Compact 8-channel Loop-back AWG based Integrated Comb Processor

L. Roel van der Zon[1], Luis A. Bru[1], Pascual Muñoz[1], Daniel Pastor[1]
Roel.vanderzon@upv.es
1) Photonics Research Labs, iTEAM Research Institute, Universitat Politècnica de València, Spain

ABSTRACT

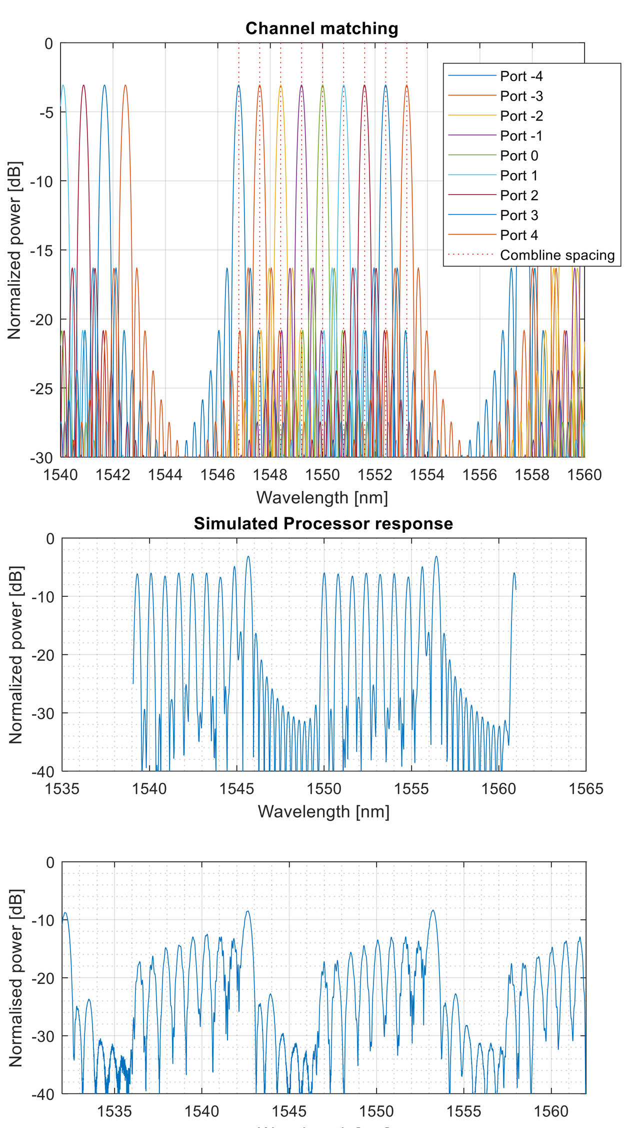
We present an 8-channel integrated comb source spectral processor based on an arrayed-waveguide grating with unconventional mounting, for improved aberration and sidelobes, in loop-back configuration. The spectral processor is fabricated in a silicon nitride platform and has a 100 GHz channel spacing.

INTRODUCTION

A spectral processor, or sometimes called waveshaper, is used to modulate a signal in phase and/or amplitude. This is an essential device for applications like data communication, phased arrays, Lidar or arbitray waveshaping. An integrated device will enable affordable acces to control over the phase and amplitude over a spectrum.

AWG DESIGN

The use of an in house developed mathematical model allowed for fast and accurate simulation of any form of AWG.



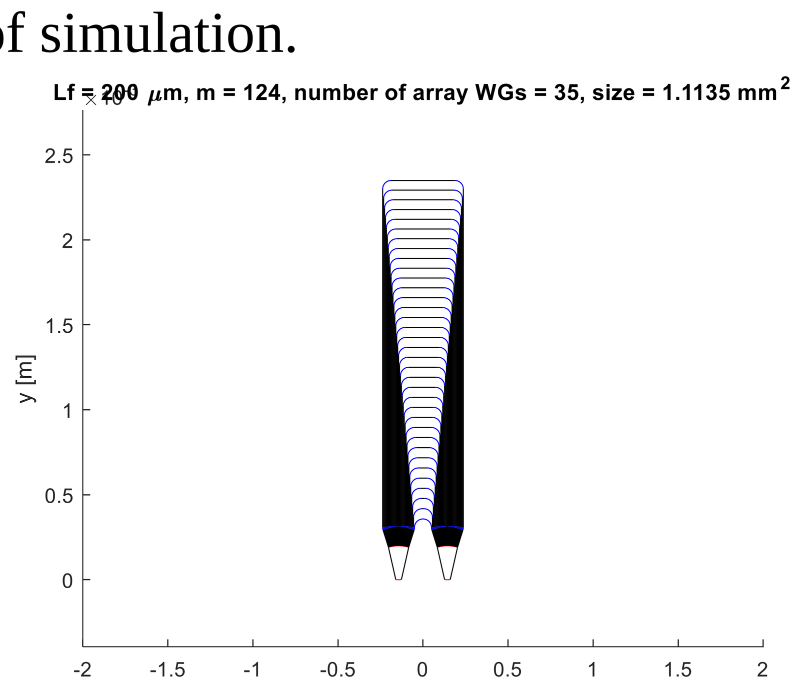
The model allows for direct design and simulation of an AWG based on the input of design parameters. The AWG output channels are placed precisely at the given channel separations, see simulation result on the left.

