Basic FBG apodization functions effects on the filtered optical acoustic signal

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ABSTRACT

This article clarified the basic fiber bragg grating (FBG) apodization functions effects on the filtered optical acoustic signal (AS). Max optical acoustic power variations after acousto optic filter is clarified with the spectral wavelength variations. FBG apodization functions are uniform, Gaussian, and Tanh. We have tested the max optical acoustic power variations after various apodization FBG functions with the spectral wavelength variations. The max AS power amplitude after the electrical combiner is reported based various apodization FBG functions. The max optical AS after FBG is studied with various FBG lengths for various FBG apodization functions at the central wavelength of 1.55 μm. The max electrical power after power combiner unit is demonstrated with different FBG lengths for various FBG apodization functions at the central frequency of 193.1 THz.

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1. INTRODUCTION BACKGROUND

Optical communication system should satisfy the following basic specifications such as determination of transmission type (analog/digital); achieving the system fidelity (higher SNR/lower BER); larger transmission bandwidth (BW); longer repeater spacing (span); less cost of system installation; reliability (error-free transmission); less cost of system maintenance; and less of complexity [1-15]. While selecting a photodetector, the following factors are considered such as minimum optical power that must fall on photodiode to satisfy BER at specified data rate; less complexity of circuit; less cost of design; and less bias requirements [16-35]. Metal oxide technology is used to reduce the rise, fall and delay times. Metal oxide technology can be employed to achieve high speed performance, minimize transistor dimensions, so large transistors can be integrated on achip. The progress of transistors integrated on a single chip versus technology year can be studied in these researches. Bipolar complentary semiconductor transistors technologies are integrated with metal oxide technology to overcome the time delay and consequently to increase the flow rates. Next step in system designing is choosing a proper optical source, the important factors are less signal dispersion; higher data rate; longer transmission distance; less cost; efficient optical power coupling; and less circuit complexity [36-58].

2. MODEL DESCRIPTION

The setup model is illustrated in Figure 1. WDM transmitter has 100 GHz frequency spacing, power of 0 dBm, modulation line coding of non return to zero and flow rate of 40 Gbps. WDM transmitter generates the light signal with the previous technical specifications. The light signal can be modulated through acousto optical filter to delete the unwanted noise from the base band. The filtered AS is forward to FGB device to smooth the filtered signal. Fiber bragg grating (FBG) has input frequency of 193.1 THz. The Laser measured has 193.1 THz frequency of and input power of 10 dBm. SGs generate bits stream and it is digitalized coding through NRZ line coding modulation scheme. The encoded light signal from laser measured is directed to the ideal circulator. Ideal circulator has two inputs, one is the filtered AS through FBG devices and another is the encoded light signal. The output of the ideal circulator is directed to APD photodetectors.

The basic function of APD photodetectors is electrical signal detection. The signal is amplified through transimpedance amplifiers. Transimpedance amplifiers have voltage gain of 600 ohm and noise figure of 6 dB. The two signals with amplification are combined together in order to be measured in the time and spectral domains.

