

# Coherent Beam Combining as a Multidisciplinary Education and Training Environment

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**Abstract:** We will show that investigation of coherent beam combining provide good multidisciplinary education and training environment for graduate students. Knowledge including optics and photonics, electronics engineering, computer science, and so on, can be learned and mastered. © 2021 The Author(s)

## 1. Introduction

Coherent beam combining of lasers is one of the research frontiers in optics and photonics [1], which is achieved based on the fundamental physical mechanism: interference among multiple diffracted coherent beams. Effectively control the multi-parameters of each laser beam, such as the optical phase, polarization, tip/tilt, intensity, optical path, and temporal shape (for pulsed beam) is the key factor for a coherently combined system [2]. Our research group have been teaching and investigating “Coherent Beam Combining” for years, and plenty of graduate student have learned or investigated this topic. It is found that coherent beam combining has proofed to be an excellent environment for multidisciplinary education and training. In this paper, by taking optical phase control as an example, we will show that the multidisciplinary knowledge could be taught to and mastered by the graduate students, which not only broaden the knowledge base for the students, but also bring good scientific research achievements.

## 2. Multidisciplinary knowledge delivered

### 2.1. Optics and Photonics

The fundamental disciplinary for a coherently combined laser system is optics and photonics, which involves the knowledge from classical courses such as laser principles, laser technology and physical optics. In addition, in order to optimize the performance, the knowledge from mechanical engineering [3] and atmosphere physics [4] are encouraged to be mastered, and thus the comprehension of the results of coherent beam combining for practical use can be enhanced simultaneously.

### 2.2. Electronics Engineering

The realization of phase control of laser beams is highly dependent on the knowledge and skills of Electronics Engineering. Without loss of generality, the phase controller can be developed based a field-programmable gate array (FPGA) OR digital signal processor (DSP) that calculate the control voltages of each laser channel on the basis of optical signal acquired by the photoelectric detector [5]. The control strategy can also be referenced from the concept of time division multiple access (TDMA) and code division multiple access, and so on [6].

### 2.3. Computer Science

With the rapid development of machine learning and wide application, it is straightforward to rise the proposal that whether machine learning can be employed for the phase control. By encouraging the graduate students to study the related knowledge and test the application potential in phase control, it is found that phase control can be achieved based on convolutional neural network (CNN) can work effectively, which provide a new solution that can generate the phase control signal rapidly without loss of precision [7,8]. Graduate students can also be well trained to master the fundamentals of machine learning.

### 2.4. Cutting-edge frontiers

Graduate students focus on coherent beam combining also have the opportunity to engage in the cutting-edge frontiers. For example, the generation, manipulation and application of orbital angular momentum (OAM) beams is one of the cutting-edge frontiers. Because of the potential enabled by multi-parameters controlling of a laser beam

Sixteenth Conference on Education and Training in Optics and Photonics: ETOP 2021,

edited by A. Danner, A. Poulin-Girard, N. Wong, Proc. of SPIE Vol. 12297, 122971D

© 2022 SPIE · 0277-786X · doi: 10.1117/12.2635550

array, it has been proved that high power OAM beam can be generated and tailored flexibly based on coherent beam combining [9,10], which significantly broaden the sight of the graduate students.

### 3. Summary and Prospect

It can be seen that graduate students involved in coherent beam combining have opportunity to experience a multidisciplinary education and training environment, by systematically read the related literatures and deeply participating the projects, they could learn and master multidisciplinary knowledge including optics and photonics, atmosphere physics, mechanical engineering, electronics engineering, computer science, and so on, at the same time, the cutting-edge frontiers can also be investigated thought the viewpoint of an laser beam array.

In the future, short course focus on coherent beam combining is to be designed, which will instruct the scientific insight of the system and technical skills for practical design. It is believed that more and more graduate students can benefit from this multidisciplinary education and training environment, and can accelerate the research and development of the related field ultimately.

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