Section 5

Electromagnetic Noise in Living Systems: Evidence from Ecosystems and a Passive Candidate Solution

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Scope: what ecosystems show about weak electromagnetic noise, and a passive nanocomposite that does not attenuate the signal, marketed by NOXTAK as SPIRO, presented as a candidate solution. **Terms:** ELF, 50/60 Hz fields; SAR, specific absorption rate; OTA, over-the-air antenna performance; HRV, heart rate variability. **RFI questions answered:** 3(f), 5(n), 5(o), 10(a), 10(c), 12, 13(a), 13(c), 14, 15(e), 16, 17, 17(b) and 18, tagged in brackets where answered.

RELATIONSHIP DISCLOSURE

The nanocomposite presented here is developed and marketed by NOXTAK as SPIRO, and EFEIA operates within the NOXTAK Corporation ecosystem. J. Joaquín Machado, the author of this summary, is EFEIA's Founder and Director, NOXTAK's founder and CTO and the named inventor on the patents in Tier 6. He serves on the IGEF Advisory Council and is an author of six of the documents cited here: his statement on the nanocomposite [6]; Korotkov 2022, where his affiliation is printed as IGEF Ltd, Germany, the body that issued the Tier 3 seal reports; Machado and Leal 2019 (Noxtak Center); his 2021 thesis; and the two 2025 JABB papers, where his affiliation is printed as EFEIA Institute. He is the client contact named on the Verkotan reports, and the field records in Table 3 are the developer's, submitted unaltered with its technical documents as Exhibits 5-1 to 5-5. NOXTAK entities were the applicant, client or customer for the Morlab, Verkotan and IGEF reports; IGEF awards its seal under an agreement governing its commercial use; the 2019 EHS series followed a protocol developed by NOXTAK. EFEIA's BEMCP evaluations "account for the integration of SPIRO® nanocomposite technology", the criteria of its EHC seal include "SPIRO® and complementary EMF filtering solutions integrated where applicable", and its EHC page states that "Treatment uses SPIRO® passive technology" (efeia.org/bemcp). Marianella Romero Fernández, author of the 2021 thesis in Tier 5, is named with Mr. Machado as co-inventor on three 2016 PCT applications (WO 2016/178041, 178042 and 178043 A1). EFEIA presents the nanocomposite on the terms it applies to every product in Section 4: what was tested, by whom, under what standard, with what result, and what remains to be done. The ecosystem evidence in Part 4A comes from independent research and does not depend on the nanocomposite; Sections 1 to 4 and 6 stand on their own, and none depends on this section.

OUR PROPOSAL

EFEIA proposes that HHS include passive, non-shielding approaches in the research it asks about in question 5(o), with this nanocomposite as the first worked case: a paired test of absorbed dose (SAR) and antenna performance on current 4G and 5G devices in accredited laboratories, controlled trials in homes and workplaces that separate the nanocomposite from other measures, and a sham-controlled physiological trial.

EFEIA also proposes that HHS treat effects on pollinators, migratory birds and livestock under question 14, through a field program led by NIEHS with the Department of the Interior, USDA and EPA (apiary trial, stopover noise surveys, farm surveys), in which the nanocomposite is tested in its own arm, analyzed separately.

EFEIA invites a technical discussion with HHS and its agencies on the underlying reports, measurement records, material documentation and replication conditions: how far the observed outcomes reach, the conditions under which they recur, and the further tests needed to establish mechanism, generalizability and biological relevance.

1 SUMMARY OF THE ISSUE [Q5(o), Q14, Q18]

Migratory birds and honey bees respond to electromagnetic fields far below the limits set for people. These findings introduce the concept on which this section rests, the noise in the man-made

electromagnetic environment, and lead to a candidate solution: a passive approach that does not attenuate the signal.

1. What ecosystems show. Weak broadband radiofrequency noise in the nanotesla range, about 1,000 times weaker than current recommended limits according to the BfS workshop review, disrupts the magnetic compass of migratory songbirds; weak broadband fields disrupted it while strong narrow-band fields did not [1-3]. In honey bees, 50 Hz magnetic fields impair learning and foraging, and Wi-Fi-band exposure reduces homing [4,5].

2. The concept of noise. EFEIA reads these findings as pointing to electromagnetic noise, the broadband component of the man-made environment, as a property to measure and manage in its own right, beyond intensity. EFEIA calls the disturbance it addresses Artificial Quantum Noise (AQN), a proposed model kept apart from the quantities instruments record [6].