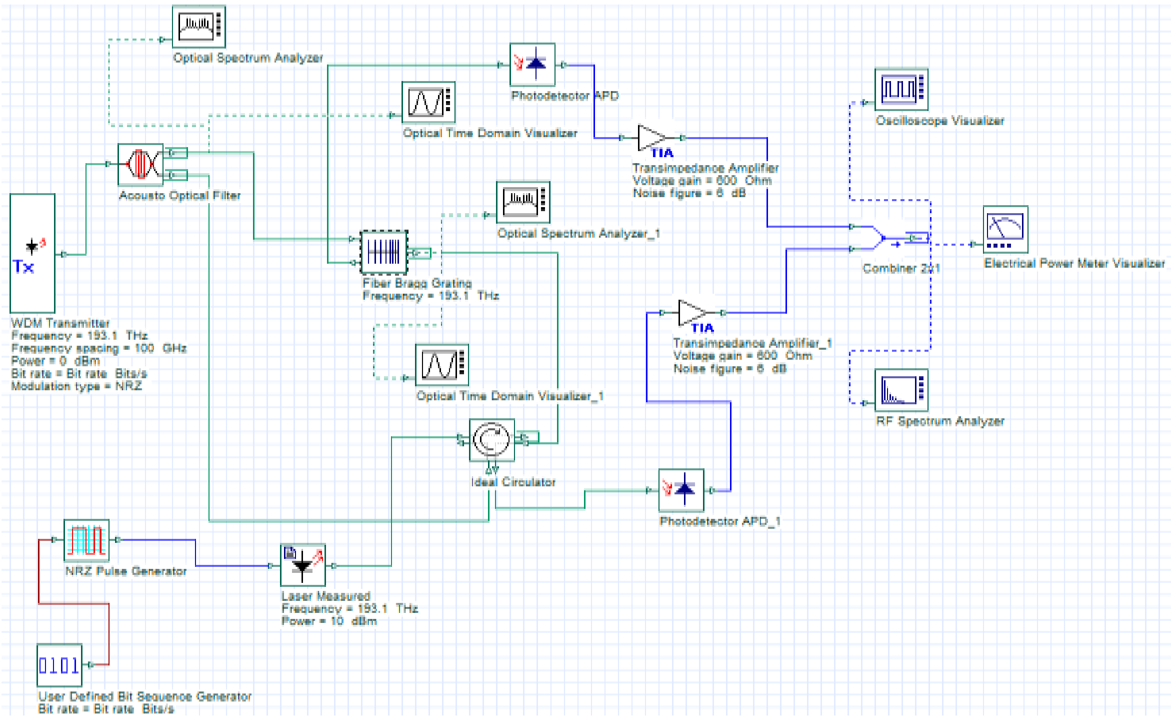

Figure 1. Proposed simulation setup description

3. PERFORMANCE ANALYSIS WITH DISCUSSIONS

We have outlined the basic fiber bragg grating (FBG) apodization function (AF) effects on the filtered optical AS. We have also studied the max optical acoustic power variations (PVs) after acousto optic filter with the spectral wavelength variations. Various FBG apodization functions are studied such as the uniform, Gaussian, and Tanh. We have examined the max optical acoustic PVs after various apodization FBG functions with the spectral wavelength variations. We have simulated the max AS power amplitude after the electrical combiner based various apodization FBG functions. The max optical AS after FBG is simulated also with various FBG lengths for various FBG apodization functions at the central wavelength of 1.55 μm. The max electrical power after power combiner unit is demonstrated with different FBG lengths for various FBG apodization functions at the central frequency of 193.1 THz. list of variables in this proposed study as shown in Table 1.

Figure 2 clarifies the max optical acoustic PVs after acousto optic filter with the spectral wavelength variations. Where max AS power is 0.5205 dBm and min noise acoustic power (MNAP) is -104.787 dBm. The max optical acoustic PVs after uniform apodization FBG with the spectral wavelength variations is reported in Figure 3. Where the max AS power is -0.206788 dBm and MNAP is -104.752 dBm. Figure 4 shows the max optical acoustic PVs after Gaussian apodization FBG with the spectral wavelength variations.

Where the max AS power is 0.318 dBm and MNAP is -104.777 dBm. The max optical acoustic power variations after Tanh apodization FBG with the spectral wavelength variations is reported in Figure 5. Where the max AS power is -0.17823 dBm and MNAP is -104.753 dBm.

Table 1. List of variables in this proposed study

Parameters	Values/Units
WDM transmitter	
Frequency	193.1 THz
Power	0 dBm
Frequency spacing	100 GHz
Extinction ratio	10 dB
Acousto opticl filter	
Bandwidth	100 GHz
Insertion loss	0 dB
Laser measured	
Frequency	193.1 THz
Power	10 dBm
FGB Device	
Frequency	193.1 THz
Length	2 mm
Effective index	1.45
Transimpedance Amplifier	
Voltage gain	27.78 dB
Noise figure	6 dB

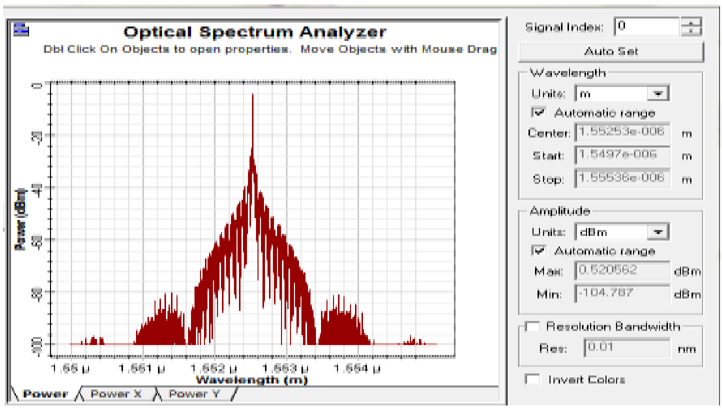

Figure 2. Max optical acoustic power variations after acousto optic filter with the spectral wavelength variations

