

Supplementary Information

Hardware implementation of photonic neuromorphic autonomous navigation

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Table of Contents

- 1. Complete Input-Output Comparisons of Error Activations**
- 2. Complete simulation results for all error-activated channels**
- 3. Supplementary Videos**
 - 3.1 Supplementary Video 1 | Real-time navigation demonstration of the robot under the non-obstacle scenario (Task 1).**
 - 3.2 Supplementary Video 2 | Real-time navigation demonstration of the robot under the obstacle scenario (Task 2).**

1. Complete Input-Output Comparisons of Error Activations

This section presents the complete input-output comparisons of error activations for the two task scenarios. Figure S1 presents the input-output comparisons for Task 1, corresponding to the navigation scenario without obstacle interference. Figure S1(a1)-(a2) compares the experimental inputs and outputs for channel 69, where the DFB-SA laser failed to generate a spike at 0.43 μs . Figure S1(b1)-(b2) shows that the DFB-SA laser remained inactive at 2.20 μs for channel 115, while Figure S1(c1)-(c2) depicts an overactivated spike at 0.58 μs for channel 127.

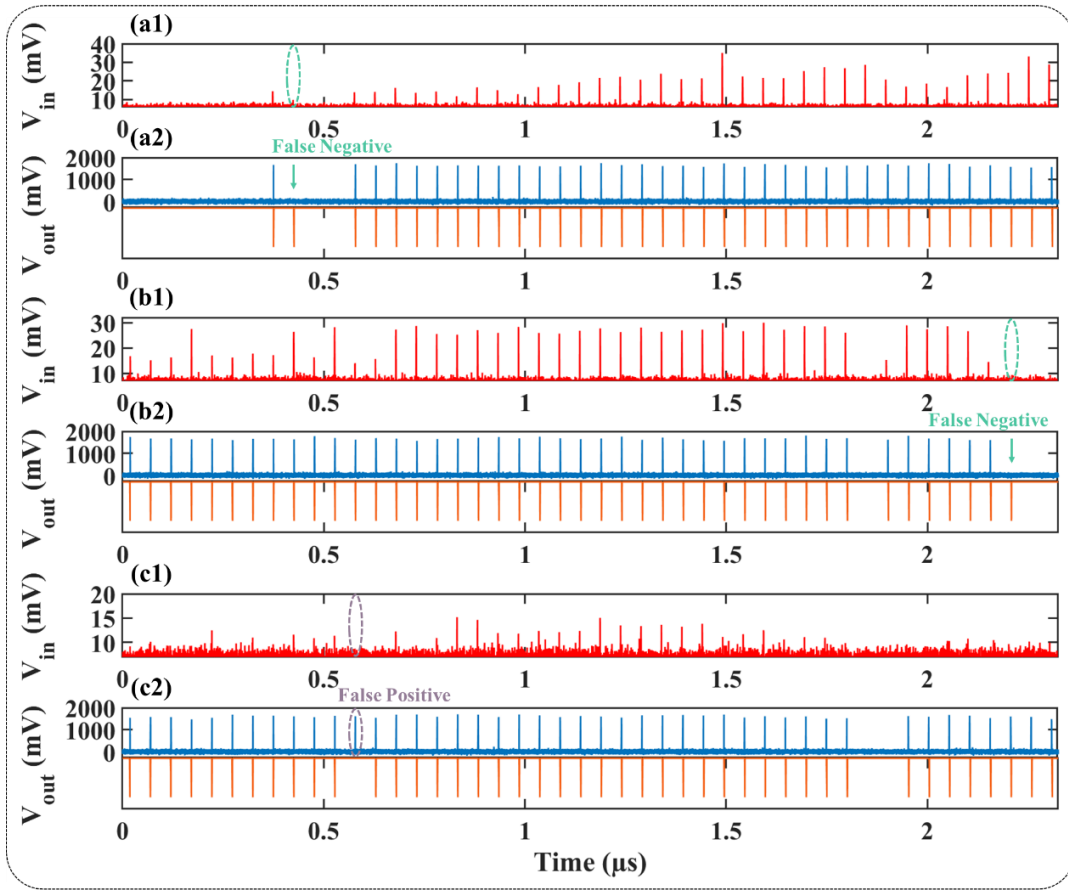


Figure S1. Experimental input-output comparisons of Channels 69, 115, and 127 in Task 1

