CLAIMS

1. A method of acousto-optic imaging comprising:

receiving a first signal from a first sub-aperture of a sensor array, wherein the first sub aperture comprises one or more array elements of a first type;

receiving a second signal from a second sub-aperture of the sensor array, wherein the second sub-aperture comprises one or more array elements of a second type different from the first type, wherein the second type is an optical sensor; and

combining the first signal and the second signal to form a synthesized aperture for the sensor array.

2. The method of claim 1, further comprising:

phase matching the first signal and the second signal.

3. The method of claim 2, wherein phase matching the first signal and the second signal comprising applying a first delay to the first signal or a second delay to the second signal, the first delay and the second delay being determined based at least in part on a difference between a first propagation time from the one or more array elements of a first type to a medium being imaged and a second propagation time from the one or more array elements of a second type to the medium.

4. The method of claim 3, wherein the first delay or the second delay is determined based at least in part on a thickness and acoustic velocity of an acoustic lens, a thickness and acoustic velocity of an acoustic matching layer, a transmit and/or receive foci, or a thickness and acoustic velocity of each of an acoustic lens and an acoustic matching layer.

5. The method of claim 1, further comprising:

filtering the first signal to reduce noise in the first signal and filtering the second signal to reduce noise in the second signal.

6. The method of claim 1, further comprising:

amplifying the first signal or the second signal by an amplification gain to amplitude match the first signal and the second signal.

7. The method of claim 1, wherein the first signal is a combination of signals originating from a plurality of array elements of the first type or the second signal is a combination of signals originating from a plurality of array elements of the second type, or both.

8. The method of claim 7, further comprising one or more of the following, before phase matching the first signal and the second signal:

generating the first signal by combining signals originating from a plurality of array elements of the first type, or a plurality of array elements of the first type and the second type; and

generating the second signal by combining signals originating from a plurality of array elements of the second type, or a plurality of array elements of the first type and the second type.

9. The method of claim 8, further comprising forming a larger effective array element from a plurality of array elements of the first type, the second type, or both the first and second types.

10. The method of claim 8, further comprising reducing the effective dimensionality of the synthesized aperture.

11. The method of claim 1, further comprising:

frequency matching the first signal and the second signal; and/or

amplitude matching the first signal and the second signal; and/or

phase matching the first signal and the second signal.

12. The method of claim 1, wherein the combination of the first signal and the second signal is a coherent combination.

13. The method of claim 1, further comprising:

selecting the first sub-aperture for transmitting acoustic signals; and

selecting the first sub-aperture or the second sub-aperture for receiving acoustic echoes in response to the acoustic signals.

14. An apparatus for imaging a target, comprising:

one or more array elements of a first type forming a first sub-aperture;

one or more array elements of a second type different from the first type and forming a second sub-aperture, the second type being an optical sensor, wherein the first sub-aperture receives a first signal having a first phase and the second sub-aperture receives a second signal having a second phase; and

a front-end configured to generate a synthesized aperture at least in part by combining the first signal and the second signal.

15. The apparatus of claim 14, the front-end is further configured to generate the synthesized aperture by phase matching the first signal and the second signal.

16. The apparatus of claim 15, wherein phase matching the first signal and the second signal comprise applying a first delay to the first signal or a second delay to the second signal, the first delay and the second delay being determined based at least in part on a difference between a first propagation time from the one or more array elements of a first type to a medium being imaged and a second propagation time from the one or more array elements of a second type to the medium.

17. The apparatus of claim 16, wherein the first delay or the second delay is determined based at least in part on a thickness and acoustic velocity of an acoustic lens, or a thickness and acoustic velocity of an acoustic matching layer, or on transmit and receive foci, or a thickness and acoustic velocity of each of an acoustic lens and an acoustic matching layer.

18. The apparatus of claim 14, wherein the front-end is further configured to generate the synthesized aperture by filtering the first signal to reduce noise in the first signal and filtering the second signal to reduce noise in the second signal.

19. The apparatus of claim 14, wherein the front-end is further configured to generate the synthesized aperture by amplifying the first signal or the second signal by an amplification gain to amplitude match the first signal and the second signal.

20. The apparatus of claim 14, wherein the front-end is further configured to generate the synthesized aperture by frequency matching the first signal and the second signal.

21. The apparatus of claim 14, wherein the first signal is a combination of signals originating from a plurality of array elements of the first type or the second signal is a combination of signals originating from a plurality of array elements of the second type.

22. The apparatus of claim 14, wherein the front-end is further configured to generate the synthesized aperture by:

frequency matching the first signal and the second signal; and/or

amplitude matching the first signal and the second signal; and/or

phase matching the first signal and the second signal.

23. The apparatus of claim 14, wherein the combination of the first signal and the second signal is a coherent combination.

24. The apparatus of claim 14, wherein the front-end is further configured to combine the first signal and the second signal by:

selecting the first sub-aperture for transmitting acoustic signals; and

selecting the first sub-aperture or the second sub-aperture for receiving acoustic echoes in response to the acoustic signals.

25. The apparatus of claim 14, wherein the front-end is further configured to combine the first signal and the second signal by:

selecting an element from the one or more array elements of the first type for transmitting acoustic signals; and

selecting the first aperture or the second sub-aperture for receiving acoustic echoes in response to the acoustic signals.