



Collaborative Research: SWIFT: Wideband Spectrum Coexistence Enabled by Photonic Circuits: Cross- Layer Design and Implementation

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Objective: Wideband Spectrum Coexistence

Congested spectrum: Sub 6GHz

Single Spectrum

Narrow bands coexist

2.4G

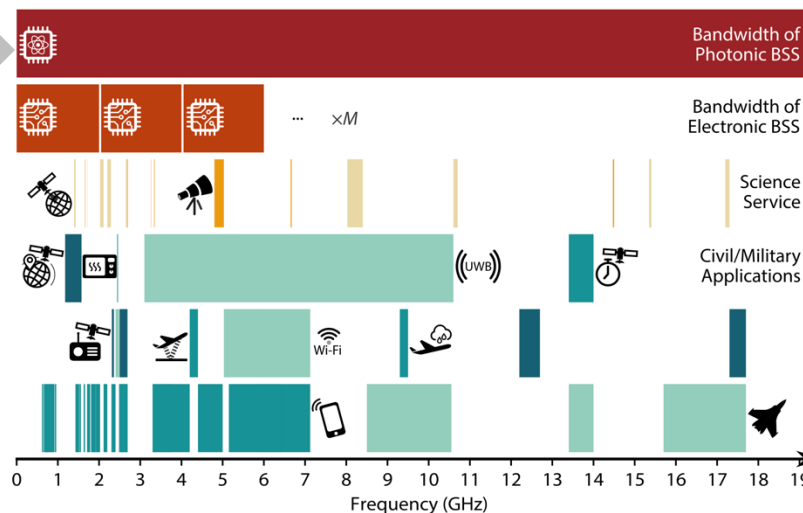
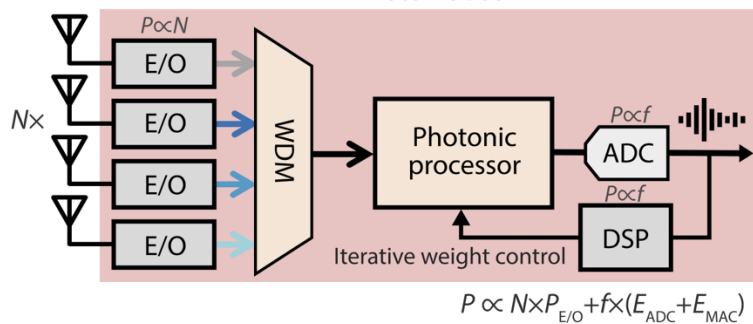
Wide bands coexist at radio frequency

"Narrow" band at optical frequency

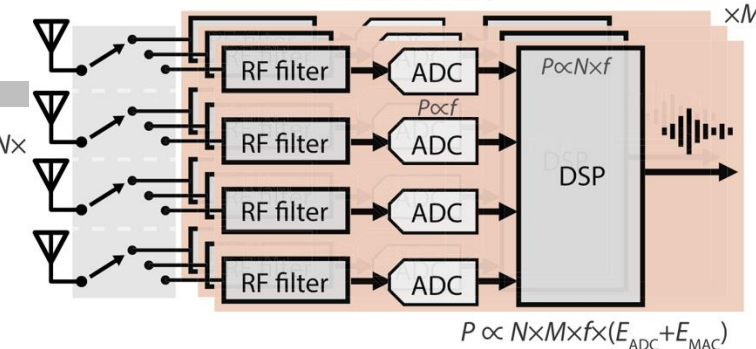
Frequency (Hz)

- Passive users cannot simply switch to higher frequencies.
- An orthogonal approach that is compatible with existing digital methods.

