CLAIMS

1. A sampling probe, comprising:

a fitting;

an elongated portion extending from the fitting; and

a restorative spring including ~~at least one~~a plurality of magnets inserted onto the elongated portion.

2. The sampling probe of claim 1, wherein the fitting includes a substantially cylindrical portion having an external teethed surface.

3. The sampling probe of claim 1, wherein the elongated portion includes an interior channel.

4. The sampling probe of claim 1, wherein the restorative spring includes at least three magnets.

5. The sampling probe of claim 4, wherein the restorative spring includes at least two magnets having a polarity oriented along a first direction and at least one additional magnet having a polarity oriented along a direction opposite to the first direction.

6. The sampling probe of claim 4, wherein at least one of the at least three magnets is a rare earth magnet.

7. The sampling probe of claim 4, wherein each of the at least three magnets is a rare earth magnet.

~~8. The sampling probe of claim 1, wherein the sampling probe does not comprise an optical sensor.~~

~~9. The sampling probe of claim 1, wherein the sampling probe does not comprise a non-magnetic metal spring.~~

~~10. The sampling probe of claim 1, wherein the sampling probe does not comprise a strain gage.~~

~~11. The sampling probe of claim 1, wherein the sampling probe does not comprise electrical contacts.~~

~~12~~8. The sampling probe of claim 4, wherein the sampling probe is disposed adjacent to a Hall effect sensor, and wherein properties of the Hall effect sensor and the at least three magnets are selected to allow the restorative spring to provide a restorative force allowing sensing of an obstacle and stopping without damaging a tip of the sampling probe.

~~13~~9. A sampling system, comprising:

a housing;

a Hall effect sensor mounted onto the housing; and

a sampling probe inserted into the housing, the sampling probe including an elongated portion and ~~at least one~~a plurality of magnets inserted onto the elongated portion.

~~14~~10. The sampling system of claim ~~13~~9, wherein the housing is selected from one of a non-ferrous housing and an anodized aluminum housing.

~~15~~11. The sampling system of claim ~~13~~9, wherein the sampling probe further includes a fitting including a substantially cylindrical portion having an external teethed surface.

~~16~~12. The sampling system of claim ~~13~~9, wherein the elongated portion includes an interior channel.

~~17~~13. The sampling system of claim ~~13~~9, wherein the at least one magnet includes at least three magnets.

~~18~~14. The sampling system of claim ~~17~~13, wherein the at least one magnet includes at least two magnets having a polarity oriented along a first direction and at least one additional magnet having a polarity oriented along a direction opposite to the first direction.

~~19~~15. The sampling system of claim ~~17~~13, wherein each of the at least three magnets is a rare earth magnet.

~~20. The sampling system of claim 13, wherein the sampling probe does not comprise an optical sensor.~~

~~21. The sampling system of claim 13, wherein the sampling probe does not comprise a non-magnetic metal spring.~~

~~22. The sampling system of claim 13, wherein the sampling probe does not comprise a strain gage.~~

~~23~~16. The sampling system of claim ~~13~~9, further comprising an analog sensor configured to allow sampling probe drift compensation via calibration of an axis of the sampling probe.

~~24~~17. The sampling system of claim ~~13~~9, further comprising a controller configured to control a movement of the sampling probe using a stroke of between about 2.5 mm and about 4.5 mm, the stroke including between about 0.75 mm and about 1.25 mm for sensing and between about 0.75 mm and about 1.25 mm for stopping.

~~25~~18. The sampling system of claim ~~24~~17, wherein the stroke further includes between about 0.75 mm and about 1.25 mm for movement noise.

~~26~~19. The sampling system of claim ~~24~~17, wherein the stroke further includes between about 0.25 mm and about 0.75 mm for overstroke.

~~27~~20. A plate sampling apparatus, comprising:

a sampling compartment including a tray configured to receive a sample plate configured to include a plurality of samples; and

a probe configured to obtain a sample from the sample plate, the probe including a fitting, an elongated portion extending from the fitting, and a restorative spring including a plurality of magnets inserted onto the elongated portion.

~~28~~21. The plate sampling apparatus of claim ~~27~~20, further comprising a Hall effect sensor.

~~29~~22. A hi-throughput cytometry system, comprising:

a flow cytometer configured to acoustically focus a sample in a flowing fluid; and

a plate sampler in fluidic communication with the flow cytometer, the plate sampler including:

a sampling compartment including a tray configured to receive a sample plate configured to include a plurality of samples, and

a probe configured to obtain a sample from the sample plate, the probe including a fitting, an elongated portion extending from the fitting, and a restorative spring including a plurality of magnets inserted onto the elongated portion.

~~30~~23. The hi-throughput cytometry system of claim ~~29~~22, wherein the plate sampler further includes a Hall effect sensor.

~~31~~24. A method for obtaining a sample, comprising:

sampling a sample plate including one or more samples in a plate sampler;

moving toward the sample plate a probe including a fitting, an elongated portion extending from the fitting, and a restorative spring including at least two opposing magnets inserted onto the elongated portion;

sensing a field strength generated by the opposing magnets in the extended position using a Hall effect sensor;

detecting an increase in the field strength generated by the opposing magnets using the Hall effect sensor;

stopping the motion of the probe toward the sample plate; and

obtaining a sample from the one or more samples in the sample plate using a probe including a fitting, an elongated portion extending from the fitting, and a restorative spring including a plurality of magnets inserted onto the elongated portion.

