Artificial Intelligence Driven Optoelectronic Data Mining for Advanced High-Integration Spectral Sensing

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Background and Dilemma

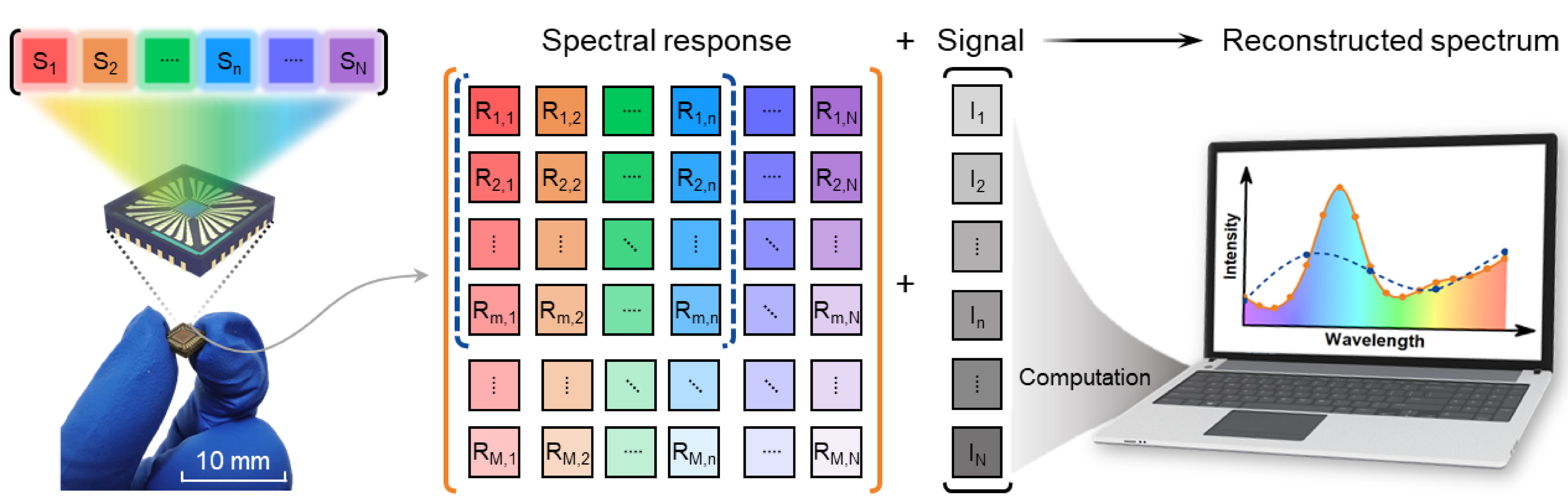

Figure 1. Transient spectra sensing based on single photodetector.

As the demand for higher performance and precision increases across spectral sensing scenarios, the development of high-integration solutions based on a single detector has emerged as a key area of research. This requires developing optoelectronic devices capable of sensing multiple optical features, and more importantly, advancing signal acquisition strategies, and data mining algorithms for optoelectronic responses. Due to the highly nonlinear or even transcendental characteristics of some optoelectronic responses feature, the detection errors of traditional Hadamard inverse processes have become uncontrollable.