3. The candidate solution. A passive nanocomposite of gold, palladium and titanium nanoscale constituents with ferromagnetic powder, stabilizing films and ceramic, with no power supply or transmitter, intended to condition the local electromagnetic environment while communications keep working [7,8]. In independent, accredited laboratories it produced up to 91% reduction in 10 g-averaged SAR across seven configurations (Figure 1), with antenna performance unchanged within uncertainty on three handsets [9-11]. Uncontrolled records show lower conducted interference and magnetic variability [12,13], and an open, randomized, placebo-controlled trial recorded changes in heart rate variability [14].

What EFEIA asks of HHS. Include non-shielding mitigation in its question 5(o) research [15], support the paired laboratory, field and sham-controlled tests, and treat effects on animals under question 14, with the nanocomposite in its own arm of the field program (Part 7).

Compliance is not protection. A phone certified below the SAR limit still delivers its dose for as many hours as it is carried, a shielded case "may actually increase RF absorption in the head" [16], and an antenna or power line that meets the human limits has not been assessed for animals.

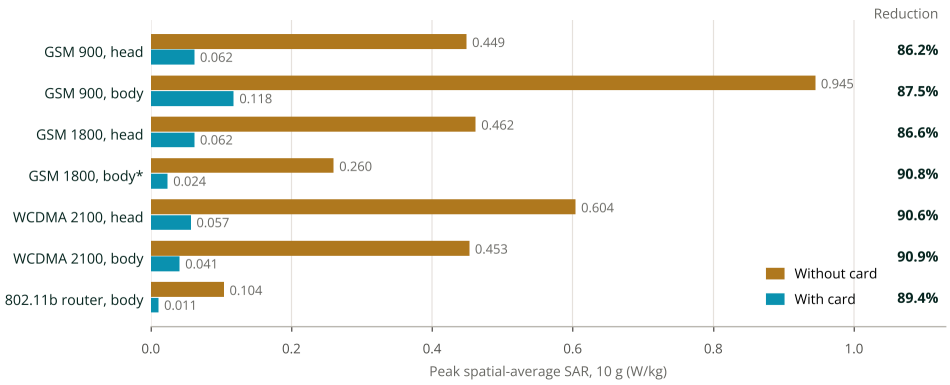


Figure 1. 10 g-averaged SAR without and with the nanocomposite card in the seven configurations measured by Shenzhen Morlab for applicant NOXTAK Technologies VBA, 2015: six on one handset (S01) and one on an 802.11b router (S02), as printed in Section 8 of each Morlab report; reductions calculated. *For GSM 1800 body, Annex B of S01 prints 0.126730 W/kg without the card (81.1%); the report does not state which value is correct. Expanded uncertainty ±21.33% (10 g, k = 2). Source: [9]; the developer's summary of the same reports is Exhibit 5-3 [17].

2 WHY IT MATTERS [Q5(o), Q14]

Ecosystems. 5-8% of global crop production, worth US$235-577 billion a year (2015 dollars), is directly attributable to animal pollination [18]. In 2014 the Department of the Interior wrote that the FCC's standards "continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today" [19]; in 2021 the D.C. Circuit remanded the FCC's decision to keep its 1996 limits, including for failure to address environmental harm [20], and the FCC's remand notice seeks comment on environmental impacts [21].

People and devices. HHS asks whether research is needed "to develop, test, and evaluate the effectiveness of procedures and techniques for minimizing exposure" [15], and the FCC seeks comment, due 22 October 2026, on its testing procedures for portable devices [21]. EFEIA pursues biological compatibility and compatibility with useful technology together; communications performance alone cannot show the first [6]. The nanocomposite is the most extensively tested non-shielding approach EFEIA can present, after about fifteen years of

development and field experience reported by the author [6].

3 CURRENT LIMITATION OR GAP [Q5(o), Q14]

[Q14, Q10(c)] **G1. No standard or monitoring for animals.** EFEIA has identified no federal exposure limit for animals and no federal program that logs RF or ELF exposure at apiaries, flyways or stopover sites; in the bird experiments, field strength alone did not predict the effect [2]. [Q14, Q15(e)] **G2. Few controlled field studies.** The EU-funded EKLIPSE review found the pollinator evidence "inconclusive due to a lack of high quality, field-realistic studies" [22]. For livestock, a Swiss study related nuclear cataract in veal calves (79 of 253) to base-station field strength at the dam's first-trimester location; the authors note that an effect of the antennas on oxidative stress has not been shown [23].

