Transactions on Radar Systems by the Technical University of Munich. An email sent on 15-Feb-2025 by prof. Gaspare Galati to the President and CEO of the IEEE, prof. Kathleen A. Kramer, describes the full story:

Dear prof. Kramer, 2025 President and CEO of IEEE,

I'm an IEEE Life Senior Member and honorary professor of Radar Systems and Applications at Tor Vergata University, Roma. Past chair of the IEEE Central and South Italy section.

For over forty years, I used to review many papers per year for IEEE and for others.

The rationale of this message follows. In July 2024 I received – by Shannon Blunt, EIC of the IEEE Transactions on Radar Systems – the invitation to review the manuscript TRS-2024-0164: ***A Note on the Efficient Operation of Quantum Radar and the Fair Classic Comparison***.

My review, uploaded on 31-Aug-2024, is copied at the end of this message.

On 17-Jan-2025 I've received by the IEEE Transactions on Radar Systems the **following message:**

> *Dear Prof. Galati,*
>
> *We have received a complaint from the authors regarding **unprofessional language** in your previous review of this paper. After conferring with the AE (Dr. Bhashyam Balaji) and the VP for Publications for the AES Society (Dr. Luke Rosenberg), the decision has been made to allow the authors to resubmit their paper for a completely new review with different reviewers. Note **the issue is not the technical matters you addressed** but the tone of the review, which was perceived to be unnecessarily antagonistic. No further action is being taken but I want to stress the necessity of keeping to the highest professional standards in the future when performing reviews, because doing otherwise undermines our ability to make full use of your technical expertise. I do hope that you will continue to serve as a valuable reviewer for TRS in the future.*
>
> *Sincerely,*
>
> *Shannon Blunt (sdblunt@ittc.ku.edu onbehalfof@manuscriptcentral.com)*
>
> *Editor-in-Chief, IEEE Trans. Radar Systems*
>
> ***End of Blunt's Message***

Therefore:

1. After having received some protests by the Authors of TRS-0164 , Shannon Blunt **does not complain at all about the technical and scientific content of my (very detailed) review**, but only about some alleged (and, in reality, absent – **see below**) "antagonistic tone" and "unprofessional language".
2. In spite of at least two Reviewer's suggestions to Reject, after having received the Author's protests, **Blunt simply "cancels" both negative Reviews** and *unbelievably* asks the Authors to re-submit the same manuscript!
3. For sure, I cannot accept neither the definition of "unprofessional language", nor the missed usage of a review which I did with a lot of work.

Hence, lacking any clarification by S. Blunt and by the IEEE, I will stop doing any review for the IEEE (not only for T-RS) and I will treat this story as a public domain one in my ensuing publications.

Summing up, I would kindly ask IEEE whether this way of operating a review for the Transactions is acceptable or not, and if not, which correcting actions are planned.

Waiting for a kind reply, I remain.

Very Truly Yours

Gaspare Galati

REVIEW by Prof. Galati
Reviewer Affiliation: University of Rome Tor Vergata Faculty of Engineering, EE
Manuscript ID: TRS-2024-0164
Manuscript Type: Correspondence/Short
Specialty/Area of Expertise: Quantum radar, Radar detection & estimation (e.g. interference/clutter covariance,CFAR)
Date Submitted:30-Jul-2024
Date Assigned: 31-Jul-2024
Date Review Returned: 31-Aug-2024

Briefly describe the research contribution to radar systems.

1. The proposed manuscript
[a] ID TRS-2024-0164 entitled "A Note on the Efficient Operation of Quantum Radar and the Fair Classic Comparison" Author(s): Utschick, Wolfgang, Peichl, Markus, Würth, Michael, Bischeltsrieder, Florian, submitted to IEEE Transactions on Radar Systems On 30-July-2024 and Reviewed on August 2024, refers to a partial meta study, or for short a partial review of published material, but does not include new experiments nor new concepts.
This applies also to more publications by (more or less) the same Authors (see item 2 - General Comment on Motivation and Rationale), i.e.:

[b] M. Würth, F. Bischeltsrieder and W. Utschick, "Quantum Radar with Genuine Tripartite Entanglement" 2023 IEEE International Conference on Quantum Computing And Engineering (QCE), Bellevue, WA, USA, 2023, pp. 354-355, doi:10.1109/QCE57702.2023.10279.

[c] or [18] F. Bischeltsrieder, M. Würth, J. Russer, M. Peichl and W. Utschick, "Engineering Constraints and Application Regimes of Quantum Radar," in IEEE Transactions on Radar Systems, vol. 2, pp. 197-214, 2024, doi:10.1109/TRS.2024.3361048.

[d] J. A. Russer, M. Würth, W. Utschick, F. Bischeltsrieder and M. Peichl, "Performance A Note on the Efficient Operation of Quantum Radar and the Fair Classic Comparison".

[e] J. A. Russer, M. Würth, W. Utschick, F. Bischeltsrieder and M. Peichl, "Circuits for Josephson Parametric Amplification in Quantum Radar," 2023 United States National Committee of URSI National Radio Science Meeting (USNC-URSI NSRM), Boulder,CO, USA, 2023, pp. 315-316, doi: 10.23919/USNC-URSI NRSM 57470.2023.10043131.

[f] F. Kronowetter, M. Würth, W. Utschick, R. Gross, and K.G. Fedorov, "Imperfect Photon detection in quantum illumination" Phys. Rev. Applied 21, 014007 – Published 5 January 2024.

In the ensuing comments it is explained that it has an interest close to zero in the field of Radar and of Quantum Radar and more generally to the readers of Transactions on Radar Systems.

I*f you are suggesting additional references they must be entered in the text box below. All suggestions must include full bibliographic information.*
Important: please also include any suggested references in your full review for the authors.
If you are not suggesting any references, type N/A.
N/A: rejection is suggested.

