Claims:

1. A correction optical element (COE) for a multi-channeled specific coherent beam combining (CBC) system , wherein the CBC system uses a fiber array comprising multiple optical fibers and a single collimation array comprising multiple collimating lenses each configured for collimation of an incoming optical beam outputted from each of the optical fibers, for coherent combining of a corresponding array of optical beams directed through the fiber array,

   wherein each pair of: a collimating lens of the collimation array and a corresponding optical fiber of the fiber array, defines a channel (ij), wherein the COE comprises at least:

   an array of correction segments, each correction segment (CSij) in the array of correction segments of the COE is customized in location and configuration to correct one or more optical aberrations of a corresponding output optical beam (Bij) outputted from each corresponding collimation lens (Lij) and a corresponding optical fiber (Fij),

   wherein the COE is configured for customized and segmented correction of optical aberrations, caused at least due to misalignment between each corresponding optical fiber's (Fij) output end and a center of a corresponding collimating lens (Lij),

   wherein the COE is configured for improving far field performances of the CBC system, wherein each correction segment (CSij) is designed by measuring wavefront of a respective output optical beam (Bij), emanating from a respective optical fiber (Fij) of the fiber array outputted from a respective collimator (Cij) of the collimation array, and

   generating a three-dimensional (3D) model of the correction segment (CSij) of the respective channel (ij), wherein the 3D model of the correction segment (CSij) is a 3D mirror image of the measured wavefront of the output optical beam (Bij) of the channel (ij), and

   wherein the correction segment (CSij) is configured as a diffractive element.

2. The COE of claim 1, wherein the COE is configured to segmentally correct, for each output optical beam (Bij), any one or more optical aberrations of: pointing errors

focusing/collimation errors; wavefront aberrations; high-order three dimensional aberrations, spatial distribution errors; comatic aberrations; field curvature aberrations, cylinder aberrations; smile errors, manufacturing errors, errors in spaces between collimating lenses in the collimation array.

3. The COE of any one or more of claims 1 to 2, wherein the COE is made of a monolithic piece being customized to have each correction segment (CSij) thereof differently custom shaped to correct one or more aberrations of the corresponding output optical beam (Bij) of the respective channel (ij).

4. The COE of any one or more of claims 1 to 3, being further designed for a CBC system in which each optical fiber connects to an input surface of a corresponding part of an endcapping element.

5. The COE of any one or more of claims 1 to 4, wherein the COE is integrally connected or configured over an output surface of the collimation array.

6. The COE of any one or more of claims 1 to 5, wherein the COE is integrally or non-integrally connected to an input surface of the collimation array, wherein bulges of lenses of the collimation array form the output surface of the COE and custom-shaped correction segments are located over an input surface of the COE, facing an output surface of the endcapping element.

7. The COE of any one or more of claims 1 to 6, wherein the COE is embedded in the collimation array and an endcapping element of the CBC system, forming a single monolithic coherent beam combination, endcapping and correction element by having an output surface of the endcapping element integrally connected to an input surface of the collimation array and an output surface of the collimation array having a correcting 3D design embossed or debossed thereover for performing combined customized and segmented collimation and aberration correction of each optical beam.

8. A method for fabricating a correction optical element (COE) for a specific multi-channel coherent beam combining (CBC) system having an array of channels, using a fiber array, which is an array of optical fibers, and a collimation array comprising multiple collimating lenses each collimating lens being configured for collimation of an incoming optical beam, for coherent combining of an array of input optical beams outputted by an endcapping element, the method comprising:

(a) each channel (ij) of the CBC system

- measuring wavefront of a respective output optical beam (Bij) , emanating from a respective optical fiber (Fij) of the fiber (Fij) array and outputted from a respective collimator (Cij) of the collimation array ;
- generating a three-dimensional (3D) model of the correction segment (CSij) of the respective channel (ij), wherein 3D model of the correction segment (CSij) is a 3D mirror image of the measured wavefront of the output optical beam (Bij) of the corresponding channel (ij);

(b) fabricating a COE having an array of correction segments, by configuring each segment of the COE according to its respective generated 3D model ;

(c) placing the COE at a determined positioning for optimal aberrations correction such that each correction segment (CSij) of the COE is positioned in a desired positioning in respect to its corresponding output optical beam (Bij); and

(d) using the COE to simultaneously correct optical aberrations of at least some of the output optical beams of the CBC system;

wherein the COE is configured for customized and segmented correction of optical aberrations, caused due to misalignments between a respective optical fiber's output end and a center of a corresponding collimating lenslet (Lij) of the collimation array of the specific CBC system,

wherein the COE is configured for improving far field performances of the CBC system, and

wherein each correction segment (CSij) is configured as a diffractive element.