The model does not consider waveguide losses, scattering or other propagation imperfections. Coupling efficiency in the slab is estimated by an overlap integral of both modes.

The simulation results correspond to the characterization of the fabricated device. Only difference are the central wavelength, and losses, which is expected for the method of simulation.

The physical dimensions are checked for design rules and can be displayed for inspection.

AWG design with special mounting method presented by Jun Zou [1]. The outgoing slab coupler ports are now spaced on an equal distance on a line tangent to the grating circle. This greatly improves sidelobes.

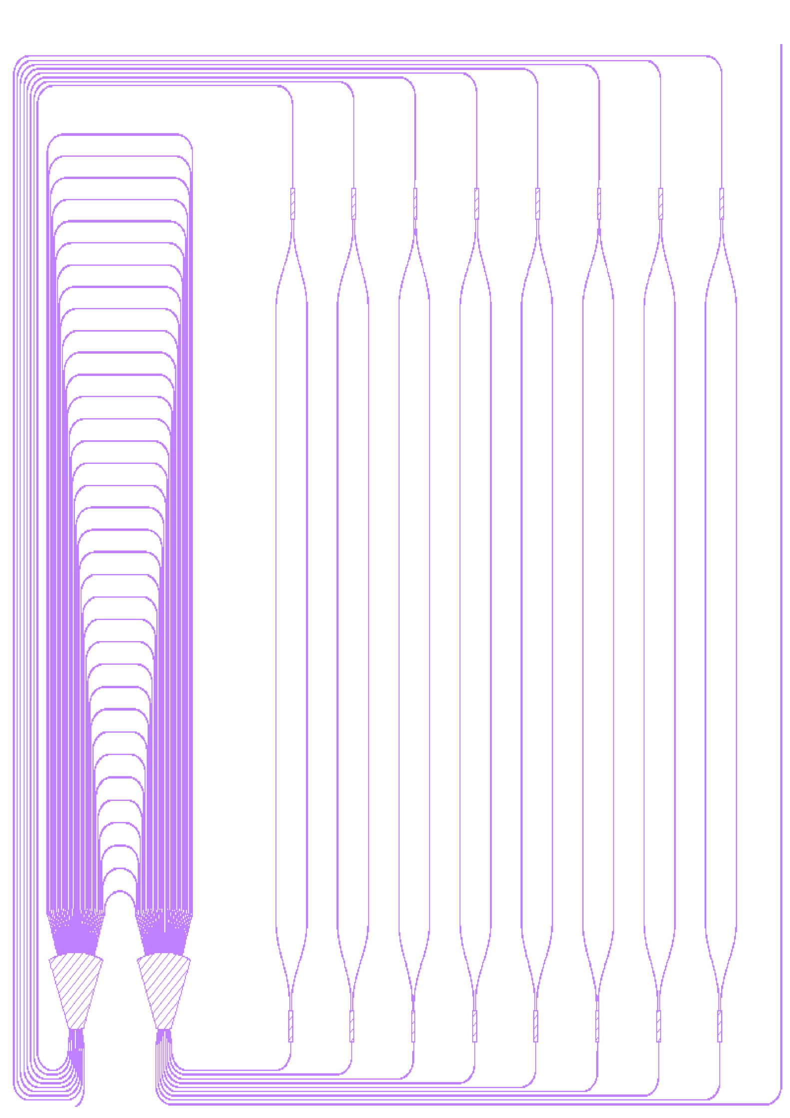


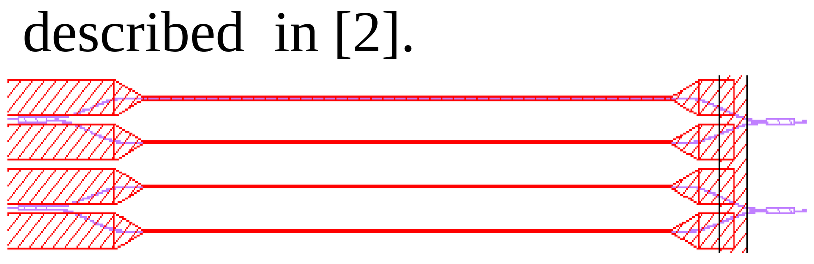
PROCESSOR LAYOUT

A loop-back configuration [3] has been chosen to avoid matching problems in case separate AWG are used for (de-)MUX.

