OGC 2022
Optoelectronics Global Conference

Interference Fading Suppression for Multi-frequency Φ-OTDR

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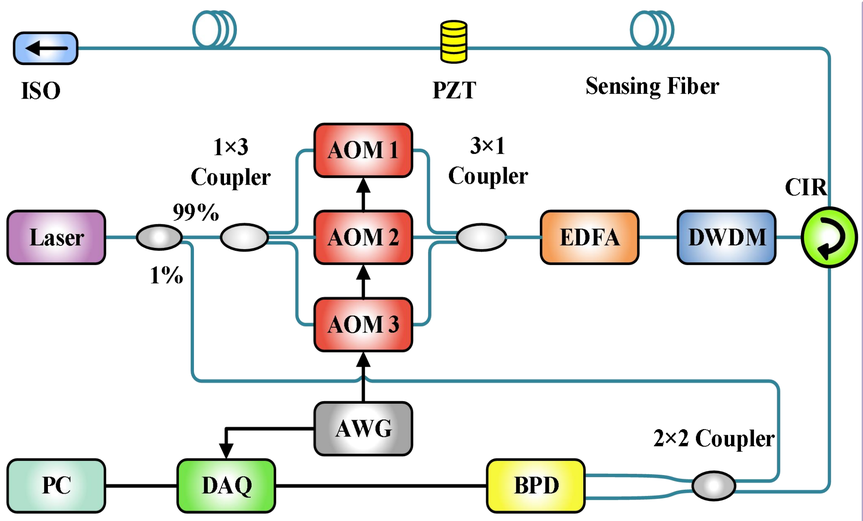
Introduction

Multi-frequency detection method has been widely concerned to suppress interference fading in Φ-OTDR. Considering the complexity and the cost, multi-frequency detection with multiple acousto-optical modulators (AOMs) may be the effective choice. However, the delay of different modulated pulse may lead to misaligned RBS signals and invalidity of fading suppression. In this paper, in order to improve the reliability of interference fading suppression, multi-frequency detection with three AOMs in parallel is adopted in Φ-OTDR. The consistency of RBS signals is then ensured through data alignment processing.

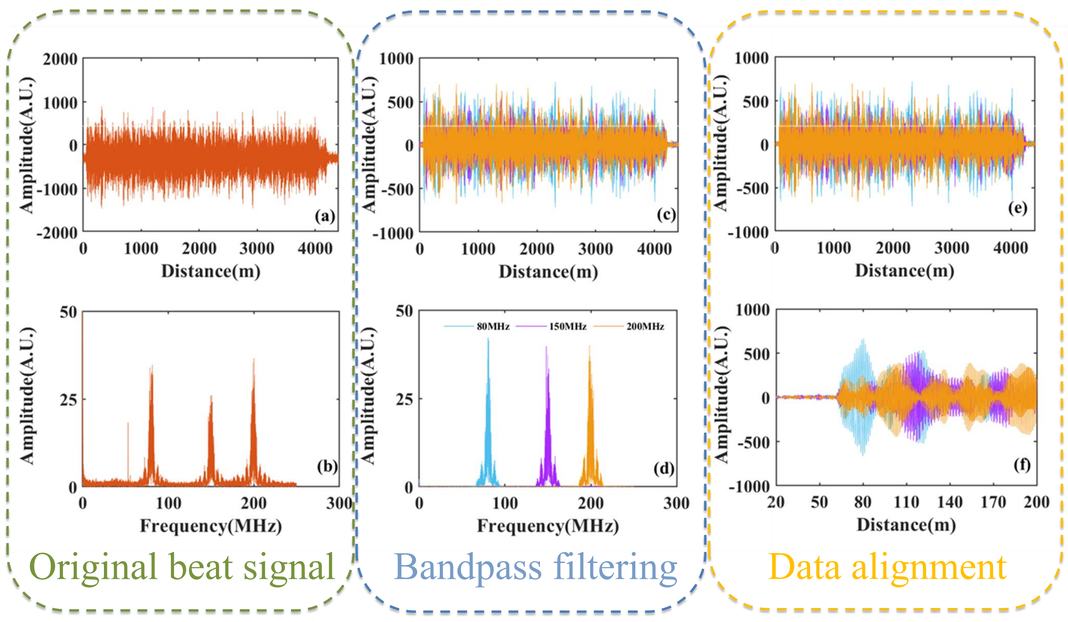
Experimental structure and principles



Experimental condition

- PZT:
  Frequency: 200Hz
  Amplitude: 2Vpp
- AOM:
  AOM1: 80MHz
  AOM2: 150MHz
  AOM3: 200MHz
- Sampling rate : 500MHz
- Length of sensing fiber: 4.2km

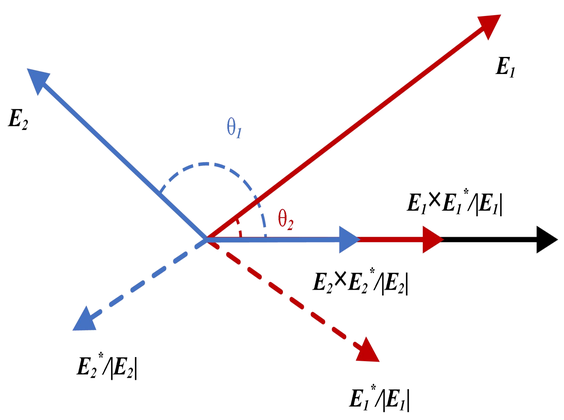
Experimental results and discussions



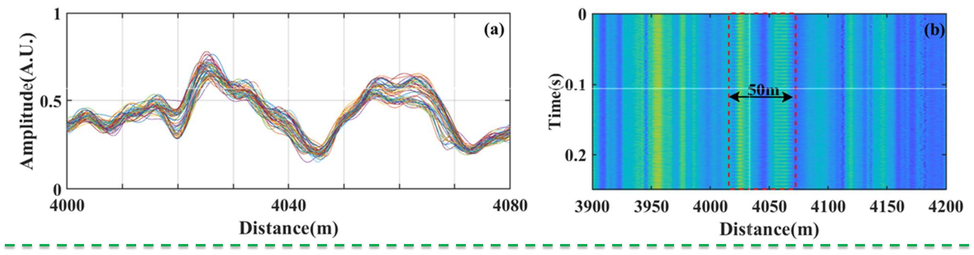
Amplitude signals can be obtained with the help of in-phase and quadrature (IQ) demodulation processing of beat signals.