Please see the research contribution and the Comments for more References *Are you recommending that the authors add any references to papers on which you are an author?*
No
Recommendation : **Reject**

Confidential Comments to the Editor

2. General comment on Motivation and Rationale of the Manuscript.

The increasing unfortunate usage of bibliometrics for ranking and careers advancements has produced (i) multiplication of papers, i.e. splitting a single content into two or more papers and (ii) multiplication of signatures, i.e. adding one or (often) more signature s to a document which is clearly the product of a single person (or a pair as a maximum). Scientific community shall learn how not to accept the multiplications of papers and of signatures.
In the frame of this Review a careful analysis of text, tables, drawings, formulas and (last but not least) Author's Bio data makes it clear that these documents , including [a], are produced by both types (i and ii) of these bad practices. Therefore, while it remains rather surprising that [c] was accepted (see below), the acceptance of [a] is not suggested, on the contrary, rejection of this (basically useless and immaterial) manuscript is strongly suggested.

3. Specific comments

Warning: It is impossible to read [a] without keeping, open in front, [c] (labeled [18] in theReferences), so much as one wonders why [a] was not inserted in [c]. Hence, most comments will necessarily apply to both [a] and [c].

3.1. By definition, a Radar is able to perform Detection and Ranging. On the contrary, in [a] and [c] they consider it (the radar) a peculiar type of "alarm system", only able to say Yes or No about the presence, in some position, of a single radar target. This point is confirmed by a celebrated expert in Quantum Radar, M. Lanzagorta: "At this point, it is important to remark that quantum illumination is a protocol to detect the presence or absence of a target at a very specific position of space. As such, quantum illumination on its own is not a quantum radar", from: M. Lanzagorta and J. Uhlmann, "Opportunities and Challenges Of Quantum Radar," in IEEE Aerospace and Electronic Systems Magazine, vol. 35, no.11, pp. 38-56, 1 Nov. 2020, doi: 10.1109/MAES.2020.3004053.

3.2. A key parameter in the proposed evaluations is the two-way attenuation; it is generally named k. Most papers on Quantum Radar Advantage , including the one underexam here,and more by the same Authors, e.g. [f], present evaluations for a two-way attenuation κ equal to 0.01 (i.e. -20 dB) while the real values in most practical radar applications are ten or twelve orders of magnitude lower (for example, at X band, for r.c.s. σ = 1 sq.m. at distance R = 1000 m and with an antenna gain (the same in transmission and in reception) of 1000 (30 dB), it results: $\kappa \cong$ 5.16 10E−13 i.e. – 122.5 dB). Hence, the presented results with k = 0.01 are useless as they would only apply to very close (e.g. 1 m within the laboratory) targets, not to a real Radar. Historically, this value has been arbitrarily written in some early papers and copied, during a decade, in the following ones, thanks to the absence of a radar engineer in the team, a misleading condition which also applies to the object of the current Review. Unfortunately, also because of the absence of scarce effectiveness of some Reviews, these unacceptably high values of κ are also present in recent literature. Example: "The solid black curve is for κ = 0.1, the dashed black curve is for κ = 0.05, and the solid red (gray offline) curve is for κ = 0.01". From: Thomas Brougham and John Jeffers, "Optimization of direct-detection quantum illumination" Phys. Rev. A 109, 052612 – Published : 7 May 2024, DOI:https://doi.org/10.1103/PhysRevA.109.0526123.3.

3.3 The statistical analysis of detection by Quantum Radar (the core of [a]) is performed with the Bayesian approach and assuming 50% probability of target absent/present. We read: "ROC curves, i.e. Fig. 2. ROC curves of type (17) for selected minimum error probabilities (equally probable hypothesis H0 and H1; see (20), (21)). "*The performance of a detector can be quantified, among other metrics, by the minimum achievable error-probability PE, min.*

The error probability PE, by assuming equally-probable hypotheses, yields [51] PE = 1/2 (PFA +(1− PD)), we thus restrict our discussion and analysis to PE,min as our figure of merit." This is useless and wrong as radar detection is always and everywhere analysed by the Neyman-Pearson criterion. The basic reason, which also radar newcomers may understand, is that - in the frame of radar surveillance - the number of targets is unknown a priori and is much less than the number of radar resolution cells (whose order of magnitude is millions). Evaluations of Detection Probability vs. Range of a standard (RCS= 1 sq.m.) for a given probability of false alarm Pfa = 10^-6) are absent in [a] as well as in the "parent" papers, making [a] of little interest also when accepting its limitation to detection.

3.4. Again on statistical analysis: we read "*Note that we apply the central limit theorem to facilitate our derivations and to approximate the observable quantities as being Gaussian distributed in cases where individual statistics are not.* First, the central limit theorem is only applicable in precise conditions, not considered in this manuscript. Second, at the end of the decision procedure, the decision variable to be compared with a threshold for target detection is, after all, an **amplitude**, i.e. a positive quantity which cannot be described by the Gaussian law. Moreover, the parent paper [c]/[18] shows an useless Fig. 2, out-of-context.

3.5. On the knowledge of target distance. We read : "*Note also that all four concepts are phase dependant in the sense that perfect knowledge on the distance between target and radar is required. This ensures a matched phase relation (i.e., time delay) between the measurement channel and the idler path or the quadrature detector. This aspect is present in all four radar protocols and will not be discussed in the following analysis, as it is not relevant for the evaluation of the best achievable detection performance.*" The distance of the target (precisely, of its backscattering phase center) shall be known apriori with an accuracy of a (small) fraction of the radiated wavelength! But no radar in the world operates in this way.

