

# Complete Ultrashort Optical Pulse Characterization based on Temporal Interferometry Using a Unbalanced Temporal Pulse Shaping System

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## 1. INTRODUCTION

### A. Applications of ultrashort optical pulses

Optical communications and optical signal processing  
Medical diagnostics and direct observation of ultrafast dynamics.

- Complete characterization of an ultrashort optical pulse is essential.

### B. How to characterize a ultrashort optical pulse?

➤ Techniques based on iterative algorithms:

- Frequency-resolved optical gating (FROG)
- Time-resolved optical gating (TROG)

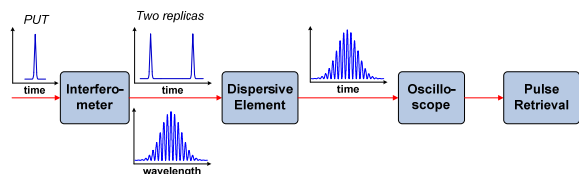
Problems: time-consuming, not implemented in real-time.

➤ Noniterative self-referencing interferometric techniques:

- Spectral phase interferometry for direct electric-field reconstruction (SPIDER)

Problems: - nonlinear material to generate frequency shear  
- low speed due to slow spectrum measurement.

- Temporal interferometry based on frequency-to-time mapping



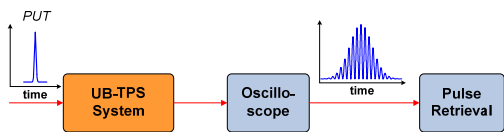
Features: linear operation, ultrafast with single-shot measurement.

Problems: poor stability due to interferometer structure.

### C. Our proposed technique

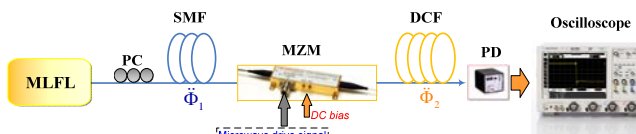
- Pulse characterization based on temporal interferometry without using an optical interferometer.

- A unbalanced temporal pulse shaping (UB-TPS) system employed to replace both interferometer and dispersive element.

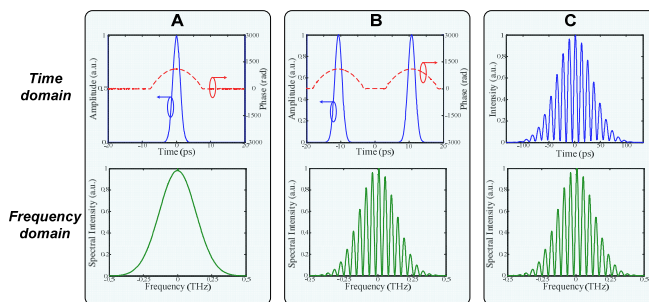
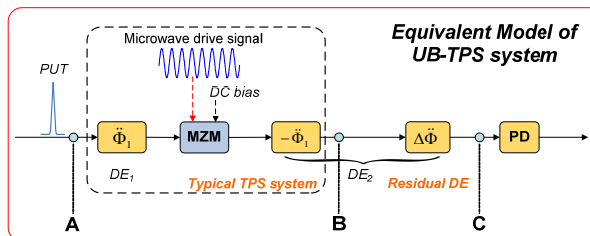


- Linear and noniterative, ensuring a high sensitivity.
- Simultaneous generation and stretching of the two replicas of the input optical pulse by UB-TPS system.
- Greatly improved stability by avoiding optical interferometers.
- Adaptive performance by tuning microwave modulation frequency and system dispersion.

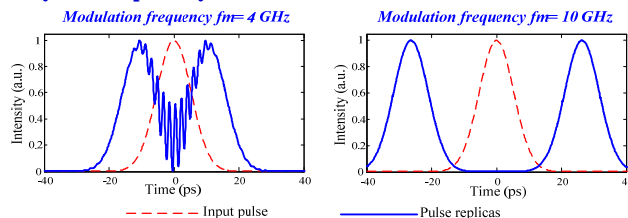
## 2. PRINCIPLE OF UB-TPS SYSTEM



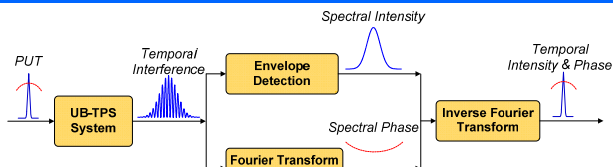
- SMF and DCF have opposite dispersion, but non-identical in magnitude.  $\Phi_1, \Phi_2 < 0$  and  $|\Phi_1| \neq |\Phi_2|$
- MZM DC-biased at minimum transmission point for DSB-SC modulation.



### ➤ System adaptability



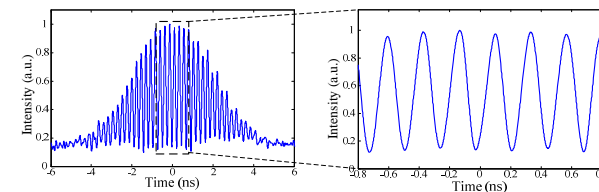
## 3. PULSE CHARACTERIZATION PROCEDURE



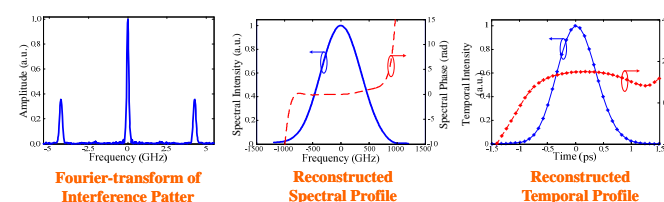
## 4. EXPERIMENT

### A. Characterization of a transform-limited optical pulse

#### ➤ Temporal interference pattern

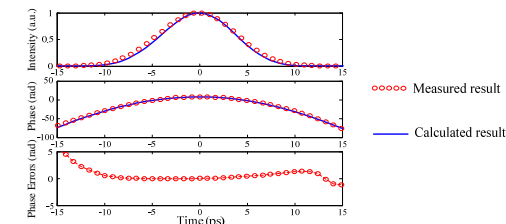


#### ➤ Fourier-transform phase retrieval algorithm

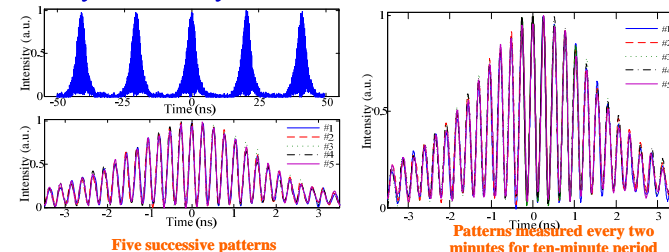


### B. Characterization of a slightly dispersed optical pulse

#### ➤ Reconstructed temporal profile of an optical pulse dispersed by 60-m SMF



### C. System stability



## 5. CONCLUSION

- The proposed approach based on temporal interferometry in an UB-TPS system without using an optical interferometer.
- Significantly increased system stability & better measurement accuracy.
- Complete characterization of a transform-limited optical pulse before and after passing through a 60-m conventional SMF was experimentally demonstrated.



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