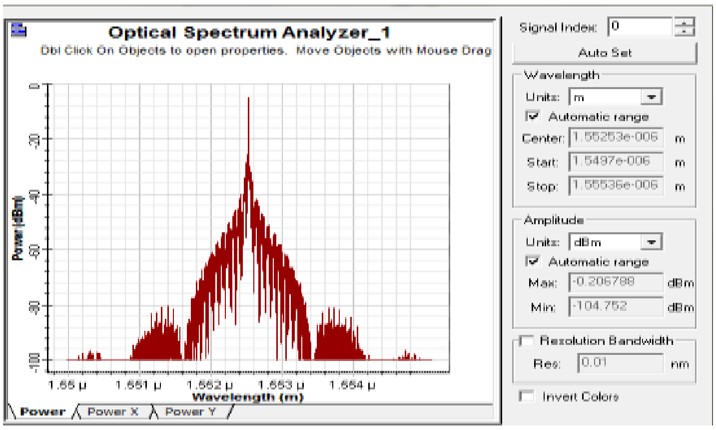

Figure 3. Max optical acoustic power variations after uniform apodization FBG with the spectral wavelength variations

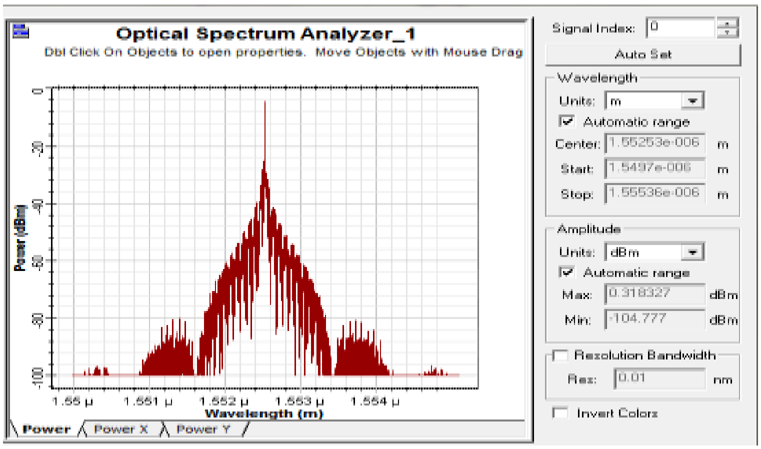

Figure 4. Max optical acoustic power variations after Gaussian apodization FBG with the spectral wavelength variations

Figure 6 demonstrates the max optical acoustic power variations (OAPVs) after Acousto Optic filter with the time variations. Where the max acoustic power is 0.00105 W and MNAP is -50 µW. The max OAPVs after uniform apodization FBG with the time variations is reported in Figure 7. Where the max acoustic power is 0.00092 W and MNAP is -43.85 µW. Besides the max OAPVs after Gaussian apodization FBG with the time variations is clarified in Figure 8. Where the max acoustic power is 0.001 W and MNAP is -47.93 µW. Figure 9 outlines the max OAPVs after Tanh apodization FBG with the time variations. Where the max acoustic power is 0.00095 W and min acoustic power is -44.05 µW. Figure 10 shows the max AS power amplitude after the electrical combiner based Gaussian apodization FBG. The max AS amplitude is 1.54958 a.u. and min AS amplitude is -0.276726 a.u. The total electrical power after the electrical combiner based Gaussian apodization FBG is demonstrated in Figure 11. Where the total AS power is 806.165 mW.