3.6. Limitations of this meta-analysis.In this manuscript, **showing no experimental results nor new analysis methodologies,** the exam of the literature is only partial and mostly devoted to : Assouly, R., Dassonneville,R., Peronnin, T. et al. Quantum advantage in microwave quantum radar. Nat. Phys. 19,1418–1422 (2023). https://doi.org/10.1038/s41567-023-02113-4.More relevant papers are ignored, such as :M. P. Mrozowski, R. J. Murchie, J. Jeffers, and J. D. Pritchard, "Demonstration of quantum-enhanced range finding robust against classical jamming," Opt. Express 32,2916-2928 (2024); Luong, David and Balaji, Bhashyam, "Quantum Radar: Challenges and Outlook: An Overview of the State of the Art", IEEE Microwave Magazine, Volume 24, Issue 9, Pages 61 – 67, September 2023; Barzanjeh, S. Pirandola, D. Vitali, J. M. Fink, Microwave quantum illumination using adigital receiver. Sci. Adv. 6, eabb0451 (2020). Pavan G, Galati G. "Range Limitations in Microwave Quantum Radar". Remote Sensing.2024; 16(14):2543. https://doi.org/10.3390/rs16142543Wei, R., et al.: Evaluating the detection range of microwave quantum illumination radar.IET Radar Sonar Navig. 1–10 (2023). https://doi.org/10.1049/rsn2.12456Thomas ; Brougham and John Jeffers: Optimization of direct-detection quantum illumination, Phys. Rev. A 109, 052612 – Published 7 May 2024.

3.7 Results of [a] and the neglect of Orders of Magnitude. The lack of valuable and interesting results is anticipated by the title: "… Efficient Operation Of Quantum Radar and the Fair Classic Comparison" . What is meant by Fair? A fair comparison can be written in a few sentences recalling that (1) Radar detection depends on energy (2) the energy of a microwave photon is so low that (at 9.4 GHz it is 6.23·10−24 J), in a typical radar application such as the marine one, that, in order to reach the needed 2.5 mJ, the quantum radar has to transmit to the target a number of photons of about Ns = 4·10 20, which (3) for less than one

photon per mode and reasonable bandwidth, requires some million years . This is a fair comparison: two systems, fixed overall performance: Range, Pd, Pfa, time-on-target.The information conveyed by Figs. 1 and 2 shows a neglect of the Orders of Magnitude and is both useless and confusing. Showing a Quantum Advantage with a scale of ten's of dB when a radar has to compensate for 120 dB's attenuation produces the same feeling as looking to a billionaire who daily counts the small coins in his pocket and records the result.
Finally, these Figs. show the ignorance of the unavoidable errors in the only experimental datum shown.Hence, rejection with no recommendation for revisions is suggested.

Comments to the Author
2. General comment on Motivation and Rationale of the Manuscript.
The increasing unfortunate usage of bibliometrics for ranking and careers advancements has produced (i) multiplication of papers, i.e. splitting a single content into two or more papers and (ii) multiplication of signatures, i.e. adding one or (often) more signatures to a document which is clearly the product of a single person (or a pair as a maximum).Scientific community shall learn how not to accept the multiplications of papers and ofsignatures.In the frame of this Review a careful analysis of text, tables, drawings, formulas and (last but not least) Author's Bio data makes its clear that these documents , including [a], are produced by both types (i and ii) of these bad practices. Therefore, while it remains rather surprising that [c] was accepted (see below), the acceptance of [a] is not suggested, on the contrary, rejection of this (basically useless and immaterial) manuscript is strongly suggested.

3. Specific comments - Warning: It is impossible to read [a] without keeping, open in front, [c] (labeled [18] in the References), so much as one wonders why [a] was not inserted in [c]. Hence, mostcomments will necessarily apply to both [a] and [c].

3.1. By definition, a Radar is able to perform Detection and Ranging. On the contrary, in[a] and [c] th are considered a peculiar type of "alarm system", only able to say Yes or No about the presence, in some position, of a single radar target. This point is confirmed by a celebrated expert in Quantum Radar, M. Lanzagorta: "At this point, it is important to remark that quantum illumination is a protocol to detect the presence or absence of a target at a very specific position of space. As such, quantum illumination on its own is not a quantum radar ", from: M. Lanzagorta and J. Uhlmann, "Opportunities and Challenges Of Quantum Radar," in IEEE Aerospace and Electronic Systems Magazine, vol. 35, no.11, pp. 38-56, 1 Nov. 2020, doi: 10.1109/MAES.2020.3004053.

3.2. A key parameter in the proposed evaluations is the two-way attenuation; it is generally named κ . Most papers on Quantum Radar Advantage, including the one underexam here,and more by the same Authors, e.g. [f], present evaluations for a two-way attenuation κ equal to 0.01 (i.e. -20 dB) while the real values in most practical radar applications are ten or twelve orders of magnitude lower (for example, at X band, for r.c.s. σ = 1 sq.m. at distance R = 1000 m and with an antenna gain (the same in transmission and in reception) of 1000 (30 dB), it results: $\kappa \cong 5.16\ 10^{-13}$, i.e. -122.5 dB). Hence, the presented results with κ = 0.01 are useless as they would only apply to very close (e.g. 1 m within the laboratory) targets, not to a real Radar. Historically, this value has been arbitrarily written in some early papers and copied, during a decade, in the following ones, thanks to the absence of a radar engineer in the team, a misleading condition which also applies to the object of the current Review. Unfortunately, also because of the absence of scarce effectiveness of some Reviews, these unacceptably high values of k are also present in recent literature. Example: "The solid black curve is for κ =

0.1, the dashed black curve is for κ = 0.05, and the solid red (gray offline) curve is for κ= 0.01". From: Thomas Brougham and John Jeffers,"Optimization of direct-detection quantum illumination" Phys. Rev. A 109, 052612 – Published : 7 May 2024, DOI:https://doi.org/10.1103/PhysRevA.109.0526123.3.

3.3 The statistical analysis of detection by Quantum Radar (the core of [a]) is performed with the Bayesian approach and assuming 50% probability of target absent/present. We read: "ROC curves, i.e. Fig. 2. ROC curves of type (17) for selected minimum error probabilities (equally probable hypotheses H0 and H1; see (20), (21)). The performance of a detector can be quantified, among other metrics, by the minimum achievable error-probability PE,min. The error probability PE, by assuming equally-probable hypotheses,yields [51] PE = 1/2 (PFA +(1− PD)), we thus restrict our discussion and analysis toPE,min as our figure of merit." This is useless and wrong as radar detection is always and everywhere analysed by the Neyman Pearson criterion. The basic reason, which also radar newcomers may understand, is that - in the frame of radar surveillance - the number of targets is unknown a priori and is much less than the number of radar resolution cells (whose order of magnitude is millions). Evaluations of Detection Probability vs. Range of a standard (RCS = 1 sq.m.) for a given probability of false alarm Pfa = 10^-6) are absent in [a] as well as in the "parent" papers, making [a] of little interest also when accepting its limitation to detection.