[Q5(o)] **G3. No test standard for non-attenuating products.** The nanocomposite was evaluated with SAR and OTA standards written for other purposes, with HRV measured to the 1996 Task Force standards [24] and with Bio-Well/GDV, a method under active scientific validation [25]. [Q13(a)] **G4. Device generation.** The accredited tests, in 2015 and 2017, used three handsets and an 802.11b router; no data yet exist for 5G NR devices or under IEC/IEEE 62209-1528:2020 [26]. **G5. Uncontrolled field records.** Phases ran at different times without controlled network traffic, and in buildings line filters that also integrate the nanocomposite were installed with the units [12,13]. **G6. Clinical design.** One open, randomized, placebo-controlled trial; a blinded, sham-controlled trial has not yet been run. **G7. From noise to mechanism.** Weak broadband noise is the disruptive feature for the bird compass; AQN and the spin-related interactions invoked for the material are the developer's proposed model, and the link between the two has not yet been tested [6,8].

4 EXISTING EVIDENCE [Q3(f), Q5(o), Q12, Q14, Q18]

4A. Ecosystems: where the effects of electromagnetic noise are documented.

Table 1. Controlled evidence on migratory birds and honey bees, as reported.

Topic	Source (grade)	Result as reported
Bird compass	Engels 2014 (a); Schwarze 2016 (a); Leberecht 2023 (a) [1,2,27]	Double-blind tests: robins lost compass orientation under anthropogenic and added broadband noise (about 2 kHz to 9 MHz, nanotesla range) and regained it in screened huts; weak broadband fields (about 35 nT summed) disrupted it, strong narrow-band fields (about 400 nT peak) did not; no disruption at 140-150 MHz, predicted cut-off near 116 MHz
Honey bees, 50 Hz	Shepherd 2018 (a) [4]	Olfactory learning 73% (control) vs 63% (20 µT; P = 0.05), 42% (100 µT) and 36% (1,000 µT) (both P < 0.001); 20-100 µT is the range the authors give at ground level below power-line conductors; successful outgoing foraging passes fell at 100 µT
Honey bee colonies, Wi-Fi bands	Treder 2023 (a) [5]	2.45 and 5.8 GHz together at 2 m: homing 95.2% (control) vs 78.6% after long-term exposure; brood development and overall longevity not significantly affected

4B. The candidate solution.

Table 2. Evidence on the nanocomposite in six tiers, with the grade of each source. Products are named as each report prints them; reductions calculated from printed values.

Tier and source (grade)	What was tested, and how	Result as reported
1. Accredited laboratories. Shenzhen Morlab, FCC-recognized test firm (listed under 47 CFR 2.948 in 2015; now A2LA-accredited, US1192) [28]; applicant NOXTAK. SAR S01, S02 (a) [9]; developer's summary, Exhibit 5-3 (c) [17]	Card (printed SPIRO CARD Level 2; S02 also prints Level 3) on one handset in six configurations (GSM 900, GSM 1800, WCDMA 2100; head and body) and on an 802.11b router; issued 17 November 2015	**Up to 91% reduction in 10 g-averaged SAR.** GSM 900 head 0.449 → 0.062 W/kg, body 0.945 → 0.118; GSM 1800 head 0.462 → 0.062, body 0.260 → 0.024 (Annex B prints 0.126730 without card: 81.1%); WCDMA 2100 head 0.604 → 0.057, body 0.453 → 0.041; router 0.104 → 0.011. Range 86.2-90.9% (calculated; 81.1% with the Annex B value). Expanded uncertainty ±21.33% (10 g, k = 2)
Morlab antenna performance E01 (a) [10]	Same series; handset identified only as "Mobile phone"; YD/T 1484-2011, YD/T 1978-2009; free space; TIRP and TIRS, 3 bands × 3 channels; issued 20 November 2015	**Unchanged within uncertainty:** largest shifts +0.79 dB (TIRP) and −0.99 dB (TIRS) against ±1.69-1.99 dB
Verkotan Oy, FINAS-accredited (T287, ISO/IEC 17025) [29]; client Noxtak Group (a) [11]	3GPP TS 34.114, free space, 17 October 2017. LG G6: WCDMA Band I (Level 3), WLAN 802.11a (Level 2). ZTE Axon: LTE Band 2 (Level 3)	LG G6 TRP 18.64 → 18.69 dBm, TRS −110.50 → −110.42 dBm; 802.11a TRP 6.19 → 6.20 dBm. ZTE TRP 15.92 → 16.12 dBm, TRS −92.33 → −91.94 dBm (3-channel means). Uncertainty 1.60 dB TRP, 1.85 dB TRS: unchanged within uncertainty. 2x2 MIMO OTA within 0.02-0.10 dB, as summarized by the developer (Exhibit 5-2) [30]

