

Follow-up search for a tentative dark photon signal near 19.5 μeV using the ORGAN-Q infrastructure

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A recent independent dark photon (DP) focused reanalysis of existing data from the TASEH axion haloscope experiment reported a tentative DP dark matter signal with local significance $\sim 4.7\sigma$ at a frequency $f \approx 4.71$ GHz, corresponding to $m_X \approx 19.5 \mu\text{eV}$ and kinetic mixing $\epsilon \sim 6.5 \times 10^{-15}$. Motivated by this report, we performed a dedicated, narrowband follow-up experiment to confirm or refute the signal with a cryogenic microwave cavity operated *without* a magnetic field, leveraging the ORGAN-Q dilution refrigeration and receiver chain. Scanning a window centered on the reported frequency over a live time of $T_{\text{int}} \sim 13$ days, we find no excess consistent with a dark photon signal as reported, and set a 95% CL of $\epsilon \leq 5.04 \times 10^{-15}$ in a narrow mass range around $\sim 19.5 \mu\text{eV}$, excluding a signal of the strength and frequency reported to 99.92% confidence. We discuss the experiment and present the exclusion limits.

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I. INTRODUCTION

The nature of dark matter remains one of the biggest mysteries in modern science [1–3]. One candidate for dark matter is an ultralight vector particle known as a “dark photon” (DP), which kinetically mixes with the Standard Model photon, producing an oscillatory effective electric field. The key parameters of the DP such as its mass (m_X) and the strength of its coupling to the Standard Model photon (ϵ), are not known, creating a wide parameter space which experiments must search [4–9]. Cavity haloscopes are a kind of experiment (typically) consisting of a tunable, cryogenic, high-(Q) electromagnetic resonant cavity coupled to a sensitive electromagnetic field readout designed to probe the photon power inside the cavity [10–12]. Sometimes these experiments are constructed specifically to search for dark photons [13–15], and sometimes they are primarily designed to search for a

different kind of dark matter, the axion. In either case typical haloscopes are natural DP detectors since the DP-induced effective electric field can drive cavity resonant modes in a similar way to the axion, and thus DPs can be detected or excluded with appropriate reanalysis of existing axion haloscope data [16,17]. Some axion haloscope experiments have published such analyses explicitly [18], and others have been recast by independent analyses [19]. Recently, a DP focused reanalysis of existing axion haloscope data from the TASEH experiment, conducted by an independent group, reported a tentative signal consistent with DP dark matter with the peak of the signal at frequency $f \approx 4.71$ GHz, with $\epsilon \sim 6.5 \times 10^{-15}$ [20]. To verify or refute this signal, we conducted an independent follow-up experiment, using a purpose-built narrow-tuning cavity haloscope at milliKelvin temperatures, employing the cryostat and low-noise receiver chain of ORGAN-Q, an axion haloscope experiment targeting a similar frequency range to TASEH, but no magnetic field. This paper summarizes the apparatus, search, analysis, and limits from that targeted follow-up campaign.

II. DARK PHOTON HALOSCOPES

A DP field of mass m_X , which kinetically mixes with the Standard Model photon with some mixing parameter ϵ

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provides a source of photons with a frequency f_X proportional to the DP mass, such that

$$hf_X = m_X c^2 + \frac{1}{2} m_X v_X^2, \quad (1)$$

where h is Planck's constant, and v_X is the velocity of the DP. If the DP is dark matter, the velocity distribution of dark matter particles creates a photon signal with a small effective line-width in frequency space. For typical cold dark matter models, it is assumed that $\Delta f_X \approx 10^{-6} f_X$, which can equivalently be defined as a dark photon effective quality factor, $Q_{\text{DP}} \approx 10^6$ [21]. While the generated photons have a small range of frequencies, as we are searching for a reported signal with a specific frequency as its peak, we will henceforth use the term dark photon frequency to refer to the *peak* of the dark photon induced frequency signal in question. The contribution from the velocity is model dependent and small compared to the rest mass since $v_X \ll c$, so it remains true that this frequency corresponds approximately to the dark photon rest mass.

A dark photon haloscope works on the principle that this DP induced field can drive electromagnetic resonant cavity modes, and the resulting power deposited in the cavity from DP conversion can be read out by coupling to a receiver chain. The signal power depends on a range of both cavity and DP parameters.