Photonic BSS



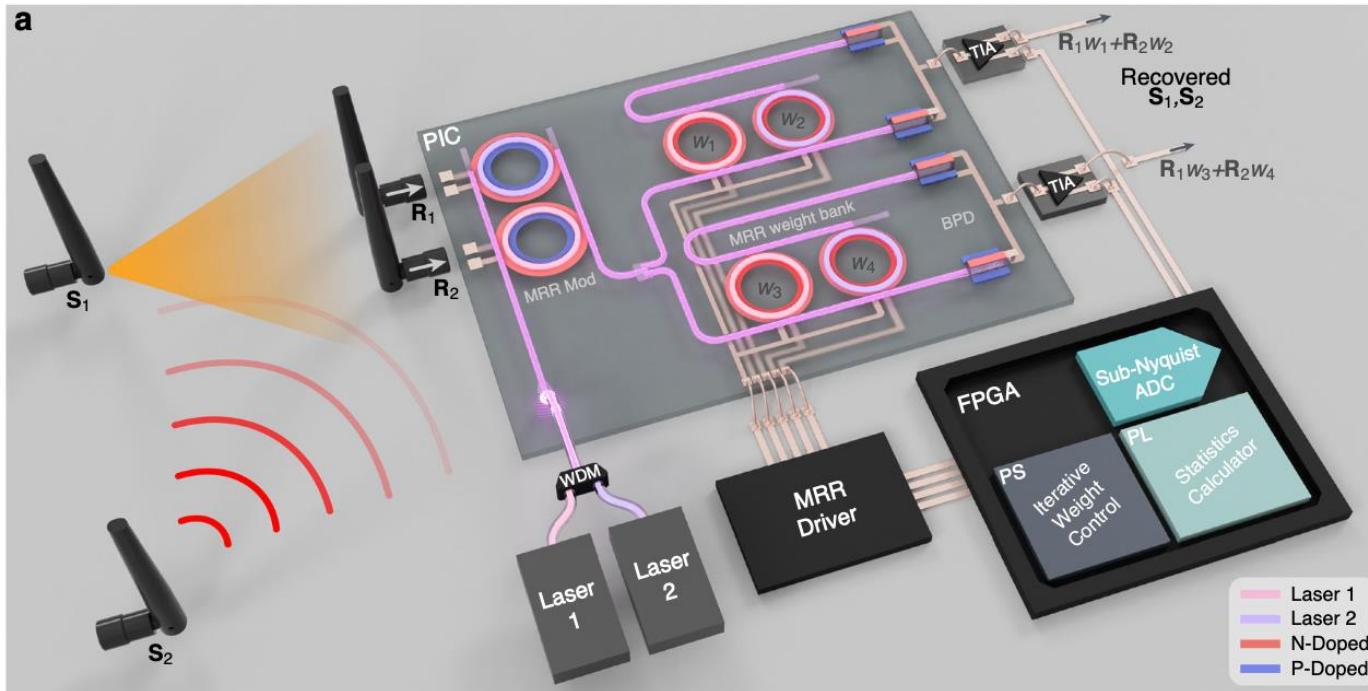
Electronic BSS



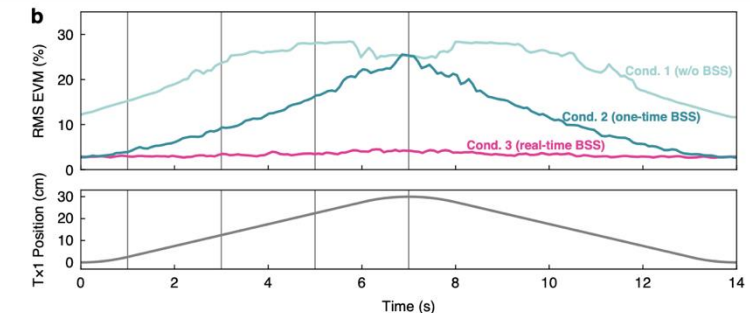
