Integrated Wavelength Filter on thin-film Lithium Niobate for a Photonic-enabled Radiometer

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Introduction

The goal of this project is to develop a CubeSat payload radiometer for Cosmic Microwave Background detection and earth observation for weather monitoring. The device is based on whispering gallery resonator optical up-conversion and optical signal processing using integrated microwave photonics techniques to achieve size and weight reduction.

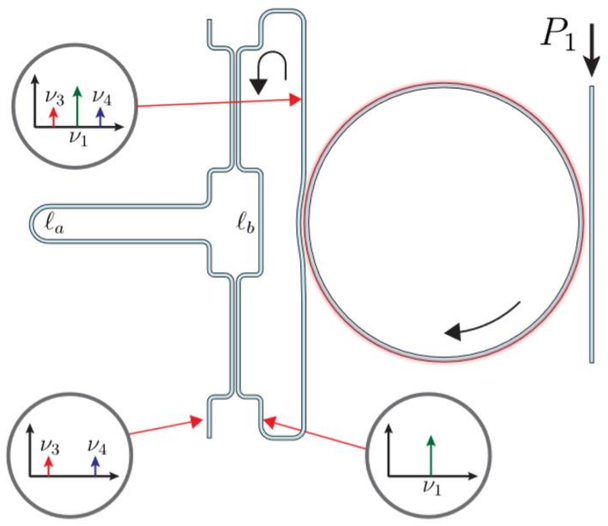


Fig. 1. Photonic Integrated Circuit for the CubeSat payload radiometer.

We present the characterization of a key component for this application, an integrated wavelength filter based on asymmetric Mach-Zehnder interferometer (AMZI). With this type of architecture the pump is critically-coupled while the sidebands are overcoupled, increasing bandwidth while maintaining high efficiency.

The Photonic Integrated Circuit

The AMZI structures have been fabricated by direct etching by 325 nm into the 600 nm Lithium Niobate layer and cladding with 1.4 μm of silicon dioxide.

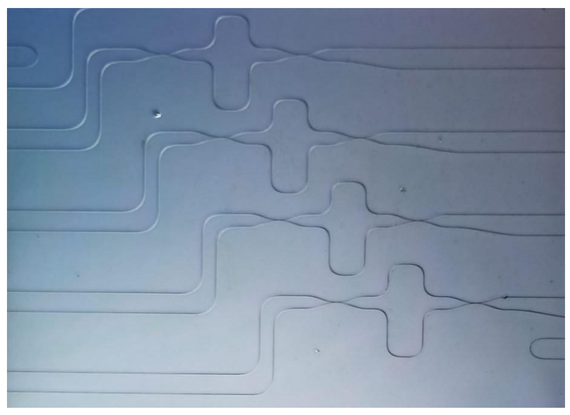


Fig. 2. The AMZIs structures under test.

All the AMZIs designs have the same optical path length imbalance between the arms (250 μm), but different waveguide gap in the directional couplers (DC) of the AMZIs: 0.65 μm (AMZI 1), 0.55 μm (AMZI 2), 0.45 μm (AMZI 3) and 0.35 μm (AMZI 4).

Characterization Setup

With this work we aim to determine the directional coupler parameters and the fabrication specifications to achieve 50/50 splitting ratio.