9. The method of claim 8, wherein the COE is configured to segmentally correct one or more optical aberrations, for each output optical beam (Bij), of: pointing errors; focusing/collimation errors; wavefront aberrations; high-order three dimensional aberrations, spatial distribution errors; comatic aberrations; field curvature aberrations, cylinder aberrations; smile errors, manufacturing errors, errors in spaces between collimating lenses in the collimation array.

10. The method of any one or more of claim 8 to 9, wherein each output optical beams (Bij), measured for determination of its respective one or more aberrations is directed from a respective optical fiber (Fij), through the endcapping element towards a correction input surface of the COE, wherein the collimation array is formed as an output surface of the COE.

11. The method of any one or more of claims 8 to 10, further comprising directing light emanating from a single light source to the fiber array, using one or more optical splitting elements.

12. The method of any one or more of claims 8 to 11, each wavefront of the output optical beam (Bij) for of each channel (ij) is measured by using one or more optical detectors and the 3D model is determined by using a processing and control unit, configured to receive and analyze output data outputted by the one or more optical detectors.

13. The method of claim 12, wherein the one or more optical detectors comprise one or more of: a camera, a charged coupled device (CCD), an array of photodiodes or photo detectors, MxN photo detectors each coupled to a different focusing lens or lenslet for separately measuring optical characteristics including the one or more optical aberrations for each channel (ij).

14. The method of any one or more of claims 8 to 13, wherein the COE is configured to be essentially positioned in parallel to the collimation array.

15. A system for coherent beam combining (CBC) comprising at least:

- at least one light source for irradiating light in a narrow wavelength band;

- a fiber array, which is an array of optical fibers configured to guide light emanating from the at least one light source forming an array of input optical beams;

- a collimation array, which is an array of collimating lenses, each collimating lens being configured only for collimation of an incoming optical beam; and

- a correction optical element (COE) that is customized for segmented correction of optical aberrations of the specific CBC system, the COE comprising an array of correction segments, wherein each correction segment (CSij) is designed by:

measuring wavefront of a respective output optical beam (Bij), emanating from a respective optical fiber (Fij) of the fiber array and outputted from a respective collimator (Cij) of the collimation array; and

generating a three-dimensional (3D) model of the correction segment (CSij) of the respective channel (ij), wherein the 3D model of the correction segment (CSij) is a 3D mirror image of the measured wavefront of the beam (Bij) of the channel (ij),

wherein the correction segment (CSij) is configured as a diffractive element, and

wherein the COE is configured for customized and segmented correction of optical aberrations, caused at least due to misalignments between a respective optical fiber's output end and a center of a corresponding collimating lens (Lij) of the collimation array of the specific CBC system,

wherein the COE is configured for improving far field performances of the CBC system.

16. The CBC system of claim 15 further comprising:

one or more optical detectors located and configured to detect optical characteristics of a coherently combined output beam that has been combined by the collimation array and corrected by the COE;

a processing and control subsystem (PCS), configured to receive output data from the one or more optical detectors and analyze the received output data to measure one or more CBC system performances characteristics of the CBC system.

17. The CBC system of claim 16 further comprising a synchronization module for synchronizing phase and/or polarization of each channel (ij) such that all phases and/or polarizations of all channels are synchronized, the synchronization module comprising a phase synchronization module configured for phase synchronization and/or a polarization synchronization module for polarization synchronization.

18. The CBC system of any one or more of claims 15 to 17, wherein each wavefront of each output optical beam (Bij) for each channel (ij) is measured by using the one or more optical detectors.

19. The COE of claims 1 to 7, wherein each wavefront of the output optical beam (Bij) for each channel (ij) is measured by using one or more optical detectors.