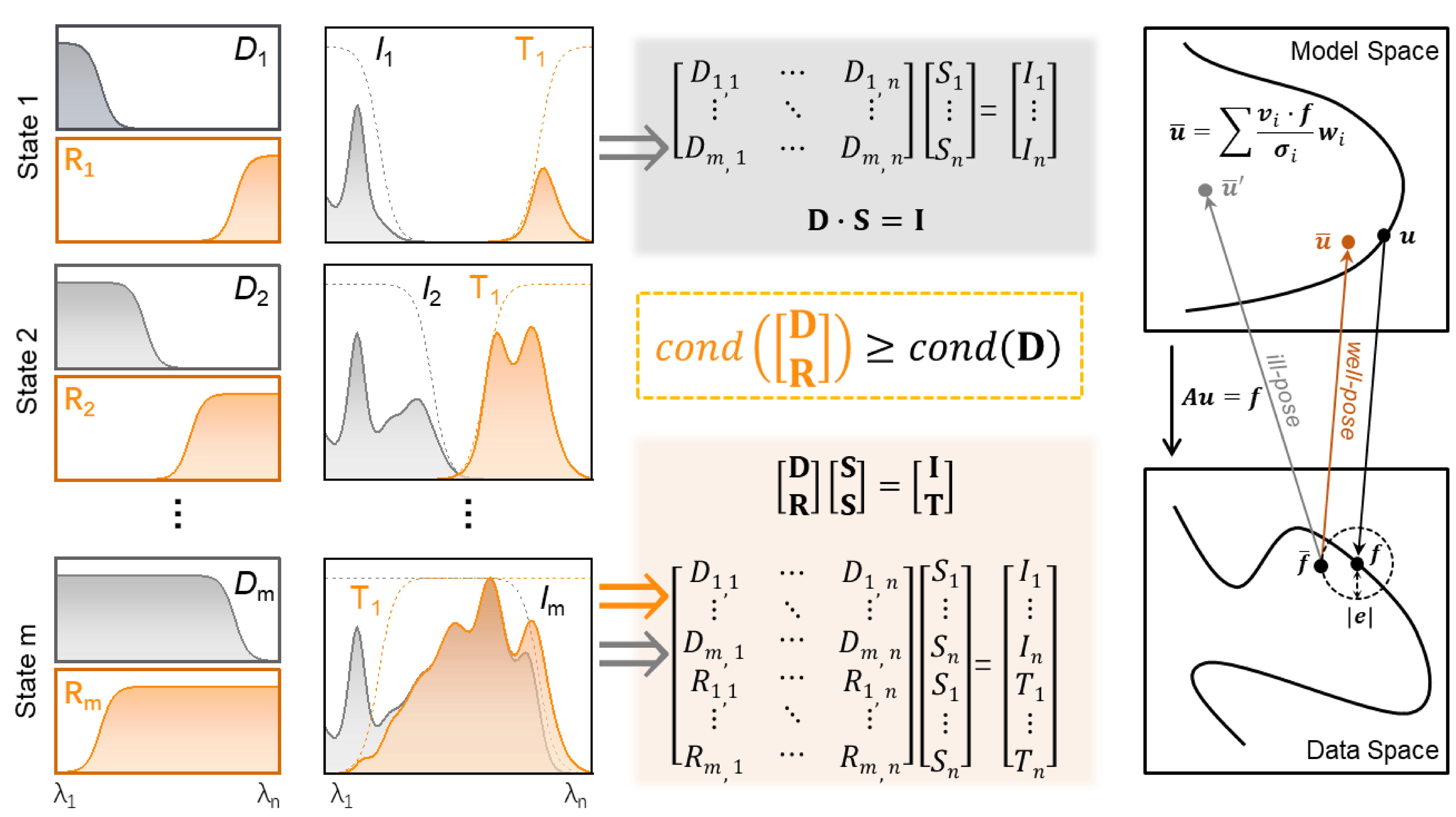

Figure 2. Hadamard inverse reconstruction distortion.

