Pulse shaping by phase-modulated fiber gratings in transmission
Miguel A. Preciado,¹ ¹ Xuewen Shu,¹ Kate Sudgen,¹
¹Aston Institute of Photonic Technologies, Aston University, Birmingham, B4 7ET, UK. Email:m.preciado@aston.ac.uk

Introduction

We propose a novel approach to pulse shaping using phase-modulated fiber Bragg gratings (FBGs) in transmission. This enables the simplification of the device fabrication while retaining the substantial advantages of FBGs in transmission.

![Fig. 1: Schematic of a pulse shaper based on a phase-modulated FBG in transmission.](image)

Numerical design method

A numerical optimization algorithm calculates the grating modulated phase, or equivalently $\Lambda(z)$, in order to obtain a spectral response in transmission that attempts to better approach the objective spectral response in transmission in terms of least minimum squares over a desired bandwidth.

![Fig. 2: Proposed method schematic based on numerical optimization.](image)

Conclusions

- No optical circulator or additional element
- Typically optimal energy efficiency
- Phase response is less sensitive to grating fabrication errors

Preliminary experimental in good agreement with the theoretical and numerical results

![Fig. 3: (Color online) Grating period (line-width) and strength (gray-dotted) of the phase-modulated FBGs for examples (a) to (f).](image)

Examples and results

As examples we design six phase-modulated FBGs in transmission for several waveforms generation.

- (a) 40-ps flat-top pulse shaper
- (b) 40-ps saw-tooth pulse shaper
- (c) 80-ps dark parabolic shaper
- (d) 40-ps bright parabolic shaper
- (e) 80-ps double saw-tooth pulse shaper type I
- (f) 80-ps double saw-tooth pulse shaper type II

![Fig. 4: (Color online) Amplitude (blue solid) and phase (green dotted) of the spectral response in transmission for examples (a) to (f).](image)

Preliminary experimental results from fabricated FBGs

- The designed grating structure was fabricated with the UV laser direct-writing system
- Grating created pitch-by-pitch.
- Hydrogen-loaded photosensitive fiber
- Stabilized by annealing at 80°C for 60 hours

The temporal results are obtained from experimental measured spectral responses of the fabricated FBGs, which phase was numerically recovered by using the Hilbert transform relation. A Gaussian pulse with 7-ps input was assumed.

![Fig. 5: (Color online) Resulting output waveforms by applying a 7-ps FWHM Gaussian pulse to the designed FBGs for examples (a) to (f).](image)