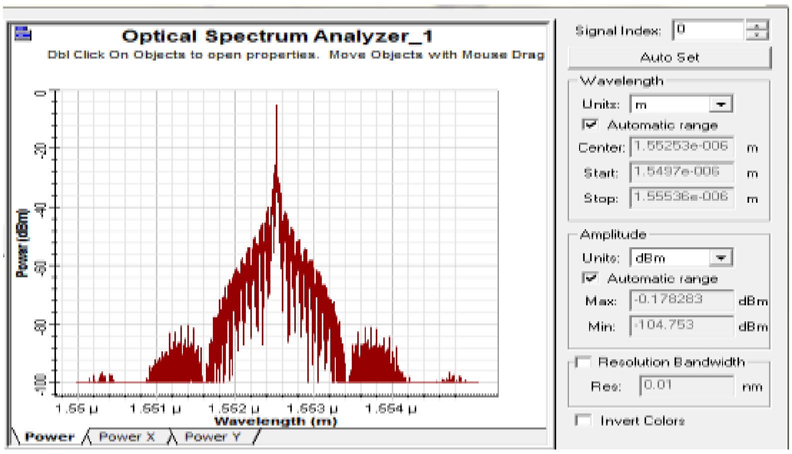

Figure 5. Max optical acoustic power variations after Tanh apodization FBG with the spectral wavelength variations

Figure 12 clarifies the max electrical power variations with the spectral frequency variations after the electrical combiner based Gaussian apodization FBG. Where the max AS power is 33.2231 dBm and min MNAP is -106.344 dBm. Figure 13 clarifies the max optical AS after FBG with FBG length for various FBG AF at 1.55 µm center of wavelength. The max optical AS decreases with the increase of FBG device length. The optimum optical AS is achieved at FBG length of 2 mm for various FBG AF. Gaussian AF reported better performance than other apodization FBG AF. Figure 14 illustrates the max AS power amplitude after power combiner unit with FBG length for various FBG AF at the central wavelength of 1.55 µm. The max AS power amplitude can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG AF has outlined better performance than other FBG AF.

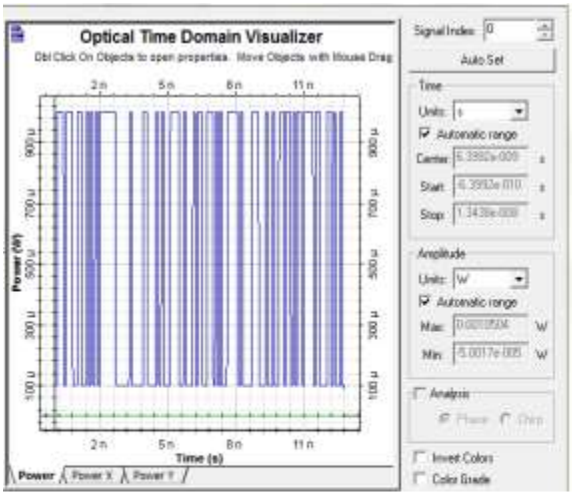

Figure 6. Max optical acoustic power variations after Acousto Optic filter with the time variations

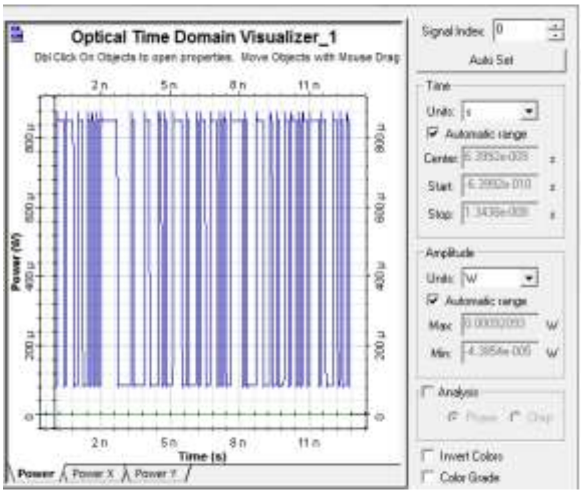

Figure 7. Max optical acoustic power variations after uniform apodization FBG with the time variations

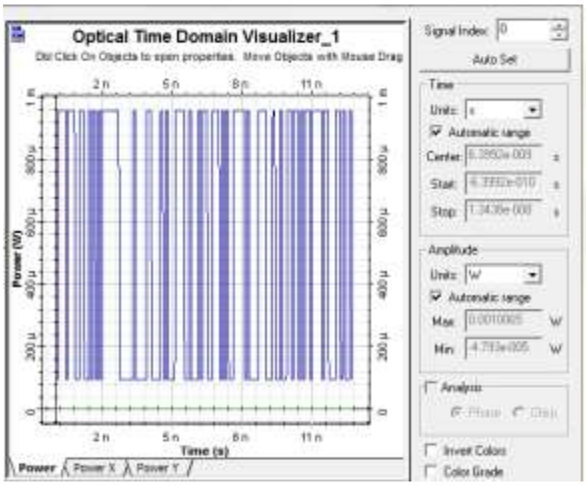

Figure 8. Max optical acoustic power variations after Gaussian apodization FBG with the time variations