3.4. Again on statistical analysis: we read "Note that we apply the central limit theorem to facilitate our derivations and to approximate the observable quantities as being Gaussiandistributed in cases where individual statistics are not." First, the central limit theorem is only applicable in precise conditions, not considered in this manuscript. Second, at the end of the decision procedure, the decision variable to be compared with a threshold for target detection is, after all, an amplitude, i.e. a positive quantity which cannot be described by the Gaussian law. Moreover, the parent paper [c]/[18] shows an uselessFig. 2 , out-of-context.

3.5. On the knowledge of target distance. We read : "Note also that all four concepts are phase-dependent in the sense that perfect knowledge on the distance between target and radar is required. This ensures a matched phase relation (i.e., time delay) between the measurement channel and the idler path or the quadrature detector. This aspect is present in all four radar protocols and will not be discussed in the following analysis, as itis not relevant for the evaluation of the best achievable detection performance." The Distance of the target (precisely, of its backscattering phase center) shall be known apriori with an accuracy of a (small) fraction of the radiated wavelength! But no radar in the world operates in this way.

3.6. Limitations of this meta-analysis. In this manuscript, showing no experimental results nor new analysis methodologies, the exam of the literature is only partial and mostly devoted to: Assouly, R., Dassonneville, R., Peronnin, T. et al. "Quantum advantage in microwave quantum radar". Nat. Phys. 19,1418–1422 (2023). https://doi.org/10.1038/s41567-023-02113-4. More relevant papers are ignored, such as M. P. Mrozowski, R. J. Murchie, J. Jeffers, and J. D. Pritchard, "Demonstration of quantum-enhanced rangefinding robust against classical jamming," Opt. Express 32,2916-2928 (2024) Luong, David and Balaji, Bhashyam, "Quantum Radar: Challenges and Outlook: An Overview of the State of the Art", IEEE Microwave Magazine, Volume 24, Issue 9, Pages

61 – 67, September 2023S. Barzanjeh, S. Pirandola, D. Vitali, J. M. Fink, Microwave quantum illumination using a digital receiver. Sci. Adv. 6, eabb 0451 (2020). Pavan G, Galati G. "Range Limitations in Microwave Quantum Radar". Remote Sensing.2024; 16(14):2543. https://doi.org/10.3390/rs16142543Wei. R., et al.: Evaluating the detection range of microwave quantum illumination radar.IET Radar Sonar Navig. 1–10 (2023). https://doi.org/10.1049/rsn2.12456Thomas.Brougham and John Jeffers: Optimization of direct-detection quantum illumination, Phys. Rev. A 109, 052612 – Published 7 May 2024.

3.7 Results of [a] and the neglect of Orders of Magnitude. The lack of valuable and interesting results is anticipated by the title: "… Efficient Operation Of Quantum Radar and the Fair Classic Comparison". What is meant by Fair? A fair comparison can be written in a few sentences recalling that (1) Radar detection depend on energy; (2) the energy of a microwave photon is so low that (at 9.4 GHz it is 6.23·10^−24 J), in a typical radar application such as the marine one, that, in order to reach the needed 2.5 mJ, the quantum radar has to transmit to the target a number of photons of about Ns = 4·10^20, which (3) for less than one photon per mode and reasonable bandwidth, requires some million years. This is a fair comparison: two systems, fixed overall performance: Range, Pd, Pfa, time-on-target.The information conveyed by Figs. 1 and 2 shows a neglect of the Orders of Magnitude and is both useless and confusing. Showing a Quantum Advantage with a scale of ten's of dB when a radar has to compensate for 120 dB's attenuation produces the same feeling as looking to a billionaire who daily counts the small coins in his pocket and records the result.
Finally, these Figs show the ignorance of the unavoidable errors in the only experimental datum shown.

dr. ing. Gaspare Galati - professore onorario/honorary professor
Università di Roma Tor Vergata / Tor Vergata University – Roma

End of Galati's Review
For those who are curious about the end of this story : K. Kramer replied on 6 March, 2025 washing her hands as follows: "As President, and even as a Member of the Board of Directors, I have a responsibility to avoid involving myself in these types of disputes" ..." My role as President does not make me the best person to whom direct a reviewer-editor ***dispute*** regarding one of IEEE's hundreds of journals" ... " IEEE does have guidelines for authors, and editors, reviewers… Please follow the processes that have been designated…"
It is clear that this answer, full of *hybris* but poor of content , neglects the fact that in this case there was not a dispute but, rather, an unacceptable way of managing the review process of an IEEE manuscript by an Associate Editor, who clearly showed to be unfit as synthesized in the following :

i) Detailed and motivated reviews suggested (by the majority of referees) to reject a manuscript.
ii) The Associated Editor (AE) communicated to the authors of the manuscript (enclosing the Referees' comments as usual) the decision of rejection.
iii) The authors complained about the decision and about the reviews, in particular, my reviews for an alleged "antagonistic" tone-
iv) The "bravehearth" AE changed his mind and communicated to the authors that he would ignore the negative reviews and the manuscript would have sent to a different set of reviewers.

Final comment. Considering the fact that Publications is the most important activity by IEEE, the above should be enough, for an effective and operational President and CEO, to remove the unfit Associate Editor.