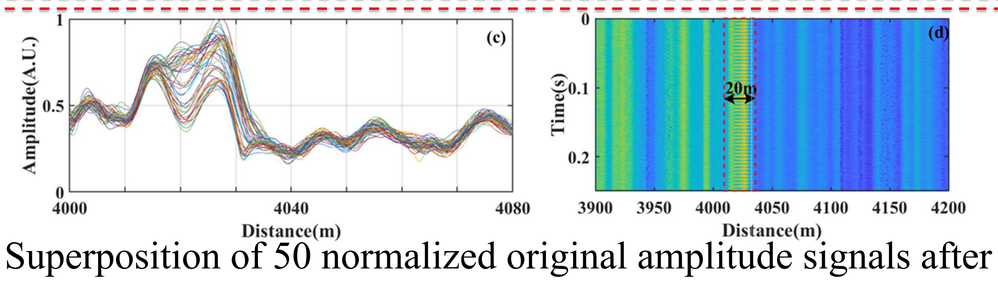
Rotated-vector-sum method

The conjugate of each vector is firstly calculated and normalized, and then the original vector is rotated to zero phase by multiplying the normalized conjugate of each vector. When all vectors are rotated to zero phase, the signal strength can be maximized by summation calculation.



Superposition of 50 normalized original amplitude signals after aggregation and waterfall diagram without data alignment.





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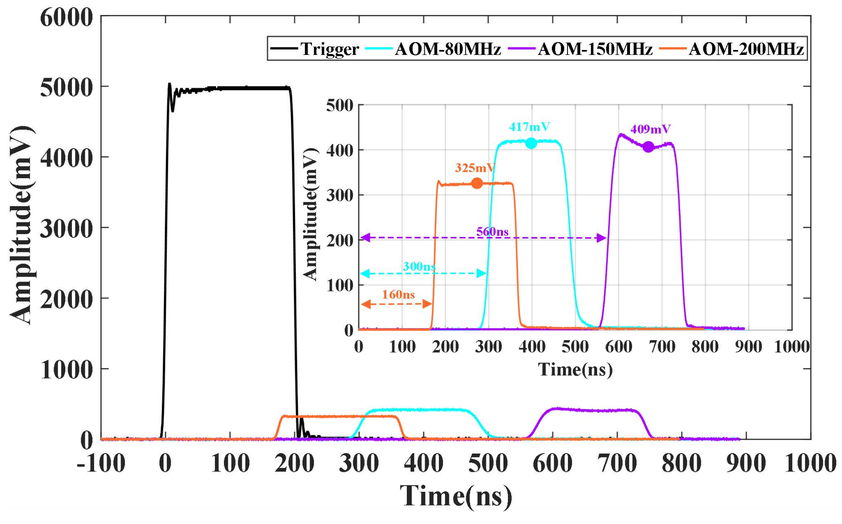
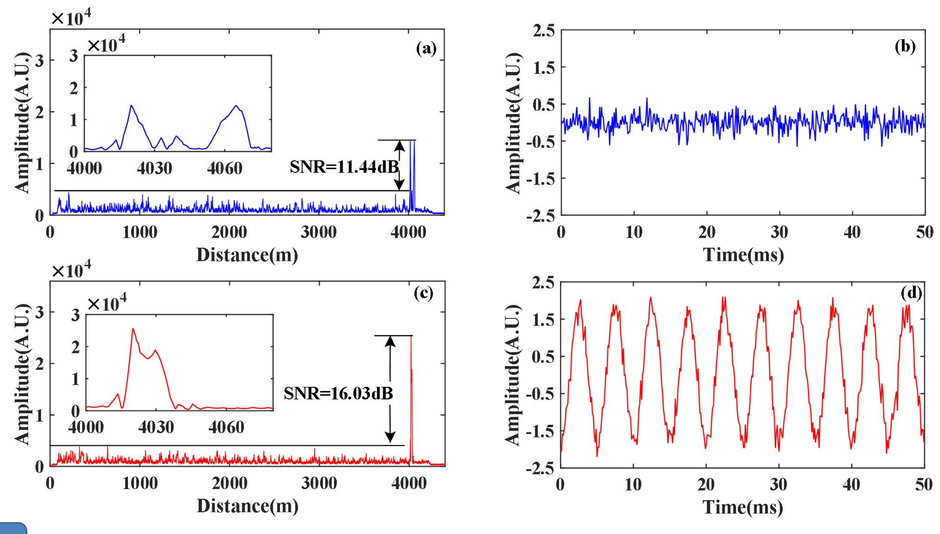


Performance

Insertion losses: 2dB

Extinction ratio:
- AOM1: 39.8dB
- AOM2: 48.46dB
- AOM3: 62.25dB

Rise time:
- AOM1: 23.4ns
- AOM2: 23.7ns
- AOM3: 9ns



Conclusion

Experimental results show that the interference fading suppression method based on the parallel AOMs and the data alignment processing can achieve a fading probability of 1.90% and a positioning SNR of 16.03dB.

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