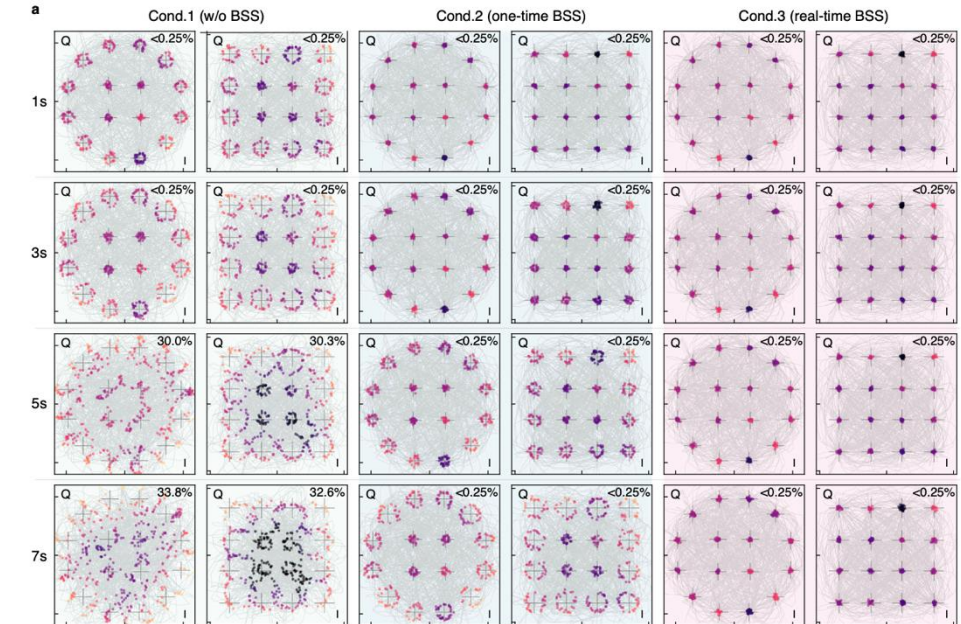
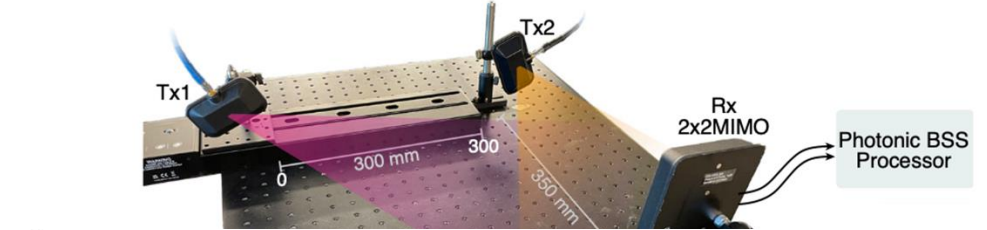
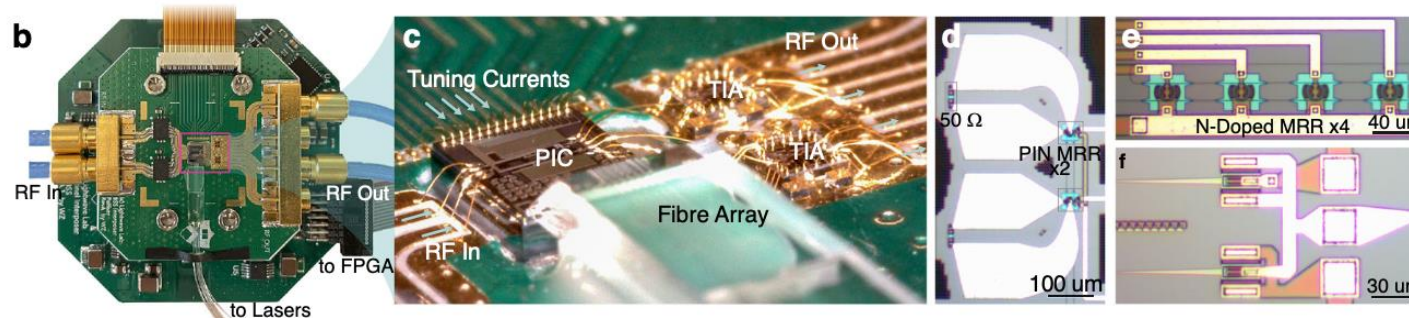