Related Messages

The above message by G. Galati to the IEEE is complemented by the following, previous ones with reseach group on Munich University (TUM) author of Quantum Radar papers:

FIRST MESSAGE

From: Gaspare GALATI <gaspare.galati@uniroma2.it>
Date: Saturday, 25. May 2024 at 16:48
To: Michael Würth <michael.wuerth@tum.de>
Cc: florian.bischeltsrieder@dlr.de" <florian.bischeltsrieder@dlr.de>, Wolfgang Utschick <utschick@tum.de>
Subject: Attenuation figure (K) for Quantum Radar

Dear prof. Würth,
I'm interested in Noise radar (https://www.researchgate.net/publication/361455088_Signal_design_and_processing_for_noise_radar) and in Quantum Radar (https://arxiv.org/abs/2403.00047) and I've just seen the paper:
[1] M. Würth, F. Bischeltsrieder and W. Utschick, "Quantum Radar with Genuine Tripartite Entanglement," *2023 IEEE International Conference on Quantum Computing and Engineering (QCE)*, Bellevue, WA, USA, 2023, pp. 354-355, doi: 10.1109/QCE57702.2023.10279.
of which you are the first author.
Can you please be so kind as to explain me the following:
various papers on Quantum Radar Advantage, including yours, present evaluations for a two-way attenuation, generally named *κ*, equal to 0.01 (i.e. -20 dB) while, because of the radar's 4^th power law, the real values in most practical radar applications are ten or twelve orders of magnitude lower (for example, at X band, for r.c.s. σ = 1 sq.m. at distance R= 1000 m and with an antenna gain (the same in transmission and in reception) of 1000 (30 dB) , it results: κ ≅ 5.16 10^−13).

Question: using for *k* the value, say, of 10^-12 (in place of 10^-2) how much is the calculated Quantum Advantage? Or: how will Fig. 2 of [1] change?

Waiting for a kind, informal answer, I send my best regards to you and your colleagues /coauthors in cc.
GG

dr. ing. Gaspare Galati - professore onorario/honorary professor

REPLY MESSAGE

Wolfgang Utschick <utschick@tum.de> 27 mag 2024, 14:33

A Gaspare, Michael, florian.bischeltsrieder@dlr.de

Dear Prof. Galati,
Thank you for contacting us. Michael and Florian are doctoral candidates in group and Florian is also with the German Aerospace Center.

Your question is very valid and the answer may not satisfy your engineering heart, as it doesn't satisfy ours either. The truth is that **the entire field is heavily dominated by physicists,** and this is one of the standard assumptions in this area. When we began researching in this direction a couple of years ago, we discovered that physicists have a very narrow view of radar systems. **Quantum illumination, as it's known in the physics community, is, to the best of our knowledge, not really suitable for radar applications at the current stage of technology. We're even skeptical about what breakthrough could change this in the near future**. You may refer to our recently published journal paper in the Transactions on Radar Systems for a detailed analysis of our perspective.
F. Bischeltsrieder, M. Würth, J. Russer, M. Peichl and W. Utschick, "Engineering Constraints and Application Regimes of Quantum Radar," in *IEEE Transactions on Radar Systems*, vol. 2, pp. 197-214, 2024, https://ieeexplore.ieee.org/document/10433854.
Best regards and best wishes from Munich

Wolfgang

Univ.-Prof. Dr.-Ing. Wolfgang Utschick
Ordinarius, IEEE Fellow
Technical University of Munich
TUM School of Computation, Information and Technology
Department of Computer Engineering
Chair for Signal Processing Methods

3. Public Institutes' WEB sites

On February 11th, 2025, an access to the Web site of the Swedish Defence Research Agency, FOI, shows a link on Quantum Radar:

https://www.foi.se/en/foi/misc/search.html?query=Quantum+radar+draws+ever+closer

A message to FOI on the same date follows:

"Can you please tell the related people that Quantum Radar has no any operational perspective, as you may see also in Wikipedia (en) or directly as follows:

For the (less and less) people interested in Quantum Microwave Radar (physically unable to get Ranges above a few meters) suggested readings are:

"Range Limitations in Microwave Quantum Radar" (over 3600 views) https://www.mdpi.com/2865432, and "On Target Detection by Quantum Radar (Preprint)", arXiv: [quant-ph], 29 February 2024, [Online]: https://doi.org/10.48550/arXiv.2403.00047.

Kind regards
Dr. ing. Gaspare Galati - professore onorario/honorary professor.

No reply was found to this message.

4. An Example of today's reviews of manuscripts

The decision for publication of a manuscript submitted to a Review (Journal, Magazine, Proceedings..) is more and more based on the Review by (only) two Reviewers. The quality of the decision process is downgrading year by year.

An example follows, where one may see an accurate review , whose detailed motivations are more then enough to reject the manuscript, and a "quick and dirty" one . The Editor's decision was "Revise".

Dear Dr XXXXXX,

Thank you for your help with the manuscript, "Learning Transformer Network XXXXXX ", which you recently reviewed for Scientific Reports.

For your records, the decision on this manuscript, based partly on your input, was: Revise. Any comments to authors have been appended below.

We greatly appreciate your assistance and participation in the review process for Scientific Reports and hope that we can continue to benefit from your expertise on future submissions.

You can keep track of your reviewer work on the new Reviewer dashboard associated with your Springer Nature account.
https://XXXXXXXXXX
Kind regards,
Peer Review Advisors
Scientific Reports

Reviewer 1
Unfortunately, I have to recommend rejection as the submission does not meet the editorial criteria of Scientific Reports for publication. In fact :

1) It seems that the authors of the manuscript did not study the basic background present in

[a] “Wang, Husheng; Chen, Baixiao; Zhu, Dongchen; Huang, Fengsheng; Yu, Xiangzhen; Ye, Qingzhi; Cheng, Xiancheng; Peng, Shuai; Jing, Jiaqiu (2022-08-07). "Chaff identification method based on Range-Doppler imaging feature". IET Radar, Sonar & Navigation. 16 (11): 1861–1871. doi:10.1049/rsn2.12302. ISSN 1751-8784.Reference 20 of this submitted manuscript.