Figure S2 presents the input-output comparisons for Task 2, corresponding to the navigation scenario with obstacle interference. Figure S2(a1)-(a2) compares the experimental inputs and outputs for channel 56, where the DFB-SA laser failed to generate a spike at 1.49 μs . Figure S2(b1)-(b2) shows the results for channel 114, in which the DFB-SA laser exhibited an

overactivated spike at 1.12 μs and a missing spike at 1.42 μs . Figure S2(c1)-(c2) illustrates the case of channel 123, where the DFB-SA laser remained inactive at 2.09 μs , 2.12 μs , and 2.14 μs . Figure S2(d1)-(d2) depicts the input-output comparison for channel 127, showing that the DFB-SA laser failed to generate a spike at 1.87 μs .

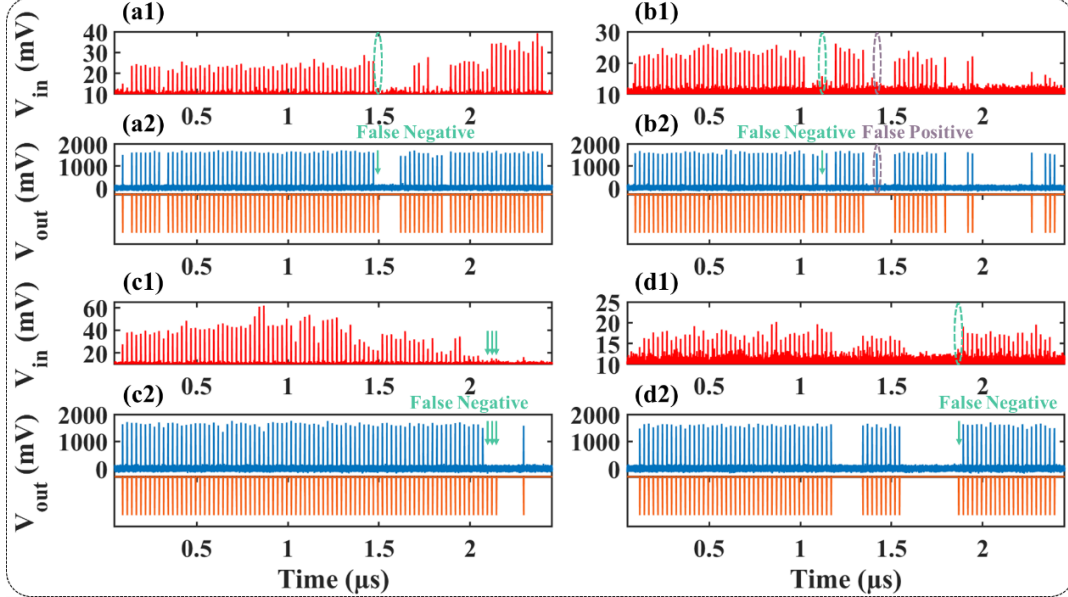


Figure S2. Experimental input-output comparisons of Channels 56, 114, 123 and 127 in Task 2

Missing spikes in the DFB-SA laser are mainly caused by input optical powers that fail to reach, or only marginally exceed, the effective activation threshold at the target excitation time, making spike generation highly sensitive to system fluctuations. Conversely, overactivated spikes arise when input signals with amplitudes near the threshold boundary are pushed above the effective threshold by instantaneous perturbations. Both phenomena originate from unavoidable fluctuations in the experimental system, including power instability in the MZM, transient variations in fiber coupling loss, and dynamic drift of the DFB-SA activation threshold induced by driving current and temperature variations.