Tier and source (grade)	What was tested, and how	Result as reported
2. University-led clinical study. Saint-Petersburg Scientific-Research Institute for Physical Culture (ethics approval) and North-Western State Medical University, with J. J. Machado. Korotkov 2022 (a) [14]	Open, randomized, placebo-controlled; 30 days; 50 healthy participants, 25 per group (mean age 21.75 ± 2.48 years); HRV, Bio-Well/GDV, sleep questionnaire	Within-group change over 30 days (no between-group test printed for HRV or Bio-Well). Active: SDNN +14.8% ($p < 0.01$), total power +27.0% ($p < 0.001$), LF +34.6% ($p < 0.001$), stress index −13.77% ($p < 0.05$). Placebo: SDNN −0.7%, total power −11.9%, LF −14.4%, stress index +0.41%
3. IGEF seal reports (b) [31]	Four products (2014, 2016); 10 people each who "in their own opinion" react to electrosmog, aged 10-76; HRV biofeedback before and after 2-31 days of use	36 of 40 participants improved
[Q3(f)] **4. EHS longitudinal preprint.** Machado and Leal 2019 (b) [32]	357 people reporting EHS, 2014-2018; 29-symptom questionnaire	102 of 144 who took up deeper assessment (71%) used the recommended configuration; the authors report painful symptoms resolved in 36 h and general symptoms in 27 days on average; 3 of 8 severe cases described as nocebo
5. Theses and further JABB papers. Romero Fernández 2021, Machado 2021 (b) [33]; Machado 2025a, 2025b (a) [34,35]	Bio-Well GDV, n = 8, during a phone call without and then with the card; environmental bioelectrography near 79 Wi-Fi signals, in two vehicles and on structured water	6 of 8 showed "cambios evidentes y significativos" [33]; environmental activity index 46.21 → 36.41 with a nanocomposite disc [33]; environmental entropy 61.95% lower on average in the vehicles [34]; GDV image area retained 97.6% of the structuring effect over 27 h [35]
6. Patents and awards (a) [7]; (c) [36]	US 9,820,418 B1 (2017), US 10,058,017 B1 (2018), US 10,145,875 B1 (2018); six foreign grants or validations; PCT applications including WO 2016/178041 to 178043 A1	Inventor Jose Machado, assigned to NOXTAK, LLC. Awards listed by NOXTAK for SPIRO: German Innovation Award 2021 (winner); Edison Awards 2020 (silver, nanotechnology); Silicon Valley International Invention Festival 2019 (gold medal); International Exhibition of Inventions Geneva 2019 (international prize); CTA 2019 Emerging Disruptive Technologies

Table 3. Field records in real use, as documented by the developer: uncontrolled before-and-after comparisons; in buildings, line filters that also integrate the nanocomposite were installed with the units. Source: Exhibits 5-4 and 5-5 [12,13].

Record (grade c)	Outcome as reported
Phone connectivity, M-02 (2022; Samsung Galaxy S22+ 5G)	Mean download over 13 tests 23.7 → 37.1 Mbps (+56.3% as printed); Wi-Fi received power unchanged at about −50 dBm; latency higher in 8 of 11 comparisons; phases about one hour apart, traffic not controlled
Phone magnetic record, M-01 (iPhone 15 Pro; 16.7 Hz to above 2 kHz)	Magnetic flux density beside the phone: mean 94.3 → 17.9 nT, maximum 749.5 → 69.5 nT, standard deviation 93.15 → 8.21 nT; low-frequency bands, not the 5G carrier
[Q13(c)] **Residential, R-01** (2025; about 2,500 sq ft; 12 line filters, 23 units)	Conducted interference about 986 → 70 mV (about 93% lower); Wi-Fi noise spatial range 12 → 2 dB; SNR extremes 28-56 → 38-61 dB
[Q13(c)] **Commercial, C-01** (2026; about 5,500 sq ft; 19 line filters, 40 units)	Zone-maximum conducted interference about 87% lower; mean Wi-Fi noise −88.25 dBm before and after; mean download 92.56 → 123.50 Mbps ($p = 0.0022$); magnetic-field standard deviation 9.61 → 5.10 nT (9 zones, $p = 0.0078$); electric-field maximum rose in one zone (174.5 → 200.9 V/m)

Animal observations (author-reported). EFEIA's consultant network reports renewed bee presence and activity over about thirty days after deployment at an urban Miami site near telecommunications infrastructure, following substantial bee mortality; improved colony vitality in cooperative apiaries; calmer GPS-collared cattle and poultry, with more eggs laid. The statement gives no dates, baselines, endpoints or records, so no figure is quoted [6]. The studies in Part 4A are context for these reports, not validation, and whether the reductions recorded in buildings occur in the bands that affect animals is untested.