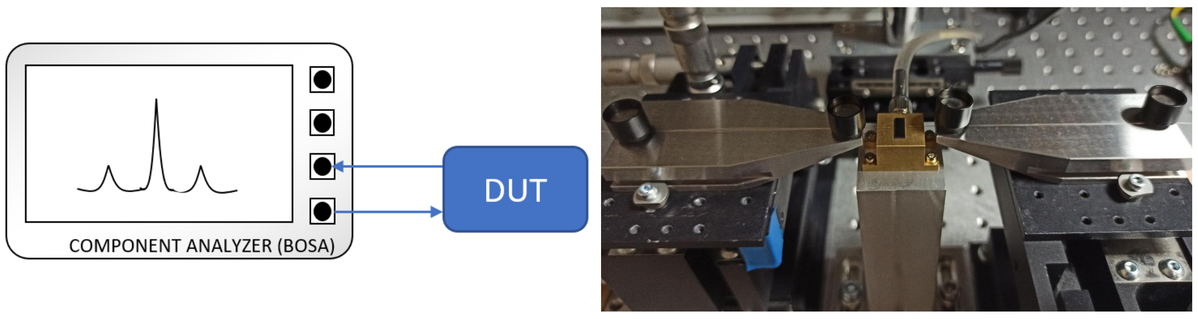
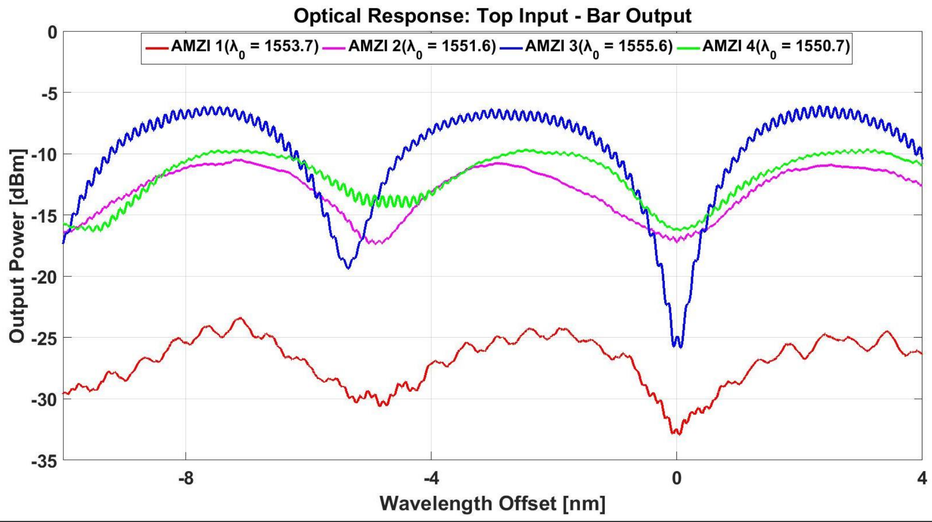


Fig. 3. Experimental Setup.

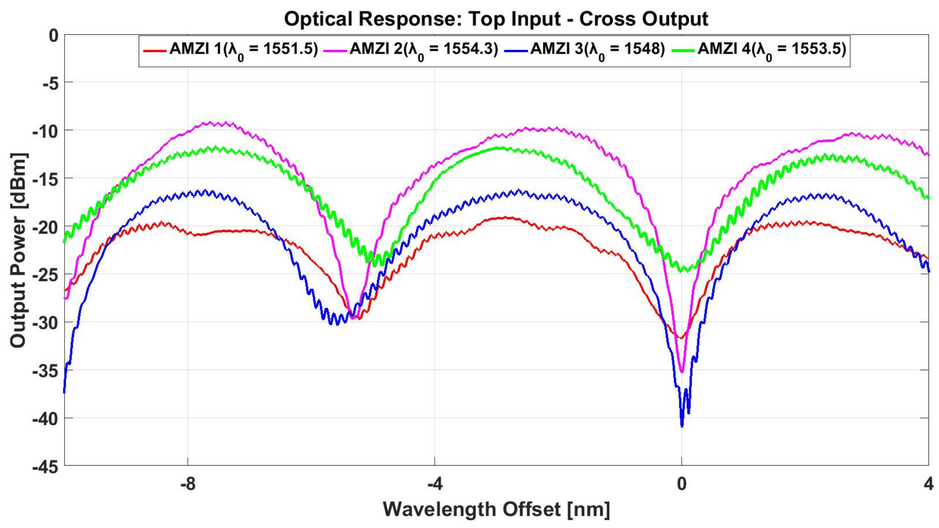
The device characterization was performed using the Component Analyzer feature of the High-Resolution Optical Spectrum Analyzer from Aragón Photonics.

Experimental Results – Transmission Response

First, light was injected to the top arm of the input directional coupler. The wavelength axis has been normalized, representing the wavelength offset to the value where the absolute minimum in the optical response is achieved.