When the frequency of a resonant mode of the cavity is tuned near the DP induced electromagnetic field frequency, the expected DP conversion signal power that can be extracted from the cavity into a receiver chain is given by [17]

$$P_{\text{DP}} = \epsilon^2 m_X \rho_{\text{DM}} V G Q \frac{\beta}{1 + \beta}, \quad (2)$$

where ρ_{DM} is the local density of dark matter, V is the volume of the cavity, $Q = \min(Q_L, Q_{\text{DP}})$ (with Q_L being the loaded cavity quality factor), β is the coupling coefficient of the cavity to the receiver chain, and G is a dimensionless form factor which quantifies the overlap between the electric field of the cavity mode, $\vec{E}$ and the dark photon field, $\vec{X}$. It is given by

$$G = \frac{|\int \vec{E} \cdot \vec{X} dV|^2}{V \int |\vec{E}|^2 dV}. \quad (3)$$

For the resonant modes typically employed in haloscope searches (and for the search described here), the TM_{0n0} modes, G can be reduced to

$$G = \frac{|\int \vec{E}_z dV|^2}{V \int |\vec{E}|^2 dV} \times \langle \cos^2(\theta) \rangle_T, \quad (4)$$

where $\vec{E}_z$ is the z-component of the cavity mode electric field, θ is the polarization angle between the dark photon field and the cavity z -direction, and $\langle \cos^2(\theta) \rangle_T$ is the time averaged value of $\cos^2 \theta$ over the time of the search.

The relevant value of $\cos^2 \theta$ for a given search depends on the model for the polarization of the dark photon field being considered, as well as the location and duration of the search. For the random polarization scenario assumed in the TASEH reanalysis, $\langle \cos^2(\theta) \rangle_T = 1/3$ [16].

In a DP haloscope, the cavity is tuned to some frequency, coupled to a low-noise readout chain, and data is acquired for some amount of time. Then, the cavity is tuned to a new frequency and more data is taken. Eventually, the presence or lack of a DP signal above the noise background of the receiver chain is used to either claim detection, or exclude DP dark matter in a mass range corresponding to the frequency range of the search, at a coupling level corresponding to the sensitivity of the search.

III. ORGAN-Q TASEH FOLLOW UP EXPERIMENT

TASEH is an axion haloscope experiment, which in 2022 excluded a region of axion dark matter space around $19.5 \mu\text{eV}$ [22]. In excluding axion dark matter, the TASEH search employed axion-specific vetoes to discount candidate signals.

As mentioned, a recent independent reanalysis of the TASEH data in the dark photon context, not using these axion specific vetoes, reported a tentative signal with $m_X \approx 19.5 \mu\text{eV}$, and $\epsilon \approx 6.5 \times 10^{-15}$ [20]. The ORGAN Collaboration is an axion haloscope experimental collaboration which has placed limits on axions and dark photons across a variety of mass ranges from a range of haloscope experiments [23–25]. ORGAN-Q is one of the experiments within the ORGAN Collaboration, and it searches for axions around 6 GHz [26]. The infrastructure that supports ORGAN-Q, such as the dilution refrigerator, readout chain and DAQ can all in principle be used for other searches in similar frequency ranges, such as the ~ 4.7 GHz range of the TASEH search. In light of this, we constructed a dedicated follow-up resonant cavity experiment using the ORGAN-Q infrastructure to confirm or refute this tentative DP signal.

The follow-up detector comprised a high-Q cylindrical copper cavity, designed to tune over a narrow frequency range with the coaxial insertion a sapphire tuning stub. The cavity was specifically designed to target the frequency range of the tentative TASEH reanalysis signal. The tuning stub was positioned and adjusted inside the cavity with a cryogenic piezoelectric actuator. The cavity was designed using simulations in COMSOL multiphysics, taking into account the cryogenic contraction of the materials, to target the frequency range in question. Comparison between the simulations and the experimental data was used to determine how much of the sapphire stub was inserted into the cavity at a given frequency, and thus extract the expected

cavity geometry factor. Given the relatively simple nature of the cavity compared to typical axion haloscopes, particularly the relatively small deviation in geometry from a perfect, empty cylinder—the experimental and simulated cavity frequency agreed to within 1%.