~~32~~25. The method of claim ~~31~~24, further comprising controlling a movement of the probe using a stroke of between about 2.5 mm and about 4.5 mm, the stroke including between about 0.75 mm and about 1.25 mm for sensing, between about 0.75 mm and about 1.25 mm for stopping, between about 0.75 mm and about 1.25 mm for movement noise, and between about 0.25 mm and about 0.75 mm for overstroke.

~~33~~26. The method of claim ~~31~~24, further comprising magnetically retracting the probe upon detection of the increase in the field strength generated by the opposing magnets using the Hall effect sensor.

~~34~~27. The method of claim ~~31~~24, further comprising generating a dimensional calibration signal upon detection of the increase in the field strength generated by the opposing magnets using the Hall effect sensor, and calibrating probe locations along three operational axes.

~~35~~28. A method for making a sampling probe, comprising:

providing a fitting;

assembling onto the fitting an elongated portion extending from the fitting; and inserting onto the elongated portion a restorative spring including a plurality of rare earth magnets.

~~36. A plate sampler apparatus, comprising:~~

~~a loading compartment including a sample probe and a tray, the tray being configured to receive a sample plate configured to include a plurality of samples;~~

~~a fluidic compartment configured to receive one or more fluid containers;~~

~~a first access door configured to allow access to the loading compartment; and~~

~~a second access door configured to allow access to the fluidic compartment.~~

~~37. The apparatus of claim 36, wherein the loading compartment further includes an actuation mechanism configured to move the tray.~~

~~38. The apparatus of claim 37, wherein the actuation mechanism is configured to move the tray, when the first access door is opened, along a direction substantially perpendicular to a direction of gravity between a first position located within the loading compartment and a second position located at least partly outside the loading compartment such that a sample plate may be loaded onto the tray from a side of the apparatus by a user of the apparatus or by robotic machinery.~~

~~39. The apparatus of claim 37, wherein the actuation mechanism is configured to move the tray, when the first access door is opened, along a direction substantially parallel to a direction of gravity between a first position located within the loading compartment and a second position located at least partly outside the loading compartment such that a sample plate may be loaded onto the tray from above the apparatus by a user of the apparatus or by robotic machinery.~~

40. The apparatus of claim 39, wherein one or more side portions of the first access door includes one or more indentations configured to hold the tray in place in the second position.

41. The apparatus of claim 39, wherein a top surface of the apparatus surrounding the first access door includes a recessed area configured to contain spilled fluid.

42. The apparatus of claim 36, wherein the tray includes a plurality of protruding corners configured to hold a sample plate in place within the tray.

43. The apparatus of claim 36, wherein the first access door is arranged within a top surface of the apparatus.

44. The apparatus of claim 36, wherein the second access door includes one or more windows allowing a user to monitor a fluid level in one or more fluid containers received in the fluidic compartment.

45. The apparatus of claim 36, further comprising a plurality of LED indicators.

46. The apparatus of claim 36, further comprising a data transfer port configured to be connected directly to an acoustic flow cytometer or to a computer in communication with an acoustic flow cytometer or to robotic machinery at least partly controlling the apparatus.

47. A hi-throughput cytometry system, comprising:

a flow cytometer configured to acoustically focus a sample in a flowing fluid; and

a plate loader in fluidic communication with the flow cytometer.

48. The system of claim 47, wherein the plate loader includes:

a loading compartment including a sample probe and a tray, the tray being configured to receive a sample plate configured to include a plurality of samples;

a fluidic compartment configured to receive one or more fluid containers;

a first access door configured to allow access to the loading compartment; and

a second access door configured to allow access to the fluidic compartment.

~~49. The system of claim 48, wherein the loading compartment further includes an actuation mechanism configured to move the tray.~~

~~50. The system of claim 49, wherein the actuation mechanism is configured to move the tray, when the first access door is opened, along a direction substantially perpendicular to a direction of gravity between a first position located within the loading compartment and a second position located at least partly outside the loading compartment such that a sample plate may be loaded onto the tray from a side of the apparatus.~~

~~51. The system of claim 49, wherein the actuation mechanism is configured to move the tray, when the first access door is opened, along a direction substantially parallel to a direction of gravity between a first position located within the loading compartment and a second position located at least partly outside the loading compartment such that a sample plate may be loaded onto the tray from above the apparatus.~~

~~52. The system of claim 51, wherein one or more side portions of the first access door includes one or more indentations configured to hold the tray in place in the second position.~~

~~53. The system of claim 51, wherein a top surface of the apparatus surrounding the first access door includes a recessed area configured to contain spilled fluid.~~

~~54. The system of claim 48, wherein the tray includes a plurality of protruding corners configured to hold a sample plate in place within the tray.~~

~~55. The system of claim 48, further comprising:~~

~~robotic machinery configured to transfer one or more fluids and samples to and from one or more sample plates and further configured to spatially manipulate the one or more sample plates so as to insert the one or more sample plates in the tray of the plate loader; and~~

~~a controller configured to control the flow cytometer, the plate loader, and the robotic machinery according to one or more experimental protocols.~~

~~56. A hi-throughput cytometry system, comprising:~~

~~a flow cytometer; and~~

a plate loader in fluidic communication with the flow cytometer, the plate loader including:

a sample probe and a tray, the tray being configured to receive a sample plate configured to include a plurality of samples;

a fluidic compartment configured to receive one or more fluid containers;

a first access door configured to allow access to the loading compartment; and

a second access door configured to allow access to the fluidic compartment.

57. A hi-throughput cytometry system, comprising:

a flow cytometer; and

a plate loader in fluidic communication with the flow cytometer, the plate loader including an actuation mechanism configured to move a tray toward a top surface of the plate loader such that a sample plate may be loaded onto the tray from above the plate loader.