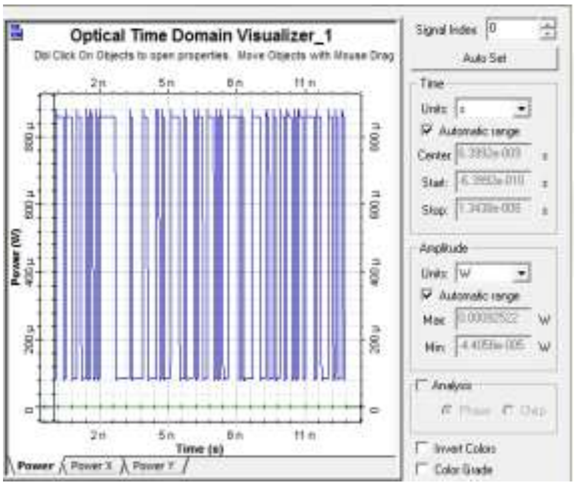

Figure 9. Max optical acoustic power variations after Tanh apodization FBG with the time variations

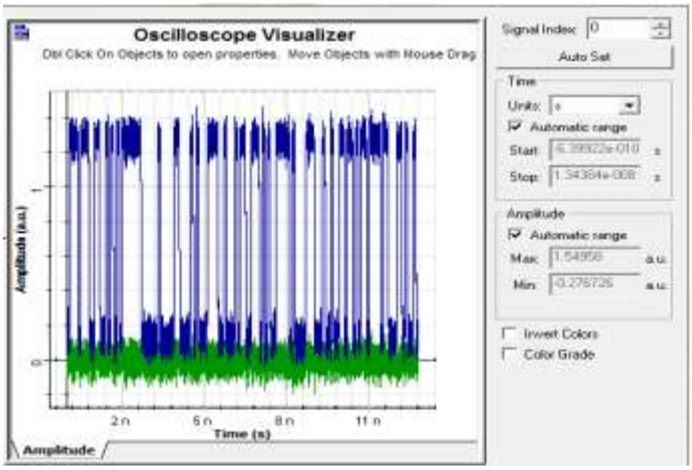

Figure 10. Max AS power amplitude after the electrical combiner based Gaussian apodization FBG

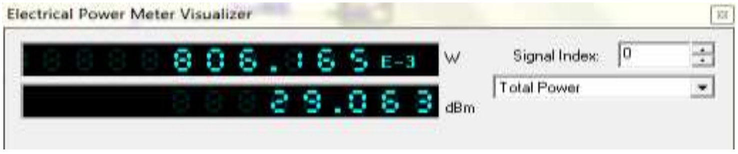

Figure 11. Total electrical power after the electrical combiner based Gaussian apodization FBG

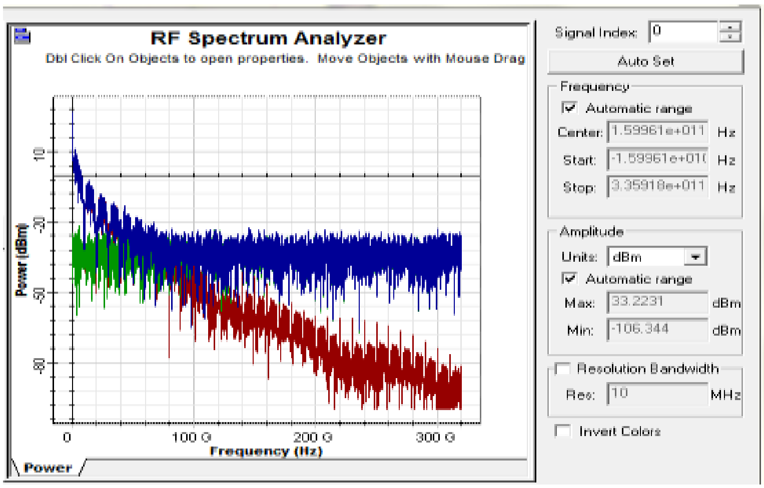

Figure 12. Max electrical power variations with the spectral frequency variations after the electrical combiner based Gaussian apodization FBG