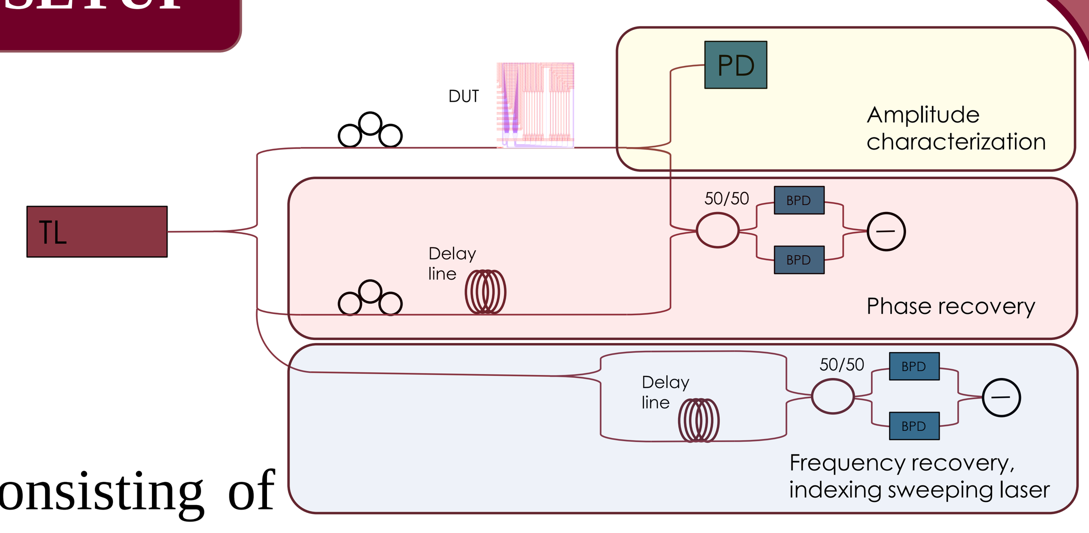
The loop is equipped with a series of MZIs. These have heaters (see figure below) on both arms to tune the phase and amplitude. The total device measures 2.4 by 2.7 mm. Spacing between the heaters is 100 µm.

The fabrication process is described in [2].