High Throughput AI Platform

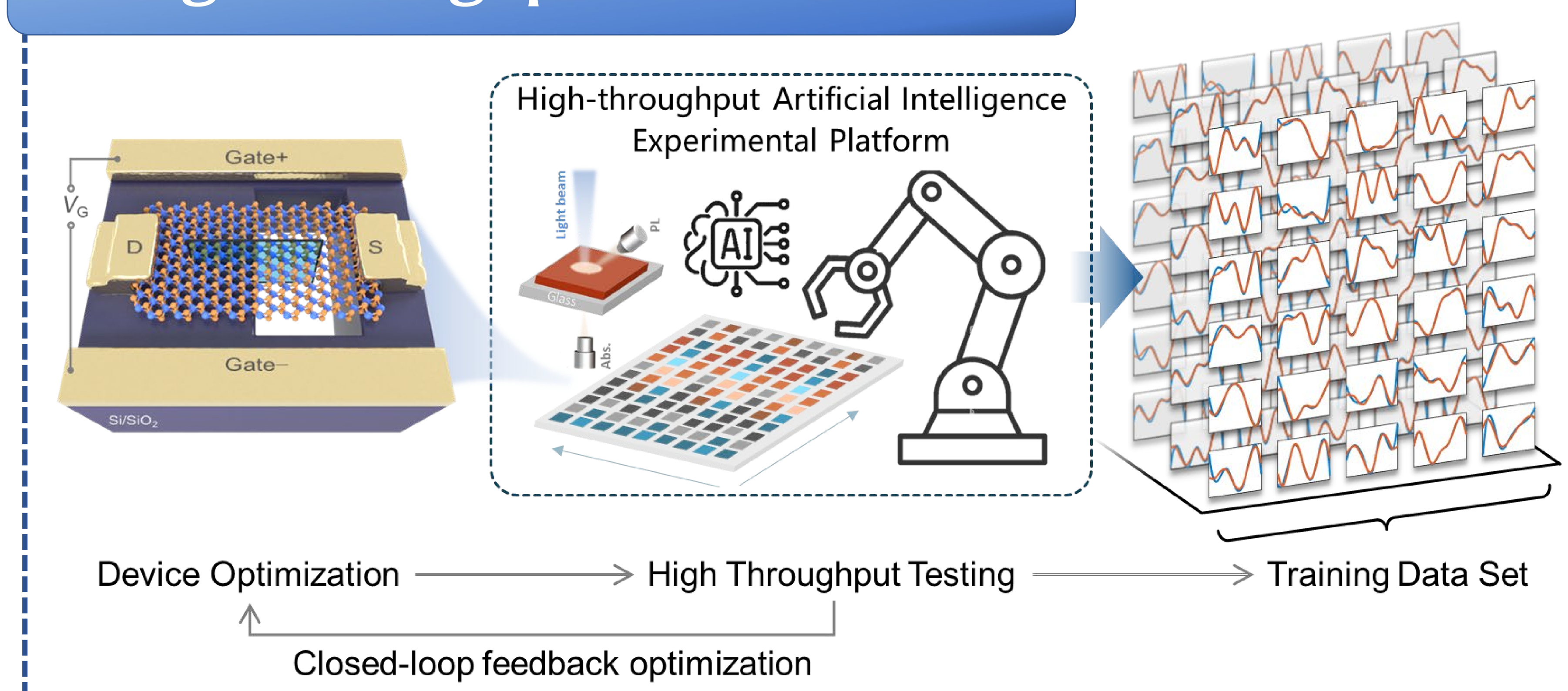

Figure 3. Training datasets are obtained using a high-throughput platform.

To address this issue, we propose an optoelectronic data mining algorithm based on artificial neural networks, which leverage their ability to effectively capture complex nonlinear relationships. Based on a self-developed high-throughput, automated optoelectronic testing platform, we obtain a rich training dataset, and the algorithm mitigates reconstruction distortions, enabling high-precision sensing of transient incident light spectra.