The cavity was mounted on the mixing chamber plate of the ORGAN-Q dilution refrigerator and cooled to 25 milli-Kelvin. No magnetic field was applied. Two antennae were inserted into the cavity, one was weakly coupled for transmission measurements. The second, strongly coupled antenna was connected via a cryogenic circulator to a first-stage HEMT amplifier mounted at the 1 K plate of the refrigerator. The signal from the output of the HEMT passed through additional amplification, and was mixed down to lower frequencies for acquisition with an FPGA-based digitizer. A Y-factor measurement setup was employed to calibrate the noise temperature of the readout chain.

A schematic of the experiment and readout chain can be seen in Fig. 1, and outputs from the cavity design simulations can be seen in Fig. 2.

Representative values of the key parameters of the search over the range of interest are summarized here

- (i) Target mode: TM_{010} .
- (ii) Frequency: $\nu_0 \approx 4.71018$ GHz.
- (iii) Cavity dimensions: radius 24.3 mm, height 97.2 mm.
- (iv) Sapphire stub dimensions: radius 1.76 mm.
- (v) Loaded quality factor: $Q_L = 19700$.
- (vi) Coupling: $\beta = 1.06$.
- (vii) Cavity volume: 180.3 mL.
- (viii) System noise temperature: $T_{\text{sys}} = 3.33$ K.
- (ix) Total integration time: ~ 13 days.
- (x) Resolution bandwidth: 397 Hz.

IV. DATA TAKING AND CALIBRATION

We collected ~ 13 live days of data in August 2025. The sapphire stub tuner stepped the resonance so that the resonant mode bandwidth covered a range around the reported DP signal frequency of 4.71018 GHz. The antenna coupling was adjusted to $\beta \approx 1$ to maximize the DP signal power while minimizing resonance distortion or mixing of the resonant mode with the standing waves in the readout circuit.

After mixing down the output signal we acquired a narrowband, high-resolution power spectrum (each spectrum was ~ 400 kHz wide and consisted of 1008 frequency points). We performed *in situ* VNA measurements of the resonance to extract Q_L , β , and frequency. The total system noise temperature T_{sys} was measured using a Y-factor method via a cryogenic switch, as shown in Fig. 1. In this configuration, the cryogenic termination (load) was mounted on a copper block equipped with a calibrated temperature sensor and a resistive heater. The block was mechanically anchored to the mixing chamber plate through a 50 mm stack of alumina washers, which provided a weak

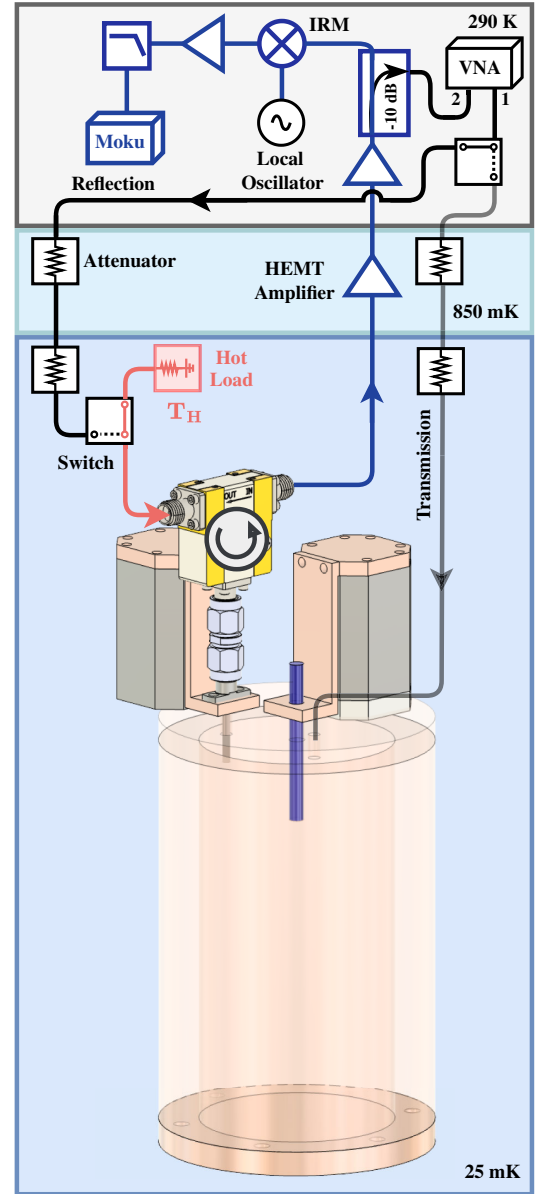


FIG. 1. Schematic of the experimental setup includes a cryogenic resonant cavity at 25 mK, coupled to a low-noise HEMT amplifier chain for signal readout (blue line). The amplified signal is mixed down using an image-rejection mixer (IRM) before being digitized by a Moku Pro. A variable-temperature hot load and switch enable calibrated noise-injection for system noise characterization. Microwave transmission and reflection paths are measured using a vector network analyzer (VNA). Cryogenic piezoelectric actuators (gray) control movement of the antenna (coupled directly to a cryogenic circulator) and the sapphire tuning stub (blue).