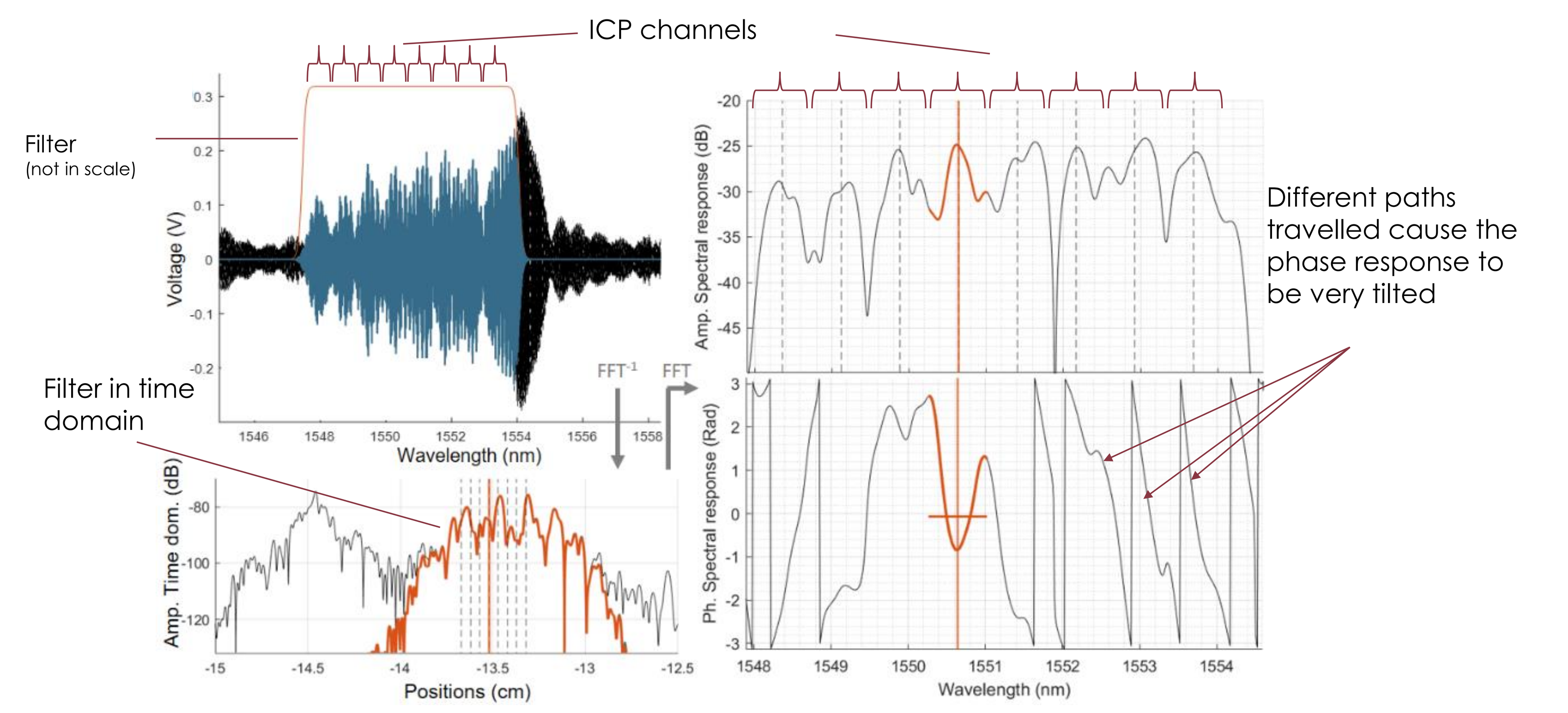


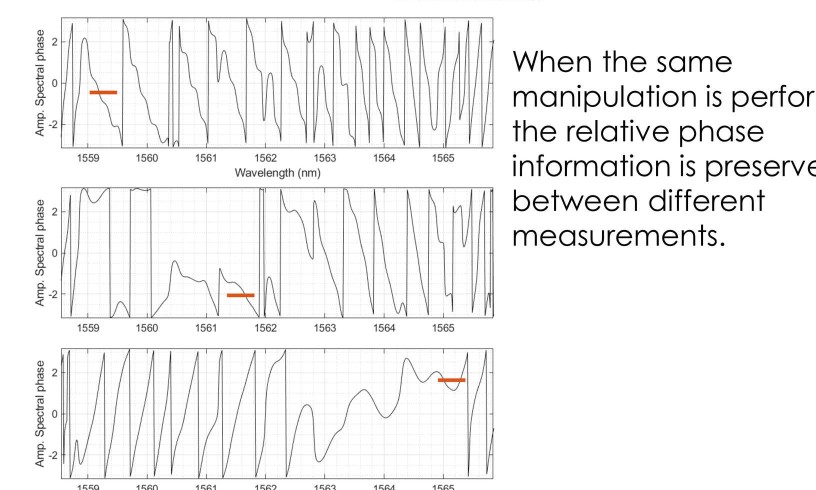


PHASE RECOVERY SETUP

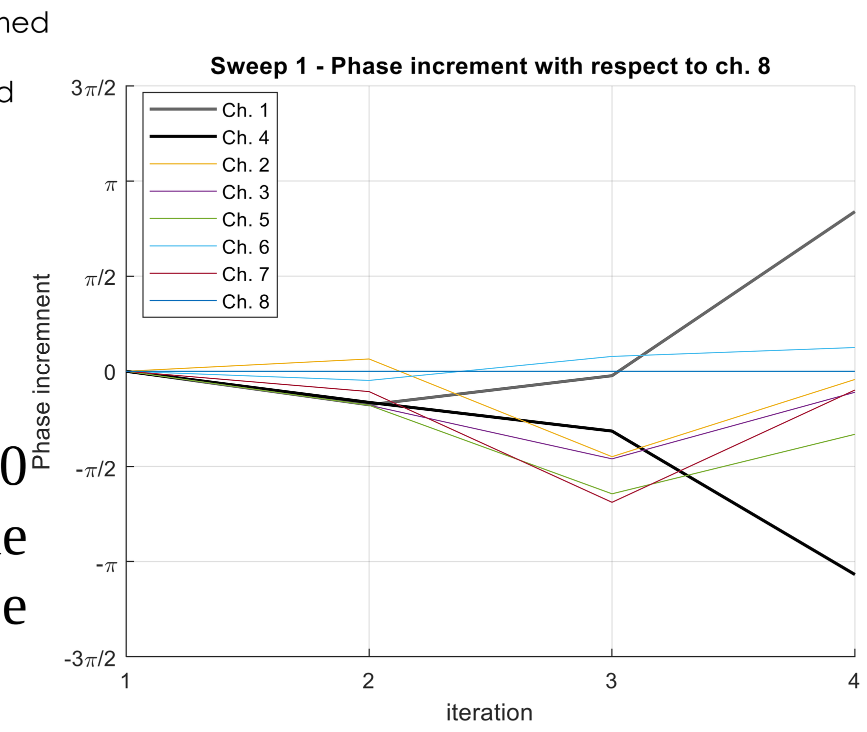


Using Frequency-comb-calibrated swept-wavelength interferometry, as deployed in [5], with adding an interferometer consisting of the device under test and a delay line, the phase response was recovered.



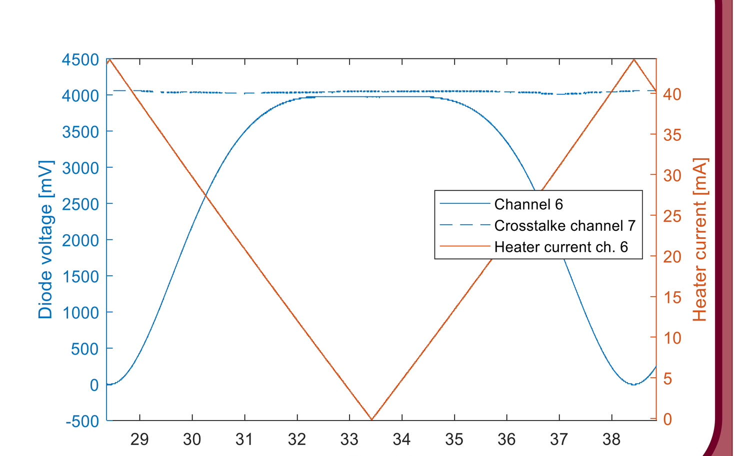


When applyig currents between 0 and 37 mA and performing the same manipulation on the data, a phase shift of 1π has been observerd.



AMPLITUDE MODULATION

The amplitude of each channel can be tuned gradually in a 22 dB range. The tested response times are below 35 µs and there is virtually no crosstalk in terms of amplitude modulation.



CONCLUSIONS

- A functional design of an 8-channel comb source processor is presented.
- The comb processor is constructed as a high resolution AWG loop-back design. The AWG is designed using a special mounting method presented by [4] and the experiments are in good agreement with the simulations.
- The channels can be independently modulated in amplitude, which can be suppressed by 22 dB. The amplitude can be controlled gradually.
- The device also allows for phase modulation, which has been tested, but without stabilizing the temperature of the device, which can lead to inconsistent results.