Key Results: System on Chip Photonic Processor

Schematic of the Photonic Processor



Packaged Palm-sized Photonic Processor

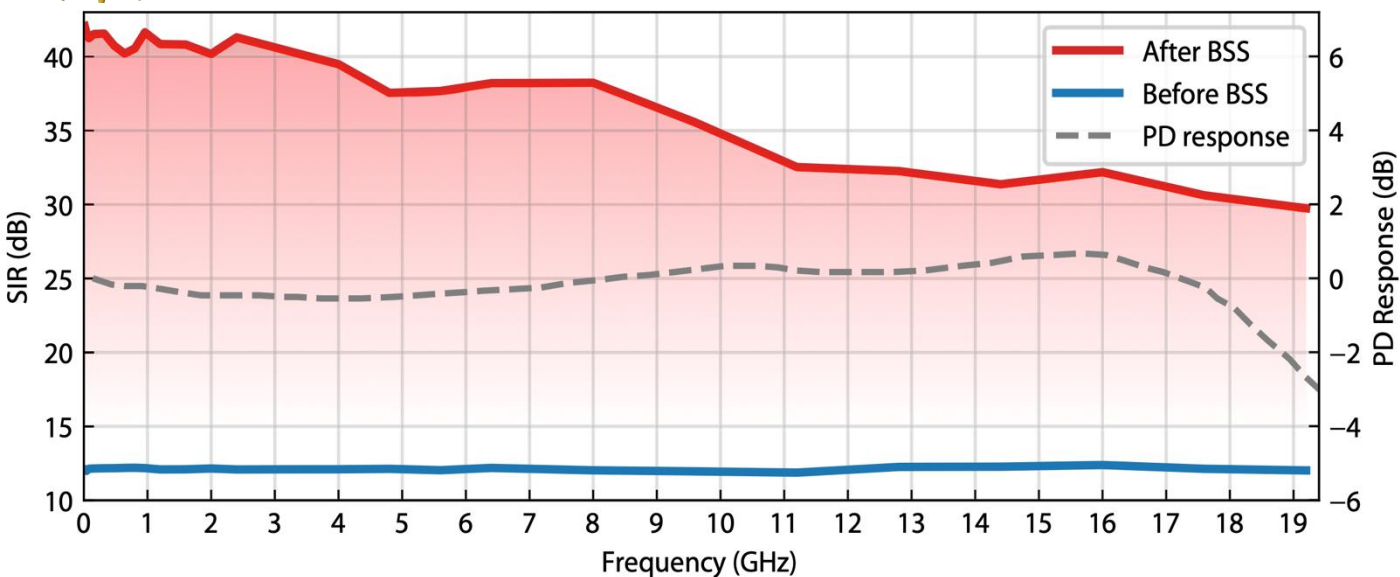


- P. Prucnal*, et al., "Real-time photonic blind interference cancellation," *Nature Communications* 14, 8197, 2023.
- P. Prucnal*, et al., "A system-on-chip microwave photonic processor solves dynamic RF interference in real time with picosecond latency," *Light: Science & Applications*, 13, 14, 2024.