thermal link. The load was heated from 170 mK to 3.32 K in eight evenly spaced steps, and the corresponding output noise powers were recorded. A linear fit of output power versus effective input temperature T_H was taken at each frequency point, giving the total system noise as a function of frequency. The mean R^2 value for the fits was 0.999. To

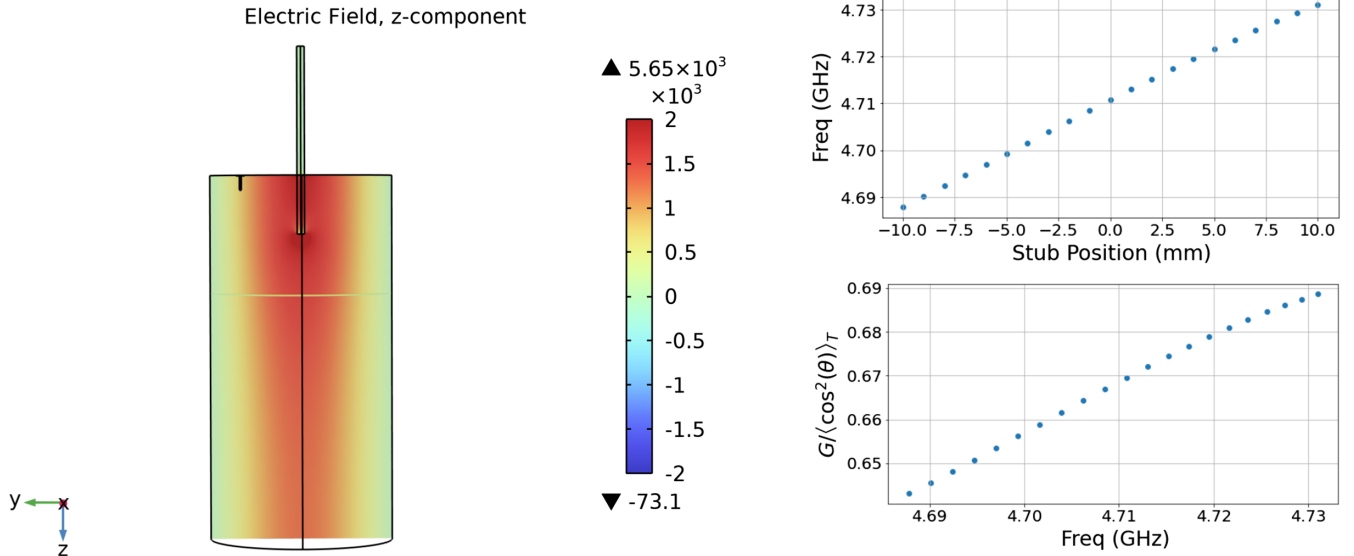


FIG. 2. Left: simplified COMSOL simulation of the cavity used in the experiment. The tuning stub, and strongly coupled antenna can be seen. The simulation was used to inform the sensitivity, and compared against experimental results. Top right: the simulated frequency against tuning stub position along the z-axis. The ‘0’ position was set such that the mode was at the frequency of interest, and the cavity was tuned around this position. Bottom right: the simulated geometry factor divided by the polarization angle normalization against frequency. The polarization normalized geometry factor presented here is equivalent to the form factor typically presented in axion haloscopes.

refer this noise to the cavity output, we measured the attenuation between the heated load setup (red line in Fig. 1) and the circulator output (the cavity input) during a separate, dedicated cooldown. From this calibration, the attenuation α_Y , was found to be $\sim 1.03 \pm 0.07$ dB, and the mean value of T_{sys} in the search region was calculated to be 3.33 K.