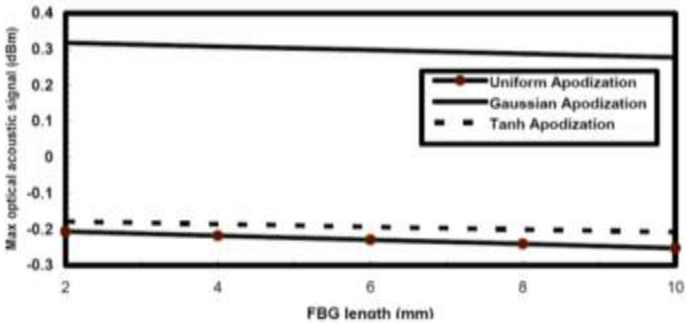

Figure 13. Max optical AS after FBG with FBG length for various FBG apodization functions at the central wavelength of 1.55 µm

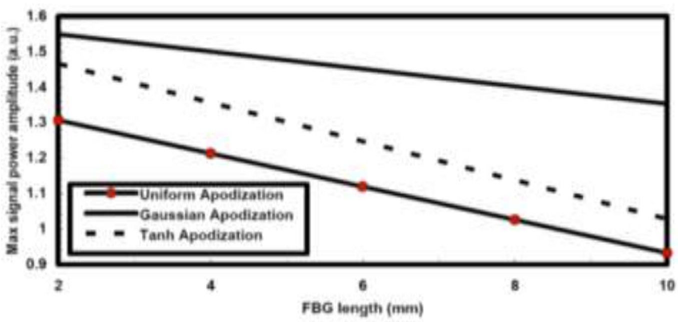

Figure 14. Max AS power amplitude after power combiner unit with FBG length for various FBG apodization functions at the central wavelength of 1.55 µm

Figure 15 clarifies the total AS power after power combiner unit with FBG length for various FBG AF at the central wavelength of 1.55 µm. The total AS power amplitude can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG AF has outlined better performance than other FBG AF. Figure 16 clarifies the max electrical power after power combiner unit with FBG length for various FBG AF at the central frequency of 193.1 THz. The max electrical power can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG AF has outlined better performance than other FBG AF.

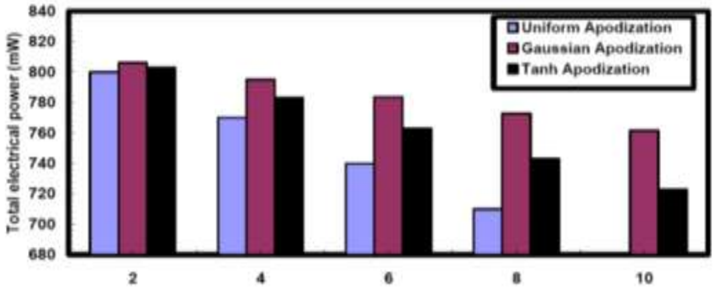

Figure 15. Total electrical power after power combiner unit with FBG length for various FBG apodization functions

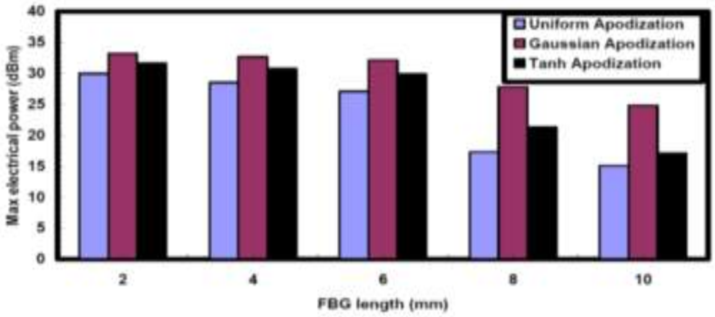

Figure 16. Max electrical power after power combiner unit with FBG length for various FBG apodization functions at the central frequency of 193.1 THz

4. CONCLUSION

We have been simulated the basic FBG apodization functions effects on the filtered optical AS. Max AS power amplitude after power combiner unit with FBG length for various FBG AF at the central wavelength of 1.55 µm. The max AS power amplitude can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG apodization function has outlined better performance than other FBG apodization functions. The total AS power amplitude can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG AF has outlined better performance than other FBG apodization functions THz. The max electrical power can be enhanced with FBG length of 2 mm for various FBG AF. Gaussian FBG AF has outlined better performance than other FBG AF. The AS power amplitude and optimized power at FBG length of 2 mm and at Gaussian FBG apodization function.

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