[b] U. Kaydok, "Chaff Discrimination Using Convolutional Neural Networks and Range Profile Data," 2020 IEEE International Radar Conference (RADAR), Washington, DC, USA, 2020, pp. 373-377, doi: 10.1109/RADAR42522.2020.9114645.” 21 of the manuscript

2) The results shown in Table 1 and in Table 2. “The comparison of the corresponding results of the quantitative evaluation metric results on the UMHD-Chaff benchmark dataset” are useless because of the absence of the relevant confidence intervals

3) The results in Figure 2. (and the following) are useless due to the (arbitrary) normalization of the y-axis.

4) There is some unclear and probably useless text such as

4.1 “Some researchers proposed chaff identification methods based on the range–Doppler features of radars 19, 20. The range profile data were utilized as input to a convolutional neural network (CNN) to discriminate chaff clouds from ships21. However, the generalization performance of the network was not validated. “(??)

4.2 “In this paper, we perform the 512-point fast Fourier transform on the chaff cloud radar echo signal, that is, the transform length is 512. Thus, the lengths of the HRRP sequence of the target radar echo signal and the HHRP sequence of the mixed radar echo signal are 217.” (?)

4.3 “In order to improve the anti-chaff jamming ability of radars, investigated target recognition technology using pulse Doppler radar based on bandwidth characteristics “(??)

5) The design of the experiment has little to do with the real applications. Chaff (today, aluminium-coated silica glass fibers cut at 50% of the wavelenght of the victim radar) is used in open air. Chaff in anecoic chamber provides a completely different velocity spectrum, which is operationally immaterial.

Reviewer 2

This paper proposes an effective and advanced deep learning model for radar chaff jamming suppression and establishes a rich mearsured dataset to validate its suppression performance. It is quite novel and has contributions on the filed. However, some minor issues require revision and improvement.

First of all, it should be noticed that in section 2, authors should provide futher specific analysis about the different normalized HRRP sequences of different measured radar echo signals corresponding to the figure 2. All these detailed information will help the readers to better understand the paper and might be valuable for the readers in general. Besides, In the evaluation criteria section, it is recommended to add a signal-to-noise ratio metric to facilitate a straightforward assessment of the quality of signals processed by the algorithm.

5. Research Projects on Quantum Radar

Some public-founder research on Quantum Radar is managed by the Departments of Defense (DoD's) and classified. Some projects appear as follows among the scarce information available on the Web.

- **QUARATE (QUAntum RAdar Team)**

Quarate project team-In this joint innovation project in the field of quantum technologies, a network of four partners from Germany, each with a commercial or scientific-technical background, was formed. German Aerospace Center (DLR), a German non-profit aerospace technology research institute- Technical University of Munich (TUM), Walther-Meißner-Institut (WMI), a research institute of the Bavarian Academy of Sciences, specialized in low temperature physics, and Rohde & Schwarz, whose scientific and technical goals, closely related with those of the WMI, consist in the setup and characterization of a radar quantum receiver and its integration into the overall system.
(https://www.rohde-schwarz.com/ca/knowledge-center/research-projects/quarate_254591.html).

It may be interesting – and someway surprising – to look at item a) and check the responsible for the QUARATE Research Unit of TUM: he is ***Wolfgang Utschick, i.e. the same professor as in the exchange of email messages shown in Section 3..***

- **FOI-R--4854—SE- ISSN 1650-1942 December 2019**

This report is part of an internally initiated project at the Swedish Defence Research Agency FOI with the purpose of understanding and evaluating the use of quantum physics in radar systems, and the potential implications thereof. Potentially, it could perform the base for future research projects. (https://www.foi.se/rest-api/report/FOI-R-4854-SE)

- **QUANTUM RADAR: Quantum Metrology and Nanotechnologies Project**

Duration: 30-04-2022 - 01-05-2025
Funding: Ministero della Difesa Segretariato Generale della Difesa e Direzione Nazionale degli Armamenti Direzione Informatica, Telematica e Tecnologie Avanzate (TELEDIFE).

The project aims to investigate new quantum techniques based on quantum states of microwave radiation (1-10 GHz band), in particular of "entangled" "twin" beams, for the realization of a prototype of "Quantum Radar" with increased precision (an increase of the signal-to-noise ratio (SNR)) of the interferometric measurements, **indispensable in the detection of the position of non-cooperating targets**, and reduction of the destructive effects due to environmental noise.

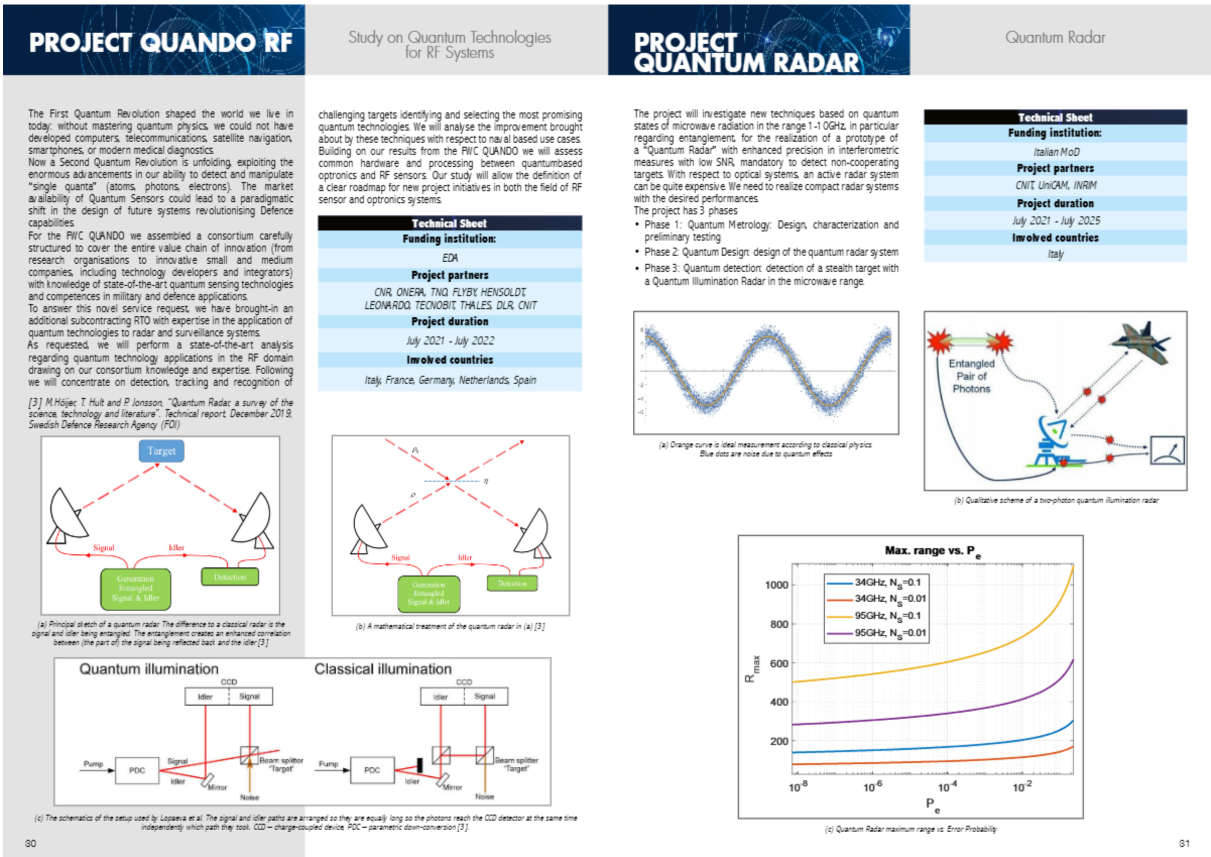
https://www.inrim.it/en/research/projects/quantum-radar.