V. ANALYSIS

With the collected data, we perform a standard haloscope dark matter signal search, adapted from the HAYSTAC procedure [27]. Since all data were collected at a fixed cavity tuning, the usual vertical combination reduces to a simple average of the traces. The resulting spectrum is normalized by dividing out a smoothed baseline obtained from a Savitzky-Golay filter, removing the frequency-dependent gain and cavity response, while leaving narrow-band features intact. The flattened spectra are scaled according to the measured system noise temperature and the expected dark-photon signal power derived from the experimental parameters.

In this analysis we applied a maximum-likelihood filter matched to the expected dark matter signal lineshape. we adopt the Standard Halo Model, assuming the dark matter velocity distribution follows a boosted Maxwell-Boltzmann profile with an effective dispersion that accounts for Earth’s motion through the halo [21,27]. Horizontal rebinning was done by summing groups of 12 consecutive bins, chosen to match the expected dark matter signal width. The resulting normalized grand power spectrum is expressed as δ_k^g/σ_k^g ,

where δ_k^g denotes the power excess in the k th grand spectrum bin and σ_k^g is the corresponding standard deviation of the noise. In the absence of a signal, a standard normal distribution centered at zero is expected. However, due to negative correlations induced the SG-filtering step, this width is reduced to $\xi^g = 0.90$. This effect was verified through a dedicated simulation in which synthetic dark photon signals were injected into Gaussian noise and processed using the same analysis pipeline. The results of 10^6 iterations of this simulation, shown as a histogram in Fig. 3, demonstrate that the signal-to-noise ratio is suppressed by a factor $\eta^{\text{SG}} = 0.81$. After accounting for the additional narrowing of the grand spectrum distribution by ξ^g , the overall attenuation of the signal-to-noise ratio is given by $\eta^{\text{SNR}} = 0.9$.

In this search, the candidate threshold was chosen such that no bins passed the threshold, and thus no rescans were performed. For full details of the statistical treatment, matched filtering, and rescan protocol, we refer to Refs. [24–27].

VI. RESULTS

No persistent excess compatible with the DP template was observed in the range of interest. Under the random polarization assumption adopted in the TASEH reanalysis, adopting the experimental parameters of our search, with $\rho_{\text{DM}} = 0.45 \text{ GeV/cm}^3$, we set 95% CL upper limits of

$$\epsilon < 5.04 \times 10^{-15},$$

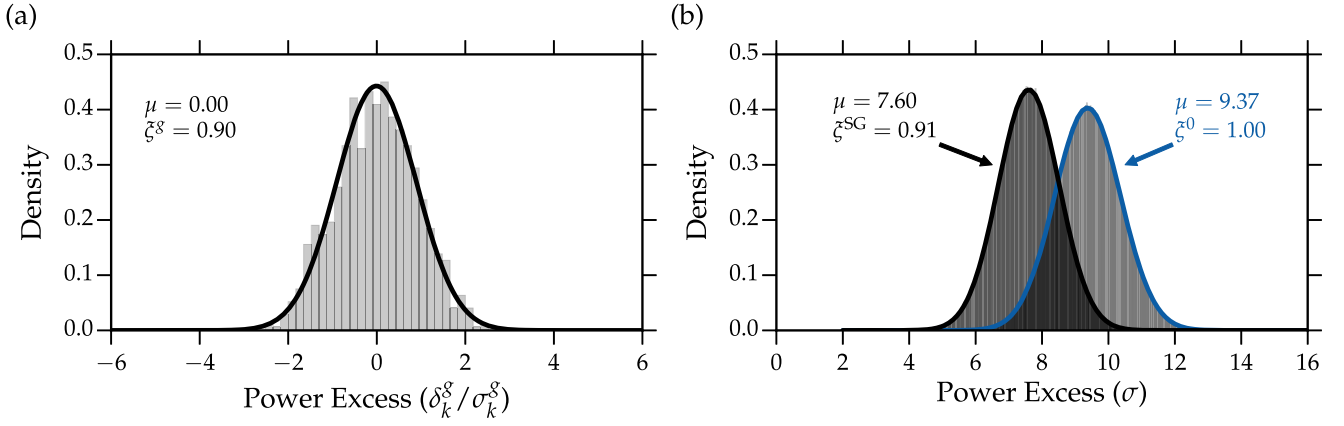


FIG. 3. (a) Distribution of normalized grand spectrum bins δ_k^g/σ_k^g following Savitzky-Golay (SG) filtering, vertical combination of overlapping spectra, and horizontal rebinning according to the Maxwell-Boltzmann signal template. The observed narrowing, quantified by $\xi^g = 0.90$, is attributed to the negative correlations introduced by the SG filter. (b) Signal-to-noise ratio (SNR) histograms for a synthetic DP signal embedded in Gaussian white noise, with one dataset passed through the SG filter (black) to simulate the analysis pipeline and the other left unfiltered (blue). The corresponding attenuation of a DP signal is quantified by the ratio of the mean SNRs, $\eta^{SG} = 7.60/9.37 = 0.81$.

