











with a periodicity that equals half the PRBS word length, hence multiple gratings can be implemented along a single PMF to realize multi-tap MWP filters, as shown in Fig. 4(a).

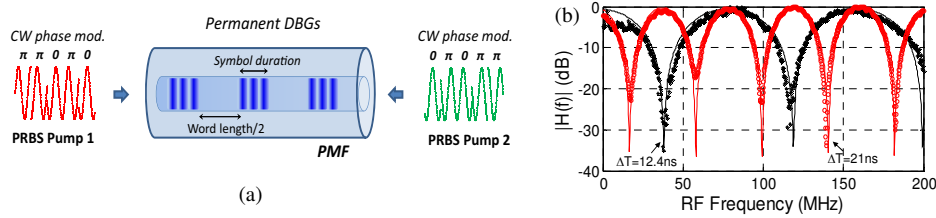


Fig. 4. (a) Generation of stationary dynamic gratings using PRBS phase modulation. (b) Spectral response of two-tap MWP filter.

In this experiment, a 2m-long PMF was used as a delaying medium and the modulation frequency of PRBS was varied between 6 and 10 GHz with 127 bits word length, which is the lowest available in our generator. Two correlation peaks could be created along the PMF with a relative delay in the range of 12.7 – 21.0 ns. The FSR of the resulting MWP notch filter ranged between 47 and 78 MHz, a variation of 66%, as shown in Fig. 4(b).

The DBGs obtained using this method are stationary and do not require periodic refreshing every  $\tau$ . Therefore, the restriction of the relative delay to the order of  $\tau$  is removed. On the other hand, the continuous power of the pumps used in this technique is much lower than the peak power of the pump pulses that were used before. Since the strength of the DBG reflection scales quadratically with the pump power, the stationary DBGs tend to be considerably weaker than pulsed ones.

#### 4. Conclusions

We have designed and experimentally demonstrated three different configurations to realize multi-tap MWP filters, based on dynamic Brillouin grating reflectors in polarization maintaining fibers. The spectral responses of the proposed novel variety of filters can be dynamically tuned and reconfigured, by simply changing the characteristics of single or multiple DBG generations, showing a FSR variation larger than 60% in a two-tap filter. The first configuration allows for any spectral range tunability, however the number of taps and the central frequency could not be scaled. MWP filters based on configurations n° 2 and n° 3 were based on multiple grating reflectors successively created along the same fiber, and the need of a reference tap with a fixed optical delay line could be eliminated. The filter FSR is governed by the number of taps and the fiber length: large FSRs require short and precise fiber lengths. In these configurations the birefringence uniformity along the fiber must be carefully inspected for a consistent frequency response. Some stability issues were found related to changes in the physical properties of the fiber. Yet, the fiber can be properly isolated. In the second configuration, two distinct dynamic Brillouin gratings were localized at the same position, so that the resonance frequency of one grating could match the incident optical carrier and another could reflect one of the two modulation sidebands. This way we could extend the central operation frequency of the filter beyond that of configuration n° 1. Lastly, the correlation technique based on the external PRBS optical phase modulation proposed in configuration n° 3 enables the generation of stationary DBGs. These alleviate the need for periodic refreshing, help extend the range of attainable FSRs, and improve the tunability and the scalability of the filter response.

#### Acknowledgments

The authors wish to acknowledge the financial support of the European Community's Seventh Framework Programme (FP 7) project GOSPEL; the GVA PROMETEO 2008/092, Infraestructura FEDER UPVOV08-3E-008, the Plan Nacional I + D TEC2011-29120-C05-05, the Swiss National Science Foundation through project 200021-134546 and the EPFL Space Center, the Israeli Science Foundation (ISF), and the KAMIN program of the Chief Scientist Office, Israel Ministry of Industry, Trade and Labor.