CLAIMS

1. A method comprising:

receiving a beam at an optical splitter in a photonic integrated circuit;

splitting the beam into a first beam and a second beam using the optical splitter;

amplifying the first beam and the second beam using a pair of semiconductor optical amplifiers in the photonic integrated circuit to result in an amplified first beam and an amplified second beam;

phase shifting the amplified first beam using a phase shifter in the photonic integrated circuit;

combining the amplified first beam and the amplified second beam using an optical combiner to form a combined beam;

detecting an optical coherence of the combined beam using a photodetector that measures a current of the combined beam;

aligning, using control circuitry, phases of the first beam and the second beam by adjusting the phase shifting of the first beam using the phase shifter, the phase shifter being adjusted by the control circuitry based on a current generated by the photodetector from detecting the combined beam, the aligning causing optically coherent combined light to be output from the optical combiner that combines the first beam and the second beam; and

propagating the optically coherent combined light on an output waveguide integrated in the photonic integrated circuit.

2. The method of claim 1, further comprising:

identifying, by the control circuitry, the current from the photodetector.

3. The method of claim 2, further comprising:

maximizing, by the control circuitry, a level of the current from the photodetector by controlling the phase shifter to phase shift the amplified first beam to maximize the current generated from the photodetector to increase optical coherence between the amplified first beam and the amplified second beam upon being combined in the optical combiner.

4. The method of claim 3, wherein the optical combiner comprises a coupler comprising a first output port and a second output port, wherein the photodetector is coupled to the first output port and the second output port is coupled to the output waveguide.

5. The method of claim 4, further comprising:

minimizing, by the control circuitry, a level of current from the photodetector by controlling the phase shifter to phase shift the amplified first beam to minimize the current generated from the photodetector, wherein minimizing the current from the photodetector increases optical coherence and optical power of light at the second output port.

6. The method of claim 1, wherein the pair of semiconductor optical amplifiers is a first pair of semiconductor optical amplifiers and the photonic integrated circuit comprises a plurality of pairs of semiconductor optical amplifiers that are coherently combined using the optical combiner, the photodetector, and the control circuitry.

7. The method of claim 6, wherein the first pair of semiconductor optical amplifiers comprises a first optical amplifier and a second optical amplifier, and the plurality of pairs of semiconductor optical amplifiers comprises a second pair of semiconductor optical amplifiers, the second pair comprising a third optical amplifier and a fourth optical amplifier.

8. The method of claim 7, wherein the pairs of semiconductor optical amplifiers are coherently combined sequentially by pairs to form the optically coherent combined light.

9. The method of claim 8, wherein the first pair of semiconductor optical amplifiers are coherently combined by maximizing the current from the photodetector by phase shifting light from the first pair, while light in the second pair of semiconductor optical amplifiers is not adjusted and is decoherently combined, at the optical combiner, with the coherently combined light of the first pair.

10. The method of claim 9, wherein the second pair of semiconductor optical amplifiers is coherently combined after the light from the first pair of semiconductor optical amplifiers is coherently combined.

11. The method of claim 9, wherein light from the second pair of semiconductor optical amplifiers is coherently combined by maximizing the current from the photodetector by phase shifting light from the second pair, the phase shifting of the light from the second pair implemented by another phase shifter integrated in the photonic integrated circuit.

12. The method of claim 10, wherein additional pairs of semiconductor optical amplifiers are integrated in the photonic integrated circuit to generate higher power coherent outputs, wherein all light from each additional pair is split using the optical splitter and is optically amplified and coherently combined based on a current value of the photodetector that indicates all light coherence in the photonic integrated circuit.

13. The method of claim 1, wherein the photodetector comprises a monitor photodiode.

14. The method of claim 1, wherein the phase shifter comprises a heater that heats an integrated waveguide that guides the amplified first beam in the photonic integrated circuit.

15. The method of claim 1, wherein the photonic integrated circuit comprises a Mach-Zehnder Interferometer (MZI) modulator including a first optical modulator to modulate the first beam and a second optical modulator to modulate the second beam.

16. A photonic integrated circuit comprising:

an optical beam splitter to receive and split a beam of light into a first beam and a second beam;

a pair of semiconductor optical amplifiers to amplify the first beam and the second beam, resulting in an amplified first beam and an amplified second beam;

a phase shifter to phase shift the amplified first beam;

an optical combiner to combine the amplified first beam and the amplified second beam to form a combined beam;

a photodetector to measure current of the combined beam;

control circuitry configured to align the phases of the first beam and the second beam by adjusting the phase shifting of the first beam using the phase shifter, the phase shifter being adjusted by the control circuitry based on a current generated by the photodetector from detecting the combined beam, the aligning causing optically coherent combined light to be output from the optical combiner that combines the first beam and the second beam; and

an output waveguide to propagate the optically coherent combined light.

17. The photonic integrated circuit of claim 16, wherein the photonic integrated circuit comprises a Mach-Zehnder Interferometer (MZI) modulator including a first optical modulator to modulate the first beam and a second optical modulator to modulate the second beam.

18. The photonic integrated circuit of claim 16, wherein the control circuitry is further configured to maximize a level of the current from the photodetector by controlling the phase shifter to phase shift the amplified first beam to maximize the current generated from the photodetector to increase optical coherence between the amplified first beam and the amplified second beam upon being combined in the optical combiner.

19. The photonic integrated circuit of claim 16, wherein the optical combiner comprises a coupler comprising a first output port and a second output port, wherein the photodetector is coupled to the first output port and the second output port is coupled to the output waveguide.

20. The photonic integrated circuit of claim 16, wherein one or more of the first beam or the second beam are coupled from one or more silicon waveguides in the photonic integrated circuit to one or more silicon nitride waveguides, the one or more silicon waveguides coupling light for the semiconductor optical amplifier and the phase shifter, the one or more silicon nitride waveguides implemented to propagate the combined light.