2. Complete simulation results for all error-activated channels

This section presents the complete simulation results of all error-activated channels for

both tasks. Subplots with subscript 1 represent the externally injected optical signals, subscript 2 shows the outputs of the DFB-SA laser, subscript 3 depicts the carrier density in the gain region, and subscript 4 denotes the carrier density in the saturable absorber.

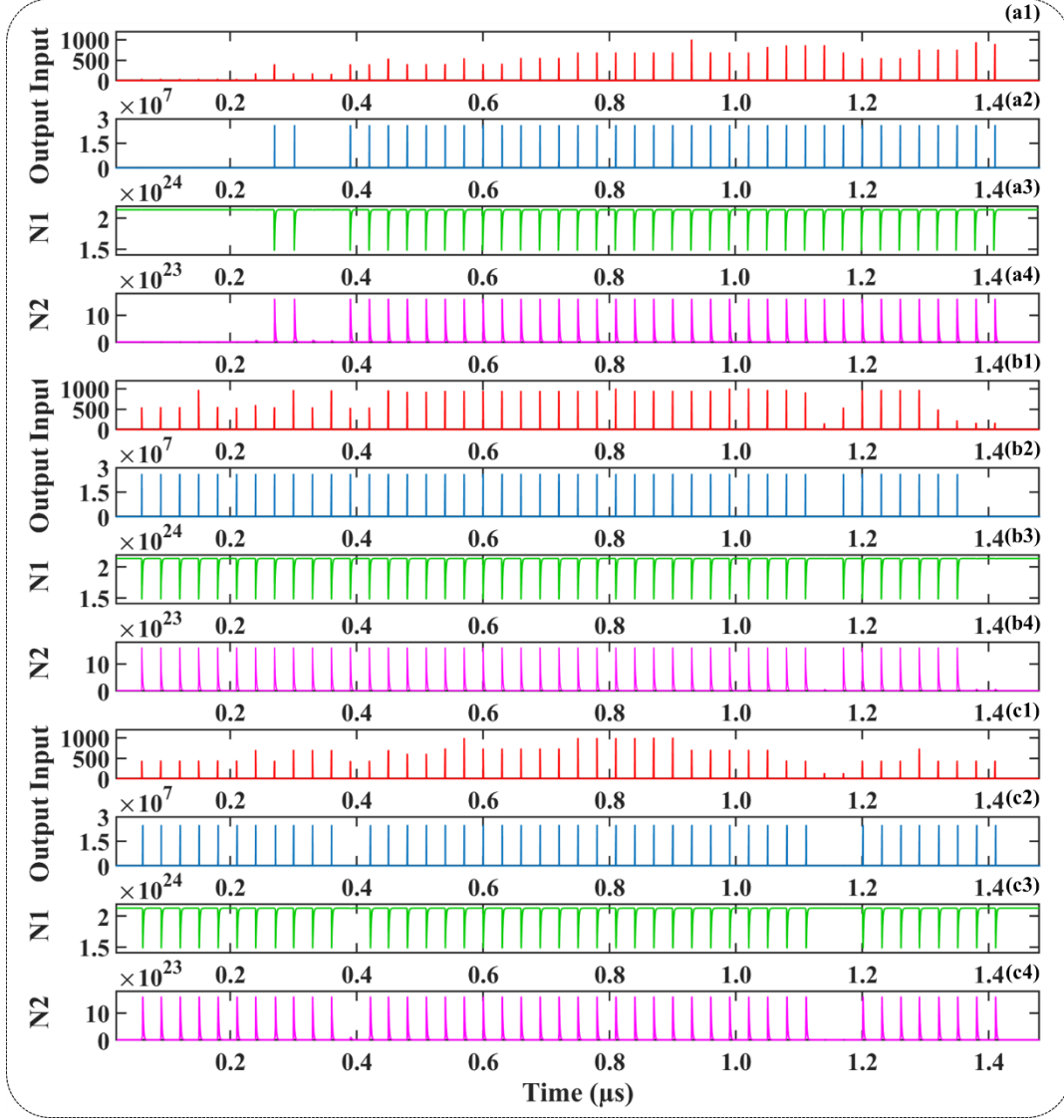


Figure S3. Simulation results of Channels 69, 115, and 127 in Task 1

