coherence length. In some embodiments, the wavelength of the reference beam (also referred to herein as the "reference wavelength") is in a range from 1070 nm (or thereabout) to 1150 nm (or thereabout) (e.g., 1100 nm). The beam splitter in the PIC 304 is provided as a dual-wavelength beam splitter, and needs to be engineered to not only evenly split the main beam at the main wavelength, but to also simultaneously split the reference beam (i.e., thereby producing a plurality of "split reference signals") at the reference wavelength. Correspondingly, all subsequent components, like the phase modulator array 204 and any subsequent beam guiding and shaping optics (e.g., the 3D waveguide 206) also need to be compatible with the wavelengths of both the main beam and the reference beam. In this case, the 3D waveguide 206 is configured to spatially-rearrange the split reference signals output from the phase modulators of the phase modulator array 204 into the pattern such that the split reference signals are coherently combinable into a combined reference signal.

The modifications discussed above to accommodate beams of laser energy at the main wavelength and at the reference wavelength preclude the use of large-mode photonic crystal fibers, which have only a fairly narrow wavelength range in which the guided mode is stable and close to single mode (1100 nm is well outside that range). However, due to the coherent addition of a large number of modes – either in separate cores or in a multimode fiber (or in a solid state amplifier) – the use of smaller mode field diameters is not a concern.

Another issue that arises from the modifications discussed above is that driving the phase differences between the different channels down to zero at the reference wavelength does not at all imply that the phase differences between the different channels can simultaneously be driven down to zero for the main wavelength. Hence, an additional phase calibration is needed. This is shown in FIG. 3, where an additional beam pickoff 308 collects a sample of the amplified main beam which is then focused (e.g., via lens 310) onto an aperture 312 with a photodetector 314 (e.g., a photodiode) behind it. A classic (slow) SPGD algorithm can be used to work out the phase relationships at the main wavelength once during calibration, where the LOCSET electronics can detect the corresponding phase relationships at the reference wavelength and stabilize any phase drifts during the calibration step, so that even very large numbers of channels can be optimized. Subsequently, every 'phase wrap' (i.e. a phase drift larger than 2 pi corresponding to the reference wavelength) can be counted and kept track of such that the overall phase relationship at the main wavelength can be controlled, even if differential path length drifts of the individual channels accumulates to many microns. For example, a differential drift of 20 μm would be measured as 18 'wraps' and a 0.36 pi phase drift (18x2 pi + 0.36 pi = 36.36 pi = 2 pi *20 μm/1100nm) at 1100 nm, but is readily translated into 19 'wraps' and a 0.83 pi phase drift at 1030 nm. Hence, the control electronics 108 can compensate for a 0.83 pi phase shift at 1030

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CLAIMS

1. A system, comprising:

a multi-channel beam splitter arranged and configured to split an input first optical signal into a plurality of split first optical signals;

a plurality of phase modulators, wherein each phase modulator of the plurality of phase modulators is operative to modify a phase of a corresponding split first optical signal of the plurality of split first optical signals in response to a control signal;

a waveguide arranged at an optical output of the plurality of phase modulators, the waveguide configured to spatially-rearrange the split first optical signals output from the plurality of phase modulators into a pattern; and

an optical amplifier arranged at an optical output of the waveguide, the optical amplifier configured to amplify the spatially-rearranged split first optical signals output by the waveguide, thereby producing a combined first optical signal.

2. The system of claim 1, further comprising:

a beam splitter arranged at an optical output of the optical amplifier, the beam splitter configured to transmit a first portion of the combined first optical signal output by the optical amplifier and reflect a second portion of the combined first optical signal output by the optical amplifier; and

a first photodetector arranged to receive the second portion of the combined first optical signal and output a corresponding first detection signal.

3. The system of claim 2, further comprising control circuitry communicatively coupled to an output of the first photodetector and to an input of each of the plurality of phase modulators, wherein the control circuitry is configured to generate and output the control signal.

4. The system of claim 1, wherein the plurality of phase modulators and the waveguide are located within a common photonic integrated circuit.

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5. The system of claim 1, further comprising a seed laser arranged and configured to generate the first optical signal.

6. The system of claim 1, wherein the first optical signal has a first wavelength in a range from 1000 nm to 1150 mm.

7. The system of claim 6, wherein the first wavelength is in a range from 1000 nm to 1060 nm.

8. The system of claim 7, wherein the first wavelength is 1030 nm.

9. The system of claim 1, wherein the number of phase modulators in the plurality of phase modulators is greater than 100.

10. The system of claim 9, wherein the number of phase modulators in the plurality of phase modulators is greater than 200.

11. The system of claim 10, wherein the number of phase modulators in the plurality of phase modulators is greater than 500.