at $f_X = 4.71018$ GHz. Our 95% CL limit on ϵ is lower than the coupling strength reported by the TASEH reanalysis within $\pm \sim 15$ expected DP signal linewidths of the reported frequency. The limits are presented along with the TASEH reanalysis signal properties in Fig. 4. The uncertainties in these limits are summarized in Table I.

The uncertainty in system noise temperature is derived from the uncertainties in the measured parameters used in

the Y-factor model (T_H and α_Y), which are carried through the analysis. The uncertainty in β and Q_L are taken as the standard errors obtained from the fits to the VNA measurements. The uncertainty in G is derived by COMSOL modeling of geometric uncertainties—both of the physical dimensions of the cavity and other components, and on the locations of the sapphire tuning stub and antennae. These uncertainties were found to be $<1\%$, but were rounded in

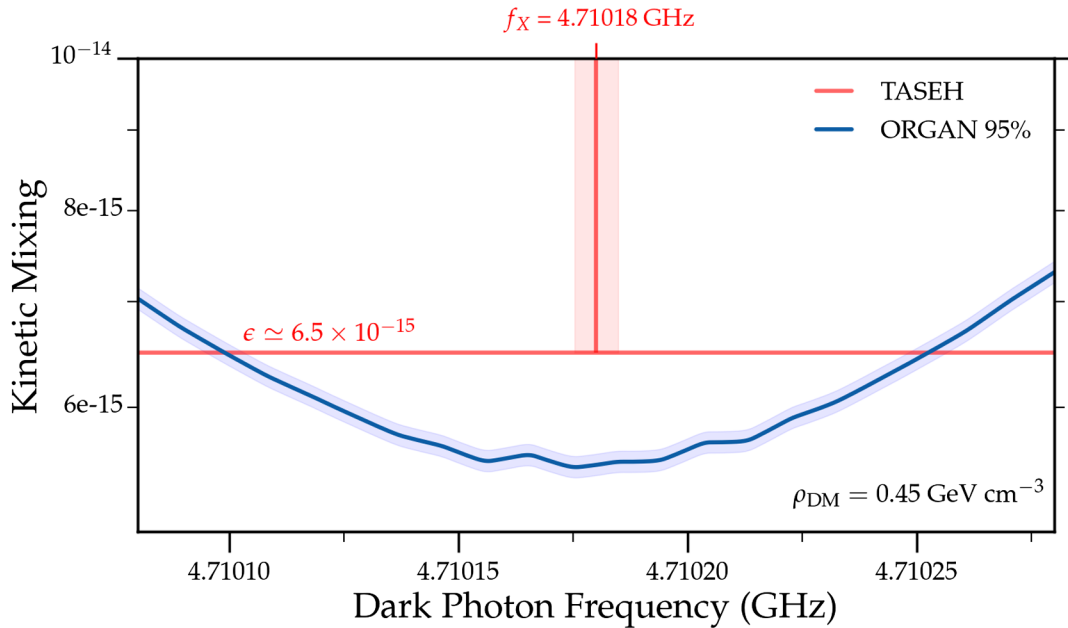


FIG. 4. Exclusion limits on the dark photon kinetic mixing parameter ϵ for the ORGAN follow-up experiment assuming the random polarization scenario. The 95% confidence level limits are shown in blue, assuming a local dark matter density of $\rho_{DM} = 0.45 \text{ GeV cm}^{-3}$. The shaded band represents the associated uncertainty in the limit. For comparison, the claimed signal reported by the TASEH Collaboration is shown in red, with the horizontal line denoting the reported mixing strength of $\epsilon \simeq 6.5 \times 10^{-15}$ and the vertical band marking the signal frequency ± 1 expected dark photon linewidth.

TABLE I. Percentage uncertainties contributing to the uncertainty on the exclusion limits.