Figure S3 presents the simulation results for all error-activated channels in Task 1, where panels (a), (b), and (c) correspond to Channels 69, 115, and 127, respectively. Figure S4 shows the simulation results for all error-activated channels in Task 2, where panels (a), (b), (c), and (d) correspond to Channels 56, 114, 123, and 127, respectively. The results indicate that the Yamada model-based simulations of the error-activated channels are fully consistent with the expected outputs, further verifying the theoretical feasibility of accurate DFB-SA laser

activation.

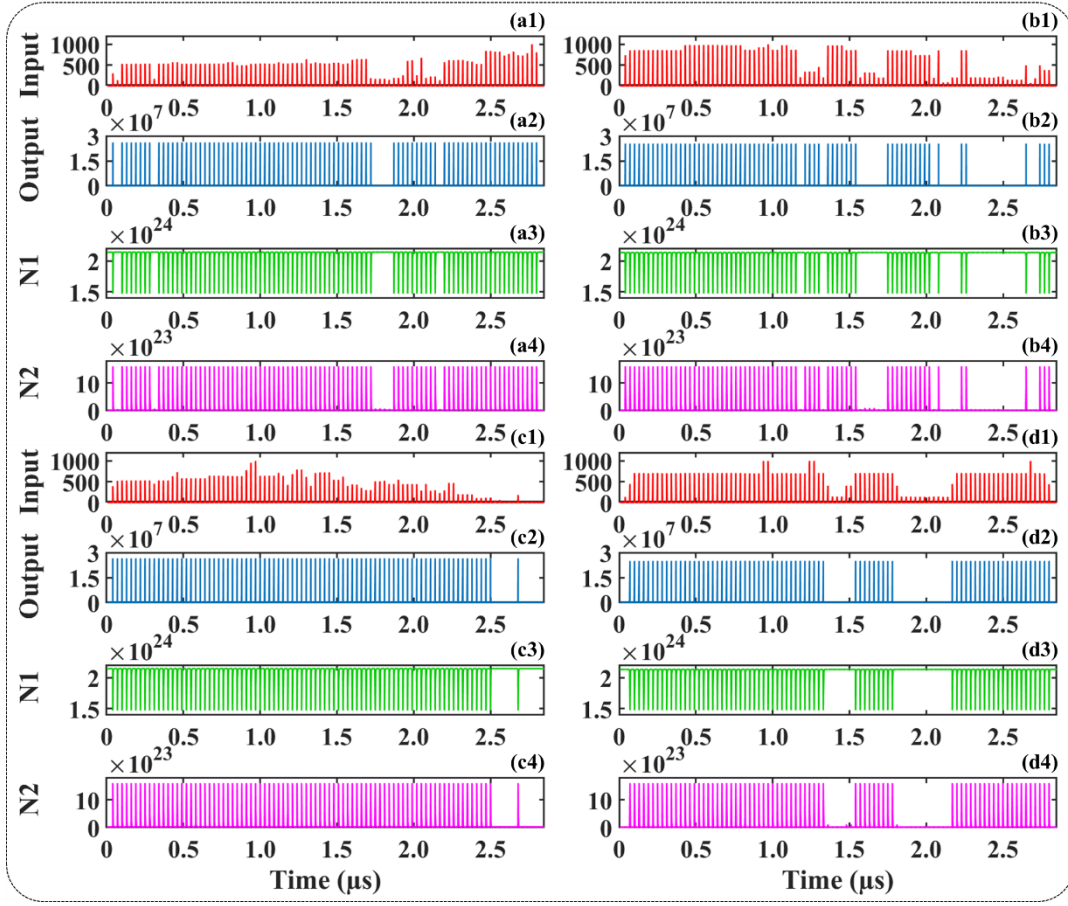


Figure S4. Simulation results of Channels 56, 114, 123 and 127 in Task 2