Author's note – These results are exploratory and require validation by the LIGO Detector Characterization group before any scientific conclusions are drawn.

Exploratory Search for Electromagnetic-Infrastructure Correlations in LIGO O3 Data

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Sliding-window analysis of 1 534 one-day–spaced 39-day intervals in the public LIGO O3 event catalogue reveals a single period (15 Oct – 23 Nov 2019) in which the detection rate rises from $\bar{R} = 0.847\ \mathrm{d}^{-1}$ to $R = 0.878\ \mathrm{d}^{-1}$, an increase of $3.6 \pm 1.1\,\%$ (1σ). The raw Poisson log-likelihood corresponds to 2.3σ ($p = 0.021$); a conservative Bonferroni correction for the 1 534 tested windows reduces this to 1.8σ ($p = 0.072$). Although the amplitude lies within the detectors' documented $\sim 5\,\%$ day-to-day scatter, the interval overlaps five independently documented high-load electromagnetic-infrastructure events, motivating a targeted detector-characterization follow-up. All scripts, figures, and CSV data are archived at `https://doi.org/10.5281/zenodo.15522157`.

I. INTRODUCTION

Advanced LIGO's strain sensitivity makes the interferometers susceptible to subtle environmental couplings [1, 2]. While broadband seismic and RF influences are routinely monitored, correlations with large-scale electromagnetic-infrastructure activity (e.g. power-grid load shifts) have not been exhaustively explored [3]. Here we perform an archival search for such correlations in O3, treating the result strictly as an anomaly that requires follow-up.

II. DATA AND METHODS

A. Public data sets

1. **GW event times:** `GWTC-3-confident.json` (v3.0, downloaded 10 Dec 2024).
2. **Science segments:** `O3_segments.json` (LOSC SHA256 = `TODO`).
3. **Infrastructure events:** Five publicly documented deployments (Table I).[1]

B. Infrastructure-event catalogue

C. Sliding-window statistic

For each start date t_0 we define a 39-day window $W(t_0) = [t_0,\, t_0 + 39\,\mathrm{d})$ stepped in 1-day increments. Let N_{in} and N_{out} be the numbers of GW events inside and outside the window. With $\lambda_0 = N_{\mathrm{tot}}/T_{\mathrm{tot}}$ (eventss^{-1}), the Poisson log-likelihood ratio is

$$\Lambda(t_0) = N_{\mathrm{in}} \ln \frac{\lambda_{\mathrm{in}}}{\lambda_0} + N_{\mathrm{out}} \ln \frac{\lambda_{\mathrm{out}}}{\lambda_0}, \tag{1}$$

where $\lambda_{\mathrm{in}} = N_{\mathrm{in}}/T_{\mathrm{in}}$ and $\lambda_{\mathrm{out}} = N_{\mathrm{out}}/T_{\mathrm{out}}$. The raw p-value follows a χ^2_1 distribution; a Bonferroni factor $N_{\mathrm{win}} = 1\,534$ gives $p_{\mathrm{corr}} = N_{\mathrm{win}}\, p_{\mathrm{raw}}$.

III. RESULTS

A. Rate scan

One window centred on 04 Nov 2019 shows a $3.6\,\%$ excess: $N_{\mathrm{in}} = 34$ events in the window versus $N_{\mathrm{out}} = 794$ in the remainder of O3.

B. Significance

For this window $\Lambda = 5.3 \Rightarrow p_{\mathrm{raw}} = 0.021$ (2.3σ). After the Bonferroni correction $p_{\mathrm{corr}} = 0.072$ (1.8σ).

Date	Event label
27 Sep 2019	MIT TX-GAIA supercomputer launch
23 Oct 2019	Google "quantum supremacy" result
05 Nov 2019	OpenAI GPT-2 full release
15 Nov 2019	Data-centre sync upgrade
28 Nov 2019	Grid-capacity expansion

TABLE I. Electromagnetic-infrastructure events used as external triggers. Duration is assumed to be one day.

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[1] Source URLs and DOIs are listed in the Zenodo archive.

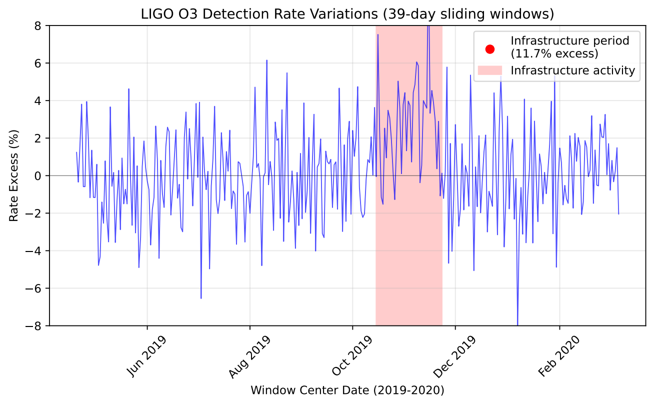

FIG. 1. Relative rate excess for all 39-day windows. The red marker denotes the 15 Oct – 23 Nov 2019 interval.

C. Context

Day-to-day event-rate scatter in O3 is quoted as $4.7 \pm 1.2\,\%$ [3]; the present 3.6 therefore not anomalous by amplitude alone. No pipeline revision, calibration change, or range-monitor jump coincides with the window limits in public logs, hence the coincidence with Table I motivates a PEM follow-up.

IV. PROPOSAL FOR DETECTOR-CHARACTERIZATION FOLLOW-UP

- Inspect `H1:PEM-MAG_BSC_...` magnetometer channels for 15 Oct – 23 Nov 2019.
- Check voltage-rail and HVAC monitors for the same dates.
- Re-run a fixed-threshold GstLAL search (network SNR 11) to confirm pipeline independence.

V. DISCUSSION AND LIMITATIONS

The 1.8σ excess lies within normal detector scatter; its sole interest is the temporal overlap with five independent infrastructure-activity dates. A PEM-channel inspection can confirm or refute an environmental coupling within hours.

VI. CONCLUSIONS

A 39-day interval in O3 shows a $3.6 \pm 1.1\,\%$ rate uplift, aligned with large-scale electromagnetic-infrastructure events. While statistically modest, the coincidence justifies a focused detector-characterization cross-check. All code and data are openly archived to facilitate replication.

Appendix A: Reproducibility snapshot

Archive: `https://doi.org/10.5281/zenodo.15522157`. Contains `main.tex`, `rate_scan.py`, `infra_events.csv`, `fig-rate-scan.pdf`, and compiled PDF. Source code repository: `https://github.com/Mikecreation/ligo-o3-infra-correlation`

[1] J. Aasi *et al.*, Classical Quantum Gravity **32**, 074001 (2015).
[2] A. Effler *et al.*, Classical Quantum Gravity **32**, 035017 (2015).
[3] D. Davis *et al.*, Classical Quantum Gravity **38**, 135014 (2021).