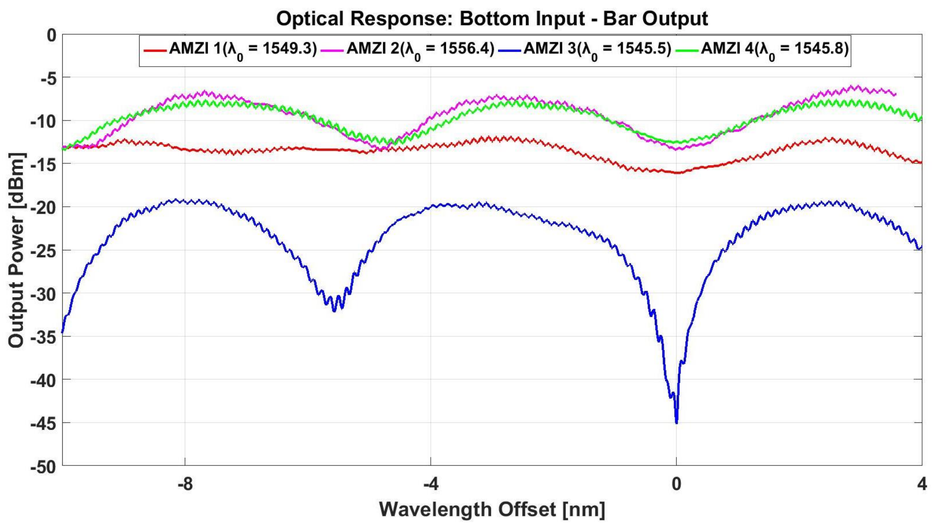


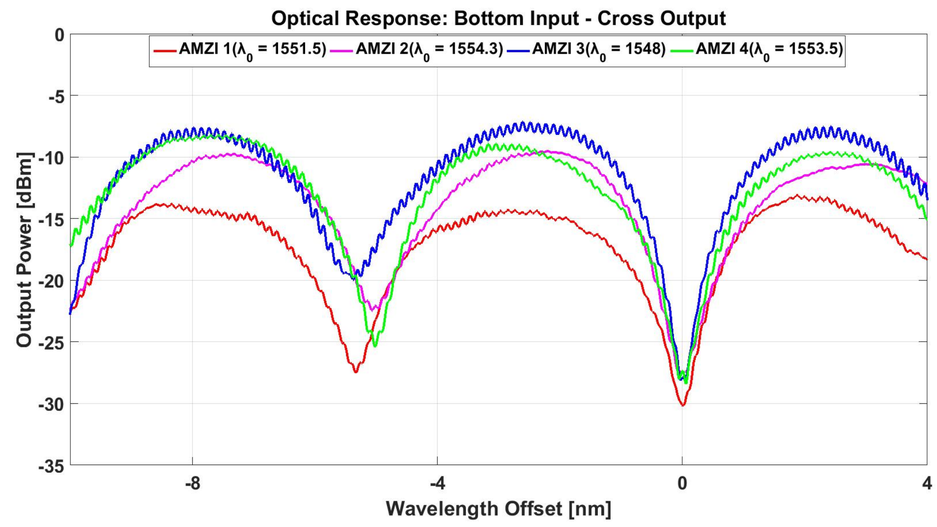
Experimental Results – Transmission Response



OPTICAL EXTINCTION RATIO (Light Injected to the top arm of the input DC)				
Output Port	AMZI 1	AMZI 2	AMZI 3	AMZI 4
Bar Port	8.5 dB	6.5 dB	19.5 dB	6.5 dB
Cross Port	12.5 dB	25.3 dB	25 dB	13 dB

The input fiber is now moved to the bottom arm of the input DC and the light is again collected from the two corresponding output waveguides of the AMZI under test:





OPTICAL EXTINCTION RATIO (Light Injected to the bottom arm of the input DC)				
Output Port	AMZI 1	AMZI 2	AMZI 3	AMZI 4
Bar Port	4 dB	6.5 dB	25 dB	5 dB
Cross Port	17 dB	18 dB	20.6 dB	19 dB

From the results can be observed that **AMZI 3** is the structure that provides the maximum suppression at both output ports when light is coupled to any arm of its input DC.

Conclusions

We presented a monolithically integrated wavelength filter that forms part of a **novel radiometer architecture for space applications that eliminates the need for cryostats**, reducing the impact of the payload in the satellite. A maximum **25 dB** of suppression was achieved with **AMZI 3** when injecting light in either of the two arms of the input directional coupler. Therefore, we can also conclude that the **DC gap that offers the splitter ratio closer to the desire 50/50 is 0.45 μm**. The FSR of the filter can be adjusted by changing the path length imbalance of the AMZI.

Acknowledgements

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