- A common Si3N4 thickness for broadband comb sources is 790nm, to overcome this difference in thickness the use of photonic interposers could be considered [1].

REFERENCES

[1] A. Rao, G. Moille, X Lu, Daron A. Westly, Davi de Sacchett, Michael Geiselmann, Michael Zervas, Scott B. Papp, John Bowers, and Kartik Srinivasan. Towards integrated photonic interposers for processing octavespanning microresonator frequency combs. Light Sci Appl 10 109 (2021).
[2] Xiaonan Hu, Marcello Girardi, Zhichao Ye, Pascual Muñoz, Anders Larsson, and Victor Torres-Company. Si3n4 photonic integration platform at 1 um for optical interconnects. Opt. Express, 28(9):13019–13031, Apr 2020.
[3] Xinyi Wang, Linjie Zhou, Liangjun Lu, Xingjun Wang, and Jianping Chen. Integrated optical delay line based on a loopback arrayed waveguide grating for radio-frequency filtering. IEEE Photonics Journal, PP:1–1, 04 2020.
[4] Jun Zou, Zichun Le, Jinhua Hu, and Jian-Jun He. Performance improvement for silicon-based arrayed waveguide grating router. Opt. Express, 25(9):9963–9973, May 2017.
[5]L.A. Bru, *Optical Frequency Domain Interferometry for the characterization and development of complex and tunable photonic integrated circuits*, PhD thesis, Universitat Politècnica de València, 2022.

This work was funded by the EU H2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement no. No 812818 (MICROCOMB)