In various embodiments of the cartridge, the housing includes a cover component, an internal component, and a base component coupled together to form a fixed structure. In some such embodiments, the cover component is disposed on a first side of the internal component, the base component is disposed on a second side of the internal component, and the circuit board is positioned between the internal component and the base component. Features of the cover component and the first side of the internal component may together define the input tunnel and the plurality of reservoirs, and features of the second side of the internal component and the circuit board may together define the analysis channel.

An additional aspect of the disclosure is directed to a sample analysis reader. In various embodiments, the reader includes a magnetic field generator, a circuit having a cartridge detection unit, a processor having memory with instructions stored thereon, and a housing with a dock for coupling to a sample analysis cartridge. In certain embodiments, when the sample analysis reader is coupled to the sample analysis cartridge, the magnetic field created by the magnetic field generator is substantially aligned with a sensor of the sample analysis cartridge, and the circuit is electrically coupled to the sensor of the sample analysis cartridge. In various embodiments, the sample analysis reader interchangeably couples to a plurality of sample analysis cartridges.

In some embodiments, the reader also includes a sonication component electrically coupled to the circuit. In such embodiments, when a sample analysis reader is coupled to the sample analysis cartridge, the sonication component is aligned with a sample preparation reservoir in the sample analysis cartridge.

In some embodiments of the sample analysis reader, the magnetic field generator includes a plurality of magnet field generators, and when the sample analysis reader is coupled to the sample analysis cartridge, the plurality of magnet field generators are aligned with a plurality of sensors lying on a plane of the sample analysis cartridge with each magnetic field generator configured to produce a magnetic field of a different strength. Such a configuration creates a magnetic field gradient within the analysis channel of the sample analysis cartridge. In some embodiments, the plurality of magnetic field generators are formed of a plurality of permanent magnets, each disposed at a different depth relative to the plane of the sensors. In other embodiments, the magnetic field gradient may be formed, for example, using a plurality of permanent magnets of increasing size or a plurality of inductors of increasing size or increasing numbers of coils.

In some embodiments of the reader, the sonication component is a piezoelectric component electrically coupled to the processor, and the piezoelectric component is positioned to transduce a mechanical event or mechanical change within the reservoir into an electrical signal. In such embodiments, a processor and/or circuitry electrically coupled to the piezoelectric component is configured to receive and interpret the electrical signal. This mechanical event in the reservoir can be transduced in the form of detected pressure applied to the piezoelectric component through flex in the sample preparation reservoir of the sample analysis cartridge upon entry of a sample collection device. Alternatively, a change in the mechanical load or mass above the piezoelectric component can cause a shift in the resonance frequency of the piezoelectric component that is detectable and/or quantifiable by the processor and/or circuitry. In other embodiments, the piezoelectric component and connected processor and/or circuitry quantify variation in the reflected wave of a pulse emitted from the piezoelectric component. In some such embodiments, the processor and/or circuitry is programmed with a threshold value for such variation in the reflected wave, the threshold set to distinguish between a state of having no collection device within the reservoir versus a collection device inserted state. In yet another example of the piezoelectric component transducing a mechanical event or mechanical change within the reservoir into an electrical signal, the piezoelectric component is configured to detect a sound wave such as the sound wave corresponding with a clicking that is actuated by mechanical parts of the sample collection device interacting with features of the input tunnel or reservoir.

In some embodiments of the sample analysis reader, the processor is configured to execute the instructions stored in memory, which when executed, cause the processor to perform a method. The method of certain embodiments includes identifying a proper test protocol for the coupled sample analysis cartridge based at least in part on cartridge identification information received from the circuit, and executing the proper test protocol. In some embodiments, executing the proper test protocol includes: stimulating the piezoelectric component to generate a test signal within the sample preparation reservoir and to detect a return signal, receiving detection signals from the piezoelectric component, the detection signals including the return signal and a resonance of the piezoelectric component, detecting entry of a sample collection device into the sample preparation reservoir based at least in part on a change in the return signal and/or a shift in the resonance of the piezoelectric component, and initiating a sonication protocol for the sonication component to mix reagents and sample particles within a liquid disposed within the sample preparation reservoir, wherein mixing facilitates hybridization of at least some of the reagents with the sample particles.

In some embodiments, the method performed by the processor when executing the proper test protocol additionally or alternatively includes receiving via the circuit, detection signals generated by the sensor of the sample analysis cartridge, and processing the detection signals. The method may also include transmitting data based at least in part on the detection signals to a mobile computing device or display device.

A further aspect of the disclosure is directed to a specialized computer for non-clinical disease detection. The specialized computer of various embodiments includes both hardware and software. For example, in some embodiments, the computer includes a dock or port for engaging at least a portion of a disease detection cartridge, the dock positioned on or within the computer. The computer of various embodiments also includes: circuitry for detecting signals generated from an oxidation reaction occurring within the disease detection cartridge, and a processor having memory with instructions stored thereon. Upon engagement with the disease detection cartridge, the processor executes the instructions, which in certain embodiments, causes the processor to perform a method that includes: detecting a classification of the disease detection cartridge from signals received from the circuitry, initiating a testing protocol specific to the classification, and generating disease detection results specific to the classification in less than thirty minutes. The method may further include transmitting the disease detection results to a remote computing device for further processing, display, and/or storage. In certain embodiments, the computer is less than 30 cm in height, less than 30 cm in width, and less than 30 cm in length. In certain embodiments, the computer is intended for use by non-trained consumers in home, office, or school settings.

One aspect of the disclosure is directed to a self-contained analyte detection kit, which securely stores, during and after