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(54) **MULTI-CHANNEL MICROARRAY APPARATUS AND METHODS**

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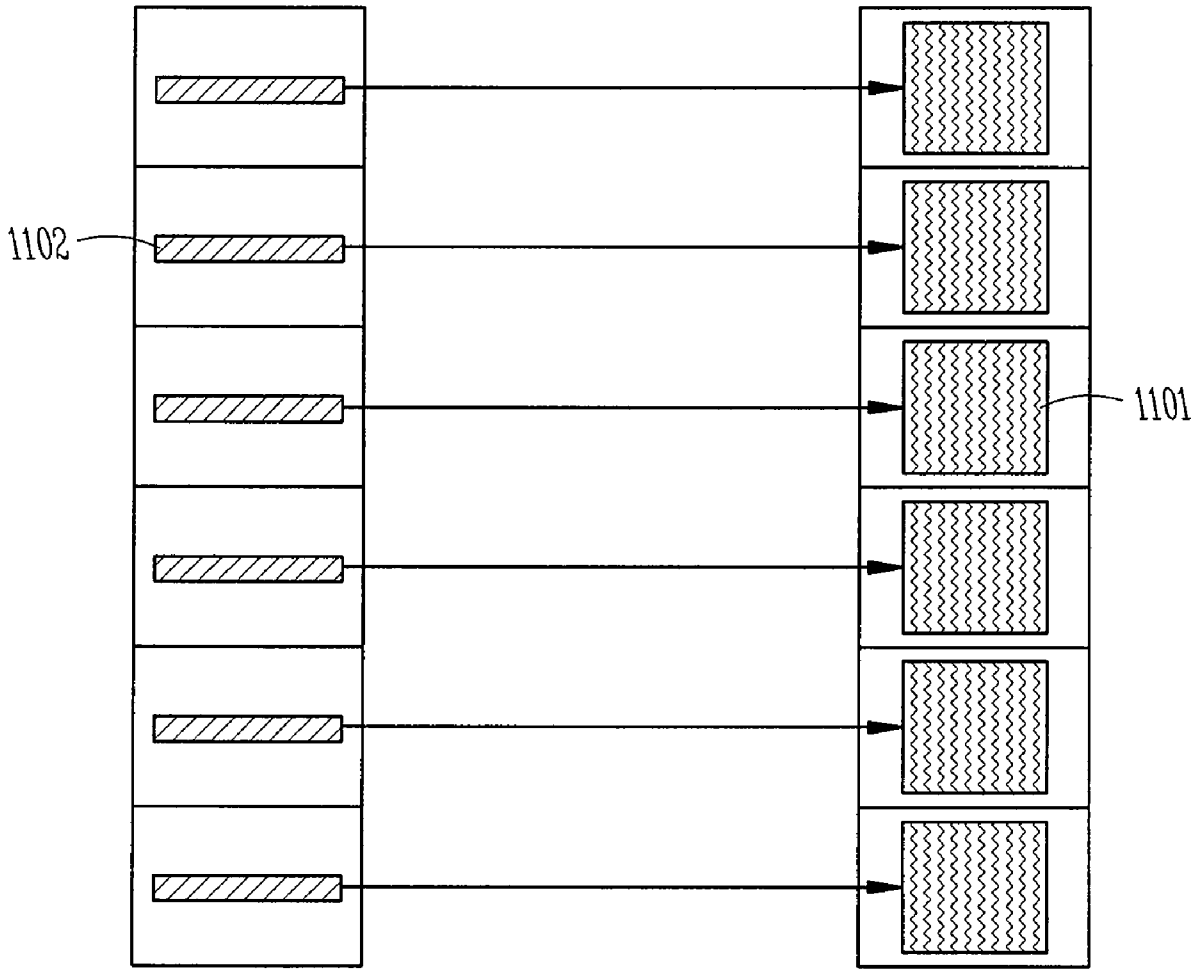
(57) **ABSTRACT**

A multi-channel microarray reader has a light source carried by a first supporting stage, a second supporting stage having a plurality of reaction assembly receiving positions, each position to receive a reaction assembly, wherein each reaction assembly includes a reaction chamber and an optical substrate to support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution. The reader also includes an imaging sensor positioned to detect fluorescence emitted from a single microarray chip and a motion control module to position at least one of the first and second supporting stages to cause a selected microarray chip to receive energy emitted from the light source and to position the imaging sensor to receive fluorescence from that microarray chip.