12. The system of claim 11, wherein the number of phase modulators in the plurality of phase modulators is greater than 1000.

13. The system of claim 3, further comprising an amplitude modulator operative to modulate an amplitude of the input first optical signal in response to a control signal, wherein the multi-channel beam splitter is arranged at an optical output of the amplitude modulator.

14. The system of claim 13, wherein the amplitude modulator and the multi-channel beam splitter are located within a common photonic integrated circuit.

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15. The system of claim 13, wherein the control circuitry is configured to output a control signal to each of the plurality of phase modulators to effect, in combination with the configuration of the pattern of the waveguide, phased-array beam steering at the optical output of the waveguide.

16. The system of claim 15, wherein the control circuitry is configured to output a control signal to the amplitude modulator based on the magnitude of the phased-array beam steering effected, at least partially, by plurality of phase modulators.

17. The system of claim 3, wherein the control circuitry is configured to output a control signal to the plurality of phase modulators based, at least in part on the first detection signal, to stabilize the phases of the split first optical signals output from the optical amplifier.

18. The system of claim 3, further comprising a reference laser configured to generate a second optical signal.

19. The system of claim 18, wherein the second optical signal has a second wavelength that is different from a wavelength of the first optical signal.

20. The system of claim 19, wherein the second wavelength is in a range from 1070 nm to 1150 mm.

21. The system of claim 20, wherein the second wavelength is 1100 nm.

22. The system of claim 18, wherein the multi-channel beam splitter is arranged and configured to split the second optical signal into a plurality of split second optical signals.

23. The system of claim 22, wherein each phase modulator of the plurality of phase modulators is operative to modify a phase of a corresponding split second optical signal of the plurality of split second optical signals in response to the control signal.

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24. The system of claim 23, wherein the waveguide is configured to spatially-rearrange the split second optical signals output from the plurality of phase modulators into the pattern such that the split second optical signals are coherently combinable into a combined second optical signal.

25. The system of claim 24, further comprising a dichroic mirror arranged between beam splitter and the optical output of the optical amplifier, the dichroic mirror configured to reflect the combined second optical signal transmit the combined first optical signal.

26. The system of claim 25, further comprising a second photodetector arranged to receive the combined second optical signal reflected by the dichroic mirror and output a corresponding second detection signal.

27. The system of claim 26, wherein the control circuitry is configured to output the control signal to the plurality of phase modulators based, at least in part on the second detection signal, to stabilize the phases of the split second optical signals output from the plurality of phase modulators.

28. The system of claim 2, further comprising a harmonic conversion module arranged to receive the first portion of the combined first optical signal, the harmonic conversion module configured to modify the wavelength of the first portion of the combined first optical signal.

29. The system of claim 2, further comprising a beam positioning system arranged to receive the first portion of the combined first optical signal and configured to deflect the first portion of the combined first optical signal.

30. The system of claim 29, wherein the beam positioning system includes at least one selected from the group consisting of an acousto-optic deflector, an electro-optic deflector, a galvanometer mirror scanner and a rotating polygon scanner.

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31. A system, comprising:

a first beam positioning system operative to deflect a laser beam having a first wavelength;

a second beam positioning system disposed within a beam path along which the laser beam is propagatable after deflection by the first beam positioning system; and

a harmonic conversion module disposed within ~~a~~ the beam path between the first beam positioning system and the second beam positioning system,

wherein the harmonic conversion module is operative to convert the first wavelength of the laser beam to a second wavelength.

32. The system of claim 31, wherein the beam positioning system includes a phased-array beam positioning system.

33. The system of claim 31, wherein the beam positioning system includes an acousto-optic deflector.

34. The system of claim 33, wherein acousto-optic deflector is a shear-wave TeO_2 acousto-optic deflector.

35. The system of claim 33, wherein acousto-optic deflector is a quartz acousto-optic deflector.

36. The system of claim 31, wherein the beam positioning system includes an electro-optic deflector.

37. The system of claim 31, wherein the first wavelength is in the infra-red range of the electromagnetic spectrum.

38. The system of claim 31, wherein the second wavelength is in the visible range of the electromagnetic spectrum.

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39. The system of claim 38, wherein the second wavelength is in the green-visible range of the electromagnetic spectrum.

40. The system of claim 31, wherein the second wavelength is in the ultra-violet range of the electromagnetic spectrum.

41. The system of claim 1, wherein each of the plurality of phase modulators is additionally operative to modify an amplitude of a corresponding split first optical signal of the plurality of split first optical signals in response to a control signal.

42. The system of claim 28, further comprising a lens arranged between the optical amplifier and the harmonic conversion module, wherein the lens is configured to collimate light in the first portion of the first optical signal received at the harmonic conversion module.

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