# Microwave Photonic Filter based on broadband source sliced by SMF–FMF–SMF structure

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## I. INTRODUCTION

The MPF based on broadband source sliced in spectrum, which has excellent single-pass selection and high-Q characteristics.

Disturbance of surroundings on interference arms will appear in the output signal of the traditional broadband source is sliced in spectrum by optical filters.

A MPF based on broadband source sliced by SFS structure is proposed. The proposed MPF also has the advantage of resisting external disturbance due to the in line SFS structure.

## II. THEORETICAL ANALYSES

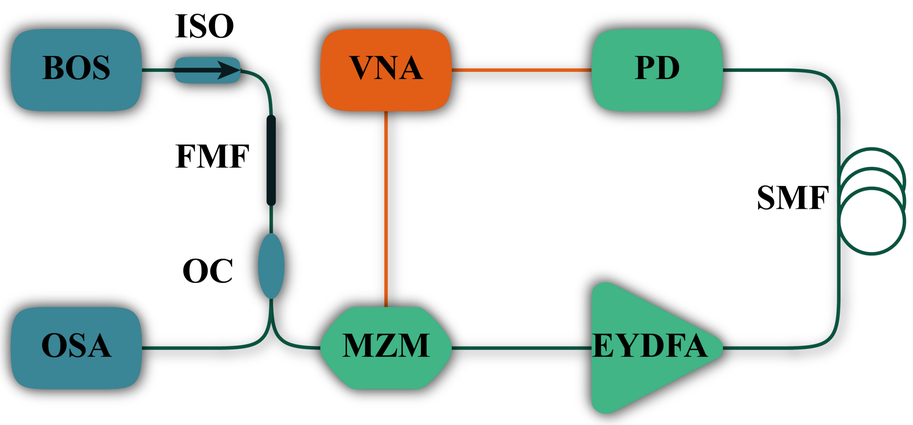


Figure 1.Schematic diagram of the proposed MPF

BOS: Broadband Optical Source, ISO: Isolator, OC: Optical Coupler,
OSA: Optical Spectrum Analyzer, VNA: Vector Network Analyzer,
PD: Photodetector EYDFA: Erbium Ytterbium Co-Doped Amplifier

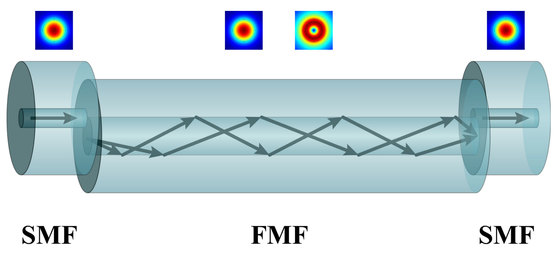


Figure 2. Structure of SFS .

$$T_{SFS}(\omega) = I_{01} + I_{11} + 2\sqrt{I_{01}I_{11}}\cos(\Delta\varphi)$$

$$\Delta\varphi = \frac{\omega}{c}\Delta n_{eff} L_{FMF}$$

- The SFS is a sandwich structure of an FMF fused between two SMFs.
- Two fusion points on the left and right are worked as optical splitter and combiner,
- FMF is the interference arm

- The frequency response observed by the VNA can be expressed as

$$H_{RF}(\Omega) = \exp(-jL_{SMF}\beta_1\Omega)\times\cos\left(L_{SMF}\frac{\beta_2}{2}\Omega^2\right)\times F_{RF}(\Omega)$$

$$F_{RF}(\Omega) = \int_{-\infty}^{\infty} d\omega S(\omega) T_{SFS}(\omega)\times\exp\left[-jL_{SMF}\beta_2\Omega(\omega-\omega_0)\right]$$

- While the spatial frequency of the sliced BOS is obtained from the following Fourier transform

$$G\left(\frac{1}{\Delta\lambda}\right) = \mathscr{F}\left\{S(\lambda)\cdot T_{SFS}(\lambda)\right\} = \int_{-\infty}^{\infty} d\lambda S(\lambda) T_{SFS}(\lambda)\exp\left[-j\frac{2\pi}{\Delta\lambda}(\lambda-\lambda_0)\right]$$

- Compared with (4) and (5), $H_{RF}$ has similar distribution to the spatial frequency spectrum G of sliced BOS.
- Furthermore, MPF has similar response to the spatial frequency of SFS on the condition that the BOS has enough bandwidth.

## III. EXPERIMENTAL RESULTS AND DISCUSSIONS

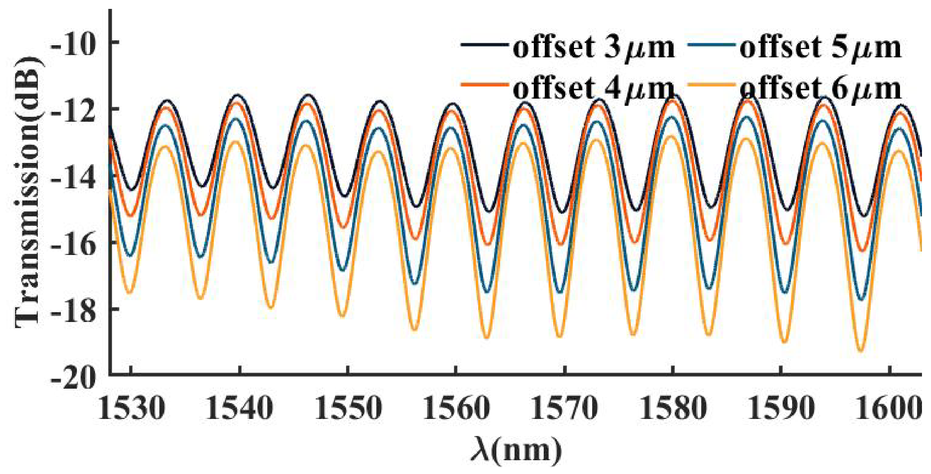


Figure 3.The transmission spectrum of SFS.