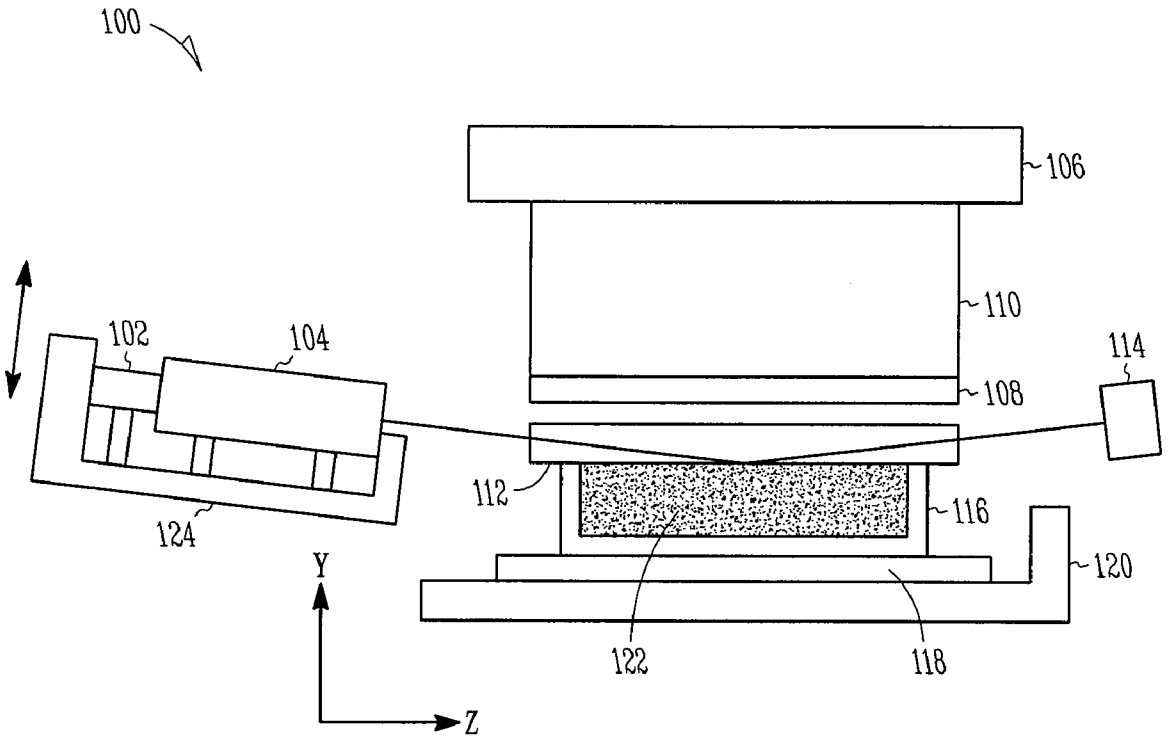


FIG. 1

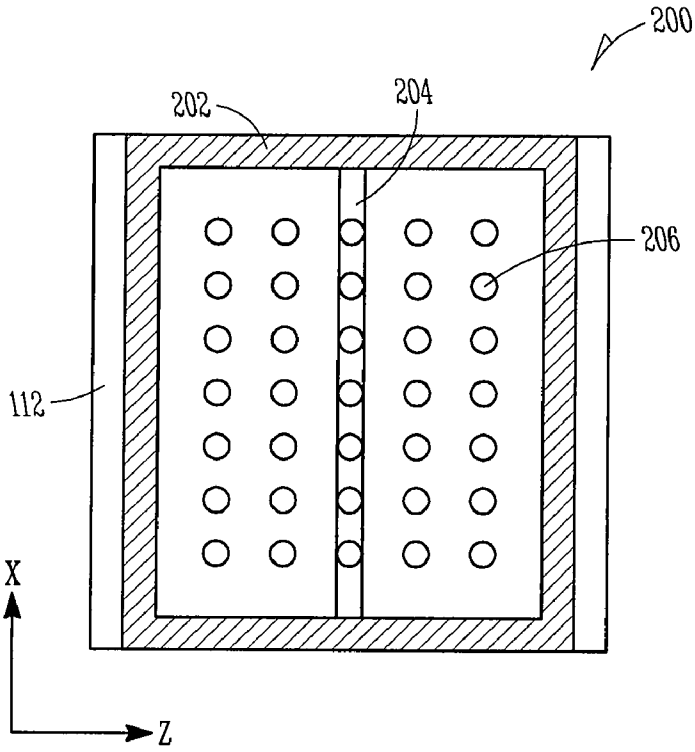


FIG. 2

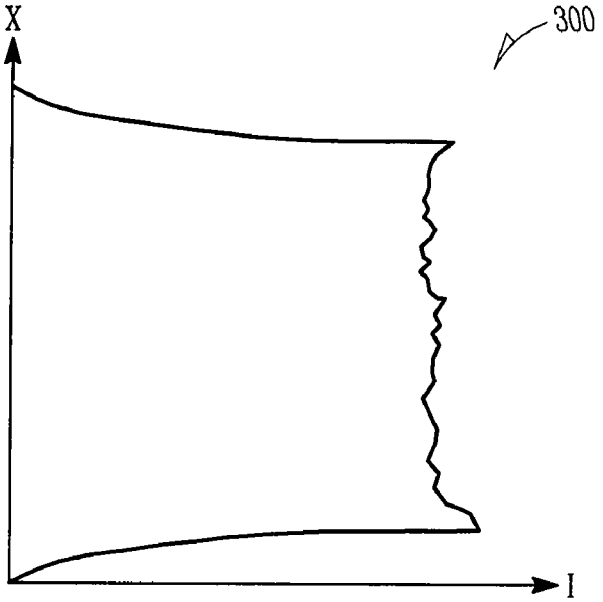


FIG. 3

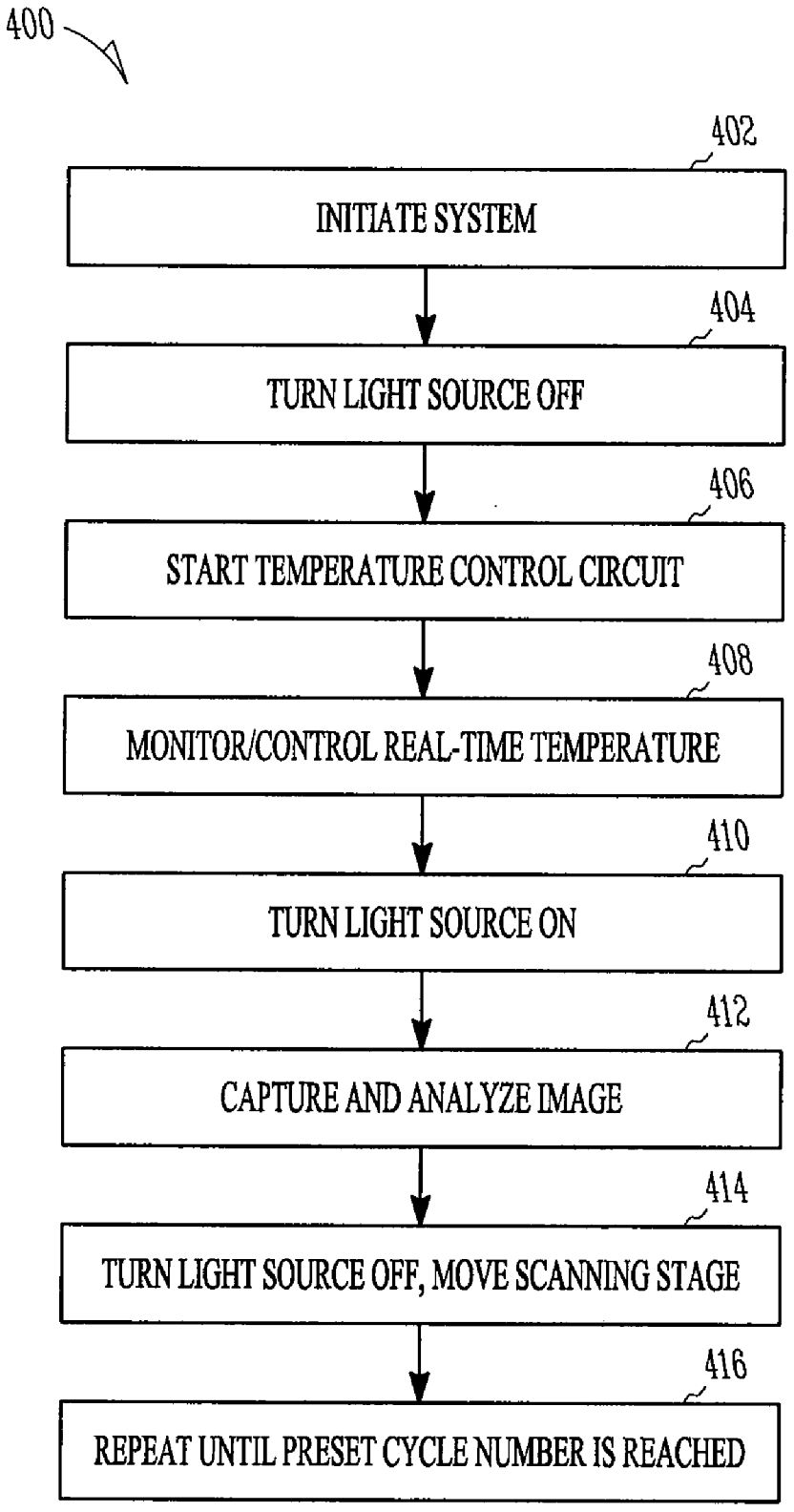

400
402
INITIATE SYSTEM
404
TURN LIGHT SOURCE OFF
406
START TEMPERATURE CONTROL CIRCUIT
408
MONITOR/CONTROL REAL-TIME TEMPERATURE
410
TURN LIGHT SOURCE ON
412
CAPTURE AND ANALYZE IMAGE
414
TURN LIGHT SOURCE OFF, MOVE SCANNING STAGE
416
REPEAT UNTIL PRESET CYCLE NUMBER IS REACHED