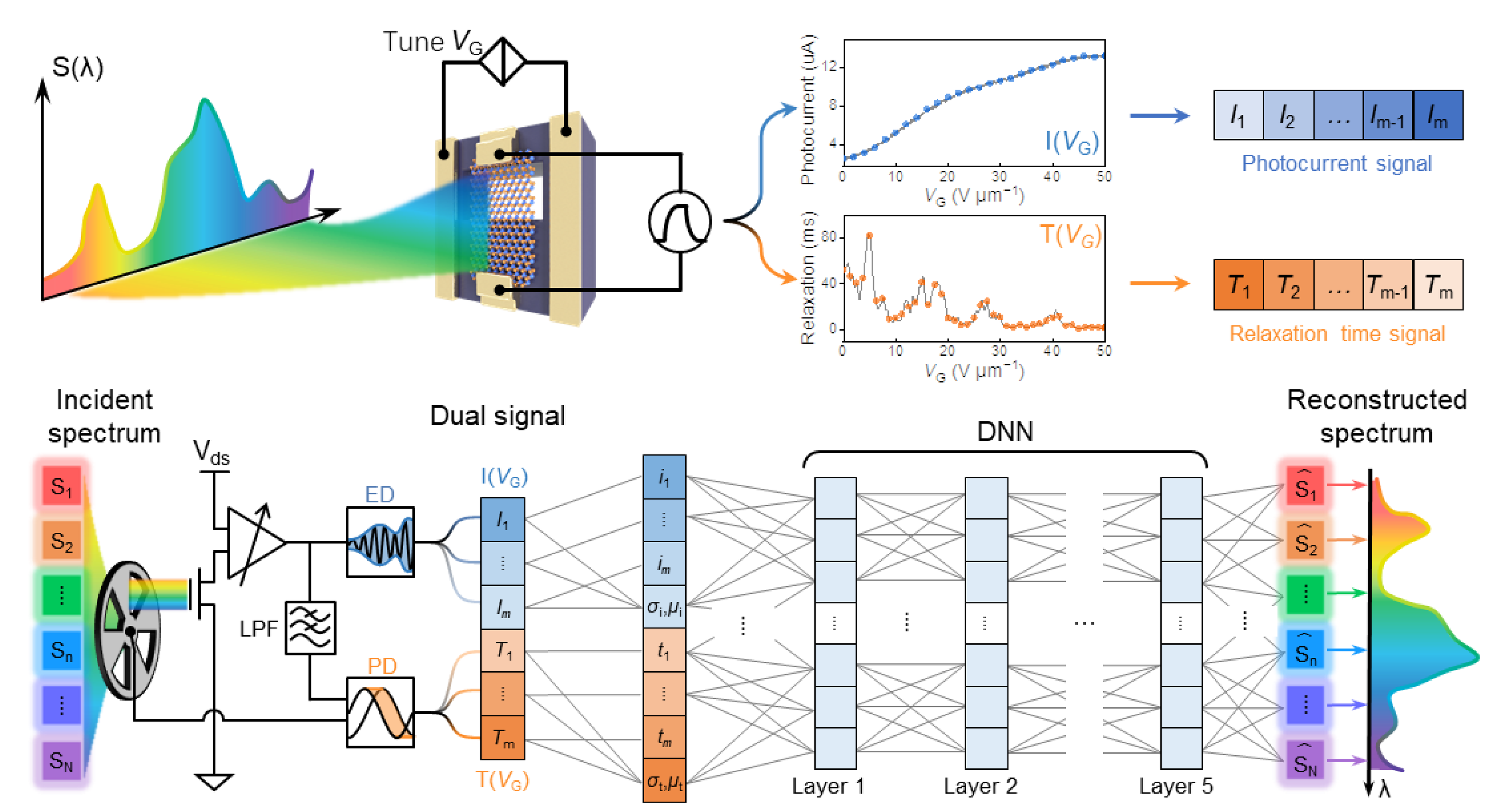

Figure 4. Transient spectra sensing based on artificial neural network.

Results and Conclusion

By efficiently capturing the waveform features of optoelectronic responses, this algorithm mitigates reconstruction distortions and enables high-precision sensing of transient incident light spectra. Using only a single photodetector pixel, we achieved a spectral resolution of 1.2 nm and a peak signal-to-noise ratio of 34 dB, reaching a world-class level comparable to that of benchtop spectrometers. It has demonstrated excellent performance in applications such as micro-regions hyperspectral imaging and transient spectrum detection. This approach provides a novel and effective strategy for achieving high integration and precision in multidimensional optoelectronic sensing.