- **PROJECT QUANDO RF**

The project will investigate new techniques based on quantum states of microwave radiation in the range 1-10 GHz, in particular regarding entanglement, for the realization of a prototype of a "Quantum Radar" with enhanced precision in interferometric measures with low SNR, mandatory to detect non-cooperating targets. We need to realize compact radar systems with the desired performances (https://labrass.cnit.it/portfolio/quantum-radar/.
It is founded by the Italian Ministry of Defence (MoD), with participants: CNIT (Italian University Consortium for Telecommunications – Radar and Surveillance Systems), UniCAM (University of Camerino, Italy), INRIM (Italian Metrology Research Institute).
The project has 3 phases:

1. Phase 1: Quantum Metrology: Design, characterization and preliminary testing.
2. Phase 2: Quantum Design: design of the quantum radar system.

3. Phase 3**: Quantum detection: detection of a stealth target with a Quantum Illumination Radar in the microwave range**.



PROJECT QUANDO RF

Study on Quantum Technologies for RF Systems

The First Quantum Revolution shaped the world we live in today: without mastering quantum physics, we could not have developed computers, telecommunications, satellite navigation, smartphones, or modern medical diagnostics.
Now a Second Quantum Revolution is unfolding, exploiting the enormous advancements in our ability to detect and manipulate "single quanta" (atoms, photons, electrons). The market availability of Quantum Sensors could lead to a paradigmatic shift in the design of future systems revolutionising Defence capabilities.
For the PWC QUANDO we assembled a consortium carefully structured to cover the entire value chain of innovation (from research organisations to innovative small and medium companies, including technology developers and integrators) with knowledge of state-of-the-art quantum sensing technologies and competences in military and defence applications.
To answer this novel service request, we have brought-in an additional subcontracting RTO with expertise in the application of quantum technologies to radar and surveillance systems.
As requested, we will perform a state-of-the-art analysis regarding quantum technology applications in the RF domain drawing on our consortium knowledge and expertise. Following we will concentrate on detection, tracking and recognition of challenging targets identifying and selecting the most promising quantum technologies. We will analyse the improvement brought about by these techniques with respect to naval based use cases. Building on our results from the PWC QUANDO we will assess common hardware and processing between quantumbased optronics and RF sensors. Our study will allow the definition of a clear roadmap for new project initiatives in both the field of RF sensor and optronics systems.

[3] M.Höijer, T. Hult and P. Jonsson, "Quantum Radar, a survey of the science, technology and literature". Technical report, December 2019, Swedish Defence Research Agency (FOI)

Technical Sheet
Funding institution:
EDA
Project partners
CNR, ONERA, TNO, FLYBY, HENSOLDT, LEONARDO, TECNOBIT, THALES, DLR, CNIT
Project duration
July 2021 - July 2022
Involved countries
Italy, France, Germany, Netherlands, Spain

(a) Principal sketch of a quantum radar. The difference to a classical radar is the signal and idler being entangled. The entanglement creates an enhanced correlation between (the part of) the signal being reflected back and the idler [3]

(b) A mathematical treatment of the quantum radar in (a) [3]

(c) The schematics of the setup used by Lopaeva et al. The signal and idler paths are arranged so they are equally long so the photons reach the CCD detector at the same time independently which path they took. CCD – charge-coupled device, PDC – parametric down-conversion [3].

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PROJECT QUANTUM RADAR

Quantum Radar

The project will investigate new techniques based on quantum states of microwave radiation in the range 1-10GHz, in particular regarding entanglement, for the realization of a prototype of a "Quantum Radar" with enhanced precision in interferometric measures with low SNR, mandatory to detect non-cooperating targets. With respect to optical systems, an active radar system can be quite expensive. We need to realize compact radar systems with the desired performances.
The project has 3 phases
- Phase 1: Quantum Metrology: Design, characterization and preliminary testing
- Phase 2: Quantum Design: design of the quantum radar system
- Phase 3: Quantum detection: detection of a stealth target with a Quantum Illumination Radar in the microwave range.

Technical Sheet
Funding institution:
Italian MoD
Project partners
CNIT, UniCAM, INRIM
Project duration
July 2021 - July 2025
Involved countries
Italy

(a) Orange curve is ideal measurement according to classical physics. Blue dots are noise due to quantum effects

(b) Qualitative scheme of a two-photon quantum illumination radar

(c) Quantum Radar maximum range vs. Error Probability

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Quantum Radar is also a part of the wider international (Italy, France, Germany, Spain) research project "QUANDO SC3" funded by the European Defence Agency (EDA), whose participants are CNR, FLYBY S.R.L., LEONARDO S.P.A., TECNOBIT, THALES R&T, DLR, time frame: December 2022 - December 2023.