FIG. 4

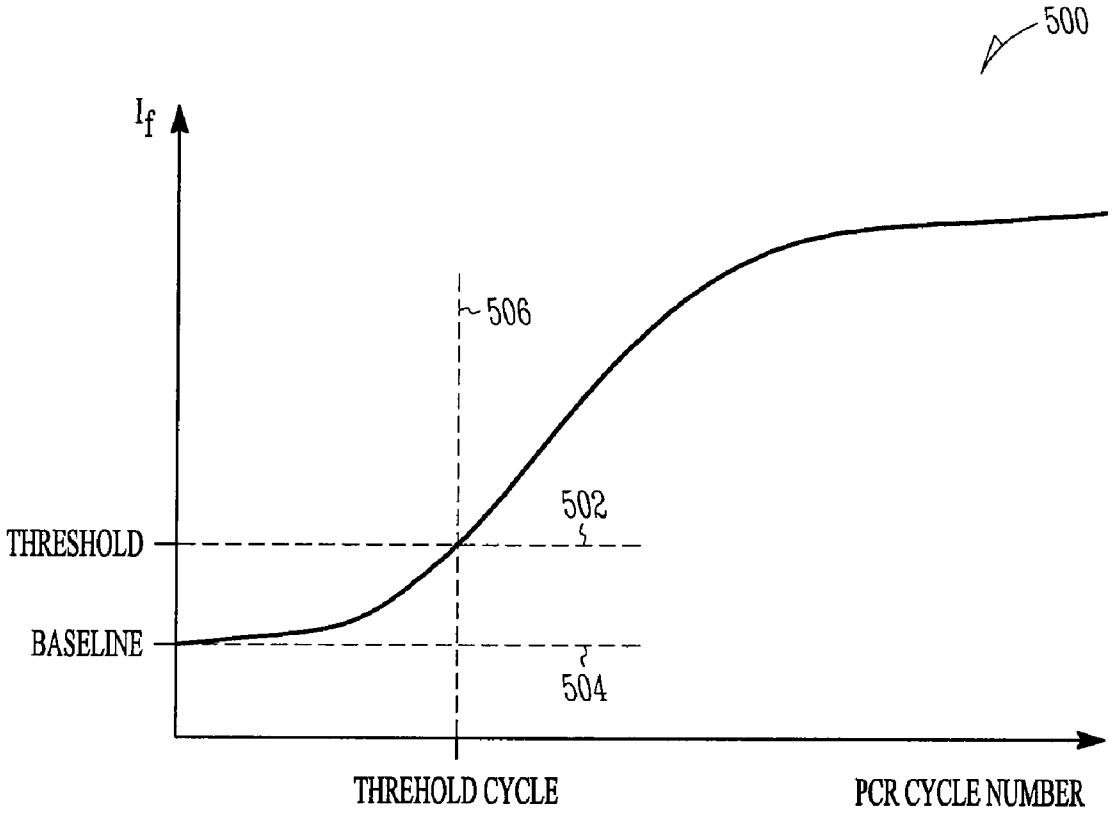

500
I_f
506
502
THRESHOLD
BASELINE
504
THREHOLD CYCLE
PCR CYCLE NUMBER

FIG. 5

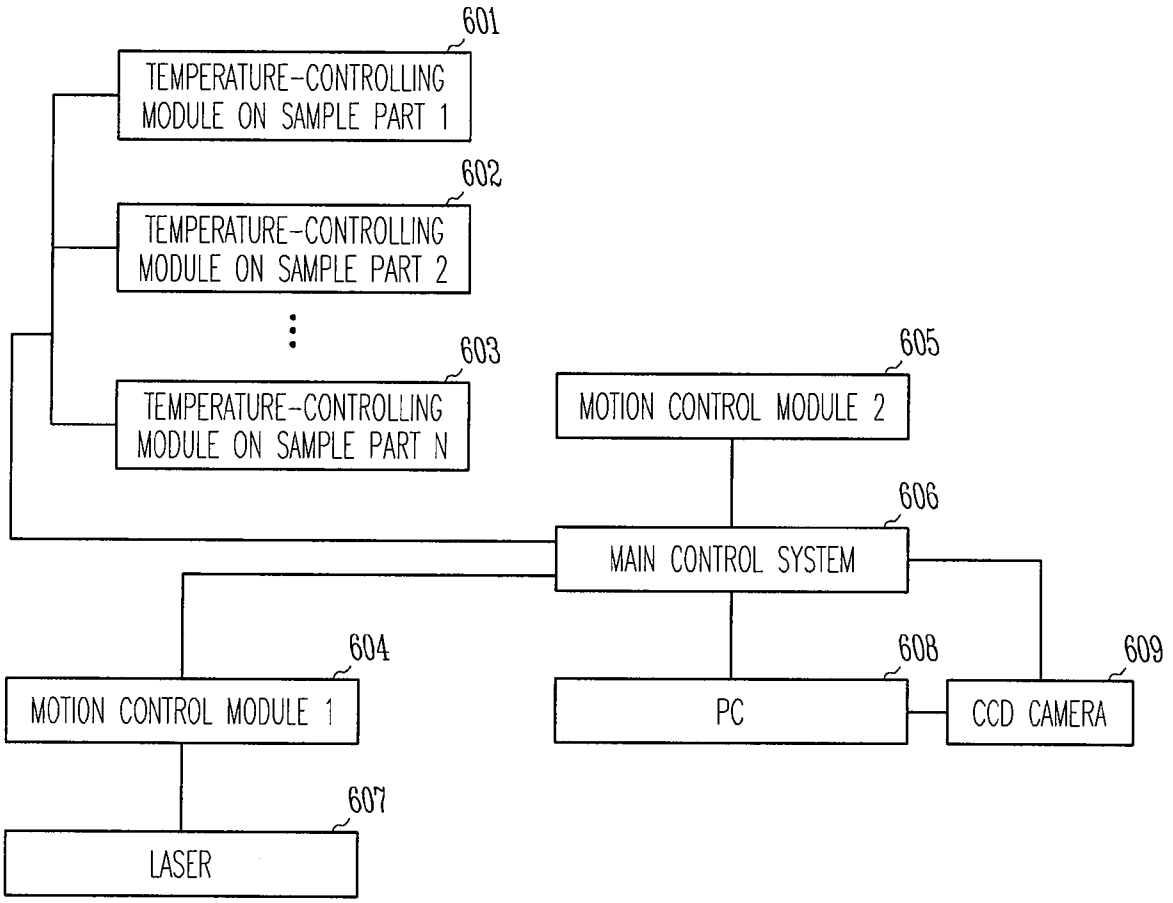

601
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART 1
602
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART 2
603
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART N
605
MOTION CONTROL MODULE 2
606
MAIN CONTROL SYSTEM
604
MOTION CONTROL MODULE 1
608
PC
609
CCD CAMERA
607
LASER