- The transmission of SFSs with core offset of 3 μm, 4 μm, 5 μm, and 6 μm,
- The FSR of transmission is about 8 nm
- The insertion loss increases with core offset, while the FSR remains constant

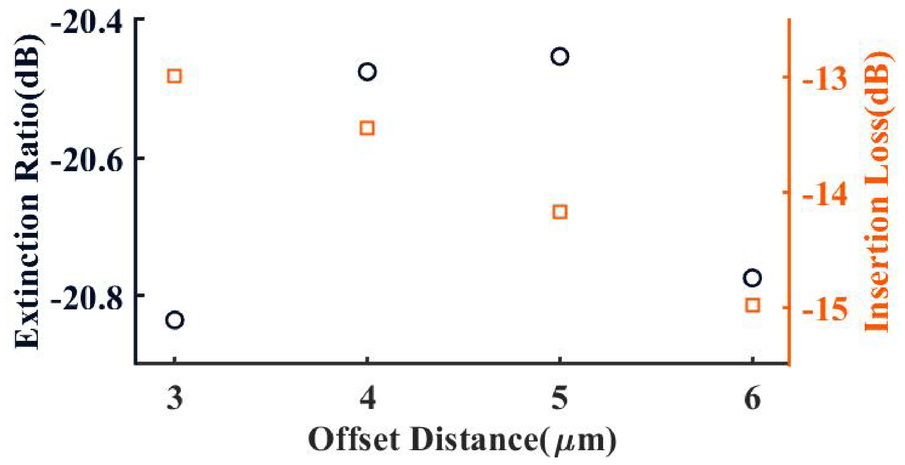


Figure 4.The extinction ratio and insertion loss of SFS.

- The extinction ratio and insertion loss with different core offset distances
- It shows a highest excitation ratio is achieved with a core offset of 5 μm.

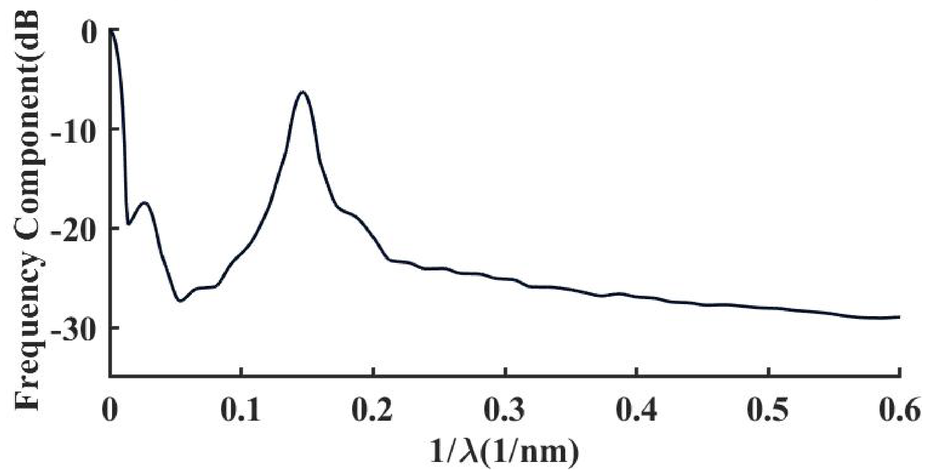


Figure 5.The frequency component of SFS.

- There is a stable peak at 0.15(1/nm),which indicates that the dominant interference modes (LP01 and LP11) in FMF are excited by core offset.

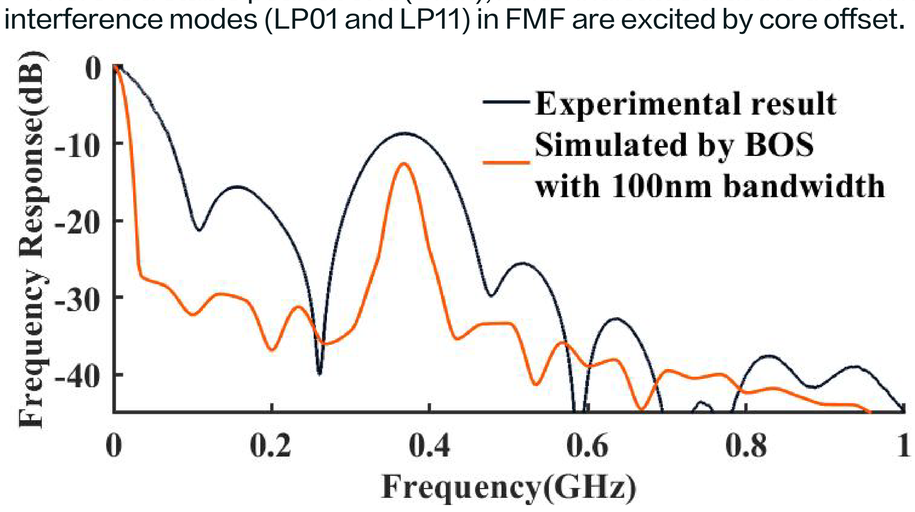


Figure 6. The frequency response of the proposed MPF.

- The frequency response of MPF are obtained in experiment and from the simulation with 100nm bandwidth.

## CONCLUSIONS

- The MPF based on BOS sliced by SFS structure is proposed.
- It has the advantage of resisting external disturbances.
- Theoretical analysis shows the filter has similar distribution to the spatial frequency spectrum of SFS.
- Experimental results show that the performance of MPF is also limited by the quality of the spectrum emitted by BOS and Amplifier.