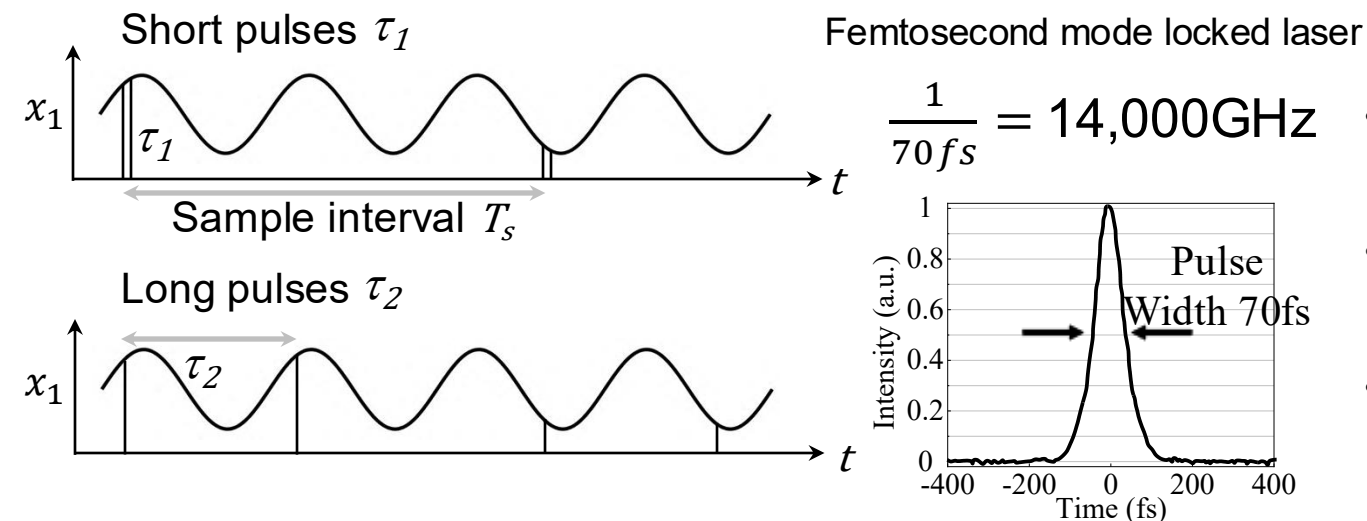


Key Results: Wideband Operation

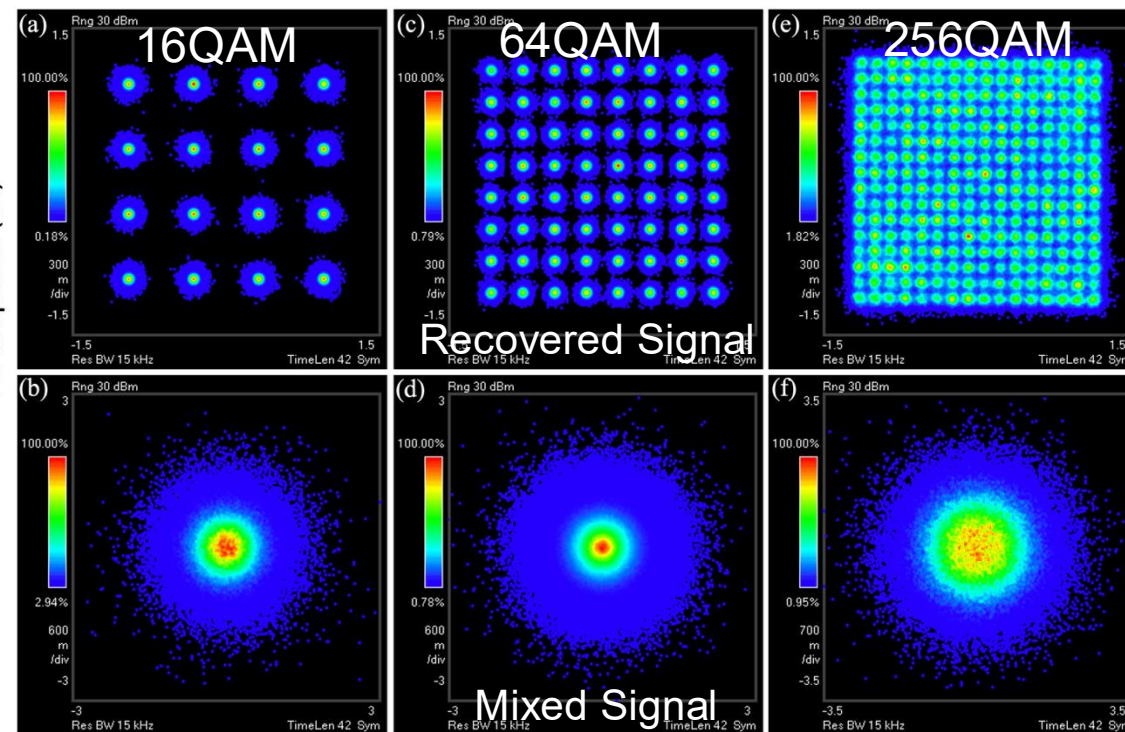
Wideband Operation



Recover SOI with undersampled signals



Modulation Format Independent

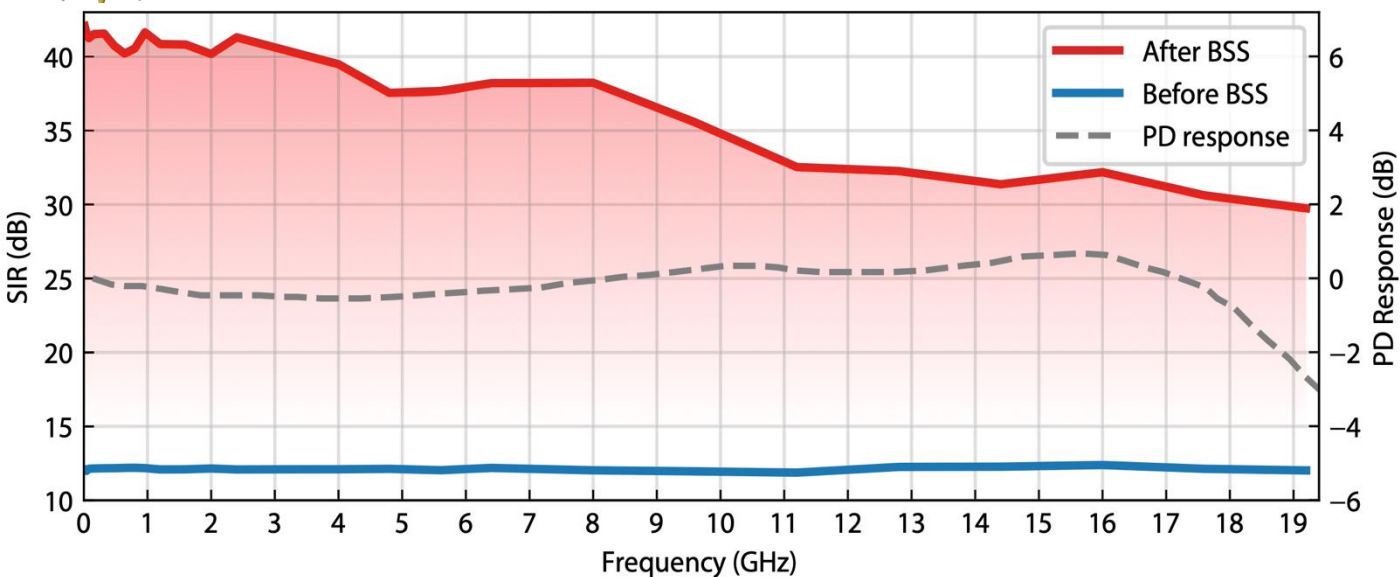


- B. Wu*, et al., "Sub-Nyquist optical pulse sampling for photonic blind source separation," *Optics Express*, 30(11), 19300 -19310, 2022.
- P. Prucnal*, et al., "Broadband physical layer cognitive radio with an integrated photonic processor for blind source separation," *Nature Communications*, 14, 1107, 2023.
- B. Wu*, et al, "Hybrid free space optical communication and radio frequency MIMO system for photonic interference separation," *IEEE Photonics Technology Letters*, 34(3), 149 – 152, 2022.