FIG. 6

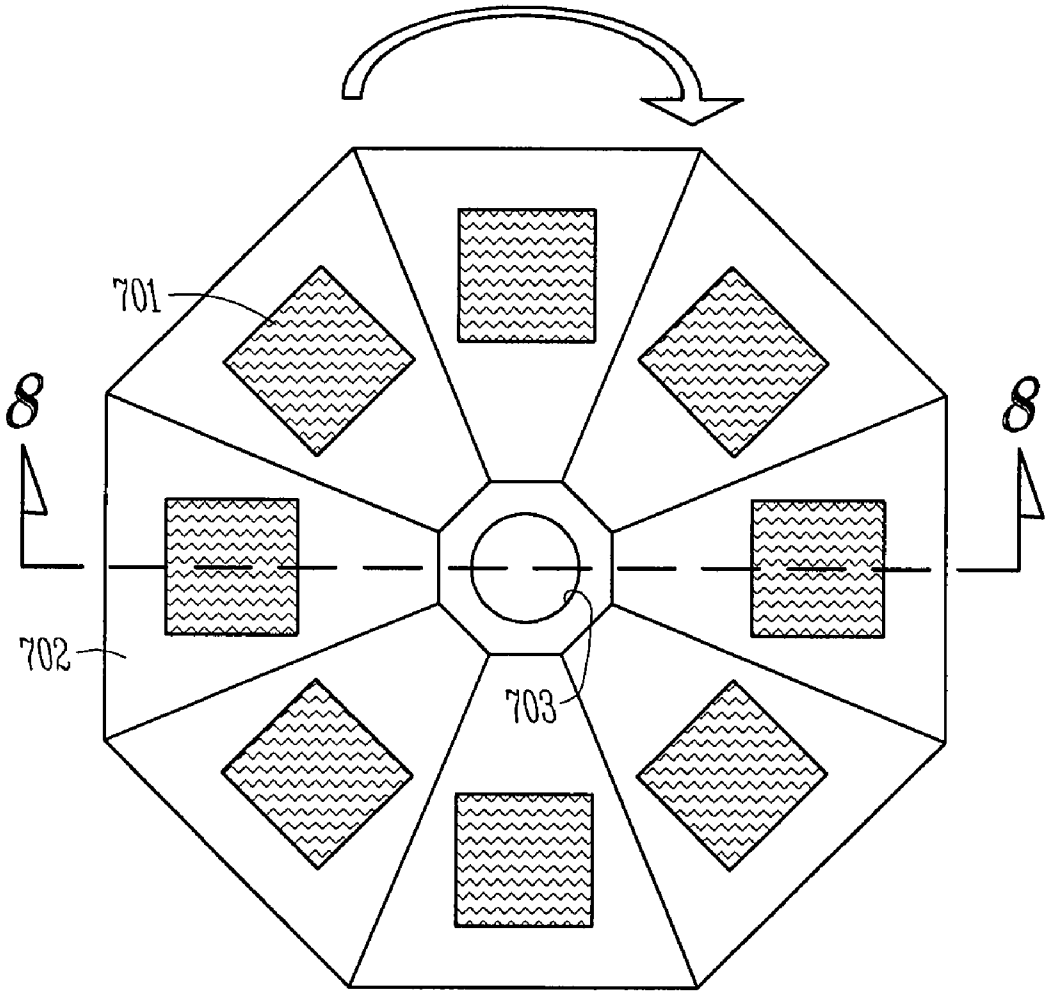


FIG. 7

200

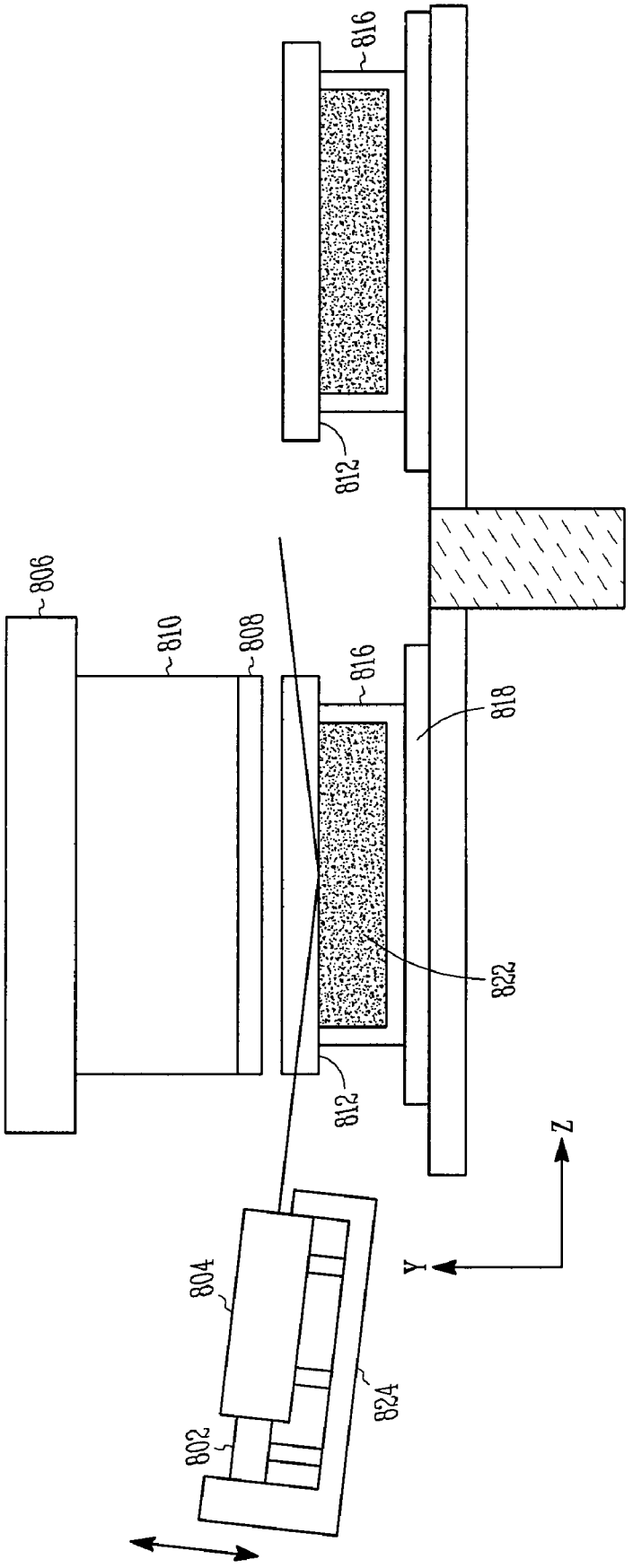


FIG. 8

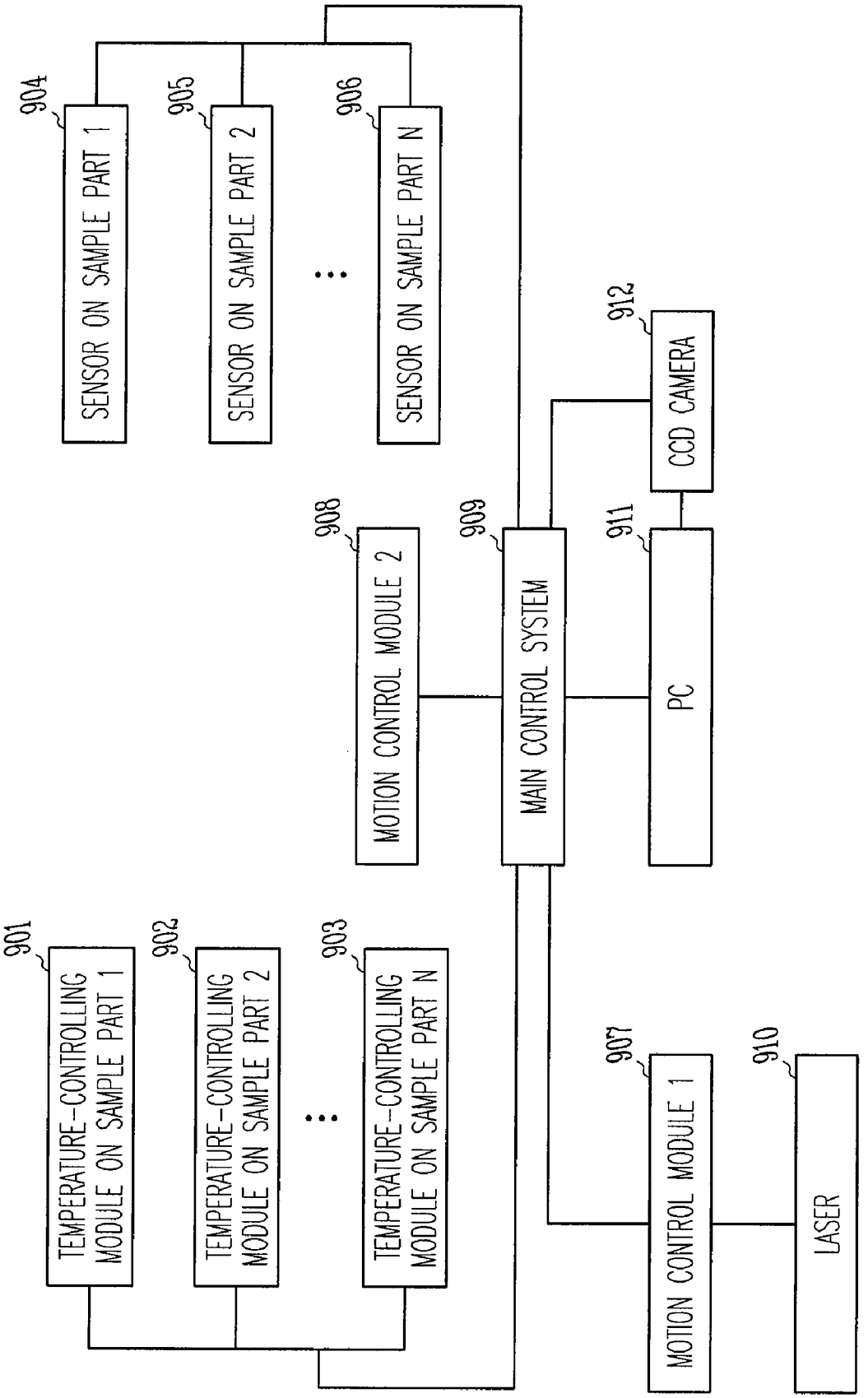

904
SENSOR ON SAMPLE PART 1
905
SENSOR ON SAMPLE PART 2
906
SENSOR ON SAMPLE PART N
912
CCD CAMERA
908
MOTION CONTROL MODULE 2
909
MAIN CONTROL SYSTEM
911
PC
901
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART 1
902
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART 2
903
TEMPERATURE-CONTROLLING MODULE ON SAMPLE PART N
907
MOTION CONTROL MODULE 1
910
LASER