T_{sys}	1.6%
β	2.4%
Q_L	2.2%
G	1.0%
Total with respect to ε	1.6%

the interest of conservative analysis. We attribute the relatively low uncertainty in G to the relative simplicity of the cavity and constituent components compared to typical haloscope searches, as well as the lack of an external magnetic field—the convolution of which with the cavity mode field adds additional uncertainty in the axion haloscope case.

VII. DISCUSSION

Our null result disfavors a universal, nontransient, instrument-independent DP dark matter signal with the parameters reported by the independent TASEH reanalysis. While we set broader 95% CL exclusions on the DP kinetic mixing in a region of parameter space around the signal, as reported above, when considering the *specific* frequency and coupling reported in the TASEH reanalysis, our result excludes a signal of that strength with 99.92% confidence. Additionally, this analysis is conducted in the random polarization scenario, as that is what was considered in the TASEH reanalysis. Regardless, we can also consider the standard fixed polarization scenario. In the fixed polarization scenario, for the location and timing of this follow-up search, following the procedure set out in [16], we compute $\langle \cos^2(\theta) \rangle_T \approx 0.3157$ for the 95% CL case—meaning that in the fixed polarization scenario, our 95% CL on ε is degraded by approximately 2.75%. Importantly, in this scenario, the TASEH reanalysis signal strength would also be degraded—and by a larger margin owing to the lower

value of $\langle \cos^2(\theta) \rangle_T$ for the location and timing of the TASEH experiment. As such, our experiment excludes the TASEH reanalysis signal in both the random and fixed polarization scenarios. We have only presented the limits in the random polarization scenario in Fig. 4 for readability and direct comparison to the TASEH reanalysis results, but the limits can be easily rescaled in the fixed scenario. Complementary to the exclusion reported here, a recent reanalysis of data from HAYSTAC also saw no evidence consistent with a dark photon signal as reported in the TASEH reanalysis [28].

VIII. CONCLUSION

We have carried out a focused, cryogenic cavity haloscope follow-up of the tentative dark photon dark matter signal reported in an independent reanalysis of TASEH data. The tentative signal is near 4.71 GHz in frequency space. Our follow-up uses the ORGAN-Q infrastructure without a magnetic field, and a dedicated detector cavity. Within our scanned window and under standard dark matter halo and TASEH reanalysis polarization assumptions we find no evidence for a dark photon and set 95% CL exclusions that are more stringent than the reported coupling, covering ± 15 expected signal linewidths around the reported frequency. We exclude the specific reported signal characteristics to 99.92% confidence.

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DATA AVAILABILITY

The data that support the findings of this article are openly available [29].

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- [1] E. O. Nadler, Dark matter: Evidence, theory, and constraints, *Am. J. Phys.* **93**, 763 (2025).
 - [2] M. Misiaszek and N. Rossi, Direct detection of dark matter: A critical review, *Symmetry* **16**, 201 (2024).
 - [3] A. Arbey and F. Mahmoudi, Dark matter and the early Universe: A review, *Prog. Part. Nucl. Phys.* **119**, 103865 (2021).
 - [4] J. Jaeckel and A. Ringwald, The low-energy frontier of particle physics, *Annu. Rev. Nucl. Part. Sci.* **60**, 405 (2010).
 - [5] M. Fabbrichesi, E. Gabrielli, and G. Lanfranchi, *The Physics of the Dark Photon* (Springer, Cham, 2021).
 - [6] P. Adshead, K. D. Lozanov, and Z. J. Weiner, Dark photon dark matter from an oscillating dilaton, *Phys. Rev. D* **107**, 083519 (2023).
 - [7] P. Arias, D. Cadamuro, M. Goodsell, J. Jaeckel, J. Redondo, and A. Ringwald, WISPy cold dark matter, *J. Cosmol. Astropart. Phys.* **06** (2012) 013.
 - [8] A. E. Nelson and J. Scholtz, Dark light, dark matter and the misalignment mechanism, *Phys. Rev. D* **84**, 103501 (2011).
 - [9] A. Filippi and M. De Napoli, Searching in the dark: The hunt for the dark photon, *Rev. Phys.* **5**, 100042 (2020).
 - [10] P. Sikivie, Experimental tests of the invisible axion, *Phys. Rev. Lett.* **51**, 1415 (1983); **52**, 695(E) (1984).