PROJECT QUANDO SC3

Quantum sensors harness fundamental quantum principles like superposition and entanglement to approach the inherent measurement limits set by physics. They promise significantly enhanced precision and accuracy, revolutionizing scientific, industrial, and commercial applications. These sensors excel in measuring various physical quantities—magnetic, electric, and gravitational fields, times, frequencies, temperatures, and pressures—with unparalleled accuracy.

Typically, a quantum sensor employs discrete quantum states (qubits) dependent on the parameter being measured.

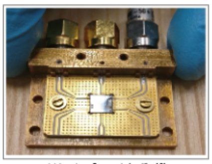
A protocol initializes the system in a known quantum state, interacts it with the measured system, and measures the qubits. This iterative process significantly improves accuracy compared to traditional sensors by utilizing entanglement techniques, quantum control, or squeezing protocols that surpass the Heisenberg limit. Quantum sensor advancements are poised to transform defense domains like C4ISR and navigation, with the potential to disrupt defense operations. The QUANDO Consortium, under EDA's directive, investigates quantum technologies for defense, focusing on quantum sensing. Collaborators across research organizations, large industrial partners, and SMEs are involved in this initiative, investigating quantum technologies' potential in optronics and radio frequency domains.

The current phase aims to synthesize an Electro Optical/Radio Frequency (EO/RF) quantum technology to solidify earlier studies and outline a potential EU defense quantum sensing roadmap. The project's objectives encompass technology identification, demonstrator design, realization, experimental testing, and result analysis, aligning with EDA's directive for an EO/RF quantum sensing proof-of-concept demonstrator.

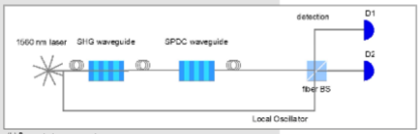
The project evaluates EO and RF quantum sensing technologies, exploring non-classical light sources, Optical Parametric Oscillators for mid-IR radiation, cryogenic Josephson Parametric Amplifiers, and Nitrogen-Vacancy centers in diamond for compact antenna receivers. Quantum Radar, utilizing quantum properties to enhance signal processing and counteract stealth properties, stands as a promising technology offering superior target detection capabilities and resilience against electronic countermeasures.

[2] D. Luong, C. W. S. Chang, A. M. Vadiraj, A. Damini, C. M. Wilson and B. Balaji, "Receiver Operating Characteristics for a Prototype Quantum Two-Mode Squeezing Radar," in IEEE Transactions on Aerospace and Electronic Systems, vol. 56, no. 3, pp. 2041-2060, June 2020.

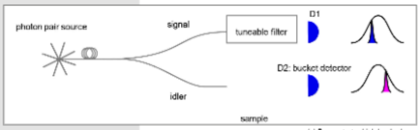
Technical Sheet
Funding institution:
EDA
Project partners
CNR, FLYBY S.R.L., LEONARDO S.P.A., TECNOBIT, THALES R&T, DLR
Project duration
December 2022 - December 2023
Involved countries
Italy, France, Germany, Spain



(a) Josephson Parametric Amplifier [2]



(b) Demonstrator components



(c) Demonstrator high-level scheme

PROJECT QUANTUM RADAR

The project focuses on exploring novel quantum techniques using microwave radiation states (1-10 GHz) to develop a prototype Quantum Radar. This radar aims to enhance precision in interferometric measurements by employing entangled microwave beams, reducing destructive effects from environmental noise when detecting non-cooperative targets.

The specification outlines a three-phase plan: Phase 1 involves design and testing, Phase 2 includes quantum design at contingent on Phase 1 success, and Phase 3 focuses on quantum detection upon Phase 2 achievements.

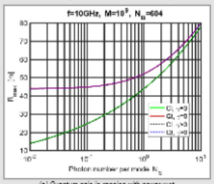
While the contract is for Phase 1, subsequent phases rely on funding confirmation, operational interest, and meeting prior phase objectives.

The overarching research objectives aim to experimentally verify a 6 dB Signal-to-Noise Ratio (SNR) increase using quantum illumination compared to classical Radar protocols. This involves generating twin signals in a Two-Mode Squeezed Vacuum (TMSV) state, where one signal is retained while the other, affected by environmental interactions, rapidly loses its entanglement.

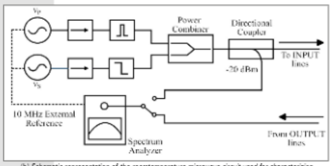
The project seeks to harness quantum properties like superposition, entanglement, and photon indistinguishability to create robust experimental models for improved detection in both microwave and optical domains. By optimizing detection methods, post-processing, and developing a superconducting parametric amplifier, the goal is to create a Quantum Radar prototype with superior SNR, power, and target distance capabilities compared to current scientific benchmarks.

[3] D. LuongarXiv:2108.10151 [quant-ph]
[4] S. Barzanjeh et al. Microwave quantum illumination using a digital receiver. Sci. Adv. 6, eabb0451 (2020)

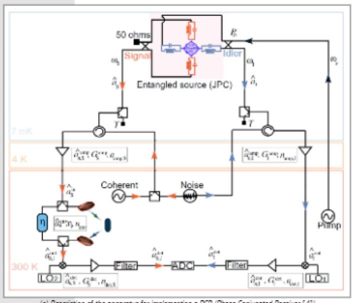
Technical Sheet
Funding institution:
Italian MoD
Project partners
UniCAM, INRIM
Project duration
July 2021 - July 2025
Involved countries
Italy



(a) Quantum gain in ranging with power w.r.t. Coherent Illumination



(b) Schematic representation of the roomtemperature microwave circuit used for characterizing the JTWPA prototype [3]



(c) Description of the apparatus for implementing a PCR (Phase Conjugated Receiver [4])