FIG. 9

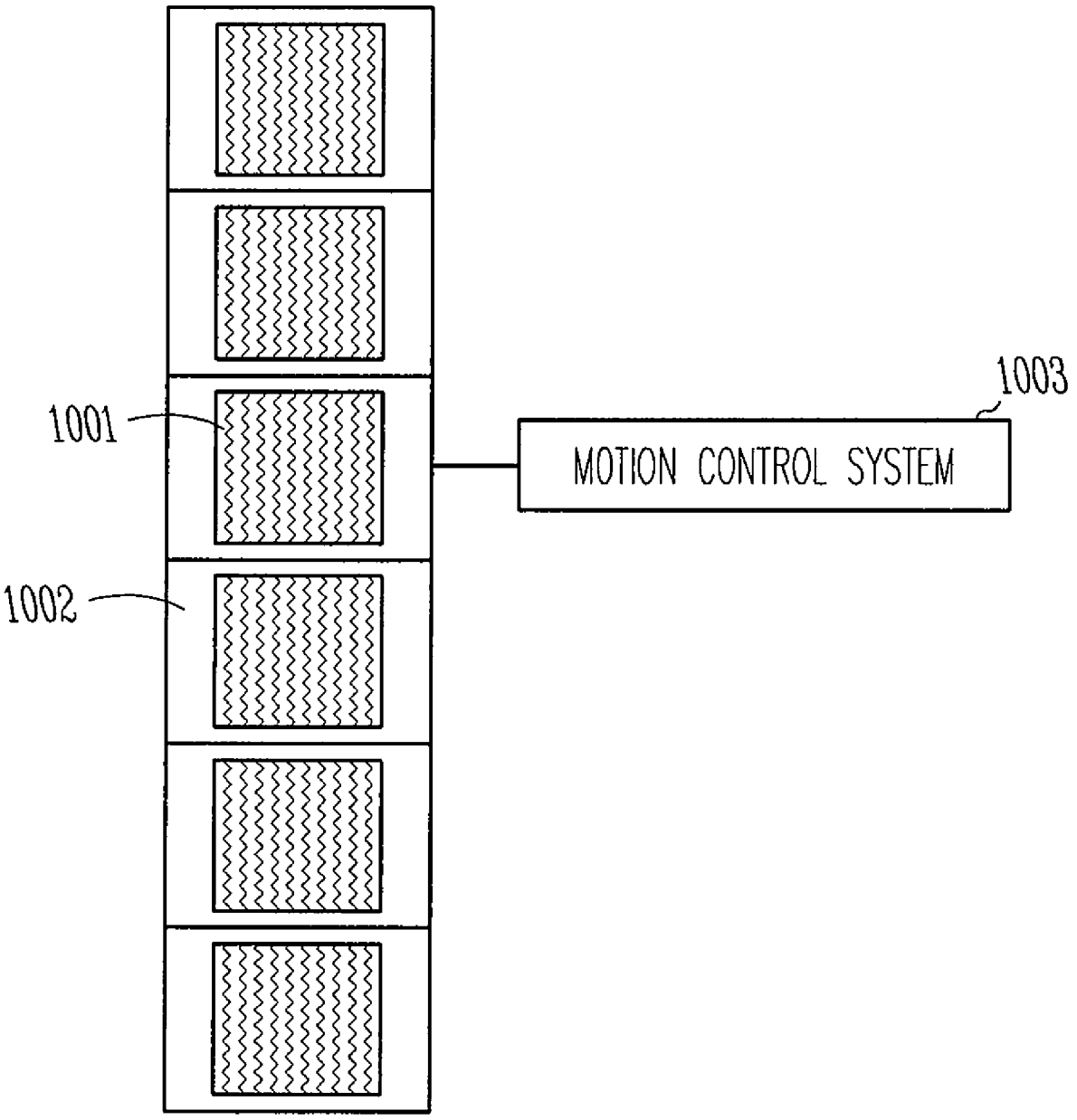


FIG. 10

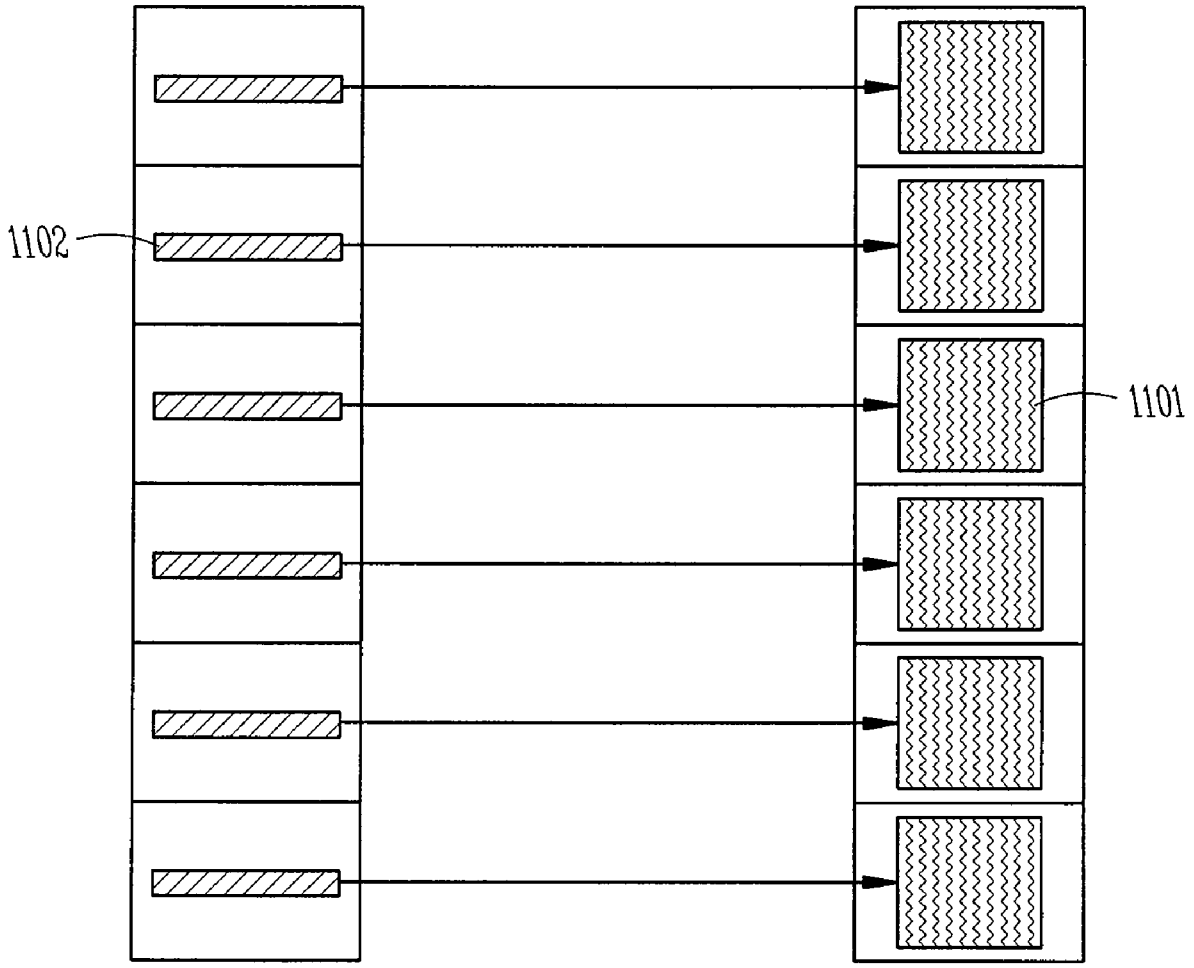


FIG. 11

MULTI-CHANNEL MICROARRAY APPARATUS AND METHODS

RELATED APPLICATIONS

[0001] This application is claims priority to co-pending PCT International Application No. PCT/CN2007/000020, filed 17 Jan. 2007 under 35 USC §120.

BACKGROUND

[0002] Microarray readers conventionally used are based on fluorescent label, confocal microscopy and evanescent field. Examples include fluorescent scanning confocal microscopy and total internal reflection (TIR) fluorescent microscopy. Existing microarray readers do not meet the need of real-time polymerase chain reaction (PCR) microarray detection.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Embodiments of the invention may be best understood by referring to the following description and accompanying drawings, which illustrate such embodiments. In the drawings:

[0004] FIG. **1** is a cross-sectional view of microarray reader **100** based on evanescent wave detection.

[0005] FIG. **2** is a perspective view of an optical substrate **200**.

[0006] FIG. **3** is a graphical view of an intensity profile of a line shape output light source.

[0007] FIG. **4** is a block flow diagram of a method of reading a microarray.

[0008] FIG. **5** is a graphical view of a fluorescent labeled polymerase chain reaction (PCR) signal curve.

[0009] FIG. **6** is a frame of some embodiments of the multi-channel microarray reader.

[0010] FIG. **7** is a perspective view of some embodiments of the sample platform.

[0011] FIG. **8** is a cross-sectional view of some embodiments of a sample platform combined with a multi-channel microarray reader.

[0012] FIG. **9** is a frame of some embodiments of multi-channel microarray reader;

[0013] FIG. **10** is a perspective view of another embodiment of a sample platform.

[0014] FIG. **11** is a perspective view of yet another embodiment of a sample platform.

DETAILED DESCRIPTION

[0015] A multi-channel microarray reader has a light source carried by a first supporting stage, a second supporting stage having a plurality of reaction assembly receiving positions, each position to receive a reaction assembly, wherein each reaction assembly includes a reaction chamber and an optical substrate to support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution. The reader also includes an imaging sensor positioned to detect fluorescence emitted from a single microarray chip and a motion control module to position at least one of the first and second supporting stages to cause a selected microarray chip to receive energy emitted from the light source and to position the imaging sensor to receive fluorescence from that microarray chip.

[0016] Referring to FIG. **1**, a cross-sectional view of a single channel microarray reader **100** based on evanescent wave detection is shown, according to some embodiments. A linear translation stage **124** supports a line shape output light source **102**, such as a laser. The wavelength of the light source **102** is chosen to be in a range to activate the fluorescent tag. In some embodiments, the light source **102** is reshaped by cylindrical lenses **104** (beam shaping elements) before contacting substrate **112**. In some embodiments, contacting includes entering the substrate **112**. In some embodiments, the cylindrical lenses **104** are diffraction optical elements or diffusing optical elements.

[0017] In some embodiments, the light source **102**, cylindrical lenses **104** and linear translation stage **124** make up a line scanning excitation system. The substrate **112** may, in some embodiments be an optical substrate, such as glass or a polymer, for example. The substrate **112** may be very thin to decrease thermal capacity and meet the demands of rapid temperature control. The substrate **112** may be about 1 mm to about 3 mm thick, for example. In some embodiments, the substrate **112** is be manufactured of a low autofluorescent material at the excitation wavelength.

