First results on an electro-optic visible multi-telescope beam combiner for next generation FIRST/SUBARU instruments

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ABSTRACT

Integrated optic devices are nowadays achieving extremely high performances in the field of astronomical interferometry, as shown by the PIONIER and GRAVITY instruments. Progress remains to be made in order to increase the number of apertures/beams/channels to be combined (up to 9) and eventually ensure on-chip phase modulation (for fringe temporal scanning). We present a novel generation of beam combiners, based on the hybridization of two integrated optic devices: (i) one producing glass waveguides, that can ensure very sharp bend radius, high confinement and low propagation losses, with (ii) a lithium niobate device providing phase modulators and channel waveguides that can achieve on-chip, fast (>100kHz) phase modulation. The aim of this work is to show our results on a hybrid device where splitting and phase modulation are achieved in the lithium niobate chip, coupled to a glass passive chip where all recombinations are done, to obtain interference fringes between the different inputs (i.e. telescopes or sub-apertures).

Keywords: integrated optics, visible interferometry, electro-optic modulation, Lithium Niobate, glass waveguides, Subaru Telescope, FIRST Instrument.

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1. INTRODUCTION

Integrated optic devices are nowadays achieving extremely high performances in the field of astronomical interferometry, as shown by the PIONIER [1] and GRAVITY [2] silica/silicon-based instruments, already installed at VLTI. Progress remains to be made in order to address other wavelengths (e.g. visible range), increase the number of apertures/beams/channels to be combined (up to 9) and eventually ensure on-chip phase modulation (for fringe temporal scanning). For that purpose, we have been working on a novel generation of beam combiners, based on the hybridization of two integrated optic devices: (i) one producing glass waveguides, that can ensure very sharp bend radius, high confinement and low propagation losses, with (ii) a lithium niobate device providing phase modulators and channel waveguides that can achieve on-chip, fast (>100kHz) phase modulation.

In this presentation we will report on our results for the transmission and modulation obtained with a beam combiner that has been developed in the context of FIRST/SUBARU 9T [3]. The prototype is based on a configuration where the phase modulation is obtained in a first-stage electro-optical modulator [4] prior to injection into the passive glass, where all the beams are recombined.

2. HYBRID BEAM COMBINER

This concept can be addressed by using an electro-optical waveguide [2]. We therefore studied a preliminary concept, where global phase modulation after splitting the input (each of the 9 inputs, split into 8), and subsequently phase modulated:

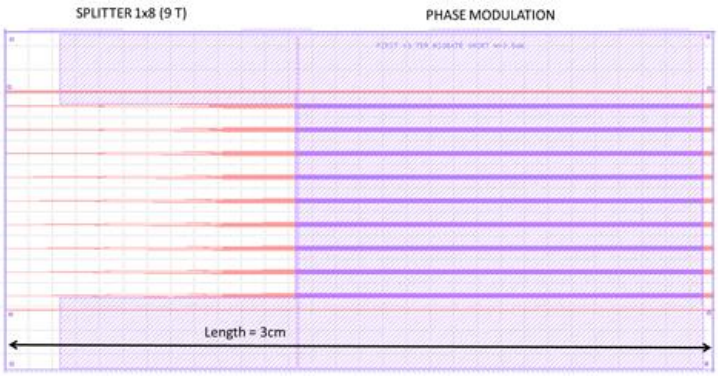

Fig. 1: Layout of the all electro-optical beam combiner. On the left, splitting each of the 9 inputs, followed by push-pull phase modulation (only a GND-Vapp signal is needed to control simultaneously all the phases).

The second stage is the passive beam combination:

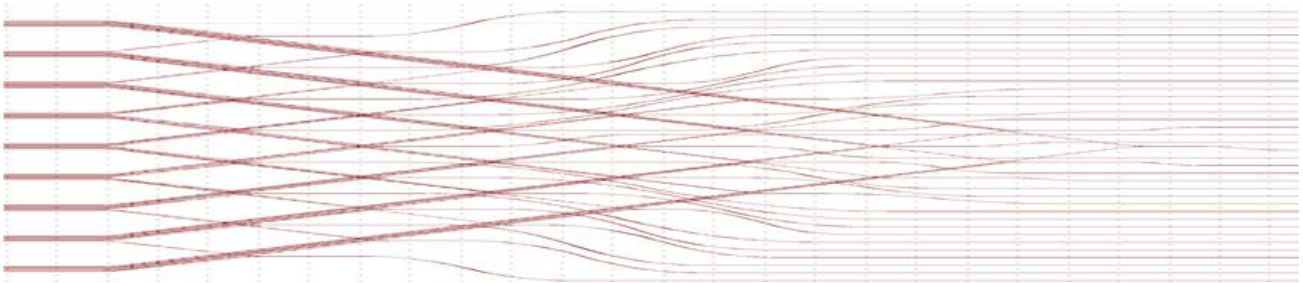

Fig. 2: Layout of the beam combination, achieved in a passive glass. On the left, the splitted 9 inputs, that will receive the phase modulated signal of stage 1 (Fig. 1), and recombine by pairs to obtain a final output of 36 signals.

The preliminary results on mode adaptation, transmission on each stage and global transmission of the hybrid device (after assembling the active and passive part) will be presented. Discussion on the efficiency of phase modulation and eventual crosstalk will be also presented. Some alternatives on reduced number of inputs (5 instead of 9) and other concepts (3D Laser Written beam combiners, in order to avoid in-plane crossings) will be discussed.

3. CONCLUSION & PERSPECTIVES

We have conceived, realized and characterized a hybrid 9T beam combiners allowing to simultaneously obtain the interference fringes of nine sub-apertures for future integration in the SUBARU/FIRST instrument. A hybrid device is for the moment the most promising instrument, that is currently being tested in the FIRST/SUBARU simulator at LESIA.

4. ACKNOWLEDGMENTS

Authors acknowledge the funding from ASHRA (Action Specifique Haute Resolution Angulaire) from INSU-CNRS, AGIR PEPS and ERC LITHIUM for funding the technological developments and realizations.

5. REFERENCES

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