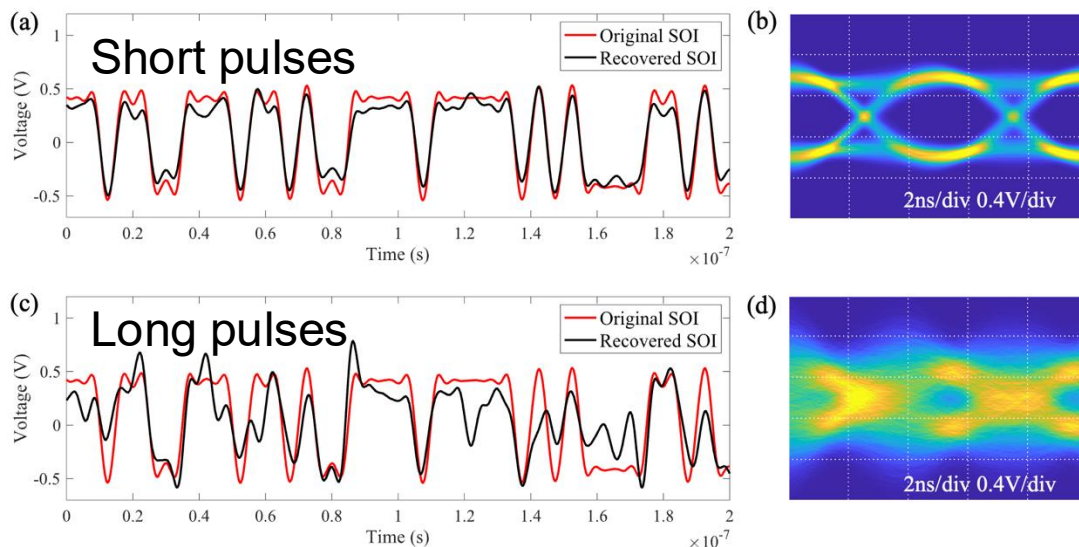


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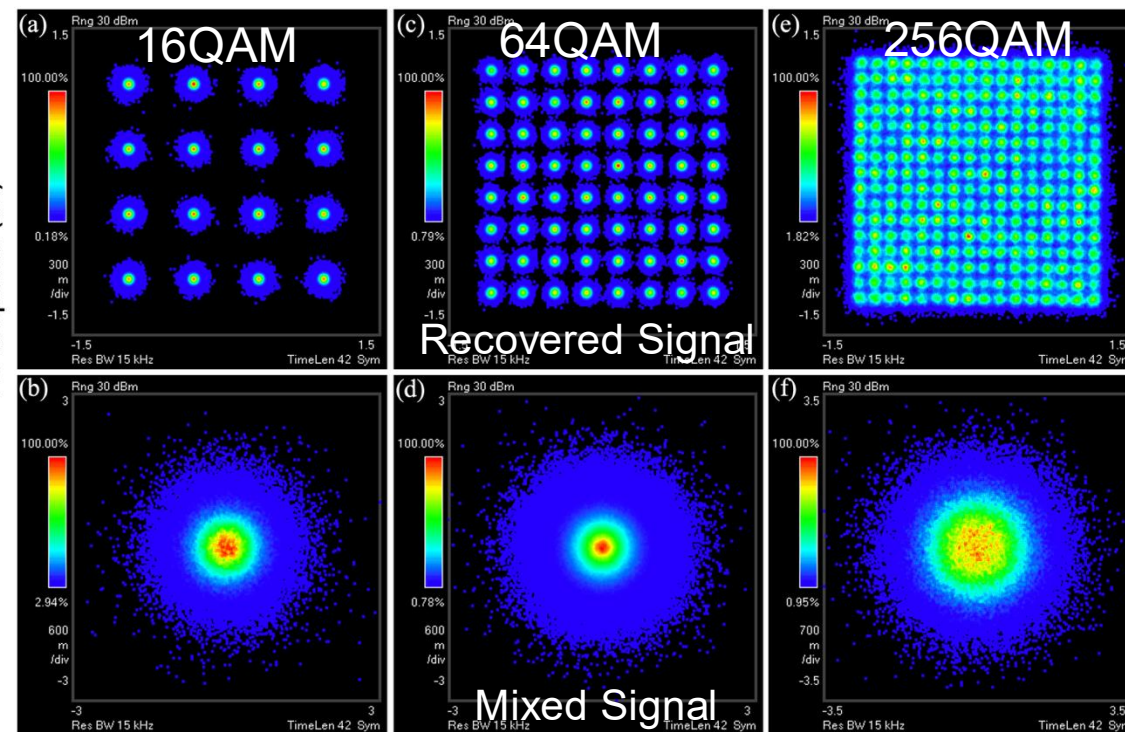
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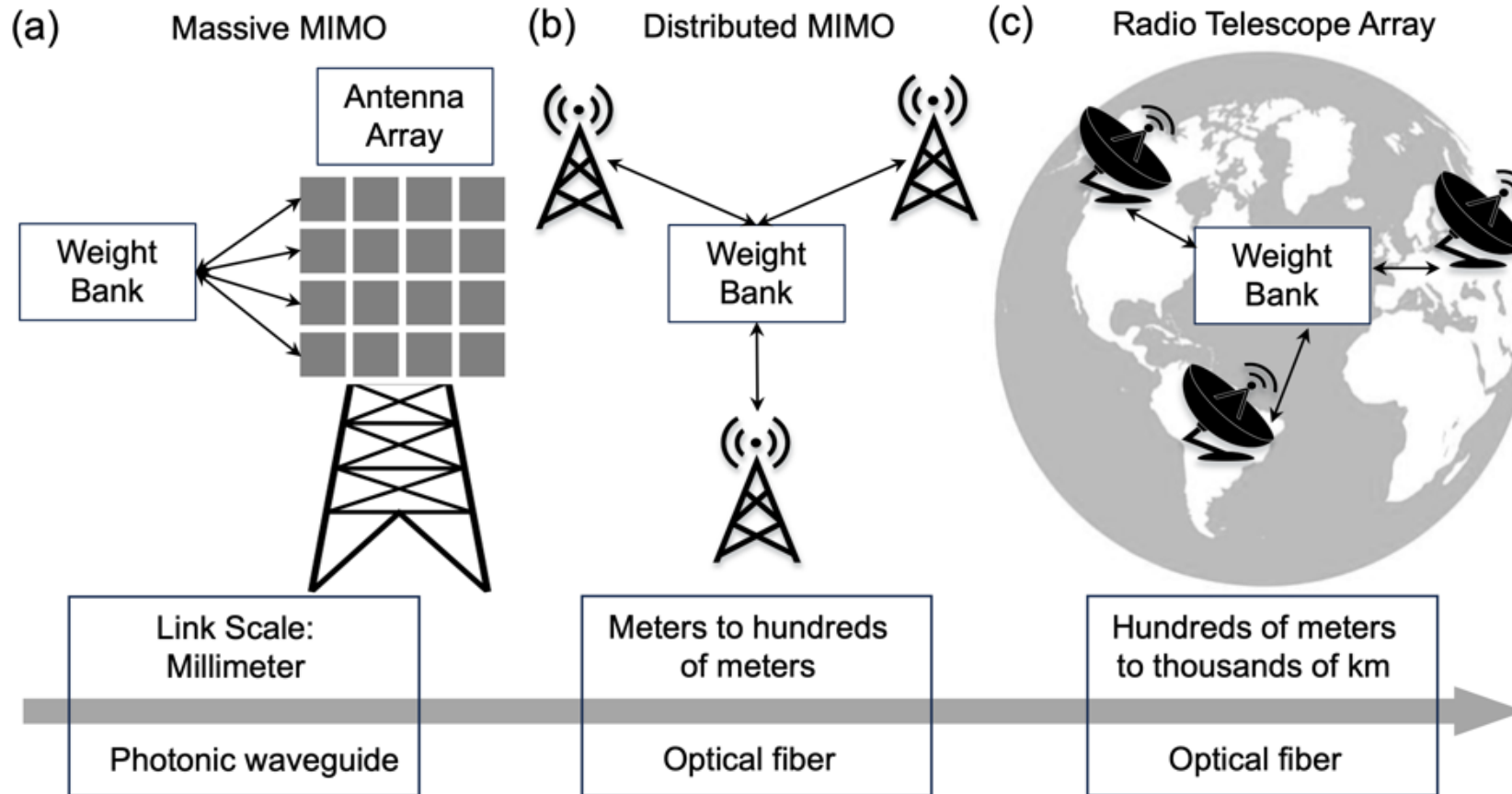
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Broader Impacts



- Coexistence solution enables continuous availability of wideband spectrum for both passive and active users.
- Wideband processor covers Sub-6 GHz to mmWave.
- Blind separation of unknown signals, bandwidths, modulation formats, clocks, and time windows.
- Cascadable analog and digital signal processing.
- Applicable to radio-over-fiber, cell densification, massive MIMO, distributed MIMO, and radio telescope arrays.