[0018] The line scanning excitation system may sustain uniform intensity (as shown in FIG. **3**. Uniform line scanning with uniformity calibration may be applied to overcome the lower speed for spot scanning, for example. To get flexible and convenient coupling, direct coupling may be applied, for example. Position variation of excitation may be adjusted by feedback control, for example. A synchronization circuit may be utilized by the line scanning excitation system to synchronize sampling, for example.

[0019] In some embodiments, the substrate **112** contacts a reaction chamber **116**, encapsulating a buffer solution **122** and making up a real-time polymerase chain reaction (PCR) microarray reaction system. The refractive index of the substrate **112** is higher than the buffer solution **122**, in some embodiments. The substrate is glued to the reaction chamber **116**, in some embodiments. The fluorescent tag may be imaged in an imaging sensor **106**, such as a cooled CCD camera **106** by imaging lenses **110**. An optical filter **108** between the substrate **112** and image lenses **110** is utilized in some embodiments to block the exciting light and pass the fluorescence. In contact with the reaction chamber **116**, a heating/cooling element **118** on a stage **120** is utilized in some embodiments for heating, cooling or stabilization of the reaction system. The element **118** may be a TEC temperature control plate, for example. Variation of any light source intensity may be monitored by detector **114**, such as a photoelectric detector.

[0020] Referring to FIG. **2**, a perspective view of an optical substrate **200** is shown, according to some embodiments. To prevent any scattering caused by an adhesive, a multi-layer reflective or absorptive coating **202** may be coated on the adhesion area on the bottom side of the substrate **200**. The coating **202** may also serve as a position marker, for example. Towards the bottom side of the substrate **200**, total internal reflection may occur where probe array **206** may be immobilized on the surface. In some embodiments, the optical substrate **200** not only serves as solid support for the microarray, but also as the optical dense media for the total internal reflection. A column of an array probe combined with florescent labeled target may be excited by line shape **204** evanescent field. To decrease the scattering at the optical substrate surface **200**, facets of the substrate **112** may be fine polished. For example, four facets may be fine polished. For example, the left side surface, right side surface, upper side surface and

bottom side surface may be polished. In some embodiments, the surface quality of the optical substrate **200** is better than 40-20 scratch-dig MIL-O-13830, for example.

[0021] Referring to FIG. **4**, a flow diagram of a method **400** of reading a microarray is shown, according to some embodiments. The microarray reader system may be initiated **402**, the light source may be turned off **404** before imaging capture and temperature control circuit initiated **406**. The real-time temperature control may be monitored **408** during the entire reading process. The light source may be turned back on **410**. Image capture and analysis **412** may be executed after the temperature reaches the preset sampling temperature. The light source may then be turned off and scanning station moved **414** to the next position. Steps **408** through **414** may be repeated until the preset cycle number has been reached **416**.

[0022] System initiation **402** may include light source intensity calibration, line uniformity calibration, light source orientation, temperature parameter configuration, image setup or combinations thereof. Image analysis may be used for calibration, for example.

[0023] Referring to FIG. **5**, a graphical view of a fluorescent labeled polymerase chain reaction (PCR) signal curve **500** is shown, according to some embodiments. A fluorescent labeled polymerase chain reaction (PCR) signal curve is plotted versus the polymerase chain reaction (PCR) cycle number. The background florescent baseline **504** marks the beginning of the polymerase chain reaction (PCR) cycle. At the threshold cycle **506**, fluorescent signal greatly increases versus time. The log of the initial target substance number is proportional to the threshold cycle **506**. The number of target substance may be deduced from threshold cycle analysis.

[0024] Referring to FIG. **6**, an example frame of some embodiments of a multi-channel microarray reader include, for example, a temperature-controlling module on sample part **1 601**, a temperature-controlling module on sample part **2 602**, a temperature-controlling module on sample part N **603**, a motion control module **1 604**, a motion control module **2 605**, a main control system **606**, a laser **607**, a computer **608**, and a charge-coupled device (CCD) **609**. The motion control module **1 604** is used to control the motion of the laser **607** and motion control module **2 605** is used to control the motion of the sample platform (not shown). The main control system **606** is used to control the whole microarray reader. The sample platform (not shown) is divided into several compartments (at least two parts) and each compartment is independent from each other compartment. Each compartment of the sample platform has an independent temperature-controlling module (e.g., **601**), which can control the temperature of the microarray chip on that compartment.

[0025] Referring to FIG. **7**, some embodiments of the sample platform include, for example, a microarray chip **701**, a turntable **702**, and a pivot **703**. In these embodiments, the sample platform is a turntable **702**, which replaces the stage **120** as shown in FIG. **1**. Each compartment of turntable **702** may contain one microarray chip **701**. In this example, the turntable **702** contains eight compartments with one microarray chip **701** in each compartment. The number of platform compartment is not limited to, for example, eight and may be any number greater than one (e.g., 1, 2, 3 . . . n). The turntable **702** may be rotated in a circular direction by motion control module **2 605**. A Servo motor (not shown) and drive (not shown) as well as step motor (not shown) and drive (not shown) may be used in motion control module **2 605**. As the turntable **702** is rotated, one microarray chip **701** in each compartment is illuminated by the laser **602** to generate a signal. The signal is detected by the charge-coupled device (CCD) camera **609**. The main control system **606** may ensure that the illumination and detection of each microarray chip **701** in each temperature cycle would not overlap over time with the other microchips contained in the other compartments. After the laser **607** scans one microarray chip **701** and the charge-coupled device (CCD) camera **609** captures that image, the turntable **702** is rotated. The process is repeated until all of the microarray chips have been illuminated and all of their images captured.

[0026] Referring to FIG. **8**, some embodiments of a sample platform combined with a multi-channel microarray reader include all of the features found in FIG. **1** and a second substrate **812**, a second sample reaction chamber **816**, and a second heating/cooling element **818**.

[0027] Referring to FIG. **9**, some embodiments of the multi-channel microarray reader include, for example, a temperature-controlling module on sample part **1 901**, a temperature-controlling module on sample part **2 902**, a temperature-controlling module on sample part n **903**, a sensor on sample part **1 904**, a sensor on sample part **2 905**, a sensor on sample part n **906**, a motion control module **1 907**, a motion control module **2 908**, a main control system **909**, a laser **910**, a computer **911**, and a charge-coupled device (CCD) **912**.

[0028] In some embodiments, each compartment of the sample platform includes a sensor. The sensors indicate the presence of a chip and in some embodiments are radiofrequency (RF) sensor, an optical sensor, a pressure sensor, and the like, or combinations thereof. These sensors are electrically connected to main control system, as shown in FIG. **9**. The role of the sensor is to detect the presence of a microarray chip in the compartment.

[0029] Typically, the multi-channel microarray reader scans the sensors automatically before adding additional microarray chips. The sensor indicates the status of the corresponding sample compartment. If a microarray chip is present in a compartment, the status of the compartment is noted. Typically, the sensors send the detection results to main control system **909**. When the laser **910** is turned on and the microarray chip is scanned, no new microarray chips should be added in the multi-channel microarray reader to avoid the influence of outer light on the detection of charge-coupled device (CCD) imaging sensor. Therefore, according to the time parameters of working temperature-controlling modules, the multi-channel microarray reader can summarize the spare time when the laser **910** is turned down and the imaging sensor would not detect the microarray chip. Subsequently, the multi-channel microarray reader may select a proper spare time (while the laser **910** is turn off) to add additional microarray chips. Typically, the multi-channel microarray reader sends the compartment holding the new microarray chip to the sample window by the motion of sample platform. Simultaneously, the computer **911** would inform the user or an optional robot to add additional microarray chips into the multi-channel microarray reader.

[0030] In some embodiments the marker sensor **904** is an optional component. In some embodiments, presence of a microarray chip in a compartment may also be detected by other methods, such as human eyes, or could be recorded by the software when the microarray chips are added.

[0031] In the above embodiments, new microarray chips can be added into the multi-channel microarray reader even if there are some microarray chips currently running. However,

in some embodiments, this function is optional. In other embodiments, new microarray chips are not added into the multi-channel microarray reader until the detection of the microarray chips in the multi-channel microarray reader is completed.

[0032] Some embodiments may include several sample loading positions, a reaction buffer container, sample loading equipments and some gear-drive equipments. Sample loading positions (not shown) are designed to deposit microarray chips. Clinical samples and their corresponding reaction buffer can be loaded into the microarray chips automatically with the aid of sample loading equipment. The main control system **908** could select a proper spare time (while the laser **909** is turn off) send the microarray chips to different sample compartments automatically.