- [11] P. Sikivie, Detection rates for ‘invisible’ axion searches, *Phys. Rev. D* **32**, 2988 (1985); **36**, 974(E) (1987).
- [12] P. Sikivie, Invisible axion search methods, *Rev. Mod. Phys.* **93**, 015004 (2021).
- [13] R. Cervantes, G. Carosi, C. Hanretty, S. Kimes, B. H. LaRoque, G. Leum, P. Mohapatra, N. S. Oblath, R. Ottens, and Y. Park *et al.*, ADMX-Orpheus first search for 70 μeV dark photon dark matter: Detailed design, operations, and analysis, *Phys. Rev. D* **106**, 102002 (2022).
- [14] S. Adachi *et al.* (DOSUE-RR Collaboration), Search for dark photon dark matter in the mass range 41–74 μeV using millimeter-wave receiver and radioshielding box, *Phys. Rev. D* **109**, 012008 (2024).
- [15] R. Kang, M. Jiao, Y. Tong, Y. Liu, Y. Zhong, Y. F. Cai, J. Zhou, X. Rong, and J. Du, Near-quantum-limited haloscope search for dark-photon dark matter enhanced by a high-Q superconducting cavity, *Phys. Rev. D* **109**, 095037 (2024).
- [16] A. Caputo, A. J. Millar, C. A. J. O’Hare, and E. Vitagliano, Dark photon limits: A handbook, *Phys. Rev. D* **104**, 095029 (2021).
- [17] S. Ghosh, E. P. Ruddy, M. J. Jewell, A. F. Leder, and R. H. Maruyama, Searching for dark photons with existing haloscope data, *Phys. Rev. D* **104**, 092016 (2021).
- [18] B. T. McAllister, A. Quiskamp, C. A. J. O’Hare, P. Altin, E. N. Ivanov, M. Goryachev, and M. E. Tobar, Limits on dark photons, scalars, and axion-electromagnetodynamics with the ORGAN experiment, *Ann. Phys. (Berlin)* **536**, 2200622 (2024).
- [19] C. A. J. O’Hare, AxionLimits: A compilation of axion and dark photon constraints, Zenodo (2020), <https://cajohare.github.io/AxionLimits/>.
- [20] Y.-H. Chang *et al.*, Dark photon dark matter constraints and a tentative signal at the TASEH experiment, [arXiv:2507.00784](https://arxiv.org/abs/2507.00784).
- [21] A. V. Gramolin, A. Wickenbrock, D. Aybas, H. Bekker, D. Budker, G. P. Centers, N. L. Figueroa, D. F. J. Kimball, and A. O. Sushkov, Spectral signatures of axionlike dark matter, *Phys. Rev. D* **105**, 035029 (2022).
- [22] H. Chang *et al.* (TASEH Collaboration), First results from the Taiwan axion search experiment with a haloscope at 19.6 μeV , *Phys. Rev. Lett.* **129**, 111802 (2022).
- [23] B. T. McAllister, G. Flower, J. Kruger, E. N. Ivanov, M. Goryachev, J. Bourhill, and M. E. Tobar, The ORGAN experiment: An axion haloscope above 15 GHz, *Phys. Dark Universe* **18**, 67 (2017).
- [24] A. P. Quiskamp, B. T. McAllister, P. Altin, E. N. Ivanov, M. Goryachev, and M. E. Tobar, Direct search for dark matter axions excluding ALPogenesis in the 63–67 μeV range, with the ORGAN experiment, *Sci. Adv.* **8**, eabq3765 (2022).
- [25] A. Quiskamp, B. T. McAllister, P. Altin, E. N. Ivanov, M. Goryachev, and M. E. Tobar, Exclusion of axionlike-particleogenesis dark matter in a mass window above 100 μeV , *Phys. Rev. Lett.* **132**, 031601 (2024).
- [26] A. P. Quiskamp, G. R. Flower, S. Samuels, B. T. McAllister, P. Altin, E. N. Ivanov, M. Goryachev, and M. E. Tobar, Near-quantum-limited axion dark matter search with the ORGAN experiment around 26 μeV , *Phys. Rev. D* **111**, 095007 (2025).
- [27] B. M. Brubaker, L. Zhong, S. K. Lamoreaux, K. W. Lehnert, and K. A. van Bibber, HAYSTAC axion search analysis procedure, *Phys. Rev. D* **96**, 123008 (2017).
- [28] X. Bai *et al.*, Search for dark photons between 16.96–19.52 μeV with the HAYSTAC experiment, [arXiv:2510.15848](https://arxiv.org/abs/2510.15848).
- [29] <https://zenodo.org/records/17972067>.