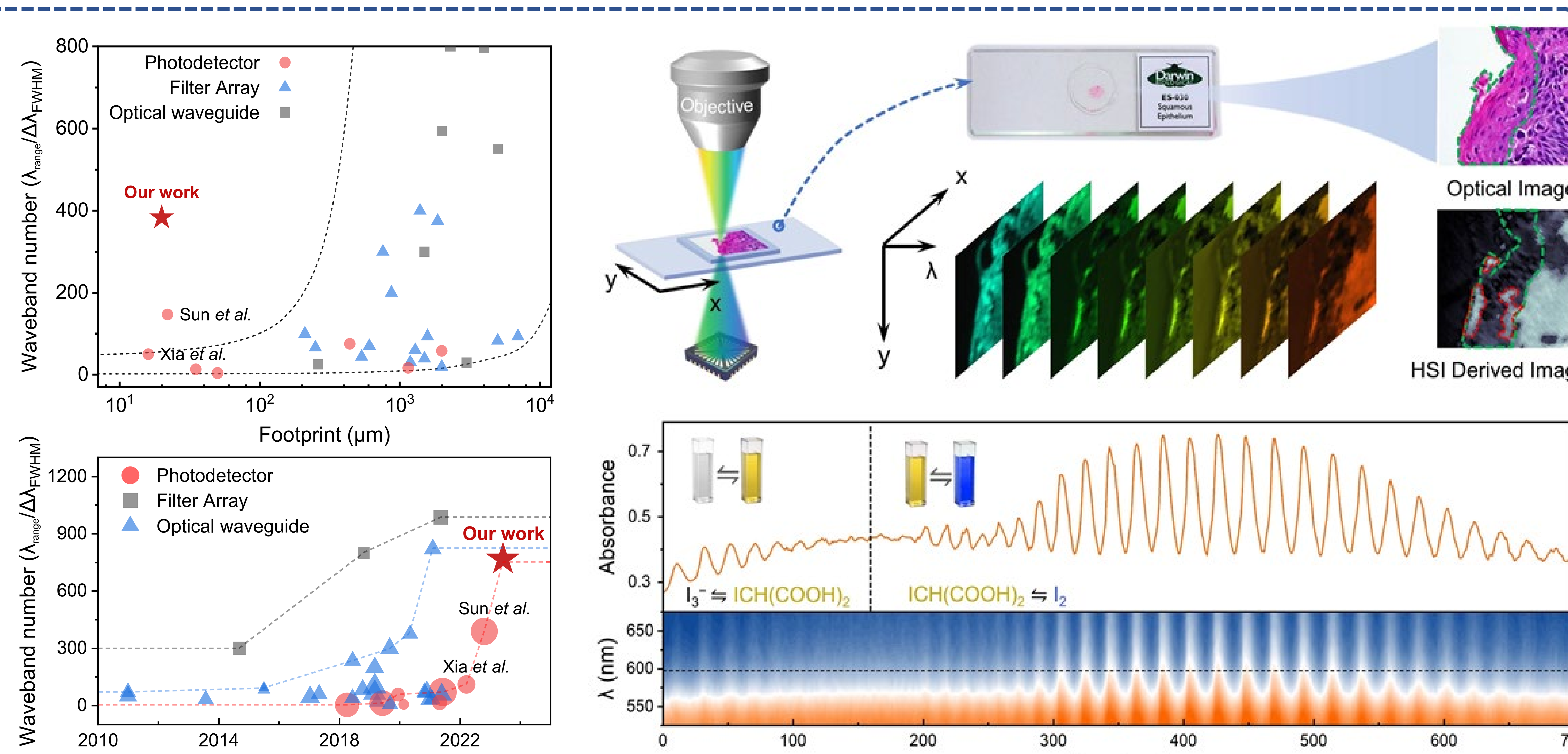

Figure 5. Performance comparison and application demonstration of our micro-spectrometers.

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References:

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