[0033] In some embodiments, microarray chip **701** may include a marker, which could be a bar code, a radiofrequency (RF) chip, a multi-layer reflective coating, or other markers. The marker could be used to help users distinguish the type of the chip. Different kinds of chips have different parameters including product number, manufacturing lot number, calibration parameter, etc. These parameters could be saved in the software and it is convenient for users to load these parameters. The marker may also serve as a position marker, for example. Accordingly in this embodiment, a bar code reader, RF detector, optical detector or other detectors may be included in the multi-channel microarray reader.

[0034] Referring to FIG. **10**, a perspective view of another embodiment of a sample platform includes, for example, microarray chip **1001**, sample compartment **1002**, and motion control system **1003**. Unlike the embodiment in FIG. **7**, the sample compartments in FIG. **10** are aligned on a the supporting stage in a column. In some embodiments the supporting stage sample platform is translationally movable by motion control system **1003**.

[0035] In some embodiments, the supporting stage platform is stationary and the imaging sensor, the light source supporting stage, or a combination of imaging sensor, light source supporting stage and chips supporting stage may be moved. For example, as shown in FIG. **11**, a perspective view of yet another embodiment of sample platform, there are several light sources or lasers **1102** aligned in a column. Microarray chips **1101** with the same number are also aligned in a column. Both the positions of microarray chips and lasers are fixed. The charge-coupled device (CCD), which is not shown in FIG. **11**, may be translationally moved along a column axis. The translation of the charge-coupled device (CCD) (not shown) may be controlled by the motion control module. Every time a light source or laser **1102** is turned on and illuminates a corresponding microarray chip **1101**, the imaging sensor captures an image. Afterward, the next laser is turned on and illuminates the next microarray chip. The charge-coupled device (CCD) is translated to this compartment and captures an image.

[0036] In one embodiment, a system and a method for using the system for detecting light emitted from an area on the surface of a microarray array is provided. By "area" of a microarray is meant a region that is the subject of detection by the subject multi-detector system. An area of a microarray may be as small as a single pixel or as broad as one or more features, dependent upon how the system is configured. In one embodiment, an area corresponds to the dimensions of a pixel.

[0037] As noted above, a pre-determined wavelength of light is a wavelength of light that indicates the presence of a particular detectable label. In certain embodiments, therefore, the pre-determined wavelength of light corresponds to the wavelength of maximal energy emission from a light-emitting label, such as a fluorescent label. While the pre-determined wavelength of light may vary, in representative embodiments it ranges from about 400 to about 800 nm, such as from about 550 to about 610 nm and including from about 650 to about 750 nm. Pre-determined wavelengths of particular interest include, but are not limited to, the emission maxima of the following fluorescent labels: xanthene dyes, cyanine dyes, coumarins, benzimide dyes, phenanthridine dyes, ethidium dyes, acridine dyes, carbazole dyes, phenoxazine dyes, porphyrin dyes, polymethine dyes, quinoline dyes, and combinations thereof.

[0038] The imaging sensors employed herein may be any instrument capable of capturing an optical emission of energy (e.g., photons) and converting that energy into an analog and/or digital signal. For instance, one or more of the imaging sensor may include, for example, a camera, a charge-coupled device, a charge-injection device, a complementary metal-oxide-semiconductor device, a video camera, a silicon photocell, a photodiode, an avalanche photodiode, a photo-multiplier tube, or a combination thereof.

[0039] Specifically, the methods described may be executed by one or more processors in accordance with instructions from a computer program product. Accordingly, some embodiments provide at least one processor programmed to run the multi-channel microarray reader as described herein.

[0040] Some embodiments further provide kits for use in connection with the multi-channel microarray reader as described herein. In one embodiment, a kit may include, for example, the multi-channel microarray reader as described herein. Additionally, some embodiments of kits include at least a computer program product including computer readable medium including programming as discussed above and, in certain kits, instructions. The instructions may include installation or setup directions.

[0041] The multi-channel microarray reader as described herein may be utilized with the microarray procedure described in, for example, U.S. Patent Application Publication No. 2006/0088844. A polymerase chain reaction (PCR) buffer contains fluorescently-tagged primers, i.e., primers having a fluorescent dye molecule attached to them, so that upon completion of each polymerase chain reaction (PCR) cycle, the amplicons produced are fluorescently tagged. The amplicons of the target DNA are then localized, using probe strands of DNA known as oligoprobes. The oligoprobes have the complementary, nucleotide sequence as the target DNA. The oligopobes are tethered to a substrate surface in a known, two-dimensional pattern, with the substrate surface forming part of the reaction cell containing the polymerase chain reaction (PCR) ingredients. During the annealing and extension phases of the polymerase chain reaction (PCR) process, the fluorescently-tagged, target amplicons hybridize to their corresponding oligoprobes. The hybridized, fluorescently tagged target amplicons are then illuminated with an evanescent wave of light of the appropriate wave-length to activate the fluorescent dye molecules of the tagged primers. This evanescent wave decays exponentially in power after entering the reaction cell via the substrate surface to which the oligoprobes are tethered, with an effective penetration range of

about 300 nm. This means that the evanescent wave penetrates far enough into the reaction cell to activate the fluorescently tagged amplicons hybridized to those oligopobes, but that it does not activate the fluorescently tagged primers in solution in the main body of the reaction cell. By monitoring the strength of the fluorescence at various locations on the substrate surface, the current abundance of amplicons of the corresponding, target DNA can be determined. This may be done in real time as the polymerase chain reaction (PCR) progresses, and the results used to obtain a quantitative or a qualitative measure of the abundance of a specific target in the original sample, in a manner analogous to the real time polymerase chain reaction (PCR) calculation.

[0042] Unless otherwise indicated, the words and phrases presented in this document have their ordinary meanings to one of skill in the art. Such ordinary meanings can be obtained by reference to their use in the art and by reference to general and scientific dictionaries, for example, *Webster's Third New International Dictionary*, Merriam-Webster Inc., Springfield, Mass., 1993 and *Hawley's Condensed Chemical Dictionary*, 14th edition, Wiley Europe, 2002.

[0043] As used herein, the term "and/or" refers to any one of the items, any combination of the items, or all of the items with which this term is associated.

[0044] As used herein, the singular forms "a," "an," and "the" include plural reference unless the context clearly dictates otherwise.

[0045] All patents and publications referenced or mentioned herein are indicative of the levels of skill of those skilled in the art to which the invention pertains, and each such referenced patent or publication is hereby incorporated by reference to the same extent as if it had been incorporated by reference in its entirety individually or set forth herein in its entirety. Applicants reserve the right to physically incorporate into this specification any and all materials and information from any such cited patents or publications.

[0046] As used herein, the term "buffer solution" refers to a solution that resists changes in the pH. A suitable reaction buffer for a microarray is described in PCT Patent Application Publication No. WO 2008/080254.

[0047] As used herein, the term "evanescent" refers to a nearfield standing wave exhibiting exponential decay with distance. A suitable evanescent wave system that may be used in the practice of embodiments of this invention is described, for example, in U.S. Patent Application Publication No. 2006/0088844.

[0048] As used herein, the term "charge-coupled device" refers to a device for forming images electronically, using a layer of silicon that releases electrons when struck by incoming light.

[0049] As used herein, the term "microarray" is a linear or two-dimensional microarray of discrete regions, each having a defined area, formed on the surface of a solid support.

[0050] As used herein, the term "nucleic acid" refers to any nucleic acid containing molecule including, but not limited to, DNA or RNA.

[0051] As used herein, the term "optical detection path" refers to a configuration or arrangement of detection means to form a path whereby electromagnetic radiation is able to travel from an external source to a means for receiving radiation, wherein the radiation traverses the reaction chamber.

[0052] As used herein, the term "polymerase chain reaction (PCR)" refers to the method of K. B. Mullis, U.S. Pat. Nos. 4,683,195, 4,683,202, and 4,965,188.

[0053] As used herein, the term "reaction apparatus" refers to a device, which can be used in any number of chemical processes involving a fluid.

EXAMPLE EMBODIMENTS

[0054] In a first example embodiment a multi-channel microarray reader, includes a light source carried by a first supporting stage and a second supporting stage having a plurality of reaction assembly receiving positions, each position to receive a reaction assembly, wherein each reaction assembly includes a reaction chamber and an optical substrate to support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution. It also includes an imaging sensor positioned to detect fluorescence emitted from a single microarray chip and a motion control module to position at least one of the first and second supporting stages to cause a selected microarray chip to receive energy emitted from the light source and to position the imaging sensor to receive fluorescence from that microarray chip.

[0055] A second embodiment is the multi-channel microarray reader of the first embodiment, wherein the second supporting stage is a turntable rotated by the motion control module.