[Q12] **F1. Well established in the laboratory:** weak broadband noise disrupts the songbird magnetic compass [1,2,27]. **F2. Emerging:** honey bee effects at 50 Hz and in Wi-Fi bands [4,5]; field evidence is limited (G2). **F3. Well established within the tested configurations:** up to 91% reduction in 10 g-averaged SAR with antenna performance unchanged within uncertainty (Tier 1). **F4. Emerging:** physiological changes (Tiers 2 to 5). **F5. Limited:** field and animal records. **F6. Open question:** the mechanism, and whether the nanocomposite acts on the noise that affects animals (G7).

5 WHAT EFEIA CAN CONTRIBUTE [Q14, Q18]

Available now. The primary reports behind Tier 1 [9-11], the studies in Tiers 2 to 5, the patent records [7] and

the recognition and accreditation records [28,29]. **Submitted with this comment:** the developer's technical documents, unaltered, each behind an EFEIA cover sheet stating its source, grade and the relationship: Exhibit 5-1, the material [8]; 5-2, compatibility and MIMO OTA [30]; 5-3, the SAR summary [17]; 5-4 and 5-5, the field records [12,13]. **Ecosystem field work.** The Apiary Protection Project protocol, in preparation, and calibrated measurements for university apiculture and ornithology groups, kept separate from any product claim. **Not in this submission:** the apiary protocol, the primary Verkotan MIMO OTA report and the bioelectrography reader's identity, held under NDA. **Worked example** for the claim-based standard in Section 4: paired SAR and antenna-performance reports, which together can catch a SAR drop caused by a degraded antenna.

6 ADDITIONAL RESEARCH NEEDED [Q5(o), Q16]

[Q5(o), Q13(a)] R1. Physical. The paired SAR and OTA test under IEC/IEEE 62209-1528:2020 on identified 4G and 5G NR handsets in ISO/IEC 17025 laboratories, adding head and hand OTA states [26]. **R2. Field.** Building trials with four arms (nanocomposite, filters, both, sham), controlled network traffic and endpoints registered in advance. **[Q5(o)] R3. Clinical.** A registered, double-blind, sham-controlled crossover trial at an academic center, HRV to the 1996 standard [24], with independent data management. **R4. Bioelectrography.** Bio-Well paired with HRV or cortisol, and with Raman or NMR for water [35]. **R5. Noise and mechanism.** A measurement definition for broadband electromagnetic noise, in the bands that affect the bird compass and in conducted interference [27]; independent materials characterization; a test of whether AQN corresponds to a measurable quantity [6].

[Q14, Q10(c), Q15(e)] R6. Ecosystem field program. Matched apiaries at graded RF and ELF exposure over several seasons [5,22]; broadband noise surveys from about 100 kHz to 145 MHz with orientation tests at migratory stopover sites [1,19,27]; exposure surveys on dairy and veal farms [23]. **R7. The candidate solution in nature.** The nanocomposite in its own arm of R6, analyzed separately: endpoints registered in advance, blinded scoring, calibrated logging at hive entrances and in barns, active and sham units from the developer, who takes no part in the analysis. **[Q10(a)] R8. EHS registry** with in-home measurement and a sham-controlled sub-study (Section 3).

7 PROPOSAL AND NEXT STEPS [Q5(n), Q14, Q16, Q17]

[Q17] P1. OASH includes non-shielding mitigation in its question 5(o) research and asks NIST, with ISO/IEC 17025 laboratories, to run R1 as the first worked example of the claim-based standard in Section 4. **[Q17(b)] P2.** NIEHS funds R2 and R3 at academic centers; the developer supplies units and takes no part in the analysis. **[Q14, Q10(c), Q15(e), Q17] P3.** NIEHS leads R6 and R7 with USDA's Agricultural Research Service, the U.S. Fish and Wildlife Service and EPA, with FDA's Center for Veterinary Medicine on farms; the monitoring program proposed in Section 2 adds sites at apiaries and stopover sites; findings go to the FCC remand record [21]. **P4.** EFEIA seeks release of the records listed in Part 5, completes the apiary protocol for pre-registration, files in ET Docket No. 13-84 by 21 October 2026 [21] and joins a technical discussion with OASH, NIST and NIEHS [6]. **[Q5(n)] P5.** Results enter the FCC record on portable-device testing and the claim-based standard.

Related: Sections 1 (instrumentation), 2 (urban electromagnetic monitoring), 3 (EHS), 4 (shielding and consumer products) and 6 (what the limits assume).

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