[0056] A third embodiment is the multi-channel microarray reader of the first embodiment, wherein the second supporting stage aligns the reaction assemblies in a column translationally movable by the motion control module.

[0057] A fourth embodiment is the multi-channel microarray reader of the first embodiment, wherein the second supporting stage aligns the reaction assemblies along a longitudinal axis and wherein the first supporting stage and the imaging sensor are positioned by the motion control module at selected locations along the axis to position the imaging sensor to detect fluorescence from a selected microarray chip.

[0058] A fifth embodiment is the multi-channel microarray reader of any one of the first through the fourth embodiment, wherein the buffer solution supports a polymerase chain reaction.

[0059] A sixth embodiment is the multi-channel microarray reader of any one of the first through the sixth embodiment, wherein the light source is a laser which activates fluorescently tagged amplicons at the substrate surface to indicate the presence of target DNA.

[0060] A seventh embodiment is the multi-channel microarray reader of any one of the first through the sixth embodiment, wherein the optical substrate is about 1 mm to about 3 mm in thickness.

[0061] An eighth embodiment is the multi-channel microarray reader of any one of the first through the seventh embodiment, wherein the optical substrate carries a marker.

[0062] A ninth embodiment is the multi-channel microarray reader of the eighth embodiment, wherein the marker comprises one of a bar code, a radio-frequency identification chip, a multilayer reflective coating and a multilayer absorptive coating, or combinations thereof.

[0063] A tenth embodiment is the multi-channel microarray reader of any one of the first through the ninth embodiments, wherein the second supporting stage includes at least two sensors for indicating whether a microarray chip is present in each position.

[0064] An eleventh embodiment is the multi-channel microarray reader of any one of the first through the tenth embodiments, wherein the imaging sensor comprises one of a

camera, a charge-coupled device, a charge-injection device, a complementary metal-oxide-semiconductor device, a video camera, a silicon photo-cell, a photodiode, an avalanche photodiode and a photo-multiplier tube, or a combination thereof.

[0065] A twelfth embodiment is a multi-channel microarray reader, comprising a light source carried by a first supporting stage; a second supporting stage for supporting at least two reaction assemblies, wherein each reaction assembly includes a reaction chamber and an optical substrate to support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution. That embodiment also includes an imaging sensor positioned to detect fluorescence emitted from the microarray chip in each reaction assembly; and means for moving at least one of the first stage, the second stage and the imaging sensor, or a combination thereof, to position a selected microarray chip for receiving light emitted from the light source and providing fluorescence to the chip to the imaging sensor.

[0066] A thirteenth embodiment is the multi-channel microarray reader of the twelfth embodiment, wherein the first stage and the imaging sensor are moving and the second stage is fixed.

[0067] A fourteenth embodiment is the multi-channel microarray reader of the twelfth or thirteenth embodiment, wherein the first stage and the imaging sensor are fixed and the second stage is moving.

[0068] A fifteenth embodiment is a method for reading a multi-channel microarray comprising forming a light beam, illuminating a first one of a plurality of microarrays with the light beam to cause fluorescently tagged amplicons associated with the microarray to fluoresce and measuring the strength of the fluorescence, and providing relative movement between the light beam and the plurality of microarrays to illuminate a further one of the plurality of microarrays with the light beam and measuring the strength of the fluorescence.

[0069] A sixteenth embodiment is the method of the fifteenth embodiment wherein providing relative movement between the light beam and the plurality of microarrays comprises moving the plurality of microarrays relative to the light beam:

[0070] A seventeenth embodiment is the method of the fifteenth or sixteenth embodiment, wherein providing relative movement between the light beam and the plurality of microarrays comprises moving the light beam relative to the plurality of microarrays.

[0071] An eighteenth embodiment is the method of any one of the fifteenth through the seventeenth embodiments, further comprising calibrating an intensity of the light beam, calibrating a line uniformity of the light beam, orientating the light beam, configuring a temperature parameter in which amplicons are formed; and setting up an image from fluorescence from a selected microarray.

[0072] A nineteenth embodiment is the method of any one of the fifteenth through the eighteenth embodiments, wherein the microarray is a polynucleotide microarray.

[0073] A twentieth embodiment is the method of any one of the fifteenth through the nineteenth embodiments, wherein the amplicons are formed in a buffer solution that supports a polymerase chain reaction.

[0074] In some embodiments, the method for assaying one or more samples in one or more microarrays further includes storing data on a computer-readable medium. In one embodiment, the computer-readable medium is a computer memory. In another embodiment, the immobilized microarray is a polynucleotide microarray. In yet another embodiment, the buffer solution supports a polymerase chain reaction.

What is claimed is:

1. A multi-channel microarray reader, comprising:

a light source carried by a first supporting stage;

a second supporting stage having a plurality of reaction assembly receiving positions, each position to receive a reaction assembly, wherein each reaction assembly includes a reaction chamber and an optical substrate to support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution;

an imaging sensor positioned to detect fluorescence emitted from a single microarray chip; and

a motion control module to position at least one of the first and second supporting stages to cause a selected microarray chip to receive energy emitted from the light source and to position the imaging sensor to receive fluorescence from that microarray chip.

2. The multi-channel microarray reader of claim **1**, wherein the second supporting stage is a turntable rotated by the motion control module.

3. The multi-channel microarray reader of claim **1**, wherein the second supporting stage aligns the reaction assemblies in a column translationally movable by the motion control module.

4. The multi-channel microarray reader of claim **1**, wherein the second supporting stage aligns the reaction assemblies along a longitudinal axis and wherein the first supporting stage and the imaging sensor are positioned by the motion control module at selected locations along the axis to position the imaging sensor to detect fluorescence from a selected microarray chip.

5. The multi-channel microarray reader of claim **1**, wherein the buffer solution supports a polymerase chain reaction.

6. The multi-channel microarray reader of claim **1**, wherein the light source is a laser which activates fluorescently tagged amplicons at the substrate surface to indicate the presence of target DNA.

7. The multi-channel microarray reader of claim **1**, wherein the optical substrate is about 1 mm to about 3 mm in thickness.

8. The multi-channel microarray reader of claim **1**, wherein the optical substrate carries a marker.

9. The multi-channel microarray reader of claim **8**, wherein the marker comprises one of a bar code, a radio-frequency identification chip, a multilayer reflective coating and a multilayer absorptive coating, or combinations thereof.

10. The multi-channel microarray reader of claim **8**, wherein the second supporting stage includes at least two sensors for indicating whether a microarray chip is present in each position.

11. The multi-channel microarray reader of claim **1**, wherein the imaging sensor comprises one of a camera, a charge-coupled device, a charge-injection device, a complementary metal-oxide-semiconductor device, a video camera, a silicon photo-cell, a photodiode, an avalanche photodiode and a photo-multiplier tube, or a combination thereof.

12. A multi-channel microarray reader, comprising:

a light source carried by a first supporting stage;

a second supporting stage for supporting at least two reaction assemblies, wherein each reaction assembly includes a reaction chamber and an optical substrate to

support a microarray chip, and wherein the reaction chamber and the optical substrate encapsulate a buffer solution;

an imaging sensor positioned to detect fluorescence emitted from the microarray chip in each reaction assembly; and

means for moving at least one of the first stage, the second stage and the imaging sensor, or a combination thereof, to position a selected microarray chip for receiving light emitted from the light source and providing fluorescence to the chip to the imaging sensor.

13. The multi-channel microarray reader of claim **12**, wherein the first stage and the imaging sensor are moving and the second stage is fixed.

14. The multi-channel microarray reader of claim **12**, wherein the first stage and the imaging sensor are fixed and the second stage is moving.

15. A method for reading a multi-channel microarray comprising:

forming a light beam;

illuminating a first one of a plurality of microarrays with the light beam to cause fluorescently tagged amplicons associated with the microarray to fluoresce and measuring the strength of the fluorescence; and

providing relative movement between the light beam and the plurality of microarrays to illuminate a further one of the plurality of microarrays with the light beam and measuring the strength of the fluorescence.

16. The method of claim **15** wherein providing relative movement between the light beam and the plurality of microarrays comprises moving the plurality of microarrays relative to the light beam:

17. The method of claim **15**, wherein providing relative movement between the light beam and the plurality of microarrays comprises moving the light beam relative to the plurality of microarrays.

18. The method of claim **15**, further comprising:

calibrating an intensity of the light beam;

calibrating a line uniformity of the light beam;

orientating the light beam;

configuring a temperature parameter in which amplicons are formed; and

setting up an image from fluorescence from a selected microarray.

19. The method of claim **15**, wherein the microarray is a polynucleotide microarray.

20. The method of claim **15**, wherein the amplicons are formed in a buffer solution that supports a polymerase chain reaction.

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